HYBRID SHAPED ULTRA-WIDEBAND ANTENNA

Qing-Qi Pei,1 Cheng-Wei Qiu,2,3 Tao Yuan,3 and Said Zouhdi2

1 Key Lab of Computer Networks and Information Security of Ministry of Education, Xidian University, Xi’an 710071, China
2 Laboratoire de Génie Electrique de Paris, Ecole Supérieure D’Électricité, Plateau de Moulon, Gil-Sur-Yvette Cedex, France 91192; Corresponding author: chengweiqiu@nus.edu.sg
3 Department of Electrical and Computer Engineering, National University of Singapore, 10 Kent Ridge Crescent, Singapore, 119620,

Received 12 March 2007

ABSTRACT: A novel planar ultra-wideband antenna with hybrid shapes of the patch and the ground is presented. Simulation and measurement have been performed. A much wider impedance bandwidth has been achieved by the hybrid design for potential application in future UWB. The measured radiation patterns show good omnidirectional performance across the operation bandwidth. The modulation and distortion of the transmitted pulse are also shown. © 2007 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 2412–2415, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22746

Key words: UWB antenna; hybrid shape; compact antenna; time-domain modulation

1. INTRODUCTION

Wireless multimedia systems are receiving increasing research and application interests. But improvements are still required to pro-
vide higher data-rate links, for instance, the transmission of video signals. Therefore, ultra-wideband (UWB) communication systems are currently under investigation and the design of a compact wideband antenna is very essential. To overcome the inherently narrow bandwidth of microstrip antennas, various techniques have been developed to cover the entire UWB bandwidth, such as L- or F-shaped probe to feed the patch [1, 2], triangular patch [3], U- or V-slot monopoles [4, 5], and etc.

In this article, we present a compact patch antenna using hybrid shaped patch as well as the ground, which exhibits better UWB operating characteristics. Because of the hybrid shape effects, a good match to antenna’s input impedance is achieved over the entire 3.1–10.6 GHz band, by optimizing parameters of the proposed antenna. Moreover, for UWB systems using time-domain modulation schemes, any distortion of the transmitted pulse shape will increase the difficulties of the detection at the receiver. The distortion induced by the proposed antenna has been presented. It shows the distortion is very small, and thus this proposed antenna has good potential in practical UWB communications.

Figure 3  $E$-plane: (a) 4 GHz (b) 7 GHz. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

Figure 4  $H$-plane: (a) 4 GHz (b) 7 GHz. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

Figure 5  Measured antenna gain in boresight vs. frequency
2. STRUCTURE

To emit the modulated UWB pulse efficiently, a novel hybrid shaped antenna is proposed, as shown in Figure 1. Antenna part is formed by two ellipses with a rectangle to smooth out the discontinuity of the overlapping areas. The ground plane is also formed in a similar way. By selecting optimal parameters of the proposed antenna, it is found that return loss has good match to 50 $\Omega$ over the entire UWB frequency band.

The antenna was fabricated on a Rogers substrate having 20 mil thickness and relative dielectric constant of 3.46. The area occupied by the antenna aperture is only $35 \, \text{mm} \times 35 \, \text{mm}$. The antenna is simulated by CST\textsuperscript{TM}. From the simulation, the optimal dimension of $T = 0.5 \, \text{mm}$, $h = 20 \, \text{mil}$, $W = L = 35 \, \text{mm}$, $L_2 = 12 \, \text{mm}$, $W_1 = 1.16 \, \text{mm}$, $a_1 = 9.6 \, \text{mm}$, $a_2 = 12 \, \text{mm}$, and $d = b_1 = b_2 = 6 \, \text{mm}$ are selected.

3. RESULTS

The prototype of the proposed antenna is shown in Figure 1(b). The reflection coefficient of the antenna is measured using an HP 8510 Network analyzer. In Figure 2, the simulated and measured results are displayed. A good agreement between simulated and measured $S$-parameter has been obtained. It can be seen that over the whole range from 3.1 to 10.6 GHz, the return loss is much lower than $-10 \, \text{dB}$.

