



CHANNEL DRIVETRAIN BUILD GUIDE

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Revision History		
Revision	Date	Description
1	05/15/2020	Initial Release

1 DESCRIPTION

1.1 HOW TO USE THIS GUIDE

This guide outlines the steps required to build a six-wheel, chain-based, differential drivetrain using parts from the FTC Starter Kit. This design is a good starting point. However, modification may be required to address the specific needs of the robot being designed. This design is flexible, allowing for different wheel types depending on the overall requirements of the drive train.

The assembly of this drivetrain is broken into a few sections. This allows for a team of people to work on different tasks to complete the build quicker. Each section begins with what parts and the quantity of parts needed to complete the steps in that section. A list of required materials is listed below.

1.2 REQUIRED MATERIALS

PART NUMBER	DESCRIPTION	QTY.
REV-41-1762	45MM X 15MM C CHANNEL - 408MM	4
REV-41-1767	45MM X 15MM C CHANNEL - 248MM	1
REV-41-1687	U CHANNEL ENDCAP	4
REV-41-1432	15MM EXTRUSION - 420MM	2
REV-41-1348	5MM X 90MM HEX SHAFT	6
REV-41-1324	3MM SPACER	12
REV-41-1323	15MM SPACER	2
REV-41-1326	THROUGH BORE BEARING - SHORT	12
REV-41-1329	THROUGH BORE BEARING - LONG	4
REV-41-1338	10 TOOTH #25 SPROCKET	8
REV-41-1365	#25 ROLLER CHAIN - 10 FT	1
REV-41-1492	M3 STANDOFF - 40MM	8
REV-41-1702	TENSIONING BUSHING - 39MM	8
REV-41-1327	SHAFT COLLAR	12
REV-41-1600	ULTRAPLANETARY GEARBOX KIT & HD HEX MOTOR	2
REV-41-1621	ULTRAPLANETARY OUTSIDE MOUNTING BRACKET	2
REV-41-1305	15MM PLASTIC 90 DEGREE BRACKET	12
REV-41-1267	90MM GRIP WHEEL	4
REV-41-1190	90MM OMNI WHEEL	2
REV-41-1359	M3 X 8MM HEX CAP SCREWS - 100 PACK	1
REV-41-1361	M3 NYLOC NUTS - 100 PACK	1

2 BUILD INSTRUCTIONS

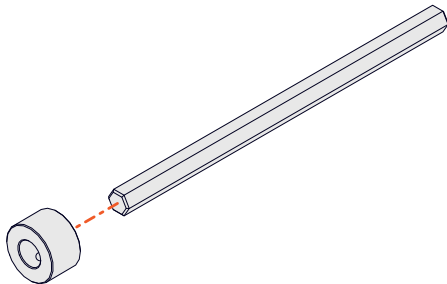
2.1 SINGLE SPROCKET SHAFT ASSEMBLY

2.1.1 Single Sprocket Shaft Assembly Parts Required

PART NUMBER	DESCRIPTION	QTY.
REV-41-1323	15MM SPACER	1
REV-41-1324	3MM SPACER	2
REV-41-1326	THROUGH BORE BEARING - SHORT	2
REV-41-1327	SHAFT COLLAR	1
REV-41-1338	10 TOOTH #25 SPROCKET	1
REV-41-1348	5MM X 90MM HEX SHAFT	1

2.1.2 Single Sprocket Shaft Assembly Steps

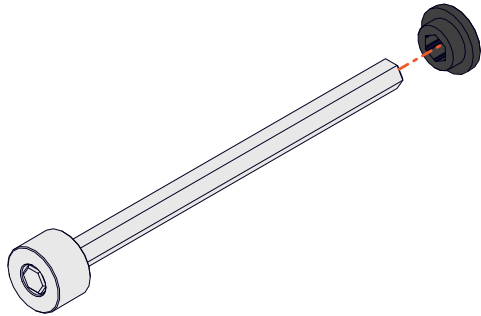
SINGLE SPROCKET SHAFT ASSEMBLY STEPS



Add a Shaft Collar flush to the end of the 5mm x 90mm Hex Shaft.

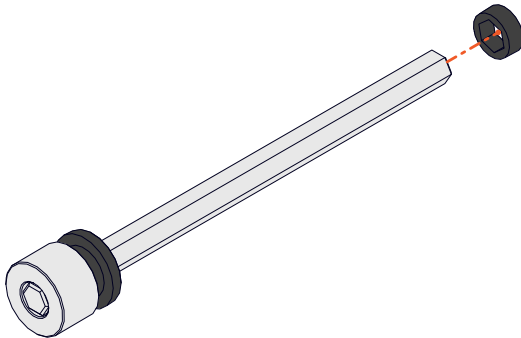
Tighten the Shaft Collar.

SINGLE SPROCKET SHAFT ASSEMBLY STEPS

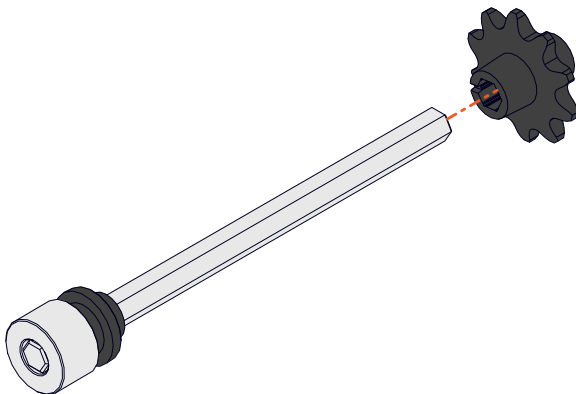


Slide a Through Bore Bearing
– Short onto the shaft.

Note the smaller portion of
the bearing faces towards
the Shaft Collar.

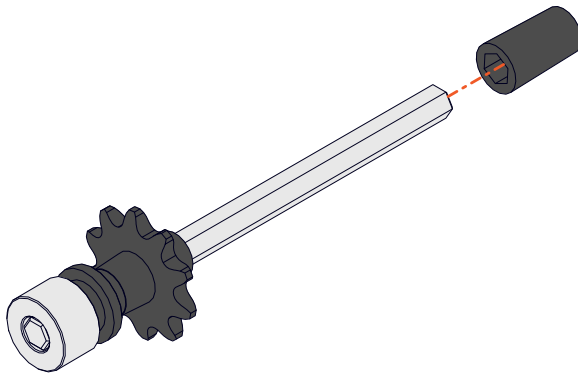


Slide a 3mm Spacer onto the
shaft.

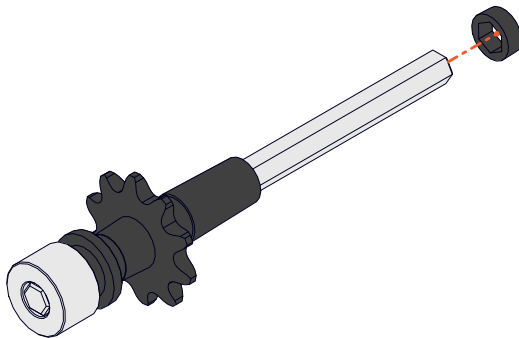


Slide a 10 Tooth # 25
Sprocket onto the shaft.

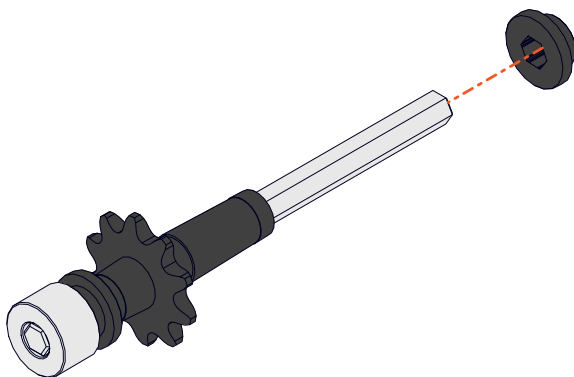
SINGLE SPROCKET SHAFT ASSEMBLY STEPS



Slide a 15mm Spacer onto the shaft.



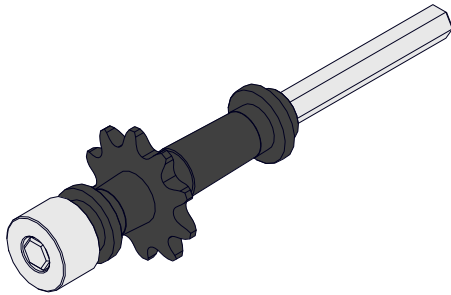
Slide a 3mm Spacer onto the shaft.



Slide a Through Bore Bearing – Short onto the shaft.

Note the smaller portion of the bearing faces away from the Shaft Collar.

SINGLE SPROCKET SHAFT ASSEMBLY STEPS



SINGLE SPROCKET ASSEMBLY COMPLETE

Repeat the above steps until there are two completed Single Sprocket Assemblies. Set aside for later.

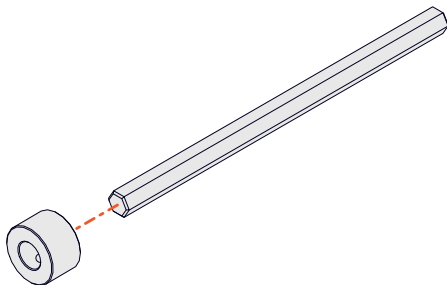
2.2 DOUBLE SPROCKET SHAFT ASSEMBLY

2.2.1 Double Sprocket Shaft Assembly Parts Required

PART NUMBER	DESCRIPTION	QTY.
REV-41-1324	3MM SPACER	2
REV-41-1326	THROUGH BORE BEARING - SHORT	2
REV-41-1327	SHAFT COLLAR	1
REV-41-1338	10 TOOTH #25 SPROCKET	2
REV-41-1348	5MM X 90MM HEX SHAFT	1

2.2.2 Double Sprocket Shaft Assembly Steps

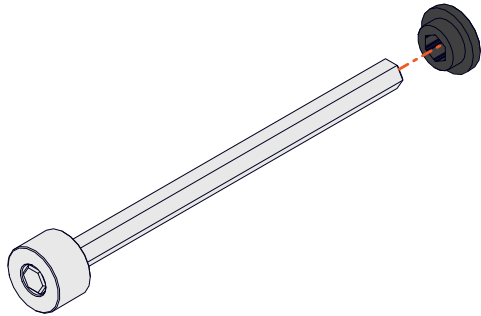
DOUBLE SPROCKET SHAFT ASSEMBLY STEPS



Add a Shaft Collar flush to the end of the 5mm x 90mm Hex Shaft.

