A Low Profile MIMO Antenna Design for WLAN Applications

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Abstract

A low profile MIMO antenna system to cover the WLAN 2.4/5.2/5.8 GHz bands is presents. This antenna system has the features of designing simplify and easy to produce. The design is base on FR4 board for the substrate and the bending ladder patch for the radiating element, by Using electromagnetic coupling feed to reduce the electrical impedance, and adjusting the ladder size can easily achieve the required operating frequency 2.24 GHz ~ 3.46 GHz and 4.61 GHz ~ 5.94 GHz, The average gains in the low band and high band are approximately 4 dBi and 5 dBi, that are suitable for short-range wireless transmission applications. In this MIMO antenna system, the antenna elements are placed in 90-degree angle of the corresponding edge, this method can achieve good isolation.

Keywords : Antennas multiple-input multiple-output (MIMO) WLAN Isolation

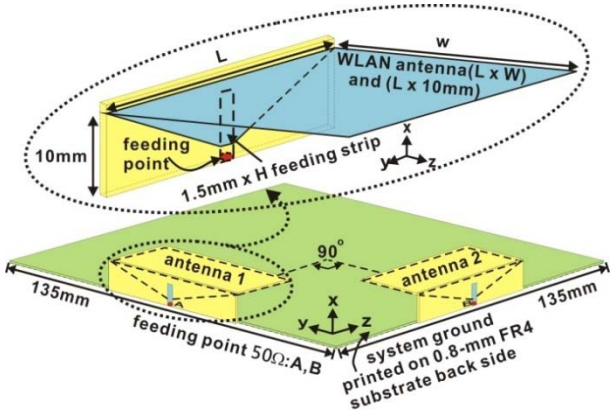
1. Introduction

Last few years, the rapid developments of the communications-related technologies were presented. For the evolution of the antenna application, they are from single frequency, dual-band, tri-band to the current multi-band or super-broadband. WLAN (Wireless Local Area Network) whose time has come, the use of wireless transmission continued to increase transmission speed for the demand on quickly, except for the addition of new protocols, the integration of multi-antenna used to multiple-input multiple-output (MIMO) to improve efficiency, quality systems and other communication channels. The wireless product design to reduce costs will be smaller in size and too close to the antennas, resulting in the isolation between the antennas is decreased and because the baseband signal processing problems, the transmission speed slows down resulting in antenna gain decreases. In this paper, we used two feed points order in 90 degrees on both sides of the ground that can effectively improve the isolation, through a simple antenna design and adjustment of parameters to achieve the 2.4/5.2/5.8 GHz bands, the simulation and measurement data to verify whether the design of this antenna to achieve the desired frequency band.

2. Antenna Description

Figure 1(a), (b) show the low profile antenna system for MIMO design and the photograph of a design prototype. The proposed Antenna 1 is composed of the three different parts, which are based on the FR4 PCB substrate (thickness of 0.8 mm, relative permittivity of 4.4, loss tangent of 0.0245). The first part is ground plane which size is 135 mm × 135 mm. The second part used double panel metals FR4 substrate, the substrate is connected to the ground substrate vertically placed, the outside metal is printed 50 Ω microstrip lines and connected with SMA coaxial cable on point A. The outside panel FR4 substrate is printed a metal ladder, this ladder is designed to 150 degree [1], that is better input impedance and higher effective gain. The second substrate is

connected to the third substrate vertically placed and metal ladder is connected to metal rectangle simultaneously. Finally, antenna 1 and antenna 2 are position of 90 degrees placed MIMO antenna system architecture.



(a)

(b)

Figure 1: (a) Low profile antenna system for MIMO design; (b) the Photograph of a design prototype.

Detailed dimensions of the antenna 1 show the Figure 2, The size of the second double panel FR4 substrate is 49 (L) mm × 10 mm and it's outside printed 50 Ω microstrip lines to be 8 (H) mm × 1.5 mm, the signal through this microstrip line coupling feed to the other side metal ladder and the top size of ladder is 49 (L) mm, bottom size of ladder is 1.5 mm, high size of ladder is 7 mm and the third substrate size of 49 (L) mm × 23 (W) mm is connected to the second substrate vertically placed.

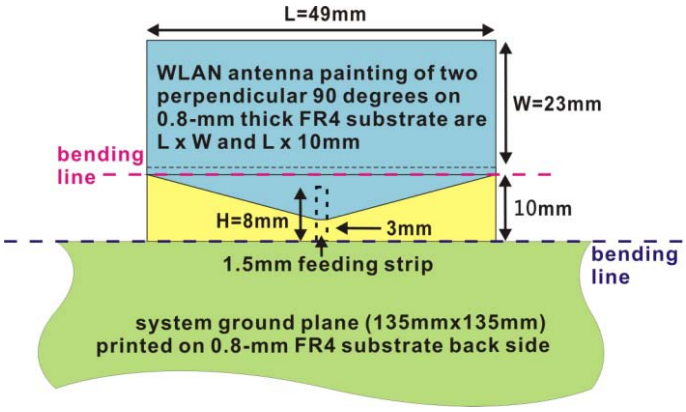


Figure 2: Detailed dimensions of the antenna 1 planar structure.

3. Results and Discussion

The antenna simulation software HFSS by revise the appropriate parameters to achieve the best return loss of antenna gain and get the ideal parameters of the antenna.

