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2023-2024 *FIRST*® Tech Challenge

Basic ‘Bot Guide for REV-Part 1

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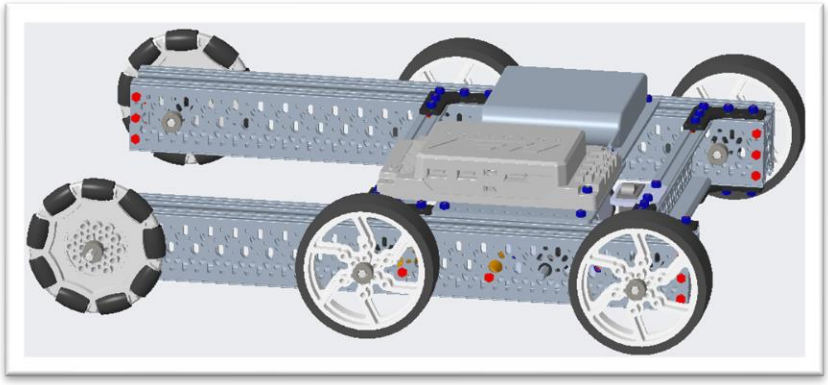
Revision History		
Revision	**Date**	**Description**
1	6/28/2023	Initial Release

Contents



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. Participants and alumni of *FIRST* programs gain access to education and career discovery opportunities, connections to exclusive scholarships and employers, and a place in the *FIRST* community for life. To learn more about *FIRST*® Tech Challenge and other *FIRST*® Programs, visit www.firstinspires.org.

Gracious Professionalism®

FIRST® uses this term to describe our programs' intent.

Gracious Professionalism® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

Watch Dr. Woodie Flowers explain *Gracious Professionalism* in this short video.

Introduction to this Guide

About this Guide

The Basic 'Bot Guide was created as a resource for teams looking for a step-by-step instructional guide to learn how to build a basic chassis and structure. There are multiple versions of this guide, previously called the "Push Bot Guide", this version the **Basic 'Bot Guide for REV Part 1** has been created to use the new and differing parts in the 2020-2021 season's REV kit of parts.

Parts

- REV FTC Competition Set
  - Tools included with this kit
- Electronics Modules and Sensors Set
- Control & Communication Set 1 or 2
- (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

- Secure the screws/nuts just enough, so parts do not slide/move relative to each other. Overtightening the screws will damage the aluminum extrusions.
- 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.
  - By designing on the computer first with CAD, the design can be tested to ensure everything will work together before actual construction.
- The Creo software is available for free to FIRST teams for use in designing robots. The CAD drawings color code the screws to help identify them (see table below).

CAD Coloring Legend

Part Number	Part	Color
REV-41-1359	M3x8mm Hex Cap Screw	red
REV-41-1361	M3 Nyloc Nuts	blue
REV-41-1360	M3x16mm Hex Cap Screw	yellow

Motor Preparation

Step 1: Add Motor Plates to Motors (Make Two)

Parts Needed

REV-41-1291 HD Hex Motor No Gearbox (2)
REV-41-1607 - UltraPlanetary Motor Plate (1 per motor, 2 total)
M3x6mm Button Head Screw (2 per motor, 4 total)

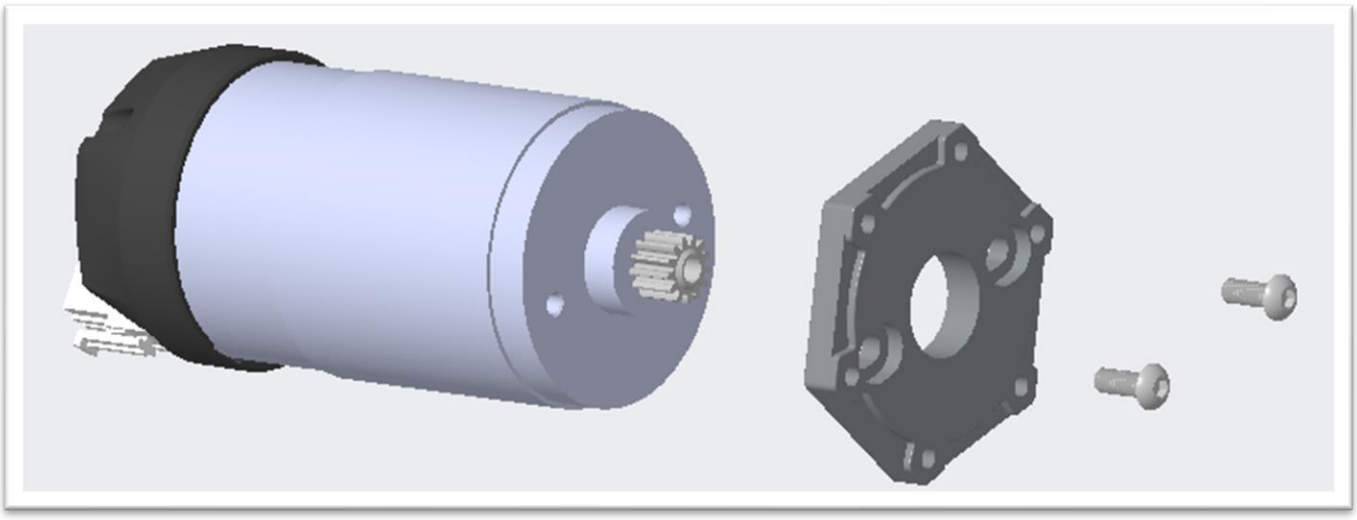


Figure 1- Unassembled view

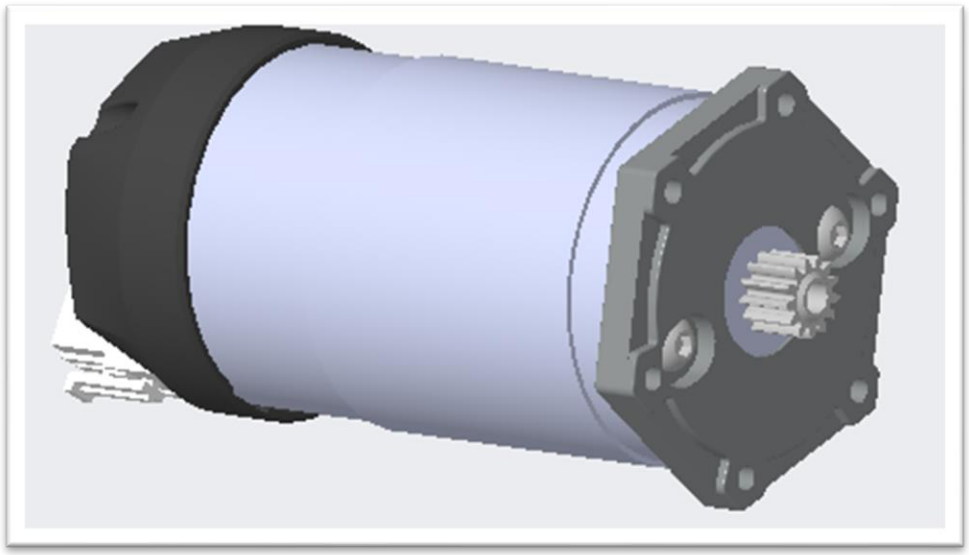


Figure 2- Assembled view

Helpful Hints

- The two button head screws and motor plate are part of the UltraPlanetary Gearbox Kit (REV-41-1600).

Step 2: Add Gear Box Cartridges to Motors (Make Two)

Parts Needed:

REV-41-1601 - UltraPlanetary Cartridge - 3:1 (1 per motor, 2 total)
REV-41-1602 - UltraPlanetary Cartridge - 4:1 (1 per motor, 2 total)
REV-41-1603 - UltraPlanetary Cartridge - 5:1 (1 per motor, 2 total)
REV-41-1615 - UltraPlanetarty Female 5mm Hex Output V2 (1 per motor, 2 total)
M3x40mm Screw (6 per motor, 12 total)

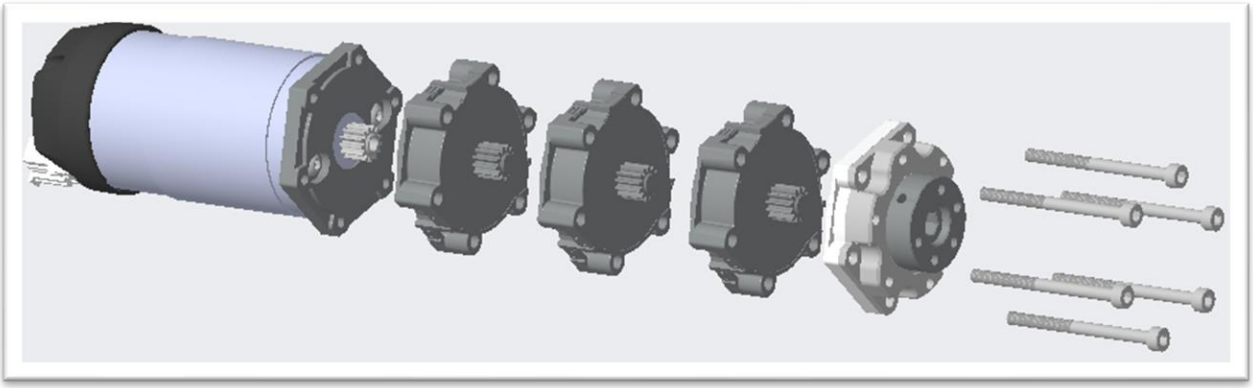


Figure 3- Unassembled view

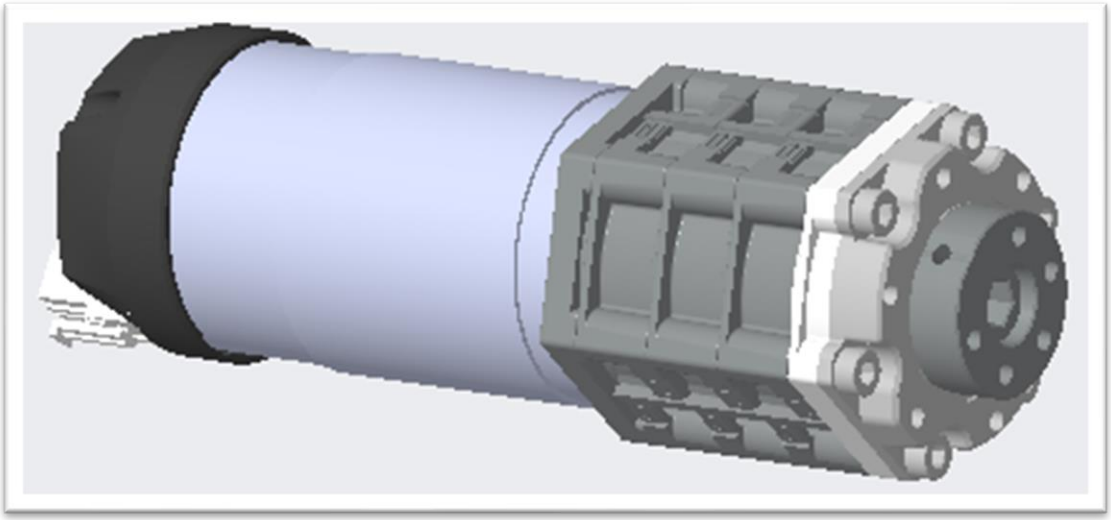


Figure 4- Assembled view

Helpful Hints

- Note that the highest ratio (5:1) is closest to the motor and that the lowest (3:1) is furthest from the motor.
- The order from motor to output is motor, (5:1), (4:1), (3:1), output.
- The gearbox cartridges, female output and screws are part of the UltraPlanetary Gearbox Kit (REV-41-1600).

Step 3: Add Mounting Plate to Motor (Make Two)

Parts Needed:

REV-41-1621 - UltraPlanetary Outside Mounting Bracket (1 per motor, 2 total)
REV-41-1359 - M3x8mm Screw (6 per motor, 12 total)
REV-41-1347 - 5mm x 75mm Hex Shaft (1 per motor, 2 total)

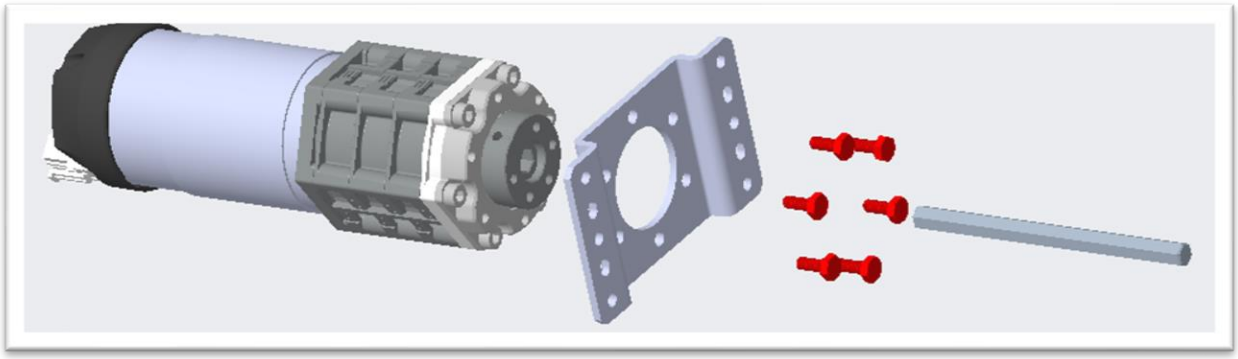


Figure 5- Unassembled view

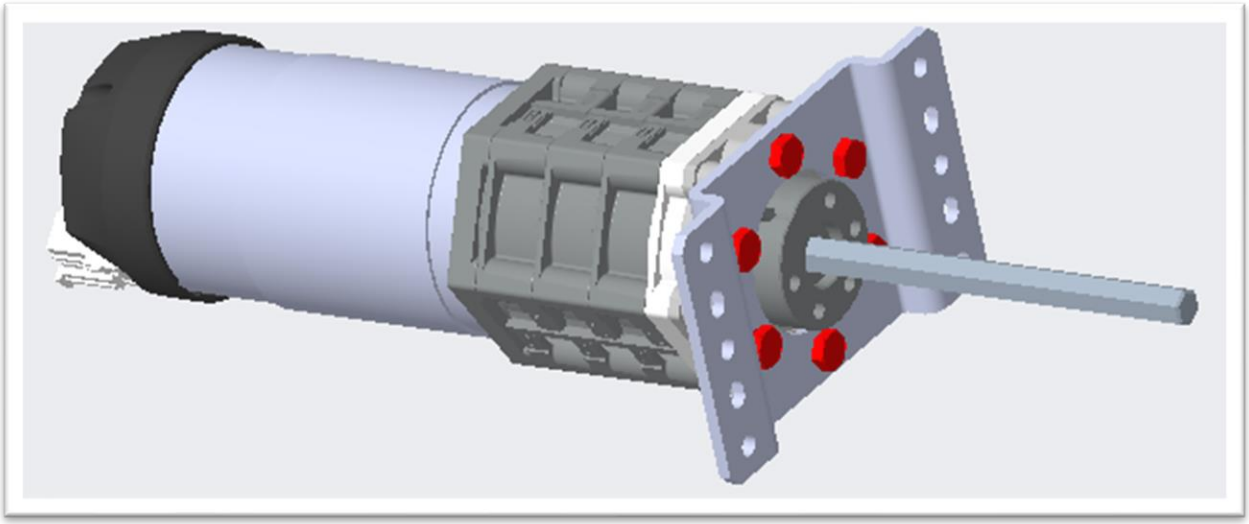


Figure 6- Assembled view

Chain Preparation

Step 1: Make Drive Chain Loops

Parts Needed
REV-41-1442 - #25 Chain Tool
REV-31-1365 - #25 Roller Chain
REV-41-1366 - Master Links (optional) (4)

