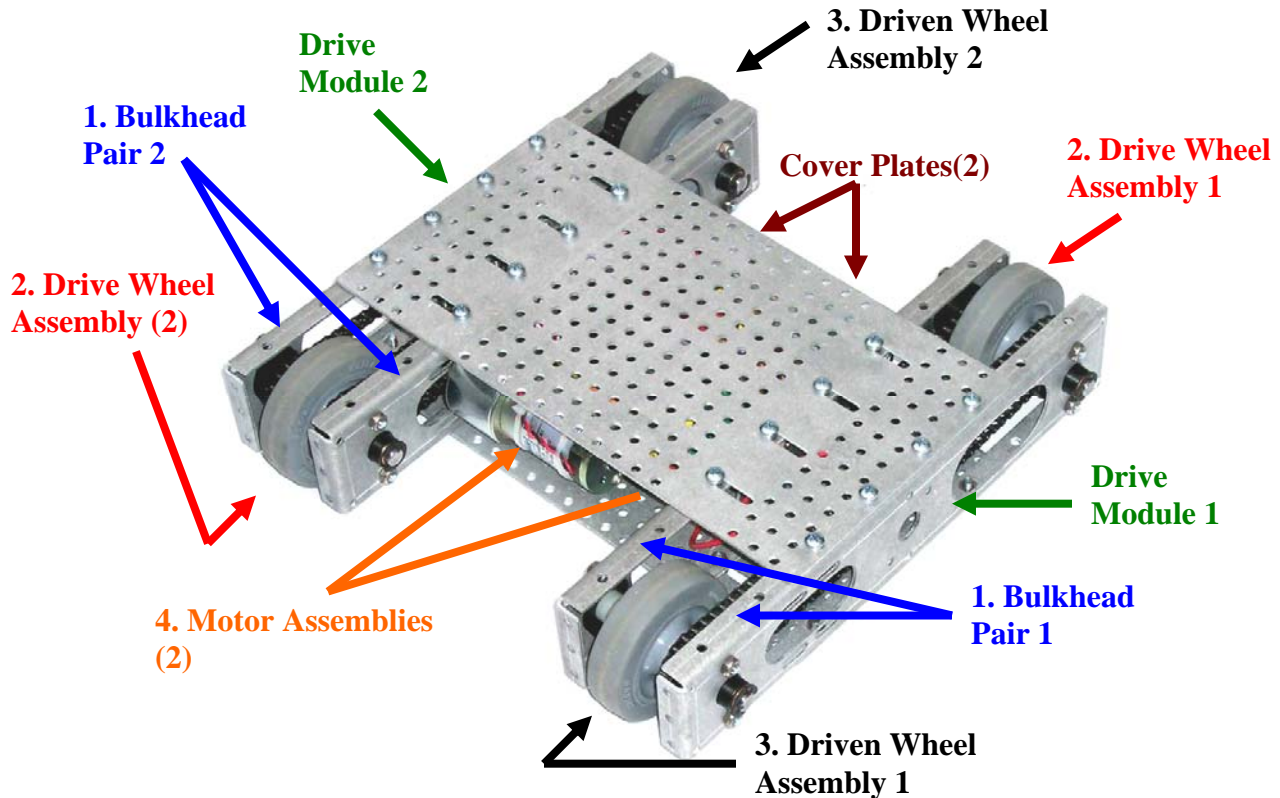


The **HMC** Heavy Metal Chassis

Construction Guide using Timing Pulleys and Belts

The Heavy Metal Chassis is constructed using two identical drive modules. Power can be transmitted from the motors to the wheels using sprockets and chains, timing pulleys and belts, spur gears, or a combination of components. The drive modules are constructed using 4 mechanical sub-assemblies. The drive modules are easily integrated into a single chassis using two cover plates.



Mechanical Sub-Assemblies

1. **Bulkhead Sets** (2 required)
There are four (4) bulkheads paired in two (2) sets. 2 students working together can construct all four bulkheads (both sets) in about 10 - 15 minutes.
2. **Drive Wheel Assembly** (2 required)
There are two (2) drive wheel assemblies. 2 students working together can construct both assemblies in about 10 - 15 minutes.
3. **Driven Wheel Assembly**
There are two (2) driven wheel assemblies. 2 students working together can construct both assemblies in about 10 - 15 minutes.
4. **Motor Assembly Timing Pulley**
There are 2 motor and pulley assemblies. 2 students working together can construct both assemblies in about 10 - 15 minutes.

Total chassis construction time for two students: 70 – 90 minutes.

Necessary Tools

Safety Glasses

Phillips Head Screwdriver #1 pt. And #2 pt.

Allen Wrench or Hex Key (sizes .050, 1/16, 5/64, 3/32, and 1/8)

3/8 "Wrench

Wire Strippers and Crimpers

Smooth File (Small)

3/16" round file (Similar to a chain saw file)

Materials

Structural/ Mechanical

Qty.

8	3/8" I.D. Flanged Bearings
2	PVC Chain Guides
4	#8-32 x 1/8" Cup Head Set Screw
8	3/8" "E" Clip
4	Bulkhead Plates
2	HMC Cover Plates
4	4" Wheel and Keyed Aluminum Bushing Assembly
4	3/8" Dia. x 4" Long Machined Axle with Key Slot
2	Gearhead Motor (9.6 Volt, 19.7:1 Standard))
6	24 tooth aluminum timing pulleys
2	14 tooth aluminum timing pulleys
2	48 tooth x .375" timing belt
2	124 tooth x .375" timing belt

Hardware

Qty.

52	#10-32 x 3/8" Phillip Machine Screws
2	#10-32 x 3/4" Phillip Machine Screws
18	#10-32 Nylon Lock nuts
6	#10 Flat Washers
38	#10 Lock Washers
*18	3/8" Bore x 5/8" OD x 0.125" Nylon Spacer Washers
*36	3/8" Bore x 5/8" OD x 0.062" Nylon Spacer Washers
*2	3/8" Bore x 5/8" OD x 5/8" Nylon Spacer Washers
2	3/32" x 2.3" Round Ended Key Stock
2	3/32" x 1.75" Round Ended Key Stock
1	Loctite™ 243 .5ml ampule

Electrical

1	SPST Toggle Switch
1	Switch Plate and Fasteners
1	Electronics Kit
(Includes motor controllers, wire and connectors.	

Note: In order to maximize the educational benefit to the students and minimize the time on task, it is advisable to let the students handle and identify all the HMC components and review this document before beginning the assembly of the HMC. It is especially helpful to study the illustrations at the end of this document in order to learn what the final assemblies look like and how the components, assemblies and modules are related.

** Kits are shipped with both 0.062", 0.125" and 5/8" thick spacer washers. Use them as needed to achieve the necessary axle spacing.*

Assembly 1

Bulkhead Sets

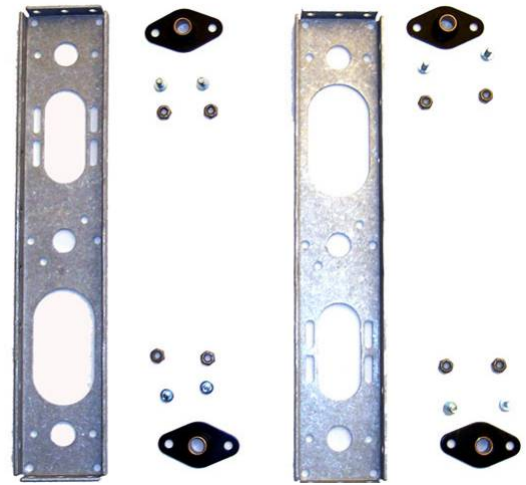
2 Assemblies (sets) required

Average assembly time: 2 students about 10-15 minutes

Note: Since it is necessary to assemble 2 identical modules it is helpful to assign one student to assemble a module and one student to assemble the other, identical module.

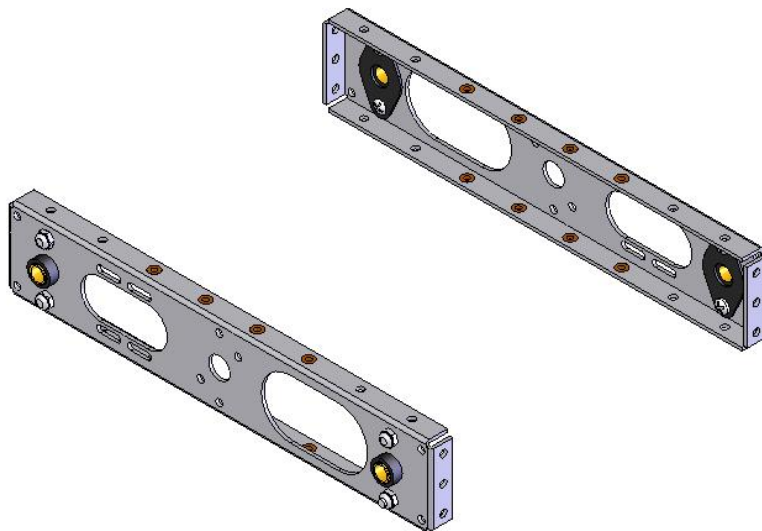
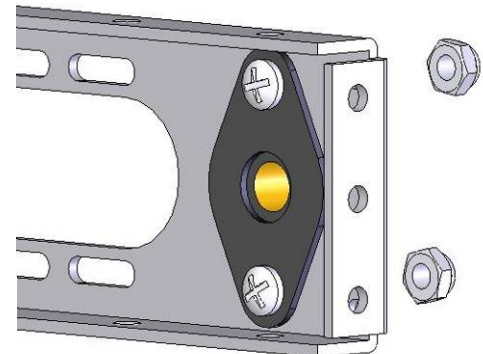
Components and Tools to Make 2 Modules

Qty.	Description
16	#10 Nylon Locking Nuts
16	#10-32 x 3/8" PH Machine Screws
4	Bulkhead Plates
8	3/8" I.D. Flanged Bearings
1	3/8" Combination Wrench (not shown)
1	#2 Phillip Head Screwdriver (not shown)



Procedure

1. Place the 3/8" I.D. flanged bearings into the mounting holes on the bulkhead as shown in the illustration below. Place the bearings through the bulkhead plates from the inside, to the outside as illustrated.
2. Attach the flanged bearings using (2) #10-32 x 3/8" Phillips head machine screws, and (2) #10-32 nylon locking nuts. Secure the nuts firmly onto the machine screws using a 3/8" wrench and a #2 Phillip head screwdriver.



The approximate torque (Tightening) specification is about 22 -26 inch pounds. If this specification is not familiar to you then take a moment to research torque specifications online or ask someone who knows.

3. Repeat the procedure for 2 additional assemblies (4 total).

Assembly 2

Drive Wheel and Sprockets

2 Assemblies required

Average assembly time: 2 students about 10-15 minutes

Note: Standard wheel diameter is 4". For reduced clearances, 3" wheels are an available option.

Components and Tools for 2 modules

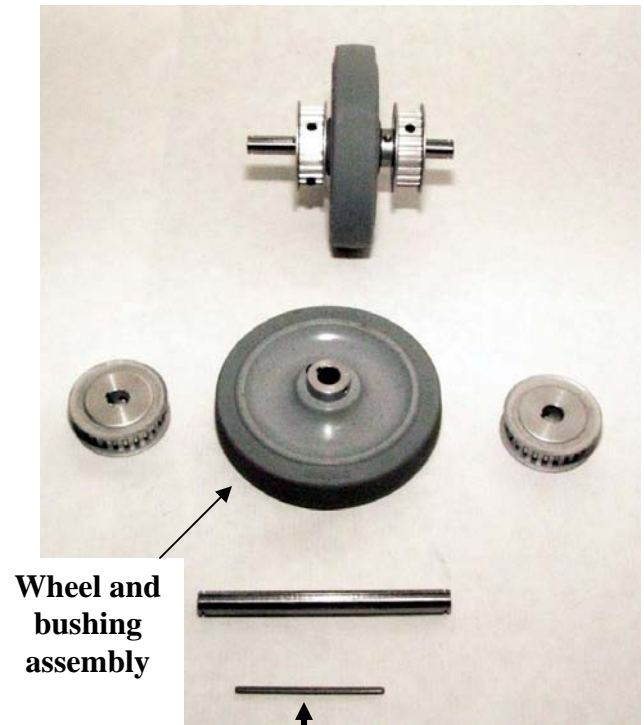
Qty.	Description
2	4" Wheel and Keyed Aluminum Bushing Assembly w/set screw.
2	#8-32 Cup Head Set Screw
2	3/8" Dia. x 4" Long Machined Axle with Key
Slot	
4	24 Tooth Aluminum Pulley With 3/32" Internal Broach and (2) #8- 32
Set	Screws
4	3/8" ID x 5/8" OD x 0.125" Nylon Spacer Washers or
8	*3/8" ID x 5/8" OD x 0.062" Nylon Spacer Washers or
2	3/32" x 3/32" x 2.3" Round End keyways
1	5/64" (0.078") Allen Wrench or Hex Key
1	3/32" Allen Wrench or Hex Key
1	6" Flat File (Fine)
1	Dial Calipers

Procedure

1. **Use the flat file to break the edges of the key slot along the entire length of the 3/8" dia. x 4" long machined axle. This will help ensure there are no burred metal edges on the axle key slot, and will allow the key stock to slide smoothly in the axle key slot.
2. Clean the axle key slot removing any dirt or foreign matter.
3. Insert the 3/32" x 3/32" x 2.3" (The longer of the 2) key stock into the key slot on the axle shaft. Position the 3/32" key stock so that one end is more than 0.750" from one end of the axle.
4. Slide one of the 24 tooth aluminum sprockets onto the shaft and key stock assembly as shown. Position the pulley flush with the end of the key stock and also 3/4" or 0.750" from the end of the axle. Tighten both pulley set screws. Pulley set screw must tighten onto keyway. Use approximately 6 – 8 inch lbs of torque when tightening the set screws.