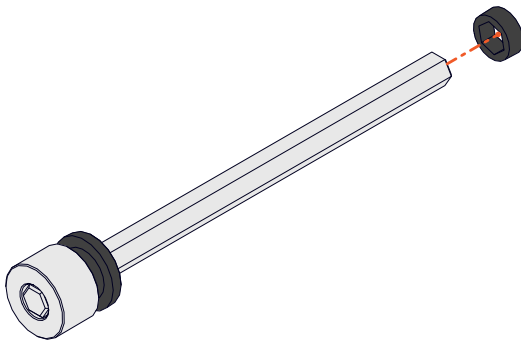
Tighten the Shaft Collar.

DOUBLE SPROCKET SHAFT ASSEMBLY STEPS

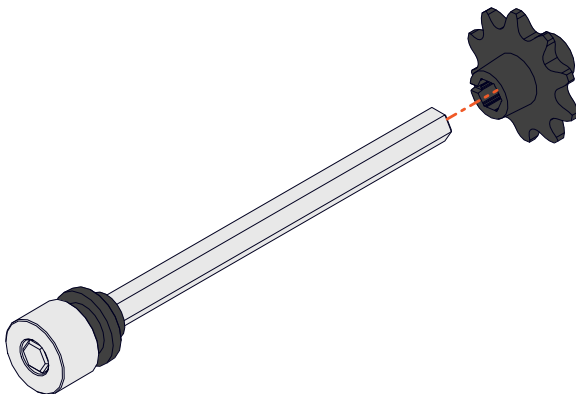


Slide a Through Bore Bearing
– Short onto the shaft.

Note the smaller portion of
the bearing faces towards
the Shaft Collar.

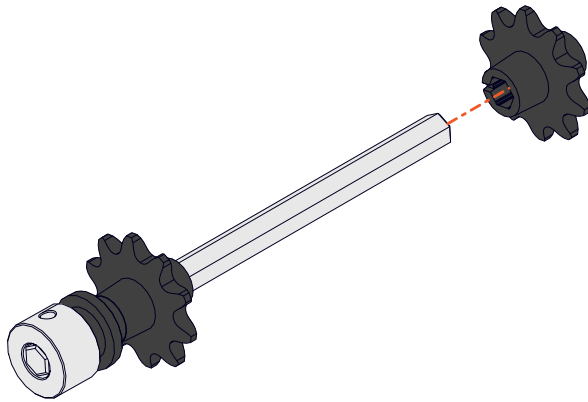


Slide a 3mm Spacer onto the
shaft.

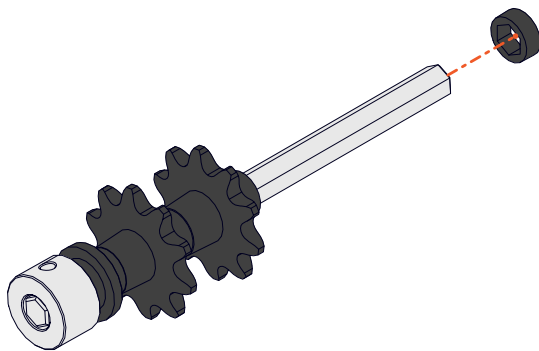


Slide a 10 Tooth # 25
Sprocket onto the shaft.

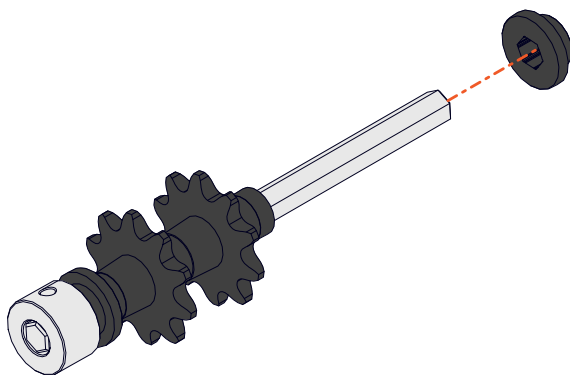
DOUBLE SPROCKET SHAFT ASSEMBLY STEPS



Slide a 10 Tooth # 25 Sprocket onto the shaft.



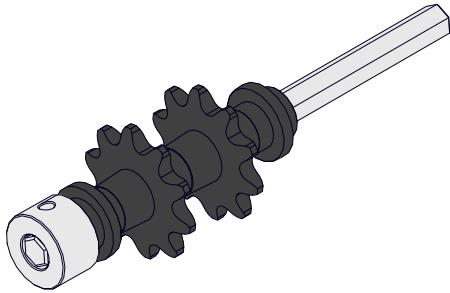
Slide a 3mm Spacer onto the shaft.



Slide a Through Bore Bearing - Short onto the shaft.

Note the smaller portion of the bearing faces away from the Shaft Collar.

DOUBLE SPROCKET SHAFT ASSEMBLY STEPS



DOUBLE SPROCKET ASSEMBLY COMPLETE

Repeat the above steps until there are two completed Double Sprocket Assemblies. Set them aside for later.

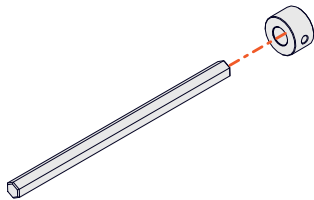
2.3 DRIVE SHAFT ASSEMBLY

2.3.1 Drive Shaft Assembly Parts Required

PART NUMBER	DESCRIPTION	QTY.
REV-41-1324	3MM SPACER	4
REV-41-1326	THROUGH BORE BEARING - SHORT	3
REV-41-1327	SHAFT COLLAR	2
REV-41-1338	10 TOOTH #25 SPROCKET	1
REV-41-1348	5MM X 90MM HEX SHAFT	1
REV-41-1190	90MM OMNI WHEEL	1

2.3.2 Drive Shaft Assembly Steps

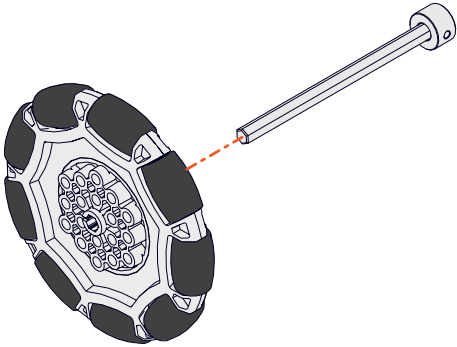
DRIVE SHAFT ASSEMBLY STEPS



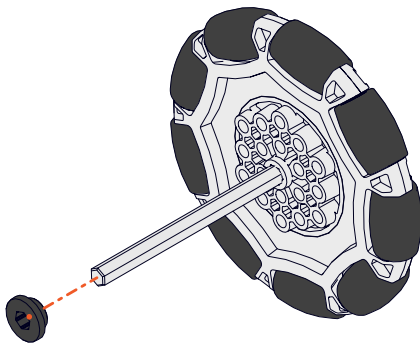
Add a Shaft Collar flush to the end of the 5mm x 90mm Hex Shaft.

Tighten the Shaft Collar.

DRIVE SHAFT ASSEMBLY STEPS

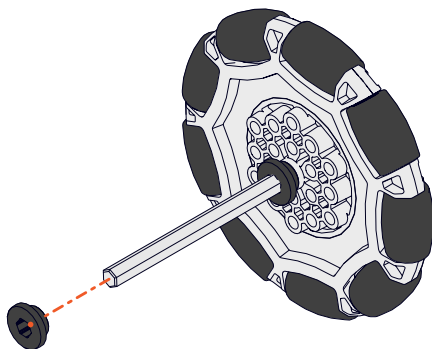


Slide a 90mm Omni Wheel onto the shaft.



Slide a Through Bore Bearing – Short onto the shaft.

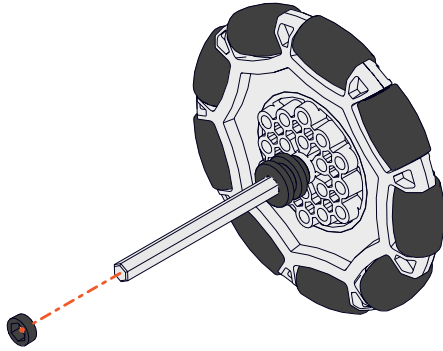
Note the smaller portion of the bearing faces towards the Shaft Collar.



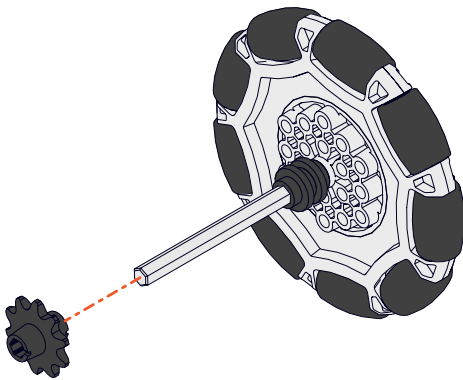
Slide a Through Bore Bearing – Short onto the shaft.

Note the smaller portion of the bearing faces towards the Shaft Collar.

