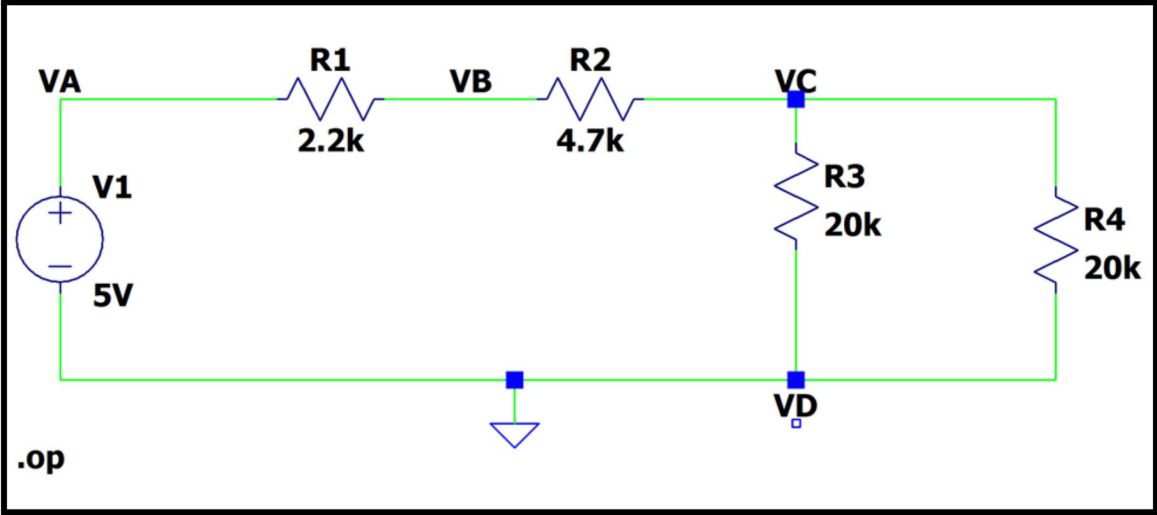


Building Block



Here we have a simple circuit with resistors **R1** (2.2 kΩ) and **R2** (4.7 kΩ) in series with a loop containing resistors **R3** and **R4** (20 kΩ each) in parallel. The circuit is powered by a 5 V DC voltage source **V1**, and nodes **VA–VD** are labeled to show where our voltage readings are taken.

Analysis:

Combining Kirchhoff's Voltage Law ($\Sigma V = 0$ in a loop) and Ohm's Law ($V = IR$) produced all the unknown node voltages and currents through each component.

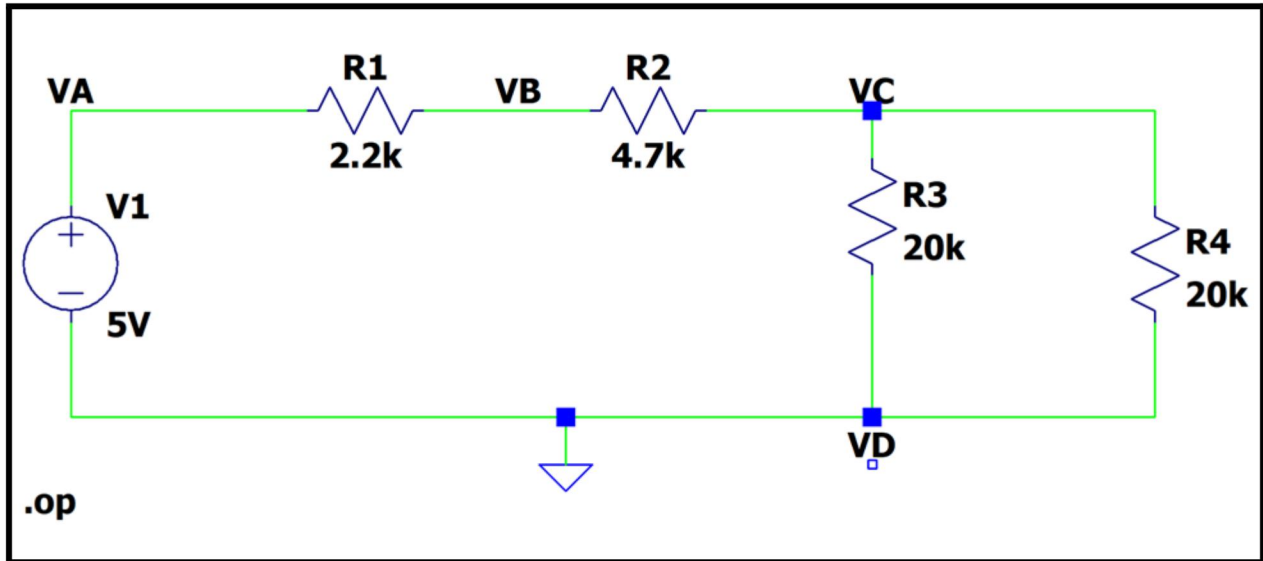
KVL + Ohm's Law, in $k\Omega$ & mA :

