Compact CPW-Fed UWB Antenna with 3.5Hz/5.5GHz Band-Notched Applications

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Abstract—A coplanar waveguide fed (CPW-Fed) monopole antenna with dual band-notched characteristics is presented in this paper. The proposed antenna consists of stepped rectangle patch, stepped ground planes and stepped feed lines. These steps improve the input impedance bandwidth and radiation characteristics. By removing a U-shaped slot and C-shaped one from the stepped patch, band rejected property in the 3.5/5.5GHz band is obtained. Moreover, the two bands can be adjusted independently. The compact antenna has the promising performance including broadband impedance matching, consistent radiation pattern and stable gain.

I. INTRODUCTION

Federal Communication Commission's (FCC)'s ruling in February 2002 for spectrum's commercial use of wide band from 3.1 GHz to 10.6 GHz has completely revolutionized the wireless and high speed data communication world [1]. In recent years, different kinds of printed planar monopole antennas[2]-[7] have been proposed for the applications in UWB system and the bandwidth of the these proposed antennas is increased by modifying the shapes of the radiation patch and groundplane. However, the band of the UWB system overlaps the narrow bands used by WiMax operating at the 3.3–3.7GHz band and WLAN in the 5.15–5.825 GHz band. So broadband antennas with band-notched characteristic are required to avoid the electromagnetic interference.

In this paper, Finite Element Method (FEM) frequency domain based full-wave computational technique is used for antenna structure optimal design and performance simulation [8]. A miniaturized band-notched UWB antenna with area of 24 by 24 mm^2 is proposed. The 3.5 GHz and 5.5 GHz notched bands are realized and adjusted using one U-shaped slot and one C-shaped slot in the radiating patch. Each slot contributes one notched band and there is no influence between each other.

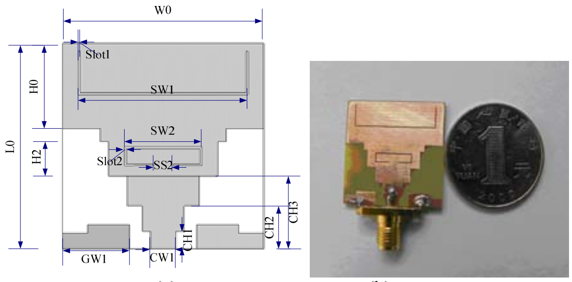
II. FEM BASED ANTENNA DESIGN

The FEM in the frequency-domain technique has been employed for the simulation domain, where the frequency-domain vector wave equation for $\boldsymbol{E}$ field can be written as:

$$\nabla \times \frac{1}{\mu} \nabla \times \mathbf{E} + \sigma_e \omega \mathbf{E} + \omega^2 \varepsilon \mathbf{E} = -j\omega \mathbf{J} \qquad (1)$$

where ω is angular frequency, $\mathbf{J}$ is the source current, σ_e is the effective conductivity, and μ and ε are the permeability and permittivity of the problem space respectively. A finite conductivity boundary and perfectly matched layer (PML) were applied in the simulation model.

Fig. 1(a) shows the geometry and the photograph of the proposed antenna. The antenna was fabricated on a FR4 epoxy substrate with h=1mm, the dielectric constant ε_r =4.4 and loss tangent tanδ=0.002. As shown in Fig.1, stepped ground plane is adopted to achieve better impedance match in low frequency band. The radiator is fed by a stepped coplanar waveguide (CPW) transmission line in order to achieve better high frequency characteristic. One U-shaped slot and one C-shaped slot are etched from the patch to achieve the notched band. The dimensions of the proposed antenna are optimized using HFSS. The design parameters are L0=24 mm,W0=24 mm, H0=10mm, H2=4 mm, SW1=20.2 mm, Slot1=0.2 mm,SW2=9.2 mm,SS2=2.4 mm, Slot2=0.2mm, GW1=8mm, CW1=3mm, CH1=2mm, CH2=3 mm,CH3=3.5 mm.



(a) (b)

Fig. 1. Geometry and photograph of antenna

III. RESULTS AND DISCUSSION

The antenna was fabricated and the photograph is shown in Fig. 1(b). The VSWR of the proposed antenna was measured using a network analyzer (Agilent N5230). The comparison of the simulated and measured VSWR of the dual band-notched antenna is shown in Fig. 2. It is noted from the measured results that the proposed band-notched antenna covers the frequency range of 3.1-10.6 GHz, and has dual band-notched characteristics (VSWR>2) in 3.2-3.7 GHz and 4.8-5.9 GHz. Therefore, the potential interferences between UWB system and the two wireless communication systems can be suppressed effectively.

