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Design and Working of Datalogger Using Microcontroller AT89C51

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Abstract: An attempt has been made to design and working a data logger using microcontroller for storing ambient temperature data. The system works around the famous 8051 family .The system is designed and developed to measure the temperature with the help of the temperature sensors and the result is stored in memory such as EEPROM for post process analysis. During the testing it is verified that there is continuous and correct acquisition of data. It is also verified that the data is sequentially stored in a memory.
Keywords: Microcontroller, Data logger, Temperature sensor

1. Introduction

Temperature is the ever-changing parameter because of exposition to huge array of stimuli from their environment. It can be measured via a diverse array of sensors. All of them infer temperature by sensing some change in a physical characteristic. One must be careful when measuring temperature to ensure that the measuring instrument (thermometer, thermocouple, etc) is really the same temperature as the material that is being measured. Under some conditions heat from the measuring instrument can cause a temperature gradient, so the measured temperature is different from the actual temperature of the system. In such a case the measured temperature will vary not only with the temperature of the system, but also with the heat transfer properties of the system.The objective of this work is to use data logging for temperature measurement. In order to meet the above requirements, a low cost, versatile, portable data logger is designed. A microcontroller based temperature data logger has been developed for measuring temperature at different input channels of ADC. The device is designed to receive data from temperature sensors and to store the results on external non-volatile electrically erasable programmable read only memory (EEPROM) for post process analysis. An integrated Liquid crystal display (LCD) is also used for real time display of data acquired from various sensors.In the present work, temperatures indicated by three channels are compared with standard temperature obtained from clinical thermometer after the intervals of time. Based on these results, the accuracy of the channels is noted and by comparing them, the most accurate one among these is found.

2. Materials and Methods

Materials

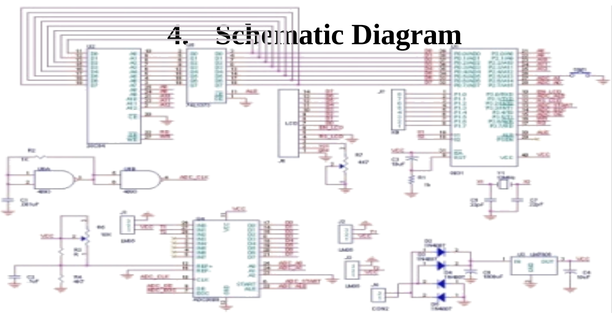
1. Microprocessor, 2. datalogger, 3. microcontroller kid, 4. Temperature Sensor (LM35), 5. Analog to Digital Converter (ADC0808) 6. Microcontroller (AT89C51), 7. Keypad Matrix (4×4 matrix) 8. Liquid Crystal Display (HD44780),
9. External Memory (AT28C64)

3. Methods:

Hardware Implementation

1.) Component selection and description.
2.) Hardware details of the system designed

4. Schematic Diagram



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5. Microcontroller AT89C51

The four I/O ports of the microcontroller are used for interfacing the external peripherals. 8 bits of port 0 are interfaced to external memory AT28C64. The memory chip AT28C64 is interfaced to the microcontroller through the latch 74LS373. 8 bits of port 1 are connected to the keyboard. First 5 bits of port 2 is connected to address lines of memory. A pushbutton is connected to P2.5. P2.6 and P2.7 are connected to the address lines of ADC. P3.0 and P3.2 are connected to pin 6 and pin 4 of LCD. P3.3, P3.4and P3.5 are connected to pin 22, 7 and 9 of ADC.P3.6 and P3.7 are connected to 22 and 27 pin of memory. Pin 30 is connected to pin 11 of latch. Pin 18 and 19 are connected to a crystal. Pin 31 is connected to V_{CC} and the Pin 9 is connected to ground via resistance of 1-kilo ohm. Pin 40 is connected to V_{CC}. Pin 30 is connected to pin 11 of Latch.

6. Memory AT28C64

8 data lines of memory are connected to port 0 of the microcontroller chip. 8 address lines are connected to latch 74LS373. The remaining address lines are connected to P2.0-P2.4. Chip enable pin is connected to ground. Output enable pin is connected to P3.7 (read pin) and Write enable pin is connected to P3.6 (write pin) of the controller chip.

7. Latch 74lS 373

It is used for the purpose of multiplexing the data. The 8 input pins are connected to address lines of memory. Data pins are connected port 0 of the controller chip. Latch enable pin of latch is connected to ALE pin of the microcontroller and the pin Output enable is connected to ground.

8. Hitachi HD44780 LCD

The 8 data pins of LCD are connected to the 8-bits of the port 0 to send data to the LCD. The control signals of the LCD module RS and EN are connected to the pins P3.0 and P3.2.RW pin is connected to ground. Pin 1 is connected to Gnd and pin 2 to V_{CC}. Pin 3 is connected to ground via variable resistance that is used to adjust the contrast.

9. Keypad

Keypad is connected to port 1 of the microcontroller chip.

