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Research Article

Design and analysis of Double Trident Slotted Microstrip Patch Antenna for UWB Systems

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Abstract

A microstrip patch antenna loaded with a double trident shaped slot fed with microstrip line is presented in this paper. The proposed antenna operates for the ultra-wideband over 3.966GHz to 10.033 GHz for S11 < 10 dB. The antenna provides the impedance bandwidth of 6.067 GHz with return loss of -21.9022 dB at 4.6644 GHz and -25.6118 dB at 8.9597 GHz. Good return loss, VSWR and radiation pattern characteristics are obtained in the desired frequency band. The antenna also operates with acceptable values of VSWR (<2) in C band and X band respectively.

Keywords: *Microstrip patch antenna, UWB, truncated ground plane.*

1. Introduction

Wireless communication systems are now becoming very popular. However, the technologies need much improvement to satisfy the higher resolution and data rate requirements. That is why ultra-wideband (UWB) communication systems covering from 3.1 GHz to 10.6 GHz released by the FCC in 2002 (FCC First Report and Order, 2002) are currently under development. Hence, the need for bandwidth enhancement arises with acceptable values of return loss and VSWR. Simple empirical models have also been proposed to determine the lower-edge frequency for a planar monopole with various planar geometries such as square, circular, trapezoidal and triangular (Ammann, 1999), (Ammann, *et al*, 1999), (Chen, 2000). These antennas can assume any shape of patch such as rectangular, circular, triangular, square etc. One of key issues in UWB communication systems is to provide wideband characteristic over the whole operating band using a compact antenna.

Due to their appealing features of wide bandwidth, simple structure, omnidirectional radiation pattern, and ease of construction several wideband monopole configurations, such as circular, square, elliptical, pentagonal, and hexagonal have been proposed for UWB applications (Chen, *et al*, 2003), (Agrawall, *et al*, 1998), (Daviu, *et al*, 2003). But the issue is that these structures are not suitable for integration with printed circuit boards because they do not have planar structures. Thus, a microstrip-fed monopole antenna is suitable candidate for integration with hand-held terminal owing to its attractive features such as low profile, low cost, and light weight (Jung, *et al*, 2005) which makes size reduction and bandwidth enhancement a major design considerations for practical applications of microstrip antennas (Wong, 2002).

In this paper, a novel compact ultra-wideband microstip-fed monopole antenna is presented. For achieving the maximum impedance bandwidth, two notches are placed at the two lower corners of the patch and a double trident shaped slot is also provided on the patch. The simulation of proposed antenna design has been done using HFSS software.

2. Antenna Configuration

Figure 1 shows the configuration of the proposed wideband monopole antenna which consists of a rectangular patch with two notches at the two lower corners of the rectangular patch, a double trident shaped slot at the center of the rectangular patch and a truncated ground plane with the notch structure. The proposed antenna is designed using FR4 substrate with dimensions18 x 16 x 1.6 mm3 and relative permittivity of 4.4 mm and the height of the substrate is 1.6 mm. The length (*L*) and the width (*W*) of the rectangular patch are 6 mm and 2 mm respectively. The length (*Lf*) and the width (*Wf*) of the microstrip feed line are 11 mm and 7 mm respectively. Two identical notches are provided at the lower end of patch having same length Ln1 to be 2mm and same width Wn1 to be 1mm. Enhancement in impedance bandwidth can be achieved because the two notches affect the electromagnetic coupling between the rectangular patch and the ground plane (Su, *et al*, 2004).

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A truncated ground plane is used to achieve good wideband matching and has been modified with a notch to control the impedance bandwidth of the monopole antenna. The length (*Lg*) and the width (*Wg*) of the truncated ground plane are 3 mm and 16 mm. The length of notch at ground plane Ln2 and width of notch at ground plane Wn2 are 0.75 mm and 4 mm respectively. The proposed double trident slotted microstrip patch antenna and the double trident slot are shown in Figure 1 and Figure 2 respectively.

