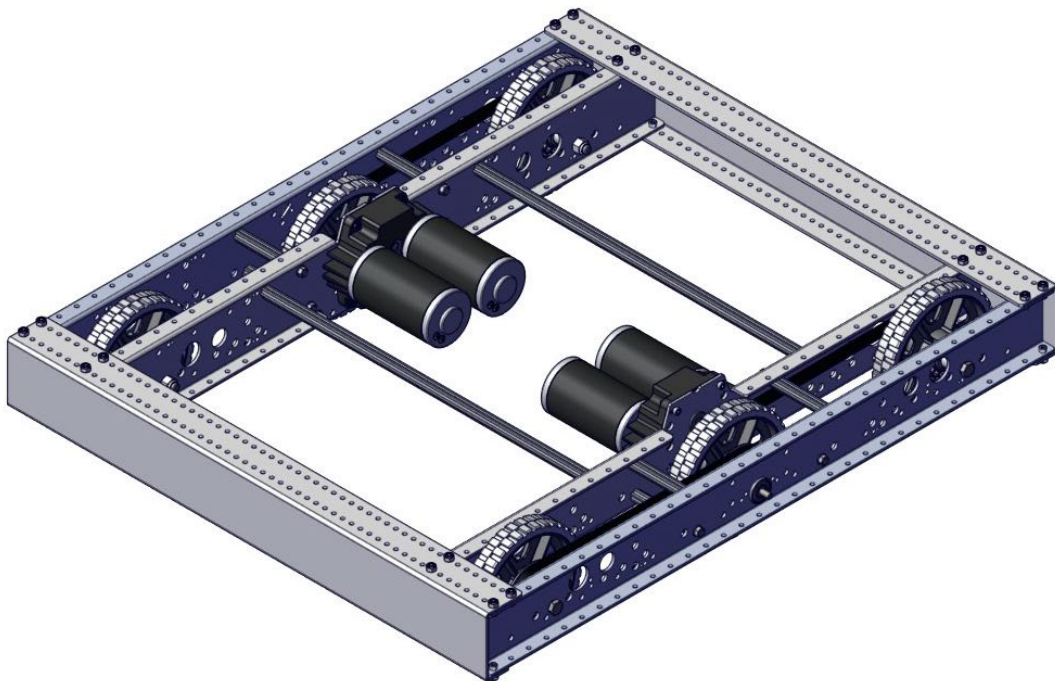




# User Guide

*AM14U5 Chassis Base Kit for the  
FIRST® Robotics Competition*



## **AndyMark – Your Robot Parts Experts**

AndyMark, Inc. was founded in 2004 by Andy Baker and Mark Koors to design and sell unique mechanical parts for competition and educational robotics. Through their volunteer work at *FIRST*® Robotics Competition events they identified a niche market and began designing and selling robotics components for *FIRST*® teams. At that time, many designs were being shared and re-created, but finding the correct fabrication resources for these parts was difficult for some *FRC* teams. AndyMark has been a proud supplier to the *FIRST*® Robotics Competition since 2005.










AndyMark's staff has over 200 years of *FIRST* team experience, and provides staffing services to many robot competition events throughout the year. Our Kokomo, Indiana home provides a central location for quick distribution across North America, as well as international shipping to over 70 countries.

### **Additional Instructions Available**

We encourage customers to seek product information at **AndyMark.com**, contact us via e-mail at **support@andymark.com**, or call Toll-Free **877-868-4770** with questions about any of our products.

Detailed assembly tips and instructional videos can be found at [AndyMark.com/FRCVideos](http://AndyMark.com/FRCVideos). Additional resources, layout prints, and CAD are available on the [AndyMark.com/KOP](http://AndyMark.com/KOP) web page.

### **AM14U5 Recommended Hand Tool List (not included)**

Component	Part Number	QTY	Part Photo
<b>Hammer</b>	Available at your local hardware store.	1	
<b>Cordless Drill or Driver</b>	Available at your local hardware store.	1	
<b>3/8" Magnetic Nut Setter</b>	<a href="#">am-2755</a>	1	
<b>1/4" Magnetic Nut Setter</b>	<a href="#">am-4607</a>	1	
<b>9/16" Socket, 3/8" Drive</b>	<a href="#">am-2743</a>	1	
<b>3/8" Socket, 3/8" Drive</b>	<a href="#">am-2740</a>	1	
<b>5/32" Ball End Hex Bit Driver</b>	<a href="#">am-2751</a>	1	
<b>3/8" Drive Quick Release Ratchet</b>	<a href="#">am-2753</a>	1	
<b>1/2" - 9/16" Open-End Wrench</b>	<a href="#">am-2746</a>	1	

## AM14U5 System Overview

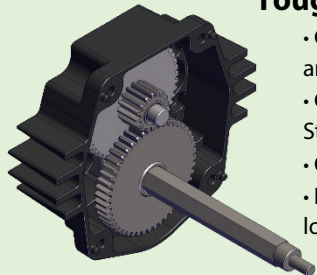
The AM14U5 system designed by AndyMark engineers is a fully customizable drive platform for the *FIRST*® Robotics Competition. The Kit of Parts Drive Chassis is a 6-Wheel Drive (6WD) AM14U5 configuration engineered to withstand the rigors of this year's game challenge. The AM14U5 Drive Chassis Kit includes standard AndyMark products and is designed to be compatible with other AndyMark products. There are many ways to use the parts included in this kit.

- Utilize these step by step instructions to quickly build the standard drive chassis.
- Take advantage of convenient built-in features to convert to another pre-engineered drive solution.
- Take the existing parts and pieces included and re-design them in a new way

### Gearbox Overview

Each AM14U5 Chassis Base Kit includes two (2) **AndyMark** Toughbox Mini Gearboxes, unassembled ([am-2598](#)). Each Toughbox Mini includes the parts needed to mount two 2.5" CIM motors ([am-0255](#)) or NEO Brushless Motors ([am-4258](#)). The gearbox also includes holes for optional encoders such as the USDigital E4T Optical Encoder ([am-3132](#)) or REV Thru Bore Hex Encoder ([am-4650](#)) on both the inside and outside of the chassis.

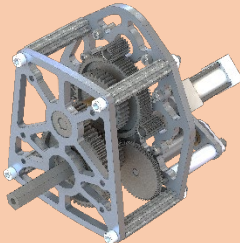
**INCLUDED**



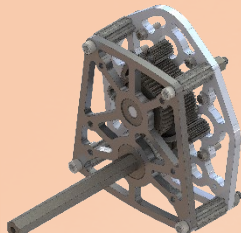
**Toughbox Mini Gearbox**

- **Gear Profile:** 20 DP, 14.5° pressure angle
- **Gear Material:** Cold-formed 4140 Steel
- **Output Shaft:** 1/2" Hex, 4140 Steel
- **Housing Material:** Nylon 6/6 with long fiber reinforcements


**OPTIONAL**



**EVO Shifter 2-Speed**



**EVO Slim Single Speed**



**Toughbox Micro**  
For use with Mecanum

### Gear Ratio Specifications:

To change the drive speed of the AM14U5, different gear ratios can be used in the Toughbox Mini. To change the ratio and drive speed, the standard 19 tooth Small Cluster Gear and 45 tooth Large Output Gear will need to be replaced with two gears totaling 64 teeth. ***The higher the ratio, the slower the output speed.***

