A CPW-Fed UWB Antenna With WLAN and WiMAX Band Rejection Characteristic

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Abstract

In this paper, a simple and compact UWB antenna is proposed by use of printed monopole fed by coplanar waveguide (CPW). To reduce unwanted interference with WiMAX and WLANs bands covering 3.4-3.69 GHz and 5.15-5.825 GHz respectively, this antenna employs two notch slots provided band-rejection performance only by one structure.

Keywords : UWB antennas, WLAN, WiMAX, Band rejection

1. Introduction

The Federal Communications Commission (FCC) authorized the unlicensed use of the 3.1-10.6 GHz spectrum for UWB application [1]. After that, many researchers have studied on the principle of UWB system [2]. Recently with commercialization's rapid growth, personalization and portability of communications equipment have been increasing. So they have focused on an antenna for designing a simple and compact one . However, due to interference problem with WiMAX (Worldwide Interoperability for Microwave Access) and WLANs (Wireless Local Area Networks) bands allocated 3.4-3.69 GHz and 5.15-5.825 GHz respectively, it is essential for UWB antenna to have band-rejection performance.

There are two methods for getting band-rejection characteristics in the UWB antenna design, one of the methods is SRR and/or SIR based techniques are reported in [3-4]. But SRR structure has two severe drawbacks that the resonant frequency can't be easily controlled by changing the geometrical parameters. And occasionally, the whole structure takes up lots of space by the use of coupling mechanism. So this work employs various shaped slots having band rejection characteristics for UWB antenna design to differentiate from SRR and/or SIR based antennas [5-6].

In this paper, a simple and compact antenna which combines modified CPW-fed monopole patch and two slots embedding double band rejection characteristic is proposed. And the most optimum geometrical parameters are determined by the use of CST Microwave Studio (MWS) so that those optimum values are applied for the antenna design. Also band-rejection characteristic is analyzed by use of the equivalent circuit model. As the return loss is less than -10 dB from 2.84 GHz to 12.32 GHz in the measurement result, the broad band characteristic can be achieved. And it is found that by use of two slots in the rectangular, the band rejection property is occurred at 3.39-3.71 GHz and 5.08-5.93 GHz respectively.

2. Antenna Design and Simulation Results

This research reports on the antenna structure composed of two slots on the rectangular patch to avoid interference problem with unwanted frequency band. This antenna is mounted on the FR4 epoxy substrate with thickness of 0.8 mm and relative permittivity 4.4. The design procedure is described as follows, first printed monopole antenna fed by CPW (coplanar waveguide) is considered to obtain the wideband performance by cutting the ground plane and patch on the slant. After that, by changing the geometrical parameters of two slots, we have to design the antenna to appear the band-rejection characteristics at the desired frequency.

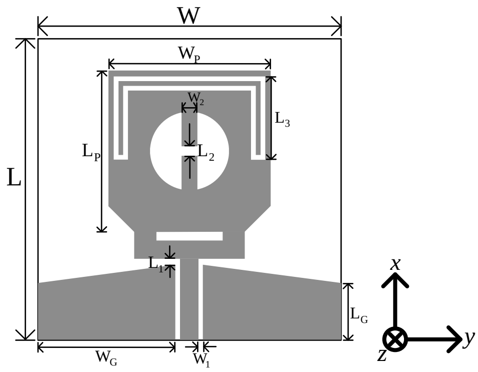

Fig. 1. The Geometry of the proposed UWB antenna with band rejection

2.1 The UWB Antenna Design

Before anything else, the antenna is designed which has the UWB characteristics in order to make a structure like in Fig. 1. This procedure is presented in Fig. 2 and Fig. 3. By selecting a CPW feed line, the feed-loss is decreased because feed line is parallel to the ground. Furthermore unlike the microstrip, active and passive element is easily attached on patch without via holes. So this structure has the merits of not only efficiency on processing but also lower parasitic effect caused by via in millimeter wave region.

