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A Compact UWB MIMO Antenna for Portable Applications

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Abstract

A novel compact multiple-input-multiple-output (MIMO) antenna for portable ultrawideband (UWB) applications is presented. This antenna consists of two modified planar-monopole antenna elements with coplanar waveguides-fed printed on one side of the substrate. To enhance isolation and increase impedance bandwidth, a tree like stubs is placed on the ground plane at the 45˚ axis. The measured results show that the MIMO antenna operates from 2.3 GHz to 13 GHz, covering WLAN, WiMAX, and UWB. The low mutual coupling and low envelope correlation coefficient of less than 0.2 across the whole frequency band proved that this antenna was suitable for MIMO/diversity systems. Also, good performance of radiation patterns and the antenna's compact size make it a good candidate for portable devices.

Keywords

Multiple-Input-Multiple-Output (MIMO) Antenna, Pattern Diversity, Planar Monopole, Ultrawideband (UWB)

1. Introduction

Since the Federal Communications Commission (FCC) in the US opened the permit of 3.1 - 10.6 GHz spectrum for applications with low power emission in 2002 [1], ultrawideband (UWB) became a rapidly growing technology. Multiple-input multiple-output (MIMO) technology can be used to improve the capacity and link quality [2] [3]. Ultrawideband (UWB) system combined with MIMO technology can provide data rates more than 1 Gb/s [4] [5]. However, one of the main challenges to the design of MIMO antennas for portable devices is low mutual coupling in small space [6] [7].

In recent years, many MIMO antennas have been proposed for UWB systems, including etching a ring slot in the ground plane [8] [9], inserting stubs between the two radiating elements [10], and good isolation was achieved by the tree-like structure between the two antenna elements. However, the operating frequency of the antenna in [4] is only from 3.1 to 10.6 GHz and the size of the antenna in [5] can be improved.

In this paper, a low mutual coupling compact UWB MIMO antenna with a bandwidth from 3.1 to 12.6 GHz is proposed. It has a compact size of 46 mm × 46 mm. Two planar-monopole antenna elements with coplanar waveguides-fed are placed perpendicularly to each other. A stub is placed on the ground plane to enhance isolation and bandwidth. Compared with the traditional UWB antenna, the proposed low mutual coupling compact UWB MIMO antenna combines with the advantages of orthorhombic structure and the decoupling structure to achieve a low mutual coupling and small size.

2. Antenna Design

2.1. Antenna Configuration

The geometry of the proposed antenna is shown in Figure 1, with an overall size of only 46 × 46 mm. It is designed on a on an FR4 substrate, with a thickness of 0.8 mm, a permittivity of 4.4, and a loss tangent of 0.02. This antenna consists of two modified planar-monopole antenna elements which were staircase-shaped square radiators. CPW were used to fed antenna elements. The ground plane consists of a tree-like stub, which can efficiently enhance wideband isolation characteristics. The geometry and the dimensions of the proposed antenna is further illustrated in Figure 1 with details.

2.2. Ioslation Stubs

In this section, High Frequency Structure Simulator (HFSS) is carried out in order to study the effectiveness of the proposed tree-like structure.

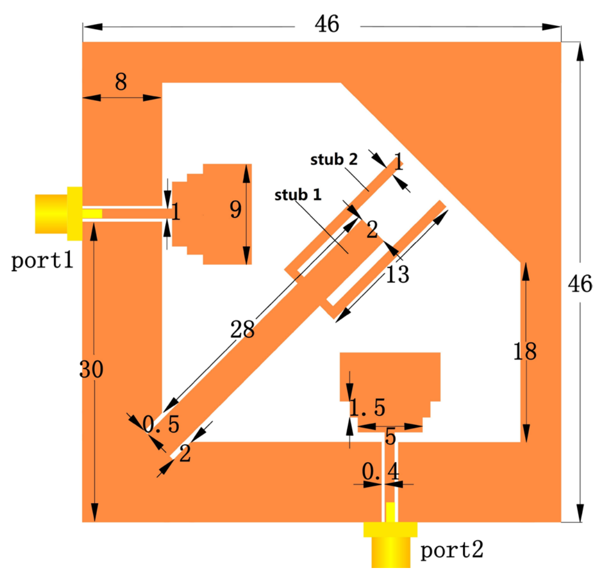


Figure 1. Configuration and parameters of proposed antenna (unit: mm).

