DOUBLE-PRINTED RECTANGULAR PATCH DIPOLE ANTENNA FOR UWB APPLICATIONS

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ABSTRACT: *A novel double-printed rectangular patch dipole antenna suitable for UWB application is presented and investigated in this article. The effects of some important antenna parameters on the return loss of the proposed antenna have been investigated. Printed on the dielectric substrate and fed by a microstrip line, the antenna has been demonstrated to provide an UWB with return loss less than −10 dB from 3.1 to 10.6 GHz and the satisfactory radiation properties. A gain variation from 4.78 to 7.89 dB is obtained. The transfer function has flat magnitude and linear phase with smooth group delay being gained, which is advantageous to the transmission of the UWB signals.* Microwave Opt Technol Lett 50: 2450–2452, 2008; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.23668

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

1. INTRODUCTION

UWB technology has recently attracted much attention for wireless communication, networking, detection radars, and other applications. One of the main issues in UWB systems is to design a compact and wideband antenna. Several UWB antennas have been introduced for applications [1].

The dipole antenna is applied for various wireless communication systems because of its omni-directional character and simple structure. But the dipole antenna has narrow frequency band so that the application of the antenna is limited. Recently, planar dipole antennas, which are suitable for wide band applications due to their wide impedance bandwidths and compact size, have been studied widely [2–6]. Various planar dipole antennas have been proposed for UWB applications, such as diamond dipole antenna [7] and double-printed circular disc antenna [8].

In this article, a novel double-printed rectangular patch dipole antenna suitable for UWB application is presented and some important antenna parameters have been investigated. Details of the design and experimental results are presented and discussed in Sections 2 and 3.

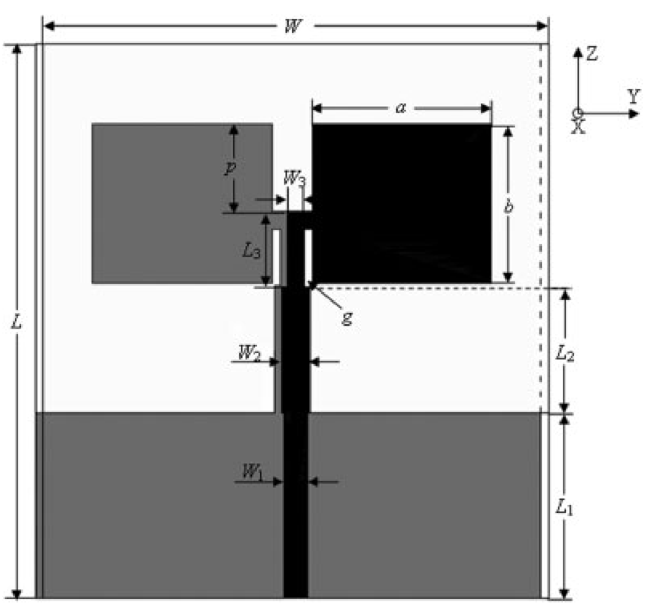

Figure 1 Geometry of the proposed antenna

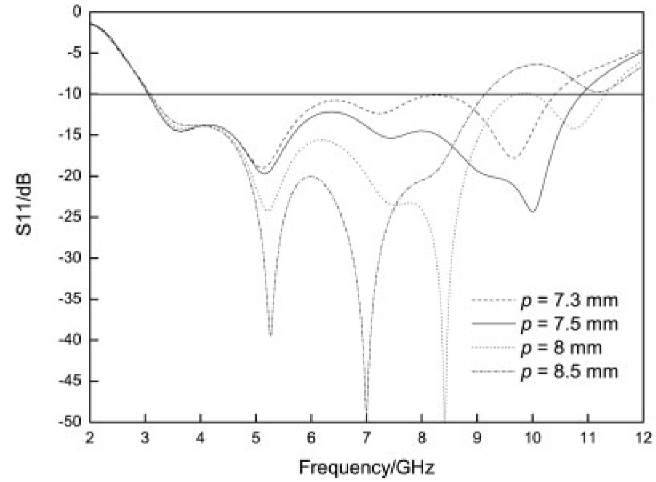

Figure 2 Simulated return loss against frequency for antennas with various p

2. ANTENNA STRUCTURE AND DESIGN

The structure of the proposed antenna is shown in Figure 1. Two rectangular patches are printed on the opposite sides to get the opposite directions currents. The different width of the feed line improved the impedance matching. The traditional microstrip at the bottom could easily get the 50 Ω of impedance matching, and the structure of parallel plate could feed the patches with the currents in opposite directions.

