Design of an Ultrawideband Antenna For Wimax/WLAN Band Rejection

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Abstract

A compact Ultrawideband (UWB) antenna with band rejection for WiMAX/WLAN bands is presented in this paper. The WiMAX spectrum uses 3.4-3.6 GHz band for its operation and the WLAN uses 2 different bands in the 5.15-5.825GHz spectrum other than the usual 2.4–2.835 GHz band. Therefore, a UWB antenna that receives signals from coexisting WiMAX/WLAN devices may get interfered intercommunicating at the particular bands described earlier since the range of operation for UWB antenna lies in 3.1-10.6 GHz band. To suppress this interference, researchers have developed various band rejected UWB designs that reject typically the WiMAX band and the 5.15–5.825 GHz WLAN band or a large part of it. The rejection can be made possible by using a U-slot in the ground plane and 2 circular split ring slots in the radiating patch. Here the intermediate band of frequency in WLAN can be effectively utilized for ultra wideband range operations.

1. Introduction

Since the Federal Communications Commission (FCC) has given permission for the unlicensed use of Ultrawideband (UWB, range of 3.1-10.6 GHz) for commercial applications, UWB technology has attracted much more attention for communication purposes [1]. The WLAN bands to be rejected here are 5.15-5.35GHz, 5.725-5.825 GHz and the WiMAX band is 3.4-3.6 GHz respectively [2]. Recently, many UWB antennas attempted to overcome the interference problem using a frequency band rejected characteristics. The most popular antenna designs with frequency band rejected function approaches are employing slots, parasitic strips, and a slit from the radiator or ground plane [3, 4]. Anyway, most of these designs have only a double notched band. More than that among the most designs of band reject antennas rejecting the WLAN bands till now, the entire 5–6 GHz frequency band has been completely rejected [5] –[8]. However, the needed band notches are 0.2 GHz for both the WiMAX band and the lower WLAN band and 0.1 GHz for the upper WLAN band. Hence, the information contained in the other frequency bands is to be kept available for other user applications [9].

In this paper, a simple and compact monopole antenna with triple band notches for WiMAX 3.5 GHz and WLAN 5.15/5.825 GHz is proposed. The antenna consists of a microstrip feed line, a ground plane and a spade-shaped radiation patch with two identical circular split ring resonators and two steps to the front side which realize the band stop-band function etched in it. By employing a U-slot defected ground structure in the ground plane and etching 2 split ring slots in the radiation patch, triple rejection filtering properties for WiMAX/WLAN can be achieved.

2. Antenna Design

Figure 1 and Figure 2 Shows the geometry and dimensions of the proposed antenna, which is printed on an F4B substrate with size of 30×34 mm^2, thickness of 1 mm, and relative permittivity of 2.65. A 50Ω microstrip feed line is designed with a width of 2.84 mm. The first design to be investigated is that with the split ring slots etching on the radiated stub. It can be found that, in particular, a slot with the split ring can generate a stronger resonance than any other shape since the current distribution is concentrated at the edge of the patch. In this case, the antenna performs a narrower and stronger band notched property for both WiMAX and lower WLAN band. To generate another narrow notched band for the upper WLAN, an embedded open-circuited stub is introduced to overcome this problem. For our concern, a conventional quarter-wave-length (l/4) micro strip spur-

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line is replaced by a quarter sized embedded open-stub with the same width, and a gap to generate a narrower bandwidth. Here an open-stub is etched in the feed line, so that we can reduce the length of the feed line. To overcome this problem, the open-stub can be embedded in the ground plane of the feed line to form a defected ground structure, and the similar steep rejection property is achieved.

