RERASSOR Manual

Document last updated 4/3/25

Research and **E**ducation – **R**egolith **A**dvanced **S**urface **S**ystems **O**perational **R**obot

This version of the RERASSOR rover attempts to reduce cost and complexity of the 3D printing, assembly, and programming required.

rerassor.com

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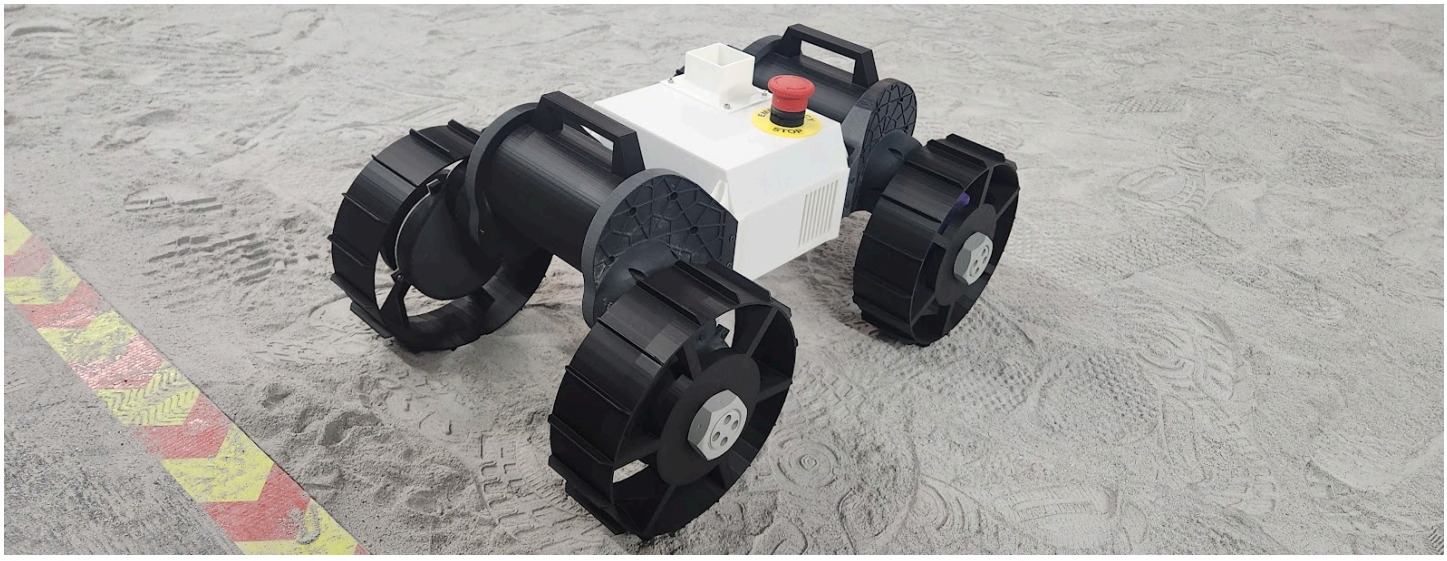
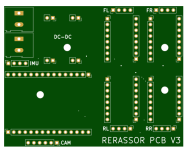
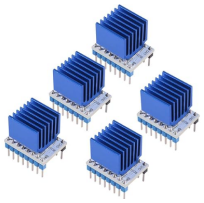


Bill Of Materials

Item	Image	Item Quantity. NOT order quantity	Amazon	Alternate Link
PLA		About 3 KG		
NEMA 17 48mm		4	https://www.amazon.com/STEPPERONLINE-Stepper-Bipolar-Connector-compatible/dp/B00PNEQKC0?s=industrial&sr=1-3	https://www.aliexpress.us/item/3256806136100768.html
PCB boards (Abbie can pick up, I have 4 extra)		1 (Although minimum of 5 is required for order)	https://www.pcbway.com/project/shareproject/RE_RASSOR_PCB_V3_8b62415e.html	Use PCBWAY
MPU9250		1	https://www.amazon.com/HiLetgo-Gyroscope-Acceleration-Accelerator-Magnetometer/dp/B01I1J0Z7Y?sr=8-3	Use Amazon
ESP32		1	https://www.amazon.com/ESP-WROOM-32-Development-Microcontroller-Integrated-Compatible/dp/B07WCG1PLV?sr=8-3	https://www.aliexpress.us/item/3256805517875317.html Select Micro
2 pin 5mm pitch terminal screw block		2	https://www.amazon.com/Yootop-50Pcs-Terminal-Connector-Arduino/dp/B07CZYGQQ3?sr=8-3	https://www.aliexpress.us/item/3256803370640670.html Select 2 pin, 5 pcs
2.54mm 8 pin female header		8	https://www.amazon.com/Female-Headers-2-54mm-Single-Connector/dp/B08T6LJ6RM/ref=sr_1_6?sr=8-6	https://www.aliexpress.us/item/3256801232229618.html Select 8P, 10pcs
2.54mm 15 pin female header		2	https://www.amazon.com/2-54mm-Female-Single-Straight-Header/dp/B0	https://www.aliexpress.us/item/3256801232229618.html

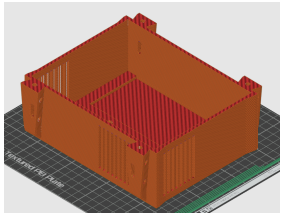
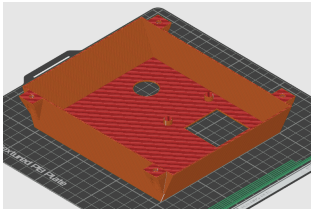
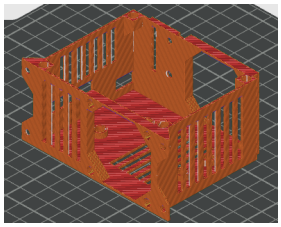
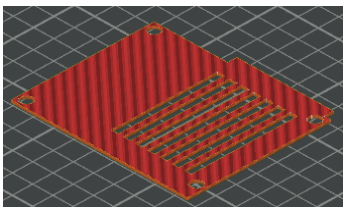
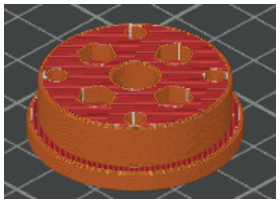
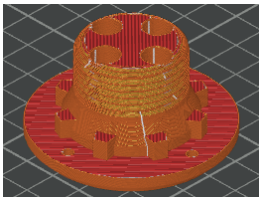
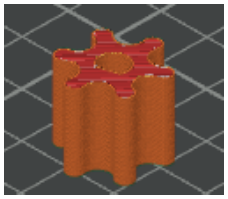
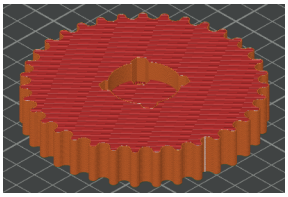
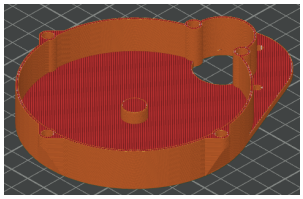
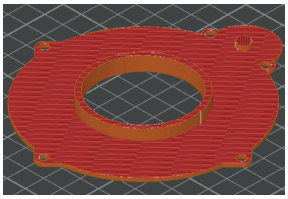
			7VP63Z78?sr=8-6#customerReviews	Select 15P, 10pcs
Bearing - 35x47x7		4	https://www.amazon.com/uxcell-6807-2RS-Bearing-35x47x7mm-Bearings/dp/B07RP6RDYL?sr=8-3	https://www.aliexpress.us/item/2251832675019976.html
Bearing - 12x28x8		4	https://www.amazon.com/uxcell-6001-2RS-Groove-Bearing-Bearings/dp/B07FDXPVLP?sr=8-4	https://www.aliexpress.us/item/3256804548368916.html
M3 socket screw assortment		1	https://www.amazon.com/iExcell-Stainless-Metric-Socket-Washers/dp/B0812TYT5L?sr=8-4	Use Amazon
12V 10a LiFePO4 battery		1	https://www.amazon.com/Lithium-LiFePO4-Rechargeable-Maintenance-Free-Lighting/dp/B097BRKCQP?sr=8-3	Use Amazon
12V battery charger		1	https://www.amazon.com/ULTRAPOWER-LiFePO4-4-stages-Motocycles-Automatically/dp/B08MPX414R?sr=8-6	Use Amazon
TMC2208s		4	https://www.amazon.com/Printer-TMC2208-Screwdriver-Controller-Ramps1-4/dp/B082LSQWZF?sr=8-2	Use Amazon
Female-Female Dupont Cables (short)		4	https://www.amazon.com/Solderless-Multicolored-Electronic-Breadboard-Protoboard/dp/B09FP1WF8Q?sr=8-5	https://www.aliexpress.us/item/3256806568245944.html Select 10CM female to female

