

Printed UWB MIMO Antenna with Different Polarizations and Band-Notch Characteristics

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Abstract—A novel ultra wideband (UWB) multiple-input-multiple-output (MIMO) antenna with different polarizations and band-notch characteristics is proposed in this letter. The antenna consists of two monopole antenna radiating elements with gradual change structure, which are placed perpendicularly to each other and printed on each side of the substrate to achieve a wide bandwidth and different polarizations. Band-rejected filtering property in the WLAN band is achieved by etching a H-shaped slot and employing a resonant L-shaped strip on two antenna elements. The proposed antenna has a small size of $27 \times 37 \times 1 \text{ mm}^3$ with a bandwidth of 128.6% (2.35–10.82 GHz). Within the required band, the isolation for the two ports exceeds 18 dB. The envelope correlation coefficient is also measured.

1. INTRODUCTION

In recent years, the ultra wideband (UWB) antenna combining with multiple-input-multiple-output (MIMO) technology is becoming a hot point in wireless communication [1, 2]. The antennas with a wide impedance bandwidth and good isolation performance are imminently required. A number of researches have been done on UWB MIMO antenna [3–9], and some antennas insert decoupling structures or use different polarizations to achieve a good isolation between two antenna elements [3–7]. But the big size limits their applications for UWB system, for antenna elements in those designs were placed on the same side of the substrate. Some designs forced on reducing the size of the UWB MIMO antennas [8, 9], but the disadvantage that the impedance band isn't wide enough to cover the whole UWB band also come with the small size.

In this letter, we propose a compact UWB MIMO antenna system. The designed antenna system has a small size of $27 \times 37 \times 1 \text{ mm}^3$ and a wide bandwidth of more than 128.6% ($S_{11}, S_{22} \leq -10 \text{ dB}$), ranging from 2.35 to 10.82 GHz covers the whole UWB band. Through two placed perpendicularly monopole antenna radiating elements, different polarizations can be achieved, the measurement show that the isolation is better than 18 dB in the whole UWB. By etching an H-slot and employing a resonant L-shaped strip on each antenna element, the notched band of 4.8–6.1 GHz which cover the WLAN band (5.15–5.85 GHz) is achieved.

2. ANTENNA DESIGN AND DISCUSSION

Based on the single port Band-Notched UWB Antenna we designed before [10], the geometry of the proposed two ports band-notched UWB MIMO antenna is illustrated in Figure 1. It consists of two UWB antenna elements, 1 and 2, which are placed perpendicularly on the different sides of the substrate (relative permittivity of 2.65). The broadband impedance bandwidth can be easily achieved by adopting the gradual change structure patches. Owing to the different polarizations, coupling between two ports

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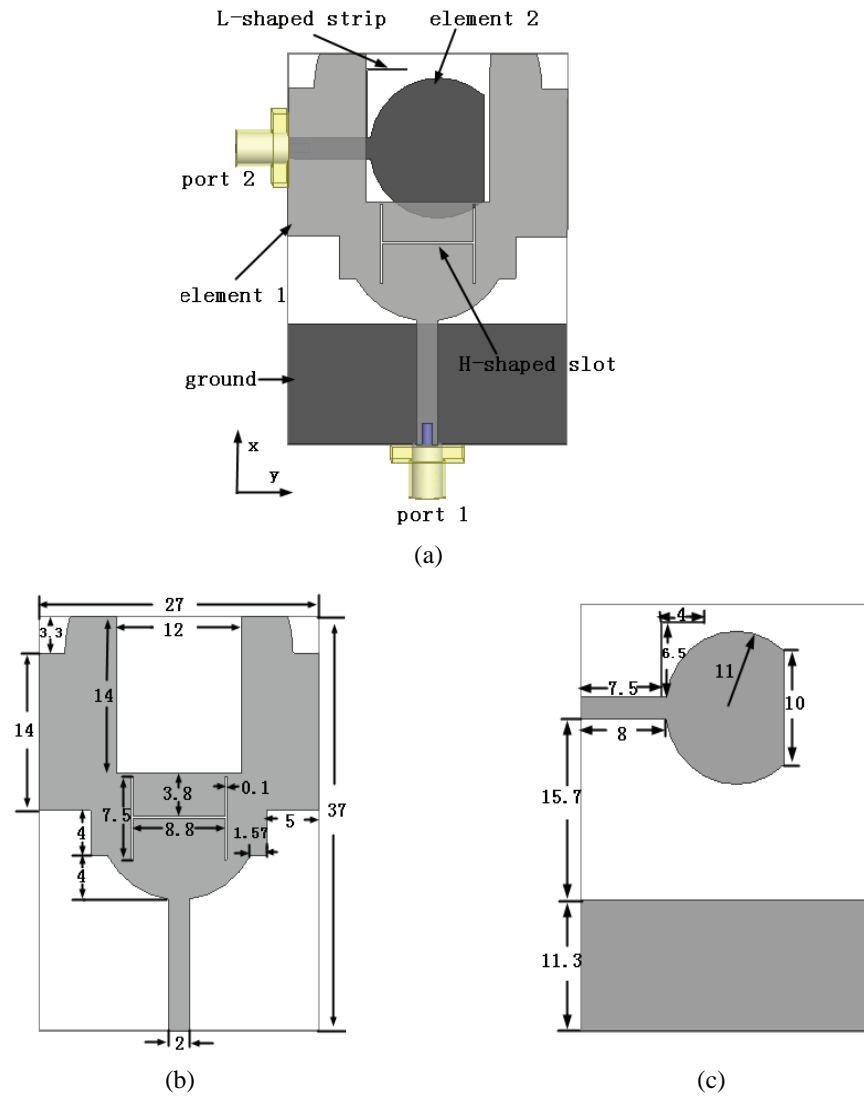


