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BIDIRECTIONAL HIGH GAIN ANTENNA FOR WLAN APPLICATIONS

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Abstract—A bidirectional high gain four-element printed dipole array for WLAN (2.4/5.8 GHz) applications is analyzed and successfully implemented in this paper. Each element used is a double-side printed dipole fed with a balance twin-lead transmission line. A wide-band balun is implemented for the dipole array. Both simulated and measured data are pretty matched. According to the measured results, the bandwidth with return loss less than -10 dB is about 280 MHz (2250–2530 MHz) and 510 MHz (5470–5980 MHz) in the two operating bands, the measured gain for 2.4 GHz band is between 4.5 and 5.9 dB, and 6.1–8.9 dB for 5.8 GHz respectively. Good shaped patterns have also been attained by tuning parameters of the dipole array.

1. INTRODUCTION

Modern communication requires the antenna satisfy the technical request for high performance, being lightweight and low profiles as well as the need to meet the additional economic constraints of low cost, simplicity, and reliability. Printed microstrip architectures have been widely investigated [1, 2] and are attractive for their conformability, small size, and cost effectiveness. The rapid progress is personal communication technologies demands integration of more than one communication system into a single compact module. Recently, there are rapid developments in wireless communications, and in order to satisfy the WLAN standards in the 2.4 GHz (2400–2484 MHz) and 5.8 GHz (5725–5825 MHz) bands, dual-band operations of the printed antennas are required.

Many kinds of dual-band antenna for WLAN operations have been reported [3–12]. The printed monopole and printed dipoles are

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widely used to provide dual-band characteristics. However, the gains of these kinds of antennas are low. In this paper, a novel dual-band bidirectional high gain dipole array antenna for application in a wireless local-area network (WLAN) access point in 2.4 and 5.8 GHz bands has been presented. With proper dimensions chosen for dipole array, the gain of the antenna is 4.5–5.9 dB for 2.4 GHz band, and 6.1–8.9 dB for 5.8 GHz band, which is much better than [13, 14]. This enhanced-gain characteristic is very attractive for practical applications.

Details of the proposed antenna design are presented, and the experimental results of a constructed prototype suitable for 2.4 and 5.8 GHz WLAN operation are also discussed.

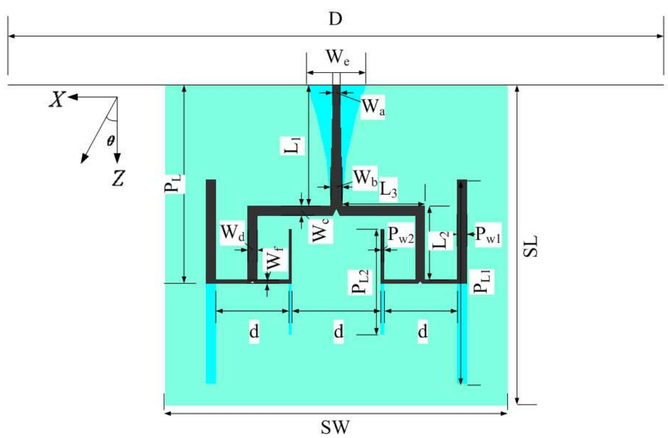


Figure 1. Geometry of the proposed antenna.

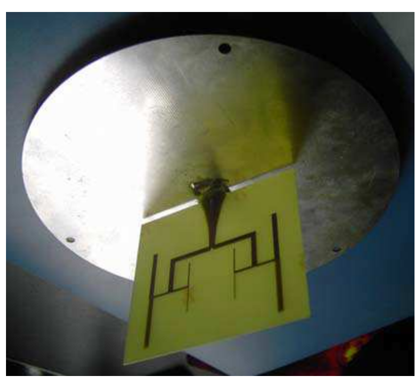


Figure 2. The photograph of the proposed antenna.

