# A Compact UWB Planar Antenna with WLAN Band-Notch Characteristic

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**Abstract** : A novel compact ultra wideband(UWB) antenna for UWB application is proposed in this paper. The proposed antenna with 22 mm × 26 mm × 1.6 mm covers the entire UWB bandwidth and has band notch characteristic for the frequency band of 5.15 ~ 5.825 GHz limited by WLAN. The antenna has a concaved ground plane and staircase shape patch to achieve the wide bandwidth, and has an U shape slot with $\lambda/4$ length to notch the band. The return loss and group delay of the proposed antenna are measured.

**Key words** : Antenna, Compact antenna, Notch antenna, Ultrawide band(UWB)

## 1. Introduction

Recently, an ultra wide-band (UWB) system has received attention[1]-[3]. This is due to the fact that it features high speed data rates, low power consumption and simple hardware configuration, and has become one of future short-range communication technologies. One of key techniques in the UWB communication system is to design an UWB antenna. The UWB antennas have to be matched in frequency range from 3.1 GHz to 10.6 GHz, and need to have non-dispersive property and omni-directional radiation patterns, and compact size. Additionally, the UWB antennas are required for the rejection of an interference on wireless LAN (WLAN) system (5.15 ~ 5.825 GHz). Therefore, the UWB antennas with notched characteristics in WLAN frequency band are recently reported in some papers[4]-[6].

In this paper, a novel UWB antenna with signal rejection capability in the WLAN frequency bands (5.15 GHz ~ 5.825 GHz) is suggested. The design and measured results of the proposed antenna are discussed in detail in the following section.

## 2. Antenna design

Fig. 1 shows the proposed UWB antenna etched on a FR4 substrate with thickness of 1.6 mm and relative dielectric constant of 4.4. It is like a printed monopole antenna fed by microstrip line. It consists of a concaved ground plane and staircase shape patch to achieve wide bandwidth.

The patch is the combination of planar half-circle and square shape patches with

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staircase to reduce the variation of gains and size of antenna.

In order to reject the WLAN frequency bands, the patch has a U shape slot with λ/4 length. The design of the UWB antenna with notch characteristic in WLAN band is done by using the Ansoft Designer software.

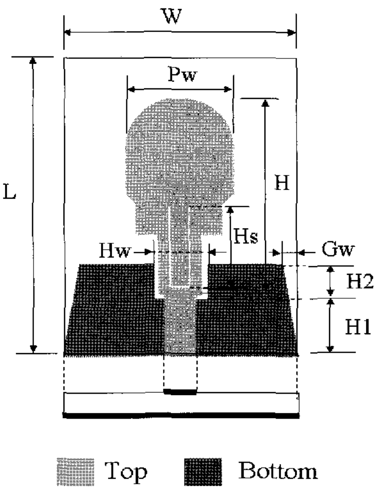



***Fig. 1 The geometry of the proposed antenna.***

Fig. 2 shows the simulated return loss of the antenna without a U shape slot as function of the height of ground plane, H2. From Fig. 2, it is found that a concaved ground plane has effect on the bandwidth and the optimum height to satisfy the entire UWB frequency band is 3mm.

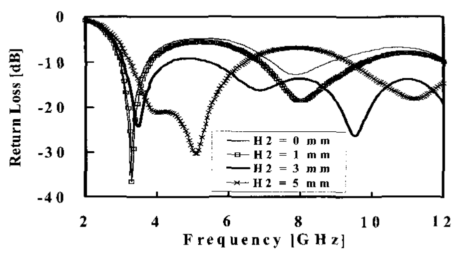



**Fig. 2 Return loss of the proposed antenna as function of the height of ground plane, H2.**

Fig. 3 shows the variation of the return loss of the antenna without a U shape slot due to the shape of ground plane changed from a rectangular to trapezoid. The small changes of the parameter of the ground plane, Gw, has also an effect on the bandwidth of the antenna as shown in Fig. 3. As Gw is increased, the 3rd resonant frequency becames higher and return loss at the frequency becomes lower.

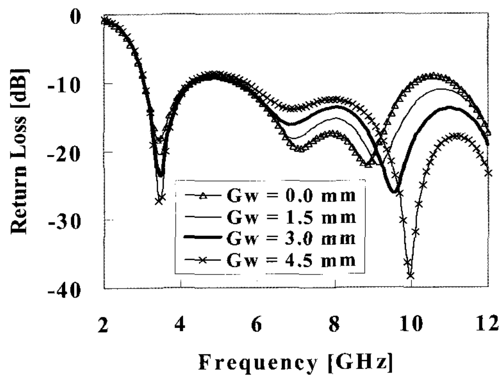



**Fig. 3 The variation of return loss of the antenna due to the shape of the ground plane.**

In order to reject the WLAN frequency bands, the antenna is designed to have a U shape slot with λ/4 length on the patch. Fig. 4 shows the effect of a U shape slot on the antenna bandwidth. It is clear that the notched frequency band can be controlled by the length of the slot and the return losses in pass band are not affected by the presence of the notched slot. Therefore, the pass and the stop frequency bands of the antenna can be designed independently each other.

