Industrial Automation Using PSOC 5LP

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Abstract: **This paper presents an efficient design for industrial temperature data logger using Programmable System on Chip (PSoC) and wireless sensor network called zigbee, this design monitors the environmental condition like temperature of industry by sending warning message to the PC via zigbee and also it displays message on LCD screen that is present in PSOC microcontroller. PSoC is a programmable embedded system on chip integrating configurable analogue and digital blocks and with the ARM Cortex M3 micro-controller on the single chip. Zigbee is one of the typical short range wireless communication technology, that transmits the temperature data efficiently between plant to central station of industry, Zigbee is used because which has been widely used in a certain application areas including the family network, control network, mobile phones and other mobile terminals in foreign countries.**

Keywords: PSoC 5LP; Zigbee; Temperature sensor;

I. INTRODUCTION

Temperature sensors are one of the fastest growing fields in the sensors market because of the abundance of applications where temperature must be monitored and controlled, including personal computers, mobile phones, automobiles, medical equipments, process industries, nuclear plants, within different sensors and many others. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications.

The digital revolution in industries requires monitoring systems to flexible and fewer complexes to analyze, for in this direction we use PSoC microntroller for industrial temperature data logger, PSoC is a programmable embedded design platform integrating discrete analog and programmable logic along with memory and a microcontroller. This solution allows not only configuration of the code that will be executed, but also of the resources that will be used along with the input/output pins they are connected to. The increased flexibility of the device architecture, combined with ease of use, provides conditions for creating customized peripheral configurations matching the needs of a wide range of applications and also it is is a self-selecting digital pin or analogue input and output unit that can significantly reduce the number of required peripheral parts and quickly fulfill the design needs.

In this paper, we present temperature measurement and transfer using wireless communication technology called zigbee. Zigbee plays a key role for transmitting and receiving the data from the user. The main advantage of this concept is real time direct measurement of the parameter through Zigbee technique. The self designed zigbee module is selected to finish the transmission and decoding of the data through PSoC microcontroller.

The rest of the paper organized as follows, section 2 describes literature survey on PSoC and zigbee systems. Section 3 describes about PSoC. Section 4 includes proposed system in implementation of industrial temperature data logger using PSoC 5LP. System design is described in section 5. Results in section 6, At last, paper end up with conclusion.

II. LITERATURE SURVEY

HiroyukiKobayashi [2011][1]describes about new wireless bio- signal acquisition system in the paper "Intelligent wireless EMG/ECG electrode employing ZigBee technology". In this paper a new wireless bio-signal system that usage including universal man machine interfaces. Also this paper describes about the system having two important components

- The Intelligent Electrode
- Data Acquisition Host

Also this paper describes about the RF transceiver which employs ZigBee technology. Result of this paper revealed that the intelligent electrode achieved enough performance for most man-machine interfaces as well as human measurement applications

Shubhasini Sugumaran, V.R.Prakash [2015][2]talks about recognition of speech signal using PSoC in the paper "PSoC based speech recognition system". In this paper they have described that the Speech recognition System (SRS) has been implemented in various processors including DPSs (Digital Signal Processors) and FPGAs (Field Programmable Gate Arrays). Hence they have studied about the Cypress Programmable System on chip (PSoC) and implemented SRS on the PSoC.

In the end result revealed that the speech recognition has been successfully done and commands are given by the user in the form of speech..

Adly, H. F. Ragai, A. E. Elhennawy, K. A. Shehata [2010][3]proposed paper named "Adaptive Packet Sizing for OTAP of PSoC Based Interface Board in WSN".

In this paper they have described about adaptive packet sizing technique which was used in IEEE 802.11 wireless network to enhance link reliability and packet delivery ratio, trying to adapt the same technique to work in IEEE 802.15.4 based networks, and specifically in wireless sensor networks. A special protocol is designed to implement adaptive packet size transmission in WSN (Wireless Sensor Network).

Gonzalez J. Martha A., Echeverry M. Cesar A, Puerto L. Gustavo A, Suárez F. Carlos A [2016][4] described about the design and implementation of a wireless sensor node that operates in 900MHz and 2.4GHz bands in the paper "Design and Implementation of Wireless Sensor Node in 900MHz and 2.4GHz bands". This design provides more benefits for wireless sensor network environments and more robustness against signal loss.

Syed Safdar Hussain, Syed Sajjad Haider Zaidi [2014] [5] have proposed about a very effective image enhancement techniques that are implemented in a digital configurable block on Programmable System on Chip (PSoC) in the paper "Digital Configurable Block Based Implementation of Image Enhancement Algorithm Using PSoC 5LP". In this paper effective image enhancement technique is done by converting a 2D grey image matrix to 1D vector and sending it to PSoC5 LP Universal Asynchronous Receiver Transmitter (UART). In the result revealed that image enhancement contras stretching need multiplication operation and 50% of UDB macro cells are utilized.

