ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 1, January 2019

Design & Development of ARM-7 Based Embedded System for Temperature Indicator

Sudhindra.F.[1], Annarao.S.J. [2] Vani.R.M[3]

Technical Officer-I, University Science Instrumentation Centre, Gulbarga University, Kalaburagi, India[1]

Head, Dept. of E&CE, HKE's Women's Poly Technique College, Kalaburagi, India [2]

Prof & Head University Science Instrumentation Centre, Gulbarga University, Kalaburagi, India[3]

ABSTRACT: Temperature is one of the important physical quantity. Monitoring and control of this physical parameter had always played important role in various fields like process control system, industrial applications, laboratory environments and in many other fields. The atomization of temperature monitoring and control is mainly depends on the use of processor or controller and the type of temperature sensor that is being adapted. The technological advancement in the filed of embedded systems has made it very simple to control and monitor the temperature even in hazardous industrial environment by the use of advanced controllers and high precision temperature sensors. Many researchers have implemented this idea on 51 architecture of microcontroller like Atmel's AT89c51 or 51 controllers. The use this controller for such purposes, not only increases the complexity of the circuit & size, but also increases power consumption. This proposes system is implemented on advanced RISC architecture based ARM-7 microcontroller to control and monitor the temperature. In this work an attempt is made for the "Development of ARM-7 based embedded system for temperature indicator". The developed system uses a Philips LPC -2148 flash programmable 16/32-bit ARM-7 based microcontroller for the precision display of ambient temperature. This is automatic, compact, reliable and low cost system. The scheme used in this project can be implemented to display any number of physical parameters. We have selected the temperature as a physical parameter because of the easy availability of sensors and other related materials. The adoptability of this system for temperature display makes it flexible and modular; hence it can be made suitable for laboratory applications. The applications of this work is in appliances like laboratory incubators, furnace, water bath, water circulating system, Electric ovens, Auto calves and sterilization units etc.

KEYWORDS: ARM-7 Microcontroller; LM-35 Temperature Sensor; Temperature selection knobs

I. INTRODUCTION

mbedded system is defined as:

- It is a system built to perform its duty, completely or partially independent of human intervention.
- It is specially designed to perform a few tasks in the most efficient way.
- It interacts with physical elements in our environment, viz. controlling and driving a motor, sensing temperature, etc.

One of the most important distinguishing factors between an embedded system and a computer is the constraints on system resources. Unlike modern day computers, an embedded system is usually designed to be more compact, energy efficient, and inexpensive. Another factor is that a computer is capable of performing a variety of tasks completely independent of each other. Though many advanced embedded systems exhibit multi-tasking capabilities, it is unreasonable to expect a system operating on washing machines to provide capability to play digital music.

Embedded systems are often required to provide Real-Time response. A Real-Time system is defined as a system whose correctness depends on the timeliness of its response An embedded system is a computer system designed to do one or a few dedicated

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 1, January 2019

and/or specific functions often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task. Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure. In this proposed system an attempt is made to control, monitor and display the temperature using LPC-2148 microcontroller.

II. RELATED WORK

The literature survey shows that, modern technologies for control & measurement of temperature have been used by the researchers. Also employed latest high precision sensing devices for this purpose. R.G. Jamkar and R.H. Chile proposes 51 architecture microcontroller based temperature indicator and controller, and has used LM35D temperature sensor for this purpose [1]. A.Rajendran and P. Neelamegam also proposes the use of 51 architecture microcontroller based system for measurement & control of temperature but with 52 series of microcontroller [2]. J. Jayapandian and Usha Rani Ravi suggest the use of single chip microcontroller for measurement & control of temperature [3]. This paper proposes advanced RISC architecture based ARM-7 microcontroller oriented embedded system that monitors & controls the temperature.

III. THE SYSTEM OUTLINE

This paper proposes an embedded system for monitoring, control and display of temperature of a water bath based on ARM-7 LPC-2148 Microcontroller. The 2000w heater which is immersed in water bath, gets automatically ON & OFF through the microcontroller's control command with respect to set temperature. The system has temperature setting knob to set the desired temperature. The system is also capable of displaying the temperature on LCD locally. As the developed system is fully automatic, no need of personal attention is required.

IV. METHODS AND MATERIALS

Fig.1 shows the functional block diagram of the proposed systems. The system is built on ARM-7 based LPC-2148 Microcontroller. The other components are LM-35DZ temperature Sensor, LCD display unit, in built ADC, Universal Asynchronous receiver transmitter (UART) and power supply unit. We will discuss few components in brief in the following sections.

