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Ultra Wideband Printed Monopole with Truncated Stub For Dual Notch Performance

Y. Laxmi Lavanya* and Prof. P. Siddaiah

Department of Electronics and Communication Engineering,
Acharya Nagarjuna University, Guntur, India.
Email: lavanya9234@gmail.com

Abstract- The printed monopole with T-shaped slot yields Ultra Wideband response from 3 GHz to over 12 GHz. Placing a stub in the T-slot gives rise to a notch band or rejection band, which is tunable by varying the position and dimensions of the stub. By further truncating the stub, a dual notch band is achieved. The center frequency of second notch band is tuned from 3.3 GHz to 5.2 GHz by increasing the truncation gap.

Keywords- notch band, stub, truncation gap.

1. INTRODUCTION:

Ultra Wideband (UWB) Antenna design has gained prominence over the recent years with the Federal Communication Commission allocating an unlicensed 7.5GHz band for commercial communication applications [1]. The band ranges from 3.1-10.6 GHz. Usually, the UWB devices operate at very low power [2]. There are many narrowband wireless systems which also operate within the UWB range, but with high operating power. These pose the problem of interference to the UWB antenna.

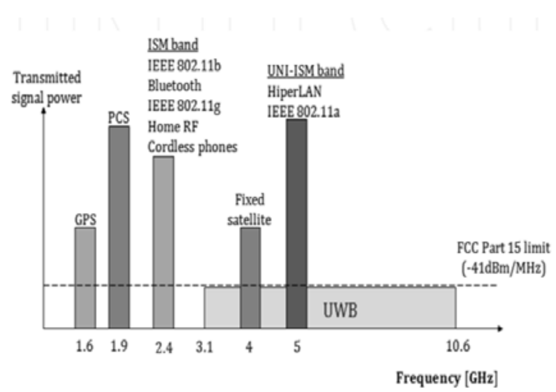

Fig. 1. Coexistence of various wireless systems with UWB band.

This problem can be suppressed by introducing a notch band or rejection band to the UWB antenna. The strength of rejection is determined by the VSWR value [3]. Higher the VSWR value, greater is the rejection.

In this paper, monopole with a stub in the T-shaped slot is presented to achieve band rejection. The stub position, width and length can be varied to tune the notch band [4].

Some applications require multiple notch bands within the UWB range to avoid interference from various high power wireless systems [5]. For this purpose, a truncation is introduced in the stub, i.e. the stub is cut. The center frequency of second notch band is also tunable from 3.3-5.2 GHz by increasing truncation gap from 0.1mm to 0.9mm. The design and performance of the antenna are presented in the further sections.

2. ANTENNA DESIGN:

The proposed UWB antenna with dual notch band is shown in figure 2. Rogers RO4003 is used as substrate, which has a relative permittivity of 3.55. The rectangular patch is tapered at the bottom. A slit is placed on the partial ground plane with exactly the same width as the feed line to achieve good matching. The T-shaped slot aids in increasing the compactness. This is because of the increase in the current path length. A stub inserted in the T-shaped slot acts as a band stop filter [6][7] to create a rejection band within the Ultra Wideband. Without truncation of stub, single notch band is attained.

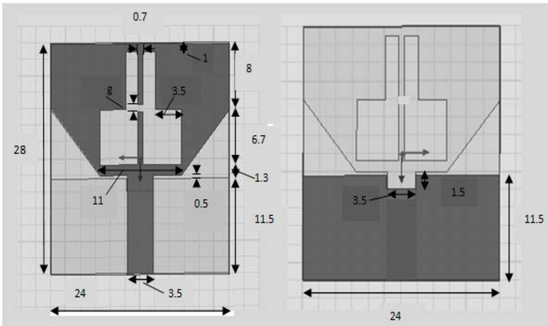

Fig. 2. Proposed design: Top view and bottom view

The stub is divided into two parts by truncating it at the center. This gives a dual notch band response. The truncation gap is varied and the results are observed.

3. SOFTWARE USED:

For simulation of the above designs, High Frequency Structure Simulator (HFSS) version 14.0 is used. The return loss curves provide the resonant and notch bands while VSWR at the notch band is the measure of strength of rejection. Apart from these, other parameters like radiation pattern and gain can be observed for evaluating the performance of the antenna.

