Labs 11 and 12

Trace Resistance and Current-Carrying Capacity

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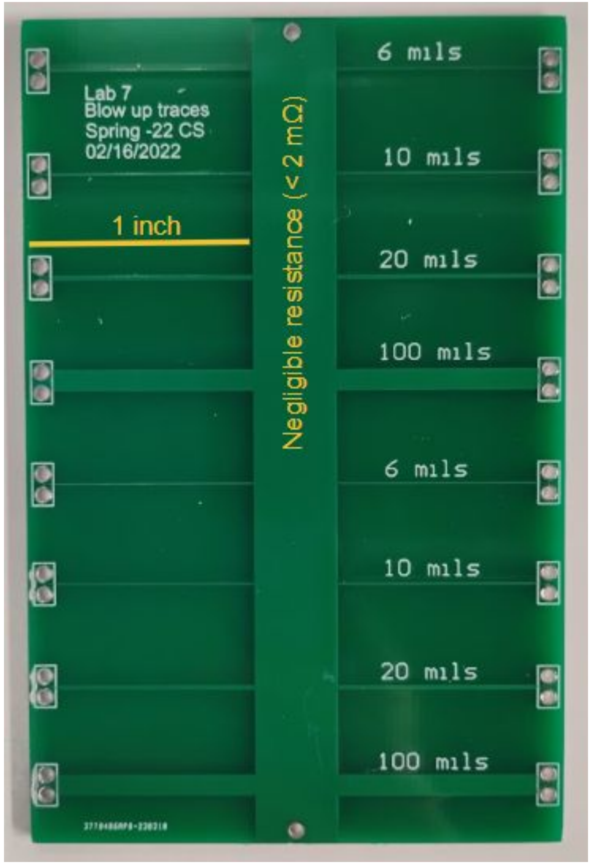
Objectives

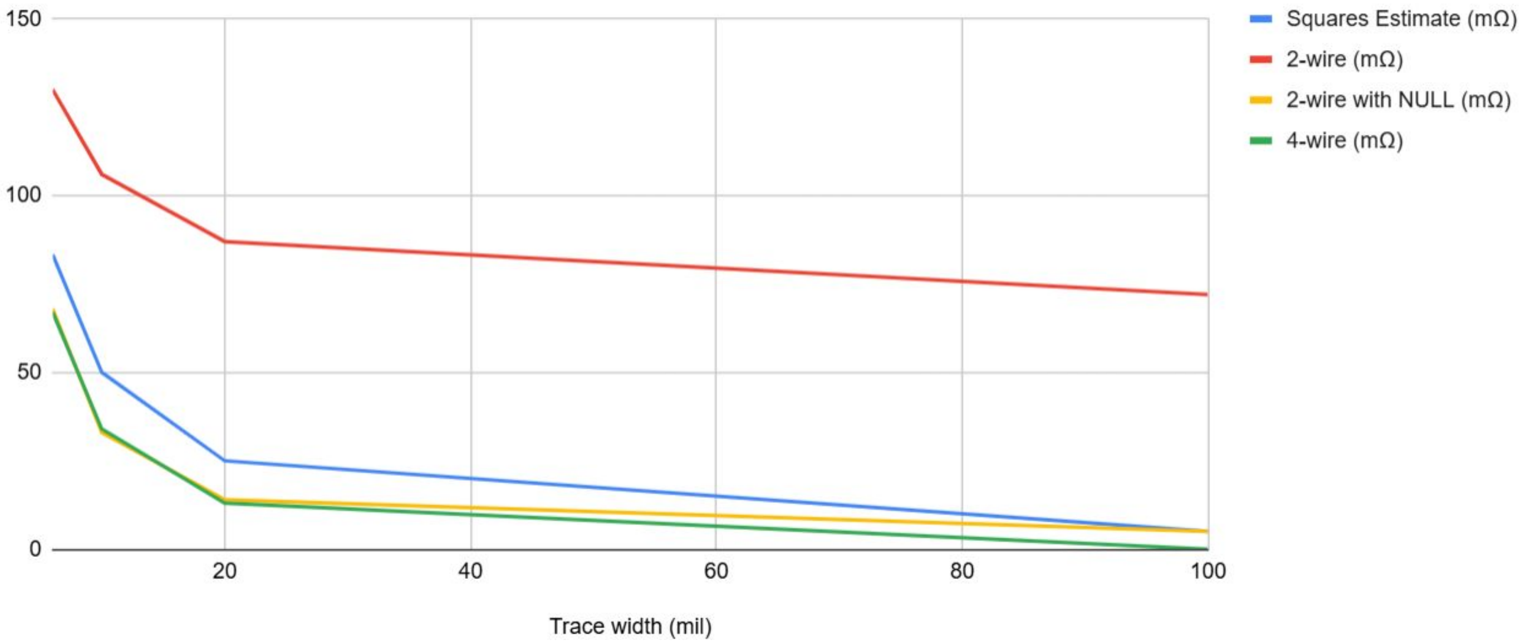
- Lab 11: Measure the resistances of 1” traces of varying width.
  - Use the 2-wire and 4-wire methods
  - Compare to estimates given by the “counting squares” method.
- Lab 12: Experimentally determine the maximum current the 6 mil trace can handle before burning.



