

PANTERA **P6**



Instruction Manual

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WARNING

You are about to embark on a wonderful adventure into the world of remote controlled (R/C) models. However, this helicopter model is not a toy and is not suited for children. A properly assembled and operated remote controlled model helicopter can bring many hours of enjoyment and pleasure, but even if properly assembled and operated, the nature of an R/C system means the radio-link between transmitter and receiver may fail, in which case even competent operators are no longer in control. In addition, due to operator neglect or accident, worn or damaged parts may cause bodily harm and/or death as well as property damage. In addition, the overall mass of the model in motion means contact with non-rotating parts may cause bodily harm and/or death as well as property damage

You, and you alone, are responsible for the safe operation of this R/C model helicopter and Audacity Models assumes no liability for harm or damage that could occur from the assembly and/or use/misuse of this product. This manual does not serve as a final and total instruction in the safe and proper assembly and operation of remote controlled model helicopters. Always have personal supervision by a modeler experienced in the safe and proper handling of R/C model helicopters.

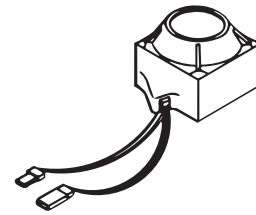
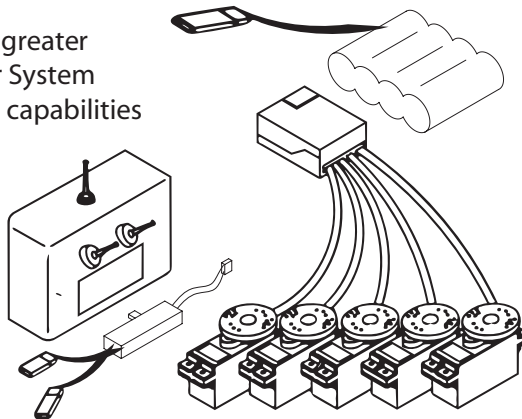


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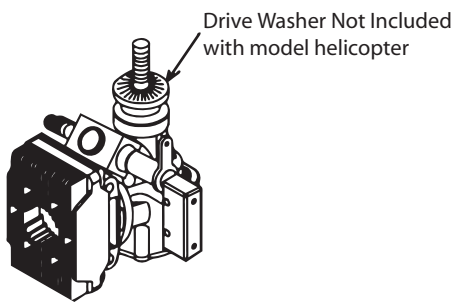


Items Needed To Complete The Model

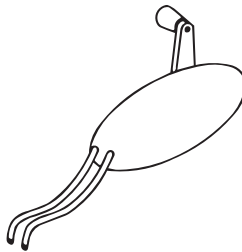
6-channel - or greater
R/C Helicopter System
w/120° CCPM capabilities



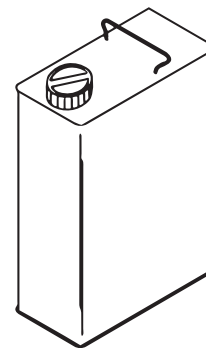
Gyroscope



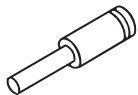
50-class Glo-Fuel Engine



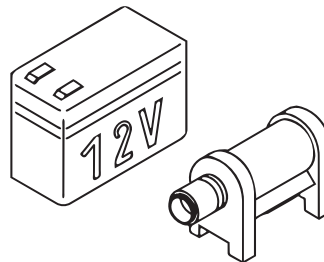
Glo-Fuel Pump



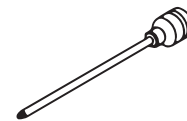
Helicopter Fuel
(15%-30% Nitro)



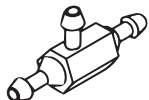
1.2V Ni-Start Battery



12V Gell-Cell Battery
and Electric Starter



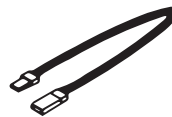
6mm Hex Start Shaft



Fuel Filter
(3-way)



12" Fuel Tubing
(1/8" Silicone)



Servo Extensions
(2 each - 4" Long)



Cyclic/Collective
Servo Control
Horns (x3)



Some Tools Needed For Assembly



Phillips Screw Driver



Nut Drivers (4mm/5.5mm/7mm)



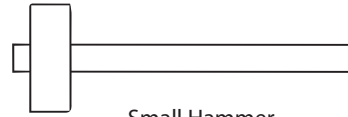
Allen Drivers (1.5mm/2mm/2.5mm/3mm)



Drill Bit 1/16"



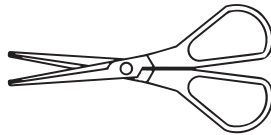
Auger - or - Reamer



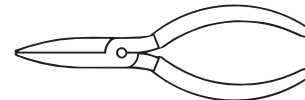
Small Hammer



Wrench (5.5mm/6mm)



Lexan Scissors



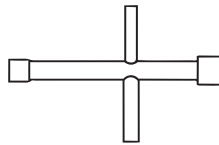
Needle-nose Pliers



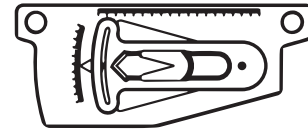
Hobby Knife



Ruler (metric) Greater Than 30cm



4-way Wrench (8-12mm)



Pitch Gauge

Thread Locker Is Used To Keep Assemblies Tight As Vibration May Cause Them To Loosen



Semi-permanent
BLUE Thread Locker

Due to the vibrations caused by operation, nuts, bolts, and set screws may have a tendency to loosen. Repeated tightening is not the solution, instead, the careful application of thread locker is required. Thread locker works something like a glue. There are various types of thread locker, from permanent types which are usually RED in color, to semi-permanent types which are usually BLUE in color. BLUE thread locker is what is recommended. Thread locker is not needed with nylon-lock nuts, nor where metal screws thread into plastic. Finally, be careful to remove all traces of oil or grease by applying a degreaser or acetone to bolts prior to assembly - clean with a paper towel until all traces are gone.

NOTE: Use care when using thread locker near bearing areas as contamination may ruin the bearing and cause it to seize.
Never use thread locker on metal to plastic

Optional Tools and Accessories:

- Dial Indicator
- Ball Link Pliers
- Piston Locking Tool
- Calipers
- 10mm deep-well thin wall socket
- 2 ea. - 5/16" or 8mm 1/4" drive socket
- 2 ea. - 1/4" drive short extensions and 1/4" handles or drives
- one sheet of thin typing paper



Identifying The Model's Hardware

All Audacity Models part numbers begin with AUD (our hobby trade association designator). To make it easy, hardware uses dimensions (dia & length) followed by type. Nuts and washers are identified by their purpose diameter (ID) and type. Thus, it's easy to decode Audacity Models hardware just by "reading" the part number. For example, an AUD2615AH is an Audacity Model 2.6mm x 15mm Allen Head bolt. Notice how the diameter is expressed in two digits to allow for an intermediate diameter other than a whole number, i.e. 26 means 2.6 mm diameter while the next two numbers allow for less than 10 mm via leading with a 0, i.e. an 08 = 8mm. Below are the Follow Codes and some further examples to help you get the hang of it.

AUD2008PH



- ① AUD = Audacity Models
- ② 2008 = 2.0mm x 08mm
- ③ PH = Phillips Head

③ Follow Code

- AH = Allen Head Bolt
- SB = Shoulder Bolt
- BH = Button Head Bolt
- PH = Phillips Head Screw
- ST = Self Tapping Screw
- SS = Set Screw

- TR = Threaded Rod
- LW = Lock Washer
- FW = Flat Washer
- NL = Nylon Locking Nut
- HN = Hex Nut
- PN = Push Nut

AUD2008PH
M2x8 Phillips Head Screw

AUD2008ST
M2x8 Self tapping Screw

AUD4004SS
M4x4 Set Screw

AUD3012AH
M3x12 Allen Head Bolt

AUD20HN
M2 Hex Nut

AUD30NL
M3 Nylon Locking Nut

AUD30LW
M3 Lock Washer

AUD20FW
M2 Flat Washer

AUD2315TR
M2.3x15 Threaded Rod



Before You Begin Assembly

The semi-kit concept and how it saves you time!

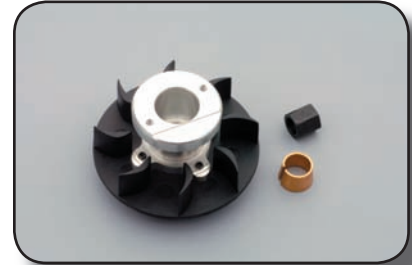
As you work your way through the manual you'll discover that many, many of the parts have been pre-assembled for you. Traditionally, model helicopters have been available in two forms. The *kit*, in which you assemble every single component and the Almost-Ready-to-Fly, or *ARF* model, where it's all done for you. The either-or problem is kits are tedious to build and ARFs leave you not knowing how to make repairs. Our audacious solution is the *semi-kit*. By pre-assembling some components for you - building the Pantera 50 is both fun and fast . . . but without the tedium. More importantly, when the inevitable happens, you'll have the experience of how to make the repairs! These are some of the components we've pre-assembled for you.



The complete head assembly is pre-assembled. This includes the head block, main rotor grips, seesaw and arms, the dampers, thrust bearings, radial bearings, spacers, washers, etc. Done!



By pre-assembling the clutch bell, the bearing has been accurately pressed into the bottom of the bell. The liner material has been trimmed and epoxied in place. Plus the pinion gear has been threadlocked to the bell and the support bearing has pressed onto the gear.



CNC-machined of 6061 aircraft aluminum, the fan hub and cooling fan are pre-assembled, (note the lovely airfoil shaped blades). We torqued these bolts evenly so the assembly is smooth running and true (also note the trick dual cone mounting system).



The autorotation one-way clutch assembly has been pre-assembled complete with sleeve, one-way clutch, washers, and snap ring. Then this has been assembled to Main Gear 1 and precisely torqued to avoid distorting the gear.



The swashplate is replete with tiny balls and screws. And these itty bitty parts can easily slip and bounce onto the floor - never to be seen again! Pre-assembling this unit is a time saver.



By pre-assembling the washout base with the washout arms and links, we've not just saved you time, but we've also ensured these precise small parts are properly assembled. While it's not particularly difficult to do, it's aggravating to deal with, so we do it for you!



Pre-assembling the linkage rods is one of those dreary tasks you'll be glad we've done for you. The lengths are spot on. This is one of those jobs which leads to Carpal Tunnel Syndrome, so trust us when we say your poor wrists will thank us!



The clutch is a deceptively simple pe-assembly. What we've done is to use our press to insert the 6 mm ID one-way clutch within the engine's clutch shoe unit. You can do it easily - but only if you have a small press - because this is no job for a hammer!

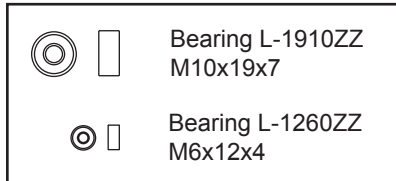


Pre-assembling the spring pin through the aft tail belt pulley and into the tail output shaft is actually pretty easy. All you need is a block of wood and a special tool. The tool, a 2 mm drift, is difficult to come by. While they're available from us - part number PDR0095, \$8.99 - the problem is most folks don't realize they need the tool until after they have the heli. So we did it for you! Finally, the tail pitch plate depends on a left-hand, i.e. reverse pitch thread, plus we've also assembled the pitch links for you.



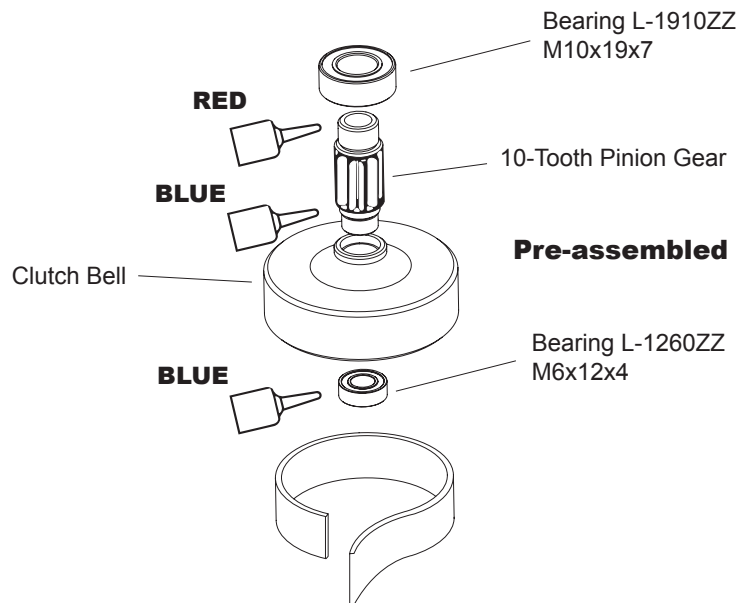
Step 1 – Clutch Bell Assembly

There are two bearings used in this assembly. They are a press fit onto the steel pinion gear as well as into the clutch bell. Since most modelers don't have a press, we have preassembled them for you, but these are the steps; ensure there's no swarf (tiny metal shavings from the machining process) on the parts. Make sure a precise alignment exists between the pinion gear and bearing and between the bearing and the clutch bell itself before operating the press. Also, regardless of which brand of threadlocker you use, take special care to prevent it from entering the bearings!



*** PRO TIP** - we've had success with an adhesive like **JB Weld®** (24-hour cure, not the JB Kwik®) steel-filled epoxy instead of the RED (permanent) thread locker prior to pressing the upper support bearing onto the pinion gear. But, if you go this route, you must first roughen the inner race of the bearing so that there's a better mechanical bite by the adhesive. We recommend use of a Dremel® tool and a **Roto-Zip® Tile Cut Zip Bit #TC1**. Thoroughly clean everything with acetone before assembly. Then put a thin coat of the epoxy on bearing's inner race (or use RED thread locker) and then a heavier coat on the pinion. Use blue threadlocker for the clutch bell bearing. Lastly, invert the assembly onto a small piece of wax paper (bearing down) to protect the surface of the table and let everything sit overnight to cure.

Finally, there will come a day when you want to remove the bearing. At this point it's no good so the judicious application of heat, which will ruin it otherwise, via a plumber's torch, is just what the doctor ordered. Anyway, just heat it up, which will soften the adhesive, and using a rag to grasp it, and it'll come right off!



Electrical tape wrapped around the clutch

Installing a Clutch Liner

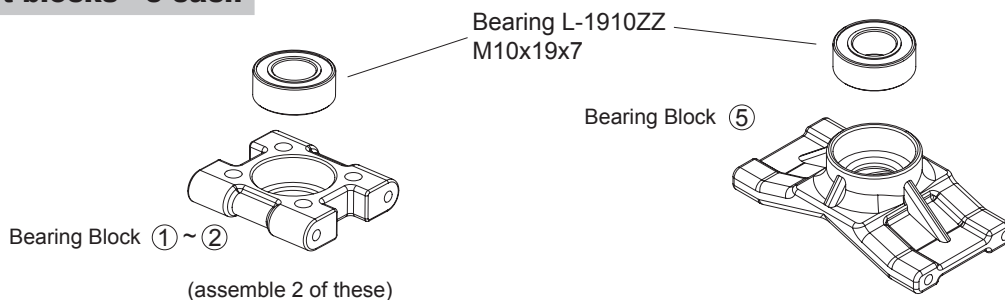
The clutch liner has been preinstalled also. When you find yourself replacing a liner, these are the steps you'll take. Dry fit the clutch liner because it may be a tad long (not always, sometimes). Don't trim it though unless you really have to because it is easy to trim too much. Next, take the clutch shoes unit and wrap it a couple of times with electrical tape and fit it into the clutch bell so that it's a tight fit against the liner. What you're looking for is the clutch shoe unit wrapped in tape to hold the liner tightly against the wall of the clutch bell. Maybe it takes three or four wraps; it depends on the thickness of your tape and how much you stretched it. Finally, mix up **JB Weld®**, the real stuff not the JB Kwik®, and after mixing, smear it lightly (and evenly) on the inside of the aluminum clutch bell, followed by a similar smearing on the clutch liner and then install the liner into the clutch bell. Wipe off excess adhesive and then pop in the preprepared clutch shoe unit (with the tape) so that it applies even pressure around the circumference of the clutch liner. Set it aside until it cures (the next day). By the way, wear disposable gloves when working with epoxy partly because it can be messy but mostly because epoxy's effect on the human system is cumulative and permanent (so don't waste any of your body's "epoxy-tolerance clock" by getting epoxy on yourself unnecessarily). Finally, epoxy clean up is easily accomplished with denatured alcohol.



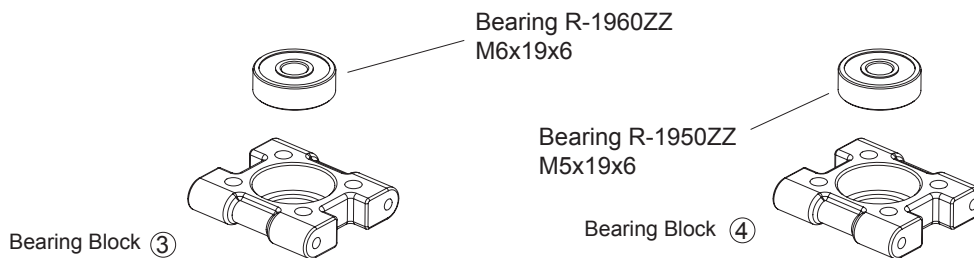
Step 2 – Bearing Block Assemblies

The Pantera 50 has removable bearing blocks, which are a feature of top of the line 90-class models! There are 3 supporting the main shaft and 2 more for the tail pinion gear assembly. Thus, not only do frames last longer than models with bearing seats molded into the side frames, but swapping out a main shaft bearing becomes a simple matter of removing four bolts versus having to split the side frame assembly - saving time when you replace bearings!

Main shaft blocks - 3 each



Tail drive pinion shaft blocks - 2 each



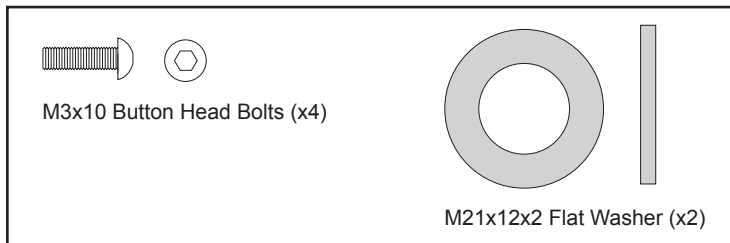
During aggressive 3D flight, the bearings supporting the Pantera's hardened 10 mm tool-steel hollow main shaft (a much harder material than stainless steel, and the same diameter as that found in a 90-class X-Cell) leads a rather tortured existence. Pantera's main shaft bearings are 40% wider than some competing model helicopters use. Also, because the Pantera features 3 main shaft bearings instead of 2, the ensuing flight loads (those transferred to the frame) are reduced resulting in a greatly increased service life!



Pantera main shaft bearing is 40% bigger

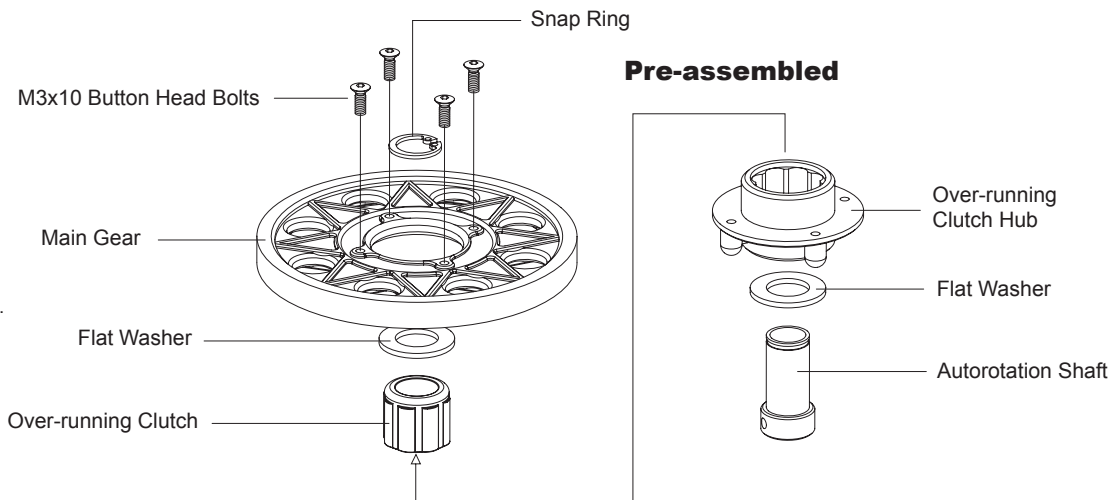


Step 3 – Main Gear & One Way Clutch



Be careful as you install the button head bolts. The goal is to tighten them evenly, but not so tight you strip the plastic hub.

*** PRO TIP** - The autorotation assembly contains a one-way over-running clutch. It's commonly referred to as a one-way bearings amongst modelers. In reality it's a one-way clutch, not a bearing.

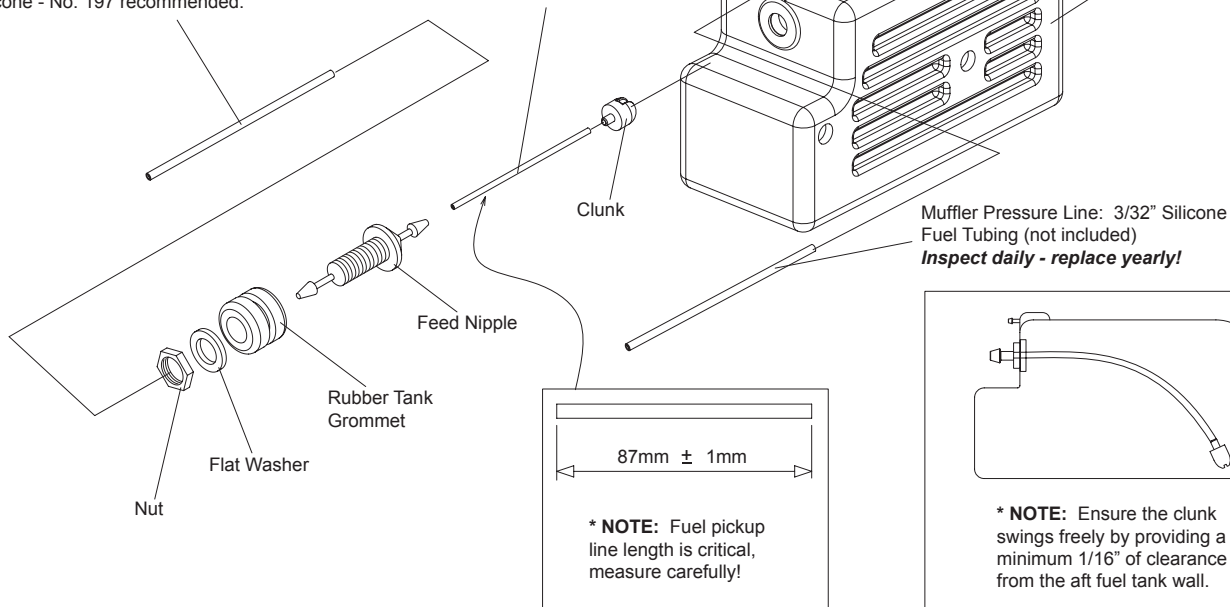


Step 4 – Fuel Tank Assembly

*** PROTIP** - Fuel Feed Line: 3/32" Silicone Fuel Tubing (not included) - Du-Bro® Medium (blue) Silicone - No. 197 recommended.

*** PRO TIP** - Fuel tubing inside the tank is destroyed from a component of the exhaust fumes. If using a muffler pressure system, after the last flight, fill the tank to the top with fuel and then drain it back out. The exhaust residue will be purged and the flex line will last much longer.

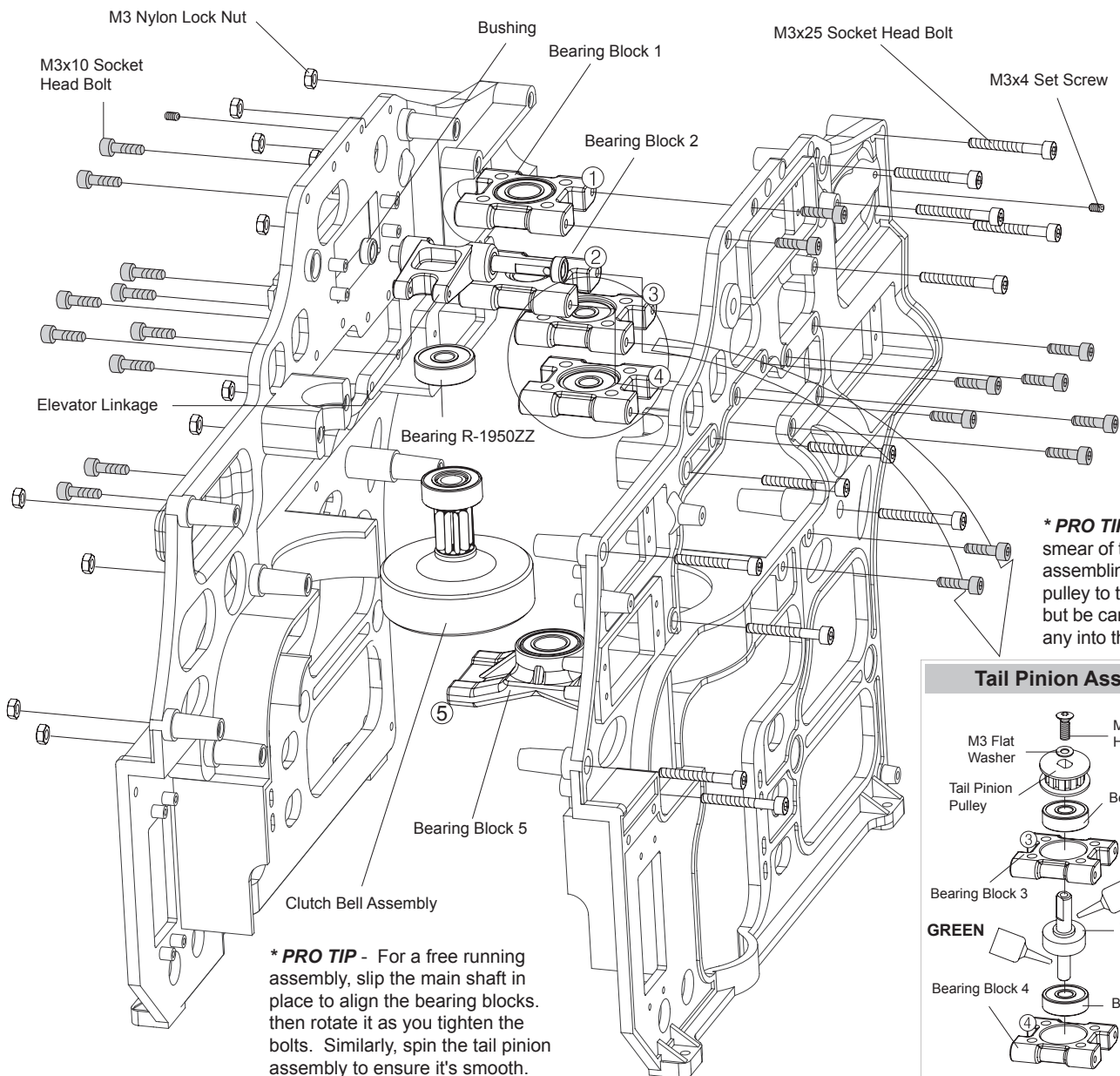
Inspect and replace yearly!



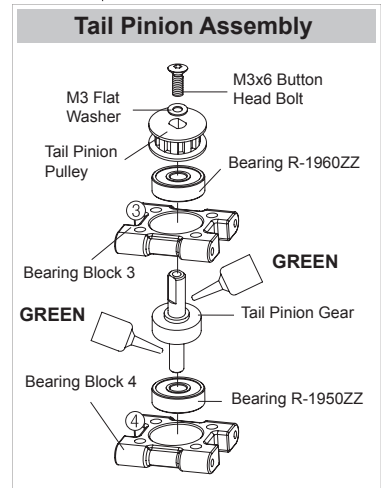
Step 5.1 – Main Frame Assembly

*** NOTE** - The main frame is a complex assembly. Study the two related pages - being careful to install the fuel tank rubber supports and placing the fuel tank into position before completing the joining of the two frame halves.

| | | | |
|--|------------------------------|--|-------------------------|
| | M3x25 Socket Head Bolt (x12) | | Plastic Bushing (x2) |
| | M3x10 Socket Head Bolt (x20) | | M3 Nylon Lock Nut (x12) |
| | M3x6 Button Head Bolt (x1) | | M3 Flat Washer (x1) |
| | M3x4 Set Screw (2) | | |

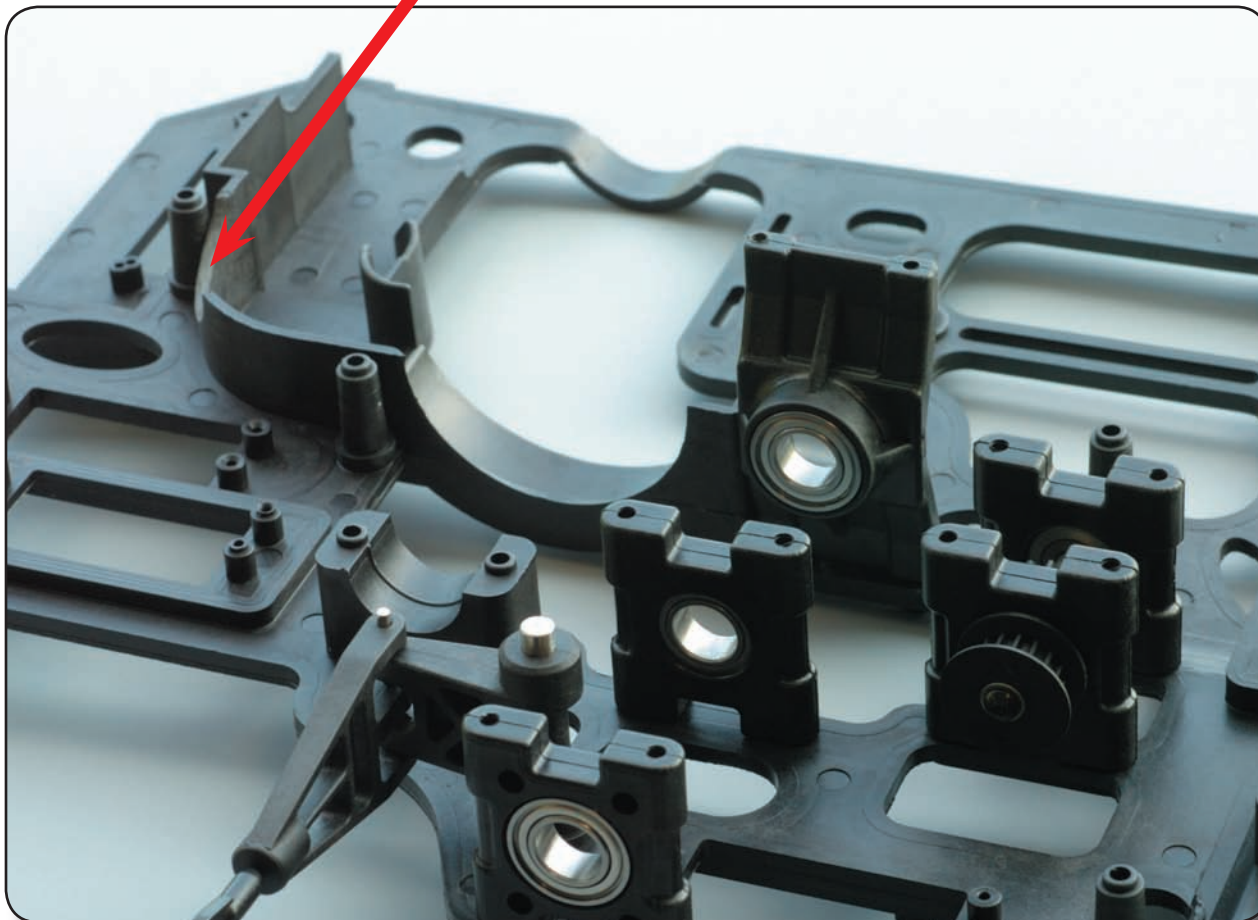


*** PRO TIP** - Use a light smear of thick CA before assembling the tail pinion pulley to the pinion shaft, but be careful not to get any into the bearing!



