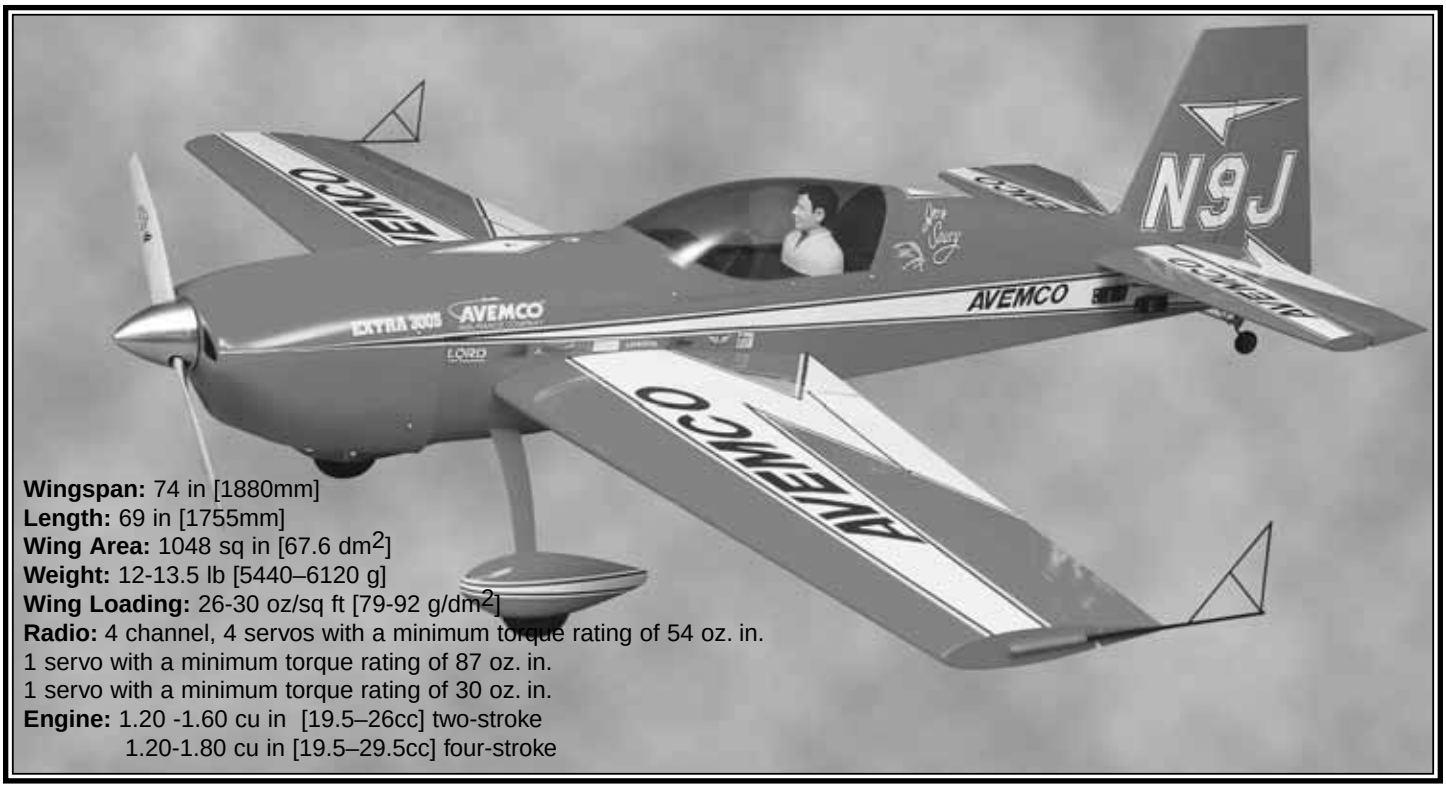
EXTRA 300S 1.60

1/4 Scale Almost-Ready-to-Fly 3D Aerobat

ARF

INSTRUCTION MANUAL



Wingspan: 74 in [1880mm]
Length: 69 in [1755mm]
Wing Area: 1048 sq in [67.6 dm^2]
Weight: 12-13.5 lb [5440–6120 g]
Wing Loading: 26-30 oz/sq ft [79-92 g/dm^2]
Radio: 4 channel, 4 servos with a minimum torque rating of 54 oz. in.
1 servo with a minimum torque rating of 87 oz. in.
1 servo with a minimum torque rating of 30 oz. in.
Engine: 1.20 -1.60 cu in [19.5–26cc] two-stroke
1.20-1.80 cu in [19.5–29.5cc] four-stroke

WARRANTY

Great Planes® Model Manufacturing Co. guarantees this kit to be free from defects in both material and workmanship at the date of purchase. This warranty does not cover any component parts damaged by use or modification. **In no case shall Great Planes' liability exceed the original cost of the purchased kit.** Further, Great Planes reserves the right to change or modify this warranty without notice.

In that Great Planes has no control over the final assembly or material used for final assembly, no liability shall be assumed nor accepted for any damage resulting from the use by the user of the final user-assembled product. By the act of using the user-assembled product, the user accepts all resulting liability.

If the buyers are not prepared to accept the liability associated with the use of this product, they are advised to return this kit immediately in new and unused condition to the place of purchase.

READ THROUGH THIS INSTRUCTION MANUAL FIRST. IT CONTAINS IMPORTANT INSTRUCTIONS AND WARNINGS CONCERNING THE ASSEMBLY AND USE OF THIS MODEL.

GREAT PLANES® MODEL MANUFACTURING COMPANY
Champaign, Illinois
Telephone: (217) 398-8970 ext. 5
Fax: (217) 398-7721

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For the latest technical updates or manual corrections to the Extra 300S visit the Great Planes web site at **www.greatplanes.com**. Open the "Airplanes" link, then select the Extra 300S 1.60 ARF . If there is new technical information or changes to this model a "tech notice" box will appear in the upper left corner of the page.

PROTECT YOUR MODEL, YOURSELF & OTHERS...FOLLOW THESE IMPORTANT SAFETY PRECAUTIONS

1. Your Extra 300S should not be considered a toy, but rather a sophisticated, working model that functions very much like a full-size airplane. Because of its performance capabilities, the Extra 300S, if not assembled and operated correctly, could possibly cause injury to yourself or spectators and damage to property.

2. You must assemble the model **according to the instructions**. Do not alter or modify the model, as doing so may result in an unsafe or unflyable model. In a few cases the instructions may differ slightly from the photos. In those instances the written instructions should be considered as correct.

3. You must take time to **build straight, true** and **strong**.

4. You must use an R/C radio system that is in first-class condition, and a correctly sized engine and components (fuel tank, wheels, etc.) throughout the building process.

5. You must correctly install all R/C and other components so that the model operates correctly on the ground and in the air.

6. You must check the operation of the model before **every** flight to insure that all equipment is operating and that the model has remained structurally sound. Be sure to check clevises or other connectors often and replace them if they show any signs of wear or fatigue.

7. If you are not already an experienced R/C pilot, you should fly the model only with the help of a competent, experienced R/C pilot.

8. While this kit has been flight tested to exceed normal use, if the plane will be used for extremely high stress flying, the modeler is responsible for taking steps to reinforce the high stress points.

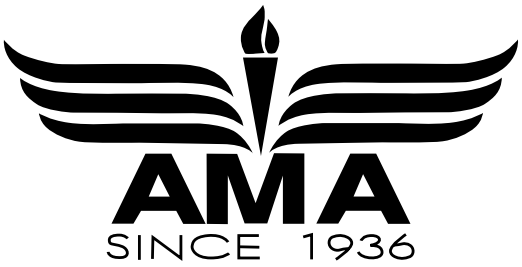
9. **WARNING:** The cowl and wheel pants included in this kit are made of fiberglass, the fibers of which may cause eye, skin and respiratory tract irritation. Never blow into a part (wheel pant, cowl) to remove fiberglass dust, as the dust will blow back into your eyes. Always wear safety goggles, a particle mask and rubber gloves when grinding, drilling and sanding fiberglass parts. Vacuum the parts and the work area thoroughly after working with fiberglass parts.

NOTE: We, as the kit manufacturer, provide you with a top quality kit and great instructions, but ultimately the quality of your finished model depends on how **you** build it; therefore, we cannot in any way guarantee the performance of your completed model, and no representations are expressed or implied as to the performance or safety of your completed model.

Remember: Take your time and follow the instructions to end up with a well-built model that is straight and true.

If you have not flown this type of model before, we recommend that you get the assistance of an experienced pilot in your R/C club for your first flights. If you're not a member of a club, your local hobby shop has information about clubs in your area whose membership includes experienced pilots.

In addition to joining an R/C club, we strongly recommend you join the AMA (Academy of Model Aeronautics). AMA membership is required to fly at AMA sanctioned clubs. There are over 2,500 AMA chartered clubs across the country. Among other benefits, the AMA provides insurance to its members who fly at sanctioned sites and events. Additionally, training programs and instructors are available at AMA club sites to help you get started the right way. Contact the AMA at the address or toll-free phone number below:



Academy of Model Aeronautics
5151 East Memorial Drive
Muncie, IN 47302-9252
Tele. (800) 435-9262
Fax (765) 741-0057
Or via the Internet at: http://www.modelaircraft.org

DECISIONS YOU MUST MAKE

This is a partial list of items required to finish the Extra 300S that may require planning or decision making before starting to build. Order numbers are provided in parentheses.

Radio Equipment

Four channel radio and four channel receiver (a six channel computer radio and six channel receiver may offer you more setup options)

(4) servos with a minimum torque rating of 54 oz. in.
(1) servo with a minimum torque rating of 87 oz. in.
(1) servo with a minimum torque rating of 30 oz. in.
(3) 24" [610mm] servo extensions (HCAM2711 for Futaba)
(2) 12" [305mm] servo extensions (HCAM2721 for Futaba)
(2) Y-connectors (HCAM2751 for Futaba) (the Y-connectors may be omitted if your radio system has the correct mixing capabilities)
(1) Servo reverser (Because the elevator servos move in opposition, either a transmitter capable of electronic mixing must be used (so one of the servos can be reversed) or a separate in-line mixing device such as the Futaba SR-10 Synchronized Servo Reverser (FUTM4150) must be used to reverse one of the servos.
(1) Radio switch harness
(1) 4.8v 1000 mAh battery (minimum)

Engine Recommendations

Recommended engine size range for the Extra 300S 1.60 ARF:

1.20 to 1.60 two-stroke
or
1.20 to 1.80 four-stroke

ADDITIONAL ITEMS REQUIRED

Hardware and Accessories

In addition to the items listed in the **"Decisions You Must Make"** section, following is the list of hardware and accessories required to finish the Extra 300S. Order numbers are provided in parentheses.

❏ R/C foam rubber (1/4" [6mm] (HCAQ1000) or 1/2" [13mm] (HCAQ1050)
❏ Fuel filler valve for glow fuel (GPMQ4160)
❏ 1 oz. [30g] Thin Pro CA (GPMR6002)
❏ 1 oz. [30g] Medium Pro CA+ (GPMR6008)
❏ Pro 6-minute epoxy (GPMR6045)
❏ Drill bits: 1/16" [1.6mm], 5/64" [2mm], 3/32" [2.4mm], 7/64" [2.8mm], 1/8" [3.2mm],
❏ Silver solder w/flux (GPMR8070)
❏ #1 Hobby knife (HCAR0105)
❏ #11 blades (5-pack, HCAR0211)
❏ Sandpaper assortment
❏ Threadlocker thread locking cement (GPMR6060)

Optional Supplies and Tools

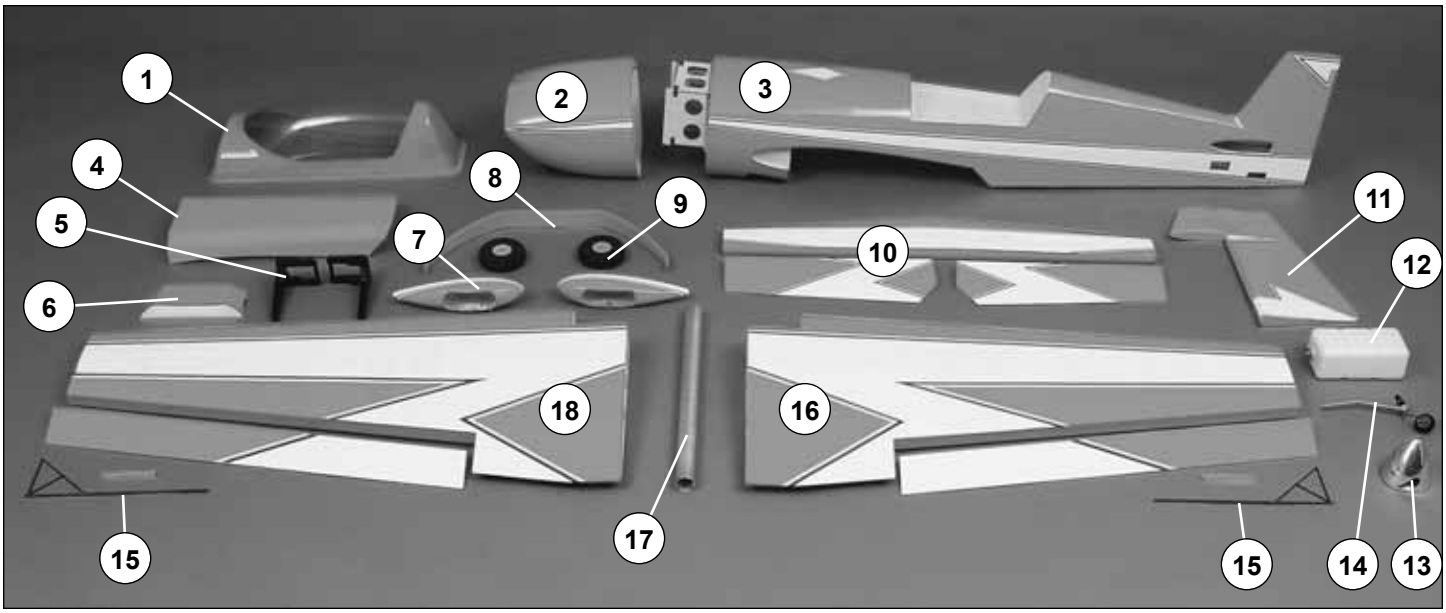
❏ 2 oz. [57g] spray CA activator (GPMR6035)
❏ CA applicator tips (HCAR3780)
❏ Mixing sticks (50, GPMR8055)
❏ Mixing cups (GPMR8056)
❏ Curved-tip canopy scissors for trimming plastic parts (HCAR0667)
❏ Masking tape (TOPR8018)
❏ Denatured alcohol (for epoxy clean up)
❏ Rotary tool such as Dremel®
❏ Servo horn drill (HCAR0698)
❏ AccuThrow™ Deflection Gauge (GPMR2405)
❏ CG Machine™ (GPMR2400)
❏ Precision Magnetic Prop Balancer™ (TOPQ5700)

KIT INSPECTION

Before starting to build, take an inventory of this kit to make sure it is complete, and inspect the parts to make sure they are of acceptable quality. If any parts are missing or are not of acceptable quality, or if you need assistance with assembly, contact **Product Support**. When reporting defective or missing parts, use the part names exactly as they are written in the Kit Contents list on this page.

