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A Novel Clover Shaped Novel UWB Antenna with Filtering Properties

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Abstract

A novel printed monopole antenna with multi stop band property is presented. The proposed antenna consists of a clover shape radiating patch to perform better in lower frequencies and a defected semi ellipse ground plane to have better impedance matching. By carving a slot on the radiating patch and adding properly designed arms, four stop bands are obtained. Antenna has a compact patch of 24mm (0.19 λ) × 24mm (0.19 λ), where λ is the wavelength of the lowest frequency of the band (2.4GHz), while showing the band rejection performance in 2.73GHz to 6.06GHz. Measured impedance bandwidth of the realized antenna is from 2GHz to 16GHz, for VSWR<1.5. Antenna shows a high gain of maximum 7.7 dB at 3.6GHz and a stable gain over 5GHz to 10GHz.

Keywords: Miniaturized antenna, UWB antenna, Notched antenna

INTRODUCTION

Recently, ultrawideband (UWB) technology is widely being used in mobile and wireless applications and has attracted much attention for communication systems. The design of an antenna is one of the most important challenging parts in these systems. For implementing UWB systems, proved by the FCC in 2002 [1], planar and microstrip monopole antennas are good choices. These antennas have undeniable advantages such as wide frequency range and omnidirectional radiation pattern. A big concern is that the frequency range for UWB systems, between 3.1GHz to 10.6 GHz will cause interference to the existing wireless communication systems, i.e. the wireless local area network (WLAN) for IEEE 802.11a, operating in 5.15–5.35 GHz and 5.725–5.825 GHz bands. To overcome the effect caused by the frequency interference from mentioned systems some UWB antennas with band-notched features have been designed. Some methods such as creating U-slot [2]-[5] and small strip bar [6], and many other methods are used. In this letter, we thus propose a printed monopole antenna that simply employs a horizontal strip slot with controllable arms to flexibly control the rejection frequency band for UWB system operation. Unlike those conventional designs, new slot using method, and quite stable radiation performance of the antenna can be achieved as the major design parameters of the presented antenna.

Antenna Design

The geometry and dimensions of the proposed antenna are presented in Fig. 1. The antenna is printed on a 1 mm-thick FR4 substrate with 24mm × 24 mm dimensions, relative permittivity 4.4 and loss tangent 0.024. The antenna is formed by a strip slot, etched out from the clover shape radiating plane of a printed circuit board (PCB), embedded a defected semi ellipse ground plane, to enhance the antenna with better impedance matching. The physical structure of the clover shape exciting patch is adapted to increase the effective electrical length and longer current path at the lower frequency bands (2-3 GHz).

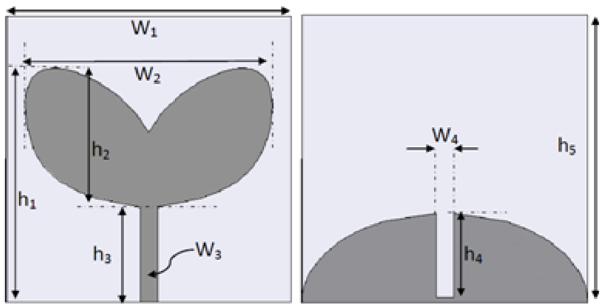

Fig.1. Geometry and details of the proposed antenna,,W1=30mm, W2=24mm, W3=1.875mm, W4=1.875mm, h1=24mm, h2=14.5mm, h3=9.5mm, h4=10mm, h5=30mm

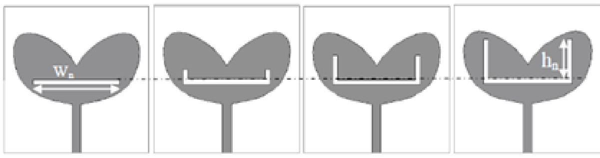

Fig.2. Geometry of the Antenna in different arm heights, Wn=18mm

The defected semi ellipse on the ground plane enhances the antenna with orthogonal current paths which improves antenna with better impedance matching factor compared to simple ellipse one. A strip slot with supplementary arms is etched from the radiating patch to enhance the antenna with desired stop bands. The design concept of the notch function is to adjust the length of the slit cut to be about quarter-wavelength at the desired notched frequency making the input impedance singular [7]. The notch frequency, given the dimensions of the band notch can be calculated by

f_{notch}= (1)

where L is the total length of the embedding slit, ε is the effective dielectric constant, and c is the speed of the light. To achieve the desired frequency rejected band, (1) is taken into account in obtaining the total length of the slit at the beginning of the design and then in each step proper arms with 2mm and 5mm and 8 mm heights are added to the strip slot to perform the four reject bands.

