

TWO NOVEL BAND-NOTCHED UWB SLOT ANTENNAS FED BY MICROSTRIP LINE

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Abstract—Two kinds of band-notched ultra wide-band slot antennas are proposed. Printed on a dielectric substrate of FR4 with relative permittivity of 4.4 and fed by a $50\ \Omega$ microstrip line, the proposed antennas introduce semicircular annular strips to reject the frequency band (5.15–5.85 GHz) limited by IEEE802.11a. The parameters which affect the performance of the antennas in terms of its frequency domain characteristics are investigated in this paper.

1. INTRODUCTION

The need of high data rates wireless communication becomes more and more urgent and various solutions have been brought forward. UWB (Ultra-Wide Band) techniques have been paid the most attention for many advantages, such as higher data rates, immunity to multipath cancellation, increased communications operational security and low interference to legacy systems [1]. Antennas are the particularly challenging aspect of UWB technology. To satisfy such a requirement, various wideband antennas have been studied [2–8]. However, the UWB communication systems use the 3.1–10.6 GHz frequency band, which includes the IEEE802.11a frequency band (5.15–5.825 GHz). Therefore, UWB communication systems may generate interference with IEEE802.11a. To overcome electromagnetic interference between UWB system and WLAN system, various UWB antennas with a notch function have been developed for UWB communication systems [9–14].

In this paper, two kinds of band-notched UWB circular slot antennas with semicircular annular strips are proposed. The bandwidths of the two proposed antennas can achieve 116% with VSWR below 2 and have a notch for the 5.15–5.825 GHz frequency band by introducing optimized semicircular annular strips. The

notched frequency band is adjustable by varying the length of the strip. Details of the proposed band-notched design are presented and discussed in this paper.

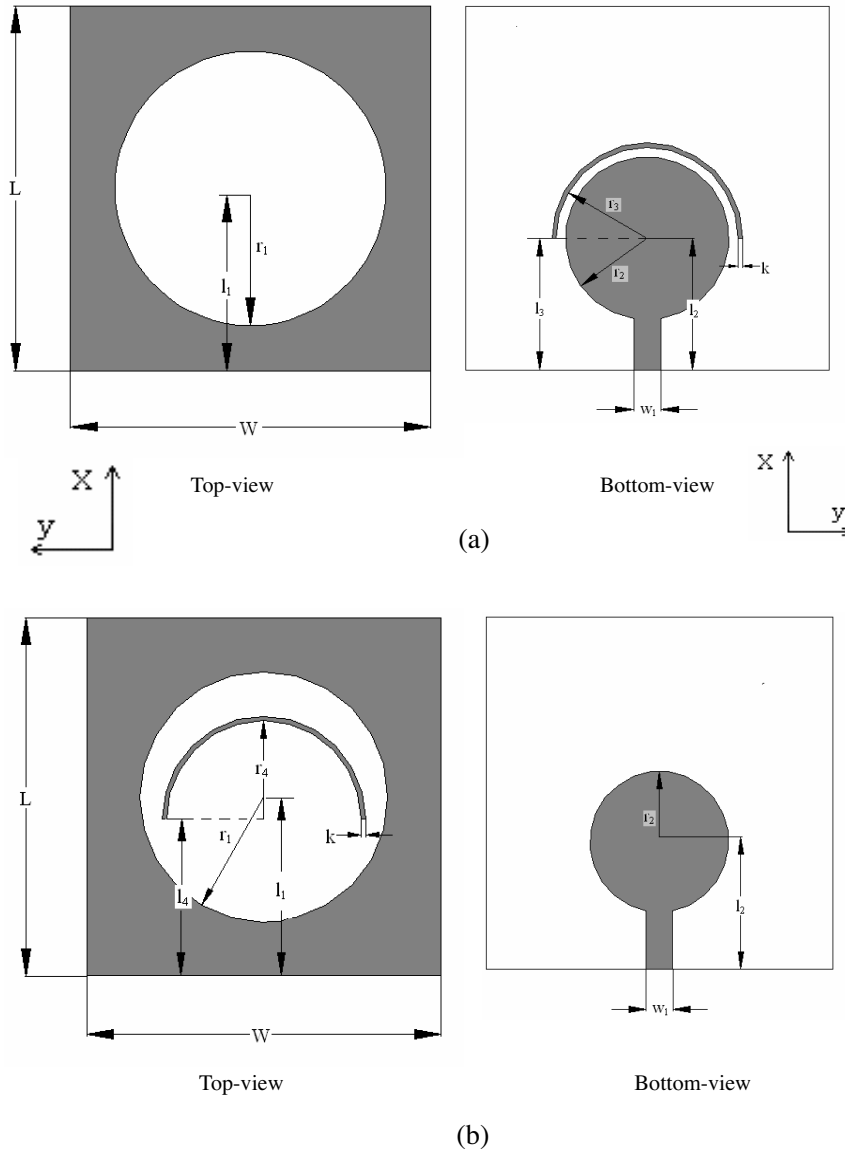


Figure 1. Configuration of the proposed slot antennas. (a) antenna 1, and (b) antenna 2.

