

EXPO

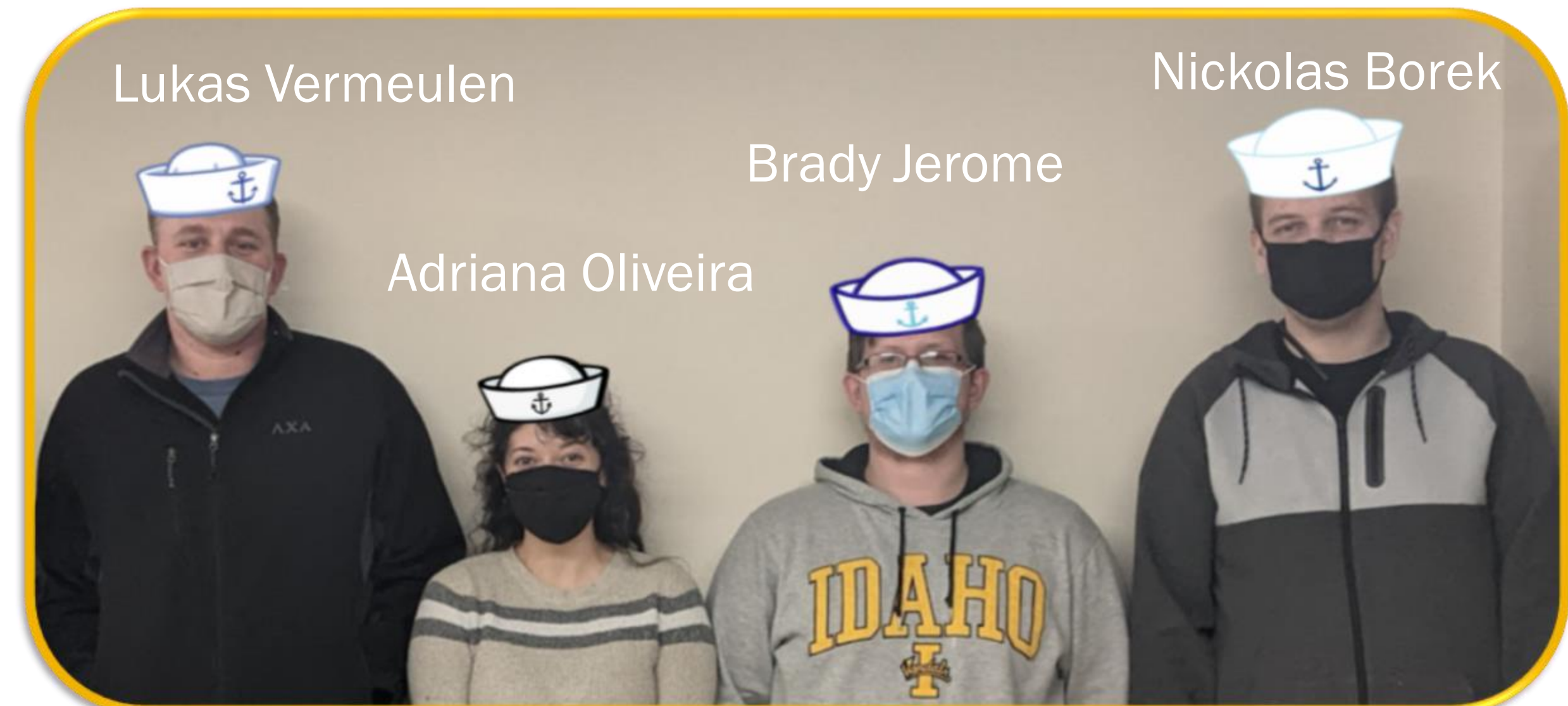
engineering ▲ design



University of Idaho
College of Engineering

THE DEVELOPMENT OF A LOW COST PYRANOMETER

PRESENTED BY THE SOLAR SAILORS:



OBJECTIVE:

CREATE A COMPETITIVE PYRANOMETER PROTOTYPE

- I Affordable alternative to market models
- I Accurate solar irradiance readings
- I Reproducible design



BACKGROUND



KILOWATTS
FOR HUMANITY

Provided services:

- I Refrigeration
- I Device charging
- I Offline servers



VALUE PROPOSITION

THE NEED:

Monitor rooftop solar energy absorption

Affected by:

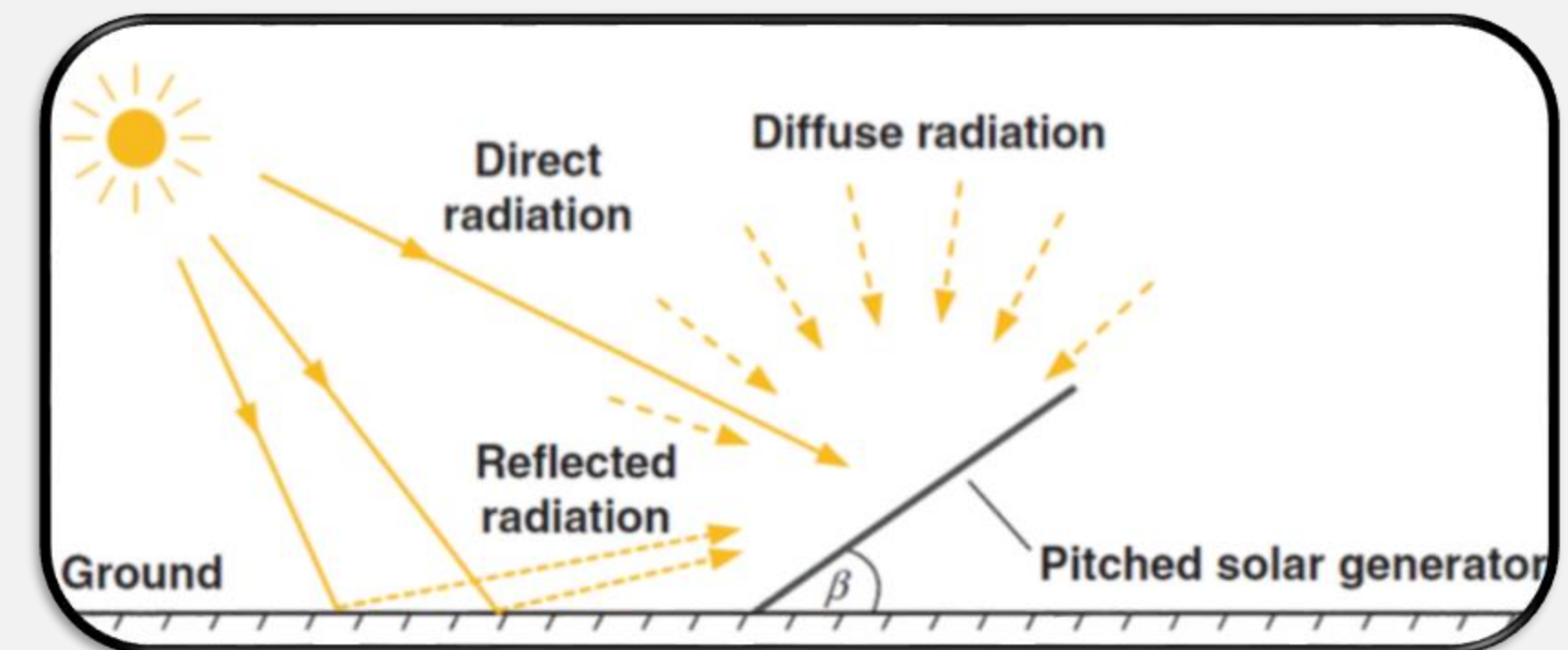
- I Weather
- I Dirt
- I Aging
- I Maintenance needs



THE SOLUTION:

Produce a cost effective pyranometer

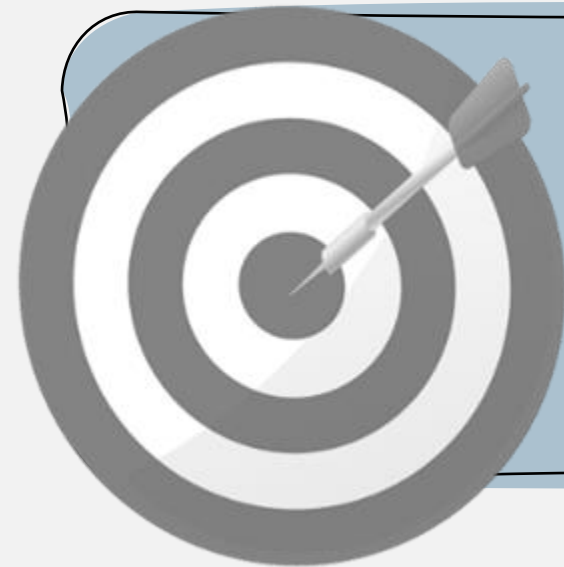
Solar Irradiance: W/m^2



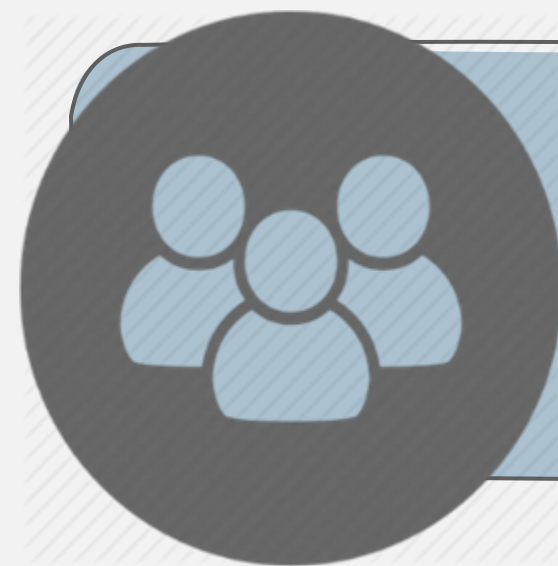
PRODUCT REQUIREMENTS



\$20 - \$80 / PROTOTYPE



LESS THAN 15% ERROR



INSTRUCTIONS & PARTS LIST

CONCEPTUAL DEVELOPMENT:

THE SENSOR

SFH 3310 Phototransistor

- I Light-sensitive transistor
- I 150° field of view
- I Cost: \$0.64 per unit
- I Wavelengths: 350 nm to 970 nm



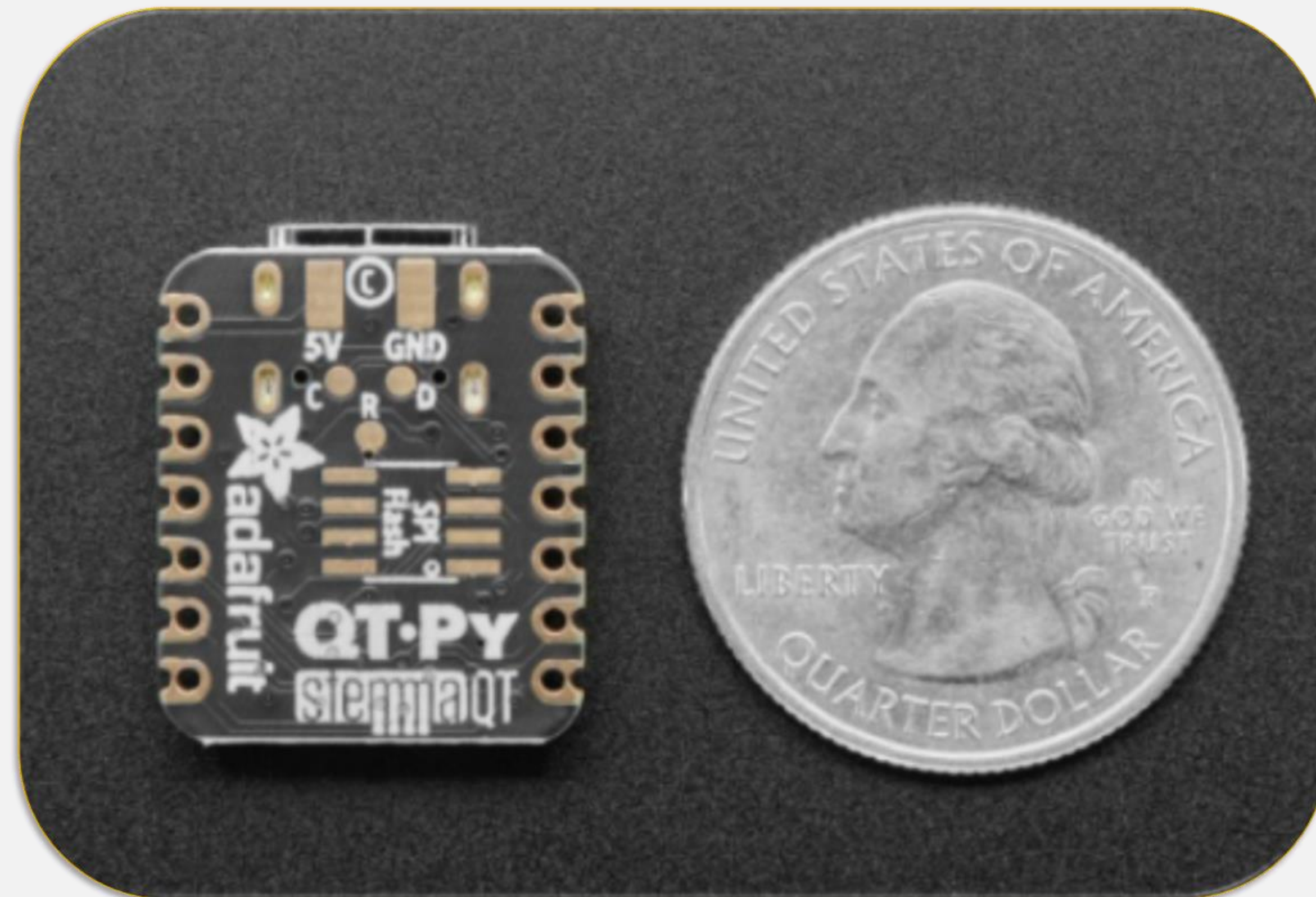
CONCEPTUAL DEVELOPMENT:

THE MICROCONTROLLER

Used for calibration

Adafruit QT PY:

- I Compact: 20 x 17.5mm
- I Cost: \$6.00 each
- I 10-bit DAC Output
- I 256 kB flash memory
- I 32 kB RAM



CONCEPTUAL DEVELOPMENT:

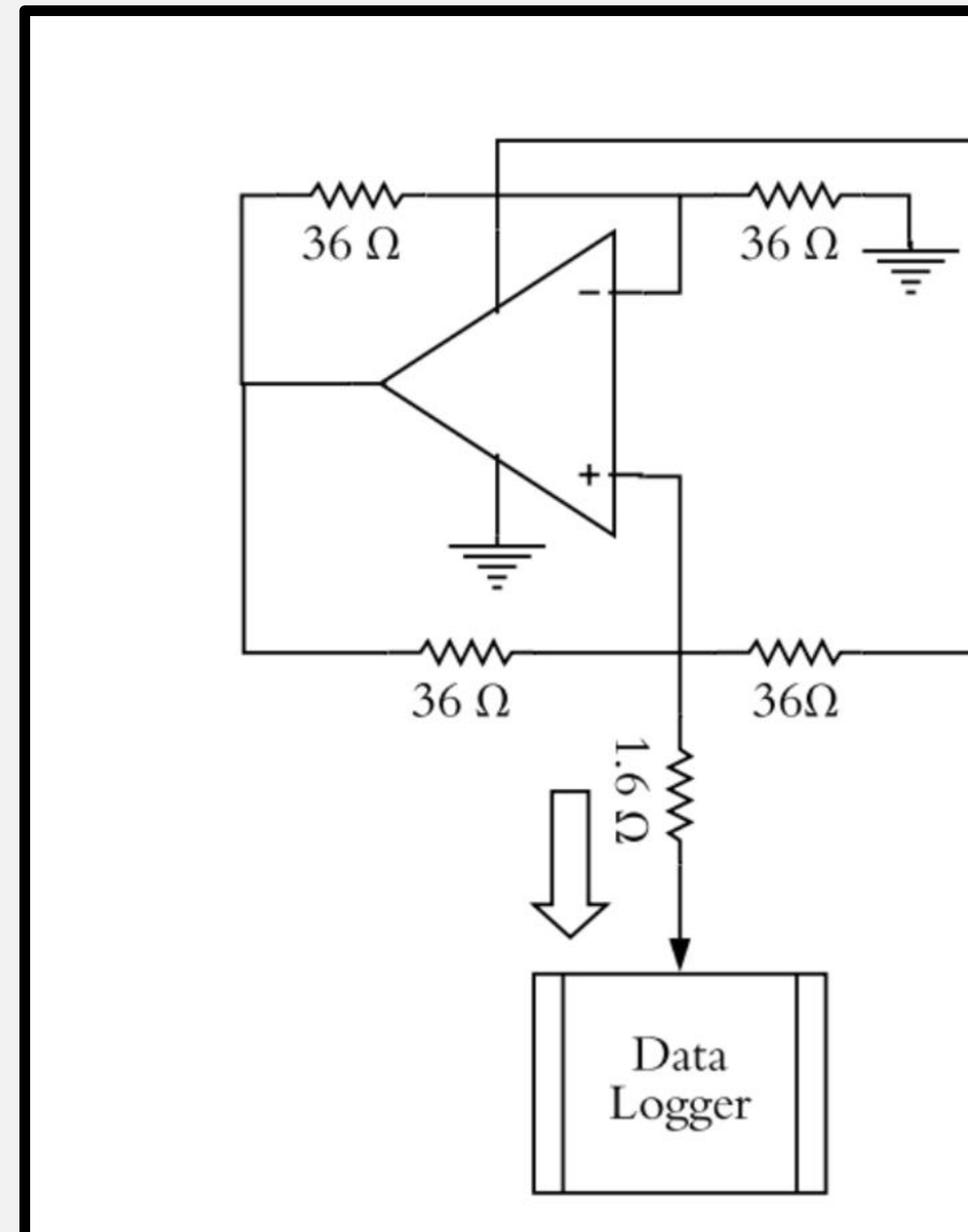
V – I CONVERTER

Used for calibration

I Analog signal: 4-18 mA

I Prevents voltage drop

I Improves accuracy



CONCEPTUAL DEVELOPMENT:

OUTPUT MAPPING

Linear Interpolation:

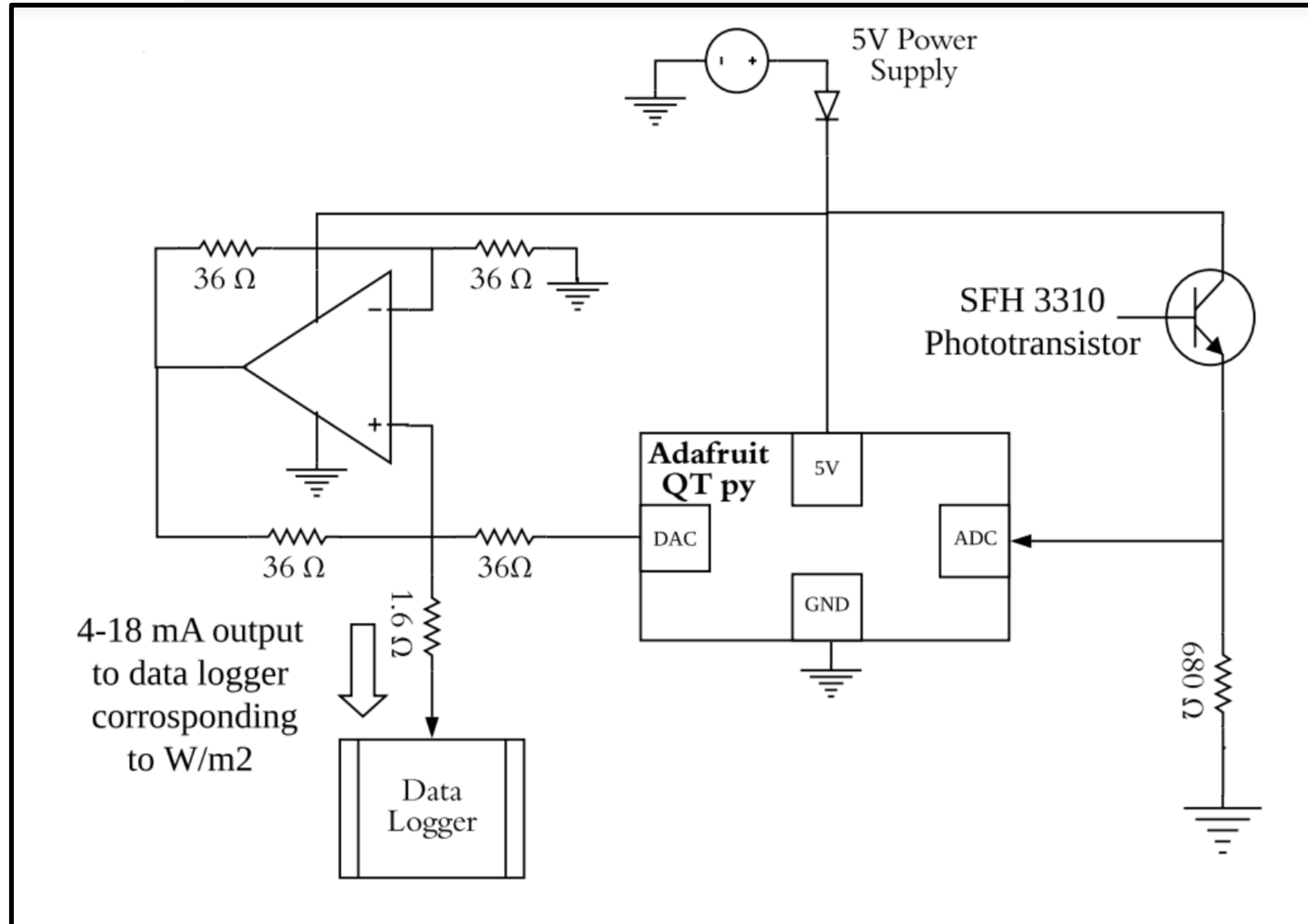
$$B = \frac{(A-a_0)(b_1-b_0)}{(a_1-a_0)} + b_0$$

A on range (a_0, a_1)

B on range (b_0, b_1)

4-18mA : 4-20mA output by programming our data logger

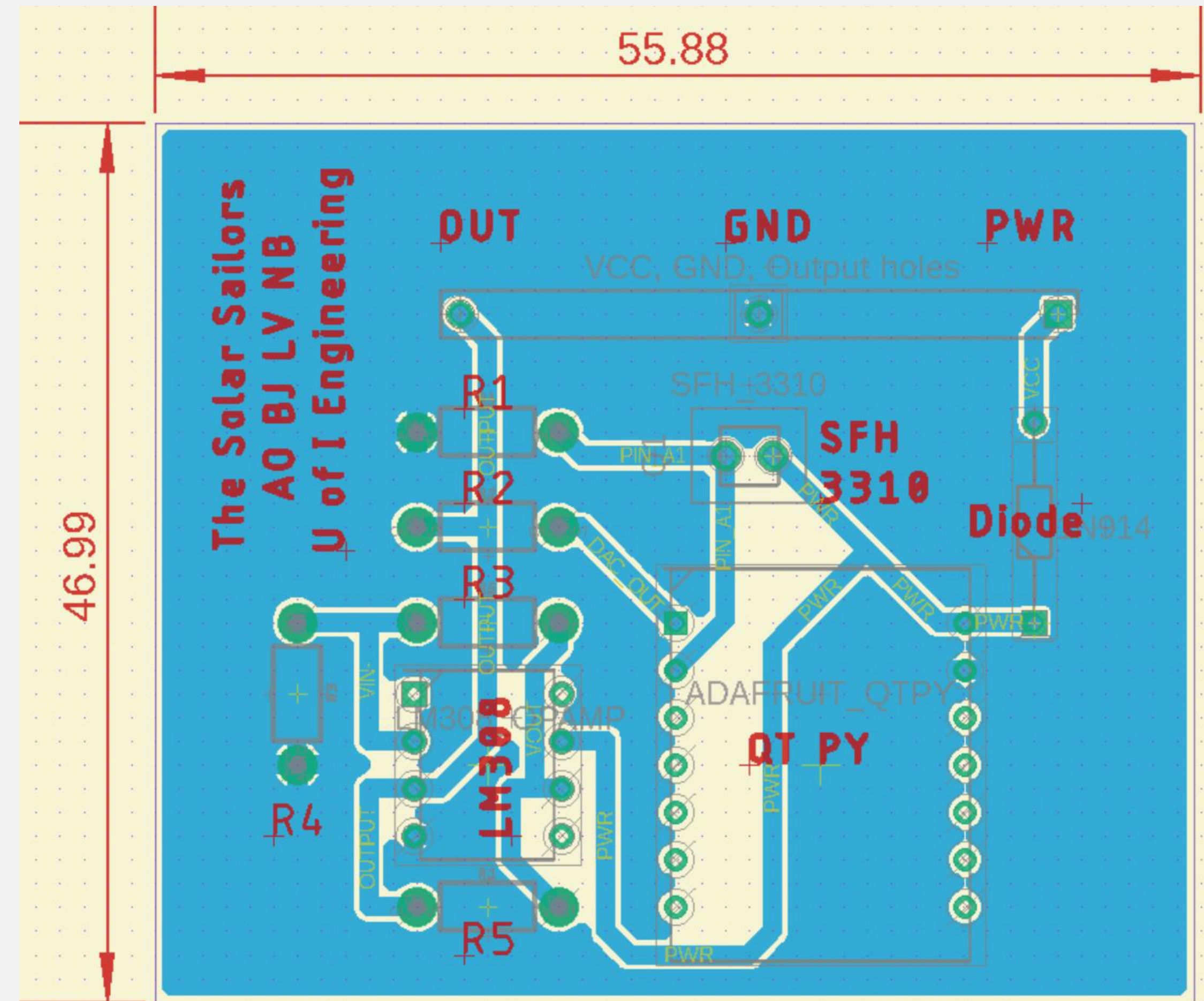
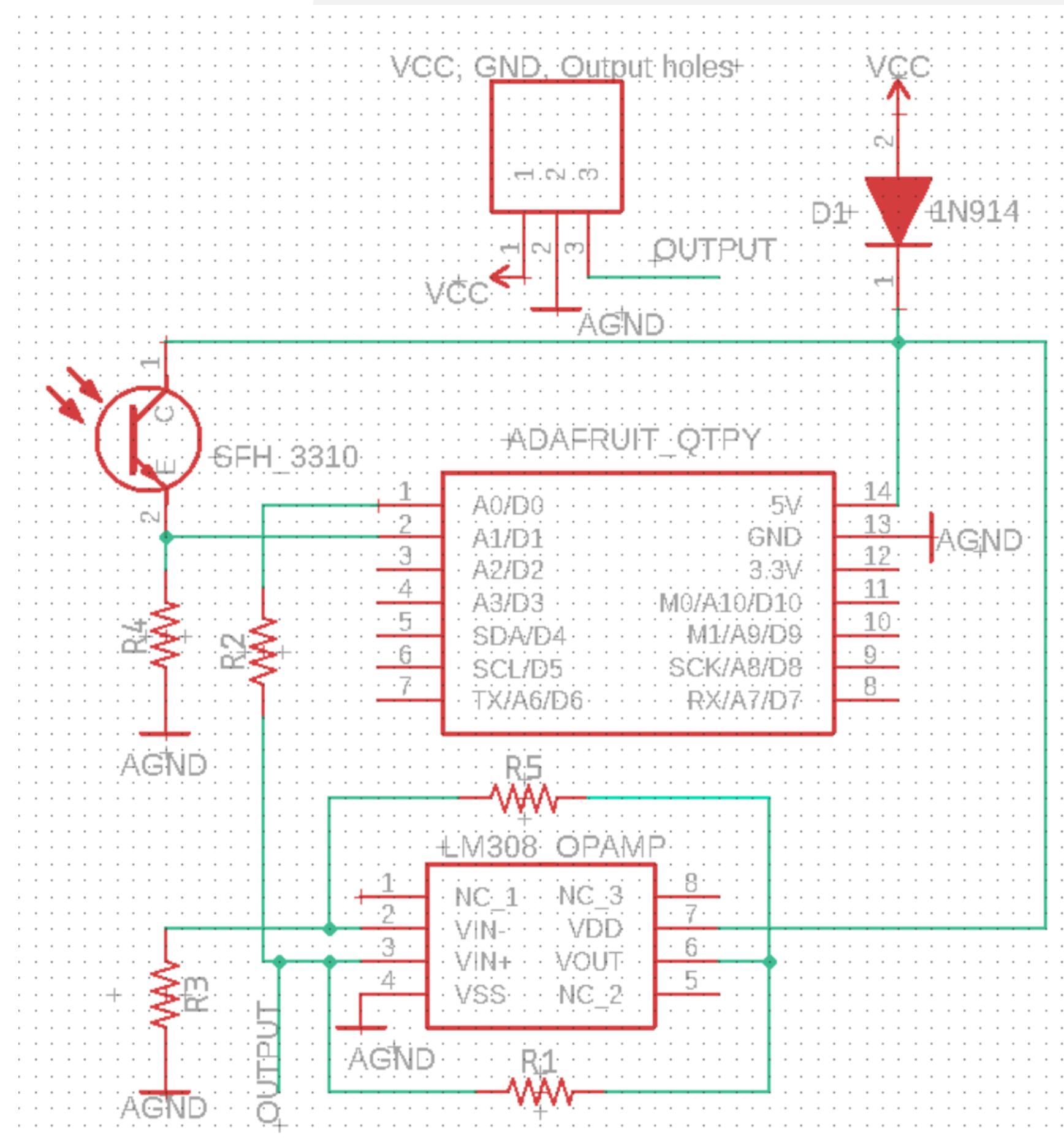
FINAL DESIGN



