

KitBot Chassis

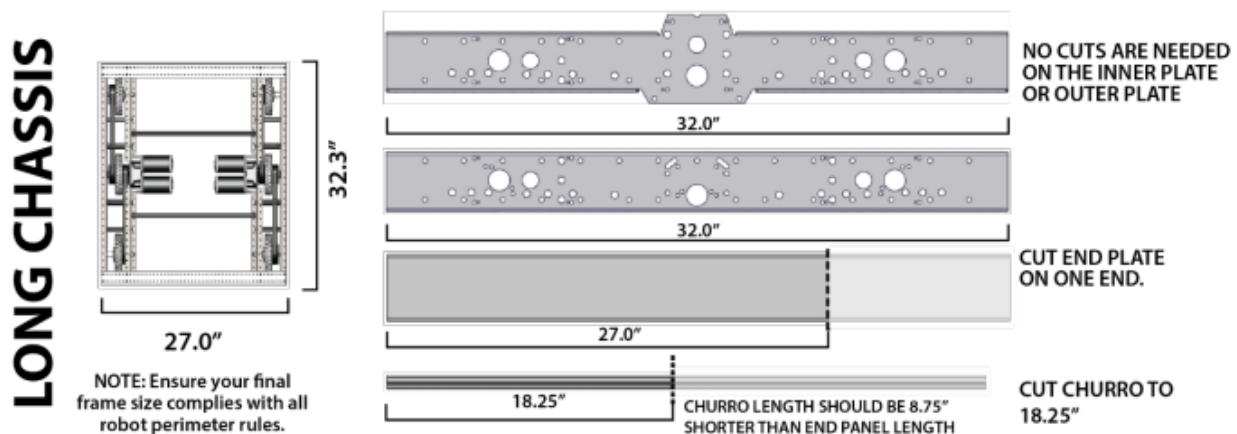
This section of the documentation is intended to aid teams that have little or no experience with the Kit of Parts chassis or those that are having problems following the AndyMark instructions.

Chassis Type

The AndyMark AM14U5 chassis is part of the Kit of Parts and is well-tested and reliable. The included 6 inch rubber treaded wheels have good traction with the field carpet and the center wheel is 1/8" lower than the front and rear wheels to make it easier for the robot to turn on the spot and make small adjustments when trying to pick up and score game pieces (this is called a "drop center" drive because the center wheel is dropped down slightly).

Chassis Size

The AndyMark "long" chassis configuration has plenty of room to mount mechanisms and electronics.



Chassis Assembly

Required tools:

- 1/4" socket and ratchet (preferred) or flat blade screwdriver or bit
 - 1/2" wrench
 - 9/16" wrenches or sockets
 - 7/16" or similar size socket
 - 3/8" socket or ratchet
 - 5/32" allen wrench or t-handle
 - Bandsaw or chop saw
- Adjustable wrenches can be used in place of the 9/16" and 1/2" wrenches

A cordless drill and 10-32 tap are optional but can make assembly faster and easier

All required parts for the chassis are from the AndyMark AM14U5 Kit of Parts chassis box except for four CIM (or CIM-replacement) motors. Two CIM motors are included in the standard Kit of Parts, with four additional CIMs included in the Rookie Kit of Parts. The chassis assembly section of the manual refers to AndyMark part numbers, so keeping the AndyMark manual open to the parts checklist may help you when following this manual.



Before beginning to assemble the chassis, the two Chassis End Plates will need to be cut down to 27" by removing 4" from one end. The two 24" churros will need to be cut down to 18.25". If the size of your team allows for it, have someone begin making these cuts while another group begins assembling the wheels. Measure out your cuts and mark them with a combination square to make sure your cuts are perpendicular and cut the plates in a bandsaw or chop saw, making sure to account for the width of your blade. Save the end plate cutoffs for later.

Wheel Assembly

Start assembling the wheels by screwing two pulley halves into one side of each wheel. Each half-pulley (AndyMark part number am-2234a-half) has one raised screw hole and one recessed screw hole on the bottom. Connect two halves together by lining the raised portion of one half with the recessed hole on the other. The ridged portion of the pulley that the belt will actually ride on should line up across the two pulleys with no gaps or misaligned teeth.

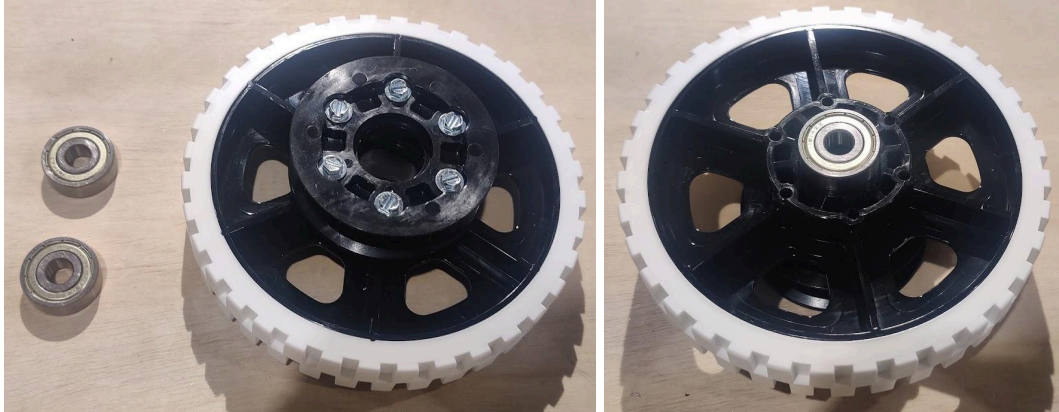


The pulley is then screwed into the matching hole pattern on one side of the 6" HiGrip wheel (am-0940b) using six 10-12 1.5" screws (am-1654). Tighten these bolts in a star pattern like you would when changing a tire on a car to ensure the pulley is aligned evenly on the wheel.

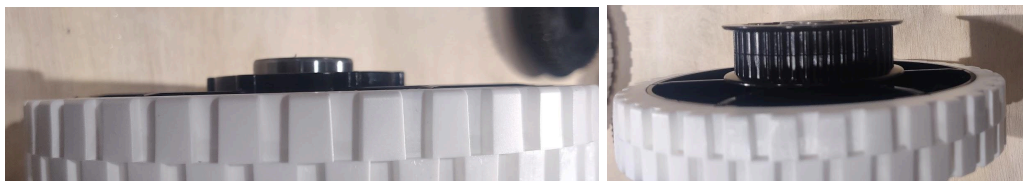


A 1/4" socket driver is preferred over a flat bladed screwdriver for fully tightening these form-threading screws as they will need more force applied to them in order to cut away the plastic hub of the wheel. The socket driver does need to be somewhat thin-walled, as a large driver will foul on the pulley before the screws are fully tightened. A ratcheting driver or a drill will also make the process much faster.

Four of the wheels will have two 1614ZZ 3/8" round inner diameter bearings (AndyMark part number am-0209) pushed into either side. One bearing will push into the open center of the pulley and the other will push into the open center of the wheel. Do not hammer or otherwise harshly strike the sides of the bearings to push them into place as this can easily damage the bearing. The bag that these bearings come in contains two bearings with a flange - a raised ridge around one of the outside edges. Set these bearings aside for later.



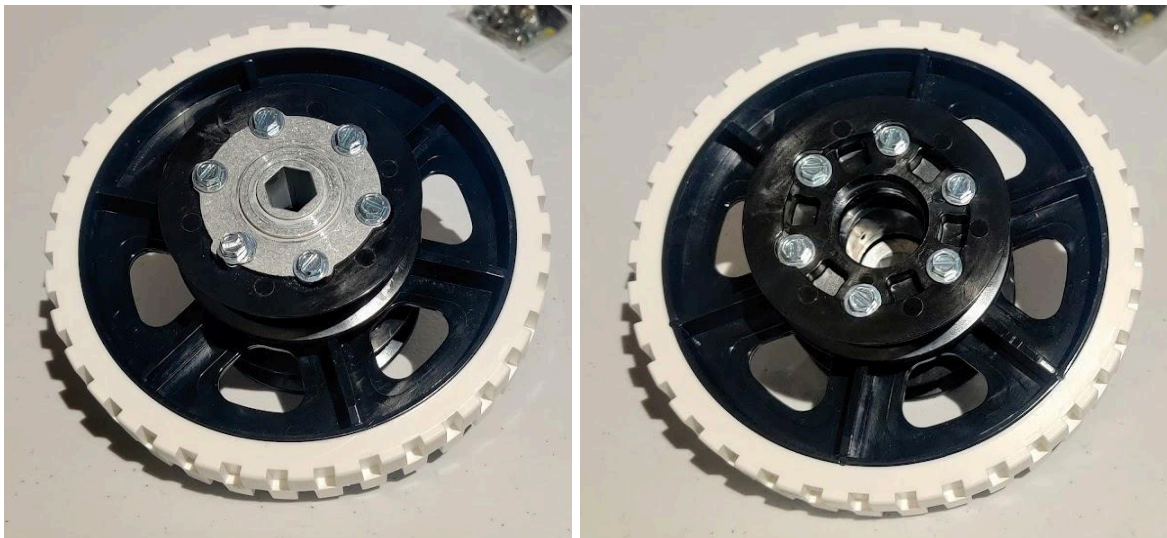
One easy way to make sure they are seated correctly is to line the wheel up on top of the bearing on a table and push the wheel down firmly until the bearing slips into place. The bearings will stick out of the bare half of the wheel slightly and be flush with the top of the pulley. These will be the front and back wheels of the robot.



The other two wheels will have one of the remaining pulleys added to the other side with a 1/2" hex hub inserted inside it. The easiest way to line up the hub is to insert one half of a pulley onto the hub's shaft and line up the screw holes in the hub with the screw holes in the pulley by putting a few of the form-threading screws through the hub and pulley. Push the other half of the pulley down to meet it, matching up the raised and recessed holes as before.



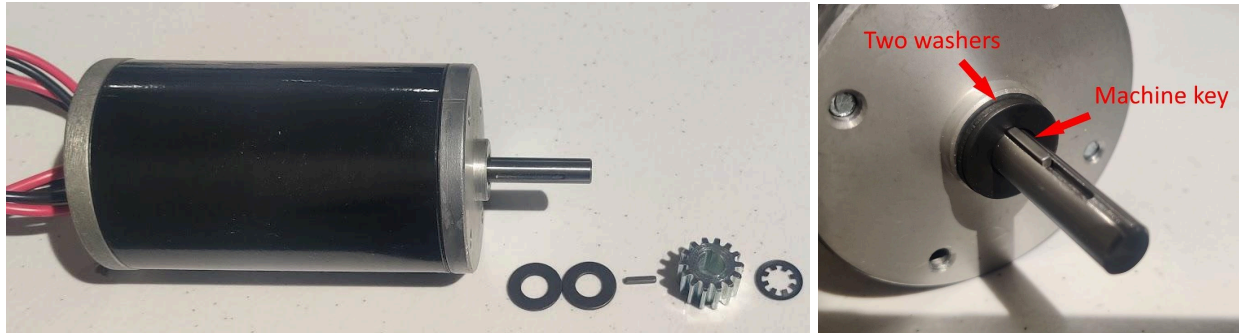
The 1.5" screws included in the 2024 Kit of Parts collide with one another when tightening them into both sides. AndyMark suggests simply continuing to screw them in, pushing the tips of the screws to either side of one another. This may be somewhat hard to do by hand, especially with a flathead screwdriver. If you have wheels from a previous year you may want to take the shorter screws out of them and insert them into the fresh wheels instead. Avoid reusing competition-used wheels as they will probably be worn down and less grippy than fresh wheels.



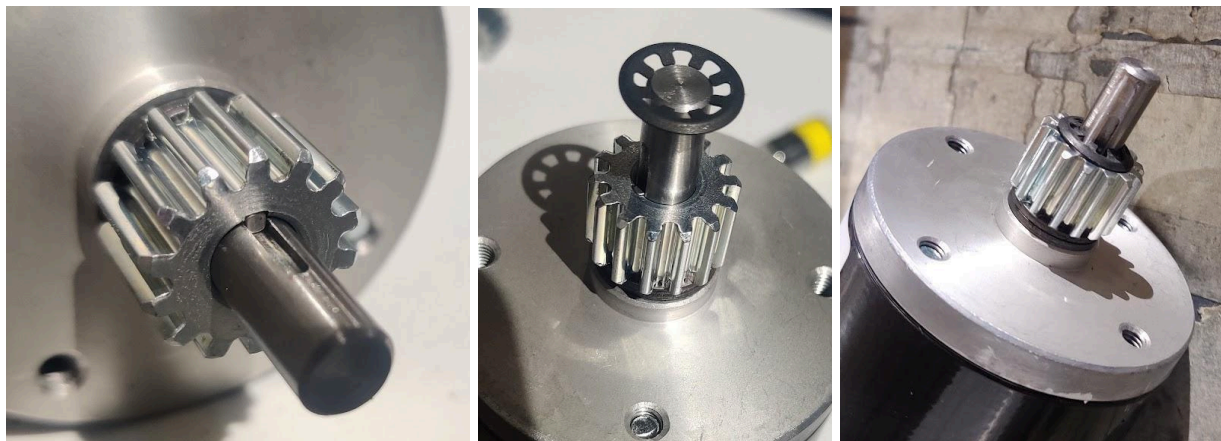
Motor and Gearbox Assembly

For each of your four drivetrain motors, place two 5/16" washers (am-1009a) onto the shaft. If your team is a rookie team, your kit of parts should include six CIM motors. If you are not a

rookie team, your kit will contain only two CIM motors, so you will need to purchase two new motors or reuse two from a previous year (recommended). Two more CIM motors are also used in the KitBot launcher mechanism if your team plans on building it. Install a machine key into the slot in the motor shaft.



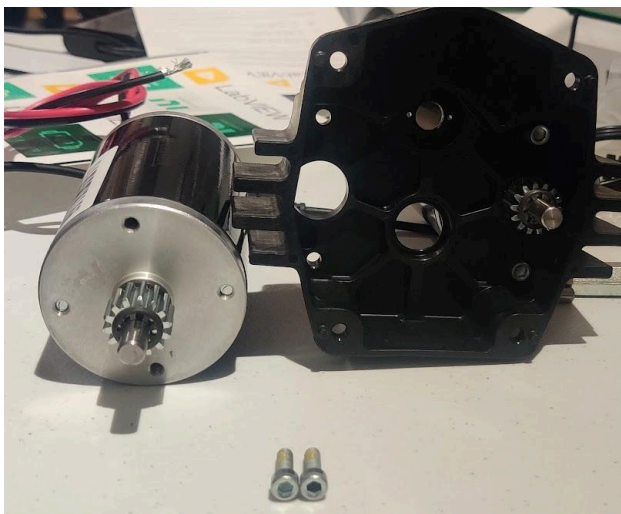
Slide a 14 tooth pinion gear (am-0034) onto the motor shaft, lining up the key with the gear's keyway. Clip the stackup onto the motor shaft using an 8mm retaining clip (am-0033) with the teeth of the clip pointing inwards. Do not push the clip fully down against the gear or it can cause the motor to bind.



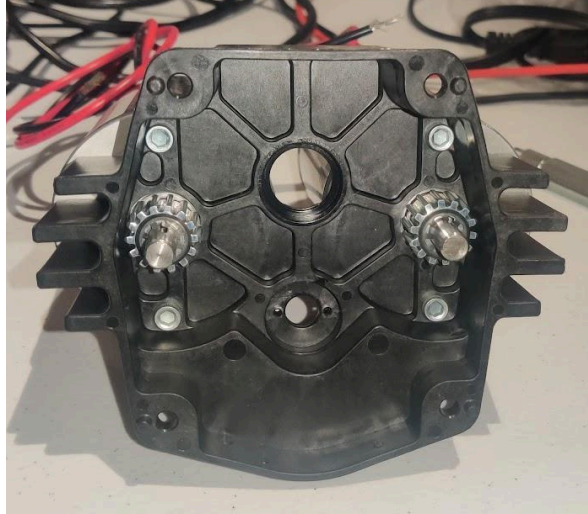
Placing a 7/16" or 3/8" socket over the clip and hitting it with a mallet can assist in pushing the clip down onto the shaft. This can be fairly difficult to do, and if the clip becomes deformed you should try to flatten it back out.



Screw two of the motors into each Toughbox Mini S gearbox housing (am-0650). The output shafts of the motors line up with the two larger holes in the gearbox housing and are screwed in using 10-32 x 0.625" bolts with thread lock already applied (am-1120) through the mounting holes above and below the input shafts and into the two mounting holes in the face of the motor. As these bolts approach fully tightened they become harder to turn. Make sure the bolts are actually fully tightened or the CIM motors will flex and rock around in the gearbox. If you can wiggle the CIM motors by hand then they need to be tightened more.



These bolts can be identified easily by the small patch of yellow or white thread lock on the threads of the bolt. Threadlocker is used on these bolts so that the motors do not vibrate them free over time. They are also shorter than the 10-32 x 0.75" bolts that come in the same bag.



