Lab 16

Differential versus Single-Ended Measurements

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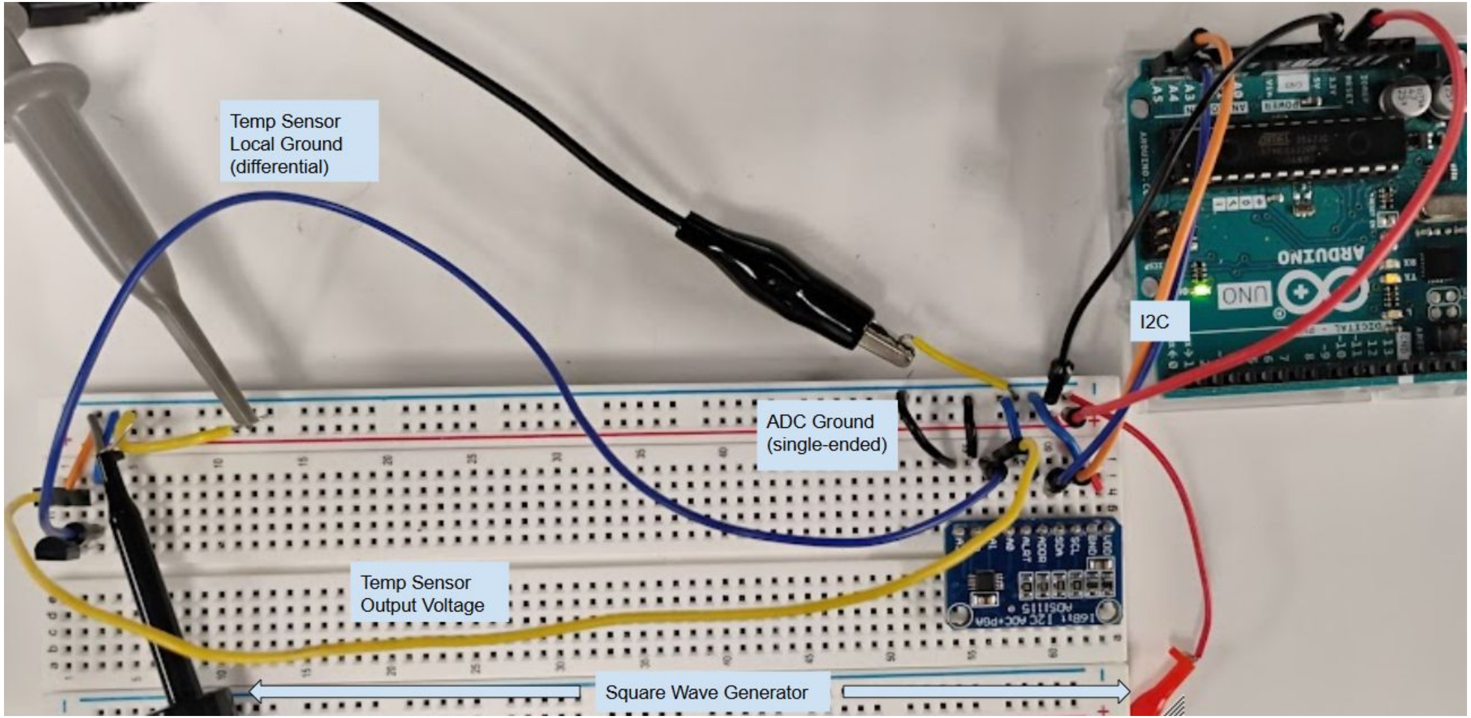
Objective

