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GSM Based Hardware Implementation of RFID Authentication System Using Actel FPGA

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Abstract— ***Radio-frequency identification (RFID) is a wireless technology that utilizes radio communication to identify objects with a unique electrical identity (EPC). The widespread deployment of RFID technologies may generate new threats to security and user privacy. The main goal of this paper is to design and implement a security system based on RFID and GSM technology which can be organized in banks, secured offices and homes. Implemented security system based on RFID and GSM technology containing security system using RFID and GSM which can activate, authenticate, and validate the user. The main advantage of using passive RFID and GSM is more secure than other systems. This system consists of Actel FPGA, RFID reader, GSM modem, dsPIC and LCD. In this system the RFID reader reads the id or password number from passive tag and sends to the FPGA. FPGA checks the card is valid or not then sends data to the dsPIC, after that dsPIC microcontroller displays the success or failure message on LCD and sends the SMS to the authorized person mobile number,which was stored in dsPIC.***

Index Terms—RFID, FPGA, dsPIC, GSM MODEM,LCD MAX232.

I. INTRODUCTION

The RADIO-FREQUENCY identification (RFID) is a contactless identification technology that enables remote and automated gathering and sending of the information between RFID tags or transponders and readers or interrogators using a wireless link. An RFID system is composed of three main components are tag, reader, and back-end database. RFID tags come in a different range of forms and can vary in memory type, storage capacity, radio frequency, and power capability. An RFID tags typically consists of an integrated circuit for handling data and an antenna for receiving and transmitting a radio-frequency signal.

In the commercial setting, RFID tags with the memory contain an electronic product code (EPC) that uniquely identifies the person identification number. The tag's sends these data whenever swipes on the RFID reader. The reader reads data from tags by broadcasting the RF signals. After the reader forwards that tag information to a backend database (FPGA), the back-end database plays an essential role in checking the validity of the tags, which is very important for privacy protection and security issues.

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II. THE HARDWARE SYSTEM

A. Block Diagram

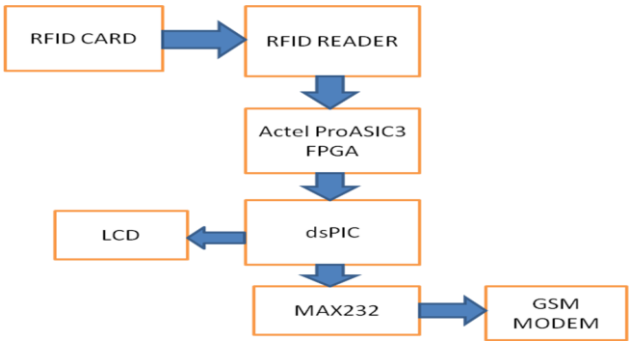

Fig 1: Block Diagram

Figure 1 shows the block diagram of proposed system. This depicts that the RFID card when swiped on the RFID reader the data which means the password in the farm of number read by RFID reader. Then it sends to the backend (FPGA) using RS232 communication cable. The data which was stored in FPGA is compared with received data from reader. After performing the matching the data is sent to the dsPIC then the success message will be displayed on LCD screen. If the matching is correct else the failed message is displayed. At the same time the message of success or failure will be delivered to authorized person mobile number which was stored in dsPIC. Compared to other RFID security systems it is one of the most reliable and uses less number of sources.

III. DESIGN AND IMPLEMENTATION

A. dsPIC Microcontroller

A micro controller is a functional computer system-on-a-chip. It consists of a memory, processor core and programmable input/output peripherals. Also Microcontrollers include an integrated CPU, memory (a small amount of RAM, programmable memory or both) and peripherals capable of input and output ports. dsPIC stands for digital signal Peripheral Interface Controller and is developed by Microchip Technology to identify its single-chip microcontrollers. These devices are very successful in 16-bit microcontrollers. The main purpose is that Microchip Technology has continuously upgraded the device architecture and added needed peripherals to the microcontroller to suit customer's requirements.

It is a high performance modified RISC CPU. It consist of modified Harvard architecture, optimized instruction sets architecture, 16X16 bit working register array, 16 bit wide data path and 8 user selectable priority levels for each interrupt.

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It has wide operating voltage range up to 2.5V to 5.5V. Reduced cost, size, and power consumption compared to a design using a separate memory, microprocessor, and input/output devices.

B. *ActelProASIC3 FPGA*

Actel is nonvolatile, low power field programmable gate arrays, mixed signal FPGAs and programmable logic solutions.

