# RFID Based Attendance System

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*Abstract* – **Most educational institutions' administrators are concerned about student irregular attendance. Truancies can affect student overall academic performance. The conventional method of taking attendance by calling names or signing on paper is very time consuming and insecure, hence inefficient. Radio Frequency Identification (RFID) based attendance system is one of the solutions to address this problem. This system can be used to take attendance for student in school, college, and university. It also can be used to take attendance for workers in working places. Its ability to uniquely identify each person based on their RFID tag type of ID card make the process of taking the attendance easier, faster and secure as compared to conventional method. Students or workers only need to place their ID card on the reader and their attendance will be taken immediately. With real time clock capability of the system, attendance taken will be more accurate since the time for the attendance taken will be recorded. The system can be connected to the computer through RS232 or Universal Serial Bus (USB) port and store the attendance taken inside database. An alternative way of viewing the recorded attendance is by using HyperTerminal software. A prototype of the system has been successfully fabricated.**

*Keywords* – **Microcontroller; RFID; Universal Serial Bus.**

## I. I. INTRODUCTION

Radio frequency identification (RFID) refers to the use of radio frequency wave to identify and track the tag implanted into an object or a living thing [1-3]. It is a wireless mean of communication that use electromagnetic and electrostatic coupling in radio frequency portion of the spectrum to communicate between reader and tag through a variety of modulation and encoding scheme [4]. Modulation refers to the variation in the amplitude, frequency or phase of a high frequency carrier signal to convey information. Encoding is a process of converting information from one format to another. RFID system usually consists of RFID reader and tag. It is very useful because it can uniquely identify a person or a product based on the tag incorporated. It can be done quickly and this usually takes less than a second.

A prototype of the system has been designed and fabricated. The RFID reader used in the system is passive type which has maximum range of detection of around 5cm above the reader. It operates at frequency of 125 kHz and 12V power supply. The system has ability to uniquely identify and take attendance for persons. The users only need to place their RFID tag on the reader to take attendance. They do not need to go through the long list to look for their name. Hence, it is very time efficient. Attendance will be taken if the encoded tag ID scanned matches the tag ID stored in the memory. Otherwise, an error message will be displayed.

Attendance taken will be more accurate with the real time clock included in the system. RS232 and Universal Serial Bus (USB) port allow the system to display the information and attendance of a particular person on Personal Computer (PC). The In-Circuit Serial Programming™ (ICSP™) pins and serial programmer integrated in the system allow update of microcontroller firmware from time to time. The power supply system designed will automatically switch to batteries power if the ac power was removed. The size of the device is considered to be small. These two features make the system portable to be carried to class or other places.

### *A. Wiegand 26-bit Format*

The passive RFID reader implemented in the system uses Wiegand 26-bit protocol format for Transistor-transistor Logic (TTL) input/output communication. Hence, it can directly connect to the microcontroller [5]. There are two outputs and one input wire from the RFID reader. The two output wires are DATA0 (usually green) and DATA1 (usually white). The card data are in binary and the RFID reader just received the radio frequency (RF) signal from the tag or card, translate it to Wiegand protocol and send the complete binary string to the microcontroller. Then, the microcontroller will combine the strings of characters from both data lines into the original set of binary data. The RFID reader performs no processing or quality checking on the data received. It only receives RF signal from tags and converts it into Wiegand format data for transmission to the microcontroller.

The format of Wiegand 26-bit and example of output from RFID reader are shown in Fig. 1 and Fig. 2 respectively. Wiegand refers to a specific reader to card interface, specific binary reader to controller interface, electronic signal carrying data, standard 26-bit binary card data format, electromagnetic effect, or card technology [5]. The term Wiegand format actually refers to the general concept of security card data encoding card format is identical in both 125kHz Proximity and 13.56MHz card to ensure any controller capable of understanding data from 125kHz and 13.56MHz system.

There are 255 possibilities for the facility code since the equivalent decimal number for 8-bit binary with all value equal to one is 255. There can be up to 65535 card ID numbers since $(2^{16}-1)$ is equivalent to 65535.