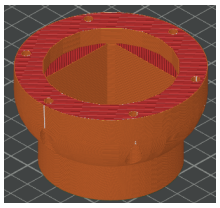
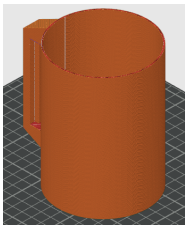
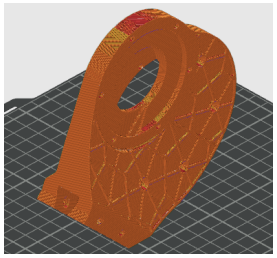
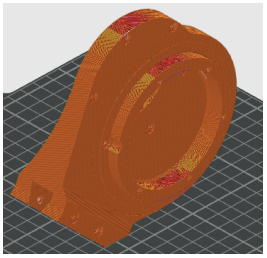
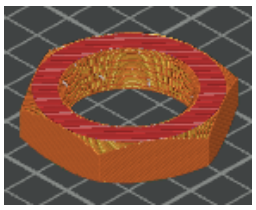
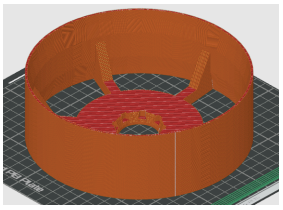
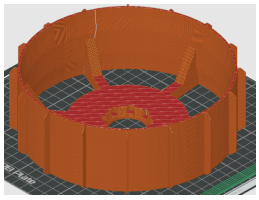
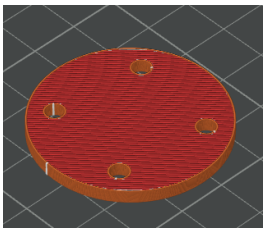
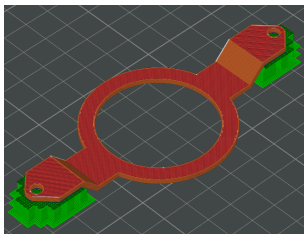
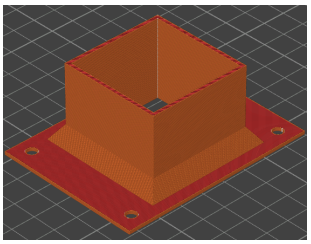
2.54mm male header breakaway connectors		A few strips	https://www.amazon.com/HiLetgo-20pcs-2-54mm-Single-Header/dp/B07R5QDL8D?sr=8-4	https://www.aliexpress.us/item/2251832786866410.html
MP1584 DC-DC Buck Converter Module		1	https://www.amazon.com/MP1584EN-DC-DC-Converter-Adjustable-Module/dp/B01MQGMOKI?sr=8-3	https://www.aliexpress.us/item/3256805684077964.html
SLA Battery Terminal Leads, Female Spade Quick Connect 6.3mm F2 Type Terminals 16 Gauge Wire		1 pair	https://www.amazon.com/Connect-Disconnect-Terminals-Insulated-Sleeves/dp/B0B8GNKV2C?sr=8-3	https://www.aliexpress.us/item/3256804003563730.html Select single head, 6.3mm
Emergency Stop Button		1	https://www.amazon.com/mxuteuk-Mushroom-Emergency-Warranty-HB2-ES544/dp/B07R8PTTDX?sr=8-3	Use Amazon
5v Fans		2	https://www.amazon.com/WINSINN-Brushless-Cooling-Graphics-Motherboard/dp/B07LBCY4K9?sr=8-1	https://www.aliexpress.us/item/3256803700037663.html Select 5V-Hydraulic
M3 Heat set inserts		Around 50, unsure exactly	https://www.amazon.com/HANGLIFE-Heat-Set-Threaded-Printing-Components/dp/B0CS6VZYL8?sr=8-4	https://www.aliexpress.us/item/3256803396040989.html Select M3 (OD 5mm), Length 4mm
Fork Spade Connectors		4	https://www.amazon.com/smseace-terminals-Insulated-Electrical-connectors/dp/B0BBFJSYVJ?sr=8-3	Use Amazon
Threadlocker Blue		1	https://www.amazon.com/Loctite-Heavy-Duty-Threadlocker-Single/dp/B000I1RSNS/ref=sr_1_6?sr=8-6	https://www.aliexpress.us/item/3256807290650452.html

3D Printed Parts

RE_RASSOR_FILES

X KG of PLA filament, 256mm^3 print bed needed

Slicer Thumbnail	Quantity	Print Notes			
 SB_Body.stl	1	0.2mm layer height, no support	 SB_Body_Top.stl	1	0.2mm layer height, no support
 SB_Electronics_Case.stl	1	0.2mm layer height, no support, note orientation	 SB_Electronics_Case_Top.stl	1	0.2mm layer height, no support
 SB_Bearing_Holder.stl	4	0.2mm layer height, no support, note orientation	 SB_Threaded_Output.stl	4	0.15mm layer height, no support
 SB_Small_Gear.stl	4	0.2mm layer height, no support	 SB_Big_Gear.stl	4	0.2mm layer height, no support, note orientation
 SB_Gearbox_Housing.stl	4	0.2mm layer height, no support	 SB_Gearbox_Top.stl	4	0.2mm layer height, no support

 SB_Motor_Housing_Nema17x__mm.stl	4	Print version corresponding to length of stepper 0.2mm layer height, no support, note orientation	 SB_Handle.stl	2	0.2mm layer height, no support
 SB_Shoulder.stl	2	0.2mm layer height, no support, note orientation Bambu studio error about floating regions is OK	 SB_Shoulder_Mirrored.stl		0.2mm layer height, no support, note orientation Bambu studio error about floating regions is OK
 SB_Nut.stl	4	0.15mm layer height, no support Might need to be scaled dependent on printer config	 SB_Wheel_Road.stl	4	0.2mm layer height, no support
 SB_Wheel_Regolith.stl	4	0.2mm layer height, no support	 SB_Spacer.stl	4	0.2mm layer height, no support
 SB_Gearbox_Top_Brace.stl	4	0.2mm layer height, with support	 SB_Body_Intake.stl	1	0.2mm layer height, no support

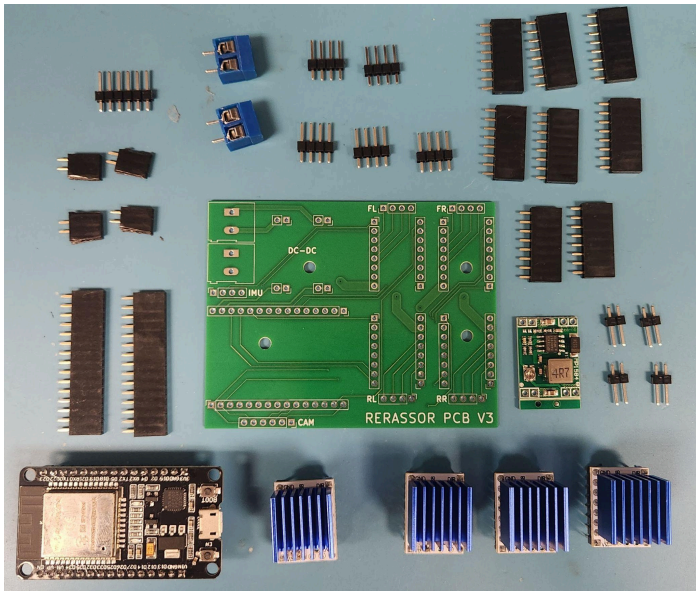
Tools Needed

- 3D Printer
- Soldering iron and solder
- Wire strippers, cutters, and crimpers
- Multimeter
- 2.5mm Hex screwdriver or Allen key
- Small and large Phillips head screwdrivers
- Flathead screwdriver
- Micro USB to USB A cable

Nice to haves

- Adjustable DC power supply
- Self adjusting wire strippers
- Soldering helper hands
- Small alligator clip wires

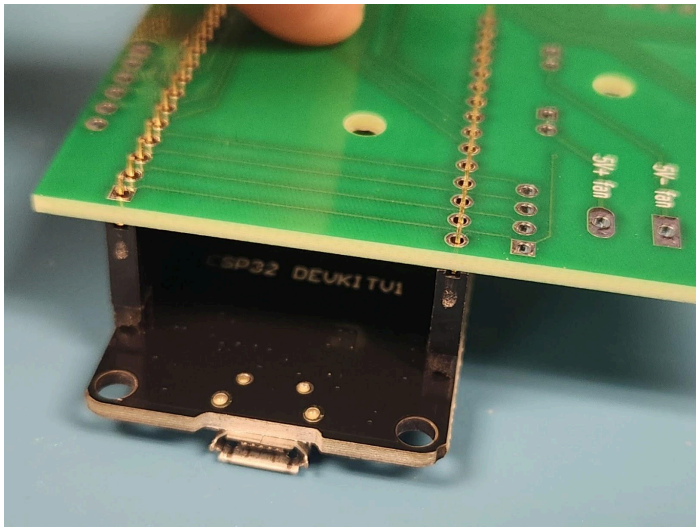
PCB Assembly



1. Gather all of the above

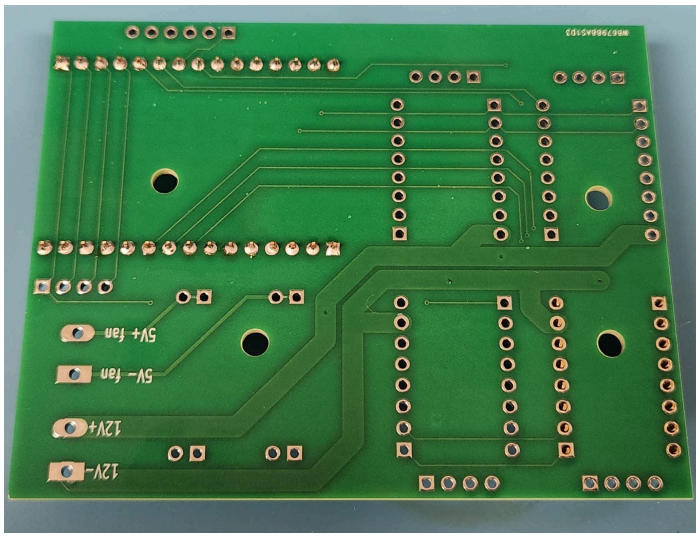
Soldering tips:

- Use less solder than you think you need.
- Let the iron's tip heat up the surface and pin before applying solder. (maybe 2 seconds)
- After applying solder, leave it there for an extra 2 seconds to let it fully melt around the pin.

