Simple Low-Cost Open-Source UHF RFID Reader

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EXTENDED ABSTRACT

In this work, we present a simple low-cost software-defined radio (SDR) based reader that can realize a complete inventory of a UHF RFID tag in real time. This paper is a direct continuation of the initial design presented in [1]. The reader is theoretically capable of generating any commands defined by the EPC Gen2 RFID protocol and processing tag response in real time. Compared to other designs [2], all tasks specific to the protocol (including clock recovery, data recovery, frame detection, etc.) are defined entirely in software and can be successfully processed by a single low-performance micro-controller.

The purpose of this work is to encourage researchers and students to study and experiment with UHF (RAIN) RFID technology, to understand its protocols and standards, and to improve the proposed reader design. All relevant design files (including schematic, PCB layout, and firmware source code) will be released as open source to the community.

A. Architecture

The proposed RFID reader is composed of two separate boards. The first board contains the RF transmitter based on Melexis TH72035 chip and the RF receiver based on a simple envelope detector and a data slicer implemented using MAX931 op amp. Schematic of that board is given in Fig. 1 and is similar to [1]. The second board is an Arduino Uno Rev3 [3] which executes the firmware implementing the EPC Gen2 protocol. The firmware is the most important and challenging part of this reader. Fig. 2 shows the photograph of the complete assembled UHF RFID reader with the Arduino platform and a connected dipole antenna.

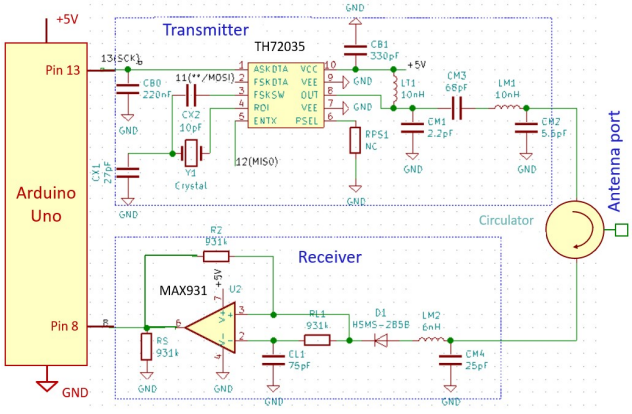

Fig. 1 Schematic of the proposed low-cost SDR UHF RFID reader.

B. Specifications and Performance

The presented reader allows one to generate any interrogator commands defined by the EPC Gen2 RFID standard and can decode any tag reply in real time. It also provides user with a full access to the timing information of the tag backscattered signal via Arduino IDE tools.

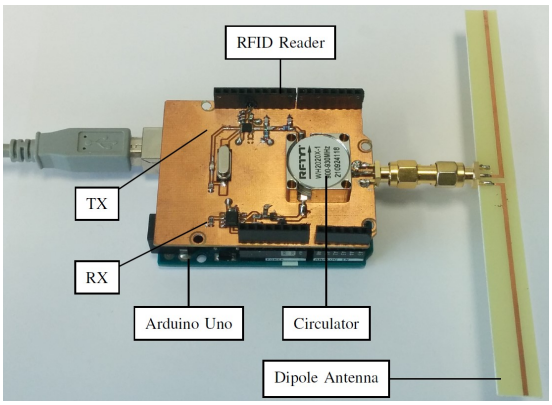

Fig. 2 Photograph of the assembled reader.

A simplest inventory round, a single slot inventory captured with the proposed reader is shown in Fig. 3. The reader can also perform complex inventory rounds with multiple slots.

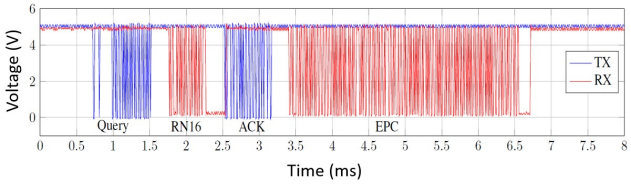

Fig. 3 Single slot inventory performed by the proposed reader.

The described reader consumes only 39 mA current (Arduino Uno consumes about 26 mA and RF board consumes about 13 mA), or 195 mW total power which is lower than any other UHF RFID reader. Tag read range of this reader is short compared to high performance commercial readers, due to its low output RF power (less than 10 dBm) and modest sensitivity of its simple envelope detector receiver relative to IQ demodulator based receivers. In our experiments using dipole antenna shown in Fig. 2 and modern Gen2 tags, the maximum reliable successful tag decoding range was about 25 cm. The maximum backlink frequency (BLF) supported by the present version of the reader is 55 KHz. The cost of this reader can be reduced to less than $50, especially if low-cost directional coupler is used instead of the circulator.

C. Conclusions

We believe that simple low-cost open-source software defined RFID reader presented here can become a good educational platform and a valuable research tool for further experimentation with UHF RFID technology that can bring many talented researchers to this field.

References

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