**Cedar Bluff, VA, United States**

## Southwest Virginia Community College Robotics Team

# Technical Documentation – *Talon*

**MATE Pioneer Class 2023 World Competition**


*Figure 1: The team with Talon*

**Members:**
Kevin Brooks
Joshua Thiel: President, CEO
Luke Jennelle: Vice President, Safety Officer
Elisabeth Presley: Secretary
Anthony King: Treasurer
Jason Moore

**Mentors:**
Joe Godsey
Charles Bundy
Brian Hale

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# Abstract

*Talon* is the final result of many hours of tireless work and much expended energy and creativity on the part of Southwest Virginia Community College Robotics (SWCCR). Our team is comprised of a mere six members, which made it somewhat difficult to accomplish all that needed to be done in the given timeframe. However, we have risen to the occasion to produce an ROV that we feel confident is more than capable of satisfactorily completing the tasks required for the 2023 MATE ROV World Championship. Designed specifically with said tasks in mind, *Talon* is equipped to address and handle the real-world issues represented and exemplified by this year's competition, such as energy efficiency and conservation and the less-than-ideal living conditions that marine life forms are often forced to endure. It is our hope that ROVs such as *Talon* will achieve their intended goal of reducing and perhaps eventually even eliminating the numerous dilemmas that plague our oceans and lakes.

***Special Features:*** One noteworthy feature of *Talon* is its buoyancy system, which consists of a single ballast tank, made of PVC pipe, mounted to the top of the frame.

***Safety Features:*** Some of *Talon's* safety features are the strain relief for the tether, properly rated fuses within the specified distances, and 3D-printed shrouds for the two Blue Robotics T200 thrusters.

***Dimensions:*** 24'' x 17'' x 18'' in.

# Project Progression by Month

**August 2022** - SWCC Robotics began the design process at the start of the Fall semester by brainstorming various buoyancy options for our new ROV. We researched numerous designs that opposing teams had used in the 2022 competition, taking into consideration how well each design performed and how simple or complex each system was. We also examined some ROVs that were currently on the market to find out which buoyancy designs were being used in the industry.

**September 2022** - Having spent the majority of August thoroughly researching an extensive variety of buoyancy designs, the team decided to pick a handful of the more widely used systems to further investigate during September. Using Fusion 360, we drew up some CAD representations for every buoyancy module chosen and subsequently built a scaled-down replica of each one to test at a later date.

**October 2022** - Having constructed the scaled-down buoyancy modules, the team began to test each one individually in a five-gallon bucket. We added weight to the bottom of each replica and manually manipulated the air flow into and out of it. After testing each module, we briefly recorded some notable pros and cons of each design before ultimately arriving at the decision to use one long ballast tank, mounted on top of the frame, to control the pitch and yaw of the ROV.

**November 2022** - With the buoyancy design decided upon, the team began working on the programming required to control the robot. We decided to implement both Arduino and Python in the code this year rather than just Arduino, which required a bit of extra time, research and effort. The team also decided on using a PlayStation 3 controller for the ROV's various subsystems, and designated members to work on either the Python portion of the code or the Arduino portion, based on individual preference.

**December 2022** - SWCC Robotics began prototyping our ROV's frame design in December. Although we briefly considered using extruded aluminum and various other materials for the frame, we ultimately decided to use PVC pipe again, designing and 3D-printing mounts and accessories as needed, which was our procedure for the year prior. Once the composition materials were decided upon, we began conceptualizing numerous frame designs of varying shapes and sizes.

**January 2023** - With the commencement of the 2023 Spring semester in January, our team began working on the design for a GO-BGC float with the assistance of a robotics class offered at the college. The class was in charge of designing and constructing the float in addition to devising a clever yet inexpensive way to build a buoyancy engine. There were several SWCC Robotics team members who were taking the robotics class in order to oversee the design and ensure that the GO-BGC float would be able to successfully complete the required tasks.

**February 2023** - During February, the team began designing *Talon*'s gripper system. After further researching numerous methods of gripper operation which we had initially observed during the 2022 competition, we made the decision to use a pneumatic-powered setup and subsequently began drafting various gripper models in Fusion 360.

**March 2023** - In March, SWCC Robotics began testing the ROV prototype as a unified assembly rather than as individual components. Minor modifications were made to various modules in order to be able to seamlessly integrate all of the various subsystems together. After some initial testing, the

team decided to use only one pneumatic gripper instead of two, and the correlating changes were made to the code.

**April 2023** - Most of April was spent further developing all that the team had already designed and constructed, such as the frame and the ballast tank. The frame was downsized by about twenty-five percent in order to maximize maneuverability and reduce drag, and the mount angle of the ballast tank relative to the frame was adjusted for increased lift capabilities. Changes and improvements were also made to the existing code, to better accommodate the semi-final iteration of *Talon*.

**May 2023** - Once May arrived, SWCC Robotics began practicing the specific tasks required for the qualifying video, using props constructed by team members. After the qualifying video had been successfully completed and submitted, the safety video was filmed and the team started working on the various segments of necessary technical documentation. Some additional tasks that were completed during this month are painting the ROV and finishing construction on the GO-BGC float.

## Company Organization

### *Project Management*

The Southwest Virginia Community College Robotics team is divided into three subcategories: mechanical, electrical, and software. Members were assigned to a division based on respective skills and personal preference. We needed at least two people allocated to each department, which was possible even with only six members total. Because SWCCR competed in the 2022 MATE ROV World Championship the previous year, all of our returning team members had a bit of prior experience. We did manage to recruit a couple of new members, who were subsequently introduced to the rules and regulations unique to MATE competitions and given a bit of a crash course in Arduino programming. Once we felt that all members were on the same relative page, we formulated a structured schedule for the 2022 - 2023 season, in order to ensure that our ROV, as well as any additional implements, would be successfully completed in time for the qualifying videos. The schedule (provided below) imparts a comprehensive view of what tasks were accomplished, and at what point in the season.