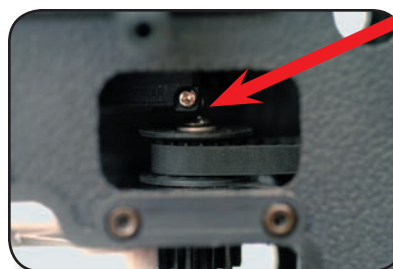
Step 5.1 – Detail Photos

*** PRO TIP -** Be careful to not cut too far when fitting the snorkel. It can be worked into place after assembly; alternatively, you can assemble all the components to the left side frame (complete with the engine in its mount with hub, fan, clutch, and start shaft installed) so you can adjust the vertical spacing. Then, and after you're satisfied with the alignment of all the components, you may complete the assembly. By the way, if you're using a header tank, now's the time to bolt in the right frame half - you've been warned!

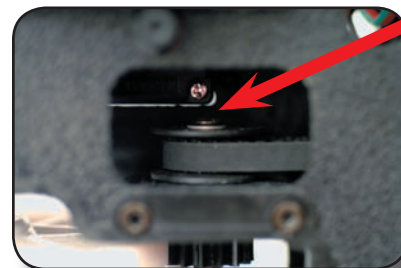


*** NOTE:** It's hard to see the bearing orientation within the blocks in the drawing to the left, but the bearing in block number 2 fits in from the bottom while the rest of the bearings (blocks 1, 3, 4, and 5) fit in from the top. However, there is an alternative method of mounting the upper block of the tail pinion that results in creating about 2mm extra clearance between the servo case and the screw head. It's quite simple in that all you do is reverse the top block so the bearing installs from the underside (instead of from the top). The downside to this is the tail belt will subsequently run ever so slightly lower than dead center within the tail boom, which hasn't caused us any grief but we figured you should know about it. Anyway, eyeball the two pictures to the right to see just how much extra clearance we're talking about.

Finally, pros will do this on the main shaft also, but we only recommend it for the tail pinion shaft. To wit, use acetone to degrease the main shaft and the tail pinion shaft as well as the inner race of the bearings then use threadlocker to secure these shafts to the bearings. The downside is removing the bearings later becomes something of a pain in the rear, but it's nothing a little application of heat won't resolve and the payoff is a much smoother running model helicopter because the shaft won't spin within the inner race! It's a small touch but it's one of the details separating the pros from everyone else.



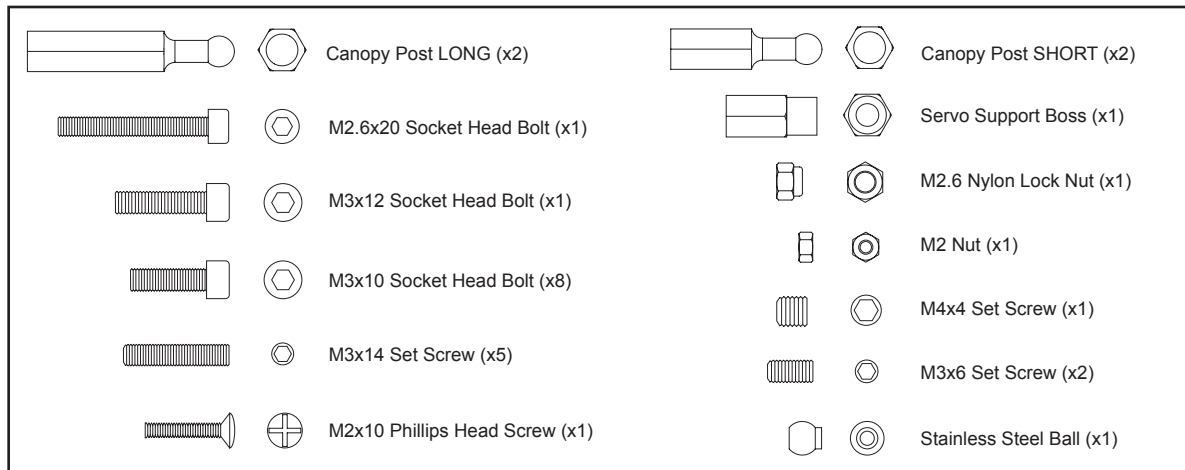
Conventional mounting - both bearings from the top



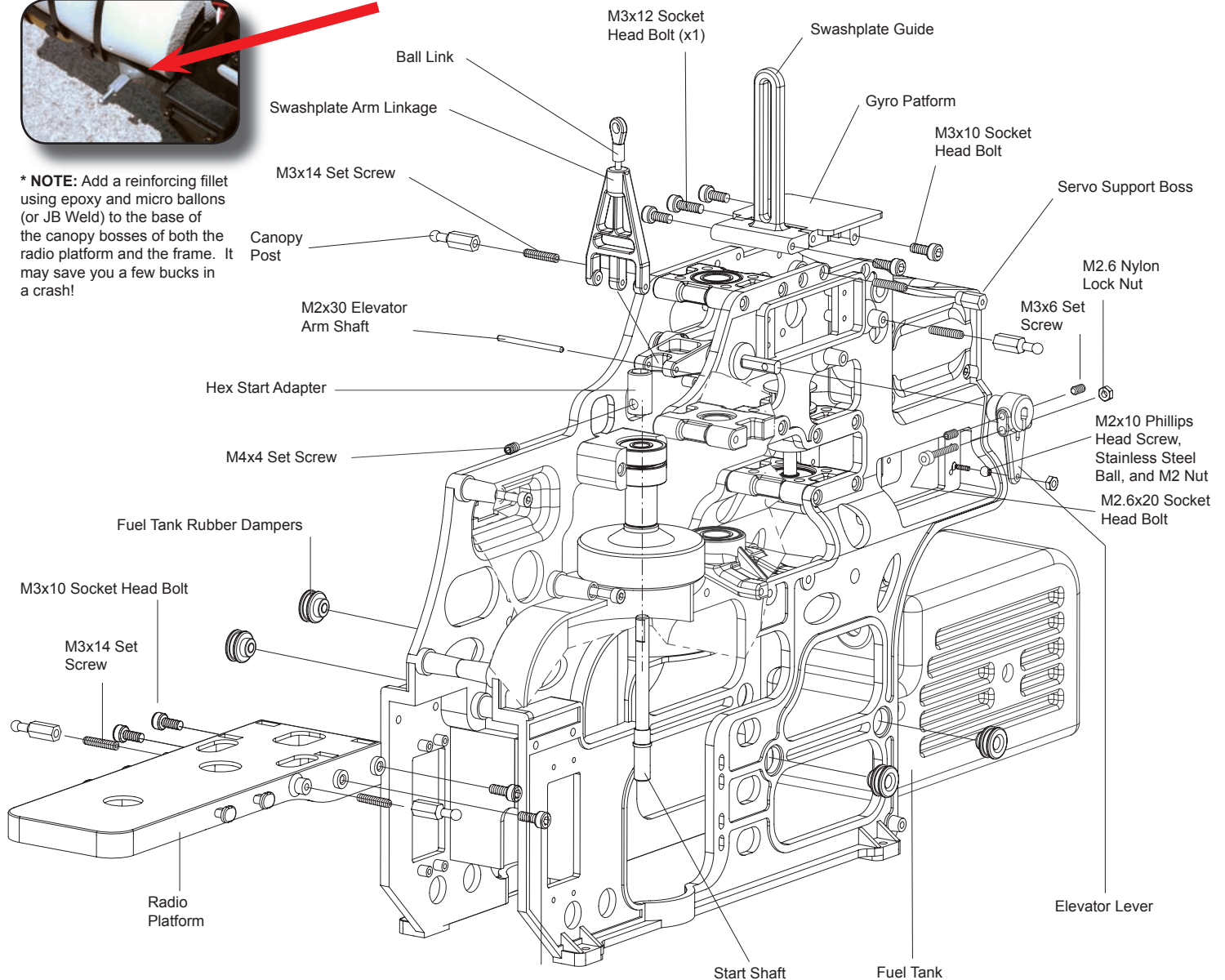
Upper bearing block inverted - bearing from the bottom



Step 5.2 – Main Frame Assembly



*** NOTE:** Add a reinforcing fillet using epoxy and micro ballons (or JB Weld) to the base of the canopy bosses of both the radio platform and the frame. It may save you a few bucks in a crash!

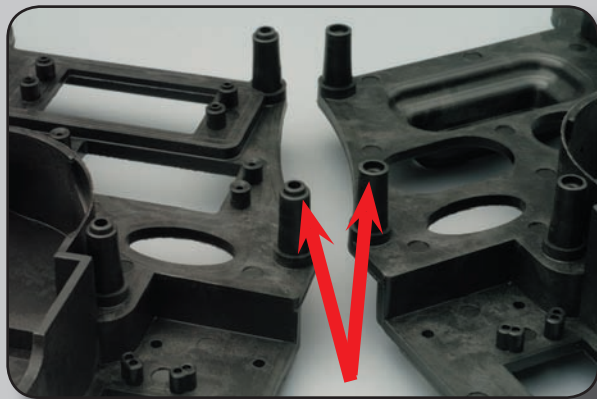


*** PRO TIP:** Mounting the servos now may be easier!

*** Note -** The single M3x12 Socket Head Bolt mounts opposite the aluminum Servo Support Boss

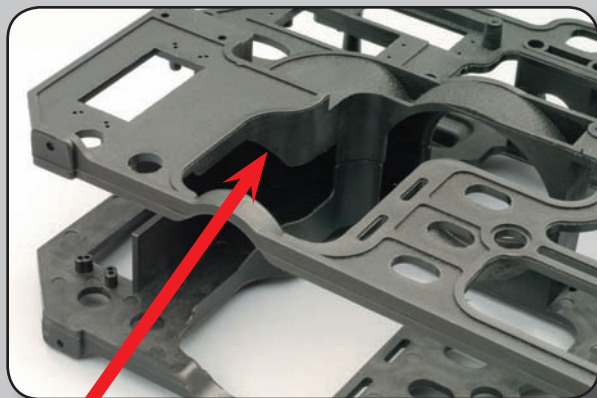
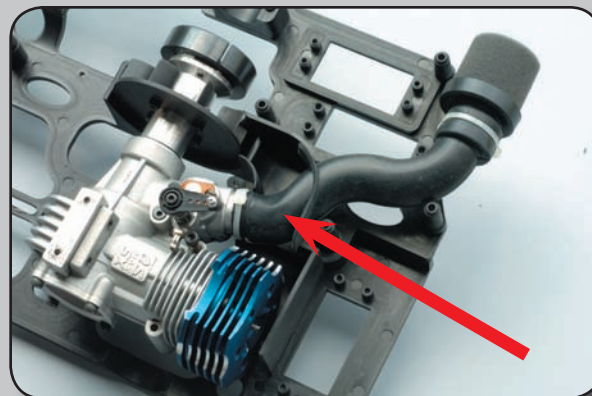


Step 5.2 – Detail Photos



If you look closely at how the two halves of the side frames of the Pantera 50 come together you'll see we've employed a method very similar to that used in fine furniture, which is called tongue and groove. However, the technique has been updated for the injection molded plastic side frames and the resulting male and female guide pins deliver similar results, i.e. tremendous strength in shear. They lock the frame halves together . . . the round peg in the round hole really works! By eliminating relative motion, i.e. side-to-side movement between the halves via design and then using high quality Allen Head bolts to secure them, the Pantera 50 delivers an extremely rigid structure. This is the solid foundation upon which you'll build when performing the most aggressive of the 3D maneuvers like tick-tocks, funnels, and piro-flips!

In this detail photo we've used a black silicone snorkel instead of the translucent snorkel supplied with the Pantera 50 in order to aid in more clearly visualizing how the assembly fits through the outer curve of the cooling shroud. Note; while it's not easily discernable in the photo, the short section of the snorkel that fits within the cooling duct itself (upstream of the cooling fins) is actually airfoil-shaped, which serves to reduce turbulence. As it turns out, the addition of the snorkel raises the cylinder head temperature at the front of the head by about 10°F, but when you consider the head is about 50°F hotter on the aft side, then obviously this is inconsequential in the grand scheme of things. The snorkel/clean air system delivers tremendous benefits by providing cool, laminar (non-turbulent), filtered air to the engine resulting in more power!











Part of how the Pantera design works is via incorporating the engine and mount as a load bearing member within the side frame assembly. This technique was pioneered within the Formula 1 racing community and widely copied by others (including us) because it results in a far stiffer frame resulting in highly predictable maneuvers. After all, what use is a hyper agile helicopter if you can't repeat the maneuver on demand because the frame gives and twists under load? Another innovation of the Pantera 50 design is the boxing in of the fourth side of the cooling shroud as demonstrated by this picture. But we had an ulterior motive in doing this because we wanted to permit the fitting of larger engines than the usual .50-.55-class engine. Boxing in the shroud lets us shoehorn in 61-class blocks, i.e. the .70-.91-class engines!

The problem with isometric drawings is they can be difficult for some folks to understand. While they're great at aiding in a clearer understanding of what goes where, they're also easy to get lost in. The purpose of this detail photo is pretty simple. Basically we want you to clearly see where the lone M3x12 Socket (Allen) Head Bolt fits. There are three bolts on the right side of the frame securing the two-piece gyroscope platform. Assembly is with M3x10 Socket head Bolts except for the middle of the three on this right side - as detailed in this photo. By the way, the left side of the model uses the AUD3014SS (M3x14 Set Screw) in the same location onto which is secured the CNC-machined 6061 aluminum Servo Support Boss.



Step 6 – Landing Gear Assembly

| | | |
|---|---|-----------------------------|
|  |  | M3x25 Socket Head Bolt (x4) |
|  |  | M3x6 Set Screw (x4) |
|  |  | M3 Nylon Lock Nut (x4) |
|  |  | M3 Flat Washer (x8) |

*** PRO TIP** - Replace the Socket Head Bolts with a pair of zip ties in each of the four mounting holes will let the gear break loose in a hard arrival thereby lessing damage. Aggressive 3D pilots may prefer the smaller AUD0033 landing gear struts because they're smaller, lighter, and present less drag.



PDR0009x Skid Guards

These prevent the gear legs from wearing through when you fly off of hard surfaces like concrete and asphalt. They're available in several colors, you just add Y for yellow, P for pink, or B for black to the end of the part number.

M3x25 Socket Head Bolt

M3 Flat Washer

Landing Gear Leg

Rubber Skid Cap

M3x6 Set Screw

Landing Gear Skid

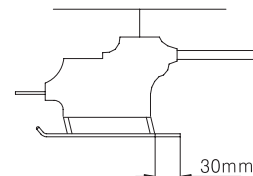
M3 Nylon Lock Nut

30mm







*** PRO TIP** - Glue the rubber skid caps into the landing gear skids with tire glue (flexible CA). If you fly off a hard surface, then adding skid guards make sense because they will protect the skids from wearing through.

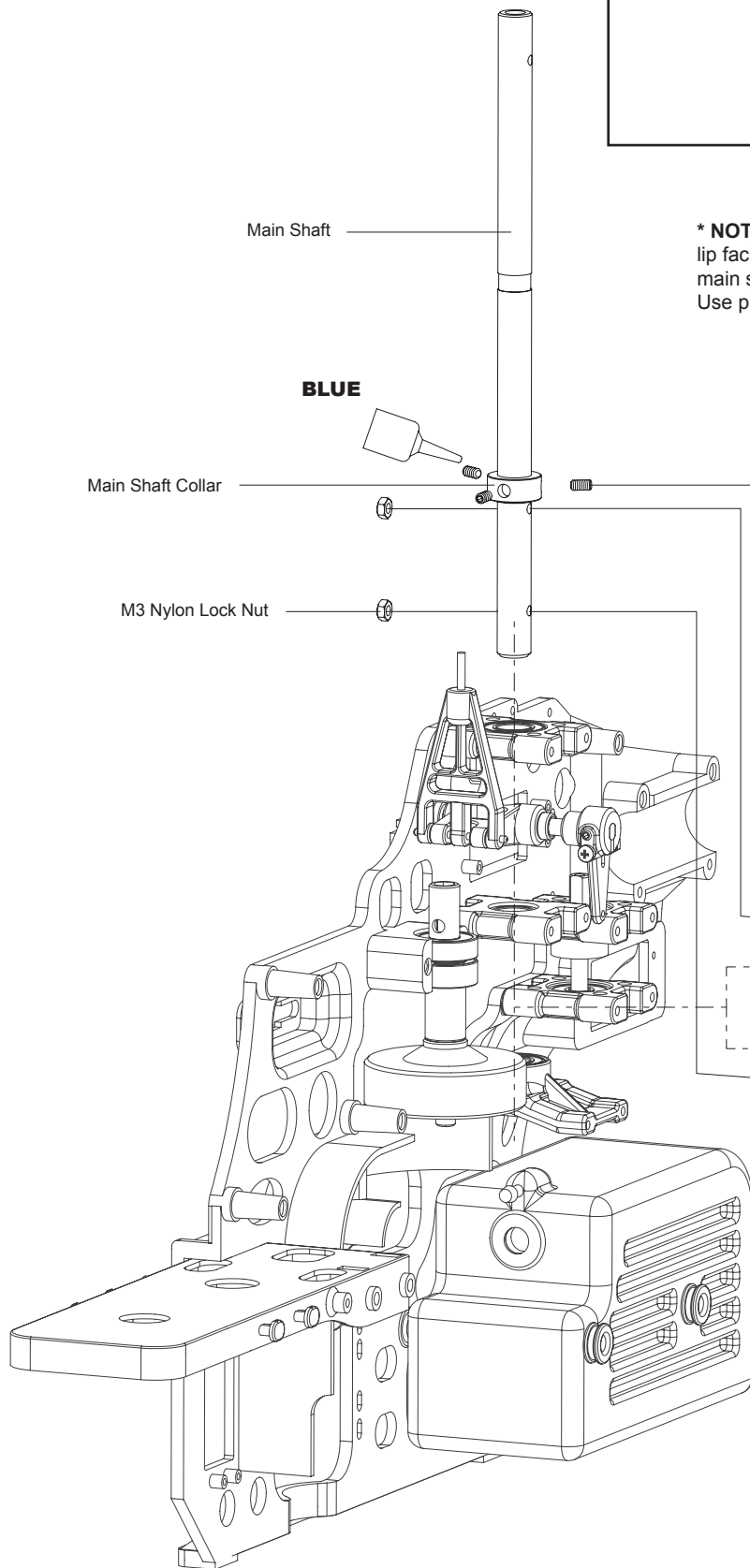
*** PRO TIP** - Fine tune the model's balance with how you mount the gear, i.e. slanted toward the rear or toward the front.

*** PRO TIP** - To better support the helicopter when the blades are stowed over the boom, angle the landing gear legs aft and set to 30mm.



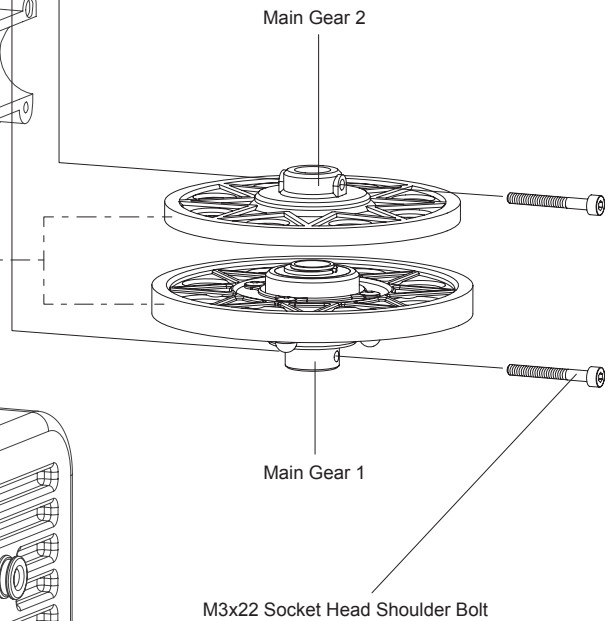
Step 7 – Main Shaft Assembly

| | | |
|--|---|--------------------------------------|
|  |  | M3x22 Socket Head Shoulder Bolt (x2) |
|  |  | M3 Nylon Lock Nut (x2) |
|  |  | M4x4 Set Screw (x3) |



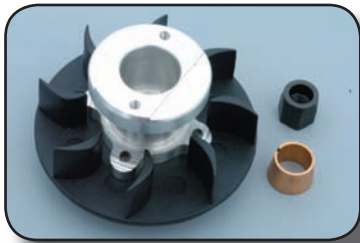
*** NOTE:** Install the main shaft collar with the lip facing down toward the bearing. Draw the main shaft up tightly and snug the set screws. Use plenty of blue thread locker!

*** NOTE:** Don't be a gorilla when you install the bolt securing the gear to the main shaft because you can easily distort the gear.

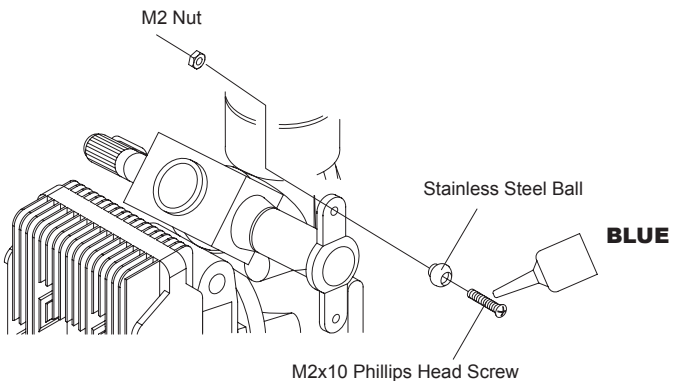
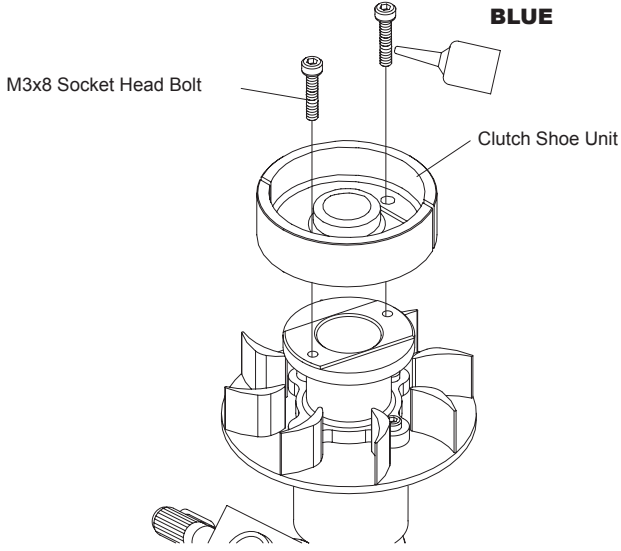
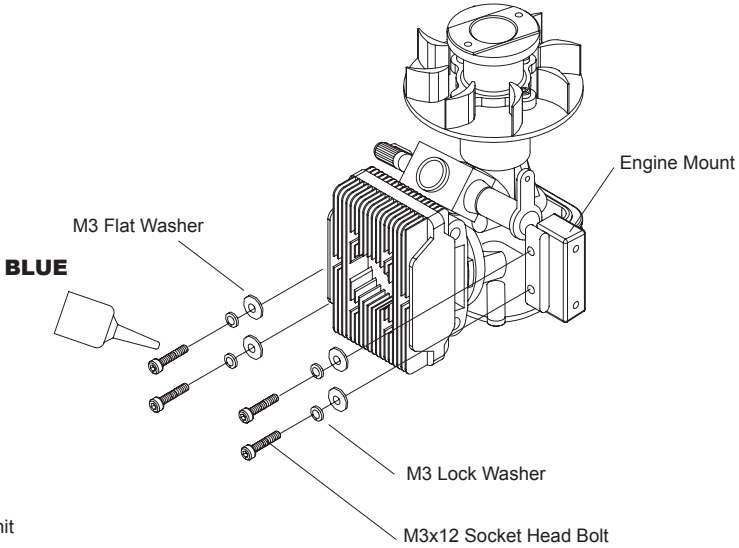
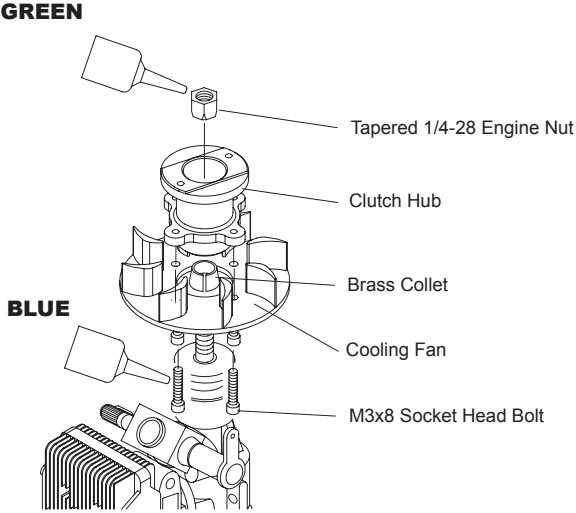


Step 8.1 – Fan and Clutch Assembly

| | | | |
|--|-----------------------------|--|--------------------------------|
| | M3x12 Socket Head Bolt (x4) | | M2x10 Phillips Head Screw (x1) |
| | M3x8 Socket Head Bolt (x4) | | M2 Nut (x1) |
| | M3 Flat Washer (x4) | | Stainless Steel Ball (x1) |
| | M3 Lock Washer (x4) | | |



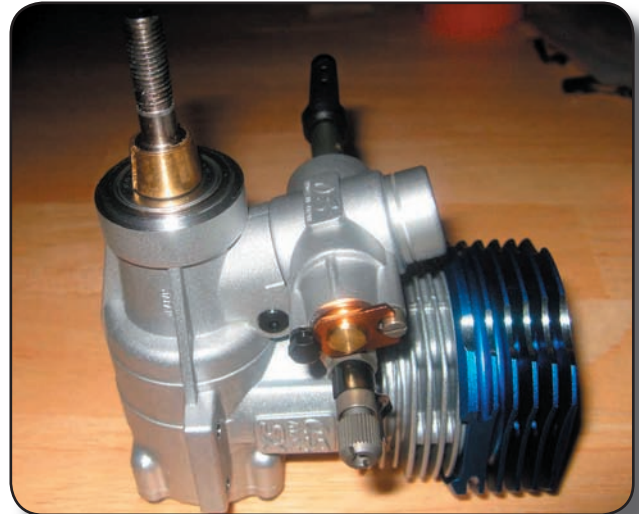
The fan hub sit between a tapered brass collet and a special tapered steel engine nut so you can adjust for minimum runout. Competing designs use a screw-on fan hub thereby forcing you to live with the resulting runout.



Step 8.2 – Fan and Clutch Assembly

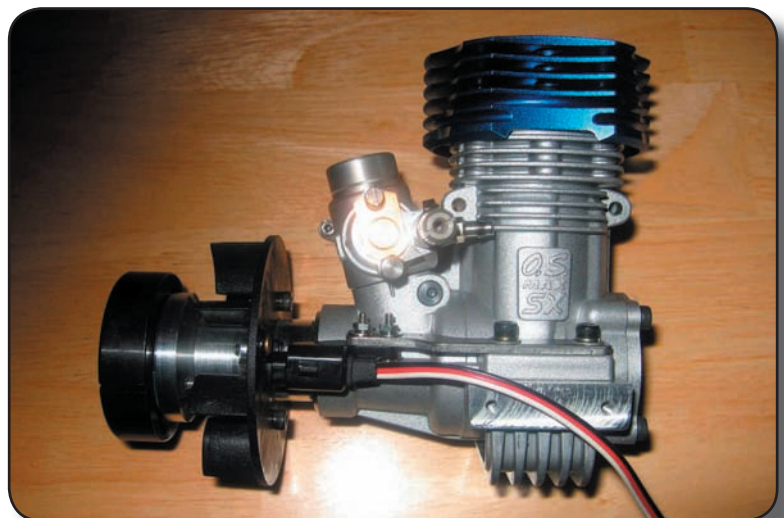
Clutch Hub Installation

Slide the brass collet down onto the crankshaft. Next, slip the clutch hub (with fan installed) into place and finger tighten the special tapered engine nut. Here is a critical step; with the crankshaft locked to prevent rotation, begin to tighten the nut with the socket - but as you do so, rotate the clutch hub assembly so that it centers. Then, taking care that the hub isn't too tight to rotate, it's smart to use a dial indicator such as the **ProModeler® PDR0091** to adjust the runout to below 0.003". While this can be a tedious process - often taking an hour or more, diligence will be rewarded with an extremely smooth running helicopter because the engine is the primary source of high frequency vibration. Once you fully tighten the tapered engine nut, check the runout one more time and apply green (wicking) thread locker such as **Loctite® 290** because if you apply blue thread locker first it may begin to set up before you finish dial indicating the clutch hub.



* **NOTE:** You can't see it in this photo, but the engine's backplate has been removed. This is so that a tool for locking the engine's crankshaft can be inserted to prevent the engine's crankshaft from rotating. The idea is that when the crankshaft is fixed in place you can adjust where the assembly fits to it by twisting slightly as you seek the least amount of runout. You remove the locking tool each time you make an adjustment and rotate the engine as you read off the runout on the face of the dial indicator. The tedious part comes in when you repeat this over and over until you find the least amount of runout.

* **PRO TIP** - If you're using a governor with a magnetic pickup, now's the time to use either thick CA or epoxy to secure the magnets into place on the underside of the cooling fan! Next, bolt the pickup to the engine mount because it's easier to do now, whilst you have the engine assembly in your hand, versus later when the engine has been installed into the helicopter's main frame assembly. Many governor pickups are supplied with two brackets, one for .50-.55-class engines and one for .61-91-class engines. If you're using the popular Futaba GV-1 Governor, the small bracket is too short and the big bracket doesn't fit. On the next page we show you what to do in order to use the large bracket with the .50-.55-class engines - it's simple!



Step 8.3 – Governor Sensor Installation



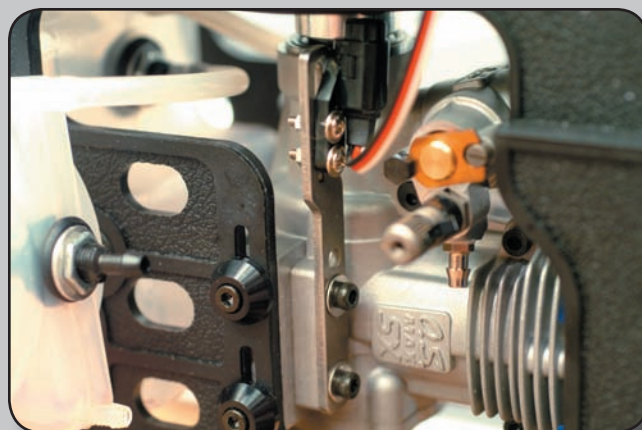
You'll need a punch to dimple the surface of the bracket to prevent the drill bit from walking on you.



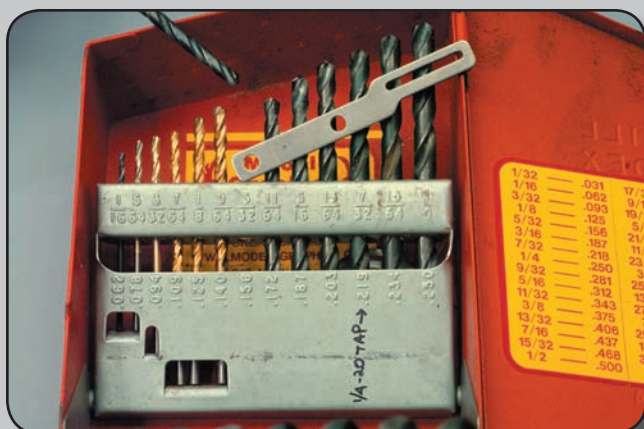
If you want your drill bits to last, the smart thing to do is use oil to lubricate the bit as it cuts. We're using 3-in-one oil, but any oil, even motor oil will do the trick just as well.



This is the sensor, the magnets, and the mounting hardware. Note how I've dimpled the surface.



There you go, the finished job with the sensor installed on a large mounting bracket. The advantage of this bracket is it's bigger and resists engine vibrations - protecting the sensor.

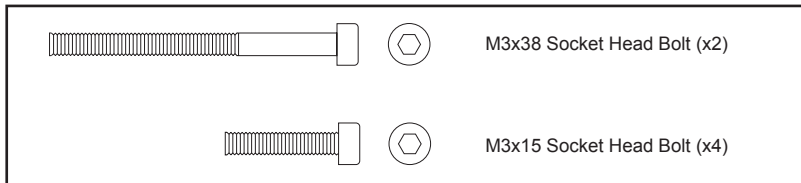


The correct size to drill the hole is with the 5/32" drill bit. However, the bracket is made of hardened steel so first make a 1/16" hole, then step through the drill series until you drill the last diameter with the 5/32" bit.

