

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

A Reconfigurable Smart Sensor Interface for Industrial WSN in IoT Environment

Ratnamala Prakash More¹, Prof. Dr. Anil. S. Hiwale²

M. E Student, Department of E&TC (Embedded & VLSI), Genba Sopanrao Moze collage of Engineering, Balewadi
Pune, Savitribai Phule Pune University, Pune India.

Department of E&TC, MIT College of Engineering Kothrud, Pune, Savitribai Phule Pune University, Pune India.

ABSTRACT: Wireless Sensor Networks (WSN) has been employed to collect data about physical phenomenon in various applications such as habitat monitoring. Internet of Things (IoT) has attracted a lot of attention and is expected to bring benefits to numerous application areas including industrial WSN systems, and environmental systems for data acquisition for IoT representation. A sensor interface device is essential for sensor data collection of industrial wireless sensor networks in IoT environments. Each sensor connected to the device is required to write complicated and cumbersome data collection code. To solve these problems a new method is proposed to design a reconfigurable smart sensor interface for industrial WSN in IoT environment. Thus it can read data in parallel and in real time with high speed.

KEYWORDS: ARM Controller, High speed, Internet of Things (IoT), Sensor Interface Device, WSN.

I. INTRODUCTION

A sensor is a device that detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal; for example, a thermocouple converts temperature to an output voltage. But mercury in glass thermometer is also a sensor; it converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. Internet of Things (IOT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. Typically, IOT is expected to offer advanced connectivity of devices, systems and services that goes beyond machine - to- machine communications (M2M) and covers a variety of protocols, domains, and applications. The inter connection of these embedded devices (including smart objects), is expected to usher in automation in nearly all fields, while also enabling advanced applications like a Smart Grid. Wireless sensor network (WSN), which integrates sensor technology, wireless communication technology, embedded computing technology and distributed information management technology, has been under rapid development during recent years [4]. A wireless sensor network is a collection of nodes organized into an interactive network. Each node consists of processing capability (one or more microcontroller's chips) and contains types of memory, with a Zigbee transceiver module and also, each node have a stable power source and the last part of a node, it is accommodate various sensors and actuators. The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc method. Such systems can revolutionize the way we live and work therefore in this project we want to use WSN technology to control and manage energy in building. Reconfigurable smart sensor interface device that integrates data collection data processing, and wired or wireless transmission. The device can be widely used in many application areas of the IOT and WSN to collect various kinds of sensor data in real time. The overall structure of reconfigurable smart sensor interface consists The central hub collects information from the different frequency channels and controls these channels through the ZigBee module. The central hub sends the state information to a server and then a user can monitor and control the present values using the web based user interface. This facility may create some easiness for the users. The system has been designed for measurement of temperature and LDR parameters. Important functions to the system are the ease of modeling, setup, and use. From the consumer point of view. With rapid development of IoT, major manufacturers are dedicated to the research of multisensory acquisition interface

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

equipment [8]. There is a lot of data acquisition multiple interface equipment's with mature technologies on the market . But these interface devices are very specialized in working style, so they are not individually adaptable to the changing IoT environment [9]. Meanwhile, these universal data acquisition interfaces is used as the core controller in mainstream data are often restricted in physical properties of sensors (the connect number, sampling rate, and signal types). Now, ARM 11 based Single board computer called raspberry pi. Raspberry pi has the advantage of low price and low power consumption, which makes it relatively easy to implement. It performs a task by way of interrupt, which makes these Multisensor acquisition interfaces parallel in collecting Multisensor data.