The measured radiation patterns at 4 and 7 GHz over the bandwidth in the $E$ plane ($ZY$ plane) and $H$ plane ($XY$ plane) are plotted in Figures 3 and 4, respectively. The antenna gain is presented in Figure 5. The symmetry and omnidirection of those patterns with regard to frequency in both planes, is particularly important in a broadband point-to-point communication. $E$-plane patterns are similar with that of monopoles, and it is also found that the omnidirection in $H$-plane (see Fig. 4) is better at lower frequency.

Previous evaluation is not sufficient in cases where time-domain modulation schemes are used. The distortion of the pulse resulting from the dispersive nature of the antenna has also to be considered. In view of this, Figure 5 shows the pulse position modulation. The red curve represents the input signal and the yellow stands for the signal at the receiver antenna. It can be observed that the distortion of the transmitted waveform in the time domain is very small, which is important to retrieve the communication data.

Each box indicates 1 ns. Hence, the oscillation of the received signal only lasts within one box, as shown in Figure 6(b). Therefore, the proposed antenna with hybrid shapes can be implemented in the modulation scheme easily and efficiently. Finally the spectrum of the antenna emitted pulse sequence at the receiver is presented in Figure 7, where the pulse has been shaped such that its major spectrum energy occupies the FCC UWB band.

4. CONCLUSION

In this article, to improve the performance of microstrip UWB antenna and consider the modulation scheme, a new configuration of UWB patch antenna is designed. The measured $S$-parameter and radiation patterns show that the antenna can be used effectively for UWB communication. Measured waveforms and spectrum of the received signal demonstrate that the proposed antenna is suitable for UWB applications. Good agreement has been obtained between calculated and measured performance.

ACKNOWLEDGMENT

This work was supported partly by the National Natural Science Foundation of China under Grant No. 60633020.
1. Introduction

The band from 3.7 to 4.2 GHz is widely used for Satellite communication. To receive the signals from the satellite it requires High gain antenna (of around 32 dB). There are various types of antennas such as parabolic dish, planar arrays etc. that can give the required gain of around 32 dB. The drawback of parabolic dish at C band is its large planer size and can not be made conformal to the host surface.

In this article, efforts have been made to design planar array. The planar array is formed using microstrip antennas (or patches). These microstrip antennas should provide sufficient bandwidth. Unfortunately the micro strip antennas have very narrow bandwidth due to the fact that they are very thin. If thickness is increased to increase the bandwidth, the cost of the patch will rise and the radiation efficiency will decrease. Therefore other techniques are used to increase bandwidth. They are as follows.

1.1 Planar Multiresonator Configuration [1]

In this method, in addition to the main patch parasitic patches are placed near and in the same plane as the main patch. This method gives 20% maximum bandwidth. The major drawback of this method is its large planer size.

References


BROADBAND PLANAR ARRAY WITH SWITCHABLE POLARIZATIONS

Uttam L. Bombale and Sanjeev Gupta
DA-IICT, Near Indroda Circle, Gandhinagar, Gujarat 382007, India; Corresponding author: uttam_bombale@rediffmail.com

Received 17 March 2007

ABSTRACT: In this article microstrip planar array of eight elements is designed and simulated. It operates in the frequency range from 3.7 to 4.2 GHz. It gives gain of 17 dB. It can produce many types of polarizations such as E_θ, E_φ, right, and left circular. In all these polarizations the cross-polar level is around 20 dB lower than the copolar level (except for E_θ for E_θ it is around 10 dB). The novel microstrip antenna element used in this article is constructed using parasitic patch and shorting pins. It gives wide bandwidth and various polarizations due to parasitic patch and shorting pins, respectively. The array is simulated using Agilent’sADS 2003A momentum software. © 2007 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 2415–2419, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22731

Key words: switchable polarizations; broadband planar array; microstrip antenna; shorting pins; electromagnetically coupled msa

2. Design

2.1 Design of Patch Antenna

The patch antenna consists of a ground plane, a radiating patch, and a parasitic patch as shown in Figure 1. The dielectric material used to