



# 2010 Toughbox

## User Guide

**AndyMark, Inc. Components Used in  
2010 FIRST Robotics Competition**



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## **1. Overview**

The Toughbox is a standard AndyMark gearbox. For the 2010 *FRC* Kit of Parts, new components of the Toughbox include a grease pack and mounting hardware for the US Digital encoder.

Each registered *FRC* team will receive parts for two Toughboxes. The Toughboxes are provided in kit form, with assembly required. CAD files and more detailed layout drawings can be found at [www.andymark.com](http://www.andymark.com).



## **2. Toughbox Overview**

The AndyMark Toughbox gearbox (am-0145) is designed for use in the 2010 FIRST Robotics Competition (FRC). Each FRC team will receive two (2) Toughboxes in their Kit of Parts (KoP).

The Toughbox is provided in kit form, with assembly required. Full assembly instructions can be found in this manual. Each Toughbox provided includes all parts to mount two 2.5" CIM Motors (provided in FRC KoP). Each Toughbox can use two of the 2.5" CIM Motors as input devices. The US Digital encoder provided in the KoP fits onto the Toughbox by using the included encoder mount pad.

Additional Toughboxes and hardware can be purchased at [www.andymark.com](http://www.andymark.com). CAD files (.stp version) are available at this same site.



## **3. Toughbox Specifications**

### Gears

AGMA 6-8  
20 dp, 14.5 deg. pressure angle  
cold formed 4140 steel

### Gear sizes

CIM Gear: 14 tooth (0.314" id w/ 2mm keyway)  
Large Cluster Gear: 50 tooth (3/8" hex bore)  
Small Cluster Gear: 14 tooth (3/8" hex bore)  
Large Output Gear: 50 tooth (1/2" hex bore)

### Gear ratios

12.76:1 total,  $50/14 * 50/14 = 12.755$

Optional gear ratios, shafts, and lightening features are available as optional parts at the [www.andymark.com](http://www.andymark.com) website.

### Output shaft

1/2" diameter 4140 steel shaft, with 1/8" wide keyway  
1/4-20 x 1/2" deep threaded hole on end  
1 machine key, 1 washer, and 1 1/4-20 screw are all provided

