

# WLAN Band Rejection MIMO–UWB Antenna with Enhanced Isolation Coefficient

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## Abstract

This paper presents a design for a WLAN band rejection MIMO–UWB antenna. The antenna consists of two coplanar waveguide fed monopole antennas with a pair of slots in the radiating patch that provides good rejection in the WLAN band. To enhance the isolation coefficient, a trident slot is etched into the ground plane. The main advantage of using the trident slot is that it possesses characteristics that are similar to single WLAN band rejection UWB antennas. The proposed antenna exhibits an isolation coefficient less than  $-15$  dB across the entire UWB band with a VSWR less than 3, and good rejection at the WLAN band. Additionally, the antenna has an omnidirectional radiation pattern within the UWB band.

**Keywords :** Antenna, UWB, MIMO, Band rejection

## 1. Introduction

In recent years, many antenna designers have been attracted to the challenging task of designing low cost and lightweight ultrawideband (UWB) antennas. Several monopole-like antenna designs—operating in the UWB band—have been proposed: these are fed by either a microstrip line or a coplanar waveguide [1-4]. Since the existing wireless local area network (WLAN) service band (5.15–5.35 GHz, and 5.75–5.825 GHz) overlaps with that of the UWB (3.1–10.6 GHz), UWB radio signals can interfere with those in the WLAN service band. To overcome this problem, UWB antennas with good bandstop performance are necessary. Several UWB antennas that use various design techniques and have sufficient bandstop characteristics have been reported [5, 6].

Recently, a multi-input multi-output (MIMO) UWB system [7] was proposed: this system has an increased channel capacity as compared to the conventional MIMO systems [8]. However, the two radiating elements were required to be at least half a wavelength apart at the lowest operating frequency of the UWB band, so that an isolation coefficient better than  $-15$  dB could be achieved. This isolation is required to overcome multipath fading problems in MIMO systems. However, the MIMO–UWB antenna size then becomes too large to meet the required isolation coefficient criterion at the lowest frequency of the UWB band. Therefore, miniaturizing the antenna size and enhancing the isolation coefficient are two of the most important considerations for MIMO–UWB antenna designs. In order to enhance the isolation coefficient, recently, wideband MIMO [9] and MIMO–UWB [10] antennas have been presented that contain slot and tree like structures between the two radiating elements. However, these enhanced isolation coefficient techniques alter the original characteristics of the antenna.

This paper describes a WLAN band rejection MIMO–UWB antenna. The antenna consists of two coplanar waveguide fed monopole antennas with a pair of slots in the radiating patch, and provides good rejection in the WLAN band. To enhance the isolation coefficient, a trident slot is etched into the ground plane. This has the advantage of providing antenna features that are similar to the single MIMO–UWB antenna. The proposed antenna has a bandwidth that covers the entire UWB band with a voltage standing wave ratio (VSWR) less than 3, an isolation coefficient less than  $-15$  dB, and good rejection at the WLAN band. Additionally, the antenna has an omnidirectional radiation pattern within the UWB band.

## 2. Antenna Geometry and Characteristics

Figure 1 shows the geometry of the WLAN band rejection MIMO–UWB antenna. The antenna was designed on a 50 mm × 60 mm Rogers RO4003 substrate with a dielectric constant of 3.38 and a thickness of 0.8128 mm. The antenna consists of two coplanar waveguide fed WLAN band rejection monopole UWB antennas with a center-to-center spacing of 30 mm ( $\lambda_0/2$  at 5 GHz) and a trident slot etched into the ground plane. The high-frequency structure simulator (HFSS) from Ansoft was used to investigate the characteristics of the antenna.

