LOW-POWER SENSOR FRONT-END ELECTRONICS WITH RFID COMMUNICATION CAPABILITIES FOR FOOD LOGISTIC DATALOGGING APPLICATIONS

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Abstract

In the framework of the "GoodFood" FP6 Integrated Project [1], a flexible transponder gas sensing system with RFID communication capabilities for food logistic applications is being proposed. The transponder, besides storing dynamic traceability information, features physical sensors (relative humidity (*rH*), temperature, light) and, depending on the application scenario, will also feature chemical gas sensors.

In this work, low-power front-end electronics based on a Texas Instruments MSP430 [2] microcontroller for sensor control and passive RFID communication in the 13.56 MHz band will be presented. The first prototypes feature a Sensirion SHT15 *rH* and *T* sensor and a commercial light sensor, while ultra-low-power MOX sensor readout is planned for the next versions. The transponder is designed to give information on food evolution and environmental conditions during transport. After being programmed with data logging parameters at the beginning of the transport phase, it should store information from the various sensors and this information should be read on arrival of the food at final destination.

Fig. 1 shows a block diagram of the transponder. The microcontroller MSP430F169 is connected to the SHT15 through a two-wire bus using a proprietary pseudo I^2C protocol [3] and provides temperature and relative humidity measurement in digital form. The light sensor is composed by a photodiode [4], the current signal is converted to voltage signal using a low power operational amplifier. The acquisition is performed using the internal ADC of the microcontroller. A thin film battery is used to power the tag during the sensing and data-logging phases.

In RFID systems, the reader radiates an electromagnetic signal that is also used by the transponder to send back the information using a load modulation technique.

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The communication between transponder and reader uses a subset of ISO-15693 directives. Focusing on the transponder, the reception of incoming commands is based on a ASK modulation with pulse position coding. Conversely, the transmission from the transponder to the reader is based on a FSK load modulation with two subcarriers. A suitable modulation circuit driven by a programmable logic device accomplishes this task.

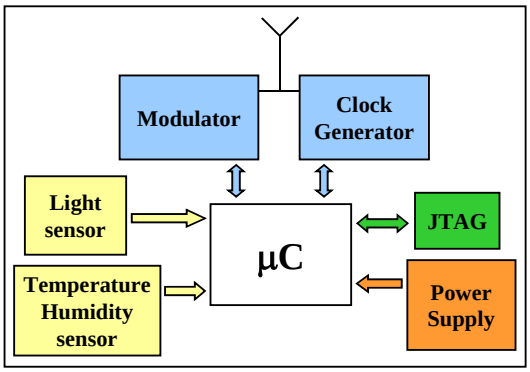

Fig.1: Block diagram of the transponder

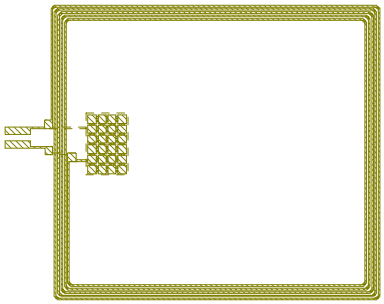
Fig.2: Layout of the flexible antenna

The antenna and the electronic circuit interconnections are built on DuPont™ Pyralux® AP flexible substrate featuring a thickness of 50.8 µm, 3.4 relative dielectric constant, 0.008 dissipation factor. The substrate is bonded to a 18 µm thick copper foil. The antenna works in *near field* operative region and so the coupling between the devices is mainly magnetic. To increase the energy received by the antenna, the resonance frequency must be carefully tuned at the operative frequency. The antenna is a five loop planar inductor, featuring a self-resonance frequency higher than 13.56 MHz, to account for the parasitic capacitance. To move the frequency resonance towards the operative frequency, the inductor is paralleled with a modular tuning capacitance (Fig. 2).
The current state of the tag development will be presented. Presently the firmware implemented on the microcontroller allows the reader to perform “read single block” and “write single block” operations. We tested the correct operation of the transponder using a commercial reader compliant to the ISO-15693 directives. The implemented commands are correctly managed using a pulse position coding 1 out of 4, a 100% ASK modulation from reader to transponder and a high data rate from transponder to reader.

ACKNOWLEDGEMENTS
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