INTELLIGENT SYSTEM FOR DECOUPLING MULTIPLE RFID TAGS

Janez Trontelj

Faculty of Electrical Engineering, University of Ljubljana, Slovenia

Key words: informatics, ID, IDentification, RFID tags, Radio Frequency IDentification tags, electrical coupling, electrical decoupling, electrical crosstalk

Abstract: A novel approach to decoupling of multiple RFID tags has been presented. It consists of reducing the effective inductance of the tag resonant coil by switching on the part of coil to produce reverse mutual coupling. This happens when the tag is in inactive state. It has been shown that up to 50 tags positioned very close to each other can be accessed in one second without any crosstalk.

Inteligentni sistem za zmanjšanje sklopov med množico radiofrekvenčnih identifikacijskih kartic

Ključne besede: informatika, identifikacija, RFID kartice za identifikacijo s frekvencami radijskimi, sklop električni, razklop električni, presluh električni

Izvleček: Opisan je nov pristop za zmanjšanje sklopa med množico radiofrekvenčnih identifikacijskih kartic (RFID tag). Princip delovanja temelji na zmanjšanju induktivnosti resonančne tuljave kartice z vključitvijo dela tuljave na način, ki povzroči nasprotni znak sklopa. To se zgodi ker je kartica v neaktivnem stanju. Do 50 kartic, ki so zelo blizu skupaj je možno prebrati v eni sekundi, brez medsebojnega presluha.

1. Introduction

Tagging of articles for identification and/or theft protection is known. For instance, many articles are identified using a bar code comprising coded information, which is read by passing the bar code within view of a scanner. Many articles also include a resonant tag for use in theft detection and prevention. More recently, passive resonant tags which return unique or semi-unique identification codes have been developed. These tags typically include an integrated circuit (IC), which stores the identification code. Such "intelligent" tags provide information about an article or person that the tag is associated with and is detected in the zone of an interrogator or reader. The tags are desirable because they can be interrogated rapidly, and from a distance.

Radio frequency identification (RFID) tags or cards generally include a resonant antenna circuit electrically connected to the IC. The IC is essentially a programmable memory for storing digitally encoded information. The interrogator (transmit antenna) creates an electromagnetic field at the resonant frequency of the RFID tag. When the tag is placed into the field of the interrogator, an AC voltage is included in the resonant antenna circuit of the tag, which is rectified by the IC to provide the IC with an internal DC voltage. As the tag moves into the field of the interrogator, the induced voltage increases. When the internal DC voltage reaches a level that assures proper operation of the IC, the IC outputs its stored data. To output its data, the IC creates a series of data pulses by switching an extra capacitor across the antenna circuit for the duration of the pulses, which changes the resonant frequency of the tag, detuning the tag from the operational frequency. That is, the tag creates data pulses by detuning itself, which changes the amount of energy consumed by the tag. The interrogator detects the consumption of energy in its field and interprets the changes as data pulses.

Although such RFID tags or cards are known, there are still technical difficulties and limitations associated with the operation of such tags. One problem with attempting to read multiple RFID tags within an interrogation zone of the interrogator is that more than one tag may be activated by the interrogator at about the same time. When such tags are located proximate to each other, the fields generated by one tag can disturb the fields generated by another tag. This problem of mutual inductance is especially significant for RFID tags, which transmit their information by detuning, as described above. As a consequence, the reading distance drops and the modulation of the tag can become completely ineffective due to the fact that such modulation depends upon the tag being in resonance (or close to it). Thus, such detuning caused by other tags can make reading of stored information impossible or nearly impossible.

Yet another problem often encountered when reading intelligent tags or cards is a large variation in the received power, for instance, when the tag nears the power transmit antenna of the interrogator. As the tag approaches the transmit antenna, the received power increases, which can cause problems due to excessive voltage or power dissipation and, because of a decrease in tag Q, an inability to sufficiently modulate the tag with the data using the aforementioned detuning approach. Such detuning or modulation problems increase the difficulty of correctly reading the tag.

