

INTRODUCING *PHANTOM*: DESIGN AND SAFETY RATIONALE

FLOAT DESIGN RATIONALE

Our vertical profiling float, *Phantom*, was designed for the depth control and remote data transmission that **Task 4: MATE Floats** requires. It prioritizes simplicity and affordability, with most internals 3D-printed and readily available electronics. The design allows for rapid disassembly, inspection, and repair between runs.

BUOYANCY ENGINE

Phantom's buoyancy engine consists of a linear actuator driving a piston within the float. A 3D-printed endcap seals the bottom of the acrylic tube, fitted with an elastomer membrane for waterproofing. As the actuator extends the piston, the membrane deforms outward. This increases the float's displaced volume and reduces its net density, causing it to ascend, and vice versa. Minimal piston movement is required, as the 2" diameter, 12" long tube selected provides a small yet capable form factor. The actuator motor is driven by a VEX motor controller receiving a PWM signal from an Arduino Nano.

COMMUNICATION

Phantom uses an APC220 RF transceiver module connected to the Arduino Nano for all wireless communication. Upon deployment, the float continuously transmits data packets at half-a-second intervals until contact is established with the shore-side receiver connected to a laptop at the mission station and is on standby until the deployment signal is received. Once the float completes its vertical profiles and is recovered, it wirelessly transmits the full depth-over-time data packets to the surface laptop. Each packet contains the required company number, timestamp, and pressure/depth data. This data is then processed through a MATLAB script, which generates the final depth-versus-time graph for judging. The float also tracks its own velocity by computing the rate of change of depth from sequential pressure sensor readings, enabling autonomous depth control using a bang-bang (on/off) control scheme.

POWER DISTRIBUTION

Phantom is powered by a single 9V battery. This perfectly fits the form factor of our 2" diameter tube that houses *Phantom*'s electronics. A measured FLA of 169 mA dictated the selection of a 200 mA fuse. A 9V-to-6/5V voltage regulator steps down the battery voltage before powering the Arduino Nano and APC220 radio module, as thermal analysis showed that routing 9V through the Arduino's onboard regulator at expected current load would heat it beyond operating temperatures. A 6V output goes to the Nano to provide some headroom for the microprocessor, and a 5V output goes to the transceiver.

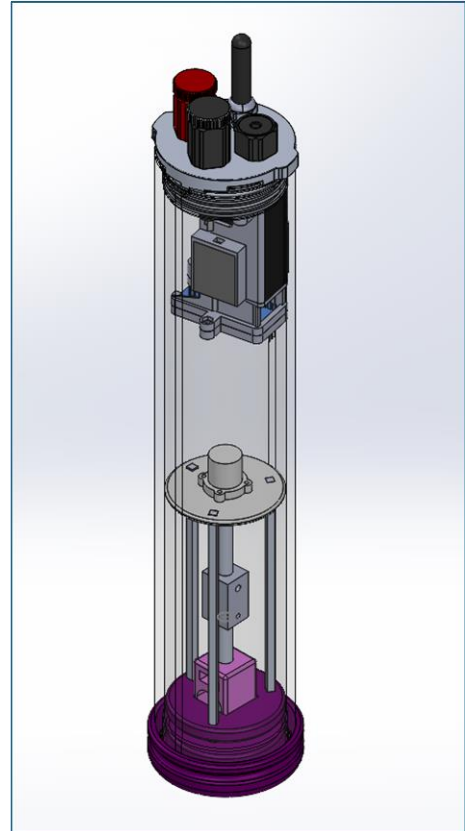


Figure 1: Isometric view of *Phantom*.