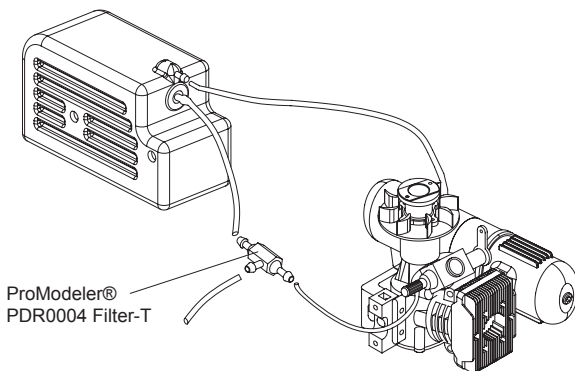
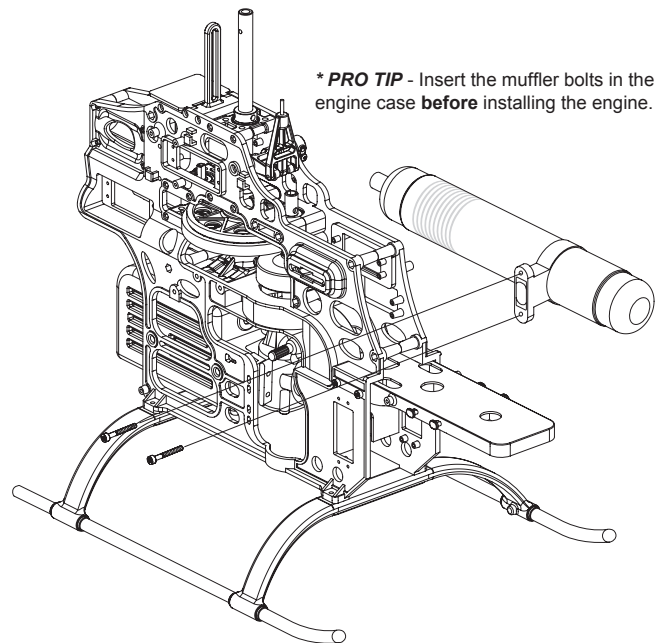
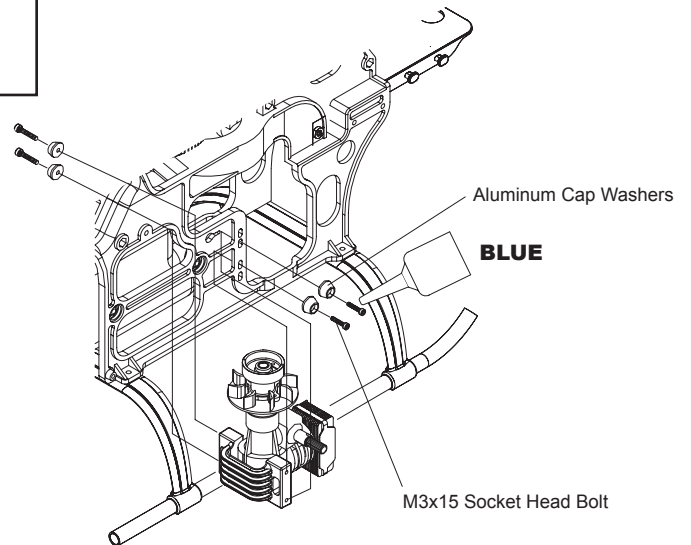
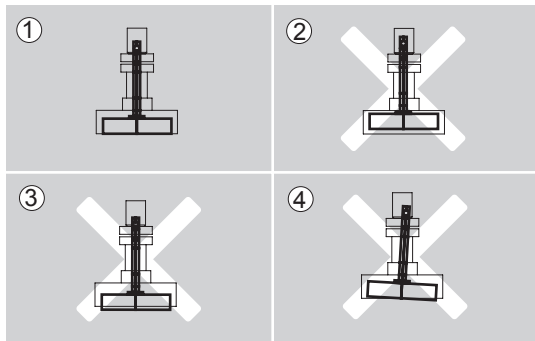
By the way, we prefer to use a Hotwings optical sensor since slinging a magnet is never a factor because it uses a piece of reflective foil instead. These are AUD



Step 9 – Engine And Fuel System



Properly aligning the clutch shoe unit with the clutch bell assembly is crucial to longevity. The goal is for the clutch shoe unit to be evenly presented within the clutch bell assembly and for the lower edge of the clutch shoe unit to align evenly with the lower edge of the clutch liner within the clutch bell. In illustration 2, the clutch shoe unit has been presented too high and the clutch shoes may be rubbing the inside of the clutch bell. In number 3, the clutch shoe unit is too low and doesn't fully contact the clutch liner. In number 4 the clutch shoe unit is presented at an angle and thus, won't contact the clutch liner evenly.



Plumb the fuel tank to the engine as shown. Use a high quality 3/32" silicone fuel tubing like blue Du-Bro® #197. The vent line of the tank goes to the muffler's pressure nipple and the tank's feed line goes to the engine. However, if you're using a 2-ounce header tank like a ProModeler® PDR0016, then the fuel tank's feed line goes to the header tank's vent line and the header tank's feed line goes to the engine (they're connected in series). Finally, it's smart to use a fuel filter. A 3-way fuel filter like a ProModeler® PDR0004 Filter-T as shown is handy because you're not removing the engine's fuel line each time you fuel up thus reducing the possibility of inflight failure. For convenience, other accessories like ProModeler® PDR0003 Shut Off & Plug make access to the fuel line easier, but if you use one, make sure to install the shut off on the engine side of the filter. Finally, the PDR0011 Fuel Filter Support makes for a handy way to mount the T-filter as an assembly to the model.



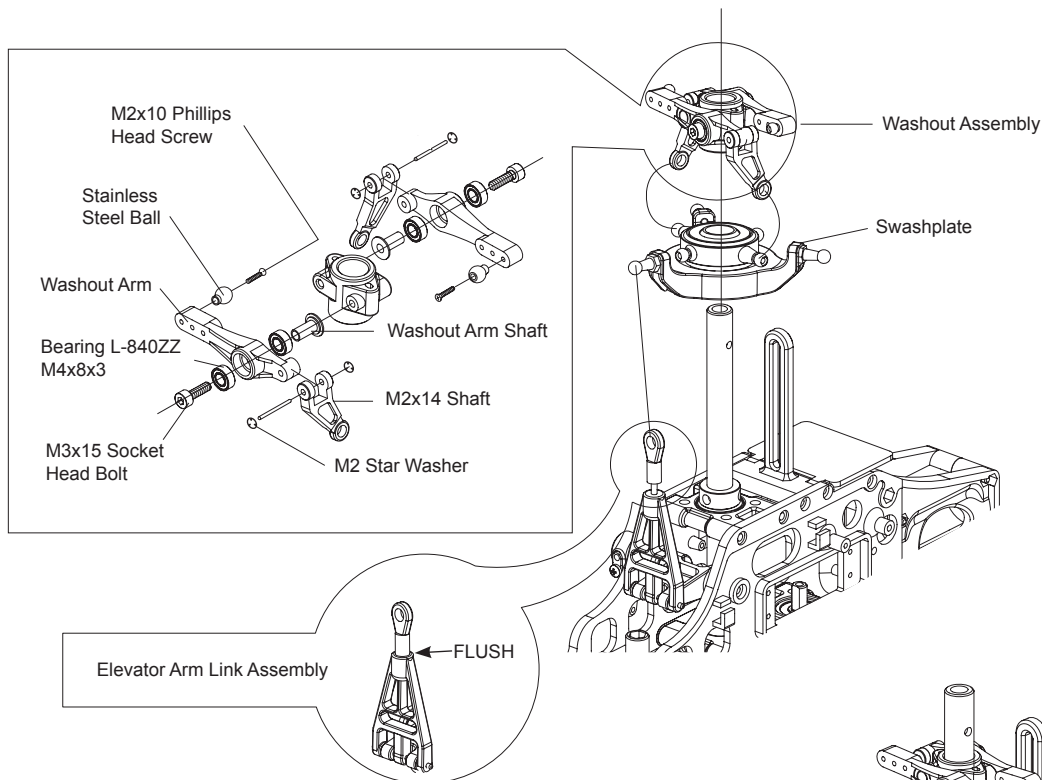
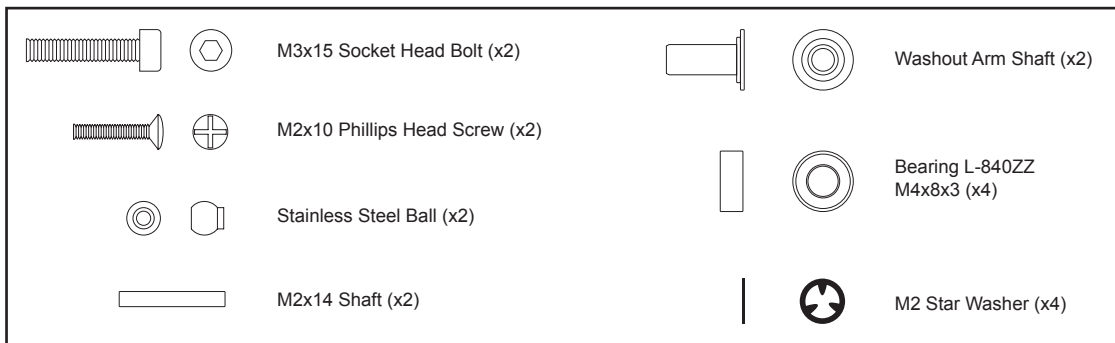
PDR0016 2 OZ. HEADER TANK



PDR0003, PDR0004, and PDR0011

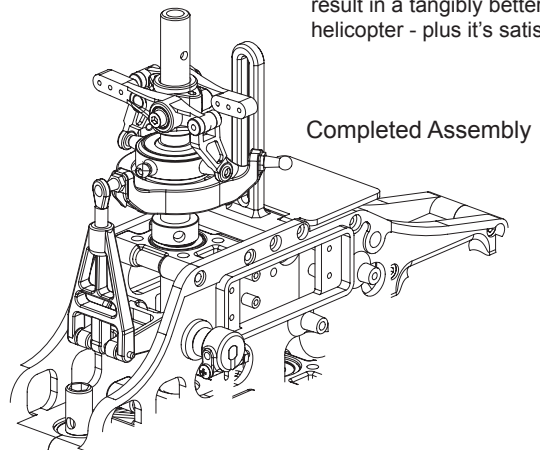


Step 10 – Swashplate and Washout



*** PRO TIP** - Eyeball the washout assembly diagram closely, then once you've slipped the washout arm with bearings onto the washout arm shaft and bolted it to the washout base, check each arm for excess play. If it's too loose, first make sure it's not the bolt which is loose. But be careful since it just threads into plastic. If that's not it, back the bolt out and remove the assembly and look to see if the washout arm shaft isn't just a hair too long. If it is you'll see it sticking past the inner race of the bearing in the washout arm - it's pretty easy to discern. If this is the case, then file off a few thousandths (or however much is needed) to make it flush, or slightly proud of the inner race. This is called "blueprinting" and top pilots blueprint every assembly of their helicopter. Most of us aren't top pilots, but blueprinting an assembly like this is a simple, easy, and free modification. And it may result in a tangibly better handling helicopter - plus it's satisfying!

*** PRO TIP** - As supplied, the Pantera may be tuned mild for novices or wild for aggressive 3D flight. Tuning it to better suit your style of flight is easy. For example, the washout arms have three holes for mounting the ball. The innermost is for novices, the outermost is for experts. Also, amongst the small bits included are four black spacers (4mm dia x 2.8mm). You may use two of them to extend the two short balls on the upper ring of the swashplate to increase agility and fly sport aerobatics, i.e. loops, rolls, stall-turns. For aggressive 3D, a ProModeler® PDR0069 3D Swashball Kit may suit you better because at 4.25mm long (instead of 2.8mm) they provide more throw and thus, are a great tool in the arsenal of the pilot seeking to extend the performance envelope via tuning.



Completed Assembly



Swashball extension

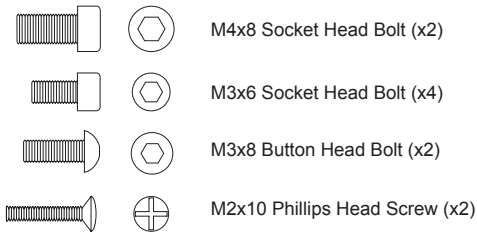


PDR0069 3D Swashball Kit

*** PRO TIP** - To make installation of the M2x10 Phillips Head screws into the plastic washout arms easier, first use an M2 Socket Head screw (without the ball) because the Allen wrench has less chance of slipping and stabbing your finger than the #0 Phillips Screwdriver. This will create threads in the plastic with less fumbling. Alternatively, use a 2mm tap to create the threads. Also, it only 2 or 3 turns of the screw to create these 'starter' threads. Finally, remove the socket head, or cap, screw and install the Phillips head screw and ball as shown.

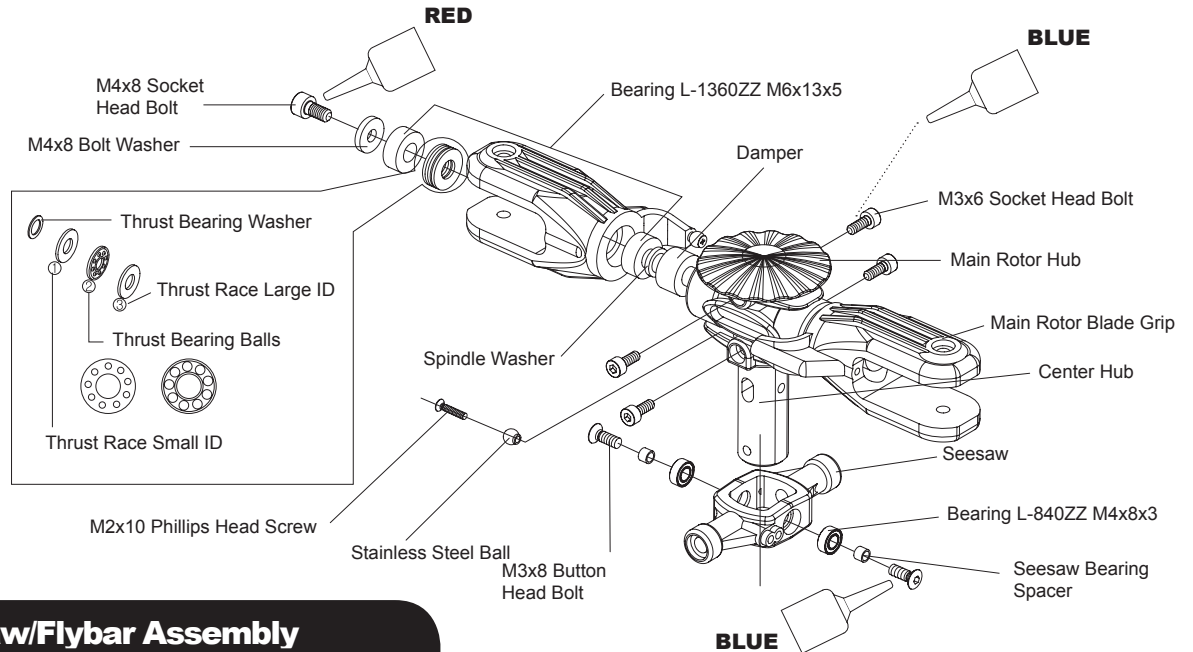


Step 11 – Rotor Head Assembly

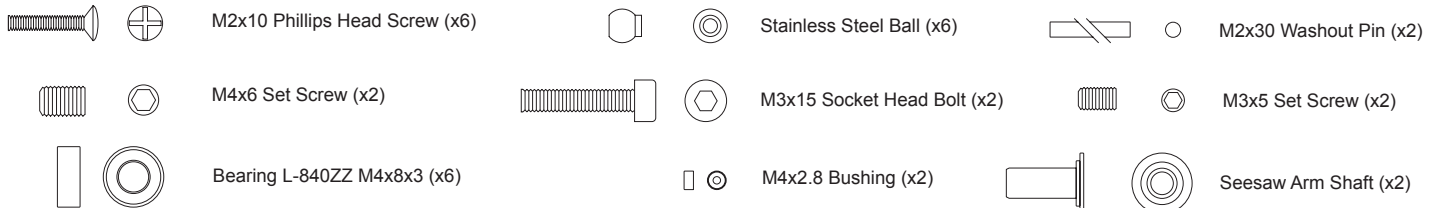


The main rotor head assembly is the heart of the Pantera 50. We've flight tested the head to 2250 RPM (140 gm. carbon blades and everything balanced to a fare-thee-well, of course) with no ill effects, but we recommend 1850 RPM as the practical RPM limit. Operate beyond this and you're on your own. That said, it's not unusual for aggressive 3D pilots to run it at 2000 RPM because the high headspeed is the key to getting the rapid response desired for quick flips and tumbles. While the head is preassembled for you, you **must** disassemble it and grease the thrust bearings because they only have a light machine oil in them. Also, ensure the small ID race is on the blade side, and cup the ball holder so that they retains grease. While you're at it, lightly smear the dampers with grease where the spindle shaft passes through them. *Re-lubricate once every 4-gallons.*

*** NOTE:** When disassembling the main blade grips (to grease the thrust bearings), only one of the two bolts will release. Thoroughly clean and reinstall that bolt using red (permanent) threadlocker. After a few hours pass, repeat the process but this time the "other" bolt should let go, clean and reinstall this one using red threadlocker as well. Also, remember, the red threadlocker is strong enough so the bolts do NOT have to be "gorilla-gripped" tight to do their job. In fact, over tightening just loads the bolts under tension prematurely and lessens their ability to withstand blade pull.

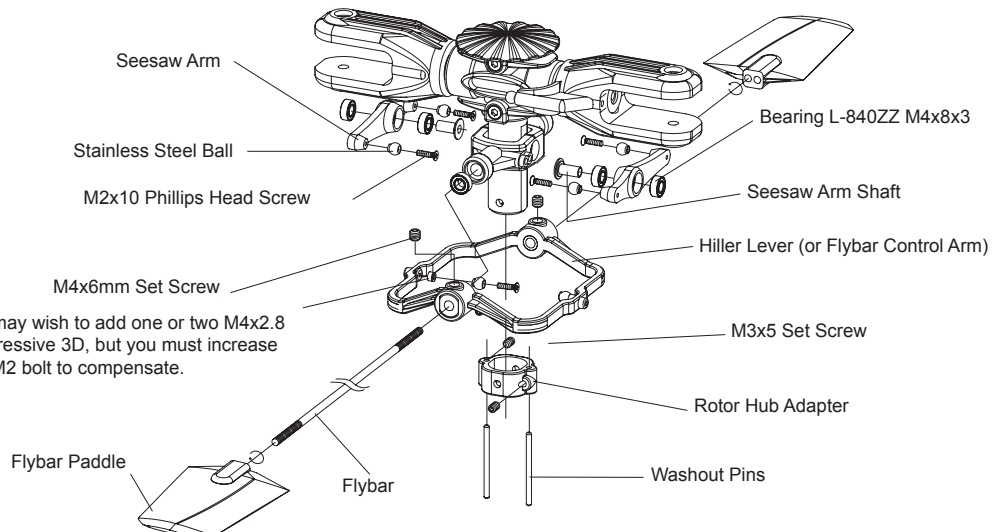


Step 12.1 – Seesaw/Flybar Assembly



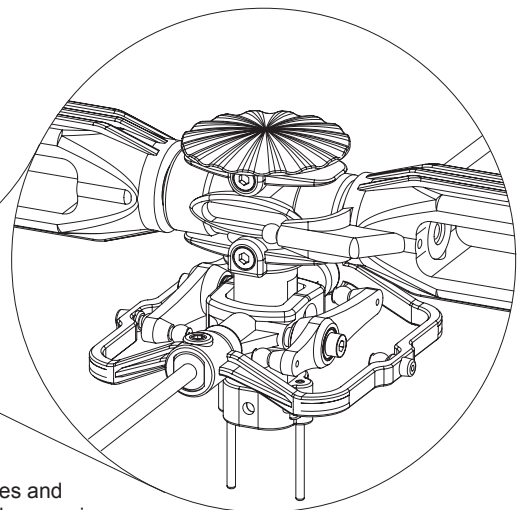
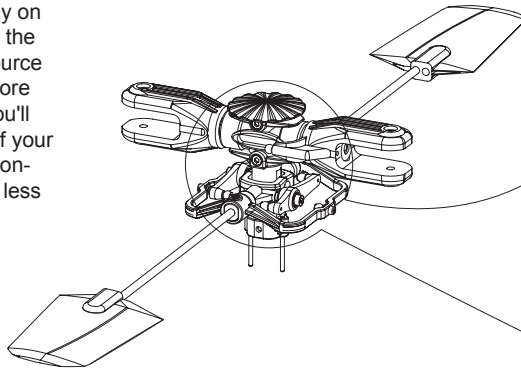
*** PRO TIP** - As with the washout arm assembly in Step 9, blueprinting the seesaw arm assembly is a prudent use of your time and efforts.

*** PRO TIP** - You may wish to add one or two M4x2.8 Bushings for aggressive 3D, but you must increase the length of the M2 bolt to compensate.

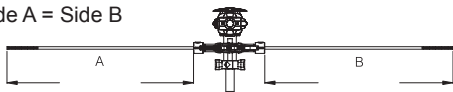


Step 12.2 – Seesaw/Flybar Assembly

*** PRO TIP** - For a silky smooth helicopter balance the entire rotating assembly on a high point type balancer because the main rotor system is the primary source of low frequency vibrations. The more time spent, the more satisfaction you'll have with the overall performance of your model and the greater component longevity you will experience because less stresses are induced.

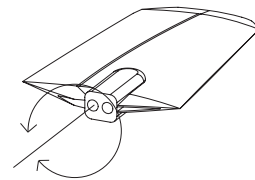


*** NOTE:** Side A = Side B



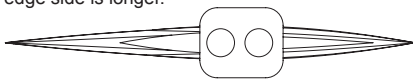
*** PRO TIP** - Weight the paddles and lighten the heavier of the two by scraping lightly with a sharp X-Acto® blade until they weigh exactly the same.

Make certain the flybar is perfectly centered within the assembly. Next, give the Hiller lever assembly (or flybar control arm) a squeeze to take up the slight play present in the system. Alternatively, while you may choose to fit washers between the aluminum insert in the Hiller lever assembly and the bearing in the end of the seesaw, we've found a squeeze works better. However, before snugging the set screws, verify the flybar is indeed centered as usually it's off a few thousandths. Measure the length accurately using a tool like a **Pro-Modeler® PDR0093 6" Digital Caliper**. Next, scribe a line on the flybar and use a Dremel® tool with a cutoff disk simply cut to the line thereby adjusting the length to be perfectly equal on both sides - but debur the end before assembly! Alternatively, screw the paddles onto the unsecured flybar (without tightening the set screws yet), align the paddles to each other, and then slide the entire assembly around until you achieve perfect balance. As it turns out, as long as it balances it doesn't really matter if one paddle is 1mm farther out than the other because it doesn't make any difference to flight quality, or vibration. The seesaw, however, must not exert any drag when you do this and the links must be left off. When it balances, carefully align the paddles to the Hiller lever assembly and gently snug the set screws. Finally, remove one set screw at a time, thread-lock, squeeze the assembly as noted above, reinsert and tighten. Repeat with the other set screw.



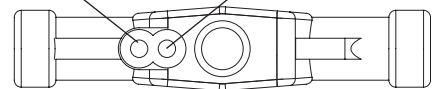
Slide a short section of fuel tubing over the end of flybar until 1" sticks past the edge. Next, add a drop of thick CA in the plastic paddle hole and screw the paddle onto the flybar until the paddle just contacts the end of the tubing. Remove the fuel tubing by splitting it with a sharp X-Acto® blade. Finally, repeat the process for the other side.

*** NOTE:** Trailing edge side is longer.



There are two sets of holes in each flybar paddle. The trailing edge hole is designed for stationary flips and tumbles as evident by prowess during stationary maneuvers and decreased stability in forward flight. Conversely, the leading edge hole is more stable in forward flight while still maintaining agility and good 3D performance.

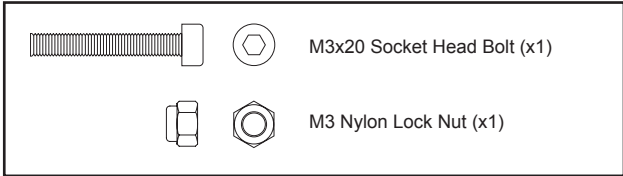
1:1 ratio **0.7:1 ratio**



Tuning Tip: The seesaw arms may be mounted in one of two holes, inboard, or closer to the center of the main shaft's rotation, or outboard, closer to the flybar paddles. The outer mounting hole result in a 1:1 Bell Hiller mixing ratio. Use these for smoother flight. The inner holes result in a 0.7:1 Bell-Hiller mixing ratio and are where you mount the arms for aggressive 3D flight.

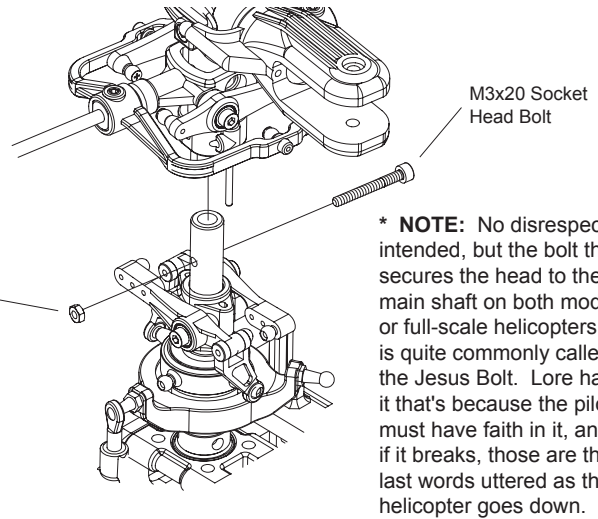
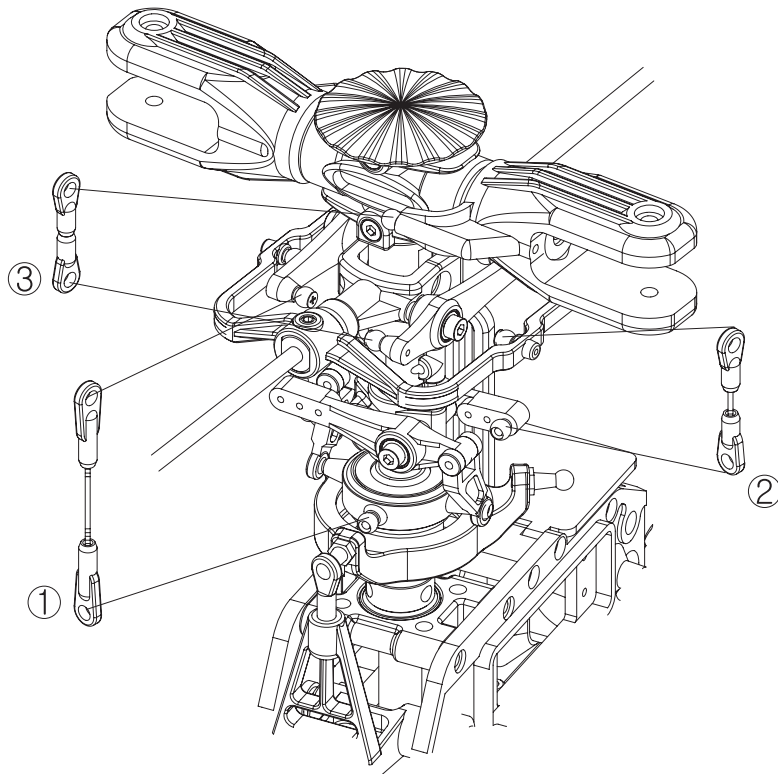


Step 13 – Upper Control Linkages



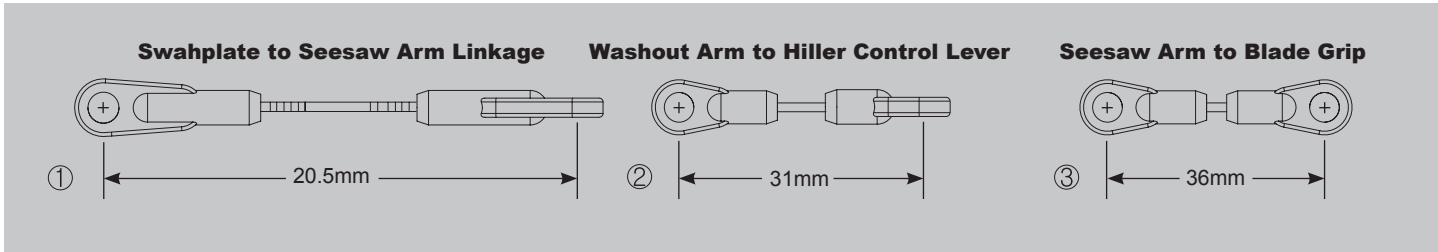
Insert the main rotor head assembly onto the main shaft. Align the opening in the aluminum center hub with that of the main shaft. Insert the Jesus bolt and tighten securely.

*** PRO TIP** - If a universal link is tight on a ball, adjust the fit by using a small pair of pliers to gently squeeze the sides of the universal link together against the ball. The proper fit is when the linkage rod swivels freely under its own weight.

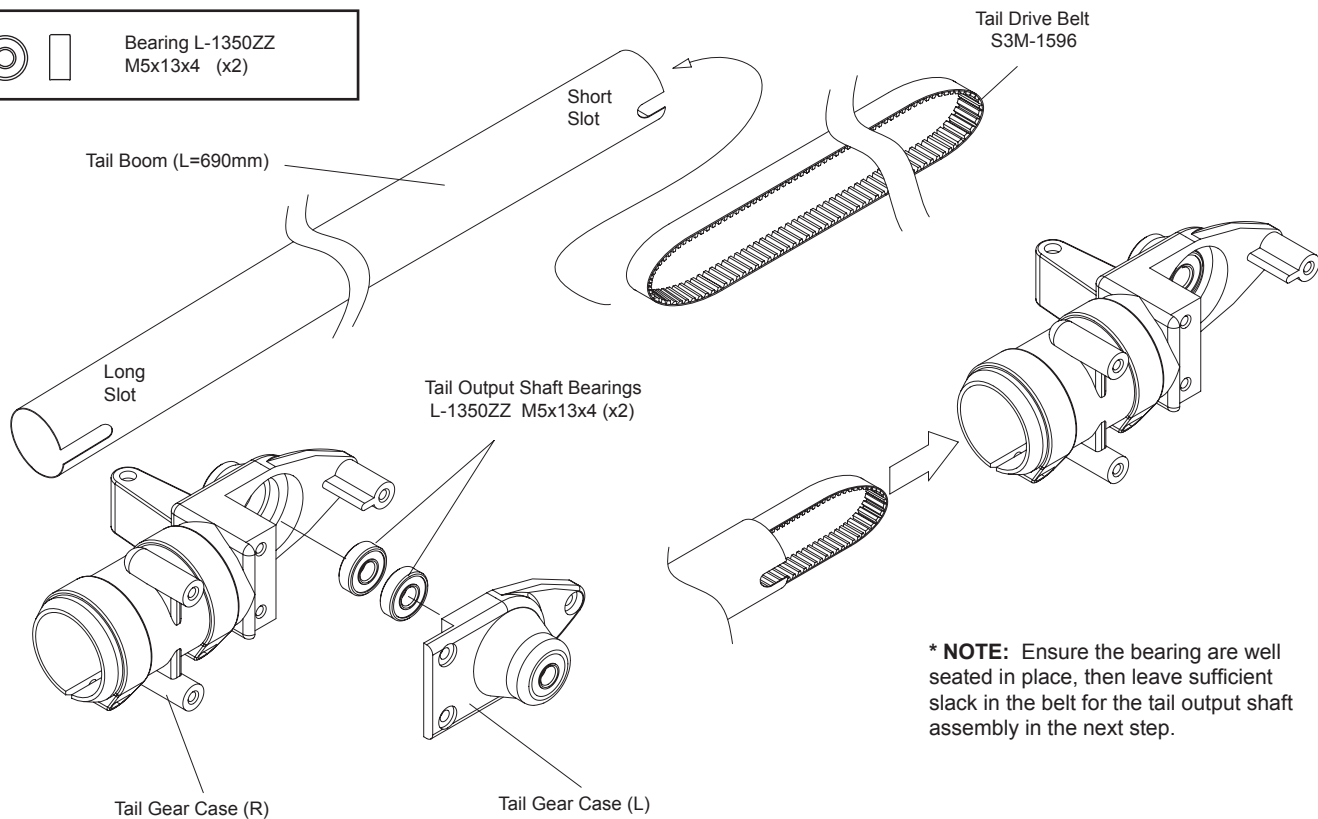
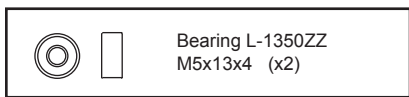


*** NOTE:** No disrespect intended, but the bolt that secures the head to the main shaft on both model or full-scale helicopters is quite commonly called, the Jesus Bolt. Lore has it that's because the pilot must have faith in it, and if it breaks, those are the last words uttered as the helicopter goes down.