4. RESULTS AND DISCUSSION:

The patches simulated in HFSS are as follows. Figure 3(a) is the structure of the patch and 3(b) is the ground plane.

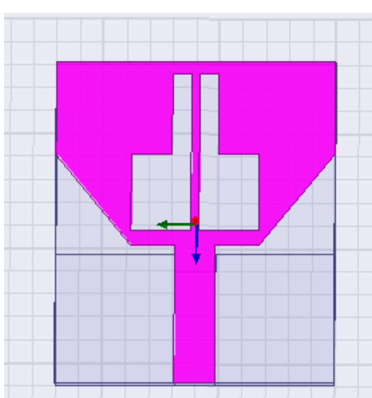

Fig. 3(a). Patch simulated in HFSS

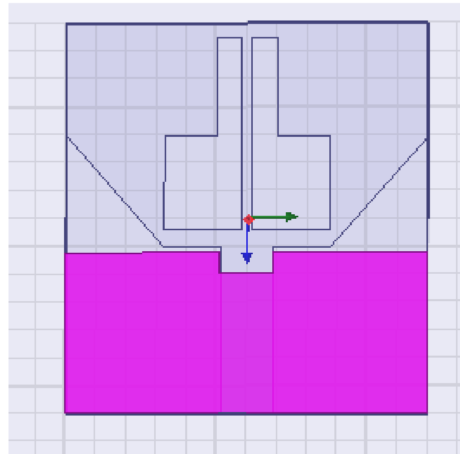

Fig. 3(b). Ground plane simulated in HFSS

The return loss curve obtained for the antenna shown in figure (3) is shown below. The notch band ranges from 6.20-7.00 GHz with notch centered at 6.5GHz.

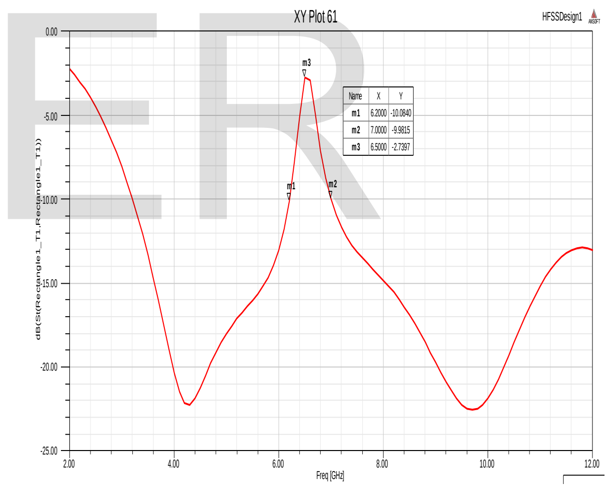

Fig. 4. Return loss curve for monopole with stub

The stub is truncated at the center and the antenna thus obtained is simulated. The truncation gap is initially set to g=0.1mm and return loss is observed.

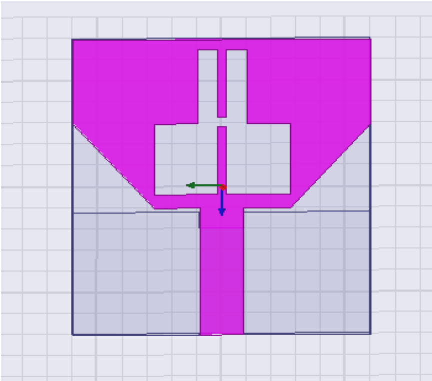

Fig. 5. Simulated patch with truncation

The truncation introduces a second notch band extending from 3.04 GHz to 3.81 GHz, centered at 3.2GHz apart from the notch band at 6.8GHz. This can be seen in figure (6). A comparison of return losses of antennas with and without truncation is also shown in figure (7).

