HANGAR 9
WE GET PEOPLE FLYING

CAP232

INSTRUCTION MANUAL

- 90% Custom built
- Designed by 8-time TOC competitor Mike McConville
- Specifically designed for excellence in precision and 3-D aerobatics
- Prepainted fiberglass cowl and wheelpants
- Plug-in wing and stab
- Precovered with genuine Hangar 9™ UltraCote®
- IMAC and Giant Scale legal
- Instructions include 3-D flying tips from Mike McConville

Specifications

Wingspan:	97 in	2,464 mm
Fuselage Length:	90 in	2,286 mm
Wing Area:	1,750 sq in	112.9 dm sq
Flight Weight:	23 to 26 lb	10.4–11.8 kg
Recommended Engines:	60 to 80 cc – gasoline	

ULTRA SERIES

Table of Contents

Introduction

Thank you for purchasing the Hangar 9™ 33% CAP 232. Because the size and weight create a higher degree for potential danger, an added measure of care and responsibility is needed when building and flying giant scale models. **If this is your first giant scale aerobatic aircraft, it's important that you carefully follow the instructions, especially those regarding hinging (pages 12-14), and the section on flying (36-41).**

Like all giant scale aerobatic aircraft, the 1/3 Scale CAP 232 requires powerful, heavy-duty servos. Servos greatly effect the flight performance, feel, and response of the model. To get the most out of your CAP, it's important to use accurate, powerful servos with a minimum of 80 oz/in of torque for elevator and rudder and 60 oz/in torque for each aileron servo. In the prototype models we used JR 8101s and JR 8411s with excellent results. A less powerful servo can lead to a crash.

The 1/3 Scale CAP 232 does not include hardware. Many experienced giant scale pilots have specific hardware preferences and can individually choose the components they prefer. Hangar 9 offers an optional Hardware Package (HAN1220-JR, HAN1221-FUT) that includes the hardware that our staff regularly uses and recommends.

Throughout the manual, the above hardware will be used during the assembly process. If using another type/brand of hardware, it's your responsibility to be sure that it's strong enough for this application and properly installed.

If you encounter difficulty in any construction sequence, please contact one of our technicians. We can provide assistance concerning the construction of your 1/3 Scale CAP 232. Contact us at:

Horizon Hobby, Inc.
4105 Fieldstone Road
Champaign, IL 61822
(217) 355-9511
www.horizonhobby.com

Warning

An R/C aircraft is not a toy! If misused, it can cause serious bodily harm and damage to property. Fly only in open areas, preferably AMA (Academy of Model Aeronautics) approved flying sites, following all instructions included with your radio and engine.

Additional Required Equipment

Radio Equipment with Computer Radio

1000mAh receiver battery pack or larger
(4) Servos with 80 oz/in of torque minimum for elevator and rudder
(JR8101, 4721, 2721, or 8411 or equivalent)
(4) Servos with 60 oz/in of torque (aileron)
(1) Servo for throttle
(6) 24" Servo Extension (JRPA102)
(1) 18" Servo Extension (JRPA101)
(2) 3" Servo Extension (JRPA093)

Radio Equipment (Non-Computer Radio)

(1) 1000mAh receiver battery pack or larger
(4) Servos with 80 oz/in of torque minimum for elevator and rudder
(JR8101, 4721, 2721, or 8411 or equivalent)
(4) Servos with 60 oz/in of torque (aileron)
(1) Servo for throttle
(3) Y-Harnesses (JRP133)
(4) 18" Servo Extension (JRPA101)
(2) 12" Servo Extension (JRPA099)
(2) 6" Servo Extension (JRPA095)

Note: Requires one reversed servo for elevator

Recommended JR® Systems

JR XP652
JR XP783
JR XP8103
JR PCM10X

JR 8103

JR 10X

Engine Requirements

62-80cc Gasoline Engine

Recommended Gasoline Engines:

Zenoah® G-62 Gasoline Engine
Zenoah GT-80 Gasoline Engine

Zenoah G-62

Zenoah GT-80

Other Items Needed (not included in the kit)

Zenoah® Gas Start Kit (ZEN20002) Includes:

Kill Switch (ZEN20000)
Oil (2-cycle) (ZEN20001)
Fuel Filler (HAN115)
Fuel Filter (HAN143)
Mixing Cup (HAN3101)
Gas Stopper (DUB400)
3' Fuel Line (DUB799)
Line Keeper (DUB677)

Tools and Adhesives Needed (not included in the kit)

Adhesives

Thick CA (cyanoacrylate) glue
CA remover/debonder
30-minute epoxy
5-minute epoxy
Silicon glue
Canopy glue
Blue Locktite
Electrical tape
Masking tape

Tools

Drill
Drill Bits: 1/16", 1/8", 5/32", 3/8", 5/16"
Medium Phillips screwdriver
Small straight screwdriver
Needle-nose pliers
Hobby knife with #11 blade
Mixing stick
Straight edge
Jig saw
Soldering iron
Measuring device (e.g., ruler, tape measure)
Scissors
Moto-tool with cut-off wheel
8-32 Tap (DUB363)
Sealing iron
Glue syringe or toothpick
Hex Wrench: 5/32" and 1/8"
Adjustable wrench
Countersink
12" or longer ruler
36" ruler

Additional Needed Items

Zenoah® 2" Prop Drive (ZEN20004) (GT-80 only)
4¼" Spinner (Tru-turn TRU4252M)
Propeller (refer to recommendations listed in your engine's operating instructions.)
2' gas compatible tubing
Cup engine mount B+B 6202 (G-62 only)
Coarse sandpaper
Radio packing foam
Antenna tube
1/8" light plywood
1/4"-20x1½" socket head screws (4) (G-62 only)
1/3 Scale Pilot (HAN8265)
Small cable ties (2)
Paper towels
Rubbing alcohol
Felt-tipped pen/pencil
Hangar 9™ UltraCote® (HANU887) (used for sealing aileron/elevator hinge gap)

Contents of Kit

Note: Photos of products may vary slightly from the contents in the box.

Replacement Parts

Fuselage (HAN1251)
Right Wing Panel with Aileron (HAN1252)
Left Wing Panel with Aileron (HAN1253)
Right Horizontal Stabilizer and Elevator (HAN1254)
Left Horizontal Stabilizer and Elevator (HAN1255)
Rudder (HAN1258)
Wing Tube (HAN1256)
Stabilizer Tubes (2) (HAN1257)
Canopy (HAN1259)
Canopy Hatch (HAN1260)
Fiberglass Painted Cowl (HAN12561)
Wheel Pants (HAN1262)
Landing Gear (HAN1263)
Decal Set (HAN1264)
True Red UltraCote® (HANU866)
White UltraCote® (HANU870)
Pearl Blue UltraCote® (HANU845)

Included in the optional Hangar 9™ 1/3 Scale Hardware Package HAN1220-JR or HAN1221-Futaba)

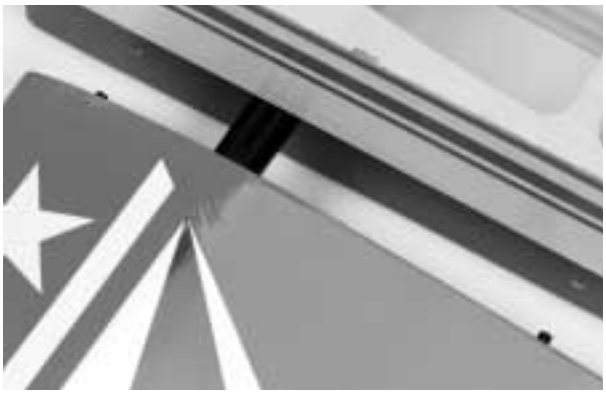
3½" Wheels (2) (DUB350L)
4½" 4-40 Threaded Pro-Links (4) (HAN3556)
5" 4-40 Thread Pro-Links (4) (HAN3557)
32 oz Fuel Tank (DUB690)
Tail Wheel Assembly with Hardware (OHI130)
4-40 Ball Links (9) (ROC87)
8-32 Swivel Control Horns (8) (ROC01B)
3/16" Main Axles (DUB249)
Super Hinge Points (24) (ROB309)
4-40 3-D Arm (1¼" long) JR Version (2) (HAN3578)
4-40 HD Arm (1" long) JR Version (6) (HAN3574)
4-40 3-D Arm (1¼" long) Futaba Version (2) (HAN3579)
4-40 HD Arm (1" long) Futaba Version (6) (HAN3575)

