X-CELL

Spectra-G

3-D

Instruction Manual

#125-100A - Extreme Head

miniature aircraft usa

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R/C HELICOPTER SAFETY

A radio controlled model helicopter is 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 his product to make it reliable in operation and easy to build. The essentially bolt together construction can proceed quite rapidly, giving 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 manufacturers 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 engine.

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.

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 a beginner, get help trimming the model first, and 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 model, radio and engine.

WARNING

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.

X-CELL LIMITED WARRANTY

The warranty covers defects in material or workmanship or missing components to the original purchaser for 30 days from the date of purchase. Miniature Aircraft, USA 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, crash damaged 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 form special materials designed for special applications and design strengths. We recommend that all replacement parts be original parts manufactured by Miniature Aircraft, USA, to ensure proper and safe operation of your model. Any part used which was manufactured by any firm other than Miniature Aircraft, USA, VOIDS all warrantees of this product by Miniature Aircraft, USA.

WARRANTY PROCEDURES

Mail all **warranty information within 15 days** of original purchase date. If service is required, send the component in question (if not missing) together with a **photocopy** of your **bill of sale** and an **accurate** description of the problem and part. Ship components fully insured and prepaid. Miniature Aircraft, USA is not responsible for any shipping damages. We will, at our discretion, notify you of any costs involved, or ship it COD. **You are required to pay all postage, shipping and insurance charges.**

X-Cell Fury Gas warranty registration

Please print or type, filling in the information listed below and mail immediately

Model No:_____Serial No:_____Price paid:_____
Owners name:_____Age_____
Address:_____Phone:_____
City:_____State:_____Zip:_____
Purchased from:_____
Dealer's address_____
_____
Comments:_____
_____

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X-CELL Spectra G-3D

INTRODUCTION

These instructions apply to the Spectra G-3D Kit #1025

Congratulations! You have purchased a quick assembling, high quality helicopter kit ideally suited for beginner through expert pilots. Please pay particular attention to each assembly step.

SYSTEM REQUIREMENTS

A minimum five channel "helicopter" type radio with electronic swash plate mixing (eCCPM) capability and three high quality servos ("digital" preferred due to their superior centering and equality).

A yaw rate gyro (basic or heading lock type) with a matched servo, to stabilize and assist in tail rotor control. Select the unit best suited to choice of radio and budget- be aware that even a beginner will appreciate the improved function of a top quality gyro, so choose wisely.

THE KIT PACKAGE

The kit includes detailed drawings showing all parts, part numbers, fastener information and complete radio installation data. Metric hardware is used throughout with correct tensile strength and heat treatment required for each position.

Each assembly step requires that only it's corresponding parts bag be used, avoiding confusion between similar appearing parts and fasteners for subsequent steps.

Also included is a bag of spare hardware, Allen wrenches (hex keys) and certain other special tools to assist in assembly.

TOOLS AND/OR MATERIALS REQUIRED

The following tools and materials are suggested to assist in building the kit:

Screwdrivers - small straight and Phillips
Plier's - small regular, needle nose, and forceps
Hand drill with drill bits
Open end wrench's - 5.5mm (7/32"), 7.0mm (9/32"), 8.0mm (5/16")
Dremel tool with sanding drum and carbide disk
Masking tape
Metric ruler
Small hammer

Vinyl two-sided tape - 1/8" thick (M.A./USA p/n 3869)
Slow and fast setting Cyanoacrylate (CA) adhesive
Heat gun
High quality synthetic grease (M.A./USA p/n 4707)
Light oil (teflon type M.A./USA p/n 4801)
Canopy finishing materials (described elsewhere in this document)
"C" clip pliers

The following are optional tools:

Ball link installation tool (M.A./USA p/n 0529)
5.0mm nutdriver (M.A./USA p/n 2957-1)
5.5mm nutdriver (M.A./USA p/n 2957-2)
7.0mm nutdriver (M.A./USA p/n 2957-4)
Flybar lock (M.A./USA p/n 0506)
Flybar alignment kit (M.A./USA p/n 0510-1)
Swashplate alignment tool (M.A./USA p/n 0513)
Pitch gauge (M.A./USA p/n 0526)
Custom hardened hex tools: 1.5mm (M.A./USA p/n 2985-1)
2.0mm (M.A./USA p/n 2985-2)
2.5mm (M.A./USA p/n 2985-3)
3.0mm (M.A./USA p/n 2985-5)

The following items are required or useful in the operation of any R/C helicopter:

A field charger for your various batteries.
Various selections of quality tools as used in the kit assembling steps.
Frequency flag displaying your radio frequency and color code (usually included with your radio).
Academy of Model Aeronautics (AMA) membership (for those individuals not residing in the USA, a membership in the model aeronautics organization of your country should be pursued). Membership in the AMA will grant you the right to fly at and participate in events around the country which take place at registered AMA sites. Additionally, this membership provides certain liability insurance to the modeler. More information can be had by calling 1-800-435-9262 or visiting the AMA website at www.modelaircraft.org.

ASSEMBLY INSTRUCTIONS

Please take the time to review all instructions and drawings before building the kit. Each step will list bags, tools and parts required to proceed.

Any position calling for the installation of steel threaded hardware into non-locking threads will refer to the addition of Blue Locktite thread locker (included). Any position using steel hardware

into plastic will refer to the addition of slow Cyanoacrylate (CA) (not included) as a thread locker. Always clean the threads with alcohol and use the locking material sparingly.

For individuals wishing to know, the following **maximum** torque values apply to metal-to-metal positions on the model.

Bolt size	NCM (metric)	Inch/pounds (US)
M3	40.0	3.5
M4	70.0	6.2

This information is provided only for interest and in no way indicates that a torque wrench is need to build the model.

When installing hardware into plastic, be aware that:
a) threads are forming, so hold the item straight while tightening.
b) you must stop tightening as soon as the flange or head contacts the plastic surface.

Frequently, the text will refer to items called “PEM” nuts. These are M2.5 and M3.0 threaded steel inserts that are factory installed in both side frames and various frame channels used in the kit. They are non-locking and require the use of Blue locktite on any related bolts or screws. Do not attempt to remove them and avoid over-tightening hardware into them. They are quite secure with only minimal tightening and Blue locktite.

ASSEMBLY SEQUENCE SUMMARY

Section: Subassembly:

I Building the rotor head
II Building the left main frame
III Installing the main shaft, main gear and front tail drive
IV Installing the right main frame
V Building the lower plate and installing the landing gear
VI Installing the fuel tank
VII Installing the swashplate, washout and rotor head assembly
VIII Building the tail rotor assembly
IX Building the tail boom assembly, boom supports and installation onto the main mechanics
X Installing the radio system and pushrods
XI Preparing the canopy
XII Rotor blade selection
XIII Final mechanical and electronic set-up
XIV Final inspection

XV Pre-flight information
XVI Starting and stopping procedure
XVII First flight adjustments
XVIII Troubleshooting guide

I. BUILDING THE ROTOR HEAD

Bags required: #1A, #1B, #1C, #1D and bag #9A

Tools or materials required:

Small Phillips screwdriver
Small hammer
Solvent (thinner or alcohol)
Loctite-Blue or Green
Slow cyanoacrylate glue (CA)
M1.5, 2.0, 2.5 and 4.0mm Allen tools
"Q-Tip" cotton swabs or tissue
Needle nosed pliers or forceps
A few inch's of masking tape
3/8" or similar socket with an O.D. of 14.0 to 16.0mm
Grease

Step 1: Building the Flybar support tube assembly

Parts required:

Qty	Part number	Part description	Found in bag
1	#0065	M3X12 Socket head bolts	1A
2	#0067	M3X14 Socket head bolts	1A
2	#0113	M3X10.5 Threaded double ball	1A
2	#0299	M4X10X4 Ball bearings	1A
1	#0509	Head button	1A
2	#0597-1	M3.0X4.7X3.2 Brass spacer	1A
1	#0844-A	Assembled head block	1A

Refer to drawing #1A

A) Select two #0299 ball bearings and the #0844-A head block assembly. Press a bearing into each end of the #0840-25 flybar tube as shown.The bearing will be flush with the edge when fully inserted.

B) Select two #0113 threaded double balls and two #0597-1 brass spacers. Install a spacer on each threaded ball and apply blue locktite to the exposed threads. Install one prepared threaded ball into each “flat” adjacent to the ball bearing at each end of the flybar support tube as shown in the drawing. Tighten with light torque.

C) Select two #0067 bolts and temporarily thread each into holes provided near the base of the head block. Note that even though the holes are threaded full depth, the bolts install from the side closest to the slot at each corner. Do not tighten until section IX, step 2E.

D) Select one #0065 bolt and the #0509 head button. Use a small piece of 180 to 220 grit sandpaper to lightly roughen the 6.0mm protrusion at the base of the head button. You are simply removing the “gloss” from the plastic. Insert the bolt from the top end and screw in 2 to 3 turns. Apply slow CA glue to the “roughened” surface and insert into the hole provided at the top of the head block. While holding the button and the head block firmly together, tighten the bolt until it’s head is about 1.0mm below the top surface of the button. Set aside to dry.

Step 2: Building and installing the Bell-Hiller mixers

Parts required:

Qty	Part number	Part description	Found in bag
2	0017	M3 Hex nuts	1B
2	0093	M3X18 Phillips bolt	1B
2	0109	M3X8 Threaded ball	1B
2	0113	M3X10.5 Threaded balls	1B
4	0159	M3X&X# Ball bearings	1B
2	0334-1	Bell Mixers	1B
2	0597-1	Brass spacer	1B
2	120-18	Main blade mount (for M5 blade bolt)	1B

Refer to drawing #1B

A) Select two #0109 threaded balls, two #0113 threaded balls and two #0334-1 bell mixers. Install one #0109 and one #0113 threaded ball into the end hole in each bell mixer, using the

previously mentioned precaution. **Slow CA is a must.**

B) Select four #0159 ball bearings and two #0597-1 brass spacers. Press one #0159 ball bearing into each bell mixer, followed by one #0597-1 brass spacer in the center. Press the remaining bearing into the opposite side of the bell mixer, capturing the brass spacer in between the bearings. Each bearing will protrude approximately 0.5mm when fully inserted.

C) Select two #120-18 main blade mounts. Examine the arm protruding from each. Two holes for bell mixer installation are provided. The “normal” position is the hole closest to the radius end of the arm (farthest from the blade gripping end). We suggest that this is the best position.

Examine the previously assembled bell mixers. In the area where the bearings are installed, note that one side is flat and one side has 1.5mm “step” or “shoulder” surrounding the bearing. The “stepped” side will face away from the pitch arm.

D) Select two #0093 special pivot bolts and two #0017 hex nuts. Note the correct orientation of the bell mixer bearings and thread into the outer pitch arm hole on the main blade mount. As with the threaded balls into plastic, screw the pivot bolt and bell mixer straight into the pitch arm, tightening it until some friction is felt when you rotate the mixer. Unscrew the pivot bolt about a quarter turn and check for free rotation of the mixer (without any end play), then install one #0017 M3 hex nut as a locking device on the exposed pivot bolt threads opposite the pitch arm. Repeat the process for the remaining blade mount.

Step 3: Installing the main axle and blade mounts

Parts required:

Qty	Part number	Part description	Found in bag
2	#0023	M5 lock nuts	1C
2	#0082-1	M4X45 special blade bolts	1C
2	#0086-1	M5X16 flanged socket head bolts	1C
1	#0316	M8X15 silicone tubing	1C
4	#0319	M8X16X5 ball bearings	1C
2	#0324	M10.6X15.8X0.9 thrust bearing spacer rings	1C
2	#0329	M8.1X13.0X.25 shim washers	1C
4	#0331	M8.1X13.0X0.5 shim washers	1C
2	#0332	M8.2X13.0X1.0 shim washers	1C

2	#0840-12	Large thrust bearings (three pieces)	1C
4	#0844-2	Dampener O-rings	1C
2	#0848-2	M8 retaining rings	1C
1	#0848-9	“C” clip tool	1C
1	#120-5	Main blade axle	1C
2	#120-7	M5X15 safety washers	1C

Refer to drawing #1C

NOTE: SPECIAL TOOL REQUIRED. External type retaining ring pliers for small external type “C” clips.

A) Select the #120-5 main blade axle. Clean the outer surface and internal threads with solvent. Dry thoroughly.

B) Select both #120-18 main blade mounts from step 2C and four #0319 ball bearings from bag 1C. Each blade mount must have two bearings pressed fully into position to function properly. You will need to select a socket with an O.D. of 14 to 16mm to use as a pressing tool to install the outer bearing. Additionally, the #0324 thrust bearing spacer ring will be utilized as a tool to concentrate the pressing force only on the outer ring of each bearing...not the dust shield or inner ring. Begin by inserting an #0319 bearing into the “blade” or “forked” end of the main blade mount. It will freely slide to within 5.0mm of it’s final position. To press the remaining distance, set the #0324 spacer ring atop the bearing followed by the socket. Stand the main blade holder upright so that the remaining flat surface for the second bearing (not the protruding pitch arm) is firmly against a wooden block or table edge. Using a small hammer, drive the socket, spacer ring and #0319 bearing deeper into the blade holder. When the bearing is fully into position, the “hollow” sound of driving the bearing into position will change and a measurement from the bearing to the radius tip of the blade holder will be approximately 47.0mm.

C) Installation of the remaining bearing is similar but often requiring much less force due to less surrounding plastic. Position the bearing above the bearing cavity and press firmly by hand. In most cases, it will snap into position. Confirm this or set it deeper by laying the #0324 spacer ring (as utilized previously) on a wooden block or table edge, position the blade mount and bearing atop it (with protruding pitch arm out of contact with table or block) and tap atop the opposite radius end of the blade mount with a small hammer. As stated, much less force is required to press this bearing into place. When fully inserted there will be 0.25mm exposed above the plastic surface. Repeat the procedure for the remaining blade mount.

D) Select the #120-5 blade axle from step 3A, and one M8 retaining ring #0848-2. Using the proper tool, open the ring only enough to allow it to slide over the axle and into position within

one of the grooves provided. **IMPORTANT:** be sure it is fully seated within the groove all the way around. Rotate it if necessary to confirm it's "seated" position.

Next, slide one #0331 shim ring (M8.1X13.0X0.5) onto the axle up against the retaining ring #0848-2. Follow with one of the assembled blade mounts #122-18 from step "B". Insert one #0324 spacer ring (M10.6 X 15.8 X 0.9) into the open end of the #0319 bearing within the blade mount.

Special note: Each thrust bearing assembly will contain one outer ring that has a smaller I.D. hole than the other outside ring. Identify this feature with both thrust bearings before proceeding. This can easily be done by sliding each outer ring onto the head axle. Test each outer race on the axle to determine which has the larger I.D. Install the larger I.D. bearing race with the grooved side away from the #0324 spacer ring previously installed in step "D". Apply grease to the groove. Next, slide the ball/cage into position, using more grease. Slide the remaining small I.D. bearing into position with the groove facing the ball/cage. Use a toothpick to apply a little Blue Locktite inside the threads at the end of the axle.