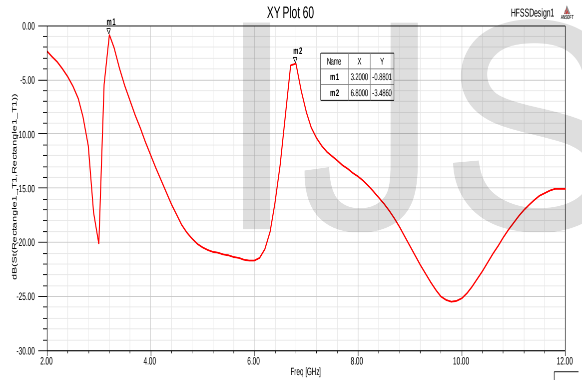

Fig. 6. Return loss curve of patch with truncated stub

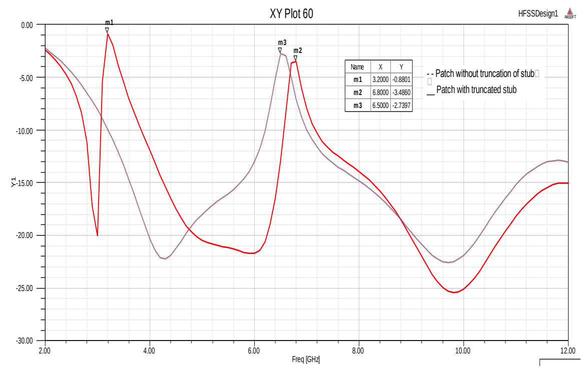

Fig. 7. Comparison of return loss of patches with and without truncation

The truncation gap is further increased in steps of 0.2mm and the results are compared with a graph and table.

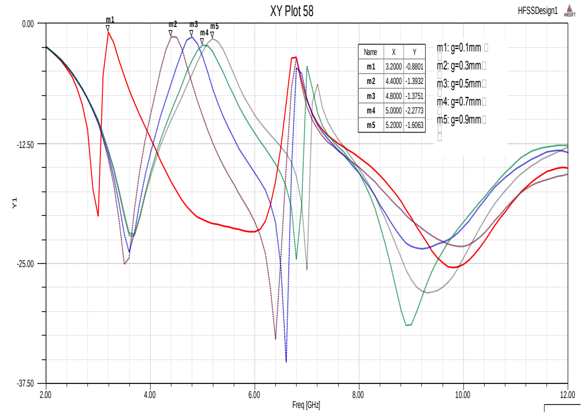

Fig. 8. Comparison of return losses of patches by varying truncation gap, g.

Table 1: Notch bands for various values of truncation gaps

Gap g in mm	First notch band in GHz	Second notch band in GHz
0	6.2-7.00	-
0.1	6.49-7.12	3.04-3.81
0.3	6.65-7.10	3.97-5.02
0.5	6.83-7.15	4.20-5.50
0.7	6.86-7.25	4.33-5.80
0.9	7.08-7.40	4.40-6.10

From the table it is evident that the second notch band can be tuned over a wide range by varying the truncation gap. A slight tuning is observed even in the first notch band. Mostly, narrow notch bands are preferred for practical applications.

Also, the strength of rejection in the notch band has to be observed. This indicates the quality of the notch band and is determined from the VSWR curve. The value of VSWR>15 indicates strong rejection band [8]. The VSWR curves for different values of truncation gap g are plotted below. A VSWR value of 19.75 is obtained at 3.2 GHz when truncation gap= 0.1mm.

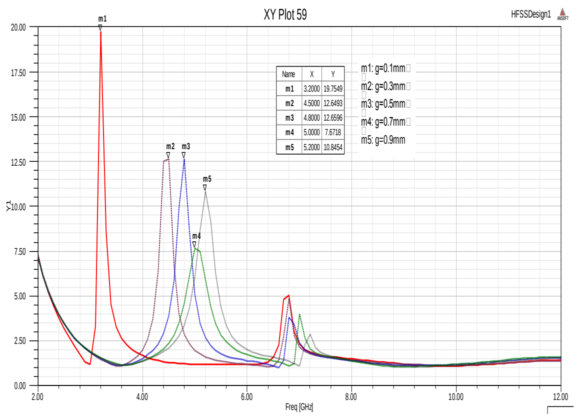

Fig. 9. Comparison of VSWR curves for different values of truncation gap, g.

5. CONCLUSION:

The occurrence of two notch bands within the Ultra Wideband is observed for the designed patch antenna with truncated stub. Depending upon the application and the band to be suppressed, the truncation gap is selected. Thus, this antenna helps to eliminate the interference caused due to other high power wireless systems. The future work may include antenna design for triple and multiple notch bands.

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