

Rover (ROV)

Build Instructions



— Department of Defense —
DoDSTEM
Science • Technology • Engineering • Mathematics

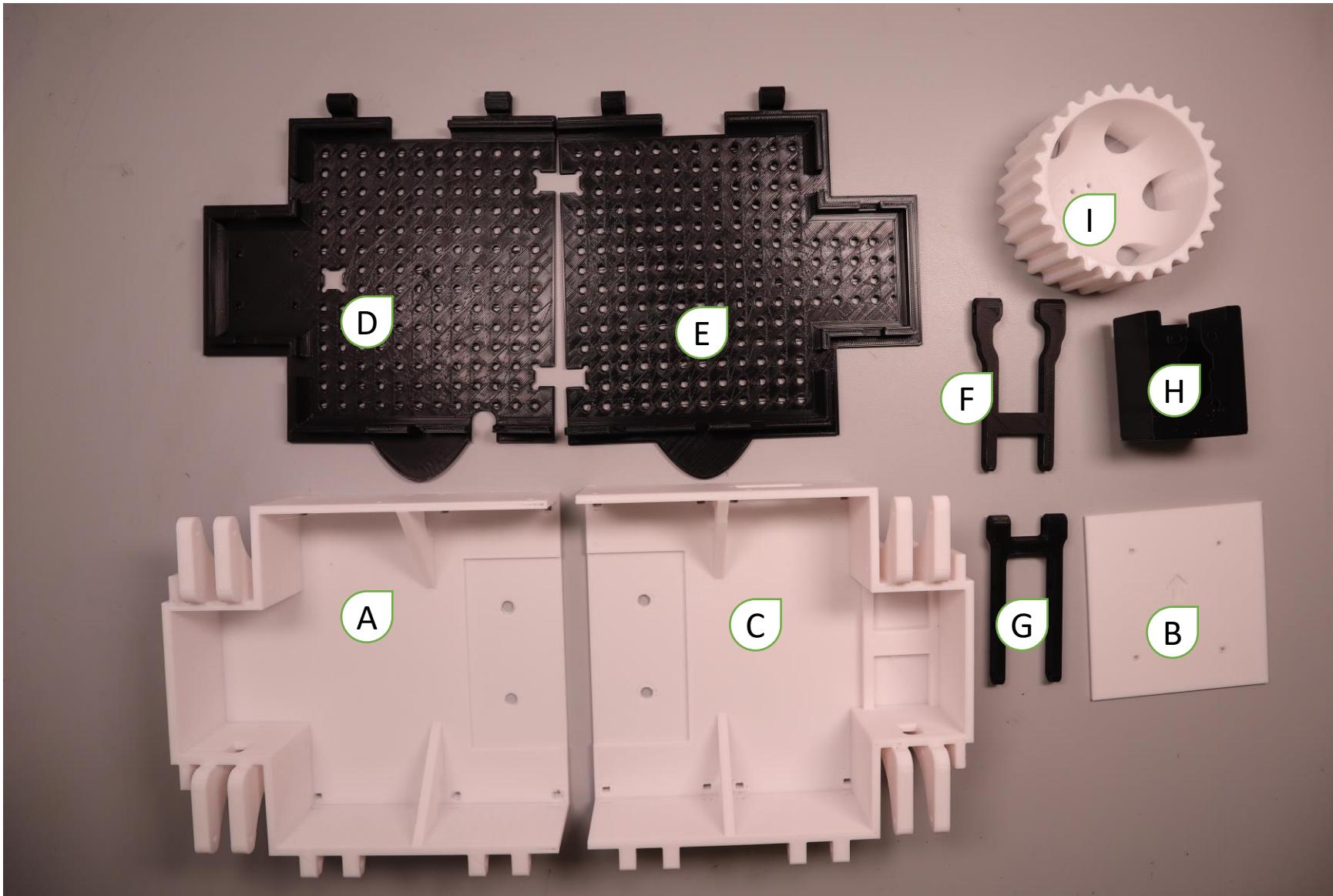
SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE



3D Printed Rover Frame Assembly



Hardware 3D Printed Rover Frame Components



- A. (1) Front Frame
- B. (1) Frame Merger
- C. (1) Rear Frame
- D. (1) Front Lid
- E. (1) Rear Lid
- F. (4) Lower Wishbone
- G. (4) Upper Wishbone
- H. (4) Motor Holder
- I. (4) Wheels

Hardware Parts Needed

Frame

- (16) M3 x 8mm Bolts
- (4) M3 x 30mm Bolts
- (4) M3 x 35mm Bolts
- (4) M3 x 40mm Bolts
- (4) M3 x 45mm Bolts
- (12) M3 x 50mm Bolts
- (28) M3 Self-Locking Nuts
- (16) M3 Washers

Wheels

- (36) M3 x 12mm Bolts
- (4) 1083 6mm Aluminum Motor Shaft
- (4) RC Shocks

Navio2

- (4) M2.5 x 14mm bolts



Super glue



Loctite Thread Locker



Sandpaper



Hardware Tools needed



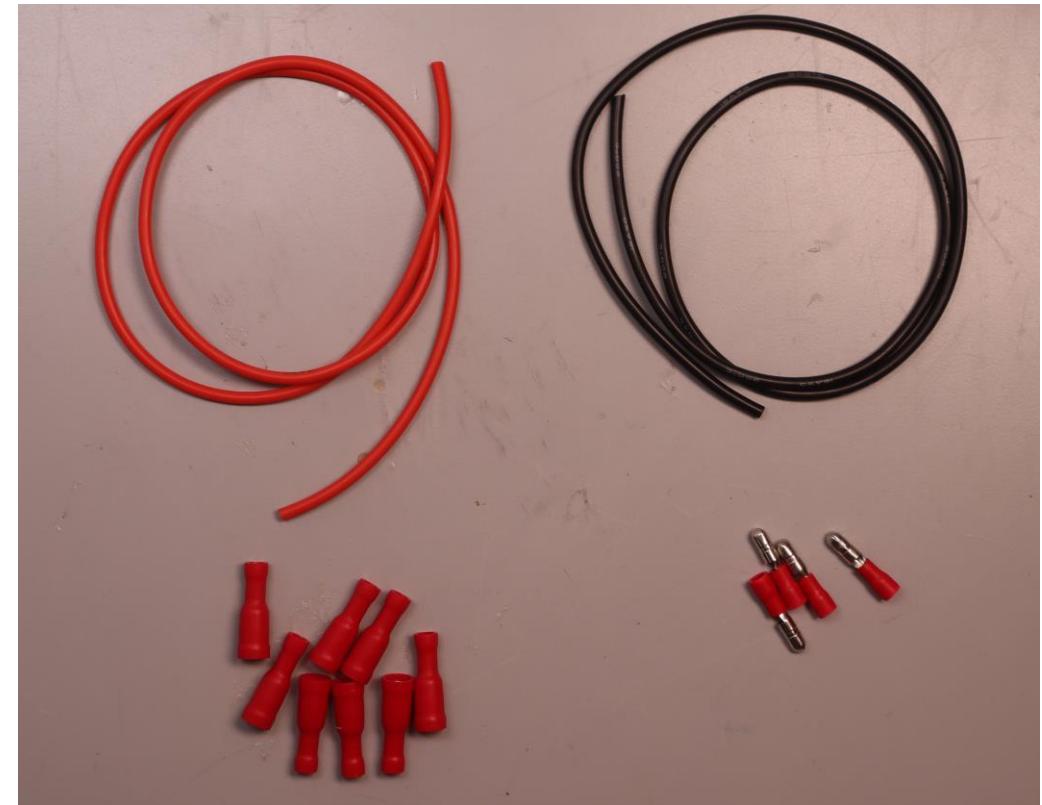
- M3 Allen Key
- M2.5 Allen Key
- Clamps
- Pliers
- Heat Gun
- Soldering Tools and Equipment
- Wire Strippers



Step 0a: Assembling Motor Driver Cables

Materials needed:

- (4) 5" Red 16 Gauge Wire
- (4) 5" Black 16 Gauge Wire
- (2) 2" Red 16 Gauge Wire
- (2) 2" Black 16 Gauge Wire
- (8) Female Bullet Connectors
- (4) Male Bullet Connectors
- Heat Shrink Wire Covers



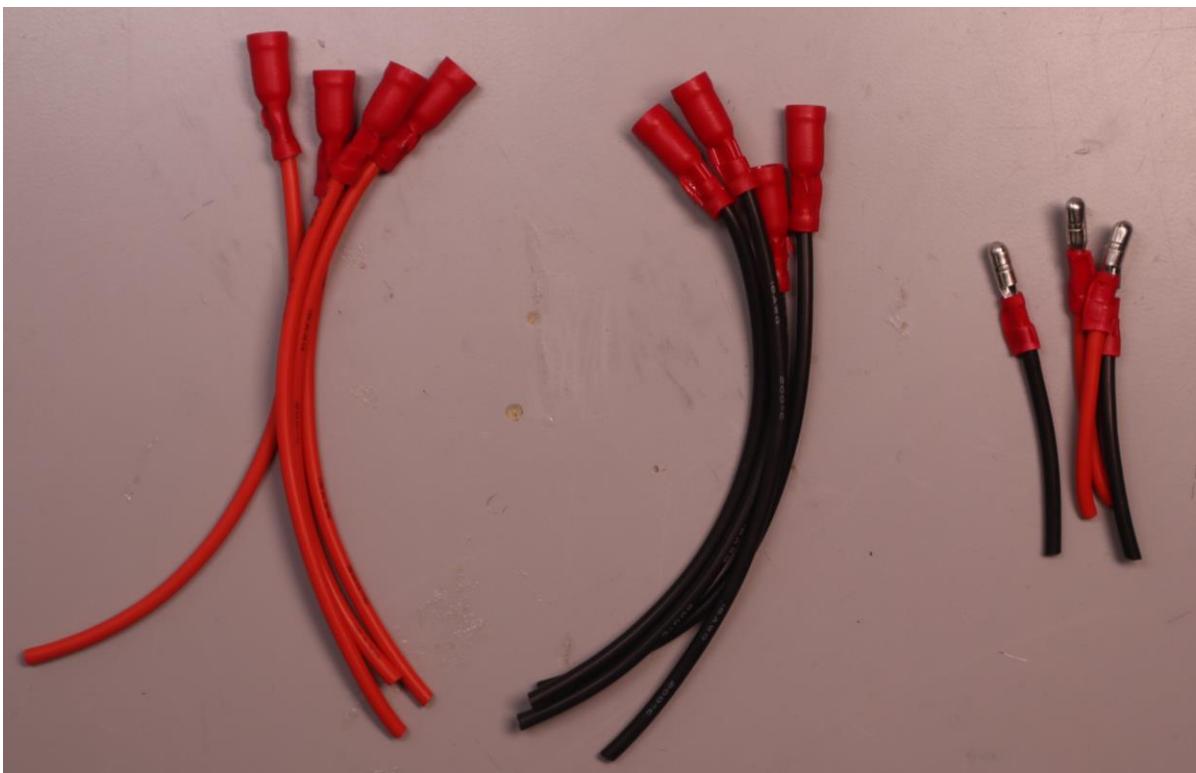
Notes

- **Do not throw away any bags, boxes, or pieces of the kit you are given. This makes it easier to store everything and confirm no parts are missing after you are finished with a kit and want to disassemble**
- **Make sure that all provided tools are returned to the kits.**

Step 0a: Assembling Motor Driver Cables (Cont.)

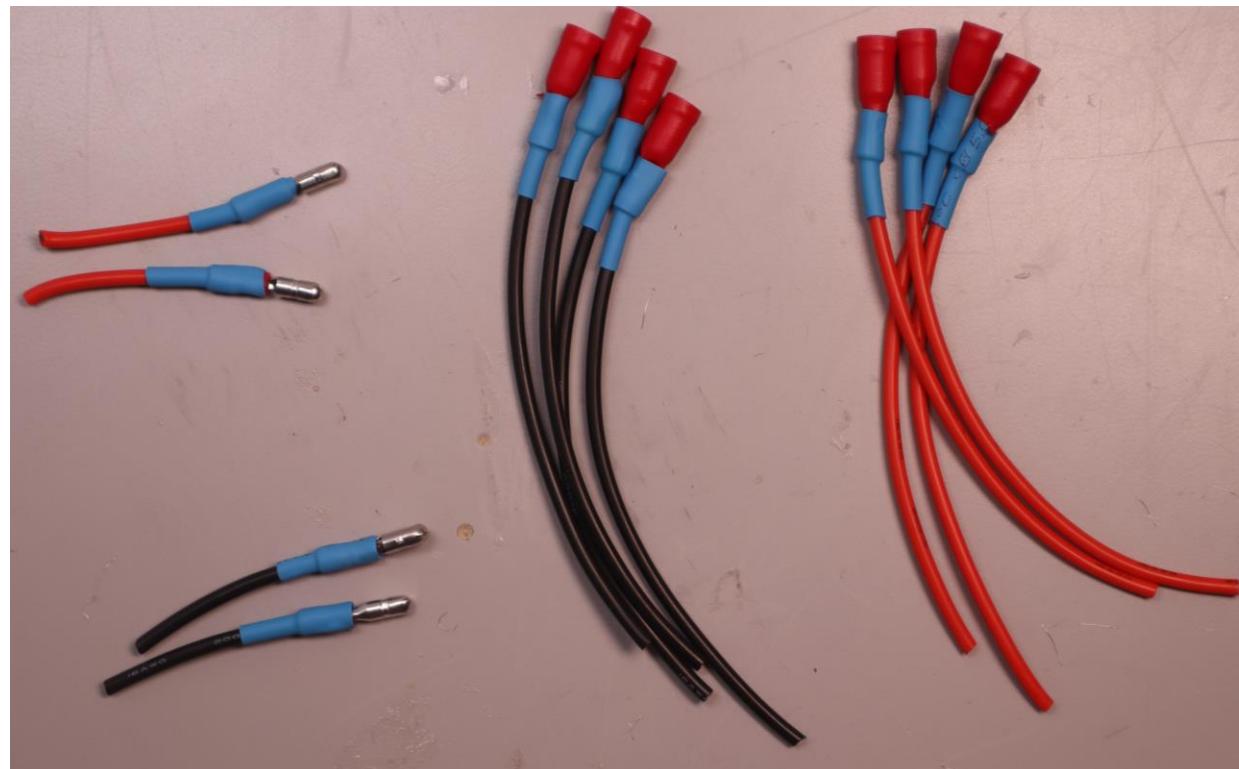
- 0.1** For all 2" and 5" wire pieces, strip roughly 0.25" of the rubber insulation.

Then, insert and crimp the Female Bullet Connectors onto the 5" pieces, and the Male Bullet Connectors to the 2" inch pieces



Step 0a: Assembling Motor Driver Cables (Cont.)

- 0.2 Add heat shrink around the connections and use a heat gun to secure in place.

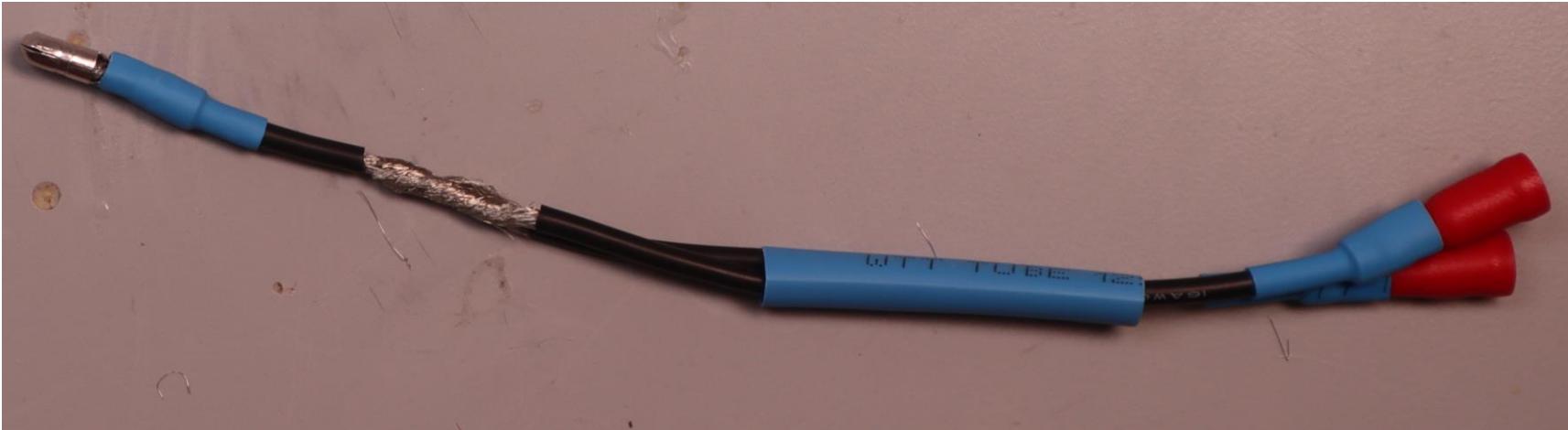


Step 0a: Assembling Motor Driver Cables (Cont.)

- 0.3** Next, trim 0.50" off the free end of each wire. You will then inter-twine two female connectors and 1 male connector of the same color.

Then use the soldering iron and solder to join the wire together.

After it has cooled, place a heat shrink sleeve over the exposed wire and heat to fit.



Step 1: Frame Assembly

Materials needed:

- Front Frame
- Frame Merger
- Rear Frame
- Sandpaper
- Clamps
- Super glue

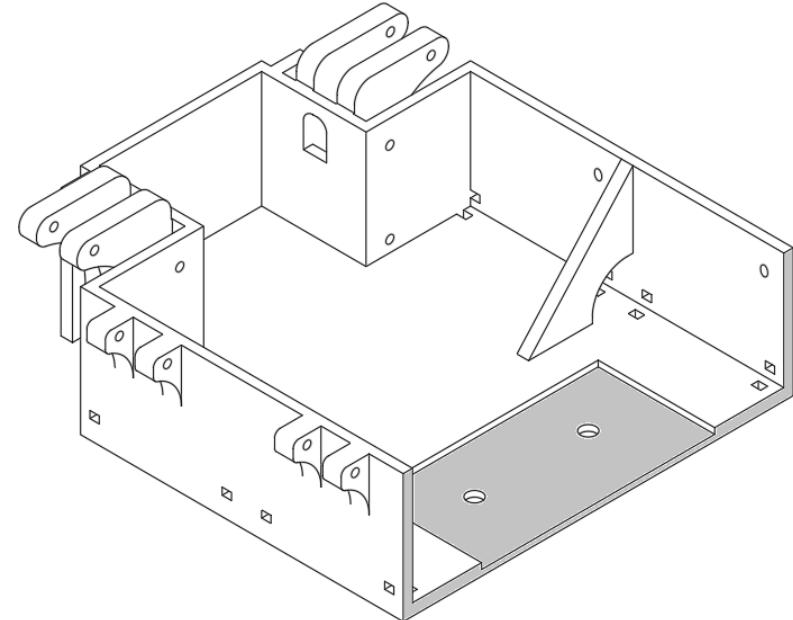


Step 1 Connect Rover Frames (Cont.)

