

# A Compact Printed UWB MIMO Antenna with a 5.8 GHz Band Notch

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**Abstract** - A compact printed UWB MIMO antenna with a 5.8 GHz band-notch is presented. The two antennas are located on the two opposite sides of a Printed-Circuits-Board (PCB), separated by a spacing of 13.2 mm and a small isolated element, which provides a good isolation. The antenna structure adopts coupled and parasitic modes to form multi-modal resonance that results in the desired ultra-wideband operation. There is a parasitic slit embedded on the main radiator and an isolated element employed between the two antennas. An excellent desired band-notched UWB characteristic was obtained by care design of the parasitic slit. The overall size of the proposed antenna is mere 40.2×54×0.8 mm; the radiation patterns of the two antennas cover the complementary space of 180°; the antenna yields peak gains varied from 5 to 8 dBi, and antenna radiation efficiency exceeding about 70~90 % over the operation band. The antenna port Envelope Correlation Coefficient (ECC) was less than about 0.07. Moreover, the antenna is easy to fabricate and suitable for any wireless modules applications at the UWB band.

**Index Terms** — MIMO Antennas, UWB antenna, band-notched, isolation.

## I. INTRODUCTION

Recently, much work has been done to investigate the wireless communication at the UWB band [1, 2]. To increase data throughput and/or combat multipath fading, the multiple-input multiple-output (MIMO), along with diversity technology, has been considered for UWB systems [3, 4]. Both MIMO and diversity require low mutual coupling among the adjoining antennas in the operating bands. Nevertheless, owing to the limited space in USB dongles and other small terminals, the mutual coupling between the UWB antennas can be very large [5]. In addition, it is even more difficult to keep a low level of mutual coupling within an UWB band than that for a narrow band one. Thus, it is indeed a challenging task to design a UWB MIMO/diversity antenna with high isolation on a very small area available in many compact wireless devices [6, 7].

In addition, the compact, printed UWB antenna system was designed with a 5.8 GHz band notch for fear of possible interference from the band. The antenna configuration is constructed by coupled and parasitic modes to form the multi-modal resonance that results in the UWB operation. This antenna not only satisfies all UWB bands but also avoids possible interference with the 5.8 GHz band. Design and experimental results for the proposed UWB MIMO

antenna are presented in the following sections.

## II. ANTENNA DESIGN

Fig. 1 shows the geometry of the proposed UWB MIMO antenna. This antenna was printed on a FR4 substrate with a thickness of 0.8 mm. The size of the system PCB is 40.2×54 mm<sup>2</sup>, which can be considered a form factor for a small wireless communication device. The two UWB antennas are printed on the two opposite sides of the PCB, separated by a distance of 13.2 mm. The clearance area (no grounding layout) is 14.5×54 mm<sup>2</sup> between the two UWB antennas. In order to avoid possible interference with the 5.8 GHz band, a parasitic slit was embedded on the antenna's main radiator, and an element between the two UWB antennas was added for isolation improvement.

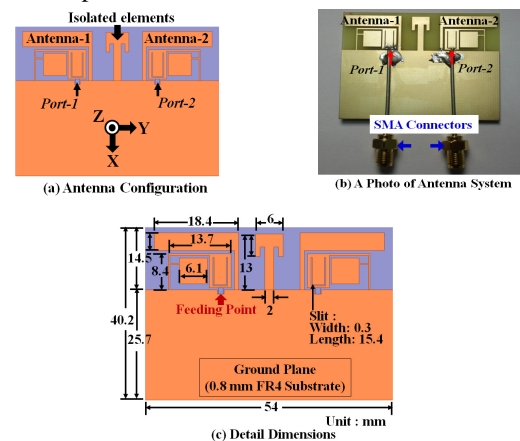


Fig. 1. Configuration, photo, and dimensions of the proposed antenna.

