



# User Guide

AndyMark, Inc. Drive System Components for 2013 *FIRST*  
Robotics Competition



<u>Contents</u>	<u>Page</u>
• AndyMark Background	2
• System Overview	2
• Donated Parts	2
• 2013 C-Base Bill of Materials	3
• Belt and Wheel Bill of Materials	4
• Toughbox Mini Overview and Specifications	5
• Toughbox Mini Bill of Material	5
• Toughbox Mini Assembly Instructions	7
• Drive System Assembly Instructions	9
• Battery Plug Usage	12

## AndyMark, Inc. Background

AndyMark was founded in 2004, when Andy Baker and Mark Koors saw a need to design and sell unique mechanical parts for the competition and educational robotics community. Many designs were being shared and re-created, but finding the correct fabrication resources for these parts was difficult for many schools and teams. AndyMark currently sells parts to all 50 states and to over 40 countries worldwide.

AndyMark is committed to supporting *FIRST* and has been a supplier of the FRC program since 2005. Customers are encouraged to seek product information at [www.andymark.com](http://www.andymark.com), or to send an email to [sales@andymark.com](mailto:sales@andymark.com). Phone calls are appreciated (877-868-4770 toll free), however, emails are preferred during the January and February *FIRST* build season. Best of luck to all of the *FIRST* teams in the 2013 FRC season!

## System Overview

The 2013 AndyMark Drive System is designed for use in the 2013 *FIRST* Robotics Competition (FRC). This Drive System includes standard AndyMark products:

- 2013 C-Base Drive Chassis (am-2239)
- Toughbox Mini Gearbox (am-2236)
- 6" HiGrip *FIRST* Wheels (am-0940)
- 3/8" Bore Wheel Bearings (am-0209)
- Belt Pulley (am-2234)

All of these parts are provided in kit form. Instructions can be found in this manual and online. CAD files and more detailed layout drawings can be found at the AndyMark website under the “*FIRST* FRC Approved” product category. HTD timing belts and aluminum pulleys from the Gates Corporation are included with these AndyMark items to complete the 2013 FRC Drive System.

## Donated Items

AndyMark is also donating these items to the FRC kit and *FIRST* Choice (FC).

• Battery Plugs, 4 per team	am-0122	<a href="http://www.andymark.com/product-p/am-0122.htm">www.andymark.com/product-p/am-0122.htm</a>
• 9015 Motor, 2 per team	am-0912	<a href="http://www.andymark.com/product-p/am-0912.htm">www.andymark.com/product-p/am-0912.htm</a>
• PG71 Garmotor, 1 per team	am-0914	<a href="http://www.andymark.com/product-p/am-0914.htm">www.andymark.com/product-p/am-0914.htm</a>
• CIM Motors, 1000 in FC	am-0255	<a href="http://www.andymark.com/product-p/am-0255.htm">www.andymark.com/product-p/am-0255.htm</a>
• PG27 Garmotor, 500 in FC	am-0915	<a href="http://www.andymark.com/product-p/am-0915.htm">www.andymark.com/product-p/am-0915.htm</a>
• PG188 Garmotor, 500 in FC	am-2193	<a href="http://www.andymark.com/product-p/am-2193.htm">www.andymark.com/product-p/am-2193.htm</a>
• Snowblower Motor, 500 in FC	am-2235	<a href="http://www.andymark.com/product-p/am-2235.htm">www.andymark.com/product-p/am-2235.htm</a>

The *FIRST* Choice order fulfillment program is a donated service from AndyMark. Many *FIRST* suppliers graciously donated their items to FRC teams, and they are distributed through this service from AndyMark. Please see [www.andymark.com/firstchoice](http://www.andymark.com/firstchoice) for more information.



## 2013 C-Base (am-2239) Bill of Material and Part Photos



Component	Qty	Part Number	Part Photo	QR Code
C-Channel	6	<a href="#">am-2222</a>		
Corner Connect	8	<a href="#">am-0212</a>		
500 Cross Hex Tube	2	<a href="#">am-2241</a>		
¼-20 x 1.75" SHCS	32	am-1058 sold as pkg: <a href="#">am-1206</a>		
¼-20 Nylock Nut	40	am-1015 sold as pkg: <a href="#">am-1160</a>		
¼-20 x 1" Thread Rolling Screw	4	am-1182 sold as pkg: <a href="#">am-1225</a>		
¼-20 x ¾" Hex Flange Screw	4	am-1271 sold as pkg: <a href="#">am-1277</a>		
Anchor Bolt	4	<a href="#">am-1267</a>		
3/8-16 x 6"	6	<a href="#">am-1268</a>		
3/8-16 Nylock Nut	6	<a href="#">am-1054</a>		
1.8" Spacer	6	<a href="#">am-2242</a>		
0.82" Spacer	4	<a href="#">am-2243</a>		

0.19" Spacer	2	<a href="#">am-2271</a>		
5/16" Washer	2	am-1001 sold as pkg: <a href="#">am-1221</a>		
Cross Hex Nut	4	<a href="#">am-2244</a>		

