Non-ROV Device Design Document

Vertical Profiling Float(Non-ROV Device) Design Overview

The vertical profiling float is designed for collecting marine information data while drifting and sinking in the ocean. As figure 1 shown, the float is comprising seven parts: buoyancy adjustment block, safety secure interface, power module, control module, water bladder, environment interface, and hydraulic supply module.

1.1 Controller inside the float

The inner components (power module, control module, and water bladder) are sealed by the O-ring mounted on the metal caps at both ends and the acrylic cylinder. A battery pack consisting of **8 AA batteries** is responsible for powering the entire system including the controller circuit with a DC converter and motor power circuitry. The onboard STM32C8T5 controller could receive the ashore command to execute floating up or sinking down by a 433MHz wireless communication module. Wireless communication is chosen for improving reliability to avoid cables stuck in tight crevices. The SID diagram also shows the scalability of the topside controller interface designed based on the UART port. Any PC console with C340 USB-TTL driver could use this system conveniently.

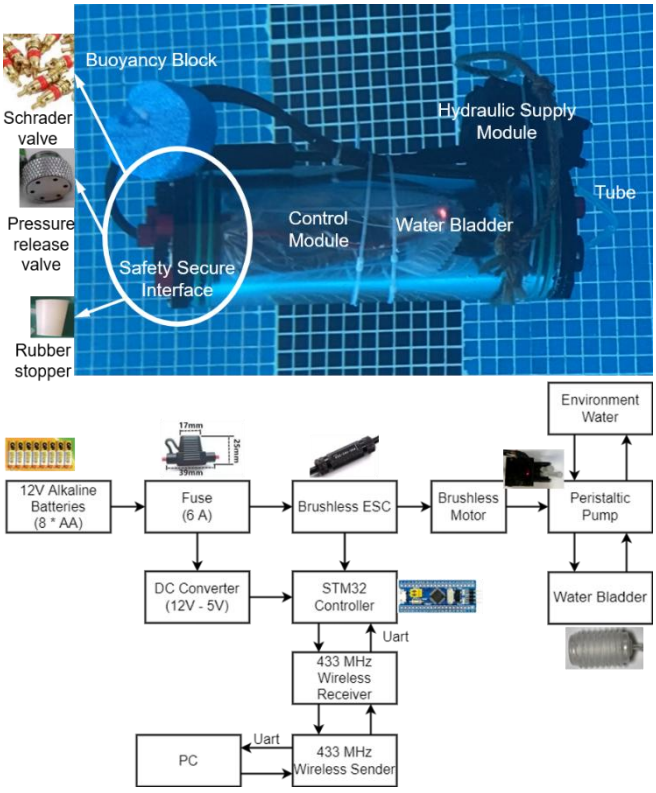

Figure 1. Vertical Profiling Float System Configuration

1.2 Outside the float

The waterproof brush-less ESC and motor with a peristaltic pump head are attached outside the acrylic cylinder for the buoyancy balance and volume optimization of the internal control bin. Through the bulkhead connector, the power and signal wire is connected with the inner electrical loop. By the forward and reverse rotation of the motor, the peristaltic pump could pump into or out of the water bladder which would change the weight balance of the float. By additionally fitting an appropriate buoyancy block, the float should be neutral buoyancy when the water bladder is in the middle of the maximum size. Our company chooses to use a small water bladder to achieve smooth underwater dynamics for a better data collection quality.

1.3 Troubleshooting

The prototype version of the float is operating by a timer that the whole equipment would run the scheduled program as time goes by. By settling desired vertical movement with certain time integration, the float could run automatically after being released by the ROV. After several pool tests, two major problems have been found: the mistake of ROV operation would influence the vertical movement time sequence of the float and the time-dependent strategy could not equally balance the water volume of the water bladder after a certain time of up and down procedure. Water imbalance of the bladder may cause severe water leakage problems as it is allocated inside the electrical cylinder.

