

Designing of Band Notched Print Antenna for Ultra Wideband Applications

Deepak Vyas, Suman Sankhla, Sunil Sharma

Abstract— In this paper a new ultra wideband (UWB) antenna is proposed with band notch characteristics to avoid interference with WLAN/HIPERLAN in 5.15 GHz – 5.85 GHz band. In proposed antenna a wide impedance bandwidth is achieved (3.15 GHz – 15.7 GHz) to fulfill requirements of UWB for future applications? The proposed antenna is investigated with partial ground plane. It has a simple geometry and by cutting three slots band rejection characteristic of proposed antenna are achieved. The measured S11 is well below 10 dB & measured radiation patterns are near omnidirectional.

Index Terms— band notch, UWB, impedance, WLAN

I. INTRODUCTION

Ultra Wideband is a carrier less short range communications technology which transmits the information in the form of very short pulses. This former military technology has gained a lot of popularity among researchers and the wireless industry after the FCC [1] permitted the marketing and operation of UWB. UWB has promised to offer high data rates at short distances with low power, primarily due to wide resolution bandwidth. The FCC in the USA has allocated a frequency band 3.1 GHz to 10.6 GHz for UWB transmission and released a mask which indicates the power levels to keep the narrow band incumbents spectrum free from interference. Compact and cheap ultra wideband antennas are needed for numerous UWB applications like wireless communications, indoor positioning and medical imaging. Several single-feed planar microstrip antennas such as Elliptically-shaped antenna with slots [2], curved rectangle with slot antenna [3], Variable slot type antennas [4], Circular shape with variable slot [5], rectangle with steps & slot [6]. In all these structures a partial ground has been proposed, providing attractive solutions that can be readily incorporated under an UWB system. Similarly in [7] a band notched UWB antenna proposed by changing partial ground geometry rather than main patch as in cases of [2-6]. But tuning of back patch is difficult task.

In this paper, a new UWB antenna is proposed with a very simple structure by cutting three slots & corner notched rectangle patch with partial ground of rectangle shape & compact size of $30 \times 24.5 \text{ mm}^2$. Here notches & slots are made in such a way that current

distribution is not effected & antenna is perfectly matched for an impedance bandwidth of 3.15 GHz – 15.7 GHz.

II. ANTENNA STRUCTURE

Proposed antenna is designed in three phases. In first phase a rectangle patch with partial ground is designed as shown in figure 1. In next phase a single step is created at lower edges of patch of figure 1 to match antenna for UWB bandwidth as given in figure 2 & in last phase a slotline of inverted hat type is etched at centre of modified patch antenna of figure 2 and design is given in figure 3 to make it a band rejected UWB antenna. Dimensions of antennas are listed in table 1.

The antenna is fabricated on FR4 (roger) substrate having thickness 1.65 mm & relative dielectric constant of 4.65. The area covered by antenna geometry is $30 \times 24.5 \text{ mm}^2$. The antenna is simulated by Zeland's IE3D, MoM based simulator tool.