### Belt Sprocket, Belt, and Wheel Bill of Materials

Component	Qty	Part Number	Part Photo	QR Code
3/8" Bore Ball Bearing (1614ZZ)	12	<a href="#">am-0209</a>		
6" HiGrip FIRST Wheel	6	<a href="#">am-0940</a>		
Self-tapping #10-24 x 1- 1/4 screw	48	am-1266 sold as pkg: <a href="#">am-1278</a>		
42 Tooth HTD Plastic Pulley Half	16	<a href="#">am-2234-half</a>		
39 Tooth HTD Aluminum Pulley	2	<a href="#">am-2265</a>		
160 Tooth HTD Timing Belt	2	<a href="#">am-2266</a>		
104 Tooth HTD Timing Belt	4	<a href="#">am-2267</a>		

## Toughbox Mini Overview and Specifications

Each FRC team receives two (2) AndyMark Toughbox Mini gearboxes ([am-2236](#)) unassembled. Assembly instructions are in this manual, and at:

[www.andymark.com/product-p/am-2236.htm](http://www.andymark.com/product-p/am-2236.htm) (Files & Documents)

Each Toughbox Mini includes all parts to mount two 2.5" CIM Motors. There are mounting holes on the housing to attach an encoder (not included). Here are the gearbox specifications:

- Gear Profile: 20 dp, 14.5 degree pressure angle
- Gear material: cold-formed 4140 steel
- CIM Gear: 14 tooth (8mm inside diameter with 2mm keyway)
- Large Cluster Gear: 50 Tooth (3/8" hex bore)
- Small Cluster Gear: 16 Tooth (3/8" hex bore)
- Large Output Gear: 48 tooth (1/2" hex bore)
- Gear Ratio: 10.71:1
- Output Shaft: 1/2" dia. 4140 steel with 1/8" keyway, and 1/4-20 x 1/2" deep threaded hole
- Housing material: Nylon 6/6 with long fiber reinforcement
- Shaft plate material: 5052 aluminum

Each gearbox includes a machine key, a washer, and a 1/4"-20 button head screw to capture shaft items.



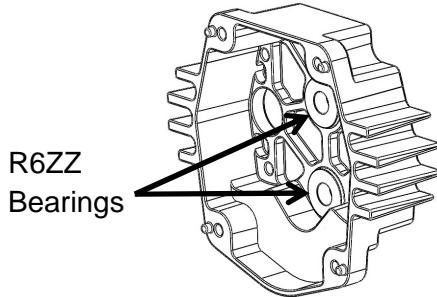
## Toughbox Mini (am-2236) Bill of Material & Part Photos (2)

Component	Qty	Part #	Part Photo	Code
TB Mini Housing	1	<a href="#">am-0650</a>		
TB Mini Shaft Plate	1	<a href="#">am-2230</a>		
TB Output Shaft	1	<a href="#">am-0153</a>		
TB Small Hex Shaft	1	<a href="#">am-0152</a>		
50 Tooth, 3/8 Hex Gear	1	<a href="#">am-0149</a>		
48 Tooth, 1/2 Hex Gear	1	<a href="#">am-0885</a>		

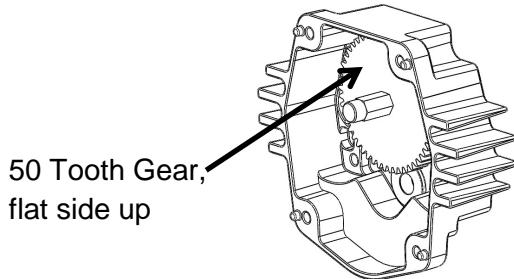
16 Tooth, 3/8 Hex Gear	1	<a href="#">am-0747</a>		
14 Tooth, 8mm Key Gear	2	<a href="#">am-0034</a>		
FR6ZZ Bearing	1	<a href="#">am-0028</a>		
FR8ZZ Bearing	1	<a href="#">am-0030</a>		
R6ZZ Bearing	2	<a href="#">am-0516</a>		
2x2x10mm Machine Key	2	<a href="#">am-1121</a>		
5/16" Washer	4	am-1009 sold as pkg: <a href="#">am-1279</a>		
8mm Retaining Clip	2	<a href="#">am-0033</a>		
10-32 x 5/8" SHCS w/ Patch	4	am-1120 sold as pkg: <a href="#">am-1246</a>		
1/8" Machine Key	1	<a href="#">am-1043</a>		
10-32 x 0.75" SHCS	4	am-1047 sold as pkg: <a href="#">am-1280</a>		
10-32 Nylock Nut	4	am-1042 sold as pkg: <a href="#">am-1211</a>		
Grease Pack	4	<a href="#">am-0908</a>		
½" eClip Ring	1	<a href="#">am-0206</a>		
¼" Washer	1	am-1027 sold as pkg: <a href="#">am-1069</a>		
¼-20 x ½ BHCS	1	am-1039 sold as pkg: <a href="#">am-1202</a>		

## Toughbox Mini Assembly Instruction

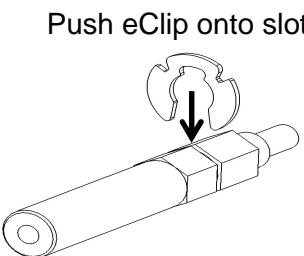
Step 1: Press R6ZZ Bearings (am-0516) into the two center holes of the TB Mini Housing (am-0650).