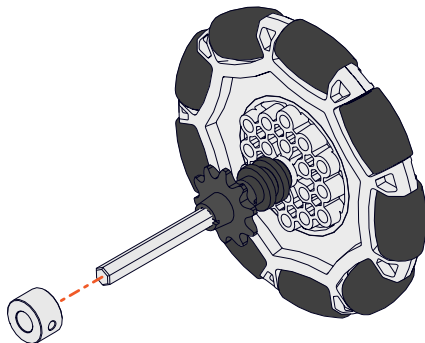
DRIVE SHAFT ASSEMBLY STEPS



Slide a 3mm Spacer onto the shaft.

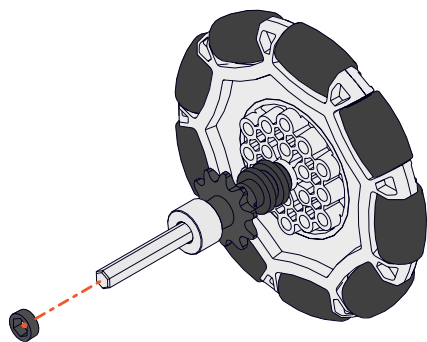


Slide a 10 Tooth # 25 Sprocket onto the shaft.

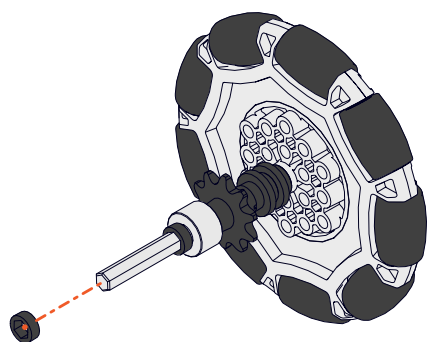


Slide a Shaft Collar onto the shaft. Keep this Shaft Collar loose.

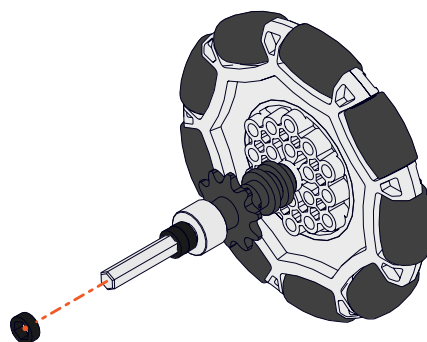
DRIVE SHAFT ASSEMBLY STEPS



Slide a 3mm Spacer onto the shaft.

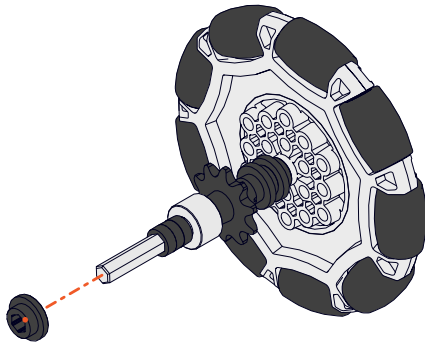


Slide a 3mm Spacer onto the shaft.



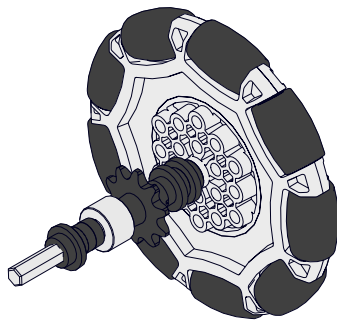
Slide a 3mm Spacer onto the shaft.

DRIVE SHAFT ASSEMBLY STEPS



Slide a Through Bore Bearing
– Short onto the shaft.

Note the smaller portion of
the bearing faces away from
the Shaft Collars.



DRIVE SHAFT ASSEMBLY COMPLETE

Repeat the above steps until
there are two completed
Drive Shaft Assemblies. Set
aside for later.

2.4 ULTRAPLANETARY GEARBOX ASSEMBLY

2.4.1 Gear Ratio Choices

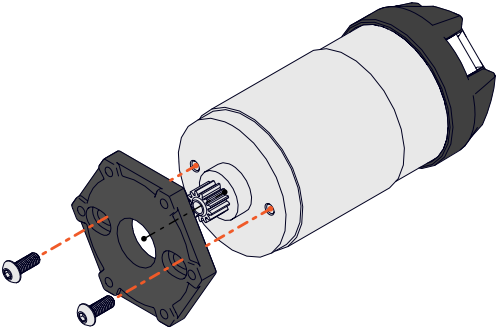
The FTC Starter Kit comes with two of the UltraPlanetary Gearbox Kits with HD Hex Motors. This is an entry point into using the REV UltraPlanetary System. There are three UltraPlanetary Cartridges supporting six different final gear reductions ranging from nominally 3:1 to 60:1. This allows for the right amount of torque for the application at hand. The motor provided already has the pinion gear pressed onto it making assembly of gearboxes easier.

When getting started with this drivetrain, it is recommended to use a nominal 20:1 Gear Ratio. This uses the UltraPlanetary 5:1 Cartridge and the UltraPlanetary 4:1 Cartridge. For more information on all gear ratio options, load ratings, and more, see the UltraPlanetary Gearbox User's Manual on revrobotics.com.

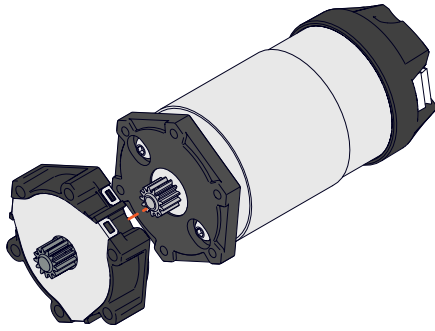
2.4.2 UltraPlanetary Assembly Parts Required

PART NUMBER	DESCRIPTION	QTY.
REV-41-1359	M3 X 8MM HEX CAP SCREWS	6
REV-41-1621	ULTRAPLANETARY OUTSIDE MOUNTING BRACKET	1
PARTS WITHIN THE ULTRAPLANETARY GEARBOX KIT		
REV-41-1291	HD HEX MOTOR	1
REV-41-1608	ULTRAPLANETARY PINION GEAR (ON HD HEX MOTOR)	1
REV-41-1607	ULTRAPLANETARY MOUNTING PLATE	1
REV-41-1602	ULTRAPLANETARY CARTRIDGE 4:1	1
REV-41-1603	ULTRAPLANETARY CARTRIDGE 5:1	1
REV-41-1604	ULTRAPLANETARY OUTPUT STAGE	1
REV-41-1609-2	M3 X 30MM CAP HEAD SCREW	6
REV-41-1609-5	M3 X 8MM BUTTON HEAD SCREW	2

2.4.3 UltraPlanetary Assembly Steps

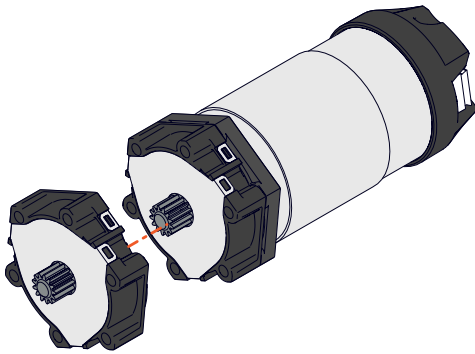
ULTRAPLANETARY ASSEMBLY STEPS	
	<p>Attach the UltraPlanetary Mounting Plate to the HD Hex Motor using two 8mm Button Head Screws.</p> <p>Note: Use the 2mm Allen Key to tighten these screws.</p>

ULTRAPLANETARY ASSEMBLY STEPS



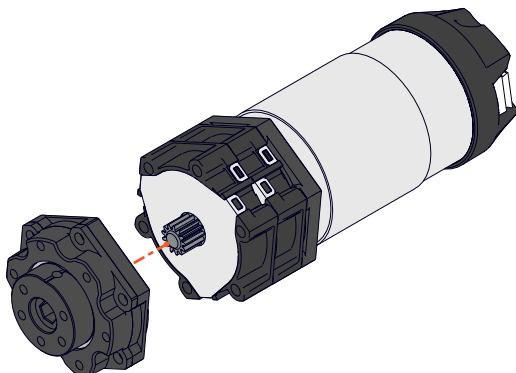
Seat the UltraPlanetary 5:1 Cartridge onto the input pinon.

Note: Placing a finger on the output of the 5:1 Cartridge and turning it helps for placement.



Seat the UltraPlanetary 4:1 Cartridge onto the UltraPlanetary 5:1 Cartridge.

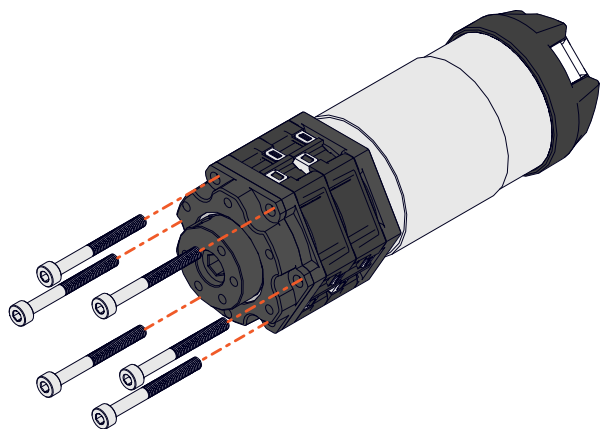
Note: Placing a finger on the output of the 4:1 Cartridge and turning it helps for placement.



Seat the UltraPlanetary Output Stage onto the UltraPlanetary 5:1 Cartridge.

Note: Placing a finger on the output of the Output Cartridge and turning it helps for placement.

