

FPGA Implementation of Automatic Industrial Monitoring System

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ABSTRACT: The process of monitoring the automatic industrial system involves many kinds of sensors. Boilers and steam turbines need automatic sequence of monitoring to prevent accidents. Industrial system focused on low cost sensor to perform in some automatic way as measuring the leakage of gas, CO₂, dust particle and fire from the manufacturing unit. The operations at a manufacturing unit can be monitored in real-time from a mobile phone. In this thesis, the automatic way of application in industry monitoring system deals with the core controller of FPGA, the analog sensor such as gas sensor, dust sensor and digital sensor such as PIR motion sensor. Gas sensors are largely used in industrial applications to monitor and detect toxic and combustible gases. A dust detection system measures the flow of particle matter emitted from the manufacturing unit. The motion detector application can be used to detect motion with PIR sensor and monitored. To alert the system's process of sensing GSM module has been used. All sensor devices has been controlled using FPGA controller which is simulated in QUATRUS II 10.0. Hardware implementation is done using ALTERA CYCLONE and the simulations results are verified

KEYWORDS:ADC (Analog to Digital Convertor), GSM, IOT (Internet Of Things), sensor data acquisition.

I. INTRODUCTION

The technology of rapid growth in wireless communication and system to develop an automotive industry application is to sensor device and to implement [1]. A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing. The process monitoring involves many industrial fields, to deal with the automotive way.

GSM is nothing but the physical items talking to each other, where machine to-machine (M2M) communications and person-to-computer communications will be extended to "things". Thus the emerging technology brought more rapid advances in modern WSN, has paid more needs and is expected to bring a numerous application areas including industrial WSN systems, and healthcare systems manufacturing,. Begin in communication has associates with a huge number of wireless sensor units, it generates many useful number of data .Sensor data acquisition interface equipment has major role in IoT data acquisition. Data collection is the essential application of WSN and more importantly it is the foundation of other advanced applications in IoT environment [2]. Key technologies that drive the future are related to smart sensor technologies including WSN, nanotechnology, and miniaturization. With are dedicated to the research of multi sensor acquisition interface equipment [3]. There are a lot of data acquisition multiple interface equipment with mature technologies on the market.

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The rest of the paper is organized as follows .Section II reviews about how the reconfigurable sensors to interface. Section III defines an interfaces and circuits board to specific monitoring applications for particular equipment. Section IV summarizes the hardware and software designs and also its usages. Section V contains simulation output results. Finally the conclusion and future work in Section VI.

II. RELATED WORK

The process to reconfigure the sensors by specific interface sections and its units. The process of enabling the certain equipment by using wireless network or else with the sensor acquisition units in particular time. The way environment monitoring for process of alerting the devices and divining to a protective mode of operation in communication of networks this plays vital role in industrial automation of survival devices. The way equipment to monitor by reconfigurable smart sensor interface device that integrates data collection, data processing, and wired or wireless transmission together. Now-a-days the sensors are much more comfortable to integrate and it provides easy way to communicate in wireless network.

In this paper, interface of reconfigurable sensors with the ADC0804 IC with the 20 pins interconnect and the modules of sensors to interface the board. The ADC to supply with pin to be gas module of 6,7,20 channels in the IC pins. ADC to each of the separate sensor modules to interconnect. FPGA is controller of the interface device. It is used to control data from Analog to Digital Converter(ADC), processing to output devices, and transmission to LCD display fig1. The equipment of monitoring and to interface device is also programmed inside the FPGA controller board. The Multiple sensors to interfaces are designed on the equipment. It can be extended to particular channels in board to interface the analog signal interface and also its digital signal to interface.