- 1.1** Using Sandpaper, you will sand the shaded zones shown in the figure on the right to a rough texture. You will also sand the bottom of the merge piece to the same texture

This will provide a good surface for superglue to bond the parts together.

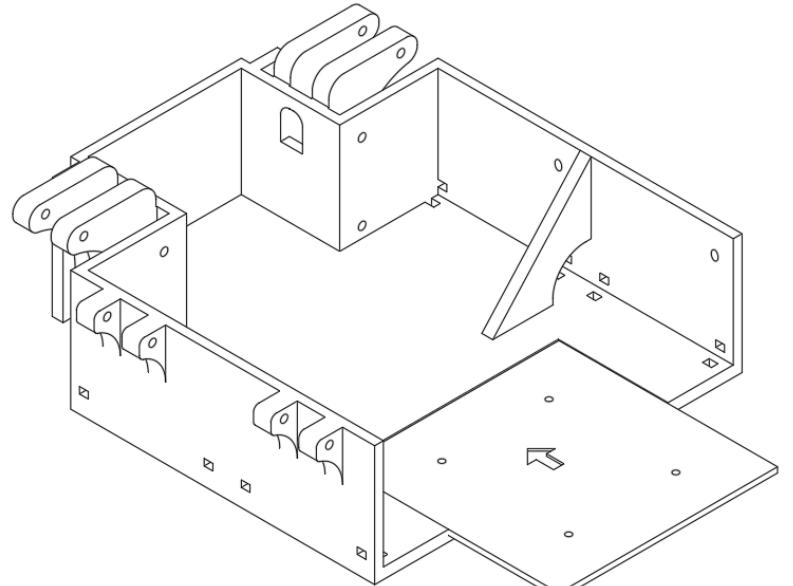
Note: Check that the pieces fit together and that there is little to no gaps through the parts when you press the frames together.



- 1.2** First, we will glue the merge piece to the front frame piece. **Note that the arrow of the merge piece points to the front of the rover.** Apply super glue only to the large square indent on one of the frames then press the merge piece into the slot.

Make sure that the sanded side of the merge piece is pressed against the sanded portion of the frame.

Note: You can use clamps to hold the part in place to dry while you work on sanding the other frame if you are doing one at a time.



Step 1 Connect Rover Frames (Cont.)

- 1.3 Once the superglue has dried, you can connect the second frame piece together with the combined section.

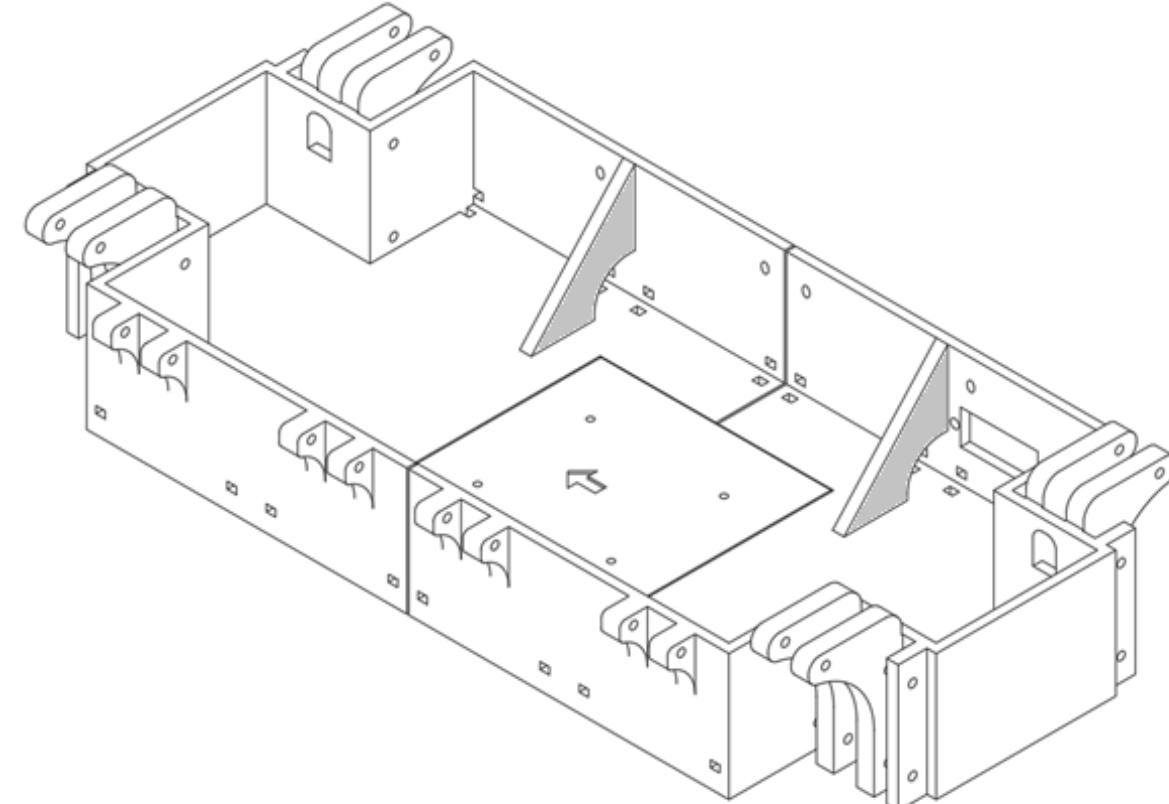
Apply superglue to both the square indent section as well as the edges that will connect with the first frame piece.

Note: Make sure to also glue the walls together.

-
- 1.4 Here it is recommended to use a pair of clamps to hold the parts together to dry.

A good placement for the clamps are the shaded grey portions of the figure on the right. If your clamps are longer, you can also clamp from the front and back of the rover.

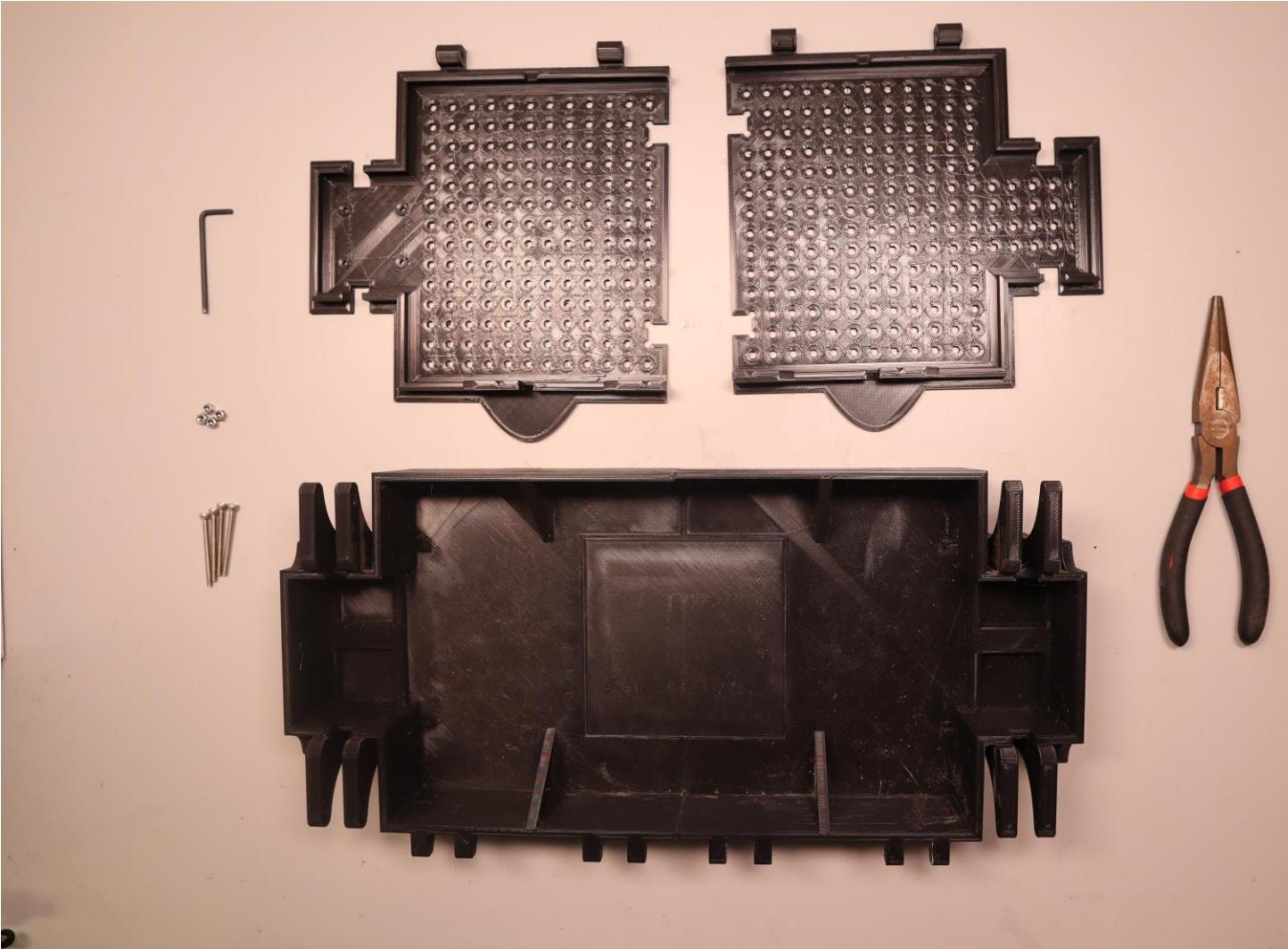
Note: Be cautious not to overtighten the clamps or else you run the risk of breaking the frame.



Step 2: Lid Assembly

Materials needed:

- Rover Frame
- Front Lid
- Rear Lid
- Sandpaper
- (4) M3 x 35mm Bolts
- (4) M3 Lock Nuts
- M3 Allen Key
- Pliers



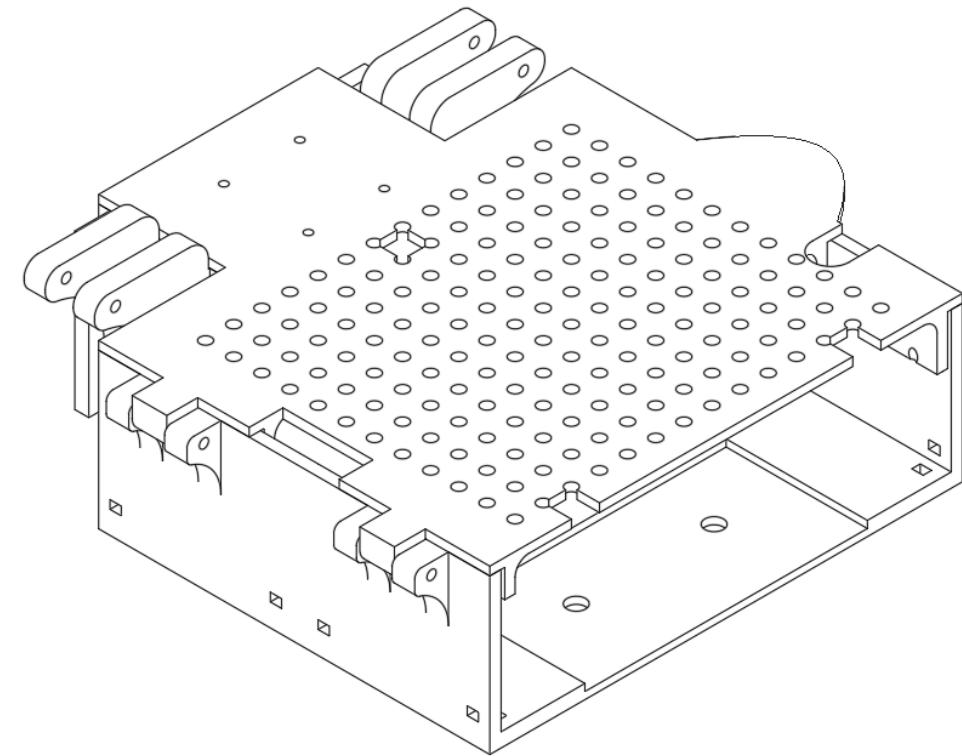
Step 2: Lid Assembly (Cont.)

- 2.1** First, we want to make sure that the lids will fit correctly into the frames. To do so we take one lid at a time and attempt to mount it onto the frame and check for pinches and resistance. Try to rotate the lid about the hinge to check how easily it opens and closes.

If it catches or pinches throughout the motion, take a piece of sandpaper to the section and try again. Do this until the lid moves freely through its motion.

- 2.2** Once the lid can move freely, you can use your M3 x 35mm bolts and locking nuts to secure the lid to the frame.

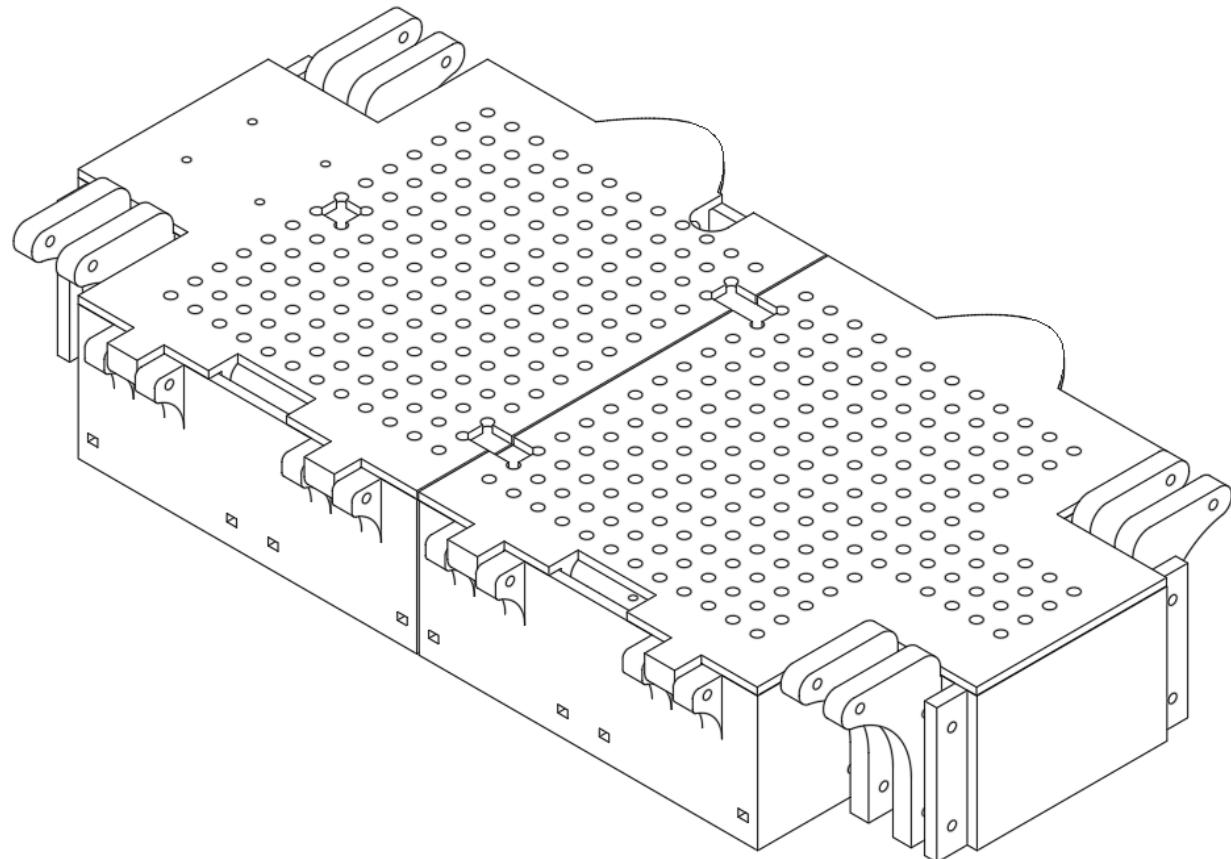
Note: Make sure to make the locking nuts tight but not tight enough to impede motion of the lid. A good trick is to tighten the nuts until the lid would hang in the air if pull upward. Then loosen the nuts until the lid falls back down.



Step 2: Lid Assembly (Cont.)

- 2.3** With the first lid on, now you can place the second lid and repeat steps 2.1 and 2.2 with an extra portion.

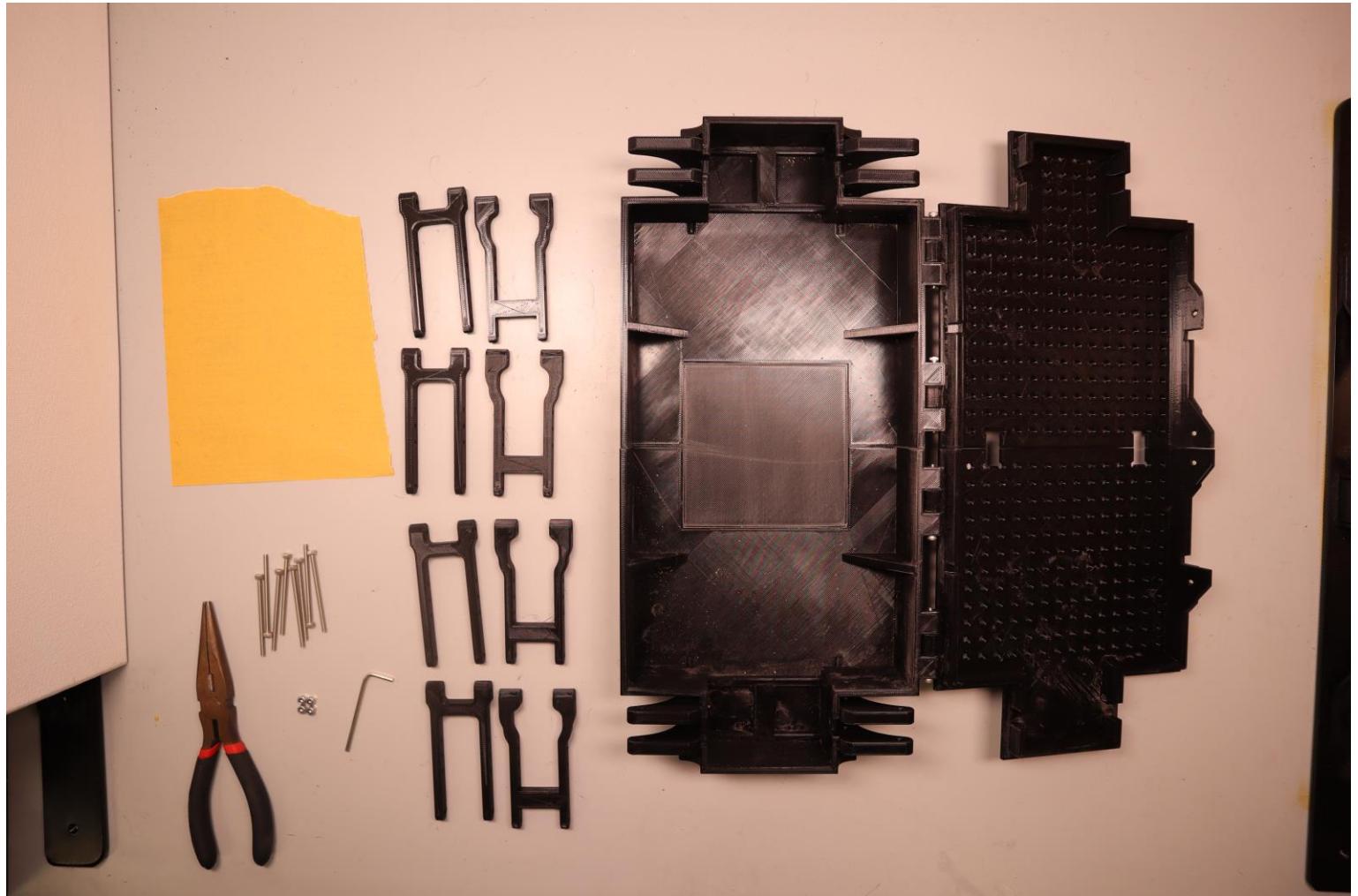
Not only are you looking for pinches with the frame, but you also want to be looking to make sure each lid can move freely without hitting the other. If they do, sand down the edges of the lids until they do not hit.



