Experiment 6

Title: - Interfacing of temperature sensor (LM35) and show output on LCD.

Pre-Lab. Requisites: -

1. Software Language C/C++
2. Working of Arduino Board.

Objectives:-

Write a program to blink a LED after every 1 second delay

Apparatus:-

1. Arduino UNO Board.
2. LCD, LM35.
3. Connecting Wires
4. Arduino Software

Theory: -

In recent years, the liquid crystal display (LCD) is finding widespread use replacing LED's. This is due to the following reason:

1) The declining prices of LCD.
2) The ability to display numbers, characters, and graphics. This contrasts with LEDs, which are limited to numbers and few characters.
3) In corporation of a refreshing controller into the LCD, thereby reliving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.
4) Ease of programming for characters and graphics.
5) Most of LCD's available in the market are based on controller HD44780. The LCD display can be interfaced either in 4-bit interface or 8-bit interface mode.

LCD pin descriptions:

1) Vcc, Vss and Vee:
   While Vcc and Vss provide +5V and ground, respectively, Vee is used for controlling LCD contrast.
2) Register Select (RS):

There are two very important registers inside the LCD. The RS pin is used for their selection as follows.

RS = 0: the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home.

RS = 1: the data register is selected, allowing the user to send the data to be displayed on the LCD.

3) Read/write (R/W):

R/W input allows the user to write information to the LCD or read information from it. R/W = 1 when reading, R/W = 0 when writing.

4) Enable (EN):

The enable pin is used by the LCD to latch information presented to its data pins. When data is supplied to data pins, a high to low pulse must be applied to the pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450ns wide.

5) Data bus (D0 – D7):

The 8-bit data pins, D0-D7 are used to send the information to the LCD or read the contents of the LCD's internal registers. To display the numbers and letters, ASCII code is to be send on these pins by making RS=1.

Pin Assignment of 16x2 LCD

Pin number	Symbol	Level	I/O	Function
1	Vss	-	-	Power supply (GND)
2	Vcc	-	-	Power supply (+5V)
3	Vee	-	-	Contrast adjust
4	RS	0/1	I	0 = Instruction input 1 = Data input
5	R/W	0/1	I	0 = Write to LCD module 1 = Read from LCD module
6	E	1, 1->0	I	Enable signal
7	DB0	0/1	I/O	Data bus line 0 (LSB)
8	DB1	0/1	I/O	Data bus line 1
9	DB2	0/1	I/O	Data bus line 2
10	DB3	0/1	I/O	Data bus line 3
11	DB4	0/1	I/O	Data bus line 4
12	DB5	0/1	I/O	Data bus line 5
13	DB6	0/1	I/O	Data bus line 6

Pin number	Symbol	Level	I/O	Function
14	DB7	0/1	I/O	Data bus line 7 (MSB)
15	VB+	1	-	Backlight Supply
16	VB-	0	-	

Table 1: Pin Assignment of 16x2 LCD

ADC Devices:

Analog to digital converters are among the most widely used devices for data acquisitions. Digital computers use binary (discrete) value but in physical world everything is analog (continuous). A physical quantity is converted to electrical signals using device called transducer or also called as sensors. Sensors and many other natural quantities produce an output that is voltage (or current). Therefore, an analog - to - digital converter is used to translate the analog signal to digital numbers so that the microcontroller can read and process them. Arduino UNO have 10-bit ADC.

The ADC chips are either parallel or serial. In parallel ADC, 8 or more pins dedicated to bringing out the binary data, but in serial ADC only one pin for data out.

Some of the major characteristics of ADC are a) resolution b) conversion time c) reference voltage (Vref).

a) Resolution

An ADC has an n bit resolution where n can be 8, 10, 16, 0r even 24 bits. The higher resolution ADC provides a smaller step size, where step size is smallest change that can be discerned by an ADC. This is shown in Table 8.1. Although the resolution for ADC chip is designed at the time of its design and cannot be changed, step size can be controlled with the help of reference voltage (Vref).

n - bit	Number of steps	Step Size (mV)
8	256	5/256 = 19.53
10	1024	5/1024 = 4.88
12	4096	5/4096 = 1.2
16	65536	5/65536 = 0.076

Table 2: Resolution verses step size for ADC.

b) Conversion time

Conversion time is defined as the time it takes the ADC to convert the analog input to digital (binary) number. The conversion time is dictated by the clock source connected to the ADC in addition to the method used for data conversion and technology used in the fabrication of the ADC chip.

In addition to conversion time, acquisition time is another major factor in judging an ADC. Acquisition time is defined as the time it takes to sample the analog voltage using sample and hold circuit. Sampled analog input is applied to actual conversion unit of ADC.

In some of the ADCs, conversion time doesn't contain the acquisition time but specified separately. Therefore, effective conversion time is addition of specified conversion time and specified acquisition time.

c) Reference Voltage (Vref)

Vref is an input voltae used for the reference voltage. The voltage connected to this pin, along with resolution of the ADC chip, gives us the step size.

step size = Vref / 2n where n= no. of bits

For example, if the analog input range needs to be 0 to 3 Volts, Vref is connected to 3 Volts. That gives 3V/1024 = 2.92 mV step size for 10-bit ADC.

Vref (V)	Vin (V)	Step Size (mV)
5.00	0 to 5	5/1024 = 4.88
2.56	0 to 2.56	2.56/1024 = 2.5
1.024	0 to 1.024	1.024/1024 = 1

Table 3: Relation between Vref, Vin and step size

Interfacing Diagram

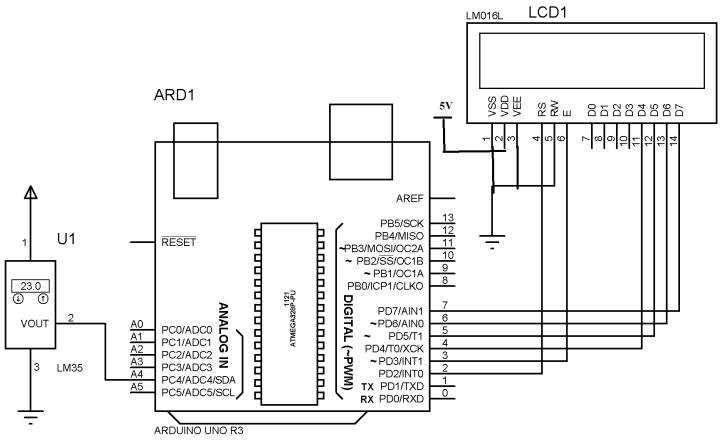

Figure 1: Interfacing LM35 and 16x2 LCD to Arduino Microcontroller

Algorithm

1. Include LCD Library Functions (LiquidCrystal.h)

2. Configure the LCD Interfacing with Arduino Pins as given below

LCD Pins	Arduino Uno
Register Select (RS)	Digital 2
Enable (EN)	Digital 3
Data bit4 (D4)	Digital 4
Data bit5 (D5)	Digital 5
Data bit6 (D6)	Digital 6
Data bit7 (D7)	Digital 7

3. In Setup function

a. Set up the LCD's number of columns and rows.

b. Print Message on first line of LCD

c. Set Cursor of LCD to 2nd line first column.

d. Print Message on second line of LCD

4. In Loop function

a. Declare the float Variable to hold the ADC output Value

b. Read Analog Input Pin (A4) using analogRead(A4) function

c. Convert the output in terms of temperature

d. Display the value of Temperature on LCD.

e. Call delay to specify the interval between two readings.

Comments & Conclusion:-