ProASIC3, the third-generation family of Actel flash FPGAs offers density, performance, and features beyond those of the ProASICPLUS family. Nonvolatile flash technology provides ProASIC3 devices the advantage of being a low power, secure, single-chip solution that is live at power-up (LAPU). ProASIC3 is reprogrammable and offers time-to-market benefits at an ASIC-level unit cost.

These features enable designers to create high density systems using existing ASIC or FPGA design flow and tools. ProASIC3 devices offer 1k bit of on chip, reprogrammable, nonvolatile Flash ROM storage and also the clock conditioning circuitry based on integrated PLL. ProASIC3 FPGAs are only to use true flash memory for logic configuration, and enabling them to provide critical firm-error immunity.ProASIC3 FPGA with their firm error immunity small form factor and low power and remove the barriers to FPGA adoption in safety critical applications.

C. RFID Modules

In this project the RFID module consist of RFID Passive tag or card and RFID reader of low frequency of 135 KHz range.

RFID CARD: In this paper low frequency passive RFID card can be used. It do not contain a battery, instead they draw their power from radio wave transmitted by the reader. The tag will briefly converse with the reader for identification and exchange of data.

As a result, passive tags can transmit information within few cm. They have a smaller memory capacity. Here the identification numbers or password can be stored in the memory.

RFID Reader: The RFID reader also called RF transceiver is the source of the RF energy used to activate and power the passive RFID card. It receives the data from the card through the magnetic flux created between the card and reader then the received data will be decoded then sent to the FPGA.

D. GSM Modem

Fargo Maestro 20 is a family of modem used in this project. It also supports GPRS Class 10 or Class 2 for high speed data transfer. It can be easily controlled by AT commands for all kinds of operations like sending SMS. It is designed for global market, works on frequencies of 900MHz to 1800MHz range.

This modem is a highly flexible plug and play quad band GSM modem. And also is supports some communication features like voice, fax, GPRS, SMS and integrated TCP/IP stack. Uses AC-DC power adaptor with the DC voltage of ratings 12V/1A.With standard 9 pin RS232 port and using telephone like audio plug the Fargo Maestro 20 can be set up with minimal efforts.

IV. SOFTWARE IMPLEMENTATION

A. *MikroC*

MikroC is a complete IDE, coding, simulating, programming and debugging for aspic microcontrollers. It is designed to give the programmer with the easiest possible solution for developing applications such for embedded systems. dsPIC and C fit together well: aspic is the most popular 16-bit chip, used in a variety of applications, and C, good for its efficiency. MicroC provides a successful match featuring highly, broad set of hardware libraries, and many number of ready-to-run examples.

Creating applications in MikroC is easy and intuitive. The project wizard allows to set up project in few clicks are name your application, set flags, select chip and get going.

Most of times, hardware libraries requires specific hardware parts to be available inside the aspic, and also some time it is possible to simulates its functions, like we have seen with UART. This IDE also helps for 8 bits PICs.

B. *Embedded-Coding Language*

The salient features of embedded programming are code speed and code size. Code speed is governed by program memory and use of program language. Goal of embedded system programming is to get maximum features in minimum space and time.

The embedded systems are programmed by using different type of languages. In this project the high level language like C can be used for programming or interfacing LCD and GSM modem with dsPIC.

This paper contains LCD disply and GSM modem as embedded components. The LCD for displaying success and failure messages and GSM modem for sending that messages and USART communication program also be written in embedded C only. After that all the programs compiled in MicroC compiler tool.

After verifying the data present in FPGA, it will send to the microcontroller. The LCD is interfacing with port D of microcontroller which displays messages on LCD.

After displaying the messages on LCD parallelly messages will be sent to the mobile number which was stored. The protocol communication takes place using RS232 cables.

C. *Actel Libero IDE*

Actel's Libero IDE offers best in class tools from EDA leaders, such as Magma, Monographic, Synaptic AD and Simplicity, and custom developed tools from Acted integrated into a single FPGA development Package. The libero tool suit supports verilog HDL language blocks with schematic modules in a design.

At Actel Corporation is a supplier of innovative programmable logic solutions, including FPGAs based on antiques and flash technologies, high performance intellectual property (IP) cores, software development tools and design services, targeted for the ASIC replacement, high speed communications and radiation tolerant markets.

And also providing the user to synthesize (compile) their designs, perform timing analysis, examine RTL diagrams, simulate a design's reaction to different value, and reach the target device with the programmer.

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D. *Verilog- Coding Language*

Verilog HDL is one of the most common Hardware Description Languages (HDL) used by integrated circuit (IC) designers and the other one is Very High Speed Integrated Circuit High Description Language (VHDL). HDL's allows the design to be simulated earlier in the design cycle in order to correct errors or experiment with different types of architectures. Designs which are described in HDL are technology independent, easy to design, easy to debug and are usually more readable than schematics, especially for large circuits.