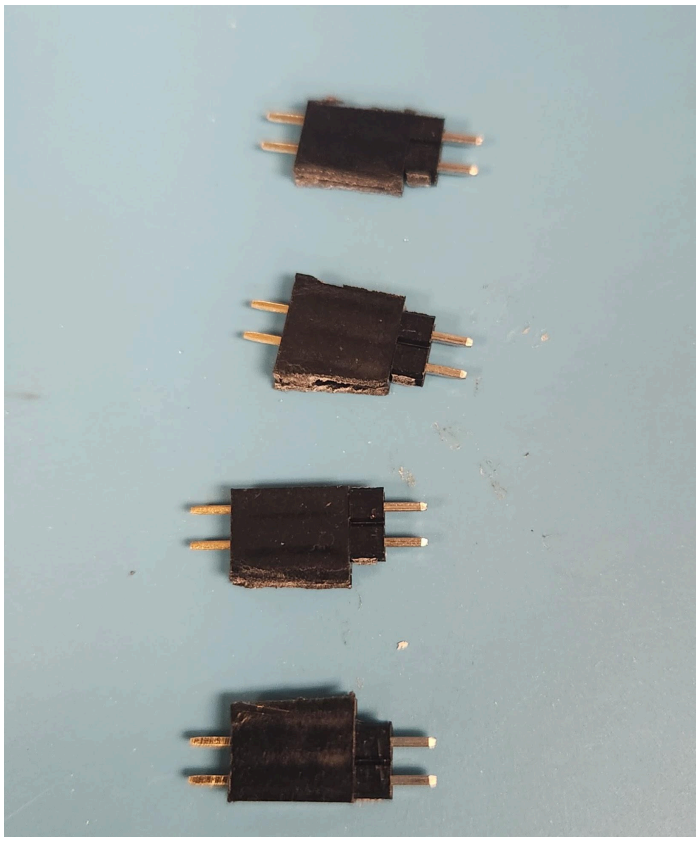


2. Start by soldering the 2 15 pin female sockets into the board. Plug the ESP32 into them for stability when soldering.

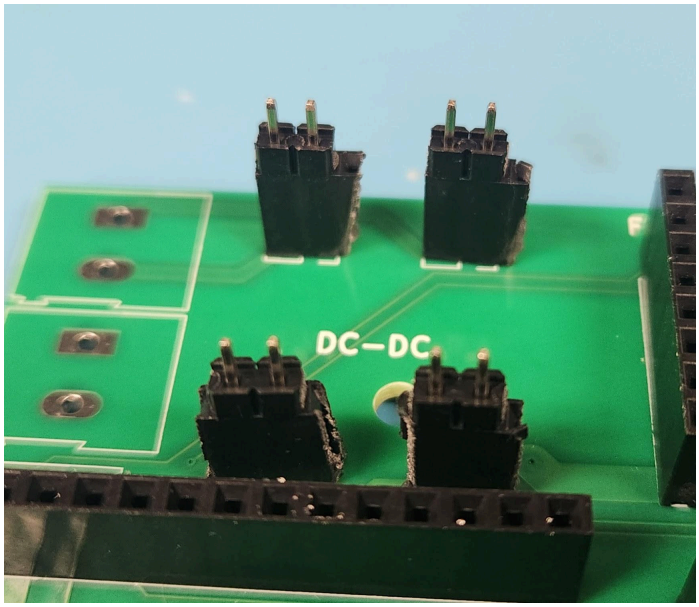
Note: All the components mount on the side that says "RERASSOR PCB V3".



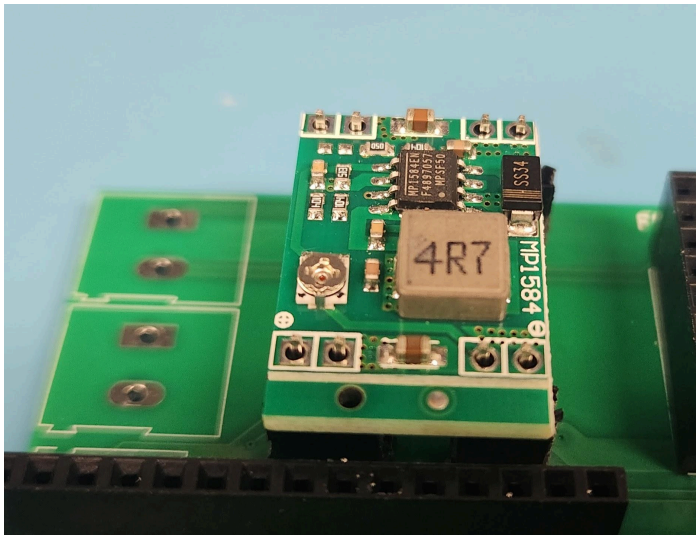
3. Insert the 2 8 pin sockets on the bottom right and solder those first for stability. Repeat for the 3 other pairs of 8 pin sockets for the stepper motor drivers



4. Create 4 2 pin female sockets by cutting some female pins to length.



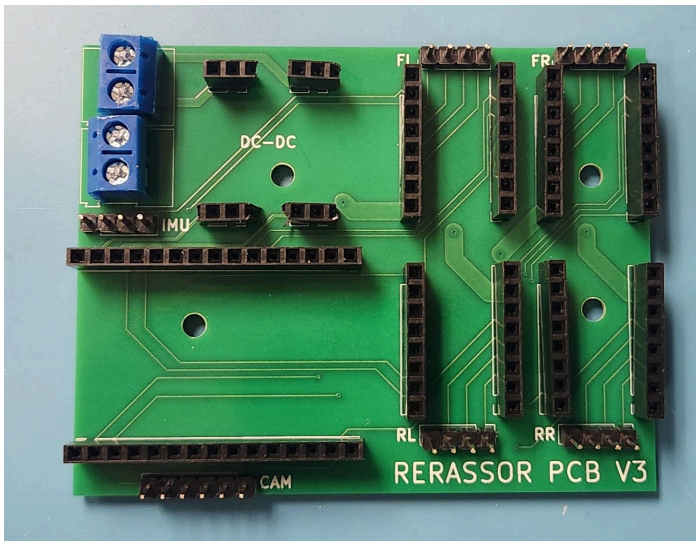
5. Insert the socket side of the pins into the board, don't solder them onto the PCB yet.



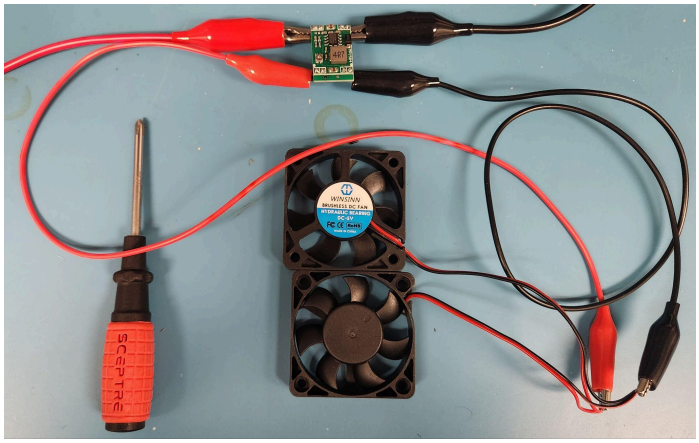
6. Place the MP1584 onto the pins, and solder the MP1584 to them.

7. Flip the PCB over and solder the other side.

Continue soldering the IMU pins, stepper motor pins, and CAM pins onto the board



8. Solder the screw terminals last, with the fan screw terminal facing into the board.



9. To tune the MP1584, you will need a 12V power source (A DC-DC adjustable power supply makes this easy, although a 12v battery will work), a multimeter, 2 pairs of alligator clips, and a screwdriver.

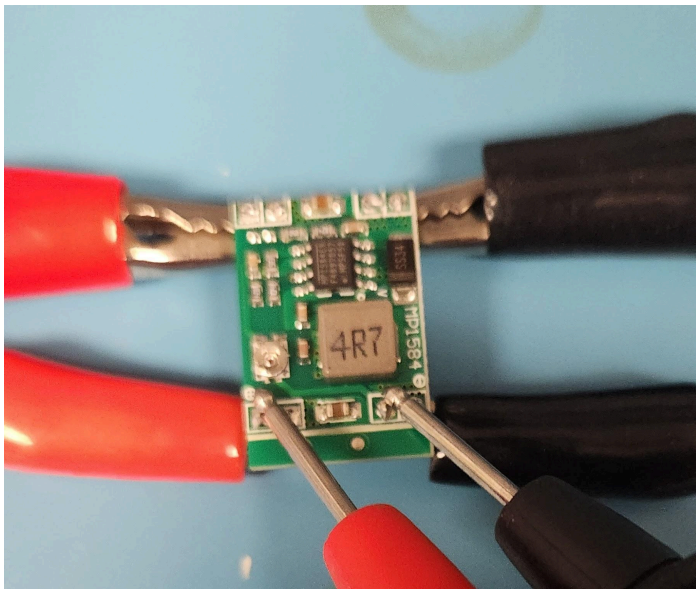
9 Continued.

When tuning, the MP1584 must have a load on it, therefore the need for the 2 fans. If you give the MP1584 12v high enough amps with no load, it will burn.

Turn the potentiometer to the halfway point. You can find this by finding the minimum and maximum and then turn it to the halfway point.

After ensuring you have a load connected to the output of the MP1584 with correct polarity, connect your 12v power source to the input of the MP1584.

After connecting/turning on the 12V power source, the fans should turn. If not, slightly adjust the potentiometer higher (clockwise).

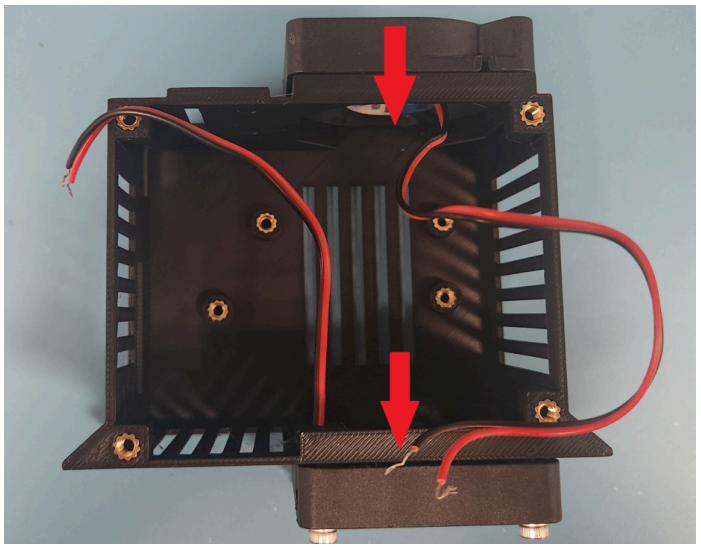


10. You can measure the DC voltage from the output side of the MP1584.

11. Ballpark 5V is fine. The ESP32 has its own voltage regulator onboard.

Electronics Case Assembly

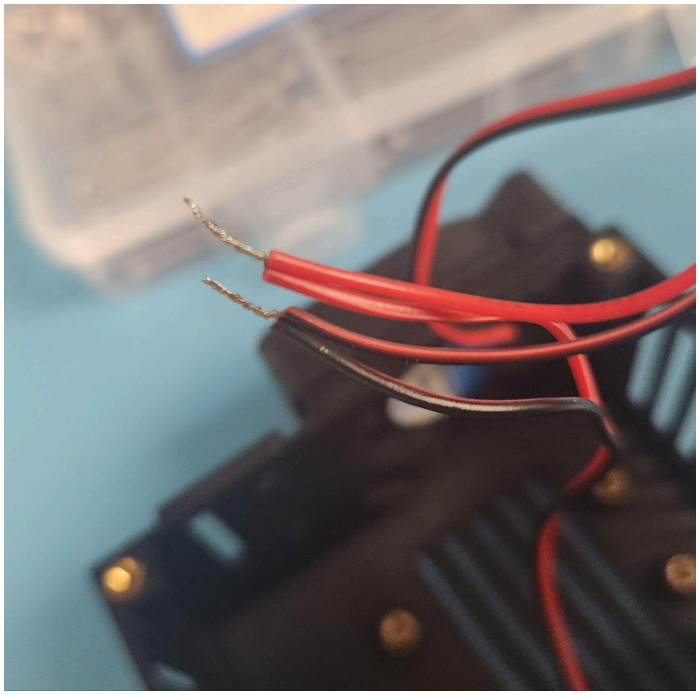
1. Insert 16 M3 heat set inserts.
   How to Install Heat Set Inserts into your…



