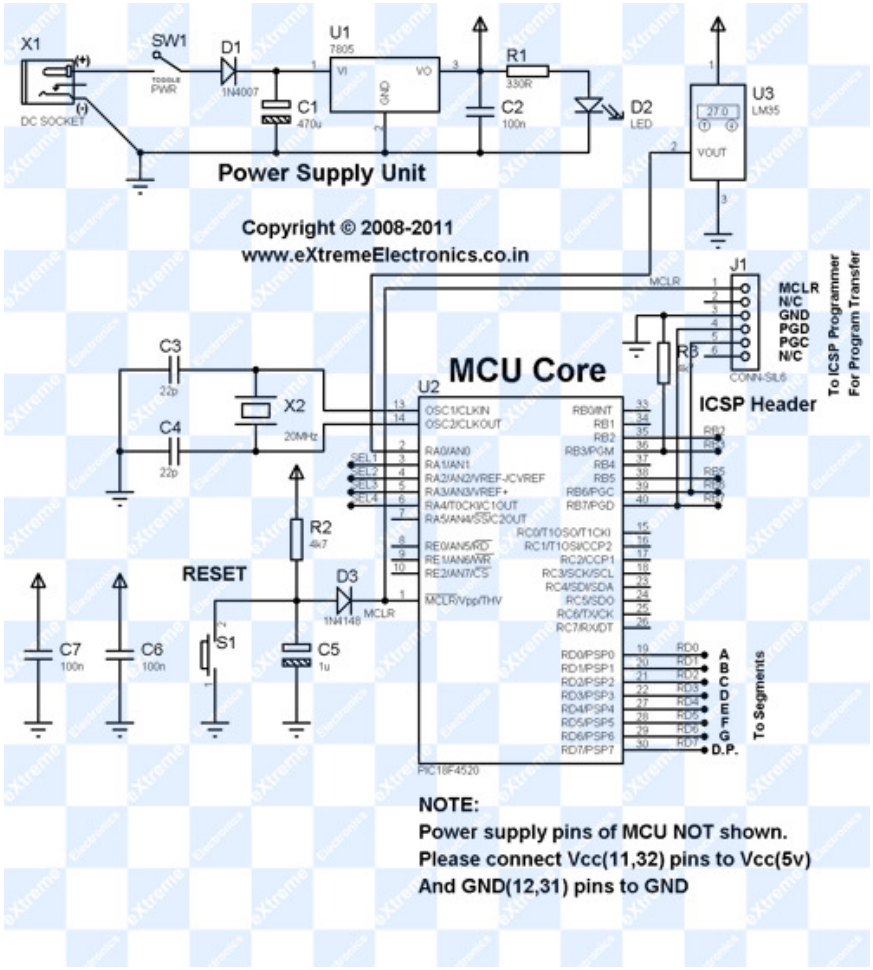
Thermometer using PIC Microcontroller

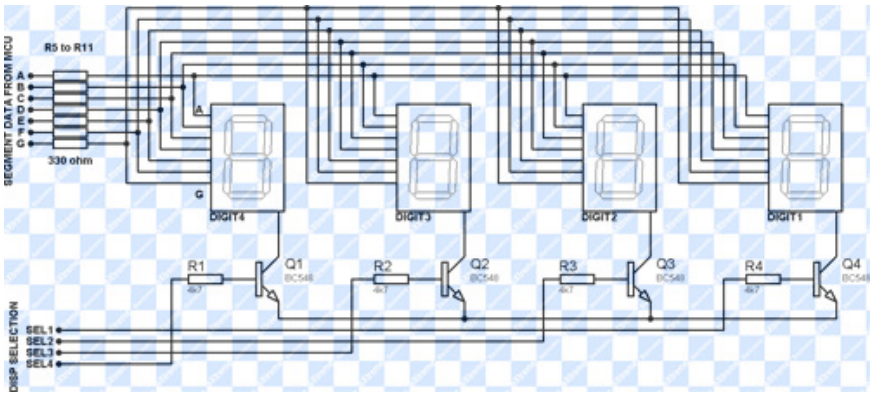
In the last tutorial we learn about the **multiplexing technique** used with seven segment displays. We learnt how it saves i/o line by using persistence of vision. Only one digit is lit at a time, but to a human eye it is too fast to catch, so we see all four digit lit the same time. In this tutorial we will make a practical use of multiplexed seven segment displays. We will use them to show current room temperature using a LM35 temperature sensor.

