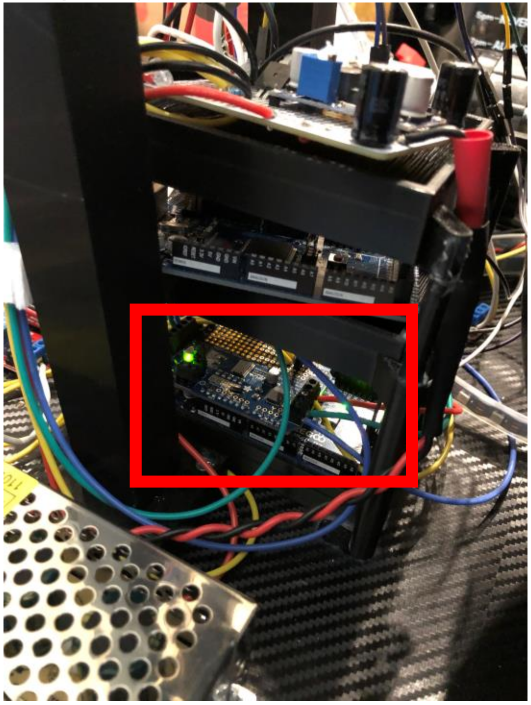
1.) Make sure the system is in the fully off state. The fully off state is when no power is connected to either the power supply or the raspberry pi. If the system is fully off, all LEDs across the system should be off including all relays and Arduinos.

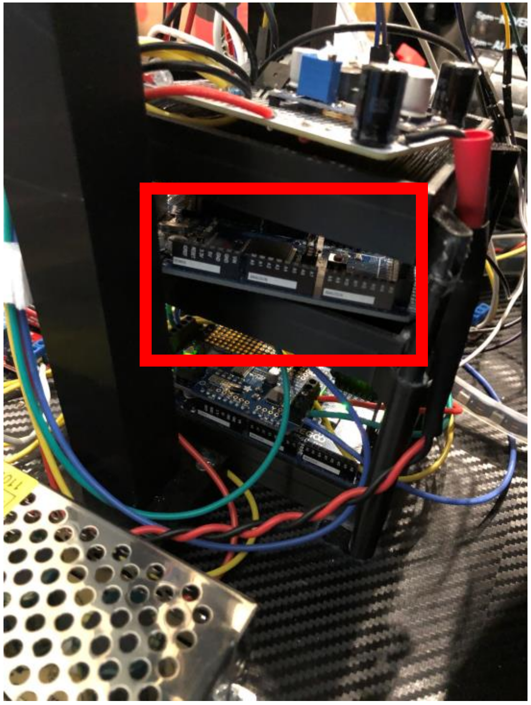
2.) Power on the Raspberry Pi without anything Arduinos plugged into it.

3.) Plug in the bottom Arduino (the Arduino running FullModelControlFINAL) to the Raspberry Pi.

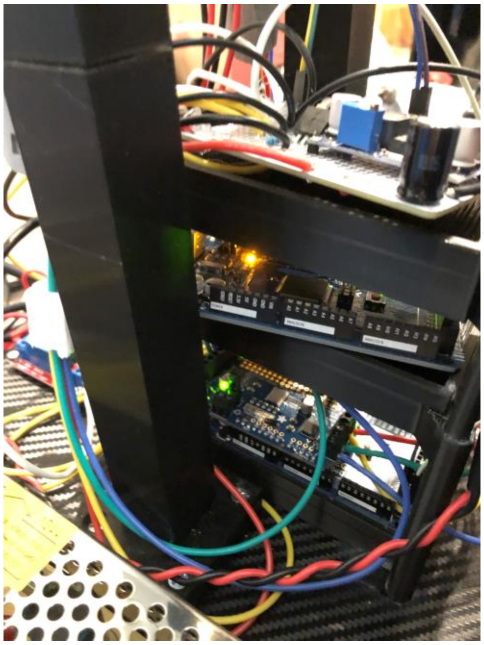


NOTE: The reason this Arduino must be plugged in first is it is the one communicating with node red via ACM0. The first Arduino plugged in will be assigned to ACM0.

