Digital Thermometer Using 8051 Microcontroller

Embedded Systems Design Laboratory

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Introduction

The aim of this project is to design and develop a digital thermometer using the 8051 microcontroller. The thermometer will measure ambient temperature using an LM35 temperature sensor and display the temperature reading on an LCD display. The 8051 microcontroller will read the analog output voltage from the LM35 sensor through an analog-to-digital converter (ADC), process the data to calculate the corresponding temperature value, and then output the temperature to the LCD display using appropriate interfacing.

Necessary Equipment

The following equipment is required for the implementation of this project:

1. 8051 Microcontroller Development Board (AT89C51)
2. LM35 Temperature Sensor
3. Analog-to-Digital Converter (ADC0804)
4. Liquid Crystal Display (LCD-LM016L)
5. Battery (5V)
6. Breadboard and Jumper Wires
7. Programming Software (e.g., Keil µVision IDE, Proteus)
8. Resistors (10K Ohm, 1K Ohm), Capacitor (150pF)

Theory

- **8051 Microcontroller**

The 8051 is an 8-bit microcontroller that was developed by Intel in 1980. It has a powerful instruction set and can access 64 KB of memory. The 8051 is widely used in various embedded system applications due to its versatility, low cost, and availability of development tools.

- **LM35 Temperature Sensor**

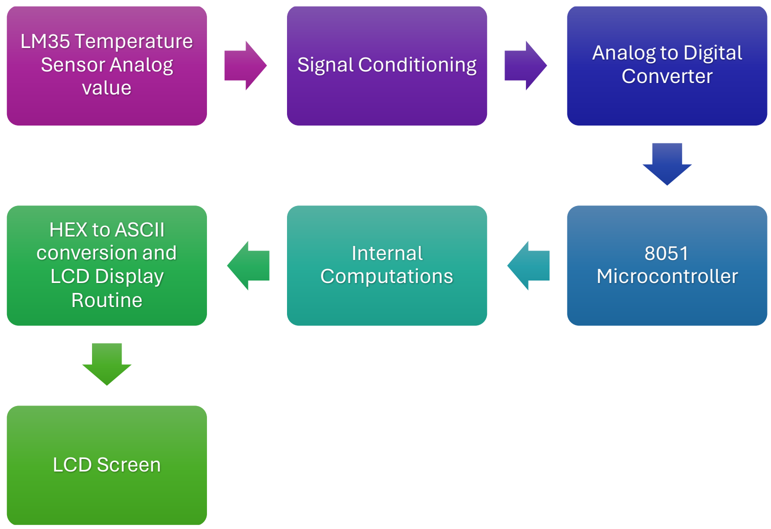
The LM35 is a precision integrated-circuit temperature sensor whose output voltage is linearly proportional to the Celsius temperature. It can measure temperatures from -55°C to +150°C with an accuracy of ±0.5°C at room temperature. The LM35 requires a supply voltage of 4V to 30V and draws only 60 µA from the supply, making it an ideal choice for low-power applications.

- **Analog-to-Digital Converter (ADC)**

The ADC is a device that converts an analog signal, such as the output voltage from the LM35 sensor, into a digital value that can be processed by the microcontroller. The ADC0804 IC is an 8-bit parallel ADC in the family of ADC0800 series from National Semiconductor. It works with +5 Volts and has a resolution of 8 bits. The conversion time varies depending on the clocking signals applied to the CLK IN pin ,but cannot be faster than 110 µs..

- **Liquid Crystal Display (LCD)**The LCD is a flat-panel display that is widely used in various electronic devices for displaying text and graphics. In this project, the LCD will be used to display the temperature reading obtained from the LM35 sensor and processed by the 8051 microcontroller.

Block Diagram



Software Implementation

The software implementation for this project will involve the following steps:

1. Initialize the microcontroller and necessary peripherals (ADC, LCD).

2. Configure the ADC to read the analog output voltage from the LM35 sensor.

3. Read the digital value from the ADC and convert it to the corresponding temperature value using appropriate scaling and calibration factors .Here the calibration is set by using Vref/2 pin of ADC0804.

4. Format the temperature value for display on the LCD.

5. Send the formatted temperature value to the LCD for continuous display.

6. Implement a delay routine to update the temperature reading at regular intervals.

Hardware Implementation

The hardware implementation will involve the following steps:

1. Connect the LM35 temperature sensor to the microcontroller development board, ensuring proper power supply and analog input connections.

2. Interface the ADC with the microcontroller development board.

3. Connect the LCD display to the microcontroller development board, following the appropriate interface protocol.

4. Provide a suitable power supply for the microcontroller, sensor, and LCD display.

5. Assemble the complete circuit on a breadboard or a printed circuit board (PCB) for testing and demonstration.

Code

```
// ADC PINS
READ BIT P2.5
WRITE BIT P2.6
INTR BIT P2.7

// LCD PINS
RS BIT P2.2
RW BIT P2.1
E BIT P2.0

ORG 00H
ACALL LCD_INIT
MOV P1,#0FFH
SETB INTR

BACK:CLR WRITE
    SETB WRITE
HERE:JB INTR,HERE
    CLR READ
        ACALL DELAY
        MOV A,P1
        ACALL HEX_ASCII

        MOV A, #80H
        ACALL COMMAND
        MOV A, R7
        ACALL DISPLAY

        MOV A, #81H
        ACALL COMMAND
        MOV A, R6
        ACALL DISPLAY

        MOV A, #82H
        ACALL COMMAND
        MOV A, R5
        ACALL DISPLAY

        ACALL DELAY
        SETB READ
        SJMP BACK
```

```
ORG 100H
DELAY:
MOV R1,#0FFH
AG:MOV R2,#01H
AG1:DJNZ R2,AG1
DJNZ R1,AG
RET

ORG 150H
LCD_INIT:
MOV A, #38H
ACALL COMMAND
MOV A, #0CH
ACALL COMMAND
MOV A, #01H
ACALL COMMAND
;MOV A, #83H
;ACALL COMMAND
;MOV A, #95H
;ACALL DISPLAY
MOV A, #83H
ACALL COMMAND
MOV A, #43H
ACALL DISPLAY
RET

ORG 200H
COMMAND:
ACALL READY
MOV P0, A
CLR RS
CLR RW
SETB E
ACALL DELAY
CLR E
RET

ORG 250H
DISPLAY:
ACALL READY
MOV P0, A
SETB RS
CLR RW
SETB E
ACALL DELAY
CLR E
RET

ORG 300H
READY:
```

