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2023-2024 FIRST® Tech Challenge

Basic 'Bot Guide for REV- Part 2

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Raytheon Technologies

Revision History		
Revision	Date	Description
1	9/20/2023	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. 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 is designed as a resource for teams looking for a step-by-step instructional guide building a basic armature for the FIRST Tech Challenge competition. There are multiple versions of this guide, previously called the "Push Bot Guide". This version of the Basic 'Bot Guide for REV Part 2 (Armature) has been created to use the 2023-2024 season's REV kit of parts.

Parts

- REV FTC Competition Set
 - Tools included with the REV FTC Competition Set
- 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 perpendicular (90° angles). It is hard to drive a crooked robot straight!
- The drive wheels are powered by two DC motors located on the back of the robot, which are relatively heavy. This weight is needed to help the wheels grip the surface better.
- Omni wheels should be located on the front of the robot, which allows the robot to turn more easily. The omni wheels' rollers slide sideways with very little friction.
- Unless otherwise noted, the top image in each step shows the necessary parts; the lower image shows the completed assembly.
- Place all completed sub-assemblies aside in a plastic container.

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

Pitsco 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

Overview

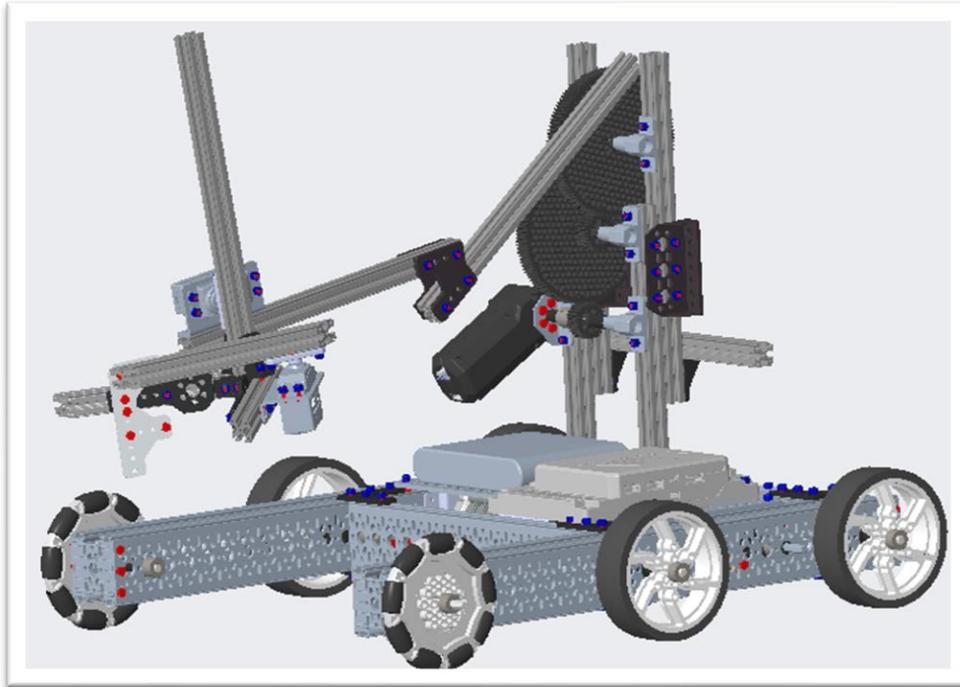


Figure 1- Front Left View

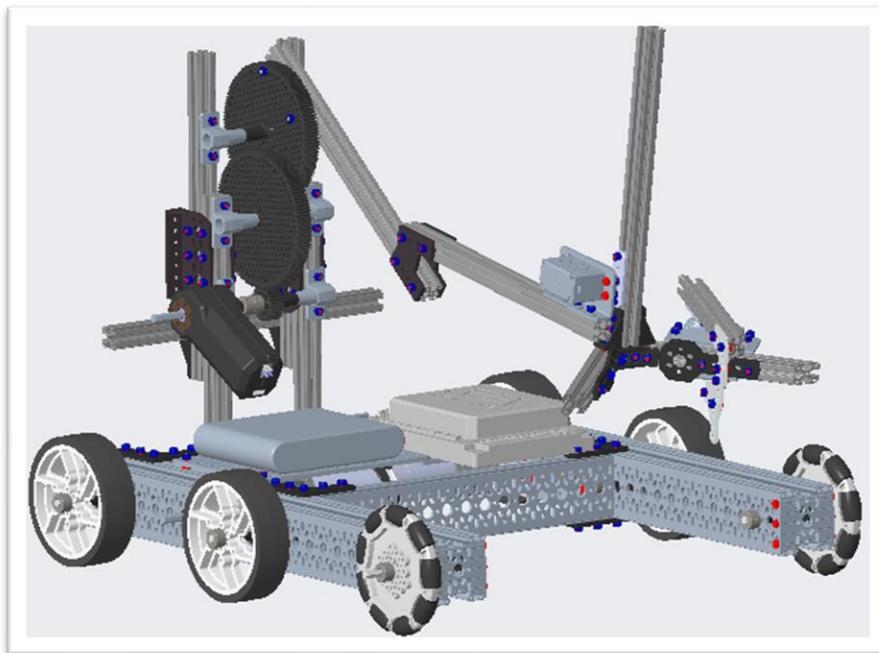


Figure 2- Front Right View

Armature

Step 1: Add Lower Stationary Extrusions

Parts Needed:

- REV-41-1431 15mm Extrusion - 225mm - 90° Ends (2)
- REV-41-1359 M3 Hex Cap Screw (4)
- REV-41-1361 M3 Nyloc Nut (4)

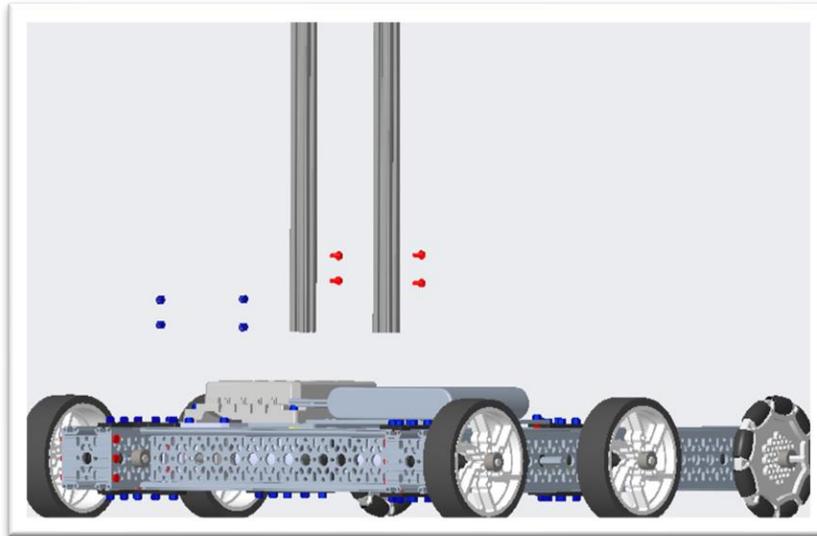


Figure 3- Unassembled view

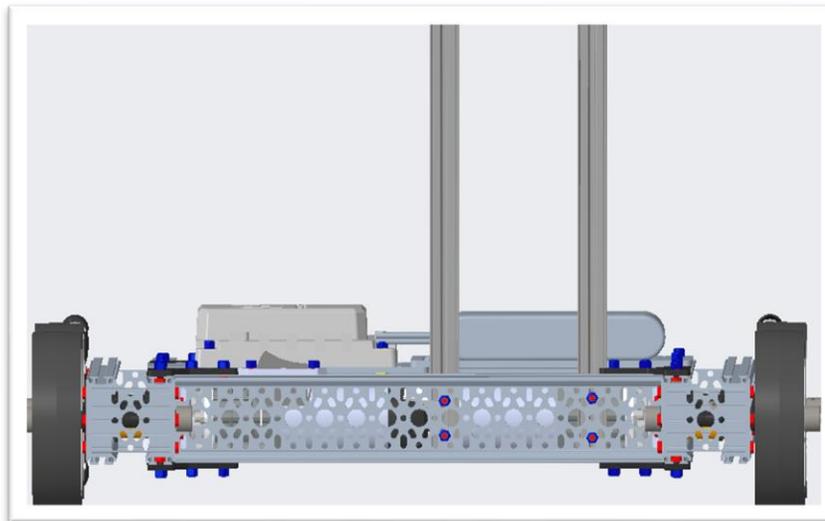


Figure 4- Assembled view

Helpful Hint

- The bottom of the extrusions should be flush with the bottom of the channel.

Step 2: Prepare Gearbox Motion Brackets

Parts Needed: *Make 4*

REV-41-1315 15mm Gearbox Motion Bracket (1x4)
REV-41-1359 M3 Hex Cap Screw (6x4)
REV-41-1361 M3 Nyloc Nut (6x4)

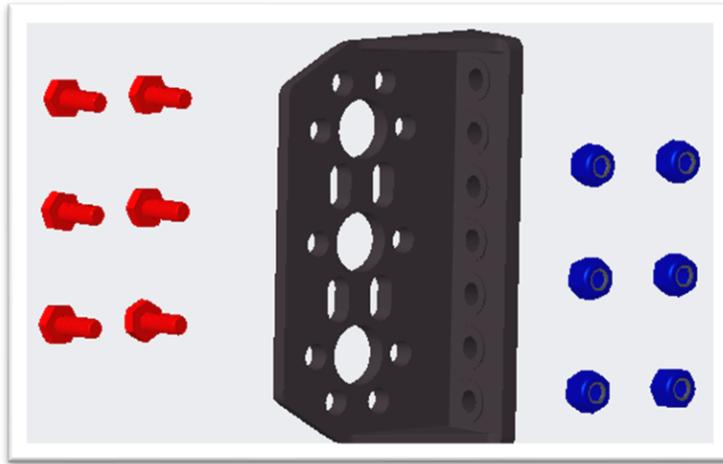


Figure 5- Unassembled view

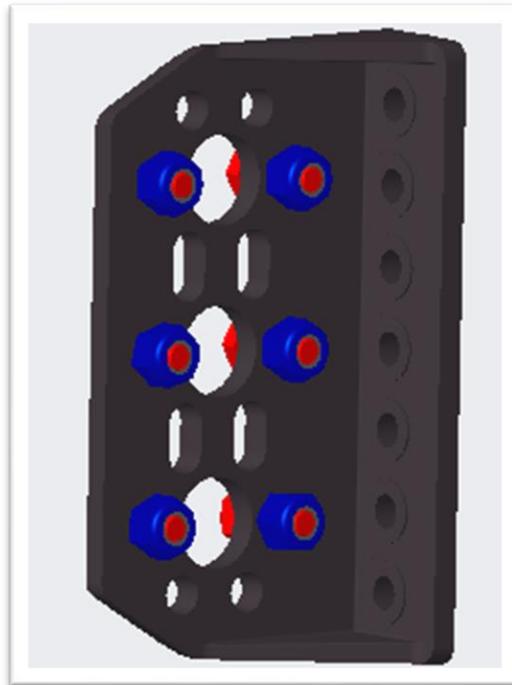


Figure 6- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 3: Add Gearbox Motion Brackets

Parts Needed:
Gearbox Motion Bracket Assemblies from the previous step (4)

