



Training and
Support

2018-2019 *FIRST*® Tech Challenge

Basic Bot Guide for TETRIX

ROVER RUCKUS



Presented By **Qualcomm**

www.firstinspires.org

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Revision History		
Revision	Date	Description
1	06/25/2018	New guide, in template
1.1	7/23/2018	Drive Motor Wire Changes, Heading Changes, Capitalization, added switch plate to Step 6 Build Left Electronics Plate, corrected a typo, added picture of finished robot, added shapes on pictures to emphasize the part or direction
1.2	7/26/2018	Title and Language changes, Initial Release

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Introduction

What is FIRST® Tech Challenge?

FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks. To learn more about FIRST® Tech Challenge and other FIRST® Programs, visit www.firstinspires.org.

FIRST Core Values

We express the FIRST® philosophies of *Gracious Professionalism®* and *Coopertition®* through our Core Values:

- **Discovery:** *We explore new skills and ideas.*
- **Innovation:** *We use creativity and persistence to solve problems.*
- **Impact:** *We apply what we learn to improve our world.*
- **Inclusion:** *We respect each other and embrace our differences.*
- **Teamwork:** *We are stronger when we work together.*
- **Fun:** *We enjoy and celebrate what we do!*

NOTICE OF NON-DISCRIMINATION

For Inspiration and Recognition of Science and Technology (FIRST®) does not discriminate based on race, color, national origin, sex, disability, age, status as a veteran who served in the military, religion, gender, gender identity, or gender expression in its programs and activities.

Keep updated at: <http://www.firstinspires.org/about/legal-notices>.

Gracious Professionalism®

FIRST® uses this term to describe our programs' intent and *Gracious Professionalism®* is not clearly defined for a reason. It has different meanings to everyone. Some possible meanings of *Gracious Professionalism* include:

- Gracious attitudes and behaviors are win-win.
- Gracious folks respect others and let that respect show in their actions.
- Gracious Professionals make valued contributions in a way that is pleasing to others and to themselves.

In the end, *Gracious Professionalism®* is part of everyday life. When professionals use their knowledge graciously and individuals act with integrity and sensitivity, everyone wins, and society benefits.

Watch Dr. Woodie Flowers explain *Gracious Professionalism* in this [short video](#).

Introduction to the Guide

Introduction

The Basic Bot Guide is designed to be a resource for teams looking for step-by-step instructional for building the basic chassis and structure needed in a *FIRST* Tech Challenge competition. There are multiple versions of this guide, previously called the “Push Bot Guide”, this version the **Basic Bot Guide for TETRIX** has been created to use the new and differing parts in the 2018-2019 season’s TETRIX kit of parts.

Parts

- TETRIX FTC Competition Set
- Electronics Modules and Sensors Set
- Control & Communication Set 1 or 2
- (Optional) Only the tools included in the FTC Competition Set will be needed to build the chassis. The screws and nuts are a standard size and having more tools may allow more students to participate at the same time.
- (Optional) A ruler is not needed to build this robot, but it is necessary to make sure that the robot is competition ready

Tips and Tricks

- Make sure that set screws are installed in every axle hub, motor hub, and axle collar.
- Refer to the legend provided in the Kit of Parts, if any parts are unfamiliar.
- Make sure that all assemblies are square. It is hard to drive a crooked robot straight!
- The drive wheels are powered by two DC motors, which are relatively heavy. The drive wheels are on the back of the robot, because that is where the most weight is. This weight is needed to help the wheels grip the surface better.
- Omni wheels are on the front of the robot, which allows the robot to turn more easily. The omni wheels can slide sideways with very little friction due to the rollers.
- Unless otherwise noted, the top image in each step shows the necessary parts; the lower image shows the completed assembly.

Computer Aided Design (CAD)

- The drawings in this document were generated using Creo Parametric Computer Aided Design (CAD) software.
- CAD software is used to design an object on a computer.
 - **By designing on the computer first, the design can be tested (via the CAD software) to ensure everything will work together before actual construction.**
- The Creo software is available for free to *FIRST* teams for use in designing robots.

CAD Coloring Legend

The CAD drawings color code the screws to help identify them, please see below table.

Pitsco Part Number	Part	Color
39098	5/16" socket head cap screw	red
39094	keps nut	blue
39111	3/8" button head cap screw	green
39097	1/2" socket head cap screw	yellow
39195	motor mount screw	orange

Construction

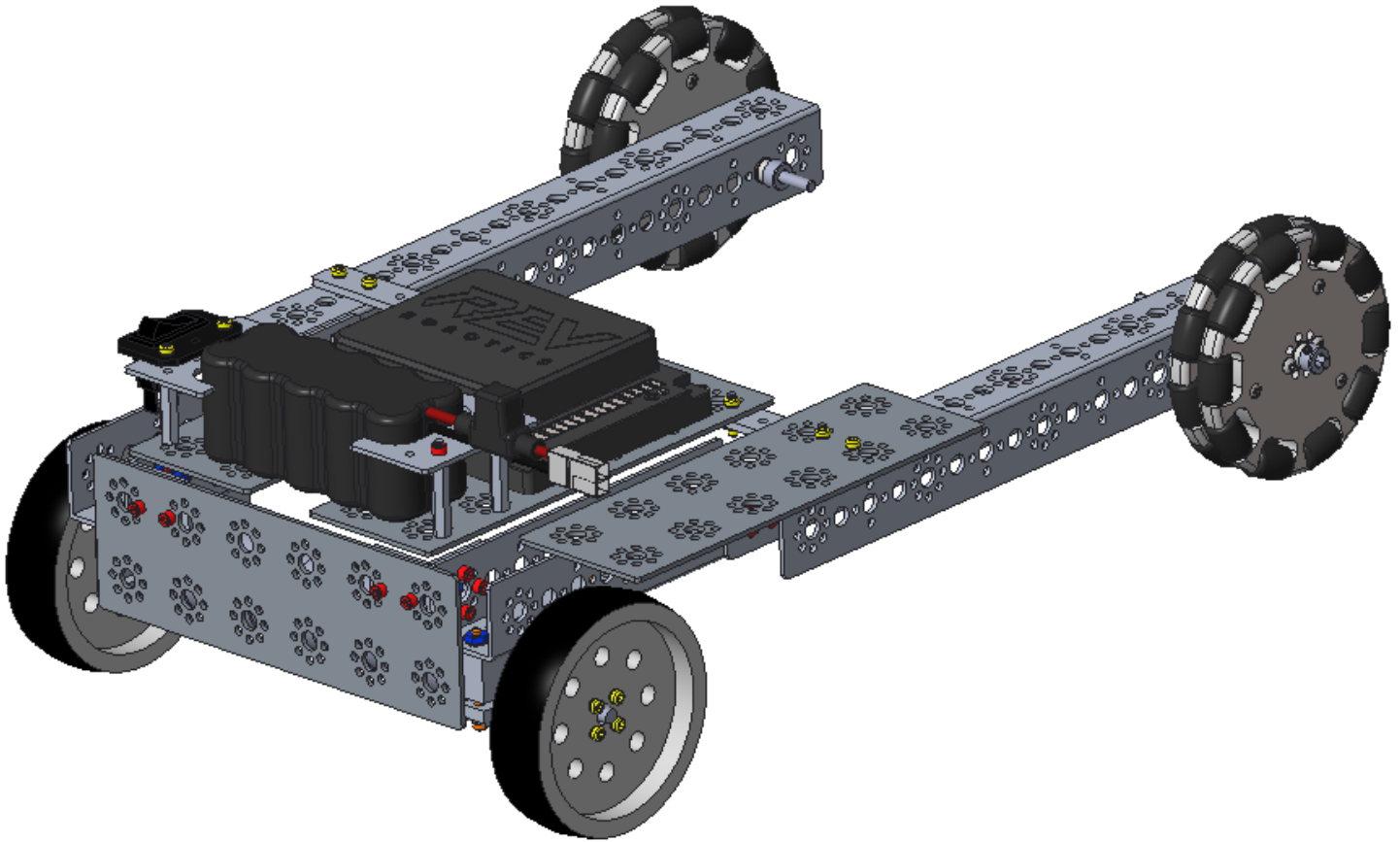
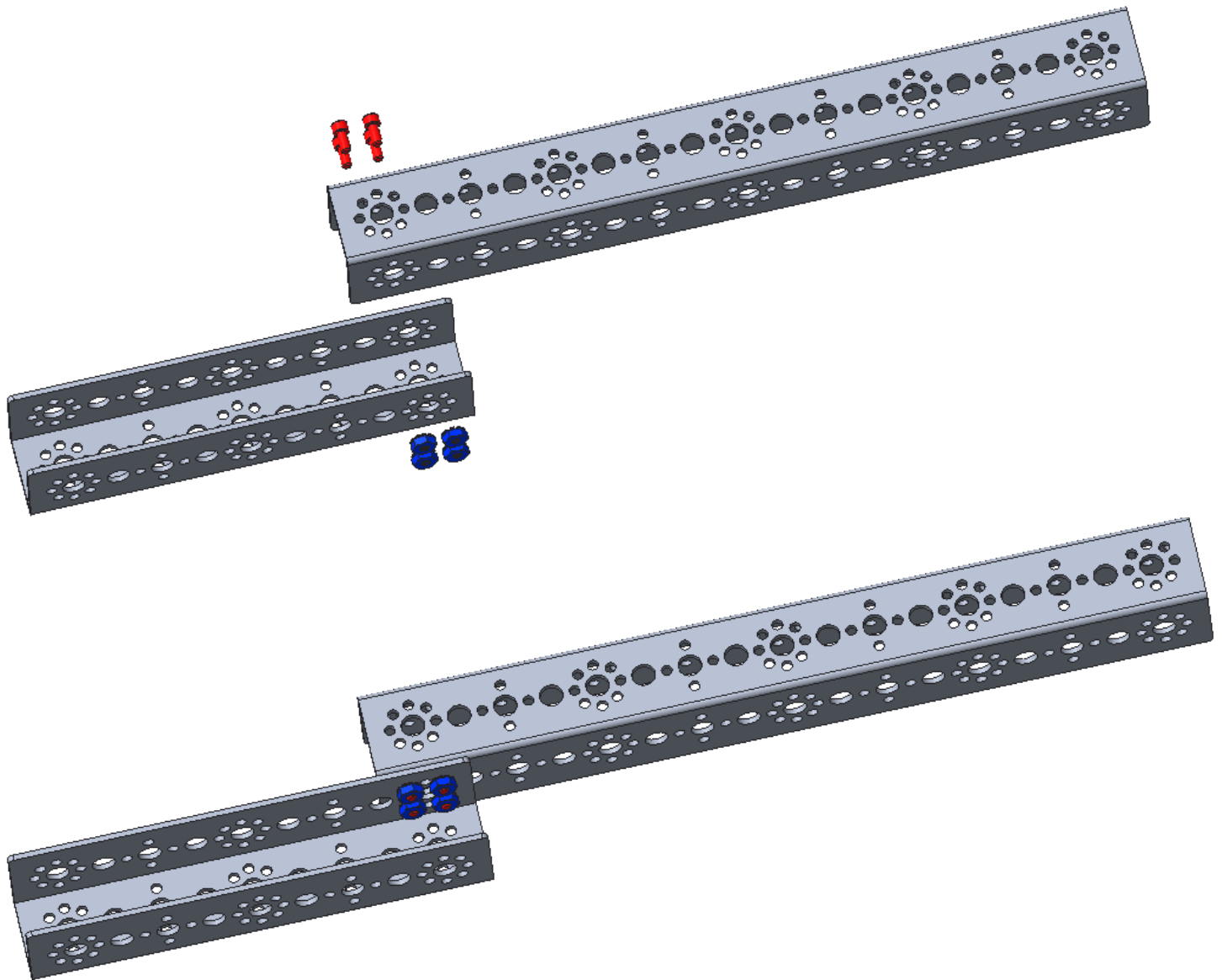


Figure 1 Completed TETRIX robot chassis

Frame

Step 1: Build the Left Rail

- 39067 - 160 mm channel (1)
- 39068 - 288 mm channel (1)
- 39098 - 5/16" socket head cap screw (4)
- 39094 - keps nut (4)



Step 2: Build the Right Rail

- 39068 - 288 mm channel (1)
- 39067 - 160 mm channel (1)
- 39098 - 5/16" socket head cap screws (4)
- 39094 - keps nuts (4)