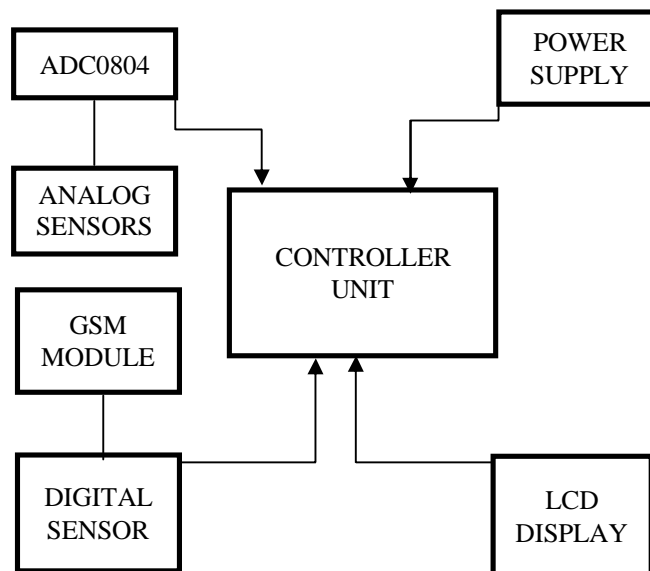


Fig .1. Controller block diagram. It shows can easily ensures that our device can connect with a number of sensors depends on the application and its need to industrial monitoring.

In terms of data received from sensor and the communication through wired interface to FPGA controller and wireless communication through GSM module through the FPGA controller unit as ALTERA.Fig1. Shows the connection of ADC with controller core to interface in the board. The sensor device used are gas module, CO2 module and the

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particle sensor which is the digital sensor. To enable the digital module sensor and display of output can be shown by the GSM unit.

III. INTERFACES AND CIRCUITS BOARD

In process of interface in practice it involves many variable sensors and interfaces such as the designed device collects analog signal and transmits the intensity sensors, CO2 sensor to an ADC. It can also collect digital signal gets transmit from the digital sensors, such as temperature measuring sensors, digital humidity sensors all on a digital signal interface units. This paper has interface of gas sensor module, particle sensor module and the CO2 sensor module. In this application of monitoring the equipment uses the fewer number of sensor nodes to interface to the controller unit as ALTERA board. This application use a low cost sensor nodes to interface and provide the outcome of real-time usage boards. It also supports for the reconfigurable nodes of sensor devices.

The power supply of 12V it's from external power source voltage circuit of 230V by step up and stepdown transformer to convert it into 12 voltage. The ADC circuit board uses a voltage regulator 7805 with positive regulator. Fig 2. Shows the interface of sensor devices, GSM and LCD display. The hardware block of ADC shows the power supply connection and varies interconnect of resistors, capacitors to configure the board. The design is to configure the input data and to conversion process to implement the information.

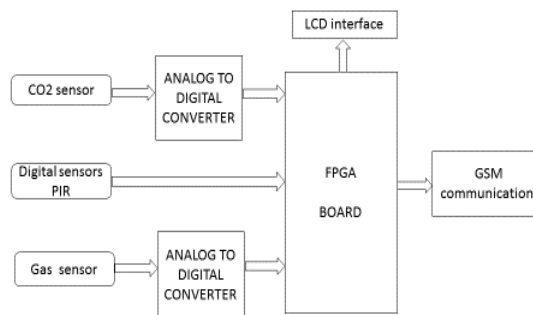


Fig .2. Interface of controller Block Diagram. The interface of this sensor units with ADC0804 is used for conversion from the analog to digital output and the formation to the controller unit of ALTERA board. The LCD display which shows the analog output value to display.

The process of GSM is to share the information of ALERT to be display.

$$V_{\text{analog}} \div (V_{\text{ref}} * 255) = \text{digital value}$$

$$V_{\text{analog}} = 4.2$$

$$V_{\text{ref}} = 5\text{v}$$

$$\text{Digital value} = (0.84 * 255)$$

$$= 214$$

$$= (11010110)_2$$

ADC conversion representation.

The circuit to represent the connection involved in block diagram for monitoring the equipment.

