Water Quality Node Building Guide

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Abbreviations

- NPT - normal pipe thread (type of threading)
- PTC - Push to connect
- OD - outer diameter
- NC - normally closed
- GND - ground
- Ways to transmit data
  - Digital
    - I2C
    - UART (aka serial) -- We do not use UART for this node
  - Analog

Components

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Mechanical

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Mechanical Components

- 10 ½ ” NPT to ¼” PTC
- 8 ¼” elbow
- 5 female PVC tees
- 3 ½” male to ½” PTC
- 2 ¼” male to ¼” PTC
- 1 ½” male to ¼” female NPT
- 1 30mm ThermoWell
- 1 PTC t-strainer
- 1 ¼” female 12V solenoid valve, normally closed
- ¼” OD tubing

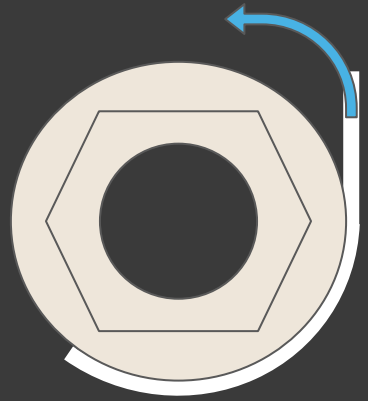
Tools needed:

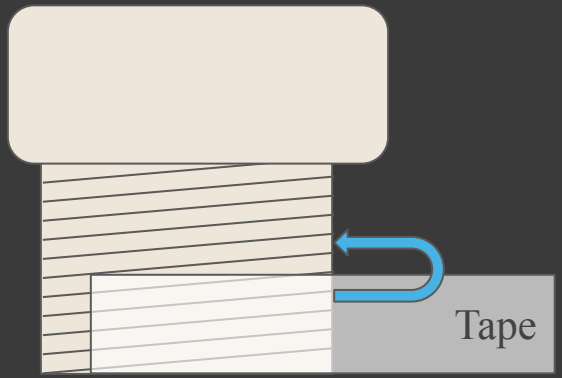
- Tape
- Wrenches (these sizes)
  *optional/not needed
- Maybe drill to drill out ptc fittings for probes and make holes in sides of boxes

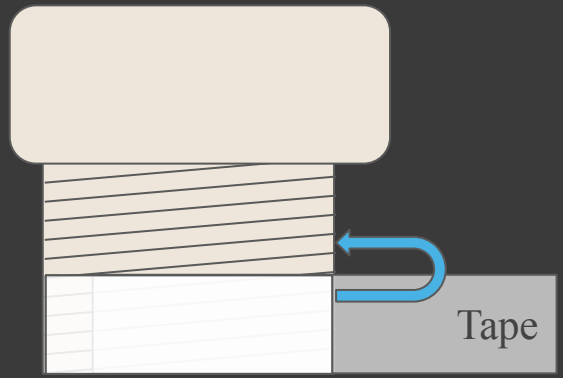
Wrap male NPT fittings in PTFE Tape

See next slide for wrapping diagram

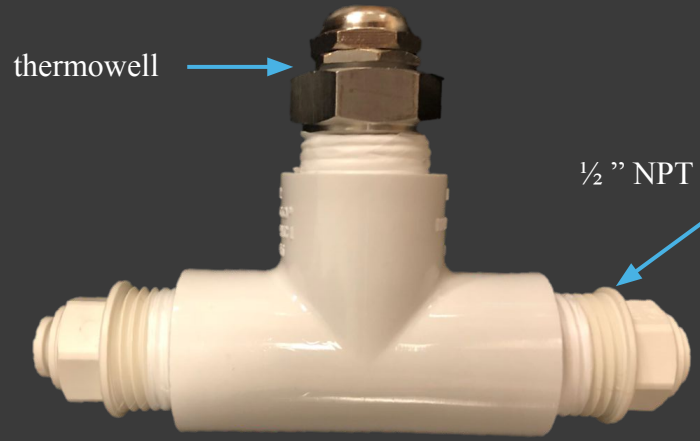
*5 - 8 layers of tape





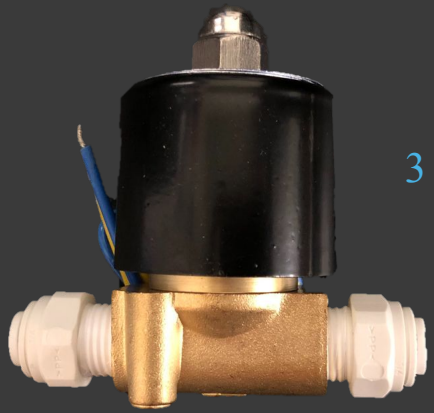


Sensor	PVC fitting used
pH, ORP, EC	½” male to PTC
Temperature	ThermoWell
Pressure	½” male to ¼” female NPT

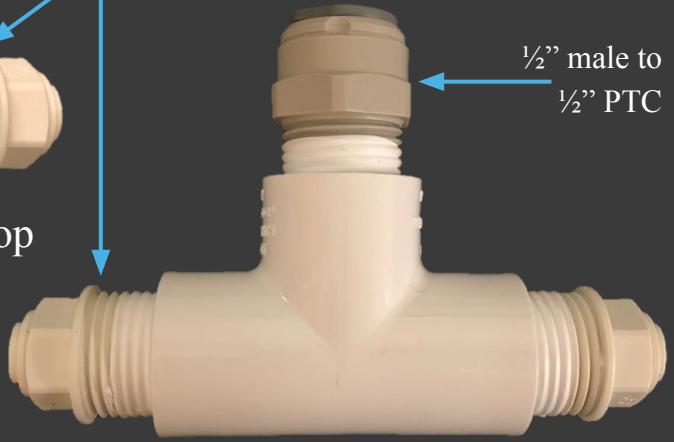


1 tee with thermowell fitting on top

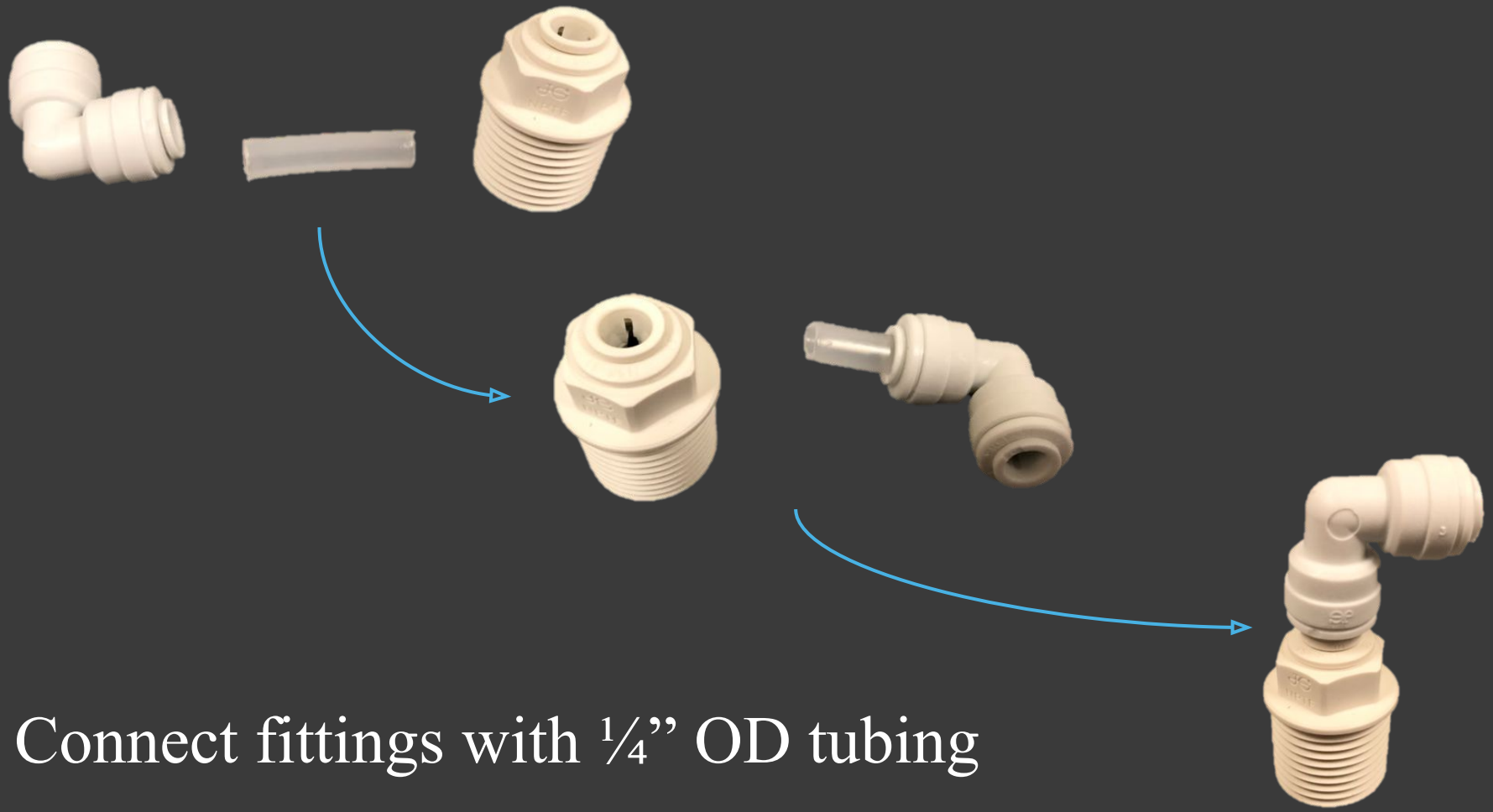
1 tee with pressure fitting on top



1 valve with ¼” PTC fittings



3 tees with probe (pH, ORP, EC) fitting on top



Connect fittings with ¼” OD tubing

Electrical

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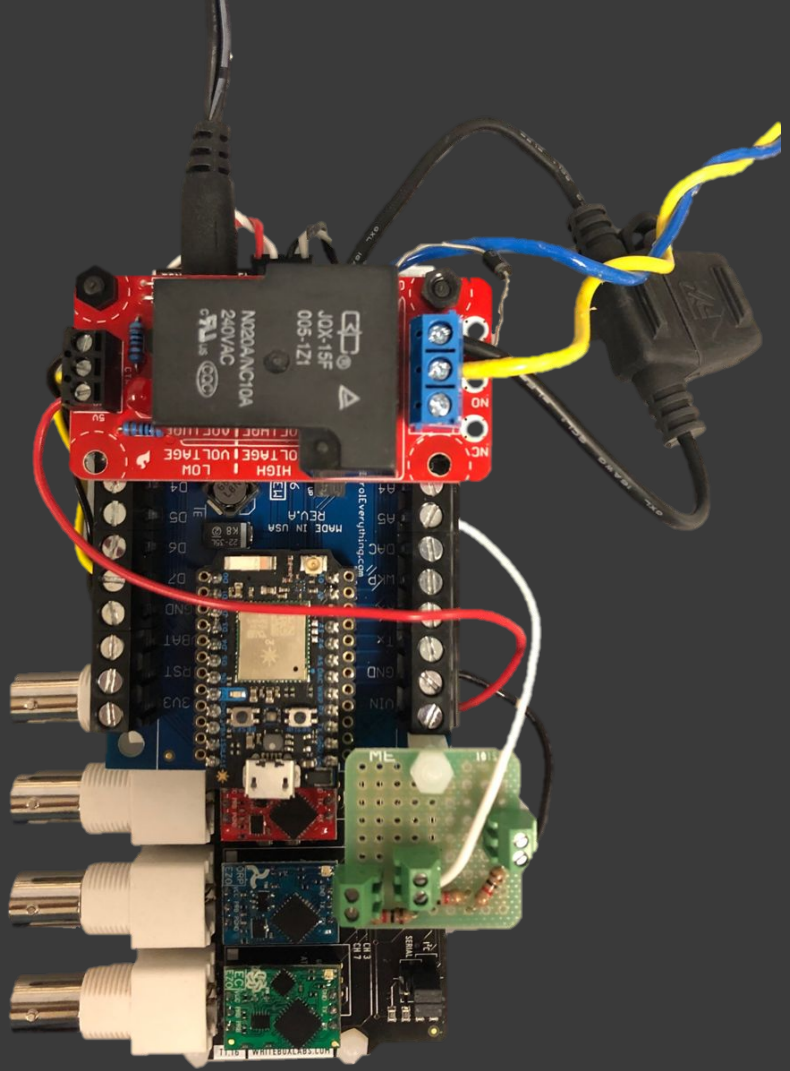