E) Select one #120-7 M5X15 safety washer and one #0086-1 M5X16 socket bolt. Install the washer on the bolt, put a socket tool in the bolt socket and insert this assembly into the open end of the blade mount, in the axle. Tighten only finger tight at this time. Note: A small amount of end play in the mount is normal.

F) Going to the opposite side of the head axle, slide one #0332 shim washer (M8.1X13.0X1.0) up against the previously installed "C" ring on the opposite side of the assembled blade mount. Select two #0844-2 O-rings and install onto the head axle up against the #0032 washer. **Note:** if a stiffer damping is desired, an additional #0031 shim or a #0329 shim (provided) may be added. Flight testing may be necessary dependant on your selection of main blades. In most cases, we do suggest the use of a #0329 thin shim and a #0332 thick shim on each side.

G) Mark the head axle at it's centerline. Wrap a small piece of tape over the unassembled end of the head axle to cover any sharp edges. Select the dampening sleeve #0316 and cut it approximately 15.0mm long (keep the rest for spares).Slide the 15.0mm piece onto a pair of needle nosed pliers or forceps. Spread it's diameter by expanding the pliers so that it can be slid over the end of the axle and onward to the center. Using forceps as a tool to slide the expanded dampener all the way to center is best. When center is reached, the forceps are easily slid out by holding the dampener stationary. The addition of this silicone tube is a small enhancement to the flight characteristics of the rotor head and in now way is considered either critical or safety related. The rotor head can be used either with or without the silicone tube.

Apply a little grease to the outside of the #0316 silicone tubing. Slide the partially assembled axle unit into the main rotor head block #0844, pushing it entirely in until the two rubber O-rings seat fully. From the opposite side, install two more #0844-2 O-rings, seating them fully into the head block. Next, slide the optional #0329 shim washer (thin) or #0331 medium shim, if chosen,

followed by one #0332 shim washer (thick). Secure in place with one M8 retaining ring #0848-2 ("C" ring), again using the proper "C" ring pliers. Expand it as little as is needed to slide it onto the axle fully in position within the groove provided. Select the special tool #0848-9 and slide onto the axle up against the "C" ring. Tighten down using one #0086-1 M5X16 flanged socket bolt and one #120-7 safety washer until the "C" ring is pushed into position within the groove in the axle. Usually a "snap" sound will confirm a proper fit. Remove the #0086-1 bolt, #120-7 washer and #0848-9 tool from the axle. Double check by rotating the "C" ring if necessary. It is important that the "C" ring is correctly installed within the groove.

Follow the above steps to install the remaining blade mount and components on the remaining side of the axle.

Using the appropriate M4 allen wrenches, moderately and simultaneously tighten each #0086-1 M5X16 flanged socket bolt. Check now to see if each pivots freely. If they do not, the most likely causes are bearings not seated fully in the blade mounts or the thrust bearings and/or spacer washers are incorrectly installed.

Note: The head of each #0086-1 bolt may be tapped while holding the main blade grip. In most cases this will seat the bearing allowing the blade grip to rotate freely.

Recheck each step if necessary. **Note:** if there is difficulty in removing the blade mount and thrust bearing, the cause is over tightening of the axle bolt(s) causing the previously discussed "flare" on the axle end. To facilitate safe removal in this situation, you can either purchase the #0532 blade mount puller, or: Insert the M5 bolt half way. Firmly hold only the blade mount in mid air. Hit the M5 bolt head with a hammer using a wooden block as a buffer to keep from marring the bolt. The O.D of the end of the axle must then be lightly filed to remove the "flare". If difficulty persists, contact M.A./USA or your local field representative for assistance.

Select two #0082-1 M5X45 special blade pivot bolts and two #0023 M5 lock nuts. Temporarily install these into each blade mount as shown.

Step 4: Installing the flybar and control arms

Parts required:

Qty	Part number	Part description	Found in bag
2	#0053	M3X5 socket set screws	1D
2	#0307	Flybar control arms	1D
1	#0566-1	Flybar	9A
2	#0840-7	M4 flat washers	1D

Refer to drawing #1D

Select two #0307 flybar control arms and two #0053 socket set screws. If work is going to proceed un-interrupted at this time, then you may choose to apply loctite to each set screw and install them loosely in the control arms. If not, then loctite must be added later.

Select the flybar and slide into the yoke bearings on the main rotor head block. Visually center the flybar. Select one #0840-7 spacer washer and one #0307 control arm. Slide the spacer followed by the arm onto the flybar, up to the bearing. Repeat for the other side. Lightly tighten each control arm set screw to assist in the next step. Carefully measure each exposed flybar end and adjust the assembly until the lengths are equal and no free play exists in and out of the head block. When the measurements are equal, it is time to align and tighten the #0307 control arms. Two choices are possible. If you intend to operate the model as a beginner (with minimum cyclic and collective travel) then you may simply align each control arm so they are level with each other and tighten the set screws firmly. If you intend to utilize full available cyclic and collective travel for 3D type flight, then it is suggested that each control arm have a downward angle of 10 degrees (or 5mm below a level, straight centerline. Measured at each ball end on the control arms). Approximate measurements are acceptable. When complete, be sure each set screw is firmly tightened with blue loctite.

Step 5: Installation of the flybar paddles

Parts required:

Qty	Part number	Part description	Found in bag
2	#0871-5	Sport paddles	1E

Refer to drawing #1D

A) Measure 22.0mm inward from each flybar end and mark with tape. The flybar is self threading into each paddle and the goal is to have each paddle level to the other and the flybar control arms. **Note:** If your chosen option was to angle the flybar control arms downward, then the visual line for alignment will be a horizontal line drawn through and connecting each ball on each #0307 control arm. A useful tool for aligning the paddles is the #0510-1 paddle gauge kit. Slow CA or epoxy is used as a paddle locking device, allowing sufficient cure time to simplify aligning the component.

B) Install each #0871-5 paddle as indicated and remove the marking tape. If all steps were accurately performed, then it should be evident that by holding the head vertical and releasing the flybar, the paddles will appear balanced. If not, then a small piece of vinyl tape can be applied to the light paddle. It is also possible to fine tune the balance by lightly

sanding the tip of the heavy paddle.

II. BUILDING THE LEFT MAIN FRAME

Bags required: #2A, #2B, #3D

Tools or materials required:
M2.5 Allen tool
M5.5 (7/32") flat wrench
Slow CA adhesive (glue)

Installing the left frame components

Parts required:

Qty	Part number	Part description	Found in bag
1	#0019	M3 Locknuts	2B
3	#0063	M3X10 Socket head bolt	2B
2	#0032	M2.9X9.5 Phillips self tapping screws	2B
1	#0053-5	M3X16 Socket set screw	2B
10	#0060-1	M3X6 Socket head bolt	2B
8	#0061	M3X8 Socket head bolt	2B
1	#0169	Bell crank pivot stud (black)	2B
1	#0874-1	Swashplate anti-rotation	2B
9	#115-20	M5X20 spacers	2B
1	#120-12	Upper main shaft block	2B
1	#120-8	Lower main shaft block	2B
1	#125-10	Vertical rear channel (216mm) w/bearing	2A
2	#125-12	½" channels (12.7mm)	2B
1	#125-32	Front doubler plate strip	2B
1	#125-33	Rear doubler plate strip	2B
1	#122-27	Rear canopy mount	2B

1	#0862-1	Rudder bell crank pivot stud	2B
1	#115-18	Main shaft bearing block	2B
2	#0089-1	M3X8 Hex bolt	2B
1	#125-15	Left main frame	2A
1	#120-10	Main shaft	3D
1	#125-30	Throttle servo plate	2B

SPECIAL NOTES:

1) This kit allows the motor to be mounted such that the cylinder is either forward facing or rearward. If you elect to mount the motor with the cylinder facing forwards, it is suggested that canopy mounts be mounted in the forward alternate mounting positions. Labeled "A" on the drawings. Use the following hardware for mounting the rear canopy studs:

* #0089-1 M3X8 hex head bolts to secure the canopy studs to the frame. Omit the use of the #0053-5 M3X16 socket set screw.

* #0060-1 M3X6 socket bolt in the upper hole of the rear vertical channel.

2) The throttle servo plate #125-30 is mounted on the left frame for a rearward facing engine. If a forward facing position is chosen, mount the #125-32 doubler plate strip on the left frame as shown in position "A" on the drawing. In this case the #125-30 plate will be mounted later in step 4.

Refer to drawing #2A

A) Select the #125-15 left main frame, one #124-10 vertical rear channel, one #0061 M3X8 socket head bolt, one #0862-1 rudder bell crank pivot stud, one #0053-5 M3X16 socket set screw and one #122-27 rear canopy mount.

Using red or green loctite, install the #0053-5 set screw into the #122-27 canopy mount. At least 6mm of the threads must protrude out of the canopy mount. Allow to thoroughly dry. Orient the main frame and rear channel as shown. Install the required hardware. Use blue loctite on the center and upper hole positions. Tighten securely.

B) Select one #0169 bell crank pivot stud and one #115-20 frame spacer. Note the position of the pivot stud outside the frame. Using loctite, install the pivot stud with the frame spacer on the inside and tighten securely.

C) Install the #125-30 throttle servo plate or the #125-32 doubler plate strip "A" to the outside

of the left frame using two #0061 M3X8 socket bolts and two #115-20 frame spacers. It is suggested that an M3 bolt be installed in one of the lower front holes of the doubler plate and the main frame, for alignment purposes only. Tighten securely using blue loctite and remove the M3 bolt if so installed for alignment.

D) Install the #125-33 rear doubler plate onto the outside of the left frame, one #0019 M3 lock nut, one #0061-1 M3X6 socket bolt, one #0061 M3X8 socket bolt, one #0063 M3X10 socket bolt and one #115-20 M5X20 spacer. As with step "C", temporarily install an M3 bolt into one of the lower rear holes of the doubler plate and the mainframe. Use blue loctite on all hardware except the #0019 nut and the #0063 bolt securing the lower side of the rear channel. Tighten securely.

E) As per the drawing and the directions that came with the motor, install one #106-41 front canopy stud using #0089-1 M3X8 hex head bolt. Tighten securely using blue loctite.

F) As per the drawing, install six #115-20 frame spacers using six #0060-1 M3X6 socket bolts. Tighten securely using blue loctite.

G) Install two #125-12 one half inch (12.7mm) channels using two #0060-1 m3x6 socket bolts. Tighten securely using blue loctite.

H) Select the #0874-1 swashplate guide and two #0032 M2.9X9.5 phillips self-tapping screws. Note the location and install the guide using slow CA adhesive on each screw. Check that the guide is mounted vertically.

I) Install the #120-12 upper main shaft bearing block (hump side upward) using two #0063 M3X10 socket head bolts and blue loctite. Do not fully tighten at this time.

J) Install the #120-8 lower main shaft bearing block as shown using one #0060-1 socket head bolt and two #0061 M3X8 socket head bolts. Use blue loctite. Do not fully tighten at this time.

K) Install one #115-18 bearing block using two #0061 M3X8 socket bolts.

L) Remove the #120-10 main shaft from bag 3D. Slide it down through the bearing blocks and securely tighten all the bolts in both blocks. Only lightly tighten the bolts in the #115-18 lower bearing block. These bolts will be removed later when installing the clutch bell alignment plates.

III. INSTALLING THE MAIN SHAFT, MAIN GEAR AND FRONT TAIL DRIVE

Bags required: #3A, #3B, #3C, #3D

Tools or materials required:

M1.5, 2.0 and 2.5 allen tools
M5.5 flat wrench
Tri-flow #4801 or automatic transmission fluid (ATF)
(optional) feeler gauge

Step 1: Installing the front tail rotor drive gear and shaft

Parts required:

Qty	Part number	Part description	Found in bag
3	#0051	M3X3 socket set screws	3A
1	#0232	15 tooth bevel gear	3A
1	#0237	M5 retaining collar	3A
1	120-9	Front transmission shaft	3A

Refer to drawing #3A

A) Select one #120-9 front transmission shaft, one #0237 retaining collar and one #0232 15 tooth bevel gear. Examine the drawing and note the orientation of each part. Insert the #120-9 front transmission shaft from the rear of the main frame through the bearing housed in the #125-10 vertical rear channel. With 25 to 30mm exposed in front of the bearing, slide the #0237 retaining collar followed by the #0232 bevel gear onto the shaft.

B) Select one #0051 M3X3 socket set screw, apply blue loctite and partially thread into the #0237 retaining collar. Push the shaft forward into the #120-8 front transmission bearing block. Apply forward pressure on the white delrin portion of the #120-9 transmission shaft while pressing rearward on the #0237 retaining collar. Tighten the #0051 M3X3 socket set screw within the collar. Check to see that no end play exists within the shaft. If there is end play, then reposition the collar to ensure no end play exists.

C) Select two #0051 M3X3 socket set screws. Note the #120-9 front transmission shaft has a flat for a set screw securing the #0232 bevel gear. Install one #0051 M3X3 set screw into the gear, tightening enough to be certain it has engaged the flat and the gear can be moved for final positioning. Final gear position can be determined after the main gear is installed, observing the rule that the bevel gear be centered within the main gear. Which ever method is utilized, always remember to install the remaining #0051 M3X3 socket set screw with blue loctite and double check the contact of the first set screw within the flat provided.

Step 2: Assemble the constant drive autorotation upper section

Parts required:

Qty	Part number	Part description	Found in bag
8	#0088-1	M3X5 Flat head screws	3B
1	#0866-5	70 tooth upper bevel gear	3B
1	#0866-6	Upper gear mounting base w/main shaft sleeve	3B

Refer to drawing #3B

A) Select eight #0088-1 M3X5 flat head screws and prepare each with blue loctite. Select the #0866-5 bevel gear and #0866-6 mounting base. Press the mounting base downward into the upper surface of the bevel gear, aligning the holes as you proceed. From the underside, install the eight #0088-1 M5X3 flat head screws, tighten them a little at a time in a "star" pattern. Tighten all with light torque.

Step 3: Install the outer main gear onto the autorotation hub

Parts required:

Qty	Part number	Part description	Found in bag
4	#0088	M3X8 flat socket head bolts	3C
1	#0865-90	90T outer main gear	3C
2	#0866-10	M14.0-20.0X0.2 shim rings	3C
1	#0866-11	M14 Teflon O-rings	3C
1	#0866-4	Lower housing w/Sprag bearing	3C

Refer to drawing #3C

A) Select four #0088 bolts and prepare with blue loctite. Select the outer main gear and note the four countersunk holes on the upper surface. Only the countersunk holes will be utilized. Press the gear atop the upper housing, align the countersunk holes, install the four bolts and tighten with light torque.

B) Select one #0866-10 shim ring and apply a little grease to each side. Set this atop the Oilite bushing (visible at the top of the upper housing, protruding through the main gear).