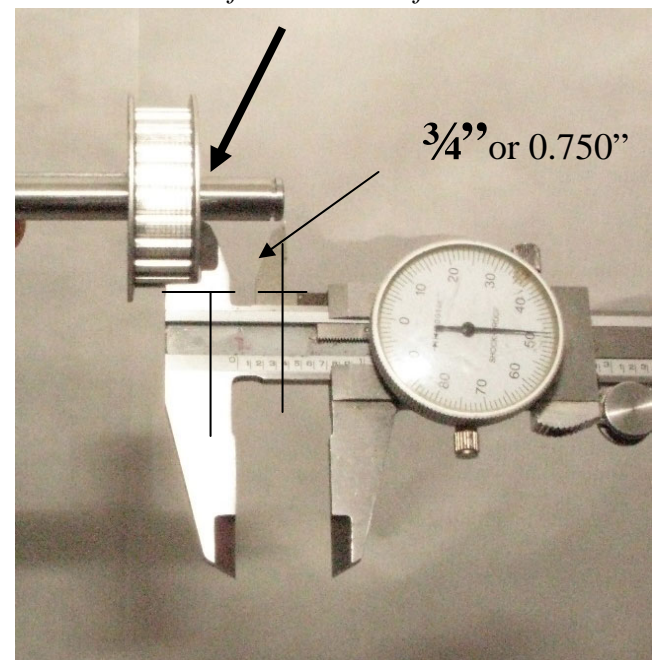
* Kits are shipped with both 0.062" and 0.125" thick spacer washers

**Note: It may be necessary to "Fit" the keyway to the axle slot. This is easily accomplished by rubbing the key stock along the file to remove a few 0.0001" from the key, until it slides easily in the key slot. This only needs to be done once and it is a standard assembly procedure.



Wheel and bushing assembly

3/32"x 2.3" long key stock positioned in the key slot, 3/4" or 0.750" from the end of the axle



Assembly 2 continued.

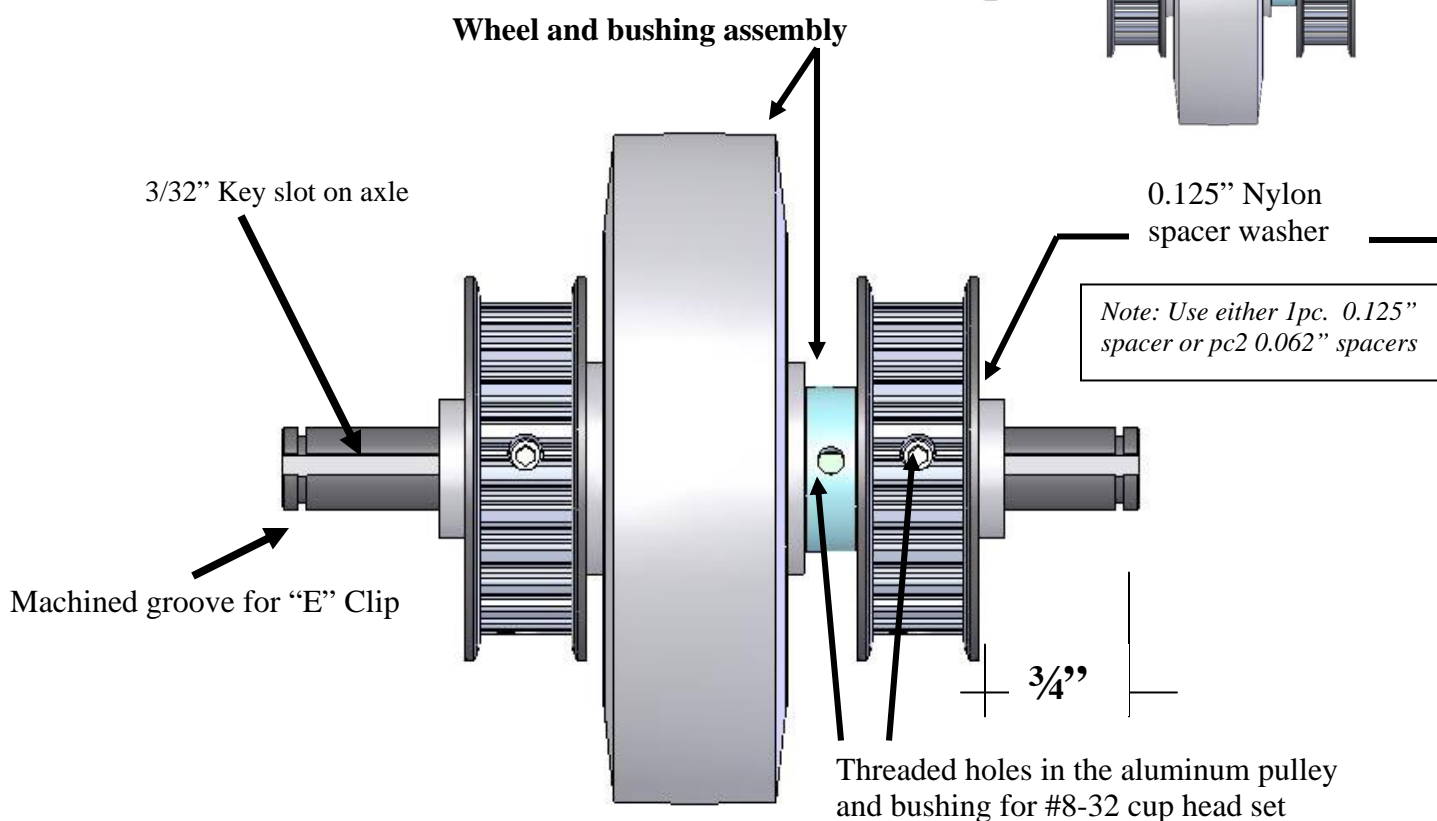
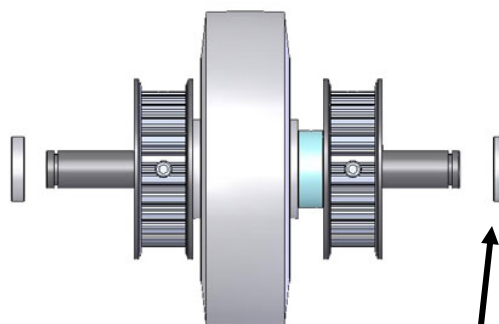
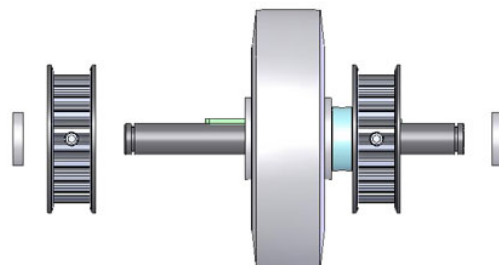
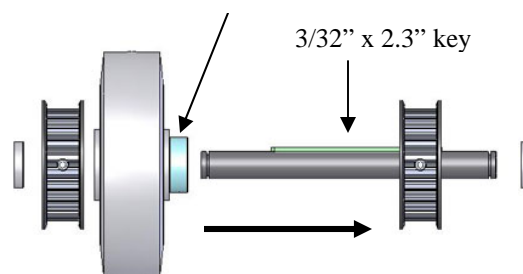
Note: Always check that the set screws are backed off before sliding any component onto the axle and key stock. Otherwise the set screw may hang up on the key stock.

- Slide the wheel and bushing assembly onto the axle.
Note: The wheel bushing boss is adjacent to the installed pulley.

Note: If the assembly is to be left in place semi permanently, then it is advisable to use a small drop of blue Loctite® 243 on the set screws. Remember that blue Loctite® comes in a red bottle! Look it up online and learn why it is used and how best to apply it!

- Tighten the #8-32 x 1/8" aluminum bushing set screw onto the 3/32" key on the 4" axle. Be careful to consider these two steps; one: Thread the set screw into the hole that is in line with the internal broach in the aluminum bushing. Two: Turn the wheel bushing set screw all the way out before sliding the assembly onto the axle. Otherwise the set screw may hang up on the key stock and it will not be possible to slide the wheel assembly onto the shaft.

Wheel bushing boss w/set screw and key broach.



Make two (2) of the assemblies illustrated above

Assembly 2 continued

- Slide a second 24 tooth pulley onto the axle on the opposite side of the wheel. Refer to the illustrations on the previous page.
- Check that all the set screws are securely tightened and the critical pulley spacing from the end of the shaft ($3/4''$) are correct.
- Add a $3/8''$ ID x $1/8''$ ($0.125''$) or two $3/8''$ ID x $1/8''$ ($0.062''$) nylon spacer washer to each end of the axle assembly as shown in the illustration on the previous page.
- Assemble another, identical unit since two of these assemblies are required to complete the Heavy Metal Chassis.

Assembly 3 Driven Wheel

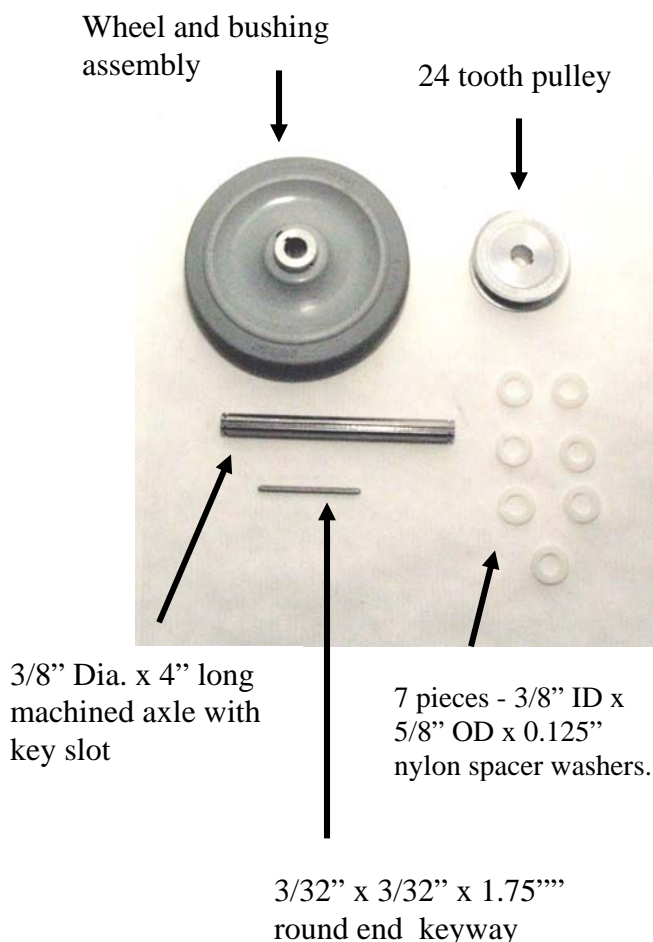
2 Assemblies required

Average assembly time: 2 students about 10-15 minutes

Necessary Components and Tools

Qty.	Description
2	3" or 4" Wheel and Keyed Aluminum Bushing Assembly
2	#8-32 Cup Head Set Screw
2	$3/8''$ Dia. x 4" Long Machined Axle with Key Slot
2	24 Tooth Aluminum Pulleys With $3/32''$ Internal Broach and (2) #8-32 Set Screws
14	$3/8''$ ID x $5/8''$ OD x $0.125''$ Nylon Spacer Washers or
28	* $3/8''$ ID x $5/8''$ OD x $0.062''$ Nylon Spacer Washers or
2	$3/32''$ x $3/32''$ x $1.75''$ Round End Keyway
1	$5/64''$ ($0.078''$) Allen Wrench or Hex Key
1	$3/32''$ Allen Wrench or Hex Key
1	6" Flat File (Fine)
1	Dial Calipers

** Kits are shipped with both $0.062''$ and $0.125''$ and $0.625''$ thick spacer washers. It is up to the users discretion to decide which size or combination of sizes to use to effect the appropriate spacing. Note: Loose is always better than tight!*

