Rev 1.0M

SYNERGY 516

500 CLASS MODEL HELICOPTER*

WWW.SYNERGYRCHELICOPTERS.COM

*500-520mm main blades. 80-85mm tail blades.

INTRODUCTION

Congratulations on your purchase of the Synergy 516 radio controlled helicopter kit!

The Synergy 516 was designed and developed by Botos Design & Distribution Inc.. The design of the Synergy 516 emerged from many years of experience in the hobby including design, research & development, and last but not least as a world class pilot who truly enjoys this wonderful hobby.

This radio controlled helicopter is NOT A TOY. It is a sophisticated piece of equipment; it was designed and intended for hobby use only. If not properly assembled, maintained, and operated, it is capable of causing property damage and bodily harm to both the operator and/or spectators. Botos Design & Distribution Inc., its affiliates, and its authorized distributors assume no liability for damage that could occur from the assembly or use/misuse of this product. If you are new to the hobby we strongly recommend seeking the help and advice from an experienced modeler.

Operating a model helicopter requires a high degree of diligence and skill. If you are new to the hobby, it is best to seek help and guidance from experienced radio controlled helicopter pilots. This will both greatly speed up the learning process and make it much safer for you. For those pilots who will be operating their Synergy 516 in the United States, we strongly recommend joining the AMA. The AMA is a non-profit organization that provides services to the model aircraft pilots. As an AMA member, you will receive a monthly magazine entitled Model Aviation and most importantly a liability insurance plan to cover against a possible accident or injury. All AMA charter aircraft clubs require individuals to hold a current AMA sporting license prior to operation of their models.

For further information, you can contact the AMA at:

Academy of Model Aeronautics
5151 East Memorial Drive
Muncie, IN 47302
(317) 287-1256

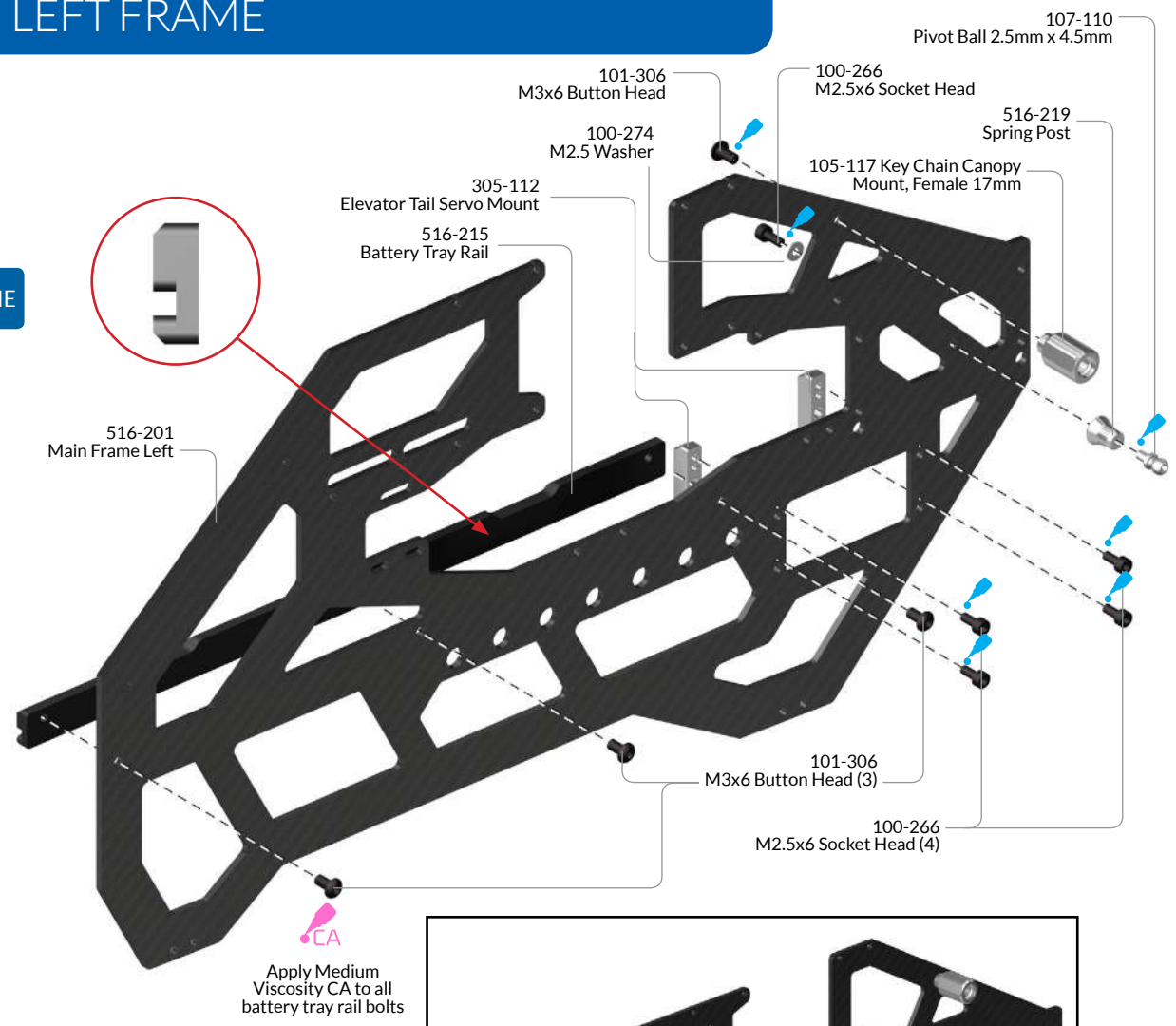
Features:

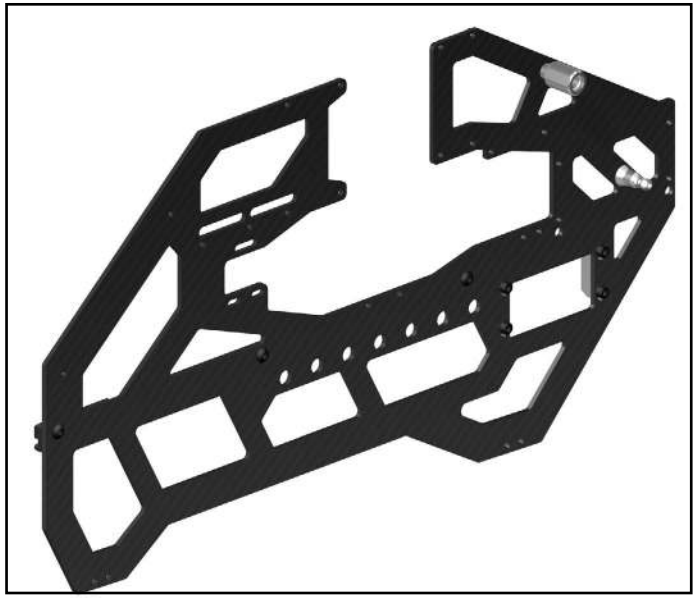
- All-metal and 2mm carbon fiber construction
- CNC machined 6061-T6 aluminum and Delrin components
- 140mm full head width for optimal disk loading
- Extra wide head block for quick cyclic response and high stability
- Capable of 2800+ RPM head speed for maximum performance
- Machined Delrin helical main drive for quiet, efficient power transfer
- 6mm width belt-driven tail with spring tension system
- 10mm main shaft with triple support bearings
- 8mm head axle with pivot rocker and solid dampers
- 6mm tail shaft with HD tail hub and HD grips
- 24mm self-supporting boom (no boom supports needed)
- Turnbuckle linkages for quick/precise adjustments
- Adjustable C.G. battery tray with quick locking system

Specifications:

Motor: 4020 class with 5mm shaft (1350-1400kV recommended)
ESC: 6S 90A or greater
Main Blades: 500-520mm (516 Rail Blades recommended)
Tail Blades: 80mm (80.6 Rail Blades recommended)
Battery: 6S 3850-4500 mAh
Cyclic Servos: Mini Required
Tail Servo: Full Size (760us tail servo recommended)
Main Ratio: 11.31-8.62:1 (18T included; 10.06:1)
Tail Ratio: 5.0-4.1:1 (20T included; 4.5:1)
Main Rotor Diameter: 1172mm (with Rail 516mm)
Tail Rotor Diameter: 228mm (with Rail 80.6mm)

LEFT FRAME

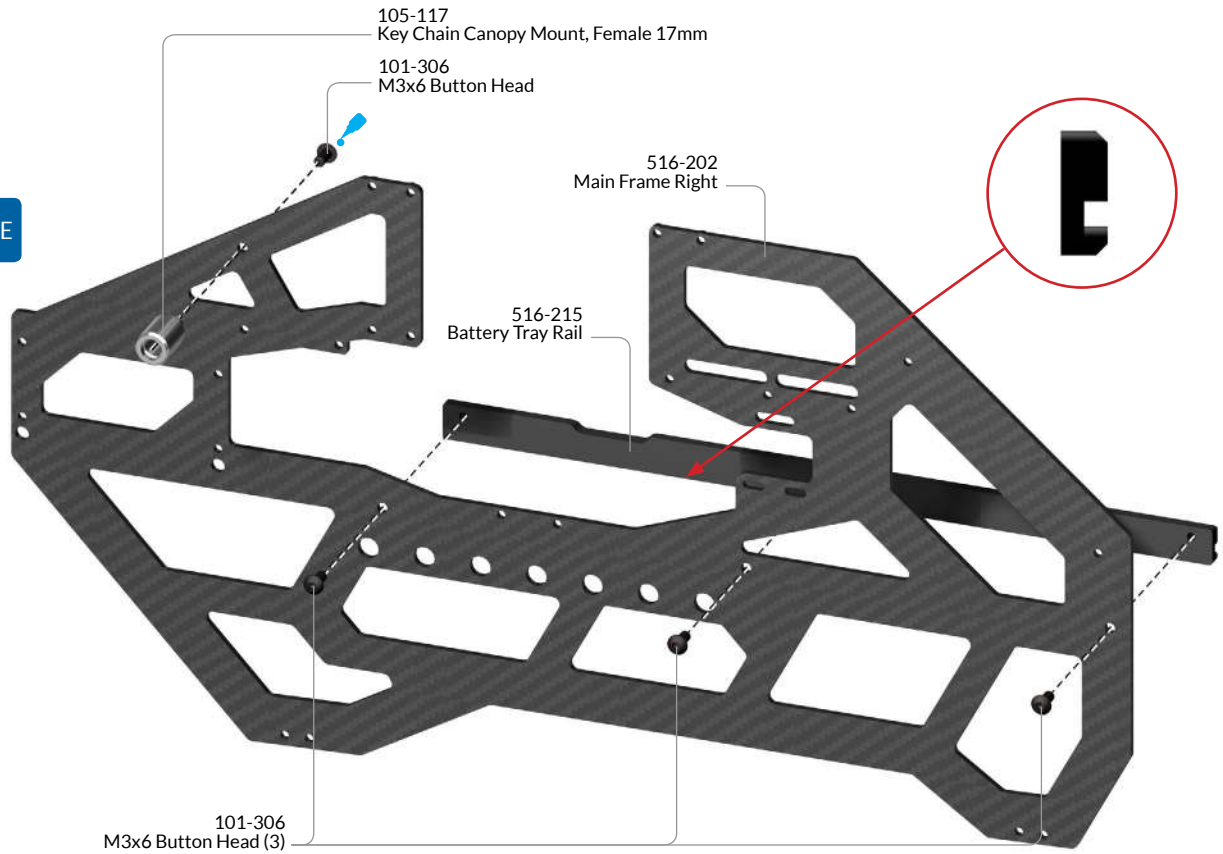




IMPORTANT: Left and right frames are not identical. Take care to use correct frame and orientation at this step. The left frame contains the cut out for the tail servo and mount hole for the spring post.

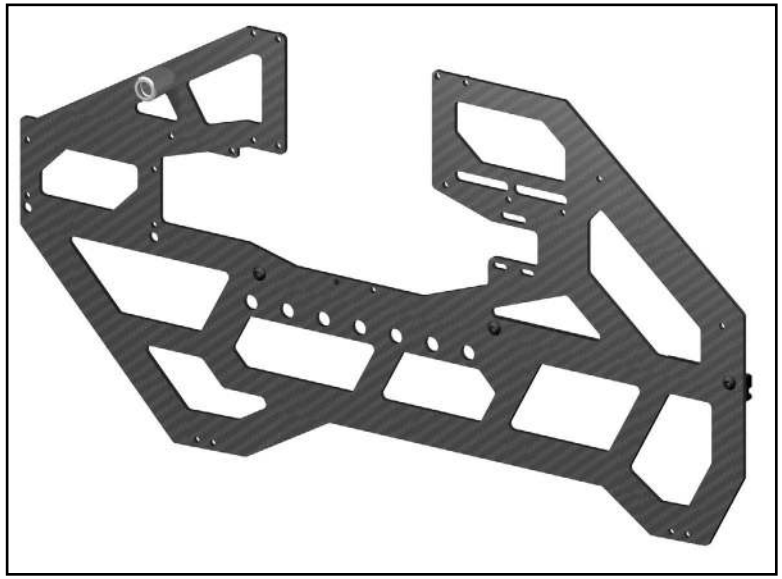
IMPORTANT: Install battery tray rail as indicated with the rail slot positioned near the bottom. Use CA to secure bolts and do not overtighten.

RIGHT FRAME



CA

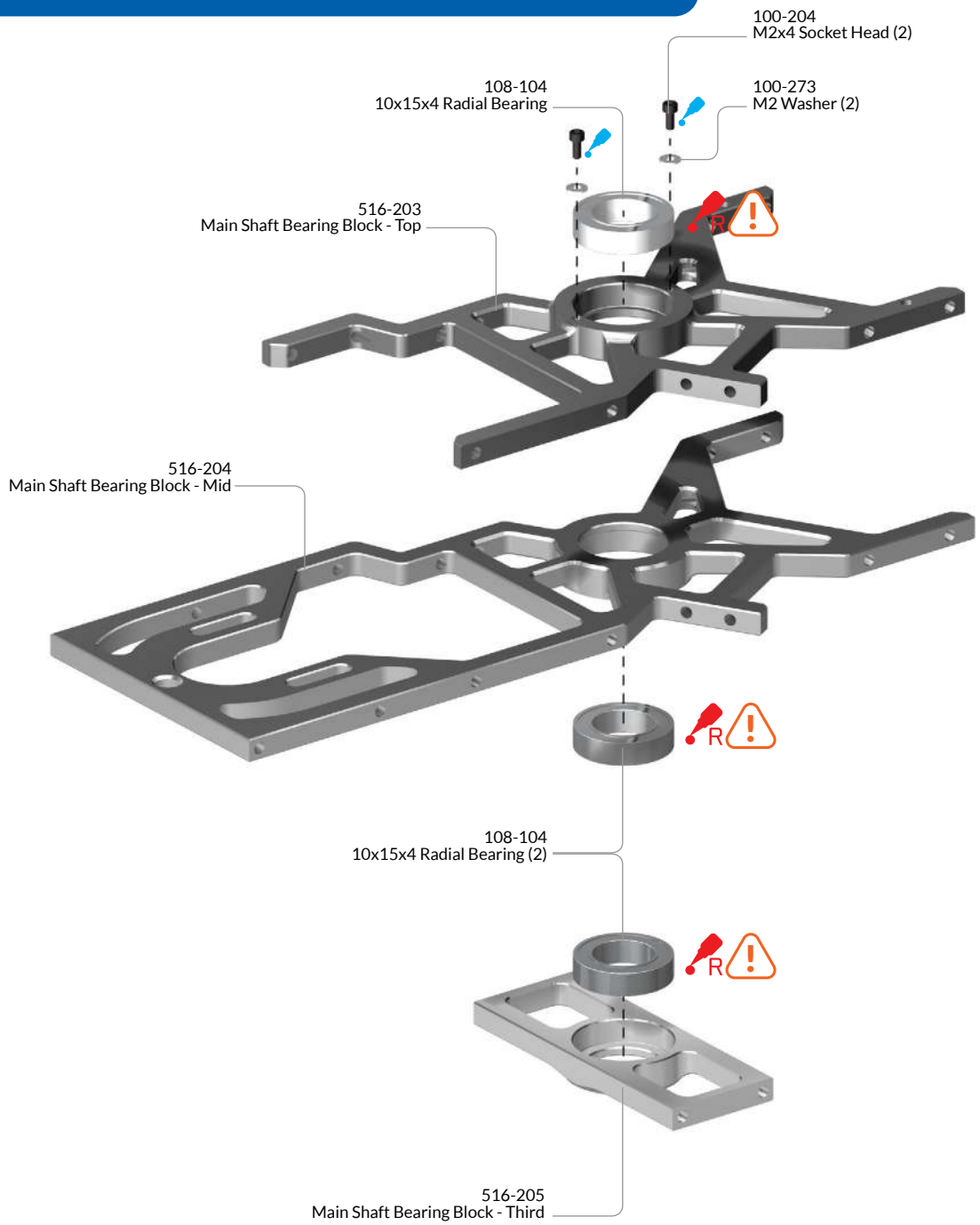
Apply Medium Viscosity CA to all (3) battery tray rail bolts



IMPORTANT: Left and right frames are not similar. Take care to use correct frame and orientation at this step. The left frame (previous page) contains the cut out for the tail servo and mount hole for the spring post.

IMPORTANT: Install battery tray rail as indicated with the rail slot positioned near the bottom. Use CA to secure bolts and do not overtighten.

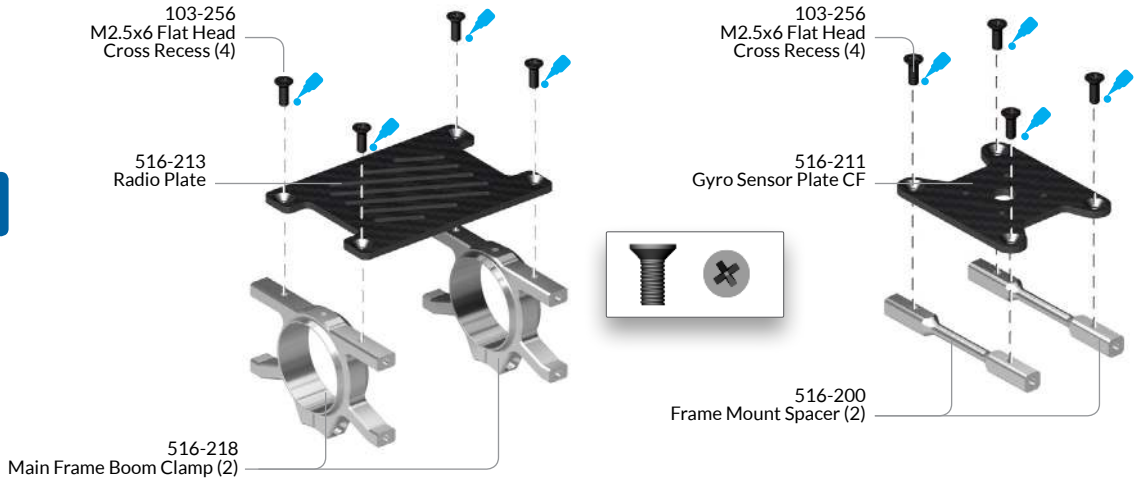
MAIN SHAFT BLOCKS



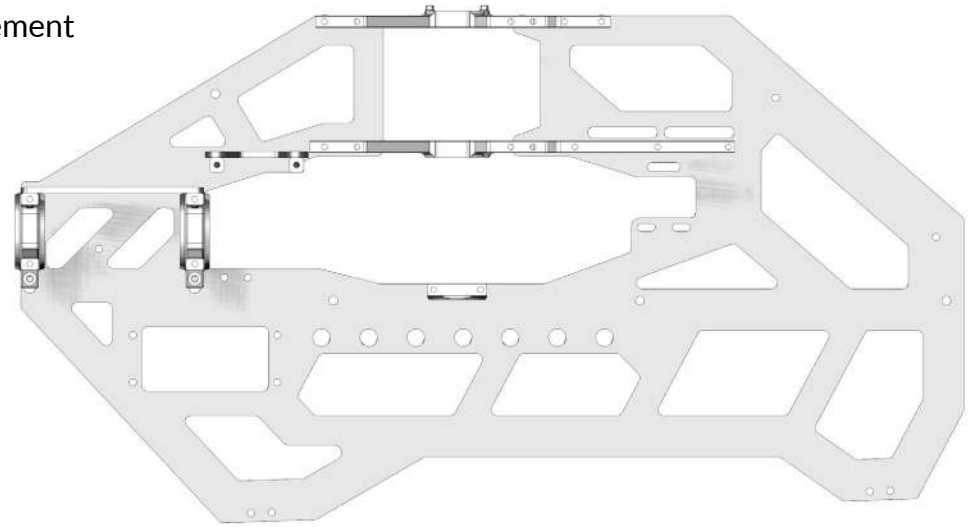
IMPORTANT: Apply **BLUE** threadlocker where indicated and do not overtighten.