Great Planes Product Support:
3002 N Apollo Drive, Suite 1
Champaign, IL 61822
Telephone: (217) 398-8970, ext. 5
Fax: (217) 398-7721
E-mail:

Parts Layout



PARTS PHOTOGRAPHED

1. Canopy
2. Cowl
3. Fuselage
4. Belly Pan
5. Engine Mount
6. Landing Gear Cover
7. Wheel Pants
8. Landing Gear
9. Wheels
10. Horizontal Stab & Elevators
11. Rudder
12. Fuel Tank
13. Spinner & Backplate
14. Tail Wheel Assembly
15. Sighting Gauges & Mounting Plates
16. Right Wing & Aileron
17. Aluminum Wing Joiner Tube
18. Left Wing & Aileron

PARTS NOT PHOTOGRAPHED

Qty	
2	Decal Sheets
1	2-56 Threaded Clevis
5	4-40 Threaded Clevises
5	4-40 Solder Clevises
1	2-56 Solder Clevis
2	3/16" x 2" Axles
1	EZ Connector
5	4-40 nuts
1	6-32 Blind Nut
9	8-32 Blind Nuts
1	2-56 nut
2	5/16 x 24 Axle Nuts
2	1/4" x 20 Blind Nuts
2	1/4-20 Wing Bolts
1	2-56 Nylon Clevis
5	Heavy Duty Control Horns
1	Retainer
1	2 x 9 Hinge Material
1	4-40 Torque Rod Horn
1	Outer Plastic Tube, 11-3/4"
13	Silicone Clevis Keepers

Qty	
4	#4 x 1/2" SMS
4	6-32 x 1/4" SHCS
22	#4 x 5/8" SMS
1	4-40 x 1/4" SHCS
12	#2 x 3/8" SMS
5	8-32 x 3/4" SHCS
1	6-32 x 5/8" SHCS
4	8-32 x 1-1/4" SHCS
4	8-32x1" SHCS
4	3/16" Wheel Collars
1	2-56 x 17-1/2" Threaded One End
1	2-56 x 12" Threaded one End
5	4-40x 4-1/2" Threaded One End
6	#4 Flat Washers
8	#2 Flat Washers
8	#8 Lock Washers
13	#8 Flat Washer
1	3" Medium Fuel Tubing
4	20x20x15mm Cowl Mounting Blocks
4	Nylon Anti-Rotation Pins
1	25mm Velcro® strip

Ordering Replacement Parts

To order replacement parts for the Great Planes Extra 300S 1.60 ARF, use the order numbers in the **Replacement Parts List** that follows. Replacement parts are available only as listed. Not all parts are available separately (an aileron cannot be purchased separately, but is only available with the wing kit). Replacement parts are not available from Product Support, but can be purchased from hobby shops or mail order/Internet order firms. Hardware items (screws, nuts, bolts) are also available from these outlets. If you need assistance locating a dealer to purchase parts, visit **www.greatplanes.com** and click on "Where to Buy." If this kit is missing parts, contact **Product Support**.

REPLACEMENT PARTS LIST

Order Number	Description	How to purchase
GPMA2350	Wing Set	Contact hobby supplier
GPMA2351	Fuselage w/belly pan	Contact hobby supplier
GPMA2352	Tail Surface Set	Contact hobby supplier
GPMA2353	Cowl	Contact hobby supplier
GPMA2354	Wheel Pants Set	Contact hobby supplier
GPMA2355	Tail Wheel Assembly	Contact hobby supplier
GPMA2356	Canopy	Contact hobby supplier
GPMA2357	Landing Gear	Contact hobby supplier
GPMA2358	Wing Joiner Tube	Contact hobby supplier
GPMA2359	Decal set	Contact hobby supplier
	Missing pieces	Contact Product Support
	Instruction manual	Contact Product Support
	Full-size plans	Not available

Important Building Notes

There are two types of screws used in this kit:

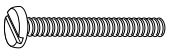
Sheet metal screws are designated by a number and a length.

For example #6 x 3/4"

This is a number six screw that is 3/4" long.

Machine screws are designated by a number, **threads per inch**, and a length.

For example 4-40 x 3/4"



This is a number four screw that is 3/4" long with forty threads per inch.

- When you see the term ***test fit*** in the instructions, it means that you should first position the part on the assembly **without using any glue**, then slightly modify or *custom fit* the part as necessary for the best fit.

- Whenever the term ***glue*** is written you should rely upon your experience to decide what type of glue to use. When a specific type of adhesive works best for that step, the instructions will make a recommendation.

- Whenever just ***epoxy*** is specified you may use ***either*** 30-minute (or 45-minute) epoxy ***or*** 6-minute epoxy. When 30-minute epoxy is specified it is **highly** recommended that you use only 30-minute (or 45-minute) epoxy, because you will need the working time and/or the additional strength.

- **Photos** and **sketches** are placed **before** the step they refer to. Frequently you can study photos in following steps to get another view of the same parts.

- The Extra 300S 1.60 ARF is factory-covered with Top Flite® MonoKote® film. Should repairs ever be required, MonoKote can be patched with additional MonoKote purchased separately. MonoKote is packaged in six-foot rolls, but some hobby shops also sell it by the foot. If only a small piece of MonoKote is needed for a minor patch, perhaps a fellow modeler would give you some. MonoKote is applied with a model airplane covering iron, but in an emergency a regular iron could be used. A roll of MonoKote includes full instructions for application. Following are the colors used on this model and order numbers for six foot rolls.

Missile Red (TOPQ0201) White (TOPQ0204)
Royal Blue (TOPQ0221) Yellow (TOPQ0203)

Note: The AVEMCO logo on the bottom of the wing is white Monokote film, not a decal.

Metric Conversions

1" = 25.4mm (conversion factor)

1/64" = .4mm	1" = 25.4mm
1/32" = .8mm	2" = 50.8mm
1/16" = 1.6mm	3" = 76.2mm
3/32" = 2.4mm	6" = 152.4mm
1/8" = 3.2mm	12" = 304.8mm
5/32" = 4mm	15" = 381mm
3/16" = 4.8mm	18" = 457.2mm
1/4" = 6.4mm	21" = 533.4mm
3/8" = 9.5mm	24" = 609.6mm
1/2" = 12.7mm	30" = 762mm
5/8" = 15.9mm	36" = 914.4mm
3/4" = 19mm	

PREPARATIONS

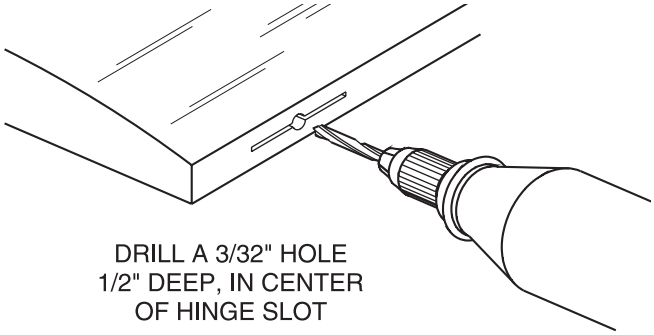
❏ 1. If you have not done so already, remove the major parts of the kit from the box and inspect for damage. If any parts are damaged or missing, contact Product Support at the address or telephone number listed in the "Kit Inspection" section on page 4.

❏ 2. Remove the tape and separate the ailerons and flaps from the wing and the elevators from the stab. Use a covering iron with a covering sock on high heat to tighten the covering if necessary. Apply pressure over sheeted areas to **thoroughly** bond the covering to the wood.

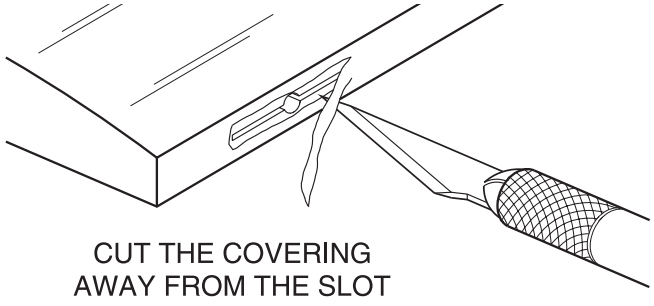
ASSEMBLE THE WING

Install the Ailerons

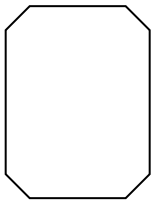
Do the right wing first so your work matches the photos the first time through. You can do one wing at a time, or work on them together.



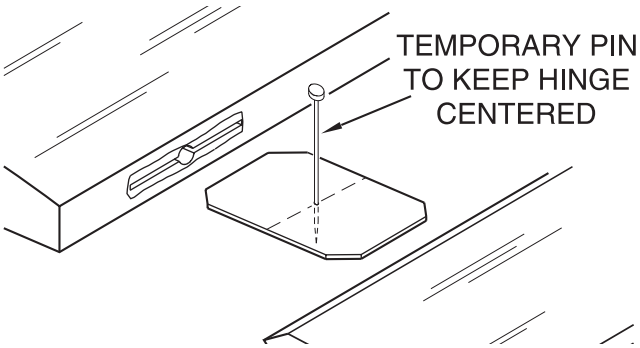
❏ ❏ 1. Drill a 3/32" [2.4mm] hole, 1/2" [13mm] deep in the center of each hinge slot to allow the CA to "wick" in. Follow-up with a #11 blade to clean out the slots.
Hint: If you have one, use a high-speed rotary tool to drill the holes.



❏ ❏ 2. Use a sharp #11 blade to cut a strip of covering from the hinge slots in the wing and aileron.

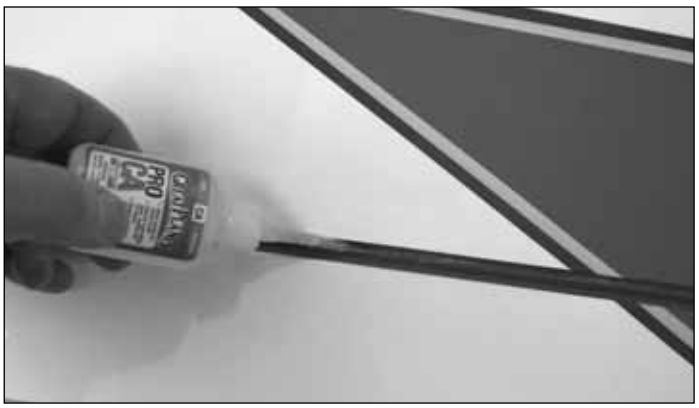


❏ ❏ 3. Cut five 3/4" x 1" [19 x 25mm] **hinges** from the **CA hinge strip**. Snip off the corners so they go in easier.

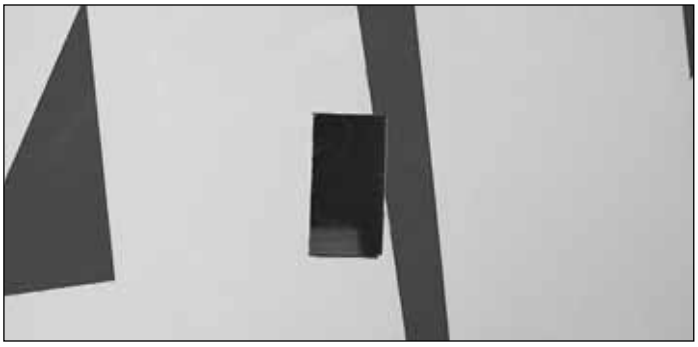


❏ ❏ 4. Test fit the **ailerons** to the **wing** with the hinges. If the hinges don't remain centered, stick a pin through the middle of the hinge to hold it in position.

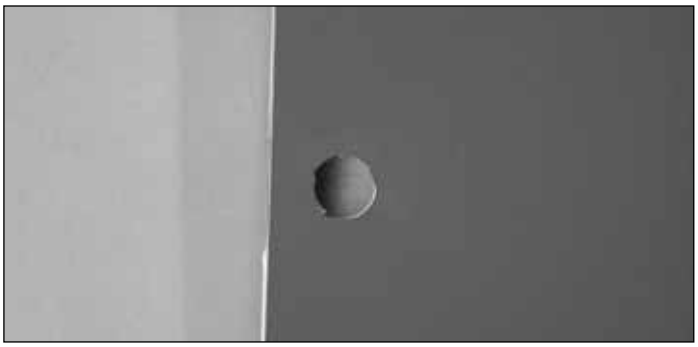
❏ ❏ 5. Remove any pins you may have inserted into the hinges. Adjust the aileron so there is a small gap between the LE of the aileron and the wing. The gap should be small, just enough to see light through or to slip a piece of paper through.



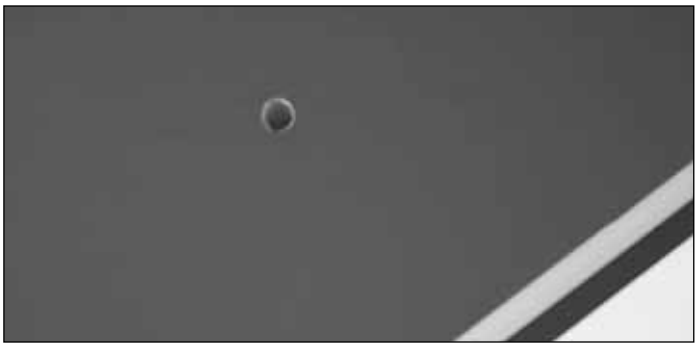
❏ ❏ 6. Apply six drops of thin CA to the top and bottom of each hinge. Do not use CA accelerator. After the CA has fully hardened, test the hinges by pulling on the aileron.



❏ ❏ 7. Cut the covering 1/8" [3mm] inside the opening in the wing for the aileron servo. Use a trim iron to seal the covering to the inner edges of the opening.



❏ ❏ 8. On the top of the wing, cut the covering away from the hole at the wing center section. This hole is for the aileron servo wire to come through, into the fuselage.



❏ ❏ 9. On the top and bottom of the wing, cut the covering away from the hole near the wing trailing edge. This hole is for the wing bolt.

❏ ❏ 10. Remove the string from inside of the aileron servo bay and tape it to the wing. **Do not pull the string out of the wing!**

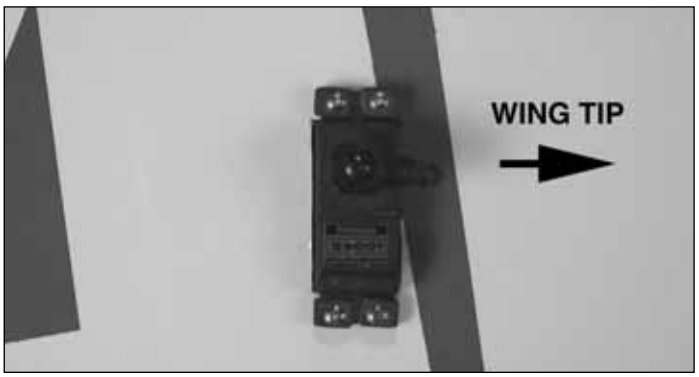
❏ 11. Repeat steps 1-10 for the left wing panel.

Install the Aileron servos & pushrods

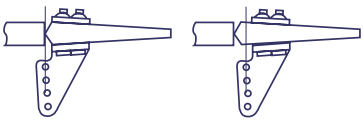
❏ ❏ 1. Installing the servos in the wing will require the use of one 12" [305mm] servo extension for each aileron servo. One Y-harness connector is required and is used to allow the aileron servos to plug into one slot in your receiver. You may have a computer radio that allows you to plug the servos into separate slots and then mix them together through the radio transmitter. If you choose to mix them with the radio rather than the Y-harness, refer to the instructions with your particular brand of radio.

❏ ❏ 2. Attach the servo extension to the aileron servo. Secure the connectors together using a large piece of heat shrink tubing, tape or other method for securing the connectors together.

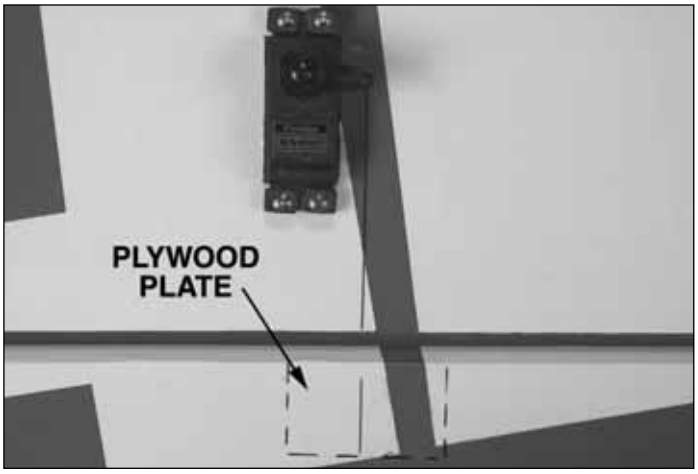
❏ ❏ 3. Tie the string from inside the wing to the end of the servo wire. Pull the servo wire through the wing with the string. Feed the servo wire out the hole in the top of the wing center section. Tape the servo wire to the wing to prevent it from falling back into the wing.

