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UNIVERSAL ACCESS SYSTEM BASED ON MICROCONTROLLER

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Abstarct: *This article deals with proposal of universal access system which would utilize the standard input-output ports of microcontroller. The whole proposal is based upon the ATmega64 processor, which makes the access system universal and very flexible. The main problem of this proposal is the USB communication decoding and creation of custom USB driver for TouchaTag reader.*

Keywords: *Keywords: ATmega64, USB, Touchatag.*

1. PROBLEM STATEMENT

The goal of this article is to create the access system based upon ATmega64 processor. Universal USB Mifare Touchatag reader and door opening device. Block scheme of the system is pictured on Figure 1.

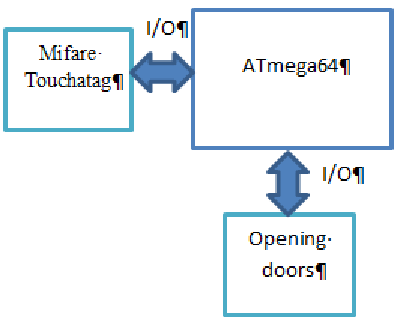

Figure 1 *Block scheme of access system connection.*Obliczenia

The main problem of this proposal is that the ATmega64 microcontroller doesn´t support the direct USB communication with reader. Therefore, the creation and programming of custom software which would function as a standard USB driver is needed.This custom software should allow the communication between the processor and reader. Due to high importance of this problem, USB decoding analysis and solution will be the main part of this article as its proper understanding is crucial for the proposal of the whole system. Door opening block consist of electrical lock and the electronic needed for its control. The system should function automatically, after the access card placement, its number should be scanned and compared to stored data file in memory. after that, the electrical lock would be initialized and the door would open for 10 seconds. After that, the lock would get locked again.

2. ATMEGA 64

This series of AVR microcomputers from the Atmel company production is based upon completely new architecture. The circuits are true RISC architecture, where the inner crystal timing frequency is not separated. This means, that for example 10MHz control crystal allows the flow of commands up to 10 million of instructions per second.
Due to relatively low operational frequency the current consumption is very low. All the AVR models have the programmable flash type memory as well as EEPROM type data memory, where the system can be programmed. Flash

memories of OnChip type can be easily programmed by command transfer. The memory programming process doesn´t need voltage conductors connection.
The AVR circuit has 32 equal registers which allow parallel access. Inscruction set contains 120 instructions, therefore very effective programs can be made.
STK600 kit which allows the tuning and testing of the driver was used for programming. The STK 600 developer board is pictured on Figure 2.

Figure 2. STK 600.

3. UNIVERSAL SERIAL BUS

This bus was developed as a replacement of older serial and paraller ports which were slow, needed lot of drivers and weren´t standardised enough. Devices can connect to this ports via Plug&Play which means that the operating system can recognize the device and and install the necessary drivers.
Therefore this interface was chosen for the purposes of microcontroller communication in this proposal. The interface is user friendly as it utilizes only two data conductors D+ and D-. Another two conductors are used for device feeding, where one conductor has +5V and the other one 0V (GND) voltage. For the communication speed selection between the MASTER and SLAVE devices the connection with pull-up resistor is used. This resistor has 1k5 value and is connected to 3,3V voltage.
For FULL-SPEED regime the resistor has to be connected to D+ conductor (12MB/s transfer speed), the device would then ask for higher transfer speed for communication with computer.
For the LOW-SPEED regime the resistor has to be connected to D- conductor (1,5MB/s) transfer speed.

For the HIGH-SPEED regime the resistor has to be connected to D+ conductor by program controlled switch with fulfilled special protocol. The selction of the possible regimes is shown on Figure.3.

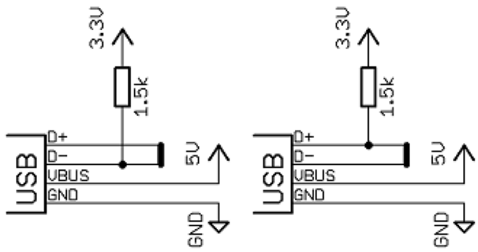

Figure 3. USB connection for low(left) and full(right) speed regime.