In order to improve the performance of impedance in the 7-8 GHz frequency range, the rectangular patch of the antenna is cut on the slant at the lower two corners as shown in Fig. 1. By use of this manufacturing technique, it is found that wideband property cannot be affected but band rejection characteristic is improved excellently.

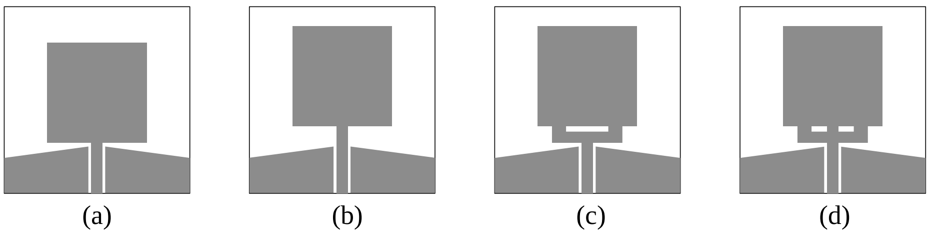

Fig. 2. Proposed antenna structure (a) single feeding line case (L_1=1). (b) single feeding line case (L_1=3). (c) double feeding line case (L_1=1). (d) triple feeding line case (L_1=1).

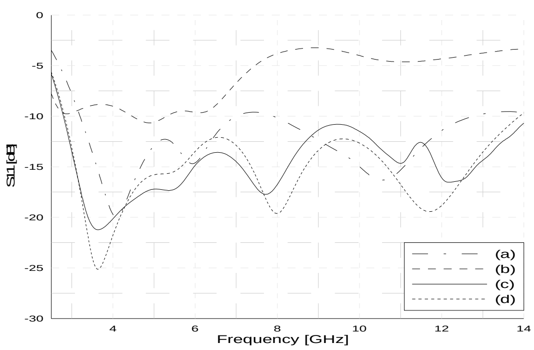

Fig. 3. The reflection coefficient properties versus feeding line number

As a result of the simulation, double feeding line scheme can be used to improve the wideband characteristic as shown Fig. 3. This is because the branch current flow on the double feeding line becomes more unaffected in comparison with those for the single feeding line case. But the reflection coefficient properties are same as both double and triple feeding line case because the branch current on the middle feeding line does not occur in the triple feed line structure. So there are mainly two current flows on the outer two feeding line in Fig. 2(d) case.

2.2 The UWB Antenna with Band-rejected Characteristic Design.

To design the UWB antenna with dual bands-notched characteristic embedded two slots into the modified patch as shown Fig. 1. Fig. 4 and Fig. 5 illustrate the reflection coefficient for different values of W_2 when $L_2 = 0.4$ mm and also values of L_2 when $W_2 = 1.1$ mm in the circular ridged slot structure. It is found that as the parameters W_2 of the circular ridged slot is increased and L_2 of the one is decreased, the central frequency of rejected band is decreased in these results. It is because of having a relation between L, C and resonant frequency like $f = 1/\sqrt{LC}$. As a results of the simulation, W_2 and L_2 are optimized 1.1 mm and 0.4 mm respectively. Furthermore double C-shaped slits which has band-notched characteristics placed in the patch due to restricted spacing, and then it can control the resonant frequency by changing the L and C values.

