

Non-ROV Device Document

Mechanical Design

Building around the required buoyancy engine design, M.I.A. has developed a float capable of performing vertical profiles, shown in Fig. 1. The system modulates overall density by employing a hydraulic circuit to adjust the float's mass while maintaining a constant volume.



Figure 1 - M.I.A. Float

Float Structure

The float's body is divided into two sealed compartments separated by an internal platform:

Electrical Compartment: Houses all electrical components and is designed for rapid access during testing and debugging. To ensure component integrity, it is fully **isolated** from the buoyancy engine to prevent internal fluid inflow and shielded from the external environment via a piston seal whilst providing necessary **pressure relief**.

Buoyancy Engine Compartment: At the bottom of the float, this section contains the hydraulic circuit (the pumps and bladder). A port facilitates fluid exchange with the external environment, while a piston seal ensures environmental sealing.

The Buoyancy Engine

M.I.A. Float's buoyancy engine employs 2 fixed displacement unidirectional pumps that perform delivery and suction, transferring water between the surrounding environment and a **collapsible** water bladder that is incorporated to contain it.

Electrical System

M.I.A. Float is supplied with **12 V** using a **NiMH battery pack**, which drives the pumps of the buoyancy engine, in addition to powering the visual cues used in our float. A DC-DC buck converter is used to step 12 V down to 5 V, and a 5 to 3.3 V linear voltage regulator is used to provide **stable and safe** power to the sensitive components, namely the **ESP32** and the **MS5873 pressure sensor**.

Current Measurements

The current acquired from the battery pack was measured in water, once while **profiling** and once while **transmitting data packets/waiting**, with the results shown in Table 1.

Table 1 - M.I.A. Float FLA Measured

Condition	FLA
Profiling	1.37 A
Transmitting	0.07 A

Battery Selection

Aligning with **MATE safety rules**, our system is powered with a rechargeable NiMH battery pack, made of 10x 1.2V NiMH AA 2500mAh batteries connected in **series** to provide the float with 12 V, shown in Fig. 3. A **2 A fuse** is installed to protect the battery from going over the safe discharge rate, shown in Fig. 4.



Figure 2 - NiMH Battery Pack



Figure 3 - Cartridge Fuse

Control System

The control system is designed to ensure precise depth regulation at both **2.5 m** and **40 cm** below the ice surface without contact.

A **cascaded PID** control architecture is implemented where the **outer** loop regulates depth by generating a target velocity based on depth error, effectively controlling how fast the float approaches the setpoint. The **inner** loop then produces **smooth** and **controlled** actuation of the buoyancy engine, reducing overshoot and improving system stability. Fig. 5 shows the control block diagram.

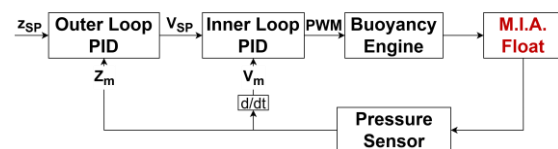


Figure 4 - Control System Block Diagram

Communication

The float utilizes the built-in Wi-Fi capability of the ESP32 to establish communication with the surface station, eliminating the need for additional hardware. A custom graphical user interface (GUI) runs on the topside laptop to receive, display and plot the float data packets. At startup, the float transmits an initial packet to the surface. The topside GUI sends a "start" command to initiate the float's profiles and "stop" after the float is recovered for data transmission.

Electrical SID

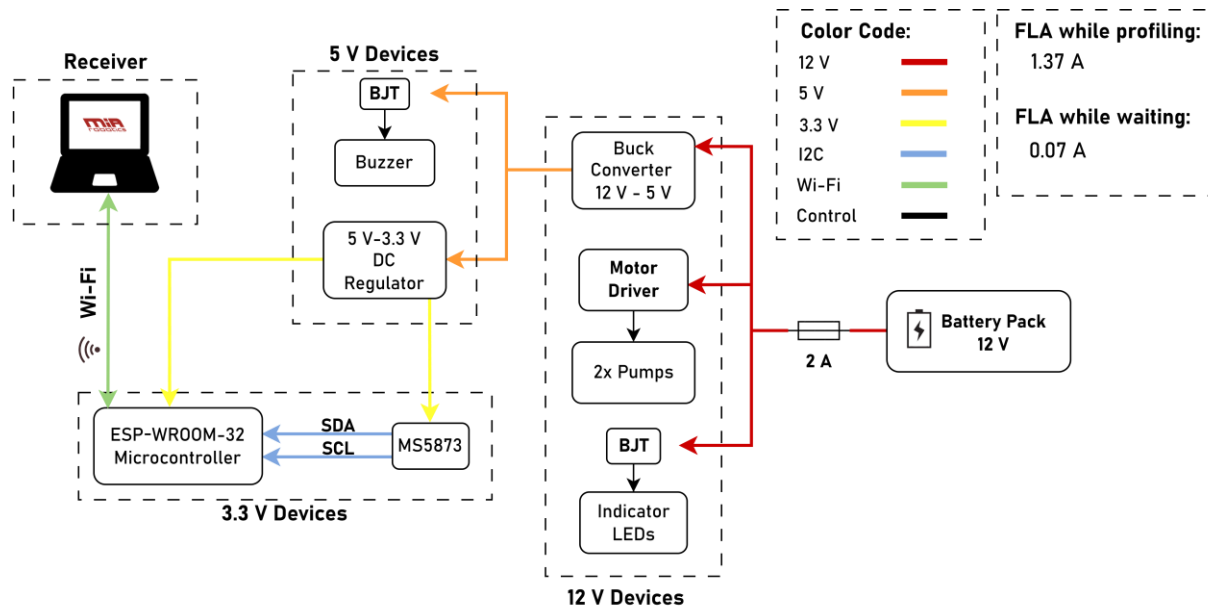


Figure 5 - M.I.A. Float Electrical SID