

X-cell WHIPLASH *Assembly Instructions*



Nitro
Helicopter Kit
MA1031-3 Flybarless

miniature aircraft usa

Step up to excellence with X-Cell



Table of Contents

Kit Introduction	3
R/C Helicopter Safety	3
Warning	3
General Guidelines	3
Academy of Model Aeronautics (AMA)	4
Kit Assembly	5
Required Tools	5
Other Required Components	5
Assembly Tips	6
Kit Contents	7
Flybarless Head Assembly (Whiplash Kit #MA1031-3)	9
Flybarless Head Parts List	9
Flybarless Head Assembly Instructions	10
Flybarless Head Link Lengths	11
Tail Assembly	17
Tail Assembly Parts List	17
Tail Assembly Instructions	18
Nitro Frame Assembly	23
Nitro Frame Assembly Parts List	23
Nitro Frame Assembly Instructions	24
Electronics Mounting Positions	33
Canopy Mounting	33
Basic Model/Radio Set Up	34
Swashplate eCCPM Set Up	35
Pitch Curve Set Up	36
Throttle Curve Set Up	37
Flybarless Stabilization Electronics	37
Kit Hardware and Parts	38
Warranty Information	39

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*For updates to this manual, or any other Miniature Aircraft manual,
go to www.miniatureaircraftusa.com.*



Kit Introduction

Thank you for purchasing the X-Cell Whiplash by Miniature Aircraft. This model is the culmination of years of designing and manufacturing R/C helicopters. It is designed with the highest standards, and will provide years of enjoyment. Whether this is your first R/C model helicopter or you are an advanced R/C helicopter modeler, the X-Cell Whiplash is a fantastic choice for a “700 size” model.

R/C Helicopter Safety

A radio controlled model helicopter is not a toy, but rather a technically complex device that must be built and operated with care. It is also a fascinating and challenging part of the R/C sport, the mastery of which is very rewarding. A model helicopter must be built exactly in accordance with the building instructions. The kit manufacturer has spent much time and effort refining this product to make it reliable in operation and easy to build. The bolt together construction can proceed quite rapidly. This gives the builder a strong sense of accomplishment that encourages hasty progress from one construction phase to the next, so that the completed model can be more quickly seen and enjoyed. It is essential to recognize and guard against this tendency. Follow building instructions exactly. Vibration and stress levels are high and all fasteners and attachments must be secure for safe operation.

Note that this is the first use of the word SAFETY in these comments. Previously the kit manufacturer's efforts to ensure reliable operation were mentioned. That is ALL that he can do. Safe operation is the responsibility of the builder/flyer and starts with careful construction and continues with selection and installation of reliable radio equipment and power systems.

The need for safety is nowhere greater than at the flying field. A number of guidelines for safe flight have been developed by experienced flyers and are set down here. It is urged that they be read, understood and followed.

Warning! – Risk of death or serious injury

Remote Control (“R/C”) Helicopters can be dangerous. Inexperienced pilots of R/C Helicopters should be trained and supervised by experienced operators. All operators should use safety glasses and other appropriate safety equipment. All operators should exercise necessary precautions when fueling, repairing, maintaining, flying and storing R/C Helicopters, and when using or storing R/C Helicopter accessories, equipment, fuels, and related materials. R/C Helicopters should be used only in open areas free of obstacles and far enough from people to minimize the possibility of injury from the helicopter or any of its components falling or flying in unexpected directions.

This helicopter is not a toy but a complex flying machine that must be assembled with care by a responsible individual. Failure to exert care in assembly, or radio or accessory installation, may result in a model incapable of safe flight or ground operation. Rotating components are an ever present danger and source of injury to operators and spectators. Since the manufacturer and his agents have no control over the proper assembly and operation of his products, no responsibility or liability can be assumed for their use.

General Guidelines for Safe R/C Helicopter Flight

- Fly only at approved flying fields and obey field regulations.
- Follow frequency control procedures. Interference can be dangerous to all.
- Know your radio. Check all transmitter functions before each flight.
- Be aware that rotating blades are very dangerous and can cause serious injury.
- Never fly near or above spectators or other modelers.
- If you're a beginner, get help trimming the model first and seek flight training later.
- Don't “track” the main blades by holding the tail boom. This is a temptation to builders who cannot hover yet and is very dangerous.
- Follow all recommended maintenance procedures for your model, radio and engine.



Academy of Model Aeronautics

Miniature Aircraft highly recommends joining the Academy of Model Aeronautics (AMA).

- AMA is the Academy of Model Aeronautics.
- AMA is the world's largest model aviation association, representing a membership of more than 195,000 from every walk of life, income level and age group.
- AMA is a self-supporting, non-profit organization whose purpose is to promote development of model aviation as a recognized sport and worthwhile recreation activity.
- AMA is an organization open to anyone interested in model aviation.
- AMA is the official national body for model aviation in the United States. AMA sanctions more than one thousand model competitions throughout the country each year and certifies official model flying records on a national and international level.
- AMA is the organizer of the annual National Aeromodeling Championships, the world's largest model airplane competition.
- AMA is the chartering organization for more than 2,500 model airplane clubs across the country. AMA offers its chartered clubs official contest sanction, insurance, and assistance in getting and keeping flying sites.
- AMA is the voice of its membership, providing liaison with the Federal Aviation Administration, the Federal Communications Commission, and other government agencies through our national headquarters in Muncie, Indiana. AMA also works with local governments, zoning boards, and parks departments to promote the interests of local chartered clubs.
- AMA is an associate member of the National Aeronautic Association. Through NAA, AMA is recognized by the Fédération Aéronautique Internationale (FAI), the world governing body of all aviation activity, as the only organization which may direct U.S. participation in international aeromodeling activities.

For more detailed information, contact the Academy of Model Aeronautics
5161 E. Memorial Drive, Muncie, Indiana, 47302
or telephone (800) 435-9262.

You may also visit the AMA website at www.modelaircraft.org



Kit Assembly

Your Whiplash kit will require a number of different supplies and tools to ensure the best final result. They are as follows:

Required Lubricants and Compounds:

1. Medium Strength Thread Locking Compound - Loctite Blue #243 (MA3200-20)
2. Tri-Flow Oil (MA3200-02)
3. Tri-Flow Synthetic Grease (MA3200-06)
4. Medium Cyanoacrylate (CA)
5. Retaining Compound - Loctite Green #648 (MA3200-22)

Required Tools:

1. M4 Nut Driver
2. M5 Nut Driver
3. M5.5 Nut Driver
4. M7 Nut Driver
5. 1.5mm Allen Driver
6. 2.0mm Allen Driver
7. 2.5mm Allen Driver
8. 3.0mm Allen Driver
9. 4.0mm Allen Driver x2
10. 5.0mm Allen Driver
11. Needle Nose Pliers
12. Phillips Screwdriver
13. Razor Knife (X-acto)

Other required components:

The X-Cell Whiplash is an airframe kit. To complete the model, several other items are required, but not included with the kit. There are many choices for these other required components, and any competent hobby retailer with R/C helicopter experience will be happy to make suggestions. You will need:

1. Engine, "90-120" size nitro helicopter engine.
2. Helicopter style muffler suited to the engine you choose.
3. Cyclic servos (Miniature Aircraft recommends high quality digital cyclic servos with no less than 80 oz. in. of torque.)
4. Throttle servo (Miniature Aircraft recommends a high quality ball bearing servo.)
4. R/C helicopter gyro (Miniature Aircraft recommends for Flybarless Kits a flybarless electronic unit with rudder gyro and for Flybar Kits only a tail "heading hold" style gyro is needed.)
5. Rudder servo suitable for use with the gyro you choose. Digital servo is recommended.
6. R/C helicopter transmitter and receiver with at least 6 channels, and eCCPM capabilities.
7. 690-710mm Main Blades and 105-115mm Tail Blades.
8. R/C helicopter starting and fueling equipment.
9. R/C helicopter engine governor is recommended, but not required for flight.



Important Assembly Tips - PLEASE READ

- Follow the instructions. The methods of construction documented in this manual have been proven to work. Do not rush the build of your model! You have purchased a world class model helicopter kit, take your time and realize that the final result is now up to you. Take the time to fully understand each step and if you are unsure please contact Miniature Aircraft, or a representative.
- Follow the order of assembly. The instructions have been organized into major sections and have been written in such a way that each step builds upon the work done in the previous step. Changing the order of assembly may result in unnecessary steps.
- Clean all metal parts. All of the steel parts in this kit are coated with a lubricant to prevent them from rusting. This coating can interfere with the adhesives and thread locks needed for assembly. Use a solvent such as alcohol or acetone to clean the various metal parts, especially threads. Be sure not to overtighten bolts as damage to bearings and other components will occur.
- It is very important to lightly sand the edges of all carbon fiber pieces. Miniature Aircraft recommends doing so prior to the assembly process. Carbon fiber edges can be sharp and can easily cut component wires and battery mounting straps. It is important to use safety precautions when creating carbon fiber dust. The use of a particulate mask, preferably one with a P100 HEPA filter is recommended. Always clean up carbon fiber dust with a damp rag right away.
- Use thread lock as indicated. Generally any bolt or screw that threads into a metal part requires thread lock. Model helicopters are subject to vibration and failing to use thread lock on any non-locking assembly may result in a part becoming loose or falling off in flight.



Kit Contents

Please take some time to familiarize yourself with the contents of the kit. The Whiplash kit has been broken down into three “bags.” Each bag contains parts and hardware. The hardware in each bag will be used only for that bag. There will be no left over parts after each bag is assembled. *The individual parts of the factory assembled parts are not listed out here. They can be found in the components section of the manual.*

Bag 1 - Whiplash Rotor Head FBL

Bag	Part No.	Part Description	Qty	Bag	Part No.	Part Description	Qty
1-A	0217	Swashplate - Factory	1	1-C	131-161	Main Blade Grip - Factory	2
1-Hardware	0051	M3x3 Set Screw	2	1-C	131-163	FBL Pitch Arm	2
1-Hardware	0107	M3x6 Threaded Steel Ball	3	1-C	131-187	Head Axle	1
1-Hardware	0109	M3x8 Threaded Steel Ball	4	1-Hardware	0107	M3x6 Threaded Steel Ball	2
1-Hardware	131-83	Anti-rotation Pin	1	1-Hardware	0061	M3x8 Socket Bolt	4
				1-Hardware	0086-1	M5x16 Flanged Socket Bolt	2
1-B	0869	Washout Link	2	1-Hardware	120-7-1	5x15 Safety Washer	2
1-B	128-176	Washout Pin	2	1-Hardware	131-183	Washer	4
1-B	128-195	Head Button	1				
1-B	128-314	Swashplate Follower - Factory	2	1-D	0133-1	M3x21.5 Ball Link	10
1-B	131-368	FBL Head Block	1	1-D	121-4	Servo To Swash Linkage Rod	3
1-Hardware	0067	M3x14 Socket Bolt	1	1-D	121-7	Swash To PA Linkage Rod	2
1-Hardware	0071	M3x18 Button Head Socket Bolt	2	1-D	131-408	FBL Main Shaft	1
1-Hardware	0447-1	M2 E-clip	4	1-Hardware	0021	M4 Lock Nut	1
				1-Hardware	0023	M5 Nut	2
				1-Hardware	0063	M3x10 Socket Bolt	2
				1-Hardware	0082-4	M5x32 Shouldered Socket Bolt	2
				1-Hardware	131-200	M4x33 Shouldered Socket Bolt	1

Bag 2 - Whiplash Tail Assembly

Bag	Part No.	Part Description	Qty	Bag	Part No.	Part Description	Qty
2-A-1	131-475	T/R Pitch Slider Assembly - Factory	1	2-B-1	131-400	TT Ends	2
				2-B-1	131-480	TT Bearing Cup	2
2-A-2	131-129	Tail Box Assembly - Factory	1	2-B-1	131-481	TT Bearing Cup O-Ring	4
				2-B-1	131-482	TT Sleeve	2
2-A-3	131-130	Tail Pitch Control Bellcrank	1	2-B-1	131-485	TT Bearing	2
2-A-3	131-131	C/F Bellcrank Bracket	1	2-Hardware	0015	2mm Hex Nut	2
2-A-3	131-132	Bellcrank Slider Cup	1	2-Hardware	0049-1	M2x12 Socket Bolt	2
2-Hardware	0019	M3 Lock Nut	1				
2-Hardware	0059-1	M2.5x6 Socket Bolt	1	2-B-2	131-558	TT	1
2-Hardware	0064-3	M3x6 Button Head Socket Bolt	2	2-B-2	131-62	Tail Boom	1
2-Hardware	0073	M3x20 Socket Bolt	1	2-B-2	131-69-1	T/R Control Rod	1
2-Hardware	0107	M3x6 Threaded Steel Ball	1	2-B-2	131-86	Tail Boom Support C/F Rod Assembly	2
2-A-4	131-64	T/R Hub	1	2-B-3	0133	M2x21.2 Ball Link	2
2-A-4	131-112	T/R Blade Grip - Factory	2	2-B-3	128-80	Aluminum Front Boom Clamp	2
2-Hardware	0009	M3 Washer	2	2-B-3	128-144	T/R Control Rod Guide	4
2-Hardware	0019	M3 Lock Nut	2	2-B-3	128-149a	Upper Rear Boom Support Mount	1
2-Hardware	0056	M3x5 Dog-Point Set Screw	2	2-B-3	128-149b	Lower Rear Boom Support Mount	1
2-Hardware	0061	M3x8 Socket Bolt	2	2-B-3	131-128	C/F Boom Clamp Plate	1
2-Hardware	0071	M3x18 Socket Bolt	2	2-Hardware	0016-2	4mm External Serrated Lockwasher	2
2-Hardware	0107	M3x6 Threaded Steel Ball	2	2-Hardware	0060-1	M3x6 Socket Bolt	4
				2-Hardware	0063	M3x10 Socket Bolt	2
				2-Hardware	0065	M3x12 Socket Bolt	3
				2-Hardware	0067	M3x14 Socket Bol	2
				2-Hardware	0078	M4x12 Socket Bolt	2
				2-B-4	131-61	C/F Vertical Tail Fin Painted	1



Bag 3 - Nitro Frame Assembly

Bag	Part No.	Part Description	Qty	Bag	Part No.	Part Description	Qty
3-A	128-57	3mm Tray Mount	3	3-Hardware	0061	M3x8 Socket Bolt	6
3-A	131-52	Delrin Tray Mount	2	3-Hardware	0069	M3x16 Socket Bolt	1
3-A	131-53	C/F Gyro Plate	1	3-Hardware	0081	M4x16 Socket Bolt	4
3-A	131-55	C/F Angled Battery Tray	1	3-Hardware	0107	M3x6 Threaded Steel Ball	2
3-Hardware	0032-2	M3x8 Tapping Screw	4				
3-Hardware	0064-3	M3x6 Button Head	6	3-E	0390	Wire Retainers	5
				3-E	0875-1	10mm Split Main Shaft Collar	2
3-Frames	131-487	C/F Left Frame - Nitro	1	3-E	131-424	Main Gear Hub	1
3-Frames	131-488	C/F Right Frame - Nitro	1	3-E	131-440	Lower Main Bearing Block	1
				3-E	131-466	Auto Hub	1
3-Hardware	0003	3mm Washer	20	3-E	131-469-1	Gear Support	1
3-Hardware	0009	3mm Washer small	10	3-E	131-470	70T Machined Crown Gear	1
3-Hardware	0032	2.9x9.5 Tapping Screw	4	3-E	132-117-B	124T Main Gear	1
3-Hardware	0060-1	M3x6 Socket Bolt	30	3-E	3200-30	20" Spiral Band for Wire and Cable	1
3-Hardware	0061	M3x8 Socket Bolt	40	3-E	3200-48	20" 3/4 Hook and Loop Tape	1
3-Hardware	0063	M3x10 Socket Bolt	5	3-E	3200-54	17" Adhesive Hook and Loop	1
				3-Hardware	0021	4mm Lock Nut	1
3-B	128-58	Frame Spacer	11	3-Hardware	0059-2	M2.5x8 Socket Bolt	2
3-B	131-21	Upper Main Bearing Block	1	3-Hardware	0088	M3x8 Tapered Socket Bolt	8
3-B	131-46	P/A Servo Rail	2	3-Hardware	0088-3	M3x7 Tapered Socket Bolt	5
3-B	131-47	C/F Servo Rail Spacer	2	3-Hardware	0620-01	15x21x.10 Shim Washer	1
3-B	131-137	Rear Doubler	2	3-Hardware	0620-02	15x21x.20 Shim Washer	1
3-B	131-186	C/F Anti-rotation Bracket	1	3-Hardware	0620-03	15x21x.30 Shim Washer	2
3-B	131-420	Mid Main Bearing Block	1	3-Hardware	131-202	Jesus Bolt OWB V2	1
3-B	131-429	C/F X-Brace	1				
3-B	132-59	Front Doubler	2	3-E-1	0133-1	M3x21.2 Ball Links	2
3-Hardware	0060-1	M3x6 Socket Bolt	4	3-E-1	106-22	Rubber Canopy Grommets	4
3-Hardware	0063	M3x10 Socket Bolt	2	3-E-1	128-59	M4 Front Boom Support Brace	1
3-Hardware	0065	M3x12 Socket Bolt	2	3-E-1	131-153	C/F Canopy Breakaway Tabs	4
				3-E-1	131-450	Front Canopy Magnet System	2
3-C	128-118	6mm Hex Adaptor	1	3-E-1	131-451	Rear Canopy Post	2
3-C	131-3	Start Shaft w/Sleeve	1	3-E-1	131-452	Canopy Post Splint	
3-C	131-117	Nitro Fan Hub	1	3-Hardware	0003	3mm Washer	2
3-C	131-119	Nitro Clutch	1	3-Hardware	0016-2	M4 External Serrated Lock Washer	2
3-C	131-120	Nitro Fan	1	3-Hardware	0061	M3x8 Socket Bolt	20
3-C	131-122	Left Engine Mount	1	3-Hardware	0081	M4x16 Socket Bolt	2
3-C	131-123	Right Engine Mount	1				
3-C	131-179	X-Block	1	3-F	115-65	Fuel Line	1
3-C	131-411	Assembled Nitro Clutch Bell	1	3-F	125-24	Fuel Filtered Pick-Up Magnet	1
3-Hardware	0004	4mm Washer	4	3-F	128-92	Fuel Tank Plug	1
3-Hardware	0057	M4x4 Set Screw	2	3-F	128-94	Fuel Nipple	1
3-Hardware	0064-3	M3x6 Button Head Socket	4	3-F	131-133	Fanshroud R + L	2
3-Hardware	0078-4	M4x8 Socket Bolt	2	3-F	131-138	Whiplash Nitro Fuel Tank	1
3-Hardware	0081	M4x16 Socket Bolt	4	3-F	131-144	Rubber Fuel Tank Mount	4
				3-F	131-145	Tank Mounting Studs	2
3-S	0818-3	Mounting Block	2	3-F	131-146	C/F Nitro Fuel Tank Plate	1
3-S	131-50	Elevator Servo Mount	2	3-Hardware	0011-5	Washer	1
3-S	131-148	C/F Servo Plates	14	3-Hardware	0014F	5mm Hex Nut - Fine Threaded	1
S-Hardware	0017-2	2.5mm Hex Nut	5	3-Hardware	0053-5	Set Screw	2
S-Hardware	0059-1	M2.5x6 Socket Bolt	4	3-Hardware	0060-1	M3x6 Socket Bolt	4
S-Hardware	0059-4	M2.5x12 Socket bolt	16	3-Hardware	0061	M3x8 Socket Bolt	2
S-Hardware	0059-7	M2.5x20 Socket Bolt	4	3-Hardware	0063	M3x10 Socket Bolt	4
S-Hardware	0116	M2.5 Threaded Steel Ball	5				
3-D	0133	Plastic Ball Link	2	BOX	131-252	Whiplash Canopy - Stomp	1
3-D	0133-1	Plastic Ball Link	2	BOX	131-233	Whiplash Nitro Instruction Manual	1
3-D	122-94	M3x97 Threaded Control Rod	1	BOX	3000-73	MA Towel	1
3-D	131-69	M2x315 Linkage Rod	1	BOX	3700-160	Blade Holder	1
3-D	131-85	C/F Rod	1				
3-D	131-107	Bellcrank Swing Arm	1				
3-D	131-109	Swing Arm Pivot Mount	1				
3-D	131-115	C/F Bottom Plate - Nitro	1				
3-D	131-136	Struts	4				
3-D	131-139	Skids	2				
3-D	131-454	4mm Tray Mount	2				
3-D	2500-39	Tuf-Strut II End Cap Black	4				
3-D	2500-40	Tuf-Strut II End Cap White	4				
3-Hardware	0015	2mm Hex Nut	1				
3-Hardware	0057	M4x4 Socket Screw	4				
3-Hardware	0060-1	M3x6 Socket Bolt	2				