Communication by USB is initialized by MASTER type device. Each transfer begins by sending of token type packet from controlling PC. Packet of data is then followed (or the annoucement that the data aren´t transferred). The confirmation of transfer (handshake) indicate whether the data transfer was succesful. Data sent by USB are transferred by NRZI (Non Return to Zero Invert, Figure 4) method. Logical zero is represented by by change of voltage levels on data conductors and logical one is represented by absence of this change.
Cycling signal is not used for transfer, therefore the synchronization sample at the beginning of each packet is dispatched, which serves for synchronization of data receiving device.
Synchronization sample consists of 7 zeroes followed by 1 in NRZI encoding. For the synchronization keeping purposes, zero is inserted if there is 1111111 sequence.

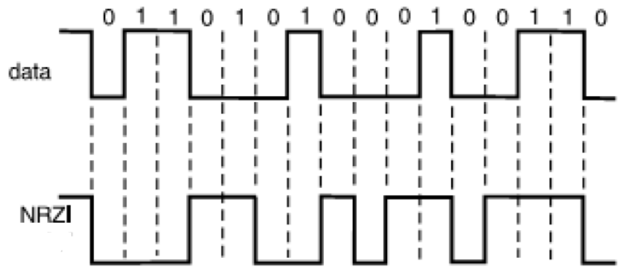

Figure 4. NRZI sample encoding.

Next is the PID (packet identificator), type, packet format and method of packet errors detection. The data transfer is in differential way. That means that the conductors have following levels: 3,3V on D+ and 0V on D-, or 0V on D+ and 3,3V on D- (invert value on both conductors). Data transferred via USB are organised into packets and start of the packet has to be labelled as SOP (start of packet) and end as a EOP (end of packet). The transfer begins when the MASTER device sends the TOKEN type packet, followed by packet or annoucement if the data aren´t transferred.

The transfer can be realised as as data stream (doesn´t have the fixed structure) or message (defined structure)

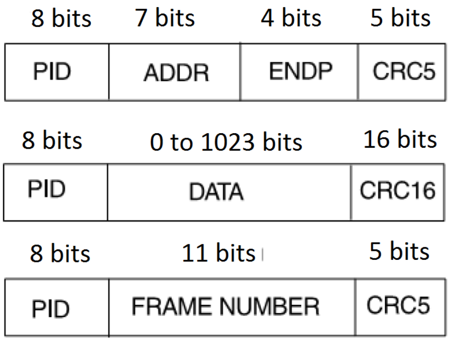

Figure 5 – Format of packets transferred via USB.

Fie
ld in TOKEN packet labelled as PID specifies the packet type (IN,OUT,SETUP), field labelled as ADDR is one of 127 possible addresses in system and each represents one function. ENDP field speifies the source or the target of data. The data packet consist of PID field, DATA field which can have 0-1023 bytes and CRC (system of errors correction). The special packet SOF (start of frame) includes the FRAME NUMBER field (number of data framework) Data framework is sent by computer with 1ms period, microframework is 1/8 size of framework, therefore ist length is 125 us-

4. MEASUREMENT AND ANALYSIS OF USB COMMUNICATION

In order to write a custom software for USB driver, standard PC USB communication had to be measured and analysed. For communication measurement 4 channel digital osciloscope Tektronix TPS 2014 was used. USB interface communication runs on data conductors D+ and D-, therefore thez need to be measured.
After the USB reader is connected, data communication runs on data conductors which determine the device and set the communication transfer speeds. Figure 6 shows such communication.

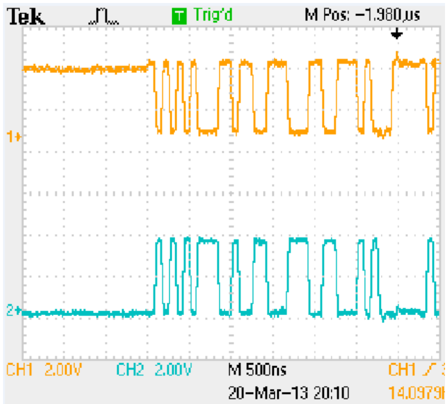

Figure 6. Connection and activation of reader.