Schematic for PIC Thermometer

Please note that this schematic is slightly different from our previous schematic on multiplexed seven segment display. The display select i/o pins were RA0,RA1,RA2,RA3 on that schematic. But in this schematic the display lines are RA1,RA2,RA3,RA4 this is because RA0 is used as analog input channel for LM35's output.

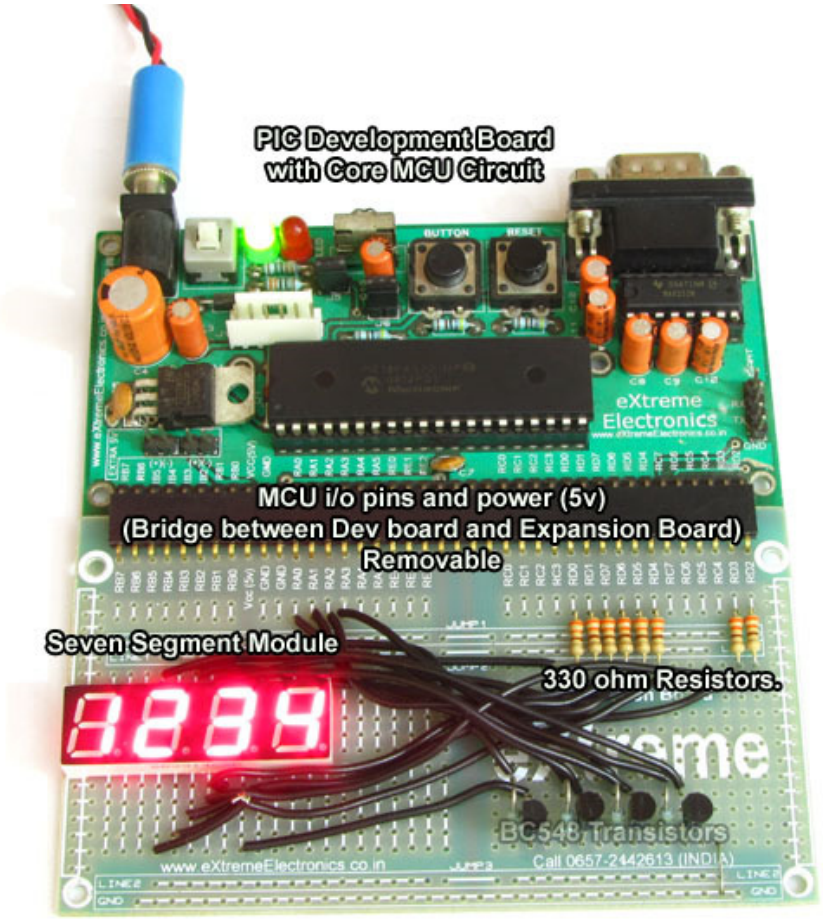


PIC Thermometer using LM35

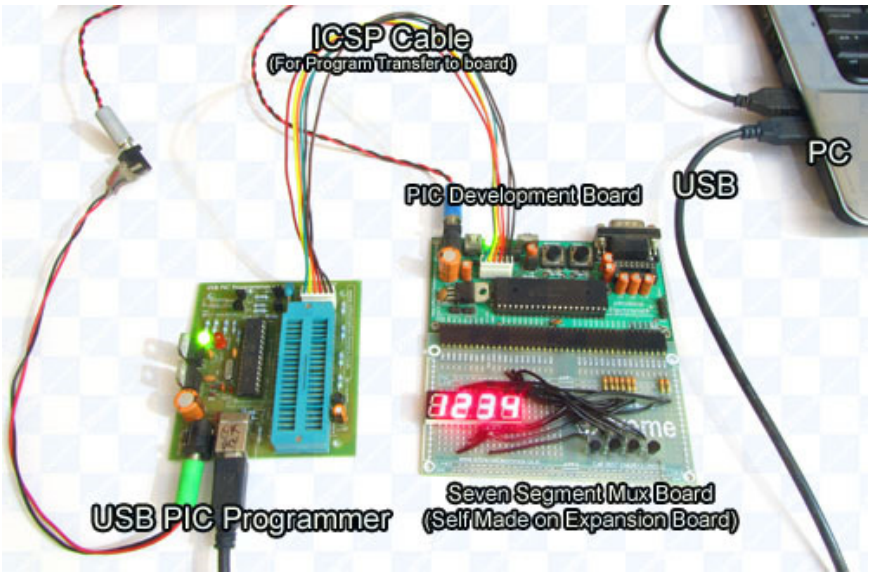


Multiplexed Seven Segment wiring

We use our PIC Development Board for making the above demo project. The PIC Development Board has all the core circuitry to sustain the MCU while the project specific part is developed on the expansion board.



