

Float Technical Report



26 Mate-Ranger

RongZhen KaiWu / Suzhou Street

Summary:

Rongzhen Kaiwu is an eco-conscious and minimalist-oriented startup specializing in remotely operated vehicles (ROVs). Building on its existing OctaXplore platform, the company has drawn on its accumulated experience and introduced innovative upgrades to launch the OctaXplore pro max, an innovative and highly scalable underwater robot framework. Committed to continuous growth and global expansion, the company strives to strengthen its presence on the world stage and contribute to global marine conservation efforts.

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1 DESIGN AND IMPLEMENTATION OF FLOAT

1.1 DESIGN SPECIFICATIONS

1.1.1 POWER SUPPLY SYSTEM

The buoyancy device is powered by a nickel-hydrogen battery with a nominal voltage of 12 V. The system integrates a fuse for circuit protection to prevent circuit damage caused by abnormal current. To ensure the stable operation of the 12V load module, a DC-DC converter (input voltage range: 3 V to 15 V, output voltage: 12 V) is adopted to stabilize the 12V output voltage. In addition, the system is equipped with a built-in DC-DC buck converter (input voltage range: 5.3 V to 26 V, output voltage: 3.3 V) to provide stable low-voltage power supply for other low-voltage modules, ensuring their reliable operation.

1.1.2 CONTROL SYSTEM

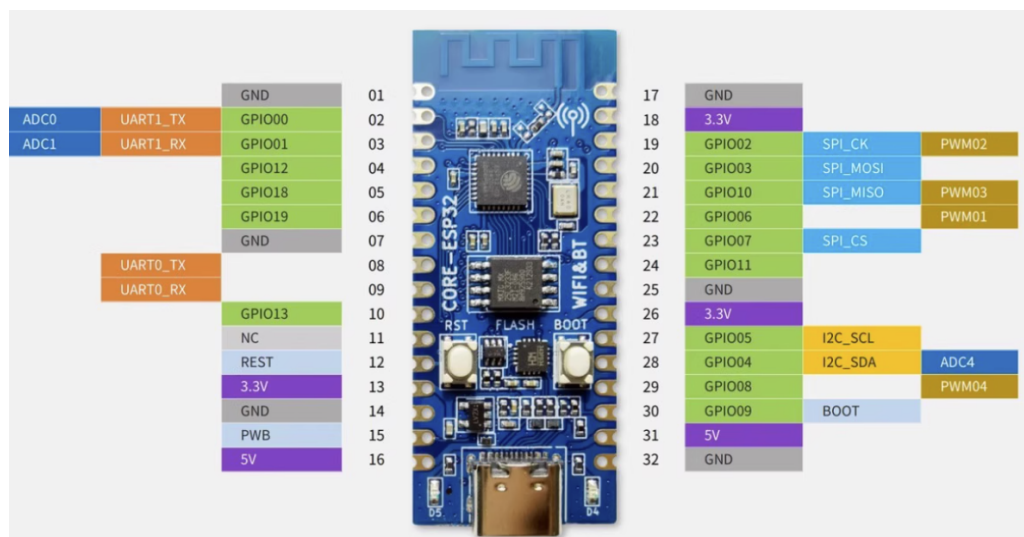


FIGURE 1: ESP32 MICROCONTROLLER

The ESP32 microcontroller serves as the core control unit, leveraging its low-power Wi-Fi/Bluetooth capabilities and versatile I/O resources for wireless communication and motor control. For motor actuation, the design utilizes the TB6612FNG motor drive board, which is powered by a DC-DC 3-15V to 12V module. This setup enables precise control over the 365 water pump.



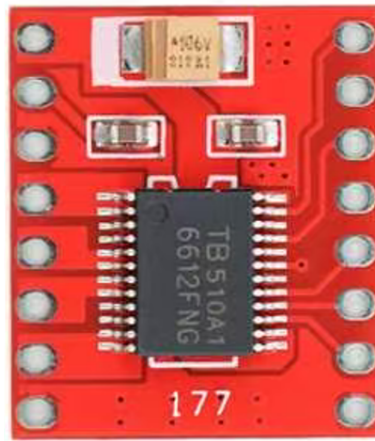


FIGURE 2: TB6612FNG MOTOR DRIVE BOARD

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1.1.3 BUOYANCY ADJUSTMENT SYSTEM

Buoyancy is dynamically regulated by a 365 water pump that pumps water into a water container. By pumping water in or out, the system adjusts the internal ballast volume to enable controlled ascent and descent.

