A Monopole Antenna with Circular Polarization

Meng-Hong Shih, Kai-Lung Hsiao, and Chien-Jen Wang

Department of Electrical Engineering, National University of Tainan, Tainan Taiwan
e-mail: cjwang@mail.nutn.edu.tw

***Abstract* - A monopole antenna with coplanar-waveguide (CPW) feeding structure is developed for multiple wireless communication system integration. By tuning one of the CPW ground-plane widths can increase the impedance bandwidth. The circular polarization at 1.57 GHz is excited without adding extra design circuits. A parasitic inverted-L radiating strip is shorted to the ground plane in order to cover the required bandwidth of the wireless local area network (WLAN) system. The measured impedance bandwidth of a S_{11}<-10 dB ranges from 1.37 to 2.82 GHz, and the 3-dB axial-ratio bandwidth is about 3.8 % with respect to 1.56 GHz.**

***Index Terms* —Coplanar waveguide, ground plane, impedance bandwidth.**

I. INTRODUCTION

Owing to their planar geometry, relative wide impedance bandwidth, easy impedance matching, small size, light weight, and good radiation efficiency, microstrip monopole antennas have attracted interest [1-3]. It is known that conventional monopole antenna is linearly polarized due to the standing-wave current distribution along the longitudinal antenna trace. Therefore, exciting circular polarization (CP) is an important research topic for the microstrip monopole antenna. Various design methods for CP excitation for microstrip monopole antennas have been proposed [4-6]. The desired frequency and CP performance of the antenna are obtained using a complicated trial-and-error tuning process.

A CP monopole antenna with CPW feeding structure that comprises an asymmetrical ground plane and a shorted inverted-L strip is proposed in this paper. By properly cutting one of the CPW ground-plane widths, wideband operation and good CP performance can be achieved. Moreover, a protruding inverted-L strip is shorted to one of the ground planes to act as a 2.5-GHz radiator.

II. ANTENNA DESIGN

The schematic configuration of the proposed CPW-fed monopole antenna is shown in Fig. 1. One side of an FR4 dielectric substrate (relative permittivity: 4.4) is etched, while the other side lacks metallization. In general, the length of a monopole antenna is usually about a quarter-wavelength. Note that, very different from a conventional structure, the CPW structure of the proposed antenna has two asymmetrical finite ground planes. In addition, an inverted-L parasitic strip, acting as a radiator, is connected to the right ground plane. The resonant length ($L_{t1} + L_{t2}$) of the parasitic path is designed to yield the 2.5-GHz band. It is noted that adding the shorted parasitic element has a slight effect on the impedance matching at 1.57 GHz. The geometric parameters of the antenna are listed in Table I.

III. RESULTS

A. Measured Frequency Characteristics

A sample of the proposed monopole antenna was fabricated and measured. A comparison of the simulated and measured reflection coefficient of the proposed antenna is shown in Fig. 2. As depicted in the figure, the measured reflection coefficients are smaller than -10 dB within the operation band. The comparison between the measured and simulated S_{11} in Fig. 2 shows some discrepancies. The discrepancies between the simulated and measured results might be due to factors such as fabrication tolerances and material parameter uncertainty. The measured impedance bandwidth of the proposed antenna for a 10-dB reflection coefficient is from 1.37 to 2.82 GHz, a 1.45-GHz impedance bandwidth (69.3%), whereas that of the conventional antenna

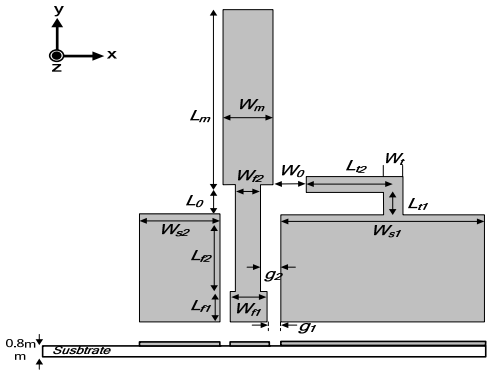

Fig. 1 Schematic configuration of proposed monopole antenna.

TABLE I
Geometrical parameters of proposed monopole antenna

Parameter	W_{f1}	W_m	L_{t2}	L_m
Unit:mm	3	7	23	34.5
Parameter	W_{f2}	W_0	L_{t1}	g_1
Unit:mm	2.6	1	3	0.25
Parameter	W_{S1}	W_t	L_{t2}	g_2
Unit:mm	38	3	16	0.45
Parameter	W_{S2}	L_{f1}	L_0	h
Unit:mm	12	5	1	0.8

is from 1.57 to 2.04 GHz, a 0.47-GHz bandwidth (26.1 %). According to the results of the measured reflection coefficient, the proposed antenna has a wide bandwidth, which is due to the three resonant modes that are excited by the asymmetrical ground planes and the shorted inverted-L strip. The simulated and measured AR results of the CP band at the broadside direction are plotted in Fig. 3. The measured 3-dB AR bandwidth is 60 MHz, from 1.53 to 1.59 GHz, with respect at the center frequency of 1.56 GHz.

B. Radiation Pattern

Figure 4 shows the normalized CP radiation patterns at 1.57 GHz for the operation frequency of GPS. The polarization of the proposed monopole antenna is right-hand circular polarization (RHCP). The power differences between the RHCP and LHCP patterns in the *xz* and *yz* planes are 16.36 and 22.43 dB. Fig. 5 shows the average efficiencies in the measurement and simulation for the operation band are higher than 75 %. The measured gains are 1.5-3.4 dBi from 1.5 GHz to 2.6 GHz.