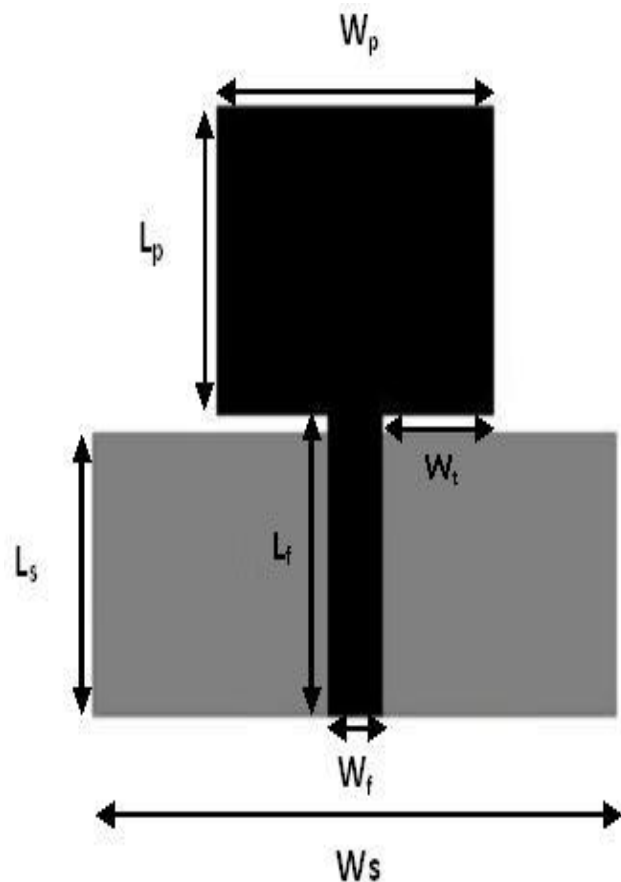


Figure1. Structure of Antenna

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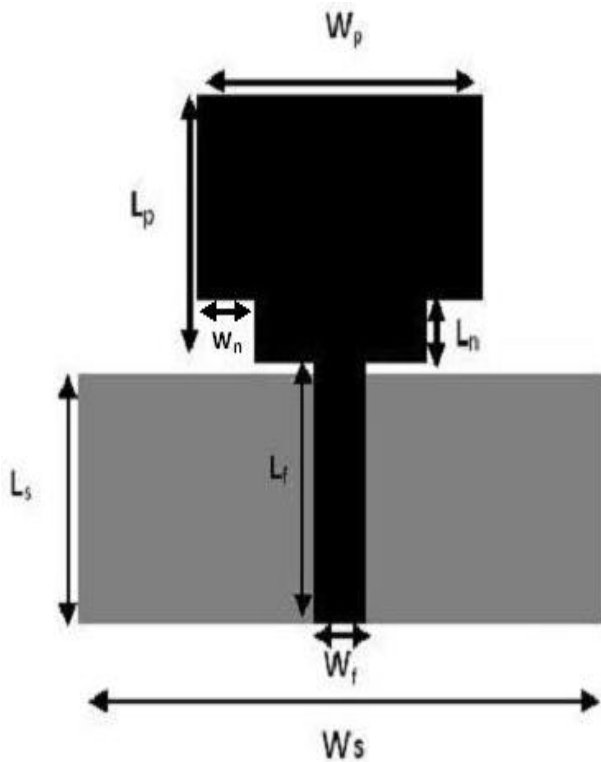


Figure 2. Proposed Design of Antenna

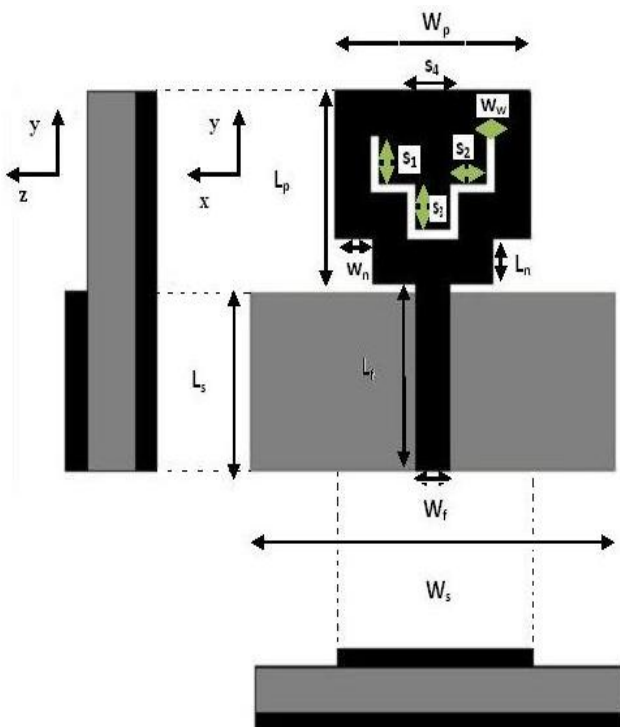


Figure 3 (a) – front view Figure 3 (b) – back view

TABLE 1 - Dimensions of Antennas

w_p	16 mm
l_p	12.5 mm
w_s	30 mm
l_s	11.5 mm
w_t	6.5 mm
w_f	3 mm
l_f	12 mm
w_n	3 mm
l_n	3 mm
s_1	3.5 mm
s_2	3 mm
s_3	3 mm
s_4	4 mm
w_w	.5 mm

