

Non-ROV device

The float we designed and built has a total length of 62 cm and a maximum outer diameter of 16.5 cm. Its main shape is given by the main body, a tube made of polymethyl methacrylate (PMMA), kept transparent in accordance with the 2026 safety-inspection recommendation. The weight is approximately 7.2 kilograms. The construction inside this tube is platform-based. The platforms contain the electrical devices, the motor, the power supply, and the buoyancy engine. The float's main body is waterproof sealed by turned aluminium end caps with O-ring seals. On the bottom end cap a ballast container is attached. On the top end cap are a ball valve, a Wi-Fi antenna, and a #310 stainless-steel U-bolt — a new requirement for 2026 to enable recovery by the MATE Competition ROV under ice. The ground station consists of a notebook and a local web server.

To keep the float waterproof, two O-ring seals are installed on each end cap. The only other openings between the inside and outside of the float are the inlet and outlet of the buoyancy engine — connected via hoses to two of the three syringes — and the ball valve. This valve is opened before diving, and a vacuum pump is used to create a vacuum inside the float. The under-pressure seats the end caps firmly against the tube. Should internal pressure rise above ambient (e.g. due to thermal expansion or a minor leak), the end caps are not mechanically clamped or threaded and will disengage before any failure, satisfying the pressure-release requirement of ELEC-NRD-006.

On the upper platform, most of the electronics are housed. A reed switch serves as the main power switch, activated externally by a magnet on an adjustable ring, removing the need for any additional through-hull connector. The core component is an ESP32, which runs the float's control system and interfaces with the ground station via Wi-Fi. Several voltage converters supply all components with the correct operating voltages from the 12 V battery. The stepper motor is controlled by the ESP32 via a dedicated driver. A Balluff pressure transducer in the lower end cap measures water pressure as a relative signal transmitted as a current; after conversion to a voltage, this data is used by the ESP32 to control the buoyancy engine. A second pressure sensor inside the float provides the atmospheric reference for the relative measurement. By comparing the two, the control system drives the stepper motor to fill or empty the syringes.

To prevent mechanical damage, limit switches are installed at the upper and lower end positions of the spindle to stop further movement. For additional safety, a humidity and temperature sensor inside the housing transmits its readings to the ESP32; a critical reading aborts the dive before any ingress can cause damage.



Figure 1: Exploded view of the Non-ROV device

The platforms are fixed at the correct distance from each other using three threaded rods secured with nuts. The platform on which the stepper motor is mounted has a spindle connected to the syringe heads. All platform components are 3D-printed.

By moving the stepper motor, the syringes are either filled or emptied. The stepper motor is connected to a planetary gearbox with a ratio of 5:1. Due to the force of water pressure, only two of the three syringes are filled with water in this configuration; the third is held closed for design symmetry.

The float's battery is arranged in a ring shape around the stepper motor. It is a 12 V battery composed of 10 NiMH Sub-C cells connected in series, with a capacity of 2200 mAh. These cells were taken from a commercially available battery pack, reconfigured into a ring shape using a 3D-printed carrier that physically restrains each cell. All power-carrying cables have a cross-section of 0.75 mm² and are rated for 5 A at 12 V. A 5 A ATO automotive blade fuse is installed within 5 cm of the battery positive terminal per ELEC-NRD-004, identifiable by the standard yellow ATO colour code and printed amperage marking. The fuse is visible through the transparent PMMA housing without disassembly, satisfying the visual-inspection requirement of ELEC-NRD-004.

The float's full load amperage was measured per ELEC-NRD-005 in both required operating modes: 250 mA in waiting mode with all systems active and motors off; 330 mA during continuous buoyancy engine operation; and a transient peak of 550 mA at stepper motor start-up.

Communication with the float is established via Wi-Fi through a waterproof antenna connected to the on-board ESP32. Once submerged, the connection is intentionally lost. Before diving, users connect to the ESP32-hosted web server to configure settings such as target pressure, buoyancy calibration, PID parameters, and dataset name, and to issue the start command. During both vertical profiles, all measurements — time stamp, pressure, depth, humidity, and temperature — are logged to non-volatile memory at a fixed 5-second interval. After recovery, once the antenna is above water again, the Wi-Fi reconnects and the ESP32 autonomously transmits the stored dataset to the ground station. The transmitted data packets follow the 2026-required format: company number, time stamp, pressure in kPa, and depth in metres (e.g. EX13 01:51:42 9.8 kPa 1.00 m). Pressure and depth are displayed graphically and in table form, with a full log file available for download.

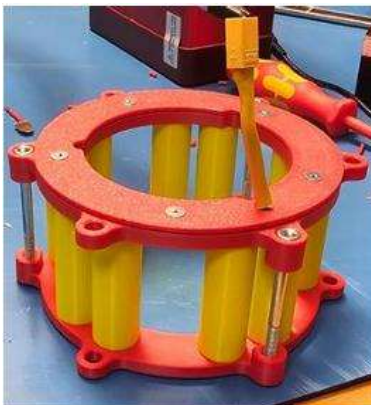


Figure 2: Picture of the Battery pack (Left) and 5A Fuse (Right)