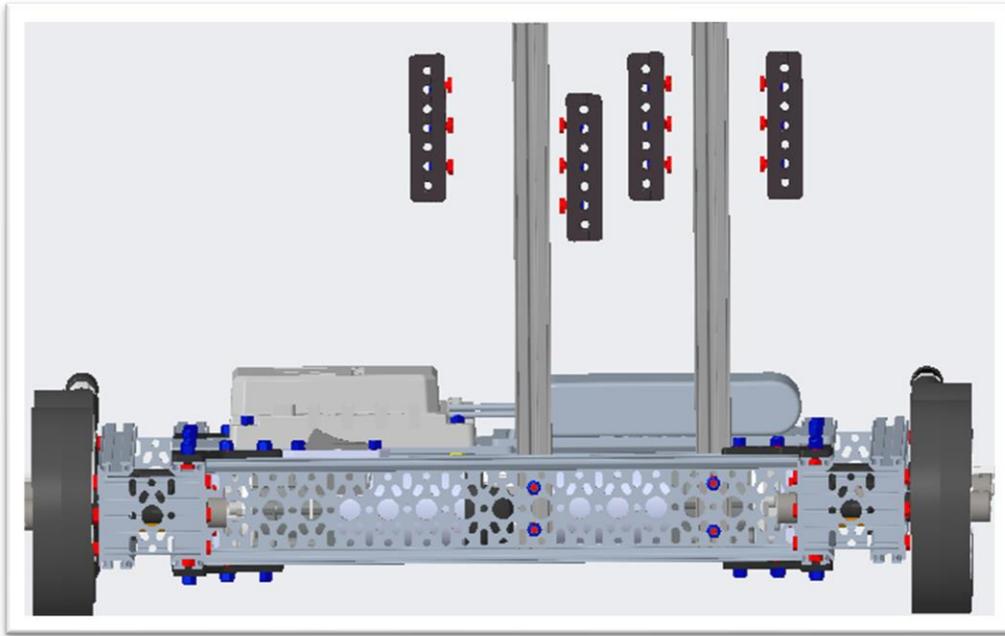


Figure 7- Unassembled view

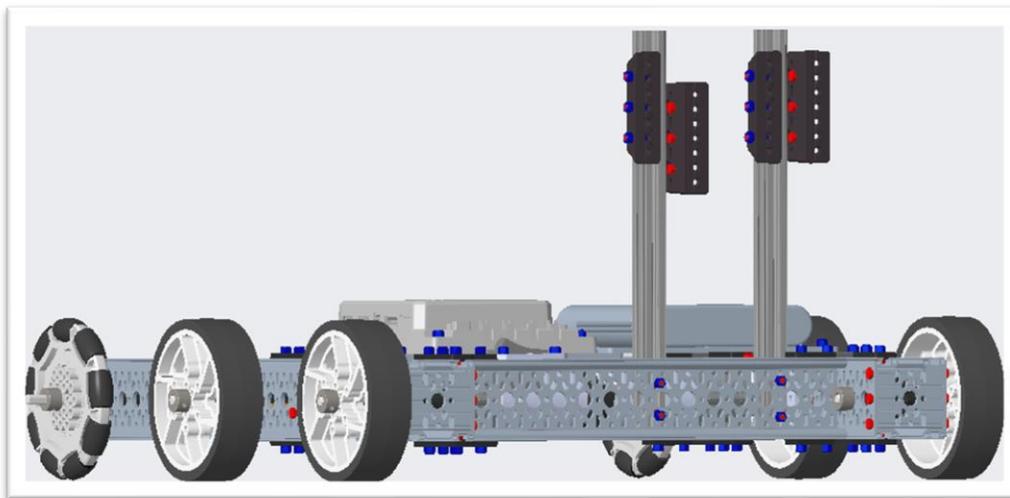


Figure 8- Assembled view

Helpful Hints

- Three of the plates should be about 12 mm from the top of the extrusions.
- The fourth plate should be about 20 mm from the top of the extrusion.
- Tighten the screws/nuts that attach the bracket to the extrusion; leave the other screws/nuts loose.

Step 4: Add Upper Stationary Extrusions

Parts Needed:
REV-41-1431 15mm Extrusion - 225mm - 90° Ends (2)

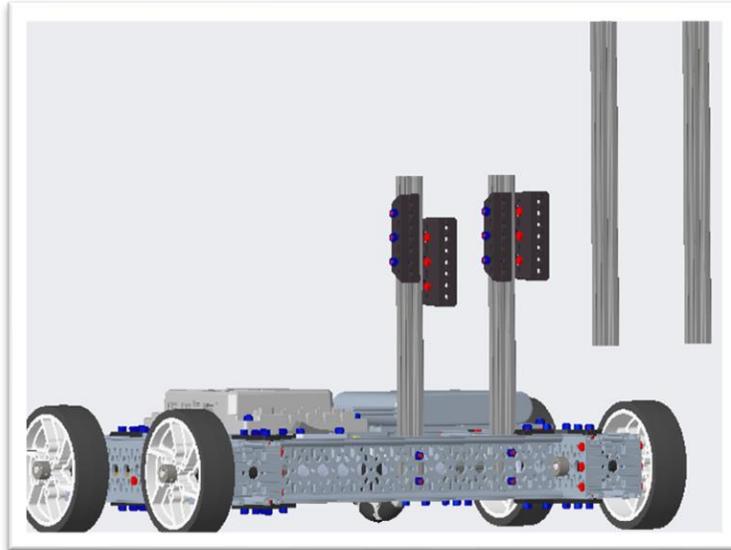


Figure 9- Unassembled view

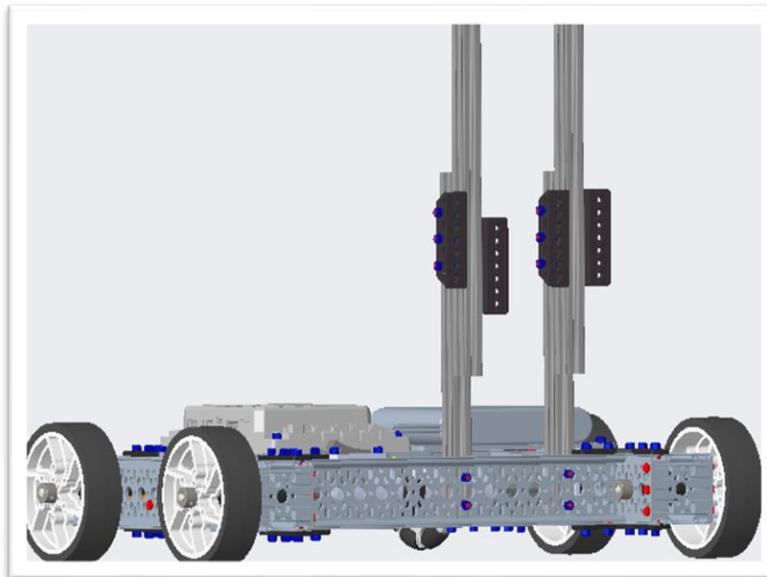


Figure 10- Assembled view

Helpful Hints

- The bottom of the extrusions should be approximately 52 mm above the top of the horizontal channel.
- The purpose of the extensions is to provide height for the scoring mechanism.
- The channels might need to be lower, if the robot isn't able to pass under the truss.
- Tighten all screws/nuts.

Step 5: Prepare Pillow Blocks

Parts Needed: Make 5

REV-41-1317 15mm Bearing Pillow Block (1x5)
REV-41-1359 M3 Hex Cap Screw (2x5)
REV-41-1361 M3 Nyloc Nut (2x5)

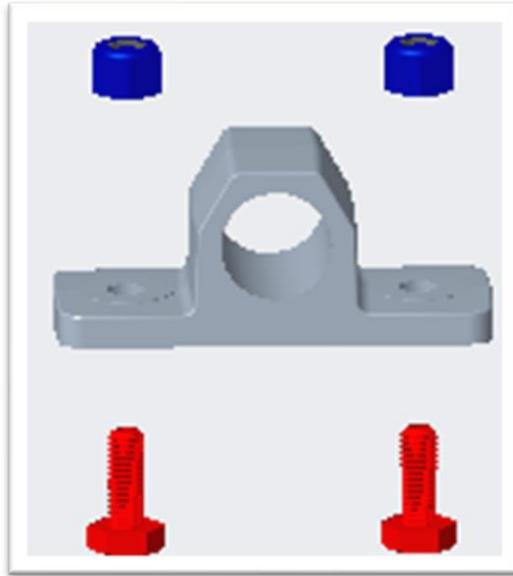


Figure 11- Unassembled view

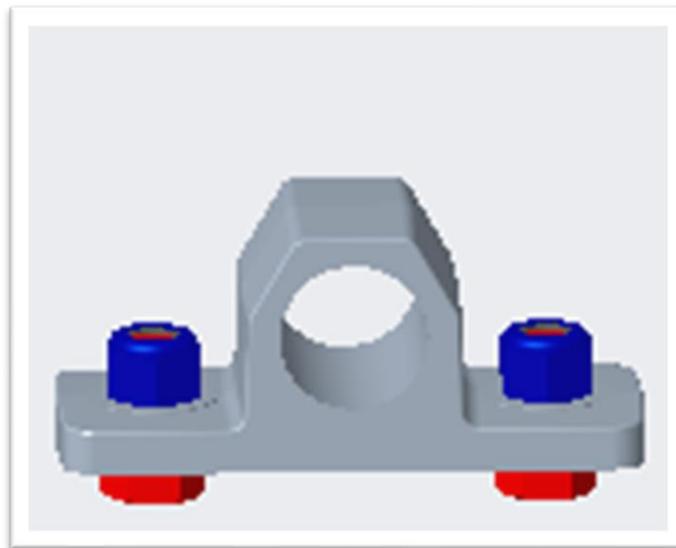


Figure 12- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 6: Prepare Motor Bracket

Parts Needed:

- REV-41-1433 15mm Metal Bent Core Hex Motor Bracket V2 (1)
- REV-41-1359 M3 Hex Cap Screw (2)
- REV-41-1361 M3 Nyloc Nut (2)

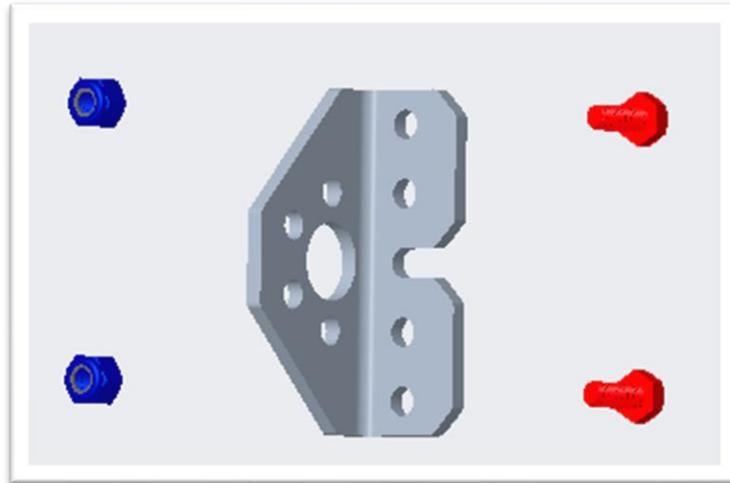


Figure 13- Unassembled view

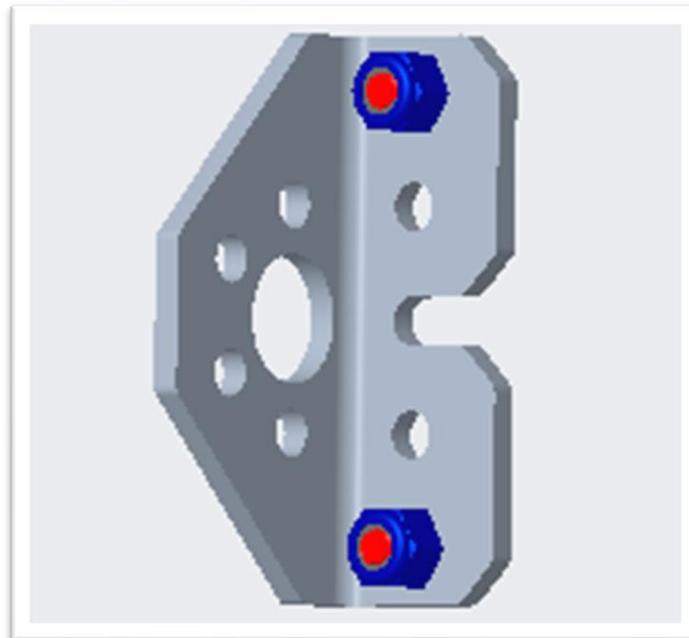


Figure 14- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 7: Add Motor Gear Train

Parts Needed:

- REV-41-1300 Core Hex Motor (1)
- Motor Bracket Assembly from previous step (1)
- REV-41-1359 M3 Hex Cap Screw (4)
- REV-41-1323 15mm Spacer (2)
- REV-41-1349 5mm Hex Shaft (1)
- REV-41-1327 Shaft Collar (2)
- REV-41-1332 30 Tooth Plastic Gear (1)
- REV-41-1322 End Cap Bearing (1)
- Pillow Block Assembly from a previous step (1)

