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Ethernet Based RFID Reader for Library Application

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***Abstract**: RFID is a new automated contact-less data capturing technique that is finding more and more applications. This paper presents the design of RFID card reader unit which is used in library application. A complete and detailed review of the reader system, Ethernet concept and communication protocols are presented.*

Keywords: RFID, PCD, PICC, UID, SEL, NVB

1. INTRODUCTION

RFID (Radio Frequency Identification) is the latest technology that to be used in libraries theft detection systems [1]. Here reader is designed to operate at 13.56MHz [2], and is involved in reading the information from the card using specific protocols.

In the library application RFID is a combination of radio frequency and microchip technologies. The information contained in microchips (tags) affixed to library materials is read using radio frequency technology. The information read, is processed and sent to a LAN connected computer to store the information on the data base, which can later be accessed when the application needs it.

By using RFID readers in libraries and also in other fields, applications become faster. Unlike EM (Electro-Mechanical) and Bar code systems [3], which have been used in libraries for decades, RFID based systems move beyond security to become tracking systems that combine security with more efficient tracking of materials throughout the library.

2. RFID SYSTEM

RFID readers are devices that perform the Interrogation of RFID transponders. A RFID system cannot be imagined without the presence of a RFID reader to perform the interrogation and in some cases the power supply of RFID tags.

RFID is an emerging technology that uses radio waves as means to identify items or objects. Figure 1 shows a typical RFID system that contains one or more RFID tags, Read/Write Antenna, a reader, and a LAN connected back-end sever.

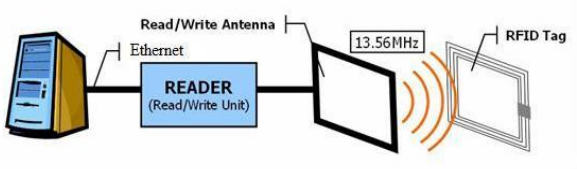


Figure 1: Block diagram of typical RFID system

An RFID system typically comprises a transceiver, its associated antenna and the transponders (tags) that carry the data. With passive tags the reader transmits a low-power radio signal through

the antenna that the tag receives via its own antenna to power an integrated chip. Using the energy it gets from the signal, the tag briefly converses with the reader for verification and the exchange of data. Once the reader receives the data, it can be sent to a controlling computer and stored in a database for further processing and analysis.

3. PROPOSED SYSTEM REQUIREMENT

The RFID card reader is designed to work at 13.56MHz frequency. The RFID card is a passive card and it gets power through the RFID reader. When RFID card is brought nearer the range of reader, the data will be read from the card and is sent to microcontroller for further processing. Reader IC used is CL RC632, card used is MIFARE tag having 1K of memory space. Figure 2 indicates the designed RFID system.

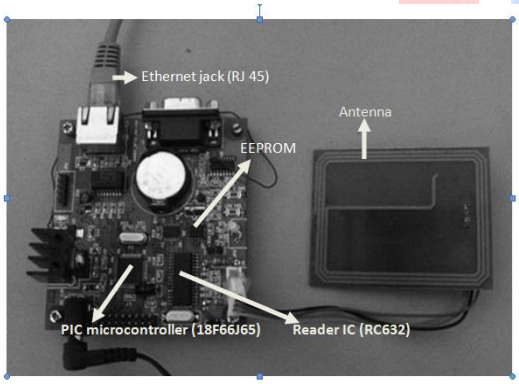


FIGURE 2: RFID reader module

Figure 3 shows the block diagram of the receiver circuitry [6]. The receiving process includes several steps. First the quadrature demodulation of the carrier signal of 13.56 MHz is done. To achieve an optimum in performance an automatic clock Q calibration is recommended. The demodulated signal is amplified by an adjustable amplifier. A correlation circuit calculates the degree of similarity between the expected and the received signal. The bit phase register allows aligning the position of the correlation intervals with the bit grid of the received signal. In the evaluation and digitizer circuitry the valid bits are detected and the digital results are send to the FIFO register. Several tuning steps in this circuit are possible.

