Open Source Rover: Electronics Assembly Instructions

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Contents

1 PCB Assembly

1.1 Motor & RoboClaw Connectors

Table 1: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		6 Pos Side Term Block	E3	10	
6 Pos Top Term Block	E4	5		5 Pos Header socket	E5	5	
5 Pos Header socket	E6	5		Soder Iron	N/A		

1. Begin by soldering the 6 Position Side entry terminal Block **E3** into the top side on the edge of the board shown below. They will be labeled with schematic reference designators J17-J26. Be sure that the wire terminal faces **OUTWARD** on all these connectors. These are the terminal blocks that will run motor power, encoder power, and encoder signals between the motors/encoders and the RoboClaw motor controllers.

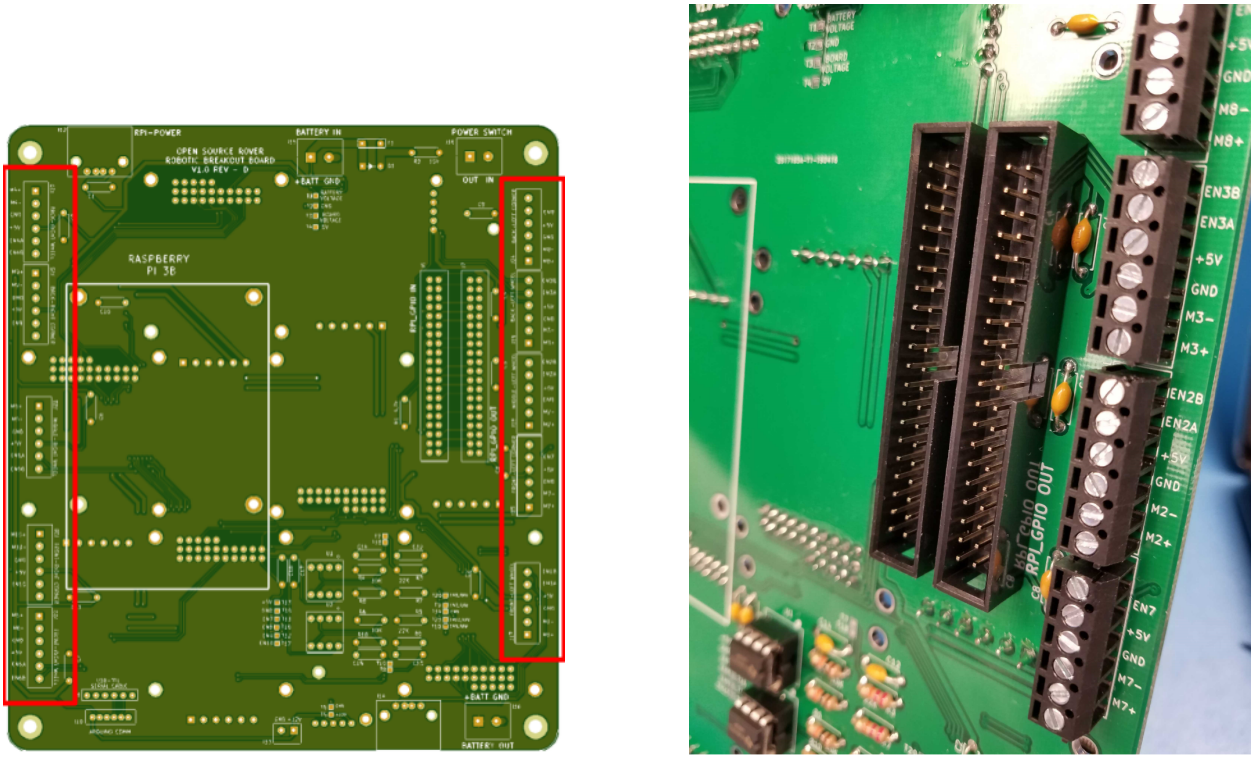


Figure 1: Assembly Step 1

2. On the Bottom of the board now solder the 6 Position Top entry terminal blocks **E4**. They will be labeled with schematic reference designators J1-5. The orientation of the wire terminal face should be AWAY from the each of RoboClaw outlines. See below image for direction. These will run battery power to the RoboClaw motor controllers, and the +/- signals for both motors into the PCB.

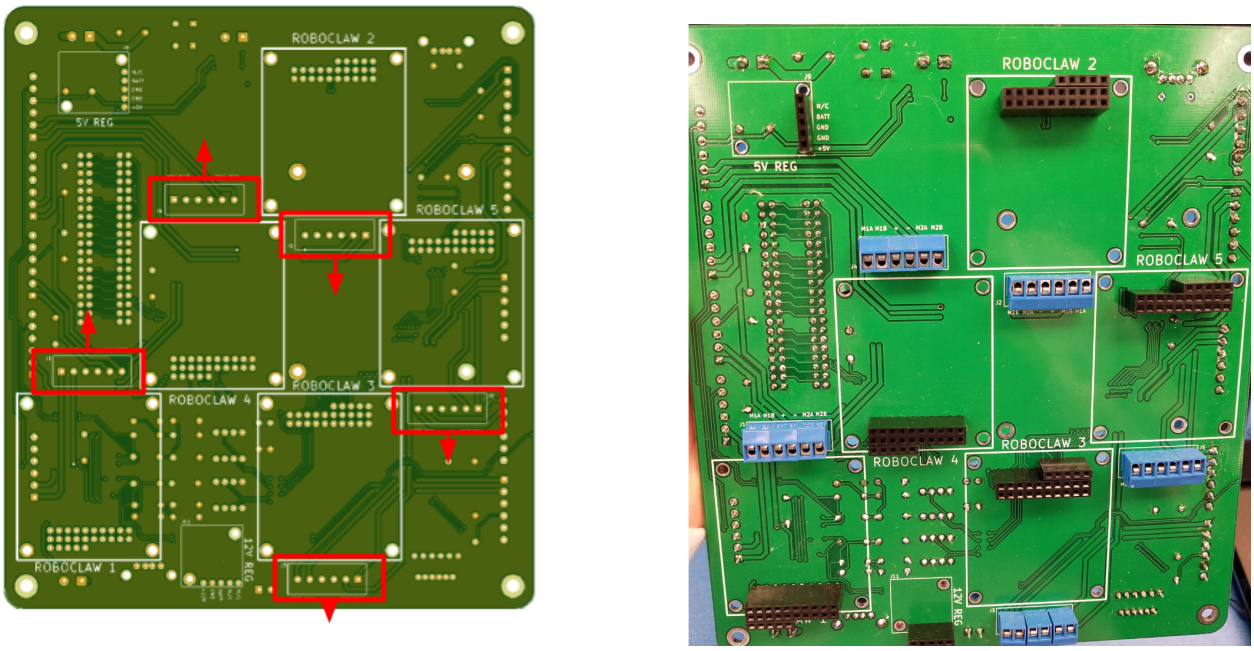


Figure 2: Assembly Step 2

3. On the Bottom of the board solder the 20 Position Female socket header connector **E5** as well as 5 Position Female socket header connector **E6**. They will be labeled with reference designators RoboClaw 1-5. These are the digital signal pins for the RoboClaw motor controllers.