Multiplexed Seven Segment Display Setup



Multiplexed Seven Segment Display Setup

HI-TECH C Code for Thermometer Project

```
/*****************************************************************

LM35 Temperature Sensor INTERFACING TEST PROGRAM

-------------------------------------------------------
Simple Program to connect with LM temperature sensor using the
internal ADC of PIC MCU.

The program displays the current environment temperature on
LED Module.

MCU: PIC18FXXXX Series from Microchip.
Compiler: HI-TECH C Compiler for PIC18 MCUs (http://www.htsoft.com/)

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eXtreme Electronics, India

For More Info visit
http://www.eXtremeElectronics.co.in

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*****************************************************************/
#include <htc.h>

#include <math.h>

#include "types.h"

#define _XTAL_FREQ 20000000ul

//Chip Settings
__CONFIG(1,0x0200);
__CONFIG(2,0X1E1F);
__CONFIG(3,0X8100);
__CONFIG(4,0X0081);
__CONFIG(5,0XC00F);



//Configure i/o ports where display is connected
//below is segment data port
#define SEVENSEG_TRIS   TRISD
#define SEVENSEG_PORT   PORTD

//below is disp select data port
#define SEVENSEG_CMN_TRIS  TRISA
```

```
#define SEVENSEG_CMN_PORT  PORTA
#define SEVENSEG_CMN_POS 1

//Simple Delay Routine
void Wait(unsigned int delay)
{
   for(;delay;delay--)
      __delay_us(100);
}

//Function to Initialise the ADC Module
void ADCInit()
{
   //We use default value for +/- Vref

   //VCFG0=0,VCFG1=0
   //That means +Vref = Vdd (5v) and -Vref=GEN

   //Port Configuration
   //Only AN0 pin is analog
   //Other ANx pins are digital i/o
   PCFG3=1;
   PCFG2=1;
   PCFG1=1;
   PCFG0=0;

   /*

      ADCON2

      *ADC Result Right Justified.
      *Acquisition Time = 2TAD
      *Conversion Clock = 32 Tosc
   */

   ADCON2=0b10001010;
}

//Function to Read given ADC channel (0-12)
unsigned int ADCRead(unsigned char ch)
{
   if(ch>12) return 0;  //Invalid Channel

   ADCON0=0x00;

   ADCON0=(ch<<2);   //Select ADC Channel

   ADON=1;  //switch on the adc module

   GODONE=1;//Start conversion

   while(GODONE); //wait for the conversion to finish

   ADON=0;  //switch off adc

   return ADRES;
}

uint8_t digits[4]={0,0,0,0};

void SevenSegment(uint8_t num)
{
   switch(num)
   {
      case 0:
                  //  .GFEDCBA

         SEVENSEG_PORT= 0B00111111;
         break;

      case 1:
               //      .GFEDCBA
         SEVENSEG_PORT= 0B00000110;
         break;

      case 2:
               //      .GFEDCBA

         SEVENSEG_PORT= 0B01011011;
```

```
            break;

        case 3:
                    //      .GFEDCBA
            SEVENSEG_PORT= 0B01001111;
            break;

        case 4:
                    //      .GFEDCBA

            SEVENSEG_PORT= 0B01100110;
            break;