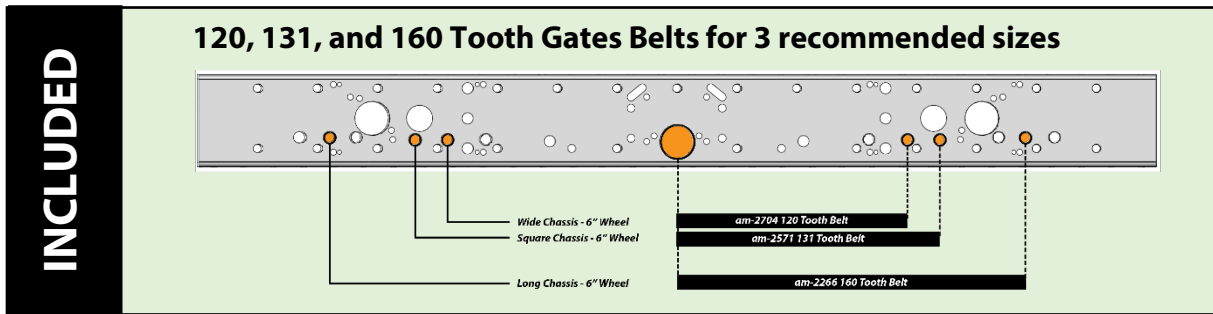
More information about these optional gears can be found at "[AndyMark.com/TBmini](#)".

Ratio	8mm Gear	Lg. Cluster	Sm. Cluster	Lg. Output	AM14U5 Speed**
5.95:1	14T	50T	24T	40T	18.0 ft/sec
7.31:1	14T	50T	21T	43T	14.7 ft/sec
8.45:1 (included)	14T	50T	19T	45T	12.7 ft/sec
10.71:1	14T	50T	16T	48T	10.0 ft/sec
12.75:1	14T	50T	14T	50T	8.4 ft/sec

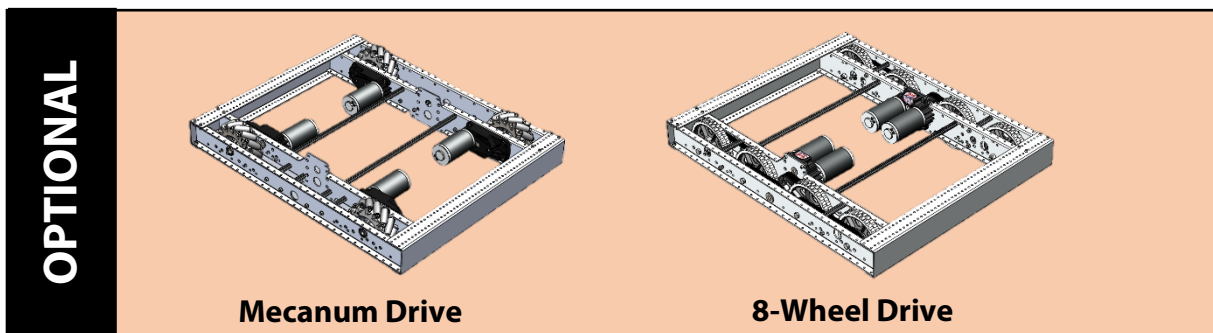
\*\*AM14U5 speed estimation is based on calculations using 6" wheels, and one CIM motor per TB Mini running at 4100 rpm, or 75% of free speed.

## Powertrain Specifications

The AM14U5 Kit of Parts Chassis Base Kit includes Gates HTD belts and the parts needed to build a 6" 6-wheel drive chassis with a direct drive center wheel in three recommended frame sizes. Other belt sizes are available on [AndyMark.com](http://AndyMark.com) or through Gates to allow for many more configurations.



Additionally, the AM14U5 parts can be used in other popular drive configurations as well. **Sprocket & Chain, Direct Drive Mecanum Wheels, and 8WD** can all be built by using the frame in this kit and swapping out some of the parts. For details on how to change your drive system visit [AndyMark.com/AM14u5](http://AndyMark.com/AM14u5)



## Wheel Overview

Included in the Drive Base Kit are 6" 80A HiGrip Wheels. These wheels are made of high-strength polycarbonate with an 80A urethane tread. These wheels provide long-lasting grip throughout the competition season. Many other wheels can be used as an alternative with minor adjustments to the plate spacing and layout.








## Wheel and Belt Assembly Bill of Materials

Component	Part Number	Quantity	Part Photo
6" HiGrip Wheel	<a href="#">am-0940b</a>	6	
1/2" Hex Hub	<a href="#">am-2568</a>	2	
Gates HTD 15mm wide, 160 Tooth Belt for Long Chassis	<a href="#">am-2266</a>	4	
Gates HTD 15mm wide, 120 Tooth Belt for Wide Chassis	<a href="#">am-2704</a>	4	
Gates HTD 15mm wide, 131 Tooth Belt for Square Chassis	<a href="#">am-2571</a>	4	
Pulley Half, 42 Tooth	<a href="#">am-2234a-half</a>	16	
<b>Wheel Screw Kit – (am-14U5_CK7)</b>			
10-12 x 1.25" Thread Forming Screws	<a href="#">am-1654</a>	48	
<b>Bearing Kit – (am-14U5_CK8)</b>			
1614ZZ Bearing	<a href="#">am-0209</a>	8	
FR8ZZ Bearing	<a href="#">am-0030</a>	2	

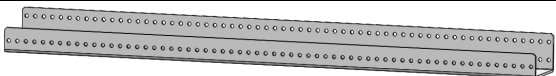

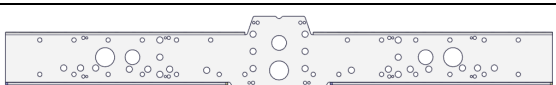












## Toughbox Mini Bill of Materials – Build two per Chassis

Component	Part Number	Quantity	Part Photo
<b>TB Mini Housing</b>	<a href="#">am-0650</a>	1	
<b>½" Hex Output Shaft Encoder Pin Ready</b>	<a href="#">am-4722</a>	1	
<b>TB Mini Small Hex Shaft</b>	<a href="#">am-0152</a>	1	
<b>TB Mini Kit 1 – am-14U5_TM1a</b>			
<b>50 Tooth, 3/8" Hex Gear</b>	<a href="#">am-0149</a>	1	
<b>14 Tooth, 8mm CIM Gear</b>	<a href="#">am-0034</a>	2	
<b>19 Tooth, 3/8" Hex Gear</b>	<a href="#">am-3645</a>	1	
<b>45 Tooth, 1/2" Hex Gear</b>	<a href="#">am-4712</a>	1	
<b>Spacer, 3/8" Hex Molded, 0.100 inches long</b>	<a href="#">am-3947-100</a>	1	
<b>¼" Dowel Pin</b>	<a href="#">am-1323</a>	2	
<b>TB Mini Kit 2 – am-14U5_TM2</b>			
<b>R6ZZ Bearing</b>	<a href="#">am-0516</a>	2	
<b>FR6ZZ Bearing</b>	<a href="#">am-0028</a>	1	
<b>FR8ZZ HexHD Bearing</b>	<a href="#">am-2986</a>	1	
<b>Red Tacky Grease Pack</b>	<a href="#">am-2768</a>	1	
<b>TB Mini Kit 3 – am-14U5_TM3</b>			
<b>2x2x10mm Machine Key</b>	<a href="#">am-1121</a>	2	
<b>5/16" Washer</b>	<a href="#">am-1009a</a>	4	