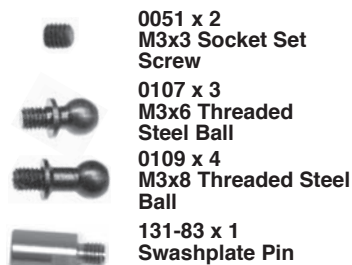


Whiplash - Flybarless Head Assembly Parts



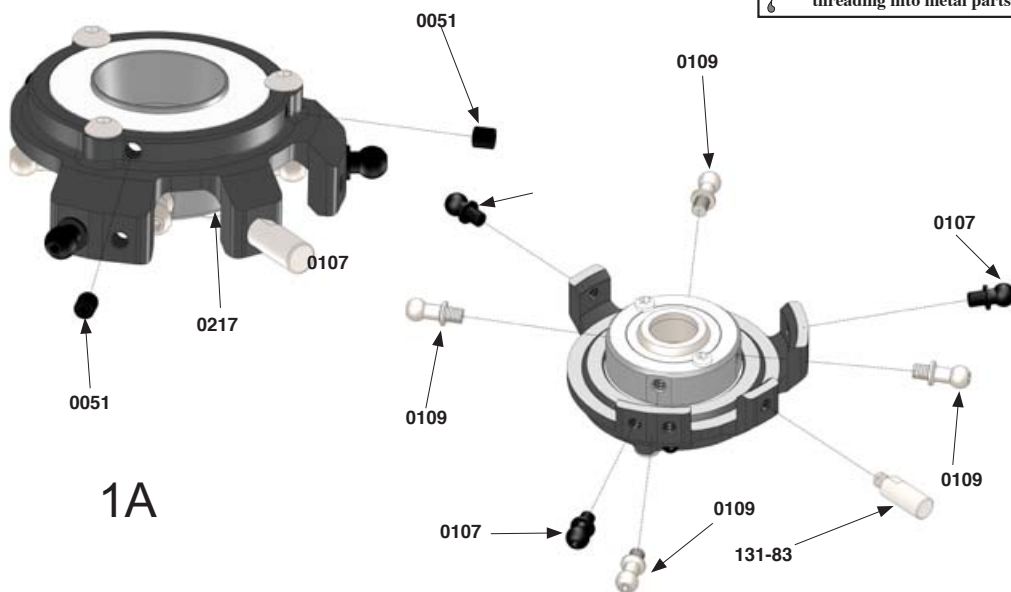
Apply a small amount of medium thread lock when threading into metal parts

Hardware for this assembly



Assembly Tip

- Install MA0051 M3x3 Socket Set Screws only until they bottom out against the lower bearing. Do not overtighten or damage to swashplate bearing will occur. *Note: these are used to adjust the bearing tolerance if it develops play over time.*



Hardware for this assembly

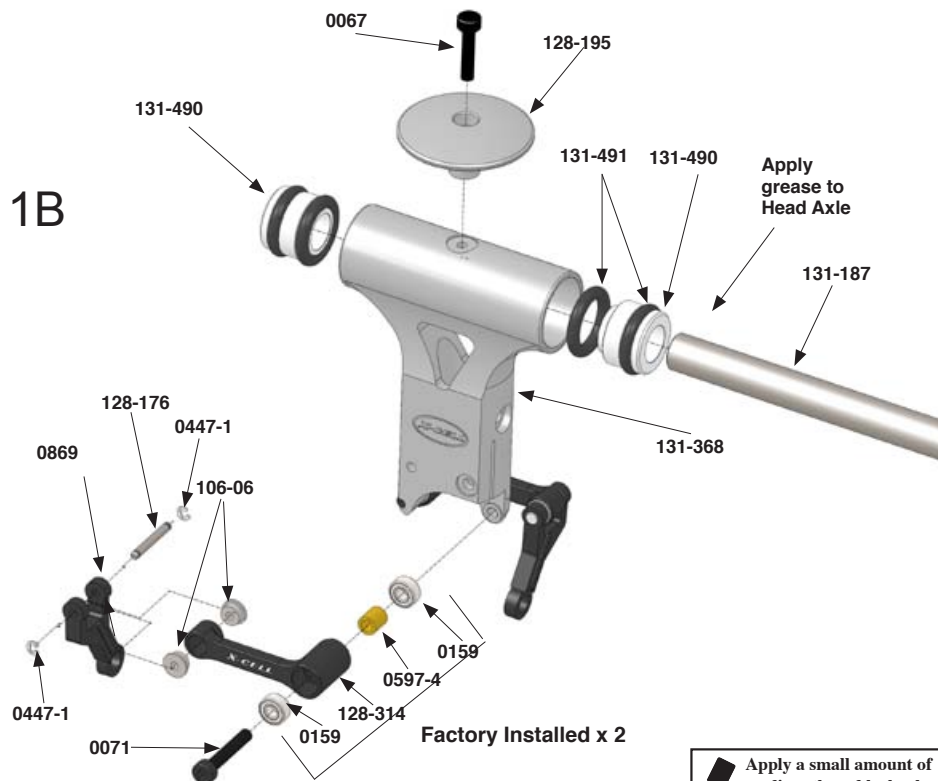
-  0067 x 1
M3x14 Socket Bolt
-  0071 x 2
M3x18 Socket Bolt
-  0447-1 x 4
E-clip
-  128-176 x 2
M2x.584 Washout Pivot Pin

Assembly Tip

- The use of a light grease such as MA3200-06 Tri-Flow Synthetic Grease is required for damper/head axle lubrication

New damper system (131-490)

1B



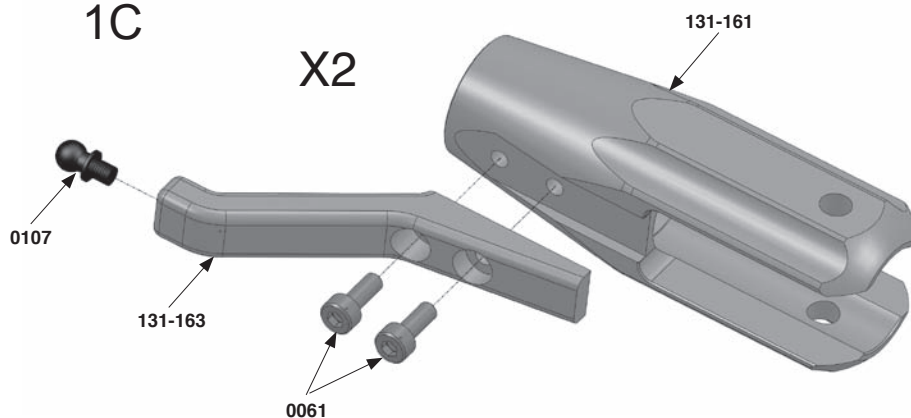
Apply a small amount of medium thread lock when threading into metal parts

Hardware for this assembly

-  0107 x 2
M3x6 Threaded Steel Ball
-  0061 x 4
M3x8 Socket Head Cap Screw
-  0086-1 x 2
M5x16 Flanged Bolt
-  120-7-1 x 2
M5x15 Safety Washer
-  131-183 x 4
9x14x.75 Washer

1C

X2

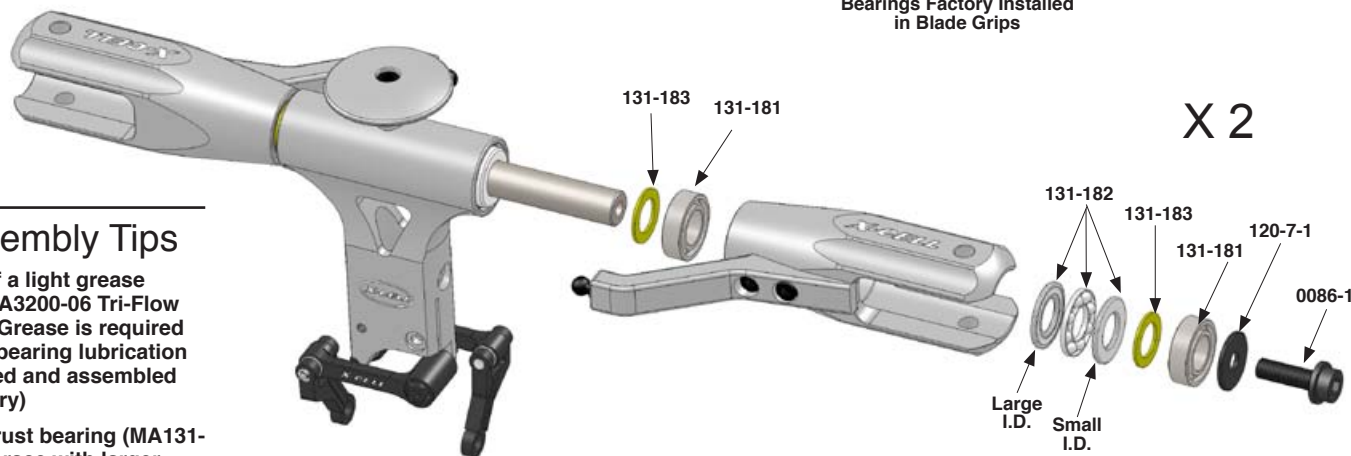


Bearings Factory Installed in Blade Grips

Assembly Tips

- The use of a light grease such as MA3200-06 Tri-Flow Synthetic Grease is required for thrust bearing lubrication (pre-applied and assembled from factory)
- 3 piece thrust bearing (MA131-182) outer race with larger I.D. (inside diameter) installs closest to hub.

X 2



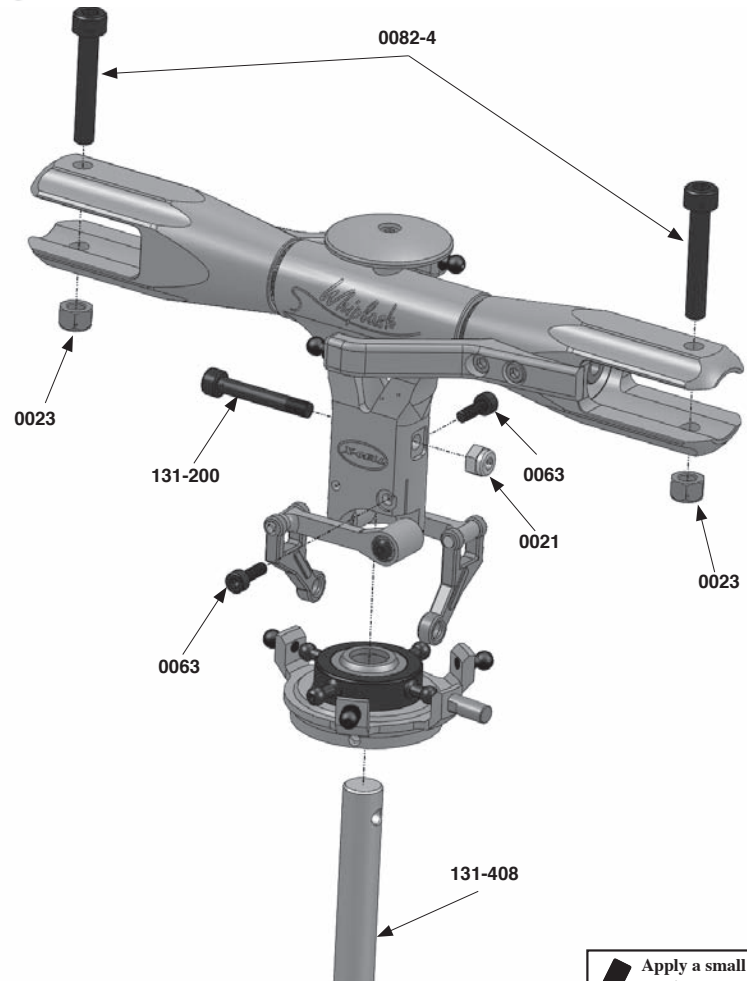


Hardware for this assembly



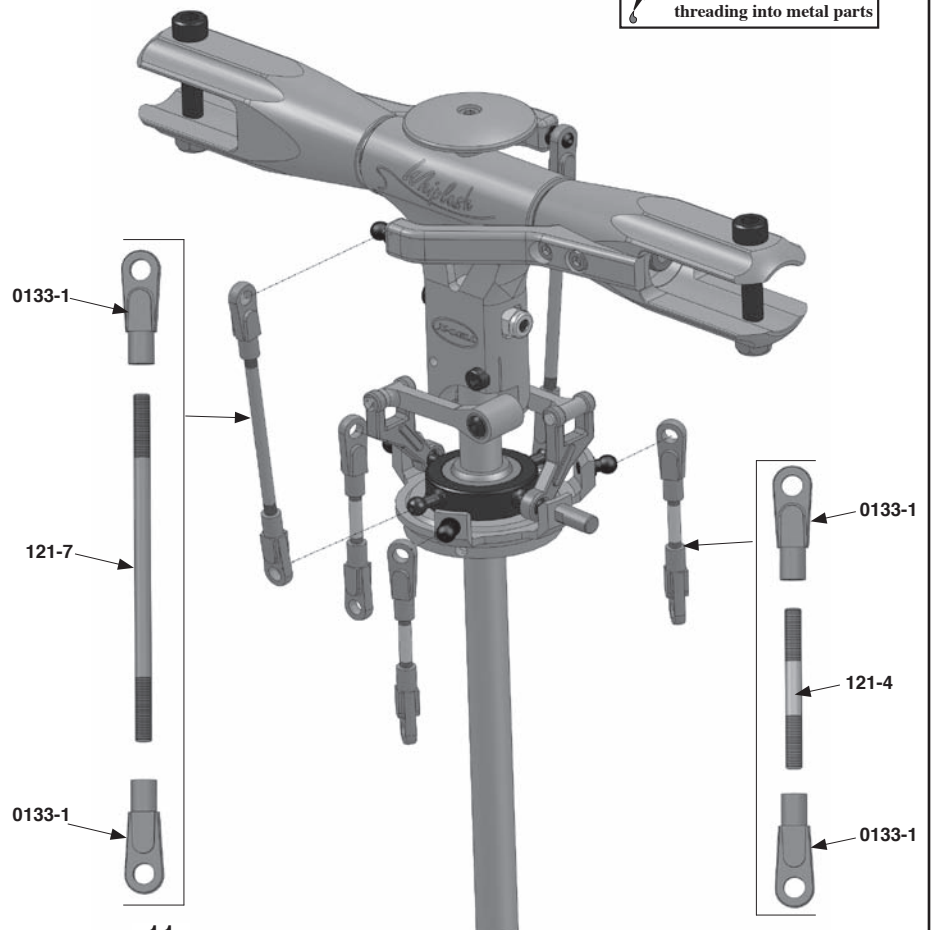
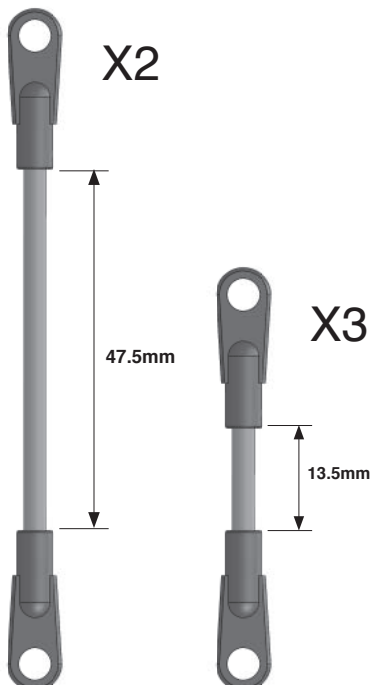
Assembly Tips

- Head, Swashplate and Main Shaft can be assembled now, or you can assemble the parts later step by step installing them to the frame.



Apply a small amount of medium thread lock when threading into metal parts

Link Arm Lengths and Installation



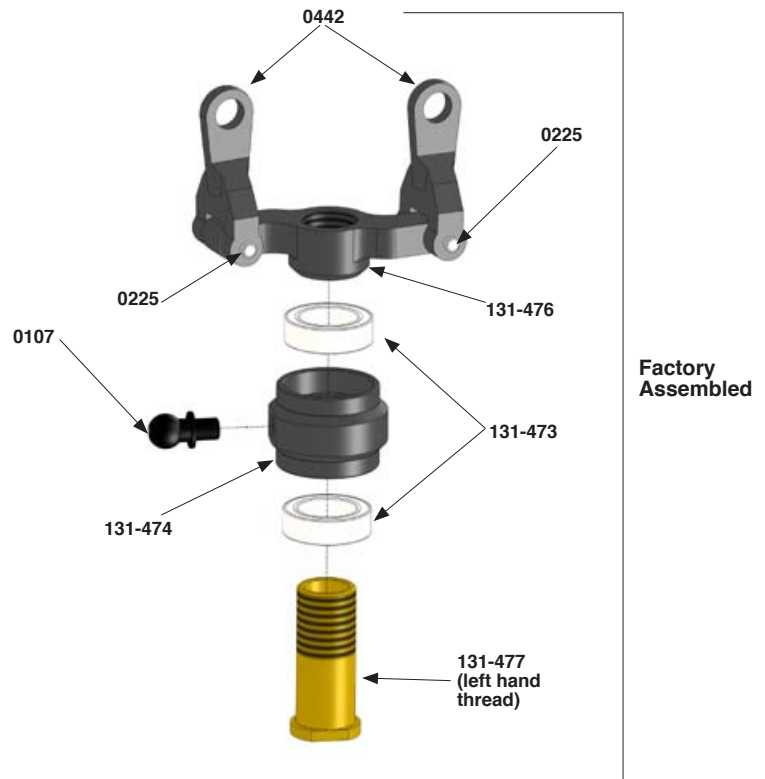
Tail Assembly Parts



Hardware for this assembly



2-A-1

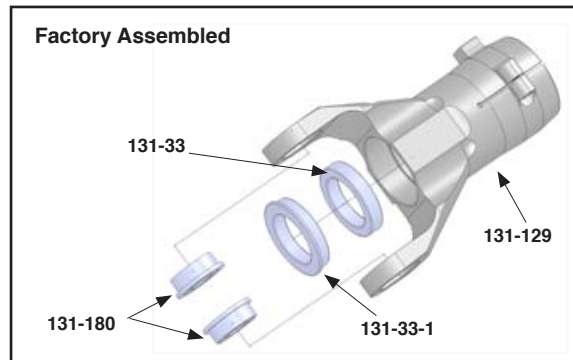


Apply a small amount of
medium thread lock when
threading into metal parts

Hardware for this assembly

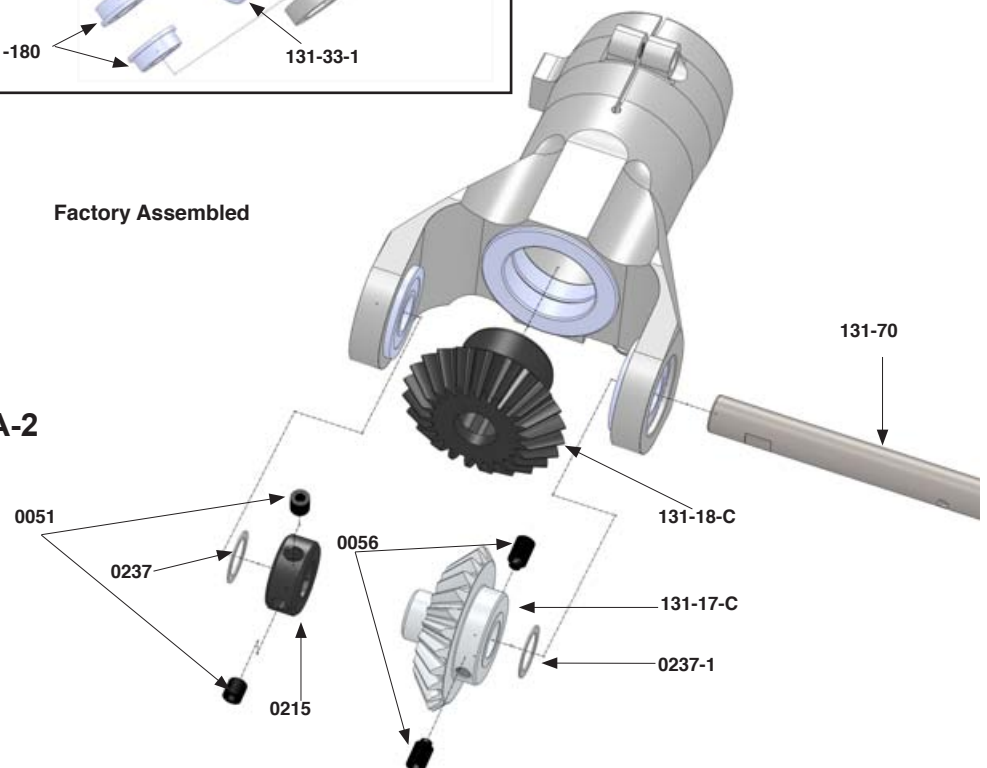


Factory Assembled



Factory Assembled

2-A-2



Assembly Tip

- Make sure to include MA0273-1 Shim Washer between MA131-17-C Output Gear and transmission case bearing.