2. ANTENNA CONFIGURATION

Figure 1 shows the geometry of the proposed dual-band planar dipole array antenna for 2.4 and 5.8 GHz WLAN, and detailed parameters of the antenna are shown in Table 1. The proposed array antenna is printed on both sides of an FR4 substrate, with a thickness of $h = 0.8$ mm, a dielectric constant of $\varepsilon_r = 4.4$, and size $70 \times 65\,\text{mm}^2$. The proposed antenna is composed of two longer dipoles and two shorter ones. The longer dipoles control the excitation of the 2.4 GHz band and the shorter ones control the 5.8 GHz band. To provide a transition between the connector and the balanced transmission line, a wide-band balun [15] is used. By carefully tuning the element spacing (d) and the distance between the element and ground (P_L), desired shaped patterns can be obtained.

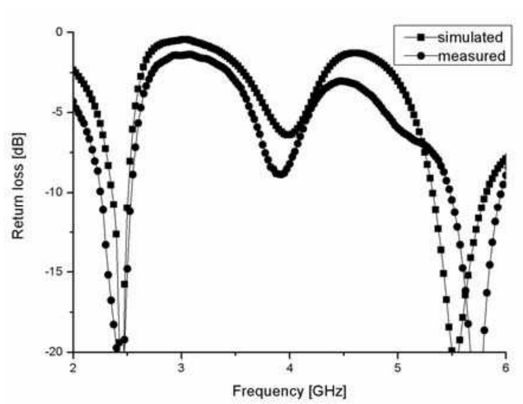
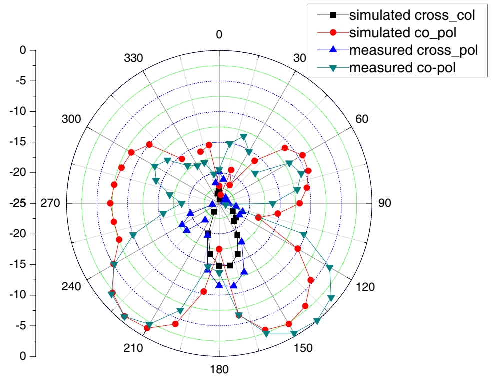


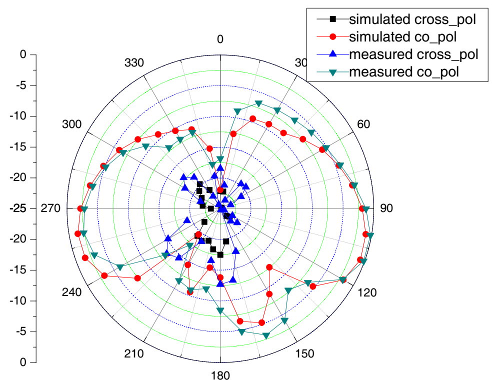
Figure 3. Simulated and measured return loss for the proposed antenna.

Table 1. Antenna parameters.

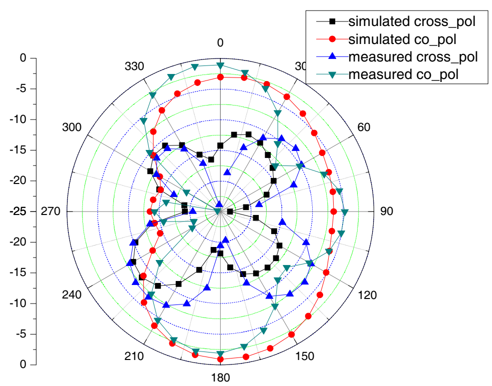
D	SW	SL	L_1	L_2	L_3
200 mm	70 mm	65 mm	26.5 mm	15 mm	15 mm
W_a	W_b	W_c	W_d	W_e	W_f
1.5 mm	2.4 mm	1.9 mm	1.9 mm	12 mm	0.7 mm
P_{w1}	P_{w2}	P_{L1}	P_{L2}	P_L	d
2 mm	0.5 mm	42 mm	22 mm	41.5 mm	15 mm