CIMs have four holes in the face of the motor. Two already have long cross-head screws inserted from the bottom of the motor to hold them together, so you may have to rotate the CIM motors around until the two open holes line up with the mounting holes in the gearbox housing.

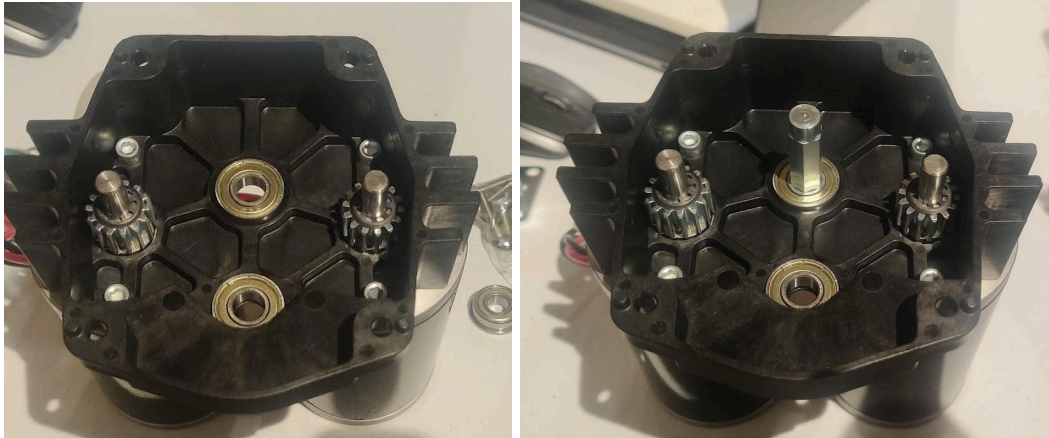


“Blocked” versus open mounting holes

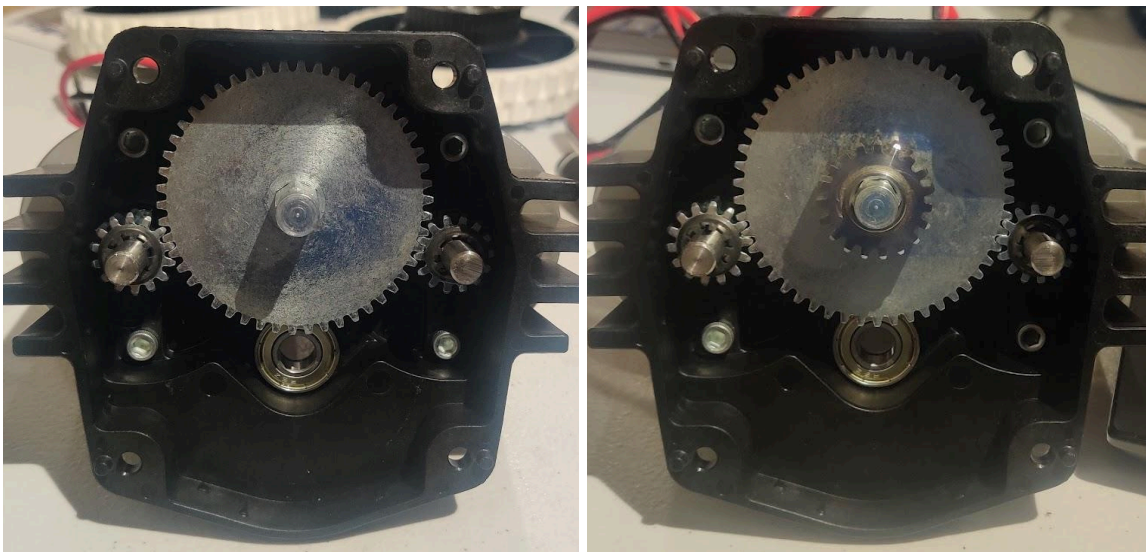
Two of the bearings used in the Toughbox have flanges while the other two do not. A flanged bearing has a small ring extending around it as shown below.



Press two R6ZZ 3/8" round inner diameter bearings (am-0516) without flanges into the two center holes of the Toughbox Mini S housing. Insert the Toughbox small 3/8" hex shaft (am-0152) into the bearing closer to the flat end of the gearbox housing.



Take the 3/8" hex 50 tooth gear (am-4720) and place it onto the 3/8" hex shaft. Then add the 19 tooth gear onto the same shaft so it sits on top of the 50 tooth gear.



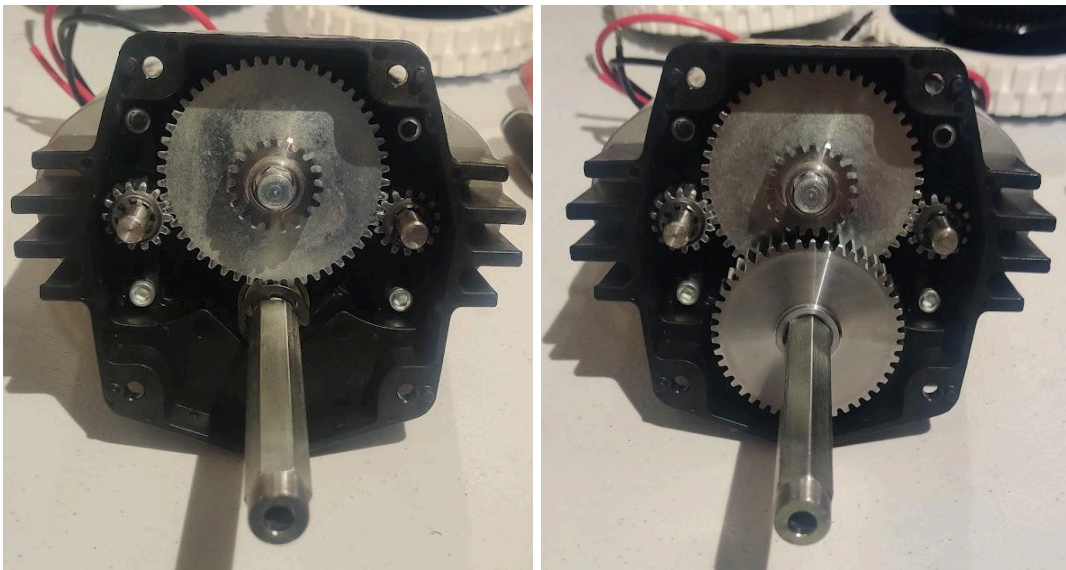
Install the 1/2" E-clip (am-0206) into the groove in the Toughbox 1/2" hex output shaft (am-4722) by pushing the shaft down onto the clip.



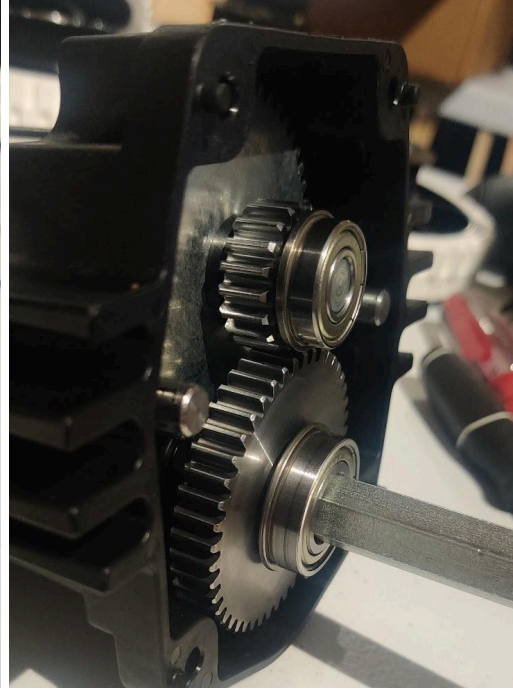
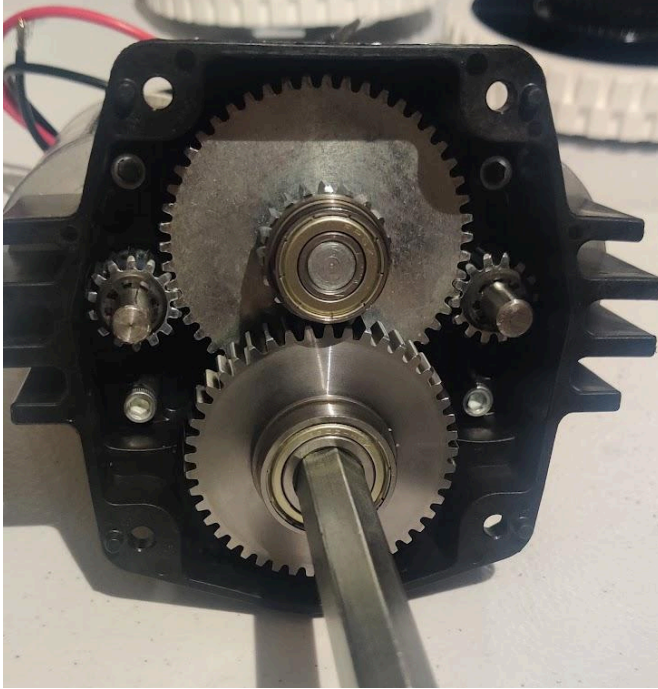
If you plan on adding encoders to the KitBot, install the encoder pin shafts (am-1323) into the 1/2" hex output shaft now. Clean the pins off and super glue them into the holes in the ends of each 1/2" hex output shaft. Let them dry before continuing.



Insert the 1/2" hex output shaft into the other R6ZZ bearing flange with the E-clip closer to the bearing. Place the 45 tooth 1/2" hex gear (am-4712) onto the output shaft.



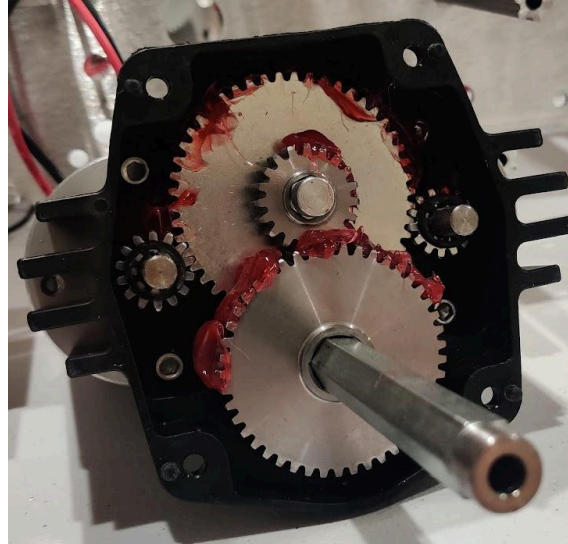
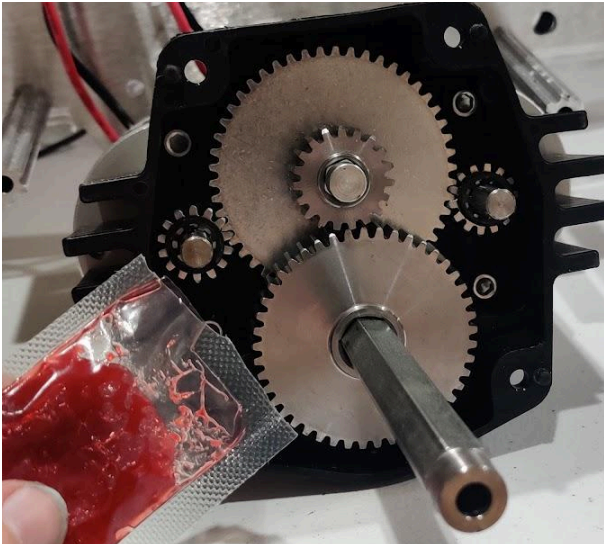
Place the FRZ6ZZ 3/8" round center bearing with flange (am-0028) onto the other end of the short 3/8" hex shaft on top of the 19 tooth gear, with the flange of the bearing closer to the gear. Place the FR8ZZ-HexHD 1/2" hex center bearing with flange on the 1/2" hex output shaft on top of the 45 tooth gear, with the flange of the bearing closer to the gear.



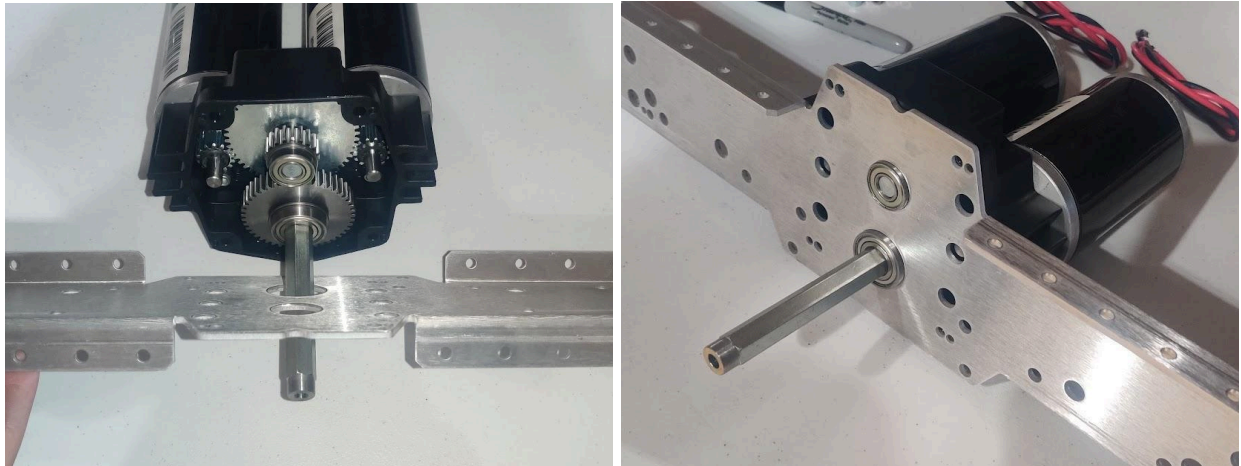
If your team has a convenient way to run your drivetrain motors now, such as an electronics test bed with motor controllers or other method of power delivery or by plugging the motors to a previous year's robot, it is recommended that you run in the gearbox "dry" for thirty minutes at this point. Before greasing the gears inside, attach the Toughbox Mini S to the Chassis Inside Plate as described below and secure it. Connect whatever method you have for powering the motors and turn it on, leaving it to run in for thirty minutes. They may start out loud but should not produce an ear-splitting "squeal" or "screech."



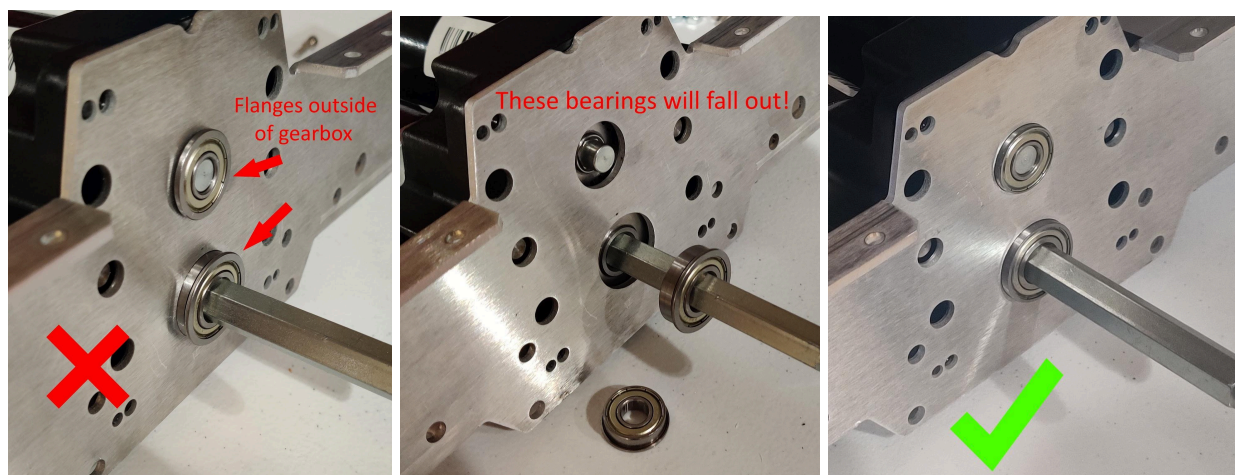
Once you have run in your gearbox, or if you do not have a convenient way to run in your gearboxes right now, apply red tacky grease (am-2768) to all the teeth of the gears. The flat surfaces of the gears are not as important as well-greasing the teeth where the gears actually mesh, and as the gearbox runs it will distribute the grease further.



(Re)attach the Toughbox Mini S to the Chassis Inside Plate of the chassis using four 10-32 x 0.75" bolts (am-1047) and four 10-32 Nylock nuts (am-1042). The flat side of the gearbox lines up with the shorter side of the roughly trapezoidal gearbox mounting area in the center of the Chassis Inside Plates and the tapered side of the gearbox mates with the longer side of the trapezoid. The flanges on the Chassis Inside Plates should face away from the gearbox on the flat side (the top of the gearbox) and towards the gearbox on the tapered side (the bottom of the gearbox).