Step 3: Wishbone Arm Installation

Materials needed:

- Rover Frame
- (4) Upper Wishbone
- (4) Lower Wishbone
- (8) M3 x 50mm Bolts
- (8) M3 Self-Locking Nuts
- M3 Allen Key
- Sandpaper
- Pliers

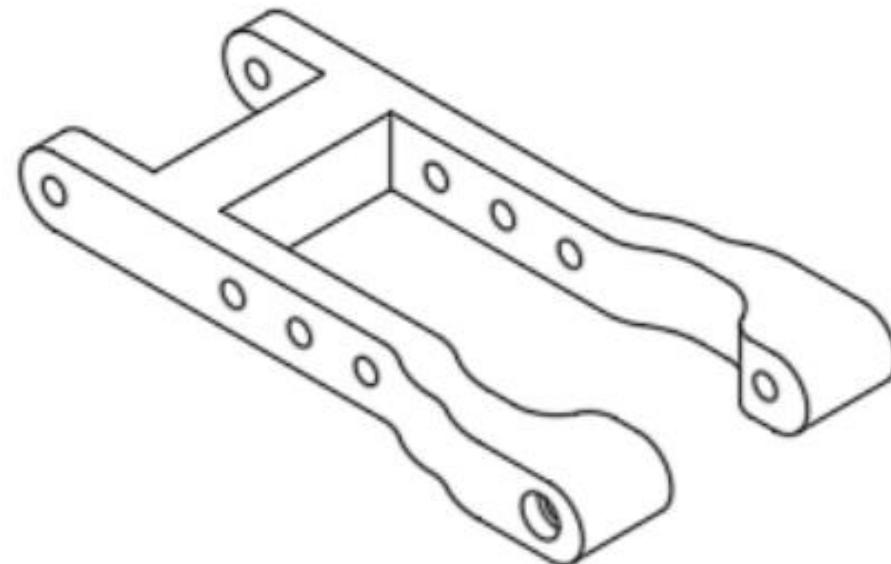
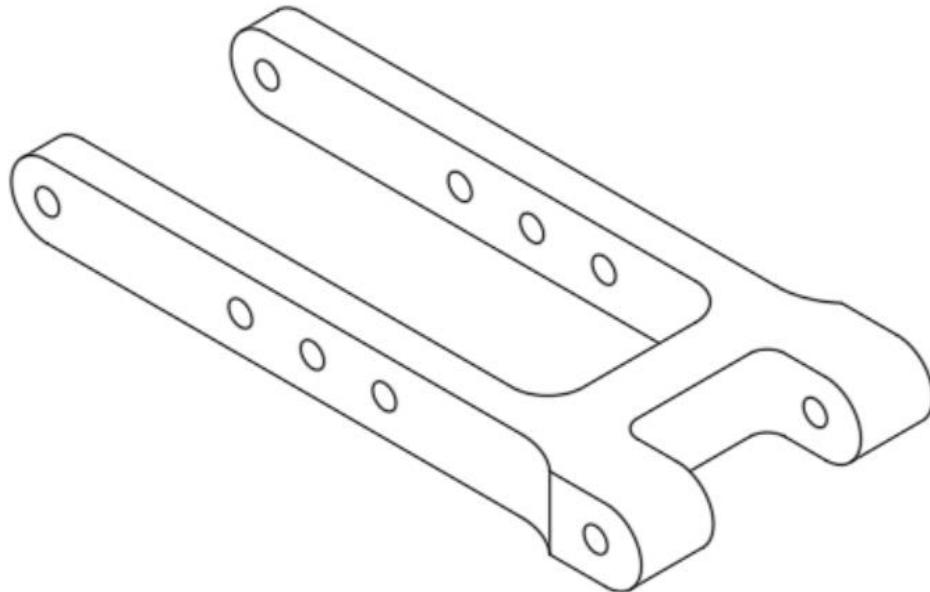


Step 3 Wishbone Arm Installation (Cont.)

- 3.1** First, check to make sure that the arms can freely rotate within their designated slots. If you have trouble rotating the arm, sand the inner slots of the rover frame.

There may be leftover bits of 3D printed material on the legs, sand those off as well.

Note: There are two different types of legs, Upper (Left Photo) and Lower (Right Photo).



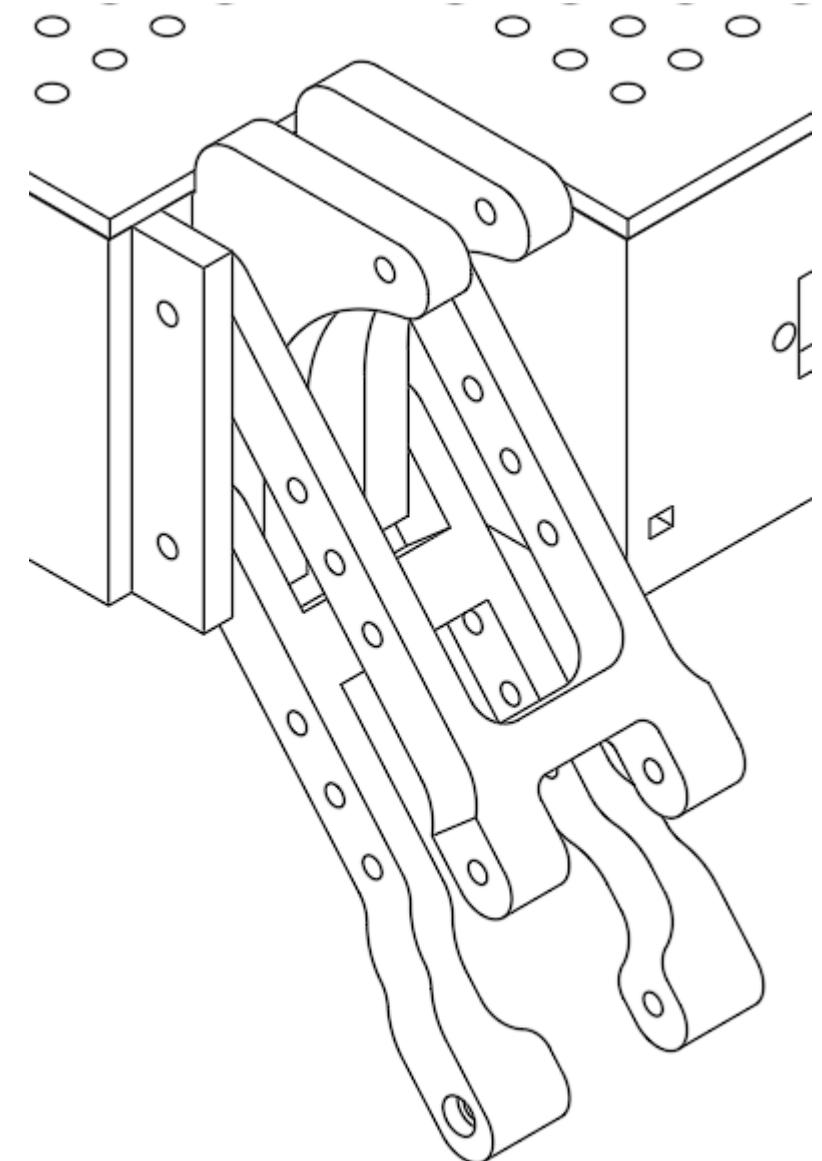
Step 3 Wishbone Arm Installation (Cont.)

Once the arms can fit nicely, install each arm using a M3 x 50mm bolt. Install the bolt from the outside pointing inward.

Once all bolts are in, attach locking nuts bolts from the inside of the rover frame

3.2

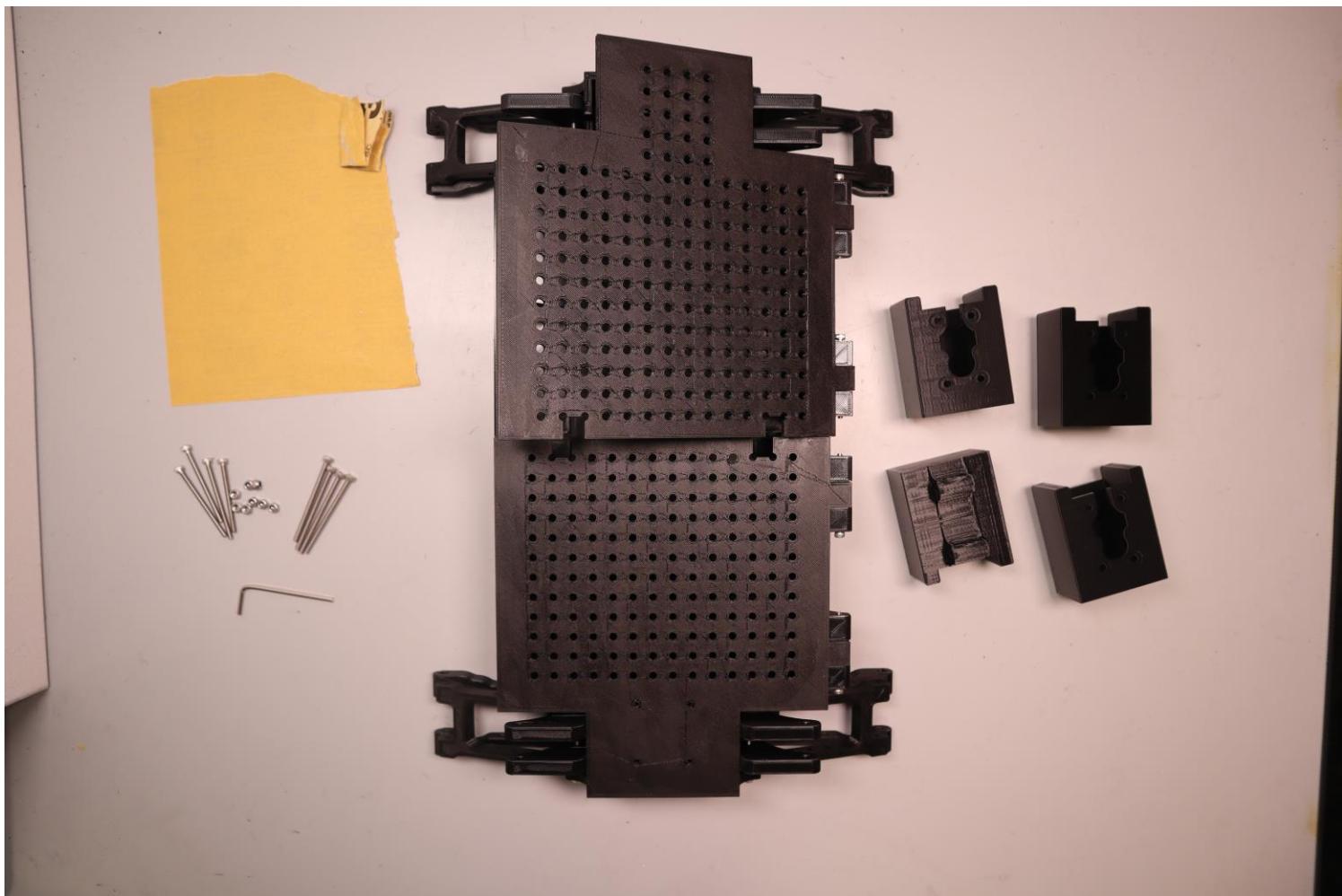
Note: Make sure to make the locking nuts tight but not tight enough to impede motion of the lid. A good trick is to tighten the nuts until the arm would hang in the air if pull upward. Then loosen the nuts until the arm falls back down.



Step 4: Motor Casing Installation

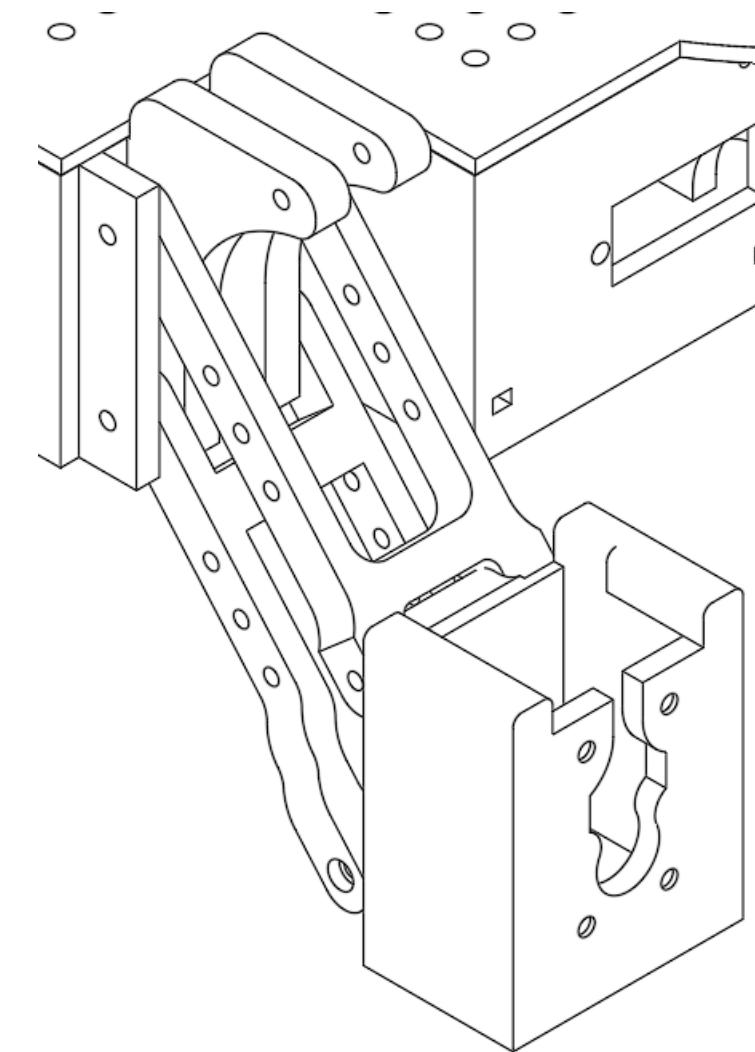
Materials needed:

- Rover Frame
- (4) Motor Holders
- (8) M3 Self-Locking Nuts
- (4) M3 x 45mm Bolts
- (4) M3 x 50mm Bolts
- M3 Allen Key
- Sandpaper
- Pliers



Step 4: Motor Casing Installation (Cont.)

- 4.1 First check to make sure the Motor Cases can easily move between the wishbone arms. If you have resistances, make sure to sand them down.



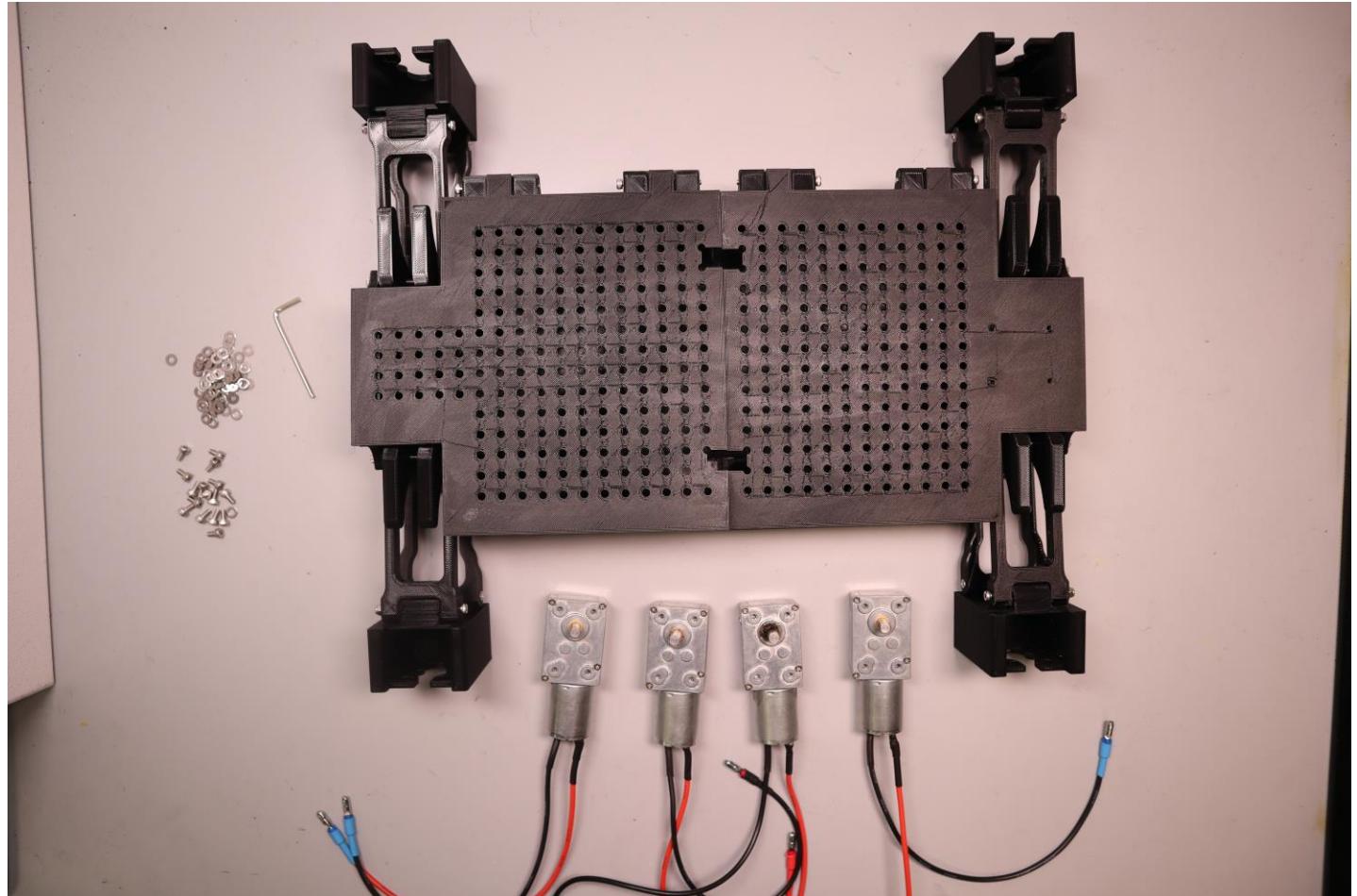
- 4.2 Attach the cases using the M3 x 50mm bolts for the lower arm, and M3 x 45mm bolts for the upper. Then attach the locking nuts.

