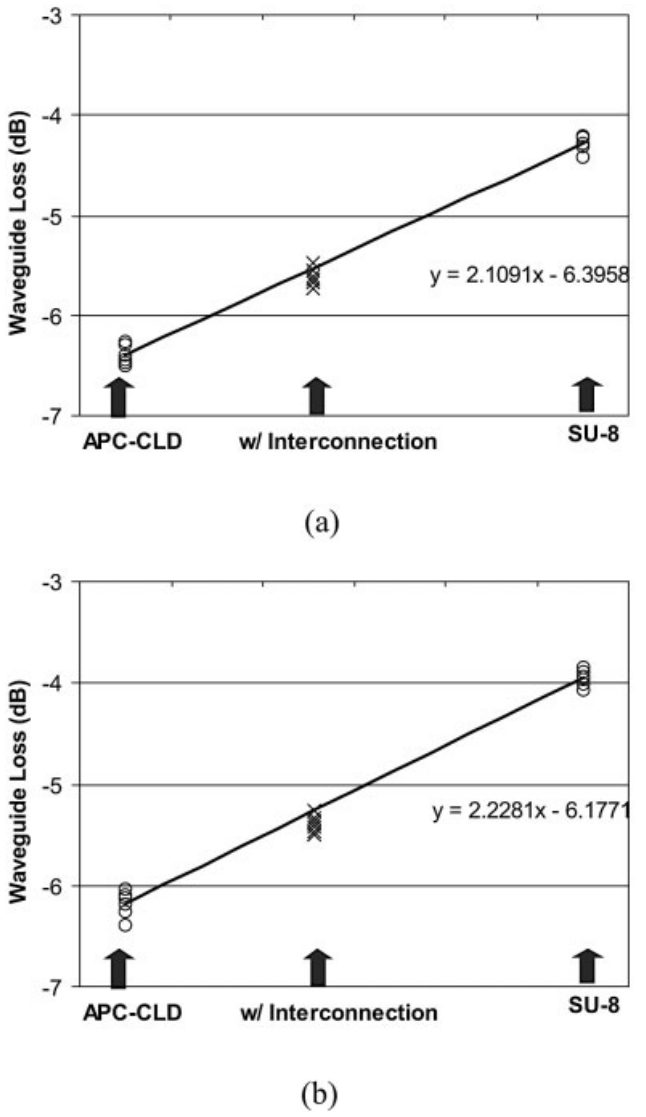

Figure 6 Excess-loss test results for waveguide interconnections: (a) inverted ridge-waveguide structure; (b) conventional ridge-waveguide structure

waveguide loss listed here includes the fiber-to-waveguide coupling loss. So the excess losses for the inverted and conventional structure are -0.10 ± 0.15 dB and -0.12 ± 0.15 dB, respectively.

6. CONCLUSION

In this paper, a low-loss interconnection between an EO polymer and a passive polymer has been designed and demonstrated. The structure is simple and easy to fabricate. The excess loss of the interconnection is small and the measurement is limited by the uncertainties in the test. Based on the data, it is safe to say that the excess loss is lower than 0.3 dB and the average of excess loss is around 0.1 dB. This structure has good tolerance to the change of geometric parameters and material properties. It is very suitable for applications in integrated optics, such as PLCs.

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PRINTED BAND-NOTCHED ULTRA-WIDEBAND QUASI-DIPOLE ANTENNA

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ABSTRACT: *A printed ultra-wideband (UWB, 3.1–10.6 GHz) quasi-dipole antenna with the band-notched characteristic is presented. The antenna mainly comprises two radiating elements: an upper semi-circular disk and a lower semi-circular disk embedded with a pair of narrow slits, whose length is about one quarter-wavelength at the desired notched frequency. Both the upper and lower semi-circular disks are of the same dimensions, thus making the proposed antenna tend to be a dipole structure. With a compact size of 25 × 25 mm^2, the proposed antenna showing UWB operation with a notched frequency band at 5 GHz is demonstrated.* © 2006 Wiley Periodicals, Inc. Microwave Opt Technol Lett 48: 418–420, 2006; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.21368

Key words: *antennas; printed dipole antennas; ultra-wideband (UWB) antennas; band-notched UWB antennas*