III. RESULTS

The prototype of proposed antenna is shown in figure 3. The reflection coefficient of antenna is measured using Rhode & Schwarze ZYA24 network analyzer. Figure 4 shows the simulated & measured S11 parameters of antenna. It is observed that for 3.1 GHz to 15.7 GHz, the return loss is much below than -10 dB.

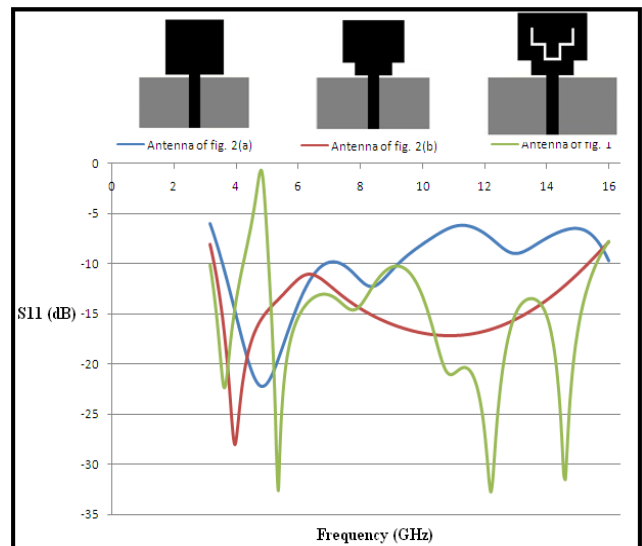


Figure 4 (a). Simulated return loss comparison of proposed Antennas

As given in fig.4 (a) there is a smooth transition from conventional patch to band rejected printed UWB antenna, the proposed band rejected antenna shows best S11 results in simulation environment as compare to other models & it is well below -10 dB except range of 5.15 to 5.85 GHz.

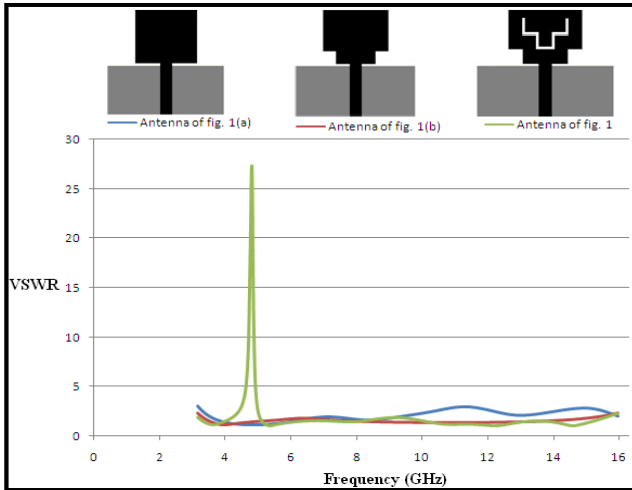


Figure 4 (b) – simulated return loss comparison of proposed Antennas

The simulated band rejection characteristics & impedance bandwidth are clearer in fig. 4(b) in VSWR curve. Here VSWR is below 2 for range of 3.15 to 15.7 GHz & a peak arises between 5 to 6 GHz.