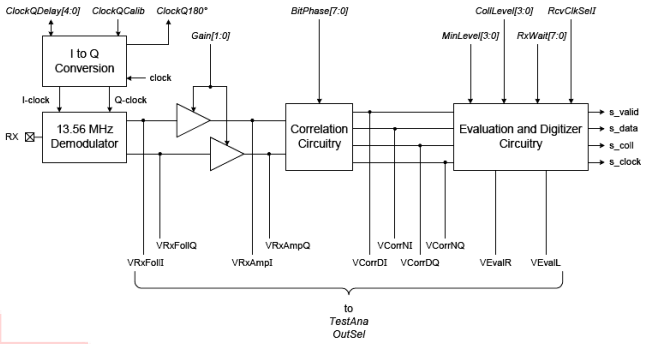


Figure 3: Block diagram of receiver circuitry

Passive RFID tags utilize an induced antenna coil voltage for operation. This induced AC voltage is rectified to provide a voltage source for the device. As the DC voltage reaches a certain level, the device starts operating. By providing an energizing RF signal, a reader can communicate with a remotely located device that has no external power source such as a battery. Since the energizing and communication between the reader and tag is accomplished through antenna coils [5], it is important that the device must be equipped with a proper antenna circuit for successful RFID applications.

The RFID reader can be designed in different ways where the antenna's resonating frequency, gain, directivity and radiation pattern can vary. Spatial filtering using adaptive smart antennas are a promising technique for implementing into RFID readers. A rectangular patch antenna has been used for microwave frequencies (13.56 MHz) as an intelligent beam scanning array for RFID readers [4].

3.1 Anti collision and Select of Tags

When more than one tag is comes in the RF range of reader then collision will take place to avoid that anticollision loop within each cascade level as shown in Figure 4. The following algorithm shall apply to the anticollision loop [7]:

Step 1: The PCD assigns SEL with the code for the selected anticollision type and cascade level.

Step 2: The PCD assigns NVB with the value of '20'.

Step 3: The PCD transmits SEL and NVB.

Step 4: All PICCs in the field shall respond with their complete UID CLn.

Step 5: Assuming the PICCs in the field have unique serial numbers, and then if more **than** one PICC responds, a collision occurs. If no collision occurs, steps 6 to 10 are skipped

Step 6: The PCD shall recognize the position of the first collision.

Step 7: The PCD assigns NVB with a value that specifies the number of valid bits of UID CLn. The valid bits shall be part of the UID CLn that was received before a collision occurred added by a 0^{th} bit or 1^{st} bit, decided by the PCD. A typical implementation adds a 1^{st} bit.

Step 8: The PCD transmits SEL and NVB, followed by the valid bits itself.

Step 9: Only PICCs of which the part of UID CLn is equal to the valid bits transmitted by the PCD shall transmit their remaining bits of the UID CLn.

Step 10: If further collisions occur, steps 6 to 9 will be repeated. The maximum number of loops will be 32.

Step 11: If no further collision occurs, the PCD assigns NVB with the value of'70'.

Step 12: The PCD transmits SEL and NVB, followed by all 40 bits of UID CLn, followed by CRC_A checksum.

Step 13: The PICC which UID CLn matches the 40 bits responds with its SAK.

Step 14: If the UID is complete, the PICC shall transmit SAK with cleared cascade bit and transit from READY State to ACTIVE State.

Step 15: The PCD shall check if the cascade bit of SAK is set to decide whether further anticollision loops with increased cascade level shall follow. If the UID of a PICC is well known, the PCD may skip step 2 - step 10 to select this PICC without performing the anticollision loop.