1. INTRODUCTION

Mainly to avoid the possible interference between ultra-wideband (UWB) systems and existing wireless local area network (WLAN) systems, the band-notching technique has been applied recently to various UWB planar antennas of the frequency band of 3.1–10.6 GHz [1]. These related band-notched planar antennas include planar metal-plate monopole antennas [2, 3], printed monopole antennas [4–6], printed slot antennas [7–9], and so on. It is noted that, among these UWB planar antennas, band-notched operation can be obtained either by loading a proper slot (such as a half-wavelength U-shape slot [2, 3, 6, 8] or a quarter-wavelength V-shape slot [4, 7]) or by inserting proper slits (such as a pair of narrow slits [5, 9]) in the antenna. However, for the band-notched UWB planar antennas reported in the literature, the slot or the slits are generally embedded in the antenna's main radiating element. Seldom is the band-notching achieved by cutting the slot or the slits in the antenna's ground plane, especially for the case of printed monopole antennas.

In this paper, we present a novel band-notched UWB quasi-dipole antenna. The band-notching is achieved by embedding a pair of narrow slits in the antenna's ground plane, with the length of the slits chosen to be a quarter-wavelength of the desired notched frequency. In addition, the antenna is printed on a dielectric substrate, with the ground plane parallel to the antenna's monopole element (see Fig. 1). The monopole element and the ground plane are further selected to be of the same size, which makes it possible to achieve a dipolelike radiation characteristic. A design example of the proposed antenna with a notched frequency band for rejecting the existing 5-GHz WLAN bands of 5.2 GHz (5150–5350 MHz) and 5.8 GHz (5725–5825 MHz) are implemented and studied.

2. ANTENNA DESIGN

Figure 1 shows the proposed printed band-notched UWB quasi-dipole antenna. The antenna is composed mainly of an upper semi-circular disk as the antenna's monopole element and a lower semi-circular disk as the antenna's ground plane. Both the upper and lower semi-circular disks are printed on 0.8-mm-thick FR4 substrate and have the same dimensions (that is, the two disks are of the same diameter D in this design), which makes the proposed antenna tend to be a semi-circular dipole structure [10]. Notice that on the back side of the FR4 substrate is printed the lower semi-circular disk, in which a V-shape notch is cut to serve as the feed gap between the antenna and the ground plane [11]. The monopole element is fed by using a 50Ω microstrip line of length about one-half the diameter D. In addition, for testing the antenna in the experiment, a 50Ω SMA connector is used, with its central conductor and outer grounding portion connected to the microstrip line and the ground plane, respectively. With the diameter D chosen to be 25 mm (whose one-quarter perimeter is about 0.2 wavelength of the frequency at 3.1 GHz), the lower-edge frequency of the antenna's impedance bandwidth obtained is less than 3.1 GHz, and good impedance matching across the UWB bandwidth can be achieved.

A pair of narrow slits are embedded at the edge of the lower semi-circular disk (the ground plane) and arranged to be symmetric and parallel to the centerline of the quasi-dipole antenna. The embedded slits have a uniform width of 0.2 mm and a length of 8 mm, and are placed at a distance of 7.5 mm from the microstrip feedline. Note that when the distance increases further, the band-notching characteristic will be degraded. On the other hand, the decreasing distance will in general lead to a wider notched frequency band in the proposed design. By adjusting both the length

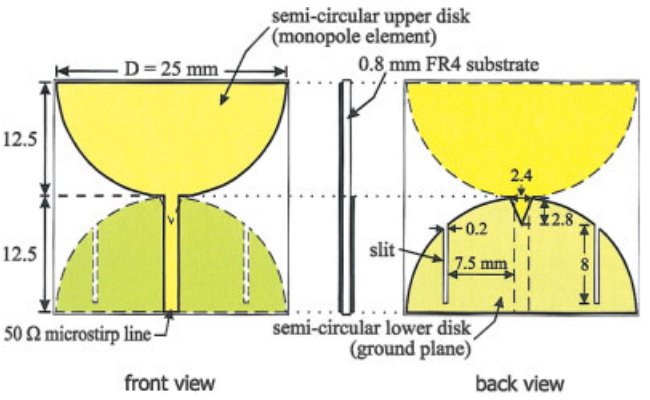

Figure 1 Geometry of the proposed printed band-notched UWB quasi-dipole antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

