The
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Exceptional Products For The World of R/C Submarines
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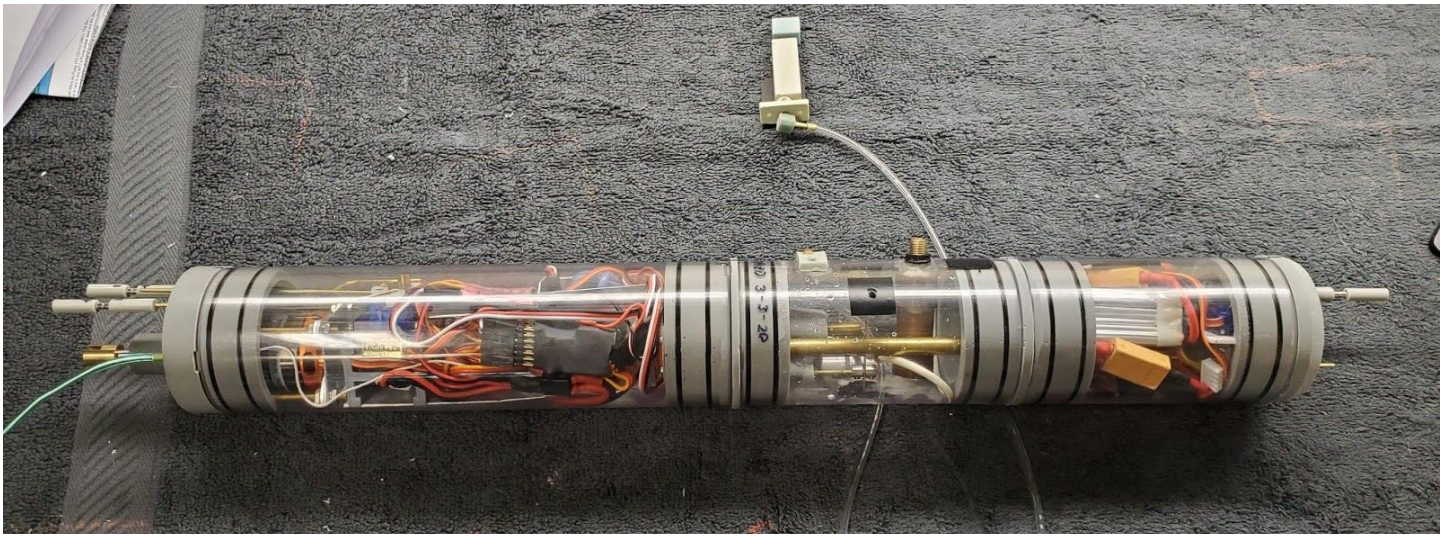


Modular SubDriver Assembly Instructions

Introduction:

Congratulations on your purchase of the MSD (Modular SubDriver) unit from the Nautilus Drydocks.

This product was developed with the invaluable aid of David Merriman III, whose contributions to the hobby cannot be overstated. His experience with design and production made this (and many other Nautilus Drydocks products) possible.

These cylinders are intended for use in “wet-hulled” submarine models where the majority of the internal hull free-floods. All of the command, control and power functions of the boat are housed in a single, removable assembly that can also be transferred between boats, provided they are of similar ballast and drivetrain requirements. This is a different methodology than the more traditional “dry-hulled” submarines where the majority of the internal volume is sectioned off and the internal components housed in a large watertight compartment.

The MSD is an evolution of the original SubDriver design. Rather than a single length of uniform diameter tubing, three sections are now used, which allows for different diameters of the three sections that make up the SubDriver. These units also feature improved access to the various compartments, simplified ballast plumbing, brushless motor power, and upgraded bulkheads.

Setup of your SubDriver is a straightforward affair. The following instructions are provided as a guide for this process, but please bear in mind that there are dozens of ways to configure internal components and electronics. If you feel that there is a better way to attack the cylinder configuration, by all means, give it a try and if it works out well, be sure to let me know!.

As always, feel free to reach out at any time with questions.

Best regards,

Bob Martin
The RCSubGuy
Owner - the Nautilus Drydocks, LLC
sales@nautilusdrydocks.com

What you should have in the box:

All SubDrivers should come with the following components:

- ❏ Main SubDriver Unit:
  - ❏ Motor bulkhead: Either single or dual motor, with external gearbox that produces two counter-rotating output shafts or without, depending on what you've ordered. This bulkhead has the motors, motor shaft seal(s) and pushrod seals pre-installed and tested, and the equipment tray connected.
  - ❏ Motor compartment cylinder - polycarbonate tubing
  - ❏ Motor compartment ballast union bulkhead with pre-installed Low Pressure Blower (LPB) with attached and tested Motor Pump Controller (MPC), ballast servo, and servo pushrod watertight seal on the after 'dry side'; a mounting flange for the optional emergency gas backup blow valve, and pass-through nipples for the induction and discharge SAS plumbing on the forward 'wet-side'
  - ❏ Ballast tank cylinder with pre-installed and tested ballast vent linkages, flood-drain holes, vent, hole to accept optional emergency gas backup bottle, and 5/16" o.d. Brass conduit
  - ❏ Power compartment ballast union bulkhead
  - ❏ Power compartment cylinder - polycarbonate tubing
  - ❏ Power compartment forward end cap with integrated servo tray and seals
  - ❏ Two installed servos with pushrods
- ❏ Three, 1/16" diameter brass linkage rods
- ❏ Mounting screws for servo tray
- ❏ Electronic Speed Controller
- ❏ BEC (battery eliminator circuit)
- ❏ Spare 1/16" pushrod seal
- ❏ Three, magnetic Klik-On linkage connectors
- ❏ Power cable, 16-gauge two-conductor zip-cord, 24" long
- ❏ Two servo extension wires for the forward servos
- ❏ Two sets of mini-Deans connectors for equipment tray disconnect
- ❏ One set of standard Deans connectors for battery
- ❏ Mini fuse holder and 15A fuse
- ❏ Heat shrink
- ❏ 5 mini servos (2 of which are pre-installed)
- ❏ 3/32" i.d., 26" long, flexible hose for antenna and leak testing
- ❏ 1/16" i.d., 20" long, flexible induction hose between MSD and snorkel
- ❏ Various extra mechanical fasteners

What you'll need to finish up your cylinder:

- ❏ Radio and radio receiver on appropriate surface frequency (75mhz in North America, 40mhz in Europe - check your local laws regarding allowable frequency ranges). GHz radios do not penetrate water. If you use one, you will need to extend the antenna above the waterline and keep it above the waterline during operation of your submarine. You can view a photo catalog of the GHz conversion methodology here.
- ❏ Optional pitch controller. I recommend our AD2 (Automatic Depth) pitch controller
- ❏ Optional failsafe device. I recommend our BLM (Battery and Link Monitor)
- ❏ Optional Depth Controller. I recommend our DC (Depth Cruiser)
- ❏ Optional waterproof lighting connector
- ❏ Optional switch. Either a standard toggle switch with waterproof boot, our MM10 (Magnetic Mission) switch, or our remote on/off switches
- ❏ 11.1-volt Lithium polymer battery of the highest capacity that will fit within the power compartment
- ❏ Silicon grease, AKA distributor grease (available at car supply stores)
- ❏ RTV silicone adhesive/gasket maker
- ❏ Two-sided tape for mounting electronic components
- ❏ Hand and power tools including side-cutters, a rotary tool, wire strippers, soldering iron, drill and drill bits, flat blade screwdriver (for prying cylinders off unions), needle-nosed pliers

NOTE: The following pages reference photos that show the installation of some optional components such as the emergency gas backup, BLM, AD2, etc. These components have separate installation and setup instructions that are not covered in this document. None of these components are required for operation of the MSD, though they are recommended.

Overview:

The MSD (Modular SubDriver) is a self-contained command and control system, comprising three modules; designed to power, change the displacement of, and control the RC submarine. The system consists of three sections: the propulsion and control compartment, the ballast compartment, and the battery compartment.

The ballast system is based around an air pump, a system that we call SAS (Semi-Aspirated System). To dive, the air is vented from the ballast tank via a vent valve. To surface, an onboard air pump (LPB) is activated, moving air from the dry compartments of the cylinder into the ballast tank, displacing water and causing the model to become more positively buoyant. Once the snorkel valve -- housed within the r/c submarines sail -- broaches the surface, it opens, breaking the slight vacuum created during the initial blow by equalizing air pressure within the MSD and continuing the blow cycle until the ballast tank is blown dry, placing the model r/c submarine at the designed surface waterline.