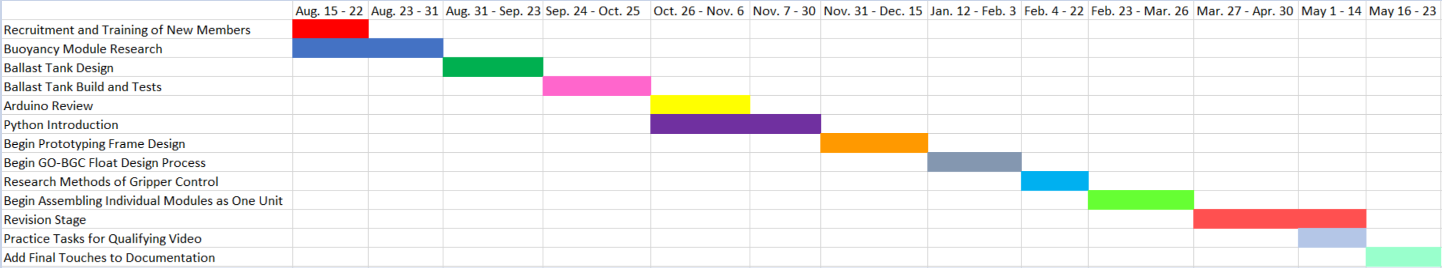



*Figure 2: Gantt chart schedule for 2022 - 2023 season*

## Company Description

The assigned roles and responsibilities of each member of our company are listed below.

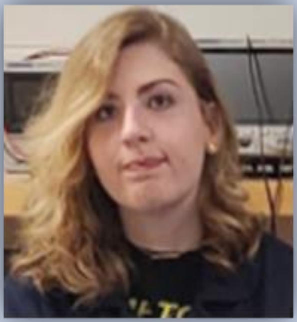
***Joshua Thiel*** - CEO, Pilot, and Head of Mechanical Engineering Department

Josh designed *Talon*'s frame structure as well as the vast majority of the GO-BGC float. He also worked extensively on the ballast tank and pneumatic gripper system.

***Luke Jennelle*** – Software Engineer

Luke worked primarily on the Python portion of the code used for *Talon*'s controls. He also wrote the code for the GO-BGC float.

***Elisabeth Presley*** - Co-Pilot and Head of Software Engineering



Elisabeth worked predominantly on the Arduino segment of the code used for *Talon*'s controls. She also oversaw the writing and compiling of the technical documentation.

***Anthony King*** – Head of Electrical Engineering Department

Anthony helped to assemble the ROV's 48-volt power supply as well as the control board. He also took care of any additional soldering that needed to be done.

***Kevin Brooks*** - Mechanical Engineer

Kevin constructed and maintained all of the props needed for the qualification video and pool practices. He was also responsible for painting *Talon*'s frame.

***Jason Moore*** - Electrical Engineer

Jason worked on assembling and managing the tether. He also aided in the design and construction of the GO-BGC profiling float.

## Design Rationale - Evolution of *Talon*

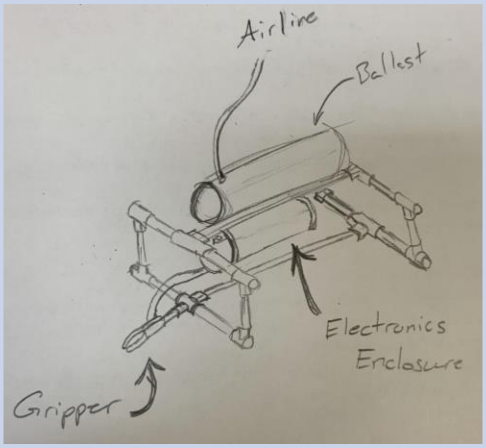



*Figure 3: Preliminary sketch of Talon*

SWCCR began the frame prototyping process in December of 2022. The preliminary design was sketched onto a piece of paper and brought to life by assembling ¾ inch PVC pipe and tees. The testing stage began immediately after assembly was completed. The electronics enclosure was mounted directly beneath the ballast tank along with the thrusters, which were attached to the enclosure via a custom designed, 3D-printed mount.

*Figure 4: Talon's initial frame build*

After initial tests, our team found that the robot was excessively large and did not have the desired control for maneuvering in the water, leading us to drastically downsize the frame. Upon testing our second, smaller design, we discovered that the ballast tank was too long, and that air was becoming trapped on the end opposite the inlet/outlet tube, resulting in an inability to either raise or lower the ROV. The proposed remedy was to shorten the ballast tank by about fifty percent and elevate the end that had the inlet/outlet tube so that air would be centralized on that side of the robot.

Figure 5: Final iteration of Talon

Once these changes had been implemented, we began a new set of tests. This time the frame proved to be somewhat fragile and was unable to support the rather large electronics enclosure. Our team consequently ended up redesigning the entire frame in order to increase the structural integrity of the ROV while simultaneously reducing its weight. After testing this new iteration and improving it through a handful of minor adjustments, we settled on the final frame design for *Talon*. The finished product is shown in Figure 5.

# Design Rationale - Mechanical

## Frame

Figure 6: Talon's completed frame build

*Talon*'s frame is constructed from ¾ PVC pipe and supplemented by several 3D-printed PLA mounts. We chose to use PVC because it is lightweight, compact, durable, readily available, and affordable. An additional feature of PVC is that it is modular, which allows the robot to be easily modified by various generic fittings that can be purchased from any local hardware store. This feature also permits the robot to be quickly and easily repaired if it sustains any damage during a task.

PLA mounts: 3D printing seemed the optimal method of obtaining the mounts necessary for attaching certain components to the ROV, as it allowed the team to design and customize the parts directly. Four mounts were designed using Fusion 360: one to secure the motors to the ROV at a 180-degree angle, one to attach the ballast tank to the top of the robot, and a third to affix the waterproof electronics enclosure to the frame. The fourth was needed to hold the EagleRay control board, as well as a relay used for pneumatic gripper control, securely in place within the enclosure.

