COMPACT MODIFIED L-SHAPED MONOPOLE ANTENNA FOR 2.4/5.2/5.8 BAND OPERATION

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1. Introduction

Wireless local-area network (WLAN) communication has experienced tremendous growth in recent years. The WLAN system facilitates wireless connection between PCs, laptops, and other equipments within a local area. Currently, the 2.4 GHz (2400-2484 MHz) band has been widely used for WLAN application. However, the market shows a strong shift from 2.4 GHz band to 5 GHz (5150-5350/5725-5825 MHz) band. As a result, to integrate different applications in one piece of electronic equipment, it is desirable for an antenna to be able to cover both 2.4 GHz and 5 GHz bands. Many related dual-band designs have been reported in the literature, including that a dipole antenna [1] and an F-shaped monopole antenna [2] were proposed for performing the 2.4 GHz and 5.2 GHz (5150-5350 MHz) dual-band operation, and an inverted-F antenna [3] for 2.4 GHz and 5.8 GHz (5725-5825 MHz) dual-band operation. As for achieving the 2.4/5.2/5.8 GHz band operation, some methods, including the uses of a sleeve dipole antenna [4] and a surface-mount monopole antenna [5] have also been obtained.

In this paper, we present a novel design by using a modified L-shaped monopole antenna with a meandered line and a conducting triangular section. The proposed antenna is compact in size, and can provide enough bandwidths for applications in 2.4/5.2/5.8 GHz bands. Details of the antenna design are described, and experimental results of a constructed prototype are presented and discussed.

2. Antenna design

Fig. 1 shows the geometry and dimensions of the proposed modified L-shaped monopole antenna for 2.4/5.2/5.8 GHz band operations. The proposed antenna is excited using a 50-Ω microstrip line. The radiating element has compact dimensions of 7×18 mm^2 and is printed on the front of an FR4 substrate (thickness 0.8 mm and relative permittivity 4.4). The ground plane is selected to be 40×45 mm^2 in the experiment and printed on the back of the substrate.

The original antenna geometry is a simple L-shaped monopole. It is clear that a simple L-shaped monopole is a simple structure to achieve a lower antenna height. But the resultant antenna was only suitable for single-band operation. For achieving the 2.4/5.2/5.8 GHz band operation studied here, a meandered line with a line width of 0.2 mm and a spacing of 0.4 mm between two adjacent vertical lines is first inserted in the horizontal section of the simple L-shaped monopole (see Fig. 1). The meandered line increases the current path of the antenna's first (or lower) resonant mode, which reduces the required antenna size for a fixed operating frequency. Moreover, it is found that, due to the added meandered line, an additional resonant mode is generated in the vicinity of the antenna's second (or upper) mode and results in a dual-resonance response in the upper band. This behavior is helpful in widening the impedance bandwidth of the upper band. Noted that, although the excitation of the antenna's resonant modes in the lower and upper bands can be obtained, good impedance matching for both of the bands is still not easy to be achieved. Furthermore, by placing a conducting triangular section on the vertical section of the modified L-shaped monopole, good impedance matching for the two bands can thus be achieved. Using the method mentioned above and the design dimensions given in Fig. 1, a prototype was constructed and studied. Results are shown in the following.

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3. Experimental results

Fig. 2 shows the measured return loss for the proposed modified L-shaped monopole antenna and the simple L-shaped monopole antenna (denoted as reference antenna). In this study, the reference antenna has the same dimensions (7×18 mm^2) as those of the proposed antenna. It is first seen that, for the reference antenna, the lower resonant mode is excited at 2822 MHz with good impedance matching, but the upper resonant mode is excited at 5416 MHz with poor impedance matching. However, for the proposed antenna, the lower resonance at 2430 MHz in the lower band and the first two resonances at 5117 and 5710 MHz in the upper band all are excited with good impedance matching. In the case, the lower band has an impedance bandwidth (10-dB return loss) of 206 MHz (2342-2548 MHz), or about 8.4% with respect to 2430 MHz; the upper band has a much wider impedance bandwidth of 1110 MHz (4877-5987 MHz), or about 20.4% with respect to center frequency at 5432 MHz. The obtained impedance bandwidths cover the 2.4 GHz band (2400-2484 MHz), the 5.2 GHz band (5150-5350 MHz), and the 5.8 GHz band (5725-5825 MHz).

Fig. 3 (a) and (b) show the measured radiation patterns at 2430 and 5432 MHz, respectively. Measurements at other operating frequencies have similar radiation patterns as shown in Fig. 3 (a) and (b), respectively. It is seen that the radiation patterns in the azimuthal plane (x-y plane) are close to omnidirectional, especially for the lower operating frequency at 2430 MHz. The antenna gains for operating frequencies in the lower and upper bands are also measured. For the lower band, the antenna gain is about 1.8-2.5 dBi. As for the upper band, the antenna gain reaches about 4.2-5.0 dBi. The obtained results indicate that the antenna gains for both of the bands have small variation.