A few things to note about this system:

1. Complete blowing of the ballast tank may not be possible until the snorkel intake valve is opened and air pressure equalizes. As air moves from the dry compartments to the ballast tank, a partial vacuum is created, one that will eventually overcome the pump's ability to draw more air. Fortunately, all you need to achieve positive buoyancy is a few ounces of displacement, so this is not an issue in the slightest.

2. Repeated submerged vent/blow cycles are not possible without the snorkel breaching surface and air pressure equalizing. Ensure that after every dive, you surface the model in order to equalize internal air pressure..While possible, it is not recommended to 'hover' the model submarine with this ballast sub-system. Doing so requires repeated adjustments of buoyancy, which can deplete air reserves in the cylinder, resulting in an eventual lack of ability to resurface. This system was designed to either run the model with the ballast tank completely flooded, or completely dry.

3. Do not rotate the MSD upside-down when submerged (likely you would only do this during testing) as this will unseat both the snorkel and safety float-valve, causing water to get into the propulsion-control compartment.

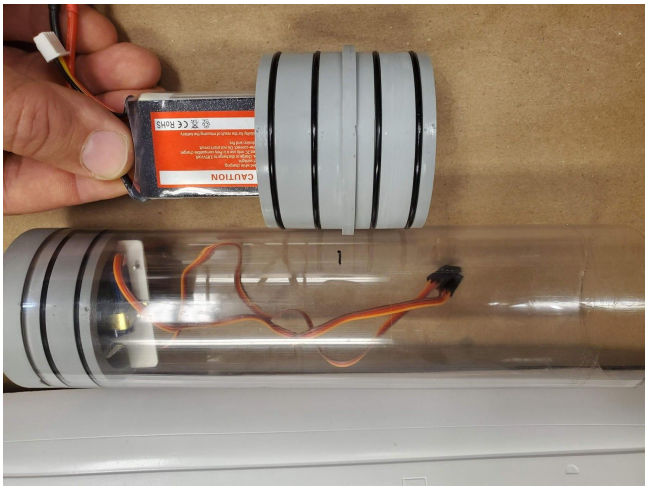
If fitting a snorkel in your model is not possible due to size constraints, an optional *internal equalization valve kit* is available that eliminates the need for the external snorkel (though not the external air intake tube). This option does, however, require the use of an additional RC channel to operate.

Your new MSD comes with standardized module sizes that allow for the highest degree of flexibility in tailoring the unit to your specific boat. In most cases, cutting the polycarbonate tubing will be required for a perfect fit and ideal performance. MSD configurations are displayed as three numbers (motor compartment diameter/ballast tank diameter/battery compartment diameter). IE: A 250/300/250 MSD has a 2.5" diameter motor compartment, a 3" diameter ballast tank, and a 2.5" diameter battery compartment.

As supplied, your cylinder should come with 8.5" long power and motor compartments, and a 12" ballast section.

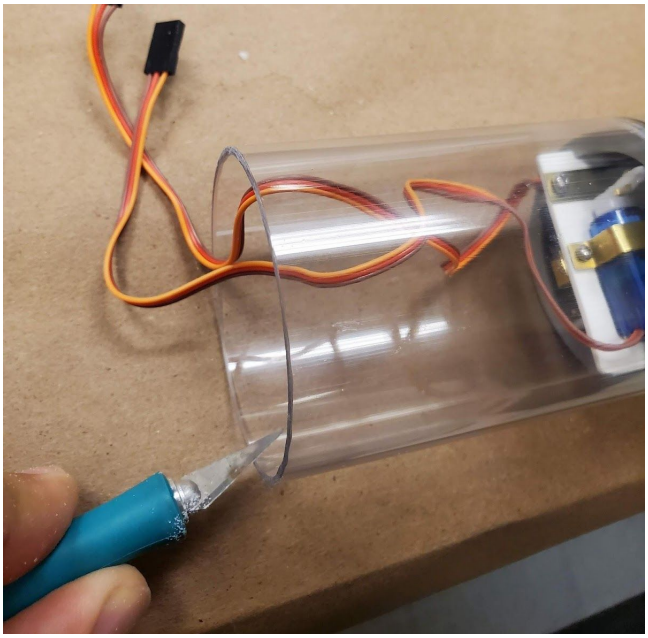
Setting up the SubDriver Cylinder:

Determining battery compartment size:



As your cylinder arrives to you, the battery compartment is a standard 8.5” in length. You can use it at this length if you have the room in your model, or you can easily cut it to an ideal size for your application.

To determine the size of your forward power compartment, remove the forward servo bulkhead and insert your battery, placing the wires facing forward toward the open end. If you have the optional remote on/off switch, ensure that you allow additional room for that component, or that it fits between the battery and cylinder wall. Note where the end of the battery is and then add another ¼” or 10mm to allow for the wires. From this mark, add another 1.4” or 35mm and mark the tube with a permanent marker. This will be your cut line.



Before removing the ballast tank cylinder from the after union, place an ‘indexing’ mark on the raised portion of the union and after-end of the ballast tank Lexan cylinder. This will insure proper reassembly of these two items later.

To cut both the power and ballast compartments, you will ideally utilize a cutoff saw with fine-toothed blade. This will create a perfectly square cut. If a cutoff saw is not available, you can also mark the entire perimeter of the tube by placing the factory-cut end on a perfectly flat surface and building up a rest that will allow you to place your permanent felt pen on it and rotate the cylinder material against the tip, creating a cut line that is perfectly perpendicular to the long axis of the tubing. Cutting the tubing can be accomplished with a fine-toothed hacksaw, a cutoff wheel on a rotary tool, or a razor saw.

Once the cut has been made, run a sharp hobby knife along the inside perimeter of the cut end to create a bevel. This is imperative for easy installation of the bulkheads with the o-ring seals. You can also use a sanding disc in a rotary tool if you prefer that method, though the knife blade works better, in my experience..

Determining ballast compartment size:

Each MSD250 comes with a standard 12" long ballast tank for maximum versatility. The tank and brass tube conduit is easily cut to size using standard hand tools.

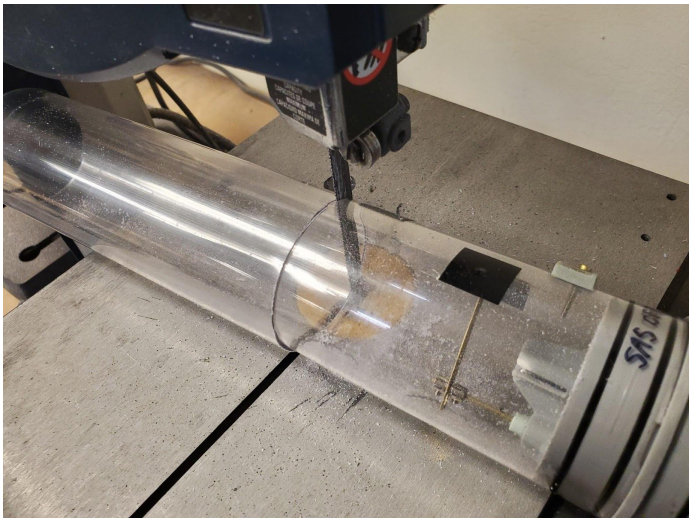
To determine what size of ballast tank you need, you need to determine the weight of your fully assembled submarine model *above the surfaced waterline*. To this weight, add another 10% as a safety factor. Polystyrene (plastic model kit), GRP and cast resin structures have a specific gravity very close to one, so this is an accurate means of determining how much ballast water will be needed to pull those structures underwater.

Each inch of length of the ballast tank will provide a set volume of ballast capacity. Take the target weight that you determined above, and divide it by the appropriate ballast tank volume value below in order to determine your ballast tank size, rounding the length up to the closest half inch..

- 2.5" diameter tanks offer 2.57oz or 72.9g of reserve buoyancy per inch.
    - For example, an 8" long tank of 2.5" diameter will offer 20.6oz (584g) of reserve buoyancy.
- 3" diameter tanks offer 3.76oz or 106g of reserve buoyancy per inch
    - For example, an 8" long tank of 3" diameter will offer 30oz (850g) of reserve buoyancy.
- 3.75" diameter tanks offer 5.97 oz or 169g of reserve buoyancy per inch
    - For example, an 8" long tank of 3.75" diameter will offer 47.8 oz (1355g) of reserve buoyancy.