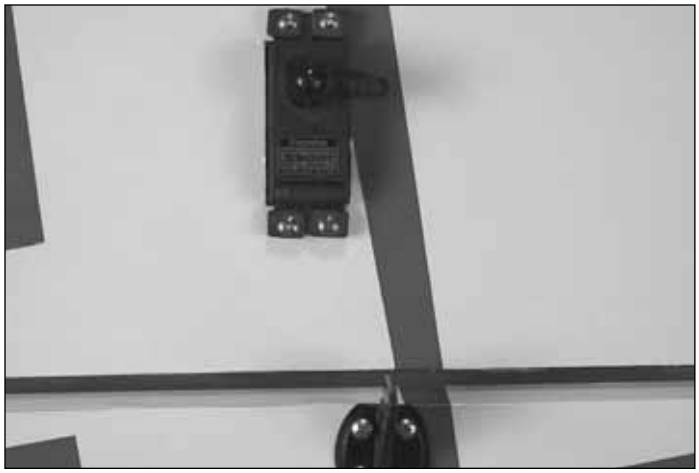


❏ ❏ 4. Temporarily position the aileron servo into the servo bay. Drill a 1/16" [1.6mm] hole through the four mounting holes of the servo, drilling through the plywood mounting plate in the wing. Install and remove a servo mounting screw into each of the four holes. Insert a drop of thin CA into the holes to harden the wood. After the glue has cured, install the servo into the servo bay using the hardware that came with your servo. Center the servo and install a servo arm as shown.



Correct Incorrect





❏ ❏ 5. The aileron has a plywood plate for mounting the control horn. Using a T-pin, lightly puncture the covering to be sure you are over the plywood plate. Position a large nylon **control horn** on the aileron, positioning it as shown in the sketch and aligning it with the servo. Mark the location for the screw holes. Drill through the marks you made with a 3/32" [2.4mm] drill bit. (Be sure you are drilling into the plywood plate mounted in the bottom of the aileron. Drill through the plate only. Do not drill all the way through the aileron!) Using a #4 x 5/8" 16mm] sheet metal screw, install and then remove a screw into each of the holes. Harden the holes with thin CA. Install the control horn with four #4 x 5/8" [16mm] sheet metal screws.

❏ ❏ 6. Locate a .095" x 12" [.095" x 305mm] **pushrod wire** threaded on one end. Screw a 4-40 nut, a silicone clevis keeper and a threaded metal clevis onto the threaded end of the wire 20 turns. Tighten the nut against the clevis and then install the clevis on the aileron control horn.

❏ ❏ 7. Be sure the aileron servo is centered. Enlarge the outer most hole in the servo arm with a Hobbico Servo Horn Drill (or a #48 or 5/64" [2mm] drill bit). Install a 4-40 metal solder clevis onto the outer most hole in the servo arm. Center the servo arm and center the aileron. Using the solder clevis as a guide, mark where to cut the pushrod wire. Remove the pushrod and clevis from the control horn and the solder clevis from the servo arm. Solder the clevis to the pushrod using the “Expert Tip” that follows.

EXPERT TIP

HOW TO SOLDER THE CLEVIS TO THE PUSHROD

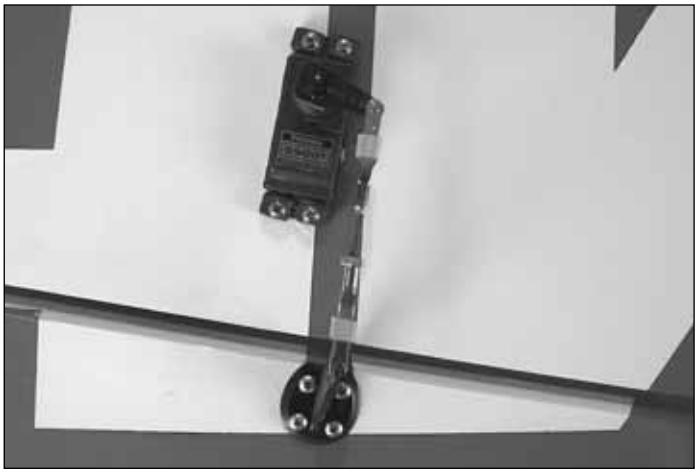
1. Where the pushrod will make contact with the solder clevis, roughen the wire with 220-grit sandpaper.

2. Use denatured alcohol to remove any oil residue from the pushrod wire.

   Note: Soldering should be done with silver solder not an electrical solder. Great Planes® has a convenient Silver solder kit (GPMR8070) that includes flux and solder.

3. Apply a couple of drop of flux to the wire. Slide the solder clevis onto the wire. Using a small torch or soldering iron heat the wire, allowing the heated wire to heat the solder clevis. Apply a small amount of solder to the joint. When the wire and the clevis are hot enough the solder will flow into the joint. Avoid using too much solder causing solder to flow out of the joint and clump. Use just enough solder to make a good joint. Allow the wire and clevis to cool.

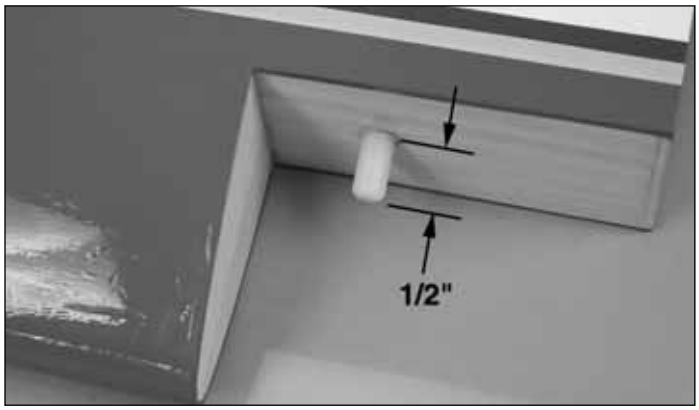
4. Put a couple of drops of oil onto a rag and wipe the joint. This will prevent rust from forming on the joint.



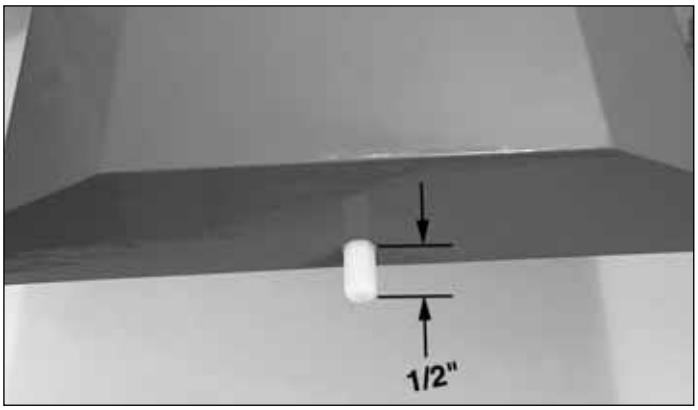
❏ ❏ 8. Install a silicone clevis retainer over the solder clevis. Install the pushrod and clevises to the servo arm and the control horn. Adjust the linkage until the aileron and the servo arm are both centered then tighten the nut against the clevis.

❏ 9. Repeat steps 1-8 for the left wing panel

Join the Wing



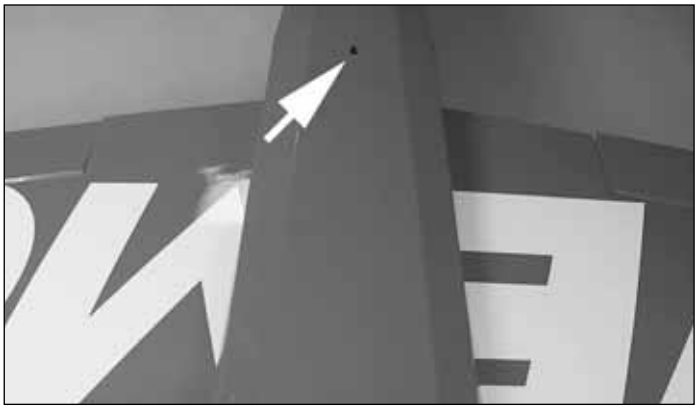
❏ 1. Locate three nylon **anti-rotation pins**. Using 6-minute epoxy, glue one into the root on one wing half and one into each of the holes in the wing's center section. The pin should extend approximately 1/2" [13mm]. Clean any excess epoxy away from the pins with rubbing alcohol before the epoxy cures.



❏ 2. Using 6-minute epoxy, glue the remaining anti-rotation pin into the hole in the leading edge of the belly pan. The pin should extend approximately 1/2" [13mm] from the belly pan. Clean any excess epoxy away from the pins with rubbing alcohol before the epoxy cures.

❏ 3. At the rear of the wing saddle you will find a hole. Cut the covering away from this hole.

❏ 4. Slide the two wing halves together onto the aluminum joiner tube. Install the wing onto the fuselage with two nylon wing bolts.



❏ 5. Cut the covering away from the hole at the bottom rear of the belly pan.

❏ 6. Insert the pin on the leading edge of the belly pan into the hole in the former. Push the belly pan onto the wing. Hold the belly pan in place with a 6-32 x 5/8" [16mm] socket head cap screw.
Note: The screw threads into a blind nut in the fuselage. Be sure the threads grab the blind nut before pushing too hard and dislodging the blind nut.

❏ 7. Remove the wing and belly pan from the fuselage.

ASSEMBLE THE FUSELAGE

Install the Fuselage Cover

Note: Because of the wide variety of engine combinations and the varying weight of the engines you can use for this airplane, we have designed a convenient place to add weight to the tail should you find that tail weight is needed. Weight can be attached to the bottom of the cover with epoxy. Install the cover now but when you balance the airplane on page 19, should you need to add weight to the tail, this is the place to install the weight.

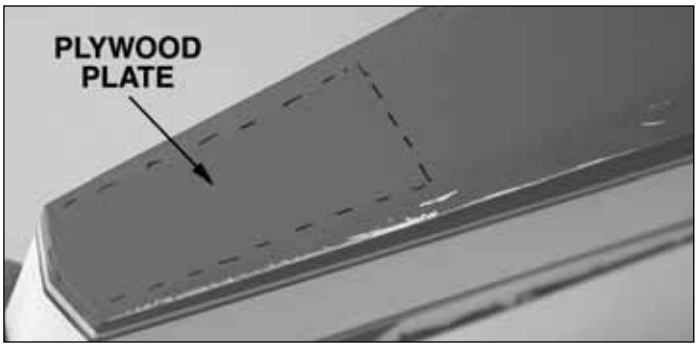
❏ 1. Position the fuselage cover in place on the bottom of the fuselage. With the cover in place, drill a 1/16" [1.6mm] hole through the cover and the plywood plate.

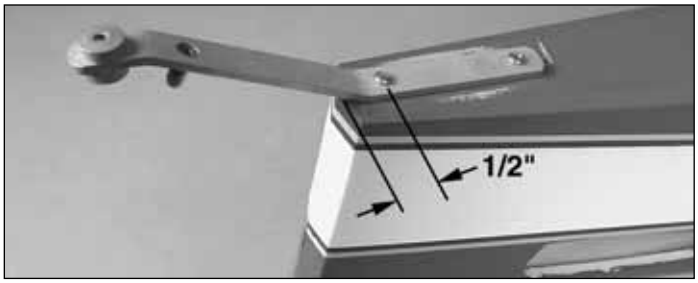
❏ 2. Enlarge the holes in the cover only by drilling them out to 3/32" [2.4mm].

❏ 3. Install then remove a #2 x 3/8" [3mm] sheet metal screw into the hole in the plywood plate. Put a couple of drops of thin CA into the hole to harden it and allow the glue to cure.

4. Install the cover onto the fuselage and secure it with two #2 x 3/8" [3mm] sheet metal screws and two #2 washers.

Install the Tail Gear & Landing Gear





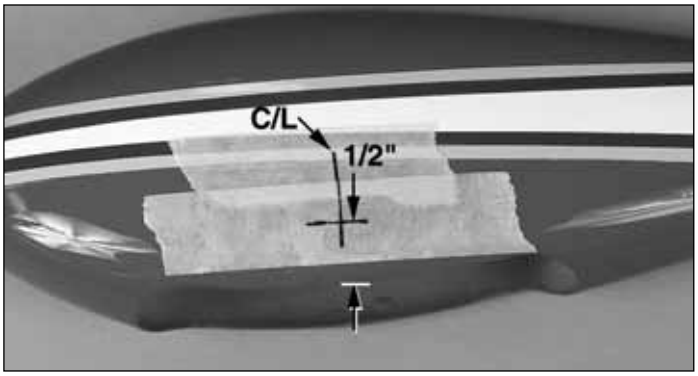
❏ 1. Located on the bottom, rear of the fuselage is a plywood mounting plate. Position the tail wheel assembly so that the rearward mounting hole is 1/2" [13mm] from the end of the fuselage. Drill a 5/64" [2mm] hole through each of the mounting holes in the tail wheel assembly. Mount the tail wheel assembly to the plate with two #4 x 5/8" [16mm] sheet metal screws.

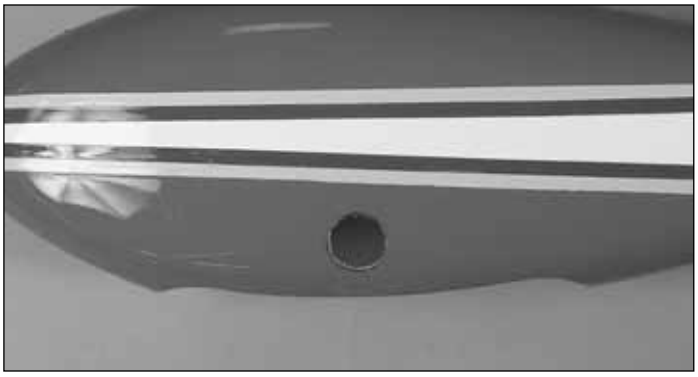
❏ 2. Parallel with the axle, file a flat spot for the steering arm set screw on the end of the tail wheel wire.

❏ 3. Using the hardware included in the bag with the tail wheel assembly, install the tail wheel to the axle with two wheel collars and set screws. Attach the wire to the tail wheel assembly with a wheel collar and set screw and the steering arm. Be sure the set screw on the steering arm is tightened against the flat spot you filed on the wire.

❏ 4. Locate the aluminum **landing gear**. Install the gear onto the bottom of the wing with five 8-32 x 1/2" [13mm] socket head cap screws. Apply a small drop of thread locking compound to each bolt before screwing them into the landing gear.

❑ 5. Glue the landing gear cover in place with RTV silicone.



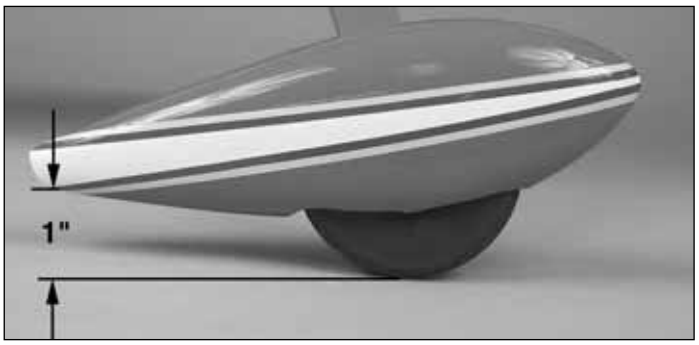


❑ ❑ 6. On one of the wheel pants place masking tape on the side of the pant. Mark the center of the wheel opening on the pant. On that centerline make a crossing line 1/2" [13mm] from the bottom of the pant. Where the two lines intersect make a 1/2" [13mm] hole in the side of the pant. Do the same for the other wheel pant. Be sure to do this on the opposite side making a right and left wheel pant.