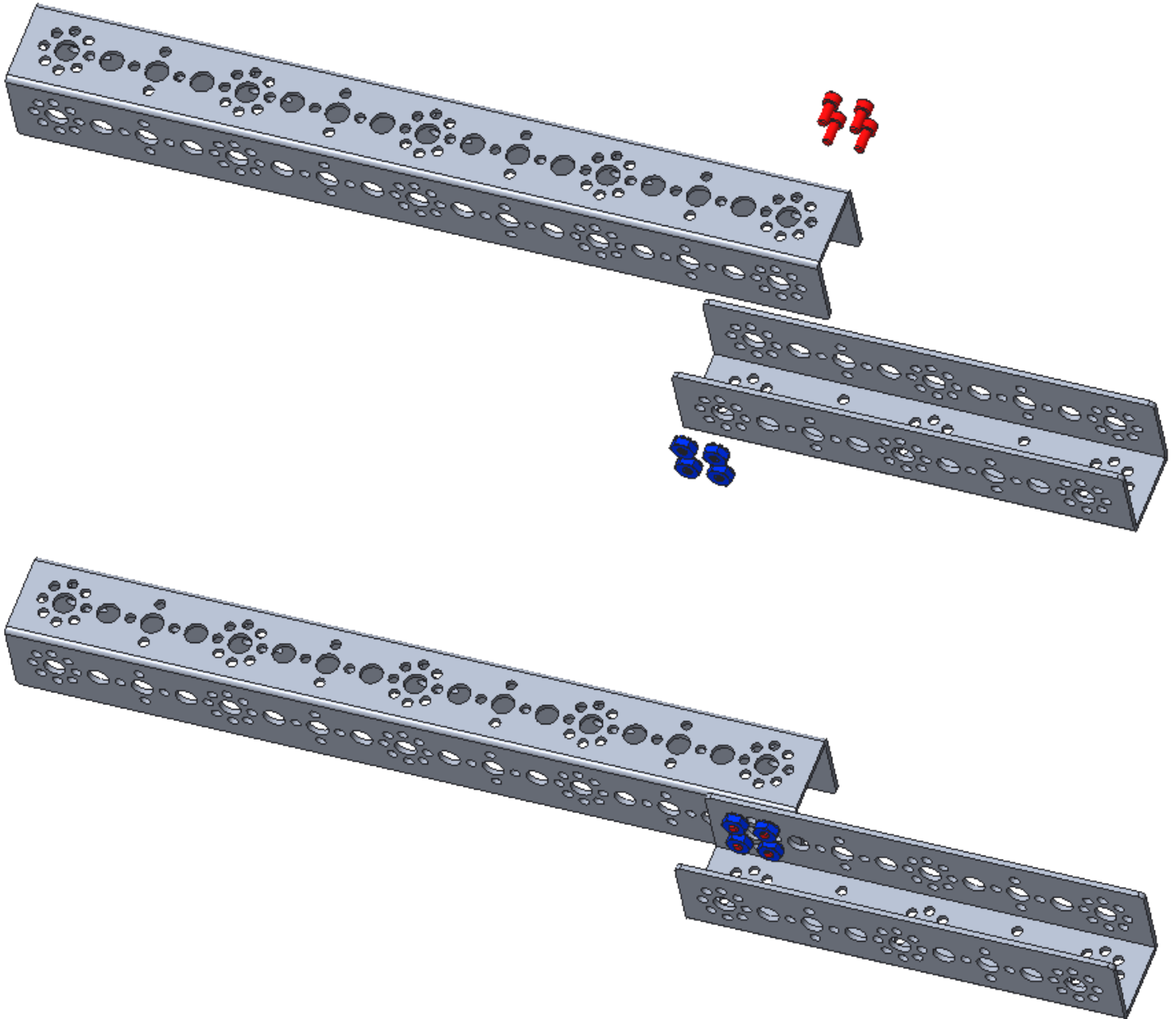


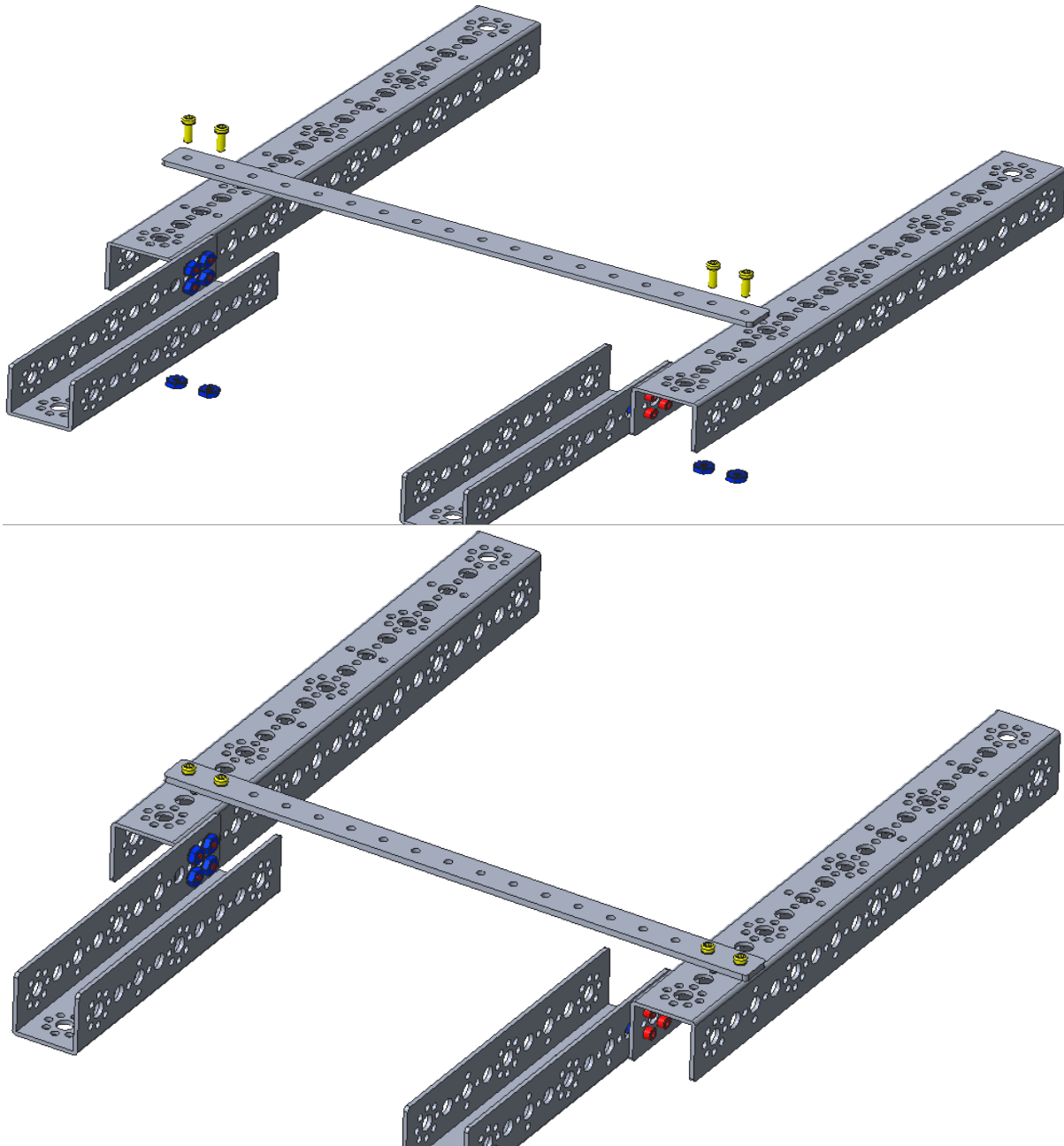
Figure 2 A mirror image of the left chassis rail assembly built in the previous step

Step 3: Connect the Left and Right Rails

39070 - 288 mm flat bar (1)

39097 - 1/2" socket head cap screws (4)

39094 - keps nuts (4)

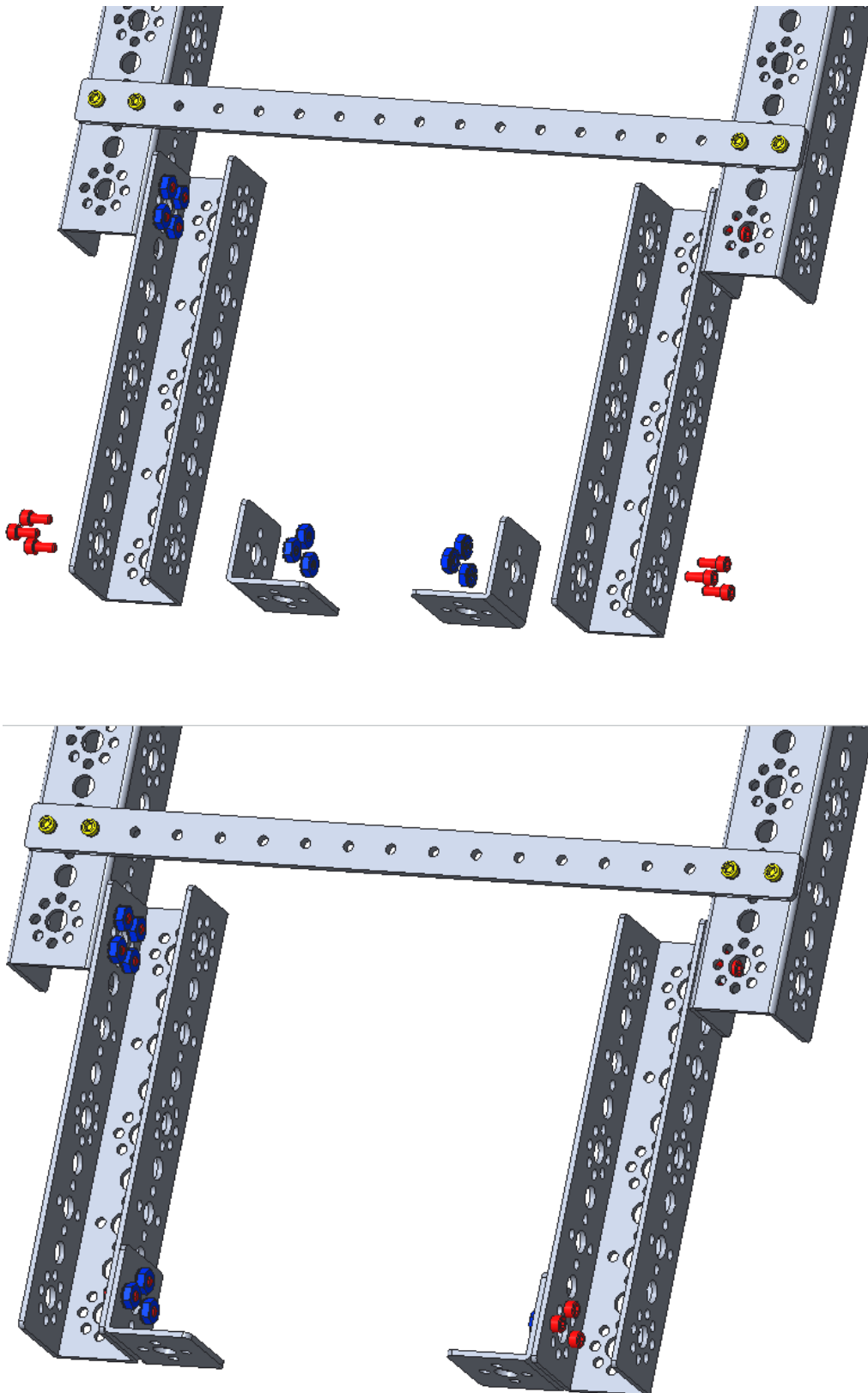


Step 4: Add Structural Support Brackets

39281 - inside corner bracket (2)

39098 - 5/16" socket head cap screws (6)

39094 - keps nuts (6)

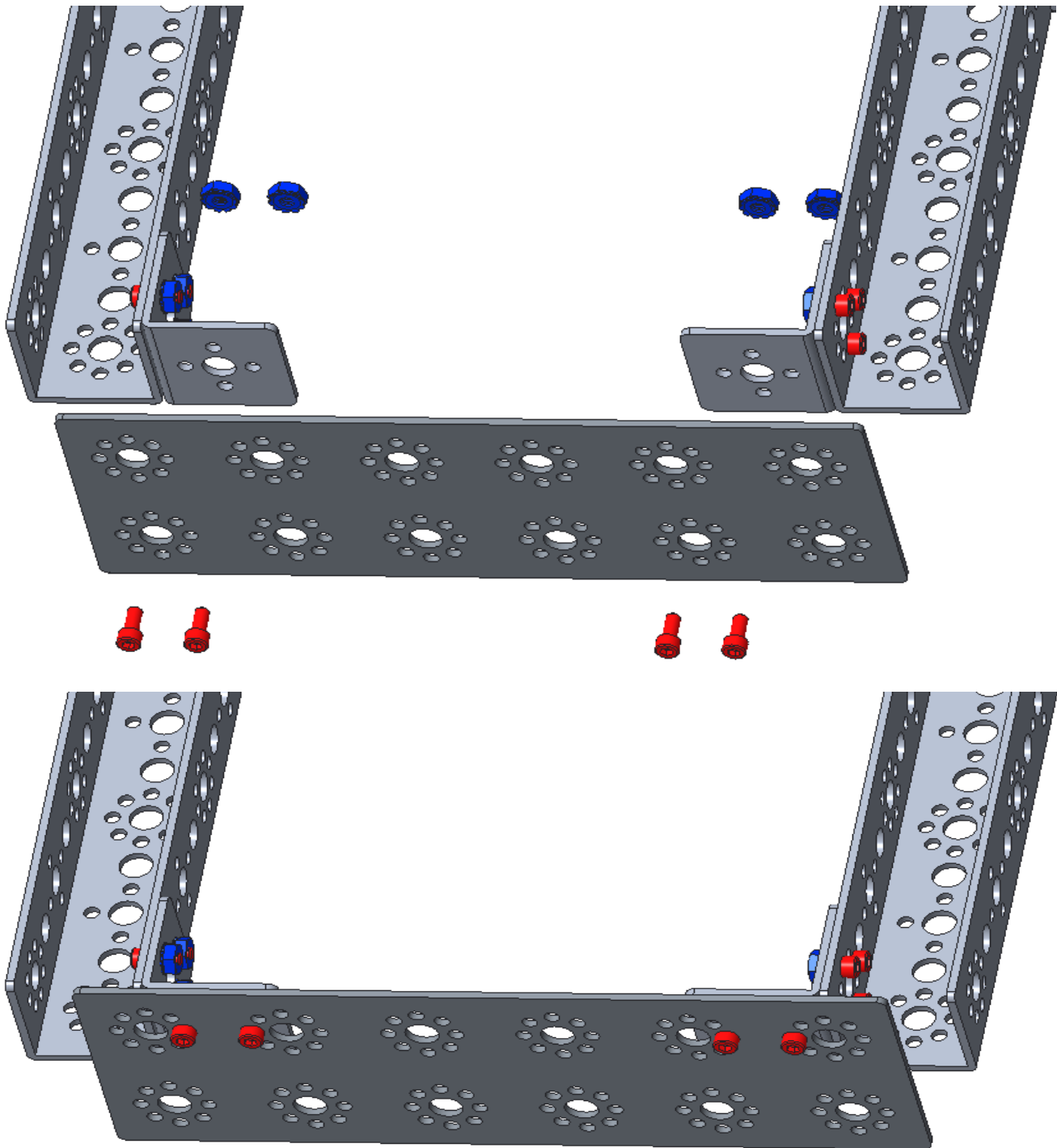


Step 5: Add the Structural Support Plate

39073 - flat building plate (1)

39098 - 5/16" socket head cap screws (4)

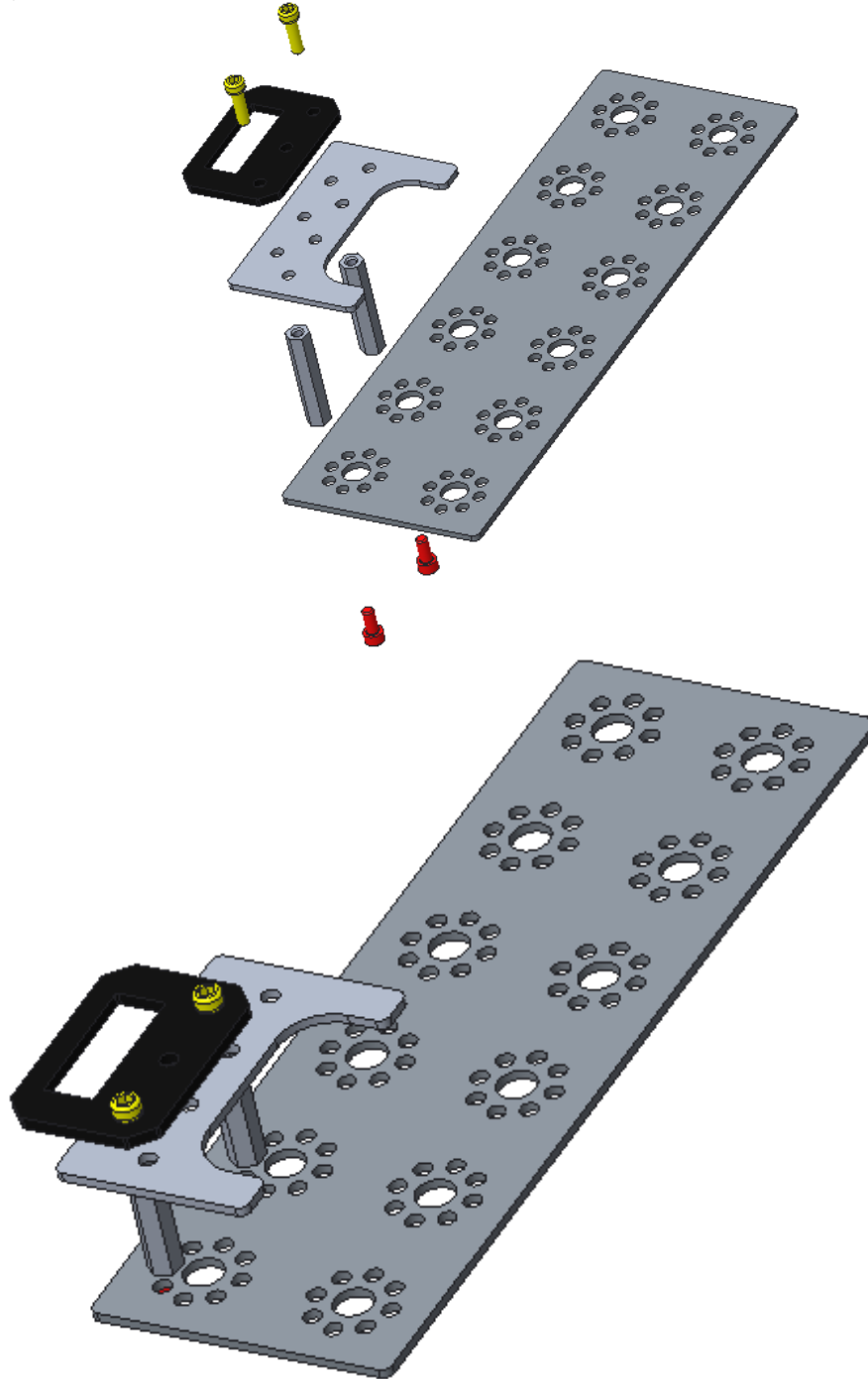
39094 - keps nuts (4)



Make sure that the frame is square. Do this by looking at the robot from above. Make sure the left and right rails are parallel and the cross braces form right angles with them. Once the frame is square, make sure that all the frame's bolts are tight. It is hard to drive a crooked robot straight!

