A Printed Inverted-F MIMO Antenna for WiFi Applications

Cheng Liu[1], **Hui Liu**[1], **Binjie Wang**[1], **Zhibin He**[1], **and Sailing He**[1, 2]

[1]Centre for Optical and Electromagnetic Research, Academy of Advanced Optoelectronics
South China Normal University, Guangzhou, China
[2]The Royal Institute of Technology, Stockholm, Sweden

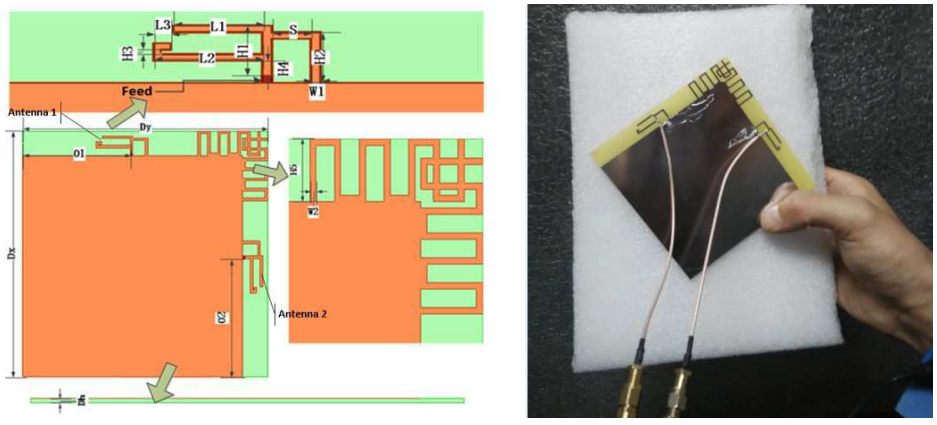
Abstract— A wideband printed inverted-F MIMO antenna designed for WiFi applications is presented. The proposed MIMO antenna which consists of two modified inverted-F antenna elements and an isolated structure is designed on a two-layer FR-4 printed circuit board (PCB). The occupied antenna area has the dimensions of 98 mm ∗ 98 mm and the thickness of substrate is 0.8 mm. The functions of antenna's structure and the effects of some parameters on the antenna performance are discussed in this paper. The designed MIMO antenna system has a wide bandwidth measured more than 0.78 GHz (2.25–3.03 GHz) at the reflection coefficient level below −10 dB. Due to a folded isolated structure, in the whole measured frequency band the mutual coupling is lower than −15 dB, the MIMO antenna has good isolation. On the xy and yz planes the max gain of MIMO antenna can achieve 3 dB. The parameters of simulating and testing are shown that this MIMO antenna has good performance for WiFi applications.

1. INTRODUCTION

In recent years, WLAN applications are expected to support high data rates. Multiple-input multiple-output (MIMO) is a key technology in the good quality and high channel capacity communication. In MIMO system both antennas are transmitting and receiving data at the same time. The inverted-F antenna is a structural deformation of the monopole antenna. It has been employed in the field of short distance wireless communication due to its low profile and simple structure.

Some scholars have done many works about the MIMO antenna recently. In [1], a printed dual-antenna system operating in the GSM and 2.4 GHz WLAN bands for mobile terminals is proposed, two grounded branches are used to get good isolation, and have good performance. In [2], five elements inverted-F antenna array for MIMO communications is designed without using any specific multi-antenna isolation techniques, optimized to enhanced capacity. Another MIMO antenna at 2.45 GHz which has broad bandwidth is designed in [3, 4]. In [5], a cross branch is used at its corner of the ground to achieve a circular polarization characteristic. In [6], a compact planar inverted-F antenna system with high isolation operating in 2.5–2.7 GHz band is proposed, the two inverted-F antennas is placing mirror symmetrical orientation.

A broadband inverted-F MIMO antenna for WLAN applications printed on top layer of 0.8 mm thick with FR4 PCB substrate is proposed in this paper. The antenna covers a broad bandwidth from 2.31 GHz to 3.13 GHz. This paper also is discussed the antenna simulation and test. In [7], some comparisons have been done to study the inverted-F antenna with circuit layout or mounted ICs effects on the antenna parameters.