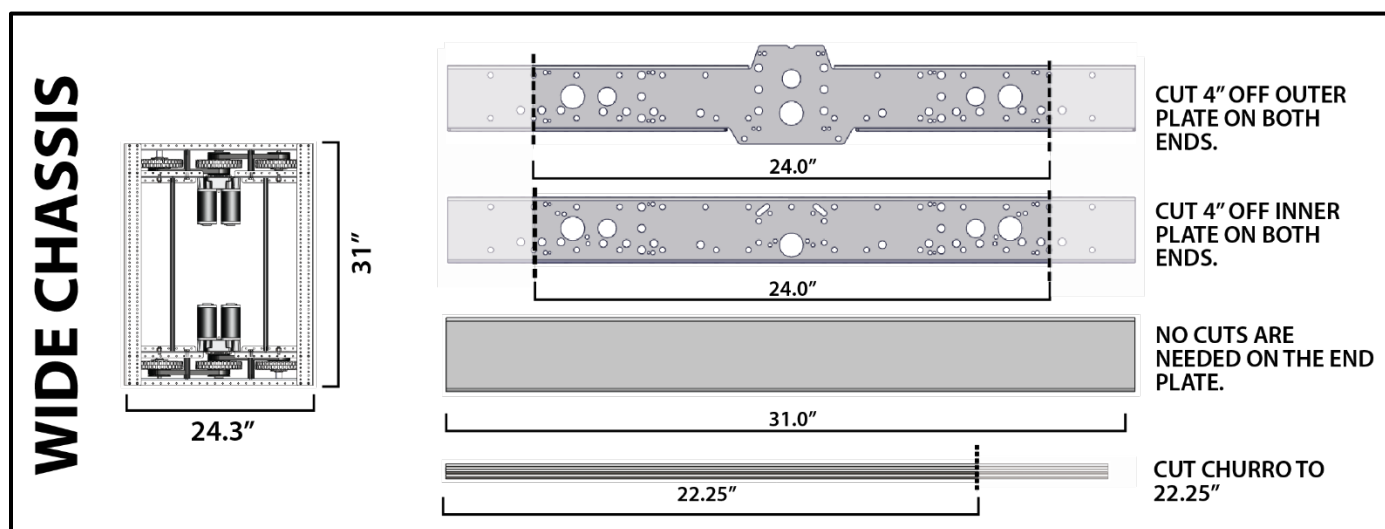
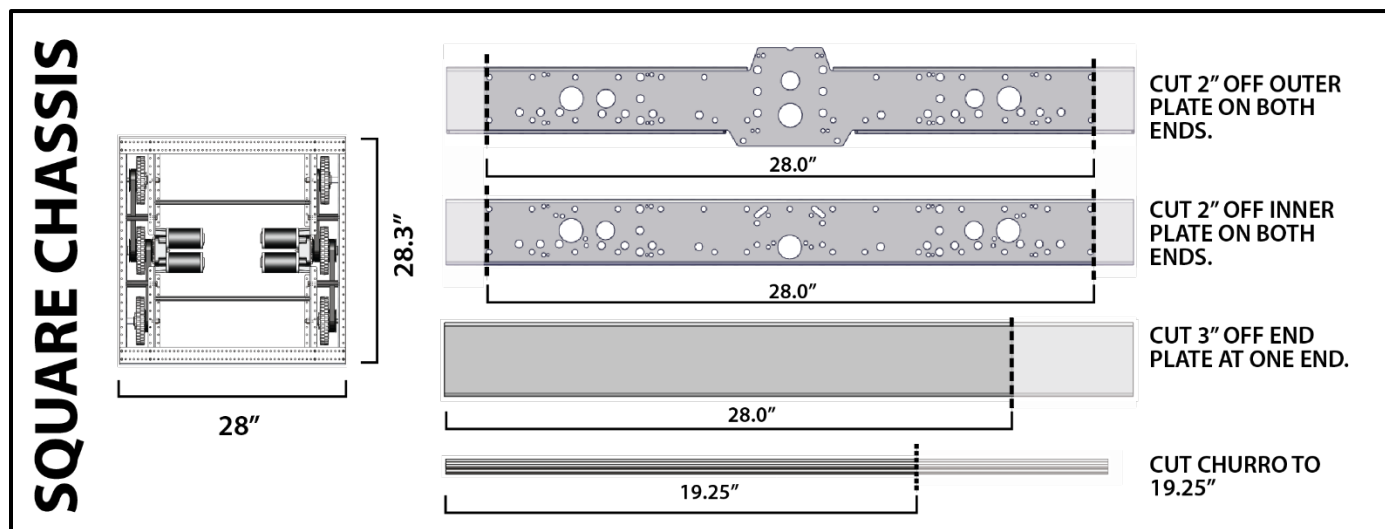
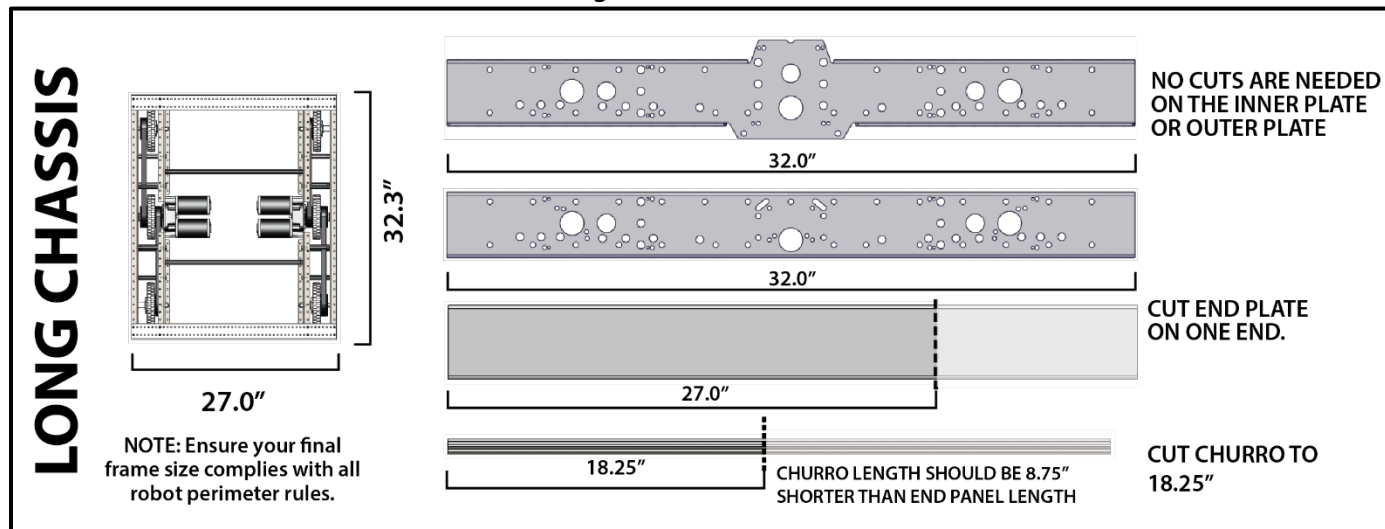
8mm Retaining Clip	<a href="#">am-0033</a>	2	
10-32 x 0.625" SHCS with Nylon Thread Lock Patch	<a href="#">am-1120</a>	4	
10-32 x 0.75" SHCS	<a href="#">am-1047</a>	4	
10-32 Nylock Nut	<a href="#">am-1042</a>	4	
1/2" E-Clip Ring	<a href="#">am-0206</a>	1	

