Ultra Wideband Antenna with Quad Band Rejection Characteristics

Asim Quddus[1], Rashid Saleem[2], Sabih ur Rehman[3], M. Farhan Shafique[4]
[1]Electrical Engineering Department, University of Engineering and Technology (UET), Taxila, Pakistan
asim.quddus@uettaxila.edu.pk
[2]Telecommunication Engineering Department, University of Engineering and Technology (UET), Taxila, Pakistan
rashid.saleem@uettaxila.edu.pk
[3]School of Computing and Mathematics, Charles Sturt University (CSU), Australia
sarehman@csu.edu.au
[4]Centre for Advance Studies in Telecommunication, COMSATS Institute of Information Technology (CIIT), Islamabad, Pakistan.
farhan.shafique@comsats.edu.pk

***Abstract*- A miniaturized Quad band-notch co-planar waveguide (CPW) ultrawideband (UWB) antenna is presented in this paper. The band-notch characteristics around S-band (2.70-3.10 GHz) and downlink C-band (3.70-4.20 GHz) are realized by etching meander-line and horizontal slot in radiating patch. Furthermore, by adding an extended stub and L-shaped slot on ground plane of the antenna, rejection in WLAN (4.90-5.75 GHz), and WPAN (6.60-7.40 GHz) is also achieved. The antenna system is realized on Rogers Duroid 5880 having compact dimensions of 28 x 30 mm^2. The proposed antenna achieves omni-directional radiation patterns while also providing rejection at desired notches.**

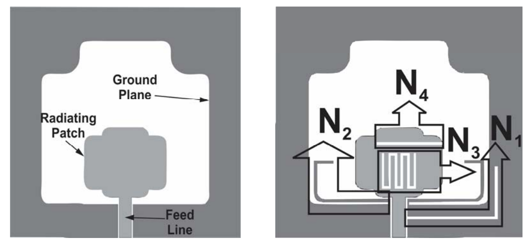
Index Terms: **Ultrawideband (UWB), Band-notch, WLAN, WPAN.**

1. Introduction

Ultrawideband System is a radio system having bandwidth of not less than 500 MHz. The US Federal Communication Commission (FCC) has allocated license free frequency band of 3.1 to 10.6 GHz for UWB. A large bandwidth of 7.5 GHz is suitable to achieve high data rate. The frequency range authorized for UWB transmission overlaps several narrow and wideband wireless standards. These wireless standards include S-band (2.7-3.1 GHz), downlink C-band (3.7-4.2 GHz), WLAN (4.9-5.75 GHz), WPAN (6.6-7.4 GHz) [1]-[3] including many others.

In antenna design, generally, aim is to reduce interference for co-existence of communication systems. Conventional filters in RF receiver may not be deployed owing to increase in complexity and size of circuitry. Interference mitigation can also be attained by applying band notching directly in UWB antenna. However, a suitable placement of these notching structures in ground, feedline and/or radiator is challenging.
Various techniques are reported for band notching. These techniques include but are not limited to slots, stubs, parasitic structures, fractals and defected ground structures [2]-[5]etc.

In this work, a CPW-fed stepped rectangular UWB antenna is presented, as shown in Fig. 1(a). Quad band-notch characteristics are achieved by introducing meander-lines and horizontal slot in radiating patch. While, to achieve other two notches an extended stub and an L-shaped slot is introduced in the ground plane of proposed antenna, as shown in Fig. 1(b).



(a) UWB Antenna (b) Quad band-notch antenna
Fig. 1.Proposed UWB antenna

Finite Element Method (FEM) based simulation in Ansys High Frequency Structural Simulator (HFSS) is employed to design and simulate proposed antenna. The radiating patch includes meander-line and horizontal slots to attain band-notch characteristics at S-band, and downlink C-band. Other two notches at WLAN and WPAN spectrum are achieved by an extended stub and an L-shaped slot on ground plane. The layout of the rest of this paper is as follows: in Section 2 antenna design and configuration is presented, simulated results are discussed in Section 3, and finally Section 4 concludes the paper.

2. Antenna Design and Configuration

(1) Antenna Structure

The geometry of proposed antenna structure is demonstrated in Fig. 2. The main radiator structure consists of a stepped-rectangular-patch having round edges, while a ground plan consists of a slotted stepped-rectangular shape with curved inner edges. The antenna is printed on Rogers Duroid 5880 with thickness 1.524 mm, relative permittivity (ε_r = 2.2) and an overall size of 28 mm × 30 mm. The radiating patch as shown in Fig. 1(b) consists of N_3 and N_4, designed to attain band-notch characteristics at S-band, and downlink C-band while WLAN and WPAN spectrum notching is achieved by adding an N_2 stub and etching out N_1 slot. The proposed antenna is examined with and without band notch structure. The geometric configuration of proposed design with band notch structures is shown in Fig. 1.