The tree-like structure consists of two stubs. Stub 1 can be seen as a reflector and mutual coupling between the two modified planar-monopole antenna elements can be weakened. With stub 2, more resonances will be introduced, and a wideband isolation can be achieved. In Figure 2, we can see the isolation across the operating band improvement by introduce stub 1 and stub 2.

3. Experiment Results and Discussion

3.1. Impedance Performance

An antenna prototype is fabricated, as shown in Figure 3. The S-parameters are measured with the Agilent E8363B vector network analyzer. Figure 4 shows the simulated and measured S-parameters of the proposed antenna. According to the measured

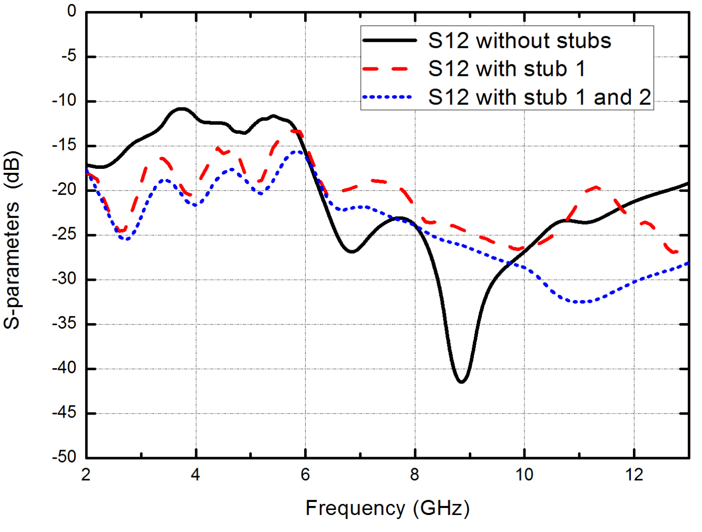


Figure 2. Simulated S12 when total number of stubs varies.

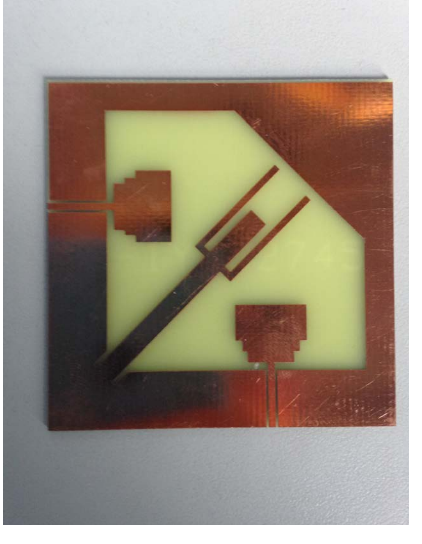
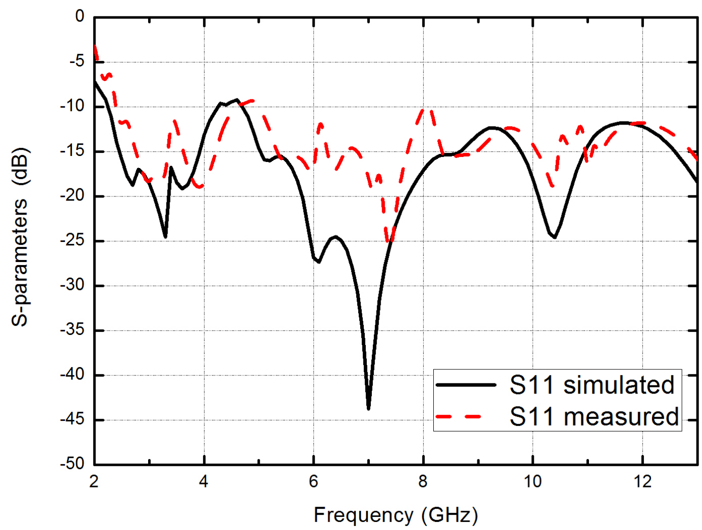


Figure 3. Prototype of proposed antenna.