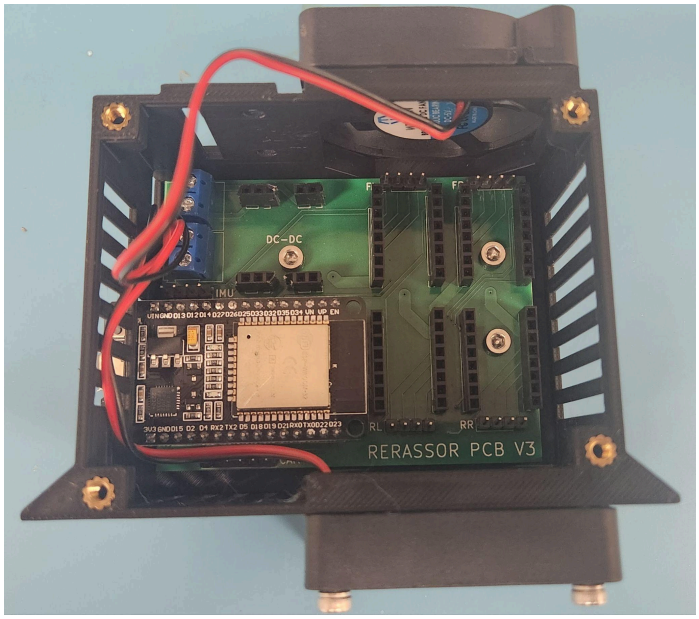
2. Attach 2 5v 5010 fans. Strip the ends of the fan wires. Top fan uses 4 M3x12. Bottom fan uses 4 M3x16 with 2 washers. Wires from

fans should go into the case. Arrows indicate direction of airflow.

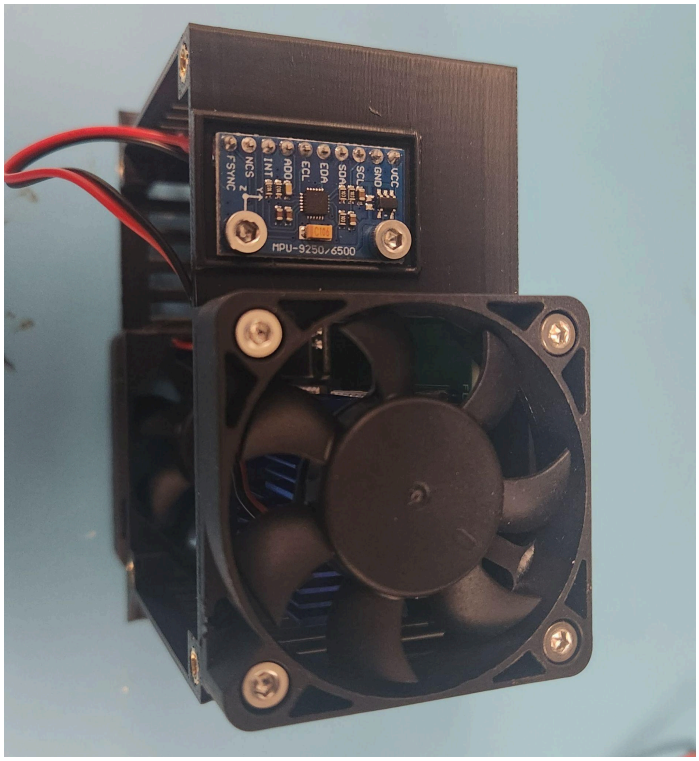
- How To Use The Automatic Wire Stripper
- How To Use Wire Strippers-FULL Tutorial



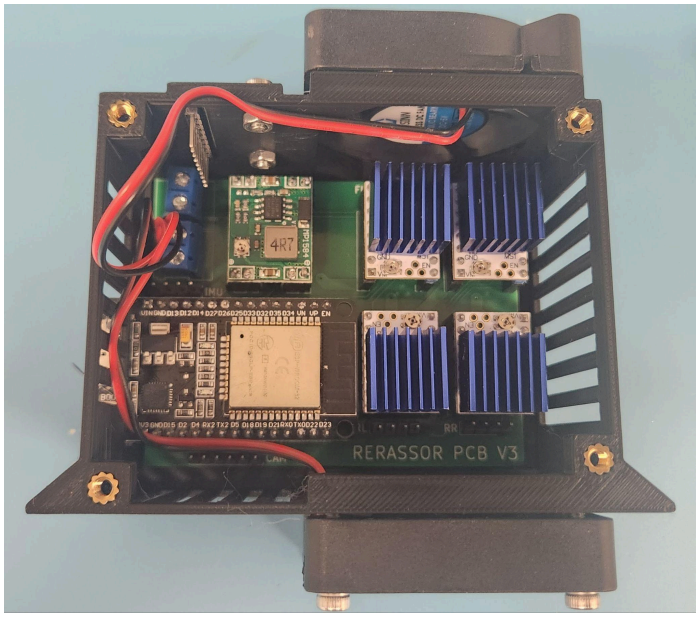
3. Twist the ends of the correctly paired wires together from the fans and add a tiny amount of solder. (hopefully I will replace this with real connectors at some point)



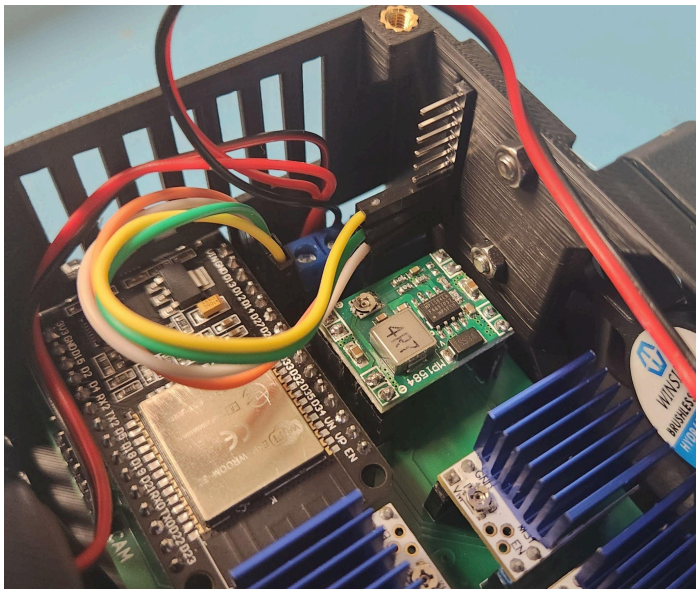
4. Before inserting the assembled PCB into the case, secure the fan wires into the appropriate screw terminal. Insert the ESP32 into the PCB, drop it into the case, and secure it with 3 M3x4 screws.



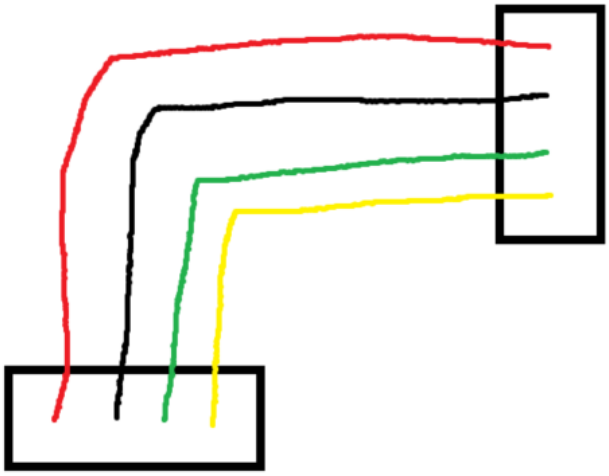
5. Insert the MPU9250 into the case, secured with 2 M3x6 and 2 M3 nuts on the back.



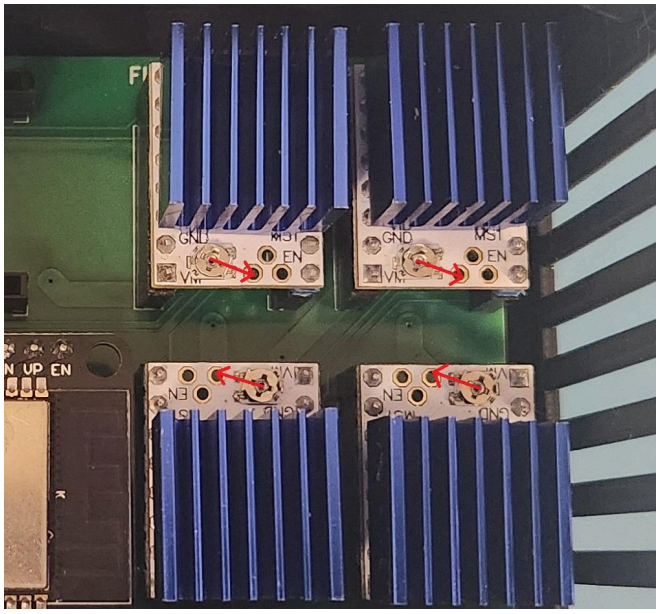
6. Insert the MP1584 (ensuring you've tuned it already) and 4 TMC2208 drivers with heatsinks attached oriented as seen above.