(2) Effect of Notching Structures

The required band to be filtered out is determined by the effective length of the notching structure, as well as by the appropriate placement of the notch structure in feedline and/or radiating element. More importantly, the desired notch frequency depends on the current distribution on or around the slots. The notching at desired frequency bands can be obtained by adjusting resonant structure length as shown in equation 1 [4].

$$f_r = \frac{C}{4L\sqrt{\varepsilon_{eff}}} \tag{1}$$

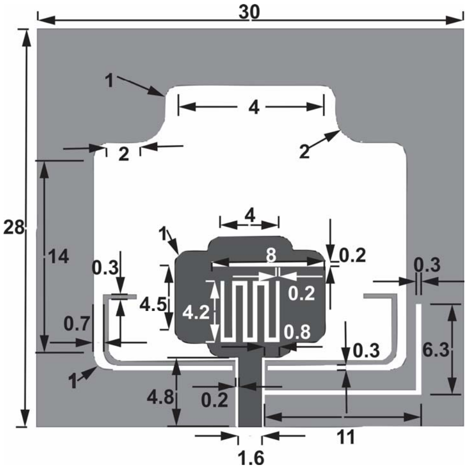


Fig. 2. Geometric structure of proposed quad band-notch antenna

3. Results and Discussions

(1) Impedance Match of Quad Band-Notch antenna

The quad band-notch antenna, shown in Fig. 1(b) provides interference mitigation to/from S-band (2.7-3.1 GHz), downlink C-band (3.7-4.2 GHz), WLAN (4.9-5.75 GHz), and WPAN (6.6-7.4 GHz). The antenna impedance match with and without quad band-notch characteristics is presented in Fig. 3. An impedance match for 2.6-12 GHz, except the four intended bands, is depicted in Fig. 3.

(2) Gain and Efficiency of Quad band-Notch Design

In general, it is desirable to have lower gain and efficiency at notching frequencies. The simulated gain and efficiency results are shown in Fig. 4. The gain varies from 1.5 to 4.75 dBi with gain values of -4.1dBi, -0.6 dBi, -1.54dBi and -5.7dBi at respective notch frequencies.

(3) Radiation Characteristics

The H-plane and E-plane radiation patterns of proposed antenna at 4 GHz, and 8 GHz are shown in Fig. 5. The radiation patterns are directional in E-plane and omnidirectional in H-plane, within the allowable limits, over the UWB frequency band.

4. Conclusion

A miniaturized CPW-fed UWB antenna with quad band-notch characteristics is proposed. A stepped rectangular patch with round edges having rectangular slotted ground plane provides bandwidth of 2.6-12 GHz. The notching characteristics are achieved by etching out meander-line and horizontal slot in the main radiator, while two more frequency bands are notched by adding an extended stub and etching out L-shaped slot in the ground plane. These notching structures are tuned to mitigate the interference in S-band (2.70-3.10 GHz), downlink C-band (3.70-4.20 GHz), WLAN (4.90-5.75 GHz), and WPAN (6.60-7.40 GHz).

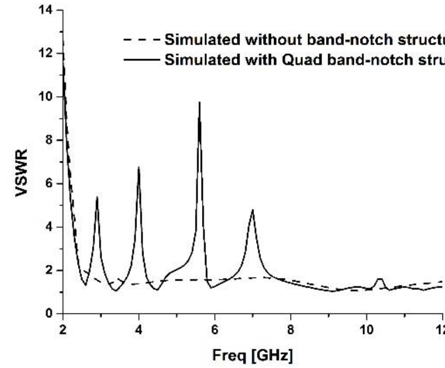
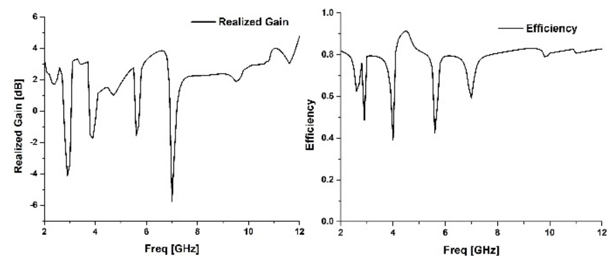
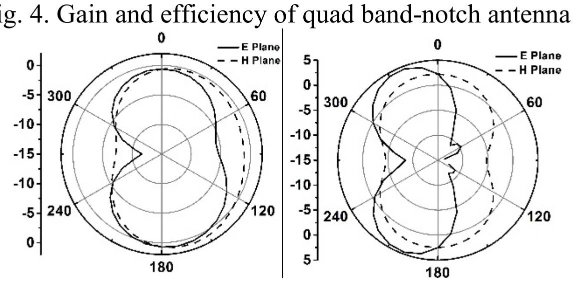


Fig. 3. Impedance match of proposed antenna with and without band-notch structure



(a) Gain (b) Efficiency

Fig. 4. Gain and efficiency of quad band-notch antenna



(a) (b)

Fig. 5. H-Plane and E-Plane Radiation patterns at (a) 4 GHz (b) 8 GHz

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