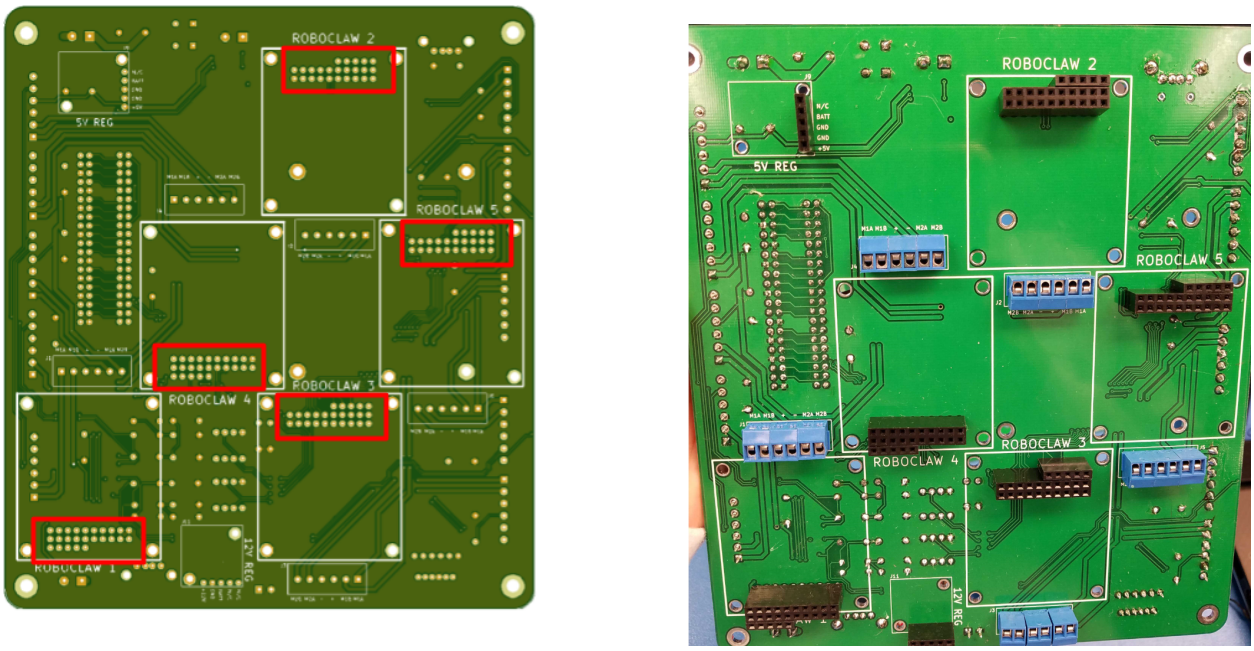


Figure 3: Assembly Step 3

1.2 Resistors and Capacitors

Table 2: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		4.7K 1/4 Watt Resistor	E7	1	
10K 1/4 Watt Resistor	E8	4		22K 1/4 Watt Resistor	E9	4	
10K 1/2 Watt Resistor	E10	1		100nF Capacitor	16	E11	

1. Solder the resistors and capacitors on the top of the board, by comparing the reference designator on the board to the part number listed below. Some of the capacitors are used to store energy for powering components to help protect against voltage fluctuations, and others are used as noise filtering mechanisms on analog signals. The resistors are needed to control the voltage that components see.

Table 3: Resistor/Capacitor reference

Item	Parts list Ref	Schematic/Board Ref
4.7K 1/4 Watt Res	E7	R1
10K 1/4 Watt Res	E8	R4,6,8,10
22K 1/4 Watt Res	E9	R3,5,7,9
10K 1/2 Watt Res	E10	R2
100nF Cap	E11	C1-17

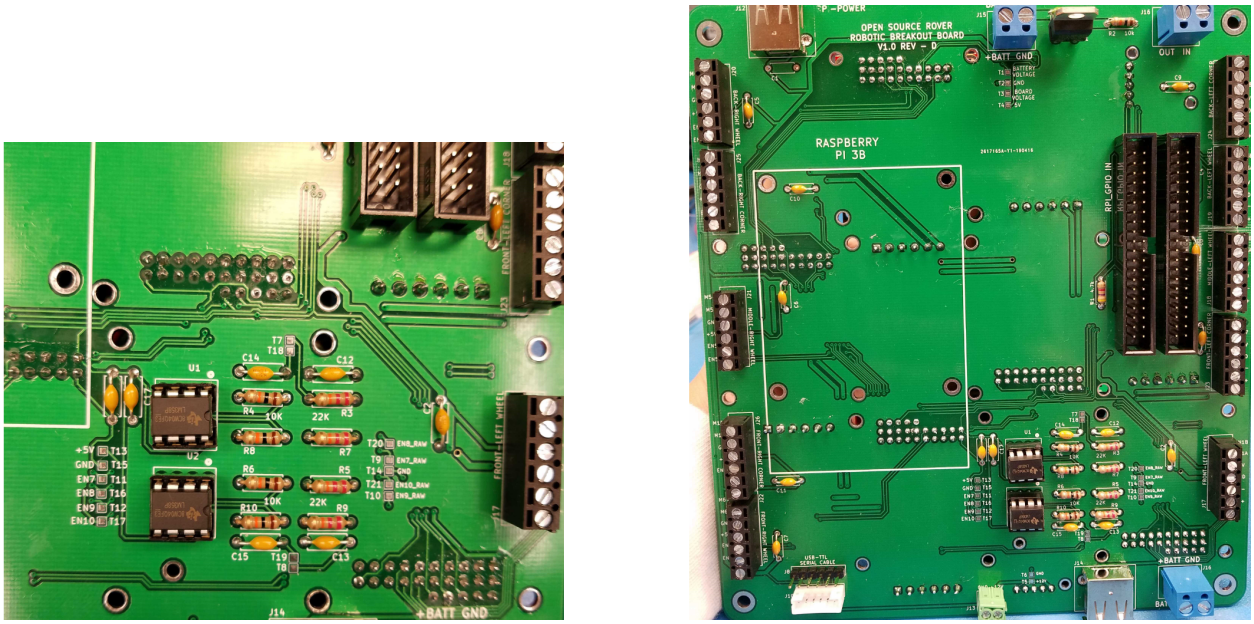


Figure 4: Assembly Step 4

1.3 Voltage Regulator connectors

Table 4: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		5 Pos Header socket	E6	2	
				Soder Iron	N/A		

1. On the Bottom of the board solder the 5 Position female header sockets **E6**. They will have Schematic reference designators of J9 and J11. These connectors are what the 12V and 5V voltage regulators will slot into.

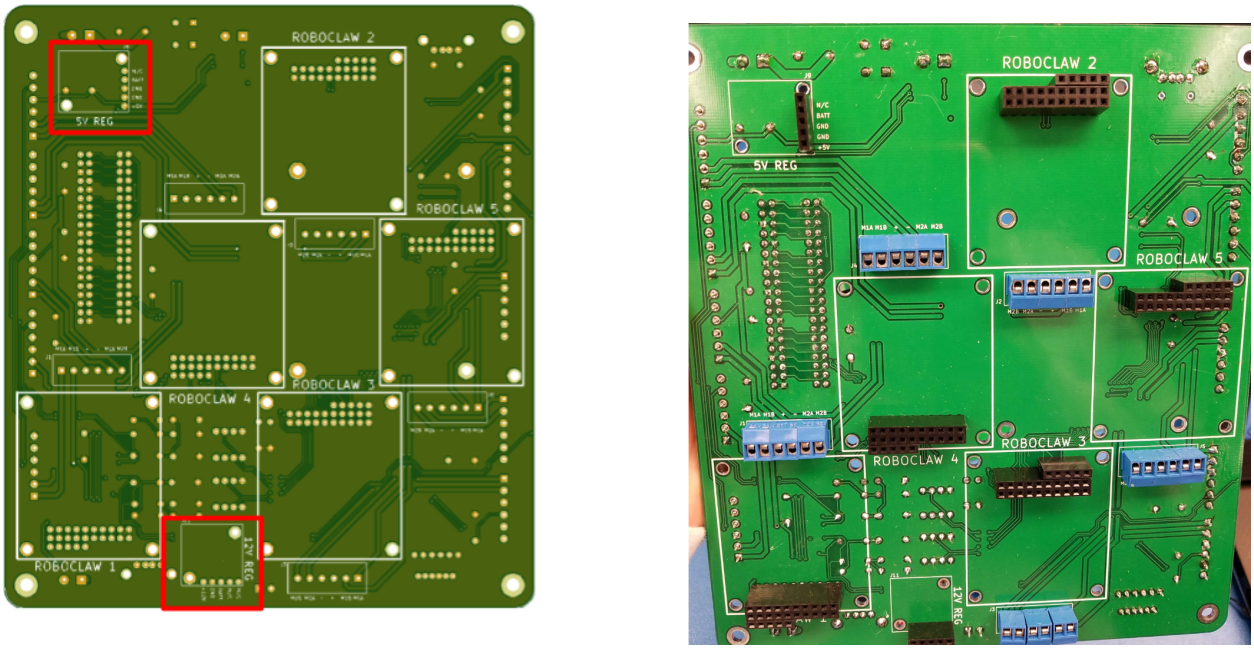


Figure 5: Assembly Step 5

1.4 Power Connectors

1.5 Voltage Regulator connectors

Table 5: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		2 Pos Side Terminal Block	E12	3	
				Soder Iron	N/A		

1. On the top of the board Solder the 2 Position Side entry terminal blocks **E13**. These will have schematic reference designators J14-16. Ensure that these componenets face **OUTWARDS**.