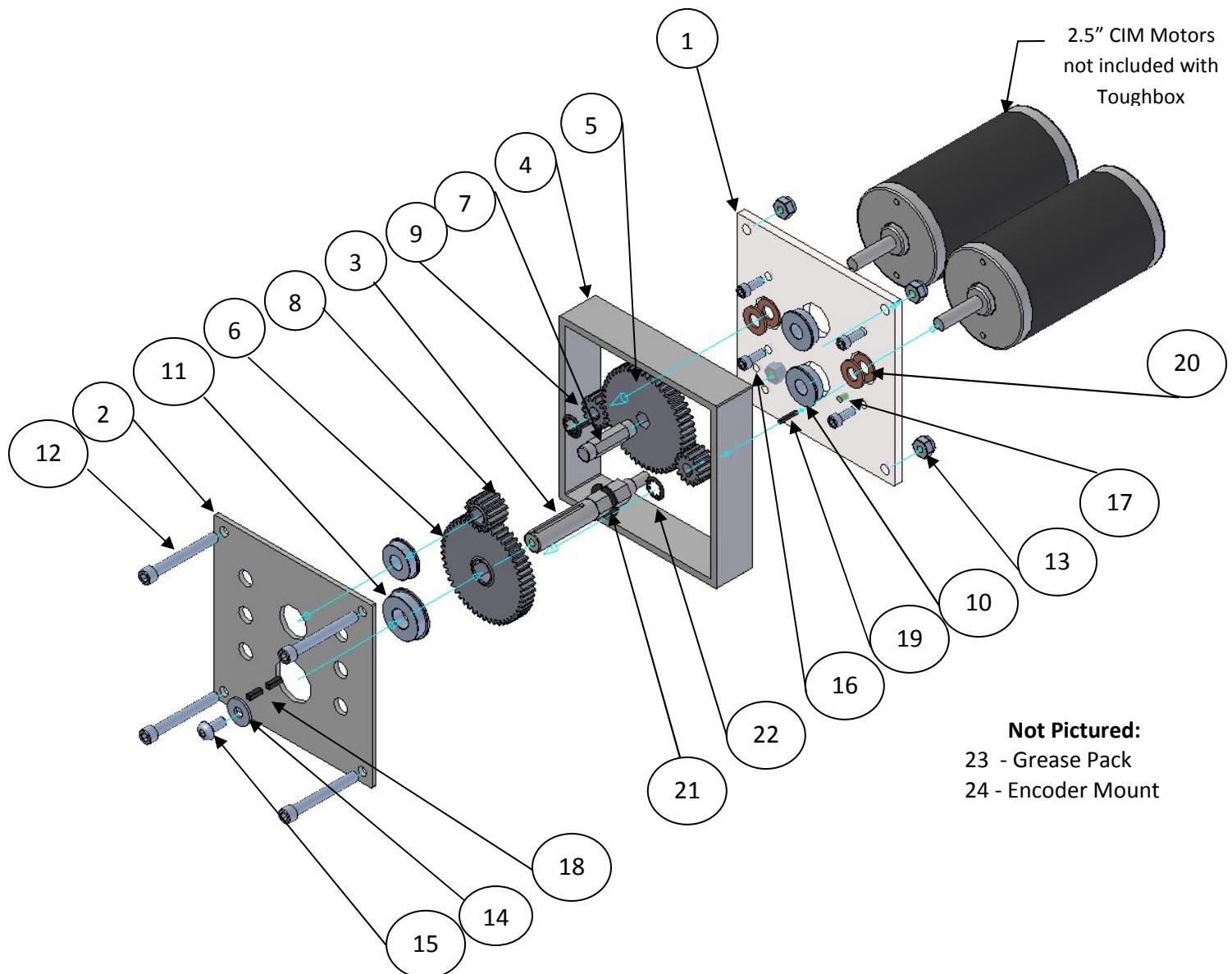
#### 4. Toughbox Bill of Material

Item #	Component	Qty	Part Number	Part Photo
1	Mount Plate	1	am-0155	
2	Shaft Plate	1	am-0261	
3	Output Shaft	1	am-0153	
4	Extrusion Cover	1	am-0260	
5	Large Cluster Gear (3/8 hex bore)	1	am-0149	
6	Large Output Gear (1/2 hex bore)	1	am-0150	
7	Small Hex Shaft	1	am-0152	
8	Small Cluster Gear (3/8 hex bore)	1	am-0151	
9	CIM Gear	2	am-0034	
10	FR6ZZ bearing	3	am-0028	

11	FR8ZZ bearing	1	am-0030	
12	1/4 - 20 x 2 shcs	4	am-1012	
13	1/4 - 20 nylock nut	4	am-1015	
14	1/4" washer	1	am-1027	
15	1/4 - 20 x 1/2 bhcs	1	am-1029	
16	#10-32 x 5/8" shcs w/ nylock	4	am-1120	
17	#10-32 x 1/2 shcs	2	am-1002	
18	2x2x10mm key	2	am-1121	
19	1/8" machine key	1	am-1043	
20	5/16 washer	4	am-1009	
21	1/2" e-Klip	1	am-0206	
22	8mm Retainer Clip	2	am-0033	
23	Grease Pack	1	am-0448	
24	Encoder Mount	1	am-0208	

## 5. Exploded View

### 2010 AndyMark Toughbox – Exploded View



## **6. Assembly Instructions**

Tools needed:

- 5/16" allen wrench
- 3/16" allen wrench
- 7/16" wrench (or socket driver)
- Small hammer



Fig. 1



Assembly tools needed



Fig. 2

Step 1: Ensure you have all parts listed in the Toughbox BOM and shown in Fig. 1.

