Lab 11 & 12 Report: Measuring Trace Resistances and Blowing them up

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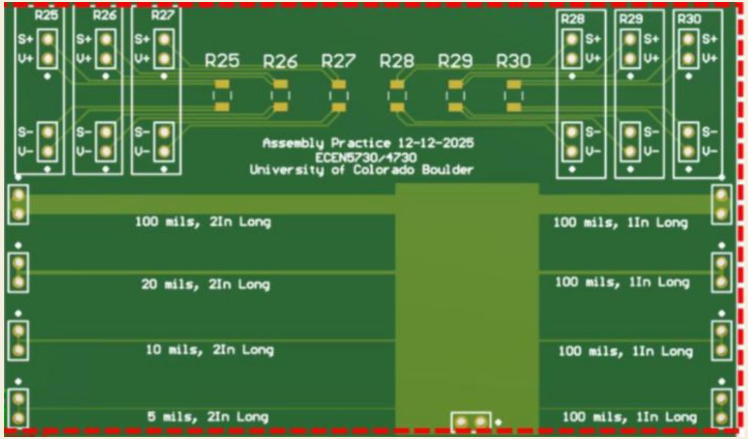
Purpose

The purpose of these labs are to learn how to measure trace resistances using several methods and determine the maximum current carrying capacity of narrow traces.

The first lab consists of using a 2-wire measurement method and comparing it to a 4-wire measurement method. The second lab has us driving high currents through PCB traces. The PCB we are using for this is shown to the right.



2-Wire vs. 4-Wire Measurements

2-Wire Method:

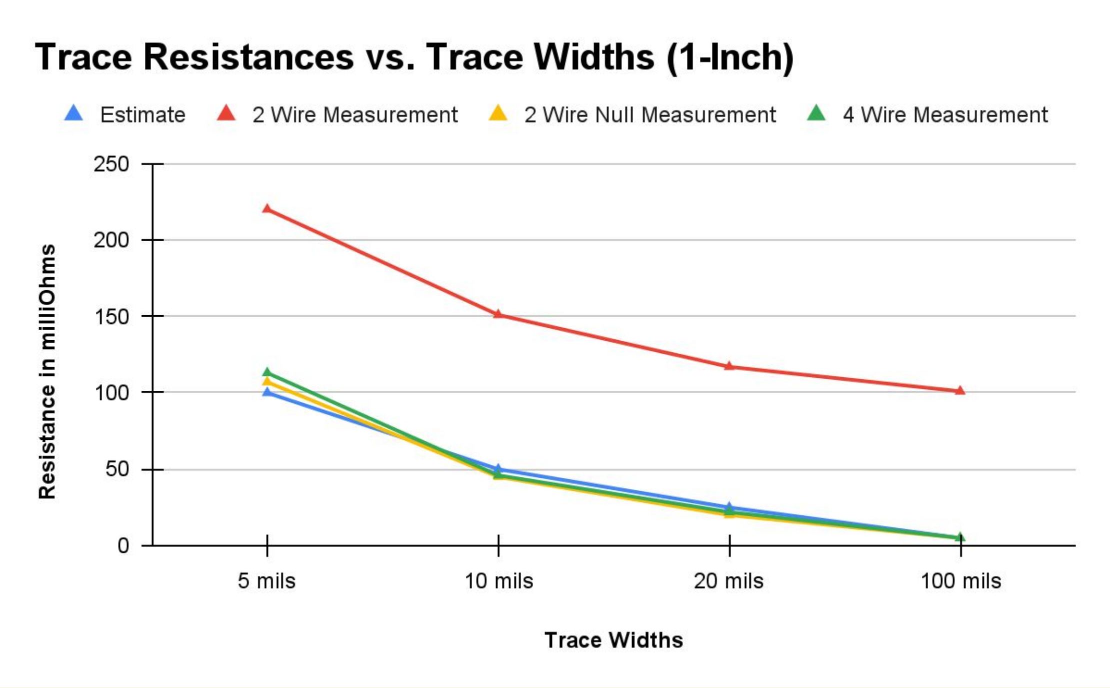
- ➢ The leads supply a test current and measure the resulting voltage drop
- ➢ Total resistance is the sum of Load Resistance and total Lead Resistance
- ➢ Best for High Load Resistances

4-Wire Method:

- ➢ Current-carrying path is separate from the voltage-sensing path
- ➢ There is essentially no voltage drop across the leads meaning only voltage across the load is taken into consideration
- ➢ Best for Low Load Resistances

1-Inch Trace Length

- Rule-of-thumb estimates assume 0.5 milliOhms per square where each square has the same width as the trace
- 2-Wire Null and 4-Wire resulted in very similar values and followed the same trends
- We can also see that the estimations using the rule-of-thumb are not perfect
- Regular 2-Wire overshot the resistance by a great deal



2-Inch Trace Length

- Similar trend to the 1-Inch Traces
- The 2-Wire measurement shown here also had a great deal of overshoot due to the includance of the Lead Resistances
- We can see that the 4-Wire method is clearly best for measuring low load resistances
- The 2-Wire Null method mathematically removes Lead Resistance which mimics the 4-Wire method

Trace Burning Setup

- ➢ Used the Saturn PCB toolkit to estimate the maximum currents that could be driven through the traces (Setup shown below)
- ➢ Wired up the traces to a power supply and began increasing current
- ➢ Noted at which points the traces became warm, hot, and blew up
- ➢ Estimated maximum of .96A of current for the 5 mil wide traces using Saturn PCB

Trace Burning Results

- The balanced thermal runaway was approximately 1A
- The toolkit greatly underestimated the amount of current that could be put through the traces before they would start to explode
  - Does not consider trace lengths as part of the estimation
- I would not feel comfortable putting more than the maximum estimated by Saturn PCB
  - Traces started to become warm soon after crossing that value

Condition	5mil (1in)	5mil (2in)	10mil (1in)	10mil (2in)
Estimated	0.96A	0.96A	1.52A	1.52A
Warm	1.21A	1.50A	2.62A	2.23A
Hot	2.72A	2.35A	3.42A	2.99A
Blow up	4.01A	3.66A	6.16A	5.67A

Conclusion

- Ideally we are able to use the 4-Wire Measurement method when working with low impedance loads
    - If using the 2-Wire Method make sure to use the null setting and mathematically subtract Lead Resistances
- Our estimation using the 0.5 milliOhms per square yielded relatively close results to the measured value
- Using conservative estimates for maximum current can only serve to protect our future boards
- Understanding trace resistances and current constraints ensures that we do not treat traces like ideal wires but rather additional elements involved in the circuit