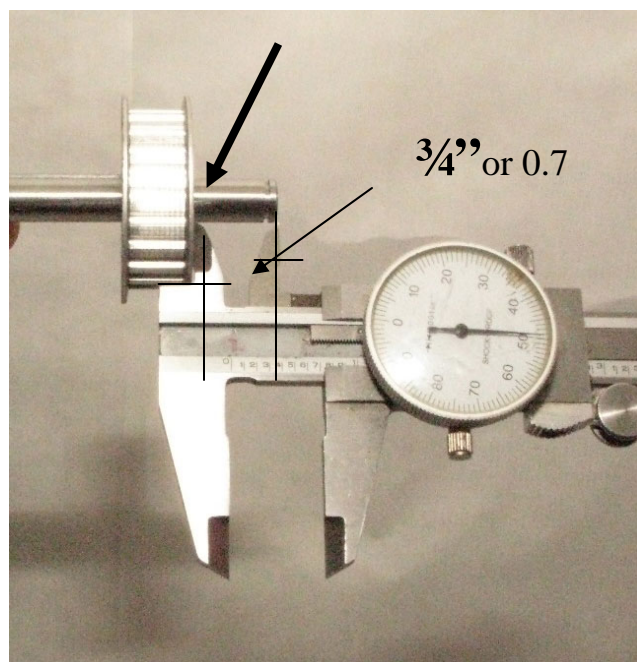


Assembly 3 continued

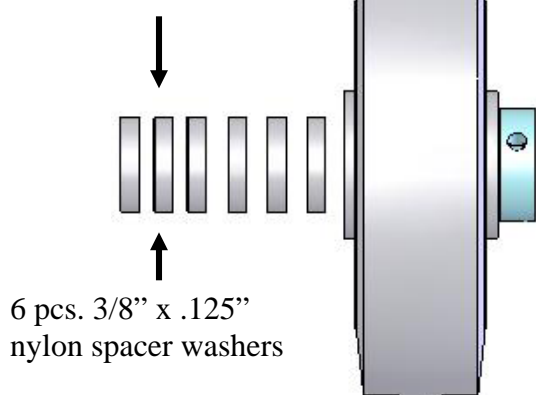
Procedure

1. Use the flat file to break the edges of the key slot along the entire length of the 3/8" dia. x 4" long machined axle. This will allow the key stock to slide smoothly in the axle key slot.
2. Clean the axle key slot removing any dirt or foreign matter.
3. Insert the 3/32" x 3/32" x 1.75" (The shorter of the 2) key stock into the key slot on the axle shaft. Position the 3/32" key stock so an end is 0.750" from the end of the axle.
4. Slide the 24 tooth pulley onto the shaft and key stock assembly as shown. Position the pulley so that it is also 3/4" or 0.750" from the end of the axle.
5. Fasten the pulley to the shaft by first tightening the pulley set screw onto the key stock. Then tighten the second pulley set screw onto the axle. Notice there are two (2) set screws on each pulley. These set screws are positioned 90 degrees from each other. Use approximately 6 – 8 inch lbs of torque when tightening the set screws.

3/32" x 1.75" long key stock positioned in the key slot, 3/4" or 0.750" from the end of the axle

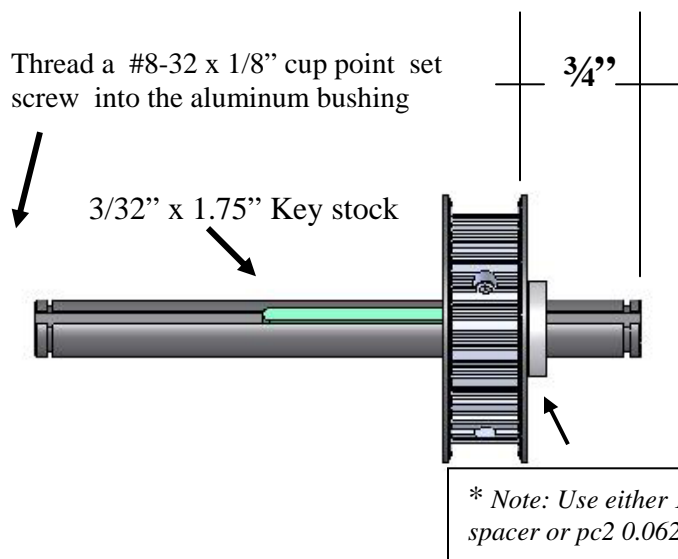


**Or 3/8" x 0.062" and 3/8" x 5/8" nylon spacer washers as needed*



Thread a #8-32 x 1/8" cup point set screw into the aluminum bushing

3/32" x 1.75" Key stock



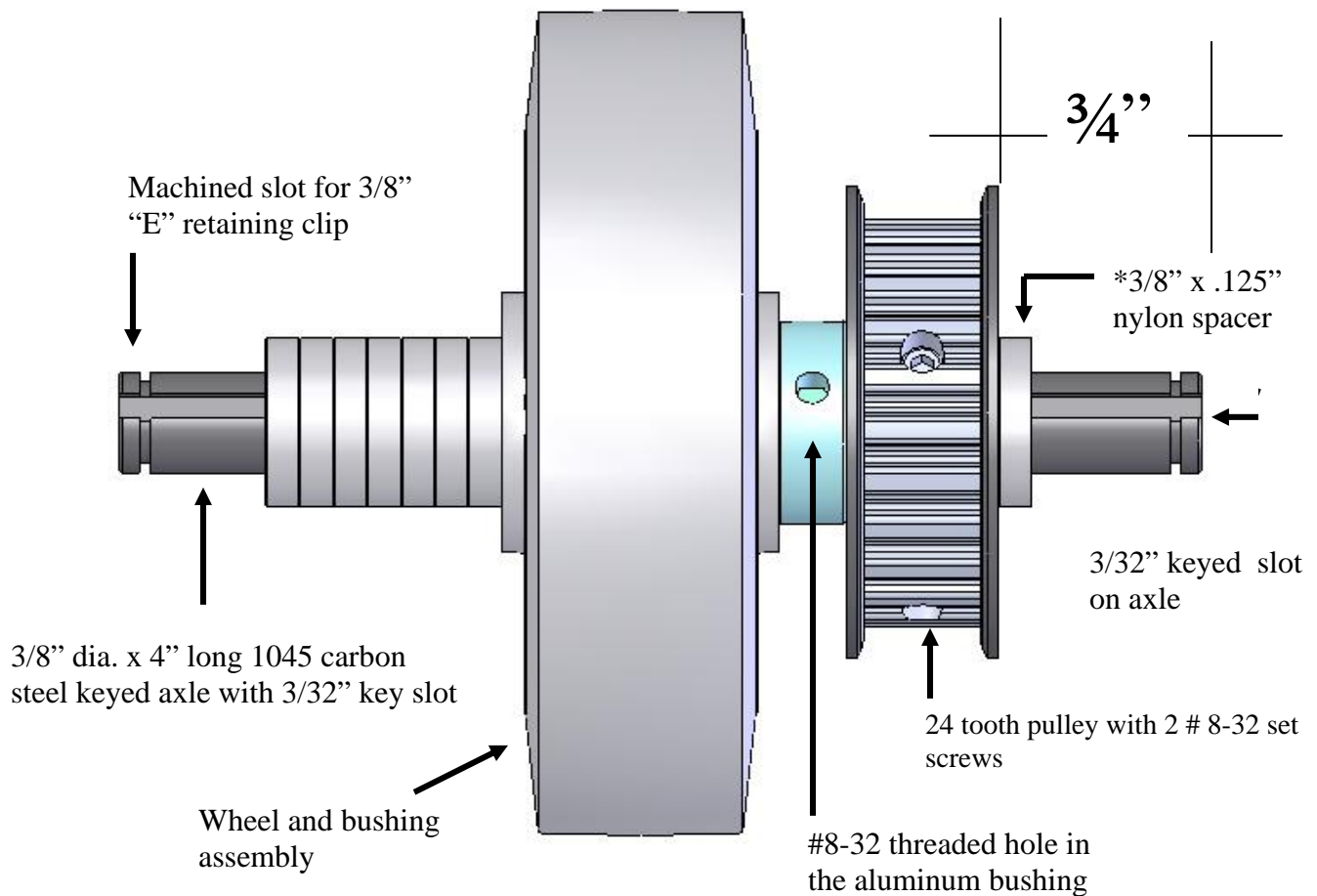
** Note: Use either 1pc. 0.125" spacer or pc2 0.062" spacers*

** Kits are shipped with both 0.062", 0.125" and 5/8" thick spacer washers*

Note: If the assembly is to be left in place semi permanently, then it is advisable to use a small drop of blue Loctite® 243 on the set screws. Remember that blue Loctite® comes in a red bottle! Look it up online and learn why it is used and how best to apply it!

Assembly 3 continued

6. Slide the wheel and bushing onto the axle assembly. Check that the wheel and bushing are securely fastened to the axle and key stock with the #8-32 set screw. Do not over tighten. 6-8 inch lbs of torque is all that is necessary to hold the assembly from sliding right and left.
7. Slide six (6) 3/8" ID x 0.125" thick nylon spacer washers onto the shaft as shown.
8. Recheck that the pulley face is 3/4" (0.750") from the end of the shaft and the key stock is not extending out past the face of the pulley and that all the set screws are securely fastened.



Construct two (2) of the assemblies illustrated above

** Kits are shipped with both 0.062" and 0.125" and 0.625" thick spacer washers. It is up to the users discretion to decide which size or combination of sizes to use to effect the appropriate spacing. Note: Loose is always better than tight!*

Assembly 4

Motor and Sprocket

2 Assemblies required

Average assembly time: 2 students about 5-10 minutes

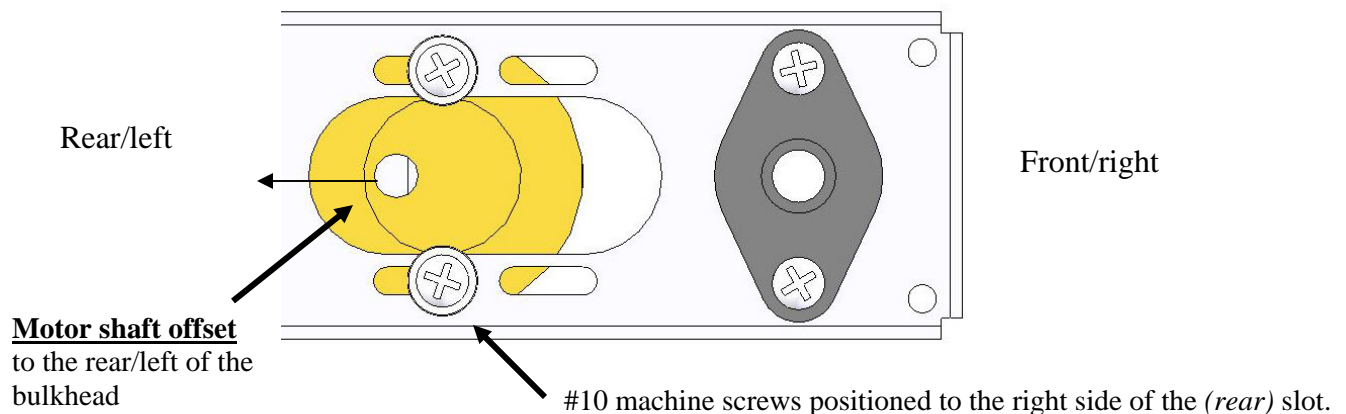
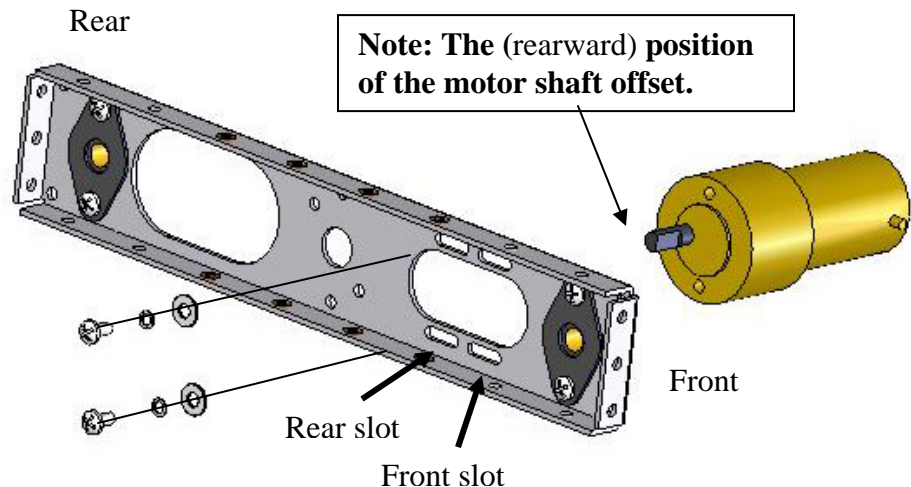
Necessary Components and Tools

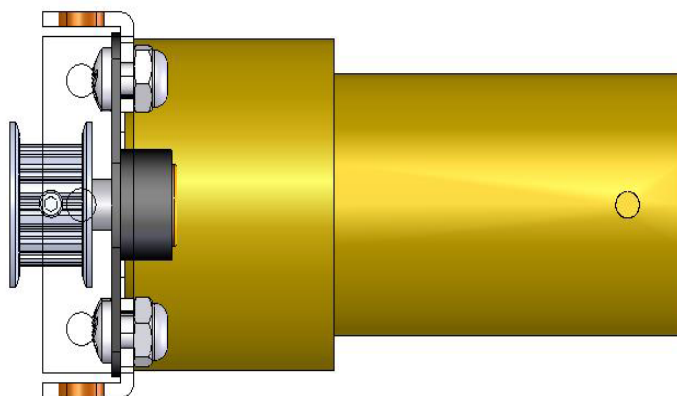
Qty.	Description
2	Gearhead motor
4	#10- 32 x 3/8" Phillips head machine screws
4	#10 lock washers
4	#10 flat washers
2	14T pulley with 1/4" bore and set screw
1	12" – 14", #2 point Phillips head screwdriver
1	3/32" Allen Wrench or Hex Key



Procedure

1. Fasten the gearhead motor to the bulkhead by threading the #10-32 x 3/8" Phillips head screws, lock washers and flat washers through the **middle** of rear most slot. *Note: Always use flat washers to mount the gearhead motors. They are used to spread the clamping force evenly over a wider area.*
2. Take care to position the motor shaft offset to the rear (left as shown in the illustrations above and below). **DO NOT POSITION THE SHAFT TO THE FRONT OR RIGHT SIDE.**





3. Lightly tighten the #10-32 Phillips head machine screws, lock washer and flat washer assemblies while keeping them to the right side of the rear slot as shown at the bottom of the preceding page.