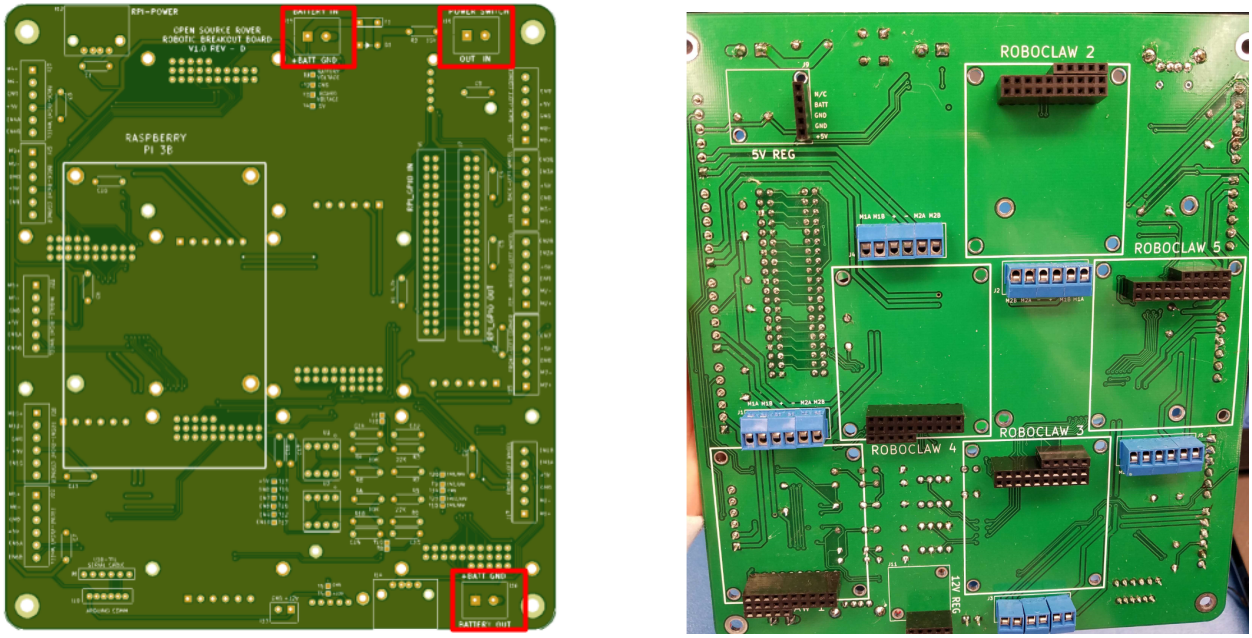


Figure 6: Assembly Step 6

1.6 Op amp DIP socket

1.7 Voltage Regulator connectors

Table 6: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		8 Pin DIP Socket	E33	2	
				Soder Iron	N/A		

1. On the top of the board solder the 8 Pin DIP socket **E33**. It will have schematic reference designator U1-2. Orientation does not matter.

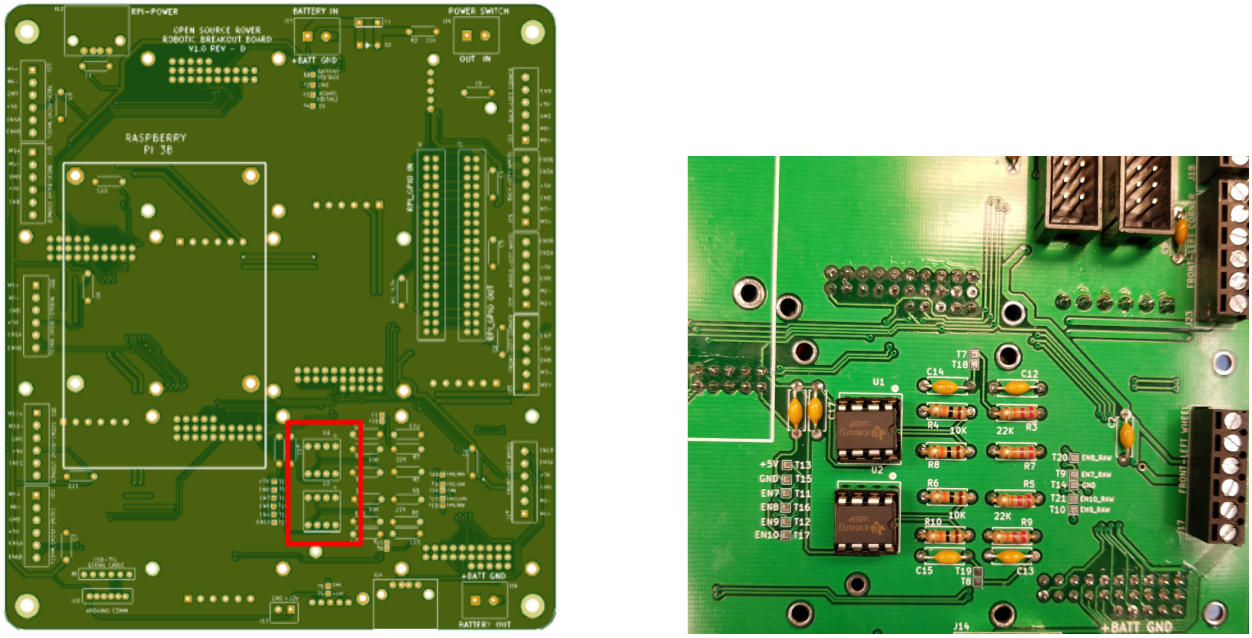


Figure 7: Assembly Step 6

1.8 RPi GPIO connector and misc headers

1.9 Voltage Regulator connectors

Table 7: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		40 Pin Header connector	E13	2	
40 Position Header Pins	E15	1		6 Position JST Connector	E14	1	
				Soder Iron	N/A		

1. On the Top of the board soder the 40 position header connectors **E13**. The Clocking notch on the headers should face **OUTWARD**. The schematic reference designators are J6 and J7.

