EMBEDDED SYSTEMS LAB PROJECT

Submitted by

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TABLE OF CONTENTS

PROBLEM STATEMENT

Write a program to interface a temperature sensor to LPC178 and display the temperature on LCD.

ABSTRACT

Temperature is the most often-measured environmental quantity. This might be expected since most physical, electronic, chemical, mechanical, and biological systems are affected by temperature. Specific chemical reactions, biological processes, and even electronic circuits perform best within limited temperature ranges. Temperature is one of the most commonly measured variables. Temperature Sensing can be done either through direct contact with the heating source or remotely, without direct contact with the source using radiated energy instead. There are a wide variety of temperature sensors on the market today, including Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared, and Semiconductor Sensors.

This project requires the students to interface a temperature sensor with an LPC 1768 ARM Microcontroller. The aim is to equip the students to be able to do the following:-

- To comprehend the software development for ARM cortex-M microcontroller using embedded C language.
- To design real-world systems using ARM Cortex-M embedded system.
- To understand various interfacing circuits necessary for various applications and programming using ARM.

INTRODUCTION- HARDWARE USED

The following components have been used

1)LPC1768

The NXP (founded by Philips) LPC1768 is an ARM 32-bit CortexM3 Microcontroller. The code has been written in Embedded C and tested out on an ALS evaluation board. A 12-bit internal Analog-to-Digital Converter has been used to convert the voltage value to its corresponding value in degrees Celsius.

2)LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. (Linear at 10.0 mV/°C scale factor)

3)1k Ohm Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. A 1k Ω resistor has a value of 1,000 ohms.

4)Zener Diode

A Zener diode is a special type of diode designed to reliably allow current to flow "backward" when a specific set reverse voltage, known as the Zener voltage, is reached.

5)Breadboard

A breadboard is a rectangular plastic board with many tiny holes in it.

6)Connector

7)Power Supply

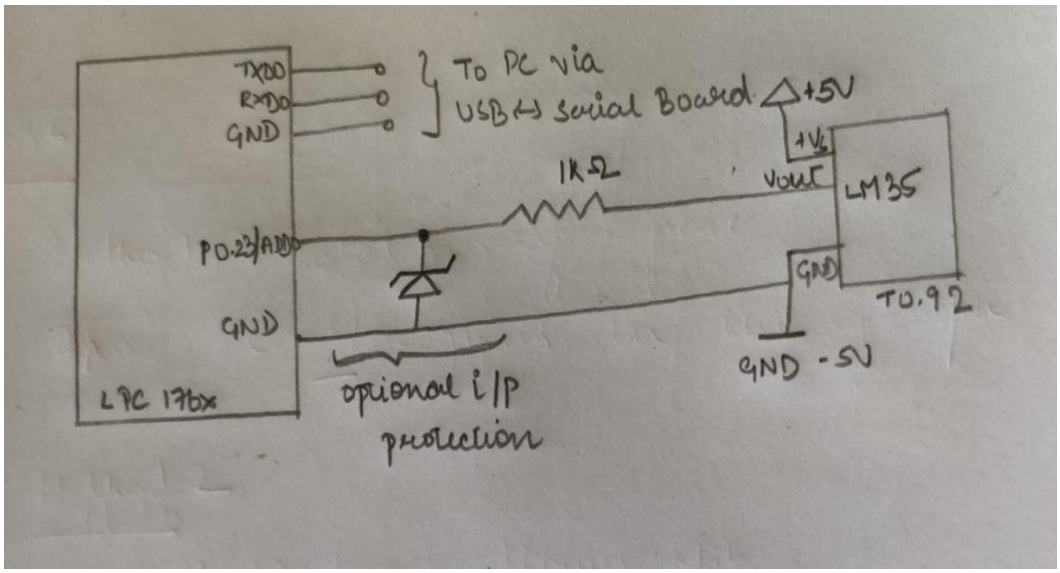
FLOW OF ACTIONS PERFORMED

Steps Followed :

