Printed Dual-Frequency Slot Antennas for WLAN operation

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1. Introduction

In recent years, there have been many dual-frequency printed slot antenna designs studied and developed [1-5]. They are attractive because their operating bands usually have wide impedance bandwidths and low surface current. However, there was very few slot antennas designed for dual-frequency operation in wireless local area network (WLAN) system.

In this paper, the dual-frequency slot antennas with different feed methods for practical application on WLAN are proposed and shown in Fig. 1(a) and (b). For antennas both with coplanar waveguide (CPW) feed in Fig. (a) and with microstrip line feed in Fig. (b), 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 feed line, is excited in lower operation frequency. The other resonant mode, contributed from the printed monopole that comprises this feed line and the ground plane, operates at higher operation frequency. Hence, the operating frequencies of two resonant modes can be controlled by certain dimensions of two radiating elements, the printed slot and the feed line, separately. Details of the antenna design and experimental results are presented and discussed.

2. Antenna designs and experimental results

Figure 1(a) and (b) show the geometry and dimensions of the dual-frequency slot antennas, antenna 1 and 2, respectively. A 50-Ω CPW feed line with the simple tuning stub in Fig. (a), having the length of 27.5 mm and the width of 5.8 mm, is used to feed antenna 1. And another 50-Ω microstrip feed line with the simple tuning stub in Fig. (b), having the length of 24 mm and the width of 3 mm, is used to feed antenna 2. Each square slot with the same side length of 25 mm in both Fig. 1(a) and (b) is printed on an inexpensive FR4 substrate of 3.2 mm in thickness and 4.4 in relative

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permittivity. For WLAN operation in the 2.4 GHz, the resonant frequency of the lower mode is determined from the dimensions of the printed square slot. Thus, a suitable height (9 mm) of the main ground plane below the microstrip feed line in Fig. (a) as well as another length (7 mm) in Fig. (b) can determine the length of the feed line to serve as a radiating monopole for the operation of higher WLAN band. Therefore, by using the suitable size of the printed slot, the feed line, and the proposed ground plane on the back of substrate, the proposed dual-frequency slot antennas having an impedance match with a return loss of better than 10 dB for WLAN can be obtained.

Figure 2 shows the measured return loss of the proposed antennas. It is seen that, for antenna 1, the lower mode has the impedance bandwidth, determined by 10 dB return loss, of about 595 MHz (2277-2872 MHz) to cover the 2.4-GHz WLAN band while the upper mode has the impedance bandwidth of about 570 MHz (5068-5638 MHz) to cover the 5.2-GHz WLAN band. For antenna 2, the lower mode has the impedance bandwidth, determined by 10 dB return loss, of about 209 MHz (2291-2500 MHz) to cover the 2.4-GHz WLAN band while the upper mode has the impedance bandwidth of about 563 MHz (5125-5688 MHz) to cover the 5.2-GHz WLAN band. The favorable impedance characteristic of CPW-fed slot antenna can be obtained in comparison to a microstrip-line-fed slot antenna. The measured radiation patterns of antenna 1 at 2.45 and 5.2 GHz for both E- and H-planes are plotted in Fig. 3. It is seen that the measured radiation patterns of the operating frequencies in WLAN bands show slot-like and monopole-like radiation patterns, respectively. Radiation patterns for antenna 2 were also measured, and the results showed similar patterns as plotted here. Also, the antenna gain of antenna 1 within the 2.4 and 5.2 GHz bands is measured. It is observed that the measured antenna peak gain levels are around 4 and 3.5 dBi for 2.45 and 5.2 GHz bands, respectively. The measured results indicate small antenna gain variation is observed.

3. Conclusions

The CPW-fed and microstrip-line-fed printed slot antennas for operating in the 2.4/5.2 GHz bands has been proposed and successfully implemented. In addition to its easy construction, each antenna prototype has the suitable impedance bandwidth for WLAN operation in the 2.4 and 5.2 GHz bands. For comparison, the slot antenna with a CPW feed has larger impedance bandwidth than that with a microstrip line feed. The radiation patterns have been measured and presented by E-plane and H-plane, and they show slot-like and monopole-like patterns. It is seen that small antenna gain variation is obtained within the operating bands.

4. References

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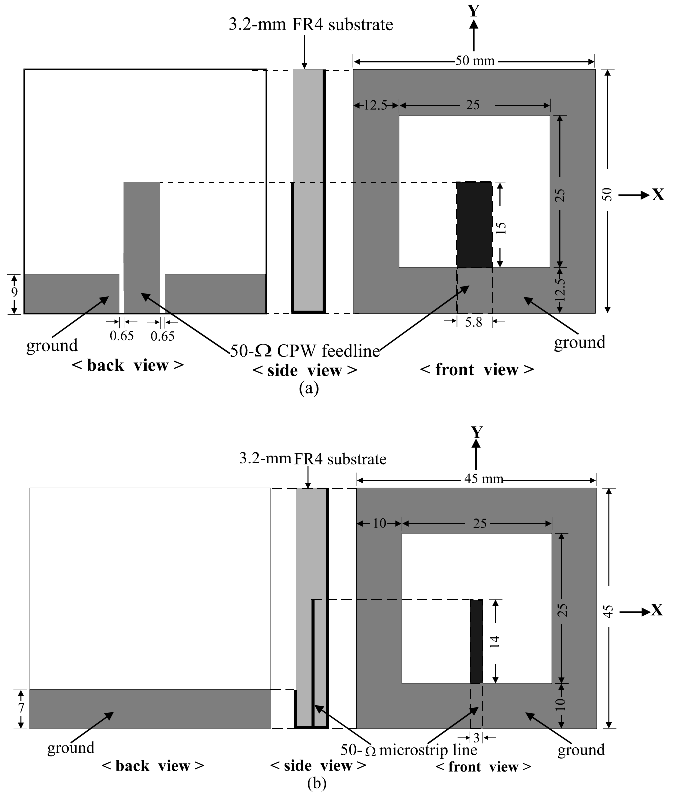

Fig. 1. Geometry and dimensions of slot antennas for WLAN operation; (a) Antenna 1: design with CPW feed. (b) Antenna 2: design with microstrip line feed.