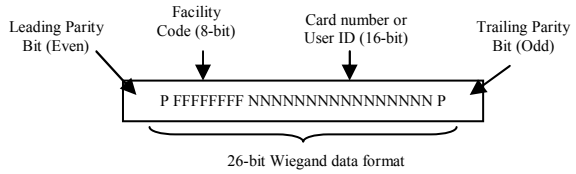


Figure 1. Standard Wiegand 26-bit format

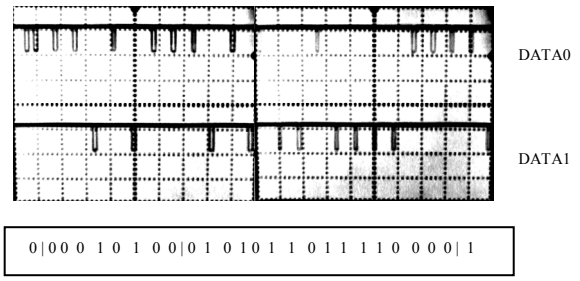


Figure 2. Example of output from RFID reader viewed on oscilloscope

Normally, there are two output data lines from the RFID reader. DATA1 line indicates logic 1 bit while DATA0 indicates logic 0 bit. In their idle state, both lines are held high. During data transfer, the appropriate data line will be low for 50us follow by period of 2ms. Each dip in the line represents a change from 5V to 0V, thus communicating the bit.

### *B. RFID Reader and Tag*

RFID reader is the device capable of extracting or reading information stored inside RFID tags. Two types of RFID reader available are active and passive RFID reader. Active RFID reader can detect the active RFID tag at few meters to line of sight while passive RFID reader can only detect passive RFID tag at a few centimeters from the reader. The RFID reader used in the system is a low cost reader for reading passive RFID tags. It operates at frequency of 125 kHz and 12V power supply. The effective detection range of the reader is around 5cm from the antenna. The RFID reader is constructed based on the EM4095 RFID transponder IC.

Each RFID tag will have unique ID or serial number which makes it suitable for distinguishing among products. Some RFID tags even contain information that can only be read by RFID reader. There are three types of RFID tags, namely active, semi-passive and passive RFID tag. The main difference between these RFID tags is that active and semi-passive RFID tags contain internal battery while passive RFID tags do not have any internal battery.

### *C. Basic Operation*

A basic RFID system usually consists of a RFID reader and RFID tag which contain a coil that serves as antenna for transmitting and receiving signals as shown in Fig. 3. All kinds of RFID system operate using similar concept. RFID readers generate radio wave that reaches the RFID tags. Then, RFID tags use backscatter technology to reflect back the radio wave which has been combined with the data through modulation to the reader [4].

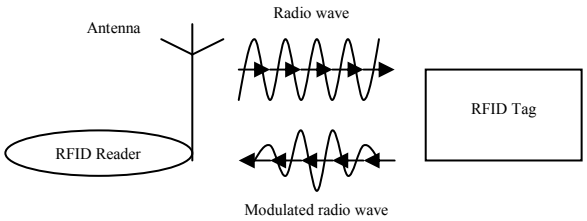


Figure 3. Basic operation of RFID system

## II. HARDWARE DESIGN

The hardware of the system consists of Microchip PIC18F4550 microcontroller, RFID reader and tag, DS1307 real time clock integrated circuit (IC), MAX232 serial communication IC, 16x2 Liquid Crystal Display (LCD), and power supply system. A simple universal serial JDM Programmer has also been integrated to the system which allows update of microcontroller's firmware from time to time.

The reason of choosing Peripheral Interface Controller (PIC) microcontroller for the project is because PIC microcontrollers are cheap and contain internal Electrical Erasable Programmable Read Only Memory (EEPROM), and other on-chip peripherals are readily available. PIC18F4550 has been chosen as the microcontroller for the system. It supports Serial Peripheral Interface (SPI), Universal Serial Bus (USB) communication and has large program memory for the development of the program code for the system.

