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WLAN NOTCH ULTRA WIDEBAND ANTENNA WITH REDUCED RETURN LOSS AND BAND SELECTIVITY

Natesh R., Arun V.
Department of ECE
Anna University Regional Centre Madurai
Madurai
nateshr.in@gmail.com, arunece@autmdu.ac.in

ABSTRACT

An ultrawideband (UWB) antenna design to notch narrowband frequency of WLAN 802.11a in 5.15GHz to 5.85 with improved return loss and band selectivity is proposed in this paper. Rectangular patch antenna with 50Ω microstrip line with stepped radiator is proposed for UWB frequency covering 3.1 GHz to 10.6 GHz. By implant half wavelength open ended slot for WLAN lower frequency of 5.15 GHz and quarter wavelength short ring for 5.85 GHz in ground plane near the feed line we can obtain a notch band with improved selectivity. In order to avoid notch with near frequency quarter wavelength slots for near frequency was produced in the ground plane to reduce the return loss.

***Keywords*—**ultrawideband (UWB) antennas, notch antenna, Rectangular patch antenna, selectivity, half wavelength open slot, quarter wavelength short ring

I. INTRODUCTION

In 2002, the Federal Communications Commission (FCC) of the United State officially released the regulation for Ultra wideband (UWB) technology. In this regulation, the spectrum from 3.1 GHz to 10.6 GHz (a fractional bandwidth of 110%) is allocated and the Equivalent Isotropically Radiated Power (EIRP) is less than -41.3 dBm/MHz for the unlicensed indoor UWB wireless communication system. According to the release regulation, UWB technology which is based on transmitting ultra short pulses with duration of only a few nanoseconds or less has recently received great attention in various fields for the short distance (< 10m) wireless communications. Because of the ultra wideband property, UWB technology has many benefits, which are high data rate (> 100 Mb/s), low power consumption, compact, low cost, excellent immunity to multipath interference and reduced hardware complexity.

UWB frequency range includes existing some narrow frequency bands such as IEEE 802.11a wireless local area networks (WLANs) using the frequency band from 5.15 GHz to 5.825 GHz and new telecommunication technology based on the IEEE 802.16, Worldwide Interoperation for Microwave Access (WiMAX) operating on 3.3-3.6 GHz, X-Band satellite communication from 7.25 to 8.395 GHz the coexistence of UWB with other systems has been an important issue. Thus, the UWB antenna should be designed with a notch in the WLAN and WiMAX frequency band because UWB transmitters should not cause any electromagnetic interference to nearby communication systems. To avoid interferences with other narrow band frequencies antenna must filter the narrow band frequencies.

Recently a number of antennas with band notch property have been proposed. In [1], describes the design of novel printed UWB antenna with reconfigurable band notch characteristics was presented by modified rectangular Patch antennas with a circular and three rectangular slots cut on it. The major problem found that the frequency range varies when both diodes are on simultaneously. In [2], describes the design of printed microstrip fed monopole antenna with triple notch bands by embedded a modified H-shaped resonator with an with an additional outer line beside the microstrip feed line, band rejected filtering characteristics around the 3.4 to 3.6 GHz WiMax frequencies, 5.725 to 8.95 to 8.395 GHz IEEE 802.11 a frequency and 7.25 to 8.395 GHz were obtained. This antenna has switchable single notch bands of 3.12 to 3.84 GHz and 5 to 6.07 GHz WLAN. Only one notch band had the flat response remaining two notch band had poor selectivity. In [3], describes the rotatable dual notch UWB of 3.3 to 4.2 GHz and 5 to 6 GHz and triple band of 2.4 to 2.9 GHz, 3.6 to 4.4 GHz and 5 to 6 GHz WLAN reconfigurable antenna by arc shaped stub and inverted L-shaped stub as resonating elements this antenna illustrates that it has compact size, easy fabrication with low cost and drawbacks observed that the gain varies from different bands in Triple band reconfigurable WLAN. In [4], describes the UWB notch antenna of four stop bands are integrated in the feed line and it has limited band notch performance. In [5], described the bandwidth enhancement of UWB antenna with dual band notch characteristics circle like slots and two nested C shaped stubs and minimum gain was achieved in the lower frequencies. In [6], described that the printed monopole antenna with dual band notch function square radiating patch with a inverted T shaped slot surrounded by C shaped slot which provide usable fractional bandwidth of 2.71 GHz to 12.06 GHz and problem arise was it didn't had a sharp selectivity on notch bands. In [7], band rejected monopole antenna is investigated by utilizing he folded strips and a new inductive coupling schemes the antenna demonstrates the band stop filter like response with high frequency selectivity and controllable bandwidth. Selectivity is difficult and bandwidth controlled is difficult. In [8], two compact UWB slot antennas with band rejected characteristics are proposed for UWB communications. In [9], planar UWB antennas with on ground band notch structures were proposed by two different slot resonators with quarter wavelength and half wavelength configurations are embedded in an arc shaped ground plane of the circular disk patch antennas in order to obtain the desired band rejection at 5.8 GHz and it didn't offers sharp selectivity. In [10], author proposed a compact planar UWB antenna with 3.4/5.5 GHz dual band notched characteristics by beveled rectangular metal patch. In [11], three types of antennas with Straight, triangular, C-shaped, H-shaped, U-shaped and pie shaped slots triple notch bands are proposed. In [12], a simple and compact UWB aperture antenna with T shaped exciting stub was proposed. In [13] the band-notches are realized by adding independent controllable strips in terms of the notch frequency and the width of the band-notches to the fork shape of the UWB antenna. In [14], described that the design of ultra wide bandwidth antenna with sharp selectivity and controllable bandwidth however nearby frequency gets notch.

