

# Low-Profile Ultra-Wideband MIMO Antenna For PDA Application

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## 1. Introduction

A multiple-input multiple-output (MIMO) communication system using multiple antennas is more advantageous than single-input single-output (SISO) communications in terms of increasing channel capacity and greater spectral efficiency [1-2]. However, it is difficult to achieve high isolation between antennas of the MIMO system embedded in a compact portable device. The efforts to overcome this problem have been studied [3-4].

In this paper, a simple and compact MIMO antenna with ultra-wideband and good isolation characteristic is proposed. To achieve improved isolation between the two antennas, two T-stubs are introduced in the proposed design. The 10 dB return loss bandwidth for the proposed antenna ranges from 2.2 GHz to 11.2 GHz. Detailed design and experimental results of the proposed antenna are presented and discussed.

## 2. Antenna Design

The configuration of the proposed MIMO antenna is shown in Figure 1. The antenna consists of two identical antennas and two T-stubs. They are located symmetrically with respect to the symmetrical axis. The two antennas are mounted near edges of both sides on the top portion of the ground plane (83 mm  $\times$  80 mm). The volume of each antenna element is 10 mm  $\times$  12 mm  $\times$  2 mm and the antenna has bended structure, as shown in Figure 1(b). The shorting stub of 1 mm width is used to improve impedance matching from 5.5 GHz to 7.5GHz, as shown in Figure 2. The overall antenna size including the ground plane is suitable for a practical personal digital assistant (PDA) application.

Since the two antennas are placed on the common ground, mutual coupling between them is strong enough to excite the additional surface current distributions on the ground plane. To improve the isolation characteristic, two T-stubs are adopted between the two antennas on the ground. The T-shaped stub is asymmetrical and has the size of 18 mm  $\times$  19 mm. Since the locations and sizes of T-stubs change the effective ground size, it is very important to find the proper positions of T-stubs to minimize the effect on the impedance matching in the operating frequency. The two T-stubs are placed at 19mm away from each feeding port. The effect of two T-stubs is analyzed by examining the surface current distributions on the ground plane with and without them. In Figure 3, the surface current distributions at 4 GHz and 8 GHz are shown with and without two T-stubs when the antenna 1 is excited and antenna 2 is terminated to 50  $\Omega$  load. The current distribution for the antennas without two T-stubs shows that strong current is generated near the antenna 2. The current distributions near antenna 2 with two T-stubs are much smaller than those for the antenna without stubs at 4 GHz and 8 GHz. In Figure 4, the surface current distributions at 4 GHz and 8 GHz are shown with and without two T-stubs when the antenna 2 is excited and antenna 1 is terminated to 50  $\Omega$  load. One can observe the strong coupling between the two antenna elements without stubs. The return loss and isolation characteristics for the proposed MIMO antenna with and without T-stubs are illustrated in Figure 5. It is shown that the resonance frequency shifts slightly to the lower frequency. The isolation characteristic between the two antennas is improved. The proposed

antenna for MIMO system was designed and analyzed by using a high frequency structure simulator (HFSS)[5].

### 3. Result and Discussion

The HP8719ES vector network analyzer was used to measure the S-parameter characteristics of the proposed antenna. Figure 6 shows the measured S-parameters for the proposed antenna. The measured results show that 10 dB return loss bandwidth ( $S_{11}$ ,  $S_{22}$ ) requirement is satisfied over the frequency bandwidth from 2.2 GHz to 11.2 GHz and the isolation ( $S_{12}$ ,  $S_{21}$ ) between the two antennas is less than  $-20$  dB over the operating bandwidth. Figure 7 shows the radiation patterns in x-z and y-z planes at 4 GHz and 8 GHz. The radiation patterns are normalized with respect to the peak gain at each frequency. Figure 8 shows the measured peak gains of each antenna as a function of frequency.

### 4. Conclusion

The two antenna MIMO system for the UWB PDA application is proposed. The proposed antenna has ultra-wide impedance bandwidth of 9 GHz (2.2 GHz  $\sim$  11.2 GHz) for  $S_{11}$  and  $S_{22}$  less than  $-10$  dB and good isolation characteristic (less than  $-20$  dB) over operating frequency. The measured antenna gain is good enough to be used for UWB system. The proposed antenna can be a good candidate for UWB MIMO system.