Electrical Components

- 1 Photon (wifi)
  - or Boron w/adapter (cellular)
- 1 Breakout board (Blue board)
- 1 Tentacle Shield
  - pH, EC, ORP, Temp EZO circuits (4 total)
- 1 Beefcake relay
- 1 Fuse (w/holder)
- 1 Diode
- 1 ProtoBoard
- 3 1k resistors
- 5 screw terminals
- 1 AC -1 2V power plug (give

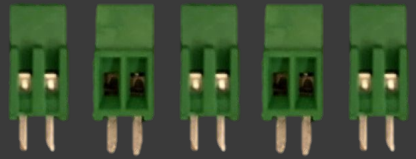
Tools needed:

- Multimeter
- Wire cutters
- Wire strippers
- Small screwdriver
- Soldering iron
- Solder

Beefcake relay

Fuse

2-prong screw terminals

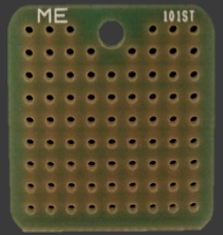


Fuse holder

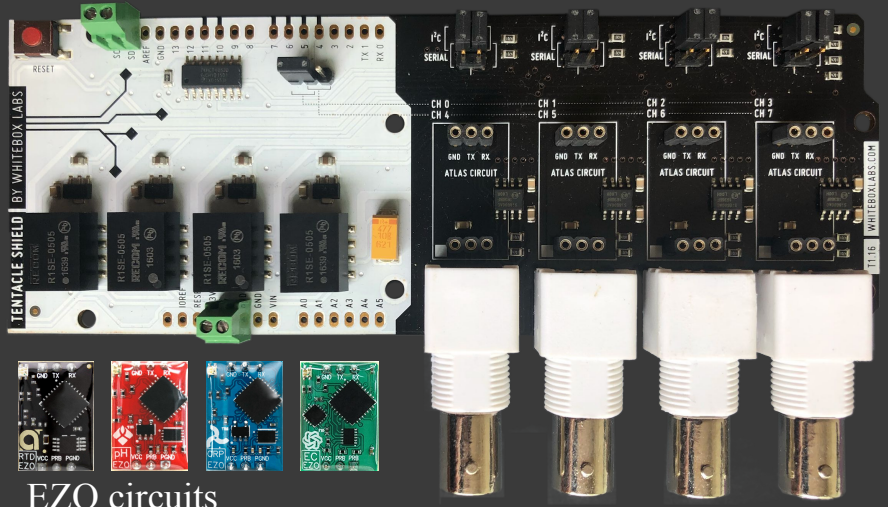
Diode

1k resistors

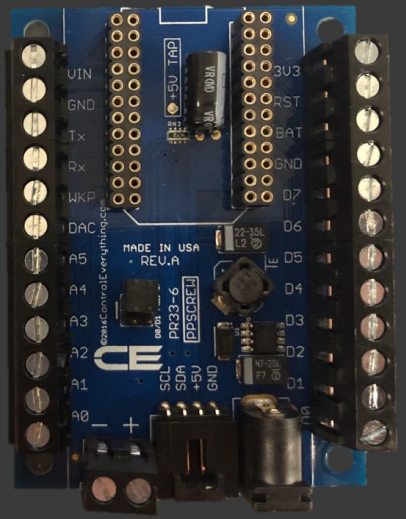
ProtoBoard



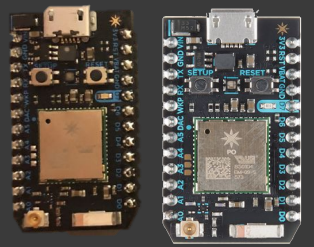
Tentacle Shield



Blue board



Photon



EZO circuits

Tentacle Shield

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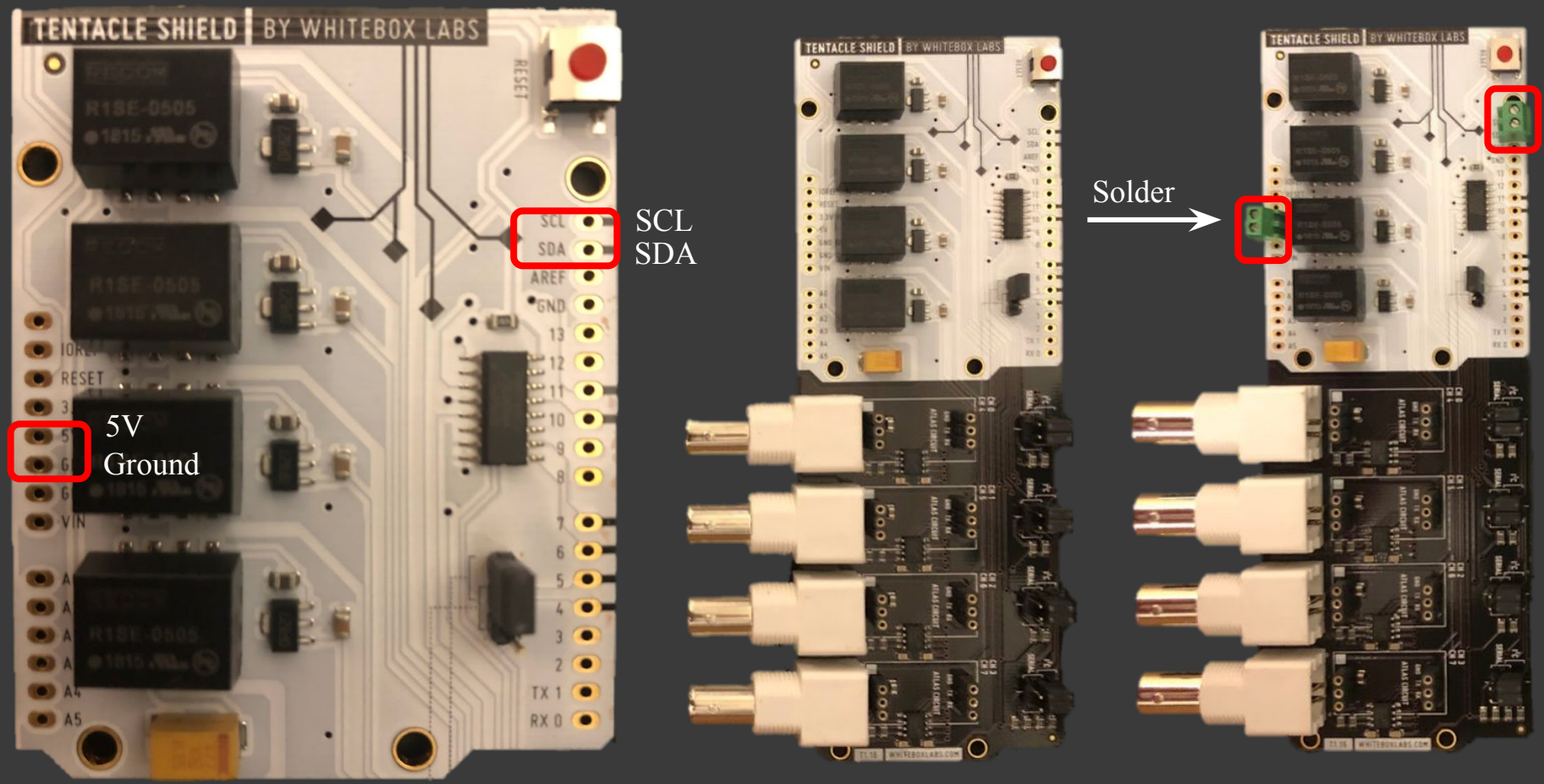
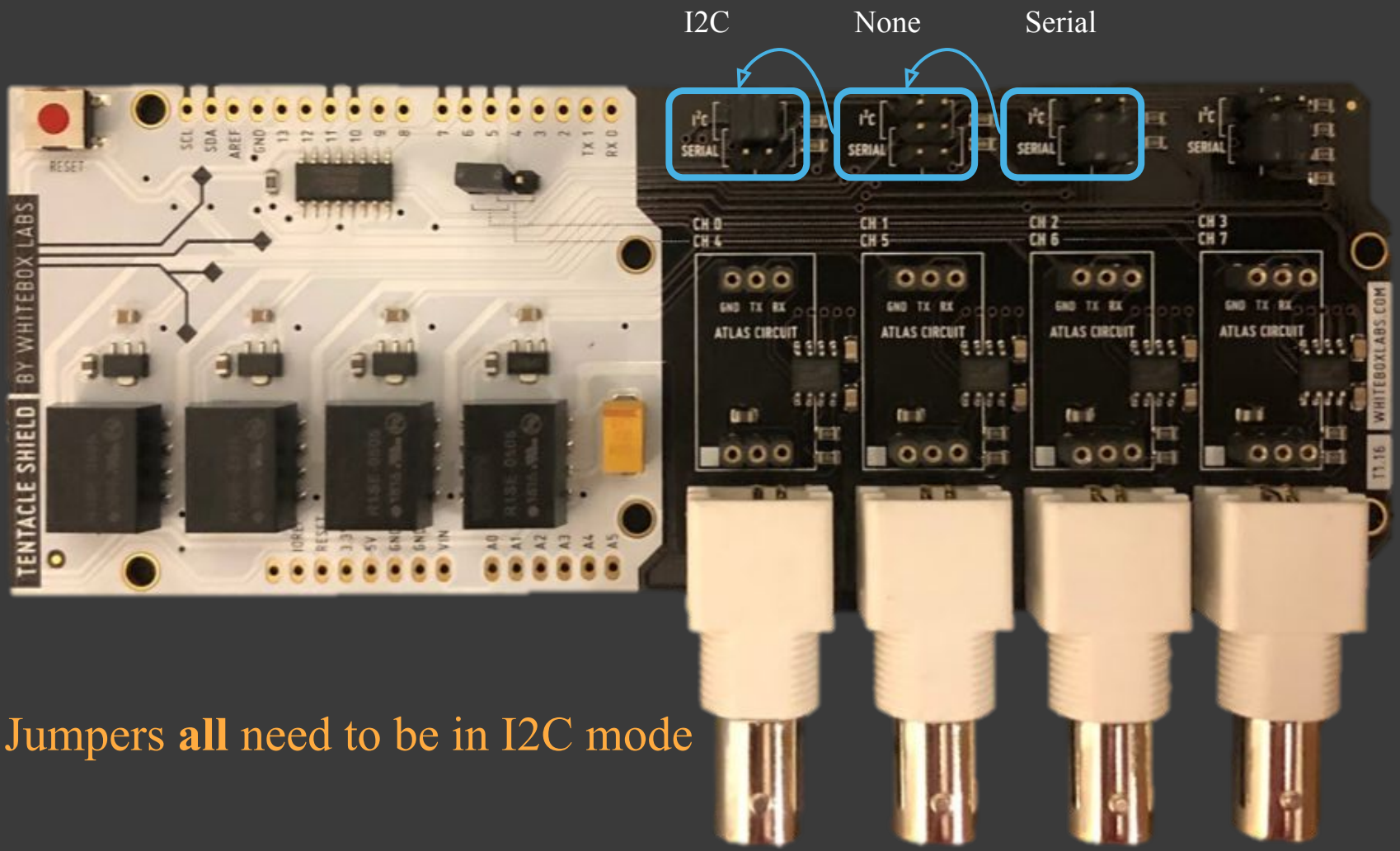
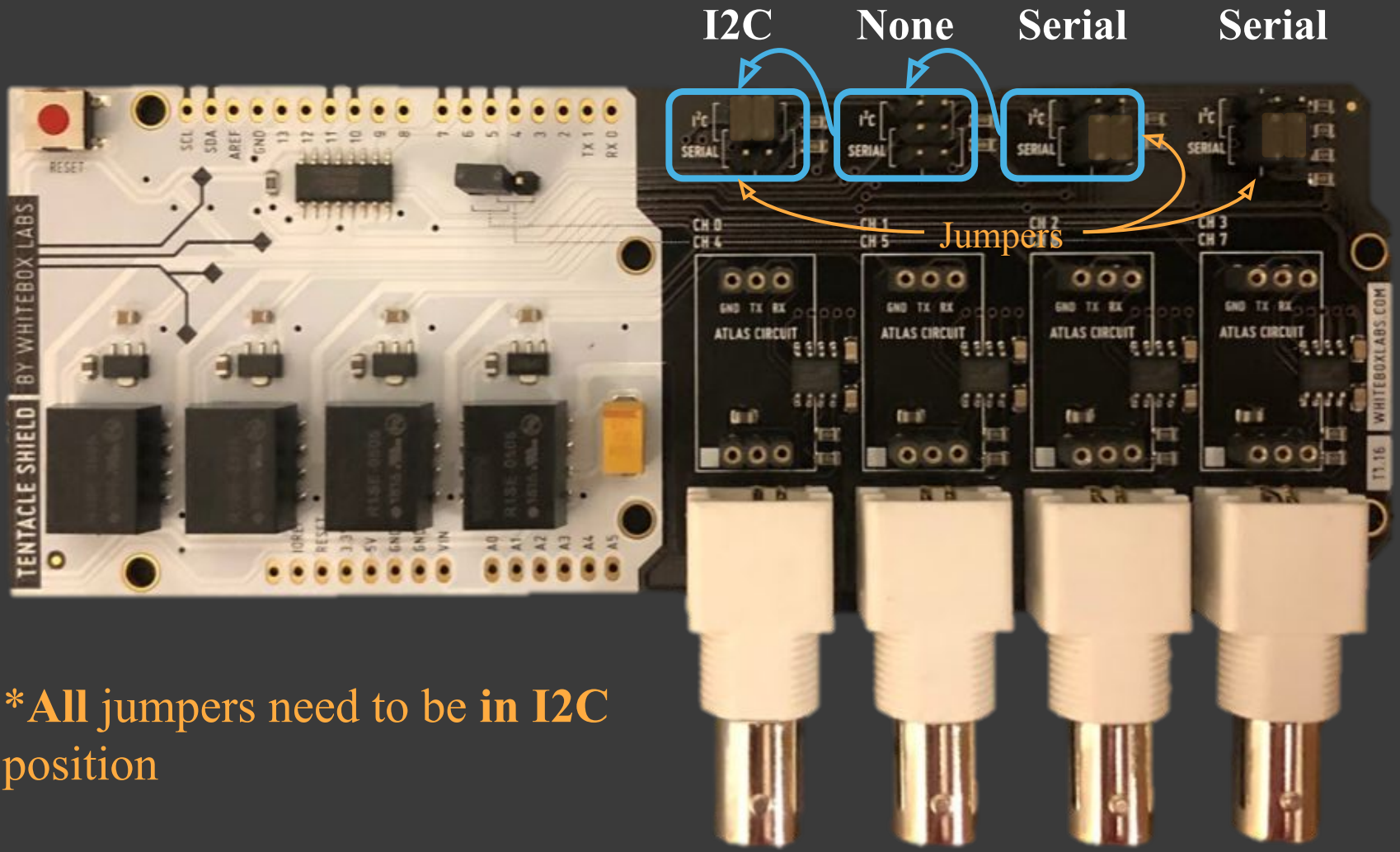