10. LM35 Temperature Sensor

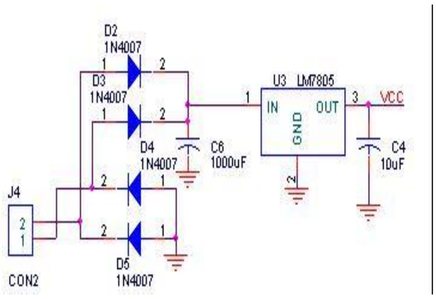
First pin is connected to Vcc, Second pin to the input channel and the third pin is connected to ground. Output of first LM35 is connected to IN0, Output of second LM35 is connected to IN1 and Output of third LM35 is connected to IN2.

11. ADC 0808

Pin 6 is connected to P3.3, Pin 9 to P3.5, Pin 7 to P3.4, and Pin 22 to P3.1 of the microcontroller chip. Schmitt trigger NAND gate is used to provide clock to the chip at pin 10.Pins 24, 25 are connected to P2.6 and P2.7 of microcontroller. The 8 data pins are connected to data pins of LCD. INO, IN1 and IN2 are connected to the outputs of the three LM35. IN3-IN7 are not connected. Pin 11 is connected to V_{CC}. Pin 13, Pin 16, Pin 23 are connected to ground. Pin 12 is connected to a variable voltage.

12. Power Supply Section

A power supply section is the regulated DC power supply of +5 Volts. +5 Volts is generated using LM7805 fixed voltage regulator. Rectification of the AC supply is carried out using 4 IN4007 diodes connected to pin 1 of LM7805.Pin 2 is connected to ground and Pin 3 is connected to V_{CC}. The output of this section is free from ripples and distortions.



13. Software Design and Development:

For the designing of algorithm of the system two steps are to be taken into account:

I. **Scanning the data**.
II. **Offline analysis**.

1.) In this algorithm, first step is to initialize the LCD panel.
2.) The keyboard is checked for the value of hours, minutes and seconds and its value is displayed on the LCD.
3.) The time displayed will then be checked for time corresponding to the channel.
4.) The address of that channel is sent to the analog to digital converter
5.) The value obtained is then converted to appropriate form for display
6.) This value is then stored in memory. The loop will repeat itself until all the values are stored in the memory.

14. Results and Discussions

Results

In this system, Temperature measurements from the three channels are taken. The performance of the three channels is distinguished on the basis of their accuracy. All the sensors are specified with accuracy. The accuracy indicates how closely the sensor can measure the actual or real world parameter value. The more accurate a sensor is, better it will perform.The readings are taken under different conditions for some time interval. Also the readings are taken at different temperatures in a time interval. Comparing the readings obtained from the three channels under the different conditions the most accurate channel among them is found.

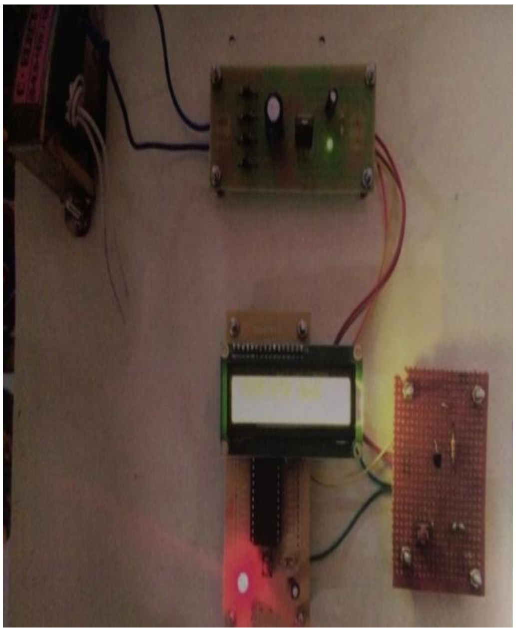


Figure 1 (a)the storage of ambient temperature in data logger

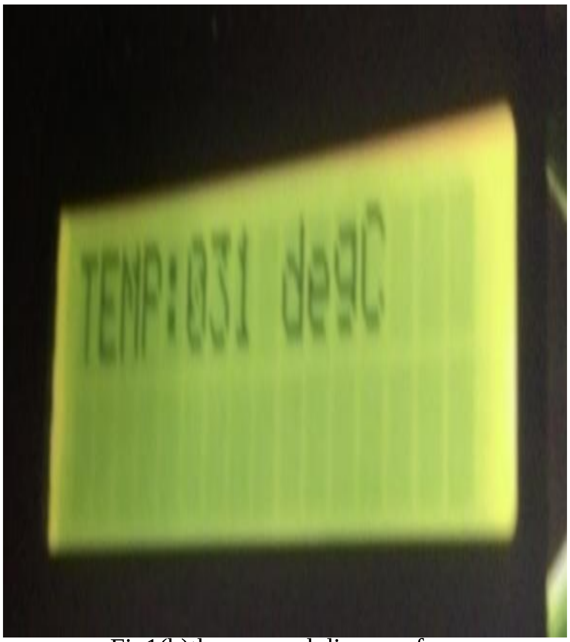


Fig1(b)the zoomed digram of ambient temperature in data logger

Table 1 experimental Results Taken Under Normal Conditions

The readings of channels at room temperature after time intervals of 5 minutes. The readings of the channels are compared with the readings of temperatures obtained from the standard temperature indications obtained from the thermometer.