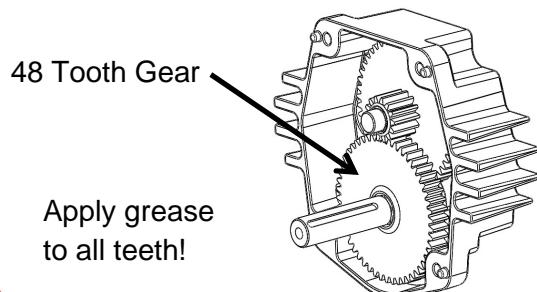
Step 3: Insert the 50 Tooth, 3/8 Hex Gear (am-0149) onto the Small Hex Shaft with the flat side up.



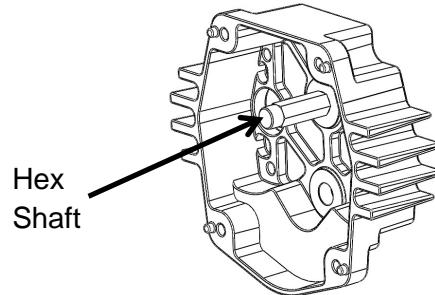
Step 5: Tap the  $\frac{1}{2}$ " eClip Ring (am-0206) into the grooved slot of the TB Output Shaft (am-0153).



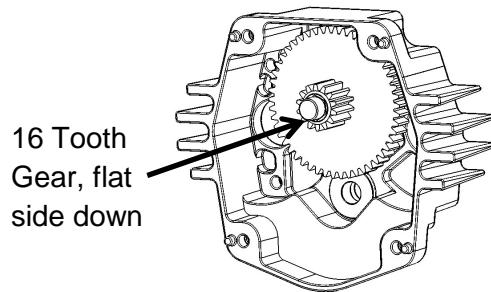
Step 7: Place the 48 Tooth, 1/2 Hex Gear (am-0885) onto the Output Shaft, flat side down. Use all four Grease Packs (am-0908) and apply grease to all of the gear teeth.



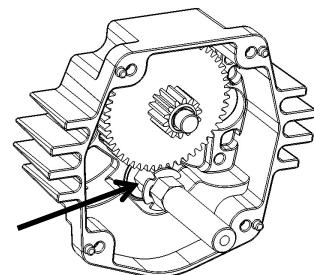
Step 2: Insert the TB Small Hex Shaft (am-0152) in the bearing near the flat edge of the Housing.



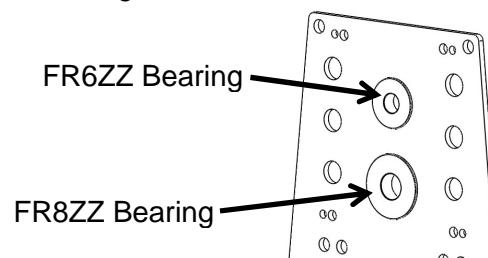
Step 4: Insert the 16 Tooth, 3/8 Hex Gear (am-0747) over the Small Hex Shaft with the flat side down.



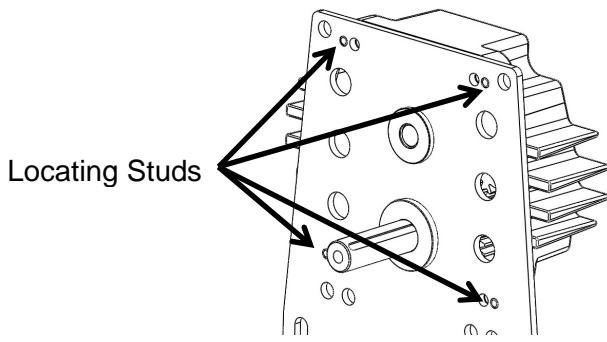
Step 6: Insert the Output Shaft small end into the remaining R6ZZ Bearing.



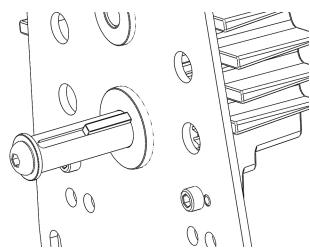
Step 8: Press the FR8ZZ Bearing (am-0030) in the large hole on the TB Mini Shaft Plate (am-2230). Press the FR6ZZ Bearing (am-0028) into the next larger hole.