4.) Plug in the top Arduino

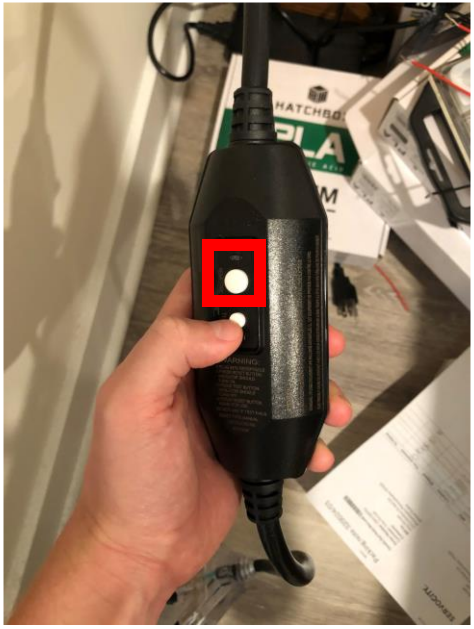


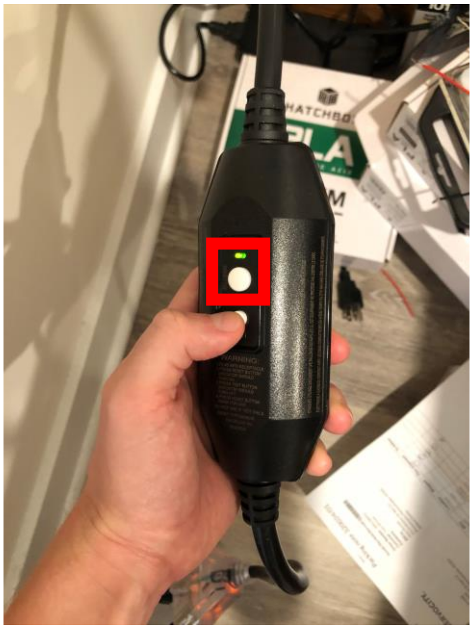
NOTE: (This Arduino only requires power from the Pi and can be plugged into any 5V 1A USB source and only requires at maximum 0.5A. Under normal conditions this Arduino does not approach a 0.5A draw, that is the fused maximum for the board.)



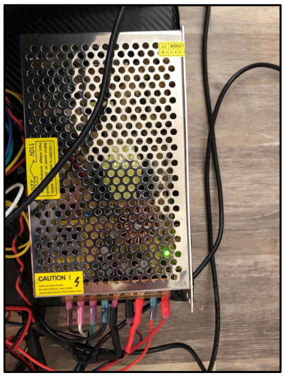
This image shows both Arduinos powered on.

5.) Plug in the GFCI providing power to all remaining systems. Once the GFCI is plugged in and all personnel are clear of the model, click the reset button to power on the system.

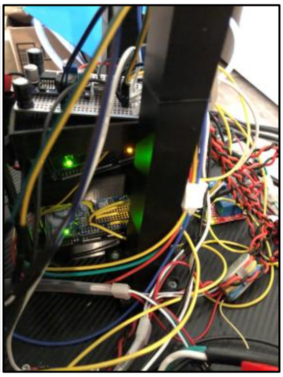




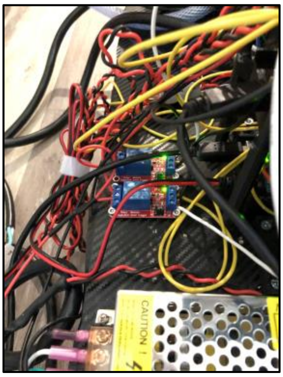
6.) The system should now be powered on. This will be noticeable by a green light on the power supply, lights on the Arduinos, relays, and Raspberry Pi.