        case 5:
                    //      .GFEDCBA
            SEVENSEG_PORT= 0B01101101;
            break;

        case 6:
                    //      .GFEDCBA

            SEVENSEG_PORT= 0B01111101;
            break;
        case 7:
                    //      .GFEDCBA
            SEVENSEG_PORT= 0B00000111;
            break;

        case 8:
                    //      .GFEDCBA

            SEVENSEG_PORT= 0B01111111;
            break;

        case 9:
                    //      .GFEDCBA
            SEVENSEG_PORT= 0B01101111;
            break;
    }
}


void SevenSegInit()
{
    //Setup i/o ports
    SEVENSEG_TRIS=0X00;
    SEVENSEG_CMN_TRIS=~((0B00001111)<<SEVENSEG_CMN_POS);

    SEVENSEG_CMN_PORT=(0B00000001<<SEVENSEG_CMN_POS);

    //Setup Timer0
    T0PS0=1; //Prescaler is divide by 256

    T0PS1=1;
    T0PS2=1;

    PSA=0;      //Timer Clock Source is from Prescaler

    T0CS=0;     //Prescaler gets clock from FCPU (5MHz)

    T08BIT=1;   //8 BIT MODE

    TMR0IE=1;   //Enable TIMER0 Interrupt
    PEIE=1;     //Enable Peripheral Interrupt

    GIE=1;      //Enable INTs globally

    TMR0ON=1;   //Now start the timer!
}

void SevenSegPrint(uint16_t num)
{
    /*


    This function breaks apart a given integer into separete digits
    and writes them to the display array i.e. digits[]
```

```
    */
    uint8_t i=0;
    uint8_t j;
    if(num>9999) return;
    while(num)
    {
       digits[i]=num%10;
       i++;

       num=num/10;
    }
    for(j=i;j<4;j++) digits[j]=0;
}


void SevenSegISR()
{
    /*

    This interrup service routine (ISR)
    Updates the displays

    */

    TMR0=150;

    static uint8_t i;

    if(i==3)
    {
       //If on last display then come
       //back to first.
       i=0;

    }
    else

    {
       //Goto Next display
       i++;
    }



    //Acivate a display according to i
    SEVENSEG_CMN_PORT=((SEVENSEG_CMN_PORT & (~(0x0F<<SEVENSEG_CMN_POS)))|(1<<(i+SEVENSEG_CMN_POS)));

    //Write the digit[i] in the ith display.

    SevenSegment(digits[i]);
}

//Main Interrupt Service Routine (ISR)
void interrupt ISR()
{
    //Check if it is TMR0 Overflow ISR
    if(TMR0IE && TMR0IF)
    {
       //Call the SevenSegISR
       SevenSegISR();

       //Clear Flag

       TMR0IF=0;
    }
}

void main()
{

    //Initialize the Seven Segment Subsystem
    SevenSegInit();

    //Initialize the ADC Module
    ADCInit();

    while(1)
    {
       unsigned int val; //ADC Value
```

```
        unsigned int t;       //Temperature

        val=ADCRead(0);    //Read Channel 0(pin2 on PIC18f4520, RA0)

        t=round(val*0.48876);//Convert to Degree Celcius

        //Print temperature to display
        SevenSegPrint(t);

        Wait(1000);
    }

}
```

To compile the above code you will need the MPLab IDE and HI-TECH C for PIC18. Both are available free at Microchips Website.