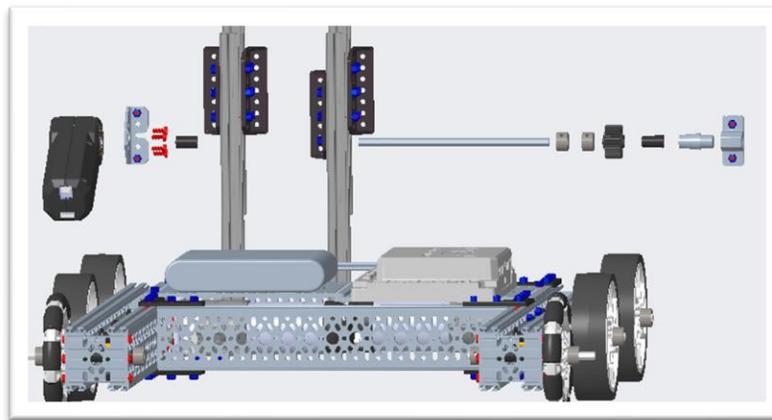


Figure 15- Unassembled view

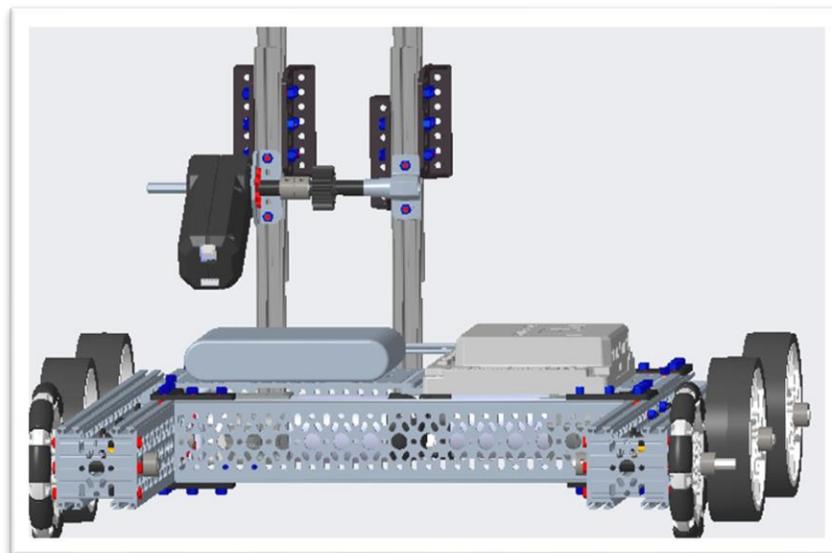


Figure 16- Assembled view

Helpful Hints

- Slide motor bracket and pillow block along extrusions.
- Leave screws/nuts loose; the train height will be adjusted in a later step.

Step 8: Add Middle Gear Train

Parts Needed:

- Pillow Block Assemblies from a previous step (2)
- REV-41-1322 End Cap Bearing (2)
- REV-41-1333 125 Tooth Plastic Gear (1)
- REV-41-1347 5mm Hex Shaft (1)
- REV-41-1325 1.5mm Spacer (1)
- REV-41-1332 30 Tooth Plastic Gear (1)

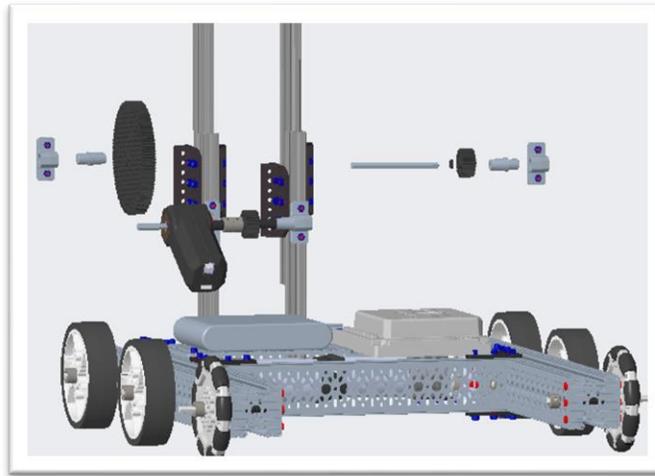


Figure 17- Unassembled view

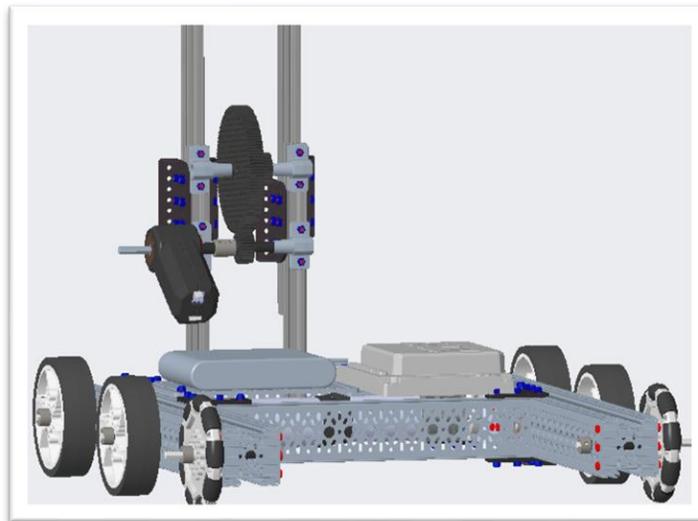


Figure 18- Assembled view

Helpful Hints

- Make the shaft perpendicular to the chassis.
- The top of the pillow blocks should be flush with the top of the lower extrusion; tighten the middle gear train screws/nuts.
- Adjust the lower gear train so the large gear meshes with the little gear; not too tight or it will bind; not too loose or it will skip.
- Tighten all screws/nuts.

Step 9: Add Upper Gear Train

Parts Needed:

- Pillow Block Assemblies from previous step (2)
- REV-41-1322 End Cap Bearing (2)
- REV-41-1325 1.5mm Spacer (1)
- REV-41-1323 15mm Spacer (1)
- REV-41-1333 125 Tooth Plastic Gear (1)
- REV-41-1347 5mm Hex Shaft (1)

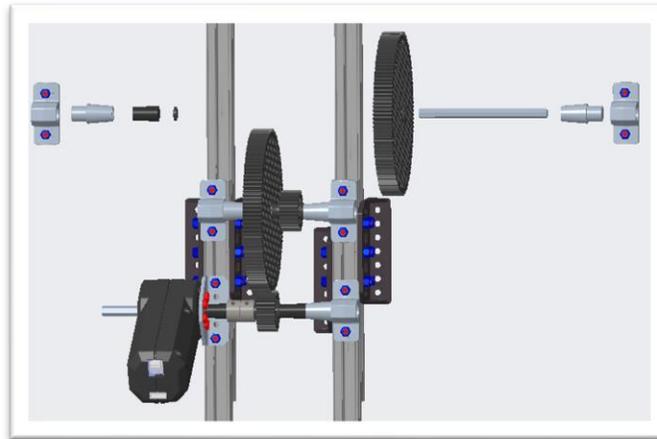


Figure 19- Unassembled view

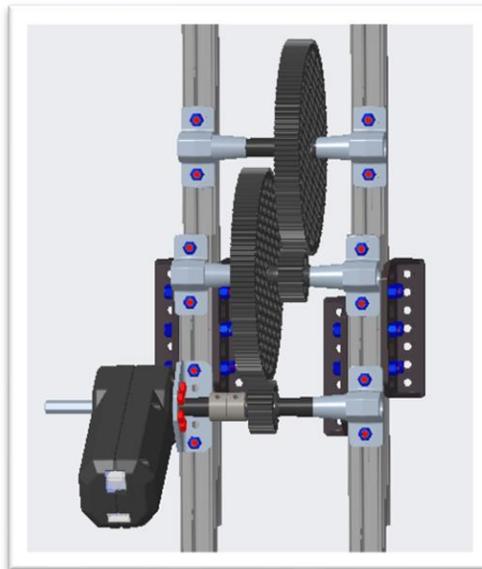


Figure 20- Assembled view

Helpful Hints

- Adjust the upper gear train so the large gear meshes with the little gear; not too tight or it will bind; not too loose or it will skip.
- Tighten all screws/nuts.

Step 10: Prepare Lap Corner Brackets

Parts Needed: *Make 4*

REV-41-1321 15mm Plastic Lap Corner Bracket (1x4)
REV-41-1359 M3 Hex Cap Screw (3x4)
REV-41-1361 M3 Nyloc Nut (3x4)

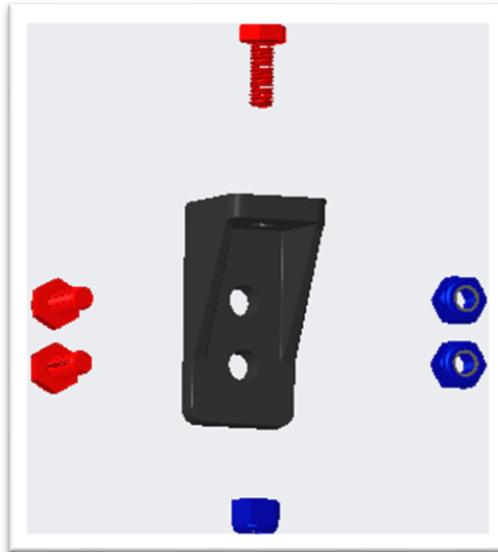


Figure 21- Unassembled view



Figure 22- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 11: Add Lap Corner Bracket Assemblies

Parts Needed:

REV-41-1431 15mm Extrusion - 225mm - 90° Ends (1)
Lap Corner Bracket Assemblies from previous step (2)

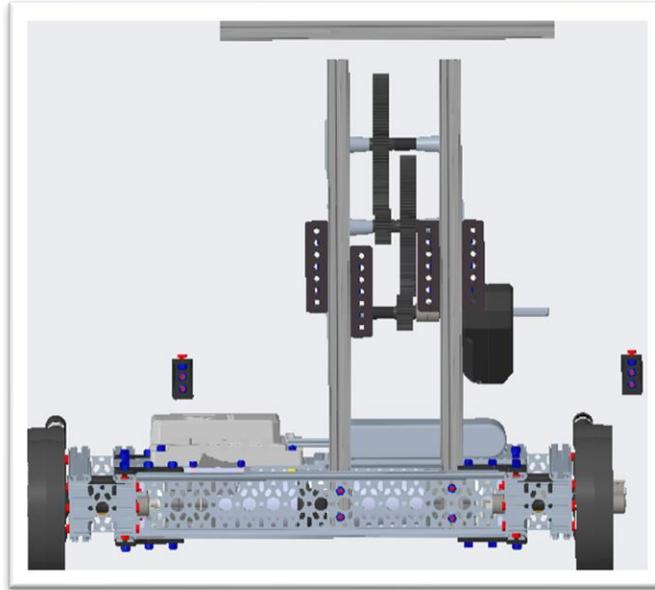


Figure 23- Unassembled view

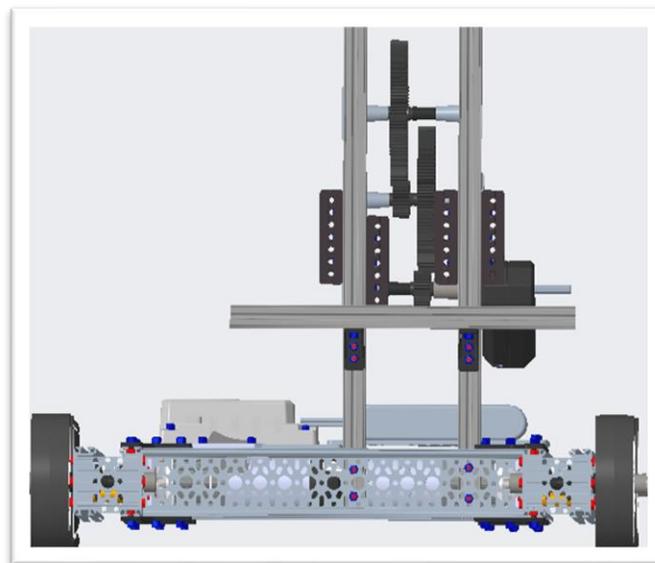


Figure 24- Assembled view

Helpful Hint

- The bottom of the brackets should be flush with the bottom of the upper extrusion; tighten the screws/nuts.