C) Select another #0866-10 shim ring, apply grease and slide upward to meet the gear mount. Select one #0866-11 Teflon O-ring and install it next to the shim ring. Set the main gear/sprag housing assembly upright on the table. Insert the upper gear/sleeve assembly downward into the sprag clutch. When it makes contact, rotate the upper assembly slightly clockwise while lightly pressing downward. When it drops inward about 5.0mm (easily noticed as you rotate and push downward) lift the combined parts off the table. Hold them inverted at about a 45 degree angle and apply a liberal amount of Tri-flow oil to that portion of the sprag clutch that is visible just inside the lower Oilite bushing in the lower hub. Rotate the unit as you apply more oil. The unit will hold about 7 to 8cc's (1/4 ounce) of oil. When oiling is completed, press the upper gear fully into the lower gear and wipe away any excess oil.

Note: never force the main sleeve into the sprag clutch. If it does not insert easily while rotating, look from beneath the sprag to be sure that the cogs look uniformly positioned. They are only retained by an outer spring and it is possible to dislocate one during insertion. If necessary, remove the sprag clutch from the housing and it will return to it's proper configuration.

Step 4: Installing the main shaft and main gear/autorotation assembly

Parts required:

Qty	Part number	Part description	Found in bag
1	#0057	M4X4 Socket head set screw	3D
2	#0059-1	M2.5X6 Socket head bolts	3D
1	#0840-6	M3X20 Dowel pin	3D
1	#0866-10	M14.0X20.0X0.2 Shim ring	3D
1	#0866-11	M14 Teflon O-ring	3D
1	#0866-12	retaining collar (black)	3D
1	#0866-13	M14X20.0X0.1 Shim ring	3D
1	#120-10	Main shaft	3D
2	#0875	Split type main shaft collars	3D

Refer to drawing #3D

A) Select the #120-10 main shaft. **Note**: the main shaft must be installed per the drawing.

Apply a little light oil to a cloth a briskly wipe down the shaft. This will remove the protective coating. It is suggested that a trial fit of the main shaft be performed prior to assembling the main shaft components. It may be necessary to loosen the lower block for alignment, and re-tighten with the main shaft in place. As noted above, insert the correct end of the main shaft into the upper main shaft bearing block at the top of the mainframe. Slide it through so that 20 to 30mm is exposed below the bearing block.

B) Select two #0875 slit type main shaft collars. Examine the collars. One end of each collar has a flat surface with a 0.3mm raised step near the bore. This end is always to face a ball bearing. Using these criteria, slide two split collars onto the main shaft exposed below the upper bearing block. The upper collar should have it's flat surface (with step) facing up to the underside of the upper bearing block and the lower collar should "face" the bearing in the middle block. Slide the main shaft further downward into and through the middle bearing block until about 6 to 7mm is exposed below.

C) Select the previously assembled autorotation, the #0840-6 dowel pin, the #0866-10 shim ring, the #0866-11 Teflon O-ring and the #0866-12 collar. It should now be determined which (or both) shim rings (#0866-10 and/or #0866-13) are required. Invert the autorotation assembly and note the Oilite bearing exposed at the base of the housing. A **shim ring** should **always** be placed next to this bushing. As a trial, install the #0866-13 M14.0X20X0.1 shim ring followed by the teflon O-ring and the black retaining collar. Temporarily insert the #0840-6 dowel pin through the collar (large I.D. hole) and into the autorotation sleeve. Rotate the outer main gear against the inner and check for smooth rotation. Move the gear up and down between the upper gear and the retaining collar. The desired situation is to have the gear rotate freely but have very little up/down play. If it is too loose, substitute shim ring #0866-10 for shim ring #0866-13. If there is no free play and the rotation is with very light friction, it can remain as is since the teflon O-rings will break in quickly. It should be noted that there is no operational problem or risk even if the unit develops as much as 0.5mm of free play (at your option the O-rings could be replaced or shim rings added). When the correct shim(s) have been determined, remove the dowel pin, retaining collar, O-rings and the shim(s). Apply a little grease to each side of the shim(s) and reinstall all items except the dowel pin.

D) Slide the autorotation unit into position and slide the main shaft downward into the lower bearing block. Align the holes within the #0866-12 retaining collar, the sleeve on the #0866-6 and the lower main shaft hole. **Note:** that the #0866-12 retaining collar has one large hole and one small hole. The large hole is for the insertion of the #0840-6 M3x20 dowel pin and the subsequent #0057 M4X4 socket set screw. The small hole is for removal of the pin using a 1.5mm allen tool or similar device. Insert the #0840-6 dowel pin as shown in the drawings. The pin should easily slide in far enough to allow installation of the set screw. If not, then there are two possible causes and various steps to cure the problem:

The pin may not fully insert due to an obstruction within the collar. Remove the

collar and trial fit the pin. Look for any metal debris lodged in the “small hole” side of the collar. If any exists, use a 1.5mm allen tool to push it out.

The pin may not insert fully sue to a misalignment of the holes in the related parts. The main shaft hole is suspect here. The easiest solution is to run a sharp 0.120" (3.0 to 3.1mm or #31) drill bit into the assembled retaining collar, sleeve and main shaft. This will deburr any offending hole and will not harm anything. The drill will stop automatically as it reaches the small hole on the opposite side of the collar and is too small to harm the threads at the inlet.

Reinstall the pin followed by the #0057 M4X4 set screw with a very small amount of blue loctite (on the set screw only).

Note: The sprag bearing should be cleaned and re-lubricated periodically (approximately every 50 to 75 flights).

E) The main shaft must now be adjusted and secured at the lower bearing block. Select one #0059-1 M2.5X6 socket head bolt, apply a little blue loctite and insert an M2 allen tool. Rotate the lower main shaft split collar (#0875-1) for access to the threaded hole and install the bolt, leaving it loose and the tool in place. Slide the #0232 bevel gear until it is very slightly forward from center within the gear teeth on the upper delrin gear #0866-5. Lightly tighten one of the set screws in the gear. Lightly pull upward on the main shaft while pressing downward on the spilt collar. Tighten the bolt in the lower collar. Select the remaining #0059-1 M2.5X6 socket head bolt and temporarily install it in the upper split collar, move the unit up to the upper bearing block and lightly tighten. The gear mesh will likely feel notchy when rotated. The adjustment is easily done by slightly moving the #0232 gear rearward until a smooth feel is achieved with minimal backlash in the gears. Be sure that both set screws in the #0232 gear have blue loctite and that one set screw is contacting the flat on the #120-9 shaft.

IV. INSTALLING THE RIGHT MAIN FRAME

Bags required: #4A, #4B, #4C, #4D, #4E, #4F

Tools or materials required:
M1.5, M2.2 and 2.5 Allen tools
M5.5 and M7.0 (5/32" and 7/32") Flat wrenches
Small phillips screwdriver
Slow CA adhesive

Step 1: Installing the elevator bellcrank

Bags required: 4A & 4B

Parts required:

Qty	Part number	Part description	Found in bag
2	#0003	M3 washer	4B
1	#0019-1	M3 locknut-low profile	4B
1	#106-41	Front canopy standoff	4B
1	#122-28	Brass sleeve .187" X .125" X .079"	4B
1	#0053-5	M3X16 Socket set screw	4B
2	#0089-1	M3X8 Hex head bolt	4B
1	#0099	M3X30 Phillips bolt	4B
1	#0105	M3X45 Threaded ball	4B
1	#0113	M3X10.5 Double threaded ball	4B
2	#0597-1	M3X3.19X4.75 Brass spacer	4B
2	#106-02	M3X7X3 Flanged bearing	4B
1	#122-27	Rear canopy standoff	4B
1	#125-18	Elevator bellcrank	4B
1	#124-22	Brass sleeve .187" X .124" X .302"	4B
1	#125-36	Right main frame	4A

Special note:

Refer back to the special note in step 2 concerning the direction of the engine mounting, the installation of the canopy studs and the #125-30 throttle servo plate.

Refer to drawing #4A

A) Mount the front canopy stud onto the right main frame #125-36 using one #0089-1 M3X8 hex head bolt. Choose the appropriate location taking into consideration the engine direction. Tighten securely using blue loctite.

B) Mount the rear canopy stud #122-27 in the forward hole position only if you have chosen to face the motor forward. Use one #0089-1 M3X8 hex head bolt. If a rearward motor direction is chosen, install the #0053-5 into the #122-27 canopy stud using red or green

loctite, leaving 6mm of stud protruding. Set aside to dry thoroughly. Installation will be done in step 2.

C) Study the drawing for proper orientation of the assembly of the elevator bellcrank #125-18. Install one #0105 threaded ball, one #0113 threaded ball and one #122-28 brass spacer. Use a small dab of slow CA on the threaded portion of each ball.

D) Press one #106-02 flanged ball bearing into one hole of the bellcrank. Follow with one #124-22 brass sleeve in the bearing cavity opposite the #106-02 bearing. Capture the brass sleeve inside the bellcrank by pressing one #106-02 flanged bearing into the remaining bearing cavity of the bellcrank.

E) As shown in the drawing, insert one #0099 M2X30 phillips bolt and one #0003 M3 washer into the appropriate hole for the elevator bellcrank on the left main frame #125-15. On the inside of the left main frame, slide one #0597-1 brass spacer, followed by the #125-18 elevator bellcrank assembly, and one #0597-1 brass spacer.

F) Position the #124-36 right main frame onto the #0099 phillips bolt in the elevator bellcrank assembly. Lightly secure in place with one #0003 M3 washer and one #0019-1 low profile locknut.

Step 2: Installing the right mainframe hardware

Bags required: #4C

Parts required:

Qty	Part number	Part description	Found in bag
2	#0019	M3 Locknut	4C
2	#0032	M2.9X9.5 Phillips self tapping screw	4C
10	#0060-1	M3X6 Socket bolt	4C
4	#0061	M3X8 Socket bolt	4C
3	#0063	M3X10 Socket bolt	4C
1	#125-32	Doubler plate strip-front	4C
1	#0169	Bellcrank pivot stud	4C
1	#125-33	Doubler plate strip-rear	4C

Refer to drawing #4B

A) Install the following hardware into the following positions as per the drawing. Use blue loctite on all the threaded parts except the #0019 locknut positions.

* Two #0063 M3X10 socket bolts into the upper main shaft bearing block #120-12.

* Two #0061 M3X8 socket bolts and one #0060-1 M3X6 socket bolt into the #120-8 center main shaft bearing block.

* One #0169 bellcrank pivot stud installed opposite the #0169 in the left main frame.

* Five #0060-1 M3X5 socket bolts into the #115-20 frame spacers as shown.

* Two #0060-1 M3X6 socket bolts into the two #125-12 one half inch (12.7mm) channels.

* One #125-32 front doubler plate strip and two #0061 M3X8 socket bolts into two #115-20 frame spacers as shown.

* One #0061 M3X8 socket bolt and one #0019 M3 locknut into the second hole from the bottom of the rear vertical channel.

* One rear canopy stud from step 1B or one #0060-1 M3X6 socket bolt into the upper hole in the rear vertical channel. See “A” on the drawing.

Securely tighten all hardware and components.

B) Install two #0032 M2.9X9.5 phillips screws into the #0874-1 swashplate guide. Tighten securely using slow CA adhesive.

C) Depending on the motor direction chosen, mount the following as shown.

Forward mounted motor:
* One #125-30 throttle servo plate
* Two #0061 M3X8 socket bolts
* One #0019 M3 locknut
* One #0060-1 M3X6 socket bolt

-OR-

Rearward mounted motor:
* One #125-33 rear doubler plate

* One #0019 M3 locknut
* One #0063 M3X10 socket bolt
* One #0061 M3X8 socket bolt
* One #0060-1 M3X6 socket bolt

Tighten securely using blue loctite except on the positions where locknuts are used.

Step 3: Installing the left and right bellcranks and gyro brackets

Bags required: 4D

Parts required:

Qty	Part number	Part description	Found in bag
2	#0051	M3X3 Socket set screw	4D
4	#0109	M3X8 Threaded ball	4D
4	#0159	M3X7X3 Ball bearing	4D
2	#0167	Bellcranks	4D
2	#0171	Retaining collar	4D
1	#0595-1	Gyro bracket “A”	4D
1	#0595-2	Gyro bracket “B”	4D
1	#115-20	Frame spacer	4D
2	#0060-1	M3X6 Socket bolt	4D

Refer to drawing 4C

A) Refer to the drawing for the orientation of the threaded balls in each bellcrank. Using small dabs of slow CA adhesive, install two #0109 threaded balls into each bellcrank.

Select two #0051 M3X3 socket set screws, two #0171 retaining collars and the previously assembled bellcranks. Note the previously installed #0169 bellcrank pivot studs previously installed near the main shaft in each main frame. Slide a bellcrank onto each #0169 pivot stud (flat side away from each frame) followed by one #0171 retaining collar. Apply blue loctite to each #0051 M3X3 socket set screw and install in each collar, adjusting each so that the bellcrank pivots freely without any end play. The set screws only require moderate tightening torque, **do not over tighten them!**

B) Select one #115-20 M3 spacer, two #0060-1 M3X6 socket head bolts, one #0595-1 type (A) gyro bracket and one #0595-2 type (B) gyro bracket. Install the brackets as shown, making sure they are securely tightened and aligned to form a uniform flat top surface.

Step 4: Assembly and installation of the rudder bellcrank

Bags required: 4E

Parts required:

Qty	Part number	Part description	Found in bag
1	#0009	M3 Washer (small)	4E
1	#0061	M3X8 Socket head bolt	4E
1	#0105	M3X4.5 Threaded ball	4E
1	#0107	M3X6 Threaded ball	4E
2	#0636	M5X10X3 Flanged bearing	4E
1	#0862-4	Brass spacer ring	4E
1	#0862-2	Rudder bellcrank	4E

Refer to drawing #4D

A) Select two #0636 flanged ball bearings, one #0862-4 brass spacer ring and one #0862-2 rudder bellcrank. Press one bearing into one side of the bellcrank, insert from the opposite side one #0862-4 brass spacer ring followed by the remaining bearing (the brass spacer will limit full insertion of the second bearing by 0.03 to 0.04mm to prevent bearing damage after installation damage on the standoff).

B) Examine the drawing and note the orientation of the bellcrank on the model and the required threaded balls (flat side facing away from the left main frame, long end downward, longer threaded ball on the long end/flat side and shorter ball on the short end facing the main frame).

C) Select one #0105 M3X4.5 threaded ball and one #0107 M3X6 threaded ball. Apply a small dab of slow CA to the threads of the ball and screw it into the proper position on the bellcrank.

D) Select one #0009 M3 flat washer (small) and one #0061 M3X8 socket head bolt. Press the bellcrank onto the standoff previously installed on the rear of the left main frame as

shown. Place the #0009 washer onto the #0061 socket head bolt and add a small amount of blue loctite to the threads. Install this into the standoff and tighten with moderate torque. Check for smooth movement of the bellcrank.

Step 5: Final main shaft adjustment

The main shaft should rotate freely and have no vertical free play. Re-check the gear mesh between the crown gear and the tail drive pinion. If needed, readjust the main shaft collars and the #0232 gear. Use blue loctite.