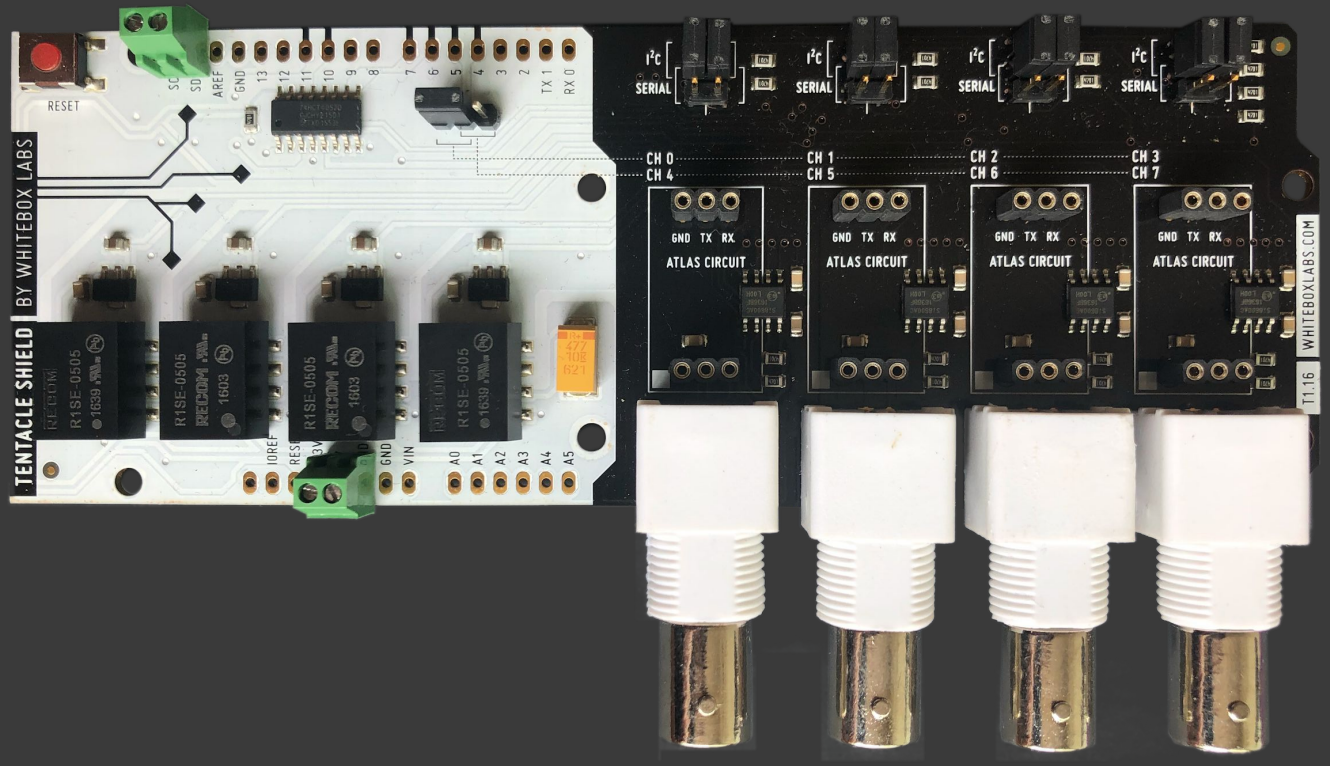
Solder terminal screw connectors to 5V and GND, SDA and SCL. Make sure to have terminal openings facing outside.



Jumpers **all** need to be in I2C mode



*All jumpers need to be **in I2C** position


TENTACLE SHIELD
BY WHITEBOX LABS
RESET
I²C
SERIAL
CH 0
CH 4
CH 1
CH 5
CH 2
CH 6
CH 3
CH 7
GND TX RX
ATLAS CIRCUIT
WHITEBOXLABS.COM
T1.16

Voltage Divider

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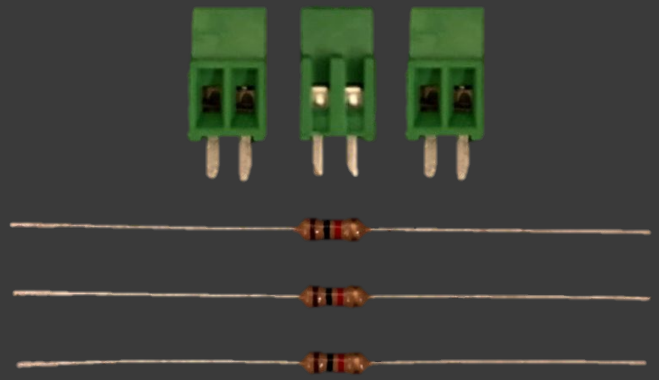
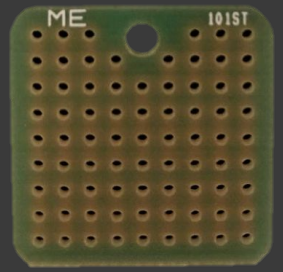
What you need:

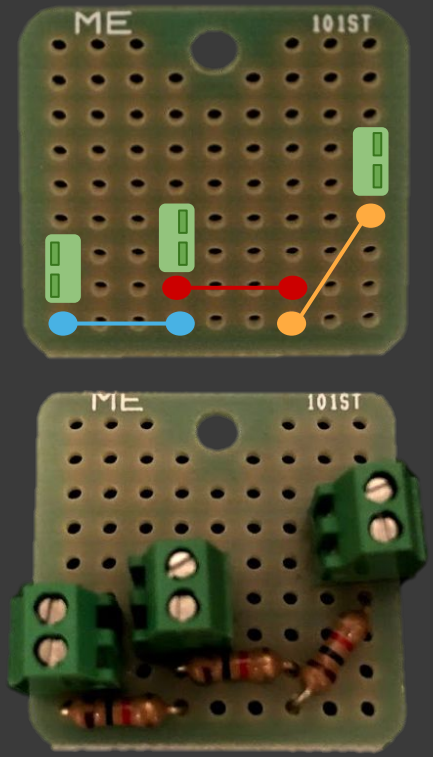
- 3 2-prong screw terminals
- 3 1000 Ω resistors
  - (to make a 2:3 voltage divider)
- 1 ProtoBoard

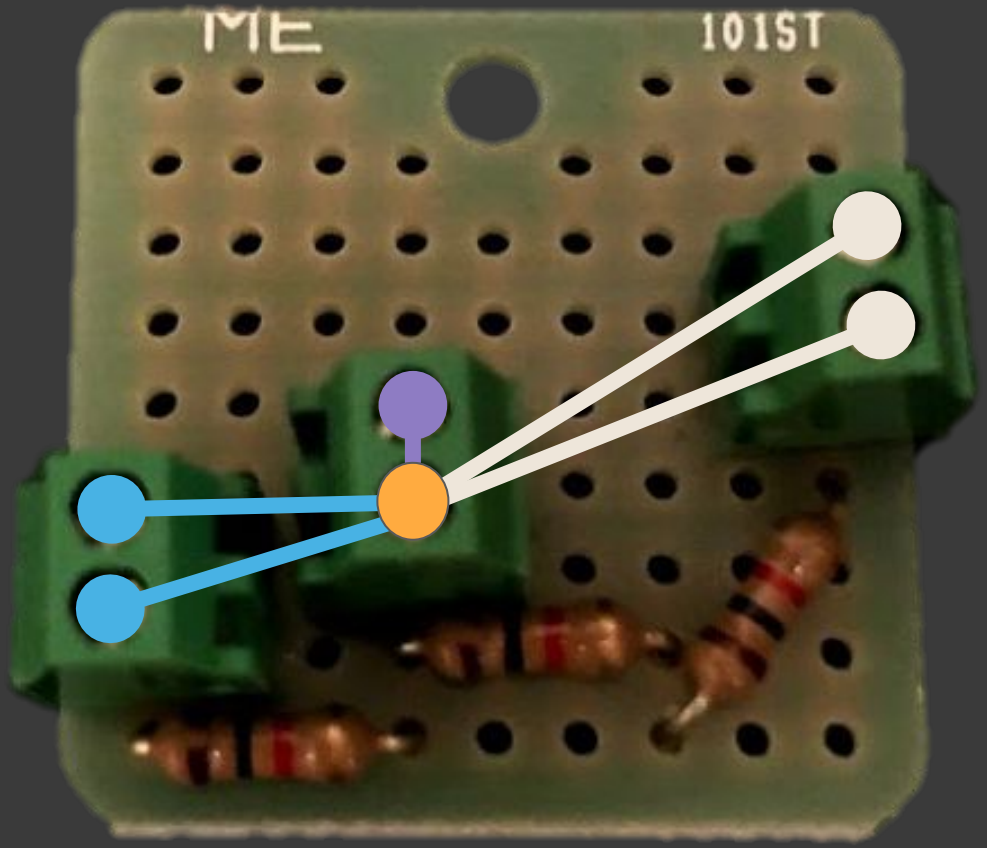


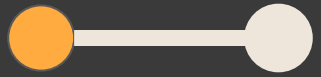


Steps

- Goal: Make a 2:3 voltage divider, if you have another way to make one, go for it
- Solder on resistors as shown, **placement DOES matter** for the terminals and resistors as of how the breadboard holes are connected to one another
- Once all resistors and terminals are soldered, test connections using a multimeter to measure resistance via screw terminal tops (see next slide for diagram)
- If resistance readings are correct, cut the excess resistor wire behind the board