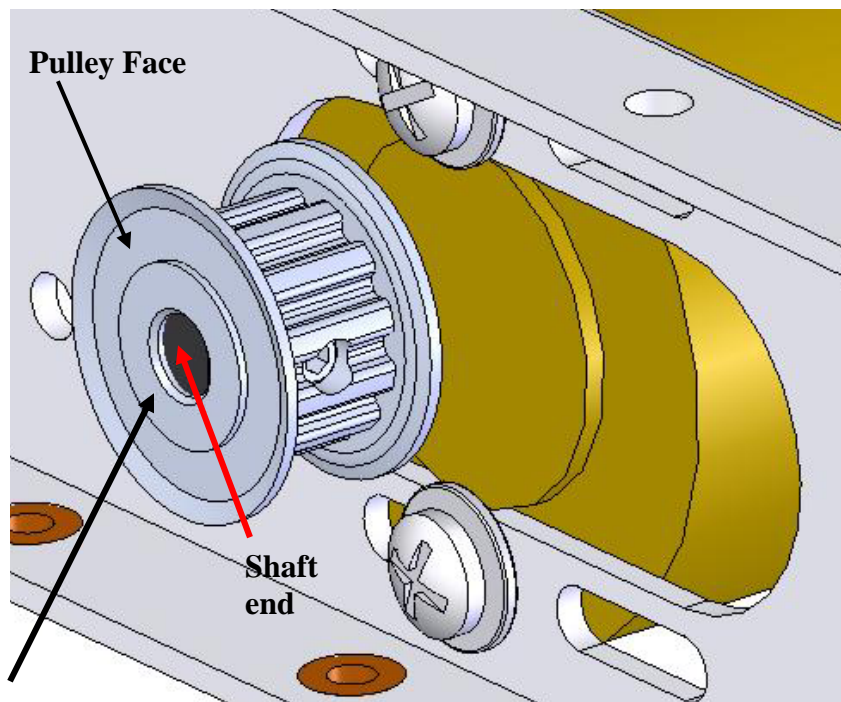
4. Position the 14 tooth, pulley onto the motor

shaft. Make sure that the set screw is backed off enough to allow the pulley to slide easily onto the motor shaft.

5. Identify the flat on the motor shaft and position the set screws directly over the flat on the shaft. Slide the pulley onto the motor shaft and gently tighten the set screw onto the flat of the motor shaft in such a way that the pulley face extrudes, at least, 0.025" beyond the end of the motor shaft. It will be necessary to re-position the pulley after the final assembly, in order to achieve optimum belt alignment. This setting will usually result in a relatively accurate initial alignment. Use the tail end of the dial calipers to make this measurement. (See below/right)

6. Tighten the set screw on the flat of the motor shaft to hold the pulley in the correct position (0.025" past the end of the motor shaft).

7. After the chassis has been fully assembled, and the belt and pulley alignment has been correctly set, remove the set screw on the motor pulley and place a small drop of blue Loctite™ thread locker onto the set screw threads. Thread the set screw into the pulley and tighten firmly to approximately 8 inch lbs



***For the initial assembly, position the face of the pulley, so it extends approximately 0.025" - 0.055" past the end of the motor shaft.**

**Note: It is often necessary to re-align this pulley after the final assembly and testing in order to achieve optimum belt and pulley alignment.*

Drive Module Construction

1.) Integrate Motor/Sprocket and Drive Wheel

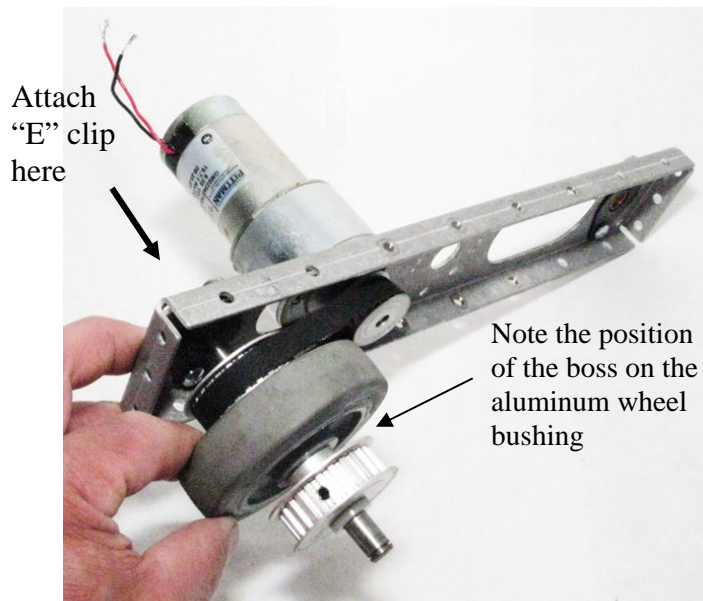
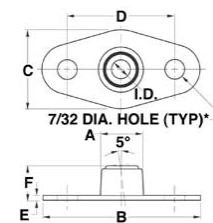
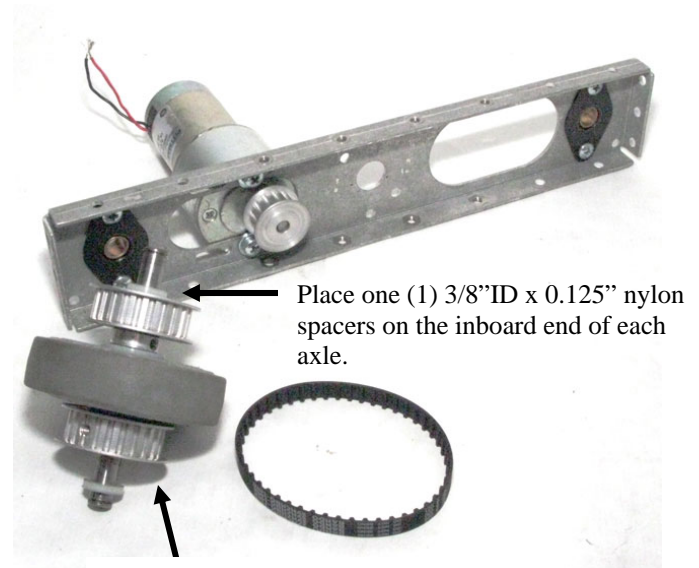
2 required. Average assembly time: 2 students
about 10 minutes per assembly

Necessary Components and Tools

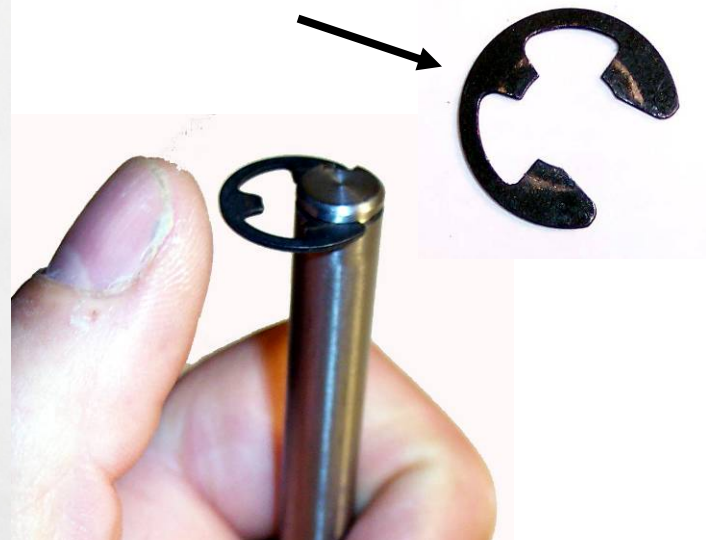
Qty. Description

- 2 Pre-made motor and bulkhead assembly
(See step 7-8)
- 2 Pre-made drive wheel assemblies (See
step 3 and 4)
- 2 Pre-made bulkhead assemblies. (See step
1 and 2)
- 2 48 tooth belts
- 2 “E” retaining clip (not shown)

1. Wrap the 48 tooth belt around the motor pulley and around the wheel pulley. Make certain that the boss on the aluminum wheel bushing is facing out and away from the flanged bearing. See photo below.
2. With the 48 tooth belt wrapped around the drive wheel pulley, place the drive wheel axle into the flanged bearing. It may be necessary to loosen the motor mounting screws in order to bring the motor pulley closer to the wheel pulley. Note that the flanged bearings are self aligning which means they can rotate in their mounting socket as much as 5 degrees. This allows for easier assembly without binding the axle.



“E” Clip



Attach the “E” clip on the inboard side of the axle as shown above left. The “E” clip can be pushed into the machined groove on the axle end with thumb pressure. Remove it by prying it off with a screw driver.

2.) Integrate Driven Wheel and 124 Tooth Belt

2 required. Average assembly time: 2 students about 10 -15 minutes.

Necessary Components and Tools

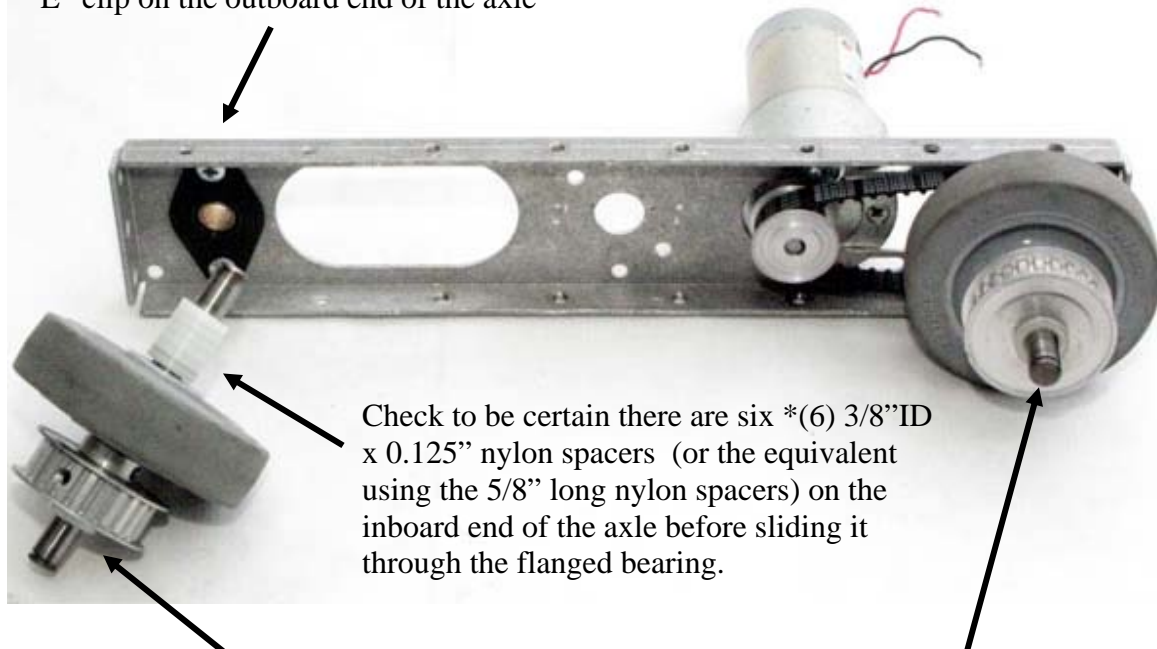
Qty. Description

- 2 Pre-made motor, bulkhead and drive wheel assemblies (See 9-10)
- 2 Pre-made driven wheel assembly (See steps 5 -6)
- 2 124 tooth timing belts
- 6 “E” retaining clips (not shown)

Procedure

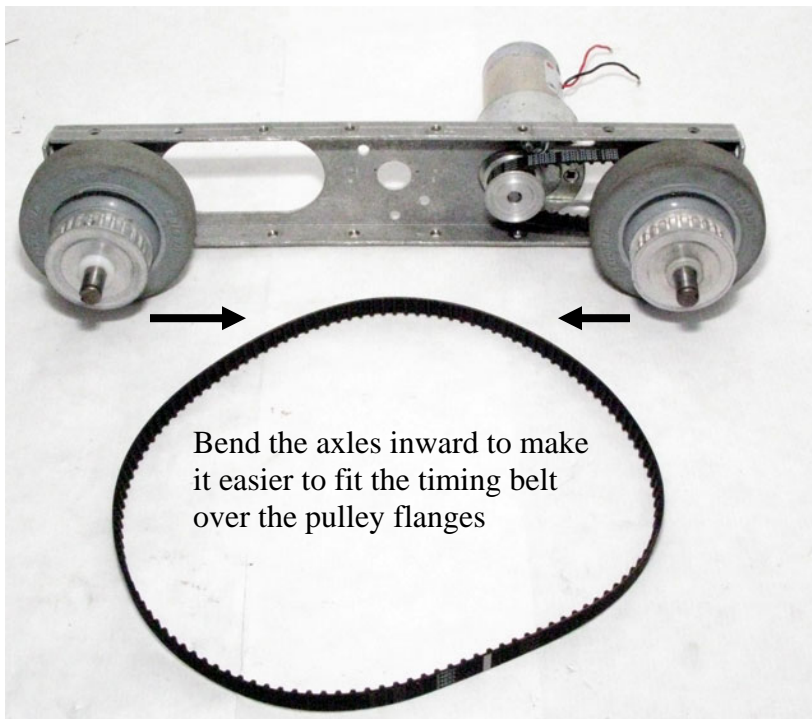
1. Fit the axle of the driven wheel assembly into the flanged bearing on the bulkhead and drive wheel assembly (See 9-10) Be certain that there are six (6) 3/8” ID x 0.125” or 12 3/8” x 0.625” thick nylon spacer washers on the inboard end of the axle. Guide the axle end through the flanged bearing and secure it with an “E” clip.