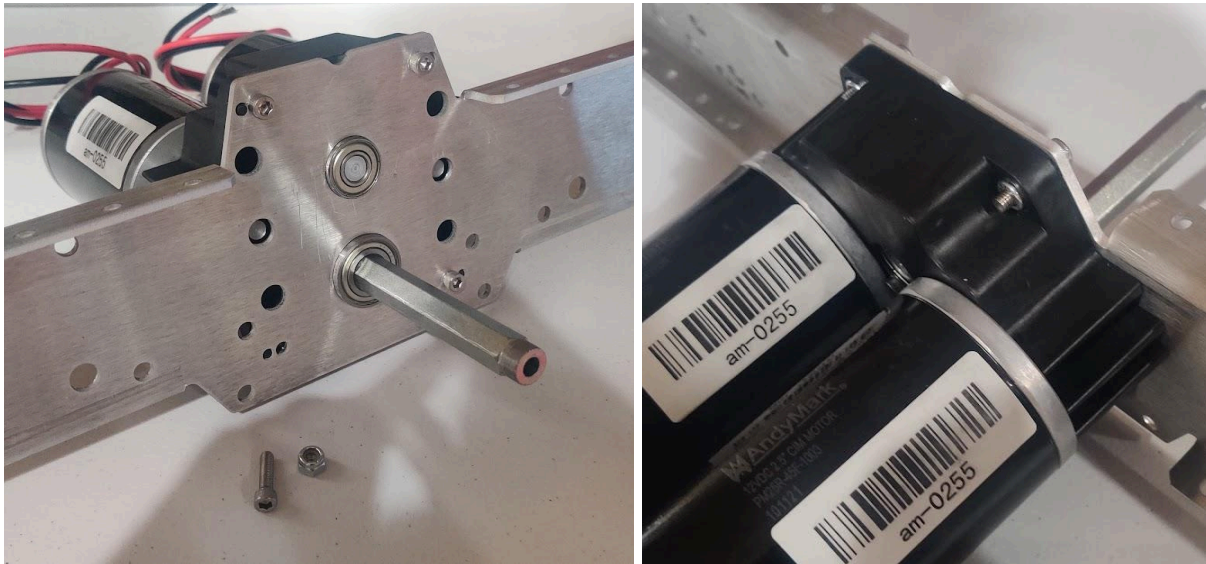


Make sure both of the flanged bearings are correctly "trapped" inside the gearbox by already being installed on the shafts when the gearbox is pushed into the Chassis Inside Plate - taking them out of the gearbox, inserting the gearbox's shafts through the holes, and then sliding the bearings onto the shafts from the other side of the Chassis Inside Plate will leave the bearings able to fall out.



If the bearings do not want to fit in the chassis holes, they can be arbor pressed into place (be sure to get the flange on the correct side of the Chassis Inside Plate so that the flange will end up inside the gearbox!) or the holes can be enlarged slightly with a deburring tool.

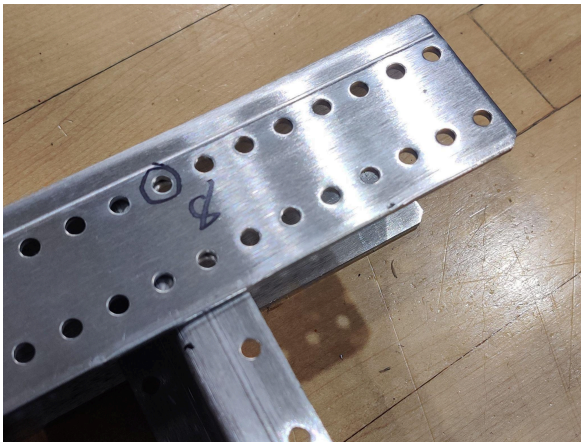
The 10-32 x 0.75" bolts should be inserted into the Chassis Inside Plate and through the gearbox casing with the 10-32 Nylock nuts inserted into the hexagonal holes in the back of the gearbox casing.



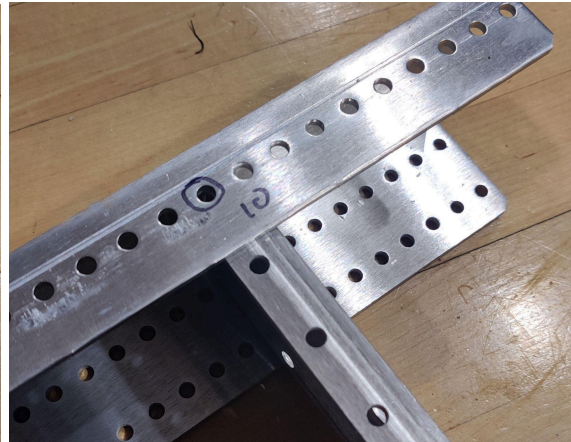
Complete these steps with both Toughboxes, affixing one to each Chassis Inside Plate.

Chassis Assembly

Insert one of the Chassis Inside Plates into one of the Chassis End Plates. The motors sticking out of the gearbox should face towards the middle of the robot with the output shaft sticking outwards. The top flange of the Chassis Inside Plates should point towards the outside of the robot while the bottom flange should face inwards. Line up the outermost hole in the upper flange of the Chassis Inside Plate with the 8th hole in from the edge of the top of the Chassis End Plate, with the first two holes in the bottom flange lining up with the 10th holes in from the edge of the bottom of the Chassis End Plate.

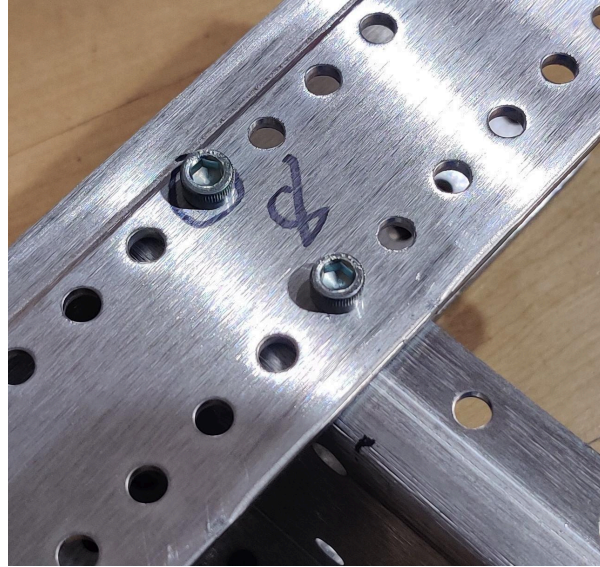


Top view



Bottom view

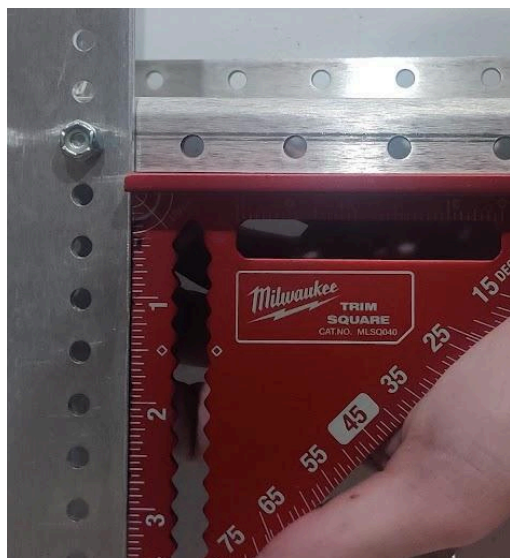
Attach the Inside and End plates with three 10-32 x 0.5" bolts (am-1002) and 10-32 Nylock nuts (am-1042) with two bolts through the longer top flange of the End Plate and the top flange of the Inside Plate and an additional bolt going through the bottom of the End Plate and the bottom flange of the Chassis Inside Plate. Mirror these steps with the other Chassis Inside Plate to attach the second side rail and gearbox to the Chassis End Plate.



The other End Plate is similarly attached to the Inner Side Plates with the holes in the top flanges lining up with the eighth holes from the edge of the top of the end plates.

If you can, prepare the electronics bellypan out of 0.5" thick plywood and slide it into place in the chassis now before the second end plate is installed.

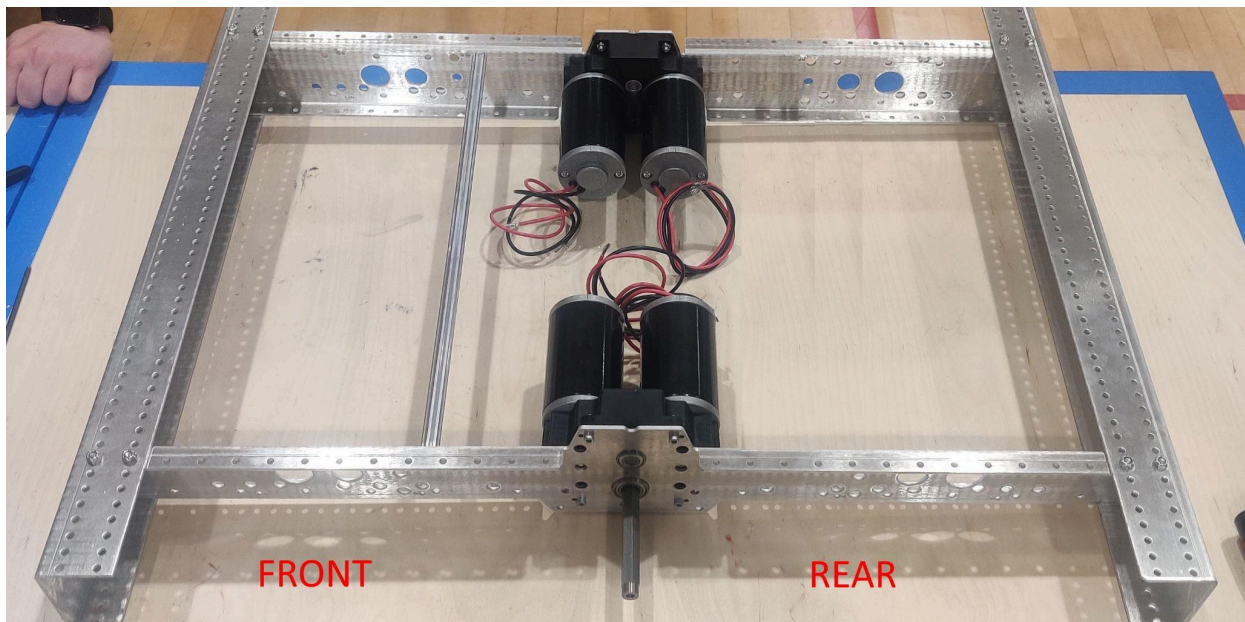
Using a carpenter's square or similar tool, check that the frame of the chassis is "square" - that is, check that all four of the corners of the chassis form 90 degree angles. If your chassis is "bent" or otherwise off-angle it will have problems driving correctly and it will be difficult to complete the rest of the robot. If necessary, loosen the bolts in the offending corners and shift the plates until they form right angles with each other.



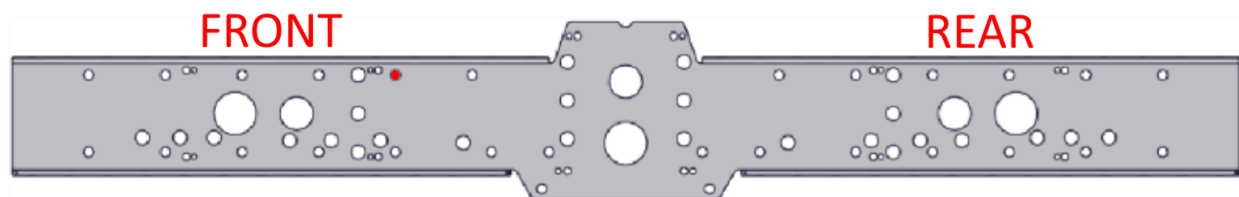
Squared corner



Not squared corner



The churro in the front part of the chassis is installed in the AndyMark recommended location. If you plan on adding the Everybot additions to the KitBot, install the rear churro one churro hole further back.

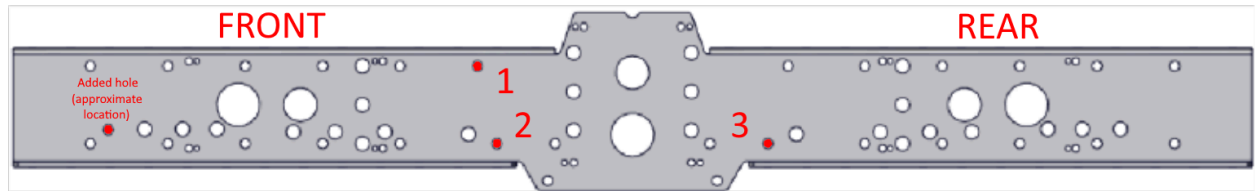


Your chassis will now have a front (the side with the churro closer to the middle) and a back (the other side of the robot with the churro closer to the Chassis End Plate). It is probably a good idea to label the chassis with front and back so your team can keep it straight when assembling the rest of the KitBot.

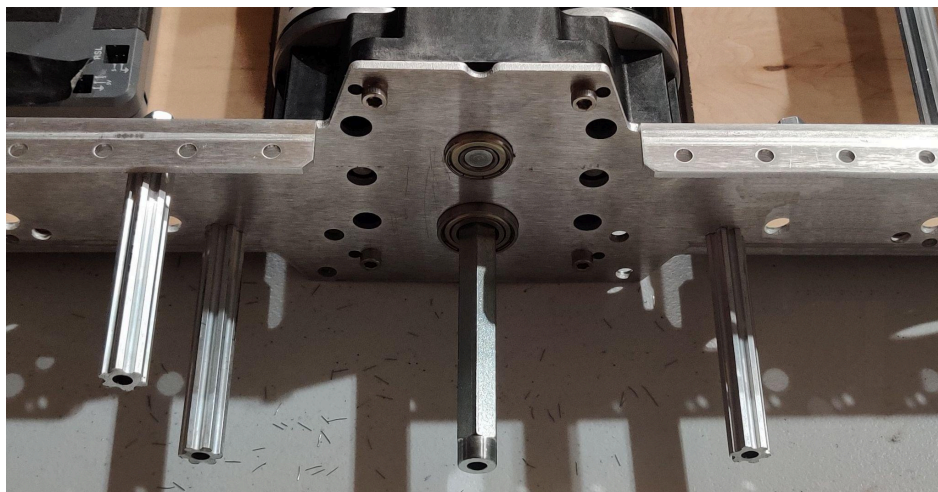
At this point, follow the [FIRST KitBot](<https://www.firstinspires.org/resource-library/frc/kitbot>) plans to machine and assemble the launcher and frame, and attach it to the chassis, making sure the front of the mechanism is on the side with the churro closer to the center of the frame. After the hole attaching the front of the superstructure to the frame is added in step 4 of section 6.2.10 and the fitment of the mechanism is satisfactory the mechanism can be removed if desired.

Attach three of the 3.375" long churros to each side of the chassis using 1/4-20 x 0.75" form-threading bolts (am-1591 or am-1310) so that the churros extend outwards from the

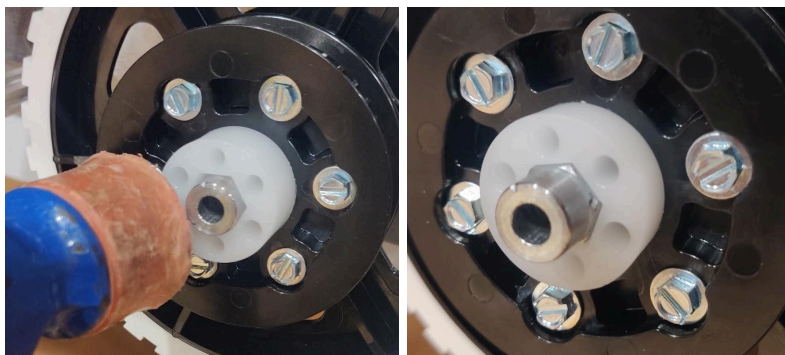
Chassis Inside Plate like the gearbox output shaft. Typically, four churros are installed on each side, but the angled portion of the KitBot mechanism mounts to one of these holes. Make sure that the installation of these churros is mirrored between the sides rather than rotated.



A 1/2" hex wrench can be used to hold churro in place while tightening the bolts with a 3/8" wrench or ratchet. These bolts will require additional force to cut the threads into the churros. If desired, the 3.375" churros can be pre-tapped for a 1/4-20 bolt on both ends.