MANUFACTURING PROCESSES



PCB DESIGN:

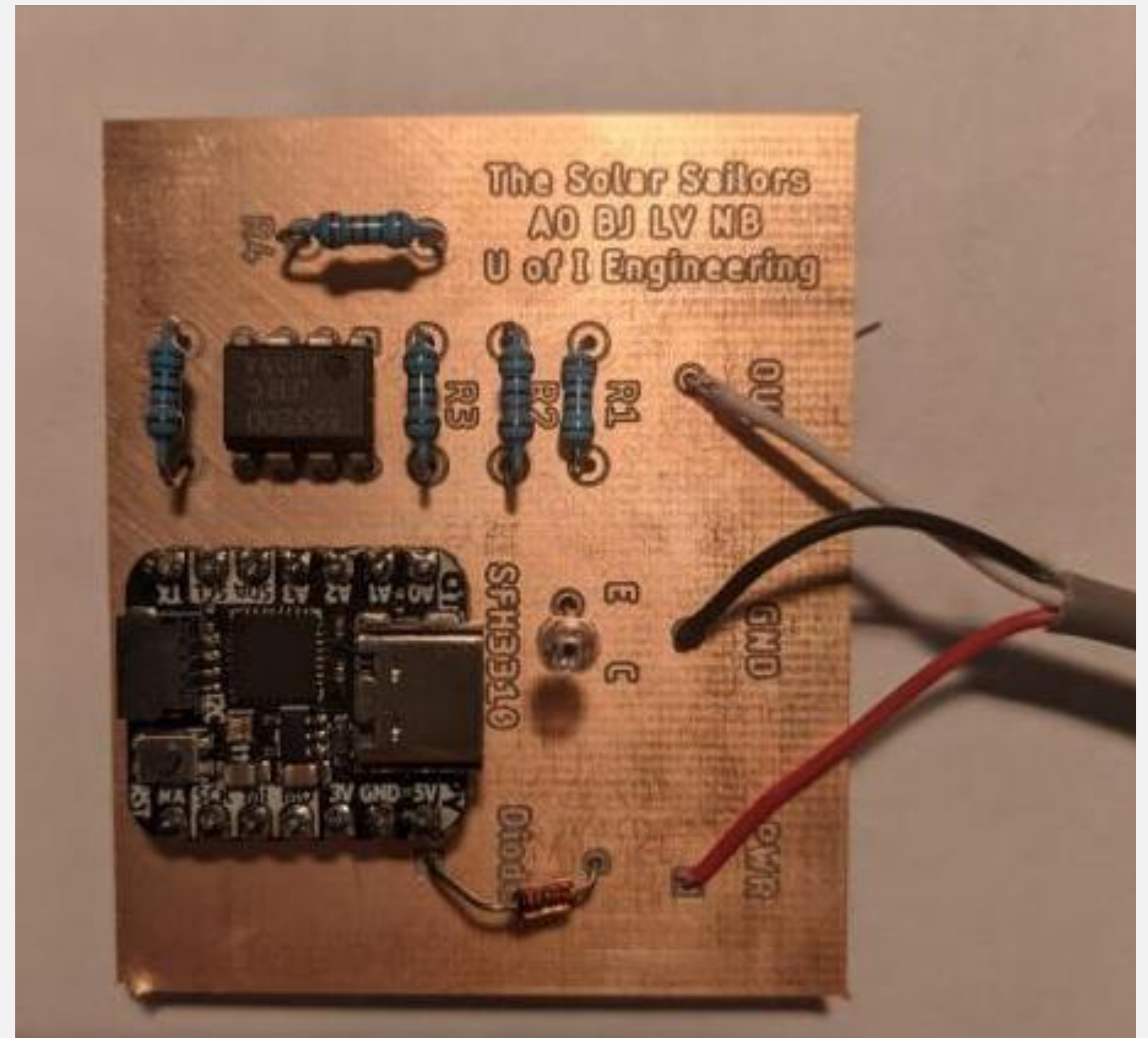


MANUFACTURING PROCESSES

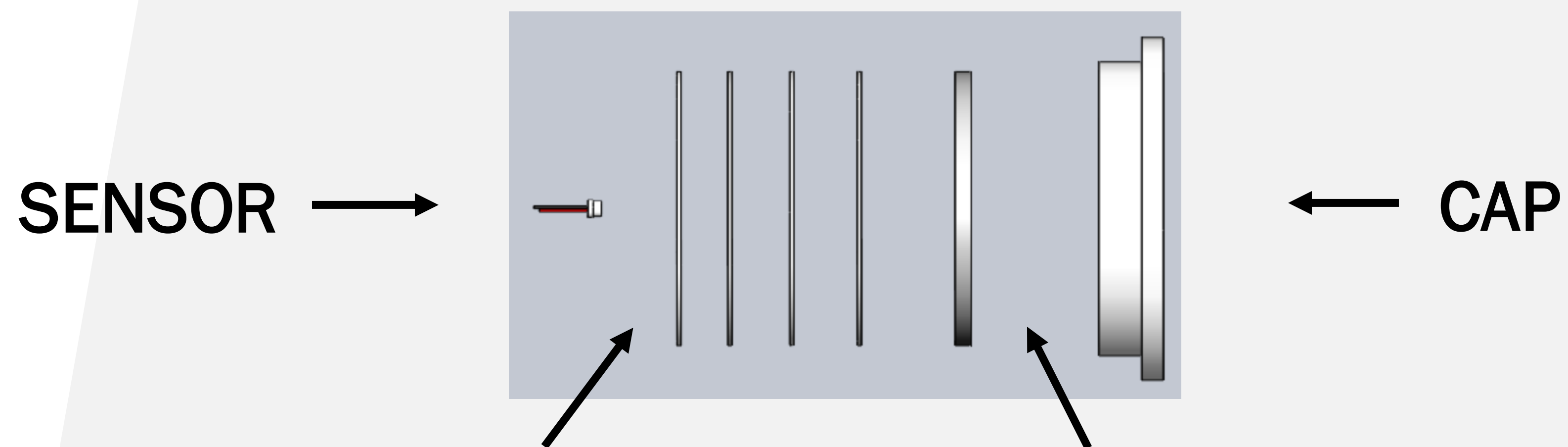
THE PCB

Features:

- I Red wire: power
- I Black wire: Ground
- I White wire: 4-18mA output



MANUFACTURING PROCESSES



SENSOR →

← CAP

TEFLON FILTERS

- I Protects from sensor saturation
- I Attenuates 73.8% / sheet

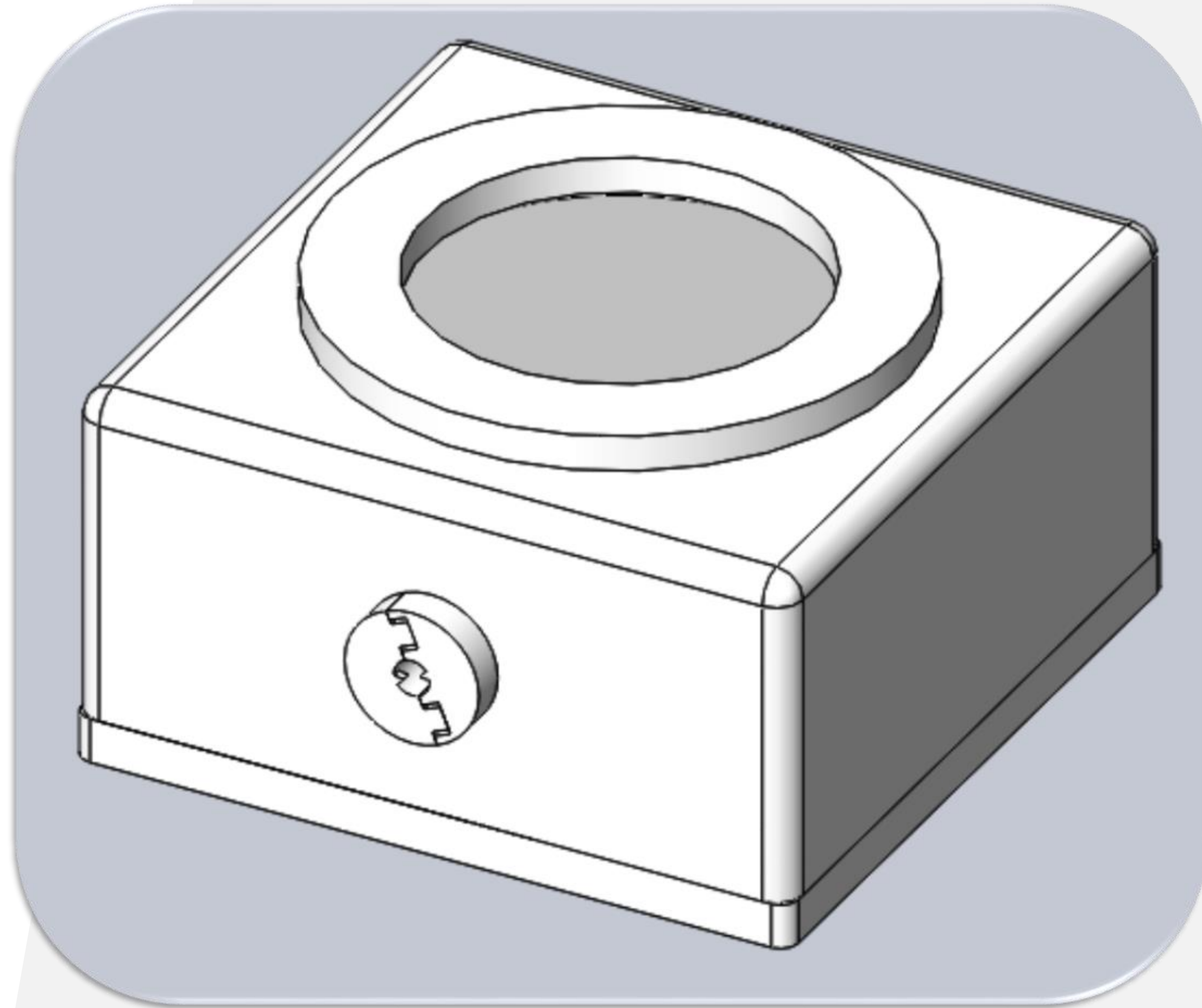
ACRYLIC DISK

- I Seals device
- I Affordable
- I Lifespan: +10 years

MANUFACTURING PROCESSES



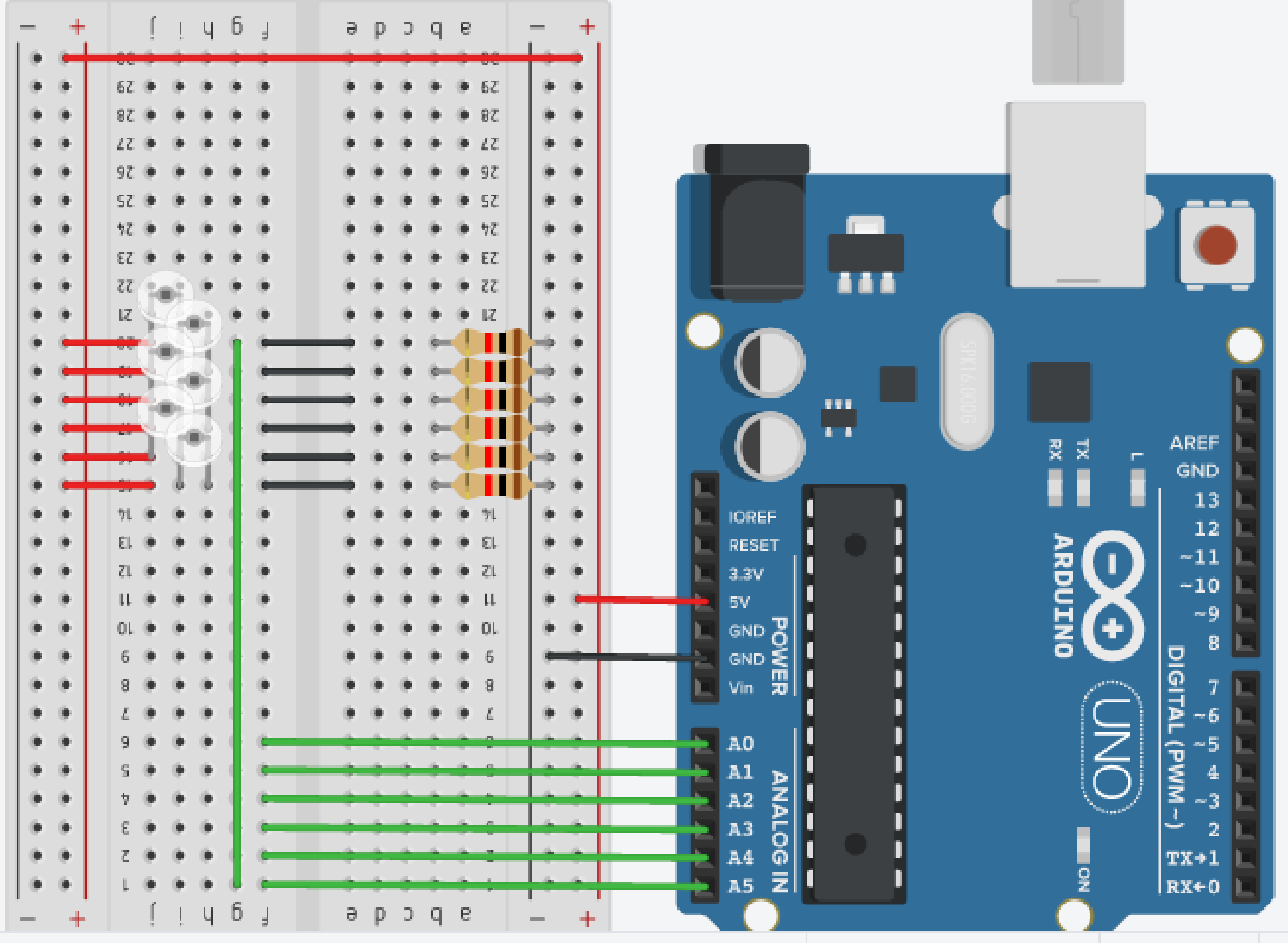
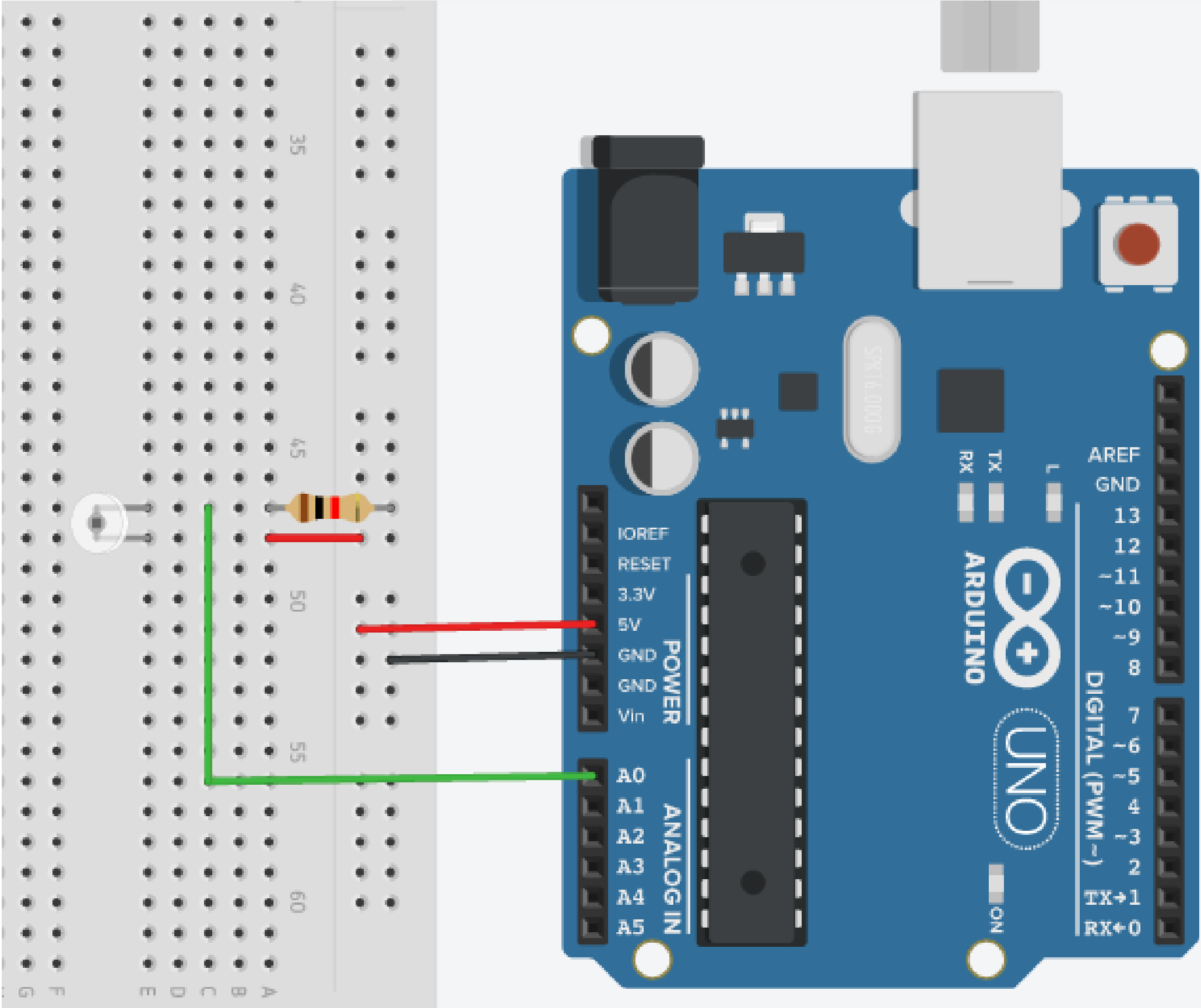
THE CASE:





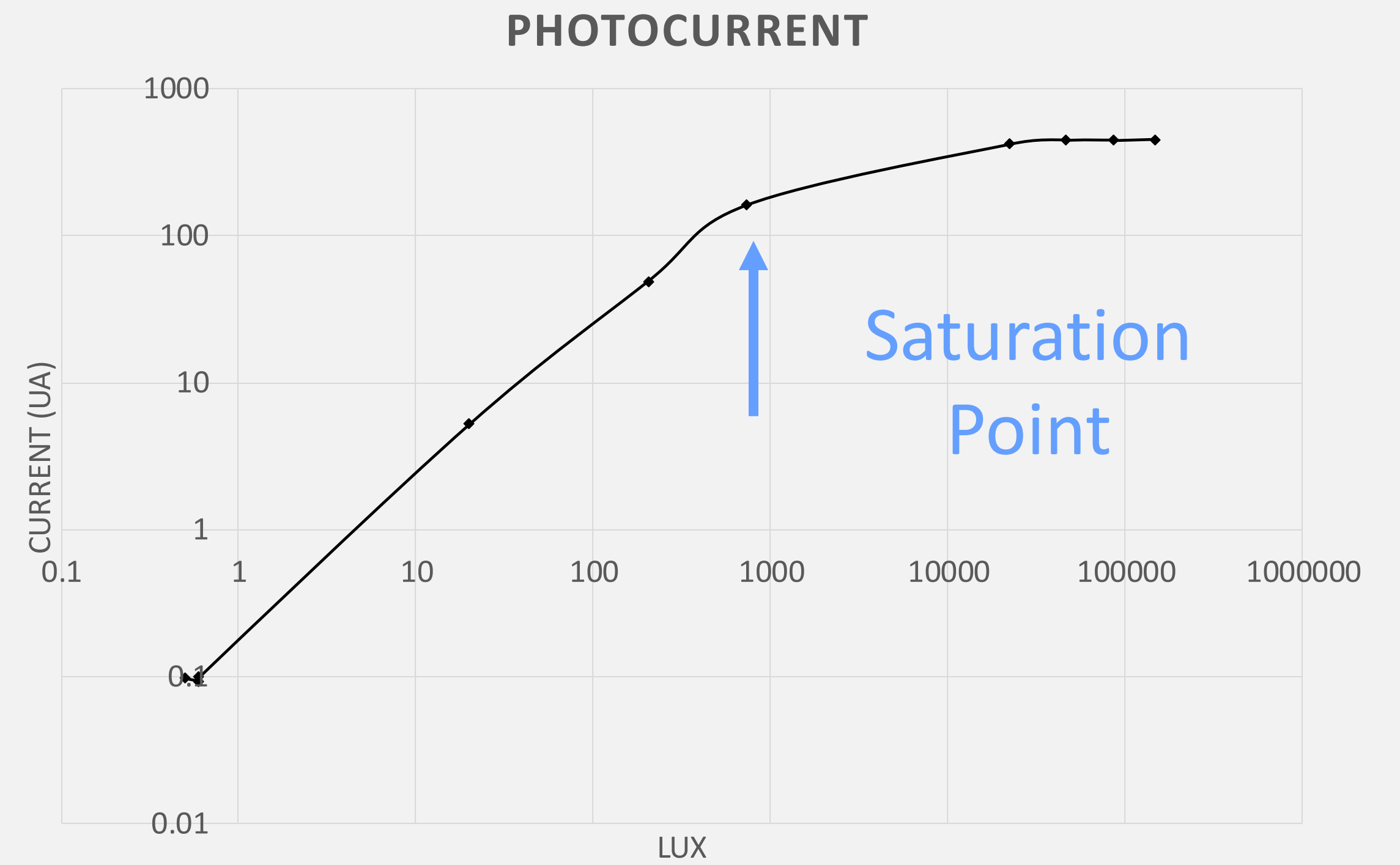
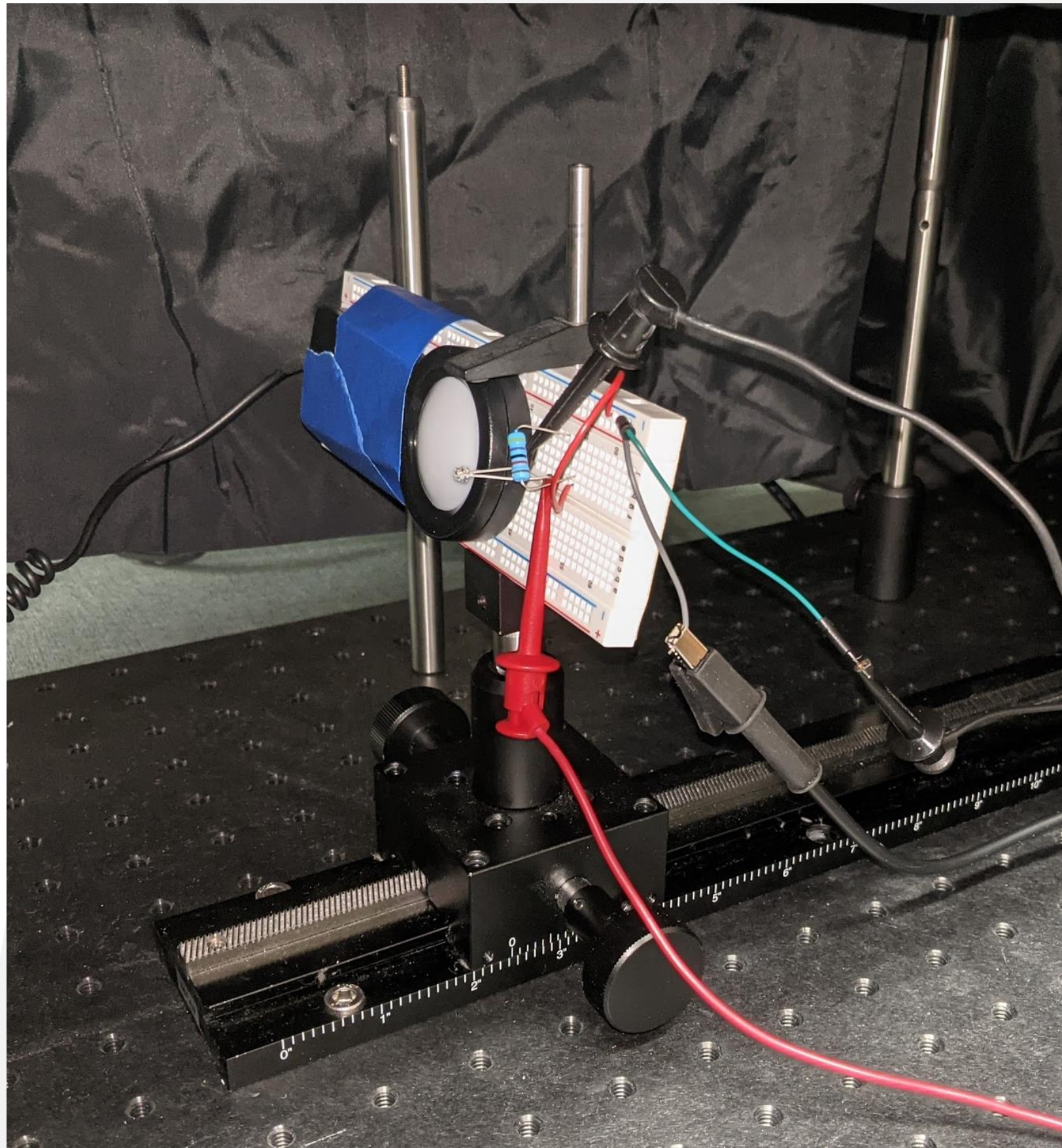
VALIDATION