(a) *x*-*z* plane

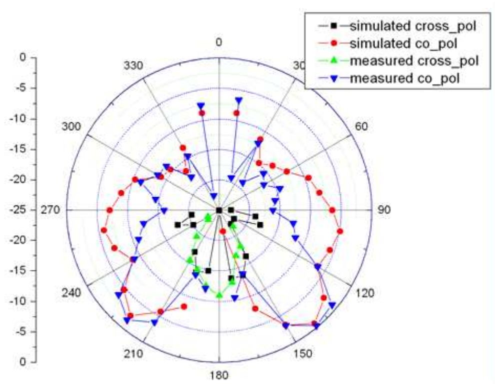


(b) *y*-*z* plane

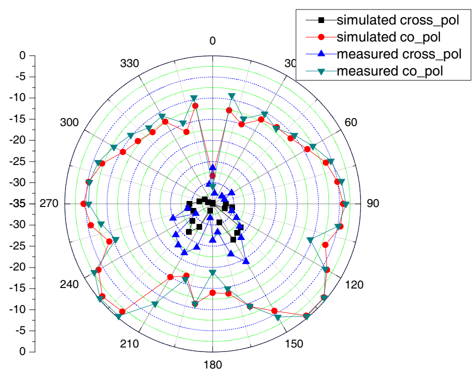


(c) θ=40^o plane

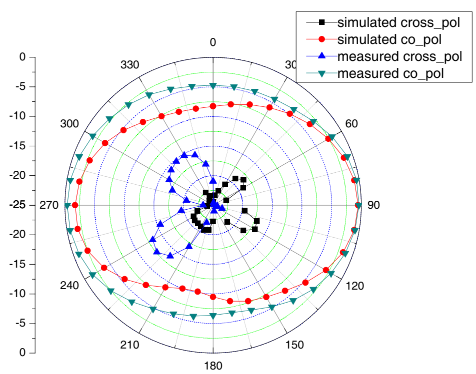
Figure 4. Measured radiation patterns at 2.4 GHz.



(a) *x-z* plane



(b) *y-z* plane



(c) θ=40° plane

Figure 5. Measured radiation patterns at 5.8 GHz.

3. EXPERIMENTAL RESULTS AND DISCUSSION

The reflection coefficients of the array antenna are simulated by HFSS software and the measured results are obtained by WILTRON37269A network analyzer. Figure 2 shows the photograph of the fabricated dipole array antenna on the top and back view. Figure 3 shows the measured return loss for the proposed antenna with a circular ground plane (shown in Figure 1), and the simulated and measured results agree very well. The measured bandwidth with return loss less than -10 dB is about 280 MHz (2250–2530 MHz) and 510 MHz (5470–5980 MHz) in the two operating bands.

Figure 4 and Figure 5 plot the radiation patterns at the centre frequencies of the 2.4 and 5.8 GHz bands. The measured results show that good bidirectional patterns can be obtained at each band and the direction of the patterns is $\theta = 40^\circ$ in the x-z and y-z plane.

Figure 6 shows the measured peak antenna gain. Across the 2.4 GHz band, the antenna gain is 4.5–5.9 dB, and 6.1–8.9 dB for 5.8 GHz respectively. The peak antenna gains are much higher than that proposed in [13, 14].

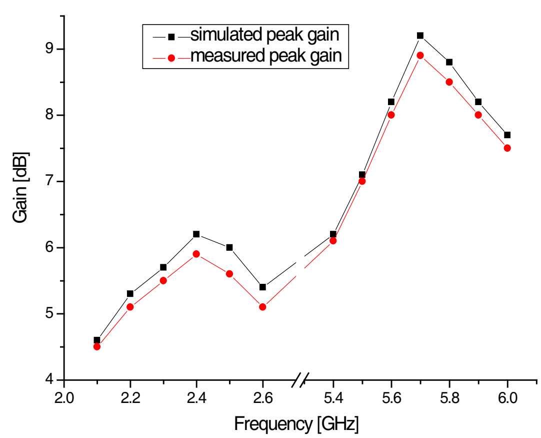


Figure 6. Measured peak gain for the proposed antenna.

