

DESIGN OF COMPACT PLANAR INVERTED-L DIVERSITY ANTENNA FOR HANDHELD TERMINALS

H. L. Xiao

School of Information and Communication
Guilin University of Electronic Technology
Guilin, Guangxi 541004, China

Z. P. Nie

School of Electronic Engineering
University of Electronic Science and Technology of China
Chengdou, Sichuan 610054, China

Abstract—Antenna diversity is a well-known technique to enhance the performance of wireless communication systems. In order to create an antenna diversity system on a wireless device, two or more antenna elements could be placed in positions. However, it is difficult to implement multiple antennas on handheld terminal. A compact planar inverted-L diversity antenna for handheld terminals is provided. Three diversity antennas operating at 2.15 GHz are designed. The isolation is found to be better than 13 dB and the usable bandwidth is about 13% in measurement. The measured radiation patterns are obtained that the proposed diversity antenna attains 2 dBi gain.

1. INTRODUCTION

In order to improve the quality of wireless downlink signal, more than one antenna can be used at terminal side. In these kinds of handheld terminals, two or more antenna elements are envisaged and thus the limited space available for antenna is an open issue. It is difficult to implement multiple antennas on handheld terminal as small as a handset. In [1], Yang Ding et al. introduced a novel dual-band printed diversity antenna operating at UMTS (1920–2170 MHz) and WLAN (2400–2484 MHz). The large substrate was used, $95 \times 60 \times 0.8 \text{ mm}^3$, which isn't able to be applied in a handheld terminal in practice. Dual-printed inverted-F antenna diversity systems for terminal devices

operating at 5.2 GHz with both switching and combing schemes were presented in [2]. However, the relatively large antenna volume and the strong coupling between its two elements restrict its application for handheld terminals. To date, there have been considerable researched compacted antennas for handheld terminals [3–5]. Many of these configurations are not suitable for handheld devices due to space limitation.

2. HANDHELD TERMINALS ANTENNA DESIGN

The configuration of one antenna element is illustrated in Fig. 1. The diversity antenna consists of three ports fed by co-axial cables. The antenna is mounted on the grounded FR4 substrate with dimension $42 \times 42 \times 1 \text{ mm}^3$ and relative permittivity $\epsilon_r = 4.26$. Each antenna volume is only $0.14 \times 0.1 \times 0.06 \lambda_0$ (where λ_0 is vacuum wavelength). The proposed diversity antenna consists of three antenna elements: antenna 1, 2 and 3. These antennas are orthogonal polarization magnetic dipoles.

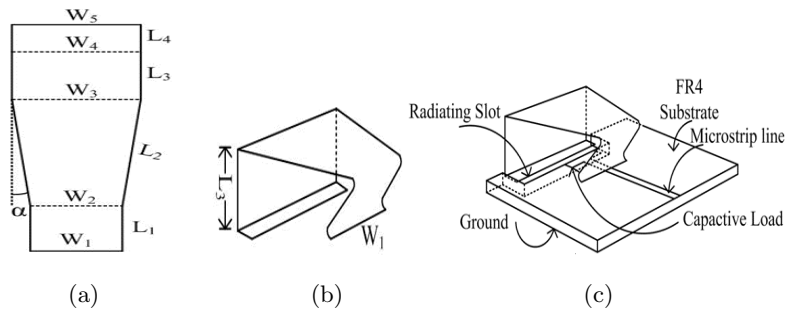


Figure 1. Construction of the diversity antenna elements: (a) plan view, (b) folding view, (c) installation view.

In order to enhance the isolation between antenna 1 and 3, two slots are designed in both sides of the FR4 substrate and copper sheets are placed in the slots. Capacitive load is adopted to modulate antenna patch in open circuit end of microstrip line as Fig. 1(c).

Figure 4 illustrates the measured S -parameters. It shows that the usable bandwidth is about 13%, and the isolation is below -13 dB at the resonance frequency.

From Fig. 5, the measured radiation patterns are obtained that the proposed diversity antenna attains 2 dBi gain. The measured results also show that such antenna design is suitable for handheld terminals.

where $h = 1$ mm, $L_2 = 20$ mm (for antenna 1 and 3) and $L_2 = 21$ mm (for antenna 2) are given.

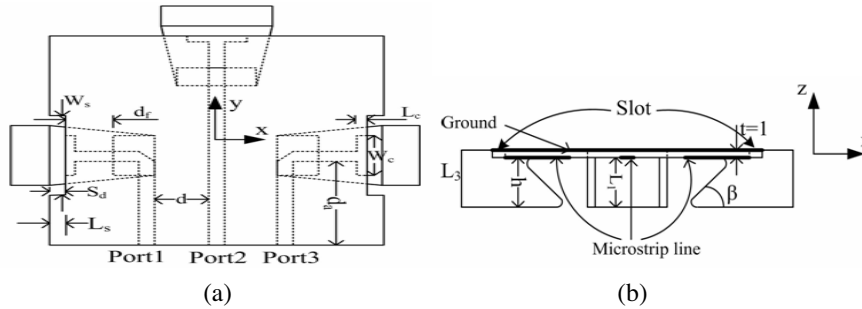


Figure 2. Configuration of the proposed diversity antenna (a) top view (b) side view.

