RADIO FREQUENCY IDENTIFICATION IN USE WITH GUARD AND SECURITY SYSTEMS

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A growing number of organizations are studying the commercial use of radio frequency identification (RFID). Several large companies have invested large sums in RFID development, and companies plan to require RFID compliance from their suppliers. Nonetheless, many companies do not yet have a full grasp of what this technology may mean to them.

Of course, the benefits RFID brings to supply-chain management, transportation and item tracking are clearly understood. They are the driving force in the movement toward this new technology. But many companies do not yet realize the value RFID can supply by providing data inputs into a company's quality management system. RFID data can be expected to be a valuable component of Six Sigma and Lean applications.

This paper reviews a RFID based system to improve the guarding process of guarded areas. The paper reviews the hardware and software efforts in the RFID implementation process that can be used in different kind of application aspects.

Keywords: ISM 433.92 MHz, RFID, Security, Guard, Access Control

1. INTRODUCTION

Previous successes using TEMICS integrated circuit (U2270B) for RFID transponder reader [1] brought to mind the possibility of using these in complex system for improving the guarding of zones and guarded areas. The idea is to increase the efficiency of the guarding process by using strict identification of the guard personnel on some period of time.

The system consists of "register modules", placed on the guard zone and an "alarming module". The idea is to ensure the guarded area monitor by automatic radio-frequency identification in the register modules by the guard personnel. If the guard/security staff does not identify using its contactless RFID cards to the register modules, then the modules sends an alarming message to the alarming module.

Because the register modules are placed all around the guarded area, it is very hard and expensive to use wire communication to the main alarming module. To solve this problem it was decided to use radio-frequency (RF) communication using some stable radio bands. The suitable radio band for this application is the ISM radio band on 433MHz [2]. Modulation used in this application is OOK. OOK modulation (On/Off Key) is the special case of ASK (Amplitude Shift Key) modulation where no carrier is present during the transmission of a zero. OOK modulation is a very popular modulation used in control applications. This is in part due to its simplicity and low implementation cost. OOK modulation has the advantage of allowing the transmitter to idle during the transmission of a “zero”, therefore conserving power.

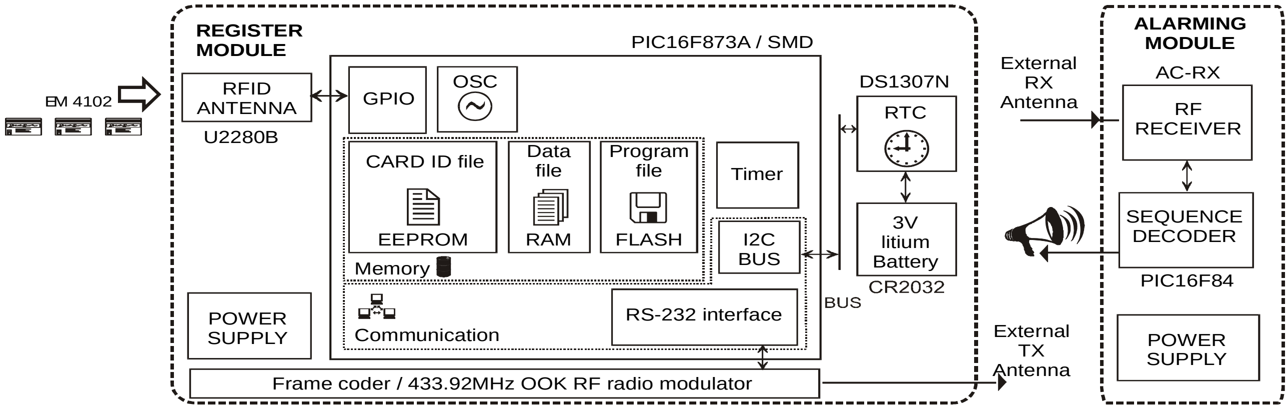


Figure 1 – Top-level diagram of the system

The register modules consist of RFID reader, battery back-up real-time clock (RTC), sequence generator, OOK RF radio modulator and main microcontroller. The RFID uses specialized integrated circuit (U2270B) for the data reading from the transponders in the identification cards. The transponders are based on EM4100 chips [3] and use Manchester data encoding. The working frequency of the RFID system is 125kHz.