The real time clock (RTC) function of the system is realized by using DS1307 IC. DS1307 communicates with PIC microcontroller serially through inter-integrated circuit ($I^2C$) interface (pin RB0/SDA and RB1/SCL). This IC uses a 32.768 kHz crystal to generate accurate clock. It is connected to a 3V button type of backup battery which keeps the oscillator running even when the main power has been cut off. The serial communication is accomplished by using MAX232 IC. The power supply of the system includes a relay used to switch between power adapter and battery power. The block diagram of the RFID based attendance system is shown in the Fig. 4. Fig. 5 shows the overall schematic diagram for RFID Based Attendance System.

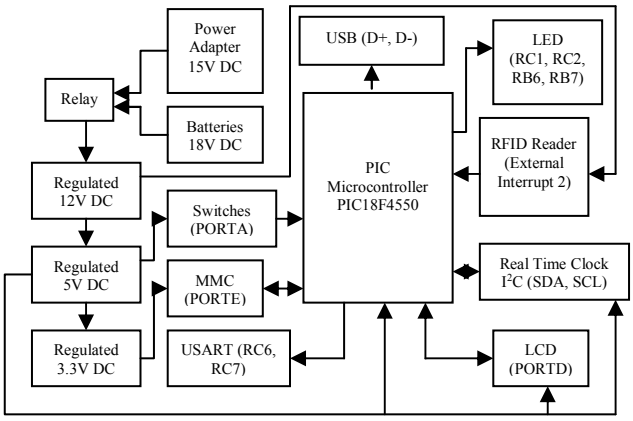


Figure 4. Block diagram of RFID Based Attendance System

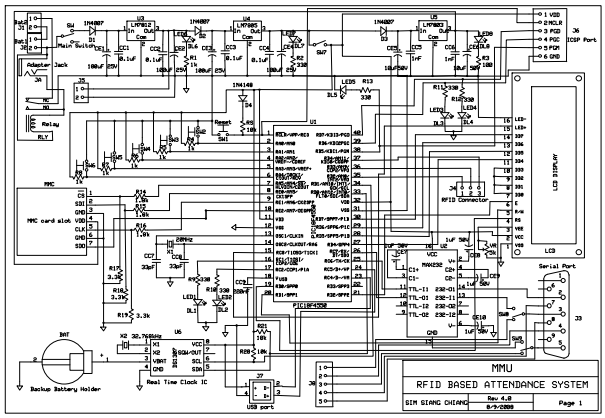


Figure 5. Overall schematic for RFID Based Attendance System

## III. MICROCONTROLLER SOFTWARE DESIGN

A program which allows the microcontroller to control the system need to be prepared and it is divided into functions or modules. The program is written in modular fashion where each part of the program is written separately. Then, all the software sub-modules will be combined to form the final software system. Before starting to write the program for the system, a basic program has been written to detect switches, turn on LED, display character on LCD, and transmit character to PC through RS232 or serial port. The first module consists of the code used to read the output from the reader based on Wiegand 26-bit format. Then, the result is compared with the ID stored in the system to determine whether the ID scanned is valid or not. The second module consists of real time clock program. The program will update the time displayed on LCD every second. The time can be set using switches. The third module written consists of code for USB communication between microcontroller and PC.

### *A. Initialization, Display and Update Time on LCD*

Timer 0 of the PIC microcontroller is used to create interrupt for displaying the time and date on the LCD. The interrupt will occur when timer0 overflow. In the initialization, suitable header and driver files are being included in the program using #include command (C language command). #fuses command set the configuration bit of the PIC microcontroller. #use RS232 setup the serial communication with PC. #use I2C setup the $I^2C$ interface for communication with real time clock IC. The initialization of the program also includes putting of global variables in RAM. Eleven bytes have being allocated to store each student ID and name. Student ID is stored at the beginning of EEPROM while student names are store starting from location byte number 100. With 20MHz crystal connected to the microcontroller, timer0 will increment every 0.4μs for this setup and overflow every 102.4 μs. Fig. 6 shows the flowchart for display time using timer 0 interrupt in the RFID based attendance system. Using timer interrupt will allow the system to perform multitasking in the program.