Capture the axle in the bearing using an “E” clip on the outboard end of the axle



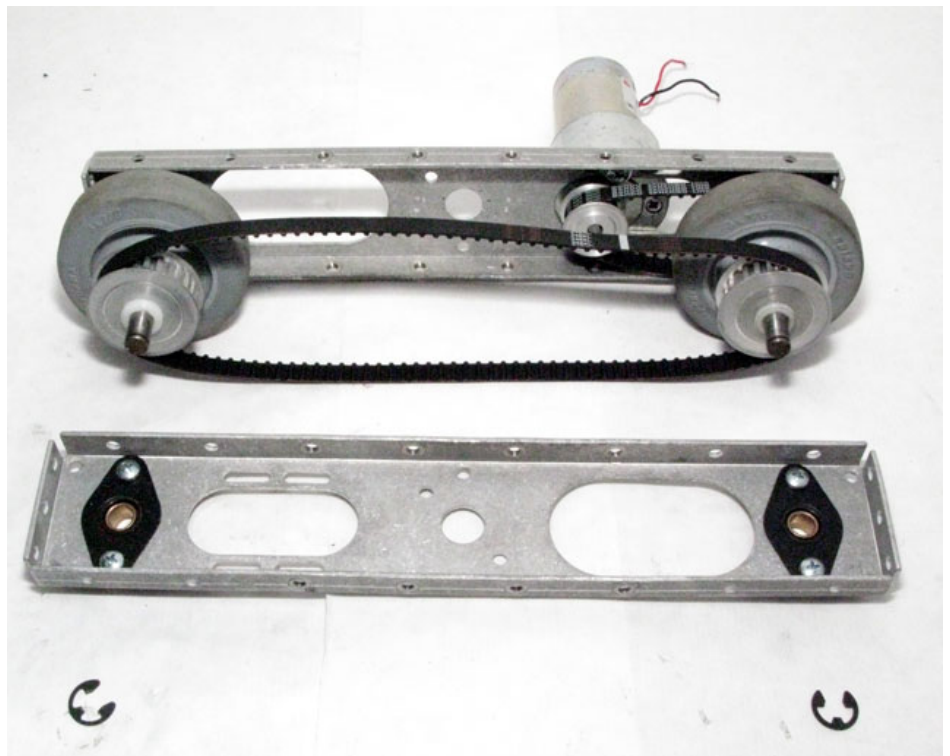
Be certain there is at least one (1) 3/8”ID x 0.125” nylon spacers on the outboard end of each axle.

Note: It is sometimes necessary to substitute different thickness spacer washers in order to achieve the best fit. Remember that a loosely spaced axle is better than a tight axle.



Note: The “E” clips are designed to be fitted and removed by hand. If it becomes necessary to fix them more permanently, simply pinch them with a pair of needle nose pliers so they conform more tightly to the shaft.

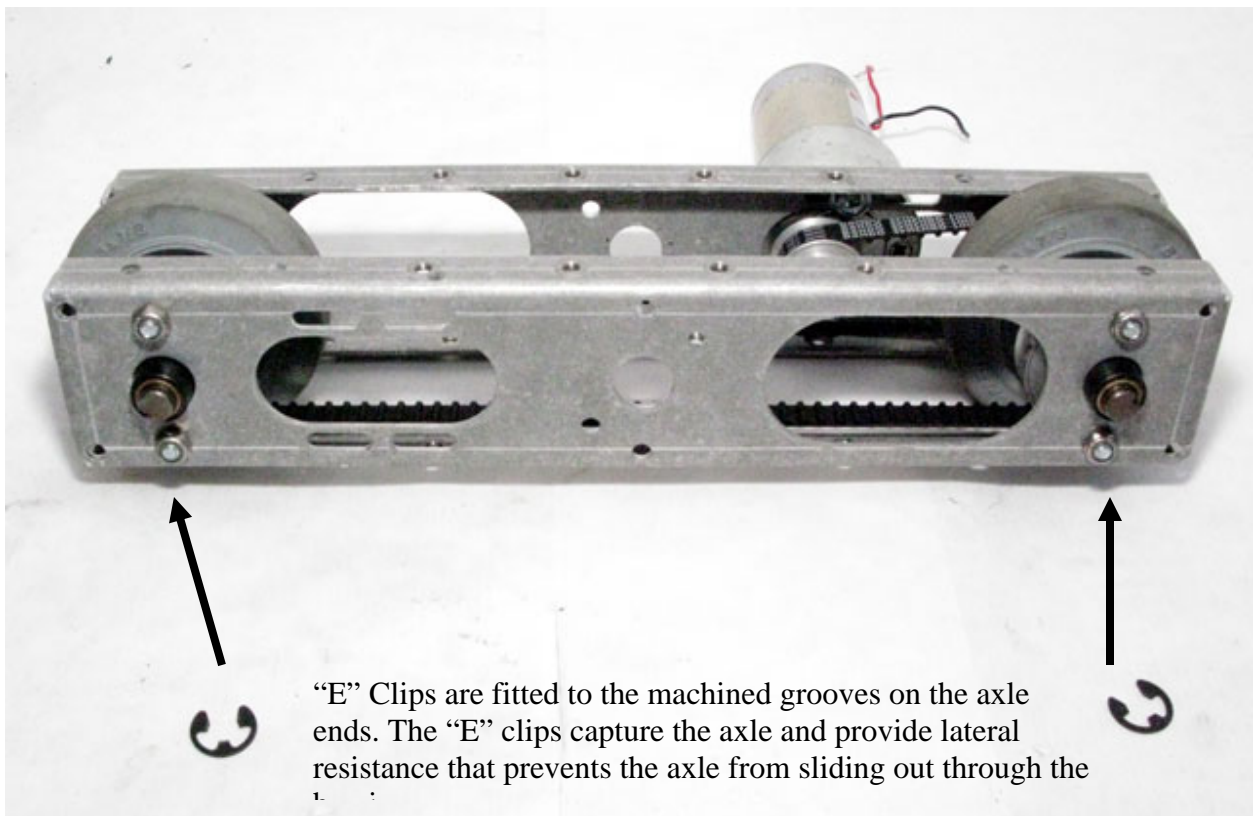
5. After completing the initial assembly of the drive module, it is necessary to perform both a visual check and a operational check to ensure correct alignment and tension of the chain and sprocket pairs. The visual inspection ensures the paired pulleys are parallel and on the same plane, and that the belts are running straight with respect to the pulley pairs. An easy way to do this is to look at the drive module assembly from directly above. Visually line the belts up with the edges of the bulkheads and check to see that the belt path and the bulkhead edges are parallel. If either of the belt and pulley pairs are not running straight and true, then the module will need to be disassembled and the necessary spacers repositioned in order to ensure correct (parallel) belt drive alignment.



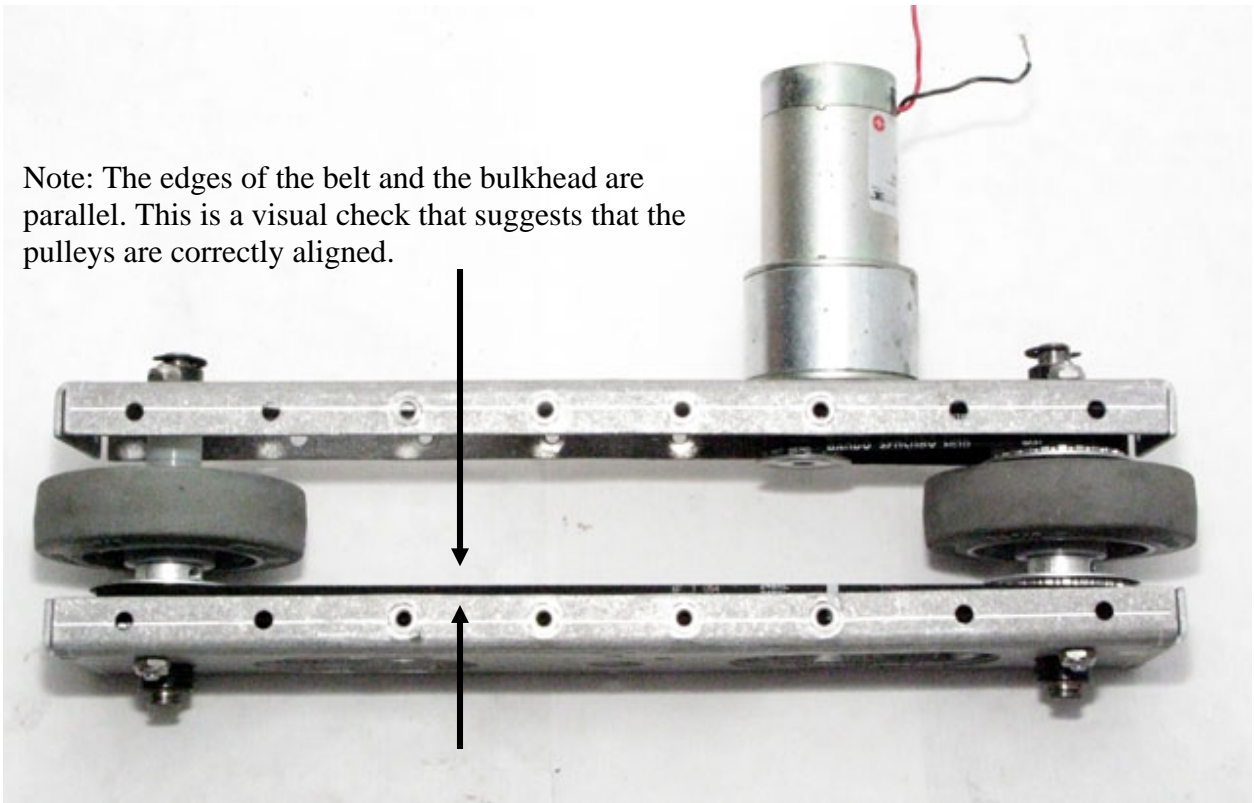
2. With the two wheel assemblies positioned in the flanged bearings and secured with “E” clips; bend the axles towards one another as shown. The flanged bearings are self aligning bearings, and they allow for up to 5 degrees of axial rotation. Bending the axles brings the pulleys closer together making it easier to fit the 124 tooth timing belt to the pulleys.
3. After the timing belt has been fitted to the pulleys, bend the axles outward and slide the axle ends into the flanged bearings on the outboard bulkhead assembly.
4. Secure the axles onto the outboard bulkhead using the “E” clips as illustrated in 9-10.

6. The 124 tooth belt and pulley system transmits power from the drive wheel to the driven wheel. The drive wheel is defined as the wheel and pulley assembly that is driven by the motor. Since the axles are riding on non adjustable bearing centers, the 124 tooth timing belt tension is non adjustable. As the belt wears and sags, it will be necessary to fit the chassis with belt tensioners. These are simply PVC spacers that take up the slack developed by a worn belt. Fitting the belt tensioners to the chassis is described in the following pages.

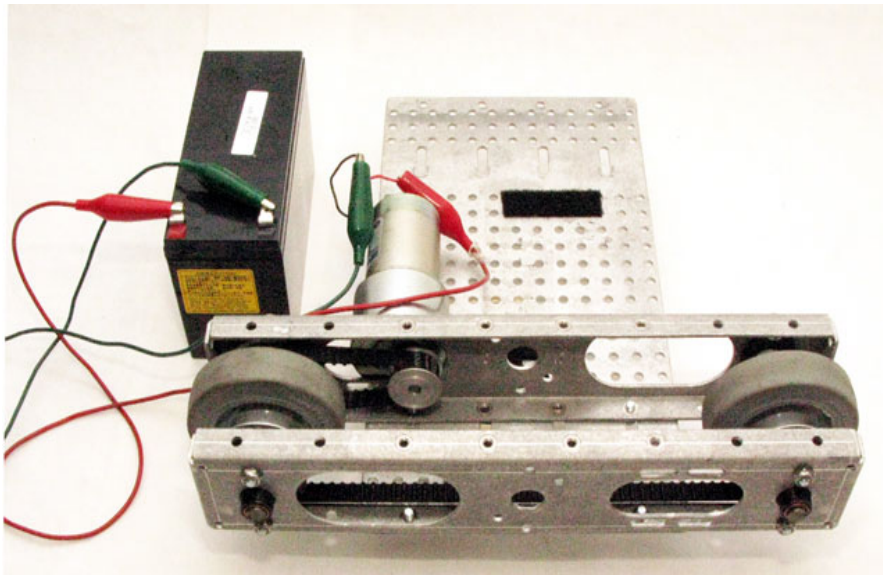
Note: The motor and drive wheel belt tension can be adjusted by loosening the motor mounting screws and sliding the motor along the mounting slots on the bulkhead. The drive and driven wheel axles are on fixed centers and the correct axle center distances and belt tension has been predetermined.