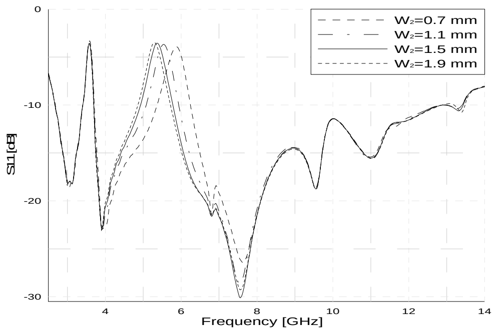

Fig. 4. The reflection coefficient properties versus W_2

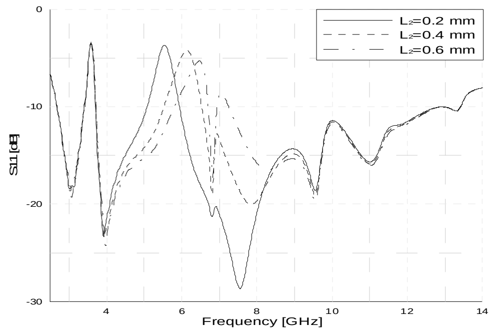

Fig. 5. The reflection coefficient properties versus L_2

As above, by handling the values of L and C of each slot can be control the resonant frequency that embedded band-notched corresponding with the structure. And good radiation occurs at other frequencies in the UWB band. Fig. 6 presented the equivalent circuit of this mechanism.

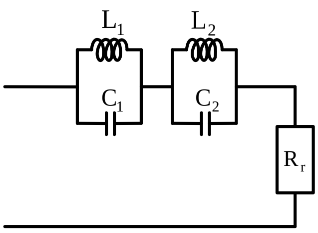

Fig. 6. Equivalent circuit model for antenna

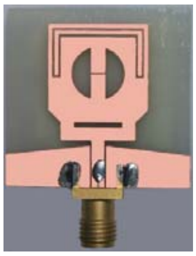

Fig. 7. Photograph of the proposed antenna

The UWB antenna with band-notched characteristic is designed as analyzing two slots respectively. The optimized parameters are as W=30 mm, L=30 mm, W_G=13.65 mm, L_G=5.5 mm, W_P=16 mm, L_P=16 mm, W_1=0.35 mm, and L_3=8.2 mm. The fabricated antenna is as shown in Fig. 7. Fig. 8 shows a comparison of the results in simulation and measurement, they almost correspond. From this results can be clearly shown that the reflection coefficient of UWB band is less than -10 dB and two rejected bands are larger than -10dB. The measured radiation patterns of the proposed antenna at 4 GHz, 7 GHz, and 10 GHz are plotted in Fig. 9.

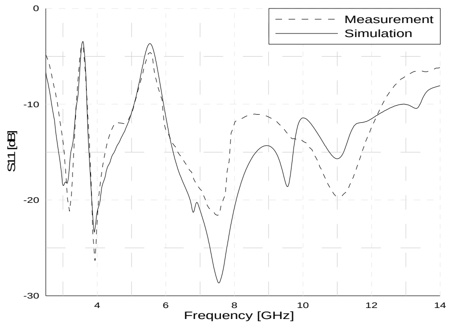

Fig. 8. Measured and simulated reflection coefficient properties

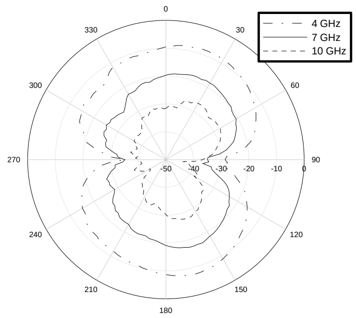

Fig. 9(a). Measured E-field pattern (y-z plane) with vertical horn.

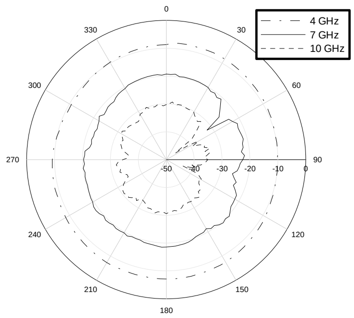

Fig. 9(b). Measured H-field pattern (z-x plane) with horizontal horn.

3. Conclusion

In this paper, a novel UWB wideband monopole antenna with band-rejection characteristic is proposed. It satisfies wider than the UWB band, 3.1-10.6 GHz by modifying a part of the ground plane and patch. And to avoid interference in frequency of WLAN and WiMAX for wireless communication, embed circular ridged slot and double-slit. And the simulated VSWR of antenna satisfied less than 2. The proposed antenna is usable for UWB systems that need to reject frequency with WLAN and WiMAX.

Acknowledgments

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