Section 1: Installing the Wing to the Fuselage

Parts Needed	Tools and Adhesives Needed
Left Wing Panel w/Aileron attached (taped in place) (HAN1253) Right Wing Panel w/Aileron attached (taped in place) (HAN1252) Fuselage (HAN1251) Wing Tube (HAN1206) 4-40 cap screw (2) 4-40 split washer (2)	Thick CA glue CA remover/debonder Hobby knife w/#11 blade Drill Bit: 1/16" 4-40 Tap and Drill Bit (DUB361)

Step 1. Locate the Wing Tube (HAN1206) and be sure it does not have any "burrs" on the ends. Also check the tube socket openings in the fuselage for covering and/or any debris. If you need to remove any covering or debris from around the inside of the tube socket openings, use a hobby knife with a sharp #11 blade and carefully clear the socket openings

Step 2. Be sure the alignment tubes located on the root rib of each wing panel are securely glued in before installing the wings. If the tubes are not secure, remove them and apply thick CA (small amount) into the tube socket and reinstall. Insert the wing tube into a wing panel and slide the wing in place on the fuselage. Make sure the wing panel alignment tubes slide into the holes in the fuselage.



Hint: Reach inside the fuselage and gently "hold" the alignment tube blocks while inserting the wing panel.

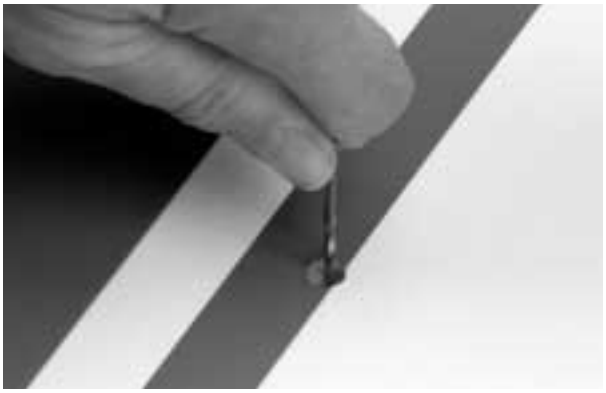
Note: If the wing alignment tubes are difficult to insert into the internal hardwood blocks located inside the fuselage, take a small round file (or carefully use your hobby knife) and adjust the opening in the block so that the alignment tubes fit properly but snugly.

Step 3. Carefully slide the other wing panel onto the wing tube that projects from the other side of the fuselage. The fit may be tight; use caution when inserting the wing panels onto the wing tube and fuselage. Reach inside the fuselage and hold the wing alignment tube blocks while inserting the wing half.

Note: The tight fit of the wing tube into the wing panels is intentional, and it will loosen with use.

Step 4. Locate the holes for the 4-40 cap screws on the top of each wing approximately 12½" from the wing root rib. These holes have been drilled for the 4-40 cap screw and split washer, allowing the screws to thread into the wing tube.

Step 5. Make sure each wing panel is pushed completely against the fuselage. Mark the location for the 4-40 cap screw holes onto the wing tube with a sharp wire or 1/16" drill bit. We suggest using a small drill bit so the hole in the wing is not enlarged.



Step 6. After the holes have been marked, remove the wing panels and drill and tap the wing tube with a 4-40 Tap and Drill Bit (DUB361). Replace the wing panels on the fuselage and trial fit the 4-40 cap screws and split washers through the wing panels and into the wing tube.

Step 7. Remove the wing panels before proceeding with "Installing the Aileron Servos."

Section 2: Installing the Aileron Servos

Parts Needed	Tools and Adhesives Needed
Wings w/ailerons attached (taped in place) **Not Included** Servos w/mounting hardware (4) (60 oz/in minimum torque) 3" Servo Extension (2) (JRPA093) 24" Servo Extension (2) (JRPA102) Y-Harness (2) (JRPA133) (3 for non-computer radios) **Included in Optional Hangar 9™ Hardware Kit** 1" Servo Arms (4) (HAN3574-JR or HAN3575-Futaba)	Phillips screwdriver Drill Drill Bit: 1/16" Electrical tape Blue Locktite

The ailerons require a minimum of 60 oz/in of servo torque. In the prototype 1/3 Scale CAP 232, we used JR8101 servos. JR's 8411s offer a crisp response—the ultimate servo choice.

JR8101 Ultra Precision Wide Bearing

Torque: 90.4 oz/in	Speed: .23 sec/60°
Weight: 1.50 oz	Size: 0.73" x 1.52" x 1.32"
Motor: Coreless	Ball Bearing: Dual

JR8411 Digital Ultra Torque

Torque: 155 oz/in@4.8V	Speed: .18 sec/60°
Weight: 2.03 oz	Size: 0.73" x 1.52" x 1.32"
Motor: Coreless	Ball Bearing: Dual

It is common to use two servos per aileron on many larger models. However, this setup requires some special attention to assure that the servos do not fight each other. If this is not done correctly, battery consumption will be greatly increased, and in the case of a high torque digital servo, the servos may be damaged. When setting up the ailerons with two servos, there are some special steps that need to be taken.

Step 1. Select two sets of servos and Hangar 9™ 1" arms that have the same neutral. All servos will have a slightly different neutral. If you are using Hangar 9 metal arms, they don't all orient the same, (i.e., the spline is not oriented the same relative to the arm). First choose one servo and arm, plug it into the aileron channel on your receiver through the Y-connection, and set to EXACT NEUTRAL, (i.e., servo arm is perpendicular to the servo centerline). Next, start plugging in your other servos one by one and installing the arms until you find one that is as close as you can get to the EXACT SAME NEUTRAL as the other servo. Repeat this process to find a second pair of servos.

Step 2. Install the servo hardware (grommets and eyelets) included with the servo.

Step 3. Plug a 3" servo extension into two servos and an 24" servo extension into the other two aileron servos. Tie a knot at the connector as shown, then wrap with electrical tape to prevent the servo connectors from pulling apart.

Section 2: Installing the Aileron Servos

CONTINUED

Step 4. Insert the servo with the 13" extension into the aileron cutout on the bottom of the wing closest to the wing root, as shown below. Be sure the output shaft is oriented toward the trailing edge of the wing. Insert the second servo with the 18" extension into the servo cutout located closest to the wing tip. Allow the servo leads to exit the root of the wing. Refer to the photo below.

Note: The servo wiring method is to be used if a computer radio is used with Flapperon mixing (recommended). In this case the Y-harnesses are plugged directly into the receiver using the aileron and appropriate auxiliary channel used for flapperon mixing (see your radio's instructions).

If a non-computer radio is used, then three Y-harnesses and two 12" extensions are required. In this case each of the two servos should be plugged directly into a Y-harness and a 12" extension connected to the Y-harness. This lead will exit the root of the wing.

