A Novel Microstrip Antenna with Double Notches

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Abstract - This paper study on the the novel octagonal UWB microstrip antenna and do double notches and optimization on it. The antenna covers the bandwidth from 3.1 GHz～10.6 GHz completely and has two band-notches in the frequency ranges of 3.4 GHz to 4.5 GHz and 5.15GHz to 5.75GHz respectively avoiding the interferences of WIMAX (3.3 GHZ ～ 3.6 GHz), C-band radar communication signal (3.7 GHz～4.2 GHz) and WLAN (5.15 GHz ～5.825 GHz). Software simulation results show that the antenna performance is good, and in addition, its features of simple structure and small size are suitable for modern wireless communication systems.

Index Terms - performance, Ultra-wideband (UWB), double notches, microstrip-transmission, VSWR

1. Introduction

The UWB antenna raises much concern due to its wide bandwidth. But in the FCC regulations for UWB spectrum (3.1~10.6 GHz), there are many widely used narrow-band communication systems, such as the Worldwide Interoperability for Microwave Access (WIMAX: 3.3~3.6 GHz), Wireless Local Area Networks (WLAN: 5.15~5.825 GHz) and C-band radar communication systems (3.7~4.2 GHz). Isolation is needed to reduce the interferences between these narrow-band systems and UWB systems. The traditional approaches not only increase the complexity of the system, and the cost is also higher. In contrast, using notched antenna has lower cost and is easier to implement filtering, therefore the UWB antenna with notch function has a very important research value.

According to the design requirements for UWB antennas, this paper selects a new octagonal UWB printed antenna designed by Hu Wei, etc, as in [1]. The four identical right-angled triangles are cut from the four corners of rectangular radiating patch printed on the substrate. The VSWR of the final antenna is less than 2 in the frequency ranges of 2.9 GHz to 11 GHz covering the frequency band which the UWB antennas require. Then a pair of UWB with double notches is gotten by etching two T-shaped slots on the octagonal patch.

2. The Structure and Properties of the Antenna

Fig.1 shows the geometry and configuration of the UWB antenna. The antenna was fabricated on an h=1.0 mm FR4 epoxy substrate with the dielectric constant ϵ_r=4.4 and loss tangent tanδ=0.02. As shown in the figure, the ground is a rectangle which is etched in the middle and at both ends. Two T-shaped slots are etched on the radiator which is a polygonal patch improved from a rectangular patch to get double notch. The polygonal radiator is fed by a 50-Ω microstrip transmission line, which is etched with two little rectangular slots to improve the performance of the antenna. The electromagnetic software HFSS is employed to perform the design and optimization process. The design parameters are W=31.5 mm, L=38 mm, a=5 mm, b=1.2 mm, L1=1.9 mm, W1=9 mm, L2=2.5 mm, W2=5.2 mm, Lt= 19 mm, Lg=21.2 mm, Ln1=5 mm, Wn1=8.3 mm, W01=0.3 mm, Ln2=5 mm, Wn2=4.8 mm and W02=0.5 mm. The design size of the radiating patch is 15.6 mm×18.3 mm.

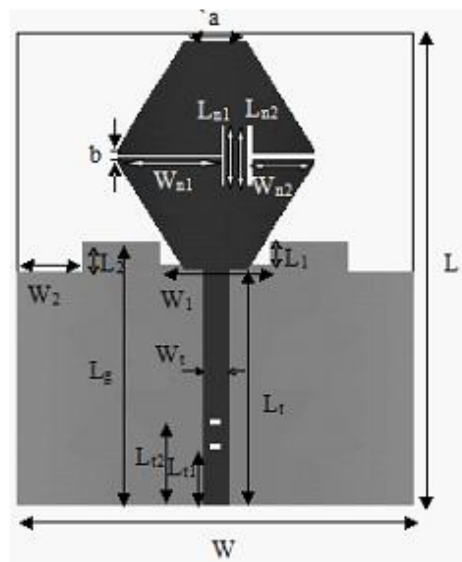

Fig. 1 Geometry and configuration of the UWB antenna.

Fig.2(a) and Fig.2(b) show the return loss (-S11) vs. frequency and VSWR vs. frequency of the UWB antenna respectively. The frequency band for this antenna extends from 3.1 GHz~16 GHz, which is covering the band from 3.1 GHz~10.6 GHz completely. Two notches (in the 3.4 GHz to 4.5 GHz range and in the 5.15 GHz to 5.75GHz) make the antenna avoid the interference of WIMAX (3.3 GHz~3.6 GHZ), C-band radar communication (3.7 GHz~4.2 GHz) and WLAN (5.15 GHz~5.825 GHz).

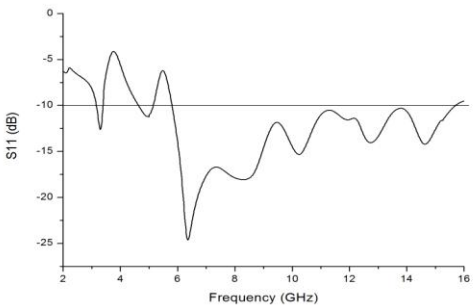

Fig. 2(a) S11 vs. frequency of UWB antenna.

