A Compact Antenna for WLAN/WiMAX Applications

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ABSTRACT

New design of a compact antenna with slot structure for multi-operating bands of wireless communication systems is presented. By using compact configuration and slot design on printed circuit board, the proposed antenna has the multi-band measured operations for covering the 2.4- and 5-GHz WLAN (2400-2484/ 5150-5350/ 5725-5825 MHz) and WiMAX (2500-2690/ 3500-3650 MHz) bands. Several properties of the proposed printed antenna for multi-band operation such as impedance bandwidth, radiation pattern and measured gain have been numerically and experimentally investigated.

1. Introduction

Compact design and multi-band operations for the wireless communication systems have been significant investigated and widely developed, which has the strong design advantages over low-profile, cost down and small size. Many antennas with broadband and multi-band performances including dipole antenna, monopole antenna, slot antenna, meander antenna and planar antenna configurations have been reported in recent years [1]-[5]. These are printed antennas with moderate radiating characteristics and can be operative at dual- and multiple- frequency bands. Moreover, the antenna fabrication designs, they have needed the design of antenna fabrication using the slot structure to provide a broadband and multi-band systems including the 2.4- and 5-GHz wireless local area network (WLAN bands).

The proposed slotted antenna of this paper is presented and experimented by way of arranging for simple configuration and slot forms, we could applied to the printed antenna, and a multi-band characteristic with the proposed antenna improves the narrow band of the compact antenna with a single metal plane for wireless system applications of the 2.4-GHz WLAN (2.4-2.484 GHz), the worldwide interoperability for microwave access (WiMAX bands) (2.5-2.69 and 3.5-3.65 GHz) and the 5-GHz WLAN (5.15-5.35 and 5.725-5.825 GHz).

2. Antenna Design

Figure 1 shows the geometry of the proposed slotted antenna for multi-band applications. It is printed on the 0.8 mm FR4 substrate of relative permittivity 4.4 and has a compact dimension of 34 mm × 15 mm in this study. The compact design of proposed antenna has an S-shaped slot, an inverted-L slot on ground plane and the feed by 50Ω coaxial line. The inner fed conductor and the outer metal sheath of the coaxial line are connected to the feed point and the ground plane and both with a distance of 1.5 mm between two points, respectively. The patch line of feed point has a matching connector of 11.5 mm × 1.1 mm. Moreover, in order to achieve a compact structure for the proposed antenna, the slot forms on metal plane are exact designed, as shown in figure 1. The optimal dimensions of proposed antenna are W_1= 4.5 mm, W_2= 7 mm, W_3= 3.7 mm, W_4= 0.5 mm, L_1= 6.35 mm, L_2= 1.5 mm, L_3= 14.8 mm, L_4= 2.3 mm, L_5= 1.35 mm, and S_1= S_2= 0.65 mm.

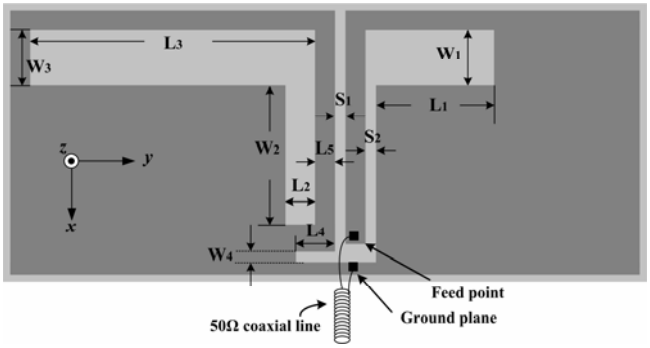

Figure 1: The geometry of the proposed antenna

3. Results

Figure 2 shows the simulated and measured return loss of the proposed printed antenna with compact and low profile structures for WLAN/WiMAXmulti-operating wireless communication applications. Figure 2 shows the measured return loss and it is noted that four distinct resonant modes at around 2.5, 3.7, 5.2, and 5.7 GHz are excited with -10 dB return loss. The measured return loss of operation bandwidth portion has a 340 MHz within 2.38 GHz ~ 2.72 GHz at the first resonance mode. Nevertheless, this resonance bandwidth has the signification operation on the 2.4-GHz WLAN system between 2.4 and 2.484 GHz and the Mobile-WiMAX system in the Taiwan between 2.5 and 2.69 GHz.

The inverted-L slot structure on ground plane shows the signification factor on the variation of the second resonance mode of 540 MHz within 3.48 GHz ~ 4.02 GHz, which cover the WiMAX (3.5-3.65 GHz) band. The two higher resonance modes exhibit bandwidth of 1460 MHz from 4.85 GHz to 6.31 GHz, covering the 5-GHz for WLAN operation (5.15-5.35 GHz and 5.725-5.825 GHz). The measured bandwidth of proposed antenna is covered three resonance bandwidths, 13.4 % on the first bandwidth for the 2.4-GHz WLAN system and the Mobile-WiMAX system, 14.4 % on the second bandwidth for the WiMAX system, and 26.2 % on the third bandwidth for the 5-GHz WLAN system, respectively.