From the analysis of the antenna by using the simulation software, the optimized values of the parameters of the proposed antenna are given in Table 1.

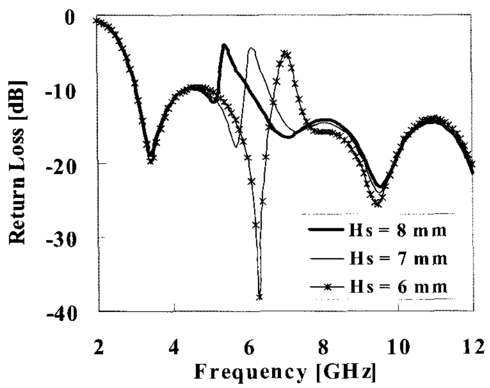



**Fig. 4 The variation of return loss of the antenna due to the length of the slot.**

**Table 1 Values of designed antenna**

| Design parameters | Optimised value (mm) |
|---|---|
| W | 22 |
| L | 26 |
| Pw | 10 |
| H | 19.7 |
| Hs | 8 |
| Hw | 5 |
| H1 | 5.5 |
| H2 | 3.5 |
| Gw | 3 |

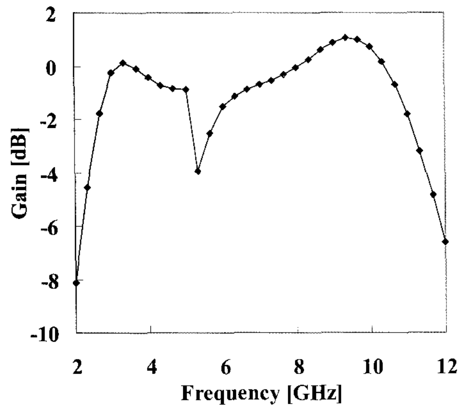
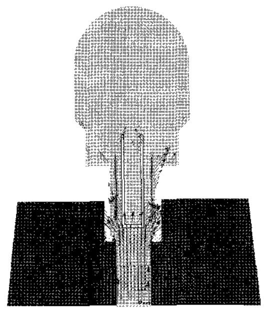
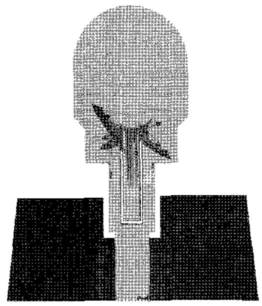



**Fig. 5 The simulated antenna gain.**

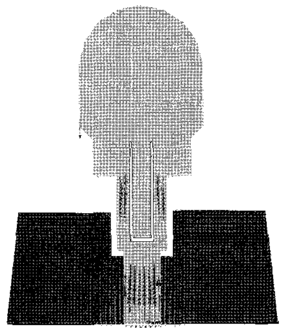
Fig. 5 shows the simulated antenna gains and a sharp decrease of gain in notched frequency band is shown. The variation of a maximum gain is required to be limited to 3 dBi in a UWB antenna system. The proposed antenna satisfy the gain requirement as shown in Fig. 5.



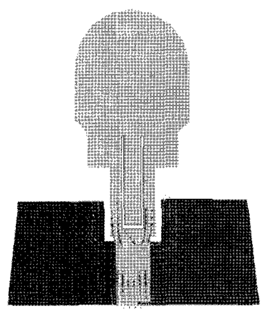
(a) 3 GHz



(b) 5.5 GHz



(c) 7 GHz



(d) 10 GHz

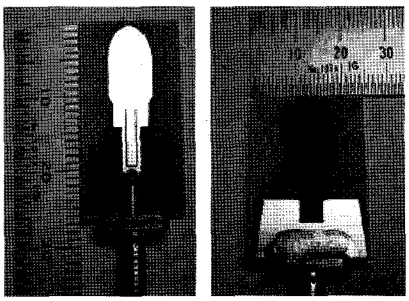
**Fig. 6 The simulated current distributions.**

Fig. 6 shows the simulated current distributions at each band. There are strong current distributions in staircase structure near a concaved ground plane at UWB bands. But strong current distributions at 5.5 GHz of a notch-band are near in a U-shaped slot and are not contribute to radiation field because the currents are out of phase.

The area of staircase structure near a concaved ground plane where current distributions are strong is a sensitive part of the tuning point in UWB band. Capacitance and inductance can be controlled by a concaved ground plane and staircase structure, respectively. By adjusting them, a wide bandwidth can be achieved.

