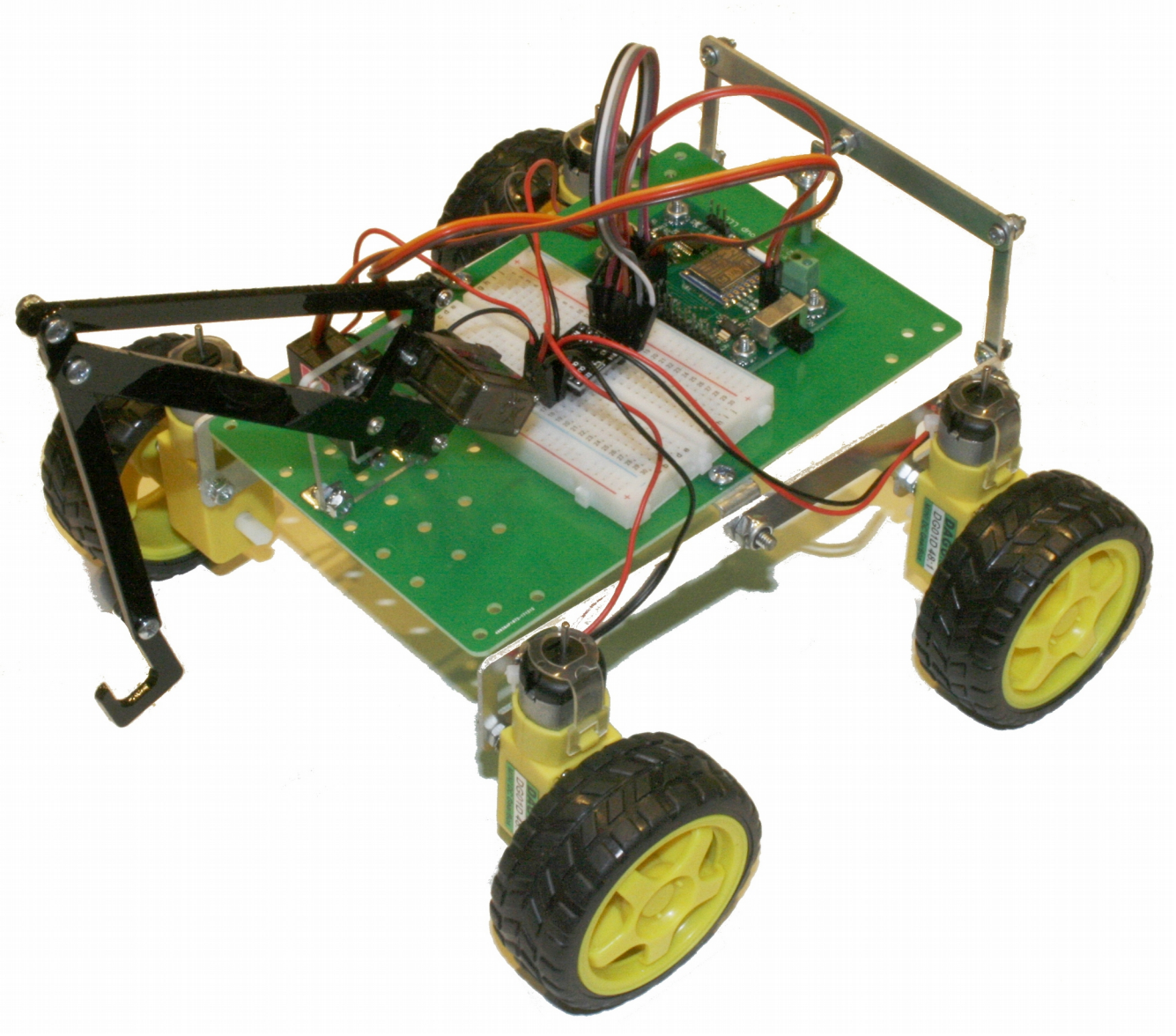
*Sten**BOT*** Rover Kit



Legal Stuff

- Stensat Group LLC assumes no responsibility and/or liability for the use of the kit and documentation.
- There is a 90 day warranty for the rover kit against component defects. Damage caused by the user or owner is not covered.
    - Warranty does not cover such things as over tightening nuts on standoffs to the point of breaking off the standoff threads, breaking wires off the motors, causing shorts to damage components, powering the motor driver backwards, plugging the power input into an AC outlet, applying more than 9 volts to the power input, dropping the kit, kicking the kit, throwing the kit in fits of rage, unforeseen damage caused by the user/owner or any other method of destruction.
- If you do cause damage, we can sell you replacement parts or you can get most replacement parts from online hardware distributors.
- This document can be copied and printed and used by individuals who bought the kit, classroom use, summer camp use, and anywhere the kit is used. Stealing and using this document for profit is not allowed.
- If you need to contact us, go to www.stensat.org and click on contact us.

Overview

Goals

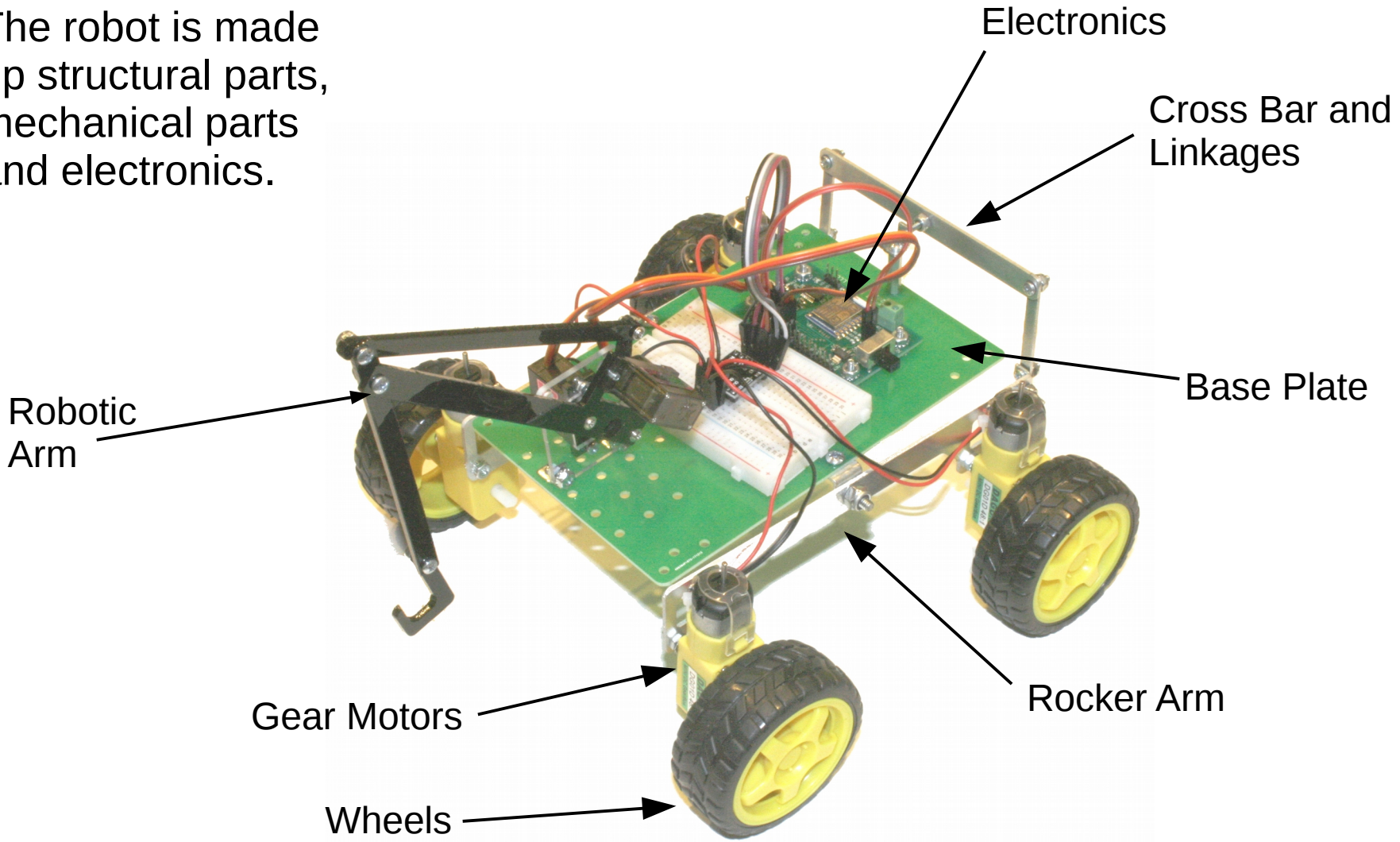
- The goal of this kit is to have a rover platform that can operate on uneven terrain and even in sand autonomously or by remote control.
- You will learn basic autonomous operations using the ultrasonic range sensor.
- For remote operations, you will learn how to configure and program the rover to be controlled by a TV remote control.

Program Overview

- Assemble Kit
- Programming to move
- Learning how to calibrate the motion
- Running the Maze
- Using sensors for collision avoidance
- Running the Maze using collision avoidance
- Remote control

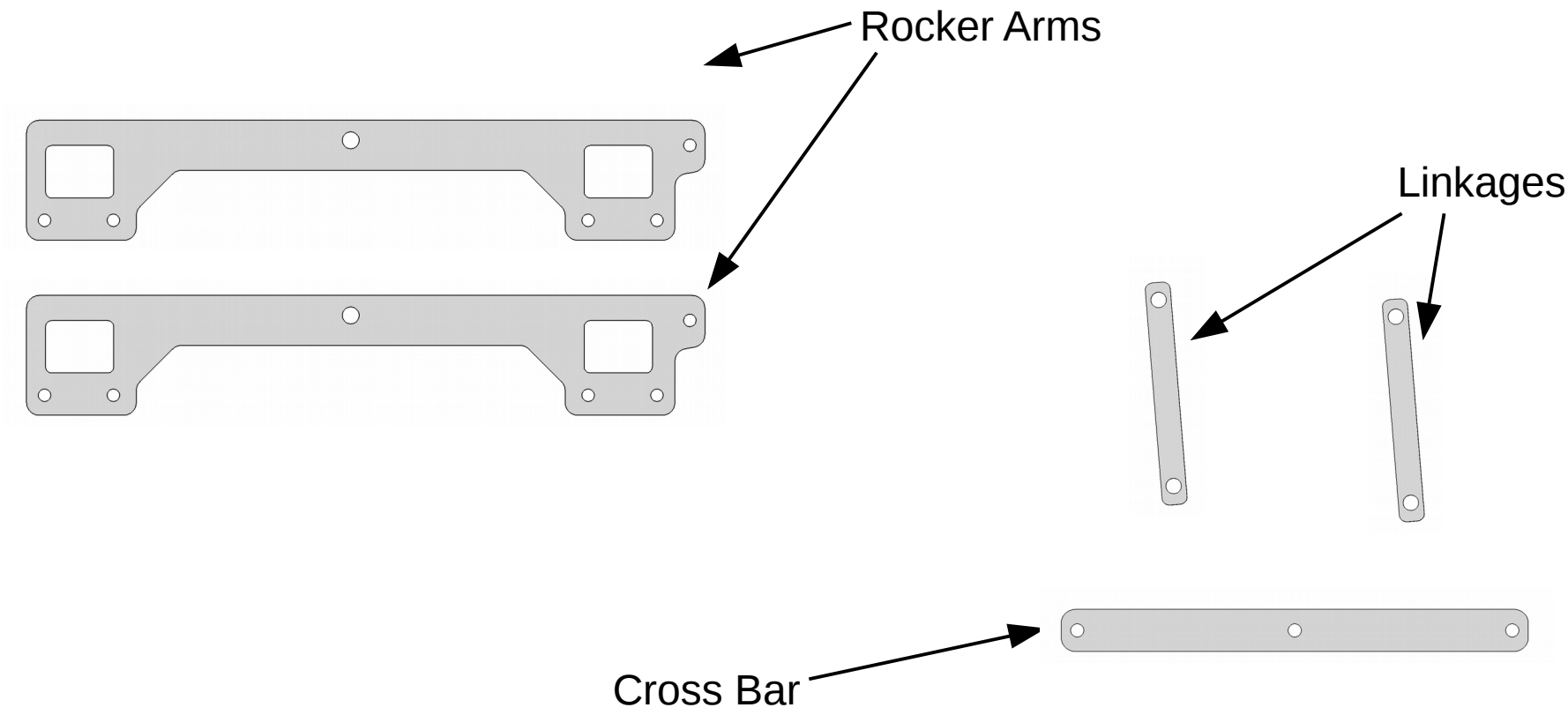
Robot Parts

- The robot is made up structural parts, mechanical parts and electronics.