Example: You have a model that will require a 3" diameter ballast tank. You weigh the upper hull and resin fittings that would be mounted above the surfaced waterline, resulting in 553g of total weight. You guesstimate that 50% of this weight will end up sitting above the surfaced waterline. 553g divided by two is 277g. Adding 10% as a safety factor yields a total displacement of 305g (rounding up). To get the tank length, 305g is divided by the 106g/inch that the 3" tank offers, resulting in a length of 2.88". Rounding up to the nearest half inch nets a 3" (76mm) desired tank length.

The tank itself is cut using the same methodology as the battery compartment.



To determine the length of the wire conduit, use the length of your new ballast tank and add 0.5” (12.7mm). The brass tube can be cut using a pipe-cutter or with a cutoff wheel on a rotary tool. Ensure that you bevel the *outside edge* of the cut end so that it does not damage the o-ring seals embedded within the unions during reinstallation.

Before you re-install the forward ballast union, you need to attach the air induction hose to the port side nipple located on the wet-side of the rear ballast union.

1. Using a hex wrench, remove the forward ballast servo pushrod retaining wheel-collar. This will free the pushrod from the ballast linkage arm, allowing you to completely remove the ballast tank Lexan cylinder from the rear ballast bulkhead, thus making access to the intake nipple far easier. Or, alternatively, you can use a hemostat to make up the hose via the after most flood-drain hole at the bottom of the ballast Lexan cylinder, just pretend you’re playing ‘doctor’.

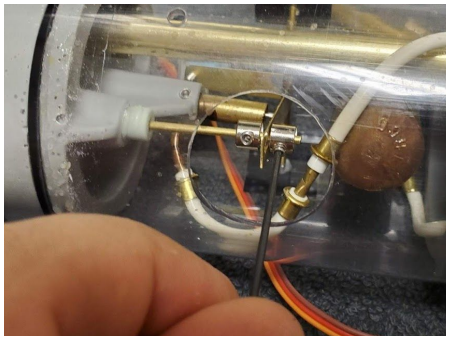
2. Your LPB has two hoses coming from it. One is off-center and one is on center. Your induction hose is the one that is *off-center* on the pump body. Identify the induction nipple, on the dry side of the ballast bulkhead, (it’s the one on the port side).

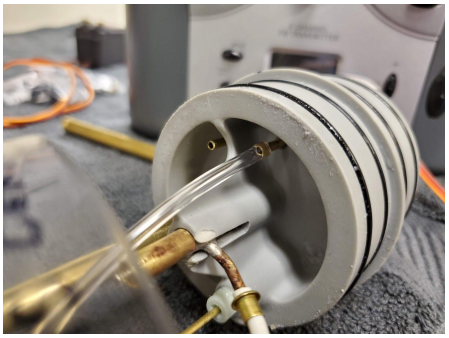
3. Attach the supplied intake hose to the other side of this brass tubing, pressing it on firmly until it overlaps the brass tube by at least ⅛”

4. Ensure that the cylinder and union registration marks line up or the vent valve will not line up with the ballast linkage-arm properly. Run the free end of the induction hose out one of the large ballast intake holes in the bottom of the ballast tank cylinder and re-install the cylinder onto the rear ballast tank bulkhead. Slide the linkage-arm through the servo pushrod and make up the forward retaining wheel-collar. Ensure that there is some degree of room between the wheel-collars with the linkage-arm sandwiched between them -- about 1/16” total should be sufficient.

5. Re-install the forward ballast bulkhead union, ensuring that its conduit hole is aligned with the after ballast union conduit hole. You’ll need to use a small screwdriver inserted through the conduit hole to move the conduit itself until it slips into the hole easily as you press the forward ballast bulkhead into place. An alternative is to wait till the ballast tank is assembled and to then push the conduit through the front end of the ballast tank union until each end of the conduit is held snub by a ballast tank bulkhead union.

6. Connect the snorkel valve to the open end of the tubing by slipping the nipple onto the end of the ballast air intake tube to a distance of at least ⅛”.





Installation of the receiver:

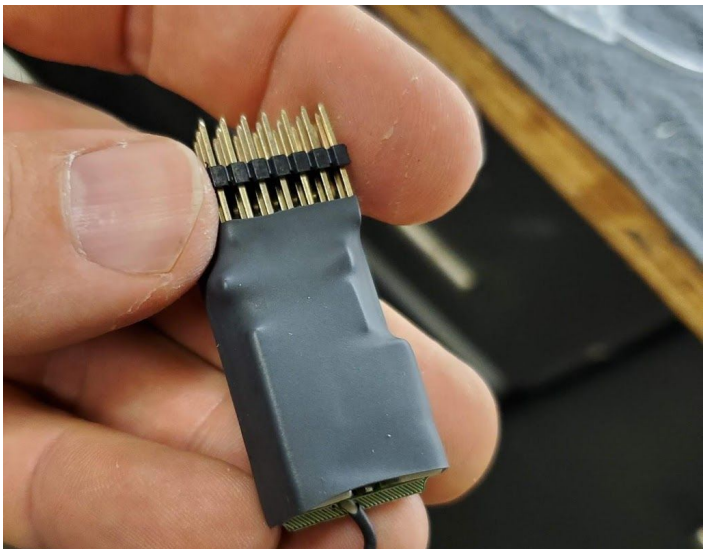
Depending on the brand of radio system that you employ, fitment and/or location of the receiver may need to be altered due to its size. In this example, I refer to the excellent Nautilus Drydocks 6-channel standard PPM receiver designed to pair with our VEX 6-channel radios.

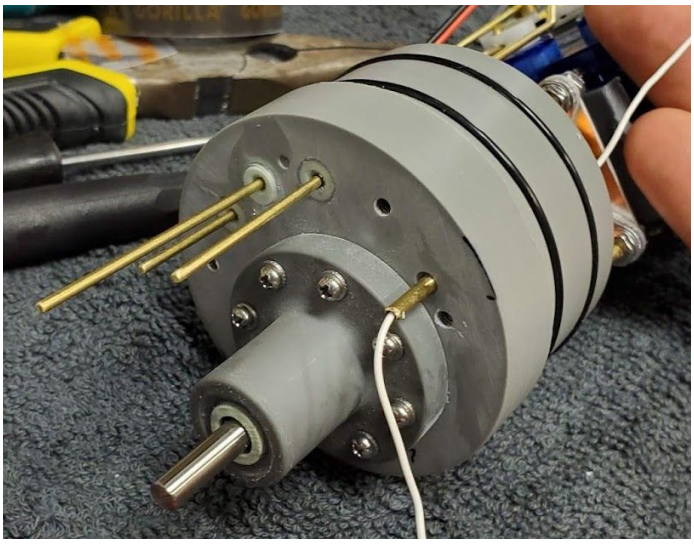
1. Remove the outer casing from the receiver by undoing the four bolts in the lower case.

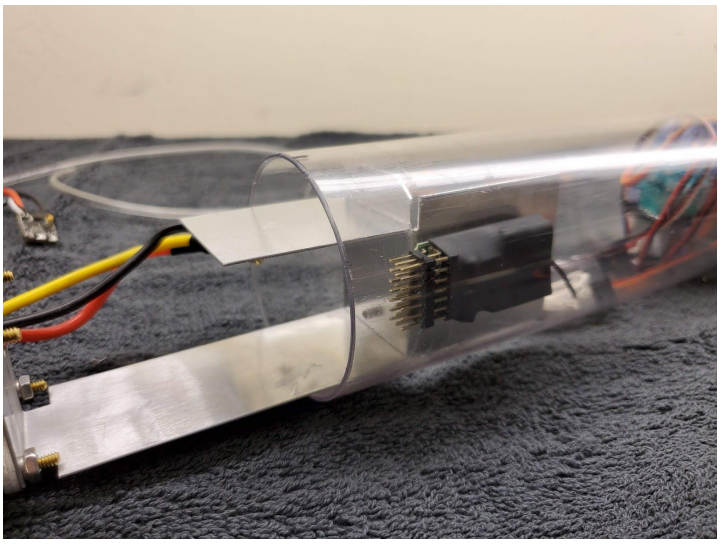
2. For any receiver removed from it's stock case, it is highly recommended that you source and install heat shrink of the applicable size in order to insulate the receiver from shorting out against any metal surfaces.