Note: Like the lid, make sure not to overtighten the nuts as you want the arm to move freely.

Step 5: Motor Installation

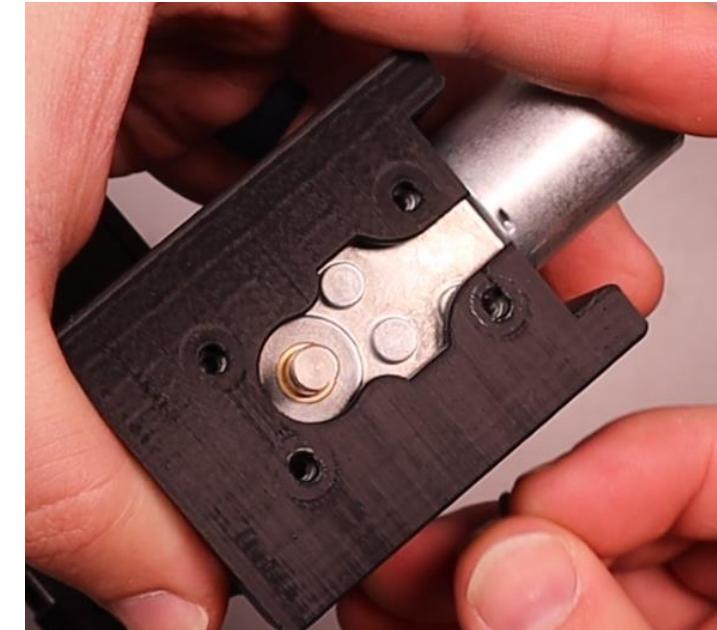
Materials needed:

- Rover Frame
- (4) Box Motors
- (16) M3 x 8mm Bolts
- (16) M3 Washers
- M3 Allen key



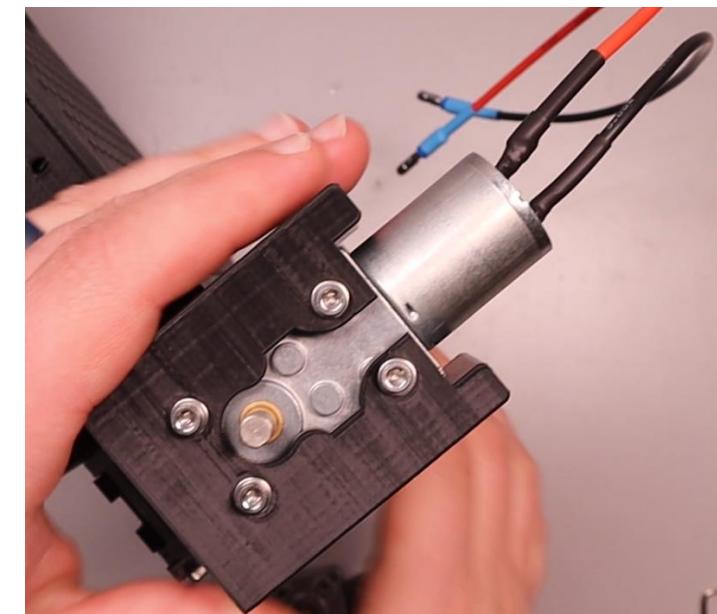
Step 5 Motor Installation (Cont.)

- 5.1 Insert the motor into the motor case, lining up the bolt holes.



- 5.2 Using 4 M3 x 8mm bolts and M3 washers, secure the motor to the inside of the case.

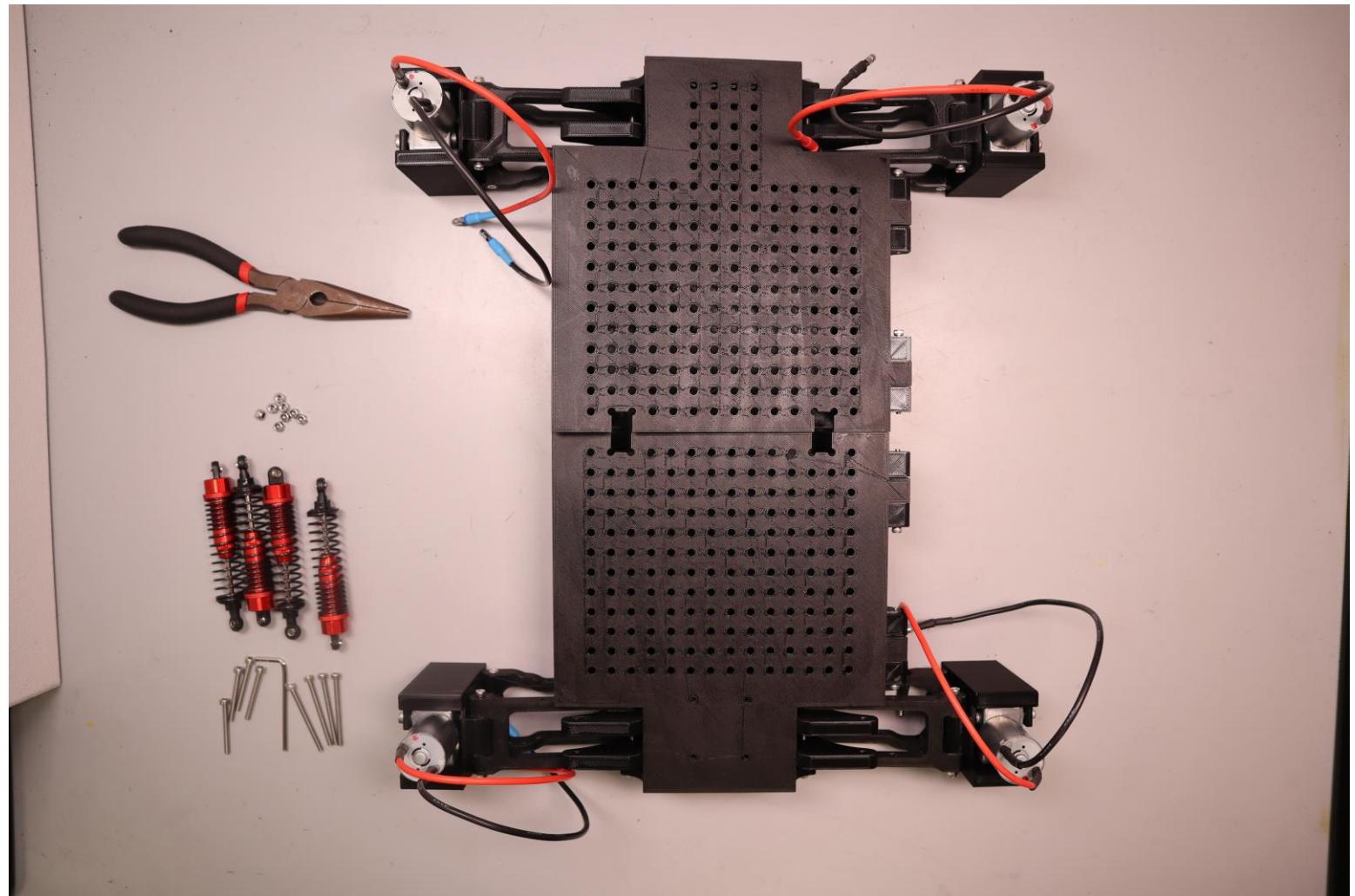
Note: Make sure not to over tighten the bolts or you run the risk of cracking the case.



Step 6: Suspension Installation

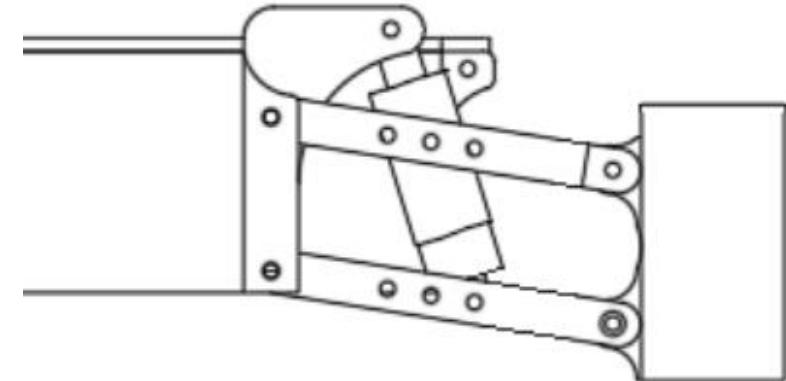
Materials needed:

- Rover Frame
- (4) Shock Absorbers
- (4) M3 x 30mm Bolts
- (4) M3 x 40mm Bolts
- (8) M3 Self-locking Nuts
- M3 Allen Key
- Pliers



Step 6 Suspension Installation (Cont.)

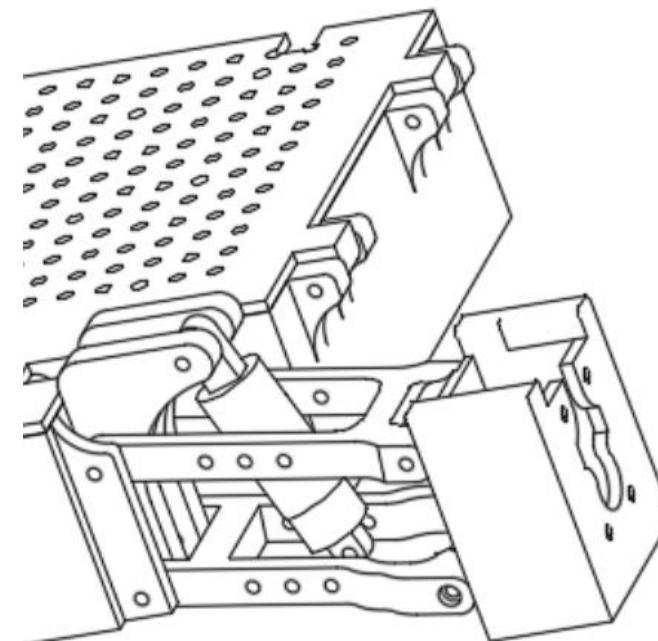
- 6.1 Here we will install the suspension system, to do this we will insert our Shock through the middle of the wishbones and place the longer spring arm in between the protruding slots of our frame.



- 6.2 The frame-side hole will use the M3 x 30mm bolts while the wishbone side will use the M3 x 40 mm bolts. To install the second bolt, you may have to compress the shock slightly to align the holes.

Attach Locking Nuts to both bolts, remembering not to over tighten.

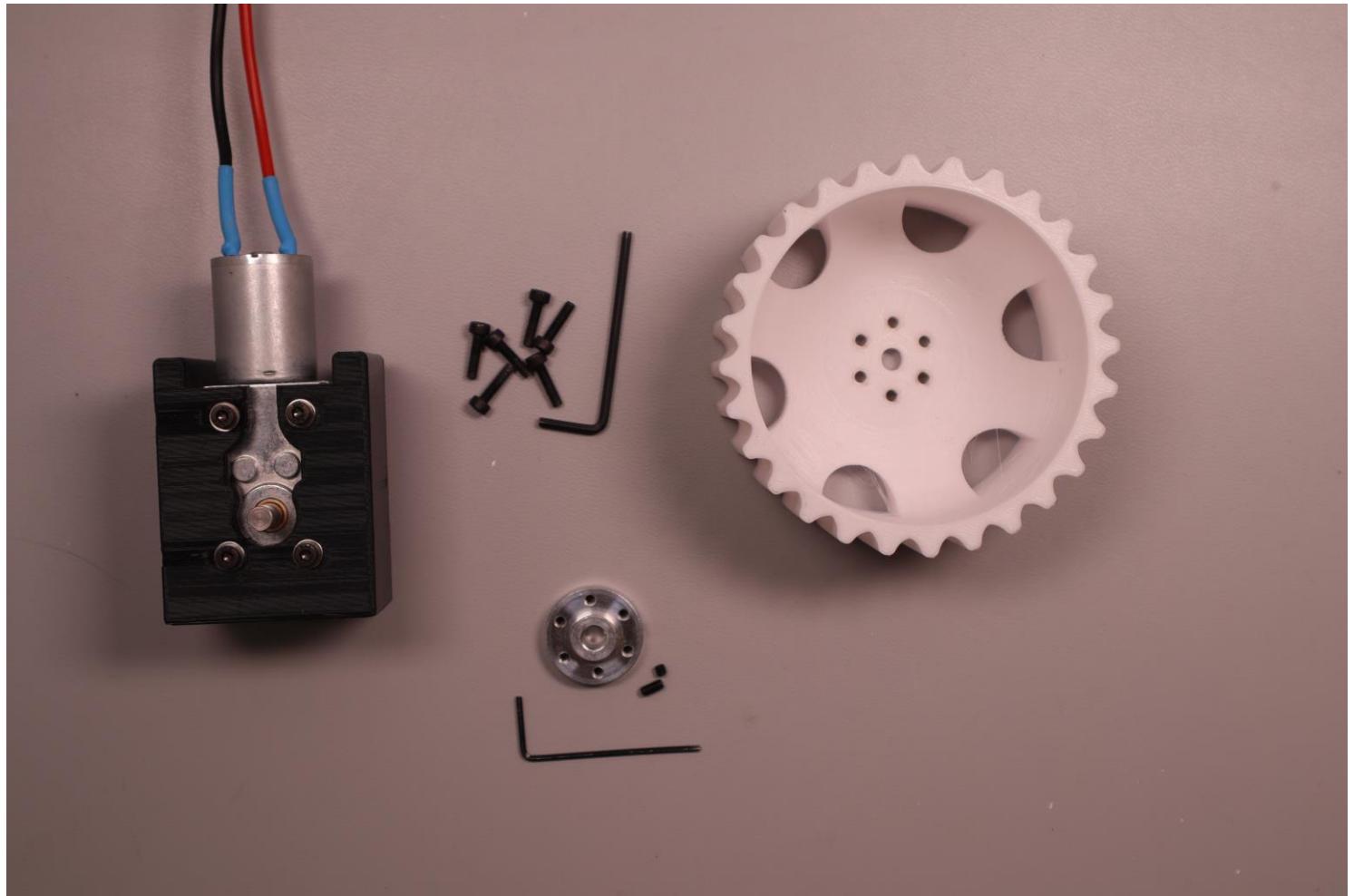
Note: It is recommended to use the furthest hole from the frame on the lower wishbone.



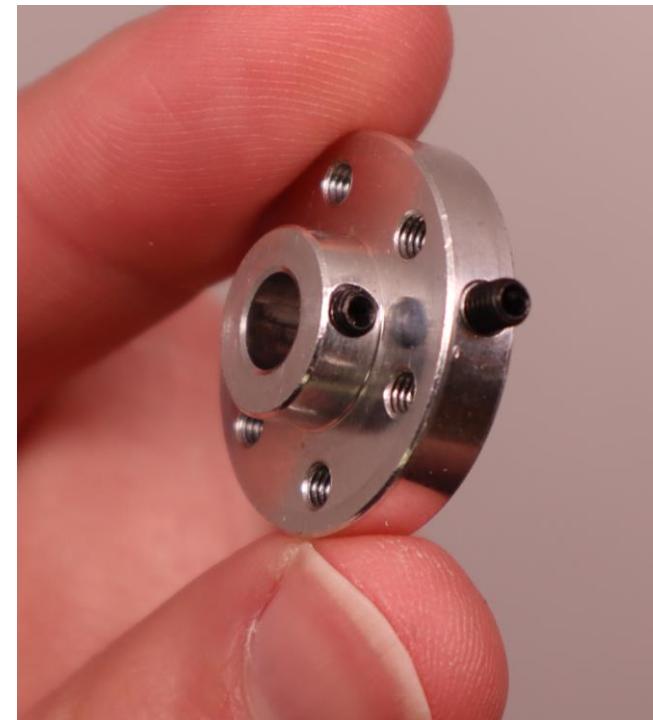
Step 7: Motor Wheel Hub and Wheel Installation

Materials needed:

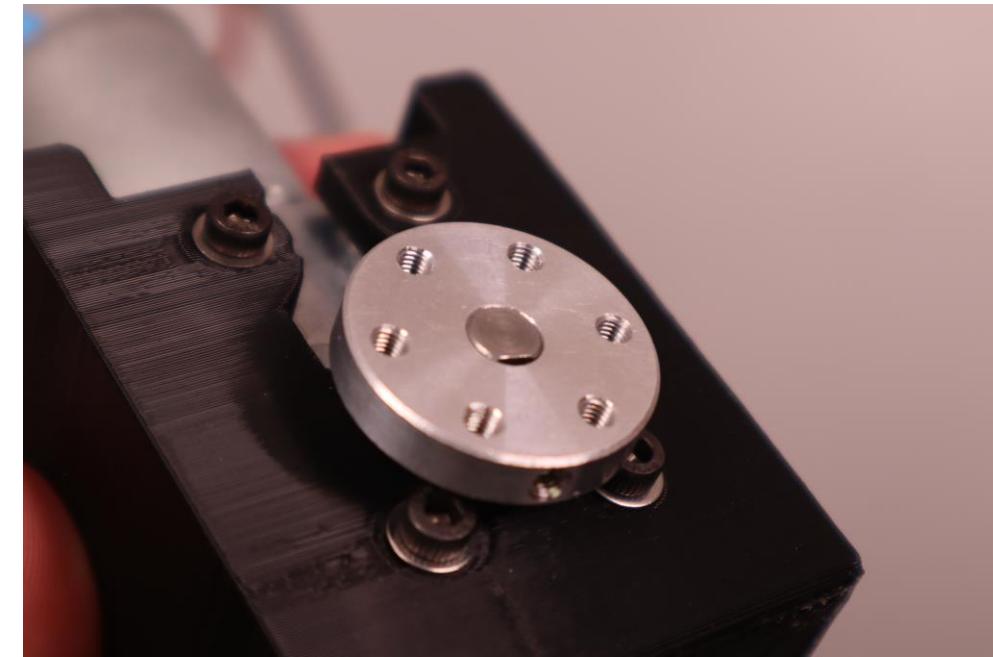
- Rover Frame
- (4) Wheels
- (16) M3 x 12mm Bolts
- (4) Motor Wheel Hub Pack
- M3 Allen Key



1. Install the provided set screws into the Motor Wheel Hub. Looking at the figures below, you will install the longer set screw in the hole to the right and the shorter set screw in the hole on the left.