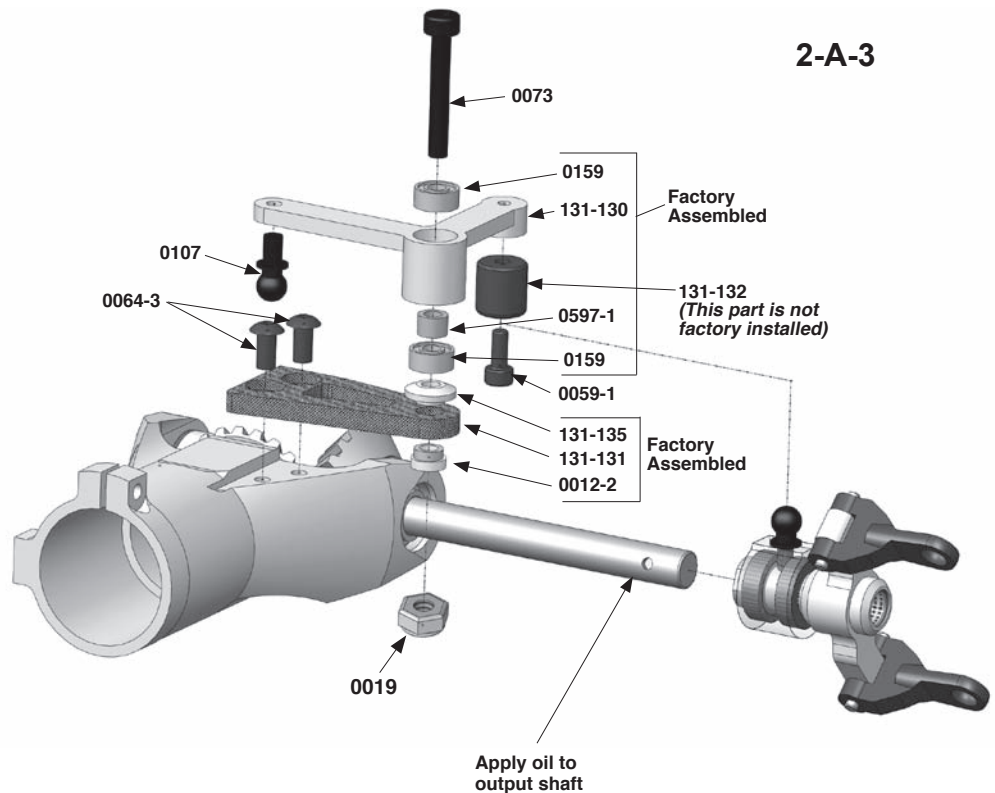
Hardware for this assembly

-  0019 x 1
3mm Hex Nut
-  0059-1 x 1
M2.5x6 Socket Bolt
-  0064-3 x 2
M3x6 Button Head Socket Bolt
-  0073 x 1
M3x20 Socket Bolt
-  0107 x 1
M3x6 Threaded Steel Ball

Assembly Tip

- The use of a light oil such as MA3200-02 Tri-Flow Oil is required for tail rotor output shaft/pitch slider lubrication

2-A-3



Apply a small amount of medium thread lock when threading into metal parts

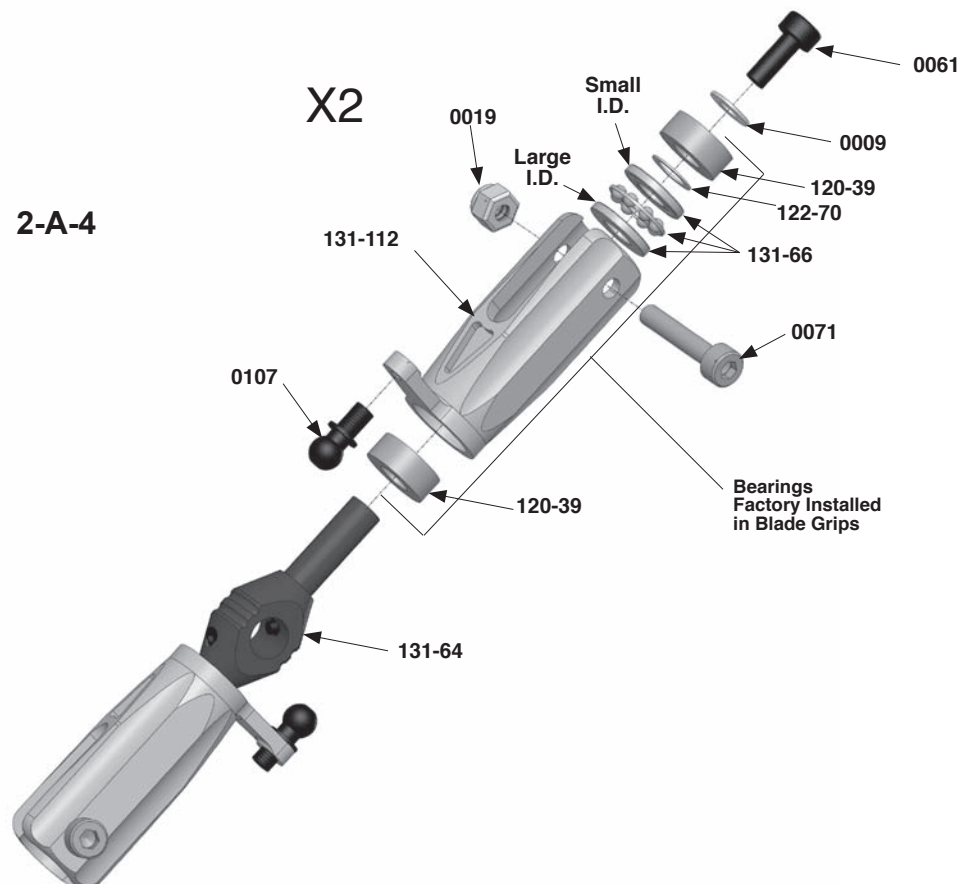
Hardware for this assembly

-  0009 x 2
3mm Flat Steel Washer
-  0019 x 2
3mm Hex Nut
-  0061 x 2
M3x8 Socket Bolt
-  0071 x 2
M3x18 Socket Bolt
-  0107 x 2
M3x6 Threaded Steel Ball
-  122-70 x 2
M.5x.25 Shim

Assembly Tips

- 3 piece thrust bearing (MA131-66) outer race with larger I.D. (inside diameter) installs closest to hub.
- Grease the center ball cage of the thrust bearing. We recommend using MA3200-06 Tri-Flow synthetic grease.
- Only hand tighten MA0061 Socket Bolt until it is moderately tight. Do not overtighten bolt or it may result in fatigue to bolt. Use green thread lock on these bolts.

2-A-4



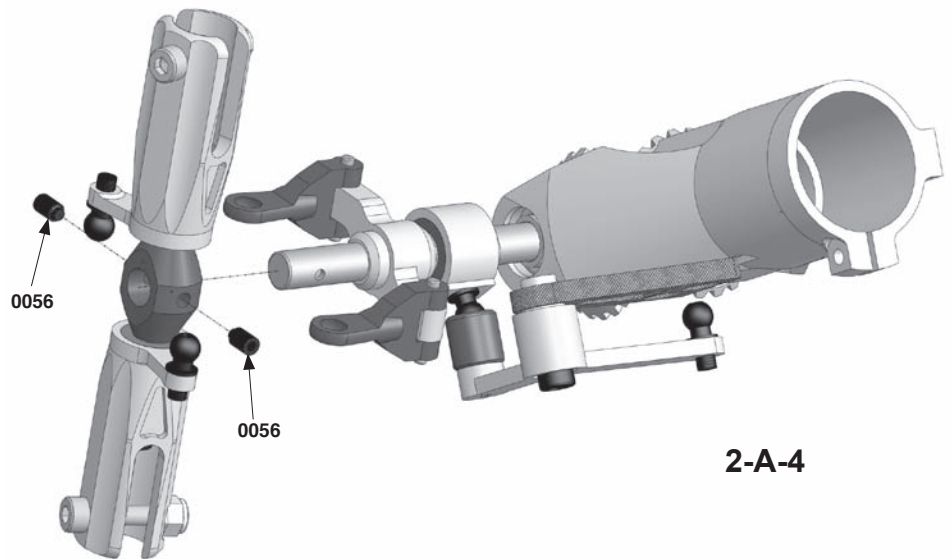
Hardware for this assembly




0056 x 2
M3x5 Dog Point
Socket Screw

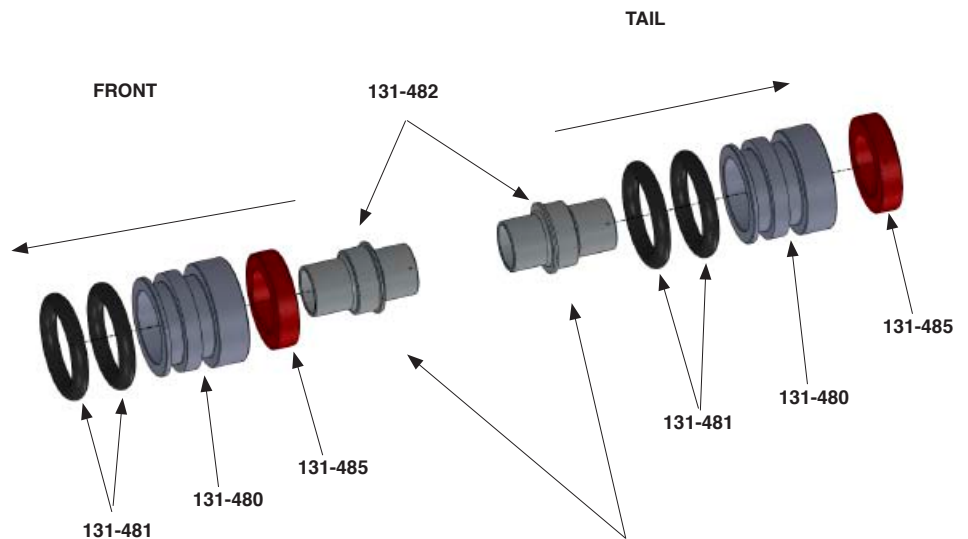
Assembly Tip

- Ensure the dog point tip is seated into the dimples on the tail rotor shaft.



2-A-4

 Apply a small amount of medium thread lock when threading into metal parts



2-B-1

Take care about the orientation of guide edge of the sleeves, one facing to the front, one one facing to the tail.

Install both bearing cup assemblies facing the same direction on torque tube.

Apply a small amount of green Loctite 648 when mounting the bearing cup assemblies on the torque tube.

Hardware for this assembly



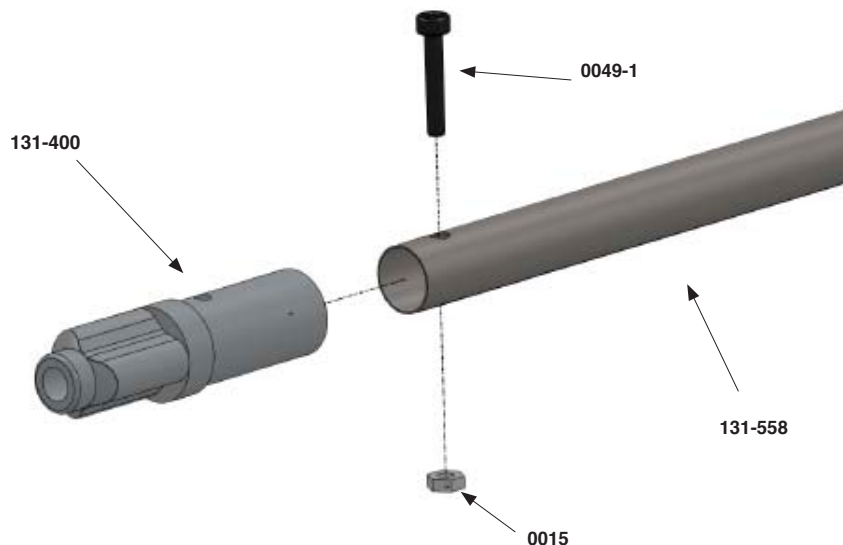
0015 2 x
2mm Hex Nut



0049-1 x 2
M2x12 Socket Bolt

ASSEMBLY TIPS

- Use only Loctite green #648 to glue TT ends to tube.
- Do not overtighten 0049-1 socket bolts as it is possible to crush torque tube.



2-B-2



NOTE: Carefully glue bearing assemblies to torque tube making sure bearing locations are NOT equal distances from torque tube ends. Allow Loctite 648 to dry (about 2 hours) before installing into tail boom.

Apply a small amount of medium thread lock when threading into metal parts

Hardware for this assembly



0060-1 x 3
M3x6 Socket Bolt

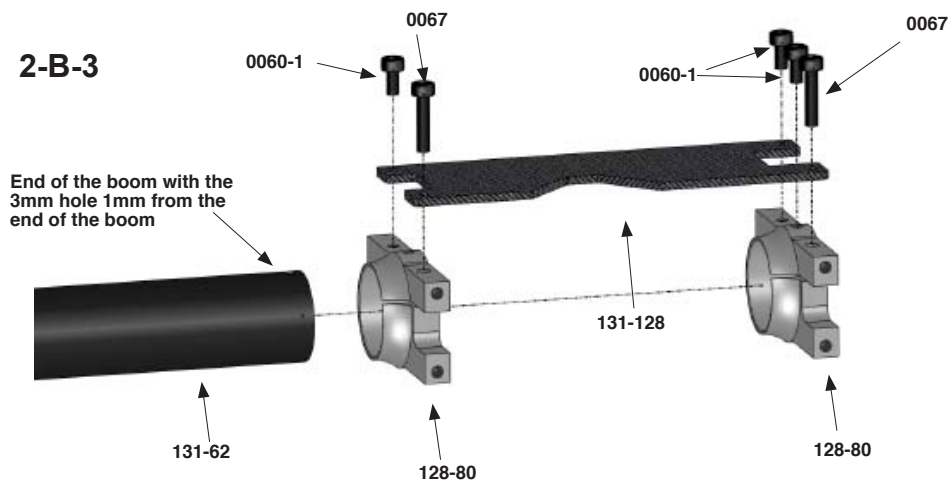


0067 x 2
M3x14 Socket Bolt

Assembly Tips

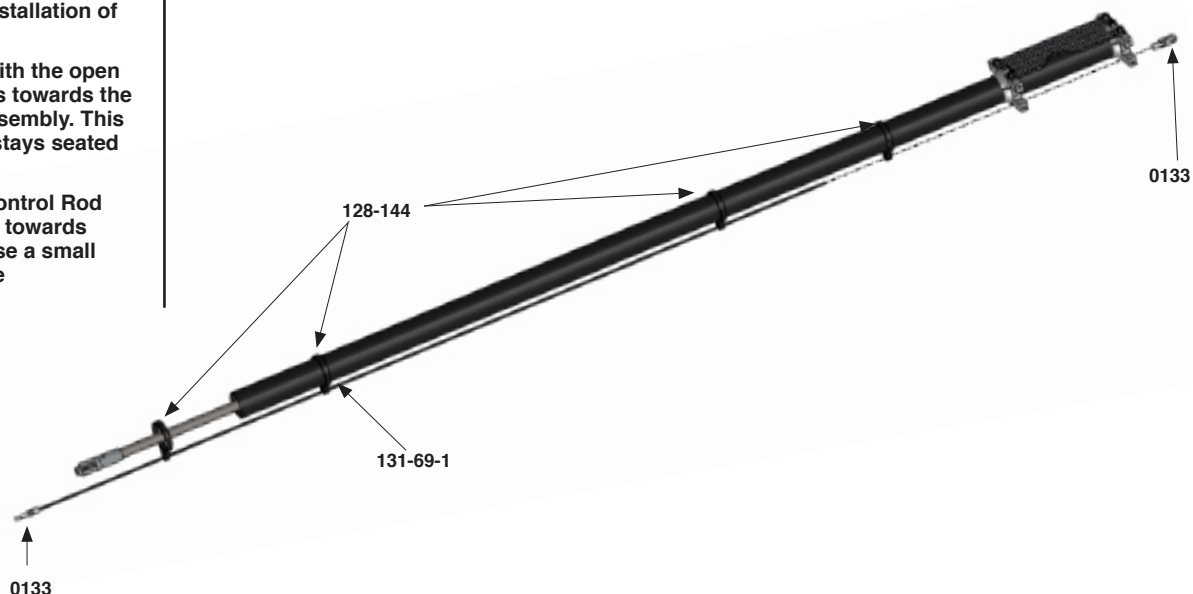
- Ensure that the boom is full inserted through boom clamps.
- Do not overtighten MA0067 Socket Bolts as it is possible to crush tail boom.

2-B-3



Assembly Tips

- Pour some light oil such as Tri-Flow into tail boom to ease installation of torque tube assembly.
- Install the torque tube with the open ends of the bearing cups towards the back of the tail boom assembly. This will ensure the bearing stays seated in the bearing cup.
- Install MA128-144 T/R Control Rod Guides with the dimples towards front of tail assembly. Use a small amount of cyanoacrylate glue to ensure each guide stays in position.



