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Research Paper

Design of UWB Antenna With Multi slot for Wireless Communication

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Abstract

A Compact dual slot ultra-wide band (UWB) Antenna for WLAN and X-Band applications is proposed. The projected antenna is designed for the planar ultra-wide band (UWB) antenna and ultra-wide band (UWB) with two band dismissals. The proposed antenna overall size is 30x40x1.6. The antenna comprises of Rectangular patch imprinted on the Flame Resistant (FR4) substrate with 50Ω input impedance. FR-4 is a composite material made out of fiberglass fabric woven with an epoxy pitch cover that is fire safe (self-dousing). "FR" implies fire resistant, and means that the material meets the standard. This patch consists of dual slot one for WLAN and one for X-band Satellite Communication System. The antenna intended with return loss (RL) >= 10db and frequency ranges between 3.1 to 10.6 GHz with VSWR<2. The antenna works for the applications of wireless local area network (WLAN) system (5.15 – 5.825 GHz), X-band downlink (7.25 - 7.75). The ultra-wide band frequency range for these wireless systems causes interference. To reduce the interference, band notching is done. The WLAN and X-Band satellite communication system bands are forbidden by inserting slots in the patch. The proposed antenna is having high gain at the pass bands while a sharp drop at the forbidden bands.

Keywords: *Compact; Dual Band; Notched; Ultra-wideband; Rectangular patch antenna.*

1. Introduction

Due to the advanced technology and demands in the wireless communication systems the ultra-wide band (UWB) antennas got a lot of consideration. As indicated by the Federal Communications Commission (FCC), the UWB recurrence go is 3.1-10.6 GHz [1]. Ultra-wide band has very great characteristics such as, it can be used for radio communication that can use low energy for short range and high bandwidth communication [2] .It is utilized as a part of several applications like radar, imaging and military correspondence. UWB antenna ought to be non-dispersive or dispersive in a controlled manner that is agreeable to remuneration. Ultra-wideband (UWB) innovation is at present spreading in various zones, for example, beat radars, radiometers, radio stargazing, recurrence jumping, spread range and OFDM [3]. The UWB antenna is commonly known for its low profile such as little difficulty, little cost, ease of fabrication, little power consumption and very low interference [1]. The UWB antenna is designed in various shapes like rectangular, inverted T-shape, egg shaped antenna, F-shaped slot antenna and inverted cone with seven rectangular steps antenna [4]. The UWB range includes C-band, WiMAX range, WLAN band, X-Band Satellite Communication applications [4].
Now-a-days different applications required different geometries like triangular, round circle, strip circle, and square and this can be done through the UWB antennas [6]. In most of the applications we use different types of antennas based on the frequency required, gain and bandwidth. Generally antennas are like monopole antennas, microstrip antennas, planar antennas etc.[5] .These antennas have an extensive application in mobile systems, WLAN with 5GHz band, X-band communication system with 7.25 GHz band, ultra-wide band (UWB) with 3.1 - 10.6GHz band. Among all the antennas, many of them prefer UWB antenna as it can eliminate same frequencies in case of interference [7]. Here in this proposal two band rejections are done at the frequencies of 5.15-5.825GHz and 7.25-7.75GHz [9-23]

2. Antenna Design

The proposed UWB antenna is in the Fig. 1, this design is based on the substrate FR4 and εr = 4.4 and tan δ = 0.02. This model contains all measurements in mm.The substrate has width W_{sub} =30, length L_{sub}=40 and height h=1.6, the rectangular patch has width W=15 and length L=10 the feed line has width W_{feed}=2.4 and length L_{feed}=20 and the ground plane has width Wg=30 and length Lg =19. In this antenna design approach the UWB antenna with H-shaped slot and M-shaped slot are placed in such a way that to get the band rejections at WLAN range and X-Band range.

The above dimensions are all according to the antenna design parameters formulae such as:

1. For Width (W) of the patch

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r+1)}{2}}} \qquad 1(a)$$

2. For calculating the Effective Dielectric Constant. This depends on the tallness of the substrate and width of the conducting patch.