Step 12: Add Inner Movable Arm Extrusion

Parts Needed:

- REV-41-1431 15mm Extrusion - 225mm - 90° Ends (1)
- REV-41-1360 M3 Hex Cap Screw (2)
- REV-41-1361 M3 Nyloc Nut (2)

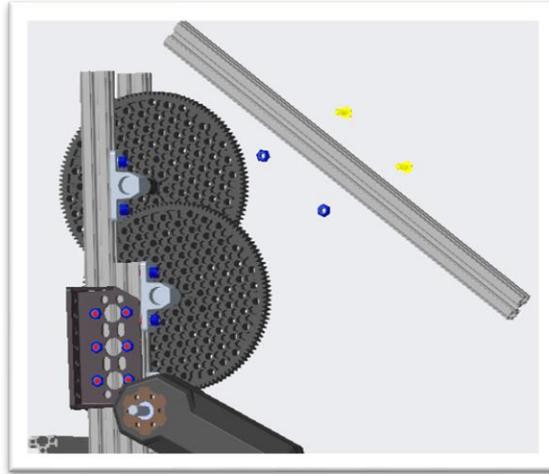


Figure 25- Unassembled view

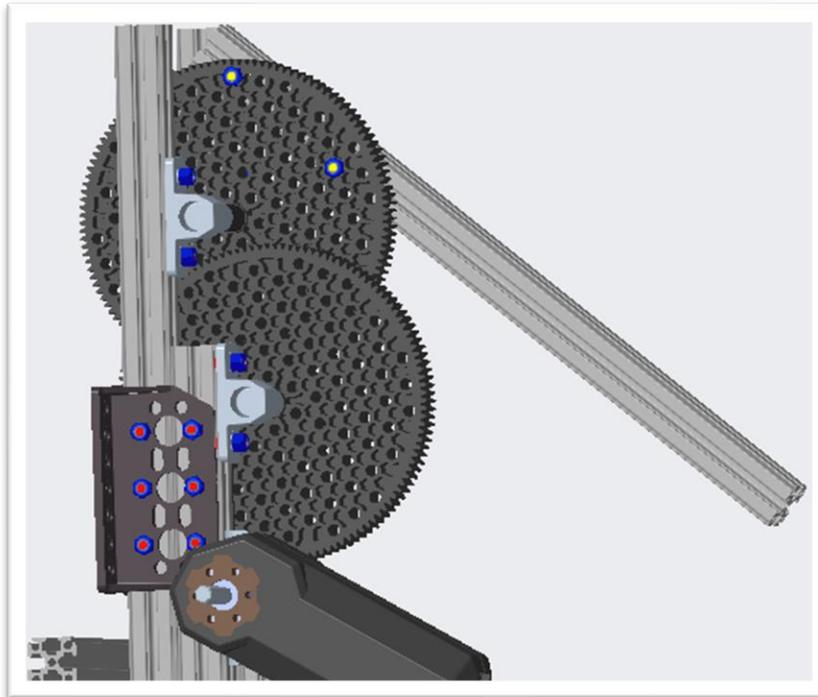


Figure 26- Assembled view

Helpful Hint

- Tighten all screws/nuts.

Step 13: Prepare 30 Degree Brackets

Parts Needed: Make 2

REV-41-1308 15mm Plastic 30 Degree Bracket (1x2)

REV-41-1359 M3 Hex Cap Screw (4x2)

REV-41-1361 M3 Nyloc Nut (4x2)

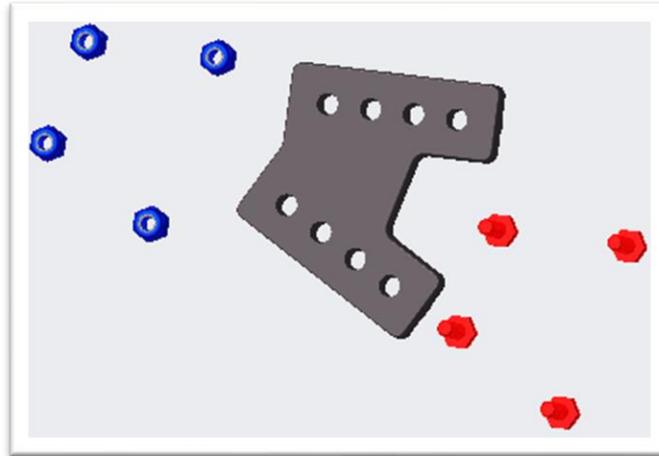


Figure 27- Unassembled view

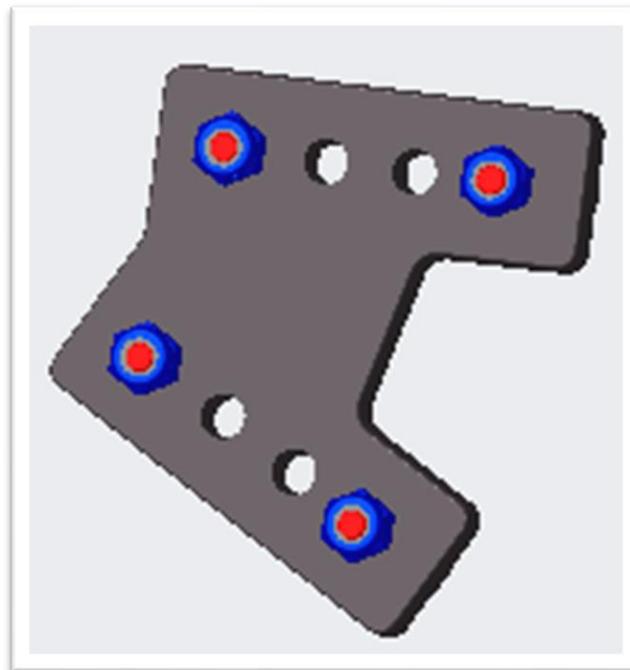


Figure 28- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 14: Add Outer Movable Arm Extrusion

Parts Needed:

30 Degree Bracket Assemblies from previous step (2)
REV-41-1431 15mm Extrusion - 225mm - 90° Ends (1)

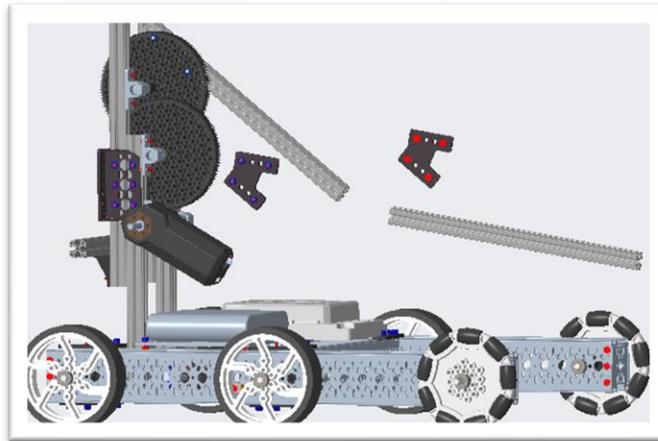


Figure 29- Unassembled view

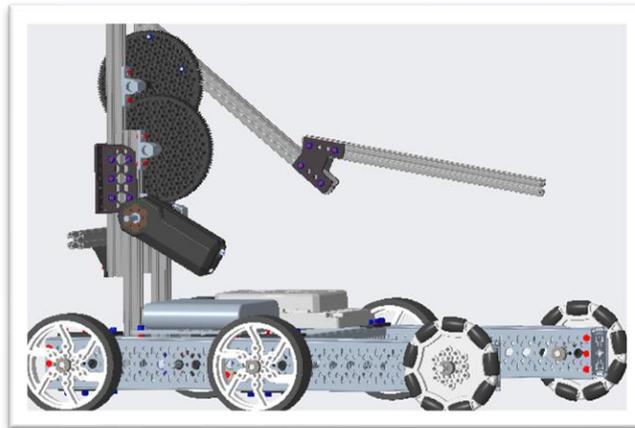


Figure 30- Assembled view

Helpful Hint

- Tighten all screws/nuts.

Step 15: Prepare Metal Bent Servo Bracket

Parts Needed: Make 2

- REV-41-1485 15mm Metal Bent Servo Bracket V2 (1x2)
- REV-41-1359 M3 Hex Cap Screw (3x2)
- REV-41-1361 M3 Nyloc Nut (3x2)

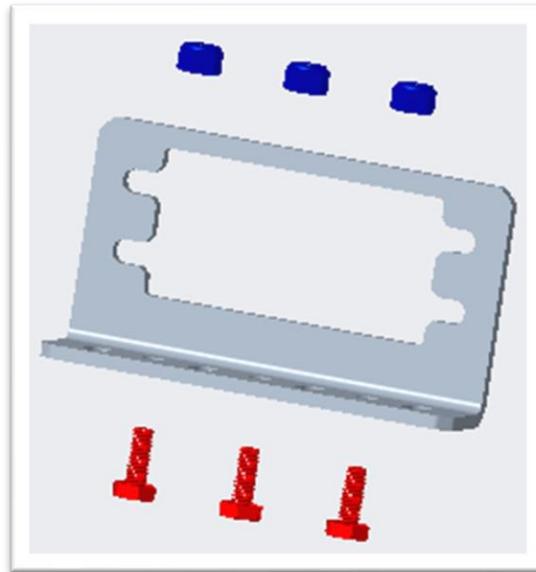


Figure 31- Unassembled view

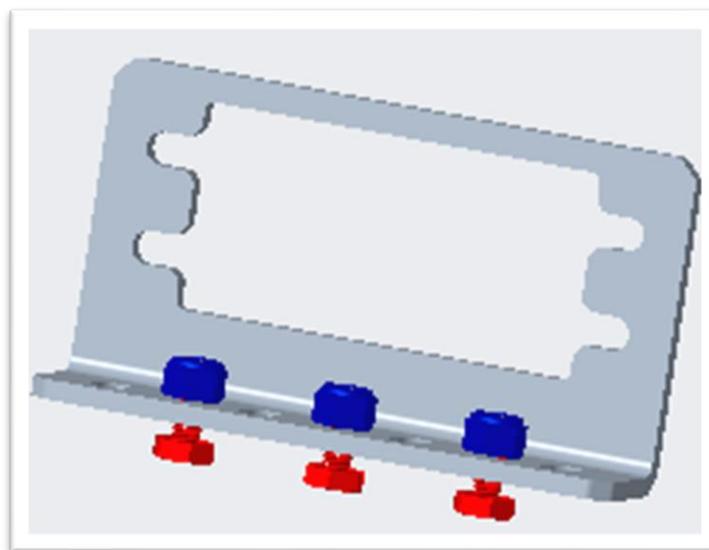


Figure 32- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 16: Prepare Servo Assembly

Parts Needed: *Make 2*

Metal Bent Servo Bracket Assembly from previous step (1x2)
 REV-41-1097 Smart Robot Servo (1x2)
 REV-41-1359 M3 Hex Cap Screw (4x2)
 REV-41-1361 M3 Nyloc Nut (4x2)

