Analysis of V-Shaped Ultra-wideband Antenna

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ABSTRACT
A V-shaped ultra-wideband antenna has been analyzed. Firstly, a rectangular planar monopole antenna has been studied and its base is tapered to obtain a better bandwidth. The feed-line is then offset for impedance matching. A bandwidth of around 14.3 GHz is obtained for this configuration. Then, a V-slot is cut in the patch and a parametric study of the width of the V-slot, the width of the patch and the strip is conducted. The optimum configuration yields a bandwidth of 14.6 GHz.

Keywords
Ultra wideband, planar monopole antenna, v-slot.

1. INTRODUCTION
In wireless applications requiring higher data rates that involve pulse communication systems, larger bandwidth (BW) (in few GHz) is needed and in such applications printed ultra-wideband (UWB) antennas have become very popular due to their small size and low cost [1]. Many microstrip variations of UWB antenna using different patch shape like, rectangular, square, circular, triangular, etc have been reported which gives BW in few GHz [1]. Most of the printed UWB antennas are fed using microstrip line or by using coplanar waveguide fed. By using different shapes for the patch and slot, ultra wideband antennas are realized [2 – 8]. The ultra-wide band response in these structures is realized due to higher BW at the individual mode. The use of different slots changes the frequencies and impedance at individual modes to realize further increase in BW. The use of multiple slots in a patch antenna and in the ground plane results in ultra-wide band response. Depending upon the slot position with respect to the excited modes, amount of fringing fields from the slotted patch area changes, which changes the patch radiating efficiency.In this paper, a V shaped UWB antenna is proposed and analyzed. First, a rectangular monopole antenna (RMPA) is studied with respect to its fundamental and higher order modes. Further, the base of the RMPA is tapered .The parametric study of variations in tapering base and position of the feed line is presented and its effects on the realized BW are studied. The tapering of the base along with offsetting the feed line position optimizes the input impedance at lower and higher order resonant modes that realizes UWB response. Further, a v-slot is cut to realize a V- shaped structure with offset microstrip feed line mechanism. In this configuration the parametric study for variation in width of the V-slot, width of the radiating patch is presented. The parametric study for variations in microstrip feed line width is also shown. The optimum performance is obtained for V-slot width of 8 mm and a patch width of 20 mm. A strip width of 4 mm ensures impedance matching. The BW of the optimum configuration is close to 15 GHz with peak gain close to _ dBi. All these antennas have been initially analyzed using IE3D software [10] on glass epoxy substrate ($\varepsilon r = 4.3$, $h = 1.6$ mm, $\tan\delta = 0.02$) followed by the experimental verifications. The impedance measurements were carried out using R & S vector network analyzer whereas the pattern and gain were measured using R & S RF source and spectrum analyzer in minimum reflection surroundings.

2. TAPERED RECTANGULAR UWB ANTENNA
A rectangular UWB antenna with a tapering base fed by microstrip line is shown in Fig. 1.The proposed UWB configurations are design to cover BW from more than 1 GHz onwards. Therefore, initially patch dimensions (a = b = 20 mm) of rectangular patch are calculated such that its first order mode frequency is around 2 GHz. The dimensions of the ground plane are L = 30 mm and W = 15 mm. The tapering is applied to the bottom part of rectangular shape and tapering width (t) is decreased to investigate its effects on realized BW. The microstrip feed-line having length 15 mm and width p = 4 mm is placed at the center of the base. The resonance curve which shows variation in mode impedance and return loss plot that shows variation in realized BW with decreasing ‘t’ are shown in Fig. 2(a, b).. The optimum BW and impedance matching is obtained for ‘t’ = 4 mm.