Figure 7- Completed Chain Loops

Helpful Hints

- Follow the instructions from the REV website (below) to use the chain tool to make 4 loops of chain either by resetting the pin or using master links.
- The 4 loops will have the following number of outer links 1 with 18 links, 1 with 23 links and 2 with 33 links
- Left side will use an 18 and 33 link chain; right will use a 23 and 33 link chain.
- https://docs.revrobotics.com/duo-build/actuators/sprockets-and-chain/chain-tool

Left Rail

Step 1: Mount Motor to Outside Channel

Parts Needed

REV-41-1762 – 45mm x 15mm C Channel - 408mm (1)
REV-41-1359 - M3x8mm Screw (4)
REV-41-1361 - M3 Nyloc Nut (4)

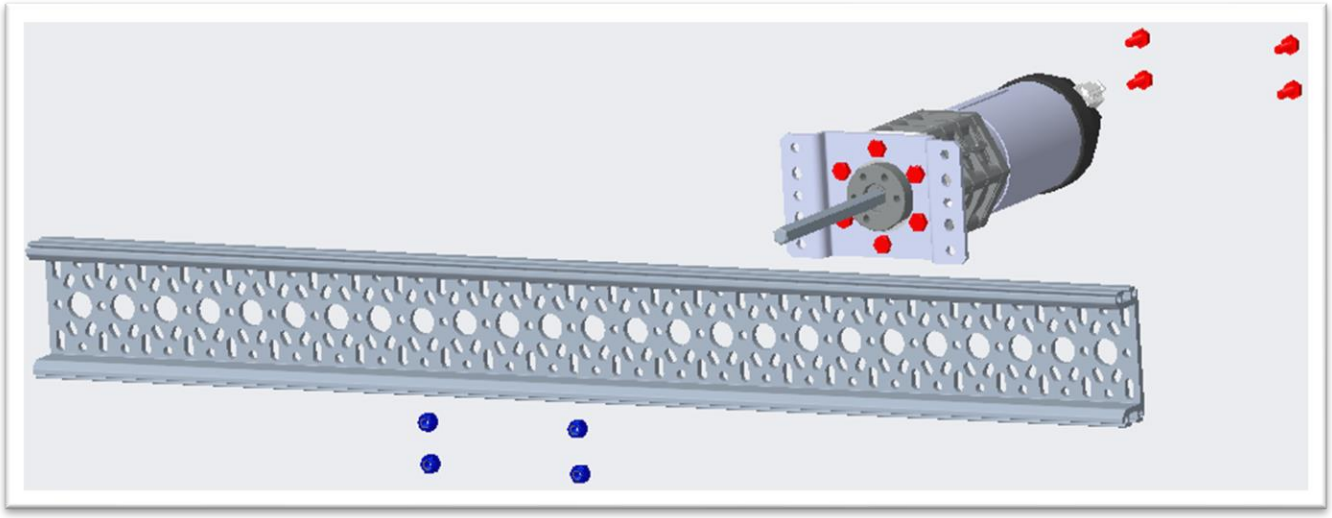


Figure 8- Unassembled view

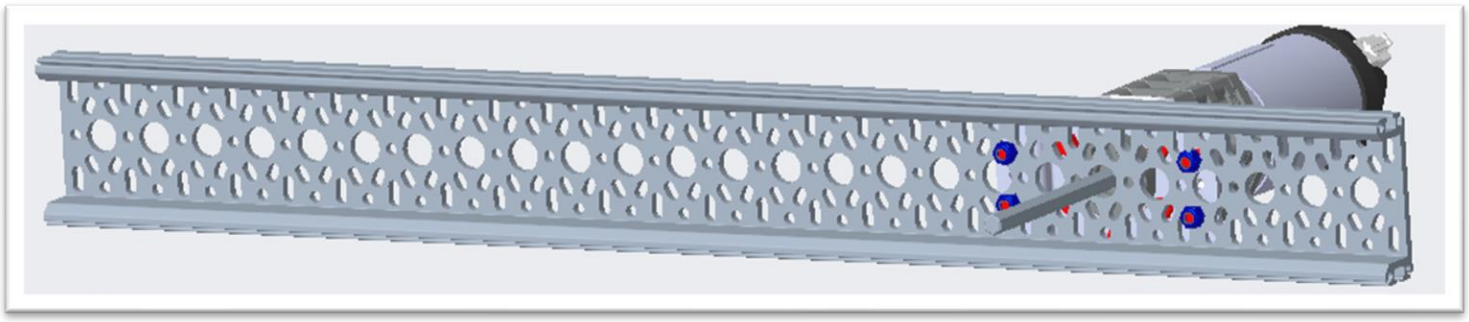


Figure 9- Assembled view

Helpful Hints

- Only one of the motor assemblies is used for this step.

Step 2: Mount Caps and Tensioning Bushings to Channel

Parts Needed:

REV-41-1687 – U Channel Endcap (2)
REV-41-1359 – M3x8mm Screw (8)
REV-41-1492 – M3 Standoff - 40mm (2)
REV 41-1702 - Tensioning Bushing - 39mm (2)

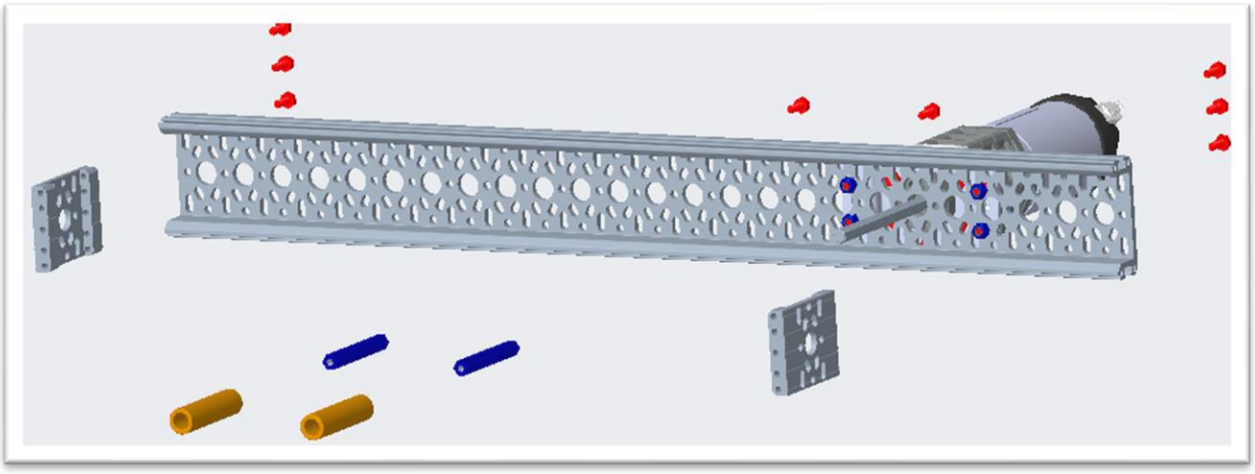


Figure 10- Unassembled view

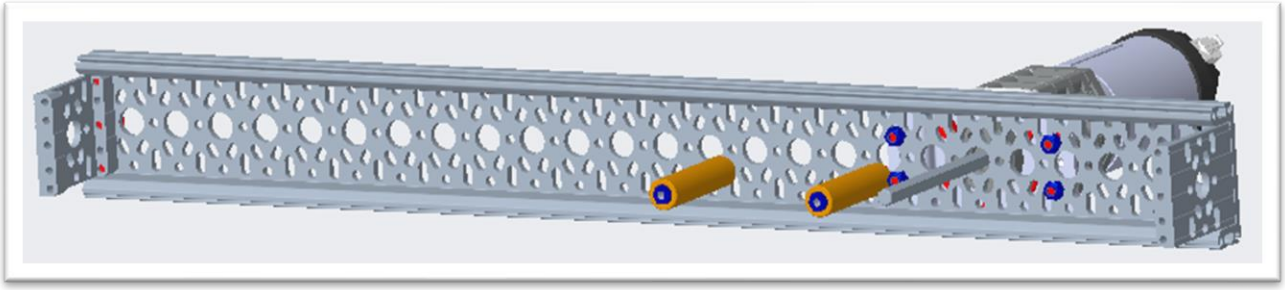


Figure 11- Assembled view

Step 3: Add Parts to Motor Axle

Parts Needed:
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1324 - 3mm Spacer (4)
REV-41-1338 - 10 Tooth #25 Sprocket (1)
REV-41-1327 - Shaft Collar (1)

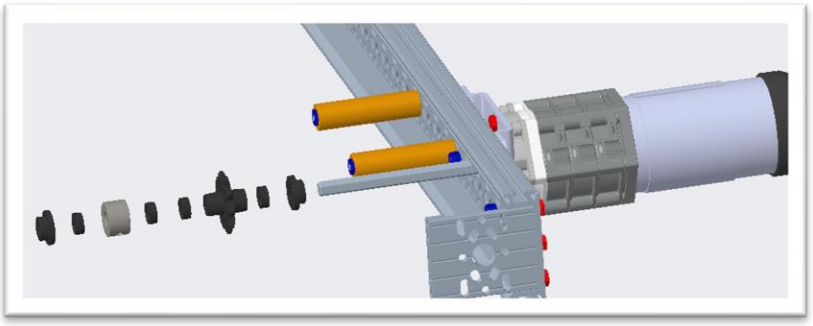


Figure 12- Unassembled view

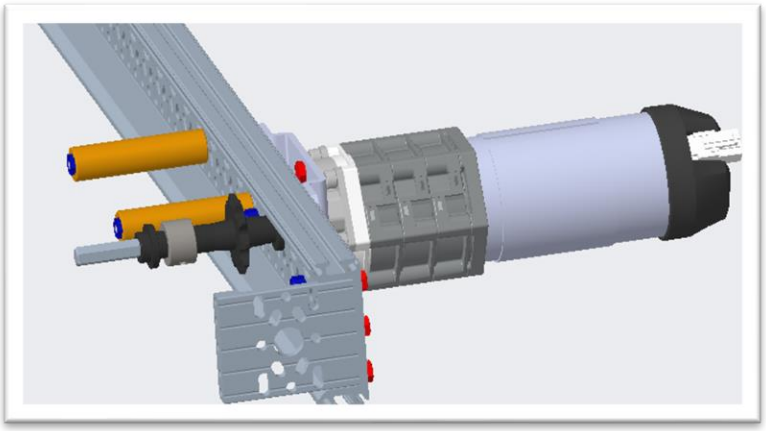


Figure 13- Assembled view

Helpful Hint

- The order from chassis rail outwards is bearing, spacer, sprocket, two spacers, collar, spacer, bearing.

Step 4: Add Rear Axle

Parts Needed:

REV-41-1327 - Shaft Collar (1)
REV-31-1348 - 5mmx90mm Hex Shaft (1)
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1324 - 3mm Spacer (2)
REV-41-1323 - 15mm Spacer (1)
REV-41-1338 - 10 Tooth #25 Sprocket (1)

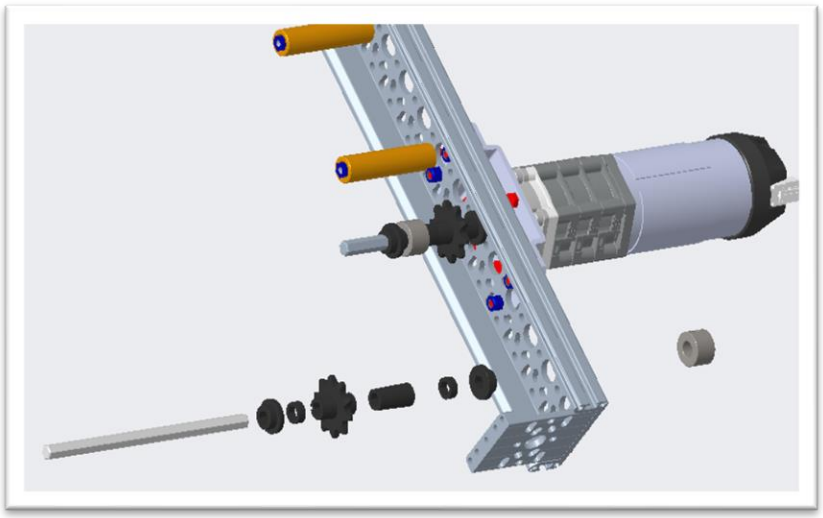


Figure 14- Unassembled View

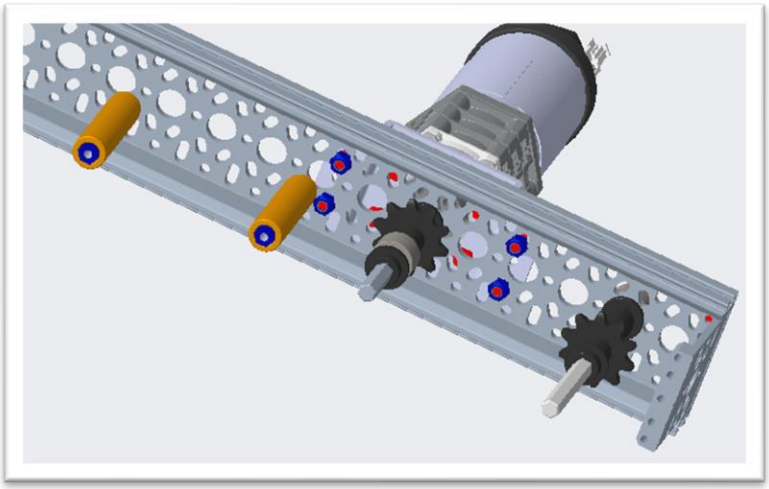


Figure 15- Assembled view

Helpful Hints

- Order from the motor side to away from motor: collar (on shaft), rail, bearing, 3mm spacer, 15mm spacer, sprocket, 3mm spacer, bearing.
- Adjust axle length, so it is flush with the collar.