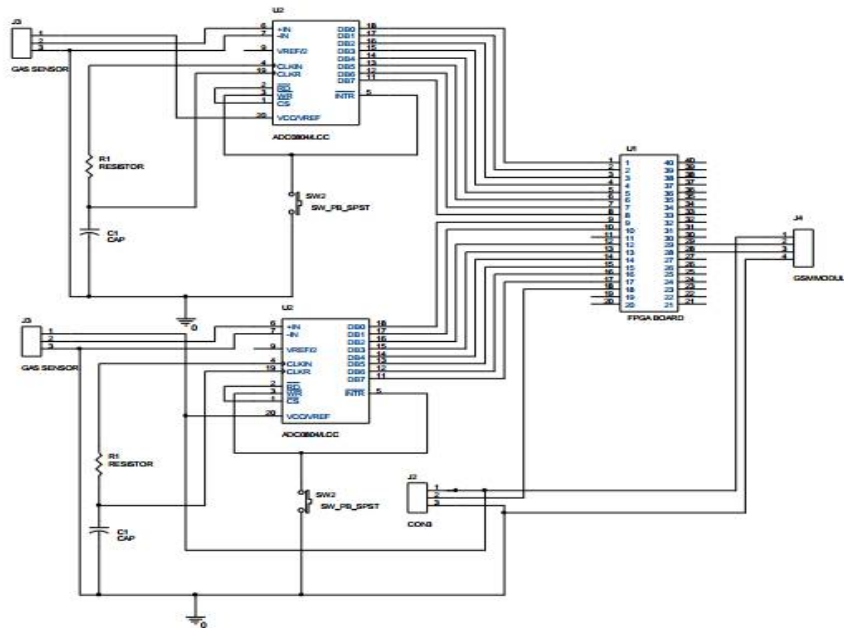


Fig. 3. Hardware Interface Diagram. The sensor nodes to interface with FPGA core controller block which has the 40 pin channel for input and output with power supply of 12V. The gas module is connected to ADC0804 and another particle module to the GSM. The GSM has the output and its receiver transmitter to the central control unit of FPGA. Receiver and transmitter process to communicate with the GSM from signal received by the core controller unit of FPGA.

IV. HARDWARE AND SOFTWARE DESIGN

The overall structure of reconfigurable sensor interface consists of ALTERA CYCLONE family and device belongs to the (EPIC37144C8), communication circuit GSM, power supply of 12V (voltage regulator 7804), ADC (0804), LCD display, an analog and digital sensors interfaces. As the fig.2 interface block diagram shows the analog and digital data received. The hardware system can also send and receive data besides the basic sensor data. It can also send data to the control centre GSM wireless module.

GSM wireless communication module can be connected with the board through the mini-USB interface and power supply of 12V as external interface. It can be used as wireless data transceiver node. when the main controller receives the data. After the data control centre finishes further processing for the received data, it related actions to sensor interface device. Data communication function can also control the running status of corresponding device by transceiver.

LCD display to collect the information and receives to display it through the 7 segment display board. Thus the monitoring the equipment as central unit controller is acting. The ALTERA which contains with 144 pins and its cheaper best controller board to industrial. The reconfigurable sensors are further useful to alter the designing without a change in software environment has been designed.

The Design of the Interface Device with FPGA is used as the main control unit in the device. Therefore, hardware programming language is needs to write complete drivers for every process in order to generate the signals. In this paper the ADC conversion modulus is taken. The modulus of sensors data conversion from analog to digital plays a key role in the system to design and implement. The hardware description language VHDL when the analog sensor signal

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accesses the system to monitor further signals. In this paper, the ADC is mainly controlled mainly for receives of data signal from the connected sensor nodes to act for conversion process. First, the system controls ADC to collect analog signals of sensor input. These digital signals after conversion are first stored in of ADC to display in the LCD for some times and later again bits get converted to analog.

Very-High-Speed Integrated Circuit Hardware Description Language (VHDL) design of the system to program over the FPGA. The VHDL language as the basic tool and write over features of the reconfigurable smart sensor interface device in system. The central core module of this system is FPGA-based reconfigurable smart sensor interface device designed

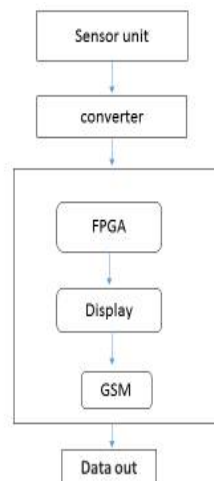


Fig.4. Work Flow. It shows the flow of information and its output.

