NUWAVE NON-ROV DEVICE - FLOAT: Charybdis

The Onboard Power System:

The onboard power system was one of the key areas for the redesign of NUWaves's buoyancy engine. Preparing for this year's MATE competition, our team emphasized the optimization of electrical power and capacity, while simultaneously minimizing footprint and points of failure. To have an onboard power system that met our desired criteria NUWave designed custom printed circuit boards. The initial on-board power system was designed to use the maximum allotted 9.6 Volts by connecting eight AA 1.2 Volt Nickel Metal Hydride (NiMH) batteries in series. Those batteries in series offered an expected capacity of 2,500 mAh, more than enough to supply the proposed design. Our team added a secondary and nearly identical 9.6 Volt battery pack in parallel, doubling battery life and maximum current supply capacity.

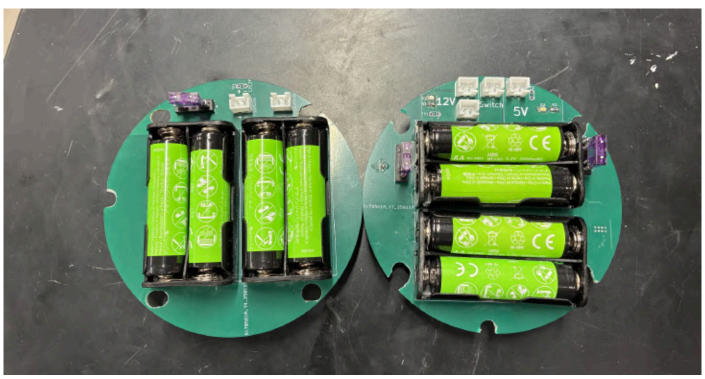

Figure 1: Primary and Secondary Battery Packs

Selecting an appropriate fuse began with determining the full load amperage (FLA) while in water. Our reported FLA is 1.56 amps while active and our waiting mode FLA is 0.33 amps. Based on this, a LittelFuse ATO blade fuse rated for 3 amps was selected as the fuse choices cited in ELEC-NRD-004 were 1A, 3A, and 5A. Our PCBs were designed with the fuses placed within 5 centimeters of the positive and negative terminals of the primary battery pack. The secondary battery pack has an independent fuse placed within 5 centimeters of its positive terminal, and the negative terminal was connected to the fuse of the negative terminal primary battery board, creating a shared fuse connection. These precautions ensured that all electronics remained protected from overcurrent throughout the buoyancy engine.

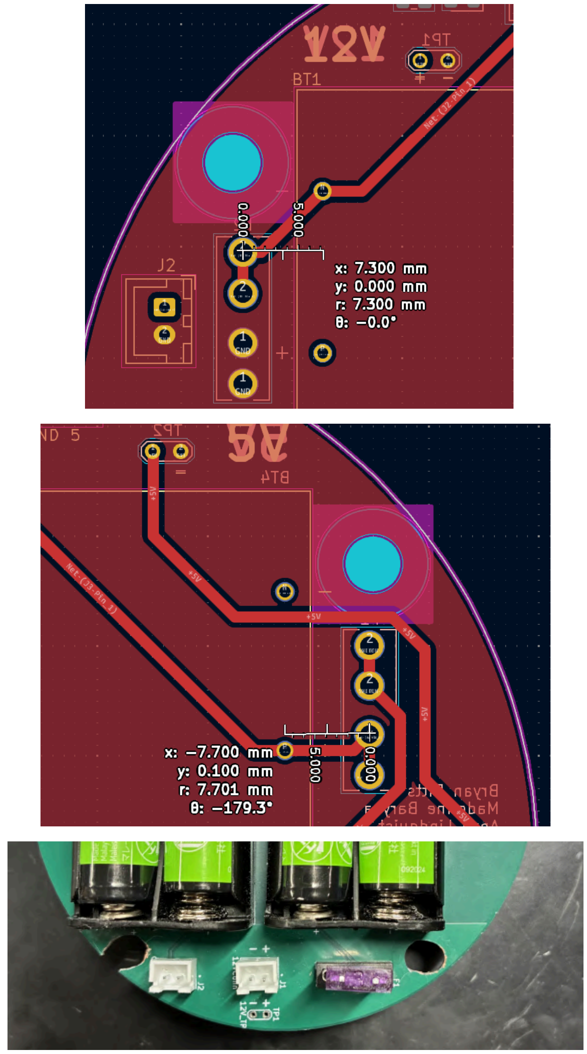

Figure 2: Distance of ATO Mini Blade Fuse(s) From their terminal

Evolving our design with custom printed circuit boards (PCBs) brought upon a new level of customization and design challenges for the buoyancy engine. All components were properly specced for their application and implementation within this design. As an additional precaution, heat sinks were added to components that were expected to dissipate the most heat, such as the Linear Dropout Regulator (LDO).

Software System:

Our system uses a Raspberry Pi Zero 2 W onboard the float that automatically connects to the Wi-Fi network generated by the router in our topside box. On the operator laptop, we initiate a secure shell (ssh) session over the Local Area Network (LAN) with the command:

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ssh pi@192.168.0.113
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to enter into the Pi's command line. Once the ssh connection is established, the operator runs the start-up shell script by entering:

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./run.sh
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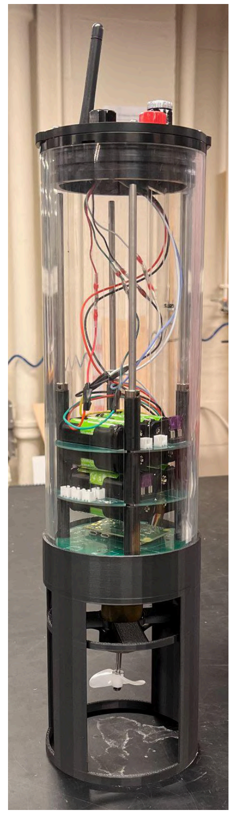
which prints the team number and the current time and initiates the control loop that executes the vertical profiles. The depth and pressure are continuously recorded once every second as the float descends and ascends, and the measurements are continuously written to a .txt file. Once it resurfaces, the Pi reconnects to the LAN and sends the collected data to the topside box. Once the startup shell script is run, this whole process is automated, and a new vertical profile can be initiated once the previous one is done by running the command again.

Mechanical System (DC):

The profiling float utilizes a BlueRobotics 4 inch series watertight enclosure for ROV/AUV application. The enclosure features interchangeable end caps with double O-ring sealed flanges on either end of a 300mm long and 112mm outer diameter cast acrylic tube, tested to a depth of 65 meters. Set in one of the end caps is a pressure relief plug 2.5 centimeters in diameter. To equalize pressure, the end caps of the acrylic enclosure sit within the tube such that should the pressure in the tube housing be greater than the outside pressure, the end caps will separate from the housing to release the internal pressure.



This system utilizes a non-buoyancy changing system consisting of a thruster on the bottom of the enclosure that propels the device through the water to complete each vertical profile. Once deployed by the ROV, the thruster activates at the surface until the device reaches the target depth of 2.5 meters. To maintain a depth of 2.5 meters, a bang-bang control scheme is used to control the activation of the thruster motor when it is detected by the Raspberry Pi that the device is outside the permitted (∓0.005 meter) range using the data collected by the BlueRobotics depth sensor. After 45 seconds the motor automatically propels the float vertically back to the surface.

Float Device Design Document
Due May 21st, 2025