## Buoyancy

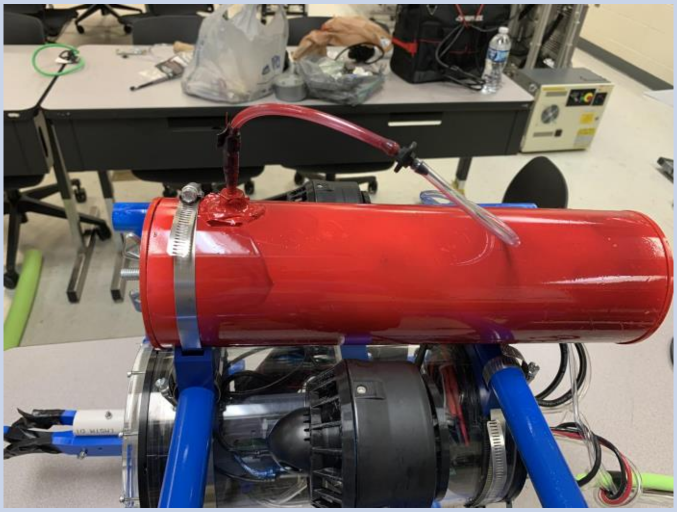


Figure 7: Talon's ballast tank mounted atop the frame

*Talon* utilizes one ballast tank of four-inch diameter thin-walled PVC pipe approximately 14.5 inches (36.83cm) in length, mounted to the top of the robot. This size ballast tank fits perfectly inside the footprint of the robot without causing any vision obstructions or maneuverability impairments. The ballast tank is secured at an angle such that the front is higher than the back; this allows for greater buoyancy at the front end of the robot, where the gripper is attached, and thereby aids in the lifting of heavy objects. There are two holes drilled into the bottom of the tank that permit it to be flooded, so that the ROV can quickly descend. A hole in the top of the tank connects to an airline which connects to two separate air pumps that drive air in and out of the tank, which allows for *Talon*'s buoyancy to be controlled quickly and easily.

## Thrusters

Figure 8: One of Talon's T200 thrusters, mounted parallel to the frame

The team mounted two Blue Robotics T200 thrusters on the ROV at a 180-degree angle (measured relative to the frame and one another) to obtain maximum horizontal propulsion. Although four motors were provided with the EagleRay kit, we decided to use only two in order to minimize the ROV's weight; additionally, because we had designed our ballast system to control all vertical movement, the other two motors were unnecessary. The motors are enclosed by PLA thruster shrouds acquired from Thingiverse [1] and are powered by electronic speed controllers (ESCs) that receive a PWM signal generated from an Arduino Mega mounted inside the electronics enclosure. A PlayStation 3 controller, which is used to send a Bluetooth signal to the Arduino, varies the speed and direction of the T200s. The motors are used for horizontal movement only; any vertical change in position is accomplished using the ballast tank.

# Design Rationale - Electrical

## Tether

SWCCR elected to use the tether that was provided with the EagleRay kit purchased from MATE, due to the fact that it was pre-equipped with many of the desired features. The tether is designed for neutral buoyancy and arrived with a 10 gauge ethernet cable already incorporated. One feature added by the team is three air lines, two of which are pressure rated to 145 PSI. Of these two, one is used to supply the pressurized air required to operate the pneumatic gripper, and the other is used to vent said gripper. The purpose of the third airline is to provide air to the ballast tank, varying the buoyancy of the ROV.

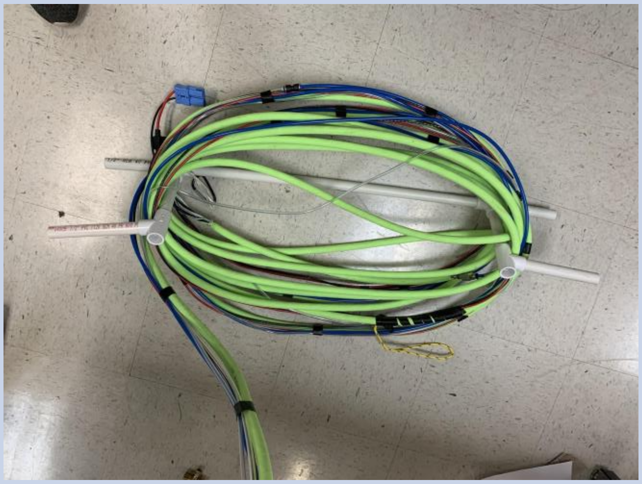


*Figure 9: Talon's tether wound around a custom spool*

Tether management protocol: The team constructed a custom-made PVC spool (pictured above in Figure 9) around which to wrap the tether so that it could be safely transported from location to location without the risk of damaging any wires or tripping anyone. This tool has been extremely useful in keeping the tether from becoming tangled, so that it is always in an organized and easily accessible state.

## Power

For the 2023 season, the team opted to upgrade from a 12-volt power supply to a 48-volt power supply. We received a 48-volt power supply as a kit from MATE ROV and assembled it in our school's mechatronics lab. We decided to use the 48-volt power supply due to the fact that it provided more power for our ROV, which we need for some of the components that we implemented in our design, such as the T200 thrusters from Blue Robotics. The 48-volt power supply also allows for greater efficiency than a 12-volt supply would in this situation, as the 48-volt supply allows us to achieve the same results with less amperage.

*Figure 10: Talon's 48-volt power supply*

# Design Rationale - Software

## *Programming*

Last year, because the team was just starting out and very few members had any experience with writing code, we kept the programming process as simple as possible, using Arduino as our only coding platform. We wanted to be a bit more sophisticated with our programming for the 2023 season, however, while simultaneously making the code more readable and easily configurable for future improvements. The three major components of our programming were the control section, the central/data processing section, and the ROV's programmable components, such as the T200 thrusters and pneumatic gripper. For the control section, the team opted to use a PlayStation 3 controller to operate the thrusters and gripper system, due to the fact that there are pre-existing PS3 libraries available within Arduino, and because the PS3 controller can easily connect to an ESP-32 microcontroller board using the built-in 2.4 GHz Wi-Fi feature. We assigned specific buttons on the controller, as well as the analog joysticks, to operate the T200 motors and the pneumatic gripper, using enumeration as an identifier. A library built specifically for connecting the PS3 controller to the ESP-32 board was implemented and modified for our benefit. For the central/data processing section, we used the PySerial library to communicate between the control section ESP-32 microcontroller and the various programmable components controlled by the Arduino Mega. The Python script processes the information and sends the desired command through to the Arduino Mega which controlled the robot's components. Such an example would be: if we move the analog stick vertically, then the y-value and its enumeration identifier value is sent from the ESP-32 to the Python script, which then reads the enumeration value, determines that we would like to move the motors, and checks for analog values. The Python script then sends its own identifying number to the Arduino relaying the speed and direction in which to move the motors.