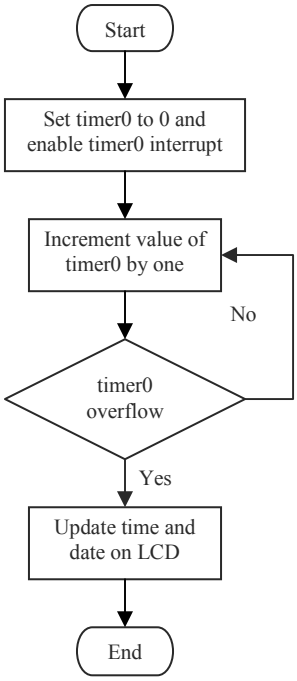


Figure 6. Flowchart for display time using timer 0 interrupt

### *B. Scanning and Verifying RFID Tag*

The RFID reader is connected to the external interrupt 2 pin of the microcontroller. Any changes on the output of the reader will trigger the interrupt service routine which will verify the tag being scanned. String compare function is used to check the tags being scanned with tags stored in memory. Fig. 7 depicts the flow chart of the program for verifying RFID tag.

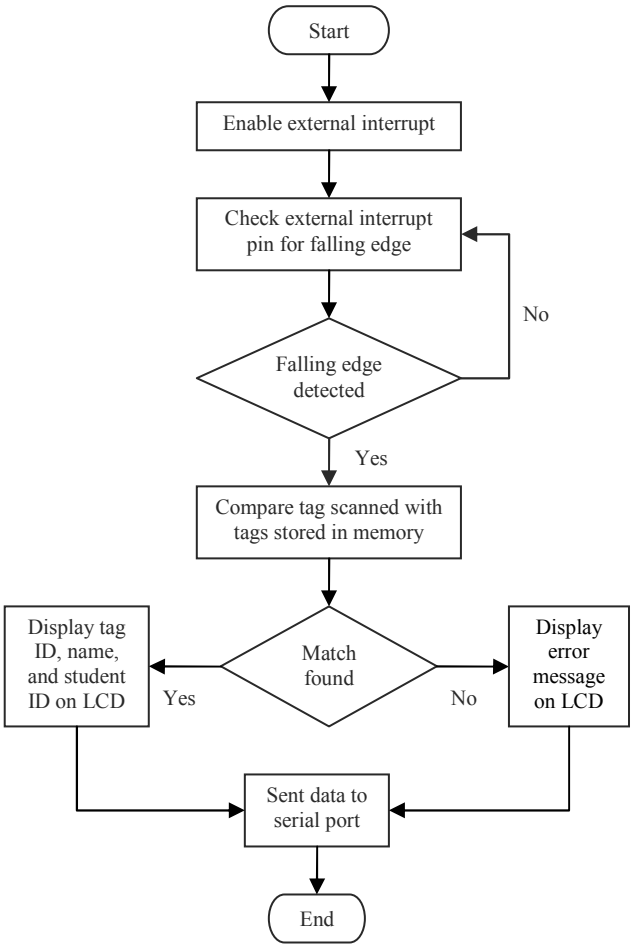


Figure 7. Flow chart for verifying RFID tag

### C. *Real Time Clock Function*

The Real Time Clock circuit communicates with PIC Microcontroller through I²C™ interface. I²C™ is a two-wire communication protocol developed by Philips. Most PIC support hardware-based I²C™. Functions have been written to read and write the calendar information in DS1307 IC. Functions for setting the time and date also has been written to allow changing of date and time by the user.

## IV. PERFORMANCE EVALUATIONS AND RESULTS

The main function of the RFID Based Attendance System designed in this project is to scan and verify a RFID tag. Then, attendance will be taken based on the ID scanned.

