Design of Dual Frequency Antenna Fed by Coplanar Waveguide

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***Abstract*—A dual frequency antenna fed by coplanar waveguide has been designed in this paper. The antenna consists of a mental ring radiator, and two grounding plane as a fed element located on both sides of the radiator. Using the high frequency simulating software, we found the reasonable size of the antenna operation frequency covered 2.1-2.6GHz and 5.15-8.3GHz. Measurement results show that the antenna with very good symmetrical radiation patterns, and with wonderful impedance bandwidth and radiation efficiency. The voltage standing wave ratio of the antenna is below 1.5 when S_{11} less than -10 dB in working frequency bands. It can be used in the wireless local area networks communication system**.

***Keywords*—dual frequency; antenna; coplanar waveguide**

I. Introduction

Recent years, with the rapid development of short distance wireless communication service, wireless local area network (WLAN) technology has made rapid progress [1]. It is widely used in portable communication equipment such as laptop and palm computer. WLAN antennas working as wireless transmission terminals at 802.llb/g (2.4-2.835 GHz) and IEEE 802.lla (5.15-5.35 GHz, 5.725-5.825 GHz) require low profile, light weight and full direction radiation[2][3]. Therefore, designing a compact WLAN dual frequency antenna is great practical significance. At the same time, the wireless communication system requires the equipment to send and receive data efficiently and reliably, and the antenna to work in Multiband. Therefore, a variety of small multi-frequency broadband antennas have been studied [4].

The problems of the antenna design include large size and probe feed, which are difficult to integrate with the system. As a planar transmission line structure, coplanar waveguide is easy to integrate with other microwave devices[5]. The design of antenna fed by coplanar waveguide mainly focuses on broad band and miniaturization. By adjusting the distance between the microstrip patch and the ground plane, a good impedance match can be obtained between the radiation patch and the feedline, thus realizing the wide impedance bandwidth [6][7]. A dual-frequency antenna fed by coplanar waveguide is designed in the passage. The antenna can operate in the bands 2.1-2.6 GHz and 5.15-8.3 GHz, and is simple and easy to make and easy to integrate[8][9].

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II. Antenna Design

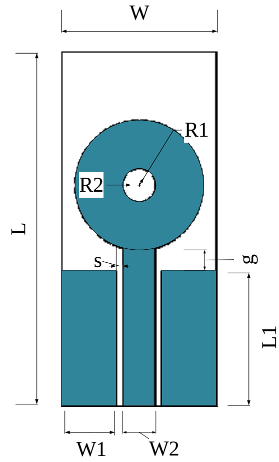


Fig. 1. Proposed antenna geometry.

The antenna is planar and divided into three parts, as shown in Fig. 1. The radiation patch is composed of a circular patch, a microstrip feeder under the ring and two grounding plane on both sides. The antenna is fed by coplanar waveguide, and the width of the feeder W2 and gap s are adjusted reasonably, which makes the antenna have better impedance matching in the range of 2.1-2.6 GHz and 5.15-8.3 GHz [10][11].

Coplanar waveguide is a typical microwave transmission structure. In this paper, FR4 (epoxy resin copperplate) is used as dielectric substrate, its relative dielectric constant is ε_r= 4.4, the thickness of dielectric substrate h = 1 .6 mm.

The antenna is a traditional circular microstrip antenna, whose main mode resonant frequency can be approximately expressed by the following formula.

$$f_c = \frac{1.841c}{2\pi r\sqrt{\varepsilon_r}} = \frac{0.293c}{r\sqrt{\varepsilon_r}}$$

Among them, C is the speed of light in free space; R is the radius of circular patch and ε_r is the effective dielectric constant.

The resonant frequency of the target antenna is 5.5 GHz. The approximate length of r is 7.6 mm, and the structure is optimized in the HFSS simulation software. The central frequency of the antenna is adjusted by changing the size of the circular patch. The width feeder w2 and gap s of coplanar waveguide feeders with characteristic impedance of 50 ohms were calculated by TX line. The circular gap in the center of the patch makes the antenna better in the corresponding frequency points to achieve impedance matching. The gap size is optimized by HFSS simulation. The optimized final parameters are shown in TABLE 1.

TABLE I. DIFFERENT DIMENSION PARAMETERS (UNIT:MM)

Parameter	W	L	W_1	L_1	W_2
Size	18.8	42.5	6.6	16.2	4
Parameter	S	g	h	R_1	R_2
Size	0.2	3	1.6	7.8	2

III. RESULTS AND DISCUSSIONS

The effects of various parameters on the antenna performance were analyzed by using HFSS simulation software. We can make the antenna to the desired frequency point and the antenna gain is highest. When the size of W changes and remaining other size unchanging, the S_{11} shown in Fig. 2.

As W increased, the low and high frequency points of the antenna shift to the right. We can adjust the parameters of the antenna to the desired frequency point. So we can make the high frequency point at 5.5GHz. When the parameter L changes and the remaining other size unchanging, the S_{11} is shown in Fig. 3.

Parameter L mainly regulates impedance matching at two frequencies. When L = 42.5 mm, impedance matching is best and antenna gain is highest. When the parameter R2 changes and the remaining other size unchanging, the S_{11} is shown in Fig. 4.

