

A NEW ULTRA-WIDEBAND MICROSTRIP-LINE FED ANTENNA WITH 3.5/5.5 GHz DUAL BAND-NOTCH FUNCTION

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Abstract—A novel and compact planar ultra-wideband wide-slot antenna with dual band-notched function is proposed. The method of creating dual band-notch function is unique from traditional ones. By embedding a U-shaped parasitic strip and a pair of T-shaped stubs in the wide slot, dual bandstops around 3.5 GHz and 5.5 GHz can be obtained. The measured results demonstrate that the proposed antenna, with a compact dimension of 20×32.5 mm, has a large bandwidth over the frequency band from 2.5 to 11.7 GHz with voltage standing wave ratio (VSWR) less than 2, except the bandwidths of 3.3 ~ 3.7 GHz for WIMAX and 5 ~ 6 GHz for WLAN. In addition, the radiation pattern has an excellent omni-directional characteristic in H -plane and a typical monopole-like pattern in E -plane.

1. INTRODUCTION

With the rapid development in modern wireless and mobile communication, the ultra-wideband technology has become one of the most fascinating technologies in in-door communication due to its great advantages including large capacity of data, high speed data rate and small size. However, a part of the bandwidth of ultra-wideband (3.1 ~ 10.6 GHz) released by Federal Communications Commission (FCC) [1] and the frequency bands of WLAN (5.15 ~ 5.825 GHz) and WIMAX (3.3 ~ 3.7 GHz), which are limited by IEEE 802.11a, HIPERLAN/2 and IEEE 802.16 overlap each other. Therefore, to reduce the EM interference between the UWB and these bands, dual band notch filters in UWB systems are necessary. Recently, several UWB antennas

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with band-notch function have been reported [2–11]. But most of the proposed antennas have only one band-notched characteristic at 5.5 GHz [2–5]. Some UWB antennas with dual band stops have been proposed [6, 7]. Both of them are small in size and broadband: one is 24.5×30 mm in size, 3–11 GHz impedance bandwidth [6], and the other is 26×30 mm in size, 2.8–11 GHz impedance bandwidth [7]. Moreover, the dual-band notched characteristics [6, 7] are created by cutting U-shaped or C-shaped slots in their radiation patch or ground. Because the shape, allocation, width and length of the slots have intensive influence on the band-notch function. These antennas are difficult to fabricate.

In this paper, a novel ultra-wideband wide-slot antenna with a smaller size (20×32.5 mm) and broader bandwidth (2.5–11.7 GHz) is proposed by embedding a U-shaped parasitic strip and a pair of T-shaped stubs in the wide slot; dual band stops around 3.5 GHz and 5.5 GHz are created, which not only avoids the potential EM interference but also removes the extra two band stop filters in the system. Details of the antenna design are described, and both simulated and measured results are given.

2. ANTENNA DESIGN

Figure 1 illustrates the geometry and configuration of the proposed antenna, which is etched on the FR4 substrate with a thickness of 1 mm and dielectric constant of 4.4. Excitation is made through a 50Ω microstrip feeding line. The proposed antenna is composed of a rectangular ground and a planar rectangular radiation patch with a wide slot. And the wide slot with dimensions of $9.5 \text{ mm} \times 24 \text{ mm}$ can supply an omni-directional pattern [12]. To obtain a good impedance matching over a broad bandwidth, the radiation patch is beveled [6]. The gap between the ground and the radiation patch is 1 mm.