❑ ❑ 7. Where you have made the hole, sand the inside of the wheel pant with 220-grit sandpaper. Then wipe the area clean with rubbing alcohol. Glue one of the plywood **wheel pant mounting plates** inside the pant with 6-minute epoxy mixed with micro balloons. (The micro balloons will help thicken the epoxy and prevent it from running excessively.) Clamp the plate to the inside of the pant until the glue has cured.

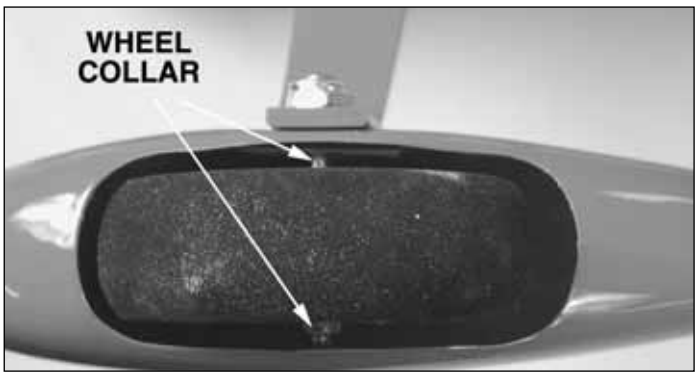
❑ ❑ 8. Install the axle and nut on each side of the landing gear

❑ ❑ 9. Using a high-speed motor tool and cut-off wheel, cut the 2" [51mm] axle to a length of 1-7/8" [47mm].



❑ ❑ 10. Temporarily slide the wheel pant and a wheel onto the axle. Position the wheel pant so that the back of the pant is 1" [25mm] from the top of your work bench. On the aluminum landing gear there are two small holes. With the wheel pant properly positioned mark the hole locations onto the wheel pant.

❑ ❑ 11. Remove the wheel and pant from the axle. Drill a 1/16" [1.6mm] hole though the marks you made on the wheel pant. Install and then remove a #2 x 3/8" [9.5mm] screw into the holes. Apply a drop of thin CA into the holes and allow the glue to cure.

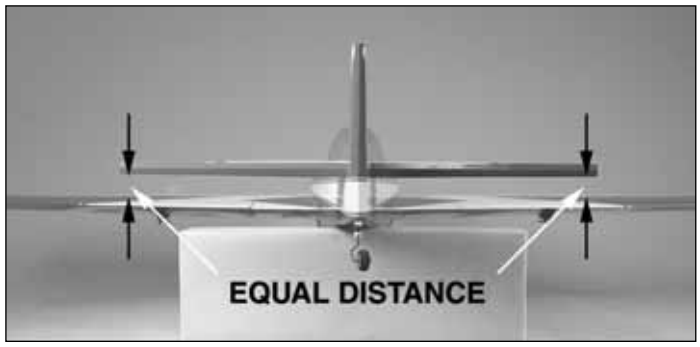


❑ ❑ 12. Install a 6-32 x 1/4" [6mm] socket head cap screw into two 5-32" [4mm] wheel collars. Install the wheel pant and the wheel with a wheel collar on each side of the wheel, onto the axle. Tighten the wheel pant to the aluminum landing gear by installing a #2 x 3/8" [9.5mm] screw into the holes in the landing gear and the holes you drilled in the wheel pant.

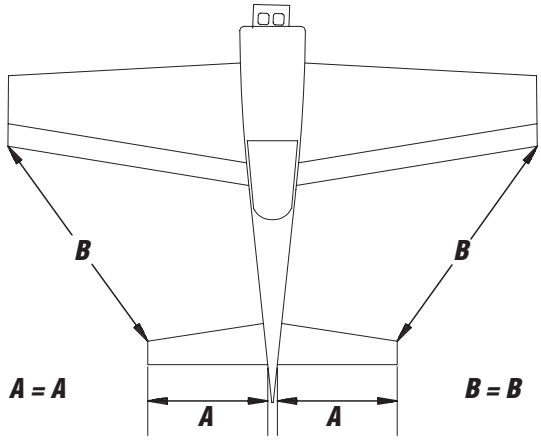
Install the Stab, Elevator & Rudder

❏ 1. Cut the covering from the openings at the rear of the fuselage for the horizontal stab.

❏ 2. Install the wing onto the fuselage. There is no need to install the belly pan.



❏ 3. Install the horizontal stab into the back of the fuselage. Center the stab, making sure the distance from center is equal on both sides of the stab. Stand back 15-20 ft. [5-6m] and check to be sure the stab is parallel to the wing. Adjust the stab saddle as needed until the stab and wing are parallel.



❏ 4. Measure the distance from the tip of each wing to the tip of the stab. Adjust the stab until the distance from the tip of the stab to the tip of the wing is equal on both sides.

❏ 5. Use a felt tip marker to mark the outline of the fuselage onto the top and bottom of the stab.

❏ 6. Remove the stab from the fuse. Use a sharp #11 hobby knife or use the following **Expert Tip** to cut the covering 1/16" [1.6 mm] inside of the lines you marked. Use care to cut **only into the covering** and **not into the wood**.

EXPERT TIP

HOW TO CUT COVERING FROM BALSA

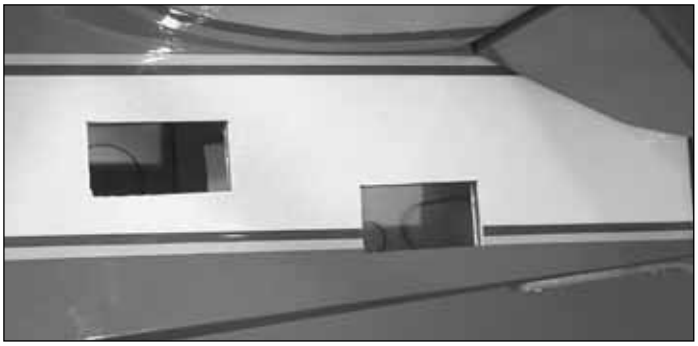
Use a soldering iron to cut the covering from the stab. The tip of the soldering iron doesn't have to be sharp, but a fine tip does work best. Allow the iron to heat fully.

Use a straightedge to guide the soldering iron at a rate that will just melt the covering and not burn into the wood. The hotter the soldering iron, the faster it must travel to melt a fine cut. Peel off the covering.

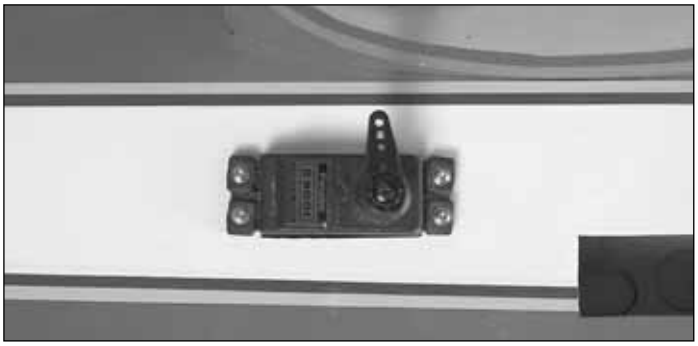
❏ 7. Use 30 minute epoxy to glue the stab into the fuse. For the most strength, apply epoxy to both sides of the stab and inside the fuse where the stab fits. Slide the stab into position. Wipe away residual epoxy with a paper towel and alcohol. Do not disturb the model until the epoxy has fully hardened.

❏ 8. Cut nine CA hinges for the elevators and rudder just as you did for the ailerons. Install the CA hinges on the elevators and the rudder using the same technique used on the ailerons. Apply six drops of thin CA on each side of each CA hinge.

Install the Elevator & Rudder Pushrods & Servos

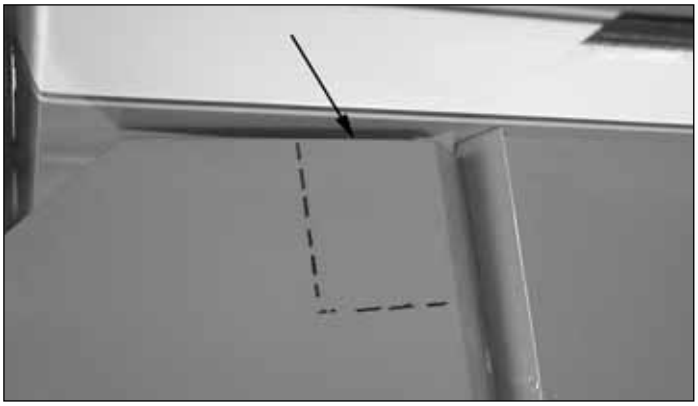


❏ 1. On left side of the fuselage you will find two servo openings. On the right side you will find one. Cut the covering from the servo openings.



❏ ❏ 2. Install your left elevator servo into the forward servo compartment on the left side of the fuselage. Drill a 1/16" [1.6mm] hole through each of the mounting holes in the servo. Remove the servo. Insert and then remove a servo mounting screw into each of the holes you have drilled. Put a drop of thin CA into each hole and allow the glue to cure. The servo will require a 24" [610mm] extension to reach the radio compartment. Install the extension onto the servo and secure it using the same method used on the ailerons. Install the servo in the compartment with the hardware provided with your servo. Center the servo. Then install a servo arm onto the servo. The servo arm should be pointing towards the bottom of the stab.

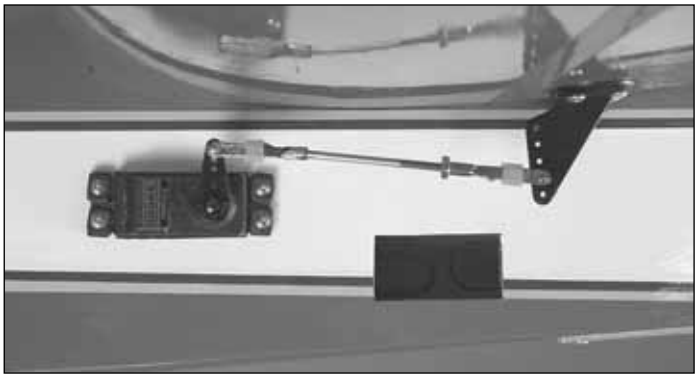
❏ 3. Repeat step two for the right side of the fuselage.



❏ ❏ 4. Look closely on the bottom of the left elevator and you will notice a plywood plate visible under the covering. The control horn must be mounted to this plate. Place a control horn in position on the elevator in line with the servo arm. Mark the location of the four mounting holes. Drill a 5/64" [2mm] hole through each of the marks, being careful not to drill through the top of the elevator. Insert and then remove a #4 x 5/8" [16mm] screw into each of the holes you have drilled. Put a drop of thin CA into each hole and allow the glue to cure. Install the control horn with four #4 x 1/2" [13mm] screws.

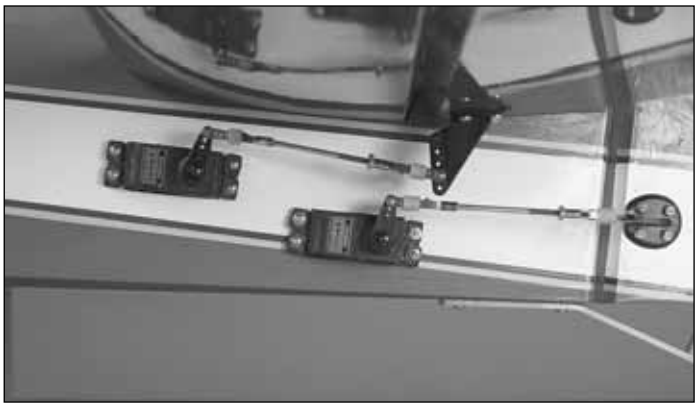
❏ ❏ 5. (Referring to the photo at step 7 will help you understand the following step.) Install a 4-40 nut, silicone clevis keeper and a threaded 4-40 aluminum clevis onto the threaded end of a .095 x 12" [2.4 x 305mm] pushrod. Tighten the nut against the clevis. Install the clevis in the second hole from the end of elevator control horn. Install a 4-40 solder clevis in the last hole on the servo arm. Center the elevator and mark the wire where it needs to be cut to be the correct length to fit into the solder clevis. Remove the clevises from the horns. Then cut the wire on the mark you made.

❏ ❏ 6. Solder the wire to the clevis using the technique described for the ailerons.

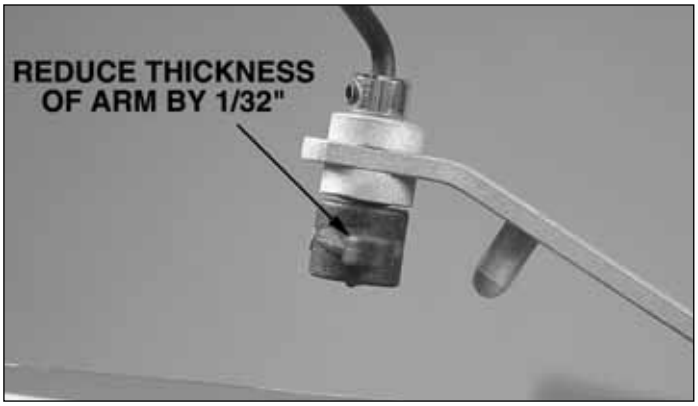


❏ ❏ 7. Install the completed pushrod to the elevator and servo, securing the clevis with the silicone clevis keeper.
Note: If you **plan** to use your Extra 300S primarily for 3D flying, read the optional rudder servo installation on page 20.

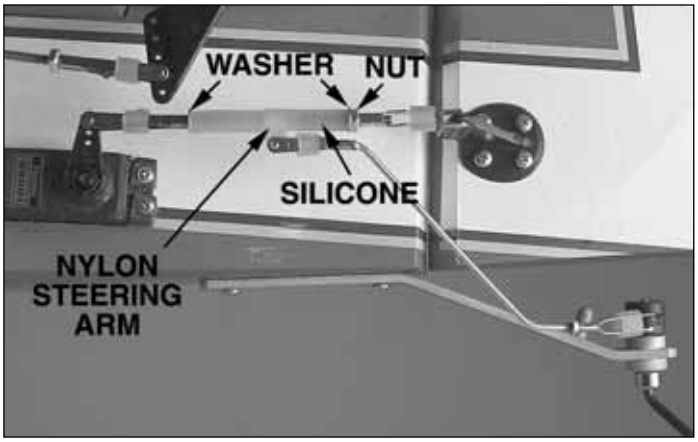
❏ 8. Repeat steps 4-7 for the right side of the fuselage.



❏ 9. Install the rudder servo in the remaining opening on the left side of the fuselage. The rudder servo should be a minimum torque rating of 87 oz. in. Use the same installation method and pushrod technique you used for the elevator.



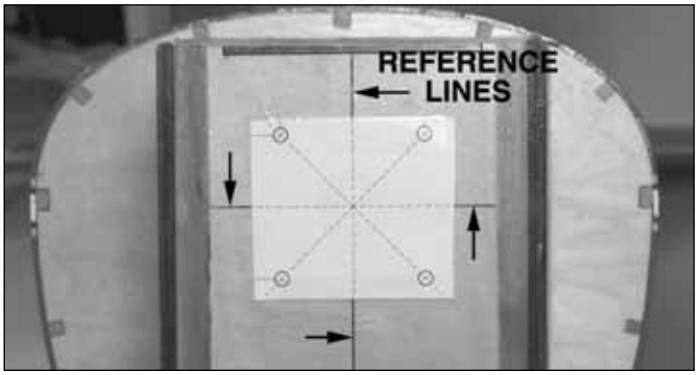
❏ 10. A 2-56 clevis will be used to attach the tail wheel steering arm to the rudder servo but the steering arm is slightly too thick for the clevis. Sand off 1/32" [.8mm] from the face of the steering arm, allowing a 2-56 clevis to fit easily over the arm.



