# Design of Exponential Tapered Slot Antenna With Band-Stop Characteristic for UWB Application

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## 1. Introduction

New communication environments typically consist of a broad range of application devices providing data, video, and audio services. The rapid developments in the wireless communications industry demand the novel antennas that can be used in wide frequency bands. In order to accomplish these requirements, we start a new design with two main concepts; a CPW feed line and a slot radiating element. The slot antenna is known as a wide bandwidth operation antenna, and the CPW feed line provides a broad band and balanced feed structure. For operating wide band, several techniques are studied such as using high order modes[1] ($TE_{10}$, $TE_{20}$, $TE_{30}$ …), parasitic patch[2,3] or meandering slits[4] at opposite edges. The designs of the CPW fed[5] slot antennas have recently much more attention due to the advantages of wide bandwidth and easy integration with monolithic microwave integrated circuits.

In this paper, we propose a new printed exponential tapered slot antenna with band-stop characteristic for UWB application. The proposed antenna has a compact size and shows wide bandwidth characteristics comparing with microstrip line fed ones and achieve Band-stop characteristic. Antenna design concepts and the details of experimental results are discussed.

## 2. Antenna Design

The proposed antenna geometry is shown in Figure 1. This antenna has a planar configuration which consists of exponential taper slot, tuning stub and CPW feeder line. The characteristic impedance of the CPW feed transmission line is 50Ω. The exponential tuning stub connected at the end of the CPW feeder line. The ring slit is added on the tuning stub. By adjusting the size and shape of the tapered slot, a good impedance matching can be achieved. A wide impedance bandwidth is obtained by exponential tapered slot. The incoming source signal through a CPW feeder line, induce electric fields between ground plane and tuning stub. Basically a dominant resonant mode($TE_{10}$) is formed in a slot at one frequency. As the source frequency is increased high order resonant modes produced in a slot. By these multi-resonance effects, the proposed antenna shows the wide band frequency characteristics.

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In this paper, the proposed the tapered slot antenna which is operated from 2.88 GHz to $\infty$. The proposed antenna is designed and fabricated using a CPW fed exponential slot. The substrate which has a dielectric constant of $\varepsilon_r = 4.4$(FR-4) is used, and it's thickness is about $1.6mm$. At first, we set the parameters of the exponential function for UWB. The additional ring slit is added to operate rejection bandwidth. Figure 2 shows the simulated return loss of the designed antenna without ring slit, On the other hand, when an additional ring slit is added at tuning stub, the rejection bandwidth is achieved. Figure 3 shows photo of fabricated antenna.

Figure 4 shows impedance bandwidth and notch band of simulated data and measured data. The simulated rejection bandwidth is adjusted by inner circumference and outer circumference of ring slit. The inner circumference is $\lambda_g/2$ at 5.15GHz. The outer circumference is $\lambda_g/2$ at 5.825GHz. The simulated rejection bandwidth is 5.125GHz to 5.831GHz.

As a result novel antenna with ring slit. Experimental results show the impedance bandwidth (10dB return loss) of a fabricated antenna is ultra wide band (about 1.2GHz~$\infty$GHz). By adjusting the exponential tapered slot length, multi resonant modes with good impedance matching are excited in the slot of the antenna. The measured rejection bandwidth (5.125GHz~6.01GHz) is achieved.

Figure 5 shows the tangential components of electric field at each mode. It can be seen that the tangential components of electric field occurred between the ground plane and tapered slot through CPW feed structure. The dominant resonant mode ($TE_{10}$) is generated at 3.93GHz. The several resonant modes are generated by an effect that the slot length is increased according to change the frequency higher. At 10.0GHz, the second order mode ($TE_{20}$) is generated. Consequently, the proposed antenna shows wide frequency bandwidth operation.

Figure 6 shows the measured radiation pattern of the proposed antenna at 4.9GHz. The proposed antenna shows good radiation patterns in the X-Z and Y-Z plane. It is observed that the radiation patterns are alike a half wavelength dipole antenna in Y-Z plane, and shows near omni-directional in X-Z plane. The antenna shows similar radiation patterns characteristics over the wide band frequency in X-Z and Y-Z plane. The Measured maximum antenna gain is 1.3dBi. The radiation efficiency of proposed antenna is about 93% at impedance bandwidth. On the other hand The radiation efficiency is about 7% at stop band.

## 3. Conclusions

In this paper, a novel small size ($W \times L = 24mm \times 24mm$) wide band antenna is proposed and fabricated. The good return-loss and radiation pattern is achieved by exponential taper slot. Also the rejection band is operated by ring slit on tuning stub. The inner and outer radius of ring slit is set for adjust rejection band. The impedance bandwidth of proposed antenna ($VSWR \leq 2$) is 1.2GHz~$\infty$, and the rejection bandwidth ($VSWR \geq 2$) is 5.125GHz to 6.01GHz. The optimum design of this new type UWB antenna does not require additional notch filter, compact antenna can be archived easily.