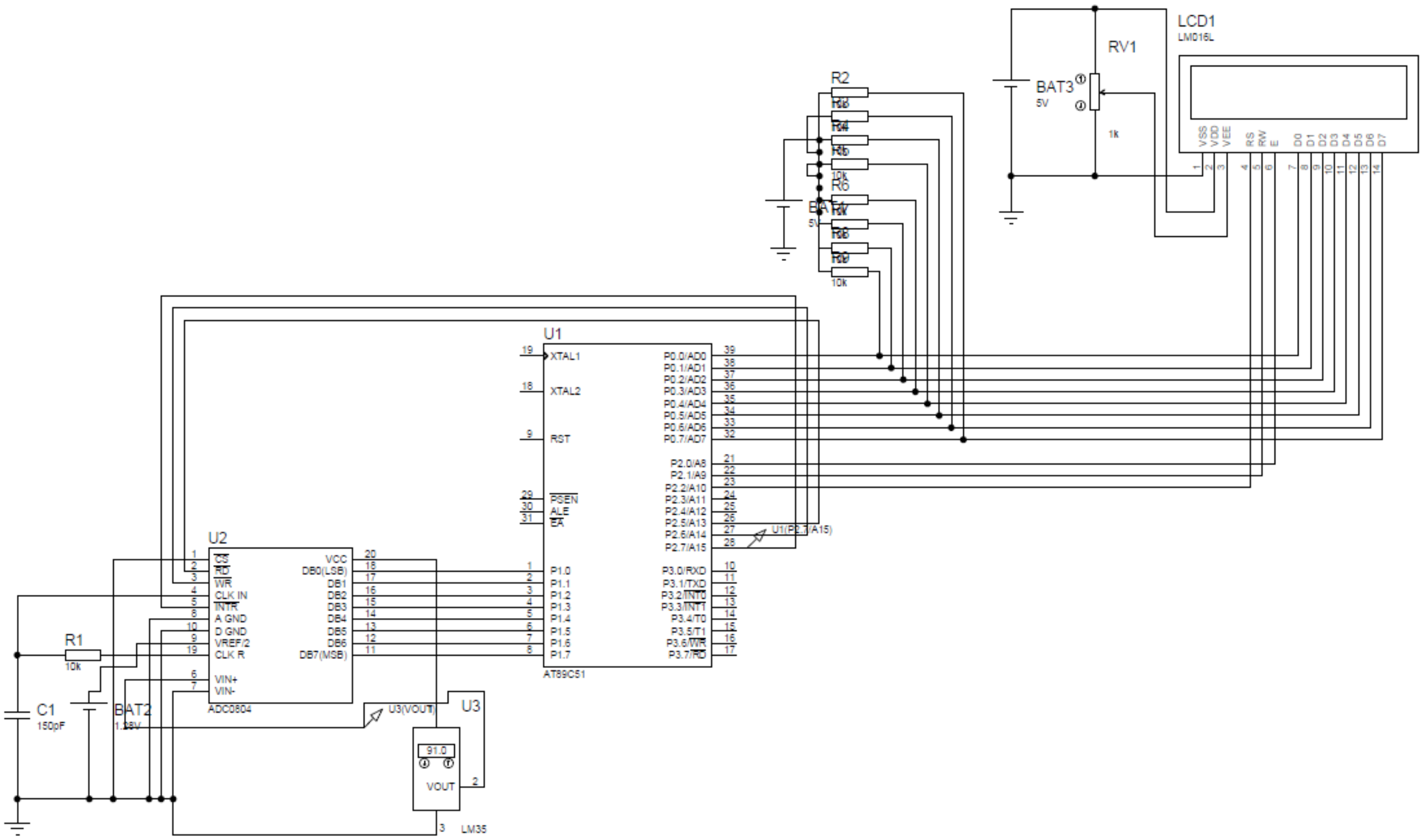
```
SETB P0.7
CLR RS
SETB RW
AGAIN:CLR E
ACALL DELAY
SETB E
JB P0.7, AGAIN
RET

ORG 350H
HEX_ASCII:
MOV B, #10
DIV AB
MOV R5, B
MOV B, #10
DIV AB
MOV R6, B
MOV R7, A
ACALL DEC_ASCII
RET

ORG 400H
DEC_ASCII:
MOV A, R5
ORL A, #30H
MOV R5, A
MOV A, R6
ORL A, #30H
MOV R6, A
MOV A, R7
ORL A, #30H
MOV R7, A
RET

END
```

Circuit Diagram:



Conclusion

This project aims to develop a digital thermometer using the 8051 microcontroller, LM35 temperature sensor, ADC, and LCD display. The successful implementation of this project will demonstrate the capabilities of the 8051 microcontroller in interfacing with various peripheral devices and performing real-time data acquisition and processing tasks. The digital thermometer can find applications in various industries, such as environmental monitoring, industrial process control, and medical devices.