The real time clock allows automatic switching of the module. When the time is in the 6 AM to 8 PM the module is switched off, while after 8 PM it is automatically switched on. The RTC also measures the time intervals between the alarming conditions. If a user did not identify on intervals of 30 minutes (using its RFID card) then an alarming condition is transmitted to the main alarming module.

Identification using valid RFID card clears the alarming timer; also clears the valid alarming condition. The valid numbers are stored in the internal EEPROM memory of the processor and can be changed independently without re-programming the firmware (program flash memory).

If an alarming condition occurs then a specific sequence of data is generated and this sequence is transmitted using RS232 data formatting by the RF modulator. This allows the message to the main alarming module to be encoded.

The main alarming module consists of RF receiver and OOK demodulator, sequence decoder and alarming circuit (alarming horn speaker). The RF receiver and demodulator are based on AUREL hybrid modules: AC-RX.

The AC-RX receiver is EC certified and in particular it complies with the European Rules EN 300 220-3 and EN 301 489. The equipment has been tested according to rule EN 60950 and it can be utilized inside a special insulated housing that assures the compliance with the above-mentioned rule. The module is low-consumption (about 2.5mA) and utilizes very good RF sensitivity of about –100dbm.

Frame sequence block decodes the received data from the register modules. If the data is valid then the alarming module turns on the horn speaker.

2. THE RFID CHAIN

The RFID transponders reading chain [4] is done on small PCB (58x58mm). It integrates the main microcontroller, the antenna for the RFID and the front-end circuit for the card reading. External real-time clock connects to board by I^2C bus, using two pins of the board connector. The used radio frequency is 125 kHz.

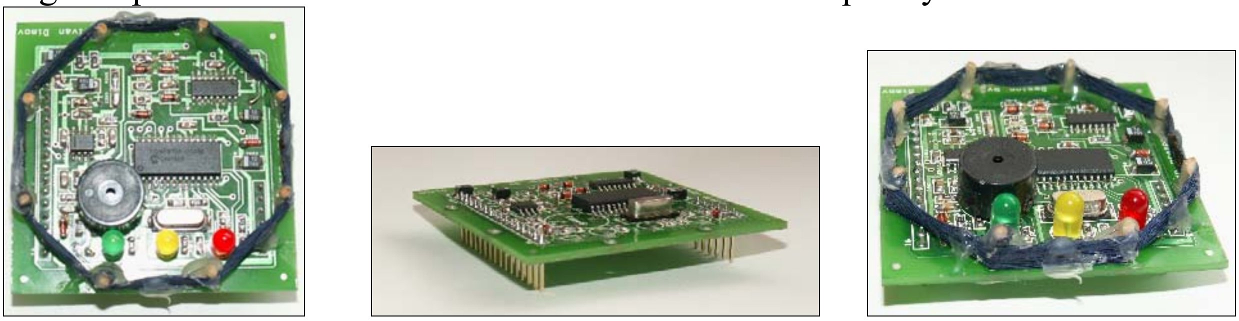


Figure 2 – RFID chain and the main microcontroller

. RFID front-end

Schematic of the RFID reader is on figure 3. All the required modules like 125khz oscillator, preamplifier, data slicer and output amplifier are in the special purpose integrated circuit (U2270B). The main advantage of the circuit is that it allows automatic oscillator frequency tuning to match the antenna to the resonance. The antenna is connected to pins ANT1 and ANT2. It is circular loop antenna with inductance around 1,35mH. Tolerance of the antenna inductance is not critical because the automatic frequency tuning of the RF oscillator ensures that the RF frequency will be exact the resonance of the antenna and the loop capacitor C105. The voltage at pin 15 of the U101 determines the working frequency. Diodes DN102, DN103 and the resistors R103 and R104 correct the oscillator frequency to be the same with the resonance of the antenna and C105.