2. ANTENNA DESIGN

Figure 1 shows the geometries and dimensions of two proposed slot antennas. The two proposed slot antennas are fabricated on a FR4 substrate with thickness 1.6 mm and relative permittivity 4.4. A circular disc patch with a radius of r_2 and a $50\ \Omega$ microstrip feed line are printed on the same side of the dielectric substrate. L and W denote the length and the width of the dielectric substrate, respectively. The width of the microstrip feed line is fixed at $w_1 = 3$ mm to achieve $50\ \Omega$ impedance. The ground plane is printed on the other side of the substrate, and a circular slot of radius r_1 is cut on the ground plane. In Fig. 1(a), a semicircular annular strip and the circular disc are printed on the same side of the dielectric substrate. In Fig. 1(b), a semicircular annular strip is introduced in the circular slot.

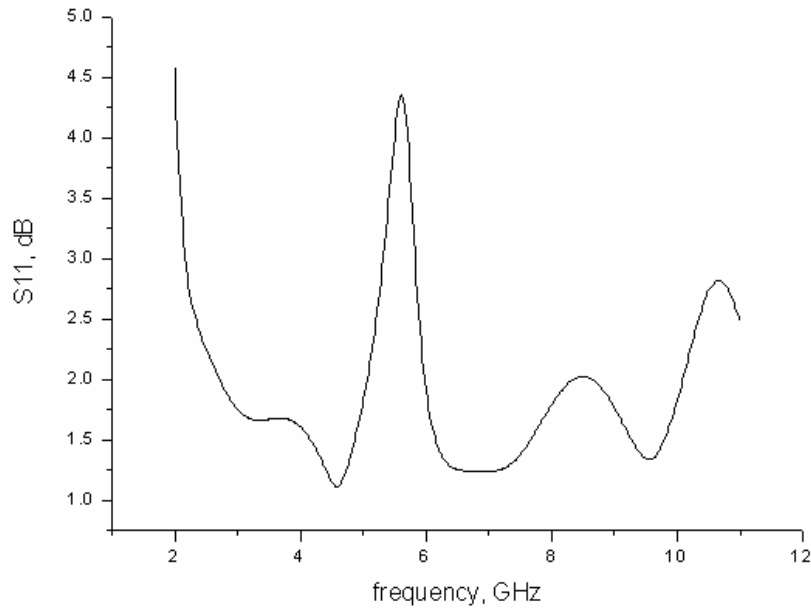


Figure 2. Simulated return loss of the antenna 1 ($L = 40$ mm, $W = 40$ mm, $l_1 = 20$ mm, $l_2 = 14.5$ mm, $l_3 = 14.5$ mm, $k = 0.5$ mm, $w_1 = 3$ mm, $r_1 = 15$ mm, $r_2 = 9$ mm, $r_3 = 10$ mm).

3. SIMULATION AND DISCUSSION

We have investigated the effects of several parameters on the VSWR of the proposed antennas using Ansoft HFSS commercial software. In the study, the size of the substrate is $40 \text{ mm} \times 40 \text{ mm}$.

