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Reactively Loaded CPW Fed Dual Notched Pentagonal Ultrawide Band Antenna

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ABSTRACT: This research proposal includes the design of a unique coplanar waveguide (CPW) fed ultra-wideband (UWB) antenna prototype with dual notch band characteristics. The microstrip line fed antenna features a configuration of geometric slots, including a rectangle, a semi-circle slots, and a pentagonal stub, along with a microstrip feedline. The antenna measures 35.4 mm × 28.82 mm. Two notches are introduced at 5 to 5.8 GHz (14.8% bandwidth) and 7.2 to 7.8 GHz (8% bandwidth) by incorporating split ring resonators (SRRs) on the bottom surface. Aside from the dual stopbands for the WLAN band (5 to 5.8 GHz) and SHF satellite communication band (7.2 to 7.8 GHz), the designed antenna operates over an impedance bandwidth from 3 GHz to 11.2 GHz with voltage standing wave ratio (VSWR) below 2. The proposed antennas have been developed, prototyped, and successfully verified. Simulation data and measurement results are thoroughly examined and analyzed. To confirm the applicability of the antenna in pulsed communication systems, the correlation among the input signal of the transmission antenna with the output signal of the reception antenna in the time domain is estimated. This confirms that the antenna prototype is well suited for wireless communication applications in military radar systems, medical imaging, consumer electronics, and more.

1. INTRODUCTION

As the constraints of integrating various sub-systems in a single compact communication system emerge, the development of a UWB antenna with notch characteristics, as one of the fundamental microwave components and operational at multiple frequencies, is becoming significant. As Federal Communication Commission (FCC) unlicensed the UWB range from 3.1 Gigahertz to 10.6 Gigahertz, UWB wireless technology has gained a lot of momentum in research [1]. Square, circle [2], crescent [3], sectoral [4], ellipse [5], and their re-structured varieties are normally employed radiating patch structures in UWB planar antennas because they can be easily combined with microwave integrated circuits that are lightweight and have low profile in nature. Other applications such as WiMAX, WLAN, IEEE 802.16, IEEE 802.11a, and ITU-T frequency bands exist in the UWB spectrum. As a result, a UWB antenna with notched frequency responses is designed to reduce the likelihood of interference between narrowband and UWB systems.

In [6], a miniaturized antenna for ultra-wideband applications is presented. To achieve a compact size, the authors use a two-stage optimization process. First, a coarse-mesh electromagnetic simulation identifies promising initial designs with good signal return. Then, a more advanced optimization refines the design for excellent performance across the entire ultra-wideband range, within an overall dimension of 418 mm^2. In [7], a miniaturized ($22 \times 22\,mm^2$) circular slot antenna is presented for ultra-wideband communication (3–16 GHz). Designed for a common circuit board material (FR4), the antenna efficiently reflects minimal signal back across the entire usable frequency range (reflection coefficient below -10 dB), making it suitable for stable UWB applications. In [8], a modified U-shaped UWB antenna with a reverse T shaped slot is demonstrated. To ensure that the antenna efficiently transmits and receives signals across the UWB, the design incorporates a narrow strip in the patch and an inverted T-shaped slot in the ground plane. The paper verifies the antenna's performance through S-parameters (indicating good impedance matching) and radiation pattern analysis. In [9], a coplanar waveguide (CPW) fed UWB microstrip antenna is developed by loading an inverted L-strip. Simulations and real-world testing of the fabricated antenna ($25 \times 25 \times 1.6\,mm^3$) demonstrate good agreement, with the antenna achieving strong performance across a wide band (2.6–13.04 GHz) in terms of impedance matching, gain consistency, radiation patterns, and signal delay. In [10], a miniaturized antenna is reported for ultra-wideband applications (3–12.9 GHz) using a coplanar waveguide feed. The key to its wide bandwidth is a novel radiating structure with two asymmetric U-shaped strips and a staircase element. Despite its compact size ($23 \times 25.5 \times 1.6\,mm^3$), the antenna achieves excellent performance with a strong signal return, stable gain, and near-omnidirectional radiation, all confirmed by good agreement between simulations and real-world testing. In [11], a UWB antenna design based on a modified circular disc monopole is proposed. The design uses a three-step adjustment process on the ground plane to achieve a wide bandwidth (3.1–10.6 GHz) with good impedance matching. Testing confirms the antenna's effectiveness for UWB applications,

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