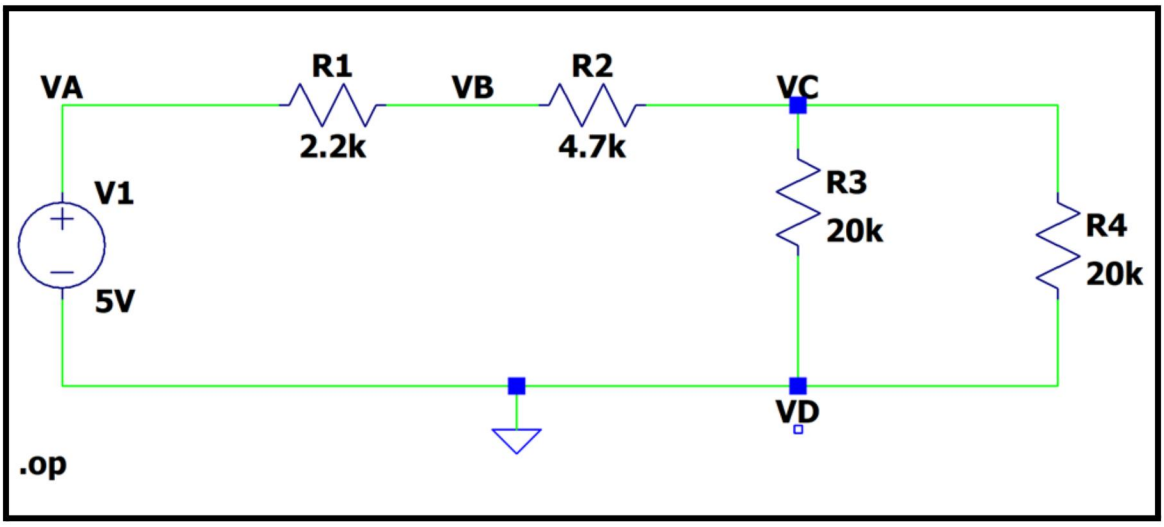
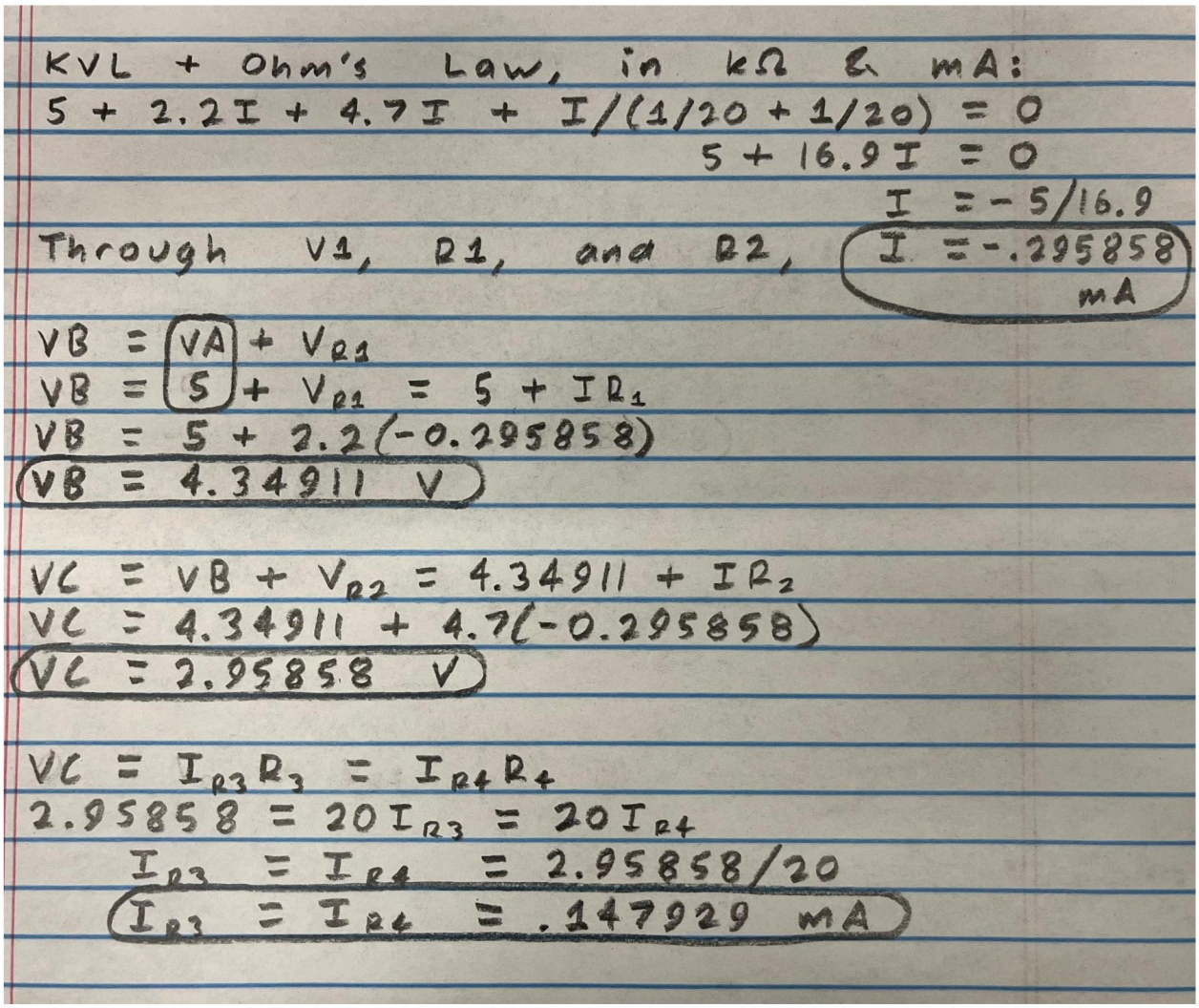
Building Block



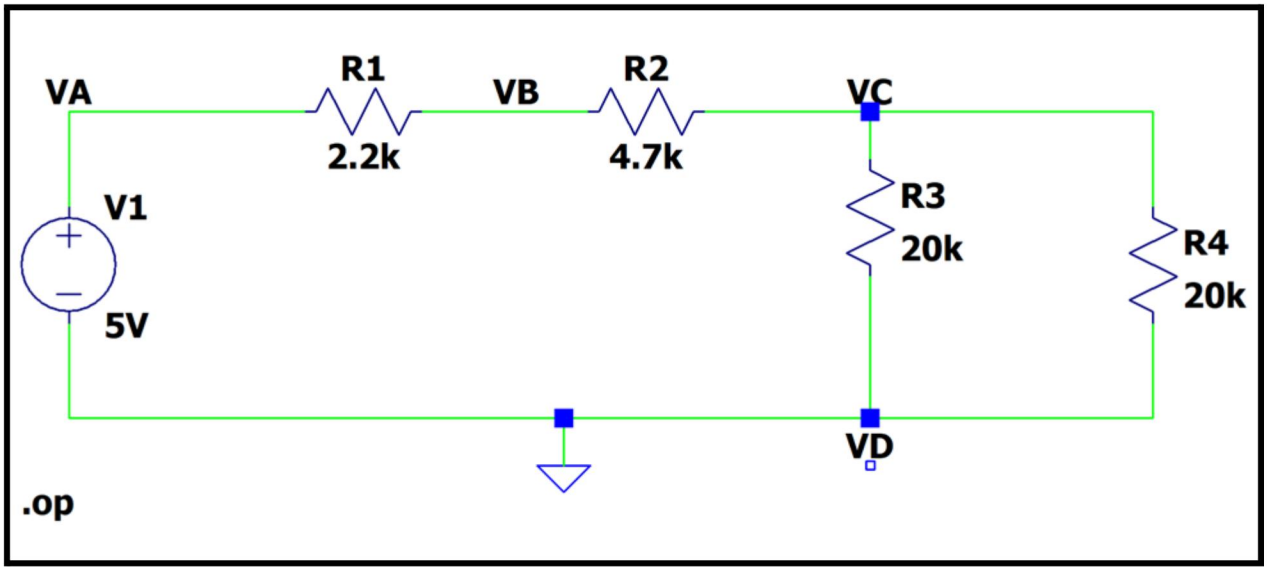
Here we have a simple circuit with resistors **R1** (2.2 kΩ) and **R2** (4.7 kΩ) in series with a loop containing resistors **R3** and **R4** (20 kΩ each) in parallel. The circuit is powered by a 5 V DC voltage source **V1**, and nodes **VA–VD** are labeled to show where our voltage readings are taken.

