ECE-232

Lab Assignment #2 - Digital Thermometer

Helpful hints & design notes

I chose to use the following connections:

**4 digit, 8 segment (7 segments+dp) LED display:**

- Need 8 digital output pins for the 8 segments. Use PC0-PC3 for a, b, c, d; use. PD4-PD7 for e, f, g, dp (this avoids using PD0 & PD1, which we will reserve for the UART)

- Need 4 digital output pins for the common collectors of the digits. Use PB1-PB4.

**Momentary SPST push-button switch:**

- Need 1 digital input pin. Use PD2 with internal pull-up

**C/F LED: (this is something extra I'm adding to my design.)**

- Need 1 digital output pin to make an LED glow when the switch is pressed. Use PD3.

**TMP-36 Temperature Sensor**

- Need 1 analog input pin. Use PC5, also known as ADC5.

Wiring diagram:

TMP36

When switch is pressed, system displays temp in C and LED glows. System displays temp in F and LED is off when switch is not pressed.

GND

+5V

LED digit segments e, f, g, dp (upper nibble)

DIG1, DIG2, DIG3, DIG4 Common Collectors

+5V

GND

PD0 (0)

PD1 (1)

PD2 (2)

PD3 (3)

PD4 (4)

PD5 (5)

PD6 (6)

PD7 (7)

(A5) PC5

(A4) PC4

(A3) PC3

(A2) PC2

(A1) PC1

(A0) PC0

(13) PB5

(12) PB4

(11) PB3

(10) PB2

(9) PB1

(8) PB0

Temp sensor analog voltage

LED digit segments a, b, c, d (lower nibble)

ADMUX = 01000101 = 0x45 will configure the ADC for Vref = AVcc = 5V and input ADC5

ADMUX = 11000101 = 0xC5 will configure the ADC for Vref = 1.1V and input ADC5

**Conversion from digital to analog voltage to physical temperature:**

Vdigital is an unsigned int between 0 and 1023 (10 bit word)

Vanalog is an analog value between 0 and 4.995 volts

Vdigital = 0 corresponds to Vanalog = 0 V

Vdigital = 1023 corresponds to Vanalog = 4.995 V

Vanalog = Vdigital x Vref / 1024 C

Vanalog = Vdigital x 5 / 1024 C (assuming Vref = 5V)

Vanalog = Vdigital x 5000 / 1024 mV

Vanalog = Vdigital x 4.883 mV

From Slide#3 of lecture L14,

Vanalog = 750 + 10(Tc - 25) mV

Vanalog = 750 + 10(Tc - 25) = Vdigital x 4.883

solving,

Tc = Vdigital x 0.4883 - 50 gives us the temperature in degrees C.

Tf = Tc \*9./5.+32.

If we want to keep the conversion flexible for different values of Vref, we can use:

Tc = Vdigital x Vref/10.24 - 50 gives us the temperature in degrees C.

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Code to update PC0 - PC3 with the lower nibble of digit while leaving PC4-PC7 unchanged:

PORTC = (PORTC&0xF0)|(digit&0x0F);

Code to update PD4 - PD7 with the upper nibble of digit while leaving PD0 - PD3 unchanged:

PORTD = (digit&0xF0)|(PORTD&0x0F);

Note: many people are reporting that their measured temperature changes by a few degrees whenever they press the F/C button. Others are concerned that their measurements fluctuate by several degrees. **Don't be concerned about these fluctuations: we are not striving for accuracy with this assigment.**

If you do want to put the time into your project to improve the accuracy & resolution, you can change the reference voltage from AVCC to 1.1V. This will give you better resolution.You can also try averaging ~ 10 adc samples together

Result: using Vref = 1.1V, and averaging 10 digital samples

Temp measurements from various other thermometers: 69.0; 69, 68.9, 69.2, 68.9,67.8.

Average: 68.8; Std Dev: 0.5

Actual temp: 68.3 - 69.3

AVR thermometer reads 70.7 so it reads high by ~ 1.9 degree F

Corresponds to 1.05 degrees C. The TMP36 specs say it is accurate to within 1 deg C at room temperature.

A picture containing text, indoor

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