of the constructed prototype at 5800 MHz (center frequency of the 5.8-GHz band), and similar directional radiation patterns are also obtained. Figure 5 shows the measured peak antenna gain for operating frequencies across the 5.2- and 5.8-GHz bands. A stable antenna gain of about 5.5–6.0 dBi is obtained.

4. CONCLUSION

A planar folded-dipole antenna printed on a dielectric substrate and comprising two back-to-back folded dipoles for spatial-diversity operation in WLAN communications has been proposed. A prototype with a wide impedance bandwidth of about 1 GHz covering the 5.2- and 5.8-GHz bands for WLAN operation has been successfully implemented, and good directional radiation patterns covering two complementary half spaces have been obtained, which makes the antenna capable of performing spatial diversity to combat the multipath interference problem and enhance the system's performance.

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A STAIR-SHAPED SLOT ANTENNA FOR THE TRIPLE-BAND WLAN APPLICATIONS

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Received 16 May 2003

ABSTRACT: *In this paper, a novel triple-band microstrip-fed slot antenna for wireless communication systems operating at 2.4, 5.2, and 5.8 GHz is demonstrated. The slot antenna is originally designed to radiate at 2.4 GHz. By etching a stair-shaped slot on the ground plane and adding several stubs at the edge to excite the first higher-order mode, we can create another resonant band at 5 GHz. According to the results, the impedance bandwidths are 227 and 778 MHz at the 2.4- and 5-GHz bands, respectively. In addition, the dimension of the proposed slot antenna is smaller than that of the conventional rectangular-slot antenna.* © 2003 Wiley Periodicals, Inc. Microwave Opt Technol Lett 39: 370–372, 2003; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.11220

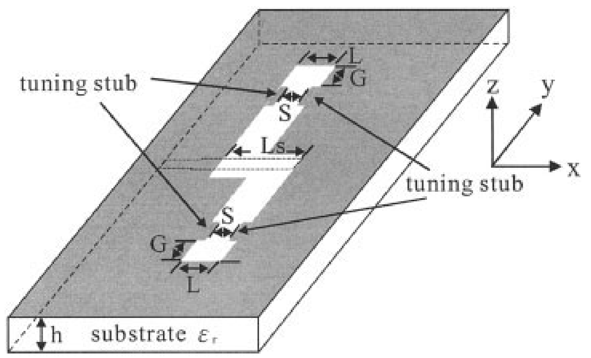


Figure 1 Schematic diagram of the stair-shaped slot antenna with four stubs at the slot edge

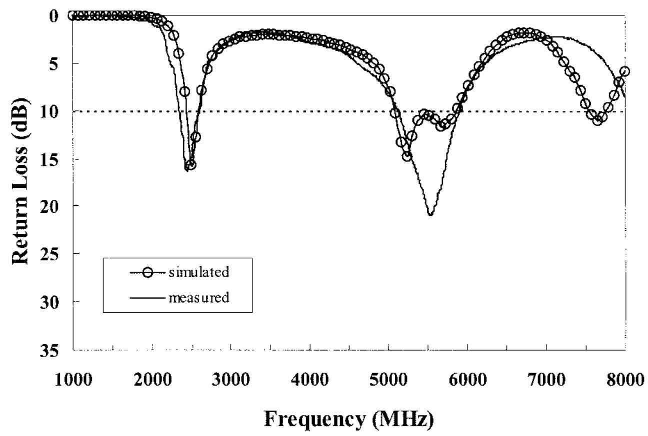


Figure 2 Comparison of the simulated and measured return loss of the stair-shaped slot antenna with four stubs at the slot edge

Key words: *slot antenna; WLAN; multiple-band antenna*

1. INTRODUCTION

The advantages of the microstrip-fed slot antenna over the patch antenna are wider bandwidth, less conductor loss, and better isolation between the radiating element and feeding network [1]. These advantages have prompted the extensive use of the slot antenna in radar and communications systems. The detailed char-

