

DOUBLE-SIDED PRINTED BOW-TIE ANTENNA WITH NOTCH FILTER FOR UWB APPLICATIONS

A. Hirata

Nagoya Institute of Technology
Nagoya, Japan

Abstract—This letter proposes a double-sided printed bow-tie antenna with a notch band. The notch filter is based on a grounded patch inserted into the feeding microstrip line. The advantage of the structure is its tunability of the notch band.

1. INTRODUCTION

Much attention has been paid to commercial ultra wide band (UWB) systems since 2002 [1]. It is of a particular interest to design a compact antenna with good impedance matching characteristics over the whole UWB frequency range (3.1–10.6 GHz). Also, gain flatness and phase linearity are required for UWB antennas to suppress a distortion of waveforms. Until now, many attempts have been conducted to widen the bandwidth of printed antennas [2–5]. In the above UWB frequency region, however, there exist overlapped spectra with other wireless communications, such as wireless local area networks (5–6 GHz) [6]. Therefore, some UWB antennas with notch-band characteristics have been proposed (e.g., [7–16]). The weakness in most of these antennas is its limited frequency tunability. In the present study, we propose to insert a notch filter into the feeding line. The influence of the notch filter on the antenna characteristics is investigated numerically.

2. ANTENNA STRUCTURE

Figure 1(a) shows the geometry of a double-sided printed bow-tie antenna [3]. The thickness and relative permittivity of the substrate are 1.27 mm and 6.15, respectively. The widths of twin-lead transmission line ($W_3 = 2.8$ mm) and microstrip line ($W = 1.87$ mm)

Corresponding author: A. Hirata (ahirata@nitech.ac.jp).

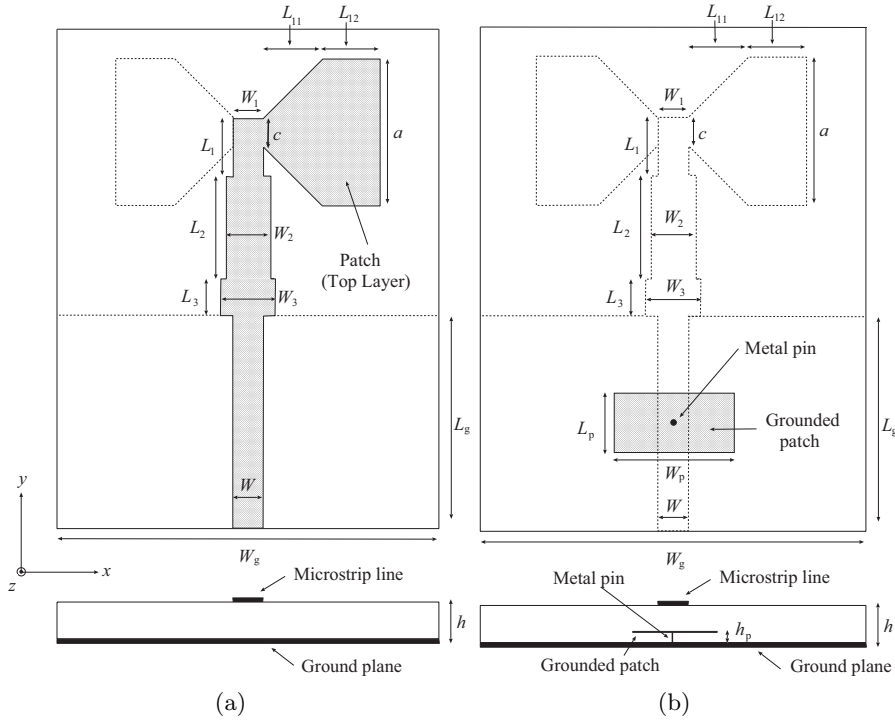


Figure 1. Geometry of the antenna proposed in [3] (a) and of the notch filter inserted (b).

were determined so that their impedances reduce to 50 Ohm. Then, the rest parameters of a matching circuit and those of the bow-tie antenna were optimized, respectively so that the return loss of the antenna became smaller than 10 dB over the UWB frequency band. The parameters obtained by this procedure were as follows: $L_{11} = 4.6$ mm, $L_{12} = 11.7$ mm, $a = 15.8$ mm, $c = 1.0$ mm, $L_1 = 3.2$ mm, $L_2 = 11.9$ mm, $L_3 = 4.6$ mm, $W_1 = 1.4$ mm, $W_2 = 2.6$ mm, $W_3 = 2.8$ mm, $W_p = 6.0$ mm, $L_p = 3.0$ mm, and $L_g = 19$ mm. The dimensions of the substrate are 36 mm (x direction) 36 mm (y direction). The substrate has a dimension of 36 mm \times 36 mm. Figure 1(b) shows the notch filter inserted in this antenna. The notch filter is based on a grounded patch. The diameter of the metallic pin was fixed to 0.14 mm. The tunability of this notch filter will be discussed in the next section.