Step 6: Installing the clutch and clutch bell

Bag required: 4F

Parts required:

Qty	Part number	Part description	Found in bag
2	#125-57	Graphite doubler plates 7.15:1	4F
1	#121-8	Clutch unit complete	4F
1	#115-45	M6 O-ring	4F
1	#121-13	13T clutch bell	4F
8	#0063	M3X10 socket head bolt	4F
6	#0060-1	M3X6 socket head bolt	4F
4	#0003	M3 washers	4F
6	#0061	M3X8 socket head bolt	4F
8	#0009	M3 washers (small)	4F

Refer to drawing 4E

A) Select the #121-8 clutch/lower bearing block/clutch driver assembly, the #115-45 M6 O-ring, the #121-13 clutch bell/pinion gear/upper bearing block assembly, and the #125-57 graphite clutch doubler plate. Slide the #115-45 O-ring onto the exposed 6.0mm shaft of the #121-8 clutch/driver/lower bearing block assembly followed by the clutch bell/pinion gear/upper bearing block assembly.

B) Remove the two #0061 screws previously installed in the lower main shaft bearing block.

C) Select four #0003 M3 washers and four #0063 M3X10 socket head bolts. Place one washer on each bolt. Repeat the same using eight #0009 M3 washers (small), four #0063 M3X10 socket head bolts and four #0061 M3X8 socket head bolts.

D) Install the #121-8 clutch/clutch bell unit in place between the frames. Examine the drawing and note the position of the #0061 M3X8 socket head bolts and the #0063 M3X10 socket head bolts through the doubler plates and into the clutch unit. Lay one graphite doubler plat in position on the left main frame. Using blue loctite, install two #0061 socket head bolts and two #0009 washers through the graphite doubler plate into the inner most holes in the clutch unit lower bearing block. Install two #0063 socket head bolts and two #0003 washers into the clutch bell upper block. Repeat this process on the right main frame. **Do not fully tighten at this time.**

E) Install two #0063 M3X10 socket head bolts and two #0009 M3 washers through the graphite doubler plates and into the outer positions in the clutch unit lower bearing block.

F) Install four #0061 M3X8 socket head bolts through the doubler plate into the lower main shaft bearing block #115-18. Use blue loctite. **Do not fully tighten at this time.**

G) Prepare six #0060-1 M3X6 socket head bolts with a small amount of blue loctite. Examine the drawing and note the position for each bolt around the perimeter of each graphite doubler plate. **Do not fully tighten at this time.**

H) Slide a small piece of paper between the clutch bell gear and the main gear. Tighten the ten bolts in each graphite doubler plate from steps “F” and “G”, starting with step “G”. Next, tighten all twelve bolts holding the clutch/clutch bell unit in the graphite doubler plates. Remove the paper.

I) The gear mesh should have minimal free play and be smooth. However, the gears may require a few flights to “break in” so disregard any minor irregularities in the mesh.

Step 7: Installing the radio plate

Bags required: 4F

Parts required:

Qty	Part number	Part description	Found in bag
2	#0019	M3 Locknut	4F
2	#0064-1	M3X8 Button head bolts	4F
1	#125-26	Tank/battery plate	4F

Refer to drawing 4F

A) Install the #125-26 tank/battery plate with fuel fitting opening towards the left side of the model. Using two #0064-1 M3X10 socket bolts and two #0019 M3 locknuts. Tighten securely.

V. Building the lower plate and installing the landing gear

Step 1: Preparing the engine unit

Tools and materials required:
M2.0, 2.5, 3.0, 4.0 and 5.0 Allen wrench's
Electric drill
Dial indicator and mounting base
5.5mm open end wrench
3/32" drill bit
Slow CA adhesive
Masking tape
Engine...Zenoah 231H (recommended and sold separately)

Bags required: 5A and 5B

Parts required:

Qty	Part number	Part description	Found in bag
3	#0060-1	M3X6 Socket bolt	5B
1	#0051	M3X3 Socket set screw	5B
2	#0546-16	Clutch dampeners	5B
1	#105-7	Carburetor arm	5B
1	#0017-5	M6 Hex nut (thin)	5B
1	#125-45	Primary engine plate	5A
1	#125-28	Carburetor guard	5B
1	#125-70	Fan shroud plate	5A
1	#125-72	Fan shroud, upper section	5A
1	#125-74	Fan shroud, lower section	5A
1	#0579-5	Fan hub w/fan	5B

7	#0086-8	M5X10 Flat head socket bolts	5B
1	#0004.5	M6X16 Flat washer	5B
1	#0086-5	M6X15 Socket head bolt	5B
2	#0078-5	M4X10 Socket head bolts	5B
1	#0546-21	Fan assembly tool	5A
3	#0004	M4 Washers	5B
1	#125-10	RF Shield	5B
2	#4694	4" Tie wraps	5B
1	#0064-3	M3X6 Button head bolt	5B
2	#0032-1	M2.9X13 Phillips bolt	5B
2	#0078	M4X12 Socket head bolts	5B

Refer to drawing #5A, 5B, 5B-1, 5B-2

A) Remove the carburetor and the lower aluminum pull starter plate provided on the Zenoah 231H engine. The lower plate will no longer be used.

If you elect to use the standard Zenoah pull start system, the pull starter engagement key mounted on the base of the crankshaft must be removed. This is easily done by inserting an allen key into one of the threaded holes in the flywheel. Rotate the flywheel until it stops. Use pliers or a screwdriver and hammer to remove th engagement key. After removal, install one #105-24 M6 hex nut. Tighten securely using blue locktite. Re-install the engagement key using blue locktite.

B) Install the #105-7 carburetor arm onto the carburetor using one #0051 M3X3 socket set screw and one #0004 M4 washer. Follow the drawing provided for correct positioning. Install the #125-28 carburetor guard and carburetor onto the engine. Tighten the carburetor screws securely.

C) Install the #125-45 primary engine plate to the base of the engine using three #0086-8 M5X10 flat head bolts. Tighten securely using blue loctite. **Note: Carefully observe the mounting direction on the drawing.**

D) If you are using the stock muffler, remove it from the engine at this time. Cut approximately 30mm from the end of the exhaust tube. This provides clearance for the landing gear skid. **Note: The use of the Hatori gasoline muffler is highly recommended.**

E) Install the fan shroud mounting plate #125-70 using four #0086-8 M5X10 flat head bolts. Tighten securely using blue loctite.
F) Wipe the inside of the fan hub #0579-5 and the tapered end of the crankshaft to ensure that they are clean. A small amount of Triflow oil may be applied to the crankshaft and collets after cleaning to aid in the alignment process.

G) Despite accurate CNC milling, variations in aluminum material can result in the slight imbalance of some fan assemblies. It is suggested that the balance of the fan be checked prior to installation. The following guidelines are useful:

1) The use of a quality balancer in good condition like the “Hi-point” is suggested.
2) Special attention is required here to ensure the unit is centered.
3) If a heavy side is determined, use approximately a 3/16" to 1/4" (4.7 to 6.3mm) drill bit to make shallow “divots” on the bottom side of the fan. **-IMPORTANT**- ***Do not drill directly beneath a fin or through the material.***

Mount the fan hub #0579-5 to the crankshaft using one #0086-5 M6X16 socket bolt and one #0004-5 M6X16 flat washer. Tighten securely using blue loctite. **NOTE:** An allen wrench for the M6X15 bolt is provided in the engines tool bag. Use the fan assembling tool #0546-21 provided to hold the fan hub securely while tightening the crank bolt. Bolt the fan to the top side of the fan hub using two #0078 M4X12 socket head bolts, tighten the crank shaft bolt securely. Remove the fan assembly tool.

H) Examine the drawing for the correct orientation of each dampener within the fan hub. In each case, the side with the small 1.0mm “dimple” (adjacent to the large through hole) is to be upward facing, away from the engine. Apply talcum powder, alcohol or a little soapy water (do not use oil, grease or silicone) to the dampener and push it fully into the slot provided until even with the top surface. Repeat the process for the second dampener. When completed, add a little talcum powder to the hole in each dampener to make clutch insertion easier.

I) A #125-110 RF Shield has been provided for the spark plug wire. Tests have shown that the use of this shield will help to reduce the RF noise being emitted from the engines ignition system. If you elect to use this part, follow steps 1 through 5 below.
Note: For even greater RF shielding, Miniature Aircraft USA offers a 5K ohm resistor spark plug cap. Order P/N #115-112.

1) Remove existing rubber spark plug boot from the spark plug wire by firmly pulling the boot from the wire. Note that inside the boot there is a spring that makes contact with the spark plug and that this spring has one end that extends up into the portion of the boot where the spark plug wire resides. This end of the spring pierces through the insulation of the spark plug wire to make electrical contact with the conductor therein. When reassembling the spark plug wire into the spark plug boot, you must be certain to

align the spring end with the hole in the spark plug wire. If needed, use a small needle nose pliers to reshape the spring end to original condition in preparation for final assembly.

2) Remove the protective tube from inside the #125-110 RF shield. Insert the coil wire into the shield as shown, until the braid covers the spark plug up to the coil. Position the ring terminal so that it aligns with the mounting hole of the coil. **Note**: You must use the mounting hole that contains the brass sleeve. This is the electrical ground of the system. Slide one of the pieces of heat shrink tubing up to the coil as far as it will go and shrink in place. Re-enforce with one #4694 4" tie wrap.

3) The shield braid needs to cover the spark plug wire to within 1/4" of the hole in the spark plug wire. It is imperative that the shield braid cannot make electrical contact with the center conductor of the spark plug wire in any way. To adjust the length of the braid, lightly run your fingers down the braid starting at the coil in order to slightly stretch it and force conformal covering. If necessary, trim the braid with a small pair of wire cutters or scissors.

4) Re-install the spark plug boot making certain that the spring end goes back into the hole in the spark plug wire. The boot is very flexible and will allow for a great deal of stretching in order to accomplish this task.

5) Slide the remaining piece of heat shrink tubing up against the boot so that it fully covers the end of the braid and shrink in place. Secure with one #4694 4" tie wrap.

J) Assemble the upper and lower fan shroud sections #125-74 and #125-75 together using two #0032-1 M2.9X9.5 phillips bolts. Tighten securely. Mount the assembled fan shroud onto the previously mounted shroud plate using #0060-1 M3X6 socket bolts and one #0064-3 M3X6 button head S/S bolt. Refer to the drawing for proper locations. Tighten securely using blue loctite.

K) Mount the ignition coil (provided with the engine) to the carburetor side of the engine using two #0078-5 M4X10 socket head bolts and two #0004 M4 washers. If you have installed the #125-110 RF shield, attach the bolt lug under the #0078-5 bolt when mounting the coil. Tighten securely using blue loctite.

Step 2: Assembling the lower plate

Bags required: 5A and 5C

Parts required:

Qty	Part number	Part description	Found in bag
4	#0009	M3 Washers (small)	5C
16	#0003	M3 washers (large)	5C
10	#0019	M3 Locknut	5C
4	#0067	M3X14 Socket head bolts	5C
6	#0069	M3X16 Socket head bolts	5C
4	#0058-1	M4X6 Socket set screws	5C
2	#0075	M3X25 Socket head bolts	5C
2	#125-40	Aluminum ladder supports	5C
4	#3937-1	Skid plugs	5C
2	#3933	White struts	5A
2	#3937	Skids	5A
1	#125-43	Secondary engine plate	5A
1	#125-41	Graphite base plate	5A
4	#3923-1	Black strut spacers	5C
4	#0017-3	M4 Hex nuts	5C
4	#0078-6	M4X16 Tapered socket bolts	5C
4	#125-29	.300" Rubber spacers	5C
2	#0064-5	M3X25 Button head bolts	5C

Refer to drawings #5C, 5C-1, 5C-2 and 5C-3

A) Select twelve #0003 M3 washers, six #0019 M3 locknuts, six #0069 M3X16 socket head bolts, two #125-41 graphite base plates, one #125-43 secondary engine plate and the assembled engine unit from step 1. Note the proper direction for installing the secondary plate #125-43. Per the drawing, assemble the selected components, observing your pre-chosen engine direction (forward facing cylinder or rearward). At this time the engine must be able to slide forward or rearward on the bottom plate, loosely tighten the bolts and nuts to allow for this.

B) Attach the two #125-40 aluminum ladder supports to the base plates using four #0003 M3 washers and four #0067 M3X14 socket head bolts. Tighten until only very slight

movement can be felt in the ladder supports. Loctite will be added later. Check the drawing for proper orientation.

C) If you elected to use the Zenoah pull starter, assemble and trial fit the unit at this time. Select the pull starter from your Zenoah engine package, four #0017-3 M4 hex nuts, four #0078-6 M4X16 tapered bolts and four #125-29 .300" spacers. Assemble as shown using blue loctite until the thread of each bolt is flush with the hex nut. As per the drawing, install the pull starter onto the two plates, adjust the nuts and bolts until slight tension is felt when removed. Further trial fit may be done at the end of section V, step 3.

D) Bolt on two landing gear struts #3933 using two #0075 M3X25 socket head bolts, two #0064-5 M3X25 button head bolts, four #0009 M3 washers, four #3923-1 strut spacers and four #0019 M3 locknuts. The shorter #0064-5 bolts are used in the front strut. Before fully tightening, slide both #3937 skids into the struts. Tighten securely.

E) Remove each skid and select four #3937-1 skid caps. Install a skid cap into each end of each skid by applying a small amount of slow CA adhesive inside the skid a pressing the cap fully in place.

F) Examine the top of each strut in the area where the skid is inserted. Each will have an 8.0mm raised “boss” for the following procedure. Using the electric drill fitted with a 3/32" (2.35mm) bit, hold the drill so that it’s bit is perpendicular to and centered over the “boss”. Drill a hole down into the boss and just into the center of the skid passthrough. Now change to a 0.135" (3.42mm) drill bit and enlarge the hole. Repeat this process for the other three “bosses”. Thread one #0058-1 M4X6 socket set screw approximately half way into each of the drilled holes.

G) Select the skids #3937. To each skid, make a mark 9.5" (240mm) from the rear (straight) end of the skid (measure from the skid end, not the cap). Wrap a piece of tape around the skid just ahead (nearer the curved end) of this mark. With the model sitting atop a flat surface, slide each skid into the struts so that the front edge of the tape contacts the front skid. Straighten the skid ends (the curved part) so that they are vertical and perpendicular to the surface of the table. Keeping the model secured in this position, tighten all four of the #0058-1 Socket set screws down against the skids. Each skid should be secured within each of the struts.

Step 3: Mounting the assembled lower base

Bags required: 5D

Tools required:

Flat type feeler gauge (preferably two sets)

Parts required:

Qty	Part number	Part description	Found in bag
8	#0063	M3X10 Socket head bolts	5D
8	#0009	M3 Washers (small)	5D

Refer to drawing #5D, 5D-1 and 5D-2

A) Slide the pre-assembled upper frame unit down onto the assembled lower base unit. Align the clutch driver pins with the holes in the dampers already installed in the fan hub. Firmly press the two units together until the bolts may be installed through the main frames and into the ladder supports #125-40.

B) Install two #0009 M3 washers and two #0063 M3X10 socket head bolts through each frame into both sides of the two #125-40 ladder supports. Individually add blue loctite to the bottom screws previously installed in the bottom side of the ladder supports.

C) While pressing the main units together, tighten the following:

* All the #0063 socket head bolts in the top of each ladder support #125-40.
* The base bolts in the bottom of the ladder supports.