(a) (b)

Figure 1: (a) Geometry with detailed dimensions of the MIMO antenna. (b) Photo of the MIMO antenna.

2. ANTENNA DESIGN

The geometry and photo of the proposed Inverted-F MIMO antenna for WiFi applications are shown in Figure 1. The antenna consists of two elements are placed in the two adjacent sides of a PCB with a volume of 98 mm ∗ 98 mm ∗ 0.8 mm. The substrate we used is FR4 layer (relative permittivity of 4.4, loss tangent of 0.02). The ground plane size is 88 mm ∗ 88mm, and the size is suit for the PCB which is mounted ICs.

To improve the isolation between the two antennas, paper [8] layouts the antenna elements with different edges and adds two folded structures in the corner between the antennas. Table 1 shows the detailed dimensions of the inverted-F antenna.

Table 1: Dimensions of the proposed antenna (unit: mm).

L_1	L_2	L_3	L_4	W_1	W_2	H_1	H_2	H_3	H_4	H_5	S	D_x	D_y	D_h	O_1	O_2
11.2	13.7	2.2	3	1	1	7	7	0.5	2	10	5	98	98	0.8	43	44

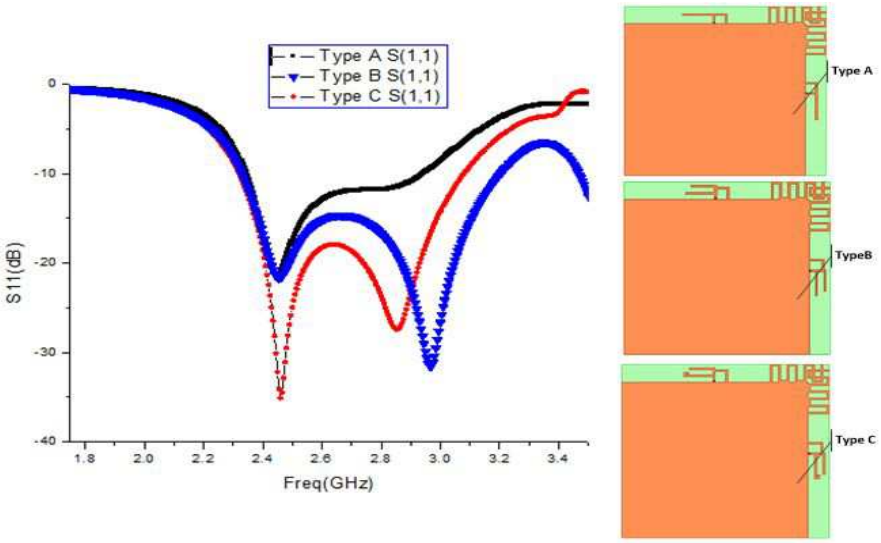


Figure 2: The S_{11} of three different type antennas.

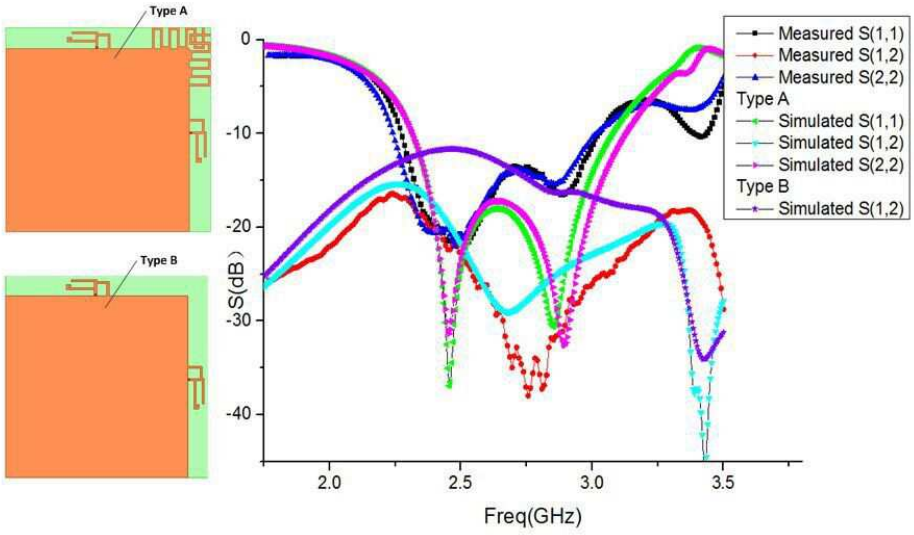


Figure 3: Simulated and measured S-parameters of proposed antenna.