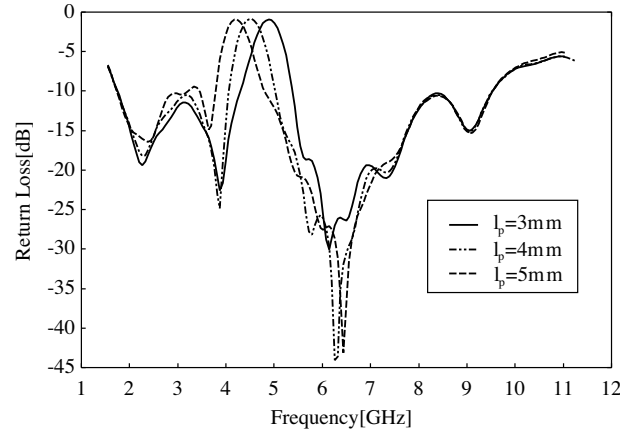


Figure 2. The effect of the metallic pin on the return loss of the antenna.

3. COMPUTATIONAL RESULTS

Figure 2 shows the dependency of return loss on the dimension of grounded patch. Computed and measured frequency characteristics of return loss without the notch filter can be found in our previous study [3]. The width of the patch w_p is fixed to be 6.0 mm, as an example. The height of the metallic pin was chosen as 0.635 mm, corresponding to a half of the thickness of the dielectric substrate h . From Figure 2, the center frequency of the notch becomes smaller with the increase of the patch width. For $l_p = 3$ mm, the center frequency of the notch reasonably coincide with 5 GHz, which is a frequency band to be rejected. In the following discussion, we fixed l_p as 3 mm.

Figure 3 shows the dependency of return loss on the height of the metallic pin. The width of the patch w_p and the height of the metallic pin is 6.0 mm, and 0.635 mm, respectively. From Figure 3, the closer the distance between the ground and the patch becomes, the wider the notch bandwidth becomes. The point to be stressed here is that the center frequency of the notch changes marginally even for different heights of the metallic pin. Additionally, the return loss of lower frequency region is distorted for larger height of the metallic pin. The reason for this distortion is that the impedance mismatch caused by the insertion of the patch cannot be neglected as the patch comes closer to the strip line.

For the parameters obtained above, the return loss of the antenna was calculated with FDTD and MoM. For comparison, the frequency

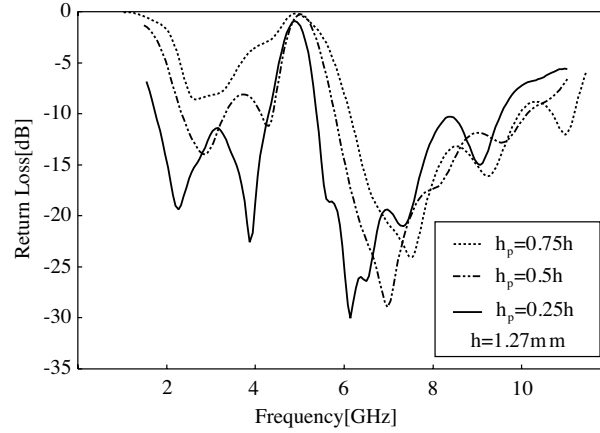


Figure 3. The effect of the dimension of the grounded patch on the return loss of the antenna.

