Dual-Band F-Shaped Monopole Antenna for 2.4/5.2 GHz WLAN Application

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Introduction

Antennas occupying a small volume of the system are very attractive for wireless local area network (WLAN) or Bluetooth applications [1], [2]. To further reduce the antenna volume and decrease the fabrication cost, the WLAN antenna using an inverted-F strip integrated on the circuit board of a communication device has been demonstrated recently [1]. However, the antenna is capable of single-band operation only. In this article, a novel dual-band F-shaped monopole antenna, which can easily be integrated on a circuit board, is proposed. The antenna comprises a vertical metal line and two (one upper and one lower) horizontal metal lines of different lengths, which are used for tuning the antenna's first two resonant frequencies to achieve dual-band operation in the 2.4 GHz (2.4–2.484 GHz) and 5.2 GHz (5.15–5.35 GHz) bands for WLAN applications. The proposed antenna printed and integrated on a small region of a microwave substrate has a compact size of 10×15 mm^2 and is easily fed by a 50 Ω microstrip line printed on the same microwave substrate. Details of the design considerations for achieving dual-band operation, and experimental results of a constructed prototype for operating in the 2.4 and 5.2 GHz bands are presented.

Design Considerations

Figure 1 shows the geometry of the proposed dual-band F-shaped monopole antenna integrated on a microwave substrate of dimensions 45×80 mm^2, which can be considered as a circuit board of a communication device. The microwave substrate used here has a thickness 0.8 mm and a relative permittivity 4.4. The dimensions given in the figure are for achieving 2.4 and 5.2 GHz operations, and are obtained with the aid of the simulation software Ansoft HFSS. The proposed monopole is printed on a small region (size 15×15 mm^2 in this study) at one of the corners of the microwave substrate, and notice that, there is a ground plane printed on the back of the substrate, except at the region (size 15×15 mm^2) below the proposed antenna. The proposed monopole has a shape looking like the

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character "F", and consists of a vertical metal line and two horizontal lines. To make the design simple, these three metal lines were chosen to be of the same width (2 mm in this study). Besides, the proposed monopole can be easily fed by a 50 Ω microstrip line printed on the same substrate.

There are two resonant paths in this F-shaped monopole: the longer one, starting from the feed point to the open end of the upper horizontal metal line, generates the first (lower) operating band; the shorter one, starting from the feed point to the open end of the lower horizontal metal line, controls the second (upper) operating mode. By adjusting the lengths of the longer and shorter paths, the desired lower and upper operating frequencies can be easily obtained.

Experimental Results and Conclusions

Based on the design dimensions given in Figure 1, a prototype was constructed and tested. Figure 2 shows the measured and simulated return loss. Two separate resonant modes at about 2.4 and 5.2 GHz are excited with good impedance matching. The lower band has an impedance bandwidth of 570 MHz, determined from 1:2.5 VSWR or 7.3 dB return loss, which covers the required bandwidth of the 2.4 GHz band (2.4–2.484 GHz) for WLAN operation. The upper band shows an impedance bandwidth of 280 MHz, which meets the bandwidth requirement of the 5.2 GHz (5.15–5.35 GHz) band for WLAN operation. Both longer and shorter resonant paths, 23 mm (0.19λ at 2.4 GHz) and 12 mm (0.21λ at 5.2 GHz), respectively, are shorter than one-quarter wavelength of a conventional straight monopole in free space. This behavior is largely due to the effect of the microwave substrate supporting the proposed monopole, which leads to decreased resonant length for the proposed monopole.

Measured antenna gain is shown in Figure 3, and the peak values for the 2.4 and 5.2 GHz bands are 2.0 and 2.7 dBi, respectively. Radiation characteristics were also studied. Figure 4 plots the measured radiation patterns at 2.45 GHz, and the results at 5.25 GHz are shown in Figure 5. Measurements at other operating frequencies show stable radiation patterns in the 2.4 and 5.2 GHz bands. More detailed results of the proposed design will be described in the presentation.