Analysis:

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



Simulation:

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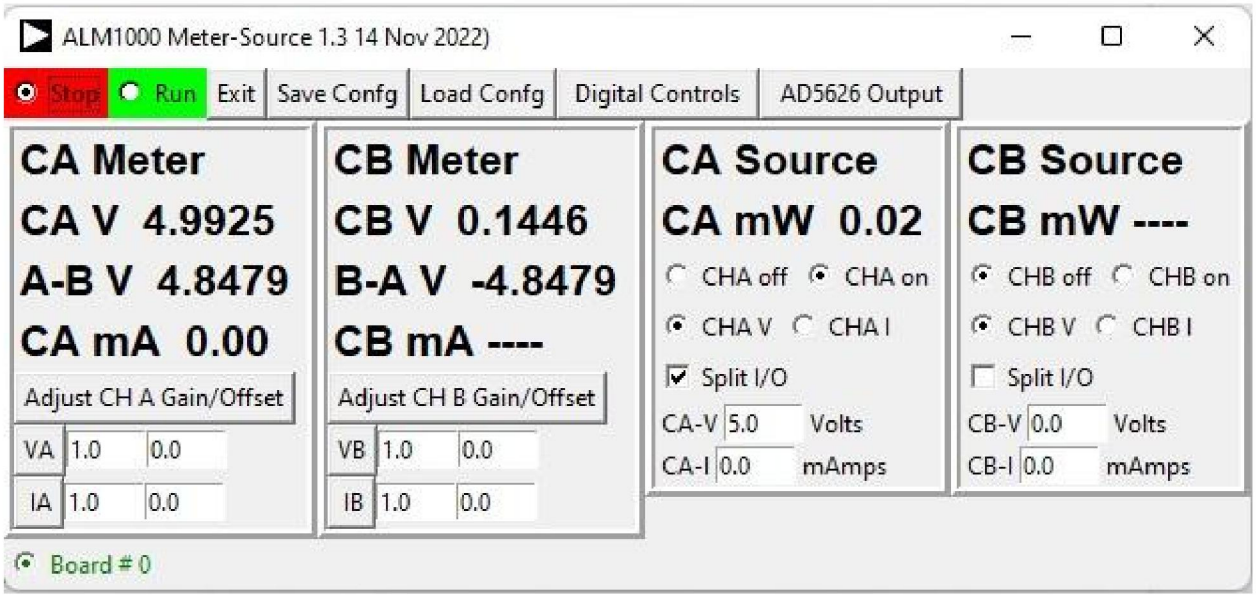
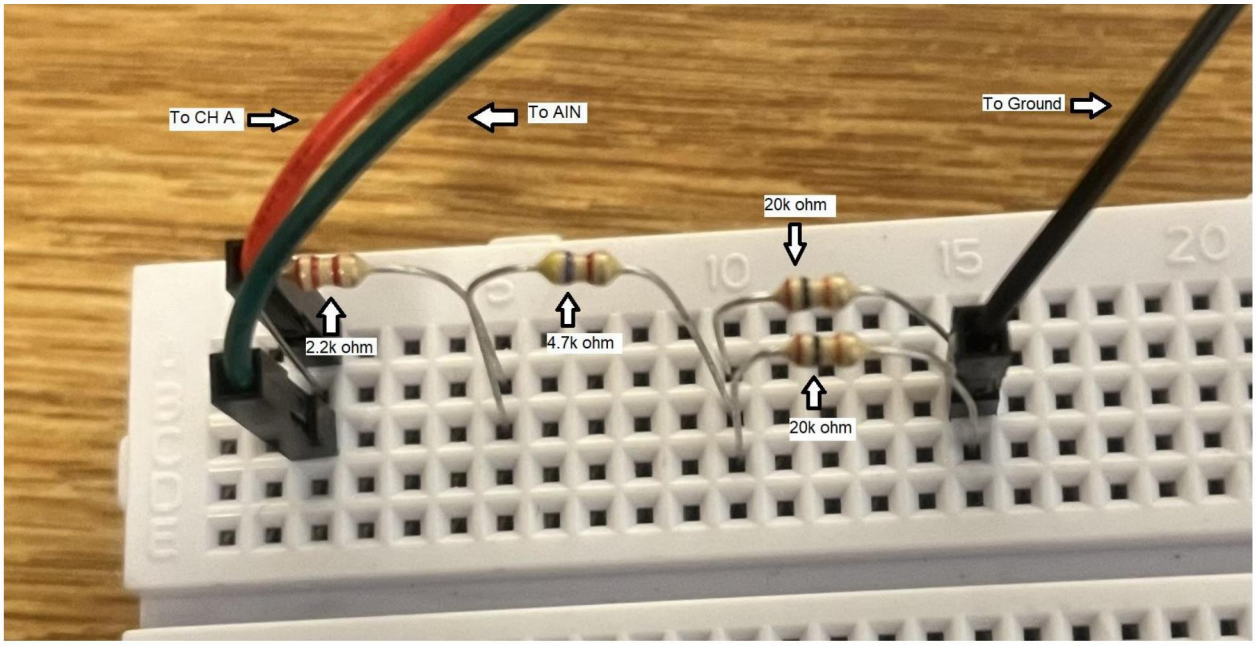