Step 2: Insert two of the 5/16" washers, the 2x2x10mm machine key, CIM Gear, and 5/16" clip onto CIM Motor shaft, shown in Fig. 2.

Step 3. Press two of the FR6ZZ bearings into the Mount Plate. Press a FR6ZZ and FR8ZZ bearing into the shaft plate. Use an arbor press, a strong push with a thumb, or light taps with a small hammer. Check that flanges are on the same side.



Fig. 3a

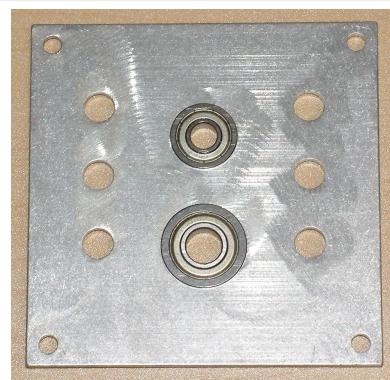


Fig. 3b

Step 4. Mount motor to Mount Plate using #10-32 screws. DO NOT ADD Loctite or other thread locking material. This has already been applied to the screws (excess Loctite or other thread locking material will eat away the polycarbonate). Make sure that the bearing flanges are not on the same side as the motor.

Step 5. Attach the 1/2" E-Klip into the groove on the Output Shaft.



Fig. 4



Fig. 5

Step 6. Place the Small Hex Shaft into the bearing closest to the motor pinion. Place the Large Cluster Gear (with the smaller hex hole) onto the Small Hex Shaft. Make sure the teeth of this gear mesh well with the CIM Gear. Also, be sure to place the gear so that the small boss (raised surface) around the hex hole is facing the bearing on the Mount Plate (see Fig. 6).

Step 7. Place the Output Shaft into the second bearing.

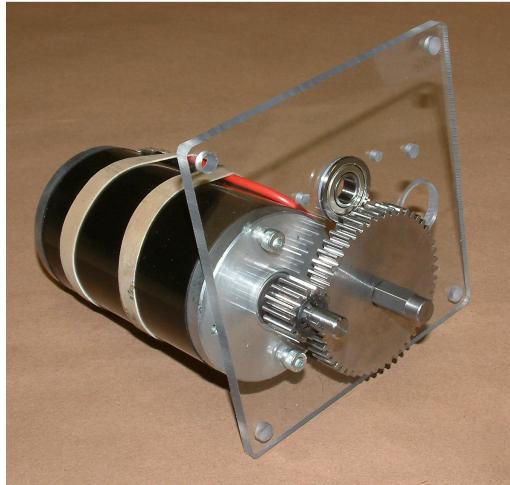


Fig. 6



Fig. 7

Step 8: Place Small Cluster Gear (small gear with 3/8" hex hole) onto the Small Hex Shaft. Place Large Output Gear onto Output Shaft. Establish that the boss on these gears are facing out. The purpose of these small bosses is to contact the inner races of the adjacent bearings.

Step 9: Place the Extrusion Cover over the assembly as shown in Fig.9. Apply grease to gear and meshes, using grease pack. It is OK to use additional heavy grease.