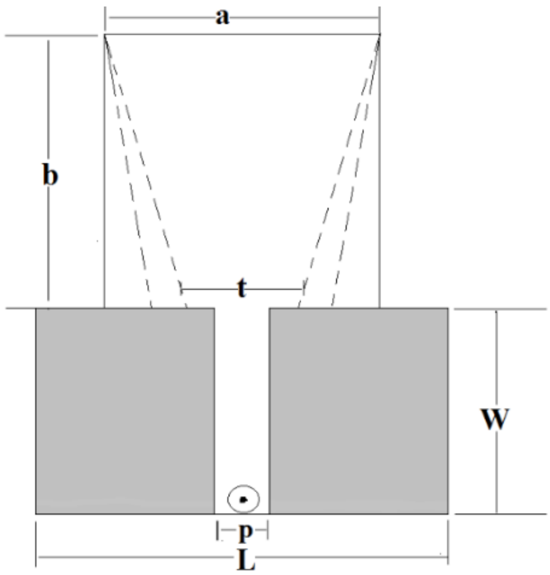
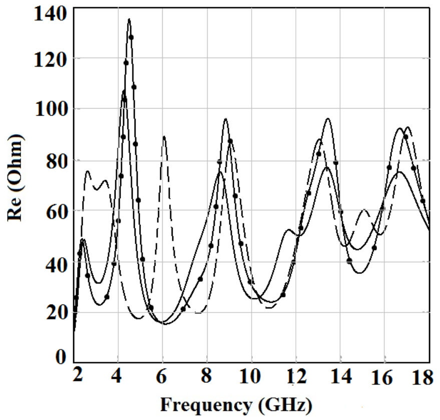
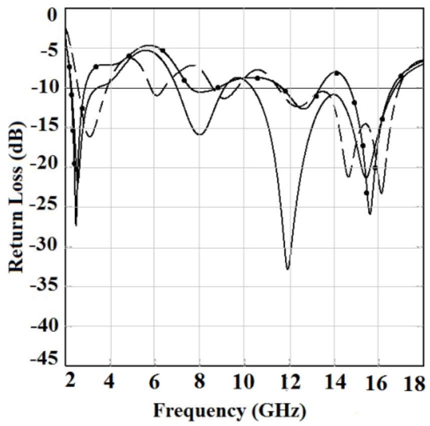


Fig. 1 Geometry of tapered rectangular UWB antenna.



(a)



(b)

Fig. 2 (a) Resonance Curve and (b) return loss plot for tapered rectangular UWB antenna

To further improve the impedance matching the position feed-line is offset by 2 mm as given in Fig.2 (c). The resonance frequency and return loss plots for this optimum configuration is shown in Fig. 3 (a, b)

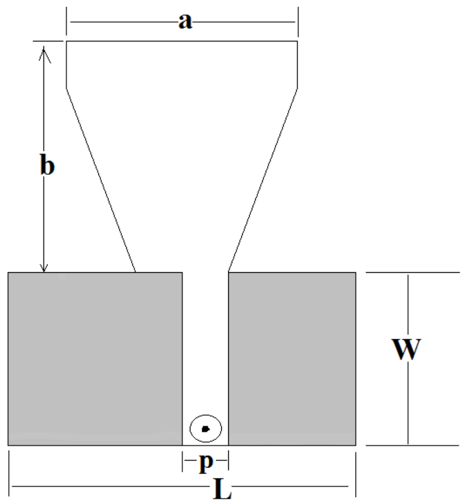
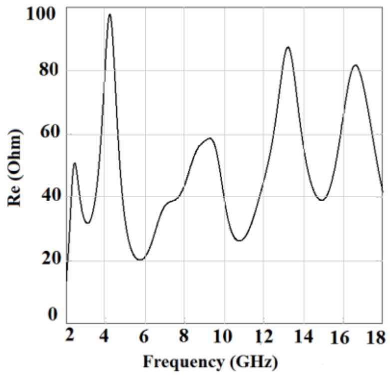
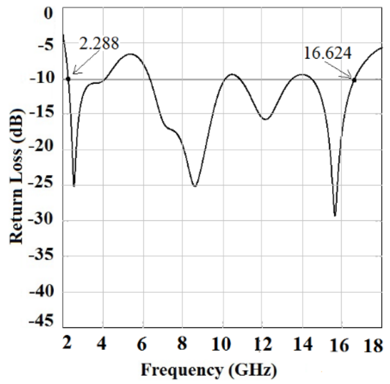


Fig. 3 Geometry for tapered offset configuration.



(a)



(b)

Fig. 4 (a) Resonance Curve and (b) return loss plot for tapered offset UWB antenna

3. V-SHAPED UWB ANTENNA

To further increase the bandwidth, a v-slot is cut inside the patch. The v-shaped UWB antenna is shown in Fig. The width of the slot, width of the patch and the width of the strip is varied.