To ensure proper fit, wear, and a predictable lifespan, main shaft bearings are secured via threadlocker and pre-assembled. Heat will be required for replacement. Apply **GREEN** or **RED** threadlocker when replacing.

BOOM BLOCKS AND GYRO TRAY



Placement

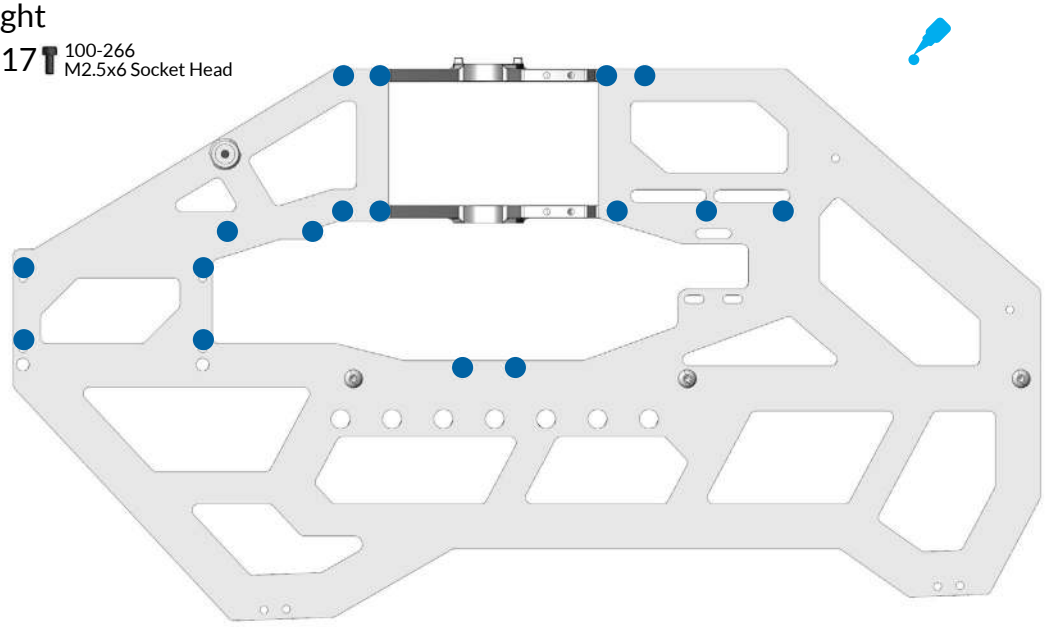


Apply **BLUE** threadlocker where indicated and do not over-tighten the cross-head screws.

FRAME BOLTS

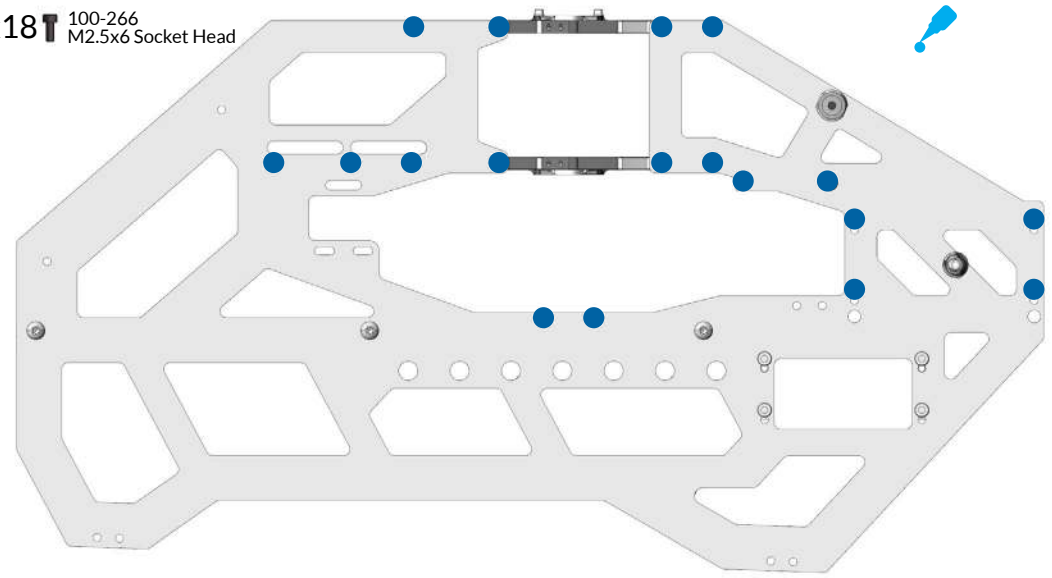
Right

x17 100-266 M2.5x6 Socket Head



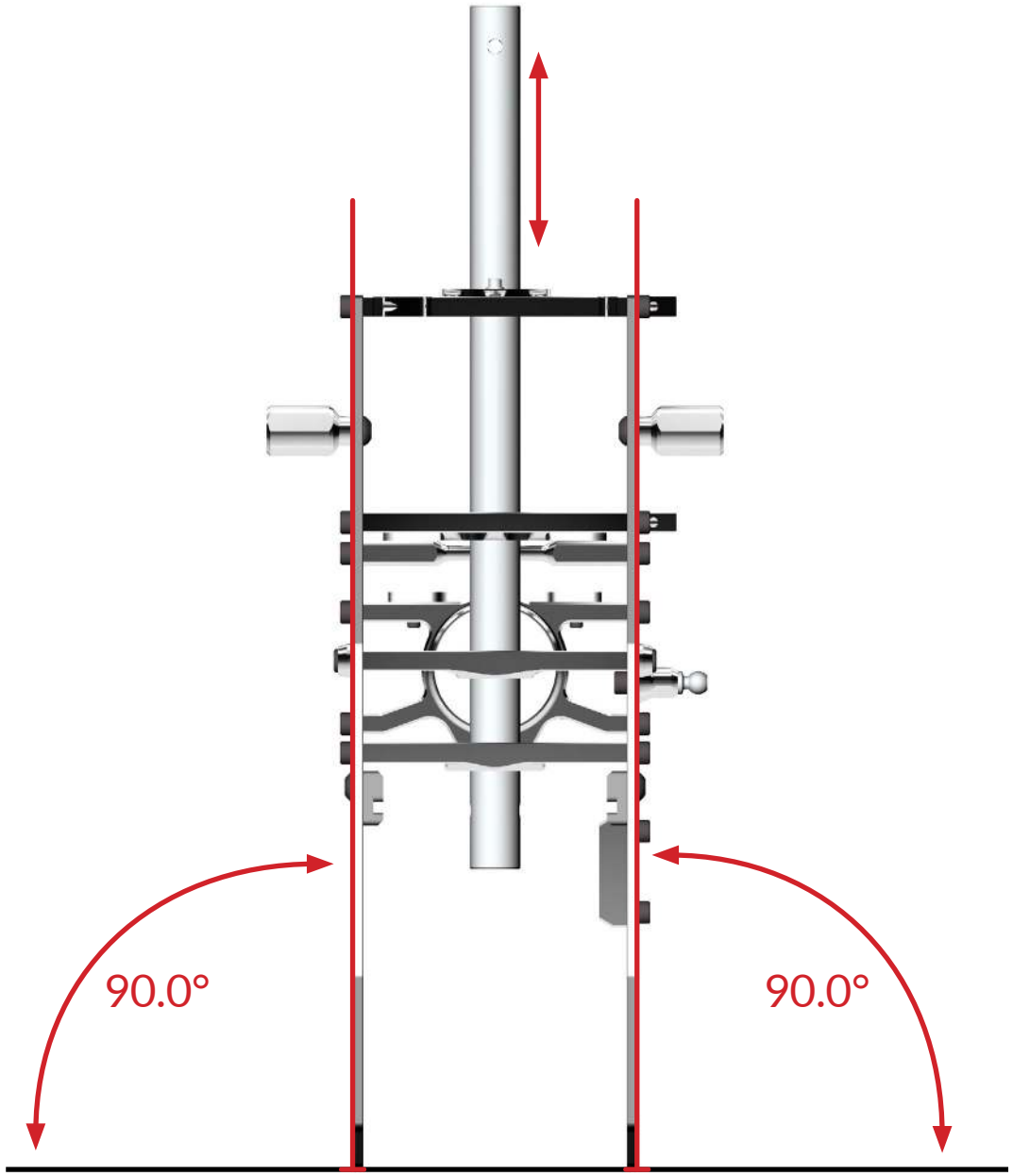
Left

x18 100-266 M2.5x6 Socket Head



Apply **BLUE** threadlocker to all frame bolts. Do not fully tighten bolts at this step.

FRAME ALIGNMENT

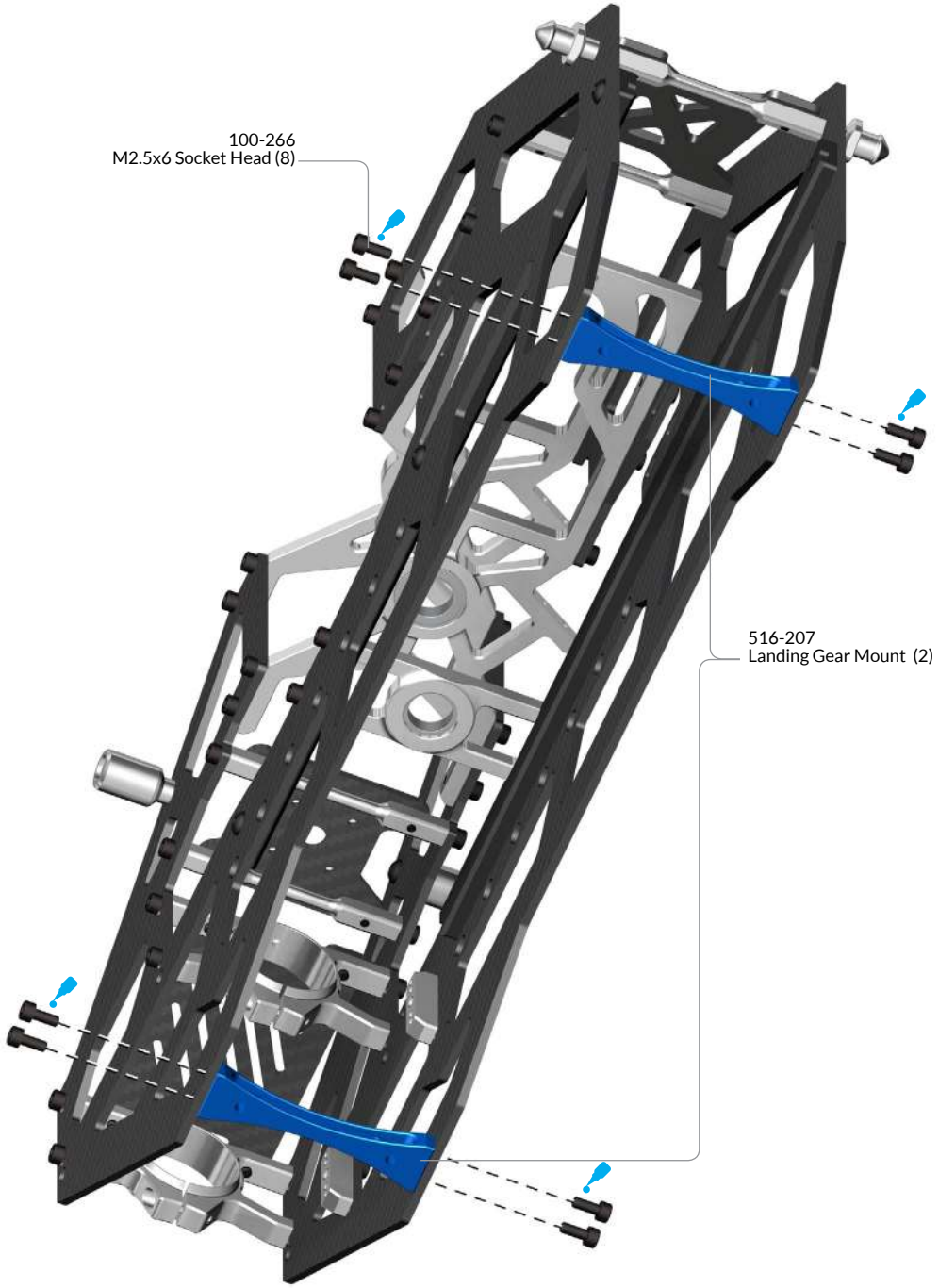


Place airframe on a true flat surface to verify that frames are square before tightening all frame bolts. Temporarily insert the main shaft to verify frame alignment.

ESC PLATE

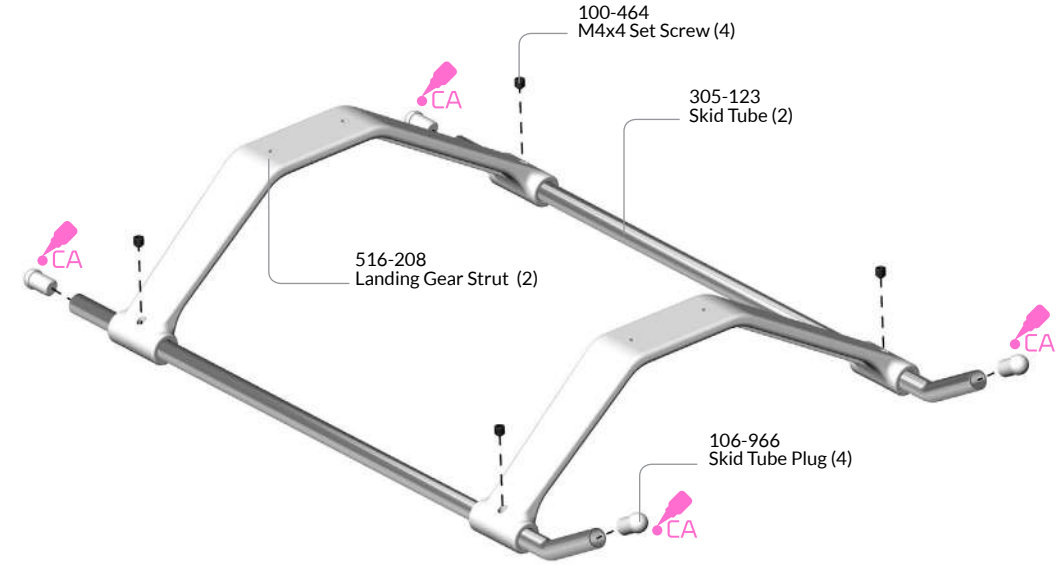
Apply **BLUE** threadlocker where indicated and do not over-tighten the cross-head screws.

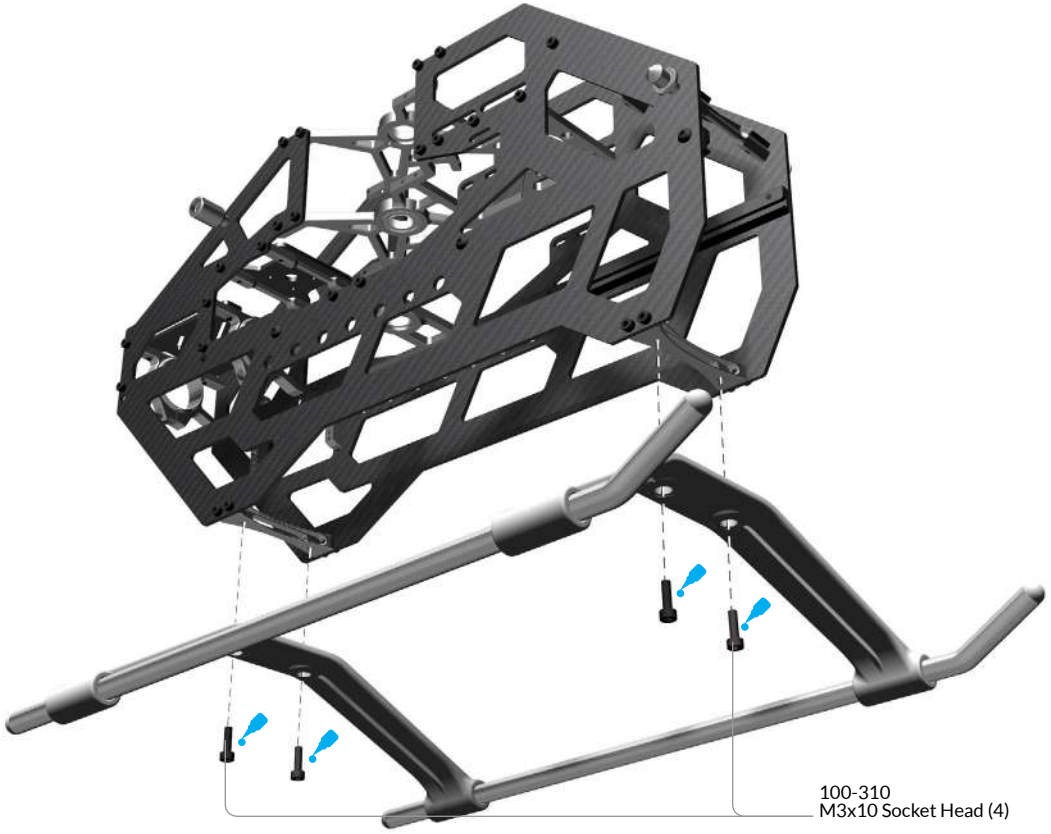
LANDING GEAR MOUNTS



Apply **BLUE** threadlocker where indicated.

LANDING GEAR

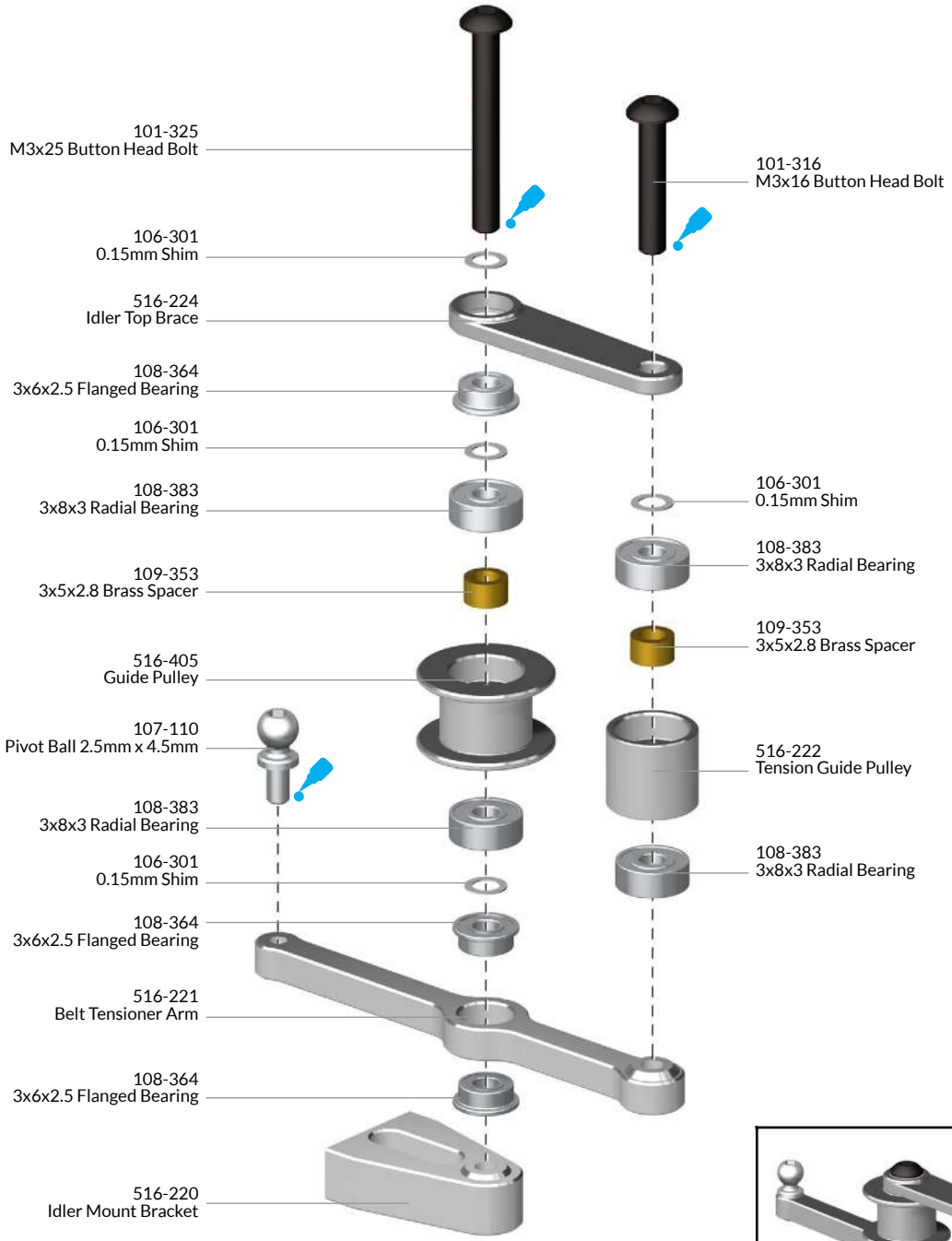


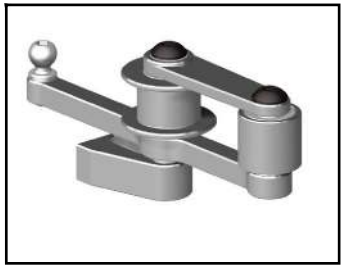


Apply **BLUE** threadlocker where indicated.