Measurement points	Multimeter reading
	2 kΩ
	1 kΩ
	0L

Wiring together

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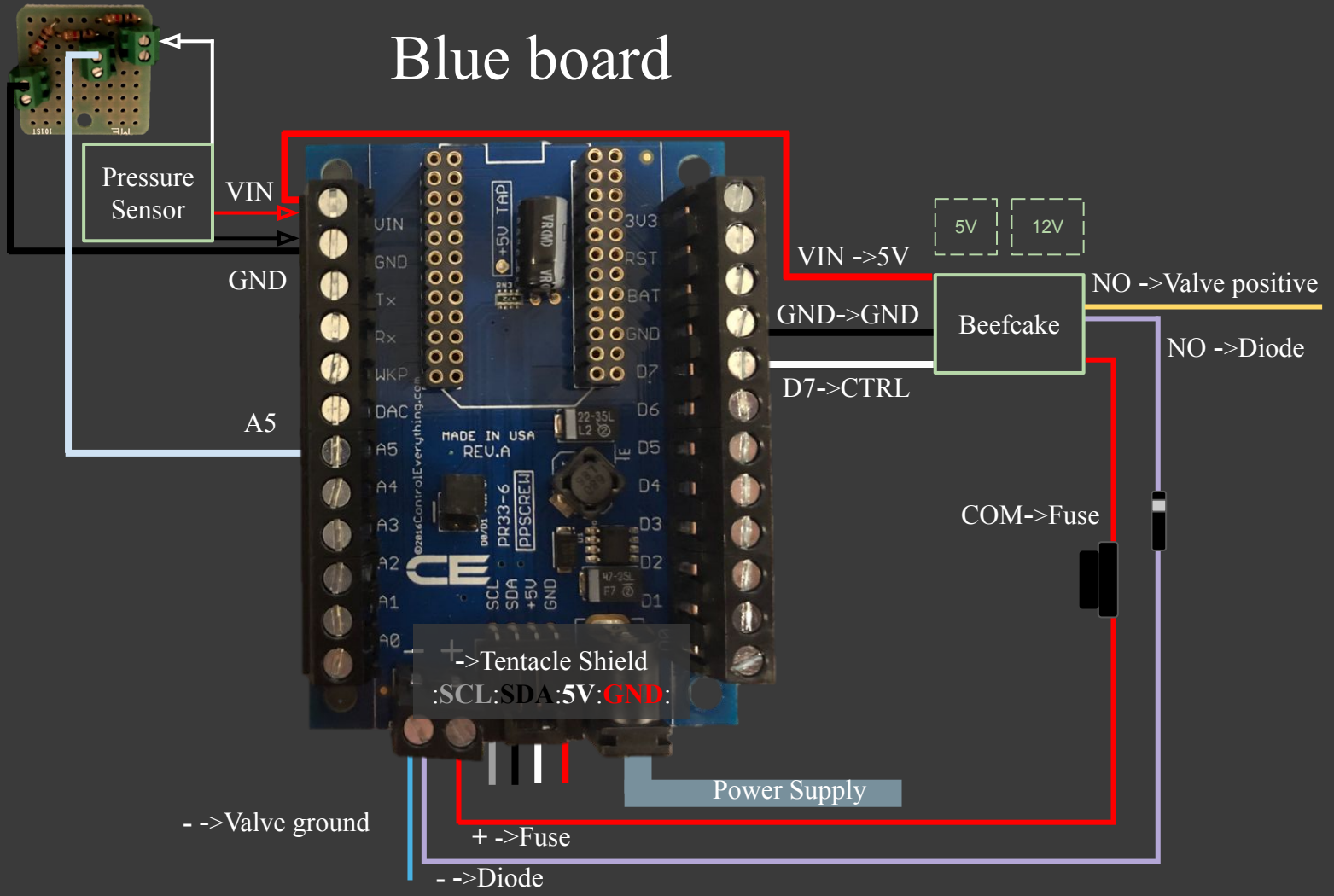
Beefcake

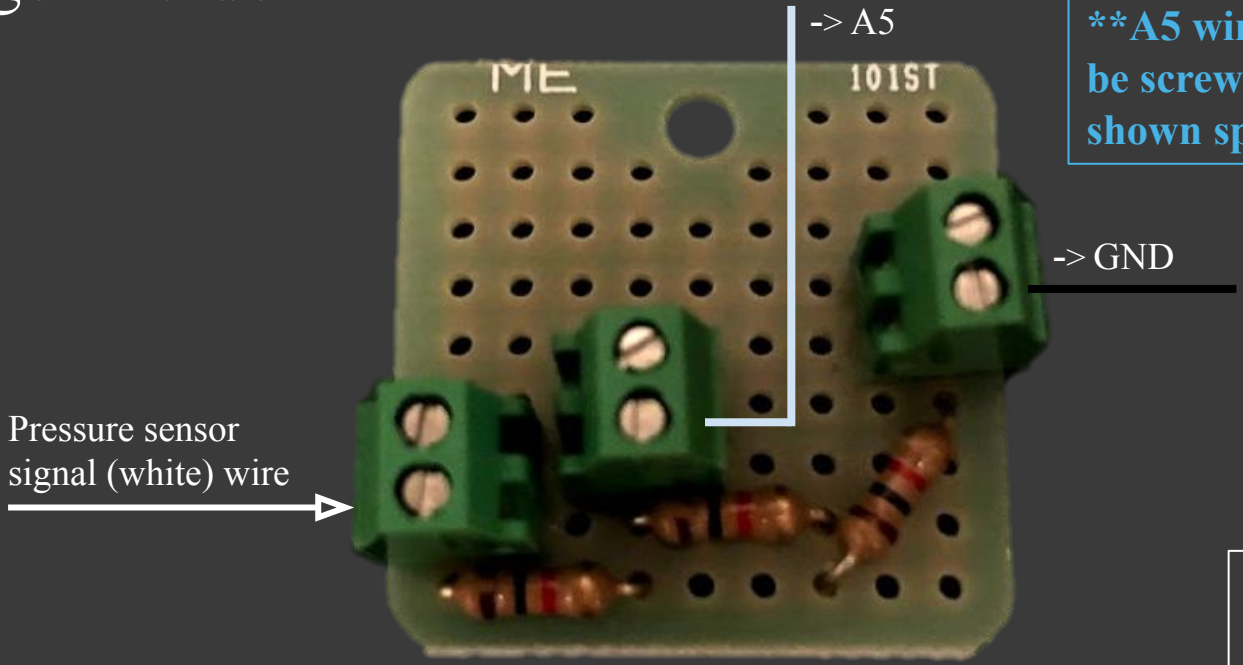
*See speaker notes for steps to build beefcake

Video: [Soldering beefcake relay]

Blue board


Pressure Sensor
VIN
GND
A5
VIN ->5V
GND->GND
D7->CTRL
5V
12V
Beefcake
NO ->Valve positive
NO ->Diode
COM->Fuse
->Tentacle Shield
:SCL:SDA:5V:GND:
Power Supply
- ->Valve ground
+ ->Fuse
- ->Diode

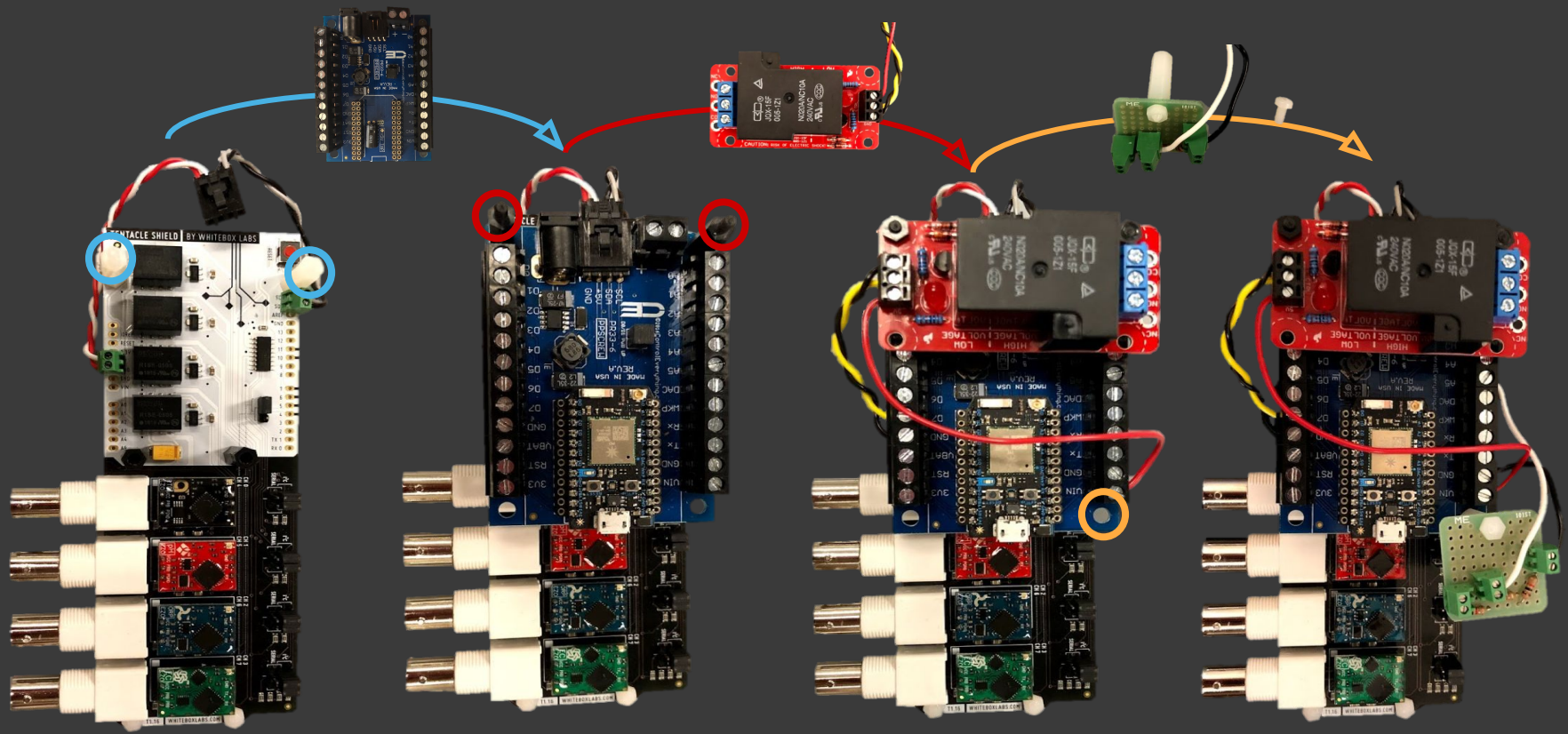
Voltage Divider



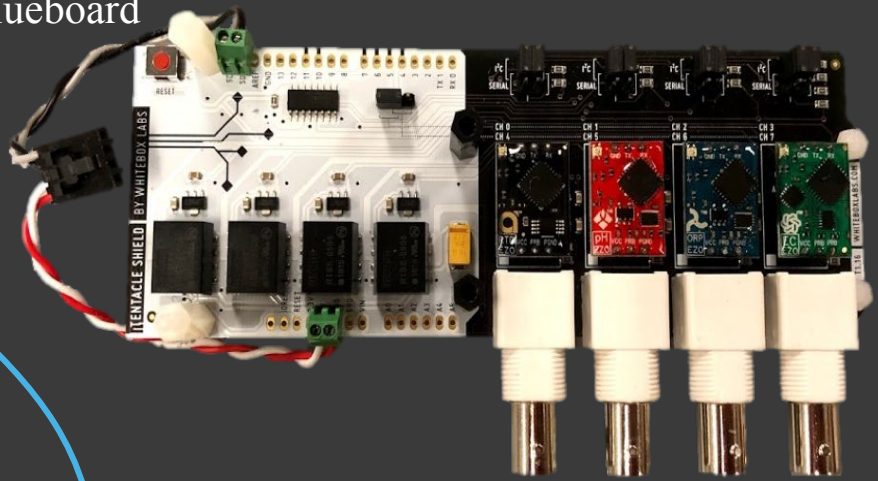
****A5 wire MUST be screwed in shown spot****