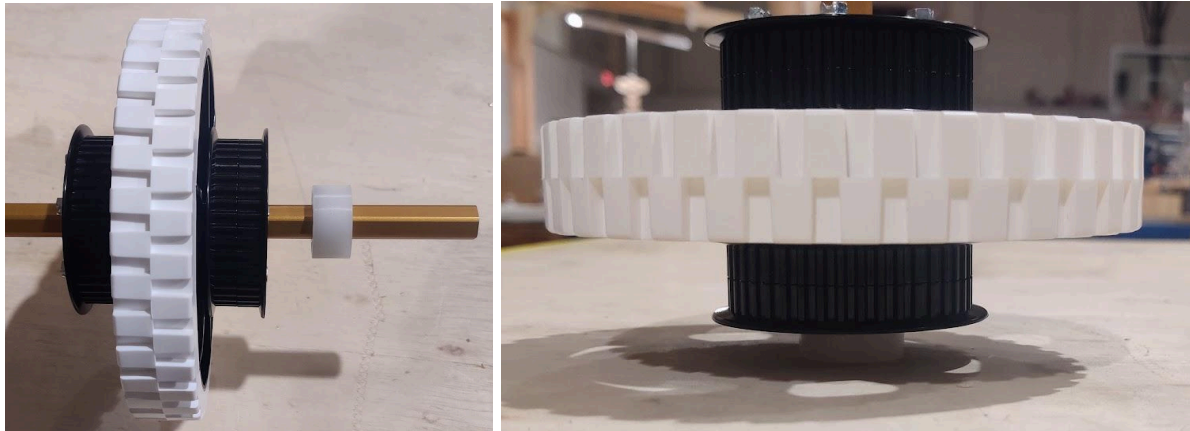


Place a center wheel with two pulleys on the Toughbox output shaft with the aluminum hex hub facing the gearbox. Place a nylon hex spacer (am-1305) onto the output shaft and press or tap it into the hole in the end of the pulley. The shaft will keep the spacer's hexagonal bore aligned with the hex hub's bore.

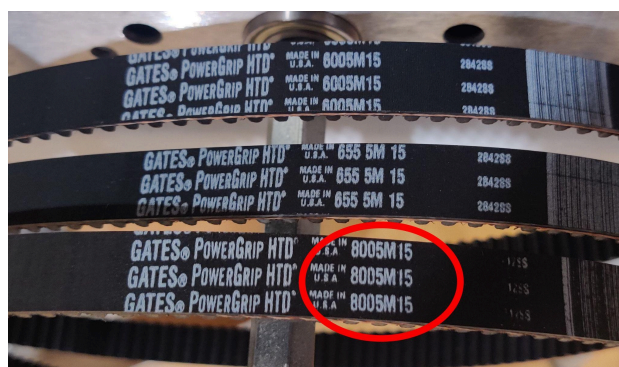


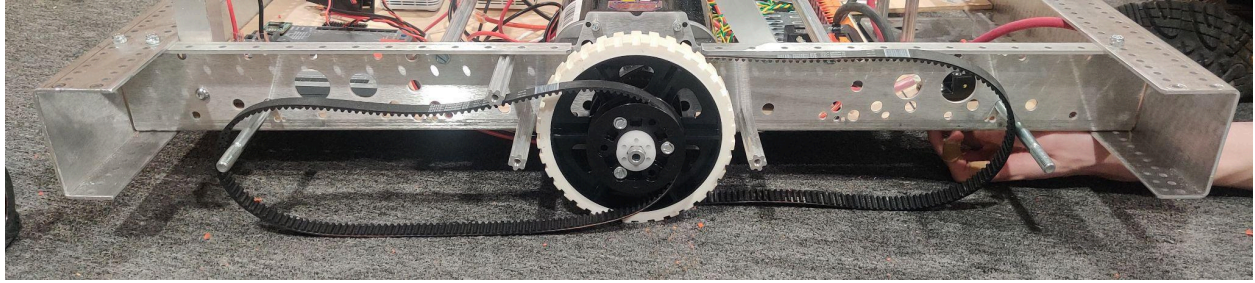
When the spacer is fully inserted into the wheel, the entire round portion at the end of the output shaft should be outside of the spacer.

If the spacer can not easily be pushed or tapped into place with a rubber mallet, you can remove the spacer and wheel and push the spacer into place by lining up the center hex patterns of the hub and spacer with a small piece of hex shaft or a churro and pushing the wheel down onto the spacer, similar to the way that the bearings were previously pushed into the front and rear wheels.

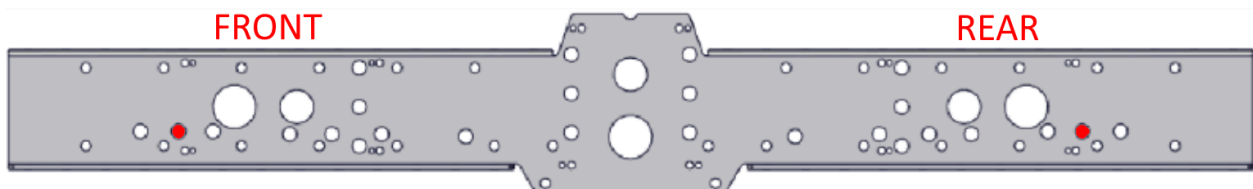


Loop two of the 160 tooth belts (am-2266, marked as 8005M15 on the belts themselves) around the center wheel. The belts will be stretched towards the front and back of the frame to couple the front and rear wheels to the driven inner wheel. The belt going towards the front of the chassis is looped around the lower churro and under the upper one, with the belt towards the rear looping around the single lower churro.

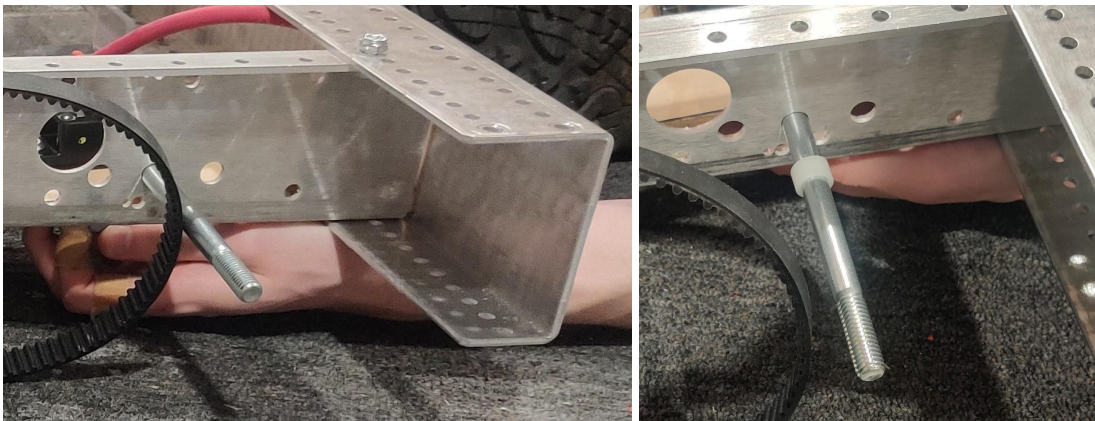




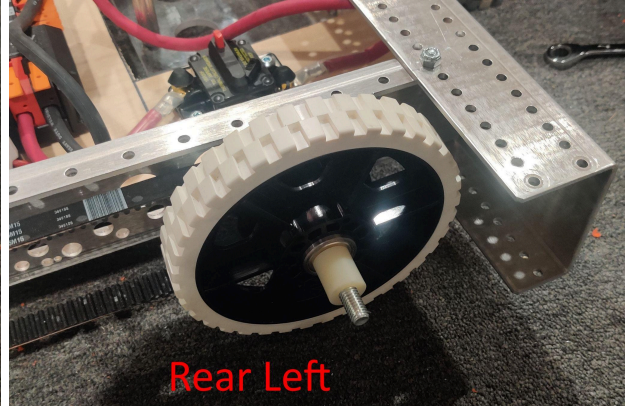
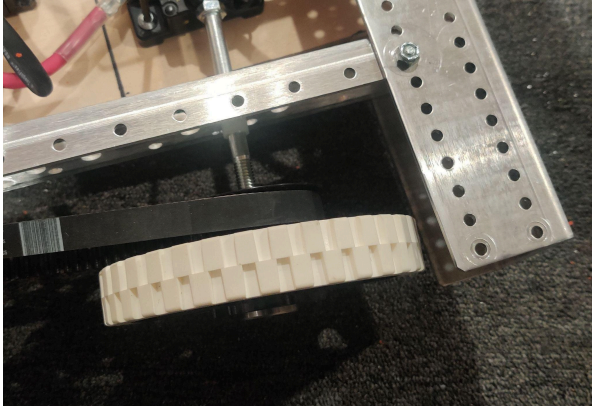
The photos in this section show the left side of the chassis with the front of the chassis to the left. The rear belts are to the inside of the chassis with the front belts closer to the outside of the frame. The orientation of the drive belts within the frame does not matter for the KitBot.



Insert one of the 3/8-16 4.25" bolts (am-1297) through the rear axle hole in the diagram above from the inside of the chassis so that it sticks out similar to the churros and gearbox output shaft. Slip a short 0.28" nylon spacer (am-1306) over the bolt.

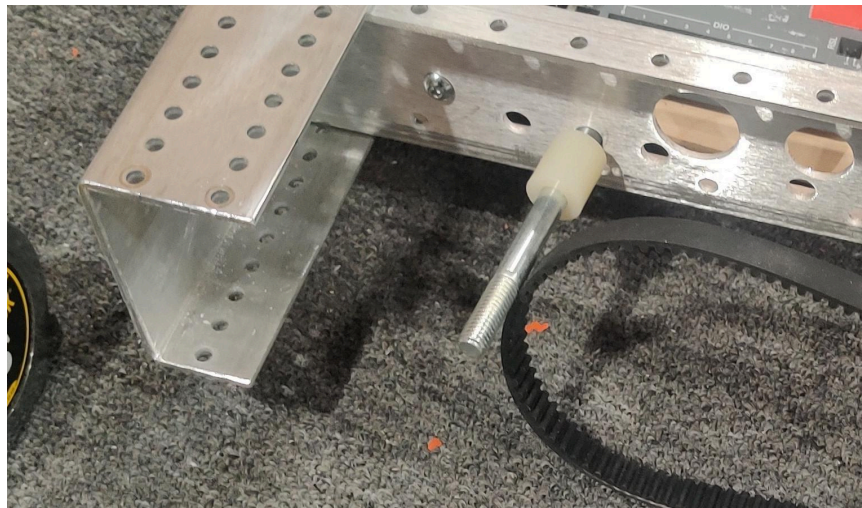


Take one of the four outer wheels and loop the belt around its pulley, making sure the pulley is towards the inside of the chassis and that the belt will run parallel with the side plates. Push the bolt through the two bearings in the wheel. You may find it is easier to pull the bolt slightly back into the chassis, line up the wheel on the end of the bolt, and then push the bolt all the way back through. Add a longer 0.85" nylon spacer (am-1307) onto the end of the bolt.

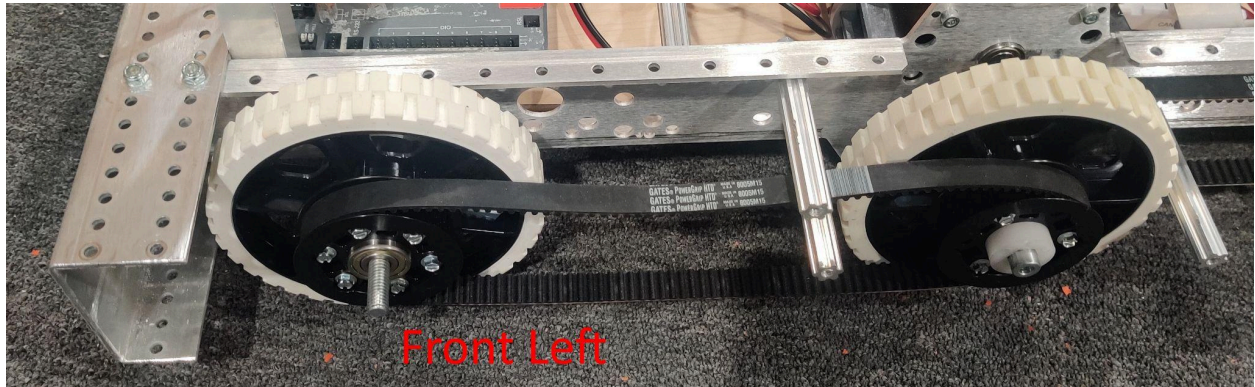


A 3/8-16 nut can be finger-tightened to the end of the axle to hold this assembly in place while setting up the other wheel on this side if desired.

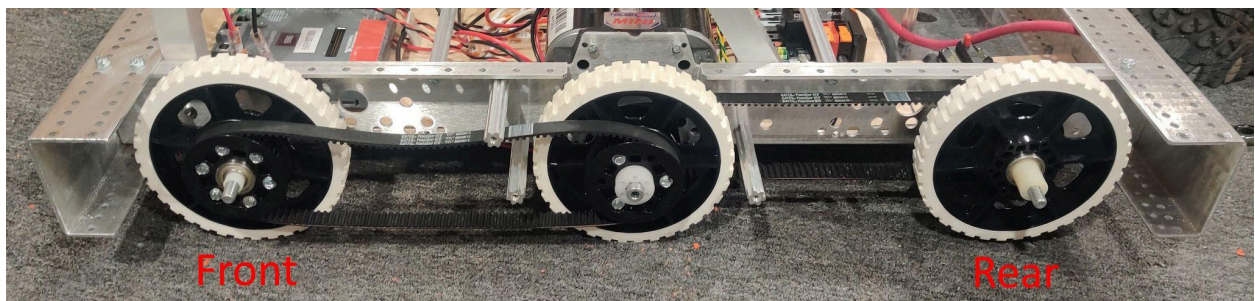
Insert another 3/8-16 4.25" bolt (am-1297) through the front axle hole in the diagram above from the inside of the chassis so that it sticks out similar to the churros and gearbox output shaft. This time, put a longer 0.85" nylon spacer onto the end of the bolt first.



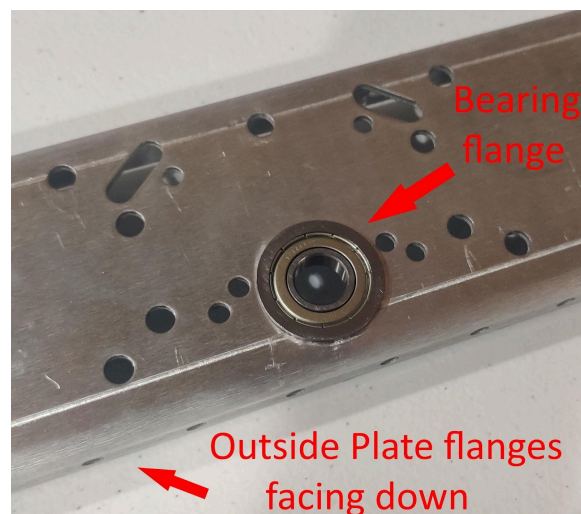
Pull the other 160 tooth belt towards the front of the robot, making sure it fits over the middle wheel's outer pulley. Take another wheel and put the belt around its pulley, making sure the pulley is toward the outside of the chassis this time so that it is similarly parallel with the Chassis Inside Plate when the bolt is pushed through the wheel's bearings.



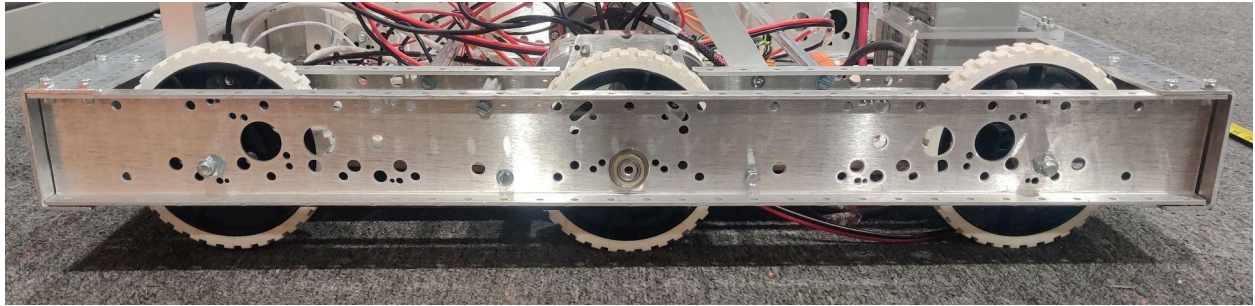
Now slip a short 0.28" nylon spacer over the end of the bolt. A nut can be tightened by hand to hold the stackup in place if necessary. With the churros, belts, wheels, and axles all in the correct position, the Chassis Outside Plate can be added.