II. ANTENNA DESIGN

A. *UWB Antenna Design*

The band notches are introduced in order to stop the function of the antenna in that particular frequency range. By this the interference between the UWB system and the narrow band system is reduced to a great extent. Introduction of the band notches helps us to avoid the use of the band stop filters and hence reducing the cost and complexity of the antenna. Nowadays demand is for miniaturized technology and MSA helps us in achieving that.

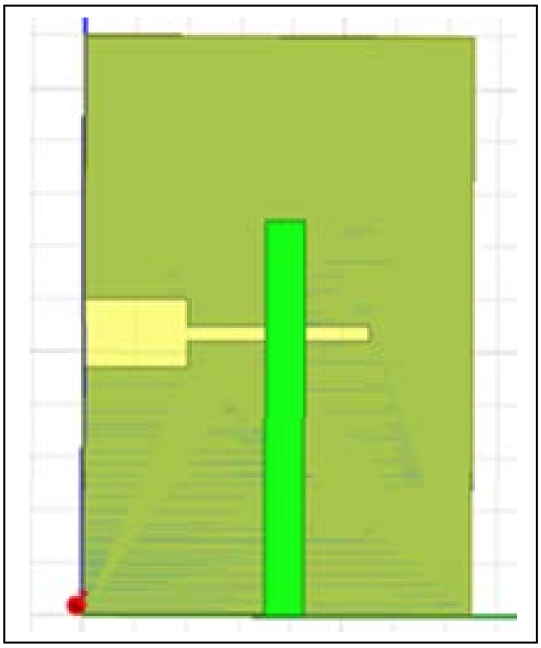


Fig. 1. **HFSS Design of UWB Antenna HFSS Design of UWB Antenna**

Fig. 1 shows that the UWB antenna designs and configuration. This antenna was fabricated on a 15 x 22 mm2 commercially available FR4 epoxy substrate with dielectric constant ε_r = 4.4 and loss tangent 0.002. As show in figure a stepped slot in the ground plane is excited by a 50Ω microstrip line. The stepped radiator can result in a transition from one resonant mode to another. By using Ansoft's High Frequency Structure Simulation (HFSS) software to optimize the parameters, good impedance match over a broad frequency range can be obtained. By adjusting the stepped slot, the antenna can achieve a wide impedance matching characteristic (3.1 GHz to above 10.6 GHz). Besides, the overall size of the antenna is reduced.

B. *Implementation of Notch Bands*

To deal with the difficulties of sharp selectivity a new band notch antenna was proposed in by slitting an open ended slot and split ring slot in antenna1. To eliminate WLAN 802.11a frequency of 5.15 – 5.825 GHz, two slots were etched. One is open ended slot for eliminate lowest band of 5.15 GHz and short ended slot were etched for 5.825 GHz on the ground plane near the feed line. The length of the open and short ended slot can be calculated approximately by

$$L_{Slot} = c/(4f_l\sqrt{\varepsilon_{eff}}) \quad (1)$$

$$L_{Ring} = c/(2f_h\sqrt{\varepsilon_{eff}}) \quad (2)$$

Where, C is the speed of light in air, f_l and f_h are the lowest and highest resonant frequencies. In order to cover the WLAN band f_l is initialized as 5.15 GHz and f_h is initialized as 5.85 GHz. ε_{eff} is the effective dielectric constant.

