# Lab 11/12 Presentation ECEN 3730

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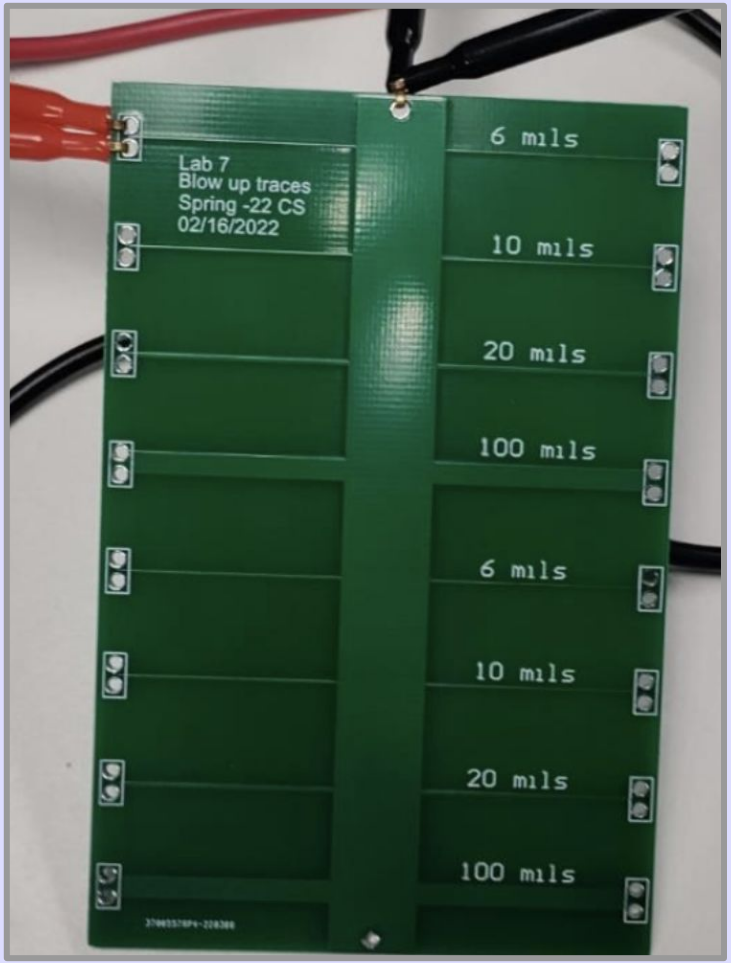
# Introduction

In this lab, we measure the resistance of 4 traces of different widths, and then attempt to blow one up.

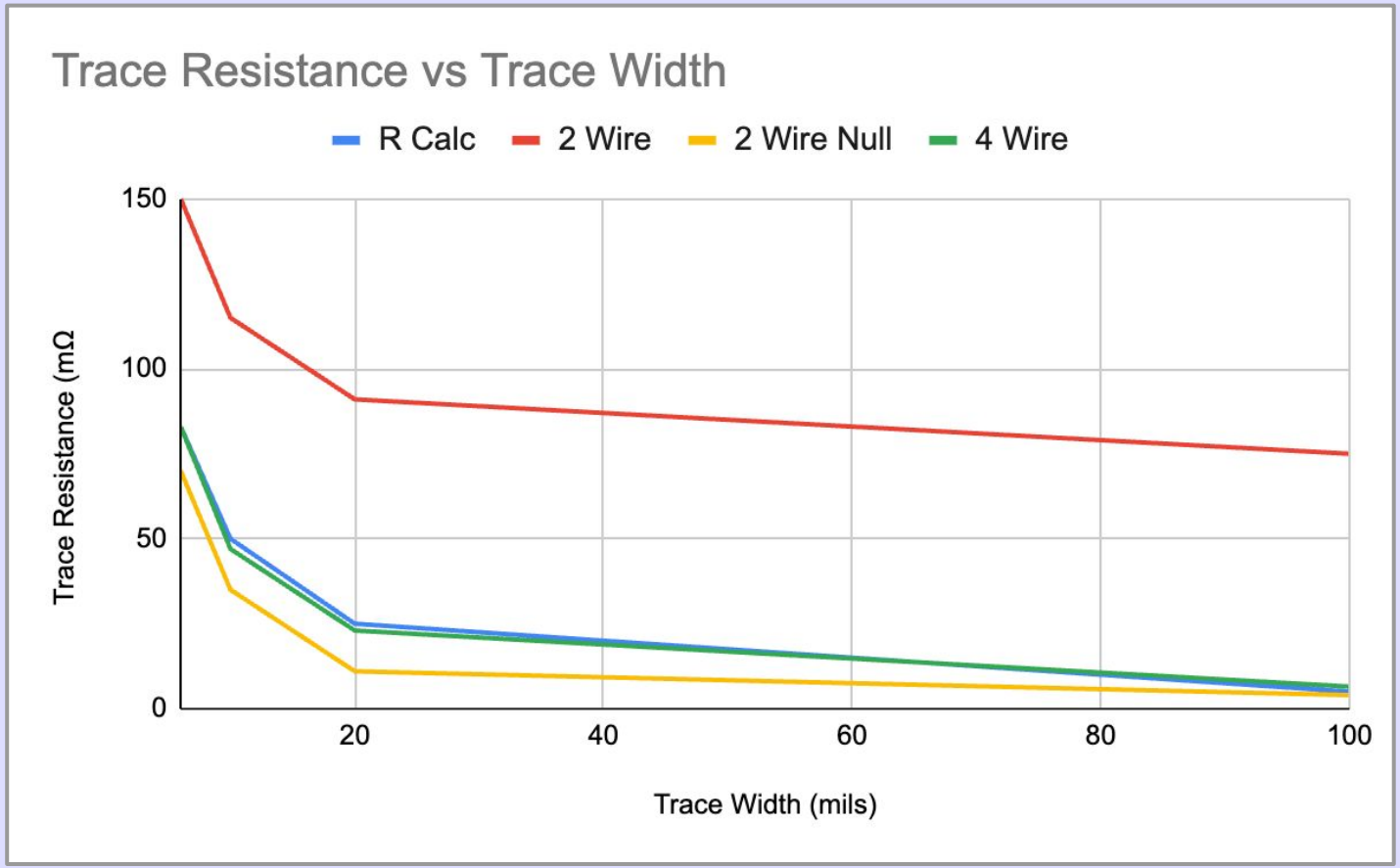
- We first apply the concept of sheet resistance in order to estimate the resistance of the traces using the ‘square’ method
- We then use the 2 wire method using the DMM
- We then perform a 2 wire null-method, where we compare to a reference resistance (similar to zeroing a scale)
- We then sweep a constant current through the traces, and observe the voltage drop on the DMM to find the resistance using the 4 wire method



