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A compact band-notched antenna with high isolation for UWB MIMO applications

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Abstract

A compact antenna module with a single band notch at wireless local area network (WLAN) (5.725–5.825 GHz) for ultra-wideband (UWB) multiple input multiple output (MIMO) applications is proposed. Proposed antenna which acquires size of $0.299\ \lambda \times 0.413\ \lambda \times 0.005\ \lambda\ \text{mm}^3$ at 3.1 GHz consists of two symmetrical radiators placed side by side on global merchandise link (GML) 1000 substrate ($\epsilon_r = 3.2$, $\tan\delta = 0.004$). Isolation between the antenna elements is >18 dB in the whole UWB band, which is achieved by introducing the vertical stub and H-slot between the monopole radiators in the ground plane. The simulated and measured results of the antenna system are in good agreement. The proposed antenna covers entire UWB with impedance bandwidth ($|S_{11}| < -15$ dB) from 3.1 to 11 GHz except at WLAN notched band. The designed antenna module bears low envelope correlation coefficient and minimal multiplexing efficiency hence fulfilling criteria suitable for various wireless MIMO applications.

Introduction

Multiple input multiple output (MIMO) and ultra-wideband (UWB) are the key technologies in this era leading to the rapid development of wireless communication systems. MIMO is a technique, which deploys multiple antennas at input and output terminals of wireless communication systems. As a result, signal to noise ratio (SNR) as well as capacity/data rate of the communication system gets enhanced. MIMO also helps in the reduction of multi-path fading thus increasing the performance of the system [1]. The major problem faced in designing the MIMO antenna system is the electromagnetic isolation between various antenna elements taking into consideration the availability of limited space [2].

UWB is a short-range communication technology, which operates in the frequency band (3.1–10.6 GHz). US-FCC (Federal Communications Commission) allocated this frequency band in 2002 and made this band unlicensed. UWB suffers from the chance of interference due to various parasitic narrowband communication systems such as worldwide interoperability for microwave access (WiMAX) (3.3–3.8 GHz) and wireless local area network (WLAN) (2.4–5.85 GHz). Thus, in order to make UWB communication reliable, antennas should possess band-notch characteristics.

The main factors that yield to the efficient designing of UWB MIMO antenna are high impedance bandwidth, less coupling which results in high isolation, low envelope correlation coefficient, and high diversity gain [3]. Till now, various UWB MIMO antennas with band-notched characteristics have been designed to achieve better wideband and isolation characteristics between various antenna elements [4–7]. In [8], band notching is obtained at WiMAX and WLAN frequencies by inserting an open-ended slot on the radiator and an inverted U-shaped slot on the ground plane. Isolation at lower frequencies (3–4.5 GHz) of UWB antenna has been achieved by introducing a narrow slot in the ground plane [9]. In [10], WLAN band-notched UWB MIMO antenna is proposed consisting of two orthogonally placed antenna elements thus achieving 18 dB electromagnetic isolation.

This paper presents a compact WLAN band-notched UWB antenna with an overall size of $29 \times 40 \times 0.508\ \text{mm}^3$ for MIMO applications. The vertical stub in the ground plane is introduced in order to decrease the mutual coupling between antenna elements. The antenna module acquires impedance bandwidth from 3.1 to 11 GHz and isolation/decoupling of more than 18 dB over the entire operating frequency band. Split ring resonator (SRR) is introduced in order to achieve the notched characteristics at WLAN band. Also, the proposed antenna attains very low envelope correlation coefficient (ECC) value of <0.0005 in the whole operating band except at the notched band thereby decreasing loss in multiplexing efficiency.

Two element UWB MIMO antenna design and analysis

All full-wave antenna simulations were done in computer simulation technology Microwave Studio® Software. Proposed antenna module consists of two symmetrical cup-shaped