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***Research Paper***

# Design of UWB Antenna with WLAN & X-Band Notch for Wireless Communication

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**Abstract**

In this proposition, a traditional UWB antenna with twofold indent channels was intended for a few remote applications. The exhibited antenna is outlined having estimations of 30 × 35 × 1.6 mm3 with a fix of rectangular staircase design. The dismissal bands are WLAN at 5 GHz (5.1 - 5.8 GHz) and the satellite X-band from space to earth (7.25 - 7.75 GHz). The patch with a step design with a modified π-formed opening gets the ultra-wide band. The UWB scope of 3.1 - 10.6 GHz affirmed by FCC can possibly cause interferences in the various wireless systems applications.. With a specific end goal to lessen these interferences, we settled on the band indent. In this proposed outline, the WLAN has scores setting a U-molded opening in the patch and the X-band has indents with a reversed T-shape in the ground plane.

***Keywords****: Dual Band Notch, Staircase Rectangular patch, Ultra-Wideband, WLAN Band, X-Band.*

## 1. Introduction

Ultra-wideband (UWB) antenna draw in awesome consideration in the remote world because of their preferences, which incorporate to a great degree low ghostly power thickness, fast information rate, high-precision extend, minimal effort and low multi-faceted nature. Since the Federal Communications Commission (FCC) permitted 3.1-10.6 GHz recurrence go band for UWB correspondence [1]. UWB technology has been used in a wide range of applications such as radars, navigation, telemetry, biomedical systems, Global positioning systems (GPS), Mobile satellite communications, remote sensing and direct broadcast system (DBS) [2].

The design of UWB antenna has numerous issues. Interference is a tough problem for UWB application gadgets [3]. UWB (3.1 GHz to 10.6 GHz) includes other sub narrowband applications like WiMAX (3.3-3.6GHz) band, C-band operating in (3.8GHz to 4.2 GHz), WLAN band system at 5 GHz (5.1 - 5.8 GHz) and X-band operating in (7.25-8.39 GHz band). One way for suppressing interference is to use spatial filters such as frequency selective surfaces (FSS) above the antenna [4].But it requires more space which is not a good aspect for antenna designing. The most of the antennas are designed with frequency band rejected function by the approach of embedding slots[5].Some of the frequently seen slots are square-slot [6],U-slot [7] , attaching bar [8],pi-slot [9], the U-shaped bar [5], V - fashioned opening [10], C - fashioned opening [11], S - fashioned opening in feed line[12] and so on many other approaches. The solid used for the substrate should be having dielectric value in the range of $2.2 \leq \varepsilon_r \leq 12$. The solid used here is FR4 epoxy with dielectric value 4.4 and Dielectric loss tangent 0.02. This design considered with 5 step staircase followed by rectangular patch & inverted π-shaped slot with requisite slots along with feed line to attain UWB range practically[13-28]. The proposed antenna is notched with two bands, WLAN and X- band satellite communication and a complete parametric analysis is done using HFSS tool. Results include parameters like VSWR, gain and radiation pattern along with return loss characteristics (S parameter). Section II discusses about Parametric Design of the basic antenna. Then Section III discusses about two notches for WLAN & X-Band of proposed antenna. Section IV relates to results & conclusion of the designed final antenna

## 2. Parametric Design of Basic UWB Antenna

Figure-1 (a) & (b) describes geometry of basic UWB Antenna which works under UWB range, practically gained (2.9GHz - 12.6GHz). For substrate we have considered FR4 epoxy because of its cost effectiveness and has a decent dielectric value of 4.4 and dielectric loss tangent 0.02, with a substrate size of 35 x 30 $mm^2$ and height of 1.6mm. For patch we have considered 5 steps of stair case design and rectangular strips united with an inverted π-shaped slot at middle of rectangular sheet to attain UWB range.

