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The design of Coplanar Waveguide Band-Notched Ultrawideband Antenna having two folded striplines

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1. Introduction

Ultra-wideband (UWB) techniques have been given attentions for future short-range high-speed indoor communications. It has the merits of high speed transmission rate, low power consumption and simple hardware configuration over conventional wireless communication systems. According to the regulation released by Federal Communication Commission (FCC), the UWB systems for indoor communications have been allocated to the spectrum from 3.1 to 10.6 GHz in order to prevent unnecessary interference with other radio systems. Although many planar and solid monopole antennas have been proposed [1]-[3], these antennas are difficult to build and integrate with RF front ends because of their large sizes. However, the use of 5.15 to 5.825 GHz frequency band has been limited by IEEE802.11a and HIPERLAN/2 for wireless local area network (WLAN) system. To avoid the interference between the UWB and WLAN systems, a band-notch in UWB systems is necessary. The conventional method to achieve a notched band is to cut a slot on the patch or to embed a quarter-wavelength tuning stub within a large slot on the patch [4]. Another way is to put parasitic elements near the printed monopole, playing a role as filter to reject the limited band [5]. Several new designs have been reported with good band-notched properties at the WLAN band [6]-[7]. In this paper, a simple wideband antenna with band-notch for UWB application is proposed. To achieve wideband and band-notch characteristics, the proposed antenna has two tilt-steps in the patch and two folded striplines in the bottom of the substrate. The 10 dB return loss bandwidth of the proposed antenna covers 3.09 GHz over 11 GHz. The antenna is yielded the band rejection performance in the frequency band of 4.83 to 5.98 GHz, which satisfies the UWB requirement.

2. Antenna Design

The geometry of the proposed coplanar waveguide (CPW) band-notched UWB antenna is shown in Fig. 1. The proposed CPW band-notched UWB antenna with two different size tilt-steps and two folded striplines is designed with the commercial software IE3D. The antenna consists of the two different sized tilt-steps in the patch for elevation of return loss at high frequency. And the two folded striplines are for band-notch from 4.83 GHz to 5.98 GHz in the bottom of the substrate. The proposed CPW band-notched UWB antenna is fabricated on a substrate with thickness of 0.762 mm (30 mil), relative permittivity of 3.48, and loss tangent of 0.004. The size of the proposed antenna is 30 × 32.95 mm^2. The patch with two tilt-steps has a height of 17.05 mm and a width of 15 mm. The optimized values of parameters are T_1 = 0.25 mm, St = 1.25 mm, T_2 = 0.5 mm, S_1 = 2.7 mm, and S_2 = 3.63 mm. The width of a feed line for 50 Ω characteristic impedance is 2.34 mm. The gap of the feed line and the ground plane, s, is 0.15 mm. The ground plane has a height of 15.5 mm and a width of 13.68 mm. The gap h of the patch and the ground plane is optimized both at 0.45 mm. The other side of the substrate has two folded striplines. The optimized values of the folded striplines are Ms = Mt = 7.4 mm, Mw = Mu = 1 mm. The location of the folded striplines, Hs = 5.25 mm.

3. The Simulated Results

The simulated return losses of the proposed antenna and the reference antenna which has no folded striplines in the bottom of the substrate are shown in Fig. 2. It shows that the proposed antenna

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satisfies the 10-dB return loss requirement in the frequency band from 3.1 to 11 GHz released by FCC for UWB system with the band rejection from 4.83 to 5.98 GHz, which includes the limited bandwidth by IEEE802.11a and HIPERLAN/2. Fig. 3 shows that the tilt-step is affected to the return loss in high frequency bandwidth. The effects of parameter M and Hs on the input impedance are simulated and shown in Fig. 4-5, respectively. Fig. 4 shows the simulated return loss for the proposed antenna in terms of different length M of the folded striplines. The proposed antenna is chosen with M = 14.8 mm due to the rejection of the limited bandwidth, 5.15 ~ 5.825 GHz. Fig. 5 shows that the location of the folded striplines is influenced to the impedance in low, middle, and high frequency bandwidths. The proposed antenna is chosen with Hs = 5.25 mm. Fig. 6 shows that the ratio of Ms to Mt is related to the return loss in both middle and high frequency bandwidths. The proposed antenna is chosen with Ms : Mt = 5 : 5. Compared to the stripline length M, the stripline location Hs, and the ratio of Ms to Mt are relatively sensitive to the input impedance over the UWB passband, as shown in the simulated results. Fig. 7 shows the simulated antenna gain. As shown in Fig. 7, the gain is decreased drastically to -3dB at the notched frequency band of 4.83 ~ 5.98 GHz.

4. Conclusions

In this paper, a compact coplanar waveguide (CPW) band-notched UWB antenna is proposed. To achieve wideband and band-notch characteristics, the proposed antenna consists of two different sized tilt-steps and two folded striplines. A parametric analysis of the proposed antenna has also been performed for various design parameters. Band-notch mechanism of the antenna is examined by IE3D software. The simulated results of the proposed antenna are satisfied the bandwidth requirement of UWB applications.