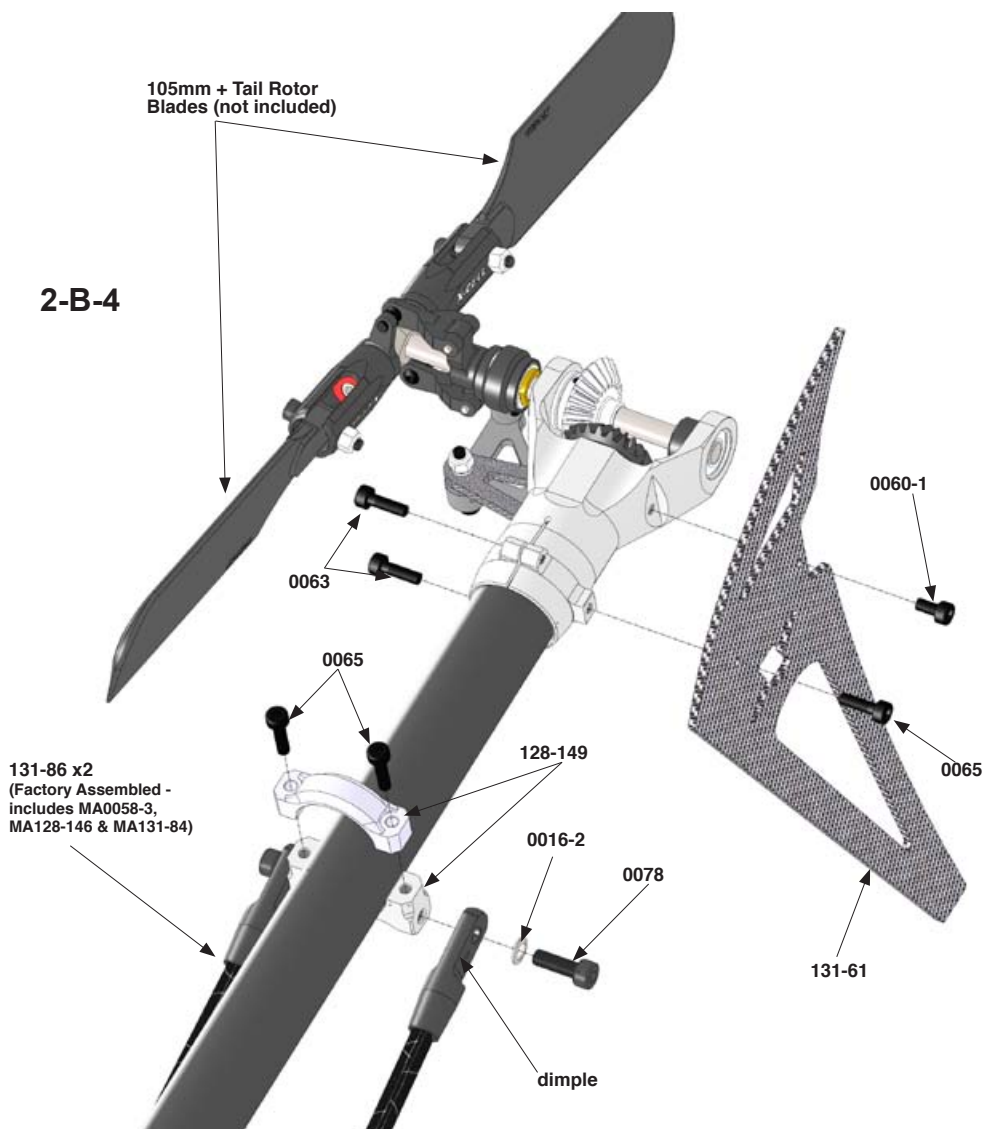
Apply a small amount of medium thread lock when threading into metal parts

Hardware for this assembly

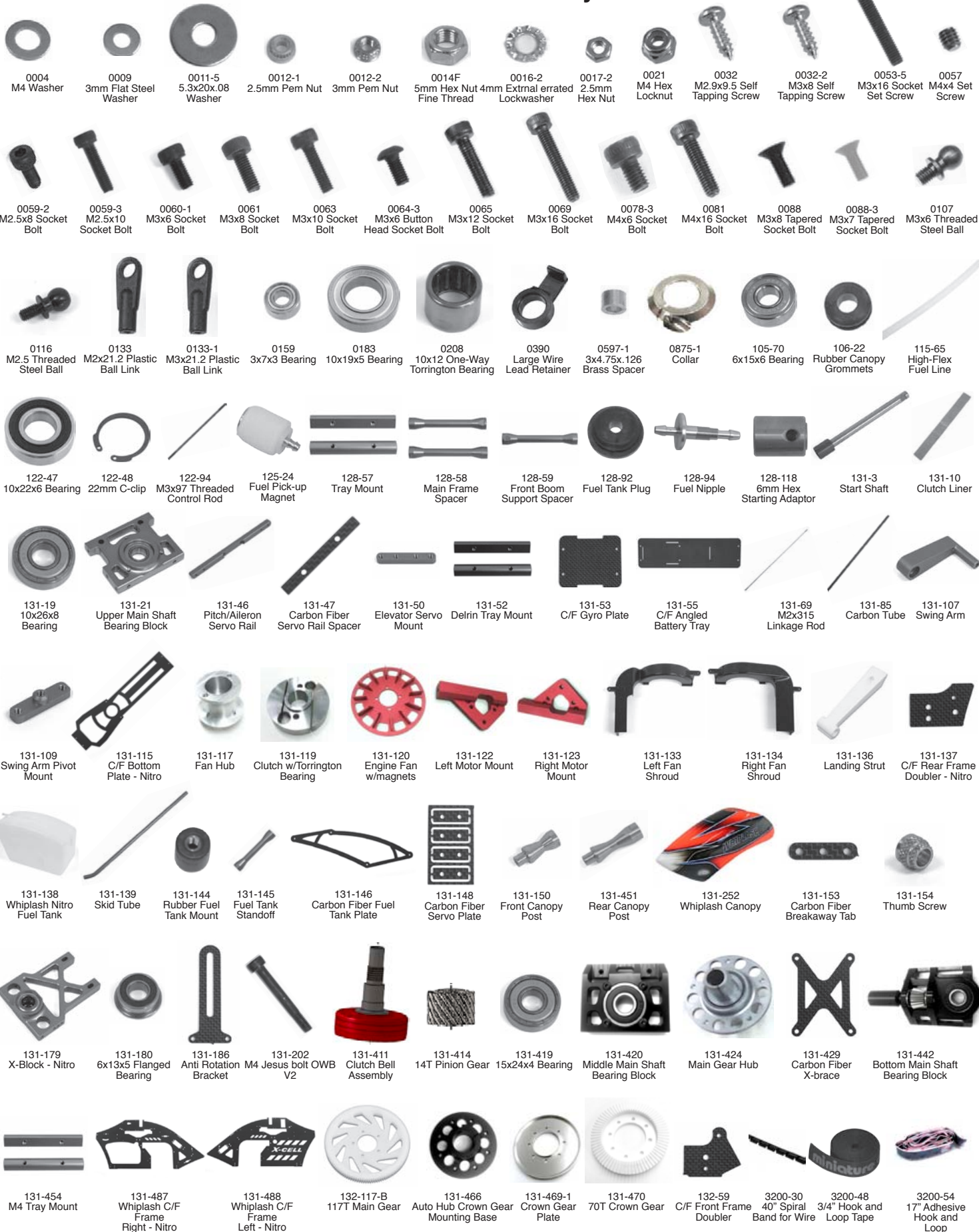
- 0016-2 x 2
4mm External Serrated Lockwasher
- 0060-1 x 1
M3x6 Socket Bolt
- 0063 x 2
M3x10 Socket Bolt
- 0065 x 3
M3x12 Socket Bolt
- 0078 x 2
M4x12 Socket Bolt

Assembly Tips

- The use of “243 blue” thread lock such as MA3200-20 (loctite blue #243) is recommended on MA0078 Socket Bolts.
- Do not overtighten MA0065 Socket Bolts on the Rear Boom Support Mounts.
- Aluminum boom support ends have a dimple on one side. The dimple indicates a slight angle built in to this part. On the Boom support assembly side that attaches to the main frame, the dimple will be facing “in.”



Nitro Frame Assembly Parts



Hardware for this assembly



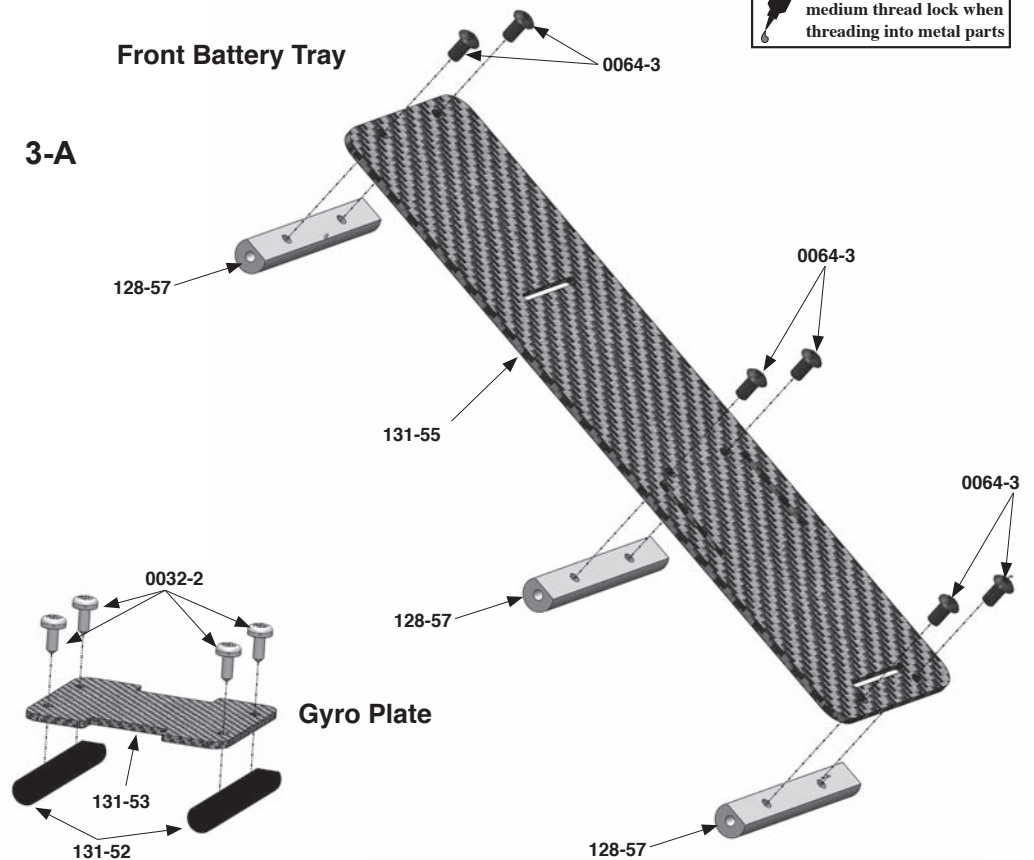
Assembly Tips

- Do not overtighten MA0032-2 Self Tapping Screw into MA131-52 Delrin Tray Mount.
- Ensure the MA131-454 M4 Tray Mounts are used in the correct locations on the ends of MA132-58 Bottom Plate.

Apply a small amount of medium thread lock when threading into metal parts

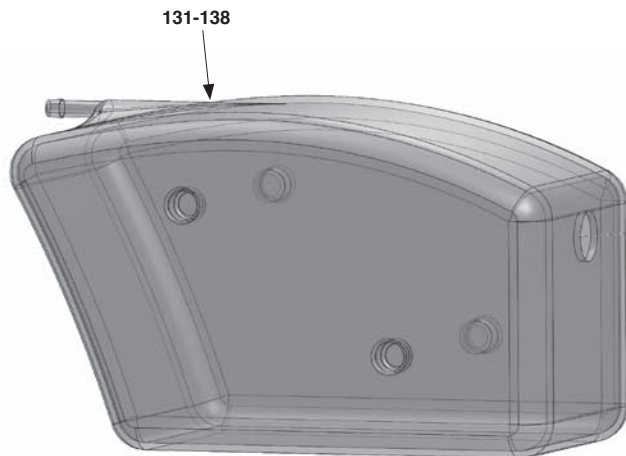
Front Battery Tray

3-A



Gyro Plate

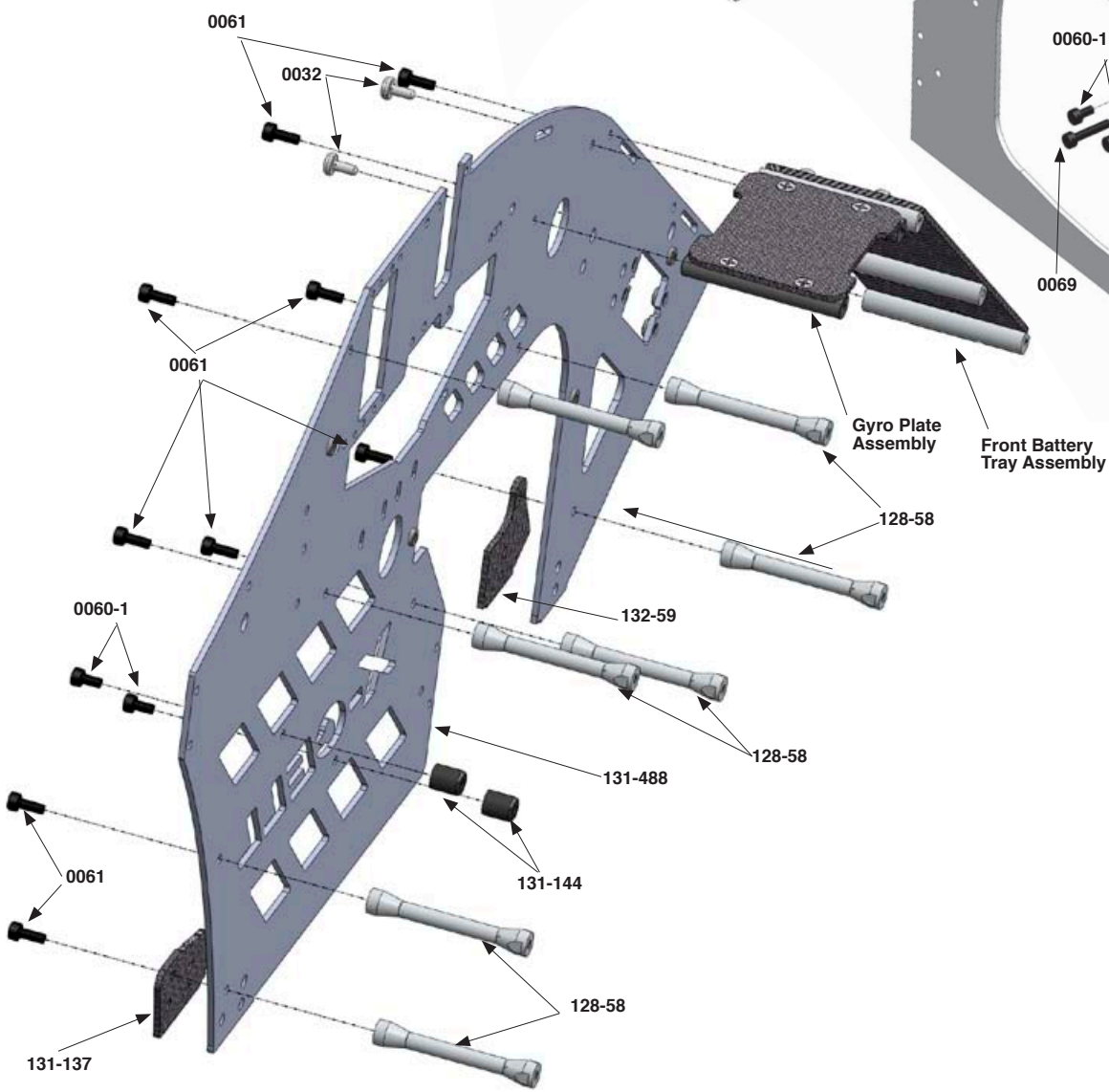
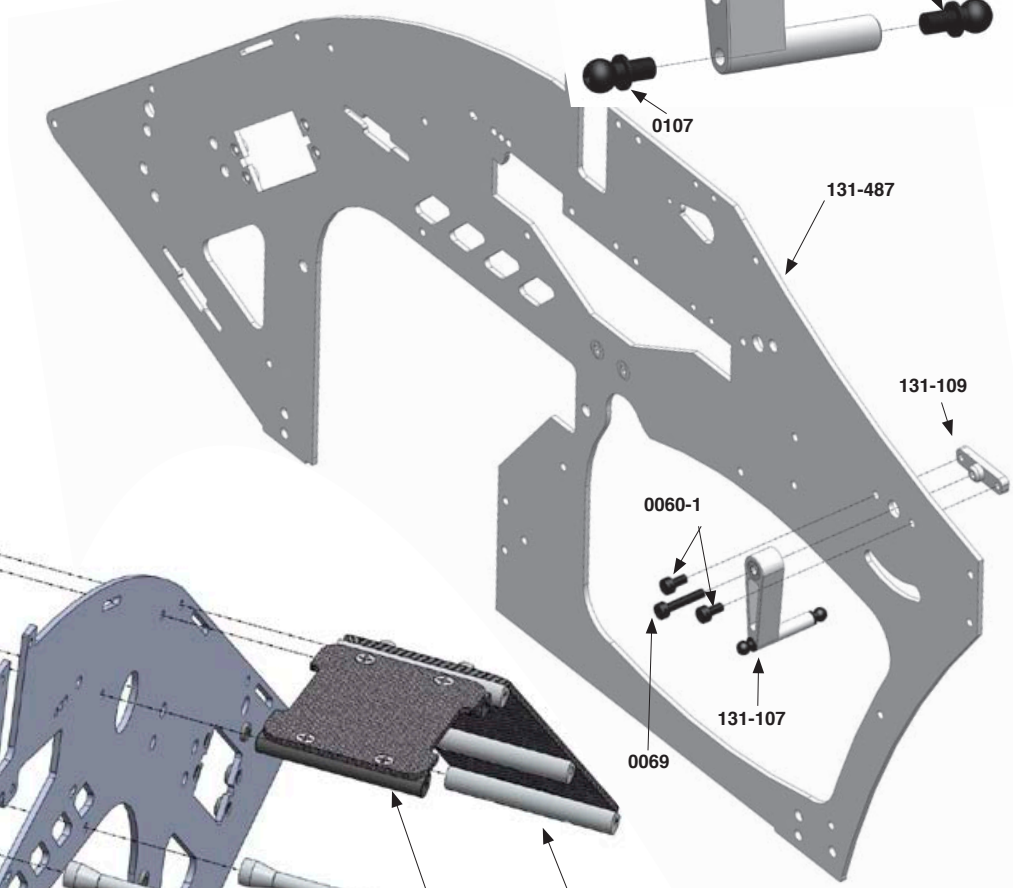
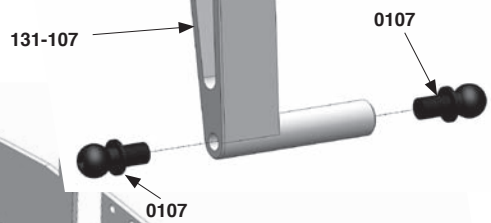
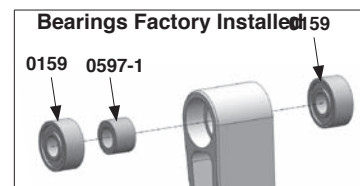
Bottom Plate




3-F

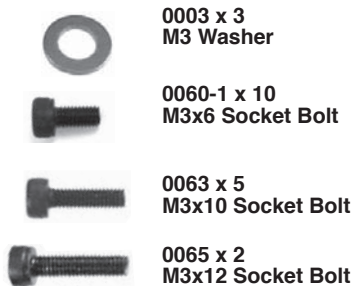
Hardware for this assembly

-  0032 x 2
M3 Self Tapping
Screw
-  0060-1 x 4
M3x6 Socket Bolt
-  0061 x 9
M3x8 Socket Bolt
-  0069 x 1
M3x16 Socket Bolt
-  0107 x 2
M3x6 Threaded
Steel Ball



 Apply a small amount of medium thread lock when threading into metal parts

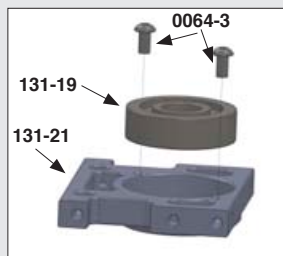
Hardware for these assemblies



Assembly Tip

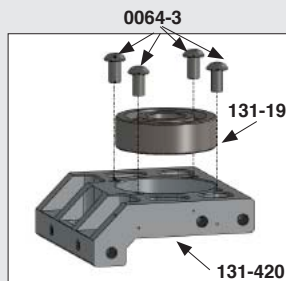
- If using JR brand servos or other "tall" servos, MA131-47 Servo Rail Spacers are included for proper servo linkage alignment, if required.
- Do not tighten the three screws for the bottom bearing block now.