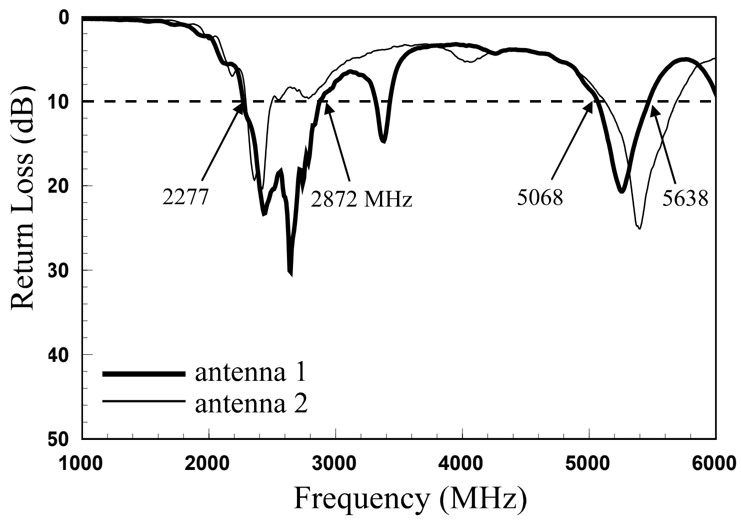

Fig. 2. Measured return loss against frequency for antennas 1 and 2 in Fig. 1.

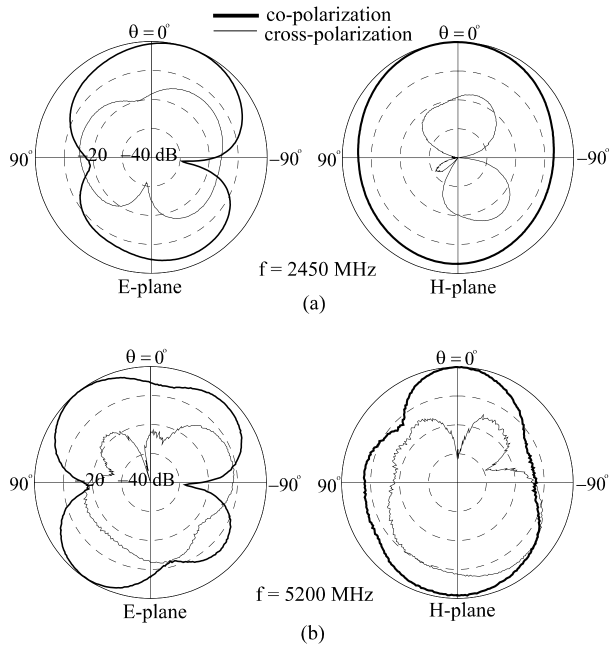

Fig. 3. Measured E-plane and H-plane radiation patterns of antenna 1: (a) for at 2450 MHz. (b) at 5200 NHz.

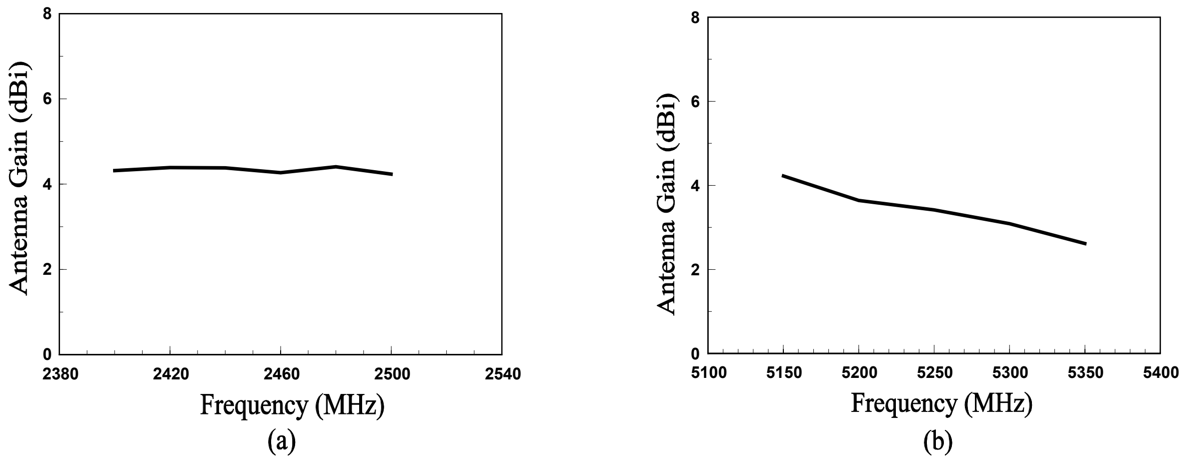

Fig. 4. Measured peak antenna gain of antenna 1 in broadside direction against frequency: (a) for 2.4-GHz band. (b) for 5.2-GHz band.