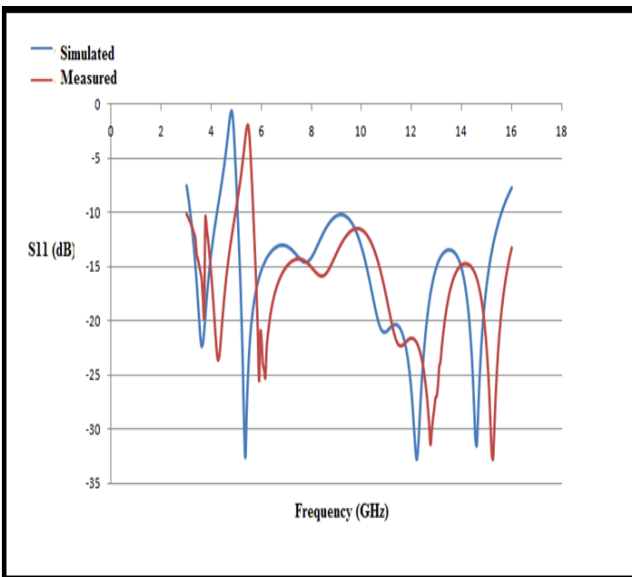


Figure 5(a) – simulated & measured return loss of proposed antenna (fig. 1)

As shown in figure 5(a), the measured results of S11 is well below -10dB mark for entire range of 3.0 – 5 GHz & then it start increasing in between 5 – 6 GHz with a maximum value of 0 dB. After 5.85 GHz it starts decreasing steadily & at 6 GHz it touches to -19 dB. After word it maintains its level of S11 consistently in between -15 to -30 dB in between 6 – 15.7 GHz. The minimum value of S11 is achieved of -29 dB at 14 GHz.

The figure 5(b) shows the simulated & measured VSWR .Which is also well below 2 for entire range of frequency band from 3 – 5 GHz as shown in figure & the value of VSWR start increasing from 2 to 10 in between 5.05 – 5.85 GHz band & after that sharply decreasing from 5.70 GHz &

touchdown value of VSWR 2 at 6 GHz. Afterword it is consistently in between 1.5 – 2 for entire band of 6 – 16 GHz.

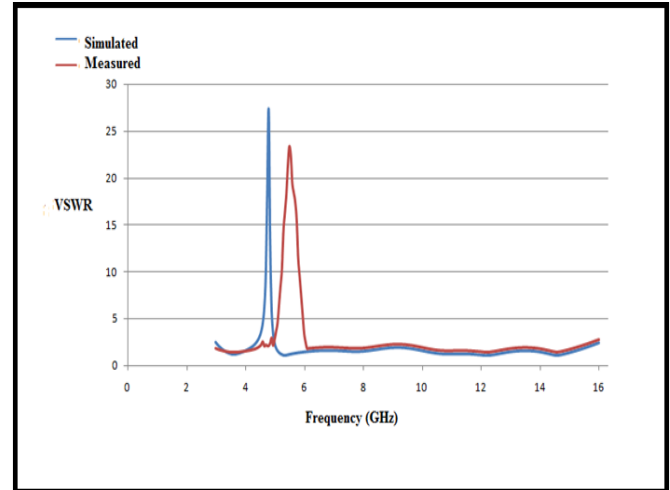


Figure 5(b)– simulated & measured VSWR of proposed antenna (fig. 3)

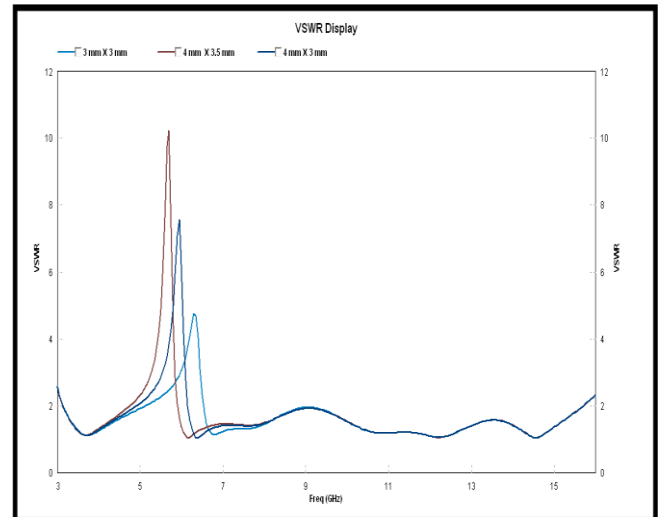


Figure 6. Simulated VSWR for proposed Band Rejected UWB antenna (fig. 3) for different values of w_t .