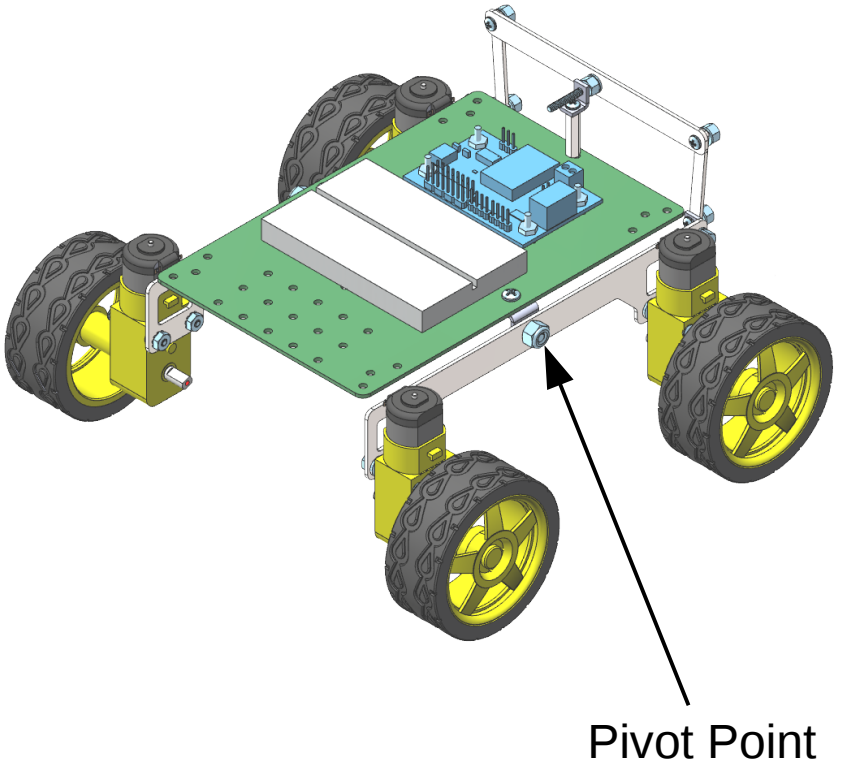
Suspension System

- The rocker arm suspension system is made of a few main components shown below



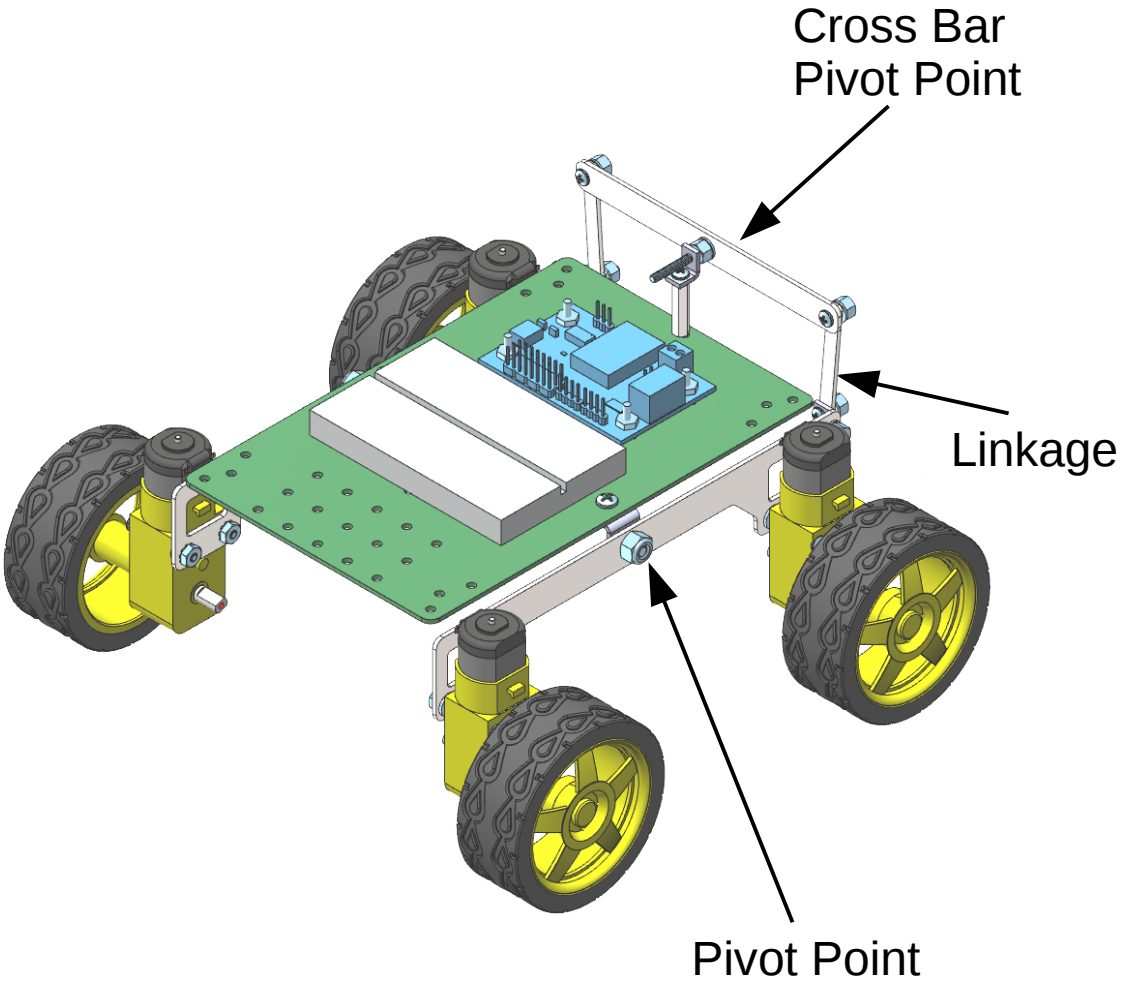
How the Suspension Works

- Two motors are attached to the ends of the rocker arms. The center of the rocker arm is attach to the base plate and pivots. This lets both wheels on the same side keep touching the ground if one drops in a dip or goes up on something.



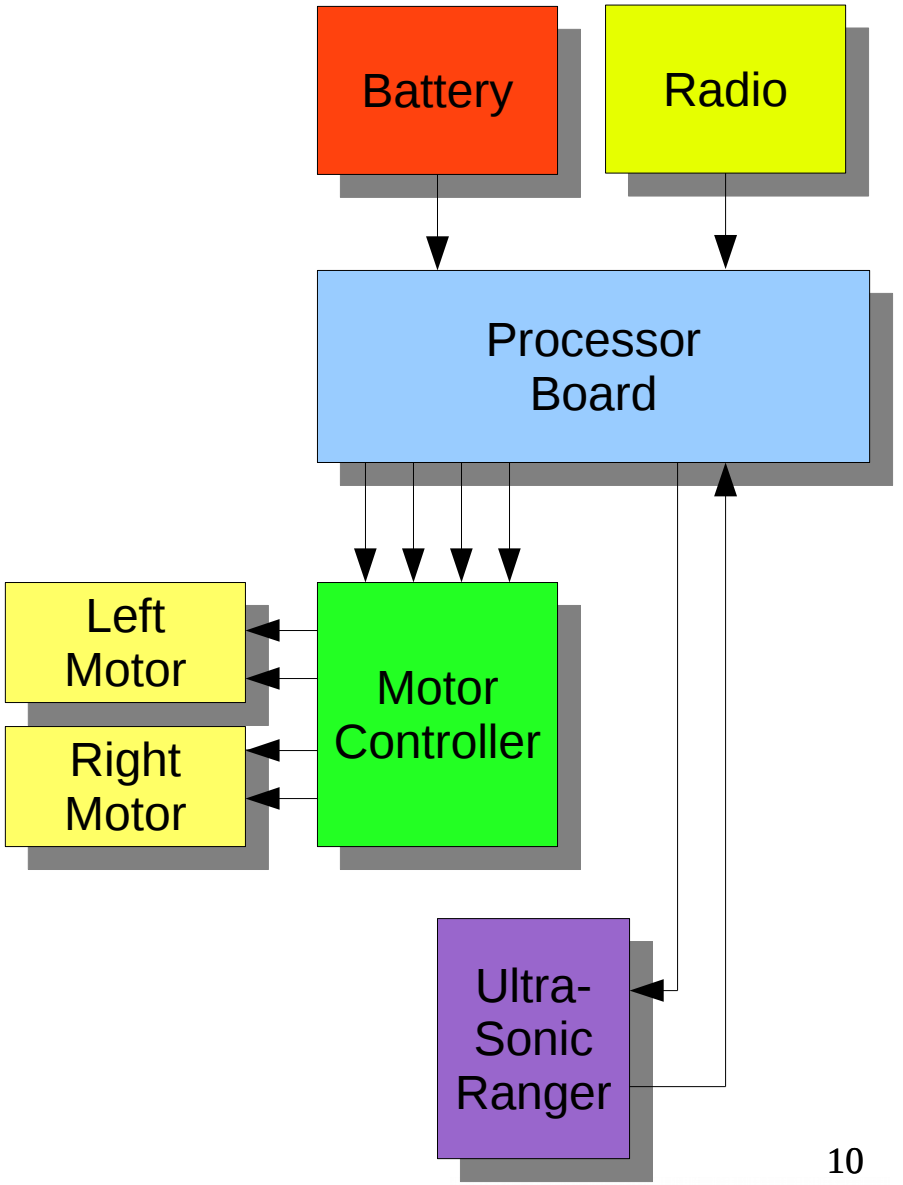
How the Suspension Works

- When the one rocker arm changes its angle, the cross bar is pushed up or down to push the other rocker arm in the opposite direction. This helps keep the wheels on the other rocker arm touching the ground. The linkages attach the rocker arms to the cross bar. The cross bar is attached to the base plate so the base plate changes its angle half way between the two rocker arms.



How the Electronics Works

- The robot electronics controls the operations. It consists of a battery for power, a processor board for the brains, a motor controller to operate the motors and an ultrasonic sensor for detecting obstacles.
- The diagram to the right shows how the electrical components are interconnected.
- The battery powers everything.
- The processor board is the brains and controls everything.
- The motor controller provides the proper interfaces to the motors for the processor board to control the motors.
- The radio provides a method for remote control.

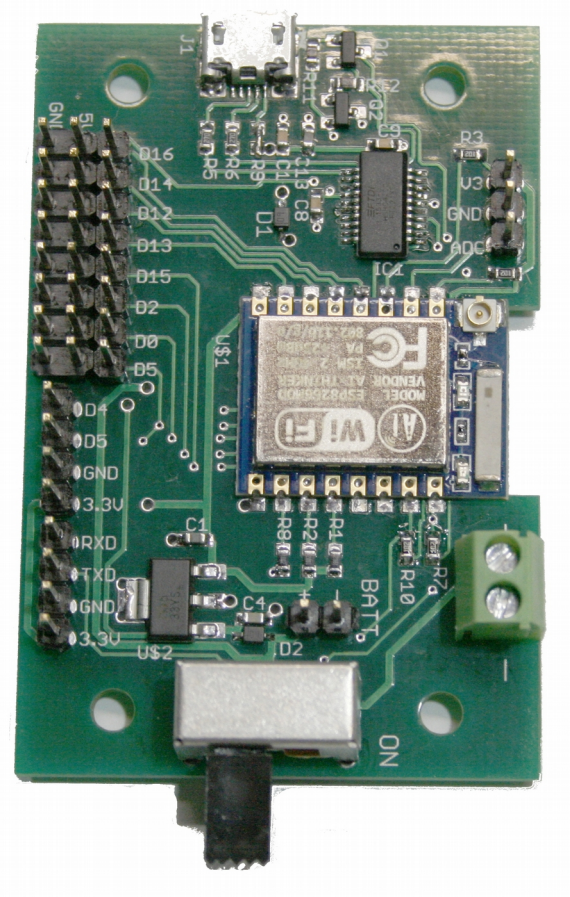


Battery

- The power source for the robot is a battery. The battery is made up of six AA cells.
- Multiple types of AA cells can be used in the robot. The simplest is alkaline cells that cannot be recharged and must be discarded when they are used up. Alkaline cells generate on average 1.5 volts. With four cells, a total of 9 volts is supplied. It will be noticed that over time, the robot will slow down as the batteries drain.
- Rechargeable cells can be used. There is Ni-Cad and nickle metal hydride or Ni-MH. These cells have a slightly lower voltage of 1.25 volts. The benefit is the cells can be recharged and reused many times. Another benefit is these cells can deliver more current without dropping the voltage unlike alkaline cells. These types of batteries also maintain the same voltage longer than Alkaline batteries. This allows the robot to maintain its speed.
- The six cells are connected in series to create a higher voltage.

