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Design of Planar Monopole Antenna for UWB Applications

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Abstract

A small-size microstrip-fed multi-band planar monopole antenna is presented. The base of the proposed antenna is a diamond-shaped patch (DSP) that covers the ultrawideband (UWB) frequency range. The range of UWB is 3.1-10.6GHz. Using narrow strips in DSP antenna, acting as resonance paths, can be integrated with the multiband antenna. It is shown that by removing the centre part of the DSP antenna, without distorting the UWB behavior, quarter-wavelength strips can be added to the notched region. This will not affect the dimension of the base antenna. The designed multiband antenna has a substrate size of 16×22×1 $mm^{2.}$ and covers the frequency bands 3.1–10.6 GHz. The antennas have omnidirectional and stable radiation patterns across all the relevant bands.

Keywords: *Monopole antenna, multi-band antenna, ultrawideband (UWB) antenna, wireless communication frequencies.*

1. Introduction

The UWB communication have greater attension commercial systems in both academic and industrial sectors. It can be used in hand-held wireless communication, UWB is the short distance communication technology, But it can perform more then 100mbps speeds in high speed communication. There are two main categories are presented in UWB. That is direct sequence UWB (DS-UWB) and multi band orthogonal frequency division multiplexing (MB-OFDM). The DS-UWB can perform two different carrier frequencies low band (3.1-5.15GHz) and high band (5.826-10.6GHz). The low band frequency is 4.104GHz and high band frequency is 8.208GHz. The MB-OFDM is divided into 14 sub-intervels. Each sub-intervels covers 528MHz bandwidth.[1][2]

The single antenna can be cover several allocated wireless frequency band in modern communication systems. The features of planer monopole antenna is low lost, simple structure, easy of fabricatons, wide bandwidth. There are two techniques are is to create the multiband monopole antenna.

The first technique to cover the desired wide bandwidth using for designed patch antenna. The lower limit frequency band increase the antenna size should be large, so introduce the notches into the DSP antenna. In second technique a small size antenna is designed to cover the highest frequency band.[3][4]

To cover the UWB range, The designed diamond shaped patch antenna, To introduced the notch in the center of the antenna. The notch cannot be affect the UWB behavior. Also using strip line in that notched region for multiband applications .The high frequency structure simulator(HFSS) software can be used to designed these antenna structures.[5][6]

2. DSP UWB Antenna Design

The structure of a suitable planar monopole radiator can be used as multiband antenna. These antenna can be act as UWB frequency range, is shown in figure. 1.The FR4 substrateis used with a dimension of 16 × 22 × 1 mm^2,and dielectric constant of substrate is ε_r = 4.4 and a loss tangent of 0.02. In figure the width of the feed line (W_f) fixed at 1.86 mm to achieve the 50 characteristic impedance, and also the feed length is L_f . The length and width of the substrate is W_s and L_s.[7]

The DSP antenna is to cover the UWB range in the designed multiband antenna. a_1, a_2, and b_1, and b_2 are the four parameters such as width and length of the DSP UWB antenna. The parameters b_1 and b_2 are the change the lower cut-off frequency of DSP antenna.

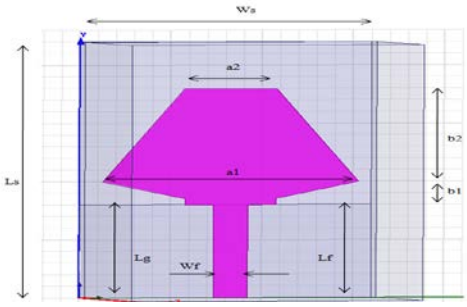

Fig.1 DSP-UWB antenna

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There are several important antenna characteristics now we can choosing some characteristics based on the antenna applicatilons.

- Return loss
- Voltage standing wave ratio
- Ratiation pattern

The frequency response of the DSP antenna is drawn between frequency response Vs return loss. In this paper the DSP antenna get the retun loss is -21.52 dB at 12.8GHz resonance frequency. shown in figure 2.

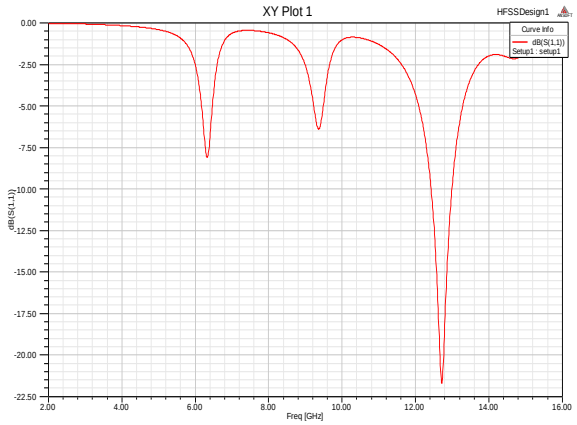

Fig 2. Return Loss

Normally in an antenna application the VSWR value is in between 1 to 2. In this antenna we get the VSWR value is 1 at 6.5 GHz frequency shown in figure 3.