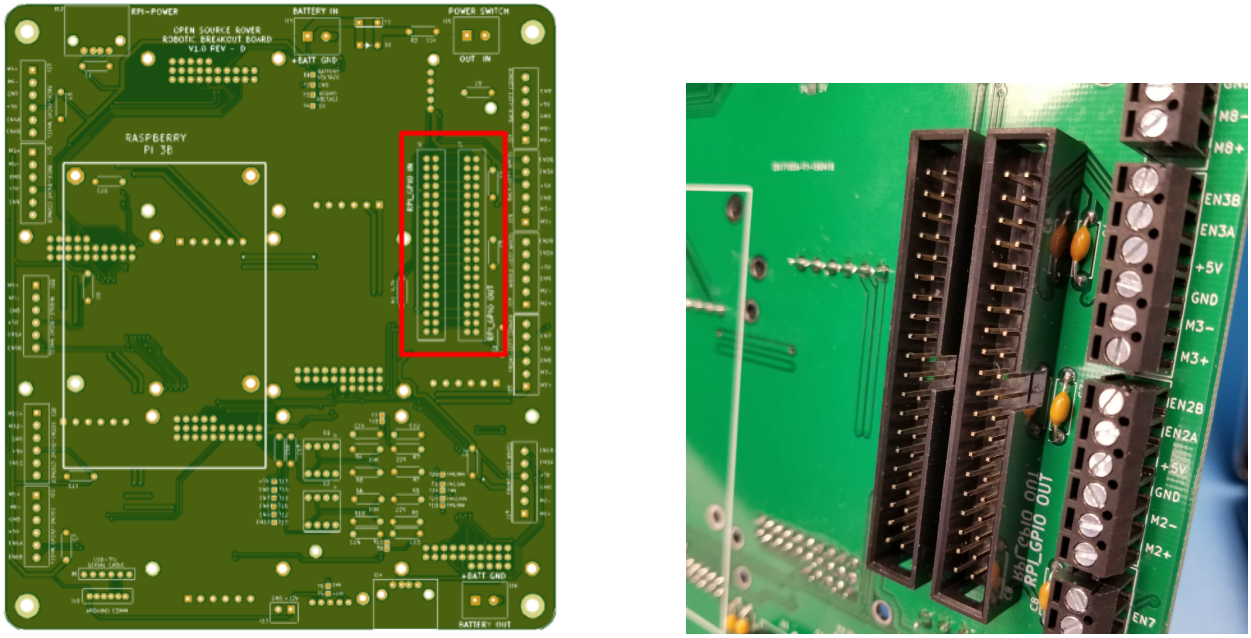


Figure 8: Assembly Step 7

2. Take the 40 pin header pins **E15** and break it into a 6 pin segment. On the top of the board solder this into schematic reference designator J8. Then solder the JST connector **J14** into the J10 schematic reference designator. The opening in the pins on the JST connector should face **INWARD**.

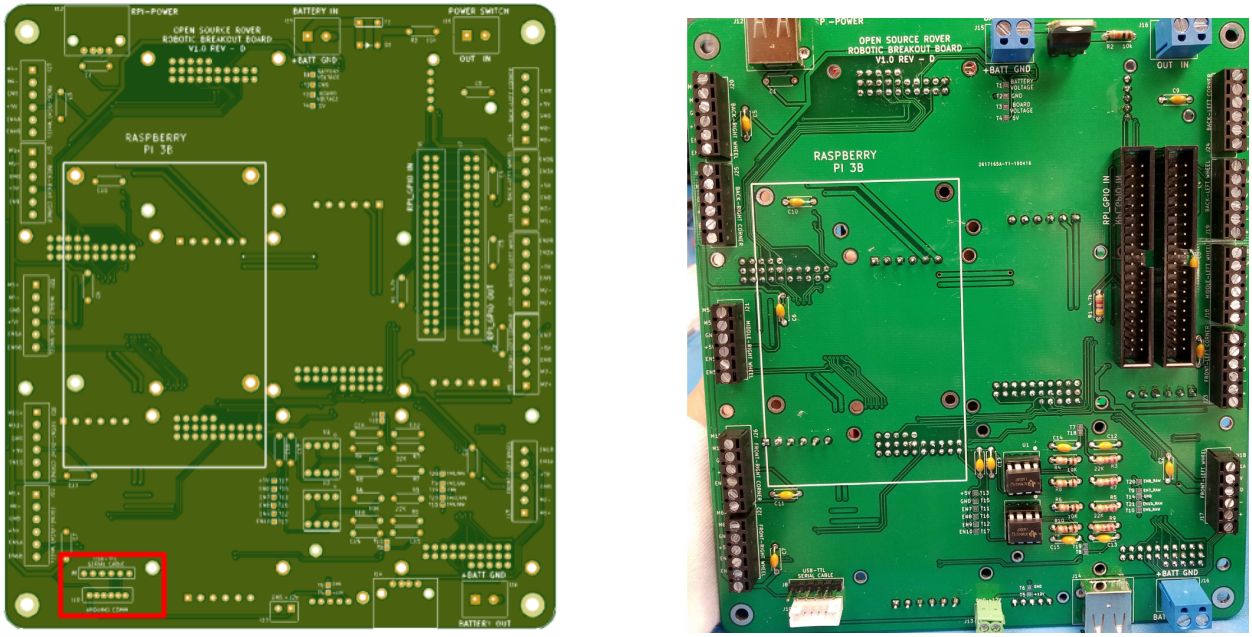


Figure 9: Assembly Step 8

1.10 USB connectors

Table 8: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		USB Connector	E34	2	
				Soder Iron	N/A		

1. On the top of the board solder the USB Connector **E34**. It will have reference designator J12 and J14.

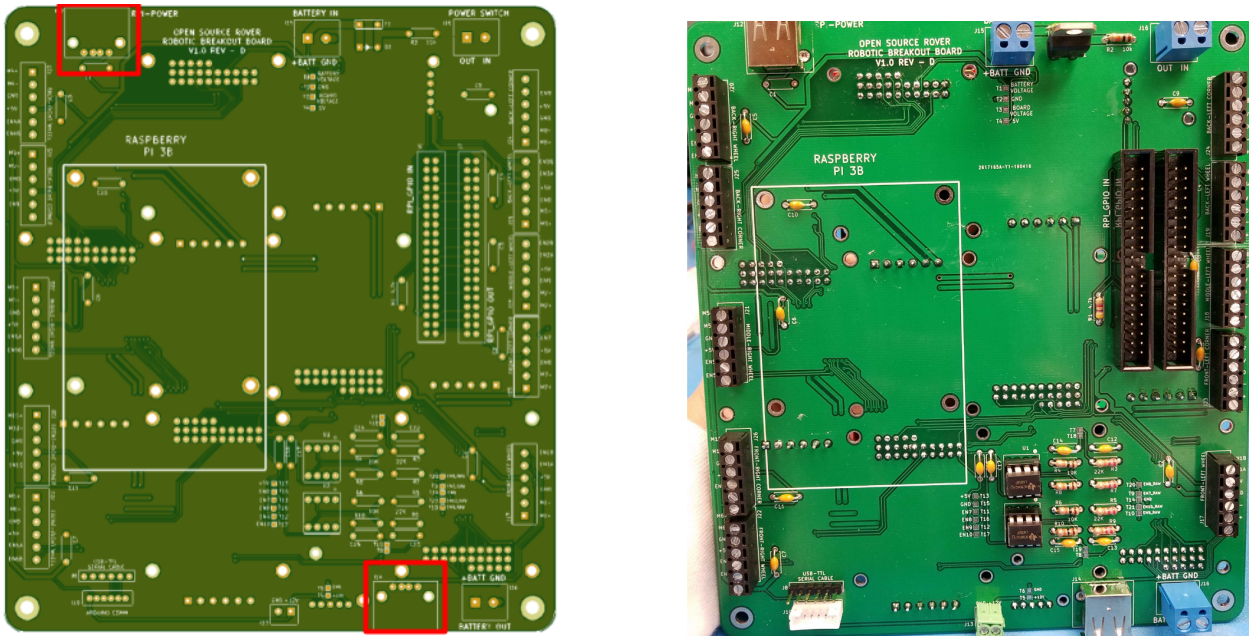
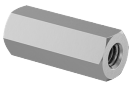
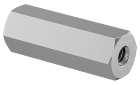
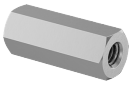


Figure 10: Assembly Step 9

1.11 Standoffs

Table 9: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
#6-32 Threaded Standoff	T4	4		#4-40 Threaded Standoff	T5	20	
#2-56 Threaded Standoff	T6	4		M2.5 Threaded Standoff	T7	4	
#6-32 3/8" Button Head Screw	B2	4		#4-40 1/4" Button head Screw	B8	40	
#2-56 1/4" Button head Screw	B13	8		M2.5 x 6mm	B10	8	

1. **Board mounting Standoffs:** Take the #6-32 Standoffs **T4** and attach them on the outter 4 mounting holes using screws **B2**. These go on the bottom side of the board, as shown below. These will be what attached the board to the robot chassis.