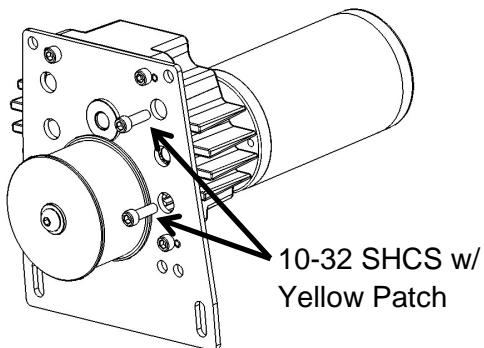
Step 9: Place the Plate and Bearings over the Housing's plastic locating studs. The Bearing flanges should be inside the gearbox.



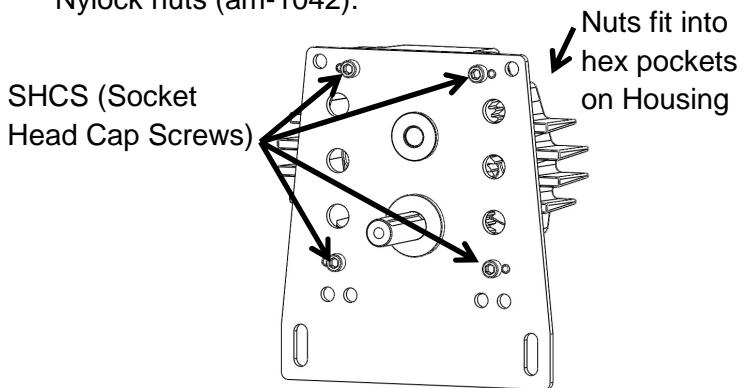
Step 11: The picture below shows where the 1/8" Machine Key (am-1043) will be inserted, after the pulley (not pictured) is finally inserted. Insert the 1/4-20 x 1/2 BHCS (am-1039) through the 1/4" Washer (am-1027) and into the end of the Output Shaft. This will keep the pulley secure.



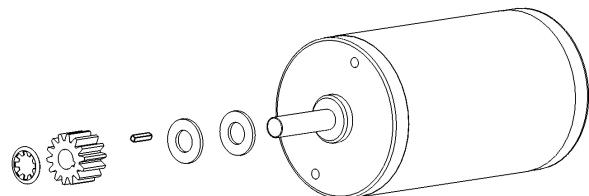
Step 13: Line up the two mounting holes of the CIM Motor with holes in the Toughbox Mini housing. Secure the motor to the gearbox with the 10-32 x 5/8" SHCS w/ Patch (am-1120).



Step 10: Fasten the Plate to the Housing with the 10-32 x 0.75" SHCS (am-1047) and 10-32 Nylock nuts (am-1042).



Step 12: Place the two 5/16" Washers (am-1009) onto the CIM Motor shaft. Place the 2x2x10mm Machine Key (am-1121) into the keyway. Push the 14 Tooth, 8mm Key Gear onto the shaft, to the face of the washers, while aligning the keyway with the Machine Key. Use a 3/8" socket to press the 8mm Retaining Clip (am-0033) onto the face of the gear.

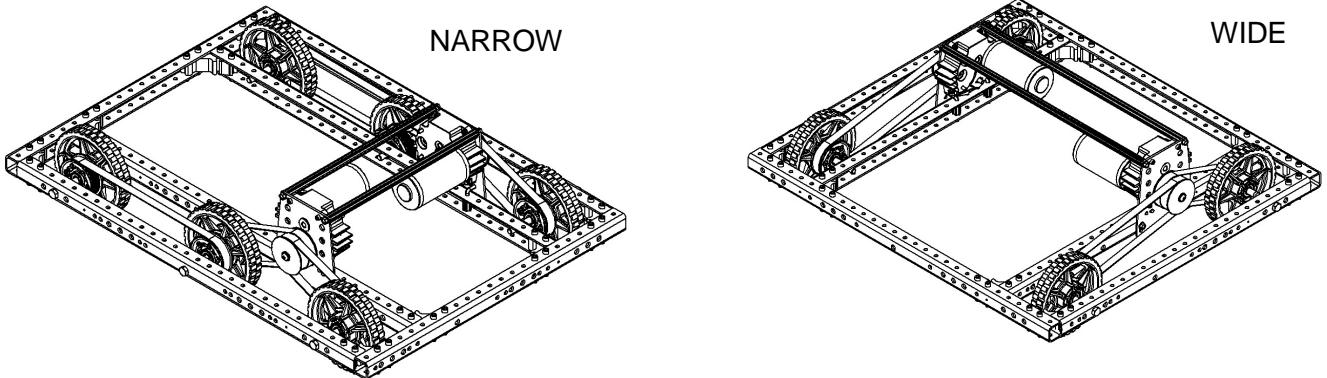


Tip: Line up one of the tongs on the Retaining Ring to keep the 2x2x14 Machine Key from wiggling out of the keyway.

