Small PIFA for WLAN of IEEE 802.11a,b,g

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Introduction

The small size of PIFA (planar inverted F antenna) with size 11 mm by 9 mm by 10 mm is designed for dual bands of IEEE802.11a,b,g. The frequency bands are from 2.3GHz to 2.62 GHz and form 5.05GHz to 5.49 GHz. The antenna is simulated by the HFSS and IE3D simulation software. The return loss and gain patterns at principal plane cuts for the two bands are measured. The average gains for the center frequency at these two bands are -0.3 dBi and -0.45 dBi.

Hardware implementation and simulation

The antenna structure and detailed size is shown in Fig. 1. The antenna material is use the FR4 substrate material. The thickness of FR4 is 0.8mm and relative permittivity is 4.4. The distance between FR4 substrate and ground plane is 10mm. The material between FR4 subsrate and graound plane is air. The size of ground plane is 15mm by 60 mm. The antenna is divided into four parts A, B, C, the D. Part A is composed of 7.5mm by 2mm rectangular shape and 3.5mm by 1mm rectangular shape. Part B is 1mm by 5mm rectangular shape. Part C is 11mm by 3mm. Part D is 1mm by 2mm. The short pin is at left side of part A. The feed point is at right side of part A. The distance between short pin and feed is 5mm. Part A is special for the resonance frequency at 5.25 GHz. And the parts B,C, and D is designed for frequency at 2.45 GHz.

We use HFSS and the IE3D software to analyze the structure of the antenna. By changing the length of the part A, the center frequency 5.25 GHz can be obtained. By changing the size of B, C, the D, the center frequency 2.45 GHz can be obtained. With special optimization, the return loss at 2.3GHz to 2.62Ghz and 5.05GHz to 5.4GHz can be obtained. And the antenna principal plane patterns are omni-directional.

Results of Measurement

The antenna pattern is measured by the spherical near field range at WCRC (wireless communication research center) of Da Yeh University. And the return loss is measured by the HP8720 vector network analyzer. The result of return loss is shown in Fig. 2. There are two impedance bandwidths. They are from 2.14GHz to 2.57GHz

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and from 5.01GHz to 5.49GHz. The antenna pattern for XZ-plane at 2.45GHz is shown Fig. 3. The red sold line is the E_θ pattern and the dot blue line is the E_φ pattern. The antenna pattern for YZ-plane at 2.45GHz is shown Fig. 4. The red sold line is the E_θ pattern and the dot blue line is the E_φ pattern. The antenna pattern for XZ-plane at 5.25GHz is shown Fig. 5. Patterns for both E_θ and E_φ are quite similar. The antenna pattern for YZ-plane at 5.25GHz is shown Fig. 6. Since there is a measured blockage near theta at 180 degrees for all Figs. 3~6, the average antenna gain is calculated without the blockage region. The calculated average gain is -0.3 dBi at 2.45 GHz, and -0.45 dBi at 5.25 GHz.

Conclusion

The size of PIFA antenna is with size 11mm by 9mm by 10mm designed for WLAN of IEEE802.11a,b,g. Four parts of the antenna are analyzed by the simulation tool to determine the desired frequency. The antenna implemented and measured. The antenna frequency bands are from 2.14GHz to 2.57GHz and from 5.01GHz to 5.49GHz. The E_θ and E_ϕ patterns at both XZ and YZ planes are measured at 2.45GHz and 5.25GHz respectively. The average gain is 0.3 dBi at 2.45 GHz and -0.45 dBi at 5.25 GHz.

References

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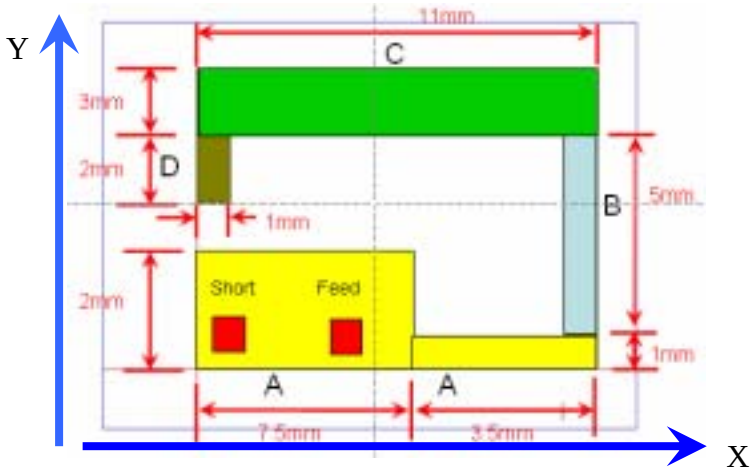