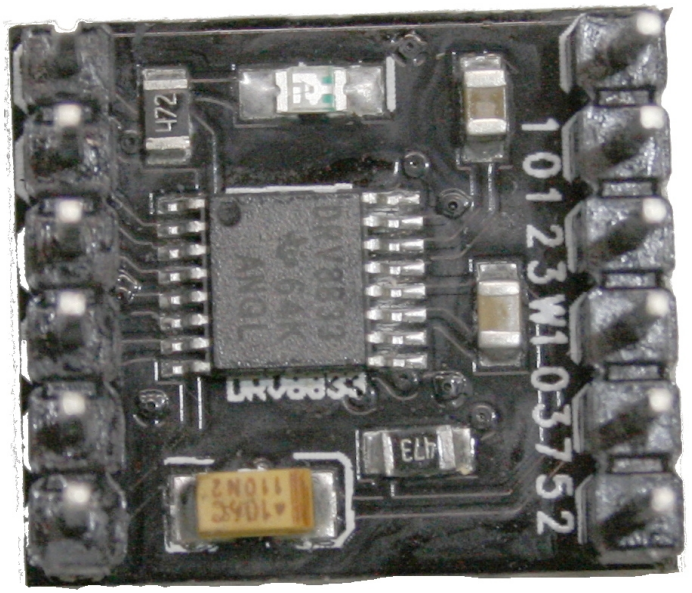
Processor Board

- The processor board is the brains of the robot. It controls everything and connects to all the sensors. This is the part that you program to control the actions of the robot.
- The processor board has multiple interfaces
  - Digital signals
  - Servo motor
  - Communications
  - Analog inputs
  - WiFi
- More details will be covered later.



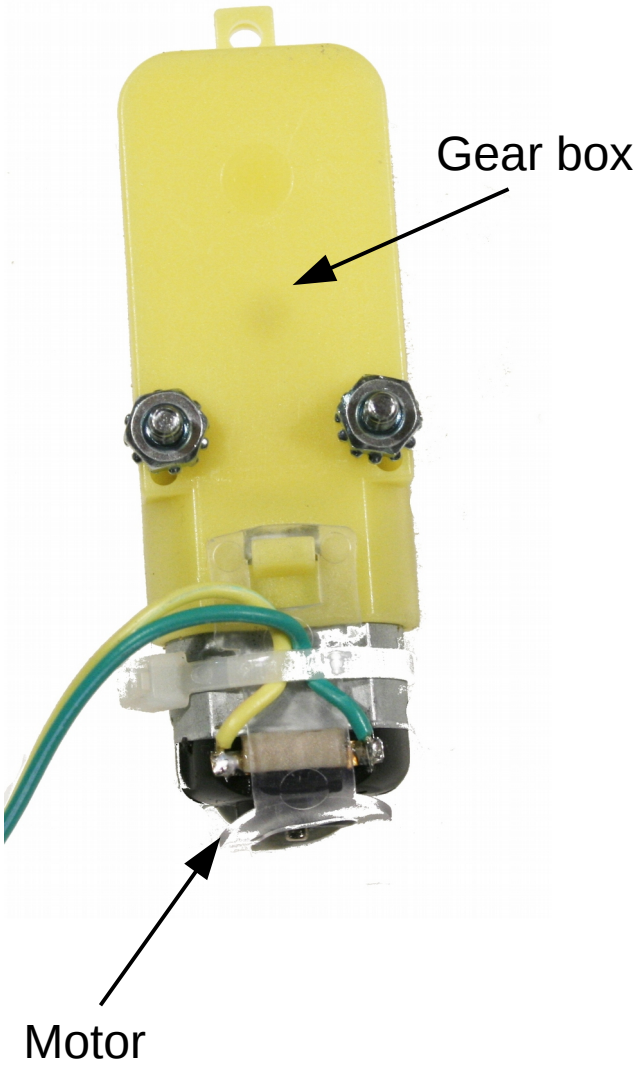
Motor Controller

- The motor controller is the interface between the motors and the processor board. It has circuitry to allow control of the motors and can handle the high currents required to operate the motors. The processor board cannot directly power the motors. The controller is capable of providing the needed current and is used as the interface.
- The black square in the picture to the right is the actual controller. It is an integrated circuit that contains all the circuitry to translate signals from the processor board to the operations of the motors. This controller can operate two sets of motors.
- More details are covered later.



The Motors

- The motors are connected to gears that translate the high speed of the motors to a slower rotations speed. This also increases the power of the motor so the wheels can turn to move the robot.
- The motor is a small DC brush motor shown at the bottom. It is inserted into the yellow gear box.
- At the top side of the picture on the opposite side is a white shaft. The wheel attaches to the shaft.
- The gears convert the high speed rotation of the motor and produces a slower rotating shaft. The torque is also increased at the shaft.



End of Section

- In this section, you learned the parts of the robot and how they all tie together.

Assembly

Robot Assembly

- The robot assembly starts with the wheels, motors and suspension system.
- Once the suspension system with the motors and wheels installed are attached to the base plate, the electronics plate is assembled and installed.

Main Rover Parts List

- 4 – 1/2” 4-40 screws
- 8 – 1” 4-40 screws
- 24 – 4-40 nuts
- 1 – Fiberglass base plate
- 4 – geared motors
- 4 - wheels
- 1 – solderless bread board
- Dual H-Bridge driver module
- 1 – processor board
- 20 – jumpers
- 1 – battery holder
- 1 – USB cable

Sensor Package

- 1 – ultrasonic range sensor
- 2 – LEDs
- 2 – 270 ohm resistors
- 1 – Photoresistor
- 1 - Thermistor
- 1 – 100K ohm resistor
- 1 – 1K ohm resistor

Rocker Suspension System Parts List

- 6 – 3/8” 4-40 screws
- 1 – 3/4” 4-40 screws
- 2 – 1/4” 6-32 screws
- 2 – 3/8” 8-32 screws
- 2 – 8-32 nylon lock nuts
- 1 – 4-40 nut
- 1 – 4-40 ¼ inch screw
- 7 – 4-40 nylon lock nuts
- 1 – 3/4” standoff
- 3 – small right angle brackets
- 2 – large right angle brackets
- 1 – Set aluminum rocker suspension components

Robotic Arm Parts List

- 2 – Servo motors with horn selection
- 4 – M2.56 screws
- 2 – 4-40 nuts
- 4 – ¼ inch 4-40 screws
- 3 – 3/8 inch 4-40 screws
- 3 – 4-20 nylon lock nuts
- 2 – small right angle brackets
- Polycarbonate robotic arm structure parts

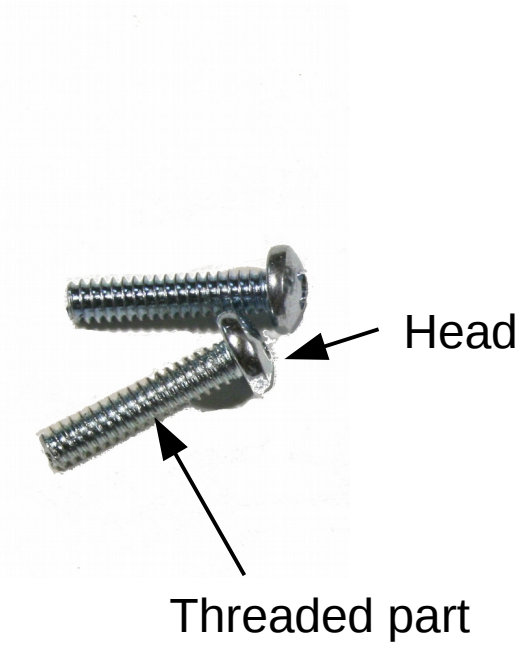
Tools Needed

- Philips screw driver
- 1/4 inch nut driver
- 11/32 inch nut driver

Definition of Components

- Screw – A cylindrical device with a raised helical thread running around it used to join things together.
  - Sizes
    - 4-40 means it is a #4 size screw with threads that wrap around 40 times per inch length.
    - #4 size is .112 inches diameter
    - #6 is .138 inches diameter
    - #8 is .164 inches diameter
  - Length is how long the threaded part of screw is.
  - The screw pictured at the right is a machine screw.
  - Screws with a pointy end are wood screws

    or sheet metal screws.



Definition of Components

- Nut – A device that mates to a screw to secure things together. The sizing is specified the same way, ie 4-40 or 6-32.
- A nylon lock nut is a nut with a piece of nylon material inserted to keep the nut from spinning freely. It is used to join things together but let them move against each other.

Nylon Lock Nut

Definition of Components

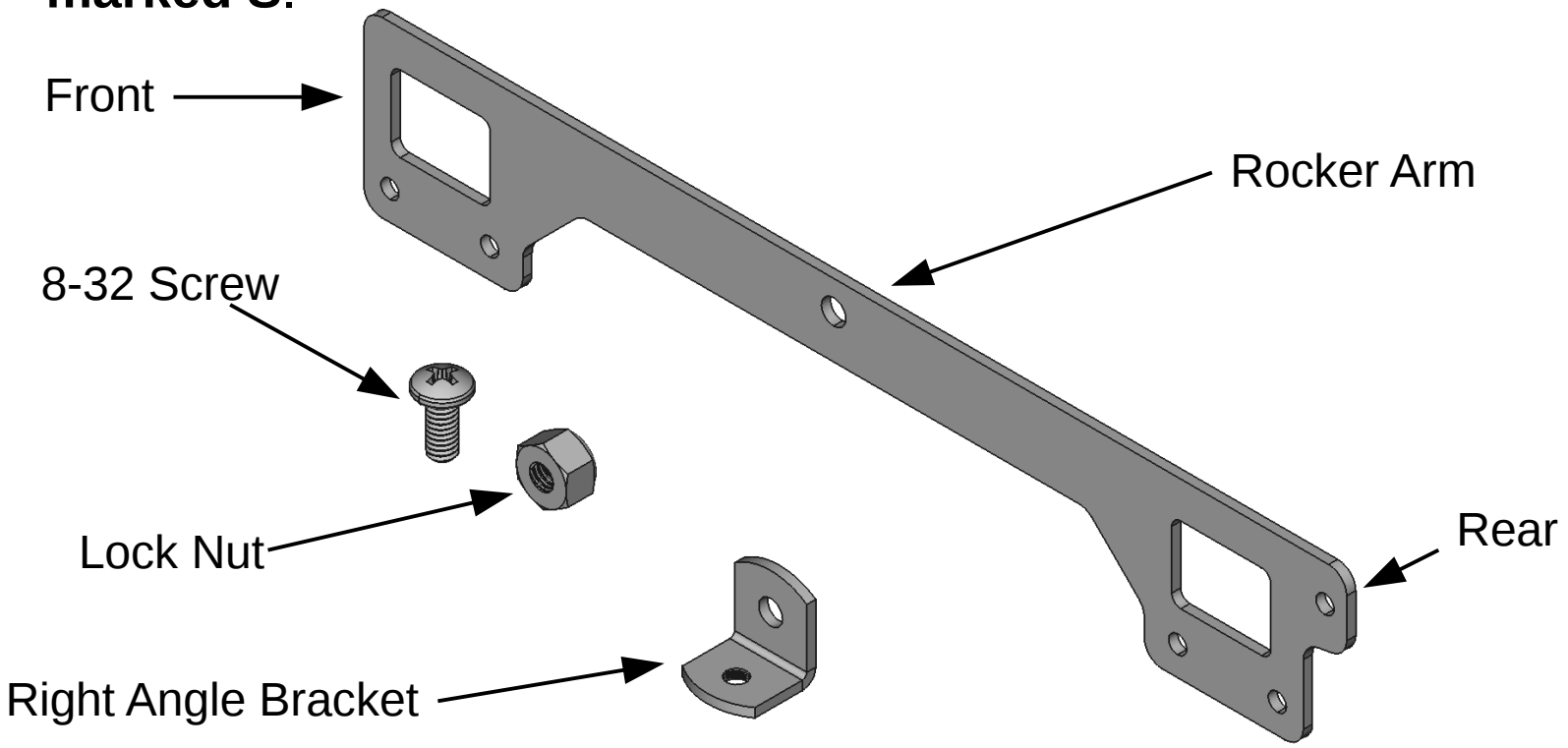
- Right angle bracket – A device that allows two things to be attached at right angles to each other.
- Standoff – A device that allows things to be attached to each other at a distance. Allows stacking. One end can be threaded like a screw and the other hollowed and threaded to be like a nut. They are made in different lengths. The rovers uses a 1.5 inch and ¾ inch long standoffs.