Upper Main Shaft
Bearing Block
(Factory Assembled)



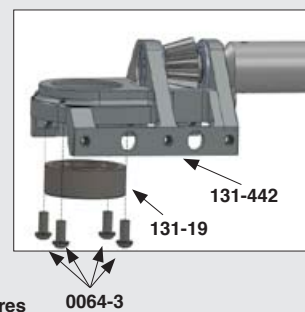
NOTE: Upper bearing block features smooth, wrench access holes

Middle Main Shaft
Bearing Block
(Factory Assembled)

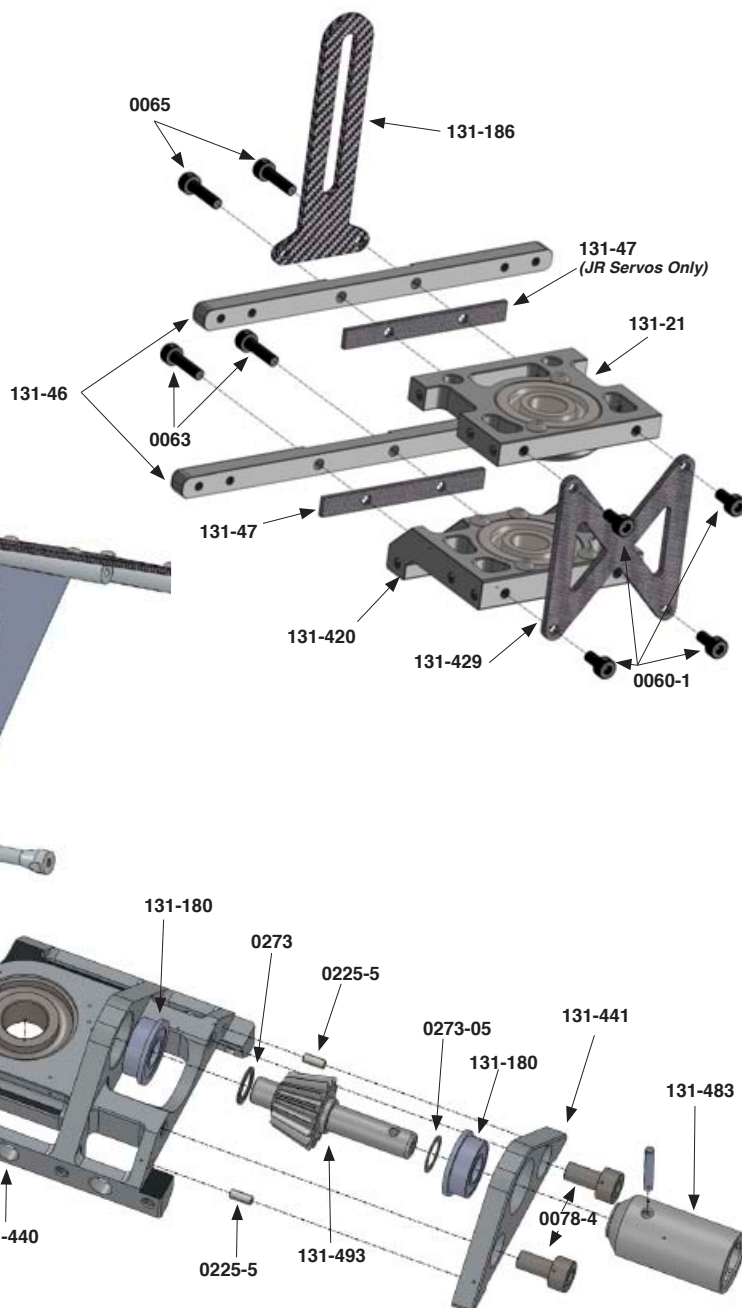


NOTE: Middle bearing block features threaded holes.

Bottom Main Shaft
Bearing Block
(Factory Assembled)

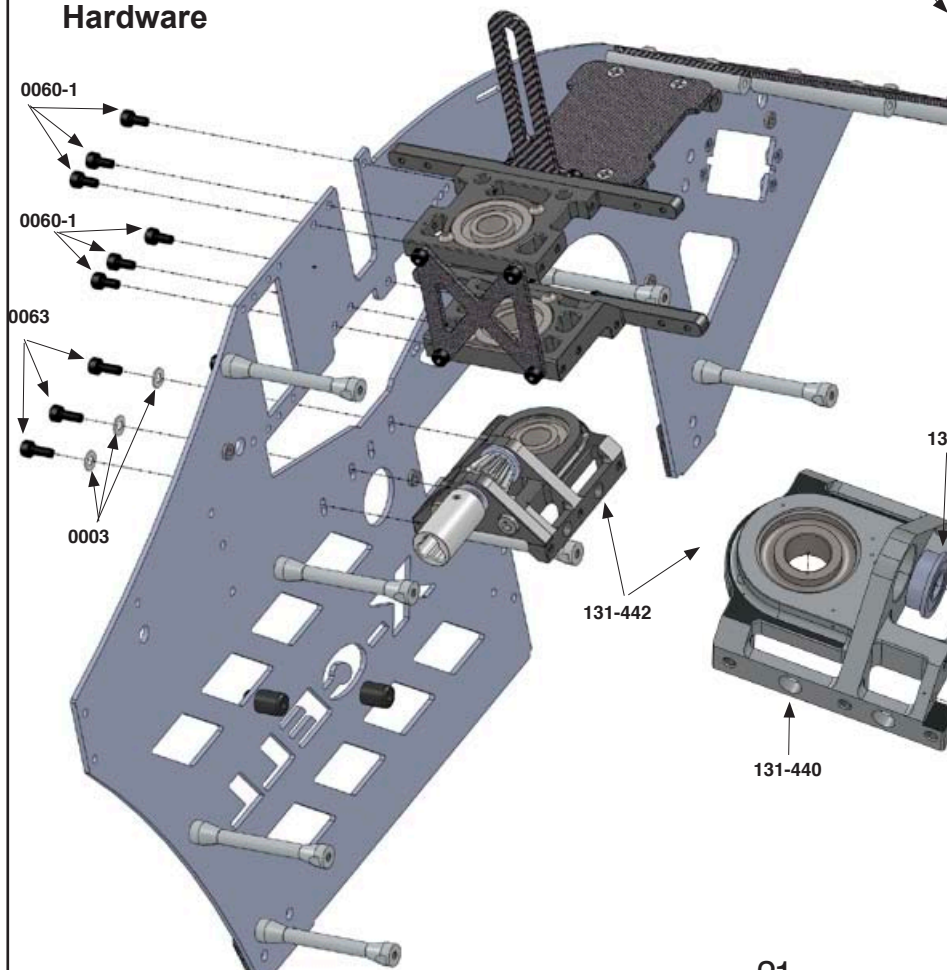


3-B



Apply a small amount of medium thread lock when threading into metal parts

Hardware

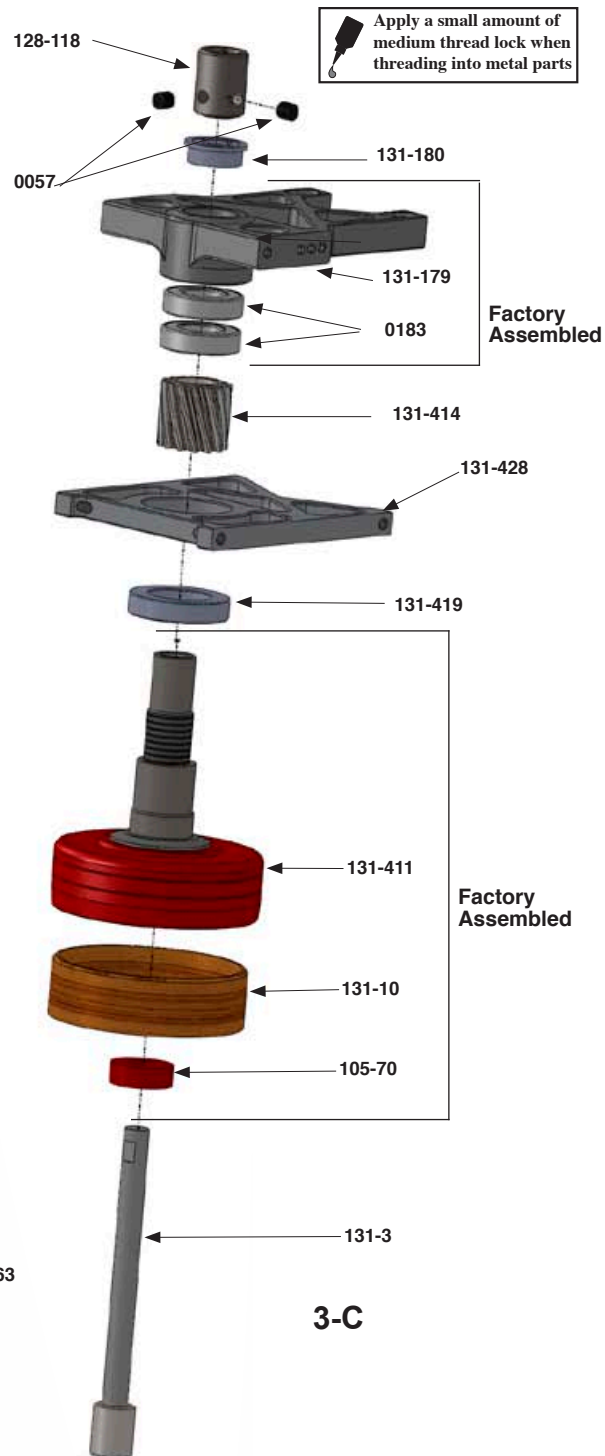
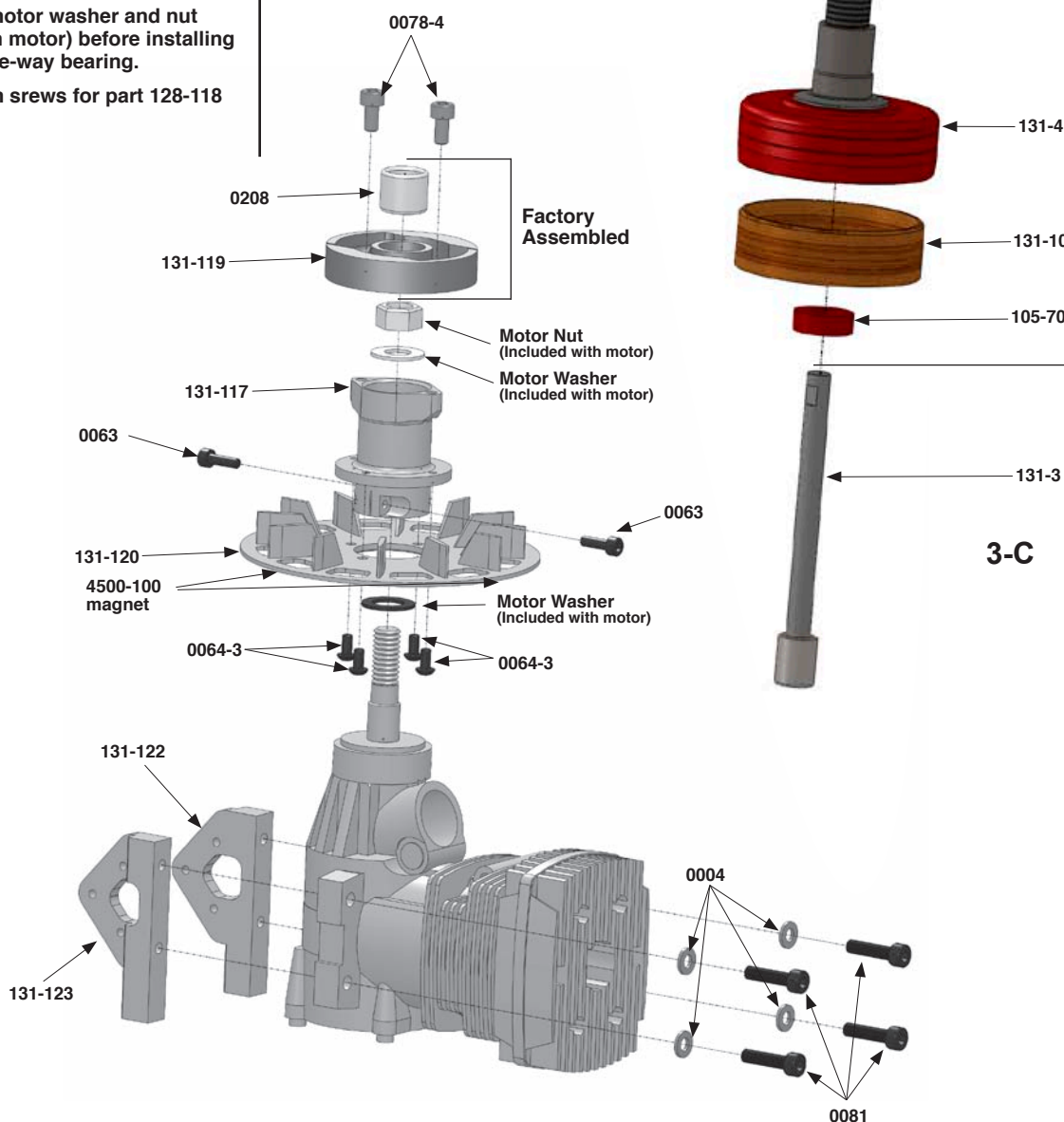


Hardware for these assemblies



Assembly Tips

- Assemble Fan Hub to Fan, then install on motor and tighten MA0063 Socket Bolts to clamp onto motor shaft.
- Next, install motor washer and nut (included with motor) before installing clutch and one-way bearing.
- Do not tighten screws for part 128-118 now.




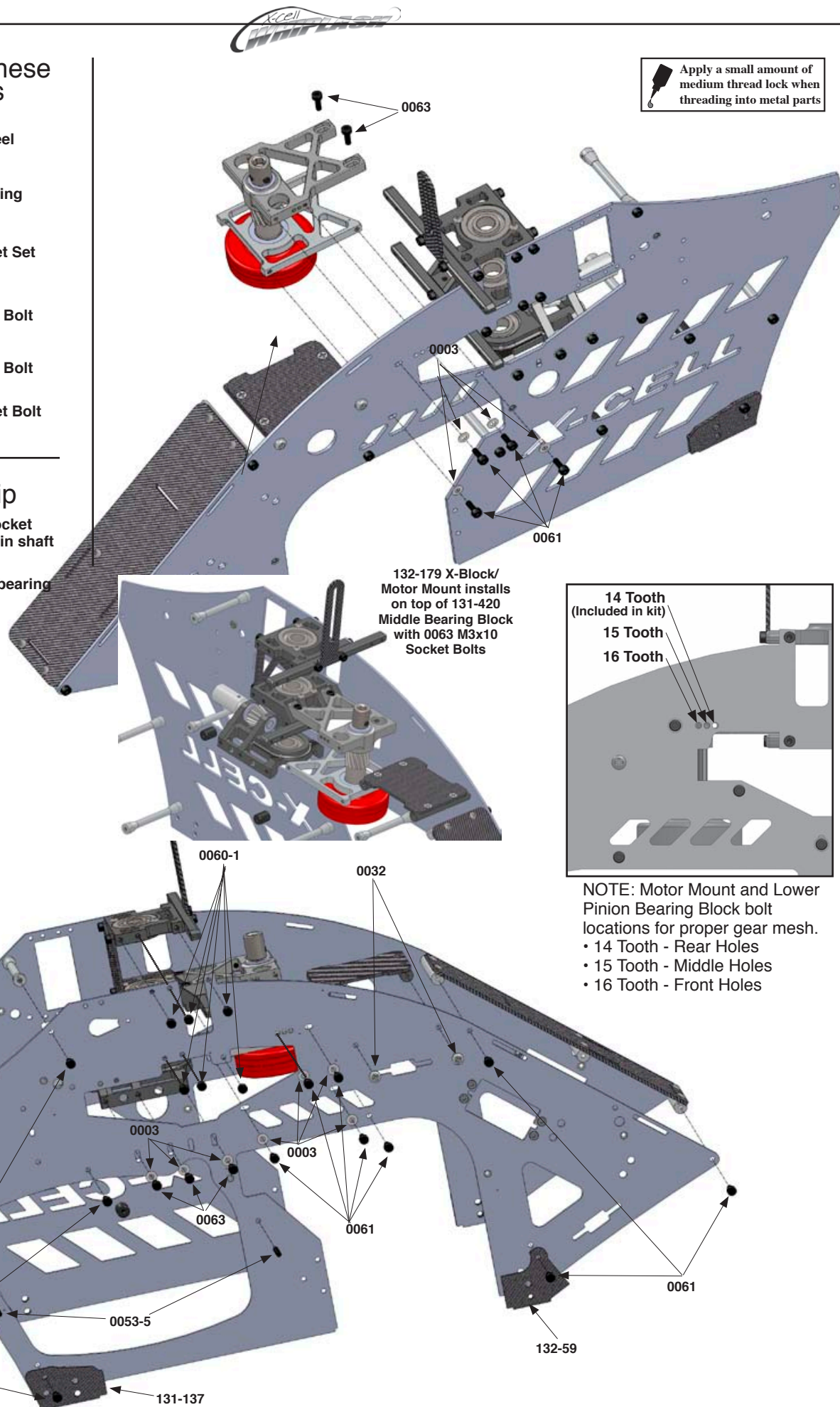
Hardware for these assemblies

-  0003 x 6
3mm Flat Steel
Washer
-  0032 x 2
M3 Self Tapping
Screw
-  0053-5 x 2
M3x16 Socket Set
Screw
-  0060-1 x 6
M3x6 Socket Bolt
-  0061 x 15
M3x8 Socket Bolt
-  0063 x 5
M3x10 Socket Bolt

Assembly Tip

- Note - MA0060-1 M3x6 Socket Bolts are used for the main shaft bearing blocks.
- Do not tighten screws for bearing block 131-428 now.