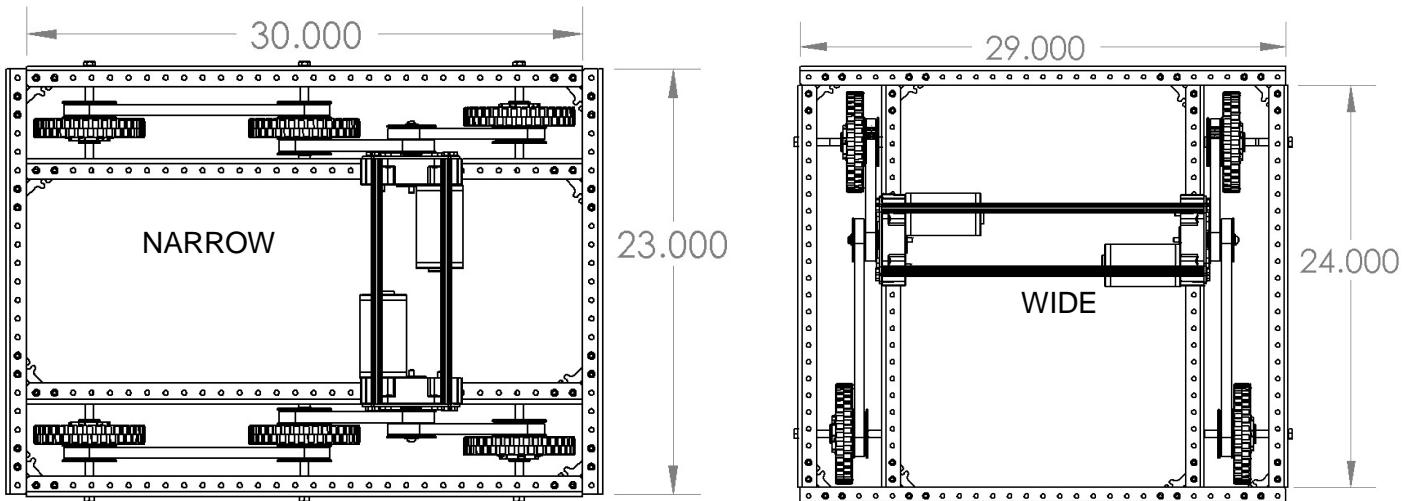
Although in picture,  
gearbox pulley is not  
attached in this step.

## 2013 AndyMark Drive System Assembly

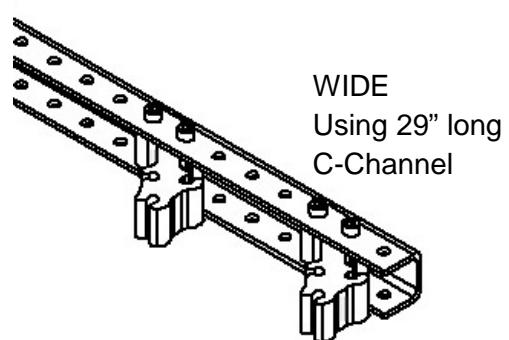
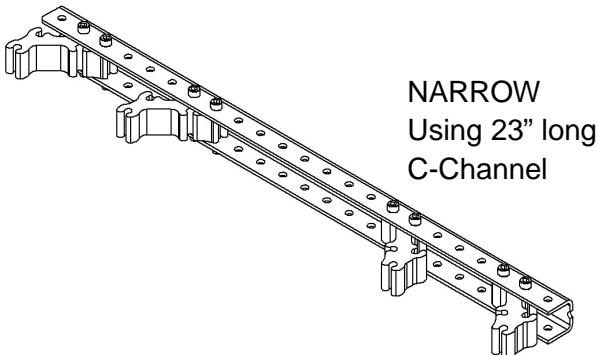
Step 1: Please notice that the 2013 C-Base uses different, shorter (30" long) C-Channel than previous years' C-Bases. Decide whether to use the C-Base in a NARROW or WIDE configuration.



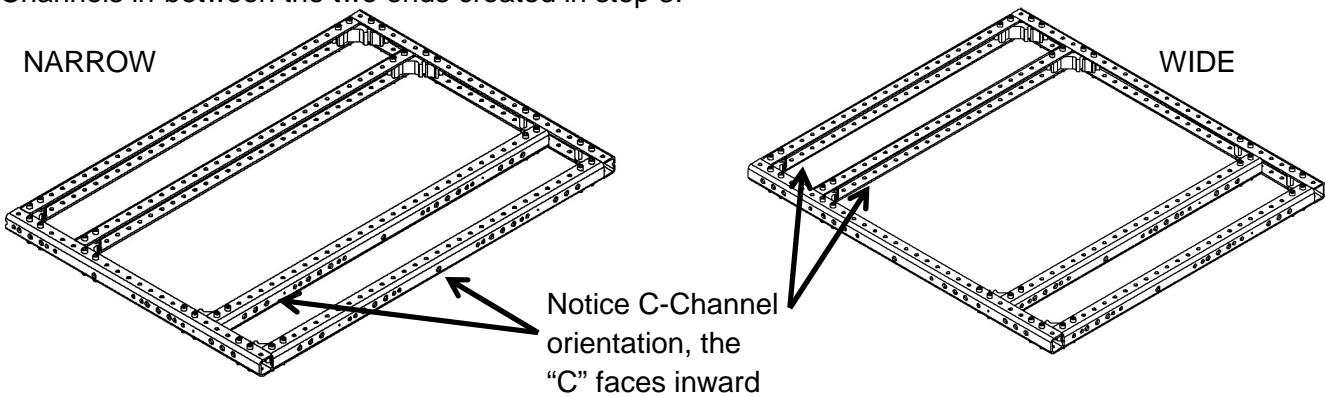
Step 2: Build the C-Base frame by measuring and cutting C-Channel. A NARROW base has two of the C-Channels at 23 inches long. For a WIDE base, two C-Channels are 29 inches long and the remaining four are 24 inches long. When cutting, plan your cuts to be on one end of the channel (do not cut from each end.) You can cut the C-Channel to custom lengths, but consider the 2013 FRC robot rules.