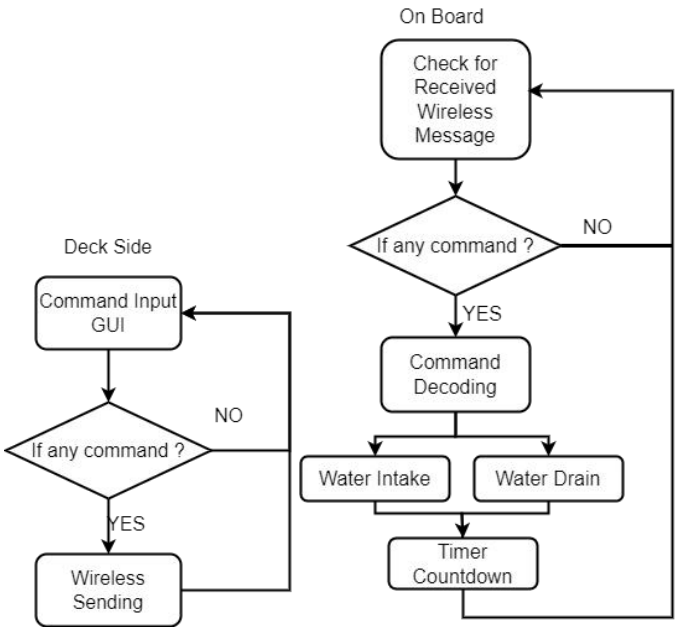

Figure 2. Control Graph

To solve this problem, the motor should be controlled under flexible manual operation to avoid the previous issue caused by the unchangeable time sequence method. Based on that, the 433MHz wireless communication module is selected for two main reasons. First, wireless communication could lightweight both the onboard and the onshore hardware design and deploy easily for most situations without wire stuck issues. Second, 433MHz microwave could work underwater as usual 2.4G would be easily influenced. Our company builds a simple but effective command protocol for the interaction between the float and deck operation station. The revolution of the motor would directly influence the floating and

sinking behavior of the buoy. Based on that, we build the universal command which consists of three parts: the speed of rotation, the direction of rotation, and the running time for the motor. It could effectively describe the needed motor behavior for vertical profiling operation. This communication protocol could be suitable for any other motor-based hydraulic system with only a few moderate modifications for different KV and torque-current characteristics.

Detailed Design Security Information

Without any thruster, cameras and independent sensors, this device does not have a power supply connection from the surface. As figure 1 shown, the onboard batteries are a set of 8 AA alkaline batteries whose total voltage is 12VDC and a 5A fuse is connected after the battery positive terminal within 5 cm. And the battery box is attached to the cylinder by a glued supporting structure.

After retrieving the float from the ocean, the inner pressure of the cylinder may be different from the atmosphere. Larger or smaller air pressure differentials should be considered, as the lumen may burst or suck the end cap too tightly. The O-ring sealed end cap is naturally safe for the bigger inner pressure and it would slide out the cylinder when the force caused by the pressure deviation is bigger than the friction force between the O-ring and acrylic cylinder wall. Besides, Schrader valves are settled at the left side of the cap for connecting the outside environment to the inner chamber when a large pressure deviation is occur. Apart from that, a pressure relief valve is deployed for automatically opening when the inner pressure is bigger than the outside. The pressure differential trigger has been adjusted to 3 psi by changing the innerspring length. For emergency situations, a rubber relief plug with a 25cm diameter is used to rapidly release the air in danger. Although pressure security is deployed, a comprehensive waterproof silicone rubber sealing is applied for all the electrical components for water leakage protection.

The SID is shown in the figure 3.

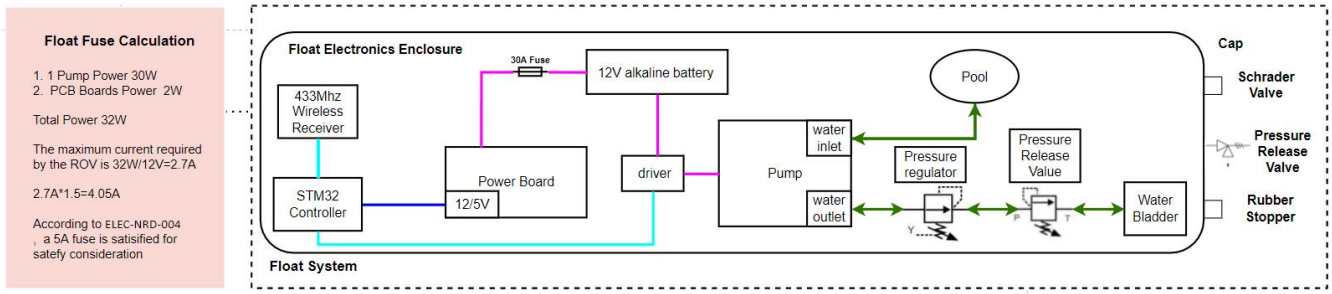

Figure 3. Float SID