A Modified Two-Strip Monopole Antenna for WMAN Applications

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1. Introduction

The Worldwide Interoperability for Microwave Access (WiMAX) and the recent wireless broadband (WiBro) have emerged as the promising technologies for broadband access in wireless metropolitan area network (WMAN) environment. WiBro, in fact, is the South Korean service name for IEEE 802.16e mobile WiMAX. It is now becoming a subset of the broader WiMAX standard. One of the potential applications of WiMAX is to provide backhaul support for mobile WiFi hotspots. In order to satisfy the integration of WiFi, WiBro and WiMAX for WMAN applications, multiband yet compact antennas are the preferred front-end for such mobile handsets/terminals.

Recently a novel type of dual-band two-strip planar antennas has been reported [1]-[2]. The two-strip antennas consist of an S-strip and a T-strip, and have no shorting via in the antenna structures. These antennas made use of the concepts of double-T antenna [3], inverted FL antenna [4], electromagnetic coupling and two-strip configuration [5]-[6]. Owing to the strong EM coupling between strips, these two-strip antennas have the advantages of not just light-weight and compact but also have the monopole-like radiation patterns with wide dual-band operations. However, these antennas [1]-[2] are mainly designed for the WiFi or Wireless LAN applications, namely 2.4 & 5 GHz bands. Further, these antennas have adopted a very thin substrate – 10 mil RT/Duroid 5880, which is a soft texture, may not be suitable to be used as a printed circuit board for microwave devices.

In this paper, we aim to report a successful modification of the two-strip monopole antenna. This antenna has been designed and fabricated at the department of Electronic and Information Engineering, the Hong Kong Polytechnic University. The modification has addressed the weakness of the original designs by employing a thicker (31 mil) Duriod substrate. The modified monopole antenna is now a penta-band rather than a dual-band antenna, in addition to the WiFi/Wilress LAN frequency bands (802.11a/b/g/n: 2.4 GHz, 5 GHz), and the 5.8 GHz UNII band, it covers also the mobile WiMAX and WiBro bands (802.16e: 3.5–3.7 GHz). The antenna geometry is presented in Section 2 whereas simulation and measurement results are compared in Section 3. Conclusion is included in Section 4.

2. Antenna Geometry

For the selection of dielectric substrate in the design of front end antenna for mobile terminals, the Flame Retardant 4 (FR4) or Epoxy resin would be a good candidate. As the first step we followed the original designs reported in [1]-[2], RT/Duriod 5880 (ε_r = 2.2) with a thickness of 0.78 mm (31 mil) is chosen as the antenna substrate in our design. Hence all the gaps, strip lengths and widths in top and bottom layers need to be optimised in order to meet the design objectives. The antenna geometry with dimensions is illustrated in Fig. 1. The S-strip having a width of W_s is printed on the bottom layer and is terminated at a ground plane. For the top layer, a double double-T strip with a width of W_s fed by a 50-Ω microstrip line, which connected to an edge-launch SMA connector, as shown in Fig. 2. Fig.2 also shows the size comparison between the modified (right) and the original (left) designs.

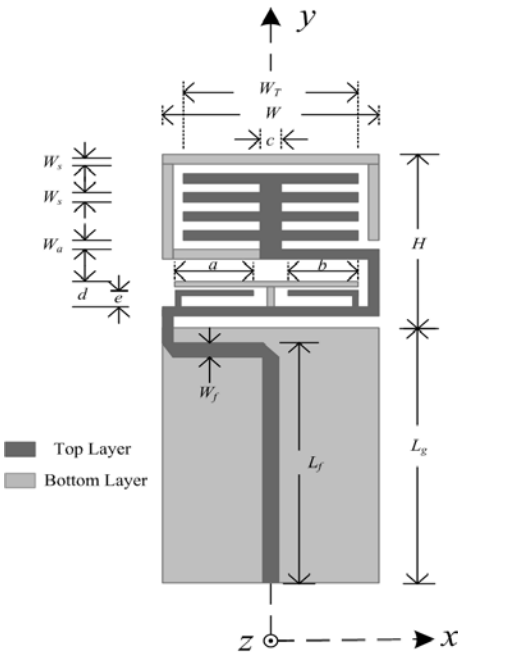

Fig. 1 Geometry of the modified monopole:
H = 11, W = 17.6, W_T = 15.3, W_s = 0.66, W_a= 0.2, W_f = 2, L_f = 20, L_g = 22, *a* = *b* = 6.6, *c* = 2, *d* = 1.1, *e* = 0.8. Unit: mm.