Accordingly, there is a need for a method of preventing RFID tags from generating fields, which disturb or affect other nearby resonant cards or tags. There is further a need

for a RFID tag whose operation is not adversely affected by large variations in received power. The present invention fulfils these needs.

2. Innovative solution for decoupling multiple RFID tags

The present solution is a radio frequency intelligent transponder. The transponder includes an integrated circuit for storing data and an inductor electrically connected to the integrated circuit. The inductor includes the first coil electrically connected to a second coil. A resonant capacitor is electrically connected to the integrated circuit and to at least one of the first and second coils, such that the resonant capacitor and the at least one connected coil have the first predetermined resonant frequency. A switch having a position A and a position B is provided for selectively allowing current to flow through the second coil. When the switch is in the first position, exposure of the transponder to an external field at or near the first resonant frequency induces a voltage in the inductor and causes the first current to flow through the inductor in the first direction, thereby generating a local field. When the switch is in the second position, exposure of the transponder to an external field at or near the first resonant frequency induces a voltage in the inductor and causes the first current to flow through the first coil in the first direction, thereby generating the first local field and the second current to flow through the second coil in the second, opposite direction, thereby generating a second local field. A sum of the first and the second local fields approaches zero.

The described solution is a radio frequency intelligent transponder comprising an integrated circuit for storing data and an antenna circuit. The antenna circuit comprises the first coil and a resonant capacitor having a predetermined resonant frequency electrically connected to the integrated circuit for providing power to the integrated circuit and for transmitting the data stored in the integrated circuit to a device reader. Exposure of the transponder to an external field at a frequency near the predetermined resonant frequency causes the first current to flow through the antenna circuit in the first direction, thereby producing the first local field, which couples the transponder with its environment. The transponder further comprises means for selectively generating the second local field, wherein a sum of the first and the second local fields approaches zero, for selectively decoupling the transponder from its environment.

Furthermore the present solution comprises an intelligent resonant tag comprising an integrated circuit for storing data and the first antenna circuit electrically connected to the integrated circuit. Exposure of the first antenna circuit to an electromagnetic field at the first predetermined radio frequency induces a voltage therein, which produces a current flowing in the first direction therethrough, thereby producing the first local field. The induced voltage also provides power to the integrated circuit such that the data stored therein is read therefrom and transmitted at the second predetermined radio frequency. The tag also comprises means for generating the second local field, which at least partially cancels the first local field generated by the first antenna circuit.

The complete solution is shown in figure 1. The resonant coil inductance in active state is the sum of inductances Lr and Lc as shown in figure 1. The series coil resistance is given by resistors Rs1 and Rs2 while switch resistance is "ON" position is given by Rs3.

Figure 2a shows the implementation of the tag. Again the total coil inductance in active state is given by the sum of LL and Lc, Rs1 is given by the quality of the resonance circuit, while resistance Rs is mainly the "ON" resistance of the integrated switch. Figure 2b shows the equivalent circuit of the tag in active state and figure 2c shows the equivalent circuit of the tag in the non-active, decoupled state.

3. Conclusions

A novel approach for decoupling of multiple RFID tags has been presented.. An ASIC has been designed to perform the described function. The photomicrograph of the ASIC is shown in fig. 3. The described system is widely used in various applications from supermarket product tags to warehouses and libraries inventory monitoring.