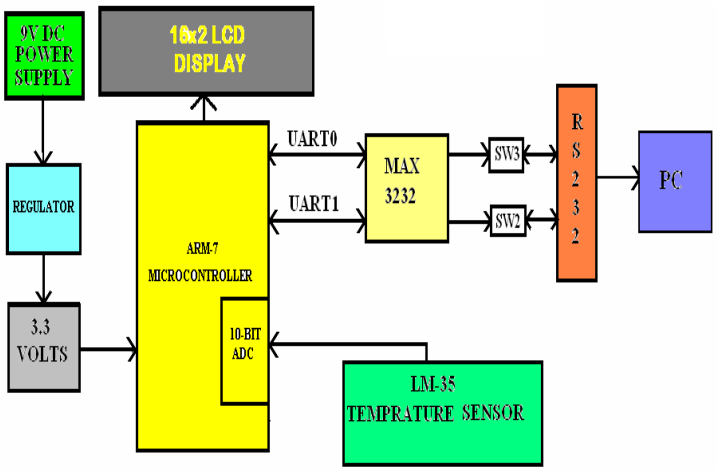

Fig.1. Functional Block Diagram of the System

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 1, January 2019

The developed embedded system block diagram is shown in the fig2.1.This consists of following blocks

* LPC-2148-ARM-7 Microcontroller
* LM-35 temperature sensor
* Liquid Crystal Display (LCD)
* Universal Asynchronous receiver transmitter (UART)
* Power supply unit

1) LPC-2148-ARM Microcontroller: The ARM-7 microcontroller used is LPC-2148, Philips make, 32-bit microcontroller which offers high performance and very low power consumption. This is the heart of the developed system because the sensing, controlling and displaying functions of the developed system are performed by the ARM controller. The microcontroller is connected to 12MHz clock generator and supply voltage of 3.3V available in 64 pin package. The ARM processor is based on reduced instruction set (RISC) architecture and related decode mechanism are much simpler than those of micro programmed complex instruction set computers. It has 32 to 512KB of on chip flash program memory. The controller uses D-type connector which is RS-232 serial I/O interface connected to UART0 available internally in the controller. The UART0 along with RS232 is use to interface microcontroller to host PC for flash programming.

Fig.2. Image of Philips Make ARM-7 LPC2148 Microcontroller

2) Temperature Sensor (LM-35DZ): LM35DZ temperature sensor is used for this work. It is a low cost temperature sensor widely used in industry and medical application. It is an industry standard semiconductor transducer, suitable for the temperature range of -50°C to +150°C. It is a direct voltage o/p device. It produces 10mV/0C of surrounding temperature. This voltage is amplified to make it suitable for the ADC to sense and for calibration. Since the output of sensor is 10mV/°C.The resolution of the ADC is 20 mV. Hence the signal is amplified precisely twice. It is used to measure body temperature as shown in fig 3.

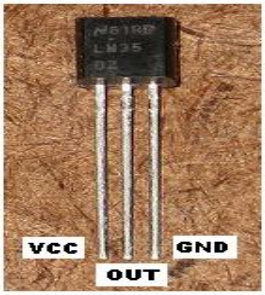

Fig.3. LM-35D Temperature Sensor

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 1, January 2019

3) Liquid Crystal Display unit: LCD module is used as the main output unit for displaying physical parameter values. It is also displays the present value of firing angle. A 2-line, 16 Character type (JHD162) LCD modules with backlit facility is used in this work. The microcontroller sends the signals to LCD module through its ports.. A liquid crystal display (LCD) is a low-cost, low-power device capable of displaying text and images. LCDs are extremely common in embedded systems, since such systems often do not have video monitors like those that come with standard desktop systems. LCDs can be found in numerous common devices like watches, fax and copy machines, and calculators. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required to run them is on board.