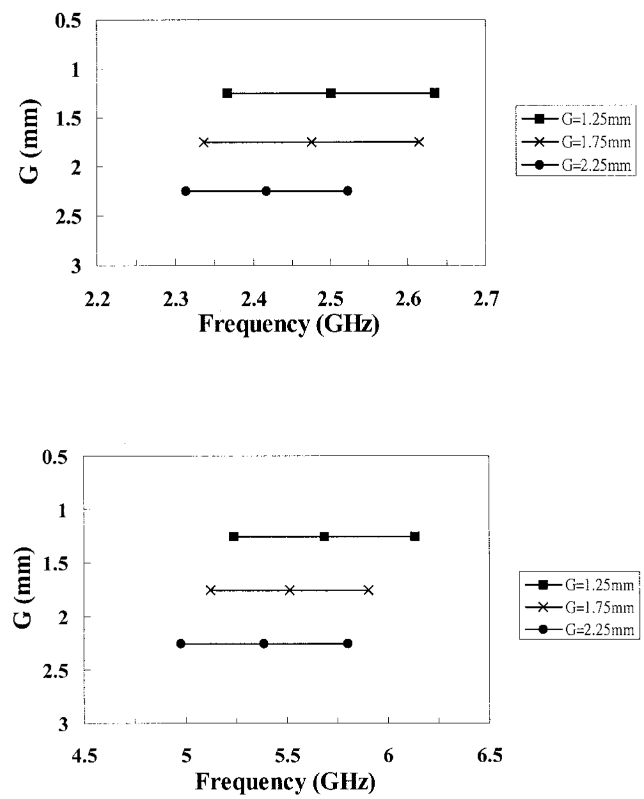


Figure 3 Comparison of *G* vs. the measured resonant frequencies of the modified stair-shaped slot antenna

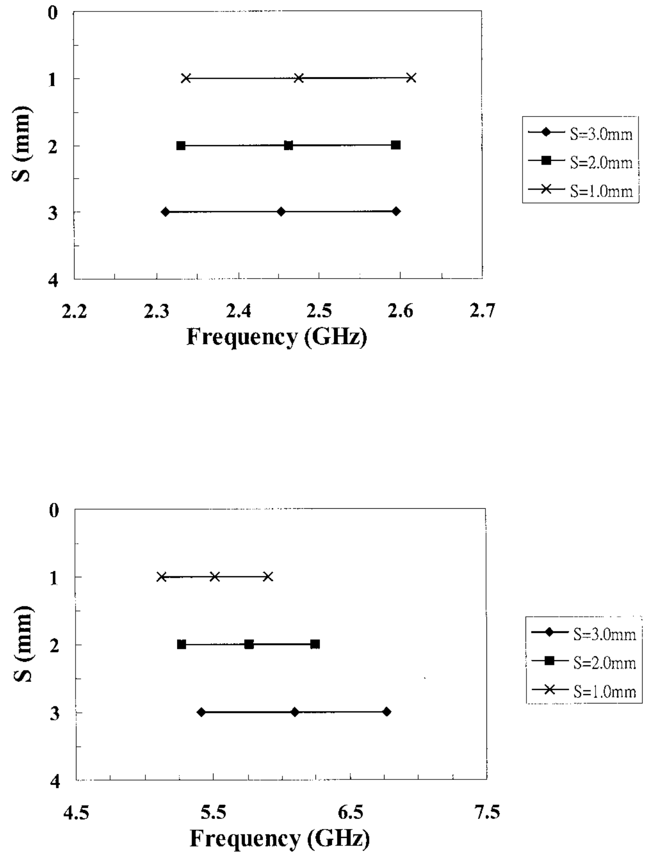


Figure 4 Comparison of S vs. the measured resonant frequencies of the modified stair-shaped slot antenna

acteristics of the fundamental mode and the first higher-order mode of the microstrip-fed slot antenna are presented by using the reciprocity theorem in a manner similar to the analysis of the waveguide [2, 3]. The slot length of the slot antenna is usually designed to be $\lambda_g/2$, where λ_g is the guided wavelength of the operating frequency. Here, we present a stair-shaped slot antenna with several matching stubs at the slot edge. The capactive coupling between the microstrip feedline and the slot edges can enhance the impedance bandwidth, and two neighboring stubs at the slot edge can lower the higher resonant band in order to meet the requirements of 5.2–5.8-GHz band wireless communication systems.