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \qquad 2(a)$$

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3. For evaluating the Effective length, & the length extension ΔL

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{eff}}} \quad 3(a)$$

$$\Delta L = 0.412h\,\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad 3(b)$$

4. For length of the conducting patch

$$L = L_{eff} - 2\Delta L \quad 4(a)$$

5. The Bandwidth equation roughly defines in what way it scales with the parameters:

$$B \propto \frac{\varepsilon_r - 1}{{\varepsilon_r}^2}\,\frac{W}{L}h \quad 5(a)$$

6. The ground length (Lg) and the ground width (Wg) are supposed to be as:

L_g = 6h+L 6(a)
W_g = 6h+L 6(b)

7. The area of the sustain point where the impedance is very nearly 50 ohms is

Along the width of the patch (x-direction)

$$X_f = \frac{W}{2} \quad 7(a)$$

Along the length of the patch (y-direction)

$$Y_f = Y_0 - dL \quad \text{----- } 7(b)$$

Where, $Y_0 = \frac{L}{\Pi}\cos^{-1}\sqrt{\frac{50}{z_0}}$

$$z_0 = \sqrt{50 * Z_{IN}}$$

$$Z_{IN} = 90 * \frac{{\varepsilon_r}^2}{\varepsilon_r - 1}\left(\frac{L}{W}\right)^2$$