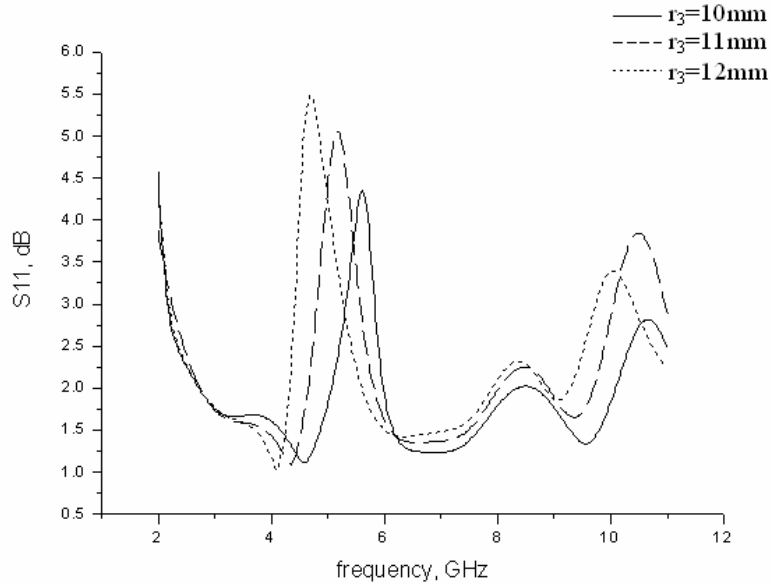


Figure 3. Simulated return loss for antennas with various r_3 . (other parameters: $L = 40 \text{ mm}$, $W = 40 \text{ mm}$, $l_1 = 20 \text{ mm}$, $l_2 = 14.5 \text{ mm}$, $l_3 = 14.5 \text{ mm}$, $k = 0.5 \text{ mm}$, $w_1 = 3 \text{ mm}$, $r_1 = 15 \text{ mm}$, $r_2 = 9 \text{ mm}$).

3.1. The Proposed Antenna Shown in Fig. 1(a)

The use of the semicircular annular strip leads to high impedance at the notch frequency. The effective length of the semicircular annular strip is equal to half a wavelength for the frequency around 4.8 GHz. This means that the notched band can be generated around 4.8 GHz. However, the actual notch frequency of the microstrip-fed slot antenna can be above or below this approximate frequency depending on the location of the strip. Fig. 3 shows the VSWR of the antenna 1. The simulated bandwidth of the proposed antenna covers 2.7 GHz to 10.1 GHz for $\text{VSWR} \leq 2$. The simulated notched band for $\text{VSWR} > 2:1$ is from 5.06 to 5.98 GHz. To investigate in detail the behavior of the antenna 1, the VSWR of the antenna with various the length of the strip are simulated. Fig. 3 indicates the simulated results for the

proposed antenna in terms of r_3 . For $r_3 = 10, 11$ and 12 mm with other fixed dimensions, the notch frequencies of the proposed antenna decrease by increasing length of the strip.

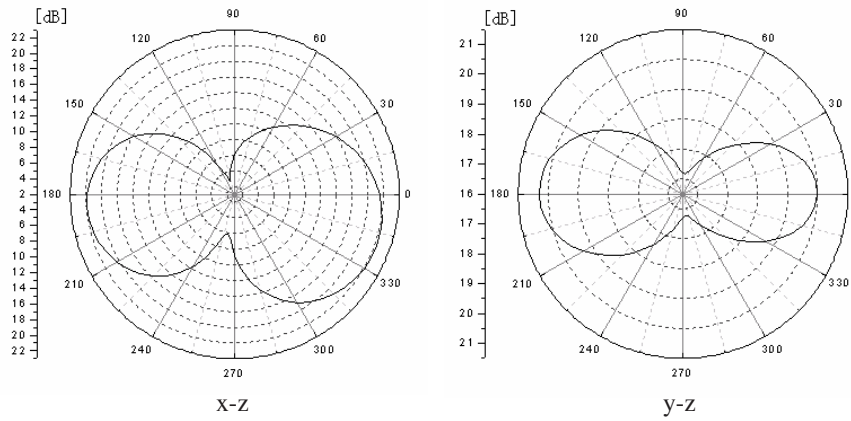


Figure 4. Simulated radiation pattern of the antenna 1 at 4 GHz.

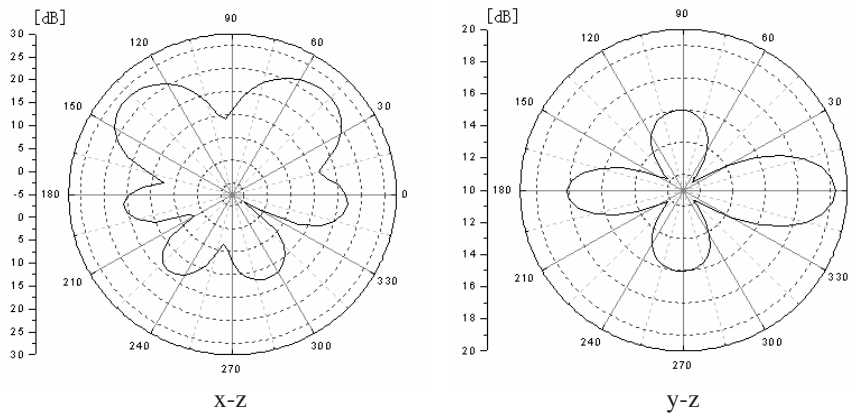


Figure 5. Simulated radiation pattern of the antenna 1 at 9.5 GHz.