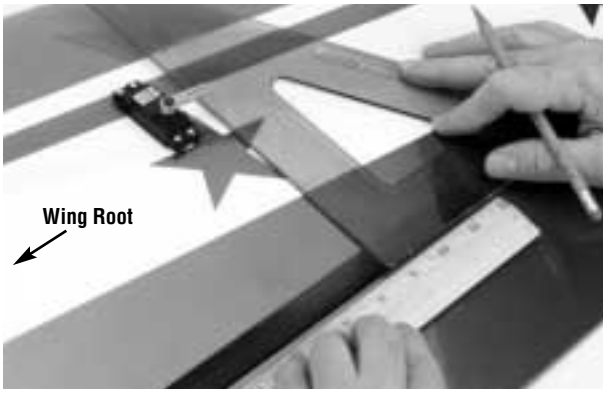
Step 5. Using the screws included with the servos, fasten the servos in place. You may find it helpful to drill a 1/16" pilot hole before installing the screws.

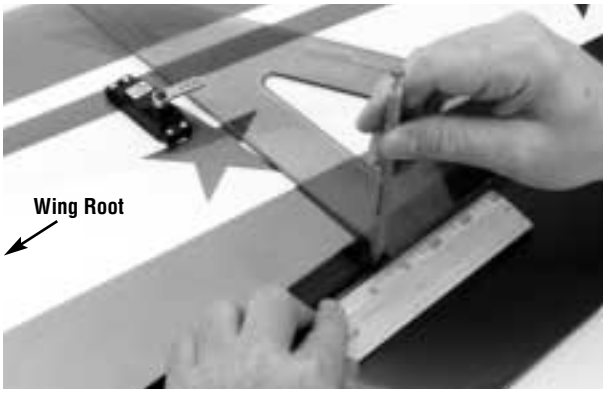
Step 6. Remove the stock arms and replace with Heavy-Duty 1" Servo Arms (HAN3574 JR or HAN3575 Futaba) to give the needed control throws and to handle the increased loads of the large surfaces. The arms need to face outward toward the wing tips as shown in the photo below. Be sure to use a drop of Blue Locktite to secure the servo arm screws if using metal-geared servos.

Section 3: Installing the Aileron Control Horns

Parts Needed	Tools and Adhesives Needed
Wings with ailerons and servos **Included in Optional Hangar 9™ Hardware Package** Control Horns (4) (Rocket City 8-32 Swivel Control Horn #ROC01B)	12" or longer ruler Drill Drill Bit: 5 /32" 8-32 Tap (DUB363) 30-minute epoxy Felt-tipped pen Rubbing alcohol Paper towels

Step 1. Using a straight edge held in alignment (90°) with the servo arms and with the hinge line as shown, mark the aileron with a pen where the straight edge intersects the aileron hinge bevel at both servo locations.



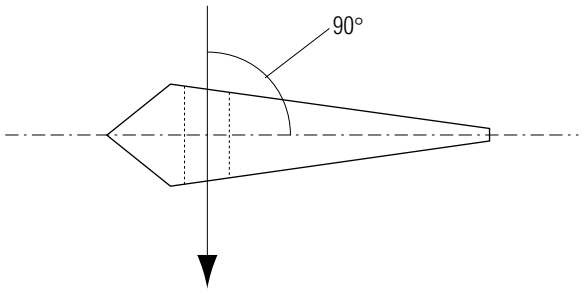


Step 2. Measure exactly 1/4" rearward from the marks above parallel to the hinge line and make another mark using a pen. These will be the positions for the control horns.

Step 3. Remove the ailerons from the wing. Use rubbing alcohol to remove any tape residue. Notice that the hinge pockets are already cut into place.

Step 4. Using a 5 /32" drill bit and hand drill, carefully drill a 5/32" hole through the aileron at the marked positions. [Drill perpendicular (90°) to the aileron cross section rather than the ailerons surface.] Be especially careful when penetrating through the bottom surface of the aileron, as it's easy to split out the wood and rip the covering. Placing a wooden block under the aileron and drilling slowly will prevent these problems. Counter sink the top of the aileron to allow the screws to fit flush.

Note: Hardwood blocks (hardpoint) are located below the sheeting; you will be drilling through these.



Section 3: Installing the Aileron Control Horns

CONTINUED

Step 5. Using an 8-32 tap, tap the holes that you just drilled in the aileron.

Step 6. Mix a small amount of 30-minute epoxy and lightly coat the inside of the tapped holes and the 8-32 x 2" Rocket City screws. From the top of the aileron, screw the 8-32 x 2" into the tapped holes and securely tighten. Wipe away any excess epoxy with rubbing alcohol and a paper towel. Screw the A-nuts in place as shown. Allow the epoxy to fully cure.

Step 7. Screw the molded swivel links onto the inboard 8-32 screw until the distance from the aileron surface to the bottom of the link is 5 /8". The outboard swivel link will be installed later.

Step 8. Install the control horns in the opposite aileron using the same method.

Section 4: Hinging and Sealing the Aileron Control Surfaces

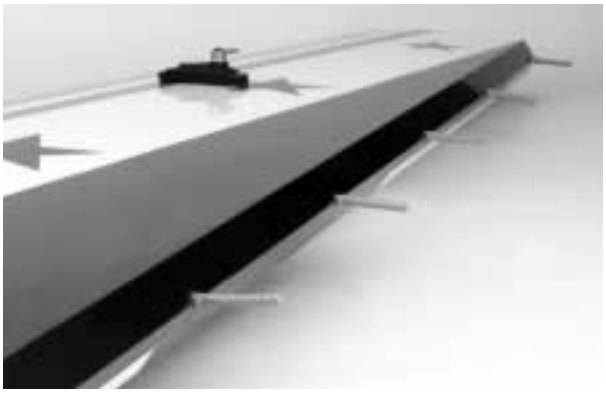
Parts Needed	Tools and Adhesives Needed
Wings with ailerons **Included in optional Hangar 9™ Hardware Package** Robart Super Hinge Points (24) (ROB309) **Not Included** Transparent Hangar 9™ UltraCote® (HANU887)	Sealing iron Hobby knife with #11 blade Ruler: 36" Glue Syringe (DLR910) (or toothpick) Coarse sandpaper Felt-tipped pen 30-minute epoxy Rubbing alcohol Paper towels

Properly hinging the control surfaces on giant scale models is vitally important! Poorly installed hinges affect the model's precision and control response and can also be dangerous. Each and every hinge needs to be securely bonded in place in both the flying surface and the control surface. The hinge pivot points need to be exactly parallel to each other and precisely located on the center of the hinge line. We regularly use Robart Super Hinge Points in all giant scale aircraft. They are easy to install, very strong, and offer smooth friction-free control. The Hangar 9 1/3 Scale CAP 232 control surfaces are predrilled to use Robart's Super Hinge Points.

Step 1. Sand each end of the hinge point hinge using coarse sandpaper. This will improve the bond of the epoxy to the hinge.

Step 2. Mix 1 ounce of 30-minute epoxy. Using a glue syringe or toothpick, place a sufficient amount of 30-minute epoxy into one of the hinge pockets on the wing's trailing edge. Install one of the hinge points until the hinge point center is flush with the trailing edge of the wing. Some epoxy should ooze out of the pocket as the hinge is installed. If not, remove the hinge and apply more epoxy. After gluing a few hinges, you'll get the hang of just how much epoxy is needed. Wipe away any excess epoxy with rubbing alcohol. Recheck that the center of the hinge point is flush and parallel with the trailing edge. Continue installing hinges in the trailing edge of the wings. The control surfaces (ailerons) will be installed after the epoxy is fully cured.

Note: Be sure that the hinge pivot pins are parallel and flush to the trailing edge. It's important to frequently mix a fresh batch of 30-minute epoxy in order to achieve good glue joint penetration. If you notice the epoxy becoming thicker, mix a new batch.