The upper control linkages have been assembled for you. However, it's incumbent upon you to verify that each linkage pair is the correct length and exactly the same as the opposite linkage . . . it's critical. This is best done accurately with a tool such as the **ProModeler® PDR0093 6" Digital Caliper** because you can make fine adjustments and thus, ensure each upper control linkage is the exact same as its complementary pair.

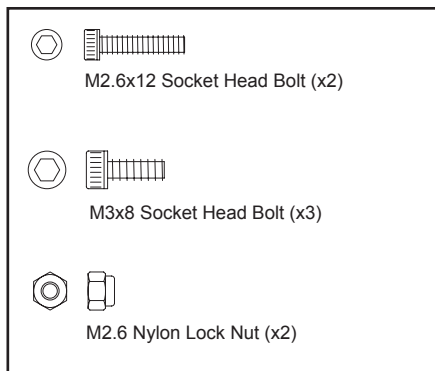


Step 14 – Tail Gear Box And Belt



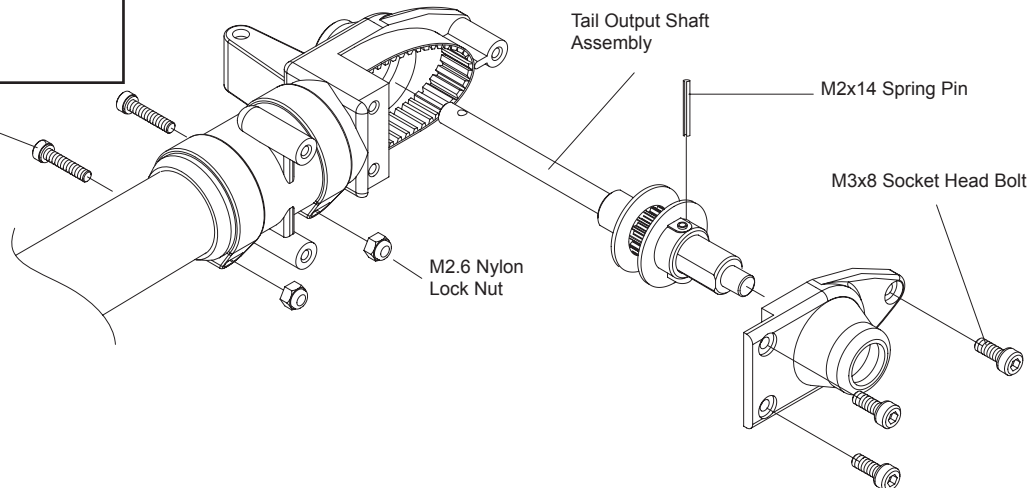
*** NOTE:** Ensure the bearing are well seated in place, then leave sufficient slack in the belt for the tail output shaft assembly in the next step.

Step 15 – Tail Output Shaft Assembly








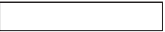


*** PRO TIP** - Use care when tightening the bolts into the tail gear case - as soon as the head contacts the case half, that's it. It's easy to overtighten and strip the threads. A temporary repair is to use a drop of medium CA in the hole then re-install the screw.

*** NOTE:** Seat the tail gear case fully onto the tail boom before snugging the bolts.



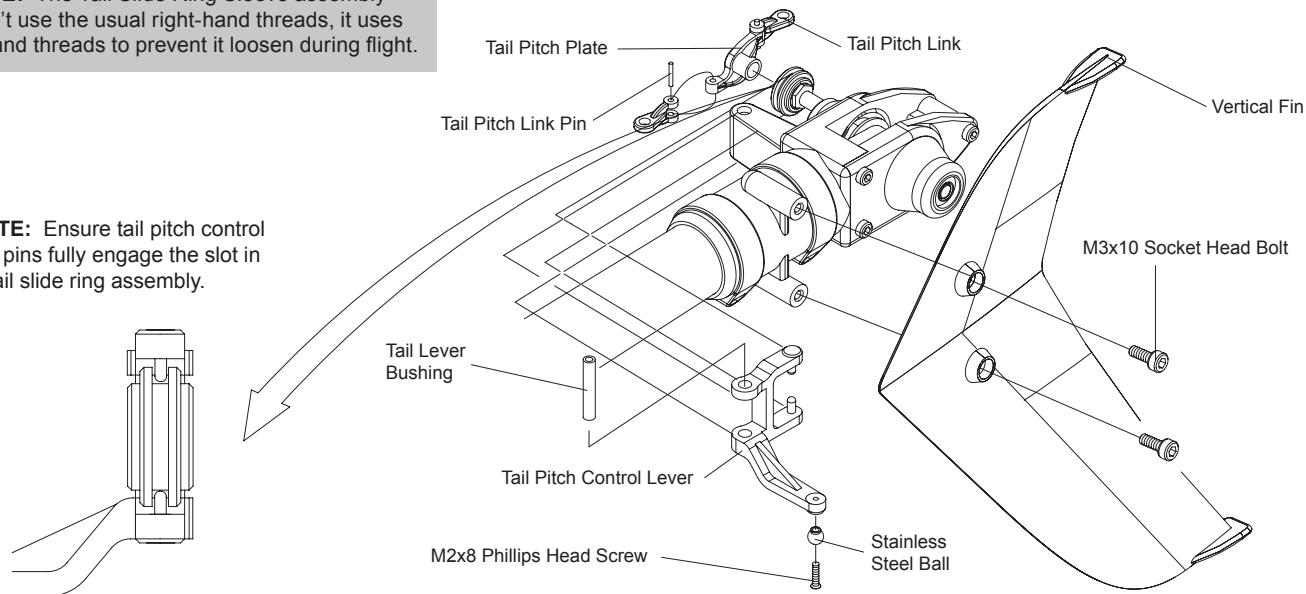
Step 16 – Tail Pitch Lever & Vertical Fin

| | | | | | |
|---|---|-------------------------------|---|---|---------------------------|
|  |  | M3x10 Socket Head Bolt (x2) |  |  | Stainless Steel Ball (x1) |
|  |  | M2x8 Phillips Head Screw (x2) |  |  | Tail Lever Bushing (x1) |

*** NOTE:** The Tail Slide Ring Sleeve assembly doesn't use the usual right-hand threads, it uses left-hand threads to prevent it loosen during flight.



*** NOTE:** Ensure tail pitch control lever pins fully engage the slot in the tail slide ring assembly.



We've been honored that some of the best 3D pilots in the world have chosen to use our models as a "beater" for practicing the presentation of their 3D routines. Thus, as a direct consequence (because they fly their model harder than mere mortals) their ideas occasionally lead to improvements or new products - like these ProModeler© PDR0079 3D Guide Pins.



This mod involves AUD0010 Tail Pitch Control Lever, and requires an X-Acto® with a #11 blade, a drill, the appropriate drill bit and 3mm tap, as well as PDR-0079 3D Guide Pins. These may increase the service life of the tail pitch control lever under the grueling abuse imposed by aggressive 3D pilots.



PDR0079 3D Guide Pins

Step 1 - Remove AUD0010 Tail Pitch Control Lever from the Tail Gear Case Assembly by using a drift to drive out the tail lever bushing - a makeshift drift can be an Allen driver.

Step 2 - Use the X-Acto® blade to slice off the two plastic nubs which fit the grooves to drive AUD0014 Tail Slide Ring.













Step 3 - Drill and tap for 3 mm. This is easy because there is a round molded recess directly opposite (on each side) from where the pins were. Just be careful to center the drill bit beforehand and go for it. If you screw up, it's not the end of the World, another AUD0010 Tail Pitch Control Lever is inexpensive.

Step 4 - Using a drop of plastic CA glue as a thread locker and an Allen driver, screw in the PDR0079 3D Guide Pins.

Step 5 - That's it! Reinstall the modified Tail Pitch Control Lever.

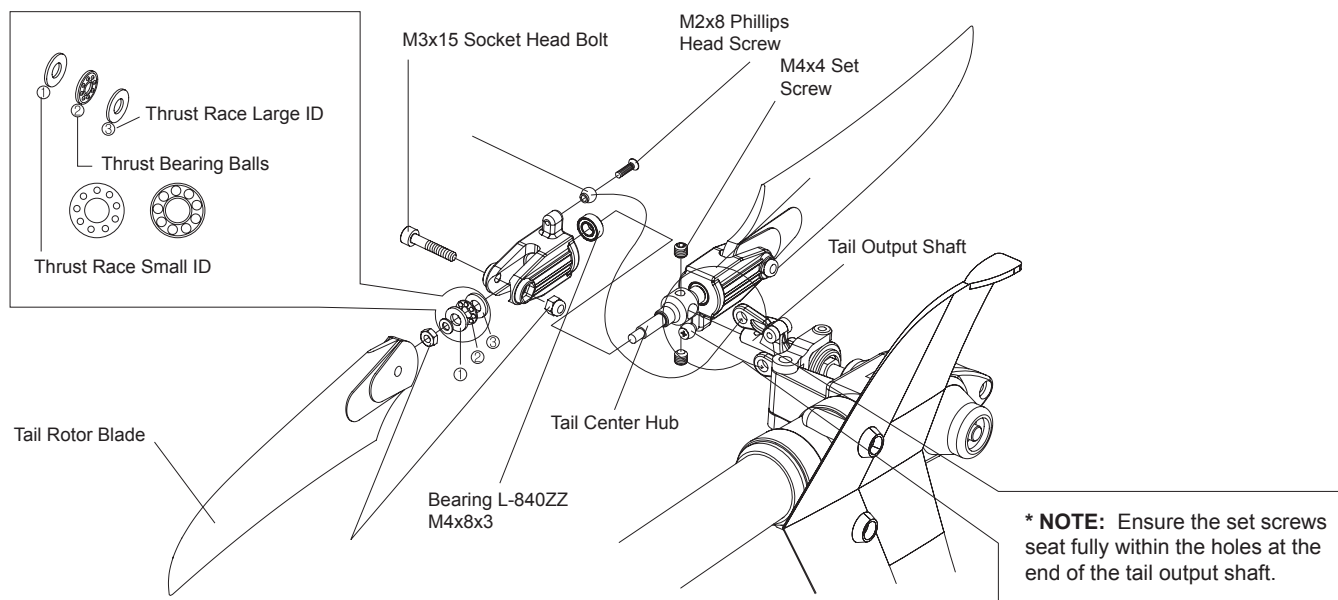


Step 17 – Tail Rotor Assembly

| | | | | | |
|---|---|-------------------------------|---|---|-----------------------------|
|  |  | M3x15 Socket Head Bolt (x2) |  |  | M3 Nylon Lock Nut (x4) |
|  |  | M2x8 Phillips Head Screw (x2) |  |  | Stainless Steel Ball (x2) |
|  |  | M4x4 Set Screw (x2) |  |  | Bearing L-840ZZ M4x8x3 (x4) |

*** NOTE:** Make certain the tail rotor blade closest to the main shaft is trailing edge down as shown in the diagram. Alternatively, when the tip of the lowermost blade is pointing toward the ground, the trailing edge should be aft, just like the rudder on an airplane or boat.

*** PRO TIP -** The thrust bearings in the tail rotor grip assembly must be greased just as with the main rotor thrust bearings. While the head was preassembled for you, the tail rotor grips weren't. Just as with the main rotor thrust bearings, carefully, ensure the small ID race is on the blade side, and similarly you want to cup the ball holder so that it retains the grease while it is rotating. Periodic maintenance is required as with the head, so plan to disassemble and re-lube them every case of fuel.



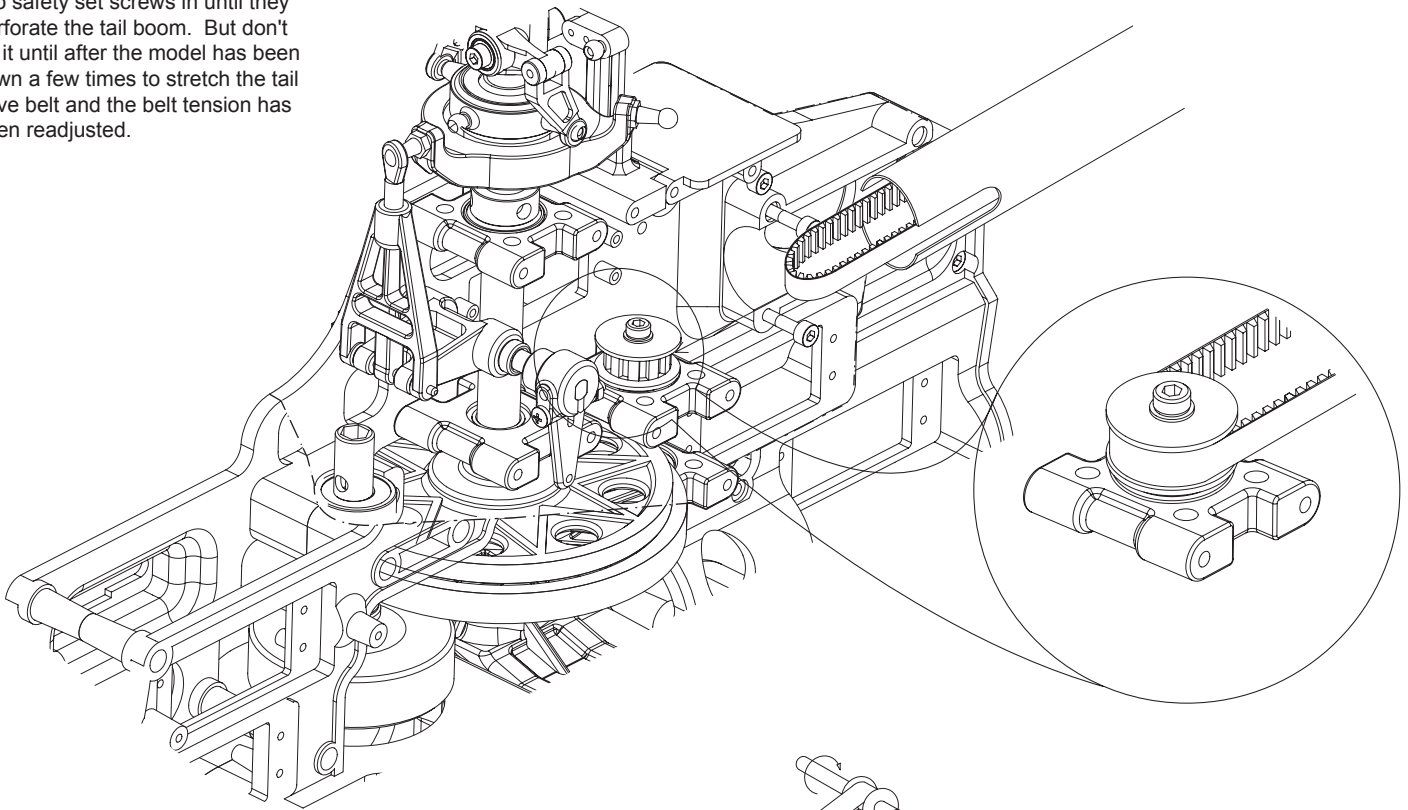
There are distinct advantages to having an ultra-high speed tail assembly - as does the Pantera 50. For example, there are maneuvers during which a slower rotating tail will blow out, thereby ruining the maneuver. A perfect example of this is the 3D maneuver called a Funnel. During the Funnel, the model is flown tail low around and around in a circle such that when it's going fast enough, the descriptive name "Funnel" fits it perfectly! However, there's a limit to how fast you can perform the Funnel largely due to the effect of wind. That's because as the model goes around and around, it is typically transitioning upwind and downwind during some portion of each cycle. However, during the downwind portion of the maneuver the pitch of the tail rotor blades must be greater than during the upwind portion (to maintain effective equal thrust). At some point the maximum available pitch (before the blade stalls) is reached. Typically it's during the downwind portion of the cycle (because during the upwind portion the blades see less "effective" pitch due to the wind). The stall, unfortunately, is the point at which an airfoil quits flying, or in the case of the tail rotor blades, quit producing sufficient thrust (tail rotor blades, main rotor blades, wings, and propellers are all airfoils, of course). The stall's onset is around 16-18°. The usual solution employed by 3D pilots is to fit longer blades as they seek to increase available thrust. This works of course, but puts greater strains on the system as it's being asked to handle a blade size it may not have been designed for, and this doesn't affect the angle at which it stalls. There's another way to skin this cat however. The answer is to spin the blades faster to generate increased thrust at a lower angle of attack, thereby delaying the onset of the stall. Thus, unlike older 50-class designs which typically use 4.5:1 (tail to main rotor ratio), the Pantera employs a much faster 5.3:1 tail gear ratio . . . about 18% faster! Hence, all things being equal, a Pantera 50 will perform a faster Funnel than other 50-class helicopters. Isn't it grand to outperform your buddies?



Step 18 – Tail Boom Assembly

It's been determined the tail rotor system is most effective when the tail rotor blades rotate such that the blade which is closest to the main rotor is rotating upwards. Thus, when viewed from the right side of the model, the disk is rotating counterclockwise. For this reason, there is a twist in the tail rotor drive belt which transfers the rotation of the tail drive pulley 90° so that it drives the tail output shaft in the proper direction. This is referred to as the orientation of the belt. The simplest way to make sure it's correct is to sight down the length of the tail boom and angle it such that you can get a little light past the tail gear box (yes, it's hard - but doable) and observe the tail drive belt is running straight up and down (and isn't kinked). Then grasp the end of the drive belt sticking out from the tail boom and give it a quarter turn to the right (clockwise). Now just slip the tail boom into the aft frame and ease the tail belt over the drive pulley. The last thing is to check that the slots in the tail boom engaged the guides in the frame and that the tail output shaft is indeed 90° to the main shaft. Set the correct tension in the belt and snug the four bolts securing the boom into the aft frame. By the way, don't be a gorilla as you can crush the tail boom pretty easily!

* NOTE: Remember to run the two safety set screws in until they perforate the tail boom. But don't do it until after the model has been flown a few times to stretch the tail drive belt and the belt tension has been readjusted.

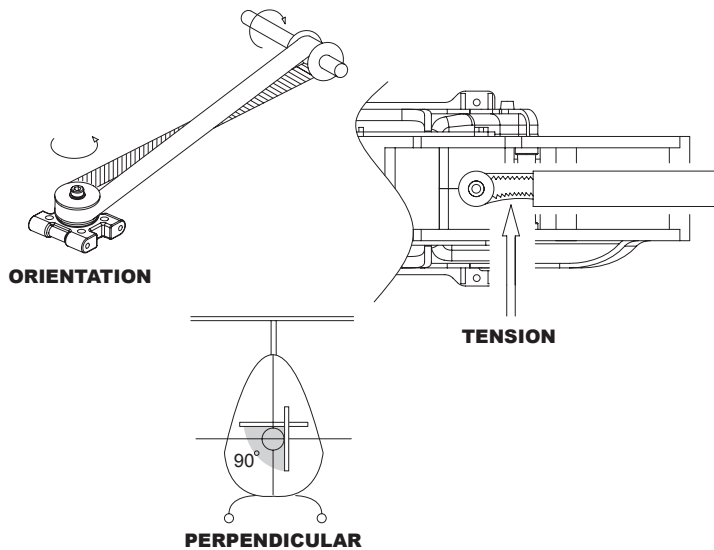


VERIFY - T.O.P.

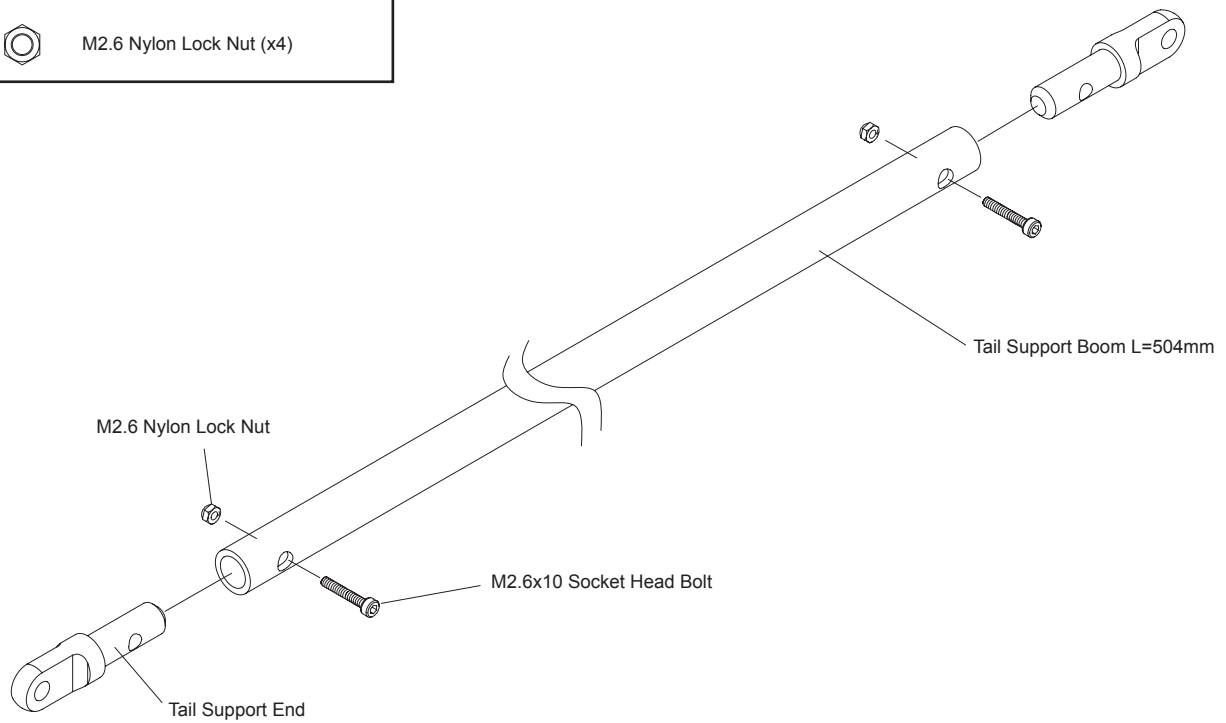
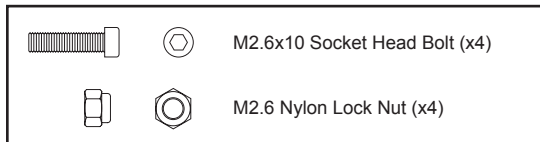
TENSION: Ensure there is a little slack in the tail rotor drive belt. Reach in with your fingertip, or with the tip of a screwdriver, and push one side against the other. They should almost touch without great effort.

ORIENTATION: The tail drive belt must be oriented correctly to ensure the proper rotation of the tail rotor output shaft. There is a 90° clockwise twist when viewed from the front of the tail boom assembly.

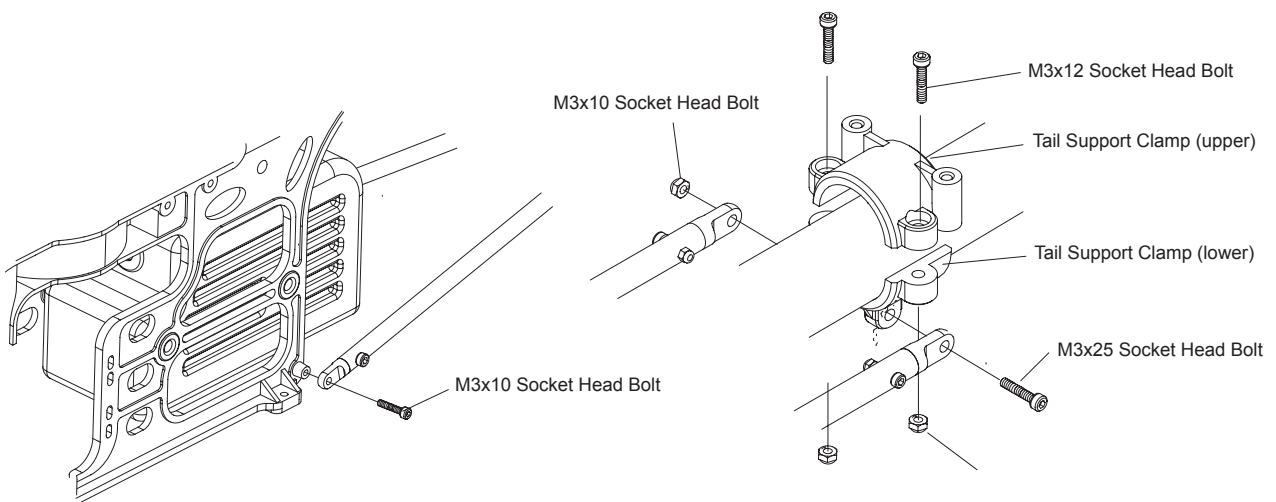
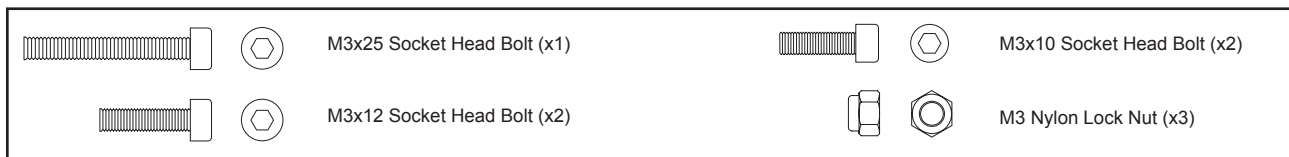
PERPENDICULAR: Ensure the slots in the forward tail boom engage the guides in the aft frame and thus, the tail output shaft is perpendicular to the main shaft



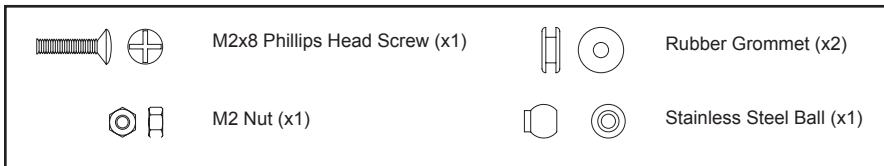
Step 19 – Tail Boom Supports



Step 20 – Tail Boom Support Clamp



Step 21 – Servo Installation

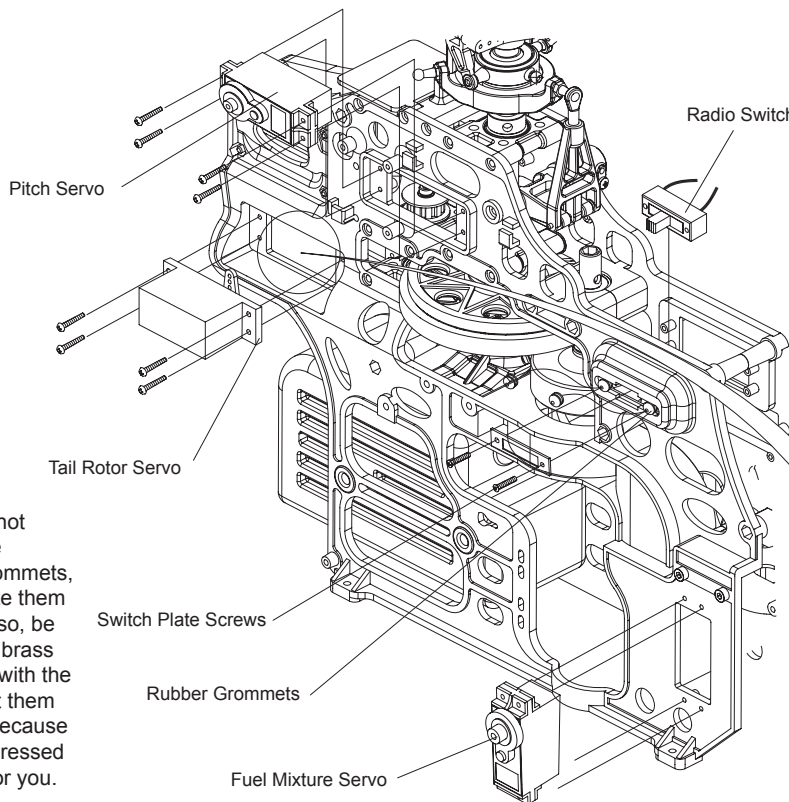
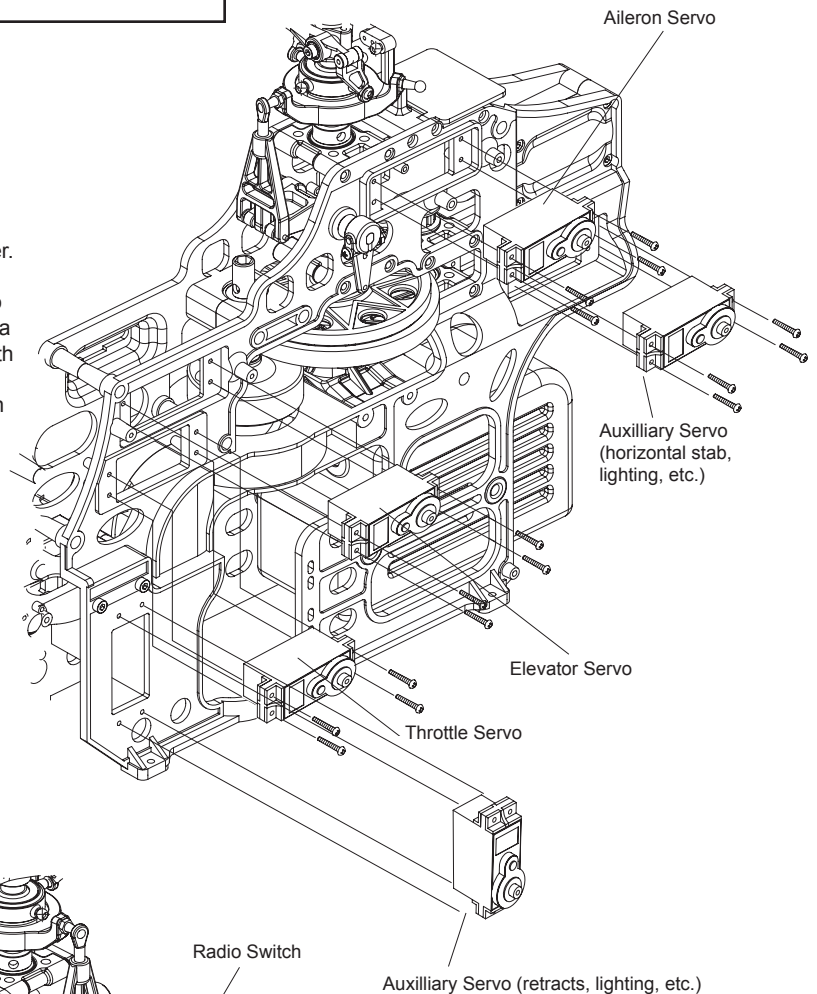


* **PRO TIP** - If you're considering digital servos, in order of importance, first upgrade to digital on the tail rotor, then the swashplate servos, and finally the throttle servo.

* **PRO TIP** - Due to the sharing of the flight loads between the three swashplate servos used by a CCPM (Cyclic, Collective Pitch Mixing) system, the individual servos do not have to be tremendously strong because their forces are additive. This means the collective system, when using 3 each 50 oz.-in. servos = a 150 oz.-in. servo in torque. Conversely, an old fashioned helicopter (with a mechanical collective system) relies on a single high torque servo to deliver equivalent power. CCPM's teamwork concept of load sharing generally results in faster collective response as well since high torque servos generally are also slower (exceptions are, naturally, ridiculously expensive). The Pantera has been flown extensively with standard 50-oz ball bearing servos with excellent results. However, while both F3C (competition aerobatics) and 3D pilots will benefit from more power, they especially benefit from faster servos. The fast *and* precise collective response of a CCPM helicopter is why CCPM become the rage amongst top 3D pilots.