*Figure 11: PlayStation 3 Controller*

## *Control System*

This year, SWCCR decided to keep our control system as simple as possible. In addition to the PS3 controller and ESP-32 board, which interact as described in the programming section above, we have a laptop that is used to pass code down to the Arduino as well as to display the video feed received from the USB cameras mounted onboard the ROV. The overall setup time for our system can be completed in less than three minutes and completely disassembled in under a minute.

# Design Rationale - Payload and Additional Tools

## *Gripper*

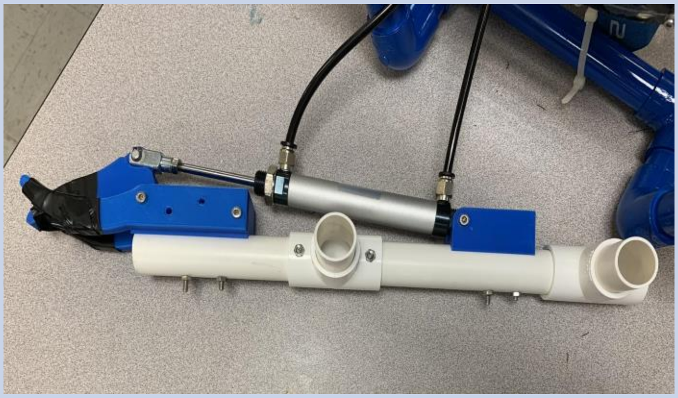


*Figure 12: Talon's pneumatic gripper system*

*Talon* is equipped with a pneumatic gripper system which consists of a single unit capable of opening up to two inches (5.08 cm). The team made the decision to use a pneumatic-powered setup following an unsatisfactory experience with inoperable waterlogged servos during both the 2022 season and the beginning of the 2023 season. Our gripper design was modeled using Fusion 360 and 3D-printed with an infill density of 15 percent, which kept print time to a minimum while simultaneously conserving material and ensuring adequate durability for the finished print. The system operates using a solenoid (contained in the electronics enclosure) connected to two separate air lines which attach to a piston. One of the two lines is used to supply air rated at 40 PSI to the gripper, while the other is used to divert pressure from the first. The purpose of the solenoid is to reverse pressure from one line to the other; this causes whichever line is not under pressure to be vented, which in turn precipitates movement of the piston, opening or closing the gripper. Although the team initially planned on having two grippers rather than one, after reviewing the video and documentation of the 2023 competition tasks, we determined that a second gripper was unnecessary for the accomplishment of our goals.

## *Cameras*

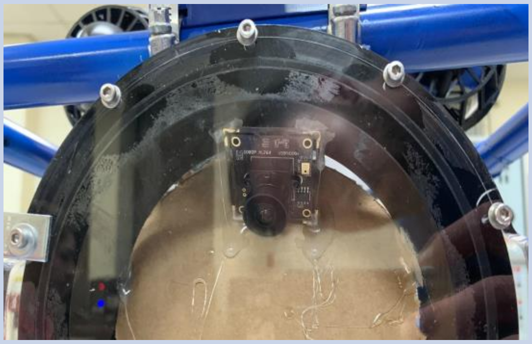


*Figure 13: One of Talon's two USB cameras*

*Talon* is equipped with two USB cameras which each possess a lens with a 110-degree field of vision. One camera is placed facing forwards at a slight downward incline in order to simultaneously provide a view of the gripper as well as any obstructions in the proximity. The second camera is mounted at a downward angle in order to display objects directly below the robot and aid in maneuvering the robot through areas that extend beyond the forward-facing camera's field of vision. In order to fulfill the mission requirements, the team felt that only two cameras were necessary, as this number provided a vision range adequate for completion of all tasks. Both cameras are encased within the electronics enclosure so that they can be safely immersed in the water. The video feed from the cameras is supplied via a USB cable and USB extender receiver, which is connected to the Arduino Mega mounted inside the watertight enclosure. The video feed is then transported from the USB receiver via an ethernet cable to a USB extender transmitter located on the surface, which relays the video feed to a laptop using another USB cable. The team made the decision to use USB cameras mainly due to the fact that we already had a USB extender, making this type of camera the easiest to implement.

### *GO-BGC Float*

The SWCCR GO-BGC float is constructed from four-inch PVC pipe roughly two and a half feet (76.2 cm) in length with one four-inch PVC test plug cap on each end. Inside the float is a 500ml syringe with a plunger attached to a ¼ x 20 all-thread rod. Threaded onto the all-thread rod is a nut with a 3D printed gear around it; the nut will be captured between two plates which prevent it from moving, thus forcing the plunger to move up and down in reference to the nut. The gear around the nut is meshed with the gear on the 360-degree servo, which results in a 3:1 gear reduction, giving the float more than enough torque to fill and empty the syringe of water. The gear reduction also reduces the workload of the servo, which in turn lowers the current draw and keeps the servo at a lower operating temperature; this consequently increases the efficiency of the servo. To prevent the plunger from traveling too far and binding up the servo, the team decided to place magnets around the outside perimeter of the plunger and a reed switch on each end of the syringe. When fully extended or retracted, the magnets on the plunger would trip the reed switch, causing the ESP-32 to stop all movement of the servo so that the servo would not put itself into a bind and potentially be damaged. The servo is controlled by an ESP-32 with Bluetooth and Wi-Fi capabilities. While the float is on the surface of the water, the user is able to connect via Bluetooth to the ESP-32 and control the descent of the float, as well as receive the current time from the on-board real time clock (RTC). In order to power the float, our team used two AAA batteries for the ESP-32 and four AA batteries for the servo. Both power supplies are fused separately based off of their individual current draw, and have their grounds tied together.