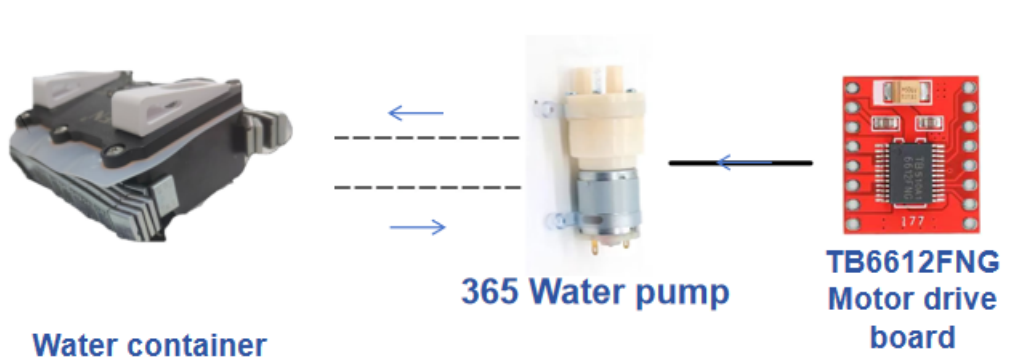


FIGURE 3: BUOYANCY CONTROL DEVICE

This is the buoyancy adjustment system used this time. We place the water storage device and the circuit separately: all circuits are placed in an independent square waterproof box, while the water storage box responsible for adjusting buoyancy is placed above the circuit waterproof box. The 365 water pump is placed together with the circuits.



1.1.4 STRUCTURAL DESIGN

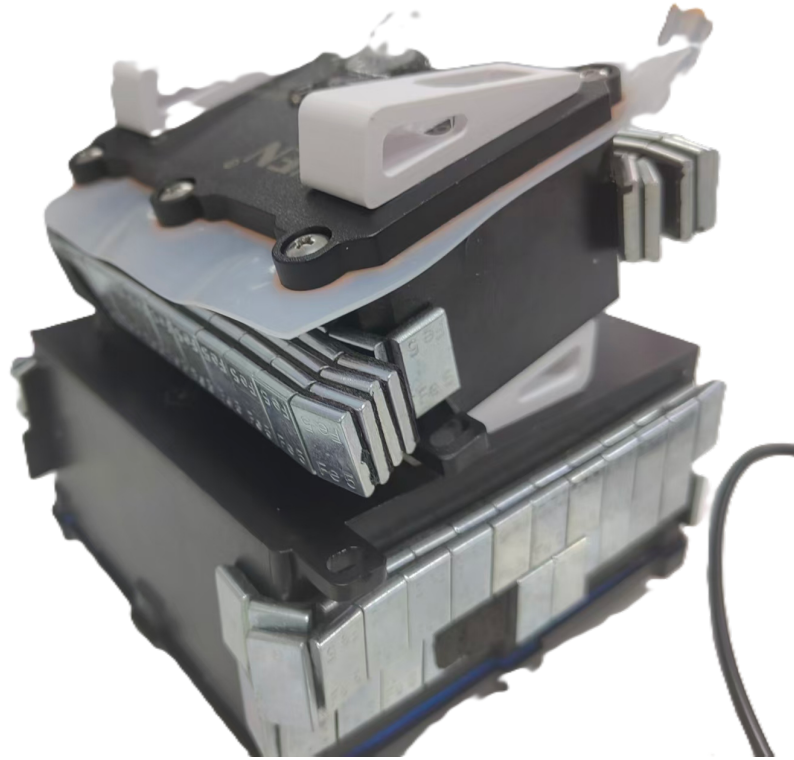


FIGURE 4: FLOAT STRUCTURE

The circuit is placed in a separate waterproof box, where the batteries and the water pump are also installed together with the circuit. The water storage box responsible for buoyancy adjustment is fixed on top of the waterproof box containing the circuit via 3D-printed mounts. A hole is drilled in the waterproof box shell, and a hose is passed through it to connect the 365 water pump. Meanwhile, another hose is led out to connect the waterproof box and the water storage box, and the gaps are sealed to ensure stable buoyancy adjustment and the normal operation of the circuit. A depth sensor and a timer provide real-time feedback to ensure precise depth management and depth adjustment.