In this paper the verilog program has been written for storing and enabling stored passwards in FPGA using FIFO module.

V. TESTING AND RESULTS

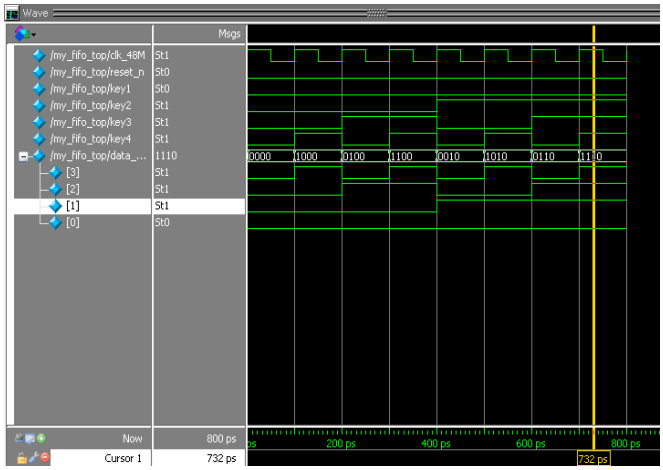

Fig 2: simulation results

The Figure 2 depicts the simulation results for the verilog code written for checking the variation of output with respect to data received from RFID card and is declared bit wise for 8 number of RFID cards. Which means the digital bits (password) in hexadecimal form are stored in each card. Those bits have been verified with the stored data bits in FPGA.

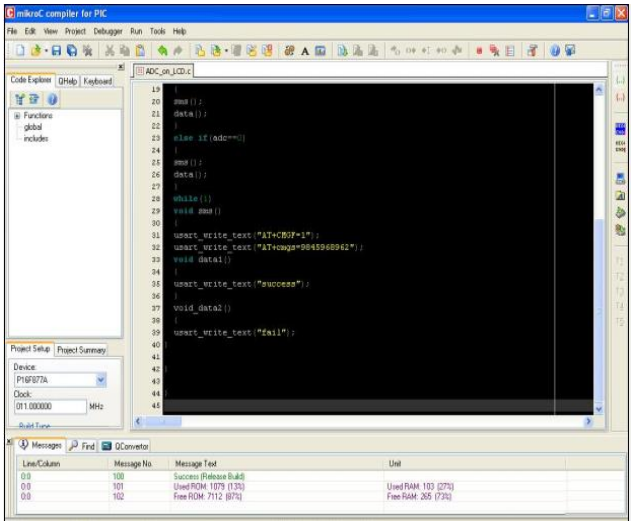

Fig 3: Compilation Output for embedded C code

The Figure3 above shows the successful compilation result using MicroC compiler software for the embedded C code written for usart communication and also for the LCD and GSM modem for sending sms.

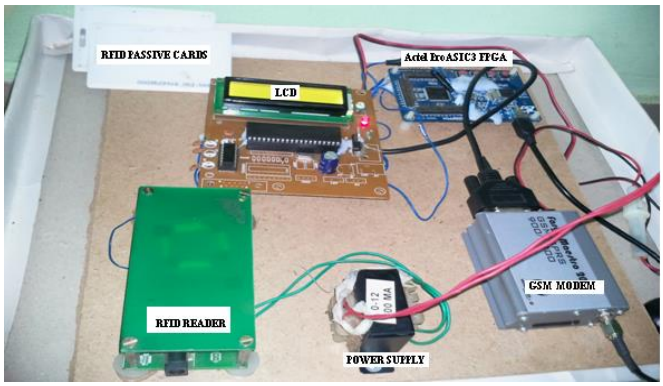

Fig 4: Project Setup

The Figure 3 shows the project hardware model. It consist of Power supply unit, RFID Reader, Actel ProASIC3 FPGA, LCD (16X2) display, dsPIC and GSM modem.

Fig 5: Success messages on LCD and mobile phone display

The Figure 5 shows the success message displayed on the LCD as well SMS is delivered to mobile, whenever the swiped RFID card is valid.

Fig 6: Failure messages displayed on lcd and mobile phone display

The Figure 6 shows the failure message on LCD as well as SMS delivered to Mobile, whenever the swiped RFID card is invalid.

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VI. CONCLUSION

This paper presents one of the new ways for RFID security systems using FPGA. The work carried till now performs security application for a particular organization or wherever it is applied. Also it is a low cost, low power, compact in size.

This design could be used in banks, homes, institutions and secured offices .It leads to easy to monitor the persons in particular locations where this security system is implemented. And also this system gives easy control, time saving and reliability.

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