3. The receiver is mounted on the vertical face of the aluminum equipment tray utilizing two-sided foam tape as illustrated below

4. Run the receiver antenna along the side of the equipment tray and out the brass tube that is embedded in the rear motor bulkhead. Ensure that it is and will remain clear of the motor housing. Use tape or zap straps, if required.







Installation of the ESC (Electronic Speed Controller):

Your kit comes with the superb BLHeli32 ESC for brushless motors. These units come pre-configured for basic operation of your cylinder. If you have the interest and desire, you can download the program that allows user-defined configuration of dozens of different aspects of the ESC. This is not necessary by any means, and I recommend this only if you are experienced in programming and brushless motor terminology and operation.

Here is the link to the user manual for the BLHeli32 ESC. If you'd care to try your hand at the configuration, here is the link to download the configurator program.

1. Your ESC will have three solder tabs on the side opposite the existing wires and receiver input lead. These are the motor leads that need to be attached to your motor.

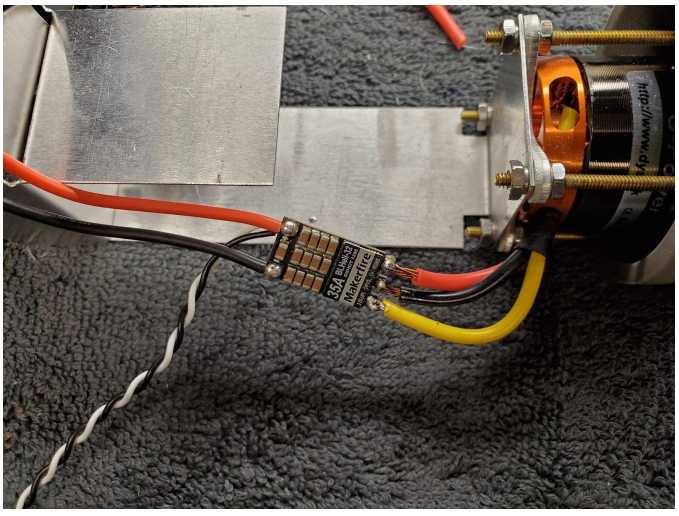
2. The copper wires coming from your motor are coated with a clear lacquer, which will need to be scraped clean with a sharp hobby knife prior to soldering. Strip the wires back approximately ¼" and splay them flat on your workbench. Scrape them clean on both sides using your knife..

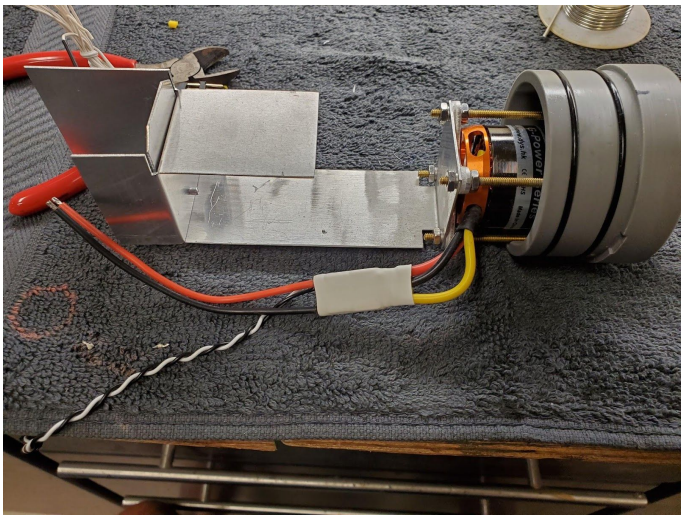
3. The black motor lead goes to the center tab of the ESC. The red and yellow wires do not have a required tab. Reversing them simply reverses the direction of rotation of the motor, something that is easily changed via your transmitter menu after everything is up and running..

4. Once you make the motor connections, test your motor's functionality by connecting the red and black wires of the ESC to your 11.1V main power, the servo lead to your receiver, and a 5V power source to your receiver. Motor control will eventually be via channel 3 (left stick vertical) if you want to use that as your test channel. Be sure to securely hold your motor bulkhead in place, or secure it with clamps prior to testing.

5. Upon power-up, you should hear a series of tones from the ESC indicating power-up and good signal from the receiver. Forward and backward movement of the stick should result in movement of the motor.

6. Once you confirm proper operation of the ESC in both directions, install heat shrink over the ESC. You will not mount the ESC quite yet, so keep it free for now..





Installation of the servos:

The MSD SubDriver can accept up to 5 servos. The two forward servos in the battery compartment come pre-installed and are intended to be used as bow plane, torpedo shutter door, retracting bow planes or any other purpose you can envision. Two of the rear servos are intended for rudder and rear dive plane control. The third rear servo is intended for people with projects that preclude the use of a separate snorkel valve. The third servo is used to actuate a manually controlled equalization valve, the complete system for which is offered separately and comes with it's own instructions. If this is not required, the third servo in the center position does not need to be installed, and not installing it will actually greatly simplify installation of your linkages.

1. The supplied servo bracket is installed just forward of the main drive motor. Transfer the location of the holes in the servo bracket to the aluminum equipment tray and drill them out with a ⅛" drill bit. Install the servo bracket using the supplied screws. (Improved servo bracket supplied in your kit actually have 4 mounting screws versus the two shown in the illustrations at right)

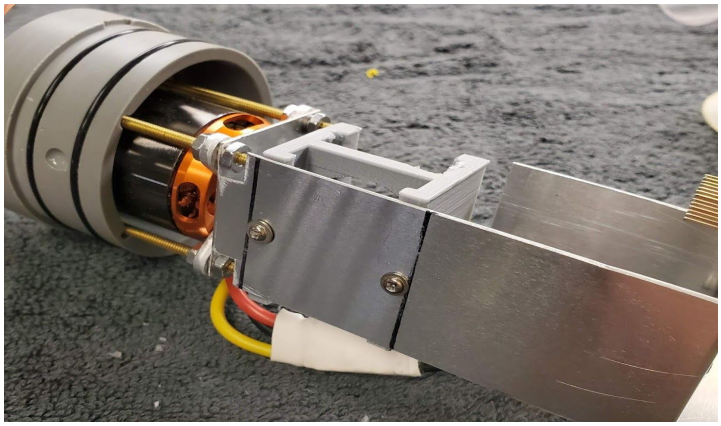
2. Run a 1/16" drill bit through the linkage seals in the rear motor bulkhead and apply some circular movement while running your drill. This 'coning out from center' will open up the servo linkage passage without harming the embedded rubber seal and provide much smoother movement with less chance of binding during operation. Apply silicone grease (often sold as, 'distributor grease) into the bores of the servo seals. Do not use petroleum based lubricants!

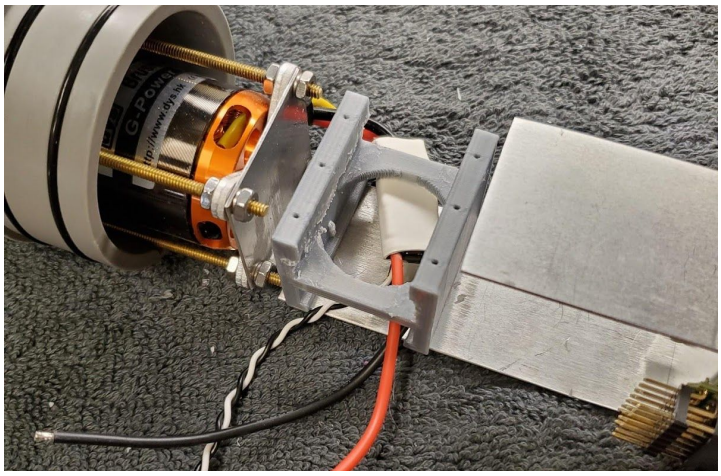
3. Using a 1/16" drill bit, drill out the servo brackets servo mounting holes in the indicated positions.

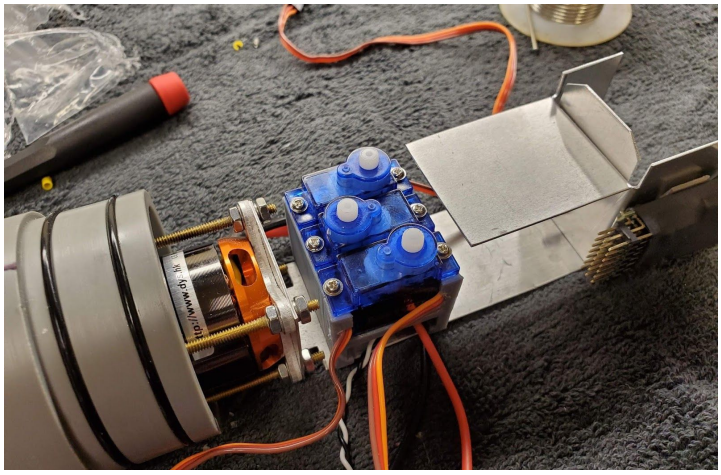
4. Slip the servos into the servo bracket from the side and align the mounting holes. Again, note that the central servo is only required if using the optional equalization valve. Screw the servos down using the included screws.