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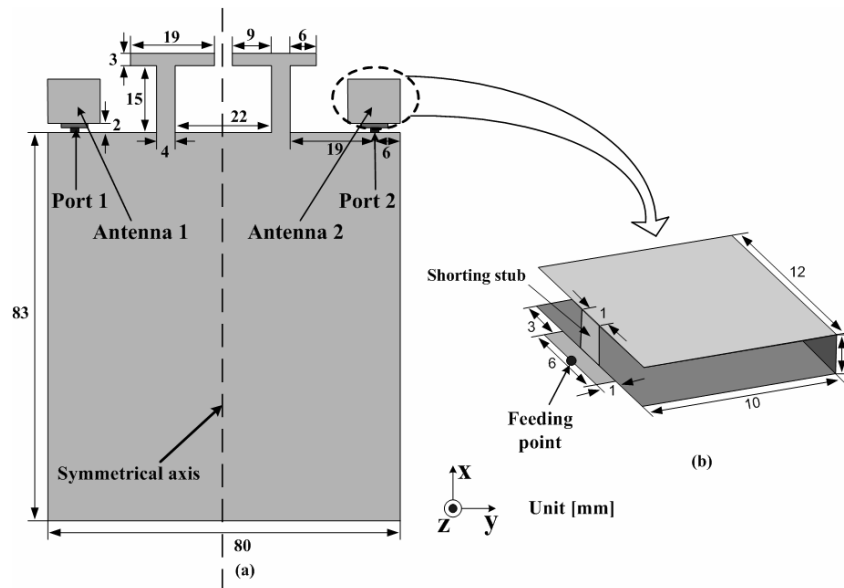


Figure 1: (a) Configuration of the proposed two- antenna MIMO system  
(b) Detailed dimensions for the antenna

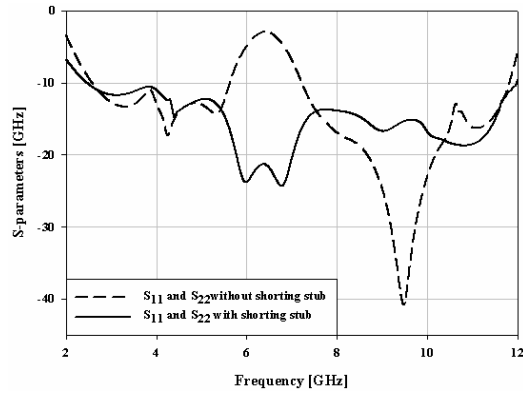


Figure 2: Calculated S-parameters for the effect of shorting stub

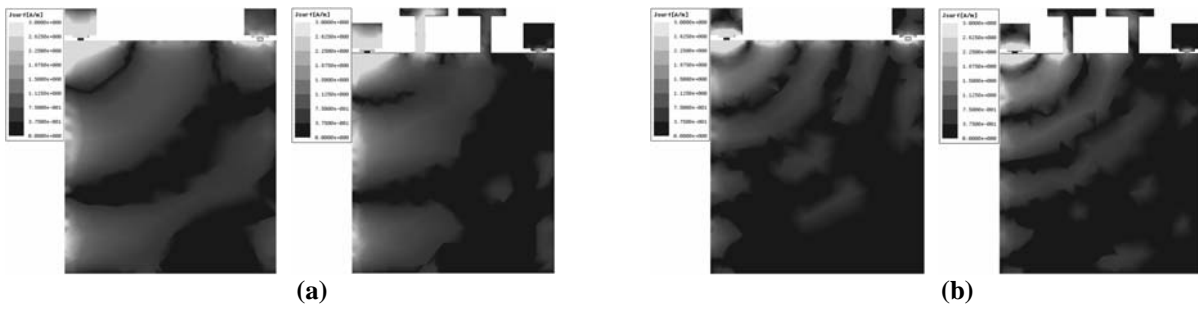


Figure 3: Calculated surface current distributions for the proposed antenna (port 1 excited):  
(a) 4 GHz and (b) 8 GHz

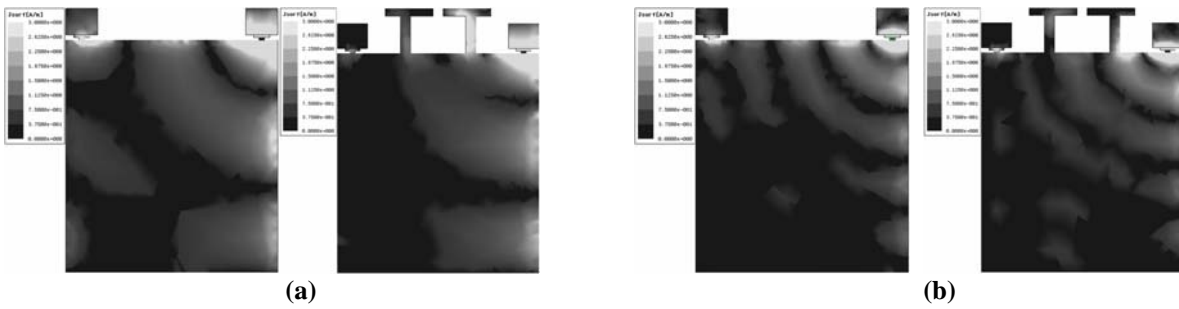


Figure 4: Calculated surface current distributions for the proposed antenna (port 2 excited):  
(a) 4 GHz and (b) 8 GHz