Sharat Chandra, Susmita Kar, Avireni Srinivasulu, D. K. Mohanta [2011][6] talk about designing an efficient distribution automation system and its implementation in remote/automatic monitoring in the paper "Distribution System Automation Based on GSM using Programmable System on Chip (PSOC)". In this paper they have described about how relays (circuit breaker) can be controlled by means of GSM Short Message Service (SMS), automatic decision making and continuous monitoring of distribution system components in real time.

Divya KR, Chetan Naik J, Shruthi G, Asha Rani [2015][7] have described about using PSoC 5LP tiny chip board as a wireless receiver in the paper "Wireless Data Transmission Using PSoC". In this paper they have described about transmission of data is carried out between any PC as a wireless transmitter and a wireless PSoC receiver. ZigBee with PC is used as transmitter module and at the receiving end PSoC board; UART board and ZigBee module have been used.

Wen-Tsai Sung, Chia-Cheng Hsu [2013][8] talk about building an intelligent environmental monitoring system using PSoC platform and ZigBee network in the paper "Intelligent environment monitoring system based on Innovative Integration Technology via Programmable System On Chip platform and ZigBee network". In this paper they have mainly discussed about employing an intelligent environmental monitoring system.

III. PROGRAMMABLE SYSTEM ON CHIP

Modern embedded control systems incorporate a micro-controller as the principal component - a self contained computer-on-a-chip consisting of a central processing unit, RAM memory for data storage, a variety of input/output functions and non-volatile program memory to hold the software written to implement the specific application. The new generation of re-configurable PSoC (Programmable System-on-Chip) controllers, which integrates all the above components, will become the dominant system architecture for the majority of micro-based designs, by employing advanced lithography and FLASH-based programming technology. The PSoC family consists of many Programmable Systems-on- Chip Controller devices. These devices are designed to replace multiple traditional MCU-based system components with one, low cost single-chip programmable device. PSoC based data logger measuring temperature and humidity levels. With the help of microcontroller it is difficult to implement multiple sensors on single chip. But PSoC family provides this flexibility and ease of designing.

A PSoC is made more versatile with the following features
1. Graphical user interface: the PSoC designer enables the users to design a graphic user interface and provide a development environment in two levels, that is, system and chip levels.
2. Mixed signal: by integrating digital and analogue blocks together a PSoC is enabled to deal with analogue and digital signals at the same time.
3. Programmable: a reduction in peripheral requirements is made by the user programmable analogue and digital blocks in the PSoC MCU.

IV. PROPOSED SYSTEM

The proposed system consists of transmitter and receiver modules. The block diagram of the proposed system as shown in figure a and fig b.

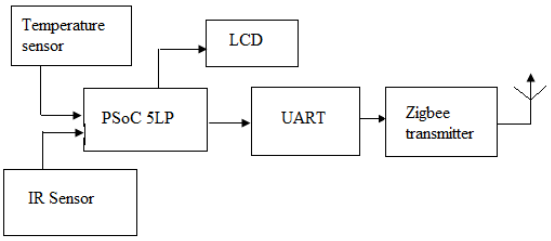

Fig a : Transmitter block diagram

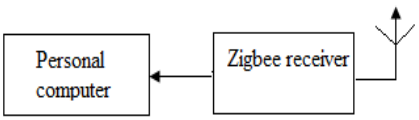

Fig b: Receiver block diagram.

The transmitter side block diagram consists of Temperature sensor the temperature of the plant is fetched or monitored by temperature sensor which is connected to PSOC 5LP. Here we are use LM35 temperature sensor because it gives accurate temperature value at real time system temperature data lmonitoring. LM 35 sensors are directly calibrated to degree Celsius, it doesn't require conversion process and also it operates at 4 to 30V. The low self healing capability of LM35 sensor has wide range of remote applications.

The next part of the transmitter is PSoC 5LP board consists of LCD display, three LEDs for monitoring system and external components sockets. PSoC collects the data from temperature sensor and compute the sensed value output. PSoC has large memory system consists of SRAM, EEPROM and flash memory. Other than these feature PSoC also have dedicated interference like Full speed USB2.0, CAN2.0, I2C and also debugging capability at on chip using JTAG and Serial Wide Debug, all these features of PSoC made development kit cost low and user friendly configurations.

The third main part of the transmitter block is wireless data communication network called zigbee, it is governed by 802.15.4 family. Zigbee has some unique characteristics like low power consumption, efficient data range and provides more number node configurations all these features of zigbee made wide range of applications. The ZigBee network layer natively supports both star and tree networks, and generic mesh networking. Every network must have one coordinator device, tasked with its creation, the control of its parameters and basic maintenance. Within star networks, the coordinator must be the central node. Both trees and meshes allow the use of ZigBee routers to extend communication at the network level.

Zigbee is connected to both transmitter and receiver side because it transmits the data from PSoC to pc, it has a feature of two way communication.

The receiver side consists of zigbee and PC, the data received from zigbee is displayed it on PC via UART. For the display here we use XCTU console. The main advantage of XCTU console is it directly prints whatever it sent data or whatever it receives data on the screen, it doesn't require queuing methods.