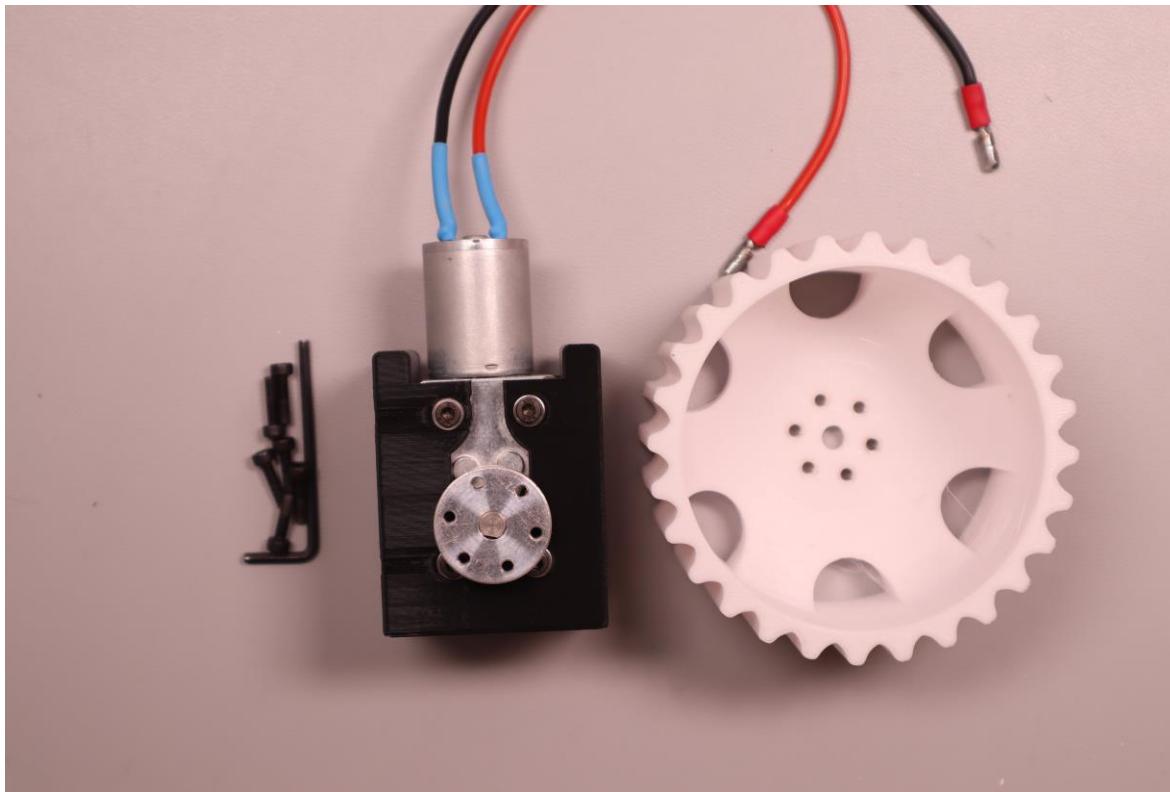


1. You will slide the wheel hub onto the motor shaft, making sure it is flush with the shaft as shown in the figures below. You want the setscrew holes to align with the flat portion of the motor shaft as shown in the figure on the left.
2. At this point, if you are not disassembling the rover later, you will want to remove the set screw and apply a drop of Loctite onto the threads of the wheel hub. This will create a glue to keep the screw in place during operation.
3. You will tighten the setscrews of the wheel hub until they pinch against the motor shaft. Be careful not to over-tighten the setscrews as you will run the risk of stripping the screw, making it extremely difficult to remove in case of maintenance.



1. Install Wheel to Wheel Hub

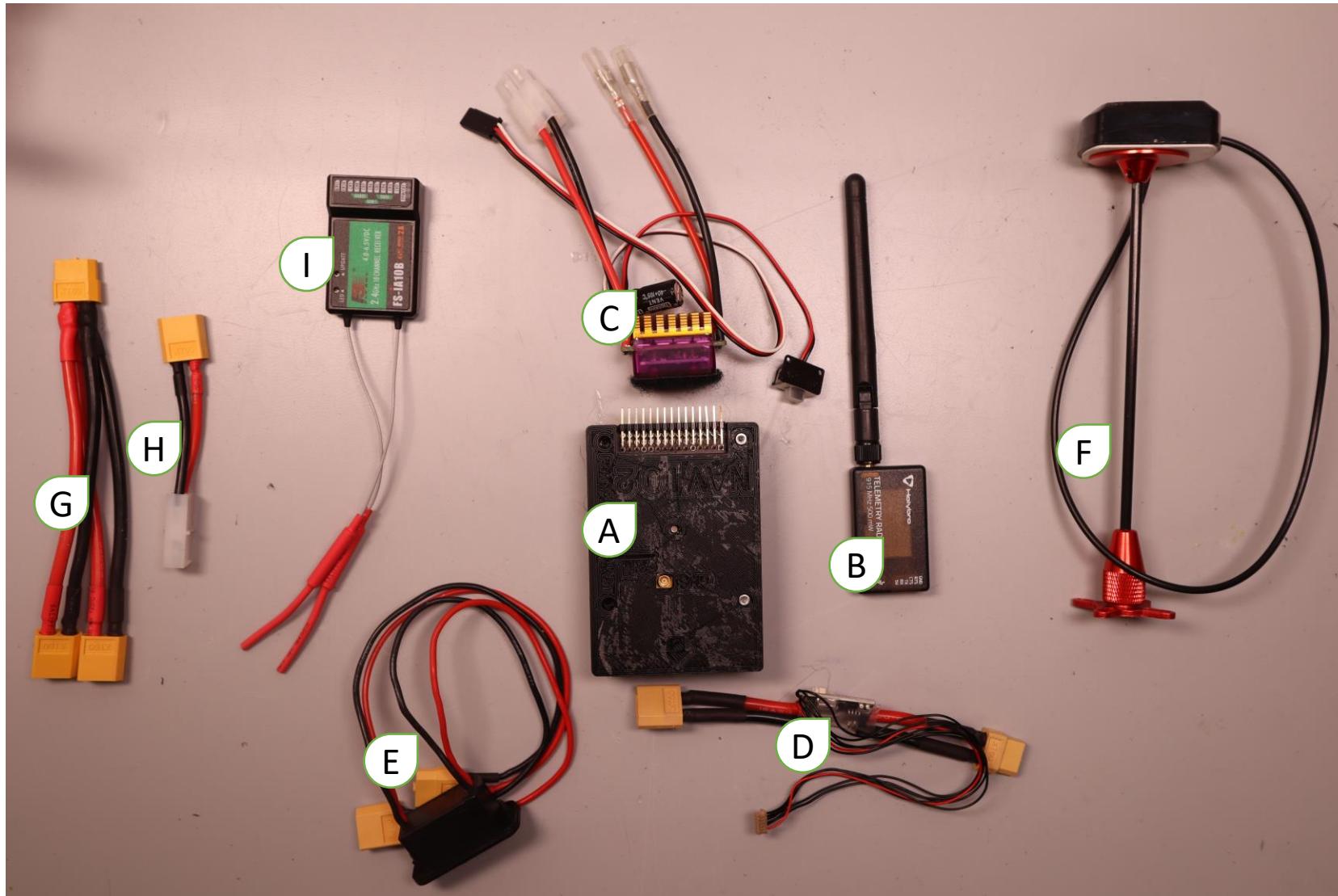
1. Install Wheel using 6 M3 x 12 mm bolts, the holes in the wheel might be a bit tight against the 3D printed wheel but they will slowly screw into the wheel hub.



Rover Electronics Installation

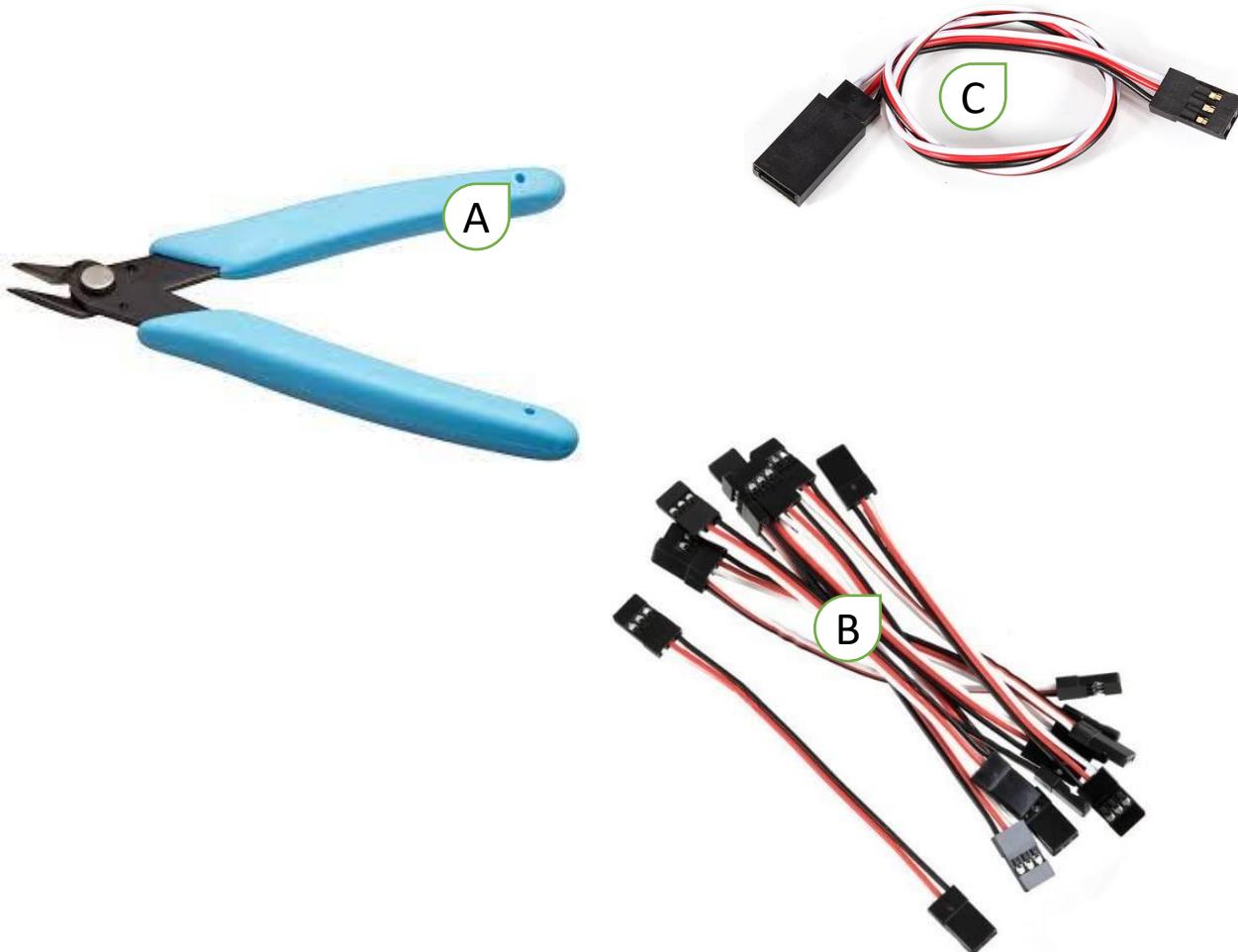


Hardware Rover Electronic Components



- A. Navio2 & Case
- B. Telemetry Radio
- C. (2) Motor Drivers
- D. Power Module
- E. Power Switch
- F. GPS Antenna
- G. Cable Splitter
- H. (2) XT60 to Tamiya Adapter
- I. Remote Control Receiver

Hardware Extra Components Required



- A. Flush Cutters
- B. Female-to-Female Servo Cables
- C. Male-to-Female Servo Cable

Step 0 Prep Servo Cables

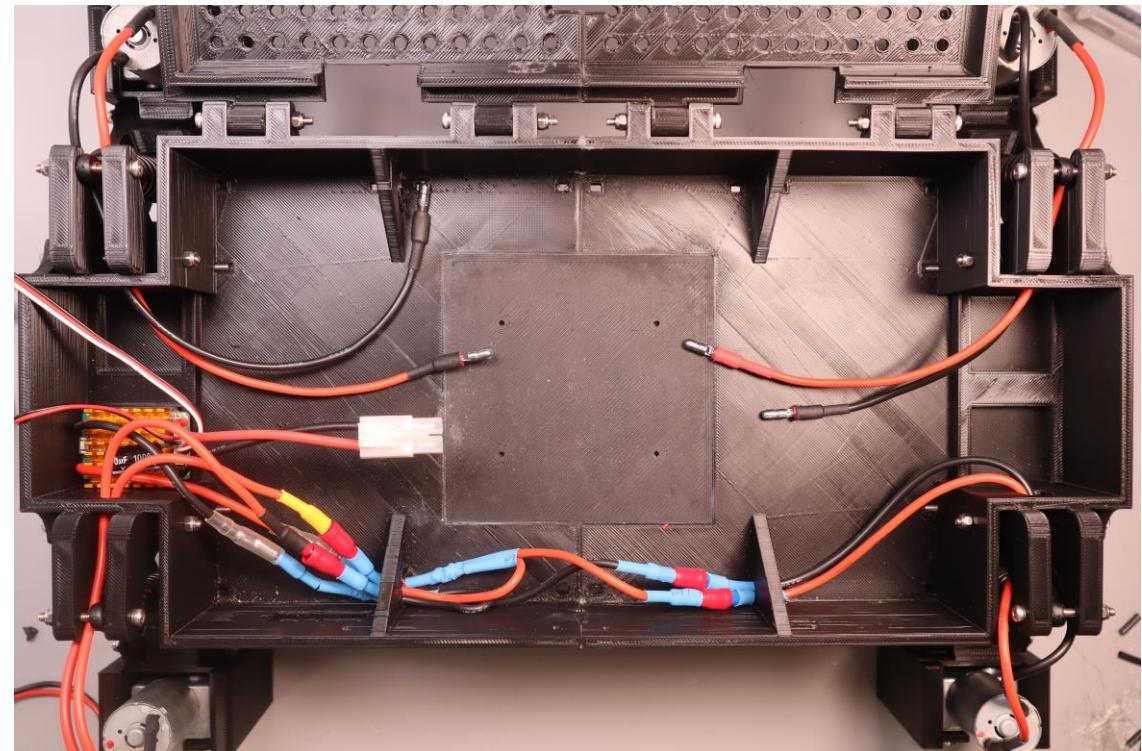
1. Each motor driver has a set of three cables in a color combination such as White-Red-Black, or Yellow-Red-Brown. This corresponds to Control-Power-Ground that allows the flight controller to not only use the attach motors, but also provides a stable power supply to the flight controller. However, we can only have one power supply connected to our servo rail, so we must remove the power line from all but one of the motor drivers.
2. For all Servo Cables (**EXCEPT ONE**) connecting your Motor Driver to your Navio2, Snip the Power Line (**RED WIRE**).

Note: Check to see if your motor driver cables have already been cut!



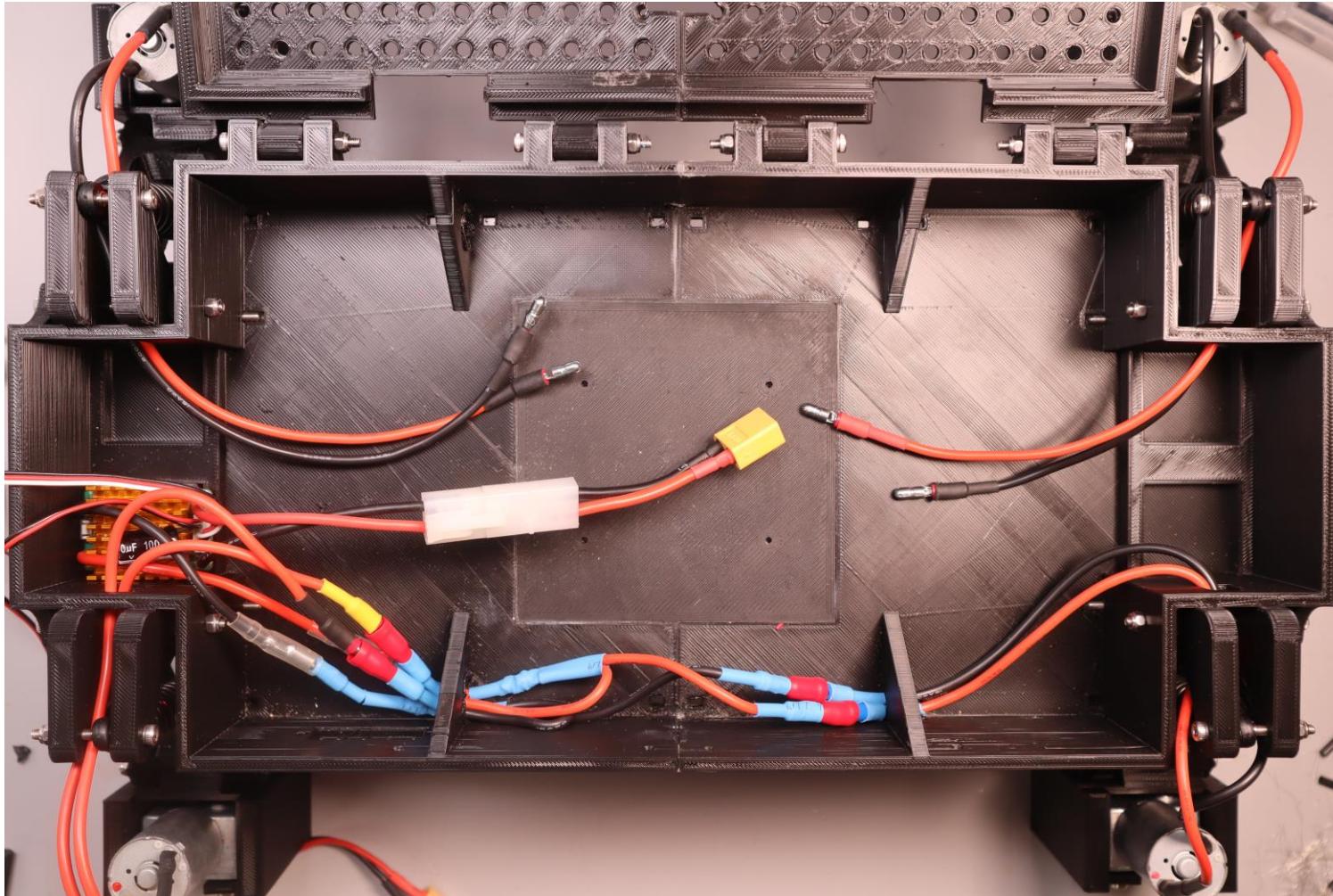
Step 1 Motor Driver Installation

1. Place both motor drivers in the rear slots of the rover
2. Then, using the motor driver cable you assembled in Step 0a, connect both the left motors to the left motor driver. Then do the same for the right motors and right motor driver.
 1. The Motor Driver Cable will allow you to connect both Motors to a single cable to be connected to your motor driver.
3. **Note: Make sure to connect all same colors together, Red to Red, Black to Black.**