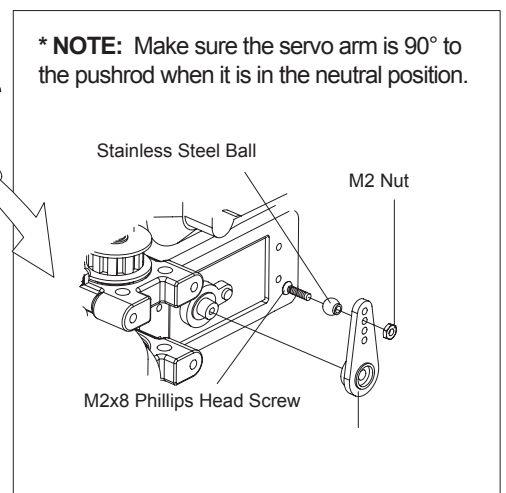
| | Sport | F3C | 3D |
|--------|-------------|--------------|--------------|
| Torque | 50 oz.-in. | 75 oz.-in. | 75 oz.-in. |
| Speed | 0.2 sec/60° | 0.15 sec/60° | 0.11 sec/60° |

* **PRO TIP** - The servo screw holes in the side frames are sized for Futaba® servo screws because they're generally the smallest, so if you're using JR® servos, you'll have to drill the holes larger. But be careful to not make the holes too large or you'll find yourself buying a new set of side frames!




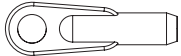
* **PRO TIP** - Do not overcompress the servo's rubber grommets, which serve to isolate them from vibration. Also, be certain to use the brass eyelets (included with the servos) and insert them from the bottom because they set the compressed grommet height for you.

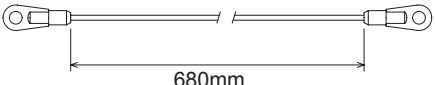
* **NOTE:** Make sure the servo arm is 90° to the pushrod when it is in the neutral position.



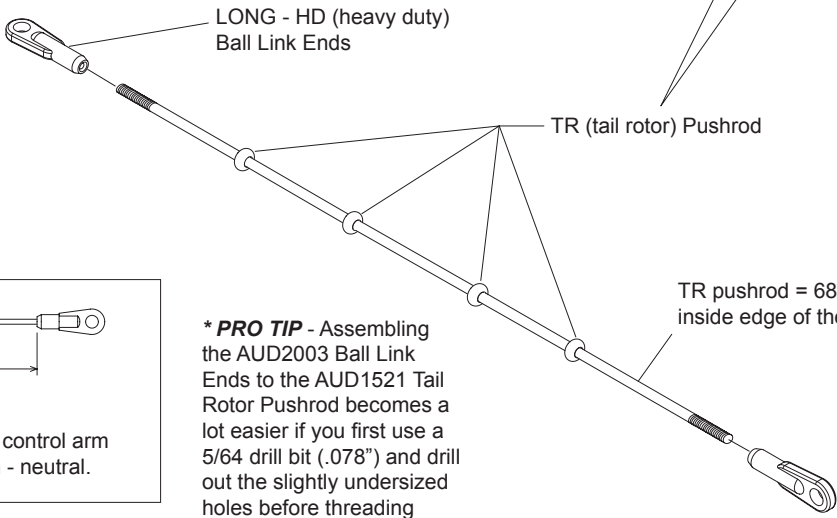
Step 22 – Tail Rotor Pushrod & H. Fin

 M2x8 Self Tapping Screw (x4)
 M3x10 Socket Head Screw (x2)

 TR Pushrod Bushings (x4)
 LONG - Ball Link Ends (x2)

 680mm
 Length when servo arm and tail rotor control arm are set perpendicular to the tail boom - neutral.

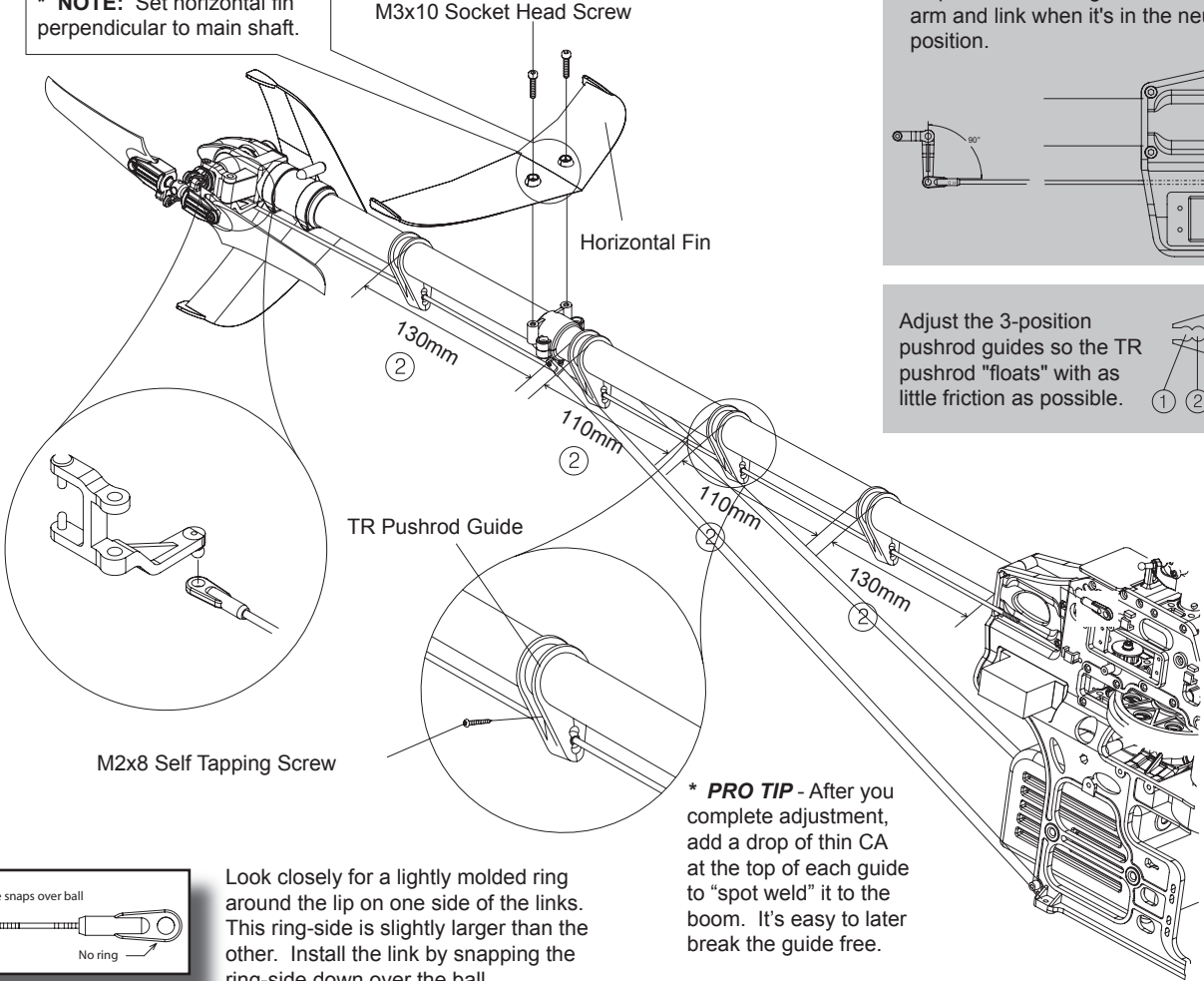
*** NOTE:** Slip pushrod bushings onto pushrod before the second ball link.



*** PRO TIP** - Assembling the AUD2003 Ball Link Ends to the AUD1521 Tail Rotor Pushrod becomes a lot easier if you first use a 5/64 drill bit (.078") and drill out the slightly undersized holes before threading them onto the pushrod.

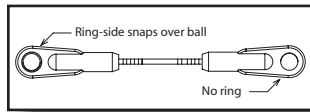
TR pushrod = 680mm between the inside edge of the ball link ends.

*** NOTE:** Set horizontal fin perpendicular to main shaft.



The TR pushrod linkage should make as perfect a 90° angle to the servo arm and link when it's in the neutral position.

Adjust the 3-position pushrod guides so the TR pushrod "floats" with as little friction as possible.



Look closely for a lightly molded ring around the lip on one side of the links. This ring-side is slightly larger than the other. Install the link by snapping the ring-side down over the ball.

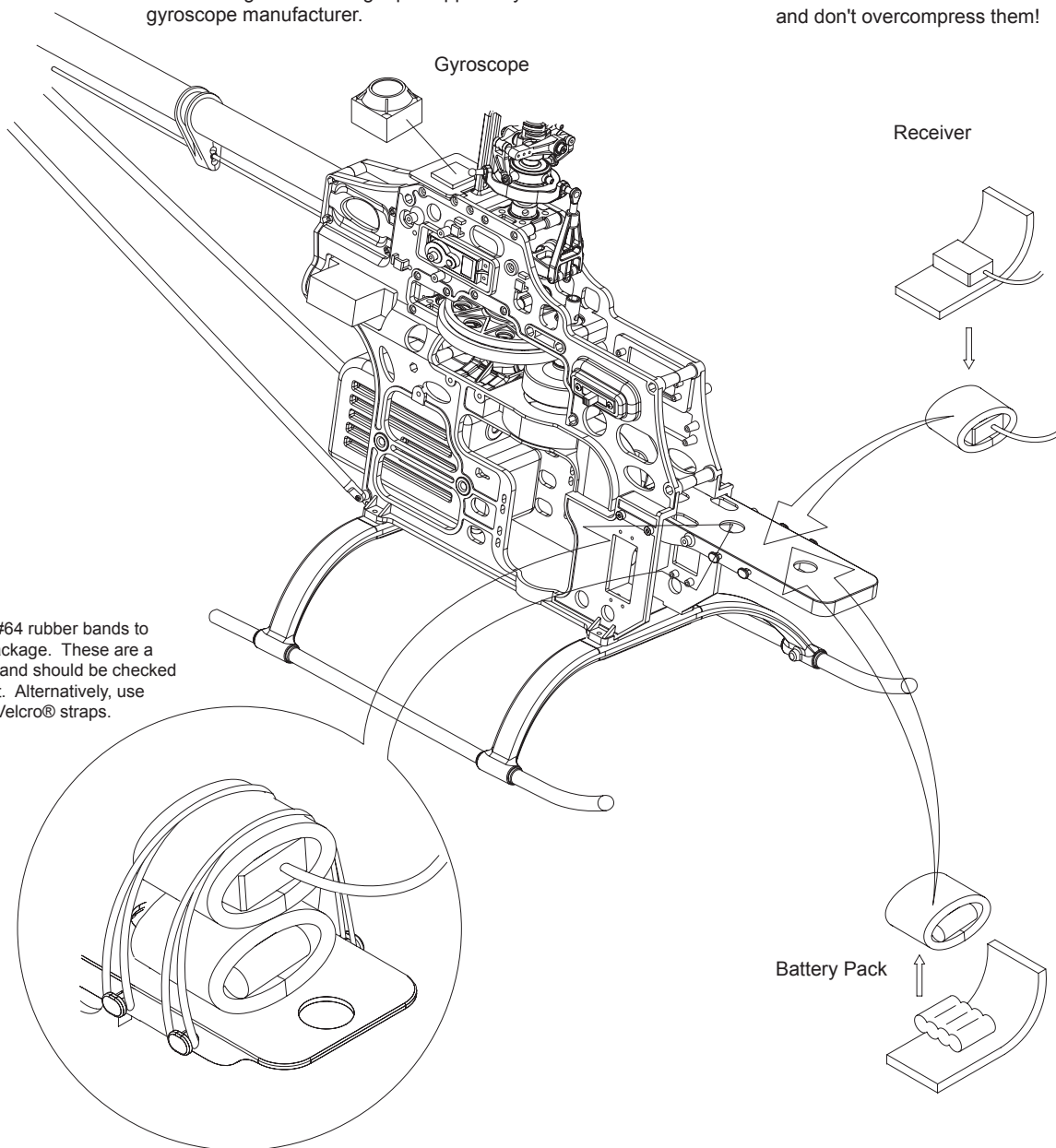
*** PRO TIP** - After you complete adjustment, add a drop of thin CA at the top of each guide to "spot weld" it to the boom. It's easy to later break the guide free.

Step 23 – Avionics Protection

The importance of protecting the avionics package (receiver, gyro amplifier, governor, and battery pack) from the primary vibrations caused by the engine and the secondary vibrations induced by the main and tail rotors cannot be overemphasized. These forces may lead to premature failure of the avionics components leading to intermittent or permanent loss of control and possibly property damage, injury, or even death. Use a high quality wrap such as Du-Bro® No. 514 - 1/2" (12.7mm) thick foam rubber. Do not use plastic bubble-wrap, open-cell foam, or servo tape for mounting these delicate components unless directed to do so by their manufacturer.

* **PRO TIP** - The gyroscope platform should be cleaned by lightly wiping down with acetone before using the mounting tape supplied by the gyroscope manufacturer.

* **NOTE:** Use the included rubber grommets to isolate the receiver switch from vibration induced failure and don't overcompress them!

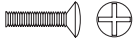
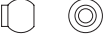




* **PRO TIP** - Use #64 rubber bands to secure avionics package. These are a maintenance item and should be checked during the preflight. Alternatively, use nylon Zip Ties, or Velcro® straps.

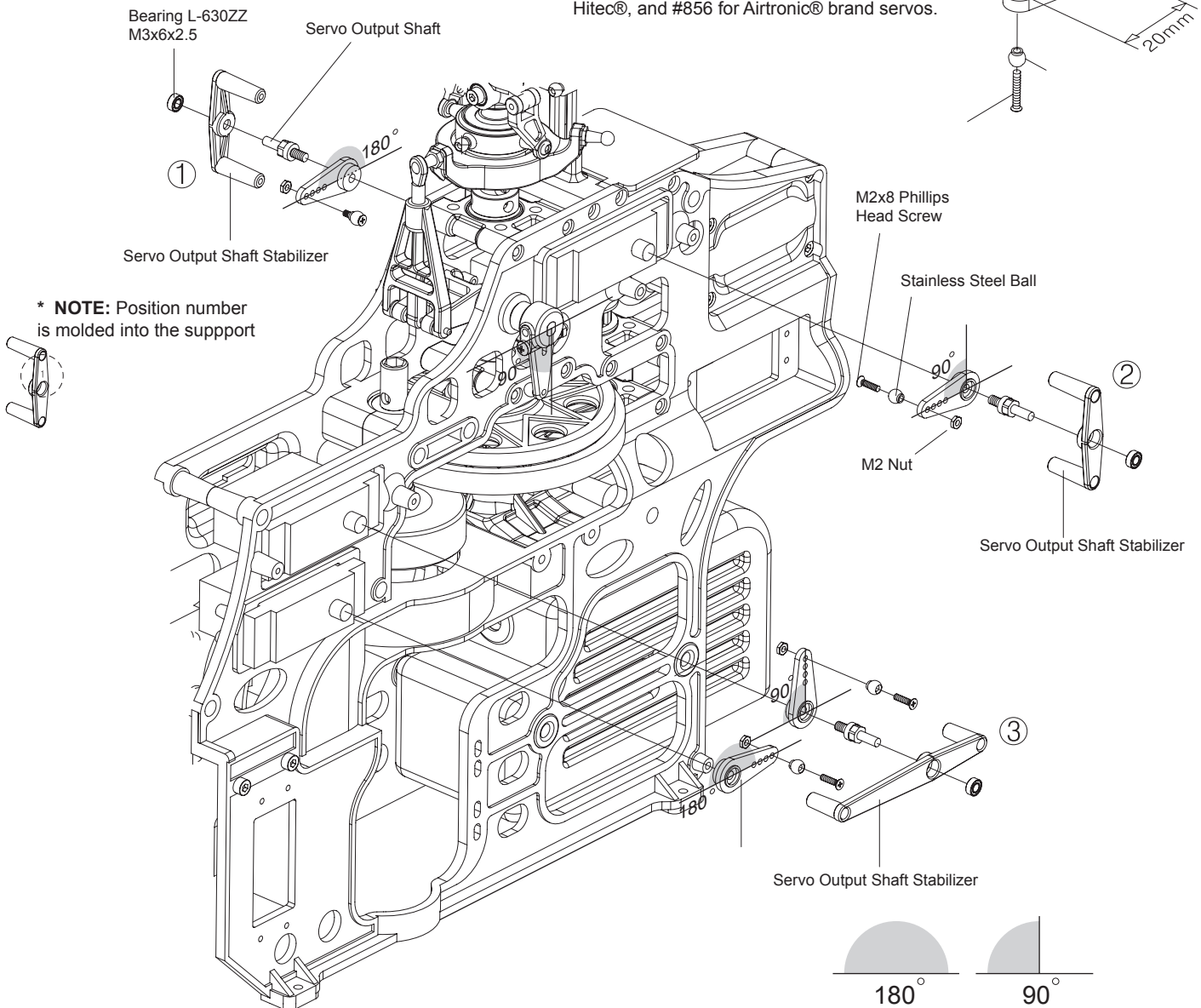
* **PRO TIP** - A sport pilot will be well served with a 4-cell 2400mAH NiCd battery pack for most uses. We designed the model with this amount of mass in mind (for proper balance). Extreme performance pilots, i.e. those performing aggressive 3D maneuvers are going to be seeking more servo speed and may wish to use either a regulated 5-cell NiCd battery pack, or even a LiPo or Li-Ion pack (typically regulated down to 5.3V, but it really depends on what your component manufacturer suggests as a voltage limit). However, it's important to realize that a 5-cell 2400mAh pack will not last as long as a 4-cell 2400mAh pack due to the higher drain caused by running the servos on higher voltage. The prudent pilot will check batteries before each and every flight with a battery checker which, places a simulated load on the battery pack.



Step 24 – Servo Arms & Control Balls

| | | | |
|---|-------------------------------|---|-------------------------------|
|  | M2x8 Phillips Head Screw (x4) |  | Stainless Steel Ball (x4) |
|  | M2 Nut (x4) |  | Bearing L-630ZZ M3x6x2.5 (x3) |

* **NOTE:** The three CCPM servos work best with an output location of about 20mm. We're partial to the HD servo arms by Du-Bro® part: #670 for Futaba®, #671 for JR®, #672 for Hitec®, and #856 for Airtronic® brand servos.



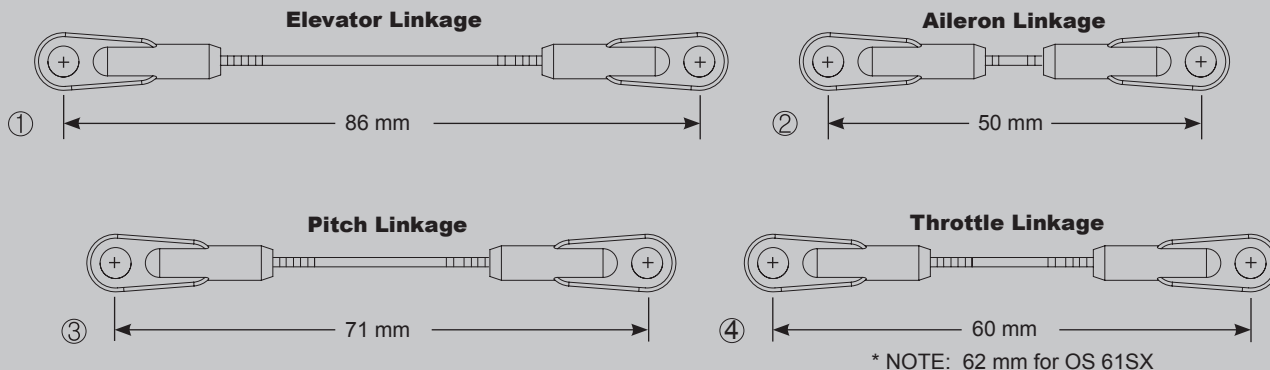
The servo output shafts included with Panthera 50 feature a 2.6mm thread and are designed for plastic gears because this is what's typically found with popular Futaba® and Hitec® servos. JR®, and other brands, however, may use a 3 mm thread - and of course, some servos may use machine threads. We cannot anticipate all the possibilities a modeler may encounter, and thus these other size may (based on demand) be available as an option. Finally, if the fit of the output shaft is too tight in the bearing, use crocus cloth or 600 grit sandpaper to polish the shaft and thereby slightly reduce its diameter to get a better fit.

* **PRO TIP** - The goal when setting up linkages is to avoid differential throw. The way to do this is to ensure a symmetrical throw results from each side of the servo output shaft, i.e. as the servo arm/control arm linkage moves. The neutral position is always mid-stick, which is when both ends of any servo arm and control arm should be perpendicular, i.e. 90° to the pushrod. Thus, when you set up your servos, first set up the model as a helicopter in the transmitter, second adjust the direction of travel for all the servos (NOR or REV). Third, work to get the best mechanical position possible for the arm on the servo splines such that you obtain either 90° or 180° to the servo case.



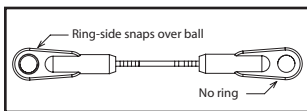
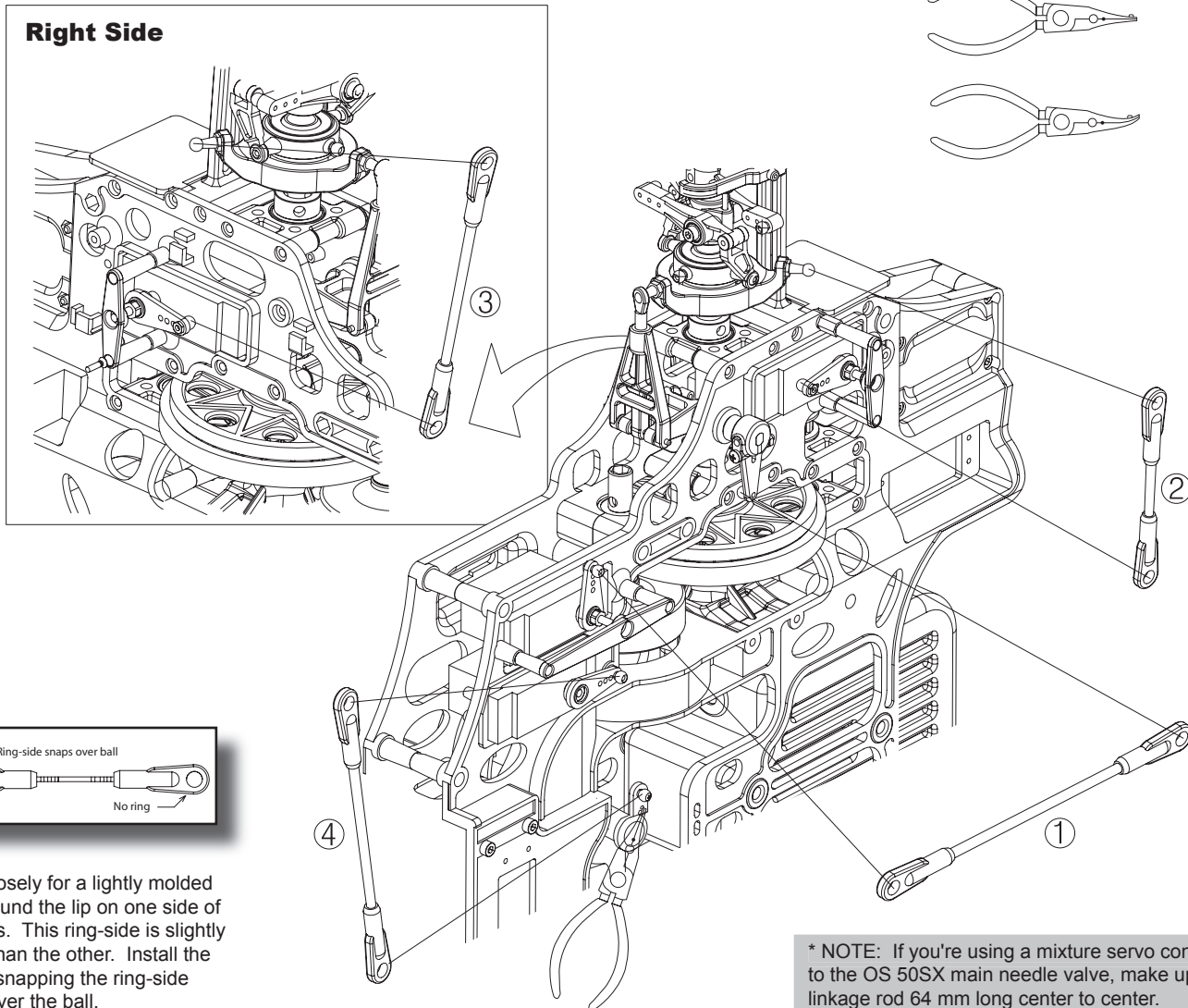
Step 25 – Servo Linkage Rods

The pushrods are preassembled for your convenience. These dimensions are approximate. For symmetrical throw, when in the neutral position, all linkages (elevator, aileron, pitch, and throttle) must make a 90° angle at each end.



* **PRO TIP** - Both curved and straight tip ball link pliers are required at different times. We prefer **ProModeler® PDR0069 Straight Tip** and **PDR0070 Curved Tip** both in our workshop and at the field.

Right Side



Look closely for a lightly molded ring around the lip on one side of the links. This ring-side is slightly larger than the other. Install the link by snapping the ring-side down over the ball.

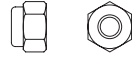
* NOTE: If you're using a mixture servo connected to the OS 50SX main needle valve, make up a linkage rod 64 mm long center to center.



Step 26 – Main Rotor Blades

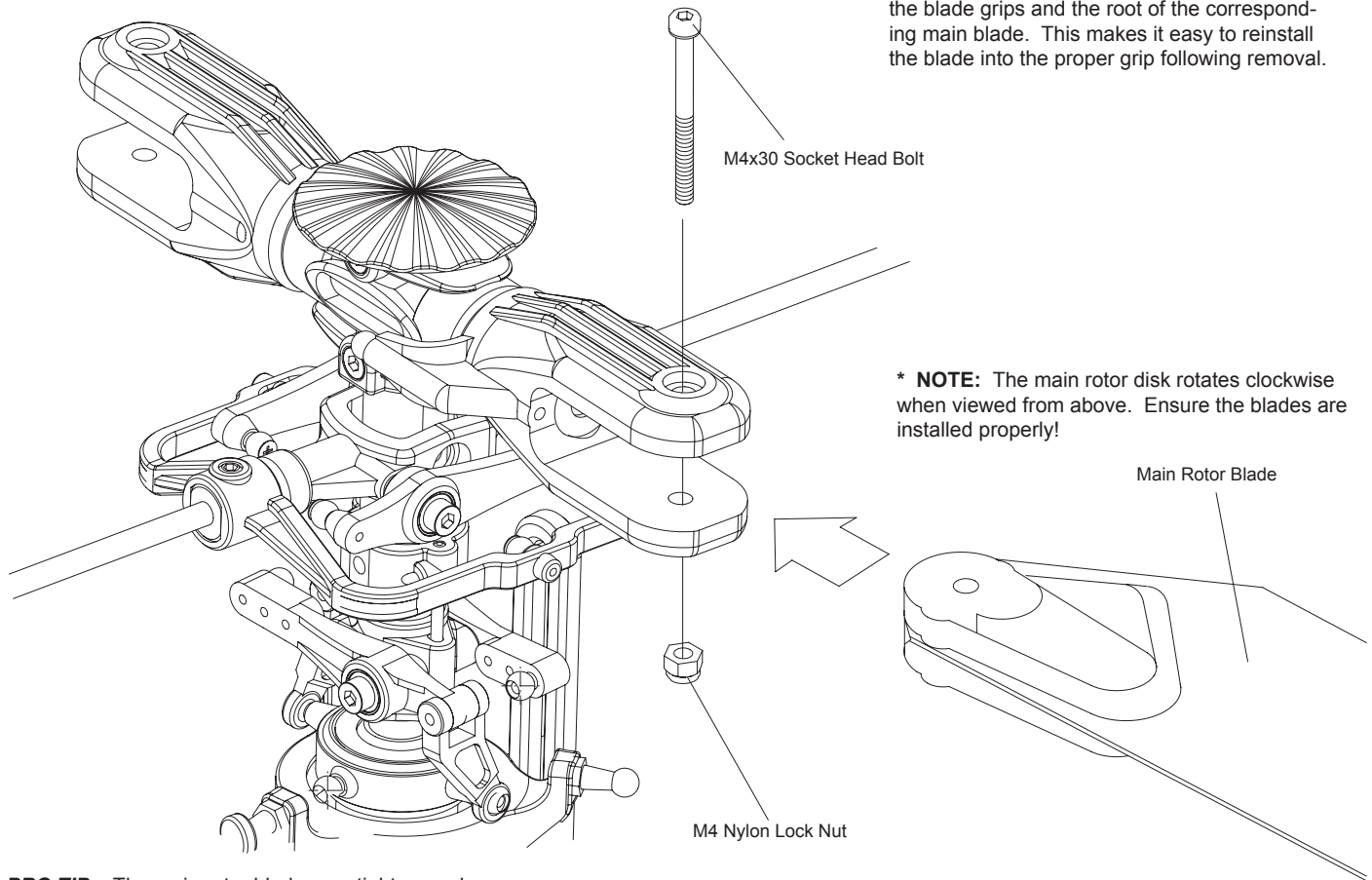


M4x30 Socket Head Bolt (x2)



M4 Nylon Lock Nut (x2)

* **PRO TIP** - Use a drop of nail polish on one of the blade grips and the root of the corresponding main blade. This makes it easy to reinstall the blade into the proper grip following removal.



* **NOTE:** The main rotor disk rotates clockwise when viewed from above. Ensure the blades are installed properly!

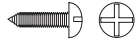
* **PRO TIP** - The main rotor blades are tight enough when you can move them by hand, yet when you hold the helicopter on its side (with the blades extended), they do not swing loose from their own weight.

* **NOTE:** The 4 large black plastic shim washers (included with the blade bolts) are 1mm thick and designed to properly position 12mm main blades within the 14mm main rotor blade grip.

The Pantera 50 is capable of accepting blades with up to a 14 mm root and a length of up to 640mm. For most pilots using a 50-class engine, a set of 600mm blades will be all they'll ever want. Very experienced pilots, i.e. those with excellent collective management skills may find it beneficial to use longer blades - perhaps a set of 620mm blades. As in all things, however, there is a trade off and increasing the rotor disk area is no different. To begin with, the resulting decreased rotor disk loading leads to increased agility. The price to be paid though is that because of the increased agility comes the ability to actually bend parts while flying because the Pantera may stop and start much more quickly, i.e. increased agility. Hence, the caveat of reserving the use of longer blades for the exclusive use of pilots demonstrably possessing superior collective management skills. The Pantera 50 has also been designed with larger engines in mind, especially for our high altitude customers such as those who live in Denver, CO or Mexico City, DF. The resulting high altitude leads to a decrease in specific power output from all internal combustion engines because of the decreased density of the air. The term for this is density altitude and pilots living where there are high-density altitudes experience tremendous power losses. For example, when at 6000' it's not unusual for a 50-class helicopter to perform as if a 30-class engine powered it! Thus, we've made it easy to install a .61 engine into the Pantera via option parts. The increased displacement helps make up for the power loss experienced by high density altitudes. However, once again the specter of a trade off raises its ugly head. To wit, the .61 engine weighs more than the .50 engine and that raises the disk loading. The solution in this case is to use longer blades to bring the disk loading back down. Naturally, somebody will wonder about installing a .70 or even a .91-class engine (since they're physically the same size as a .61) into a Pantera . . . to which we respond - don't be crazy! This specific power output is more than the mechanism is designed to accept, plus the 8.7:1 gearing is perfect for either the .50 or the .61 but not so perfect for the .70 or the .91. Hence, proceed at your own risk if you decide to be crazy and don't say we never told you not to do it because we are saying so right now - don't do it.