4. Conclusions

A novel modified L-shaped monopole antenna has been proposed and implemented. The proposed antenna occupies a small size of 7×18 mm^2, and has two wide impedance bandwidths covering the 2.4 GHz (2400-2484 MHz), the 5.2 GHz band (5150-5350 MHz), and the 5.8 GHz band (5725-5825 MHz). Good radiation characteristics for the proposed antenna have also been observed.

References

[1] Y.H. Suh, and K. Chang, "Low cost microstrip-fed dual frequency printed dipole antenna for wireless communications," *Electron. Lett*., 2002, **36**, (14), pp. 1177-1179.

[2] S.H. Yeh, and K.L. Wong, "Integrated F-shaped monopole antenna for 2.4/5.2 GHz dual-band operation," *Microw. Opt. Technol. Lett.*, 2002, **34**, (1), pp. 24-26.

[3] S.K. Kim, J.K. Park, S.H. Choi, and J.Y. Park, "A new dual-band planar inverted-F antenna for ISM-band applications," *Microw. Opt. Technol. Lett.*, 2003, **39**, (3), pp. 211-214.

[4] T.L. Chen, "Multi-band printed sleeve dipole antenna," *Electron. Lett*., 2003, **39**, (1), pp. 14-15.

[5] S.W. Su, S.T. Fang, and K.L. Wong, "A low-cost surface-mount monopole antenna for 2.4/5.2 /5.8 GHz band operation," *Microw. Opt. Technol. Lett.*, 2003, **36**, (6), pp. 487-489.

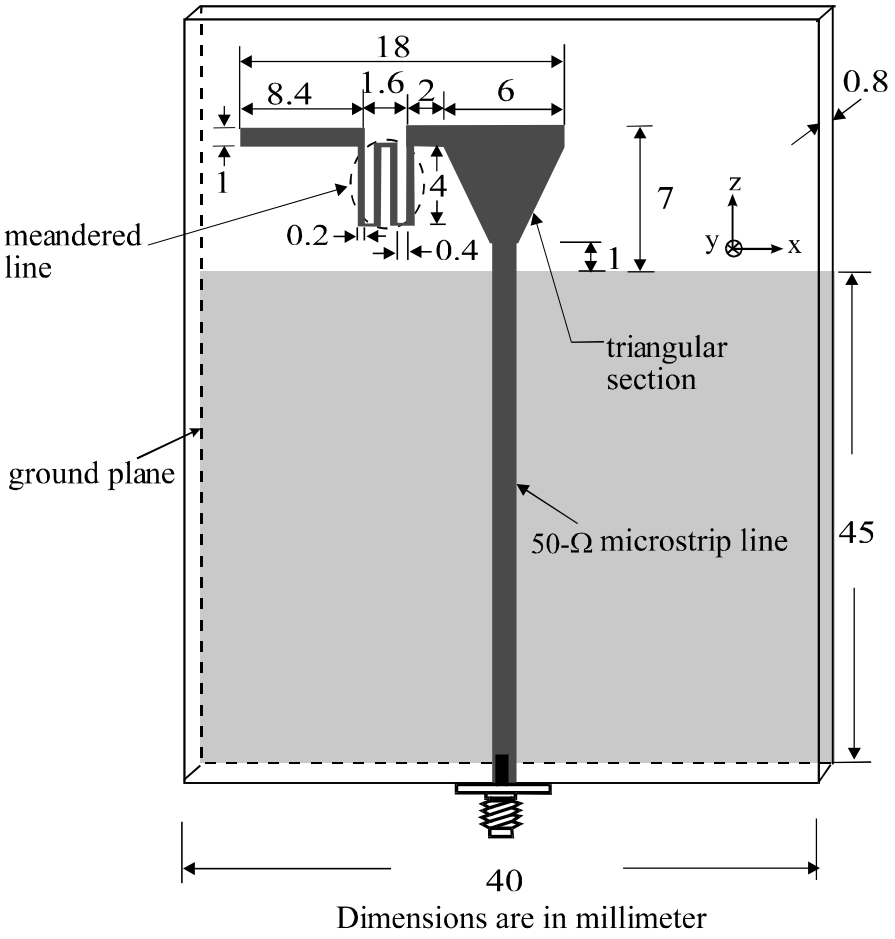


Fig. 1 Geometry of the proposed modified L-shaped monopole antenna for 2.4/5.2/5.8 GHz band operation.