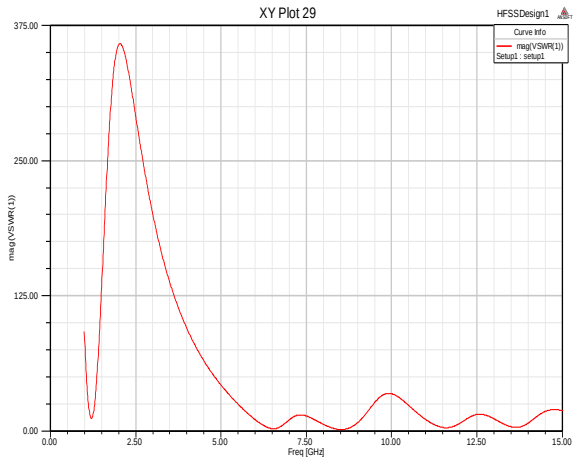

Fig 3. VSWR

The radiation pattern of the antenna is plot of relative field strength of the radio waves emitted by the antenna at different angles. The radiation pattern of the DSP antenna is shown in figure 4.

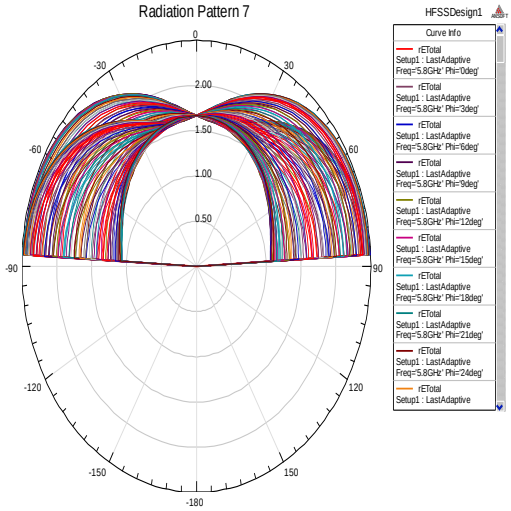

Fig 4. Radiation pattern

To introduce the notch in middle part of the DSP UWB antenna because of efficient UWB frequency range. Notch will not affect any antenna parameters of basic DSP-UWB antenna. To achive efficient UWB frequency range in DSP-UWB antenna with notch region. [8]

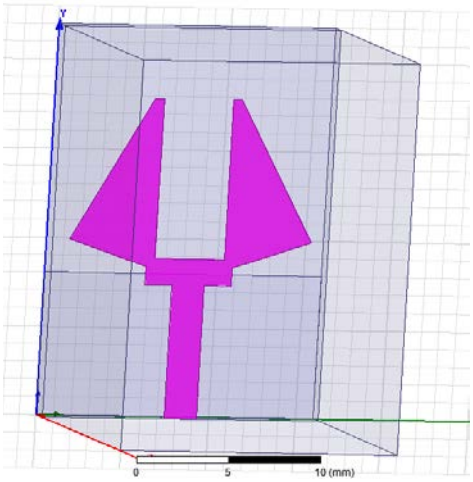

Fig 5. DSP UWB antenna with notched region

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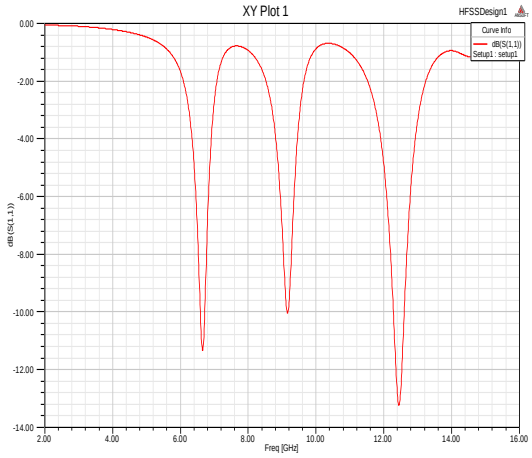

Fig 6. Return Loss

From the return loss graph it is seen that in frequency at 6.8GHz it has a value of return loss is -11.02dB.,9GHz it has a value of -10dB. and 12.3GHz it has a value of -13.3dB.

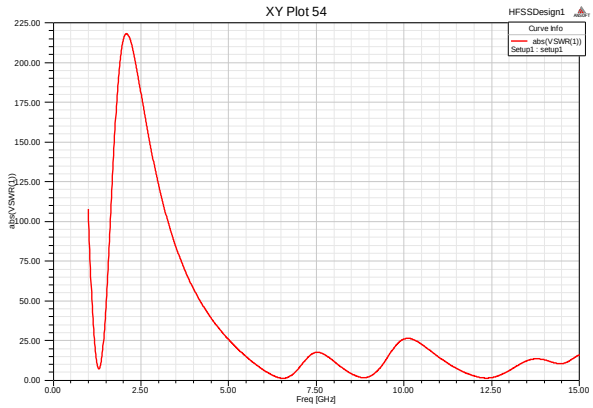

Fig 7. VSWR

From the VSWR graph it is seen that in frequency at 6.5GHz the value of VSWR is 1.

