4. CONCLUSION

A dual-mode BPF with spurious response suppression using microstrip patch resonator is proposed in this article. Open-stubs added on the feed-lines suppress the spurious response and enhance the stopband rejection greatly without much circuit size enlargement. Furthermore, using this technique, a reduced-size dual-mode BPF with spurious response suppression using misrostrip slotted patch resonator has been developed. The slots on the patch resonator results in the size reduction (14.3%) and can reduce the radiation loss. The reduced-size dual-mode BPF provides much lower insertion loss of 1.02 dB, when compared with the BPF in Figure 1(b). Moreover, the rejection of the spurious response achieves 28.2 dB, and the high stopband rejection is enhanced greatly. The simulated and measured results have been presented and both are in good agreement.

REFERENCES

1. J.S. Hong and M.J. Lancaster, Realization of quasielliptic function filter using dual-mode microstrip square loop resonators, Electron Lett 31 (1995), 2085–2086.
2. L. Zhu, B.C. Tan, and S.J. Quek, Miniaturized dual-mode bandpass filter using inductively loaded cross-slotted patch resonator, IEEE Microwave Wireless Components Lett 15 (2005), 22–24.
3. R. Wu and S. Amari, New triangular microstrip loop resonators for bandpass dual-mode filter applications, IEEE MTT-S Int Symp Dig, Long Beach, CA (2005), 941–944.
4. S.-W. Fok, P. Cheong, K.-W. Tam, and R.P. Martins, Microstrip dual-mode bandpass filter design with simultaneous size reduction and spurious response suppression, in IEEE MTT-S Int Symp Dig (2005), Long Beach, CA 2175–2178.
5. W.-H. Tu and K. Chang, Miniaturized dual-mode bandpass filter with harmonic control, IEEE Microwave Wireless Components Lett 15 (2005), 838–840.
6. L.-H. Hsieh and K. Chang, Dual-mode elliptic-function bandpass filter using one single patch resonator without coupling gaps, Electron Lett 36 (2000), 2022–2023.
7. Ö. Akgün, B.S. Tezekici, and A. Görür, Reduced-size dual-mode slotted patch resonator for low-loss and narrowband bandpass filter applications, Electron Lett 40 (2004), 1275–1276.

BROADBAND PLANAR SHORTED MONOPOLE ANTENNA FOR DTV SIGNAL RECEPTION IN A PORTABLE MEDIA PLAYER

Wei-Yu Li,[1] Kin-Lu Wong,[1] and Jeen-Sheen Row[2]
[1] Department of Electrical Engineering, National Sun Yat-Sen University, Kaohsiung 804, Taiwan
[2] Department of Electrical Engineering, National Changhua University of Education, Changhua 500, Taiwan

Received 2 August 2006

ABSTRACT: *A novel broadband planar shorted monopole antenna suitable for digital television (DTV) signal reception for portable media player (PMP) applications is presented. The proposed shorted monopole antenna uses an internal matching circuit consisting of a chip capacitor and two narrow strips, which leads to a wide operating bandwidth (2.5:1 VSWR) of 340 MHz (about 53% centered at about 638 MHz) for the antenna. This wide bandwidth makes it very suitable for DTV signal reception in the 470–806 MHz band. In addition, owing to its planar structure, the proposed antenna can be firmly attached onto the surface of the PMP casing, when not in operation. This property is attractive for keeping the aesthetic appearance of the PMP equipped with the proposed antenna. Details of the experimental and simulation results are presented and analyzed. The design approach of selecting a proper chip capacitor for the proposed antenna is also discussed.* © 2007 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 558–561, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22189

Key words: *planar antennas; broadband monopole antennas; DTV antennas; portable media players (PMPs)*

1. INTRODUCTION

Portable media player (PMP) is a kind of mobile entertainment device, with which users can play their favorite movies and music anywhere and any time. Recently, with the digital TV broadcasting being expected to replace all the analog TV broadcasting in the coming years [1], the PMP equipped with a digital television (DTV) receiver is expected to be very attractive for many users. For this purpose, a DTV receiving antenna suitable for PMP applications with a wide operating bandwidth covering the DTV band in the 470–806 MHz band [2–5] is greatly desired. For conventional wire monopole antenna, its operating bandwidth is usually about 10% only, making it difficult to cover the whole the DTV band.