Section 4: Hinging and Sealing the Aileron Control Surfaces

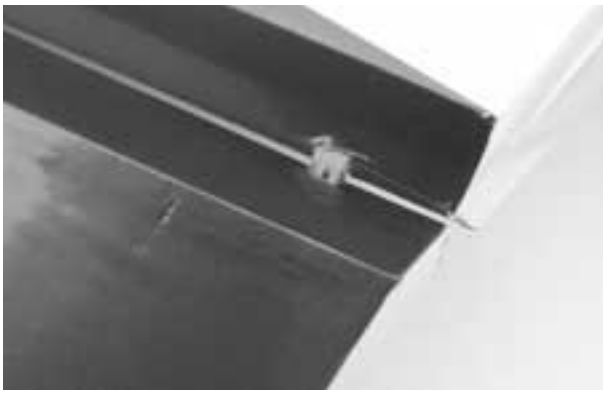
CONTINUED

Step 3. Allow the epoxy to fully cure for at least six hours. When cured, work each hinge throughout its full motion several times using your hands. This will break free any epoxy that may have found its way into the hinge joint. Move the hinge throughout its full travel until no resistance is left. This may take as many as 40 or 50 times.

Step 4. Mix 1 ounce of 30-minute epoxy. Using a syringe or toothpick, place a sufficient amount of epoxy in each of the hinge pockets in one aileron half.

Step 5. Carefully insert the aileron on the wing, making sure the hinges are inserted into their respective hinge pockets. Press the aileron and wing together such that less than 1/64" hinge line gap exists between the aileron and wing. The bevels should virtually touch. Using a paper towel and rubbing alcohol, wipe away any visible epoxy around the hinges.

Step 6. Double-check the hinge gap and allow the epoxy to fully cure for at least six hours. Repeat the process for the other wing half.



Step 7. When the epoxy has fully cured, move each control surface throughout its travel range several times to break away any epoxy in the hinge. Be sure to deflect the surface fully.

Sealing the Hinge Gaps

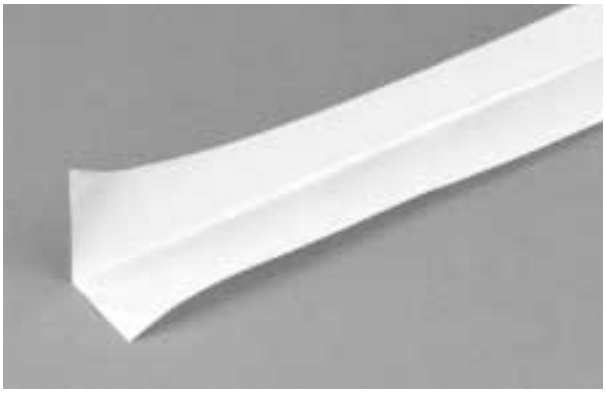
It's imperative that the aileron and elevator hinge lines be sealed airtight to prevent flutter. Sealing the hinge line has several advantages. A sealed hinge line gives a greater control response for a given control deflection. It also offers more precise, consistent control responses and makes trimming easier.

Caution: Sealing the aileron and elevator hinge line is mandatory. Failure to do so may cause control surface flutter, resulting in a crash.

Section 4: Hinging and Sealing the Aileron Control Surfaces

CONTINUED

Step 8. Cut two pieces of transparent UltraCote® (not included) for sealing the ailerons to approximately 3" x 42". Fold both pieces of UltraCote® down the center with the adhesive side to the outside, making a sharp crease at the fold.



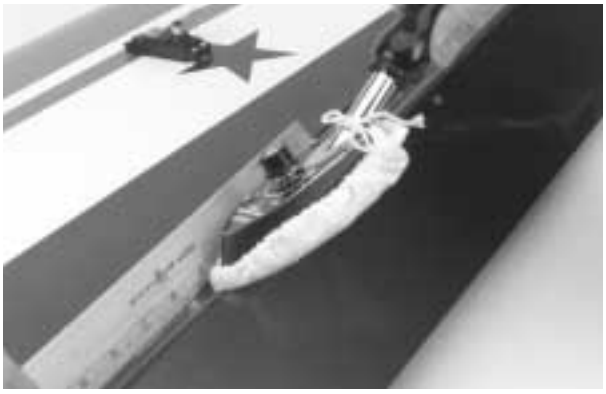
Step 9. Using a ruler, measure 1/2" from the folded crease and mark the pieces with a pen.

Step 10. Using a sharp hobby knife with a #11 blade and a straight edge, carefully cut through both layers of UltraCote® covering at the 1/2" point marked in Step 2. Cut both pieces.

Step 11. Mark and cut both folded coverings to an overall length of 40". These pieces will be inserted and ironed down into the hinge bevel on the bottom of the ailerons.

Step 12. Remove the backing from one piece of the UltraCote®. Place the folded crease side to the center of the hinge line on the bottom of one wing half. Using a straight edge as shown, hold one side of the covering in place while ironing down the opposite side with a sealing iron. We recommend setting the iron temperature to 320° for this operation.

Step 13. Fully deflect the aileron in the up position. Place the straight edge over the hinge line covering that you just ironed down in Step 5 with the edge of the straight edge placed firmly at the bottom of the hinge line as shown. Iron down this side of the covering, making sure the aileron is fully deflected.



Step 14. Repeat the process for the other aileron.

Section 5: Installing the Aileron Linkages

Parts Needed	Tools and Adhesives Needed
Wings with ailerons attached **Included in Optional Hangar 9™ Hardware Kit** 5" 4-40 Pro-Links (4) (HAN3557) 4-40 Ball Links (4) (ROC87)	Blue Locktite

Step 1. Screw a 4-40 ball link five to six turns onto a 5" long 4-40 linkage. Screw the opposite end of the linkage five to six turns into the clevis that is to attach to the swivel control horn that was installed in Section 3. Attach the linkage to the swivel horn on the inboard servo only with the bolt supplied. Adjust the linkage length until the hole in the ball link aligns with the outer hole in the servo arm when the aileron is neutral and the servo arm is centered.

Note: Hangar 9 Titanium Pro-Links feature right-hand threads on one end and left-hand threads on the other, allowing for easy, accurate adjustment without disconnecting the linkages. Consistently putting the right-hand threads toward the servo arms on all servos will prevent you from getting confused as to which way to turn the linkage to lengthen or shorten the link. Hangar 9 also offers a Pro-Link Wrench (HAN3558) to make adjustments easier.

Step 2. Using the 4-40 screws (don't substitute a standard screw) and nuts included in the Rocket City package, attach the ball link to the outer hole in the arm from the bottom side as shown on both servos. The sequence is screw, ball link, servo arm, and nut. Don't forget to use blue Locktite. The tapered standoff is not used.

Step 3. Temporarily plug the servos into the receiver and set the programming to get the aileron functioning correctly (see page 32 of the manual for correct control throws). Only the inboard aileron is driving the aileron at this time.

Step 4. Set the control horn for the outboard servo the same distance from the aileron centerline (not bottom surface of aileron) as the inboard servo.

Section 5: Installing the Aileron Linkages

CONTINUED

Step 5. Deflect the ailerons stick to full right. Hold it there (easiest way to have your TX set to PCM: hold and then turn off the TX). Hold the clevis on the outboard servo up to the horn and note how the holes align. Turn the transmitter on and hold full left aileron and again note how the holes align. The holes have to line up nearly perfectly. If they don't line up perfectly, adjust the horn length (distance out from the aileron) in or out a few turns, and recheck. Repeat this process until it is nearly perfect at full deflection in both stick directions and at neutral.

Step 6. Attach the swivel clevis to the horn with the supplied screw.

Section 6: Installing the Rudder and Elevator Servos

Parts Needed

Fuselage

Not included

Servos (4) (a minimum of 80 oz/in of torque)
w/mounting hardware
Small cable ties (2)
Using a computer radio
24" Servo Extensions (4) (JRPA102)
Using a non-computer radio
Y-Harnesses (3) (JRPA133)
18" Servo Extensions (4) (JRPA099)

Note: If using a non-computer radio, one of the servos used for elevator must be a reversed-direction servo. See the "Radio Setup" section for more details on page 34.