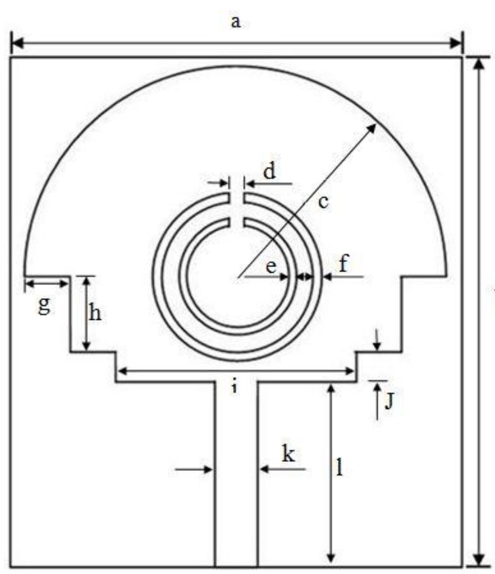


Figure 1. Antenna configuration-top view

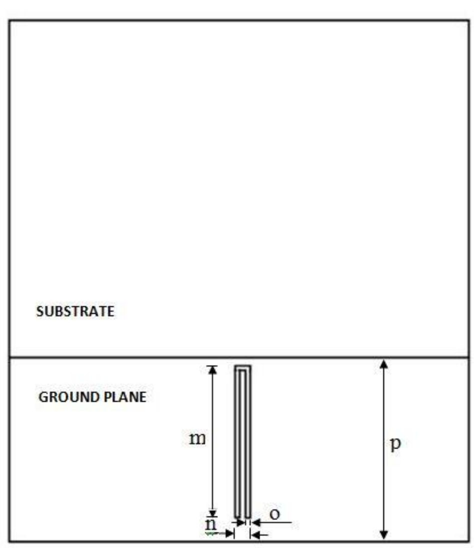


Figure 2. Antenna configuration-bottom view

Table 1: Dimensions of the band rejection antenna

Dimensions	**Values (mm)**
width of the Substrate (a)	30
Length of the Substrate (b)	34
Radius of the semicircle (c)	14
Slit size of split ring (d)	1
Thickness of the first split ring slot (e)	0.42
Thickness of the first split ring slot (f)	0.60
Step size from semicircle (g)	3
Width of the First Rectangular step (h)	5
Length of the Second Rectangular step (i)	16
Width of the Second Rectangular step (J)	2
Width of the microstrip line (k)	2.84
Length of the microstrip line (l)	12.4
Height of the U-slot (m)	9.6
Width of the U-slot (n)	0.6
Thickness of the U-slot (o)	0.2
Length of the partial ground plane (p)	12

The optimized values of the band rejection antenna are given in the Table1.

3. Simulated Results

3.1 VSWR

The voltage element of a standing wave in a transmission line consists of the forward wave merged on the reflected wave. Reflections occur as a result of discontinuities, such as imperfections in transmission line, or if a transmission line is terminated with a value other than its characteristic impedance.

VSWR in relation with the Reflection Coefficient is given in (1)

$$VSWR = (1+\Gamma) / (1-\Gamma) \quad (1)$$

VSWR is always a real and positive number for antennas. Smaller values of VSWR results in better impedance matching to the transmission line and more power is delivered to the antenna. The ideal value of VSWR is 1.0 which is impractical .For the rejection purpose the VSWR value has to be made high.

From Figure 3 It can be seen that the proposed antenna exhibits three steep rejected bands in3.4-3.6, 5.15 – 5.35 and 5.725 – 5.825 GHz, while maintaining wideband performance from 3.1 to 10.6 GHz for VSWR value below 2, covering the entire UWB frequency band. On the three rejected bands, the VSWR touches the values 7.4, 4.0 & 4.2 respectively which enables the rejection.

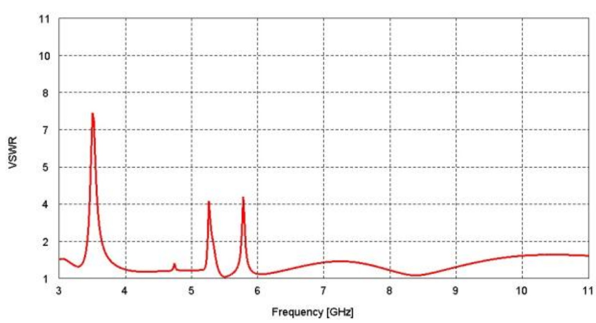


Figure 3: VSWR of the Band rejection Antenna

3.2 Return Loss

Return loss is an important parameter in the antenna performance; it gives how much power is lost while the antenna is radiating .If there is any discontinuity in the transmission line more power will be lost. Return loss can be expressed in terms of power as shown in (2).