Standoff

Right Angle Bracket

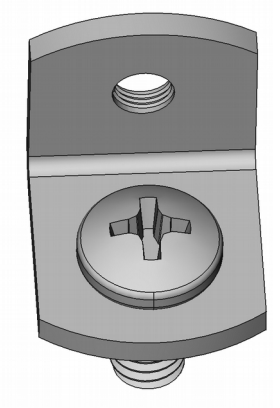
Start of the Assembly

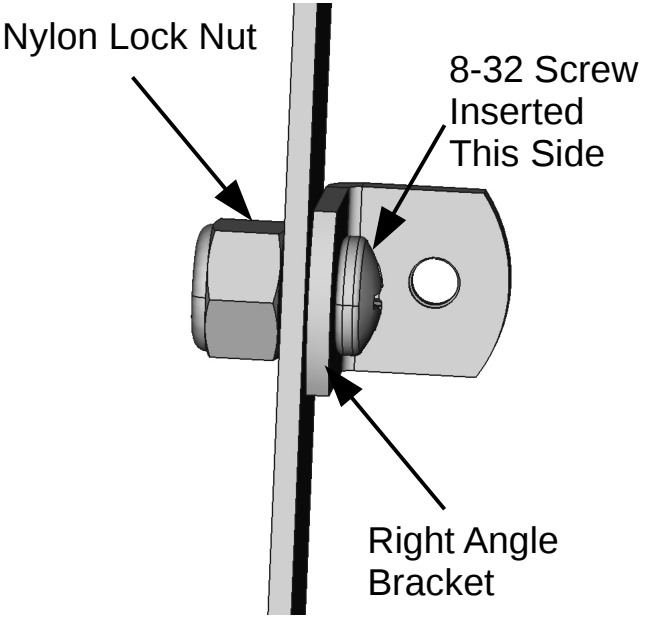
- The assembly will start with the wheels and suspension system.
- Below is a picture of the components. One side is shown. The second side will be assembled as a mirror image. **Use the hardware in the bag marked S**.



Rocker Arm Assembly

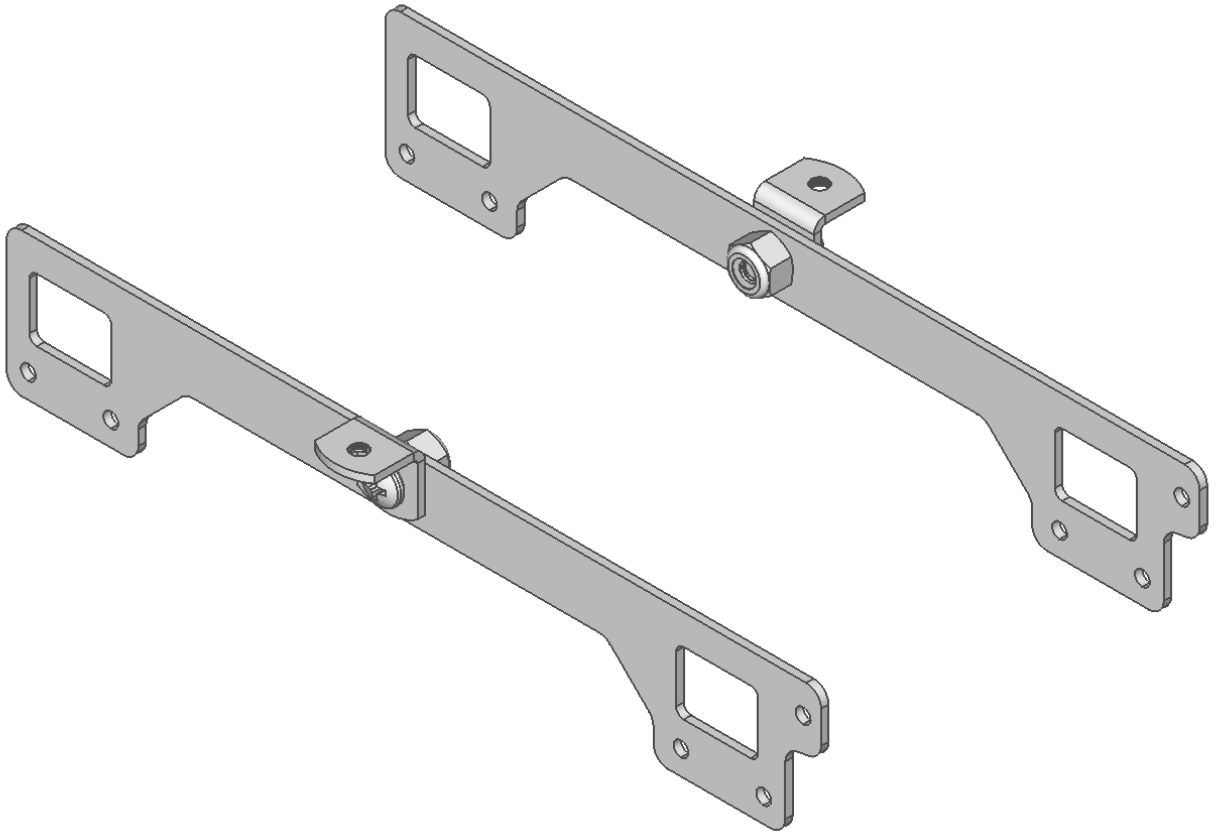
- The rocker arm will mount to the robot base plate using the right angle bracket.
- The 8-32 screw is inserted into the larger hole on the right angle bracket as shown in the top right.
- Insert the screw with the bracket through the hole in the center of the rocker arm.
- Insert the lock nut onto the screw. The lock nut has a nylon insert that makes the nut go on tight. A 11/32 nut driver or pliers will be needed to tighten the nut onto the screw.
- Tighten the nut all the way. Once tight, turn back the nut driver a little bit so the rocker arm can move freely but have little side to side wiggle.





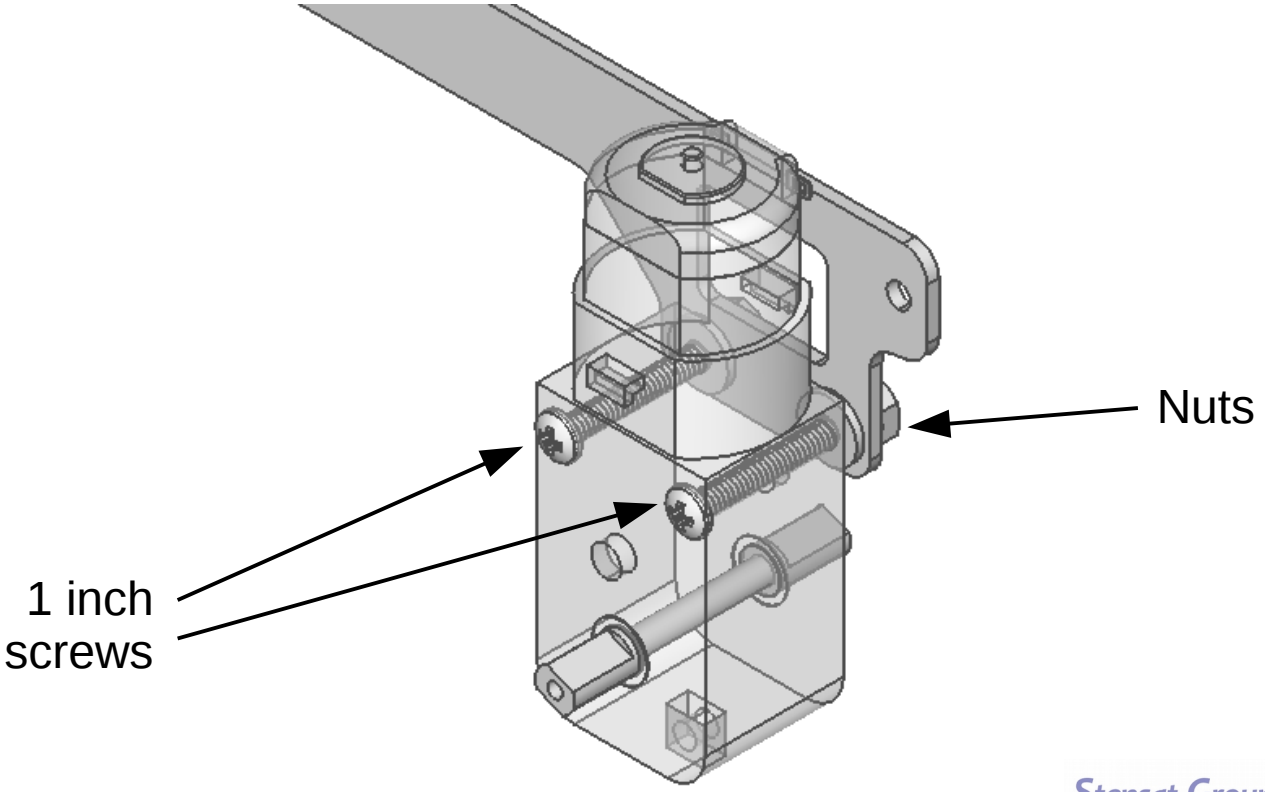
Rocker Arm Assembly

- Assemble the second rocker arm the opposite of the first one.
- The two rocker arms should look like the picture.



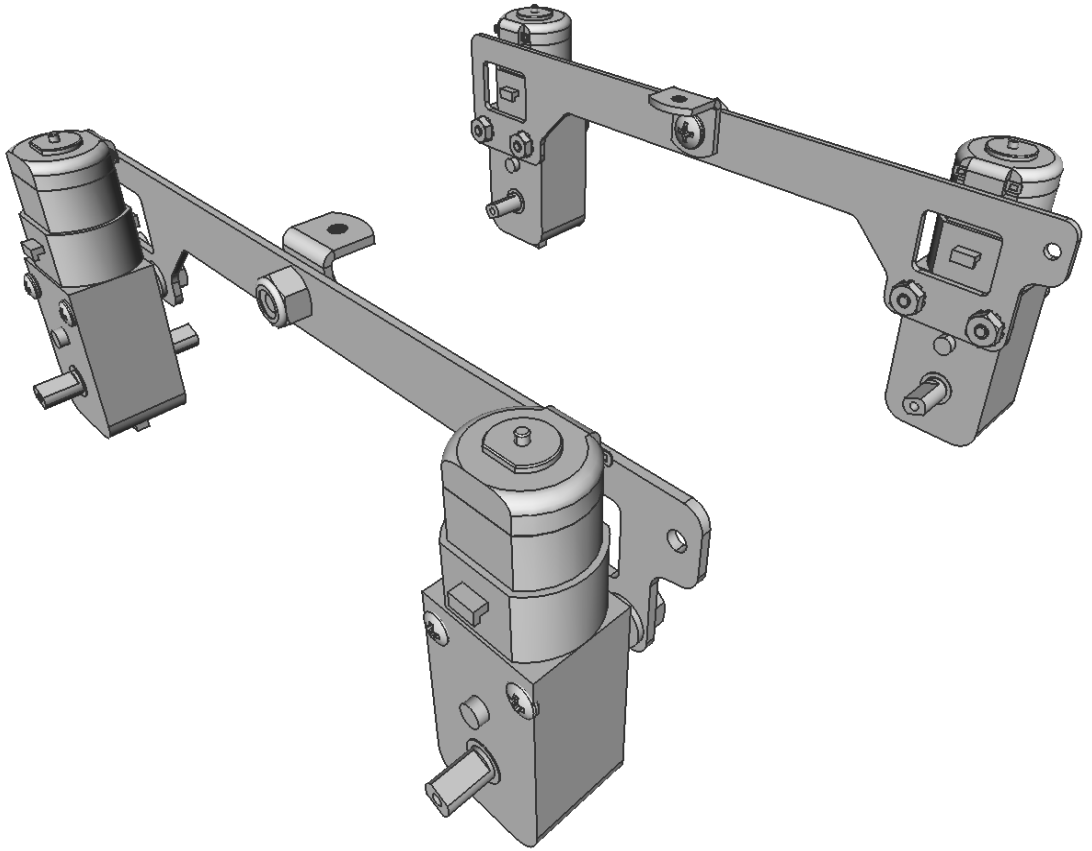
Motor Installation

- To install the motors on the rocker arm, Insert the two 1 inch screws into the holes in the motors. **Insert on the side with the wires connected.**
- Insert the motor on the rocker arm and secure with nuts.
- Repeat for the second motor.