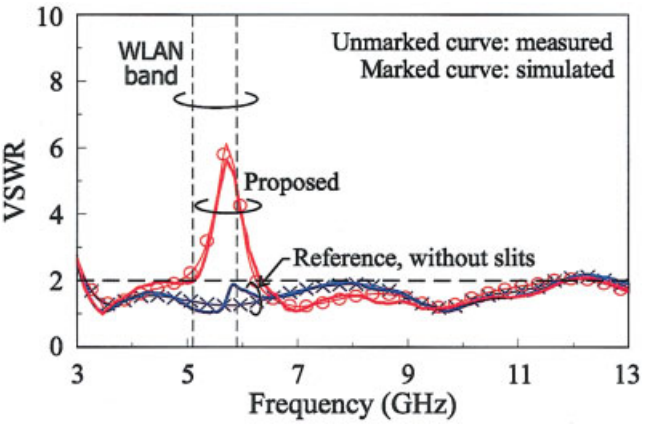

Figure 2 Measured VSWR for the proposed antenna and the reference antenna (the antenna in Fig. 1 without the slits). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

of the slits to be about a quarter-wavelength of the desired notched frequency [5], a notched frequency band for the proposed UWB quasi-dipole antenna can be achieved. In this case, a destructive interference for the excited surface currents in the antenna will occur, which causes the antenna to be nonresponsive at that frequency. The detailed simulated surface-current distributions in the antenna at the notched frequency are analyzed in section 3.

3. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 2 shows the measured and simulated VSWR for the proposed antenna and the reference antenna (the case without the slits cut in the lower semi-circular disk). Agreement between the measured data and simulated results obtained using the simulation software Ansoft HFSS (High-Frequency Structure Simulator) [12] is observed. It is seen that an UWB bandwidth (defined by 2:1 VSWR) covering 3.1–10.6 GHz is obtained for the reference antenna. For the proposed antenna, a clear band-notched characteristic is achieved in the 5-GHz WLAN band, with the lowest and highest frequencies of the notched band at about 5.1 and 6.2 GHz, respectively.

Figures 3 and 4 plot the measured radiation patterns at 4 and 8 GHz, respectively. It is first seen that dipolelike radiation patterns are obtained, which are the same as those of the reference antenna

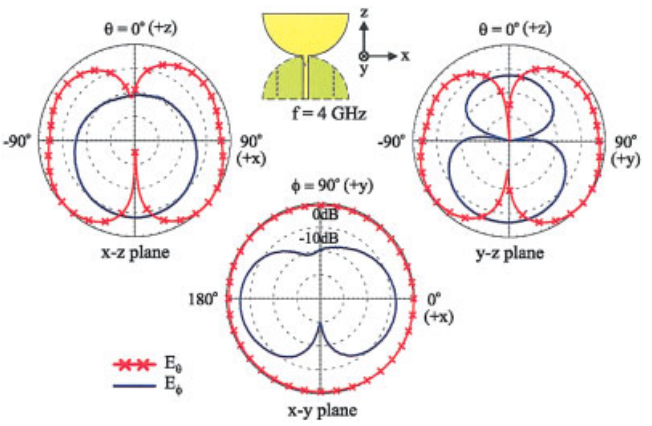

Figure 3 Measured radiation patterns at 4 GHz for the proposed antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

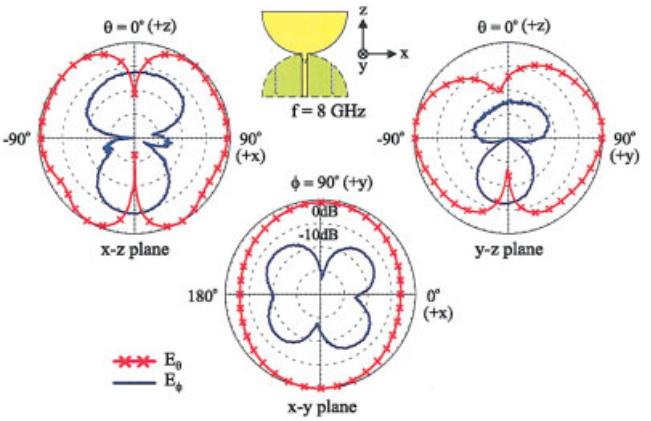

Figure 4 Measured radiation patterns at 8 GHz for the proposed antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

