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Series SRR loaded UHF RFID tag

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Abstract

An RFID tag based on a series loaded split ring resonator (SRR) to operate in the European UHF RFID band of 865-867 MHz is reported. A chip of impedance 27-j212Ω is connected at the terminals of the antenna and the read range measurements of the RFID tag are performed in the UHF RFID band. The proposed UHF tag exhibits appreciably good read range over a wide azimuth and elevation angular ranges.

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*Keywords:*UHF band;RFID; RFID Tag;SRR.

1. Introduction

Radio frequency identification (RFID) technology is a topic of recent interest and widespread popularity. The use of radio-frequency identification (RFID) systems in the ultrahigh- frequency (UHF) band is used in many applications and services, such as automatic identification, logistic management, asset tracking and security surveillance[1]. RFID has several benefits over the other automated identification methods such as a higher reading range, faster data transfer, and ability to simultaneously read a massive amount of tags.

An RFID tag consists of an antenna and microchip connected at its terminals. Proper antenna design for the RFID systems in the ultrahigh- frequency (UHF) band is a major challenge in the RFID tag design[2]. Many

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researchers have reported a variety of dipole and folded dipole fed RFID tags for the UHF band[3,4]. Numerous papers were reported on RFID tag design with modifications on the dipole antenna, whose arms are meandered to produce inductive reactance were reported[5,6]. Meandering helps to achieve conjugate match with chips impedance with a reduction in the overall size of the antenna. Maximum read range and orientation sensitivity are the two important RFID tag characteristics. In order to get optimum operating condition, the antenna impedance should be matched correctly to the chip impedance. A T- matching technique is also widely used in the design of RFID tags for proper impedance matching [7,8].

Recently few researchers introduced split ring resonators (SRR) models to produce better capacitive and inductance reactance in the RFID tag design .The effect of SRR structure in the miniaturization of the tag was discussed in[9,10]. SRR consists of two concentric metal rings separated by a gap and both having splits at opposite sides. Magnetic resonance is induced by splits at the rings and by the gap between the inner and outer rings. If the excitation magnetic field is perpendicular to the plane of the magnetic field so as to induce resonating currents in the loop and generate equivalent magnetic dipole moment.

In this paper we introduced a UHF RFID tag loaded with a Square Split ring resonator (S-SRR) to operate in the European UHF RFID band (865-867MHz). The S-SRR's are connected in series to form a printed dipole shown in Fig.1 produces the similar effect of a meander line for producing inductive input impedance which is required for conjugate impedance matching with the chip. This novel tag exhibits an appreciably good read range over a wide azimuth and elevation angular ranges.

Geometry and fabrication

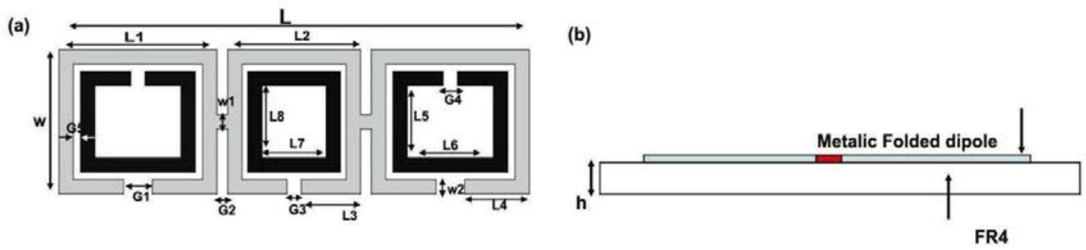

Fig. 1. (a) Structure of the UHF RFID tag; (b) side view.

The geometry of the proposed antenna is presented in Fig. 1.The tag antenna consist a series of S-SRR structures loaded to form a printed dipole. The design presented in this communication is much smaller in size than the meandered based designs. The S-SRR loaded in series reduces the overall size and produce inductive input impedance required for conjugate impedance matching with the chip. A chip of impedance 27-j212Ω at 866 MHz is connected at the terminals of the proposed antenna. The tuning of the tag antenna and the series connected S-SRR parameters are carried out with the CST Microwave studio and the optimized parameters of the proposed RFID tag antenna is shown in the Table 1.

Table 1.Dimensions for the Proposed Antenna.

