Design of a High Isolation Dual-band MIMO Antenna for WLAN and WIMAX Applications

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Abstract— A high isolation dual-band multiple-input multiple-output (MIMO) antenna of two antenna elements is presented for WLAN and WiMAX applications. Each element consists of two meandering strips which locate at the top and bottom sides of the substrate respectively. The proposed MIMO antenna operates in the 2.45 GHz WLAN band and 3.55 GHz WiMAX band. And the antenna has high isolation over 2 dB in the two operation bands, which is obtained by the vertical structure, a neutralization line and a narrow slot between the two elements. The return loss and the isolation of the antenna are investigated simulation. The results show that the proposed MIMO antenna has high isolation and good impedance match characteristic, making it suitable for WLAN and WiMAX applications.

1. INTRODUCTION

In recent years, the demand of high date rate and wide band for modern wireless communication systems have has increased rapidly [1, 2]. Multi-input and multi-output (MIMO) technology can enhance data transmission speed and give a resistant to multiple path fading, which has been widely investigated. As a MIMO system, the transmitter or receiver needs two or more antenna elements [3, 4]. However, multiple antenna elements need to be placed closely in a small space within the limitation of the space which will produce strong coupling and make it hard to satisfy the requirements of system design [5]. Hence, it is a great challenge to design a MIMO antenna system with small size and high isolation.

Consequently a large amount of methods have been presented to design MIMO antennas with low coupling. Various slots such as I-shaped slot have been successfully used to obtain high isolation in MIMO antenna systems [6, 7]. A MIMO antenna has been designed by adding a neutralization line to achieve high port-to-port isolation in the 700 MHz band [8]. Mushroom-like electromagnetic band-gap (EBG) structure has been fabricated to suppress surface waves [9, 10]. Also, loading resonators between the antenna elements were effective methods to reduce the mutual coupling [11–15].

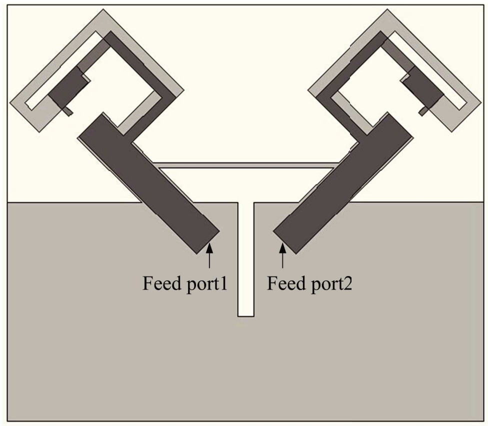
In this paper, a dual-band MIMO antenna with small size and high isolation is presented for WLAN and WiMAX applications The proposed MIMO antenna has two orthogonal antenna elements, each of which consists of two meandering strips located at the top and bottom sides of a FR4 substrate with the dielectric constant of 4.3. The MIMO antenna covers the bandwidths of WLAN 2.45 GHz (2.4–2.484 GHz) and WiMAX 3.55 GHz (3.4–3.69 GHz). A high isolation over 20 dB in both low and high frequency bands is obtained by orthogonally arranging antenna elements and using a neutralization line and a narrow slot

2. ANTENNA DESIGN

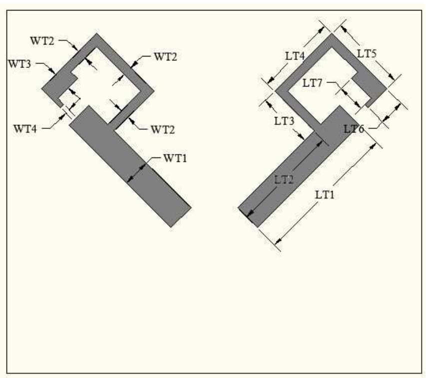
The configuration of the proposed dual-band MIMO antenna is shown in Fig. 1. The proposed MIMO antenna, printing on a FR4 substrate with a thickness of 1.6 mm, consists of two orthogonal antenna elements which are connected by a neutralization line. In addition, a narrow slot is etched between the two feed ports. As for the antenna element, it is comprised of two meandering strips which are printed on the both sides of the substrate. The top strip is connected with a 50-Ohm coaxial line, while the bottom meandering strip is set under the top one. The top view and the bottom view of the MIMO antenna is depicted in Figs. 1(b) and (c) respectively. The proposed MIMO antenna is optimized by using CST and the optimal parameters are listed in Table 1. The total lengths of the top and bottom meandering strips are 26.75 mm (about quarter wavelength at 2.45 GHz) and 41.7 mm (about half wavelength at 3.55 GHz) respectively.

