ULTRAPLANETARY SYSTEM

USER'S MANUAL

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1 ULTRAPLANETARY OVERVIEW

The REV UltraPlanetary System is a cartridge based modular gearbox designed to handle the rigors of the competition and the classroom. Users can configure a single-stage planetary using one of three different reduction cartridges, build multi-stage gearboxes through stacking individual cartridges together, and choose two different ways for transferring power through the output stage through face mounting to the stage or choosing the length of 5mm hex shaft best suited for the application.

The UltraPlanetary Gearbox Kit includes an input stage and pinion gear pressed onto the REV HD Hex Motor. Building on the ability to iterate and adjust designs easily using the REV Building System, the UltraPlanetary System consists of pre-assembled and lubricated cartridges allowing for swapping gear ratios on the fly and with ease. The system also allows for the user to choose the length of 5mm shaft to fit their application or to face mount a sprocket, gear, wheel, or structure using the REV Motion Pattern on the output stage.

Using the UltraPlanetary Gearbox System with other 550 class motors, like the NEO 550 Brushless motor, requires pressing of an UltraPlanetary 550 Motor Pinion (REV-41-1608) onto the motor, use of the UltraPlanetary 550 Motor Plate (REV-41-1607), along with use of individual cartridge reductions and an UltraPlanetary Female 5mm Hex Output (REV-41-1604).

The UltraPlanetary has a variety of options for mounting with four different brackets available for mounting to REV Extrusion, REV C Channel, or REV U Channel.

Figure 1: Assembled UltraPlanetary Gearbox Kit

1.1 FEATURES

The REV Robotics UltraPlanetary System includes the following features:

- Three different gear ratio cartridges providing twenty-seven gear ratios ranging nominally from 3:1 to 125:1.
- Pre-assembled cartridges for superior performance and ease of use.
- Flexible output allowing for the designer to choose shaft length or mounting driven parts directly to the output stage.

1.2 KIT CONTENTS

The REV Robotics UltraPlanetary Gearbox Kit comes with the following:

- REV-41-1291 - HD Hex Motor – QTY 1
- REV-41-1608 – UltraPlanetary Pinion Gear (pressed onto REV-41-1291) – QTY 1
- REV-41-1607 – UltraPlanetary Mounting Plate – QTY 1
- REV-41-1601 – UltraPlanetary Cartridge 3:1 – QTY 1
- REV-41-1602 – UltraPlanetary Cartridge 4:1 – QTY 1
- REV-41-1603 – UltraPlanetary Cartridge 5:1 – QTY 1
- REV-41-1604 – UltraPlanetary Output Stage – QTY 1
- REV-41-1609 – UltraPlanetary Hardware Pack – QTY 1
- REV-41-1347 – 5mm x 75mm Hex Shaft – QTY 1

Individual stages, hardware, and pinions can be purchased separately to optimize the gearbox for the application. For more information on optimizing gear ratios check the REV Robotics Motor Guide.

1.3 CARTRIDGE FEATURES

The REV Robotics UltraPlanetary Cartridges are nominally 10mm thick and made of a plastic (reinforced nylon) molded ring gear with hardened steel planet and sun gears. Cartridges are pre-assembled and lubricated allowing for more time for iterating designs rather than assembling individual stages of gearbox. Check individual CAD Models for exact dimensions for each cartridge.