1.2 OPERATING INSTRUCTIONS

1.2.1 PROCEDURES

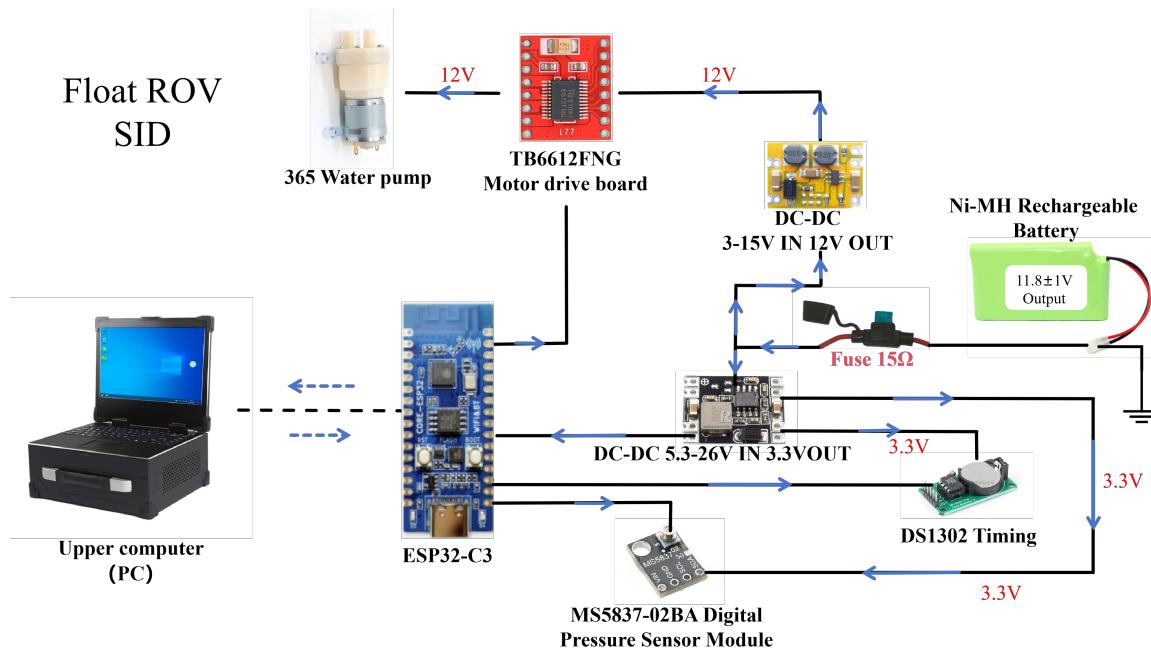
Before deployment, connect the XH2.54 cable and check its status as well as the reliability of the fuse. After power-on, connect to Wi-Fi via the control terminal, then click Drain on the control interface of the computer to expel air from the air tank. Assign tasks, adjust the target depth and the target number of task executions. When floating on the water surface, the buoy will transmit the time-depth profile data to the shore in this manner. The program set controls the sensors and waits for confirmation messages

1.2.2 SAFETY & MAINTENANCE

- **Environment:** Testing should be conducted in freshwater; saltwater may compromise sensor accuracy.
- **Power:** Monitor battery voltage to prevent under-voltage disruptions.
- **Mechanical Checks:** Regularly inspect the pressure vent for blockages and ensure the syringe mechanism remains unobstructed for consistent buoyancy control.