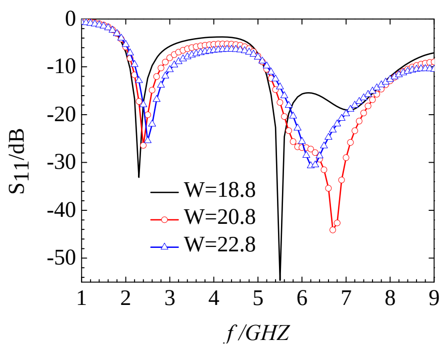


Fig. 2. Simulated return loss of the proposed antenna for various length of W.

Parameter R2 has no effect on bandwidth, mainly regulating impedance matching at the second frequency point, which is best when R2 = 2mm. The return loss of antenna and Voltage standing wave ratio of antenna is shown in Fig. 5 and Fig. 6. The far field radiation patterns at the two frequencies are shown in Fig. 7.

Finally, we found the reasonable sizes of designed antenna; and fabricated it with those sizes, photo is depicted in Fig.8. Using the vector network analyzer in our lab, experiment result is shown in Fig.9; the simulated result is also given in the same figure as comparison.

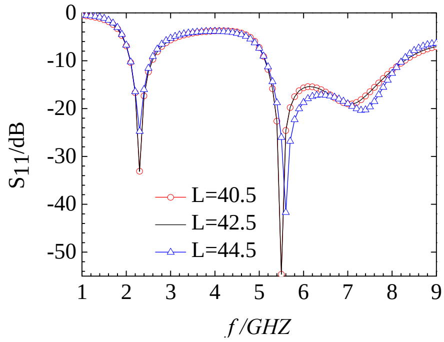


Fig. 3. Simulated return loss of the proposed antenna for various length of L.

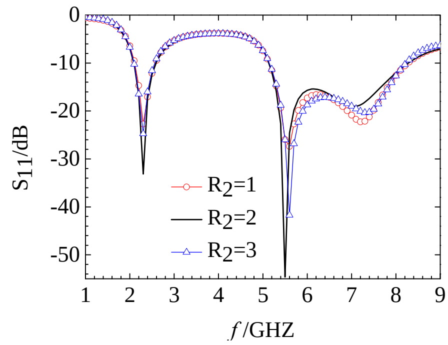


Fig. 4. Simulated return loss of the proposed antenna for various length of R_2.

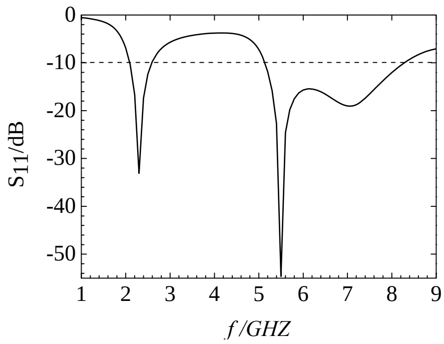


Fig. 5. Simulated return loss of antenna.

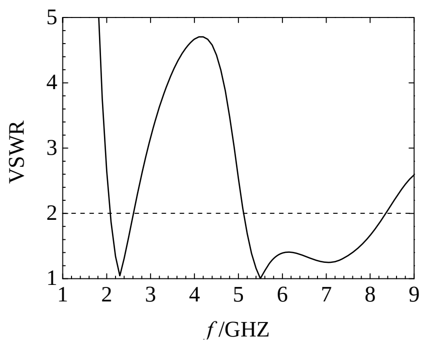
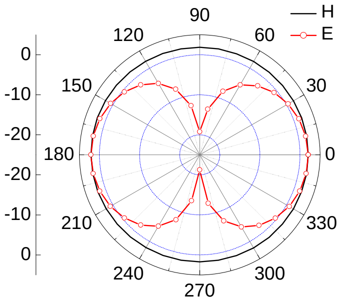
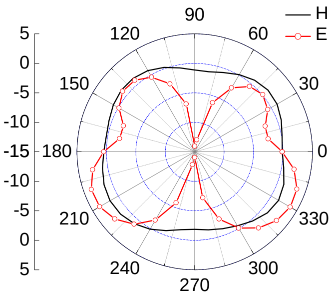


Fig. 6. Voltage standing wave ratio of antenna.



(a)



(b)

Fig. 7. Far field radiation patterns (a)2.4GHz, (b)5.5GHz.

Fig. 8. Photo of Antenna sample.

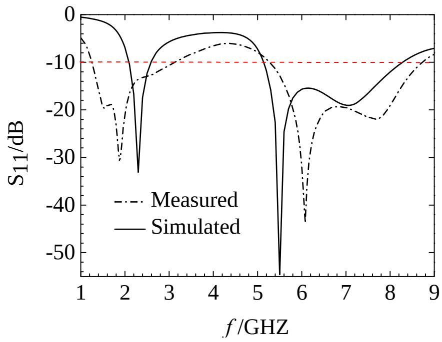


Fig. 9. Simulated and measured return loss of antenna.

IV. Conclusion

A dual frequency antenna with coplanar waveguide is designed, which can effectively miniaturize and facialization of the antenna and can work simultaneously in the frequency bands 2.1-2.6 GHz and 5.15-8.3 GHz, covering the WLAN working band. Antenna structure is simple, easy to make, structure parameters are easy to adjust, in wireless WLAN communication will have a better future. But the size of the antenna is a little big.The antenna doesn't cover the WIMAX band. We will continue work to make the antenna smaller and better.

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