In Figs. 4 and 5, the simulated radiation patterns of the antenna 1 at 4 and 9.5 GHz are shown. They start to deteriorate with the increase of frequency, this probably because the seriously unequal phase distribution and larger magnitude of high order mode at higher frequencies on the slot are not improved.

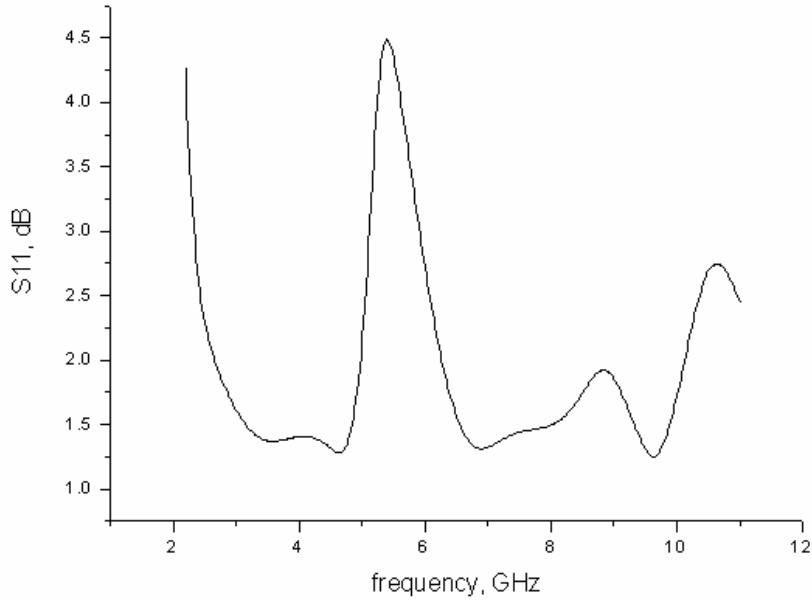


Figure 6. Simulated return loss of the antenna 2. ($L = 40$ mm, $W = 40$ mm, $l_1 = 20$ mm, $l_2 = 14.5$ mm, $l_4 = 18$ mm, $k = 0.5$ mm, $w_1 = 3$ mm, $r_1 = 14$ mm, $r_2 = 8$ mm, $r_4 = 10.5$ mm).

3.2. The Proposed Antenna Shown in Fig. 1(b)

The antenna 2 employs a semicircular annular strip in the circular slot of the ground. The VSWR of the proposed antenna is shown in Fig. 6. The simulated bandwidth of the proposed antenna covers 2.66 GHz to 10.12 GHz with a notched band of 4.96–6.24 GHz for $VSWR > 2:1$. Compared Fig. 6 with Fig. 3, it is seen that the notched band of antenna 2 is wider than that of antenna 1, this probably because the surface current continuity of the ground plane is significantly perturbed by the semicircular annular strip. Fig. 7 shows the VSWR of the antenna with various r_4 , it is seen in Fig. 7 that the notch frequencies of the antenna 2 are lowered by increasing r_4 .

Figures 8 and 9 show the simulated radiation patterns of the antenna 2 at 4 and 9.5 GHz. At 4 GHz, the radiation patterns of the antenna 2 are similar to those of the antenna 1. However, for 9.5 GHz, the radiation patterns of the antenna 2 are worse than those of the antenna 1, the reason of the phenomenon probably is that the locations of the semicircular annular strips of two antennas are different.