(not shown here for brevity). It is also seen that in the azimuthal plane (x–y plane), the antenna tends to have stronger radiation in the $\pm y$ direction than in the $\pm x$ direction, especially for higher operating frequencies. This behavior is generally due to the destructive radiated fields in the $\pm x$ direction caused by the path-length difference of the large antenna width [13]. Also note that special care must be taken to avoid the unwanted radiation from the SMA connector and coaxial line, which can affect the radiation of electrically small UWB antennas to have large ripples as shown in [14], especially for higher operating frequencies in the elevation planes. Figure 5 presents the measured antenna gain for the proposed and reference antennas. The results clearly show a sharp antenna-gain decrease in the notched band.

The simulated (Ansoft HFSS) surface-current distributions in the antenna were also studied. It is observed that, in the lower semi-circular disk, relatively much larger surface current distributions are seen around the slits and the flow of the currents is exactly out of phase on both sides of the slits (see Fig. 6). This characteristic causes the antenna's input impedance to be much larger than 50Ω (about 250Ω at the notched frequency 5.5 GHz), which effectively cuts out the excited surface currents from the microstrip feedline to the upper semi-circular disk (the monopole element), thus making the antenna nonresponsive at that frequency band.

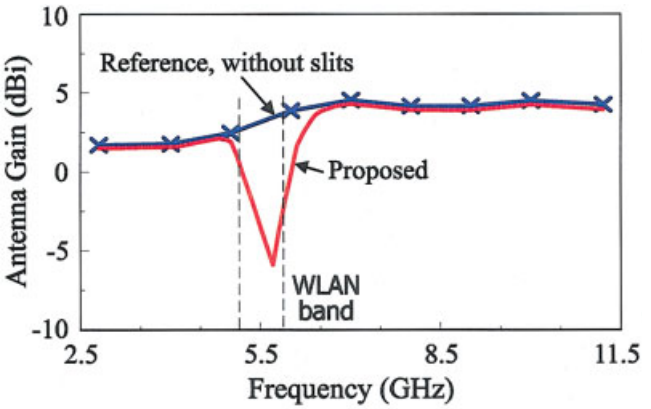

Figure 5 Measured antenna gain for the proposed and reference antennas. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

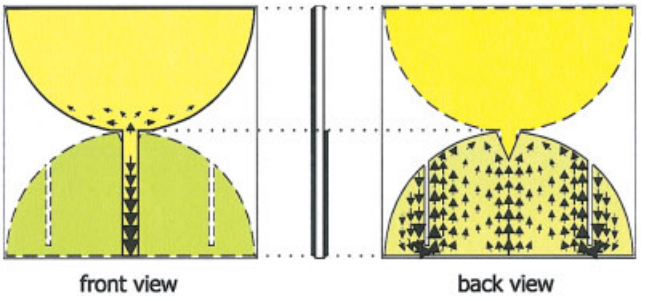

Figure 6 Simulated surface-current distributions at 5.5 GHz for the proposed antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

4. CONCLUSION

A microstrip-fed printed UWB quasi-dipole antenna that employs the band-notched technique for rejecting the 5-GHz WLAN bands has been proposed. Band-notching was easily achieved by cutting a pair of narrow slits in the lower semi-circular disk, which functions as the antenna's ground plane. Prototypes of the proposed antenna have been successfully implemented and tested. In addition to the band-notched operation achieved, good dipolelike radiation performances for frequencies out of the rejected band have also been observed.

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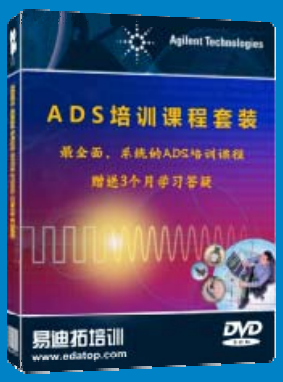

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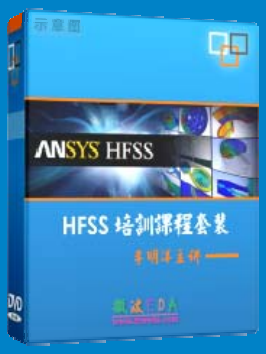

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