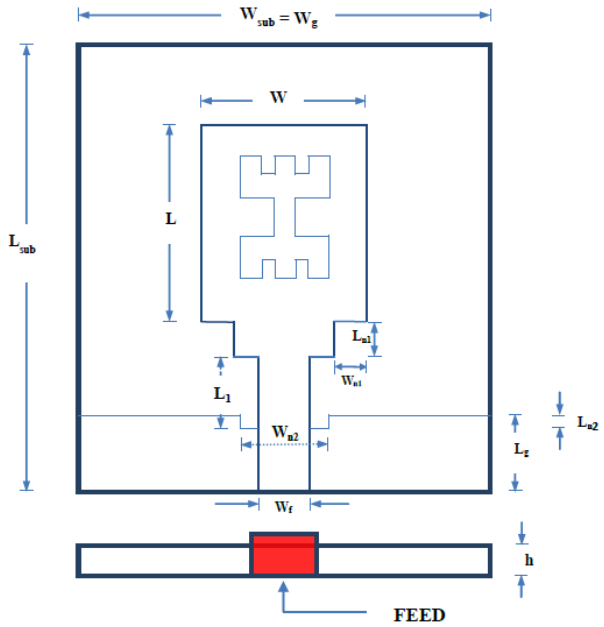


Fig.1 The Geometry of proposed antenna

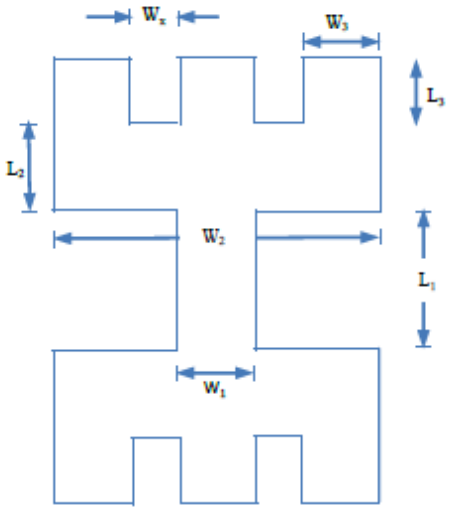


Fig.2 Double trident slot on the patch

Simulation

The simulated results are obtained using the Ansoft simulation software high-frequency structure simulator (HFSS). This software is widely used in determining the antenna parameters like return loss, VSWR, current distribution and radiation pattern.

Figure 3 shows the return loss characteristics of the proposed antenna designed and simulated. The proposed antenna provides a return loss of -21.9022 dB and -25.6118 dB at 4.6644 GHz and 8.9597 GHz respectively.

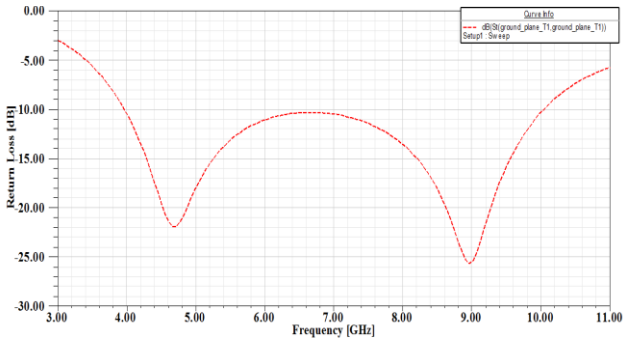


Fig.3 Return Loss of the proposed antenna

The voltage standing wave ratio (VSWR) obtained for this antenna are 1.3985 at 4.6644 GHz and 0.9113 at 8.9597 GHz. Figure 4 shows measured and simulated VSWR characteristics of the proposed antenna.

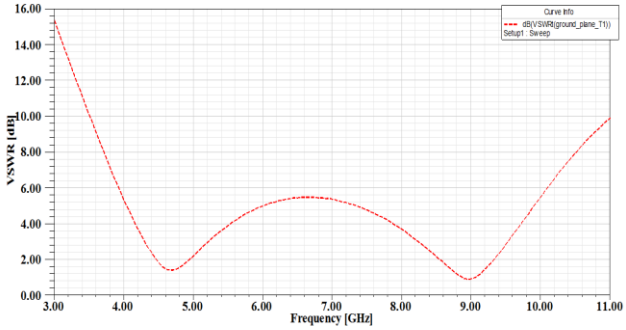


Fig.4 VSWR of the proposed antenna

Figure 5 shows the current distribution of proposed antenna.