Figure 1. Geometry of the proposed antenna, (a) overall view, (b) top view, (c) bottom view.

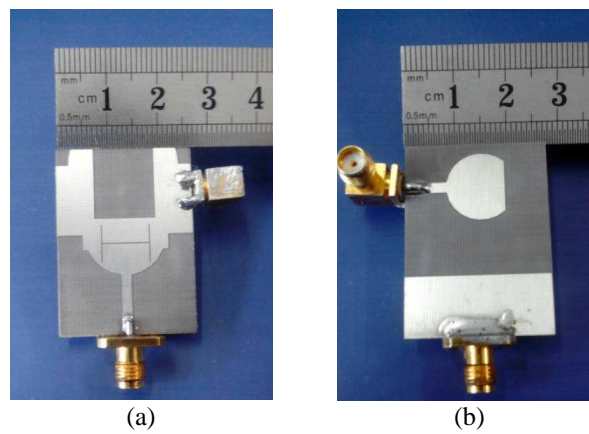


Figure 2. Photograph of proposed antenna.

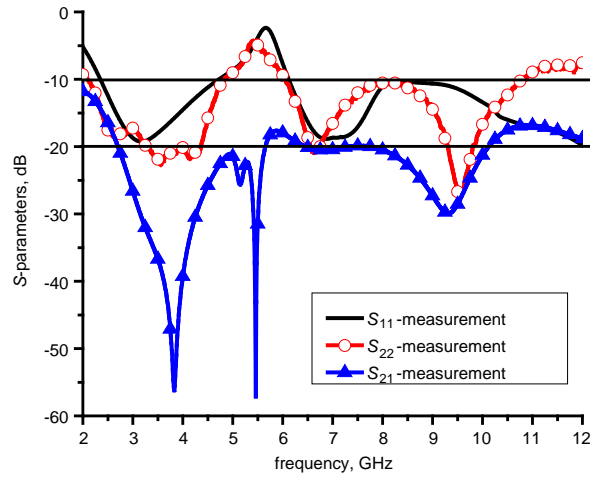


Figure 3. Measured S -parameters for proposed antenna.