TIP: Use CA or 30-minute epoxy to secure skid tube plugs.

BELT TENSION ARM

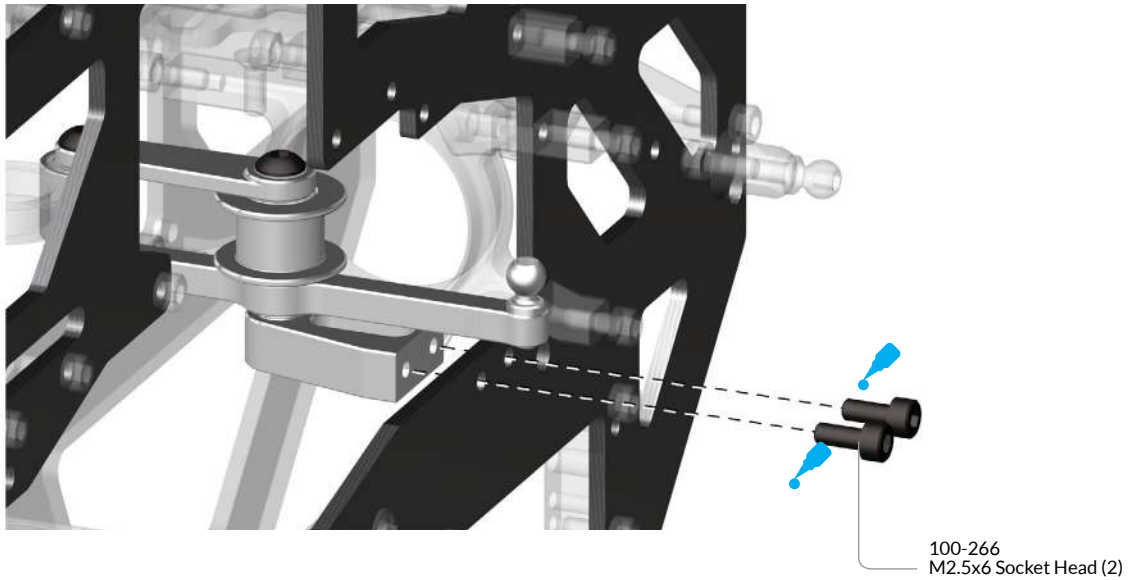


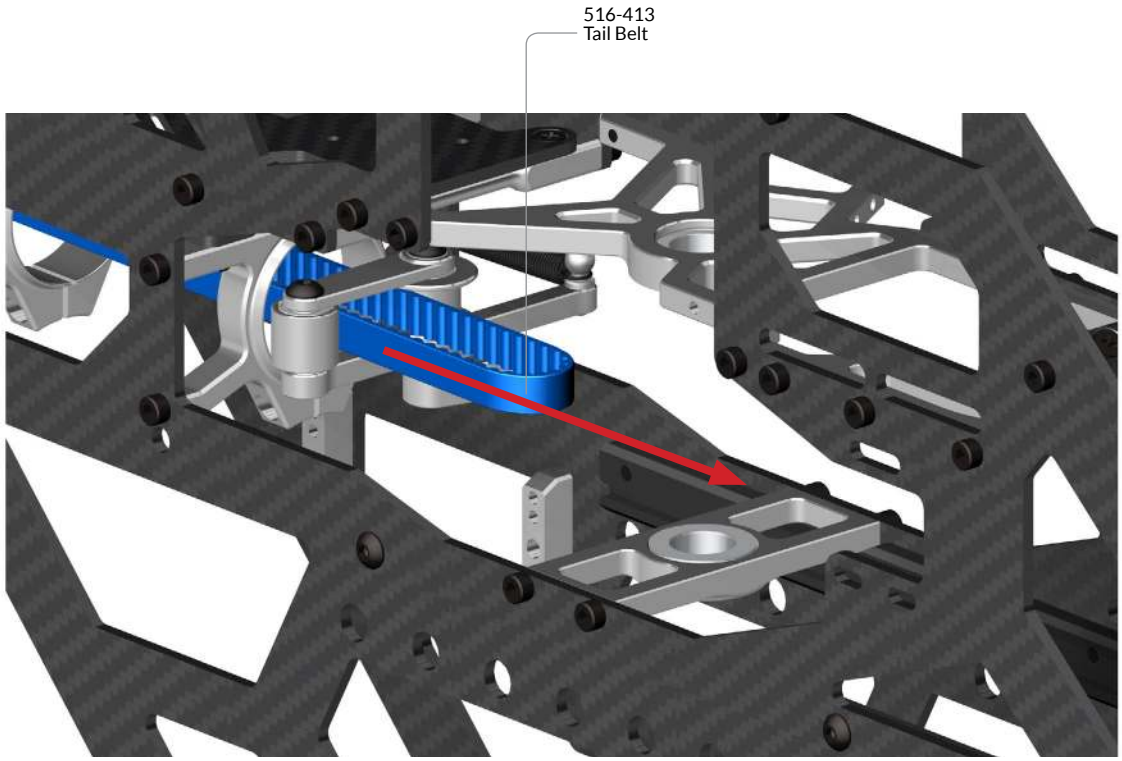


IMPORTANT: Remove bolts, pivot ball, and apply **BLUE** threadlocker where indicated.

IMPORTANT: Guide Pulley 516-405 with wall guides is the stationary pulley.

BELT TENSION ARM



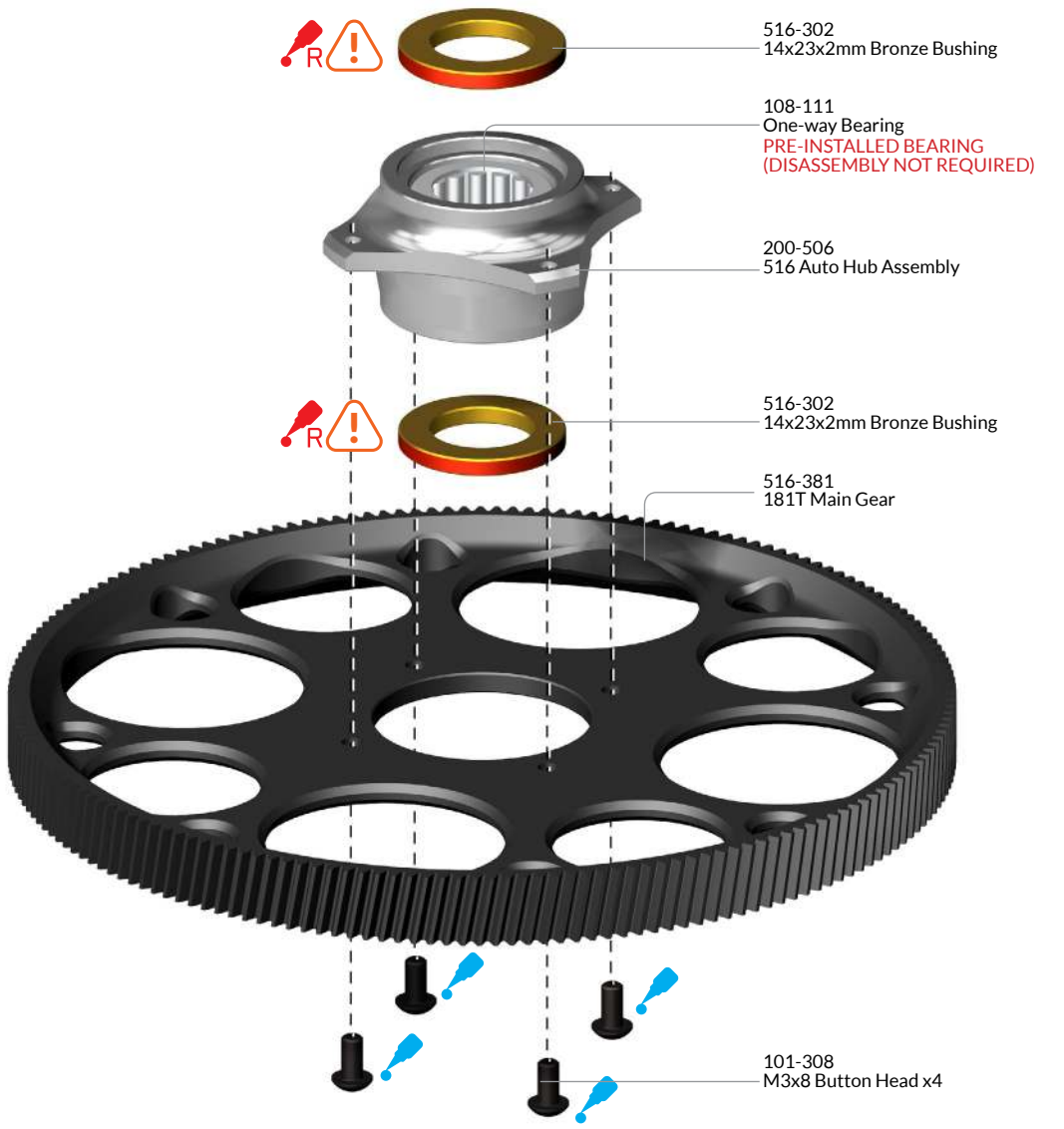


Apply **BLUE** threadlocker where indicated.

Insert tail belt at this stage of the build.

Feed belt through the rear side of the boom support blocks and in between the idler guides.

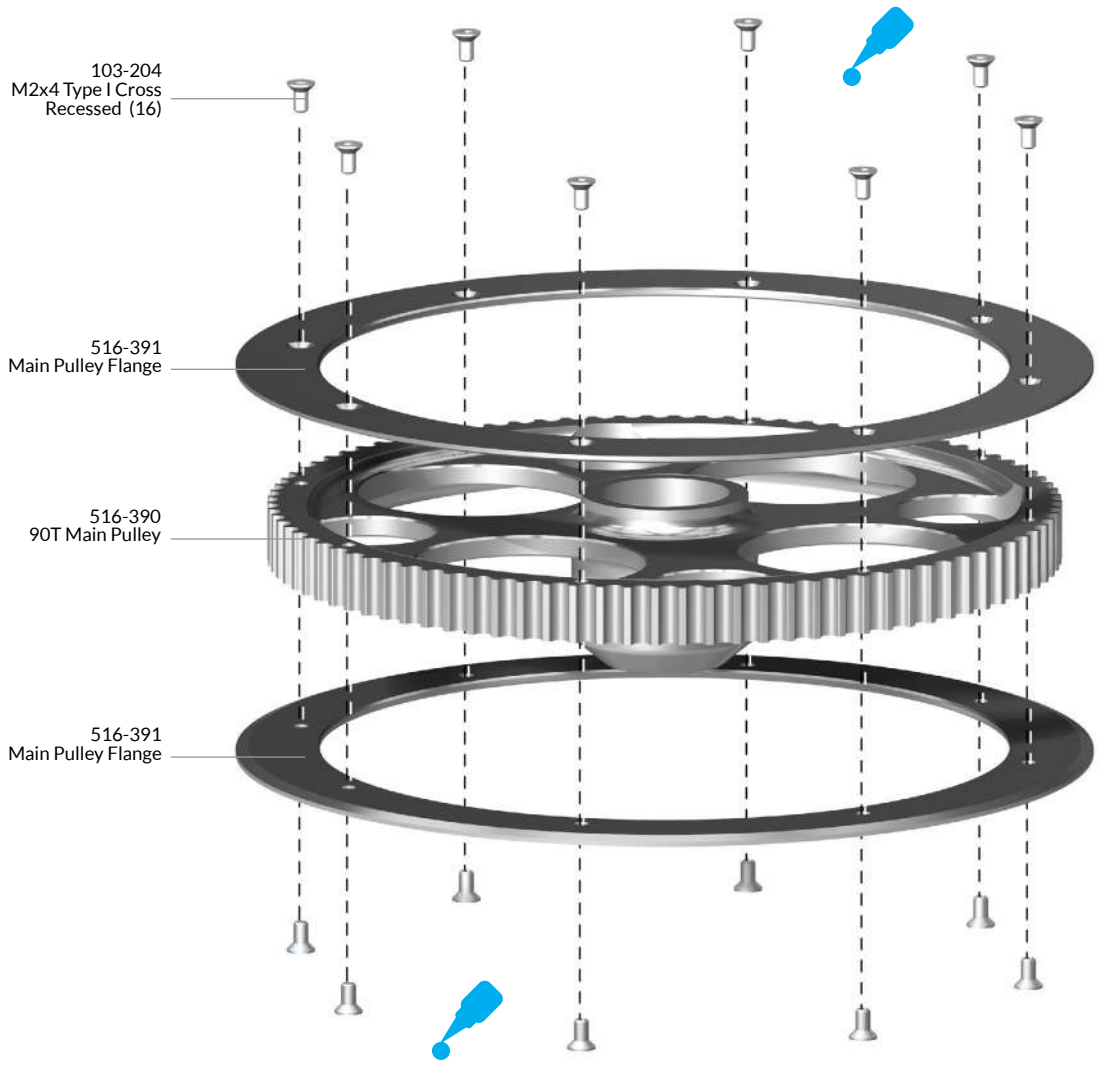
MAIN GEAR AND AUTO HUB

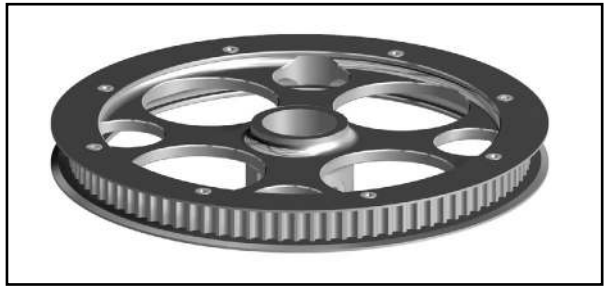


IMPORTANT: Apply a thin coating of **RED** threadlocker to the outside of the bronze bushings. Use only a thin layer to prevent contamination of the one-way bearing inside the hub.

IMPORTANT: Remove and apply **BLUE** threadlocker and do not overtighten 101-308 M3x8 Button Heads in the main gear.

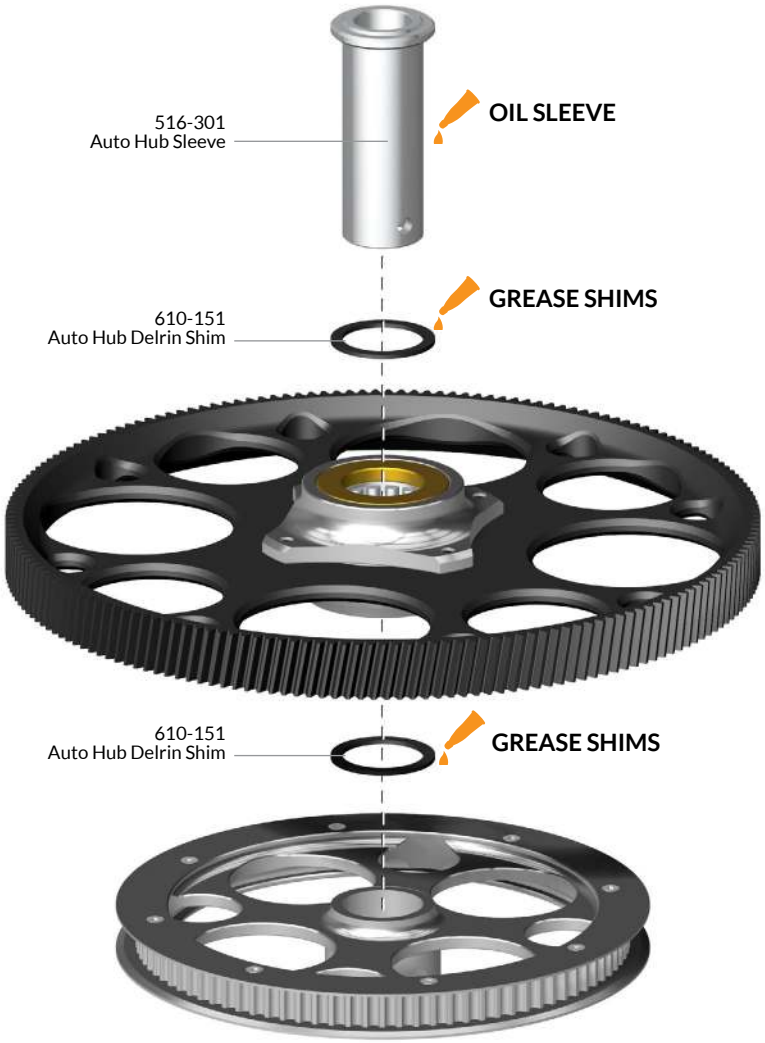
MAIN BELT DRIVE PULLEY

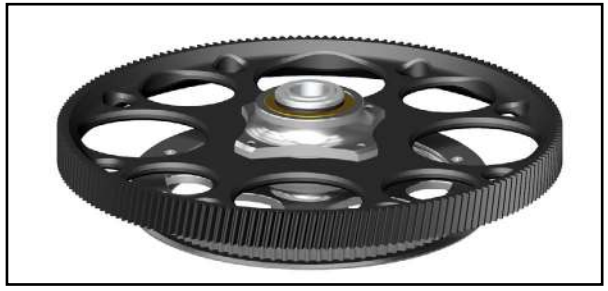




IMPORTANT: Full disassembly is required. Apply **BLUE** threadlocker to ALL bolts. Do not over-tighten bolts.