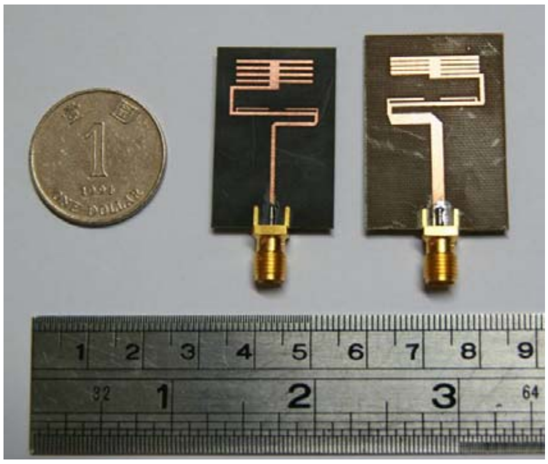

Fig. 2 Photo of the modified design (right) compared to the original design (left) [2].

3. Results and Discussion

A modified two-strip planar monopole antenna has been fabricated and measured. Fig. 3 shows the comparison of the simulated and measured return-loss versus frequency. As can be seen, the measured result has a good agreement with the simulation. In addition to the WiFi/Wireless LAN frequency bands, viz., 2.4 GHz & 5 GHz, the modified monopole covers the mobile WiMAX / WiBro at 3.5 GHz. The two-strip antennas have many tuning parameters that make the frequency adjustment difficult. The present design has a trade-off between the wide dual-band and the extra band at 3.5 GHz. Fig. 4 shows the simulated and measured radiation patterns at the three essential frequencies in 3 principle planes. For conical cuts of $\theta = 90^o$ (*x*-*z* plane), the patterns are essentially an omni-directional shape.

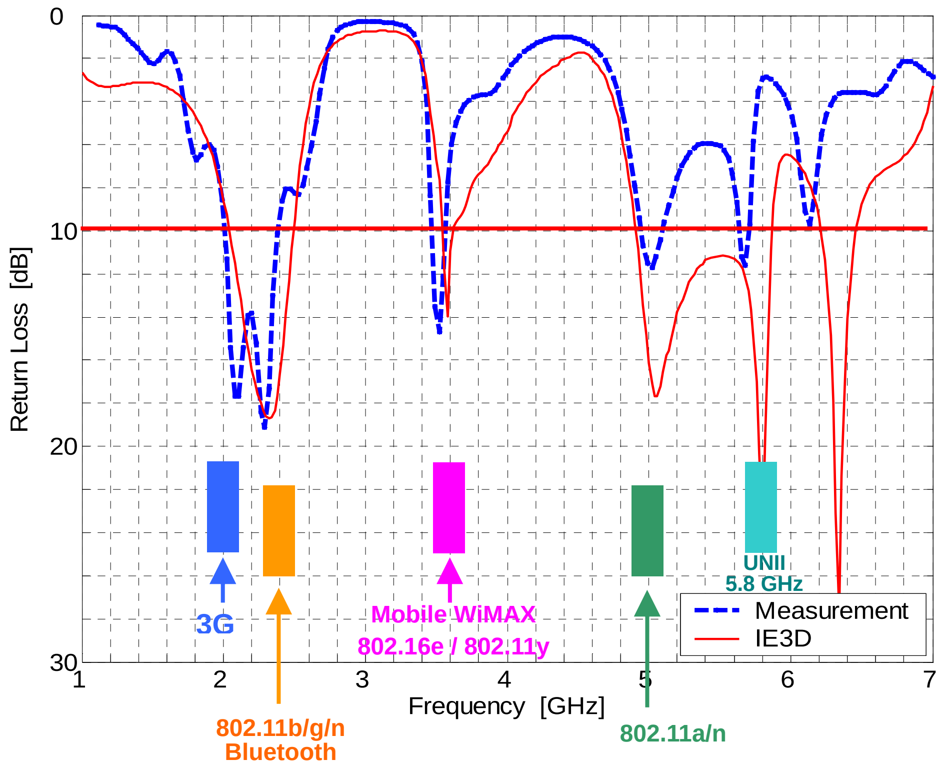

Fig. 3 The return loss versus frequency of the modified two-strip monopole antenna.