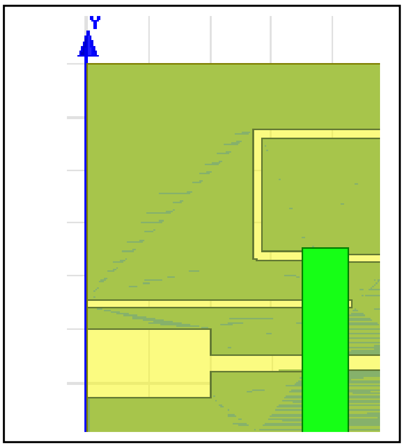


Fig. 2. **HFSS Design of UWB Antenna with WLAN Notch Band**

In fig. 2 design shows the implementation of open ended slot and short ring for improve the selectivity of WLAN 802.11a band from 5.15 GHz to 5.825 GHz. Notches were implemented in ground plane of UWB antenna. Notch bands can be adjusted easily by varying the length and width of the slot. The width of the feeding microstrip line is 1.5 mm and its characteristic impedance is 50Ω. The gap distance between the radiating patch and the ground plane is fixed at 0.08mm.

But WLAN 802.11a operates in the range of 5.15 GHz to 5.825 GHz and interferes with UWB devices. So instead of using a band stop filter at the receiver antenna we have etched a open ended slot and short ended ring on the ground plane in order to facilitate band rejection facility around 5.15 to 5.85 GHz, so that the interference is minimized.

C. Implementing Slots

In the previous notch Band implementation selectivity of the WLAN notch band was improved but in nearby frequencies return loss got higher. In order to reduce the return loss in near frequencies slot implemented as shown in Fig. 3.

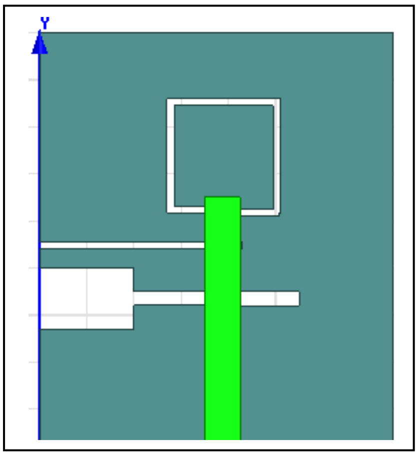


Fig. 3. **HFSS Design of UWB Antenna with slots**

In order to reduce return loss in the near frequencies quarter wavelength slots calculated as in (1). Slot lengths for two slots are 6mm and 5mm respectively. By using this slots return loss can be reduced.

III. RESULTS AND DISCUSSIONS

A. Results of UWB Antenna

Simulated return loss and VSWR result of UWB antenna are shown in Fig. 4 and Fig. 5. Return loss results shows that below -10 dB from 3.6 GHz to 10.6 GHz and VSWR gets the better improvement is VSWR ≤ 1.5 from 3.6 GHz to 10.6 GHz.

Results shows that the frequency band starts from 3.8 GHz to 10.6 GHz. In that frequency band Return Loss less than -10 dB and VSWR results less than 1.5. But the UWB frequency band generally covers from 3.1 GHz to 10.6 GHz but in these results it starts from 3.8 GHz only. By varying the slot impedance bandwidth changed and subsequently we can vary the frequency band.

