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A Tapered Fork-Shaped Antenna With Small Ground Plane for UWB Applications

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ABSTRACT

A tapered fork-shaped antenna having small ground for ultra-wide band (UWB) antenna is proposed in this paper. Finite element method has been successfully employed to simulate and optimize the feed line, ground, and tapered fork-shaped diameter to enhance the performance of the antenna in terms of bandwidth obviously for the ultra-wideband purposes. An acceptable impedance matching performance has been achieved, which is a band wider than the UWB band that is defined by the Federal Communications Commission (FCC). In this paper, the detailed design parameters including the key elements in bandwidth enhancement is presented. The results of the finite element simulations have been presented as well indicating the return loss and radiation pattern of the proposed antenna.

KEYWORDS

Radiation Patterns, Return Loss, Small Ground Plane, Tapered Fork Shaped Antenna, UWB

1. INTRODUCTION

Recently, there has been much interest in developing high data transfer rate systems, which are known as UWB (Ultra Wide Band) communication systems. Since the FCC released a 10-dB bandwidth of 7.5 GHz (3.1-10.6 GHz) with an effective isotropic radiated power (EIRP) and a spectral density of -41:3dBm/MHz for communication applications, UWB technology has been receiving a great deal of attention from various academic and industrial sectors (Federal Communications Commission, 2002).

A lot of interest has been generated in the research and development of UWB short range wireless communications, remote sensing, radar imaging and localization applications, which is due to the introduction of an extremely wide spectrum of 3.1-10.6 GHz for commercial applications. In recent days, numerous planar antennas have been proposed and explored because of their advantages. As such, some of these planar antennas with ultra-wideband characteristics have been reported in (Amro et al., 2016; Bostani, 2017; Bostani & Denidni, 2009; Ching et al., 2007; Clerk et al., 2005; Evans & Ammann, 2003; Fezai et al., 2015; Gopikrishna et al., 2007; Nour et al., 2016; Wu et al., 2008; Yin et al., 2008).

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The advances in the field of ultra wideband had been so significant that the details in the design is finding more attention in the publication (Alsath & Kanagasabai, 2015; Bekasiewicz & Koziel, 2016; Kim et al., 2005; Liang et al., 2005; Zhu et al., 2016). The focus had been on miniaturization on one side and on the art effects in the structure on the other side (Amini et al., 2015; Islam et al., 2015; Vendik et al., 2017).

Obviously, the innovations in the structure will translate into the changes in the performance. Looking at the impedance matching performance, some of the new designs are focusing on rejecting part of the band as there is a great deal of interference in some frequencies within the FCC allocated UWB band (Li et al., 2016). The new industrial scientific and medical (ISM) band at 5.8 GHz is one of those examples that the antennas with the band notch always try to avoid that band (Bakariya et al., 2015; Dastranj, 2017; Yadav et al., 2016). They adjust the structure the way that a built-in filter stops the unwanted frequencies whether it is in the ISM band or any other known band for particular purposes for specific applications and associated spectral management.

One of the key issues faced in UWB communication systems is the design of a compact antenna, while achieving wideband operation over the entire UWB spectrum. Various wideband monopole configurations have been introduced (circular, elliptical, square, hexagonal and pentagonal) for UWB application due to their structure simplicity, omni-directional radiation pattern features and ease of fabrication. Bluetooth and WLAN are some of the many applications that take advantage of license-free frequency of operation in the Scientific, Industrial and Medical (ISM) bands, besides UWB.

In this paper, detailed description and the simulation results of the proposed antenna design will be presented in Sections 2 and 3, respectively. Finally, Section 4 will present the conclusion.

2. ANTENNA DESIGN

Figure 1 presents the configuration of the proposed wideband antenna, which consists of a tapered fork shaped patch with rectangular ground. The proposed antenna, which has dielectric dimension of 69 mm × 69 mm, is constructed on FR4 substrate with thickness of 1.6 mm and relative dielectric

Figure 1. Configuration of the proposed UWB antenna