        --- Operating Point ---

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
```

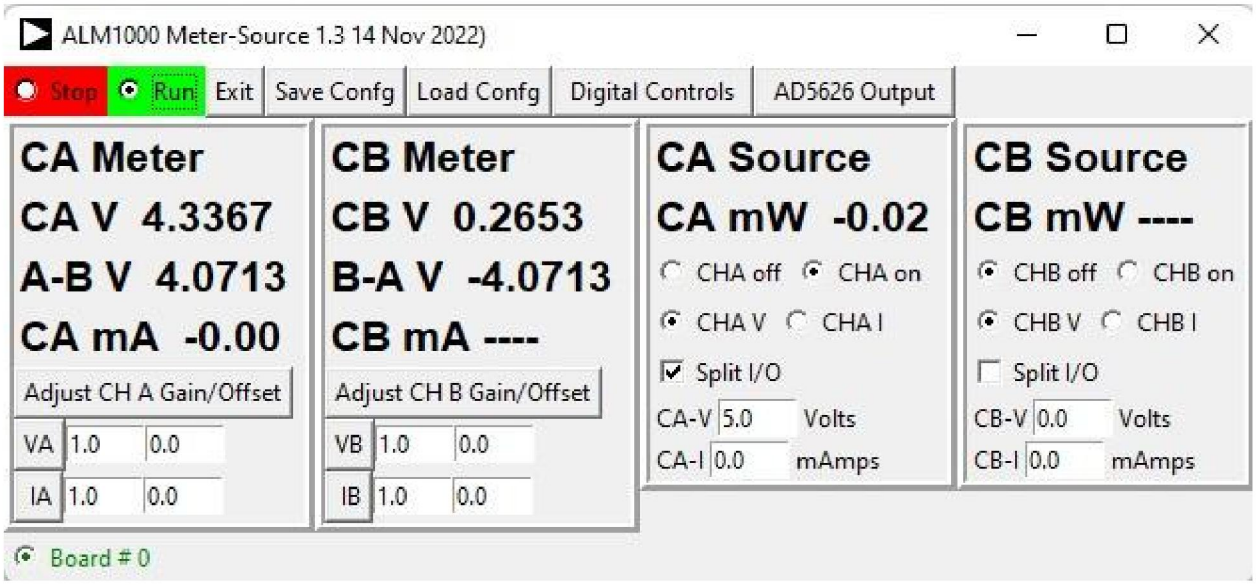
Measurement:

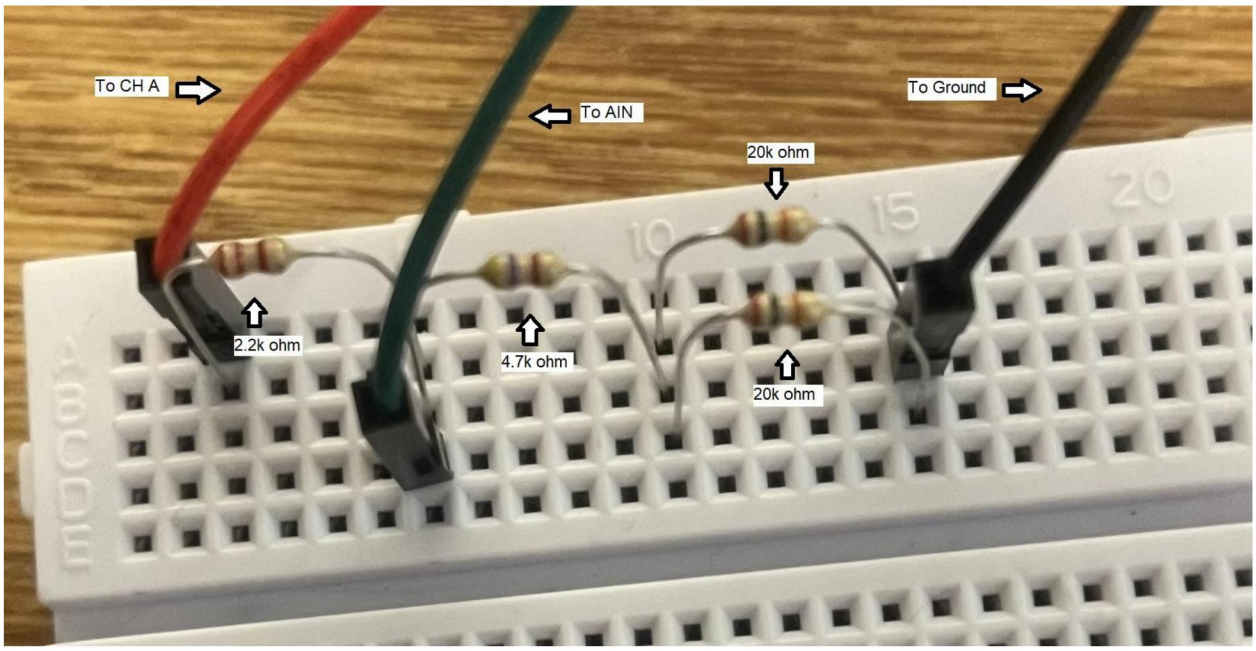
Node A:



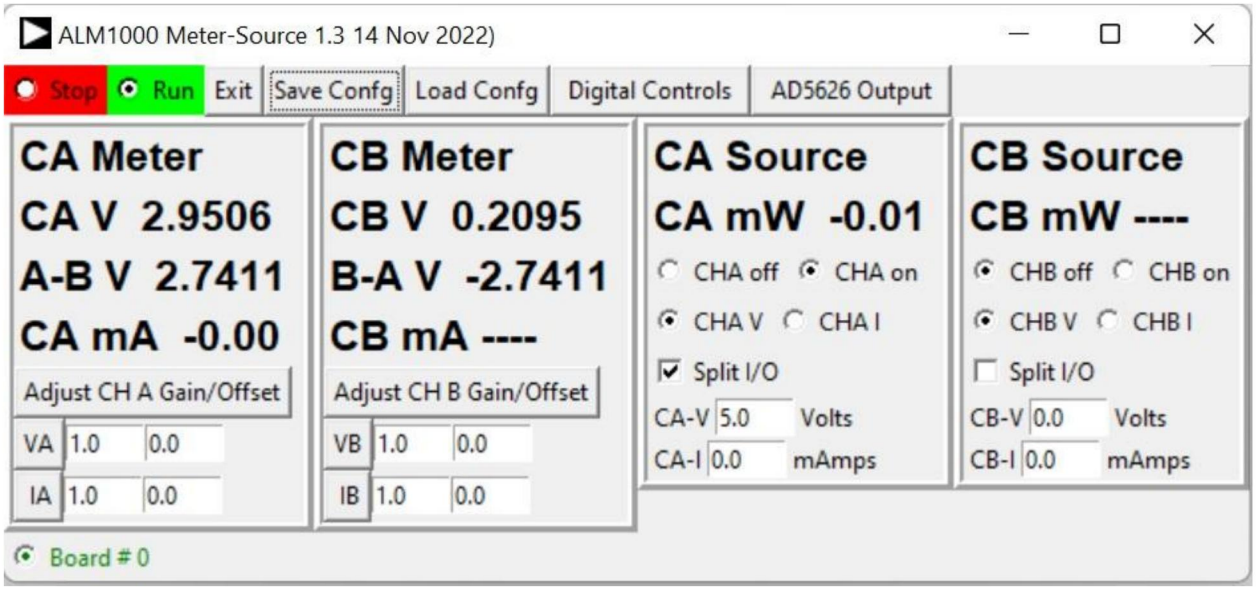