3. RESULTS AND DISCUSSION

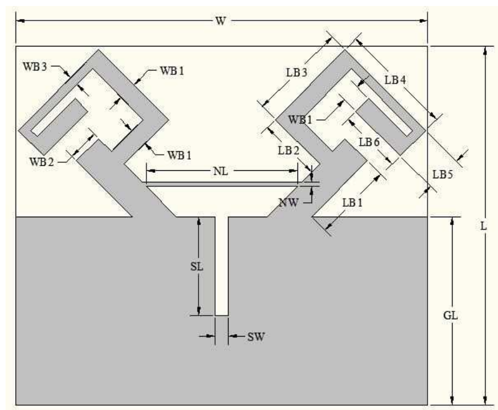
The simulated S-parameters are shown in Fig. 2. It can been observed that the proposed MIMO antenna operates in both WLAN 2.45 GHz and WiMAX 3.55 GHz bands, and good impedance



(a)



(b)



(c)

Figure 1: The configuration of the proposed MIMO antenna. (a) Total view. (b) Top view. (c) Bottom view.

Table 1: The optimal parameters of the proposed antenna.

Parameters	W	L	$WT1$	$WT2$	$WT3$	$WT4$	$LT1$	$LT2$	$LT3$
Unit (mm)	46	40	3.1	1	2	0.5	16	12	6.2
Parameters	$LT4$	$LT5$	$LT6$	$LT7$	$WB1$	$WB2$	$WB3$	$LB1$	$LB2$
Unit (mm)	9	8.6	2.95	3.1	2	3.5	1	8.78	7
Parameters	$LB3$	$LB4$	$LB5$	$LB6$	GL	NW	NL	SW	SL
Unit (mm)	11	12.7	4	7	21	0.5	16.86	1.5	11

match characteristic is achieved. In this MIMO antenna, the polarization modes of two antenna elements are different, namely one is vertical polarization and the other one is horizontal polarization. Thus, the antennas with perpendicular polarization modes are completely mismatch and cannot receive signals from each other in theory, and hence the mutual coupling caused by space waves is also reduced. Furthermore, the neutralization line connecting the two antenna elements can cancel the current because of the phase-reversal. And the narrow slot can hinder the surface currents flowing to the non-excited antenna element. The neutralization line and the narrow slot are effective on suppressing the mutual coupling caused by surface waves. Therefore, superior isolation performance beyond 20 dB is obtained Current distributions at 2.45 GHz and 3.55 GHz for port1 are shown in Fig. 3. When port1 is excited, port2 is terminated with 50-Ohm matched load. It can be seen that the current density is very weak on the non-excited antenna element, which further verifies the good isolation characteristic of the proposed MIMO antenna.

The 3-D radiation patterns for port1 or port2 at different frequencies are displayed in Fig. 4. It can be seen that radiation directions are also orthogonal since the structures of the proposed

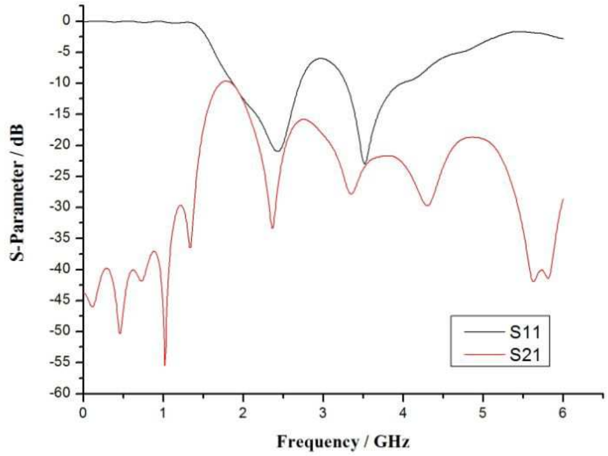


Figure 2: The simulated S-parameters.