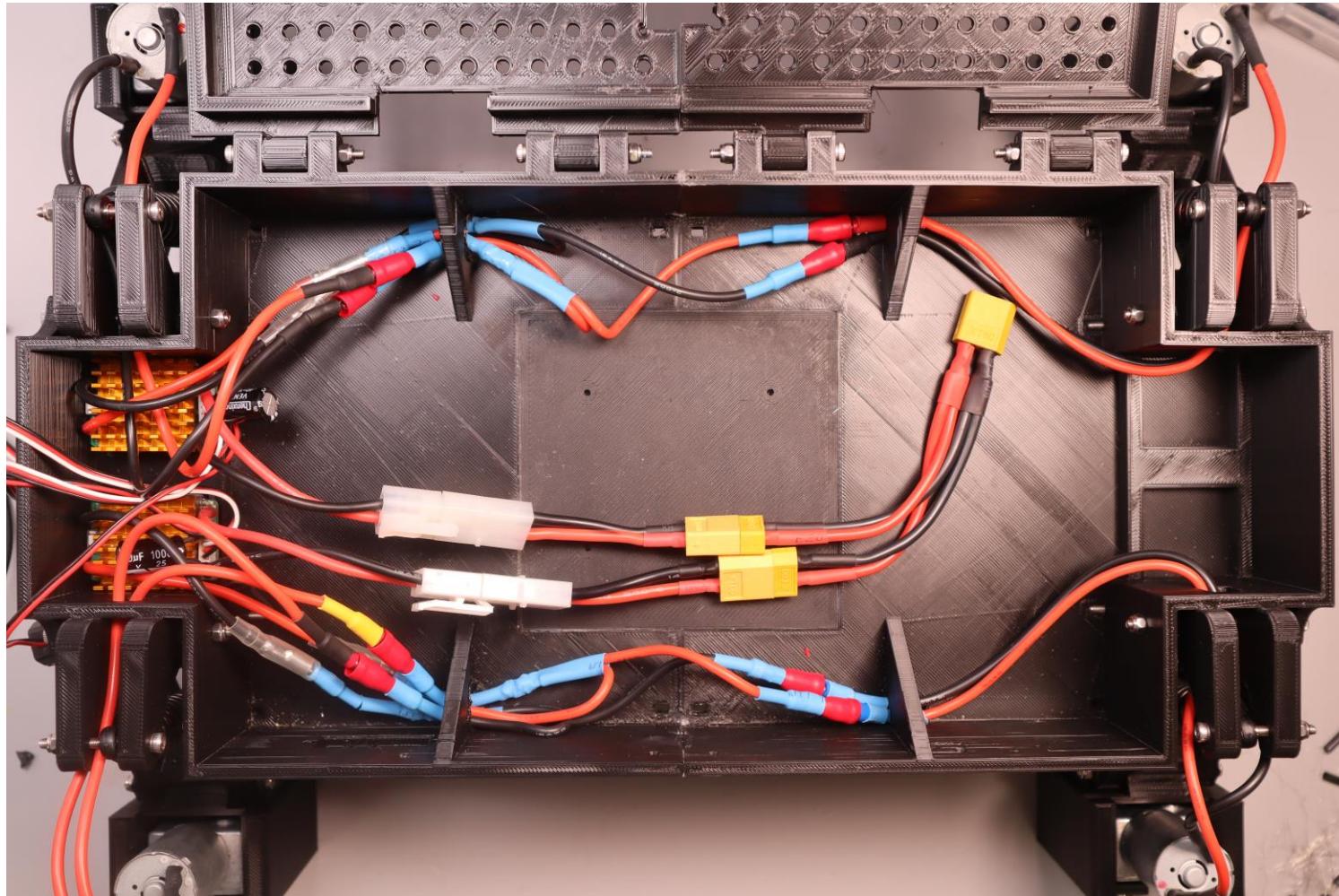
Step 1 Motor Driver Installation (Cont.)

Attach the Motor Driver Power Cable Adapter

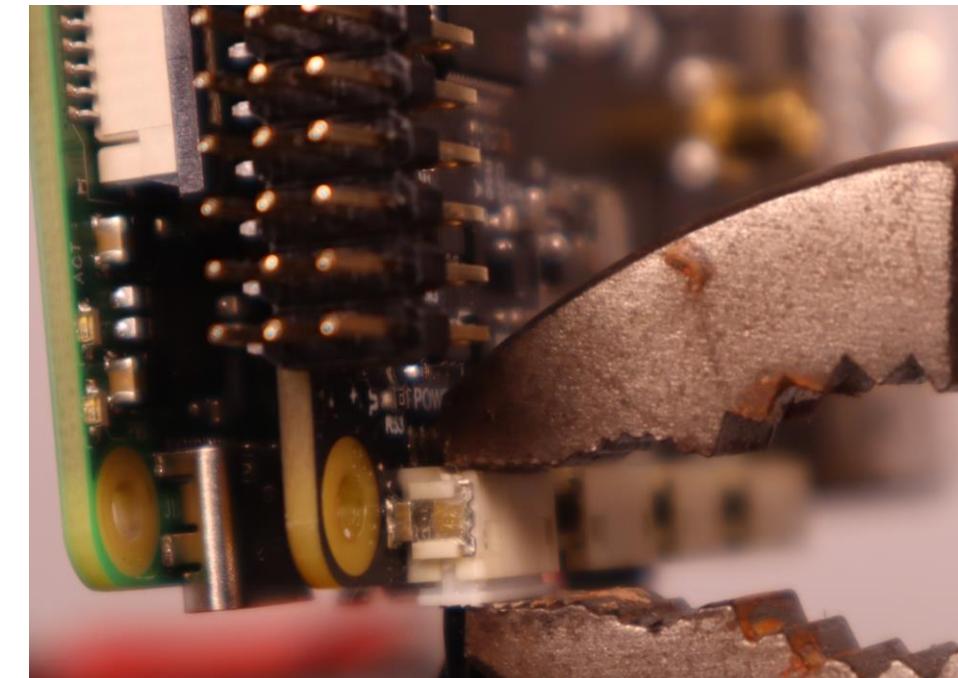
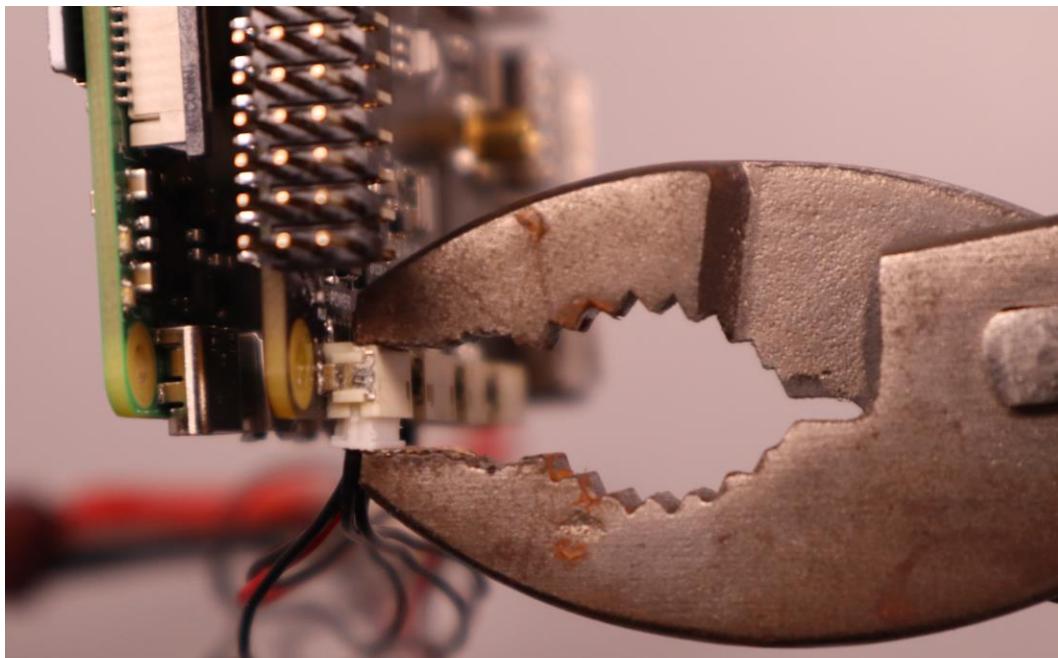


Step 1 Motor Driver Installation (Cont.)

Follow the same setup for the second motor driver, then attach both drivers to the XT-60 Splitter

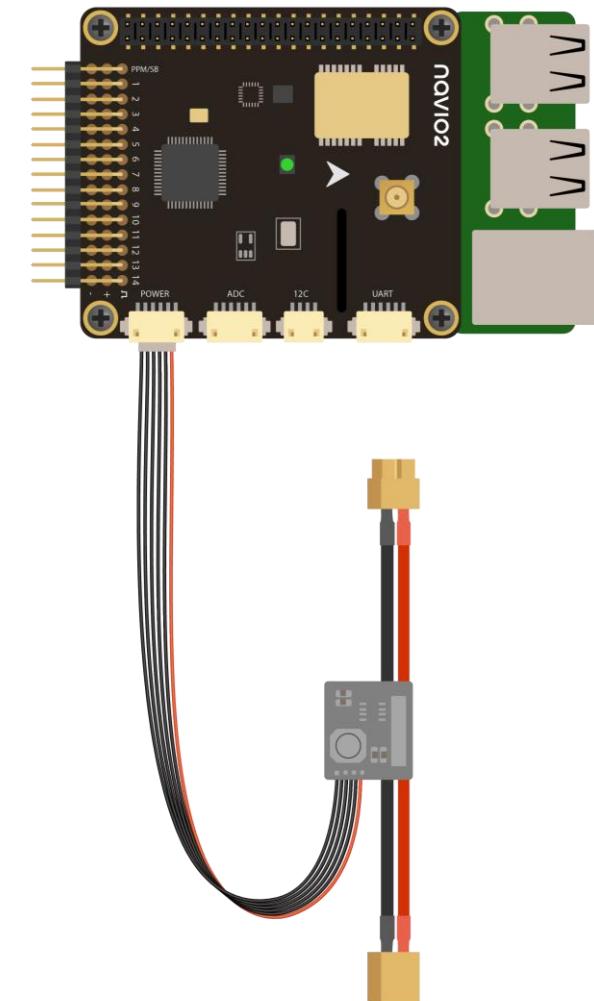
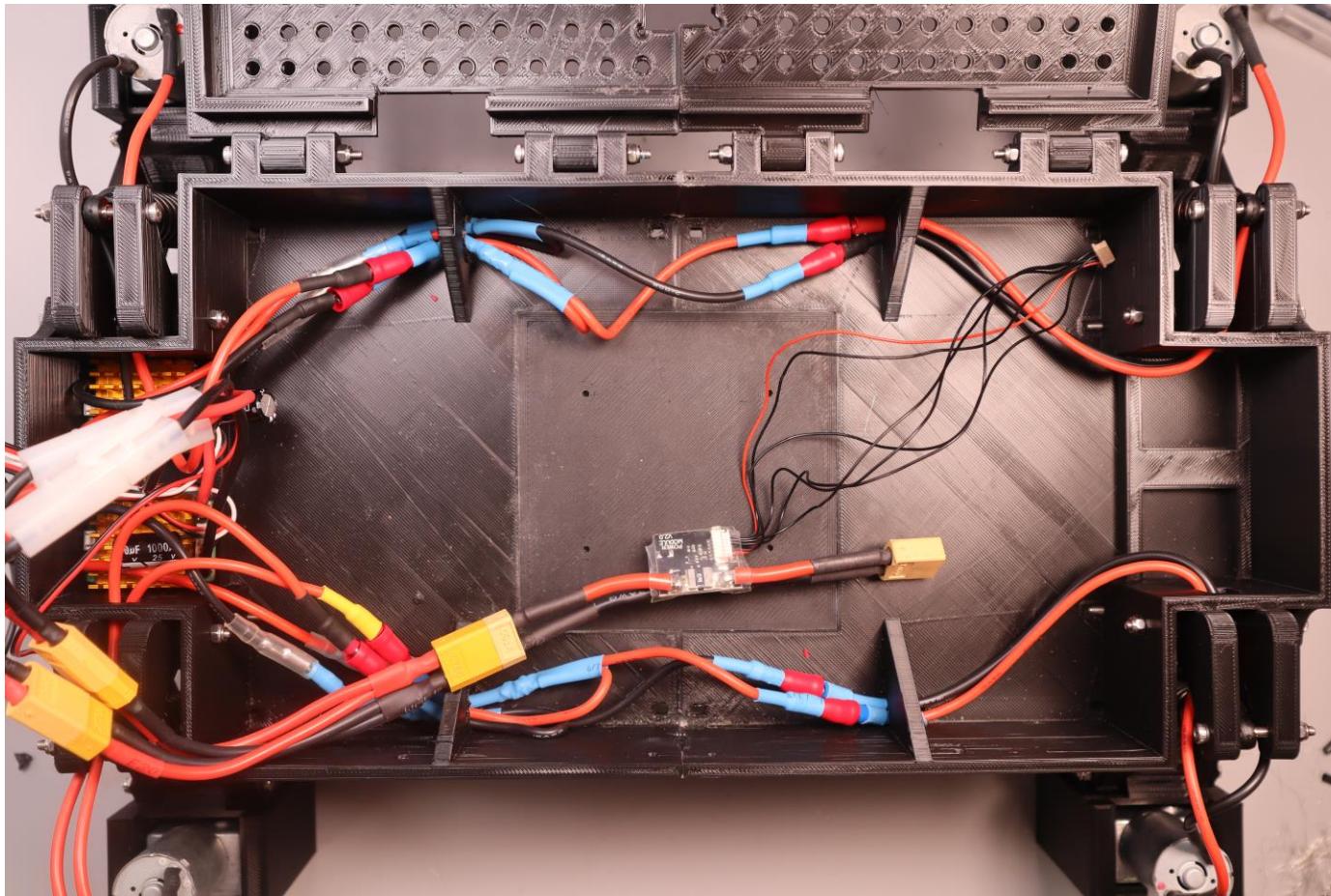


1. Brand new equipment can make inserting the Power Buck cable and Telemetry cable into the Navio2 more difficult
2. To resolve this, we must be extra careful the first few times inserting the cables, or else you run the risk of breaking off the port on the Navio2.
3. To avoid this, we want to support the back and top of the navio2 port when we insert the cable. Also, using tools like a small pair of pliers to apply even force across the connector and the port can also reduce the chance for breakage.
4. Shown in the figures below, we support both the port and the insert and gently close the pliers, making sure not to crush the wires or apply too much force. This should slowly ease into the port and reduce the chance of breaking.