In this article, for PMP applications, we present a promising planar shorted monopole antenna using an internal matching circuit technique [5] to achieve a wide operating bandwidth of larger than 50% for DTV signal reception in the 470–806 MHz band. When in operation, the proposed planar monopole antenna is protruded from the PMP ground plane with a length of less than 80 mm, which is only about 0.125 wavelength of the desired lower edge frequency at 470 MHz. While not in operation, the proposed planar monopole antenna is very promising to be bent and attached onto the surface of the PMP casing, which is an attractive property for keeping the aesthetic appearance of the PMP equipped with the DTV antenna. Detailed design of the proposed DTV antenna is first described, and experimental and simulation results are presented and analyzed. Effects of the internal matching circuit on bandwidth improvement of the proposed antenna are also studied.

2. ANTENNA DESIGN

Figure 1 shows the geometry of the proposed broadband planar shorted monopole antenna for DTV signal reception in a PMP. The proposed antenna shown in the figure is in use condition and is protruded from the left upper corner of the PMP ground plane, which is selected to be of size 80 $\times$ 120 mm^2 in this study. The planar monopole antenna has a width of 17 mm and a length of 90 mm, with 11 and 79 mm below and above the top edge of the PMP ground plane, respectively. The protruded length of 79 mm corresponds to only about 0.125 wavelength of the desired lower edge frequency at 470 MHz. Also note that the selected width of the planar monopole antenna is less than the thickness of general practical PMPs. In this case, when not in operation, the proposed planar monopole antenna can be bent and firmly attached onto the surface of the PMP casing as shown in Figure 2, keeping aesthetic appearance of the PMPs.

The planar monopole antenna is short-circuited to the PMP ground plane through an inverted-L shorting strip located in the notched no-ground region (size 20 $\times$ 20 mm^2) as shown in the figure. With the short-circuiting, the proposed planar monopole antenna can be placed close to the PMP ground plane. By further incorporating an internal matching circuit [5], which consists of a chip capacitor (length 2 mm and width 1.2 mm) and two identical narrow metal strips (length 4 mm and width 2 mm), improved

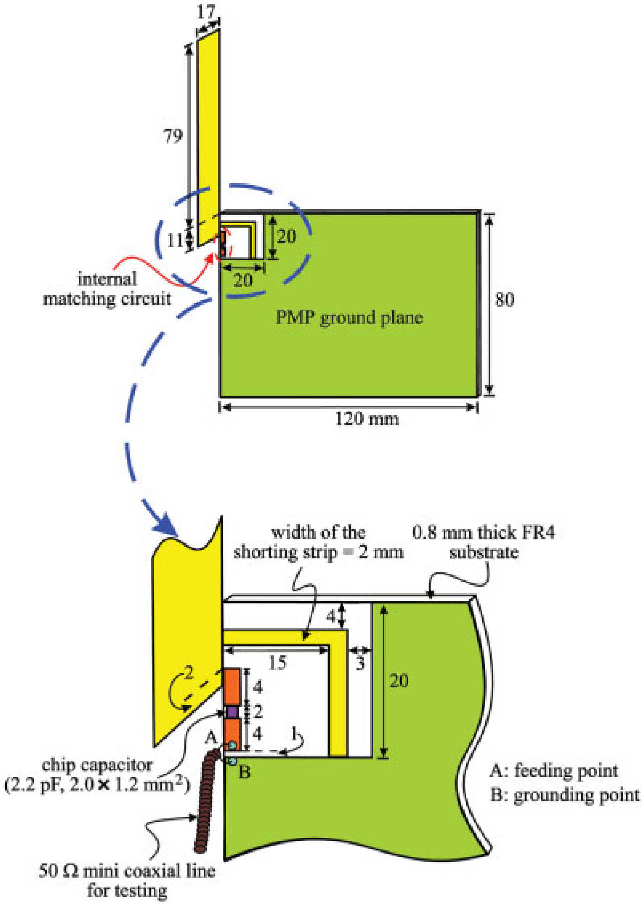

Figure 1 Geometry of the proposed broadband DTV planar shorted monopole antenna with an internal matching circuit for application in a portable media player. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

impedance matching over a wide frequency range covering the desired 470–806 MHz band can be obtained. The preferred value of the chip capacitor is 2.2 pF in this study. Detailed design approach of selecting the preferred chip capacitor for the proposed antenna will be discussed with the aid of Figure 8 in Section 3.