2. ANTENNA DESIGN

The schematic configuration of the stair-shaped slot antenna with four stubs is shown in Figure 1. FR-4 was used as a substrate with a dielectric constant of 4.4 and thickness of 0.8 mm. A stair-shaped slot was etched on the ground plane of the substrate as the radiating element. The width of the microstrip feed line on the bottom plane of the substrate, used for the probe excitation of the slot antenna, is 1.4 mm and the characteristic impedance is 52Ω at 2.4 GHz. The capacitive coupling between the microstrip feed line and the two slot edges leads to improved impedance characteristics. Four tuning stubs are symmetrically added at both edges of the stair-shaped slot to excite the first-order mode. The position G of the stub was located at an offset of 1.75 mm from the sidewall of the slot and the separation S of the stub was 1 mm. This separation between two neighboring stubs was tested to modify the impedance characteristics so that the initial frequency of the higher resonant band could be reduced.

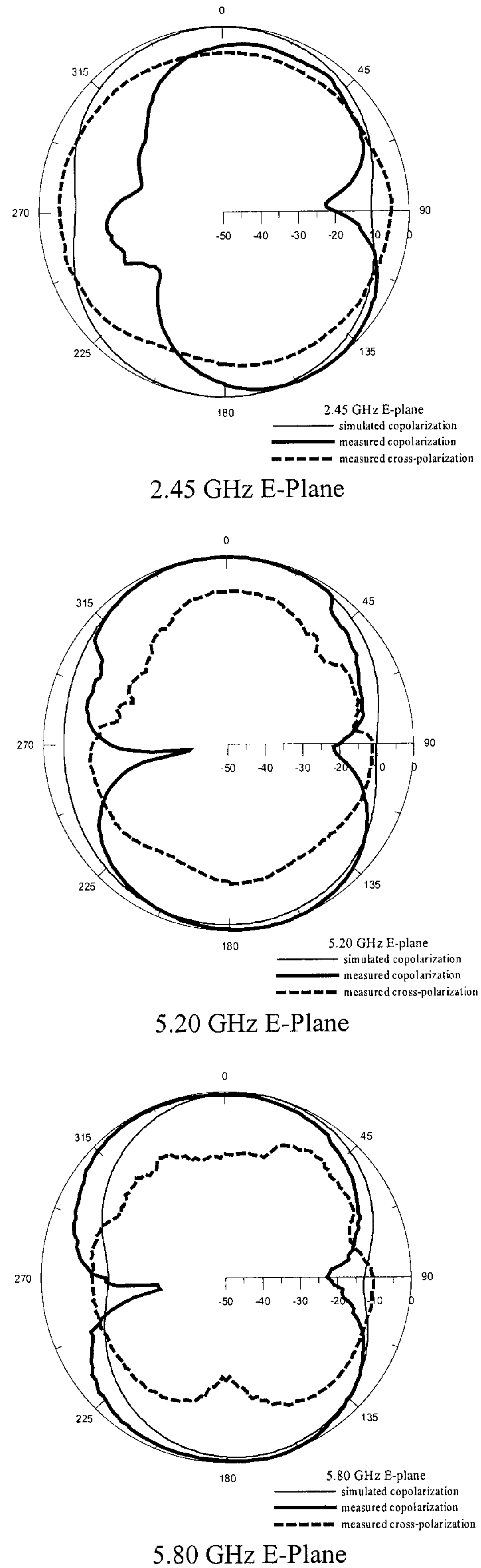
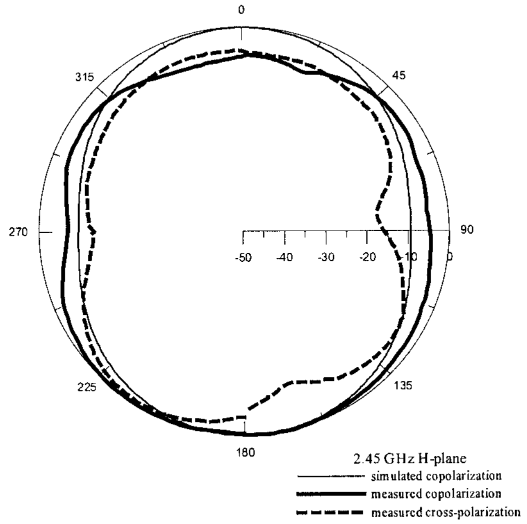
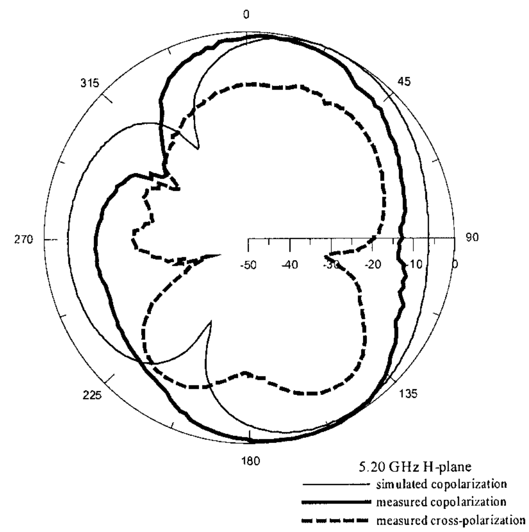