MAIN DRIVE ASSEMBLY

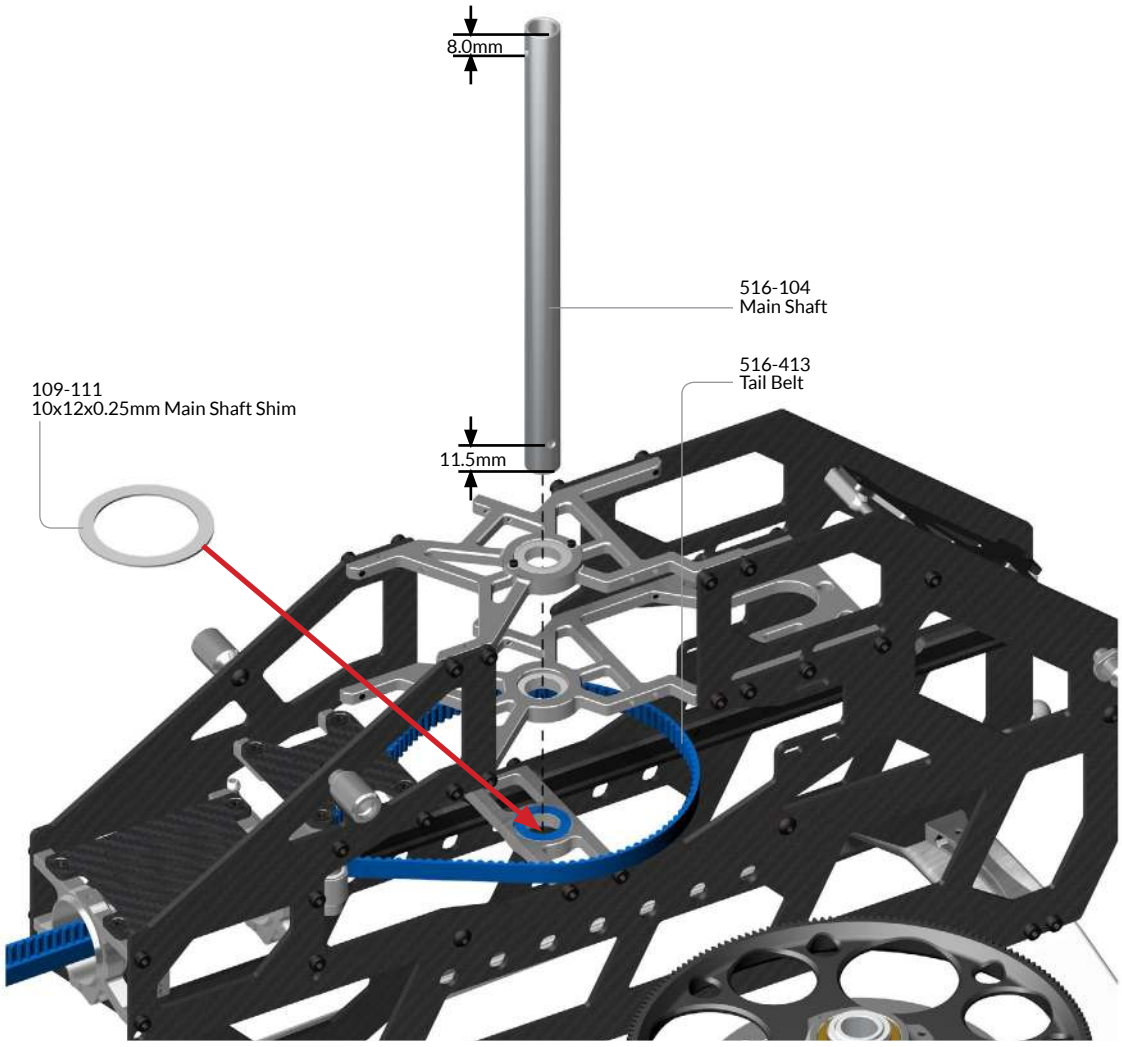


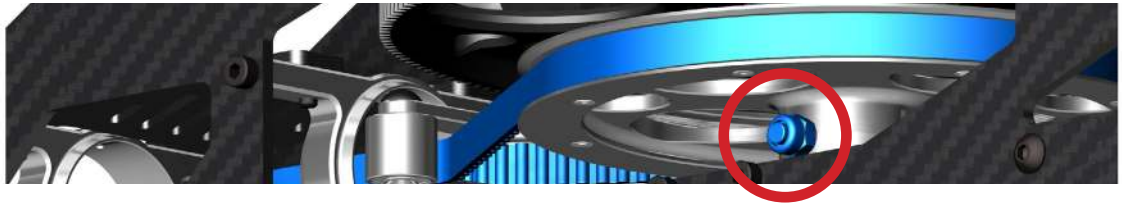


TIP: Use extreme pressure synthetic grease to lubricate Delrin washers. Avoid applying grease to the sleeve and one-way bearing. Boto-Lube Part BD-001 for optimal performance.

TIP: Lubricate the Auto Hub Sleeve and one-way bearing with Tri-Flow or equivalent light machine oil. Do not use grease.

MAIN DRIVE INSTALLATION





Feed tail belt around the main drive pulley at this stage of the build.

MAIN SHAFT ORIENTATION: The hole nearest the end of the shaft is the top.

Position indicated shim below main drive unit and then insert the M3x25 Shouldered Bolt.

IMPORTANT: Do not overtighten!

TIP: Use a 5.5mm nut driver when securing the M3 bolt.

Blade Size Considerations:

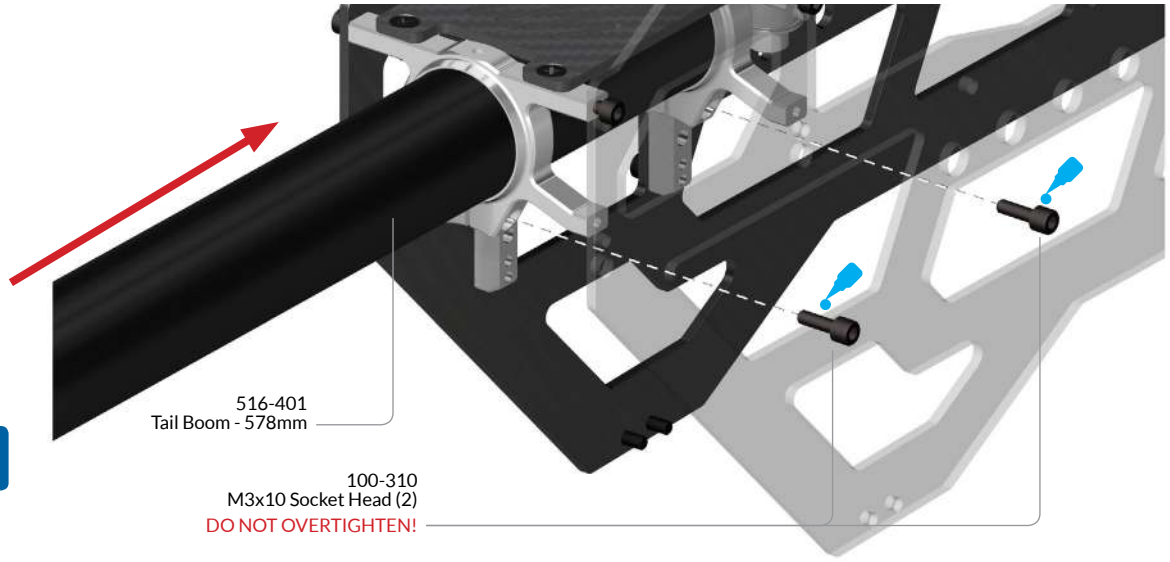
For low head speed setups (2,300 rpm or less), Synergy offers an optional tail pulley to increase tail rotor rpm. See page 21 for tail rotor rpm setup.

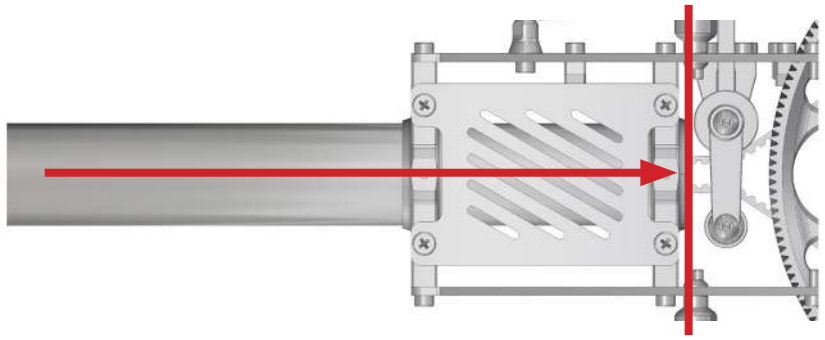
IMPORTANT: Combined main and tail blade length should not exceed **603MM**.

Example configurations:
Rail 516 Mains + Rail 80.6 Tails = 596.6mm.

520 Mains + Rail 80.6 Tails = 600.6mm.

BOOM INSTALLATION





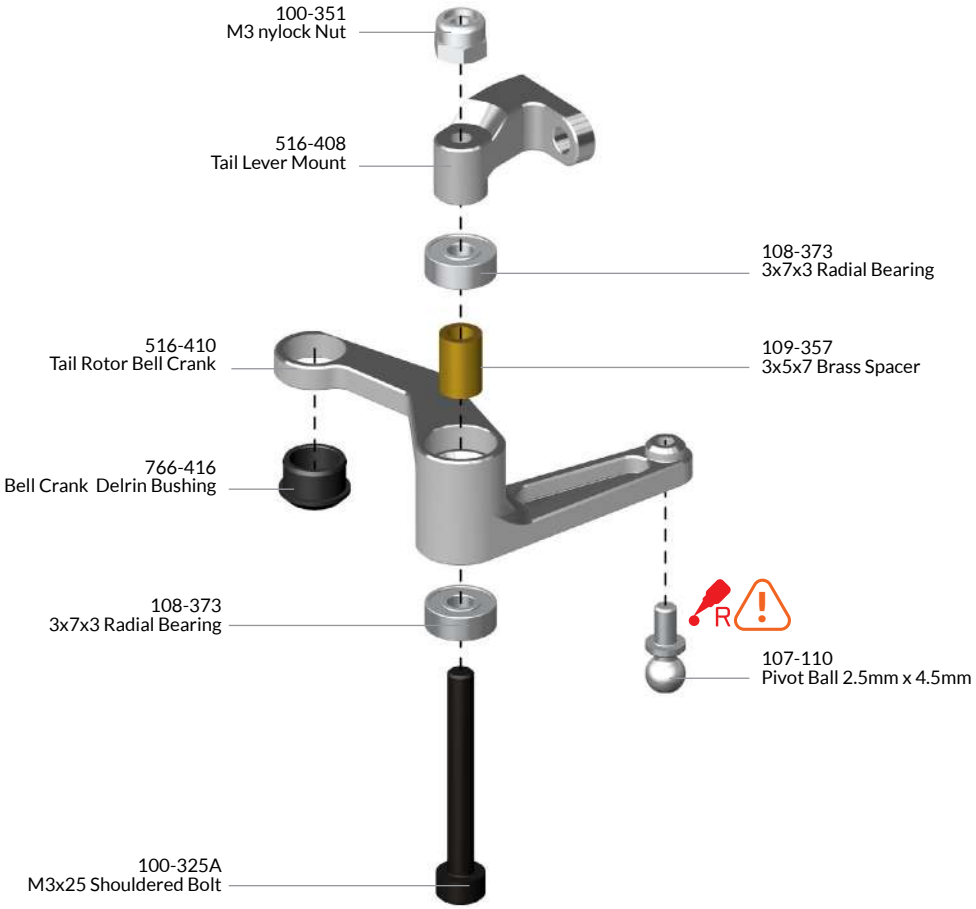
Insert boom flush with the front of forward boom clamp.

Feed tail belt through the boom and insert boom into the boom support blocks until positioned as indicated.

IMPORTANT: Apply **BLUE** threadlocker to boom clamp bolts and do not overtighten!

Do not overtighten Tail Control Clamp M2 bolt!

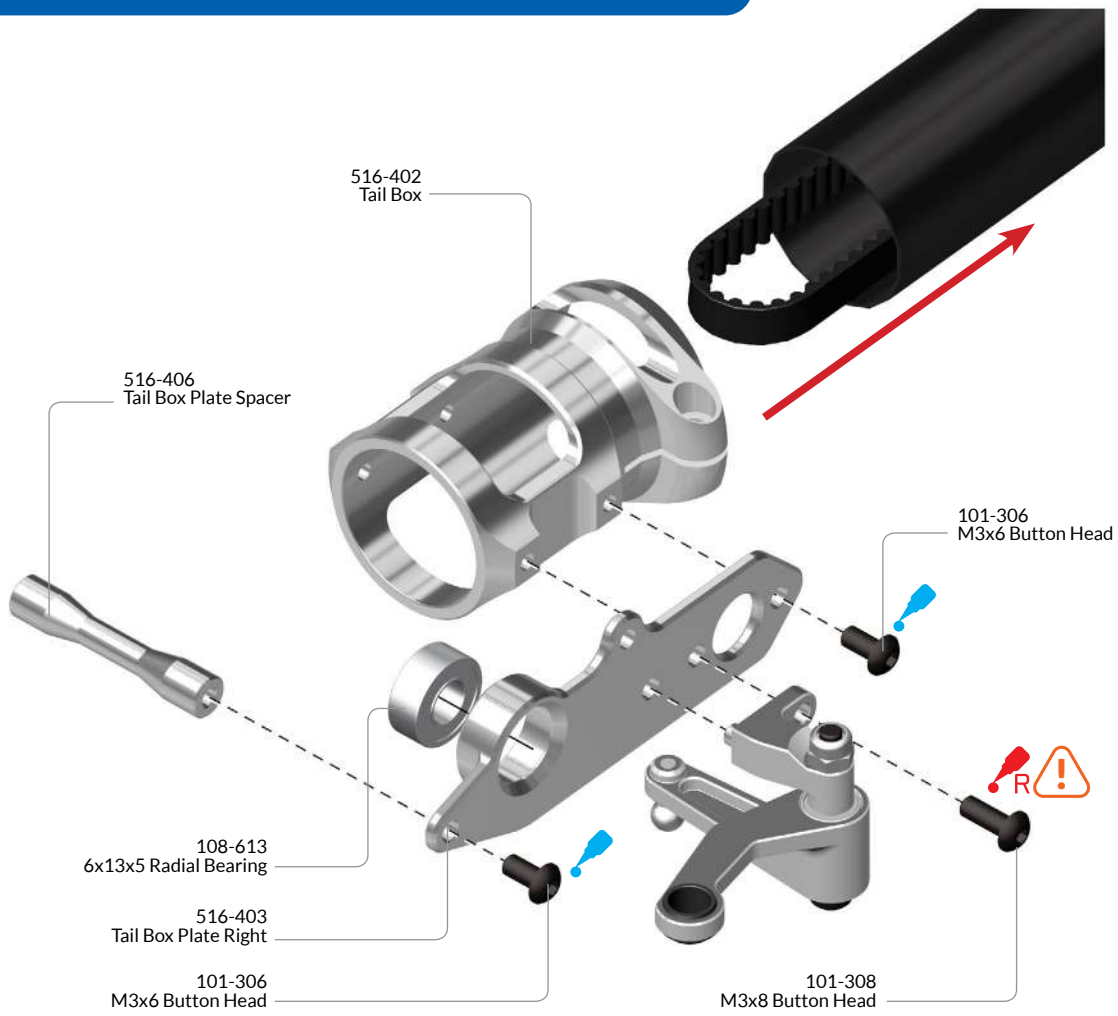
TAIL - TAIL PITCH LEVER

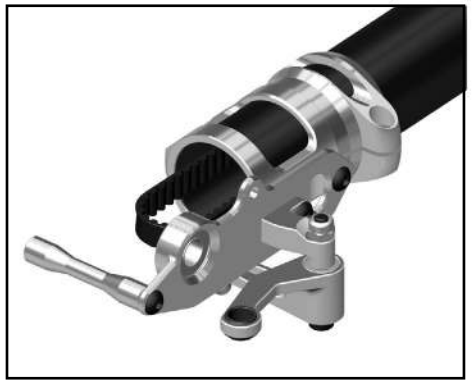


IMPORTANT: Remove and secure pivot ball using **RED** threadlocker.

TIP: CA may be used to secure Bell Crank Insert Guide.

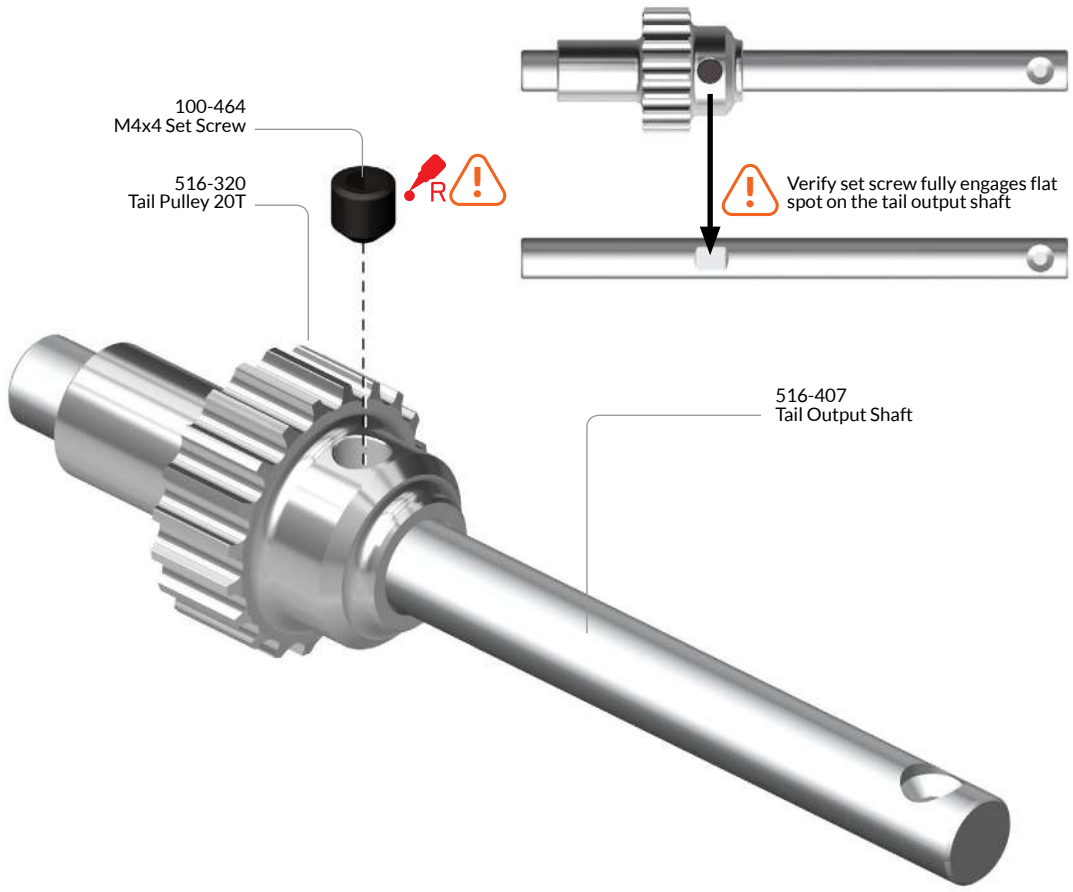
TAIL - RIGHT SIDE





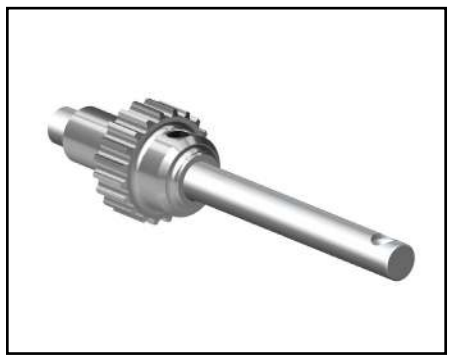
Apply **RED** or **BLUE** threadlocker where indicated.

TAIL - SHAFT AND PULLEY



18T: **Optional**
516-318
Tail Pulley 18T

20T: **Included** In Kit
516-320
Tail Pulley 20T



IMPORTANT: Apply **RED** threadlocker to set screw and verify it fully engages flat spot on the tail output shaft. Heat may be required when removing.

