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An Inset CPW-Fed Antenna for UWB Application

Tae-Hwan Kim*, Choon-Sik Cho*, Jae W. Lee*, and Jaeheung Kim**
*School of Electronics, Telecommunications and Computer Engineering, Hankuk Aviation University
**School of Electrical and Electronic Engineering, Kangwon National University
E-mail : * kth9677@hau.ac.kr, *cscho@hau.ac.kr, *jwlee1@hau.ac.kr, ** jaeheung@kangwon.ac.kr

I. Introduction

The 3.1 ~ 10.6 GHz frequency allocated for the Ultra-Wideband (UWB) radio application by the FCC in 2002 has attracted much attention in the industry and the academia. The UWB system requires a wideband performance because it has a need of hundreds of Mbps bit rate and short pulse radiation. To achieve the required bandwidth with compact size, low power and easy manufacture the main issue in antenna design for the UWB system. The antenna design is one of the main issues in the UWB system.

For providing a wide bandwidth, various antenna types such as circular, elliptical, square, rectangular and pentagonal monopole antennas have been discussed so far [1-4]. Among all these structures, the circular and the elliptical monopole antennas were reported to show a better wide impedance bandwidth. Although three-dimensional configurations for the UWB antenna have been widely reported, they have a problem in the implementation of low profile and easy fabrication.

In this paper, an inset CPW (Coplanar waveguide)-fed antenna is proposed, which shows compact size, low cost, easy fabrication and much wider bandwidth. Inset feeding improves the impedance bandwidth at the lower frequencies due to an increased path length of the current caused by slitting the radiator [5-6]. CPW-fed antennas provide many attractive advantages such as wide bandwidth, uniplanar structure, and easy integration with MMICs and active devices. Furthermore, CPW-fed antennas also exhibit a larger bandwidth compared with conventional microstrip antennas [7]. The antenna can operate the resonance type at lower frequency and the traveling type at higher frequency. Therefore, an extremely wide bandwidth can be achieved.

In this paper, we will first present a detailed structure of the proposed antenna using an inset CPW feed in Section II. Then we will show the proposed antenna performance by the simulated and experimental results in Section III.

II. Antenna Design

Fig. 1 (a) shows the geometry of the proposed UWB antenna integrated with CPW-fed line. It trims the bottom edge of the radiator as shown in Fig. 1 (c) and

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forms a circular curve which removes abrupt discontinuities from the feed line to the radiator. Because antennas with abrupt discontinuities show large reflections, it is necessary for antenna geometries to employ more continuous curve which shows a smooth impedance transition from the antenna feed to the radiator mouth and thus provides a low-Q radiator with a constant input impedance. In addition, an inset is employed between the feed line and the radiator to improve the lower frequency performance shown in Fig. 1 (a).

The proposed antenna utilizes a tapered ground plane. A gradual tapering of the ground plane also provides an enhanced impedance bandwidth. The overall antenna geometry is then similar to a sandglass shape. The proposed antenna with a dimension $26 \times 30\ mm^2$ is printed on the top side of an FR4 substrate with a thickness, 1.6 *mm* and a dielectric constant, 4.6. On both sides along the feed line, two limited ground planes with a same dimension are symmetrically located. The optimized value of the CPW-line for 50Ω input matching is a strip width 2.5 *mm* and a gap width 0.33 *mm*. The height of the radiator, *L1+L2* determines the low frequency limit. The radiator width *W1* is a critical parameter to attain a wideband characteristic. The optimized antenna dimensions acted for a UWB antenna are obtained as: *W1*= 26 *mm*, *W2* = 0.33 *mm*, *L1* = 9 *mm*, *L2* = 5.95 *mm*, *L3* = 2 *mm*.

III. Simulated and Experimental results

The measured return losses for the rectangular patch antenna as shown in Fig. 1 (c) and the proposed sandglass shape antenna as shown in Fig. 1 (a) are plotted in Fig. 2. It is observed that compared to a general square patch antenna, the proposed antenna with a smooth circular curve at the bottom edge shows a good impedance matching over wide frequency band. Fig. 3 depicts the experimental results of VSWRs for the antenna with an inset feed and that without it. The inset feed is more suitable for the UWB operation.