Step 5: Add Center Axle

Parts Needed:

REV-41-1327 - Shaft Collar (1)
REV-31-1348 - 5mmx90mm Hex Shaft (1)
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1338 - 10 Tooth #25 Sprocket (2)
REV-41-1324 - 3mm Spacer (1)

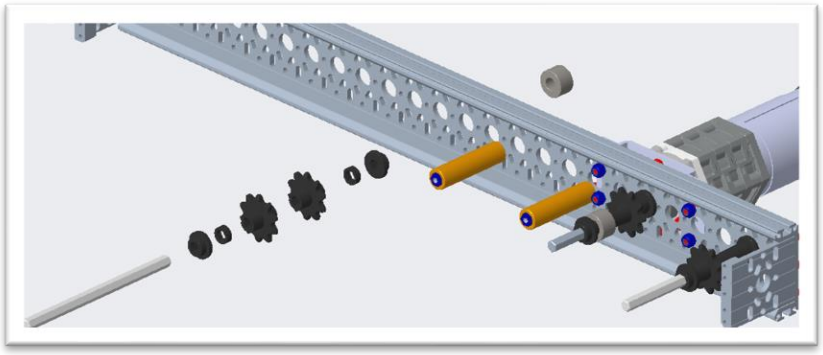


Figure 16- Unassembled View

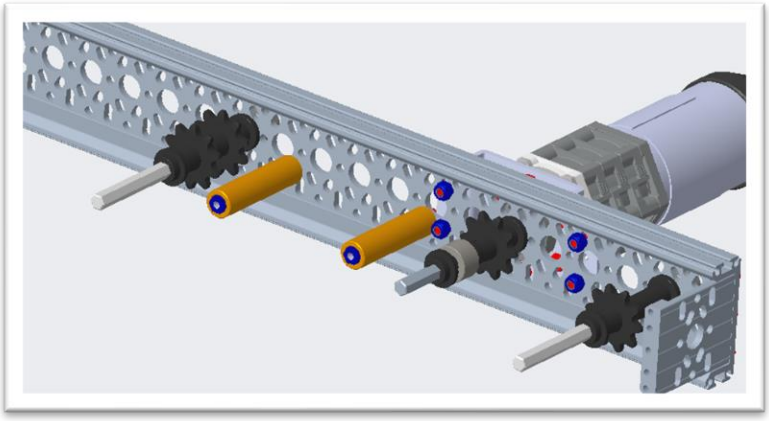


Figure 17- Assembled view

Helpful Hints

- Order from the motor side to away from motor: collar (on shaft), rail, bearing, 3mm spacer, both sprockets, 3mm spacer, bearing.
- Adjust axle length, so it is flush with the collar.

Step 6: Add Chains to Sprockets

Parts Needed:
Short Chain Loop (1)
Long Chain Loop (1)

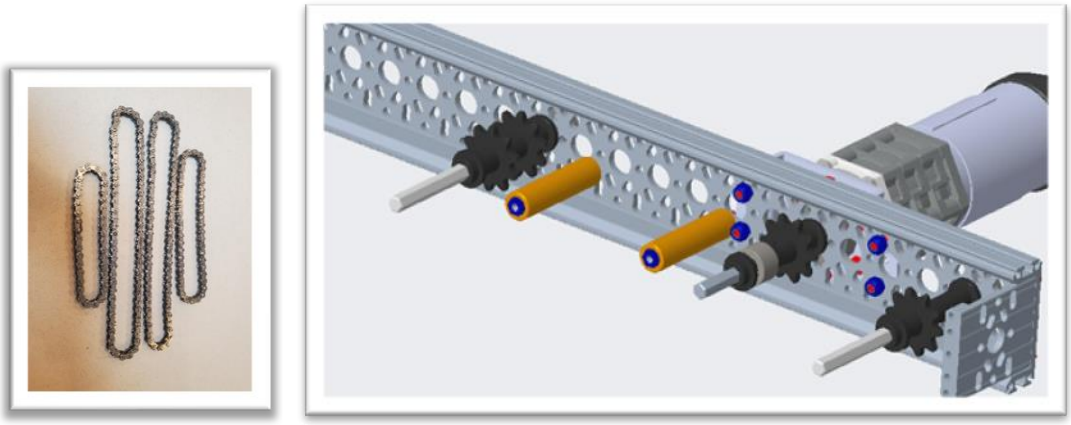


Figure 18- Unassembled View

Figure 19- Assembled view

Helpful Hints

- Put the short chain onto the sprockets between the motor and the center axle.
- Put the long chain onto the sprockets between the center and rear axle.

Step 7: Add Front Axle

Parts Needed:
REV-41-1327 - Shaft Collar (1)
REV-31-1348 - 5mmx90mm Hex Shaft (1)
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1324 - 3mm Spacer (2)
REV-41-1323 - 15mm Spacer (2)

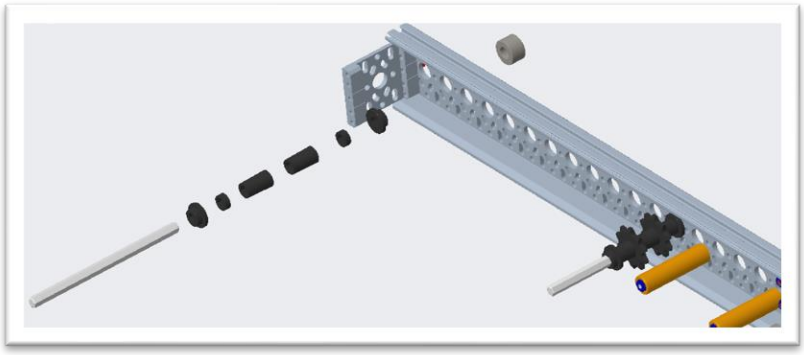


Figure 20- Unassembled View

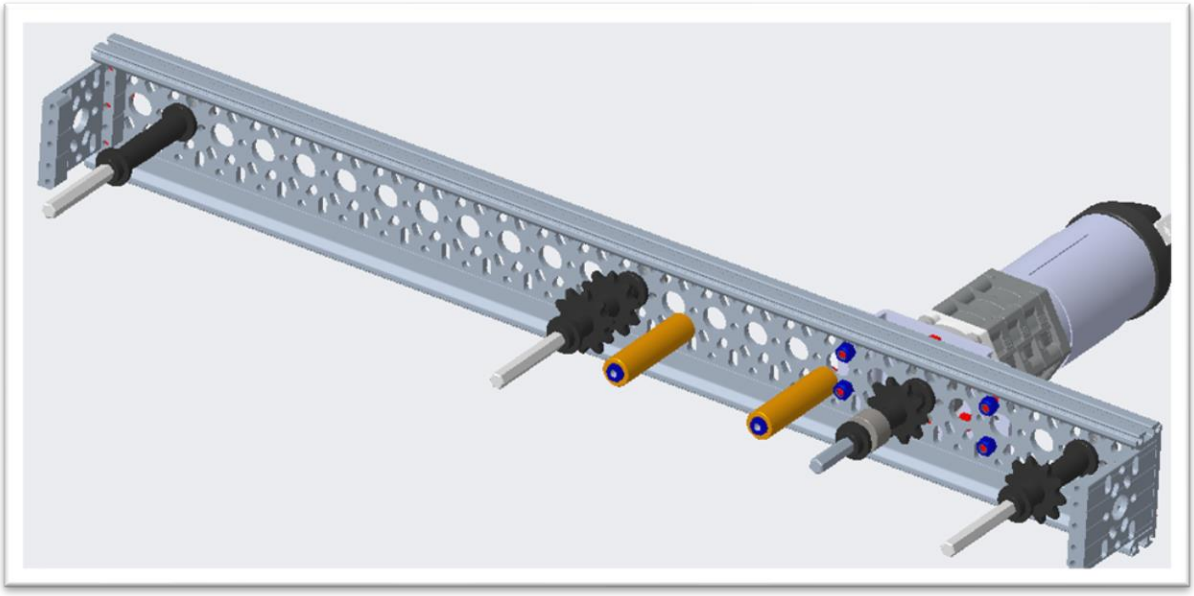


Figure 21- Assembled view

Helpful Hints

- Order from the motor side to away from motor: collar (on shaft), rail, bearing, 3mm spacer, both 15mm spacers, 3mm spacer, bearing.
- Adjust axle length, so it is flush with the collar.
- This image fails to show the chains that were installed in a previous step.

Step 8: Add Inside Channel to Rail

Parts Needed:

REV-41-1762 – 45mm x 15mm C Channel - 408mm (1)
REV-41-1359 - M3x8mm Screw (8)

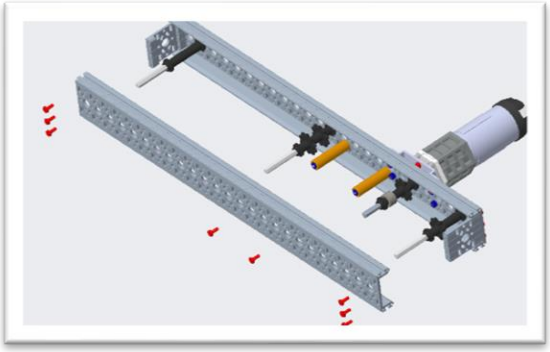


Figure 22- Unassembled View

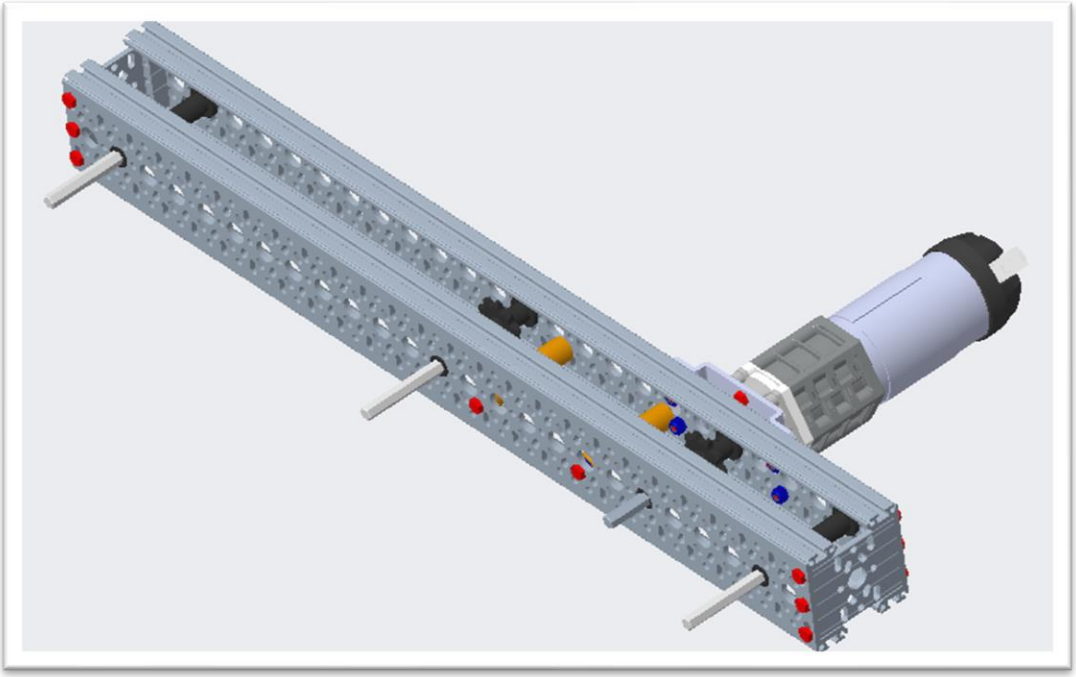


Figure 23- Assembled view

Helpful Hint

- This image fails to show the chains that were installed in a previous step.

