A Compact Printed Antenna with Band-stop Characteristic for UWB Application

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Abstract — A Compact antenna with a band-stop characteristic for ultra-wideband application is proposed. To increase the impedance bandwidth of the proposed antenna, a tapered ground and circular slot are used. By attaching an inverted Y-shaped open-circuited stub in the circular ring, the band-stop characteristic is obtained. The designed antenna satisfies the voltage standing wave ratio requirement of less than 2.0 in the frequency between 3.12 GHz and 10.73 GHz while showing the band stop performance in the frequency band of 5.15 GHz to 5.78 GHz. This antenna shows an omnidirectional radiation pattern similar to that of a monopole antenna.

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1. INTRODUCTION

With the advent of ultra-wideband (UWB) communication system operating from 3.1 GHz to 10.6 GHz, there has been increasing demand for antenna capable of operating at an extremely wide frequency range. Planar monopole antennas have received much attention due to their attractive merits such as wide impedance bandwidth, simple structure, and omnidirectional radiation pattern [1, 2]. However, due to the size limitation, additional efforts to miniaturize the total size are needed to incorporate an antenna inside portable terminals such as PDAs, laptop computer, and so on.

Since the existing wireless LAN service band (5.15 GHz–5.825 GHz) overlaps the UWB service band, UWB radio signal can interfere with those of WLAN band service. To overcome this problem, UWB antennas with good band-stop performance are necessary. Several UWB antennas with the band-stop characteristic have been proposed [3, 4].

In this paper, the design of a compact printed antenna with band stop characteristic for UWB application is presented. To achieve the wideband characteristic, a circular slot and tapered ground are used. Band-stop characteristic is achieved by attaching an inverted Y-shaped open-circuited stub in the circular ring. The design procedure is described, and simulated and measured results are presented.

2. ANTENNA DESIGN

The configuration of the proposed antenna is shown in Figure 1. The antenna is printed on the

![Figure 1: Geometry of the proposed antenna.](image1)

![Figure 2: Simulated VSWR for different R_slot.](image2)
FR4 substrate with height (h) of 1.6 mm and relative permittivity of 4.4 and has a dimension of 18 mm × 20 mm (W_{sub} × L_{sub}).

The antenna consists of annular ring patch, tapered ground and an inverted Y-shaped open-circuited stub. In this antenna design, a 50 Ω microstrip feed line is used to excite the annular ring patch. The radius (R_{slot}) of an annular ring slot is a key factor to control the impedance bandwidth at higher band and the gap distance (G_{gap}) of a tapered ground is a prime element to decide the impedance bandwidth at lower band. To obtain the band-stop characteristic, an inverted Y-shaped open-circuited stub is attached to the circular ring. A band-stop characteristic is controlled by the length of an inverted Y-shaped open-circuited stub.

3. SIMULATIONS AND MEASUREMENTS ANALYSIS

The antenna is modeled numerically by using Ansoft’s High-Frequency structure simulator (HFSS) [5]. Figure 2 shows the simulated VSWR characteristic of a proposed antenna for different circular slot radii (R_{slot}). In this design, the circular slot provides the mechanism to enhance the impedance bandwidth for the higher band. Figure 3 shows the VSWR characteristics for various value of G_{gap}. It is observed that the lower frequency is significantly affected by the variation in length G_{gap}. On the other hand, the higher band is insensitive to the change of G_{gap}.

![Figure 3: Simulated VSWR for different G_{gap}.](image)

![Figure 4: Simulated VSWR for various L_{s3}.](image)

![Figure 5: Measured VSWR for the proposed antenna.](image)

![Figure 6: Measure antenna gain.](image)

To further demonstrate the effect of an inverted Y-shaped open-circuited stub length on the band-stop frequency, an inverted Y-shaped stub is attached to the circular ring. Figure 4 shows the simulated results for the proposed antenna with various values of an inverted Y-shaped open-circuited stub length (L_{s3}). From the comparison of the results shown in Figure 4, one can conclude
that the band-stop frequency for the proposed antenna is controlled by an inverted Y-shaped open-circuited stub length, which functions as a half-wavelength resonant structure. Figure 5 shows the measured VSWR characteristic with and without an inverted Y-shaped open-circuited stub. After adding a circular slot and tapered ground, the measured bandwidth of the antenna ranges from 3.12 GHz to 10.73 GHz for VSWR less than 2. This antenna has band-stop band of 5.15 GHz to 5.78 GHz after an inverted Y-shaped open-circuited stub is attached to the circular ring.

Figure 5 presents the measured antenna gain. As shown in Figure 6, gain decreases drastically at the band-stop frequency of 5.47 GHz. The measured radiation patterns in the y–z plane and x–z plane at 4 GHz, 6 GHz and 9 GHz are illustrated in Figures 7(a), (b) and (c), respectively. Dipole-like radiation patterns in the y–z plane and nearly omni-directional radiation pattern in the x–z plane are observed for copolarization.

4. CONCLUSION

A compact antenna with band-stop characteristic has been proposed and implemented for UWB applications. The proposed antenna has a simple configuration and is easy to fabricate. To obtain the wide bandwidth characteristic, a circular slot and tapered ground are used. The dimensions of a circular slot and tapered ground were optimized by the parametric analysis and resulted in wide bandwidth performance from 3.12 GHz to 10.73 GHz. Furthermore, by attaching an inverted Y-shaped open-circuited stub into the circular slot, the band-stop characteristic is obtained in WLAN (5.15 GHz ~ 5.78 GHz) while the wide impedance bandwidth is maintained.

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REFERENCES