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A New Design of Planar Frequency Reconfigurable Antenna with WiMAX and WLAN Band Rejection for UWB Applications

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Abstract

In this paper, a new reconfigurable frequency microstrip antenna with an ability of two rejecting intruder frequency WLAN and WiMAX bands for UWB applications is presented. In this antenna, a defect ground structure (DGS) and a U-shaped slot which is located on the ground plane have been used to improve bandwidth. Antenna impedance matching has been achieved through creating two symmetric incision on the microstrip feed line the antenna. Also rejecting Intruder frequency bands are omitted by two slots on the radiation patch, and the performance of omitting rejecting frequency bands is controlled by putting two switches on the slots of radiation patch. Simulation results show that the designed antenna is able to cover a frequency band 3.1-10.9 GHz (UWB) and does the performance of omitting rejecting frequency bands in two frequency band 3.3-3.8 GHz (WiMAX) and 5.1-5.9 GHz (WLAN).

Keyword: Reconfigurable Antenna, Band Rejection, Ultra Wideband (UWB).

INTRODUCTION

Nowadays, microstrip antennas according to their particular physical and electromagnetic properties , such as compression, using multiple frequency bands, effortless design and manufacture , more economical and it is appropriate that these antenna be used in integrated circuits ..., In comparison with other antennas they have more advantageous to be used instead. Development of wireless communications and rising demand for working frequency bands has caused the radio spectrum congestion and different defined radio systems interact and overlap with each other[1] . In recent years, along with the frequency band which is defined by the U.S. A Federal Communications Commission (FCC) for commercial communications, the interest in UWB technology has increased [2]. But other frequency bands like WiMAX and WLAN in this frequency range caused interference between these frequency bands and UWB system. This problem has led to the proposing of different UWB antennas with the ability of rejecting frequency bands e in recent years. But most of the proposed antennas or just one of those intruder bands have been removed or if have the ability to remove some annoying frequency bands, no control over the frequency bands rejection [3]-[12].

In this paper, a new frequency reconfigurable microstrip antenna is presented to reject Intruder frequency bands for UWB applications. This antenna can remove two frequency bands 3.3-3.8 GHz (WiMAX) and 5.1-5.9 GHz (WLAN). The antenna bandwidth has been improved by using the Defect Ground Structure (DGS) and a U-shaped slot. Also by creating two symmetric incisions on the designed microstrip feed line antenna, antenna impedance matching in the frequency range of work has been improved. Then by creating Characteristic has been added to performance antenna. Also two pin diodes have been used on the slots of radiation patch to control the frequency band rejection.

ANTENNA DESIGN

The geometry structure of the proposed antenna is shown in Figure 1.

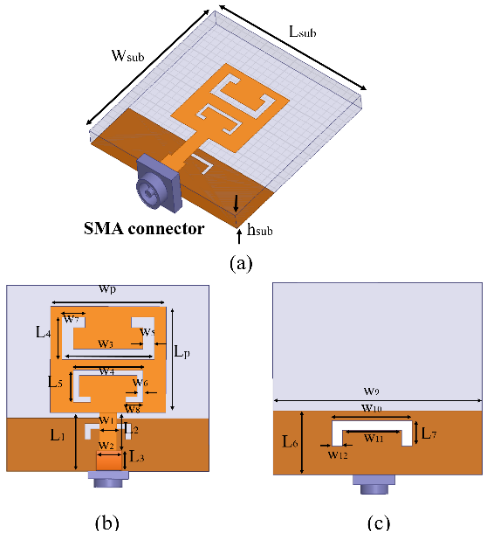

Figure 1. Geometry of proposed antenna. (a) Side view. (b) Top view.(c) bottom view

The antenna was built on a 0.8 mm thick substrate with a relative Permittivity of 4.4 and a loss tangent of 0.02.