*Pressure sensor wire and GND wires can be in either of the 2 slots in screw terminal

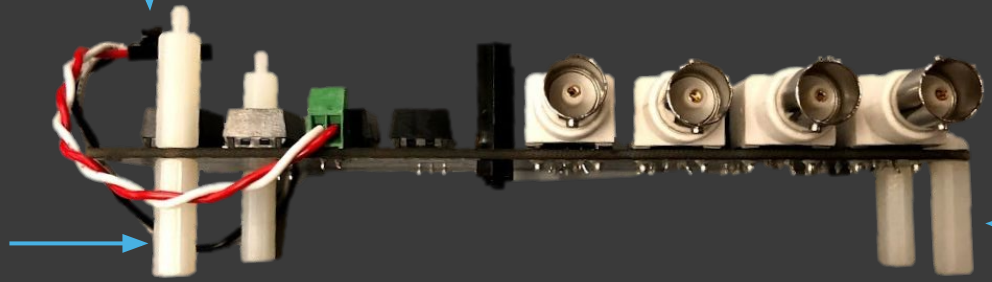
Tentacle + Blueboard + Beefcake + Voltage Divider



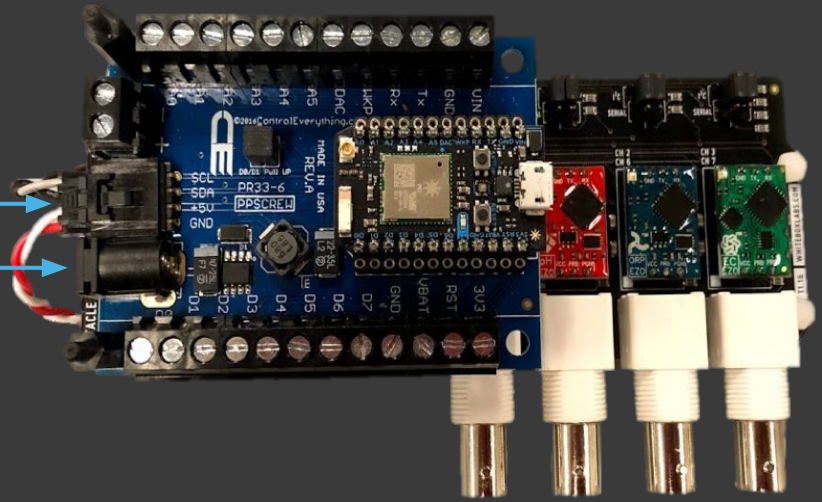
Plugs into blueboard



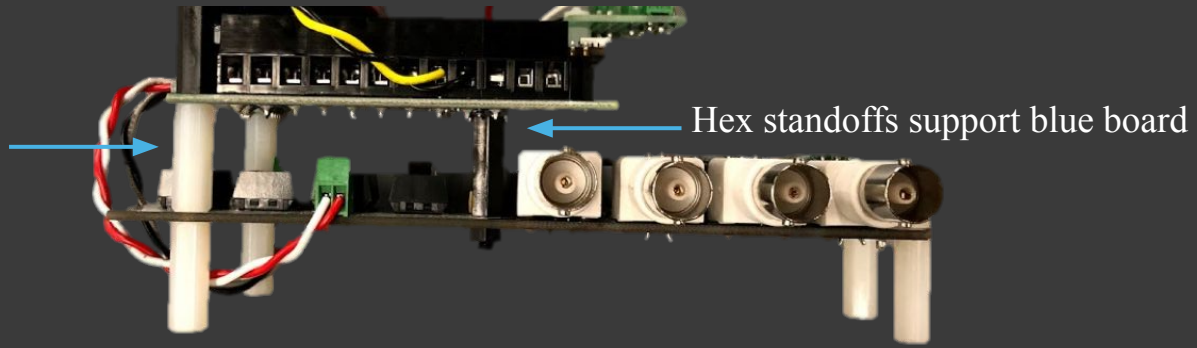
Tentacle shield with with wiring and circuits attached

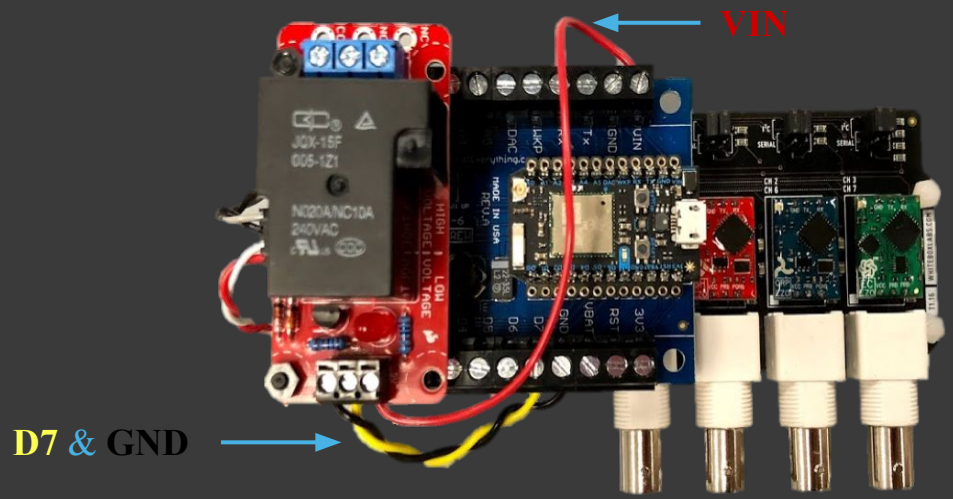


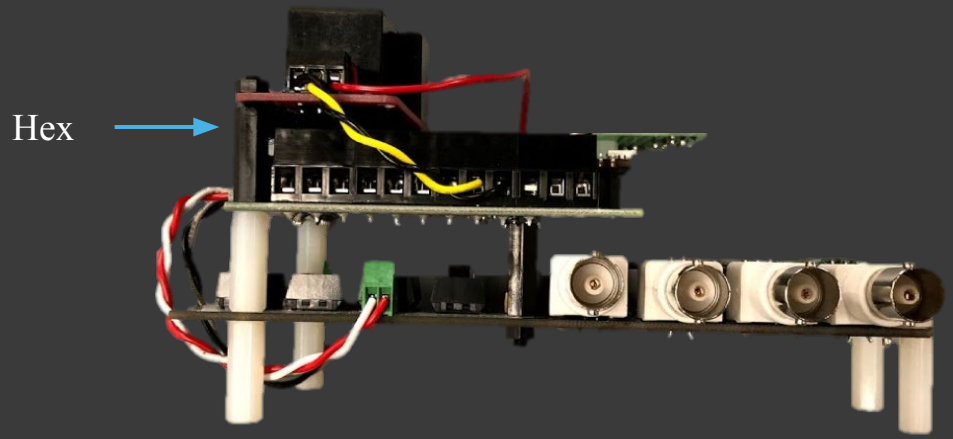
← Female threaded hex standoffs used to elevate Tentacle



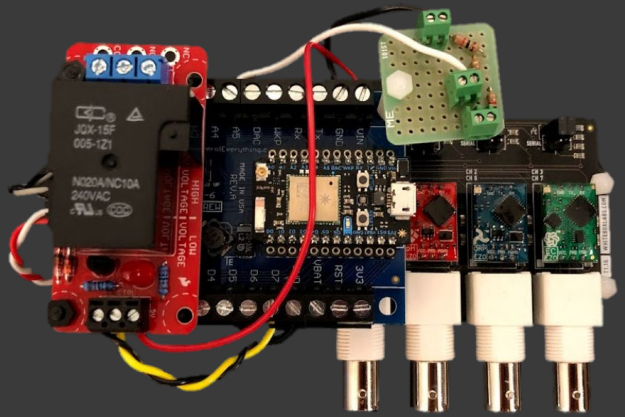
Blue board with photon attached rests on top of tentacle shield using hex standoffs for support

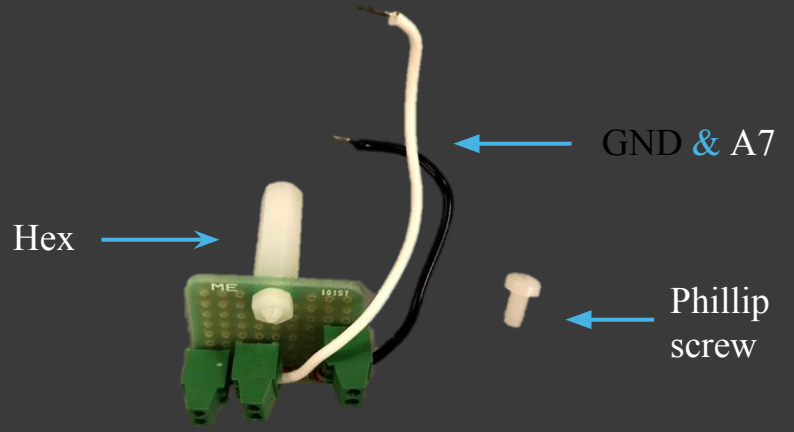




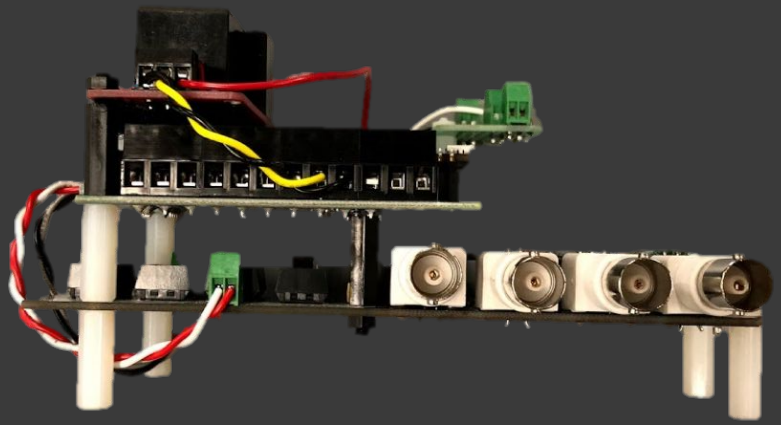


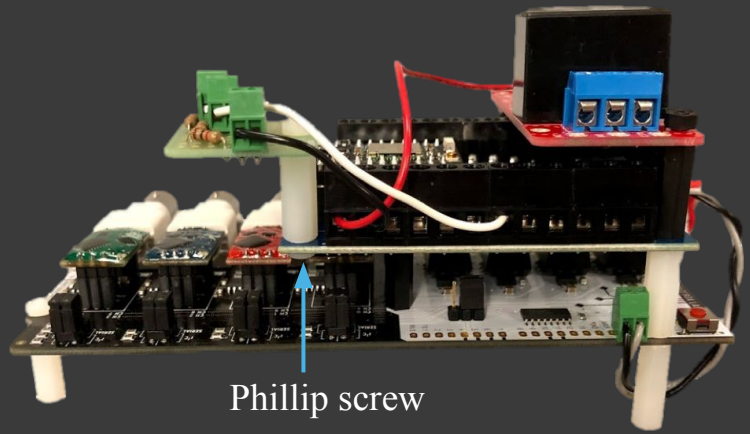
Beefcake rests on top of blueboard (supported by hex standoffs on left side) and is wired onto blueboard