## III. EXPERIMENT AND RESULTS

The simulated and measured  $S_{11}/S_{21}$  of the antenna are shown in Fig. 2. The antenna was shown to have d matching and isolation characteristics ( $S_{11} < -10$  dB and  $S_{21} < -17$  dB) over the frequency band 3.1-10.6 GHz, while the frequency band 5.4-6.1 GHz is notched to prevent the interference from WLAN (5.8 GHz band) applications. In the experimental results, there was a slight gap between the measured and the simulated results (10 GHz band). And, the measured one did show  $S_{11}$  above -10dB.

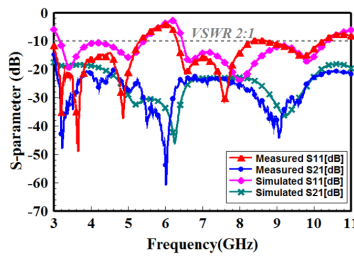


Fig. 2. Simulated and measured coefficients (S11/S21) of the proposed antenna.

Figure 3 shows the far-field, 2-D radiation patterns at the 3.2, 5.4, 8.2, and 10 GHz bands for antennas 1 and 2. Specifically, the figure demonstrates polarization diversity in the radiation patterns obtained for ports 1 (antenna 1) or 2 (antenna 2) at the operating bands. In the figure, the directional separations were  $70^\circ$ - $180^\circ$  apart in the main radiated directions excited at ports 1 or 2 at the 3.2, 5.4, 8.2, and 10 GHz. This polarization also results in excellent isolation for the MIMO antenna system.

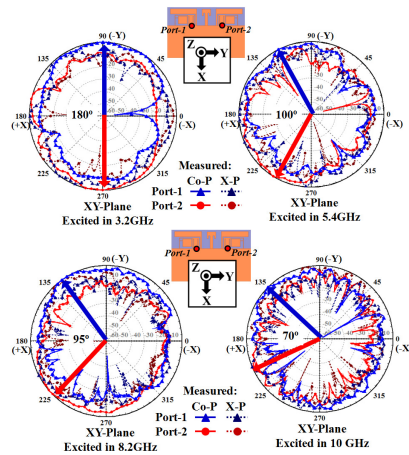


Fig. 3. Measured 2-D radiation patterns at frequencies of 3.2, 5.4, 8.2, and 10 GHz for antennas 1 and 2.

Figure 4 shows the peak gain and the antenna radiation efficiency for the proposed antenna. The measured peak gain varied from 5 to 8 dBi, and the radiation efficiency is larger than 70%. In Figure 5, measured Envelope Correlation Coefficient (ECC,  $\rho_e$ ) between the two antennas is shown. It was obtained using a Bluetest reverberation chamber. ECC was less than about 0.07 in the UWB band, up to the measurement capability.

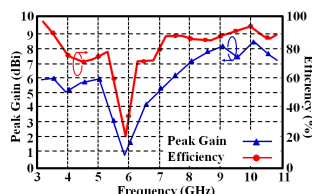


Fig. 4. Simulated antenna gain and radiation efficiency for the two antennas.

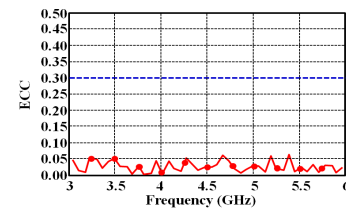


Fig. 5. Measured Envelope Correlation Coefficient (ECC) for the MIMO antenna system; Note that measurement chamber was limited to 6 GHz.

#### IV. CONCLUSION

A printed UWB MIMO antenna is proposed. It was designed as a symmetrical compact size with a band-notch at the 5.8 GHz (WLAN) frequency band to avoid possible interference. The antenna was fabricated on a PCB, and its performance was measured. The antenna yields peak gains varied from 5 to 8 dBi, and antenna radiation efficiency exceeding about 70~90% at the operation band. The antenna port Envelope Correlation Coefficient (ECC) was less than about 0.07. Moreover, the antenna is easy to fabricate and suitable for any wireless modules applications at the UWB band.

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