Vertical Profiling Float - SOLENOPSIS

Vertical profiling floats are devices used to perform a series of vertical profiles while recording and transmitting data to a ground station. SOLENOPSIS is controlled by a buoyancy engine, which changes the displacement of liquid in order to manipulate the density of the float. The buoyancy engine system consists of a linear actuator, a 300 mL syringe, a custom-made syringe plunger, and a 250 mL IV bag. The 300 mL syringe tip is secured to a 250 mL IV bag. The linear actuator transforms the rotational motion of metal gears to linear motion, which pushes a custom-fit plunger to displace fluid in the syringe and IV bag system, changing the density of the device. Using the movement of fluids to create a density differential, a change in vertical displacement can be achieved.

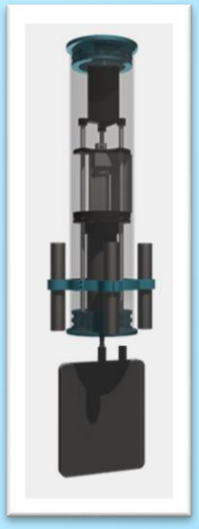

Figure 1. Render of the Float

The buoyancy engine and electrical system are enclosed by a 485.15mm long acrylic tube with a 114.3 mm outer diameter with custom resin-cast endcaps. Three equidistant ⌀8 mm stainless steel rods, each 350 mm in length, are used to form the internal structure of the float. 3D printed static platforms for the syringe flange and linear actuator are set into place using shaft collars. To bring the float to the desired initial density, 25.4mm stainless steel rod segments are secured by 3D printed external clamps as a method of neutral buoyancy control. These materials were chosen for their cost effectiveness, pressure rating, and sizing according to MATE guidelines.

The endcaps of SOLENOPSIS are resin-cast from a negative silicone mold that was created using a FDM 3D printed model. This process was implemented as it allowed us to utilize 3D printing's low-cost ease of manufacturing while ensuring our final endcap was watertight. O-rings were integrated into the endcaps to create a watertight seal in the tube. The lower endcap utilizes epoxy to seal the connection between the endcap and the syringe barrel, and the top endcap is embedded with the BlueRobotics pressure sensor that uses an O-ring to ensure watertightness.

SOLENOPSIS is powered by a 12V NiMH battery pack. The unit utilizes an onboard ESP32 WROOM CP2012 module to control the motor and communicate with the base station through the module's existing Wi-Fi capabilities. The XL4015 buck converter is used to safely downshift the 12V from the battery pack into 5V for powering the ESP32. The ESP32 is also utilized as a second buck converter to downshift the incoming 5V to 3.3V for various components of the float.

The float's ESP32 microcontroller is programmed to control the robot's depth automatically by using a PID loop. After being powered and connected to Wi-Fi, SOLENOPSIS begins its descent. Once the BlueRobotics MS5837 pressure sensor detects a depth of 2.5 meters, the PID loop adjusts the position of the linear actuator to maintain the target depth of

2.5 meters for 45 seconds, with some allowable error. The BlueRobotics pressure sensor records depth and pressure every 5 seconds with a corresponding timestamp, and the data is stored in the ESP32's memory until the robot resurfaces. SOLENOPSIS sends the recorded data using an HTTP POST request to a server for visualization. This process of collecting and sending data does not require any manual control or interaction from a user.

The design of SOLENOPSIS includes numerous safety precautions. A 5-amp ATO type blade fuse was used to comply with safety standards. To meet voltage specifications, the XL4015 buck converter and ESP32 were used to regulate the 12V battery input down to 5V and 3.3V. SOLENOPSIS also runs off a 3.5-amp current which is within the 5-amp guideline. The battery pack is also secured with tape under the electrical housing.

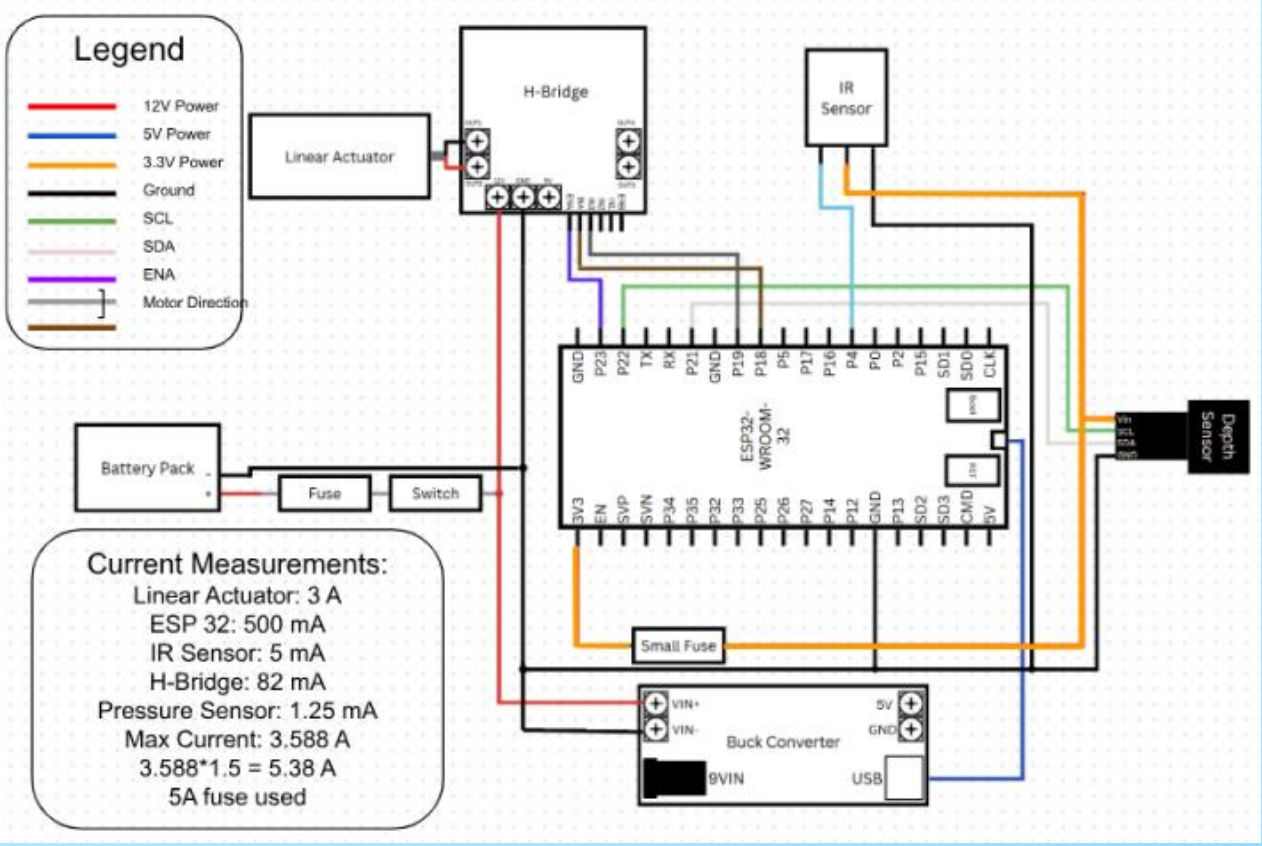

Figure 2. Float SID