Step 6: Build Left Electronics Plate

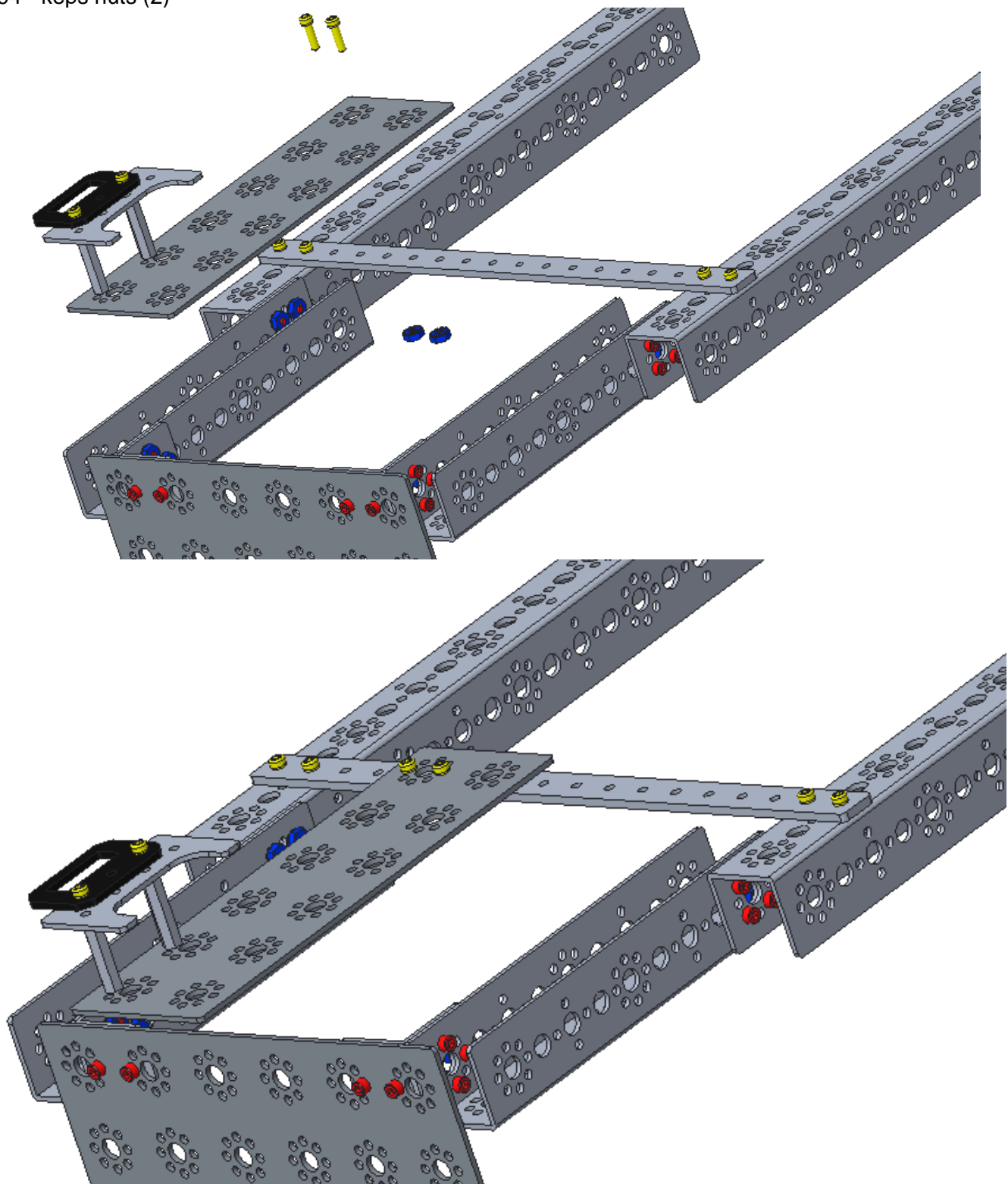
- 39073 - flat building plate (1)
- 39107 - 32 mm stand-off post (2)
- 39098 - 5/16" socket head cap screws (2) (red)
- 39097 - 1/2" socket head cap screws (2) (yellow)
- 38009 - battery clip (1) [inside the electronics kit] (half of the package)



Step 7: Attach Left Electronics Plate to Frame

39097 - 1/2" socket head cap screws (2)

39094 - keps nuts (2)



The plate does NOT attach to the frame at the clip/Structural Support Plate.

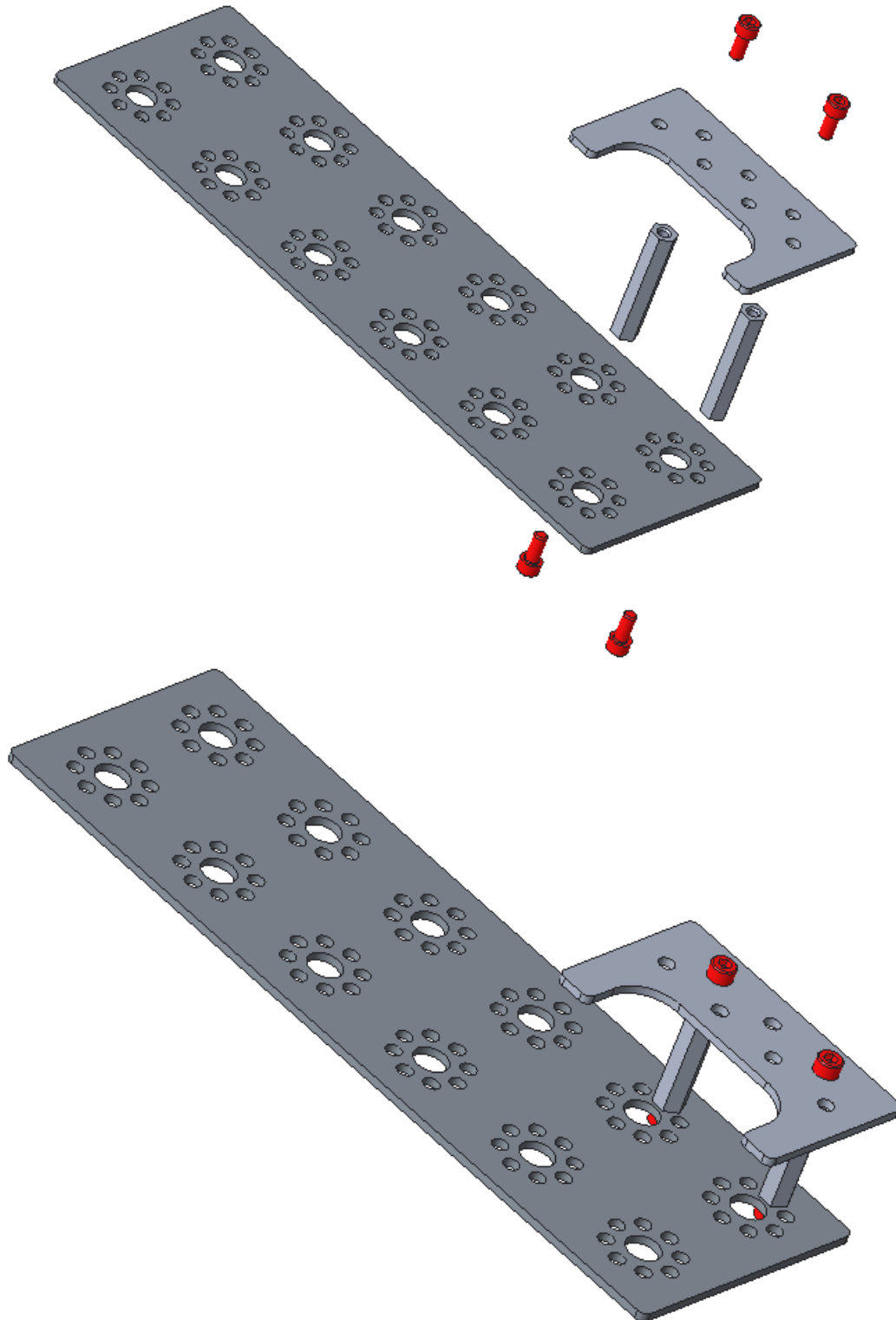
Step 8: Build Right Electronics Plate

39073 - flat building plate (1)

39107 - 32 mm stand-off post (2)

39098 - 5/16" socket head cap screws (4)

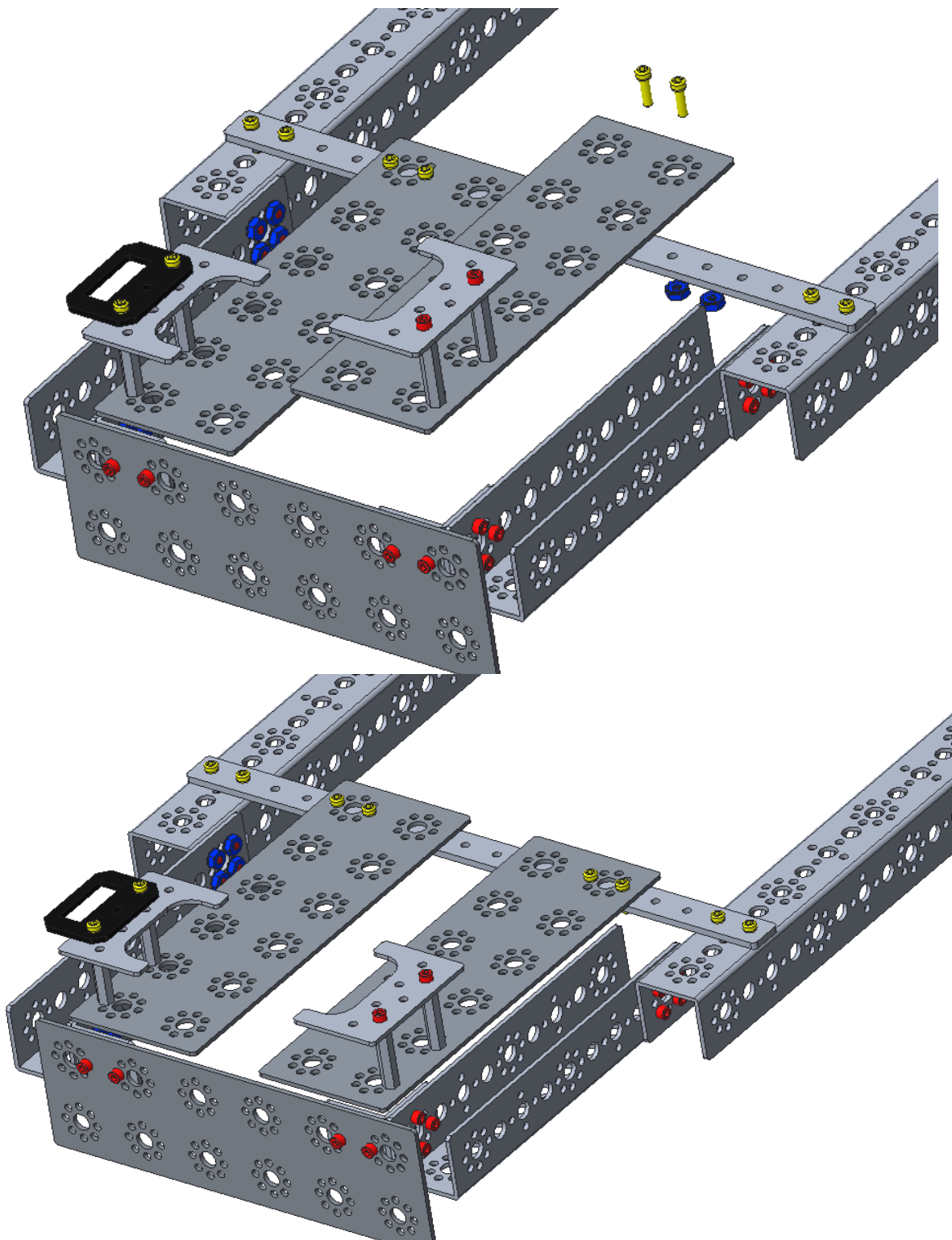
38009 - battery clip (1) [inside the electronics kit] (half of the package)



Step 9: Attach Right Electronics Plate to Frame

39097 - 1/2" socket head cap screws (2)

39094 - keps nuts (2)

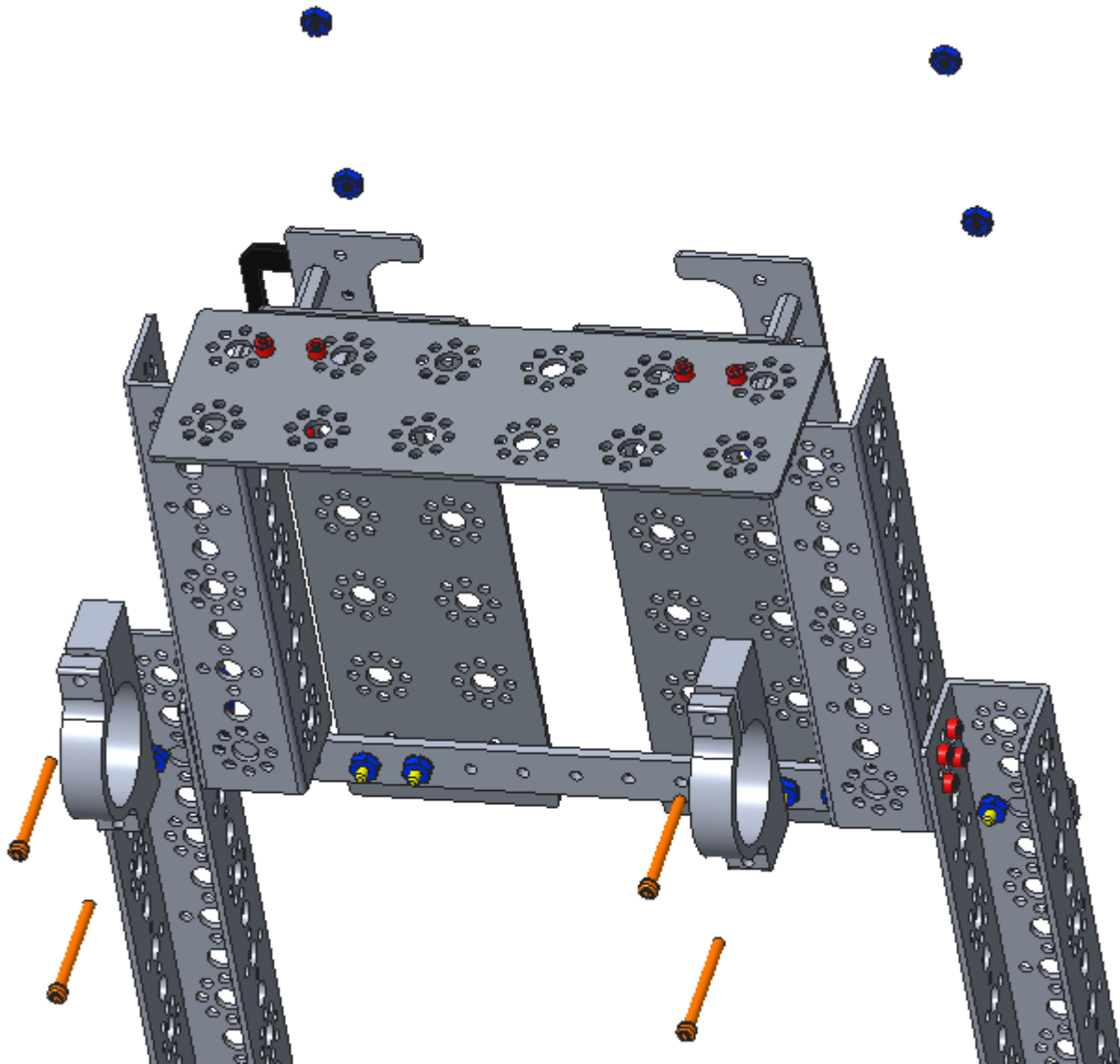


The plate does NOT attach to the frame at the clip/Structural Support Plate.