*Figure 14: CAD rendering of GO-BGC float*

*Figure 15: Constructed GO-BGC float*

*Figure 16: GO-BGC float encased in tube*

## Pre-launch Testing Methods

### *Mechanical*

In order to ensure that all of the mechanical components of *Talon* are functioning properly before launch, the team powers up all systems, hook up the pneumatics, and turn on the PS3 controller. We then search for any signs of visible damage by physically looking the robot over, making sure that all components are attached properly, listening for the sound of an airline leak, and checking to see that the inside of the electronics enclosure is dry. If everything is as it should be, we attempt to test each sub-system individually using the controller. If a sub-system is found to not be functioning as intended, we will narrow down the list of potential issues and troubleshoot the best that we can with the given tools.

There are many features that SWCCR incorporated into our ROV to ease the testing process. All of the components are modular and can therefore be individually removed from the robot, meaning that at no point in time does the entire robot have to be deconstructed to remove them. One such example would be the pneumatic gripper; one can simply disconnect the airlines via the in-line connectors and subsequently dislodge the gripper from the frame. This allows the team to isolate the gripper and hook it up to a manual solenoid to test individually. The ability to remove components and test one-by-one if necessary is extremely beneficial, saving much time and effort.

## Electrical

There are multiple cues that the team looks for prior to each deployment that suggest that *Talon*'s electrical systems are functioning as intended. One indication that the motors are ready for launch, i.e., receiving power as well as the appropriate code commands, is given by a sequence of beeps emitted by the ESCs when powering up. In the past, there have been occasions when only one ESC issued this noise, and the team consequently inferred that the other thruster was not receiving power and *Talon* was therefore not ready for launch. We also check the laptop executing our code to ensure that it is receiving a signal from the ESP-32, verifying that the PS3 controller is connected.

## Software

In order to identify and diagnose issues with our code, SWCCR always employs the "trace it back" method. In the event that a program doesn't execute due to multiple "errors" that should not pose any issue, our software engineers systematically comment out blocks of code, beginning with the first portion of the code flagged for containing an error, and run the program after each exclusion to determine whether the issue has been resolved. This method allows us to locate and eliminate mistakes in our code with relative ease.

In the event that our program is running but not fulfilling its intended purpose in controlling some component, our software engineers collaborate with members from our electrical department, who check all wiring connections and take measurements with meters or oscilloscopes to rule out any potential issues internal to the component itself.

## Ballast System

Before deploying *Talon,* we test for any punctures or abrasion to the airline that could possibly leak, in addition to checking each connector to ensure that nothing has worked its way loose. The copilot will begin pumping air into the ballast tank while another team member inspects for air leaks in the line or around the barb leading to the tank. After these steps, we will place the ROV in the water, fill the ballast tank with water, and begin to pump air into it. If there are no air bubbles coming to the surface, then there are no leaks in the ballast system. If any air bubbles are observed, we will be able to pinpoint the location of the leak by continuing to pump air into the tank and thereby revealing the spot from which the bubbles are originating.

# Challenges Faced

### *Mechanical*

- The team struggled immensely to sufficiently waterproof the servos initially used for gripper movement, causing us to eventually switch to pneumatics.

- The initial size of our ballast tank caused *Talon*'s overall buoyancy to be overwhelmingly positive and we had a bit of difficulty determining the size needed to obtain neutral buoyancy.

### *Electrical*

- The team initially intended to use a twelve-volt relay for the pneumatic gripper system, but due to the fact that the Arduino logic signal is only capable of outputting five volts, we ended up having to purchase and use five-volt relays instead.

### *Software*

- The team had some initial difficulty enacting communication between Arduino and Python, as we had never attempted this before. After reviewing much example code, however, we were eventually able to successfully implement this feature. We ended up using enumerators for many of our various code segments, as they allow for a more organized, readable, and compact code structure, thereby making the troubleshooting process much more manageable.

# Lessons Learned

- Team bonding is an integral part of every team; without good chemistry between team members there is a drastic decrease in overall efficiency.

- An organized schedule with a specific amount of time allotted for each stage of the design process is an indispensable tool to have, as it allows the team to have some idea as to their amount of progress or lack thereof for the duration of the season.

- “Waterproof” servos are NOT necessarily waterproof. SWCCR’s original iteration of *Talon*’s gripper system operated using servos, but after many waterlogged servos and consequently

non-functional grippers, we decided to employ a pneumatic-powered design instead, which turned out to be far more reliable.

# Future Improvements

- Increase the ROV’s maneuverability by further downsizing the frame
- Design the gripper mechanism with the ability to rotate
- Use a more compact electronics enclosure to reduce positive buoyancy
- Create and implement an electronically controlled ballast system

# Safety

## *Overview*

In an engineering environment, it is of the utmost importance to uphold and enforce strict safety regulations. SWCCR was provided with all safety equipment necessary and maintained that safety equipment for regular use. Each team member was taught methods of maintaining a safe environment as well as ways to prevent any accidents from transpiring. In the event that an accident did occur, team members were made aware of the appropriate actions to take in order to deescalate the situation. Furthermore, we ensured that the team’s JSA (Job Safety Analysis) was scrupulously adhered to any time that *Talon* was deployed.

## *Lab Protocol*

SWCCR made sure to use the appropriate eyewear and gloves in any situation for which these items were needed or recommended. Appropriate lab safety protocols were enforced; for instance, team members were made to always wear close-toed shoes and were not allowed to have liquids in close proximity to any of the lab equipment. Amenities such as an eyewash station, fire extinguisher, and first aid kit were also housed within the lab where the team worked. Additionally, all systems both on board and separate from the ROV were closely inspected before power was supplied to them.

### *ROV Safety Features*

There were many safety features incorporated in *Talon*'s design. One such feature was the guards placed on the T200 thrusters. Another is that the air pressure used for operation of the pneumatic gripper system was regulated to constantly be at or below a rating of 40 PSI. A third feature incorporated is that the gripper is not capable of exerting enough pressure to injure a person's hand or fingers in the event of an accident. Finally, we also added strain relief to our tether to ensure that there would not be excess tension placed on any wires.