Included in optional Hangar 9™ Hardware Kit

1" Heavy-Duty Servo Arms for Elevator (2)
(HAN3574-JR or HAN3575-Futaba)
1¼" Heavy-Duty Servo Arms for Rudder (2)
(HAN3578-JR or HAN 3579-Futaba)
4½" 4-40 Linkages (4) (HAN3556)
4-40 Ball Links (4) (ROC87)
Swivel Control Horns (2) (ROC01B)

Tools and Adhesives Needed

Phillips screwdriver
Small straight screwdriver

The rudder and elevators require a minimum of 80 in/oz of servo torque. In the prototype 1/3 Scale CAP 232, we used JR8101 and JR8411 servos with excellent results. Using servos with less torque could cause a crash.

Computer Radio

Step 1. If using a 7-channel or greater computer radio with mixing (highly recommended), install four 24" servo extensions, one on each servo. Tie a knot at each connector and tape to prevent inadvertent disconnection. Also install the servo hardware (grommets and eyelets) at this time.

Non-Computer Radio

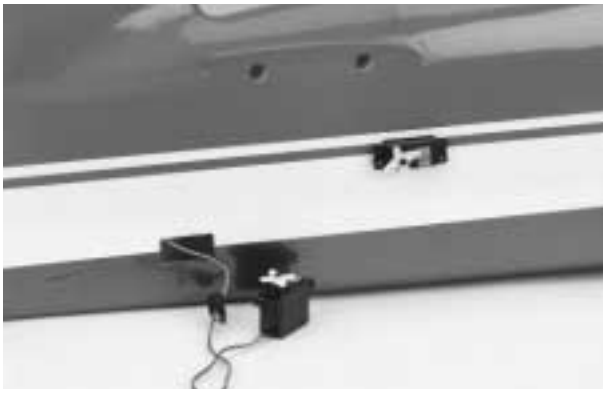
Step 1a. If using a non-computer radio, install four 18" servo extensions, one on each servo. Tape and tie a knot at each connector to prevent inadvertent disconnection. Install one side only of the two Y-harnesses to two of the servos, also tying knots to prevent disconnection. The other two servos will be hooked up to the Y-harness when installed in the airplane. One elevator servo will need to be a reversed-direction servo.

Section 6: Installing the Rudder and Elevator Servos

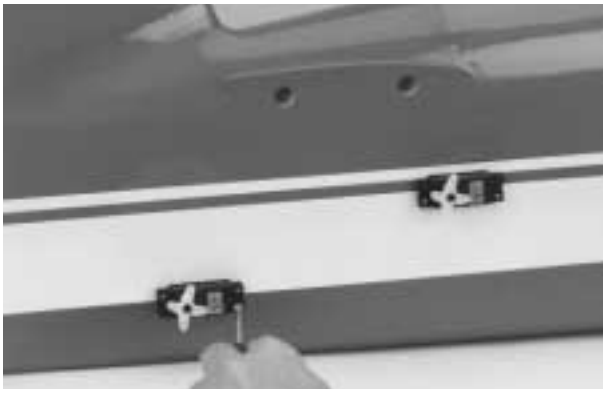
CONTINUED

Step 2a. Install the servos in the fuselage tail section with the output shaft to the rear as shown in the photo below. If using a non-computer radio, be sure to install one of the servos with the Y-harness attached in the top opening (elevator) and the other servo with the Y-harness attached in the bottom opening (rudder). Install the other servos in the opposite side of the fuselage being sure to connect the servo to the other open connector of the respective Y-harnesses. Don't forget to knot and tape the connectors.

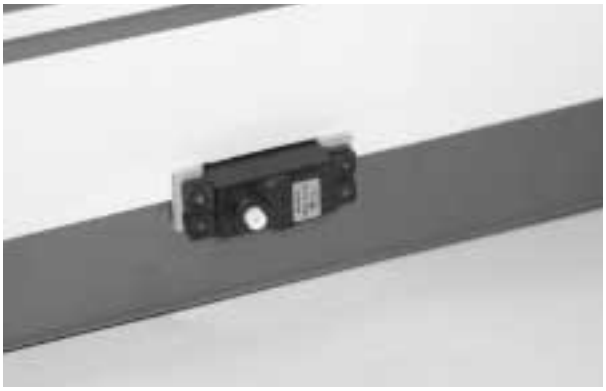
Note: One of the elevator servos must be a reversed servo.



Step 3a. Using the screws included with the servos, fasten the servos in place. You may find it helpful to drill a 1/16" pilot hole before installing the screws.



Note: With some servos, such as the JR 8411, it is necessary to install the Lite-Ply servo spacers to the outside of the fuselage to prevent the rudder servos from touching each other.



Section 7: Installing the Elevator, Control Horns, and Linkages

Parts Needed	Tools and Adhesives Needed
Stabilizers w/elevators 4-40 x 3/8" screws (2) Tail tubes (2) #4 split washers (2)	Drill Drill Bit: 5/32" 8-32 Tap (DUB363) 30-minute epoxy Rubbing alcohol Paper towels Ruler Hex Wrench: 5/32"

Not Included

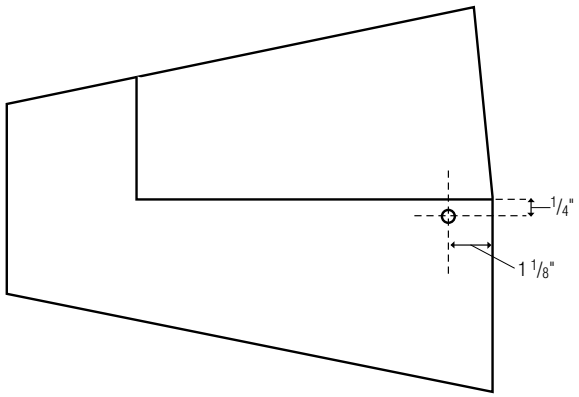
Transparent Hangar 9™ UltraCote® (HANU887)
Sealing iron
Hobby knife with #11 blade

Included in Optional Hangar 9™ Hardware Package

Robart Hinge Points (ROB309)
Rocket City B-32 Swivel Control Horn (ROC01B)
Control horns (2)
4-40 Ball Links (2) (ROC87)
4-40 Pro-Links (2) (HAN3556)

The technique for installing the control horns in the elevators is similar to the aileron control horn installation.

Step 1. To properly locate the position of the control horn on the bottom of the elevator, measure inward 1 1/8" from the root and rearward 1/4" from the top of the bevel. Mark this position on both elevators.



Step 2. Using a 5/32" drill bit and hand drill, carefully drill a 5/32" hole through the elevators at the above marked position. It's important to drill 90° to the elevator's centerline to the elevator's surface. Be especially careful when penetrating through the bottom surface of the elevator as it's easy to split out the wood and rip the covering. Placing a wooden block under the elevator and drilling slowly will prevent these problems. If you choose to use the counter sink screws included, counter sink the top of the elevator to allow the screws to fit flush.

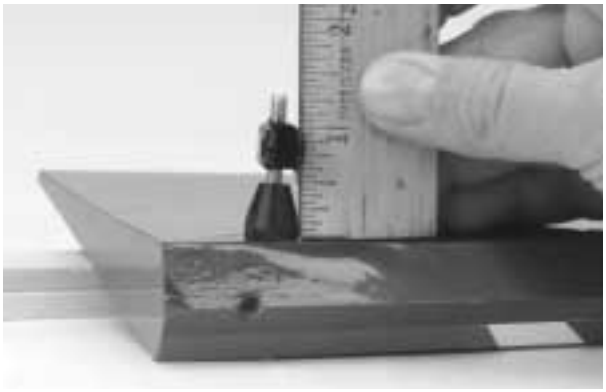
Step 3. Using an 8-32 tap, thread the holes that you just drilled in the elevators.