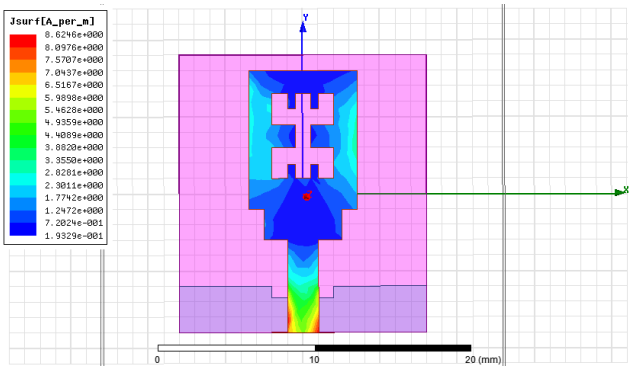
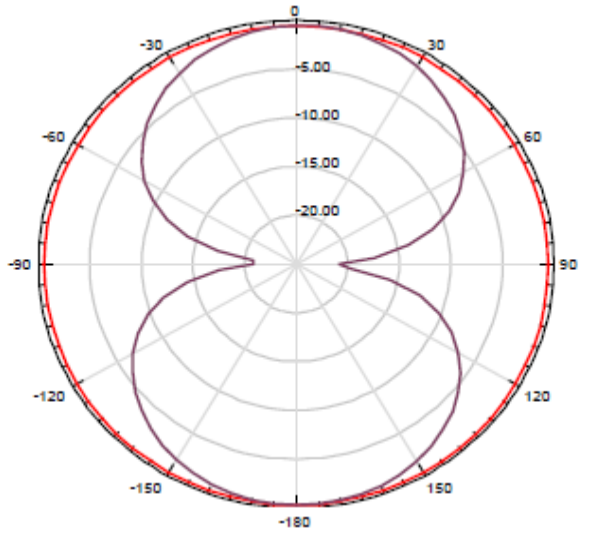
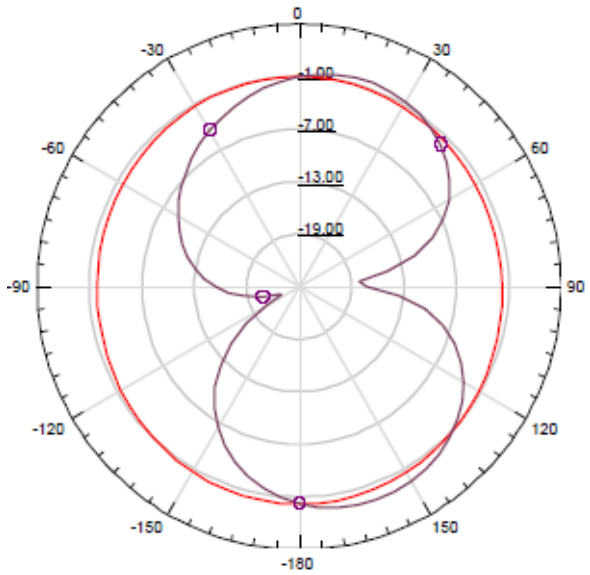


Fig.5 Current distribution of the proposed antenna

The Radiation pattern of the proposed antenna shows good Omni-directional pattern in xy-plane at 4.6644 GHz and at 8.9597 GHz for ϕ=0° and ϕ= 90° and is shown in Figure 6(a) and 6(b) respectively.



(a)



(b)

Fig.6 Radiation Pattern of proposed antenna in xy-plane at (a) 4.6644 GHz (b) 8.9597 GHz

Conclusions

A novel trident-shaped slotted microstrip patch antenna for achieving a very wide impedance bandwidth has been proposed. A very wide impedance bandwidth of about 6.067 GHz (3.966 GHz to 10.033 GHz) has been achieved for the proposed antenna enabling it to be a good candidate for hand-held UWB application. The proposed antenna meets the -10 dB return loss requirement from 3.1 to 11 GHz and provides good antenna characteristics like return loss, VSWR and radiation patterns.

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