Also note that there is a small feed gap of 1 mm between the internal matching circuit and the PMP ground plane. In the experiment for testing the proposed antenna, a 50-Ω mini coaxial line is used across the small feed gap, with the central conductor of the

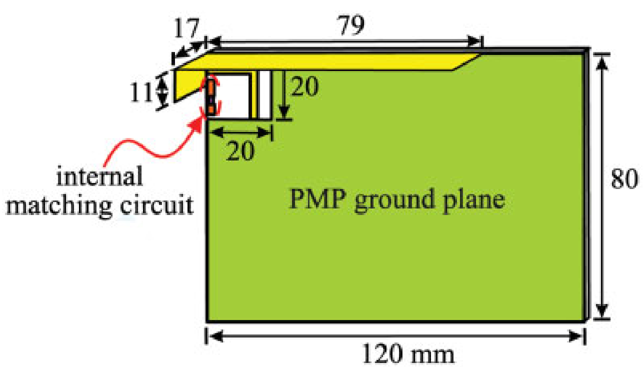

Figure 2 Geometry of the proposed antenna when not in operation. The PMP casing is not shown in the figure. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

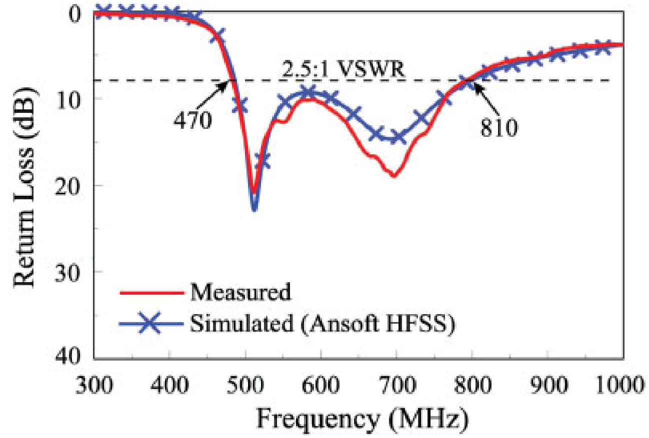

Figure 3 Measured and simulated return loss for the proposed antenna with C = 2.2 pF. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

coaxial line connected to the feeding point (point A in Fig. 1) and the outer grounding sheath connected to the PMP ground plane at point B (the grounding point).

3. RESULTS AND DISCUSSION

The proposed planar shorted monopole antenna shown in Figure 1 was constructed and studied. The chip capacitor in the internal matching circuit is selected to be 2.2 pF. Figure 3 shows the measured and simulated return loss for the constructed prototype. The simulated results are obtained using Ansoft simulation software HFSS (high frequency structure simulator) [6]. From the results, good agreement between the measurement and simulation is seen. The measured impedance bandwidth, defined by 2.5:1 VSWR, reaches 340 MHz (470–810 MHz), which is about 53% centered at 638 MHz, the desired center frequency of the 470–806 MHz band. The obtained bandwidth makes the proposed antenna very promising to cover the whole DTV band in the 470–806 MHz band. Also note that the bandwidth definition of 2.5:1 VSWR is generally acceptable for DTV signal reception in practical applications.

Figure 4 shows a comparison of the measured return loss for the proposed antenna with and without the chip capacitor. When

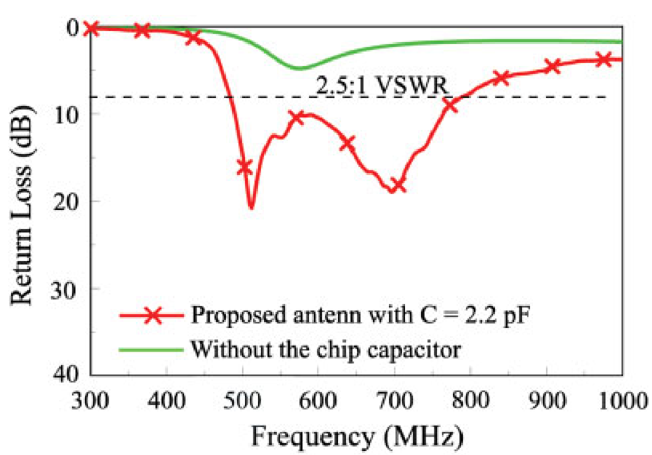

Figure 4 Measured return loss for the proposed antenna with and without the chip capacitor in the internal matching circuit. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

there is no chip capacitor in the internal matching circuit, the chip capacitor is replaced by a connecting metal strip of size 2 × 2 mm^2. It is clearly seen that the impedance matching of the proposed antenna is greatly enhanced over the DTV band, when the chip capacitor is added in the internal matching circuit. The reason of poor impedance matching for the case without the chip capacitor is mainly owing to the large inductance introduced by the inverted-L shorting strip in the input impedance of the antenna.