Note: The edges of the belt and the bulkhead are parallel. This is a visual check that suggests that the pulleys are correctly aligned.



It is a good idea to make frequent visual checks as the assembly comes together. In the photo above it is easy to check the belt alignment between the two wheel pulleys by noting the parallel relationship between the belt and the edge of the bulkhead. If these two surfaces are not parallel, it might suggest that the axle spacing or pulley positions need to be changed or adjusted. The same visual inspection process can be applied to the motor and wheel pulley and belt assembly.



7. An operational check can be made by setting the drive module on a stable platform such as a book, or wood block and energizing the motor with a 9-12V battery. Watch and listen for signs of abnormal operation such as wobbles, loose pulleys and noises that suggest obvious problems.

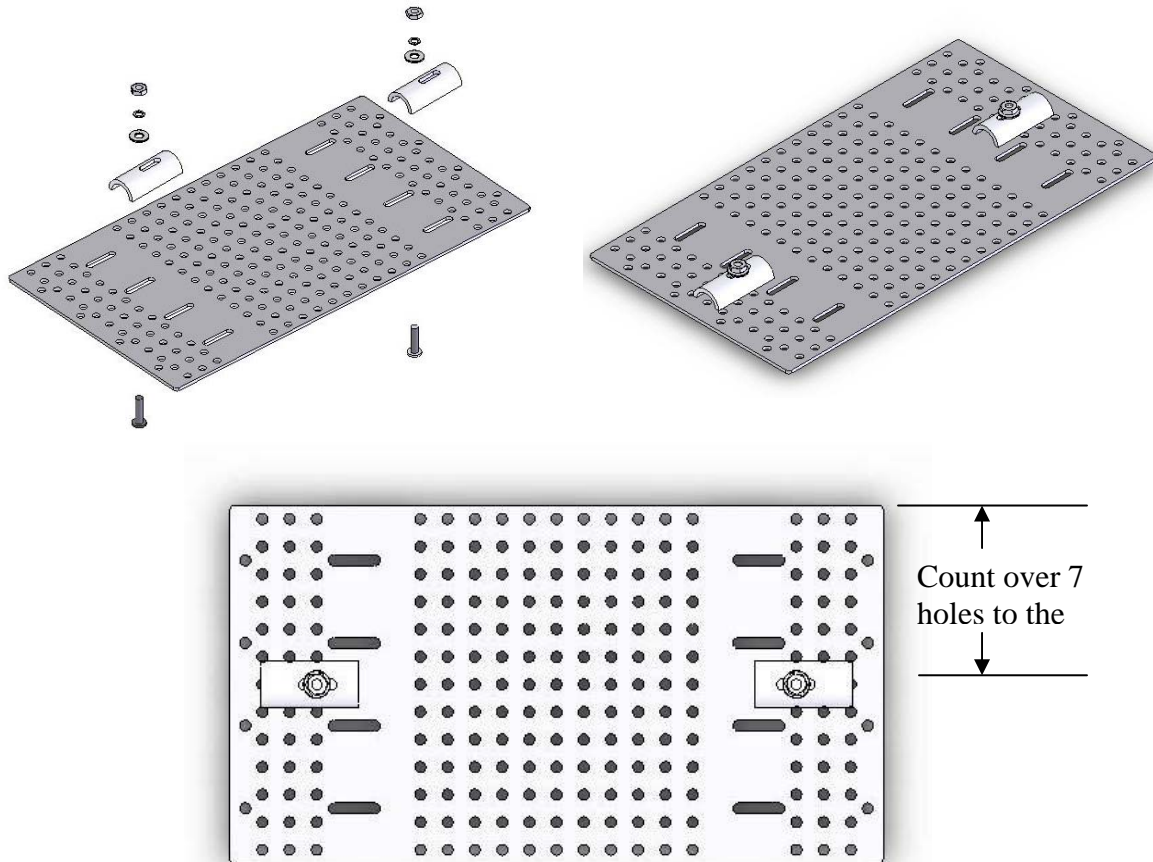
Note: Always have two people perform the operational check. The drive module wheels should not be in contact with any surface or object. Never hold the module while it is being energized. Keep hands free of the rotating chain and sprockets

3.) Belt Tensioner Installation

(2 required) (Average assembly time: 2 students about 5 minutes)

Components and Tools

Qty.	Description
2	PVC Chain guides
2	#10-32 x ¾" Phillips Head Machine Screws
2	#10 Flat Washers
2	#10 Lock Washers
2	#10-32 Hex Nuts



Belts run more efficiently when they are loose. Tight belts drag on the pulleys and create excessive radial loads on the bearing surfaces. This causes premature wear and wastes battery current through increased frictional losses and heat. Since the wheel pulleys are on fixed centers, it may eventually become necessary to provide belt tensioning as the belts loosen with wear.

To accomplish this, a PVC tensioner is fastened onto the **bottom chassis plate only** during installation. The illustration below shows the initial position of the belt tensioner. Final adjustment can be made when the chassis is assembled, and the tensioner can be tightened in place. Pay close attention to the position of the tensioner with respect to the hole pattern as shown.

Note that the degree of tensioning can be adjusted by shimming the

4.) Chassis Integration

Average assembly time: 2 student about 10 -15) minutes)

Necessary Components and Tools

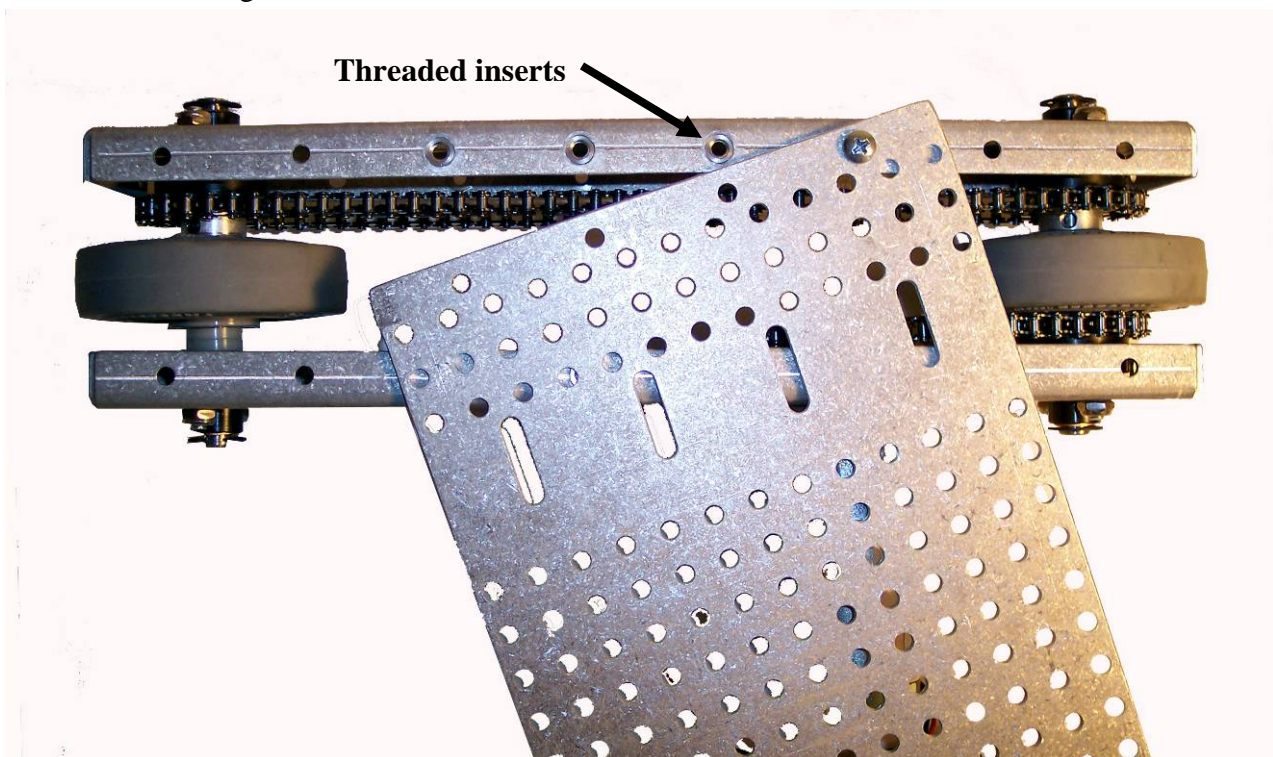
Qty. Description

- 2 Pre-made drive module (See 11-12)
- 2 Cover plates
- 32 #10-32 x 3/8" Phillips head machine screws
- 32 #10 lock washers
- 1 12" – 14", #2 point Phillips head screwdriver (not shown)
- 1 3/16" diameter rat tail file (Not shown)

Procedure

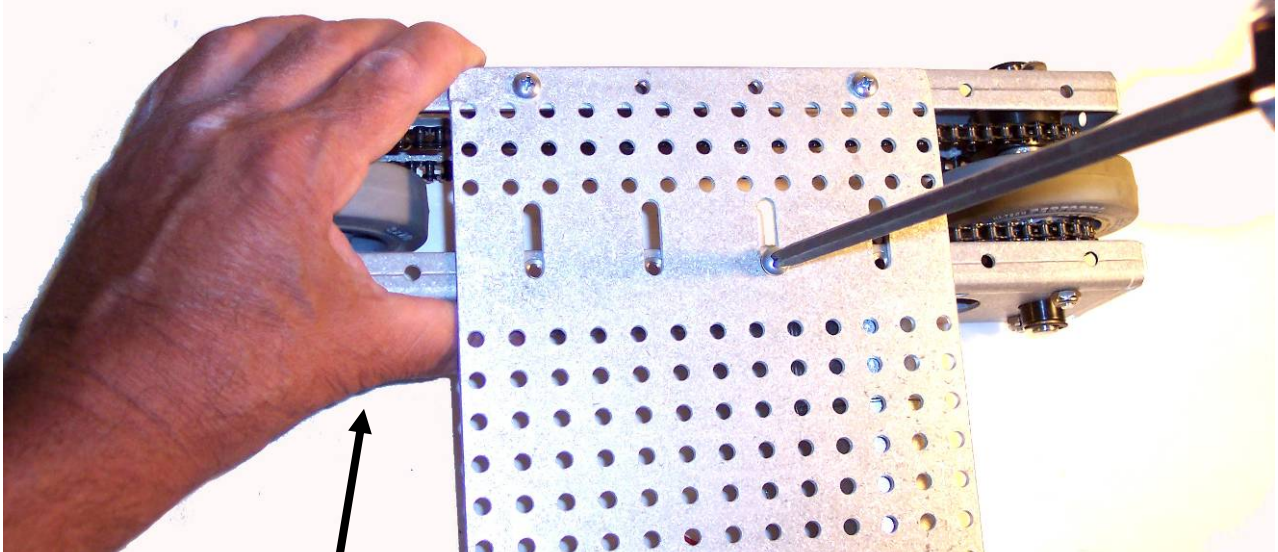
Note: This is the final step in the mechanical assembly of the Heavy Metal chassis. It will be necessary to fit up the completed machine, check and adjust fits and interferences and then remove one of the cover plates in order to wire the motors and control components. However, assembly and disassembly is quickly and easily accomplished since the Heavy Metal chassis makes efficient use of threaded inserts to secure the cover plates.

1. Align the 4 outside holes of the cover plate with the 4 outboard threaded inserts along the top of the bulkhead and attach the cover plate with 4 machine screws and lock washers. Do not tighten the screws at this time.