Section 7: Installing the Elevator, Control Horns, and Linkages

CONTINUED

Step 4. Mix a small amount of 30-minute epoxy and lightly coat the inside of the threaded holes and the 8-32 x 2" Rocket City screw. From the top of the elevator, thread the 8-32 screws into the tapped holes and tighten. Wipe away any excess epoxy with rubbing alcohol and paper towels.

Step 5. Screw the molded swivel link onto the 8-32 screw until the distance from the elevator surface to the bottom of the link is 5/8". Repeat this for the other elevator.



Step 6. Glue the elevator hinges in place using the same techniques used to hinge the ailerons. After hinging the elevator, use the same techniques to seal the elevator hinge gaps. Use transparent UltraCote® for the bottom of the elevator.

Note: Since the holes in the long stabilizer tube are not drilled or tapped, you will have to make sure this is done so the stabilizers can be securely attached to the fuselage. Check the tube opening sockets on both sides of the fuselage and remove any covering or debris with a sharp #11 blade.

Step 7. Locate the holes in each of the stabilizer's top surface. The holes have been drilled for the 4-40 cap screw and split washer. These screws are used to secure each stabilizer to the fuselage. The longer of the two tail tubes will require holes to be drilled in each end for the 4-40 cap screws.

Step 8. Insert the shorter of the tail tubes into the forward hole in the rear of the fuselage. Insert the longer of the tail tubes into the rear hole in one of the stabilizers halves, then insert into the rear hole of the fuselage and slide it onto the smaller tube in the fuselage until it touches the side of the fuselage. This may fit tightly; use caution not to damage the stabilizer half.

Section 7: Installing the Elevator, Control Horns, and Linkages

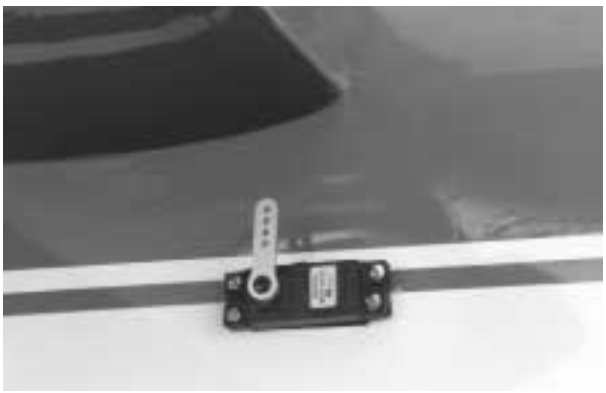
CONTINUED

Step 9. Install the other stabilizer half onto the tubes on the other side of the fuselage. Carefully slide the stabilizer onto the tubes until it contacts the side of the fuselage. When both stabilizer halves are touching the fuselage sides, make a mark through the hole for the 4-40 cap screw onto the tail tube located near the trailing edge of the stabilizers. We suggest using a 1/16" drill bit to make the mark. If you use a larger drill bit, use caution not to round out the hole.

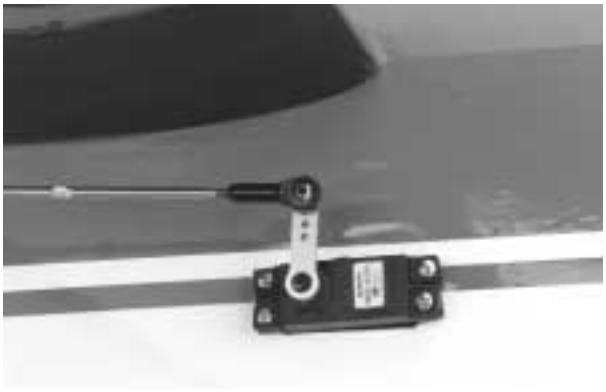
Step 10. Remove the stabilizers and drill and tap the long tail tube. Reinstall the stabilizers and thread the 4-40 cap screws and split washers into place, securing the stabilizers to the fuselage.

Caution: Check the security of the screws before each flight.

Step 11. Remove the servo arms from the elevator servos and replace them with Hangar 9™ heavy-duty 1" arms. The arms need to face up as shown in the photo below. Be sure to use a drop of blue Locktite on the servo arm screw if using metal-geared servos.



Step 12. Screw a 4-40 ball link five to six turns onto a 4½" long 4-40 linkage. Screw the opposite end of the linkage into the swivel control horn on the elevator. Adjust the linkage length until the hole in the ball link lines up with the outer hole in the servo arm when the elevator is neutral and the servo arm is centered.

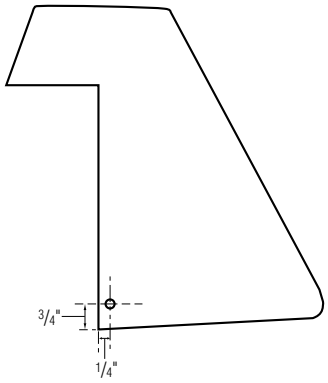


Step 13. Using the 4-40 screws and nuts included in the Rocket City package, attach the ball link to the outer hole in the arm. The correct sequence is 4-40 screw, ball link, servo arm, and 4-40 nut. (Don't use the spacer/standoff.) Be sure to use blue Locktite.

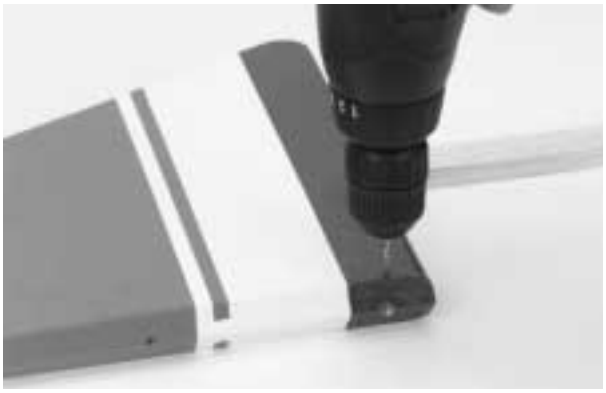
Section 8: Installing the Rudder, Control Horns, and Linkages

Parts Needed	Tools and Adhesives Needed
Rudder Fuselage **Not Included** Control Horns (2) (ROCO1B) 4-40 Ball Links (2) (ROC87) 1/2" 4-40 Pro-Links (2) (HAN3556)	Drill Drill Bit: 5/32" Phillips screwdriver Straight screwdriver 8-32 Tap (DUB363) 30-minute epoxy Rubbing alcohol Paper towels Ruler

Step 1. Mark the position for the rudder control horn with a felt-tipped pen. The correct location is 3/4" up from the bottom of the rudder and 1/4" rearward from the edge of the rudder bevel.

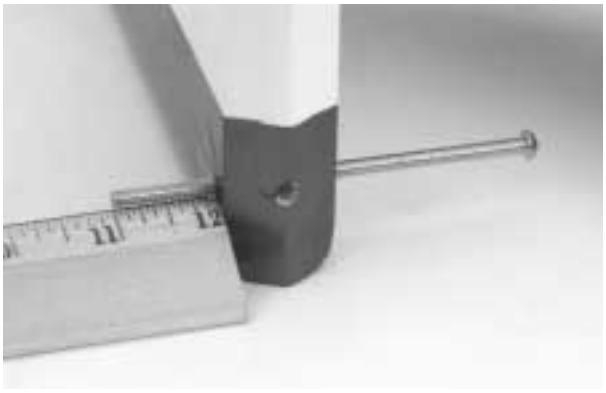


Step 2. Using a 5/32" drill bit and hand drill, carefully drill a 5/32" hole through the rudder perpendicular (90°) to the rudder centerline at the marked position. Be especially careful when penetrating through the backside of the rudder.



Step 3. Using an 8-32 tap, thread the hole you just drilled in the rudder.

Step 4. Mix a small amount of 30-minute epoxy and lightly coat the center of the threaded portion of the 4" long 8-32 bolt included with the Rocket City Swivel Horn package. Thread the bolt into the tapped hole in the rudder until 1" of thread is exposed on the opposite side.