Radiation characteristics of the proposed antenna were also studied. For this study, Ansoft simulation software HFSS is used, which is expected to provide reliable information for the proposed antenna. Figure 5 shows the simulated radiation pattern at 510 MHz, in which monopole-like radiation pattern with good omnidirectional radiation is observed. The corresponding results at 700 MHz are also presented in Figure 6. From the results, the obtained omnidirectional radiation characteristics are still good. Figure 7 shows the simulated antenna gain and radiation efficiency of the proposed antenna. The simulated antenna gain is in a range of about 0.3–1.7 dBi. The simulated radiation efficiency for frequencies over the 470–806 MHz band is seen to be better than 75%.

Finally, the design approach of selecting the proper chip capacitor in the internal matching circuit is discussed. Figure 8 shows the measured impedance traces of the proposed antenna with and without the chip capacitor in the frequency range of 300–1000 MHz in the Smith Chart. It is seen that, when there is no chip capacitor (the chip capacitor is replaced by a connecting metal strip of size 2 × 2 mm^2), all impedances are inductive and there are three intersections between the impedance trace and the 50-Ω resistance circle. This implies that it is possible to shift the impedance trace of the proposed antenna along the 50-Ω resistance circle by using a capacitive internal matching circuit, which consists of a chip capacitor and two narrow metal strips in this study.

The frequencies at the three intersections are 514, 634, and 910 MHz, and their corresponding impedance values are 50 + j144.6 Ω, 50 + j81.2 Ω, and 50 + j155.5 Ω, respectively. To compensate for the inductances at 514 and 634 MHz, the chip capacitors with 2.14 and 3.09 pF should be used, respectively [5]. However, since there are no available chip capacitors having the exact capacitances, the chip capacitors with 2.2 and 3.1 pF are used in this study. In Figure 8(a), the measured results for the case with C = 2.2 pF are shown. For the case with C = 3.1 pF, the results are shown in Figure 8(b). In both cases, much enhanced bandwidths are obtained. The obtained bandwidths reach 340 MHz (470–810 MHz) and 228 MHz (502–730 MHz) for the cases of C = 2.2 and 3.1 pF, respectively. Hence, from the obtained results, the chip capacitor with 2.2 pF is chosen as the preferred chip capacitor for the proposed antenna. Also note that the case for the intersection at 910 MHz is not considered, because the operating frequencies in this case are not covered by the desired DTV band.

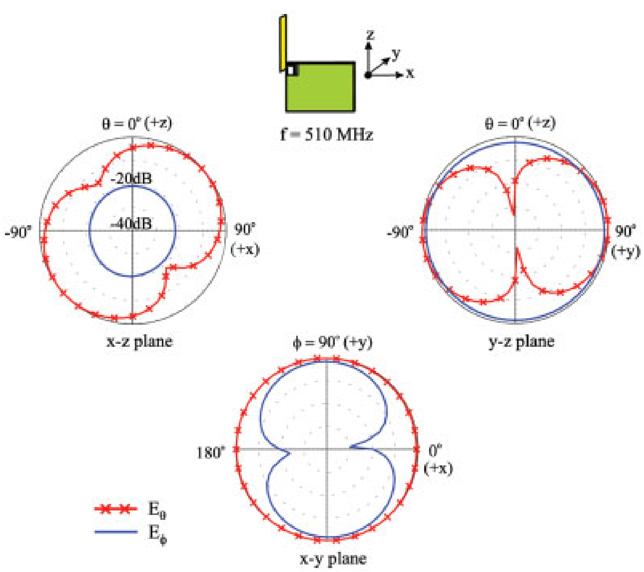

Figure 5 Simulated radiation pattern at 510 MHz for the proposed antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