Step 27 – Canopy & Windshield



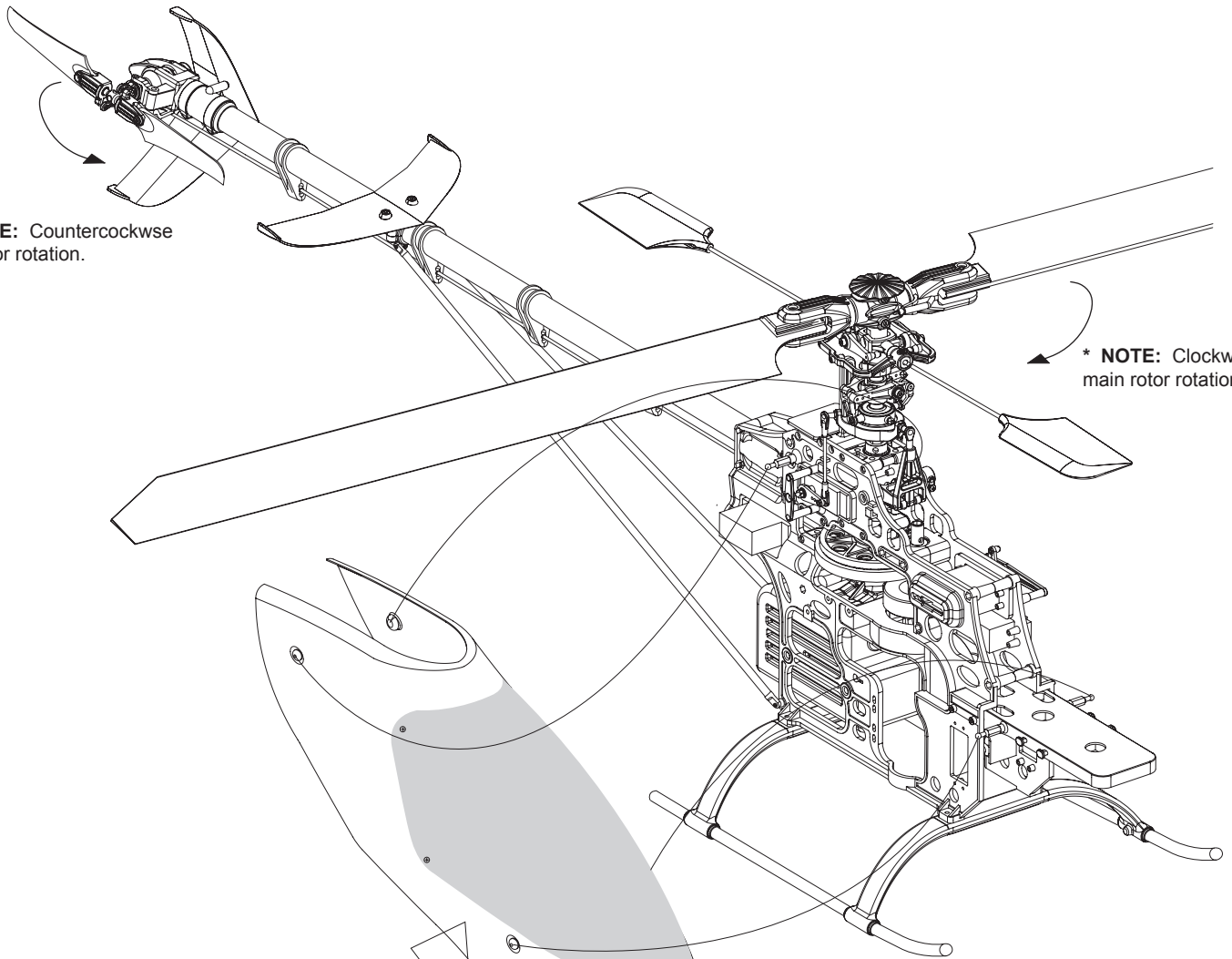
M2x8 Self Tapping Screw (x6)



Canopy Mount Rubber Grommet (x4)

* **NOTE:** Counterclockwise tail rotor rotation.

* **NOTE:** Clockwise main rotor rotation.

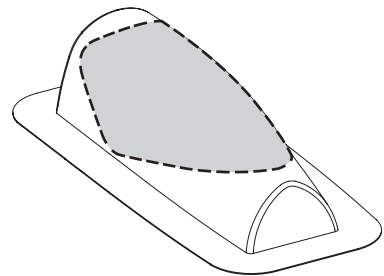


M2x8 Self Tapping Screw

* **PRO TIP** - Use a small drill bit, or even a modeler's pin as an auger, to make the holes to start the screws.

Canopy

Canopy Mount Rubber Grommet



* **PRO TIP** - Cut to the molded trim line using Lexan-type scissors and fasten with self-tapping screws.



Step 28.1 – Set-Up Tips

This segment of the manual deals with setting up your helicopter. The set-up includes both mechanical and electronic adjustments to the model.

BACKGROUND

There are two prevailing schools of thought regarding model helicopter set-up. One school of thought sets up the model helicopter primarily oriented for upright flight. The other sets it up for symmetrical flight - this simply means the model is as liable to hover inverted as upright. This is how models for 3D are set up.

If you are a beginner, you will probably have an easier time of learning to fly with a set-up oriented toward upright flight. That's because there is a greater range of pitch to T/C (throttle/collective) stick motion. The T/C stick travels between low and high pitch and hover occur with the T/C stick in the middle of the full range (with the model upright).



way to set up the machine is to perform a 3D set up and then adjust for an upright orientation within the transmitter electronics. It doesn't get easier than this!

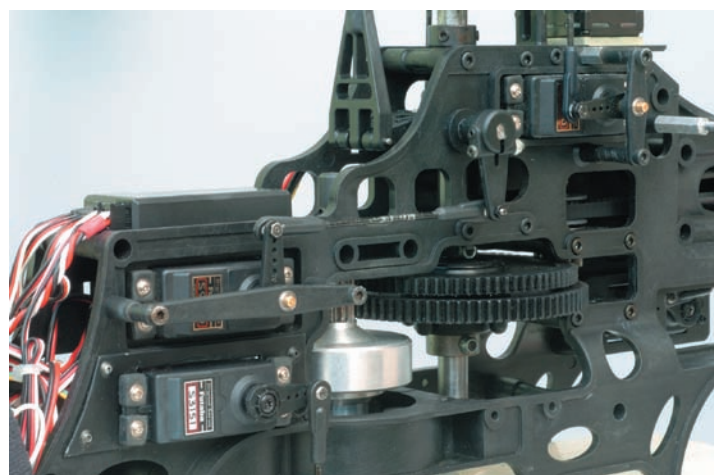
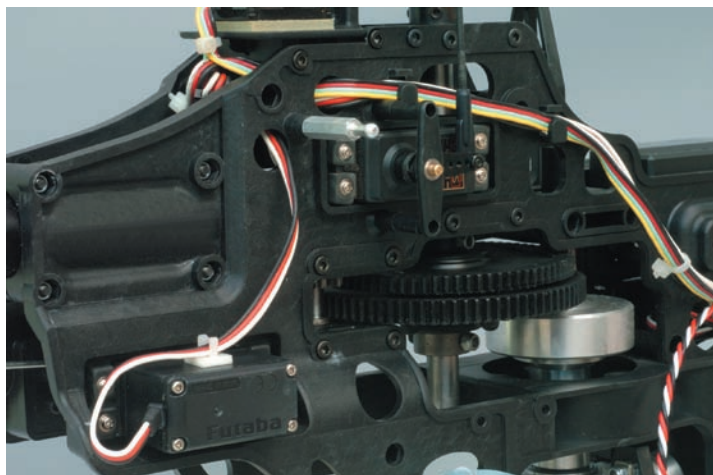
MECHANICAL SET-UP: Cyclic & Collective Pitch

As it turns out, mechanically it's more important to have the CCPM (Cyclic and Collective Pitch Mixing) linkages at their respective neutral position in a model set up for symmetrical flight. You can easily adjust the model for a predominantly upright flight regimen simply by using the radio system. The converse - or a set up that is mechanically biased for upright flight, and using the radio system to adjust for a symmetrical set-up, isn't a sound practice due to asymmetrical throws.

The **Pantera 50** makes it easy to accomplish this because it's designed for a symmetrical 3D set-up. This means that when the transmitter's control sticks are at mid-stick, i.e. half-way through their travel, the models linkages all form 90° where they attach to servo arms, and linkages. Also, the mixing arms are level, and the main rotor blades are level as well, i.e. at 0°. Hence, there are absolutely no mechanical compromises (for the more rigorous 3D duty) as are found in helicopters with a mechanical mixing heritage!

Building the linkages, as shown in the manual, results in the linkages being in the neutral position when the control sticks are in their neutral position (i.e. mid-stick for both the T/C stick and the cyclic sticks of the transmitter). All that is left is to ensure that each servo arm is at its respective neutral positions - 90° to the push-rod. (Figure 1)

If you look down on the swashplate from above it is immediately apparent the **Pantera 50** uses a 120° CCPM system because there are three servos (spaced at equal intervals, or 360° divided by 3 = 120°) controlling the outer ring of the swashplate. The inner ring, however, is spaced at 90° per usual convention. (Figure 2) While mechanical mixing methods of controlling the



Step 28.2 – Set-Up Tips

swashplate exits, and even 4-servo CCPM (as used principally in Europe), and both are practical methods of inputting controls to the swashplate system (fore/aft cyclic, side-to-side cyclic, plus collective), greater overall system precision and reliability results from the use of 3-servo CCPM. That's because old fashioned mechanical mixing systems develop play in the system

over time as they wear, ultimately the play becomes slop. With a 4-servo CCPM set up, it's easy enough to see where failure of a system with 3 servos is 33% less likely than one with 4 servos.

Inherent in the design of the *Pantera 50* is the elegantly very simple to understand concept of reducing the number of parts in the model. This increases the reliability because there are fewer things which can possibly fail. This is particularly important with the and the old mechanical mixing system because they have exactly the same chances of electronic failure (they use 3 servos as well) and they have many more mechanical linkages, which as they wear may fail.

Mechanical set-up is very important insofar as ensuring the linkages form 90° angles to the servo arms at neutral. Equally important is the idea of mechanical leverage. An even application of leverage to the bearings of the servo occurs when the ball links are installed on the inside face of the three CCPM servo arms at a distance of 20mm from center.

Figure 2

**Perpendicular to
the tail boom**

**Parallel to the
tail boom**

THROTTLE - MECHANICAL SET-UP:

Mechanically setting up the throttle is next. The pushrod length shown for neutral position is approximately the hover throttle opening also, but this dimension is really taken to be mid-point between WOT and idle (not fully closed). This means you set it up with this length, but plan to adjust it after the helicopter has been flown - but *before* making really precise electronic adjustments to the throttle curves. (Figure 5)



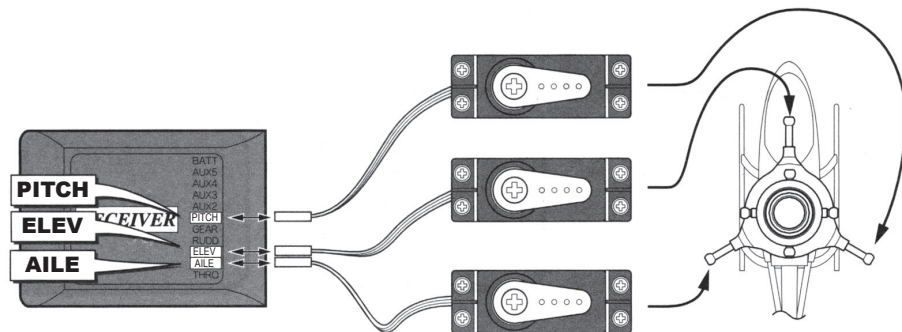
TAIL ROTOR - MECHANICAL SET-UP:

Mechanically setting up the tail rotor (T/R) is next. The pushrod length shown for the neutral position is for hovering. Again, this is the point at which both tail rotor control arm and tail rotor servo arm make a 90° to the tail boom. We keep harping about this because otherwise instead of symmetrical throw in the linkage, there is differential throw. This means different motion (more to one side than the other) on each side of neutral - it makes flight and adjustments less predictable. Again, as with the throttle linkage, this given length is a starting point - you may need to make slight adjustments after flying the helicopter model. Also, if you are using a heading-hold or heading-lock gyroscope, this dimension is quite likely accurate enough as is and will not need further adjustment. (Figure 6)

ELECTRONIC SET-UP: Introduction

While we like to think the sequence is to always perform an electronic set-up *after* mechanical set-up, in fact, the processes interact to a certain degree. For example, in order to perform the mechanical set-up we need for the servos to be plugged into their respective channels *and* for each servo to be centered, or in its neutral position. We are aided in this process somewhat because we know how long to build each pushrod (for the theoretical center). However, reality intrudes as despite the best efforts of world class engineers and manufacturing processes, the practical effect of the end user installing servos from different manufacturers (and even accessory servo arm manufacturers) means in effect we're really giving you a really close point from which to start making slight tuning adjustments. The more precisely the neutral position for each servo is set, the closer the initial set up will be to the final set-up. In any case, the mechanical and electronic set-up we suggest will be close enough to permit successful test flights from which fine tuning can depart. Next, consult with the radio system's manual and verify the three CCPM servos are plugged into the receiver - something like this. (Figure 3)

Figure 3



Do the same for the throttle and tail rotor servos - as well as the gyroscope, the switch harness, and the flight pack battery. Once that's done, ensure you've routed the antenna via the antenna tube (3.1) and protected the avionics from vibration (6.4).

ELECTRONIC SET-UP: Background

We've discussed the two predominant flight set-ups; one oriented for upright flight and other oriented to symmetrical flight. We've also touched on the concept of pitch and throttle curves. Let's elaborate on all this a bit.

As it turns out, the pure symmetrical set-up is fictional since helicopters initiate and end flight with the engine at idle and the rotor blades stopped. Thus, the symmetrical set-ups shares similarity to the upright oriented set-up in what's called the Normal Flight Condition, or Normal Mode. However, first let's review how a helicopter flies before we proceed.

For a helicopter to fly it depends on the lift generated by the rotating main blades. These blades are tilted at an angle, just like a fan or a propeller has an angle and hence, as they spin, they move air. Introduce a positive angle into the blades (leading edge higher than the trailing edge) and they produce lift because they push the air downward while simultaneously *lifting* the helicopter off the ground. The more angle, the faster the helicopter is lifted. But in practice, the practical amount of angle is limited by two things, the horsepower available to spin the main rotor and the angle at which the blades will stall, or stop producing more lift than drag. More on this later.

Similarly, if you introduce a negative angle (or negative pitch as it's more commonly referred to) into the rotor system, the helicopter will push the air upwards forcing the model onto its landing gear. From this simple fact derives the idea that negative pitch combined with a model whose orientation is upside-down and we have the basis for inverted flight. As it turns out, the helicopter doesn't care whether it's right side-up or upside-down!

Examine the airfoil of the main blades and you'll see a strong resemblance to the airfoil of a wing. That's because it is a wing! In fact, it's really not uncommon to refer to helicopters as rotary wing aircraft vs. airplanes known as fixed wing aircraft.

Control of the helicopter is established through

the introduction of additional angles of pitch (both positive and negative) within the overall gross angles we mentioned earlier. Let's look at an example.

Suppose a helicopter uses 5.5° of pitch to hover (the converse holds true as it would use about the same, or -5.5° i.e. *negative* pitch to establish a hover inverted and thus, the convention is introduced of indicating when pitch is negative, otherwise, it's assumed to be positive). Anyway, from a hover, for the helicopter to move forward, the linkages of the rotor system would introduce a little bit more pitch on one side of the rotor disk and remove a bit of pitch from the other. These result in a tilting of the entire rotating disk forward - which would cause the helicopter itself to also tilt forward and thus, move forward. Coming to a stop would entail the reverse, or the tilting the disk aft.

R/C model helicopters use a combination of Bell and Hiller mixing to provide both direct and indirect control over adding and subtracting the small amounts of pitch involved in controlling the rotor disk. It is beyond the scope of this manual to enter into greater technical depth. Let's return to the idea of blade angles, or pitch, as they relate to stalling the blades.

As it turns out, depending on the airfoil, a blade (or a wing for that matter) stalls between 14° and 18° of pitch, or angle of attack (how much higher the leading edge is related to the trailing edge). Because the main rotor may have as much as $10-11^\circ$ of pitch during maneuvers, and because the addition of control inputs will increase the pitch on one side of the rotor disk by as much as $5-6^\circ$ (whilst simultaneously reducing the pitch on the other side, of course - but we're only concerned with where the blade stalls), we need to beware the possibility of stalling part of the main-rotor disk (causing an extended loss of symmetry in lift). The reason for touching on this is related to the extreme power of 50-class engines when coupled with the agile airframe of the **Tiger 50** helicopter which means if you are not careful, you may find yourself on the wrong side of the limits imposed by physics! In short, be aware of the fact that there *are* limits.



ELECTRONIC SET-UP: Pitch Curves

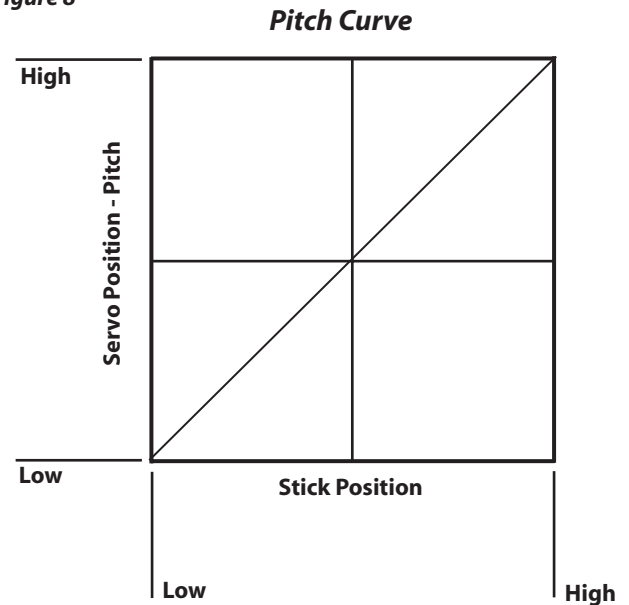
We suspect that in the course of learning about model helicopters you've heard the term pitch curve or throttle curve bandied about. All that's meant by this is the graphical representation of what happens to a control (servo) when a stick on the transmitter is deflected (moved). Let's see if we can shed some light on this. We'll begin with pitch curves since they're easy to visualize and they relate to orientation (upright or symmetrical set-up).

First some terms and definitions - so that we're all on the same page. We start by assuming you are using a Mode 2 setup in your transmitter. This is Throttle/Collective as well as the Tail Rotor on the left-hand control stick and the fore/aft as well as the side-to-side cyclic controls on the right-hand control stick. Holding the transmitter in both hands and moving the T/C stick towards you will decrease throttle and collective pitch while moving it away, or up, increases T/C pitch. T/C servos are linked electronically. Push the tail rotor stick to the left and the nose of the heli goes to the left - and vice versa. The rotation caused by the T/R is about the axis of the main rotor, i.e. the helicopter will spin around in circles.

The right-hand joystick controls cyclic pitch (which is the adding and subtracting of pitch from the collective pitch). Cyclic pitch tilts the rotor disk and causes changes in direction. Side-to-side, or aileron, cyclic causes rotation about the longitudinal axis (the length - or tail boom axis) so the machine will roll. As you would expect, move the joystick to the right and the machine will roll to the right. In a similarly fashion, the fore/aft directions for the joystick (or control stick) causes the machine to roll about the fore/aft axis. Pushing the joystick away from you dips the nose and a pull towards you raises the nose. Continue to hold the control and the helicopter will rotate in place about that axis (when combined with the well timed and skillful application of collective pitch in both positive and negative directions as well as some T/R to hold position). Did you expect this to be easy? It's not - which is why there are more fixed wing pilots than rotating wing pilots! But you *can* master it.

So what does a pitch curve look like? This is what a collective pitch might look like. (Figure 8)

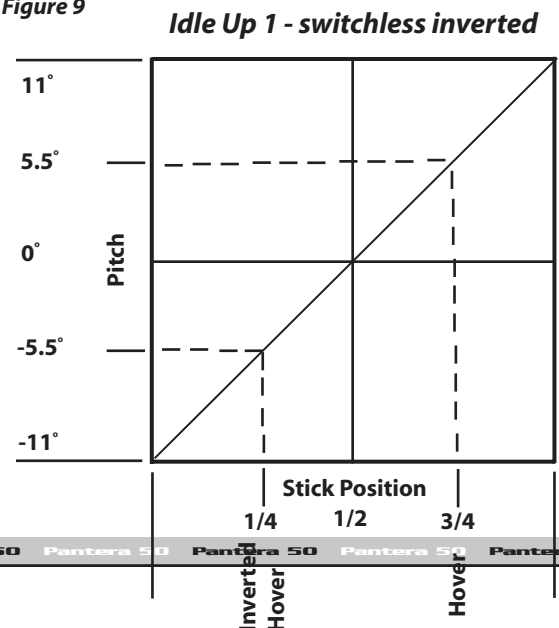
Figure 8



If you're thinking, *That's not a curve, that's a straight line!* You're right as in this case, the pitch curve *is* a straight line. It's an example of the pitch curve for a switchless inverted set-up. Let's put some numbers to the curve to see if it helps.

Below, the pitch curve represents the pitch range from 11° to -11° with mid-stick being 0° . This is the pitch curve of a helicopter, which can perform equally well inverted and right side-up. Either extreme of the joystick represents 11° of deviation from 0° and the upright hover occurs around 3/4-stick while the inverted hover occurs at about 1/4-stick, both with 5.5° pitch. (Figure 9)

Figure 9



The shorthand for the pitch curve in Figure 9 would be -11, 0, 11. It would be understood that we meant -11°, 0°, 11° but the degrees could just as easily be left off. The proper name for the curve in Figure 9 would really be:

Switchless Inverted Pitch Curve, Idle Up 1

The *Switchless Inverted* part you already understand to mean a set-up for symmetrical flight, while *Pitch Curve* is now self-explanatory. The *Idle Up 1* part refers to the flight mode used for most aerobatics. Depending on the brand radio you select, these names may be different . . .

Futaba-brand radios may refer to **Idle Up 1**, or **I1** and **JR**-brand radios may refer to **Flight Mode 1**

. . . but they both mean the very exact same thing!

This brings us to something else. Your radio may, in addition to these flight modes, refer to others like Hold Condition, or Hold Mode, and Normal Condition, or Normal Mode, and even Idle Up 2, or Flight Mode 2. We'll get to these later.

By the way, Futaba uses the Flight Condition while JR uses the word Mode - but we figure they really just do it to confuse us! Don't worry if you hear people referring to Mode this or Mode that but you notice they fly Futaba equipment - it just means they've been hanging around folks who use JR equipment - it's not a sin! Plus, of course, there are other brands too - like Airtronics, Hitec, et al. and each have proprietary terminology you'll need to get the hang of.

Oh, and in case you're wondering, no we're not going to teach you how to program a *specific* radio to the **Tiger 50** in this manual. There are too many radio systems with excellent manuals which explain *exactly* how to set-up a CCPM heli for us to replicate all their work. That, plus the radio models change almost yearly, so anything we put in the manual would soon be obsolete!

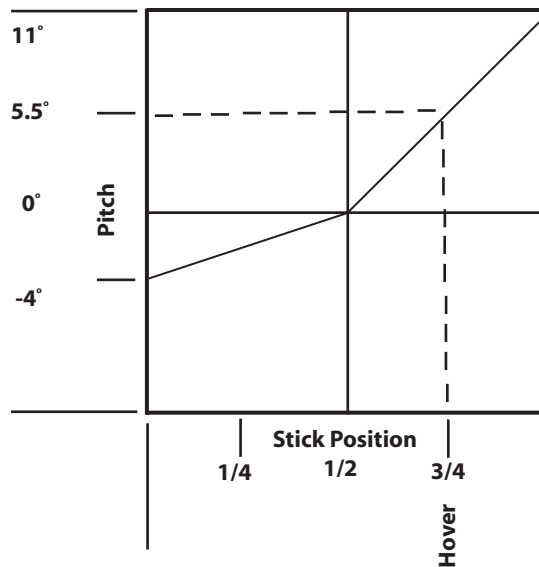
Instead, our goal is to give you a grounding in both how and why certain flight modes exist,

combined with some pitch values - which will get your helicopter close to a final set-up - close enough to fly and just make minor trim changes.

As you may suspect, this section was created for folks to whom this is all new. Experienced pilots will just glance at the pitch values we suggest and be on their way without a further glance at this manual!

Since we've discussed the switchless inverted pitch curve Idle Up 1 set-up, let's discuss the Normal Pitch Curve for the same set-up. The Normal Pitch Curve is the one used to start the chopper, carry it to the flight line, and take-off as well as for recovery of the model at the end of a flight. Flying around is done in Idle Up 1 - understand? The goal is for this curve to exactly match the Idle Up 1 curve from mid-stick on up because you don't want the heli to jump up or down when you engage the switch due to a difference in pitch curve profiles. Thus, the top end pitch will be the same; the hover pitch will also be the same (and will still occur at 3/4 stick - exactly as it does for idle Up 1). Similarly, mid-stick will continue to be 0° of pitch. The differences in the pitch curve will only be apparent in the run up to hover. The end result will be a smooth transition between the Normal Mode and the Idle Up 1 flight mode, which can be accomplished from hover pitch on up. At the bottom of the pitch range, there will be about -4° of pitch to enable easy landings even in a stiff breeze (Figure 10)

Figure 10
Normal & Hold - switchless inverted



By the way, if it's not clear, you measure pitch at the blades with a pitch gage while ensuring the flybar is absolutely level. Your hobby dealer will have pitch gages available. With a switchless inverted set-up, there's not often a need for a Idle Up 2 Flight Condition. Some expert pilots who use the condition often mimic Idle Up 1 so as to not have problems if they inadvertently toggle the switch past the Idle Up 1 position. Other expert pilots will have almost the exact same curve loaded but with slight changes to suit perhaps greater wind. We're treading on the territory of professionals. If you don't know *why* you would want an Idle Up 2 (in addition to an Idle Up 1), you likely don't need to worry about it.

This brings us to the Hold Condition. We recommend the Hold Condition pitch curve should look identical to the Normal Curve. The Hold Condition is used for practicing autorotation landings - simulated engine out landings.

The end result is you will have the ability to switch between flight modes, be it Normal, Idle Up 1, (or 2), and Hold without the helicopter doing anything strange. What's more, you can always find the unloaded point on the rotor disk (0°) because it's mid-stick for every single flight condition. This is a tremendous advantage in flight management and will permit the easiest way to master aerobatic flight with the **Tiger 50**.

At this point you may be wondering how do you decide what the top end pitch will be? This is determined by the power of the engine. Some engines being stronger than others can pull 11° of pitch with no problem, others can only pull (without sagging) 10.5° of pitch, etc. It depends on the engine. However, while we can directly *measure* the pitch of the main rotor, we don't have an easy way to measure power output. The easy answer to this is max pitch corresponds to max throttle opening. Usually. The top-level aerobatic pilots however keep a little in reserve at top end pitch so they can add *more* power to make up for the cyclic demands of pitch and power during maneuvers - but that's beyond the scope of this manual. We'll get into all this a bit later when we discuss Throttle Curves.

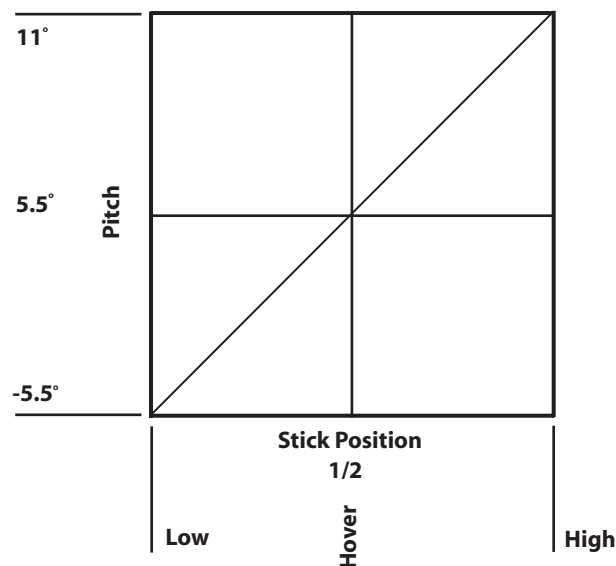
We've pretty well covered the pitch curves for an experienced pilot who wants to perform any 3D maneuvers within their repertoire.

Upright Orientation: Normal Pitch Curve

Next we'll discuss the minor changes made to the pitch curves for the pilot who is not really interested in extreme aerobatic flight. First up is the Normal Pitch Curve (for upright oriented flight). As you'll see, the curve really doesn't look very different at all, but the values are quite a bit different as the hover point now occurs at mid-stick. In fact, this is a much better set-up for hovering as the sensitivity of the T/C stick is reduced by half! Top end pitch is not changed either. Bottom end pitch is changed to the negative value of the hover pitch. In this case, it's -5.5° (though some pilots may not like the bottom end pitch quite so steep, it does allow greater precision and control for spot landings by adding the ability to drop quite steeply by adding loads of negative pitch).

By the way, have we mentioned just how easy it is to make the changes to the curves? It's done simply by changing the ATV (total amount of servo throw) for each of the three CCPM servos. Of course this is done with the pitch gage installed on the blade so you can interactively make adjustments. It's quite easy and takes only a few minutes to program into the transmitter! (Figure 11)

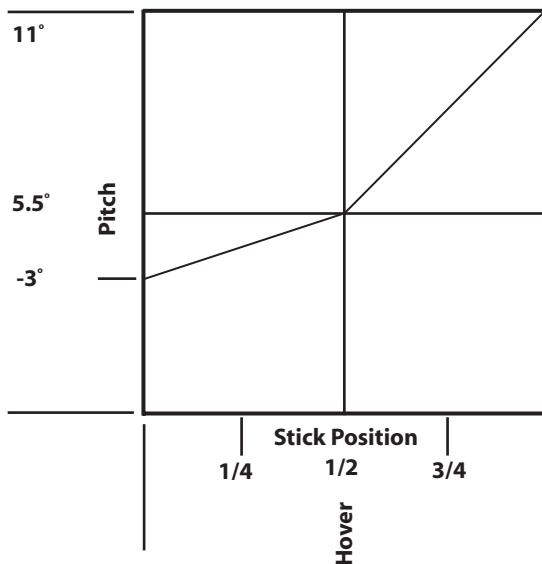
Figure 11 **Normal & Hold - upright orientation**



You may have noticed the T/C stick is no longer symmetrical for the Normal Curve in an upright oriented system because there's 11° of pitch between low pitch and hover and only 5.5° of pitch between hover and high pitch. Earlier we mentioned many pilots don't like the low end of the pitch range setup so sensitive. This is very easy to adjust with the transmitter by decreasing the low-end ATV values of the three CCPM servos.

Below is another Normal Pitch curve - one that many pilots may find more comfortable. However, be aware that in high winds, it may be harder to get the helicopter back down because you'll find a need for more and more negative pitch as the wind speed increases. In fact, in a stiff breeze, a helicopter with only 0° of pitch, seemingly doesn't want to come down! (Figure 12)

Figure 12
Normal & Hold - upright orientation

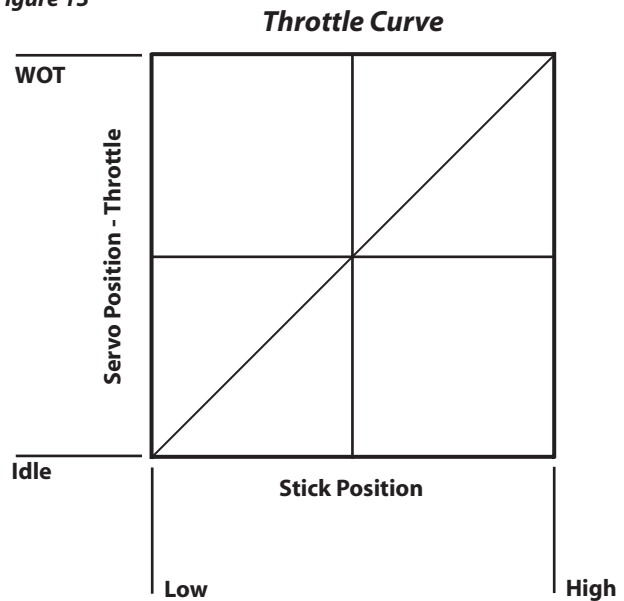


For an upright, or sport, orientation, there's also a need for an Idle Up 1 Pitch Curve because while the helicopter spends most of its time upright, it doesn't spend *all* its entire time upright. This heli will occasionally perform both loops and rolls during which it will be briefly inverted. What does the Idle Up 1 Pitch Curve look like for a machine with a sport orientation? Exactly like the one above! The difference isn't in the pitch curves but in the throttle curves. Why? Because it's critical to always maintain rotor speed, most especially when the helicopter is in the inverted portions of the maneuvers. This leads up to discussing throttle curves.

ELECTRONIC SET-UP: Throttle Curves

As with pitch curves, throttle curves are just the graphical representation of servo position as it relates to stick position. In this case, the stick is the T-part of T/C, or throttle. High stick corresponds to high pitch. The throttle curve for a Normal pitch curve might look like the one below. Notice, how the throttle is closed at low stick and wide open (WOT) at high stick and somewhere in the middle for mid-stick, or hover. (Figure 13)

Figure 13



The whole idea of throttle curves is for the throttle to add or subtract power to the main rotor system (by opening or closing the throttle) so as to maintain the RPMs of the main rotor constant. Seems simple enough as increasing main blade pitch means you increase the load, which would slow down the main rotor blades unless we also increased the throttle. Similarly, reducing the load on the main rotor system by reducing the pitch would lessen the load on the engine which is compensated for by closing the throttle the appropriate amount - understand? Hence, the reason why we refer to the throttle collective stick as the T/C stick is because the throttle and the collective pitch move at the same time, or are linked. Usually.