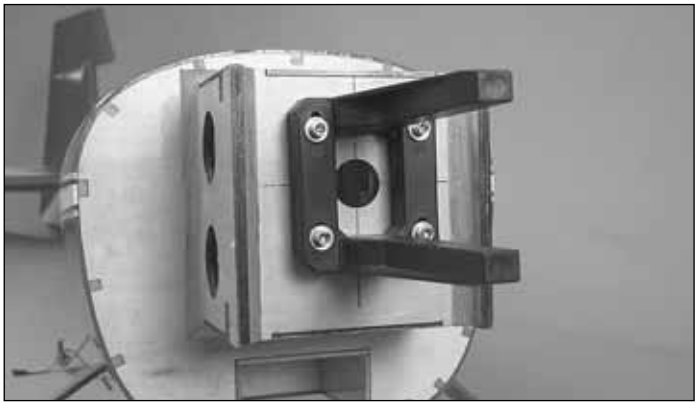
❏ 11. Examine the photograph to help in making the tail wheel steering control arm. Remove the clevis from the rudder control arm. Then remove the 4-40 threaded clevis and 4-40 nut from the pushrod wire. Slide a #4 washer onto the rudder pushrod followed by a 1" piece of silicone fuel tubing, the nylon steering horn, another piece of 1" silicone fuel tubing and another #4 washer. Reinstall the 4-40 nut onto the pushrod followed by the 4-40 aluminum clevis. Adjust the rudder clevis and then tighten the 4-40 nut against the clevis.

❏ 12. Install a 2-56 nut completely onto the threaded end of the .074 x 6" [1.9 x 152mm] wire. Cut 1/2" [13mm] off of the threaded end of the wire. Unscrew the nut from the threads; this will clean up the threads allowing the 2-56 clevis to easily thread onto the wire. Re-install the nut followed by a 2-56 aluminum threaded clevis. Bend the wire as shown in the photograph in step #11. Install the wire and clevis to the tail wheel steering arm. Install a 2-56 solder clevis onto the nylon steering horn. Center the tail wheel with the rudder. Cut the non-threaded end of the wire to length to fit into the solder clevis. Remove the wire and clevises from the model. Solder the 2-56 solder clevis to the end of the wire using the same technique used on the pushrod wires. Install the wire to the tail wheel and the nylon steering horn. Minor adjustments to the steering arm can be made at the threaded clevis. Once adjusted properly, tighten the nut against the clevis.

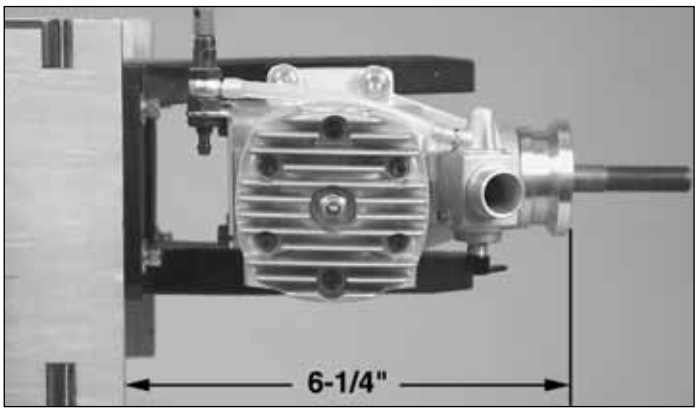
Install the Engine, Fuel Tank & Throttle Servo



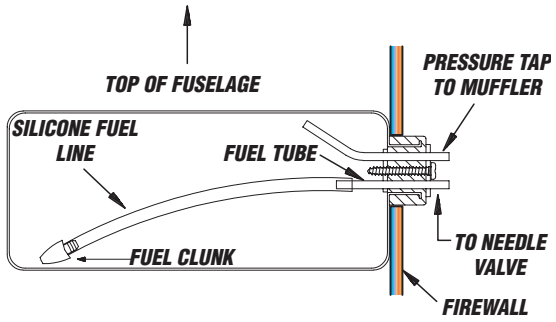
❏ 1. Using a fine tip marker, extend the reference lines on the firewall. Tape the engine mounting pattern located on page 27 to the firewall. Align the reference lines on the pattern with the lines on the firewall. Drill through the firewall on the reference holes with a 3/16" [4.8mm] bit.



❏ 2. Install the engine mount onto the firewall with four #8 x 1-1/4" [32mm] socket head cap screws, #8 flat washers and #8 lock washers. When installing the mount be sure you orient it as shown so that the engine can be mounted on its side.



❏ 3. Mark the location of the engine mount holes on the mount. Drill a 9/64" [4mm] hole through each of these marks. Run an 8/32 tap through each hole. Mount the engine to the mount with four #8 x 1" [25mm] socket head cap screws, #8 flat washers and #8 lock washers. Mount the engine so that the distance from the front of the firewall to the front of the engine thrust washer is 6-1/4" [159mm].

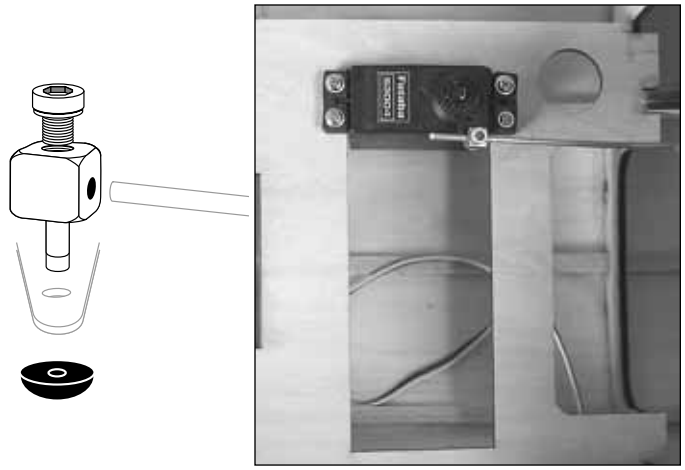


❏ 4. Assemble the **fuel tank** as shown in the sketch. When tightening the center screw be sure not to over tighten it. You just want it snug enough to pull the rubber stopper tight against the tank.

❏ 5. Install the tank into the fuselage with the neck of the tank through the firewall. Hold the tank in place inside the fuselage by gluing a balsa stick (not included) across the back of the tank.

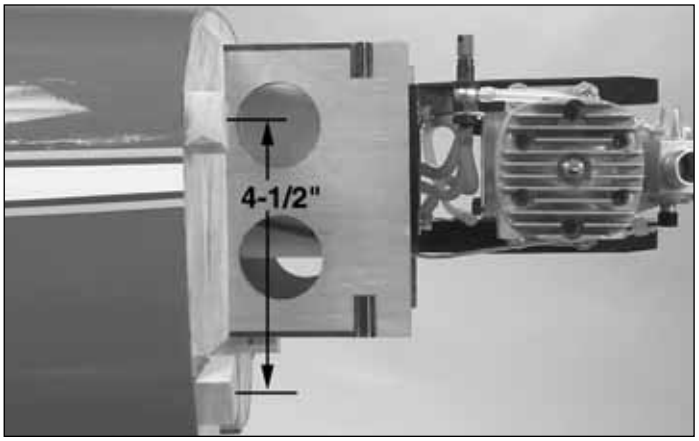
❏ 6. Install silicone fuel tubing, (not included in the kit) onto the aluminum tubes from the fuel tank. The line with the fuel clunk will feed to the fuel inlet at the needle valve and the other will attach to the pressure tap on the muffler. For our installation we chose to use an external fill valve. If you choose to do this, follow the instructions with your particular brand of fuel valve. Should you choose not to install a fuel filler valve you can fill the fuel tank by removing the fuel line to the carburetor and filling through it. Depending how you cut out the cowling to accommodate the engine, the cowling may make it difficult to access the carburetor. You can also install a third line to the tank and use it for filling the tank. The method you use is your choice but make your decision before moving onto the installation of the fuel tank.

❏ 7. Drill a 13/64" [5.2mm] hole in the firewall in line with the throttle arm. Locate the 11-3/4" gray plastic tube. Roughen one end of the tube with 220-grit sandpaper. Insert the unsanded end of the tube into the hole you have drilled. Glue the tube flush to the firewall. Install a nylon clevis and silicone clevis keeper onto the threaded end of the .074 x 17-1/2" [445mm] wire approximately 20 turns. Insert the wire throttle pushrod into the plastic tube. The pushrod will need to be bent to work with your particular engine and muffler. When bending the pushrod wire be sure that the wire does not make contact with the engine or muffler. Metal to metal contact can set up radio interference. Be sure the throttle pushrod operates smoothly after all of the bends have been made.

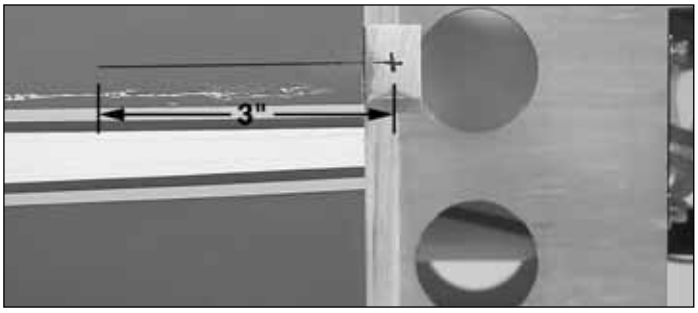


❏ 8. Attach the nylon clevis to the throttle arm. Install the throttle servo into the servo tray inside the fuselage. Mount it using the same method used on the servos you have already installed. Install a screw-lock connector onto the servo arm securing it to the arm with the nylon retainer. Insert the wire into the hole in the screw-lock connector and secure it with a 6-32 x 1/8" [3mm] socket head cap screw.

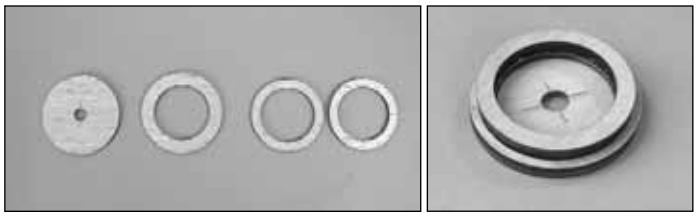
INSTALL THE COWL



❏ 1. Locate four hardwood **cowl mounting blocks**. Position one block just above the trim stripe on the fuselage. Using 6-minute epoxy glue one block to the firewall, flush with the fuselage. Glue the second block to the firewall, locating it approximately 4-1/2" [114mm] below the other block. Repeat this on the other side of the fuselage.

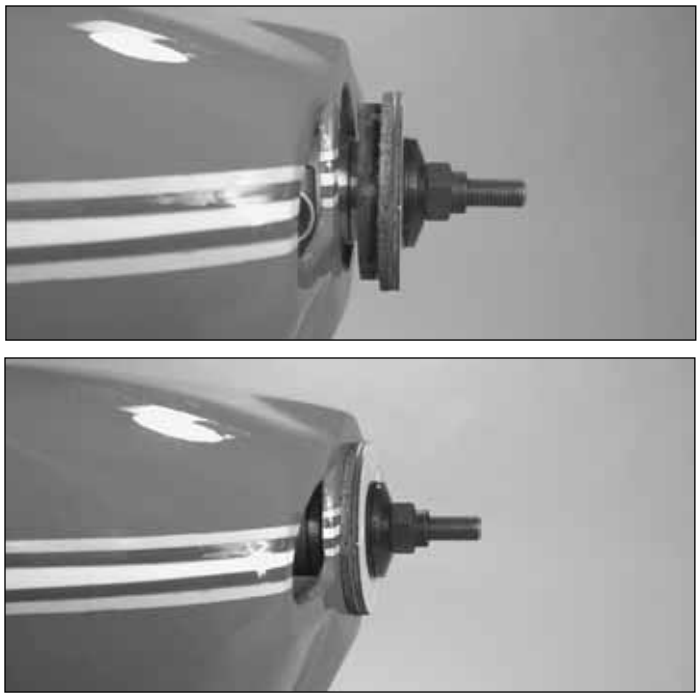


❏ 2. Make a mark in the center of each block. Using a felt tip marker draw a 3" [76mm] line back onto the fuselage. Do this on each of the four mounting blocks.



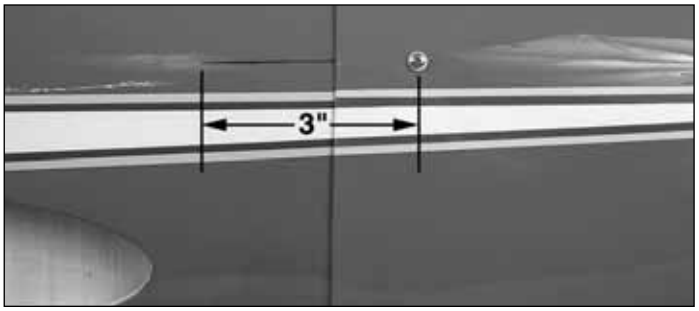
❏ 3. Locate one 1/8" [3mm] balsa disk, one 1/8" [3mm] balsa ring and two 1/8" [3mm] balsa rings. Glue the 1/8" [3mm] balsa ring onto the 1/8" [3mm] balsa disk, carefully aligning the outer edges. Glue the two 1/8" [3mm] rings together forming a 1/4" [6mm] ring. Glue the 1/4" [6mm] balsa ring onto the 1/8" [3mm] balsa ring, carefully aligning the inside edges.

❏ 4. These disks will now be an alignment tool for centering the cowl. The hole in the center of the plywood plate is designed to fit the crankshaft of an O.S.® 1.20. If you are using a larger engine than the 1.20, the crankshaft is most likely larger. Use a propeller reamer to make the hole in the center of the plywood plate fit your particular engine crankshaft.



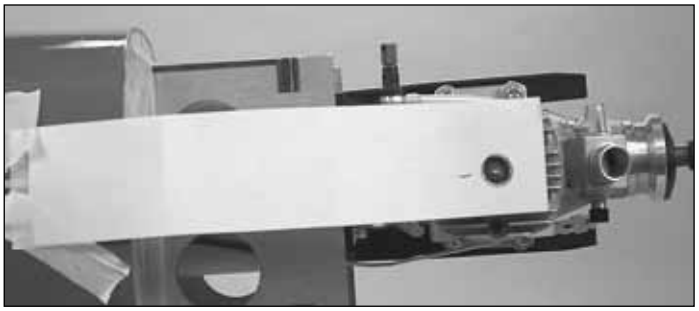
❏ 5. Install the cowl over the engine. Slide the alignment tool over the crankshaft and firmly against the engine thrust washer. Tighten the prop nut and washer against the plywood plate. With the alignment tool tight to the engine thrust washer, slide the opening in the cowl over the alignment tool. When the front of the cowl is tight against the alignment tool the cowl is properly centered and is positioned for the proper clearance between the spinner back plate and the cowl.

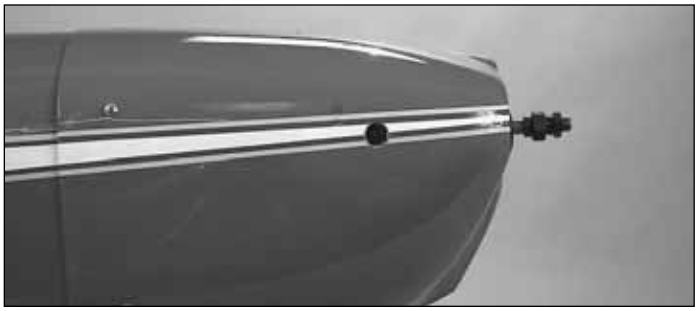
❏ 6. Keeping the cowl tight against the alignment tool, position the cowl so the paint lines on the cowl and fuselage are in alignment with each other. When properly positioned, tape the cowl in place to the fuselage.



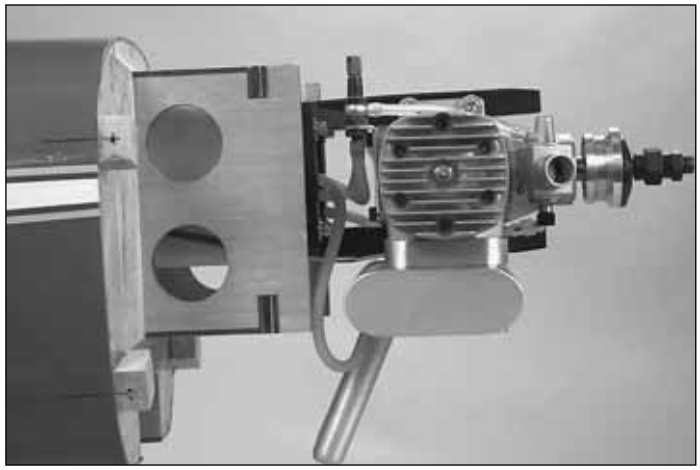
❏ 7. Measure 3" [76mm] back to the cowl from the end of the reference lines you made. Drill a 3/32" [2.4mm] hole through the cowl and into the cowl mounting block. Install a #4 x 1/2" [13mm] sheet metal screw and a #4 flat washer into each of the holes drilled. Remove the alignment tool after the cowl has been secured with the four screws.