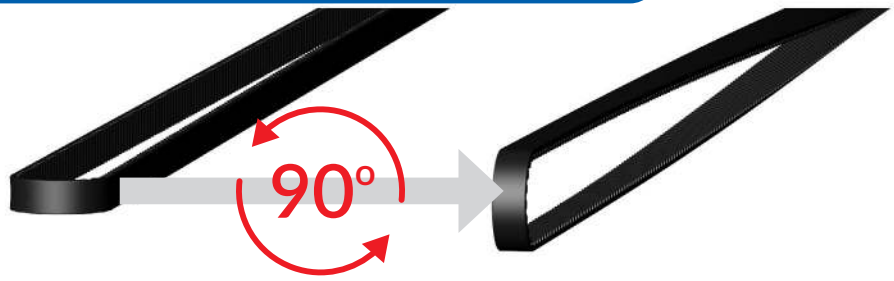
Tail Rotor Considerations:

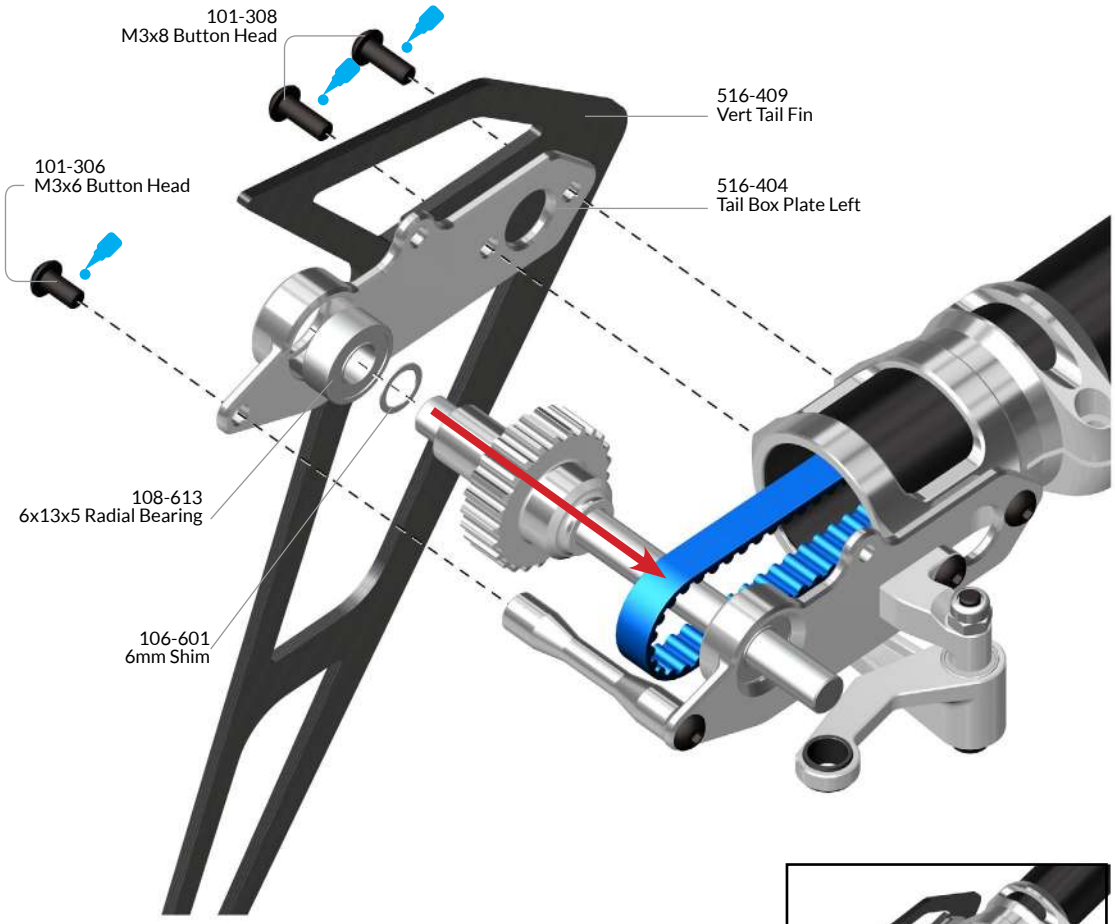
IMPORTANT: Stock tail rotor rpm is optimized for Rail 80.6 tail blades with head speeds **2,300 RPM or greater**.

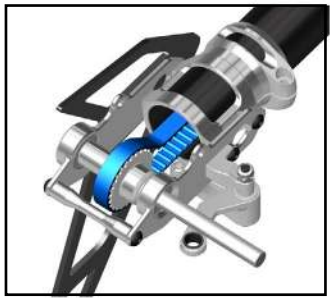
2,200 RPM or Less:
Synergy offers an optional tail pulley (18T) to increase the speed of the tail rotor if desired.

Available Tail Ratios:
18T: 5.0:1
20T: 4.5:1

TAIL - BELT AND LEFT SIDE





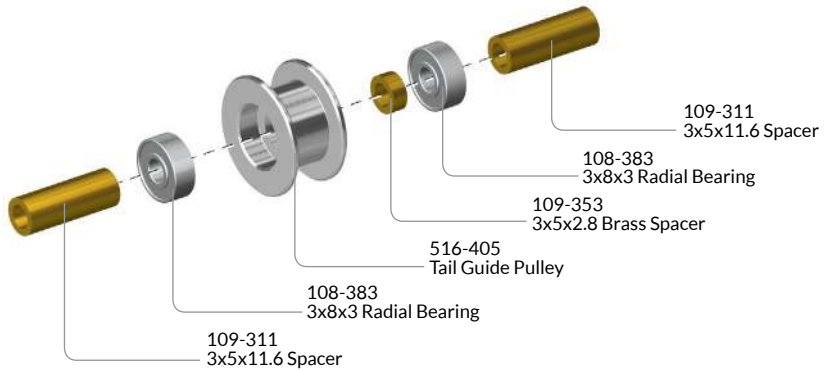


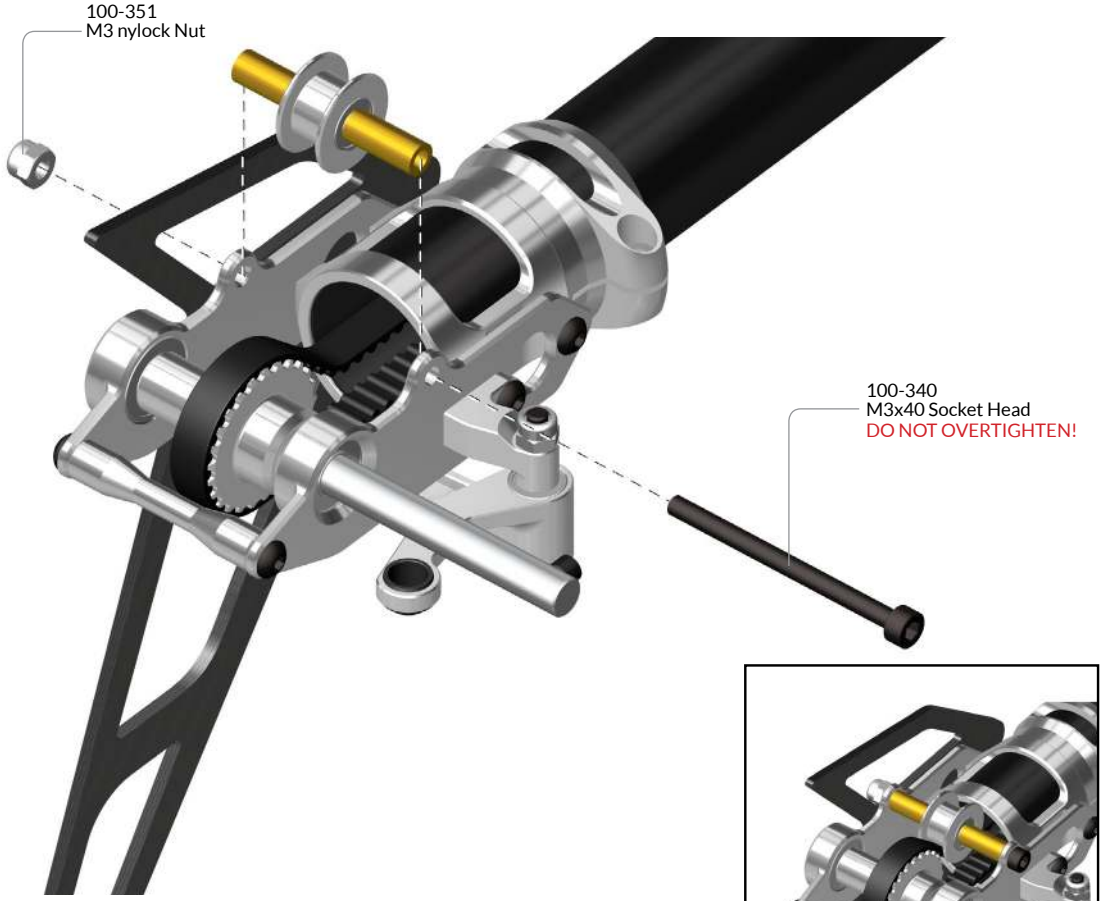
Verify tail belt is not twisted then rotate 90 degrees COUNTER-CLOCKWISE and install onto tail shaft pulley.

Apply **BLUE** threadlocker where indicated.

IMPORTANT: Tail belt should only have ONE 90 degree twist. Verify tail rotor rotates counter-clockwise when viewed from the right, while the main rotor rotates clockwise when viewed from above.

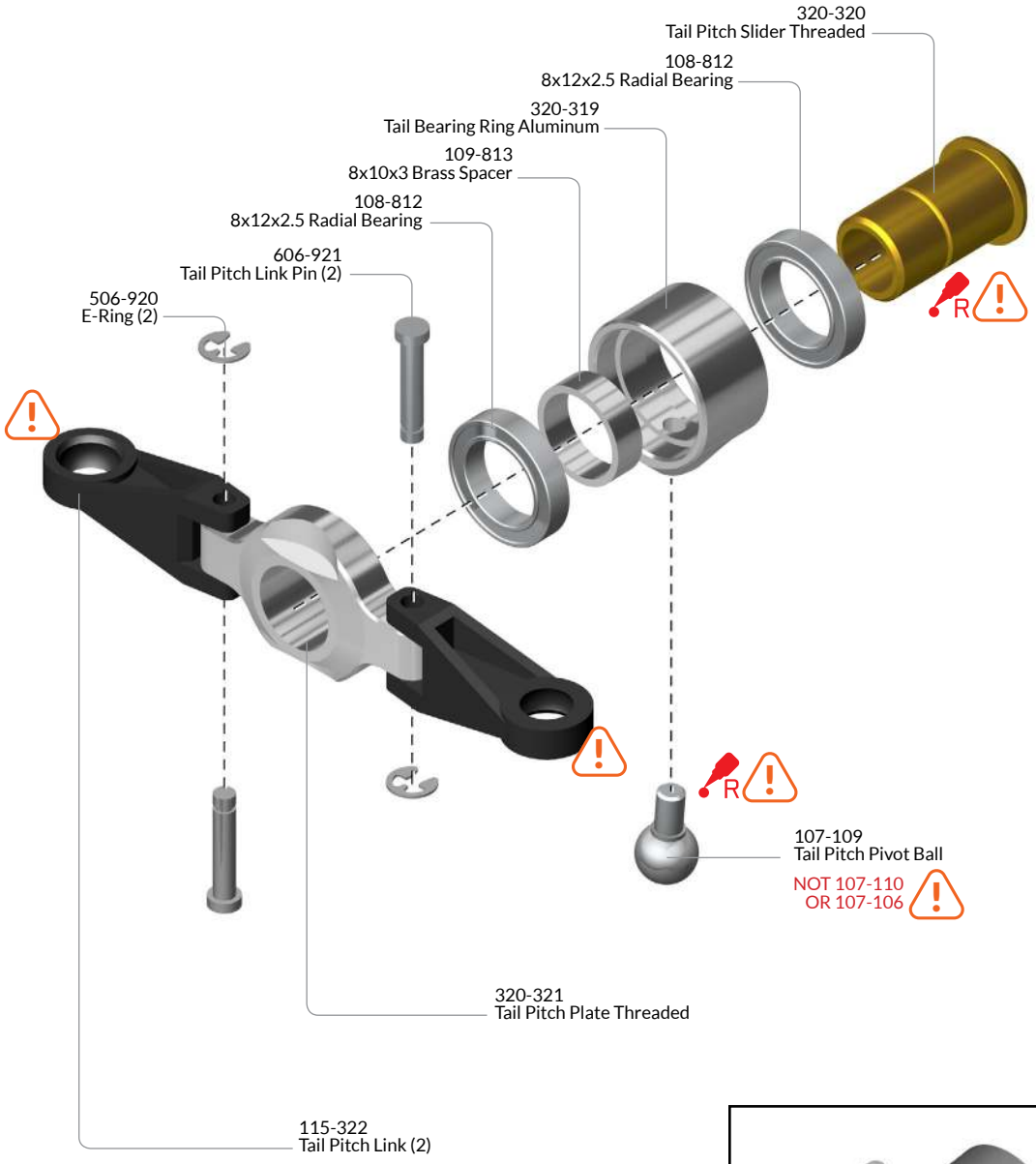
TAIL - BELT GUIDE PULLEY





IMPORTANT: Do not overtighten M3x40 bolt 100-340.

TAIL - PITCH SLIDER

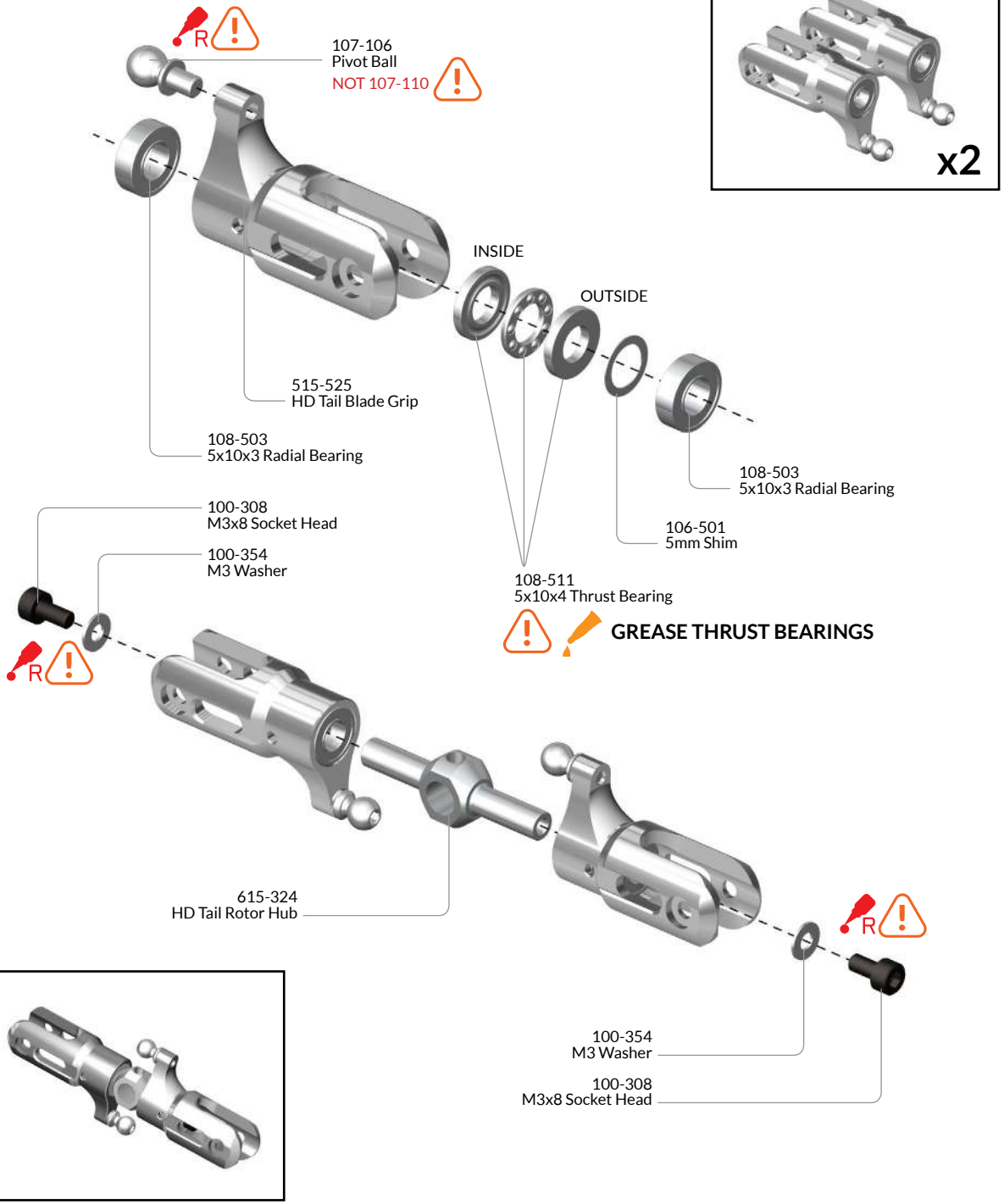


IMPORTANT: Disassemble and apply a small amount of **RED** threadlocker to the brass sleeve and tighten gently. DO NOT OVERTIGHTEN or damage can occur.

IMPORTANT: Brass sleeve is REVERSE THREADED. Use caution while threading.

IMPORTANT: Disassemble and apply **RED** threadlocker to 107-109 Tail Pitch Pivot Ball.

TAIL - HUB AND GRIPS



TIP: Use extreme pressure synthetic grease on all thrust bearings for optimal performance. Boto-Lube Part **BD-001**

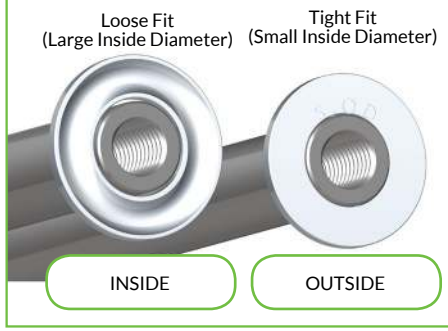
IMPORTANT: Full disassembly is required. Apply **RED** threadlocker to both tail grip pivot balls and bolts.

IMPORTANT: Apply threadlocker to inside threads of the Tail Hub rather than the Socket Head bolt. This will prevent threadlocker from contaminating the radial bearing, causing it to seize.

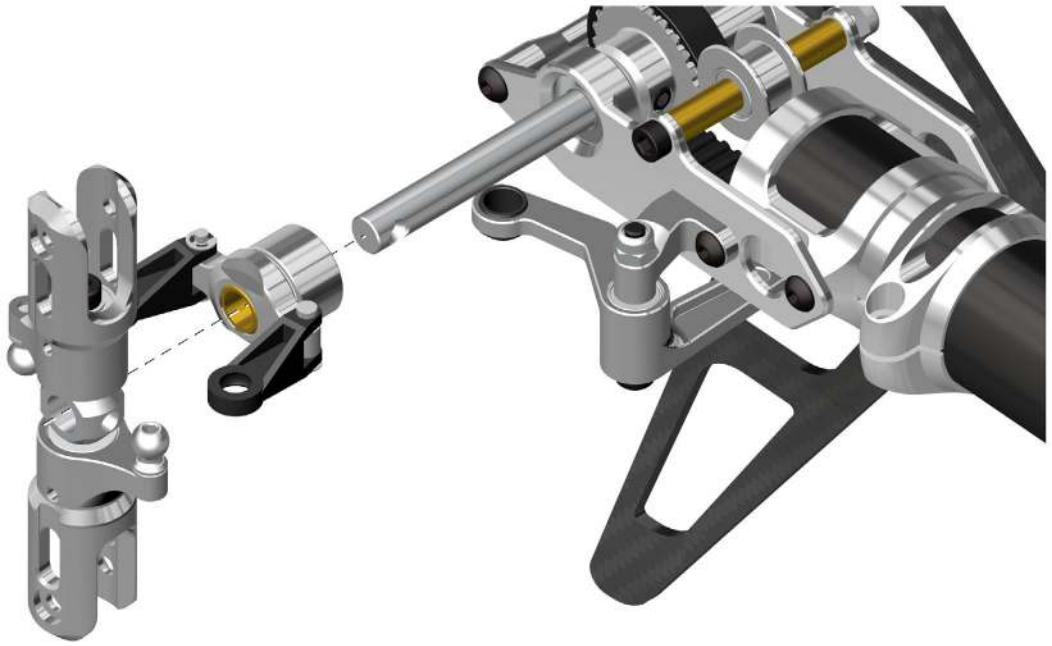
NOTE: Tail Blade Grips have in/out play by design. Do not attempt to add shims to the assembly in a effort to remove play.