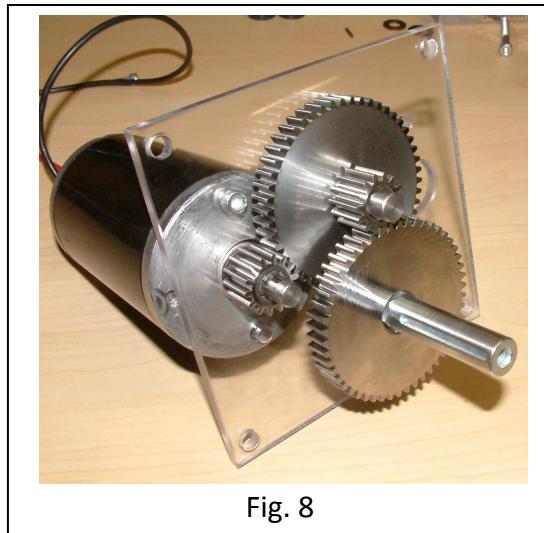


Fig. 8

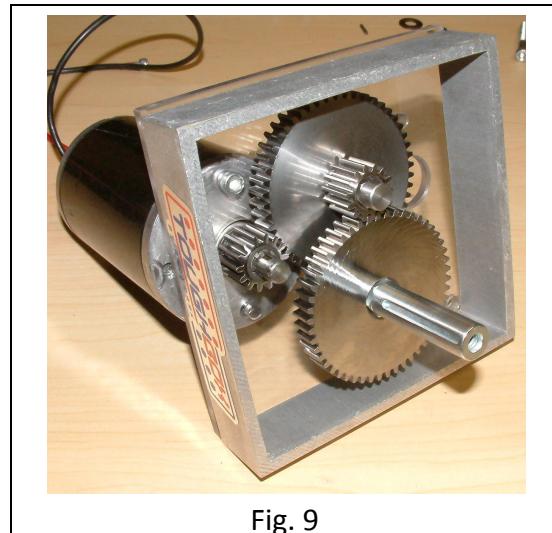
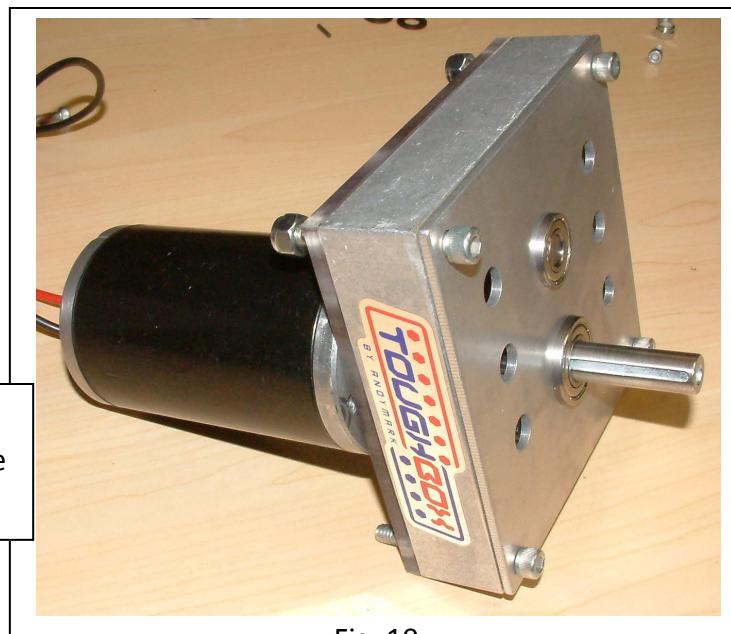


Fig. 9

Step 10: Place the Shaft Plate onto the Output Shaft so the bearing flanges are on the inside of the gearbox. The Shaft Plate should slide all of the way so that the Extrusion Cover is sandwiched between the Mount Plate and Shaft Plate. There should be no gaps. Insert all 1/4-20 x 2" Screws (4) into the holes on the Shaft Plate and through the 4 holes on the Mount Plate. Assemble the 1/4-20 Nylock Nuts and tighten all with a 3/16" allen wrench and 7/16" wrench or socket.



Two CIM motors can be assembled onto the Toughbox, if needed

Fig. 10

## **7. Assembly of Encoder Package onto Toughbox**

US Digital has provided this encoder in the *FRC Kit of Parts*.

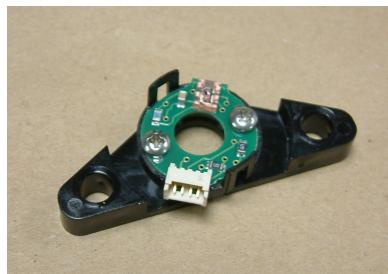
Step 1: Two holes (0.170 diameter) are located on the polycarbonate Mount Plate, near the output shaft bearing. Tap these two holes with a #10-32 thread cutting tap (fig. 11).