Drive Motors and Drive Wheels

Step 1: Add Drive Wheel Motor Mounts

39089 - motor mounts (2) with included bolts (4) and included nuts (4)



Do not tighten the motor mount bolts that control the clamp (i.e. the gap on one side of the mount) until the motors have been inserted (next step). When this bolt is tightened, the motors can't be inserted into the mount.

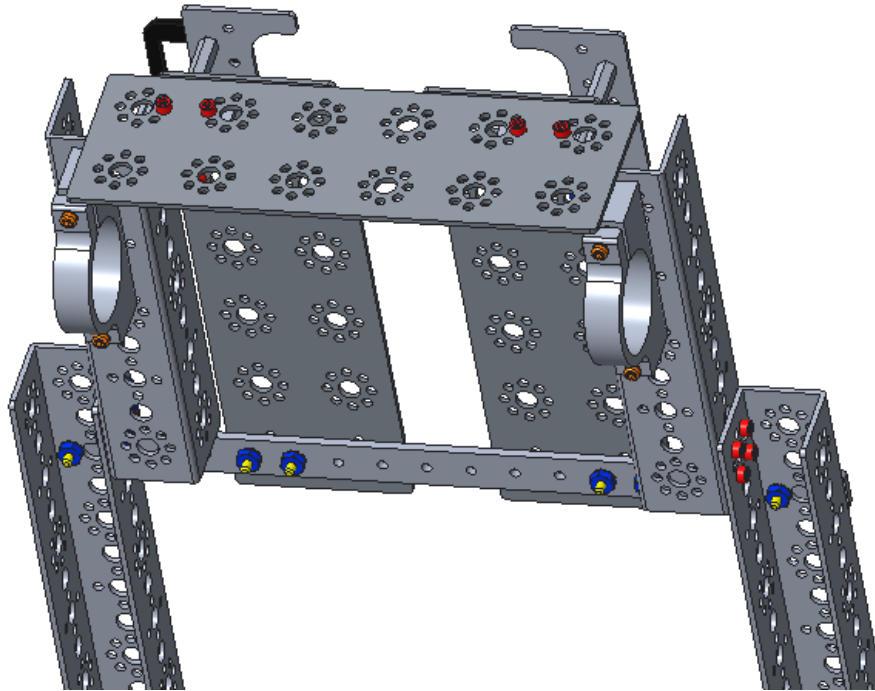


Figure 3 view from the bottom of the robot

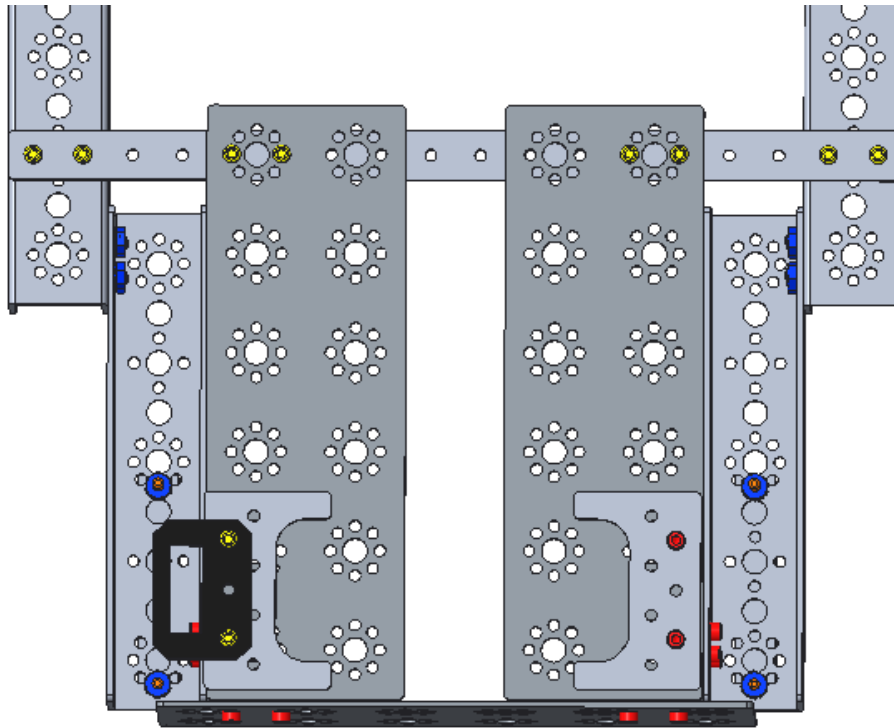
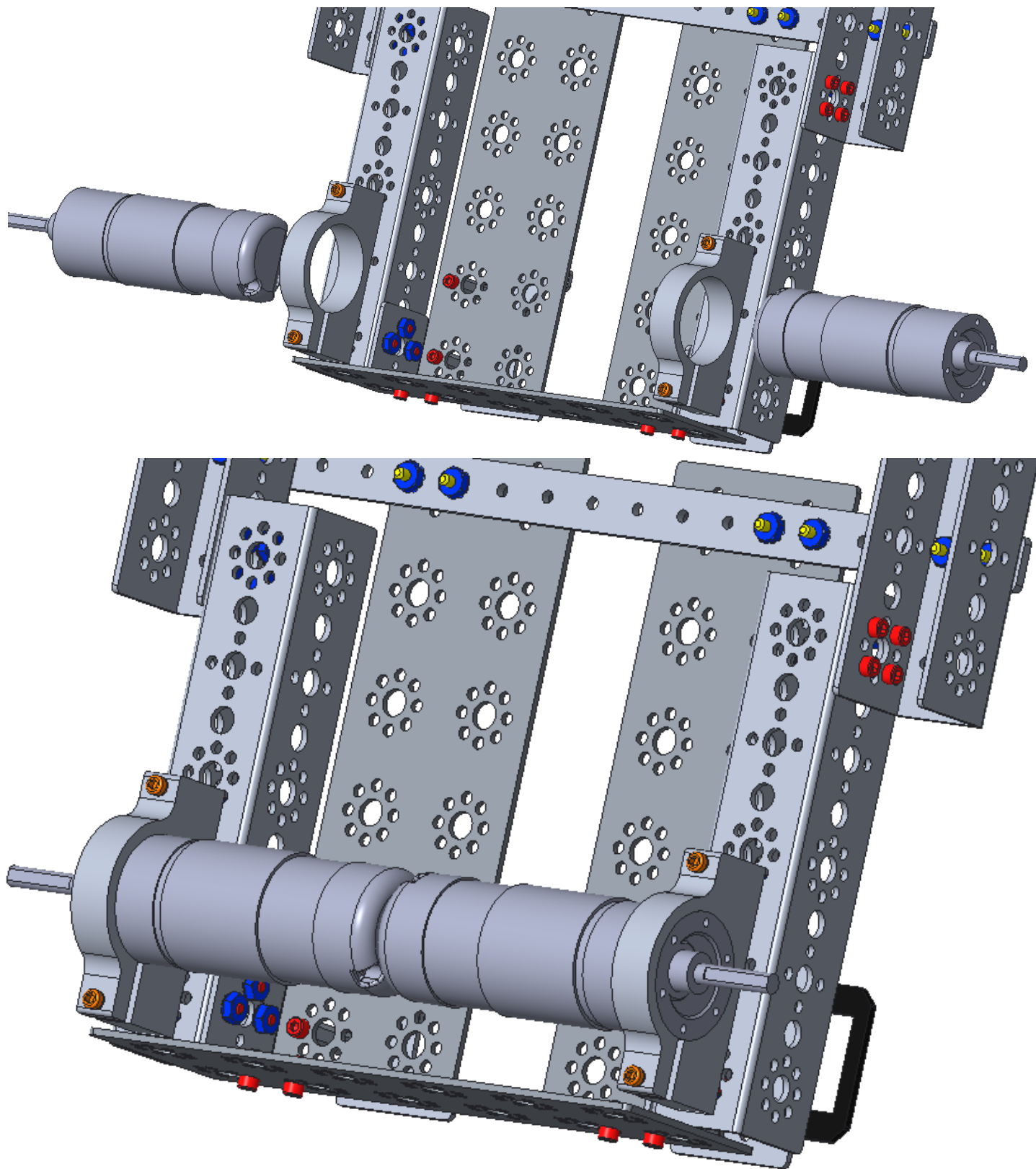


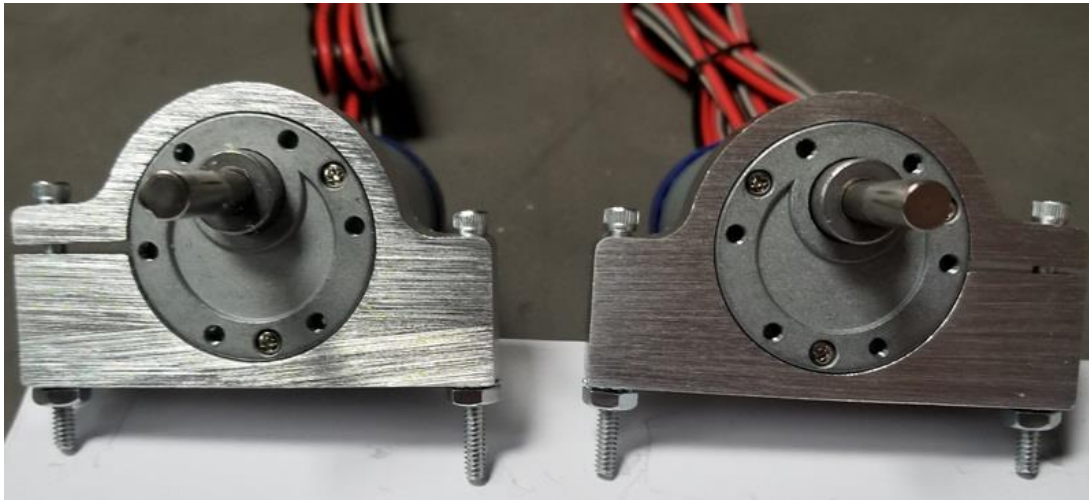
Figure 4 view from the top of the robot

Step 2: Add Drive Motors

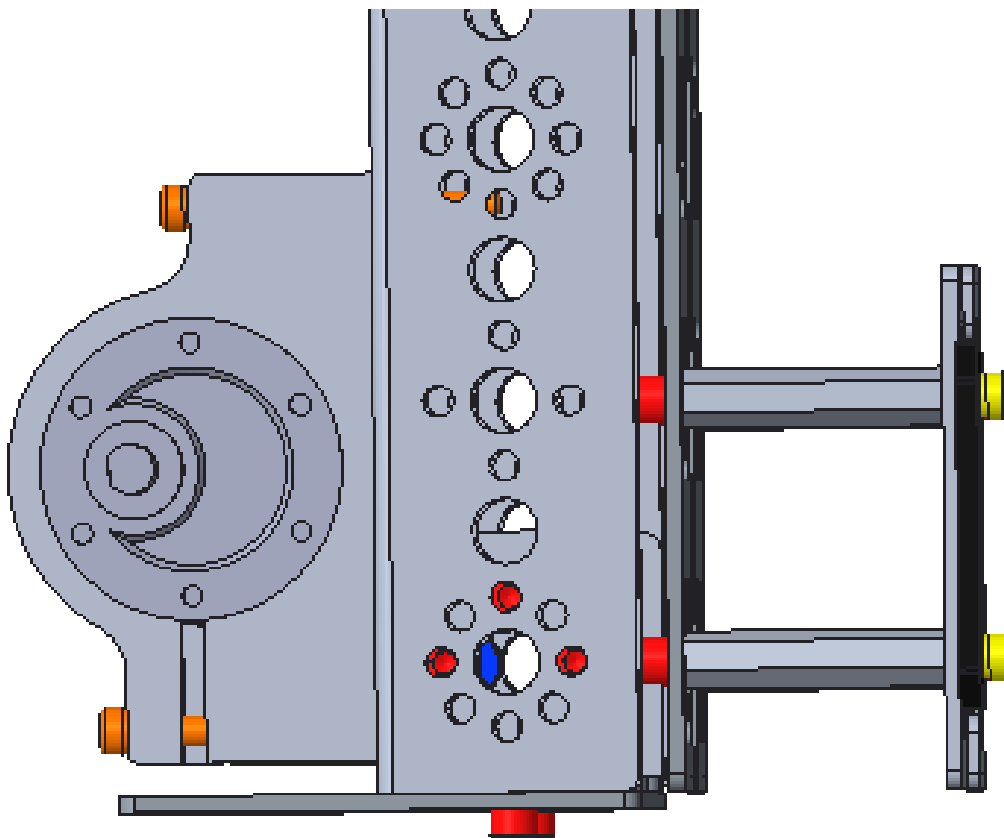
44260 - TorqueNADO Motor (2) with included wire wraps (2)