 Apply a small amount of medium thread lock when threading into metal parts



Hardware for these assemblies



0057 x 4
M4x4 Set Screw




0061 x 8
M3x8 Socket Bolt

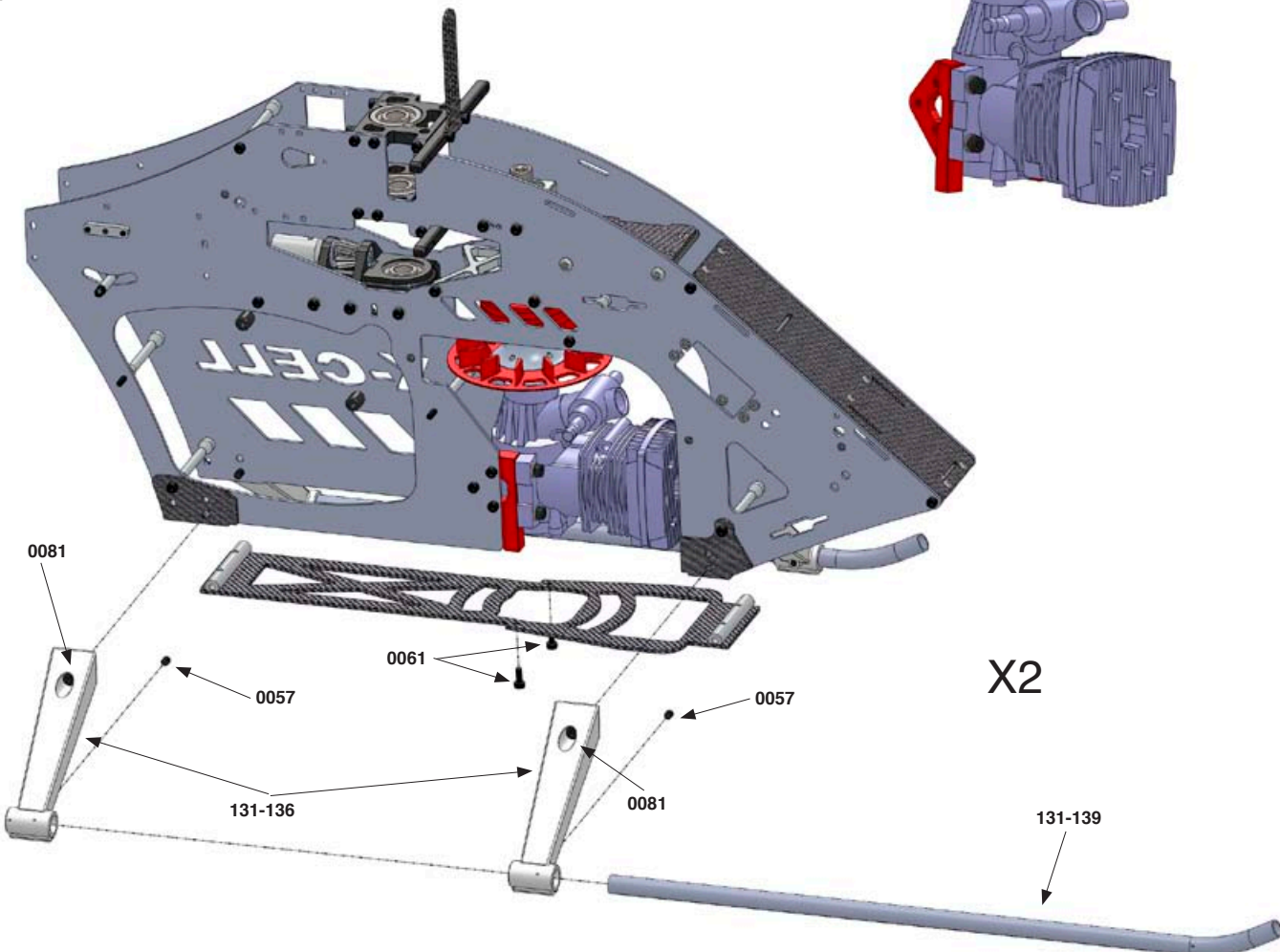
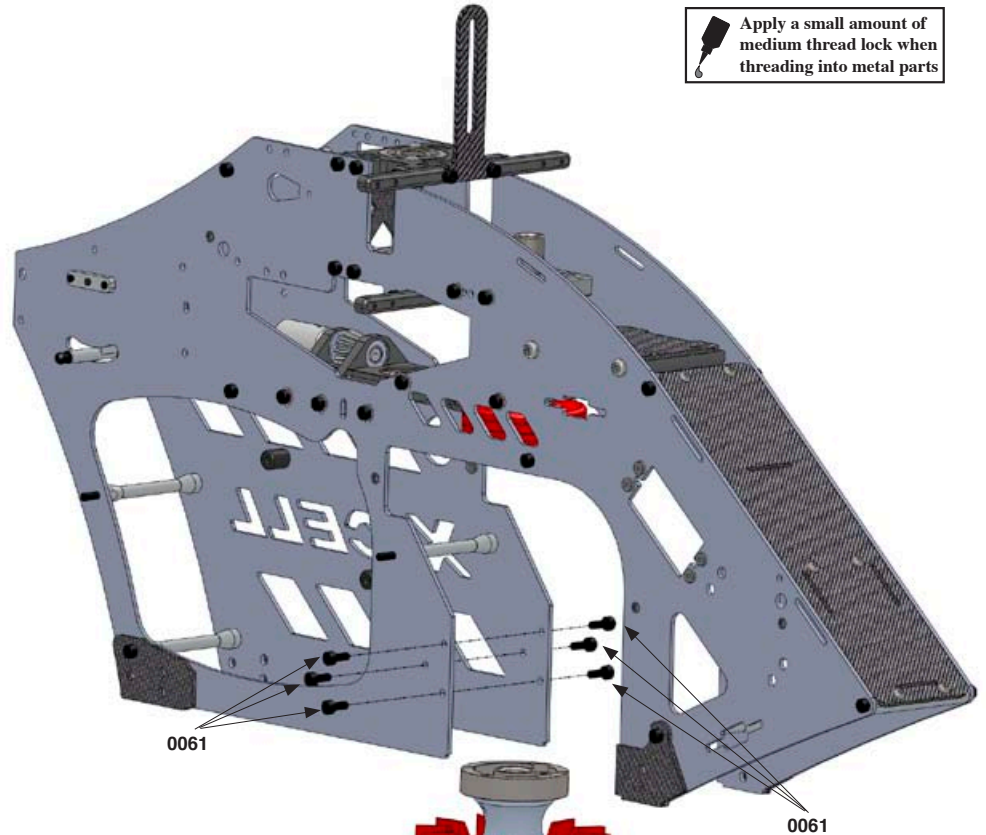


0081 x 4
M4x16 Socket Bolt

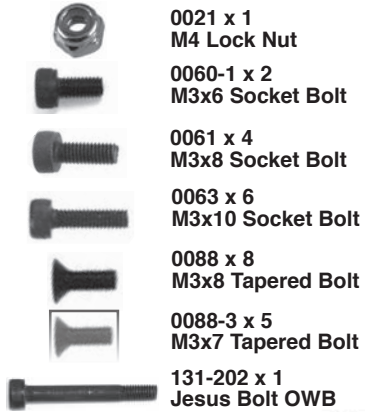
Assembly Tip

- Tighten the MA0057 M4x4 Set Screw securely against the landing gear tube using thick cyanoacrylate glue.
- Press startshaft 131-3 to the top and tighten screws at part 128-118
- Install engine and take care that it is aligned properly (start shaft can be rotated easy clockwise)
- Tighten screws of bearingblock 131-428 now (use loctite blue #243)

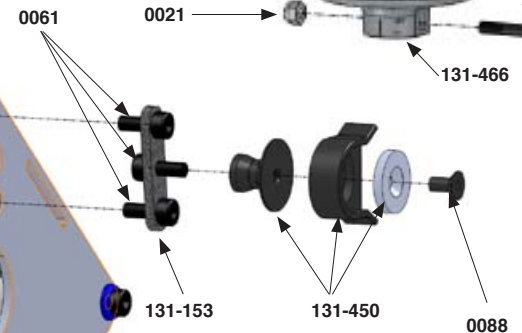
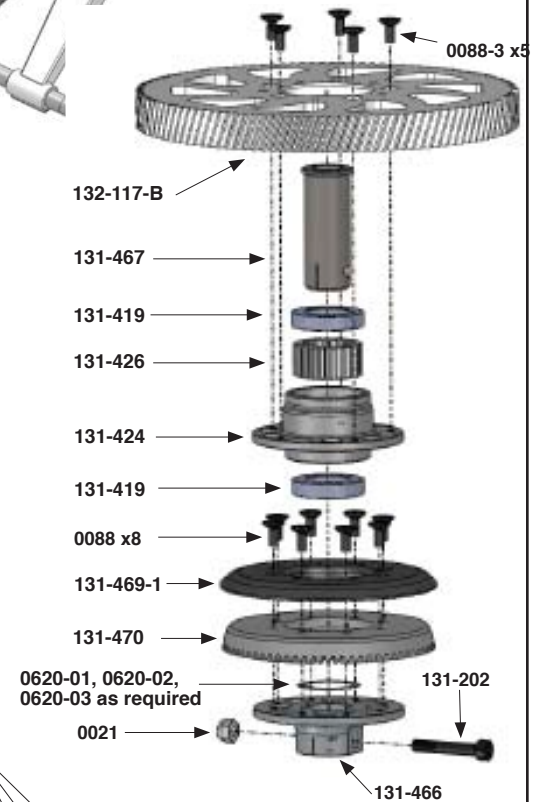
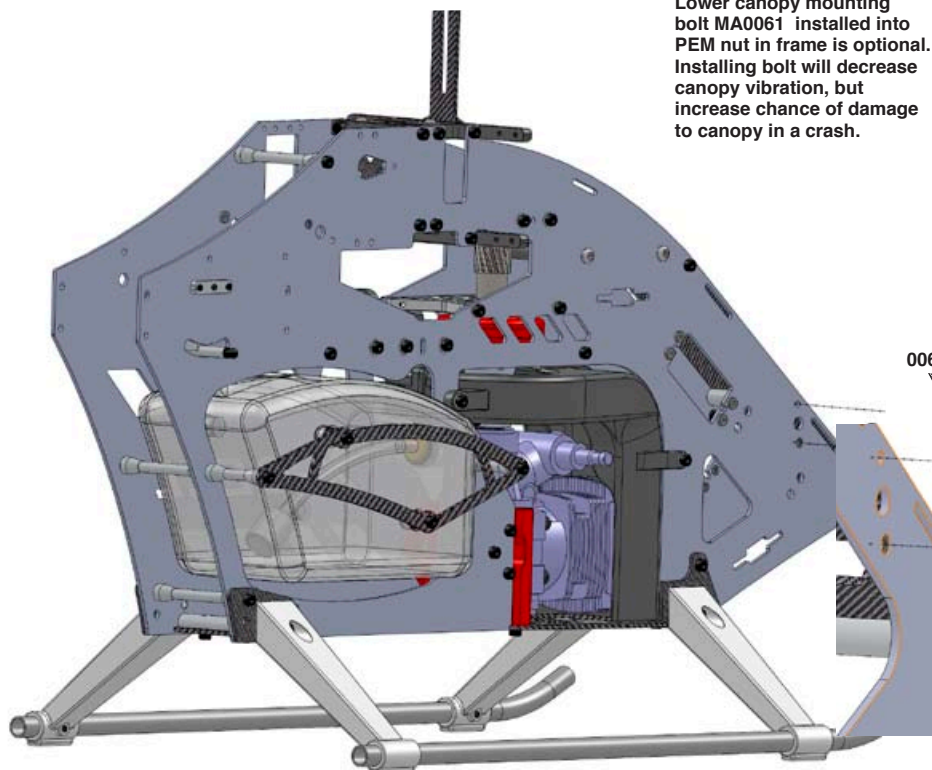
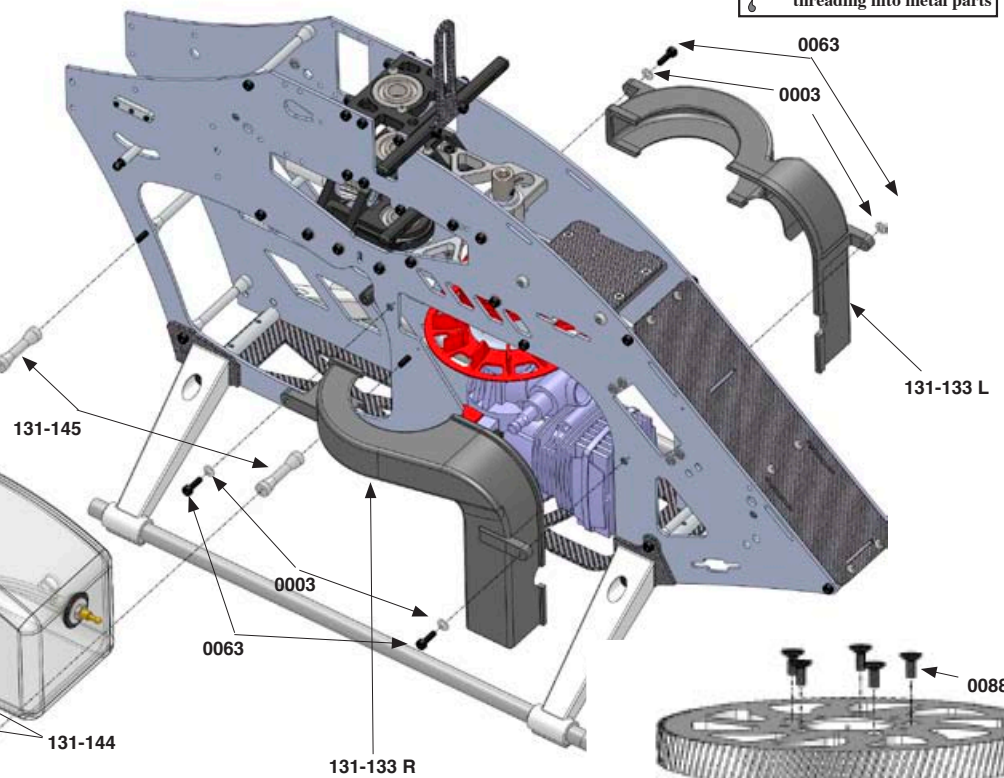
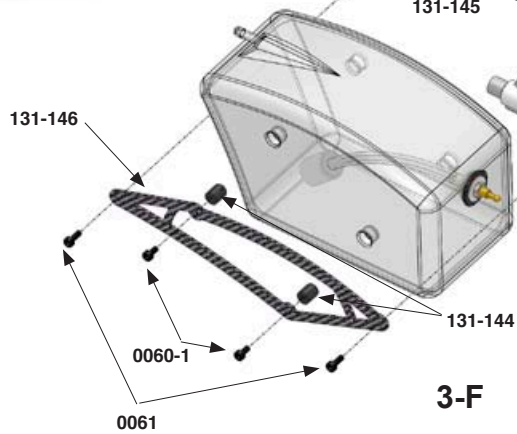
 Apply a small amount of medium thread lock when threading into metal parts



Hardware for these assemblies



Apply a small amount of medium thread lock when threading into metal parts



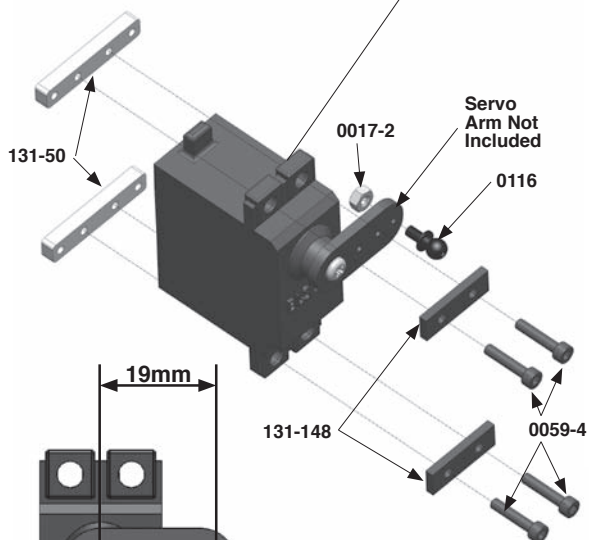
X2

Hardware for these assemblies

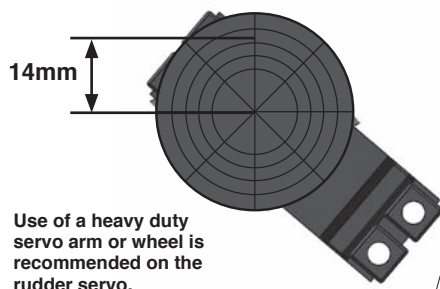
-  0017-2 x 4
2.5mm Hex Nut
-  0059-1 x 4
M2.5x6 Socket Bolt
-  0059-4 x 16
M2.5x12 Socket Bolt
-  0116 x 4
M2.5 Threaded Steel Ball

Assembly Tip

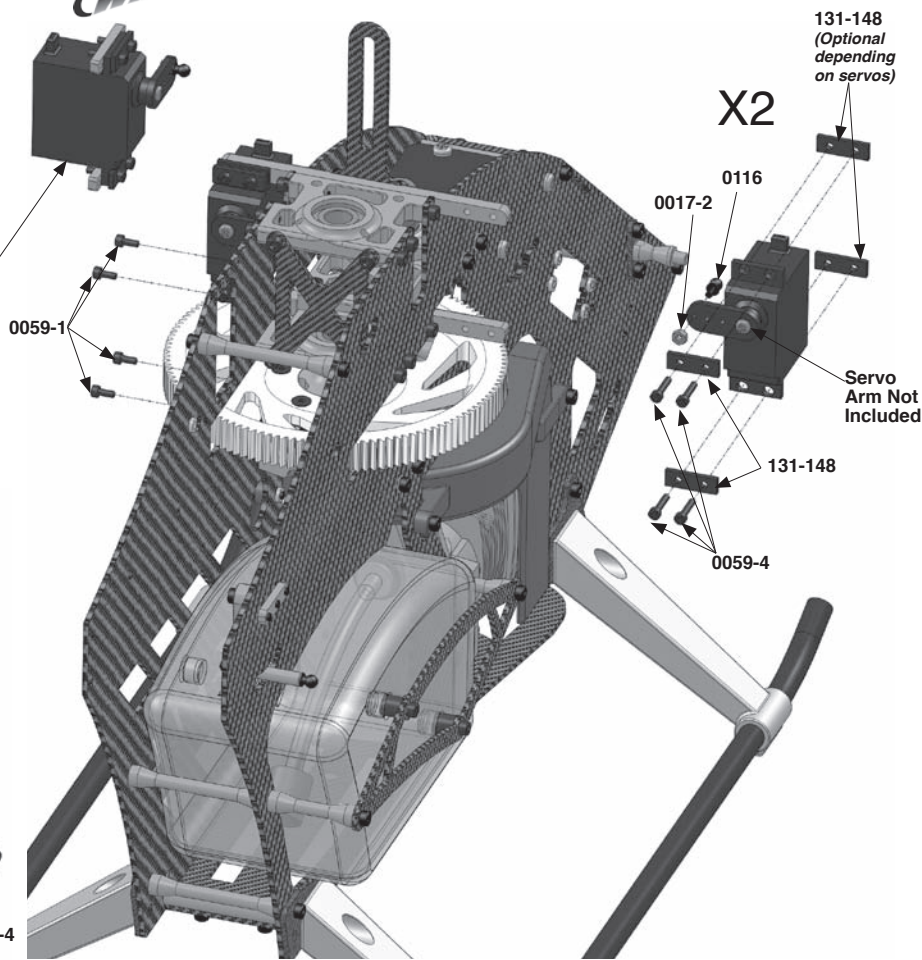
- MA131-148 Servo Spacers are included for proper servo linkage alignment, if required.



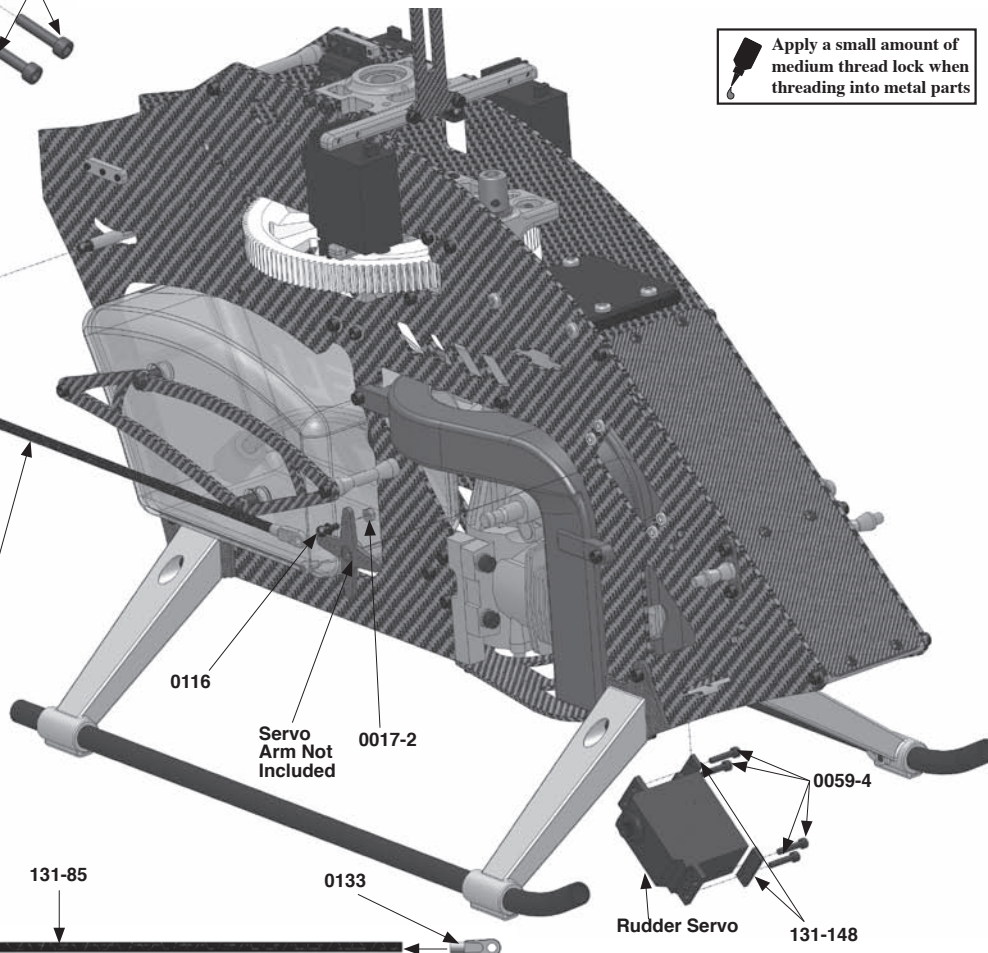
Use of heavy duty servo arms is required on the cyclic servos.