$$5 + 2.2I + 4.7I + I/(1/20 + 1/20) = 0$$
$$5 + 16.9I = 0$$
$$I = -5/16.9$$

Through V_1 , R_1 , and R_2 , $I = -0.295858$ mA

$$V_B = V_A + V_{R_1}$$
$$V_B = 5 + V_{R_1} = 5 + IR_1$$
$$V_B = 5 + 2.2(-0.295858)$$
$$V_B = 4.34911 \text{ V}$$
$$V_C = V_B + V_{R_2} = 4.34911 + IR_2$$
$$V_C = 4.34911 + 4.7(-0.295858)$$
$$V_C = 2.95858 \text{ V}$$
$$V_C = I_{R_3}R_3 = I_{R_4}R_4$$
$$2.95858 = 20I_{R_3} = 20I_{R_4}$$
$$I_{R_3} = I_{R_4} = 2.95858/20$$
$$I_{R_3} = I_{R_4} = 0.147929 \text{ mA}$$

Simulation:



```
--- Operating Point ---  
V(va):      5          voltage  
V(vb):      4.34911   voltage  
V(vc):      2.95858   voltage  
I(R4):      0.000147929 device_current  
I(R3):      0.000147929 device_current  
I(R2):      -0.000295858 device_current  
I(R1):      -0.000295858 device_current  
I(V1):      -0.000295858 device_current
```

Measurement:

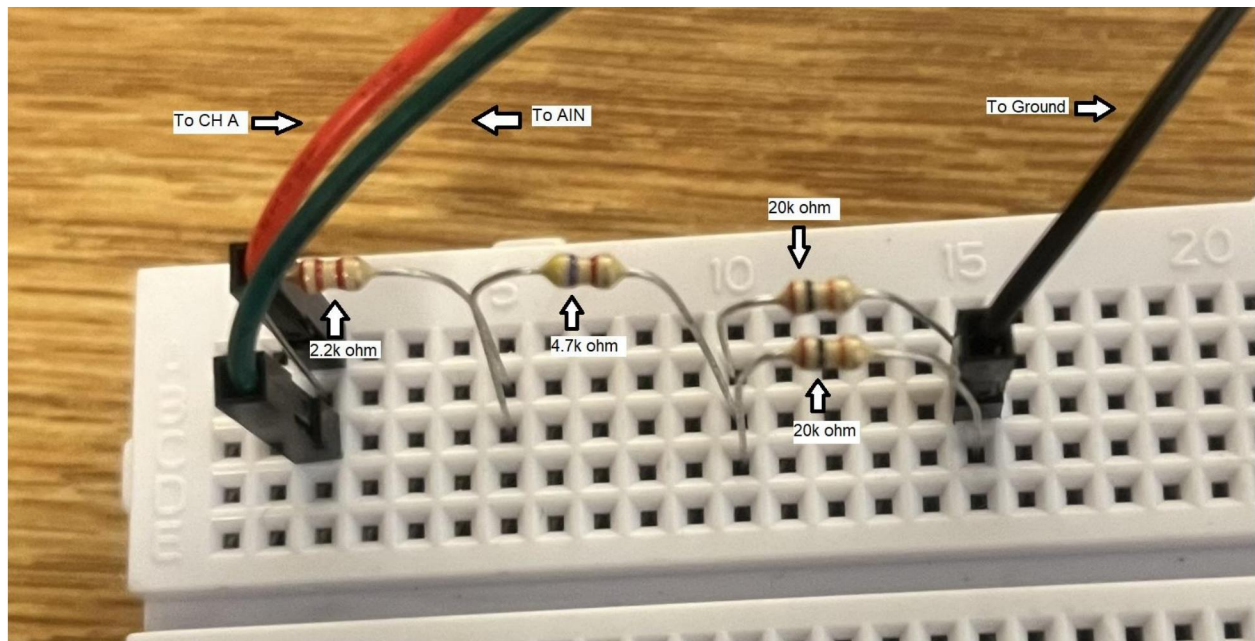
Node A:

ALM1000 Meter-Source 1.3 14 Nov 2022)