The antenna design includes a square radiation patch with dimensions of 10×10 mm^2 ,With a defect ground substrate which is located on the substrate fr4 material with dimensions 30×30 mm^2 and fed by a microstrip feed line 50Ω. To improve the performance of antenna a parametric study has been done on the design parameters. Also the effects of key design parameters on the input reflection coefficient are investigated. The final values of the parameters of the proposed antenna design are presented in

Table 1. Ansoft HFSS Software is used for simulating and analyzing the proposed antenna and obtaining S parameters [13]. Also, to verify the results of the CST Microwave Studio software is employed [14].

Table 1. Final dimensions of the proposed antenna

Parameter	***Dimension(mm)***	***Parameter***	***Dimension(mm)***
L_{Sub}	30	w_1	1.5
W_{Sub}	30	w_2	1.9
h_{Sub}	0.8	w_3	8
L_p	10	w_4	6
w_p	10	W_5	2
L_1	8	W_6	1
L_2	6	W_7	4
L_3	2	W_8	3
L_4	4	W_9	30
L_5	3	W_{10}	6
L_6	7	W_{11}	4
L_7	1.5	W_{12}	2

RESULTS AND DISCUSSION

Structure of the antennas which has been examined in simulation studies is shown in Figure 2.

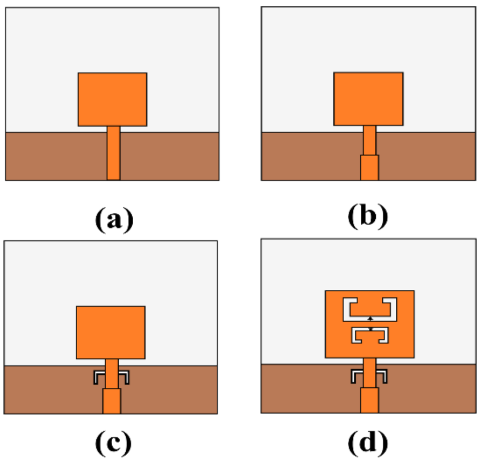

Figure 2. (a) Basic Square antenna with a DGS structure in ground plane .(b) Square antenna with a DGS structure in ground plane and two symmetric incision in the microstrip feed line. (c) Square antenna with a U shaped slot on the ground plane and two symmetric incision in the microstrip feed line. (d) Proposed antenna.

The return loss of the antennas which has been examined in simulation studies is shown in Figure 3.

As can be seen in Fig. 3, the microstrip antenna base has two resonances in the range UWB, and impedance matching in mid-band is not optimal. With the creation of two symmetrical incisions in the microstrip feed line, frequency response in mid-band antenna is improved. Parameter L2 has a significant impact on antenna impedance matching designed antenna. Fig. 4 shows the return loss of the antenna for the change of L2 parameter. As it can be seen by changing the amount of L2 antenna impedance matching will change and the optimum Value is L2 = 6 mm.

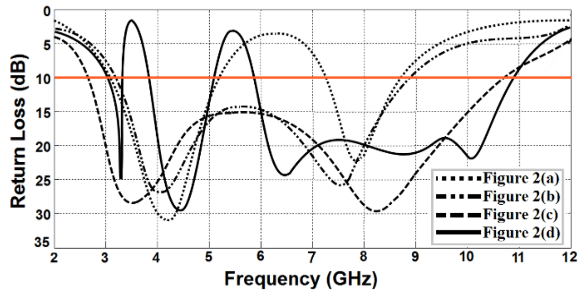

Figure 3. Simulated return loss characteristics for antennas shown in Fig. 2.

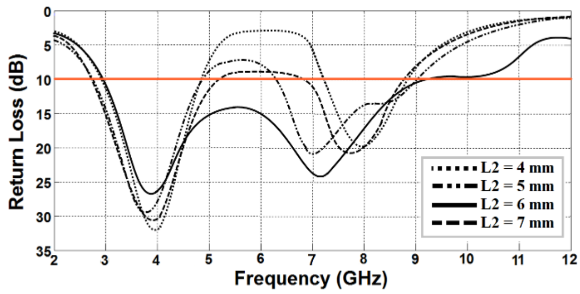

Figure 4. Simulated return loss of proposed antenna with different L2.

