Diversity Slot Antenna with a Back Ground for Dual-Band WLAN Operations

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1. Introduction

In recent years, there have been many printed dual-band antenna designs studied and developed in wireless communications for the IEEE 802.11 standards in the wireless local-area network (WLAN) band such as in [1-4]. In these designs, they provide a dual-band operation for the application to wireless communication systems. In order to solve the problem of multi-path fading in wireless communication systems, most WLAN systems need to consider the dual diversity in practical applications. Therefore, a dual-band antenna design with the special diversity used in wireless communication systems is necessary.

In this paper, the diversity dual-band antenna design for practical application for the 2.4-GHz and 5.8-GHz WLAN bands is proposed in Fig. 1. For this configuration of CPW-fed diversity slot antenna with a ground plane on the back, it is expected that the resonant frequencies associated with two resonant modes can be excited. One resonant mode, contributed from the printed slot fed by the widened T-shaped tuning stub is excited in lower operation frequency; and because this T-shaped tuning stub and the back ground plane, the other resonant mode can operate at higher operation frequency. Hence, the operating frequencies of two resonant modes are controlled by certain dimensions of two radiating elements, the printed slot and the T-shaped tuning stub, separately.

2. Antenna designs and experimental results

Figure 1 shows the geometry and dimensions of the diversity dual-band antenna printed on a 1.6-mm FR4 substrate. The diversity antenna consists of two symmetrical square-slot antenna elements, each of which is fed by a 50-Ω CPW feed line. In order to provide a good receive and transmit diversity performance, the proposed antenna design comprises two antenna elements sufficiently spaced apart to achieve spatial diversity. Each of the dual-band antenna elements has a square slot with dimensions of 30 × 30 mm^2 and a widened T-shaped tuning stub with dimensions of

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$20.2 \times 10.3\ mm^2$ having the height of 1.5 mm. For the WLAN operation in the 2.4-GHz band, the resonant frequency of the lower mode is determined from the dimensions of the printed square slot. A suitable height (8.9 mm) of the ground plane below the CPW feed line can determine the length of widened T-shaped tuning stub to serve as a radiating monopole for the operation of higher 5.8-GHz WLAN band. Moreover, between the two antenna elements, there is a T-shaped ground plane protruded from the main ground plane. From the experimental results, a good isolation that is smaller than –20 db can be obtained, if the T-shaped ground plane comprises a central vertical strip (length 10 mm, width 4 mm) and a horizontal strip with the dimensions of $61 \times 18\ mm^2$. Thus, by using the suitable size of the printed slot, the CPW feed line with a widened T-shaped tuning stub, and the proposed ground plane on the back of substrate, the proposed dual-band diversity antenna with good impedance matching and isolation can be obtained.

In Fig. 2, the measured and simulated reflection coefficient S_{11} and isolation S_{21} of the proposed diversity slot antenna are shown. It is clearly seen that, with a suitable ground plane, the diversity antenna for the WLAN operations can be obtained and successfully constructed. The measured impedance bandwidth of the lower mode, defined by –10 dB reflection coefficient, provides an operating bandwidth of 328 MHz (from 2288 to 2616 MHz); on the other band, the higher mode has a bandwidth of about 619 MHz (from 5456 to 6075 MHz). It is also seen that, from measured and simulated results, the isolation for operating frequencies across the both WLAN bands can be less than –20dB and, in general, the simulated results from the simulation software IE3D^{TM} agree with the measured data. Figures 3 shows measured and simulated radiation patterns of the proposed antenna at 2450 and 5800 MHz with port 1 and port 2 excitations for both E- and H-planes, respectively. Similar to the diversity antenna design studied in [5], the measured radiation patterns of port 1 and port 2 excitations can generally cover complementary space regions that provide spatial diversity. It is seen that the measured radiation patterns of the operating frequencies in WLAN bands show similar slot-like and monopole-like radiation patterns, respectively. Owing to the symmetric structures of two antenna elements of a diversity antenna, the measured antenna gain for both port 1 and port 2 excitations are about the same. The measured antenna gain levels are around 1.2 dBi in the 2.4-GHz WLAN band and around 3.5 dBi in the 5.8-GHz WLAN band. Also, it is found that the antenna gain variations within both operating bands are less than 2 dBi.

3. Conclusions

The diversity dual-band slot antenna with a T-shaped CPW feed line for the WLAN operations has been demonstrated. The constructed prototype has the suitable impedance bandwidth for both WLAN operations in the 2.4 and 5.2 GHz bands. It is seen that the proposed ground plane on the back of this diversity antenna design serves as a reflecting plate that provides good isolation for operating frequencies. In addition, this antenna design provides spatial diversity to overcome the multi-path interference in the signal strength and shows comparable E_θ and E_φ radiation fields in the radiation patterns, which is suitable for WLAN operations in wireless mobile communication devices.