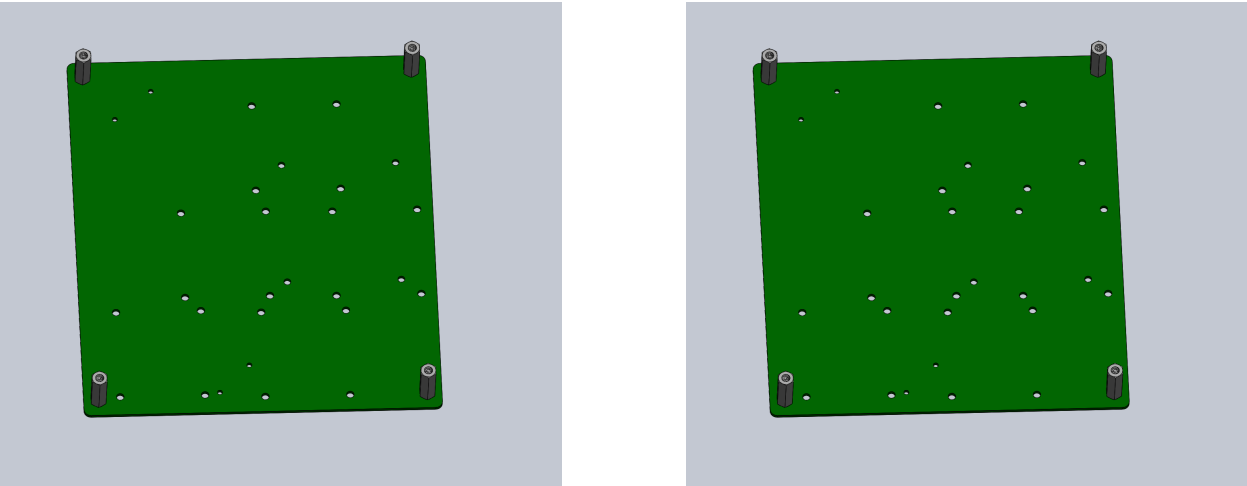


Figure 11: Mounting Standoffs

2. **RoboClaw mounting Standoffs:** Take the #4-40 Standoffs **T5** and attach them using screws **B8** on the bottom side of the board. You can tell the RoboClaw mounting holes as the ones that are inside the RoboClaw Silk Screen rectangle.

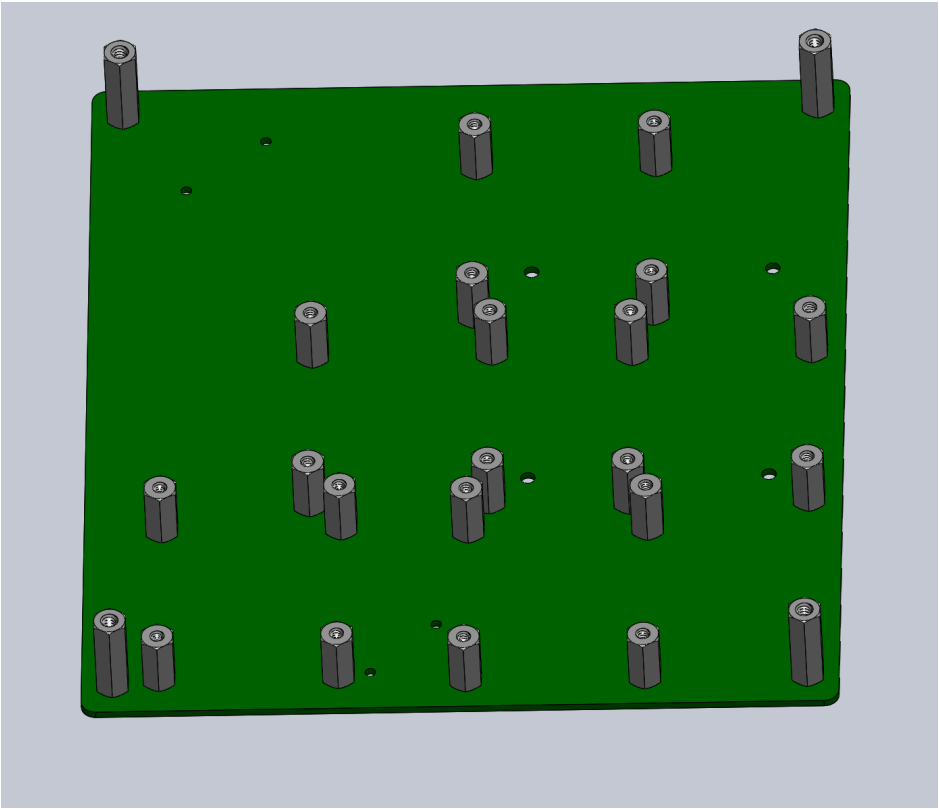


Figure 12: RoboClaw Mounting Standoffs

3. **Voltage Regulator Standoffs:** Take the #2-56 Standoffs **T6** and attach them to the bottom of the board using screws **B13**.

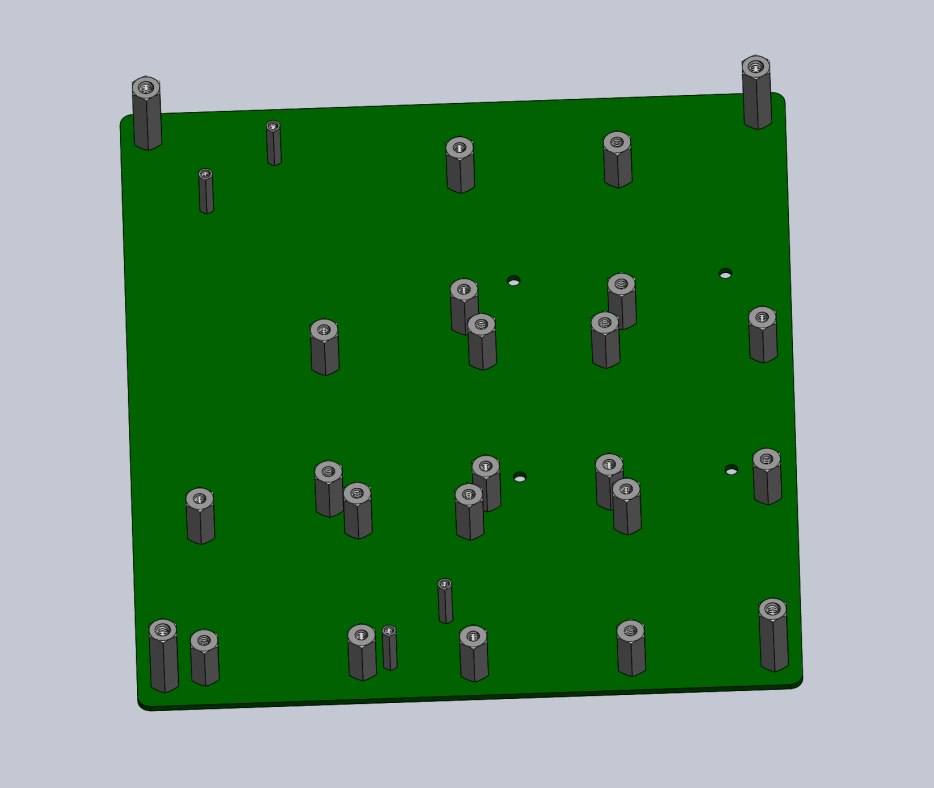


Figure 13: Voltage regulator Mounting Standoffs

4. **Raspberry Pi Standoffs:** Take the M2.5 Standoffs **T7** and attach them to the top of the board using screws **B10**.