But still the bandwidth of the antenna does not cover total frequency range of UWB systems. Then with the creation a U-shaped slot on the ground plane, the antenna covers total frequency band of the UWB systems. Then with add two slots to the radiation patch, Performance of rejecting frequency bands are added to the antenna.

At the final stage by putting two pin diodes on the slot of patch and changing their state, performance intruder frequency bands rejection is controlled. The proposed structure has capacity to work in two different modes. When both switches are off, the antenna operates in mode A. In mode A, the antenna is cover total frequency range UWB systems. When both switches change the state and turn on the antenna operates in mode B. In this mode, the antenna which is proposed in this paper is able to cover the frequency band 3.1-10.9 GHz by removing frequency band 3.3-3.7 GHz (WiMAX) and 5.1-5.9 GHz (WLAN).Parameter L7 has a significant impact on improving the bandwidth of the designed antenna. For this purpose, a parametric study is done on the parameters L7. Figure 5 shows the return loss of the antenna for the change of L7 parameter on the U-shaped slot.

As it can be seen by increasing the amount of L1 of 0.5mm to 2mm antenna bandwidth will change and the optimum Value is L7 = 1.5 mm.

Figure 6 shows the Simulation results return loss of proposed antenna in mode A and mod B. for verify the results of the CST Microwave Studio software and Ansoft HFSS Software are used. As it can be seen in the figure, the results obtained from both software is similar and this confirm validity of the results.

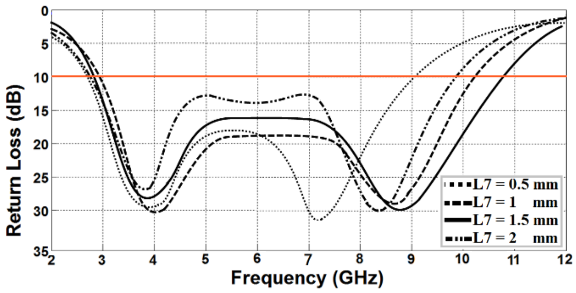

Figure 5. Simulated return loss characteristics of proposed antenna with different L7.

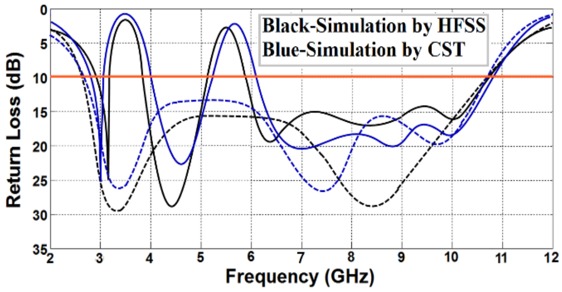

Figure 6. Return loss of proposed antenna in mode A (dash) and mode B (solid).

Figure 7 shows the simulated peak gain of the proposed antenna. It is observed that Sharp gain decreases occur both in 3.3–3.8 GHz and 5.1–5.9 GHz bands. However, for other frequencies outside the rejected bands, the antenna gain is nearly constant in the entire UWB band.

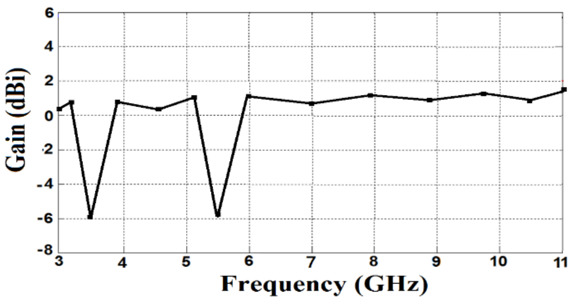

Figure 7. Simulated gain of proposed antenna.