To achieve the band-notched characteristic around 5.5 GHz, a pair of T-shaped stubs are set into the wide slot and the length of which can be postulated as [6]:

$$f_{notch} \approx \frac{c}{2L_1\sqrt{\epsilon_{re}}} \quad (1)$$

Moreover, to create another stopband around 3.5 GHz, a U-shaped parasitic strip is embedded in the wide slot, whose total length is $2 \times L_2 + S_2$, and it can be postulated as:

$$f_{notch} \approx \frac{c}{L_{total}\sqrt{\epsilon_{re}}} \quad (2)$$

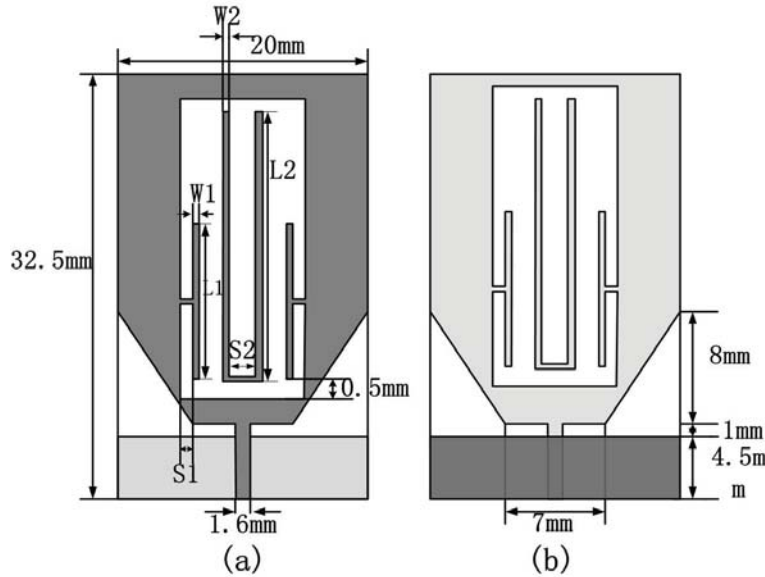


Figure 1. Geometry of the proposed antenna (unit: mm), (a) top view, (b) back view.

where L_1 is the length of the T-shaped stub; L_{total} is the total length of the U-shaped parasitic strip; c is the speed of the light and ϵ_{re} is the effective dielectric constant. According to formulae (1) and (2), we can obtain the length of the T-shaped stub and U-shaped parasitic strip at the very beginning of the antenna design, which are 13 mm and 41 mm respectively.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The optimized parameters are summarized in Table 1; according to which, a prototype of the antenna is fabricated and measured. Fig. 2 shows the photographs of the fabricated antenna. Fig. 3 shows the simulated and measured VSWR of the proposed antenna. It is

Table 1. The optimized parameters of the proposed antenna.

Parameters	L1	W1	L2	W2	S1	S2
Value (mm)	12.5	0.5	23	0.5	1	2

apparent that the UWB antenna can cover the frequency band 2.5–11.7 GHz for VSWR < 2 and except the WIMAX (3.3 ~ 3.7 GHz) and WLAN (5.15 ~ 5.825 GHz) bands. The measurement also shows the center frequencies of the dual notched bands (WIMAX and WLAN bands) are about 3.5 GHz and 5.2 GHz. Fig. 4 illustrates the measured far-field radiation patterns at three different frequencies, 3 GHz, 6 GHz and 10 GHz, for the proposed antenna. According to Fig. 4, the



Figure 2. Photograph of the proposed antenna.

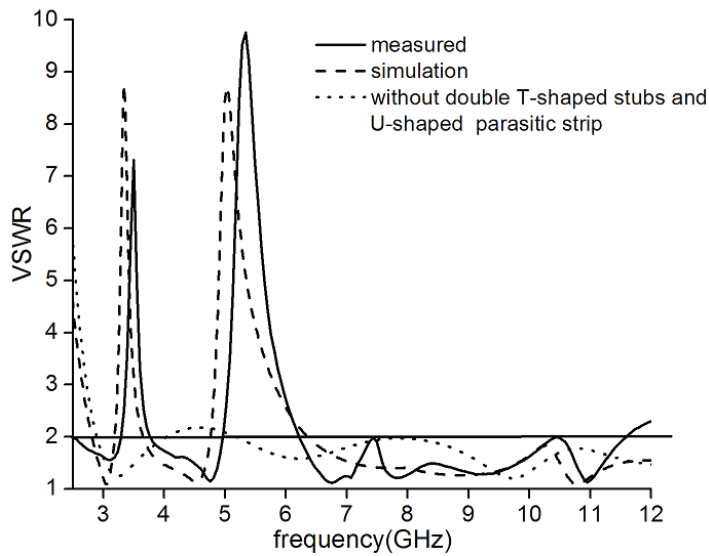


Figure 3. Simulated and measured VSWR of proposed antenna.