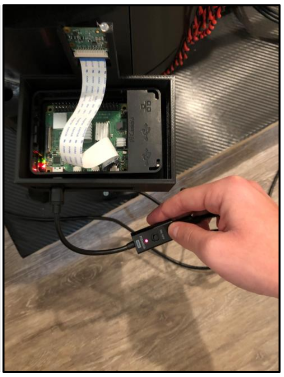
Power Supply



Arduinos



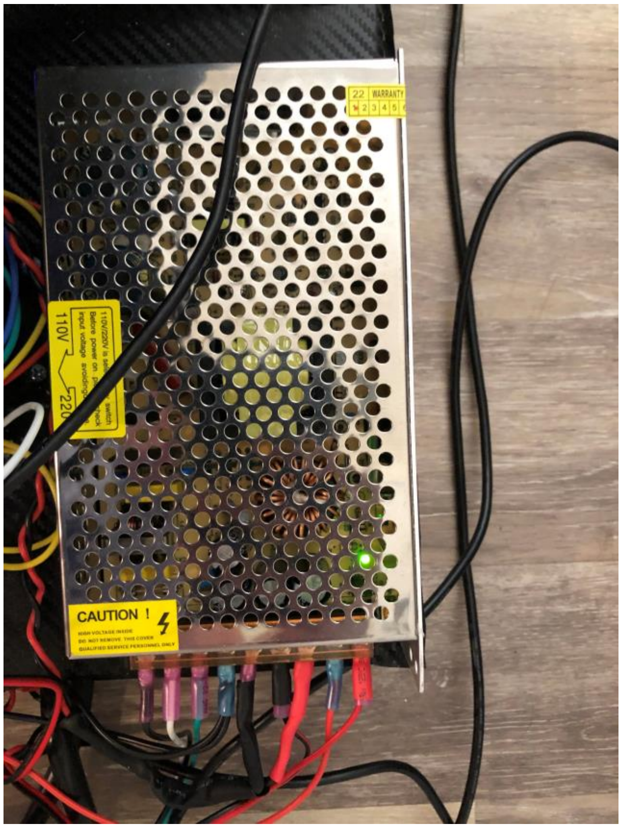
Relays



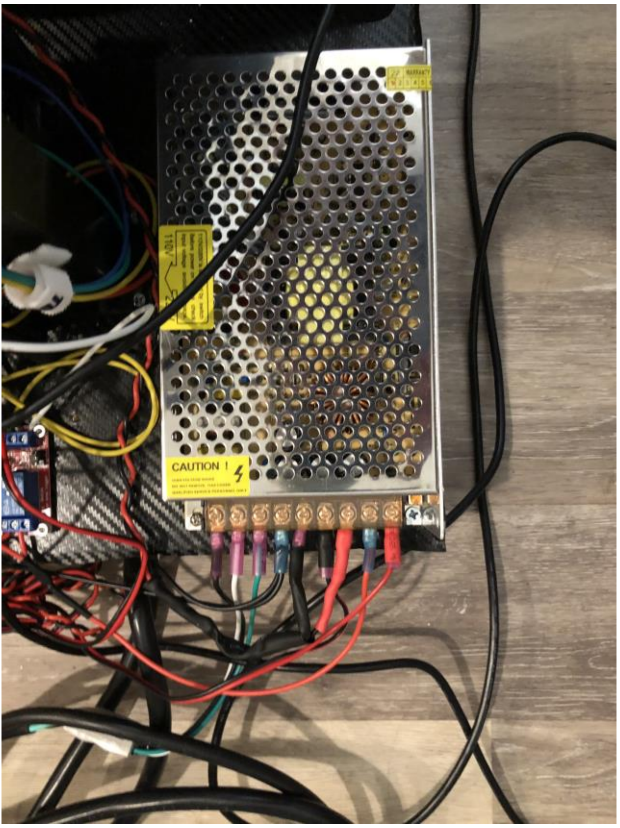
Raspberry Pi

## IMPORTANT SAFETY NOTE:

When the green light is on on the power supply, great care should be taken around all electrical systems. The use of the GFCI, verification of proper grounding of all exterior metal components on pumps and clutches, and usage of low voltage systems when possible is intended to keep the system as safe as possible. However, between the power supply and the pumps, there are areas of 120VAC and 12VDC. Thus, it is important to be cautious when the system is on. Assuming all components are functioning normally, the system is safe when the green light on the power supply is off. The safety procedures used by the team during prototyping also required that the system be unplugged to be considered fully discharged and the electrical systems safe to touch.