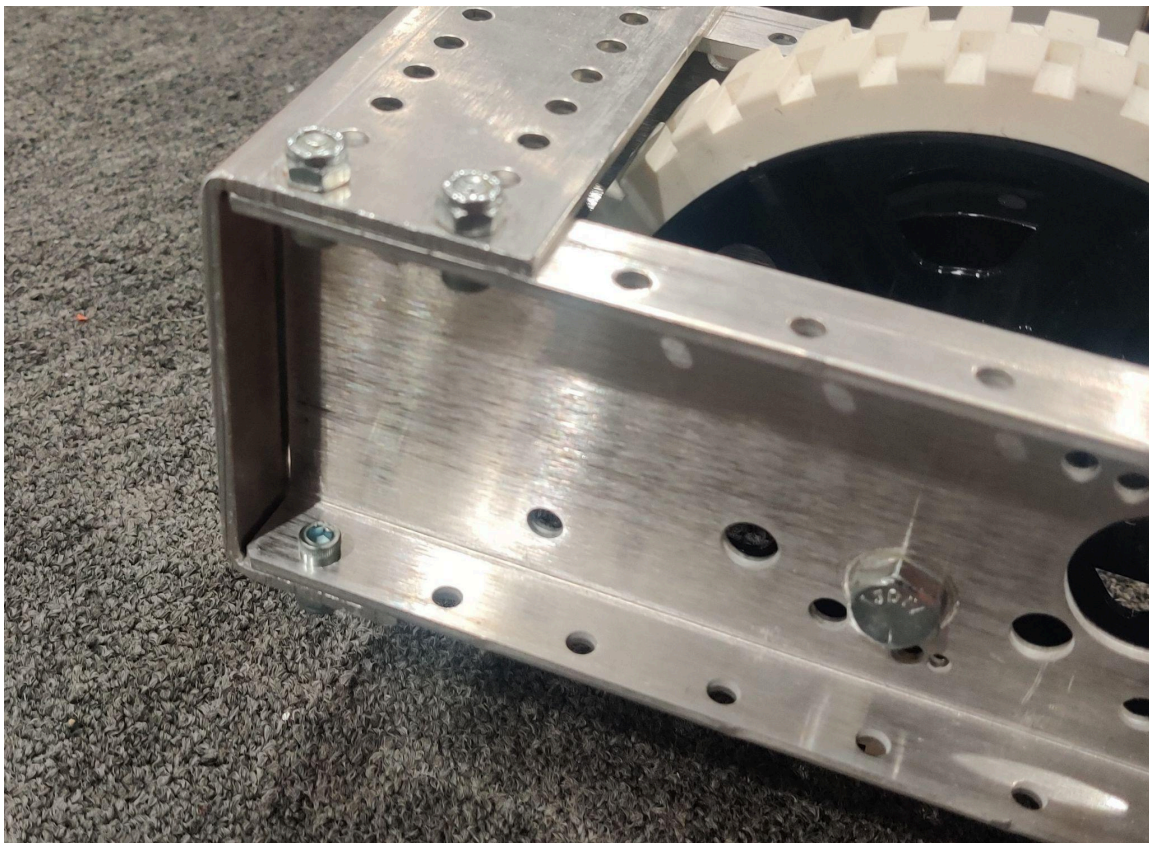
Press a FR8ZZ 1/2" round bearing (am-0030) into the center hole of each Chassis Outside Plate, being sure to press it in from the opposite side of the Outside Plate's flanges so that the bearing will be trapped in place correctly. Remove any nuts from the end of the front and rear axles and make sure that none of the spacers fall off the ends.



With the Outside Plate's flanges pointing out, line the bearing up with the Toughbox output hex shaft and hold the front and rear wheels in place so the axle bolts line up with the matching holes in the Outside Plate. Push the Chassis Outside Plates into the front and back chassis end plates so that the holes in the Outside Plate's flanges line up with the outermost holes in the Chassis End Plates.



Secure the Chassis Outside Plates in place using six 10-32 x 0.5" bolts and 10-32 Nylock nuts each. Secure the front and rear axles by tightening the 3/8-16 nuts onto the axle bolts so that the wheels can still spin. The axle bolts and nuts are both tightened using a 9/16" socket or wrench. Attach the four 3.375" churros to the Chassis Outside Plate using 1/4-20 x 0.75" form-threading bolts (am-1591 or am-1310).



The same steps are followed on the other side of the chassis to complete the drivetrain. Both sides can be assembled simultaneously as long as your team has enough space, tools, and people.

KitBot Electrical

The KitBot electrical system can be wired using wire and connectors included in the Kit of Parts, with the electrical components coming in the Rookie Kit of Parts or retained from previous seasons for non-rookies. The electrical system can be wired using whatever legal combination of newer REV and older CTRE control system components your team has. Rookie teams receive a full system of the newer REV control system components which this guide will primarily focus on because it is assumed that teams with older control systems have some experience with FRC wiring.

[How to Wire a Robot video from FIRST](<https://www.youtube.com/watch?v=IGglhxYuSHM>)

For more visual aid we highly recommend watching this video. Wiring a battery, main breaker, motor controllers, the roboRIO, RSL (Robot Signal Light) and CAN bus is covered.

[Introduction to FRC Robot Wiring](<https://docs.wpilib.org/en/stable/docs/zero-to-robot/step-1/intro-to-frc-robot-wiring.html>)

A that FIRST linked that we also want to echo. Here are two large pieces of information when using this resource:

- Use CAN over PWM, we have had issues with SPARK MAXs in PWM mode and found CAN to be significantly more reliable
- We heavily recommend using inline

[WAGO](<https://www.andymark.com/products/wago-221-series-inline-splicing-connector-with-lever>) [connectors](<https://www.revrobotics.com/rev-15-2491/>) over the quick disconnect crimps included in the Kit of Parts as they are easier to implement and require less training and no crimping.

If you plan on using the quick disconnects included in the kit, please see our video:
<https://youtu.be/NsIfpSyZNOo> on crimping them



WAGO (requires no crimping)



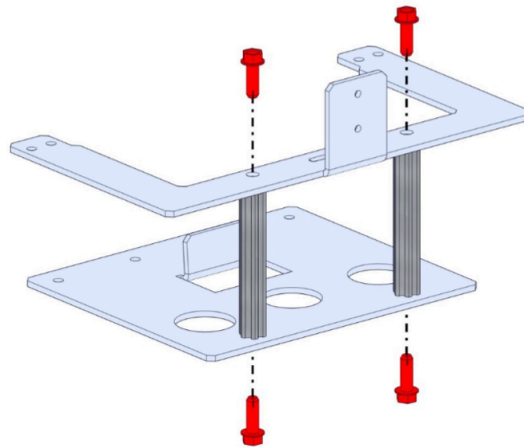
Quick disconnect (requires crimping)

For more tips on navigating this resource please the Everybot Evergreens electrical section.

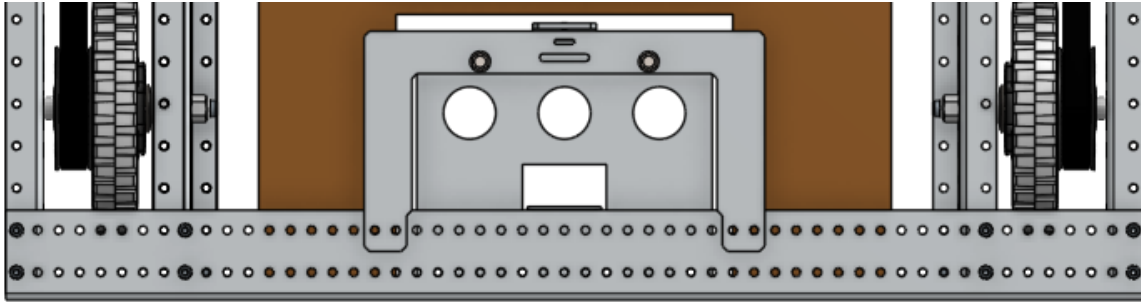
Battery Bracket

The battery bracket is included with the AndyMark Kit of Parts Chassis that you most likely received in your kickoff kit on kickoff. We will include instructions for assembling the battery bracket but the [official AndyMark instructions](<https://cdn.andymark.com/media/W1siZiZlsljWmJAvMDEvMDMvMTgvMjgvNDUvYmFhYmY4ZTUtZjEzNC00ZDRILTg3MTMtOWM0ODMzNzQ4OTJjL0FNMTRVNCBCYXR0ZXJ5IFRyYXkgQXR0YWNobWVudC5wZGYiXV0/AM14U4%20Battery%20Tray%20Attachment.pdf?sha=362671bd2d9d78da>) can be found in the linked text. Some of the images and text in the following section come from the AndyMark manual.

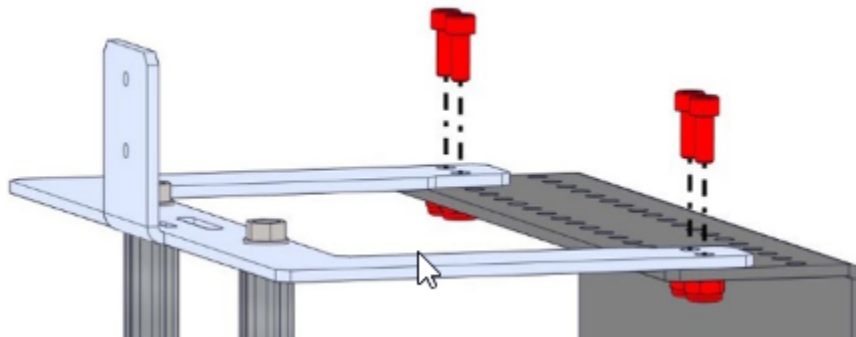
“Place two 3.375” Churros (am-2569) between the Bottom Plate (am-3959) and the C Plate (am3958). Secure the Churros to the plate with four 1/4-20 x 0.750” Thread Forming Screws (am-1310). Make sure the tabs on both plates are pointing upwards.” - AM instruction



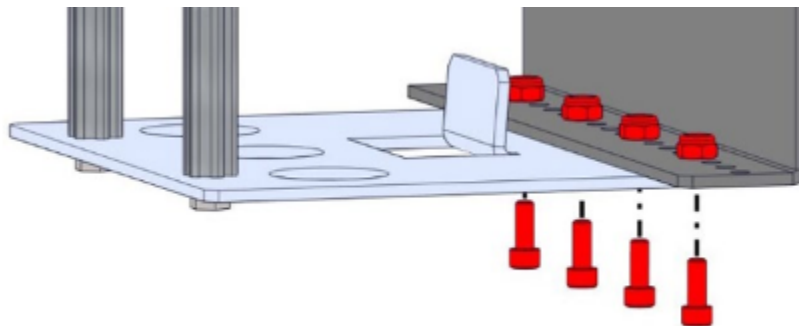
The bracket is installed slightly off center in the back of the robot (the opposite side from the scoring mechanism). Looking at the rear Chassis End Plate from behind the robot, the leftmost hole in the top plate of the AndyMark Battery Bracket should be located in the 18th hole along the Chassis End Plate top flange when counting from the left edge to the right. This will be 8.75” away from the left side of the chassis when viewed from the back. Make sure the top plate is on top of the Chassis End Plate upper flange and the lower plate is below the Chassis End Plate lower flange.



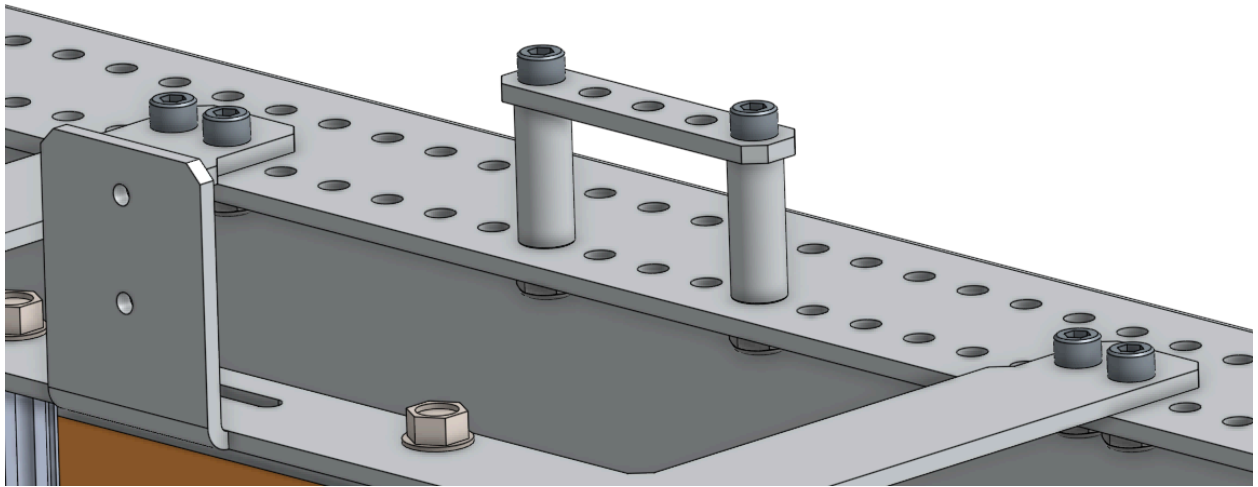
Use four 0.5" 10-32 socket head bolts to secure the top plate to the chassis. The socket head should be pointed up, with the nylock nuts on bottom. The bolts use a 5/32" allen key and the nuts require a 3/8" wrench, ideally a ratcheting one.



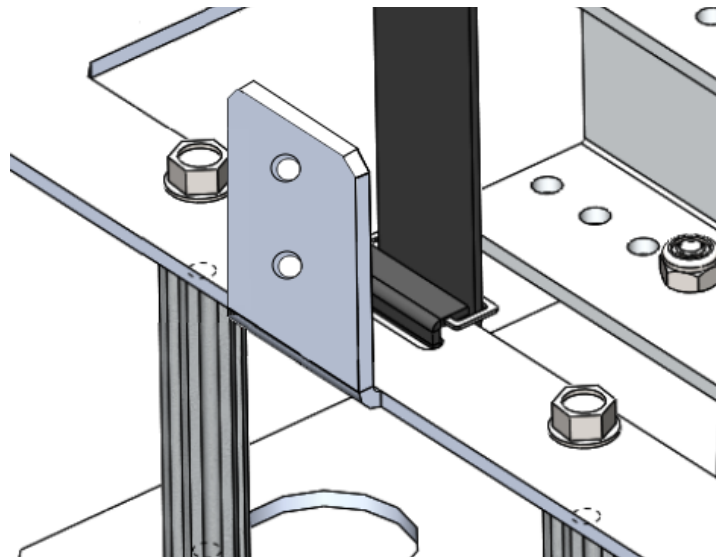
Use four 0.5" 10-32 socket heads to secure the bottom plate to the chassis, this time with the bolt head facing the floor.



Next install the battery clamp, which is the strip with 5 holes, on top of the cylindrical spacers with the 1.5" 10-32 bolts with nylock nuts underneath. There should be five open holes from the plate to one side of the top battery plate to the location of the battery clamp.