Parametric Study Of The Antenna

The Ansoft high frequency structure simulator (HFSS) was employed to validate the proposed design. A fabricated prototype for the proposed UWB antenna was constructed and tested. A vector network analyzer (Agilent-N5230A) is utilized to measure and verify the antenna performance. Figs. 4 and 5 illustrate the simulated and experimental VSWR against frequency of the antenna. Fairly good agreements between the simulations and measurements have been achieved. As observed, the measured impedance bandwidth for the proposed antenna is from 2 to 16 GHz, rejecting the frequency band

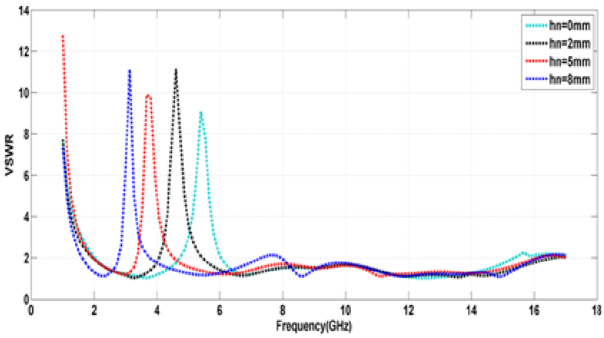

Fig.3. VSWR of notch antenna in different arm heights

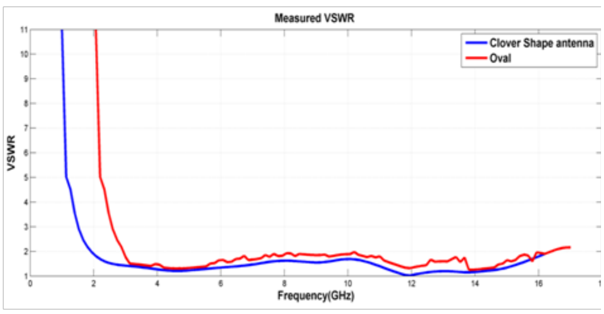

Fig.4. VSWR of the clover shape antenna compared to the oval one

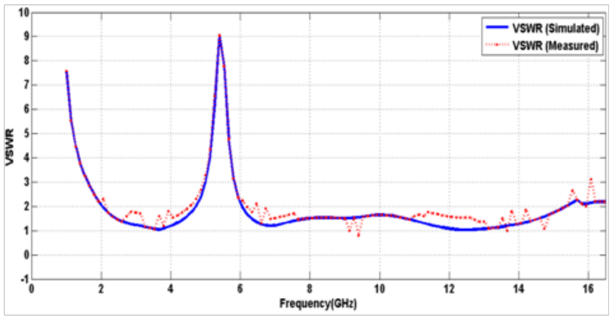

Fig.5. Measured and Simulated VSWR of the proposed antenna

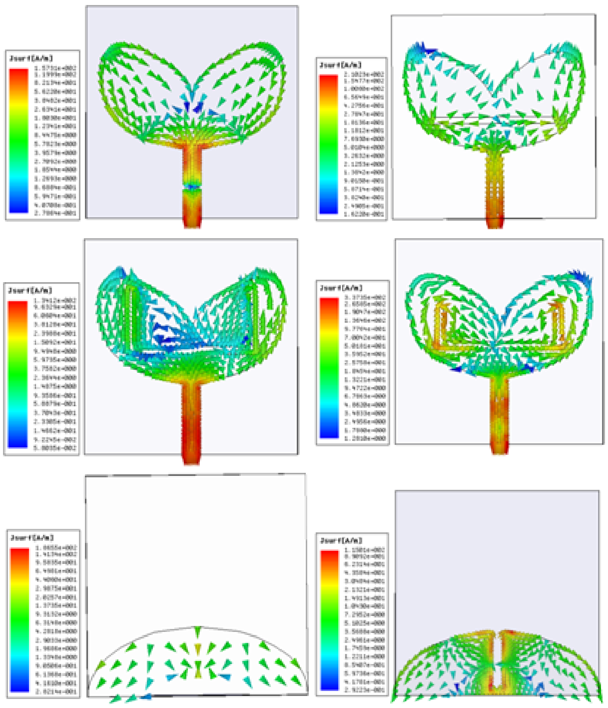

Fig.6. Current surfaces of the proposed antenna at 3.4GHz

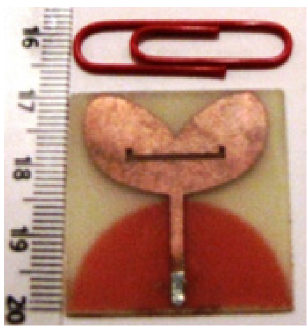

Fig.7. Photograph of the presented antenna

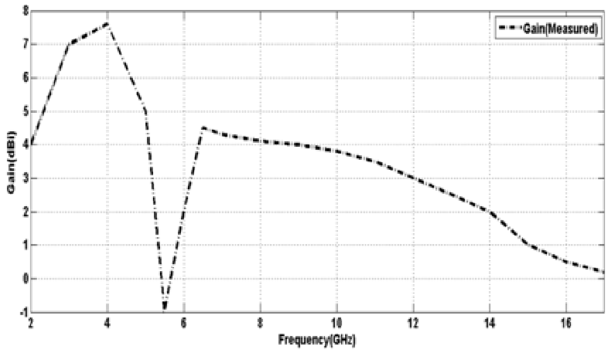

Fig.8. Measured gain of the proposed antenna

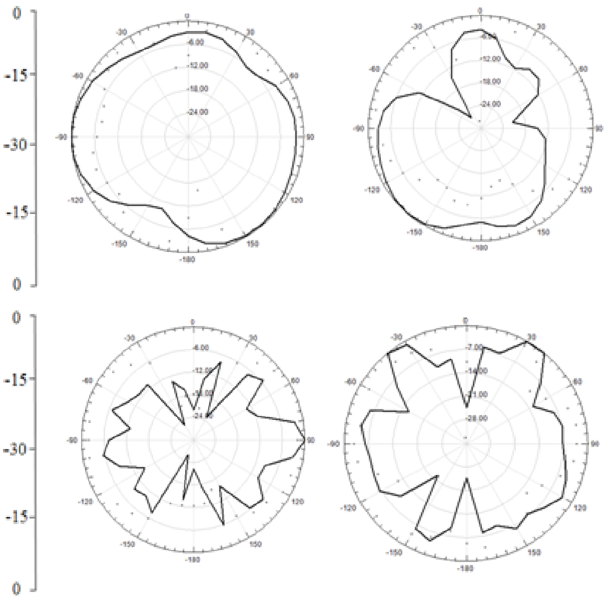

Fig.9. Radiation pattern at 12.2 GHz (a) ϴ = 0 (b) ϴ = 90

of 2.73GHz to 6.06GHz, so the effects due to the frequency interference can be avoided well. To further analyze the band-notched property, the surface current distribution of the antenna at the center-rejected of 3.4 GHz has been simulated in Fig. 6. We can see that compared to the simple oval patch, a stronger resonance surrounding the strip slot in the clover shape patch occurred apparently. This causes a good impedance matching property for the presented design. With the help of the simulator