Electrical Systems Charged

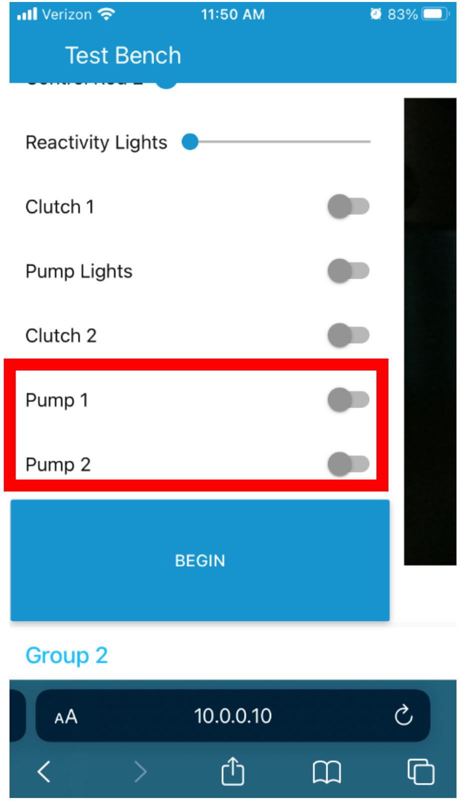


Electrical Systems Discharged

Once the system is on, and if the test bench interface is loaded in node-red (see ECE02_NodeRedChange.pdf for instructions on switching between the testbench and the simulator), the following interface components will correspond to the following hardware components.

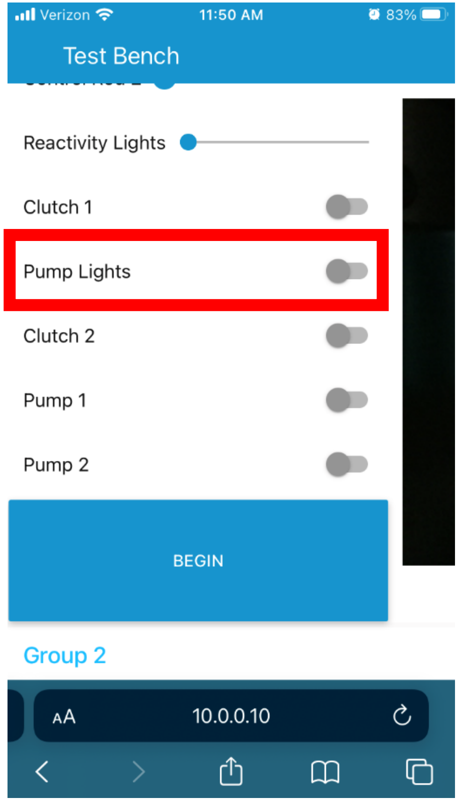
NOTE: To start the test bench, the first step is to click BEGIN.

1.) Pumps



The pumps themselves do not provide a sizeable visual. It is easiest to tell they are on based on the noise they make. For this reason, we have the next component the Pump Lights

