A UWB Antenna with a Stop-band Notch in the 5-GHz WLAN band

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Abstract: A new UWB antenna, the Sail-boat antenna, is proposed that provides a stop-band notch in the 5-GHz WLAN band. The CPW-fed Sail-boat antenna offers a compact planar structure. Measured results for input impedance, VSWR, patterns, and gain demonstrate that the antenna provides the stop-band notch of 11 ~ 13.5 dB in the WLAN band.

Keywords: UWB antenna, broadband antenna, frequency notch, CPW feed, WLAN

1. Introduction

Many planar broadband antennas have been studied and reported for UWB (Ultra-wideband) applications that use a variety of antenna configurations, including monopole and dipole based structures [1-10]. Co-planar waveguide (CPW)-fed [11-12] and microstrip line-fed [13-14] UWB antennas have also been examined in an attempt to improve performance over the monopole and dipole structures. Most of the UWB antennas have a continuous broad bandwidth, covering bands used for other wireless communication applications. Therefore, the UWB antenna could play an important role in interference with other wireless applications. For example, the WLAN band in the frequency range of 5~6 GHz coexists with the UWB frequency band of 3.1 ~ 10.6 GHz. Thus, it is desirable to have a UWB antenna that provides a stop-band notch in the frequency band of 5 ~ 6 GHz in order to reduce potential interference between the UWB and Wireless LAN (WLAN) bands.

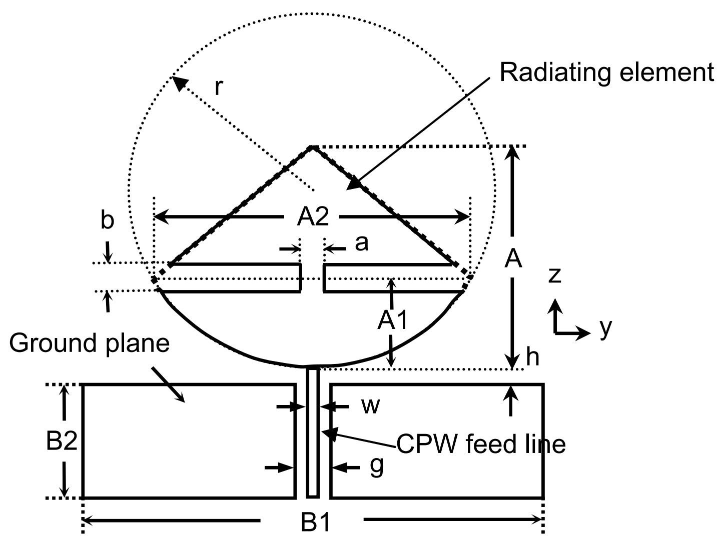
A few broadband antennas with a stop-band notch have been reported recently, including: disc antennas with a wire on the top of disc [15], elliptical disc antennas with triangular and elliptical slots [16], and a CPW-fed planar antenna with a V-shaped slot [17].

In this paper, a new UWB antenna structure is proposed that provides a stop-band notch. The antenna is called the Sail-boat antenna because of its sailboat like appearance. The antenna structure has its origins in the Planar Inverted Cone Antenna (PICA) [8], which has the shape of a teardrop and has more than 10:1 impedance bandwidth. The Sail-boat antenna presented here is CPW fed.

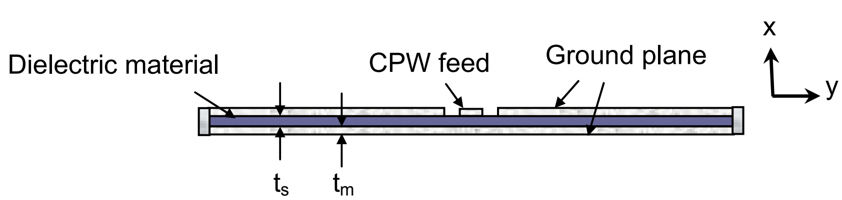
The antenna was measured in an anechoic chamber at Intel Corporation to evaluate its characteristics, including input impedance, VSWR (voltage standing wave ratio), patterns, and gain vs. frequency.