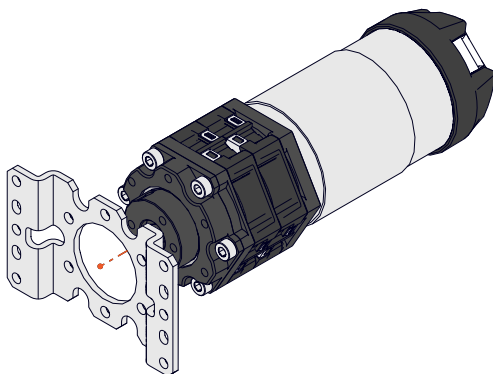
ULTRAPLANETARY ASSEMBLY STEPS



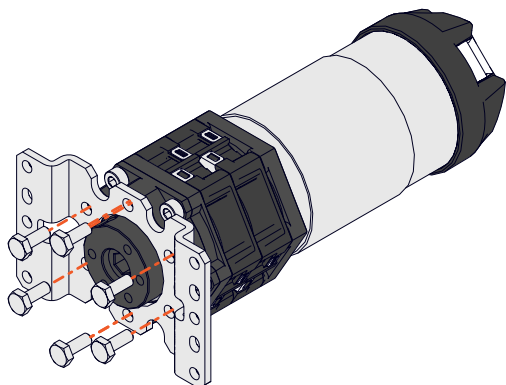
Insert six of the 30mm Cap Head Screws into the holes in the outer ring off the Output Cartridge.

Tighten these screws down until they are snug not tight.

Note: The 30mm length is the 2nd longest screw provided with the UltraPlanetary Gearbox Kit.



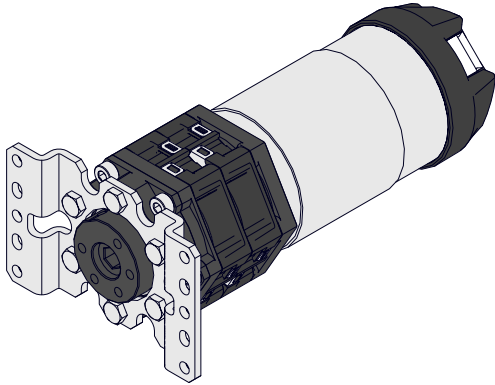
Align the UltraPlanetary Outside Mounting Bracket with the mounting holes on the Output Cartridge.



Insert six 8mm Hex Cap Screws into the mounting holes.

Tighten the screws until they are snug.

ULTRAPLANETARY ASSEMBLY STEPS



ULTRAPLANETARY ASSEMBLY COMPLETE

Repeat the above steps until there are two completed UltraPlanetary Assemblies. Set aside for later.

2.5 BREAKING AND REFORMING CHAIN

2.5.1 Basics of Chain

This drivetrain uses sprockets and chain to transmit motion from the UltraPlanetary Gearbox and Drive Shaft to the rest of the drivetrain. The figure below shows the major components of chain.

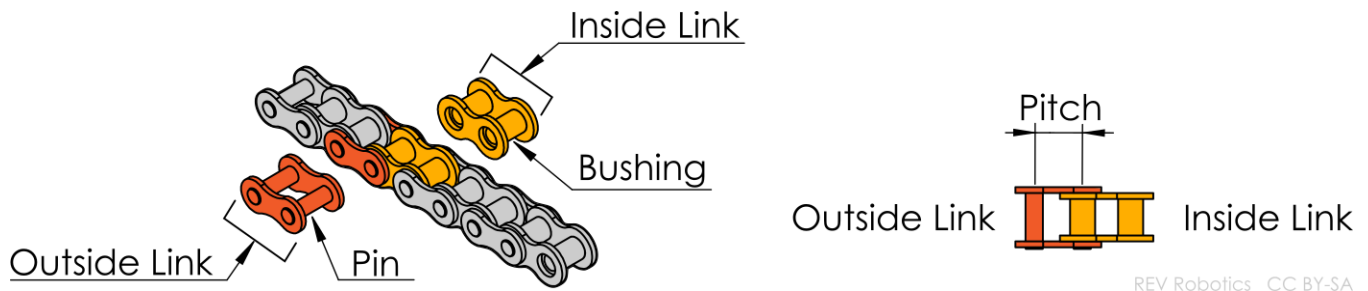


Figure 1: Anatomy of Chain

Outside Links consist of two outside plates which are connected by two **pins** that are pressed into each plate. The **pins** in the outside link go through the inside of the hollow **bushings** when the inner and outer links are assembled. The **pins** can freely spin on the inside of the **bushings**.

Inside Link consist of two inside plates that are connected by two hollow **bushings** which are pressed into each plate. The teeth of the sprocket contact the surface of the **bushings** when the chain is wrapped around a sprocket.

Pitch is the distance between the centers of two adjacent **pins**. The REV 15mm Build System uses #25 (0.25") chain.

To find more information about chain check out the Sprocket and Chain Guide on REVrobotics.com.

2.5.2 Introduction to the Chain Tool

In the FTC Starter Kit is a #25 Chain Tool. This custom-designed tool allows teams to easily break and re-assemble #25 chain. The mandrel is used to push out the chain pin. If using master links, the pin can be completely removed, but the depth guide screw allows the option of partially pressing out the pin and then re-assembling without master links.

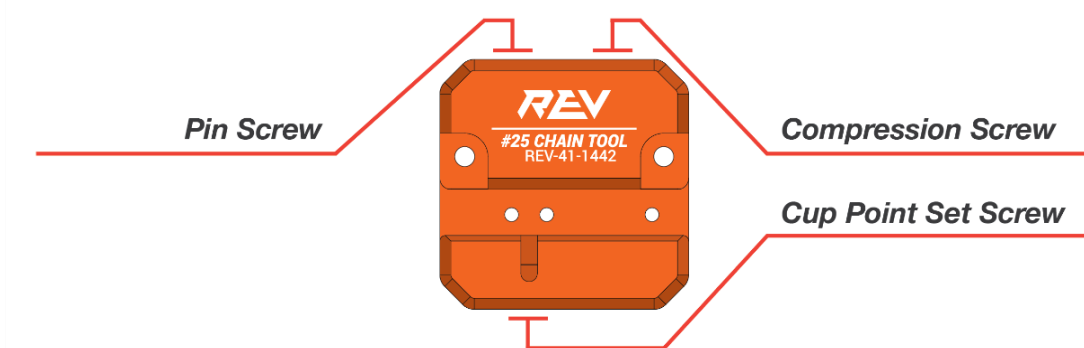


Figure 2: #25 Chain Tool Diagram

For more information on the #25 Chain Tool, see the Chain Tool product page for the User's Manual and How To video.

2.5.3 Creating the Chain Loop – Resetting Chain Method

For this drivetrain, four chain loops that are 56 links long are needed. When counting links for chain, both the inner and outer links need to be counted. Counting the number of bushings is another way to get the correct chain length. To successfully reform chain, the total count of links must be an even number with one inner link and one outer link exposed. This allows the chain tool to press the pin back into the bushing, through an inner and outer link, reconnecting the chain. Below are the steps to use the #25 Chain Tool to reset the pin into the chain. If you would like to use master links see the #25 Chain Tool User's Manual for more information.

CREATING A 56 LINK CHAIN LOOP



Unscrew the Pin Screw and Compression Screw such that they are flush with the chain channel.

Ensure the Cup Point Set Screw is fully engaged in the Chain Tool.



Insert #25 chain into the chain channel and align the desired link between the two vertical pins in the channel.

Note: Count 56 bushings from an exposed inner link.



Next secure the chain in place with the compression screw. Tighten until the chain cannot shift within the channel.

Note: Be careful to not overly push the pin out in the next step it will be impossible to put it back in, and a master link will be needed. As result of manufacturing tolerances, the cup point set crew may be close enough to use as a hard stop for the pin.

CREATING A 56 LINK CHAIN LOOP



Screw the Pin Screw down until the pin almost touches the Cup Point Set Screw. The user should **stop pushing the pin out before it leaves the back plate the outer link**. Considerable pressure will be felt before the pin comes all the way out. Removing the chain from the tool to check if the pin is fully unseated from the bushing is recommended.

The final result will be the pin still partially connected to the chain (see photo as example).



Put the Inner Link bushing into the Outer Link. Align the Pin in the Compression Screw hole.



Turn the Compression Screw until the Pin is fully seated back into the chain channel.



56 Link Chain Assembly Complete

Repeat these steps until you have four 56 Link Chain Assemblies.