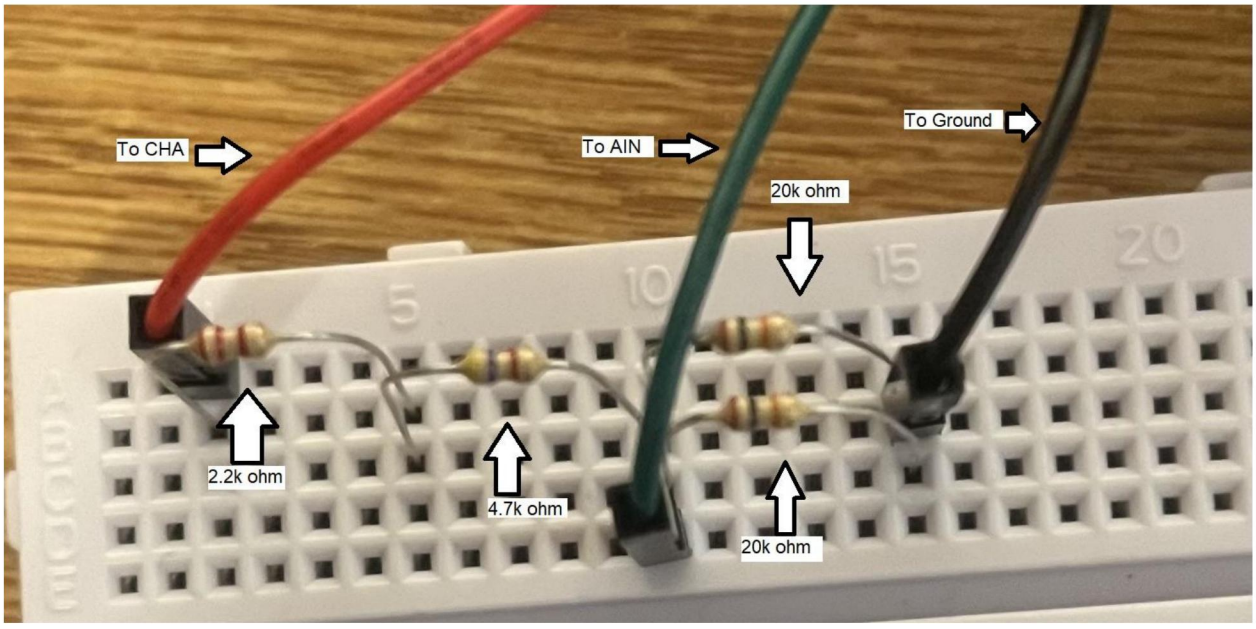
Node B:


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
CHA off
CHA on
CHA V
CHA I
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
Split I/O
CB-V 0.0 Volts
CB-I 0.0 mAmps