II. RELATED WORK

A wireless smart sensor platform targeted for instrumentation and predictive maintenance systems is presented. The Generic smart sensor platform with „plug-and-play“ capability supports hardware interface, payload and Communications needs of multiple inertial and position sensors, and actuators, using a RF link for communications, in a point-to-point topology. The design also provides means to update operating and monitoring parameters as well as sensor/RF link specific firmware modules „over-the-air“. Sample implementations for industrial applications and Systemperformance is discussed. In this project has used on Zigbee. This cost is too high and the WSN are controlled by remote access. Radio Frequency Identification and Wireless Sensor Network are two important wireless technologies that have wide variety of applications and provide limitless future potentials. However, RFID and sensor networks almost are under development in parallel way. Integration of RFID and wireless sensor networks attracts little attention from research community. This paper first presents a brief introduction on RFID, and then investigates recent research works, new products/patents and applications that integrate RFID with sensor networks. Four types of integration are discussed. They are integrating tags with sensors, integrating tags with wireless sensor nodes, integrating readers with wireless sensor nodes and wireless devices, and mix of RFID and sensors. New challenges and future works are discussed in the end. RFID readers have relatively low range and are quite expensive; we envision that the first applications will not have RFID readers deployed ubiquitously. The applications which allow mobile readers to be attached to person's hands, cars or robots will be good candidates. Wireless sensor networks (WSNs) have become a hot research topic in recent years clustering is considered as an effective approach to reduce network overhead and improve scalability. Wireless sensor network is one of the pervasive networks which sense our environment through various parameters like heat, temperature, pressure, etc[1]Since sensor networks are based on the dense deployment of disposable and low-cost sensor nodes, destruction of some nodes by hostile action does not affect a military operation as much as the destruction of a traditional sensor,

Which makes the sensor network concept a better approach for battlefields? [2]. The transmission between the two nodes will minimize the other nodes to show the improve throughput and greater than spatial reuse than wireless networks to lack the power controls. Adaptive Transmission Power technique to improve the Network Life Time in Wireless Sensor Networks using graph theory [3].We have distance comparison between the neighbor nodes and also local level connected from the nearest edges in wireless sensor networks. The proposal of system is to develop a sensor interface device is essential for sensor data collection of industrialWireless Sensor Networks (WSN) in Internet of Things (IoT) environment. It is planned to style a re-configurable sensible device interface for industrial WSN in IoT atmosphere, during which ARM is adopted as the corecontroller. Thus, it will scan information in parallel and in real time with high speed on multiple completelydifferent device information. Intelligent device interface specification is adopted for this style. The device iscombined with the most recent ARM programmable technology and intelligent device specification. By detecting thevalues of sensors it can easily find out the Temperature, Vibration, Gas present in the industrial environment. Sothat critical situation can be avoided and preventive measures are successfully implemented.The proposed method overcomes the drawback present in existing system by using wireless sensor network. The designed system is by using ARM 32-bit micro controller which supports different features and algorithms for the development of industrial automation systems. Using ARM controller we can connect all types of sensors and we can connect 8 bit microcontroller based sensor network to ARM controller using different wired or wireless technology. Many open source libraries and tools are available for ARM-Linux wireless sensor network development and controlling. We can monitor and control the wireless sensor network remotely using internet and web server. The system describes the development of a wireless industrial environment measuring temperature, humidity,

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

atmospheric pressure, soil moisture; water level and light detection. Where the wireless connection is implemented to acquire data from the various sensors, in addition to allow set up difficulty to be as reduced. By using Wi-Fi technology we send the sensors data to authorized person.

III. INTERNET OF THINGS (IoT)

With the advancements in Internet technologies and WSNs, a new trend is forming in the era of ubiquity [7], [4]. “IoT” is all about physical items talking to each other, where machineto- machine (M2M) communications and person-to-computer communications will be extended to “things” [9], [3]. Key technologies that drive the future of IoT are related to smart sensor technologies including WSN nanotechnology, and miniaturization [8]. Since IoT is associated with a large number of wireless sensor devices, it generates a huge number of data [1]. Sensor data acquisition interface equipment is one of the key parts in IoT applications. Data collection is the essential application of WSN and more importantly it is the foundation of other advanced applications in IoT environment [2]. IoT is a major drive to support service composition with various applications [3]. The architecture of IoT is illustrated as in Fig. 1.