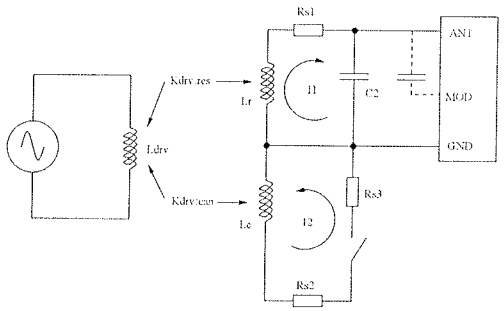

Figure 1: An equivalent electrical circuit diagram of an interrogator and resonant frequency identification (RFID) device

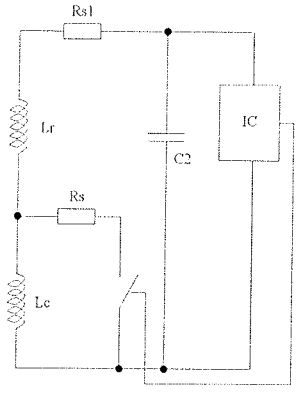

Figure 2a: An equivalent electrical circuit diagram of the intelligent RFID tag

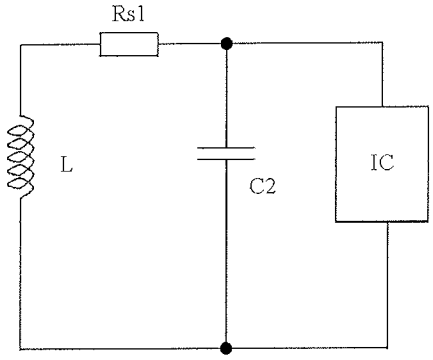

Figure 2b: *A schematic diagram of the equivalent electrical circuit of the RFID tag in an active state*

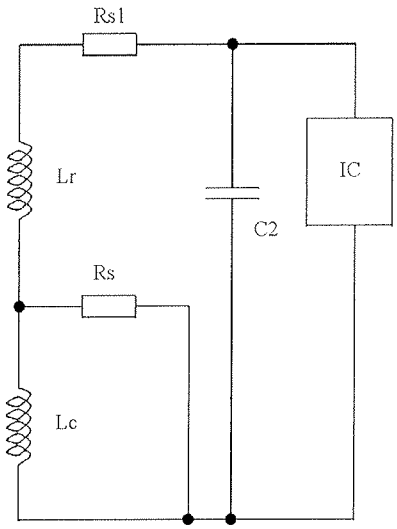

Figure 2c: *A schematic diagram of the equivalent electrical circuit of the RFID tag of fig. 2a in an inactive state*

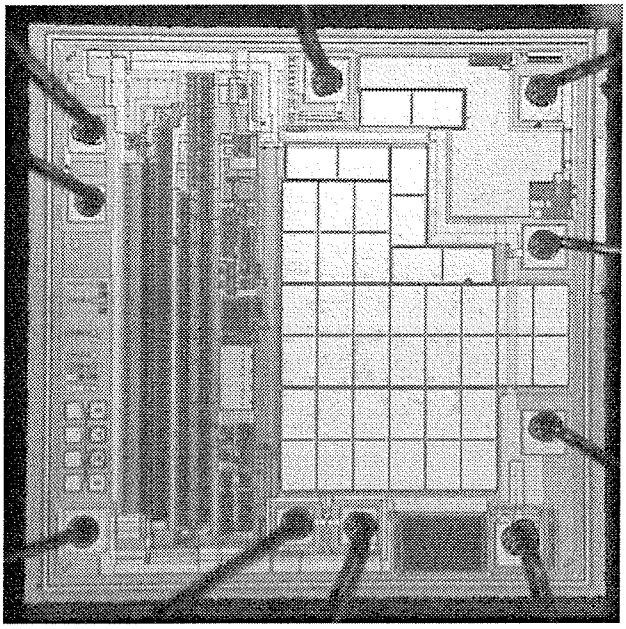

Figure 3: *The photomicrograph of the ASIC*

References

/1/ Trontelj J., "Apparatus for magnetically decoupling an RFID tag", *Patent no. US6208235*, March 27, 2001, US Patent Office

Janez Trontelj
Faculty of Electrical Engineering
Tržaška 25, 1000 Ljubljana, Slovenia
E-mail: janez.trontelj1@guest.arnes.si

Prispelo (Arrived): 26.10.01 *Sprejeto (Accepted): 10.12.01*