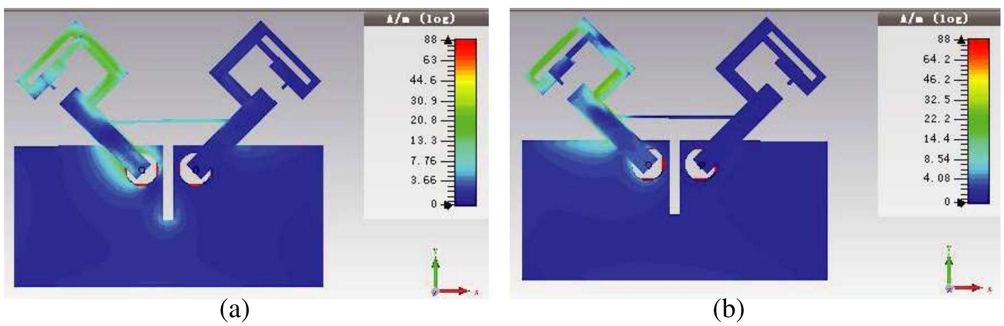


Figure 3: Current distributions at 2.45 GHz and 3.55 GHz for port1. (a) 2.45 GHz. (b) 3.55 GHz.

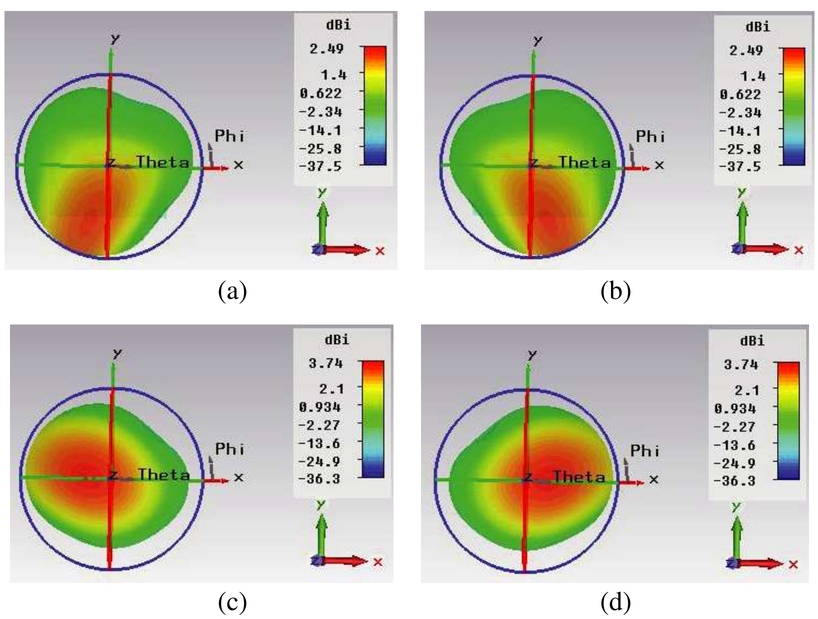


Figure 4: The 3-D radiation patterns for port1 or port2 at different frequencies. (a) Port1: 2.45 GHz. (b) Port2: 2.45 GHz. (c) Port1: 3.55 GHz. (d) Port2: 3.55 GHz.

antenna elements are orthogonal, which means it can provide pattern diversity.

4. CONCLUSION

A dual-band MIMO antenna has been designed and discussed for WLAN and WiMAX applications in this paper. The proposed MIMO antenna consists of two antenna elements which are perpendicular to each other. By using this structure, mutual coupling caused by space waves have been effectively reduced. In addition, the neutralization line and the proposed narrow slot are fabricated to improve the isolation. Thus, it has been achieved that good isolation characteristic over 20 dB in both 2.45 GHz WLAN band and 3.55 GHz WiMAX band. The results show that the proposed MIMO antenna can be a good candidate for MIMO systems.

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