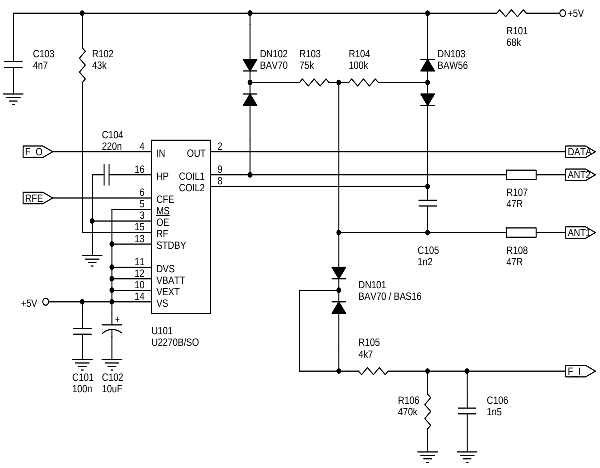


Figure 3 – RFID circuit

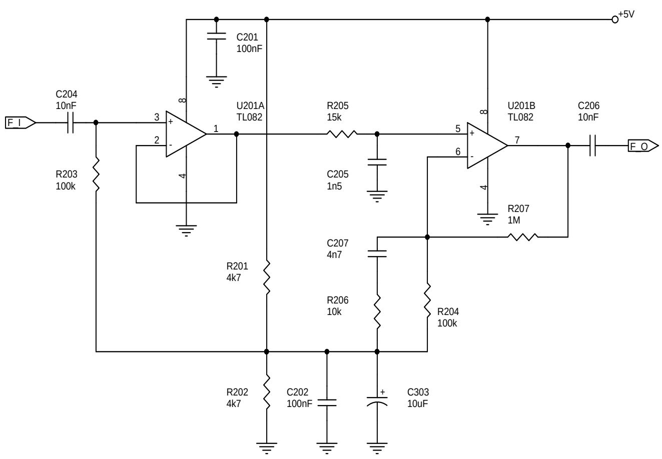


Figure 4 - Active filter design

2.2. External filter

Transceiver applications using the U2270B that require maximum reading distance also need increased data detection sensitivity. The amplifier (figure 4) consists of a dual Opam. One part is used as an impedance converter for the input decoupling of the low-pass filter R203, C204. The second part of the Opam is configured as an AC amplifier increasing the modulation edges. To suppress the 125-kHz field frequency, the low-pass cut-off frequency is matched to 10 kHz.

2.3. Data decoding

The data, which comes from the transponder in the IFID card, is Manchester encoded. Five columns and ten rows group this data. Every row and column has a parity cell to ensure the error-free transfer. To decode the Manchester code we used a state machine based on figure 5 [5].

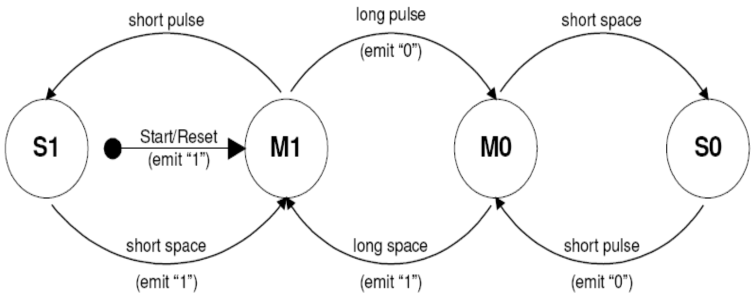


Figure 5 – State machine decoder

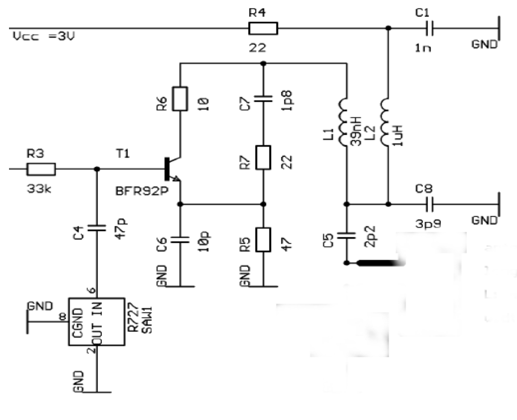
The state machine takes categorized pulse/space events as input and generates 50-bits code as output. When the state machine is started it emits a "1", and enters the M1 state. Emitted bits are left-shifted into a 50-bit data store. Any event not illustrated as a state transition results in an error, at which point the decoder should reset and restart.