❏ 8. Remove the cowl. Put a couple of drops of thin CA into the holes in the mounting blocks to harden the threads.





❏ 9. Cut a piece of card stock 2" x 10" [51 x 254mm]. Tape it to the side of the fuselage in line with the glow plug. Mark the location of the glow plug on the card stock. Re-install the cowling so the card stock is outside of the cowl. Transfer the glow plug location to the cowl and cut the hole for the glow plug using a high speed rotary tool. Use this same technique for locating the needle valve.



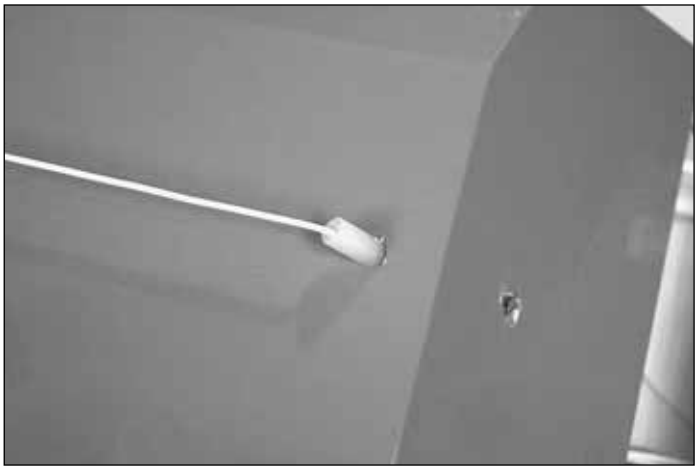
❏ 10. Remove the cowl and install the muffler for your engine. We used the Bisson Pitts muffler (BISG4116) for the O.S. 160. Make the appropriate cut out in the cowl to accommodate your choice of muffler.

❏ 11. Once you have completed cutting the cowl, reinstall the cowl and install the prop and spinner.

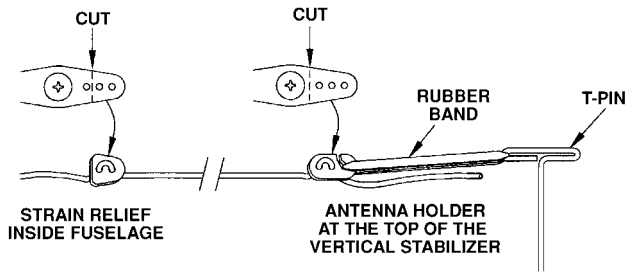
RADIO INSTALLATION

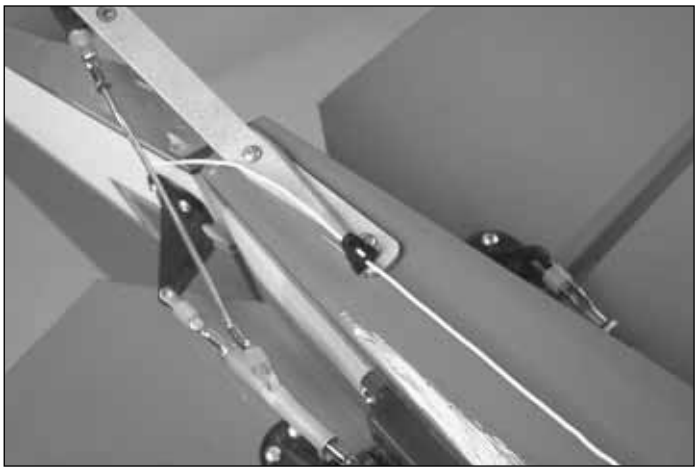
❏ 1. Cut the 10" [254mm] piece of Velcro® into two 5" [127mm] lengths.

❏ 2. Install the receiver and battery as shown. Install a piece of foam under the battery and receiver. Use the Velcro to hold them in place. Plug all of the servos into the proper channel in the receiver. Install a switch and charge jack into the fuselage. Plug the battery into the switch and secure the connector with a piece of heat shrink tubing, tape or other method of securing the connectors to prevent them from accidentally separating.



❏ 3. Drill a hole in the bottom of the fuselage approximately 3/4" [19mm] behind the wing. The hole should be slightly under-sized from the outer dimension of the silicone you choose to use. Install a 3/4" [19mm] length of silicone fuel tubing (not included) into the hole.



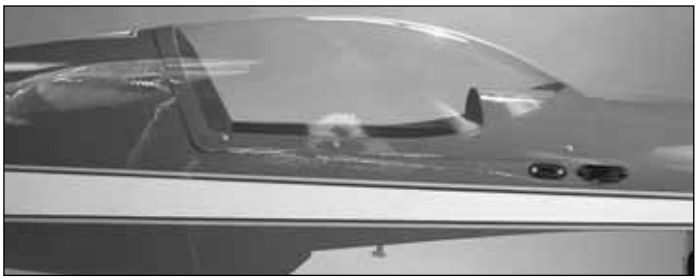


❏ 4. From a servo horn, make a strain relief as shown. Install the receiver wire through the silicone tube you installed in the fuselage. Secure the end of the antenna wire around the tail wheel with a rubber band.

FINISHING TOUCHES

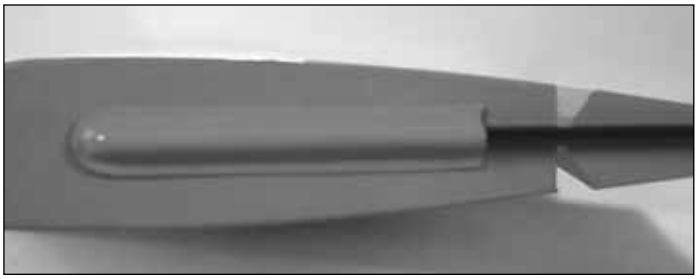
❏ 1. Before installing the canopy you may wish to paint the cockpit area and install a pilot. Once the paint has dried install the instrument panel decal.

❏ 2. Cut the canopy on the cut lines. Look inside the cockpit. You will see that there is a plywood rail on each side. This rail also extends into the fuselage. If you look inside of the fuselage you can see this rail. This rail will provide a secure mount for screwing the canopy in place. If you prefer, you can glue the canopy in place.

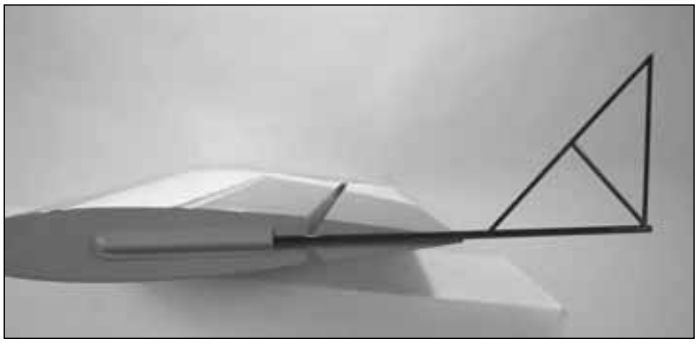


❏ 3. Position the canopy on the fuselage. Drill three 1/16" [1.6mm] holes through the canopy and fuselage on both sides of the canopy. **Before you drill be sure you are drilling over the mounting rails!** Remove the canopy and drill a 3/32" [2.4mm] hole through each of the holes in the canopy. Install and then remove a #2 x 3/8" [9.5mm] sheet metal screw into each of the canopy mounting holes in the fuselage. Apply a drop of thin CA into the holes to harden the threads in the plywood rails. Install the canopy using three #2 x 3/8" [9.5mm] sheet metal screws and three #2 washers on each side of the canopy.

We have included the option of installing an "aerobatic sighting reference guide tube" on each of the wing tips. These are commonly found on most aerobatic airplanes. These are not meant to be permanently mounted and left on during flight (though you could if you wish). They are for static display and are easily removable before flight.



❏ 4. Position the ABS plastic tube holders on the wing tip as shown. Trace the outline of the tube holders onto the wingtip. Cut away a strip of the covering just inside the reference lines. Glue the tube holders in place with 6-minute epoxy. Do this for both wing tips.



❏ 5. Slide the aerobatic sighting reference guide tube into the tube holder when you wish to display the airplane with them on.

Apply the Decals

❏ 1. Use scissors or a sharp hobby knife to cut the decals from the sheet.

❏ 2. Be certain the model is clean and free from oily fingerprints and dust. Prepare a dishpan or small bucket with a mixture of liquid dish soap and warm water—about one teaspoon of soap per gallon of water. Submerse the decal in the soap and water and peel off the paper backing. **Note:** Even though the decals have a "sticky-back" and are not the water transfer type, submersing them in soap & water allows accurate positioning and reduces air bubbles underneath.

❏ 3. Position the decal on the model where desired. Holding the decal down, use a paper towel to wipe away most of the water.

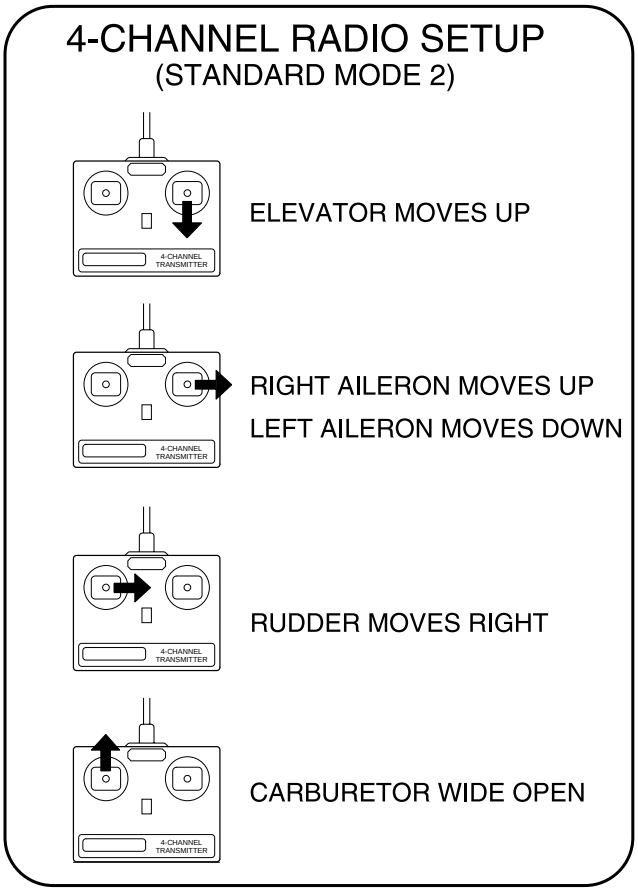
❏ 4. Use a piece of soft balsa or something similar to squeegee the remaining water from under the decal. Apply the rest of the decals the same way.

PREPARE TO FLY

Check the Control Directions

❏ 1. Turn on the transmitter and receiver and center the trims. If necessary, remove the servo arms from the servos and reposition them so they are centered. Reinstall the screws that hold on the servo arms.

❏ 2. With the transmitter and receiver still on, check all the control surfaces to see if they are centered. If necessary, adjust the clevises on the pushrods to center the control surfaces.



❑ 3. Make certain that the control surfaces and the carburetor respond in the correct direction as shown in the diagram. If any of the controls respond in the wrong direction, use the servo reversing in the transmitter to reverse the servos connected to those controls. Be certain the control surfaces have remained centered. Adjust if necessary.

Set the Control Throws

Use a Great Planes AccuThrow (or a ruler) to accurately measure and set the control throw of each control surface as indicated in the chart that follows. If your radio does not have dual rates, we recommend setting the throws at the **low** rate setting.

NOTE: The throws are measured at the **widest part** of the elevators, rudder and ailerons.

These are the recommended control surface throws:

	High Rate	Low Rate
ELEVATOR:	1/2" up [12.7mm] 1/2" down [12.7mm]	3/8" up [9.5mm] 3/8" down [9.5mm]
RUDDER:	4" right [102mm] 4" left [102mm]	2-1/2" right [64mm] 2-1/2" left [64mm]
AILERONS:	1" up [25.4mm] 1" down [25.4mm]	5/8" up [15.9mm] 5/8" down [15.9mm]

IMPORTANT: The Extra 300S 1.60 ARF has been **extensively** flown and tested to arrive at the throws at which it flies best. Flying your model at these throws will provide you with the greatest chance for successful first flights. If, after you have become accustomed to the way the Extra 300S flies, you would like to change the throws to suit your taste, that is fine. However, too much control throw could make the model difficult to control, so remember, "more is not always better."

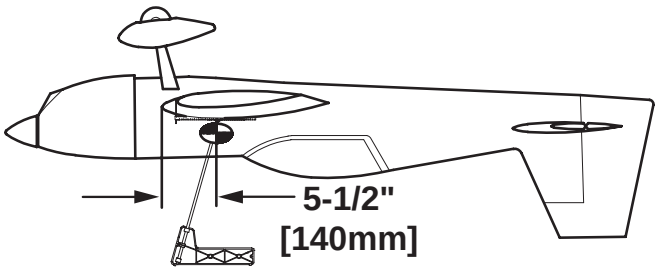
Balance the Model (C.G.)

More than any other factor, the **C.G.** (balance point) can have the **greatest** effect on how a model flies, and may determine whether or not your first flight will be successful. If you value this model and wish to enjoy it for many flights, **DO NOT OVERLOOK THIS IMPORTANT PROCEDURE.** A model that is not properly balanced will be unstable and possibly unflyable.

At this stage the model should be in ready-to-fly condition with all of the systems in place including the engine, landing gear, covering and paint, and the radio system.

❑ 1. Use a felt-tip pen or 1/8"-wide tape to accurately mark the C.G. on the bottom of the wing on both sides of the fuselage. The C.G. is located 5-1/2" [140mm] back from the leading edge of the wing.

This is where your model should balance for the first flights. Later, you may wish to experiment by shifting the C.G. up to 3/4" [19mm] forward or 1/2" [13mm] back to change the flying characteristics. Moving the C.G. forward may improve the smoothness and stability, but the model may then require more speed for takeoff and make it more difficult to slow for landing. Moving the C.G. aft makes the model more maneuverable, but could also cause it to become too difficult to control. In any case, **start at the recommended balance point** and do not at any time balance the model outside the specified range.



❏ 2. With the wing attached to the fuselage, all parts of the model installed (ready to fly) and an empty fuel tank, place the model upside-down on a Great Planes CG Machine, or lift it upside-down at the balance point you marked.

❏ 3. If the tail drops, the model is "tail heavy" and the battery pack and/or receiver must be shifted forward or weight must be added to the nose to balance. If the nose drops, the model is "nose heavy" and the battery pack and/or receiver must be shifted aft or weight must be added to the tail to balance. If possible, relocate the battery pack and receiver to minimize or eliminate any additional ballast required. If additional weight is required, nose weight may be easily added by using a "spinner weight" (GPMQ4645 for the 1 oz. weight, or GPMQ4646 for the 2 oz. weight). If spinner weight is not practical or is not enough, use Great Planes (GPMQ4485) "stick-on" lead. A good place to add stick-on nose weight is to the firewall (don't attach weight to the cowl—it is not intended to support weight). Begin by placing incrementally increasing amounts of weight on the bottom of the fuse over the firewall until the model balances. Once you have determined the amount of weight required, it can be permanently attached. If required, tail weight may be added inside of the hatch on the bottom of the fuse and gluing it permanently inside.
Note: Do not rely upon the adhesive on the back of the lead weight to permanently hold it in place. Over time, fuel and exhaust residue may soften the adhesive and cause the weight to fall off. Use #2 sheet metal screws, RTV silicone or epoxy to permanently hold the weight in place.