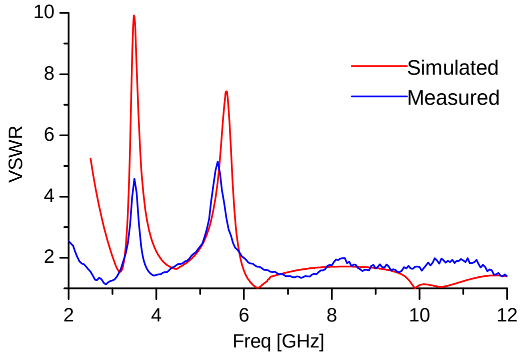


Fig. 2. Measured and simulated VSWR of proposed antenna

The length and the location of the U-shaped and C-shaped slots affect the centre frequency of the notched bands. The effects of varying SW1 on the band-notched characteristics are shown in Fig.3. It is obvious that SW1 mainly affects the central frequency of the lower band notch at 3.5 GHz. The centre frequency of the notched-band (3.5GHz) is decreased when increasing SW1. Similarly, it is noted that the parameter SW2 controls the other notched band (5.5GHz) as shown in Fig.4. The centre frequency of the notched band around 5.5 GHz decreases with longer slot. Based on the observation the effects of mutual coupling between the dual band notches are slight, and the dual band-notched characteristics can be adjusted independently.

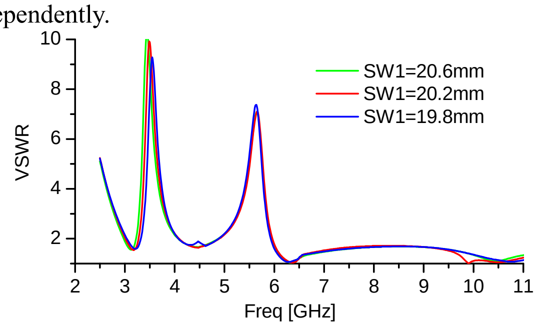


Fig. 3. Effect of varying the length of SW1

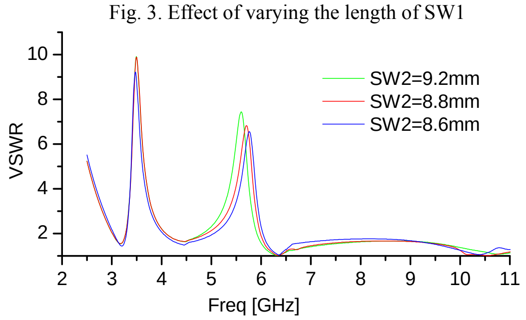
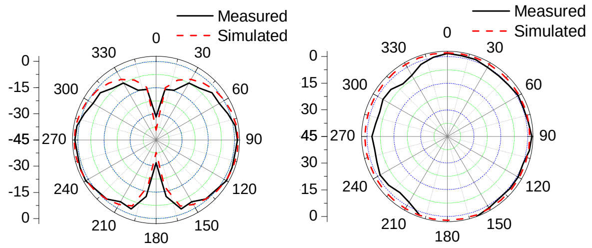


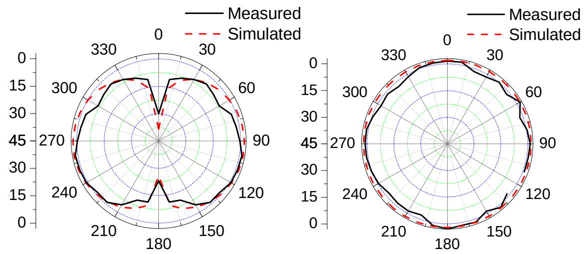
Fig. 4. Effect of varying the length of SW2

The far-field radiation characteristics at 3.1, 4.5, and 8 GHz are given in Figs. 5-7, respectively. Nearly omnidirectional radiation patterns in the H-plane and dipole-like radiation patterns in the E-plane are obtained at these frequencies. The measured and simulated results match well except in some orientations at 3.1, 4.5GHz. It is because the antenna was measured in the outdoor antenna test system. Due to the limitations of laboratory instruments, the radiation patterns above 10 GHz were not measured. It is noted that the gain decreases abruptly at 3.5 GHz and 5.5 GHz, which means good band-notched characteristics have been achieved and the potential interferences between UWB systems can be minimized effectively. The detailed results will be presented in the full paper.



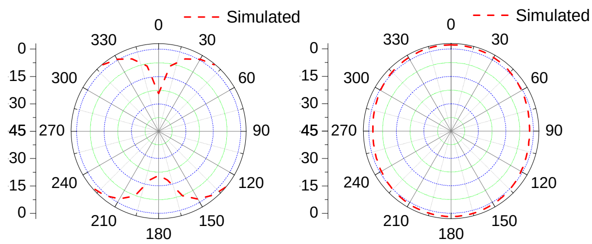
(a) E-plane (b) H-plane

Fig. 5. Measured and simulated radiation patterns at 3.1 GHz



(a) E-plane (b) H-plane

Fig. 6. Measured and simulated radiation patterns at 4.5 GHz



(a) E-plane (b) H-plane

Fig. 7. Simulated radiation patterns at 8GHz

IV. REFERENCES

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