## AM14U5 Chassis Frame Bill of Materials

Component	Part Number	QTY	Part Photo
AM14U Family End Plate	<a href="#">am-3920</a>	2	
AM14U5 Outer Plate	<a href="#">am-3921a</a>	2	
AM14U5 Inner Plate	<a href="#">am-3922a</a>	2	
500 Churro, 24"	<a href="#">am-3101-2</a>	2	
<b>AM14U5 – Churro Screw Kit – am-14U5_CK1</b>			
1/4-20 x 0.75" Thread Rolling Screw	<a href="#">am-1591</a> or <a href="#">am-1310</a>	20	
<b>AM14U5 – Axle Kit – am-14U5_CK2</b>			
3/8-16 x 4.25" HHS Bolt	<a href="#">am-1297</a>	4	
3/8-16 Nylock Nut	<a href="#">am-1054</a>	4	
<b>AM14U5 – Spacer Kit – am-14U5_CK3</b>			
0.570" Hex Spacer	<a href="#">am-1305</a>	2	
Plastic Spacer 0.280"	<a href="#">am-1306</a>	4	
Plastic Spacer 0.850"	<a href="#">am-1307</a>	4	
<b>AM14U5 – Frame Hardware Kit – am-14U5_CK4</b>			
10-32 x 0.5" SHCS	<a href="#">am-1002</a>	24	
10-32 Nylock Nut	<a href="#">am-1042</a>	24	
<b>AM14U5 Churro Kit – am-14U5_CK5</b>			
500 Churro, 3.375"	<a href="#">am-2569</a>	8	

## Frame Diagrams & Cut Lines:

The AM14U5 is designed for multiple configurations. Chassis pieces **should be measured** and cut down to size; some possible configurations are shown below. Ensure that your final frame size complies with all current rules. Belts for recommended **LONG**, **SQUARE** and **WIDE** configurations are included in the full AM14U5 Kit.





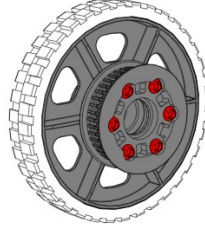
## 6" HiGrip Wheel and Pulley Assembly Instructions

### Outer Wheels (QTY 4)

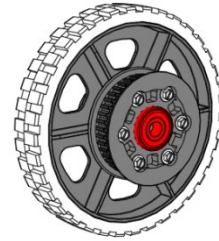
**Step 1:** Add two pulley halves (am-2234a-half) to the wheel (am-0940b).



**Step 2:** Using six 10-12 x 1.5" (am-1654) thread forming screws, attach the pulley halves to the wheel.



**Step 3:** Press two 1614ZZ bearings (am-0209) into the wheel/pulley, one into each side.



**4X**

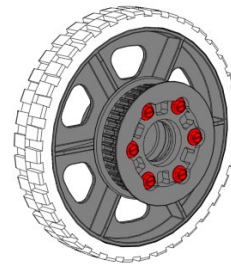
**NOTE:** Tighten the screws in a star pattern to ensure the pulley aligns evenly on the wheel.

### Center Wheels (QTY 2)

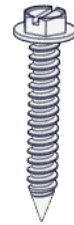
**Step 1:** Add two pulley halves (am-2234a-half) to the wheel (am-0940b).



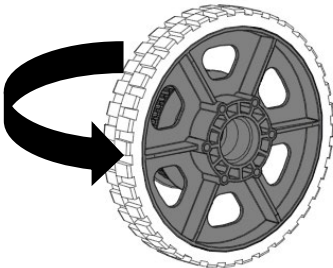
**NOTE:** Tighten the screws in a star pattern to ensure the pulley aligns evenly on the wheel.



**Step 2:** Using six 10-12 x 1.5" (am-1654) thread forming screws attach the pulley halves to the wheel.



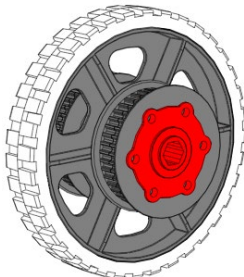
**Step 3:** Flip wheel over.



**Step 4:** Add two more pulley halves (am-2234a-half) to the wheel.



**Step 5:** Insert one 1/2" Hex Hub (am-2568) into the pulley on one side of the wheel.



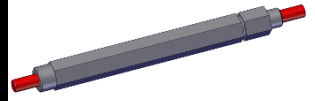
**Step 6:** Add six 10-12 x 1.5" (am-1654) thread forming screws to attach the pulley and hub to the wheel.



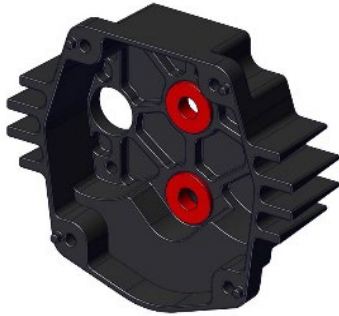
**2X**

# Toughbox Mini "T23" Version Assembly Instructions – Build 2 gearboxes

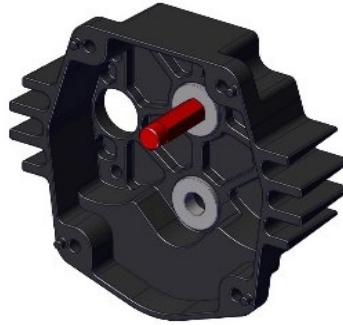
**Optional Encoder Pin Install:** Thoroughly clean off any oil on the encoder pins. Using super glue, add an encoder pin to either end of the encoder shaft. Let the glue dry. For more information on choosing encoders and pin locations please visit [AndyMark.com/TBMini](http://AndyMark.com/TBMini)



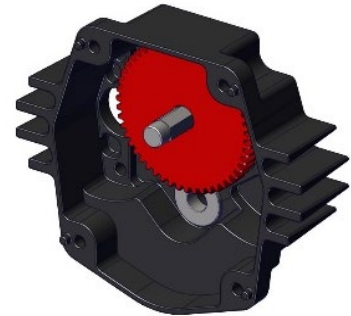
**Step 1:** Press two R6ZZ bearings (am-0516) into the two center holes of the TB Mini Housing (am-0650). Ensure they are fully seated and inserted all the way into the housing.