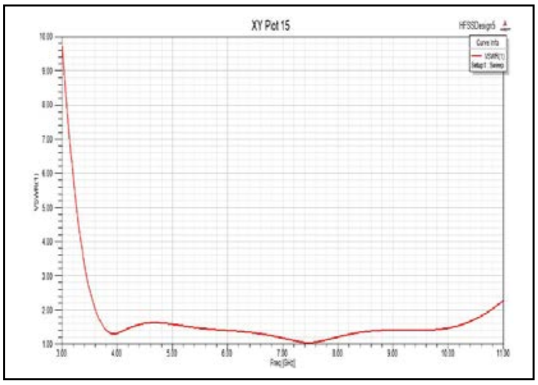


Fig. 4. **VSWR Results of UWB Antenna**

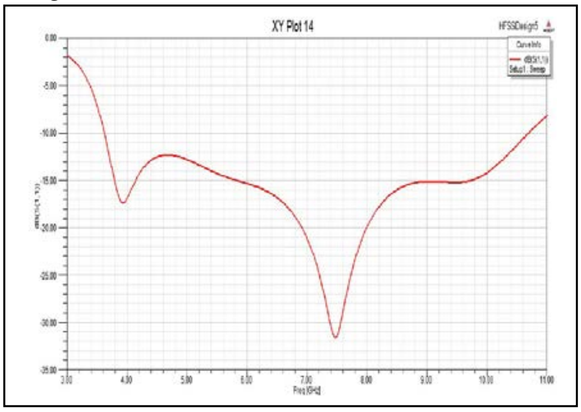


Fig. 5. **Retrurn Loss Results of UWB Antenna**

B. Results of UWB Antenna with Notch Bands

Figure 6.7 and 6.8 shows the result of return loss and VSWR for 5.15 & 5.85 GHz notch band UWB antenna. Here return loss is lesser than -10 dB for 3.6 GHz to 10.6 GHz. Because of implementing ring and open ended slot for the frequency of 5.15 & 5.825 GHz return loss ≥ -10 dB for 5.15 GHz to 5.825 GHz and VSWR value ≥ 1.5 for the frequency range of 5.15 GHz to 5.825 GHz.

The return loss, and VSWR across the UWB in the pass band and notch frequencies of the reference antenna and dual-band notched antenna are studied using computer simulation. Results shows that the there is mitigation of narrowband frequency of 5.15 to 5.85 GHz. Selectivity of the notch band improves so there is no mitigation with the WLAN 802.11a frequency band. The return losses of the notch band antenna are shown in Figure 6.7. Across the UWB, excluding the notched bands the simulated return losses of the reference antenna are larger than 10 dB, satisfying the UWB requirement. In the notched bands, the return loss of the notched antenna is substantially smaller than 10 dB. Hence selectivity of the notch band improved.

Fig. 6. VSWR Results of UWB Antenna with Notch Bands

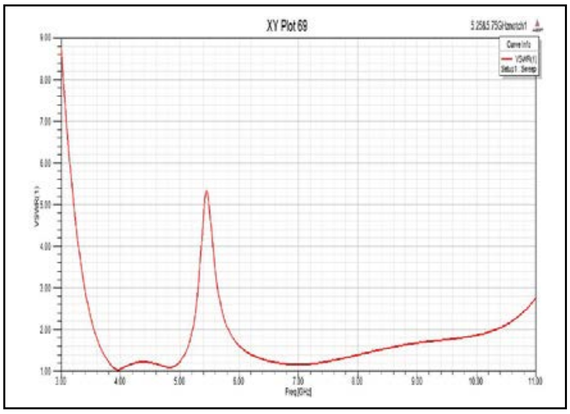
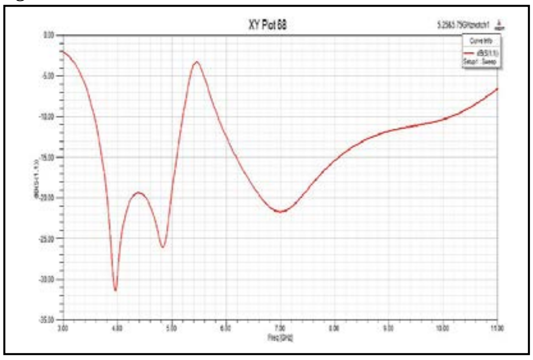


Fig. 7. **Retrurn Loss Results of UWB Antenna**



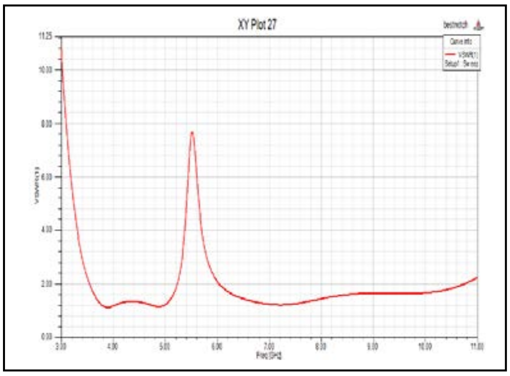


Fig. 8. **VSWR Results of UWB Antenna with Slots**

C. Results of UWB Antenna with Slots

In the previous method Return Loss performance shown in Fig. 7 shown that Return Loss performance was shown high in the nearby frequencies. So there is possible with cut near frequencies. . By inserting slot as Return Loss greatly reduced as shown in Fig. 8 and Fig. 9.

IV. RESULTS

Thus the Design of UWB antenna with notch band of 5.15 GHz to 5.825 GHz of WLAN 802.11a was simulated with improved frequency selectivity and reduced Return Loss was done and the result was verified using Ansoft's HFSS software. Results show that the notch band selectivity was improved. Notch band was varied by varying the length of the slot and width of the slots. The proposed antenna was very compact in size and simple to be use in portable UWB systems. In future this work will extend into dual band notch for dual band notch and the antenna to be implemented and to be fabricate and test the antenna.

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