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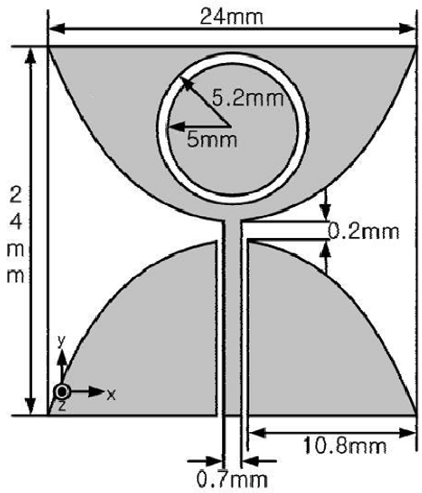



Fig. 1 Geometry of proposed antenna

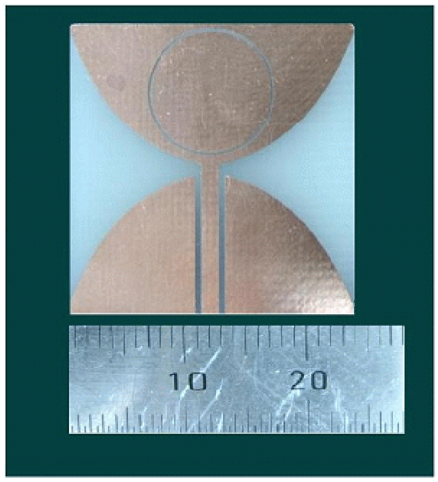



Fig. 3 Photo of fabricated antenna

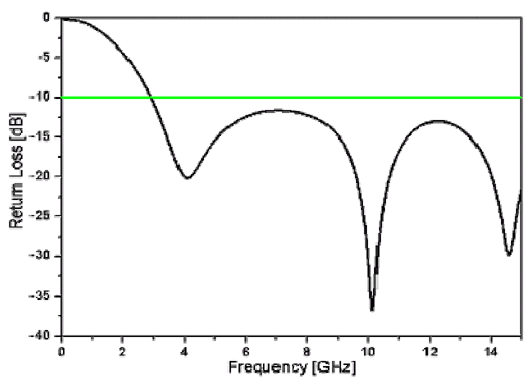



Fig. 2 Simulated return loss of antenna Without ring slit

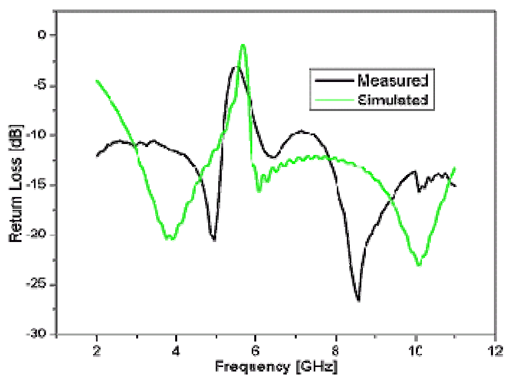
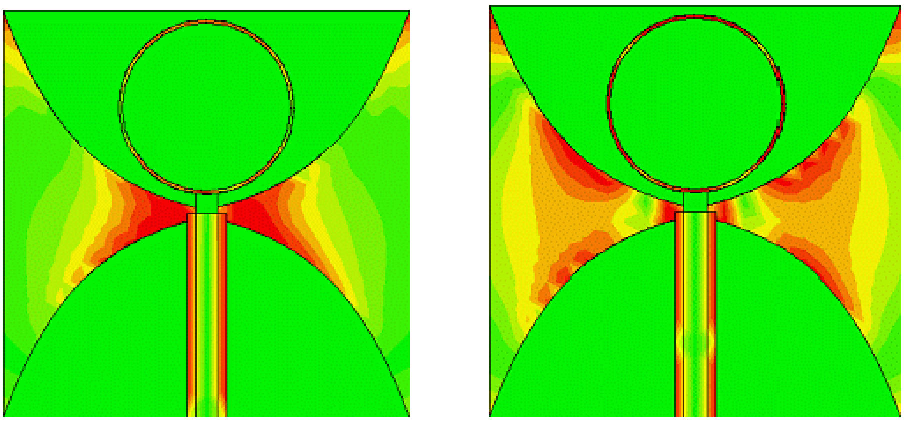
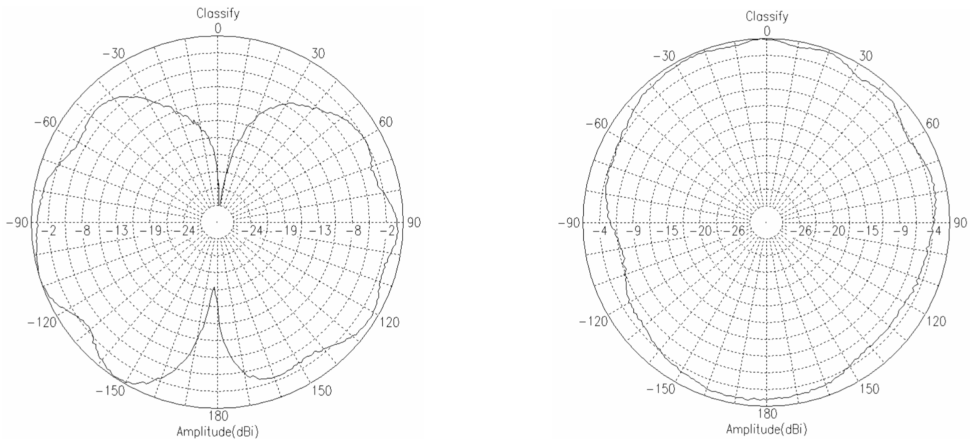



Fig. 4 Return loss of proposed antenna



$(a) TE_{10}$ $(b) TE_{20}$

Fig. 5 Tangential Electric Field of antenna




**Y-Z plane** **X-Z plane**

Fig. 6 Measured radiation pattern of antenna at 4.9GHz