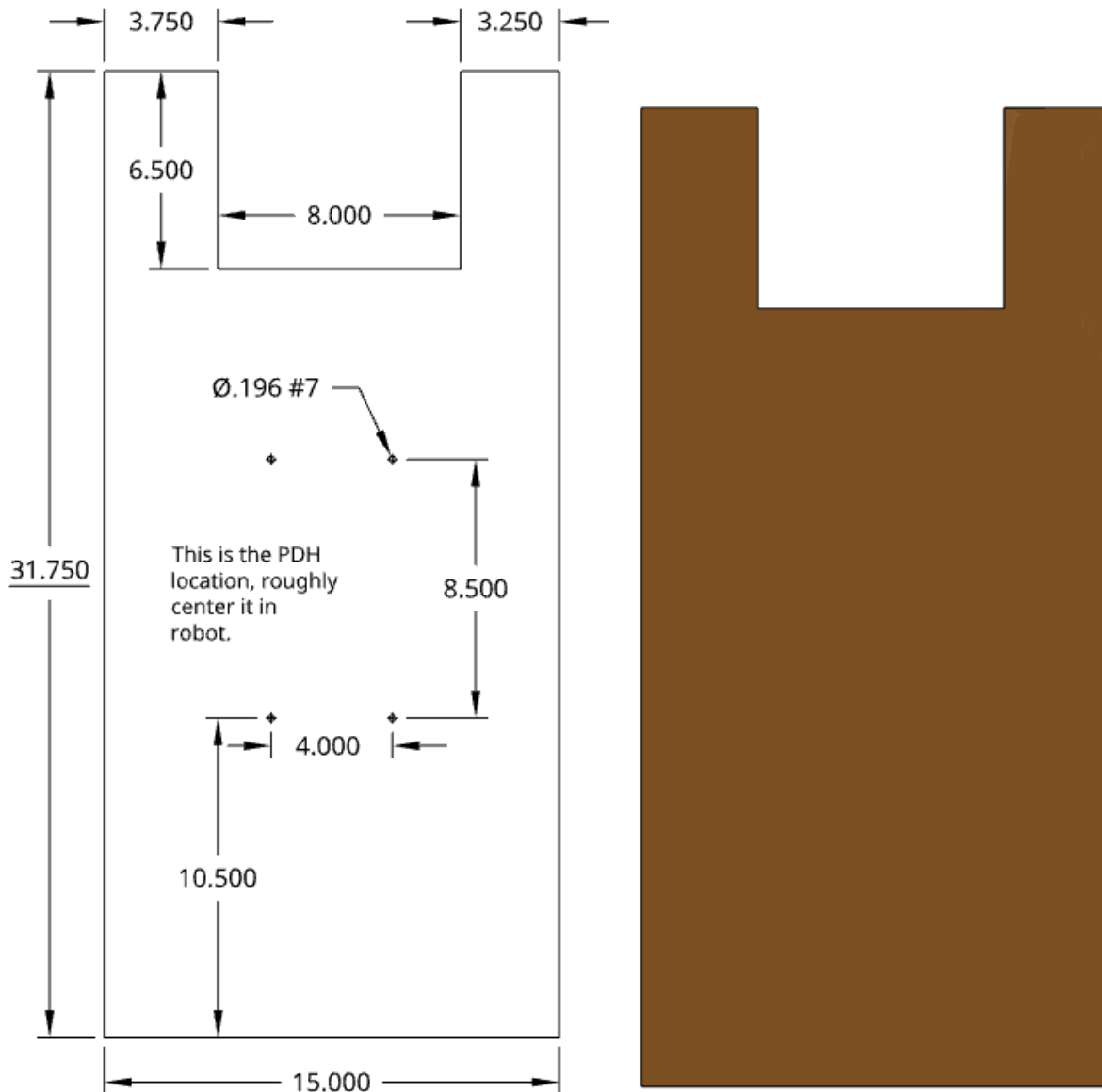


"Feed the battery strap through the top of the slot, loop around and through the buckle. This strap can be left permanently attached to this bracket." - AM instruction

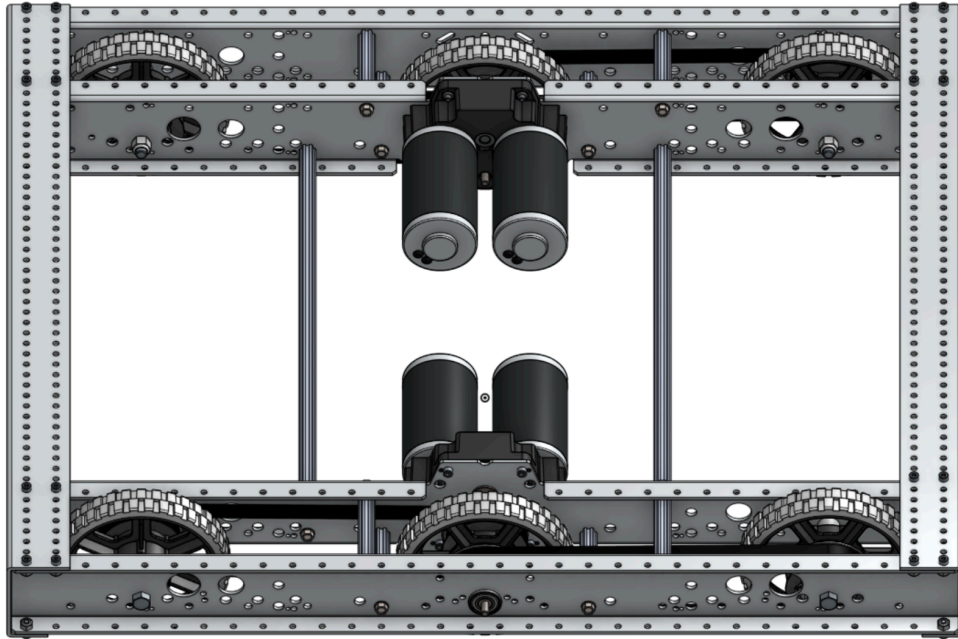


Bellypan

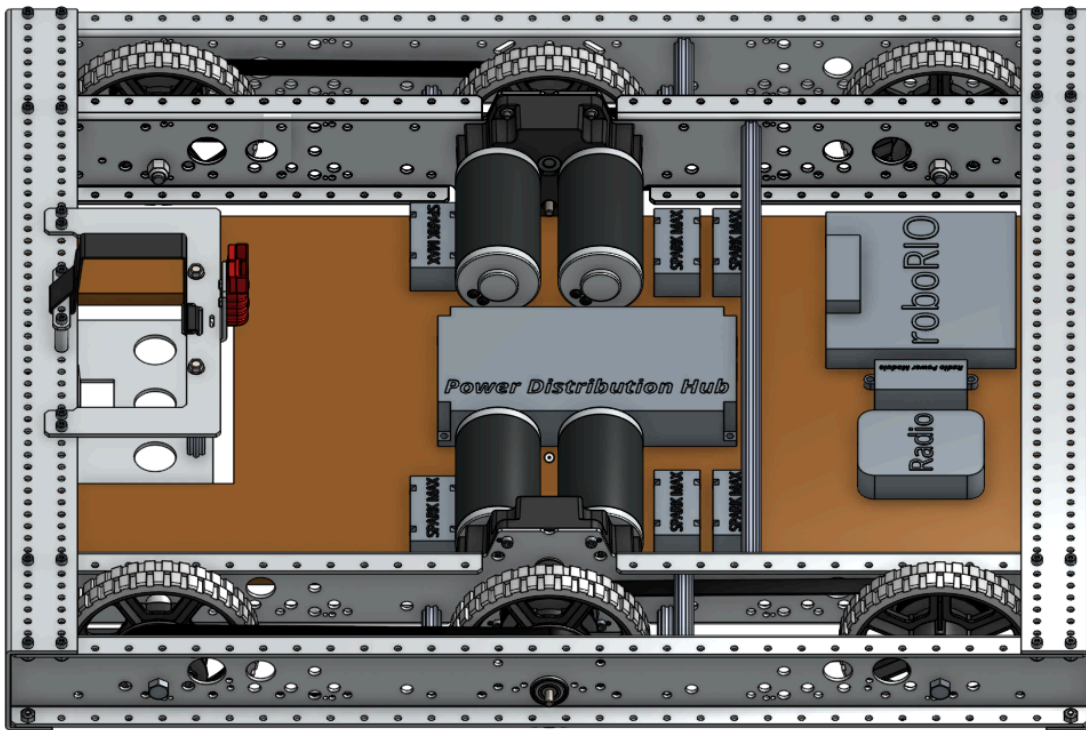
The KitBot shopping list includes a sheet of 1/2 inch thick plywood intended to be cut down to form the bellypan and electronics board of the robot. The plywood sheet should be cut down to 15" by 31.75" to fit within the chassis with an 8" wide and 6.5" deep cutout located 3.75" from one side and 3.25" from the other to fit around the battery bracket.



The easiest way to install the bellypan is to slide it in from the front or rear of the chassis with the front or rear end plate removed. If you have referenced the KitBot CAD, the churros across the inside of the chassis may be positioned too low and interfere with the bellypan. Move the churros up to the AndyMark recommended holes if needed.



FIRST official KitBot CAD churro locations

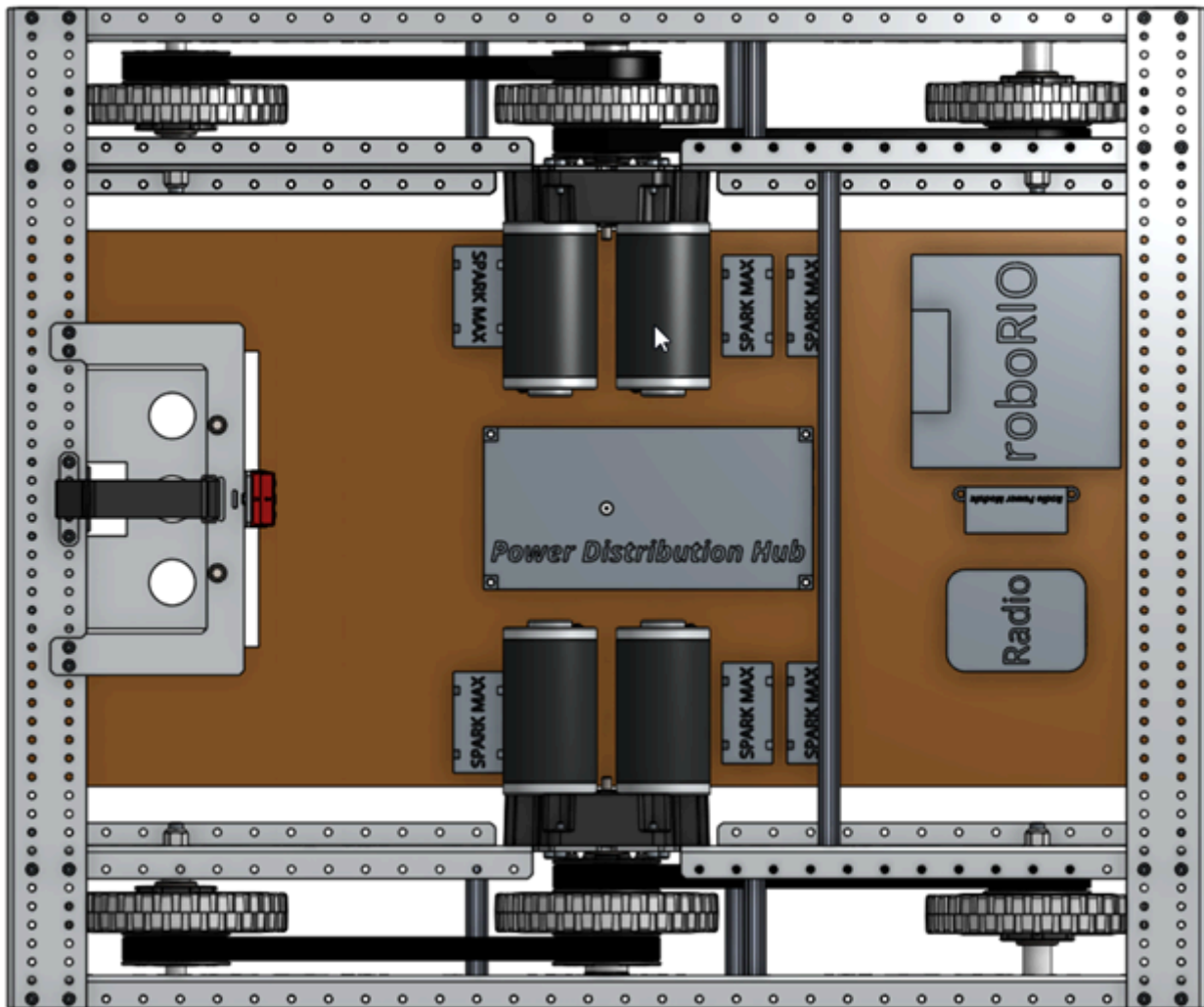


Our recommended churro locations (Everybot compatible)

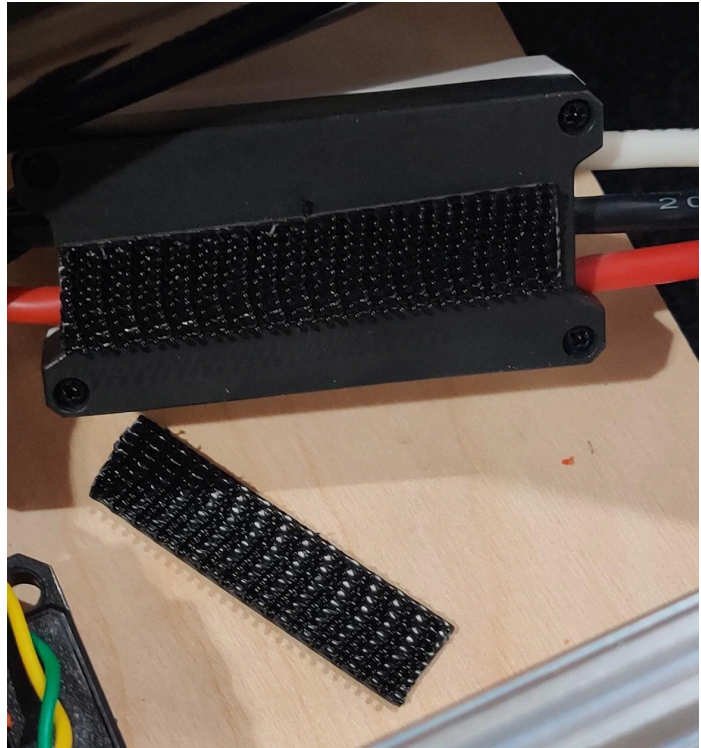
The bellypan should be bolted down to the Chassis End Rails to keep it from shifting around inside the robot. We used four 10-32 x 0.75" bolts towards each of the four corners of the plywood bellypan. The easiest way to do this is to turn the robot on its side and use a #7 drill bit to match drill through a hole in the Chassis End Plate bottom flange where there are no electrical components. Have someone else hold the bellypan down in the frame so that the drill goes directly into the wood instead of pushing the bellypan up into the chassis, being sure to keep their hands away from where the drill bit will come through the wood. Install the bolts one at a time after drilling the holes to ensure all four holes will end up lining up. Insert them from the bottom so just the head of the bolt hangs down below the frame.

Component Layout

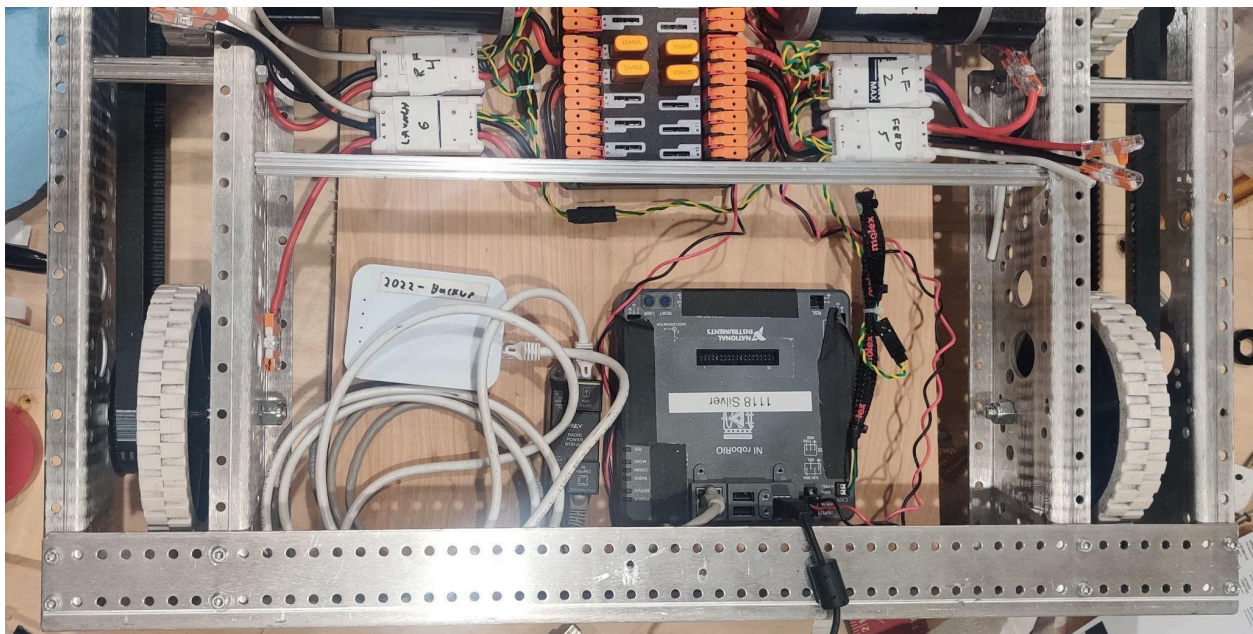
The component layout shown and described here is merely one potential layout and your team can choose to lay out your electrical system in any sensible way you want. If you plan on adapting your KitBot into an Everybot the layout described here should be easily adapted to account for the changes between the two designs.



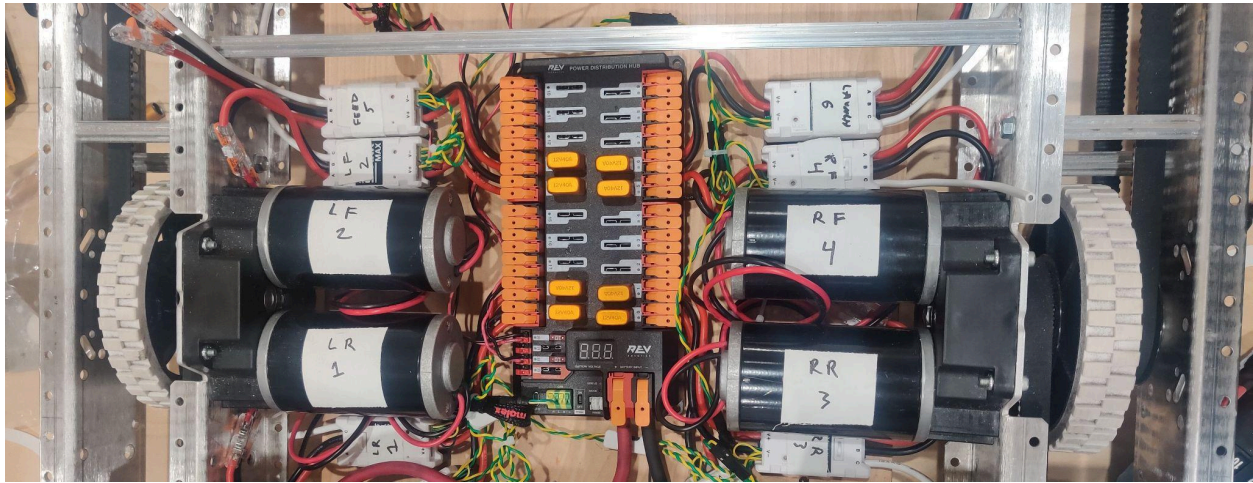
We attached our components using a mix of zip ties through hand-drilled holes in the 1/2" plywood and stickyback dual lock (included in the Kit of Parts) for ease of installation and component removal if necessary. A more secure mounting system may be desirable for a competition robot that will see heavy use and collisions. Zip ties around or through mounting features of components are a good option.