COMMAND for GSM

```

AT
AT+CMCF=1
AT+CNMI="xxxxxxxxxx",
ALERT (default line)
A - "41"
T - "54"
+ "2B"
= "3D"
  
```

The GSM command lines for initialization and 10 digit number considered as the "x". The system to implement it by using the command lines. The fig.4 shows the flow control to data out.

The software used for simulation is QUARTUS 10.0 version and its Software design to monitoring system which includes two parts. Firstly, the program uses the hardware description language (VHDL) based on FPGA, to control different sensor data and the last communication processing to the system design.

The modules development mode is to develop various functional modules such sensor nodes. First, to implement functions in the development process, and then summarize the functions to a complete the system by way of original instantiation. Secondly, the sensor data to modify the corresponding sensor data according to different application systems. The requirements of data and then the difficulty of modifying the program is solved. FPGA system hardware resource consumption is shown in Fig. 2. To convert the analog to digital here uses the clock divider concept. The binary divider concept which is most important to divide and give to the controller and then to LCD display. GSM it uses the count values to calculate the delay. Baud rata to calculate with 50MHZ by 9600. LCD to display by concept of clock divider and in GSM uses the binary divider concept. In this sensor node platforms designed for fast development of

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various environmental monitoring applications also be detected. To simulate the coding software tool used as QUARTUS 10.0 version and hardware modules are sensor nodes, ALTER cyclone, GSM, LCD display and ADC0804. The external power supply of 12V and the controller ALTERA with minimum of 3.3V supply to the board.

V. SIMULATION OUTPUTS

The simulation outputs of LCD Display, GSM, final integrated outputs and also the hardware setup are discussed.

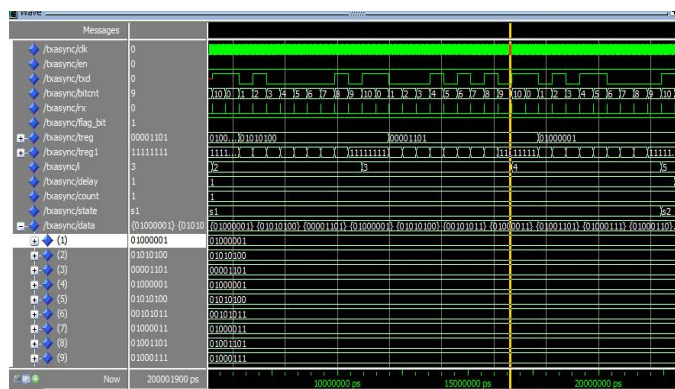
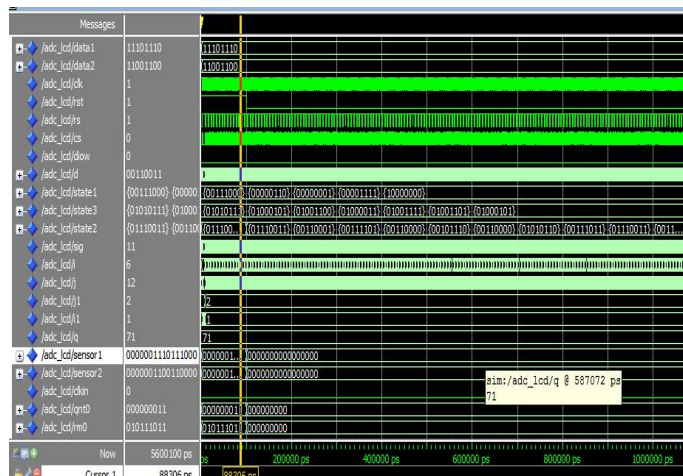


Fig 5.GSM: signals given - bitcnt, Rx ,enable, Treg, i, delay. Inputs: clk , en . Outputs: txd. The GSM to display the output in several count values and it takes the baud rate of 9600. It uses the input frequency by the required frequency signal. The input is clock and the particle enable, signals given as the bit counter, receiver input of comments.