## 2.) Pump Lights



Verizon 11:50 AM 83%

Test Bench

Reactivity Lights

Clutch 1

Pump Lights

Clutch 2

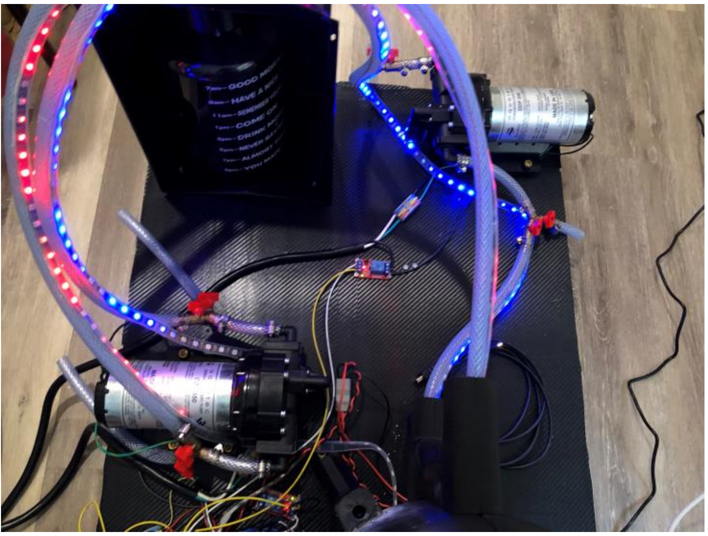
Pump 1

Pump 2

BEGIN

Group 2

AA 10.0.0.10

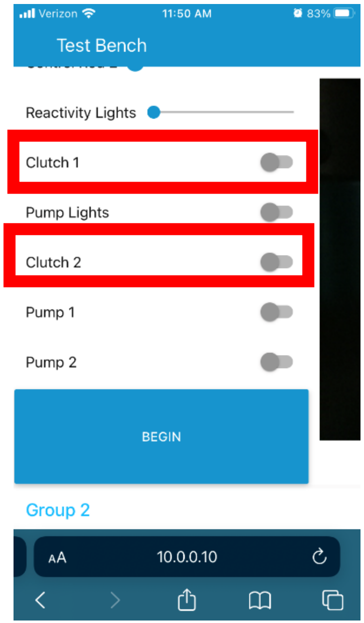


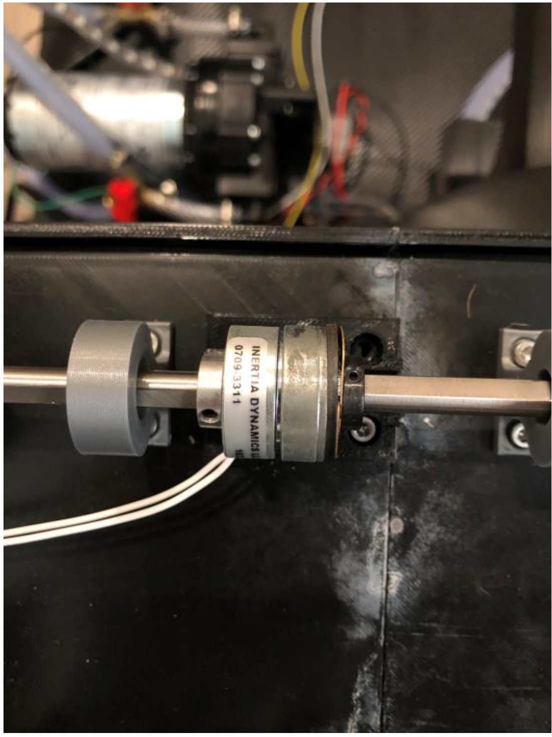
When the switch is on, these lights will move in the direction of the flow of water and will light up red to signify the hot side of a loop and the cold side of a loop in an actual reactor. When the switch is turned off, the lights remain on but stop moving to demonstrate the stop of the flow of water.

NOTE: The initial state of the system is for these LEDs to be off. Turning on the switch will bring them online to the moving state and turning the switch off again will then place them into the stationary state.

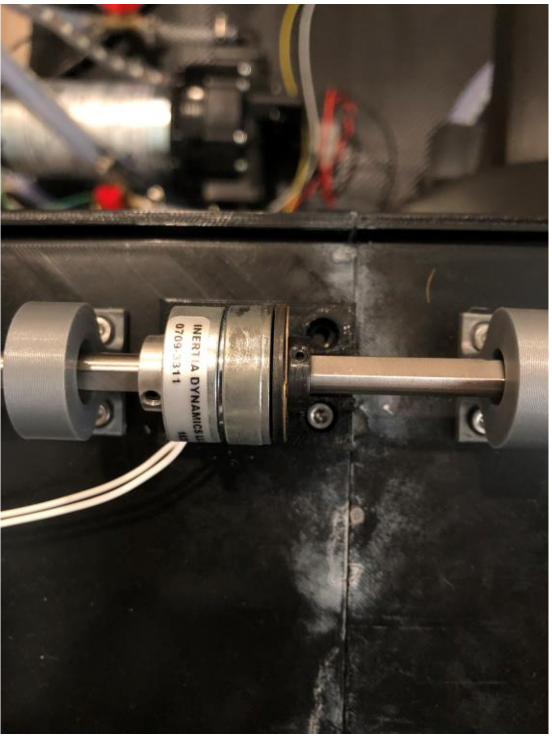
### 3.) Clutches

The clutches have a slight visual indication that they are on. This is visible by the closing of the gap between the main body of the clutch and the pad as seen below.