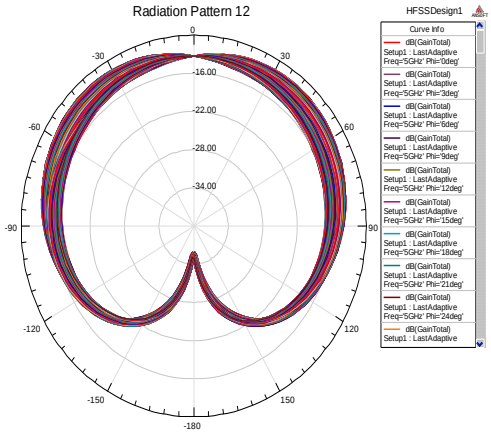

Fig 8. Radiation pattern

3. Multiband Antenna Configuration

In this section, the design of a multiband UWB antenna is presented . The structure of multiband UWB antenna is shown in figure 9. Add the strip line in the notched part of the DSP-UWb antenna. The stip line size is 0.2mm. Strip line used for the multiband application , this results are suitable for UWB application , to obtain any resonance frequency between 3.1 to 10.6 GHz.

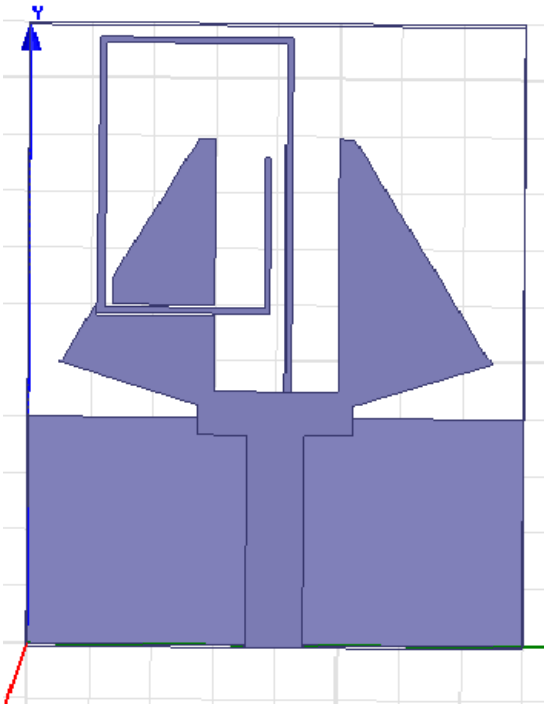

Fig 9. Multi-band DSP antenna

The resonance frequency of the multiband DSP-UWB antenna is achive the frequency range of 3.1-10.6GHz

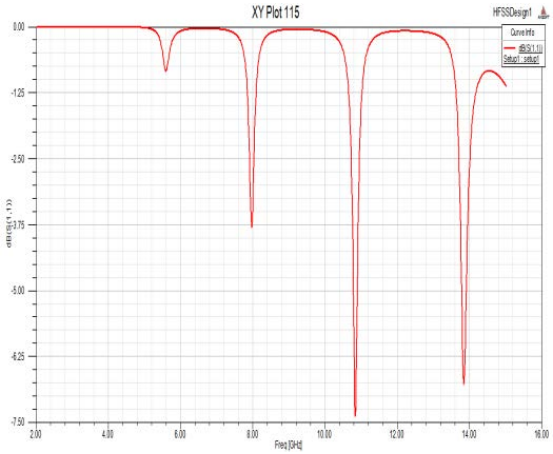

Fig 10. Return loss

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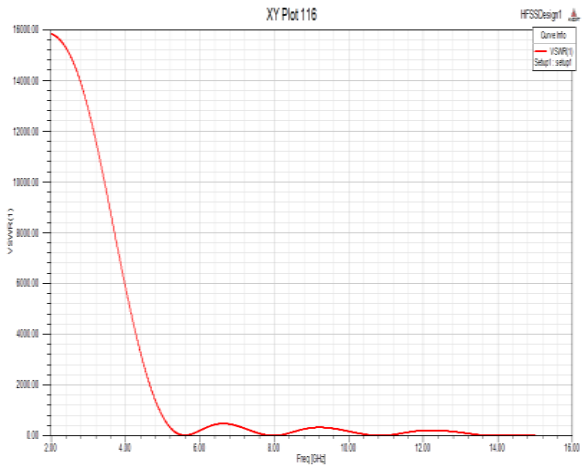

Fig 11. VSWR

4. Conclusion

A diamond shaped microstrip patch antenna with included narrow strips leading to a small size multi-band planar monopole antenna has been presented. The diamond shaped patch antenna covers the UWB frequency range. By changing the length of the added resonant strips in the notched region, the centre frequency of the multi resonances below the UWB frequency can be finely tuned. The fabricated antenna has been designed for Ultra wide band frequency range. The multiband antennas showstable omnidirectional radiation patterns over all the frequency bands as well as relatively consistent group delay across the UWB frequencies. The proposed quad-band antenna is suitable for MB-OFDM applications.

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