7. Plug the IMU into the PCB with 4 short female-female dupont connectors as pictured above.

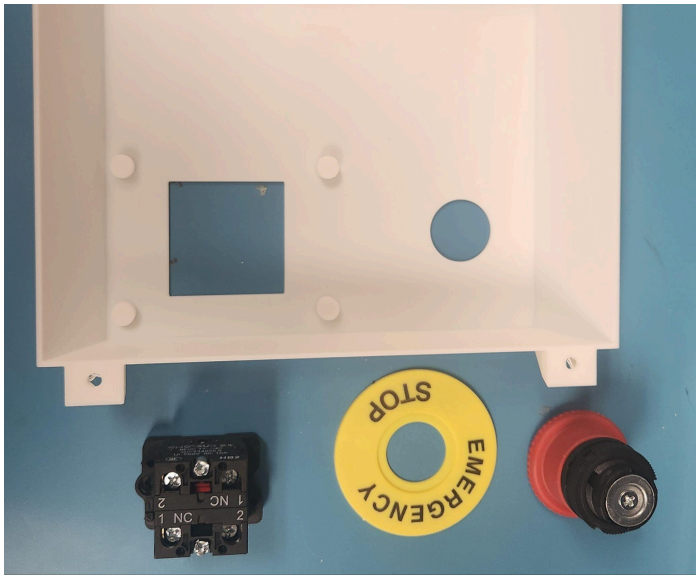


7 Continued.
This is the wiring diagram of the MPU9250 to the PCB. The top 6 pins on the MPU9250 are unused. When flashing the ESP you should unplug the top wire (yellow in this case).

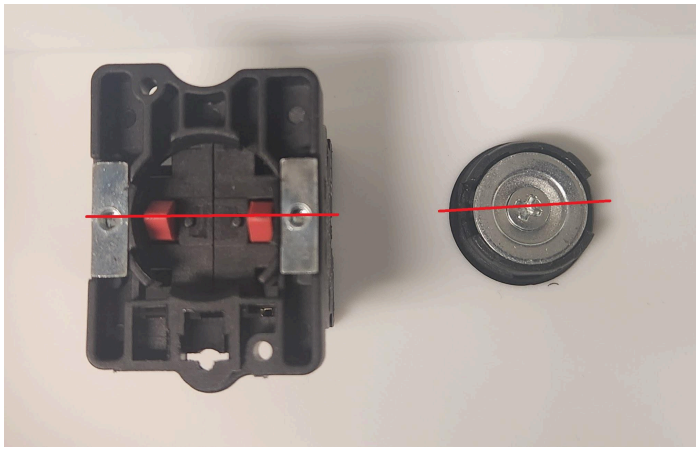


8. Turn the potentiometers on the TMC2208s such that the flat spot is pointing in the direction of the arrows as seen above.

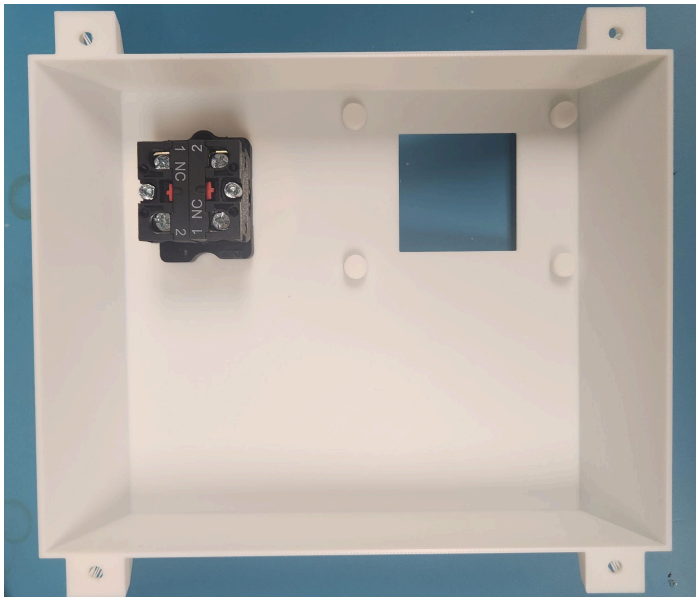
Electronics Wiring ⚠



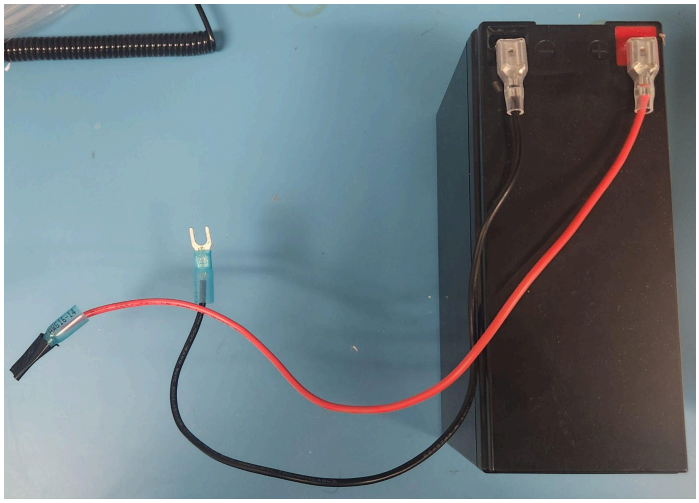
1. Detach the E-Stop button halves. See this picture for help.



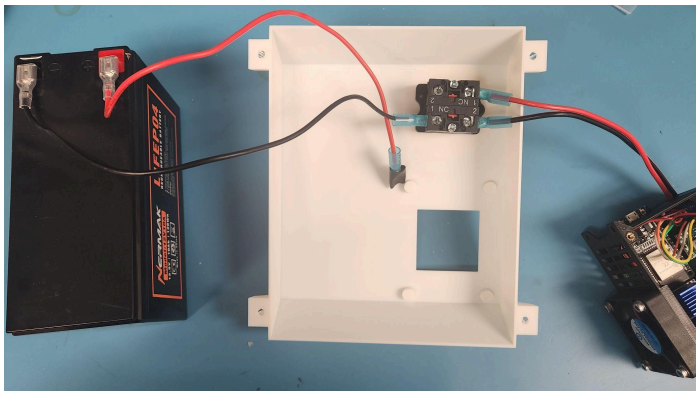
2. When sandwiching the body top in between the top and bottom half of the e-stop, ensure the alignment is as pictured above.



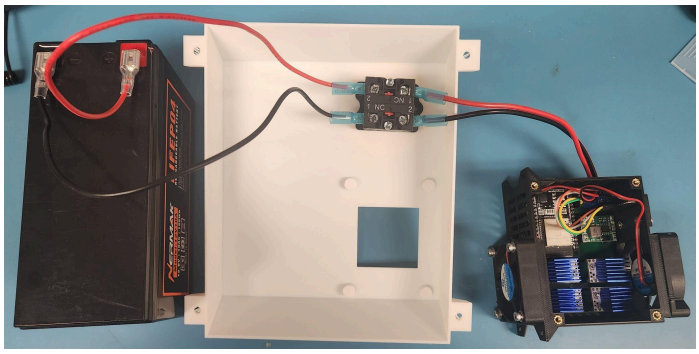
3. Orient the e-stop as seen above. (Actually, it should be rotated 90 degrees either way from what is pictured here and in the following steps.)



4. Crimp spade connectors to the quick connect battery connector wire. Add some solder for more strength. It is VERY important to ensure the spade connectors here don't touch. Tape one off for safety.



5. Create more spade connector wires to go from the e-stop to the 12v input terminal on the PCB.



6. After triple checking your polarity is correct and you've tuned the MP1585 to output 5v, connect the remaining batter wire to the e-stop. The polarity of the wires goes directly across the e-stop as pictured. Turn it on and check that the fans spit and the ESP32 is powered on, but be prepared to press the e-stop if you see or smell anything funky.

Flashing ESP32

1. Prerequisites:

- Arduino IDE: Download and install from https://www.arduino.cc/en/software.
- ESP32 Board: Ensure you have your ESP32 board.
- Micro-USB Cable: For connecting the ESP32 to your computer (must be able to transfer data).
- Rover Client Code: Download roverclient.ino from https://github.com/colemaring/RE-RASSOR-lightweight/blob/main/roverclient.ino

2. Arduino IDE Setup:

- Install ESP32 Board Support:
  - Open Arduino IDE.
  - Go to Tools > Board > Boards Manager.
  - Search for "esp32" and install the "esp32 by Espressif Systems" package.
  - Restart the Arduino IDE.
- Install Required Libraries:
  - Go to Sketch > Include Library > Manage Libraries.
  - Search and install the following libraries:
    - WebSockets by Markus Sattler
    - TMC2208stepper by Teemuatlut
    - ArduinoJson by Benoit Blanchon
    - MPU9250 by hideakitai
- Open the Code:
  - Open roverclient.ino in the Arduino IDE.

3. Configuration:

- Network and Credentials:
  - Locate the following lines in the code (near the very top):
    - const char* ssid = "yourssid";
    - const char *password = "yourpassword";

        - const char *url = "/?name=yournamehere&yoursecrethere";
    - Replace "yourssid", "yourpassword", "yournamehere", and "yoursecrethere" with your network credentials, rover name, and secret.
- Select Board and Port:
    - Connect your ESP32 to your computer.
    - Go to Tools > Board and select "ESP32 Dev Module".
    - Go to Tools > Port and select the correct COM port for your ESP32.
        - If the port doesn't appear, install the CP210x driver: https://www.silabs.com/developer-tools/usb-to-uart-bridge-vcp-drivers?tab=downloads

4. Uploading the Code:

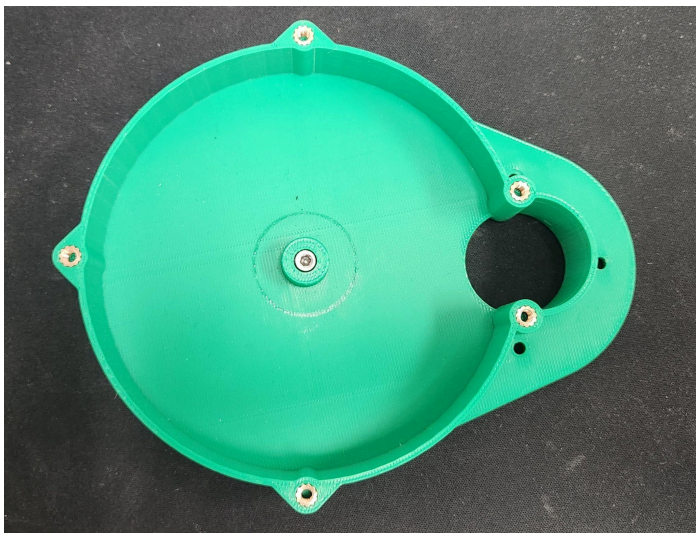
- Ensure the top wire on the IMU is unplugged before flashing
- Click the "Upload" button in the top left (right arrow) in the Arduino IDE.

5. Troubleshooting:

- Board Not Flashing:
    - Ensure the IMU is disconnected during the flashing process.
- ESP32 Port Not Detected:
    - Verify the CP210x driver is installed correctly.
    - Try a different USB port.
    - Ensure the usb cable is a data transfer cable, and not just a power cable.