Voltage divider wired to blue board, attached to blue board using hex standoff





Flashing code

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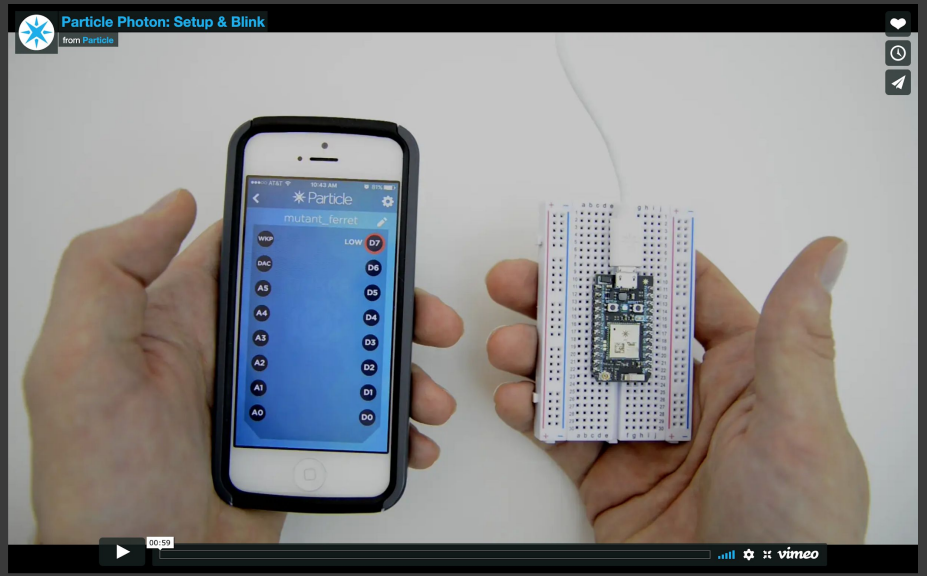
Setting up Photon

- Download Particle mobile app
- Create an account
- Connect your Photon (guide)
- Optional: Tinker
  - Can be used to control individual pins on Photon without writing code
  - Might be useful for learning but not necessary for node building



Flashing code wirelessly

- Go to build.particle.io
- Select desired code under “My apps”
- On sidebar, click “devices”
- Select device(s) to flash (star icon)
- On sidebar, click “flash” (lightning icon)

Testing

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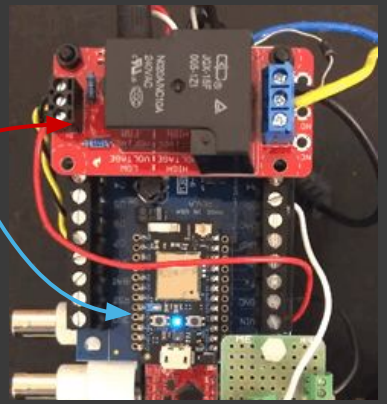
Testing the power supply with Blue board

- Connect Blue board to the Photon (no other connections)
- Power the board
- Measure the 5V and ground for the I2C connection and for VIN and 3V3
- If photon board is flashed, measure the digital pin (D7) sending the pulse (3.3V)
- If that's good, power off the board
- Connect the I2C wires to the Tentacle Shield
- Repower Blue board and make sure it reads each I2C circuit (each circuit flashes indicating it took a reading)
- If it reads, disconnect the power and move on to test Beefcake Relay (next slide)

Testing Beefcake relay

- While power is off, set up the Beefcake relay onto Blue board (should still be connected to Tentacle)
- The supply voltage for the beefcake is 5V
  - Connect to Vin and ground
- Connect the middle wire (yellow) to the digital pin that triggers the relay switch
  - D7 pin on Blue board (Photon D7 pin light will turn on)
- Power the Blue board
- Relay switch should turn on
  - Hear a click and LED on Beefcake should light up



Testing solenoid valve

- How a solenoid valve works
- Attach tube into inlet and outlet
  - Make sure water flow is in the correct direction (arrow on valve)
- Turn water pressure back on
- Power blue board to run code that opens valve
- Water should come through valve
  - Photon light (D7 pin) should turn on while valve is open
- Once light on Photon goes out, valve should close
- Shut off power and pressure from water source

Changing between UART/I2C mode with Whitebox I2C Toggler

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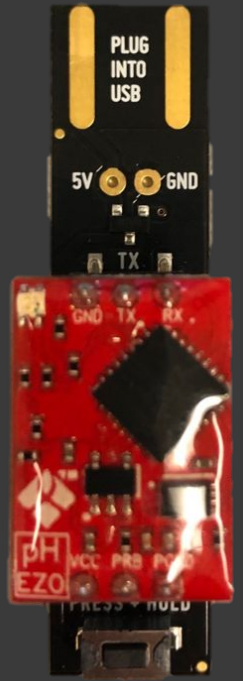
What you need:

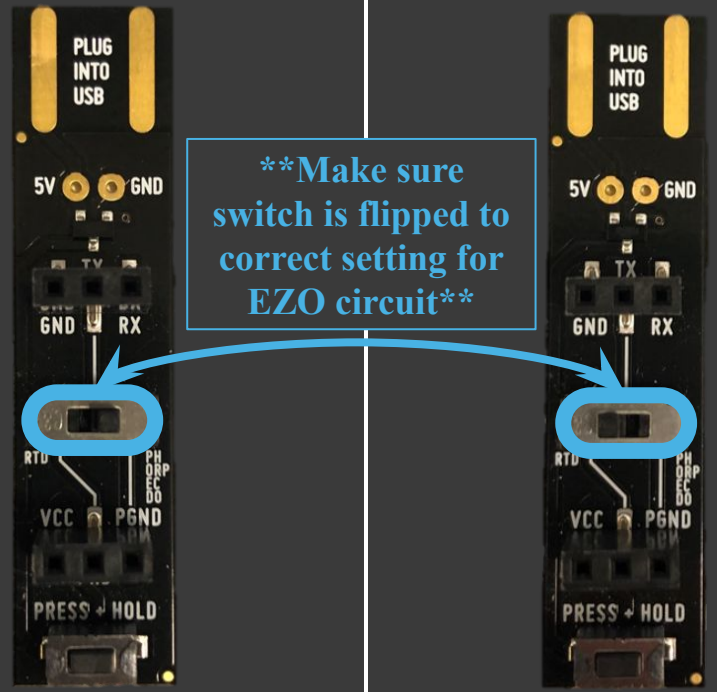
- 1 Whitebox I2C Toggler
  - (Might have received a free toggler from Tentacle Shield order)
- EZO circuits to switch

Set up:



EZO circuit switching:

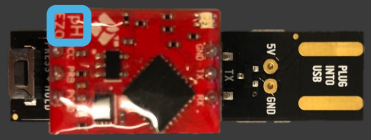
pH, ORP, EC	RTD (temp)



Steps

***Orientation of circuit matters**

- Make sure switch is in correct setting for EZO circuit switching
- Place EZO circuit on Toggler
  - EZO side should be next to the bottom



- Plug Toggler into USB port
- Hold down button and wait until colors flash then solid colors go:
  - Green -> Blue (UART->I2C)
  - Blue -> Green (I2C->UART)
  - Want circuits in I2C mode for node
- Unplug toggler from USB and done

UART -> I2C mode

Tentacle shield testing and QA

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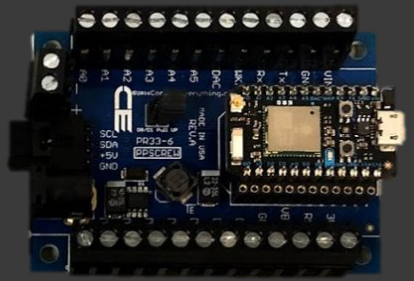
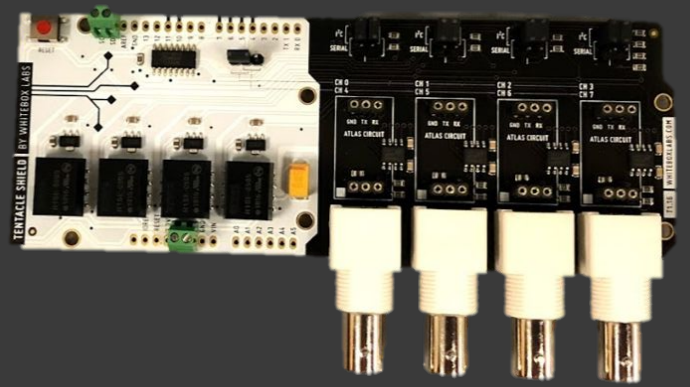
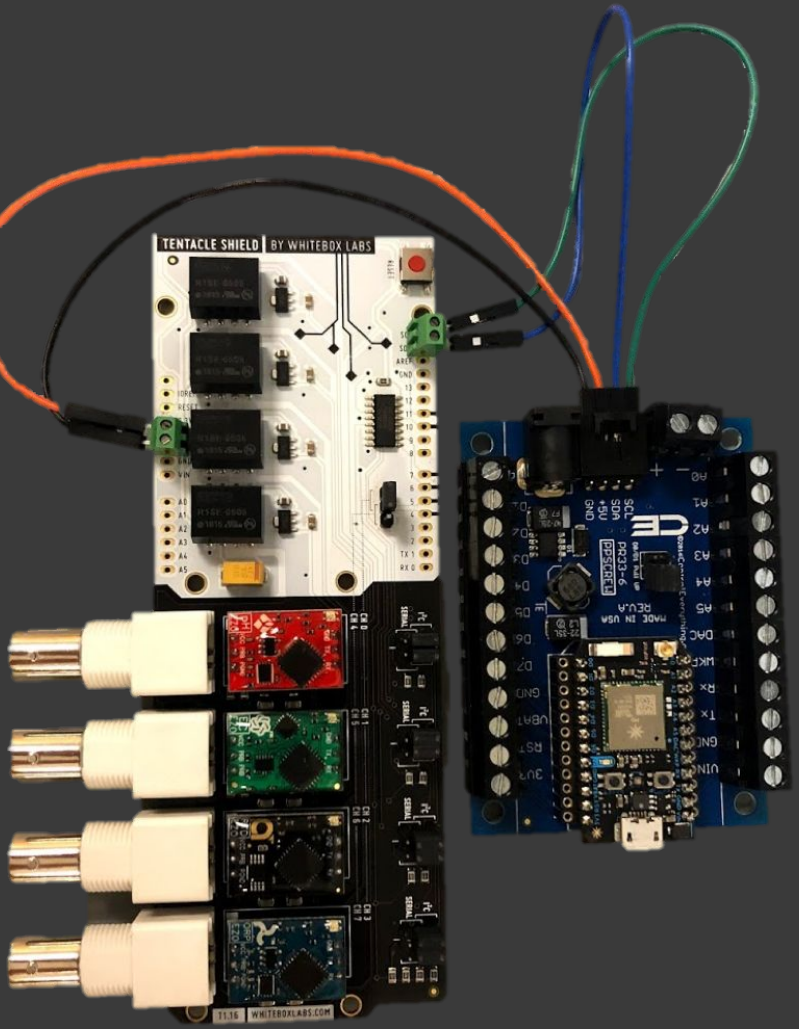
What you need:

- 1 Blue board w/Photon
- 1 Tentacle shield
- 4 EZO circuits



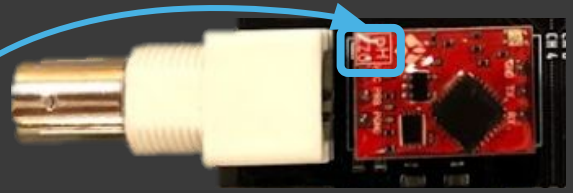


Set up:

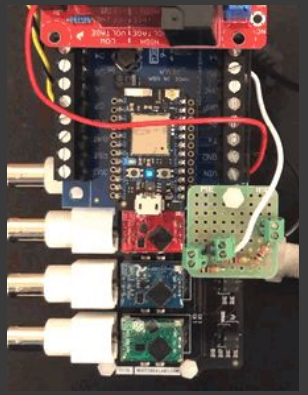


Steps

- Place the circuits on the Tentacle Shield
  - EZO side should be next to the white block



- Connect jumper cables (or appropriate wire) into the correct pins and tighten
  - 5V & ground, SDA & SCL
- Power the Blue board, make sure photon is flashed
- Blue light on the Photon should turn on
- Circuits will light up blue when first powered if it is properly connected to power source (5V and ground)
- Each circuit should flash
  - If they don't, make sure that the SDA and SCL wires are connected properly
  - pH and ORP will do a multiple flash due to having temperature correction reading enabled



Calibration

Table of Contents

What you need:

- 1 Blue board w/Photon
- 1 Tentacle shield
- 4 EZO circuits

pH

1. Place probe in pH 7.00 solution
2. “R” till readings level out
3. “Cal,mid,7.00”
4. Rinse with water
5. Place in pH 4.00 solution
6. “R” till readings level out
7. “Cal,low,4.00”
8. Place in pH 10.00 solution
9. “R” till readings level out
10. “Cal,high,10.00”
11. “Cal,slope” to record base and acid slope

- Order matters! Mid, low, then high, could do 1 or 2 point calibration, but recommend doing 3 point calibration

EC

1. "Cal,dry"
2. Put in 12,880 µS solution
3. "R" till readings level out
4. "Cal,low,12880"
5. Rinse with water
6. Put in 80,000 µS solution
7. "R" till readings level out
8. "Cal,high,80000"
9. "Cal,?"
    a. Should return "?Cal,2"
10. "R" and record average 80,000 reading
11. Rinse with water
12. Put in 12,880 "R" till readings level out
13. "R" and record average 12,880 reading

- Make sure no air bubbles in slot opening
- Enable other readings if not using K1.0 then also need to send K,n where n is the number the sensor is (0.1 or 10)

Enable EC

O, [parameter],[1,0]	enable or disable output parameter
O,?	enabled parameter?

Example	Response
O,EC,1 / O,EC,0	Wait 300ms · 1 Dec · 0 Null — enable / disable conductivity
O,TDS,1 / O,TDS,0	Wait 300ms · 1 Dec · 0 Null — enable / disable total dissolved solids
O,S,1 / O,S,0	Wait 300ms · 1 Dec · 0 Null — enable / disable salinity
O,SG,1 / O,SG,0	Wait 300ms · 1 Dec · 0 Null — enable / disable specific gravity
O,?	Wait 300ms · 1 Dec · ?,O,EC,TDS,S,SG ASCII · 0 Null — if all are enabled

Parameters

EC	conductivity
TDS	total dissolved solids
S	salinity
SG	specific gravity

Followed by 1 or 0

1	enabled
0	disabled

*** If you disable all possible data types your readings will display "no output".**

Optional to enable other readings, type in the code to the left to enable whichever parameters you want.

ORP

1. Place probe in 225 mV ORP solution
2. “R” until readings level out
3. “Cal,225”

- Solution must be in opaque container as to avoid contact with sunlight

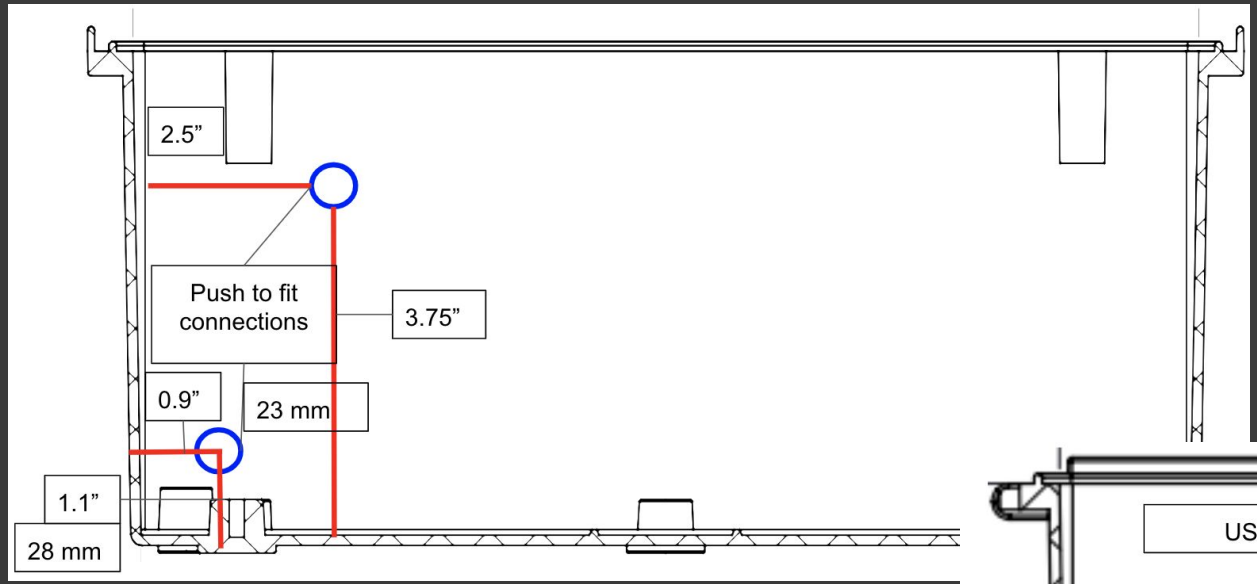
Assembly

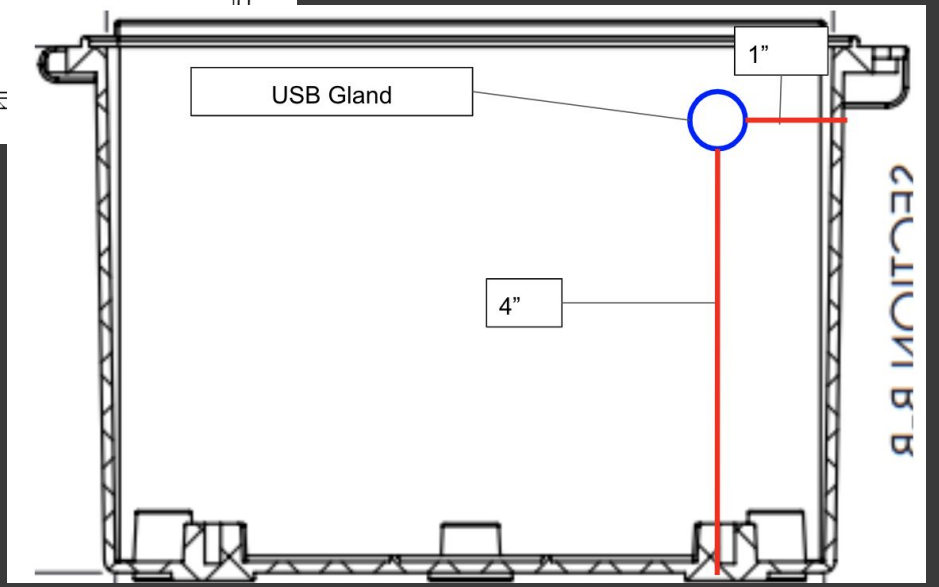
Table of Contents

Steps

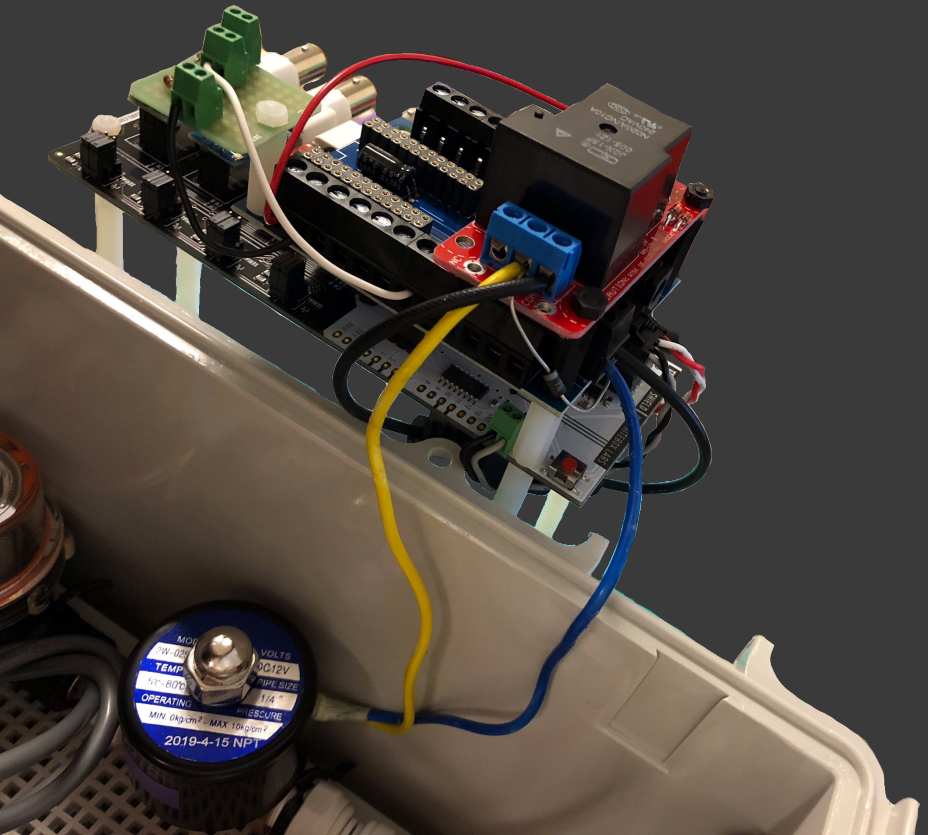
- Twist tie tees into panel
- Put in glands and connect to mechanical system with tubes
- Put in electronic gland
- Wire electronics on (but can keep separate)
- Hook up to water supply and run
    - If no leaks - screw in electronics into panel

**RECOMMEND RUNNING ALL SET UP FOR 1 DAY JUST TO SEE IF THERE ARE NO LEAKS OVER TIME AND EVERYTHING IS REPORTING AS IT SHOULD


2.5”
Push to fit connections
3.75”
0.9”
23 mm
1.1”
28 mm


1”
USB Gland
4”