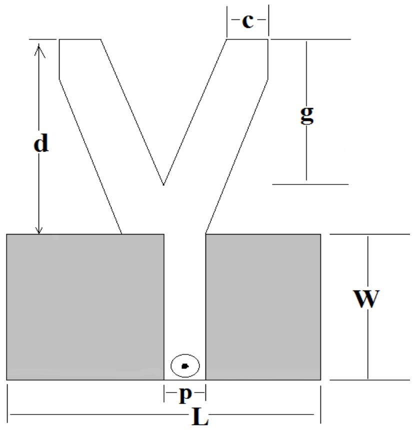
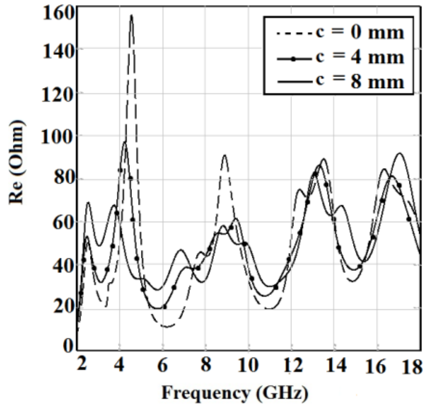
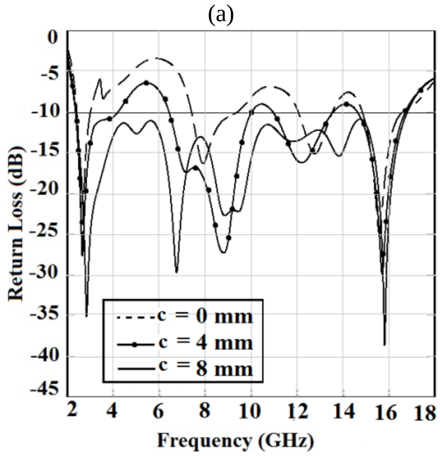


Fig. 5 Geometry of V-shaped UWB antenna.

First, the width of the slot, c, is varied and the resonance curve and return loss plots are given in Fig and respectively. It is observed from the resonance curve that the as the width goes on increasing, better impedance matching is obtained. The return loss plot shows that for c = 8 mm, the bandwidth obtained is the greatest.



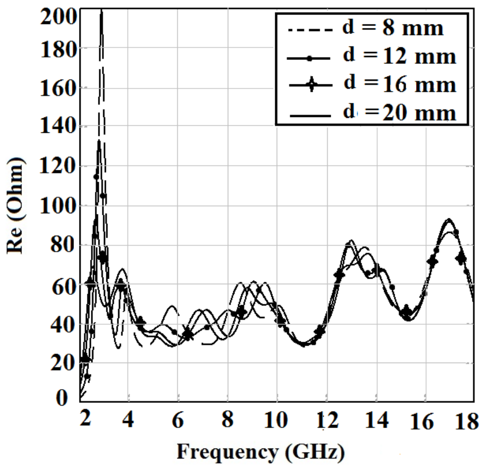
(a)



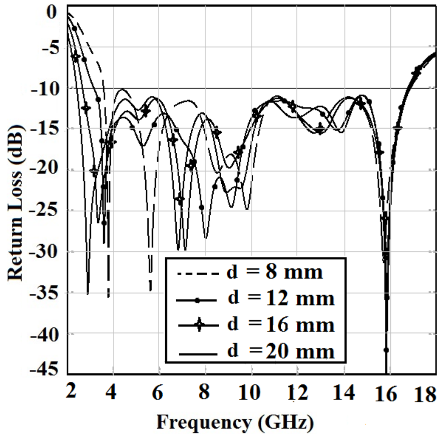
(b)

Fig. 6 (a) Resonance Curve and (b) return loss plot for variation in width of V-slot.

Next, the width of the patch, d, is varied and the resonance curve and return loss plots are given in Fig and respectively. It is observed from the resonance curve that for a width of d = 20mm impedance matching is obtained. It yields BW of 14.6 GHz.