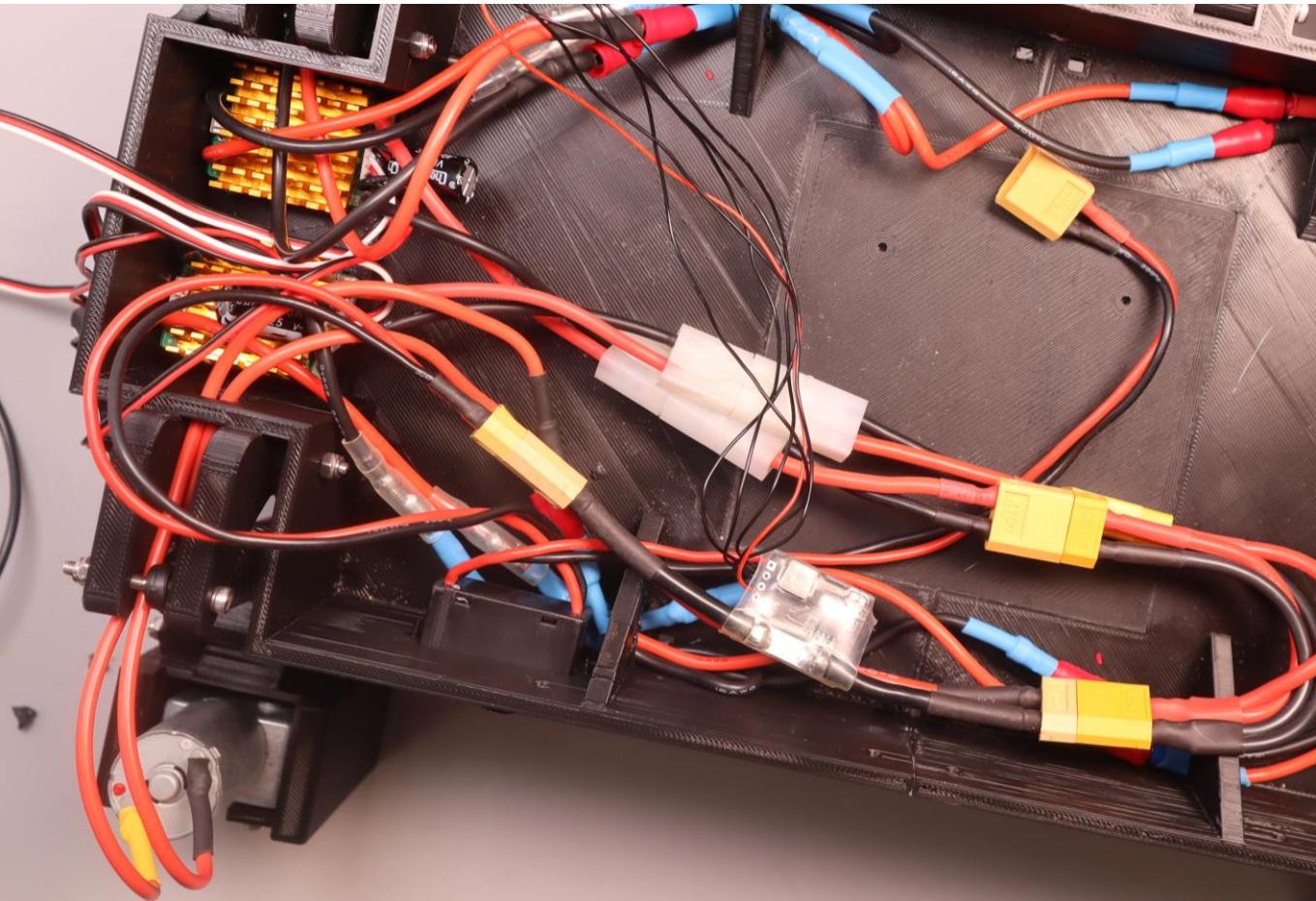
Step 3 Power Module Installation

1. Connect the Power Module to the Motor Driver splitter
2. Connect the Small Wiring Cable to the Navio2 PWR Slot



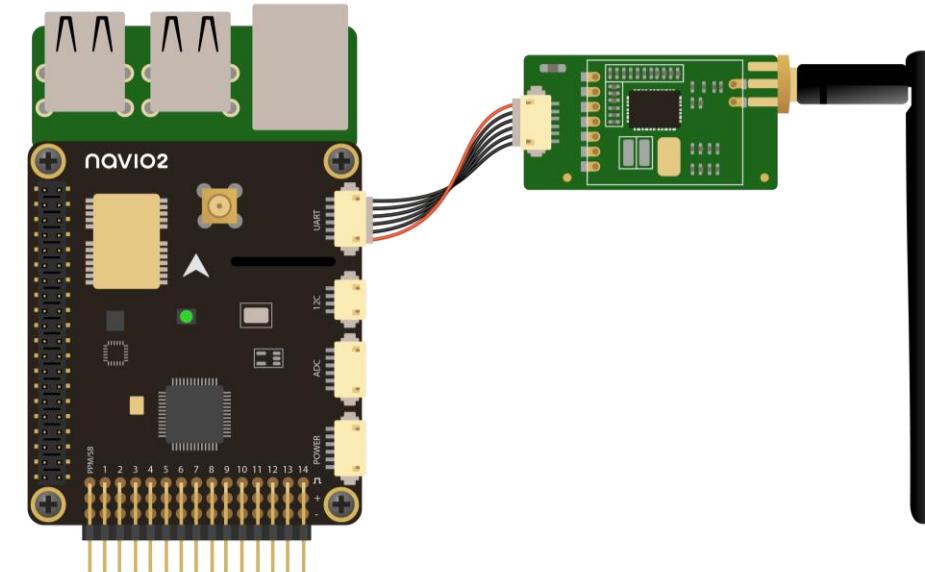
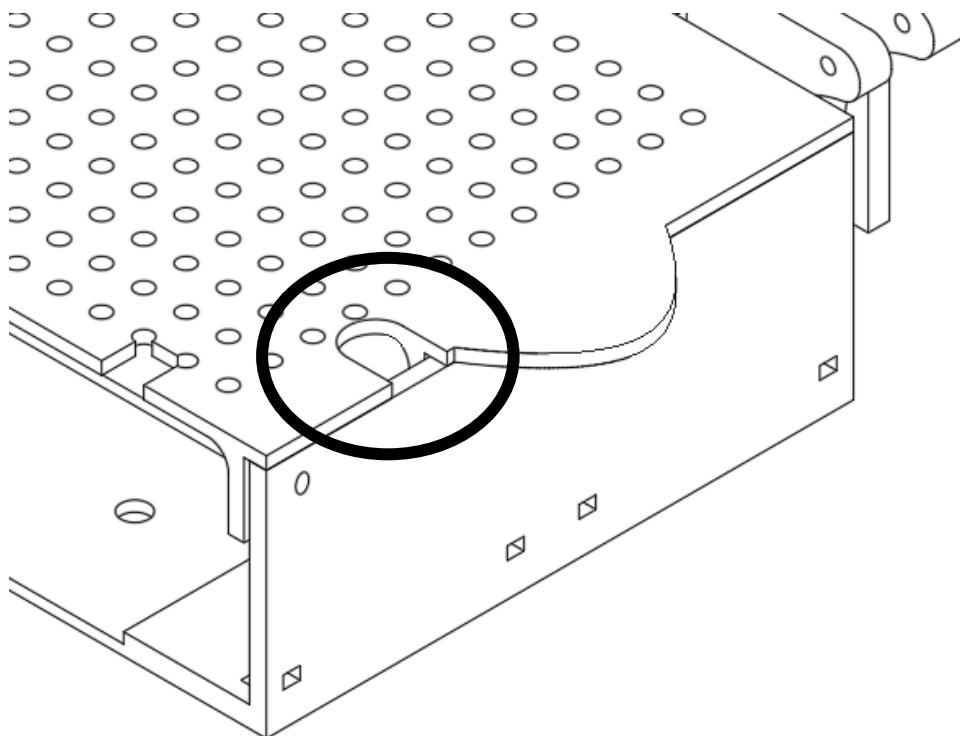
Step 4 Power Switch Installation

1. Place Power Switch in square cut-out on the Rear Rover Frame
 - If needed, sand to fit
2. Connect one of the cables of the switch to the power module



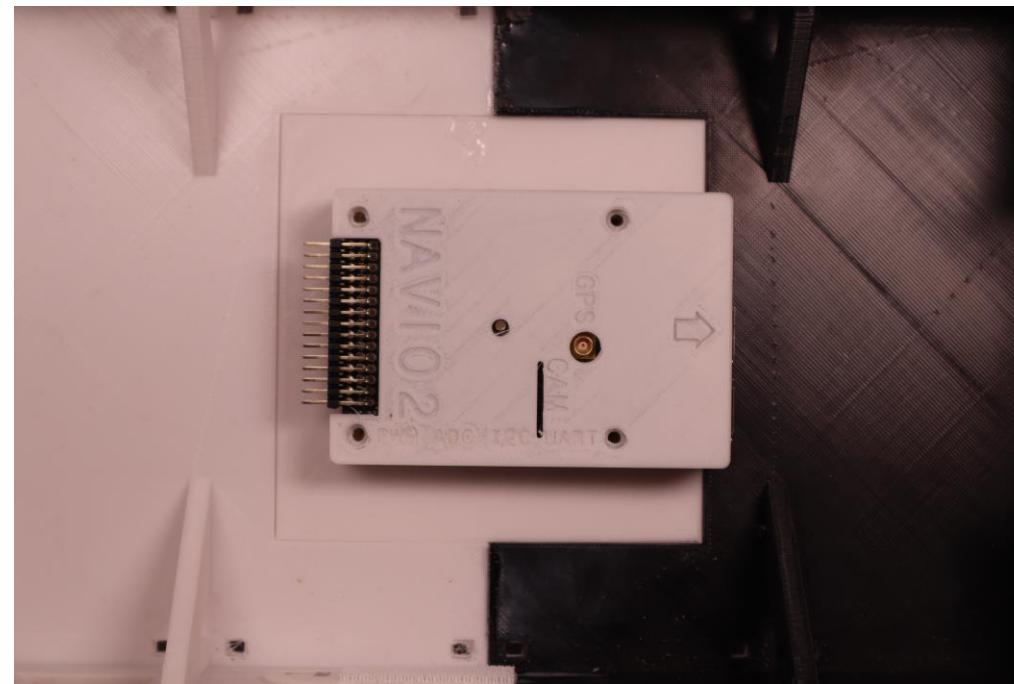
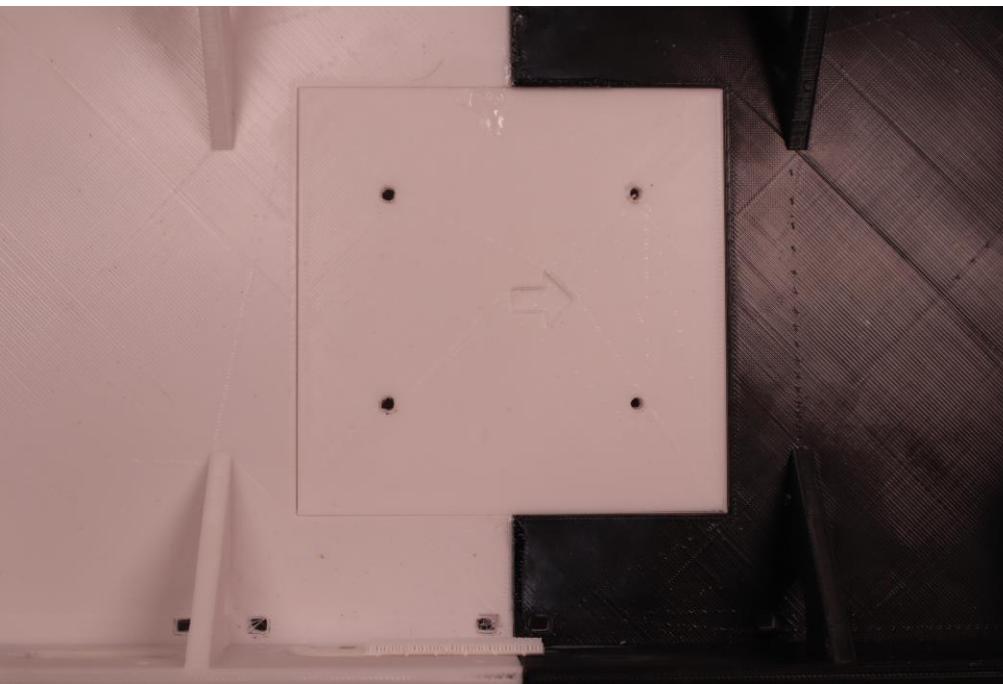
Step 5 Telemetry Radio Installation

1. Connect your Telemetry Cable to the UART Slot of your Navio2
2. Place Telemetry inside the chassis so that the antenna sticks out from the hole near the front handle of the rover frame.



Step 6 Navio2 Installation

1. Using M2.5 x 14 screws from the underside of the rover, you can secure the Navio2 to the frame with the Arrow pointed forward
2. The Arrow of the Navio should face the same direction as the arrow on the merge plate.
3. **Note: Make sure you have formatted your SD Card and inserted it before mounting to the Chassis as you can not remove the SD card while the case is mounted.**

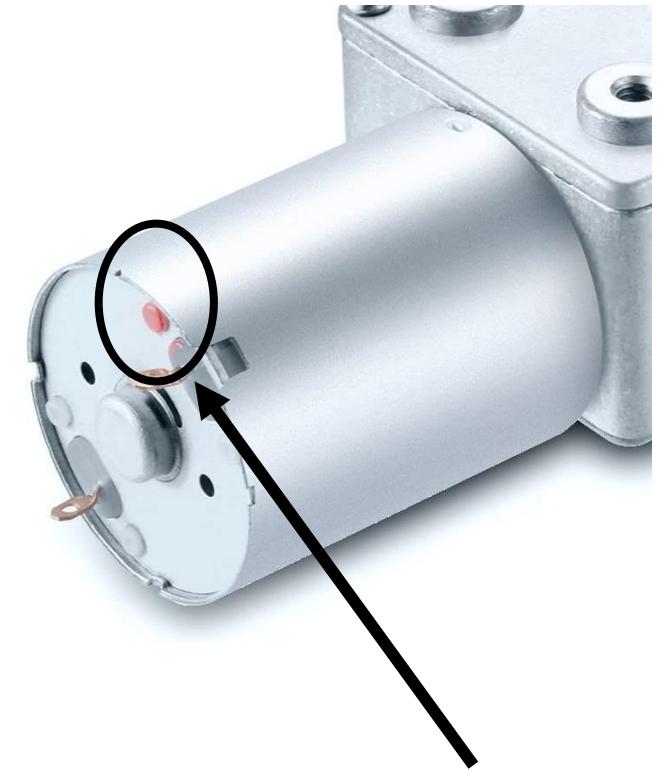


Step 7 Motor Connections if Soldering Motors

The motors in use have a red dot next to one of the power leads. If you connect your positive terminal here and negative terminal to the other, the motor will spin clockwise when facing you. Using this knowledge, we know what wiring order to attach to each side of our rover

For the right-side motors, you will attach the red wire of your motor driver to the ***red labeled*** power lead of your motors, with black attached to the other lead.

The left-side motors are opposite, you will attach the black wire of your motor driver to the red labeled power lead of your motors, with red attached to the other lead



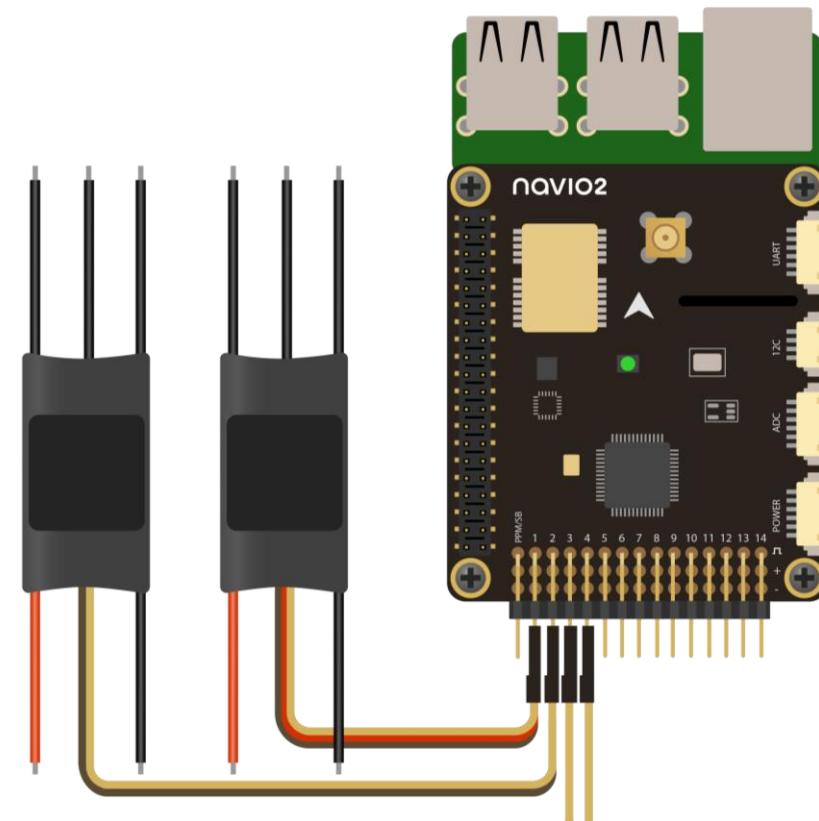
***Red Label**

Step 7 Motor Driver Connections

1. Attach the left motor driver cable to PWM Pin 1 (Second set of pins from the left)
2. Attach right motor driver Cable to PWM Pin 3 (Fourth set of pins from the left)
3. Note: Ensure you have the correct orientation, where the white cable is on top.

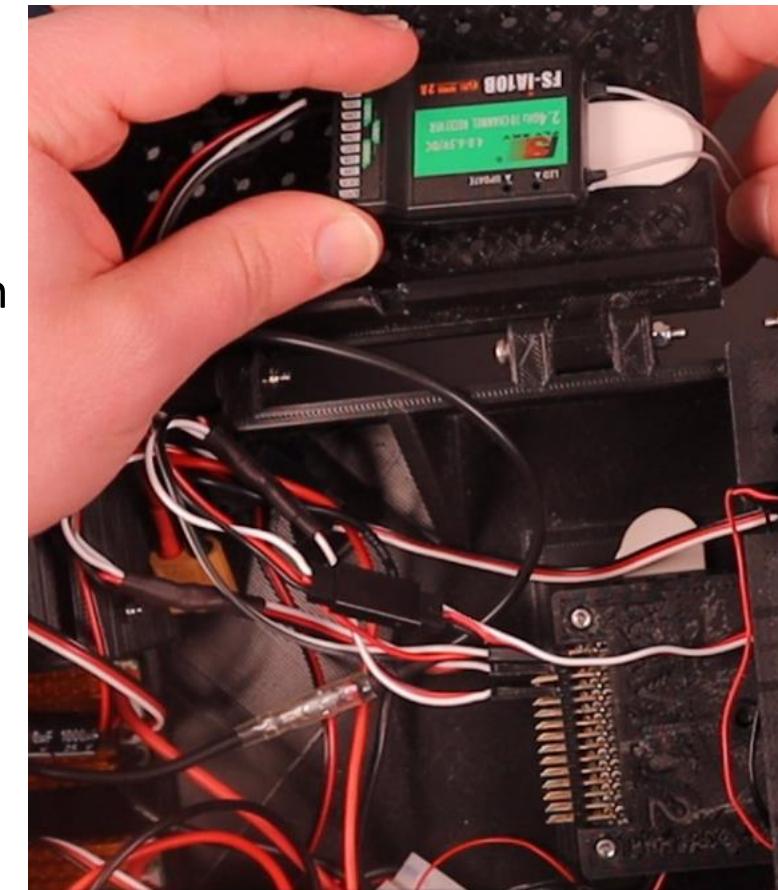
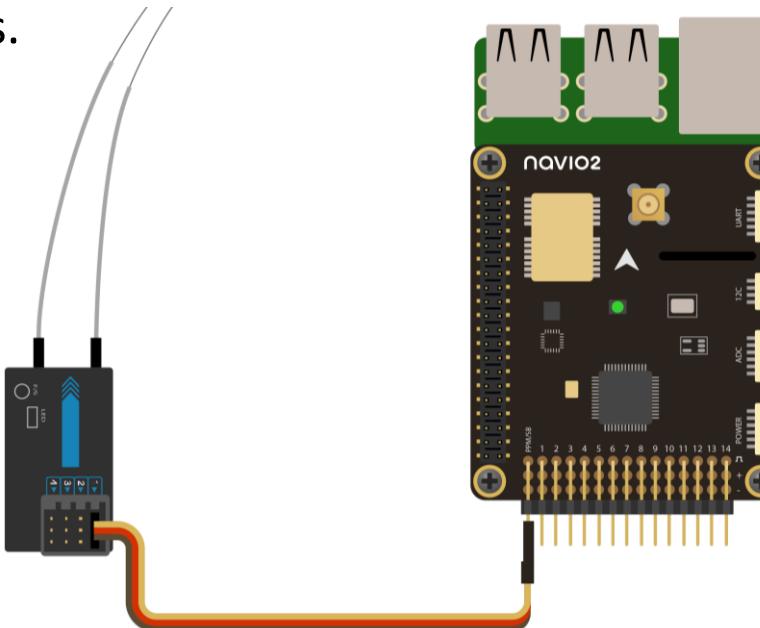
White/Yellow = Servo Signal, Red = Power, Black = Ground

4. Note: Remember that **only one of the motor drivers** should be providing power.
5. Navio Connections are in the following order from top row of pins to the bottom: Signal, Power, Ground