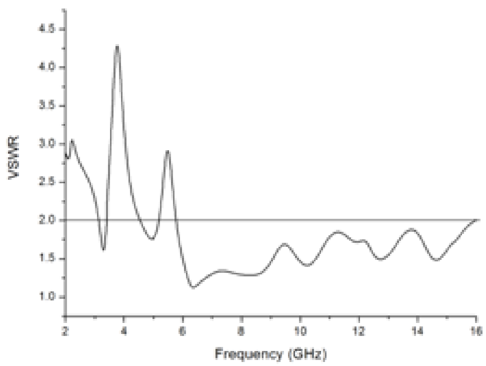

Fig. 2(b) VSWR vs. frequency of UWB antenna.

3. The Novel UWB Antenna Design and Analysis

The UWB antenna gets double notches due to the two T-shaped slots on the radiating patch. The left T-shaped slot produces the notch in the 3.4 GHz to 4.5 GHz range and the right one produces the notch in the 5.15 GHz to 5.75 GHz range. The length and width of the slots will affect the performance of the double notches. Fig.3(a) and Fig.3(b) show that the length and the width of the right T-shaped slot changing will affect the left slot, thus influencing the bandwidth and center frequency of the double notches.

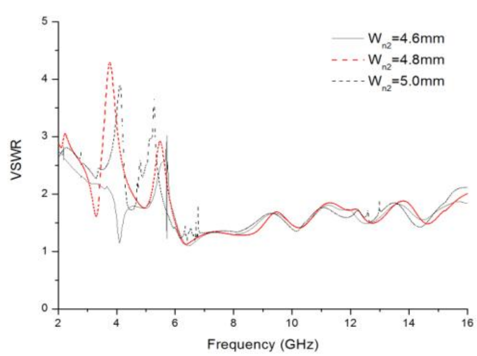

Fig. 3(a) The change in the antenna performance when Wn2 changes.

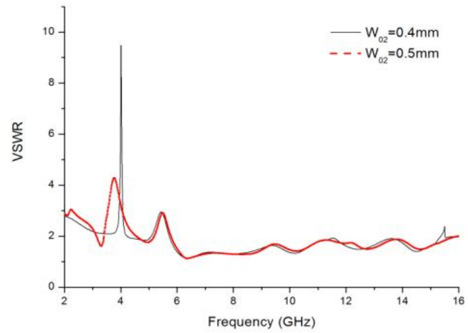

Fig. 3(b) The change in the antenna performance when W02 changes.

For better notch performance, two little slots are etched on the microstrip transmission line of the antenna. The distances from two slots to the bottom edge of the substrate are Lt1=4.5 mm and Lt2=6.5 mm respectively. The sizes of the two slots are both 1 mm×0.5 mm. Fig.4 shows that the two slots have a great influence on the performance of the antenna and these are vital designs of the UWB antenna.

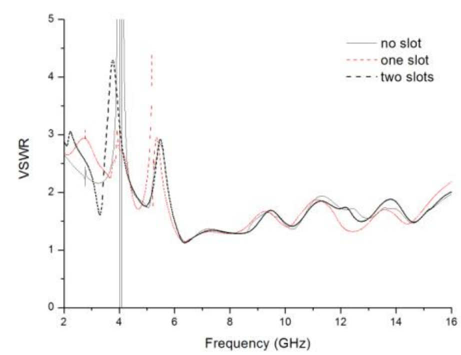

Fig. 4 The influence of the slots etched on the microstrip transmission line on the UWB antenna.

Fig.5(a) and Fig.5(b) show the E-plane and H-plane radiation pattern of the UWB antenna at 3, 6 and 9 GHz respectively. The E-plane and H-plane radiation pattern is better omni-directional at lower frequencies.

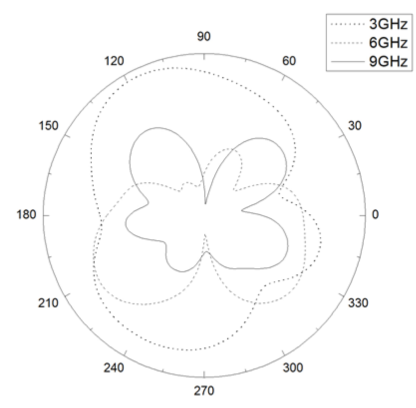

Fig. 5(a) Simulated E-plane radiation pattern of the UWB antenna at 3, 6 and 9GHz.

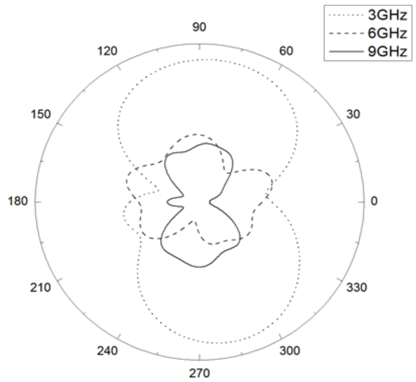

Fig. 5(b) Simulated H-plane radiation pattern of the UWB antenna at 3, 6 and 9GHz.

4. Conclusions

A UWB antenna configuration with double notches is presented in this paper. Two T-shaped slots etched on the radiator and two little rectangular slots etched on the microstrip transmission line play a vital role in realizing the performance of the UWB antenna. The proposed UWB antenna configuration is simple and compact in size with stopbands in the ranges of WIMAX, WLAN and C-band.

References

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