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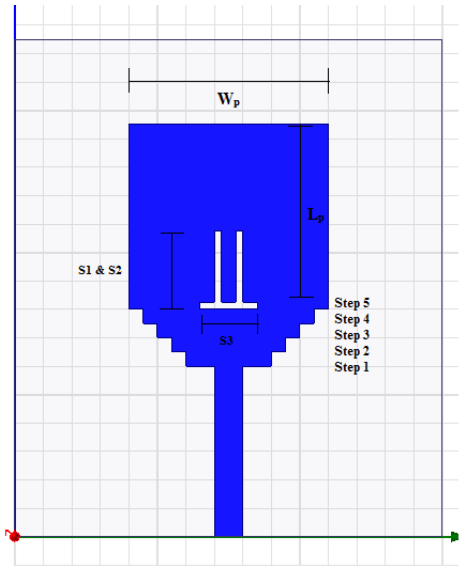



**Figure 1(a):** UWB basic antenna (top view)

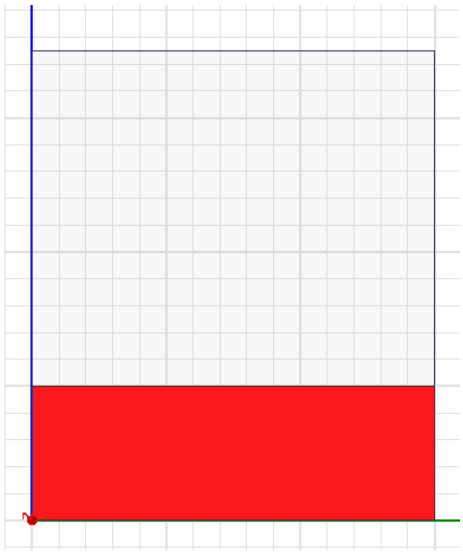


**Figure 1(b):** UWB basic antenna (bottom view)

The following table gives parametric dimensions of proposed antenna without any notching.

**Table 1:** Parametric values of basic UWB antenna

| S.No. | Parameter | Value in mm |
|---|---|---|
| 1 | Length of conducting Patch | 12 |
| 2 | Width of conducting Patch | 14 |
| 3 | Length of FR4 Substrate | 35 |
| 4 | Width of FR4 Substrate | 30 |
| 5 | Length of line feed | 12 |
| 6 | Width of line feed | 2 |
| 7 | Length of Ground plane | 10 |
| 8 | Width of Ground plane | 30 |
| 9 | S1 (π-shaped slot) | (0.5,5) |
| 10 | S2 (π-shaped slot) | (0.5,5) |
| 11 | S3 (π-shaped slot) | (4,0.5) |
| 12 | Step1,<br>Step2,<br>Step3,<br>Step4,<br>Step5 | (6, 1),<br>(8, 1),<br>(10, 1),<br>(12, 1),<br>(14, 1) |

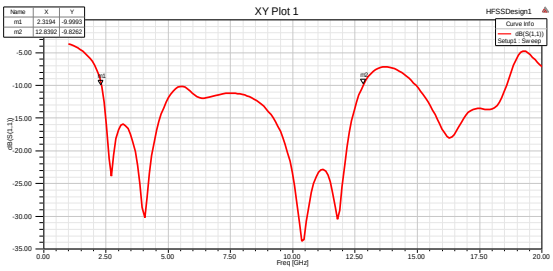



**Figure 2(a):** RL of UWB Antenna

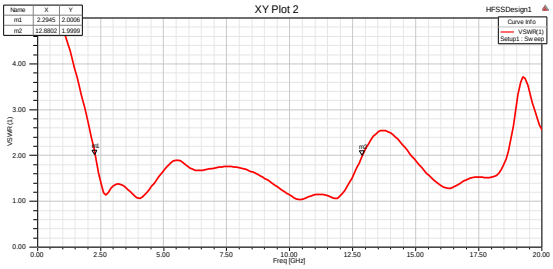



**Figure 2(b):** VSWR of UWB Antenna

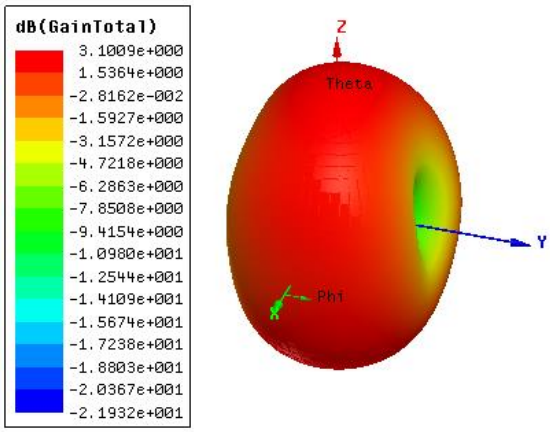



**Figure 2(c):** 3D Gain of UWB Antenna

The above figures 2 (a), (b), (c) represents that the basic UWB antenna has obtained acceptable performance in terms of Return loss, VSWR & Gain.