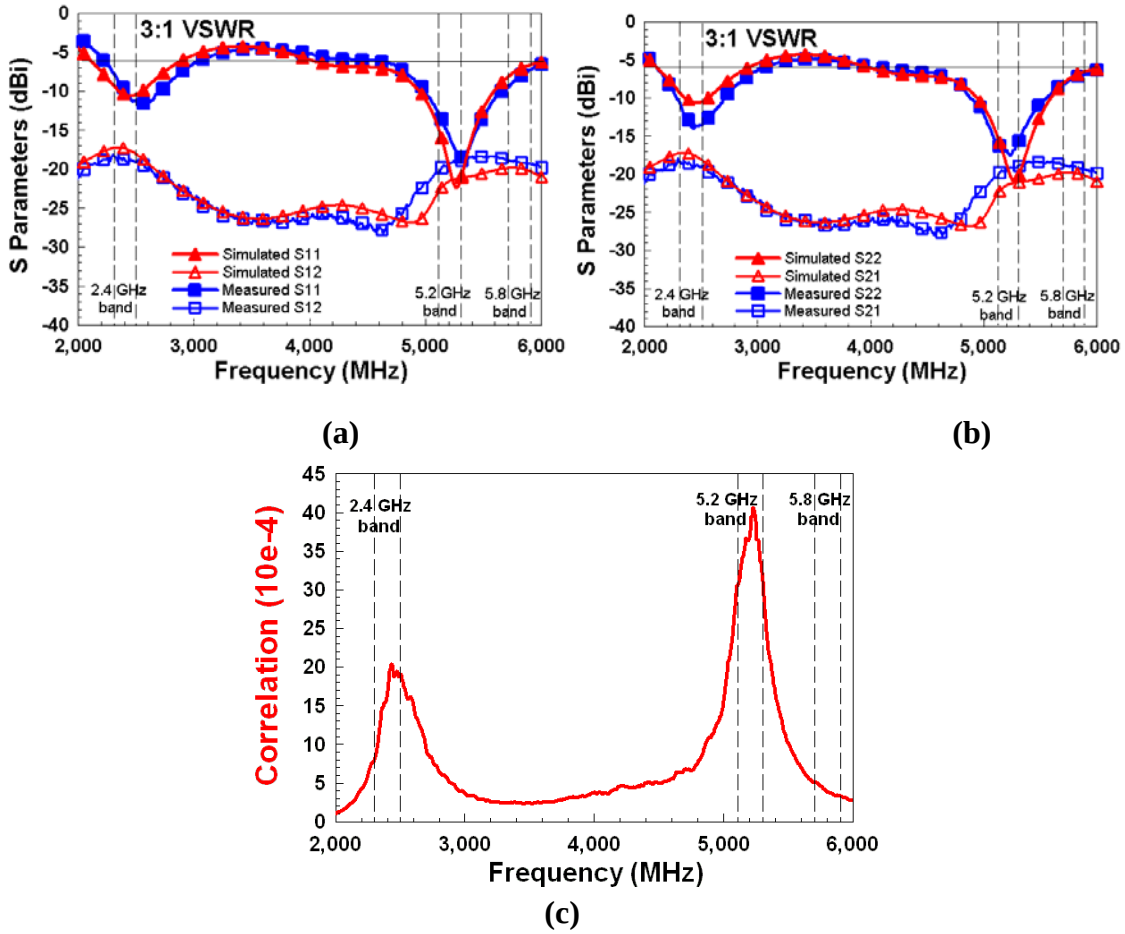


Figure 3: Simulated and measured for the antenna1, antenna2. (a) Return loss and insertion loss (S_{11} and S_{12}) for antenna 1; (b) Return loss and insertion loss (S_{11} and S_{12}) for antenna 2; (c) Calculated envelope correlation for the two antennas.

The voltage standing wave ratio is 3:1 and best simulation of the resonant frequency parameters is H=8 mm, W=23 mm, L=49 mm. Figure 3 (a), (b) antenna 1 and antenna 2, we found that simulated and measured value is not much difference and the ideal frequency band fall. And the antenna 1 and antenna 2 was placed 90 degrees, so the angle of two antennas placing can effectively of the good isolation [2]. The S12 and S21 of the insertion loss are minimum the following -18 dB.

The figure 3 (c) shows the Calculated envelope correlation for the two antennas. The two antennas in the 2.4/5.2/5.8 GHz band, many practical examples [3], [4] of parameter measured ρ_e (1), first relevant parameters need to simulate, and then by a complex asterisk (*) means conjugate parameters, S11 and S12 in part by the value multiplied by -1. Finally, the real imaginary parts from the ρ_e of the parameters on the numerator are calculated to gain and the absolute value thereof and the denominator would be easier to obtain, because a portion of the value was not involved. This correlation is still the band of 0.007, requirements more better than the industry norm of 0.3 and infrastructure specification proposed of 0.7 [5]

$$\rho_e(1,2) = \frac{|S_{11}*S_{22}+S_{12}*S_{22}|^2}{[1-(|S_{11}|^2+|S_{21}|^2)]*[1-(|S_{12}|^2+|S_{22}|^2)]} \quad (1)$$

4. Conclusion

The proposed low profile design of MIMO antenna with good isolation and easy production are presented, using the couple feed to reduce the resistance, and simple ladder design to get better input impedance and finally adjusted rectangle patch can easily achieve the frequency band for 2.24 GHz ~ 3.46 GHz and 4.61 GHz ~ 5.94 GHz, and the envelope correlation for the proposed antenna system is under 0.05. More detailed results and discussions will be given in the presentation

References

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