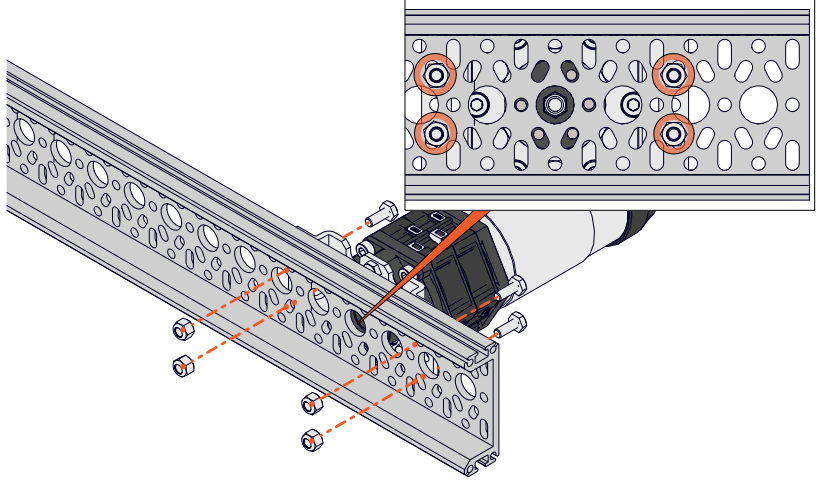
2.6 DRIVE RAIL ASSEMBLY

2.6.1 Drive Rail Parts Required

PART NUMBER	DESCRIPTION	QTY.
REV-41-1359	M3 X 8MM HEX CAP SCREWS	6
REV-41-1621	ULTRAPLANETARY OUTSIDE MOUNTING BRACKET	1
REV-41-1762	45MM X 15MM C CHANNEL - 408MM	2
REV-41-1687	U CHANNEL ENDCAP	2
REV-41-1492	M3 STANDOFF - 40MM	8
REV-41-1702	TENSIONING BUSHING - 39MM	8
REV-41-1359	M3 X 8MM HEX CAP SCREWS - 100 PACK	1
REV-41-1361	M3 NYLOC NUTS - 100 PACK	1
ASSEMBLIES		
ASSEMBLY 1	SINGLE SPROCKET ASSEMBLY	1
ASSEMBLY 2	DOUBLE SPROCKET ASSEMBLY	1
ASSEMBLY 3	DRIVE SHAFT ASSEMBLY	1
ASSEMBLY 4	ULTRAPLANETARY ASSEMBLY	1
ASSEMBLY 5	56 LINK #25 CHAIN LOOP	2

2.6.2 Drive Rail Assembly Steps

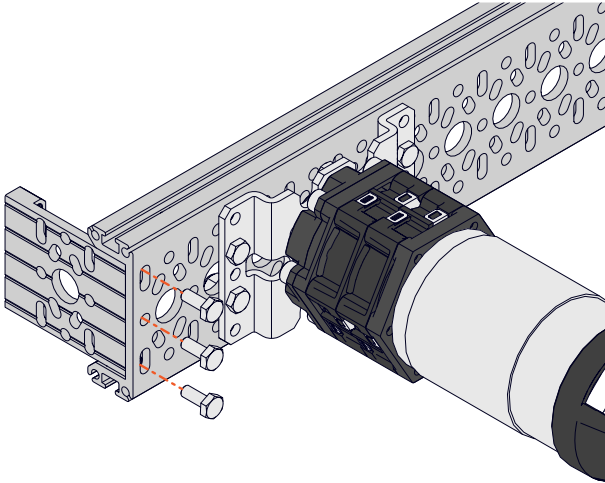
DRIVE RAIL ASSEMBLY STEPS



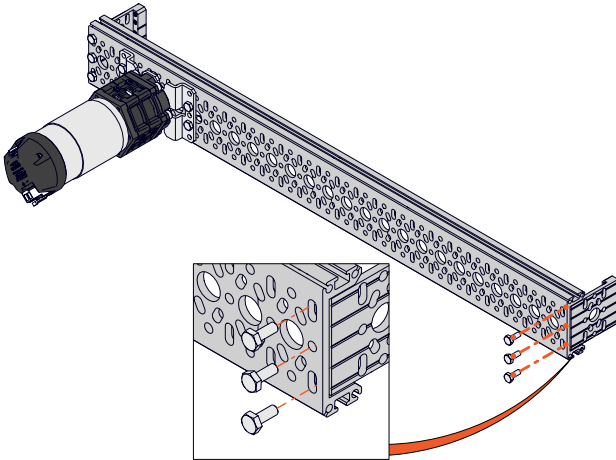
Place M3 Screws and M3 Lock Nuts in the correct locations. Tighten until nuts are snug.

Note: The Output Cartridge of the UltraPlanetary Gearbox lines up with the fourth large (9mm) hole from the end of the C Channel.

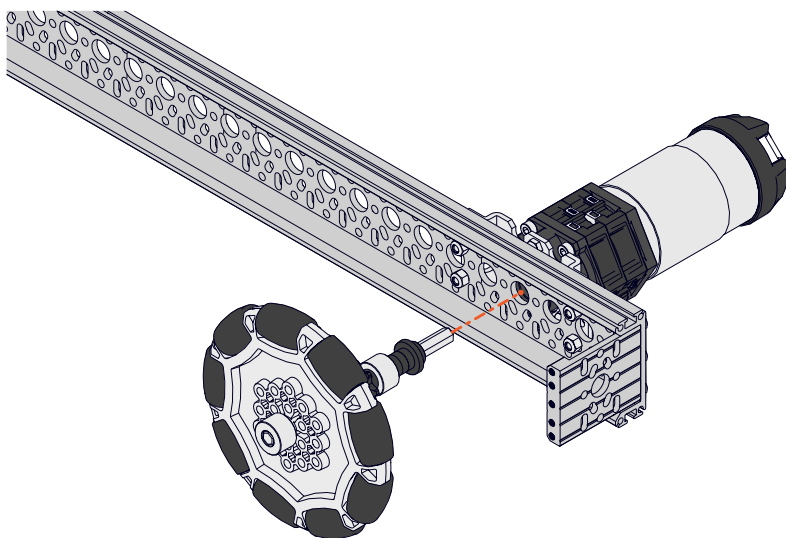
DRIVE RAIL ASSEMBLY STEPS



Attach a U Channel End Cap to the Motor end of the C Channel. Add three Hex Cap Screws to hold it in place. Tighten the Hex Cap Screws.

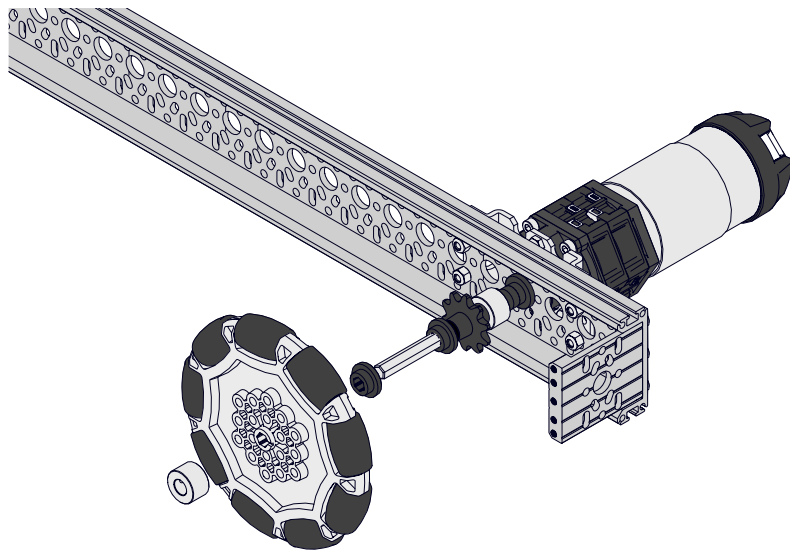


Attach a U Channel End Cap to the other end of the C Channel. Add three Hex Cap Screws to hold it in place. Tighten the Hex Cap Screws.

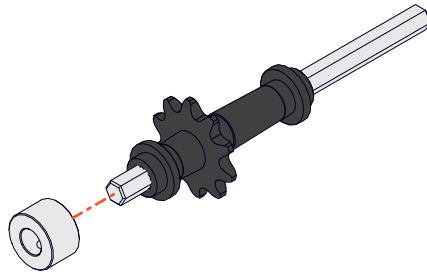


Align the Hex of the shaft with the UltraPlanetary Gearbox. Insert the Drive Shaft Assembly into the UltraPlanetary Female Hex output.

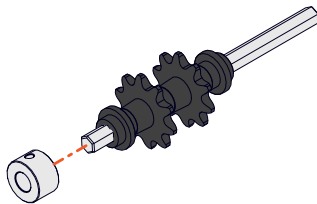
DRIVE RAIL ASSEMBLY STEPS



Remove the Shaft Collar, Omni Wheel, and one Through Bore Bearing – Short from the Drive Shaft Assembly.

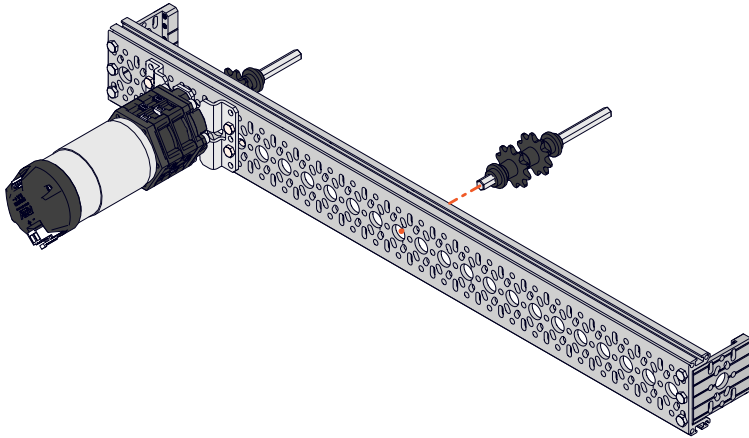


Remove the Shaft Collar from the Single Sprocket Assembly. Set aside for use later.

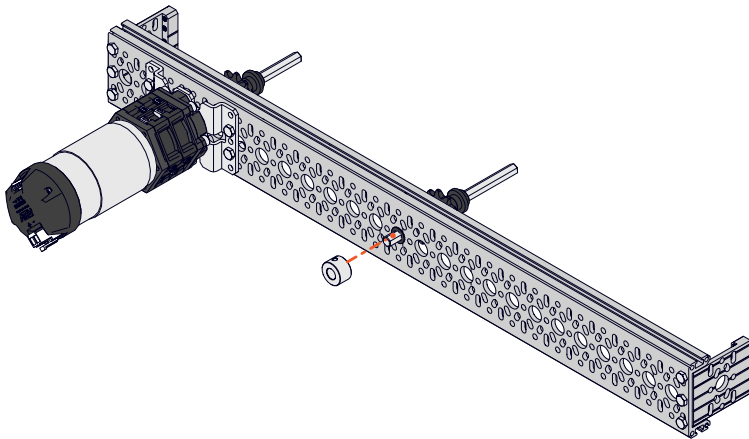


Remove the Shaft Collar from the end of the Double Sprocket Assembly. Set aside for use later.