Step 2: Assemble the circular encoder circuit board and the circular encoder plastic base (black plastic piece with 2 clips sticking up) to the Mount Pad (black plastic trapezoidal piece) with the two small screws (#3-48). The screws will cut threads into the Mount Pad. The circuit board connector should be sticking out the long flat side of the Mount Pad (fig. 12).

Fig. 11



Fig. 12.



Step 3: Mount the assembly created in Step 2 to the Toughbox Mount plate, with the 2 - #10-32 screws supplied in the Package (fig. 13).

Fig. 13

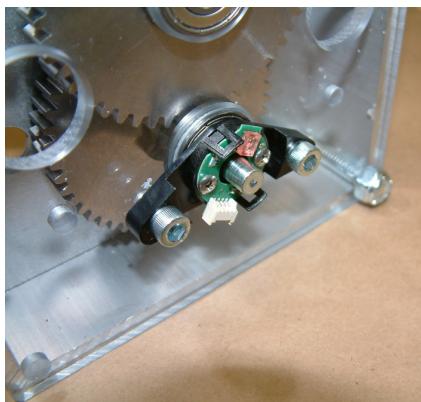
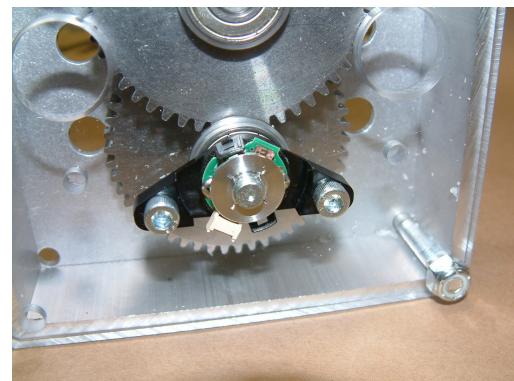


Fig. 14



Step 4: Place the encoder wheel on to the 1/4 inch output shaft protrusion so that the encoder lines are facing the circuit board. The outside face of the encoder wheel should be flush with the tips of the clip tips of the encoder plastic base (fig. 14, and fig. 15).

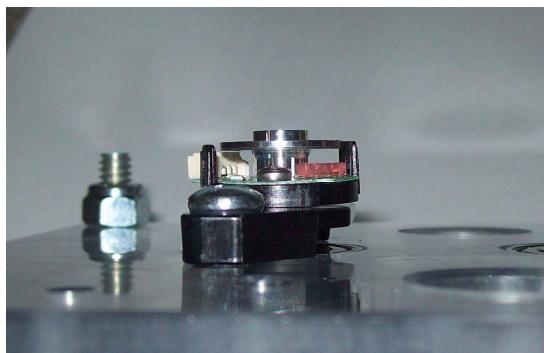


Fig. 15



Fig. 16

Step 5: Press the Encoder Cap on to the encoder plastic base so that the cutout on the Cap is aligned with the connector (fig. 16), and snap the Encoder Cap on to the clips.

Step 6: Plug in the cable.

Optional Motor Mount: The motor could be installed after the gearbox is assembled. Here are pictures for instruction:



Fig. 17



Fig. 18

Put 14 tooth gear onto motor, then place motor into assembled Toughbox. Carefully install the #10-32 mounting screws by using a long-handled allen wrench. You can see the screw fit into the motor mounting holes by looking through the polycarbonate motor mount plate.