Use of a heavy duty servo arm or wheel is recommended on the rudder servo.



Apply a small amount of medium thread lock when threading into metal parts

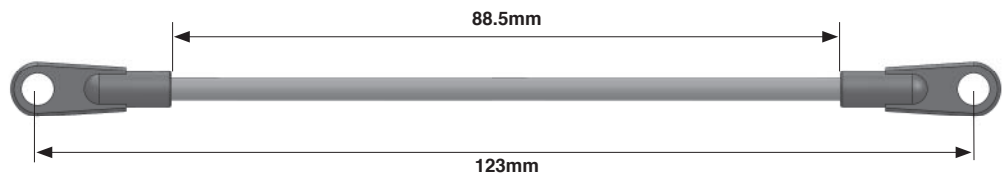
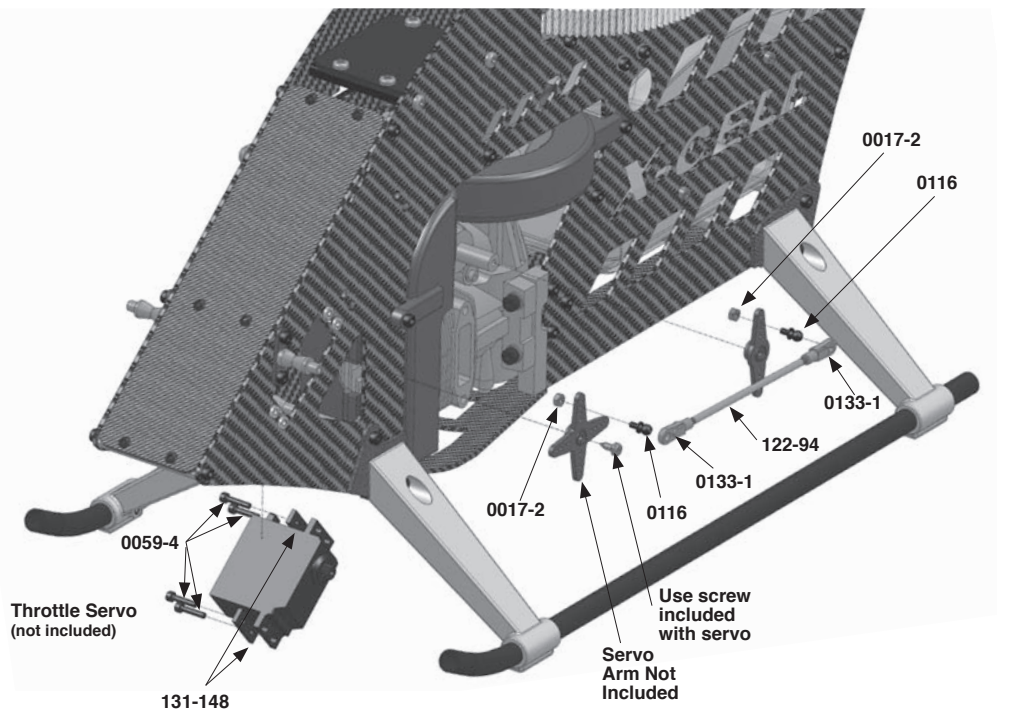
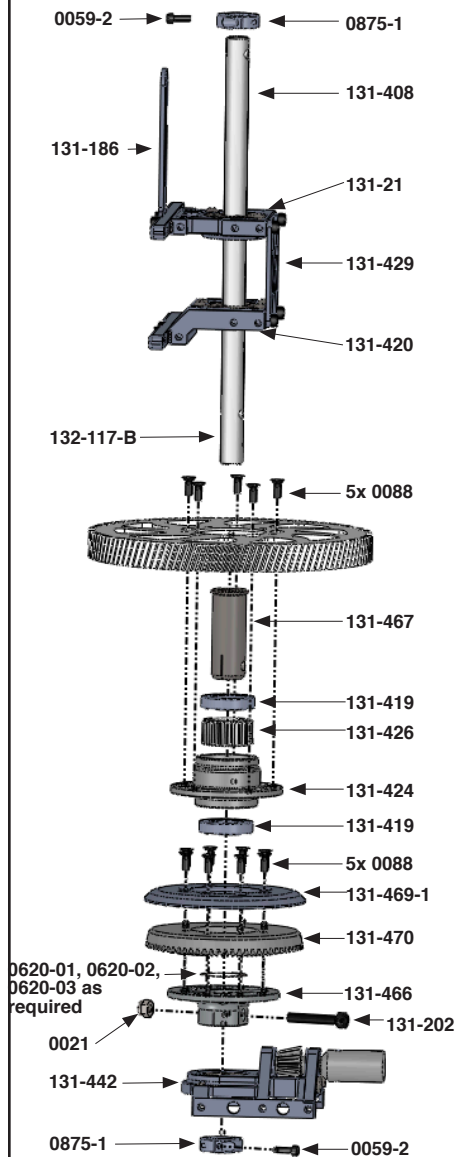


Hardware for these assemblies

-  0017-2 x 2
2.5mm Hex Nut
-  0059-4 x 4
M2.5x12 Socket Bolt
-  0061 x 6
M3x8 Socket Bolt
-  0116 x 2
M2.5 Threaded Steel Ball

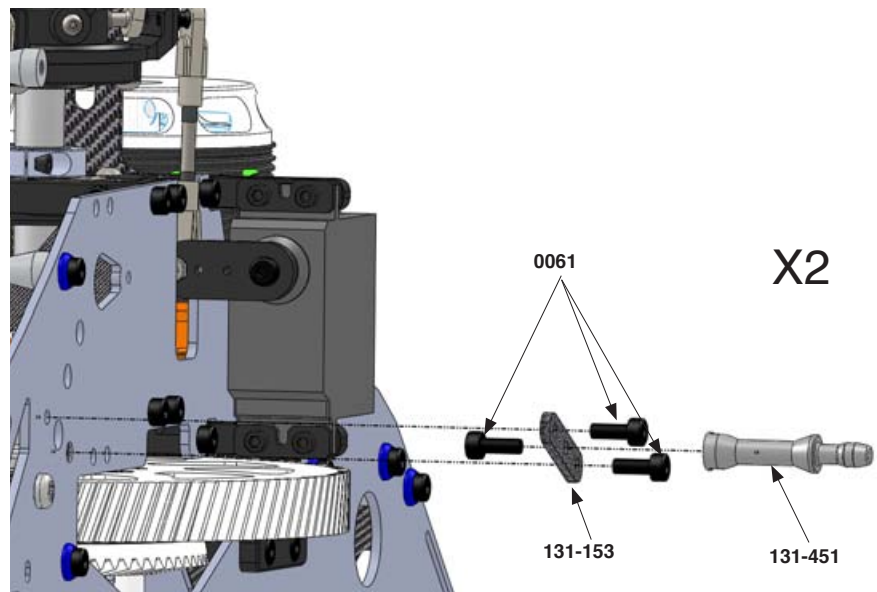
Assembly Tip

- Throttle linkage length is only an estimate. Linkage lengths will vary depending on motor and servo brand.



Apply a small amount of medium thread lock when threading into metal parts

Rear canopy mounting bolt MA0061 installed into PEM nut in frame is optional. Installing bolt will decrease canopy vibration, but increase chance of damage to canopy in a crash.





Hardware for these assemblies

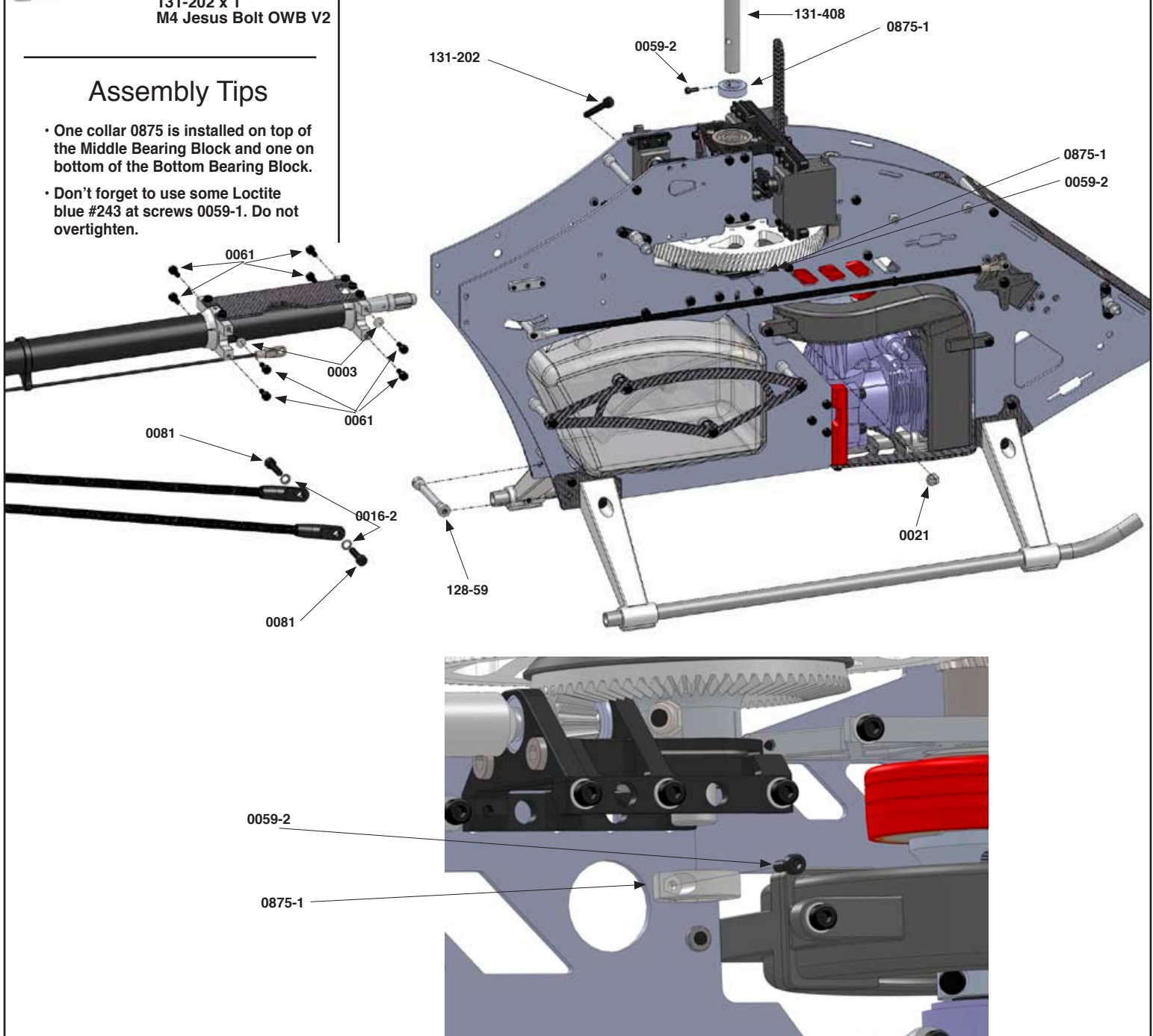


Assembly Tips

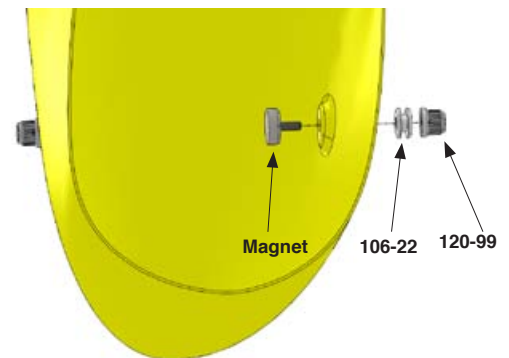
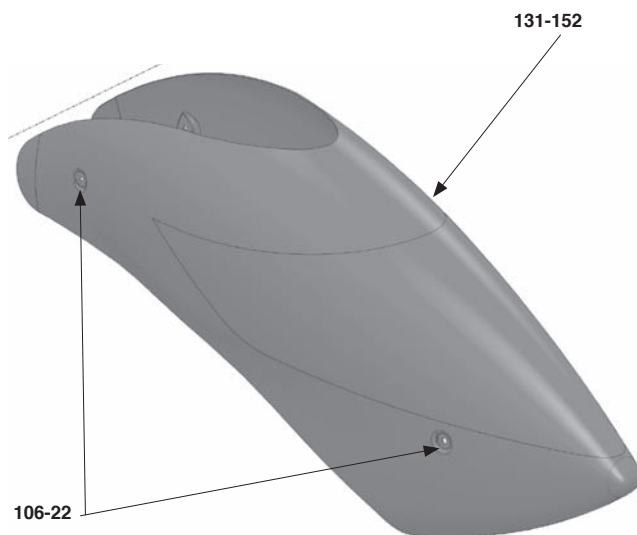
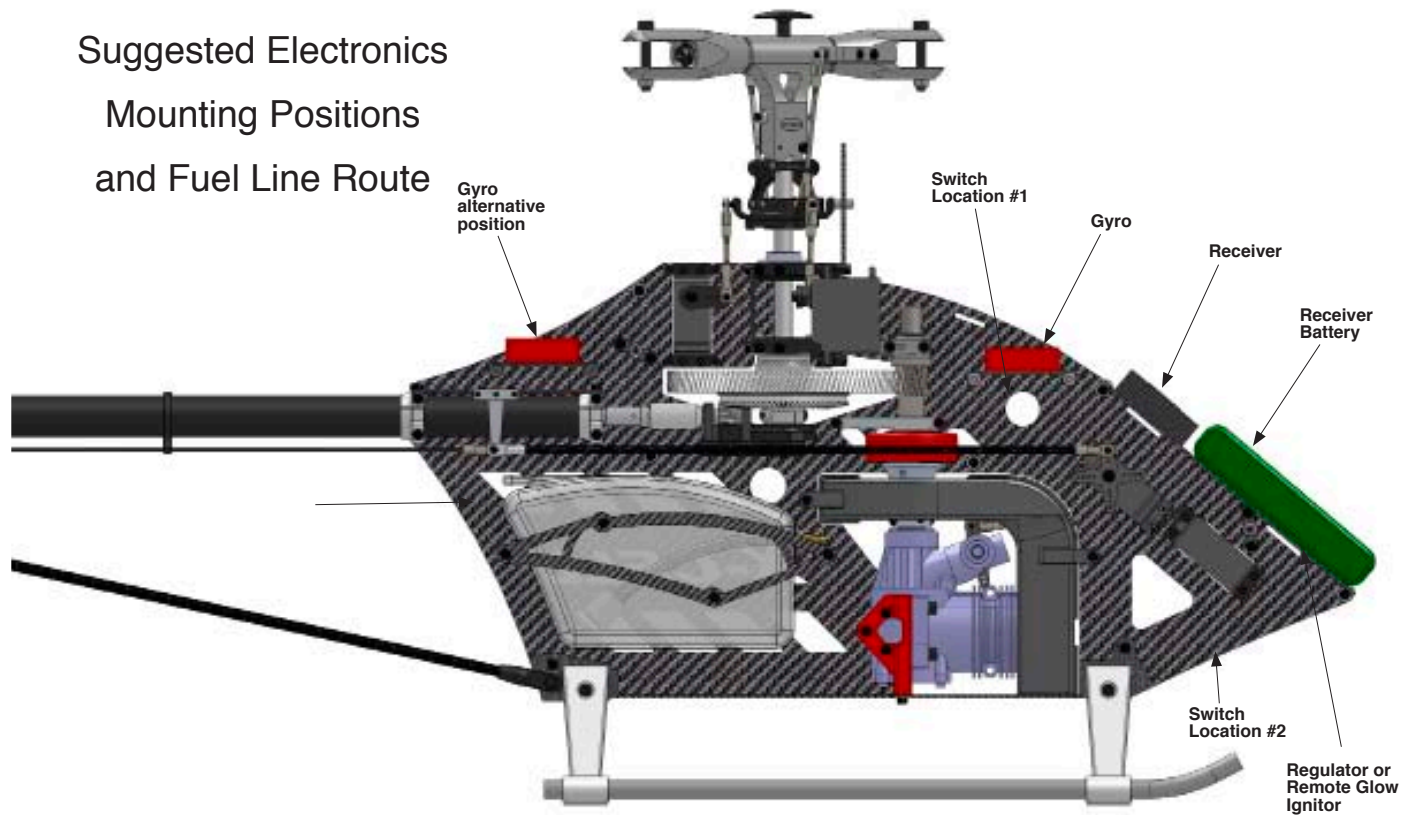
- One collar 0875 is installed on top of the Middle Bearing Block and one on bottom of the Bottom Bearing Block.
- Don't forget to use some Loctite blue #243 at screws 0059-1. Do not overtighten.

Apply a small amount of medium thread lock when threading into metal parts

After Main Shaft is bolted to the Main Gear, adjust Bottom Main Shaft Bearing Block to eliminate any vertical play. Tighten Bottom Bearing Block bolts.



Suggested Electronics Mounting Positions and Fuel Line Route



Hardware for this assembly



106-22 x 4
Rubber Canopy
Grommet

Assembly Tips

- The use of a hole reamer is recommended make the holes in the canopy for the canopy mounts. Final hole size should be 0.300" or 7.6mm
- Use CA glue to secure the grommets into the canopy. Be careful no to get it on the outside of the canopy as it will damage the finish.



Basic Model/Radio set up

The X-Cell Whiplash is an eCCPM model. This means that the servos that are connected to the swashplate move together to achieve the function requested from the transmitter input. The transmitter mixes the channels required to achieve the correct movement of the swashplate. The X-Cell Whiplash uses a very simple “direct” servo to swashplate system that decreases the overall parts count and complexity of the model.

The very first thing to do, is center the swashplate servos. Simply align the servo horns so they are 90 degrees to the servo, and the linkage is 90 degrees to the servo horn. Ideally, you rotate the servo horn until the servo is centered, eliminating the the need for using sub-trim.

For the pitch, aileron, and elevator servos:

In your radio

- ATV (servo endpoints) should be at 100%.
- Set all trims and sub-trims to center or zero.
- Set an initial linear pitch curve as a straight line (sample points: 0%, 25%, 50%, 75%, and 100%).
- Make sure there is no mixing enabled for cyclic channels at this point.
- Center the collective stick and make sure all the cyclic channels are centered.

On your model

- Mount each ball into a servo arm hole approximately 19-20mm from the center of each arm.
- Slide the servo horns for each channel onto each servo exactly in the middle of its travel.
- Failing to get them set at center will create interaction in your swash plate travel.
- If possible, center the horns on the servos without using any sub trim. As a last resort, use the sub trim function to precisely center each servo.
- Make sure you install hex nuts on the ball retainer bolts using thread locking compound.
- Make sure you install servo arm retainer screws.

For the rudder servo:

In your radio

- Make sure the gyro is in non-heading hold mode. Refer to your gyro manufacturer as to how to enable this.
- Rudder servo endpoints (ATV) should be at 100%.
- Make sure there is no mixing enabled for rudder channel at this point (some radios mix throttle to rudder by default).