2 SID



This section elaborates on the system integration of the underwater buoyancy adjustment platform, centered on the ESP32-C3 microcontroller as the core control unit. On the shore, an ESP32 control panel is established, which connects to a PC (upper computer) once the buoy surfaces to achieve real-time visualization of depth data and system status. Underwater, the ESP32-C3 is integrated with a DS1302 real-time clock (RTC) module for accurate time stamping and an MS5837-02BA digital pressure sensor fixed at the buoy's bottom. This sensor measures hydrostatic pressure to transmit high-precision depth information in real time, forming a closed-loop sensing system that enables precise data reading and automatic control of the actuation module. The actuation system comprises an TB6612FNG motor drive board and a 365 water pump; the TB6612FNG H-bridge driver controls the pump's forward/reverse rotation, pumping water into or out of a sealed water container to adjust the buoy's total weight, thereby realizing precise ascent, descent, and neutral buoyancy at target depths. Automatic control is implemented by uploading pre-written control algorithms from the shore to the ESP32-C3. The entire system is powered by a 12V Ni-MH rechargeable battery, ensuring stable and pollution-free operation. A dual DC-DC converter system stabilizes voltage: a 3–15V to 12V converter supplies power to the motor driver and pump, while a 5.3–26V to 3.3V converter steps down voltage for the ESP32, sensors, and RTC module, with a fuse added for overcurrent and short-circuit protection. During operation, depth data is logged every 200 ms, synchronized with DS1302 timestamps. Upon reaching 2.5 m, the buoy stabilizes for 10 seconds before reversing the pump to surface; it then transmits the complete time-depth profile to the shore-based PC, waits for confirmation, and repeats the autonomous cycle.



3 PHYSICAL DISPLAY AND DESCRIPTION

This float is equipped with internal pressure adjustment via a single water pump, whose water intake and discharge operations are controlled by a motor. It is waterproof and fitted with a counterweight to maintain stability in the water. A depth sensor and a timer are installed at the bottom of the float to perform the required tasks. The top of the float is raised to accommodate the communication device, and through buoyancy adjustment, the float can finally be kept just above the water surface to expose the signal transmission section.



FIGURE 5: FLOAT OUTSIDE

The float adopts a modular design, with the circuit module and water storage tank placed separately and connected by 3D printed components. The raised upper part of the housing is designed for installing communication equipment, while the bottom is equipped with a depth sensor and a timer to ensure accurate underwater positioning and data collection. The float features a minimalist external design in line with a minimalist concept, while guaranteeing the stability and functionality of the device in water.



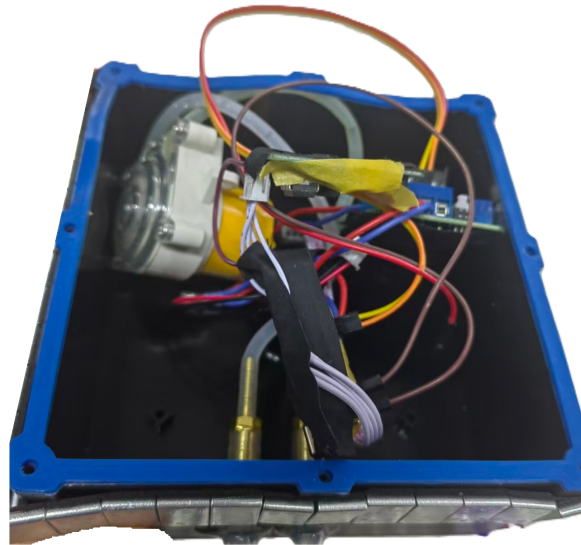


FIGURE 6: FLOAT INSIDE

The figure illustrates the overall layout inside the float and reflects the principles of modular and automated design. Our team integrated the power system, control unit and buoyancy adjustment components into an integrated structure. The battery is integrated with the control circuit for power supply, and other sensors or expansion modules are installed on the top for automatic control and signal transmission, so as to adapt to the needs of different application scenarios and facilitate signal transmission after floating on the surface. The circuit board and sensing interface are arranged at the bottom, with a variety of sensors mounted on the board. It is equipped with an MS5837 pressure sensor to determine whether the float has reached the lowest position and provide real-time feedback on underwater pressure changes. A DS1302 timer is also provided to accurately time and adjust the diving and floating cycles, ensuring precise depth control and stable operation. Finally, a water storage box is installed on the upper part with a 3D-printed bracket to ensure stable depth adjustment of the device. This compact and reasonable layout effectively improves the overall stability and response speed of the system, enabling the float to maintain reliable and continuous operation in complex underwater environments.