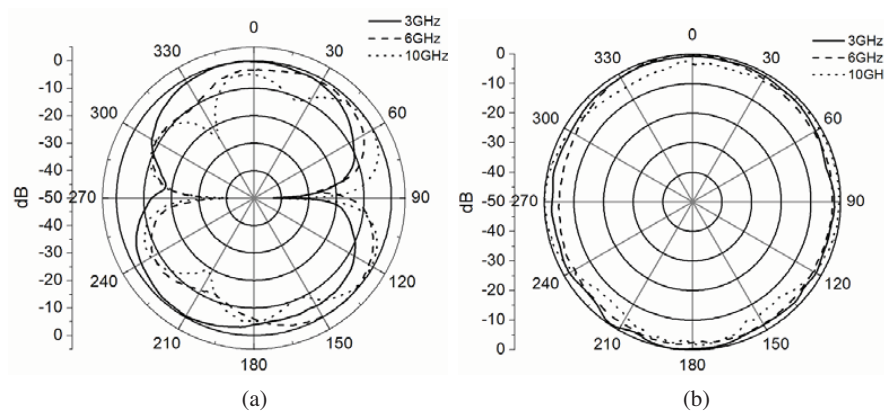


Figure 4. Measured radiation patterns of proposed antenna, (a) *E*-plane, (b) *H*-plane.

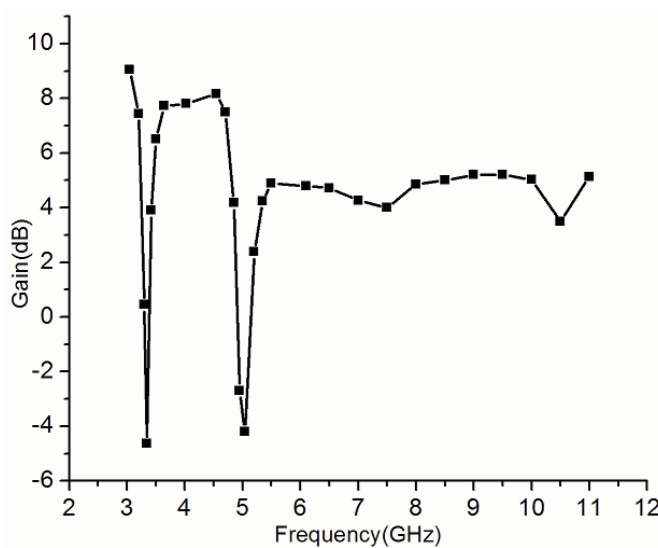


Figure 5. Gain of proposed antenna.

radiation patterns show an excellent omni-directional characteristic in *H*-plane and a typical monopole like pattern in *E*-plane. The antenna gain versus frequency is given in Fig. 5, where two desired sharp gain decrease in the vicinity of 3.5 GHz and 5.2 GHz.

4. CONCLUSION

A novel and compact planar ultra-wideband wide-slot antenna with dual band-notched function is proposed. By embedding a U-shaped parasitic strip and a pair of T-shaped stubs in the wide slot, dual band stops around 3.5 GHz and 5.5 GHz can be obtained, which not only avoids the potential EM interference with existing WIMAX and WLAN operating band but also removes the extra two bandstop filters in the system. In addition, the proposed antenna has a good radiation characteristic on the operating frequency.

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