Planar Multi-Band Monopole Antenna for WLAN/WiMAX Applications

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***Abstract* - A novel compact design of planar multi-band monopole antenna for WLAN/WiMAX system is proposed. By insetting a pair of mirrored L-shaped monopole strips, multi resonant modes close to 2.45 / 3.5 / 5.5 GHz band are excited to meet the specifications of WLAN/WiMAX system. The obtained impedance bandwidth across the operating bands can reach about 160 / 1100 / 2690 MHz for the 2.45 / 3.5 / 5.5 GHz bands, respectively. Only with the antenna size of 30 × 42 × 0.8 mm^3, the proposed monopole antenna has the compact operation with more than 20% antenna size reduction. The measured peak gains and radiation efficiencies are about 3.2 / 3.5 / 5.4 dBi and 72 / 98 / 96% for the 2.45 / 3.5 / 5.5 GHz band, respectively, with nearly omni-directional pattern in the XY-plane.**

***Index Terms* —LTE, WiMAX, Slot array antenna.**

I. INTRODUCTION

Owing to low cost, lightweight and process simplicity, planar multiband monopole antennas have become popular candidates in recent years to provide quick and easy wireless access for multimode communication systems. The currently presented antenna designs suitable for multi-band operations in the 2.45 GHz (2.4 – 2.484 GHz), 3.5 GHz (3.4 – 3.69 GHz) and 5.5 GHz (5.15 – 5.95 GHz) bands for WLAN/WiMAX applications have been reported in [1-9]. However, there is the disadvantage of being larger antenna size for these above MAs [1-7] and increasing demand for antennas having more compact size to be suitably embedded in the practical portable devices for WLAN/WiMAX application. Therefore, in this article, we propose a novel planar T-shaped monopole antenna with a pair of mirrored L-shaped strips for multi-band WLAN/WiMAX communication. And, from the related measured results, it provides relatively wider impedance bandwidth of 160 / 1100 / 2690 MHz for the 2.45 / 3.5 / 5.5 GHz bands, respectively. The proposed planar monopole antenna also provides the nearly omni-directional radiation patterns with maximum measured peak antenna gains and radiation efficiencies of 3.2 / 3.5 / 5.4 dBi and 72 / 98 / 96 % across the operating bands, respectively. Also, compared with the presented antenna designs in the literature [1-7], this proposed monopole antenna has more than 20% antenna size reduction to achieve compact operation. Details of the proposed monopole antenna design are described, and experimental results for the obtained performance operated across the 2.45 / 3.5 / 5.5 GHz bands are presented and discussed.

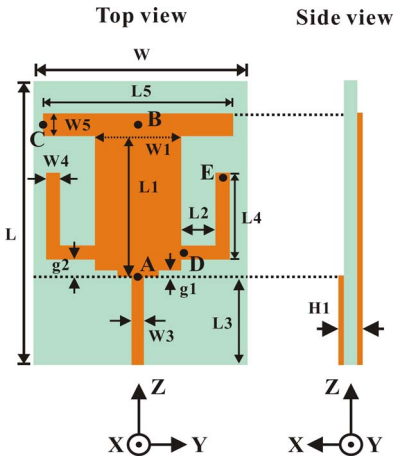


Fig. 1. Geometry and photo of the proposed T-shaped monopole antenna with a pair of mirrored L-shaped strips for multi-band operation.

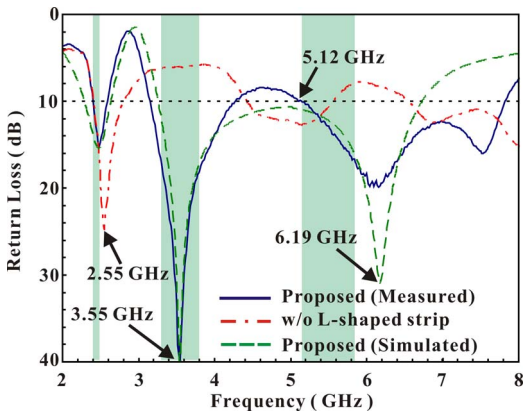
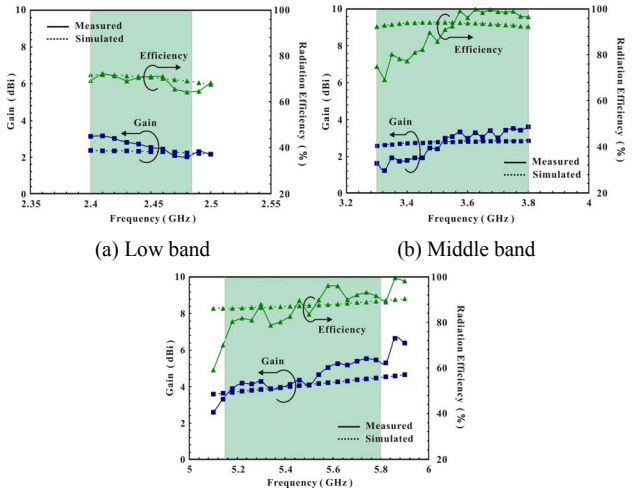


Fig. 2. Simulated and measured return loss against frequency for the proposed T-shaped monopole antenna with the L-shaped strips or not.