5. Figures

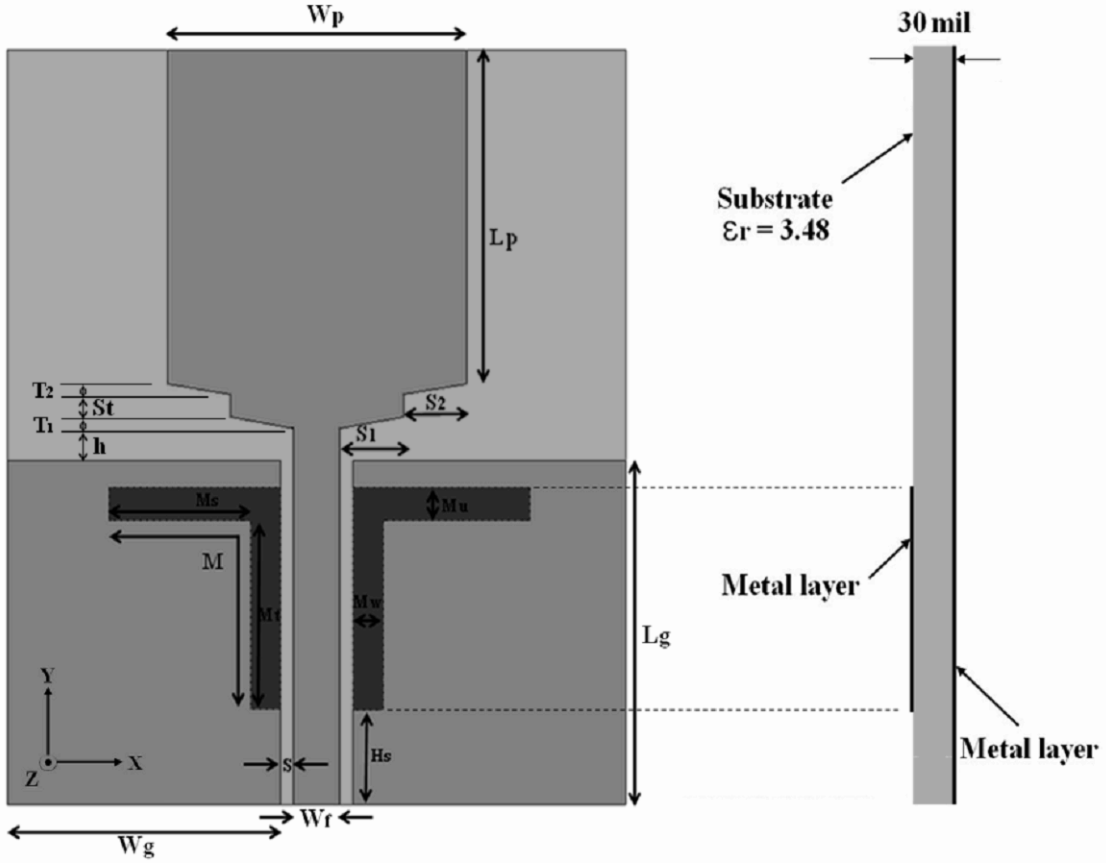

Fig. 1 The geometry of the proposed antenna

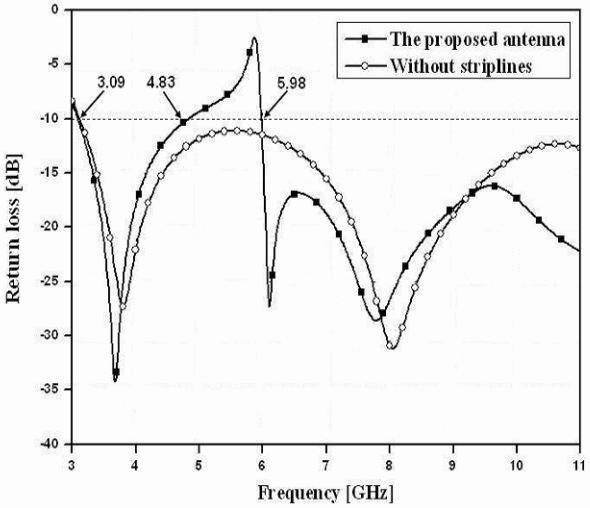

Fig. 2. Simulated return loss of the proposed antenna and the reference antenna.

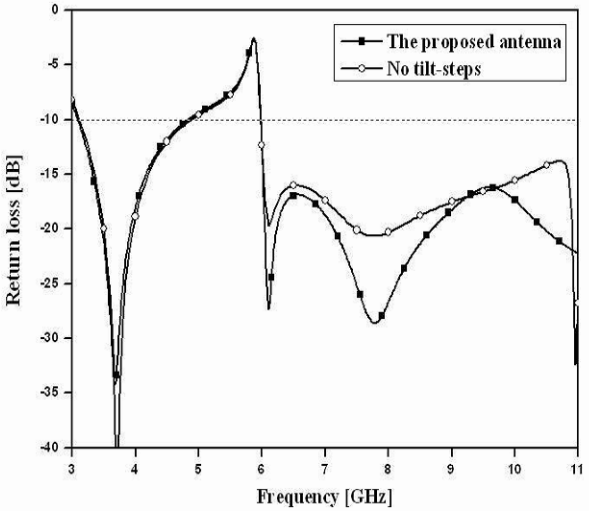

Fig. 3. Simulated return loss of the proposed antenna and no tilt-steps antenna.