Usually? Yes, the usual relationship means high pitch and high throttle while low pitch is linked to low throttle. But there are times when this isn't the case - during Idle Up and Hold.

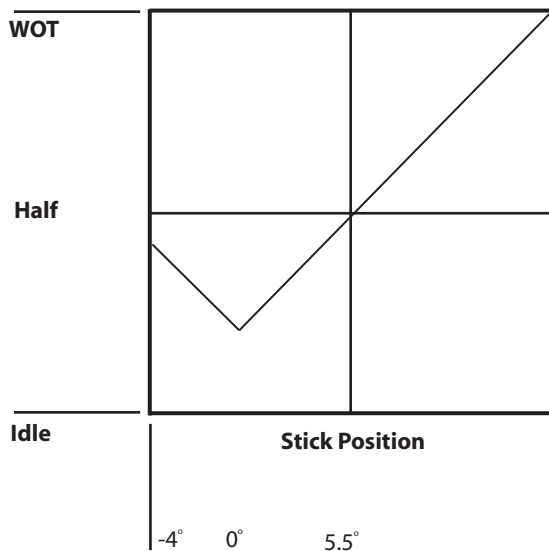


Throttle Curves: Idle Up and Hold Conditions

While the throttle and the collective pitch servos move at the same time, or are linked, for Normal pitch curves, as soon as a helicopter is inverted, the pitch servo moves in the opposite (negative) direction. If the system closed the throttle it would mean disaster, as the rotor speed would decay! Similarly, to practice autorotation, the pilots wishes to disconnect the throttle from the collective stick, in effect setting the engine at idle while permitting the pilot to perform the autorotation maneuver as if the engine had died. Then, if the maneuver isn't coming along well, the pilot flips the hold switch back, the engine roars back to life from idle, and the helicopter can enter normal flight again. Both of these are conditions where the linking of throttle and collective in their usual relationship isn't desired. They are accomplished by throwing a switch.

In the case of Idle Up, the pilot flips the Idle Up switch (which may actually have three positions, Off, Idle Up 1, and Idle Up 2). Engaging this switch tells the radio system to convert both the Normal Pitch curve (when Idle Up switch is Off) to the Idle Up 1 Pitch and the Idle Up 1 throttle curves. The purpose is to keep the rotor speed constant. The actual amount of throttle required is subject to experimentation. If you don't know how to fly inverted, get an experienced pilot to help you - or you'll be in big trouble! Below is what an Idle Up 1 throttle curve might look like for an upright oriented helicopter. (Figure 14)

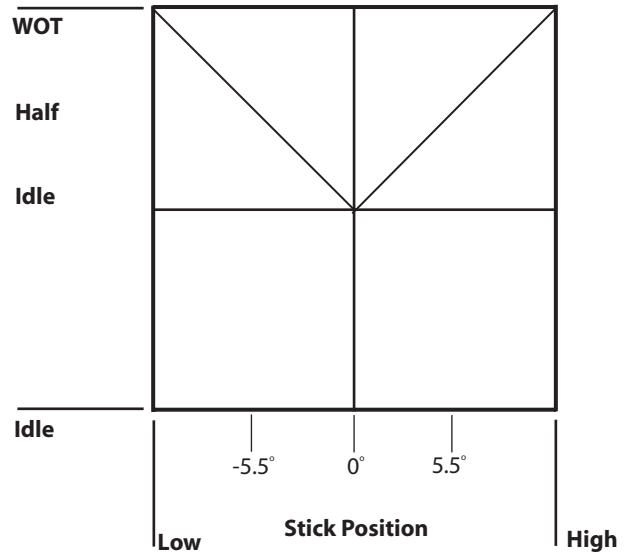
Figure 14 *Throttle Curve*



What's immediately apparent is the throttle closes until it hits 0° pitch at which point as the pitch goes negative, the throttle opens up again (some) in an effort to keep the main rotor blade speed constant.

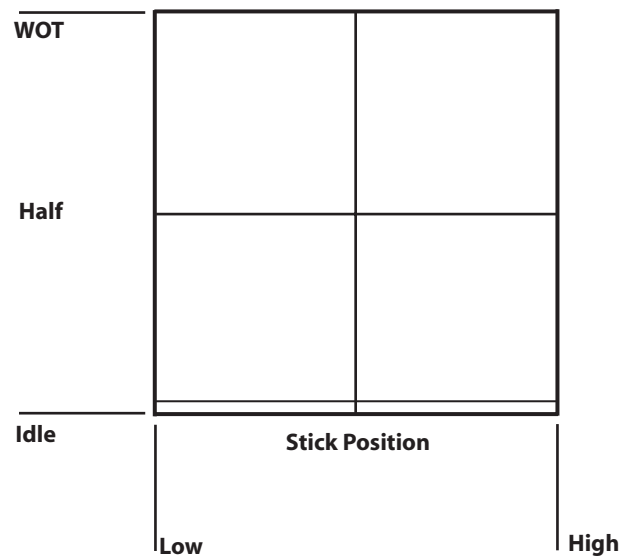
Below is the throttle curve for Idle Up 1 for a full-on extreme performance helicopter. (Figure 15)

Figure 15 *V-shape Throttle Curve*



This is what's known as a V-shape throttle curve. It follows the Idle Up 1 pitch curve from Figure 9. You'll note, the low-point for the throttle opening corresponds to about 0° pitch. This is close to an idle setting - but it must be adjusted in flight. The throttle for hover pitch is about the same as for the normal curve. The last curve is the one for Hold. Again, this isn't a curve, it's just a straight line that represents a faster (reliable) engine idle. (Figure 16)

Figure 16 *Hold Throttle Curve*

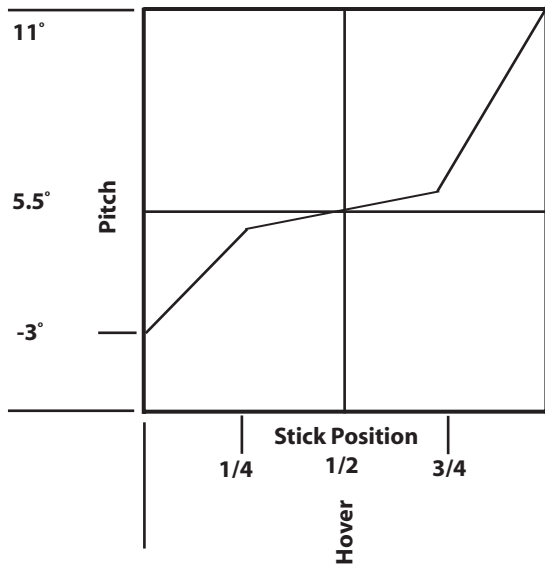


The amount of throttle in the Hold curve is also determined by experiment. Usually the idle setting is a little bit higher than normal, not a lot, just enough to ensure the engine will *not* die during the descent. That's because if you bail from the maneuver (autorotation practice) by flipping the switch back and the engine is dead, then you are committed to completing the autorotation - or crash! Since the reason you usually bail from a practice autorotation is you've screwed it up somehow, you then find yourself in big trouble. Make certain the engine idles reliably.

In practice, these Pitch and Throttle Curves often don't look like the beautiful straight lines we've used for the manual. Often, to keep main rotor speed from decaying, or from going too fast, the pitch throttle points will not be quite as perfect as those we've shown. It's also worth noting that for all of the example curves demonstrated, we've assumed you've had a radio, which can set 5 points for all the curves. These points are, low-stick, 1/4-stick, mid-stick (or 1/2-stick), 3/4-stick, and full-stick.

For example, many pilots will have a Normal Pitch curve (upright orientation) which looks more like this. (Figure 17)

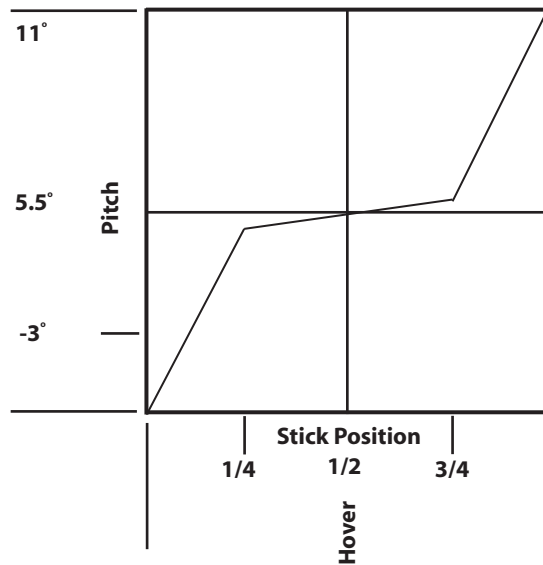
Figure 12
Normal Pitch-upright orientation



The flattened part of the curve is so collective pitch control for the helicopter isn't quite as sensitive. Similarly, the Normal Throttle Curve for an

upright oriented helicopter will look more like this. (Figure 18)

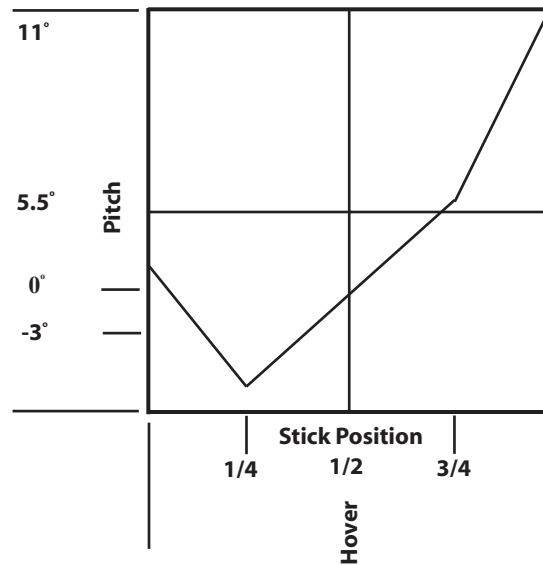
Figure 18
Normal Throttle Curve - sport



What's happening here is the throttle decreases sharply until the stick is at 3/4-stick then flattens near the hover (mid-stick) position. Again, the curve stays fairly flattish between the 1/4 and 3/4-stick positions which help keeps throttle sensitivity good near hover. From the 1/4-stick position the curve drops steeply again towards an idle setting.

This is what the Idle Up 1 throttle curve might look like for an upright, or sport, oriented helicopter. (Figure 19)

Figure 19
Idle Up 1 Throttle Curve - sport

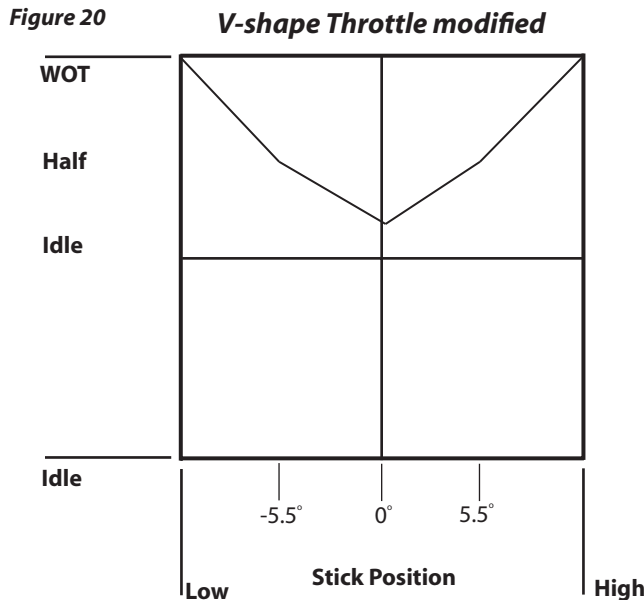


The low point in the curve corresponds to 0

of pitch and then the curve climbs as the throttle is opened to account for the fact the main rotor blade system is being loaded again as pitch increases from 0° to -3° of pitch.

The fly in the ointment is the limitation of having only 5 points on these curves. If you have ever wondered why top pilots use radio systems like flagship 9 and 10-channel systems from the likes of Futaba and JR, the reason is these systems have more capabilities - chief amongst them, more points on the curves.

Now let's look at the Idle Up 1 throttle curve for a switchless inverted, or extreme performance, helicopter. (Figure 20)



This throttle curve looks much like the V-shape throttle curve from Figure 15, but the main difference is the shallowing out of the curve between hover-throttle and 0° pitch. Also note the throttle doesn't go fully to idle during 0° pitch as the pilot is not going to spend much time with the main rotor unloaded at this point. Instead, this is actually simply a transition point on the way to re-loading the rotor disk as pitch goes negative.

In setting up the throttle curves, you must bear in mind that while we can measure the pitch we set up into the main rotor disk (using a pitch gage), we cannot however, measure the power settings. Hence, the first thing you set after

establishing the neutral point for all the linkages (and ensuring the control and servo arms make perfect 90° angles as they meet) is the desired pitch for 0° -pitch, hover-pitch, and full-pitch stick positions. These, of course, are low-stick, 1/2-stick, and full-stick for an extreme performance oriented helicopter. Then, once each of these stick positions are set, leave the settings alone.

Since we cannot measure power using calipers, a ruler, or any gage we will establish the proper throttle position via flight-testing - empirically! For most pilots, max pitch is the simplest to set because the carburetor is at WOT (wide open throttle) position. Remember, depending on the capabilities of your radio system, you may actually use 95% power at max pitch and keep 5% in reserve for maneuvers (throttle ATV needs be at 100% - physical WOT). If the engine will not pull the max pitch you established, then the solution is to reduce the pitch curve at that point. If the rotor speed is too high at max pitch, and you already have all the extra throttle (5%) you want in your pocket for maneuvers, then increase the main blade pitch at high stick using pitch ATV.

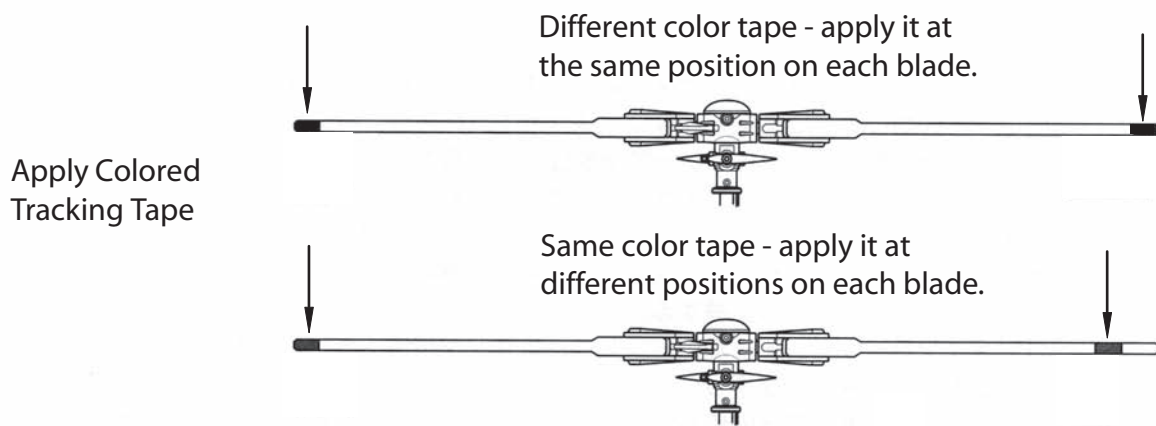
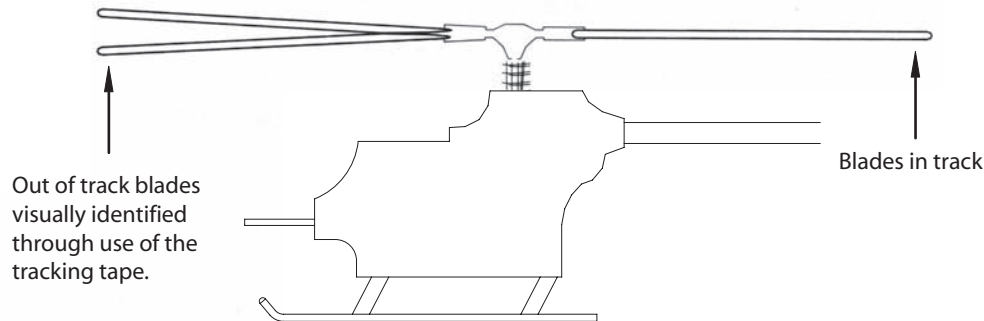
For the Normal mode, you will use the engine's good-idle speed as the setting for low-stick. Hover power is initially a straight line between the two other positions and is dialed in when actually hovering the machine. If when hovering the rotor speed is too low, then increase the mid-stick position throttle curve. Conversely, if the rotor RPMs are too high, reduce engine power at mid-stick. At this point, as we mentioned earlier, it is important to again verify the hover throttle position has the linkage at 90° to the pushrod. At all costs we desire to keep differential throw to a minimum - with throttle this will promote a linear delivery of the power. All adjustments to the rotor speed are done with throttle curves.

ELECTRONIC SET-UP: Gyroscope

As a rule, piezo crystal gyroscopes have replaced old-technology mechanical spinning gyros. These usually feature heading-hold. When in this mode, turn off the Revolution mix in the radio (all flight modes using heading-hold will have REVO turned off). That's completes initial set-up - now it's time to go to the field!

FIELD SET-UP: Blade Tracking

You've completed an initial set-up on the workbench; now it's time to make some fine adjustments. The first thing to do is remove the canopy because this will permit easy access to the linkages. This will have a negligible effect on trimming the model, but the prudent modeler may add about 6 oz. of weight to the radio platform to compensate. If the helicopter does not drift too much, proceed to blade tracking before trimming the model. If the machine is in need of so much trim that tracking the blades will be difficult, then perform some trimming first. Hopefully the machine is accurately built and very little, if any, trim will be needed. The procedure is to lift the machine into a low hover (skids a few inches off the ground) and verify the blade tracking. It's great to have an experienced helicopter pilot's help at this stage. Apply tracking tape and verify the blades are in track.



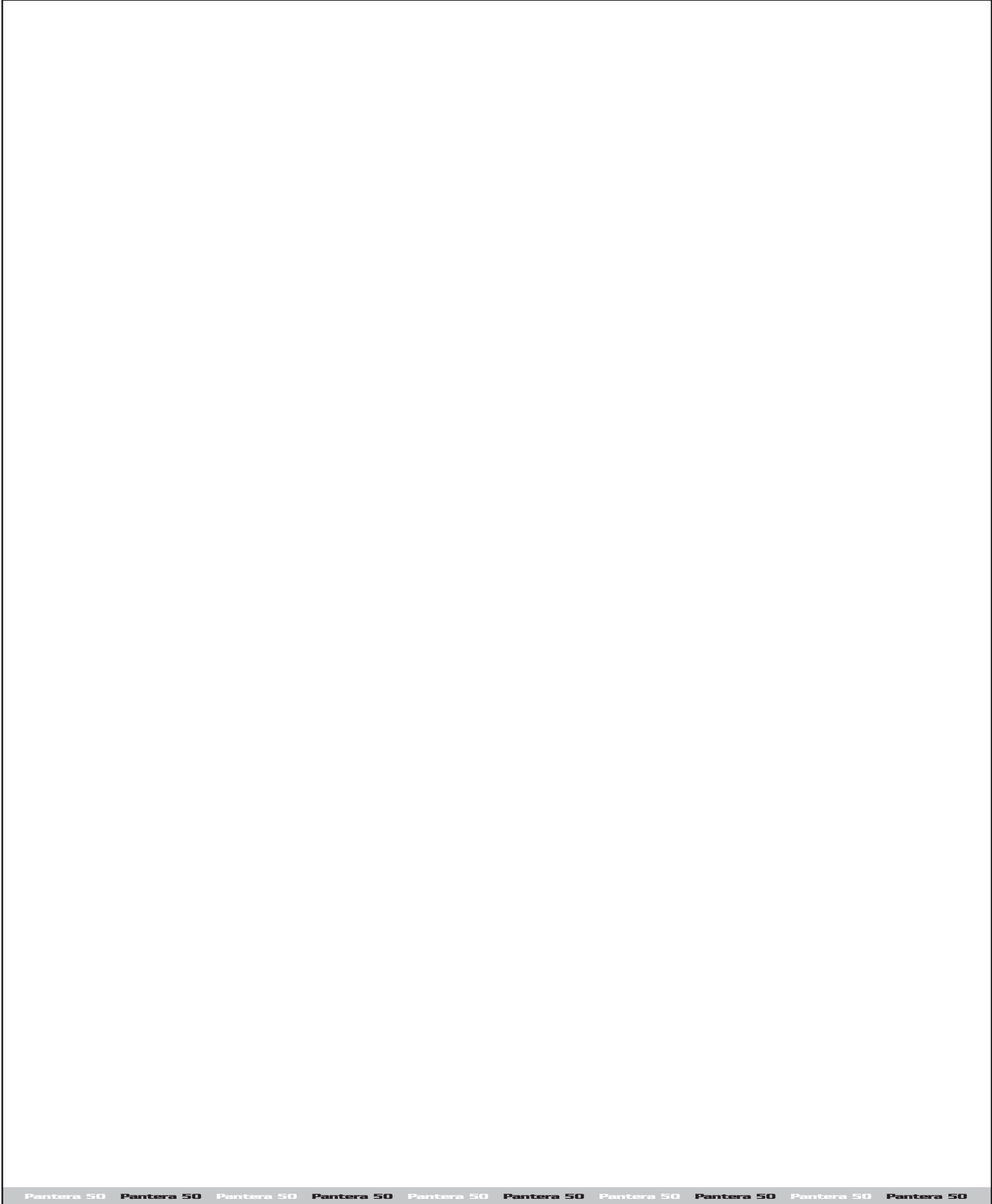
FIELD SET-UP: Trimming & Linkage Adjustment

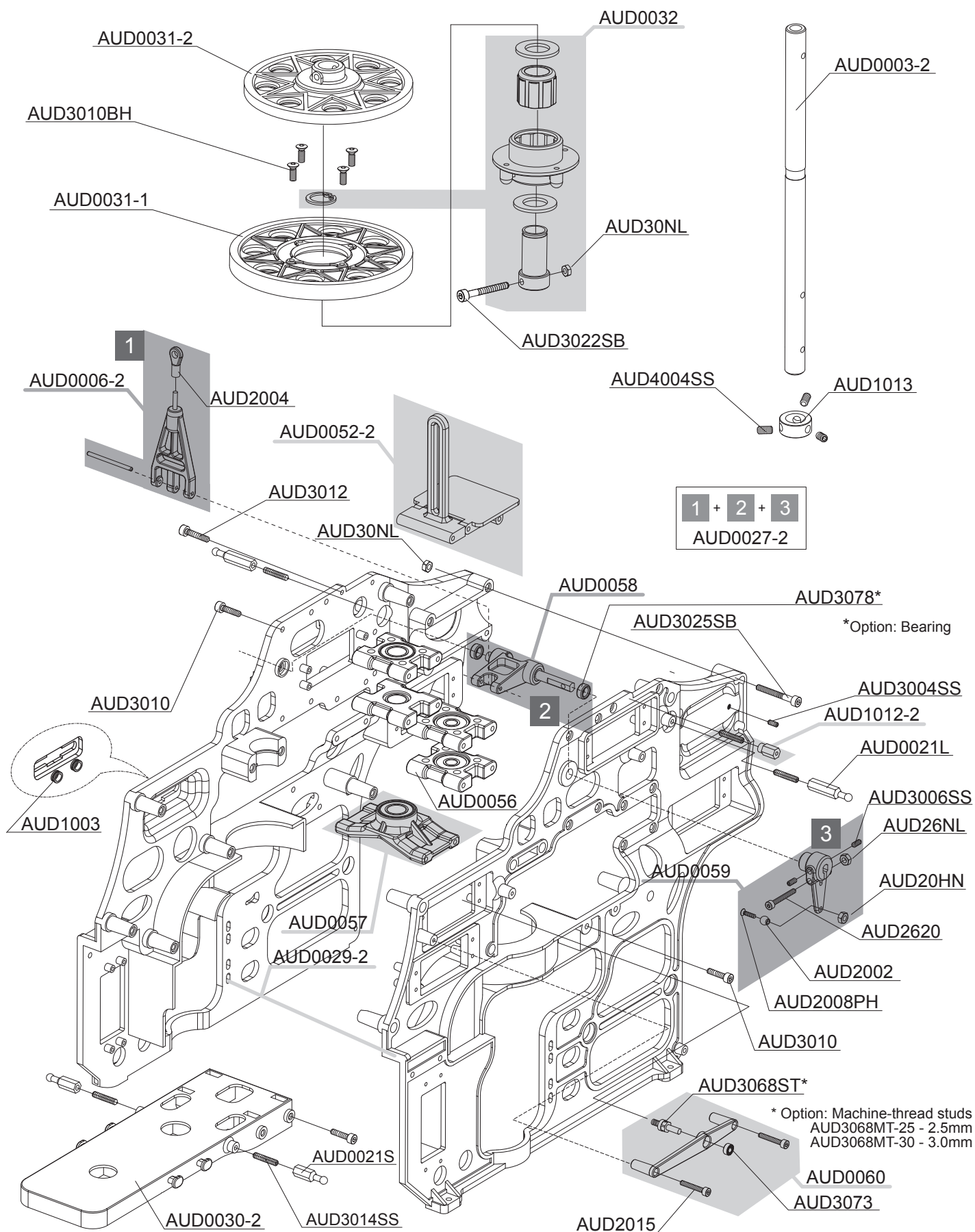
After tracking the blades, remove the tracking tape, it's time to make trim adjustments. Lift the helicopter into a high hover (skids at eye level) so that ground effect doesn't affect the model. If the model holds position fairly well, or only needs 1 or 2 clicks, you're done. If more than this is needed, make mechanical linkage adjustments to compensate, re-center the trims on the transmitter, and try again. Verify the neutral position for both the throttle and T/R linkages are correct in the hover.

FIELD SET-UP: Dynamic Blade Balance

Remove balance-weight and re-install canopy. Lift model in high hover. If there are some small vibrations, try to dynamically balance the main rotor. Pick a blade and add a wrap or two of tracking tape at the CG of the blade. Lift into a hover and if it's worse, remove the tape and try adding it to the other blade. If it's better but not perfect, add a bit more. This is a trial and error process, which most pilots don't bother with, but time spent here will deliver a much smoother performing helicopter.







| PART # | DESCRIPTION | QTY | REMARKS |
|-----------|--|-----|---|
| AUD0003-2 | Shaft, Main, steel, hollow | 1 | |
| AUD0006-2 | Swashplate Link Assembly | | |
| | Swashplate Link | 1 | |
| | Elevator Arm Pin | 1 | |
| | Ball Link, Short (AUD2004) | 1 | |
| AUD0021L | Canopy Standoff, Long | 2 | Mounts on AUD3014SS |
| AUD0021S | Canopy Standoff, Short | 2 | Mounts on AUD3014SS |
| AUD0027-2 | Elevator Control Assembly | | Combines AUD0006-2, AUD0058 and AUD0059 |
| | Swashplate Link | 1 | |
| | Elevator Arm Pin | 1 | |
| | Ball Link, Short (AUD2004) | 1 | |
| | Elevator Link | 1 | |
| | Bushing, Nylon | 2 | |
| | Elevator Lever | 1 | |
| | Screw, Set (AUD3006SS) | 2 | |
| | Bolt, Allen Head (AUD2620AH) | 1 | |
| | Nut, Nylon Locking (AUD26NL) | 1 | |
| | Joint Ball (AUD2002) | 1 | |
| | Screw, Phillips Head (AUD2008PH) | 1 | |
| | Nut, Hex (AUD20HN) | 1 | |
| AUD0029-2 | Main Frame Set | 1 | |
| AUD0030-2 | Radio Platform, Long | 1 | AUD0030, Short (for aft CG - 3D flight) |
| AUD0031-1 | Main Gear 1, Lower | 1 | |
| AUD0031-2 | Main Gear 2, Upper | 1 | |
| AUD0032 | Autorotation Assembly | | |
| | Snap Ring, M11 | 1 | |
| | Washer, Flat | 2 | |
| | Clutch, One-Way, Autorotation | 1 | |
| | Housing | 1 | |
| | Autorotation Shaft | 1 | |
| | Bolt, Allen Head (AUD3022AH) | 1 | |
| | Nut, Nylon Locking (AUD30NL) | 1 | |
| AUD0052-2 | Gyroscope Platform Assembly | | |
| | Gyroscope Platform | 1 | |
| | Swashplate Anti-Rotation Guide | 1 | |
| AUD0056 | Bearing Block (all 4 are the same) | 1 | Mounts with 4 ea. AUD3010AH |
| AUD0057 | Bearing Block, Offset | 1 | Mounts with 4 ea. AUD3010AH |
| AUD0058 | Elevator Link Assembly | | |
| | Elevator Link | 1 | |
| | Bushing * | 2 | * Option: AUD3078 Bearing |
| AUD0059 | Elevator Lever Assembly | | |
| | Elevator Lever | 1 | |
| | Screw, Set (AUD3006SS) | 2 | |
| | Bolt, Allen Head (AUD2620AH) | 1 | |
| | Nut, Nylon Locking (AUD26NL) | 1 | |
| | Joint Ball (AUD2002) | 1 | |
| | Screw, Phillips Head (AUD2008PH) | 1 | |
| | Nut, Hex (AUD20HN) | 1 | |
| AUD0060 | Servo Shaft Stabilizer Assembly | | |
| | Servo Shaft Stabilizer, plastic | 3 | |
| | Stud, Servo, Self-Tapping* (AUD3068ST) | 3 | * Option: Stud, Servo, Machine-Thread AUD3068MT-25 - M2.5mm AUD3068MT-30 - M3.0mm |
| | Bearing (AUD3073) | 3 | |
| | Bolt, Allen Head (AUD2015AH) | 6 | |
| AUD1003 | Rubber Grommet, Switch | 2 | |
| AUD1012-2 | Servo Support Boss Assembly | | |
| | Servo Support Boss, aluminum | 1 | |
| | Screw, Set (AUD3014SS) | 1 | |
| AUD1013 | Main Shaft Collar Assembly | | |
| | Main Shaft Collar | 1 | |
| | Screw, Set (AUD4004SS) | 3 | |
| AUD3068ST | Stud, Servo, Self-Tapping* | 3 | * Option: Stud, Servo, Machine-Thread |



AUD4004SS

AUD0001

AUD3006BH

AUD30FW

AUD3077

AUD0002

AUD3008

AUD0035-2

AUD3081

AUD0026-2

AUD0038

AUD0056

AUD3076

AUD0061

AUD0037-2

AUD1011-2

AUD1510

AUD0036-2

AUD20HN

AUD3008

AUD3080

AUD0034

AUD30FW

AUD2008PH

AUD30LW

AUD2002

AUD3015

AUD3012

AUD1014

AUD2350R

PDR0053

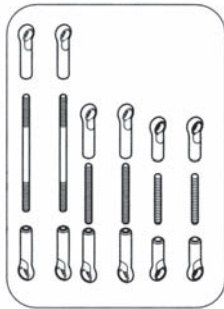
AUD2003

AUD3038



| <i>PART #</i> | <i>DESCRIPTION</i> | <i>QTY</i> | <i>REMARKS</i> |
|---------------|------------------------------------|------------|-----------------------------|
| AUD0001 | Hex Start Adapter Assembly | | |
| | Hex Start Adapter | 1 | |
| | Screw, Set (AUD4004SS) | 1 | |
| AUD0002 | Front Tail Belt Pulley Assembly | | |
| | Pulley, Front | 1 | |
| | Bolt, Button Head (AUD3006BH) | 1 | |
| | Washer, Flat (AUD30FW) | 1 | |
| AUD0026-2 | Clutch Bell Assembly | | |
| | Clutch Bell | 1 | |
| | Gear, Tail Pinion | 1 | |
| | Bearing (AUD3076) | 1 | |
| | Clutch Lining (AUD1510) | 1 | |
| AUD0034 | Engine Mount, OS 50SX bolt pattern | 1 | |
| AUD0035-2 | Shaft, Start | 1 | |
| AUD0036-2 | Fan, Cooling | 1 | |
| AUD0037-2 | Fan Hub | 1 | |
| AUD0038 | Clutch Assembly | | |
| | Clutch | 1 | |
| | Bolt, Allen Head (AUD3008AH) | 2 | |
| AUD0056 | Bearing Block | 1 | Mounts with 4 ea. AUD3010AH |
| AUD0061 | Engine to Fan Hub Mounting Kit | | |
| | Nut, Tapered, Engine - 1/4-28" | 1 | |
| | Collet, Split, brass | 1 | |
| AUD1011-2 | Gear, Counter | 1 | |
| AUD1014 | Washer, Dress | 4 | |
| AUD1510 | Clutch Lining | 1 | |
| AUD3072 | Bearing | 1 | |