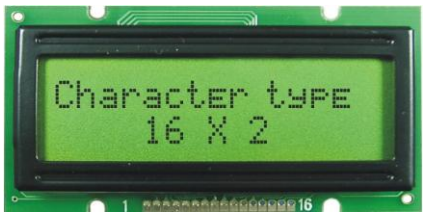

Fig.4. 16x2 LCD display Unit

4) Universal Asynchronous receiver transmitter (UART): The LPC2141/42/44/46/48 each contain two UARTs. In addition to standard transmit and receive data lines, the LPC2144/46/48 UART1 also provide a full modem control handshake interface. Compared to previous LPC2000 microcontrollers, UARTs in LPC2141/42/44/46/48 introduce a fractional baud rate generator for both UARTs, enabling these microcontrollers to achieve standard baud rates such as 115200 with any crystal frequency above 2 MHz. In addition, auto-CTS/RTS flow-control functions are fully implemented in hardware (UART1 in LPC2144/46/48 only).

Features

- 16 byte Receive and Transmit FIFOs.
- Register locations conform to '550 industry standard.
- Receiver FIFO trigger points at 1, 4, 8, and 14 bytes
- Built-in fractional baud rate generator covering wide range of baud rates without a need for external crystals of particular values.
- Transmission FIFO control enables implementation of software (XON/XOFF) flow control on both UART's
- LPC2144/46/48 UART1 equipped with standard modem interface signals. This module also provide full support for hardware flow control (auto-CTS/RTS).

5) Power supply unit: The system power supply unit consists of a step down transformer, regulator, filter, isolator etc. It will produce 3.3v DC power supply for the controller. It also provide power supply to 2000w heater through relays to attain specified temperature.

V. SYSTEM SOFTWARE

The proposed system is a dedicated embedded system which is based on ARM-7 LPC-2148; hence, software was written in Micro Vision's keil-4 without using any general operating system by using assembly and embedded C language & it is stored in the memory of the controller. When power is switched ON the system comes to ON condition from RESET position then the program is executed and controller freshly takes readings for local display on LCD.

VI. SYSTEM OPERATION

As soon as the system is powered ON, the processor automatically executes the system program stored in EPROM. The temperature sensor LM35D senses the temperature around it. The LM35 is connected to the ADC which is

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 1, January 2019

available internally in the ARM processor. The ADC starts receiving the analog signals from the temperature sensor and reads these signals by successive approximation method and converts them into digital data in real time mode. The processor sends the current value of digital information of the temperature to LCD and the LCD is programmed to display the value of temperature. A provision is also made to the developed system to interface it to the computer through serial communication device i.e RS-232. Any change to the existing program and modifications to the system hardware can be done to interface to computer. When a RS232 is used in the designed system for PC interface, a level converter MAX-3232 is also used to convert the I/O signal strength. As RS-232 signals are of ± 5 and ± 12 volts. TTL logic is used to reduce these signal strength to 3.3v. The UART0 is used in between reset switch SW3 and RS 232 for reset and interfacing the processor. UART1 is used in between switch SW2 and MAX 3232 for communication purpose as TX and RX. The system is very efficiently used to measure and display the ambient temperature around the sensor designed for laboratory purpose. No manual attention is required for the system to display the temperature.

VII. EXPERIMENTAL RESULTS & DISCUSSIONS

The designed system was very rigorously tested in the laboratory for different set temperatures and shown satisfactorily results. As the system totally automatic, there is no need of personal presence of an operator. The system is built on ARM-7 microcontroller, hence it uses low power consumption. The developed system is compact, portable and can readily be used in such application where precision monitoring of temperature is necessary.

VIII. CONCLUSIONS

In this work an attempt is made to design & develop an embedded system for display of Temperature by using Philips make LPC-2148 ARM Microcontroller. In this system temperature around the sensor LM-35 is sensed and displayed, by using LCD display unit. The necessary hardware & software is developed for interfacing. The developed software is stored in the flash memory of the ARM microcontroller which reduces the hardware of the system. So the developed system is very compact, reliable & low cost system.

REFERENCES

1. R.G. Jamkar and R.H. Chile "Microcontroller based Temperature Indicator and Controller", J. Instrum. Soc. India 34(3) pp.180-186, Sept-2004.
2. A.Rajendran and P. Neelamegam "Design of AT89C52 Microcontroller based system for the measurement of Temperature and control", J. Instrum. Soc, India 35(I) pp. 99-105, March-2005.
3.J. Jayapandian and Usha Rani Ravi "An Embedded Single Chip Temperature Controller Design" J. Instrum, Soc. India 38(2) pp.132-136, June-2008.
4.The 8051 Microcontroller Architecture, Programming and Applications- Kenneth J Ayala, Penram International, Second Edition.
5. Sensors and Transducers- D. Patranabis, Prentice-Hall of India Pvt Ltd, New Delhi, Second Edition.