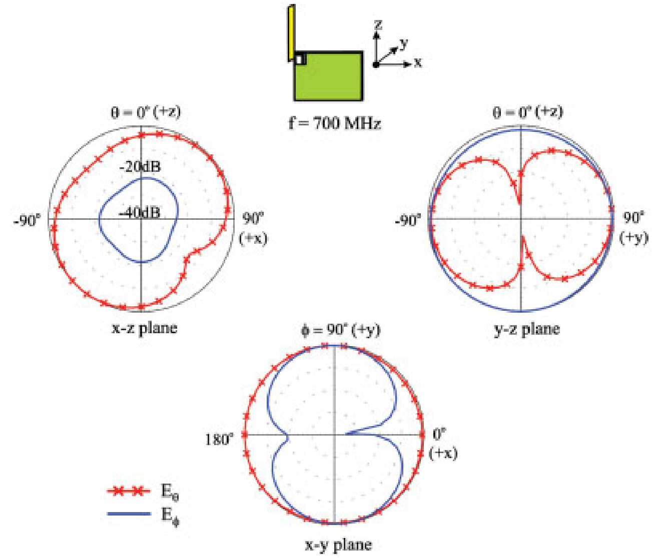

Figure 6 Simulated radiation pattern at 700 MHz for the proposed antenna. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

4. CONCLUSION

A broadband planar shorted monopole antenna for DTV signal reception in the 470–806 MHz band for PMP applications has been proposed. By using an internal matching circuit, which comprises a chip capacitor and two narrow metal strips, the proposed antenna can achieve a wide operating bandwidth with good impedance matching covering the whole DTV band. The proposed antenna is protruded from the left upper corner of the PMP ground

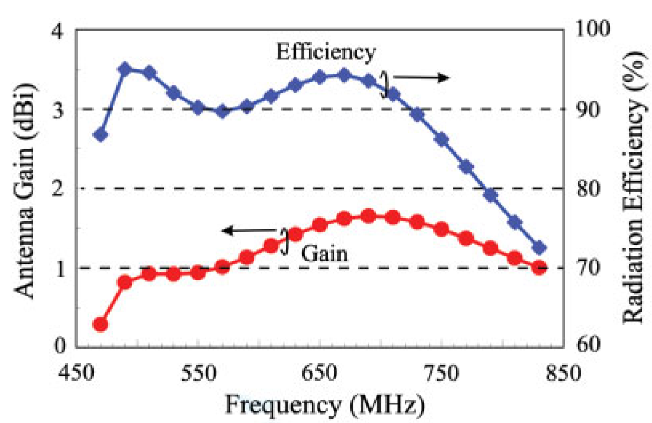

Figure 7 Simulated antenna gain and radiation efficiency of the proposed antenna with C = 2.2 pF. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

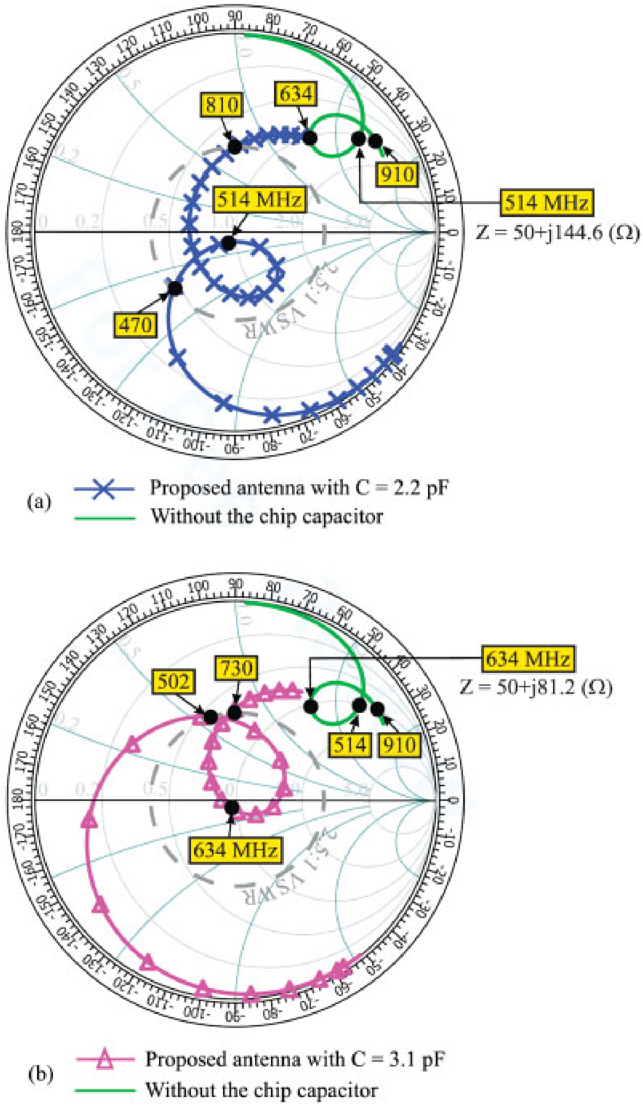

Figure 8 (a) Measured impedance in the Smith chart for the proposed antenna with C = 2.2 pF and the case without the chip capacitor. (b) Measured impedance in the Smith chart for the proposed antenna with C = 3.1 pF and the case without the chip capacitor. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