On your model

- The ball should go into a hole approx 13-15mm from the center of the servo wheel.
- With your rudder stick centered, rotate the servo wheel until you find a spot that aligns properly and then slide the servo wheel onto the servo exactly in the middle of its travel. Do not use any sub-trim.
- Now make sure that the T/R bell crank is aligned. The 90 degree pitch slider on the tail case should be in the center of its travel. Adjust the links as necessary to ensure this is correct.
- Make sure you install hex nuts on the ball retainer bolts using thread lock.
- Make sure you install servo arm retainer screws.
- Set up the gyro according to the manufacturers specification in the manual included with the gyro.



Swashplate eCCPM Set Up:

Now that you've built your new Whiplash helicopter, you have to make the servos work together. The Whiplash is an eCCPM model, and requires a specific radio program for the servos that control the swashplate. eCCPM is a mix that is already programmed in your transmitter, you just have to fine tune it to your Whiplash and here's how:

The very first thing you need to do is tell your radio that a 120 degree eCCPM mix must be used. All modern transmitters should have 120 degree eCCPM built programmed from the factory. Consult the manual that came with your radio! Before you turn on your Transmitter and power up your servos, you need to make sure they are centered. With your transmitter and receiver powered on, put collective stick in the exact center with all three swashplate servo horns removed. Then put the horns on so they are 90 degrees to the linkage. This centers the servo horn on the servo and assures that there will be equal travel on either side of the servo's center point. If you find that you cannot get the servo horn exactly at center, you have two choices. You can flip the horn 180 degrees, sometimes the splines will line up perfect, this is the preferred method. You can also use a bit of "sub-trim" to center the servo. You really want to avoid using subtrim because it makes leveling the swashplate a little more involved.

Now you need to make sure that your servos are all working together. What we mean is the three collective servos need to be plugged into the appropriate channels, i.e. the elevator (which is the servo that controls the center ball on the swash) needs to be plugged in to channel 3, the aileron and pitch servo (the ones that control the sides of the swashplate) need to be plugged into channels 2 and 6 (it doesn't matter which channel just either servo, into either 2 or 6 on the RX).

The channel assignments for ail, elev, rudder, throttle and pitch may vary depending upon the brand and model of your radio. Consult the transmitter manual or use the TX servo monitor (if it has one) to ensure that the correct servo is receiving its signal from the correct channel. Note: the position of the pitch and aileron servos in relationship to the elevator as indicated in your radios setup manual are important. Make sure you connect them exactly as the radio manual shows when the swashplate is viewed from above.

Then, using the servo reverse screen, you need to make sure that the servos are doing the proper function. All the servos need to move up (or down) when the collective stick is moved up or down (it doesn't matter if the collective is reversed, we'll fix that later). If it doesn't, you need to (one at a time) reverse the channels on the servo reverse screen until all the servos move in the same direction when the collective stick is moved.

Now the aileron and elevator functions need to be sorted out. When you move the right stick right and left, the swashplate should tilt to the right and left (it doesn't matter if it moves right when you push the stick left, we'll fix that later). Also, when you move the right stick forwards and aft, the elevator should tilt forward or back (at this point it doesn't matter if the function is reversed, proper direction will be addressed in the next step).

Now that the SERVOS are all moving in together, we need to be sure that the SWASHPLATE is moving correctly for a given command. Pull up the Swash Mix screen. Futaba calls it "Swash AFR" There should be 3 functions and they'll look like this:

Aileron: 60%
Elevator: 60%
Pitch: 60%

So, if the the swashplate tilts left when you move the cyclic (right) stick TO the right, make the value of 60% for Aileron NEGATIVE or -60%, and likewise for the elevator. If the swash tilts forward when you pull the cyclic stick BACK, make the value of 60% NEGATIVE or -60% to correct it.

The swashplate should move up and down with the collective stick, and if you RAISE the collective stick, the blades should show POSITIVE PITCH. And if you LOWER the collective stick, the blades should show NEGATIVE pitch. IF that function is reversed, again, make the value of 60%, NEGATIVE 60% or -60%.

To ensure that your Whiplash is set up as precise as possible, it is very important that you follow the pitch curve set up guide and properly level the swashplate. There are several different tools for determining if your swashplate is level. We recommend the MA3000-10 Swashplate Leveling Tool.

Place the swashplate leveler on the swashplate and ensure that it is level. The collective stick should be at the center with zero degrees pitch on the blades. At this same time as described in the pitch curve set up guide, the swashplate should then be in the center of its travel, and the midpoint of the pitch curve should read 50%. If the swashplate is not level, you can use subtrim to level it, but the preferred method would be adjusting the linkages that connect the swashplate to the servos! If you find that you have to use more than a couple of clicks of subtrim on any channel, you should put it back to zero, and adjust mechanically by adjusting the linkages to the swashplate. After the swashplate is perfectly level at center stick, you need to level it at the extreme pitch range, i.e. full positive pitch and full negative pitch.

Place the Collective stick at full positive stick with the swash leveling tool attached. If the swashplate is not level, you will use the End Point screen or Travel Adjust screen. For instance, if the swashplate tilts slightly to the right at full positive pitch, then you will need to increase the travel for the servo that controls that swashplate ball. Now put the collective stick at full negative and repeat the same procedure with the end points. You do have to be careful that you don't create any binding at the extremes of the swashplate's travel.



Pitch Curve Set Up:

It is important that you build your model exactly the way we describe in this manual. Make sure all your linkage rods are exactly the length determined in the manual included with your helicopter kit.

First, go to the pitch curve menu in your radio for Idle up 1, or Stunt mode 1. You'll see numbers, a graph, or both. There will generally be 5 points you can adjust. You'll have to imagine the points (1,2,3,4,5) as representing points on the collective stick, where point 1 represents full bottom stick, and 5 represents full top stick. Obviously that makes point 3 center stick and that's where we start.

Ensure that point 3 on the pitch curve (center stick) to equal 50% of the swashplate's up and down travel, meaning the in the middle of it's available travel. So, turn on your transmitter, and receiver, flip the flight mode switch to idle-up 1 or Stunt mode, and scroll to the pitch curve menu. Now place the left stick in the center.

Use a pitch gauge, (we recommend the Mavrikk 3802) ensure that there is 0 degrees pitch on both rotor blades and that the mixing arms, and washout arms are perpendicular to the mainshaft. If any of this is untrue, you'll need to make it so, by adjusting slightly the length of the pushrods.

Now that you've got 0 degrees at center stick, and point 3 on the pitch curve has a value of 50% (don't deviate here!) We can adjust the pitch at full top and bottom collective stick positions. Generally we want to have the same amount of pitch on the bottom stick position as we do on the top stick position in idle up or stunt mode. That means positive 10 degrees on top stick, and negative 10 degrees on bottom stick (some pilots are now using more pitch 12, 13 or even 14 degrees, but most people find 10 degrees to be an acceptable initial setting to learn 3D flying).

With the transmitter still in idle up, or stunt mode place the collective stick at the top of it's travel, and take a reading of the pitch gauge and remember that number. It should be a positive pitch value and 10 degrees is a good place to start. Now place the collective stick at the full bottom of it's travel. It should be a negative pitch value and again -10 degrees is a good place to start. If the value is not close to 10 degrees then making it so is a simple adjustment of the swash mix function in your transmitter. In this menu, "swash mix" or "swash AFR", there are three options. Elevator, Aileron, and Pitch. Adjusting the pitch value, adjusts the total up and down travel of the swashplate. Making the number higher gives you a greater pitch range, and making the number lower gives you a smaller pitch range.

If you find that at full top stick, you get a negative pitch value, and at bottom stick you get a positive pitch value, you would go back to that "swash mix" menu, and make the value the opposite, Meaning if it was 60%, make the number -60%. That will change the direction of the swash travel.

Now, You'll notice that your pitch "curve" isn't really a curve at all, it's a straight line. You can adjust this if you wish by changing points 2 and 4. Right now, point 2 is 25%, and point 4 is 75%. You can change those values and it will affect how "jumpy" or responsive the collective is. Usually leaving it a straight line is best until you really get the "feel" for 3D flying.

If you're a beginner chances are you'll want to fly your model around in "normal" mode. Normal mode means that at full bottom stick the engine is at idle and the blades are not turning. You also don't have any need for there to be negative 10 degrees of pitch, usually more like -4 degrees is best.

This can easily be achieved by raising points 1 and 2. Scroll in the transmitter menu to pitch curve for normal mode, and increase point 1 from 0% to about 35%, and then you can usually inhibit point 2, so it makes a straight line from point 1 to point 3, which should still be 50%.

The Pitch Curve for throttle should usually look real similar to stunt mode. Throttle hold is generally used for performing autorotations.



Throttle Curve Set Up:

Build the throttle linkage as shown previously. This linkage length may change but ideally, you'll want the servo linkage 90 degrees to the servo horn. This ensures equal travel in both directions.

Turn on your transmitter. Scroll to the "throttle curve" screen and notice that there are points, usually 5, that all have an assignable percentage. For example point 1 is 0% and point 5 is 100% (of the servo's travel). Ensure that when the throttle/collective stick is at the mid point (point 3) that the engine's carburetor is exactly $\frac{1}{2}$ or 50% open (or otherwise stated in the manual included with the engine). This is crucial to easy set up. You may have to loosen the throttle arm on the carburetor for this to happen. Place the throttle stick to $\frac{1}{2}$ and see where the carburetor opens to. On most popular engines today there is a mark that shows the halfway point. If it is not quite $\frac{1}{2}$ way open you can use sub trim to make it so, but you don't want to use too much. Too much sub trim can make further set up more difficult.

Move the throttle stick to full throttle. The servo should open the carburetor to full open. If it opens less you can increase the end point in your radio so that it opens further, and if the servo binds (servo keeps wanting to move but the carburetor is fully open,) you can decrease the endpoint. Ideally you want the endpoints as close to 100% and 100% as possible.

If you are experiencing the need for more servo movement, try moving the ball link out one hole on the servo arm. Conversely, if you need much less servo movement, you can move the ball link one hole in.

Once you have this set up in normal mode you'll have to start and fly the helicopter to determine whether you need further throttle adjustment. From what we've found this is a good starting point.

Setting up for Idle up or stunt mode is a little different, as you'll want full throttle on either end of the collective/throttle stick travel. Scroll to the idle up menu in your radio, and you'll again find points such as 1,2,3,4,5. If you do not have a governor you have to set up a fixed throttle curve that controls the throttle. If you have a governor, please follow the set up instructions from the manufacturer of the governor. Without a governor you'll rely on the throttle curve to control the engine rpm while you're managing the collective stick. Make points 1 and 5 100%. Make point 3 50% Then you'll want a friend with an optical tachometer (we recommend MA3000-50 Optical Heli Tachometer) to observe the head speed of your helicopter. Make sure to follow the rotor speed recommendations given by the manufacturer of the rotor blades you are using. If the head speed is too low, then increase the value of point 3 by 5% increments until you get the head speed you desire.

Flybarless Stabilization Electronics:

If you have chosen a Flybarless model, it is possible to fly your model without additional stabilization electronics, but Miniature Aircraft highly recommends using Flybarless Stabilization Electronics. There are several that are commercially available, and while they all generally accomplish the same thing, they all are set up and programmed differently. Contact your favorite R/C helicopter retailer and/or talk to your friends to decide which one will be the best for you.



Whiplash Kit Parts & Hardware

0003	M3 Washer	105-70	6x15x5 Bearing	131-130	Tail Pitch Control Bellcrank
0004	M4 Washer	106-02	3x7x3 Flanged Bearing	131-131	C/F Tail Bellcrank Bracket
0009	M3 Washer Small	106-06	2x5x1.5 Flanged Bearing	131-132	Bellcrank Slider Cup
0011-5	M5.3x20 Washer	106-22	5x11 Grommet	131-133	Whiplash Fan Shroud - Left
0012-1	2.5mm Pem Nut	115-65	High Flex Fuel Line	131-134	Whiplash Fan Shroud - Right
0012-2	3mm Pem Nut	120-7	5x15 C/F Safety Washer	131-135	Bracket Washer
0014F	5mm Hex Nut - Fine Thread	120-25	Swash To Mixer Linkage Rod	131-136	Strut
0016-2	M4 External Serrated Lock Washer	120-39	5x10x4 Ball Bearing	131-137	C/F Rear Doubler - Nitro
0017-2	M2.5 Hex Nut	121-4	Servo To Swash Linkage Rod	131-138	Whiplash Nitro Fuel Tank
0019	M3 Lock Nut	121-7	Swash To PA Linkage Rod	131-139	Skid Tube
0021	M4 Lock Nut	122-47	10x22x6 Bearing	131-144	Rubber Fuel Tank Mount
0023	M5 Nut	122-48	22mm Circlip	131-145	Fuel Tank Standoff
0032	M3 Self Tapping Screw	122-70	M5x.25 S/S Shim Washer	131-146	C/F Fuel Tank Plate
0050-1	M2.5 Set Screw	122-94	M3x97 Threaded Control Rod	131-148	C/F Servo Plates
0051	M3x3 Set Screw	125-24	Fuel Filtered Pick-up Magnet	131-150	Front Canopy Post
0053-5	M3x16 Set Screw	127-86	M6x9.7x1.0 Shim Washer	131-151	Rear Canopy Post
0056	M3x5 Dog-Point Set Screw	128-57	Tray Mount	131-153	C/F Breakaway Tab
0057	M4x4 Set Screw	128-58	Main Frame Spacer	131-154	Thumb Screw
0058-3	M4x16 Set Screw	128-59	M4 Frame Spacer	131-161	Main Blade Grip
0059-0	M2.5x4 Socket Bolt	128-80	Front Boom Clamp	131-163	FBL Pitch Arm
0059-1	M2.5x6 Socket Bolt	128-92	Fuel Tank Plug	131-166	4x8x3 Flanged Bearing
0059-3	M2.5x10 Socket Bolt	128-94	Fuel Nipple	131-179	Whiplash Nitro X-Block
0060-1	M3x6 Socket Bolt	128-118	6mm Hex Adaptor	131-180	6x13x5 Flanged Bearing
0061	M3x8 Socket Bolt	128-144	T/R Control Rod Guide	131-181	9x17x5 Radial Bearing
0063	M3x10 Socket Bolt	128-146	Boom Support End	131-182	9x17x5 Thrust Bearing (F9-17)
0064-3	M3x6 Button Head Socket Bolt	128-149a	Upper Rear Boom Support Mount	131-183	9x14x.030 Washer
0064-4	M3x16 Button Head Socket Bolt	128-149b	Lower Rear Boom Support Mount	131-184	9x14x.080 C/F Damper Washer
0065	M3x12 Socket Bolt	128-176	Washout Pin	131-186	Anti Rotation Bracket
0067	M3x14 Socket Bolt	128-195	Head Button	131-187	Head Axle
0069	M3x16 Socket Bolt	128-196	Aluminum Bell Mixer	131-200	M4x33 Shouldered Socket Bolt
0071	M3x18 Socket Bolt	128-314	Swashplate Follower Arm	131-202	M4 Jesus Bolt OWB V2
0073	M3x20 Socket Bolt	131-3	Start Shaft	131-252	Whiplash Canopy
0078	M4x12 Socket Bolt	131-10	Clutch Liner	131-368	FBL Head Block
0078-3	M4x6 Socket Bolt	131-17-B	Bevel Gear Shaft Side	131-400	Torque Tube End
0081	M4x16 Socket Bolt	131-18-B	Tail Bevel Gear TT Side	131-408	FBL Main Shaft
0082-4	M5x32 Shouldered Socket Bolt	131-19	10x26x8 Main Shaft Bearing	131-411	Clutch Bell
0086-1	M5x16 Flanged Socket Bolt	131-21	Upper Main Shaft Bearing Block	131-420	Middle Main Shaft Bearing Block
0088	M3x8 Tapered Socket Bolt	131-23	6x13x5 Flanged Bearing - Tail Shaft	131-424	Main Gear Hub
0088-3	M3x7 Tapered Socket Bolt	131-33	15x21x4 Bearing - Tail Gear	131-429	C/F X-Brace
0107	M3x6 Threaded Steel Ball	131-40	Bottom Main Shaft Bearing Block	131-440	Bearing Block Mount A
0109	M3x8 Threaded Steel Ball	131-46	P/A Servo Rail	131-441	Bearing Block Mount B
0116	M2.5 Threaded Steel Ball	131-47	C/F Servo Rail Spacer	131-442	Bearing Block
0133	M2x21.2 Ball Link	131-50	Elevator Servo Mount	131-473	7x11x3 Bearing - Control Ring
0133-1	M3x21.2 Ball Link	131-52	Delrin Tray Mount	131-474	Control Ring
0159	3x7x3 Bearing	131-53	Gyro Plate	131-475	T/R Pitch Slider Assembly
0183	10x19x5 Bearing	131-54	M4 Tray Mount	131-476	Tail Pitch Yoke
0208	10x12 One-Way Torrington	131-55	C/F Angled Battery Tray	131-477	Brass Slider
0214	Upper Swash Ring	131-60	C/F Tail Fin	131-480	Delrin TT Bearing Cup
0214-1	Lower Swash Ring	131-62	Tail Boom	131-481	TT Bearing Cup O Ring
0215	M6 Tail Shaft Collar	131-64	Tail Hub	131-482	Sleeve
0216	Heim Ball	131-66	4x10 Thrust Bearings - Tail Grips	131-483	Tail Drive Hub
0217	Swash Plate Assembled	131-69	M2x315 Linkage Rod	131-485	12x18x4 Ball Bearing
0218	20x32x7 Swash Bearing	131-69-1	T/R Push Rod	131-487	C/F Right Frame - Nitro
0219	Washout Center Hub	131-70	Tail Output Shaft	131-488	C/F Left Frame - Nitro
0225	Link Pin	131-83	Anti Rotation Pin	131-490	Damper Sleeve
0225-5	Link Pin	131-84	Boom Support Rod	131-491	Damper 80D O-ring
0273	6x10x.011" Steel Washer	131-85	Carbon Pushrod Sleeve	131-558	Torque Tube
0273-05	6x10 Steel Washer	131-86	Assembled Boom Support	132-117-B	Main Gear 117T
0283	6x10x3 Flanged Bearing	131-107	T/R Bellcrank Swing Arm	132-59	C/F Front Doubler Electric
0319	8x16x5 Bearing	131-109	Swing Arm Pivot Mount	3000-73	Towel
0390	Large Wire Lead Retainer	131-112	T/R Blade Grip	3200-30	Spiral Band For Wire And Cable
0442	T/R Pitch Link	131-115	C/F Bottom Plate - Nitro	3200-48	3/4" Hook & Loop Tape
0447-1	M2 E Clip	131-117	Nitro Fan Hub	3200-54	3/4" Adhesive Hook & Loop
0597-1	M3x4.75x.126" Brass Spacer	131-119	Nitro Clutch	3700-160	Foam Blade Guard
0597-4	Brass Spacer	131-120	Engine Fan	4500-100	Magnet
0620-01	.10 Washer	131-122	Left Motor Mount		
0620-02	.20 Washer	131-123	Right Motor Mount		
0620-03	.30 Washer	131-128	C/F Boom Clamp Plate		
0869	Washout Link	131-129	Tail Box		



Warranty

The warranty covers defects in material, workmanship, or missing components to the original purchaser for 30 days from the date of purchase. Miniature Aircraft will replace or repair, at our discretion, the defective or missing component. Defective components **MUST BE** returned to us prior to replacement.

Any part which has been improperly installed, abused, crashed, or altered by unauthorized agencies, is not covered. Under no circumstances will the buyer be entitled to consequential or incidental damages. The components used in this kit are made from special materials designed for special applications and design strengths. We recommend that all replacement parts be original parts manufactured by Miniature Aircraft to ensure proper and safe operation of your model. Any part used which was manufactured by any firm other than Miniature Aircraft **VOIDS** all warranties of this product by Miniature Aircraft.

***For updates to this manual, or any other Miniature Aircraft manual,
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