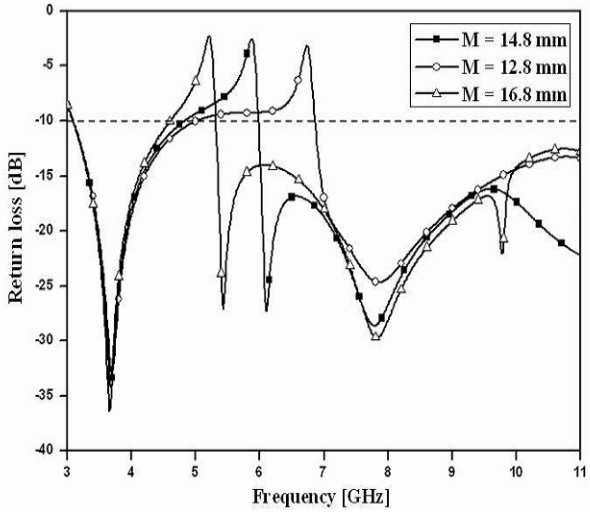

Fig. 4. Simulated return loss of the proposed antenna with different length, M.

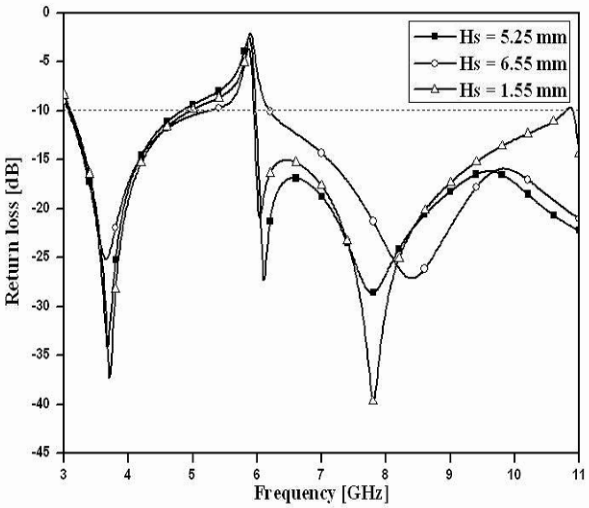

Fig. 5. Simulated return loss of the proposed antenna with different length, Hs.

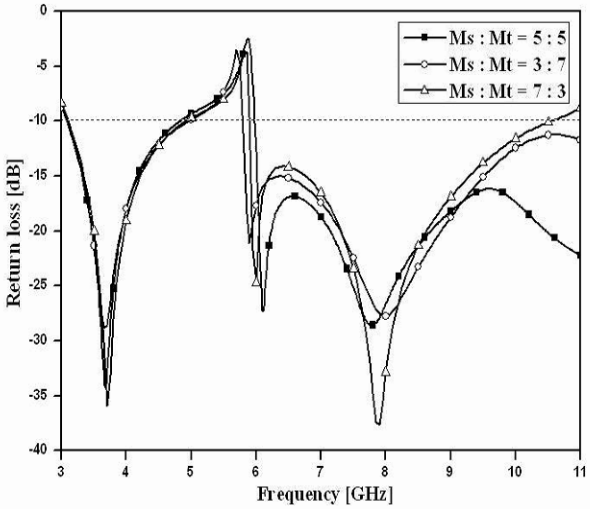

Fig. 6. Simulated return loss of the proposed antenna with different ratio, Ms : Mt.

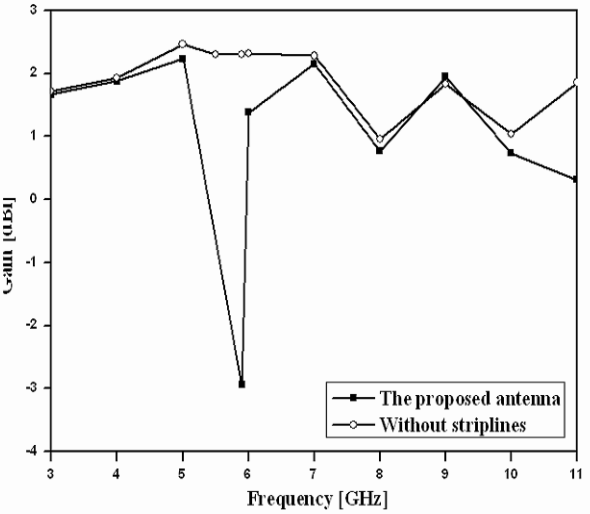

Fig. 7. Simulated total gain of the proposed antenna and the reference antenna.

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