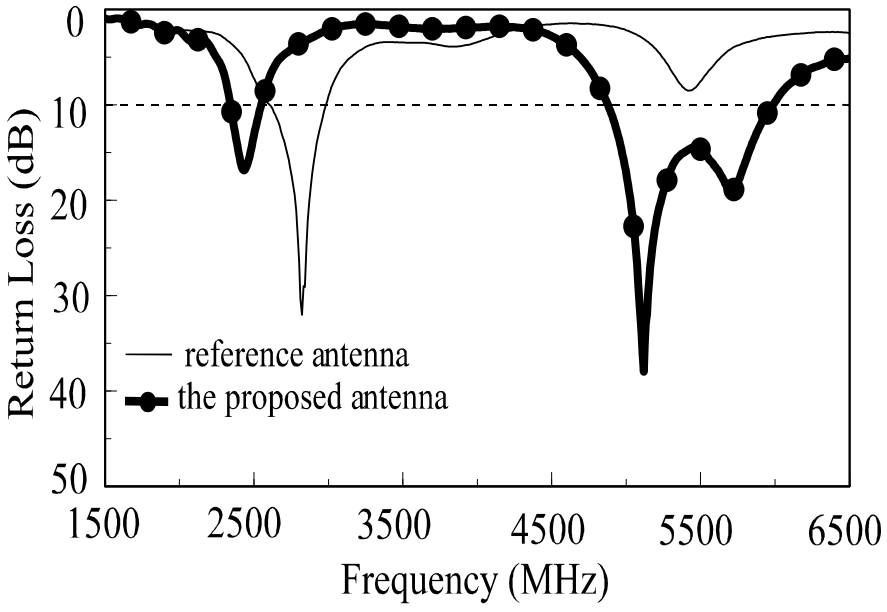
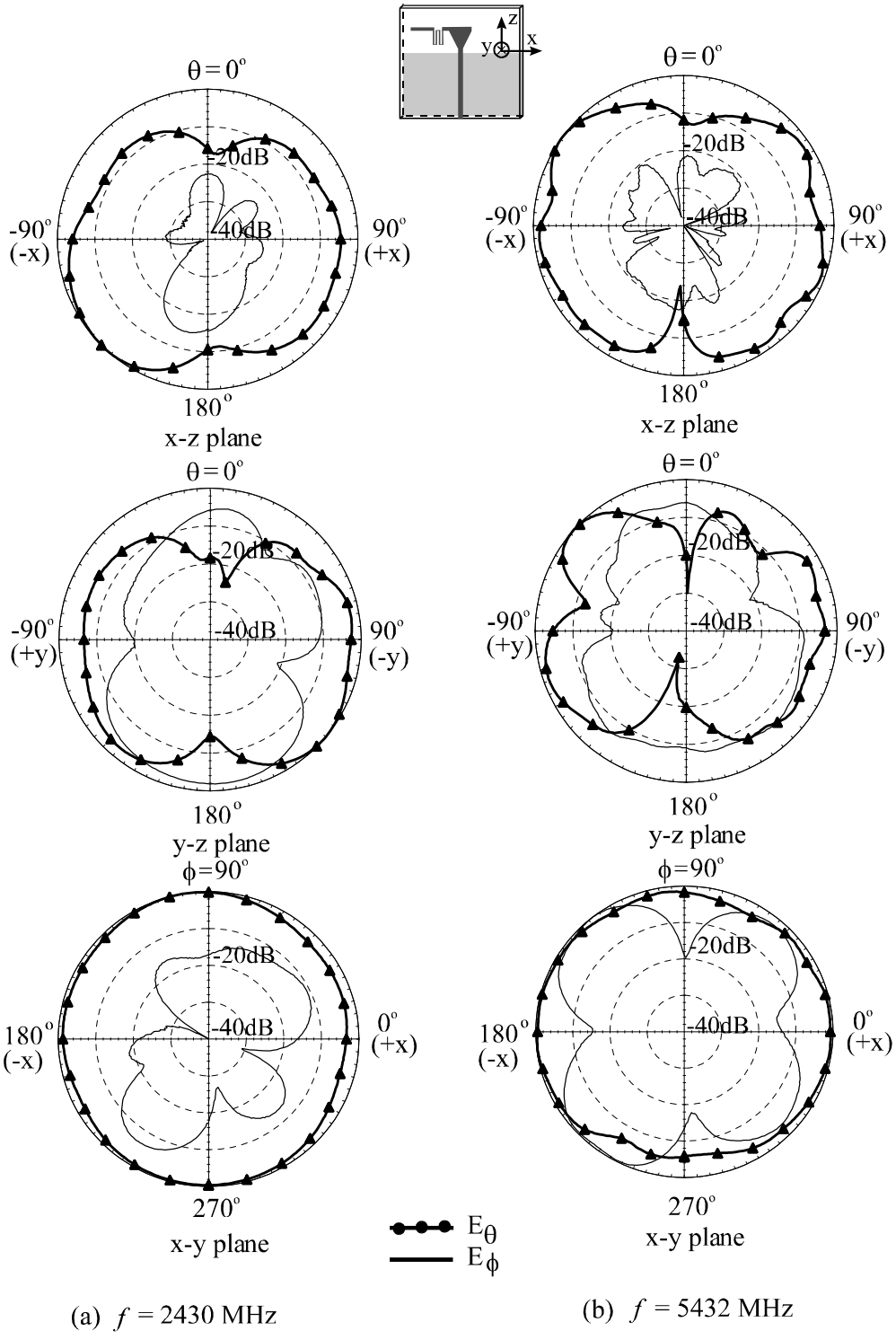


Fig. 2 Measured return loss for the proposed modified L-shaped monopole antenna and the simple L-shaped monopole antenna (reference antenna). The design dimensions are given in Fig. 1.



(a) f = 2430 MHz (b) f = 5432 MHz

Fig. 3 Measured radiation patterns for the proposed antenna. (a) f = 2430 MHz；(b) f = 5432 MHz