A Low-Profile Folded Planar Monopole Antenna

SHUN-YUN LIN
Department of Electrical Engineering
Cheng Shiu Institute of Technology
Kaohsiung, Taiwan
Email: linsy@ema.ee.nsysu.edu.tw

1. Introduction

According to the published articles [1-4], the planar monopoles can be formed with different shapes, such as circlar, square, trapezoidal and pentagonal. Tuning techniques such as adding a shorting pin in edge and beveling the lower edge have been used to enhance the impedance bandwidth. However, the height of all these studied antennas are greater than $0.16\lambda_0$ (the free space wavelength of the lowest operating frequency of the antenna).

In this paper, we present a low-profile planar monopole antenna. The proposed antenna is a rectangular planar monopole with a folded end. Its total height is of about $0.12\lambda_0$, which is lower than the former designs. In the design, a shorting plate is adding at the edge of the rectangular plane to decrease the lower frequency for impedance matching. Furthermore, the offset center feeding is used to increase the upper frequency. From the experimental results, the impedance bandwidth covers DCS (1720 – 1880 MHz), PCS (1850 - 1990 MHz), UMTS (1920 - 2170 MHz), and ISM bands (2400 - 2484 MHz, 5725 – 5852 MHz). Also, the measured radiation patterns show that the proposed antenna is omnidirectional. All these performances suggest that the proposed antenna is suitable for application in wireless communication system.

2. Antenna Design

The structure of the proposed low-profile planar monopole is shown in Fig. 1. In this design, a folded plate with folding dimensions of d and h_2 is connected to the top of a rectangular plate whose height and width are h_1 and w, respectively. The combined length of h_1, h_2, and d is a constant of 40 mm. In addition, a shorting plate of width 1.5 mm is added to the edge of the rectangular plate, and a SMA connector is located away from the center of the y-axis to feed the proposed antenna. The added shorting plate and the offset center feed are used to decrease the lower frequency and increase the upper frequency of the impedance bandwidth, respectively. The low-profile planar monopole is mounted above the square ground plane of length of 100 mm. All patches used in this structure are made of copper of thickness 0.15 mm.

3. Experimental Results

Several prototypes of the proposed antenna have been successfully constructed (antennas A - D). The parameters of these proposed antennas are listed in Table I, where the height h is selected to obtain the optimum impedance bandwidth. Fig. 2 shows the measured and simulated return-loss for the antenna B. The simulated result is obtained using the commercially available software Ansoft HFSS, which uses the finite element method to analyze microwave problem. The measured return loss of the reference antenna, which is without a folded end, is also presented in Fig. 2 for comparison. It is seen that the return loss for the range of frequency behind the first resonant mode is swept, and the impedance bandwidth for 2.5: 1 VSWR is from 1.7 GHz to higher than 6 GHz. This performance almost corresponds to all present wireless communication system. Fig. 3 shows the measured return loss for the proposed prototypes, which are designed with various folding dimensions of *d*. From the measured results, we can observe that the lower frequency of impedance bandwidth is increased slightly and impedance matching becomes better as the folding dimension decreased.

Fig. 4 plots the measured radiation patterns for antenna B at the center frequency of the cellular communication systems: DCS, PCS, and UMTS. Moreover, the measured radiation patterns at 2450 HMz and 5800 HMz of the center frequency of ISM bands are also presented in Fig. 5. The monopole-like patterns are observed for all measured frequencies. This characteristic suggests that the azimuthally radiation pattern for proposed antenna is omnidirectional. Probably owing to the asymmetric configuration, the higher cross- polarization and asymmetry of radiation pattern at 5800 MHz are seen. The measured antenna gains for 1800, 1920, 2050, 2450, 5800 MHz are 4.9, 5.4, 4.9, 5.4, 6.4 dBi, respectively.

Table I. Parameters and Performance for the proposed low-profile folded planar monopole antenna with various folding dimensions; w = 30 mm, S = 3 mm, and G = 100 mm. The impedance bandwidth (BW) is determined by 2.5:1 VSWR.

	h mm	h_1 mm	h_2 mm	d mm	Total height mm	BW MHz
Reference	2.5	40	0	0	42.5	1245-1515; 2750-4730
Antenna A	0.8	22	12	6	22.8	1627-6000
Antenna B	0.8	22	14	4	22.8	1700-6000
Antenna C	0.8	22	15	3	22.8	1730-6000
Antenna D	0.8	22	16	2	22.8	1755-6000

4. Conclusions

A novel design of a low-profile planar monopole antenna for multi-band operations has been proposed and experimentally studied. The designed antenna is mainly a folded rectangular monopole with an offset center feeding and a shorting plate at the corner of the planar monopole. The obtained results show that the lowering in the antenna's height and very wide impedance bandwidth are achieved. Moreover, omnidirectional radiation and an average gain of 5.4 dBi over the all wireless communication bands are also obtained. All these performances indicate that the proposed antenna is suitable for application in wireless communication systems.