3. REAL-TIME CLOCK (RTC)

The real-time clock in this application uses battery back up. We based the Dallas DS1307 chip [6]. The DS1307 Serial Real-Time Clock is a low power; full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially via a 2-wire, bi-directional I^2C bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply.

4. RF MODULATOR

Radio communication chain is based on SAW resonator using 433.92 MHz carrier frequency. The design is low-cost, single transistor Colpitts oscillator [7] with common base. The oscillator is switched on and off in step with the data telegram. The maximum modulation frequency is about 2.5 kHz (or 5 kbit/s in NRZ code). The oscillator's transient time of 30μs prevents a higher modulation rate. The additional components L1,



C8 belong to the feedback circuit and are designed for harmonic suppression and matching the antenna to the output of the transistor. L2 is for DC biasing. The high ratio of C6/C7 in combination with R7 prevents the oscillator to generate spurious oscillation at 50 to 100 MHz above the desired SAW oscillation frequency. The oscillation frequency depends on C6, C7, C8 and L1. So it is necessary to use components with 5% tolerance. C4 is for DC blocking (33pF...100pF), R5 and R3 for biasing.

5. Goals in the Project

Fortunately, RFID technology and security applications fit together very well. In order to be widely useful our modules needed of several attributes:

- To be inexpensive – component used in the modules are widely available on the market;
- To be simple to build and maintain;
- To implement automatic frequency correction to the RFID antenna resonance;
- To use readily available parts;
- Good wireless coverage – the distance between the register and alarming modules is at least 250 meters using license free ISM radio band;

6. System Performance

The modules are enclosed in plastic waterproof boxes. The registration antenna for the RFID is placed in the front panel of the box. The measured registering distance between the ID card and the module is about 15cm. The transmitted power is limited to 10mW, which is 10dbm. This ensures about 250 meters of communication distance between register and alarming modules.

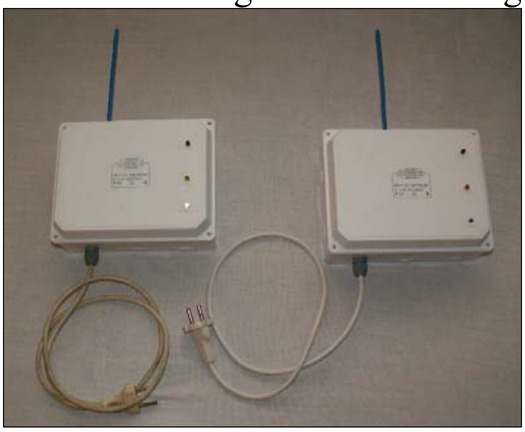


Figure 7 – Register modules (PES-433TX)

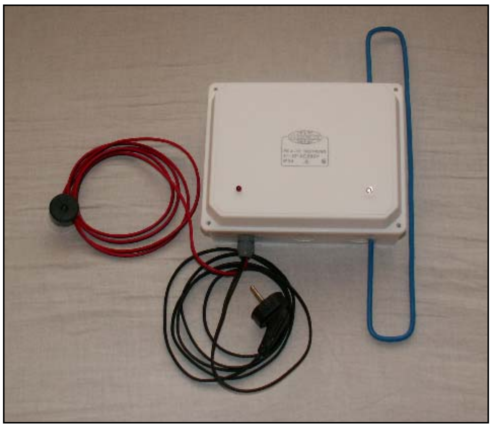


Figure 8 – Alarming module (PES-433 RX)

7. Conclusion and Future Work

Presented system is not so simple, but is flexible in use and cost-effective. It significant improves the quality of the security in guarded areas. It is based on two contemporary technologies: radio-frequency identification (RFID) and wireless radio data communication between the nodes on license free ISM bands.

Future work will be directed in developing a software database module to the systems to allows full data logs. Also the wireless radio data communication will be based on ZigBee [8] standard (IEEE 802.15.4).

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