Step 3: Secure Drive Motors

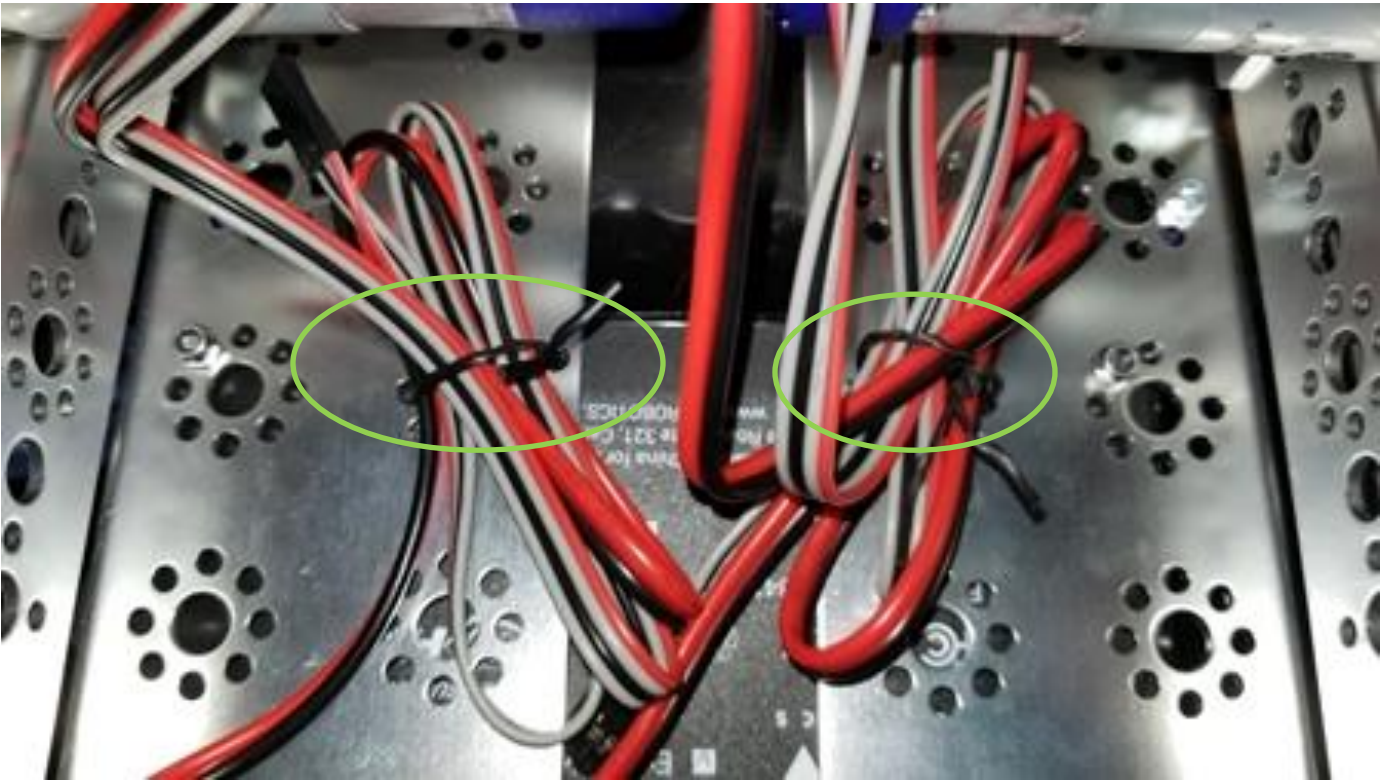


Tighten the motor mount bolt, so the motor will not rotate



Mount the motor, so that the axle is far away from the frame and so that the hole aligns with the slot (as shown above). The left rail's motor is on the left. The right rail's motor is on the right.

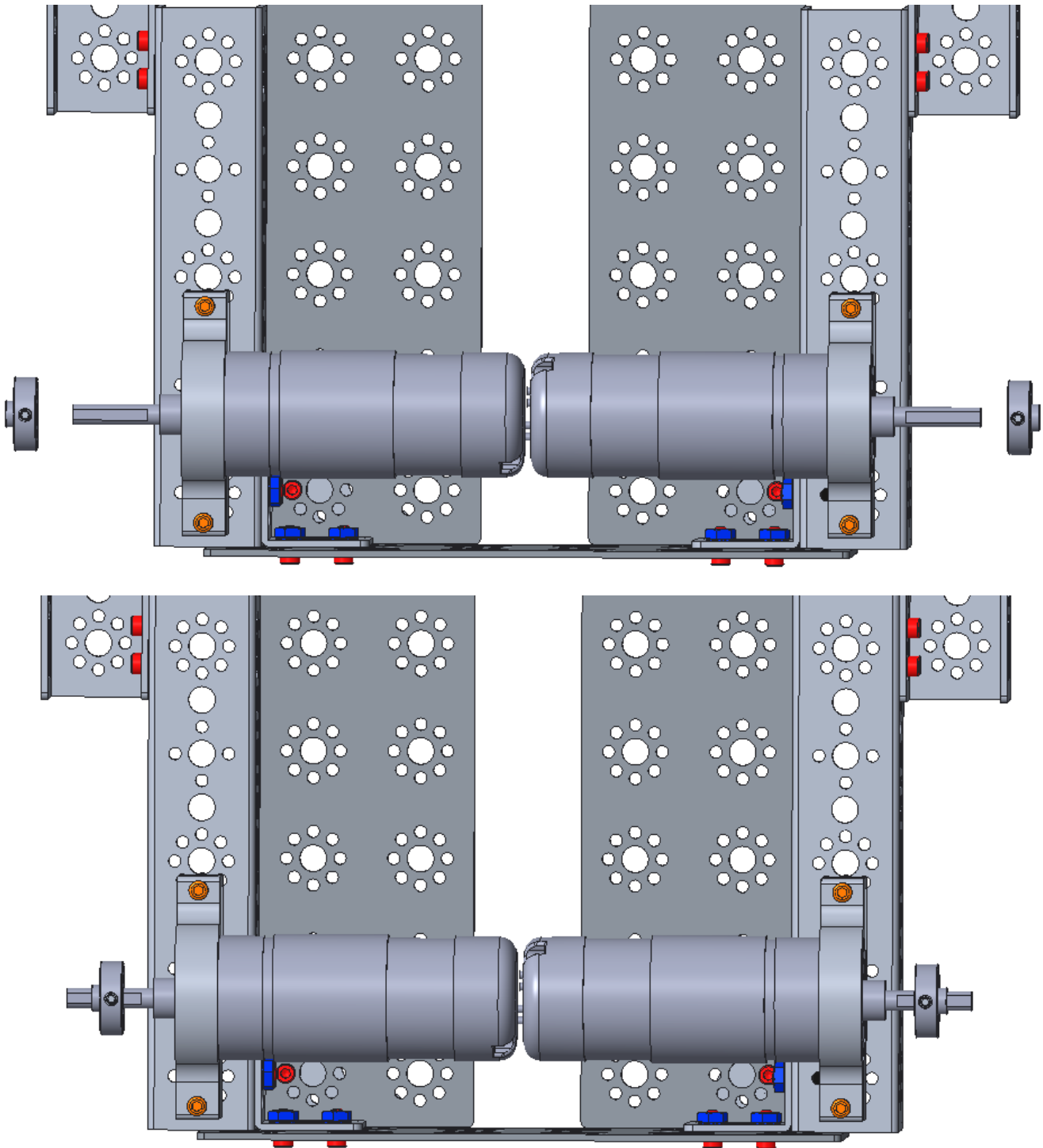
Step 4: Secure Drive Motor Wires



Use the plastic covered wire that holds the loops of motor wire together to secure the wires to the Electronics Plating

Step 5: Add Motor Hubs

39079 - motor shaft hubs (2) with included set screws (2)



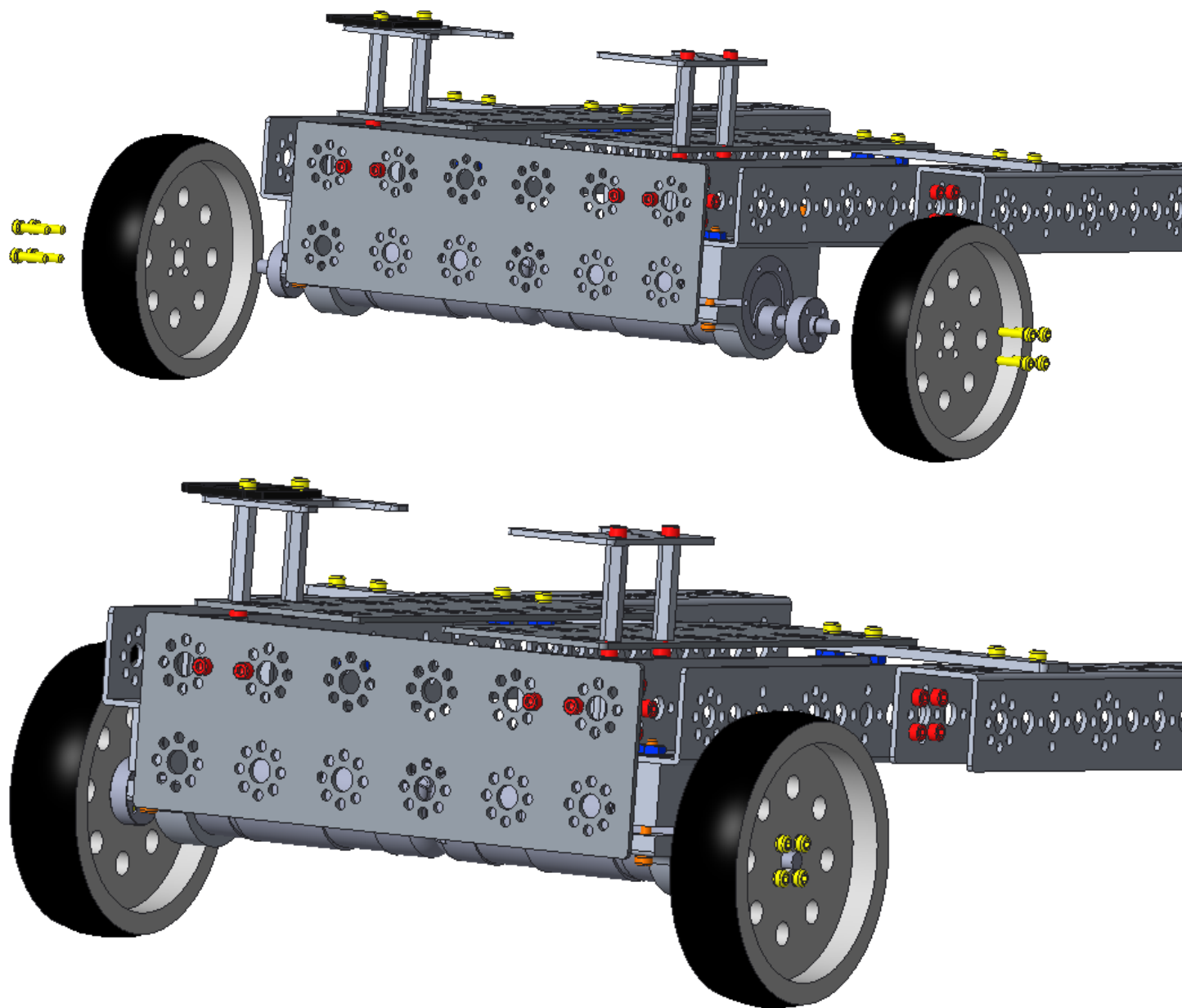
Install the hubs 10 mm from the outside end (the end furthest from the motor) of the axle.

Install motor hub set screws, so that the screws are on the flat side of the motor's axle, which will prevent the hubs from spinning on the axles.

Step 6: Add Drive Wheels

39055 - 4 inch wheels (2)

39097 - 1/2" socket head cap screws (8)



Caster Wheels

Step 1: Build the Omni Wheel Assembly

36466 - 4" omni wheel halves (2); with included joining ring (1) and included screws (4)

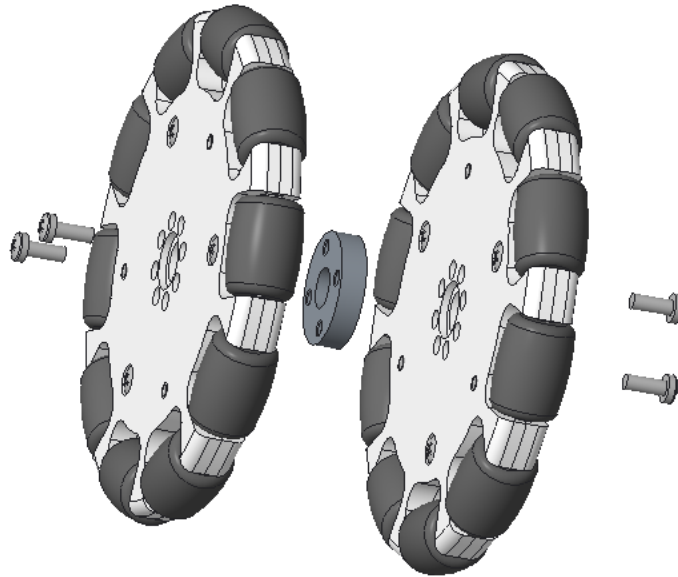
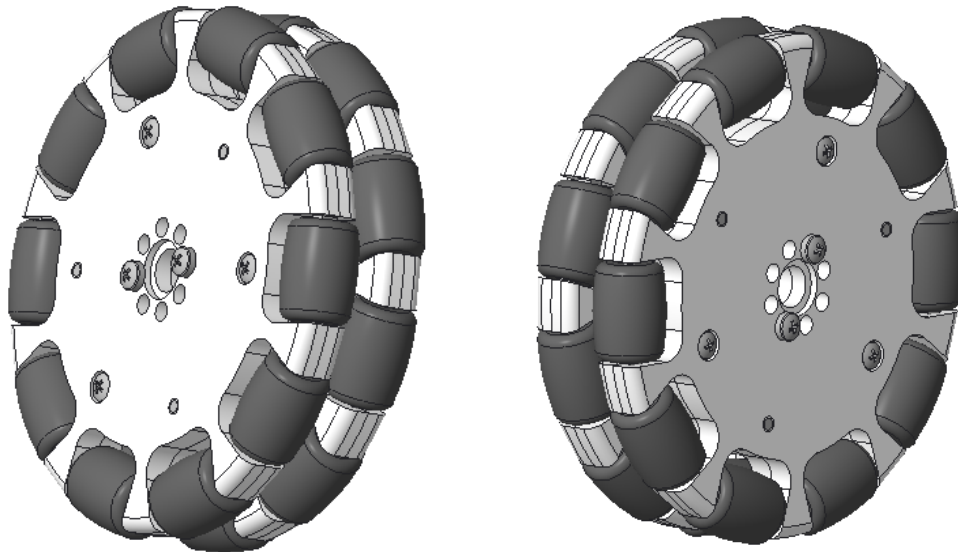


Figure 5 The above image shows only one wheel assembly. Perform this step on both assemblies



Assemble according to the instructions that come in the omni wheel pack, noting that screws on one wheel are in opposite holes from the screws on the other wheel.