- Download Microchip's MPLAB v8.70
- HI-TECH C Compiler for PIC18 MCUs - Lite mode v9.66 (Requires free registration)

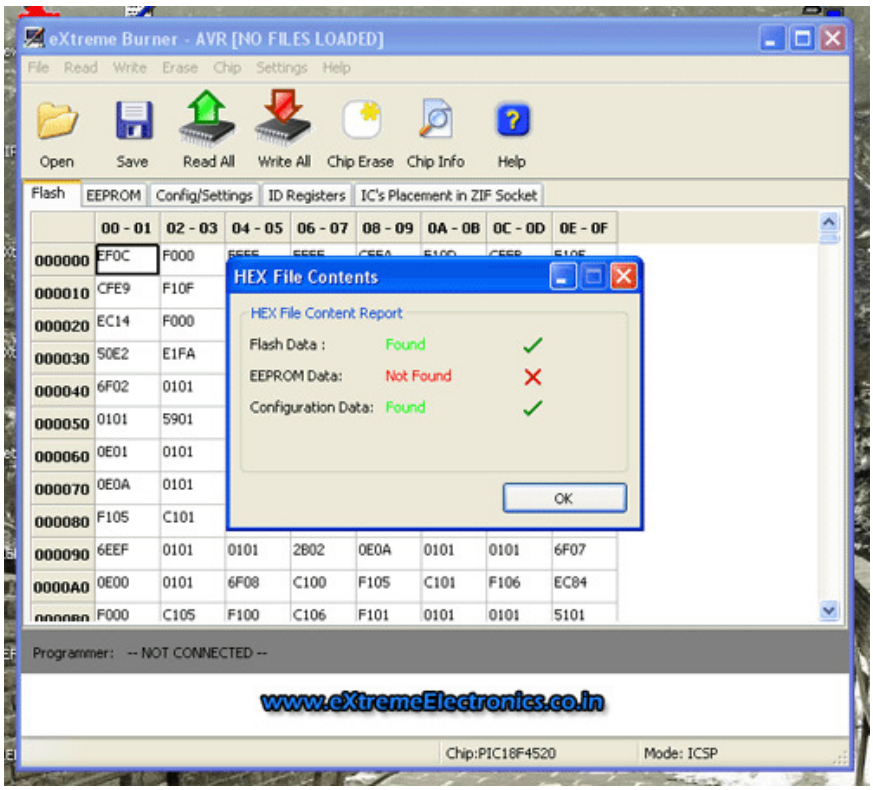
If you are new to these tools then please see the following tutorials :-

- PIC Hello Word Project (Please read carefully and setup the software exactly as described)

Burning the HEX File to PIC MCU

Hex file contains data for three different segments,

- The **FLASH** (Stores the program)
- The **EEPROM** (This is a non volatile memory that can be accessed(read/write) by the program. It retains the data even when MCU is switch off, you can specify EEPROMs initial content in hex file. In this project this feature is not required so our hex file DO NOT contain the initial EEPROM contents.
- **CONFIG bytes** are a special location inside the chip that is used to configure many aspects of the chip like clock source, brown out detector, watch timer, startup times. See page 249 on PIC18F4520's datasheet. This section is most important for proper working of program so make sure this section is programmed when you write the chip. If you use our **USB PIC Programmer**. Then as soon as you load the hex file it shows the sections that are present on the hex file.



HEX File Report

As you can see it states that Flash Data (Your Program), and Configuration Data are present on the hex file, while EEPROM data is not present. When you are ready to transfer the data to the chip select ***"Write All"*** from the toolbar or Select menu ***Write->All***. This ensures that Configuration memory is also written. If you write only the Flash section(By selecting ***Write->Flash***) the program **WON'T WORK**.

You need to take similar steps when using other programmers like PICKIT3 etc.

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Downloads

- Complete MPLab Project for **PIC18F4520** running at 20MHz
- Hex File Ready to burn for PIC18F4520 running at 20MHz
- Complete MPLab Project for **PIC18F4550** running at 48MHz
- Hex File Ready to burn for PIC18F4550 running at 48MHz

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