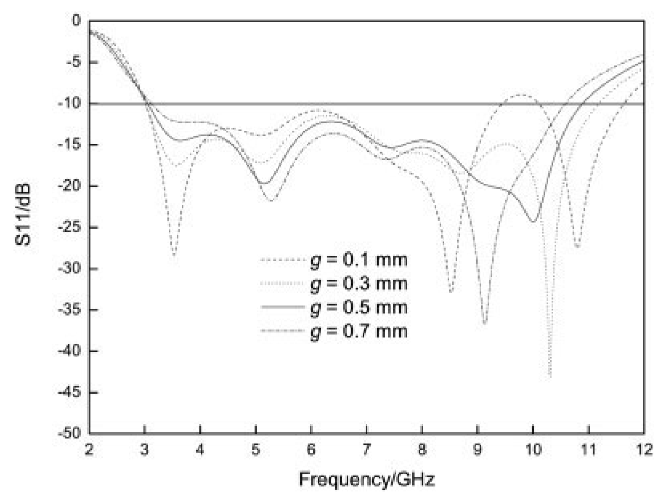

Figure 3 Simulated return loss against frequency for antennas with various g

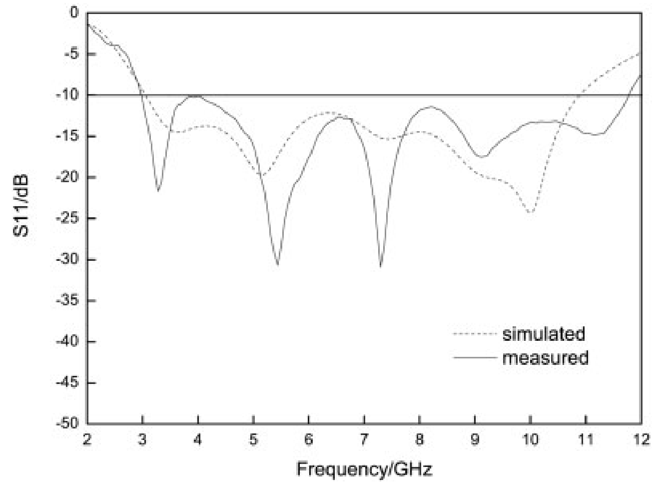

Figure 4 Measured and simulated return loss of the proposed antenna

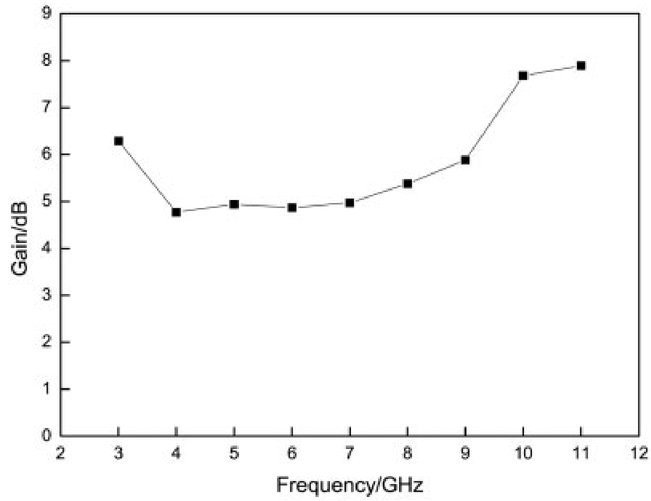

Figure 6 Measured peak gain from 3 to 11 GHz

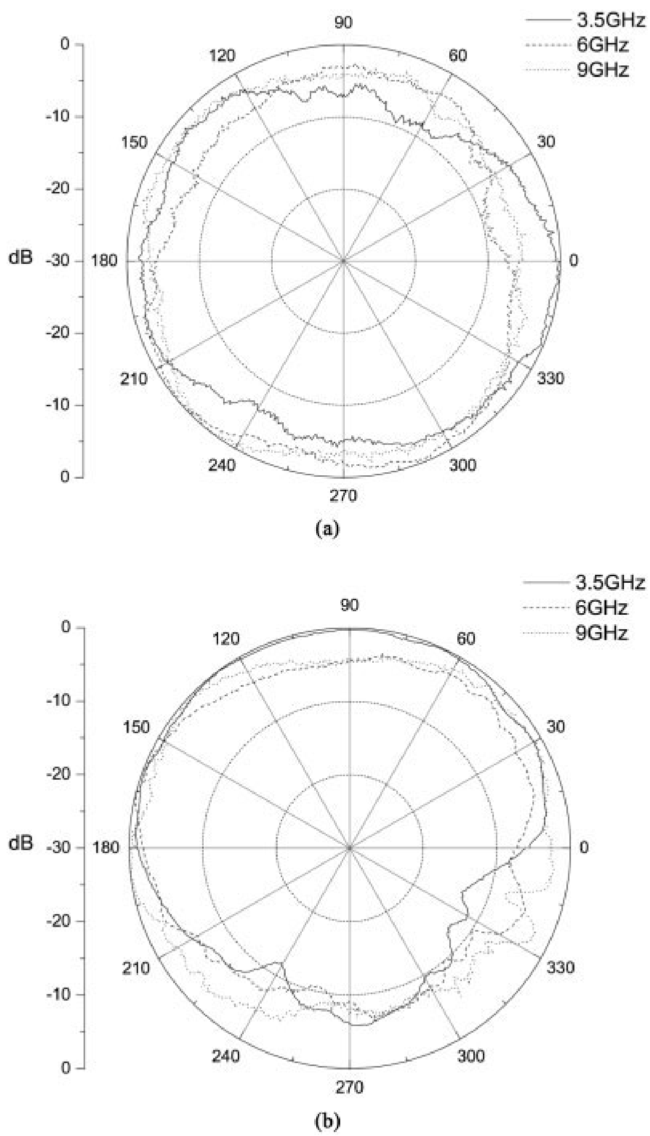

Figure 5 Measured radiation patterns the antenna at different frequencies. (a) *XY*-plane (*E*-plane); (b) *XZ*-plane (*H*-plane)

The antenna is printed on a substrate which is 0.8-mm thick and has a dielectric constant of 2.78. The parameters are: $W = 46$ mm, $L = 48$ mm, $W_1 = 2.2$ mm, $L_1 = 16$ mm, $W_2 = 2.6$ mm, $L_2 = 11$ mm, $W_3 = 1.5$ mm, $L_3 = 6.5$ mm, $g = 0.5$ mm, $p = 7.5$ mm, $a = 16.3$ mm, $b = 13.7$ mm.

Figures 2 and 3 show the simulated return loss with various p and g. It can be seen that the return loss is strongly affected by the parameters p and g. By optimizing the parameters p and g, the antenna can obtain an ultra-wideband impedance matching.

3. EXPERIMENTAL RESULTS

A test antenna was fabricated and the return loss of the antenna was measured by using the HP8722ES Vector Network Analyzer. As shown in Figure 4, the simulated results agree well with the measured ones. The measured bandwidth of return loss less than -10 dB is from 2.95 to 11.76 GHz. It covers the UWB of 3.1–10.6 GHz for short wireless communications. The difference between the simulated and measured values may be due to the effects of coaxial-to-microstrip transition, which is included in the measurements but not taken into account in the calculated results.

The measured radiation patterns of the proposed antenna at 3.5, 6, and 9 GHz are shown in Figure 5. Figures 5(a) and 5(b) show the *E*-plane and *H*-plane patterns, respectively. It can be observed