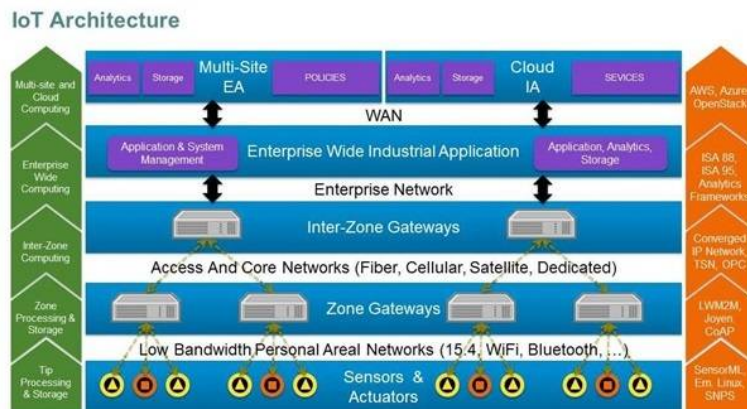


Figure No. 01 IOT Architecture

It consists of three layers: 1) perception layer; 2) network layer; and 3) application layer [34]. The design of data acquisition interface is mainly applied to the perception layer of IoT [5]. The perception layer of IoT is mainly composed of sensors, Zigbee, M2M terminals, and various data collection terminals [6]. The data acquisition interface is responsible for the integration and collaboration of various environments and collection of sensor data. Examples of such a workflow include an environment monitoring system that adopts sensors to temperature and light [7]. Environment monitoring is one of the IoT application fields, where complex water quality information, is used to determine the environmental quality at the same time. However, currently, there are few data collection device that are dedicated to quality monitoring on the market. Such devices can ensure high speed of data acquisition for multiple sensors and adapt to complex and various sensor types well. Thus, we design and implement a WSN data acquisition interface that can be used for environmental monitoring.

IV. IMPLEMENTATION

The overall structure of reconfigurable smart sensor interface Consists as below

A. Raspberry Pi

The Raspberry Pi is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high-definition video. We want to see it being used by kids all over the world to learn how computers work, how to manipulate the electronic world around them, and how to program. The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

B. Zigbee

Zigbee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries and the mesh networking provides high reliability and larger range. Zigbee has been developed to meet the growing demand for capable wireless networking between numerous low power devices. Zigbee is an established set of specifications for wireless personal area networking (WPAN), i.e. digital radio connections between computers and related devices.

C. Temperature Sensor (lm35)

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigradescaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\ \mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to $+150^{\circ}\text{C}$ temperature range.

D. LDR LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1,000,000 ohms, but when they are illuminated with light, the resistance drops dramatically. Thus in this project, LDR plays an important role in switching on the lights based on the intensity of light i.e., if the intensity of light is more (during daytime) the lights will be in off condition. And if the intensity of light is less (during nights), the lights will be switched on.

E. Ethernet

Ethernet is a shared-media LAN, which means that all stations on the segment use a part of the total bandwidth. Depending on the type of Ethernet implemented, this total bandwidth is a 10 Mbps (Ethernet), 100 Mbps (Fast Ethernet), or 1000 Mbps (Gigabit Ethernet). In a shared Ethernet environment all hosts are connected to the same bus and compete with each other for the bandwidth. In such an environment packets meant for one machine are received by all the other machines.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