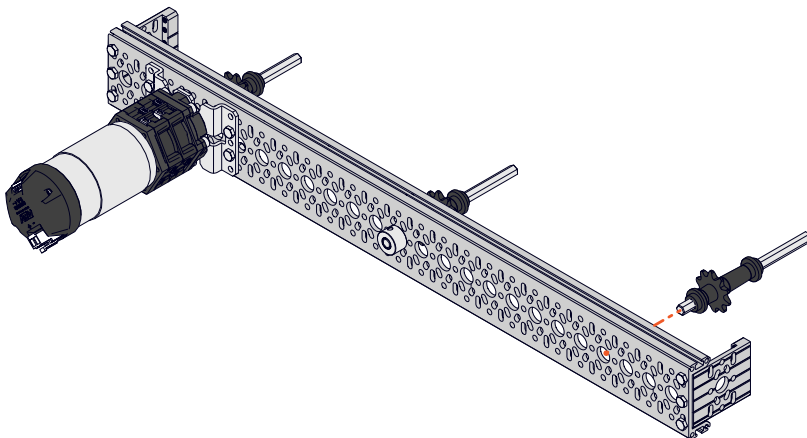
DRIVE RAIL ASSEMBLY STEPS



Insert the Double Sprocket Assembly, short end towards the Motor, into the thirteenth large (9mm) hole from an End Cap.

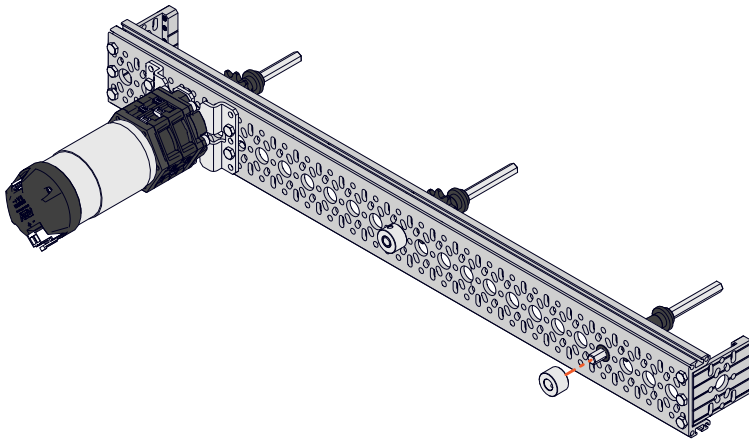


Add a Shaft Collar to the end of the shaft. Tighten down the set screw.

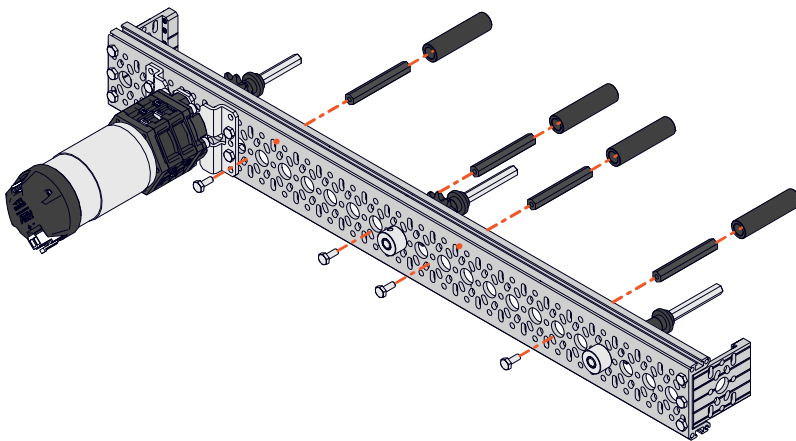


Insert the Single Sprocket Assembly, sprocket side toward the motor, into the fourth large hole from the non-Motor End Cap.

DRIVE RAIL ASSEMBLY STEPS

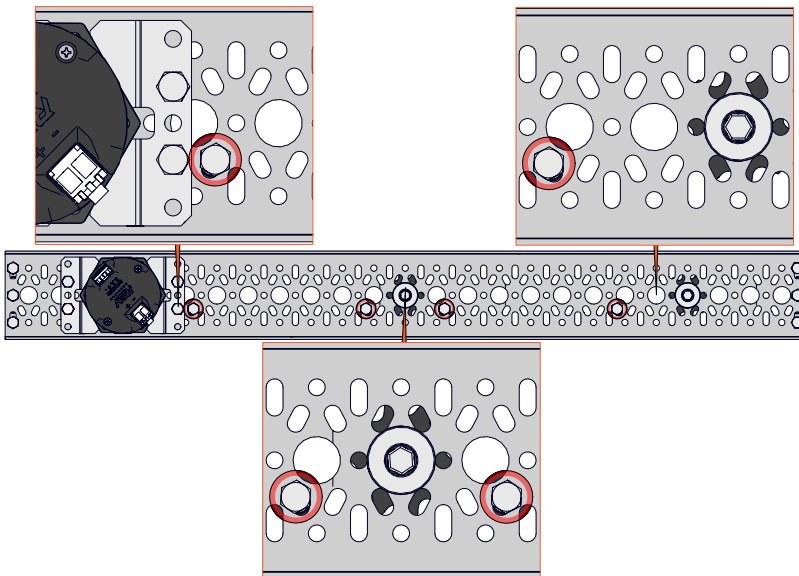


Add a Shaft Collar to the end of the shaft. Tighten down the set screw.



Add four M3 Standoffs - 40MM along the C Channel for chain tension with M3 Hex Cap Screws. Add Tension Bushings onto each Standoff

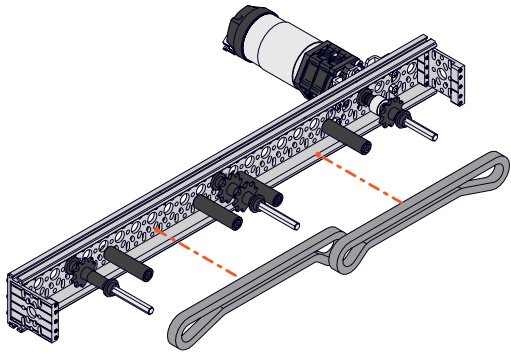
Note: See the next step for locations.



Tighten down the Hex Cap screws once the Standoffs are in the correct locations towards the bottom of the slotted holes.

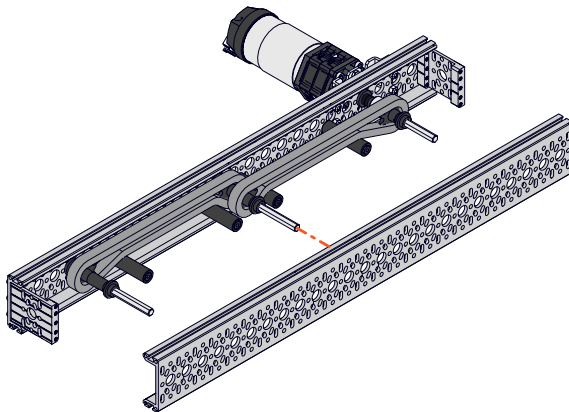
Note: Screws should be tightened just enough to hold the standoffs in place. Chain tension is adjusted later in the drive rail construction.

DRIVE RAIL ASSEMBLY STEPS



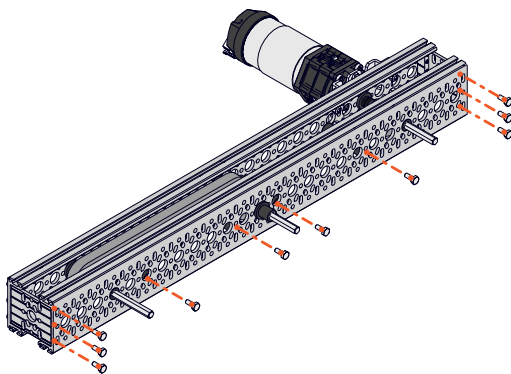
Add the 56 Link Chain Loop to the Sprockets.

Note: Keeping the Standoffs with Tensioning Bushings loose can help getting the chain loops on the Drive Rails.



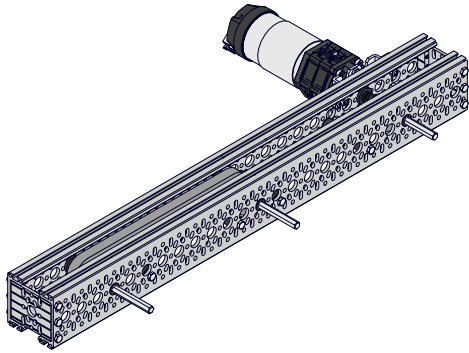
Take a 45mm X 15mm C Channel – 408mm and seat the large holes on the bearings on each shaft.

Note: Make sure the bearings are square and the Channel End Cap holes line up.



Take ten Hex Cap Screws and secure the 45mm X 15mm C Channel – 408mm to the rest of the assembly. Screw into the End Caps and the Standoffs to keep the chain tensioned.

DRIVE RAIL ASSEMBLY STEPS



DRIVE RAIL ASSEMBLY COMPLETE

Repeat this step until you have two Drive Rail Assemblies.