Stop Run Exit Save Config Load Config Digital Controls AD5626 Output

CA Meter CA V 4.9925 A-B V 4.8479 CA mA 0.00 Adjust CH A Gain/Offset VA 1.0 0.0 IA 1.0 0.0	CB Meter CB V 0.1446 B-A V -4.8479 CB mA ---- Adjust CH B Gain/Offset VB 1.0 0.0 IB 1.0 0.0	CA Source CA mW 0.02 <input type="radio"/> CHA off <input checked="" type="radio"/> CHA on <input checked="" type="radio"/> CHA V <input type="radio"/> CHA I <input checked="" type="checkbox"/> Split I/O CA-V 5.0 Volts CA-I 0.0 mAmps	CB Source CB mW ---- <input checked="" type="radio"/> CHB off <input type="radio"/> CHB on <input checked="" type="radio"/> CHB V <input type="radio"/> CHB I <input type="checkbox"/> Split I/O CB-V 0.0 Volts CB-I 0.0 mAmps
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Board # 0



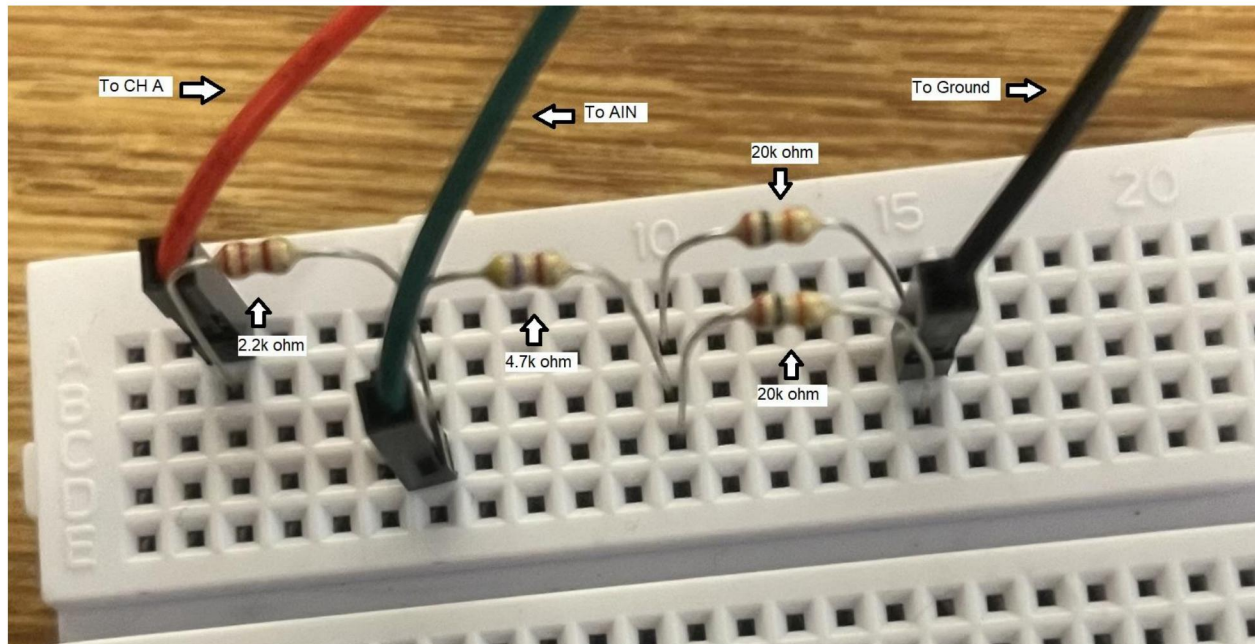
Node B:

ALM1000 Meter-Source 1.3 14 Nov 2022

Stop Run Exit Save Confg Load Confg Digital Controls AD5626 Output

CA Meter CA V 4.3367 A-B V 4.0713 CA mA -0.00 Adjust CH A Gain/Offset VA 1.0 0.0 IA 1.0 0.0	CB Meter CB V 0.2653 B-A V -4.0713 CB mA ---- Adjust CH B Gain/Offset VB 1.0 0.0 IB 1.0 0.0	CA Source CA mW -0.02 <input type="radio"/> CHA off <input checked="" type="radio"/> CHA on <input checked="" type="radio"/> CHA V <input type="radio"/> CHA I <input checked="" type="checkbox"/> Split I/O CA-V 5.0 Volts CA-I 0.0 mAmps	CB Source CB mW ---- <input checked="" type="radio"/> CHB off <input type="radio"/> CHB on <input checked="" type="radio"/> CHB V <input type="radio"/> CHB I <input type="checkbox"/> Split I/O CB-V 0.0 Volts CB-I 0.0 mAmps
--	--	---	---