Section 8: Installing the Rudder, Control Horns, and Linkages

CONTINUED

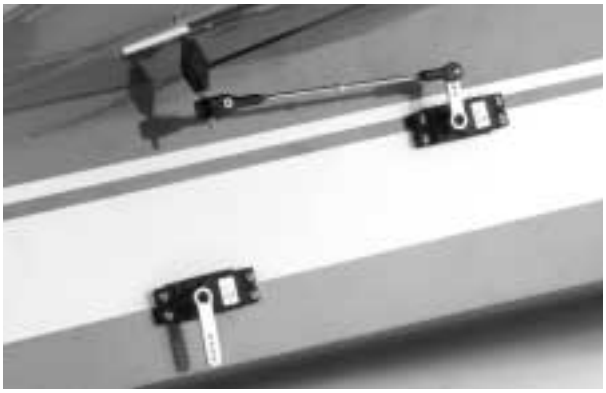
Step 5. Using a Moto-tool and a cut-off wheel, cut the bolt on the side with the head so that 1" of thread is exposed.

Step 6. Thread an A-nut (included with swivel clevis) onto each side of the threaded rod and securely tighten against the rudder.

Step 7. Screw a molded swivel link onto each side of the 8-32 threaded rod so that it is tight against the A-nut.

Step 8. Hinge the rudder using the same techniques as with the aileron and elevator.

Step 9. Remove the stock servo arms and replace them with heavy-duty 1¼" arms. The arms need to be positioned as shown below.



Step 10. Screw a 4-40 ball link five to six turns onto a 4½" long 4-40 linkage. Screw the opposite end of the linkage into the swivel control horn that was installed in Section 7. Adjust the length until the hole in the ball link lines up with the outer hole in the servo arm when the rudder is in neutral and the arm is centered.

Step 11. Using the 4-40 screws and nuts included in the Rocket City package, attach the ball link to the outer hole in the arm. The correct sequence is 4-40 screw, ball link, servo arm, and 4-40 nut. (Don't use the spacer/standoff). Be sure to use blue Locktite.

Step 12. Repeat Steps 10 and 11 for the other rudder servo.

Section 9: Installing the Landing Gear and Wheel Pants

Parts Needed	Tools and Adhesives Needed
Wheel pants (2) 4-40 x 5/8" socket head screws (2) 4-40 blind nuts (2) 10-32 x 1" landing gear mounting screws (4) 10-32 nuts (4) #4 split washers (2) #4 washers (2) Aluminum Landing Gear (HAN1263) Fuselage	Drill Drill Bit: 1/8" Hex Wrenches: 5/32" and 1/8" Adjustable wrench Felt-tipped pen Blue Locktite

Included in optional Hangar 9™ Hardware package

3 1/2" Wheels (2) (DUB350TL)
3/16" x 2" Axles (2) (DUB24)
3/16" Wheel Collars (4) (DUB141)

Step 1. Install the axles in the landing gear as shown and secure in place using an adjustable wrench.

Note: A plywood mounting plate is glued in place inside the wheelpants for mounting the wheel pant to the landing gear.

Step 2. Mark the position on the wheel pant where the axle will pass through on the plywood side. It's helpful to hold the wheel in place over the wheel pant to judge the correct position. Mark the position on both wheelpants with a felt-tipped pen, being sure to mark the same side that the plywood plate is installed.

Section 9: Installing the Landing Gear and Wheel Pants

CONTINUED

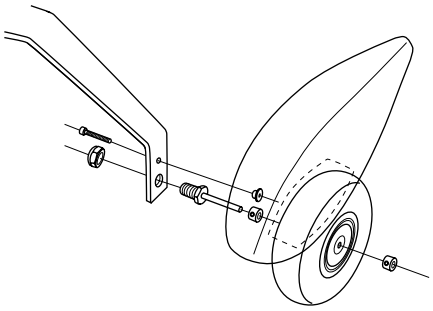
Step 3. Drill a 3/8" hole at the marked position on the wheel pants. Be careful when drilling through the backside of the plywood plate, as it's easy to split through the wood. It may be easier to drill a smaller hole first, then progressively increasing to a larger bit size.

Step 4. Fit the wheel pants over the axle and align with the landing gear as shown. With the wheel pants properly aligned, mark the mounting hole (small hole above axle hole) position through the landing gear on the wheel pants using a felt-tipped pen.

Step 5. Remove the wheel pants and carefully drill a 1/8" hole through the pants at the marked hole.

Step 6. Install the 4-40 blind nut from inside the wheel pants as shown. Later we will fully seat the blind nut into the plywood when installing the wheel pants onto the landing gear.

Step 7. Install onto the axle in the following order: wheel pant, 3/16" collar, wheel, then another 3/16" collar. It will be necessary to fit the parts inside the wheel pant and slide them onto the axle.



Step 8. Fasten the wheel pants in place using 4-40 x 5/8" screws with washer and split washer through the landing gear and into the blind nut in the wheel pants. Use blue Locktite and securely tighten the screws to properly seat the blind nuts.

Section 9: Installing the Landing Gear and Wheel Pants

CONTINUED

Step 9. Center the wheels in the wheel pants and tighten the collars against the wheels so that they are held in place. Use blue Locktite on the collar set screws.

Step 10. Mount the landing gear to the fuselage using four 10-32 x 1" screws and locking nuts.

Section 10: Attaching the Tail Wheel

Parts Needed	Tools and Adhesives Needed
Fuselage **Included in optional Hangar 9™ Hardware package** Ohio Superstar Large Tail Wheel Assembly (#OHI130) **Not Included** #6 x 3/4" Sheet Metal Screws (2) (DUB386)	Phillips screwdriver Drill Drill Bit: 1/8" Felt-tipped pen

Step 1. Assemble the tail wheel per the instructions included with the tail wheel assembly. The nylon control horns included with the tail wheel assembly are not used.

Step 2. Position the tail wheel in place as shown, centering on the rear of the fuselage. Using a felt-tipped pen, accurately mark the two hole positions through the tail wheel bracket.

Step 3. Remove the bracket and drill 1/8" pilot holes at the previously marked positions.

Step 4. Using two #6 x 3/4" sheet metal screws, fasten the tail wheel bracket in place. Note that the hardwood plate is positioned in the rear of the fuselage, allowing these screws to be firmly tightened.

Hint: Remove the #6 x 3/4" screws and wick thin CA into the holes to strengthen the threads. When dry, reinstall the screws.

Step 5. Using the provided spring, hook up the tiller arm to the rudder per the instructions included with the tail wheel assembly.

Section 11: Installing the Receiver, Battery, and Fuel Tank

Parts Needed	Tools and Adhesives Needed
Fuselage	5-minute epoxy

Not Included

1000mAh or larger battery pack
Receiver
Receiver switch
1/8" light plywood
Radio mounting foam (thick gyro tape also works well)
Cup hooks
Rubber bands #64

Step 1. Remove the hatch to allow access to the interior of the fuselage. Using the included templates on the back cover of the manual, cut out the battery tray from 1/8" light plywood.

Step 2. If using the Zenoah® GT-80, it will be necessary to mount the battery pack slightly behind the wings trailing edge to properly balance the model. The lighter Zenoah G-62 requires the battery be mounted in the nose. Using 5-minute epoxy, attach the battery tray in the fuselage in the front or rear position.

Section 11: Installing the Receiver, Battery, and Fuel Tank

CONTINUED

Step 3. Using foam and rubber bands (or Velcro® straps), securely attach the battery to the battery tray.

Step 4. The gas tank mounts just ahead of the wing tube close to the center of gravity. Assemble the tank per the instructions included with the tank. Be sure to use a gas-compatible stopper and tubing.

Step 5. Place foam on the floor of the tank compartment. Secure the tank in place by wrapping rubber bands or Velcro straps around the tank and tank floor. Cup hooks can be used to hook the rubber bands to the tank floor. Later we will run the fuel lines.