❏ 4. **IMPORTANT:** If you found it necessary to add any weight, recheck the C.G. after the weight has been installed.

Balance the Model Laterally

❏ 1. With the wing level, have an assistant help you lift the model by the engine propeller shaft and the bottom of the fuse under the TE of the fin. Do this several times.

❏ 2. If one wing always drops when you lift the model, it means that side is heavy. Balance the airplane by adding weight to the other wing tip. **An airplane that has been laterally balanced will track better in loops and other maneuvers.**

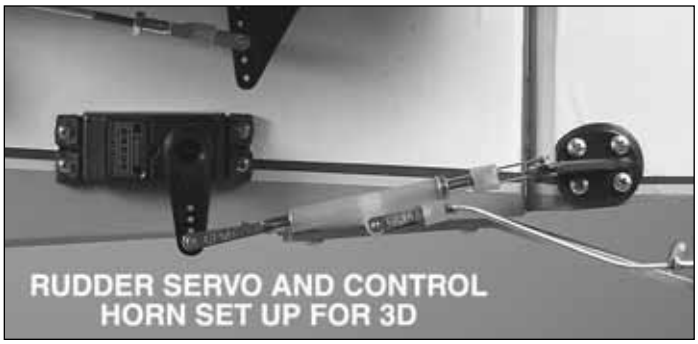
3-D PERFORMANCE SETTINGS

The Great Planes Extra 300S 1.60 ARF will perform 3-D aerobatics easily if you use the largest engines recommended within the engine range. If you setup your airplane to do 3D maneuvers, you will need to be throttle conscious; that is, never apply full throttle on straight and level flying or in dives to prevent flutter.

3D Control Throws

ELEVATOR:	3/4" up [19.1mm]	3/4" down [19.1mm]
RUDDER:	6-1/2" right [165.1mm]	6-1/2" left [165.1mm]
AILERONS:	2" up [51mm]	2" down [51mm]

3D Rudder Servo/Control Horn Installation

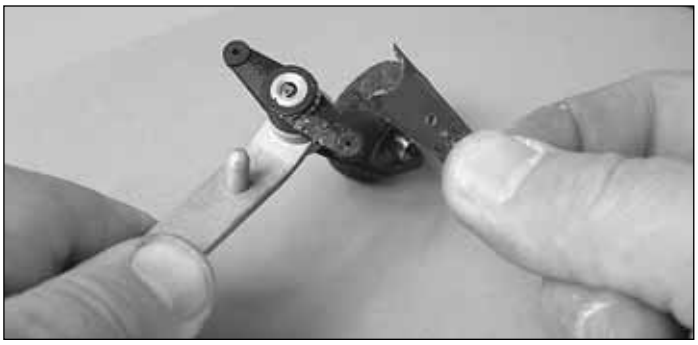


❏ 1. Because 3D flying requires very large control throws you need to mount the servo arm so that it is pointing towards the bottom of the fuselage instead of towards the stab as shown on page 13 of the instruction manual. This also requires that you mount the control horn at the very bottom of the rudder. The standard aerobatic linkage set up is a very straight linkage between the servo and the rudder but there is a chance that at the extreme ends of the

recommended 3D control throws you could have a conflict between the elevator and rudder servos and servo arms. If your primary flying will be 3D we recommend you set the linkage as shown for 3D flight.

Note: When using the extreme throws of 3D flight you need to make the tail wheel control arm longer so that the mechanical linkage from the rudder servo to the rudder will not limit the distance the rudder can travel.

❑ 2. Cut one of the Dubro Super Strength Arms as shown.



❑ 3. Glue the cut servo arm to the arm on the tail wheel with CA.

❑ 4. Install a small screw though both horns.

Complete the assembly following the instructions on page 14 step 10 of the instruction manual

3D Servo Arms

Larger than stock servo arms are highly recommended for getting the 3D throws for the Extra 300S ARF. Do not move the pushrods in on the control horns to get the increased throw, as doing that intensifies any play in the system. Dubro Super Strength Arms sets (DUBM6670) were used on the test models.

3D Servos

The large control throws require servos with great centering. The digital servos are second to none in this department. Digital servos such as the Futaba S9250 (FUTM0220) should be used on all control surfaces of this airplane for optimum performance. The test models were also flown successfully in 3D mode with analog Futaba S9304 (FUTM0095) servos.

EXPERT TIP

COMPUTER RADIOS

As you prepare to fly your Extra 300S 1.60 ARF for the first time, there are a few features on computer radios we'd like to mention. There are many others, of course, but these are commonly used features on most computer radios. If you are using a non-computerized radio, this information may still be of interest to you for future installations.

ATV or Travel Volume: ATV is a wonderful feature of computer radios which allows you to make minor adjustments to how far a servo travels at its extremes. For example, you install the throttle pushrod, and it's almost perfect, except you have some binding at wide open. Instead of struggling with the clevises to try to keep full throttle but not have the binding, you can turn down the ATV slightly until the binding is gone. Why only adjust ATV slightly? Control linkages are really just a lesson in leverage. The less distance the servo is moving for a given throw at the surface, the less leverage you have given the servo to do the job. Thus the lower you set the ATV the less power you are leaving for the servo to apply to the surface. Additionally, a servo has only so many points within its range of motion. By cutting its range in half, you've also diminished the precision of the servo by 50%. Because of both of these issues, we strongly recommend setting the high rates as close as possible to 100% on the ATV.

Dual Rates: Setting dual rates helps make your model easier to fly in a variety of situations. For example, an expert pilot who wants to do torque rolls will need a large amount of control throw. However, he does not want that same huge volume of throw when he is trying

to do smooth loops or slow rolls. Low rates give your model a soft feel, with aggressive responsiveness just a flip of a switch away.

Exponential, the best of both rates: Exponential is a feature which modelers tend to either love or hate. The benefits of exponential are that they make the elevator, for example, feel like it is on low rates when you are moving the stick near center; however, when you get farther from center the model gets progressively more responsive. The reason this is helpful is that it allows you to make soft, minor adjustments when small corrections are needed, but still allows you sufficient throw to make major changes at full stick. For example, you can smoothly level the wings while flying along straight and level without over-controlling, yet still have enough aileron throw at full stick to complete a one-second roll.

Idle Down and Throttle Kill: Idle down allows you to have a switch set for a high idle, ideal for most aerobatics where you have little or no risk of dead sticking, as well as a lower idle setting for, say, landings, taxiing, and minimum throttle maneuvers such as spins. The throttle kill setting on most computer radios will idle your engine down whatever percent you set it so that your engine will shut off when the switch is thrown and the throttle stick is in the idle position. This is an excellent safety feature to shut off your engine in emergency situations.

PREFLIGHT

Identify Your Model

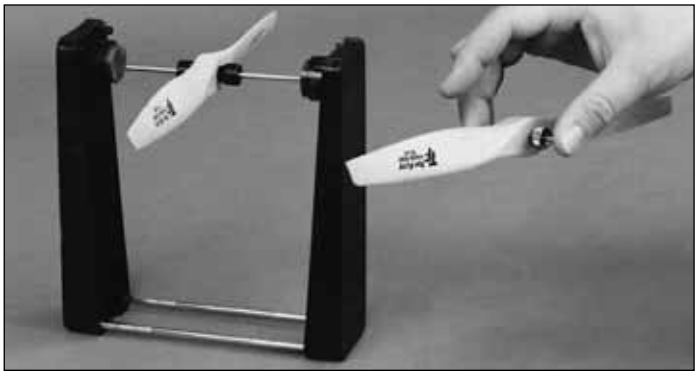
No matter if you fly at an AMA sanctioned R/C club site or if you fly somewhere on your own, you should always have your name, address, telephone number and AMA number on or inside your model. It is **required** at all AMA R/C club flying sites and AMA sanctioned flying events. Fill out the identification tag on the decal sheet and place it on or inside your model.

Charge the Batteries

Follow the battery charging instructions that came with your radio control system to charge the batteries. You should always charge your transmitter and receiver batteries the night before you go flying, and at other times as recommended by the radio manufacturer.

NOTE: Checking the condition of your receiver battery pack is **highly recommended**. All battery packs, whether it's a trusty pack you've just taken out of another model, or a new battery pack you just purchased, should be cycled, noting the discharge capacity. Oftentimes, a weak battery pack can be identified (and a valuable model saved!) by comparing its actual capacity to its rated capacity. Refer to the instructions and recommendations that come with your cycler. If you don't own a battery cycler, perhaps you can have a friend cycle your pack and note the capacity for you.

Balance Propellers



Carefully balance your propeller and spare propellers before you fly. An unbalanced prop can be the single most significant cause of vibration that can damage your model. Not only will engine mounting screws and bolts loosen, possibly with disastrous effect, but vibration may also damage your radio receiver and battery. Vibration can also cause your fuel to foam, which will, in turn, cause your engine to run hot or quit. We use a Top Flite Precision Magnetic Prop Balancer™ (TOPQ5700) in the workshop and keep a Great Planes Fingertip Prop Balancer (GPMQ5000) in our flight box.

Ground Check

If the engine is new, follow the engine manufacturer's instructions to break-in the engine. After break-in, confirm that the engine idles reliably, transitions smoothly and rapidly to full power and maintains full power—indefinitely. After you run the engine on the model, inspect the model closely to make sure all screws remained tight, the hinges are secure, the prop is secure and all pushrods and connectors are secure.

Range Check

Ground check the operational range of your radio before the first flight of the day. With the transmitter antenna collapsed and the receiver and transmitter on, you should be able to walk at least 100 feet away from the model and still have control. Have an assistant stand by your model and, while you work the controls, tell you what the control surfaces are doing. Repeat this test **with the engine running** at various speeds with an assistant holding the model, using hand signals to show you what is happening. If the control surfaces do not respond correctly, **do not fly!** Find and correct the problem first. Look for loose servo connections or broken wires, corroded wires on old servo connectors, poor solder joints in your battery pack or a defective cell, or a damaged receiver crystal from a previous crash.

ENGINE SAFETY PRECAUTIONS

Failure to follow these safety precautions may result in severe injury to yourself and others.

Keep all engine fuel in a safe place, away from high heat, sparks or flames, as fuel is very flammable. Do not smoke near the engine or fuel; and remember that engine exhaust gives off a great deal of deadly carbon monoxide. Therefore **do not run the engine in a closed room or garage**.

Get help from an experienced pilot when learning to operate engines.

Use safety glasses when starting or running engines.

Do not run the engine in an area of loose gravel or sand; the propeller may throw such material in your face or eyes.

Keep your face and body as well as all spectators away from the plane of rotation of the propeller as you start and run the engine.

Keep these items away from the prop: loose clothing, shirt sleeves, ties, scarfs, long hair or loose objects such as pencils or screwdrivers that may fall out of shirt or jacket pockets into the prop.
Use a "chicken stick" or electric starter to start the engine. Do not use your fingers to flip the propeller. Make certain the glow plug clip or connector is secure so that it will not pop off or otherwise get into the running propeller.

Make all engine adjustments from behind the rotating propeller.

The engine gets hot! Do not touch it during or right after operation. Make sure fuel lines are in good condition so fuel will not leak onto a hot engine, causing a fire.

To stop a glow engine, cut off the fuel supply by closing off the fuel line or following the engine manufacturer's recommendations. Do not use hands, fingers or any other body part to try to stop the engine. To stop a gasoline powered engine an on/off switch should be connected to the engine coil. Do not throw anything into the propeller of a running engine.

AMA SAFETY CODE (excerpts)

Read and abide by the following Academy of Model Aeronautics Official Safety Code:

GENERAL

1. I will not fly my model aircraft in competition or in the presence of spectators until it has been proven to be airworthy by having been previously successfully flight tested.

2. I will not fly my model aircraft higher than approximately 400 feet within 3 miles of an airport without notifying the airport operator. I will give right of way to and avoid flying in the proximity of full scale aircraft. Where necessary, an observer shall be utilized to supervise flying to avoid having models fly in the proximity of full-scale aircraft.

3. Where established, I will abide by the safety rules for the flying site I use and I will not willfully and deliberately fly my models in a careless, reckless and/or dangerous manner.

7. I will not fly my model unless it is identified with my name and address or AMA number, on or in the model.

RADIO CONTROL

1. I will have completed a successful radio equipment ground check before the first flight of a new or repaired model.

2. I will not fly my model aircraft in the presence of spectators until I become a qualified flyer, unless assisted by an experienced helper.

3. I will perform my initial turn after takeoff away from the pit, spectator and parking areas and I will not thereafter perform maneuvers, flights of any sort or landing approaches over a pit, spectator or parking area.

4. I will operate my model using only radio control frequencies currently allowed by the Federal Communications Commission.

CHECK LIST

During the last few moments of preparation your mind may be elsewhere anticipating the excitement of the first flight. Because of this, you may be more likely to overlook certain checks and procedures that should be performed before the model is flown. To help avoid this, a check list is provided to make sure these important areas are not overlooked. Many are covered in the instruction manual, so where appropriate, and refer to the manual for complete instructions. Be sure to check the items off as they are completed.

- ❏ 1. Fuelproof all areas exposed to fuel or exhaust residue such as the wing saddle area or the engine spacer if needed.
- ❏ 2. Check the C.G. according to the measurements provided in the manual.
- ❏ 3. Be certain the battery and receiver are securely mounted in the fuse. Simply stuffing them into place with foam rubber is not sufficient.
- ❏ 4 Extend your receiver antenna and make sure it has a strain relief inside the fuselage to keep tension off the solder joint inside the receiver.
- ❏ 5. Balance your model *laterally* as explained in the instructions.

❑ 6. Use thread locking compound to secure critical fasteners such as the screws that hold the carburetor arm (if applicable), Screw-Lock pushrod connectors, etc.
❑ 7. Add a drop of oil to the axles so the wheels will turn freely.
❑ 8. Make sure all hinges are **securely** glued in place.
❑ 9. Reinforce holes for wood screws with thin CA where appropriate (servo mounting screws, cowl mounting screws, etc.).
❑ 10. Confirm that all controls operate in the correct direction and the throws are set up according to the manual.
❑ 11. Make sure there are silicone retainers on all the clevises and that all servo arms are secured to the servos with the screws included with your radio.
❑ 12. Secure the connections between servo wires and Y-connectors or servo extensions, and the connection between your battery pack and the on/off switch with vinyl tape, heat shrink tubing or special clips suitable for that purpose.
❑ 13. Make sure any servo extension cords you may have used do not interfere with other systems (servo arms, pushrods, etc.).
❑ 14. Secure the pressure tap (if used) to the muffler with high temp RTV silicone, thread locking compound or J.B. Weld.
❑ 15. Make sure the fuel lines are connected and are not kinked.
❑ 16. Balance your propeller (and spare propellers).
❑ 17. Tighten the propeller nut and spinner.
❑ 18. Place your name, address, AMA number and telephone number on or inside your model.
❑ 19. Cycle your receiver battery pack (if necessary) and make sure it is fully charged.
❑ 20. If you wish to photograph your model, do so before your first flight.
❑ 21. Range check your radio when you get to the flying field.

FLYING

The Extra 300S 1.60 ARF is a great-flying model that flies smoothly and predictably. It does not, however, possess the self-recovery characteristics of a primary R/C trainer and should be flown only by experienced R/C pilots.

Fuel Mixture Adjustments
A fully cowled engine may run at a higher temperature than an un-cowled engine. For this reason, the fuel mixture should be richened so the engine runs at about 200 rpm below peak speed. By running the engine slightly rich, you will help prevent dead-stick landings caused by overheating.