Step 2: Add Bronze Bushings to the Omni Wheel Assemblies from the previous step
39091 - 11 mm bronze bushings (4)

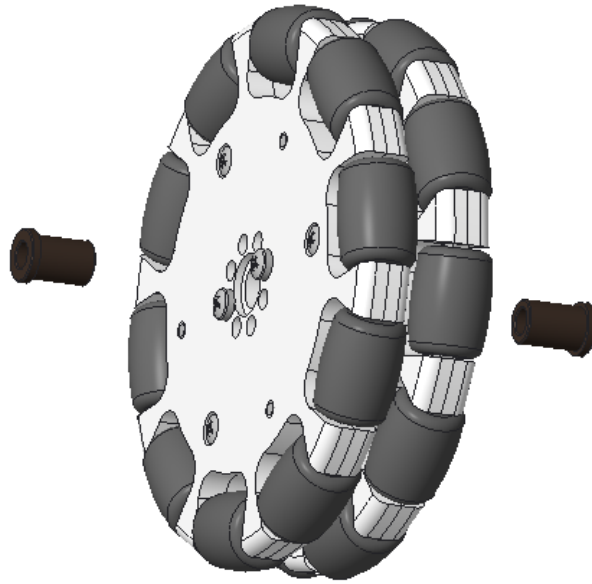
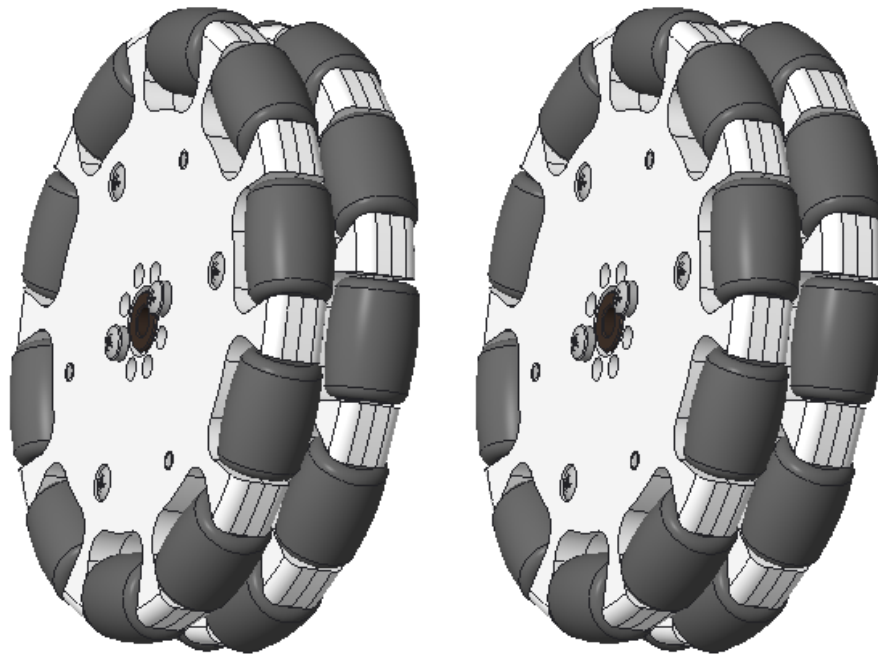


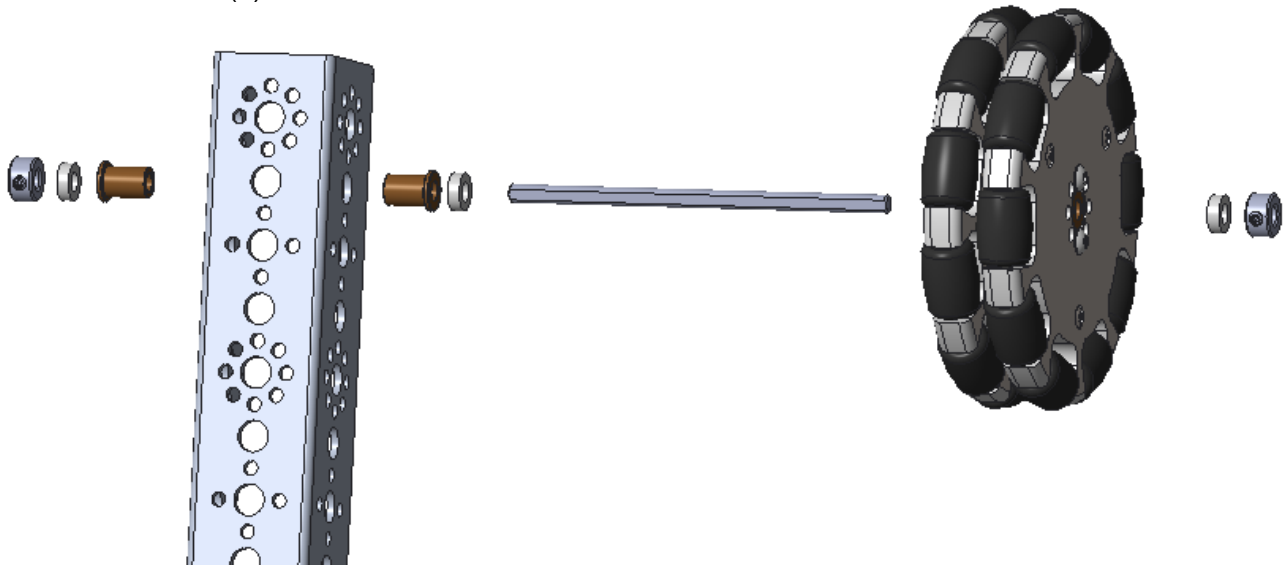
Figure 6 The above image shows only one wheel assembly. Perform this step on both assemblies.



Sometimes the bronze bushings are hard to insert. To make this easier, secure an axle collar onto an axle. Slide a bronze bushing down the axle. Slide the omni wheel down the axle and press it against the axle collar. A video showing a gear mounted to an axle is available that shows this trick, visit: <https://www.facebook.com/322705934572847/videos/506108019565970/>.

Step 3: Add the Omni Wheel Assemblies to the Frame chassis omni wheel assemblies (2)

- 39100 - 1/8" axle spacers (6)
- 39092 - axle set collars (4)
- 39091 - 11 mm bronze bushings (4)
- 39088 - 100 mm axles (2)



Order from the outside in: axle set collar, 1/8" axle spacer, omni wheel assembly, 1/8" axle spacer, 11 mm bronze bushing, channel, 11 mm bronze bushing, 3/8" spacer, axle set collar

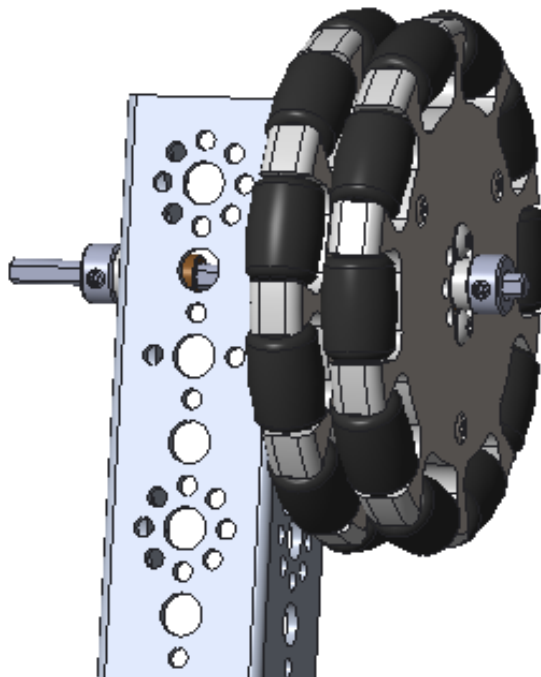


Figure 7 above shows only the left wheel. The right wheel is a mirror image.

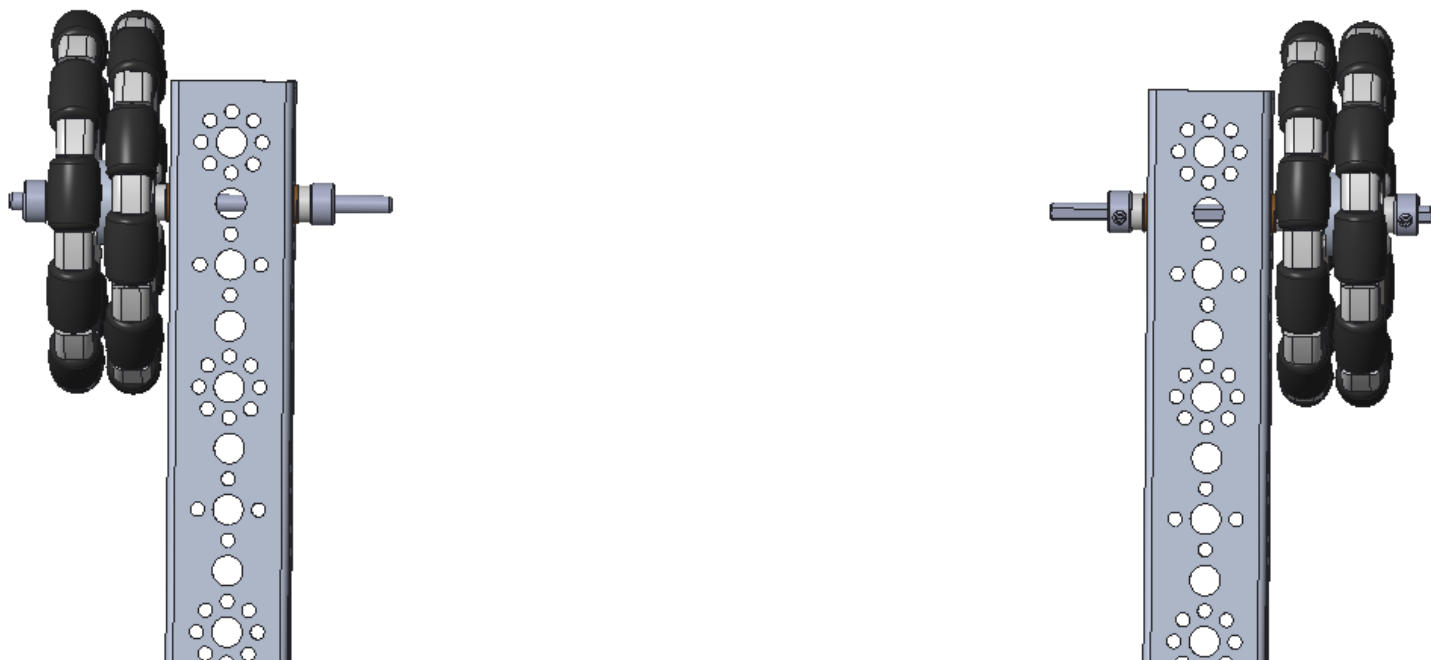


Figure 8 The image above shows both wheels

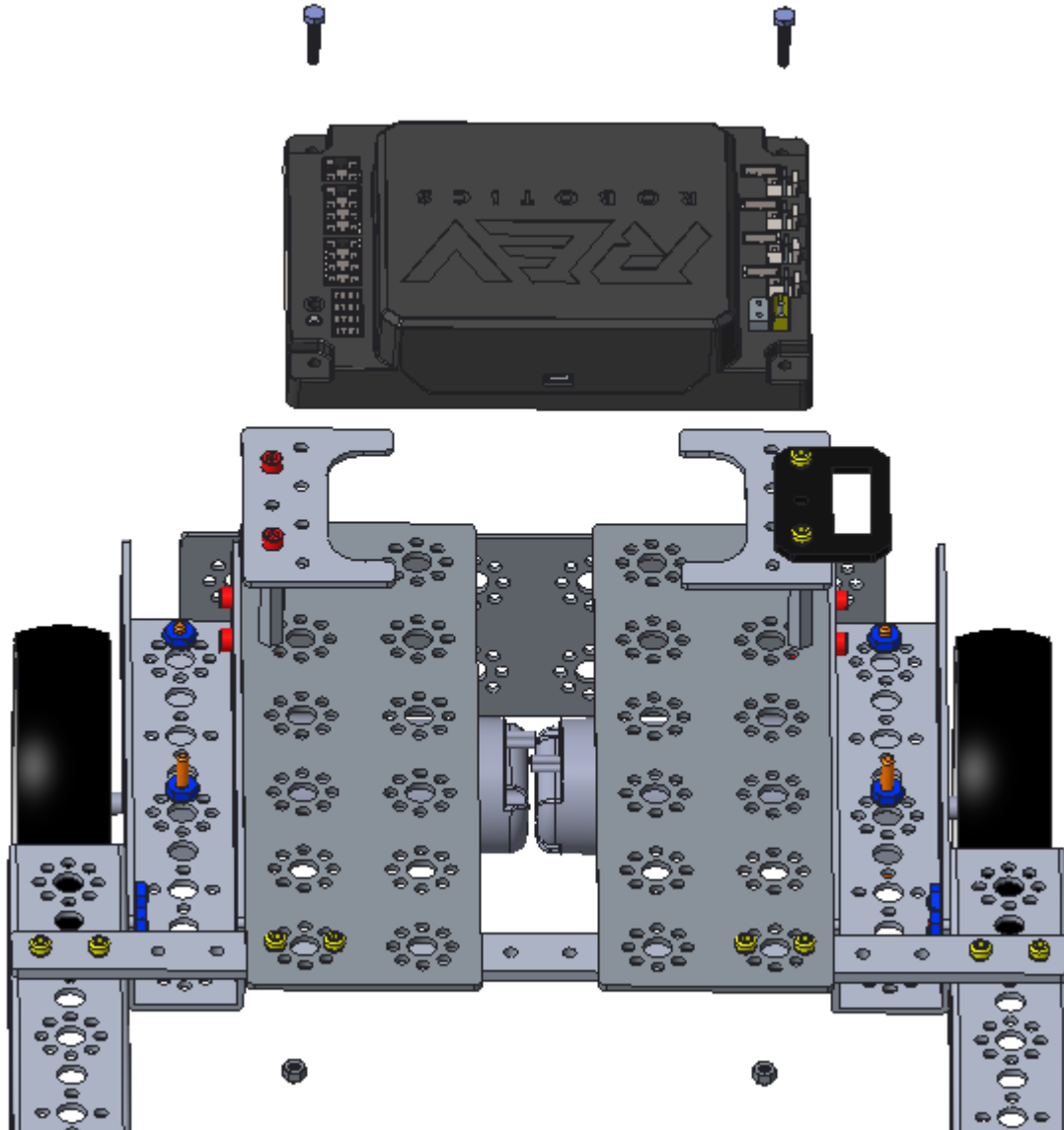
Motor and Sensor Controller

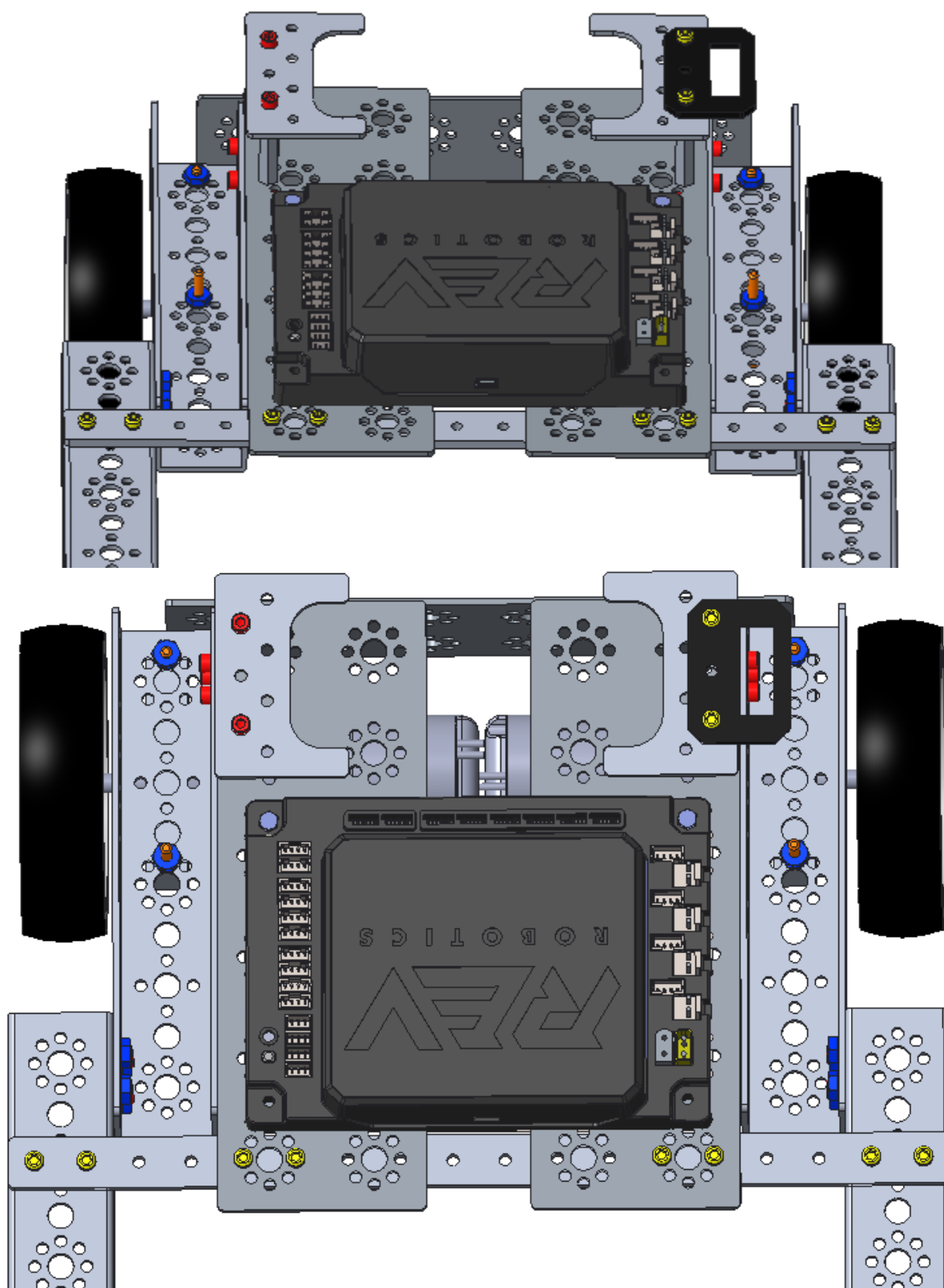
Step 1: Add the Rev Robotics Expansion Hub