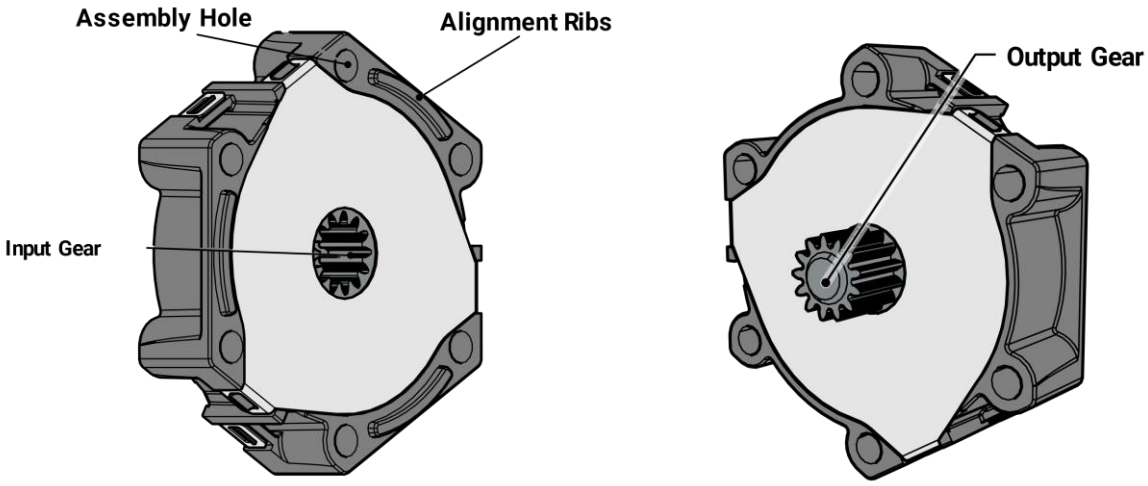


Figure 2: Cartridge Features

Alignment Ribs: Protrusions on the input side of the cartridge to help seat stages of the system together.

Assembly Holes: M3 assembly holes for attaching cartridges to input and output stages.

Input Gear: Sun Gear with a sliding fit for a 13 tooth, M0.55, gear.

Output Gear: 13 tooth, M0.55, carrier gear.

Each cartridge was designed with reliability, durability, and ease of use in mind while having a variety of output ratios when used in combination. Cartridges are referred to at the gear ratio of their closest whole number. For exact gear ratios of individual stages see APPENDIX A.

1.4 OUTPUT STAGE FEATURES

The REV Robotics UltraPlanetary Output Stage is nominally 17mm thick with 6mm protruding from the casing for output motion. The Output Stage is pre-assembled and made of a plastic (reinforced nylon) molded body with a ball bearing carrying the load of the Female Output Gear. Check the CAD Model for exact dimensions of the Output Stage.

