CHAPTER 48

ELECTRONIC & COMMUNICATION ENGINEERING

Doctoral Theses

01. BAJAJ (Chandni)
Design and Analysis of Resonant Antennas for RFID Applications.
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Abstract

Radio frequency identification (RFID) plays a vital role in automated identification and connectivity of devices in an Internet of Things (IoT) network. An efficient long-range RFID reader is a major requirement to detect tagged-objects with maximum accuracy. The efficiency of the reader depends on the characteristics of the integrated or externally-connected antenna. Initially, a stacked-configuration is adopted to increase the gain of the antenna in the UHF/2.45 GHz bands without increasing the profile of the antenna. Thereafter, CP is introduced to the design by adding a feed network and making changes to the previous design. The new design is a three-layer structure with a feed element in the bottommost substrate. To fulfil the need of a rather simpler way of achieving CP while keeping the structure compact, cross-dipole technique is adopted for the design of the antenna. In this technique, the orthogonal dipole elements are crossed on the top and bottom layer of the substrate. Using this design approach, a UHF/2.45 GHz cross-dipole antenna is designed using two dipole pairs. Thereafter, To achieve even higher data rates, a 2.45/5.8 GHz antenna is proposed using two dipole pairs. Further, to improve the tag-detection accuracy of the reader in both indoor as well as outdoor applications, a GPS-L1 band is added along with UHF/2.45/5.8 GHz bands. However, above-mentioned cross-dipole configurations suffer from low peak gains which will lead to smaller reading range of the readers. To enhance the gain of the cross-dipole RFID reader antennas, artificial magnetic conductor (AMC) surfaces are integrated as reflectors in the configuration. A single band UHF antenna is integrated with a UHF 5 x 5 AMC array reflector surface. Introduction of AMC reflector results in peak gain enhancement of 5.91 dB at 900 MHz. Consequently, a dual band (2.45/5.8 GHz) cross-dipole antenna is integrated with a dual band AMC array surface. The metasurface backing results in gain enhancements of 4.1 dBi in the 2.45 GHz band and 4.6 dBi in the 5.8 GHz band. However, the mutual coupling between the dipole elements used to achieve different RFID bands is observed to be a gain-limiting factor in a multiband cross-dipole configuration. So, a single spiral-shaped dipole pair is used to achieve triple band (GPS-L1/2.45 GHz/5.8 GHz) characteristics in a cross-dipole configuration. However, in a real-time application like vehicular-to-infrastructure communication, a much higher reading range and 360° coverage of the interrogation zone of the RFID reader is required. Consequently, five AMC-backed cross-dipole antennas are integrated in the form of a cube resulting in a cubic metasurface-based array (CMSA) antenna.

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