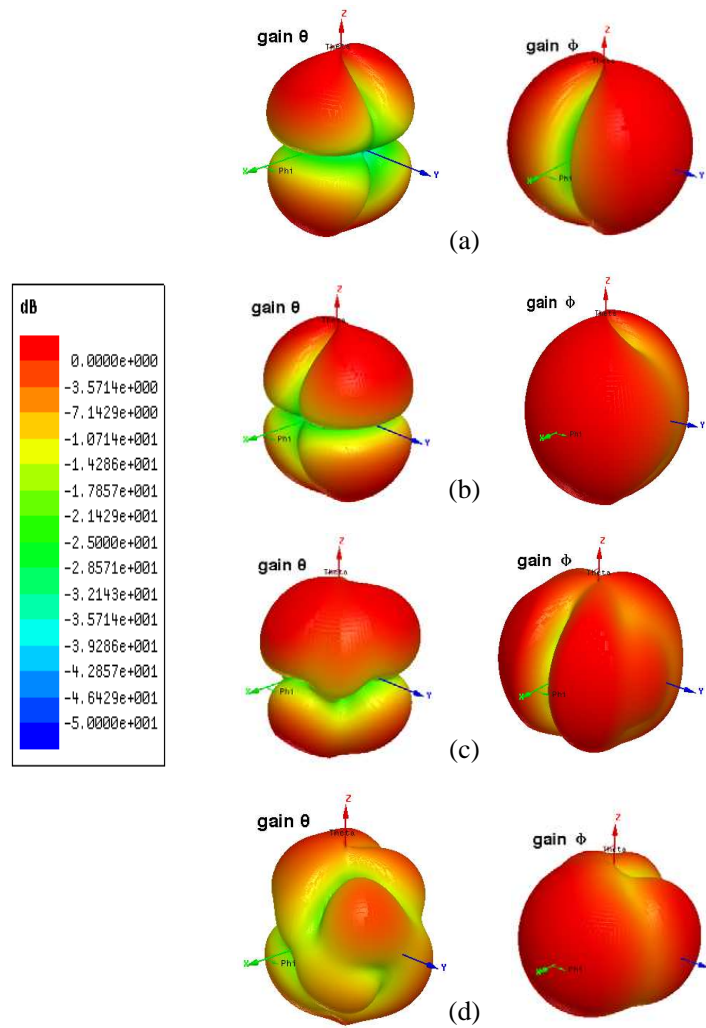


Figure 4. Radiation patterns for proposed antenna (a) port 1 at 4 GHz, (b) port 2 at 4 GHz, (c) port 1 at 8 GHz, (d) port 2 at 8 GHz.

is below 18 dB in the UWB band. Element 1 is an approximate U-shaped radiation patch with an etched H-shaped slot, while element 2 is a goblet shaped UWB antenna which utilizes a resonant L-shaped strip for the band-notch characteristics. When the antenna proposed works at the notched band, surface currents concentrate on the H-shaped slot or the L-shaped resonant strip and antenna impedance changes tempestuously at this frequencies, which causes the band-notch properties of the

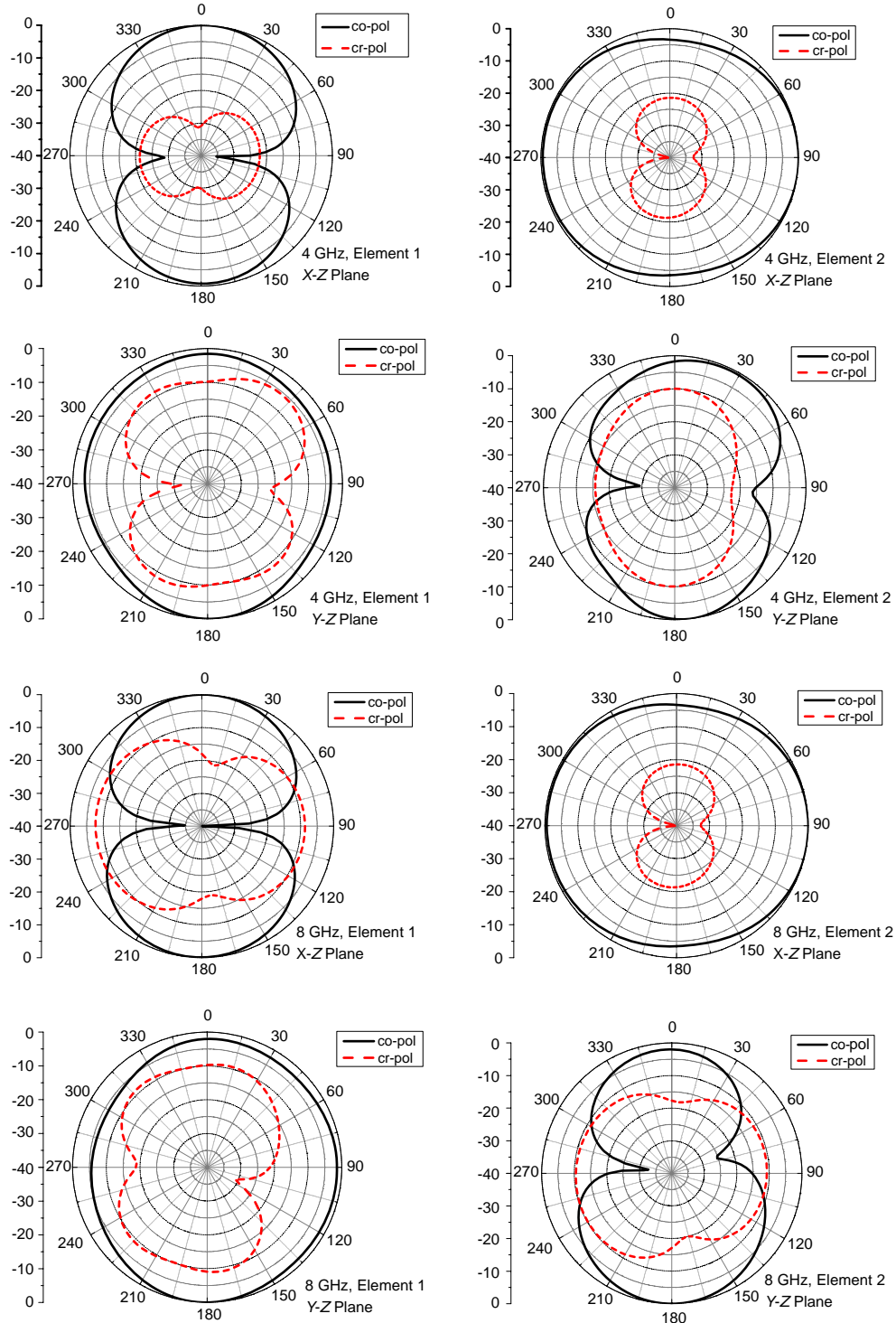


Figure 5. Simulated radiation patterns of the antenna at 4 and 8 GHz in the x - z and y - z planes.

