Quasi-isotropic electrically small antennas for UHF-RFID passive tags based on 2-turns spiral resonators

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Most of the current RFID passive tags in the UHF band are based on resonant dipoles, which are usually meandered in order to reduce dimensions. The dipole antennas provide single linear polarization, which involves the existence of blind spots in some regions of the radiation pattern (Brouwer, *Proc. of KNAW*, 11, 850-858, 1909) (e.g. the dipole antenna has a toroidal radiation pattern with two nulls in the direction of dipole axis). Thus, passive tags are not detected when the reader is placed in the direction of a blind spot. To overcome this drawback, some passive tags use specific ASICs with two fully independent, differential inputs enabling isotropic (or quasi-isotropic) reading patterns. However, two orthogonal antennas are required to avoid blind spots. Consequently, more complex tags with increased dimension are required.

The goal of this work is to design passive UHF-RFID tags providing a quasi-isotropic reading pattern, by means of a single electrically small antenna. Several configurations of antennas were explored and studied. The 2-turns spiral resonator 2-SR (Baena *et al*., *Physical Review B*., 69, paper 014402, 2004) was analyzed to operate as an antenna, reaching good performance. The electric current distribution along the 2-SR provides an axial magnetic dipole moment, as occurs with small loop antennas. Moreover, the electric charge distribution in the 2-SR produces an electric dipole moment orthogonal to the magnetic dipole moment with a 90 degrees phase shift. Both electric and magnetic moments can be properly adjusted to obtain a quasi-isotropic radiation diagram. As a proof of concept, a 2-SR-based antenna was designed to be matched to a specific RFID ASIC. Furthermore, some reduction techniques were also put into practice to minimize the tag dimensions, maintaining its performance. The passive UHF-RFID tags were fabricated and the read ranges were measured, obtaining several meters.