At this point you should connect 4 stepper motors to the PCB stepper motor pins randomly. Power on the e-stop and check that all motors are spinning at least in some direction when clicking a direction on rerassor.com. If this test was successful you can unplug and continue assembly below

Drive Unit & Shoulder Assembly



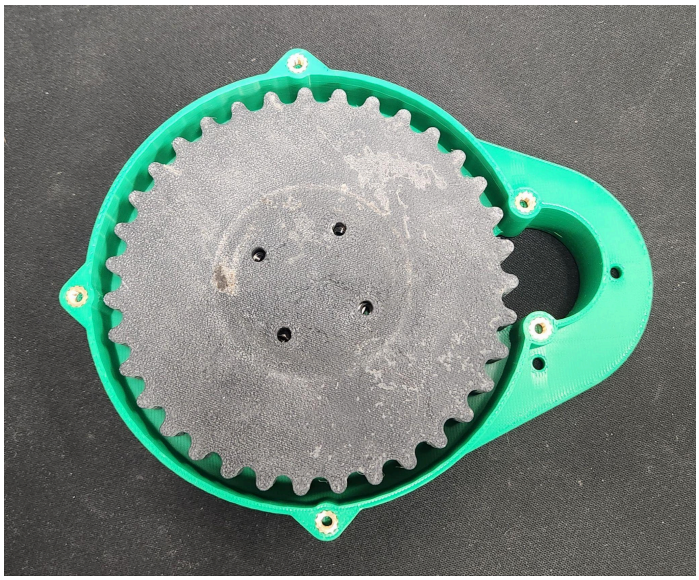
1. Insert 5 M3 heat set inserts into SB_Gearbox_Housing.stl. Place an M3x8 screw into the middle hole and fasten on the other side with an M3 nut. This should be

tight and threadlocker is recommended.

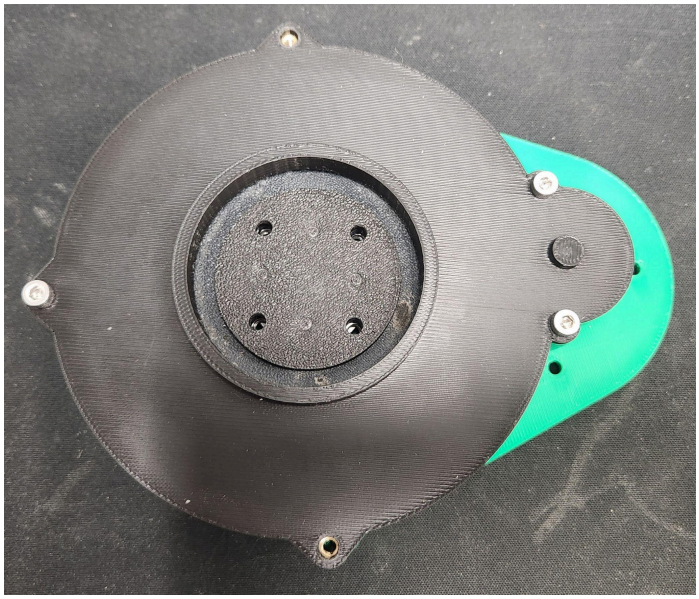
https://en.wikipedia.org/wiki/Thread-locking_fluid

2. Take SB_Big_Gear.stl and preload 4 M3 nuts, ensuring they are laying flat.

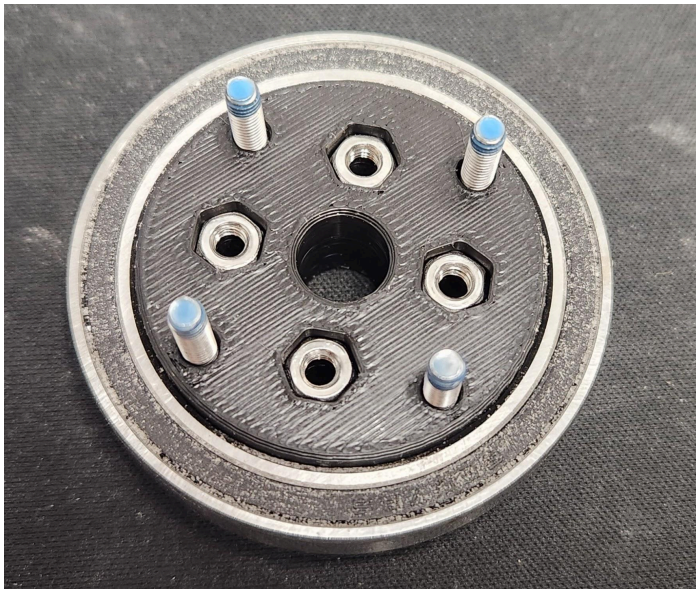
3. Press a 12x28x8 bearing into the SB_Big_Gear.stl assembly.



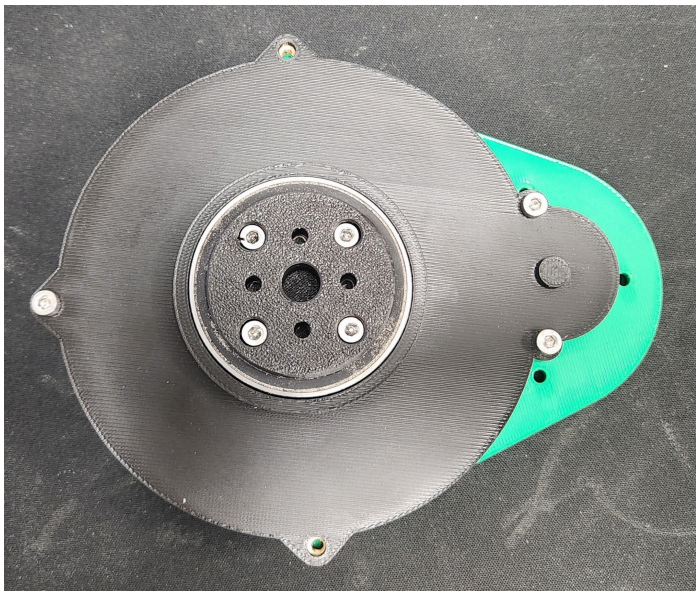
4. Push the SB_Big_Gear.stl assembly onto the SB_Gearbox_Housing.stl assembly. The gear should spin freely with minimal grinding.



5. Loosely attach SB_Gearbox_Top.stl with 3 M3x4 screws. Leave the top and bottom screwless. We will finish tightening after attaching the bearing holder. Place SB_Spacer.st on top of the gear and align the holes.



6. Preload 4 M3x16 screws, 4 M3 nuts, and the 35x47x7 bearing onto SB_Bearing_Holder.stl. Be sure to clear out any excess plastic before inserting the M3x16 screws. Threadlocker is recommended on these screws.



7. Press the SB_Bearing_Holder.stl assembly onto the SB_Gearbox_Housing.stl assembly. Ensure the M3x16 screws correctly align with the holes on the SB_Big_Gear.stl. Tighten snug.

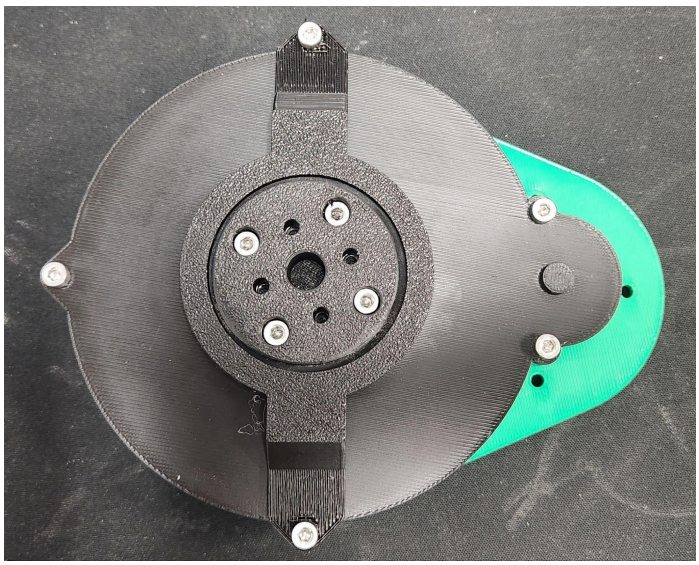
7 Continued.

I recommend flipping the gearbox upside down and pressing the gearbox onto the bearing holder assembly.

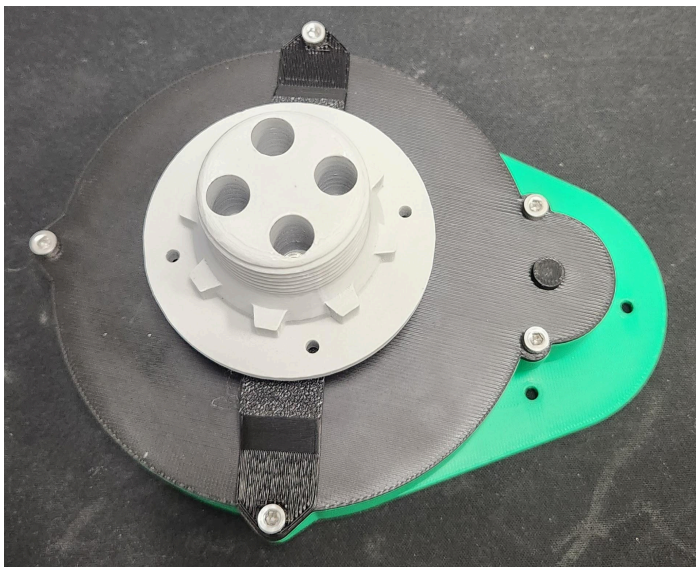
If these screws aren't going in, it means the nuts inside the gear assembly are no longer lying flat. Give it a few shakes until the nuts are properly aligned. When shaking, ensure the screw is slightly backed out so the nut has room to move around in its place.

This is a design flaw in SB_Big_Gear, I welcome you to try and design a fix for this problem.

Sometimes the nuts in SB_Big_Gear will strip the plastic that should hold it in place. As a result, the nut will rotate instead of thread/tighten. In this case you'll have to undo the gearbox top, remove the gear assembly from the gearbox housing, and use a small flathead screwdriver to wedge the nut in place while tightening it from the screw side.