Unit: mm

W_c	L_c	d_a	d_f	d	L_s	W_s	L_1
6.5	1.5	17	5	6	2.5	16	8
L_3	L_4	f_d	W_1	W_2	W_3	W_4	W_5
9	5.5	8	10	10	14	14	14



Figure 3. Photograph of the planar inverted-L diversity antenna.

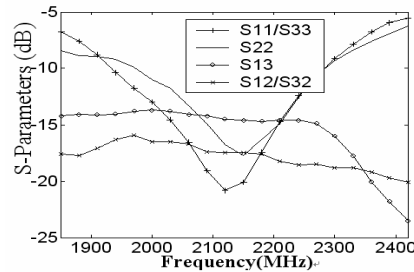


Figure 4. Measured S parameters of the diversity antenna.

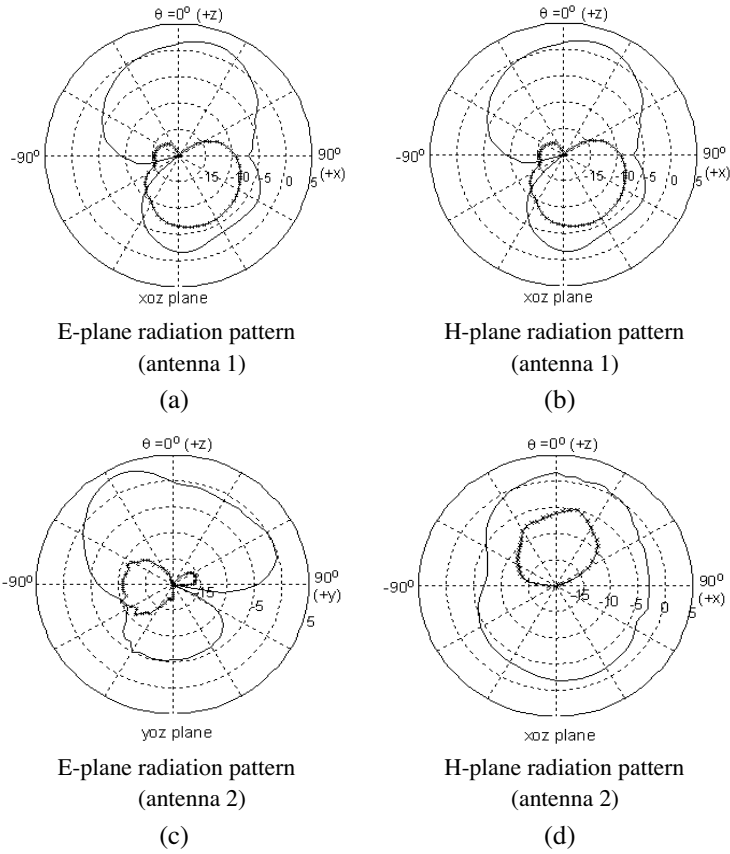


Figure 5. Measured radiation patterns of the planar inverted-L antenna at 2.15 GHz, (solid line) co-polarization and (dotted line) cross polarization.

3. CONCLUSION

A compact planar inverted-L diversity antenna for handheld terminals is provided. Three diversity antennas operating at 2.15 GHz are designed. The isolation is found to be better than 13 dB and the usable bandwidth is about 13% in measurement. The measured radiation patterns are obtained that the proposed diversity antenna attains 2 dBi gain. The measured results also show that such antenna design is suitable for handheld terminals.

ACKNOWLEDGMENT

We acknowledge financial supported in part by the National High-Tech Research and Development Program under Grant 2002AA123032, and in part by the Doctor Foundation of GUET, China.

REFERENCES

1. Ding, Y., Z. Du, K. Gong, and Z. Feng, "A novel dual-band printed diversity antenna for mobile terminals," *IEEE Transactions on Antennas and Propagation*, Vol. 55, No. 7, 2088–2096, 2007.
2. Karaboikis, M., C. Soras, G. Tsachtsiris, and V. Makios, "Compact dual-printed inverted-F antenna diversity systems for portable wireless devices," *IEEE Antennas and Wireless Propagation Letters*, Vol. 3, No. 1, 9–14, 2004.
3. Yeap, S. B., X. Chen, J. A. Dupuy, C. C. Chiau, and C. G. Parini, "Low profile diversity antenna for MIMO applications," *Electronics Letters*, Vol. 42, No. 2, 69–71, 2006.
4. Douglas, M. G., M. Okoniewski, and M. A. Stuchly, "A planar diversity antenna for handheld PCS devices," *IEEE Transactions on Vehicular Technology*, Vol. 47, Issue 3, 747–754, 1998.
5. Nielsen, J. O. and G. F. Pedersen, "Mobile handset performance evaluation using radiation pattern measurements," *IEEE Transactions on Antennas and Propagation*, Vol. 54, Issue 7, 2154–2165, 2006.