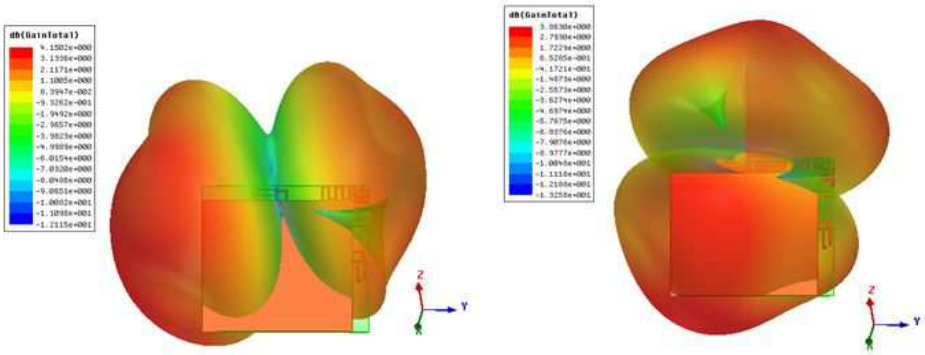


Figure 4: 3D overlay radiation field of antenna 1 and antenna 2.

Table 2: Measured and simulated S-parameters at 2.45 GHz.

S-parameters	Measured (dB)	Simulated(dB)
S_{11}	−21.4	−35
S_{12}	−22.4	−19.6
S_{22}	−20.3	−31

3. RESULTS AND DISCUSSIONS

In this paper, the inverted-F MIMO antenna is simulated and optimized by the ANSYS HFSS. In order to get broad bandwidths, another branch with the length of L_2 was used. The branch with the length of L_3 is added to get better S_{11} parameter at 2.45 GHz. The comparison of S-parameter is shown in Figure 2. The antenna only has one radiation branch with the length of L_1 is called type A antenna, type B antenna has two radiation branches with the length of L_1 and L_2, type C antenna is added branch with the length of L_3.

The simulated and measured S-parameters of the proposed MIMO antenna are shown in Figure 3. There are two types of antennas, type A is the whole antenna and type B antenna is the antenna without the isolation structure. While the MIMO antenna system maintaining the better isolation due to the structure. Its simulated −10-dB impedance bandwidth is 0.82 GHz (2.31–3.13 GHz) and measured bandwidth is 0.78 GHz (2.25–3.03 GHz). Between 1.75 and 3.5 GHz, the measured mutual coupling is lower than −15 dB. Both simulated and measured all have good S-parameters. The simulated and measured S-parameters at 2.45 GHz for the MIMO antenna are tabulated in Table 2.

The simulated of 3D overlay radiation field patterns are shown in Figure 4. Antenna 1 with lumped port 1 is shown in the left side of Figure 4, antenna 2 with lumped port 2 is shown in the right side. In the radiation direction, the gain can achieve more than 3 dB.

4. CONCLUSION

A broadband Inverted-F MIMO antenna has been designed and tested in this paper. The antenna is used in WiFi application. The MIMO antenna system consists two inverted-F antenna elements, is printed on a PCB. The antenna has a wide bandwidth of more than 0.78 GHz (2.25–3.03 GHz) at the reflection coefficient level below −10 dB. Thanks to the folded isolated structure, in the whole measured frequency band the mutual coupling is lower than −15 dB. The MIMO antenna shows good performance in applications. The structure of this inverted-F MIMO antenna is simple. So the antenna is easy to design and use in practice.

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