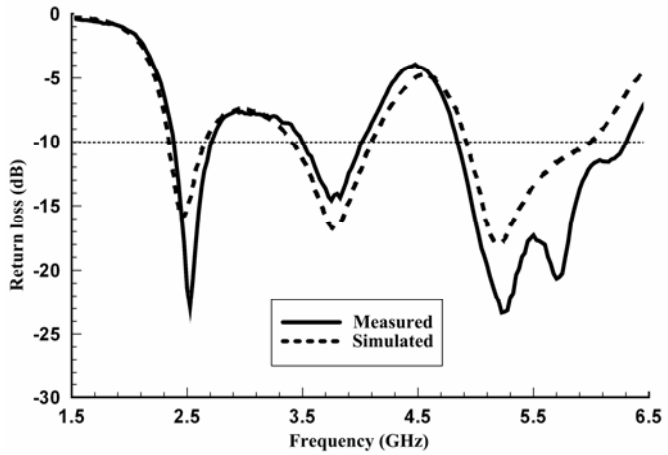

Figure 2: The simulated and measured return loss of the proposed antenna

The measured radiation patterns of the proposed compact antenna at 2.45 GHz, 3.6 GHz, and 5.8 GHz are illustrated with Figures 3-5, respectively. It is noticed that the radiation patterns in two main planes at the wireless communication operations are conventional dipole antenna of the same. The x-z plane radiation pattern is omnidirectional pattern at three presented operations. So the radiation patterns are generally omnidirectional over the entire bandwidth, similar to a conventional antenna for WLAN and WiMAX systems.

The variation ranges of maximum measured gain at all radiation planes are varied from 3.9 dBi to 1.6 dBi within 2.4 GHz ~ 2.7 GHz at the first operation frequency band, from 2.3 dBi to 0.9 dBi within 3.5 GHz ~ 3.9 GHz at the second operation frequency band and from 1.7 dBi to 0.8 dBi within 5.1 GHz ~ 5.9 GHz at the third operation frequency band, respectively. Through proposed antenna measured results to display, not only have multi-band effect but also reach the operating applications of the WLAN and WiMAX systems.

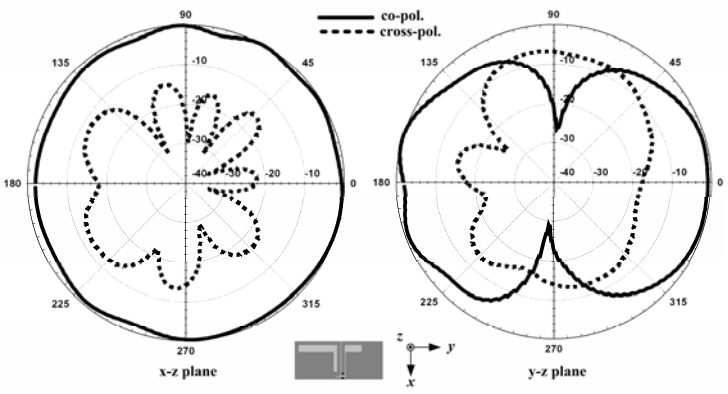

Figure 3: Measured radiation patterns of the proposed antenna at 2.45 GHz

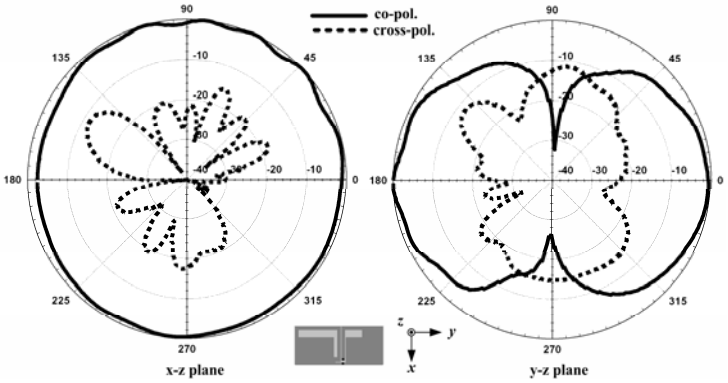

Figure 4: Measured radiation patterns of the proposed antenna at 3.6 GHz

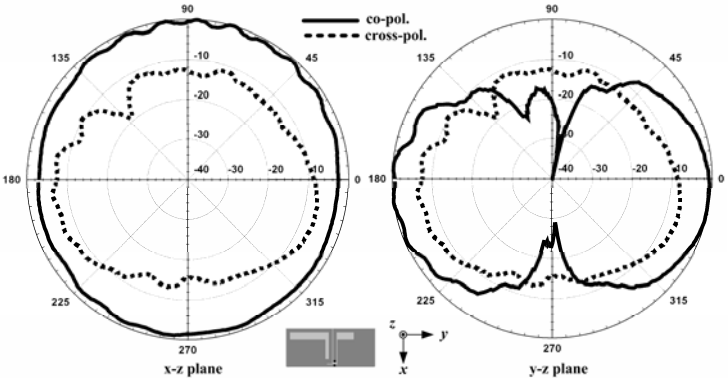

Figure 5: Measured radiation patterns of the proposed antenna at 5.8 GHz

4. Conclusion

A new compact antenna with slot structure has been developed and could achieve the multi-band wireless communication operation. From the investigation of proposed antenna, it is found that the compact antenna design including S-shaped slot and inverted-L slot structures make a strong effect on the antenna's operating resonance modes. Experimental results show that by using proposed design and tuning their dimensions, operating bandwidth, measured gain and radiation patterns can be obtained for 2.4-GHz WLAN/ WiMAX/ 5-GHz WLAN applications.

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