## 3. Result

Fig. 7 shows the fabricated UWB antenna on FR4 substrate with thickness of 1.6 mm. The comparison of the measured and the simulated return losses of the antenna in terms of frequency are shown in Fig. 8. The measured and simulated impedance bandwidths (RL ⟨ - 10dB) are from 3 GHz to more than 10.6 GHz excluding therejection band of 5.15 to 5.825 GHz.



(a) Top view (b) Bottom view

**Fig. 7 The fabricated antenna on FR4 substrate.**

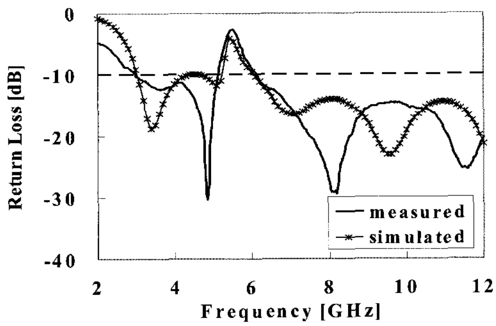
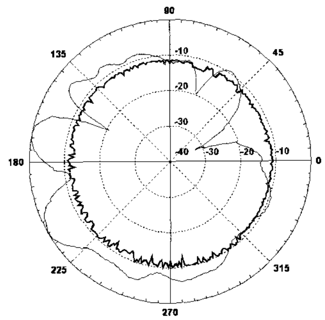
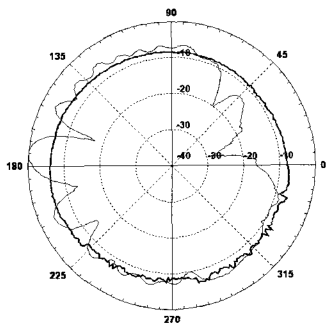



**Fig. 8 The measured and simulated return loss of the proposed antenna.**

Fig. 9 shows the measured radiation patterns of the antenna at 3.1 GHz, 5 GHz, 7 GHz and 10 GHz. It is found that the radiation pattern of the proposed antenna has an acceptable approximate omni-directional as like as monopole antenna because the shape of proposed antenna is a similar to a printed monopole.



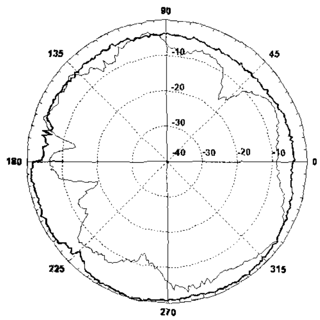
(a) 3.1 GHz



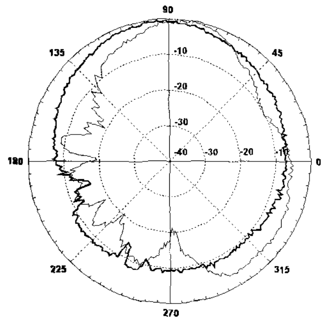
(b) 5 GHz

**Fig. 9 The measured radiation pattern of the antenna.**

(—— H-plane —— E-plane )




(c) 7 GHz




(d) 10 GHz

**Fig. 9 To be continued**

The group delay variation of a UWB antenna is an important parameter because the 1 ns group delay variation cause a pulse distortion and it can be a serious problem in UWB communication systems. Fig. 10 shows the measured group delays between the two proposed antennas separated by 15cm where the two antennas are in far field region. The measured delay variation over UWB band except notched-WLAN band are less than 1 ns, as shown in Fig. 10.

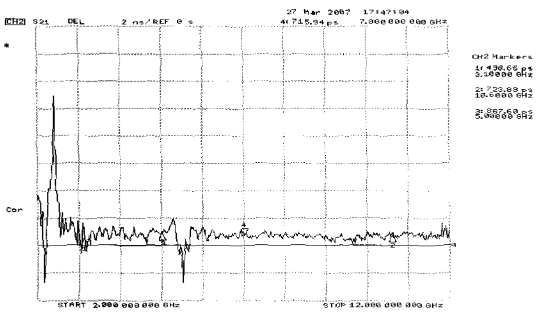


**Fig. 10 The measured group delay of the antenna.**

## 4. Conclusion

A noble UWB antenna with band-notch characteristic has been proposed in this paper. To achieve ultra wide band and band rejection, the proposed antenna is formed by a concaved ground plane and staircase shape patch with a U shape slot of $\lambda/4$ length. The measured return losses and group delays show that the proposed antenna is applicable to UWB communication systems.

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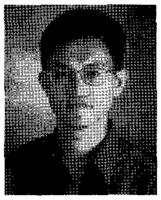
## Author Profile



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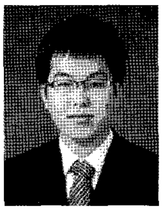

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