Fig. 1 Antenna geometry

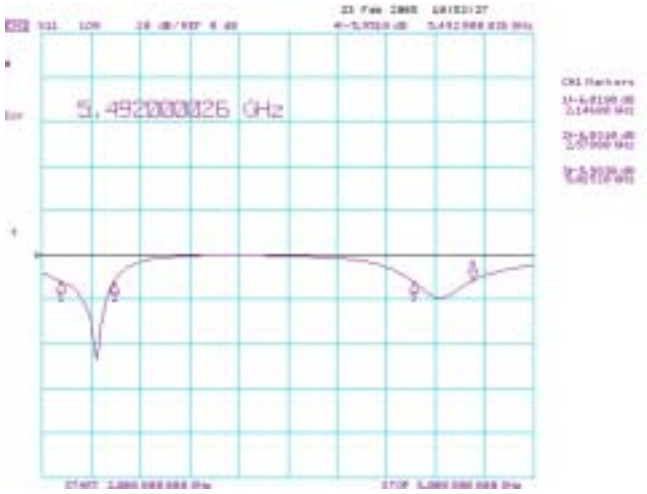

Fig. 2 Measured return loss

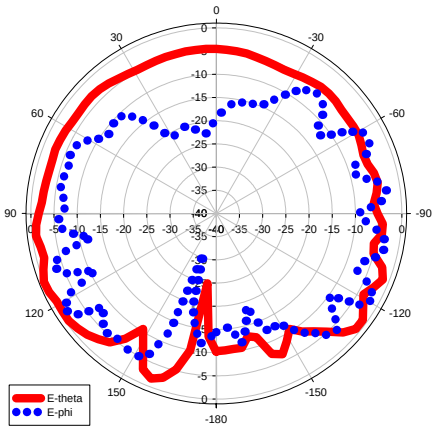

Fig. 3 XZ-plane patterns at 2.45GHz

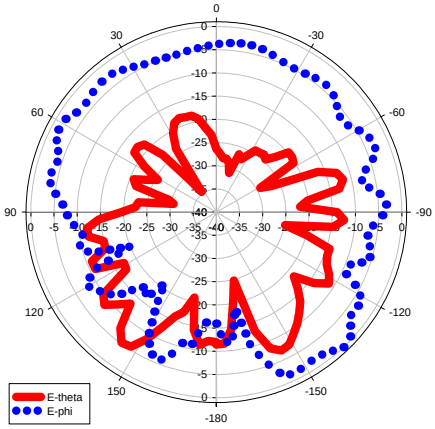

Fig. 4 YZ-plane patterns at 2.45GHz

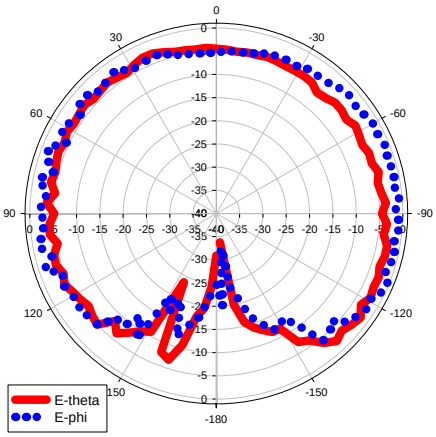

Fig. 5 XZ-plane patterns at 5.25GHz

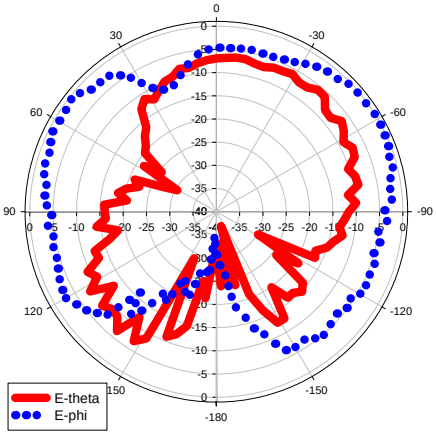

Fig. 6 YZ-plane patterns at 5.25GHz