4. References

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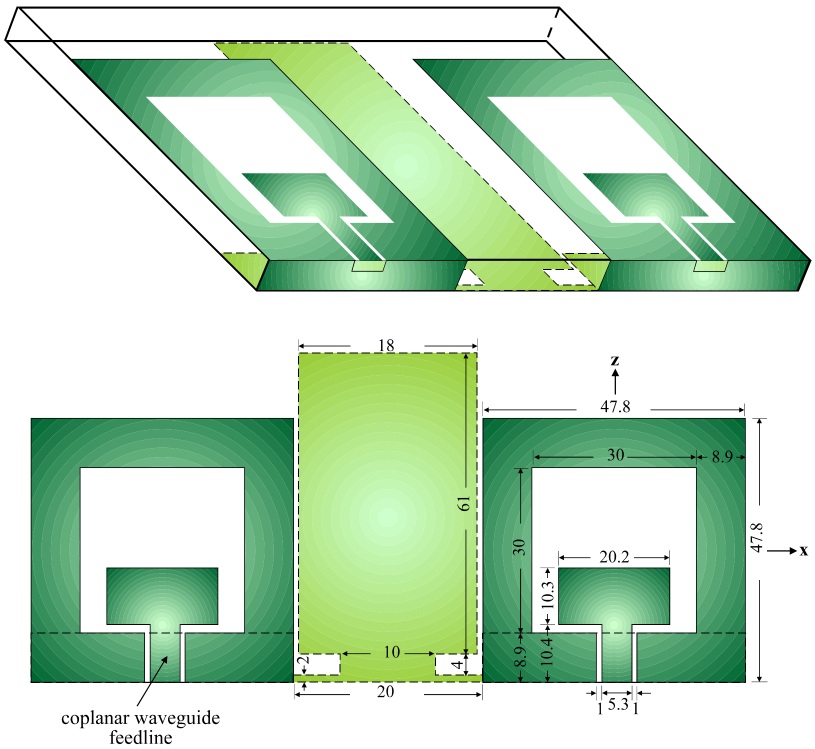

Fig. 1. Geometry and dimensions of the proposed diversity antenna design in 3-D and top views.

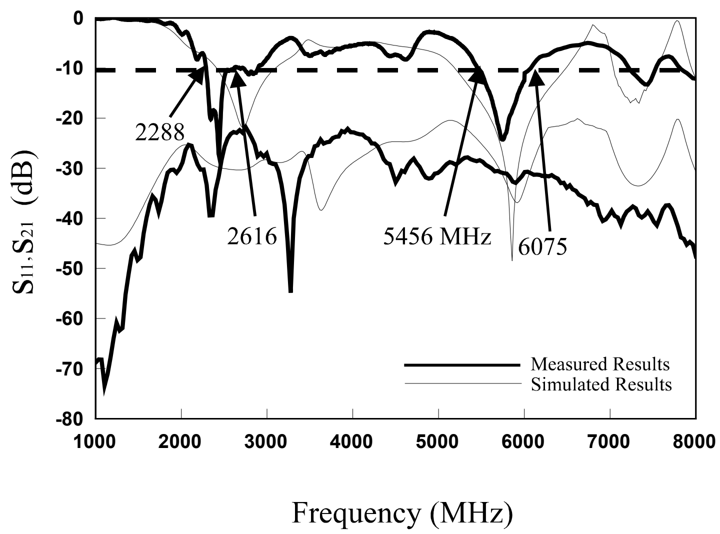

Fig. 2. Measured and simulated results of S_{11} and S_{21} against frequency of the proposed diversity antenna shown in Fig. 1.

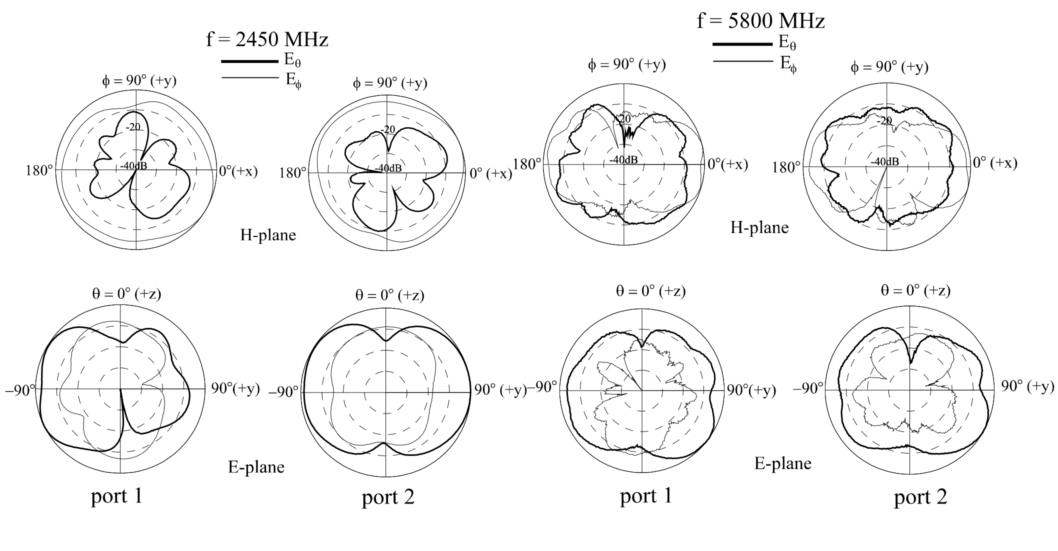

Fig. 3. Measured radiation patterns of port 1 and port 2 excitations of the proposed diversity antenna at the frequencies 2450 and 5800 MHz.