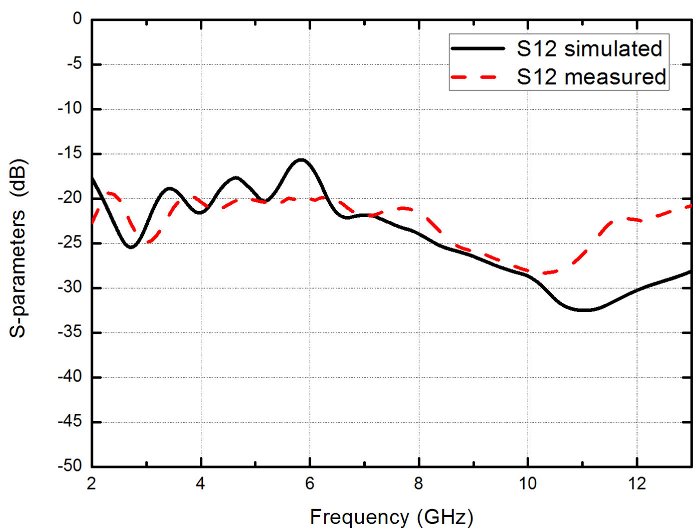
results, the impedance bandwidth (defined by a return loss of no less than 10-dB) is from 2.3 GHz to 13 GHz. According to the measurement shown in Figure 4(b), the isolation between the two modified planar-monopole antenna elements is less than 20-dB. So that this antenna is suitable for portable devices.

3.2. Radiation Performance

The radiation patterns are measured with the anechoic chamber SATIMO Star Lab. Figure 5 shows the radiation patterns at 2.5 GHz, 6.5 GHz, and 10.5 GHz, Port 1 is excited while Port 2 is terminated with a 50-Ω load. The measurement gain of port 1 is plotted in Figure 6. The gains range from 3 to 6.5 dBi across the frequency band from



(a)



(b)

Figure 4. Measured and simulated S-parameters of proposed antenna: (a) S11; (b) S12 a.