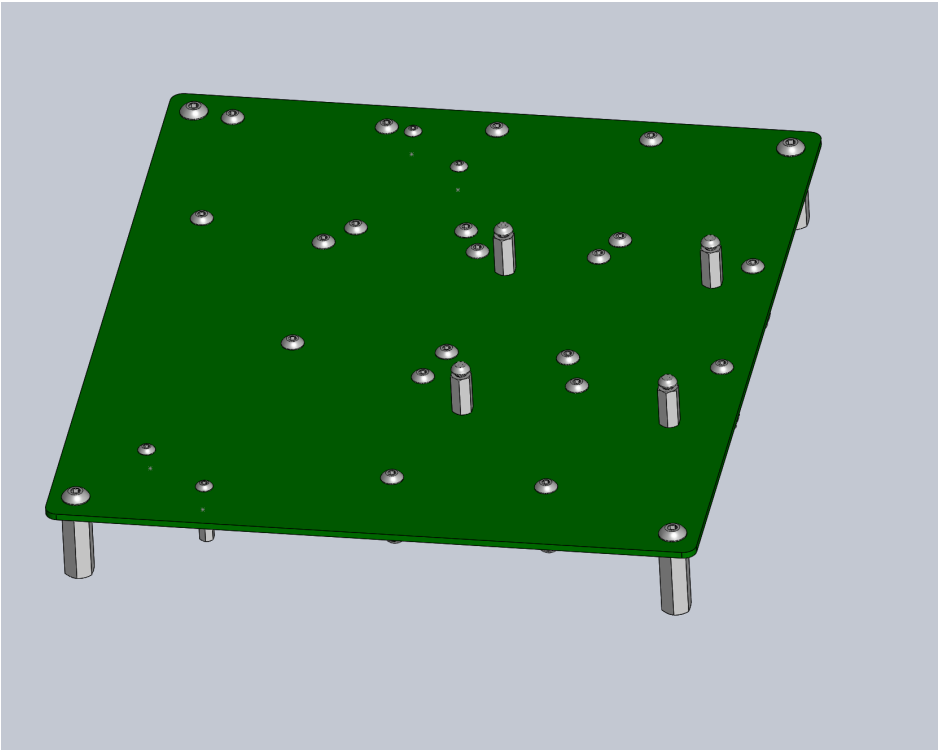


Figure 14: Raspberry Pi Standoffs

2 Component Integration and Testing

This next section will go over the process of integrating the electronics onto the Control Board and the testing to verify at each step that the board/components are working as expect. You should perform this section with the board outside of the robot chassis. It is important to do these steps one at time so we can verify each step of the way that electronics are working as intended, so we do not accidnetally break one of our components by plugging something else in wrong.

2.1 Power Distribution System

Table 10: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		Battery	E36	1	
Tamiya Battery Connectors	E35	1		Red 24 AWG	W1	1	
Black 24 AWG	W2	1		5V Regulator	E22	1	
12V Regulator	E23	1		RoboClaw Motor Controller	E20	5	

1. Begin by powering the board. In order to do this we will be bypassing the switch and volt meter, so this connection will look a little bit different than when you fully install the board into the rover. Insert the red wire on the Tamiya Battery Connector **E35** into the IN terminal on connector **J16**, and the black wire to the GND terminal on the connector **J15**.

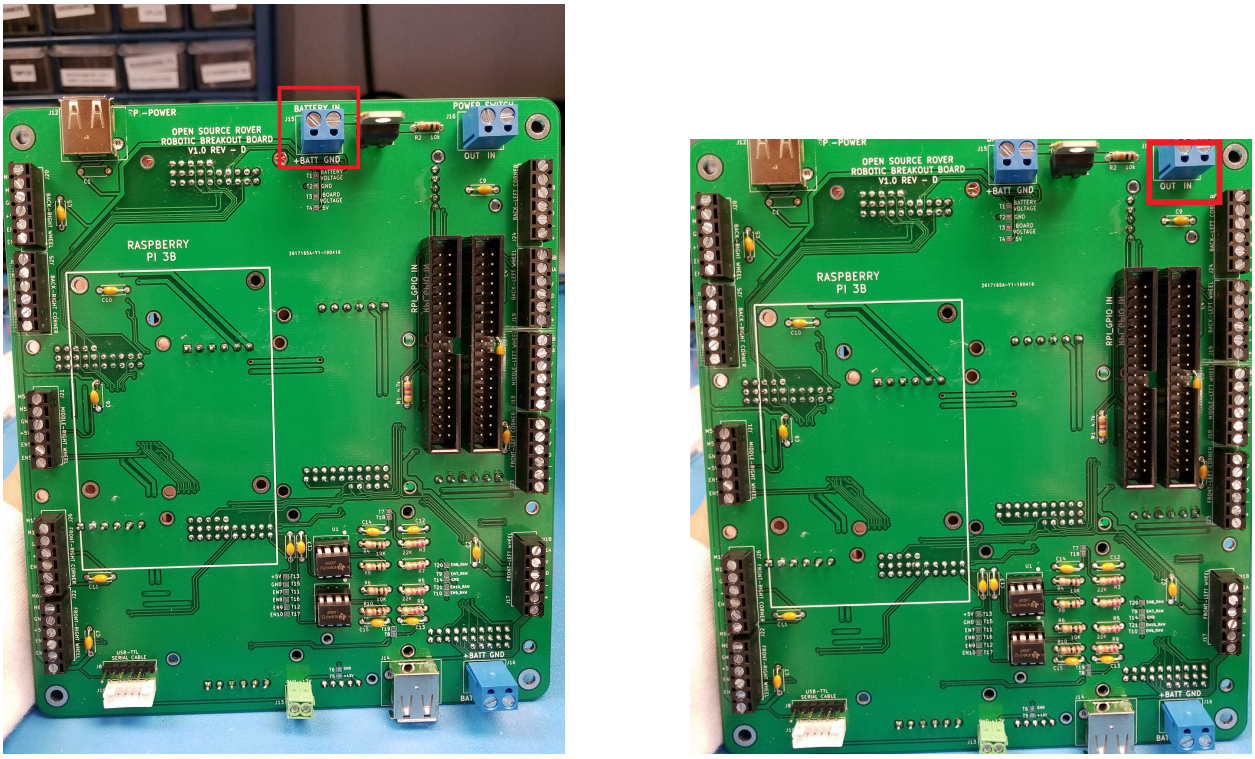


Figure 15: Test Step 1

2. Using a Digital Multimeter (DMM) probe the voltage accross the test points T1 and T2. These will tell you the voltage level that the board is at, which is the direct voltage of the battery. Verify that from T1 to T2 reads a positive number, and is between 12V and 16.7V depending on the charge state of your battery.