plane in operation condition. On the other hand, when not in operation, the planar structure of the proposed antenna makes it very suitable to be bent and attached onto the top surface of the PMP casing to achieve an aesthetic appearance. The proposed antenna has been successfully implemented, and the detailed design approach of selecting the proper chip capacitor in the internal matching circuit has also been presented. Over the DTV band in the 470–806 MHz band, good radiation characteristics have also been obtained for the proposed antenna.

REFERENCES

1. FCC. Digital television, major initiatives of federal communications commission. http://www.fcc.gov/dtv
2. U.S. Frequency Allocations, Office of Spectrum Management, National Telecommunications and Information Administration, U.S.A. http://www.ntia.doc.gov/osmhome/allochrt.html
3. K.L. Wong, C.I. Lin, T.Y. Wu, and J.W. Lai, A planar DTV receiving antenna for laptop applications, Microwave Opt Technol Lett 42 (2004), 483–486.
4. C.M. Su, L.C. Chou, C.I. Lin, and K.L. Wong, Internal DTV receiving antenna for laptop application, Microwave Opt Technol Lett 44 (2005), 4–6.
5. K.L. Wong, Y.W. Chi, B. Chen, and S. Yang, Internal DTV antenna for folder-type mobile phone, Microwave Opt Technol Lett 48 (2006), 1015–1019.
6. http://www.ansoft.com/products/hf/hfss/, Ansoft Corporation HFSS.

NEW DESIGN OF A CPW-FED ULTRAWIDEBAND SLOT ANTENNA

Jwo-Shiun Sun, Yi-Chieh Lee, and Syuan-Ci Lin
Department of Electronic Engineering, National Taipei University of Technology, Taipei, Taiwan, Republic of China

Received 12 July 2006

ABSTRACT: *A new design of slot antenna by CPW-fed is proposed for ultrawideband (UWB) applications. The proposed antenna consists of a CPW-fed and a pair of symmetry curved radiating slot. The designed tapered slot antenna covers the bandwidth from 3 to 20 GHz. Simulated and measured results of the new design CPW-fed UWB slot antenna show fairly good performance.* © 2007 Wiley Periodicals, Inc. Microwave Opt Technol Lett 49: 561–564, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.22197

Key words: *CPW-fed; ultrawideband; tapered; slot*

1. INTRODUCTION

The ultrawideband (UWB) radio transfers data more than the Bluetooth, and the distance of UWB radio is not limited smaller than 5 m. These applications of UWB radio include searching the

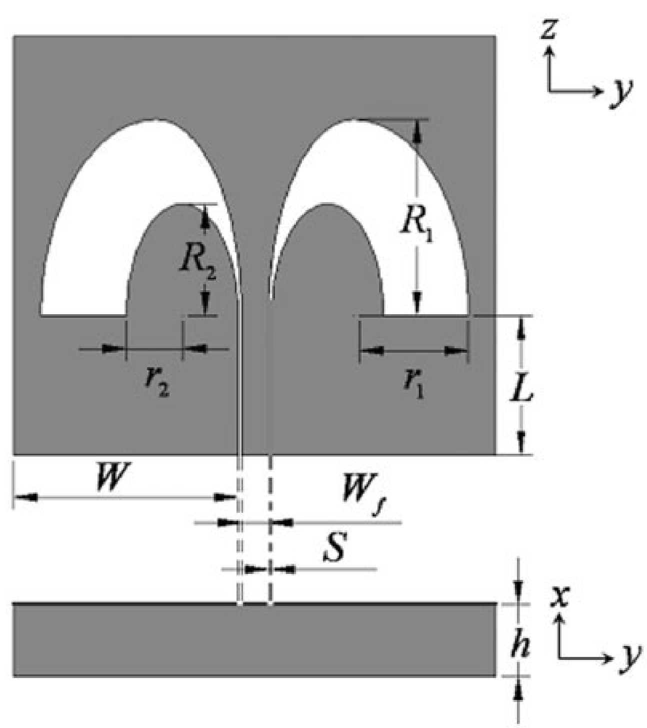

Figure 1 Geometry of the proposed CPW-fed UWB antenna