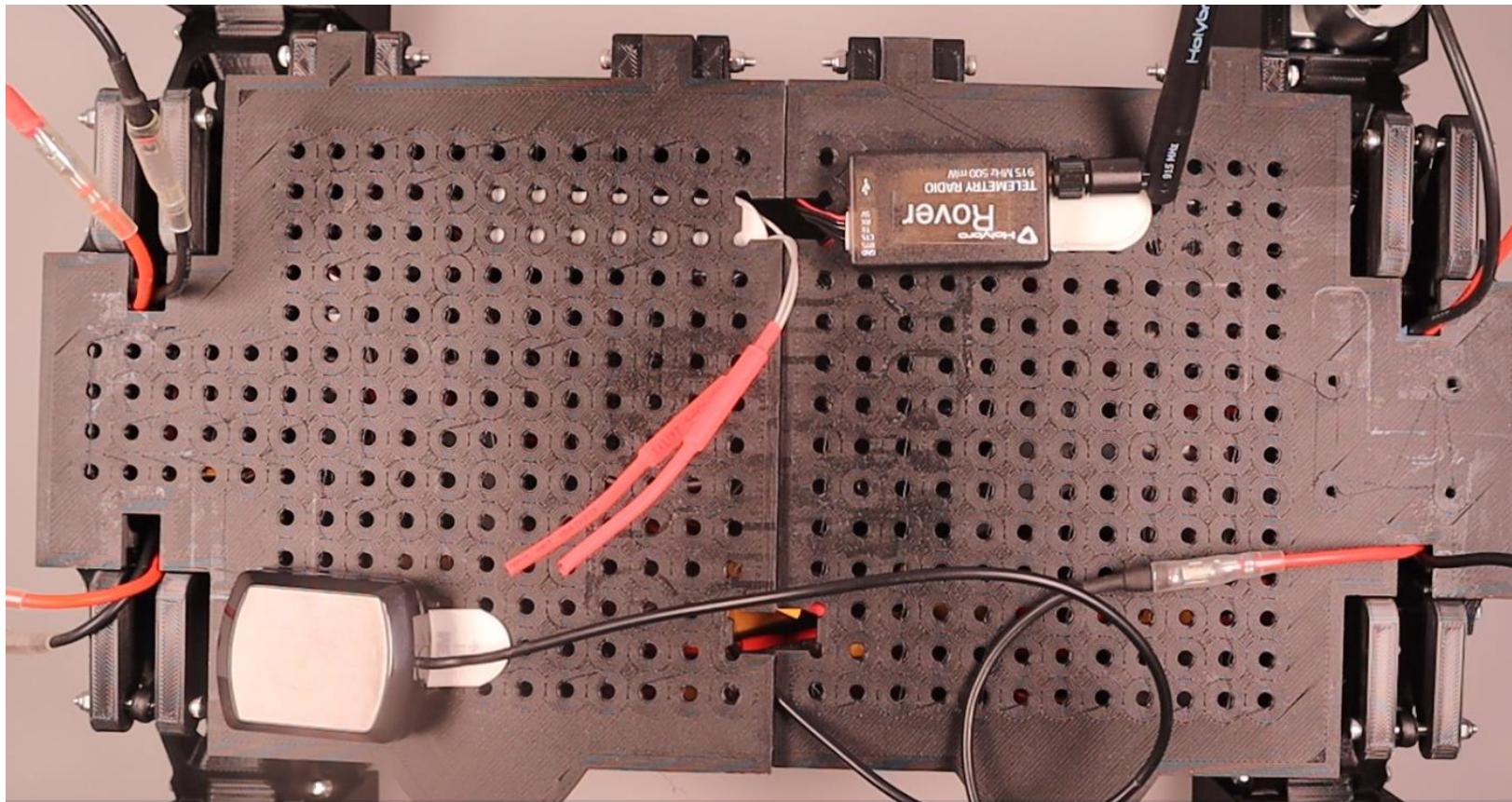
Step 8 Radio Installation

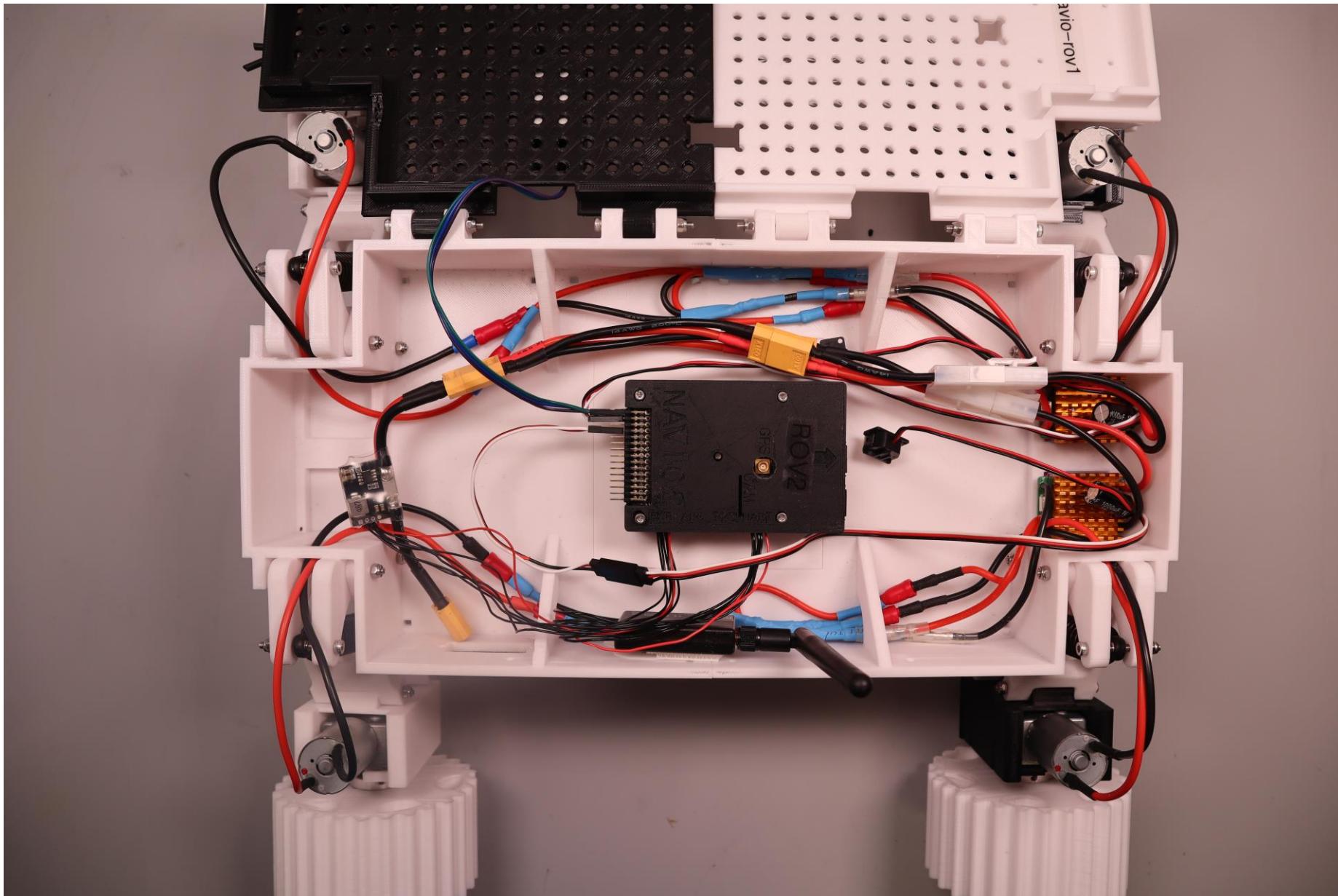
1. Connect Channel 1 of the Radio Receiver to the First Set of pins of the Navio2.
2. This will contain all the RC Inputs
3. Mount to the Lid of the Rover, Ensure some space between telemetry radio and GPS antenna to prevent interference.
Also, when mounting, test the range of motion of the lid and be aware of how the wiring length can interact with the motion.
Best practice is to feed the RC cable through the hole near the hinge of the lids.

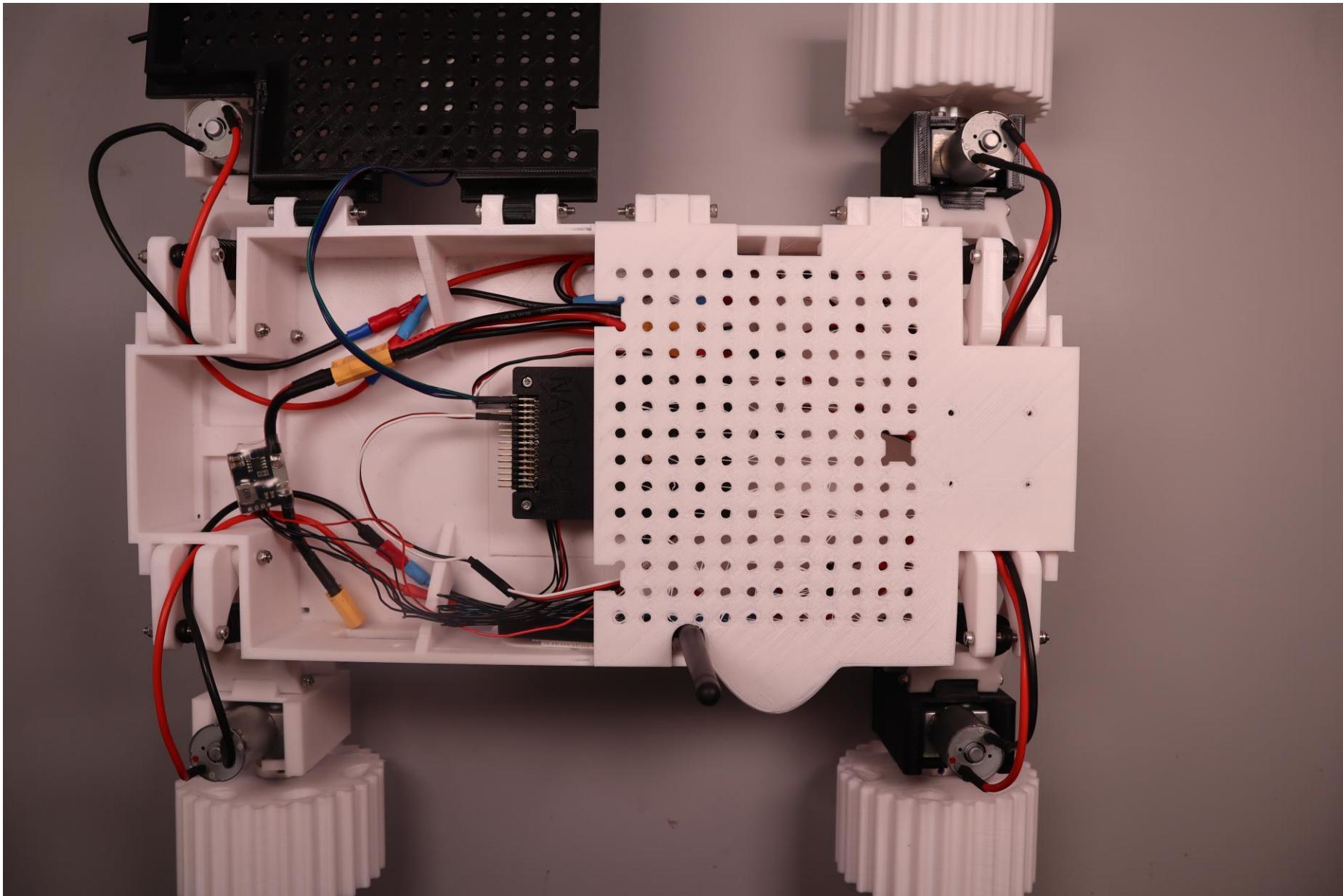


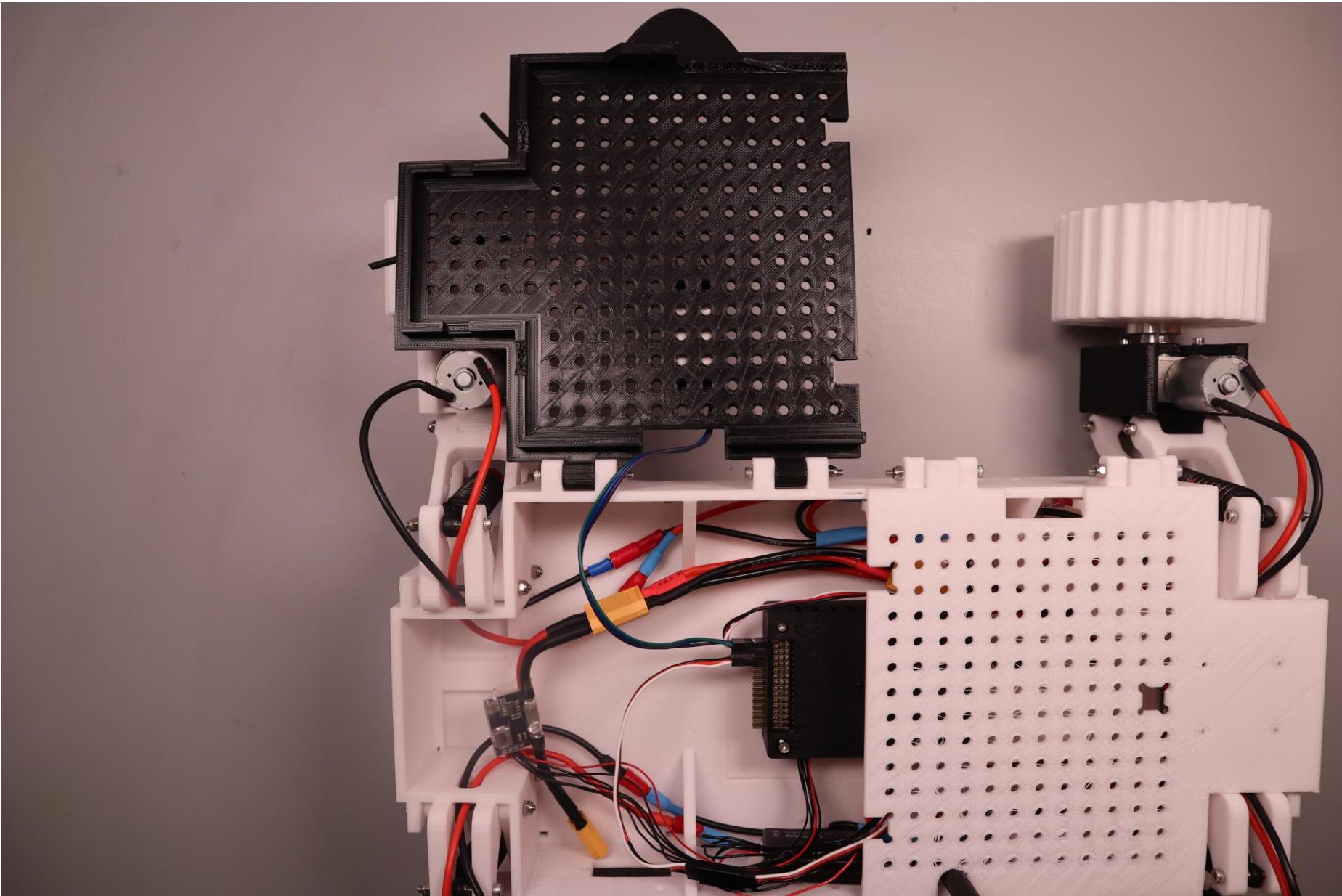
Step 9 GPS Antenna Installation

1. Connect the GPS Antenna to the GPS Slot on the Navio2
2. Feed to the top of your rover through the holes near the hinges of the lid. Then secure to the lid using either a stand or Velcro.



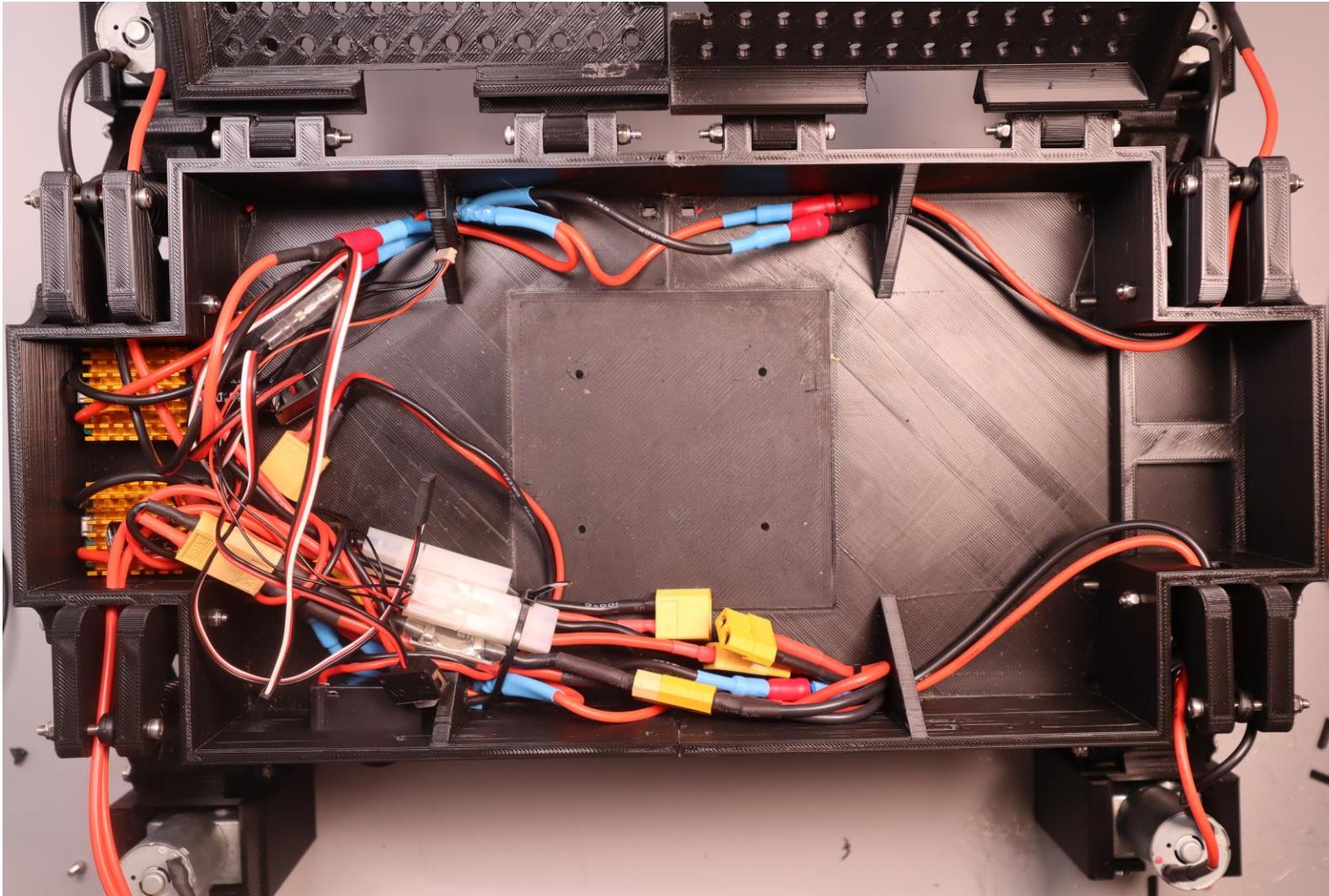






Wire Management

Use zip ties to secure wiring to the sides of the rover frame.



Sources

- <https://docs.emlid.com/navio2/hardware-setup/>