Step 9: Add Wheels to the Rail

Parts Needed:
REV-41-1327 - Shaft Collar (3)
REV-41-1329 - Through Bore Bearing - Long (2)
REV-41-1190 - 90mm Omni Wheel (1)
REV-41-1267 - 90mm Grip Wheel (2)

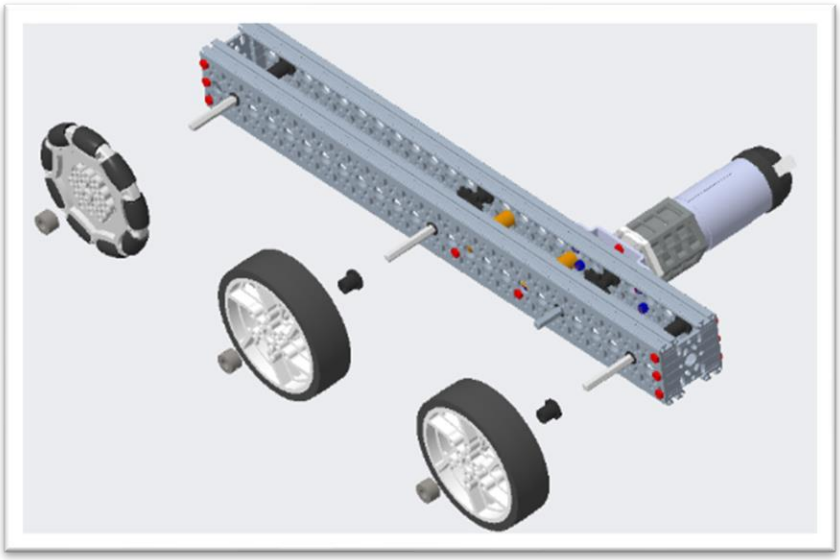


Figure 24- Unassembled View

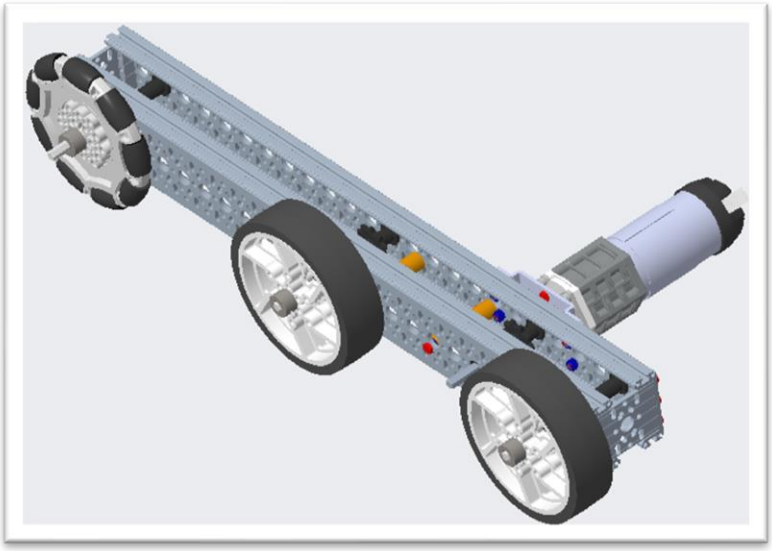


Figure 25- Assembled view

Helpful Hints

- The shaft collar of the front axle (omni wheel axle) is not flush with the end of the shaft.
- The other collars are flush with the end of the axles.
- This image fails to show the chains that were installed in a previous step.

Right Rail

Step 1: Mount Motor to Outside Channel

Parts Needed

REV-41-1762 – 45mm x 15mm C Channel - 408mm (1)
REV-41-1359 - M3x8mm Screw (4)
REV-41-1361 - M3 Nyloc Nut (4)

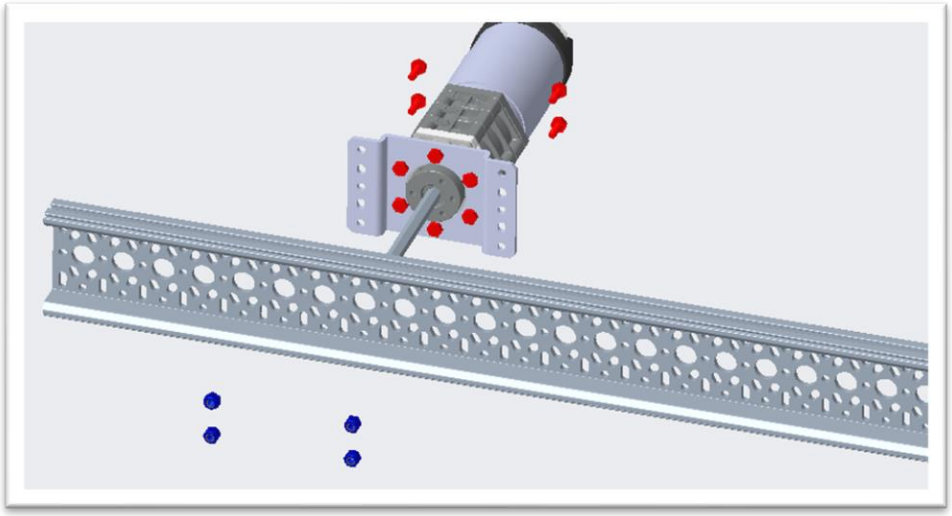


Figure 26- Unassembled view

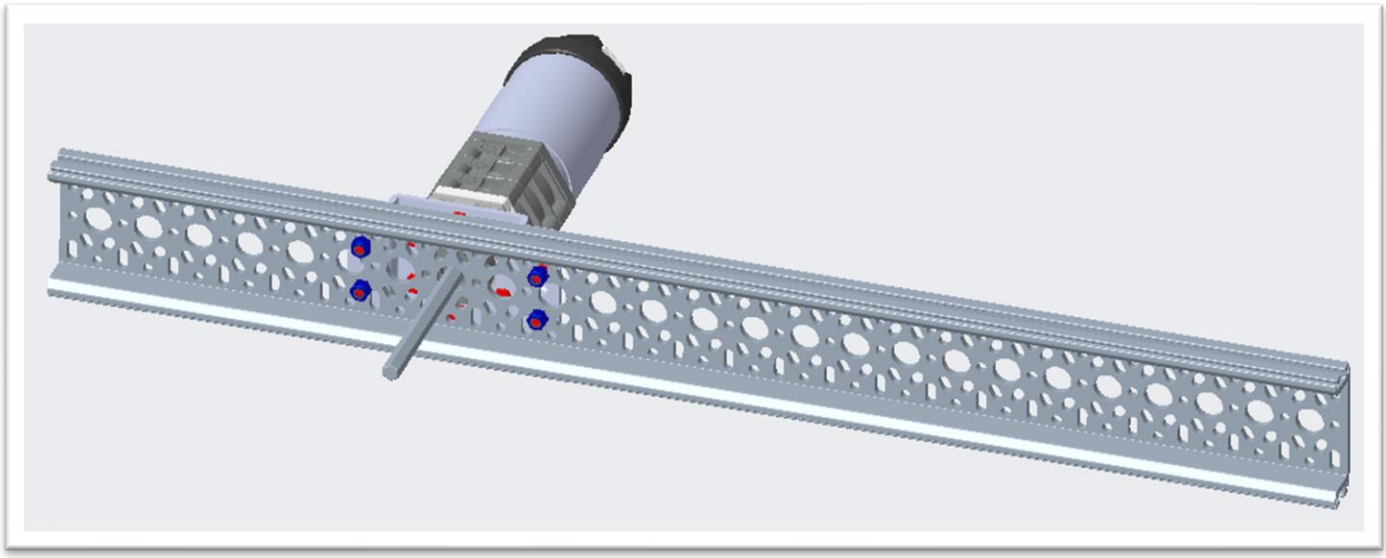


Figure 27- Assembled view

Helpful Hints

- Only one of the motor assemblies is used for this step.
- Note that the position of the motor on the beam is **NOT** identical to the left chassis.

Step 2: Mount Caps and Tensioning Bushings to Channel

Parts Needed:
REV-41-1687 – U Channel Endcap (2)
REV-41-1359 – M3x8mm Screw (8)
REV-41-1492 – M3 Standoff - 40mm (2)
REV 41-1702 - Tensioning Bushing - 39mm (2)

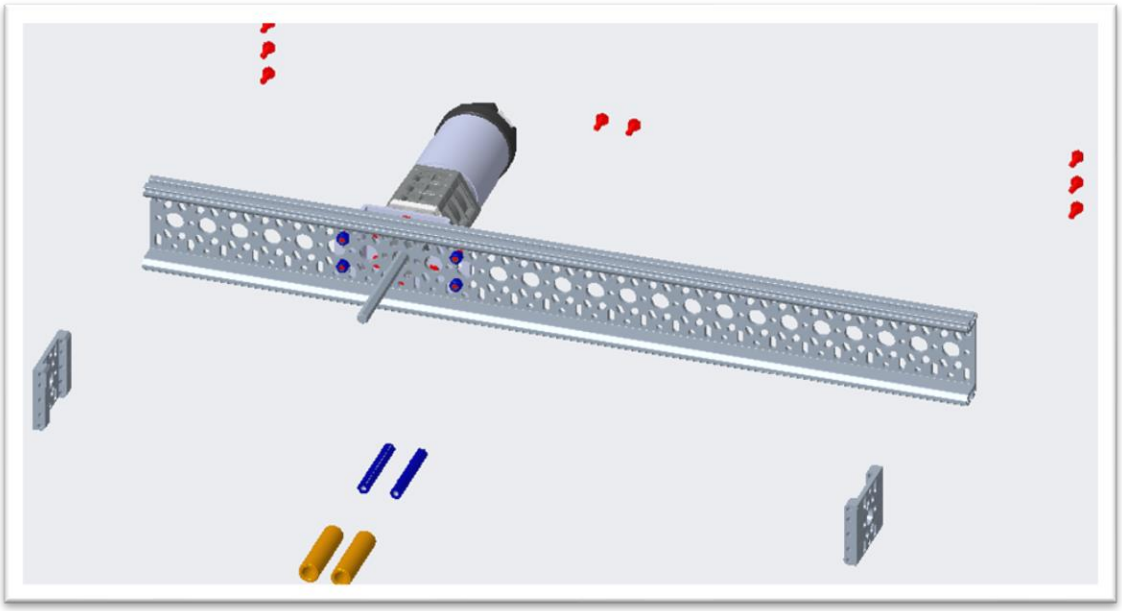


Figure 28- Unassembled view

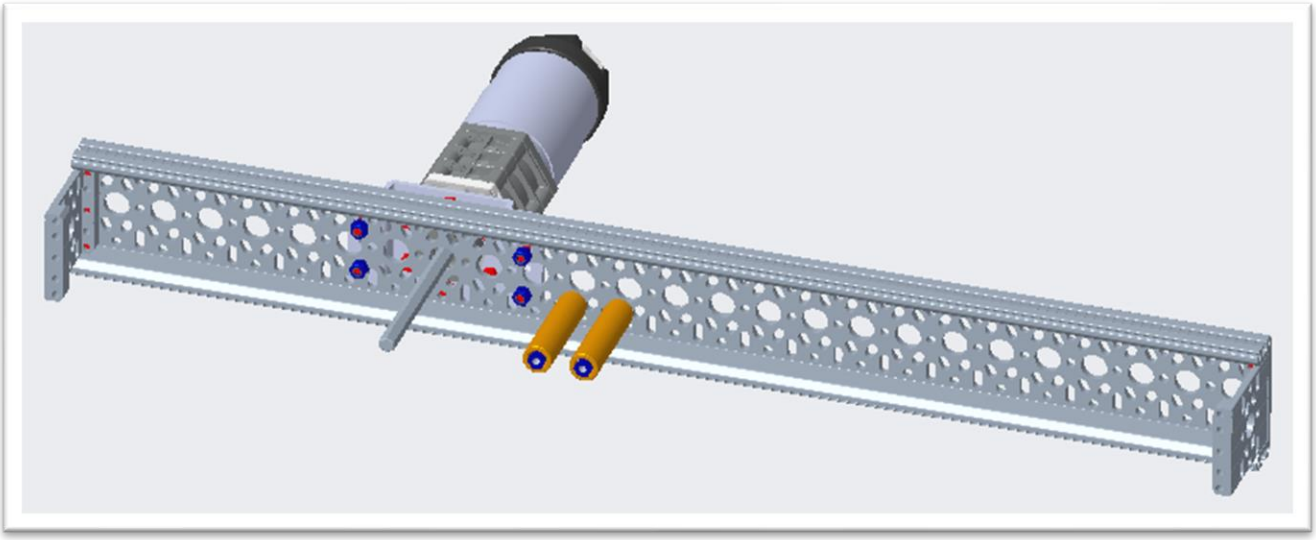


Figure 29- Assembled view

Helpful Hints

- Note that the position of the tensioning bushings on the beam are **NOT** identical to the left chassis.