The surface current distribution is plotted in Fig. 4. It is noted that inset feeding is more effective to meander the excited surface current path and thus to lower the resonant frequency of the antenna. A sharp rising performance of VSWR is also shown at the higher frequency in Fig. 3. It is because at the high frequencies the currents are concentrated near the bottom-center of the radiator and slitting that area suppresses the high frequency mode. This hence reduces the unwanted signal interference and the power loss above 10.6 GHz which is beyond the UWB frequency band. Therefore, increasing the slot length *L3*, the overall working frequencies are shifted toward the desired band.

Simulated radiation patterns are plotted in Fig. 5. Note that at the lower frequency the elevation (yz-plane) patterns have a symmetry along $\theta = 90^\circ$ and the azimuthal (xz-plane) patterns are nearly omni-directional as expected but at the higher frequency the radiation patterns are distorted. Fig. 6 shows the simulated results of maximum gain versus frequency. Simulated results of the antenna are obtained by using a commercially available software, CST MW studio [8].

IV. Conclusions

A new inset CPW-fed antenna was proposed for the UWB application. Notching the bottom edge of the radiator forming a smooth circular curve leads to an enhanced impedance bandwidth. Inset feeding also assists a good impedance matching at the lower frequency and eliminates the power loss at the higher frequency. The lower limit of the frequency can be overcome with a limited size of antenna. The proposed antenna works well from 3 through 11 GHz which includes UWB application band.

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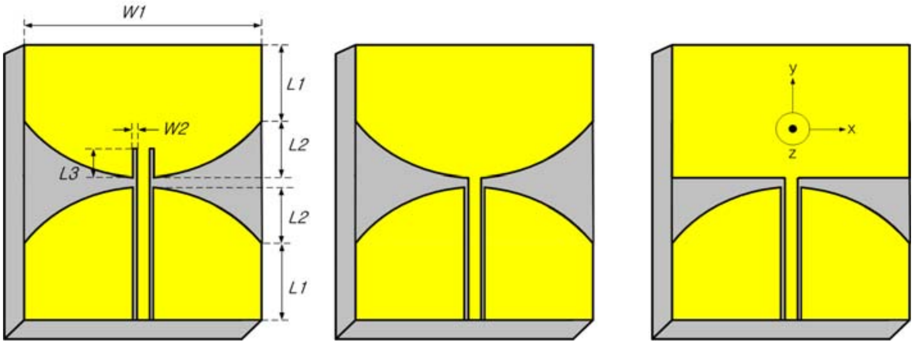
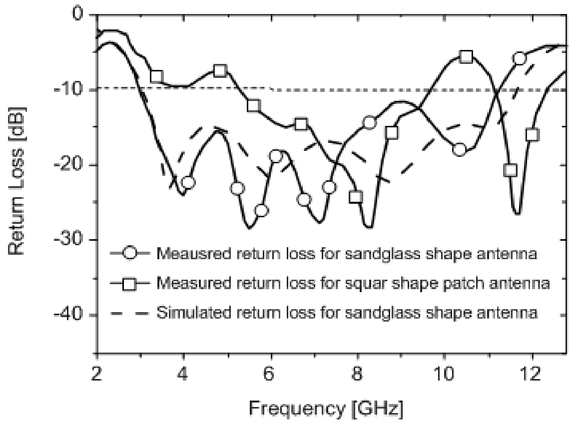


(a) Sandglass type with insets **(b) Sandglass type without insets** **(c) Rectangular type**

