

N.S.S. (Nyara, Sehaj, & Summer, the names of the children of our late professor Gurinder Khaira) Float



Fig. 9 — NSS Float CAD model



Fig. 10 — Tenergy NiMH Battery Pack 12 V, 2000 mAh



Fig. 11 — 3 A EasyID ATC Automotive Blade Fuse

- A photo of the non-ROV device, battery pack, and fuse is included above. **Battery:** Tenergy 12 V 2000 mAh NiMH (P/N 30005), 10 sub-C cells in series, bare-lead termination. **Fuse:** 3 A EasyID ATC automotive blade fuse, inline on the positive lead.
- Theoretical full load current (12 V battery side):

Component	V	I	P	Waiting @12V	Buoyancy @12V
Peristaltic pump	12 V	0 / 1.4 A	0 / 16.8 W	0.000 A	1.400 A
DRV8833 motor driver	3.3 V	~2–5 mA	6.6 / 16.5 mW	0.0006 A	0.0016 A
HC-12 transceiver	5 V	16 / 100 mA	80 / 500 mW	0.0078 A	0.049 A
Bar30 (MS5837) sensor	3.3 V	1.25 mA	4.1 mW	0.0004 A	0.0004 A
Raspberry Pi Pico	3.3 V	25 / 40 mA	82.5 / 132 mW	0.0081 A	0.013 A
Buck converter losses (15%)	—	—	17 / 100 mW	0.0014 A	0.0098 A
TOTAL FLA	—	—	—	≈ 0.018 A	≈ 1.47 A

I values shown as <waiting> / <buoyancy-change>. Low-voltage rails are stepped down from the 12 V bus through a buck regulator; per-component currents are reflected back to the 12 V side using $P = V \cdot I$ and an assumed 85% converter efficiency.

• **Battery pack design for full-load current and voltage requirements:** The 12 V nominal pack matches the peristaltic pump motor's rated voltage directly with no boost conversion; the Pico (1.8–5.5 V input) and HC-12 (3.2–5.5 V) are powered through a buck regulator from the same bus. NiMH chemistry holds terminal voltage close to 12 V across most of its discharge curve, keeping the pump within its operating range for the entire mission. Tenergy sub-C NiMH cells sustain several amps continuously, so the 1.47 A buoyancy-change FLA is well within the pack's capability with no voltage sag. At 24 Wh (2000 mAh $\times$ 12 V), capacity exceeds two full profiles plus the pre-descent handshake and post-recovery data dump. All power passes through a single inline **3 A ATC blade fuse** on the positive lead (next standard size above the buoyancy-change FLA, per ELEC-NRD-005). The pack is housed inside the float's pressure vessel, which is built to ELEC-NRD-006 with a ≥ 2.5 cm pressure-relief opening. NiMH was preferred over Li-ion for its overdischarge tolerance, lack of protection-circuit requirement, and lower fire risk in a sealed underwater enclosure.

• **Buoyancy engine:** A peristaltic-pump-driven variable-buoyancy engine moves water between the surrounding pool and an internal reservoir, changing the float's average density. **To descend**, the pump runs in the intake direction, drawing water in and increasing the float's mass without changing its external volume. **To ascend**, the pump reverses, expelling water and reducing the float's mass. This satisfies the MATE buoyancy-engine definition (DOC-004) — fluid is moved between the inside and outside of the float to displace water and change density; no propeller or water jet is used for propulsion. Target depth is held by a PID control loop on the Pico using the Bar30 (MS5837) pressure sensor as feedback, commanding the pump to intake, expel, or stop to maintain depth within the ± 33 cm tolerance for each 30 s hold. A peristaltic pump was selected because it provides bidirectional flow by motor-direction reversal, isolates the working fluid from the motor via tubing, and holds position when stopped.

• **Communication with the shore-side receiver:** A pair of HC-12 transceivers operating in the 433 MHz ISM band — one on the float (above the waterline on the antenna mast), one at the shore-side station via USB-to-serial. The Raspberry Pi Pico samples the Bar30 sensor, assembles data packets containing **pressure, time, and depth**, and pushes them over UART to the HC-12 transmitter. Before descending, the float sits in a WAIT state listening for a START command from shore; upon receipt it transmits an initial packet and transitions to DIVE, confirming the link is operational before committing to a profile. All packets are also logged onboard; after recovery the complete log is transmitted to shore for depth-vs-time scoring.