The front of the bellypan contains the roboRIO, radio, and power delivery for the radio (either the Radio Power Module or Voltage Regulator Module). These components had strips of dual lock applied with mating strips on the wood bellypan. The adhesive on the rear of the dual lock may not grip the plywood surface over time, and zip ties or bolts (or a polycarbonate bellypan) would probably hold up better during competition.



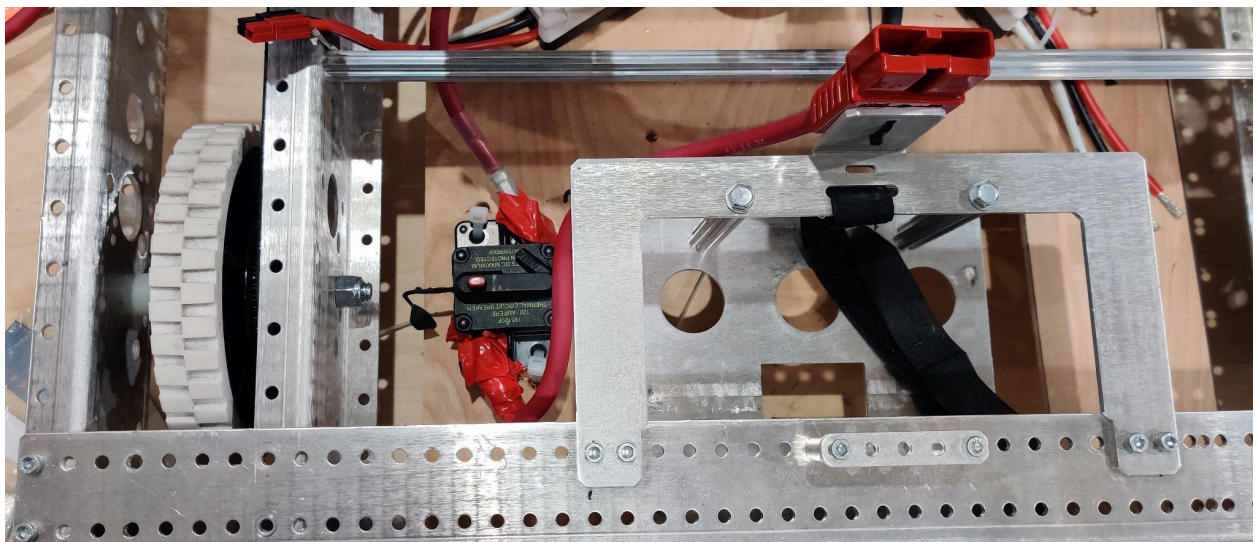
The middle of the bellypan holds the Power Distribution Hub (PDH). The PDH is held down with dual lock to make it easy to lift up to insert and remove wires for the motor controllers. The six motor controllers sit on either side of the drivetrain motors. The two rear drivetrain motor controllers sit behind the motors while the two front drivetrain motor controllers and the feeder and launcher motor controllers are in front of the drivetrain motors. Two more Spark Max motor controllers will be added if your team plans on adding the Everybot additions to the KitBot, one in the rear and one in the front.



The main breaker is located to the left of the battery bracket and was zip-tied down, but bolts are generally preferred.

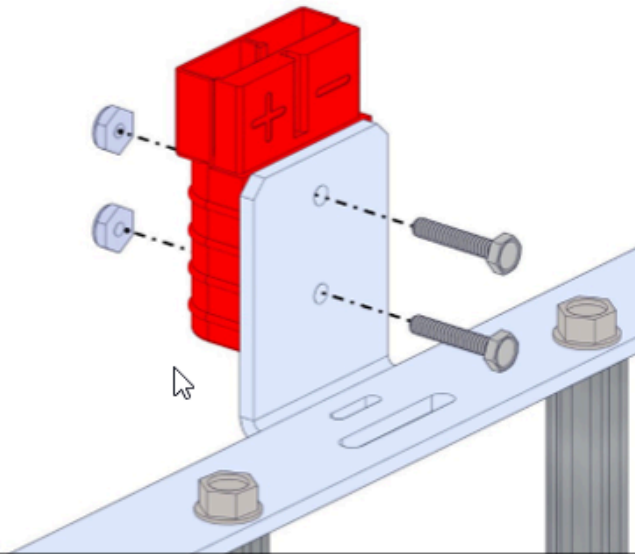
Power Wiring

Thick 6 gauge wire (provided in the [Kit of Parts](<https://firstfrc.blob.core.windows.net/frc2024/KOP/2024KOPChecklist-BlackTote.pdf>)) is used to connect the battery connector to the main breaker and Power Distribution Hub or Panel. Take one of the provided battery cables with a large plastic Anderson connector on one end and crimp a ring terminal to just the red wire if using a newer REV Power Distribution Hub (PDH) or both the red and black wires if using the older Power Distribution Panel (PDP). Eight 6AWG ring terminals are included in the Rookie Kit of Parts that can be used for this. Make sure the crimp is secure by pulling on it after crimping, if these connections are loose they can and will cause your robot to lose power as they are knocked around in matches.



The Anderson Connector can be screwed into the tab on the battery bracket using the provided nuts and bolts and the black wire can be connected to the negative terminal on the power distribution board using either the WAGO lever or the bolt post depending on which version you are using. The red wire on the battery connector should then be attached to the “BATT” side of the main breaker (this is not strictly necessary, either the BATT or AUX terminal will work).

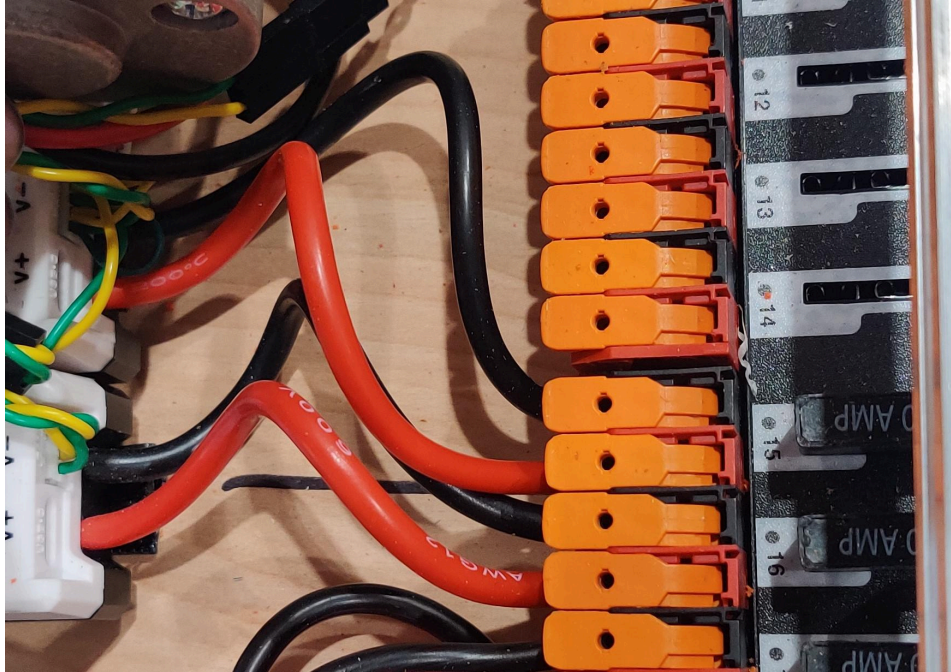
“Secure the Robot Side SB-Series Battery Connector to the tab on the C Plate using two #6-32 x 0.750” Hex Head Screws (am-1424) and #6-32 Nylock Jam Nuts (am-1419). The wires from this connector should go to your main robot breaker and power distribution panel.” - AM instruction



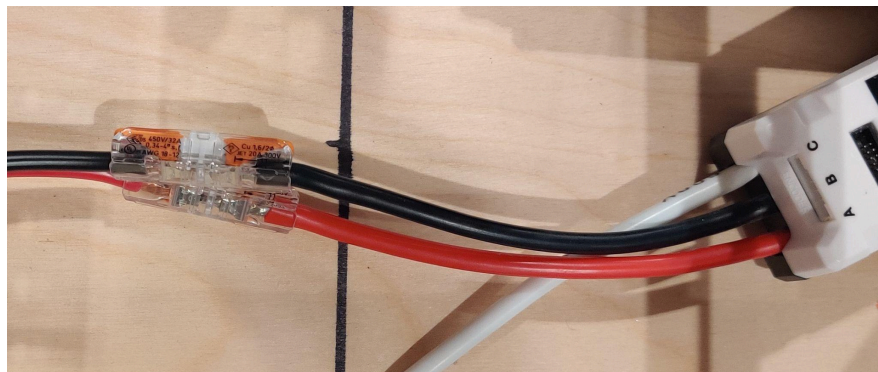
Note: The screws should be oriented such that the heads of the screws are on the Tab side.

Cut a section of the red 6 gauge wire provided in the kit down to an appropriate length and crimp a ring terminal on one end if using the PDH or both ends if using the PDP. Bolt the ring terminal to the AUX side of the main breaker and attach the other side to the positive terminal of the PDH/PDP. Cover any exposed metal on the main breaker connectors with electrical tape.

The six Spark Maxes should be able to be plugged directly into the PDP/PDH by stripping the red and black wires on the power input side of the motor controllers (the side with only the red and black wire coming out, not the side with red, black, and white wires) and inserting the wire into the PDP/PDH in adjacent red and black ports, inserting the red wire into the red receptacle and the black into the black. The slot used does not matter as long as you remember to place breakers into the slots that are used. If necessary, use 12 gauge wire to make extensions to connect the power input wires to the PDH/PDP outputs, with a WAGO connector or other quick disconnect connecting the controller to the extension wire.



The motors are plugged into their motor controllers by stripping the ends of the red and black motor wires (if necessary) as well as just the red and black wires coming out of the motor output side of the Spark Maxes. Connect the red to red and black to black using WAGOs or another quick disconnect.



Do not worry about the white wire if using the provided CIM motors for the KitBot. Wrap some electrical tape around the white wire if it is unused to prevent the wire inside from contacting metal components of the robot. It does need to be connected (along with the hall effect sensor cable) if using NEO motors. In our testing we preferred CIMs over NEOs in all locations.

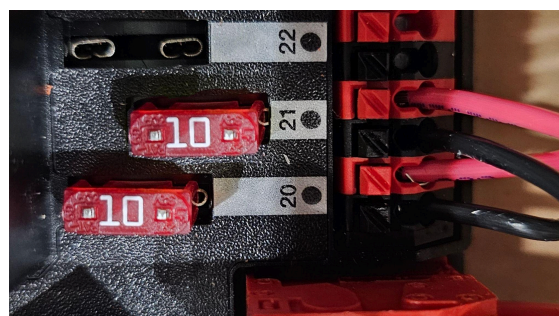




When the motors are plugged in to their controllers, it is probably a good idea to label the motors and controllers with what they are as well as their ID numbers. The numbering for both the default PWM control code and our adapted CAN control code are as follows:

- 1 - Left rear drive motor
- 2 - Left front drive motor
- 3 - Right rear drive motor
- 4 - Right front drive motor
- 5 - Feed motor (lower of two mechanism motors)
- 6 - Launch motor (higher of two mechanism motors)

Two pairs of 18 gauge wire run from the PDH auxiliary power slots to the roboRIO power connector and the Radio Power Module or Voltage Regulator Module power inputs. On the PDH the slots numbered 20 to 22 near the battery voltage indicator can be used for the roboRIO or radio power, just install 10 amp fuses in the slots used. The positive red wire screws into the "V" (for voltage) connector of the roboRIO's power terminal and the negative black wire goes to the "C" (for common) connector.



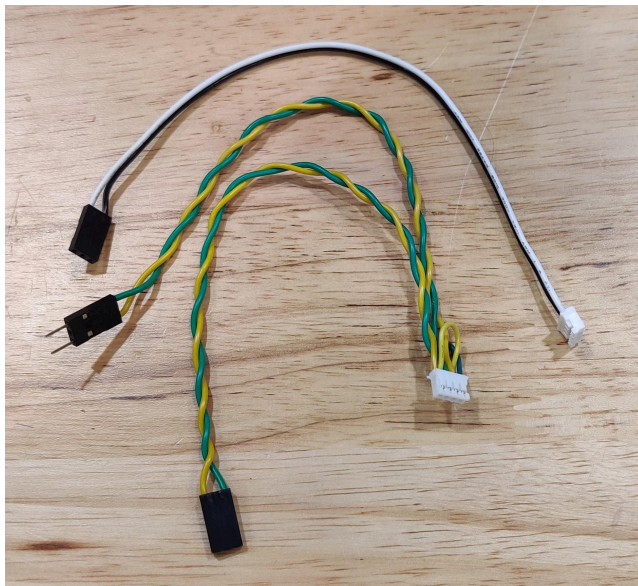
When using the Radio Power Module, the Ethernet cables (covered in the Data section) connecting the roboRIO to the radio through the module will provide the radio with power. If you are using the Voltage Regulator Module, a passive Power Over Ethernet (POE) injector like the orange REV cable included in the kit of parts is recommended. The POE cable should have the red and black wires with ferrules preinstalled inserted into the 12V/2A terminals on the VRM, with the optional barrel jack plugged into the other pair of 12V/2A connectors if desired.



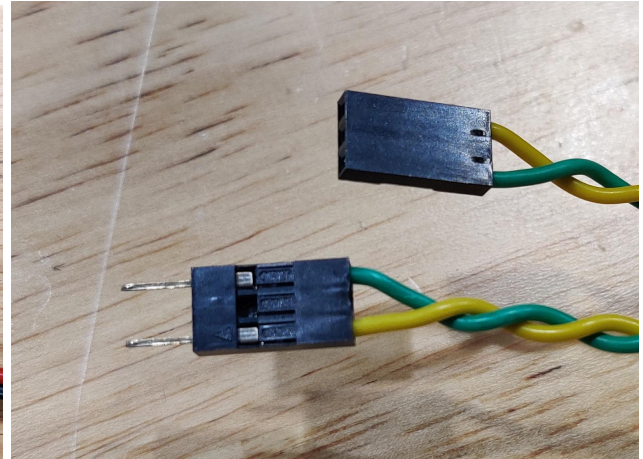
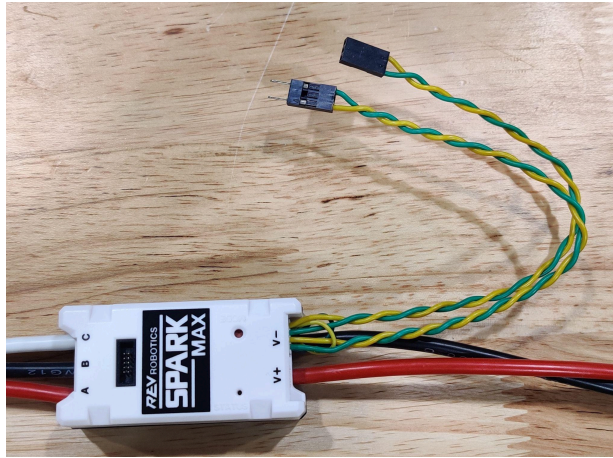
Data Wiring

We suggest using the CAN bus over PWM cables to control the motor controllers as the wiring is neater and there are sometimes issues with using PWM control with Spark Max controllers. The CAN network or “bus” consists of a daisy-chain connecting every component on the bus. The CAN bus begins at the CAN ports located near the power connector on the roboRIO and terminates at the CAN connectors on the PDP or PDH, passing through each of the Spark Max motor controllers on the way.