$$RL\ (dB) = 10\log_{10} (Pi/Pr) \quad (2)$$

Where Pi is the incident power and Pr is the reflected power Return loss is mainly expressed in terms of scattering parameters or S parameter .It describes the response of the N-port network. The first number in the subscript of S parameter represents responding port and second number represent incident port. In order to achieve good impedance matching antenna should be matched with transmission line i.e. reduce the power reflected from the antenna and maximize power delivered to the antenna.

From Figure 4 It is clear that first rejection is occurring in the 3.4-3.6GHz, second in 5.15 – 5.35GHz band and the third rejection at 5.725 – 5.825 GHz .In these particular bands the S11 value goes above -10dB where this threshold value is taken as the normal operating range for any antenna .The rejection occurs since the values are -2.34dB, -4.43dB and -4.23dB for the particular rejected bands and not in the entire UWB range where the value is less than -10dB.

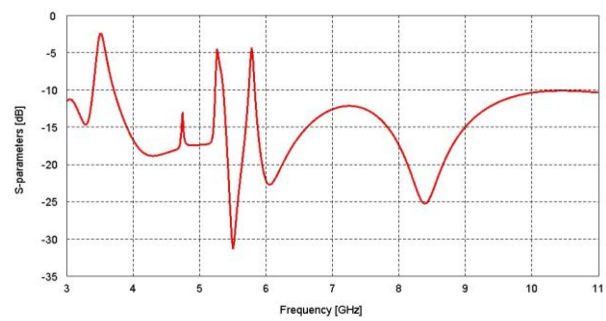
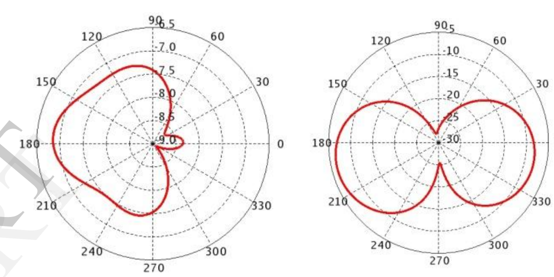


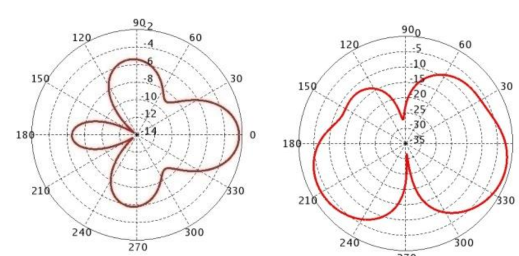
Figure 4: Return Loss of the Band rejection Antenna

3.3 Radiation Pattern



(a) x-z plane plot (b) y-z plane plot

Figure 5. Radiation patterns of proposed antenna at 5.24GHz



(a) x-z plane plot (b) y-z plane plot

Figure 6. Radiation patterns of proposed antenna at 8.33GHz

The simulated normalized radiation pattern in the x-z plane and y-z planes are given in Figure 5 and Figure 6.

4. Conclusion

In this paper, a novel UWB planar monopole antenna with triple band rejected characteristic is proposed. The three stop bands are generated by etching two circular split ring slots in the radiation patch and one U-slot in the ground plane. The proposed antenna is capable of covering the entire UWB frequency band and has good radiation performance. It achieves single band rejection for WiMAX 3.5 GHz and dual band rejection in WLAN 5.15/5.825 GHz, which can eliminate the interference among UWB systems and WiMAX/WLAN systems. The measured result shows that the VSWR goes above 2 for the notched frequency ranges between 5.15 – 5.825 GHz and 3.4 -3.6 GHz.

5. References

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