

# High Gain Cavity Backed UWB Antenna with and Without Band Notch Feature

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**Abstract**— High directivity antennas are often used in communication systems to meet specific coverage requirements. This paper presents a unidirectional, high gain UWB antenna. A reference UWB antenna is considered and a metallic cavity is built around it, this arrangement along with a stacked parasitic patch shows a maximum increase of 8.5 dB in the gain of the UWB antenna. A maximum increase of 8.43 dB in the gain is seen for the UWB antenna having band rejection feature.

**Keywords**—Ultra-wide band; Band Notch; Cavity

## I. INTRODUCTION

In the recent years UWB systems have become very popular because of their high data rates. Accordingly, the UWB antennas have gained as much popularity and interest from the researchers and designers. A variety of UWB antenna designs have been proposed. To mitigate the interference of the narrow band systems to the UWB systems, various UWB antennas having band notch characteristic have also been proposed, like [1-3].

Some UWB systems like ground penetrating radar (GPR), through wall radar and medical imaging systems require high gain and high directivity UWB antennas. To meet this requirement various UWB antenna designs and techniques have been proposed. In this paper we have presented a cavity-backed UWB antenna with and without band rejection property. Further, it is shown that using stacked parasitic patch (SPP) in a cavity-backed UWB antenna further enhances the gain and directivity. Cavity-backed narrow band antennas have been extensively reported [4-7], but the use of cavity for the UWB antenna is very rare. This research shows a simple cavity design to increase the gain of UWB antennas with and without band notch property. Compared to some previously proposed cavity-backed antennas, like [8-10], this design is simple, provides high gain, relatively smaller in size, almost unidirectional radiation pattern throughout the operating band and can have band rejection property as well. All the simulations are conducted using CST MWS 2010.

## II. ANTENNA DESIGN AND CONFIGURATION

Fig. 1a and 1b shows the reference UWB antenna; this antenna has an operating bandwidth of 3.1 GHz to 10.6 GHz (FCC's defined range for UWB systems [11]). The gain and

S11 plots for this antenna are shown in Fig. 4a and 5b respectively. To increase the gain of the antenna, reflectors were placed on all sides except the front side of antenna. This arrangement formed a box shaped cavity around the antenna. The resulting structure is shown in Fig. 2a. The gain and S11 plots for this antenna are shown in Fig. 4a and 5b respectively. By placing a parasitic patch above the radiating patch in stacked formation, the gain is seen to increase slightly. The details of the resulting structure can be seen in Fig. 2b.

The band rejection is achieved by making identical U-shaped slots on the radiating and parasitic patch, as shown in Fig. 1c. The gain and S11 plots for various configurations of this antenna are shown in Fig. 4c and 5d respectively. Except the slots, all other dimensions are the same as that of the Cavity-backed UWB antenna with SPP.

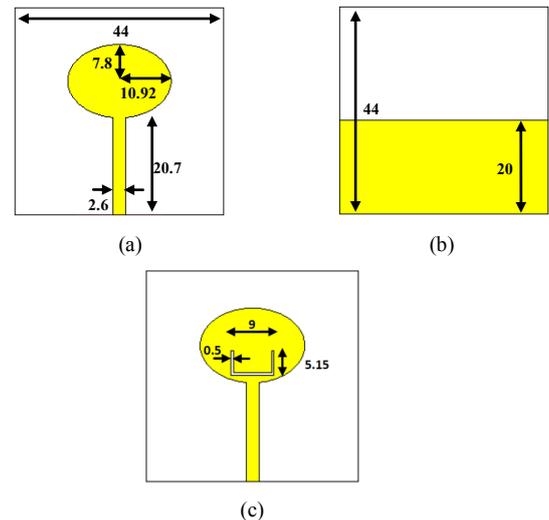


Fig. 1. (a) Front side of reference antenna (b) back side of reference antenna (c) reference antenna with slot in the patch [12] (units: mm)