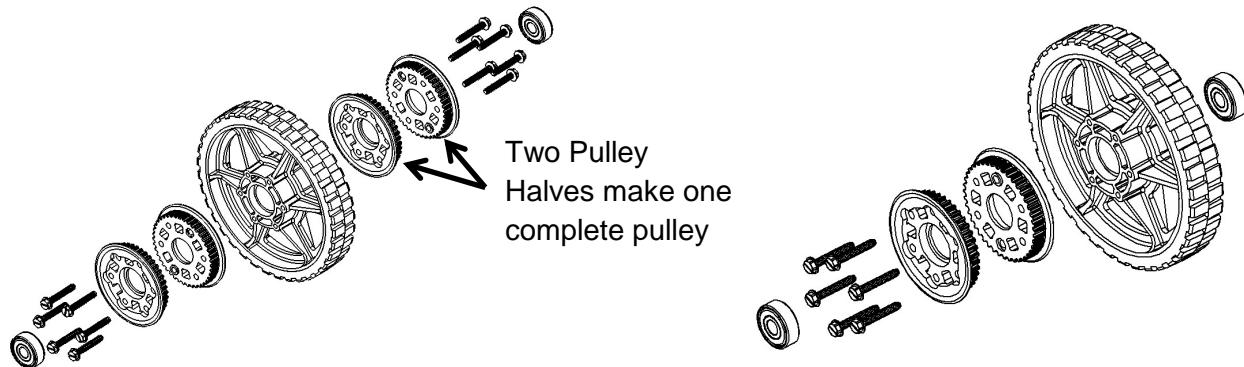
Step 3: Assemble the Corner Connects (am-0212) onto the C-Channels (am-2222.) Use 1/4-20 x 1.75 bolts and 1/4-20 Nylock nuts provided. Create two sections using the example below.



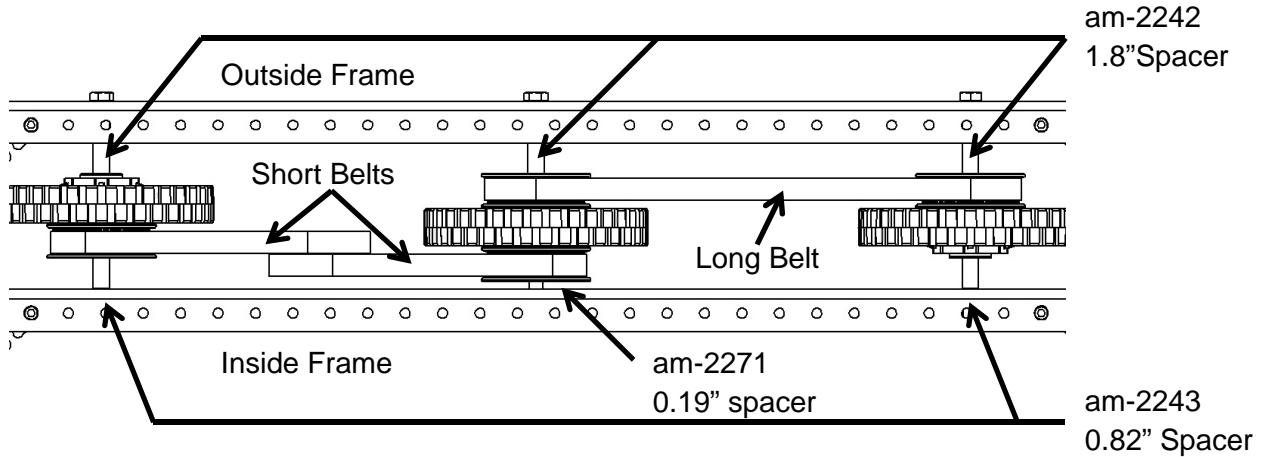
Step 4: Complete the frame perimeter by using the remaining 1/4-20 bolts to fasten your remaining C-Channels in-between the two ends created in step 3.