TINKER CAD SIMULATION



VALIDATION

SENSOR TESTING



VALIDATION

FILTER TESTING



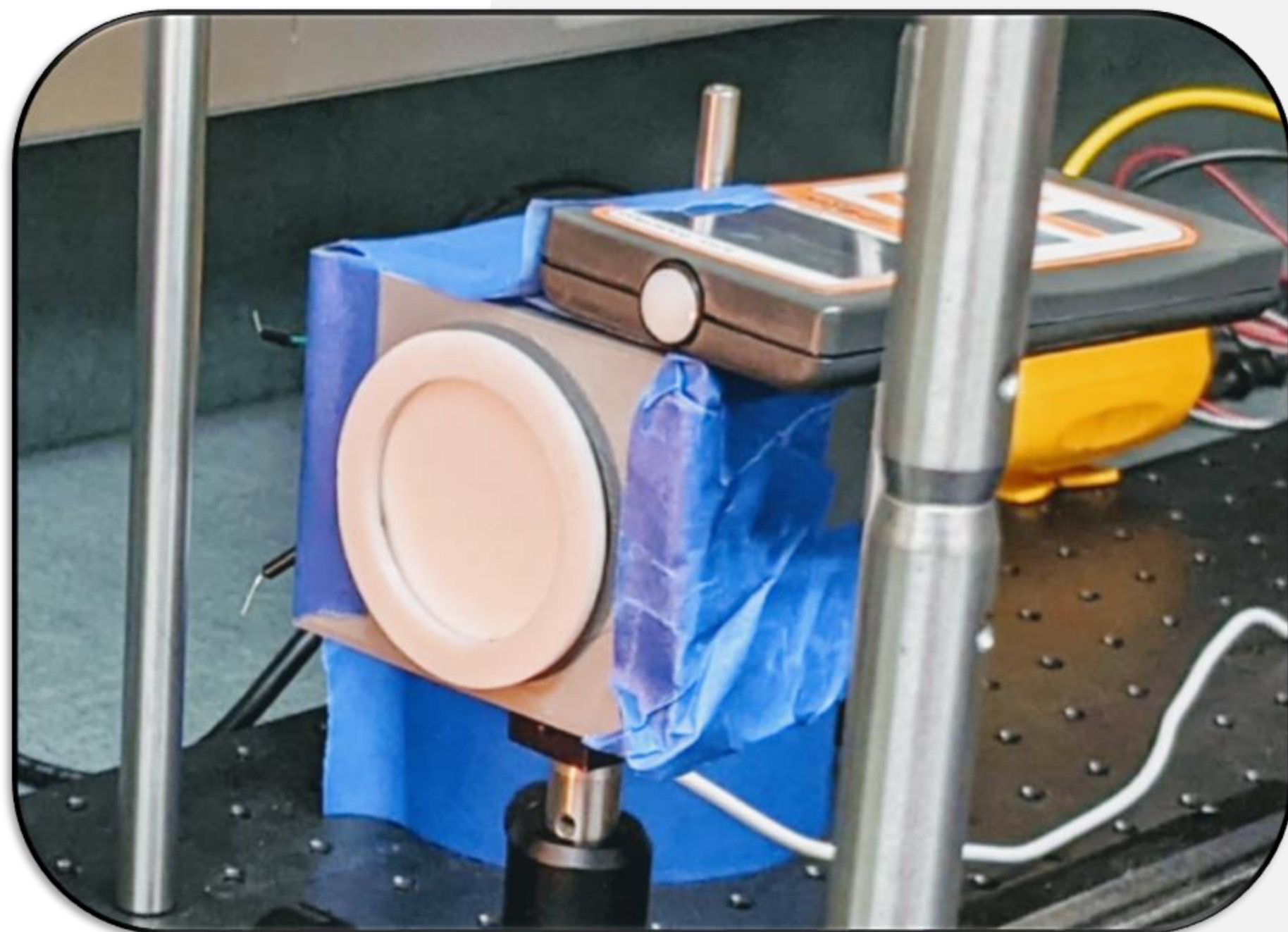
Teflon sheets evenly distribute light

I Attenuates 73.8% of incoming lux / sheet

I Four sheets required

VALIDATION

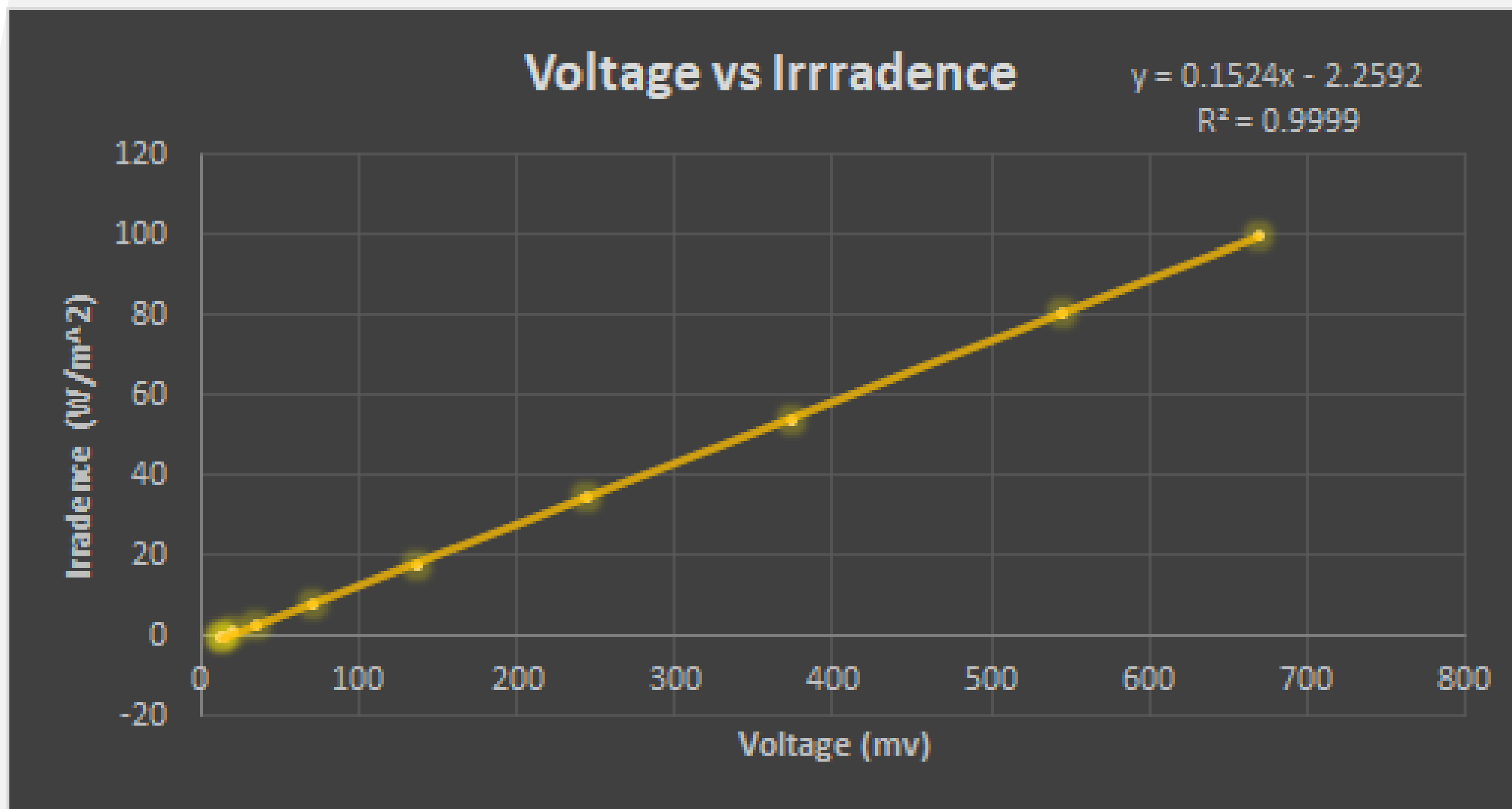
INDOOR CALIBRATION TESTING



MP-100: Pyranometer Integral Sensor

VALIDATION

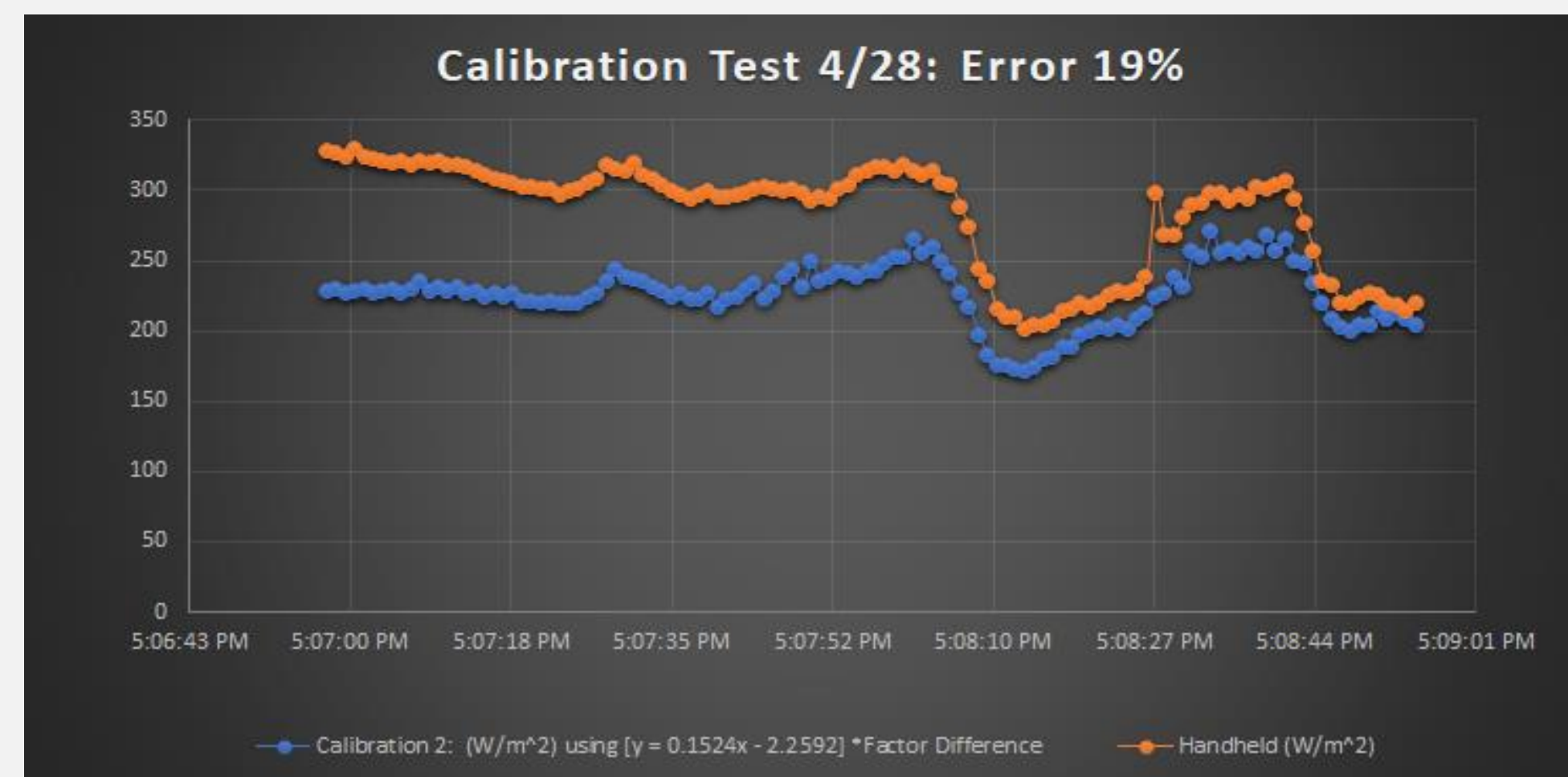
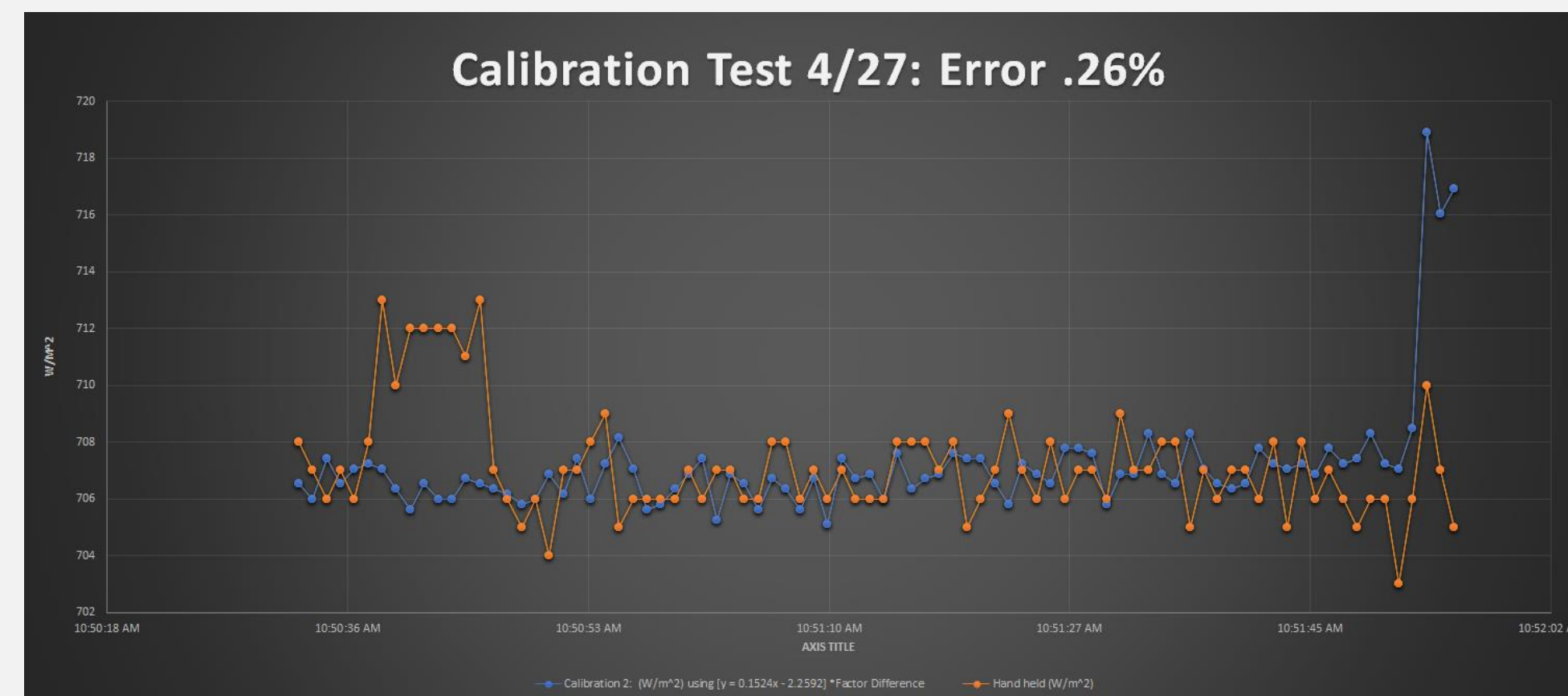
INDOOR CALIBRATION CURVE





