UWB antenna with notched band at 5.5 GHz

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Introduction: Ultra-wideband (UWB) technology being a high-speed short distance wireless communication system has attracted much attention both in industry and academia. Much research has already been done in the field of UWB and much effort has been made in the design of UWB antennas. Although UWB is allocated to operate within the frequency spectrum of 3.1–10.6 GHz, it shares a part of its spectrum with the high-powered narrow band of IEEE 802.11a WLAN and HIPERLAN/2, operating in the 5.15–5.825 GHz band. This narrow band can cause a potential interference with UWB resulting in severe degradation of system performance. One primary solution to this problem is to use several spatial filters that can filter out the interfering narrow band/s. The other effective, simple and commonly used solution is to design antennas that are capable of filtering the problematic band, i.e. antenna with band notch characteristics. Different techniques have already been proposed to realise antennas with band notch characteristics. The conventional technique to realise notched band is to etch different types of slots in the radiating elements or in the ground plane [1, 2]. Alternatively, uses of parasitic elements, split ring resonator and electromagnetic bandgap structure have also been reported [3–5]. For example, a tapered slot antenna with a band-notched function was proposed in [2]. By inserting an Archimedean spiral slot into the microstrip-slot-line transition, the antenna with an overall dimension of 50 × 50 mm achieved UWB performance with a notched band of 4.6–6.2 GHz. In [4], a planar monopole antenna with standard band-notch characteristics was proposed. A coupling strip was placed at the centre of the patch to create a notch band of 5.12–6.08 GHz. In [5], Yoon et al. proposed a compact band-notched ultra-wideband antenna. To achieve the notched frequency band of 4.85–6.04 GHz, an inverted L-slit was embedded at the edge of the radiating patch. The antennas proposed in [2, 4, 5] features with large size and the achieved notched band for WLAN is higher than the required band of 5.15–5.825 GHz resulting in degradation of received information and lower signal quality.

In this Letter, a compact planar slot antenna with a notched band at 5.5 GHz is proposed for UWB applications. Two symmetrical parasitic slits are etched in the slot of the ground plane to create the desired notch band. By adjusting the size and position of the strips, it is found that with a compact profile, the proposed antenna achieved an ultra-wide operating band with a notched band of 5.1–5.81 GHz. The antenna exhibits symmetric radiation characteristics with good gain, except at the notched band.

Antenna specification and design: The design and specification of the proposed antenna are depicted in Fig. 1. Fig. 1a illustrates the top view of the basic UWB antenna which consists of a microstrip line fed rectangular radiating patch and a ground plane with a tapered shape slot. The radiating patch is fabricated on one side of 22 mm × 24 mm FR4 substrate of dielectric constant 4.6 and thickness 1.6 mm, while the ground plane is printed on the other side. The length and width of the microstrip feed line at the input port are fixed at 6 and 3 mm, respectively, in order to attain 50 Ω characteristic impedance. The tapered shape slot in the ground plane reduces the slot area and has a strong coupling with the radiating element, and helps to achieve sufficient impedance to cover the entire ultra-wideband (as shown in Fig. 4).

Experimental results: A prototype of the proposed antenna was fabricated with optimised parameters and the performance was measured in an anechoic chamber using Agilent E8362C vector network analyser. Fig. 4 depicts the simulated and measured VSWRs along with the VSWR of the antenna without notched band. Good agreement has been observed between simulated and measured results. The measured result shows that the proposed antenna is characteristic with ultra-wide operating bandwidth (VSWR ≤ 2) ranging from 3.08 to more than 11 GHz with a notched band of 5.11–5.81 GHz. This notch band can successfully minimise the potential interference between UWB and WLAN systems. Slight discrepancy in the results is mainly due to fabrication errors and fluctuations of the substrate’s relative permittivity.
The realised peak gain of the proposed antenna is depicted in Fig. 4. A relatively flat gain is observed over the entire operating band, except in notched band which exhibits significant reduction in its magnitude. The measured \(xz\) \((E)\)- and \(yz\) \((H)\)-plane radiation patterns of the proposed antenna at 3.6, 5.5 and 8 GHz are illustrated in Fig. 5. It is observed from the plot that the radiation patterns are omnidirectional and stable in \(yz\)-plane. In \(xz\)-plane patterns, two nulls have been observed in broadside direction and the patterns are similar to that of monopole antennas. It is also noted from the patterns that at notched frequency of 5.5 GHz, the gains are uniformly suppressed in all directions which clearly indicates the effect of filter structure.

Conclusions: The design and prototyping of an UWB slot with band notch characteristics is proposed. By etching two symmetrical parasitic slits to the antenna structure, it is found that the proposed design can successfully create a notched band for WLAN without altering the basic antenna size. The notched band can be controlled and adjusted by properly selecting the length and position of the slits and insertion of these slits does not affect antenna performance much, except at notched band. Measured results confirmed that the proposed antenna achieved ultra-wide operating band with a notched band at 5.5 GHz and can solve interference problem caused from WLAN. The features of compact profile, wide bandwidth, omnidirectional radiation patterns and good gain, except at the notched band, makes the proposed antenna a good candidate for practical UWB applications.

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2 May 2013
doi: 10.1049/el.2013.1476
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References