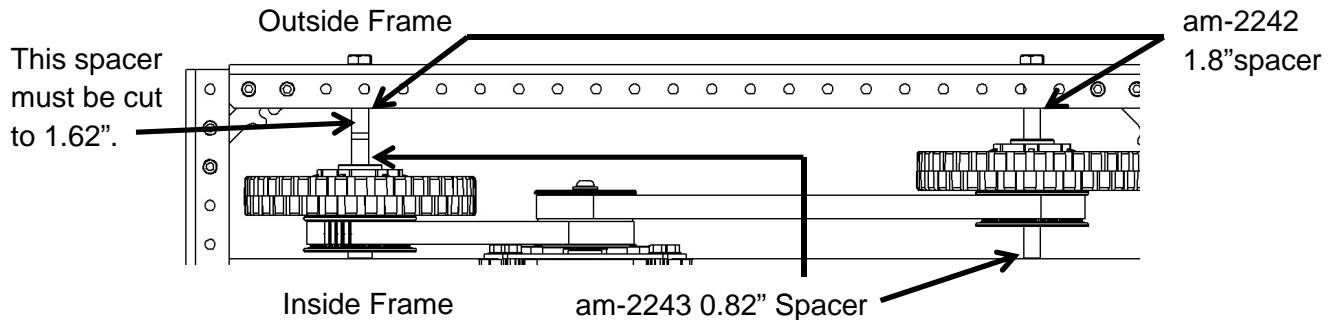
Step 5: Using the thread forming screws (am-1266) attach the 42 Tooth HTD Plastic Pulley Halves (am-2234-half) to the 6" HiGrip Wheel. For all WIDE base wheels and the outer wheels of the NARROW base, use the example on the right below. For the two inner wheels of the NARROW base, use the example on the left below. After securing the pulley(s) to the wheel, press in the bearings, two per wheel.



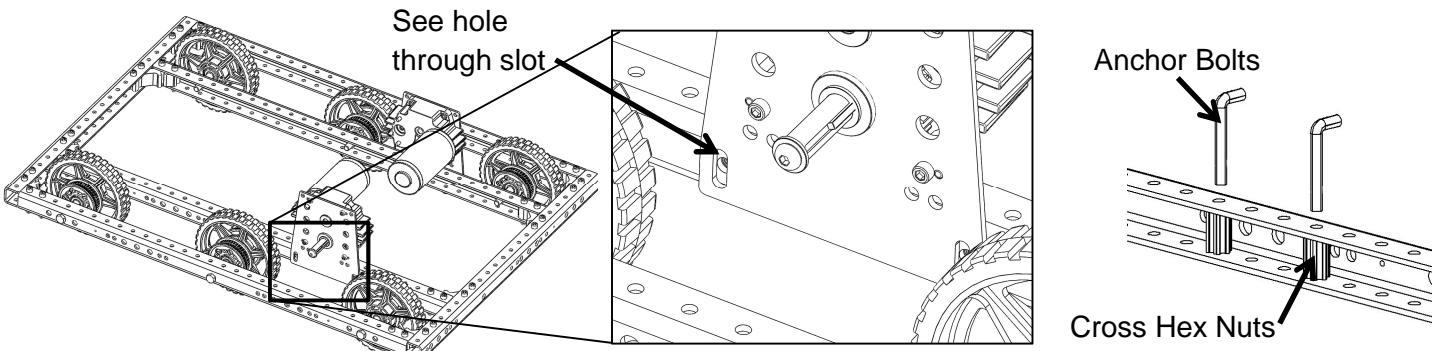
Step 6: Place the assembled wheels and the loose belts onto the axles as shown in the picture below for the NARROW base. Use the spacers to align the wheels. Place the belts around the pulleys. The long belt should be a tight fit between the middle wheel and right wheel.



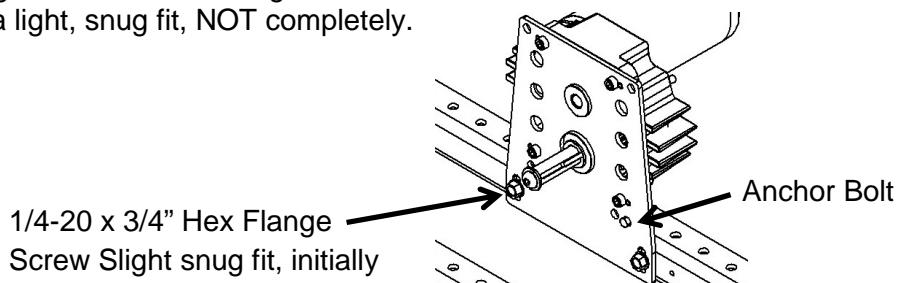
When constructing the WIDE base, two of the 1.8" spacers (one for each side) will need to be cut down to 1.62" (0.18" length removed) to ensure the rear axle assembles correctly.