CAUTION (THIS APPLIES TO ALL R/C AIRPLANES): If, while flying, you notice an alarming or unusual sound such as a low-pitched "buzz," this may indicate control surface *flutter.* Flutter occurs when a control surface (such as an aileron or elevator) or a flying surface (such as a wing or stab) rapidly vibrates up and down (thus causing the noise). In extreme cases, if not detected immediately, flutter can actually cause the control surface to detach or the flying surface to fail, thus causing loss of control followed by an impending crash. The best thing to do when flutter is detected is to slow the model **immediately** by reducing power, then land as soon as safely possible. Identify which surface fluttered (so the problem may be resolved) by checking all the servo grommets for deterioration or signs of vibration. Make certain all pushrod linkages are secure and free of play. If it fluttered once, under similar circumstances it will probably flutter again unless the problem is fixed. Some things which can cause flutter are; Excessive hinge gap; Not mounting control horns solidly; Poor fit of clevis pin in horn; Side-play of wire pushrods caused by large bends; Excessive free play in servo gears; Insecure servo mounting; and one of the most prevalent causes of flutter; Flying an over-powered model at excessive speeds.

Takeoff

Before you get ready to takeoff, see how the model handles on the ground by doing a few practice runs at **low speeds** on the runway. Hold "up" elevator to keep the tail wheel on the ground. If necessary, adjust the tail wheel so the model will roll straight down the runway. If you need to calm your nerves before the maiden flight, shut the engine down and bring the model back into the pits. Top off the fuel, then check all fasteners and control linkages for peace of mind.

Remember to takeoff into the wind. When you're ready, point the model straight down the runway, hold a bit of up elevator to keep the tail on the ground to maintain tail wheel steering, then gradually advance the throttle. As the model gains speed decrease up elevator allowing the tail to come off the ground. One of the most important things to remember with a tail dragger is to always be ready to apply **right** rudder to counteract engine torque. Gain as much speed as your runway and flying site will practically allow before gently applying up elevator, lifting the model into the air. At this moment it is likely that you will need to apply more right rudder to counteract engine torque. Be smooth on the elevator stick, allowing the model to establish a **gentle** climb to a safe altitude before turning into the traffic pattern.

Flight

For reassurance and to keep an eye on other traffic, it is a good idea to have an assistant on the flight line with you. Tell him to remind you to throttle back once the plane gets to a comfortable altitude. While full throttle is usually desirable for takeoff, most models fly more smoothly at reduced speeds.

Take it easy with the Extra 300S 1.60 ARF for the first few flights, gradually getting acquainted with it as you gain confidence. Adjust the trims to maintain straight and level flight. After flying around for a while, and while still at a safe altitude with plenty of fuel, practice slow flight and execute practice landing approaches by reducing the throttle to see how the model handles at slower speeds. Add power to see how she climbs as well. Continue to fly around, executing various maneuvers and making mental notes (or having your assistant write them down) of what trim or C.G. changes may be required to fine tune the model so it flies the way you like. Mind your fuel level, but use this first flight to become familiar with your model before landing.

Aerobatics

The Extra 300S 1.60 ARF is capable of doing virtually all aerobatic maneuvers including 3-D flying. Before flying with 3-D control throws it is recommended that you fly the plane at the recommended high and low rates. Maneuvers such as rolls, loops, snaps, hammerheads, etc can all be executed on low rates. Use of high rates will allow for more advanced maneuvers such as the lomcevak, flat spin and knife-edge. Use of the 3-D rates will make the plane unstable. Unsuspecting pilots could find themselves in trouble quickly with these extreme control throws. If you are inexperienced with 3-D flying we recommend you practice a couple of mistakes high until you become familiar with the plane's characteristics. If your radio has multiple rate capability, use of a rate switch that will allow you to toggle back and forth between normal and 3-D rates is a good idea.

You will find that with the plane properly set up, there is not any maneuver that the Extra 300S 1.60 ARF is not capable of performing. You will only be limited by your ability!

Landing

To initiate a landing approach, lower the throttle while on the downwind leg. Allow the nose of the model to pitch downward to gradually bleed off altitude. Continue to lose altitude, but maintain airspeed by keeping the nose down as you turn onto the crosswind leg. Make your final turn toward the runway (into the wind) keeping the nose down to maintain airspeed and control. Level the attitude when the model reaches the runway threshold, modulating the throttle as necessary to maintain your glide path and airspeed. If you are going to overshoot, smoothly advance the throttle (always ready on the right rudder to counteract torque) and climb out to make another attempt. When you're ready to make your landing flare and the model is a foot or so off the deck, smoothly increase up elevator until it gently touches down. Once the model is on the runway and has lost flying speed, hold up elevator to place the tail on the ground, regaining tail wheel control.

One final note about flying your model. Have a goal or flight plan in mind for **every** flight. This can be learning a new maneuver(s), improving a maneuver(s) you already know, or learning how the model behaves in certain conditions (such as on high or low rates). This is not necessarily to improve your skills (*though it is never a bad idea!)*, but more importantly so you do not surprise yourself by impulsively attempting a maneuver and suddenly finding that you've run out of time, altitude or airspeed. Every maneuver should be deliberate, not impulsive. For example, if you're going to do a loop, check your altitude, mind the wind direction (anticipating rudder corrections that will be required to maintain heading), remember to throttle back at the top, and make certain you are on the desired rates (high/low rates). A flight plan greatly reduces the chances of crashing your model just because of poor planning and impulsive moves. **Remember to think.**

Have a ball! But always stay in control and fly in a safe manner.

GOOD LUCK AND GREAT FLYING!

APPENDIX

FLIGHT TRIMMING

Note: *The following article has been reprinted in part for future reference and also as a guide for your flight instructor or experienced flying partner to help you with trimming your model. If further information is required, please contact your local hobby dealer, local flying club or call Great Planes at (217) 398-8970*

A model is not a static object. Unlike a car, which you can only hunt left or right on the road (technically, a car does yaw in corners, and pitches when the brakes are applied), a plane moves through that fluid we call air in all directions simultaneously. The plane may look like it's going forward, but it could also be yawing slightly, slipping a little and simultaneously climbing or diving a bit! The controls interact. Yaw can be a rudder problem, a lateral balance problem or an aileron rigging problem. We must make many flights, with minor changes between each, to isolate and finally correct the problem.

The chart accompanying this article is intended to serve as a handy field reference when trimming your model. Laminate it in plastic and keep it in you flight box. You just might have need to consult it at the next contest! The chart is somewhat self-explanatory, but we will briefly run through the salient points.

First, we are assuming that the model has been C.G. balanced according to the manufacturer's directions. There's nothing sacred about that spot — frankly, it only reflects the balance point where a prototype model handled the way the guy who designed it thought it should. If your model's wing has a degree more or less of incidence, then the whole balance formula is incorrect for you. But, it's a good ballpark place to start.

The second assumption is that the model has been balanced laterally. Wrap a strong string or monofilament around the prop shaft behind the spinner, then tie the other end to the tail wheel or to a screw driven into the bottom of the aft fuse. Make the string into a bridle harness and suspend the entire model inverted (yes, with the wing on!). If the right wing always drops, sink some screws or lead into the left wing tip, etc. You may be surprised to find out how much lead is needed.

At this point the model is statically trimmed. It's only a starting point, so don't be surprised if you wind up changing it all. One other critical feature is that the ailerons must have their hinge gap sealed. If shoving some Scotch tape or Monokote into the hinge gap to prevent the air from slipping from the top of the wing to the bottom, and vice-versa, bothers you, then don't do it.

To achieve the maximum lateral trim on the model, the hinge gap on the ailerons should be sealed. The easiest way to do this is to disconnect the aileron linkages, and fold the ailerons as far over the top of the wing as possible (assuming they are top or center hinged). Apply a strip of clear tape along the joint line. When the aileron is returned to neutral, the tape will be invisible, and the gap will be effectively sealed. Depending on how big the ailerons are, and how large a gaping gap you normally leave when you install hinges, you could experience a 20 percent increase in aileron control response just by this simple measure.

Your first flights should be to as certain control centering and control feel. Does the elevator always come back to neutral after a 180° turn or Split-S? Do the ailerons tend to hunt a little after a rolling maneuver? Put the plane through its paces. Control centering is either a mechanical thing (binding servos, stiff linkages, etc.), an electronic thing (bad servo resolution or dead band in the radio system), or C.G. (aft Center of Gravity will make the plane wander a bit). The last possibility will be obvious, but don't continue the testing until you have isolated the problem and corrected it.

Let's get down to the task of trimming the model. Use the tachometer every time you start the engine, to insure consistent results. These trim flights must be done in calm weather. Any wind will only make the model weather vane. Each "maneuver" on the list assumes that you will enter it dead straight-and-level. The wings must be perfectly flat, or else the maneuver will not be correct and you'll get a wrong interpretation. That's where your observer comes in. Instruct him to be especially watchful of the wings as you enter the maneuvers.

Do all maneuvers at full throttle. The only deviation from this is if the plane will routinely be flown through maneuvers at a different power setting.

Let's commence with the "engine thrust angle" on the chart. Note that the observations you make can also be caused by the C.G., so be prepared to change both to see which gives the desired result. Set up a straight-and-level pass. The model should be almost hands-off. Without touching any other control on the transmitter, suddenly chop the throttle. Did the nose drop? When you add power again, did the nose pitch up a bit? If so, you need some down thrust, or nose weight. When the thrust is correct, the model should continue along the same flight path for at least a dozen plane lengths before gravity starts to naturally bring it down.

Do each maneuver several times, to make sure that you are getting a proper diagnosis. Often, a gust, an accidental nudge on the controls, or just a poor maneuver entry can mislead you. The thrust adjustments are a real pain to make. On most models, it means taking the engine out, adding shims, then reassembling the whole thing. Don't take shortcuts.

Don't try to proceed with the other adjustments until you have the thrust line and/or C.G. correct. They are the basis upon which all other trim settings are made.

Also, while you have landed, take the time to crank the clevises until the transmitter trims are at neutral. Don't leave the airplane so that the transmitter has some odd-ball

combination of trim settings. One bump of the transmitter and you have lost everything. The trim must be repeatable, and the only sure way to do this is to always start with the transmitter control trims at the middle.

The next maneuver is somewhat more tricky than it looks. To verify C.G., we roll the model up to a 45° bank, then take our hands off the controls. The model should go a reasonable distance with the fuse at an even keel. If the nose pitches down, remove some nose weight, and the opposite if the nose pitches up. The trick is to use only the ailerons to get the model up at a 45° bank. We almost automatically start feeding in elevator, but that's a no-no. Do the bank in both directions, just to make sure that you are getting an accurate reading of the longitudinal balance.

We now want to test the correct alignment of both sides of the elevator (even if they aren't split, like a Pattern ship's, they can still be warped or twisted). Yaw and lateral balance will also come into play here, so be patient and eliminate the variables, one-by-one. The maneuver is a simple loop, but it must be entered with the wings perfectly level. Position the maneuver so that your assistant can observe it end-on. Always loop into the wind. Do several loops, and see if the same symptom persists. Note if the model loses heading on the front or back side of the loop. If you lose it on the way up, it's probably an aileron problem, while a lose of heading on the way back down is most likely a rudder situation.

Note that the Yaw test is the same looping sequences. Here, however, we are altering rudder and ailerons, instead of the elevator halves. We must repeat that many airplanes just will not achieve adequate lateral trim without sealing the hinge gaps shut. The larger you make the loops (to a point), the more discernable the errors will be.

The Lateral Balance test has us pulling those loops very tightly. Pull straight up into a vertical and watch which wing drops. A true vertical is hard to do, so make sure that your assistant is observing from another vantage point. Note that the engine torque will affect the vertical fall off, as will rudder errors. Even though we balance the wing statically before leaving for the field, we are now trimming it dynamically.

The Aileron Coupling (or rigging), is also tested by doing Hammerheads Stalls. This time, however, we want to observe the side view of the model. Does the plane want to tuck under a bit? If so, then try trimming the ailerons down a small bit, so that they will act as flaps. If the model tends to want to go over into a loop, then rig both ailerons up a few turns on the clevises. Note that drooping the ailerons will tend to cancel any washout you have in the wing. On some models, the lack of washout can lead to some nasty characteristics at low speeds.

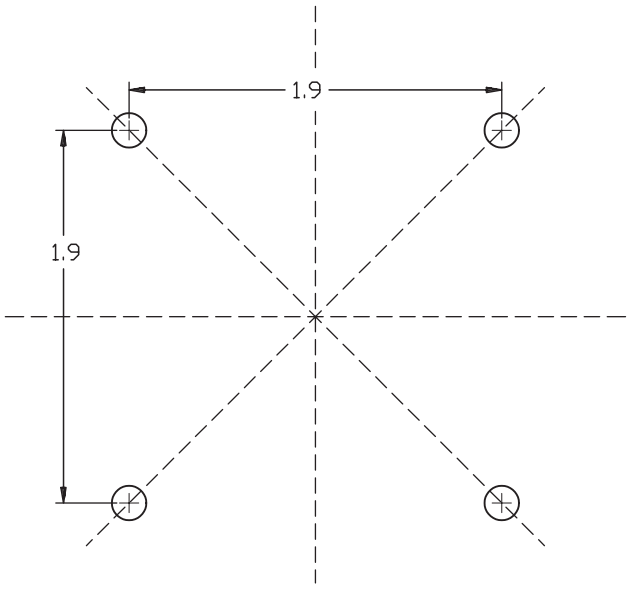
Again, we reiterate that all of these controls are interactive. When you change the wing incidence, it will influence the way the elevator trim is at a given C.G. Re-trimming the wing will also change the rigging on the ailerons, in effect, and they may have to be readjusted accordingly.

The whole process isn't hard. As a matter of fact it's rather fun — but very time consuming. It's amazing what you will learn about why a plane flies the way it does, and you'll be a better pilot for it. One thing we almost guarantee, is that your planes will be more reliable and predictable when they are properly trimmed out. They will fly more efficiently, and be less prone to doing radical and surprising things. Your contest scores should improve, too.

We wish to acknowledge the Orlando, Florida, club newsletter, from which the basics of the chart presented here were gleaned.

Reprinted in part by Great Planes Model Manufacturing Company, courtesy of Scale R/C Modeler magazine, Pat Potega, Editor, August 1983 issue.

See the Flight Trimming Chart on the back cover



ENGINE MOUNT TEMPLATE

Photocopy or cut out this template and use it to mount your engine.

TRIM FEATURE	MANEUVERS	OBSERVATIONS	CORRECTIONS
CONTROL CENTERING	Fly general circles and random maneuvers.	Try for hands off straight and level flight.	Readjust linkages so that Tx trims are centered.
CONTROL THROWS	Random maneuvers	A. Too sensitive, jerky controls. B. Not sufficient control.	If A, change linkages to reduce throws. If B, increase throws.
ENGINE THRUST ANGLE[1]	From straight flight, chop throttle quickly.	A. Aircraft continues level path for short distance. B. Plane pitches nose up. C. Plane pitches nose down.	If A, trim is okay. If B, decrease downthrust. If C, increase downthrust.
CENTER OF GRAVITY LONGITUDINAL BALANCE	From level flight roll to 45-degree bank and neutralize controls.	A. Continues in bank for moderate distance. B. Nose pitches up. C. Nose drops.	If A, trim is good. If B, add nose weight. If C, remove nose weight.
YAW[2]	Into wind, do open loops, using only elevator. Repeat tests doing outside loops from inverted entry.	A. Wings are level throughout. B. Yaws to right in both inside and outside loops. C. Yaws to left in both inside and outside loops. D. Yaws right on insides, and left on outside loops. E. Yaws left in insides, and right on outside loops.	If A, trim is correct. If B, add left rudder trim. If C, add right rudder trim. If D, add left aileron trim. If E, add right aileron trim.
LATERAL BALANCE	Into wind, do tight inside loops.	A. Wings are level and plane falls to either side randomly. B. Falls off to left in loops. Worsens as loops tighten. C. Falls off to right in loops. Worsens as loops tighten.	If A, trim is correct. If B, add weight to right wing tip. If C, add weight to left wing tip.
AILERON RIGGING	With wings level, pull to vertical climb and neutralize controls.	A. Climb continues along same path. B. Nose tends to go to inside loop. C. Nose tends to go to outside loop.	If A, trim is correct. If B, raise both ailerons very slightly. If C, lower both ailerons very slightly.

1. Engine thrust angle and C.G. interact. Check both.
2. Yaw and lateral balance produce similar symptoms. Note that fin may be crooked. Right and left references are from the plane's vantage point.