Low-Cost Metal-Plate Dipole Antenna for 2.4/5.2 GHz WLAN Operation

Yung-Tao Liu1, Jui-Hung Chou2, Saou-Wen Su3, Fa-Shian Chang3, and Hong-Twu Chen3

1Department of Physics, R.O.C. Military Academy, Feng-Shan 83059, Taiwan (liuyt@mail.cma.edu.tw)
2Network Access Strategic Business Unit, Lite-On Technology Corp., Taipei 23585, Taiwan
3Department of Electrical Engineering, R.O.C. Military Academy, Feng-Shan 83059, Taiwan

1. Introduction

Dipole antennas are simple in structure and have good radiation characteristics. Most of them are in the form of printed dipole structures [1-3] with two radiating arms spaced apart. However, for practical applications, coaxial-line-fed dipole antennas of a small form factor [1] are more costly by etching on a printed circuit board (PCB) than by stamping a piece of metal plate. In fact, small metal-plate dipole antennas are very scant in the literature owing probably to the structure of two separate radiating arms such that dipoles can not easily be fabricated. In this paper, we demonstrate a simple, low-cost, metal-plate dipole antenna for dual-band WLAN operation in the 2.4 GHz (2400-2484 MHz) and 5.2 GHz (5150-5350 MHz) bands. The dipole antenna has a planar structure stamped from a single metal plate only and comprises two radiating arms and a shorting strip that short-circuits both radiating arms. Furthermore, by cutting an L-shaped slit in each radiating arm, two separate operating bands can easily be achieved for dual-band operation. Better omnidirectional-radiation patterns for the 2.4 GHz operation can be also obtained, compared with compact coaxial-line-fed metal-plate PIFAs such as designs in [4, 5]. The antenna is suitable to be assembled in corners of wireless electronics devices or PC peripherals for WLAN applications.

2. Antenna Design

Fig. 1 shows the configuration of the proposed antenna. The antenna is constructed from stamping a single, flat metal plate at low cost and consists of two radiating arms perpendicular to each other and a shorting strip that connects both radiating arms. The designed dipole structure can be installed at around corners inside wireless electronics devices for practical applications. The antenna can be fed by using a short 50-Ω mini-coaxial line, with its central signal lines connected to the point A and its outer grounding sheath soldered to the point B. The points A and B can be designated vice versa due to the dipole antenna symmetrical in shape. Both radiating arms are rectangular in shape with the dimensions 20.5 mm (L) × 8 mm (W). The center operating frequency of the antenna lower-resonant mode in the 2.4 GHz band can be generally determined by the length (L) and width (W). The sum of the L and W corresponds to a free-space quarter-wavelength at 2442 MHz. Further, with the presence of a proper L-shaped slit cut in each radiating arm, two additional, shorter radiating arms, which form a smaller dipole antenna, are obtained for generating a higher (new) resonant mode for the 5.2 GHz band operation. Thus, the proposed, metal-plate dipole antenna is capable of performing WLAN operation in the 2.4 and 5.2 GHz bands. In addition, a wideband shorted dipole antenna, based on the proposed design in this paper, are also studied and will be presented for WLAN/WiMAX dual-mode operation in the 2.4 GHz WLAN band and the 2.5 GHz licensed WiMAX band.

3. Results and Discussion

Fig. 2 shows the measured and simulated return loss of a design prototype. Good agreement between the measured and simulated results is observed. For frequencies over the 2.4/5.2 GHz WLAN bands, the measured impedance matching is all better than 10 dB return loss. The lower resonant mode shows a wide bandwidth of 289 MHz (2280-2569 MHz), which easily covers the 2.4 GHz band for WLAN operation. The higher resonant mode also has a wide impedance bandwidth of 472 MHz (5150-5622 MHz), which meets the bandwidth requirement of the 5.2 GHz WLAN band. Fig. 3 and 4 plot the
measured radiation patterns at 2442 and 5250 MHz, respectively. Similar to conventional wire-dipole radiation characteristics, good omnidirectional-radiation pattern in the x-z plane are first seen for the 2442 operation. The omnidirectional radiation exists in the cut (see segmented line in inset) that is a symmetrical plane, in geometry, for the proposed, L-shaped dipole antenna. For the case at 5250 MHz, however, less omnidirectional, x-z-plane pattern can be obtained. This is largely because the surface currents, over the slit, in the smaller dipole arms and in the top portions of the radiating arms respectively are in the opposite direction. Thus, the radiated fields in the direction normal to the antenna can be destructive to some degree. Fig. 5 shows the measured peak antenna gain and radiation efficiency. The antenna gain in the 2.4 GHz band has a gain level of about 3.3 dBi, with radiation efficiency about 84%. In the 5.2 GHz band, the antenna gain varies within a small range of about 4.1 to 4.9 dBi and radiation efficiency exceeds 80%.

4. Conclusions

A novel, flat metal-plate dipole antenna capable of providing a dual-band operation in the 2.4/5.2 GHz WLAN bands has been proposed. The proposed design with a single metal-plate structure composed of L-shaped radiating arms and a shorting strip can offer a promising antenna solution for keeping cost down. In addition, the dual operating bands can easily be controlled by the L-shaped slits in the dipole antenna. Good radiation characteristics of the proposed antenna have been also observed.

References

Figure 2: Measured and simulated return loss for design prototype

Figure 3: Measured radiation patterns at 2442 MHz
Figure 4: Measured radiation patterns at 5250 MHz

Figure 5: Measured peak antenna gain and measured radiation efficiency for antenna studied in Fig. 2