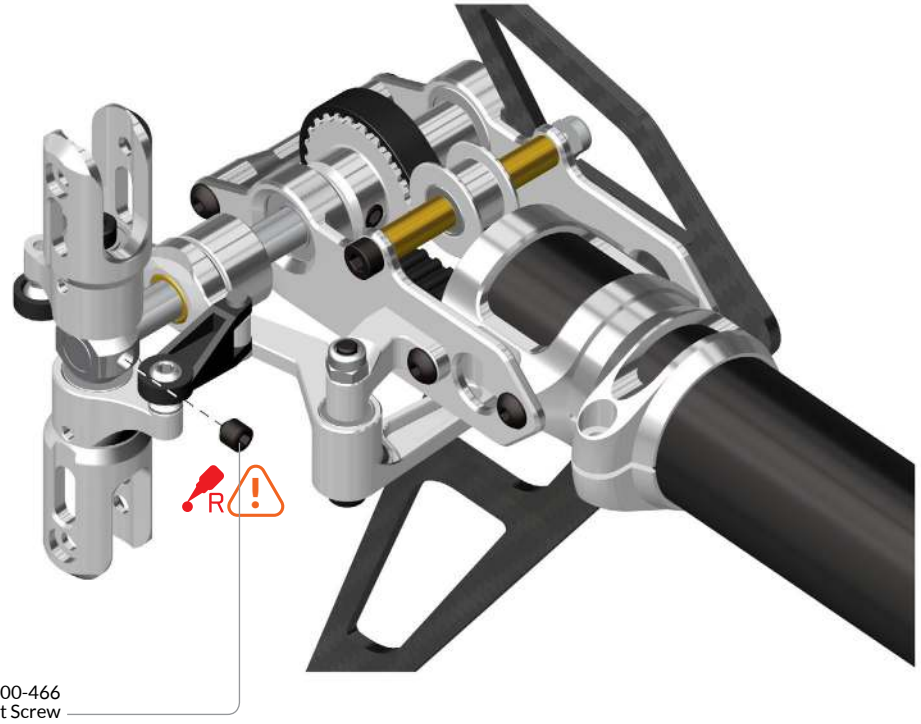
THRUST BEARING TIP

Use the tail hub to determine inside and outside races:



TAIL - FINAL ASSEMBLY

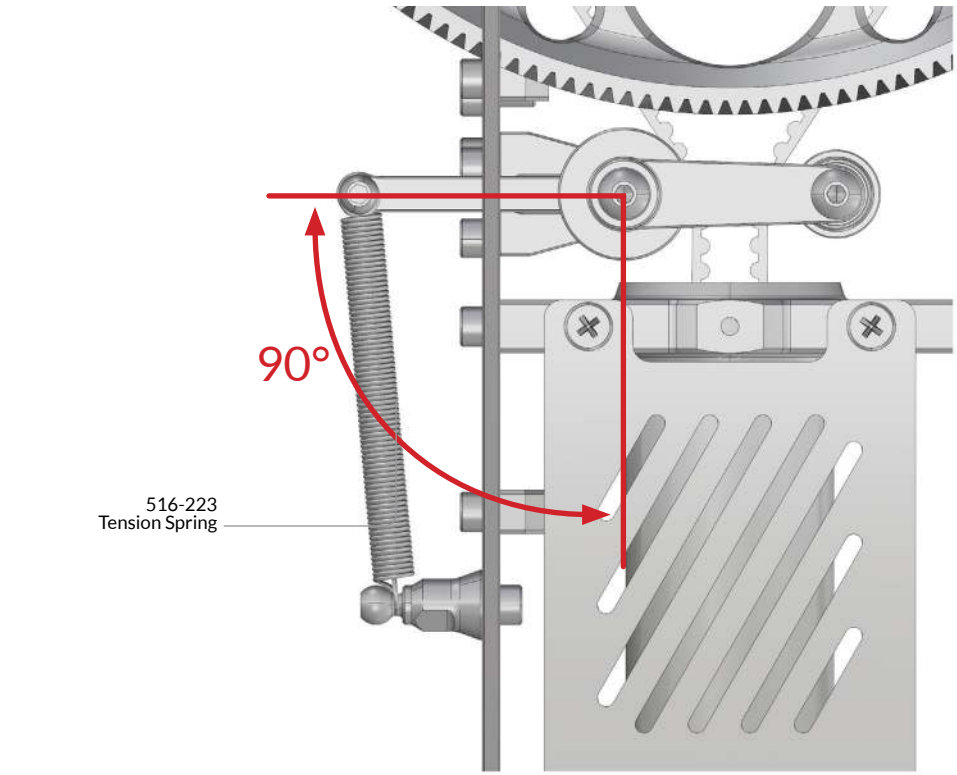


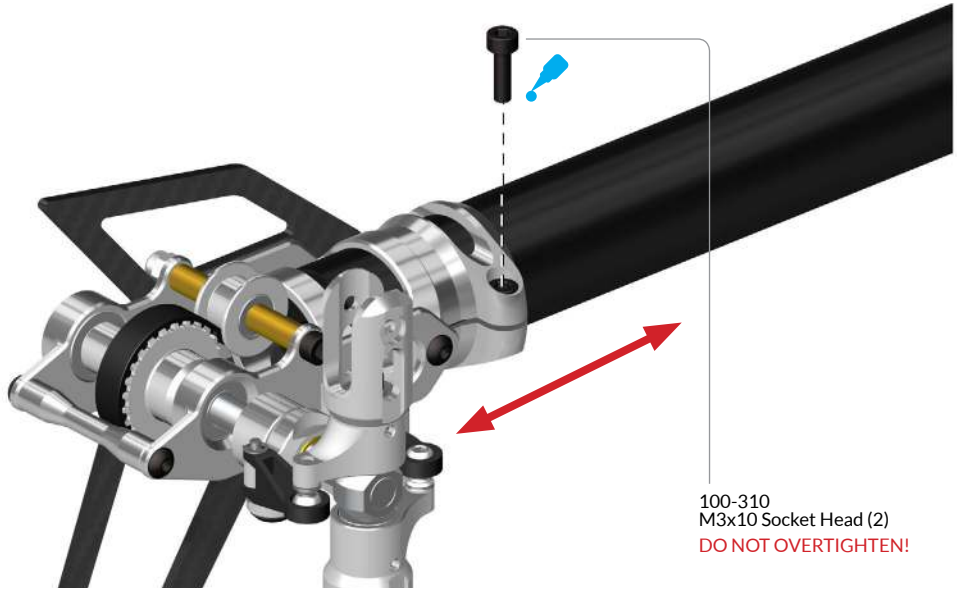


IMPORTANT: Secure tail hub set screw using **RED** threadlocker.

For optimal performance, apply light machine oil to the tail shaft.

BELT TENSION SETTING

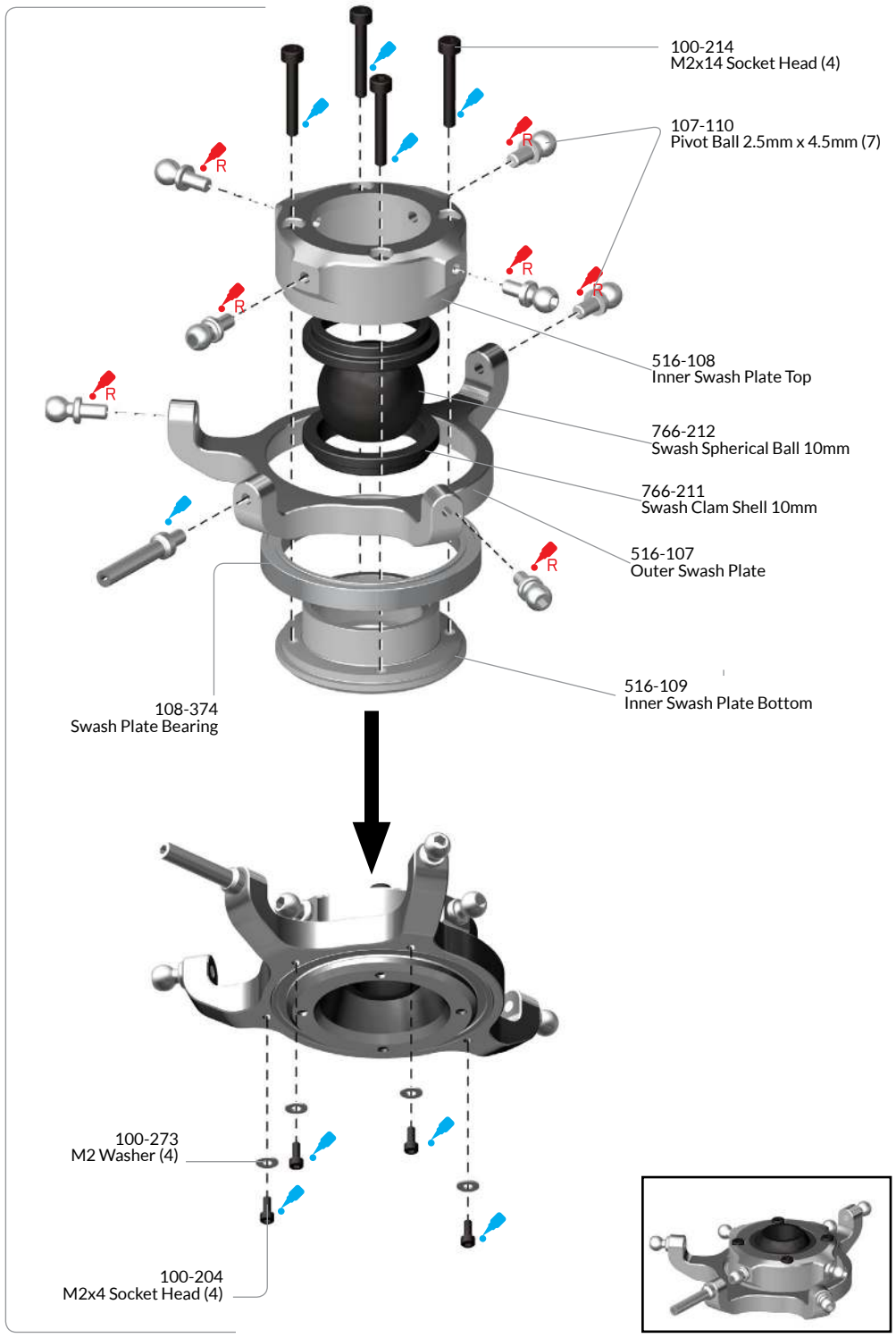




IMPORTANT: Adjust belt tension by sliding tail box until tension arm is positioned 90 degrees to the frame, then secure with indicated bolt.

NOTE: Verify tailbox alignment, vertical fin should be parallel to the frames.

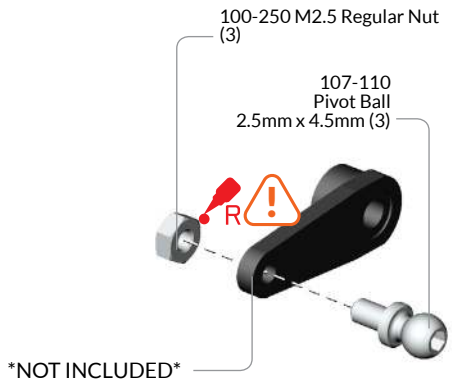
SWASH PLATE

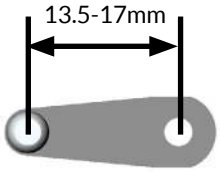


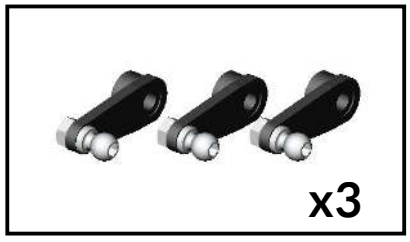
IMPORTANT: Apply **BLUE** threadlocker to M2 bolts 100-214 and lightly tighten to 10 in-oz torque (finger tight). Replace all 4 bolts after crashing the model.

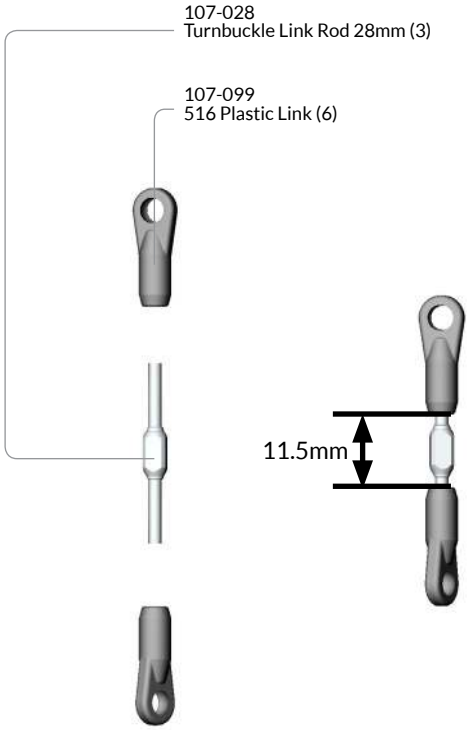
IMPORTANT: Full disassembly is required. Apply **RED** threadlocker to all swash pivot balls. Heat may be required for removal.

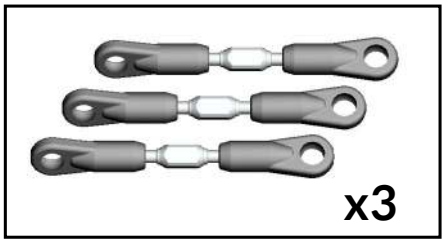
CYCLIC ARMS AND LINKAGES











Depending on the flybarless unit and servos chosen, optimal geometry can be achieved using servo arms with ball linkages placed at a distance of 15mm to 17mm from the center of rotation.

NOTE: Turnbuckle linkages have reverse threads on one end. The final length may vary slightly per individual model.

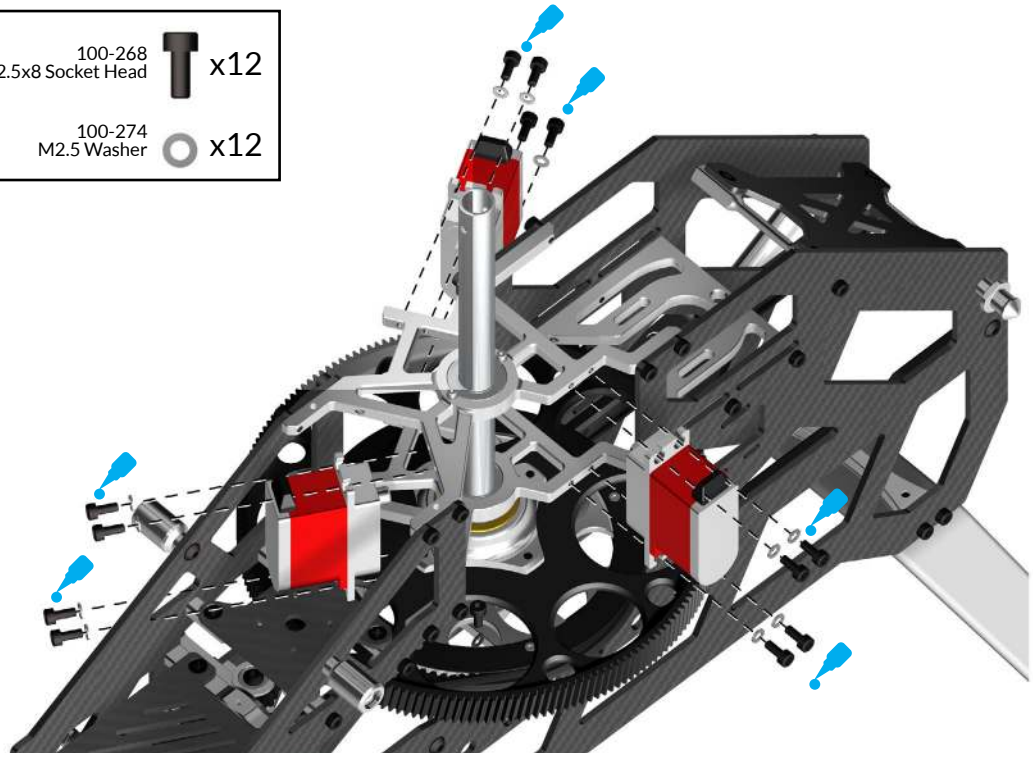
For optimal geometry, all servo linkages should be equal in length.

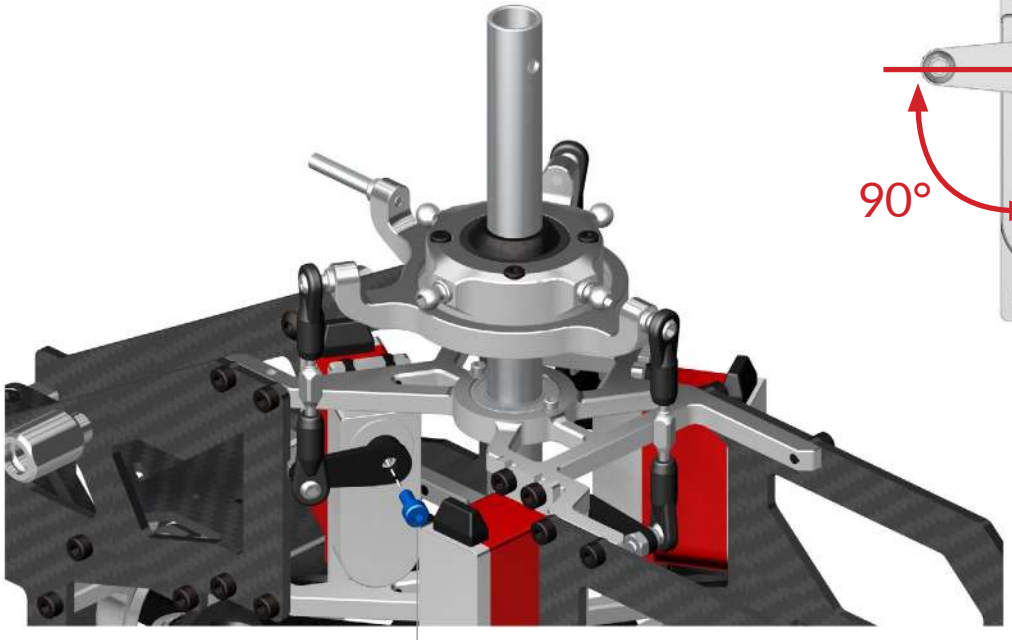
IMPORTANT: Apply **RED** threadlocker to all pivot balls. Heat may be required for removal.

IMPORTANT: Pre-drill servo arm with 2.5mm or 3/32" drill bit before installing the Pivot Ball.

CYCLIC SERVO INSTALLATION

100-268 M2.5x8 Socket Head	x12
100-274 M2.5 Washer	x12





Synergy does not supply with the kit: Servos, servo horns, and servo horn bolts.

Apply **BLUE** threadlocker where indicated.

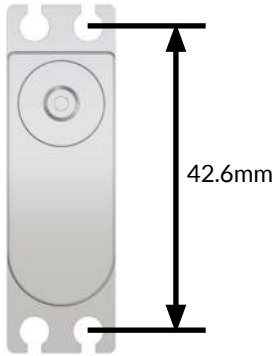
Use care when configuring the flybarless controller to verify servo arms are near or at 90 degrees. Use small trim adjustments if necessary.

NOTE: The Synergy 516 swash and head geometry has a high cyclic ratio for quick cyclic response. Reduction of the flybarless controller's cyclic ring may be necessary in order to prevent binding of the swash plate linkages at collective extremes.