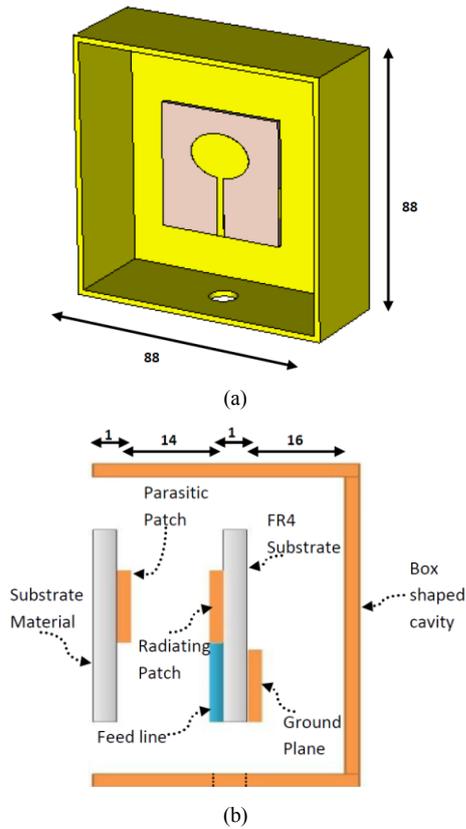


Fig. 2. (a) Cavity backed UWB antenna simulation model (b) Block diagram for Cavity backed UWB antenna with SPP (units: mm)

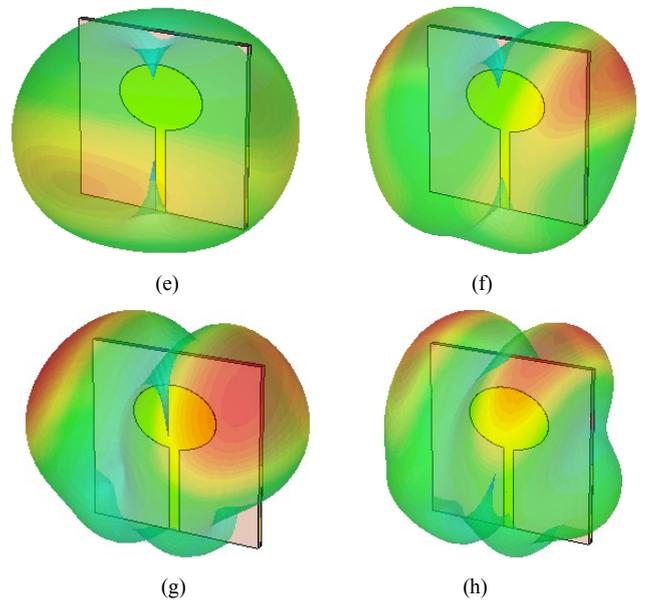
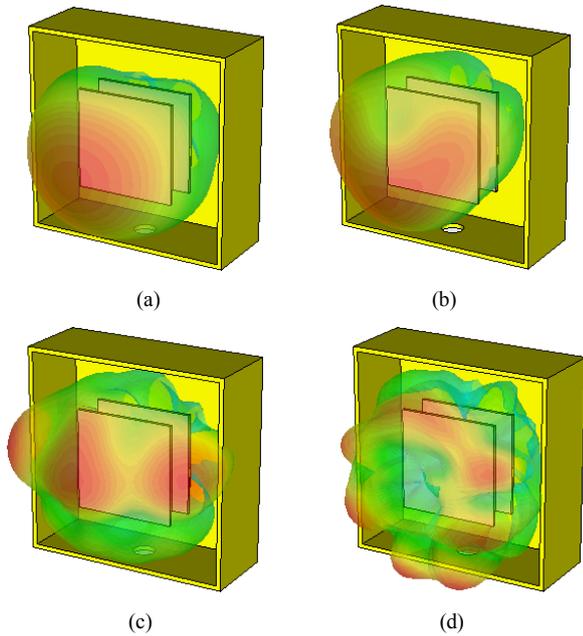


Fig. 3. Far field radiation pattern of proposed antenna at (a) 3.1 GHz (b) 5 GHz (c) 7 GHz (d) 9 GHz. (e) far field radiation pattern of reference antenna at 3.1 GHz (f) 5 GHz (g) 7 GHz and (h) 9 GHz.

### III. RESULTS AND DISCUSSION

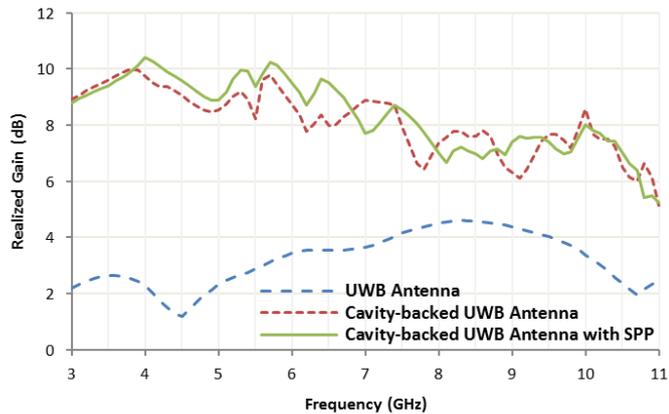
A simple cavity-backed UWB antenna has been proposed in this research. The gain plots of the antenna show significant increase in the gain throughout the UWB range of frequencies, as a result of cavity backing. A maximum of 10dB gain and a maximum increase of 8db have been achieved in this configuration. The addition of SPP slightly increases the gain to a maximum of 10.5dB, but the distance of SPP may be varied to achieve higher gain. The use of cavity has incredibly concentrated the radiations in the forward direction, hence increasing the directivity of antenna. Throughout the operating band the antenna radiates only in the forward direction as shown in Fig. 3. A broadside UWB reference antenna has been converted to an almost unidirectional antenna with high gain.