5. Rub some silicon grease onto the supplied pushrods and run them through the seals from the inside of the motor bulkhead. If no central servo is being used, you will need to run the brass pushrod in the central seal in order to block water from entering through it.

6. Connect your servos to your receiver and power on your transmitter, then your receiver. This will ensure that the servos are all in the centered position during linkage installation.





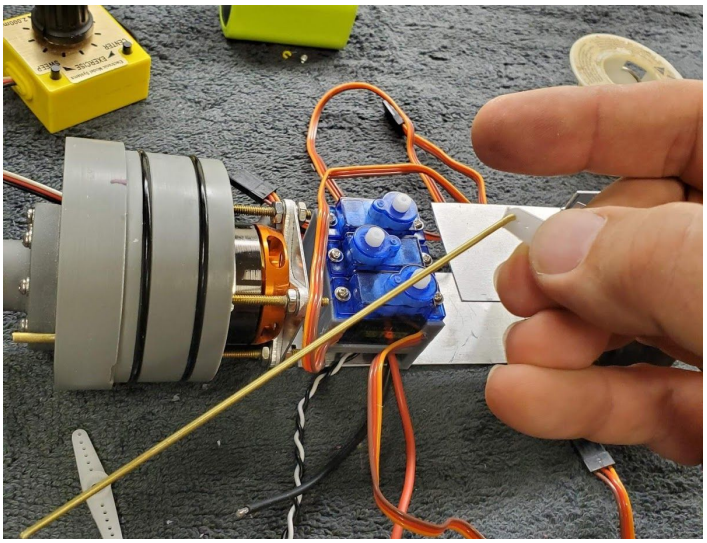


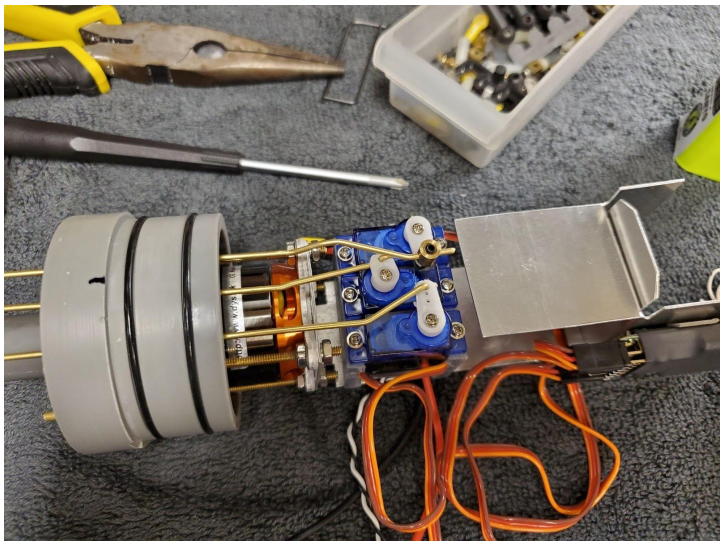
7. Determine the length of the servo bell-crank that you'd like (distance from center of rotation to pushrod attachment point). I find an overall length of approximately ½" (12.7mm) is adequate. You want a long enough bell-crank that you get good travel, but that the two servo bell-crank tips don't hit each other during operation. Trim the bell-crank to the desired length and then drill out the outermost hole of your servo bell-crank with a 1/16" drill bit. Slip the servo bell-crank over the z-bend of the pushrod.

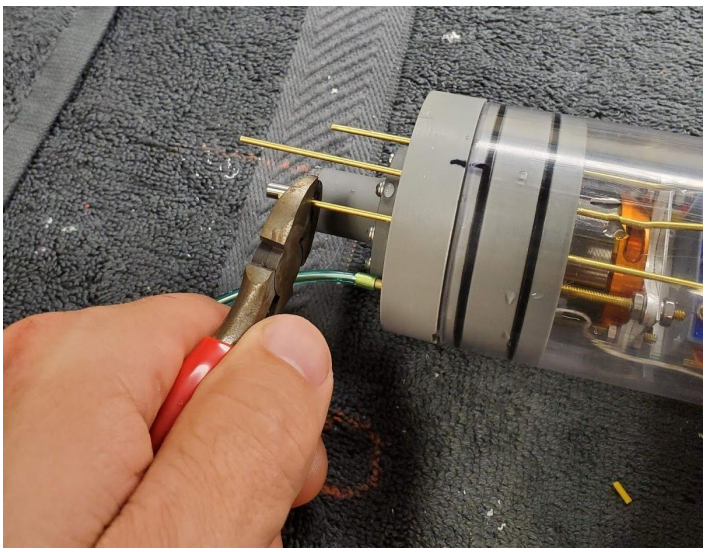
8. Install your servo bell-cranks onto your servos, ensuring that they are mounted so that the tips of the bell-cranks point directly inward, perpendicular to the SubDriver's longitudinal axis. You will note that the pushrods will likely be under tension and not line up well with the pushrod seals in the motor bulkhead. Using needle nosed pliers, bend the rods so that they exit the cylinder perfectly parallel to the cylinder longitudinal axis (check both horizontal and vertical alignment)

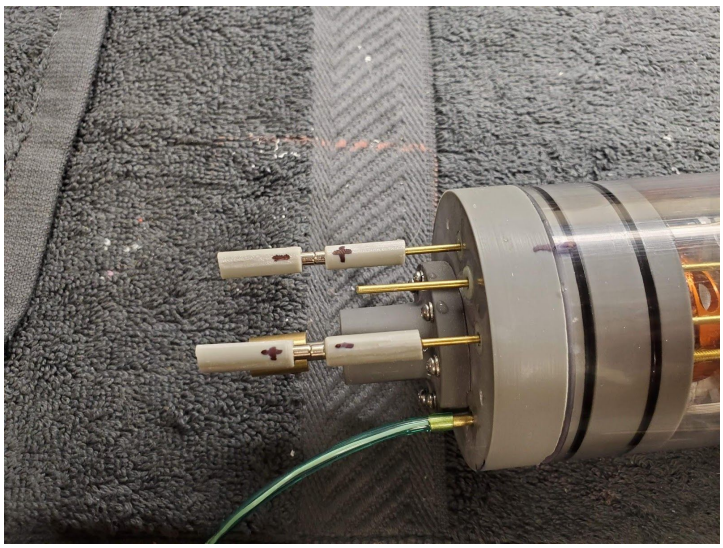
9. Cut the ends of the pushrods approximately 1" from the motor bulkhead's after (wet-side) face. Deburr the snipped off end of the pushrods -- this will prevent cutting of the pushrod seal should the pushrod have to be removed at a later date. Rough up the last ½" of the rod with coarse grit sandpaper. Press-fit one of the magnetic connectors onto the rod and secure with a drop of thin CA glue at the base. As a tip, if you alternate the magnetic connectors, incorrect linkages will actually be repelled during linkage makeup. See the photo below marking magnet polarity.

10. Slip your ESC under the servos in the space provided. There should be no need to secure it as it has very little room to move around once in place.







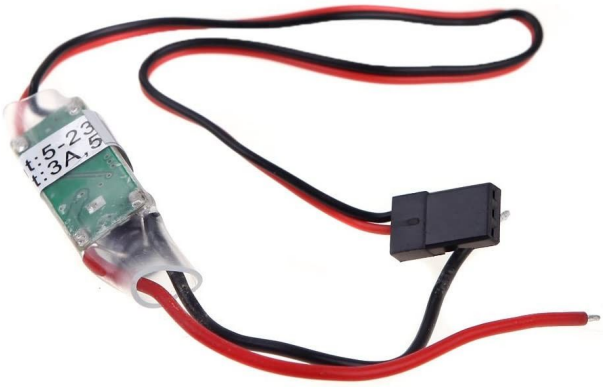


Installation of the Battery Eliminator Circuit:

The MSD uses a separate BEC module to provide 5V power for your receiver. Ensure that your BEC is rated to provide at least 3 Ampere's continuous -- an r/c submarine tends to present an above average load because of all the electronic devices employed. Installation is very straightforward. The unit comes with the receiver input connection already in place. Connect this to your receiver's battery port. Most receivers have a universal power bus internally, so you can actually plug the BEC into any channel port and it will power the receiver.