Board # 0



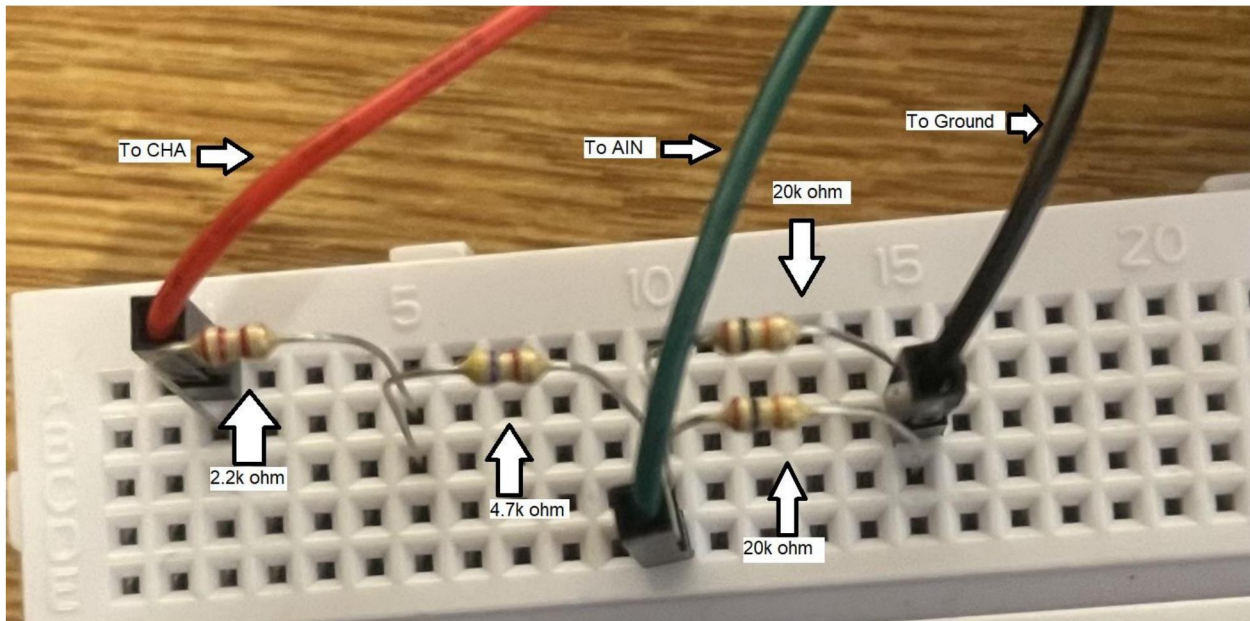
Node C:

ALM1000 Meter-Source 1.3 14 Nov 2022

Stop Run Exit Save Confg Load Confg Digital Controls AD5626 Output

CA Meter CA V 2.9506 A-B V 2.7411 CA mA -0.00 Adjust CH A Gain/Offset VA 1.0 0.0 IA 1.0 0.0	CB Meter CB V 0.2095 B-A V -2.7411 CB mA ---- Adjust CH B Gain/Offset VB 1.0 0.0 IB 1.0 0.0	CA Source CA mW -0.01 CHA off CHA on CHA V CHA I <input checked="" type="checkbox"/> Split I/O CA-V 5.0 Volts CA-I 0.0 mAmps	CB Source CB mW ---- CHB off CHB on CHB V CHB I <input type="checkbox"/> Split I/O CB-V 0.0 Volts CB-I 0.0 mAmps
--	--	---	---