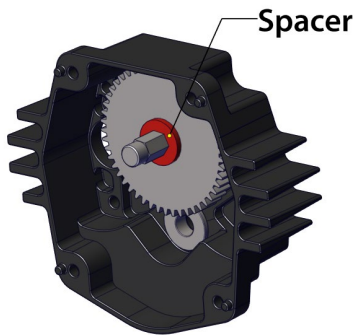
**Step 2:** Insert the TB Small Hex Shaft (am-0152) into R6ZZ bearing closest to the flat edge of the housing.



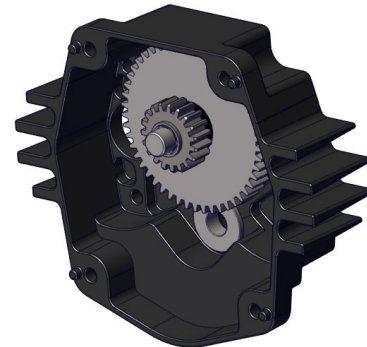
**Step 3:** Place the 50 tooth gear (am-0149) on the TB Small Hex Shaft with the **small round boss touching the bearing** and the flat side of the gear facing away from the housing.



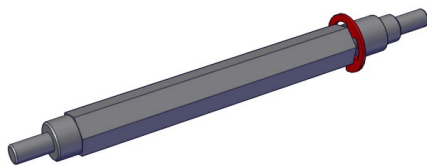
**Step 4:** Place the (am-3947-100) 3/8" Hex x 0.100" Spacer onto the TB Small Hex Shaft.



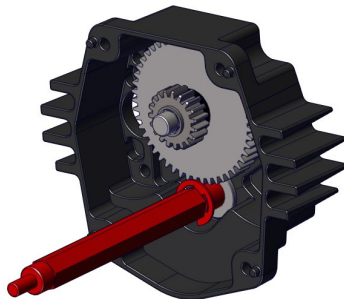
**Step 5:** Place the 19 tooth gear (am-3645) on the TB Small Hex Shaft.



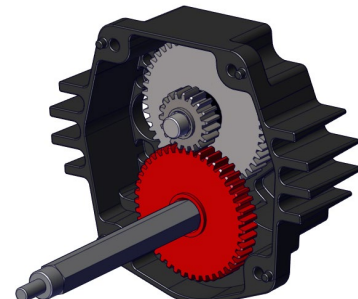
**Step 5:** Tap the 1/2" E-Clip (am-0206) onto the groove on the TB Hex Output Shaft.



**Step 6:** Insert the end closest to the E Clip of the TB Hex Output Shaft into the other R6ZZ bearing.



**Step 8:** Place the 45 Tooth Gear (am-4712) on TB Hex Output Shaft.

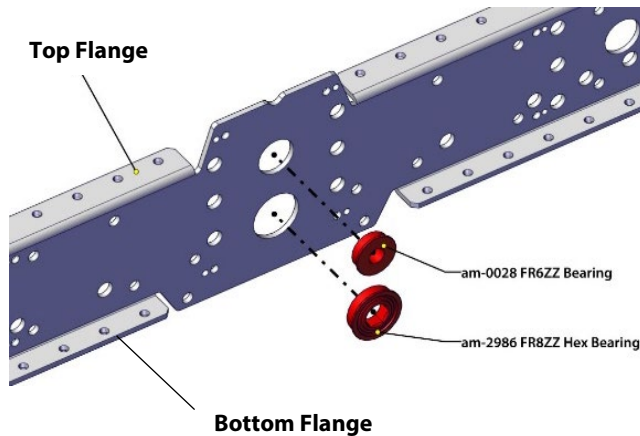


**Step 9:** Apply Red Tacky Grease (am-2768) to all of the gear teeth.

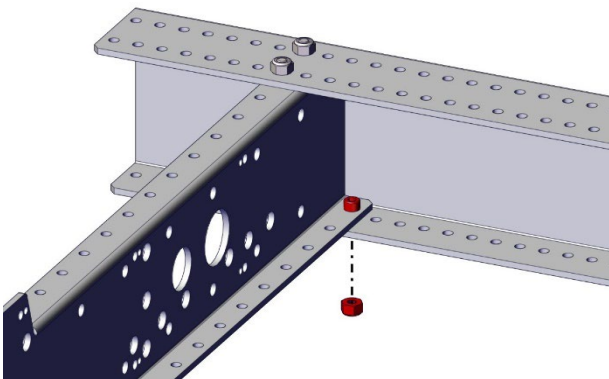


# Chassis Assembly Instructions

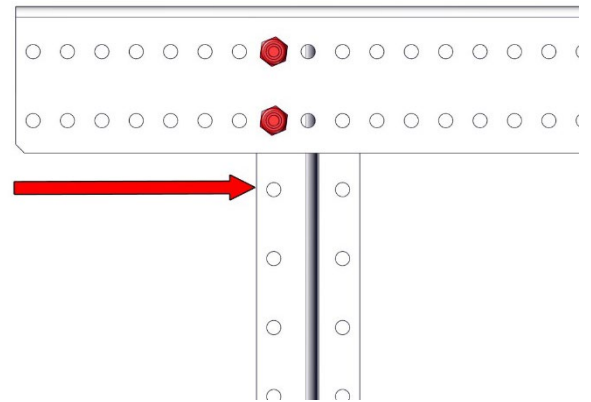
**Step 1:** Press a FR6ZZ (am-0028) and a FR8ZZ-HexHD (am-2986) bearing into the center holes on each Inside Plate (am-3922a). Make sure the **bearing flanges are on the same side** as the bottom flange of the Inside Plate.



**Step 3:** Secure the bottom flange to the End Plate with an additional 10-32 x 0.500 socket head screw and 10-32 Nylock nut.

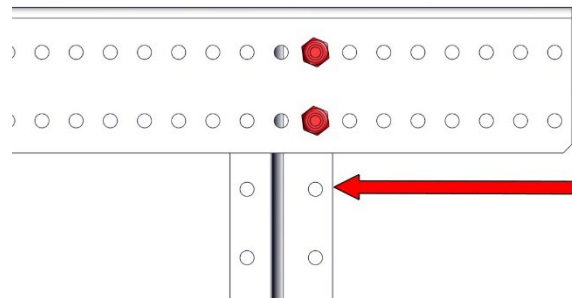


**Step 2:** Attach the top flange of an Inside Plate to the top (large) flange of an End Plate (am-3920) at the 8th hole in from the end with two 10-32 x 0.500 socket head screws (am-1002) and two 10-32 Nylock nuts (am-1042).