The BEC can be installed against the forward face of the servo tray using two sided tape.

At this time, we will not yet attach the BEC's power leads. Proceed to the next step.



Installation of the power and servo extensions:

Main power and servo wires need to move from the forward compartment to the rear compartment through the ballast area. The brass conduit is the passage that enables this.

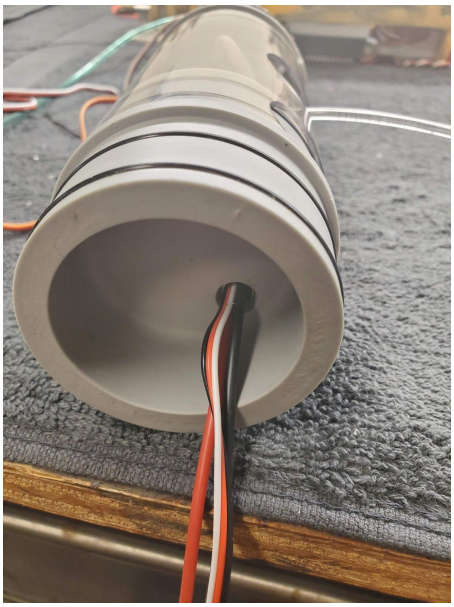
1. You need to cut the male end from the servo extension wire(s) in order for them to fit through the conduit. Cut the servo extension approximately 2 to 3” from the end. This would be a great time to mark the leads if you will be running both so that you can easily identify which lead goes to which servo. I typically scribe onto the plastic connectors for a permanent mark.

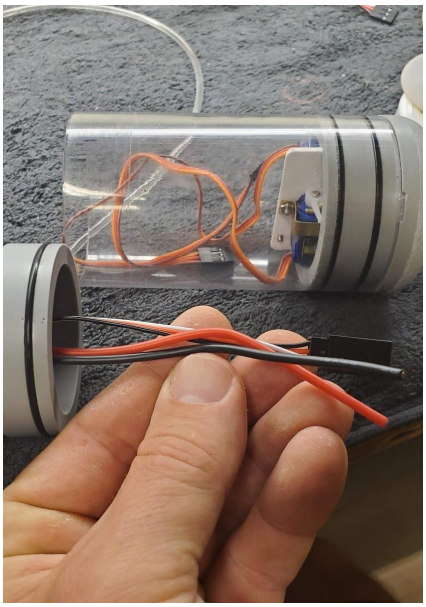
2. Bundle the red, black and extension wire(s) and insert them into the wire conduit starting from the battery compartment side. You will need to wiggle and massage them through the passage until they emerge from the other side. Note that this is a tight fit, and running both servo extensions, while possible, is tricky.

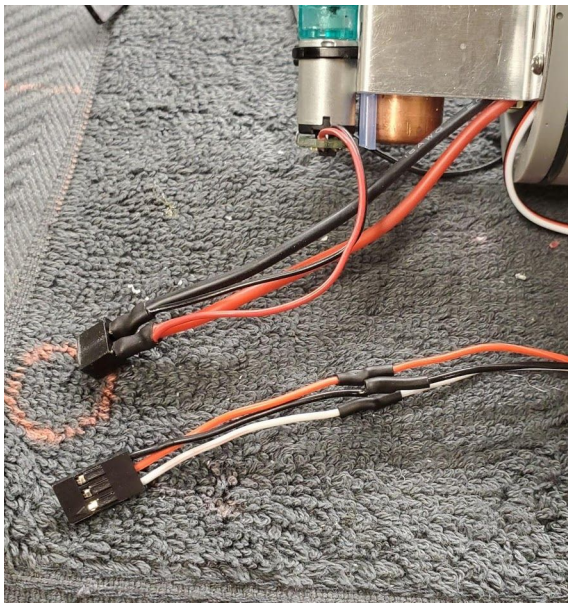
3. Pull the wires through the conduit until the ends remaining in the battery compartment are of the same length as the battery compartment cylinder length.

4. On the motor compartment side, trim the red and black wires to approximately 4” in length from the end of the ballast bulkhead. Connect the red and black wires from the Mini Pump Controller (MPC) mounted on the rear of the air pump to these power leads and to them solder on a FEMALE mini-Deans connector.

5. Cut the servo wire extension(s) so that the overall length, including the end that you cut off earlier, results in an overall length of 9” from the end of the ballast bulkhead. Re-join the male servo connections to the wire(s). This length may seem excessive, but it is necessary in order to connect them to the receiver once the motor compartment cylinder is in place.



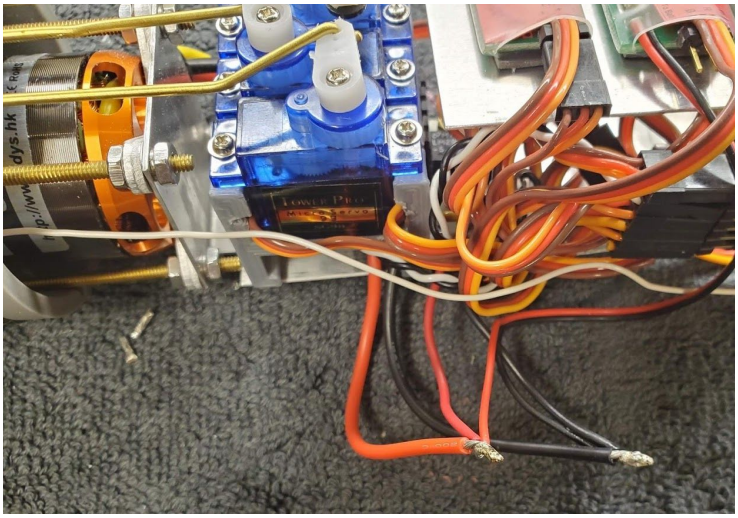


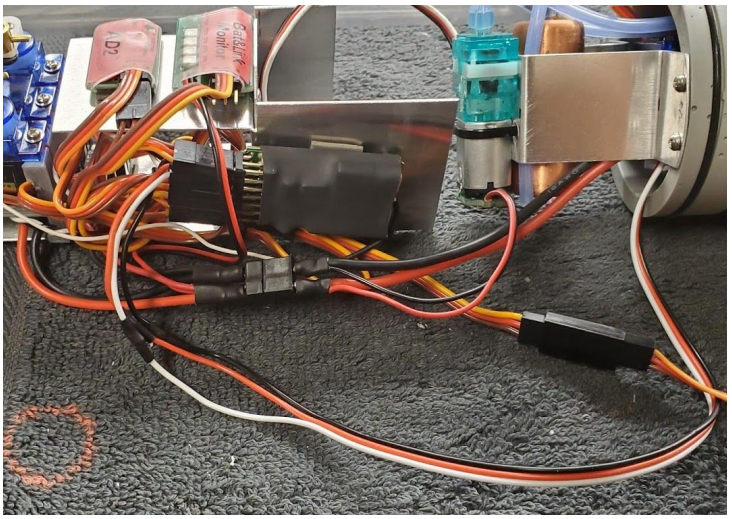


On the motor compartment tray, there are potentially three sets of power leads that need to be spliced together. These are:

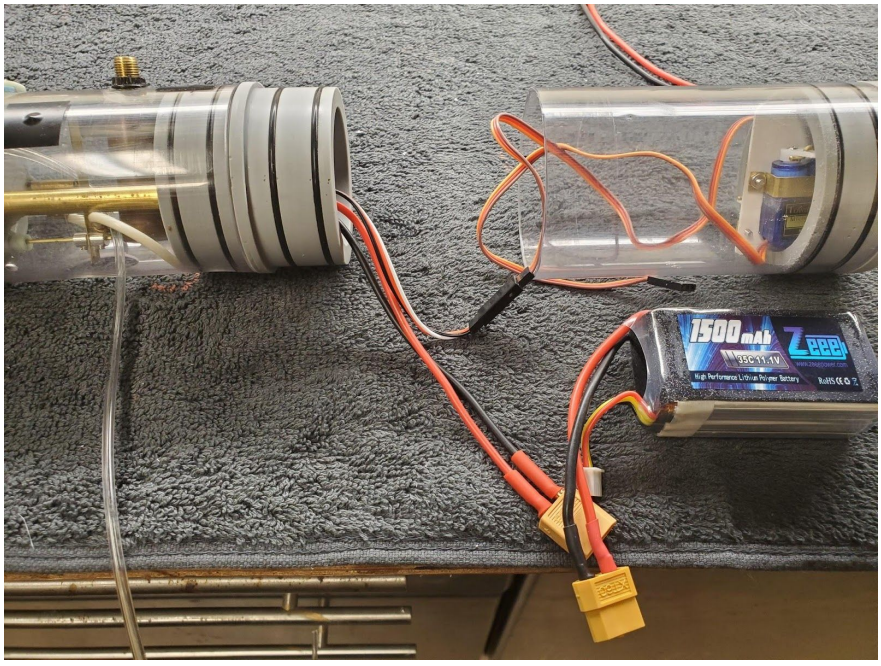
1. ESC positive and negative
2. BLM positive and negative
3. BEC positive and negative

Connect the positive (red) wires together and the negative (black) wires together. Solder these to a single red and black wire of 5” length and terminate them with a MALE mini-Deans connector. This will connect with the main power lead that you just finished up in the previous step.