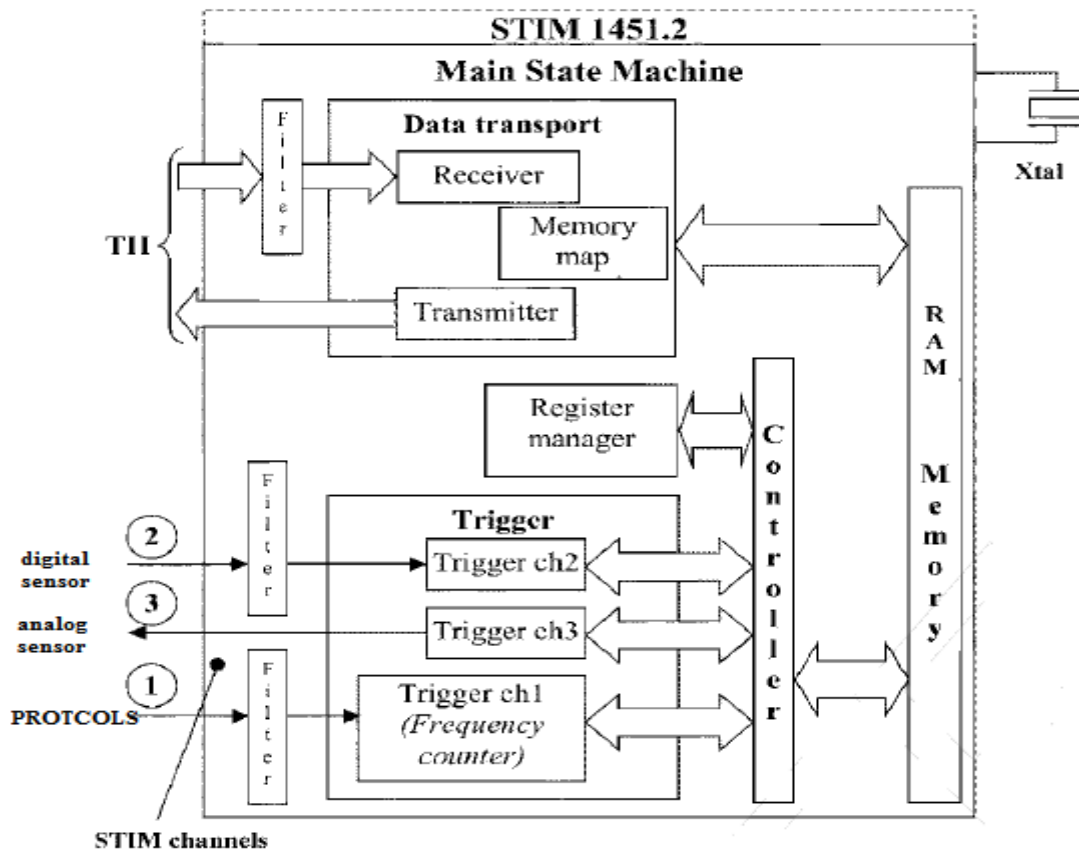


Figure no02: Block Diagram of the Project

To design a reconfigurable smart sensor interface device that integrates data collection, data processing, and wired or wireless transmission together. The device can be widely used in many application areas of the IoT and WSN to collect various kinds of sensor data in real time. To program IP core module in its ARM. Therefore, our interface device can automatically discover sensors connected to it, and to collect multiple sets of sensor data intelligently, and parallel with high-speed. ARM is the core controller of the interface device. It is used to control data acquisition, processing, and transmission intelligently, and make some preprocessing work for the collected data. The driver of chips on the interface device is also programmed inside the ARM. Multiple scalable interfaces are designed on the equipment. It can be extended to 8-channel analog signal interface and 24-channel digital signal interface. This ensures that our device can connect with a number of sensors among the application of industrial IoT or WSN and guarantees the diverse collection of the information. In terms of data transmission, our design can achieve communication through Universal Serial Bus interface. Therefore, we can choose different transmission mode of the device in different industrial application environments. The designed device collects analog signal transmitted from color sensors, light intensity sensors, and other similar sensors through an analog signal interface. It can also collect digital signal transmitted from the digital sensors, such as temperature sensors, digital humidity sensors, and so on, through a digital signal interface. The ADC module and signal interface on the interface device are controlled by the ARM, which makes it possible to collect the 8-channel analog signals and 24-channel digital signals circularly, and sets these collected data into the integrated Static Random Access Memory on the interface device. The collected data can be transmitted to the host computer side by way of USB serial communication so that the user can analyze and process the data.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

V. IMPLEMENTATION DETAILS

The Introduction of the Hardware Architecture The overall structure of reconfigurable smart sensor interface consists of CPLD chip (XC2C256 chip), crystals and peripheral circuit, communication circuit for turning USB to serial port (PL2303HXC chips and peripheral circuits), power supply of 1.8 and 3.3 V (LM1117 chip, voltage regulator and filter circuit), an SRAM memory (TC55V400 chip), high-speed 8-channel ADC (ADS7870 chip and peripheral circuit), LED indicator light, an analog extended interface, and three digital extended interfaces. Every extended interface among them can connect eight independent sensors, namely, the reconfigurable smart sensor interface device can access eight analog signals and 24 digital signals. Fig. 3 shows the CPLD hardware block diagram. The hardware system can also send and receive data besides the basic sensor data acquisition. It can send data to the control center via USB serial port or Zigbee wireless module. Zigbee wireless communication module can be connected with the board through the mini-USB interface or the extensible GPIO interface