The radiation pattern of the antenna which is proposed in this paper for three different working frequencies in the E-Plane and H-Plane is shown in Figure 8. As can be deduced from this figure the antenna has radiation characteristics suitable for its wide frequency band. And radiation pattern of the magnetic field plane is all the directional and Uniform that this is a significant advantage for many applications of UWB systems.

In study of UWB antenna, since the antenna works in a wide range of frequencies, in addition to check the antenna in the frequency domain, time domain performance of the antenna must also be examined to confirm the accuracy of its performance. One of the important parameters that must be examined is the group delay. Figure 9 shows the groups delay of the antenna designed in this paper.

As seen in this Figure, the group delay of the antenna in its wide frequency range performance is well less than 2 nano second. And indicates that this design is suitable for UWB applications.

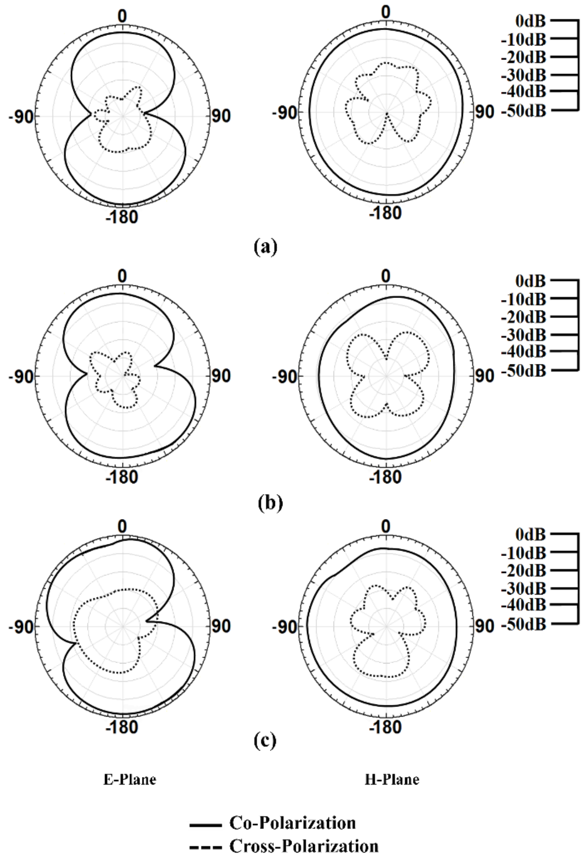

Figure 8. Simulated radiation patterns of the proposed antenna.(a) 4 GHz and (b) 6.5 GHz (c) 9.5 GHz.

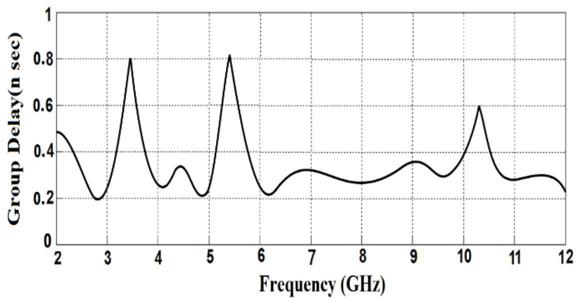

Figure 9. Group delay of the proposed antenna

CONCLUSION

In this paper, a frequency reconfigurable microstrip antenna with the ability of intruder frequency bands-rejection for UWB systems is presented. The antenna bandwidth is improved by using a defect ground structure with a U-shaped slot. And have been used two slots on the radiation patch to remove the intruder frequency bands WLAN, WiMAX, which will interfere with UWB systems. The performance of above Intruder frequency bands rejection is controlled by two switches that are located on slots of radiation patch. From the features of this antenna which can be noted are extended bandwidth, good radiation performance and small dimensions. But the main advantage of this antenna compared to the previous designed antenna is the ability to control intruder frequency bands rejection. In this way that when all the switches are on, the antenna covers the frequency band 3.1-10.9 GHz and with turning off the switches the frequency band WLAN and WiMAX will be removed. All the mentioned advantages makes this antenna a good choice of UWB systems.

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