This technique when extended to UWB antenna having band rejection property, showed similar results with the band rejecting property preserved. The use of cavity raised the gain to a maximum of 9.5 dB, while the addition of SPP increased the gain up to a maximum of 10.2 dB as shown in Fig. 4c. The sharp decrease in the gain of antenna shows the rejected band. The rejected band of the cavity-backed antenna is slightly wider than the reference antenna as seen in Fig. 4d, which can be adjusted by changing the dimensions of the U-shaped slot.

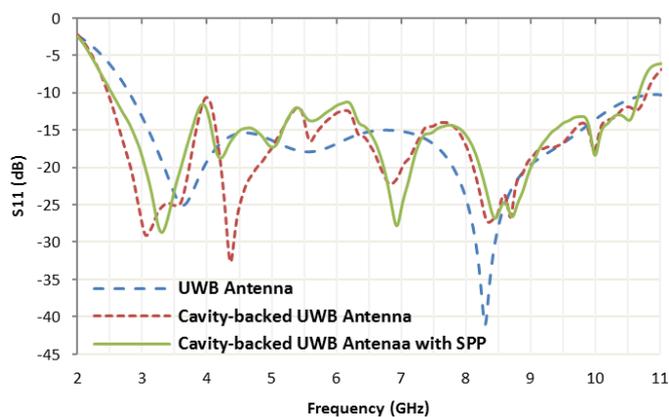
### IV. CONCLUSION

In this research a high gain and highly directional UWB antenna based on the concept of cavity backing is proposed. It is shown that SPP technique can also be used along with the cavity, which further improves the antenna gain. The proposed antenna radiates only in the forward direction throughout the operating band (3.1 GHz to 10.6 GHz). This property makes it a good candidate for use in GPR, through wall radars, medical imaging systems and other systems requiring directional antennas. Further, it is shown that the same technique works

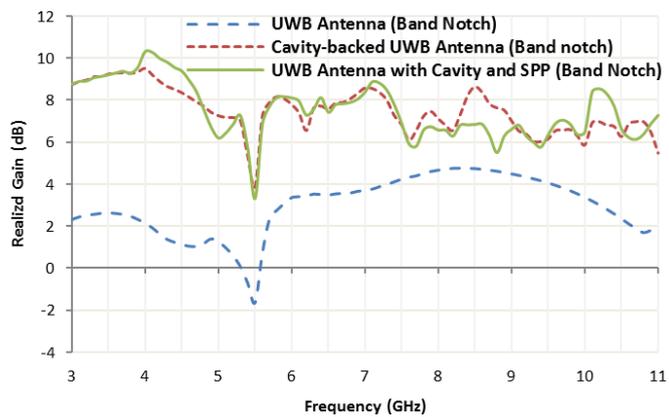
equally well for the UWB antenna having band rejection property.



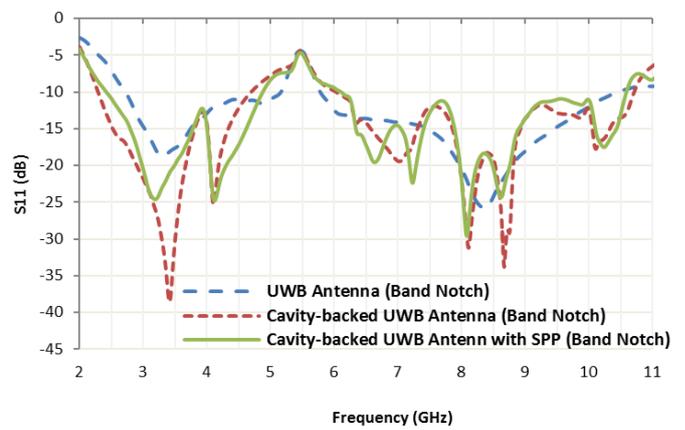
(a)



(b)



(c)



(d)

Fig. 4. (a) Gain for different configurations of antenna (b) S11 for different configurations of antenna (c) Gain of different configurations of antenna with Band notch (d) S11 of different configurations of antenna with band notch

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