The passive RFID reader generate radio frequency field and transmit to surrounding using antenna of the reader. If there is any passive RFID approach the reader, a small power will be induced from the radio wave to the tag and allow modulated electromagnetic wave to be sent back to the reader. The reader receives the modulated signal from the tag and produces an output in Wiegand 26-bit format. The output is sent to microcontroller through DATA0 and DATA1 lines for further processing. The use of external interrupt pin for DATA0 will allow the scanning and verification function to be triggered when there is a change on output of DATA0 line.

The microcontroller receives the data from the reader and reconstructs the signal in Wiegand 26-bit format. Then, the result will be used to compare with the ID stored in the memory of microcontroller. If the ID exists, the respective name, student ID, and attendance will be displayed on the LCD. All those information are transferred to PC through RS232 port. It can be viewed using Hyper Terminal software. If the ID cannot be found on the memory, then an error message will be displayed on LCD as well as on PC.

The system has real time clock circuit included. The backup power supply of real time clock circuit will make sure that the time is still running even when the system has been powered off. There is no need to set the time every time the system has been turned on. The attendance taken is stored inside internal EEPROM of the microcontroller together with the time it has been taken. The attendance stored can be retrieved from EEPROM and used to update the attendance in database.

The USB port in the system allows access to the attendance stored inside internal EEPROM of PIC microcontroller. The data can be viewed using hyper terminal. Attendance at particular location in the EEPROM also can be modified.

The performance of the RFID based attendance system has been evaluated on different tag positions and distance. A simple detection range test has been conducted to evaluate the maximum detectable distance from the reader for different tag orientation. The main purpose of the test is to evaluate the performance of the system in terms of the detection range. The test proved that the reader has about 5cm detection range if scan from top position. Table 1 show the range of detection for passive RFID reader used in this system.

Table 1.
Range of detection for passive RFID reader used

| Tag Orientation / Location of Reader | Parallel with reader | Perpendicular with reader | $45^0$ with reader |
|---|---|---|---|
| Top | 5cm | 0cm | 4cm |
| Side | 1cm | 2cm | 2cm |
| Corner | 0cm | 0cm | 0cm |
| Bottom | 4cm | 0cm | 3cm |

## V. DISCUSSION

The advantage of the system over other similar product available is very vital and can usually affect the consumer decision in choosing a product. The RFID Based Attendance System developed in this project also has some advantages over other similar market products. It is cheaper compare to those systems current in the market. The round shape design of the system makes it look attractive. With other physical advantages such as small in size, portable, compact design and light weight, the

system is perfectly suitable as a portable access control or attendance taking device. The dual power feature of the system allows the system to be powered by power adapter or batteries.

Another improvement done to the power supply system is the use to relay to automatically switch to battery power if there is any power interruption in power from power adapter. This will prevent the loss of data. Other advantages of the system are high-speed tag verification and high accuracy. Therefore, the time needed to take the attendance will be minimized. The use of interrupts in the system makes the program code becomes more efficient. Interrupts allow multitasking in the system. Several tasks can be executed at the same time. The button switch and LCD integrated in the system is user friendly. User information will be displayed on LCD to show proper identification. Communication with PC also allowed through the RS232 port and USB port that can be accessed easily. USB port in the system allows viewing and changing of attendance stored in internal EEPROM of the microcontroller.

One of the possible future extension works for this project is implementation of Multimedia Card (MMC) in the system. With MMC included, attendance can be retrieved directly from files stored inside MMC card. The attendance in those files can be updated together with the time of attendance being taken. Student information can be obtained and displayed based on the RFID tag scanned.

## VI. CONCLUSION

A low cost RFID Based Attendance System prototype has been successfully developed. The prototype of the system provides several advantages over conventional method of taking attendance in class. The prototype developed in this project is compact and light weight. Besides, it can run using power adapter or battery power. Therefore, it is very portable and can be carried to the class for taking the attendance.

The attendance taken is secure and accurate since the tag ID encoding is done using Wiegand 26-bit format. The prototype is user-friendly with easily accessible switches and communication ports. Attendance can be stored and retrieved easily. Another advantage of the system is it has high identification and verification speed. This system can be applied not just in the classes but also in working places with the feature total working hours can be recorded.

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