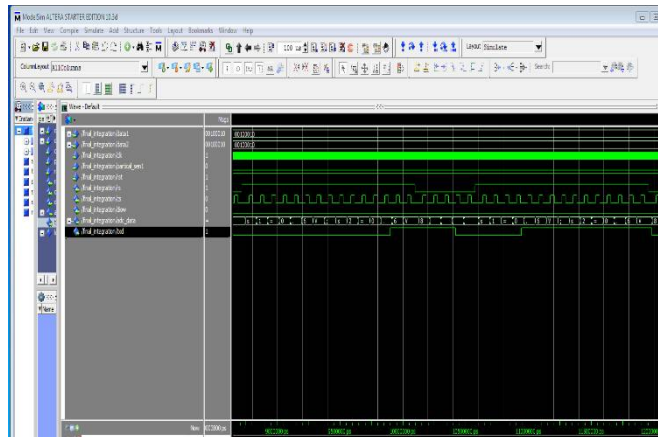


The Fig.6. Shows the LCD initialization and its signals to display. The process of LCD unit to its initialization as “38”, “06”, “0F”, “80”, “57”, “45”, “4C”, “43”, “4F”, “4D”, “45”. The analog output to be displayed in the LCD by conversion process in ADC. As a clock, data of sensor values, reset are the input of the circuit to execute.

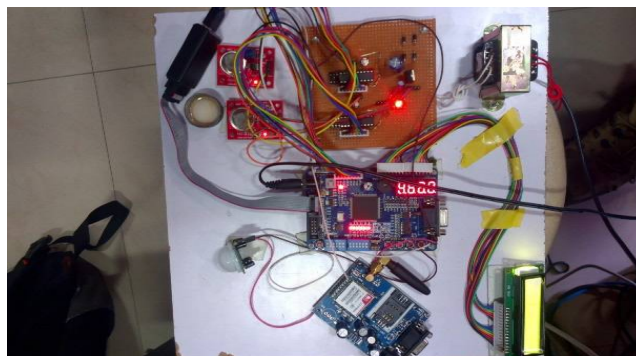
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The Fig.7. the Final integration output and input given as 00100010 and 00100010 and PIR sensor as enable '1' with clock as 1 and reset as 1. Output is display as WELCOME initially and S1 =0.6 v and S2 = 0.68 v and GSM output as high and low.



The Fig.8. Shows the full completed hardware setup. The hardware setup modules which contains the Sensor nodes as input , Analog-to-Digital Conversion (ADC), Power supply, central core FPGA unit, LCD Display, GSM and mobile. The maximum voltage to operate the ALTERA CYCLONE BOARD is 3.3V. This has the input frequency of 50 MHz which is generated from the crystal oscillator. The GSM module and ADC is coded in VHDL language. Finally the output can be measured through mobile network and LCD display its current status.

VI. CONCLUSION

The automatic monitoring of industrial system deals with the core controller of FPGA, the analog sensor such as gas sensor, dust sensor and digital sensor such as PIR motion sensor. To monitor industrial equipment, various sensors have been used and their voltage range is 4.4 V. This ensures a safer monitoring system. The parameters of Area, Power and timing report are analysed. The consumption of area is 937 LUT's, power obtained is 48.11mW and delay is 9.065ns from QUARTUS II 10.0. The maximum voltage to operate the ALTERA CYCLONE BOARD is 3.3V. This has the input frequency of 50 MHz which is generated from the crystal oscillator. The GSM module and ADC is coded in VHDL language. Finally the output can be measured through mobile network and LCD display its current status. This work can be enhanced further by connecting proximity sensor, and various other sensors depending on the industry requirement. The automatic monitoring system using IoT(Internet of Things) can be considered for the future work.

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