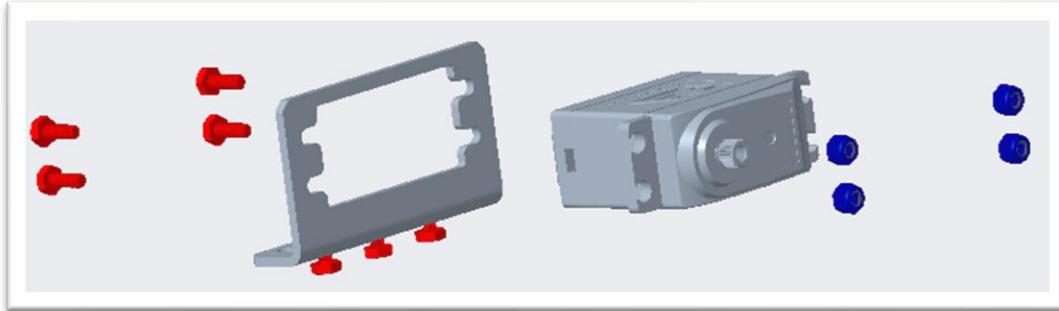


Figure 33- Unassembled view

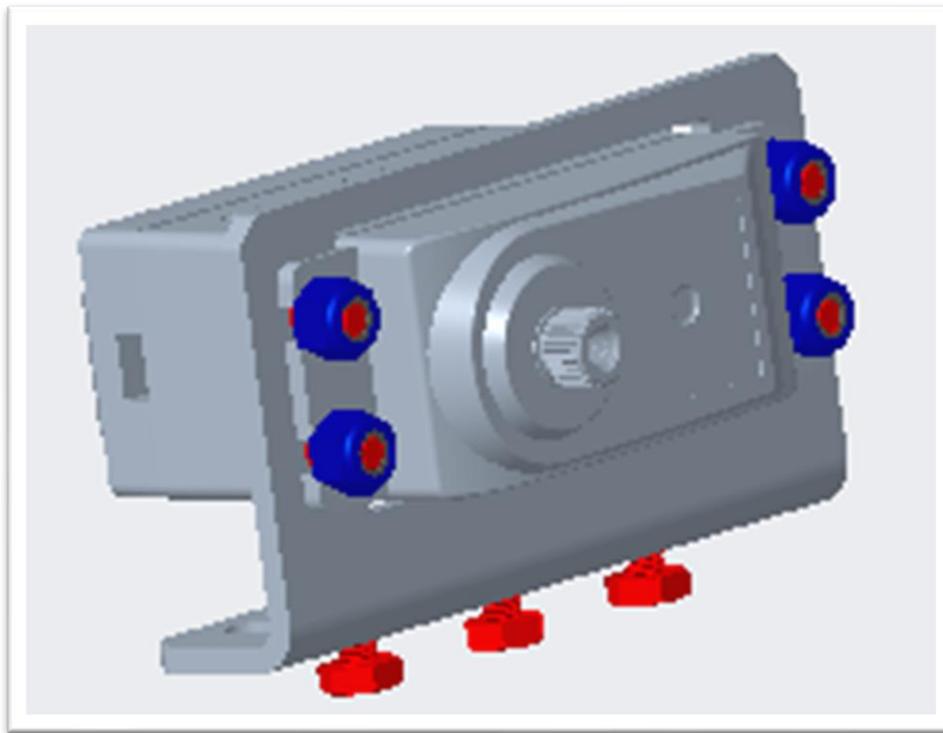


Figure 34- Assembled view

Helpful Hints

- Tighten the screws that hold the servo in the bracket.
- Leave the other screws/nuts loose to slide into extrusions in a later step.

Step 17: Add Arm Servo

Parts Needed:
Servo Assembly from previous step (1)

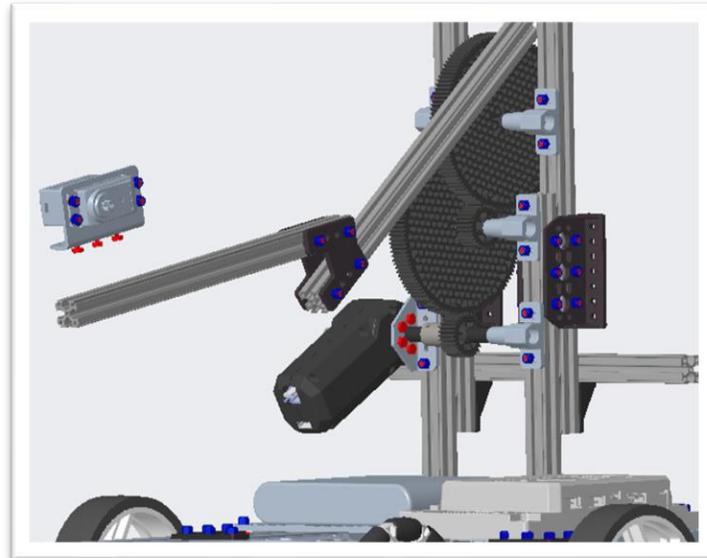


Figure 35- Unassembled view

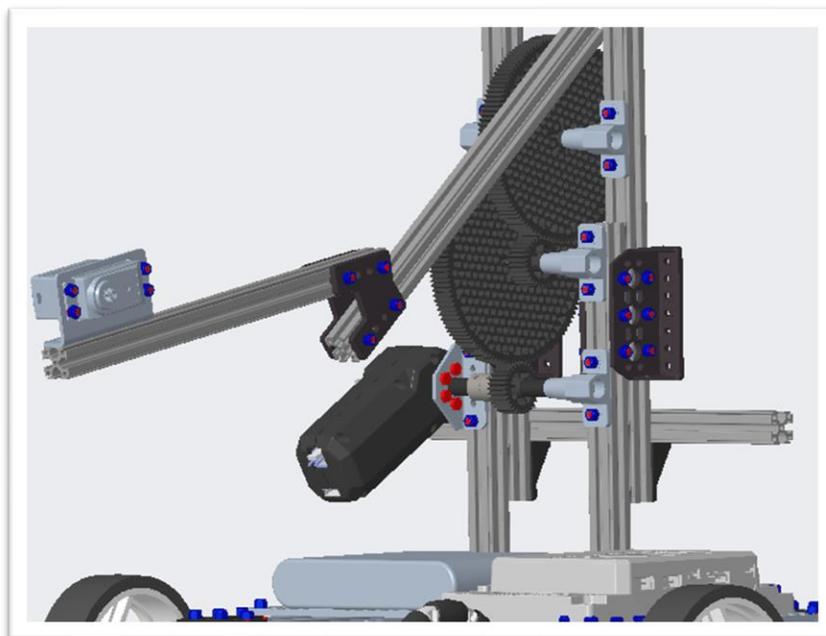


Figure 36- Assembled view

Helpful Hint

- The bracket should be flush with the end of the extrusion.

Step 18: Prepare Aluminum Double Servo Arm

Parts Needed: Make 2

REV-41-1820 Aluminum Double Servo Arm (1x2)
REV-41-1359 M3 Hex Cap Screw (2x2)
REV-41-1361 M3 Nyloc Nut (2x2)

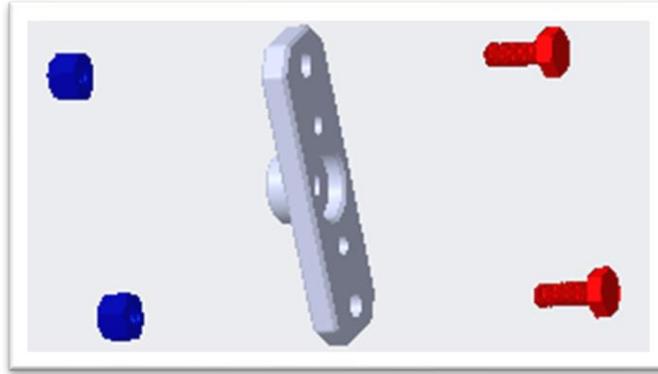


Figure 37- Unassembled view

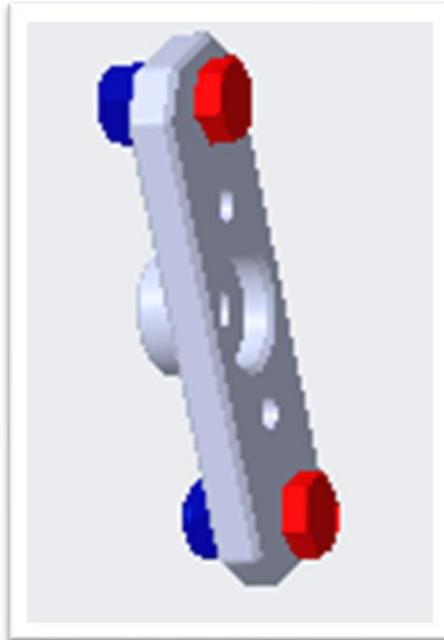


Figure 38- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 19: Add Double Servo Arm to Arm Servo

Parts Needed:
REV-41-1359 M3 Hex Cap Screw (1)
Aluminum Double Servo Arm Assembly from previous step

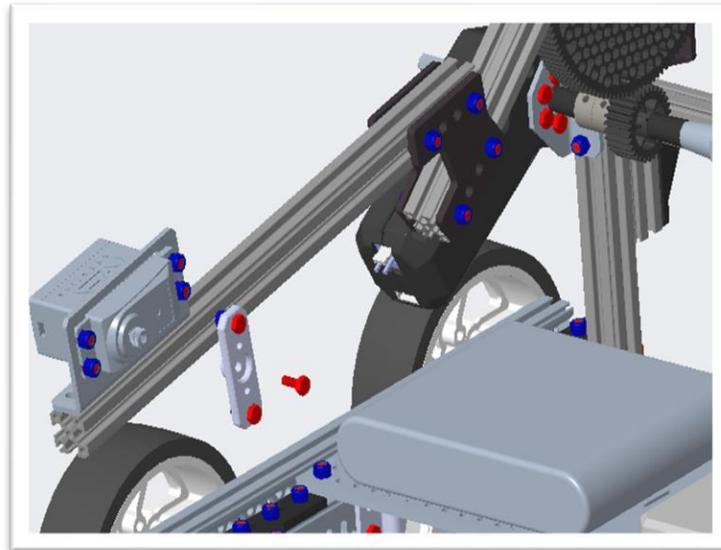


Figure 39- Unassembled view

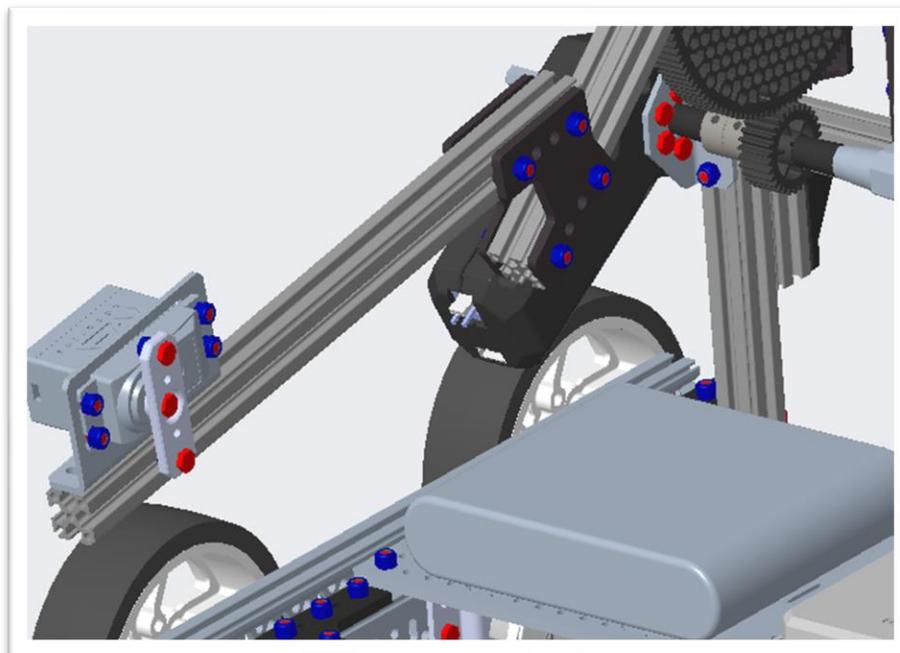


Figure 40- Assembled view

Helpful Hint

- The arm will be adjusted in a later step.