FIGURE 7: FLOAT DEPTH SENSOR

The design of the bottom of the float focuses on safety and functionality. At the center is the **MS5837 high-precision pressure-depth sensor**, which can monitor underwater depth in real time with high accuracy and stable output, supporting reliable data collection during underwater operation. The bottom adopts a fully enclosed waterproof box structure, which provides effective physical protection and sealing for the internal electronic components and circuit system, preventing water ingress and damage. This waterproof enclosure effectively isolates moisture and water pressure, ensuring the normal operation of the sensor and other electrical parts in underwater environments.



4 INSTRUCTIONS FOR USE OF THE FLOAT

4.1 REGULAR INSPECTION

Periodically disassemble the float to inspect its electrical circuitry and seal integrity. When not in use for an extended period, disconnect the power supply.

4.2 BATTERY PREPARATION

Before use, replace the battery or recharge it to ensure the float has sufficient power. Upon powering up, the float will automatically initiate a program to expel water from the internal syringe used for buoyancy adjustment. It will then adjust its weight within the reserved space inside the float based on local atmospheric and water pressure, ensuring that the top part of the float remains above the water surface when submerged, but not excessively protruding.

4.3 BUOYANCY CHECK

During use, recheck the seal integrity and carefully place the float into the water, ensuring that the buoyant force slightly exceeds its own weight after submersion.

4.4 OPERATION AND MONITORING

Set the predetermined routes and corresponding depth values for the mission via the computer program. Once the program is activated, the float will automatically perform a series of operations, including diving, hovering, data collection, and surfacing. Please monitor the entire operation process closely. In case of any abnormal situation, stop using it immediately and conduct maintenance.

4.5 POST-USE CARE

After use, retrieve the float, dry its surface, and disconnect the power supply. Store the float in a dry place, avoiding direct sunlight.



5 BUDGET AND COST ACCOUNTING

No.	Item	Function	Unit Price (Yuan)
1	K-705 Sealant	Waterproofing	8
2	XH2.54 Wire	Power Supply	1.2
3	12V Polymer Battery Pack	Power Supply	20
4	3-15V to 12V Module	Voltage Regulation	4.6
5	4-20V to 3.3V Module	Step-down	0.8
6	L298N Motor Driver	Water Pump Driving	9
7	Waterproof Conformal Coating	Waterproofing	35
8	ESP32C3 Classic Edition Development Board	Float Control	11.7
9	DS1302 Clock Module	Timing	2.09
10	MS5837-02BA Pressure Gauge	Depth Adjustment	36.3
11	60W Hot Melt Hole Opener	Drilling	9.8
12	IP68 Waterproof Enclosure 120×70×48	Waterproofing	12.15
13	Large Waterproof Enclosure 134×134×66	Waterproofing	22.7
14	PTFE Air Collection Bag 16×14cm	Waterproofing	1.8
15	365 Diaphragm Water Pump	Buoyancy Adjustment, Water Intake & Discharge	6.75
16	6-8mm Pipe Adapter	Hose Connection & Fixing	1.5
17	7.5mm ID / 9.7mm OD Hose	Buoyancy Adjustment, Water Intake & Discharge	6.6
18	30° 1mm Silicone Membrane	Waterproofing	10
19	7 Counterweight Blocks	Buoyancy Adjustment	14
—	Net Cost Total	—	224.5

This float has many advantages. First, its cost is well-controlled. The total cost of 224.5 yuan is reasonable and can save money for the team. The cost of key components is properly allocated. By controlling the quantity, it ensures the function without over-investment. Secondly, it has high cost-performance. Its functions are comprehensive, including power supply, propulsion control, depth monitoring, and wireless data transmission. All components are versatile and economical, meeting the requirements and are easy to obtain. Finally, the quantity is properly configured. It meets the functional requirements and avoids redundancy, ensuring the overall cost-effectiveness.