Step 3: Add Parts to Motor Axle

Parts Needed:
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1324 - 3mm Spacer (4)
REV-41-1338 - 10 Tooth #25 Sprocket (1)
REV-41-1327 - Shaft Collar (1)

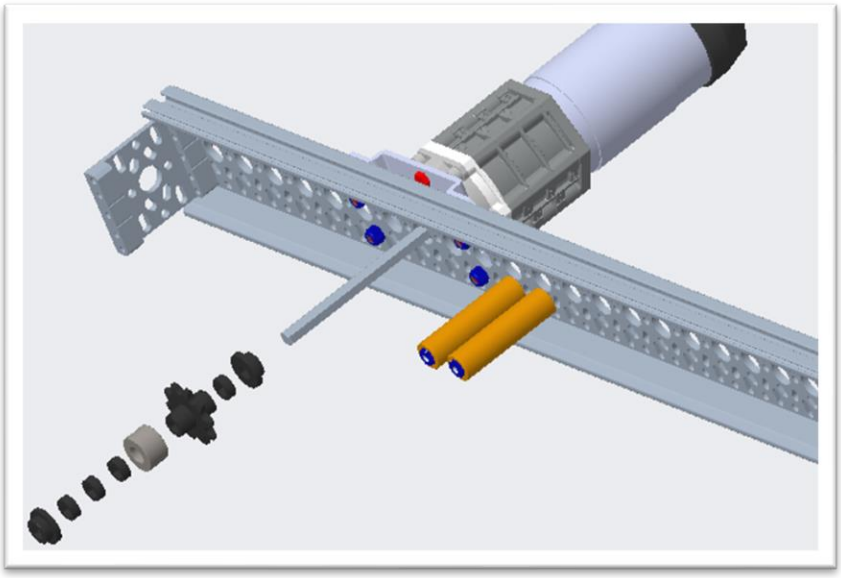


Figure 30- Unassembled view

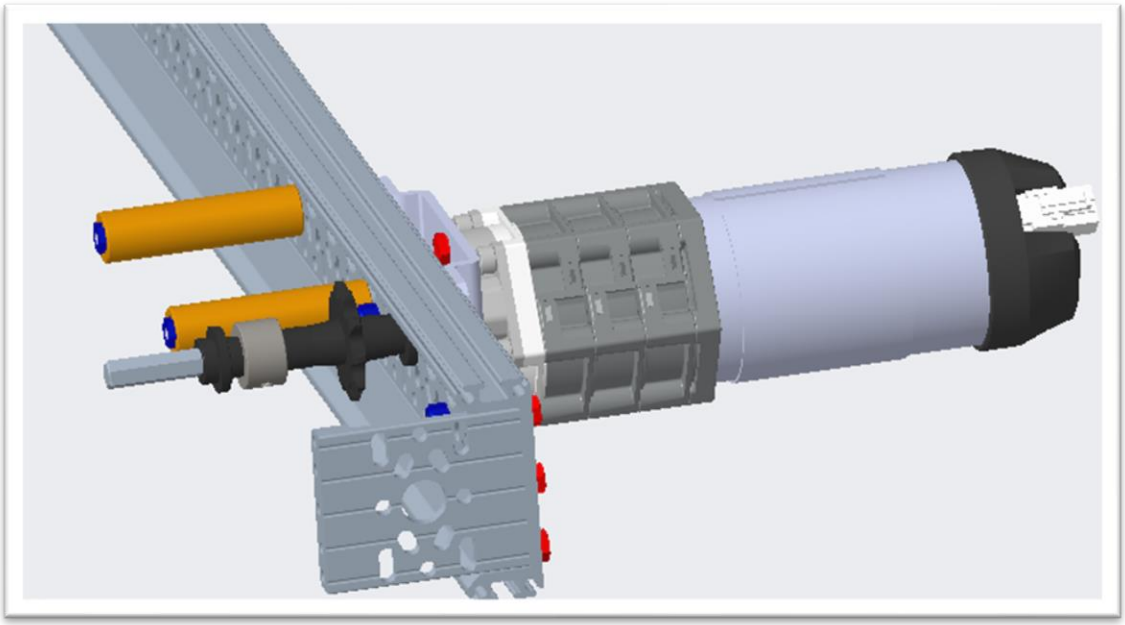


Figure 31- Assembled view

Helpful Hints

- The order from chassis rail outwards is bearing, spacer, sprocket, collar, three spacers, bearing.

Step 4: Add Rear Axle

Parts Needed:

REV-41-1327 - Shaft Collar (1)
REV-31-1348 - 5mmx90mm Hex Shaft (1)
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1324 - 3mm Spacer (2)
REV-41-1323 - 15mm Spacer (1)
REV-41-1338 - 10 Tooth #25 Sprocket (1)

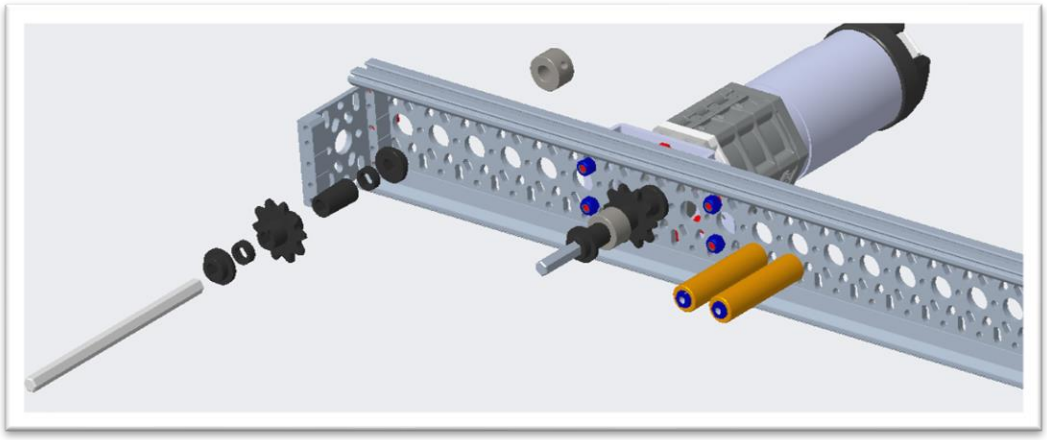


Figure 32- Unassembled View

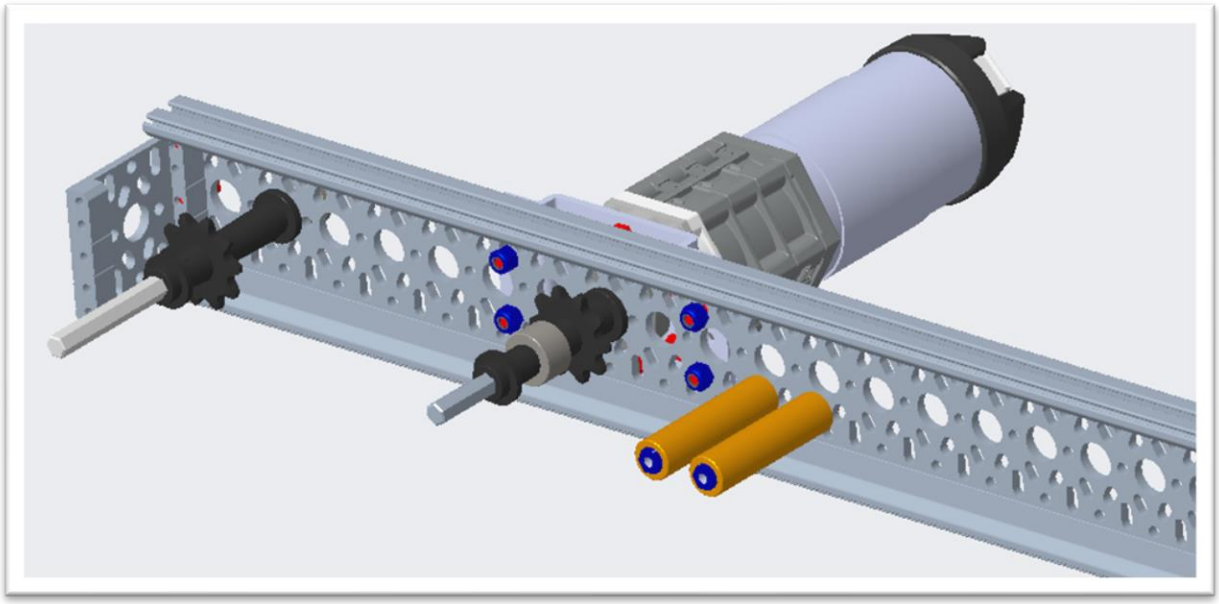


Figure 33- Assembled view

Helpful Hints

- Order from the motor side to away from motor: collar (on shaft), rail, bearing, 3mm spacer, 15mm spacer, sprocket, 3mm spacer, bearing.
- Adjust axle length, so it is flush with the collar.

Step 5: Add Center Axle

Parts Needed:
REV-41-1327 - Shaft Collar (1)
REV-31-1348 - 5mmx90mm Hex Shaft (1)
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1338 - 10 Tooth #25 Sprocket (2)
REV-41-1324 - 3mm Spacer (1)

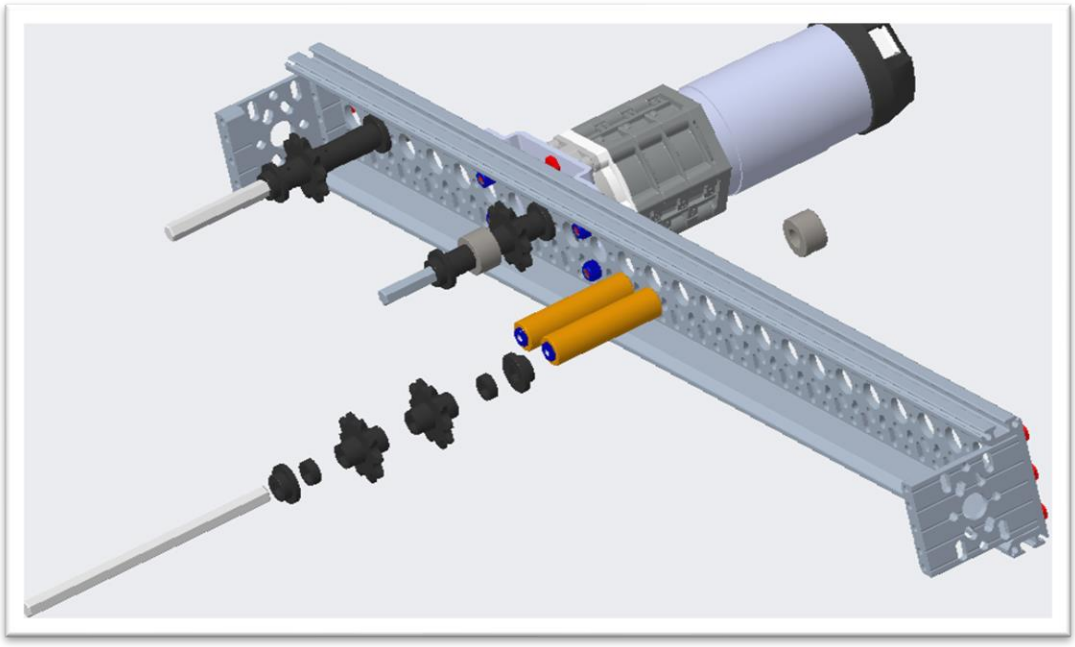


Figure 34- Unassembled View

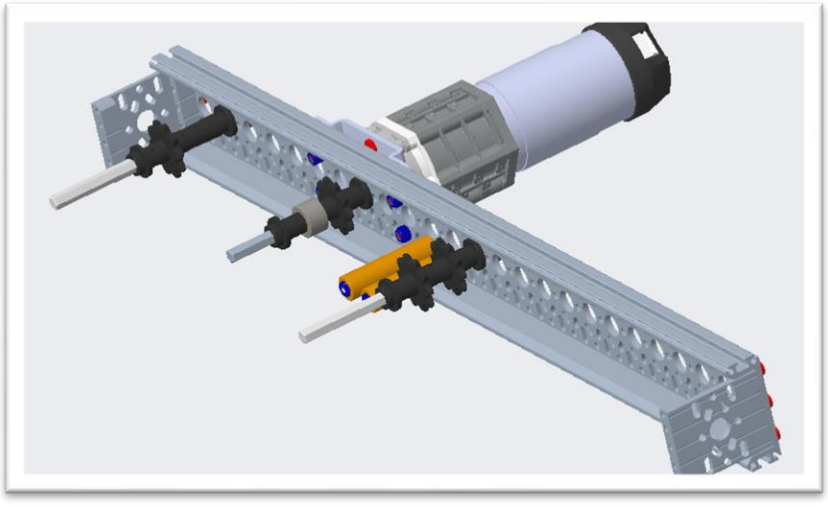


Figure 35- Assembled view

Helpful Hints

- Order from the motor side to away from motor: collar (on shaft), rail, bearing, spacer, sprockets, 3mm spacer, bearing.
- Adjust axle length, so it is flush with the collar.

Step 6: Add Chains to Sprockets

Parts Needed:
Short Chain Loop (1)
Long Chain Loop (1)

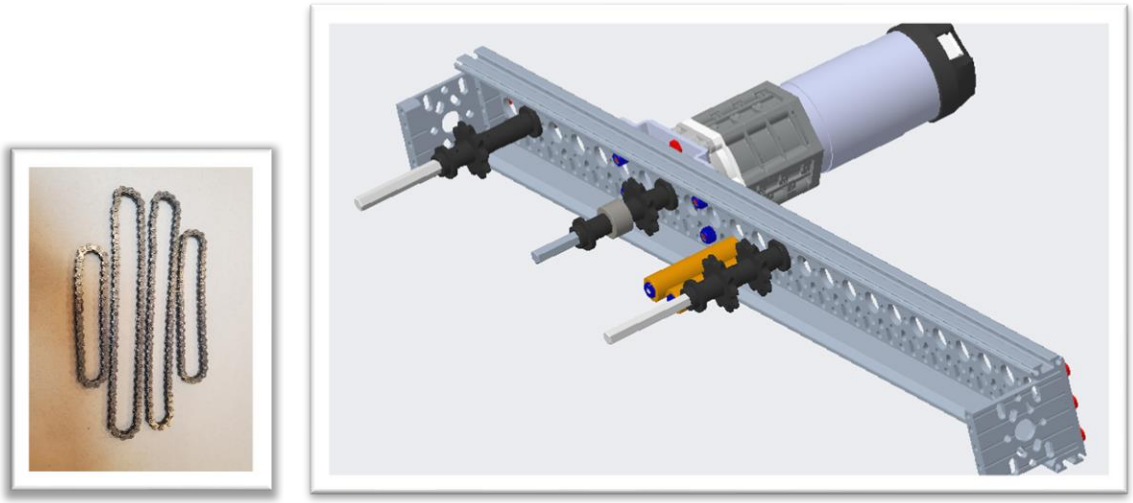


Figure 36- Unassembled View

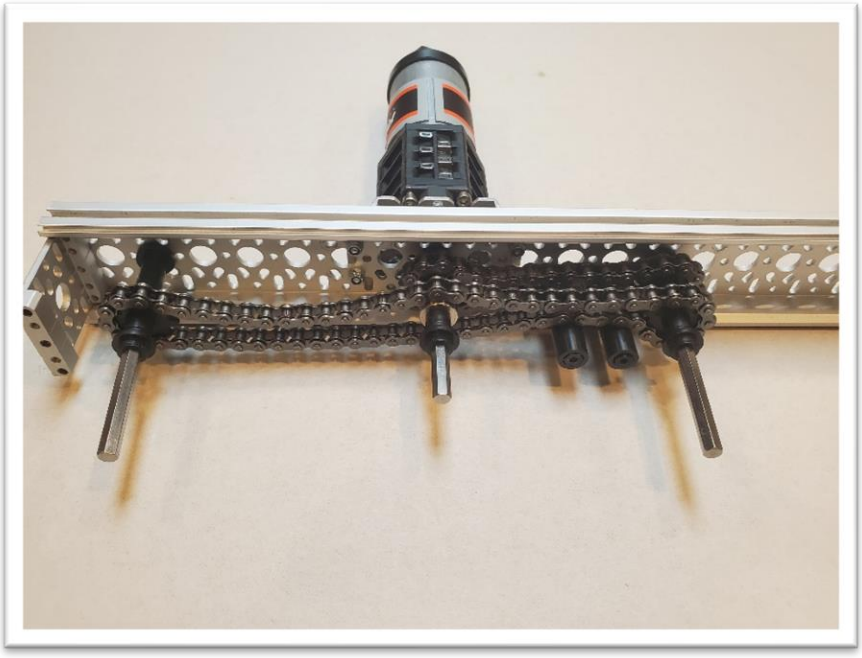


Figure 37- Assembled view

Helpful Hints

- Put the short chain onto the sprockets between the motor and the center axle.
- Put the long chain onto the sprockets between the center and rear axle.