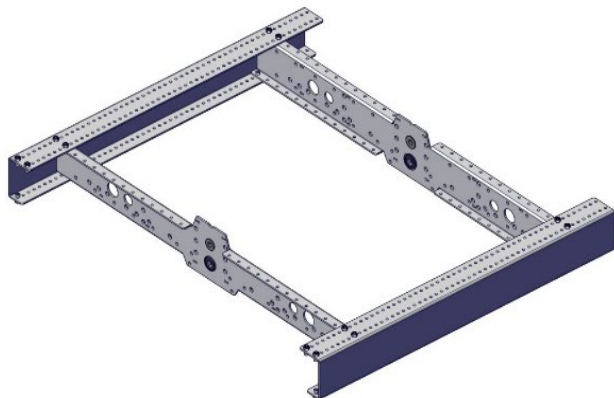
**NOTE:** The top flange of the Inside Plate should point toward the short side of the End Plate

**Step 4:** Repeat steps 2-3 on to attach the other Inside Plate to the End Plate.

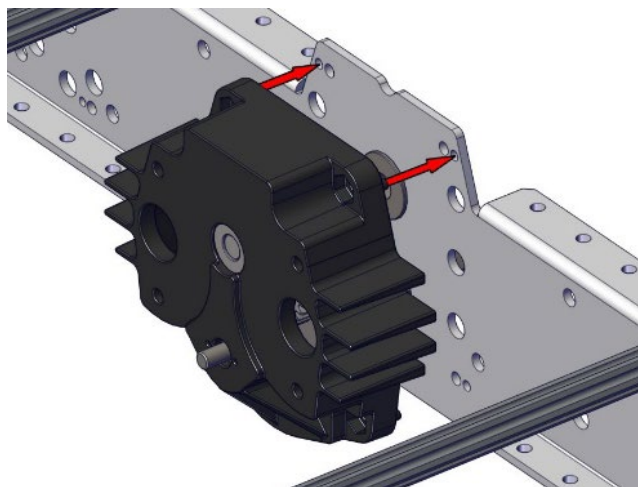


**NOTE:** The top flange of the Inside Plate should point toward the short side of the End Plate

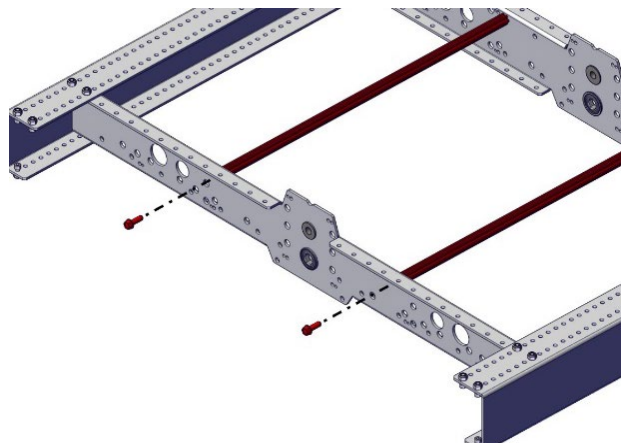
**Step 5:** Attach the other End Plate to the other end of the Inside Plates.



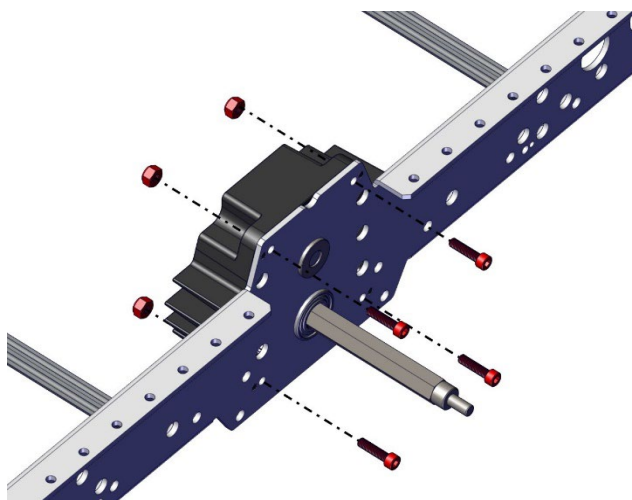
**Step 7:** Place one Toughbox Mini onto each Inner Plate ensuring the shafts are inserted into the flanged side of the bearings, and using the plastic studs to align the housing. The top flange of the Inside Plate will be facing away from the gearbox.



**Step 6:** Attach the two (cut to length) Long Churros between the Inside Plates using four ¼-20 x 0.750" thread forming screws (am-1591). A ½" wrench can be used to hold the churro while tightening.



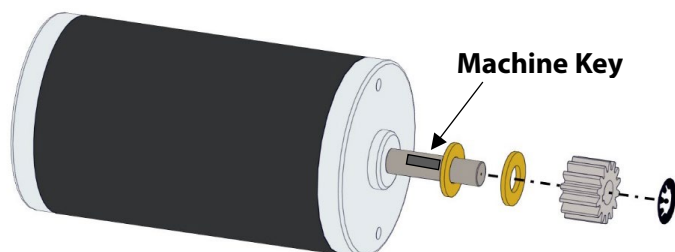
**Step 8:** Attach one Toughbox Mini to each Inside Plate with four 10-32 x 0.75" SHCS (am-1047) and four 10-32 Nylock nuts (am-1042). The nuts will fit into the hex pockets on the Toughbox Mini housing and will hold the nut while tightening.



**NOTE:** Be careful not to overtighten these screws. The gears should spin freely when the shaft is rotated by hand.

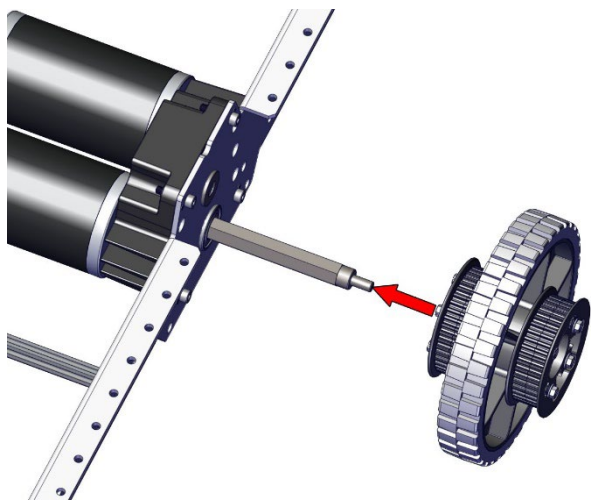


**Step 9:** Slide two 5/16" washers (am-1009a) onto each CIM motor shaft against the round boss of the motor. **Place the Machine Key (am-1121) into the keyway of the motor shaft.** Slide the 14 tooth (am-0034) gear onto the shaft up to the washers, while aligning the keyway of the gear to the key. Use a 7/16" socket to press the 8mm Retaining Clip (am-0033) onto the face of the gear, with the tabs of the clip pointing toward the motor shaft.

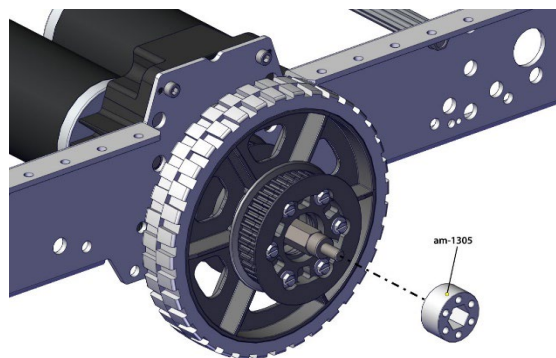


**NOTE:** Each drive gearbox can accept up to 2 motors. Repeat this step for each motor.

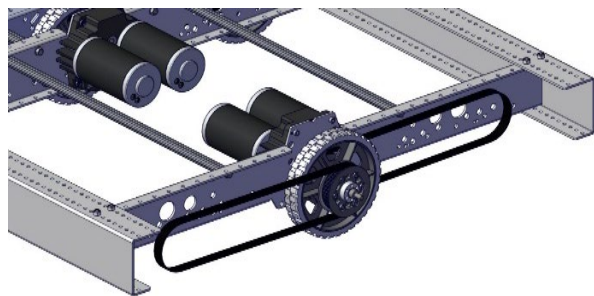
**Step 11:** Place a Center Wheel Assembly onto each Toughbox Hex Output Shaft with the aluminum hub facing towards the Inside Plate.