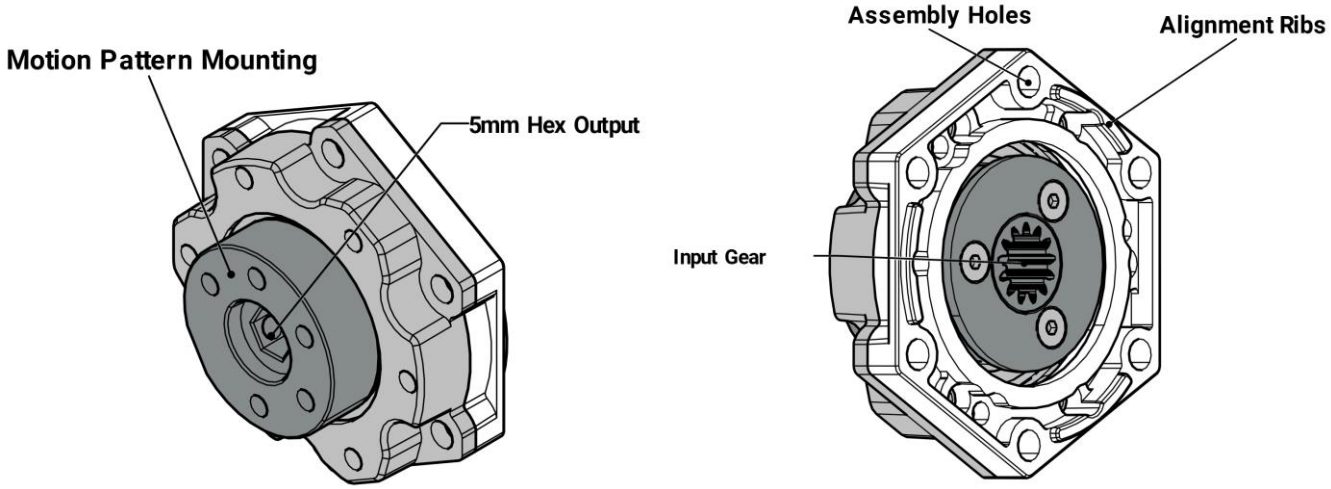


Figure 3: Output Features

Alignment Ribs: Protrusions on the input side of the output stage to help seat stages of the system together.

Assembly Holes: M3 assembly holes for attaching the output stage to cartridge and input stages.

Input Gear: Piece with sliding fit for a 13 tooth, M0.55, gear.

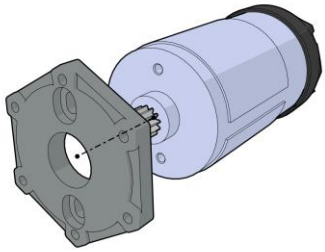
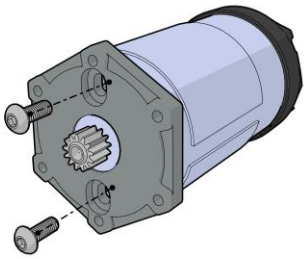
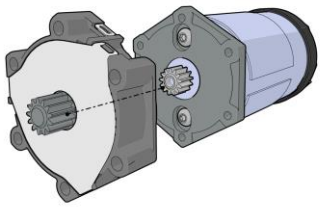
Female Output Gear: Female 5mm hex output for custom length shafts. Motion pattern present for directly attaching sprockets, gears, structure, and wheels.

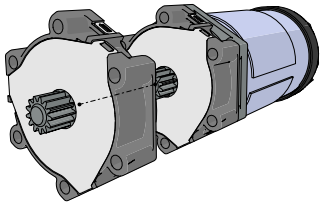
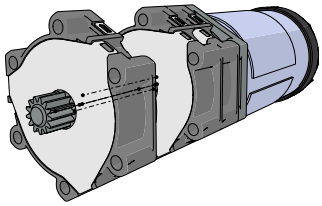
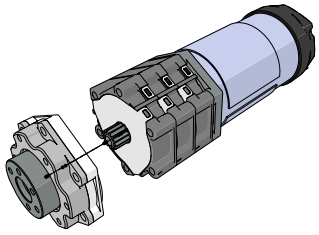
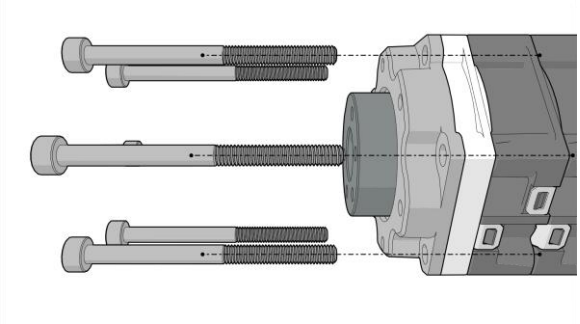
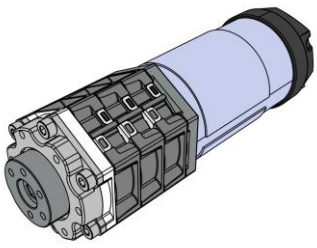
2 ASSEMBLY INSTRUCTIONS

The REV Robotics UltraPlanetary standard configuration comes with the gearbox deconstructed allowing for the user to modify the total reduction needed for the application. Below are steps for assembling a nominally 54:1 reduction gearbox. For specifics on final gear reductions are in APPENDIX A.

To follow these steps you will need all of the parts in the UltraPlanetary Gearbox Kit and a 2mm Allen Wrench.

