ECE-232
Lab Assignment #2 - Digital Thermometer
Helpful hints & design notes

I chose to use the following connections:

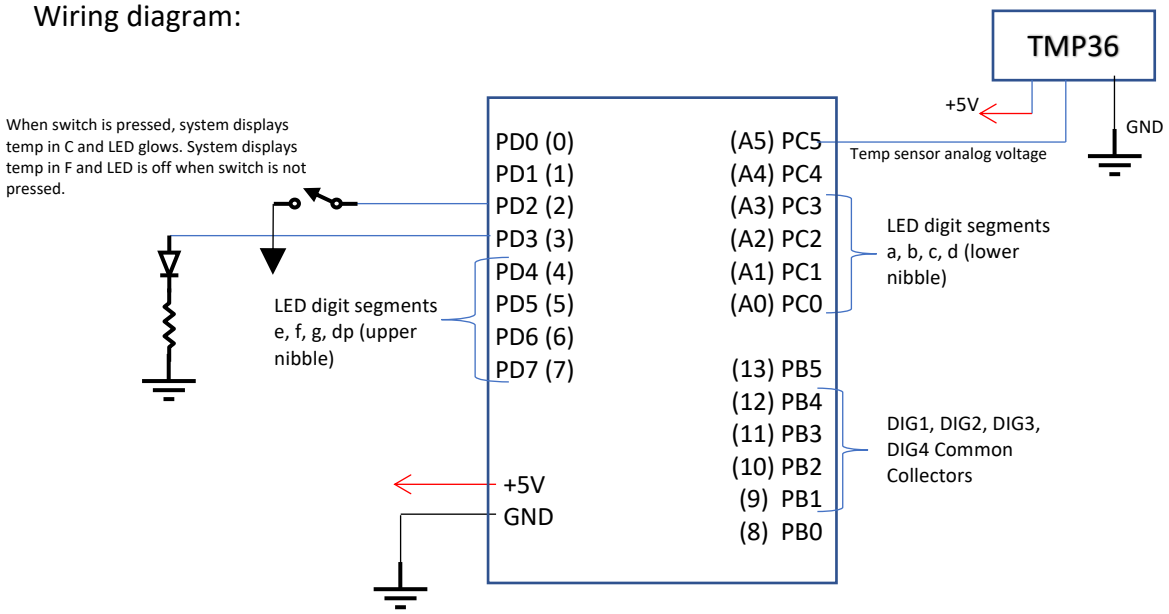
4 digit, 8 segment (7 segments+dp) LED display:
- Need 8 digital output pins for the 8 segments. Use PC0-PC3 for a, b, c, d; use. PD4-PD7 for e, f, g, dp (this avoids using PD0 & PD1, which we will reserve for the UART)
- Need 4 digital output pins for the common collectors of the digits. Use PB1-PB4.

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:



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:

$V_{digital}$ is an unsigned int between 0 and 1023 (10 bit word)
V_{analog} is an analog value between 0 and 4.995 volts
$V_{digital}$ = 0 corresponds to V_{analog} = 0 V
$V_{digital}$ = 1023 corresponds to V_{analog} = 4.995 V

$V_{analog} = V_{digital}$ x Vref / 1024 C
$V_{analog} = V_{digital}$ x 5 / 1024 C (assuming Vref = 5V)
$V_{analog} = V_{digital}$ x 5000 / 1024 mV
$V_{analog} = V_{digital}$ x 4.883 mV

From Slide#3 of lecture L14,
$V_{analog} = 750 + 10(T_c - 25)$ mV
$V_{analog} = 750 + 10(T_c - 25) = V_{digital}$ x 4.883

solving,

$T_c = V_{digital}$ x 0.4883 - 50 gives us the temperature in degrees C.
$T_f = T_c$ *9./5.+32.

If we want to keep the conversion flexible for different values of V_{ref}, we can use:

$T_c = V_{digital}$ x V_{ref}/10.24 - 50 gives us the temperature in degrees C.

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);

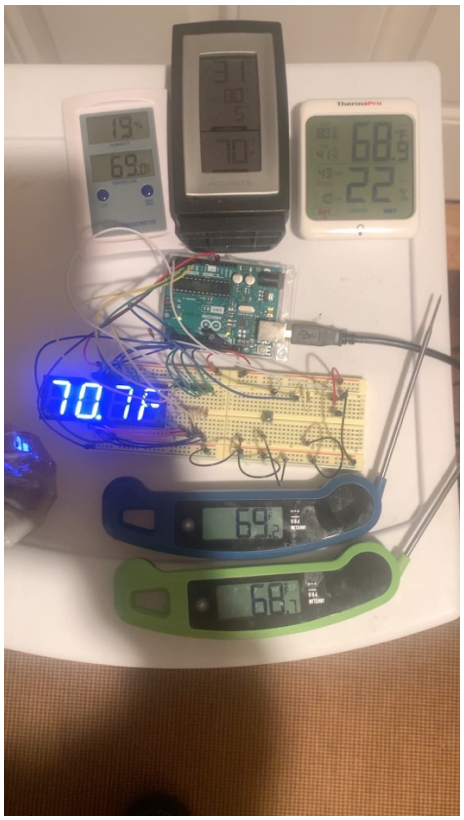
Note: many people are reporting that their measured temperature changes by a few degrees whenever they press the F/C button. Others are concerned that their measurements fluctuate by several degrees. **Don't be concerned about these fluctuations: we are not striving for accuracy with this assigment.**

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.



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