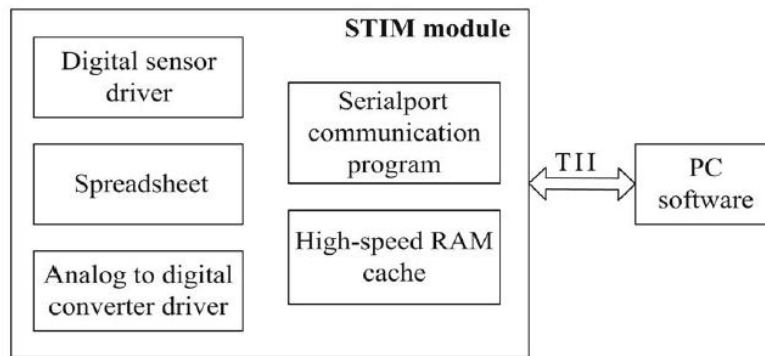


Figure No 03. Overall structure diagram of VHDL part of the system.

It can be used as wireless data transceiver node when the main controller receives trial or executive instructions [39]. After the data control center finishes further processing for the received data, it needs to feedback related actions to sensor interface device. Data communication function can also control the running status of corresponding peripheral device.

VI. RESULTS AND DISCUSSION

Proteus VSM uses ISIS schematic capture software to provide the environment for design entry and development. The ISIS software combines ease of use with powerful editing tools. It is capable of supporting schematic capture for both simulation and PCB design. Designs entered in to Proteus VSM for testing can be net-listed for PCB layout either with Proteus PCB Design products or with third party PCB layout tools. ISIS also provides a very high degree of control over the drawing appearance, in terms of line widths, fill styles, fonts, etc. These capabilities are used to provide the graphics necessary for circuit animation. Very-High-Speed Integrated Circuit Hardware Description Language (VHDL) design of the system includes two parts. One part to uses the VHDL language as the basic tool and write related features of the reconfigurable smart sensor interface device by referring to the standard of IEEE1451.2 agreement. It reflects the difference between reconfigurable smart sensor interface device and general data acquisition card, which has a great effect in intelligently collecting sensor data. The other part is programming the interface driver based on VHDL hardware description language. It mainly covers programming of each hardware chip driver and sensor driver on the device. Fig. 4 shows the overall structure diagram of VHDL part of system.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