**Step 12:** Place the Hex Spacer (am-1305) onto each Toughbox Mini Hex Output Shaft and press into the round cavity in the pulley. The shaft will help align the spacer hex bore with the wheel hub hex bore.

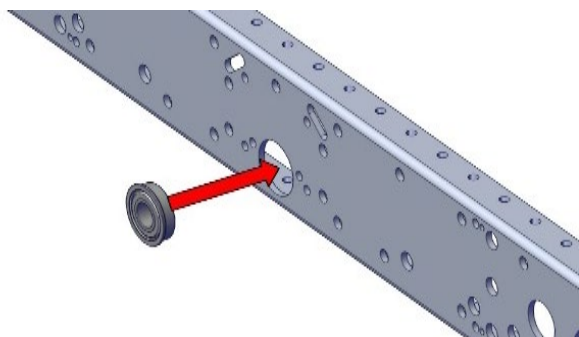


**Step 13:** Select the appropriate belts for your chassis configuration, and loop one belt over each Pulley on each Center Wheel Assembly.

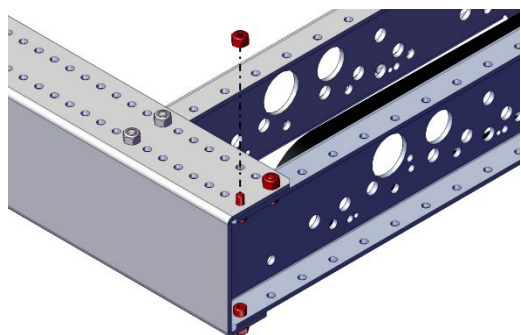


*The long chassis requires 160 tooth belts (am-2266).  
The wide chassis requires 120 tooth belts (am-2704).  
The square chassis requires 131 tooth belts (am-2571).*

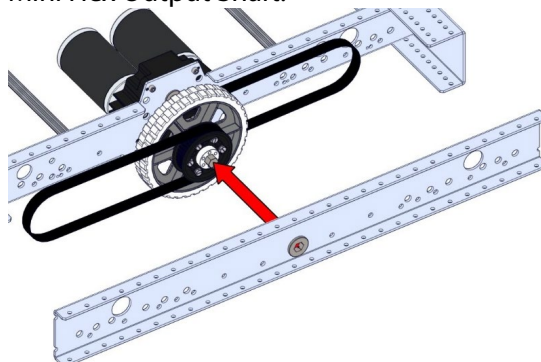
**Step 14:** Press the FR8ZZ Bearing (am-0030) into the center hole of each Outside Plate (am-3921a). The bearing flange will be on the side **opposite** the plate flanges to ensure the bearings do not fall out during operation.



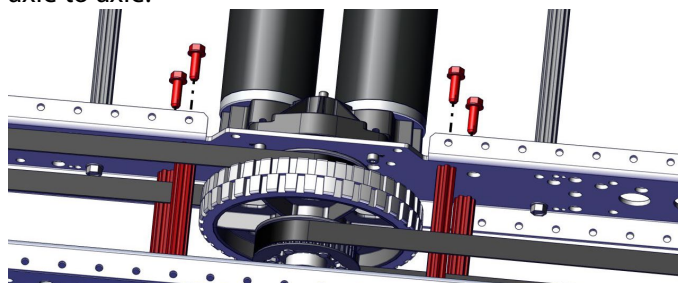
**Step 16:** Secure the Outside Plates to each End Plate using six 10-32 x 0.500 socket head screws (am-1002) and two 10-32 Nylock nuts (am-1042).



**Step 15:** Place each Outside Plate into the ends of both End Plates with the flanges of the Outside Plate pointing away from the Inside Plate. Ensure the Bearing is aligned to and installed on the Toughbox Mini Hex Output Shaft.

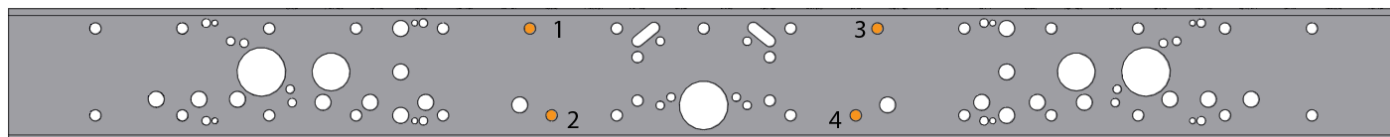


**Step 17:** Attach four 3.375" Churro Standoffs (am-2569) (see below for recommended locations) with 1/4-20 x 0.75" Thread Forming Screws (am-1591) onto each Inside Plate. A 1/2" wrench can be used to hold the churro while tightening. Make sure to loop belts over the churro to ensure the belts have a straight path from axle to axle.



**BOTTOM VIEW**

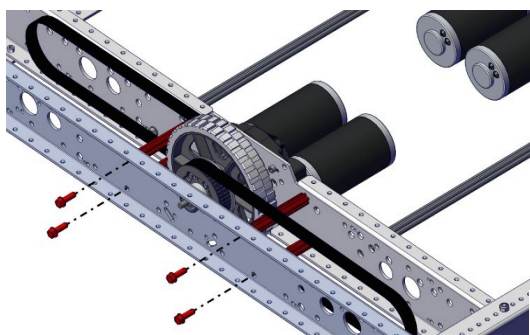
#### Recommended Support Churro Locations



**NOTE:** The Churro Standoffs are intended to help with the structure of the chassis. Be sure to install four on each Inner Plate.



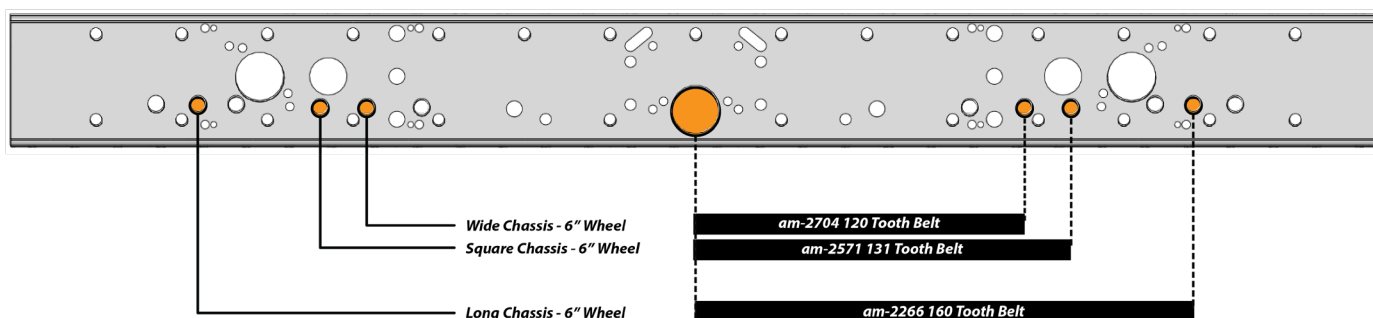
**Step 18:** Secure the Outside Plates to each Churro Standoff using 1/4-20 x 0.75" thread forming screws (am-1591). A 1/2" wrench can be used to hold the Churro Standoffs while tightening.