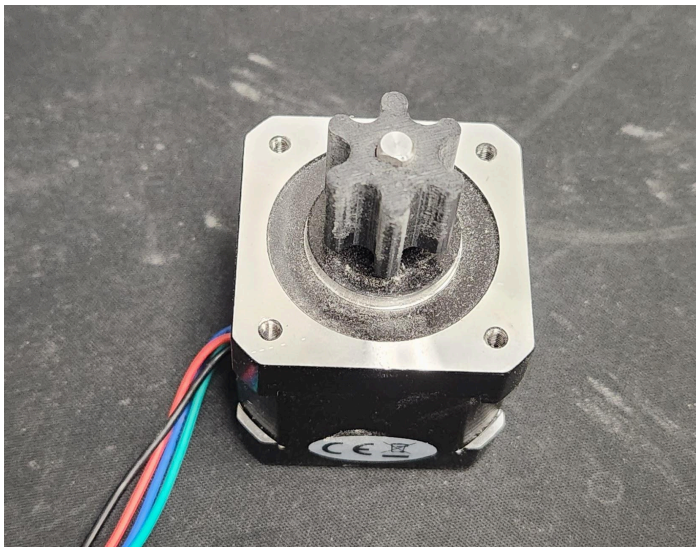


8. Attach SB_Gearbox_Top_Brace.stl with 2 M3x6 screws. Leave these screws slightly loose.

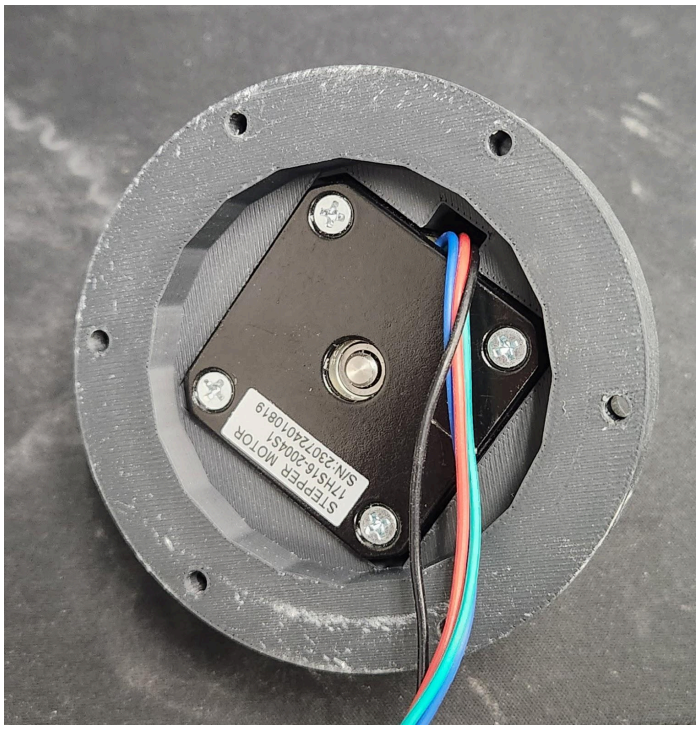


9. Attach SB_Threaded_Output.stl to the bearing holder assembly with 4 M3x25 screws. Threadlocker is recommended on these screws.

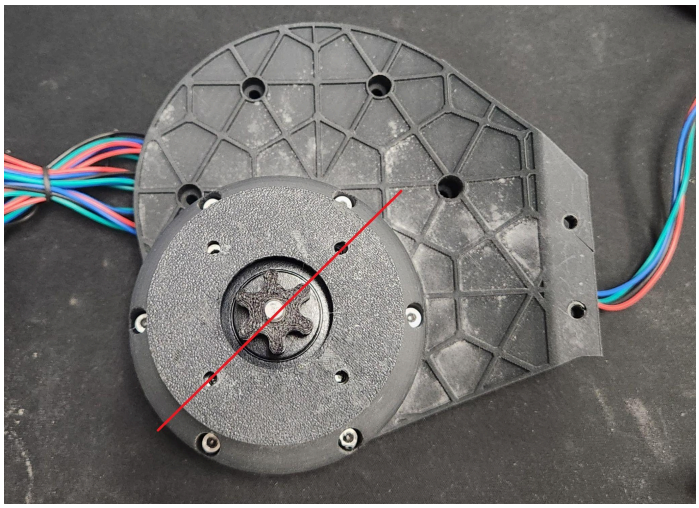
Now you can tighten SB_Gearbox_Top.stl onto SB_Gearbox_Housing.stl.



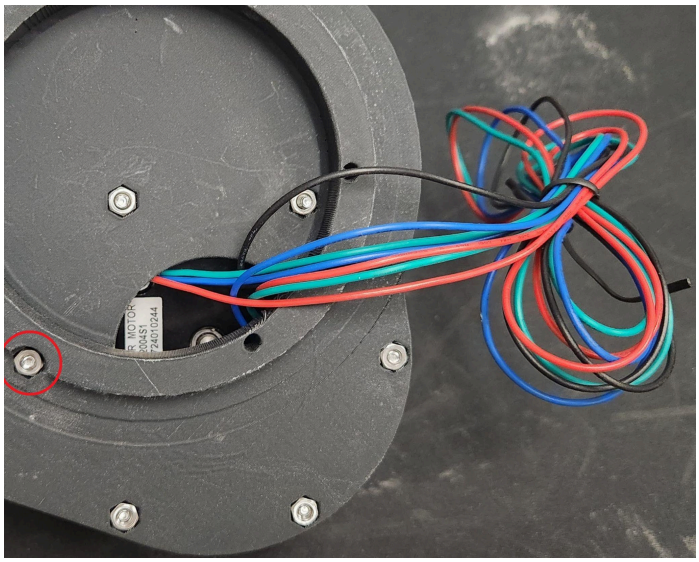
10. Slide SB_Small_Gear.stl onto the stepper motor shaft.



11. Slide the stepper motor into SB_Motor_Housing_Nema17x__mm.stl, ensuring the stepper motor wires align with the cutout.

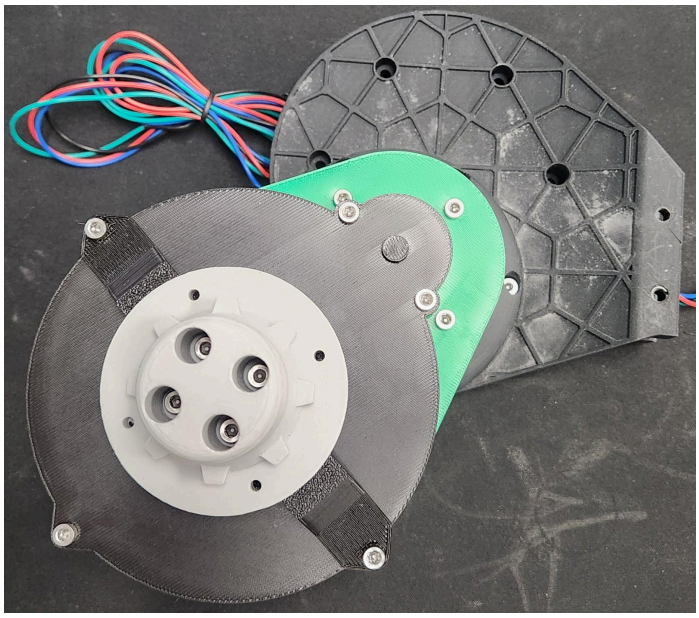


12. Attach the motor housing to SB_Shoulder.stl. Feed the wires though the hole in the shoulder piece and tie out some excess wire through the back. Note the orientation of the motor housing piece when attached to the shoulder piece. Mirror the orientation when attaching to its mirrored counterpart. Attach with 6 M3x20 - 35 screws.



The screw circled in red should be M3x20, otherwise the SB_Handle will not sit properly. If a M3x20 doesn't reach/thread the nut, you can leave it empty.

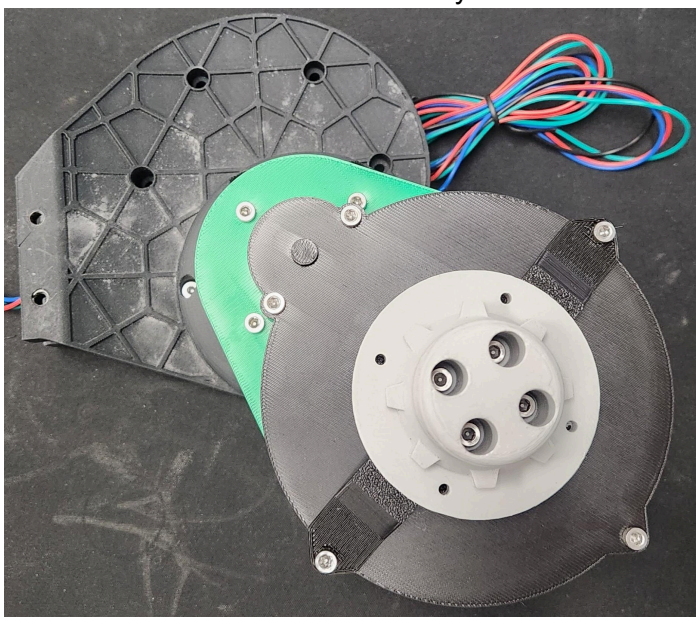
Not pictured is about 6 inches of the connector side of the wire going through the part of the shoulder that connects to the body.



13. Attach the gearbox assembly to the shoulder assembly/motor housing with 3 M3x8 screws. Ensure the gears are meshed when attaching. Heavy resistance is normal when spinning SB_Threaded_Output.stl

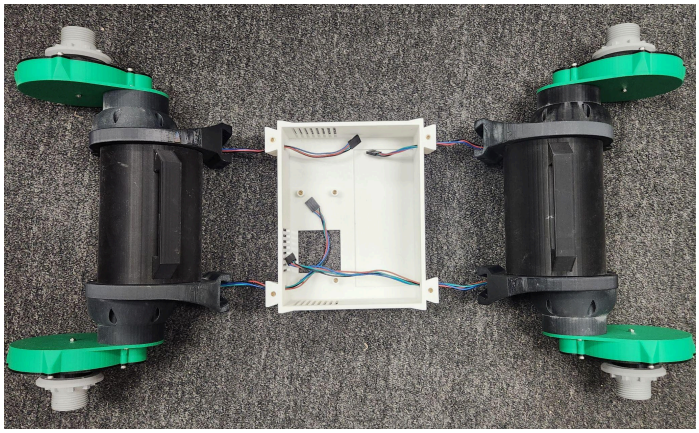
When attaching this, it is easiest to hold the assembly in the air above you and allow gravity to pull the stepper motor down so you can thread the screws into it. If that doesnt work, stick a finger into the shoulder piece around the back to hold the stepper motor in place.