Step 20: Prepare Plastic Inside Corner Bracket

Parts Needed:

- REV-41-1320 15mm Plastic Inside Corner Bracket (1)
- REV-41-1359 M3 Hex Cap Screw (4)
- REV-41-1361 M3 Nyloc Nut (4)

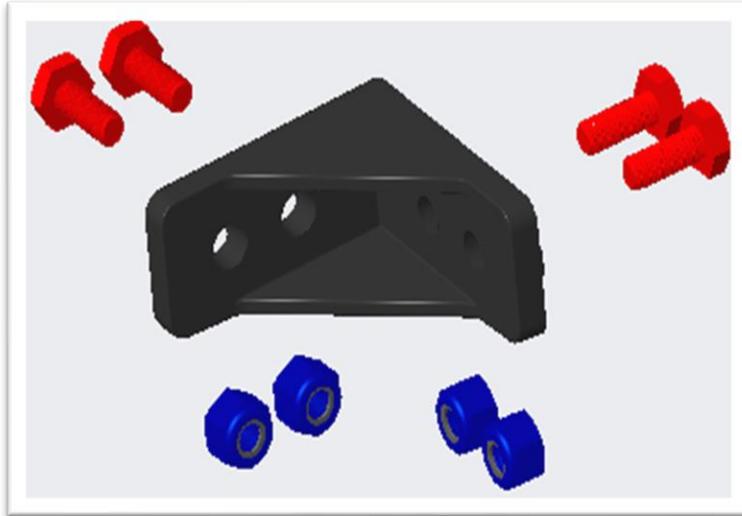


Figure 41- Unassembled view

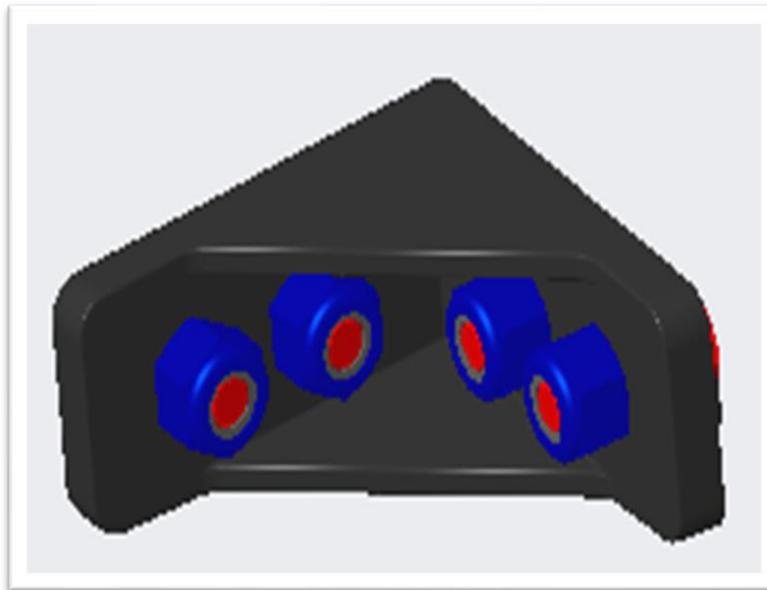


Figure 42- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 21: Make Pixel Holder

Parts Needed:

- Plastic Inside Corner Bracket Assembly from previous step (1)
- REV-41-1430 15mm Extrusion - 150mm - 45° Ends (2)

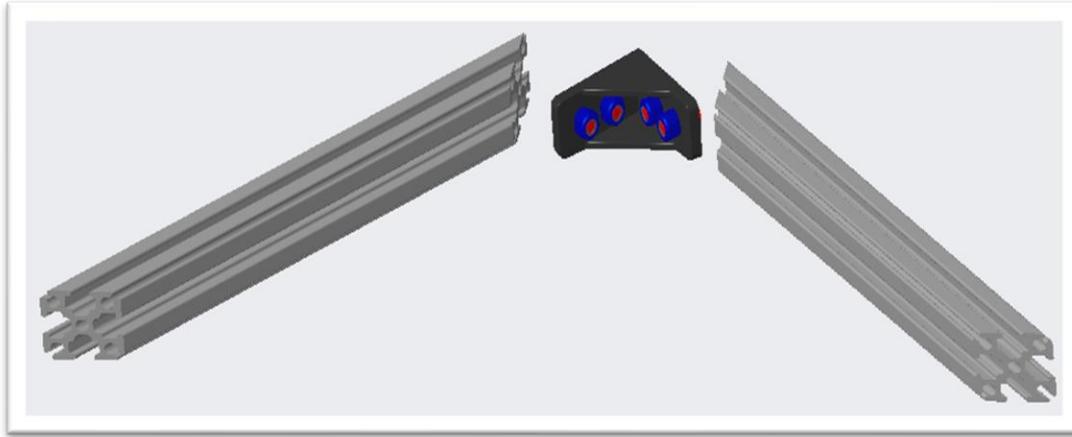


Figure 43- Unassembled view

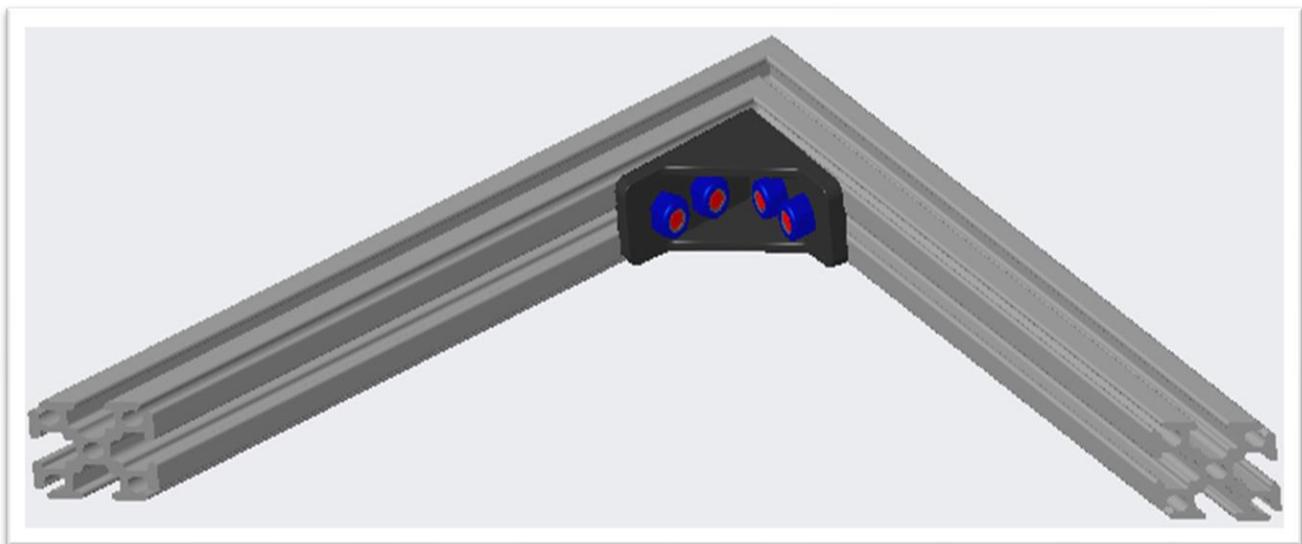


Figure 44- Assembled view

Helpful Hint

- Tighten all screws/nuts.

Step 22: Make Pixel Back Stop

Parts Needed:

- REV-41-1431 15mm Extrusion - 225mm - 90° Ends (1)
- Lap Corner Bracket Assemblies from a previous step (2)

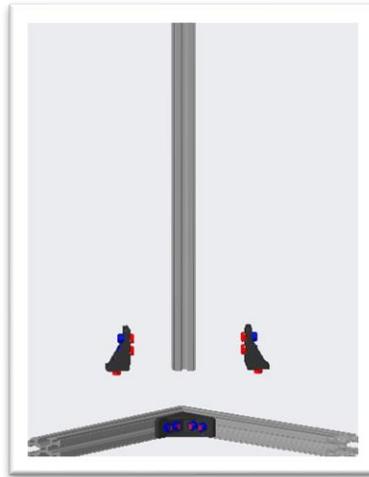


Figure 45- Unassembled view

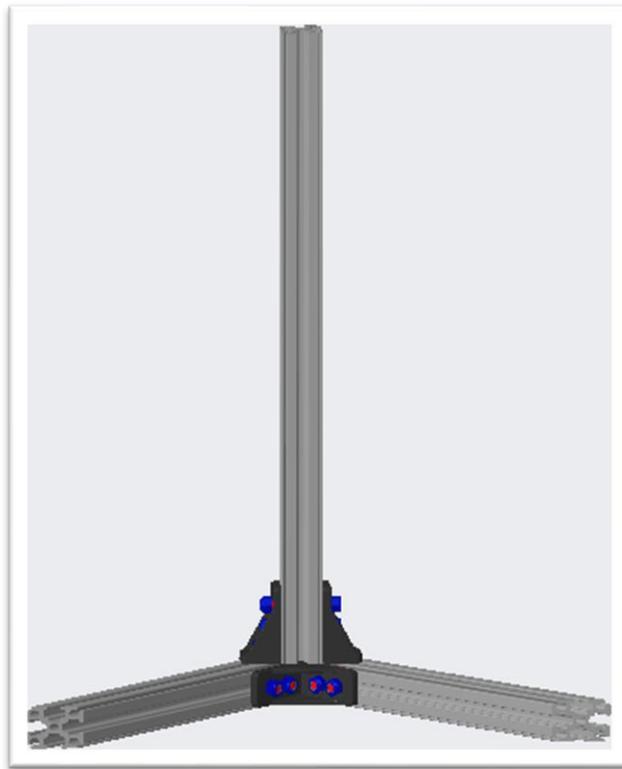


Figure 46- Assembled view

Helpful Hint

- Tighten all screws/nuts.

Step 23: Add Pixel Back Stop

Parts Needed:
Pixel Back Stop Assembly from previous step (1)

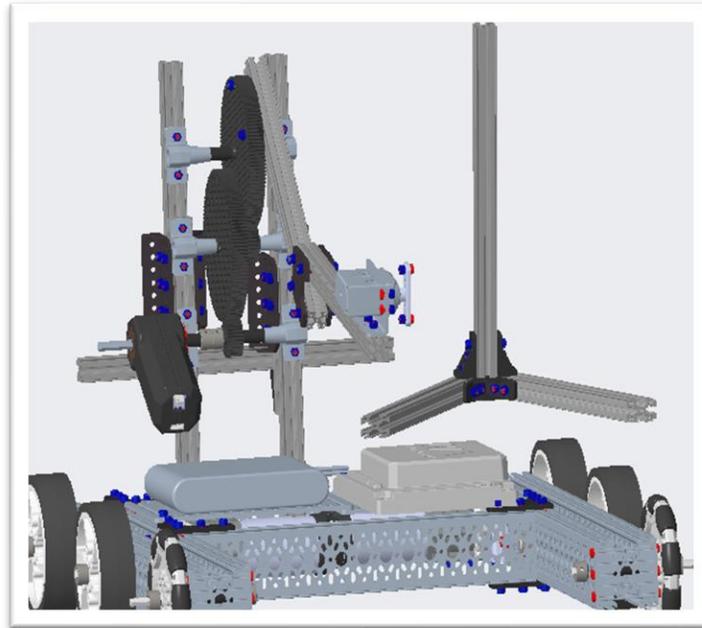


Figure 47- Unassembled view

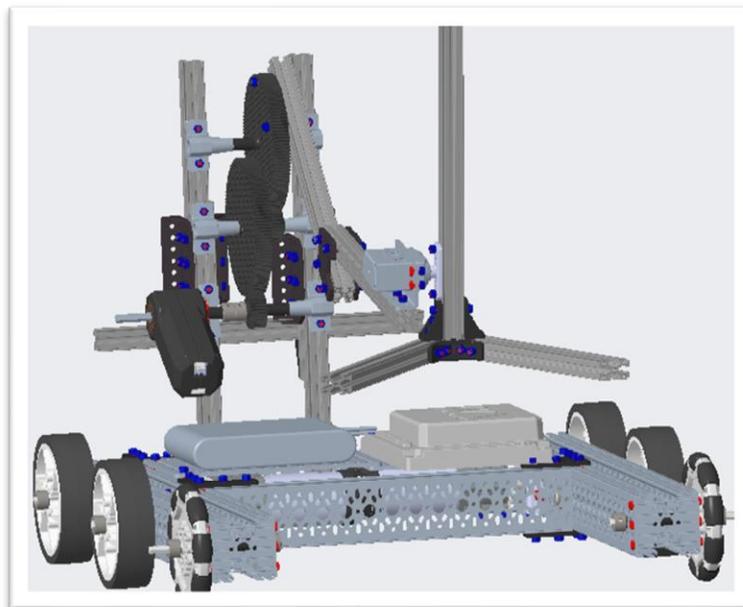


Figure 48- Assembled view

Helpful Hint

- The lap bracket of the back stop should be flush with the double servo arm.