HFSS again, we can further study an operation range for the stop-band with different strip slot arm heights. Results given in Fig. 3 indicate that the stop-band can be flexibly adjusted from 2.73GHz to 6.06GHz, corresponding to the strip slot arm height, from 2 to 8 mm. It is further seen that the antenna performance in the operating band is less sensitive as the stop-band varies, so that good radiation performance of the antenna can be maintained. According to this advantage of the antenna, a critical problem to the frequency shifting caused by the antenna to be integrated within the portable devices as an internal antenna may be addressed well.

The photograph of antenna is presented in Fig. 7. Measured gain and far-field radiation patterns of the UWB monopole antenna are given in the selected frequencies of 4.06 GHz and 12.2GHz in Figs. 8 and 9 respectively. Dot curves gives the co-polarization, black lines give the cross polarization of the antenna for two principle planes for = 0 (xz-plane) and = 90 (yz-plane). As it is seen from Fig. 8 antenna shows a stable gain over its operating frequencies.

CONCLUSION

A compact planar band-notched monopole antenna suitable for UWB operation has been presented and studied in this letter. Compared to prior designs, the proposed antenna can easily and flexibly control its stop-band property so that better radiation performance can be achieved. With the help of this controllable stop band, frequency interference issues may be better addressed as well. Furthermore, properties such as good omnidirectional coverage, stable transmission characteristics, and excellent pulse handling capability indicate that the proposed compact antenna is well suitable for integration into

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