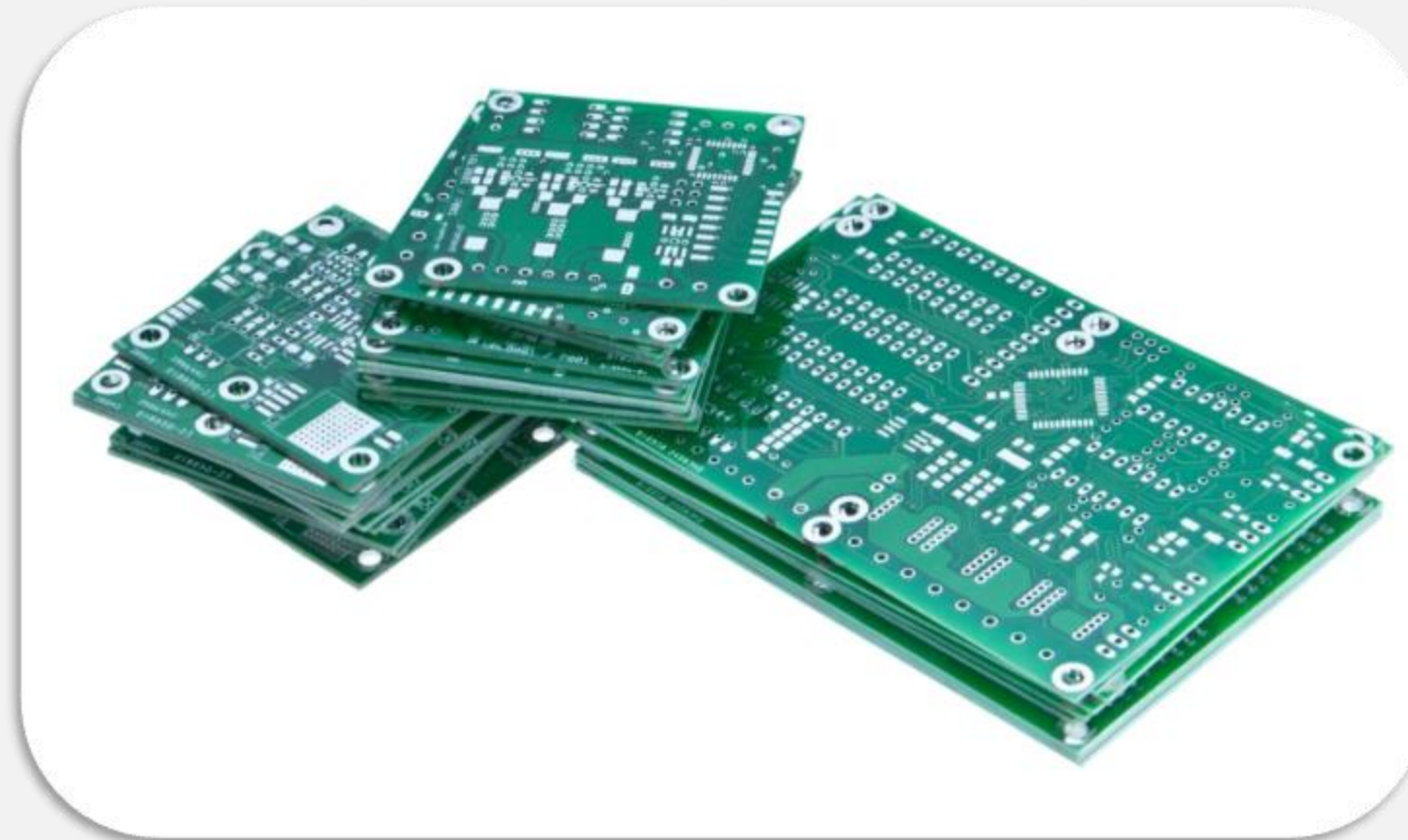
VALIDATION

OUTDOOR TESTING



RECOMMENDATIONS

- I Print professional PCB
- I Add a dome lens
- I Run weather proofing analysis
- I Test alternative sensors



DELIVERABLES



I PCB Gerber file

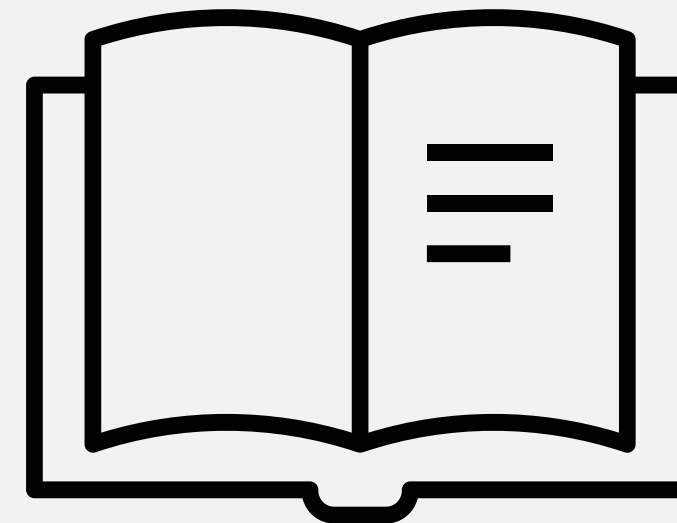
I Circuit diagrams

I Parts list

I Solidworks case design

I Instructions

I Completed prototypes



CONCLUSION

I Cost: \$22 / build

I Calibration error: 0.26 - 19% error

I Instruction manual is in progress

ANY QUESTIONS?