Step 24: Prepare Rod End Brackets

Parts Needed: *Make 2*

REV-41-1304 15mm Plastic Rod End Bracket (1x2)
REV-41-1359 M3 Hex Cap Screw (2x2)
REV-41-1361 M3 Nyloc Nut (2x2)

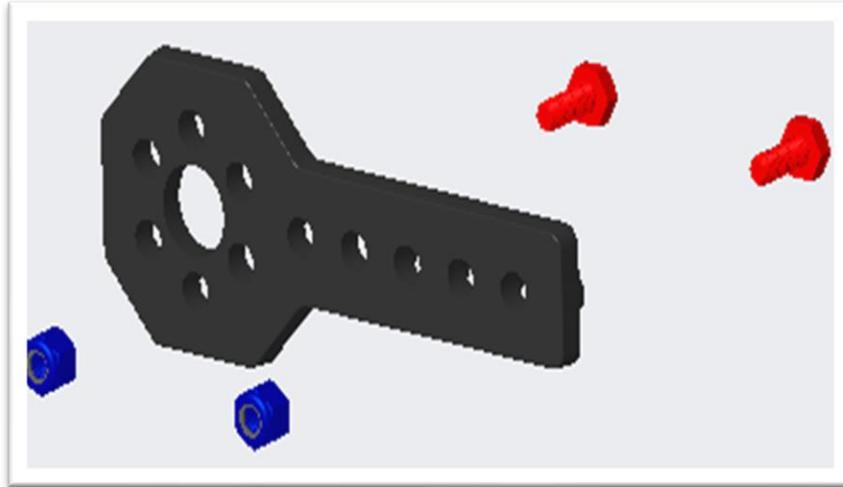


Figure 49- Unassembled view

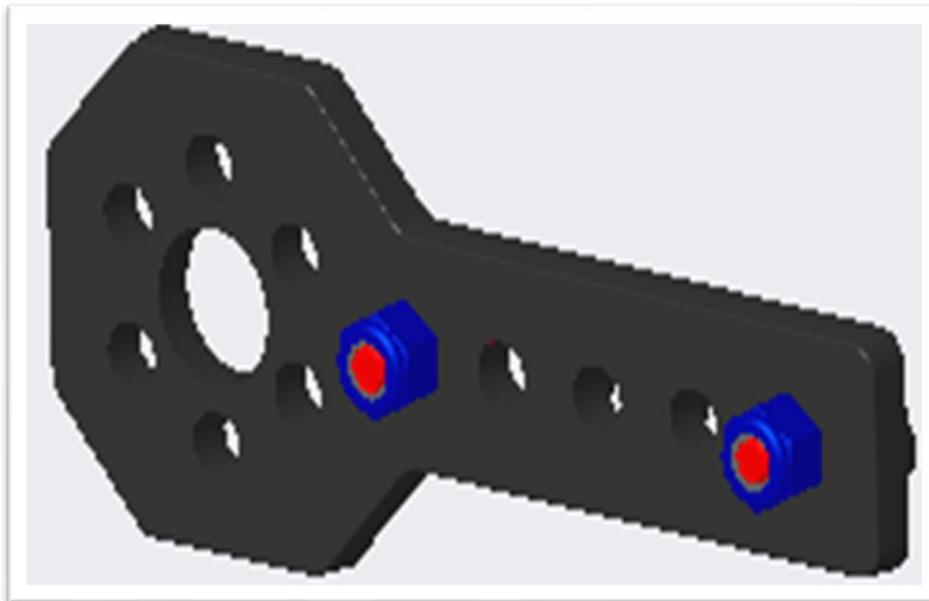


Figure 50- Assembled view

Helpful Hint

- Leave the screws/nuts loose to slide into extrusions in a later step.

Step 25: Add Rod End Bracket Assemblies

Parts Needed:
Rod End Bracket Assemblies from previous step (2)

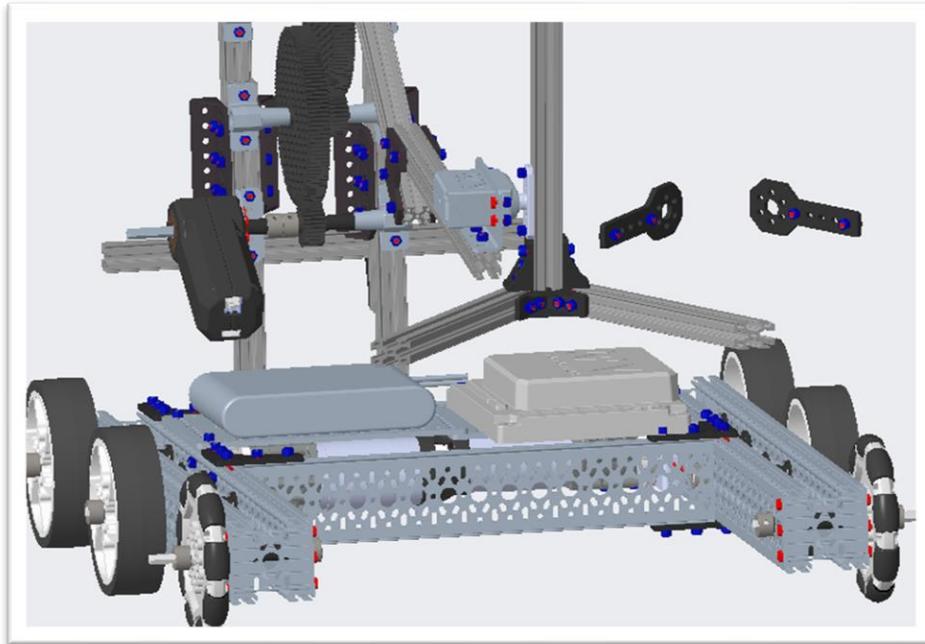


Figure 51- Unassembled view

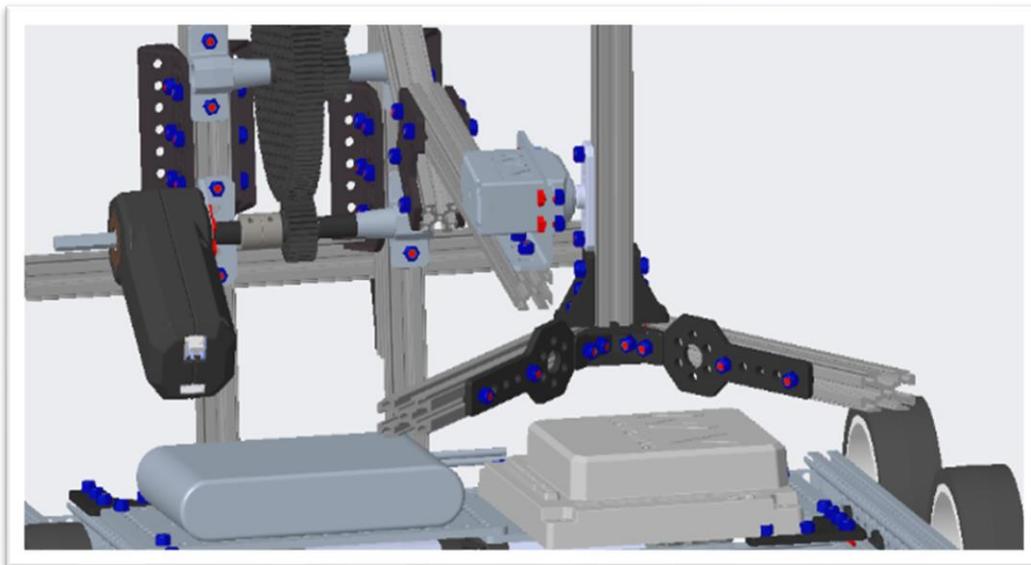


Figure 52- Assembled view

Helpful Hint

- The rod ends should be flush with the inside corner bracket assembly.
- Tighten all screws/nuts.

Step 26: Add Pixel Holder Servo

Parts Needed:
Servo Assembly from a previous step (1)

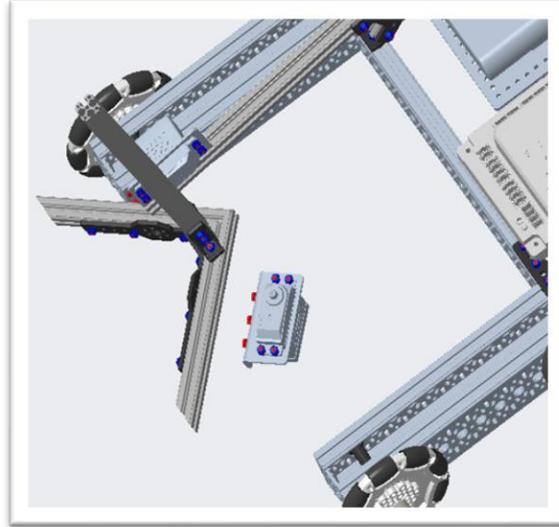


Figure 53- Unassembled view



Figure 54- Assembled view

Helpful Hint

- During testing, adjust the location of the servo so that it holds the pixels securely in the holder.
- Tighten all screws/nuts.

Step 27: Add Pixel Holder to Pixel Holder Servo

Parts Needed:

- Double Servo Arm Assembly from a previous step (1)
- REV-41-1359 M3 Hex Cap Screw (1)

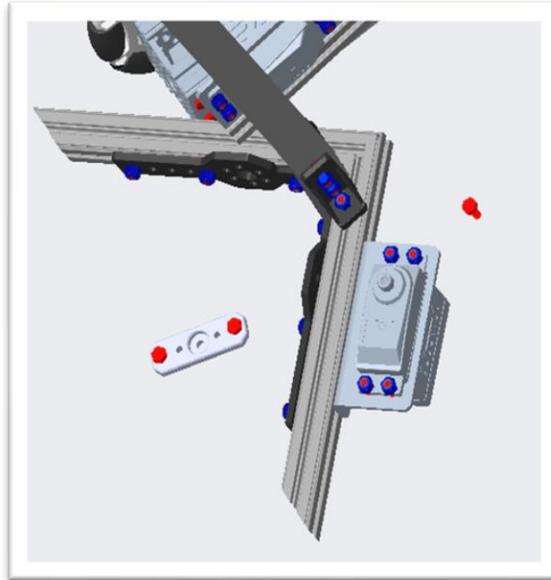


Figure 55- Unassembled view

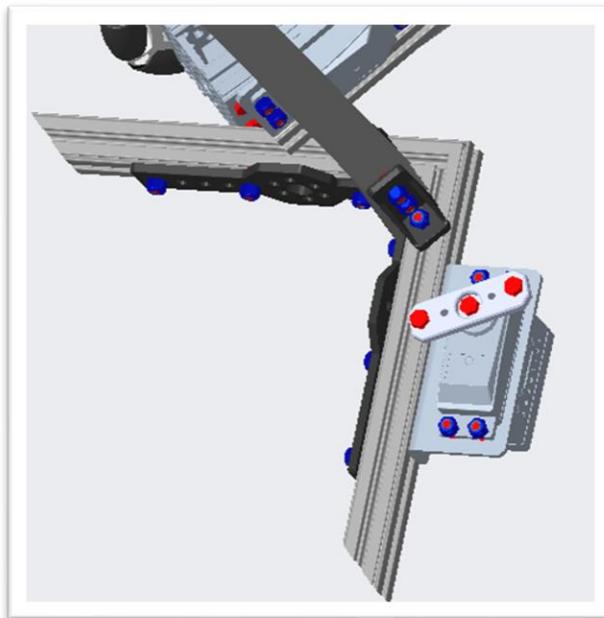


Figure 56- Assembled view

Helpful Hint

- The arm will be adjusted in a later step.

