

NAUTILUS-R

Autonomous Underwater Buoyancy Float Engineering Specification

Mechanical Architecture

The **Nautilus-R** buoyancy float utilizes a medical syringe configuration driven by a Usongshine 17HS4401S stepper motor acting as its core buoyancy engine. By stepping the motor to actuate the syringe plungers, the float systematically ingests or expels surrounding water. This mechanism precisely alters the structural density of the float, enabling it to sink, hover, and rise through the water column dynamically without requiring external propulsion thrusters.

All core components are housed safely within a non-locking 120 mm clear acrylic enclosure. The structural endcaps are securely sealed using high-tolerance double O-rings, which additionally serve a critical safety role as a mechanical pressure relief system; they are engineered to pop outward in the event of internal positive pressure anomalies caused by battery off-gassing.

Externally, adjustable weights carry 600 g of ballast to keep the float perfectly upright during underwater profiling operations. Internally, the structural layout isolates the heavy battery pack, stepper motor, custom central PCB, and ESP32 microcontroller at the top layer for rapid deployment access, while routing the ultrasonic transducers and syringe end-points safely at the bottom to maintain an optimal, stable center of gravity.



Figure 1: Nautilus-R Unit

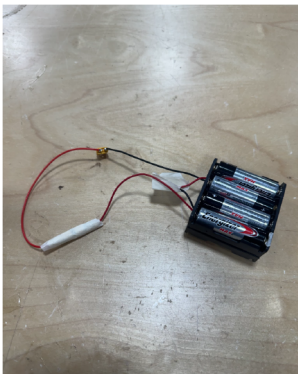


Figure 2: Fused Battery Pack

Electrical Infrastructure

The computing core consists of an ESP32-WROOM-32 Microcontroller managing an MS5837 pressure/temperature sensor alongside a dual-transducer array to monitor ambient external conditions. Power is supplied via an 8-cell (12 V total) LR6 1.5 V Energiser Max battery pack configured in series. To avert catastrophic failures, a 1 A fuse is integrated directly onto the cathode line of the battery pack, protecting downstream logic if current surges beyond the nominal 0.3 A–0.6 A.

Software & Profile Logic

The profile sequence initializes at the surface, where the ESP32 deploys a localized WiFi Access Point hosting an interactive web application framework for data telemetry. Once a shore-side receiver establishes a connection, operators obtain access to real-time utilities, including float initialization, telemetry graphing in mbar (or hPa), mission profile configuration, and emergency stops.

Upon deployment, system sensors auto-recalibrate and re-zero to reference 0 m sea-level pressure. The ESP32 drives the stepper motor to draw in ambient water, prompting a controlled descent until the bottom mechanical limit switch is engaged. At this threshold, the ESP32 dynamically switches to a reactive bang-bang control loop architecture, combining live data feeds from both the ultrasonic sensors and external pressure readings to maintain a static depth lock.

Throughout the mission, the MS5837 logs local pressure data up to a maximum internal memory buffer of 120 discrete readings, transmitting the payload wirelessly upon operator query. The device maintains its target depth hold for exactly 45 seconds before reversing the stepper assembly to purge water until triggering the top limit switch, safely returning the float back to the surface layer.

Table 1: Stepper Subsystem Current Profiles

Component Node	Current Draw
ESP32 Microcontroller + MS5837 Sensor	~0.2 A
Usongshine Stepper Motor	~0.33 A
Float Full Load Amps (FLA)	~ 0.54 A
Selected Safety Fuse	1.00 A

Blue : Power
Purple : GND
Brown : 3.3V Logic
Pink : I2C
Green : Communication

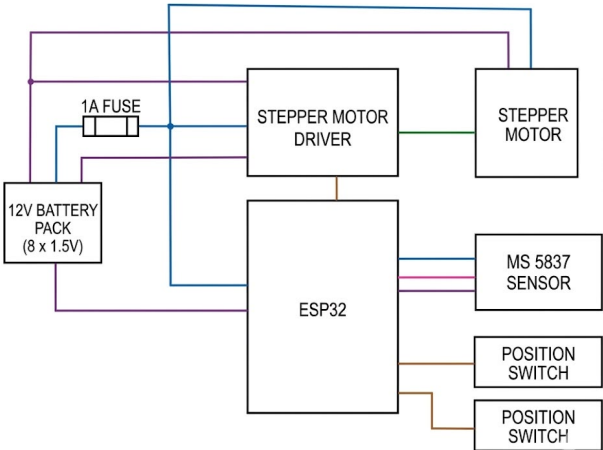


Figure 3: System Interface Diagram (SID)