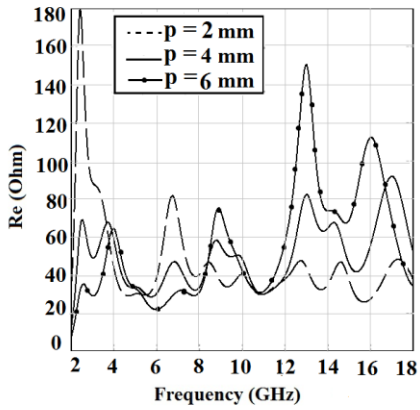
(a)



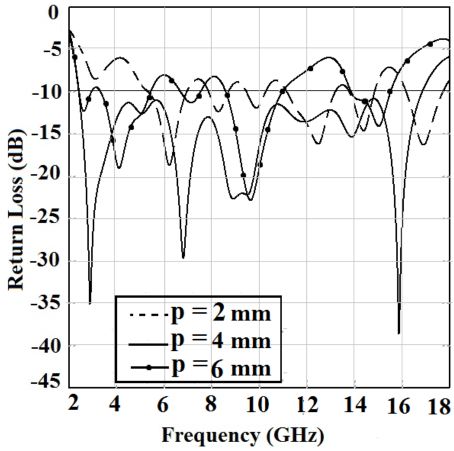
(b)

Fig. 7 (a) Resonance Curve and (b) return loss plot for variation in width of the patch.

Lastly, the width of the feed-line is varied. The resonance curves and the return loss plots for variations in the strip width are given in Fig and respectively. For a width of 2 mm impedance match is obtained at higher frequencies but not lower frequencies whereas for a width of 6 mm, impedance matching is obtained at lower frequencies but not for higher frequencies. Hence a strip width of 4 mm is chosen which a yields an optimum BW of 14.6 GHz.



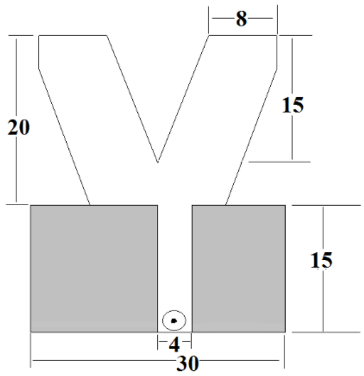
(a)



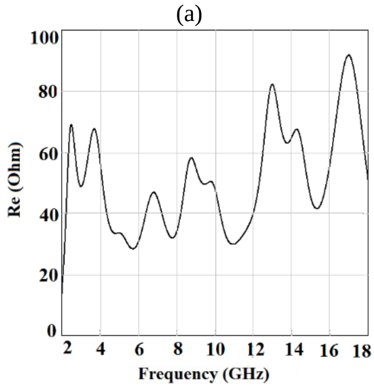
(b)

Fig. 8 (a) Resonance Curve and (b) return loss plot for variation in strip width.

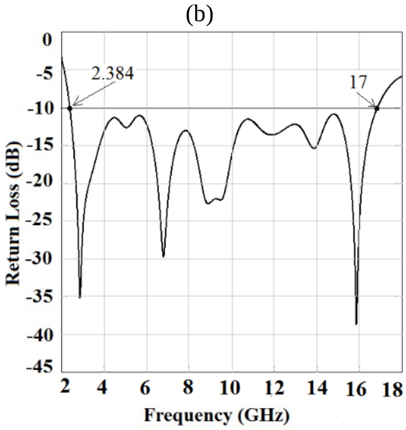
The optimum configuration is shown in Fig. and all dimensions are given in mm. The resonance curve and return loss plots are given in Fig and respectively. This configuration yeilds a BW of 14.6 GHz.



(a)



(b)



(c)

Fig. 9 (a) Geometry (b) Resonance Curve and (c) return loss plot for of the optimized v-slot configuration.

4. CONCLUSION

A V-shaped ultra-wideband antenna has been proposed. A rectangular planar monopole antenna has been studied and results for a tapered base have been presented. For impedance matching, the feed-line is offset from the center. A V-slot is then cut in the patch and a parametric study of the width of the V-slot, the width of the patch and the strip is conducted. The optimum configuration yields a bandwidth of 14.6 GHz. A modal analysis of the V-slot configuration and its frequency formulations will be presented in further research.

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