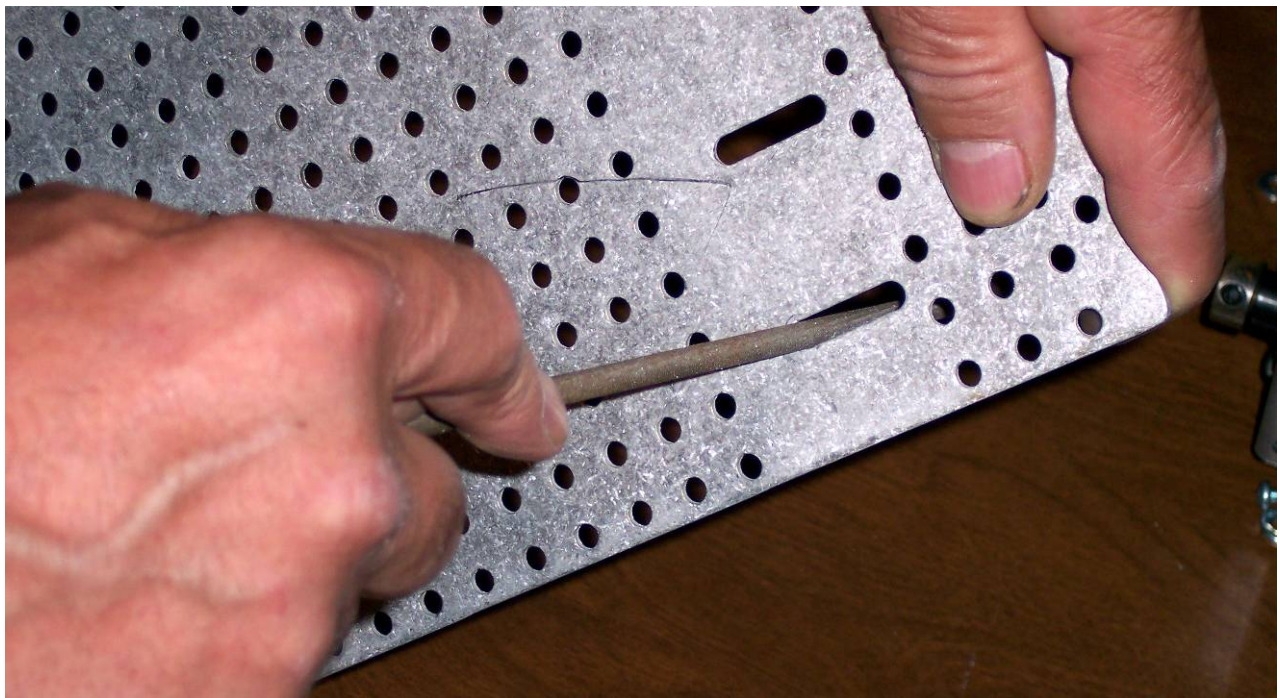


Note: Chassis integration is the same for either the chain or belt option. The image below shows the assembly procedure with the standard chain option.

2. Align the 4 slots on the cover plate with the 4 threaded inserts on the inboard side of the bulkhead. In order to do this, it may be necessary to gently squeeze the bulkheads together. If the squeeze force necessary to align the cover plate slots with the threaded inserts becomes too great, it will add unnecessary friction to the drive system. To alleviate this problem increase the length of the slots by filing them with a 3/16" diameter round or rat tail file similar to those used to sharpen a chain saw (see the illustration below). When lengthening the slot becomes necessary, it is usually only a matter of increasing the length by 0.015" - 0.025".



Gently squeeze the bulkheads together to bring the slots and threaded inserts into alignment.



If necessary, lengthen the slots by filing them with a 3/16" round file

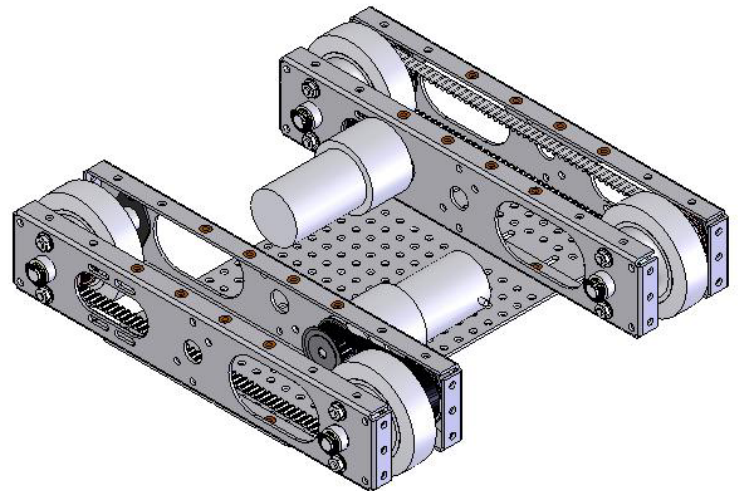
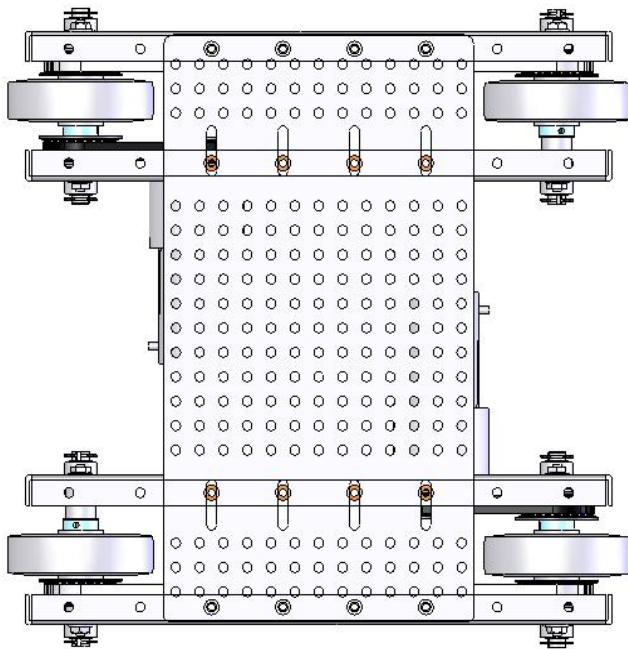
3. Repeat the process described to attach the second drive module and the second cover plate. When both cover plates have been attached and the Phillips head screws have been tightened to approximately 22 -26 inch pounds of torque, it will be necessary to check the drag on the drive train components. Excessive drag is usually caused by too much squeeze between the bulkhead plates, or a misalignment in the drive train components. To test for excessive drag simply hold the completed chassis and turn the wheels by hand. First one side, then the other. Compare the force needed to turn them. The force should be equal, and it should “Feel” smooth and loose. The only force you will be turning against are the forces of the chain drives, the gear box friction and the magnetic drag of the motor on the steel armature plates. Less drive train drag means better performance, smoother throttle response and longer run times from a charged battery!
4. After the final assembly has been completed, take a moment to check and adjust the belt tension between the motor and wheel pulleys. The best suggestion for proper tensioning is to have the belt as loose as possible, but not so loose that the belt skips a tooth when the spinning wheel is under a load or stalled. To adjust the belt tension, loosen the (2) #10-32 phillip head pan screws that mount the motor to the bulkhead. With the screws loose, slide the motor away from the wheel pulley. This causes the tension on the belt to increase. **DO NOT OVER TENSION THE BELT** by forcing it away from the wheel pulley. Use only enough belt tension to achieve belt tooth engagement without slippage or skipping. A belt that skips over the pulley teeth will quickly be destroyed.

The Completed HMC Chassis Assembly

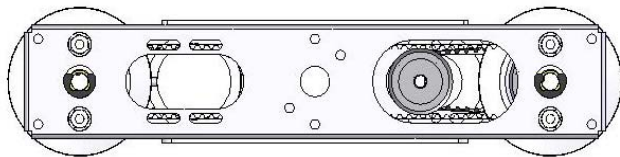
Shown in Multiple Views

Note: This version is shown with XL timing pulleys and belts. The GEARS timing pulley and belt drives are interchangeable with the #25 pitch chain and sprocket components sold with the standard HMC chassis. This allows the user to easily and quickly fit their HMC chassis with either chain drives for more robust performance, or belt drives in order to create a lighter chassis. Combination chain and belt drives are also easily assembled since the chain and belt components are interchangeable with respect to bore sizes and axle spacing.

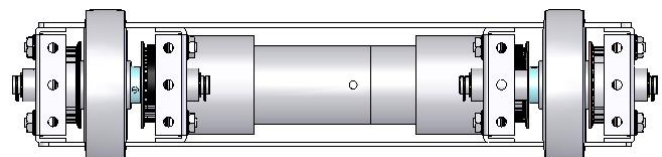
Top View



Isometric View



Front View

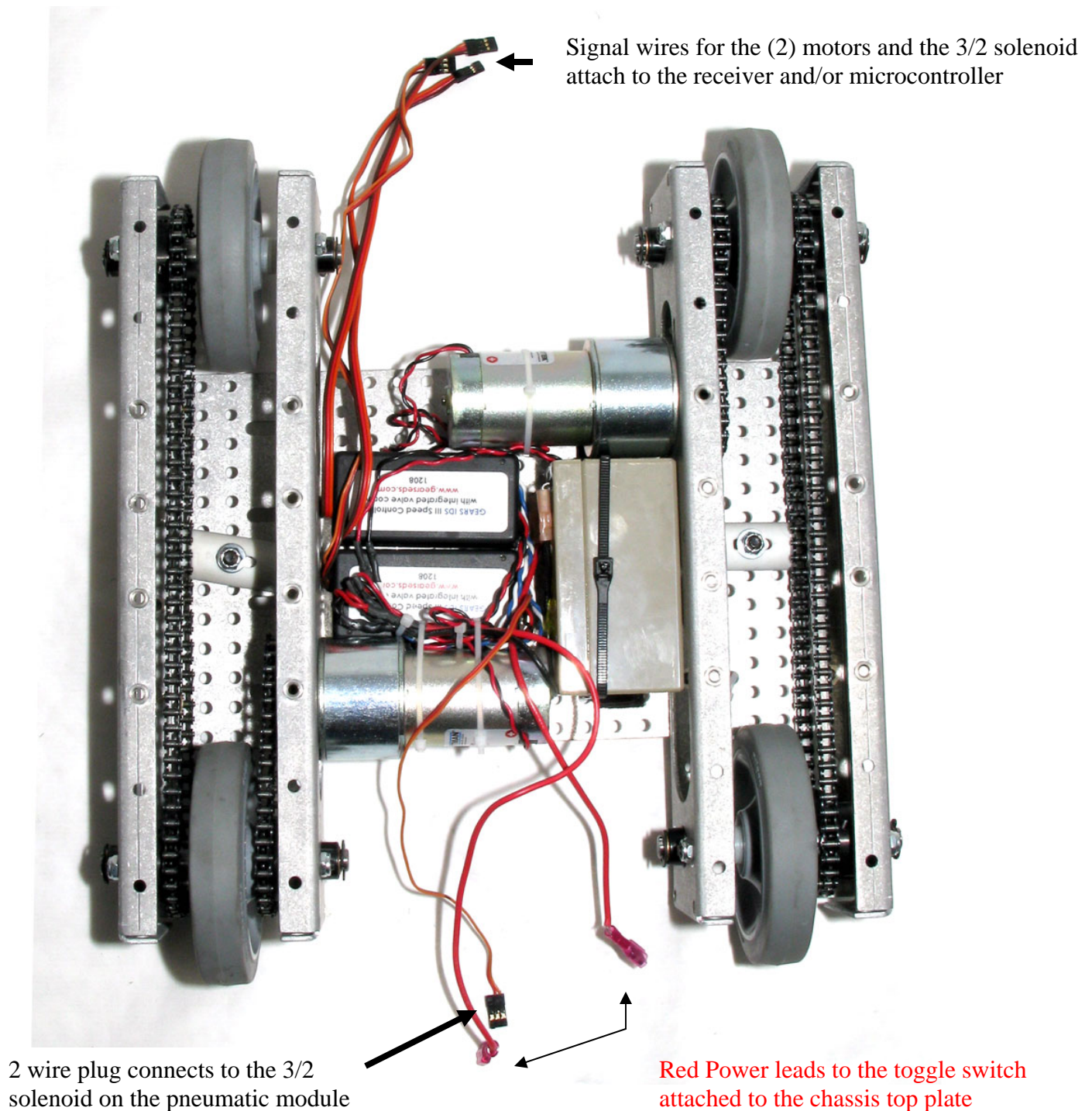


Right View

The Isometric view is shown with the top plate removed in order to more clearly illustrate how the assemblies are related.