Board # 0

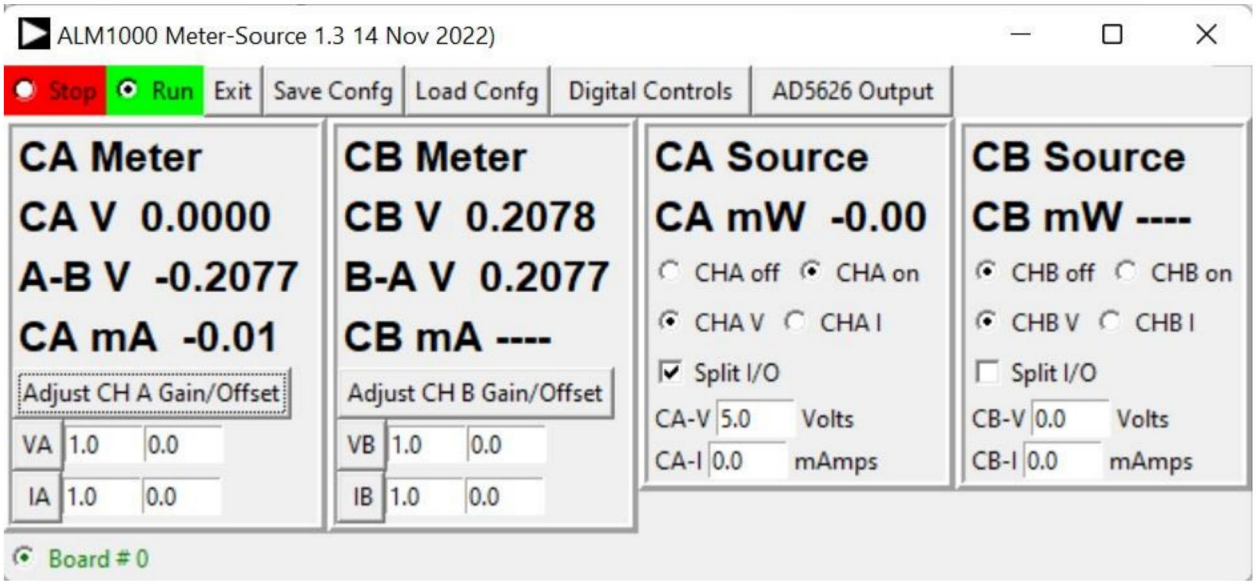

To CH A
To AIN
To Ground
20k ohm
2.2k ohm
4.7k ohm
20k ohm

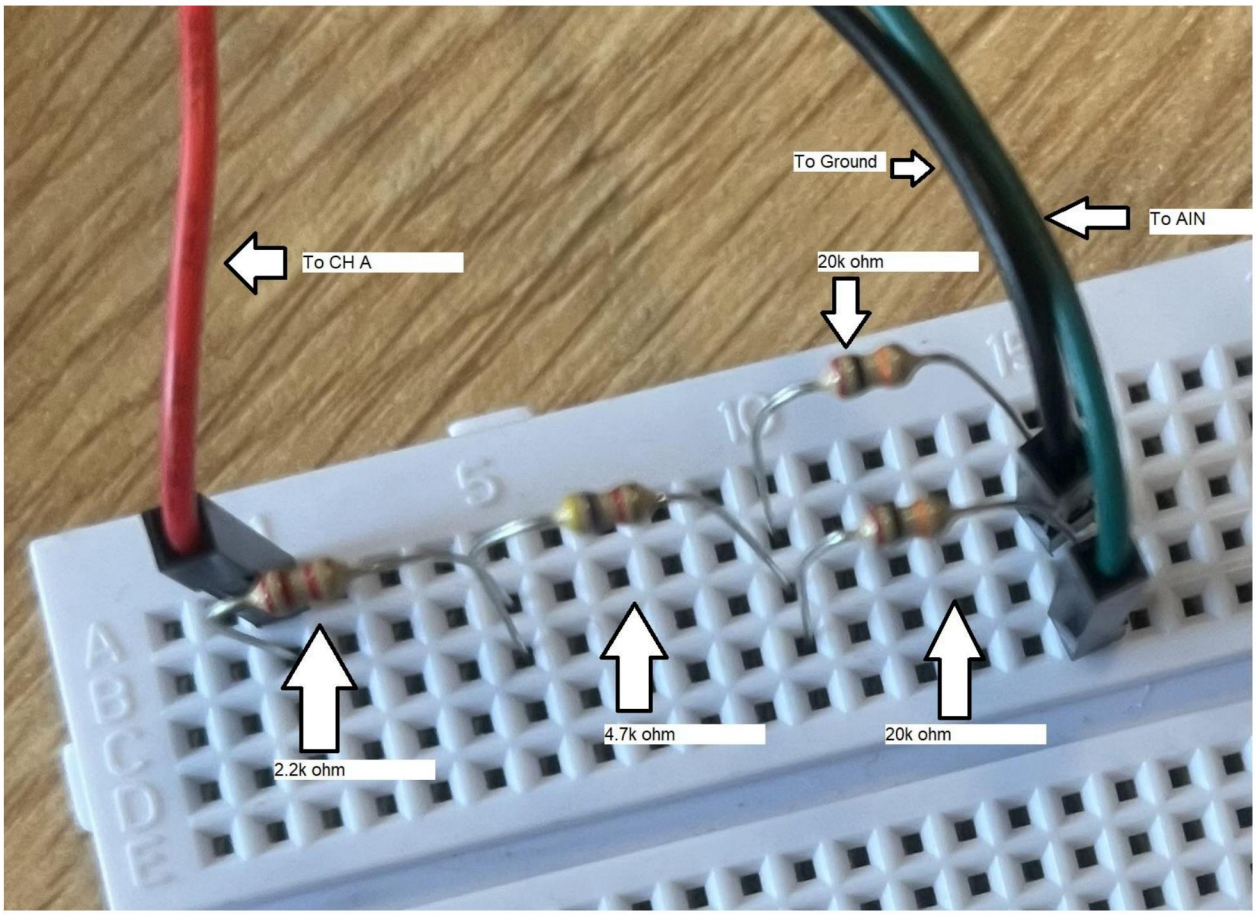
Node C:


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
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
Split I/O
CB-V 0.0 Volts
CB-I 0.0 mAmps
Board # 0


To CHA
To AIN
To Ground
20k ohm
2.2k ohm
4.7k ohm
20k ohm

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
CHA off
CHA on
CHA V
CHA I
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
Split I/O
CB-V 0.0 Volts
CB-I 0.0 mAmps
Board # 0


To Ground
To AIN
To CH A
20k ohm
4.7k ohm
20k ohm
2.2k ohm

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.