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0\varepsilon_r\mu_0}}$$

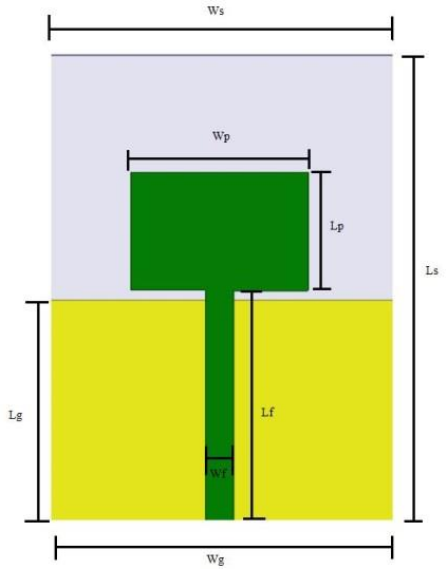


Figure 1: UWB antenna

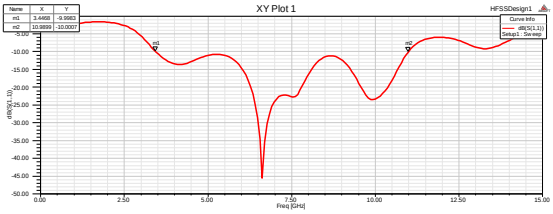


Figure 2(a): RL of UWB Antenna

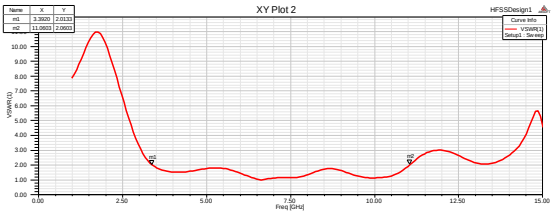


Figure 2(b):VSWR of UWB Antenna

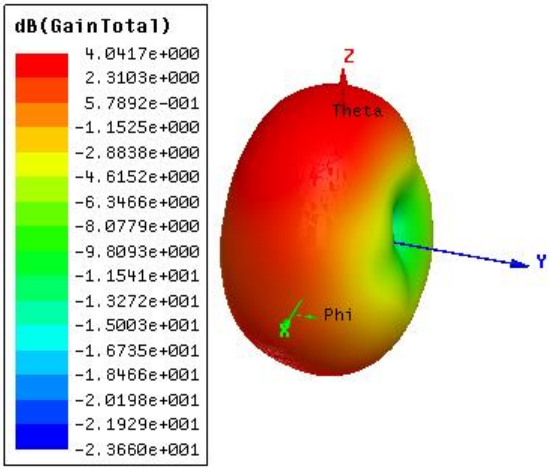


Figure 2(c): 3D Gain of UWB Antenna

Rejection of WLAN Band

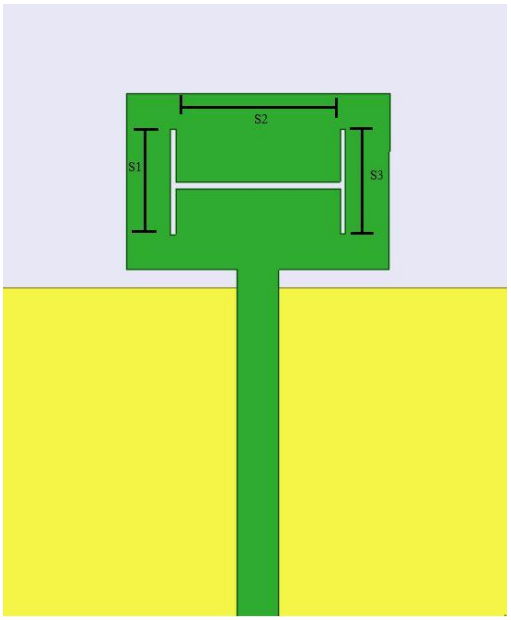


Figure 3: UWB Antenna with WLAN notch

The above figure shows the H-shaped slot inserted on the conducting patch which is used for rejecting the WLAN band in the UWB range.

The dimensions of the H-Shaped slot are tabulated as below:

Table 1: Dimensions of H-shaped slot

S.No.	Parameter	Value in mm
1	S1 of H-Shaped slot	(0.3,6)
2	S2 of H-Shaped slot	(10,0.4)
3	S3 of H-Shaped slot	(0.3,6)