AUD0025U-2

AUD3066

AUD3015

AUD1015-2K

AUD3069

AUD1015-2

AUD2002

AUD3071

AUD2010PH

AUD0004-2

AUD2003

AUD3068ST

AUD2340R

AUD3064

AUD1001

AUD0039

AUD2010PH

AUD2013PH

AUD2002

AUD2330R

AUD3068ST

AUD2003

AUD0003-2

AUD2003

AUD2360R

AUD3068ST*

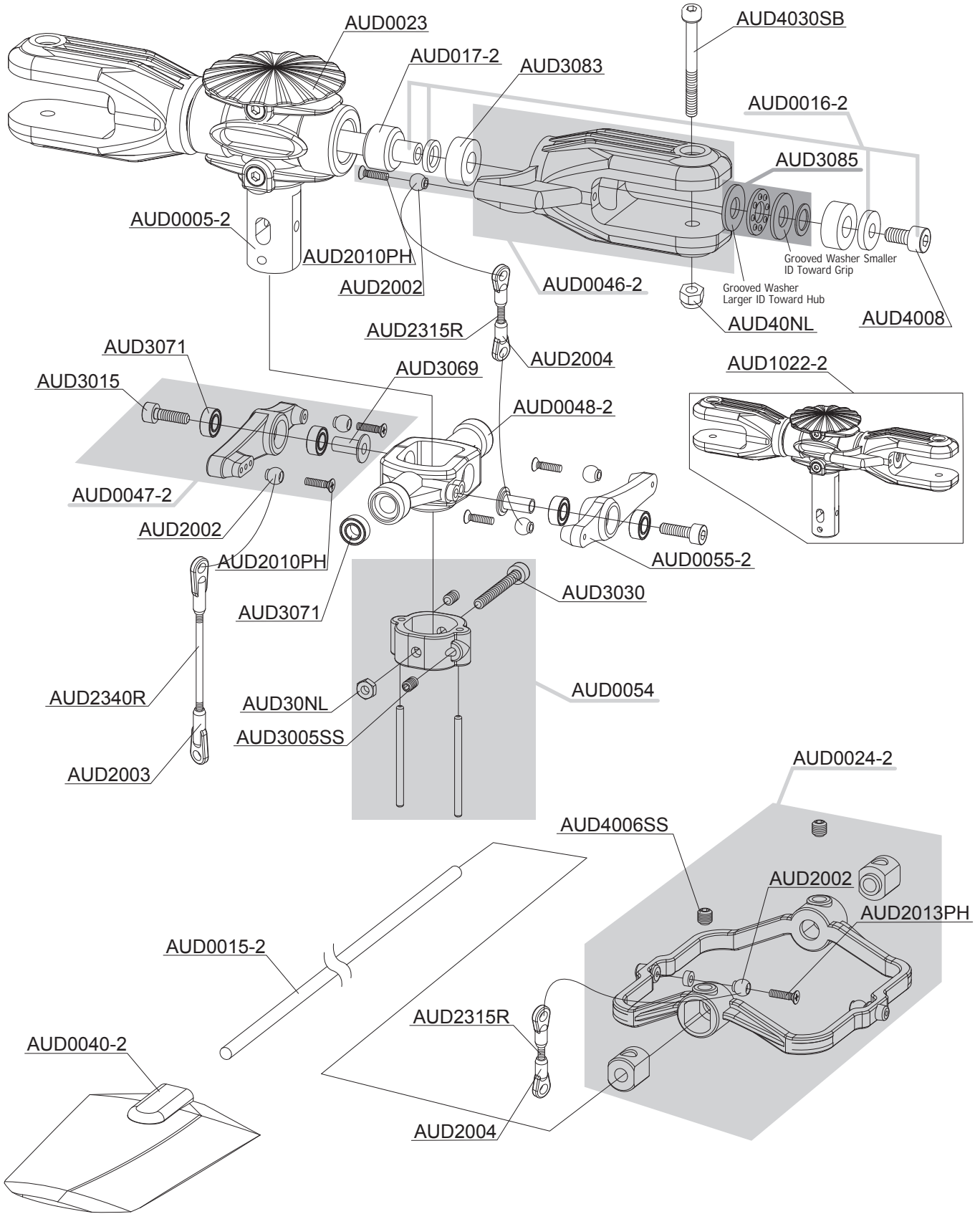
AUD2012PH

* Option: Machine-thread studs
 AUD3068MT-25 - 2.5mm
 AUD3068MT-30 - 3.0mm



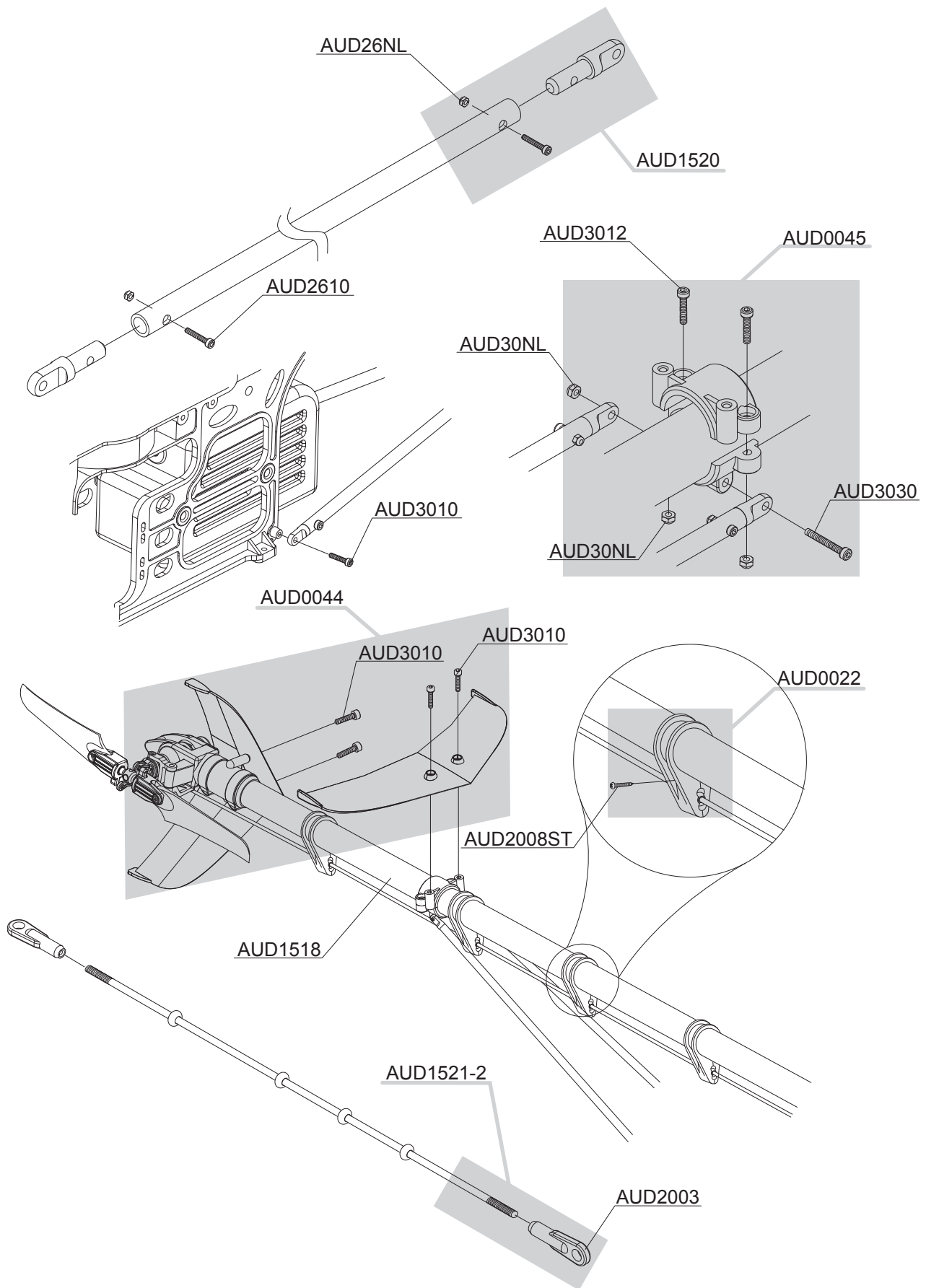
| PART # | DESCRIPTION | QTY | REMARKS |
|------------|----------------------------------|-----|---|
| AUD0003-2 | Shaft, Main, steel, hollow | 1 | |
| AUD0004-2 | Washout Base | 1 | |
| AUD0025U-2 | Upper Linkage Set | | |
| | Ball Link, Long | 8 | |
| | Ball Link, Short | 4 | |
| | Threaded Rod (AUD2330TR) | 2 | |
| | Threaded Rod (AUD2340TR) | 2 | |
| | Threaded Rod (AUD2360TR) | 2 | |
| AUD0039 | 120° Swashplate Assembly | | |
| | Swashplate | 1 | |
| | Ball Arm | 3 | |
| | Joint Ball (AUD2002) | 4 | |
| | Screw, Phillips Head (AUD2010PH) | 2 | |
| | Screw, Phillips Head (AUD2013PH) | 2 | |
| AUD1001 | Washout Link Assembly | | |
| | Washout Link | 2 | |
| | Spring Pin (AUD3066) | 2 | |
| | Nut, Push (AUD3064PN) | 4 | |
| AUD1015-2 | Washout Arm | 2 | |
| AUD1015-2K | Washout Arm Assembly | | |
| | Washout Arm (AUD1015-2) | 2 | |
| | Bearing (AUD3071) | 4 | |
| | Arm Shaft (AUD3069) | 2 | |
| | Bolt, Allen Head (AUD3015AH) | 2 | |
| | Joint Ball (AUD2002) | 2 | |
| | Screw, Phillips Head (AUD2010PH) | 2 | |
| AUD3068ST | Stud, Servo, Self-Tapping* | 3 | * Option: Stud, Servo, Machine-Thread AUD3068MT-25 - M2.5mm AUD3068MT-30 - M3.0mm |
| | | | |
| | | | |





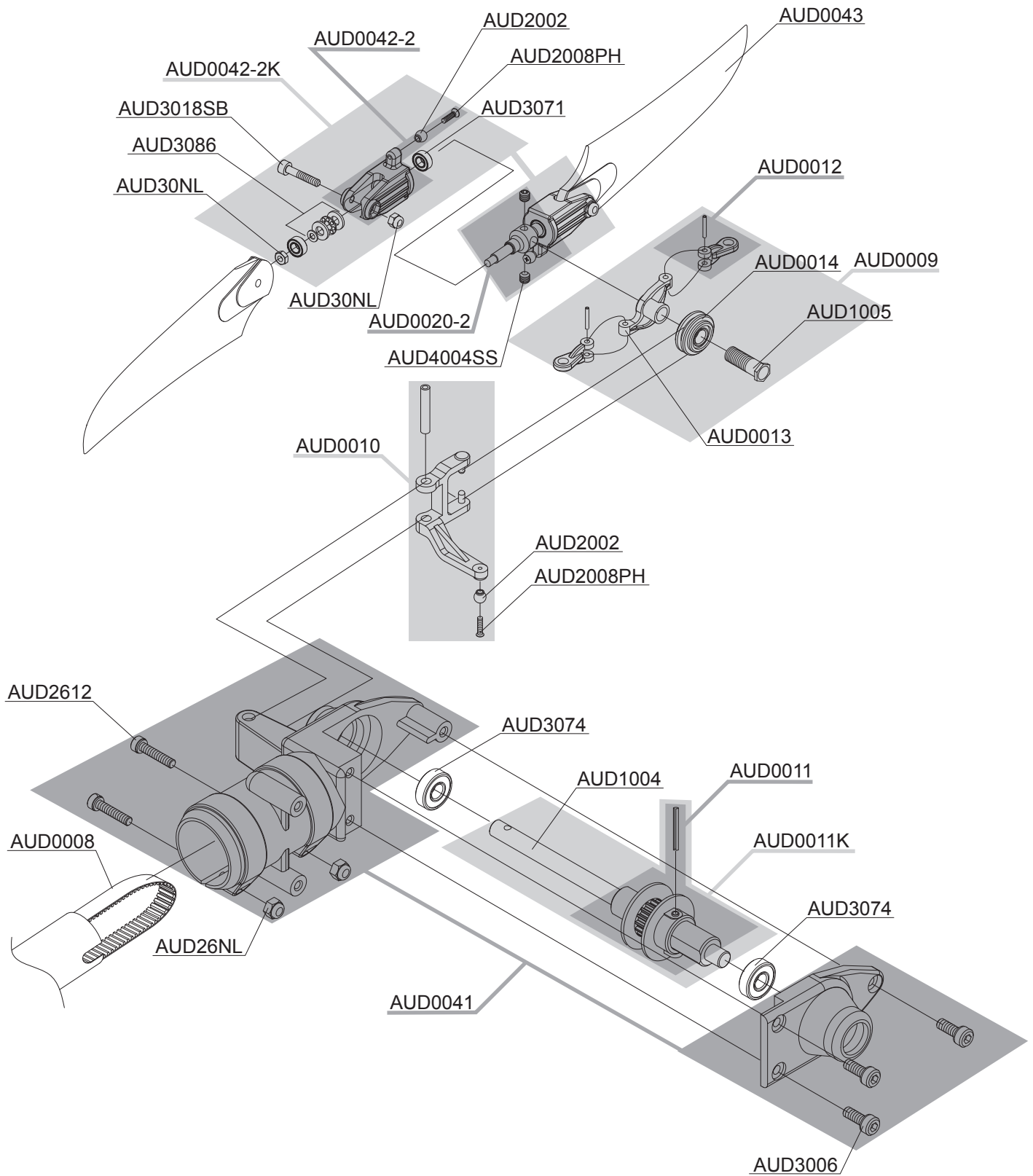
| PART # | DESCRIPTION | QTY | REMARKS |
|------------|--------------------------------------|-----|--|
| AUD0005-2 | Center Hub, aluminum | 1 | |
| AUD0015-2 | Flybar, 4mm | 1 | Option: PDR0066-2 3D Flybar |
| AUD0016-2 | Spindle Shaft Assembly | | Steel, fits between grip and damper M4x11x2, steel, high strength |
| | Shaft, Spindle | 1 | |
| | Spacer | 2 | |
| | Washer, Spindle | 2 | |
| | Allen Head Bolt (AUD4008AH) | 2 | |
| AUD0017-2 | Damper, 6mm ID | 2 | Urethane, High Performance |
| AUD0023 | Main Rotor Hub | 1 | |
| AUD0024-2 | Hiller Control Lever Assembly | | * Option: Up to two per side |
| | Hiller Control Lever | 1 | |
| | Flybar Stopper, aluminum (M2x4x5) | 2 | |
| | Bushing, Black* (M2x4x3) | 2 | |
| | Screw, Set (AUD4006SS) | 2 | |
| | Joint Ball (AUD2002) | 2 | |
| | Screw, Phillips Head (AUD2013PH) | 2 | |
| AUD0040-2 | Flybar Paddle | 2 | 3D, aft position is more aggressive |
| AUD0046-2 | Main Blade Grip Assembly | | |
| | Main Blade Grip | 2 | |
| | Joint Ball (AUD2002) | 2 | |
| | Screw, Phillips Head (AUD2010PH) | 2 | |
| AUD0046-2K | Grip/Spindle Kit | | |
| | Spindle Shaft Assembly (AUD0016-2) | 1 | |
| | Main Blade Grip Assembly (AUD0046-2) | 1 | |
| | Damper (AUD0017-2) | 2 | |
| | Bearing (AUD3083) | 4 | |
| | Bearing, Thrust (AUD3085) | 2 | |
| AUD0047-2 | Seesaw Arm Assembly | | |
| | Seesaw Arm (AUD0055-2) | 2 | |
| | Joint Ball (AUD2002) | 4 | |
| | Bolt, Allen Head (AUD3015AH) | 2 | |
| | Screw, Phillips Head (AUD2010PH) | 4 | |
| | Bearing (AUD3071) | 4 | |
| | Shaft, Seesaw Arm | 2 | |
| AUD0048-2 | Seesaw | 1 | |
| AUD0054 | Rotor Hub Adapter Assembly | | |
| | Rotor Hub Adapter | 1 | |
| | Washout Guide Pin | 2 | |
| | Bolt, Allen Head (AUD3020AH) | 1 | |
| | Screw, Set (AUD3005SS) | 1 | |
| | Nut, Nylon Locking (AUD30NL) | 1 | |
| AUD0055-2 | Seesaw Arm | 2 | |
| AUD1022-2 | Rotor Head Assembly | | |
| | Main Rotor Hub (AUD0023) | 1 | |
| | Center Hub (AUD0005-2) | 1 | |
| | Spindle Shaft Assembly (AUD0016-2) | 1 | |
| | Main Blade Grip Assembly (AUD0046-2) | 2 | |
| | Damper (AUD0017-2) | 2 | |
| | Bearing (AUD3083) | 4 | |
| | Bearing, Thrust (AUD3085) | 2 | |





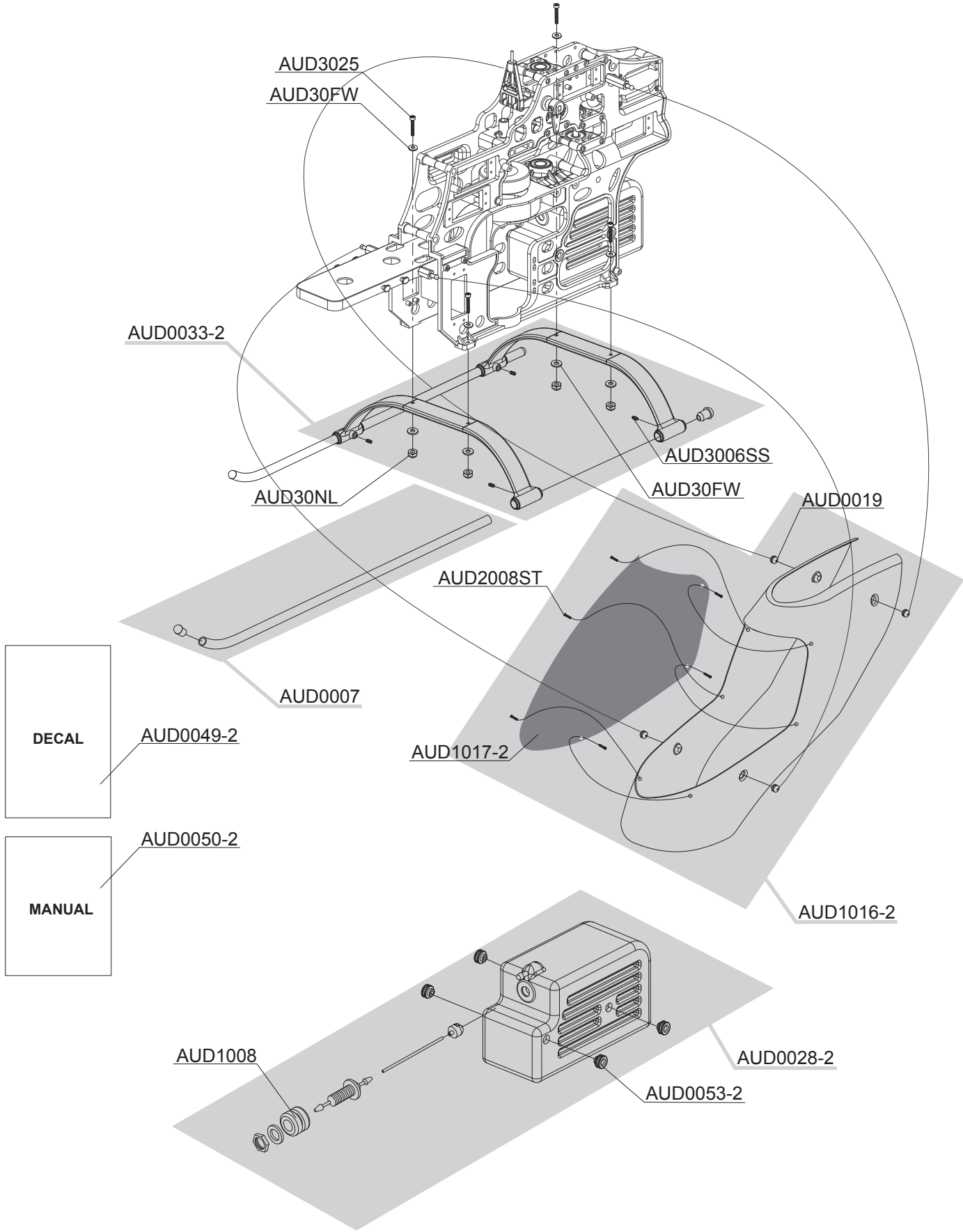
| <i>PART #</i> | <i>DESCRIPTION</i> | <i>QTY</i> | <i>REMARKS</i> |
|---------------|---------------------------------|------------|----------------|
| AUD0022 | Push Rod Guide Assembly | | Red color |
| | Push Rod Guide | 4 | |
| | Bushing, Push Rod, nylon, red | 4 | |
| | Screw, Self Tapping (AUD2008ST) | 4 | |
| AUD0044 | Tail Fin Set | | |
| | Fin, Horizontal | 1 | |
| | Fin, Vertical | 1 | |
| AUD0045 | Tail Support Clamp Assembly | | |
| | Tail Support Clamp (Upper) | 1 | |
| | Tail Support Clamp (Lower) | 1 | |
| | Bolt, Allen Head (AUD3012AH) | 2 | |
| | Bolt, Allen Head (AUD3030AH) | 1 | |
| | Nut, Nylon Locking (AUD30NL) | 3 | |
| AUD1518 | Tail Boom, aluminum | 1 | |
| AUD1520 | Tail Boom Support Assembly | | |
| | Aluminum Boom Support | 2 | |
| | Boom Support Ends | 4 | |
| | Bolt, Allen Head (AUD2610AH) | 4 | |
| | Nut, Nylon Locking (AUD26NL) | 4 | |
| AUD1521-2 | Tail Rotor Push Rod Assembly | | |
| | Tail Rotor Push Rod | 1 | |
| | Ball Link End (AUD2003) | 2 | |





| PART # | DESCRIPTION | QTY | REMARKS |
|------------|--|-------------------|---------|
| AUD0008 | Tail Drive Belt | 1 | |
| AUD0009 | Tail Slide Ring Assembly | | |
| | Tail Pitch Link Assembly (AUD0012) | 1 | |
| | Tail Pitch Plate (AUD0013) | 1 | |
| | Tail Slide Ring (AUD0014) | 1 | |
| | Tail Slide Ring Sleeve (AUD1004) | 1 | |
| AUD0010 | Tail Pitch Control Lever Assembly | | |
| | Tail Pitch Control Lever | 1 | |
| | Bushing | 1 | |
| | Joint Ball (AUD2002) | 1 | |
| | Phillips Head Screw (AUD2008PH) | 1 | |
| AUD0011 | Tail Pulley Assembly | | |
| | Tail Pulley | 1 | |
| | Spring Pin (AUD3066) | 1 | |
| AUD0011K | Tail Pulley/Output Shaft Kit | | |
| | Tail Pulley Assembly (AUD0011) | 1 | |
| | Shaft, Tail Output (AUD1004) | 1 | |
| AUD0012 | Tail Pitch Link Assembly | | |
| | Tail Pitch Link | 2 | |
| | Tail Pitch Link Pin | 2 | |
| AUD0013 | Tail Pitch Plate | 1 | |
| AUD0014 | Tail Slide Ring | 1 | |
| AUD0020-2 | Tail Rotor Center Hub Assembly | | |
| | Tail Rotor Center Hub | 1 | |
| | Screw, Set (AUD4004SS) | 2 | |
| AUD0041 | Tail Gear Case Assembly | | |
| | Tail Gear Case (Right) | 1 | |
| | Tail Gear Case (Left) | 1 | |
| | Bolt, Allen Head (AUD2612AH) | 2 | |
| | Bolt, Allen Head (AUD3006AH) | 3 | |
| | Nut, Nylon Locking (AUD26NL) | 2 | |
| AUD0042-2 | Tail Rotor Grip Assembly | | |
| | Grip, Tail Rotor Blade | 2 | |
| | Joint Ball (AUD2002) | 2 | |
| | Screw, Phillips Head (AUD2008PH) | 2 | |
| AUD0042-2K | Tail Rotor Grip Assembly | | |
| | Tail Blade Grip Assembly (AUD0042-2) | 1 | |
| | Tail Rotor Center Hub Assembly (AUD0020-2) | 1 | |
| | Bearing (AUD3071) | 4 | |
| | Bearing, Thrust (AUD3086) | 2 | |
| | Bolt, Shoulder (AUD3018S8) | 2 | |
| | Nut, Nylon Locking (AUD30NL) | 4 | |
| | AUD0043 | Tail Rotor Blades | 2 |
| AUD1004 | Shaft, Tail Output | 1 | |
| AUD1005 | Tail Slide Ring Sleeve | 1 | |





| <i>PART #</i> | <i>DESCRIPTION</i> | <i>QTY</i> | <i>REMARKS</i> |
|---------------|--|------------|----------------|
| AUD0007 | Landing Skid Assembly | | |
| | Landing Skid | 2 | |
| | Skid Cap | 4 | |
| AUD0019 | Canopy Rubber Mounting Grommet | 4 | |
| AUD0028-2 | Fuel Tank Assembly | | |
| | Fuel Tank | 1 | |
| | Clunk | 1 | |
| | Silicone Fuel Tubing | 1 | |
| | Nipple | 1 | |
| | Fuel Tank Washer | 1 | |
| | Fuel Tank Rubber Bung (AUD1008) | 1 | |
| | Flat Nut (M7) | 1 | |
| | Fuel Tank Mounting Grommet (AUD0053-2) | 4 | |
| AUD0033-2 | Landing Gear Strut Assembly | | |
| | Landing Gear Strut | 2 | |
| | Set Screw (AUD3006SS) | 4 | |
| AUD0049-2 | Decal Set | 1 | |
| AUD0050-2 | Manual | 1 | |
| AUD0053-2 | Fuel Tank Mounting Grommet | 4 | |
| AUD1008 | Fuel Tank Rubber Bung | 1 | |
| AUD1016-2 | Canopy Assembly | | |
| | Canopy (Body, Plastic, White) | 1 | |
| | Windscreen (AUD1017-2) | 1 | |
| | Self-Tapping Screw (AUD2008ST) | 6 | |
| | Canopy Mounting Grommet (AUD0019) | 4 | |
| AUD1017-2 | Windscreen Assembly | | |
| | Windscreen (Smoked Plastic, Translucent) | 1 | |
| | Self-Tapping Screw (AUD2008ST) | 6 | |



| BALL LINKS & BALL JOINTS | | |
|-------------------------------------|--|-----|
| PART # | DESCRIPTION | QTY |
| AUD2002 | Ball Joint Set, Stainless Steel | |
| | Ball Joint | 5 |
| | Screw, Phillips Head (M2x10), AUDM2010PH | 5 |
| AUD2003 | Ball Link End, Long, nylon, black | 10 |
| AUD2004 | Ball Link End, Short, nylon, black | 5 |

| BOLTS, ALLEN HEAD | | |
|--------------------------|----------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD2015AH | Bolt, Allen Head (M2x15) | 2 |
| AUD2610AH | Bolt, Allen Head (M2.6x10) | 2 |
| AUD2612AH | Bolt, Allen Head (M2.6x12) | 2 |
| AUD2620AH | Bolt, Allen Head (M2.6x20) | 2 |
| AUD3006AH | Bolt, Allen Head (M3x6) | 2 |
| AUD3008AH | Bolt, Allen Head (M3x8) | 2 |
| AUD3010AH | Bolt, Allen Head (M3x10) | 2 |
| AUD3012AH | Bolt, Allen Head (M3x12) | 2 |
| AUD3015AH | Bolt, Allen Head (M3x15) | 2 |
| AUD3022AH | Bolt, Allen Head (M3x22) | 2 |
| AUD3025AH | Bolt, Allen Head (M3x25) | 2 |
| AUD3030AH | Bolt, Allen Head (M3x30) | 2 |
| AUD3038AH | Bolt, Allen Head (M3x38) | 2 |
| AUD4008AH | Bolt, Allen Head (M4x8) | 2 |

| BOLTS, ALLEN HEAD, SHOULDER | | |
|------------------------------------|------------------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3018SB | Bolt, Allen Head, Shoulder (M3x18) | 2 |
| AUD3025SB | Bolt, Allen Head, Shoulder (M3x25) | 2 |
| AUD4030SB | Bolt, Allen Head, Shoulder (M4x30) | 2 |

| BOLTS, BUTTON HEAD | | |
|---------------------------|---------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3006BH | Bolt, Button Head (M3x6) | 2 |
| AUD3010BH | Bolt, Button Head (M3x10) | 2 |

| SCREWS, PHILLIPS HEAD | | |
|------------------------------|------------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD2008PH | Screw, Phillips Head (M2x8) | 5 |
| AUD2010PH | Screw, Phillips Head (M2x10) | 5 |
| AUD2012PH | Screw, Phillips Head (M2x12) | 2 |
| AUD2013PH | Screw, Phillips Head (M2x13) | 2 |

| SCREWS, SELF TAPPING | | |
|-----------------------------|----------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD2008ST | Screw, Self Tapping (M2x8) | 2 |

| SCREWS, SET | | |
|--------------------|--------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3004SS | Screw, Set (M3x4) | 2 |
| AUD3005SS | Screw, Set (M3x5) | 2 |
| AUD3006SS | Screw, Set (M3x6) | 2 |
| AUD3014SS | Screw, Set (M3x14) | 2 |
| AUD4004SS | Screw, Set (M4x4) | 2 |
| AUD4006SS | Screw, Set (M4x6) | 2 |

| RODS, THREADED | | |
|-----------------------|------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD2315TR | Threaded Rod (M2.3x15) | 2 |
| AUD2330TR | Threaded Rod (M2.3x30) | 2 |
| AUD2340TR | Threaded Rod (M2.3x40) | 2 |
| AUD2350TR | Threaded Rod (M2.3x50) | 2 |
| AUD2360TR | Threaded Rod (M2.3x60) | 2 |

| NUTS, NYLON LOCKING | | |
|----------------------------|---------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD26NL | Nut, Nylon Locking (M2.6) | 2 |
| AUD30NL | Nut, Nylon Locking (M3) | 2 |

| NUTS, HEX | | |
|------------------|---------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD20HN | Nut, Hex (M2) | 2 |
| AUD30HN | Nut, Hex (M3) | 2 |

| NUTS, PUSH | | |
|-------------------|----------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3064PN | Nut, Push (M2) | 2 |

| WASHERS, FLAT | | |
|----------------------|-------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD30FW | Washer, Flat (M3) | 2 |

| WASHERS, LOCK | | |
|----------------------|-------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD30LW | Washer, Lock (M3) | 2 |

| SPRING PINS | | |
|--------------------|-------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3066 | Spring Pin | 2 |

| STUDS, SERVO OUTPUT SHAFT | | |
|----------------------------------|----------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3068ST | Stud, Self Tapping | 3 |
| AUD3068MT-25 | Stud, Machine Thread, M2.5 | 3 |
| AUD3068MT-30 | Stud, Machine Thread, M3 | 3 |

| ARM SHAFTS | | |
|-------------------|-------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3069 | Arm Shaft | 1 |

| BEARINGS | | |
|-----------------|--------------------------|-----|
| PART # | DESCRIPTION | QTY |
| AUD3071 | Bearing, M4x8x3 | 1 |
| AUD3072 | Bearing, Oneway M6x10x12 | 1 |
| AUD3073 | Bearing, M3x6x2.5 | 1 |
| AUD3074 | Bearing, M5x13x4 | 1 |
| AUD3076 | Bearing, M6x12x4 | 1 |
| AUD3077 | Bearing, M10x19x7 | 1 |
| AUD3078 | Bearing, M5x8x3 | 1 |
| AUD3080 | Bearing, M5X19X6 | 1 |
| AUD3081 | Bearing, M6x19x6 | 1 |
| AUD3083 | Bearing, M6x13x5 | 1 |
| AUD3085 | Thrust Bearing, 6mm | 2 |
| AUD3086 | Thrust Bearing, 4mm | 2 |