REV-31-1153 expansion hub (1)

REV-41-1360 screws (2)

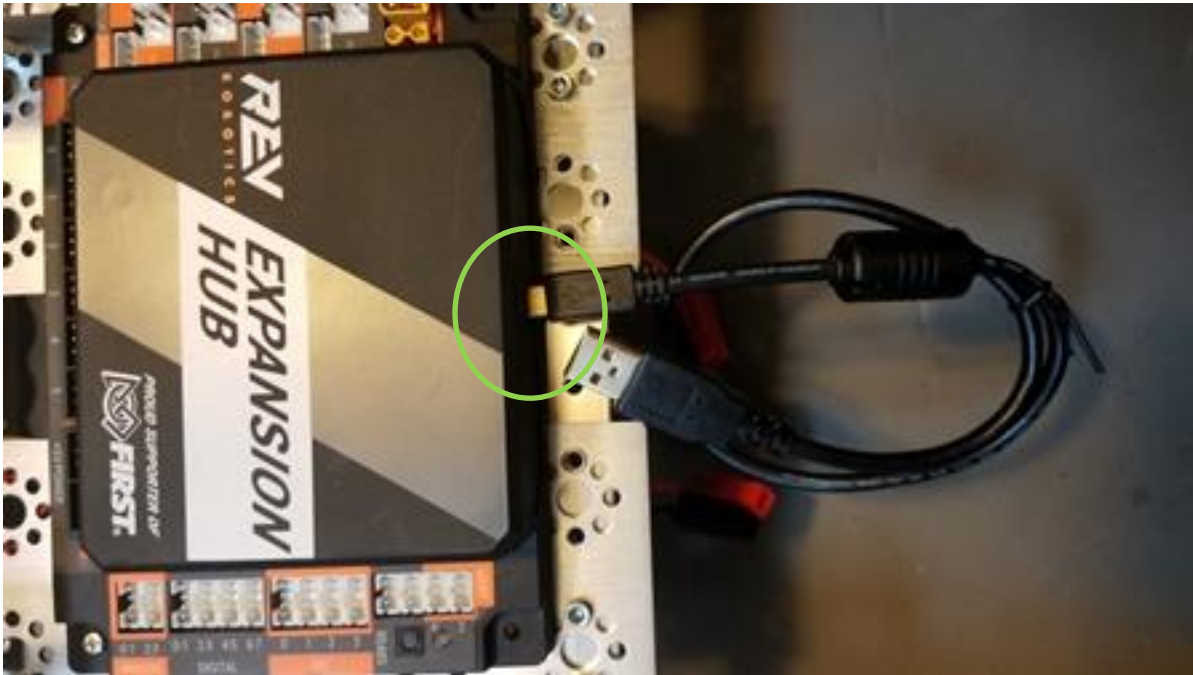
REV-41-1361 M3 Nyloc Nuts (2)





Step 2: Add the Expansion Hub to Phone Cable

5446 - Monoprice USB Cable (1)



Plug the Mini USB plug into the Expansion Hub

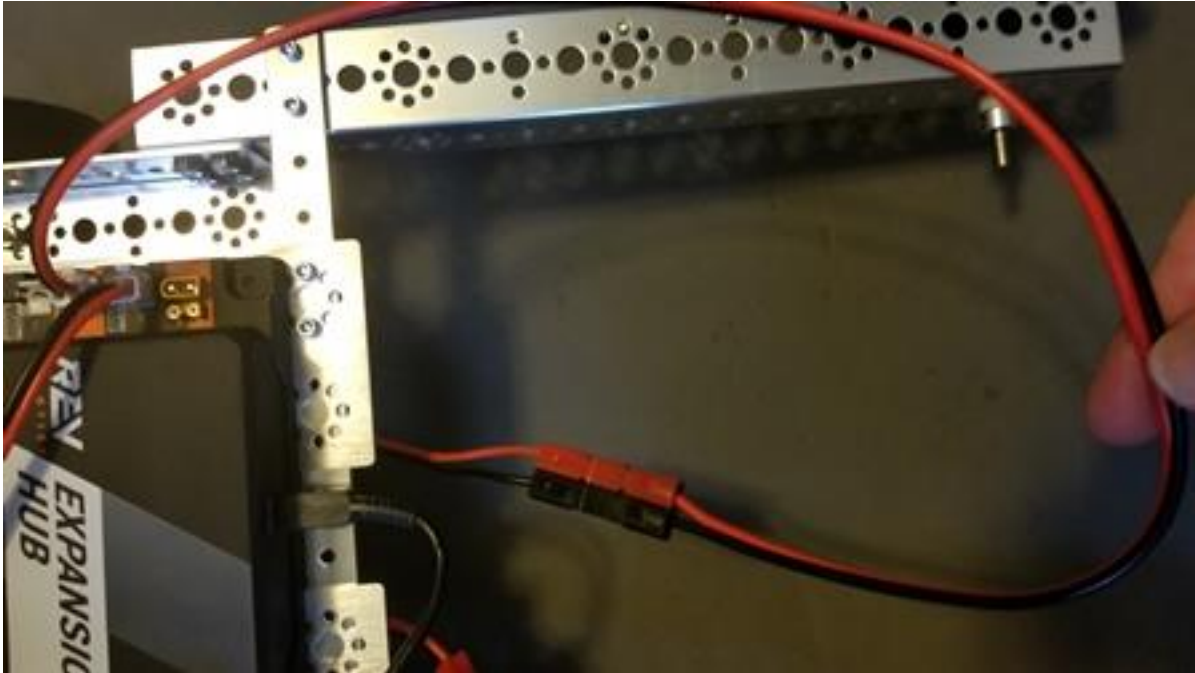
Step 3: Add the Left Drive Motor Power Cable

REV-31-1381 JST to Anderson Power Pole Cable (1)



Step 4: Add the Right Drive Motor Power Cable

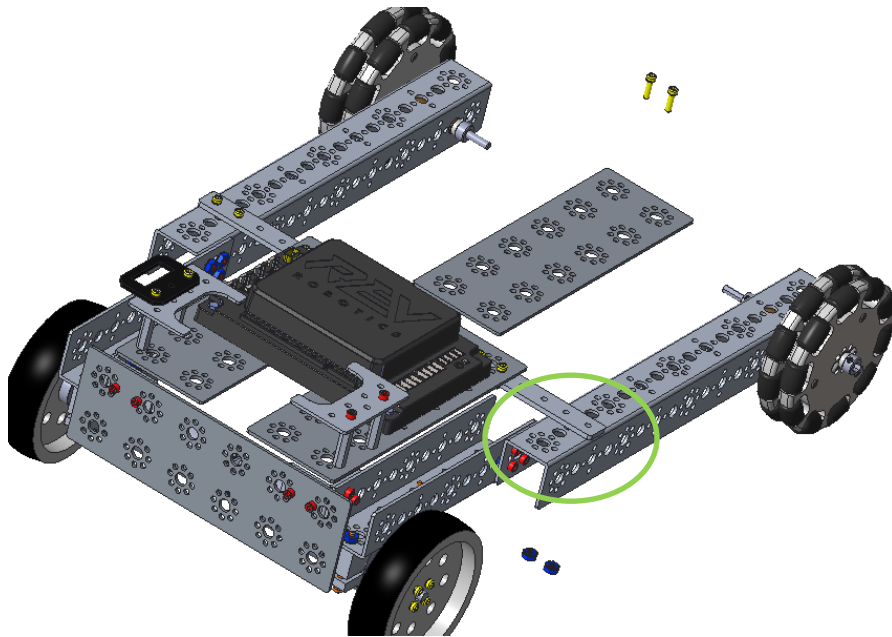
REV-31-1381 JST to Anderson Power Pole Cable (1)



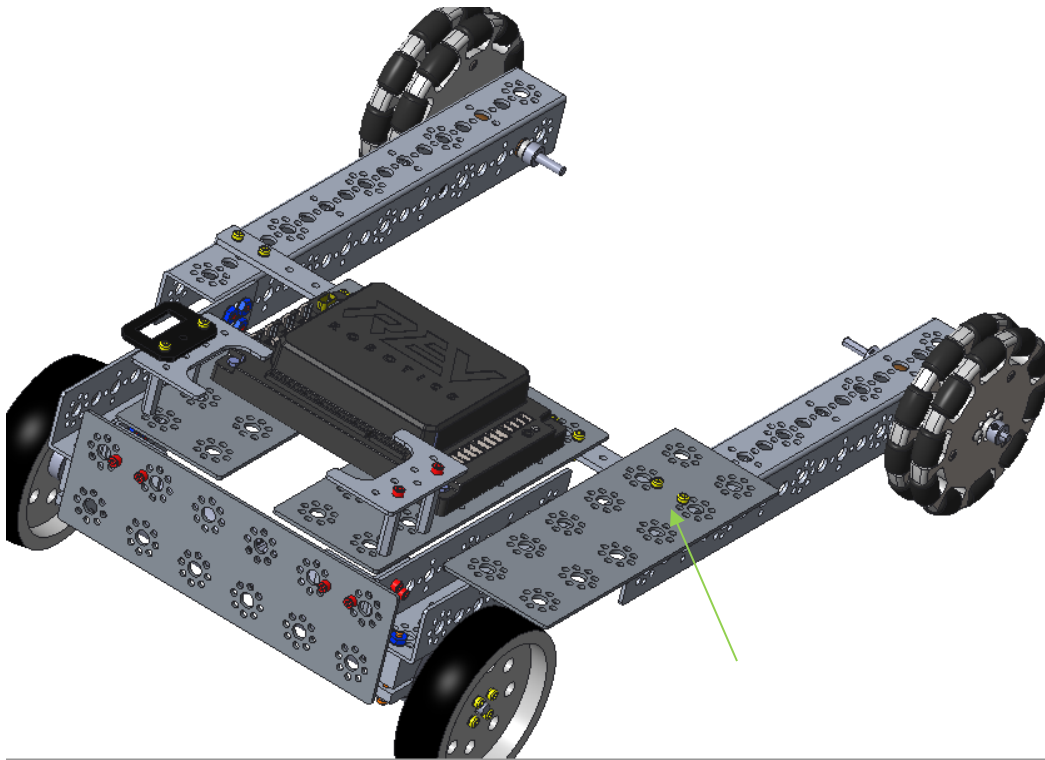
Robot Controller

Step 1: Add the Phone Support Plate

39073 - flat building plate (1)



Remove the two screws that are already on the right rail, add the plate and then reattach the screws



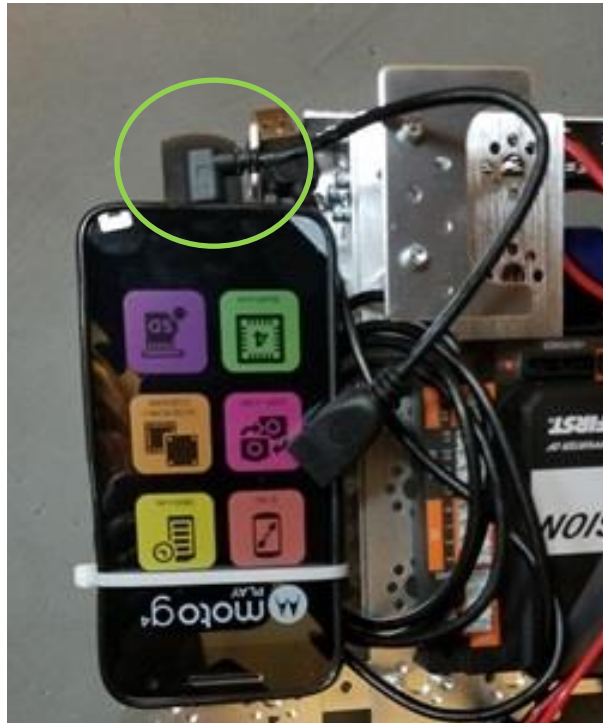
Step 2: Add the Robot Controller Cell Phone to the Holder

31902 - zip tie (1) Cell phone configured as the robot controller



It is recommended that an approved material such as non-skid be layered between the phone and the plate to prevent damage to the phone. The foam that comes in the phone's packaging works well for this.

Step 3: Connect the Robot Controller to the Expansion Hub (Part 1) USB On the Go Adapter Cable (1)



Plug the Micro USB plug into the bottom of the cell phone.

