Experiment – 3

Title: Interfacing sensors to PIC.

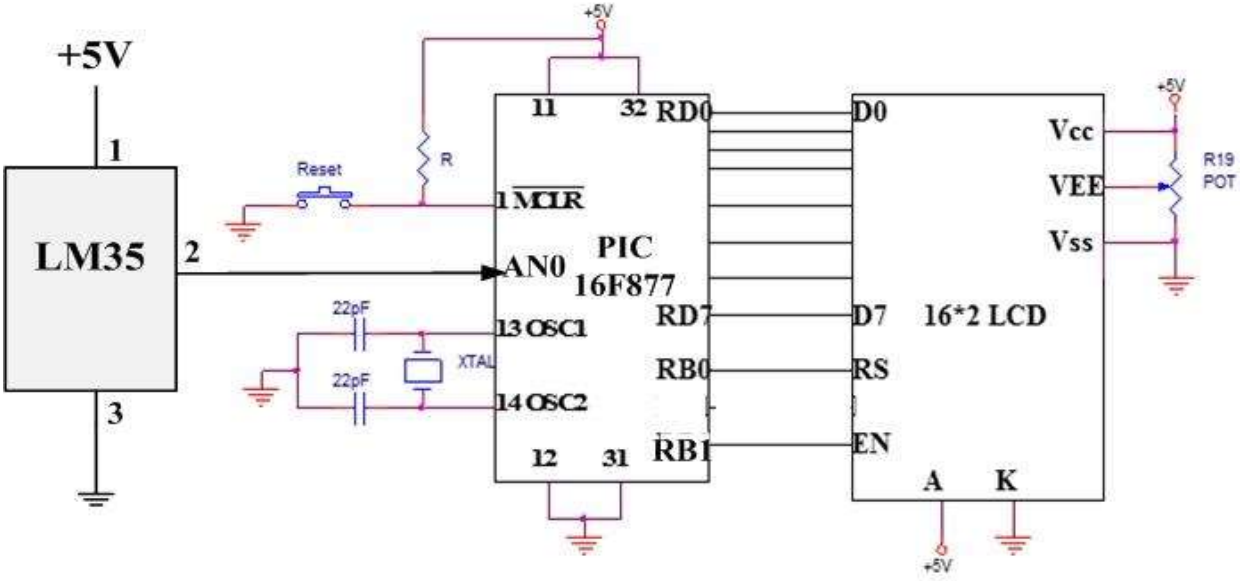
Aim: To interface sensor (LM35) to PIC and display result on LCD.

Objectives:

- To study concept of interfacing sensor (LM35).
- To study MPLAB IDE software.
- To study use of ADC to interface sensors.

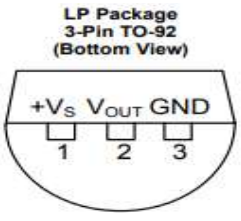
Software Used: MPLAB IDE

Block Diagram:



Theory:

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level. The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. This sensor has sensitivity of 10mv/°C, operates from 4 V to 30 V.



Pin Diagram of LM 35 Sensor

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0
ADCS1	ADCS0	CHS2	CHS1	CHS0	GO/$\overline{\text{DONE}}$	—	ADON
bit 7							bit 0

bit 7-6 **ADCS1:ADCS0:** A/D Conversion Clock Select bits
00 = Fosc/2
01 = Fosc/8
10 = Fosc/32
11 = FRC (clock derived from the internal A/D module RC oscillator)

bit 5-3 **CHS2:CHS0**: Analog Channel Select bits
000 = channel 0, (RA0/AN0)
001 = channel 1, (RA1/AN1)
010 = channel 2, (RA2/AN2)
011 = channel 3, (RA3/AN3)
100 = channel 4, (RA5/AN4)
101 = channel 5, (RE0/AN5)(1)
110 = channel 6, (RE1/AN6)(1)
111 = channel 7, (RE2/AN7)(1)

bit 2 **GO/$\overline{\text{DONE}}$:** A/D Conversion Status bit
If ADON = 1:
1 = A/D conversion in progress (setting this bit starts the A/D conversion)
0 = A/D conversion not in progress (this bit is automatically cleared by hardware when the A/D conversion is complete)

bit 1 **Unimplemented**: Read as '0'

bit 0 **ADON**: A/D On bit
1 = A/D converter module is operating
0 = A/D converter module is shut-off and consumes no operating current

Figure: ADCON0 REGISTER

U-0	U-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	—	—	—	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

bit 7 **ADFM:** A/D Result Format Select bit
1 = Right justified. 6 Most Significant bits of ADRESH are read as '0'.
0 = Left justified. 6 Least Significant bits of ADRESL are read as '0'.

bit 6-4 **Unimplemented:** Read as '0'

bit 3-0 **PCFG3:PCFG0**: A/D Port Configuration Control bits:

PCFG3: PCFG0	AN7(1) RE2	AN6(1) RE1	AN5(1) RE0	AN4 RA5	AN3 RA3	AN2 RA2	AN1 RA1	AN0 RA0	VREF+	VREF-	CHAN/ Refs(2)
0000	A	A	A	A	A	A	A	A	VDD	VSS	8/0
0001	A	A	A	A	VREF+	A	A	A	RA3	VSS	7/1
0010	D	D	D	A	A	A	A	A	VDD	VSS	5/0
0011	D	D	D	A	VREF+	A	A	A	RA3	VSS	4/1
0100	D	D	D	D	A	D	A	A	VDD	VSS	3/0
0101	D	D	D	D	VREF+	D	A	A	RA3	VSS	2/1
011x	D	D	D	D	D	D	D	D	VDD	VSS	0/0
1000	A	A	A	A	VREF+	VREF-	A	A	RA3	RA2	6/2
1001	D	D	A	A	A	A	A	A	VDD	VSS	6/0
1010	D	D	A	A	VREF+	A	A	A	RA3	VSS	5/1
1011	D	D	A	A	VREF+	VREF-	A	A	RA3	RA2	4/2
1100	D	D	D	A	VREF+	VREF-	A	A	RA3	RA2	3/2
1101	D	D	D	D	VREF+	VREF-	A	A	RA3	RA2	2/2
1110	D	D	D	D	D	D	D	A	VDD	VSS	1/0
1111	D	D	D	D	VREF+	VREF-	D	A	RA3	RA2	1/2

A = Analog input D = Digital I/O

Figure: ADCON1 REGISTER

Procedure:

- Make necessary connections to connect the LCD to PIC target board. Connect PORTD to the data pins of LCD and PORTB to the control pins. Also connect o/p of LM35 sensor to AN0 / RA0 pin.
- Switch on the power.
- Start MPLAB IDE software PC and write a program for sensor interfacing.
- Perform the configuration settings and build it.
- Connect the PICKit3 programmer to the Target board.
- Program the .hex file into the PIC.
- Reset the microcontroller and observe the output on LCD.

Program:

```
#define _XTAL_FREQ 16000000
#include <xc.h>
#define RS RB0
#define EN RB1
void ADC_init(void);
unsigned int ADC_READ(void);
void LCD_init(void);
void lcd_cmd(unsigned char value);
void lcd_data(unsigned char value1);
void H2D(unsigned char hexdata);
unsigned char L,M,H;
void main(void)
{
unsigned int ADC_result;
ADC_init();
LCD_init();
while(1)
{
ADC_result=ADC_READ();
ADC_result=ADC_result*5;            //resolution of ADC is 4.88mv
ADC_result=ADC_result/10;             //LM35 sensitivity 10mV/C
H2D(ADC_result);
lcd_cmd(0x01);
lcd_data('T');
```

```
lcd_data('=');
lcd_data(H | 0x30);
lcd_data(M | 0x30);
lcd_data(L | 0x30);
__delay_ms(500);                    //500ms delay
}
}

void ADC_init(void)
{
TRISAbits.TRISA0=1;      // AN0 set as analog i/p
TRISAbits.TRISA1=1;      // AN1 set as analog i/p
ADRESH=0;
ADRESL=0;
PIR1bits.ADIF=0;          //ADC flag clear
ADCON1=0X8E;          //MAKE AN0 as analog port
ADCON0=0x40;          //Select Chanel 0, conversion clock = FOSC / 8
}

unsigned int ADC_READ()
{
ADCON0bits.ADON=1;            //ADC ON
__delay_ms(2);                //2ms delay
ADCON0bits.GO=1;              //start a/d conversion
__delay_us(1);
while(PIR1bits.ADIF==0);
__delay_us(1);
ADCON0bits.ADON=0;          //ADC Off
PIR1bits.ADIF=0;
return (((unsigned int)ADRESH)<<8)|(ADRESL);
}

void LCD_init(void)
{
TRISD=0X00;                                                    //make PORTD o/p
```

```
TRISB=0X00;                                  //make PORTD o/p
__delay_ms(100);                             //delay
EN=1;
__delay_us(2);
EN=0;
__delay_ms(3);                               //2ms delay
lcd_cmd(0x38);
lcd_cmd(0x0E);
lcd_cmd(0x01);
__delay_ms(2);                               //2ms delay
lcd_cmd(0x06);
lcd_cmd(0x80);
}

void lcd_cmd(unsigned char value)
{
PORTD=value;
RS=0;
EN=1;
__delay_us(2);
EN=0;
__delay_ms(3);                               //2ms delay
}

void lcd_data(unsigned char value1)
{
PORTD=value1;
RS=1;                                        //Select data reg
EN=1;
__delay_us(2);
EN=0;
__delay_ms(3);                               //2ms delay
}

void H2D(unsigned char hexdata)
```

```
{
unsigned char x;
x=hexdata/10;
L=hexdata%10;
M=x%10;
H=x/10;
}
```

Applications: (Write applications of Sensor interfacing here)

Result: Interfacing of sensor with PIC microcontroller is studied successfully and observed the result on LCD.

Teacher's Sign