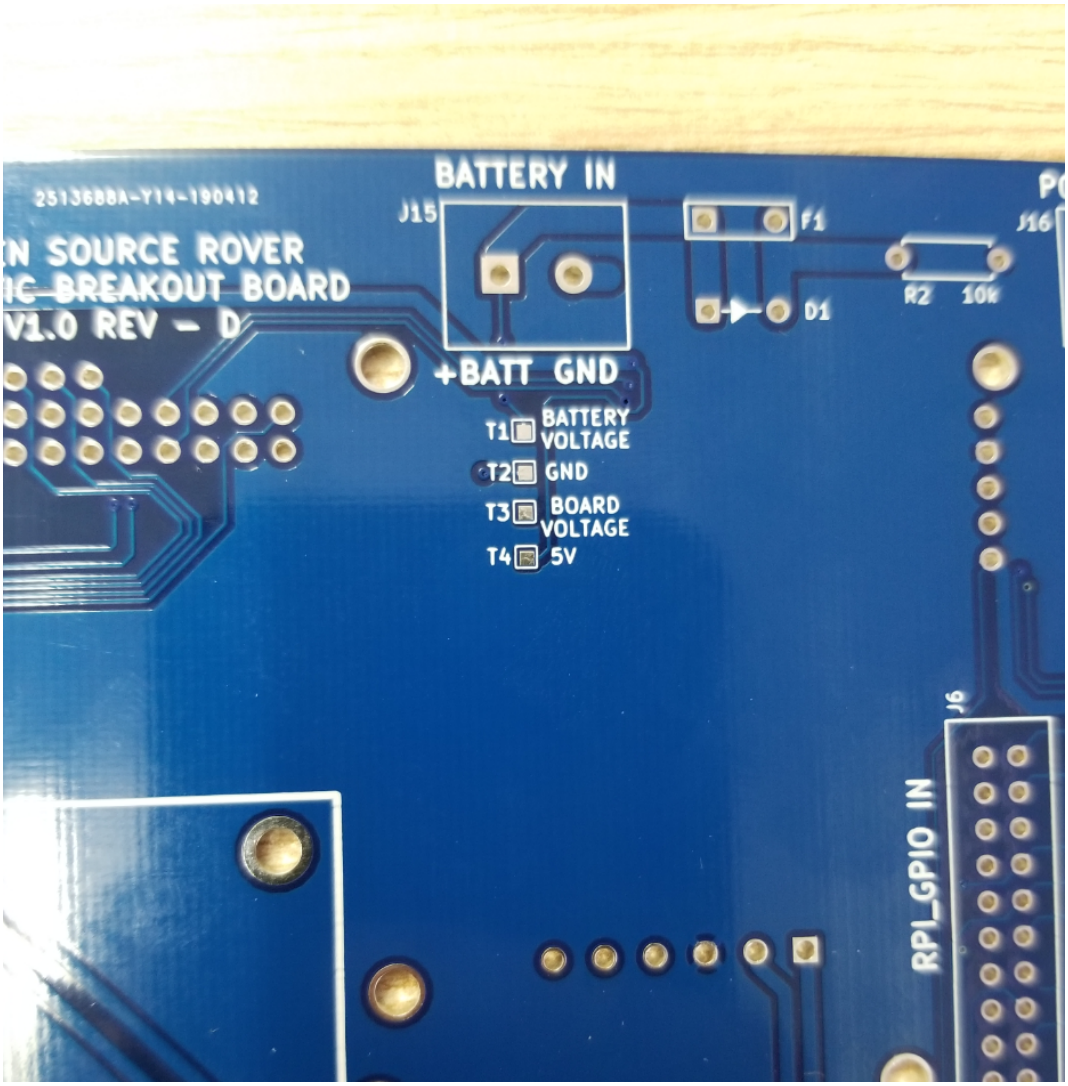


Figure 16: Test pads

3. Next jumper wires need to be made to connect the RoboClaw motor controller Power terminals to the RoboClaws. Unplug the tamiya battery connector (in future steps I will not explicity say to unplug the battery, but at each step while inserting components and working on the board you should disconnect the battery). Take the red and black 24 AWG wires **W1 and W2** and cut 15 segements of 2 inches CHECK ON THIS LENGTH LATER of each, so that you have 15 red and 15 black pieces. Using wire strippers strip the ends at about 0.1 check on length at each end. Insert these into the terminal blocks on the RoboClaw Motor Controllers **E20** in the following way:

Table 11: Parts/Tools Necessary

Terminal	Wire Color
M1A	Red
M1B	Black
+	Red
-	Black
M2A	Red
M2B	Black

4. Starting by inserting one of the Roboclaws into the slot on the bottom of the board labeled ROBOCLAW 2. Connect the wires directly accross to from RoboClaw motor terminal block to the terminal block on the control board.

   INSERT IMAGE OF ROBOCLAW WITH WIRES IN IT AND ROBOCLAW CONNECTION TO BOARD

5. Plug in the battery. an LED on the RoboClaw will turn on, verify that it is green. If it is red it means there is an error. Error codes can be traced by looking at the roboclaw user manual:

   - https://www.basicmicro.com/downloads

6. Repeat this process one RoboClaw at a time until all 5 RoboClaws have been plugged into the board, following the order of 2, 3, 4, 1, 5

7. Take the two voltage regulators **E23 and 24** and solder on their header pins, on the top side of the board (the side with large capacitors on it).

8. Insert the 5V regulator into the control board. Then test from Testpoint T4 to T1 and verify that it reads 5V. If it does not make sure the 5V regulator is slotted in properly.

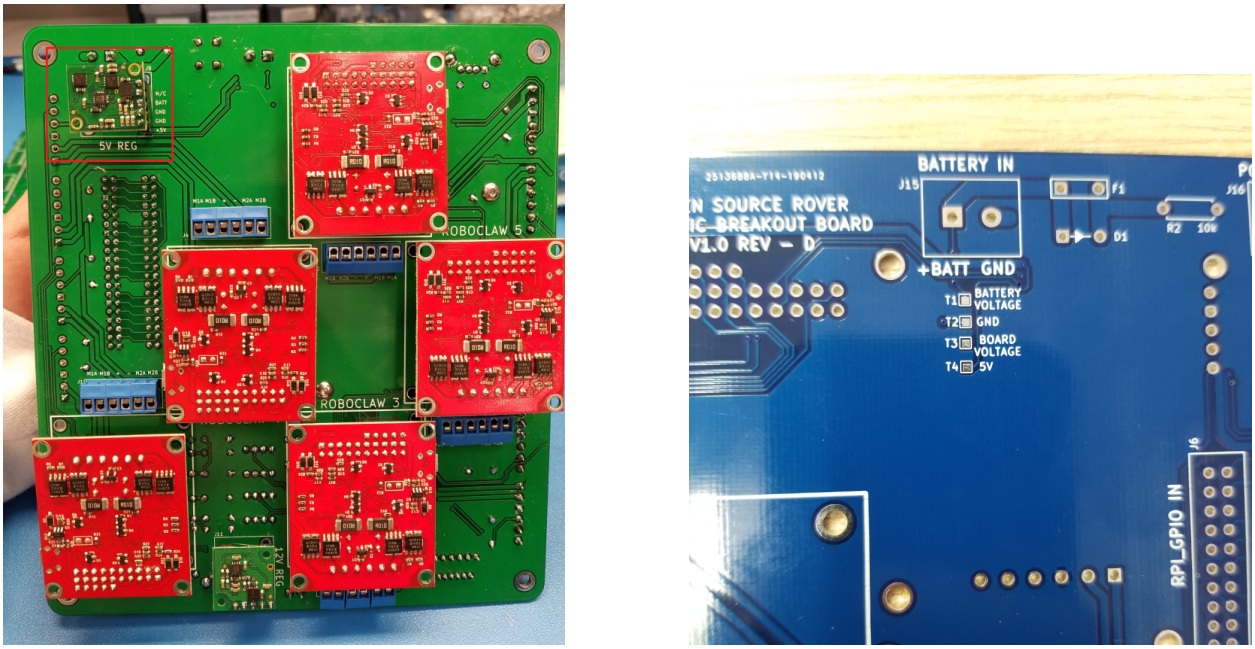


Figure 17: Test Step 5

9. Insert the 12V regulator into the control board. Then test from Testpoint T11 to T21 and verify that it reads 12V. If it does not make sure the 12V regulator is slotted in properly.

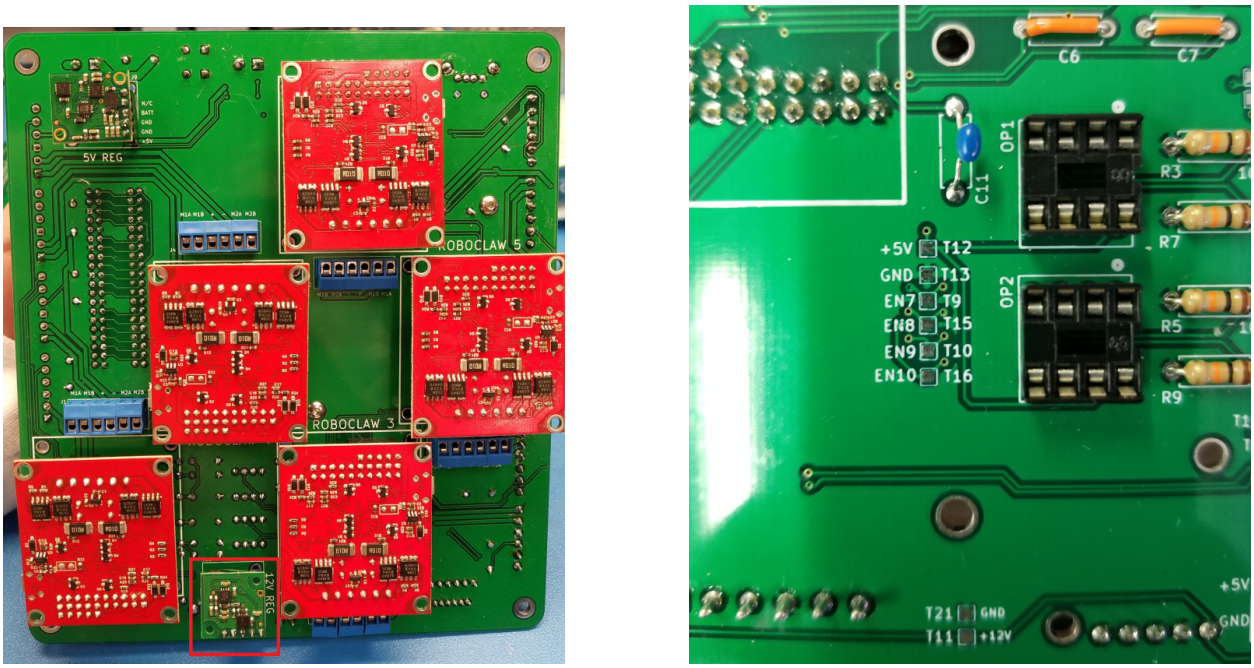


Figure 18: Test Step 6

If all voltage test points read expected values and all the RoboClaw motor Controllers have green LEDs then the power systems has been verified and you are ready to move onto testing and setup of the motor controllers.