References

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[2] S. H. Yeh, S. T. Fang, and K. L. Wong, "Dual-Band Shorted Patch Antenna for Dual ISM-Band Application," *Microwave Opt. Technol. Lett.*, vol. 32, pp. 79-80, 2002.

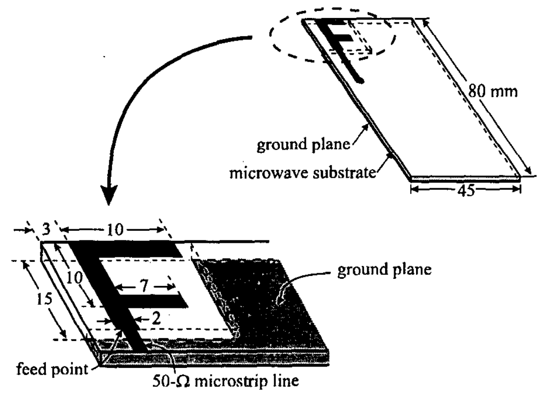

Fig. 1 Geometry of the proposed monopole antenna.

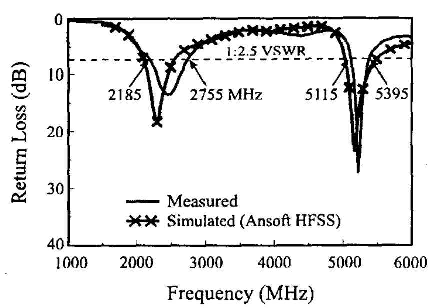

Fig. 2 Measured and simulated return loss.

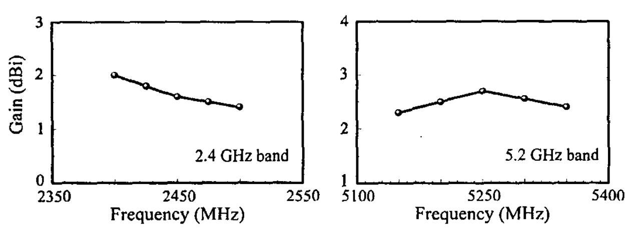

Fig. 3 Measured antenna gain.

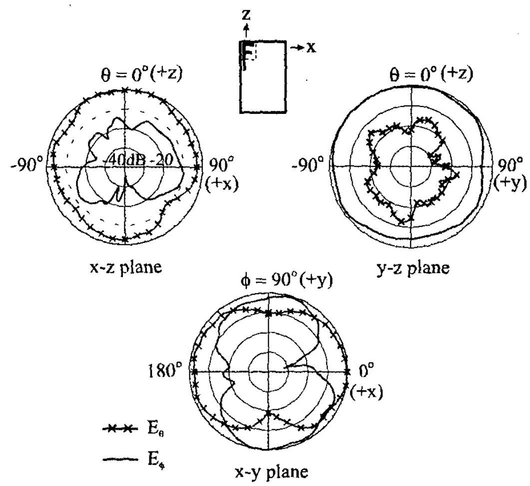

Fig. 4 Measured radiation patterns at 2450 MHz.

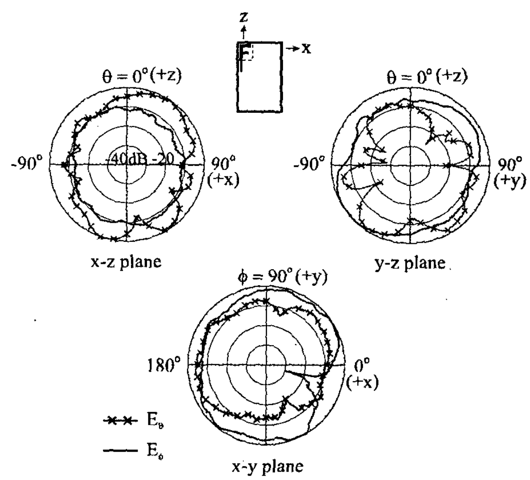

Fig. 5 Measured radiation patterns at 5250 MHz.