Mounting Motors

- Install the motors on the second rocker arm.
- They should look like the mirror of each other.
- Make sure the bracket is on the opposite side of the rocker arm from the motors.
- Make sure the wires from the motors are router toward the center of the rocker arms.

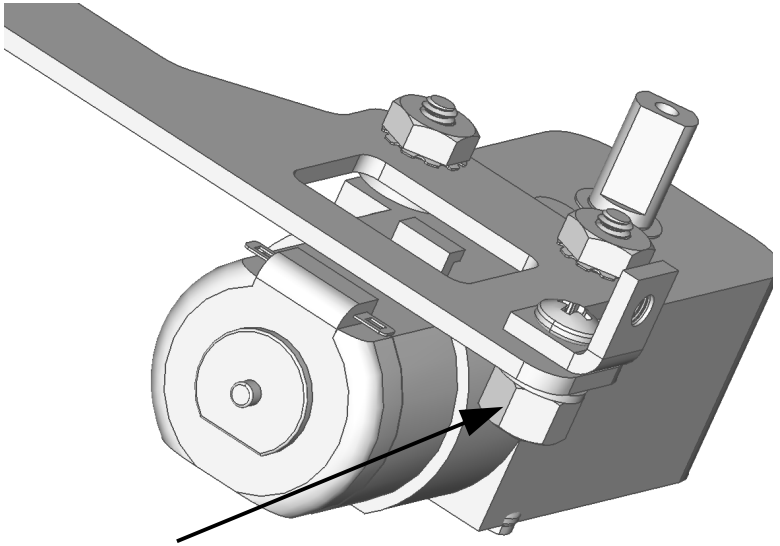


Suspension Linkage Bracket

- Before installing the rocker arms, small right angle brackets for the suspension linkage need to be installed. **Locate the bag marked L.**
- Locate the two small right angle brackets, 4-40 lock nuts, and 3/8 inch 4-40 screws.
- Insert the screws into the smaller hole of the right angle brackets. The hole is threaded so a screw driver is needed. Screw in the screws as shown in the lower right. Make them tight.

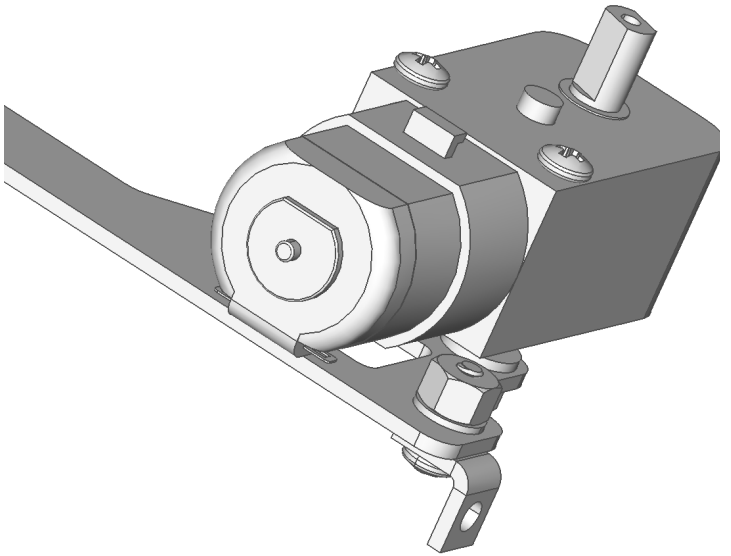
Suspension Linkage Bracket

- Mount the brackets onto the back side of the rocker arms as shown.
- Install the 4-40 lock nut on to the screw from the motor side and tighten with a ¼ inch nut driver.
- Tighten until the nut does not turn any more.
- Loosen the nut one turn. The right angle bracket needs to be loose.



Lock Nut

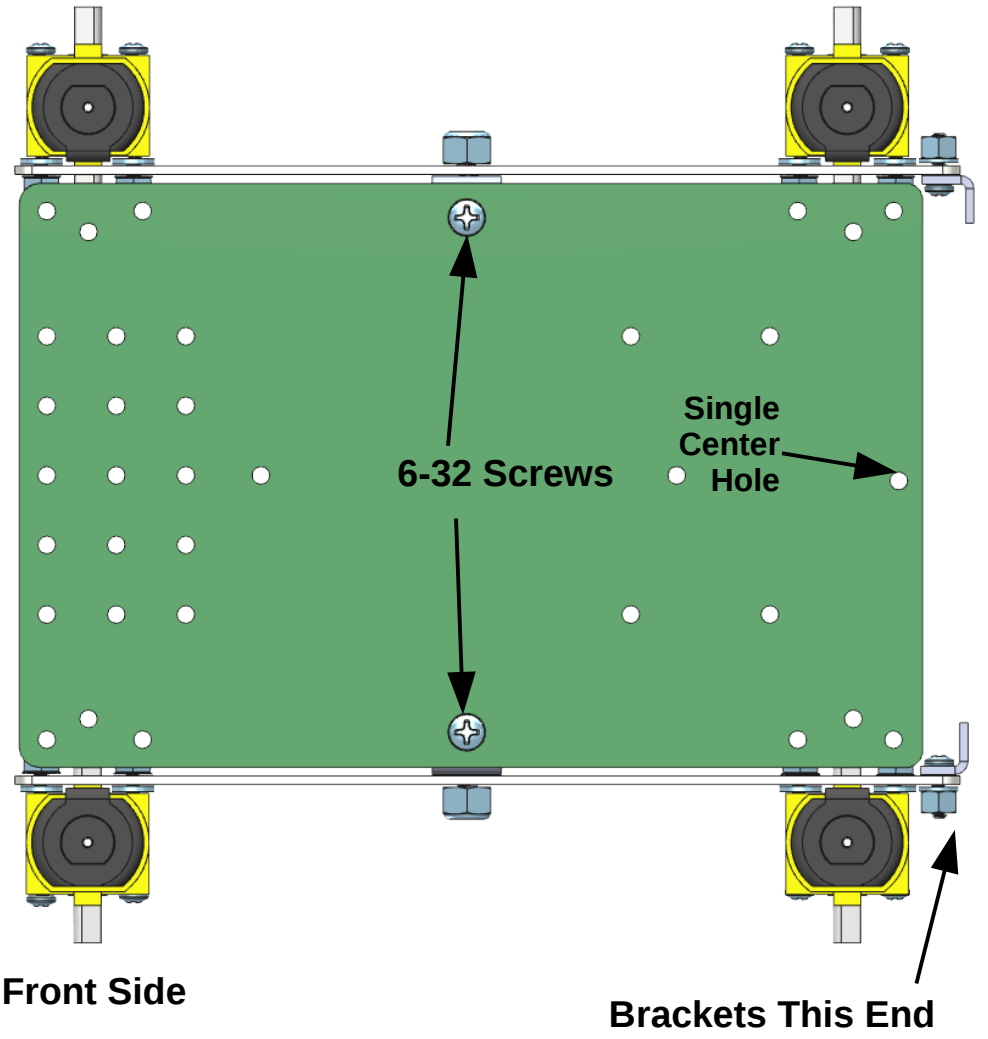
Left Rocker Arm



Right Rocker Arm

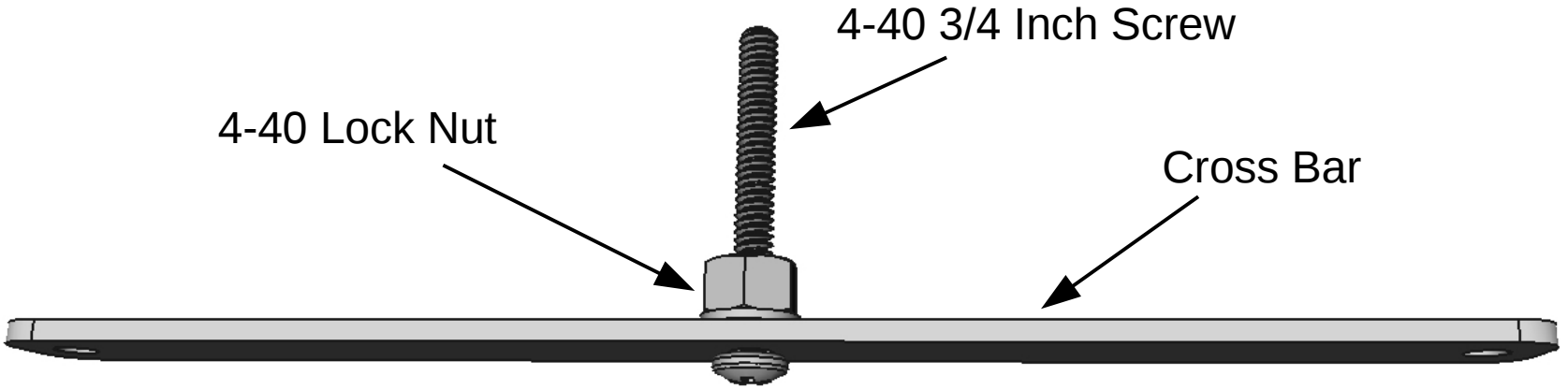
Mounting the Rocker Arms

- Mount rocker arms to the base plate. The end of the rocker arm with the right angle brackets must be positioned to end with the single center hole.
- Use the ¼ inch 6-32 screws.
- Insert the screws in the center holes along the edges of th plate shown.
- Screw in the right angle bracket of the rocker arm with the 6-32 screws.
- Before tightening, adjust the rocker arms so they are parallel with the edge of the base plate.
- Tighten the screws when the rocker arms are parallel.



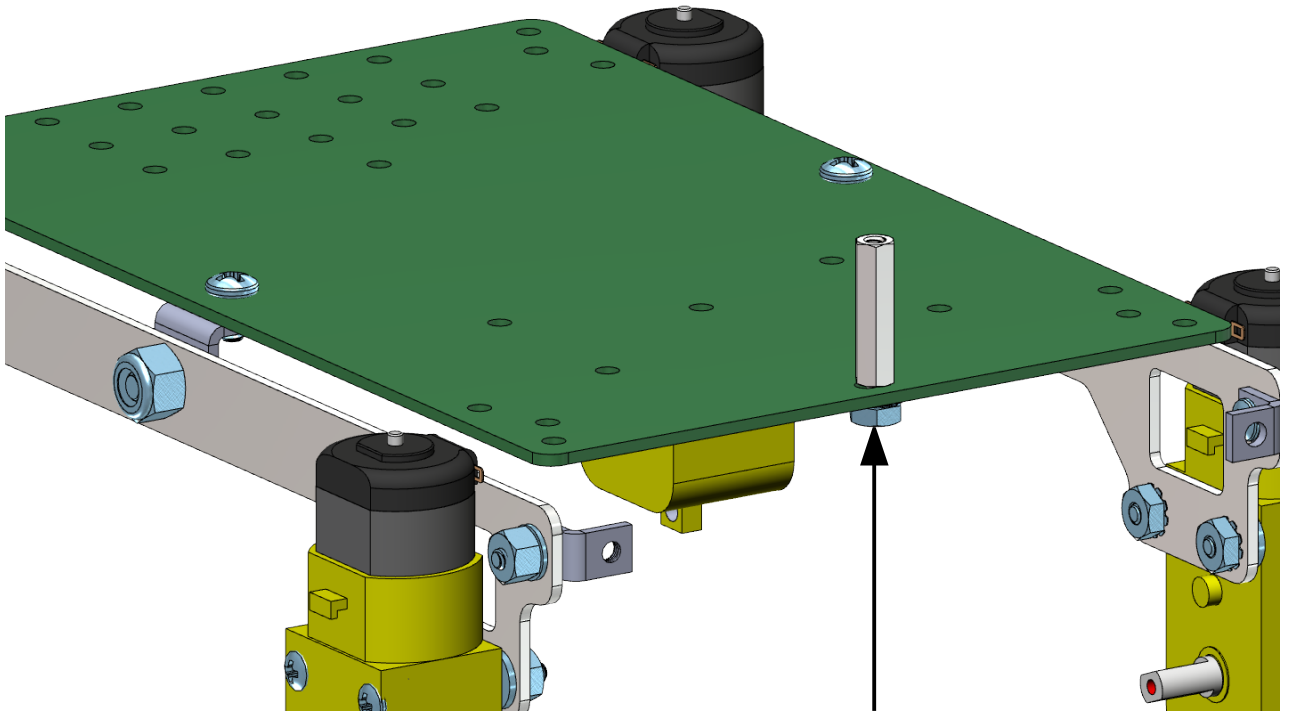
Suspension Linkage

- Now, assemble the cross bar.
- Get a 3/4 inch 4-40 screw and 4-40 lock nut.
- Insert the screw into the center hole of the cross bar.
- Insert the lock nut and tighten all the way.
- Once tightened, loosen the lock nut about a ½ turn.
- The cross bar should rotate freely on the screw.