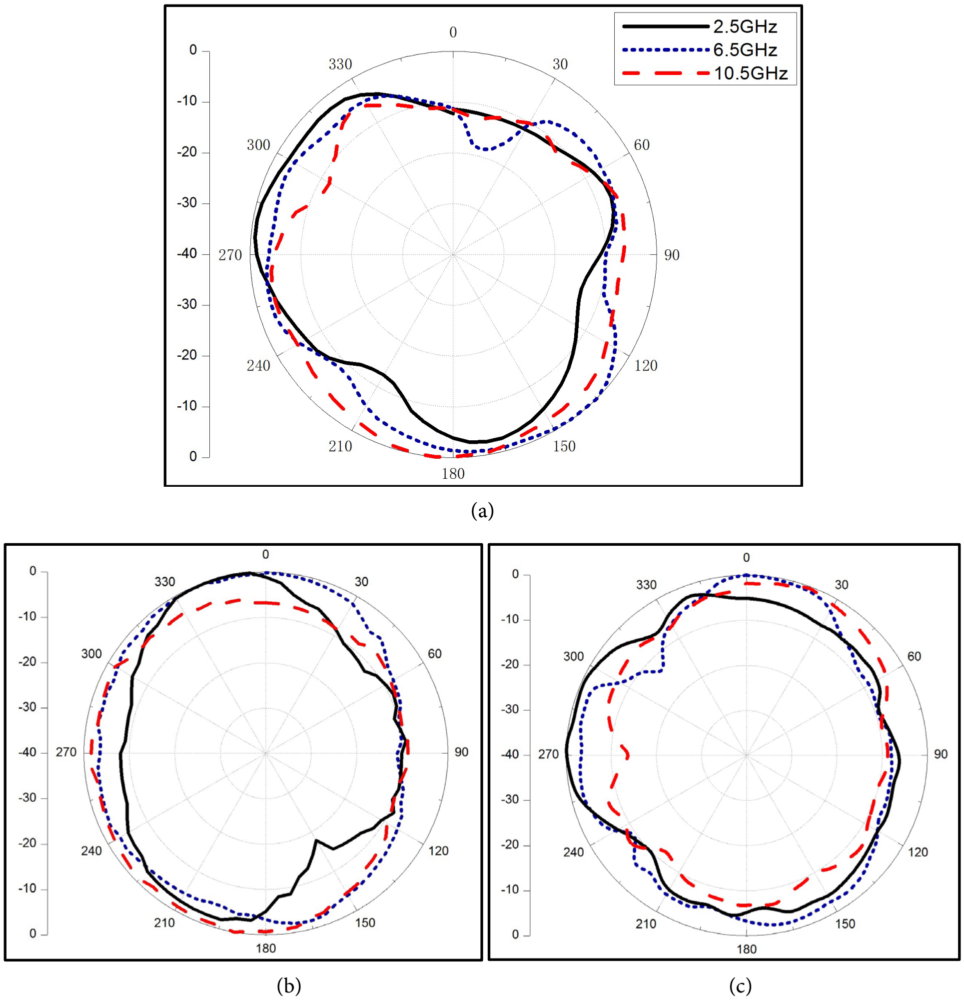


Figure 5. Measured radiation patterns of proposed antenna at 2.5 GHz, 6.5 GHz, and 10.5 GHz: (a) XY plane; (b) XZ plane; and (c) YZ plane.

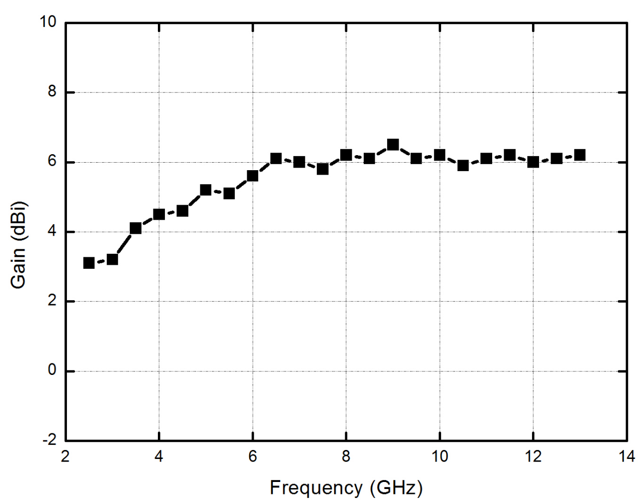


Figure 6. Measured gain of proposed antenna.

2.9 - 13 GHz. As shown in Figure 5, the proposed antenna has nearly Omni-directional radiation pattern, and it can be similar to traditional dipole antenna.

3.3. Diversity Performance

The envelope correlation coefficient (ECC) is an important parameter for evaluating the performance of the diversity system. The proposed antenna is below 0.01 across the whole operating frequency, shows that the antenna is suitable for a diversity system.

4. Conclusion

A dual port pattern diversity UWB antenna was presented. This antenna consists of two modified planar-monopole antenna elements and a tree-like stub is extended from the ground plane, which enhances the isolation coefficient more than 20-dB. An impedance bandwidth of 2.3 GHz to 13 GHz was obtained, and measurements of radiation patterns, antenna gain, and the ECC were shown. The antenna's compact size makes it suitable for portable MIMO/diversity applications.

Acknowledgements

Thanks for the guidance of Professor Zhigang Lu.

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