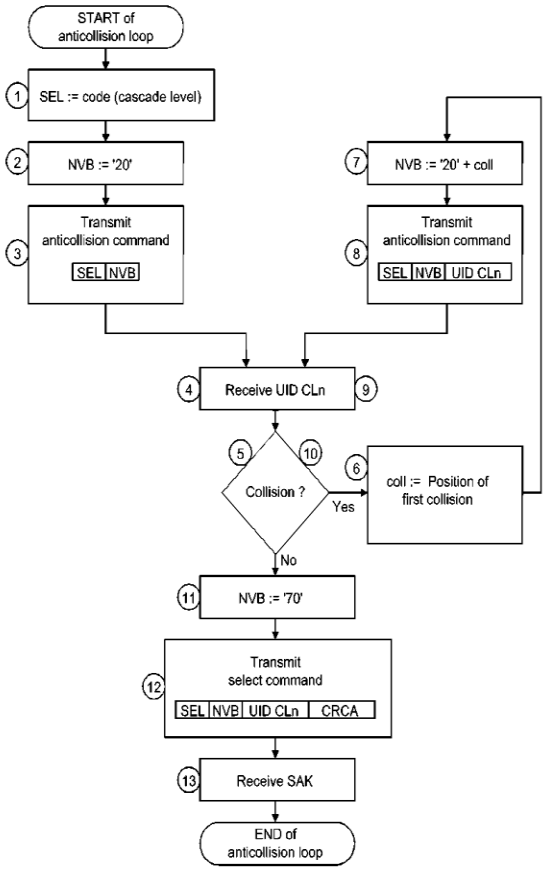


Figure 4: Anticollision loop, flow chart for PCD

3.2 Introduction to Ethernet

Computer Networking allows one computer to send information to and receive information from another. We can classify network technologies as belonging to one of two basic groups. Local area network (LAN) technologies connect many devices that are relatively close to each other, usually in the same building. The library terminals that display book information would connect over a local area network.

The Ethernet standard has grown to encompass new technologies as computer networking has matured. Specified in a standard, IEEE 802.3, an Ethernet LAN typically uses coaxial cable or special grades of twisted pair wires. Ethernet is also used in wireless LANs. Ethernet uses the CSMA/CD access method to handle simultaneous demands. The most commonly installed Ethernet systems are called 10BASE-T and provide transmission speeds up to 10 Mbps.

Reader uses the TELNET in the application layer of TCP/IP protocol to show the tag UID on the computer when tag is shown to reader module. By reading these ID's a individual student and also book can be identified.

In library management application RFID Tags are attached to books is as shown in Figure 5 and Figure 6 when these tagged book shown to the reader as shown in Figure 7, ID read from the reader and send it to Host computer via ethernet cable ID will be displayed on the TELNET port.

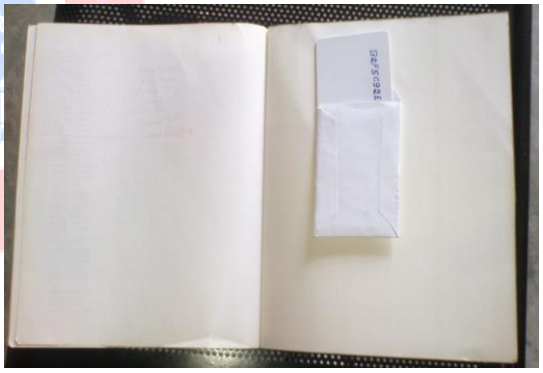


Figure 5: RFID tag attached to a book

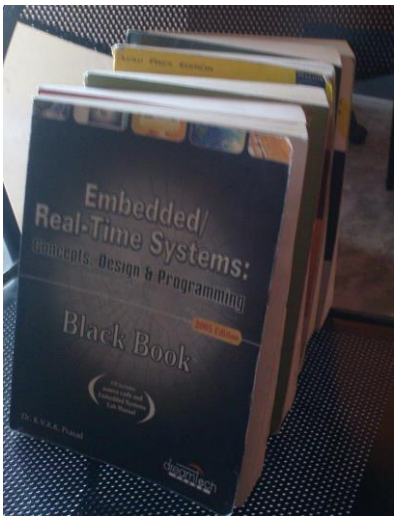
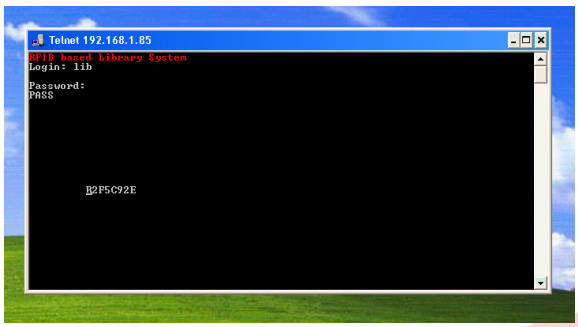


Figure 6: RFID tagged books

Figure 7: Tagged book showing to the antenna

4. RESULTS

Reader which is designed to operate at the frequency range of 13.56 MHz energized by the RFID tag attached to the book in a library and is reads the UID send it to LAN connected computer that can be seen on the TELNET window as shown in Figure 8.



5. CONCLUSION

This paper has made the RFID reader process more effective than existing reader due its special features and the computerized process reduces human errors and increases the efficiency. System is more user-friendly, effective and secured. This can be used not only for library application also used in any RFID based system. TELNET port is used here to show the read tag ID.

The problems, which existed in the earlier system, have been overcome to a large extent. It is expected that this system will go a long way in satisfying user requirements. The computerization of the Library Management will not only improves the efficiency but also reduces human stress.

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