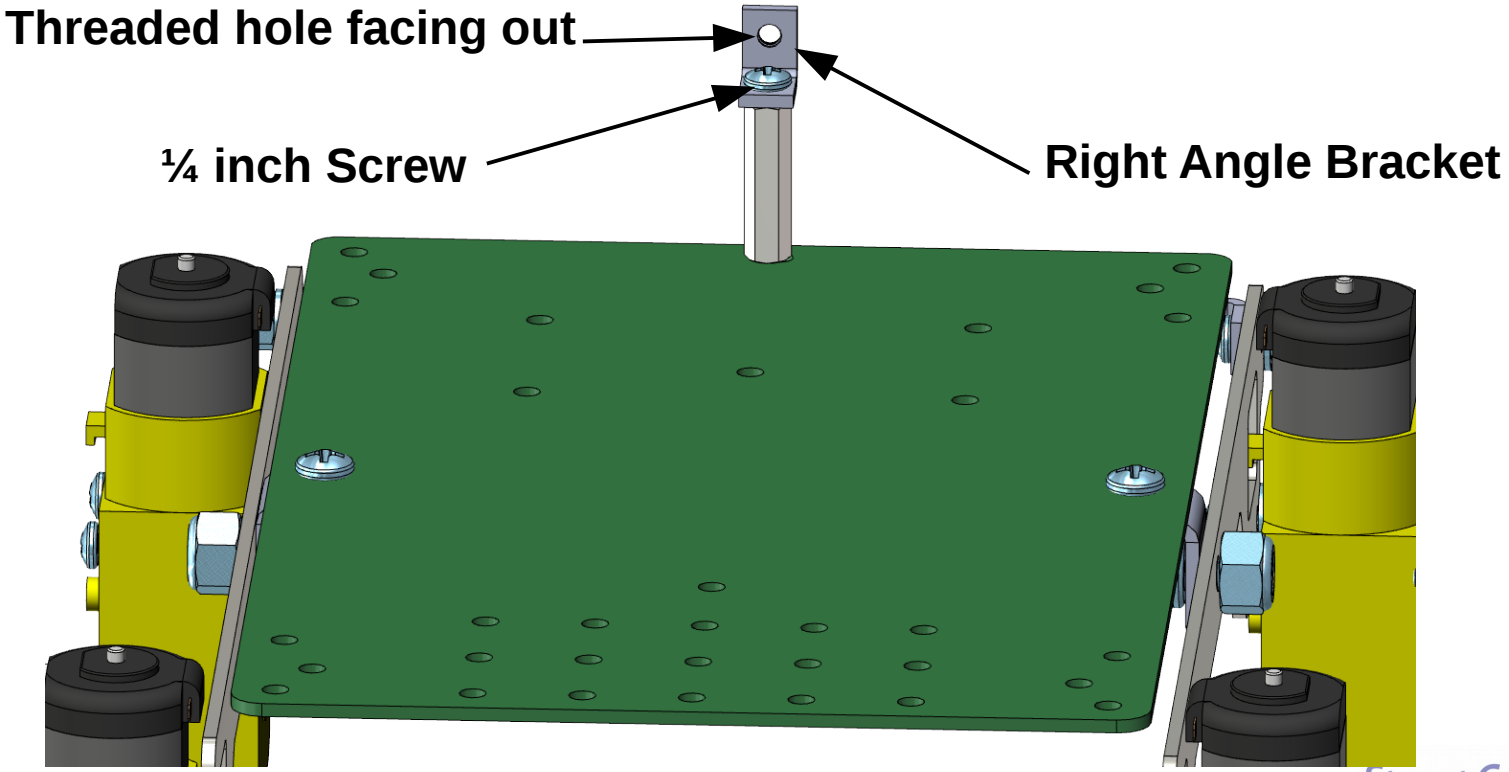
Cross Bar Mount

- Install a ¾ inch standoff in the center back hole of the base plate. The hole is marked “Suspension.” Insert the threaded side of the standoff in the hole and secure with a 4-40 nut from the underside of the base plate. Do not over tighten as you may break the standoff. It is made of aluminum. Once the nut is tightened by hand, **a quarter turn with the nut driver is sufficient. Too tight and you can break the standoff.**



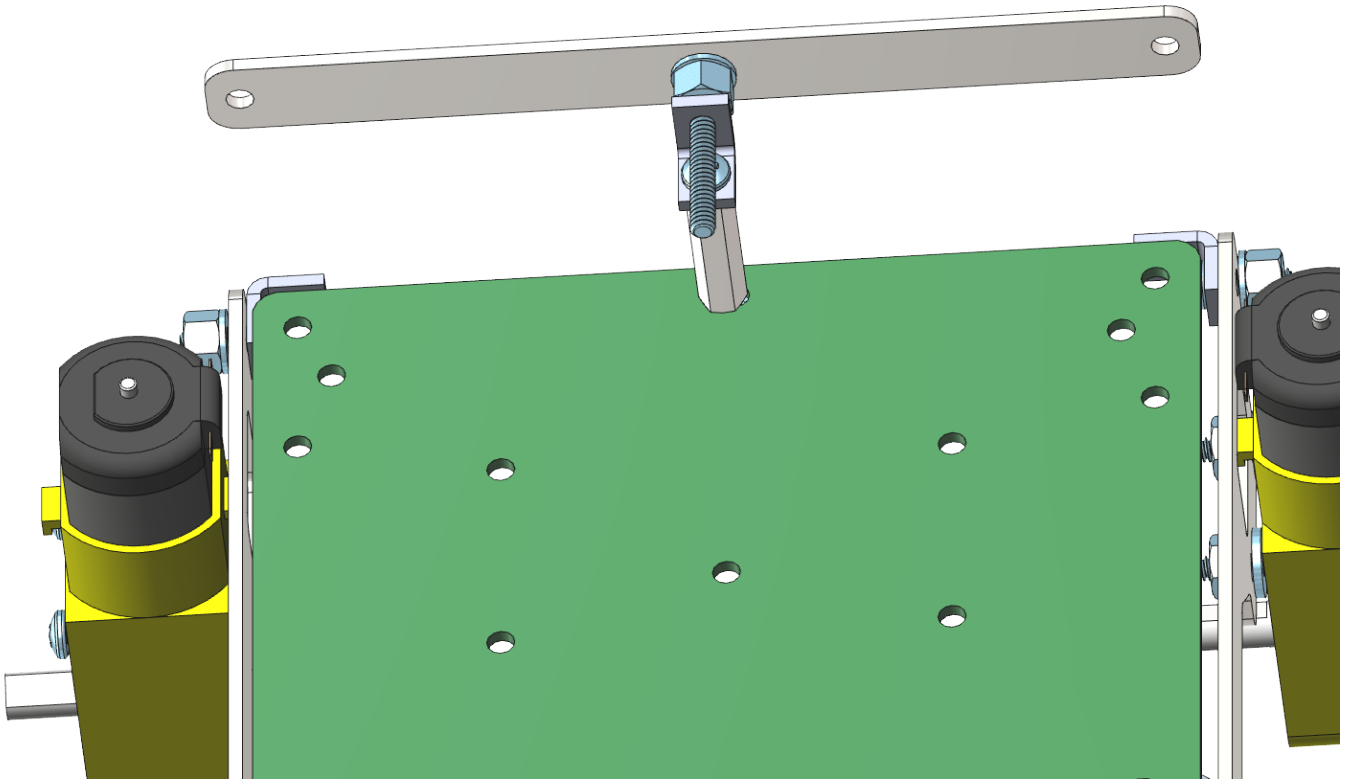
Cross Bar Mounting Bracket

- Install a small right angle bracket on top of the standoff and secure with a ¼ inch 4-40 screw. Use the larger hole of the right angle bracket.
- Align the bracket as shown.



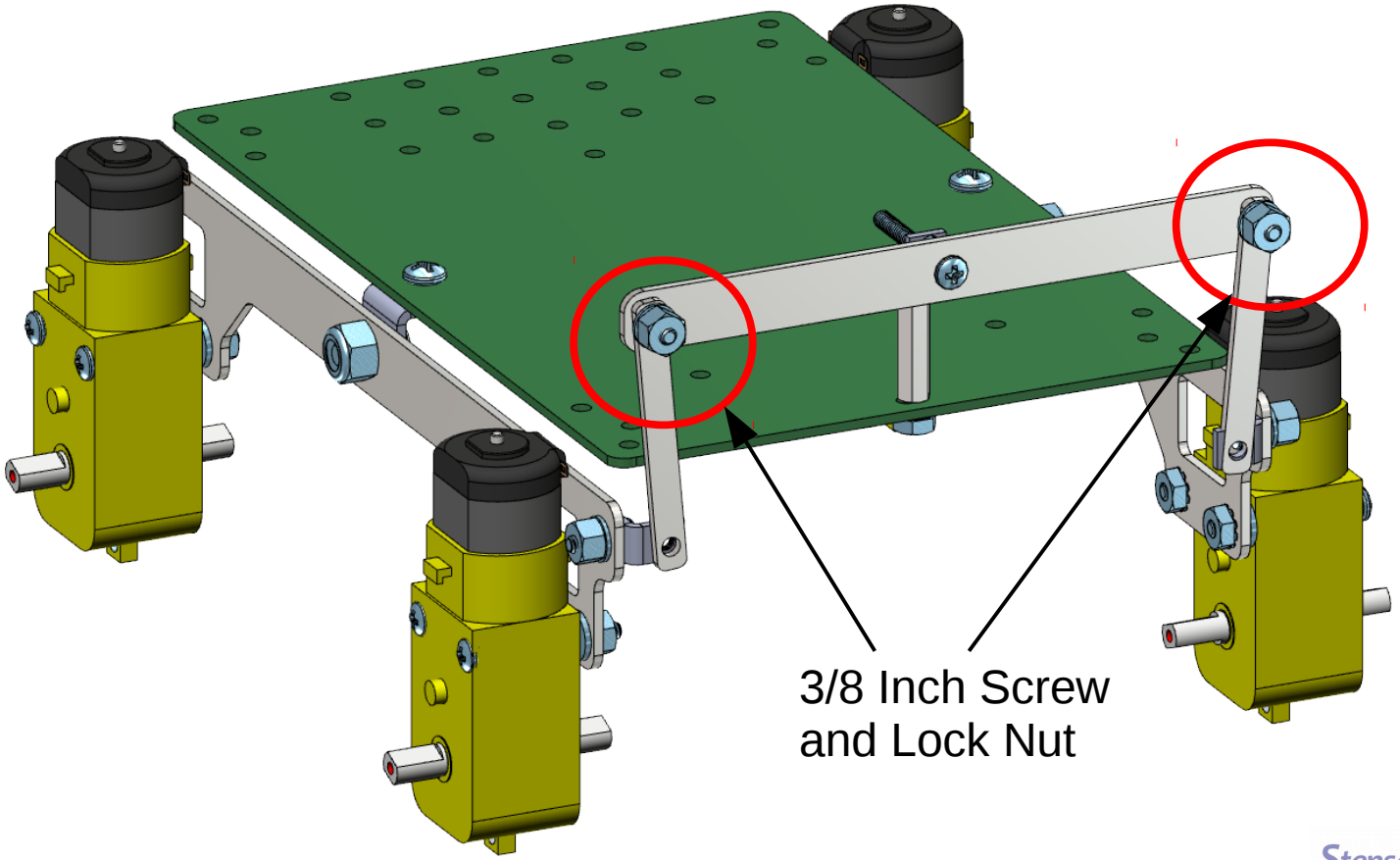
Installing Cross Bar

- Screw the cross bar into the right angle bracket secured on the standoff. Don't screw in all the way. Leave about ¼ inch of threads.