4. CONCLUSIONS

A novel double-side printed dipole array antenna for WLAN operation has been successfully demonstrated in this paper. The proposed antenna shapes the coverage pattern of the wireless data transmission and shows dual-band impedance bandwidth covering 2.4 and 5.8 GHz bands. The gains of the antenna are excellent high in the two operating bands. This enhanced-gain characteristic is very attractive for practical applications. The antenna can be used as a hallway antenna or ceiling mount antenna for WLAN application.

REFERENCES

1. Tong, K. F., K. Li, T. Matsui, and M. Izutsu, "Wideband coplanar waveguide fed coplanar patch antenna," *IEEE Antennas and Propagation Society International Symposium*, 406–409, 2001.
2. Wilkinson, W., "A class of printed circuit antennas," *IEEE Antennas Propagat. Symp. Dig.*, 270–274, 1974.
3. Chen, H. M., J. M. Chen, P. S. Cheng, and Y. F. Lin, "Feed for dual-band printed dipole antenna," *Electron. Lett.*, Vol. 40, 1320–1322, 2004.
4. Suh, S. Y., A. E. Waltho, L. Krishnamurthy, D. Souza, S. Gupta, H. K. Pan, and V. K. Nair, "A miniaturized dual-band dipole antenna with a modified meander line for laptop computer application in 2.5 and 5.5 GHz WLAN band," *IEEE Antennas and Propagation Society International Symposium*, 2617–2620, 2006.
5. Zhang, Z., M. F. Iskander, J. C. Langer, and J. Mathews, "Dual-band WLAN dipole antenna using an internal matching circuit," *IEEE Trans. Antennas Propagat.*, Vol. 53, 1813–1818, 2005.
6. Su, S. W. and J. H. Chou, "Low cost flat metal-plate dipole antenna for 2.4/5-GHz WLAN operation," *Microw. Opt. Tech. Lett.*, Vol. 50, 1686–1687, 2008.
7. Liu, W. C., "Optimal design of dual band CPW-fed G-shaped monopole antenna for WLAN application," *Progress In Electromagnetics Research*, PIER 74, 21–38, 2007.
8. Wu, Y. J., B. H. Sun, J. F. Li, and Q. Z. Liu, "Triple-band omni-directional antenna for WLAN application," *Progress In Electromagnetics Research*, PIER 76, 477–484, 2007.
9. Wang, F. J. and J. S. Zhang, "Wide band cavity-baked patch antenna for PCS/IMI2000/2.4 GHz WLAN," *Progress In Electromagnetics Research*, PIER 74, 39–46, 2007.
10. Ren, W., "Compact dual-band slot antenna for 2.4/5 GHz WLAN applications," *Progress In Electrimagnetics Research B*, Vol. 8, 319–327, 2008.
11. Gao, J. P., X. X. Yang, J. S. Zhang, and J. X. Xiao, "A printed volcano smoke antenna for UWB and WLAN communications," *Progress In Electromagnetics Research Letters*, Vol. 4, 55–61, 2008.

12. Jolani, F., A. M. Dadgarpour, and H. R. Hassani, "Compact M-slot folded patch antenna for WLAN," *Progress In Electromagnetics Research Letters*, Vol. 3, 35–42, 2008.
13. Wu, T. Y., S. T. Fcing, and K. L. Wong, "Printed monopole array antenna for WLAN operation in the 2.4/5.2/5.8 GHz bands," *Microwave. Opt. Technol. Lett.*, Vol. 37, 370–373, 2003.
14. Lin, C. C., C. M. Su, F. R. Hsiao, and K. L. Wong, "Printed folded dipole array antenna with directional radiation for 2.4/5 GHz WLAN operation," *Electron. Lett.*, Vol. 39, No. 24, 2003.
15. Gans, M., D. Kajfez, and V. H. Rumsey, "Frequency independent baluns," *Proc. IEEE*, 647–648, 1965.