Step 7: Add Front Axle

Parts Needed:

REV-41-1327 - Shaft Collar (1)
REV-31-1348 - 5mmx90mm Hex Shaft (1)
REV-41-1326 - Through Bore Bearing - Short (2)
REV-41-1324 - 3mm Spacer (2)
REV-41-1323 - 15mm Spacer (2)

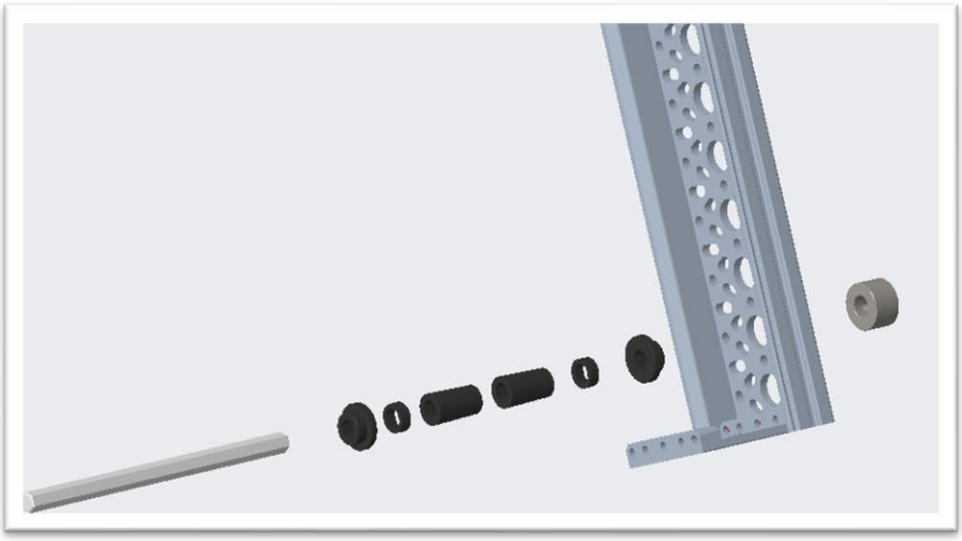


Figure 38- Unassembled View

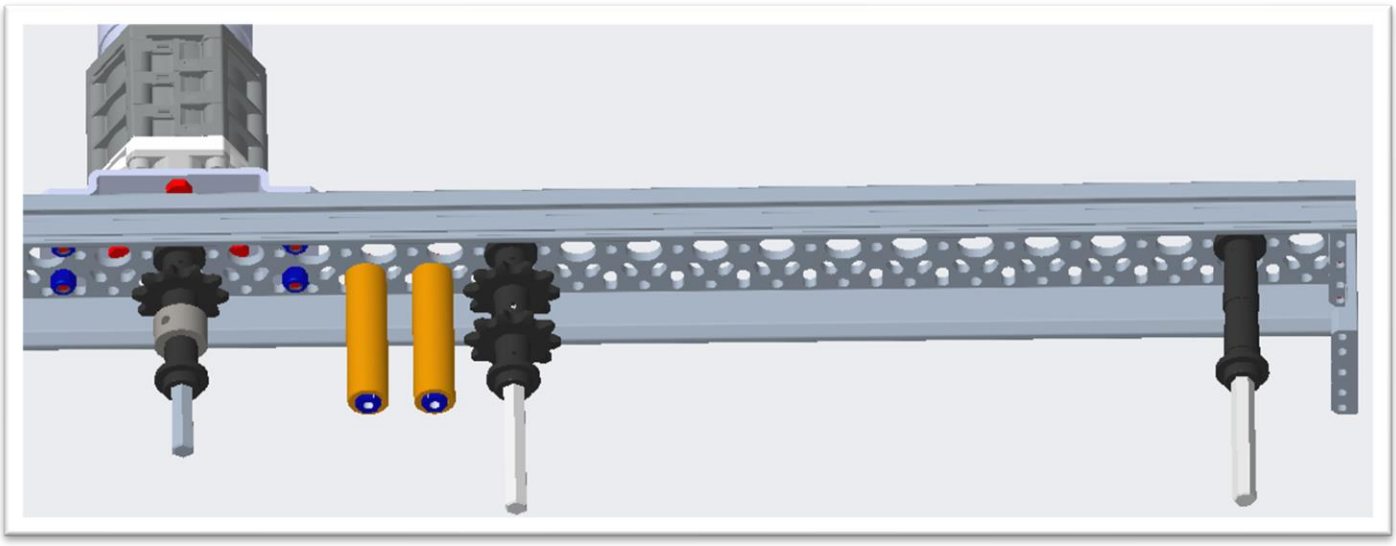


Figure 39- Assembled view

Helpful Hints

- Order from the motor side to away from motor: collar (on shaft), rail, bearing, 3mm spacer, both 15mm spacers, 3mm spacer, bearing.
- Adjust axle length, so it is flush with the collar.
- This image fails to show the chains that were installed in a previous step.

Step 8: Add Inside Channel to Rail

Parts Needed:
REV-41-1762 – 45mm x 15mm C Channel - 408mm (1)
REV-41-1359 - M3x8mm Screw (8)

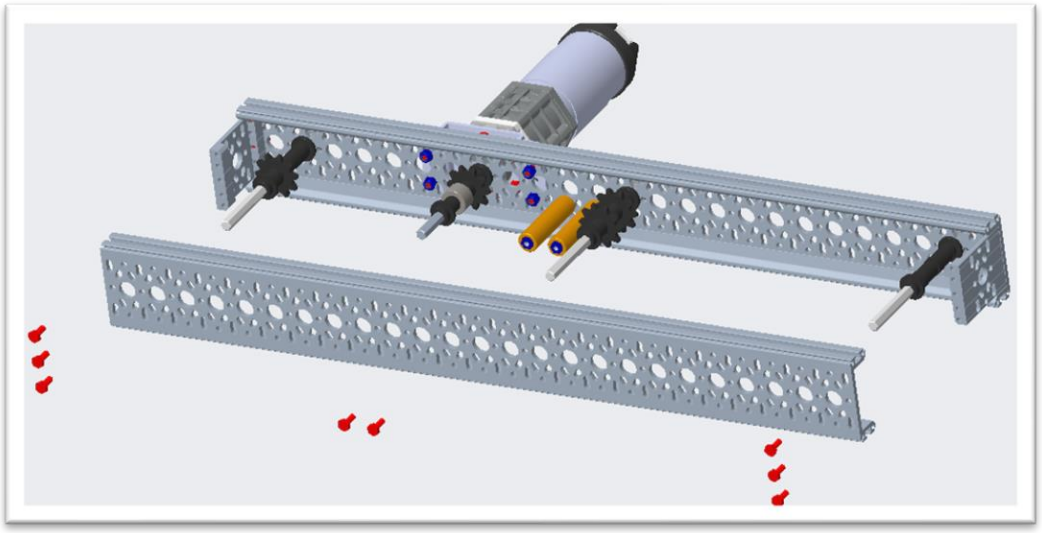


Figure 40- Unassembled View

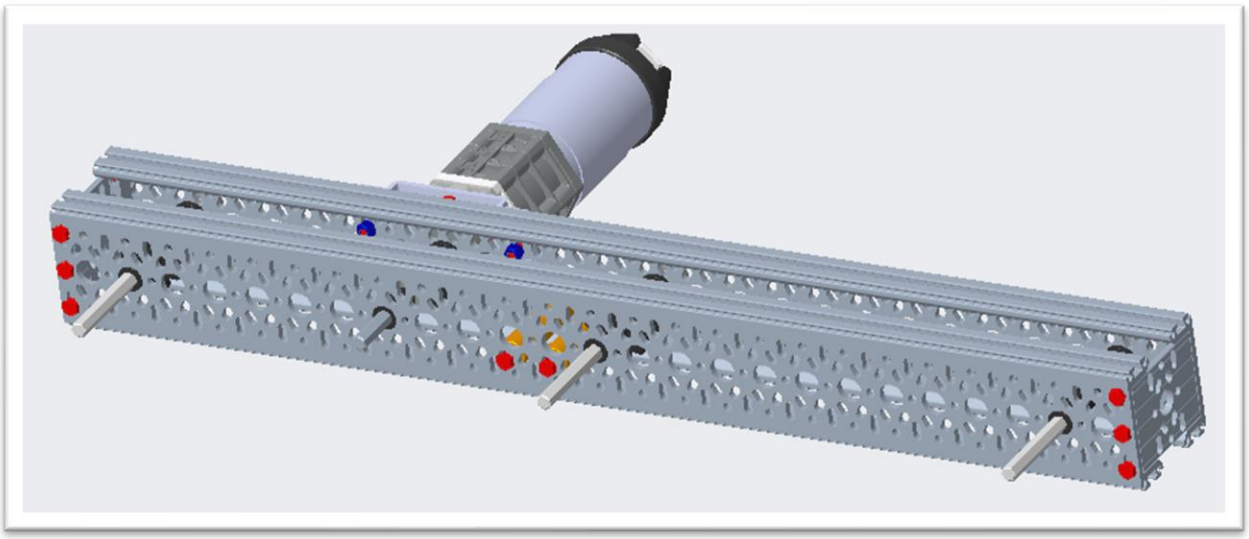


Figure 41- Assembled view

Helpful Hints

- This image fails to show the chains that were installed in a previous step.

Step 9: Add Wheels to the Rail

Parts Needed:

REV-41-1327 - Shaft Collar (3)
REV-41-1329 - Through Bore Bearing - Long (2)
REV-41-1190 - 90mm Omni Wheel (1)
REV-41-1267 - 90mm Grip Wheel (2)

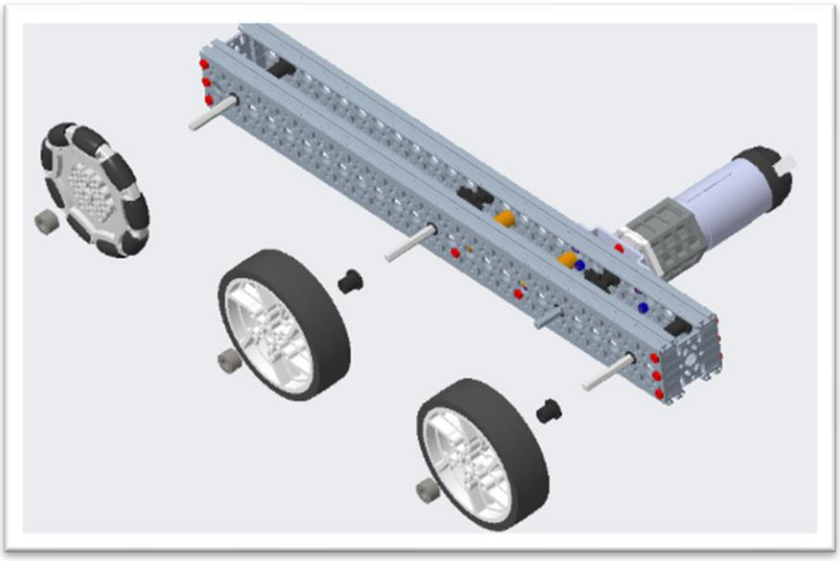


Figure 42- Unassembled View

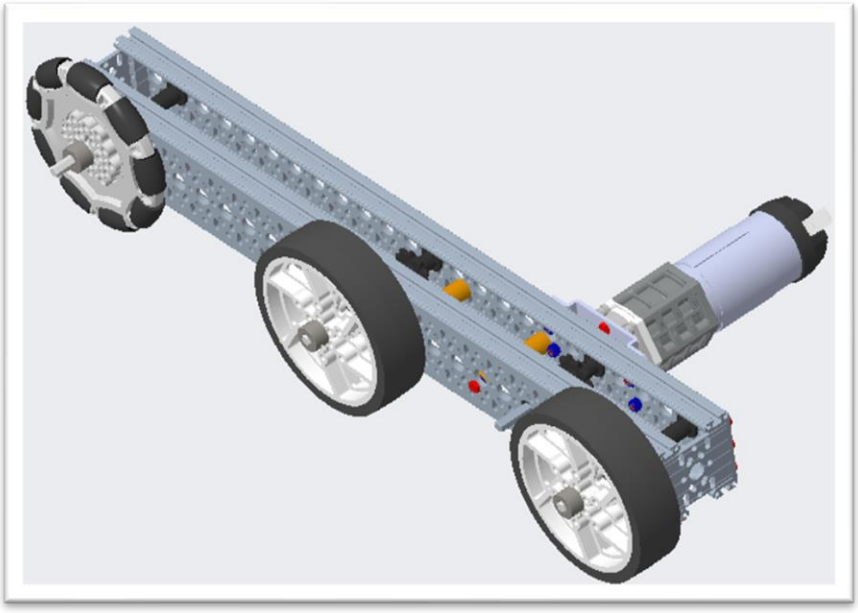


Figure 43- Assembled view

Helpful Hints

- The shaft collar of the front axle (omni wheel axle) is not flush with the end of the shaft.
- The other collars are flush with the end of the axles.
- This image fails to show the chains that were installed in a previous step.