For 1oz copper, R = 0.5mΩ/square

| **Line Width** | # Of Squares | **R (Estimate)** | **2 Wire** | **2 Wire (null)** | **4 wire** |
|---|---|---|---|---|---|
| **6 mil** | 1000 / 6 = 166.7 | 166.7 * 0.5 mΩ = 83mΩ | 150 mΩ | 70 mΩ | 83 mΩ |
| **10 mil** | 1000 / 10 = 100 | 100 * 0.5 mΩ = 50mΩ | 115 mΩ | 35 mΩ | 47 mΩ |
| **20 mil** | 1000 / 10 = 50 | 50 * 0.5 mΩ = 25mΩ | 91 mΩ | 11 mΩ | 23 mΩ |
| **100 mil** | 1000 / 100 = 10 | 10 * 0.5 mΩ = 5mΩ | 75 mΩ | 4 mΩ | 6.5 mΩ |

| **4 Wire Measurement:** | Current supplied (A) (CC Mode) | DMM Reading (mV) | Resistance (mΩ) |
|---|---|---|---|
| 6 mil | 1 A | 83 mV | 83 mΩ |
| 10 mil | 1 A | 47 mV | 47 mΩ |
| 20 mil | 1 A | 23 mV | 23 mΩ |
| 100 mil | 1 A | 6.5 mV | 6.5 mΩ |

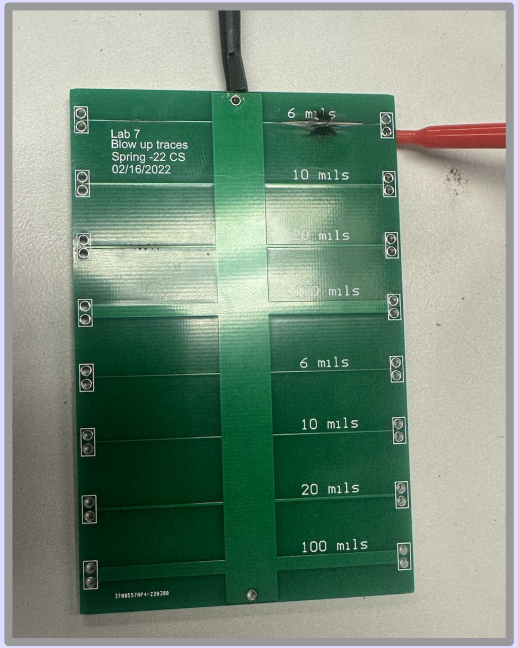

Trace Resistance vs Trace Width
R Calc
2 Wire
2 Wire Null
4 Wire
150
100
50
0
Trace Resistance (mΩ)
20
40
60
80
100
Trace Width (mils)

# Blowing up Trace

To blow up the 6 mil trace, I first started with the Saturn PCB Tool, which calculated that for a 120℃ (216℉) increase in temperature, I would need to source 1.8 A through the trace.

- Knowing this, I started with 2 A. After around 30 seconds, I could begin to feel the trace get hot.
- I then ramped the current to 3 A, and felt the temperature rise even further.
- At 4 A, the trace took roughly 10 seconds to begin burning and eventually blow entirely.
- As the trace heated up, the voltage increased due to thermal loss (increase in resistance)

I then repeated this method for the 100 mil trace, testing up to 10 A, the limitation of the power supply. In this case, the trace never blew up.



# Conclusion

- Trace resistance is easy to estimate using just geometry and known sheet resistance.
- Two wire measurements are fast but include loop resistances, which affects the accuracy for small resistance values
- Four wire measurements are essential for accurate readings of small resistances because they remove the influence of loop and contact resistance
- Using a constant current source simplifies resistance calculations and allows easy validation of theoretical predictions.
    - Using the 4 wire method on the DMM even further drastically simplifies the measurement
- 6 mil trace took roughly ~4 A to blow, where as 10 A could not blow up the 100 mil trace.