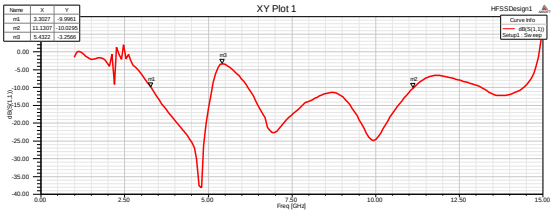


Figure 4(a): RL of UWB for WLAN notch

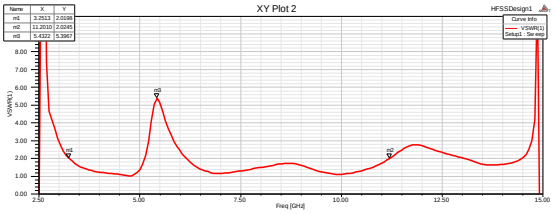


Figure 4(b): VSWR of UWB Antenna for WLAN notch

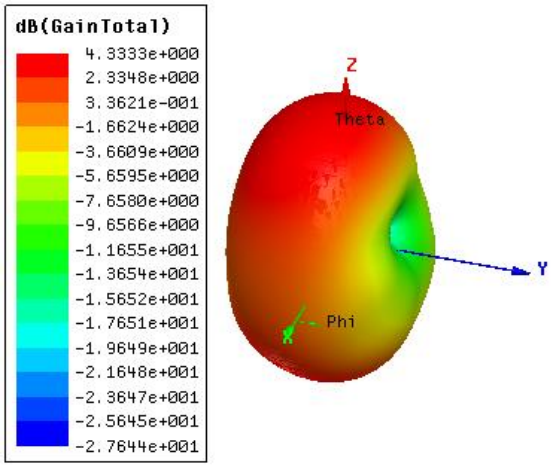


Figure 4(c): 3D Gain of UWB Antenna for WLAN notch

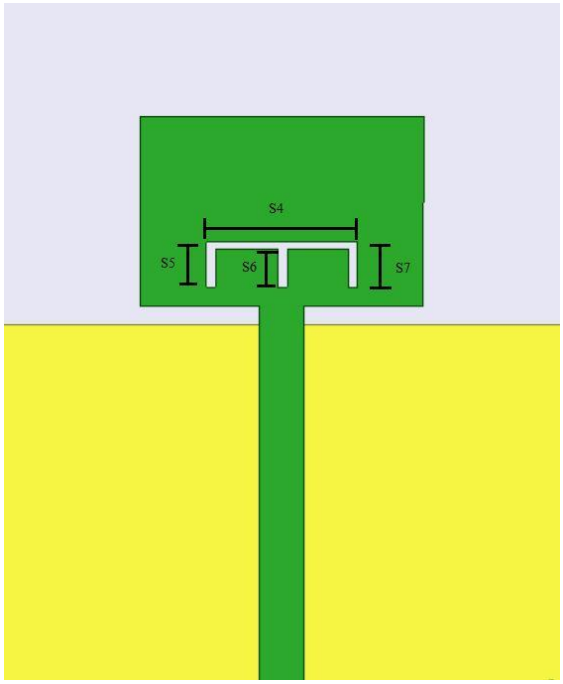


Figure 5: UWB Antenna with M-Shaped slot

The above figure shows the M-shaped slot inserted in the above figure to reject only the X-Band in the UWB range.

Table2: The design dimensions as follows:

S.No.	Parameter	Value in mm
1	S4 of M-Shaped slot	(8,0.36)
2	S5 of M-Shaped slot	(0.5,2)
3	S6 of M-Shaped slot	(0.5,2)
4	S7 of M-Shaped slot	(0.5,2)

