Project Manual

Simulation Steering Wheel

ESCE 2010 - Fall 2025

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1 Operational Amplifier as an Amplifier

1.1 Building Block

For this building block, I used an operational amplifier AD8226([1]). With 8 inputs, I connected the load cell to pins 1 and 4 as the differential inputs and a 220Ω resistor as the gain resistor to produce a 5V output. Its only a 220Ω because the 6th pin(REF) has a 2.5V input from the voltage divider.

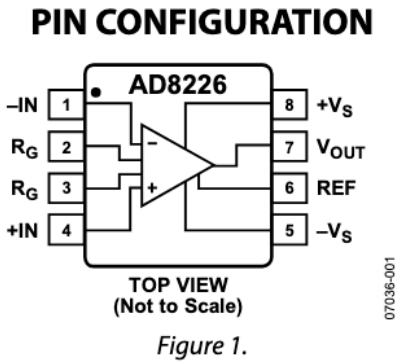


Figure 1: Amplifier Schematic

1.2 Analysis

For the AD8226 amplifier, its gain equation is equal to

$$G = 1 + (\frac{49.4k\Omega}{R_G}) = 1 + \frac{49400}{220} \approx 225$$

According to adafruit, the difference output for the load cell is 10mV. For the output to be registered by the LED, it needs a gain of 250x after being offset by the reference 2.5V. With a resistor of 220Ω, the gain is 225x which gives the output is the necessary 5V(4.74V).

1.3 Simulation

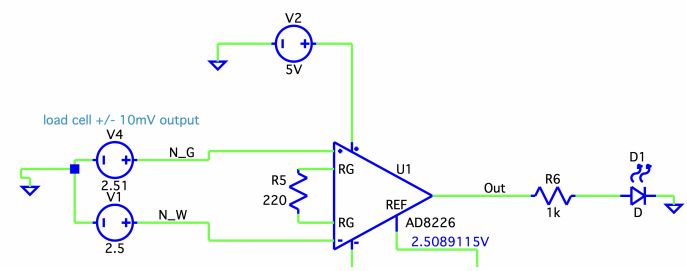
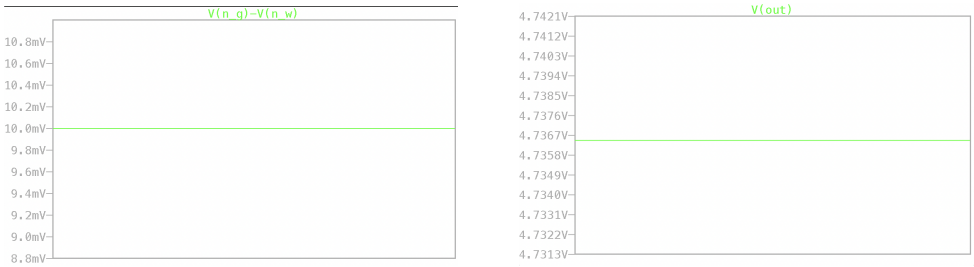


Figure 2: LTSpice Simulation

1.4 Measurement



(a) Input (b) Output

Figure 3: Amplifier

Graph a represnts the load cells input of 10mV, which going through the amplifier takes a 2.5V offset from the REF pin then has a 250x gain to output around 5V, or 4.74V.

1.5 Discussion

Anaylsis correctly matches the simulation's measurements as expected. As it replicates the actual data provided by the manufactures, this is likely. There are no issues with these measurements and although not noted, they are equivalent to the physical simulated values produced on a breadboard circuit with a minor margin of error.

2 Voltage Divider

2.1 Building Block

This block measures the reduction of voltage through a voltage dividers. No schematic is provided as this is a simple circuit to create, and can use any pair of resistors of equal ohm.

2.2 Analysis

This voltage divider is to supply a 2.5V to the AD8226 reference input as a baseline for the voltage comparison with the load cell output(also about $2.5V \pm 10mV$)

$$V_{out} = V_{in} * \frac{R_1}{R_1 + R_2}$$

2.3 Simulation

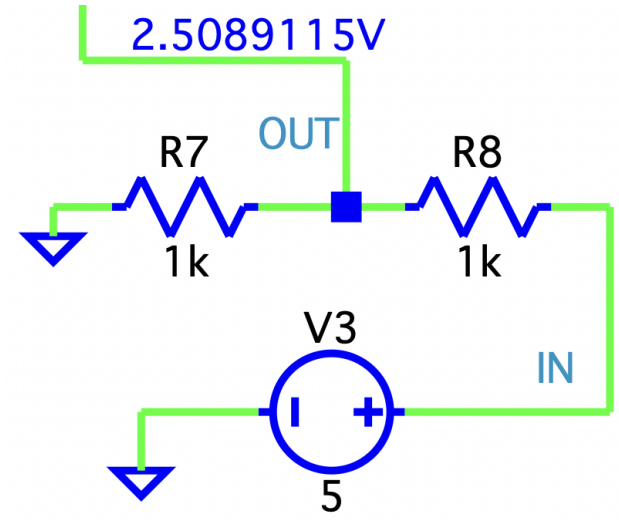


Figure 4: Voltage Divider

2.4 Measurement

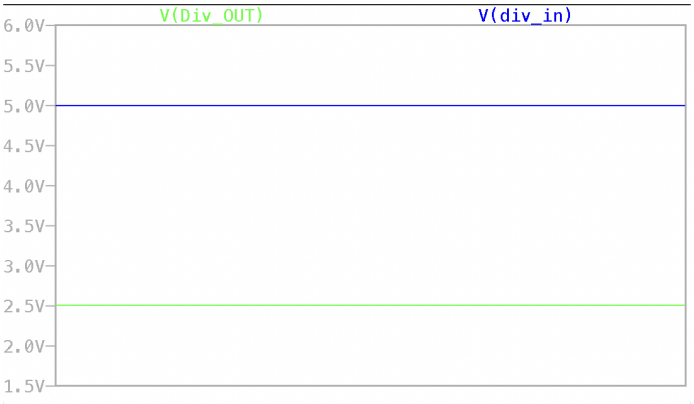


Figure 5: Amplifier Graph

2.5 Discussion

The voltage divider is a simple application of a circuit that splits in half the output voltage. Measurements and analysis both line up, though real world data has a larger margin of error. This is expected as this circuit simply reduces voltage in half using basic arithmetic.

3 References

References

[1] Analog Devices, Inc., "Ad8226: Wide supply range, rail-to-rail output instrumentation amplifier — data sheet (rev. d)." https://www.analog.com/media/en/technical-documentation/data-sheets/ad8226.pdf, 2019. Rev. D; accessed: 2025-10-08.