II. ANTENNA DESIGN AND EXPERIMENTAL RESULTS

Fig. 1 illustrates the geometry of the proposed T-shaped monopole antenna with a pair of mirrored L-shaped strips. A 50Ω microstrip line is etched as the feeding structure on the inexpensive FR-4 substrate with the antenna volume of 30 × 42 × 0.8 mm^3, dielectric constant $\varepsilon_r = 4.7$ and loss tangent tan $\delta = 0.0245$. First, for achieving the resonant mode at 2.45 GHz band, the surface current length of the T-shaped patch (A → B → C) is chosen to be about 34 mm corresponding approximately to 0.28 and 0.59 wavelengths of 2.45 / 5.5

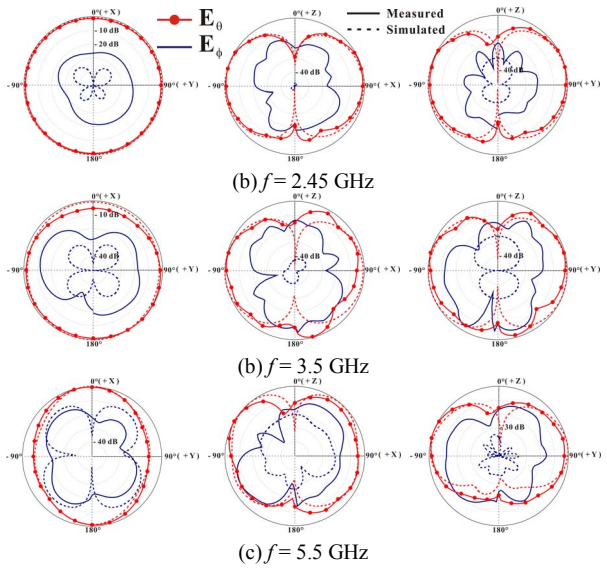
GHz bands. Then, the excited length (A → D → E) including the L-shaped strip (L2 + L4) is chosen to be about 28 mm corresponding approximately to 0.32 wavelength of 3.5 GHz operation. Fig. 2 shows the related simulated and experimental results of return loss for the proposed T-shaped monopole antenna design of Fig. 1 with the L-shaped strips or not. From the experimental results, the measured impedance bandwidth (RL ≧ 10 dB) can reach 6.5 / 29.8 / 40.2 % (160 / 1100 / 2690 MHz) for 2.45 / 3.5 / 5.5 GHz bands, respectively, which provides much greater bandwidths for all operating bands to meet WLAN/WiMAX specifications.



(a) Low band (b) Middle band

(c) High band

Fig. 3. Measured and simulated 2D radiation patterns for the proposed T-shaped monopole antenna with a pair of mirrored L-shaped strips.



(b) f = 2.45 GHz

(b) f = 3.5 GHz

(c) f = 5.5 GHz

Fig. 4. Measured and simulated 2D radiation patterns for the proposed T-shaped monopole antenna with a pair of mirrored L-shaped strips.

The measured peak gains and radiation efficiencies across the operating bands are shown in Fig. 3 with the simulated results as comparison. As shown in Fig. 3(a), the antenna gain is varied from about 2.1 to 3.2 dBi and the radiation efficiency is about 64% – 72% for 2.45 GHz WLAN operation. Over the 3.5 GHz band, the antenna gain is about 1.6 – 3.5 dBi with the radiation efficiency about 74% – 98% as shown in Fig. 3(b). And, the antenna gain is about 3.3 – 5.4 dBi and the radiation efficiency is about 80% – 96% over the 5.5 GHz band. The measured two-dimensional (2-D) radiation patterns at 2.45, 3.5 and 5.5 GHz are plotted in Fig. 4 with the simulated results as comparison. It is easily found that the radiation patterns are with good omni-directional radiation pattern in the XY plane and broadside radiation in the XZ and YZ plane which resemble typical dipole patterns in symmetry with respect to the antenna axis (θ = 0) since the proposed antenna is symmetrical.

III. Conclusions

A novel compact design of planar T-shaped monopole antenna with multi-band operation for WLAN/WiMAX system has been proposed. The obtained impedance bandwidth across the operating bands can reach about 160 / 1100 / 2690 MHz for the 2.45 / 3.5 / 5.5 GHz bands, respectively. Only with the antenna size of 30 × 42 × 0.8 mm^3, the proposed monopole antenna has the compact operation with more than 20 % antenna size reduction. The proposed planar monopole antenna also provides the nearly omni-directional radiation patterns with maximum peak antenna gains and radiation efficiencies of 3.2 / 3.5 / 5.4 dBi and 72 / 98 / 96 % across the operating bands, respectively.

Acknowledgment

This paper was supported by the Ministry of Science and Technology (MOST), Taiwan, R.O.C., under Grant NSC97-2221-E-022-005-MY3 and NSC101-2221-E-022-011-MY2.

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