In figure 2 the design has three slots in patch geometry. By changing the area of these slots one can tune band rejection characteristics of UWB antenna. Here these dimensions are designated as s_1 & s_4 . By changing these dimensions one can achieve above mentioned objective which is visualized in figure 6 (VSWR curve).Here three different sets of s_1 & s_4 are tested as in shown in table 2. Here filtered out band, its bandwidth & amount of filtration are totally depend upon these two geometric parameters.

The current distribution for proposed antennas for band rejected rectangular patch antennas is shown in Figure 7. Based on the current distribution of proposed antennas calculated by IE3D, we can find that the currents are concentrated near the slits at the notched frequency, while they are distributed mostly near the edges of the arms at the other frequencies. Therefore, we can expect that inserted slits have a function to notch the particular frequency band, Here slot line work as stub that plays a short circuit. Therefore, it

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prevents the antenna from impedance matching at the notched frequency.

Table 2. Comparison of w_w for proposed Band Rejected UWB antenna

w_s (mm)	Band (GHz)	Peak value of VSWR
1.5	4.2 – 5.00	27.7
1	4.5 – 5.3	16.2
.5	5.05 – 6.00	8.5

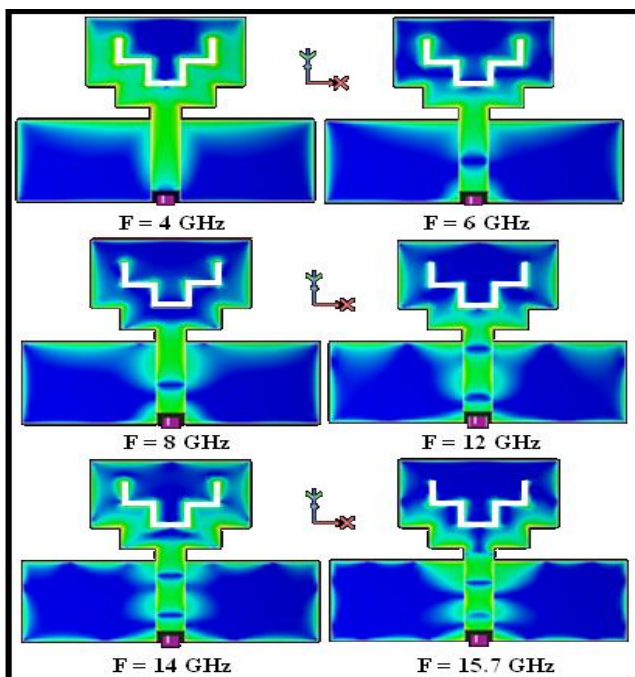
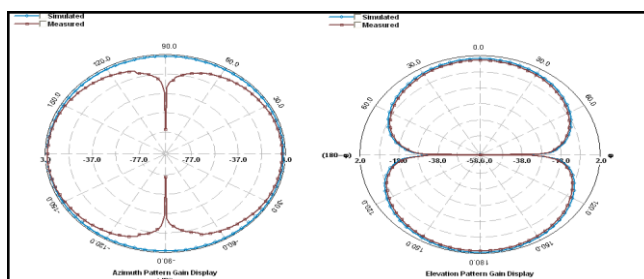
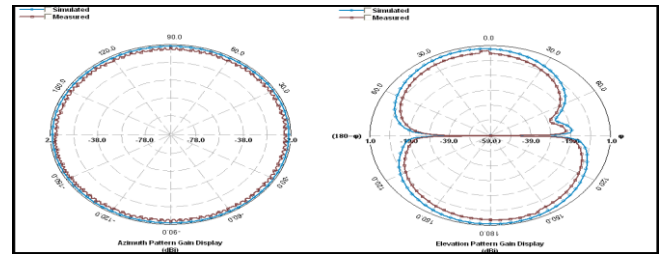