Board # 0



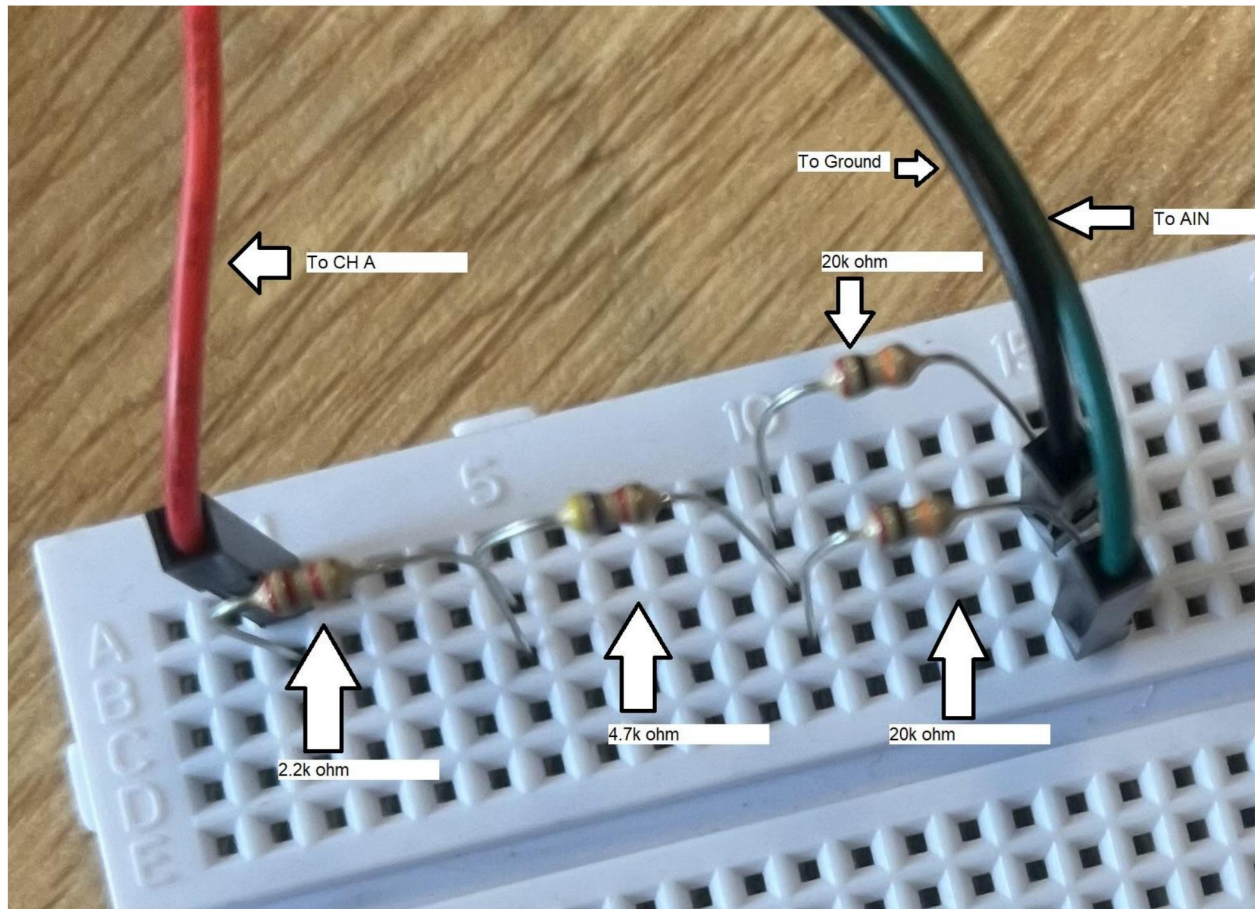
Node D:

ALM1000 Meter-Source 1.3 14 Nov 2022

Stop Run Exit Save Confg Load Confg Digital Controls AD5626 Output

CA Meter CA V 0.0000 A-B V -0.2077 CA mA -0.01 Adjust CH A Gain/Offset: VA 1.0 0.0 IA 1.0 0.0	CB Meter CB V 0.2078 B-A V 0.2077 CB mA ---- Adjust CH B Gain/Offset: VB 1.0 0.0 IB 1.0 0.0	CA Source CA mW -0.00 <input type="radio"/> CHA off <input checked="" type="radio"/> CHA on <input checked="" type="radio"/> CHA V <input type="radio"/> CHA I <input checked="" type="checkbox"/> Split I/O CA-V 5.0 Volts CA-I 0.0 mAmps	CB Source CB mW ---- <input checked="" type="radio"/> CHB off <input type="radio"/> CHB on <input checked="" type="radio"/> CHB V <input type="radio"/> CHB I <input type="checkbox"/> Split I/O CB-V 0.0 Volts CB-I 0.0 mAmps
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Board # 0



Discussion:

1. Prove Ohm's Law, KCL, and KVL in a circuit.

The calculated, simulated, and measured values are within an acceptable range of each other. The simulated and calculated values for the voltages across R1 and R2, as well as at node C, are the exact same. The only variation we see is between these values and those measured on the M1k board. These slight variations can be attributed to unaccounted resistances of the wires. Another discrepancy is that the M1k doesn't output a constant voltage; rather, it fluctuates over time. Overall, our results back up Ohm's law, KCL and KVL.

Grading Note: A table comparing voltages and currents from each step should also be included