Back in the battery compartment, solder the supplied ***15A mini fuse holder*** in line with your positive battery wire and then solder a battery connector to your main power leads. The one shown below is an XT-style connector, but you could be using a standard Deans, a Tamiya or many others. Note that the photo below does not show the fuse holder as this buildup included a remote switch with built-in fuse. ***Use of some sort of fuse is absolutely required for the safe operation of your model.***



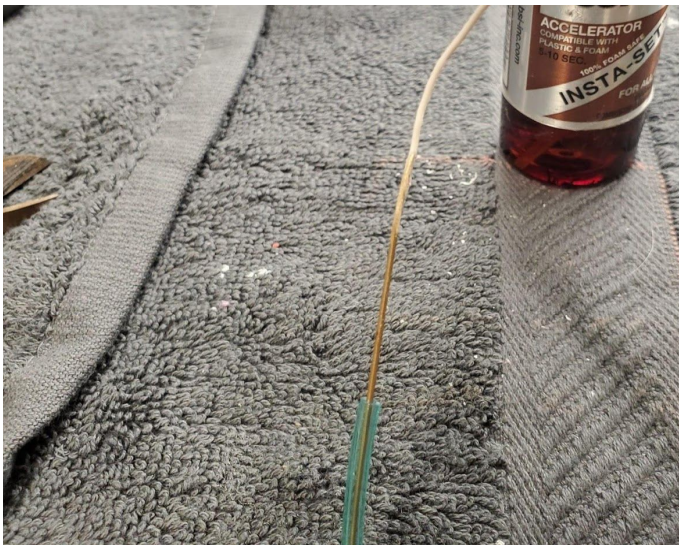
Installing the Antenna/Test tube:

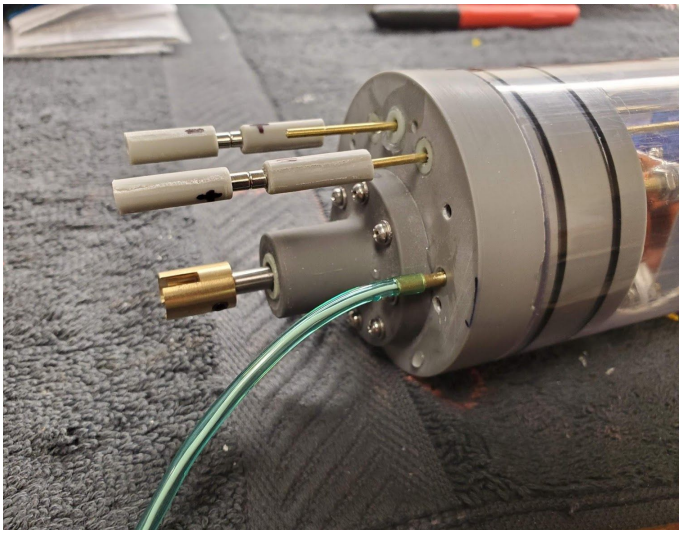
The following step involves running the antenna down a length of supplied rubber tubing to allow it to be run externally along the entire length of your submarine's hull. This also has the added benefit of creating a passage that you can use to pressure test your cylinder *before every run* in order to identify leaks.

1. It is possible to insert the antenna into the hose using silicone lubricant and a massive degree of patience. You need to insert the end of the antenna into the hose and push it through the entire length. This requires a large degree of pushing, twisting and (likely) cursing. What I find to be far preferable is to obtain a 3ft length of thin brass wire, piano wire or equivalent. Thread this through the hose until it emerges from the other side. Glue the tip of the antenna wire to this rod and then pull it back through the hose.

2. Press the cylinder-side end of the rubber hose over the brass tube to a distance of at least ⅜".

3. Use a piece of 3/32" diameter solid rod to cap the end of the tube to prevent water from entering your cylinder.





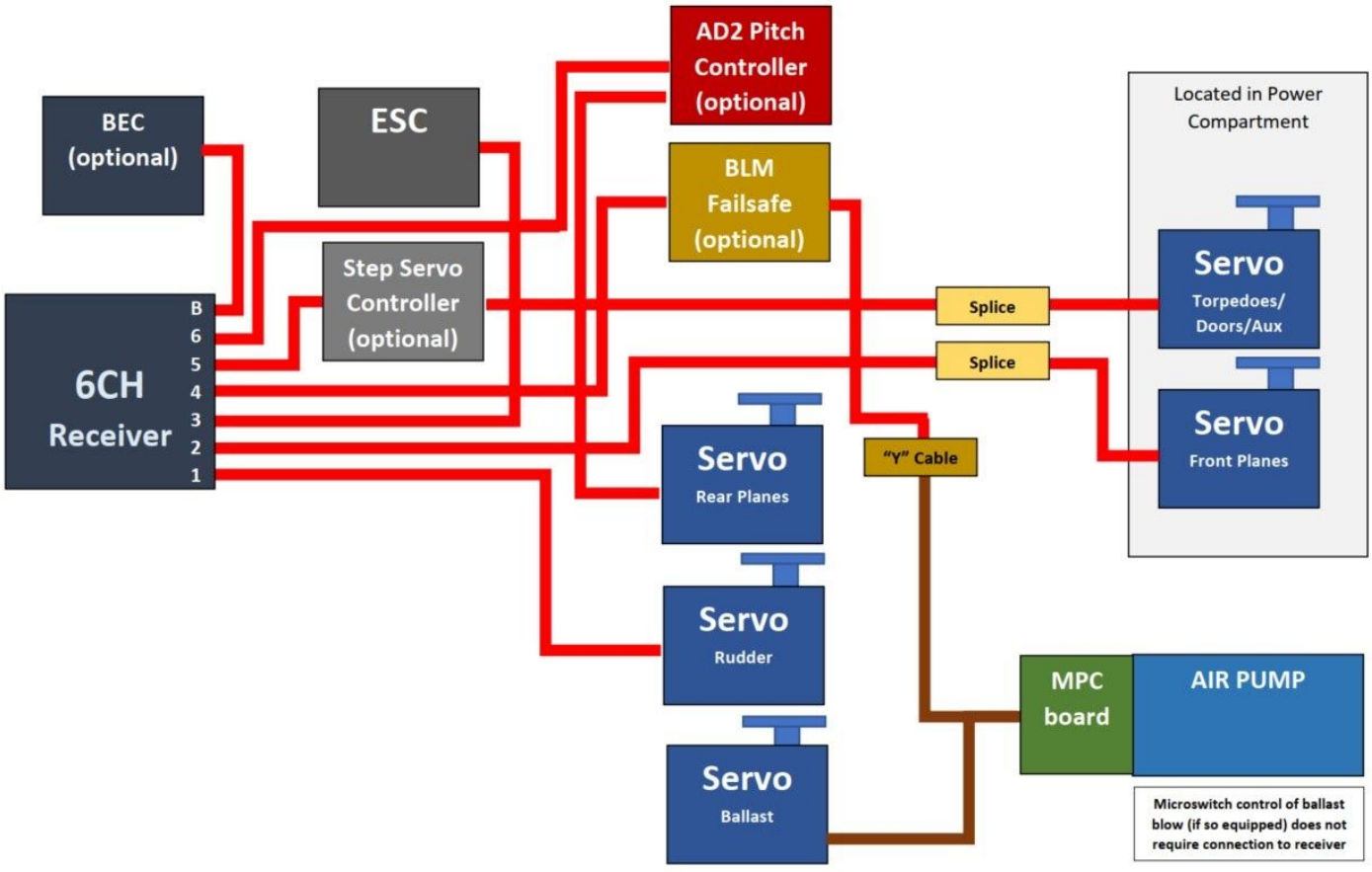
Receiver Connections:

Connection of your components to the receiver is largely a matter of personal preference. I recommend the following setup and connections. Note that if you are using the VEX radio systems, it can operate in two modes, those being “23” and “12”. For our application, ensure that you are operating in mode 23.:

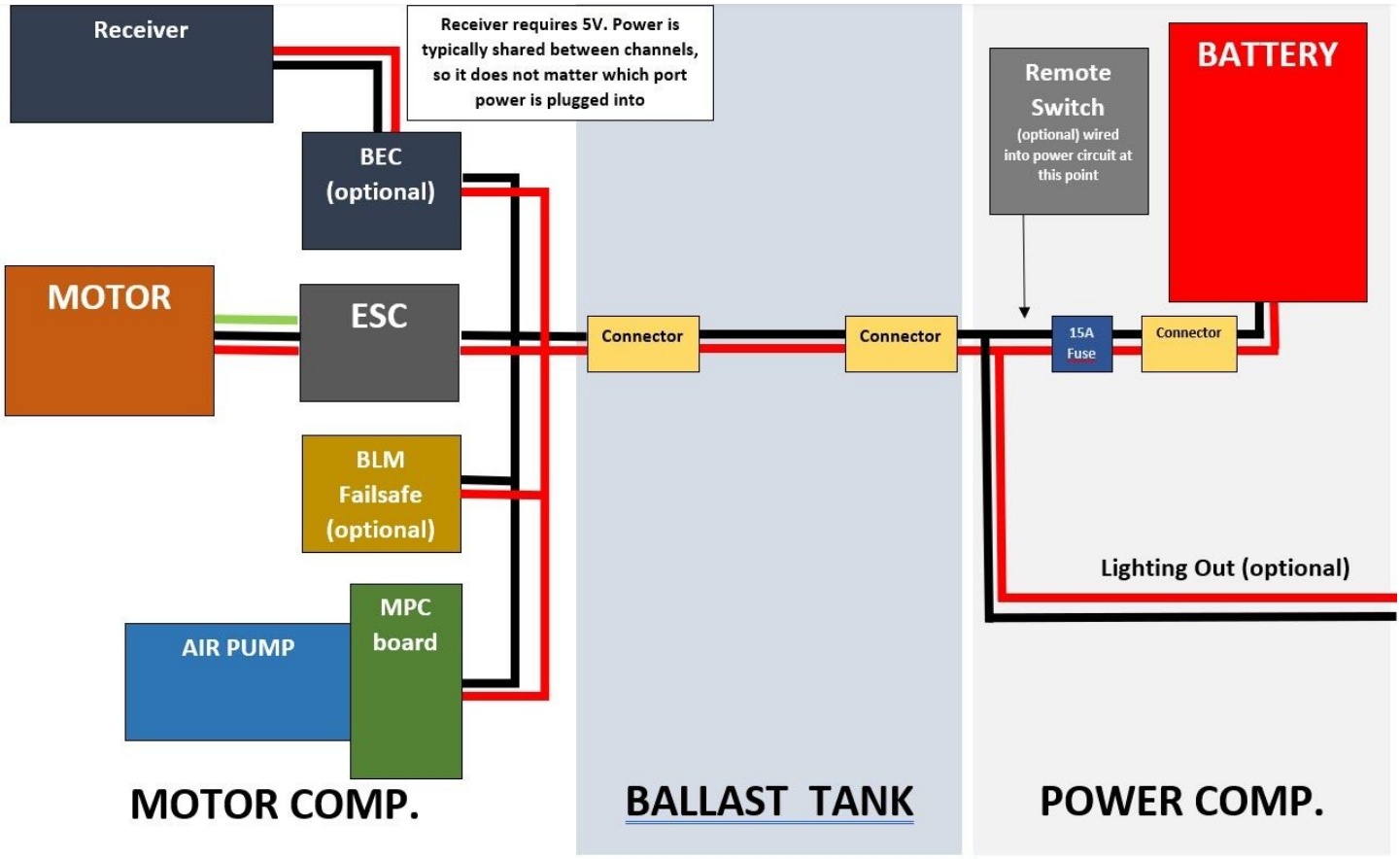
RX Channel:

1. Rudder (right stick horizontal)
2. Bow Planes (right stick vertical)
3. Throttle (left stick vertical)
4. Ballast blow/vent (via optional BLM)
5. Spare/torps/retracts/etc.
6. Rear dive plane override (when using the optional AD2 pitch controller) (left stick horizontal)

RECEIVER WIRING DIAGRAM:



MAIN POWER WIRING DIAGRAM:



Final Assembly and checks:

When assembling your cylinder after all connections have been made, you need to ensure that wires are bundled as neatly as possible, secured in such a manner that the likelihood of pinching or stretching is reduced as much as possible. As you slide your equipment trays and bulkheads into place, do so slowly and watch carefully for trapped wires or component interference.

Once you have your cylinder fully assembled:

1. Power on your transmitter
2. Connect your battery
3. Turn on your remote switch (if installed)
4. Listen for ESC startup sound
5. Cycle all servos, checking for binding, reduced travel or interference
6. Check forward and reverse function of the main drive motor
7. Check ballast vent travel. In neutral position, the valve should be closed with tension on the linkage. In open position, the vent valve should be open approximately 1/16”
8. Check ballast blow function. The air pump should come on with switch activation. Check the intake line to ensure proper connection and that air is being *sucked in* when the pump is on and not blown out.
9. Check function of the pitch controller (if installed). Tilt the cylinder forward and back and look for full travel on the rear dive plane servo as the AD2 works to correct pitch.
10. Turn off cylinder with remote switch
11. Disconnect battery
12. Turn off transmitter

PRE-DIVE CHECKLIST:

- ❏ Check that all equipment secured with 2-sided tape is securely mounted
- ❏ Check that all electrical connections are tight
- ❏ Check all heat-shrink insulators are intact
- ❏ Lubricate the wet and dry side of the pushrod seals and main drive shaft seal with silicone oil
- ❏ Lubricate the wet side of the ballast pushrod seal with silicone oil
- ❏ Inspect all bulkhead union seals carefully for damaged o-rings, contaminants or misalignment
- ❏ Lubricate all bulkhead seals with silicone grease
- ❏ Charge the bottle for the emergency gas backup (if installed)

Prior to every run, submerge your cylinder in a pool or bathtub. Vent the ballast tank and allow it to fully fill with water.. Unplug the receiver antenna tube and gently blow into it. Watch for any air bubbles and note exactly where they emerge, if any. Repair, if needed. Be sure to re-cap your hose!

Do not over-pressure the cylinder during this stage as you can actually blow the end caps off the cylinder, flooding your SubDriver.

POST-DIVE CHECKLIST:

- ❏ Completely vent any remaining pressure in the emergency gas backup storage vessel (if installed)
- ❏ Remove the MSD system from the model submarine
- ❏ Check the cylinder for any signs of water droplets, water pooling, or excessive condensation. Some small degree of misting inside your cylinder is normal, particularly if you live in a humid area, however more than a small amount is usually indicative of a leak.
- ❏ Rinse all exterior surfaces of the MSD with fresh water
- ❏ Remove the battery compartment bulkhead and motor bulkhead/tray completely from the model
- ❏ Remove LiPo battery and charge on proper computerized battery charger. Charge batteries to proper storage voltage. Do not fully charge if you'll be storing for extended periods of time.

Do not store the SubDriver with end caps in place. Any small degree of moisture inside can, over time, deteriorate sensitive electronics. Store with end caps off and the cylinder wrapped in a protective bag to stop any grease from getting on things that it shouldn't.

CONGRATULATIONS!

While I'm sure this exercise did not go as quickly or easily as you'd have liked, you've learned the intimate details of the MSD SubDriver, a unit that should, with proper operation and maintenance, see many years of enjoyment in multiple boats.

If you have any questions or have comments about improving anything, I'd love to hear from you. Please feel free to reach out at any time.

Thank you for your business, and *happy hunting!*

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