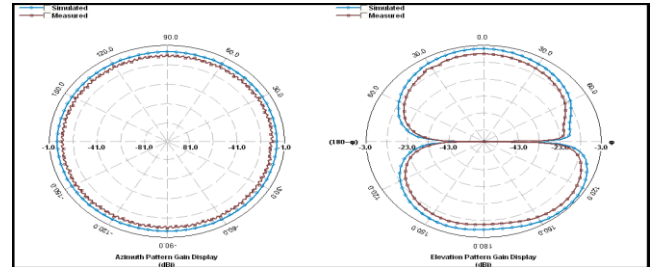
Figure 7 Current distribution of band rejected UWB antenna



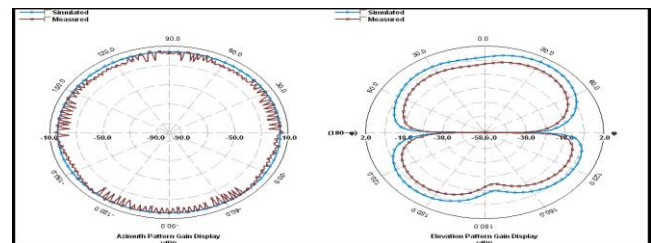
F = 4GHz.



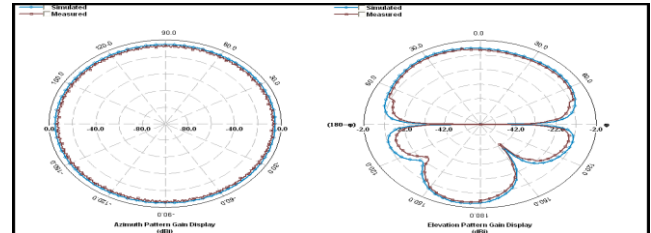
F = 6 GHz.



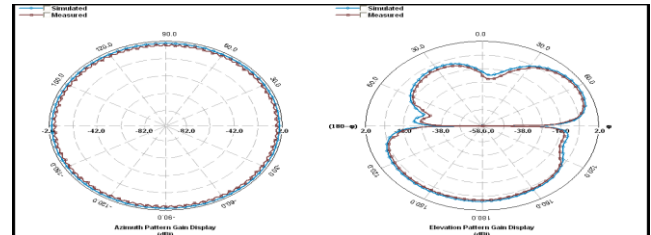
F = 8 GHz.



F = 12G Hz.



F = 14 GHz.



F = 15.7G Hz.

Figure 8 Simulated & Measured azimuthal & elevation angle of proposed band rejected UWB antenna (fig.2)

All the antennas exhibit omnidirectional pattern for H-plane at 4 GHz, 6 GHz, 8 GHz, 12 GHz, 14 GHz and 15.7 GHz for each type of antenna where it is a characteristic of monopole antenna. All antennas exhibit perfect 8 shape lobe pattern for E-plane at lower frequencies as we increase frequency the lobe start tilting from 0° towards positive side as shown in figure 8.

In figure 9 simulated & measured gain of proposed band rejected antenna (fig. 2) has been shown, the gain of antenna is very low & reduced at notch frequencies drastically.

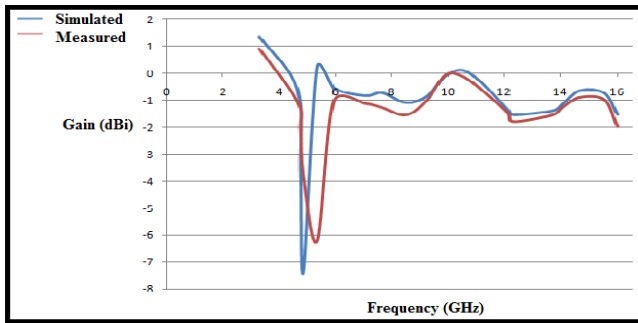


Figure 9 Simulated & Measured gain of proposed band rejected UWB antenna (fig.2)

IV. CONCLUSION

. A novel compact band notched ultra wideband rectangle printed antenna has been designed. The impedance bandwidth is much higher than required UWB band which can be used by future application of UWB systems. Moreover by visualizing radiation pattern, the proposed antenna can be effectively used for UWB applications.

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