A Compact Modified E-Shaped Monopole Antenna for USB Dongle Applications

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Abstract - This paper presents a compact modified E-shaped monopole antenna for USB dongle applications. The proposed antenna consists of a modified E-shaped patch fed by a microstrip line with rectangle ground plane. A gradual taper with right angle and step structure of the feeding line are applied for the impedance matching enhancement. The prototype antenna provides the multiband operating frequency of 2.45, 3.5 and 5.5 GHz covering all WLAN/WiMAX frequencies. Bi-directional in xz-plane and nearly omni-directional in yz-plane radiation patterns are given by the proposed antenna. With a compact dimension of 20×40×0.8 mm³, this antenna is proper to use for the USB dongle devices.

Index Terms — USB dongle antenna, Modified E-shaped antenna, Multiband antenna.

1. Introduction

Presently, wireless communication technology has been continuously developed for dongle devices or compact mobile wireless applications. Those devices usually are designed supporting various systems such as Global Positioning System (GPS), Radio Frequency Identification (RFID), Worldwide Interoperability of Microwave Access (WiMAX), Wireless Local Area Network (WLAN) and mobile phone. Because confine size, the antenna designing for dongle devices is attended and challenged. Many USB dongle antennas were designed and proposed with various shapes such as monopole antenna [1], L-shaped strip [2], planar inverted-F antenna [3], T-shaped strip with U-shape slot [4], folded arm and meandered arm [5] and stepped circular radiator [6]. Although those antennas were designed for multiband operations, some antennas were not operated to cover all WLAN/WiMAX frequencies.

In this paper, a compact monopole antenna for the USB dongle device covering entire the WLAN/WiMAX systems is proposed. By using a modified E-shaped patch with gradual taper feeding line, the proposed antenna can operate with the frequency ranges of 2.3-2.63, 3.26-3.65 and 5.0-5.78 GHz. The details of antenna design and the measured results will be described in the next section.

2. Antenna Design and Measurement Results

The IE3D software is employed to design and optimize the proposed antenna on an FR-4 substrate with thickness of 0.8 mm, permittivity constant (εr) of 4.4 and loss tangent of 0.02. Chemical etching is used for the prototype antenna fabrication. The configuration with major parameters and photograph of the proposed antenna are displayed in Figs. 1(a) and 1(b), respectively. The proposed antenna is designed on a substrate with dimension of 20 × 40 mm². The design steps are as following. Firstly, an E-shaped patch is used with right angle of microstrip transmission line resulting in size reduction. To generate the desired frequencies, the modified E-shaped is applied. Then, the taper feed line with step structure is introduced for impedance matching improvement. Finally, all parameters are optimized to achieve the proper resonant frequencies and sufficient bandwidth.

As shown in Fig. 2, a comparison of the simulated and measured |S11| results shows that the 1st and 2nd bands are coincident except the third band, a little mismatching at center resonant frequency is occurred. The discontinuity from the SMA connector to microstrip line and fabrication tolerance may be caused of this error. The proposed antenna provides operating frequencies of 2.3-2.63, 3.26-3.65 and 5.0-5.78 GHz covering WLAN/WiMAX systems. In the design procedures, there are three parameters affecting the antenna characteristic, as shown in Figs. 3(a)-3(c). It is found that gap distance (g) shows high effect to the resonant frequency of the middle band. There is a little effect to the 1st band and moderate effect to the matching impedance of the 3rd band. The resonant frequency of the 3rd band can be controlled by L3 parameter, as shown in Fig. 2(b). The hp parameter is used to control the 1st and 2nd resonant frequencies, as shown in Fig. 3(c).

The measured radiation pattern results are shown in Fig. 4. It is seen that bi-directional in xz-plane and nearly omni-direction in yz-plane at all bands are given by the proposed antenna.
3. Conclusion

A compact modified E-shaped monopole antenna for USB dongle applications is presented. The modified E-shaped patch is used with gradually tapered microstrip feed line. The right angle with step structure is applied for size reduction. The operating frequencies of 2.3-2.63, 3.26-3.65 and 5.0-5.78 GHz are given by the prototype antenna. Additional, bi-directional in \(xz\) plane and nearly omni-directional in \(yz\) plane are achieved. It is proved that the proposed antenna is a good candidate to use with the USB applications.

Acknowledgment

The authors would like to thank Mr. Nonchanutt Chudpooti at the Wireless Communication Research Group, Department of Electrical and Computer Engineering, King Mongkut’s University of Technology North Bangkok for antenna measurement.

Fig. 2 A comparison of the \(|S_{11}|\) simulated and measured results of the proposed antenna.

Fig. 3 Parameter study of (a) \(g\), (b) \(L_3\) and (c) \(h_p\).

Fig. 4. Measured 2-D radiation patterns of the proposed antenna in \(xz\)-plane and \(yz\)-plane.

References