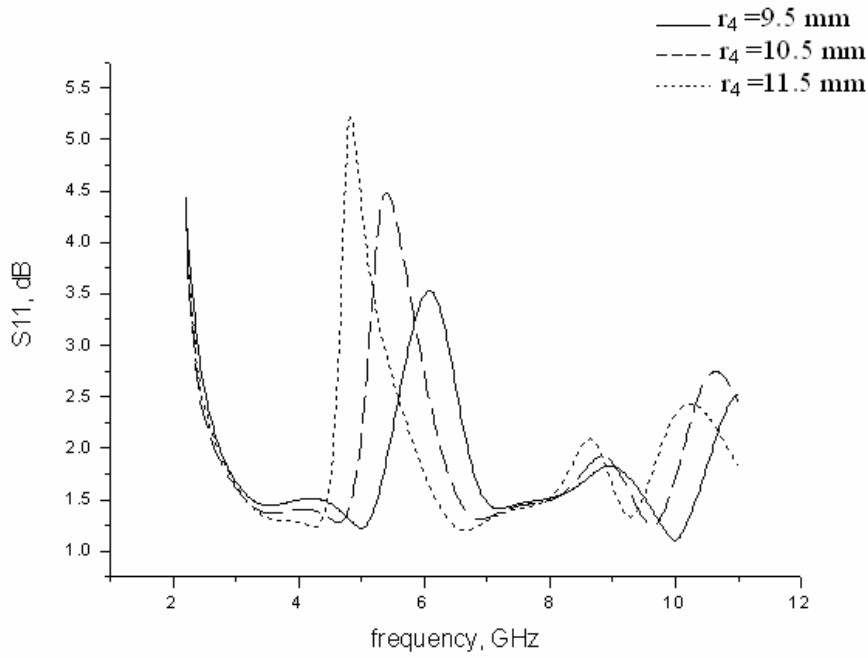


Figure 7. Simulated return loss for antennas with various r_4 . (other parameters: $L = 40$ mm, $W = 40$ mm, $l_1 = 20$ mm, $l_2 = 14.5$ mm, $l_4 = 18$ mm, $k = 0.5$ mm, $w_1 = 3$ mm, $r_1 = 14$ mm, $r_2 = 8$ mm).

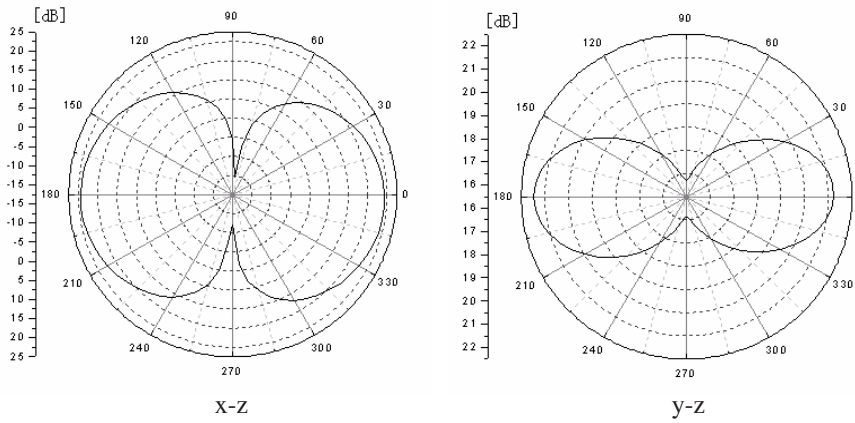


Figure 8. Simulated radiation pattern of the antenna 2 at 4 GHz.

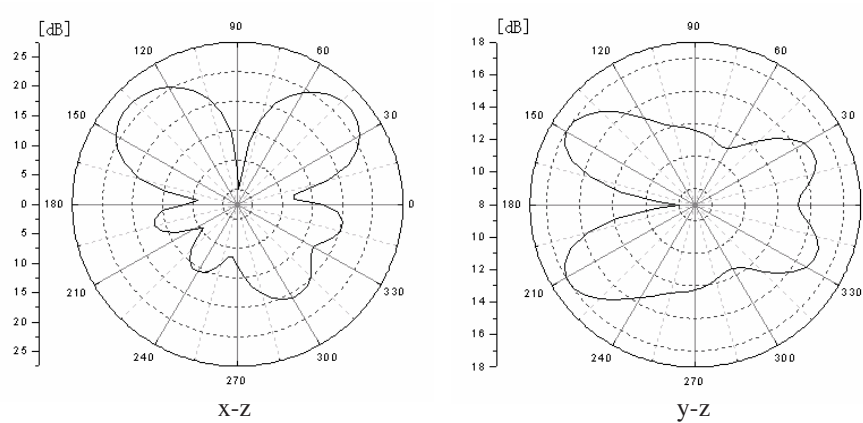


Figure 9. Simulated radiation pattern of the antenna 2 at 9.5 GHz.

Generally speaking, the design concept of the band-rejection function is to make the input impedance singular (minimum resistance) at the sub-resonant frequency. To implement it, a narrow-band resonant structure is added to the original wide-band antenna area [15]. Based on this concept, the above two antennas using the parasitic strips in different location, as illustrated in Figs. 1(a)–(b), are accomplished.

4. CONCLUSION

Two kinds of band-notched ultra wide-band slot antennas are proposed in this paper. Semicircular annular strips are introduced to the slot antennas in order to obtain the band elimination characteristic. The notch frequency can be adjusted by changing the strip length. Numerical study of the principal physical parameters of two structures is carried out.

ACKNOWLEDGMENT

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