2.2 RoboClaw Testing and Verification

In this section you will be going one by and and testing the operation of the RoboClaw Motor controllers. You will be doing this by using the GUI provided by the manufacturer of the motor contollers. The GUI can be found at the following link, under general downloads, then BasicMicro Motion Studio

- https://www.basicmicro.com/downloads

To use the GUI insert a USB to micro USB cable from your computer to the motor controller you are going to be testing. For this step in the testing procedure we found it easiest to test using a set of male-male jumper wires, connected between the motor terminal being tested and the motor. Any way you wish to connect the wires from the terminal block to the motor wires is fine though.

2.2.1 Drive Motor Blocks

Do the following procedure for the terminal blocks labeled J17-22, these correspond to the driving motors for the rover. Make sure that while you are plugging in connections your board is powered off. The terminal blocks correspond to the motor controlelrs/outputs in the following manner:

Table 12: Parts/Tools Necessary

Terminal Block Label	RoboClaw Board Label	Motor Output Channel
J17	RC1	M1
J18	RC1	M2
J19	RC2	M1
J20	RC2	M2
J21	RC3	M1
J22	RC3	M2

1. Connect the wires in the following manner

Table 13: Parts/Tools Necessary

Signal	Terminal Block Label	Motor Connector Wire Color
Motor (+)	M+	Red
Motor (-)	M-	Black
Ground	GND	Green
+5V	+5V	Blue
Encoder A	ENA	Yellow
Encoder B	ENB	White

2. Power on the board, after a minute in the Basic Motion GUI you should see an available device appear. It might require an update to proceed, have it install the latest firmware update and then connect to the device.

3. Click on the PWM tab. We will use this to send a PWM signal to the motor and test that connections are all made correctly to the motor/encoder.

4. Slowly move the slide bar for the corresponding motor output channel (Either M1 or M2 from the above table) for the terminal you are testing. Verify that the motor spins (we will worry about direction later), and that the encoder value is also changing (we'll worry about it increasing or decreasing correctly later as well). Switch direction of the

slide bar and verify that it spins the other direction and the encoder value does the opposite of previous as well. If these are not happening then go back and check that you are using the correct Motor controller, terminal block etc. If all that is correct you will have to begin testing solder contact between the componenets on the board itself.

5. Repeat this process for all the drive motor terminal blocks, labeled J17-22.

2.2.2 Corner Motor Blocks

Do the following procedure for the terminal blocks labeled J23-26. These correspond to the Corner motos for the rover. Terminal blocks correspond to the motor controllers/outputs in the following manner:

Table 14: Parts/Tools Necessary

Terminal Block Label	RoboClaw Board Label	Motor Output Channel
J23	RC4	M1
J24	RC4	M2
J25	RC5	M1
J26	RC5	M2

1. Connect the wires to the motor in the following manner

Table 15: Parts/Tools Necessary

Signal	Terminal Block Label	Motor Connector Wire Color
Motor (+)	M+	Red
Motor (-)	M-	Black

2. The main different between the drive and corner motor system is the encoders used. We want to test the voltage division circuit used on the Control board, which will expect up to a 5V signal in from the Absolute Hall effect encoder. To simulate this

connect the +5V terminal on the motor terminal block straight into the ENA signal in the same terminal block.

3. Connect to the motor contoller in the Basic Motion GUI. Under the General settings tab under Encoders change the type of Encoder from Quadrature to Absolute. You should see that the encoder values change to a number somewhere around 1600. As long as it is a fairly constant value and is in the range of 1400-2000 then everything is working. If that is not recheck that the OP-amp is installed in the correct direction. If this number still isn't correct then make sure you correctly installed all the resistors/capacitors in the assembly steps.

4. Under the PWM tab move the slide bar and verify that the motor spins accordingly.

5. Repeat this process for all the corner motor terminal blocks, labeled J23-26.

2.3 Raspberry Pi Install

Next up is to verify that power to the Raspberry Pi is working. For this you'll need a working operating system install on the SD card. Look foward to the Software Install steps to get the install instructions of that.

INSERT LINK TO SOFTWARE DOC?

Table 16: Parts/Tools Necessary

Item	Ref	Qty	Image	Item	Ref	Qty	Image
OSR Control Board	E1	1		Raspbery Pi 3B	E21	1	
40 Pin Ribbon Cable	E29	1		USB to Micro USB Cable	E27	1	

1. Insert the Raspberry Pi into the Board, making sure that the USB ports face downward on the board. Figure 19 show this orientation.

2. Plug in the micro USB cable **E27** to the USB power port labeled J12 and the Raspberry Pi. Then Plug in the ribbon Cable **E29** into the Raspberry Pi GPIO header pins and the **J6** 40 pin GPIO connector.

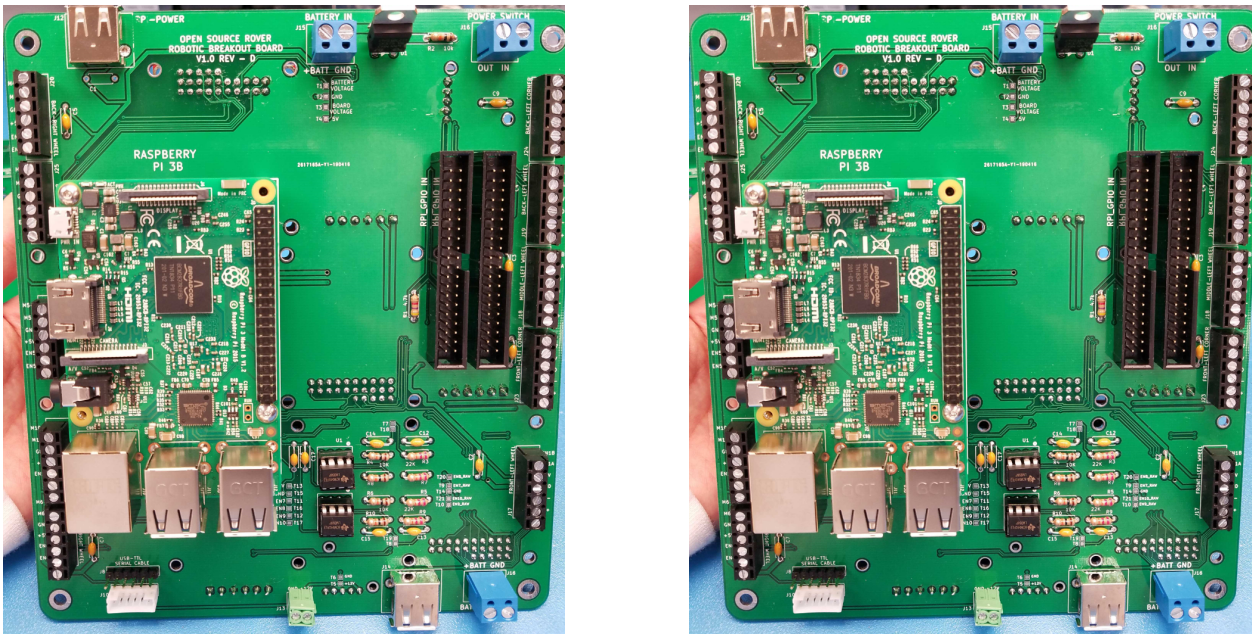


Figure 19: RPi Install

Change second image to RPI with ribbon cable and usb cable plugged in