References

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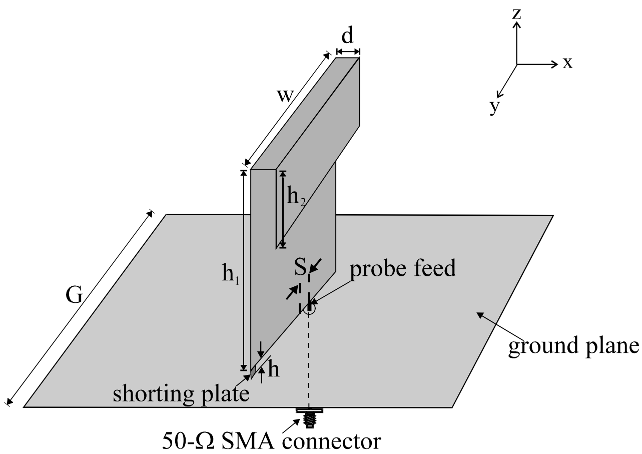

Fig. 1 Geometry of the proposed low-profile folded planar monopole antenna for wireless communication

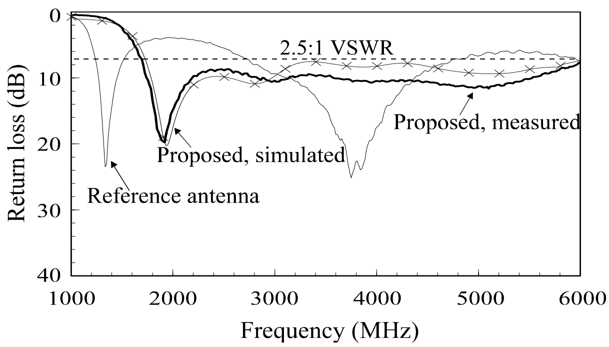

Fig. 2 Measured and simulated return loss for the proposed low-profile planar monopole antenna B. The reference antenna is the case without a folded end.

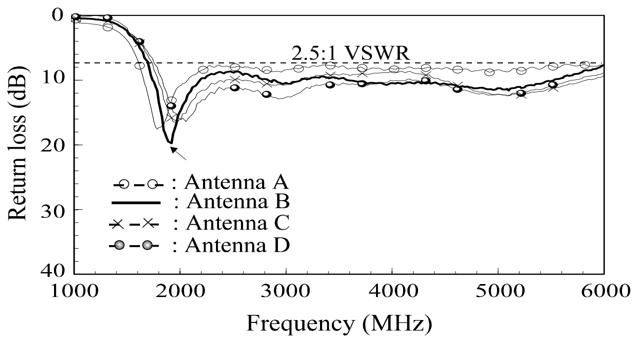

Fig. 3 Measured return loss for various folding dimensions of the proposed antenna. Parameters of antennas A, B, C and D are described in Table I.

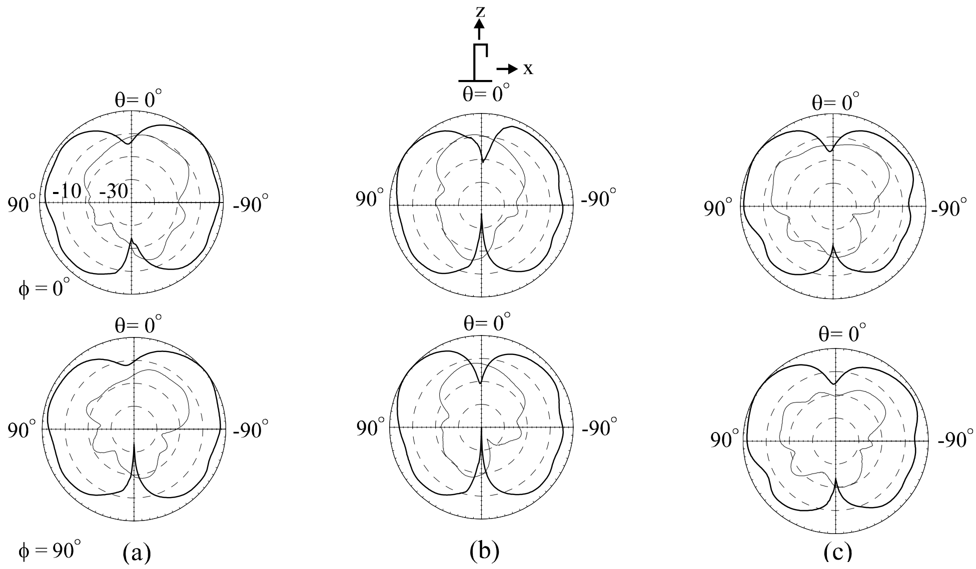

Fig. 4 Measured radiation patterns for antenna B at the center frequencies of the cellular communication systems. (a) 1800 MHz for DCS. (b) 1920 MHz for PCS. (c) 2050 MHz for UMTS systems.

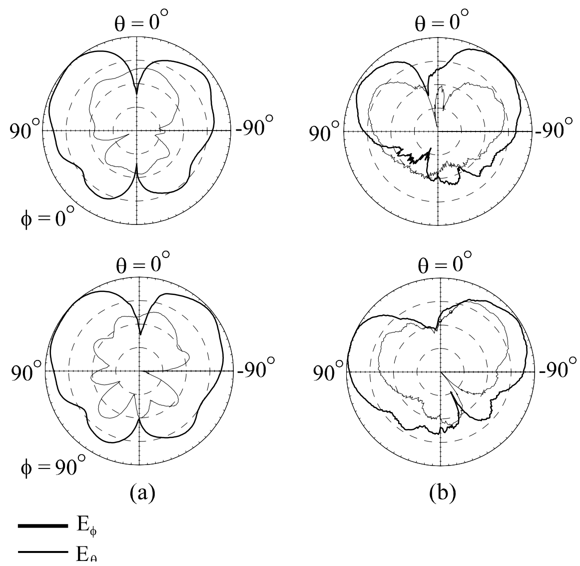

Fig. 5 Measured radiation patterns for antenna B at the center frequencies of the ISM bands. (a) 2450 MHz. (b) 5800 MHz.