Chassis Preparation

Step 1: Add Screws to Corner Brackets (Make Eight)

Parts Needed:

REV-41-1305 – 15mm Plastic 90 Degree Bracket (1 per assembly, 8 total)
REV-41-1359 – Screw, Hex Cap, M3, 8mm (5 per assembly, 40 total)
REV-41-1361 – Nut, Locking, M3 (5 per assembly, 40 total)

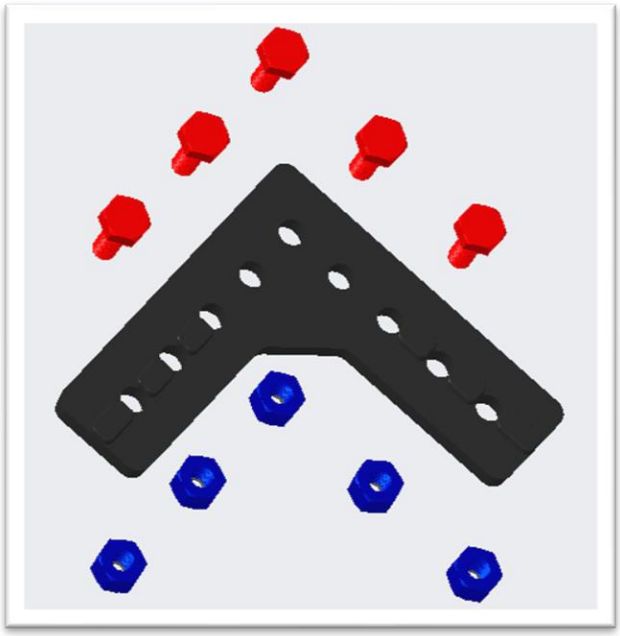


Figure 44- Unassembled view

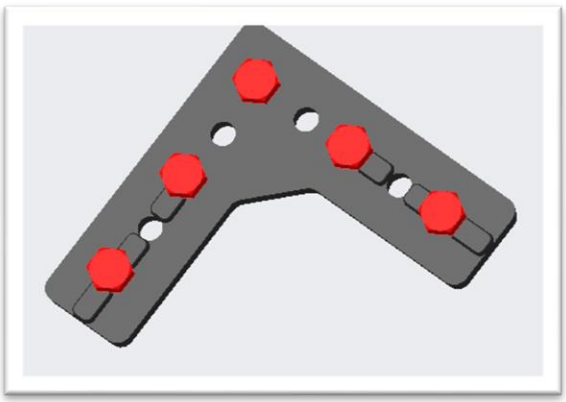


Figure 45- Assembled view

Helpful Hints

- Screw the nuts onto the screws just until it's difficult to turn them; just so that the nuts don't fall off.
- The screw heads will need to slide along the center of an extrusion in a later step.

Step 2: Add Screws to Battery Plate (Make Two)

Parts Needed:

REV-41-1166 – Battery Holder Plate (1 per assembly, 2 total)
REV-41-1359 – Screw, Hex Cap, M3, 8mm (2 per assembly, 4 total)
REV-41-1361 – Nut, Locking, M3 (2 per assembly, 4 total)

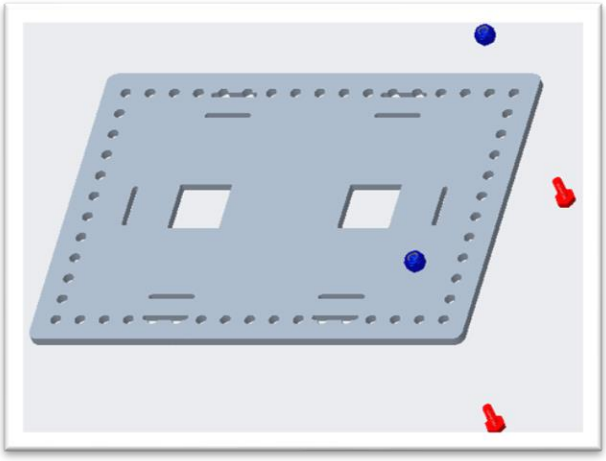


Figure 46- Unassembled view

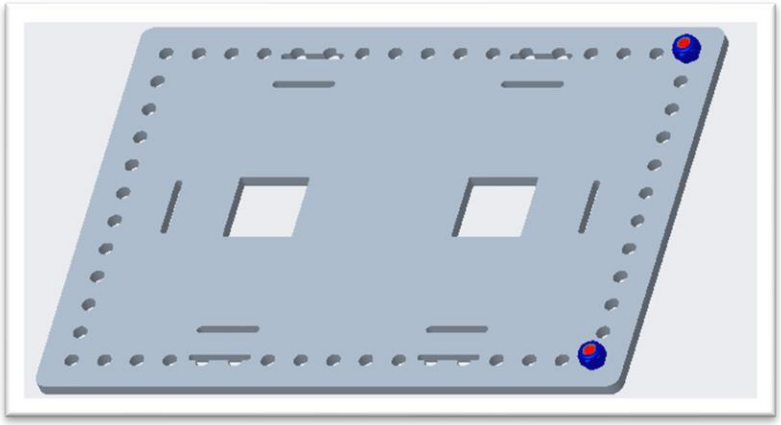


Figure 47- Assembled view

Helpful Hint

- Screw the nuts onto the screws just until it's difficult to turn them; just so that the nuts don't fall off.
- The screw heads will need to slide along the center of an extrusion in a later step.

Step 3: Assemble Switch

Parts Needed:
REV-31-1387 Switch Cable and Bracket (1)
REV-41-1359 – Screw, Hex Cap, M3, 8mm (2)
REV-41-1361 – Nut, Locking, M3 (2)

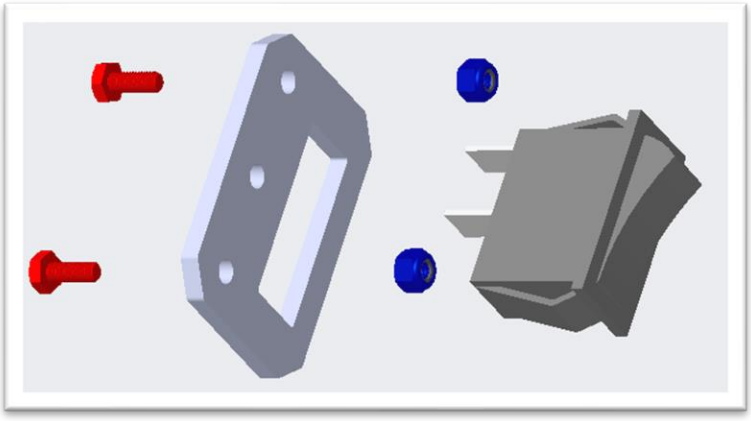


Figure 48- Unassembled view

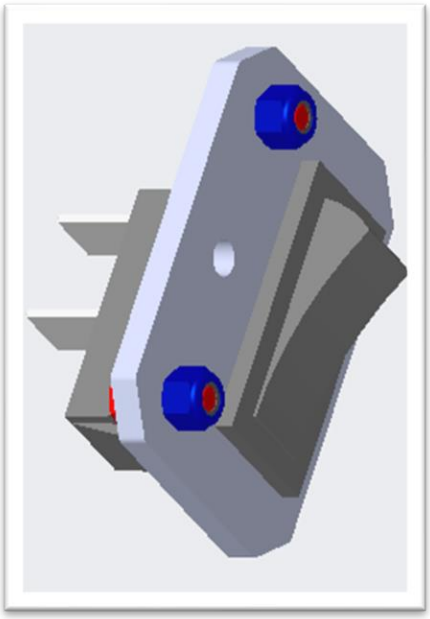


Figure 49- Assembled view

Helpful Hint

- Screw the nuts onto the screws just until it's difficult to turn them; just so that the nuts don't fall off.
- The screw heads will need to slide along the center of an extrusion in a later step.

Chassis

Step 1: Asemble Rear Cross Channel and Rails

Parts Needed:

REV-41-1767 – 45mmx15mm C Channel - 248mm (1)
Corner Bracket Assembly (4)
Power Switch Assembly
Left Rail Assembly
Right Rail Assembly

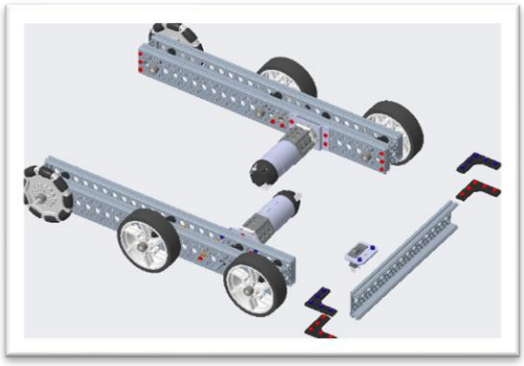


Figure 50- Unassembled view

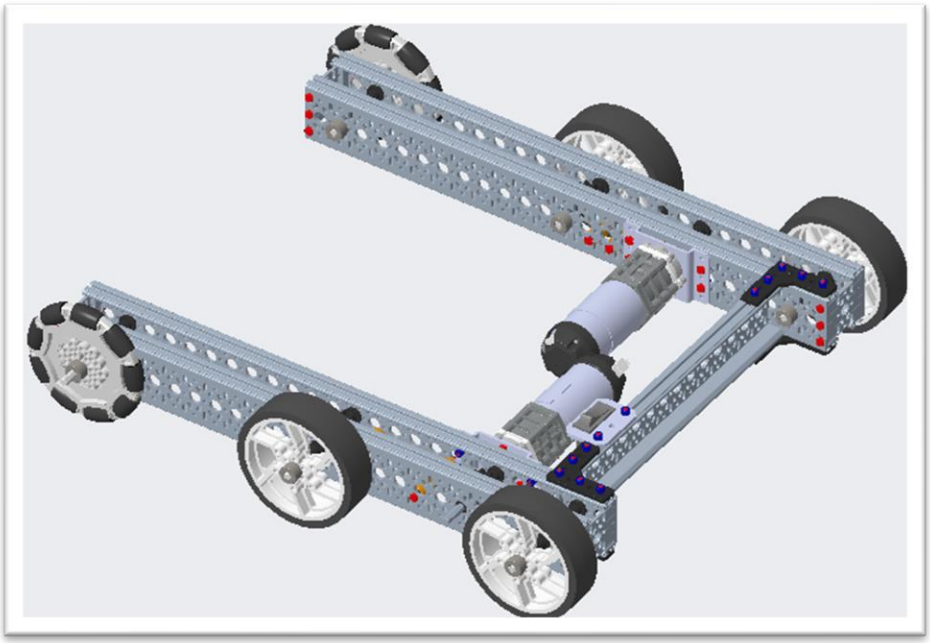


Figure 51- Assembled view

Helpful Hints

- Slide the screw heads along the center of the extrusion.
- Cross channel should touch left and right rails.
- All angles should be 90 degrees.
- The switch assembly should touch the bracket nearest to the left rail.
- Secure the screws by tightening them to the point they no longer slide along the extrusion.

Step 2: Add Battery Plates to Channel

Parts Needed:
Battery Plate Assembly (2)
Chassis

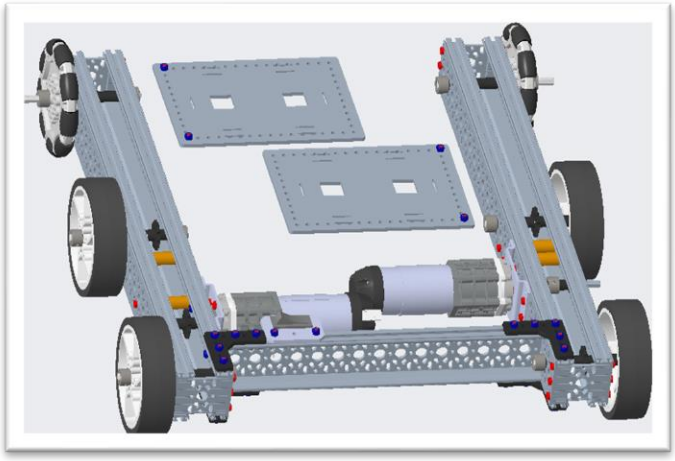


Figure 52- Unassembled view

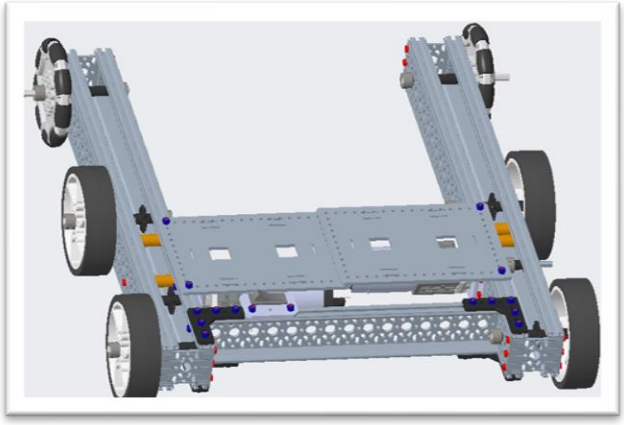


Figure 53- Assembled view

Helpful Hint

- Slide the screw heads along the center of the extrusion.
- The left battery plate should touch the switch plate
- The right battery plate should align with the left battery plate front-to-back and be above the left battery plate.
- All angles should be 90 degrees.
- Secure the screws by tightening them to the point they no longer slide along the extrusion.