2. The Antenna Structure

Figure 1 shows the CPW-fed Sail-boat antenna. There are slots on each side of the disc in the middle of the original PICA (Planar Inverted Cone Antenna) element (bold dotted line). The dotted circle conforms to the circular base of the radiating element. The radiating element is printed on the dielectric material Duroid RT 5870, which has a dielectric constant of 2.33 and a thickness of 0.43 mm (17 mils). The height (A) of the antenna in Fig. 1 is about a quarter wavelength at the low-end operating band; that is, $A = \lambda_L/4$ where λ_L is the wavelength at the lowest acceptable performance frequency. All of the dimensions noted in Fig. 1 influence the electrical performance of the antenna and can be varied to obtain optimum performance. The CPW line is designed for a characteristic impedance of 50 Ω and the radiating element is fed from the CPW line as shown in Fig. 1a. Note that the CPW feed line is designed with a ground plane on back of the board as illustrated in Fig. 1b. Each end of the ground plane is taped with copper tape for electrical continuity. The detail dimensions of the CPW-fed Sail-boat antenna are listed in Table 1.



(a) Front view of the CPW-fed Sail-boat antenna (solid curves).



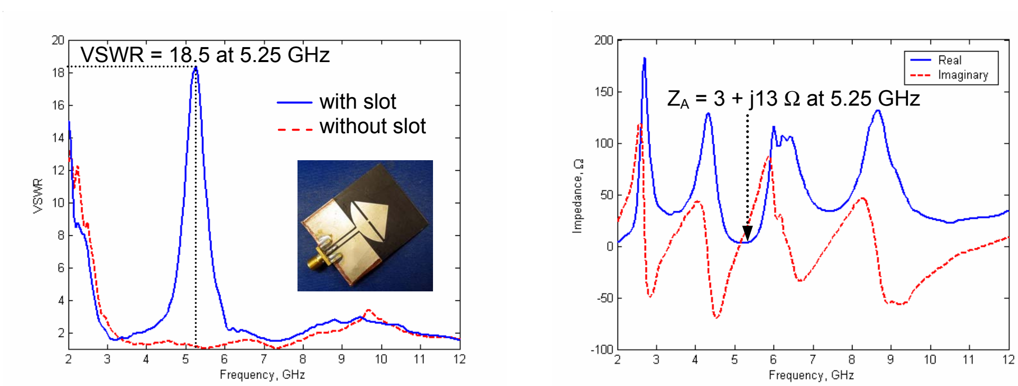
(b) Side view of the CPW-fed Sail-boat antenna.
Figure 1. Geometry of the CPW-fed Sail-boat antenna (solid curves).

Symbol	Size
r	15.2 mm (0.6”)
A	17.8 mm (0.7”)
A1	7.6 mm (0.3”)
A2	25.4 mm (1.0”)
h	0.64 mm (0.025”)
a	0.64 mm (0.025”)
b	1.27 mm (0.05”)
t_s	0.43 mm (0.017”)
t_m	0.04 mm (0.0015”)
w	1.27 mm (0.05”)
g	3.0 mm (0.12”)
B1	35.6 mm (1.4”)
B2	17.8 mm (0.7”)

Table 1. Dimensions of the antenna in Fig. 1.

3. Measured Results

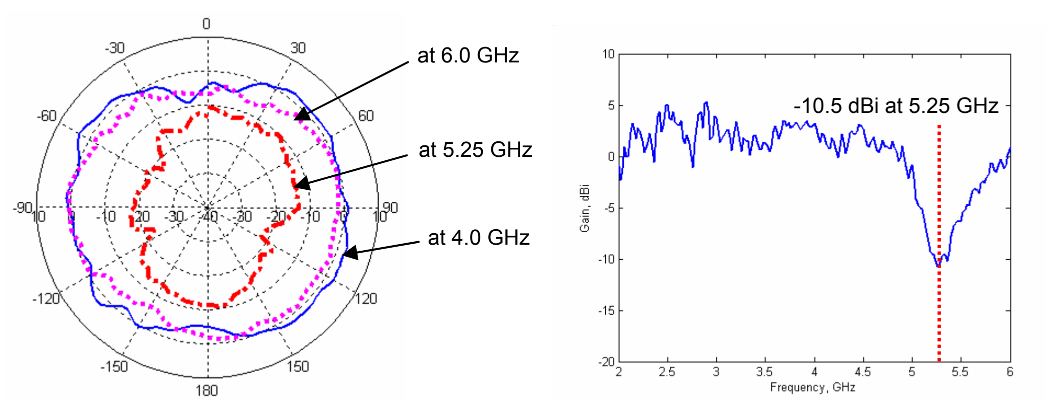
The Sail-boat antenna of Fig. 1 and Table 1 was constructed and measured in terms of input impedance, VSWR, gain patterns, and gain vs. frequency. The voltage standing wave ratio (VSWR) was measured using an Agilent 8719ES vector network analyzer. Figure 2 shows the measured VSWR and input impedance. It can be seen from Fig. 2a that the CPW-fed Sail-boat antenna provides a sharp stop-band notch in the frequency range of 5.0 ~ 6.0 GHz with a VSWR value of about 18.5 at 5.25 GHz by inserting the slots. The measured impedance in Fig. 2b shows that the high VSWR in the WLAN band results from a low input impedance – about Z_A=3+j13 Ω at 5.25 GHz.