## **8. Battery Plug Usage**

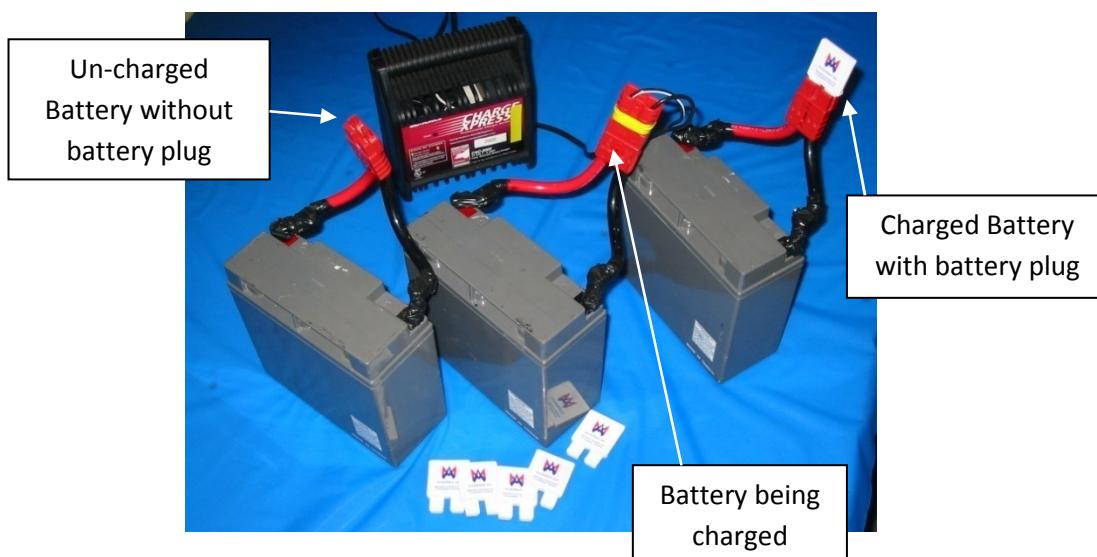
Four white plastic AndyMark battery plugs (am-0122) are included in the Drive System kit.

These plugs are intended to be flags for charged batteries. They also serve as a safety insulators for charged batteries.



Procedure for using these plugs:

1. Remove charged battery from charger
2. Insert white Battery Plug into the charged battery's red Anderson connector.
3. Place battery on shelf
  - a. As battery waits for its chance to power a robot, anyone who sees that battery with the white plug will know it is a charged battery
4. Remove battery plug before installing battery on robot
5. Remove un-charged, spent battery from robot, but don't put the white battery plug back in (or someone will think that it is charged)





## **9. Background on AndyMark**

Andy Baker and Mark Koors have been *FIRST* mentors since 1998, serving on FRC team 45, the TechnoKats. Before starting AndyMark, they worked as engineers at Delphi Automotive Electronics in Kokomo, Indiana. In 2004, Andy and Mark started AndyMark.

For a few years, Andy and Mark ran the company out of their homes while they were still working as engineers at Delphi. In 2007, AndyMark moved into the Inventrek technology park in Kokomo. Shortly afterward, both Andy and Mark went to work full-time at AndyMark.

Andy and Mark serve as volunteers at many events within the *FIRST* community. AndyMark sponsors three *FIRST* Robotics teams in the Kokomo area (45, 292, 1760), and also is a sponsor of the Boilermaker Regional, the Indiana Robotics Invitational (IRI) and the CAGE Match. Both Andy and Mark are well-respected in the *FIRST* community: Andy won the Championship Woodie Flowers Award in 2003, while Mark was recognized as the Championship Volunteer of the Year in 2007. You can find Andy and Mark at many FRC Regional events, and the Championships every year. Andy often serves as an inspector or referee at events, while Mark is a prominent FTA for many events.

AndyMark, Inc. has been a supplier to the *FIRST* Kit of Parts since 2005, and has increased their donation to *FIRST* every year.

AndyMark, Inc. provides unique, high quality products for mobility robotics, in a timely fashion. AndyMark is your robot parts experts. For more information on AndyMark products, see the [www.andymark.com](http://www.andymark.com) and [www.tektray.com](http://www.tektray.com) websites.

95% of all of AndyMark parts are fabricated and assembled in the USA.