## 3. Design of Notches

### 3.1 Rejection of WLAN band

For notching WLAN band the U-shaped slot is inserted as shown in figure 3 is made on rectangular part of patch. U- Shaped slot is formed by combining 3 slots as a single slot. The design specifications of U-slot are shown in table 2.

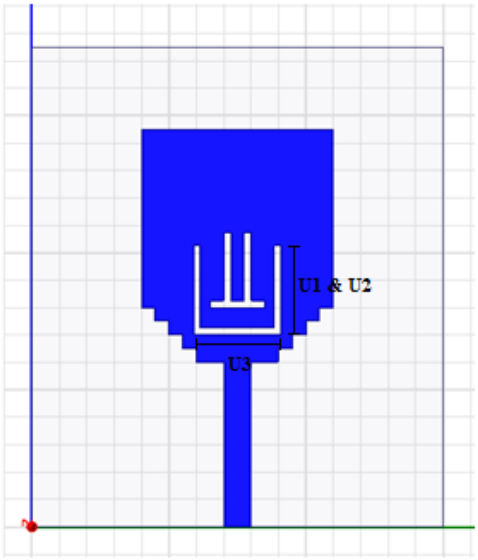



**Figure 3:** UWB antenna with WLAN notch (U-Shaped)

**Table 2:** U-slot dimensions for WLAN notch

| S.No. | Parameter | Value in mm |
|---|---|---|
| 1 | U1(U-slot) | (0.5, 6) |
| 2 | U2(U-slot) | (0.5, 6) |
| 3 | U3 (U-slot) | (6.4, 0.5) |

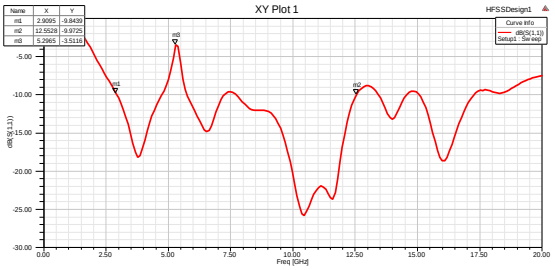



**Figure 3(a):** RL of UWB with WLAN notch

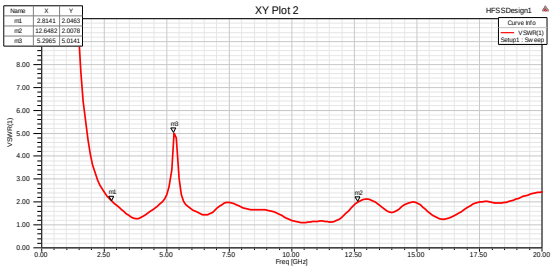



**Figure 3(b):** VSWR of UWB with WLAN notch

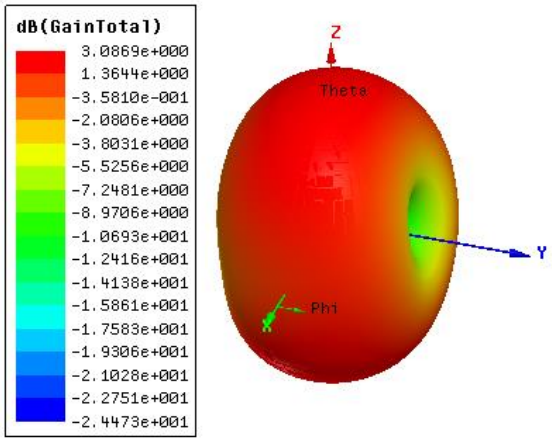



**Figure 3(c): 3D Gain of UWB with WLAN notch**

### 3.2 Rejection of X-Band

For notching X-band 7.25 GHz to 7.75 GHz (Space to Earth) an inverted T - slot is made on ground exactly at the center as shown in figure 4. Inverted T- shape is formed by uniting two rectangle slots whose dimensions will be specified in table 3.