V. SYSTEM DESIGN

Hardware design can easily perform on PSoC IDE called PSoC Creator 2.2, it provides hardware design, debugging of circuit and programming of device. The hardware design for industrial temperature data logger using PSoC as shown in fig c.

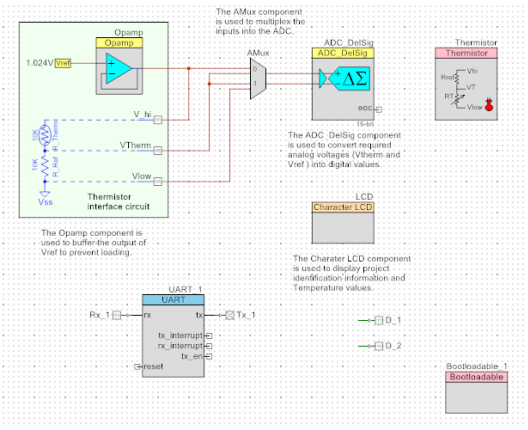

Fig c: editor window

Hardware configuration consists of OPAMP, UART, Thermister, and Character LCD. It provides complete schematic of the project. The pin configuration of the system as shown in figure d.

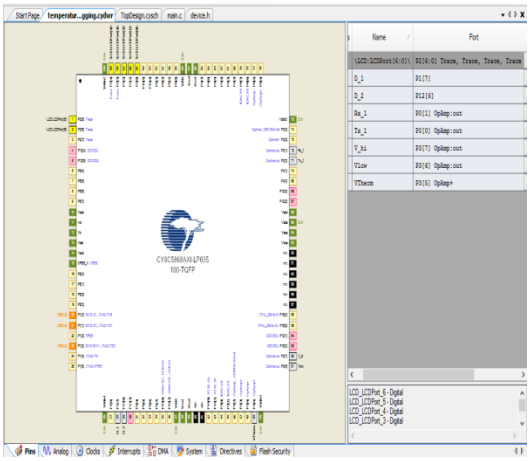

Fig d: pin configuration window

VI. RESULTS

The experimental results are carried out at different interval of time; the corresponding temperature values are recorded. The output of temperature sensor value is send it PC through the zigbee communication and it also displayed it on LCD screen. The complete set up of the system as shown in figure e and f.

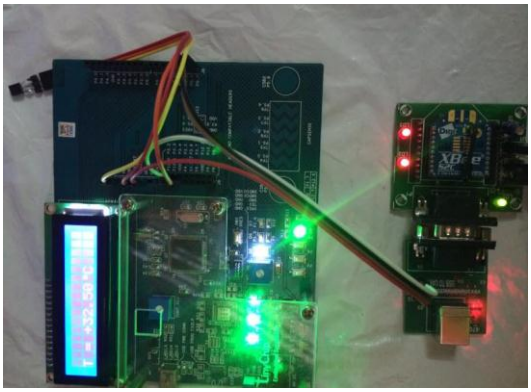

Fig e : Transmitter side module

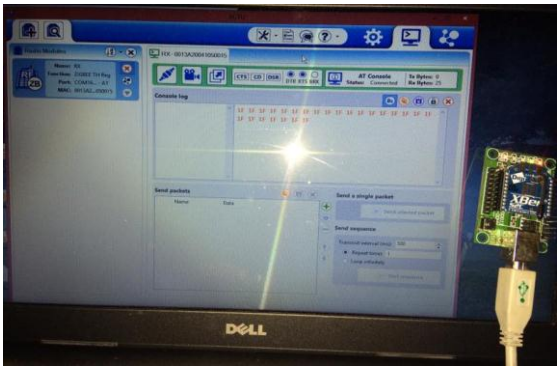

Fig f: receiver side module.

In both sides xbee modules are connected. PSoC with zigbee module as shown in figure e. The output of the LCD screen as shown in figure g, it is room temperature sensed by LM35 sensor.

Fig g:LCD Screen output

The data is also transferred to the PC using zigbee , the output displayed in PC screen as shown in figure h.

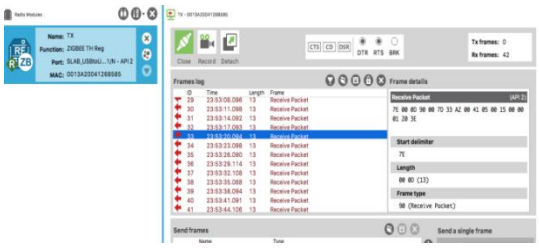

Fig h: PC Screen output.

CONCLUION

Using PSOC we can sense temperature, humidity and light intensity simultaneously and displayed values on LCD. We can use this system to control the power consumption. The PSoC implementation of dual sensor system presents a new methodology to approach sensor solutions using silicon based transducer. The implementation takes the advantage of dynamically configuration changing for measuring different physical parameters. It's simplicity and effectiveness makes it suitable for fast prototyping and low cost solutions.

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