D) slightly snug the center bolt on each side of the engine units lower graphite plate. Both the plate on the engine and the main bottom plate should be flush to each other. If adjustment is needed, slightly tap the lower engine unit plate forward or rearward. Use a set of feeler gauges between the top of the fan hub and the bottom of the clutch driver to check that the two units are parallel to each other. **Note:** Two feeler gauges used simultaneously works very well. The gap will be approximately 0.020". If you are using two feeler gauges, leave them in place until all bolts have been tightened. Tighten the remaining four outer bolts at the engine base. Re-check with the feeler gauges. If the gap is not even, loosen the six bolts holding the base of the engine unit and readjust.

VI. Installing the fuel tank

Bags required: 6A

Tools and materials required:
Sharp knife or razor blade
1/8" and 3/16" Drill bit
5.5mm Open end wrench
Forceps

Parts required:

Qty	Part number	Part description	Found in bag
1	#125-24	Fuel tank	6A
1	#125-20	Inner fuel line	6A
1	#125-22	Filtered fuel clunk	6A
2	#0405	Fuel vents	6A
2	#0011	M5 Washer	6A
2	#0013	M5 Nut	6A
1	#0408	Fuel pick-up fitting	6A
1	#0409	90 Degree external tank fitting	6A
2	#4691	Tie wraps 17"	6A
1	#105-100	Main fuel line 31"	6A
2	#4346	“T” fitting	6A
1	#125-23	One way fuel valve	6A
1	#3869	Two sided tape	6A
2	#4348	Fuel line plug	6A

Refer to drawing 6A, 6A-1, 6B and 6B-1

A) The positions for mounting the fuel tank vary depending on the direction chosen for engine installation. Refer tot he drawing for the optional tank mountings. If a rearward engine direction was chosen, we suggest that the fuel tank be mounted in position No. 1. Position No. 2 is also a possibility but will require additional canopy trimming. Position No. 3 is for a forward mounted engine position.

B) A template has been provided for drilling the positions for mounting the overflow and air inlet fuel tank fittings. Drill the holes starting with a drill bit of approximately 1/8" diameter. Follow that with a 3/16" diameter drill bit. Carefully clean all debris from the holes and inside the fuel tank. Drill a similar size hole directly in the center of the fuel tank cap for mounting the fuel pickup (90 degree) fitting.

C) Select one #125-22 filtered fuel clunk, one #0408 fuel pick-up fitting, one #0409 ninety degree tank fitting and one #125-20 inner fuel tank line. Examine each component making

sure that all holes are clean and unobstructed. Select the #125-20 fuel line and press one end fully onto the nipple on the non-threaded end of the #0408 fuel pick-up fitting. Press the other end fully onto the #125-22 filtered fuel clunk. Do not shorten the fuel line, it is supposed to loop around the base of the fuel tank when installed.

D) Insert the prepared fuel pick-up tube, clunk and fitting out through the hole in the tank cap and secure with one #0409 ninety degree external tank fitting. Tighten securely making sure that the 90 degree fitting ends up pointing rearward. A 5.5mm hex is provided on the pick-up fitting to aid in tightening. Install the #0405 vent fittings in the top of the tank and secure them with two #0011 washers and two #0013 hex nuts.

E) Thoroughly blow out the inside of the tank to remove any debris and install the cap. Screw the cap in place with light pressure until it stops and then turn it 1/8 rotation further.

F) Cut the piece of two sided tape in half and remove the protective covering. Align the tank at the position chosen and press it firmly against the graphite plate. Install the #4691 17" tie wraps as shown, and cinch them down firmly to secure the tank position.

G) Select the #105-100 main fuel line. Note the following chart which indicates the length of fuel line needed for the various connections. Make all cuts with a sharp knife or razor blade.

Position #1

Fuel pick-up line	13" (330.2mm)
Fuel overflow line	11" (279.4mm)
Fuel return line	16.5" (419.1mm)

Position #2 and #3

Fuel pick-up line	4.5" (114.3mm)
Fuel over flow line	7" (177.8mm)
Fuel return line	13" (330.2mm)

Install the cut fuel lines in their appropriate positions. For fuel filling purposes, install one #4346 “T” fitting in the carburetor return line. Install a 1" (25mm) piece of fuel line onto the “T”. Press one #4348 plug into the end of the 1" line. This will be the filling port.

Install another ‘T” fitting #4346 and plug #4348 onto the end of the vent line. Followed by one #125-23 one-way fuel vent. Refer to the drawing for proper locations.

VII Installing the swashplate, washout unit and rotor head assembly

bags required: 9A

Tools and materials required:

M1.5 and 2.5 Allen tools
Medium phillips screwdriver
Small good quality pliers
Small flat screwdriver

Step 1: Assembling the swashplate

Parts required:

Qty	Part number	Part description	Found in bag
1	#0009	M3 Flat washer (small)	7A
4	#0051	M3X3 Socket set screws	7A
1	#0065	M3X12 Socket head bolt	7A
3	#0107	M3X6 Threaded balls	7A
4	#0109	M3X8 Threaded balls	7A
1	#0159	M3X7 Ball bearing	7A
1	#0217	Swashplate	7A
1	#0597-3	M3.0X4.75X4.6 Brass spacer	7A

Refer to drawing #7A

A) Select and examine the #0217 swashplate. Note the four M3 threaded holes at each 90 degree position about the base of the lower swashplate ring. Select four #0051 M3X3 socket set screws and prepare each with blue loctite. These four holes and set screws are for periodically minimizing any free play that may develop as the swashplate bearing wears (excessive free play can cause inaccuracies in control inputs). Install each set screw loosely. The adjustment procedure is to rotate the inner swashplate ring within the outer ring and adjust the set screw until a slightly irregular or “notchy” feeling occurs, then loosen the set screw just enough to return the assembly to smooth operation. Repeat the procedure for each set screw. In most cases, this procedure should be done after every 20 gallons of fuel. This procedure can easily be done on an assembled model by simply disconnecting the related ball links.

B) Examine the swashplate once again and note the positions for installation of the threaded balls into the inner ring. Four of the six threaded holes (those at each 90 degree position) are utilized. Three threaded holes (at 120 degree intervals) are utilized for three #0107 M3X6 threaded balls in the outer ring. Select four #0109 M3X8 threaded balls and three #0107 M3X6 threaded balls. Prepare each with blue loctite and install in each position previously

indicated.

C) Slide the swashplate down the main shaft. Rotate it so that one outer control ball is pointed rearward and the remaining two balls are pointing forward at an angle on each side of the mechanics. This orientation will align one empty threaded hole straight forward at the #0874-1 anti-rotation unit.

D) Select one #0009 M3 flat washer, one #0065 M3X12 socket head bolt, one #0159 M3X7 ball bearing and one #0597-3 M3 brass spacer. Slide everything with a hole onto the #0065 bolt beginning with the ball bearing, followed by the brass spacer and finally the washer. Apply a small amount of blue locktite to the exposed threads of the bolt, insert the assembly through the #0874-1 anti-rotation unit and then into the swashplate and tighten securely. The swashplate should now be free to slide on the main shaft without rotating.

Step 2: Assembling the washout unit

parts required:

Qty	Part number	Part description	Found in bag
1	#0057	M3X3 Socket set screw	7B
2	#0097	M3X22 Special phillips 12.9 hard bolt	7B
2	#0107	M3X6 Threaded ball	7B
4	#0159	M3X7 Ball bearings	7B
1	#0219	Plastic washout hub	7B
2	#0221	Washout arm	7B
2	#0597-2	M3X3.4 Brass spacer	7B
1	#0840-6	M3X20 Dowel pin	7B
2	#0869	Washout ball links	7B
2	#106-07	M2X16 Pivot pins	7B
5	#106-08	M2 Circlips	7B

Refer to drawing #7A and 7A-1

A) Select two #0107 M3X6 threaded balls, two #0597-2 brass spacers, four #0159 m3x7 ball bearings and two #0221 washout arms. Examine the drawing and note the position for the #0107 threaded ball on each arm. Apply a small amount of slow CA adhesive to the threads

of each ball and install one ball in each arm as shown. Press one ball bearing into each arm (noting that when fully inserted, each will protrude approximately 0.75mm) and install one #0597-1 brass spacer in the opposite side of the arm against the bearing. Follow this with another bearing thus capturing the spacer between the two bearings.

B) Select two #0097 special phillips bolts and one #0219 washout hub. Examine the drawing and note the orientation of each washout to the hub. Install each arm onto the hub using a #0097 special phillips bolt. Tighten each until a slight drag is felt when rotating each arm, then loosen the bolts about one quarter turn. Each arm should pivot freely without any end play.

C) Select two #0869 washout ball links, two #106-07 M2X16 pivot pins and four #106-08 M2 circlips (a spare is also included).
Note: The #106-08 circlips are most easily installed on the #106-07 pivot pins by the following method: Lay the circlip on a flat surface. Hold the #0106-07 pivot pin with a pair of pliers, while aligning one end of the pivot pin vertically on top of the circlip. Using a small hammer, tap the pin into the circlip. This will start the circlip onto the pivot pin. Drill a small hole just a little bigger than the pivot pin into a piece of hard wood. Align the pivot pin/circlip over the hole and slightly tap the pin again. This will drive the pin through the circlip. Repeat on the opposite end of the pivot pin after the #0869 links and the #106-05 arms have been joined together. The washout links #0869 should have no end play and pivot freely. If they do not pivot freely, slide an X-acto knife or razor blade around the pin, in between the plastic link and the washout arm. This will remove any plastic burrs.
D) Slide the assembled washout unit down onto the main shaft and snap the two #0869 washout links onto any two opposite #0109 threaded balls on the inner ring of the swashplate. The washout unit should slide freely on the main shaft. If there is drag, slightly polish the main shaft or the inside of the washout hub #0219.

E) Select the previously assembled rotor head, the #0057 M4X4 socket set screw and the #0840-6 dowel pin. Slide the rotor head down onto the main shaft and align the cross hole at the upper end of the main shaft with the hole in the head block just below the flybar pivot bearings (Note: the larger of the two holes in the head block is for dowel insertion and the smaller hole is for pushing the pin back out using a 1.5mm allen tool). Alignment can be accomplished by holding the rotor head while rotating the main gear clockwise and viewing the holes from the side at eye level.

Important precaution: There have been instances where builders thought they had all the holes aligned but the main shaft was actually fully beneath the head block holes. To avoid this, it is helpful to confirm the alignment by simply inserting a 2.0 or 2.5mm allen tool in place of the dowel pin and lifting the model by the rotor head. It pays to be cautious.

If the dowel pin will not fully insert through the main shaft with moderate pressure, rotate the head 180 degrees upon the main shaft and repeat. The dowel pin is always to be installed

with the “chamfered end” first. Once the dowel pin is properly fitted, secure it with the #0057 M4X4 set screw and a small amount of blue loctite. Apply blue loctite sparingly and only to the set screw to avoid contacting the dowel pin and making later servicing more difficult. Next, tighten the previously installed #0067 M3X14 socket head bolts clamping the base of the head block about the main shaft, being sure to use blue loctite only on the screws themselves.

VIII. BUILDING THE TAIL ROTOR ASSEMBLY

Bags required: 8A, 8B and 8C

Tools and materials required:

M1.5 Allen tool
Ratchet wrench or small breaker bar
Thin walled M7.0 (9/32" to 5/16") Socket
Small hammer
Small phillips screwdriver
Small straight screwdriver

Step 1: Assembling the tail rotor hub and blade holders

Parts required:

Qty	Part number	Part description	Found in bag
2	#0019	M3 Locknuts	8A
2	#0021	M4 Locknuts	8A
2	#0097	M3X22 Phillips machine bolts	8A
2	#0446-4	M4X0.003" Shim washer	8A
2	#0457	Thrust bearing (3 pieces)	8A
2	#0873-1	Tail blade mounts	8A
2	#120-39	M5X4X10 Ball bearings	8A
2	#115-68	105mm Tail blades	8A
1	#122-65	Steel tail rotor hub	8A

Refer to drawing #8A and 8A-1

A) Select two #120-39 M5X4X10 ball bearings and two #0873-1 tail blade mounts. Press one bearing into each tail blade mount towards the control arm side. The bearing should be flush with the outer surface of the tail blade mount.

B) Select two #0457 thrust bearings. Each is made up of a ball cage (with balls) and two grooved outer races. This assembly will only function when arranged properly within the blade mount. Examine each grooved outer race and determine which one has the larger inside diameter (a simple test is to slide each onto the #122-65 steel tail rotor hub and select the one that fits loosely). This race will be the first part of the thrust bearing installed into the tail rotor blade mounts. Using a socket or wooden dowel that will fit into the tail rotor blade mount, install the larger I.D. thrust bearing race (grooved side facing outwards) into the #0873-1 tail rotor blade mount. Use light pressure until fully seated. Repeat with the other thrust bearing race and blade mount. Next apply grease (a small amount will do) to the cupped side of the ball cage and the grooved side of the outer bearing race (small I.D. race).

IMPORTANT:
Thoroughly remove any excess grease from the center I.D. hole in the ball cage and the outer bearing race. This is to ensure that no grease smears onto the threads of the #122-65 tail rotor hub. With the forked end of the tail rotor blade grips facing upwards, install the bearing cage (cupped side facing down) followed by the outer race (grooved side facing down) on top of the previously installed inner bearing race. Again, look for any grease residue in the I.D. openings.

C) Select the #122-65 steel tail rotor hub, one #0873-1 tail rotor blade mount, one #0446-4 M4 shim washer, one #0021 M4 locknut and a thin walled 7mm socket or nut driver. While holding the tail rotor hub in a vertical position, slide one of the #0873-1 tail rotor blade mount assemblies onto the tail rotor hub, followed by one #0446-4 .003" shim washer. Using a small screwdriver or toothpick, apply green loctite to the threaded portion of the #0021 M4 locknut. Install the locknut using a thin walled 7mm socket wrench onto the threaded portion of the tail rotor hub. Select any tool that will insert into the tail rotor hub center hole to stop rotation. Tighten the #0021 M4 locknut until a slight amount of tension is felt on the tail rotor blade grip while rotating. Slightly back off the M4 locknut until the tail rotor blade grip rotates freely with little or no end play. Repeat the process for the opposite tail rotor blade mount. Adjust the end play to match the first blade mount installed.