This picture shows the measured signals on data conductors of USB port. Channel 1 represents the signal on D+ data conductor, channel 2 is on conductor D-. After the analysis, it is evident, that it is a HIGH-SPEED transfer because the daa conductor D+ is connected to positive potential +3,3 V. End of the transferred data is represented by pair of bits of logical 0 value. This comunication framework represents the communication when detecting the device by USB port. Following picture (Figure.7) shows the initialization of reader.

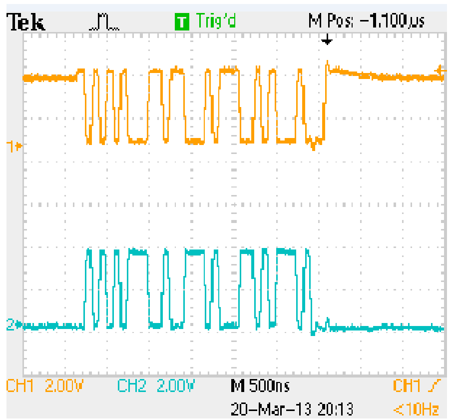

Figure 7. Initialization of reader.

This data framework initializes the reading and reader is activated to turn on state and is ready for card placement. This is very important framework because it has to be transmitted continuously to reader in order to be ready for card placement. If the reader is activated, the reading from card can begin. Following figures (Fig. 8) and (Fig. 9) shows two different data transfers for testing card 1 and 2.

Based upon alaysis of transfer we can determine the data with which the card represents itself, like the card number, which is needed for our system in order to identify the permission for access into he object.

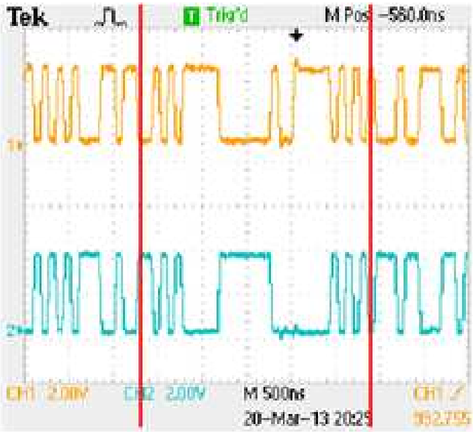

Figure 8. Test card 1 reading.

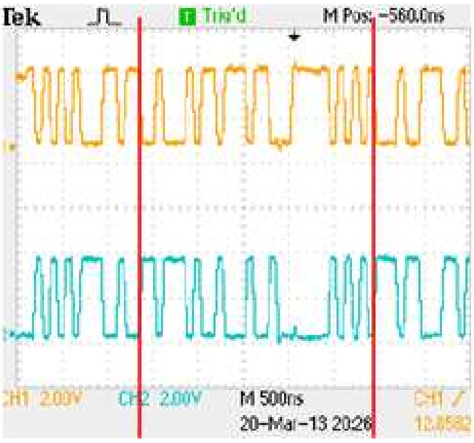

Figure 9. Test card 2 reading.

On the first look it seems that the difference is marginal, but it is not true. The important information from data communication are marked by red lines. It is the data framework representing the data information about the placed card number. Data framework is transferred by NRZI encoding, and Table 1 can be used for decoding.

Bus state	Level D+	Level D-	Note
Differential ‚1‘	H	L	
Differential ‚0‘	L	H	
Single Ended Zero (SE0)	L	L	end of packet, reset...
Single Ended One (SE1)	H	H	not allowed

Table 1. NRZI decoding table.

With this table we can encode the data framework and convert it to standard binary code or into any other number system. After this analysis, we should be able to program microcontroller so it could handle such communication. There can be additional problems with timing and speed of communicarion, but it will have to be solved by experiment.

5. CONCLUSIONS.

This paper dealt with proposal of access system based upon microcontroller. As can be seen from Figure 1, the hardware proposal pictured by block scheme is not very difficult.
The most problematic part of the whole proposal which was the most part of this article is the decoding of USB communication. For proper decoding, several testing measurements had to be conducted, so we could gain insight into problem. After such analysis, the development of driver can be conducted. For USB reader control, the standard I/O pins of microcontroller will be used.
The main asset of this article is that with similar way we can write a code for driver for different device than Mifare Touchatag reader which opens broad possibilities of microcontroller ATmega64 utilization.

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