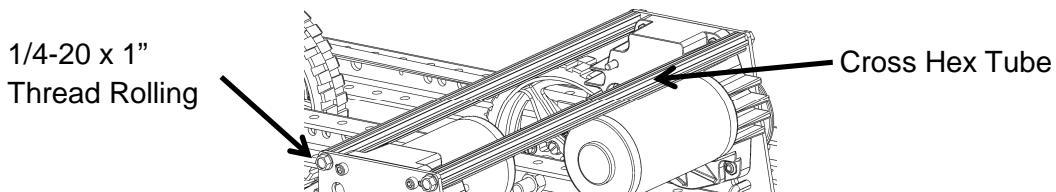
Step 7: Locate the two 1/4" holes where the Anchor Bolt and Cross Hex Nut will be located for each Toughbox Mini. Thread Anchor Bolts completely into the holes with the Cross Hex Nuts in place. The long end of the Anchor Bolts should be sticking through the bottom of the C-Channel by about 1/2".



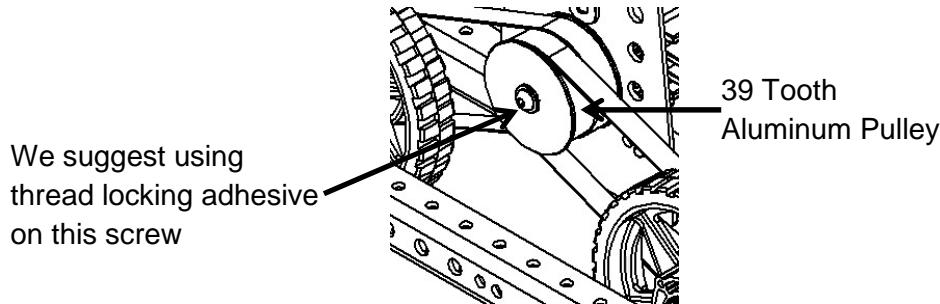
Step 8: Place the Toughbox Mini onto the C-Channel as shown in the picture below, with the housing on the inside of the frame. The Anchor Bolts engage two holes on the Toughbox Mini Shaft Plate. Ensure that slots of the Toughbox Mini Shaft Plate are lined up with the C-Channel holes. Insert the two 1/4-20 x 3/4" Hex Flange Screw through the slot of the Toughbox Mini Shaft Plate and fasten with a 1/4-20 Nylock Nut. Only tighten this nut to a light, snug fit, NOT completely.



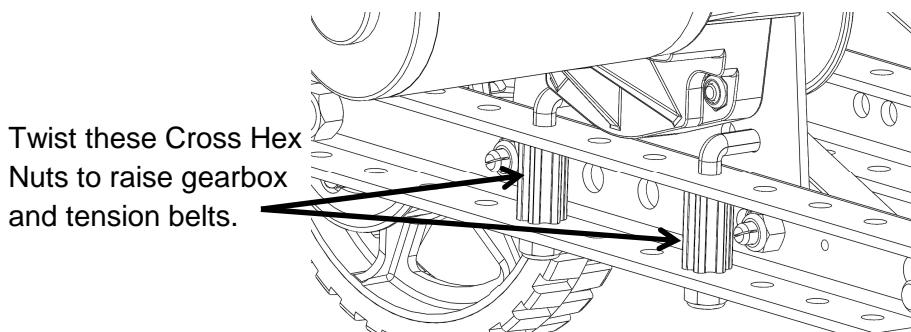
Step 9: Insert the Cross Hex Tubes. For the NARROW base, cut two Cross Hex Tubes to 13.25 inches. For the WIDE base, leave the Cross Hex Tubes at 19.25 inches. Fasten the Cross Hex Tubes to the Toughbox Mini Shaft Plates with the 1/4-20 x 1" Thread Rolling Screw (am-1182).



**Step 10:** On the Toughbox Mini output shaft, remove the button head cap screw and washer. Slip the 104 Tooth HTD Timing Belts (am-2267) over the 39 Tooth Aluminum HTD Pulley (am-2265). Slide the Pulley onto the shaft, rotating it to line up with the machine key. Place some thread locking adhesive onto the button head cap screw and securely attach it and the 1/4" washer onto the end of the shaft.



**Step 11:** By rotating the Cross Hex Nuts, the gearbox raises until the belts are tensioned correctly. When the tension is set, tighten the lock nuts under the cross hex nut and the bolts that run through the slots.



## Battery Plug Usage

Four plastic battery plugs (am-0122) are included in the 2013 AndyMark Drive System kit. These plugs are intended to be flags for charged batteries. They are not to be used on uncharged batteries.



Procedure for using these battery plugs:

1. Remove charged battery from charger.
2. Insert battery plug into the charged battery's red connector.
3. Place battery on shelf. Anyone can see now that battery is charged.
4. Remove battery plug before installing battery on robot.
5. Remove uncharged, spent battery from robot, but do not put battery plug back in to uncharged battery, or someone else will think it is charged.



Uncharged battery without plug

Battery being charged

Charged battery with plug