

1.0 Buoyancy Engine and Vertical Profiling

The profiling float achieves vertical movement by changing its overall volume using a buoyancy engine. The system uses four 50 mL syringes mounted on a shared syringe plate. To descend, a 12 V linear actuator drives the plate forward, drawing water into the syringes and increasing the float's overall density. To ascend, the actuator reverses, expelling water and restoring positive buoyancy. Linear bearings are fitted to the syringe plate to prevent tilting and to ensure all four syringes fill and empty evenly, eliminating any imbalance between individual syringes. The linear actuator is controlled via an IBT-2 motor driver connected to an ESP32 microcontroller.

2.0 Sensors and position feedback

Two sensors provide real-time state feedback. A depth sensor monitors the current depth of the float during a dive profile. A VLX53 time-of-flight sensor tracks the position of the syringe plate, reporting whether the syringes are fully open, fully closed, or at an intermediate position. All sensors are managed through a custom-designed PCB that integrates the ESP32, motor driver interface, sensor connections, and SD card module into a single compact board.



Figure 1 outer HDPE shell

3.0 Structure body and sealing

The float body is machined from high-density polyethylene (HDPE), chosen for its buoyancy, corrosion resistance, and machinability. The internal assembly is supported by precision-machined rings that hold all mechanical and electrical components in fixed alignment. Watertight integrity is maintained by two removable end caps each fitted with dual rubber O-rings, rated for underwater operation at the target depth. Two pop-off pressure relief caps are also installed; these automatically vent any excess internal pressure buildup, protecting the housing and electronics from structural failure. The top end cap incorporates two sealed cable glands that route pneumatic tubing to the syringes, allowing water exchange while preserving the internal seal. If it builds up inside the housing, preventing structural damage or potential component failure. The top cap also contains two sealed cable glands that route pneumatic tubing to the syringes. These sealed connections allow water exchange while maintaining the internal waterproof seal of the float.



Figure 2 pop off caps with 2 orings

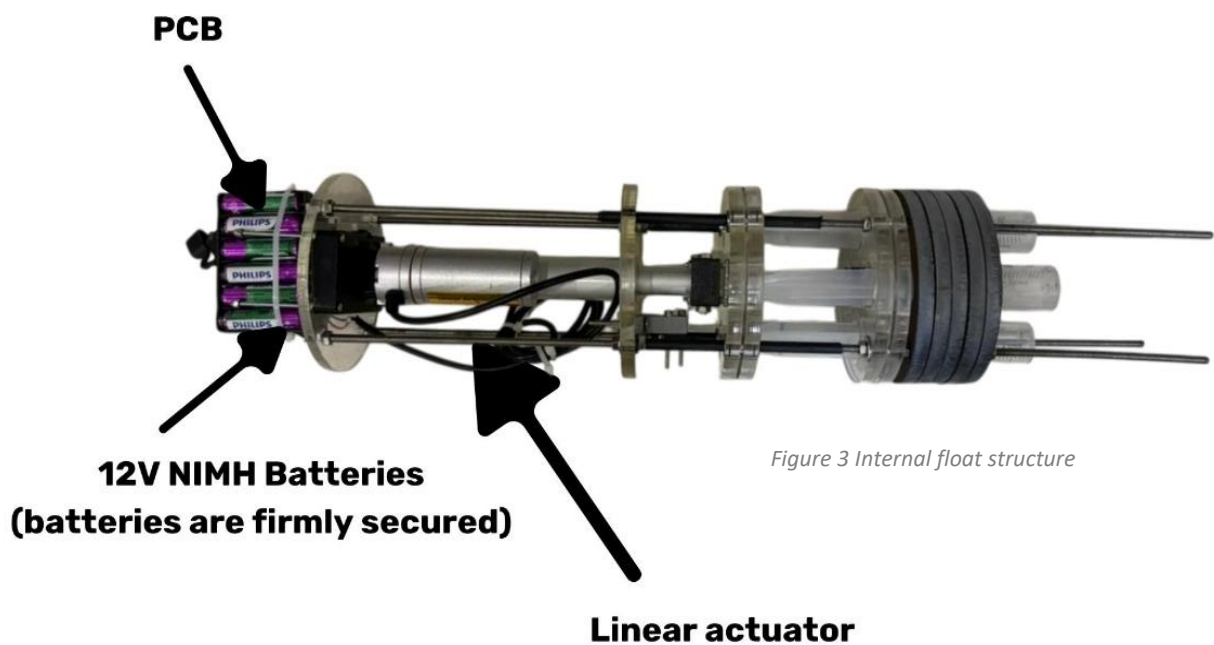


Figure 3 Internal float structure

4.0 Electrical System and Battery Design

The float electronics are controlled by an ESP32 microcontroller, which manages the buoyancy engine operation, sensor data collection, and communication with the shore-side receiver. Power is supplied by a rechargeable NIMH AA 12 Volt battery pack was created using 10 AA batteries connected in series sized to safely provide the required system voltage and full-load current. The battery circuit includes inline fuse of 2 Amps to protect the electronics from over-current conditions. This fuse disconnect the power if the current exceeds safe operating limits, preventing damage to the motor driver, microcontroller, or other electrical components. The battery capacity and discharge capability were selected to ensure the system can safely deliver the maximum current required during motor operation while maintaining stable voltage for the control electronics.

Figure 5 Battery pack used and in line 2 amp fuse installed



Fuse Calculations (Main input fuse)

Fuse used: 2 A (Gray)

- Linear actuator =1.3A
- ESP 32=0.25A
- SD card module =0.1A
- VLX sensor =0.1A
- Depth sensor=0.1A

Non-ROV-device full load amps in water =1.85 A

Figure 4 Full load amps table

5.0 Communication with Shore Receiver

The float communicates with the shore-side receiver using the ESP32's wireless communication capability. When the float reaches the surface, the ESP32 transmits collected data wirelessly to the receiver station located on shore. This allows operators to retrieve mission data and monitor system status without physically recovering the float.