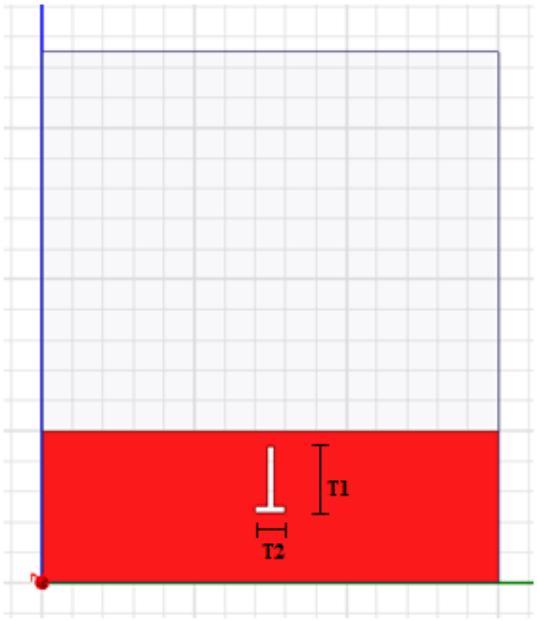



**Figure 4:** UWB antenna with X-Band notch in ground plane (inverted T-Shaped)

**Table 3**: Inverted T-slot dimensions for X-Band notch

| S.No. | Parameter | Value in mm |
|---|---|---|
| 1 | T1(inverted T-slot) | (0.4, 4) |
| 2 | T2(inverted T-slot) | (2,0.4) |