Integrating the HMC Chassis with the Pneumatic Module

This section is provided for students and teachers who use both the GEARS- Pneumatic Module and the HMC Chassis in their engineering program

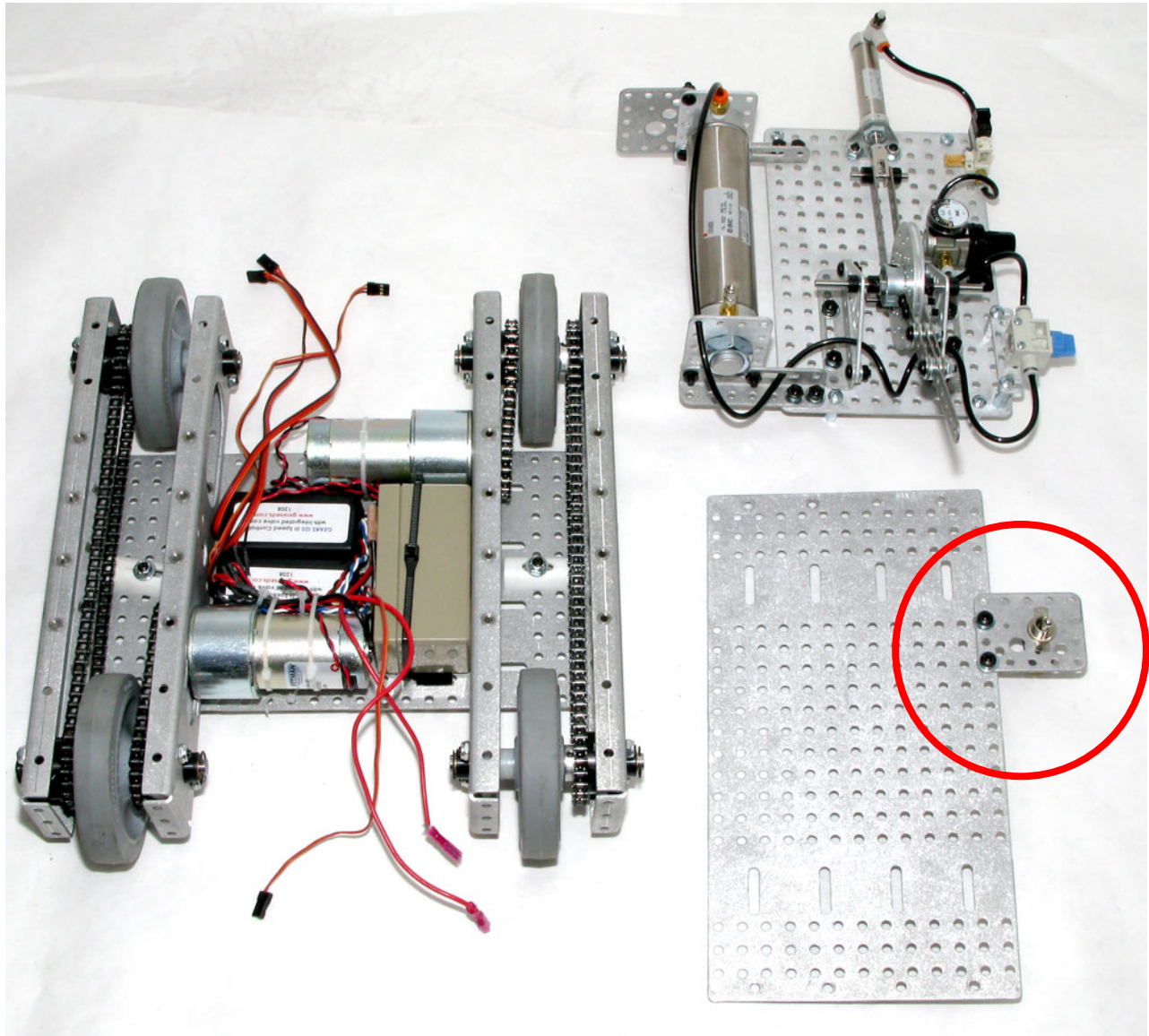


The image above illustrates how to position the GEARS-III motor controllers and the battery. They are both secured in place with either Velcro or zip ties.

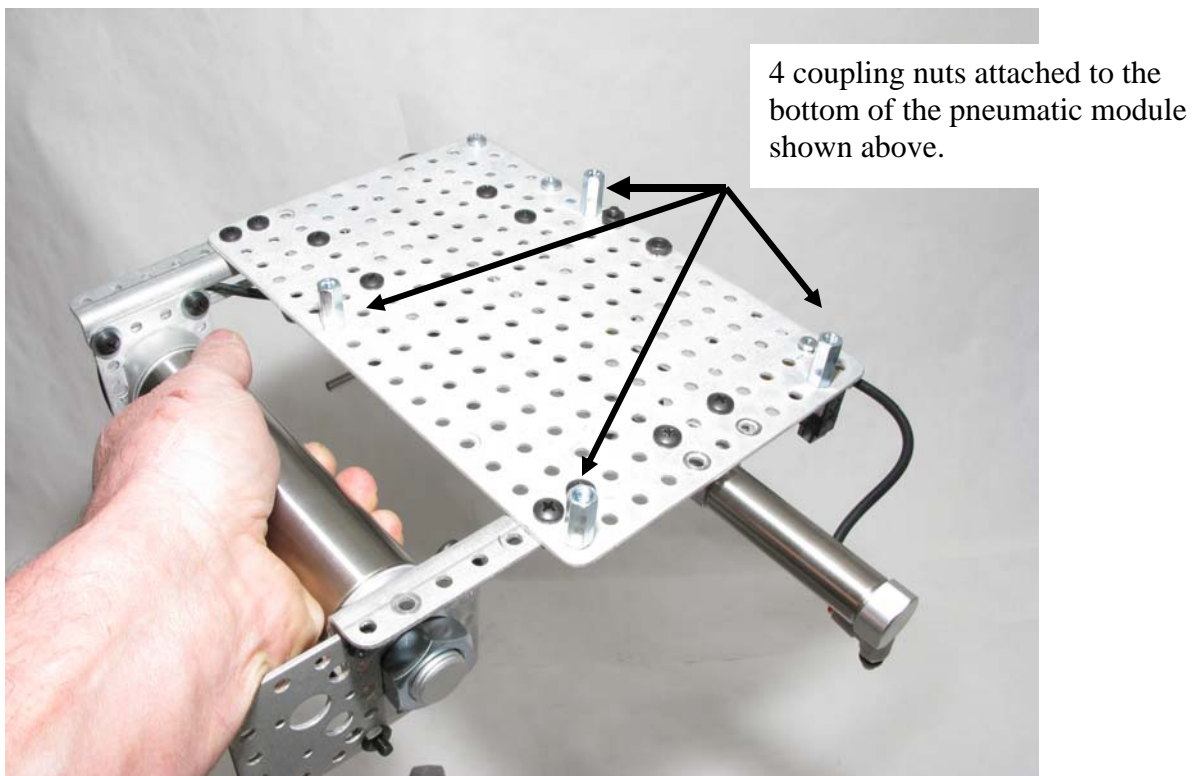
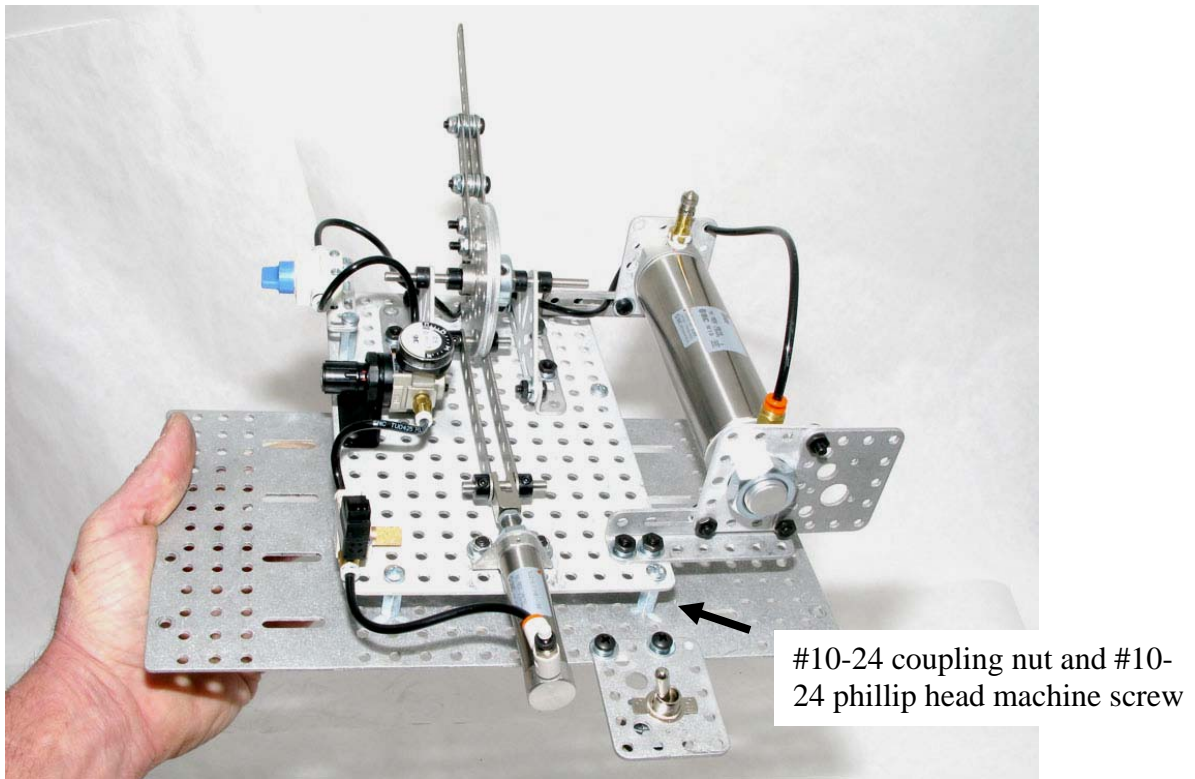
The image below illustrates the completed chassis, the chassis top plate and the pneumatic module prepared for integration. This example is wired using the GEARS III, 2 channel controllers

Note: The SPST toggle switch, switch plate and mounting hardware have been attached to the chassis top plate. See **red** circle below.

For information on how to complete the wiring of the motor controllers, battery and switch, please refer to the appropriate wiring instructions included separately with the HMC product.

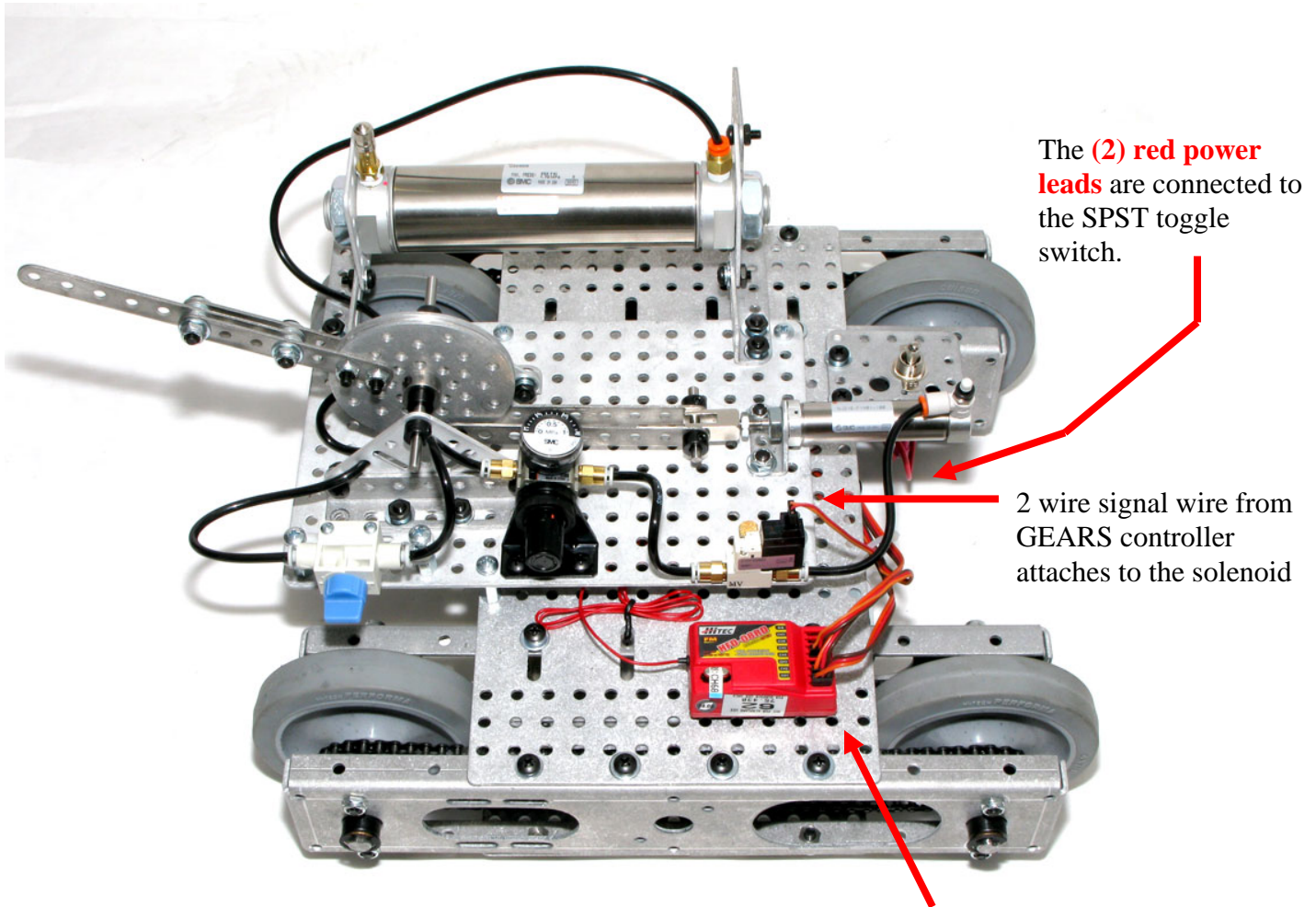


The image below shows the pneumatic module attached to the chassis top plate. This is done using (4) #10-24 coupling nuts, and (8) #10-24 phillip head machine screws and lock washers.



The Integrated HMC Chassis with the Pneumatic Module

The image below shows the chassis top plate and pneumatic module assembly integrated with the HMC chassis.



The (2) **red power leads** are connected to the SPST toggle switch.

2 wire signal wire from GEARS controller attaches to the solenoid

Signal wires from the (2) GEARS III motor controllers are shown connected to an RC radio receiver. The motor signal wires are connected channels 1 and 2.

The pneumatic solenoid signal wire is attached to channel 4.