## Acknowledgements

SWCCR is first and foremost deeply grateful to our team mentors, who have consistently supported, inspired and encouraged us in all of our efforts and endeavors thus far; without them, many of us would most likely have never discovered our passion for engineering or robotics. Secondly, we would like to thank Southwest Virginia Community College for the financial support provided, without which we would have been unable to travel to the competition site. We would also like to acknowledge the towns of Lebanon, Virginia and Richlands, Virginia, who have allowed us to use their pools for numerous practice sessions. Finally, we would like to thank MATE II (Marine Advanced Technology Education) for organizing the 2023 World Championship; in doing so, they have provided us with a truly outstanding opportunity to explore underwater robotics in an environment that challenges and encourages us each step of the way.


## References


[1] Awarny. "Reinforced Blue Robotics Thruster Mount", Thingiverse, https://www.thingiverse.com/thing:1497003 (accessed March 21, 2023).

# Appendix

## *Appendix A: Safety Checklist*

SOUTHWEST VIRGINIA COMMUNITY COLLEGE ROBOTICS CHECKSHEET

___ Safety Equipment On

___ All Equipment Is Counted For

Inspection of ROV:

- ___ Motors
- ___ Arms
- ___ Cameras
- ___ No Leaks

___ Control system

___ Check Tether

___ PS3 Controller/ESP-32 connection

___ Connect Computer

___ Connect Power Supply

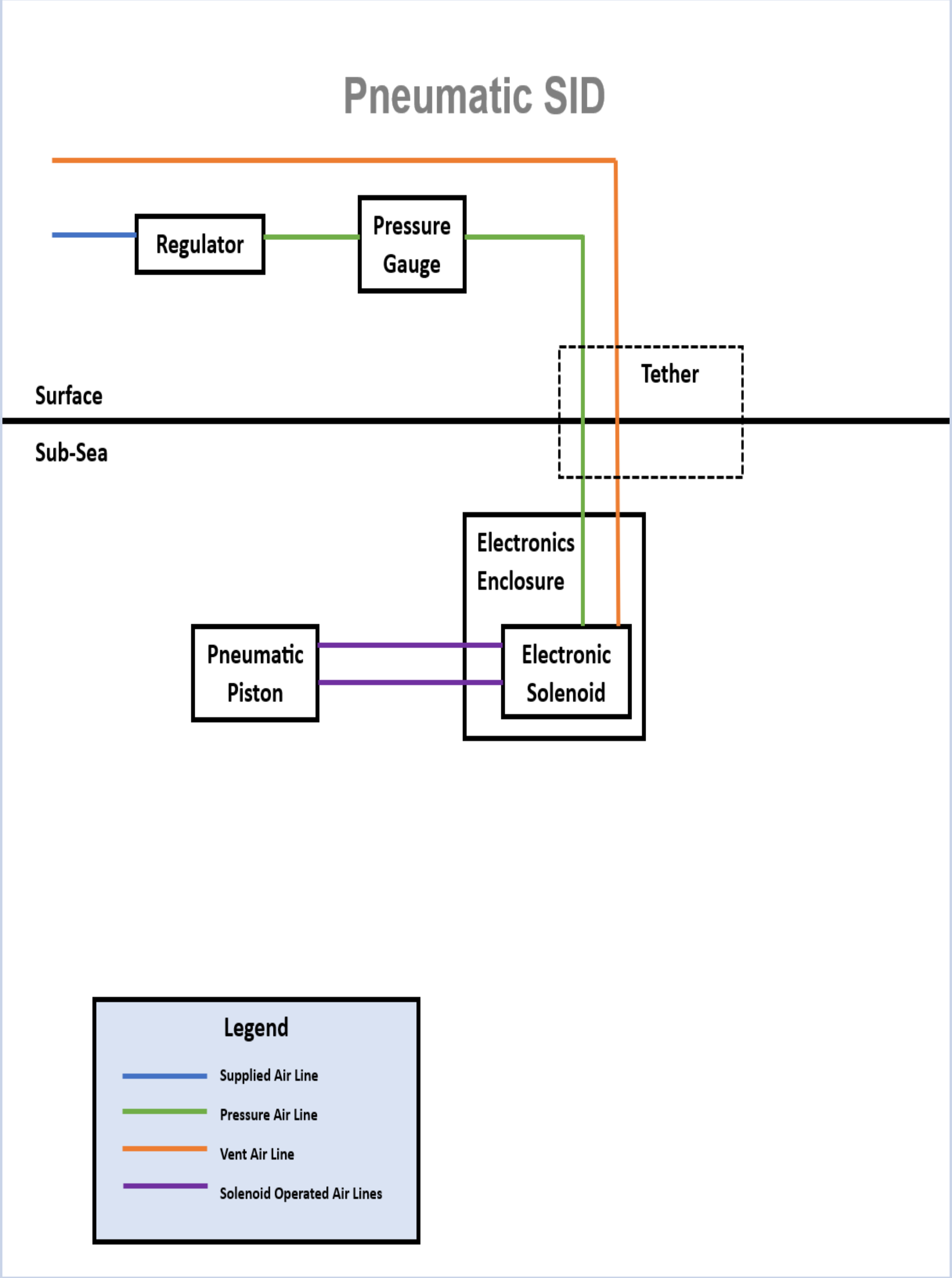
___ Pneumatic system

Test Functionality:

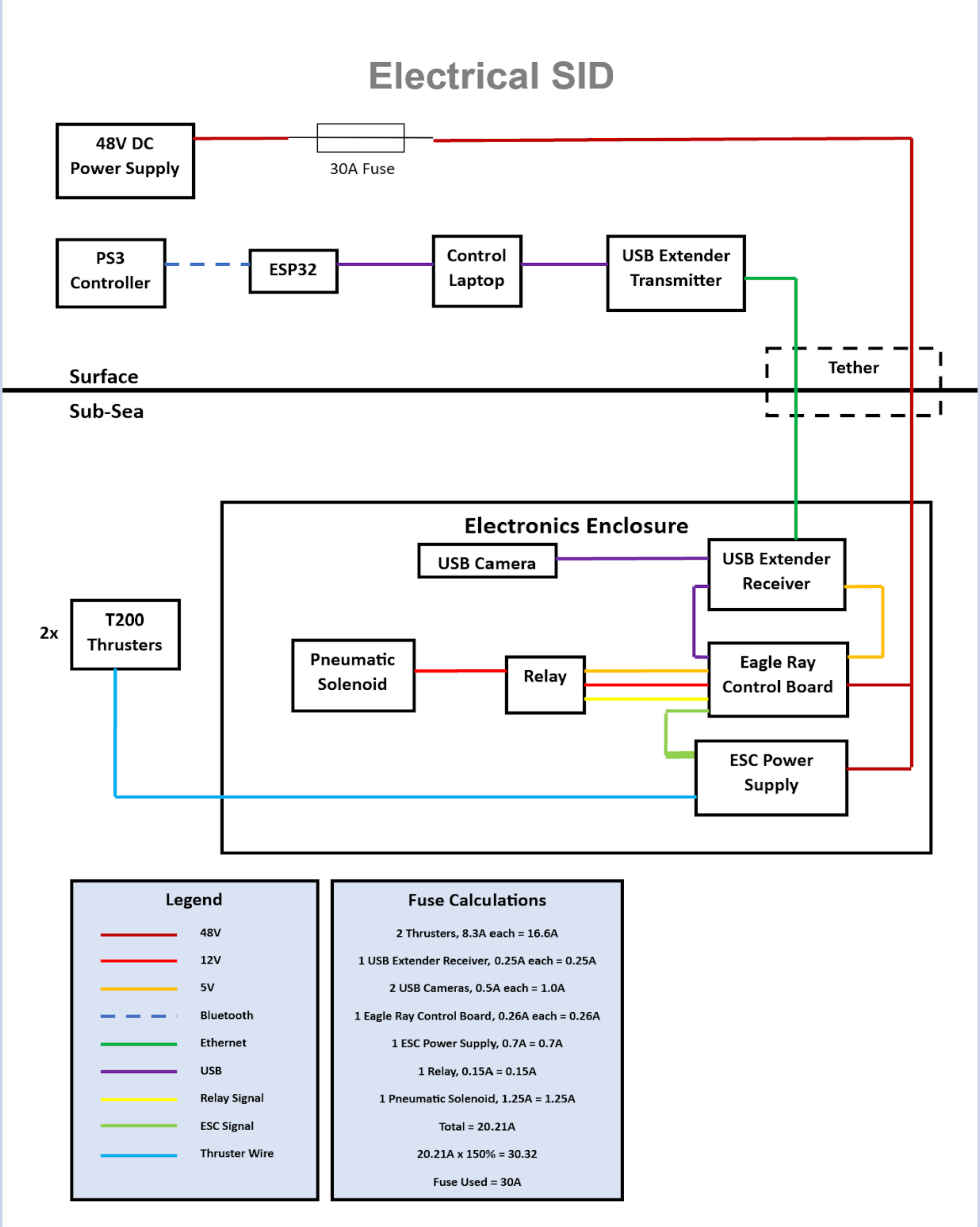
- ___ Motors
- ___ Arm
- ___ Cameras

____ Time: 5 minutes to setup, 15 minutes of ROV operation, 5 minutes to cleanup

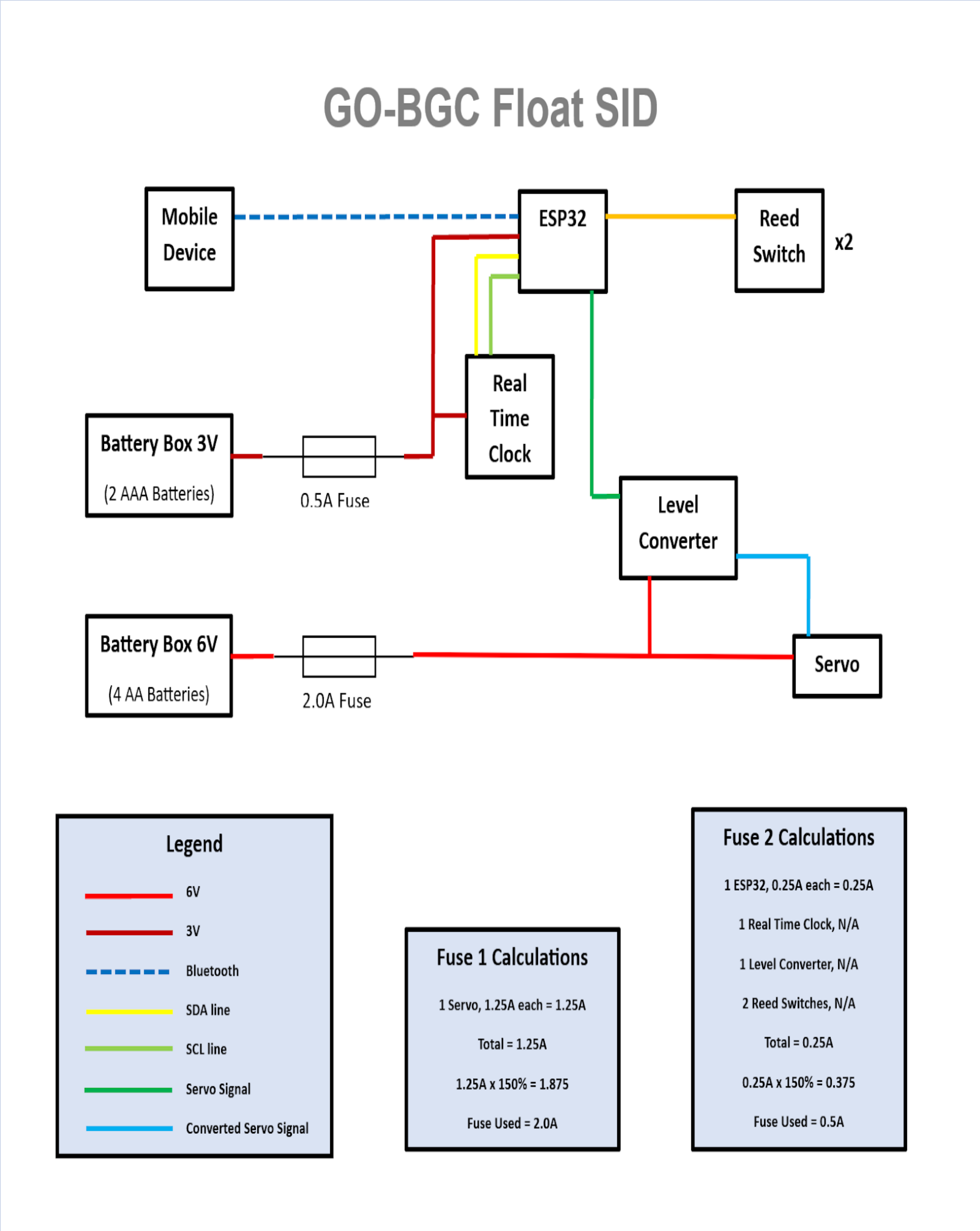
## *Appendix B: Pneumatic SID*



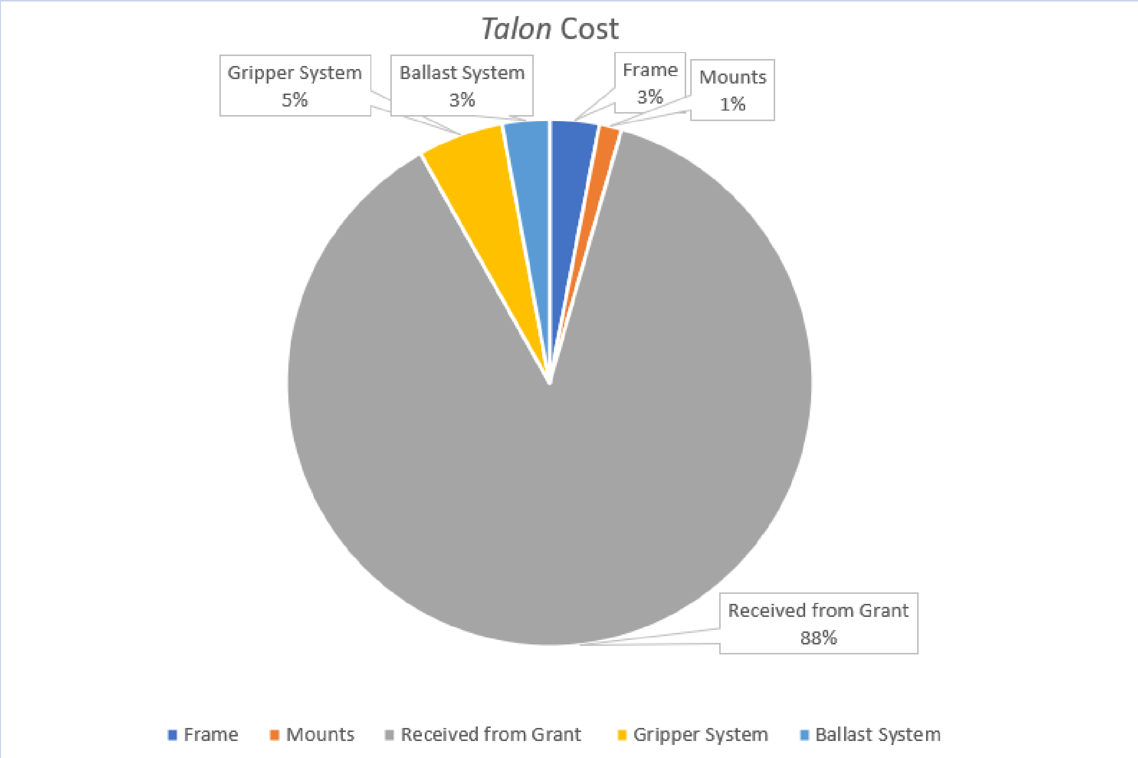
## Appendix C: Electrical SID



## *Appendix D: GO-BGC SID*



# *Appendix E: Budgeting and ROV Cost*




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | **Reporting Period:** | |
| **School Name** | Southwest Virginia Community College | | | | | **From:** | 8/15/2023 |
| **Instructor/Sponsor:** | | Joe Godsey | | | | **To:** | 5/24/2023 |
| **Funds** | | | | | | | |
| **Date** | **Type** | **Category** | **Expense** | **Description** | **Sources/Notes** | **Amount** | **Running Balance** |
| 2/8/2023 | Purchased | Hardware | PVC | PVC pipe, Tees, Elbows | Frame | $36.95 | $36.95 |
| 2/19/2023 | Purchased | Hardware | Stainless Fasteners | Screws, Hose Clamps | Mounts | $16.68 | $53.63 |
| 3/14/2023 | Parts Donated | Hardware/Electronics | Eagle Ray ROV Kit | Acrylic enclosure, 48V power supply | Received from Grant | $1,062 | $1,115.63 |
| 3/22/2023 | Purchased | Pneumatics | Individual Components | Air line, Solenoid, Connectors, Piston | Gripper System | $63.96 | $1,179.59 |
| 3/30/2023 | Purchased | Bouyancy | Individual Components | Pipe, Air line, Connectors | Ballast System | $35.22 | $1,214.81 |
| 5/20/2023 | Cash Donated | Travel | | Hotel Rooms, Food | Used for World Competition | $8,554 | $9,768.81 |
| 5/20/2023 | Cash Donated | Travel | | Hotel Rooms, Food | Donated by MATE ROV | ($4,250.00) | $5,518.81 |
| 5/20/2023 | Cash Donated | General | | Funds donated by college | Used for General ROV Construction | ($500.00) | $5,018.81 |
| | | | | | | | |
| | | | | | | **Total Raised** | ($500.00) |
| | | | | | | **Total Spent** | $9,768.81 |
| | | | | | | **Final Balance** | $5,018.81 |