Provided “Blow up traces” PCB

Results

Lab 11

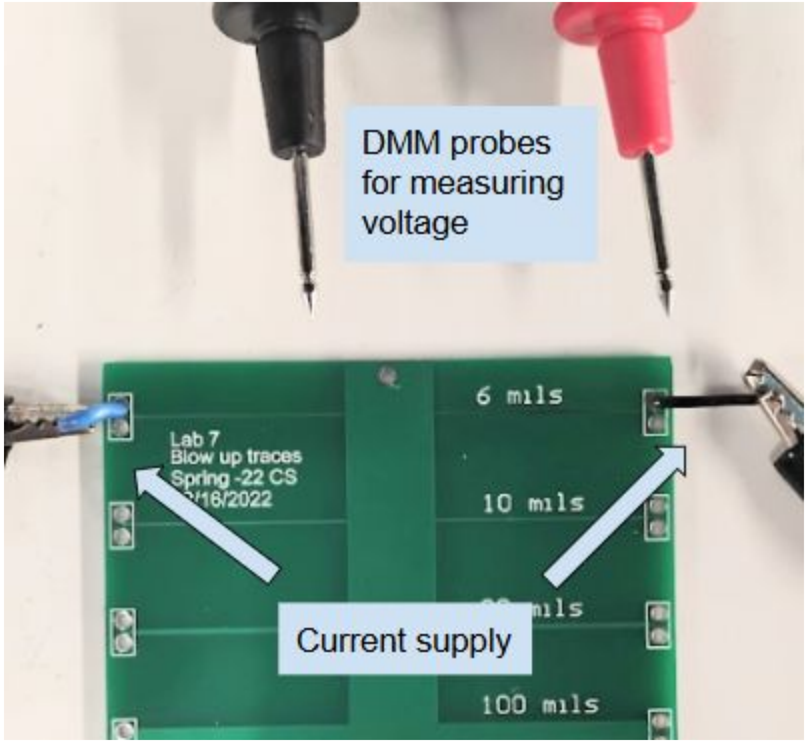


Trace width (mil)	Squares	Squares Estimate (mΩ)	2-wire (mΩ)	2-wire with NULL (mΩ)	4-wire (mΩ)
6	166.7	83.3	130	68	67
10	100	50	106	33	34
20	50	25	87	14	13
100	10	5	72	5	0

Results

Lab 12

- 0.86 A: Limit given by online calculator for keeping change in temperature less than 45℃.
- 1 A: Still cool
- 2 A: Warm to the touch
- 3 A: Hot to the touch, gradual thermal runaway observed
- 4 A: Trace burnt



Conclusions

- There was good agreement between the 4-wire measurements and the 2-wire measurements with NULL on.
    - However, it was also observed that setting the NULL offset value could be finicky. On the other hand, the 4-wire method requires extra wires to drive current, so there is a trade-off.
- The Counting Squares estimate provided only slightly higher values, and was the quickest and easiest method.
- The 6 mil trace could take 1 A of current with no problem, and 3 A for at least a minute.

Auxiliary Slides

Thermal Runaway

- As the copper heated up, it’s resistivity increased, which meant that the voltage across the trace increased, and even more power was dissipated in the trace.

- For example, when the voltage was 416 mV and the current 3.71 A, the resistance of the trace was 112 mΩ (67% greater than our Lab 11 measurement).

Benchtop multimeter and power supply

Thermal Runaway

- This phenomenon means that the trace may burn if carrying current below the limits found for a very long time, and that the duty cycle of the current is also an important consideration.

Benchtop multimeter and power supply