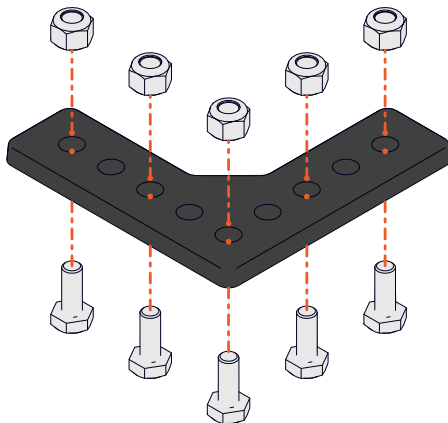
2.7 FINAL ASSEMBLY

2.7.1 Bracket Pre-Loading Parts Required

PART NUMBER	DESCRIPTION	QTY.
REV-41-1305	15MM PLASTIC 90 DEGREE BRACKET	12
REV-41-1359	M3 X 8MM HEX CAP SCREWS	60
REV-41-1361	M3 NYLOC NUTS	60

2.7.2 Pre-Loading Brackets Assembly Steps

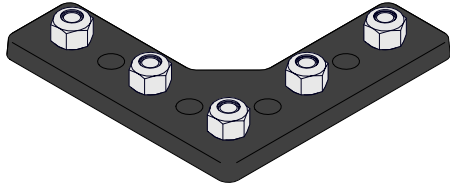
PRE LOADING BRACKET ASSEMBLY STEPS



Take a bracket and finger start one Hex Cap Screw and Nyloc Nut per hole.

Note: The side of the bracket with "ribs" must have the Hex Cap Screw head.

PRE LOADING BRACKET ASSEMBLY STEPS



PRE-LOADED BRACKET COMPLETE

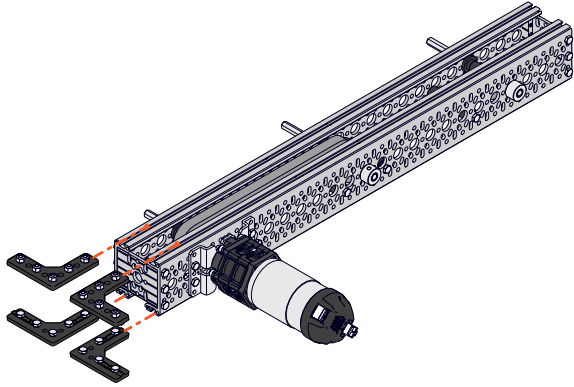
Repeat this step until you have twelve Pre-Loaded Brackets.

2.7.3 Final Assembly Parts Needed

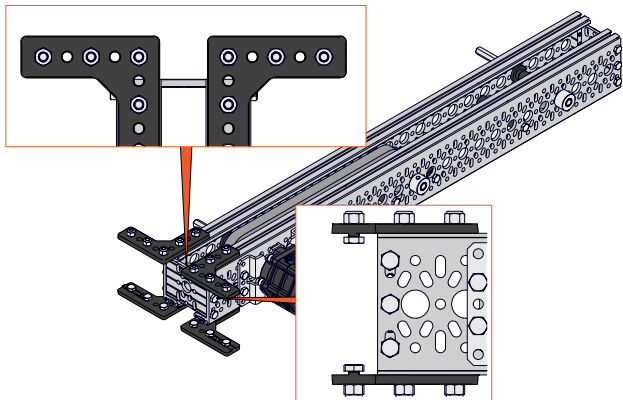
PART NUMBER	DESCRIPTION	QTY.
REV-41-1767	45MM X 15MM C CHANNEL - 248MM	1
REV-41-1432	15MM EXTRUSION - 420MM	2
REV-41-1326	THROUGH BORE BEARING - SHORT	2
REV-41-1329	THROUGH BORE BEARING - LONG	4
REV-41-1267	90MM GRIP WHEEL	4
REV-41-1190	90MM OMNI WHEEL	2
REV-41-1327	SHAFT COLLAR	6
	ASSEMBLIES	
ASSEMBLY 6	DRIVE RAIL ASSEMBLY	2
ASSEMBLY 7	PRE-LOADED BRACKET	12

2.7.4 Final Assembly Steps

FINAL ASSEMBLY STEPS

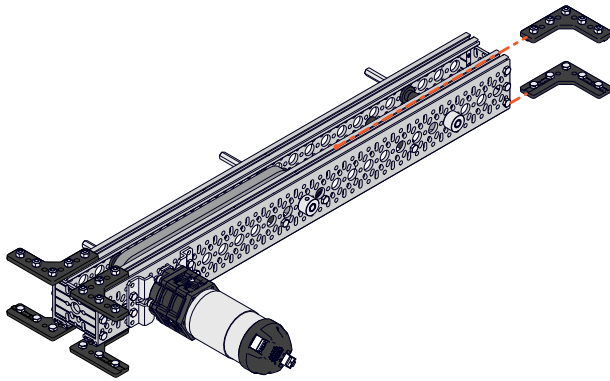


Slide the four Pre-Loaded brackets onto the Drive Rail Assembly as shown.

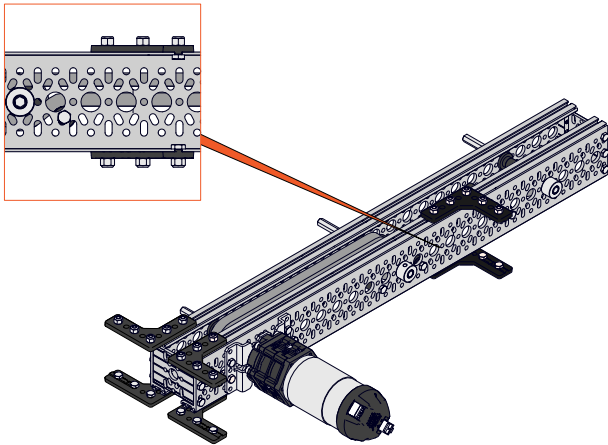


Align the Pre-Loaded Brackets where 6 Hex Cap Screws and Nylock Nuts are exposed.

FINAL ASSEMBLY STEPS

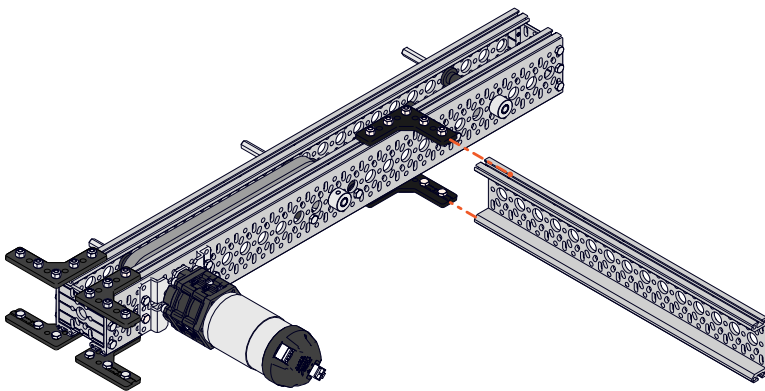


Add two Pre-Loaded Brackets to the Motor side C Channel.



Have the edge of the bracket roughly at the center of the large (9mm) hole. Start with the second hole to the right of the Double Sprocket Assembly.

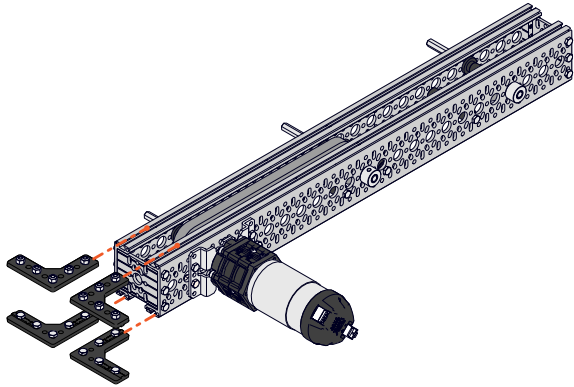
Tighten the Nyloc Nuts until they are snug



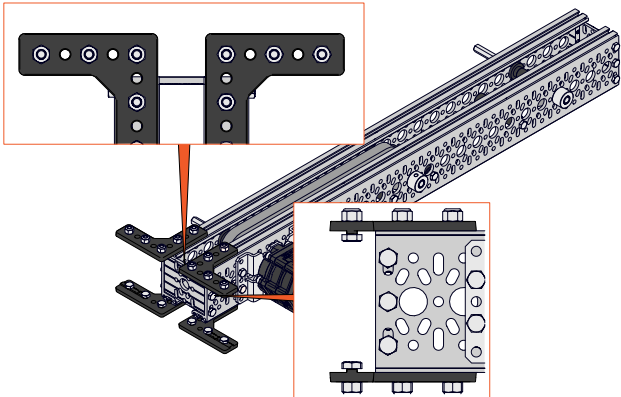
Slide the 45mm X 15m C Channel - 248MM onto the Preloaded Brackets as shown.

Tighten the Nyloc Nuts until they are snug.

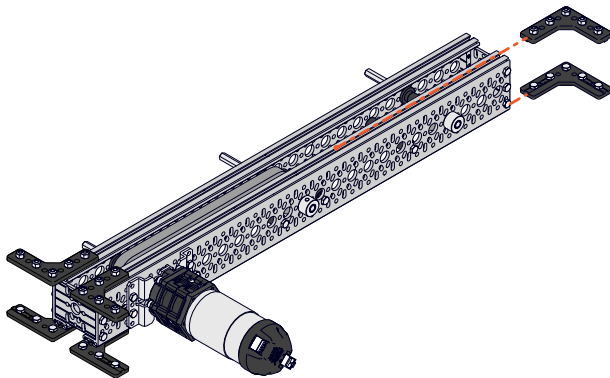
FINAL ASSEMBLY STEPS



Repeat sliding four Pre-Loaded brackets onto the other Drive Rail Assembly as shown.