Connecting Valve

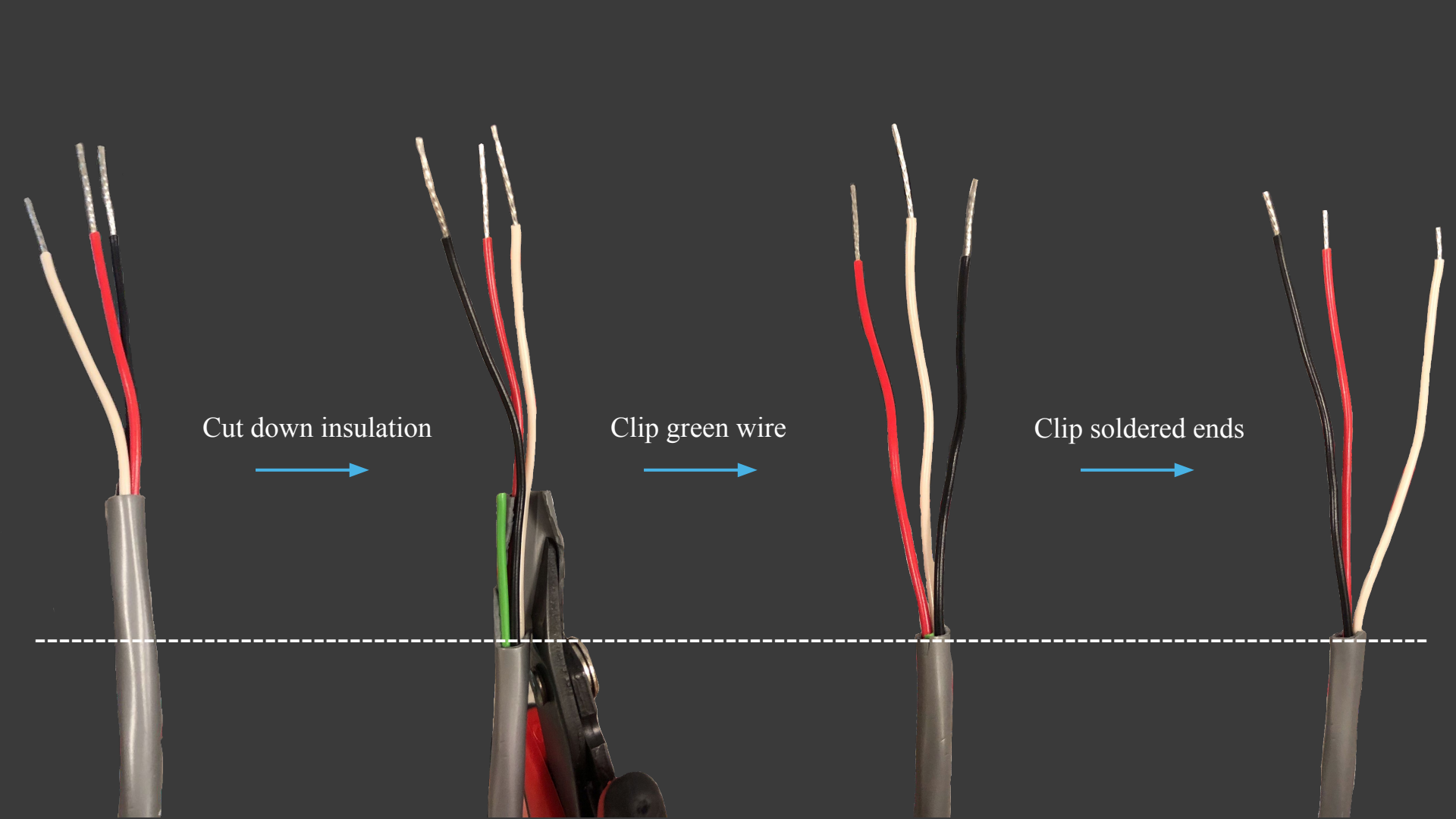


- Refer to [wiring guide]
- Yellow wire goes to beefcake, blue wire goes to blueboard
- Diode runs from blueboard to beefcake (side with white line on beefcake side)

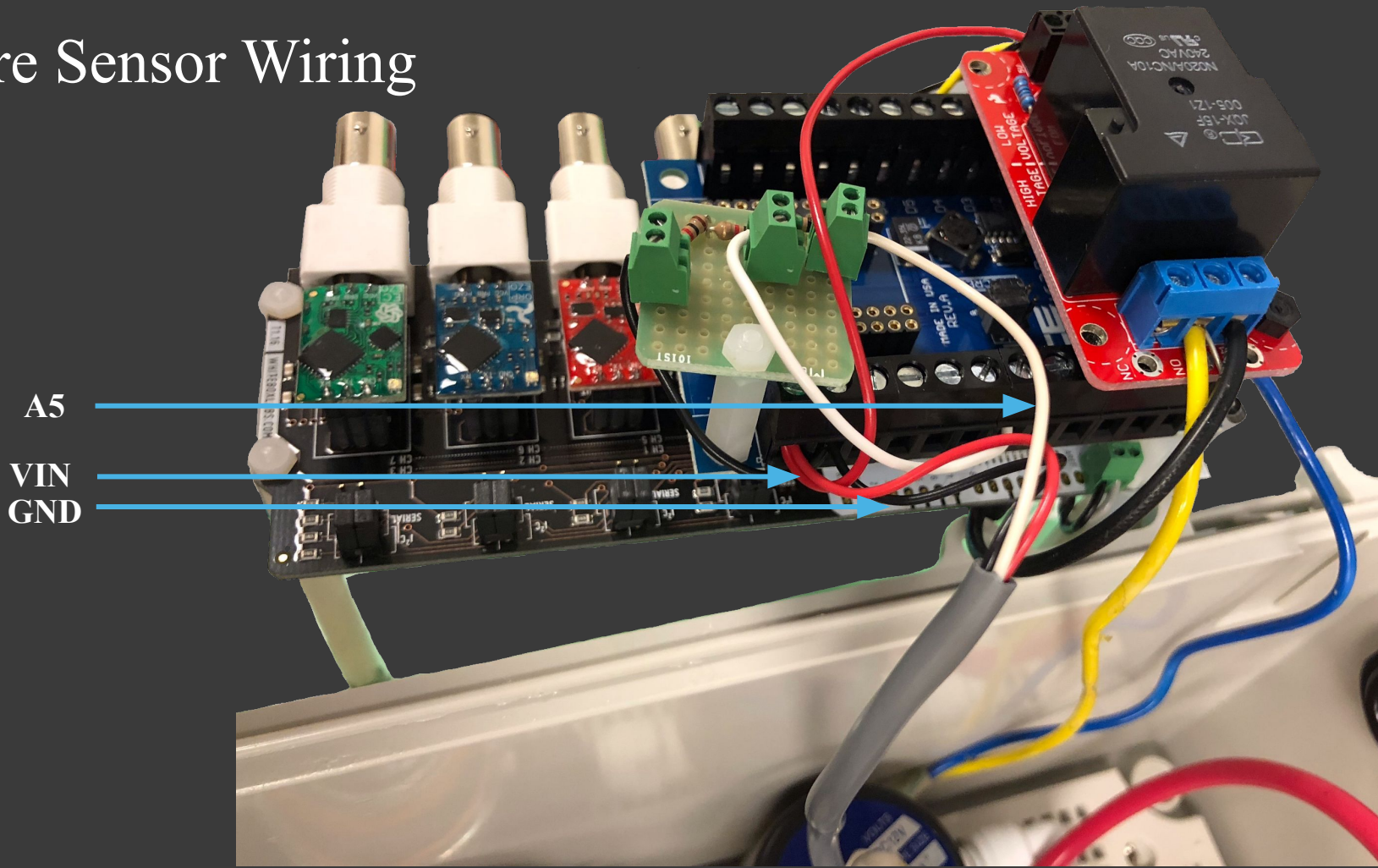
Connecting Pressure Sensor

- White, black, red wires are too short so we need to cut the grey insulation down
- Cut green wire so that it remains under the insulation
- Clip the soldered ends of the wires so that they fit into the pins on the tentacle and voltage divider
- Connect wires based on wiring guide

* This process may differ if using a different pressure sensor. What matters is that it is all wired correctly

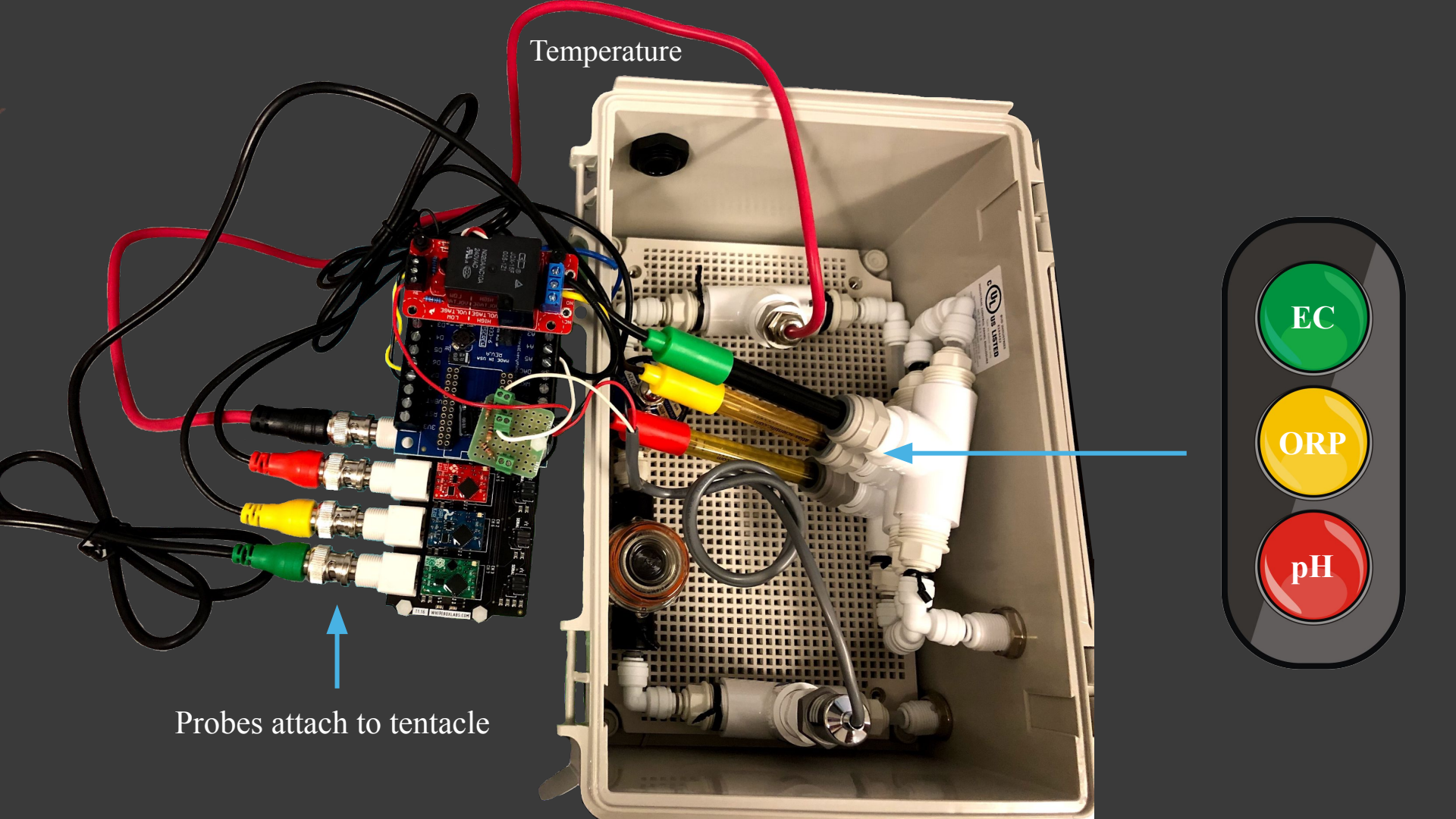

Cut down insulation
Clip green wire
Clip soldered ends

Pressure Sensor Wiring



Attaching probes to Tentacle Shield

- In the tubing, from bottom to top, the order is: pH probe (red), ORP probe (yellow), EC probe (green)
- The ends of the probes attach to the tentacle shield
- The temperature probe also attaches there
- Make sure each probe is attached to the corresponding circuit


Temperature
EC
ORP
pH
Probes attach to tentacle

Twist tie placement on enclosure board