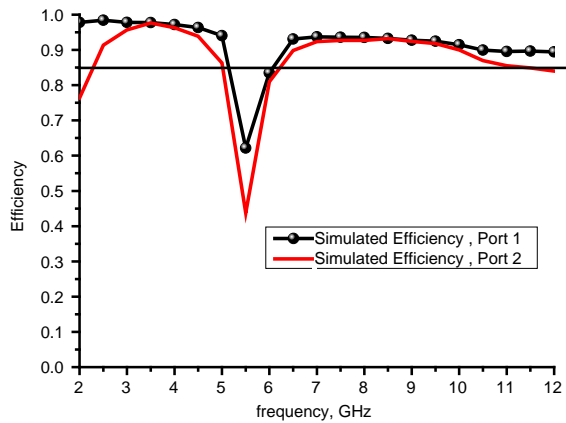


Figure 6. Simulated efficiency of MIMO antenna.

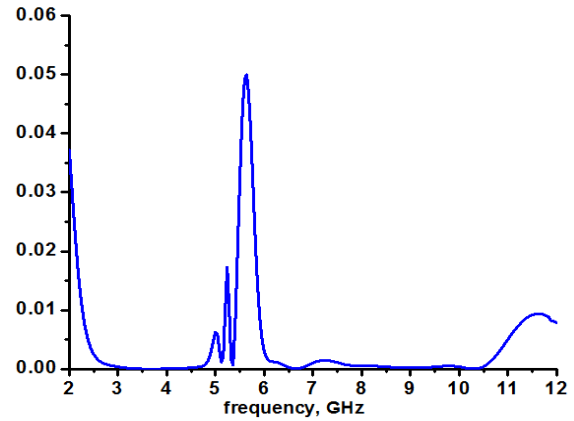


Figure 7. Measured envelope correlation coefficient.

proposed antenna. The centre frequency and bandwidth of the notched band are controllable by change the length and width of the H-shaped slot or the L-shaped resonant strip. As the length increases, the notched band shifts towards the lower frequency. Meanwhile, as the width increases, the notched band shifts towards the lower frequency and the bandwidth also decreases. The study of those had been done in the UWB antenna we designed before [10]. A prototype of the proposed antenna fabricated according to the final optimal parameters is shown in Figure 2.

3. EXPERIMENTAL RESULTS

The measured S -parameters for the proposed UWB MIMO antenna which is performed with an Agilent E8363B network analyzer are shown in Figure 3. The impedance bandwidth ($S_{11}, S_{22} \leq -10$ dB) is 128.6%, ranging from 2.35 to 10.82 GHz. Within the whole UWB band the isolations between two antenna elements are larger than 18 dB, which is quite enough for UWB MIMO applications.

Figure 4 shows the 3D radiation patterns of the UWB MIMO antenna system at the frequency of 4 and 8 GHz. The simulated radiation patterns of the antenna in the x - z and y - z planes are shown in Figure 5. In these figures, the x - z plane is the E -plane for Element 1 and H -plane for Element 2, while the y - z plane is the E -plane for Element 2 and H -plane for Element 1, respectively. As can be observed, the polarizations for two elements are quite orthogonal to each other.

The simulated efficiency of the antenna is shown in Figure 6. It can be seen that the simulated efficiency are above 85% across the UWB band. In the notched band of 4.8–6.1 GHz which cover the WLAN band (5.15–5.85 GHz) the efficiency decrease tempestuously, for the surface currents concentrate on the H-shaped slot or the L-shaped resonant strip.

The envelope correlation coefficient is an important estimation of UWB MIMO system performance which can be calculated by using the measured S -parameters of antenna. Figure 7 shows the measured envelope.

4. CONCLUSIONS

A novel printed UWB MIMO antenna with different polarizations and band-notch characteristics is designed, simulated, fabricated and tested. The proposed antenna exhibits 128.6% impedance bandwidth ($S_{11}, S_{22} \leq -10$ dB) from 2.35 to 10.82 GHz with high polarization which level is large than 18 dB. Band-rejected filtering property in the WLAN band is achieved by etching a H-shaped slot and employing a resonant L-shaped strip on two antenna elements. Low envelope correlation coefficient over the whole UWB band is achieved over the whole UWB band. Because of these characteristics, the UWB MIMO antenna system with band-notch characteristics we designed is very suitable for UWB MIMO system applications.

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