Fig. 1. Geometry of the proposed antenna



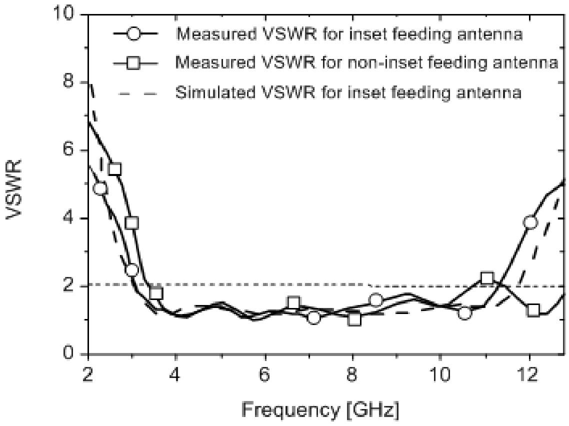
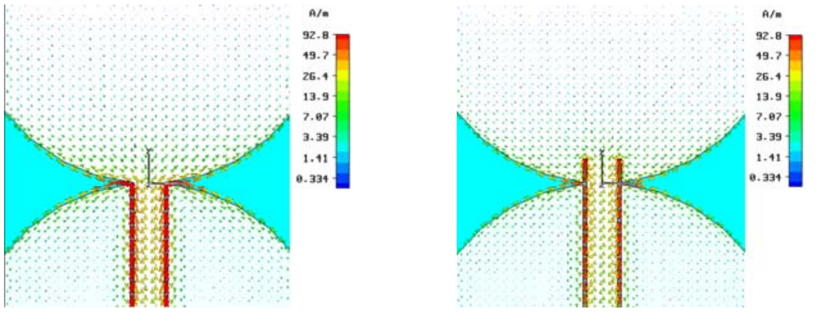


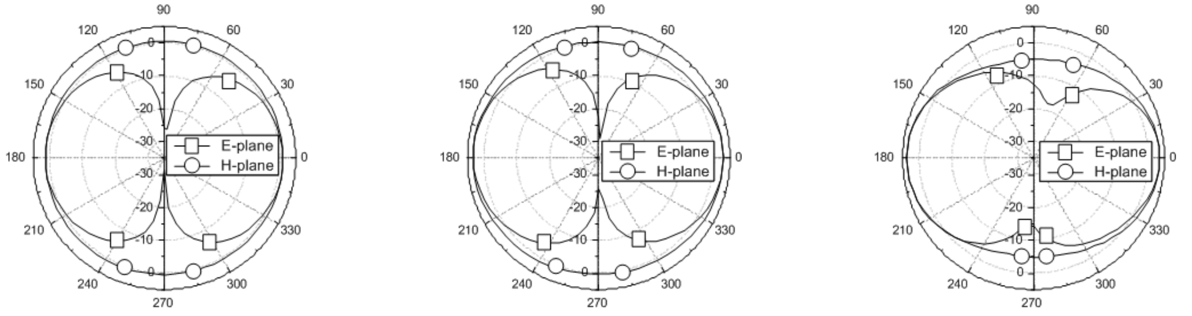
Fig. 2. Comparison of return loss rectangular patch antenna and sandglass shape antenna

Fig. 3. Comparison of measured VSWR inset feeding antenna and non-inset feeding antenna



(a) non-inset feeding antenna (b) inset feeding antenna

Fig. 4. **Surface current distribution** at 3.1 GHz



(a) f = 3.1 GHz (b) f = 5 GHz (c) f = 8 GHz

Fig. 5. Simulated radiation patterns

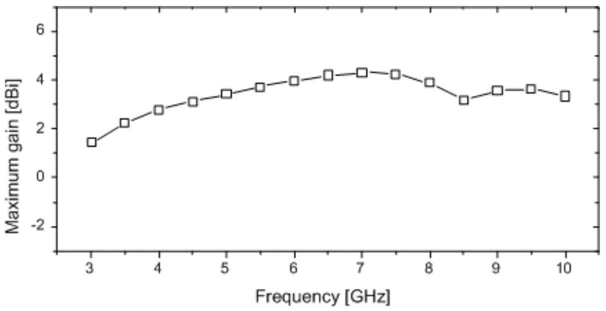


Fig. 6. Simulated maximum gain of proposed antenna