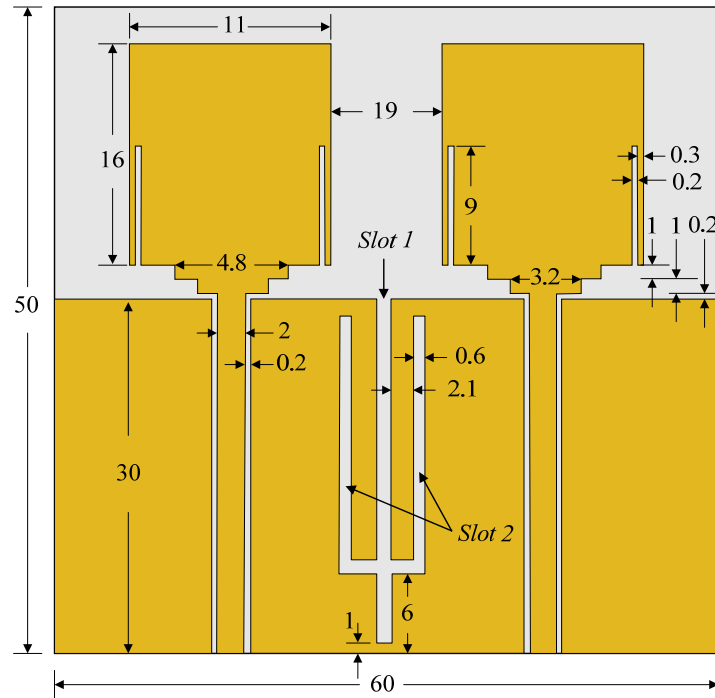


Figure 1. Geometry of the WLAN band rejection MIMO–UWB antenna (units in mm).

In this study, the technique used for WLAN band rejection was to etch a pair of slots into the radiating patch. The simulation results showed that the center frequency of the rejection band was mainly controlled by the length of the slot, whereas the rejection bandwidth was determined by the width and the distance from the vertical edges of the slots. The trident slot was employed to improve the isolation coefficient; it also has the advantage of maintaining characteristics that are similar to single UWB antennas. As shown in Figure 2, the rejection band characteristics of the single antenna are completely retained in the MIMO antenna. The rejection bands of the single and MIMO antennas are 5.15–5.95 GHz and 5.2–5.8 GHz, respectively.

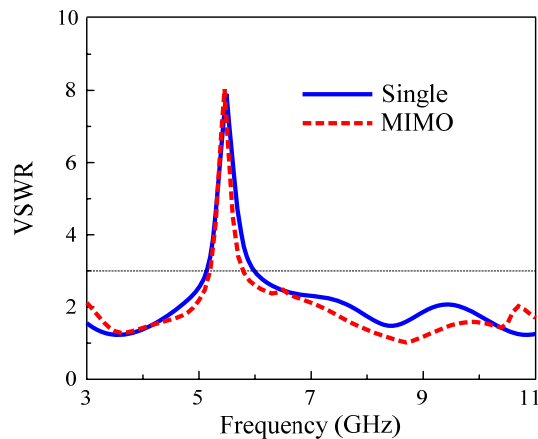


Figure 2. VSWR of the single and WLAN band rejection MIMO–UWB antennas.

Figure 3 shows the effect of the trident slot on the antenna isolation coefficient. The isolation coefficient ( $S_{21}$ ) is found to be below  $-15$  dB in the low-frequency region, without slots.  $S_{21}$  is slightly improved in the high-frequency region but remains almost the same in the low-frequency region, as is the case when just 1 slot is present.  $S_{21}$  is below  $-15$  dB across the entire UWB band with the trident slot. Additionally, the isolation coefficient is greatly improved in the rejection band (5–6 GHz) and is not influenced by the trident slot. Figure 4 shows the radiation patterns of the WLAN band rejection MIMO–UWB antenna in the  $xz$ -plane and the  $yz$ -plane, at 3.5, 6.5, and 9.5 GHz. It can be seen that good omnidirectional radiation patterns are obtained for the UWB band with peak gains of 1.27, 3.26, and 4.56 dBi at 3.5, 6.5, and 9.5 GHz, respectively.

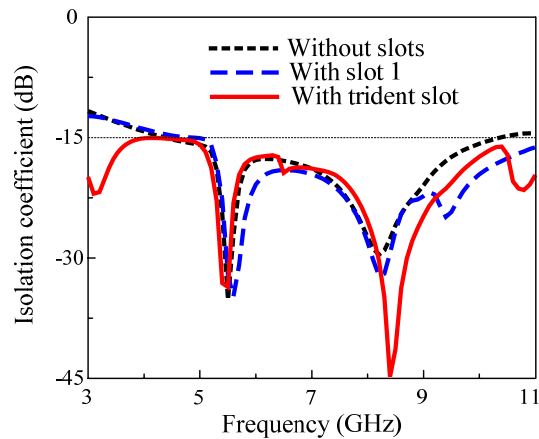


Figure 3. Isolation coefficient of the WLAN band rejection MIMO–UWB antenna.