D) **NOTE:** The opportunity exists, at the time, to balance the hub assembly. If a very thin coat of grease was applied to the thrust bearings, then balancing can be done at this time. If, however, you used more grease than suggested, we recommend waiting until one flight is complete since the excess grease will no longer be a factor in the balancing process. Balancing the assembly is ***highly recommended.***

The following will describe the process. If a balancer is not available, obtain a 5mm shaft (such as a tail rotor output shaft) and a large glass with a smooth top rim of at least 90mm

(3.5") in diameter. Use the shaft as a pivot point by inserting it into the hub and sliding the hub to the center. The shaft will then sit atop the glass allowing the hub assembly to pivot freely. The proper balance method is called a “four point balance”. Two steps are involved. At first, no blades will be installed on the assembly, just the #0097 bolts and #0019 locknuts. Always orient the blade mounts with the threaded control arms in opposite directions (as they would be on the model). First, rotate the unit atop the glass so that the tips of each blade mount point at the 6 and 12 O’clock positions. Releasing them in this position should result in the assembly remaining vertical. Second, rotate the assembly until it is at the 3 and 9 O’clock positions. If the assembly will not remain at the 3/9 O’clock position, then you can select a shim or washer and install it under the blade pivot bolt in the blade mount. It may be necessary to trim the washer to adjust it’s weight. Select two #115-68 tail rotor blades. Install each blade oriented as shown in drawing 8A, noting that each leading edge corresponds to a pitch arm control ball on each blade mount. Temporarily tighten each blade so that they will not pivot easily during handling. Rotate each blade so that the leading edges can be simultaneously pressed against a straight edge (table top) while pulling out firmly. This will approximate the flying position of the blades. Set the assembly (with the 5mm shaft still temporarily installed) atop two glasses on a level table top (or suitable blade balancer) and observe which, if any, blade appears heavier. Balance can be achieved easily by either adding a small piece of tape to the lighter blade tip or trimming a little plastic from the heavy blade tip. Loosen each blade pivot bolt until the blades will pivot freely (but not by their own weight alone). Remove the 5mm shaft.

Step 2: Assembling the pitch slider

Parts required:

Qty	Part number	Part description	Found in bag
2	#0015	M2 Hex nut	8B
1	#0101	M2X5 Threaded ball	8B
2	#0049	M2X10 Socket head bolt	8B
1	#0435	Tail rotor pitch slider (brass)	8B
2	#0443	M6 Retaining ring	8B
2	#0859-16	Pitch links w/bearings	8B
1	#120-14	Tail rotor pitch yoke	8B
2	#0439	Ball bearings	8B
1	#0437	Plastic pitch ring	8B

Refer to drawing: 8B

A) Select one #0101 M2X5 threaded ball an one #0437 plastic pitch ring. Install the threaded ball into the plastic pitch ring using a small amount of slow CA adhesive on the threads of the ball. Do not over tighten.

B) Select two #0439 ball bearings. Place each on a clean surface, “ball” side up and add grease. Press one into each side of the #0437 pitch ring so that the ball side faces inward.

C) Select the #0435 tail rotor pitch slider. Examine the previously prepared #0437 plastic pitch ring. The “boss” which supports the #0101 threaded ball has one side that is rounded. This rounded side will face the flange at the end of the #0435 tail rotor pitch slider. Slide the #0437 plastic pitch ring fully up to the flange of the tail rotor pitch slider.

D) Select the #120-14 tail rotor pitch yoke. Examine the drawing and note that the angled parts face away from the plastic pitch ring. Slide the tail rotor pitch yoke onto the tail rotor pitch slider up to the previously installed plastic pitch ring.

E) Select two #0443 M6 retaining rings. They are “cupped”, and this “cupped” side will face away from the pitch yoke. Stand the pitch slider/ring/yoke assembly upright on the flange of the slider. Position one of the #0443 retaining rings over the exposed end of the pitch slider. Use a small hammer and a 7.0mm (9/32" to 5/16") socket to cautiously tap the retaining ring downward to meet the pitch yoke assembly. The desired effect is that the components of the pitch slider have no end play and the pitch ring freely rotates with no binding of the ball bearings. If you go too far with the retainer, place a small piece of hardwood or plastic across the exposed end of the brass pitch slider, support the pitch yoke near it’s ends and tap the wood very lightly with a small hammer or tool handle. The retaining ring should move enough to relieve the bearings. Be very careful not to distort the pitch slider at the end. Orient the second retaining ring such that the prongs fall in between the first ring. Apply a small amount of slow CA adhesive in the “cupped” area of the retaining ring to lock it in place.

F) Examine the pitch yoke #120-14 noting that one side of each arm has a molded cavity which accepts an M2 hex nut. Press #0015 M2 hex nut into each arm. The opposite side of the arm will be used for mounting the #0859-16 pitch links. Mount each pitch link by inserting one #0049 M2X10 socket head bolt through the flange side of one of the bearings in the pivot then through the pitch yoke arm #120-14. As described, use a small amount of blue loctite inside the threads of the M2 hex nuts. Tighten securely. **Note:** When properly assembled, each pitch link plate will be “captured” between the bearing flange and the mounting surface. This is important as a security if any bearing would fail. The same is true for the later connection to each tail blade grip.

Step 3: Final assembly of the tail rotor gearbox

Tools and materials required:

1.5 and 2.5mm allen tools
Blue loctite

Parts required:

Qty	Part number	Part description	Found in bag
1	#123-75A	Assembled gearbox housing	8C
2	#0049	M2X10 Socket head bolt	8C
2	#0056	M3X5 Dog point set screw	8C
1	#0097	M3X22 Phillips machine bolt	8C
2	#0159	M3X7 ball bearing	8C
1	#0445	Tail rotor bellcrank	8C
1	#0597-3	M3X4.6 Brass spacer	8C
1	#0015	M2 Hex nut	8C
1	#0019-1	M3 Locknut (thin type)	8C
1	#0103	M2X5 Threaded ball	8C

Refer to drawings #8C and 8C-1

A) Select one #0597-3 brass spacer, two #0159 M3X7 ball bearings and one #0445 tail rotor bellcrank. Press one bearing into one side of the bellcrank. Insert one #0597-3 brass spacer in the opposite side followed by another #0159 ball bearing. Each will protrude approximately 0.75mm when fully inserted. Select one #0103 threaded ball and one #0015 M2 hex nut. Examine the drawing and note which side of the bellcrank is the top and note that there are three control ball mounting holes to select from. This kit will utilize the center hole. From the bottom of the bellcrank, insert the #0103 threaded ball into the center hole of the bellcrank. From the top of the bellcrank, assemble one #0015 M2 hex nut onto the slotted screw, using blue loctite. Select the previously assembled pitch slider from step 2 and one #0097 M3X22 special phillips bolt. Slide the pitch slider assembly onto the output shaft with it's control ball pointing downward. Press this control ball into the hole provided in the top of the tail rotor bellcrank and position the bearings of the bellcrank directly under the mounting hole in the #123-84 bellcrank support. Select one M3X22 special phillips bolt and insert it through the bearings in the bellcrank from the bottom side of the bellcrank and thread into the #123-84 bellcrank support. Adjust the tightness of this bolt until the bellcrank has no vertical free play and yet pivots smoothly. From the opposite side of #0097 bolt, install one #0019-1 M3 thin

locknut onto the threaded portion of the #0097 bolt protruding out of the #123-84 support arm. Tighten up against the end of the pivot bolt. This acts as a safety, locking the #0097 special phillips bolt into position.

B) Select the pre-assembled tail rotor hub assembly. Examine the drawings and note the orientation of the hub, blade mounts and gearbox. For further clarity, hold the hub assembly and view it as though you were looking directly at the 5mm diameter through hole (the output shaft hole). Position the blade mounts so that they point to the 3 and 9 o'clock positions. The correct view should show a blade holder to your left (9 o'clock) having it's control arm pointing up while the blade mount to the right (3 o'clock) should have it's control arm pointing down. **Note:** for future reference, considering the view you now see, the tail rotor blade for the "left blade mount" would have it's leading edge pointing upward and the blade for the "right blade mount" would have it's leading edge pointing downward. Slide the hub assembly onto the output shaft, aligning the M3 threaded holes in the hub with the M2 countersunk holes in the shaft. Select two #0056 M3X5 "dog point" socket set screws. The term "dog point" refers to the 2mm protrusion at the end. This will directly engage the 2mm diameter holes in the output shaft. Prepare each with blue loctite and install into the hub and through to the holes in the output shaft. Tighten each simultaneously a little at a time until fully tight. **Note:** recheck the tightness periodically with the previously mentioned method in mind.

C) Connect the two pitch pivots #0859-16 to the hole in the arm of the T/R blade mounts using two M2X10 socket head bolts #0049. Use slow CA adhesive on the tip of the bolt, taking care not to let any get into the bearings. Tighten securely.

Note: For future replacement of the delrin tail gears, we highly recommend the purchase of our #0555 roll pin application tool.

IX. BUILDING THE TAIL BOOM ASSEMBLY, BOOM SUPPORTS AND INSTALLATION ONTO THE MAIN MECHANICS

Bags required: 9A, 9B, 9C and 9D

Tools and materials required:

- 1.5 and 2.5mm Allen tools
- 5.5mm (7/32") Flat wrench
- Small pliers
- Small straight blade screwdriver
- Small phillips screwdriver
- Hand drill with 1.3mm (.055") drill bit
- Heat gun
- "J-B Weld" epoxy adhesive
- Small piece of 180 to 220 grit sandpaper

Light oil or “Vaseline” petroleum jelly

Step 1: Installing the tube drive and push rod guides

Qty	Part number	Part description	Found in bag
2	#0003	M3 Washer (large)	9B
2	#0009	M3 Washer (small)	9B
4	#0015	M2 Hex nut	9B
4	#0016	M2.5 Serrated lock washer	9B
5	#0019	M3 Lock nut	9B
2	#0027	M2.2X9.5 Phillips screw	9B
2	#0032	M2.9X9.5 Phillips screw	9B
2	#0043	M2X10 Slotted bolt	9B
2	#0044	M2X12 Slotted bolt	9B
2	#0061	M3X8 Socket head bolt	9B
8	#0063	M3X10 Socket head bolt	9B
1	#0065	M3X12 Socket head bolt	9B
4	#0077	M3X30 Socket head bolt	9B
2	#0186	Front tail boom clamp halves	9B
2	#0477	Push rod guide supports	9B
1	#125-78	Graphite horizontal fin	9A
1	#125-76	Graphite vertical fin	9A
2	#0800-5	O-rings	9B
2	#0868-5	push rod guides	9B
1	#0870-2	Horizontal fin mount W/4mm holes	9B
1	#0867-15	Torque tube	9A
8	#0017	M3 Hex nuts	9B
1	#123-88	gear case alignment shim	9B

1	#123-86	Rear transmission clamp (A & B)	9B
1	#120-15	33" metal tail boom	9A

Refer to drawing #9A, 9A-1, 9A-2 and 9A-3

A) Select the #0867-15 heavy duty torque tube assembly. The ball bearings at the center are surrounded by plastic housings which require the addition of two O-rings #0800-5. Select and install these O-rings. Apply a light coat of oil or Vaseline lubricant to the O-rings and slide the torque tube assembly into the tail boom #120-15.

B) Slide one #0870-2 horizontal fin mount onto the rear of the torque tube, this is the end with the two 3mm holes 180 degrees apart from each other. Position the fin mount approximately 175mm from the end. Install one #0065 M3X12 socket bolt, two #0003 M3 washers and one #0019 M3 locknuts into the bottom holes of the #0870-2 fin. Do not fully tighten.

C) Select two #0016 M2.5 “toothed” lock washer, four #0015 M2 hex nuts, two #0043 M2X10 slotted machine screws, two #0477 push rod guide supports, two #0044 M2X12 slotted machine screws and two #0868-5 push rod guides. Wrap the #0477 support around the boom as shown in the drawing and install one #0043 screw from above and a #0015 hex nut from below. Tighten only enough so that adjustment is still possible. Slide one support to a position approximately 285mm from the forward end (towards the canopy) of the tail boom and the second support approximately 295mm from the rear edge of the first support.

Install one #0868-5 push rod guide, one #0016 lock washer, one #0015 hex nut and one #0044 M2X12 slotted screw into the horizontal hole within each of the #0477 push rod guide supports.

D) Select four #0017 M3 hex nuts, four #0063 M3X10 socket head bolts and one set of #123-86 tail transmission clamps. Examine the tail boom noting the two holes positioned 180 degrees apart from each other. Each clamp half has a corresponding cross hole that must align with the holes in the tail boom. Press four #0017 M3 nuts into the recessed nut cavities in the clamp side “A”. Temporarily insert an M3 bolt into the raised cross hole in the clamp half and install onto the left side of the tail boom. Insert the M3 bolt into the corresponding hole in the tail boom. Position clamp half “B” onto the right side of the tail boom. Again, temporarily insert an M3 bolt through the clamp and into the boom. Secure the two clamp halves “A & B” together using four #0063 M3X10 socket head bolts. Only tighten until the clamp halves exhibit no play on the tail boom. Remove the two M3 bolts from the raised portion of each clamp half. A very slight amount of the tail boom will protrude out of the clamp, approximately 0.013".

E) Apply a small amount of grease to the torque tube drive end. Position the #123-88

gearbox alignment shim onto the end of the tail boom and simultaneously press the gearbox fully into the tail boom so as to completely engage the clamp. Rotate the gearbox until the two cross holes in the clamp halves align with the threaded holes in the gearbox. A 2mm allen wrench may be inserted through the tail clamp to aid in the alignment process. Lightly thread a #0061 socket head bolt into the holes to check the alignment. Be careful not to cross thread the bolt in the gearbox, reposition the clamp if needed. Remove the bolt. Select two #0061 M3X8 socket head bolts and install one #0009 M3 flat washer followed by one #0016 M2.5 serrated lock washer on each bolt. Install each bolt assembly into the boom clamp and the rear transmission. Do not fully tighten.

F) Secure the rear transmission to the rear clamp using four #0063 M3X10 socket head bolts and four #0017 M3 hex nuts. Use blue loctite on each bolt. Do not fully tighten.

G) Tighten the rear assembly in the following sequence:
* Tighten the four bolts holding the two clamp halves together using blue loctite.
* Tighten the four bolts holding the gearbox to the clamp.
* Tighten the two side through bolts.
* Do not tighten anything so much that the rear clamp becomes distorted.

H) Select two #0027 M2.2X9.5 phillips self tapping screws, two #0032 M2.9X9.5 phillips self tapping screws and one #125-78 horizontal fin. Install the horizontal fin atop the #0870-2 horizontal fin mount with two #0027 screws. Install the #125-76 vertical fin onto the #123-86 gearbox clamp using two #0032 screws.

I) Select four #0019 M3 lock nuts, four #0077 M3X30 socket head bolts and two #0186 front tail boom clamp halves. Examine the drawing and note the hardware securing the front tail boom clamp halves to the main frame. Leave all bolts loose.

J) Apply a small amount of grease to the torque tube drive end. Install the tail boom into the #0186 clamps. Hold the main gear while rotating the tail rotor hub and apply forward pressure on the tail boom assembly. After less than one rotation, the tail boom assembly should move further forward Verify that the toque tube universal joints are properly engaged). Push the tail boom as far forward as possible. **DO NOT PULL BACK ON THE TAIL BOOM. THE STOPS MOLDED IN THE BOOM CLAMPS ARE DESIGNED TO ALLOW FREE PLAY IN THE TORQUE TUBE.** Lightly tighten all four mounting bolts. View the model straight from the rear and rotate the boom as needed to ensure that the gearbox output shaft appears perpendicular to the main shaft. Apply slight pressure forward on the tail boom while tightening all four boom clamp bolts.