2.1 ULTRAPLANETARY ASSEMBLY

Take the UltraPlanetary Mounting Plate and press it against the motor with pinion.	
Take the two M3 x 8mm Button head screws and insert them into the mounting plate. Tighten the mounting plate to the motor.	
Take the 5:1 Cartridge and place it onto the input pinon. Note: Placing a finger on the output of the Cartridge helps for placement.	

Repeat the above step with the 4:1 Cartridge and place it onto the output of the 5:1 cartridge. Note: Placing a finger on the output of the Cartridge helps for placement.	
Repeat the above step with the 3:1 Cartridge and place it onto the output of the 4:1 cartridge. Note: Placing a finger on the output of the Cartridge helps for placement.	
Take the Output Cartridge and place it onto the output of the 3:1 Cartridge. Note: Placing a finger on the output of the Cartridge helps for placement.	
Take 6 of the M3 x 40mm screws and insert them into the outer recessed ring of the UltraPlanetary Gearbox.	
UltraPlanetary Gearbox assembly is complete and ready for mounting and shaft selection.	

2.2 OUTPUT MOUNTING OPTIONS

The Output Cartridge of the UltraPlanetary Gearbox allows for two different methods of powering motion, attaching any length of 5mm hex shaft and attaching a sprocket, gear, or wheel to the motion pattern on the Output Cartridge. For adding a shaft on the UltraPlanetary Gearbox just loosen the set screw, slide in a hex shaft, and tighten the set screw.

REV wheels, sprockets, and gears all have the motion pattern on them. To attach a REV wheel, sprocket, or gear, line up the motion profile and add M3 hardware to bolt it into place.

2.3 HARDWARE KIT INFORMATION

The UltraPlanetary Hardware Kit comes with four different lengths of M3 socket head bolts for assembling the gearbox. See Table 1: Hardware Chart for more information.

Table 1: Hardware Chart

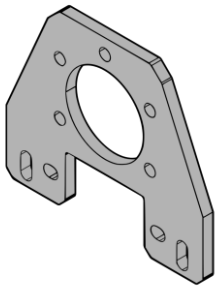
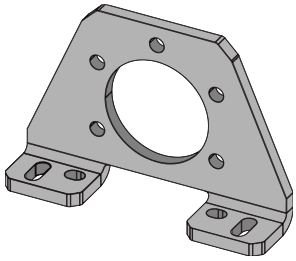
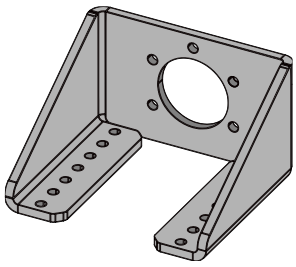
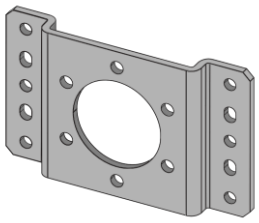
Number of Cartridges	Hardware Needed
Output Only	M3x10mm
1 Cartridge and Output	M3x20mm
2 Cartridges and Output	M3x30mm
3 Cartridges and Output	M3x40mm

3 ULTRAPLANETARY BRACKETS

3.1 ALL ULTRAPLANETARY BRACKETS

REV UltraPlanetary Metal Motor Brackets are nominally 3mm thick and made from 5052 aluminum. Check individual CAD models for exact dimensions for each bracket. Table 2 shows all of the UltraPlanetary Mounting Brackets.

Table 2: UltraPlanetary Metal Motor Brackets

			
Flat Mounting Bracket REV-41-1624	Bent Mounting Bracket REV-41-1623	Long Reach Mounting Bracket REV-41-1625	Outside Mounting Bracket REV-41-1621

3.2 USING MOUNTING BRACKETS

3.2.1 Mounting to REV Extrusion Profile

The UltraPlanetary Bent Mounting Bracket (REV-41-1623) and the UltraPlanetary Flat Mounting Bracket (REV-41-1624) are designed for use with the REV Extrusion Profile located on the REV 15mm Extrusion and REV Channel.