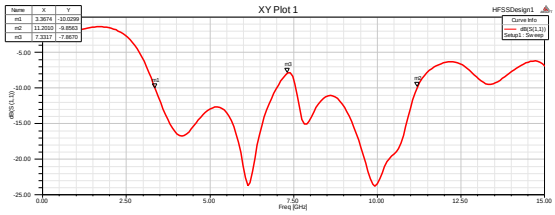


Figure 6 (a): RL of UWB antenna for X-Band notch

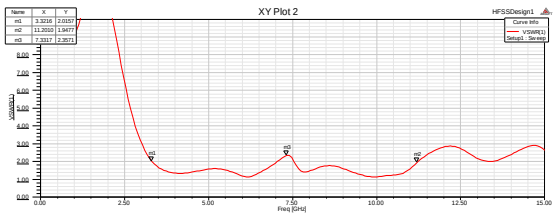


Figure 6 (b): VSWR of UWB for X–band notch

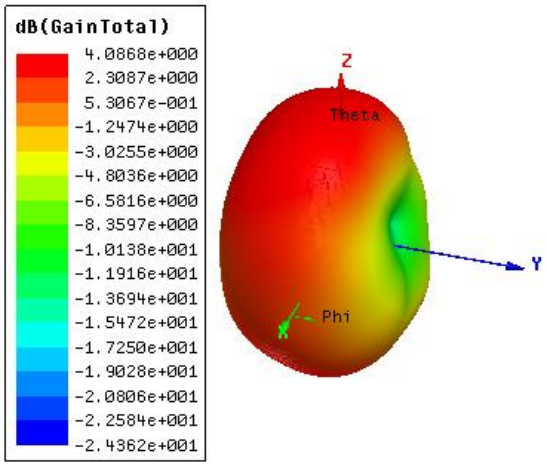


Figure 6 (c): 3D Gain of UWB for X–band notch

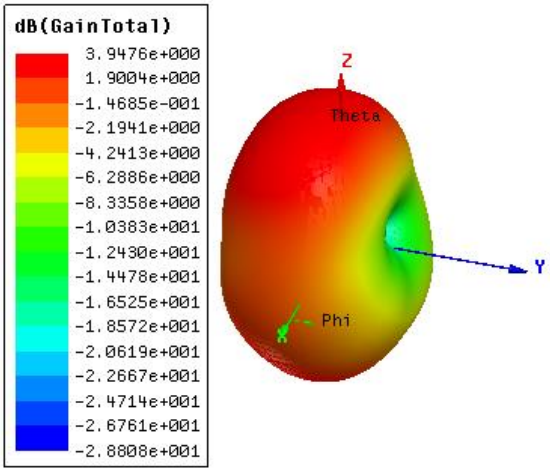


Figure 8(c): 3D Gain of UWB with dual notch

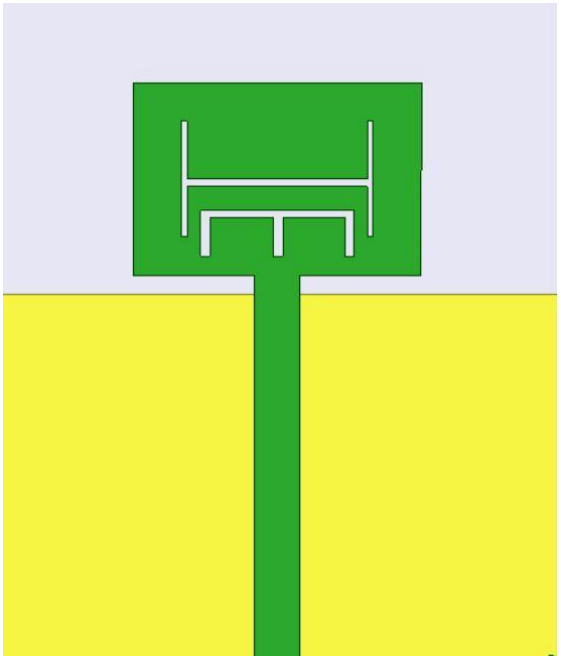


Figure 7: Proposed UWB Antenna with two slots

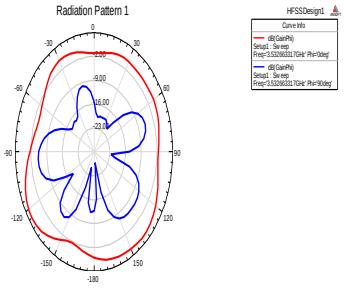


Figure 8(d): E-Plane at f = 3.5GHz

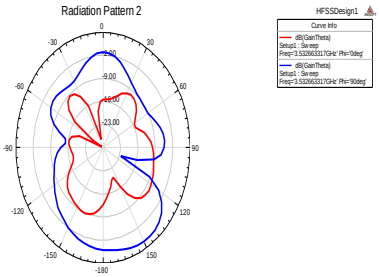


Figure 8(e): H-Plane at f = 3.5GHz

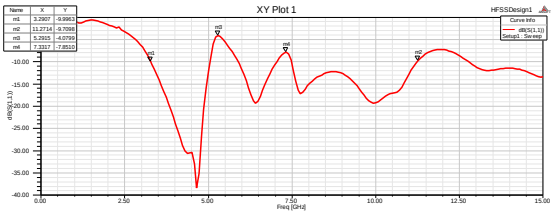


Figure 8(a): RL of UWB with dual notch

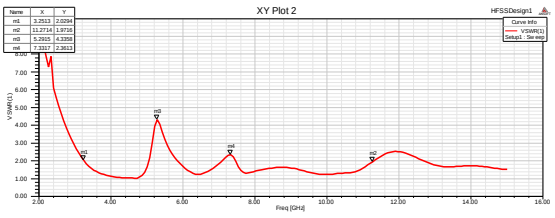


Figure 8(b): VSWR of UWB with dual notch

3. Conclusion

Finally, the proposed antenna has got very good characteristics . By inserting the H-shaped slot the rejection has happended perfectly at WLAN frequency range. And by inserting M-shaped slot the rejection at X-band has occurred. The VSWR response shows that rejection is done appropriately for the selected bands. Also , the radiation characterists tells us the gain obtained from the proposed antenna is also an acceptable value. The band width obtained is from 3.29 GHz to 11.27GHz.

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