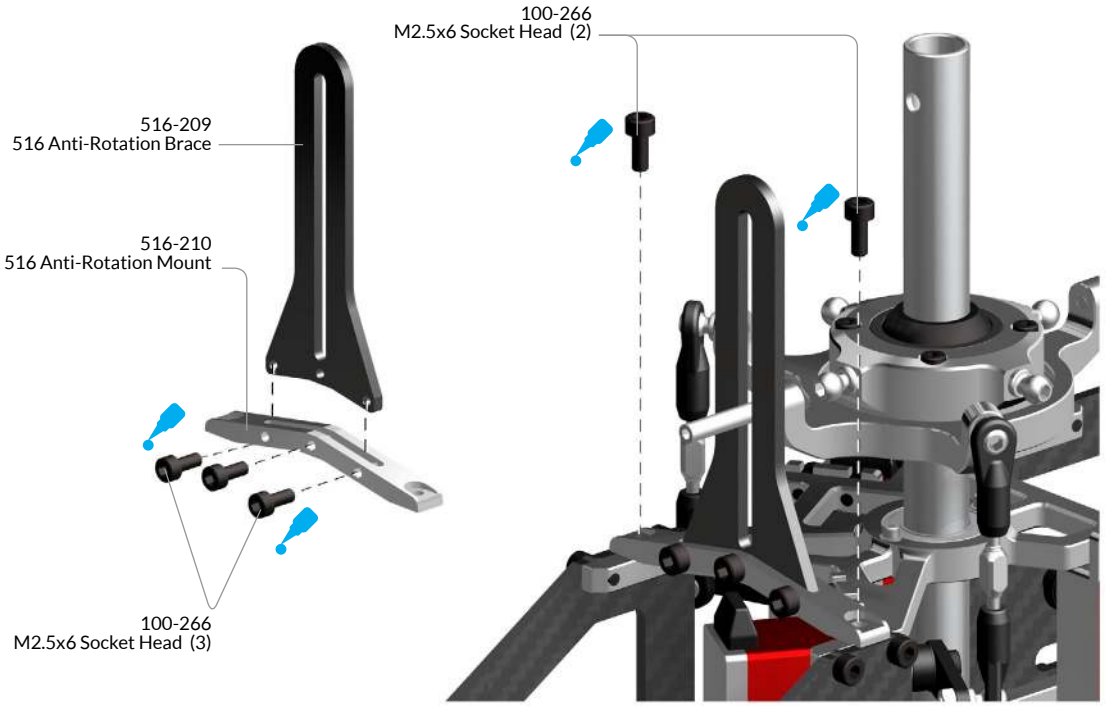
MINIMUM SERVO TORQUE: 100 oz/in or 7.2 kg/cm.

Use high-voltage brushless or coreless cyclic servos for optimal performance.

NOTE: Mini cyclic servos with a mounting tab spacing of 42.6mm are recommended.



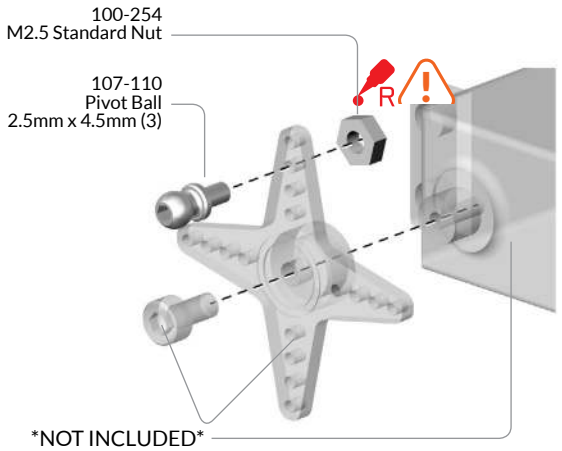
ANTI-ROTATION GUIDE

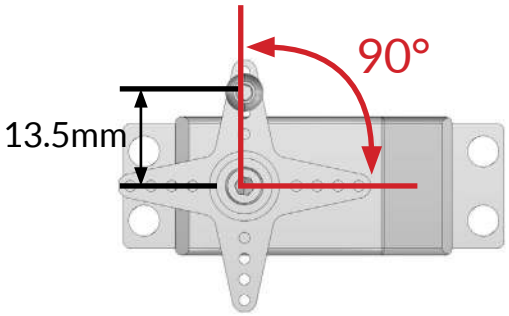


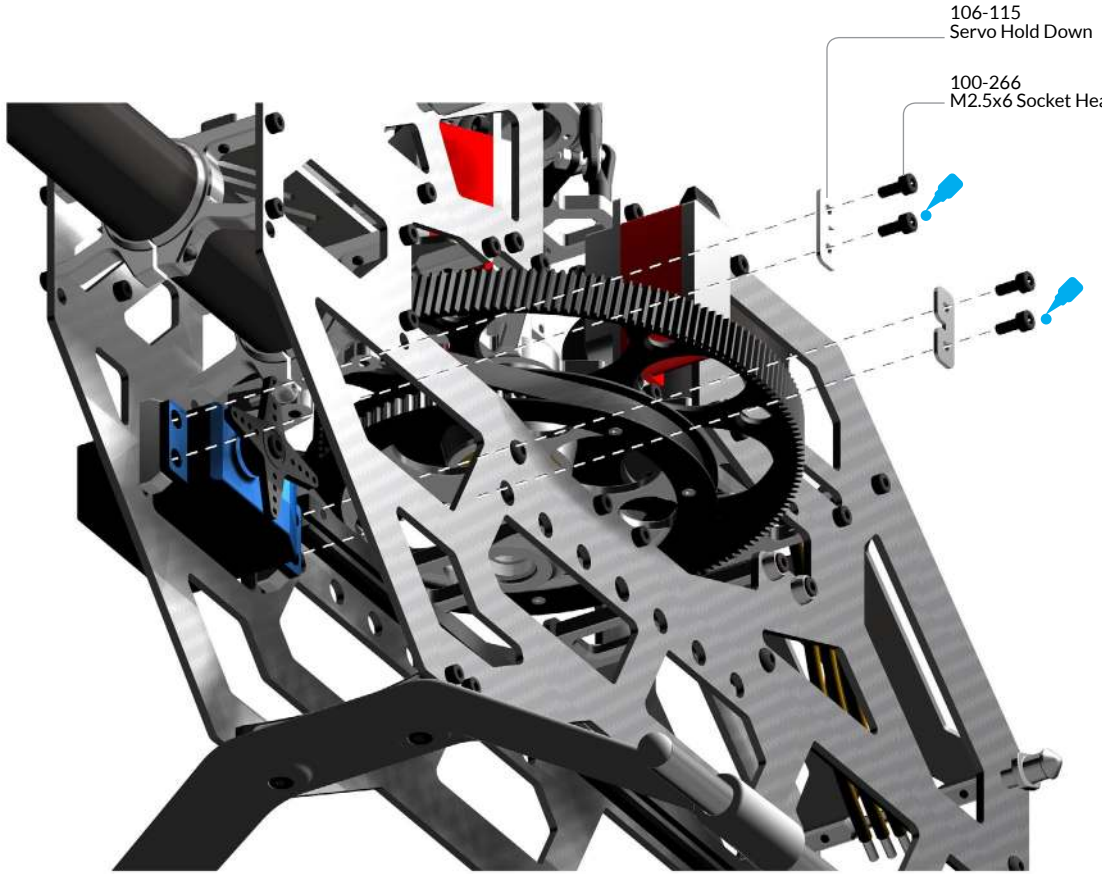
Apply **BLUE** threadlocker where indicated.

Note: Anti-Rotation Mount has threaded holes on the side closest to the main shaft and through holes on the opposite side. Orient correctly!

TAIL SERVO INSTALLATION







Use care when configuring the flybarless controller to verify tail servo arm is as close to 90 degrees as possible. 13.5mm servo arm is recommended for optimal tail geometry and throws.

Synergy does not supply with the kit: servos, servo horns, and servo horn bolts.

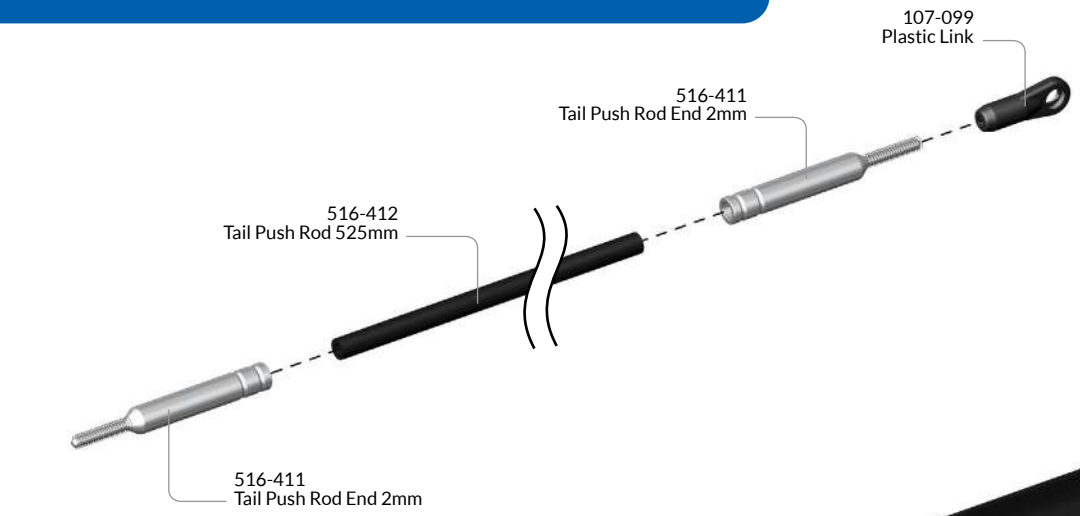
Apply **BLUE** and **RED** threadlocker where indicated.

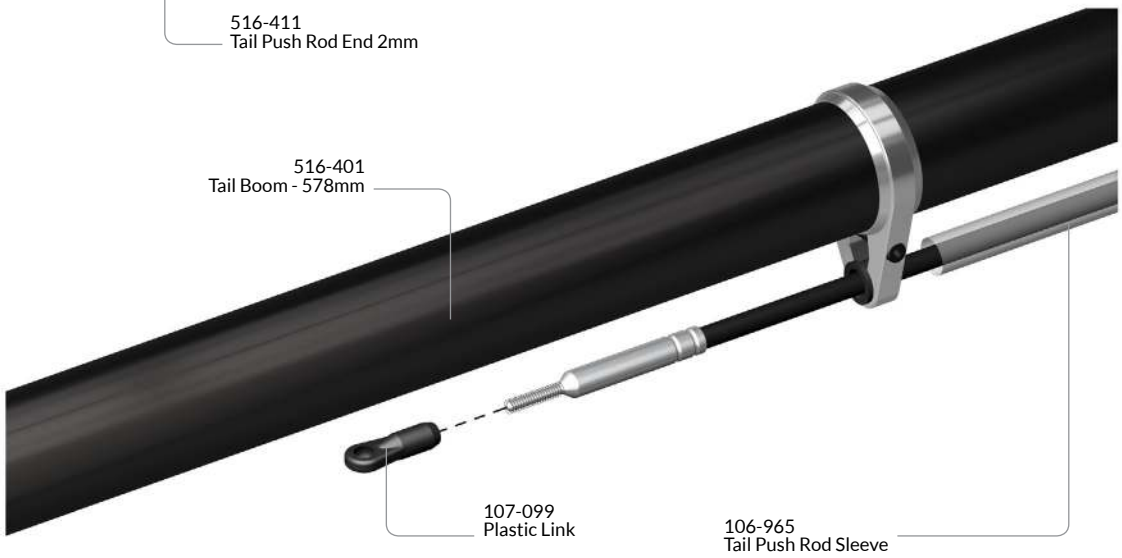
IMPORTANT: Pre-drill servo arm with 2.5mm or 3/32" drill bit before installing Pivot Ball.

MINIMUM TAIL SERVO TORQUE:
60 oz/in or 4.3 kg/cm.

Use a high-voltage brushless or coreless 760us narrowband tail servo for optimal tail performance.

TAIL CONTROL ROD



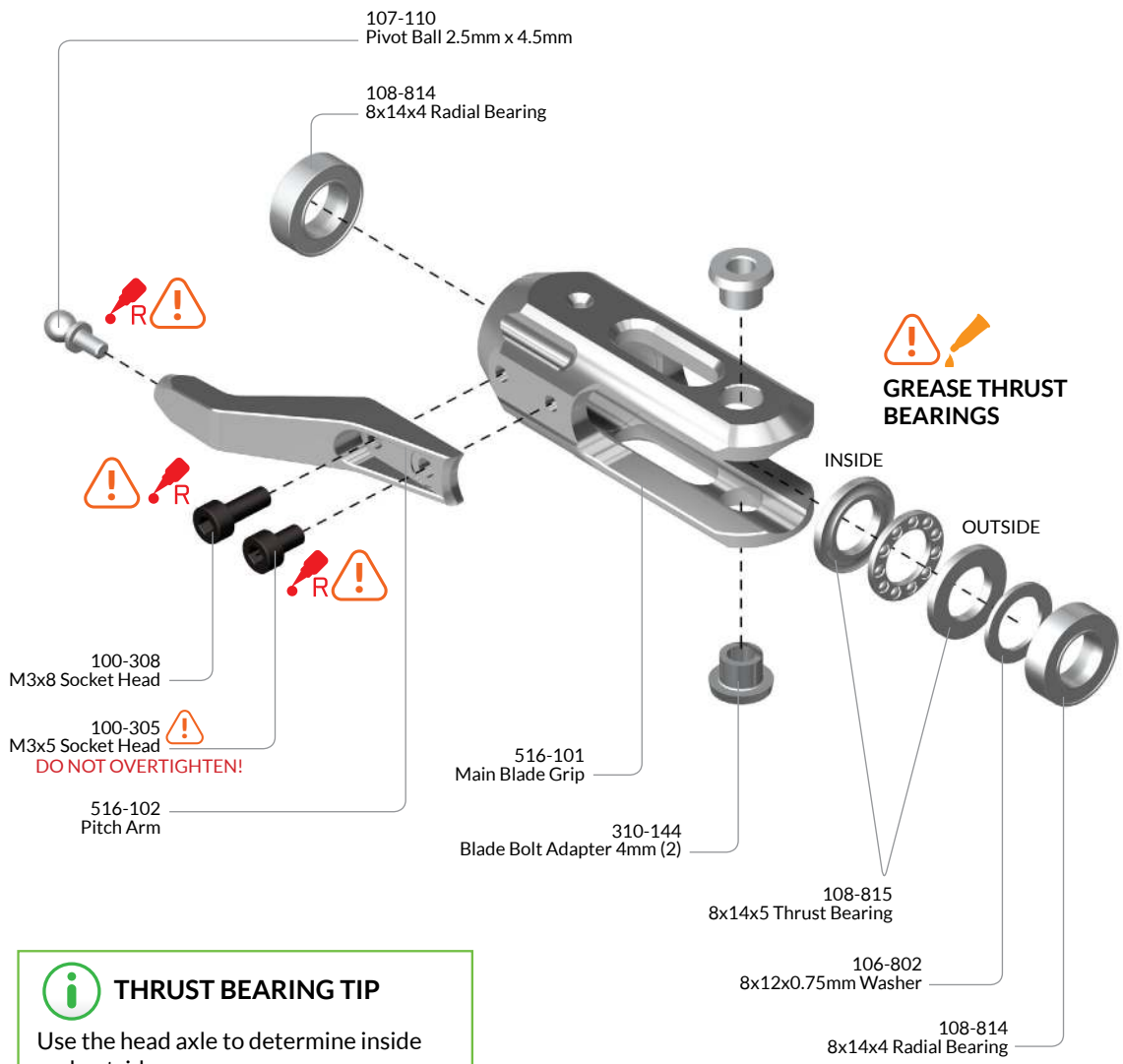


IMPORTANT: Lightly sand carbon rod with 400 grit sandpaper before applying epoxy. Use 30-Minute or longer curing Epoxy. Quick or 5-Minute Epoxy is not recommended.

TIP: Insert tail control rod into the tail rod support prior to installing the second linkage.

Use care when configuring the flybarless controller to verify tail pitch arm is 90 degrees at center tail position. 3-5 degrees of pitch compensation against torque is recommended for optimal flybarless behavior.

MAIN HEAD GRIPS



IMPORTANT: Full disassembly is required. Apply **RED** threadlocker to Pitch Arm bolts and pivot balls.

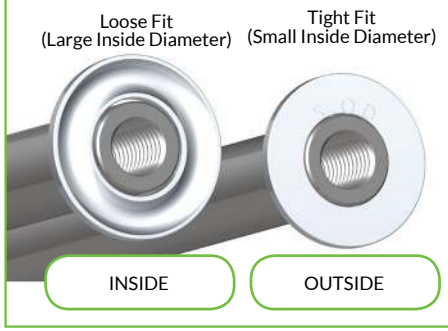
IMPORTANT: Install Pitch Arm first, then remove any excess threadlocker from inside the grip before installing the bearings. This will prevent contaminating the thrust and radial bearings.

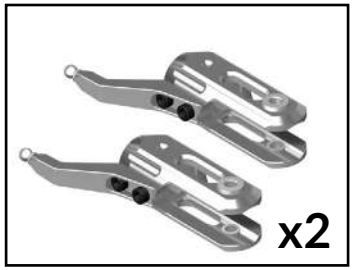
IMPORTANT: Verify that 100-305 M3x5 is used where indicated. A longer bolt will damage the radial bearing. Do not overtighten!

TIP: Extreme pressure synthetic grease is recommended for thrust bearings for optimal performance. Verify correct orientation and location of all bearings and shims. Boto-Lube Part **BD-001**

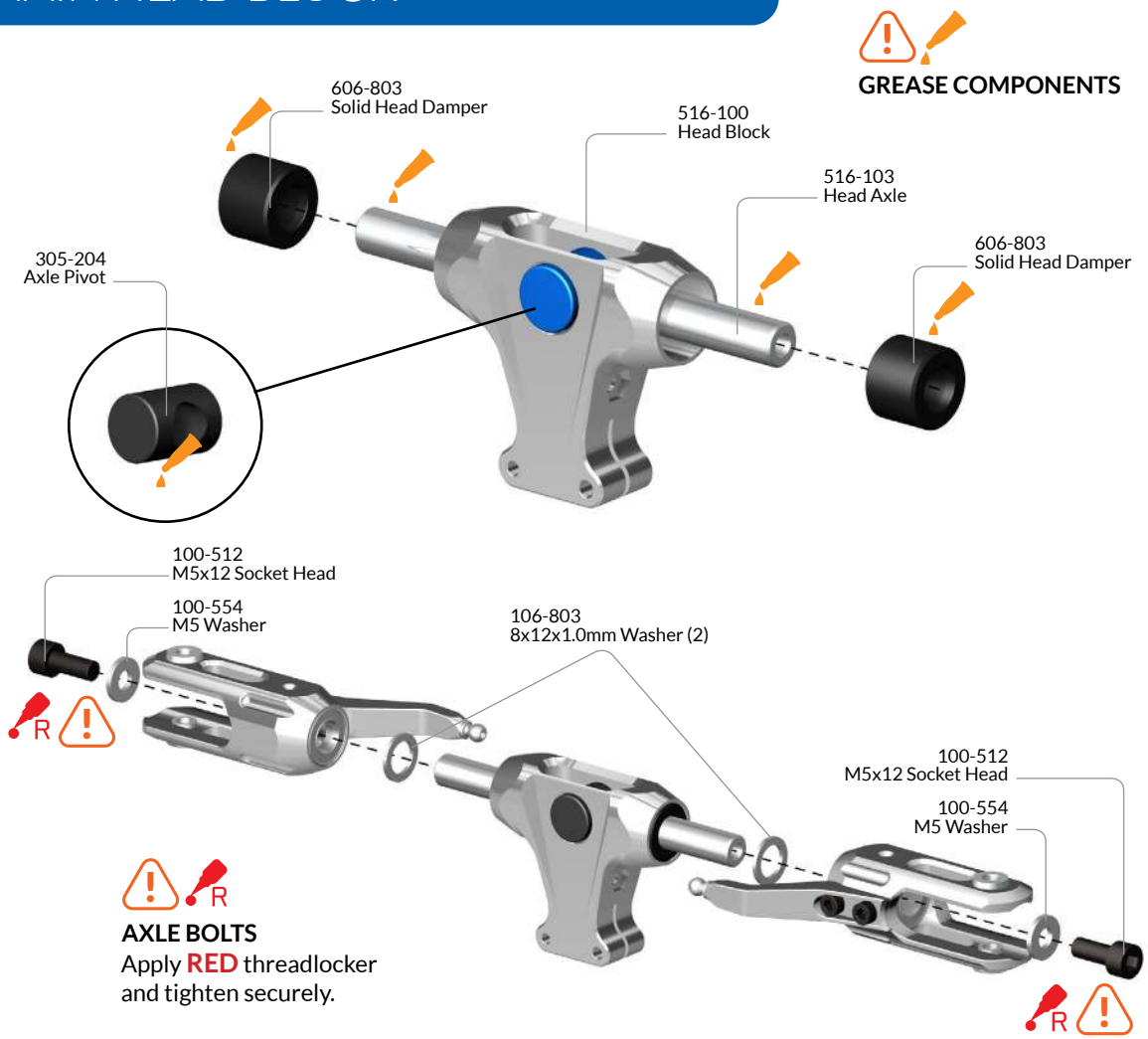
THRUST BEARING TIP

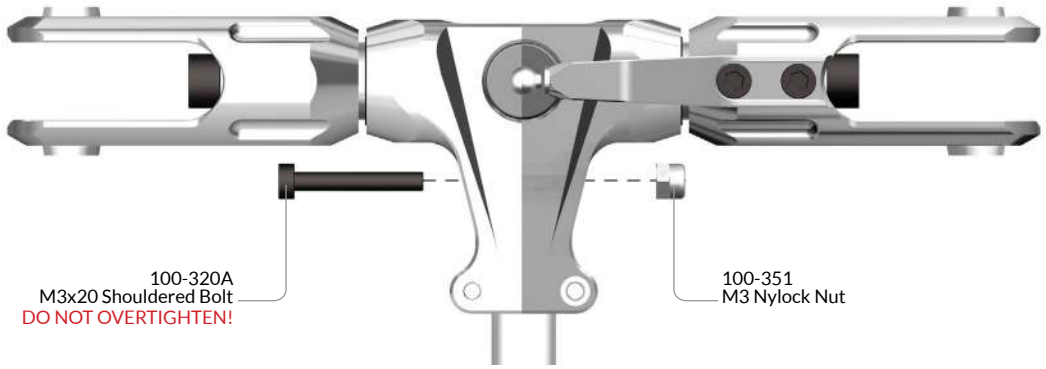
Use the head axle to determine inside and outside races:





MAIN HEAD BLOCK



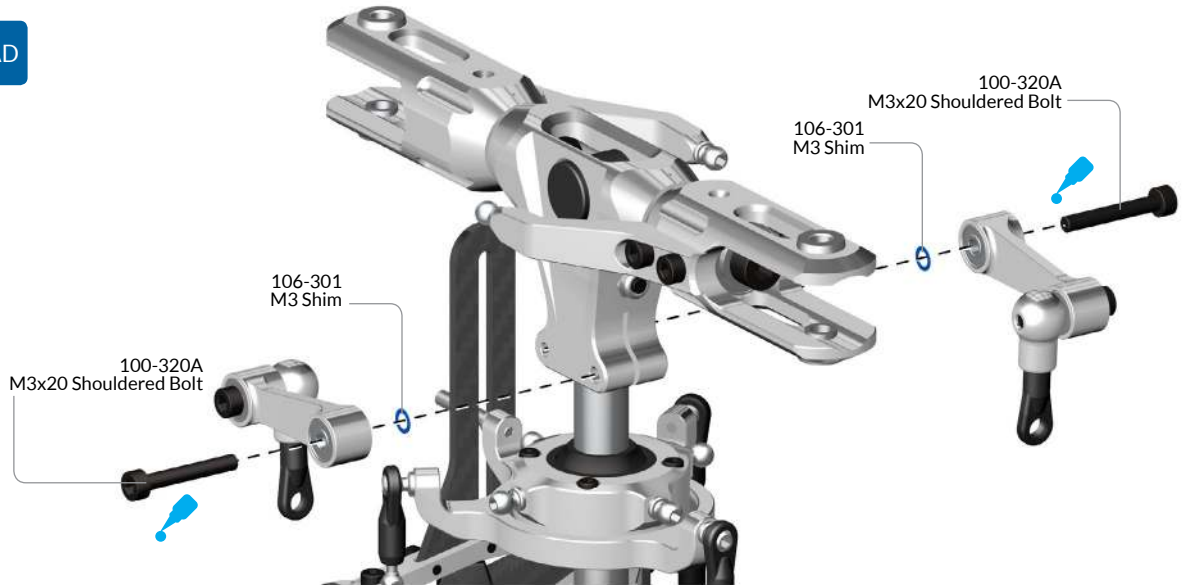


IMPORTANT: Full disassembly of the head is required. Apply **RED** threadlocker to both main head axle bolts and tighten firmly.

IMPORTANT: Apply threadlocker to inside threads of the Head Axle rather than the Socket Head bolt. This will prevent threadlocker from contaminating the radial bearing, which may cause it to seize.

TIP: Extreme pressure synthetic grease is recommended for dampers and axle rocker. Verify **ALL** points of contact are greased prior to installation. Use Boto-Lube Part **BD-001.**

RADIUS ARMS | HEAD INSTALLATION

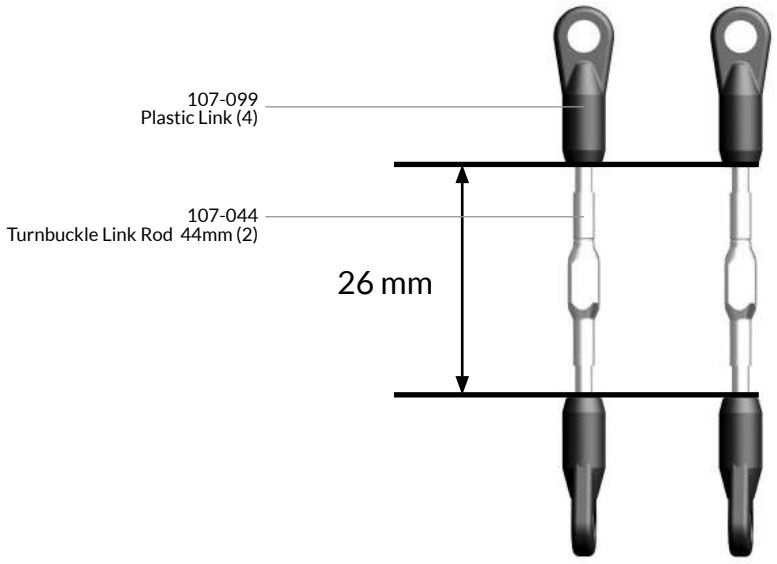


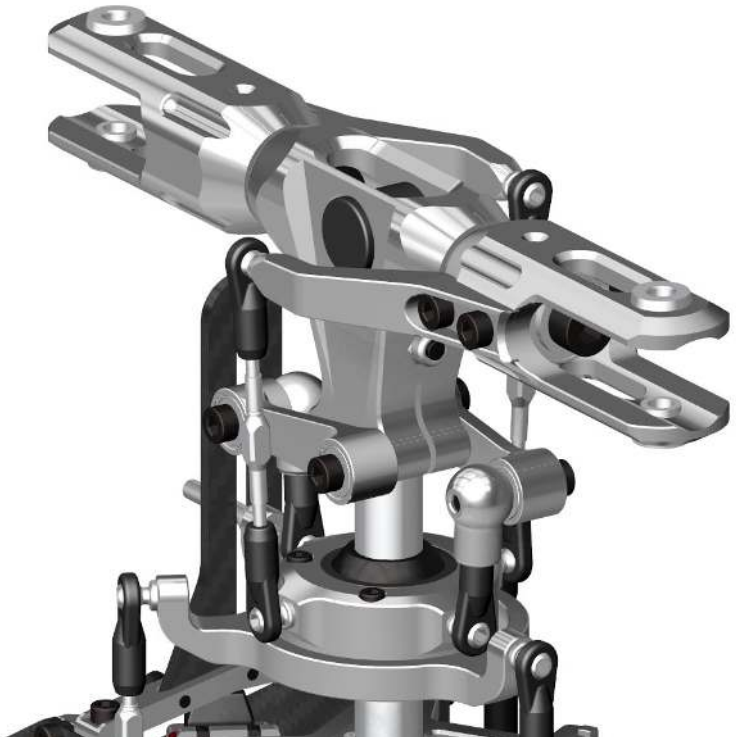
IMPORTANT: Disassembly is required. To prevent damaging bolt 100-316, remove linkage with set screw 100-272 before any disassembly.

Apply **BLUE** threadlocker to all radius arm bolts and set screws.

IMPORTANT: Pinch bolts 100-320A should have equal torque applied. Do not overtighten. Apply **BLUE** threadlocker.

PITCH LINKAGES



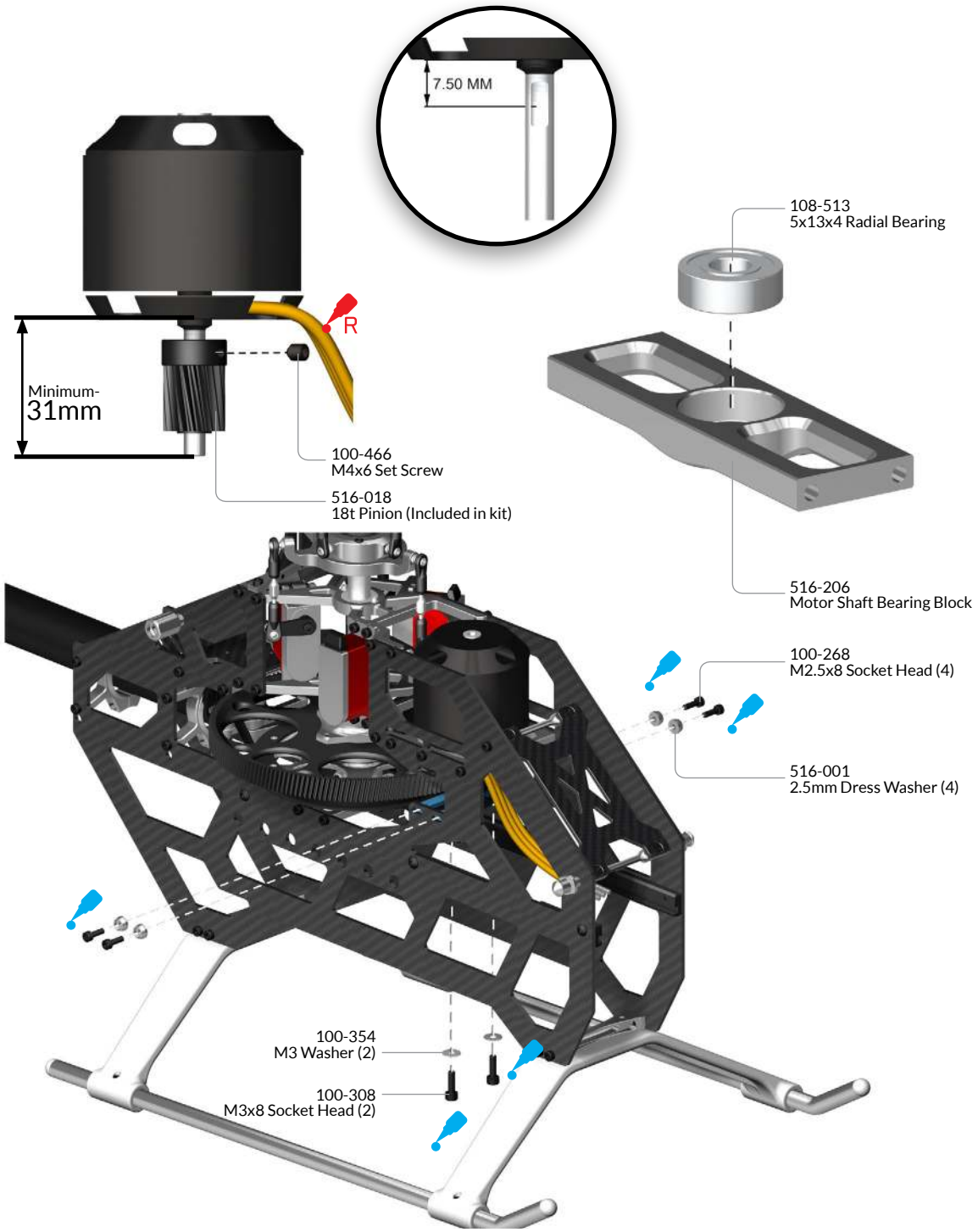


Turnbuckle linkages have reverse threads on one end. 26 mm length is not final, rather a starting point. The final length may vary.

TIP: Adjust turnbuckles to achieve proper blade tracking.

Recommended collective pitch range:
+/- 12-15 degrees.

MOTOR AND INSTALLATION



IMPORTANT: To prevent pinion slippage, verify motor shaft has a flat area where indicated to capture the set screw. Some motors will not have this, use a dremel to add a small flat area.

IMPORTANT STEPS:

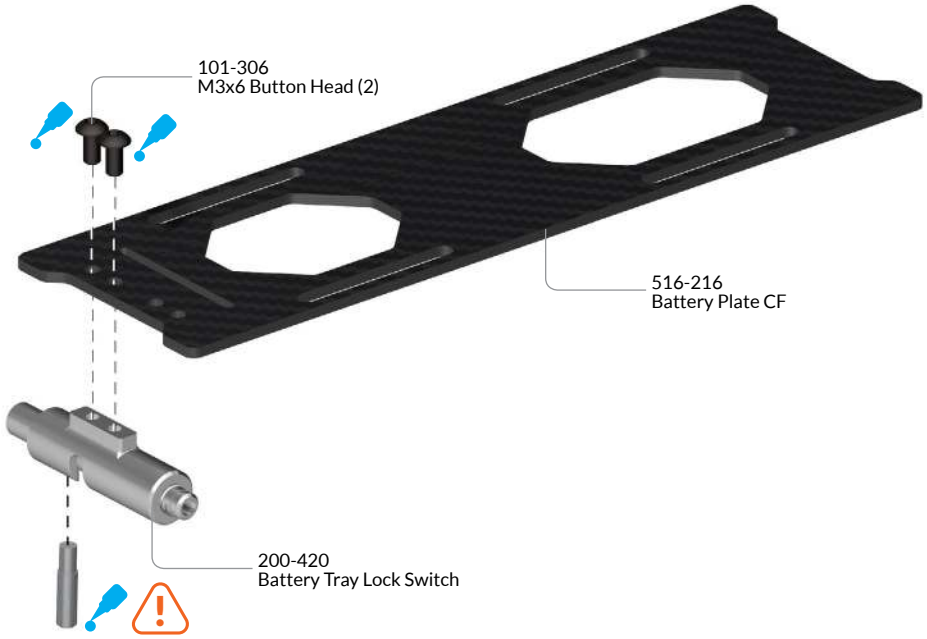
1. Install pinion on the motor shaft but do NOT tighten the M4 set screw at this step.
2. Install the motor and bearing block using the indicated hardware.
3. Temporarily tighten the motor and bearing block.
4. Verify the pinion is in contact with the support bearing, then secure M4 set screw using **RED** threadlocker. Verify that the set screw is in full contact with shaft flat area.
5. Loosen all motor and bearing block bolts to set appropriate gear mesh. Allow minimal backlash without binding of the main gear.

IMPORTANT: When securing the motor, verify motor bolts do not penetrate the stator wires or internal damage to the motor may occur. External motor shaft should be at least 31mm to engage support bearing.

OPTIONAL COMPONENTS

516-016 - 16t Pinion
516-017 - 17t Pinion
516-019 - 19t Pinion
516-020 - 20t Pinion
516-021 - 21t Pinion

BATTERY TRAY AND CANOPY

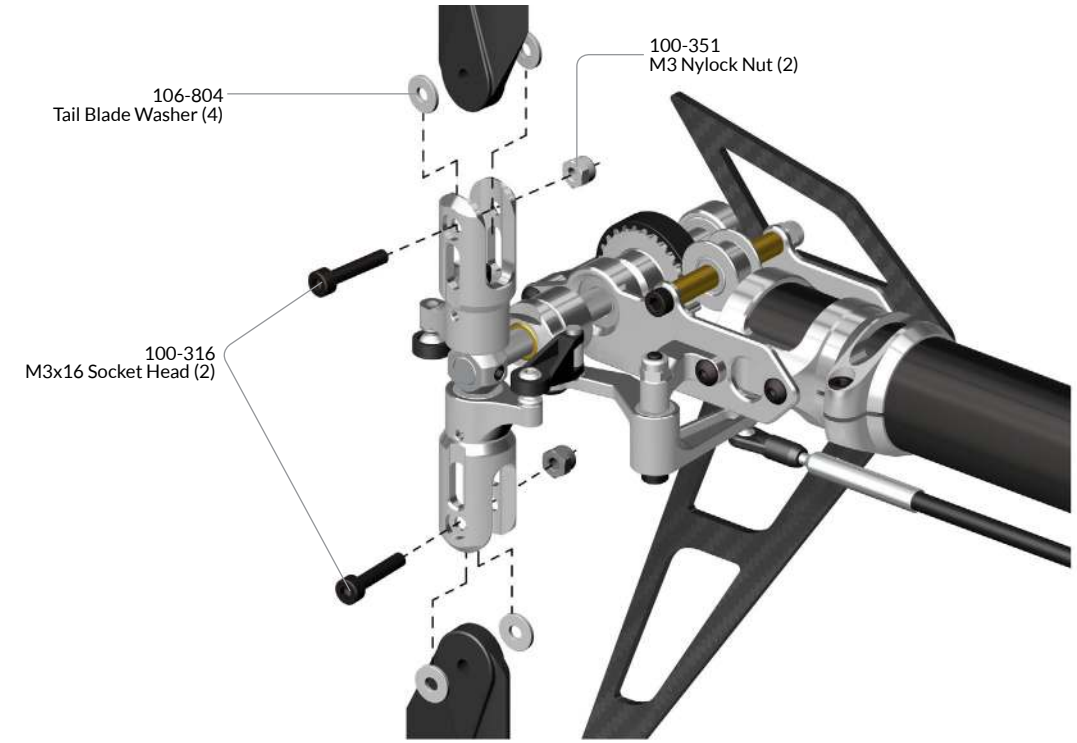


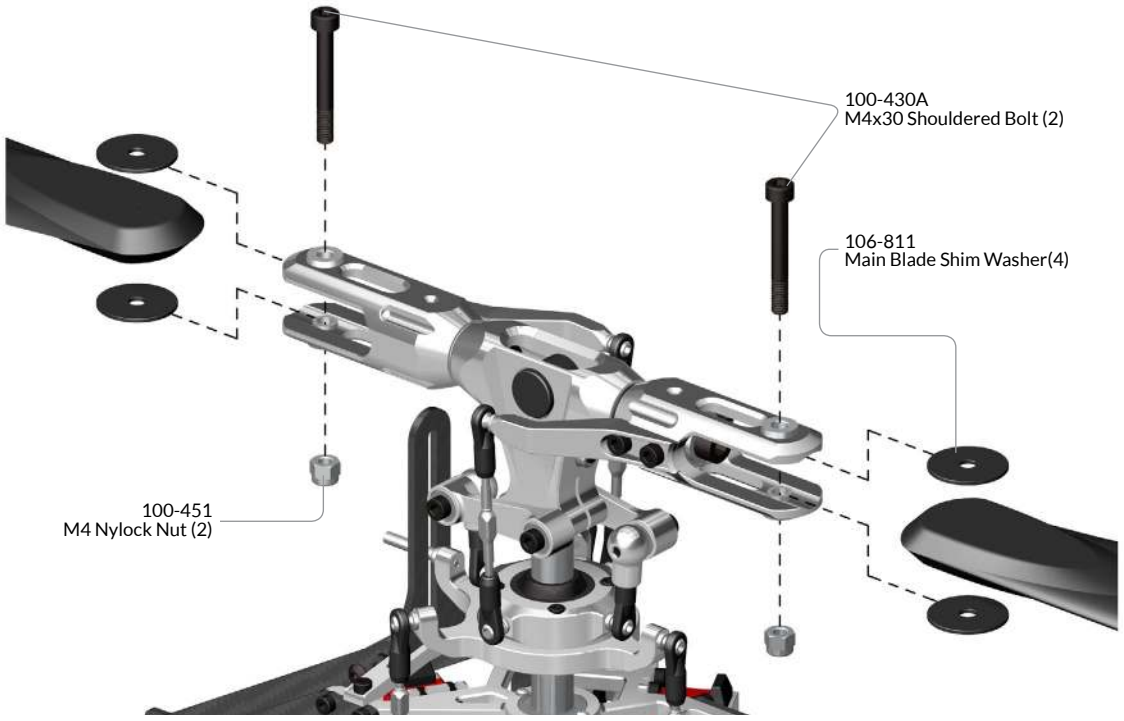
NOTE: Apply **BLUE** threadlocker where indicated.

TIP: Use CA to secure grommets to canopy.

IMPORTANT: Remove and apply **BLUE** threadlocker to BATTERY LOCK HANDLE.

BLADE INSTALLATION





Synergy does not include blades in the kit.

80.6mm Rail tail blades and 516mm Rail main blades are recommended.

COMPLETE MODEL