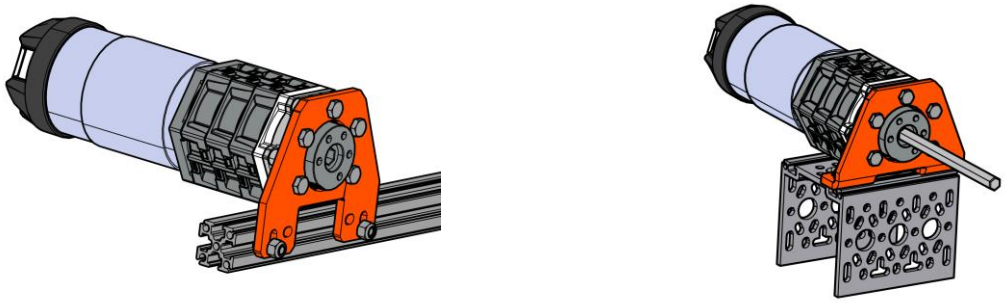


Figure 4: Mounting Brackets on 15mm Extrusion and Channel

3.2.2 Mounting on Channel

The UltraPlanetary Outside Mounting Bracket (REV-41-1621) is designed for use with the REV Extended Motion Pattern present on REV Channel. Using the slotted holes of the Extended Motion Pattern allows for a centered location of the hex shaft. Consider using a 5mm Hex Bearing Block (REV-41-1683) when using the U Channel to provide extra support for the shaft.

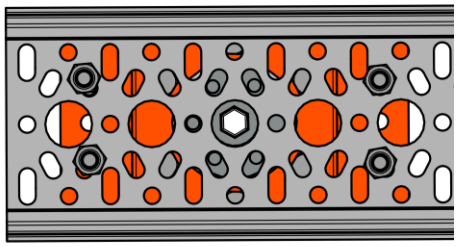


Figure 5: Outside Mounting Bracket on C Channel

APPENDIX A CARTRIDGE DETAILS

APPENDIX A.1 ACTUAL CARTRIDGE GEAR RATIOS

PART NUMBER	PRODUCT NAME	NOMINAL GEAR RATIO	ACTUAL GEAR RATIO
REV-41-1601	UltraPlanetary Cartridge 3:1	3:1	2.89:1
REV-41-1602	UltraPlanetary Cartridge 4:1	4:1	3.61:1
REV-41-1603	UltraPlanetary Cartridge 5:1	5:1	5.23:1

APPENDIX A.2 FINAL GEAR REDUCTION FOR TWO STAGE GEARBOXES

Nominal gear ratios are used to reference the product name for ease of use for the following chart. For actual gear ratios please reference APPENDIX A.1.

Stage 1	Stage 2		
	3:1	**4:1**	**5:1**
3:1	8.4	*	*
4:1	10.5	13.1	*
5:1	15.2	18.9	27.4

CAUTION

When building your gearbox make sure the highest gear reduction is closest to the motor. Asterisked cells are omitted as they have a lower gear reduction closer to the motor.

APPENDIX A.3 FINAL GEAR REDUCTION FOR THREE STAGE GEARBOXES

Nominal gear ratios are used to reference the product name for ease of use for the following chart. For actual gear ratios please reference APPENDIX A.1.

Stages 1 & 2	Stage 3		
	3:1	**4:1**	**5:1**
3:1 & 3:1	24.3	30.4	43.9
3:1 & 4:1	30.4	37.9	54.8
3:1 & 5:1	43.9	54.8	79.3
4:1 & 4:1	37.9	47.4	68.5
4:1 & 5:1	54.8	68.5	99.0
5:1 & 5:1	79.3	99.0	143.1

APPENDIX B LOAD RATINGS

Ratings are based on testing conducted by REV Robotics on the UltraPlanetary system. During testing, the output gear of the cartridge fails at 40 N-m. All load ratings are based on a safety factor of 1.2 to accommodate manufacturing tolerances.