Step 28: Add Extrusion to Pixel Holder Servo

Parts Needed:
REV-41-1430 15mm Extrusion - 150mm - 45° Ends (1)

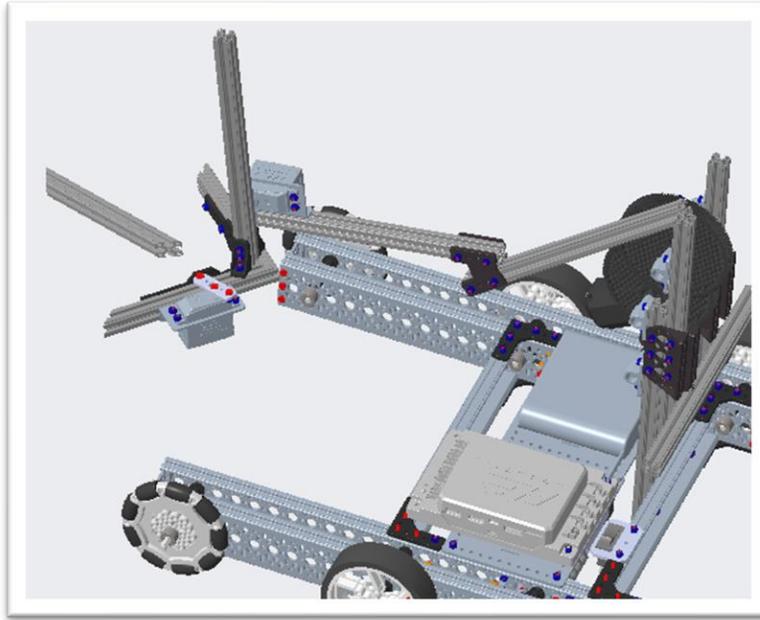


Figure 57- Unassembled view

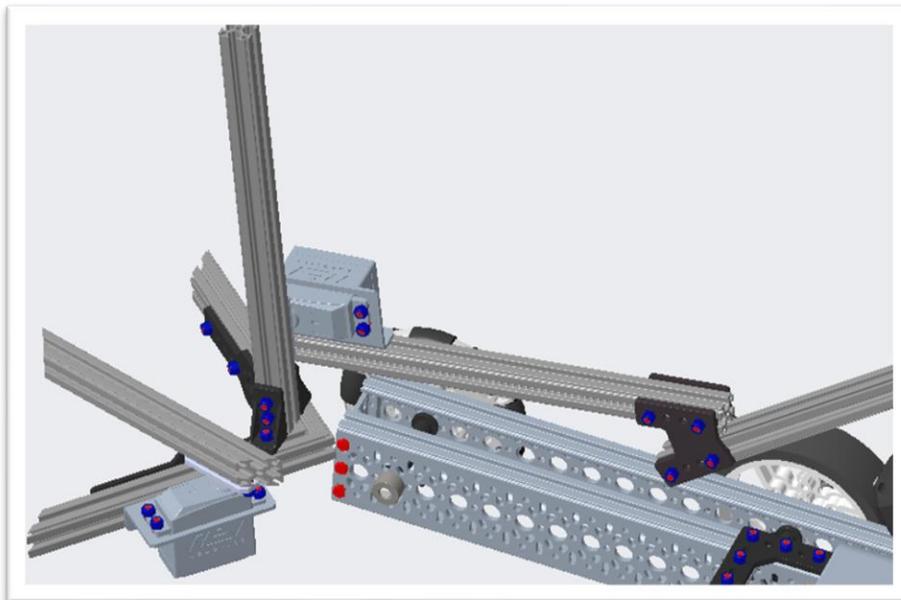


Figure 58- Assembled view

Helpful Hint

- Tighten all screws/nuts.

Step 29: Add First 90 Degree Bracket

Parts Needed:

- REV-41-1480 15mm Metal 90 Degree Bracket (1)
- REV-41-1359 M3 Hex Cap Screw (2)
- REV-41-1361 M3 Nyloc Nut (2)

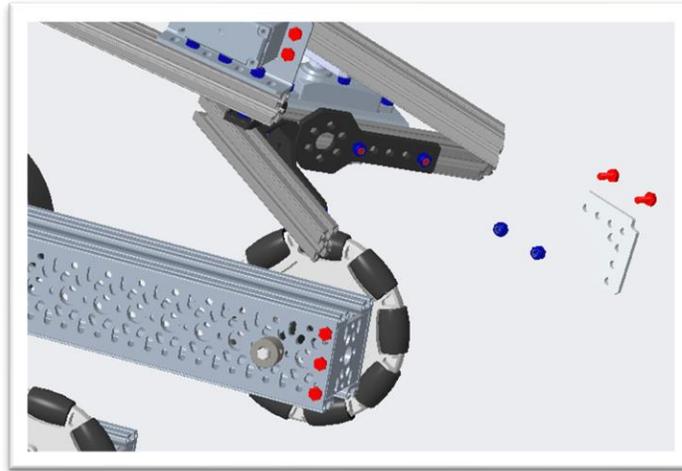


Figure 59- Unassembled view

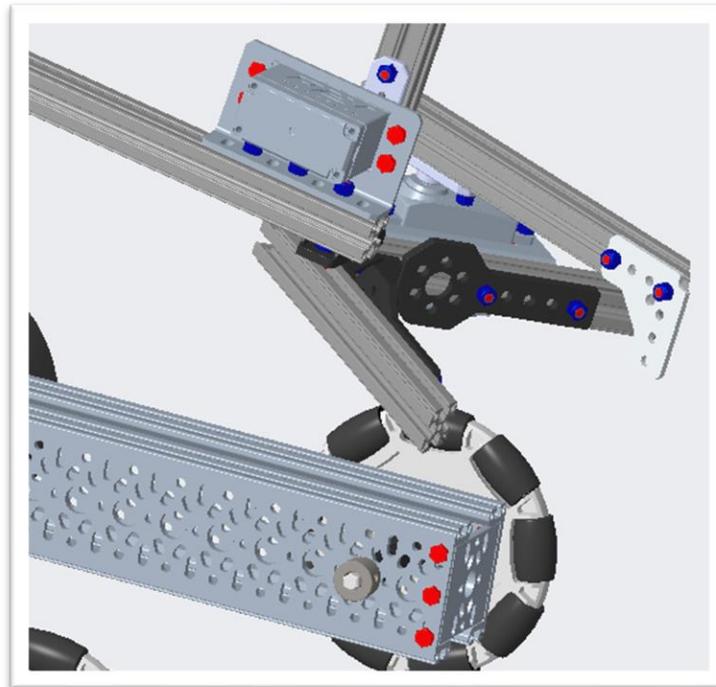


Figure 60- Assembled view

Helpful Hint

- The bracket should be flush with the end of the extrusion; tighten all screws.

Step 30: Add Second and Third 90 Degree Bracket

Parts Needed:

- REV-41-1480 15mm Metal 90 Degree Bracket (2)
- REV-41-1359 M3 Hex Cap Screw (4)
- REV-41-1361 M3 Nyloc Nut (4)

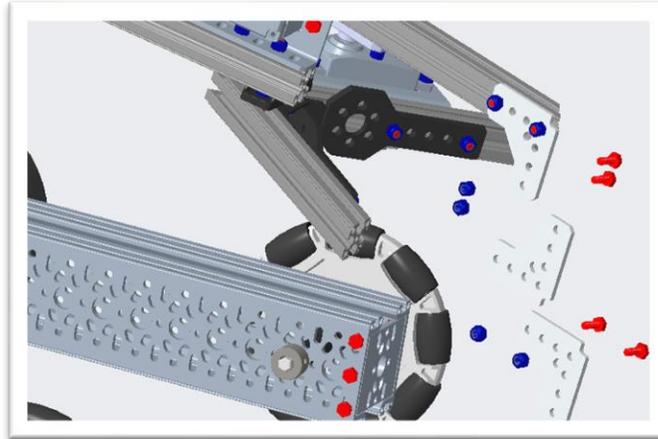


Figure 61- Unassembled view

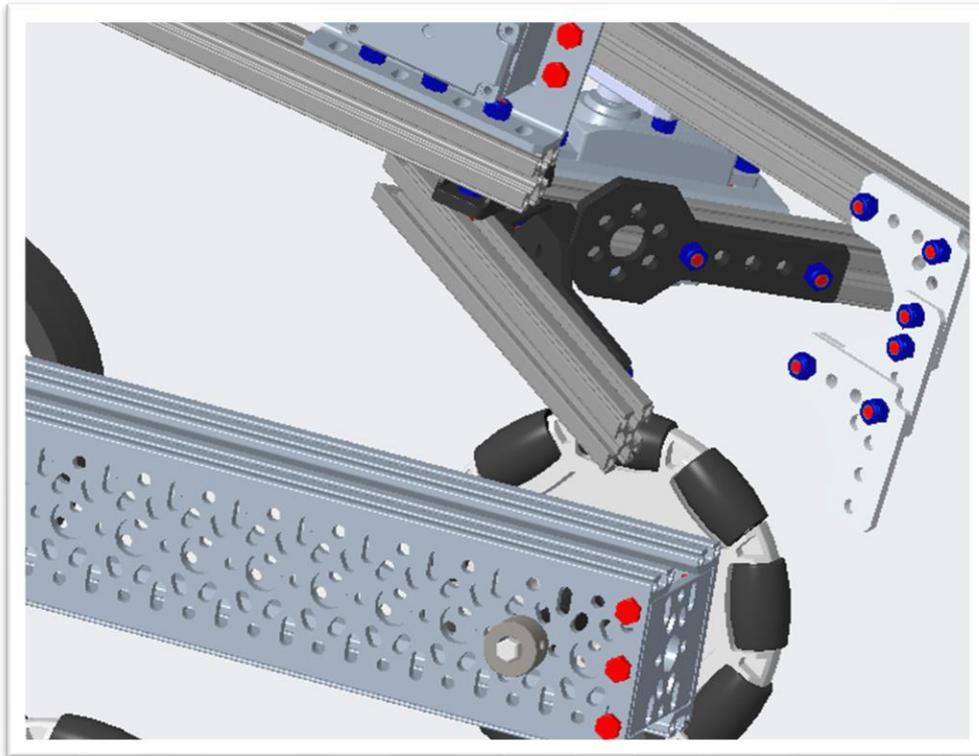


Figure 62- Assembled view

Helpful Hint

- Tighten all screws/nuts.

Electrical

Step 31: Add Arm Motor and Servo Power Cables

Parts Needed:

- REV-41-1300 2-Wire Power Cable [from the Core Hex Motor Kit] (1)
- REV-11-1130 36in PWM Cable (1)

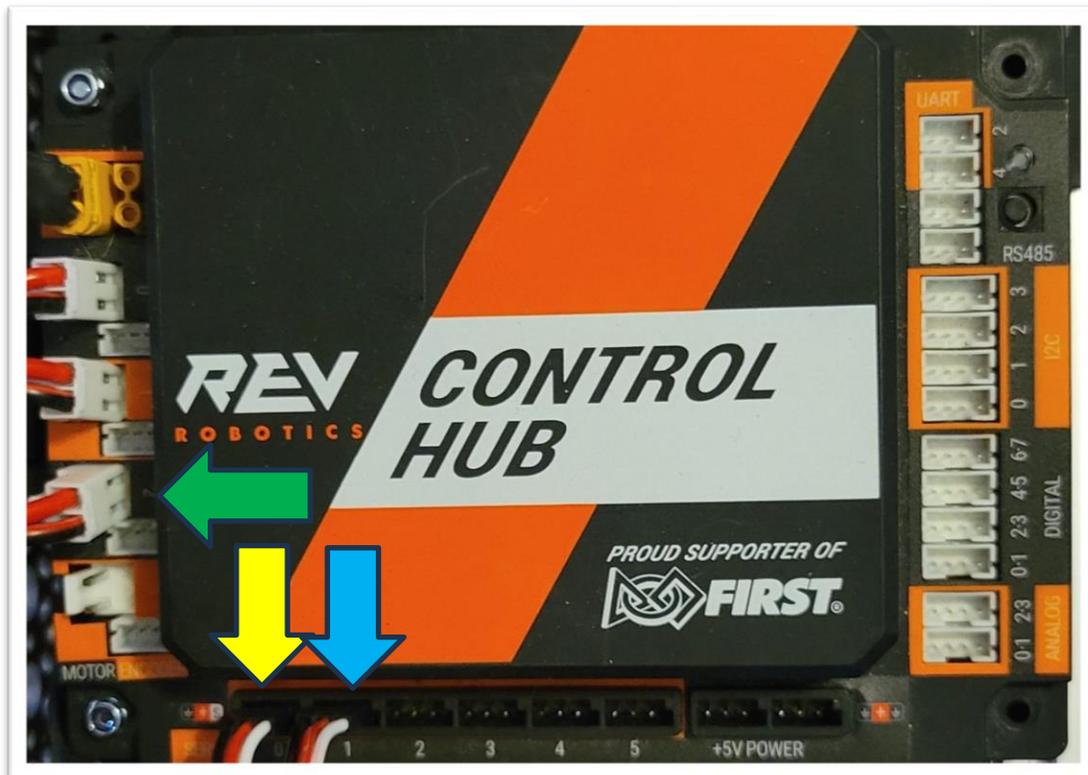


Figure 63- Control Hub

Helpful Hints

- Plug the arm motor into port 2 shown by the green arrow.
- Plug the pixel holder servo into port 0 shown by the yellow arrow.
- Plug the arm servo into port 1 shown by the blue arrow.

Step 32: Adjust Servos

Tools Needed:
REV-31-1108 SRS Programmer (1)

Helpful Hints

- The pixel holder servo needs to be adjusted (i.e. programmed) so that it holds the pixel firmly, but not with so much force that it pops out. The SRS programmer may not accomplish the amount of adjustment needed; use mechanical adjustments to accomplish this.
- The arm servo needs to be adjusted so that the pixel holder assembly is flush to the floor when the arm is down. This allows it to be rotated to a 30 degree angle when the arm is behind the robot for scoring.

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.

Appendix A – Resources

Game Forum Q&A

<https://ftc-ga.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

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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!