(a) Measured VSWR. (b) Measured input impedance.

Figure 2. Measured VSWR (referenced to 50 Ω) and input impedance of the CPW-fed Sail-boat antenna illustrated in Fig. 1 with the dimensions listed in Table 1.

Antenna patterns were measured in an anechoic chamber at Intel Corporation. Azimuth gain patterns (xy-plane) are plotted in Fig. 3a at selected frequencies of 4.0, 5.25, and 6.0 GHz. The Sail-boat antenna radiates omni-directionally in xy-plane at the frequencies of 4.0 and 6.0 GHz similar to a dipole antenna. The gain pattern measured at 5.25 GHz demonstrates that the antenna has much lower gain in the desired stop band than at other frequencies (4.0 and 6.0 GHz). Figure 3b shows that the peak gain varies from 0.5 dBi to 3 dBi over the frequency range from 3.0 to 5.0 GHz and that the peak gain decreases significantly in the frequency band of 5.0 ~ 6.0 GHz. The minimum gain is observed at the frequency of 5.25 GHz and has a value of -10.5 dBi, demonstrating that the Sail-boat antenna achieved the stop-band notch of 11~13.5 dB at the frequency of 5.25 GHz. The measured radiation pattern in the stop-band notch at 5.25 GHz is also shown in Fig. 3a. The stop-band notch at 5.25 GHz is due to the slots of the Sail-boat antenna. Additional measured results (including higher frequencies) will be provided in the presentation.



(a) Measured gain patterns in xy-plane.

(b) Maximum gain vs. frequency.

Figure 3. Measured radiation patterns in azimuth plane (xy-plane) and maximum gains vs. frequency of the CPW-fed Sail-boat antenna in Fig. 2 with the dimensions listed in Table 1.

4. Conclusions

A new antenna structure, Sail-boat antenna, is proposed that provides a stop-band notch in the 5-GHz WLAN band. Measured VSWR, input impedance, gain patterns, and maximum gain vs. frequency data demonstrate that the CPW-fed Sail-boat antenna provides stop-band notch of 11 ~ 13.5 dB in the frequency range of WLAN band. Therefore, the antenna can be used in UWB systems to reduce interference between UWB and WLAN communication systems when the two radios are collocated.

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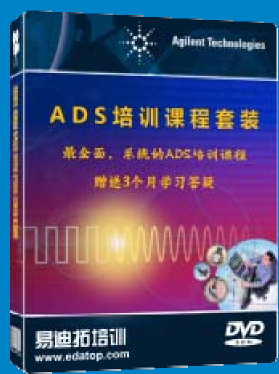

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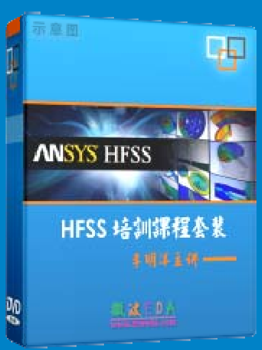

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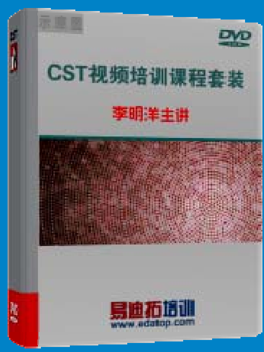

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