### 3. Conclusions

This study presents a design for a WLAN band rejection MIMO–UWB antenna that uses a trident slot in the ground plane to enhance the isolation coefficient. The main advantage of using the trident slot is that it possesses characteristics that are similar to single WLAN band rejection UWB antennas. The proposed antenna exhibits an isolation coefficient less than  $-15$  dB across the entire UWB band with a VSWR less than 3, and good rejection at the WLAN band. Furthermore, the omnidirectional radiation pattern of the antenna has been shown to be relatively stable across the operating bandwidth. These results have shown that the proposed antenna could be widely applied to MIMO–UWB systems.

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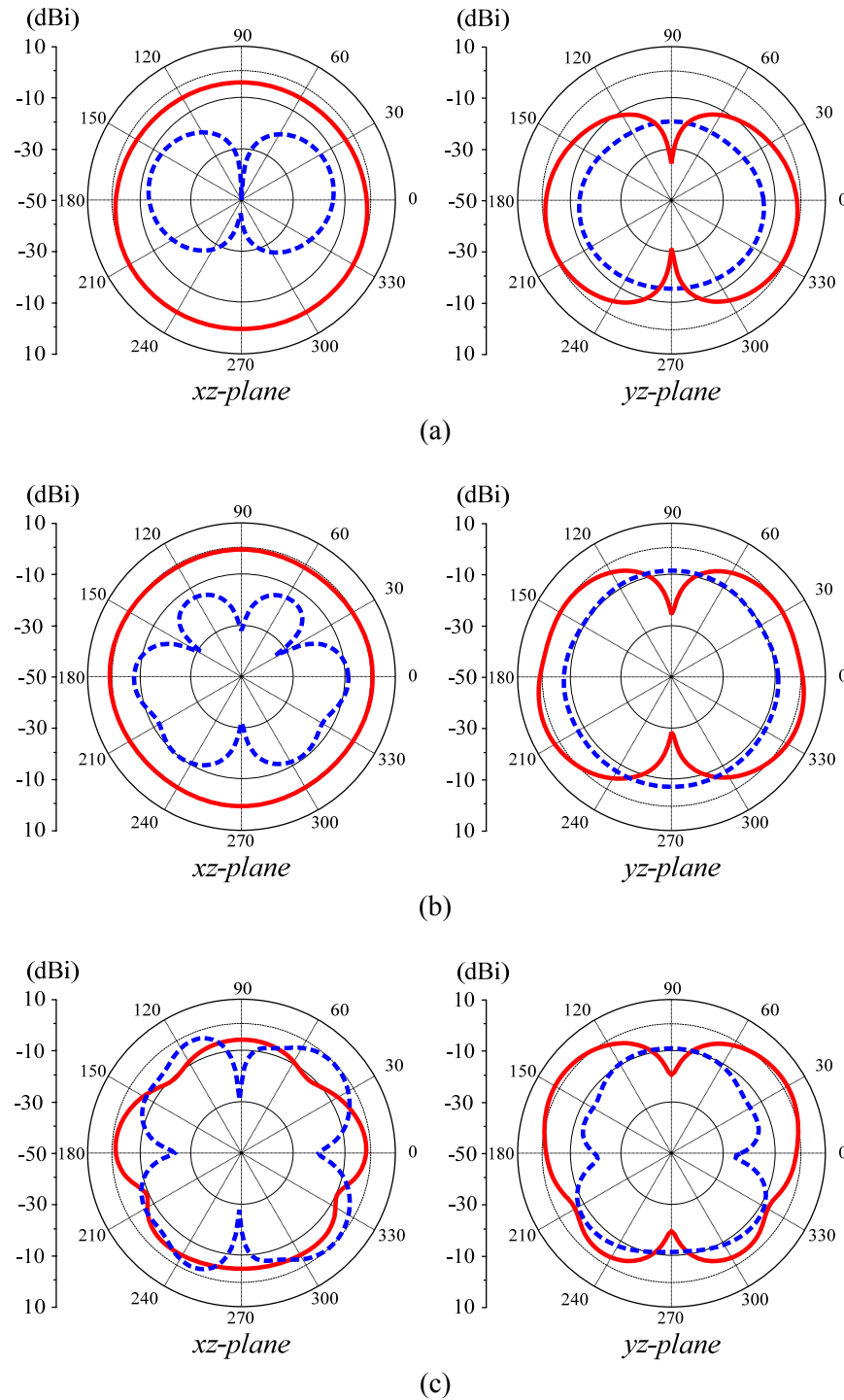


Figure 4. Radiation patterns of the antenna at (a) 3.5, (b) 6.5, and (c) 9.5 GHz in the  $xz$ -plane and  $yz$ -plane. — co-polarization, - - - cross-polarization.