NOTE
Load ratings assume that the output has minimal overhung loading through either face mounting to the UltraPlanetary Output, having a motion component mounted close to base of the Output, or have a shaft supported at its end.

Load rating tables use a red rating system. If the motor and gear ratio combination is highlight in red the torque created by the motor can damage the gearbox. Non-highlighted combinations are within acceptable torque ranges.

The main header for the individual tables has the motor type. Nominal gear ratios are used to reference the cartridge for ease of use in the following charts. For actual gear ratios for an individual cartridge please reference APPENDIX A.1. The final actual gear ratios are indicated in the cells.

APPENDIX B.1 LOAD RATINGS FOR TWO STAGE GEARBOXES

CAUTION
When building your gearbox make sure the highest gear reduction is closest to the motor.

HD Hex Motor – REV-41-1291			
Stage 1	**Stage 2**		
	3:1	**4:1**	**5:1**
3:1	8.4	10.4	15.1
4:1	10.4	13.0	18.9
5:1	15.1	18.9	27.4

NEO 550 - REV-21-1651			
Stage 1	**Stage 2**		
	3:1	**4:1**	**5:1**
3:1	8.4	10.4	15.1
4:1	10.4	13.0	18.9
5:1	15.1	18.9	27.4

APPENDIX B.2 LOAD RATINGS FOR THREE STAGE GEARBOXES

HD Hex Motor - REV-41-1291			
Stages 1 & 2	**Stage 3**		
	3:1	**4:1**	**5:1**
3:1 & 3:1	24.3	30.4	43.9
3:1 & 4:1	30.4	37.9	54.8
3:1 & 5:1	43.9	54.8	79.3
4:1 & 4:1	37.9	47.4	68.5
4:1 & 5:1	54.8	68.5	99.0
5:1 & 5:1	79.3	99.0	143.1

NEO 550 - REV-21-1651			
Stages 1 & 2	**Stage 3**		
	3:1	**4:1**	**5:1**
3:1 & 3:1	24.3	30.4	43.9
3:1 & 4:1	30.4	37.9	54.8
3:1 & 5:1	43.9	54.8	79.3
4:1 & 4:1	37.9	47.4	68.5
4:1 & 5:1	54.8	68.5	99
5:1 & 5:1	79.3	99	143.1

APPENDIX B.3 LOAD RATINGS FOR FOUR STAGE GEARBOXES

HD Hex Motor – REV-21-1291						
Stage 1 & 2	**Stages 3 & 4**					
	3:1 & 3:1	**3:1 & 4:1**	**3:1 & 5:1**	**4:1 & 4:1**	**4:1 & 5:1**	**5:1 & 5:1**
3:1 & 3:1	69.8	87.1	126.2	108.8	157.7	228.5
3:1 & 4:1	87.1	108.8	157.7	136.0	197.0	285.4
3:1 & 5:1	126.2	157.7	228.5	197.0	285.4	413.4
4:1 & 4:1	108.8	136.0	197.0	169.8	246.0	356.5
4:1 & 5:1	157.7	197.0	285.4	246.0	356.5	516.4
5:1 & 5:1	228.5	285.4	413.4	356.5	516.4	748.2

NEO 550 – REV-21-1651						
Stages 1 & 2	**Stages 3 & 4**					
	3:1 & 3:1	**3:1 & 4:1**	**3:1 & 5:1**	**4:1 & 4:1**	**4:1 & 5:1**	**5:1 & 5:1**
3:1 & 3:1	DO NOT USE					
3:1 & 4:1						
3:1 & 5:1						
4:1 & 4:1						
4:1 & 5:1						
5:1 & 5:1						