Parameters	L	L1	L2	L3	L4	L5	L6	L7	L8
Values(mm)	65	22	18	8.25	9	10	12	8.9	10
Parameters	W	W1	W2	G1	G2	G3	G4	G5	

Values(mm)	20	1.42	2	4	1.5	2	2	1

The series loaded S-SRR shaped RFID tag is printed on a 1.6 mm thick FR-4 substrate with relative permittivity $\varepsilon_r = 4.3$. Fig 2. Shows the photograph of fabricated UHF RFID tag loaded with series connected Split ring resonator (S-SRR) structure.

Fig 2. Photograph of the fabricated RFID tag with optimized parameters

The read range measurements are carried out with an STAIR0507E reader with a receiver sensitivity of -80 dBm and RF power of 30dBm with circularly polarized antennas. The tag is mounted on a movable platform with an arrangement for placing the tag for different azimuth and elevation angles. Placing the tag at a particular orientation, the read range is measured by moving the turn table with the tag to the maximum distance to which the tag can be read for that orientation.

Results and Discussion

The simulated results of the variation of real and imaginary input impedance along with that of the RFID chip of the tag antenna with frequency is shown in the figure 3. It can be seen from the graph that the real part of the antenna impedance at 868 MHz is 27 ohms and imaginary part of the antenna impedance at 868 MHz is 217 ohms which is close to the conjugate impedance of the RFID.

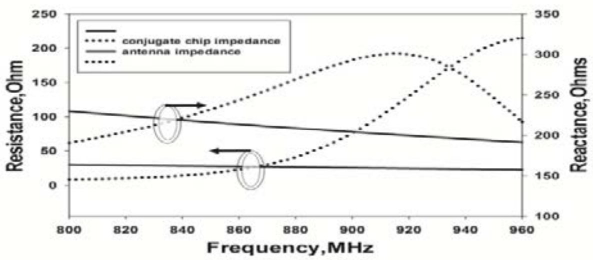

Fig. 3. Simulated input impedance variation with frequency for the proposed tag antenna and RFID chip

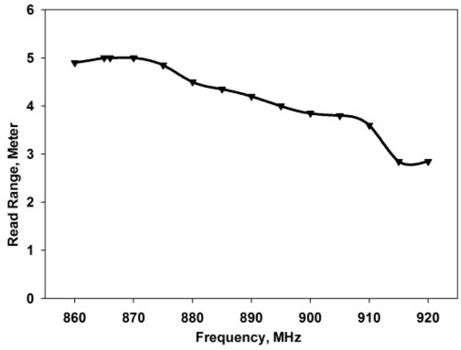

Fig. 4. Measured read range of the proposed tag antenna with frequency.

The read range for a frequency of 860MHz to 930MHz which covers the entire UHF RFID band so that it can be used globally. Fig 4. shows the read range for a frequency of 860MHz to 930MHz . It is evident from the figure that the proposed tag exhibits appreciable read range in both the European (866 MHz)and the North American(915 MHz) UHF RFID band. The measured variation of read range with the azimuth and elevation angles of the fabricated SRR loaded RFID tag is shown in the Figure.5.

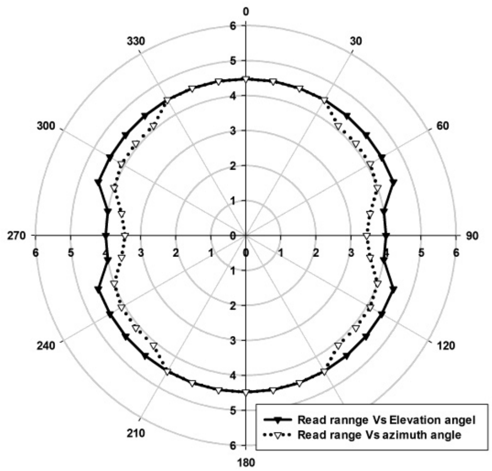

Fig. 5. Measured variations of read range with angles for the RFID tag at in the UHF band 866 MHz

Conclusion

The series SRR loaded UHF RFID tag with enhanced performance over the azimuth and elevation angular ranges is presented. The proposed UHF tag exhibits exhibits appreciably good read range over a wide azimuth and elevation angular ranges.

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