Step 2. Installing the tail boom supports

Parts required:

Qty	Part number	Part description	Found in bag
6	#0004	M4 Washer	9C
2	#0021	M4 Lock nuts	9C
4	#0048	M3.5X25 Socket set screw	9C
2	#0081	M4X16 Socket head bolts	9C
4	#0872-7	Molded “ball & socket” end... M4 hole	9C
2	#0872-9	Graphite tubes	9A
2	#0087	M4X20 Socket head bolts	9C

Refer to drawing #9B

A) Select four #0048 M3.5X25 socket set screws and two #0872-9 graphite tubes. Clean each set screw thoroughly with alcohol or laquer thinner. Use a cotton swab (Q-tip) to clean inside each end of each carbon tube. Roll a small piece of 180 to 220 grit sandpaper into a small tube and use it to roughen the inside surface of each end of each tube.

Select four #0872-7 molded boom support ends. Each has a 6.3mm diameter hole in the end followed by a 3mm hole set approximately 10mm deeper. Install a #0048 set screw from above into each 3mm hole so that approximately 7.5 to 8.5mm is exposed past the end of the molded boom support end.

Examine the “ball and socket” end of the #0872-7 molded boom support ends. The factory installed ball has a molded “boss” of approximately 6.3mm diameter on either side of the ball. One side of the “boss” protrudes 1mm while the other is 1.5mm. The 1.5mm thick side should always face the mounting surface to which the tail boom brace will be fastened. This is of particular importance at the front mounting positions.

B) Select two #0087 M4X20 socket head bolts, four #0004 M4 washers and two #0021 M4 lock nuts. As per the drawing, install two #0872-7 molded ends from step “A” using the hardware provided. Tighten securely.

C) Select the #0872-9 graphite tubes and the two remaining prepared molded boom support ends from step “A”. Note the 1.5mm hole on each boom support end. During proper assembly, a small amount of glue will exit this hole.

Graphite tubes can be bonded with “J-B Weld” epoxy or similar slow curing epoxies or even slow CA adhesives. The epoxies will allow much more time for positioning during assembly steps while the slow CA adhesive will allow only a minimal amount of working time...be

prepared if you choose CA adhesives.

D) Apply a liberal amount of your chosen adhesive to the threads exposed on the brace end and inside the graphite tube end. Insert one tube into one brace end until it stops (about 9.5 to 10mm) and secure it from moving while the glue sets. Repeat for the remaining brace.

E) Select two #0004 M4 flat washers, two #0081 M3X16 special phillips bolts and the two prepared graphite tubes from the previous step. It is suggested that both braces be aligned and fitted prior to final gluing. Install one washer on one #0081 bolt and insert into one brace end. With the graphite tube pointing forward, temporarily thread the bolt and brace into one of the molded holes on either side of the horizontal fin mount. Repeat the process for the remaining brace on the opposite side of the fin mount.

F) Align the brace ends attached to the lower plate with both graphite tubes and slide the horizontal fin mount forward until the graphite tubes insert into the holes in the front brace ends. Check to see that everything sits naturally without any binding. Level the horizontal fin and tighten the bolt on the bottom of the fin mount.

G) Remove both side bolts that secure the rear of each brace to the horizontal fin mount. Stand the model vertically on it's radio tray (easiest in a corner of the room or between your knees while in a seated position). For each brace/graphite tube, prepare the open end of the tube and the threaded part of the brace end on the main mechanics with the glue of your choice. Insert the tube fully into the end and align the rear with the horizontal fin mount and re-install the bolt. Repeat the procedure for the opposite side and keep the model vertical until the glue dries. This procedure assures that the tail boom and braces sit straight and without any pre-load induced from their own weight.

Step 3: Installing the graphite tail rotor push rod

Parts required:

Qty	Part number	Part description	Found in bag
2	#0133-1	Special ball link	9D
2	#0868-4	Heat shrinkable teflon tubes	9D
2	#0868-7	M3X60 Threaded stud	9D
1	#0868-11	Graphite pushrod 31"	9A

Refer to drawing: 9C

A) Select two #0868-7 threaded studs. Clean each with alcohol or laquer thinner. Each stud is to be installed into the graphite tube to a depth of 20mm. Select the #0868-10 graphite

pushrod. Prepare each stud by applying J-B Weld epoxy (or similar slow curing epoxy or thick CA adhesive) and insert each into the tube to the correct depth. Set aside to dry or apply mild heat from a hair dryer (epoxies only).

B) Select one #0133-1 special ball link and two #0868-4 teflon shrink tubes. Slide each teflon tube onto the graphite tube (final positions to be determined later) and thread the ball link onto the threaded stud of the graphite tube, concealing about 7.0mm of the threads. From behind the tail rotor gearbox, slide the graphite pushrod assembly (leading with the threaded end which has no ball link installed) through each previously installed pushrod guide. Select the remaining #0133-1 special ball link and thread it onto the pushrod to a depth of about 7mm. Connect one link to the front bellcrank and the other to the rear bellcrank. Temporarily slide each teflon tube to the ends of the graphite tube so they do not interfere with final adjustment. Adjust each ball link until the front bellcrank is vertical and the rear bellcrank is parallel with the rear of the tail rotor transmission case.

C) Manually operate the pushrod and make preliminary adjustments to each guide so that it operates freely and is approximately centered within each guide. Tighten each #0868-5 pushrod guide and #0477 guide support. Slide the teflon tubes into position within each guide so that complete operation of the pushrod does not surpass the length of either teflon tube. Mark the position of each and disconnect both ball links so that the pushrod and teflon tubes can be moved away from each guide. Use a heat gun to shrink each teflon tube and reinstall the pushrod in it's proper location.

X. INSTALLING THE RADIO SYSTEM AND PUSHRODS

Bags required: 10A through 10G

Tools and materials required:
- Small phillips screwdriver
- 1.5mm allen tool
- Small pliers or forceps
- 4 Large heavy duty servo wheels or arms
  - (J.R. super servo horn set-purchased separately)
  - (Futaba-45mm diameter wheel-standard with servos)
- Thick, two sided foam tape
- Slow CA adhesive or epoxy

Step 1. Installing the radio system

Parts required:

Qty	Part number	Part description	Found in bag

16	#0038	M2.5X10 Phillips machine screws	10A
1	#106-22	Rubber grommet (large)	10A
1	#115-94	Rubber grommet (medium)	10A
2	#125-48	Rubber grommet (small)	10A
4	#0575-3	8.0X9.0X20.0mm Plastic block	10A
4	#0037	M2.5X25 Phillips bolt	10A
1	#115-30	Red velcro 34"	10A
3	#0389	Wire retainer (small)	10A
2	#0390	Wire retainer (large)	10A
2	#0044	M2X12 Slotted screws	10A
2	#0065	M3X12 Socket head bolt	10A

Refer to drawings #10A, #10A-1 and #10A-2

A) All servos (except throttle) mount using #0038 M2.5X10 phillips machine screws into threaded steel inserts (factory installed “PEM” nuts) in the side frames. The throttle servo will use four #0575-3 plastic blocks under the servo mounting ears with four #0037 M2.5X25 phillips machine screws. All servos mount to the outside surface of the side frames with the exception of the upper most servo, which mounts to the inside of the right main frame. Each should be installed using blue loctite. The bolt spacing for each servo has been selected to allow the installation of all popular servos with minor deflection of the servo’s rubber grommets and bushings. The following table will indicate the servo number, frame position, receiver connection and model connection:

Servo number	**Frame position**	**Receiver connection**	**Model connection**
1	Top of right frame, servo spline facing rearward	Elevator	Rear bell crank
2	Second from top of left frame, servo spline facing forward	Aileron	Left front bell crank

3	Third from top of right main frame spline facing forward	Pitch	Right front bell crank
4	Fourth from top of left main frame spline facing rearward	Rudder	Rudder bell crank
5	Throttle plate #125-30 spline facing motor	Throttle	Carburetor

Examine the drawings to be sure each servo is in the correct front/rear position.

B) Select your battery pack (1800mAHr or greater). Apply two strips of thick foam tape to the battery pack. The location of the battery pack may be varied depending upon the location of the fuel tank. If the fuel tank is mounted on the bottom plate next to the motor unit, the battery may be mounted either on the bottom rear or the top front side of the front plate #125-26. The following are recommended, keep in mind that this can vary if need to correct CG:

* Rearward facing motor—battery on front top side of the 125-26 plate.
* Forward facing motor—Battery on rear bottom side of the 125-26 plate. (Tank in rear)

Fasten the battery so that it is evenly spaced in it's chosen location. Install the red velcro around the battery so that it is held firmly. Cut the velcro to allow a 1 inch (25mm) overlap.

C) Repeat the same procedure with the receiver, matching the thick foam tape with the right frame inside upper opening in the left main frame. Install one rubber grommet #106-22 into the 0.25" hole located on the right main frame just behind the receiver position. Install an additional #115-94 rubber grommet into the hole provided in the #125-26 plate. Route the antenna wire through these grommets. Do not bundle the antenna wire with itself or any other wires. Keep the wire away from other electronics or any graphite edges. Fuel line serves as an excellent protection against sharp graphite edges. If using a full length antenna, use a piece of tubing small enough to run the antenna wire through. This may then be secured to the landing gear struts near the skids, allowing the antenna to point rearward. If using a whip antenna, attach the base of the antenna to the front plate or the bottom side of the bottom plate pointing forward.

If you have chosen to use a governor unit and a gyro unit that both have amplifier box's, mount the amplifiers in the following positions:

* Governor amp just below the receiver on the inside of the right main frame using thick foam tape.
* Gyro amp mounted opposite the receiver on the outside of the right main frame using thick foam tape.

Install the red velcro around the receiver and amplifier box's.

D) Install the gyro sensor onto the gyro shelf being sure to follow the instructions included with the unit.

E) Install the switch on to the upper front side of the #125-41 bottom plate as shown. Install two #125-48 rubber grommets between the main switch body and the graphite plate and secure using the longer screws provided (#0043 or #0063). Take care to center the switch so there can be no contact in either the "on" or "off" position with the graphite plate.

F) It may be necessary to use a servo extension lead on both the throttle servo and the switch harness. Make all necessary servo, gyro and switch connections in an orderly manner, routing wires to avoid contact with frame edges and moving parts. Use the #0389 (single servo wire) and #0390 (dual servo wire and/or gyro wire) wire retainers to secure the wiring. These items will press onto the head of any M3 socket head bolt. The bolts retaining the upper most #115-20 hex frame spacer are ideal positions to install #0389 for servos #1 and #2. Bolts retaining the gyro mounting brackets are suitable positions for #0390 retainers.

Step 2: basic radio programming

Preliminary adjustments must be made to the radio before installing servo arms (wheels) and pushrods. Typical settings are listed for popular radios.

J.R. X8310/PCM 10 series
Select swash type function 65.
Select 120 C.C.P.M. function.
Retain all "default" C.C.P.M. settings of 60%.
Set aileron, elevator and pitch ATV's to 100%.

Futaba 8UHP/9CH/9ZH
Select SR3 swash type in model menu.
Retain "default" settings of 60% for aileron, elevator and pitch.
Set aileron, elevator and pitch ATV's to 100%.

Note: Do not adjust ATV for any trimming or setup changes. Use only AFR or SWH menus for trimming adjustments.

Step 3: Installing servo arms (wheels) and pushrods

Note: Servos #1 through #4 require large servo output positions. For J.R., use the heavy duty J.R. super servo arms (available as an option from J.R. in a package of five) in the outer hole (20.0mm from the center screw). For Futaba, use the large 45.0mm diameter wheel (included with all Futaba servos) in the outer hole (19.5mm from the center screw).

All servos must be in the "neutral" position, i.e. the half way point in their travel, before proceeding. If you are a beginner, the amount of negative pitch that you will not be using can be eliminated electronically within your radios pitch curve prior to flight.

Servos #1, #2 and #3 are set at neutral positions by placing the throttle stick at the center of it's travel and verifying that all trims for aileron, elevator and collective are centered. Servo #4 is set to a neutral position as per the instructions accompanying your gyro. Servo #5 is set to neutral by setting the middle point in your throttle curve to 50% and placing the throttle stick and related trim at the halfway point.

Always maintain a minimum of 5mm of pushrod threads going into a ball link.

Servos #1, #2 and #3

Parts required:

Qty	Part number	Part description	Found in bag
3	#0015	M2 Hex nut	10B
3	#0103	M2X5 Threaded ball	10B
6	#0133-1	Ball links 2.5mm (long, grey)	10B
3	#122-95	M2.6X129.0 Pushrod	10B

Refer to drawings: #10B and #10B-1

A) Select the #122-95 pushrod and two #0133-1 ball links. Install each ball link and adjust to the preliminary length of 112.7 mm (measured as the amount of pushrod exposed between the links).

B) Select the appropriate servo arm (wheel), neutralize the servo and temporarily press the arm onto the servo output spline so that the arm or hole is chosen that results in perfect vertical centering above the retaining screw. Test the position until this criterion is satisfied, note that each arm or hole will align to a different position on the spline. Note the correct arm or hole and remove from the servo. Install the #0103 control ball onto the backside of the control arm or wheel (so that it will ultimately face the left side frame). Secure from the outside with blue loctite and one #0015 hex nut. Install the arm, leaving the retaining screw

out for step 6. Snap the prepared pushrod in place connecting the servo to the rear swashplate bellcrank.

C) Select the #122-95 pushrod and two #0133-1 ball links. Install each ball link and adjust to the preliminary length of 112.7 mm. As with servo #1, the arm for servo #2 must be the correct size and positioned so that the arm or hole that will fall directly below the retaining screw is chosen (make sure to neutralize the servo). Servo #2 utilizes the control ball to the inside of the servo wheel. Select and install one #0015 hex nut and one #0103 control ball with blue loctite. Snap the prepared pushrod in place connecting the servo to the left cyclic bellcrank. Select another #122-95 pushrod and two #0133-1 ball links. Install each ball link and adjust for a preliminary length of 112.7 mm.

D) As with the previous two servos, the arm or wheel for servo #3 must be of the correct size. Contrary to servo #2, servo #3 requires that the control ball be on a center line directly above the retaining screw. As with servo #2, this servo will utilize the control ball to the **inside** of the arm or wheel towards the right frame. Select one #0015 M3 hex nut and one #0103 control ball and install into the arm with blue loctite. Snap the prepared pushrod in place connecting the servo to the right cyclic bellcrank.

Servo #4

Parts required:

Qty	Part number	Part description	Found in bag
1	#0015	M2 Hex nut	10C
1	#0103	M2X5 Threaded ball	10C
2	#0133	Ball links (long)	10C
1	#0679	M2X170mm Pushrod	10C
1	#122-98	M4X170mm Graphite tube	10C

Refer to drawing: #10B-1

A) Select the #0679 pushrod and two #0133 ball links. Install each ball link and adjust to the preliminary length of 158mm. As per your gyro instructions, install a control horn with a length resulting in a ball position that is 13-15mm out from the center. Neutralize the servo and temporarily press the arm onto the servo spline so that the output hole is beneath and on a vertical center line with the mounting screw. Select and install one #0015 M2 hex nut and one #0103 control ball on the outside of the control arm. Snap the prepared control pushrod in place connecting the servo to the rudder bellcrank. The rudder bellcrank control ball

should be vertical at this time, adjust the control rod length if necessary.