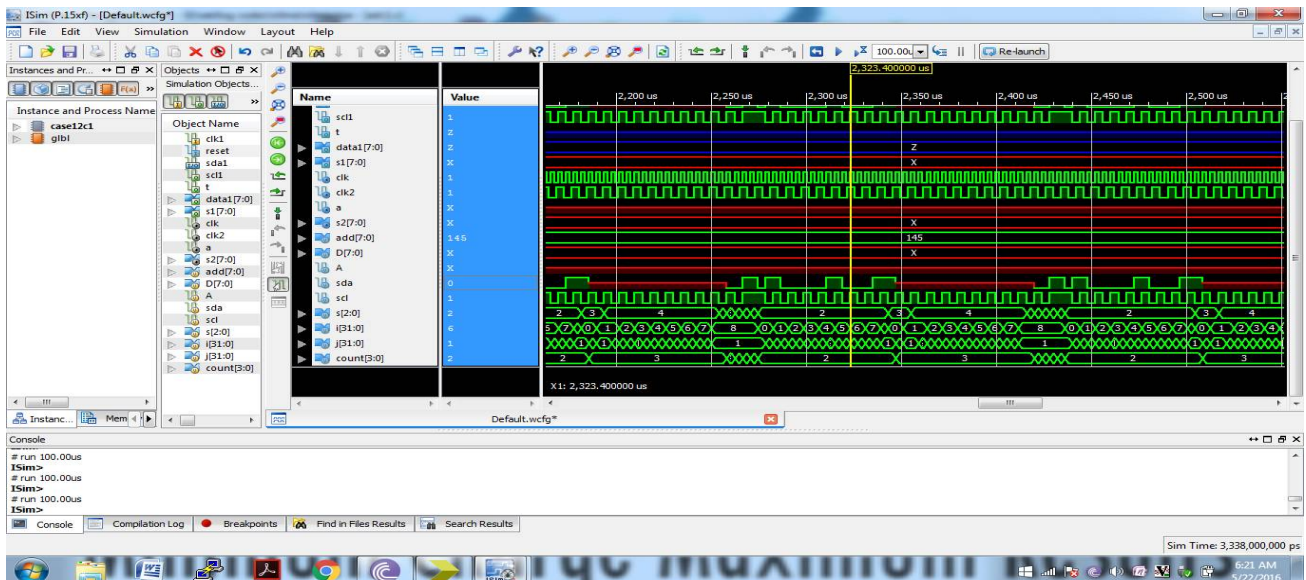


Figure: No 04 I2C simulations

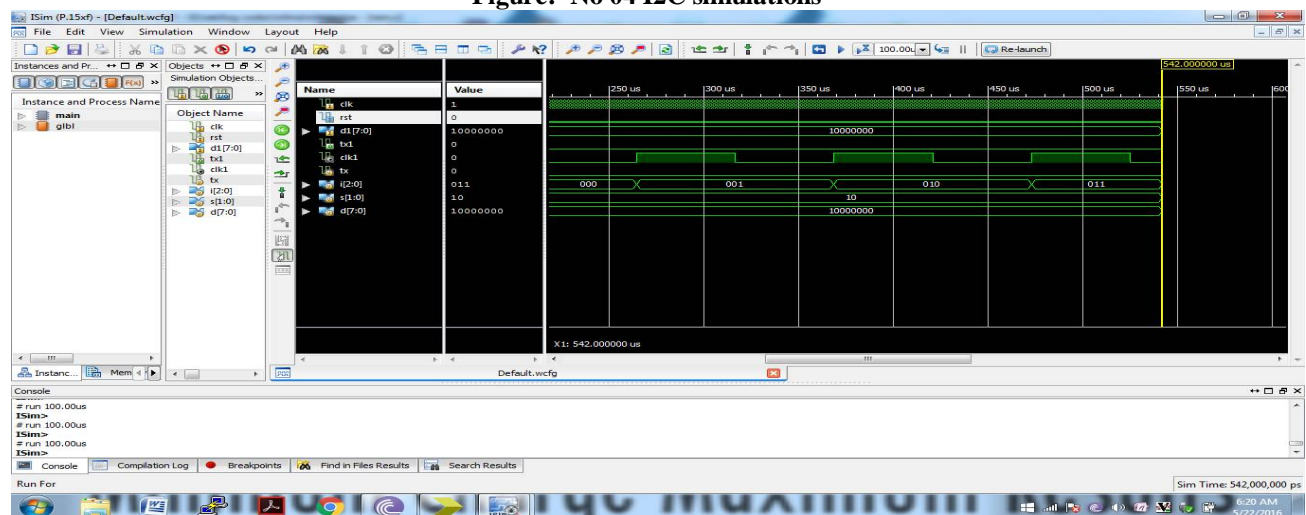


Figure No 05 Serial Simulations

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

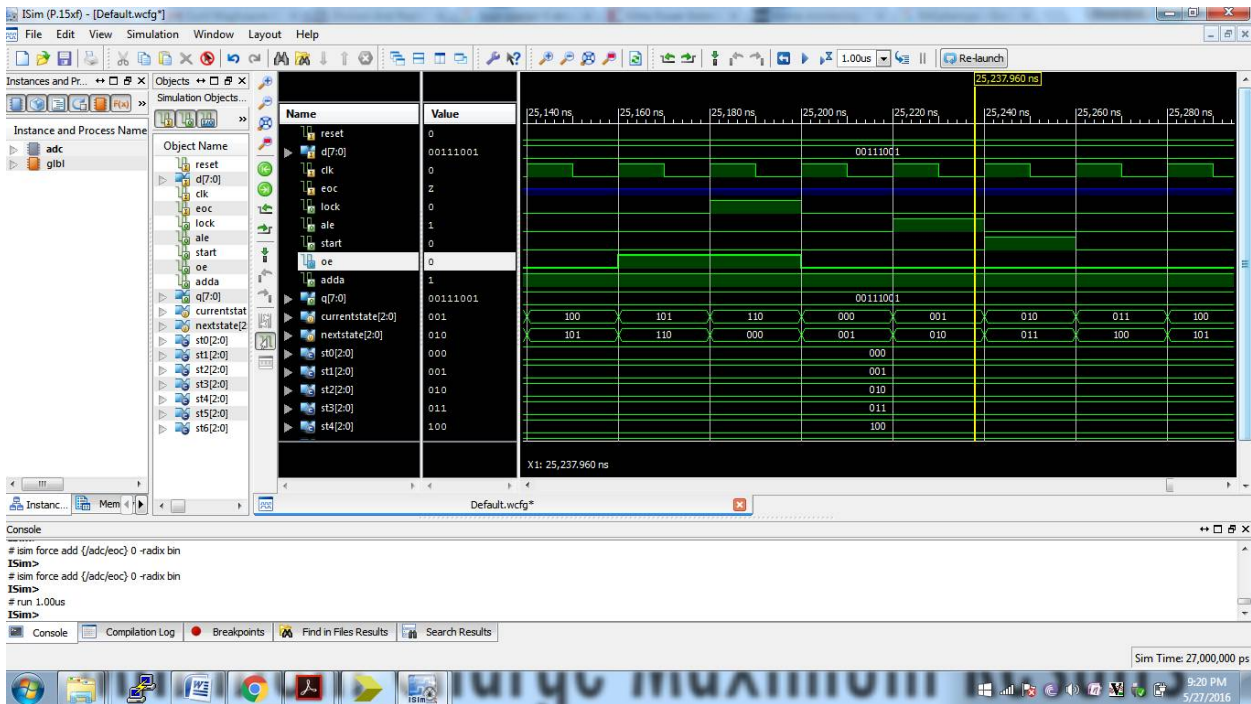


Figure No 06 ADC simulation

V. CONCLUSION AND FUTURE WORK

The smart sensor interface for industrial WSN in IoT environment system can collect sensor data intelligently. It was designed based on ARM and the application of wireless communication. It is very suitable for real-time and effective requirements of the high-speed data acquisition system in IoT environment. The ARM greatly simplifies the design of peripheral circuit, and makes the whole system more flexible and extensible. Different types of sensors can be used as long as they are connected to the system. On setting the values of each sensors then the Temperature, Gas, Vibration values are known. The values of Temperature are 67.4c is measured. The Vibration and Gas sensor is either Low or Medium, it means Low indicates that there is no gas and vibration, then Medium indicates there is a Gas and Vibration present. By this way the critical situation can be avoided. The design system applies interface standard that is used for smart sensors of automatically discovering network. The sensors are not based on protocol standard. The data acquisition interface system can achieve the function of plug and play. High execution speed, flexible organization structure, IP design could reuse. It will have a broad space for development in the area of WSN in IoT environment.