IV. Conclusion

In this paper, we present the design of a CPW-fed monopole antenna with circular polarization. With an asymmetrical feeding structure and shorted inverted-L strip, the proposed antenna provides a larger impedance bandwidth than that of a conventional monopole antenna. Moreover, the proposed antenna is very simple, thus making it a candidate radiating element for multi-functional devices with wireless communication systems, such as GPS, DCS, PCS, IMT-2000, WLAN, and LTE.

References

[1] W. C Liu, M. Ghavami, W. C. Chung, "Triple-frequency meandered monopole antenna with shorted parasitic strips for wireless application," *IET Microw. Antennas Propag.*, vol. 3, no. 7, pp. 1110-1117, 2009.

[2] M. Koohestani1 M.N. Moghadasi1 B.S. Virdee, "Miniature microstrip-fed ultra-wideband printed monopole antenna with a partial ground plane structure", *IET Microw. Antennas Propag.*, vol. 5, no. 14, pp. 1683-1689, 2011.

[3] W. C Liu, M. Ghavami, W. C. Chung, "Triple-frequency meandered monopole antenna with shorted parasitic strips for wireless application," *IET Microw. Antennas Propag.*, vol. 3, no. 7, pp. 1110-1117, 2009.

[4] C. J. Wang and Y. C. Lin, "New CPW-fed monopole antennas with both linear and circular polarisations", *IET Microw. Antennas Propag.*, vol. 2, no. 5, pp. 466-472, Aug. 2008.

[5] C. F. Jou, J. W. Wu and C. J. Wang, "Novel broadband monopole antennas with dual-band circular polarization", *IEEE Trans. Antennas and Propag.*, vol. 57, no. 4, pp. 2176-2183, Apr. 2009.

[6] J. W. Wu, J. Y. Ke, C. F. Jou, and C. J. Wang, "A microstrip-fed broadband circularly polarized monopole antenna", *IET Microw. Antennas Propag.*, vol. 4, no. 4, pp. 518-525, 2010.

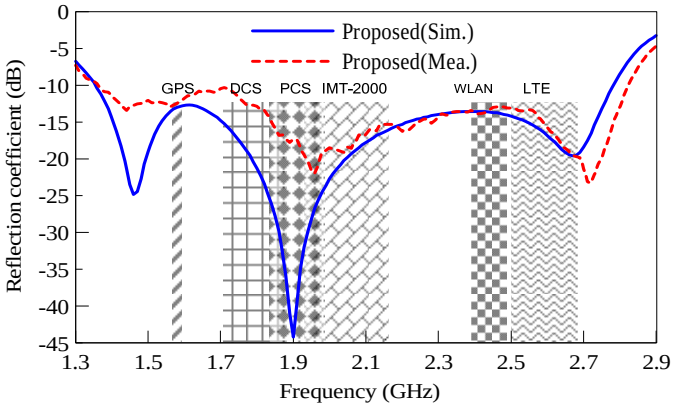

Fig. 2. Comparison of simulated and measured reflection coefficients.

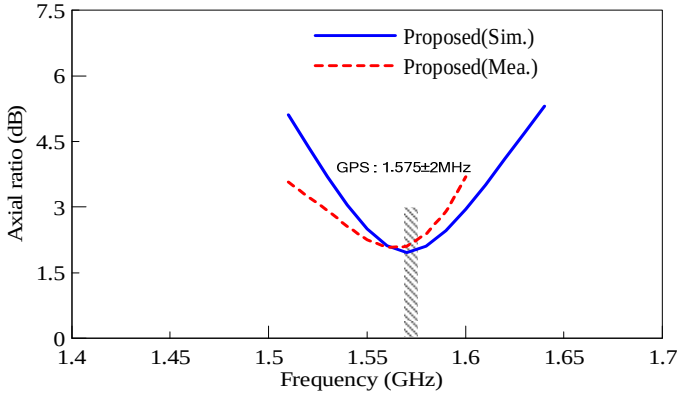

Fig. 3. Simulated and measured AR results of the proposed antenna.

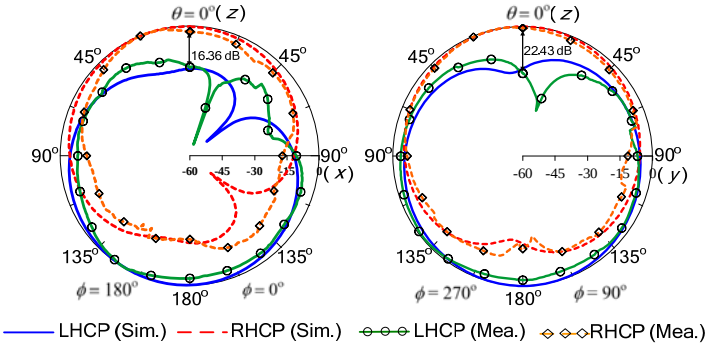

Fig. 4. Normalized RHCP and LHCP radiation patterns at 1.57 GHz.

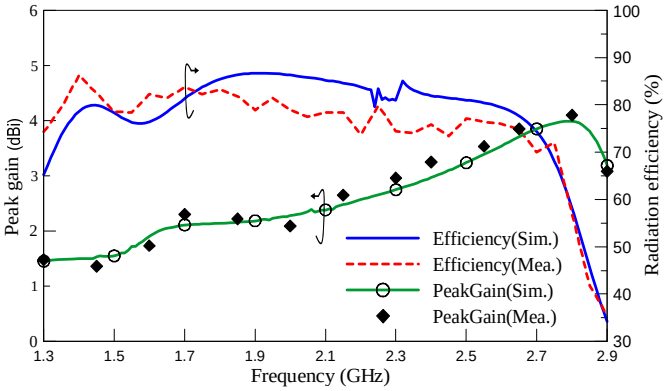

Fig.5. Gain and efficiency of the proposed monopole antenna.