Time (in minutes)	Standard Temperature (°C)	Ch1 (°C)	Ch2 (°C)	Ch3 (°C)
8:05	37.9	36	00	00
8:10	37.9	36	00	00
8:15	37.9	36	38	00
8:20	37.9	36	38	00

8:25	37.9	36	38	00
8:30	37.9	36	38	37
8:35	37.9	37	38	37
8:40	37.9	37	38	37
8:45	37.9	37	39	37

TABLE 2 EXPERIMENTAL RESULTS TAKEN AT LOW TEMPERATURE CONDITIONS

The readings obtained from the three channels at interval of 5 minutes at air conditioned temperatures. The readings of the channels are compared with the readings of temperatures obtained from the standard temperature indications obtained from the thermometer.

Time (in minutes)	Standard temperature (^{0}C)	Ch1	Ch2	Ch3
10.05	37	34	00	00
10:10	37	34	00	00
10:15	37	34	33	00
10:20	37	34	33	00
10:25	37	34	33	00
10:30	37	34	33	32
10:35	37	34	33	32
10:40	37	34	33	32
10:45	37	34	32	32
10:50	37	34	32	32
10:55	37	34	32	32

TABLE 3 EXPERIMENTAL RESULTS TAKEN AT DIFFERENT TEMPERATURES:

The readings of the channels at different temperatures in a time of 30 minutes. The readings of the channels are compared with the readings of temperatures obtained from the standard temperature indications obtained from the thermometer.Results of measurements taken at different temperatures.

Time (in minutes)	Standard temperature (^{0}C)	Ch1(^{0}C)	Ch2(^{0}C)	Ch3(^{0}C)
30	37.2	34	35	36
30	37.5	32	34	33
30	38.1	35	36	35
30	38.3	34	36	35
30	38.8	35	36	36
30	39.6	36	38	38
30	41.1	40	42	43

TABLE 4 EXPERIMENTAL RESULTS TAKEN OVER A LONG TIME

The readings of channels for a long time of 12 hrs. The readings of the channels are compared with the readings of temperatures obtained from the standard temperature indications obtained from the thermometer.

Time(in minutes)	Standard temperature (^{0}C)	Ch1(^{0}C)	Ch2(^{0}C)	Ch3(^{0}C)
8:00	37	00	00	00
8:30	37	34	35	35
9:00	37	35	36	36
9:30	37	34	35	35
10:00	37	34	35	36
10:30	37	35	36	36
11:00	37	36	37	36
11.30	37	36	37	36
12:00	37	36	37	36
12:30	37	36	37	36
1:00	37	36	37	37
1:30	37	36	37	37
2:00	37	36	37	37
2:30	38	36	37	37
3:00	38	36	37	37
3:30	38	36	37	37
4:00	38	36	37	37
4:30	38	36	37	37
5:00	38	36	38	37

15. Discussions

From the above tables of readings obtained by comparing standard temperature with the temperature of channels, the accuracy of the channels is to be discussed. Accuracy is the degree of conformity of a measured/calculated quantity to its actual (true) value that is the quality of nearness to the truth or the true value. From table 1, it is clear that Channel 2 is more close to the standard reading. The error found is .1% .the error of channel 1 is found to be 1.9% and of channel 3 is .9%. So channel 2 is more accurate one among the three because lesser is the error more will be the accuracy.

From table 2, it is clear that channel 2 is more accurate because of less deviation among the values and close to standard one.

From table 3, it is clear that the temperature of channel 2 is more constant than other channels and also close to standard temperature .So channel 2 is more accurate at different temperatures.

From table 4, the temperature of channel 2 is more close to standard temperature for a long time, as compared to other channels.

From the above discussion, it is concluded that among the three channels, the channel 2 is most accurate at different temperatures and under different conditions.

16. Conclusions:

The data logger is an invaluable tool to collect and analyse experimental data, having the ability to clearly present real time results, with sensors and probes able to respond to parameters that are beyond the normal range available from most traditional equipment. Data loggers used for measuring the temperature might have certain limitations in terms of speed, memory and cost. Also data loggers with increased number of channels are complex.

In this work, an attempt has been done to design a data logger, which is of less cost, portable, very low power consumption, self contained. It is an efficient data logger, which works in real time mode. The reduced number of channels also makes the system simple. The logger can use up to 8 channels of analog to digital converter in performingits task but tha will result in increased number of channels.

A step-by-step approach in designing a Microcontroller based system for temperature measurement has been followed. According to the study and analysis of various parts of the system, a design has been carried out. The results obtained from the measurement have shown that the system perform well under all the conditions.From this work, it is concluded that in this system among the three channels, Channel 2 more accurately measures the temperature in the given span of time.

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