REFERENCES

- [1] S. Li, L. Xu, X. Wang, and J. Wang, "Integration of hybrid wireless networks in cloud services oriented enterprise information systems," *Enterp. Inf. Syst.*, vol. 6, no. 2, pp. 165–187, 2012.
- [2] Q. Li, Z. Wang, W. Li, J. Li, C. Wang, and R. Du, "Applications integration in a hybrid cloud computing environment: Modelling and platform," *Enterp. Inf. Syst.*, vol. 7, no. 3, pp. 237–271, 2013.
- [3] L. Wang, L. D. Xu, Z. Bi, and Y. Xu, "Data cleaning for RFID and WSN integration," *IEEE Trans. Ind. Informat.*, vol. 10, no. 1, pp. 408–418, Feb. 2014.
- [4] Y. Fan, Y. Yin, L. Xu, Y. Zeng, and F. Wu, "IoT based smart rehabilitation system," *IEEE Trans. Ind. Informat.*, vol. 10, no. 2, pp. 1568–1577, 2014.
- [5] W. He, G. Yan, and L. Xu, "Developing vehicular data cloud services in the IoT environment," *IEEE Trans. Ind. Informat.*, vol. 10, no. 2, pp. 1587–1595, 2014.
- [6] M. T. Lazarescu, "Design of a WSN platform for long-term environmental monitoring for IoT applications," *IEEE J. Emerg. Sel. Topics Circuits Syst.*, vol. 3, no. 1, pp. 45–54, Mar. 2013.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

- [7] L. Xu, "Introduction: Systems science in industrial sectors," *Syst. Res. Behav. Sci.*, vol. 30, no. 3, pp. 211–213, 2013.
- [8] Z. Pang et al., "Ecosystem analysis in the design of open platform based in-home healthcare terminals towards the internet-of-things," in *Proc. IEEE 15th Int. Conf. Adv. Commun. Technol. (ICACT)*, 2013, pp. 529–534.
- [9] L. Benini, "Designing next-generation smart sensor hubs for the Internet of Things," in *Proc. 5th IEEE Int. Workshop Adv. Sensors Interfaces (IWASI)*, 2013, p. 113.
- [10] Y. Chen and V. Dinavahi, "Multi-FPGA digital hardware design for detailed large-scale real-time electromagnetic transient simulation of power systems," *IET Gener. Transmiss. Distrib.*, vol. 7, no. 5, pp. 451–463, 2013.
- [11] A. Myaing and V. Dinavahi, "FPGA-based real-time emulation of power electronic systems with detailed representation of device characteristics," *IEEE Trans. Ind. Electron.*, vol. 58, no. 1, pp. 358–368, Jan. 2011.
- [12] R. Dafali, J. Diguët, and J. Creput, "Self-adaptive network-on-chip interface," *IEEE Embedded Syst. Lett.*, vol. 5, no. 4, pp. 73–76, Dec. 2013.
- [13] J. H.-L. Lu et al., "Low-power, wide-dynamic-range semi-digital universal sensor readout circuit using pulsewidth modulation," *IEEE Sensors J.*, vol. 11, no. 5, pp. 1134–1144, May 2011.
- [14] Z. Pang et al., "An RTOS-based architecture for industrial wireless sensor network stacks with multi-processor support," in *Proc. Ind. Technol. (ICIT)*, 2013, pp. 1216–1221.
- [15] L. Xu, "Information architecture for supply chain quality management," *Int. J. Prod. Res.*, vol. 49, no. 1, pp. 183–198, 2011.
- [16] W. Viriyasitavat, L. Xu, and W. Viriyasitavat, "A new approach for compliance checking in service workflows," *IEEE Trans. Ind. Informat.*, vol. 10, no. 2, pp. 1452–1460, 2014.
- [17] S. Li, L. Da Xu, and X. Wang, "Compressed sensing signal and data acquisition in wireless sensor networks and internet of things," *IEEE Trans. Ind. Informat.*, vol. 9, no. 4, pp. 2177–2186, Nov. 2013.
- [18] Z. Hanzalek and P. Jurcik, "Energy efficient scheduling for cluster-tree wireless sensor networks with time-bounded data flows: Application to IEEE 802.15.4/ZigBee," *IEEE Trans. Ind. Informat.*, vol. 6, no. 3, pp. 438–450, Aug. 2010.
- [19] T. Wang, T. Shi, and B. Zhao, "The implementation of an intelligent IEEE1451.4 sensor data acquisition system," *Microcomputer Inf.*, vol. 23, no. 4, pp. 1131–1133, 2007.
- [20] K. C. Lee et al., "IEEE-1451-based smart module for in-vehicle networking systems of intelligent vehicles," *IEEE Trans. Ind. Electron.*, vol. 51, no. 6, pp. 1150–1158, Dec. 2004.