Repeat steps 1-12 4x
Below is how the mirrored assembly should look.

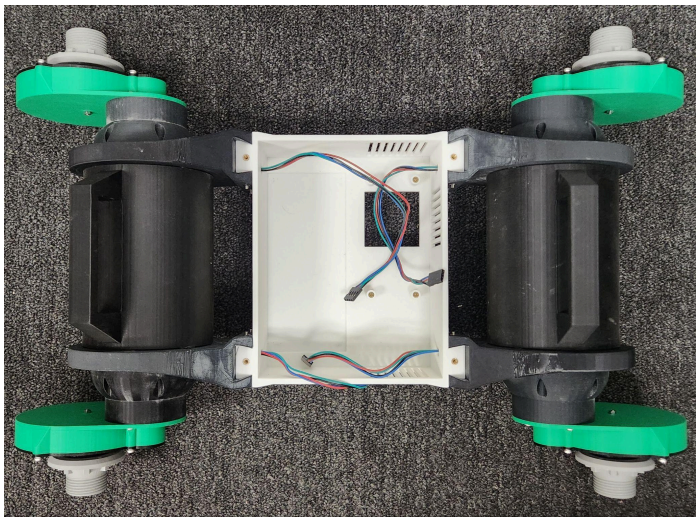


Body Assembly

1. Insert 8 M3 heat set inserts into SB_Body.stl

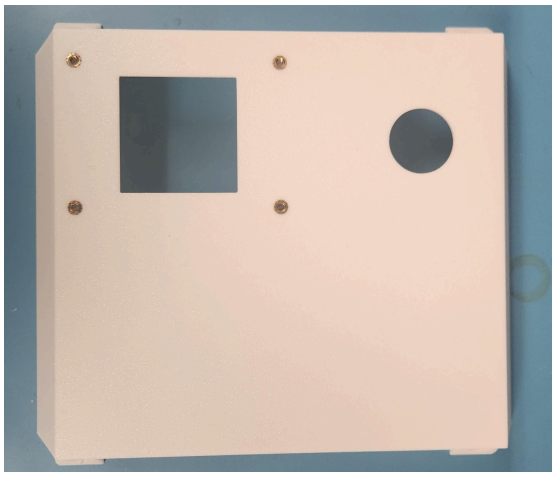


2. Slide the shoulder pieces onto the SB_Handle.stl pieces, hiding the stepper motor's excess wire, and thread the stepper motor wire into SB_Body.stl.

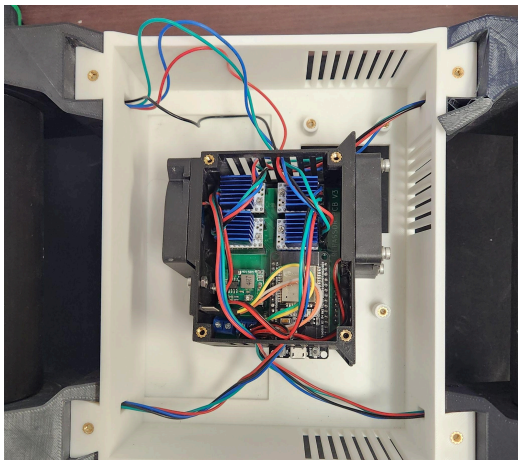


3. Slide the shoulder pieces onto the body. Keep the stepper motor wires taut to ensure they are not pinched in this process.

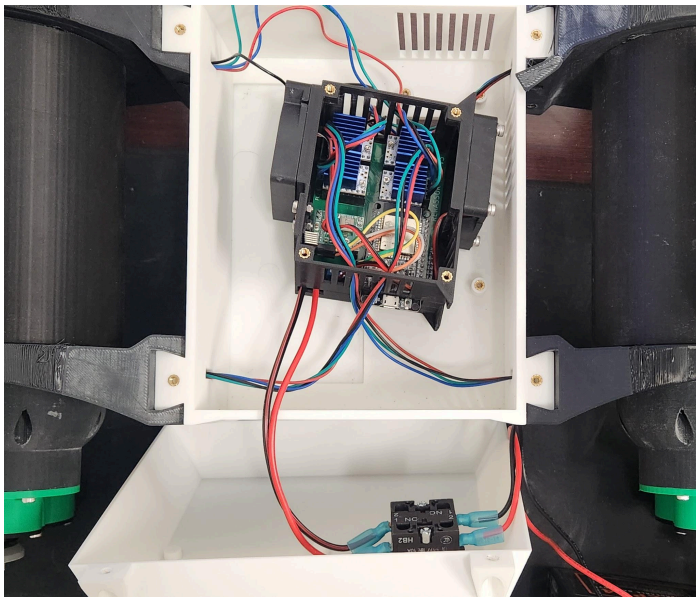
4. Attach each shoulder piece via 2 M3x40 screws and 2 M3 nuts.



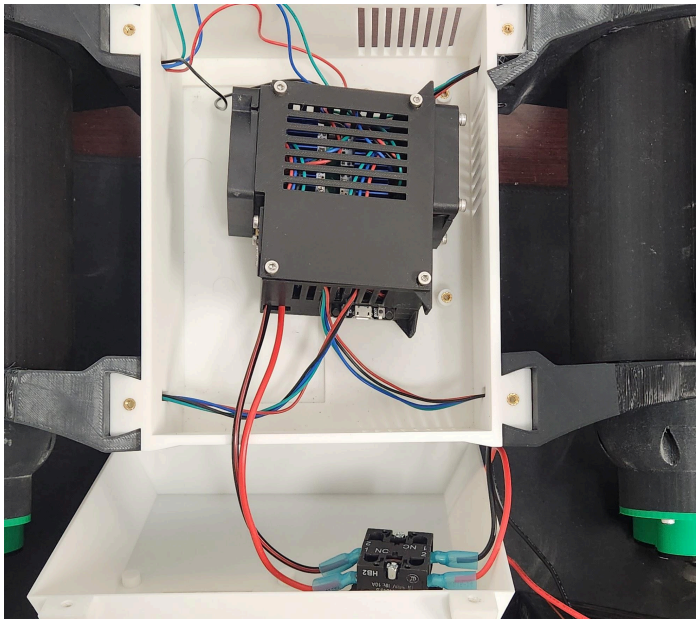
5. Insert 4 M3 heat set inserts into SB_Body_Top.stl.



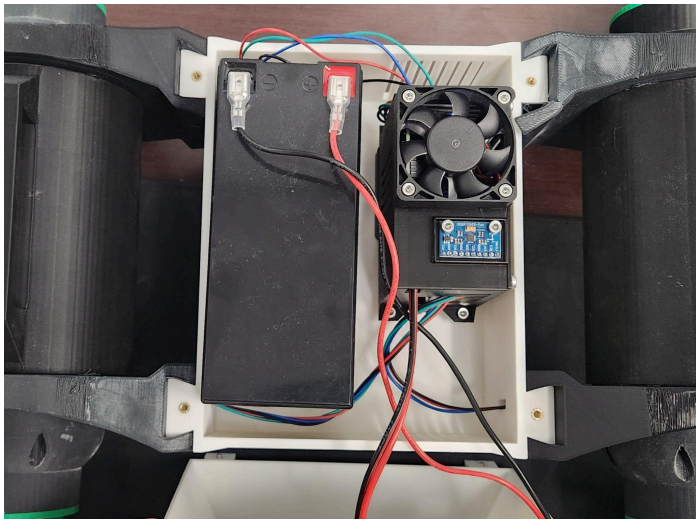
6. Plug in the respective stepper motor wires into their assigned spots, designated FR, FL, RL, RR. The stepper motor wires should go through the sides of the case. The non flat side faced inward towards the motor driver.



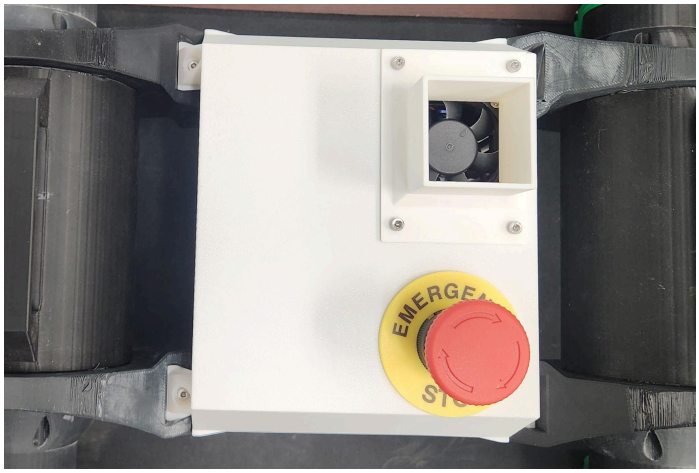
7. Attach the wires from the e-stop back to the PCB



8. Attach the electronics case top with 4 M3x4 screws.



9. Secure the electronics case onto the body with 4 M3x4 screws. Position the 12V battery into its appropriate spot.



10. Attach the body top to the body with 4 M3x4 screws. The wires coming out of the e-stop sometimes get in the way but it does fit.

Finally, attach 4 SB_Road_wheel or SB_Regolith_Wheel, ensuring the SB_Threaded_Output meshes onto the wheels, and fasten with 4 SB_Nuts.

I recommend using SB_Road_Wheel.

Troubleshooting

ESP32 flashing problems
Fans not spinning up when given board 12v
- Correctly tuned MP1584 with multimeter?

MP1584 blown up
- Cheaply made & need constant load

ESP32 not connecting to website
- Network issues?
- Try using a different browser (non-Chromium)

Buttons on website not moving motors
IMU data not showing on website
Inconsistent connection to website
Motors spinning wrong way
- Reverse polarity

Motors stopped working
- Overheat possible
- Motor driver killed. More likely is that there was a 12v short circuit somewhere. Ensure the 12v input wires are secure in their screw terminals and that even a strand cannot touch the other wire. Hopefully PCB v4 will address this issue.

If Arduino IDE error about entering flash mode, unplug IMU connections. see (https://randomnerdtutorials.com/esp32-pinout-reference-gpios/). GPIO 2 connected to on-board LED, must be left floating or LOW to enter flashing mode.

Contact: cmaring@ucf.edu