Worksheet: Measure Temperature

Learning Objectives

- Understand how the TMP36 sensor voltage changes with temperature.
- Perform voltage-to-temperature calculations.
- Collect sensor readings from the TCLab.
- Reflect on accuracy, error sources, and calibration improvements.

Estimated Time Allocation (≈60 minutes)

Section	Activity	Time
1	Understand the TMP36 Sensor	10 min
2	Voltage-to-Temperature Calculations	20 min
3	Sensor Data Collection	20 min
4	Reflection & Reporting	10 min

1. Understanding the TMP36 Sensor (10 min)

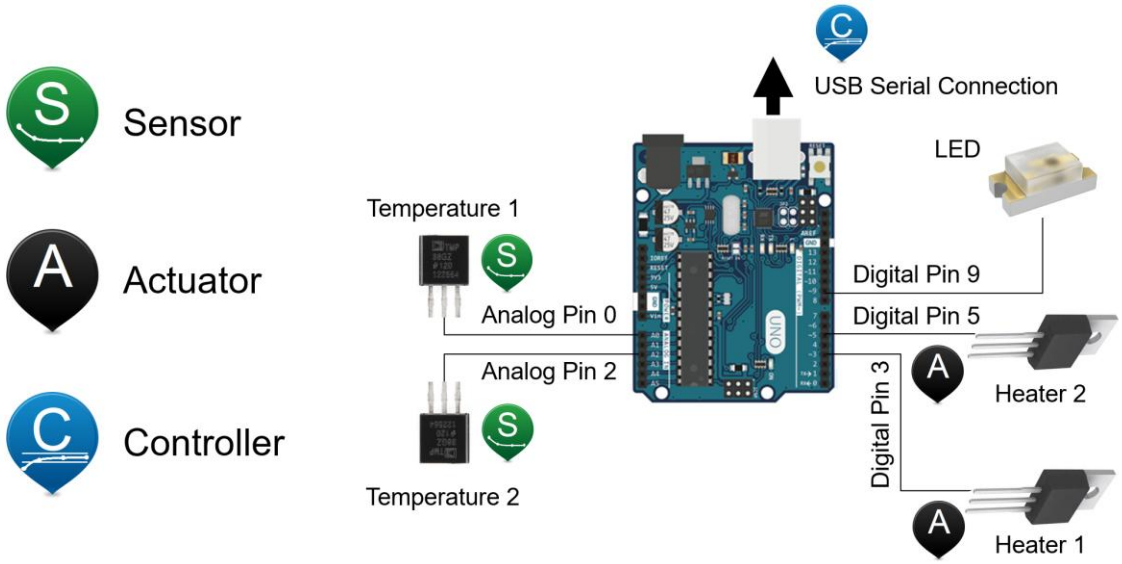
The TCLab uses TMP36GZ analog temperature sensors. The voltage output (in mV) is linearly related to temperature via:

$$T\ (°C) = 0.1 \times mV - 50$$

Sensor characteristics:

- Accuracy: ±1 °C at 25 °C
- Accuracy: ±2 °C across –40 °C to 150 °C
- Output range: 0 – 1.75 V

Diagram of the TMP36GZ sensors in the TCLab is shown below. Temperature is measured with Pins A0 and A2 by reading the voltage of the center pin. The other two pins provide power and ground to the TMP36GZ sensors. There are two temperature sensors: T1 and T2.



Questions (see https://apmonitor.com/pdc/index.php/Main/TCLabSensor):

1. What is the gain (slope), zero offset, and span of the TMP36 sensor?

2. What mV output corresponds to 25 °C?

3. What mV output corresponds to 80 °C?

4. What temperature corresponds to:
   - 0.5 V signal? _____
   - 1.2 V signal? _____

2. Voltage-to-Temperature Calculations (20 min)

Use the given formula to fill in the calculations below:

mV or V	Calculated Temperature (°C)	Show Your Work
?	25 °C output	
?	80 °C output	
0.5 V input	?	
1.2 V input	?	

3. Sensor Data Collection (20 min)

Record the measured values from the TCLab sensors:

1. Current temperature of T_1 (°C and mV)

2. Current temperature of T_2 (°C and mV)

Show how you computed mV from the Celsius value using the inverse formula.

4. Reflection & Reporting (10 min)

1. The parameters of the formula T (°C) = 0.1 × mV – 50 may be slightly different for different sensors due to manufacturing variability. How could you calibrate the sensor to determine the correct values instead of 0.1 and 50?

2. Compare room temperature (find a thermostat) to readings from the TCLab. Also, do T1 and T2 match? Why or why not?

3. List potential sources of error (e.g., ADC resolution, sensor accuracy). For example, what is the smallest temperature change that can be recorded with a 10-bit ADC on the Arduino?

4. Suggest one modification to improve measurement accuracy (e.g., averaging samples, calibration offset).

Quick Checklist

[ ] Gain, zero, span identified
[ ] Voltage-to-temperature calculations completed
[ ] Inverse function derived and used
[ ] T_1 and T_2 recorded in both °C and mV
[ ] Reflection written with insights and an improvement suggestion