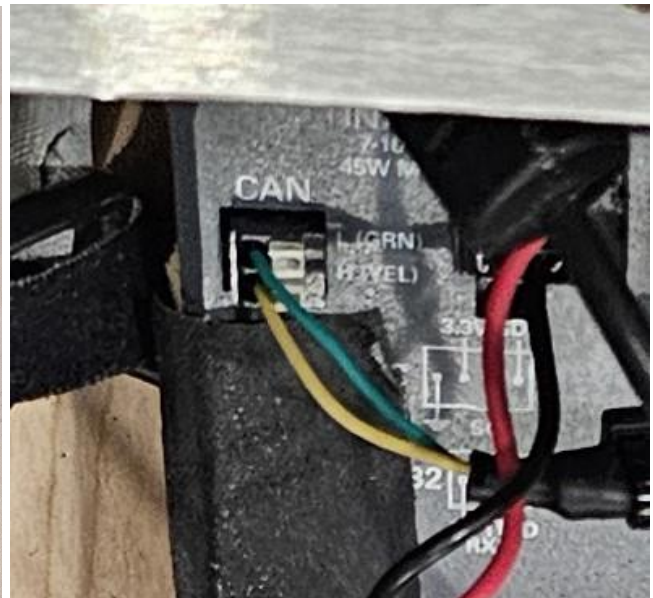
The Spark Maxes come with two data cables, a black and white PWM cable and a CAN cable with two pairs of yellow and green wires which plug into the keyed white connector next to the USB C port on the power input side of the controller. The side of the connector with the small tab faces down when inserting it into the port.



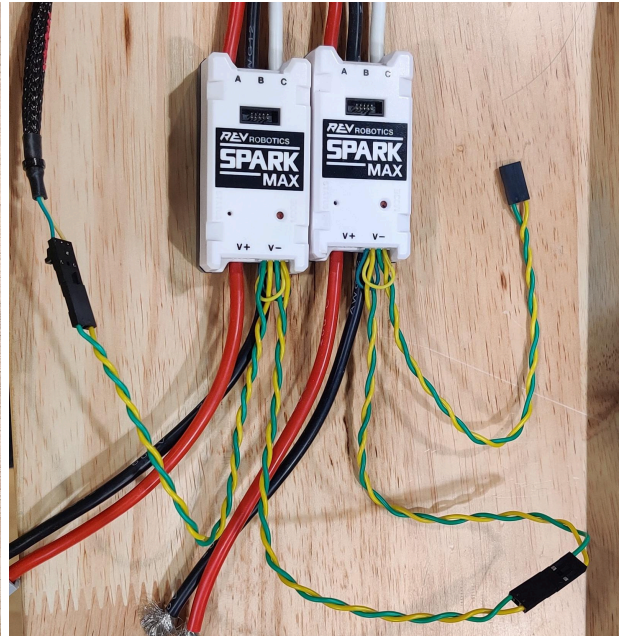
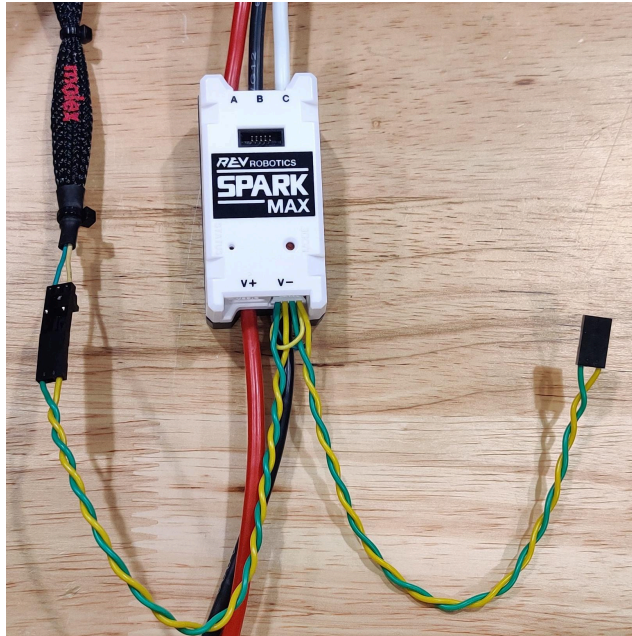
One of the pairs of yellow and green wire will connect to the previous device in the chain and the other will connect to the next, with the order things are plugged in being irrelevant to the function of the bus.



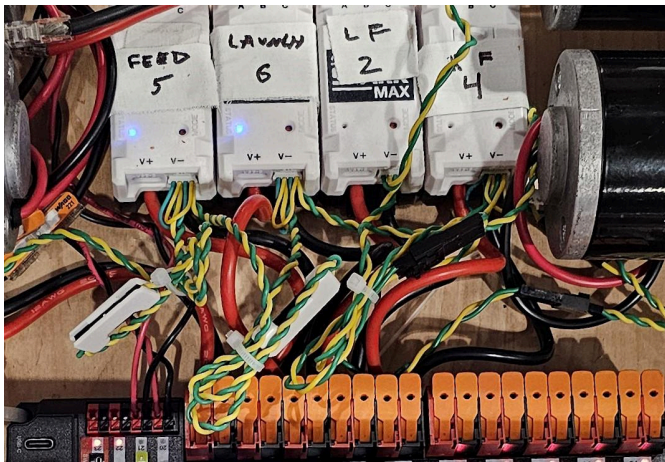
The Spark Max CAN cables come with servo-style pin header connectors. One connector has the protruding pins while the other has the mating receptacle. There is a CAN connection kit provided by Molex in the black Kit of Parts tote that has some cables that can be used to connect these servo-style pin headers to the terminals on the roboRIO and PDP/PDH as they expect a bare wire connection. Take one of these wires and remove the pre-cut section of insulation on the end that does not have a servo connector. Insert the yellow wire into the H (YEL) connector on the roboRIO and the green wire into the L (GRN) port. The other end of the cable can then be plugged into one of the motor controller connectors of the opposite type.



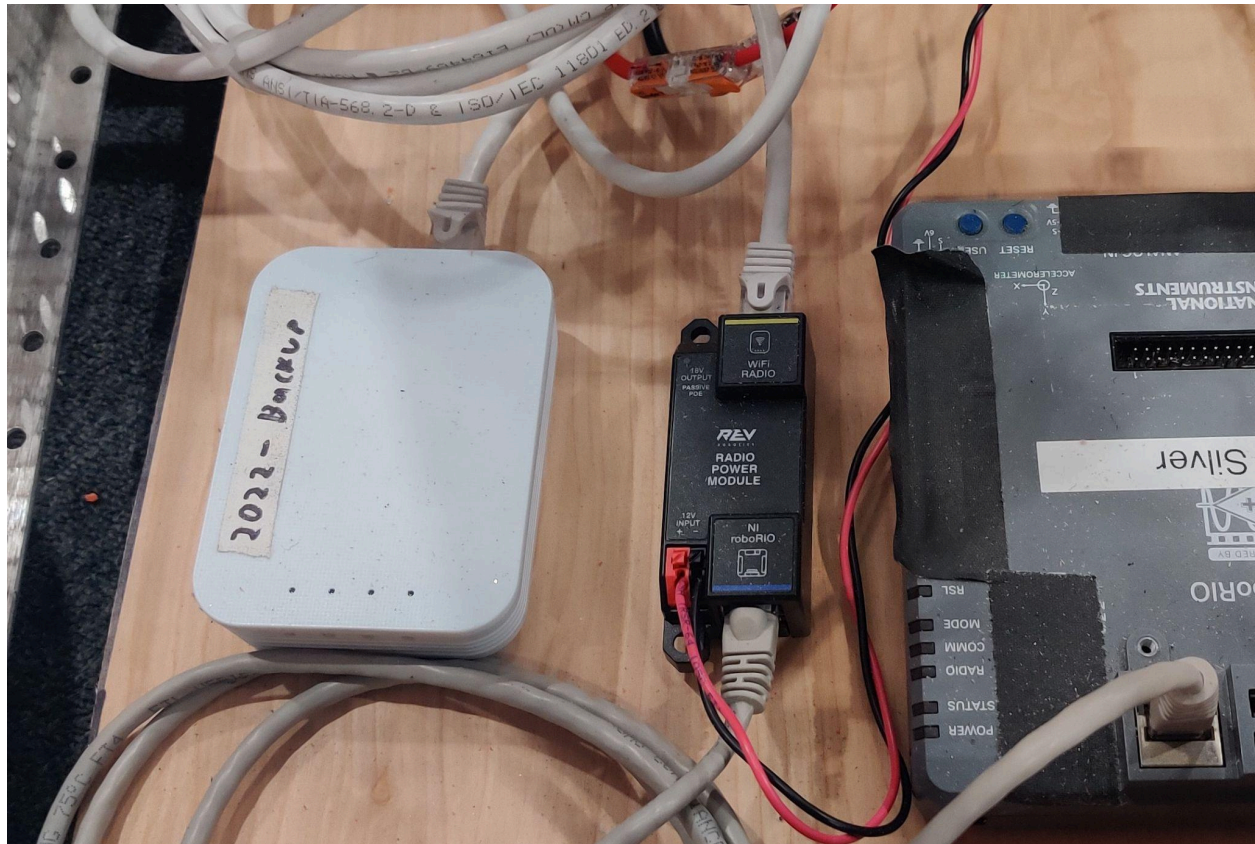
The other connector on that same motor controller can then be plugged into the opposite type on the next controller and so on until the CAN chain has passed through every motor controller, leaving one controller on the “end” of the chain with a free connector. Match the colors of the wires at every connection (yellow to yellow and green to green).



The white clips provided with the Spark Maxes can be used to hold the servo connectors together, and excess wire can be bundled together with zip ties. Take a Molex CAN cable with the opposite connector to the free Spark Max cable end and plug it into the Spark Max. The Molex connectors have tabs for a locking system which the REV cables do not have, meaning the white clips will not fit over the connection, so a strip of electrical tape or other method of holding the two connectors together so they can not be shaken loose during competition is a good idea. Remove the precut section of insulation from the other side of the Molex wire and plug the wires into either the left or right pair of connectors on the PDP/PDH's CAN terminals, making sure the terminating resistor (labeled TERM) is turned on to complete the CAN chain.



The radio needs to be plugged into the Ethernet jack on the roboRIO. If the Radio Power Module (RPM) is being used, run one Ethernet cable from the roboRIO's port to the roboRIO side of the RPM and a second cable from the Radio side of the RPM to the port on the radio closer to the barrel jack.



If the VRM is being used with a Power Over Ethernet cable, plug the Ethernet cable end into the radio port closer to the barrel jack and plug an Ethernet cable between the Ethernet jack on the other end of the POE cable and the Ethernet jack on the roboRIO.

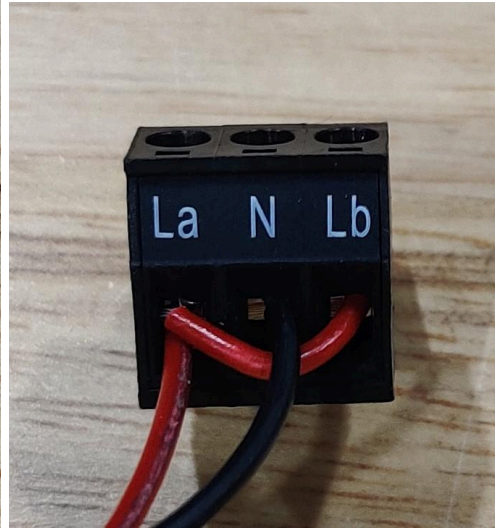
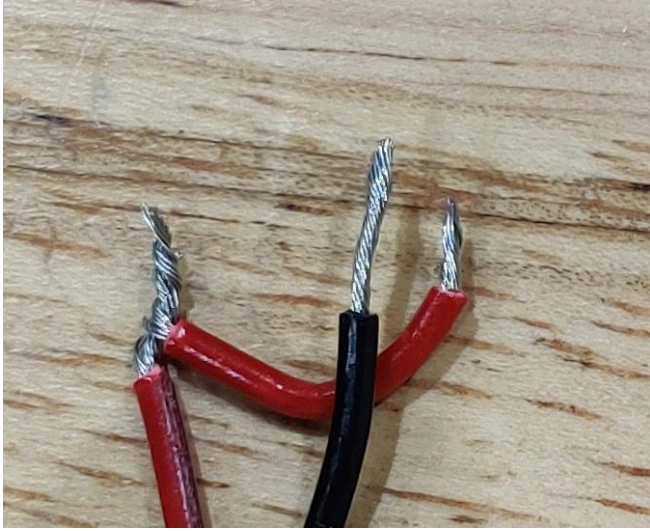
The Ethernet jack closer to the barrel connector is the only port that can accept the 12 volt POE power the robot provides, and plugging into the outer port with either the VRM or RPM will not actually power the radio.

Miscellaneous

The Robot Signal Light (RSL) visually indicates what state of operation your robot is currently in. It is wired into the RSL port on the roboRIO. The Rookie Kit of Parts includes a 2-wire jumper cable that can have one end cut off and the blue Molex sample kit in the regular black Kit of Parts tote includes a 2-wire cable that has a connector on only one end.



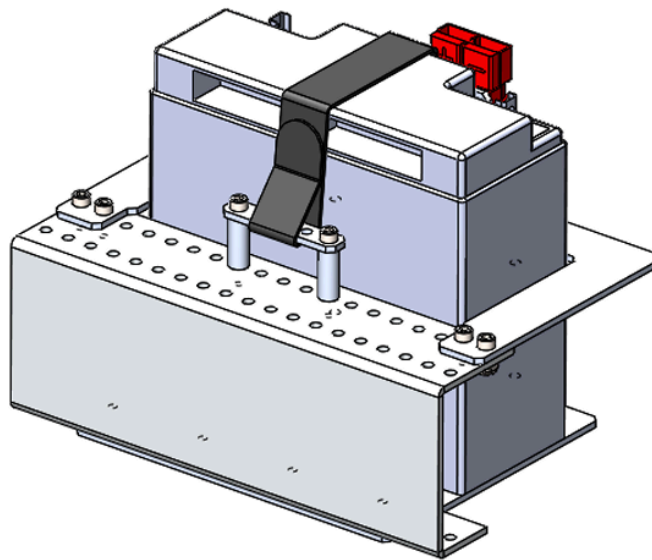
The connector end of either cable is plugged into the RSL port with the red wire in the S position and the black wire in the ground position (the small lines in a triangular symbol). On the chopped off end of the cable, cut off a short section of red wire that will be used to connect the two outer La and Lb terminals. Strip off the ends of the wires and twist one end of the jumper cable with the red wire it was cut off from so that the two wires can be inserted into the same terminal on the RSL. The red wire can then be connected to either outer terminal with the jumper connecting it over to the other outer terminal as well. The black wire is connected to the center N terminal. The screws on the side of the terminal block will clamp down on the wire when tightened. The RSL can be mounted anywhere that satisfies the wording of rule R709, with our suggestion being the crossbar on the front of the KitBot mechanism structure.



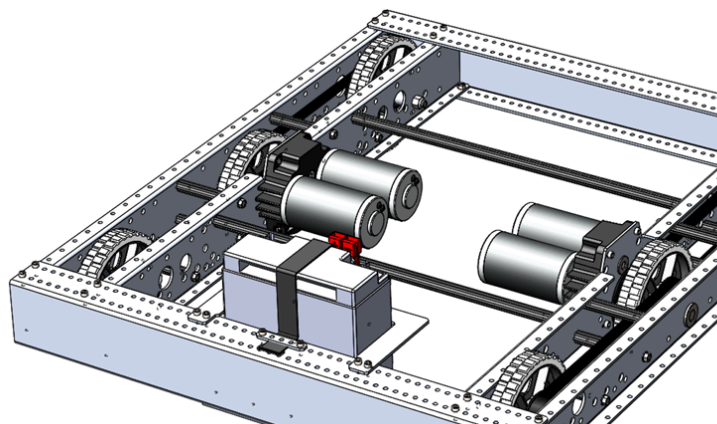
Securing the Battery

Derived from the AM battery bracket manual.

“Insert the Battery into the Battery Tray with leads facing upward and on the same side as the SB Connector. Pull the strap around the center of the battery and underneath the spacer and clamp assembly.”



“Plug the SB connector from the battery into the SB connector mounted to the tray. Secure with a cable tie around both connectors through the small slot in the C Plate to ensure the battery will stay connected during match play.”



Double check that all wires are securely connected with no bare strands of wire showing and that red wires are in red receptacles and black wires are in black receptacles. The main breaker of the robot functions as the power switch, and pushing in the lever on the side of the switch turns it on. Before turning the robot on it is good practice to say "Clear!" and ensure others around the robot are clear of it as it could begin to move unexpectedly when turned on. Assuming everything is wired correctly, the PDH should have its battery level indicator light up, each motor controller should begin blinking, the roboRIO should begin to boot up with status lights, the radio should begin to boot up with blue status lights, and after a moment the robot signal light should turn solid orange. If it does not appear that a component is receiving power, check that its slot in the PDH has a breaker (or fuse, for the roboRIO and Radio Power Module) and that the wires are securely plugged in. After wiring, some control system components like the roboRIO and radio will need to be imaged with the correct firmware and the Spark Maxes will need their CAN ID numbers set.