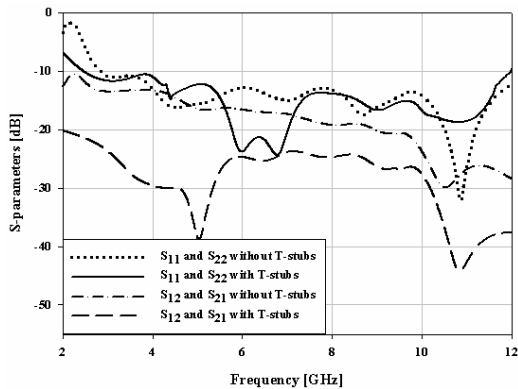


Figure 5: Calculated S-parameters characteristics with and without stubs

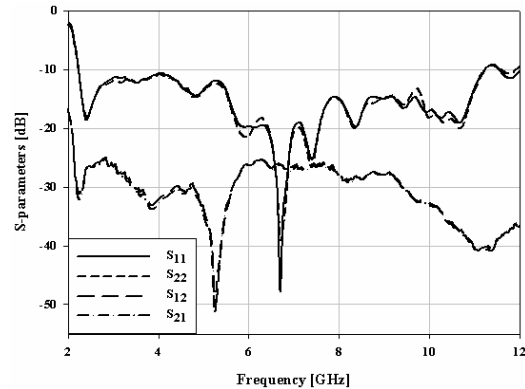


Figure 6: Measured S-parameters for the proposed antenna

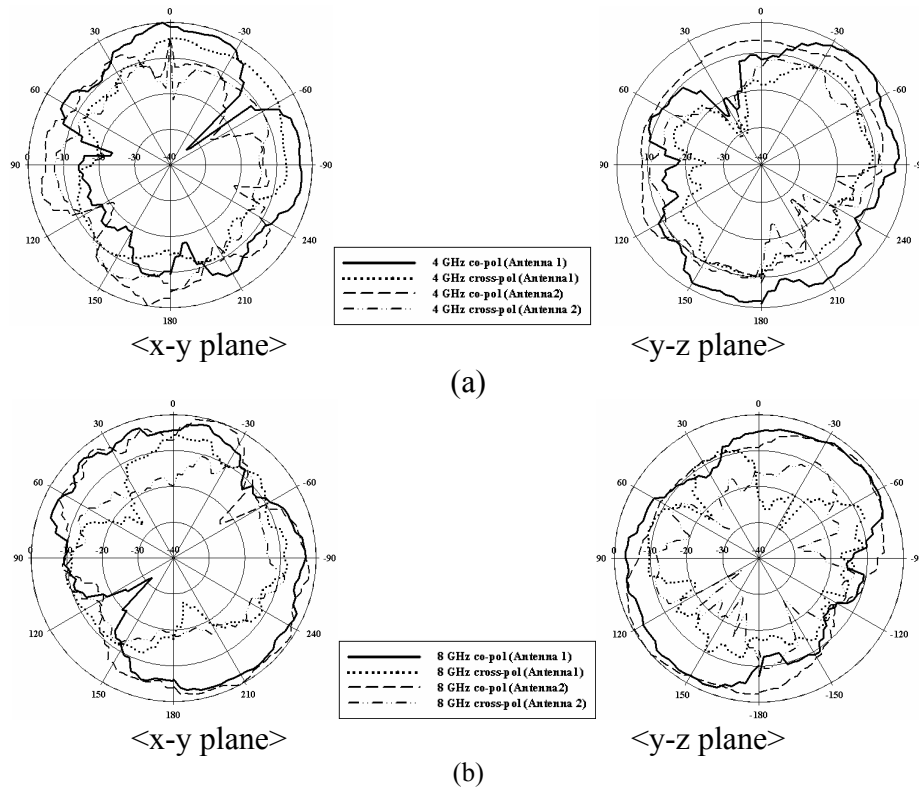


Figure 7: Measured radiation patterns for the proposed antenna: (a) 4 GHz and (b) 8 GHz

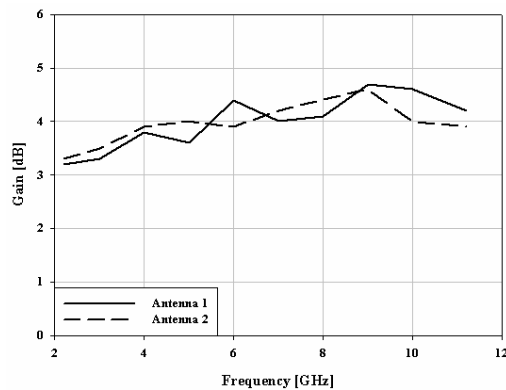


Figure 8: Measured gain for the proposed antenna

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