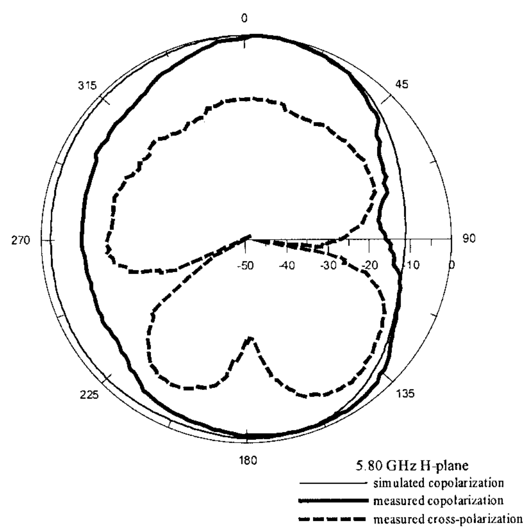
Figure 5 Simulated and measured radiation patterns of the E and H planes of the proposed slot antenna at 2.45, 5.20, and 5.80 GHz



2.45 GHz H-Plane



5.20 GHz H-Plane



5.80 GHz H-Plane

Figure 5 Continued

3. SIMULATED AND MEASURED RESULTS

Figure 2 shows the comparison of the simulated and measured return losses of the stair-shaped slot antenna with four stubs, made by utilizing the commercial simulation tool Ansoft HFSS V8.0 and an HP 8510C network analyzer. Figures 3 and 4 show the comparison of the stub location G or the stub separation S versus the measured resonant frequencies of the modified stair-shaped slot antenna. It is found that the operating frequencies of the lower and higher resonant bands are reduced when G increases and the higher resonant band of the slot antenna is lowered when S decreases. Two neighboring stubs can be treated as a capacitor and the loading effect due to the capacitive coupling enhances the matching condition. The measured results indicate that the lower resonant band of the proposed slot antenna ranges from 2.337 to 2.614 GHz and the higher resonant band achieves the bandwidth from 5.124 to 5.902 GHz. Figure 5 presents the simulated and measured radiation patterns of the E and H planes of the slot antenna at 2.45, 5.20, and 5.80 GHz. The beam positions of the maximum power of the slot antenna are not located in the broadside direction due to the nonrectangular slot. By applying the techniques described in this paper, the slot width is also reduced to be 32.75 mm less than 34.3 mm ($\lambda_g/2$) at 2.45 GHz. The size of the slot antenna is reduced by approximately 5%. The proposed slot antenna can be a candidate for the Tx/Rx antenna of portable devices, such as notebooks, tablet PCs, or PDAs.

ACKNOWLEDGMENTS

This work is currently supported by the National Science Council, Taiwan, under grants NSC 91-2213-E-035-037 and NSC 91-2218-E-035-006. The authors would like to thank Prof. Rey-Bin Huang, National Chi-Nan University, Nantou, for providing equipment for the measurements used in this paper. The authors would also like to thank the National Center for High Performance Computing, Hsinchu, Taiwan, for their contribution of the Ansoft HFSS V 8.0 simulation tool.

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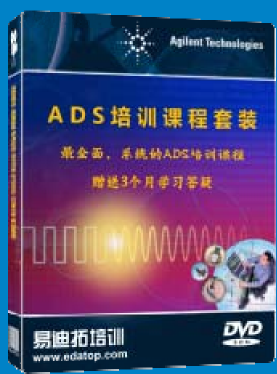

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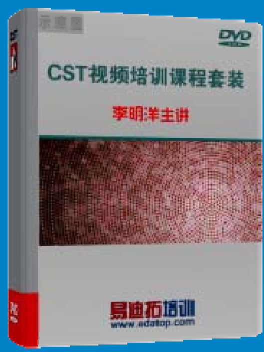

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