Step 3: Add Front Cross Channel

Parts Needed:

REV-41-1767 – 45mmx15mm C Channel - 248mm (1)
Corner Bracket Assembly (4)
Chassis

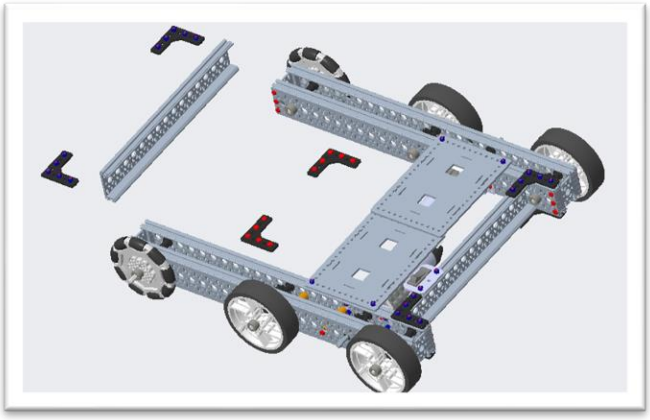


Figure 54- Unassembled view

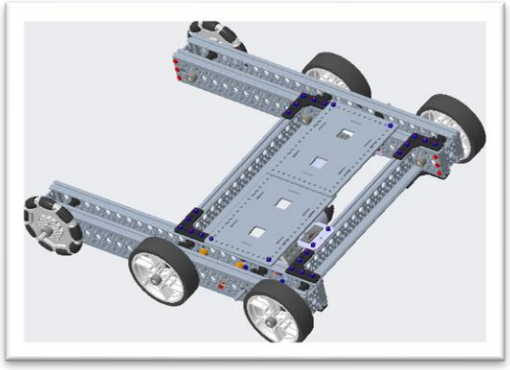


Figure 55- Assembled view

Helpful Hint

- Slide the screw heads along the center of the extrusion.
- Cross channel should touch left and right rails.
- The brackets should touch the battery plates.
- All angles should be 90 degrees.
- Secure the screws by tightening them to the point they no longer slide along the extrusion.
- There should be approximately 155mm between cross channels. This distance isn't critical, but it should be even between both sides. It may be easier to install if the front wheels are removed then re-installed.

Step 4: Add Control Hub and Battery

Parts Needed:
REV-31-1595 - Control Hub (1)
REV-31-1302 - 12V Slim Battery (1)
REV-41-1360 – Screw, Hex Cap, M3, 16mm (2)
REV-41-1361 – Nut, Locking, M3 (2)
Chassis

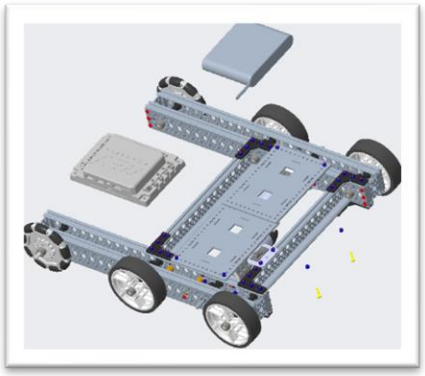


Figure 56- Unassembled view

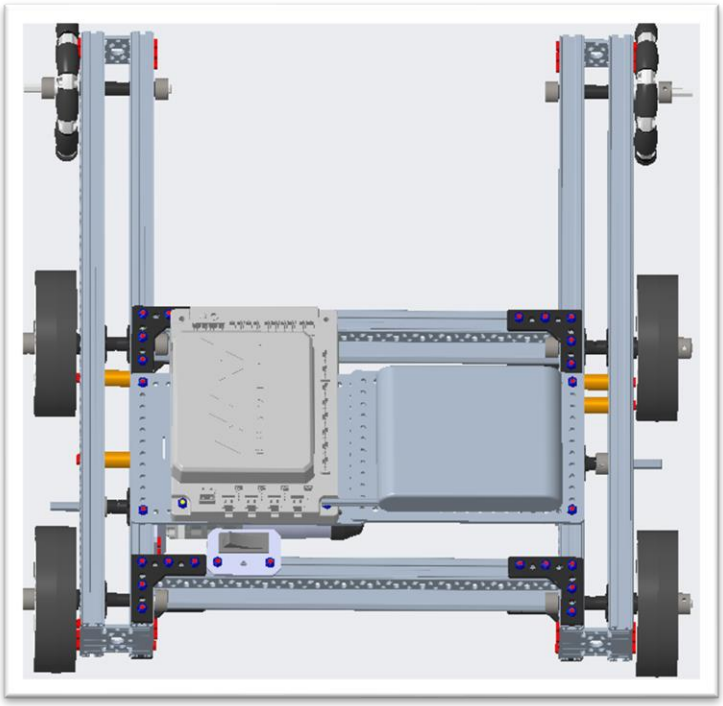


Figure 57- Assembled view

Wiring

Step 1: Add the Left Drive Motor Power Cable

Parts Needed:

Motor Power Cable (1 – comes with the core hex motor – REV-41-1300)

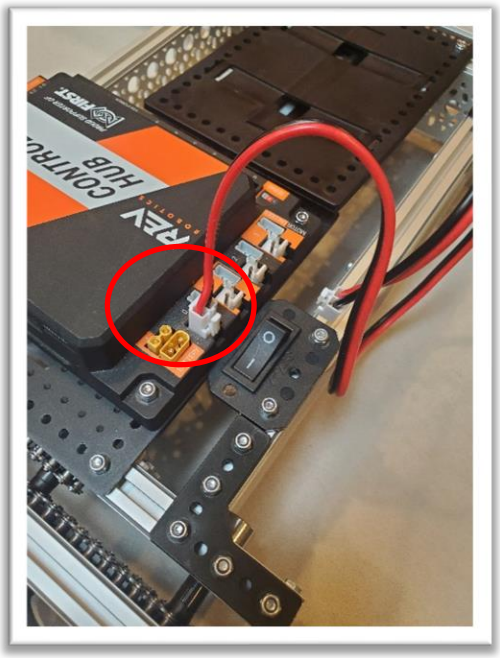


Figure 58- Control Hub View

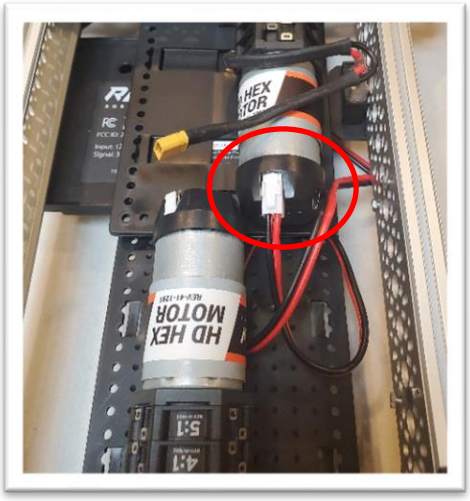


Figure 59- Motor View

Helpful Hint

- Plug one end of the cable into port zero (0) of the control hub.
- Plug the other end of the cable into the motor.
- In the far right image, the robot is upside down.

Step 2: Add the Right Drive Motor Power Cable

Parts Needed:

Motor Power Cable (1 – comes with the core hex motor – REV-41-1300)

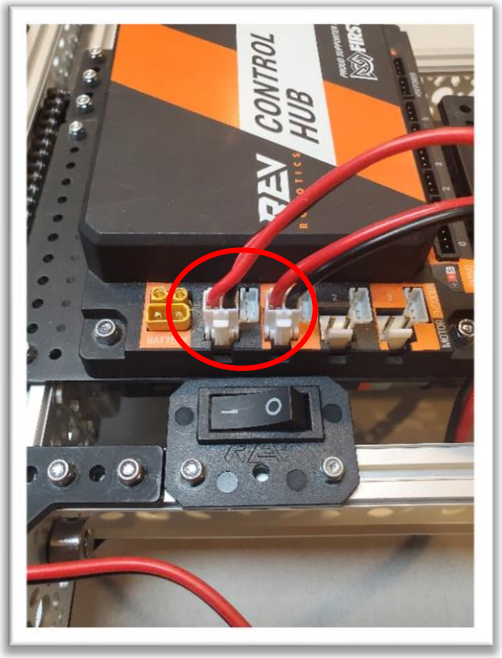


Figure 60- Control Hub View

Figure 61- Motor View

Helpful Hint

- Plug one end of the cable into port one (1) of the control hub.
- Plug the other end of the cable into the motor.
- In the far right image, the robot is upside down.

Step 3: Connect the Switch to the Control Hub

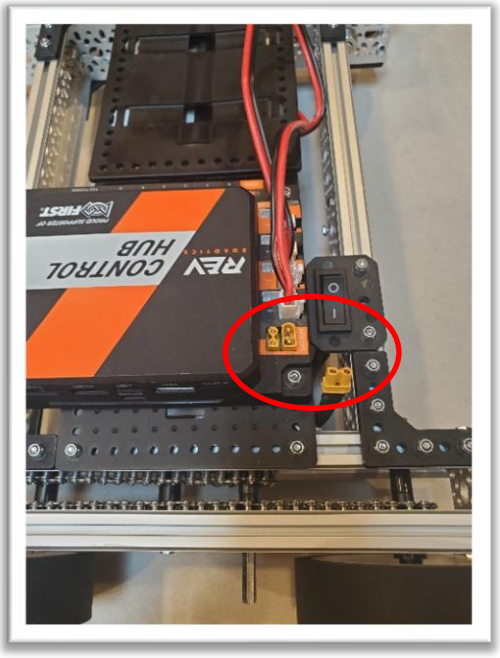


Figure 62- Unconnected View

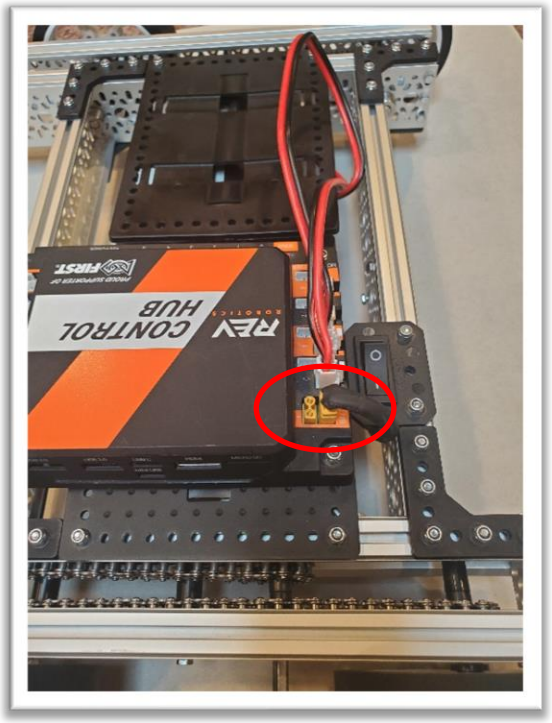


Figure 63- Connected View

Helpful Hint

- The plugs on the switch wires are keyed - only the correct plug will fit into the Control Hub.

Step 4: Add the Battery

Parts Needed:
REV-31-1302 – Slim Battery, 3000mAh (1)
REV-41-1161 – Zip Tie, 160mm (2)

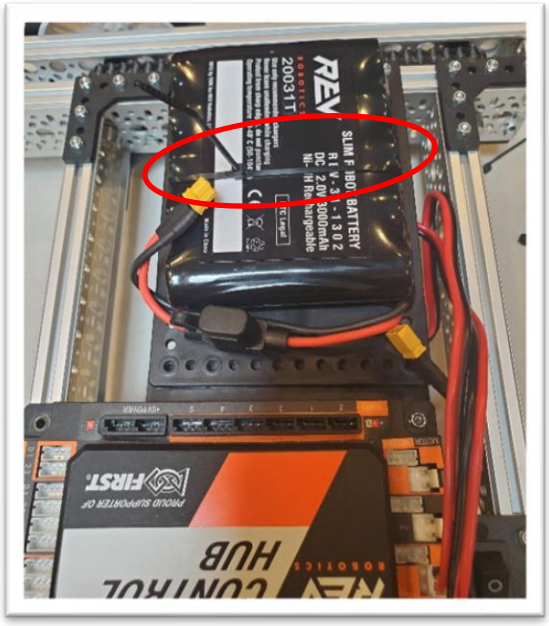


Figure 64- Assembled view

Helpful Hints

- Use two zip ties connected to each other to secure the battery to the plate.
- Securing the battery to the chassis prevents it from being separated from the chassis during game play.

Step 5: Connect the Battery to the Switch

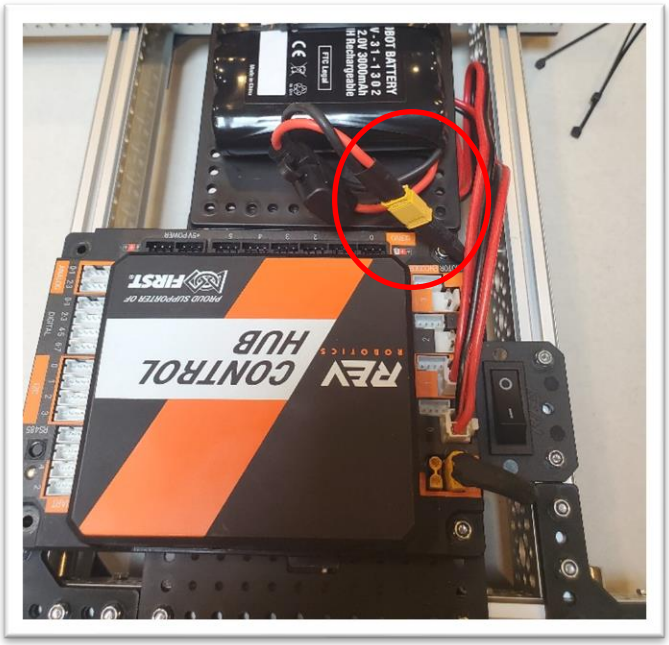


Figure 65- Connected view

Helpful Hint

- The plugs on the switch wires are keyed - only the correct plug will fit into the battery connector.

Final Steps

What's Next?

- You have now constructed the frame of your Basic 'Bot, 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. Testing will also show whether more cables need to be secured or re-routed.
- Check the game rules for all the applicable stickers
- Make sure to also go over the robot checklists:
    - Robot Self-Inspection Checklist
    - Robot Reliability Checklist

Resources

Visit the FIRST website for programming resources, robot building resources, more instructions and game rules.

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

Appendix A – Resources

Game Forum Q&A

https://ftc-qa.firstinspires.org/

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.

Volunteer Forum

Volunteers can request access to role specific volunteer forums by emailing FTCTrainingSupport@firstinspires.org. 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 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!