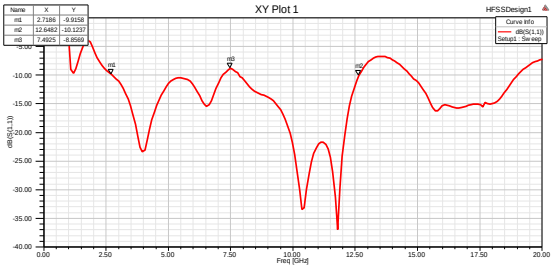



**Figure 4(a):** RL of UWB with X-Band notch

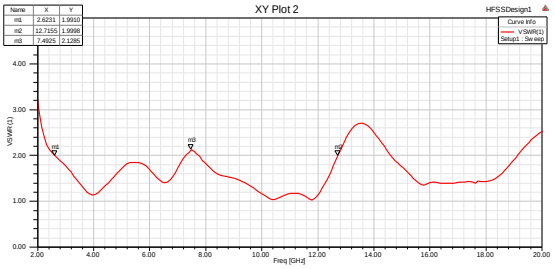



**Figure 4(b):** VSWR of UWB with X-Band notch

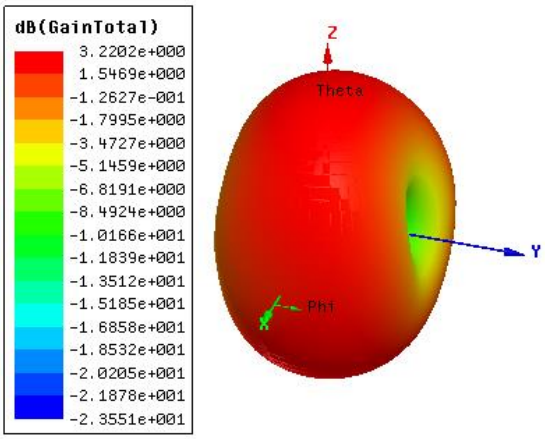



**Figure 4(c):** 3D Gain of UWB with X-Band notch

### 3.3 Proposed UWB antenna with Dual notches

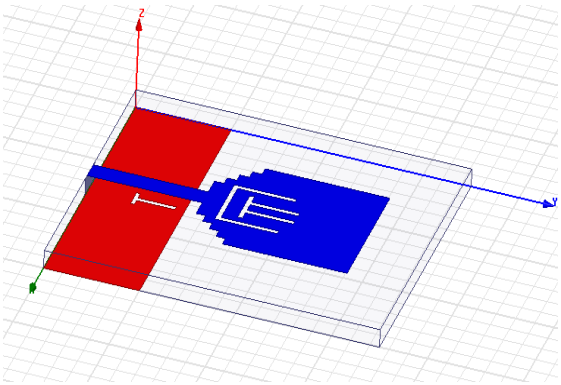



**Figure 5:** UWB with dual notch

The above figure 5 represents the UWB antenna with dual notches. On the upper side of the patch the U-shaped slot and the inverted T-slot at the ground plane are embedded. The projected antenna rejects two bands as seen in the response of the following graphs.

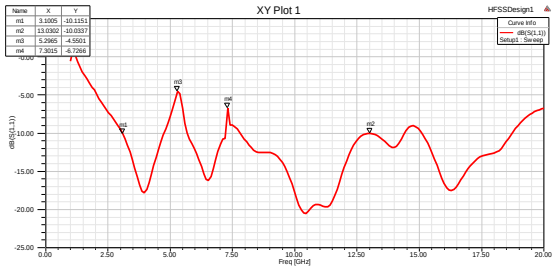



**Figure 5(a):** RL of UWB with dual notch

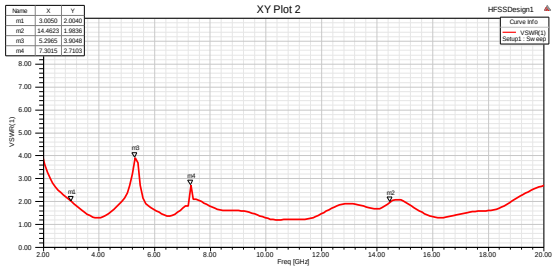



**Figure 5(b):** VSWR of UWB with dual notch

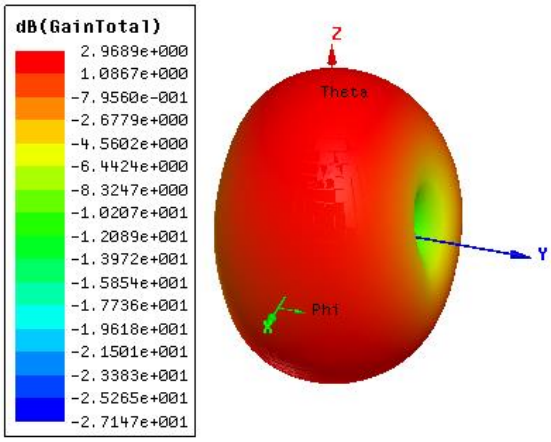



**Figure 5(c):** 3D Gain of UWB with dual notch

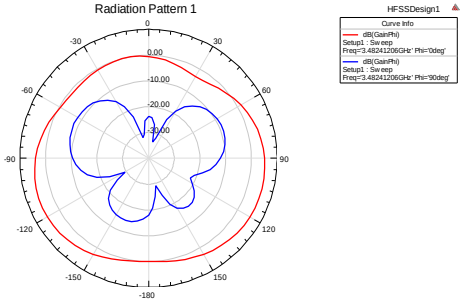



**Figure 5(d):** E-Plane radiation pattern at 3.48GHz

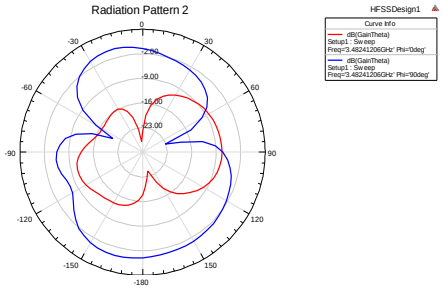



**Figure 5(e):** H-Plane radiation pattern at 3.48GHz

## 4. Conclusion

Finally, the new staircase based UWB antenna with compact size has been designed by inserting inverted π-shaped slot to obtain the FCC allotted bandwidth. Also rejected WLAN & X-band successfully by acceptable results in terms of return loss, VSWR & Gain

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