**BOTTOM VIEW**

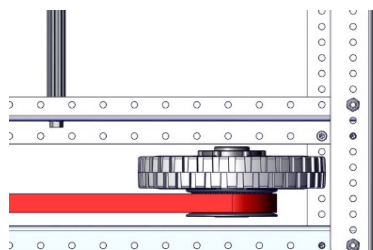
**Step 19:** There are different axle bolt locations for each chassis configuration. Locate the hole to match the chosen belt and frame size.

### Hole Diagram for 6" Wheels



**NOTE:** Axle bolts must be installed from the outside of the chassis. If they are inserted into the Inside Plate first, the included bumper hardware will not fit.

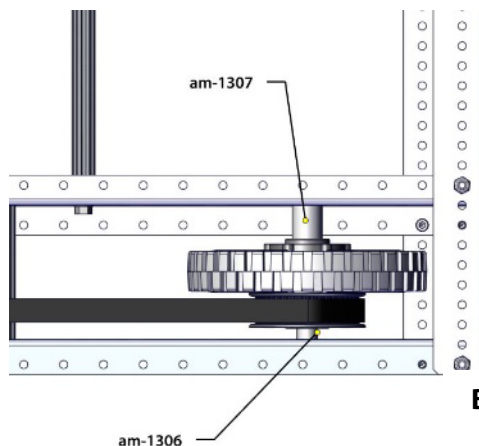
**Step 20:** Take an Outer Wheel Assembly, loop the belt onto the pulley, and insert the wheel between the Inside and Outside Plates. Ensure the belts are straight. One end will have the pulley closer to the outside plate, the other closest to the inside plate.



**BOTTOM VIEW**

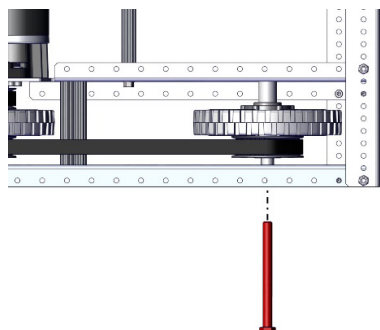
**NOTE:** The belts should be parallel to the side plates.

**Step 21:** For the pulleys that are closest to the Outside Plate, the Short Axle Spacer (am-1306) will be closest to the outside plate. The Long Axle Spacer (am-1307) will be closest to the inside plate.



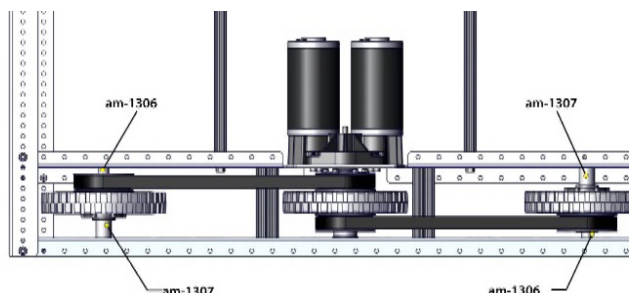
**BOTTOM VIEW**

**Step 22:** There are different axle bolt locations for each chassis configuration. Slide a  $\frac{3}{8}$ " axle bolt (am-1297) through the spacers and wheel assembly, with the head of the bolt on the outside of the chassis.



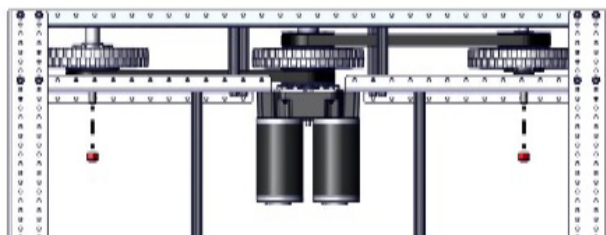
**BOTTOM VIEW**

**Step 24:** For the belt runs that are closest to the Inside Plate, the Short Axle Spacer (am-1306) will be closest to the Inside Plate. The Long Axle Spacer (am-1307) will be closest to the Outside Plate.

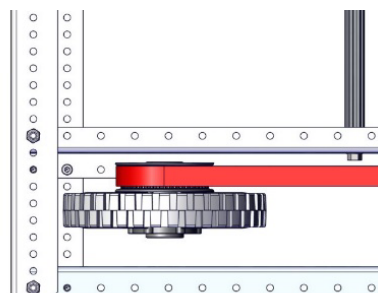


**BOTTOM VIEW**

**Step 26:** Install one  $\frac{3}{8}$ -16 Nylock Nut (am-1054) on each Axle Bolt. Tighten the bolt and nut until the spacers just begin to touch Inside and Outside Plates. The wheels should still easily turn, and the axle bolts should be able to spin with a light turn of a wrench.

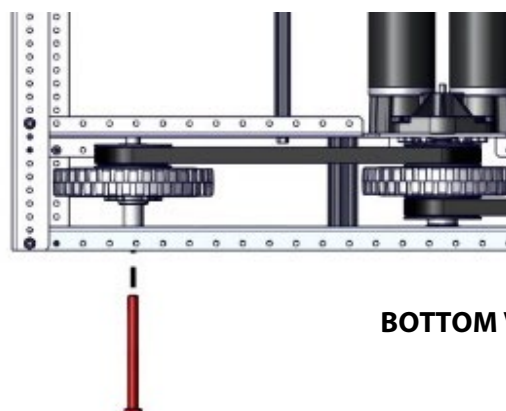


**Step 23:** Add another Outer Wheel Assembly to the other end of the chassis. Loop the belt onto the pulley and insert the assembly between the Inside and Outside Plates. This assembly should have its pulley facing opposite of the first assembly.



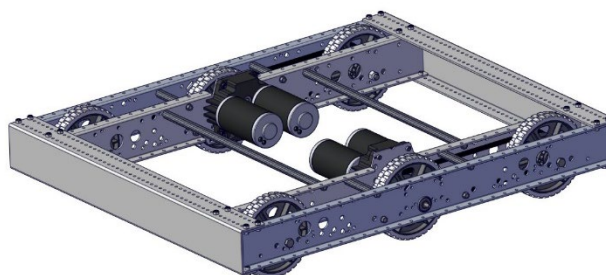
**BOTTOM VIEW**

**Step 25:** Slide a  $\frac{3}{8}$ " axle bolt (am-1297) through the spacers and wheel assembly, with the head of the bolt on the outside of the chassis.



**BOTTOM VIEW**

**Step 27:** Repeat steps 19 through 26 to install wheels on other side of chassis.



**NOTE:** An optional Axle Nut Holder (am-4595) can be used to hold the axle nut for easier wheel maintenance.

**You've completed the AM14U5 Kit of Parts Chassis.**

**For more information, tips and instructions on how to mount your battery, bumpers, encoders and more visit [AndyMark.com](http://AndyMark.com).**