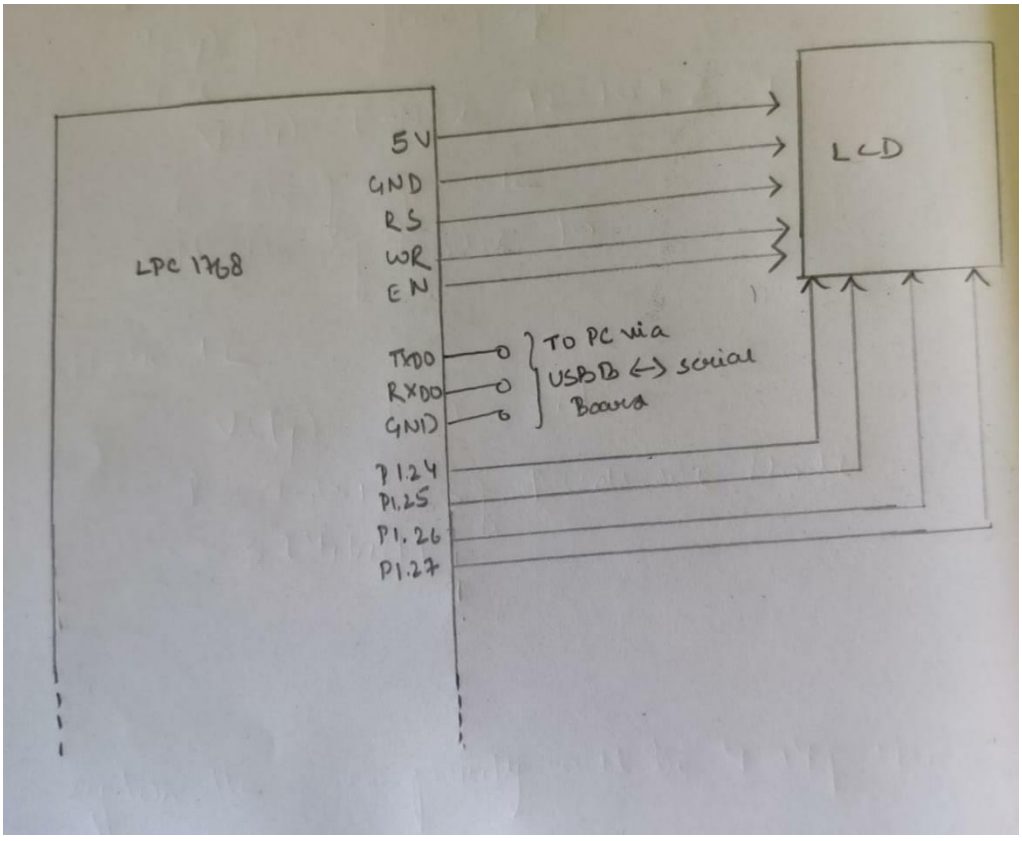
- The output of the sensor gives us the temperature. The following steps show how the code works:
- We start by configuring the pins, port pin 0.4- 0.7 used to configure the LCD in 4-bit mode, p 0.8 as the Rs pin, and p 0.9 as the enable pin
- Initialize the led by giving the set of commands.
- Configure the ADC registers.
- Wait until the DONE bit is set to 1
- Load the value of the addr0 register into temp.
- AND the value of temp with 0xfff0 and right shift by 4 to extract the value.
- Divide the value of temperature by 12.41 to get the value of temperature and store the value into a float variable final.
- Convert the float value into a string and store it into a string variable temper.
- Display the string on the LCD serially.

PIN DIAGRAMS

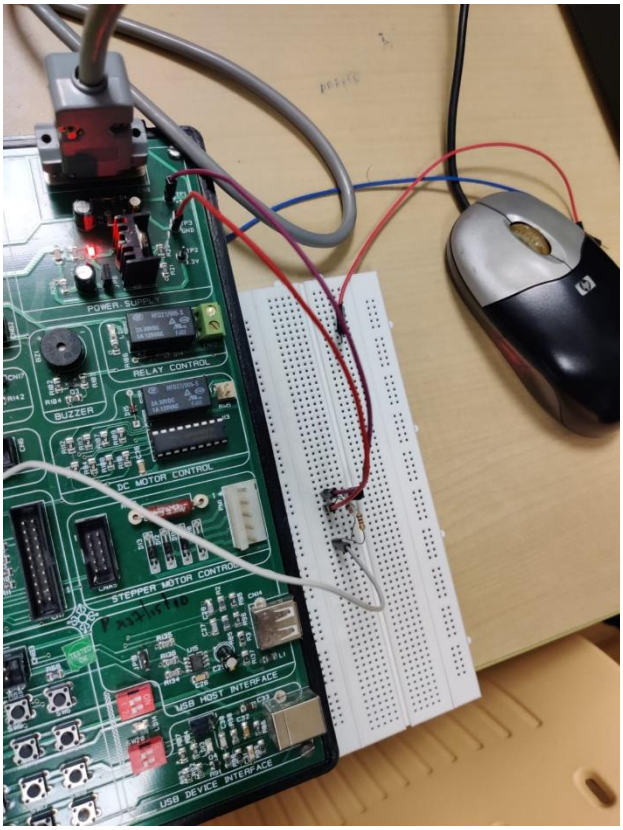
LM35 temperature sensor connection to LPC1768:



Connection to LCD



Connection across breadboard



CODE

```
#include<LPC17xx.h>
#include <stdio.h>
unsigned int i,j, temp;
float final;
char temper[20];
unsigned long LED =0x00000010;
#define rsctrl 0x00000100 //po.8
#define enctrl 0x00000200 //po.9 enable lcd
#define dtctrl 0x000000f0 //p0.4-7 4 bit mode
void lcd_init();
void wr_cn();
void clr_disp();
void delay();
void lcd_com();
void wr_dn();
void lcd_data();
void clear_ports();
void lcd_puts(unsigned char *);
unsigned int i,temp1=0,temp2=0;
int main(void)
{
 SystemInit() ;

 SystemCoreClockUpdate();
 LPC_PINCON->PINSEL1|=(1<<14);
```

```
while(1)
{
	LPC_ADC->ADCR=(1<<0) | (1<<21) | (1<<24);
	while(((temp=LPC_ADC->ADDR0) & (1<<31))==0);
	temp=LPC_ADC->ADDR0;
	temp&=0xFFF0;
	temp>>=4;
	final=(float)(temp/12.41)/12;
	sprintf(temper,"%3.2fC",final);
	lcd_init();
	temp1=0x80;
	lcd_com();
	delay(800);
	lcd_puts(&temper[0]);
}

}
void lcd_init(){
	LPC_PINCON->PINSEL0=0;
	LPC_GPIO0->FIODIR|=dtctrl;
	LPC_GPIO0->FIODIR|=rsctrl;
	LPC_GPIO0->FIODIR|=enctrl;
	clear_ports();
	delay(3200);
	for(i=0;i<3;i++)
	{
		temp2=(0x30);
```

```
            wr_cn();
            delay(30000);
        }
        temp2=(0x20);
        wr_cn(); delay(30000);
        temp1=0x28; lcd_com();
        delay(30000); temp1=0x0c;
        lcd_com(); delay(800);
        temp1=0x06; lcd_com();
        delay(800); temp1=0x01;
        lcd_com(); delay(10000);
        temp1=0x80; lcd_com();
        delay(800);
}
void lcd_com()
{ temp2=temp1&0xf0;
        temp2=temp2;
        wr_cn();
        temp2=temp1&0x0f;
        temp2=temp2<<4;
        wr_cn(); delay(1000);
}
void wr_cn()
{
        clear_ports();
        LPC_GPIO0->FIOPIN=temp2;
        LPC_GPIO0->FIOCLR=rsctrl;
```

```
	LPC_GPIO0->FIOSET=enctrl;
	delay(25);
	LPC_GPIO0->FIOCLR=enctrl;
}
void lcd_data()
{
	temp2=temp1&0xf0;
	temp2=temp2;
	wr_dn();
	temp2=temp1&0x0f;
	temp2=temp2<<4;
	wr_dn();
	delay(1000);
}
void wr_dn()
{
	clear_ports();
	LPC_GPIO0->FIOPIN=temp2;
	LPC_GPIO0->FIOSET=rsctrl;
	LPC_GPIO0->FIOSET=enctrl;
	delay(25);
	LPC_GPIO0->FIOCLR=enctrl;
}
void delay(unsigned int r1)
{
	unsigned int r;
	for(r=0;r<r1;r++);
```

```
}
void clr_disp()
{
	temp1=0x01;
	lcd_com();
	delay(10000);
}
void clear_ports()
{
	LPC_GPIO0->FIOCLR|=rsctrl;
	LPC_GPIO0->FIOCLR|=enctrl;
	LPC_GPIO0->FIOCLR|=dtctrl;
}
void lcd_puts(unsigned char *buff)
{
	unsigned int i=0;
	while(buff[i]!='\0')
	{
			temp1=buff[i]; i++; lcd_data();
	}
}
```

RESULT

The LCD displayed a reading of 24.5C upon testing with an LPC 1768 on 2 December 2021. The temperature value kept fluctuating between 24 and 28C, maintaining an average of 26C, which was approximately the temperature of the lab with the air conditioner running. We also observed that temperature value increased slightly upon placing our finger on the sensor, displaying the sensor's effectiveness.

The output obtained can be seen in the output in the image below.