Temperature Scanning Controller Design

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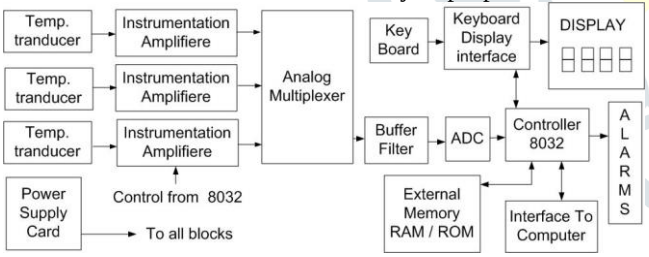
Extended Abstract : Most industrial processes function only within a specified temperature range. It is imperative in most process and control industries, that the temperature of the power electronic devices be maintained within its operating range for optimum performance. It is therefore important to know the temperature of various devices operating in industrial applications. This paper presents the design and implementation of a Microcontroller Based Temperature Scanner which is a device that can be used to measure temperature and display the temperature in centigrade directly on a seven segment display. It has the ability to measure temperature on eight different channels, provides for automatic scanning for all channels or allows the user the option to select the channel which he wants to scan. The designed device is used for measuring the temperature at different points of a system. The device, with the help of the RS-232 interface to a personal computer, can be used for data logging. It is also to be used along with support control circuitry to provide controller action.

Introduction

The microcontroller based temperature scanner is a device that is used to detect and display temperature variations in the given environment. The temperature sensors used in the device has an operating range of 10° to 300°. The designed temperature scanner can serve as a stand alone device with an in-built digital display along with visual and audile alarms programmed trigger when certain temperature limits are exceeded. The designed system has the facility of storage and manipulation of data. Data is transferred from the microcontroller to the PC through an RS232C cable so that temperature sensed can be displayed in a graphical format or can be stored for further use and analysis purposes.



The block diagram of the designed system consists of the following blocks, viz.,

Sensors: Transducers (thermocouples, RTD, are used for conversion of physical quantities such as light, heat, humidity, temperature, etc into electrical form before they are measured and controlled.

Signal conditioning card (Instrumentation amplifier, analog multiplexing, analog filtering and buffering, ADC): used to get the desired input to the successive stages and consists of multiplexers, buffers, integrators, attenuators, bridges, amplifiers.

Display: Physical parameters being measured are displayed on a digital display or a PC, which is a 4-digit (3 digits for displaying temperature and 1 digit for channel) 7-segment display of common anode type.

Microcontroller, RAM / ROM: The output of the signal conditioning device which is in analog form is converted to digital form using an ADC and given to the microcontroller which manipulates the digital signal which corresponds to the physical quantity being measured.

Alarms: Generated when temperature limits are exceeded.

Keyboard: Interactive mechanism between the system and the user is provided by means of a keyboard.

Power Supply: PS card (230V, / 18-0-18V, 3 A, ±5V, ±9V, ±12V) provide the necessary voltage to every block of the temperature scanner.

Provision for communication with PC: This establishes serial communication between the system and its components to transfer the data between the two.

Hardware design: The system is indigenously designed and developed keeping in mind the latest industrial requirements of accurate temperature scanning such as number of channels being 8, temperature range being 10 to 300°, temperature resolution being 0.5° over the entire operating range, warnings in the form of LED alarms. The features of the designed system being user friendliness and cost-effectiveness. The design considerations are as follows.

MCS-51 microcontroller with minimum external hardware and powerful instruction set is designed and is operated on 10 MHz clock. An external EPROM of 16K memory size was used. 8K of external RAM has been used to store the scanned data and provide buffering. While accessing external program or data memory port 0 acts as a multiplexed address and data bus which needs to be demultiplexed using a latch, an octal latch 74LS373 is used. The scanned data may be required to be used for further analysis. A serial port is provided to allow the system to be interfaced to allow the system to be interfaced with a personal computer (PC) which as two purposes, viz. analysis can be performed on scanned data and system software can be developed. Line driver IC's 1488 and 1489 are used for this purpose. Resolution of the ADC (ICL 7109, 12-bit ADC) was decided on the basis of temperature range and the resolution with which temperature is to be measured and was used. 3 to 8 decoder to generate interfacing signals for chips other than memory is used. Display is interfaced to using latch and display drivers.

The system consists of four main cards.

1.The Main CPU card (The data acquisition card)
2.The RTD card
3.The LM-35 card
4.The power supply card

The sensor cards and the CPU card are made separate so as to accommodate any other types of sensors and its signal conditioning circuit without any modifications to the main CPU card.

System Software

The software is developed in the MCS 51 family assembly language. This is stored in the external EPROM. The 8032 on power up fetches instruction code from the EPROM and executes them. The software is designed to perform the following functions

1. Selection of a particular channel.
2. Reading of digital data from that channel.
3. Calculation of temperature based on input from channel.

4. Display of the temperature on a 7-Segment display.

Reasons for using Assembly Language:

- To speed up computer operation: Programs written in assembly language can be stored compactly in code memory and less time is spent fetching the code.
- To reduce the size of the program: Assembly language requires no extra overhead code because the assembly language programmer is aware of the exact needs of the program for any given situation.

Assembly language programming process: The program was written in mnemonics using a text editor and stored on a disk with a .ASM extension. Using an assembler, the .ASM assembly file was converted into a machine code. OBJ file. The .OBJ file contains the machine code instructions in binary form.

The various routines that have been utilized to implement the above mentioned functions are

1. RAM Test: The Ram test is used to check the storage locations to ensure that data can be written to them as well as read without any corruption of data.

2. Mode Selection: The system can function in two modes, Auto and Manual mode. On start-up, the system awaits the user input for choice of mode and then enters the corresponding routine.

3. Auto Mode: In this mode, at first, the temperature of channel 1 is displayed for a certain period. Then the temperature of the next channel is displayed and so on the device keeps sequencing through the different channels.

4. Manual Mode: When the system enters this mode, the device displays the temperature of channel, by default. The user can cycle through the different channels with the help of the scroll-up and scroll-down keys.

5. Scroll-Up: This routine causes the system to display the temperature of the upper channel.

6. Scroll-Down: This routine causes the system to display the temperature of the lower channel.

7. Debounce: The debounce routine is used to provide a time delay after a key is pressed, to prevent the accidental detection of the ringing of the key as a valid key press.

8. Data Manipulation: The digital data is read from the ADC and is manipulated to obtain the equivalent BCD value of the temperature being sensed.

9. Alarms: This routine is invoked whenever temperature being sensed exceeds certain specified limits. The routine causes an LED to glow when the temperature falls below 25°C and another LED to glow when the temperature rises above 150°C.

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