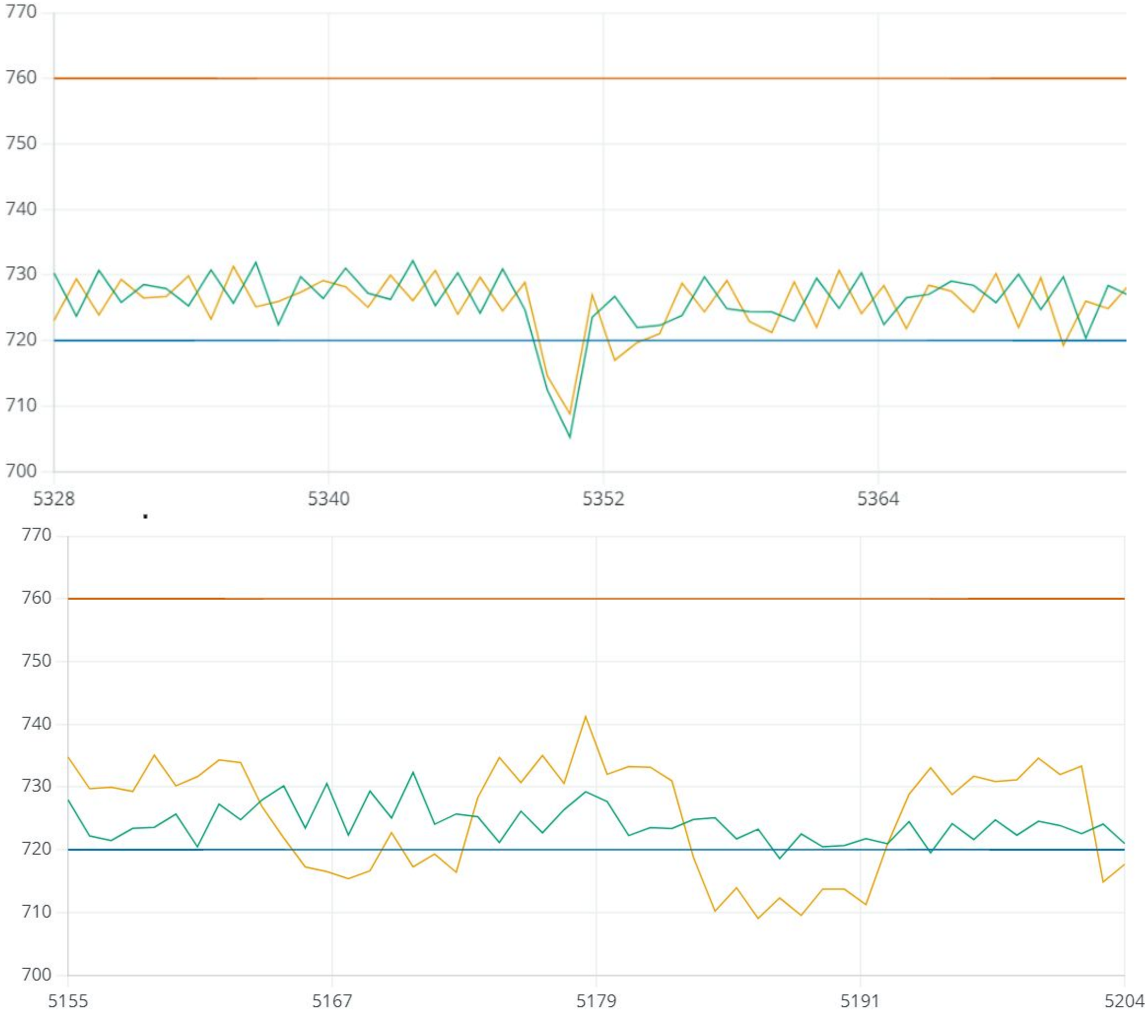
Compare single-ended and differential temperature sensor measurements with and without currents driven on the return rail.



Results

Top: Single-ended (yellow) and differential (green) measurements with no current driven on return rail.

Bottom: Single-ended (yellow) and differential (green) measurements with 0.5 Hz square wave driven on return rail.



Conclusions and Lessons

Currents on return rail create a non negligible difference between single-ended and differential measurements.

Single-ended measurement fluctuated between ~8 mV above and below differential measurement. ±8 mV was also the voltage measured across the ground rail with the scope.

For the TMP36 temperature sensor, this corresponds to an error of ±0.8 ℃.

Differential pair can protect high precision signals from being influenced by return plane noise, with the trade-off being an extra wire to run.

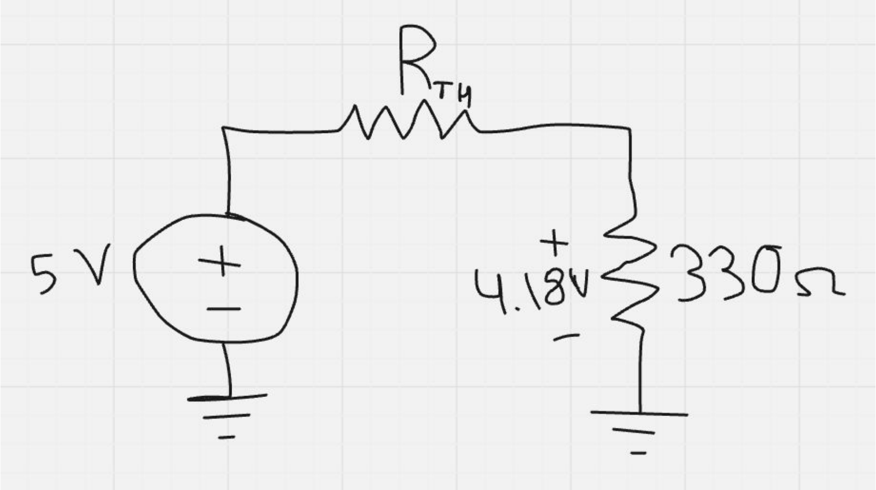
Auxiliary Slides

SBB Rail Resistance Calculation (1/2)

We first determine the function generator's internal impedance by supplying a voltage across a known resistor.

- Voltage across R_th = 5 - 4.18 = 0.82 V
- Current I = 4.18/330 = 0.013 A
- R_th = 0.82 / 0.013 = 63 Ω

We can now verify that driving 20 Vpp square wave across SBB rail will not melt it, as the maximum current will be ~0.16 A, less than the 0.2 A limit noted in the lab manual.



SBB Rail Resistance Calculation (2/2)

We then connect the function generator to opposite ends of the SBB's column, and measure the voltage across the same distance.

- Voltage across Thévenin resistance is $V = 10 - 0.008 = 9.992$ V
- Current $I = 9.992 / 63 = 0.159$ A
- Rail resistance $R_r = 0.008 / 0.159 = 0.05\ \Omega$