Step 4: Connect the Robot Controller to the Expansion Hub (Part 2)

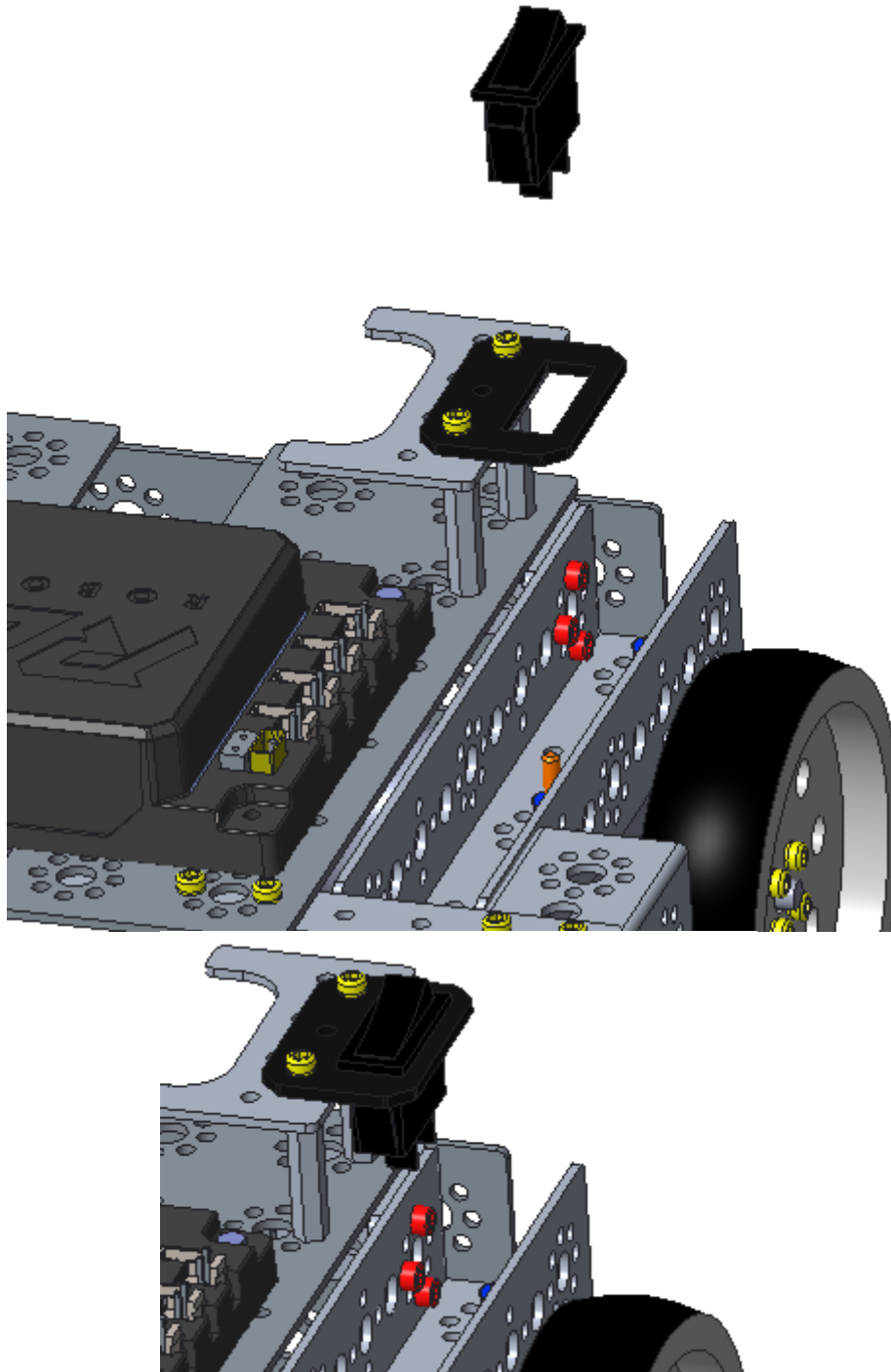


Plug the USB-A plug (from the phone) into the USB-A plug (to the Expansion Hub).

Power Switch

Step 1: Adding the Switch

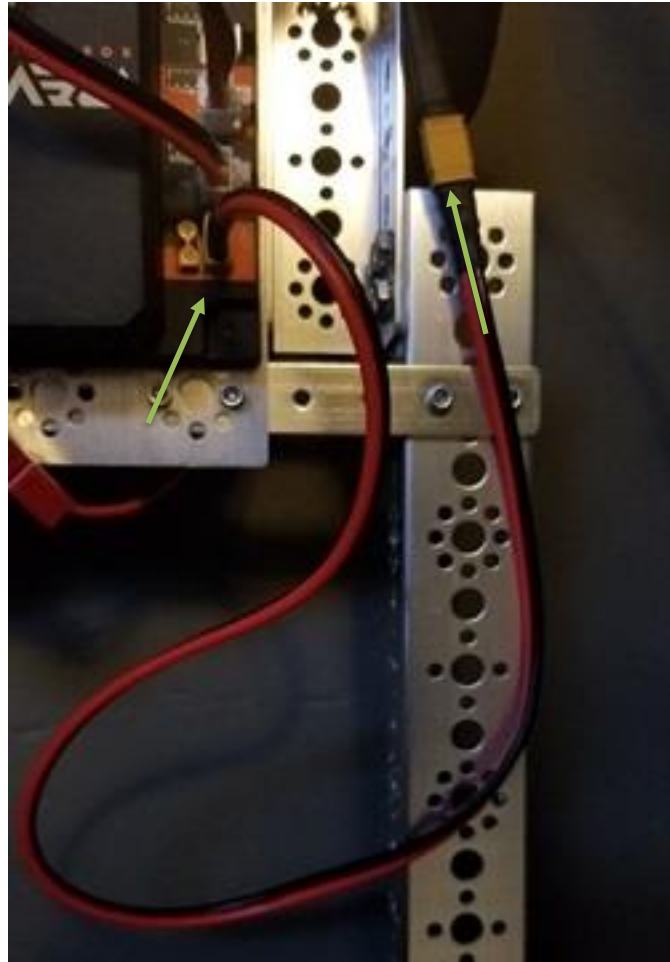
REV-31-1387 Switch



The wires attached to the switch are not shown in this step.

Step 2: Connect the Switch to the Motor and Sensor Controller

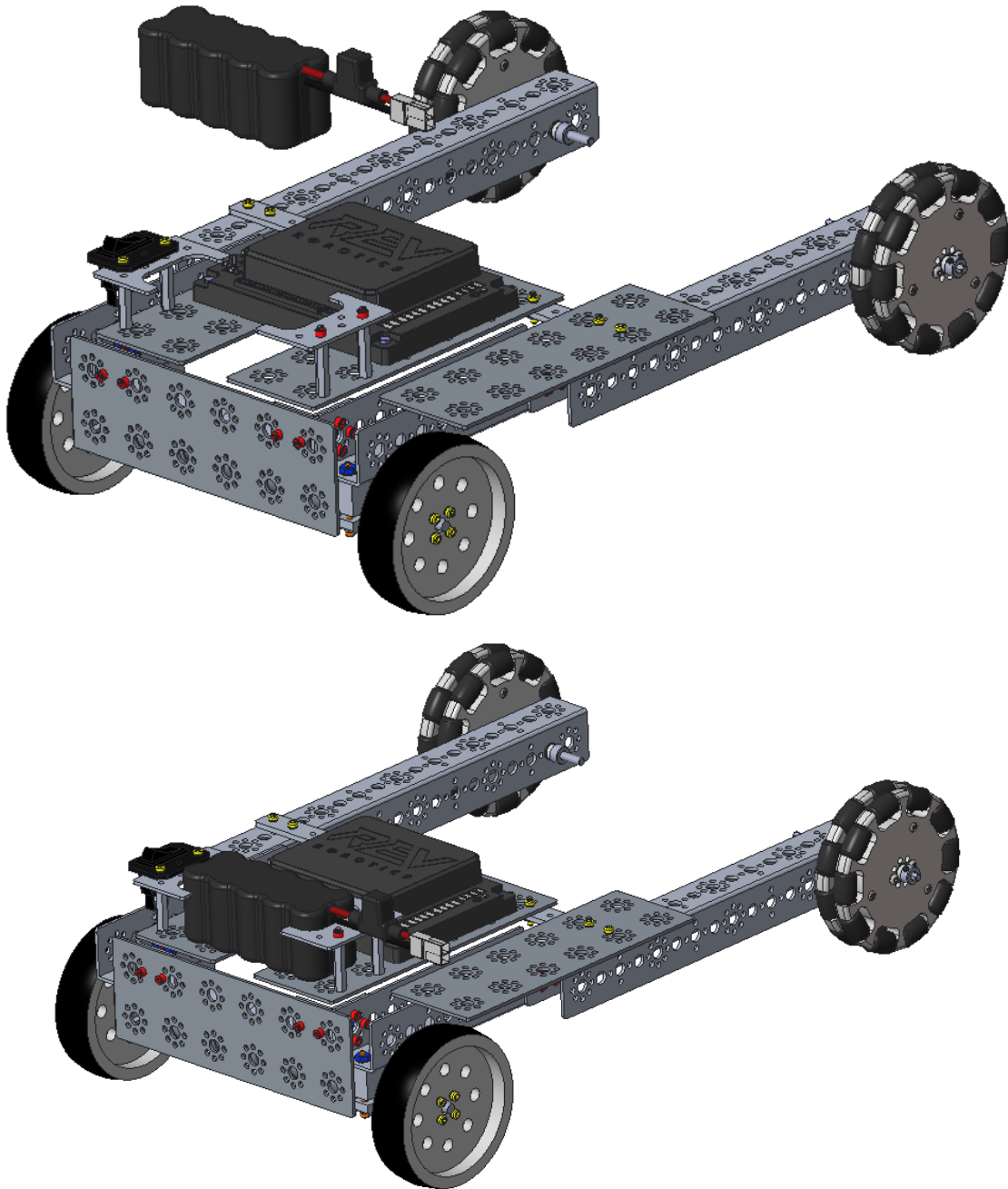
XT30 Extension Cable



Battery

Step 1: Adding the Battery

39057 - battery



Step 2: Connect the Battery to the Switch



It is recommended that the battery be secured in the holder using a zip tie or some other mechanism to prevent it from being separated from the robot during competition.

Additional Supplies

- Zip ties should be purchased for securing wires to the chassis. The standard four-inch size works well for this
- Electrical tape can be used to secure motor wires to the motor.
- Longer zip ties or Velcro straps can be used to keep the battery from falling out of the robot in case it tips over.

Final Steps

The frame has been built, however programming will be needed to make the robot functional. Testing should be done to determine whether anything needs to be changed or optimized for the season's game rules. It will also show whether more cables need to be secured or re-routed. Numbers and other stickers will be needed to make the robot competition ready.

Check the game rules for all the applicable stickers- [The Game Manual Part 1](#) includes a robot inspection checklist. Though it is no longer a rule, it is suggested that you use the self-inspection checklist before a competition to be sure that you are prepared on the day of competition and don't have any disallowed parts on the robot.

Visit the FIRST website for programming instructions and game rules.

The frame alone can be used in a competition. However, the robot can be even better with armature. Watch for the release (later in the season) of the Push 'Bot Armature Guide by visiting our website (www.ssirobotics.lydean-david.net/) or Facebook page (www.facebook.com/ssirobotics/).

Special Thanks and Best Wishes

FIRST® Tech Challenge would like to sincerely thank the creators of this document **Dave and Lydean Spangler**. The Spangler's have worked tirelessly over many years and seasons to create, update and improve this document to give teams a "how to" guide for building the robot chassis of the robot to build upon and improve. We are forever grateful for their help and support in this endeavor.

Please direct any questions or comments about this guide to: firsttechchallenge@firstinspires.org and put "Questions about the Robot Chassis Build Guide for TETRIX" in the subject line and we will redirect the emails to the appropriate responders.

Appendix A – Resources

Game Forum Q&A

<http://ftcforum.usfirst.org/forum.php>

Anyone may view questions and answers within the FIRST® Tech Challenge Game Q&A forum without a password. To submit a new question, you must have a unique Q&A System User Name and Password for your team.

Volunteers that apply for a specific volunteer role will receive an email from FTCTrainingSupport@firstinspires.org with their username and password to the forum. You will receive access to the forum thread specific to your role.

FIRST Tech Challenge Game Manuals

Part 1 and 2 - <https://www.firstinspires.org/resource-library/ftc/game-and-season-info>

FIRST Headquarters Pre-Event Support

Phone: 603-666-3906

Mon – Fri

8:30am – 5:00pm

Email: Firsttechchallenge@firstinspires.org

FIRST Tech Challenge Event On-Call Support

*These numbers are available for event personnel only. Please **do not** call these numbers if you are a team looking for a ruling, a decision, or assistance. We trust that you will not misuse this resource.*

Day of Event Robot Control System Support: 603-206-2450

All other Day of Event support: 603-206-2412

FIRST Websites

FIRST homepage – www.firstinspires.org

[FIRST Tech Challenge Page](#) – For everything FIRST Tech Challenge.

[FIRST Tech Challenge Volunteer Resources](#) – To access public Volunteer Manuals.

[FIRST Tech Challenge Event Schedule](#) – Find FIRST Tech Challenge events in your area.

FIRST Tech Challenge Social Media

[FIRST Tech Challenge Twitter Feed](#) - If you are on Twitter, follow the FIRST Tech Challenge Twitter feed for news updates.

[FIRST Tech Challenge Facebook page](#) - If you are on Facebook, follow the FIRST Tech Challenge page for news updates.

[FIRST Tech Challenge YouTube Channel](#) – Contains training videos, Game animations, news clips, and more.

[FIRST Tech Challenge Blog](#) – Weekly articles for the FIRST Tech Challenge community, including Outstanding Volunteer Recognition!

[FIRST Tech Challenge Team Email Blasts](#) – contain the most recent FIRST Tech Challenge news for Teams.

Feedback

We strive to create support materials that are the best they can be. If you have feedback about this manual, please email firsttechchallenge@firstinspires.org. Thank you!

Appendix B: Bill of Material (BoM) List

This list does not include the cell phones, the Rev Robotics Expansion Hub, nor the cables that connect the electronics.

Qty	Common Name	CAD Name
2	288 mm Channel	39068_TXM-288MMCHANNEL
2	160 mm Channel	39067_TXM-160MMCHANNEL
24	6-32 x 5/16" SHCS	39098_TXM_SHCS_6-32_0_3125
30	Kep Nut	39094_KEP_NUT
1	288 mm Flat Bar	39070_TXM-288MM_FLAT_BAR
18	6-32 x 1/2" SHCS	39097_SHCS_6-32_X_0_5
2	Inside Corner Bracket	39281_TXM-INSIDECORNERBRACKETS
4	Flat Building Plate	39073_TXM-FLATBUILDINGPLATES
4	6-32 x 32 mm Stand Off	39107_TXM-STAND-OFF-6-32X32MM
2	Battery Clip	38009_TXM-BATTERY-CLIP
1	Switch Plate	ACRYLIC_SWITCH_BRACKET (part of REV-31-1387)
2	Motor Mount	39089_TXM-MOTORMOUNT
4	6-32 x 1 1/2" SHCS	39195_TXM-SHCS_6-32_X_1_5 (part of 39089_TXM-MOTORMOUNT)
2	TorqueNADO Motor	44260_TXM_TORQUENADO_DC_MOTOR
2	Motor Hub	39079_TXM-MOTOR-SHAFT-HUB
2	4" Wheel	39055_TXM-4_INCH_WHEEL
4	Bronze Bushing	39091_TXM-BRONZE_BUSHING
6	1/8" Axle Spacer	39100_TXM-AXLESPACERS_0_125
4	Axle Set Collar	39092_TXM-AXLESETCOLLARS

2	100 mm Axle	39088_TXM-STEEL_AXLE_100MM
2	4" Omni Wheel Pack	36466_TXM-4_INCH_DUAL_OMNI_WHEEL
1	Expansion Hub	REV-31-1153
2	M3 Screw for Expansion Hub	REV-M3X16M (Part No. REV-41-1360)
2	M3 Nyloc Nut	M3_LOCKNUT (Part No. REV-41-1361)
1	Switch	SWITCH (part of REV-31-1387)
1	Battery	39057_TXM-12V_3000MAH_BATTERY