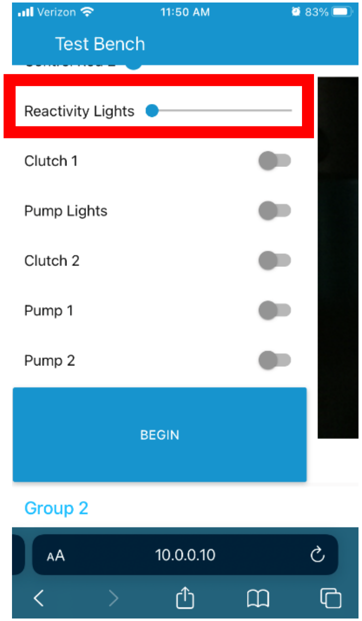
Closed



Open

4.) Reactivity Lights

The reactivity lights can vary in intensity and will look similar to the below picture when on dimly.



Test Bench

Reactivity Lights

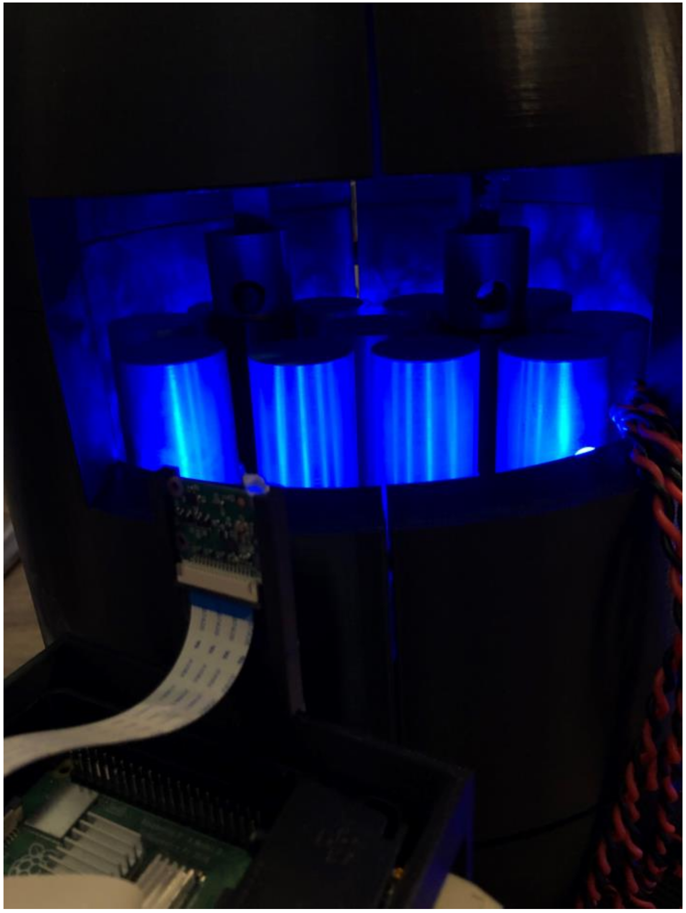
Clutch 1

Pump Lights

Clutch 2

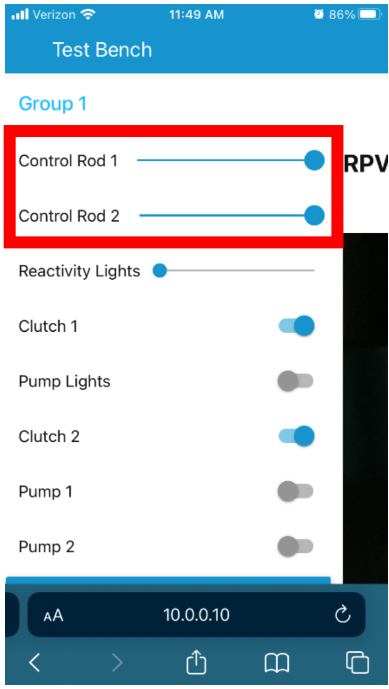
Pump 1

Pump 2



5.) Control Rods

The control rods are driven by two stepper mottors, one for each rod, when the clutches are closed. The picture below shows the rods at the fully extracted state. If the clutches are deactivated while the control rods are raised, they will fall into the reactor. This demonstrates a reactor SCRAM.



Verizon 11:49 AM 86%

Test Bench

Group 1

Control Rod 1

Control Rod 2

RPV

Reactivity Lights

Clutch 1

Pump Lights

Clutch 2

Pump 1

Pump 2

AA 10.0.0.10