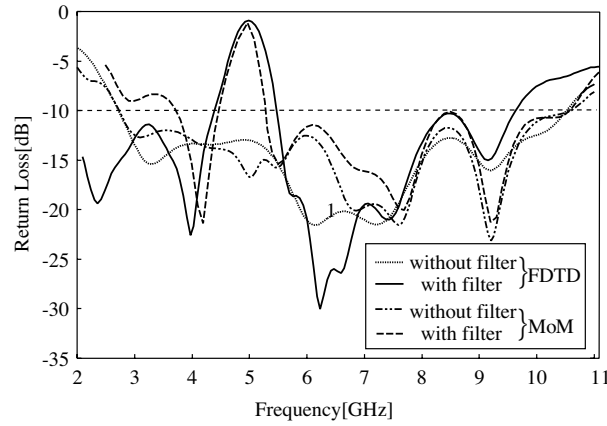


Figure 4. Comparison of antenna return loss with and without the notch filter calculated by the FDTD method and Method of Moment.

characteristics without notch filter are also given. From Figure 4, the effectiveness of the notch filter was confirmed even if we use different computational method.

Figure 5 illustrates radiation patterns of the proposed antenna at frequencies of 3, 5, and 9 GHz. As seen from Figure 5, the radiation patterns at frequencies of 3 and 9 GHz are not distorted with the insertion of the filter. As expected, the radiation patterns at 5 GHz are suppressed, especially for co-polarization component, suggesting

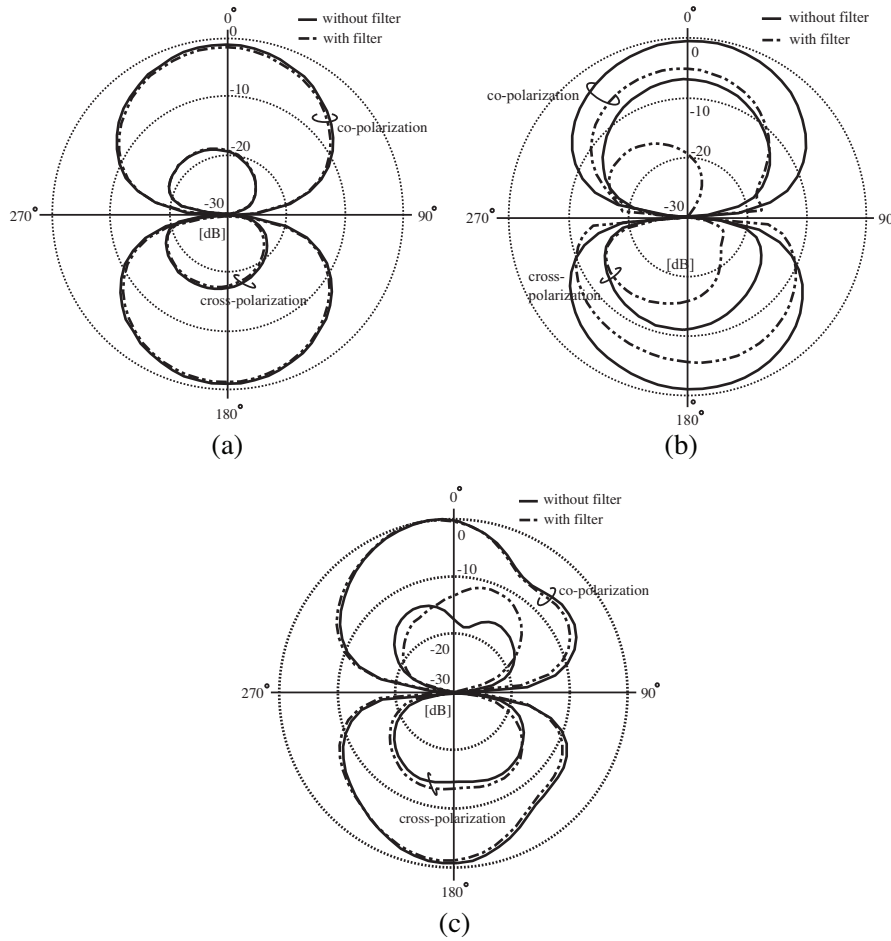


Figure 5. Radiation patterns of the antenna with notch filter at (a) 3 GHz, (b) 5 GHz, and (c) 9 GHz.

the effectiveness of our proposal.

In the present study, the computational results for gain flatness and phase response of the structure proposed were not shown. The frequency dependence of gain was rather flat except for the notch band, as can be expected from the figure in our previous study [4], together with Fig. 4. Similarly, the phase response of the antenna was almost linear except for the stop band (see also [4]).

4. SUMMARY

The present study proposed a double-sided printed bow-tie antenna with a notch band. The notch filter is based on a grounded patch inserted into the feeding line. The tunability of the notch band has been demonstrated. The effect of notch filter on the radiation characteristics at the remaining frequencies are found not to be significant.

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