4. Conclusion

In this paper, we aim to report a successful modification of the two-strip monopole antenna. The modified antenna has a relatively thick substrate that can be easily integrated with microwave devices. The monopole antenna now becomes a penta-band antenna with monopole radiation characteristics. In addition to the WiFi frequency bands (802.11a/b/g/n: 2.4 GHz, 5 GHz), it covers the mobile WiMAX band (802.16e: 3.5–3.7 GHz). It has its potential application that to be used as the front-end antenna for the mobile terminals for the wireless metropolitan area network (WMAN), where the mobile WiMAX provides backhaul support for the mobile WiFi hotspots.

Acknowledgments

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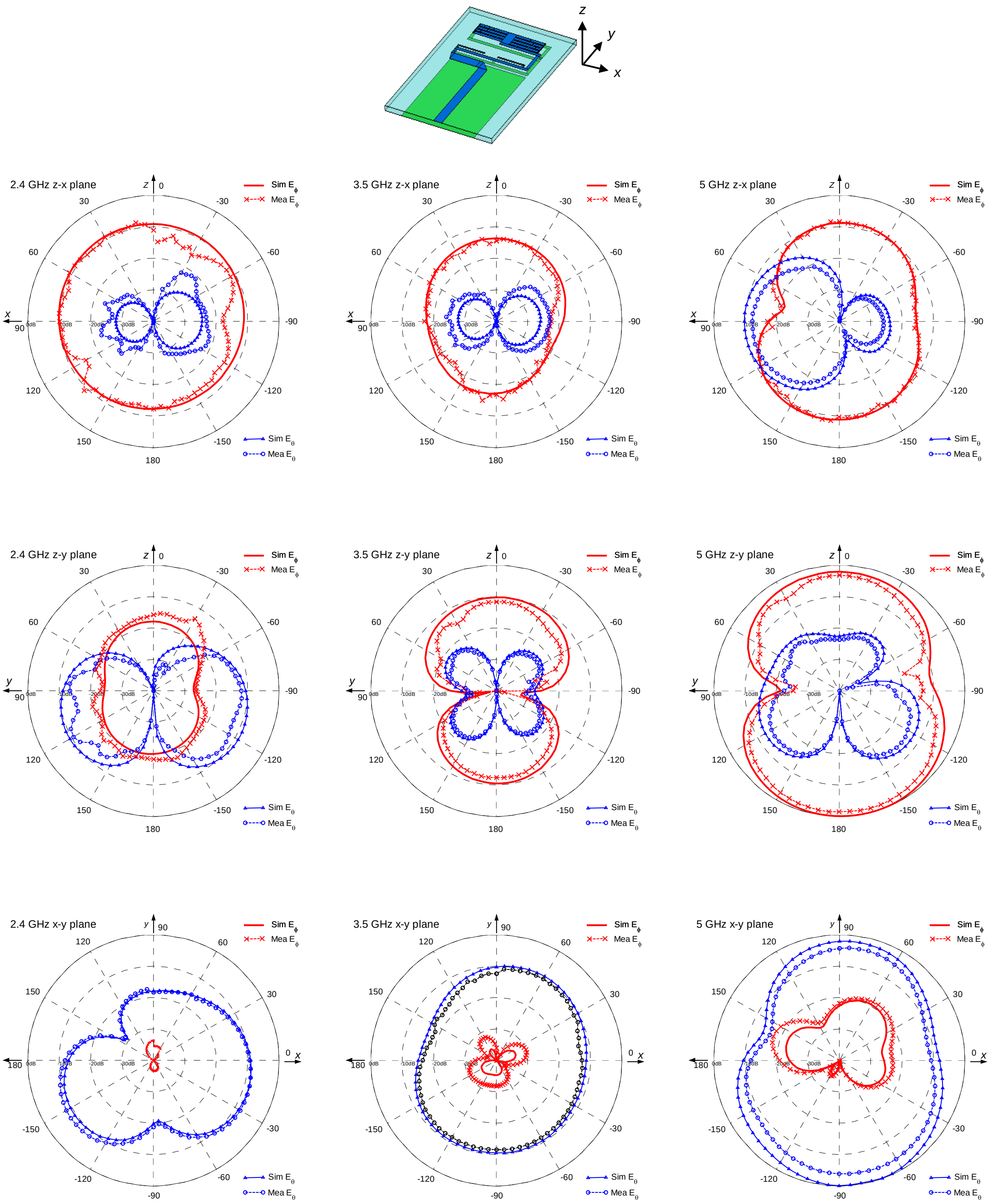

Fig. 4 The measured and simulated radiation patterns at 2.4 GHz, 3.5 GHz and 5 GHz in three principle planes.