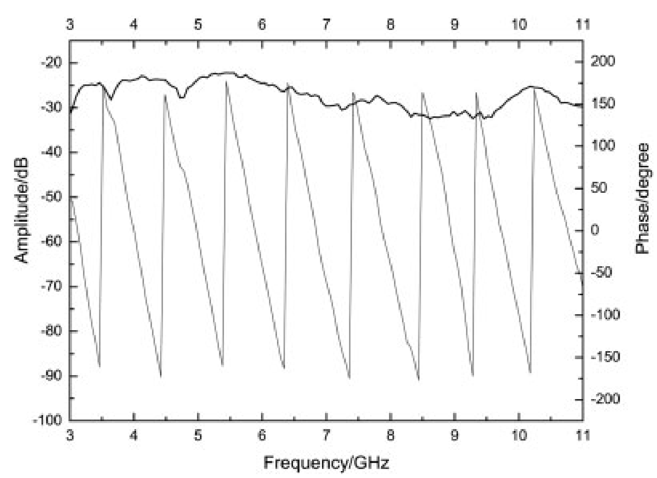

Figure 7 Measured magnitude and phase of $S21$

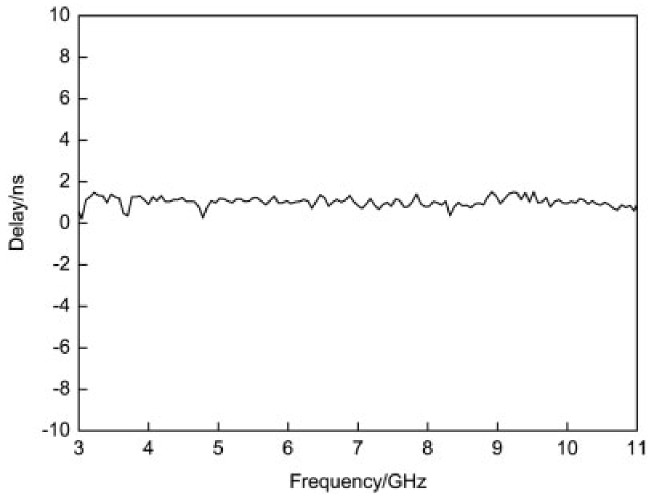

Figure 8 Measured group delay

that the patterns in *E*-plane and *H*-plane are approximately omni-directional over the entire operating bandwidth and suits UWB application. Figure 6 shows the measured peak gain of the proposed antenna. It is evident that the gain is relatively flat and change between about 4.78 to 7.89 dB.

Since UWB systems use short pulses to transmit signals, it is crucial to study the transfer function for evaluating the proposed antenna's performance and designing transmitted pulse signals. In this article a pair of proposed antennas are used as the transmitting and receiving antennas. Considering the antenna system as a two-port network, the transmission scattering parameter *S*21 which indicates the transfer function is measured by using an HP8722ES Vector network analyzer. For the measurement, the distance between the two antennas is 10 cm.

The measured parameter *S*21 and group delay are shown in Figures 7 and 8. It can be seen that the magnitude of *S*21 is relatively flat and the phase is nearly linear in the operation band. The group delay variation is less than 1.5 ns in this bandwidth. The measured results show that the group delay of the antenna system corresponds well to the magnitude of the transfer function. So it proves that the antenna has good time-domain characteristics for UWB applications.

4. CONCLUSION

A printed dipole antenna of double-side rectangular patch for UWB communications is proposed and investigated. The measured return loss less than -10 dB completely covers the UWB range of 3.1–10.6 GHz. The measured gains are relatively flat and change from 4.78 to 7.89 dB and the radiation patterns are approximately omni-directional within the UWB bandwidth. Besides, the proposed antenna has good time-domain characteristics for UWB applications.

ACKNOWLEDGMENT

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SPHERICAL REPRESENTATION OF OMNIPOTENT SMITH CHART

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ABSTRACT: *In this article, A spherical representation of omnipotent Smith chart (OSC) for lossy nonreciprocal transmission lines (LNTLs) is presented. Such representation is an extension of OSC to deeply understand the general transmission lines with not only positive parameters but also negative ones. The spherical OSC has great potential in the application of RF systems which involve active devices. The mathematical expressions and the three-dimensional (3D) graphics of the representation are showed in detail.* © 2008 Wiley Periodicals, Inc.
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Key words: *spherical representation; omnipotent Smith chart; active RF devices*

1. INTRODUCTION

As the coming out of omnipotent Smith chart (OSC), solutions of lossy nonreciprocal transmission lines (LNTLs) problems become possible with the help of this novel graphical tool [1, 2]. To the author's best knowledge, OSC is now one of the most general graphical tools compared to other kinds of improved Smith charts which have been reported [3–7]. However, an initial drawback always lies in all those Smith charts including OSC, which is the neglect of cases with negative impedance. Although efforts have been made to design an extended OSC specifically to meet the requirement of negative impedance analysis [2], it was at the sacrifice of the usage for positive impedance. What engineers mostly call for is a single graphical tool capable of illustrating RF devices containing lossy, nonreciprocal devices with both active and passive components.

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