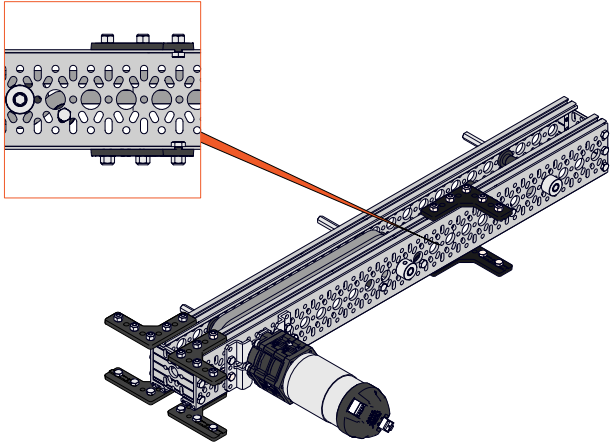


Repeat aligning the Pre-Loaded Brackets where 6 Hex Cap Screws and Nylock Nuts are exposed.



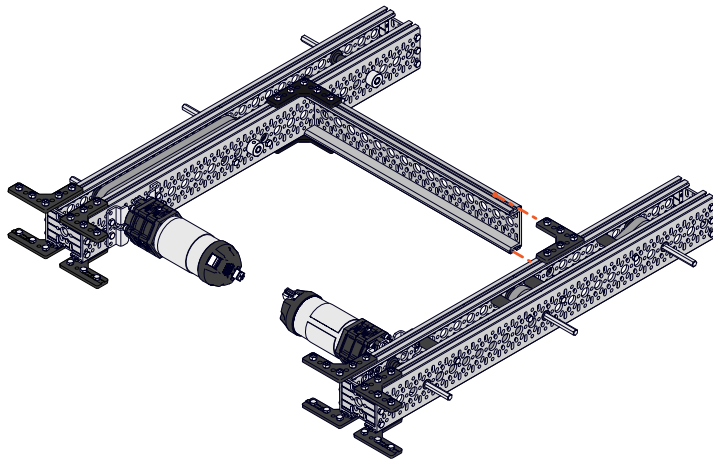
Repeat adding Pre-Loaded Brackets to the Motor side C Channel.

FINAL ASSEMBLY STEPS



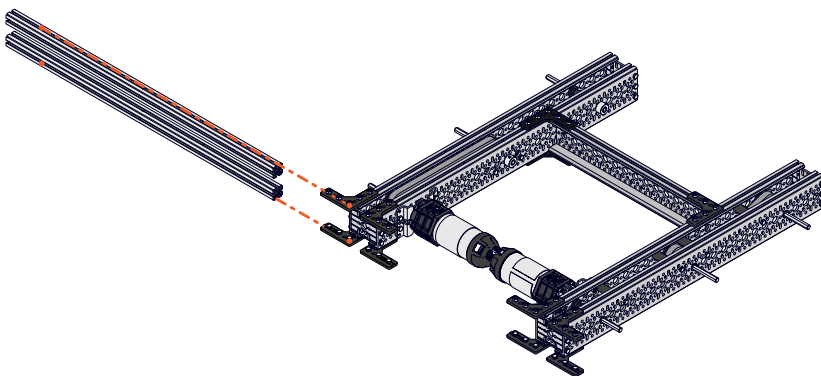
Have the edge of the bracket roughly at the center of the large (9mm) hole. Start with the second hole to the right of the Double Sprocket Assembly.

Tighten the Nyloc Nuts until they are snug



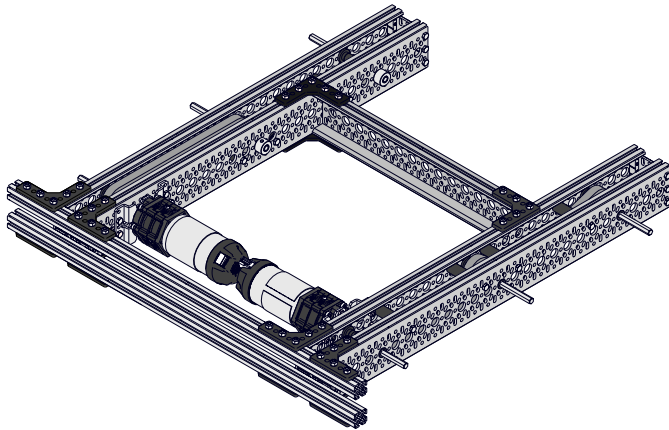
Slide the second Drive Rail on.

Once in place, tighten the Nyloc Nuts until they are snug.



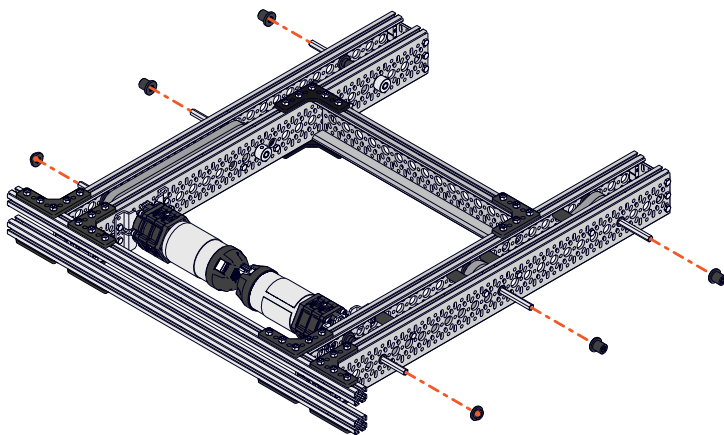
Slide two pieces of 15mm Extrusion – 420mm into the Pre-Loaded Brackets until they are through both sets brackets. On 15mm Extrusion is for the top and the other for the bottom.

FINAL ASSEMBLY STEPS



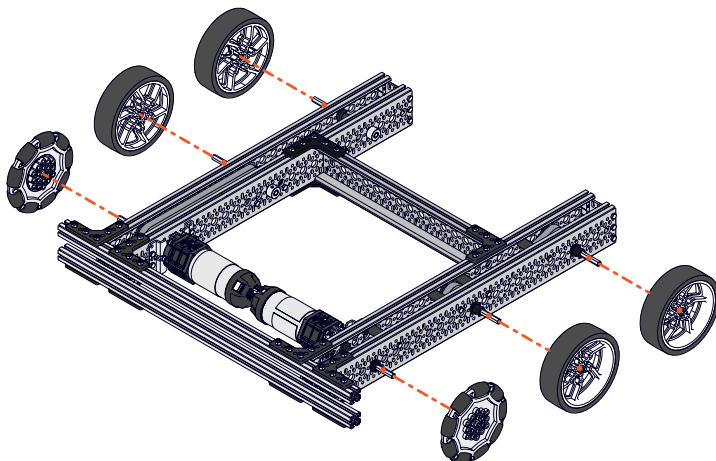
Align the 15mm Extrusion – 420mm so approximately the same amount of Extrusion is left on the end of each Bracket.

Tighten the Nyloc Nuts until they are snug.



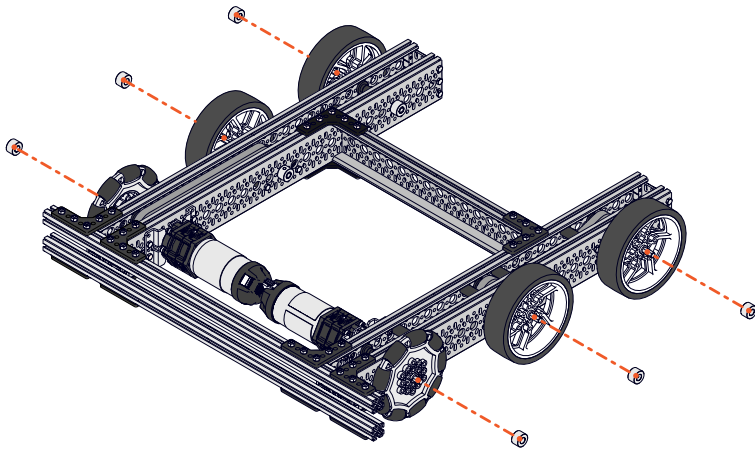
Add a Through Bore Bearing – Short to both of the Drive Shafts and Through Bore Bearing – Long to the remaining shafts.

Note: the smaller section on the bushing faces away from the Channel

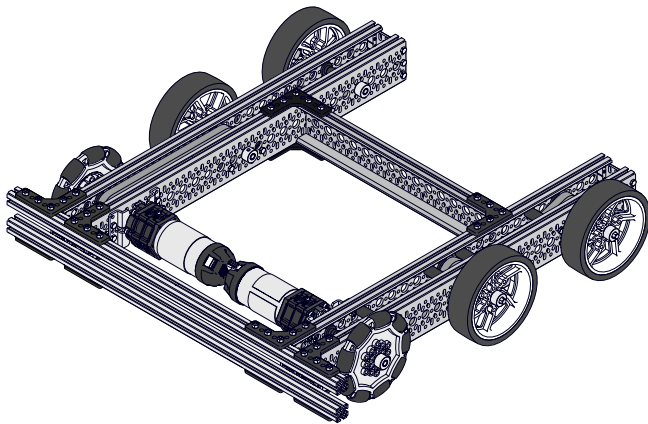


Take the Grip and Omni wheels and place on the shafts as shown.

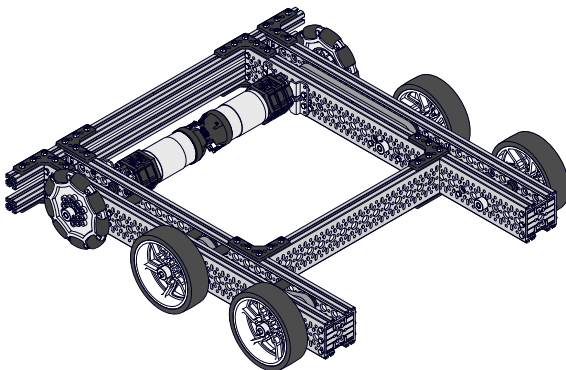
FINAL ASSEMBLY STEPS



Add one shaft collar to the end of each shaft.



Tighten down the shaft collars on each wheel to secure them in place.



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