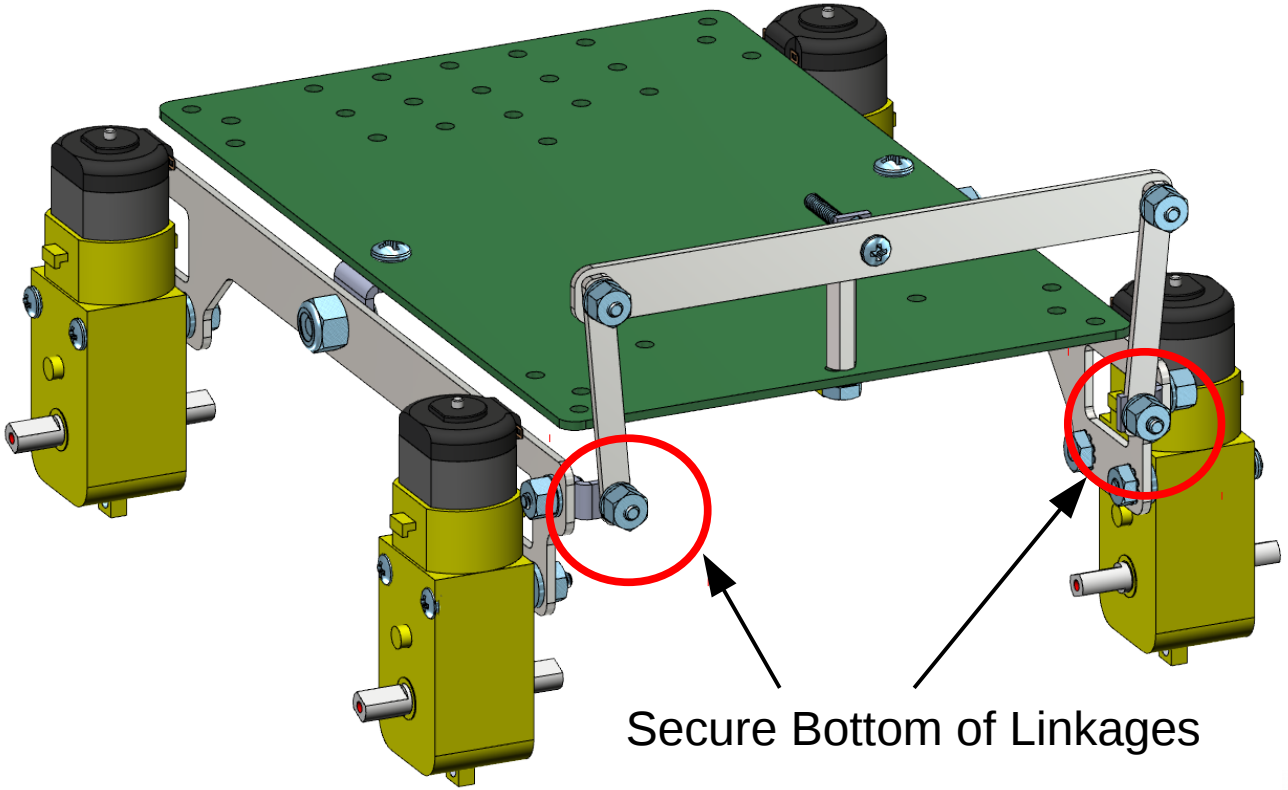
Installing the Linkages

- Install the two linkages on to the cross bar. Use the 3/8 inch long 4-40 screws and lock nuts.
- Tighten the lock nuts and then loosen by a ½ turn of the nut driver.



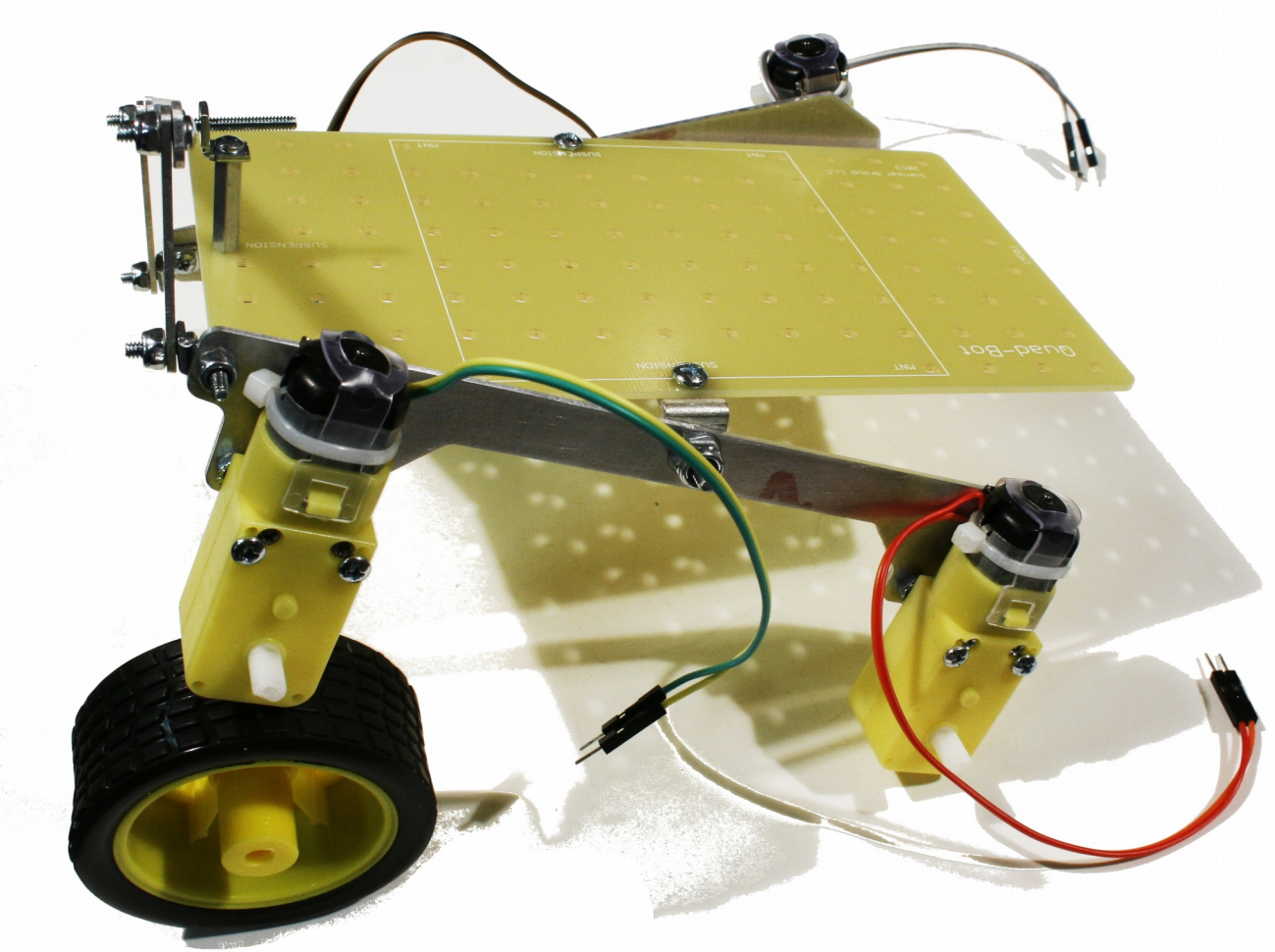
Linking the Linkages

- Use another 3/8 inch 4-40 screw and 4-40 lock nut and secure the bottom end of the linkages to the brackets on the rocket arm.
- Tighten the lock nuts and then loosen with a half turn.



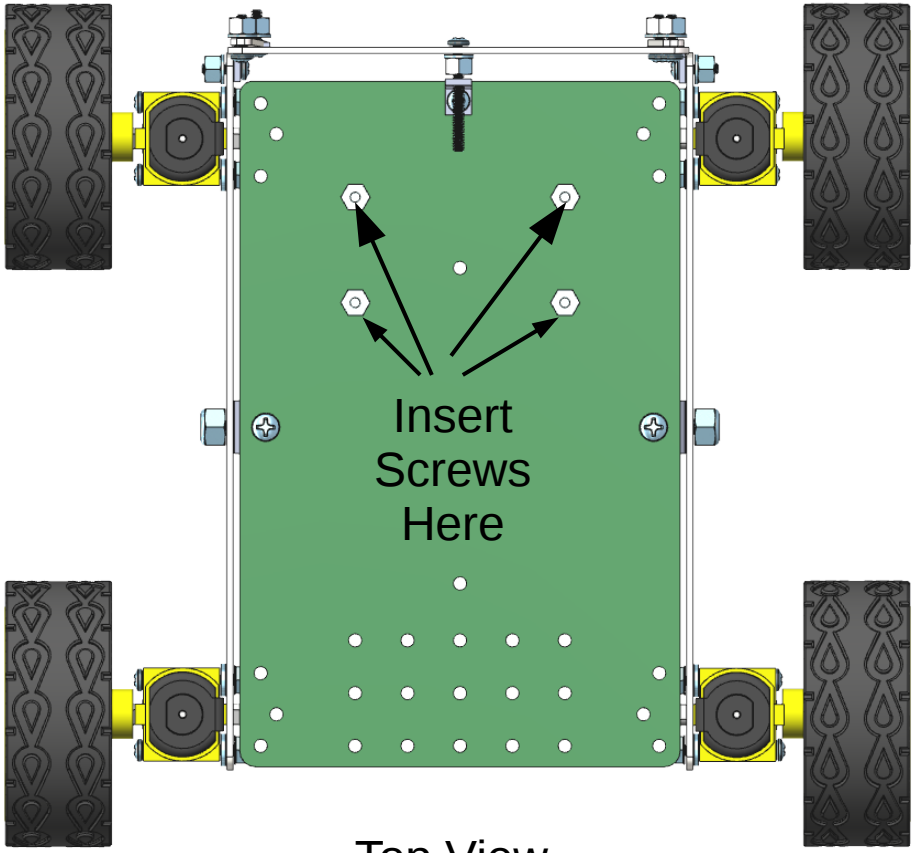
Testing the Suspension

- Make sure all linkage connections are loose. This allows the rocker arms to move freely and keep the base plate stable.
- Lift one motor and make sure all the other three motors stay on the surface. Up two three inches of height should be possible.
- Insert the wheels onto the geared motors. You will see flats on the shafts. Align the wheels to the flats.