B) Select the #122-98 graphite tube. Sand the ends of the tube until the overall length matches the exposed rod in between the ball links. Remove one ball link. Wipe the pushrod with alcohol and apply a patch of slow CA or epoxy about 10mm long in the center of the pushrod. Slide the graphite tube over the pushrod and re-install the remaining ball link, tightening it fully against the graphite tube. Align each link in the same orientation and wipe away any excess glue. Snap the assembled rod in place.

Servo #5

Parts required:

Qty	Part number	Part description	Found in bag
2	#0015	M2 Hex nut	10D
2	#0103	M2X5 Threaded ball	10D
2	#0133-1	Ball links (long)	10D
1	#122-94	M2.6X97mm Pushrod	10D

Refer to drawing: #10C

A) Select two #0133-1 ball links and the #122-94 Pushrod. Install the two ball links onto the pushrod and adjust so that holding the prepared pushrod up to the original measuring points (the servo center screw hole and the carburetor barrel center point) will show each directly on center and visible through the hole in each ball link.

B) Select a servo control arm or wheel which give's a hole position 14-15mm from center. With the servo at "neutral" (throttle stick halfway up and the throttle curve at 50%) position the servo arm so that it's output is visually perpendicular to a line connecting the servo spline to the carburetor arm mounting bolt centerline. Determine the position of the carburetor barrel at 50% throttle and attach the carburetor arm with the same criteria. Install one #0015 M3 hex nut and one #0103 control ball in each arm using blue loctite.

C) Snap the prepared pushrod in place connecting the servo to the carburetor.

Step 4: Installing the swashplate lower pushrods and head rods

Parts required:

Qty	Part number	Part description	Found in bag
3	#0227	M2X42 Pushrods	10E
2	#0335	M2X75 Pushrods	10E
14	#0133	Ball links (long)	10E
4	#0135	Ball links (short)	10E
2	#0313	M2X10 Pushrods	10E
2	#0337	M2X27 Pushrods	10E

Refer to drawing: # 10D

A) Select six #0133 ball links and three #0227 pushrods. Install two links on each pushrod, adjusting each until approximately 26mm (if calipers are used, make them 25.2mm each) of pushrod is exposed between the links. Snap each prepared pushrod onto each control ball on the outer swashplate ring and the corresponding cyclic bellcrank below. Orient each ball link on each pushrod so each link is uniformly centered on it's respective control ball.

B) Select four #0133 ball links and two #0337 pushrods. Install two ball links on each pushrod, adjusting each to a length of 16mm of exposed rod between the links. Snap each prepared pushrod in place connecting each flybar control ball to each of the #0221 washout arms.

C) Select four #0133 ball links and two #0335 pushrods. Install two ball links on each pushrod, adjusting each to a preliminary length of 61mm of exposed pushrod between the ball links. Orient each link perpendicular to the opposite. Snap one prepared pushrod in place connecting the #0109 outer ball (in position farthest from the blade holder) of the #0334-1 bell mixer with one of the two remaining #0109 control balls of the inner swashplate ring. Repeat the process for the opposite side. More information will be provided later in this text regarding the bell mixer ratio choices available on this model.

D) Select four #0135 ball links (short type) and two #0313 pushrods. Install two ball links on each pushrod, adjusting each perpendicular to the other and a gap of 0mm between the links. Snap one prepared pushrod in place connecting the outer ball (in position nearest the blade holder) of the 0334-1 bell mixer with the #0113 double ball installed in the flybar yoke. Repeat the process for the opposite side of the rotor head.

XI. Preparing the canopy

Bag required: 11A

Tools or materials required:

Slow CA adhesive

(optional) painting materials (see text supplied with the decal sheet)

Note: Refer to the *"Suggested locations for decals"* sheet. Drill holes and cut out areas as shown. Painting can be done before or after the following steps but trial fitting is suggested.

Step 1: Installing mounting hardware and fitting the canopy

Parts required:

Qty	Part number	Part description	Found in bag
4	#106-22	Rubber grommet (large)	11A
1	#122-90	Canopy	11A
1	#125-80	Decal sheet	11A
4	#122-99	Canopy retaining knobs	11A
4	#0053-5	M3X16 Set screw	11A

Refer to drawing: #11

Note: Depending on the motor position selected, the canopy will require minor trimming. Refer to the trim guides provided. Before gluing any grommets into position, finish step "B" first.

A) Select four #106-22 rubber grommets and the canopy. Drill one 1/8" (0.125) hole in the center of each mounting pocket in the canopy sides. Slide the canopy in position on the model. Using any size 3mm screws, attach the canopy to the model. Observe weather any of the holes need to be repositioned. Do so until all four screws easily mount without distorting the canopy. Open each hole to a dimension of approximately 0.260" to 0.265" (6.6 to 6.73mm) using an "H" drill bit or taper reamer.

B) Insert a grommet into each hole. Assemble each canopy knob using one #0053-5 M3X16 socket set screw. Tighten securely using red or green loctite. Trial fit the canopy using the assembled retaining knobs. Adjust if necessary. Once you are satisfied with the fit, go to the inside and secure the perimeter of each grommet to the canopy with CA adhesive.

Step 2: Canopy finishing suggestions

At your option, the canopy can be used as supplied "white" or painted to your satisfaction. If painting is chosen, these instructions assume you have the necessary experience and materials to

do the job. Therefore, only the steps required to finish the canopy in “white” are described below. **Note:** If you are changing the color, be aware that the decals are best applied only over white or very light colors.

Note: Refer to table 3: Finishing methods and procedures. After choosing your finishing methods, please consider the following list of optional materials:

3M Scotch Brite pad or fine steel wool
3/4" masking tape
Strong detergent
Masking paper or newspaper
Alcohol or paint prep solvent (such as Dupont #3919 Prep-sol)
“Tack” cloth

Paint selection: Paint must be chosen that is fuel proof or compatible with fuel proof clear coats. Automotive poly-urethanes are best but modelers epoxy or urethane can also be used. Always apply a light coat first, allowing 15 to 30 minute set-up time, before final gloss coats.

Table 3: Finishing methods and procedures

Painting	Finish choice	
	Clear coat method	Non clear coat method
Characteristics:	Longer completion time, high gloss, best decal protection, slightly increased weight.	Quicker completion time, shorter decal life, lightest weight.
Procedures		
Step (1)	Wash thoroughly with warm water and detergent.	Wipe with alcohol or paint prep solution.
Note: The canopy can be left as is or further detailed. If you wish to smooth it further, apply 3/4" masking tape (two layers thick) onto either side of the seam and sand with 400 grit wet-or-dry sandpaper. If overall painting is chosen, imperfections in the seam can be filled with glazing putty or similar material.		
Step (2)	Scuff overall with Scotch Brite pad or fine steel wool. Wipe again with cleaner.	Mask area surrounding the “window”. Scuff window area with Scotch Brite pad or fine steel wool and wipe again with cleaner.

Step (3)	Mask area surrounding the “window” and spray with color of choice. Remove masking tape.	Spray “window” area with color of choice. Remove masking tape.
Decal application	**Dry method**	**Wet method**
Characteristics:	Quicker but only one opportunity to apply decals.	Slower, easy re-positioning of decals.
Procedures		
Step (4)	Carefully cut decals from sheet using sharp scissors or a clean modelers knife. Study decal application sheet for suggested positioning.	
Step (5)	Apply decals and firmly burnish to canopy surface using the decal backing paper and firm finger pressure.	Apply window cleaner to canopy. Position each decal and remove excess liquid with a soft rubber squeegee. Allow to dry, canopy is completed.
Step (6)	Wipe the canopy with a tack cloth and apply clear coat of choice by first applying a very light “tack” coat and allowing it to dry for 15 to 30 minutes. Follow this with a “wet” coat. Canopy is completed.	

XII. Rotor blade selection

It is recommended that a blade length of 700 to 710mm be used. A good quality rotor blade is suggested. Miniature Aircraft USA offers a variety of high quality rotor blades suitable for this model.

XIII. Final mechanical and electronic set-up

Note: The following procedures will be described using a pitch gauge, flybar lock and paddle gauges. The use of these items is highly recommended since without them an accurate set-up is very difficult to achieve. Refer to the beginning of this manual for the correct part numbers.

A) Install the rotor blades, noting that the leading edge of each corresponds to a bell mixer on each blade grip (clockwise rotation as viewed from above). The pivot bolts must be tightened the correct amount. This is best described by indicating what is too loose and too tight. If the model is leaned to one side and the blades swing together by their own weight,

they are too loose. If a flybar paddle is held in one hand, a blade tip in the other and an effort is made to fold the blade, the resultant force should not deflect the flybar tip by more than 1" (25mm). These are approximate values.

B) Install a flybar lock onto the rotor head. Install a pitch gauge onto one rotor blade.

C) Set all transmitter trim levers, gimbals and servos/bellcranks at neutral as described in section X, step 3. The swashplate can now be adjusted to a level position (perpendicular to the main shaft and parallel to the main gear/frames) by adjusting the rods below it. This procedure can be accomplished with the help of a straight edge or bubble level placed across the top surface of the swashplate outer ring. The final confirmation is done at the rotor blade. Read the pitch at the blade (the exact value in degrees does not matter at this stage). The pitch reading should not change as you rotate the head, checking it at 90 degrees points, fore, aft, right and left. Miniature Aircraft USA offers an excellent tool for leveling the swashplate, order #0513.

Note: Adjustments should be split at opposite sides (half turn longer on the left side and half turn shorter on the right side, for example).

D) Adjust the rods (#0337) from the washout to the flybar control arms until the flybar arms and the washout arms are level.

E) Adjust the rods (#0335) from the swashplate to the bell mixers until the bell mixers are level with the flybar.

F) The flybar paddles must now be aligned with the swashplate. This can be confirmed by visually comparing the paddles to the swashplate from the side view. Some pitch gauges will adapt to the paddles or you can use the X-Cell paddle gauges #0510-1. The flybar lock can be removed for this step if tilting the flybar helps your view. Adjust each paddle until they are level and parallel with each other.

G) The collective pitch range can now be adjusted. It is suggested that “3D” settings be used initially by everyone (as a setup guide) then modified electronically to suit individual needs (such as beginners or intermediate pilots). All “3D” settings should only be utilizing an “idle-up” function within the radio. If you are a novice, this idle-up function can be deactivated later (prior to flight). As a novice or expert, you will benefit from having the desired “zero” or “neutral” mechanical set-up which results from using the “3D” settings as a starting point. Refer to Table 4: Initial Pitch/throttle settings:

Table 4: Initial pitch/throttle settings

Desired flying style/type	Throttle/collective low stick pitch	Throttle/collective half stick pitch	Throttle/collective Full stick pitch	Rotor head RPM

Basic flying and hovering	-2 degrees (20%)*	+5 degrees (50%)	+8 degrees (90%)	1500
Mild aerobatics/ autorotation (idle-up1)	-4degrees (60%)	+4 degrees (60%)	+10 degrees (100%)	1700 to 1800
3-D flying (idle-up 2)	-10 degrees (100%)	0 degrees (50%)	+10 degrees (100%)	1800 to 1850

* Percentages shown are approximate throttle settings

H) Switch your radio into Idle-up 2 and move the collective/throttle stick to exactly half stick. Adjust the #0335 pushrod (from the swashplate to the bell mixer) so that the blade reads exactly zero degrees of pitch. Repeat for the opposite blade. Move the stick to full up and down positions, reading the pitch at each. If previous steps were followed accurately, the range above and below zero should be the same. Any fine tuning can be done in the “swash type” (SWH) or (AFR) menus (do not readjust ATV settings for this). Novice and intermediate pilots can turn this idle-up function off and set their desired pitch settings within the “Normal” or “Idle-up 1" pitch curves.

I) Cyclic pitch can now be set. With the flybar lock and pitch gauge in place, position the rotor head so that one blade is directly over the tail boom. Move the collective/throttle stick until exactly zero degrees of collective is shown on the pitch gauge. Do not move this stick again. Apply full right and left cyclic or “aileron”, reading the pitch at each end point. The result should be +/- 7 to 7.5 degrees. Adjust SR3 mode (CCPM swashplate mode) or AFR as needed. Rotate the rotor head so that the flybar is directly over the tail boom and repeat the process for fore/aft cyclic or “elevator”.

J) Dual rates for “aileron”, “elevator” and/or rudder can be set at 60% if desired. These can be fine tuned at any time.

K) Set the throttle settings to approximately those shown on the chart or to the requirements of a governor if used.

XIV. Final inspection

Recheck overall for loose fasteners, interfering components or incorrect radio installation. Operate all radio controls making certain that none are reversed and that the throttle can properly close the carburetor. Check to see that no control linkages are binding.

Be certain that the gyro functions in the proper direction.

XV. Pre-flight information

At home:

Be sure you have all necessary equipment to operate or service the model. Be sure all batteries are fully charged.

At the flying site:

Observe any flying site rules.
Check the frequency board or any nearby pilots to be sure your frequency is clear.
Range check your radio as per your radio manufacturers instructions.
Pre-check all controls.
Obtain assistance from more experienced pilots if possible.
Never leave the transmitter in a position that would allow it to be handled or upset while you not attending it...keep it cased when not in use.

Starting the model:

Check your battery status whenever possible. Most factory shipped batteries can only sustain three “full tank” flights on a charge. Do not take any unnecessary risks. Always turn off all components between flights.

XVI. Starting and stopping procedures

Please refer to the operators guide.

Throttle and pitch curves:

After the needle valves are adjusted the model can be trimmed for hover. The throttle curve should be adjusted so that the model is almost to the hover head speed just above quarter stick. This helps the model lift off smoothly and also allows you to do slow vertical descents without fear of the engine running too slow. The throttle curve above half stick should be adjusted so that slow vertical ascents can be made without the engine speeding up or slowing down. Simultaneously adjust the hover pitch and hover throttle for the desired hovering rpm at half stick. Next, adjust the high and low side of the normal pitch curve until the model has the response you want in a hover.

Tail rotor trimming:

Adjust tail rotor trim as per your gyro instructions.

Tail rotor compensation for torque:

Note: Not required if you are using a heading lock type gyro and never intend to switch out of that mode. All adjustments are made from hover (at least 15' in altitude) with a “trimmed” tail rotor. When properly adjusted, the model should not rotate to the right or left when ascending or descending. See your radio manufacturers instruction manual.

Swashplate trimming:

When the helicopter drifts to the left or right, adjust the “aileron” transmitter trimmer until

stabilized. When the helicopter drifts forward or backwards, adjust the “elevator” trimmer until stabilized.

Main rotor dynamic blade tracking:

The tracking of the main rotor blades may be checked just prior to lift off. Be sure to maintain a safe distance from the machine. The adjustments can be made by changing the length of the hiller rod (#0335) on either side of the head. A piece of colored tape may be applied to one blade tip in order to visually determine which blade is high or low.

Tracking procedure:

-Low blade speed >>Lower the high blade
-High blade speed >>Raise the low blade
-If blades are out of track ½" or more >>Recheck original pitch settings

We wish you good luck and many happy hours of flying!
If you have any further questions, feel free to call us.

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