Processor Board Mount

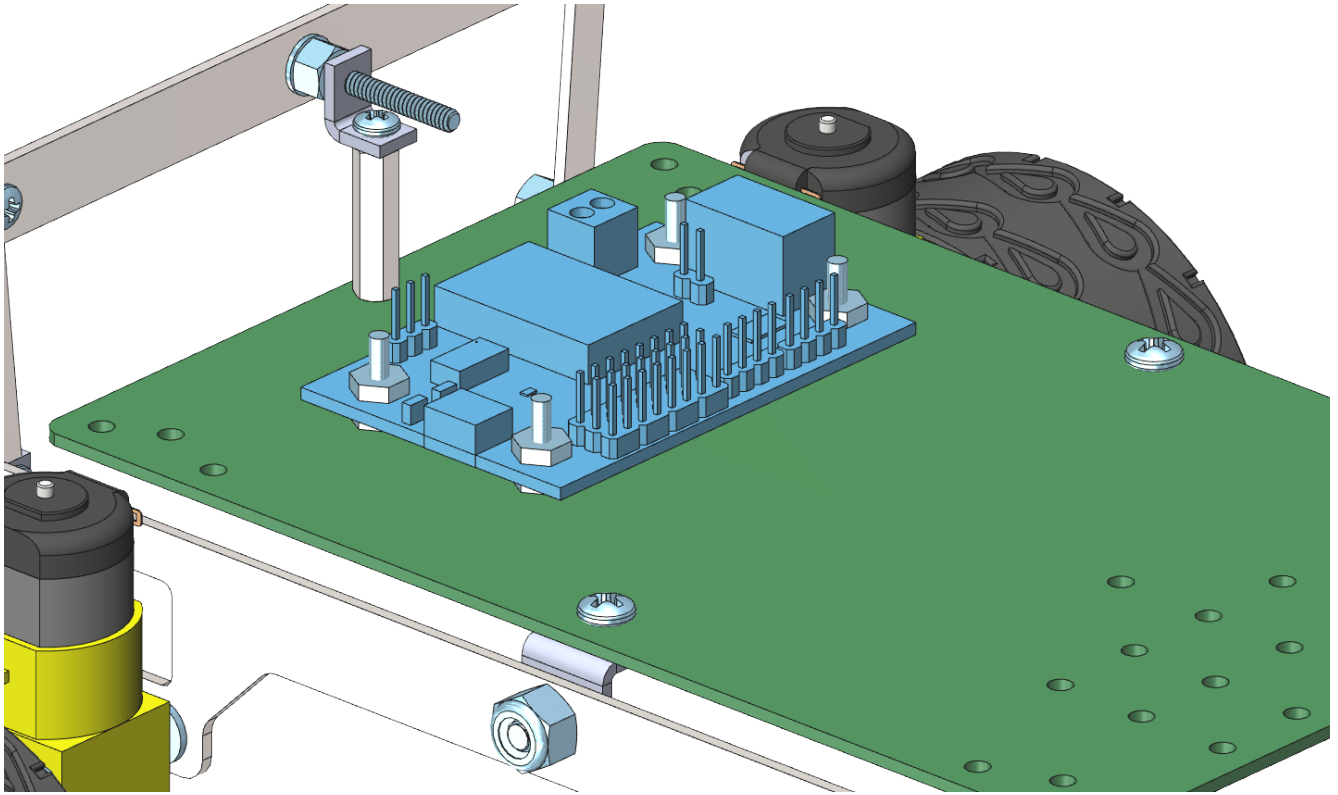
- Insert four ½ inch 4-40 screws from the bottom into the holes of the base plate as shown in the picture.
- Secure the screws with nuts.



Top View

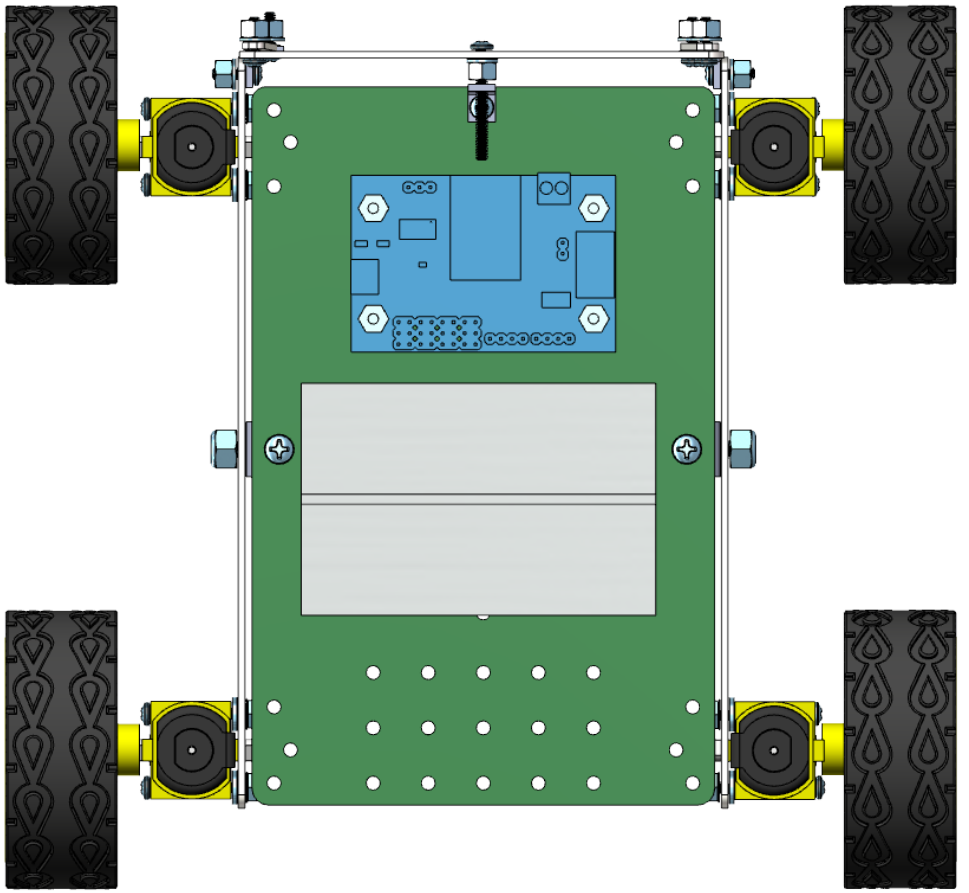
Processor Board Mount

- Insert the processor board onto the four screws as shown. (Processor board shown in purple for clarity)
- Secure the processor board with four nuts.



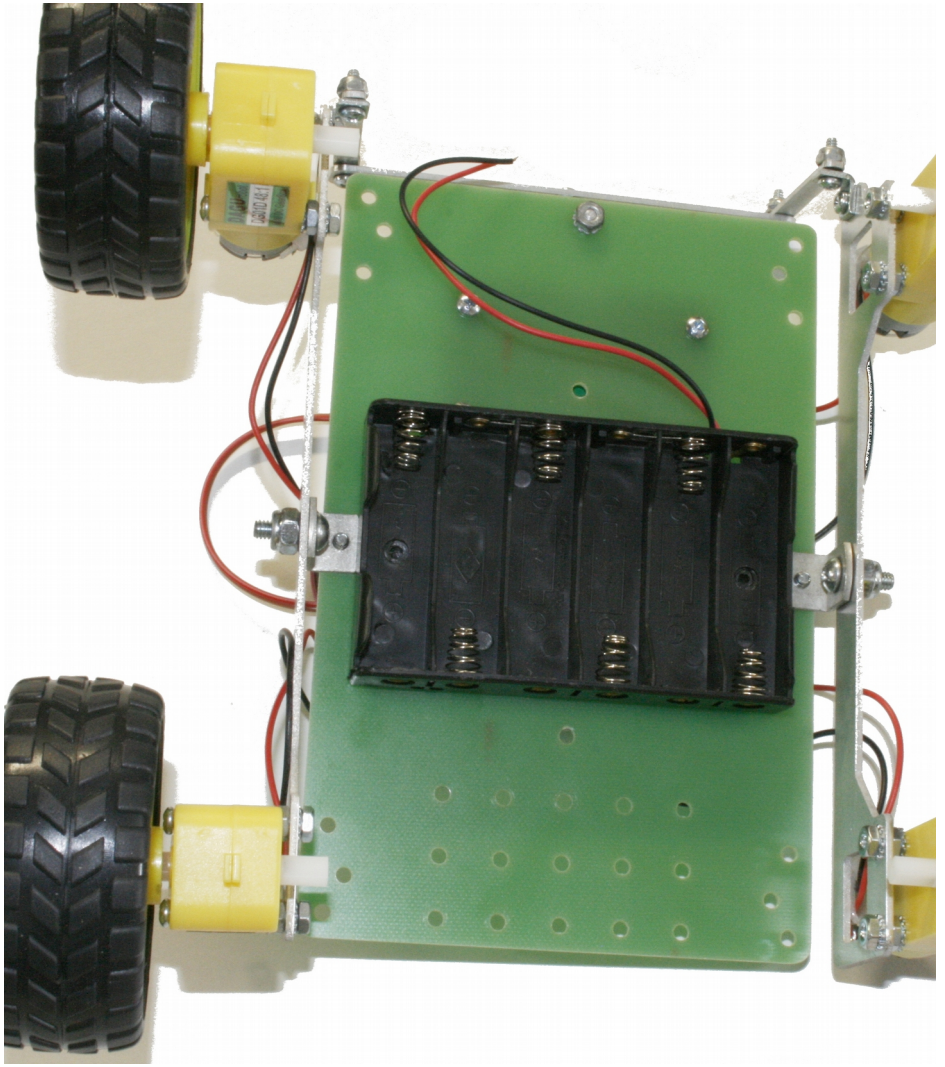
Processor Board Mount

- Take the solderless breadboard and remove the film covering the double sided tape on the bottom.
- Position the solderless breadboard in the center of the base plate between the two screws and press it onto the base plate.
- Leave room in the front for the robotic arm.



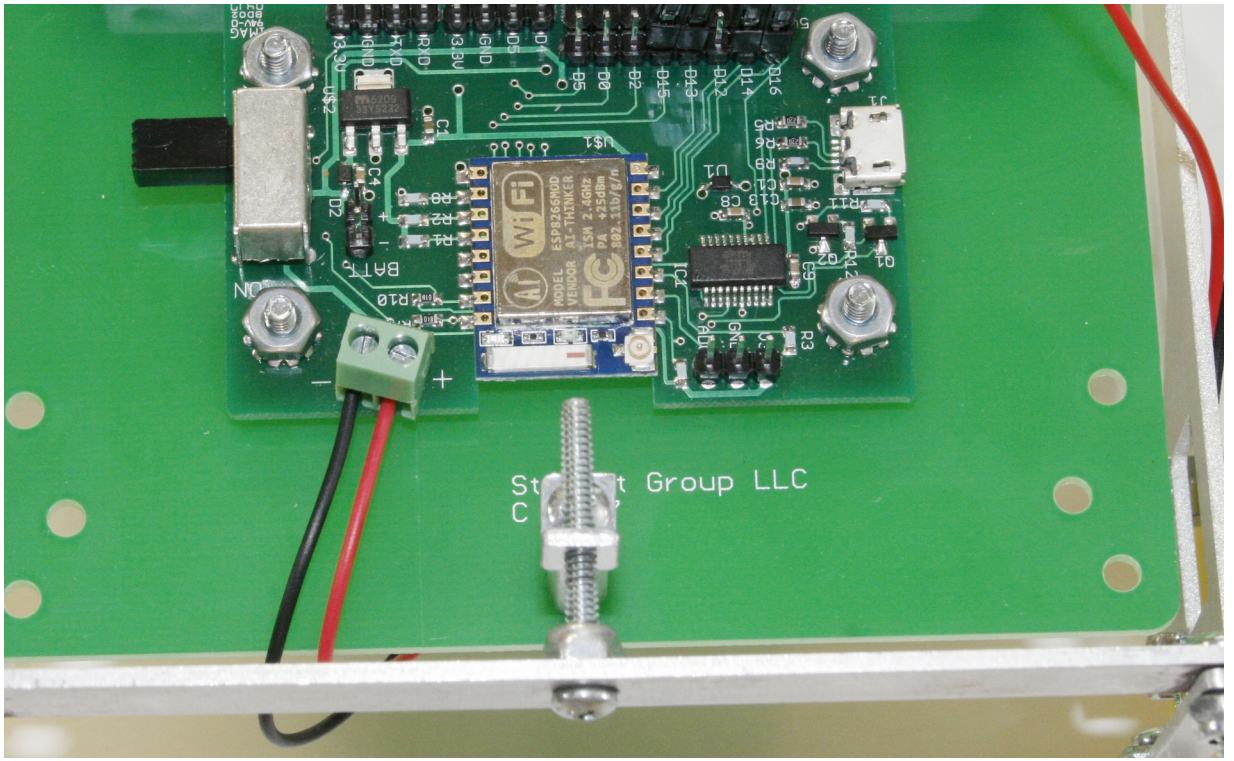
Battery Holder

- Take the battery holder, remove the film covering the double sided tape, and stick it to the underside of the rover as shown. Make sure the battery holder leads are positioned to the back of the rover.



Battery Holder

- With a small blade screw driver, insert the red and black wires into the terminal block one at a time and secure them by tightening each terminal.
- The red wires goes into the terminal with the **+** next to it.
- The black wire goes into the terminal with the **–** next to it.



End of Assembly

- This completes the assembly of the rover.