Step 6. Using 5-minute epoxy, fasten the receiver mount in place as shown below.

Step 7. Using foam and rubber bands (or Velcro straps), fasten the receiver in place as shown. An antenna tube (not included) can be used to route the antenna out the rear of the fuselage.

Step 8. Mount the receiver switch in a convenient location in the side of the fuselage.

Section 12: Mounting the Engine and Cowl

Parts Needed

Fuselage
Engine-mounting adapter plate (G-62 only)
Fiberglass cowl w/included mounting hardware
1/4" x 20 socket head cap screws,
split washer, and blind nuts (4)

Not Included

Engine
Zenoah® 2" Prop Drive (ZENE20004) (GT-80 only)
Cup Engine Mount (B+B6202) (G-62 only)
2' of Gas-Compatible Fuel Tubing (DUB800)
Throttle servo
18" Servo Extension (JRPA009)
1/4-20 x 1½" Socket Head Screws (4)
(DUB646)(G-62 only)
4-40 x 6" threaded rod (choke rod)
1/8" plywood
Fuel Filler (HAN115)
Kill Switch (ZEN20000)

Included in Optional Hangar 9™ Hardware Package

6" 4-40 Rod Threaded (DUB802)
4-40 Solder Link (DUB604)
4-40 Ball Links (2) (ROC87)

Tools and Adhesives Needed

Moto-tool w/cut-off wheel and drum sander
Drill
Drill Bit: 5/16"
Jig saw
Phillips screwdriver
Scissors
Tape
Soldering iron and silver solder
5-minute epoxy

The Hangar 9™ 1/3 Scale CAP 232 accepts gas engines ranging from 60 through 80cc's. The prototype CAPs were flown using Zenoah® G-62s and GT-80s. The G-62 offers good sport performance and is a good choice for doing all IMAC basic and sportsman maneuvers. While the G-62 equipped CAP doesn't quite provide unlimited vertical performance, most experienced sport flyers find that the G-62 offers plenty of power for all but the most aggressive types of aerobatics.

If you're a 3-D fanatic or an Advanced or Unlimited IMAC class competitor, Zenoah's GT-80 offers unlimited power for vertical multiple Snaps, Hovers, and Torque Rolls.

Using a GT-80

Before beginning this section, remove the standard GT-80 prop drive and replace with the 2" prop drive (ZEN20004).

Step 1. Using 5-minute epoxy, glue the 1" x 1" square plywood plates to the back of the firewall centered over the four predrilled mounting holes. Blind nuts will be mounted in these plates. When the epoxy has cured, drill through the front of the firewall and the plywood plates at the four engine mounting hole locations using a 5/16" drill bit.

(continued — Step 1 illustration)

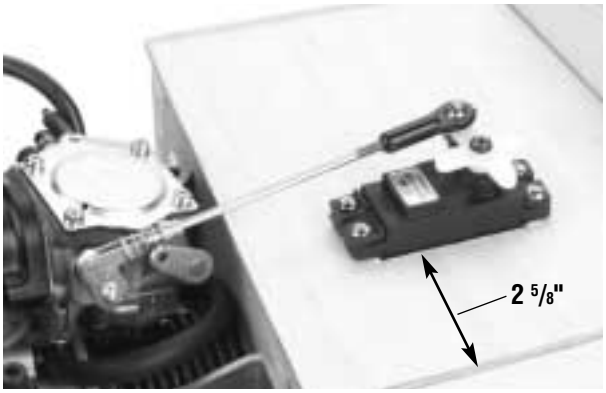
Step 2. Fit the engine to the firewall using four 1/4 x 20 socket head screws, split washers, and blind nuts provided.

Section 12: Mounting the Engine and Cowl

CONTINUED

Step 3. If using the GT-80 (or 445), the throttle servo is position as shown in the top of the engine box. Using a pen, mark the opening for the servo 2 5/8" from the left side of the top plate. Note that the top plate is tapered to accommodate the firewall right thrust angle. Be sure to mark the servo opening in the correct position. Use a jig saw to cut out the servo opening in the top plate. It will be necessary to cut clearance openings for the blind nuts in this plate.

Step 4. Using 5-minute epoxy, glue the top plate in place. Mount the throttle servo using the hardware included with the servo. Using a 4-40 threaded rod, a solder link, and a 4-40 ball link, make up the throttle pushrod to the appropriate length. Securely solder the solder link in place and attach the 4-40 ball link to the pushrod and the servo arm.



Step 5. If using a Zenoah® GT-80, attach a 4-40 x 6" threaded rod to the choke lever using a 4-40 ball link. The 4-40 rod runs down through the engine mount and exits the bottom of the cowl.

Step 6. Run the fuel lines from the pick up in the tank to the carburetor and run the vent line out the bottom of the fire wall. We recommend using a fuel filler and a kill switch mounted in the cowl for convenient fueling and safety.

Step 7. Using a Moto-tool with a cut-off wheel and drum sander, cut an air outlet in the bottom of the cowl as shown. The approximate size should be 5" x 5". It may also be necessary to cut out an area for the mufflers to exit depending on the mufflers and engine you use.

Step 8. Mount the Fuel Filler and Kill Switch in the cowl in a convenient location, then mount the cowl in place using the included 4-40 hardware.

Section 12: Mounting the Engine and Cowl

CONTINUED

Using a G-62

Step 1. Remove the metal engine mount (if attached) from the G-62. Attach the B+B Cup engine mount.

Step 2. Using 5-minute epoxy, glue the 1" x 1" square plywood plates to the back of the firewall centered over the four predrilled mounting holes. Blind nuts will be mounted in these plates. When the epoxy has cured drill through the front of the firewall using a 5/16" drill bit through the plywood plates at the four engine mounting hole locations.

Step 3. Install the engine on the adaptor plate and then to the firewall using 1/4-20 x 1½" socket head cap screws, split washers, and blind nuts.

Step 4. Mount the Zenoah® throttle linkage to the engine as per the instructions included with the engine. Cut out the servo hole in the bottom plate as shown and mount the servo. Using a 4-40 threaded rod, a solder link and a 4-40 ball link, make up the throttle pushrod to the appropriate length. Securely solder the solder link in place and attach the 4-40 ball link to the pushrod and the servo arm.

Step 5. Install the muffler. An optional muffler (BIS07163) is recommended.

Step 6. Using a Moto-tool with a cut-off wheel and a drum sander, cut an air outlet in the bottom of the cowl as shown. The approximate size should be 5" x 5". It may also be necessary to cut out an area for the mufflers to exit, depending on the mufflers and engine you use.

Section 13: Hatch Assembly

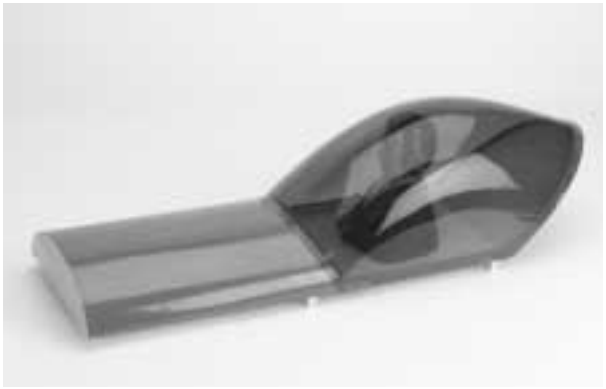
Parts Needed	Tools and Adhesives Needed
Hatch (HAN1260) Canopy (HAN1259) 4-40 Screws with Split washers and #4 Washers (2) (HAN1214) Decals for instrument panel or Optional Hangar 9™ Scale Panel (HAN187)	Scissors Hex Wrench: 5/32" Canopy glue (Pacer Formula 560 or equivalent) Silicon glue (3M® caulking) Masking tape

Not Included

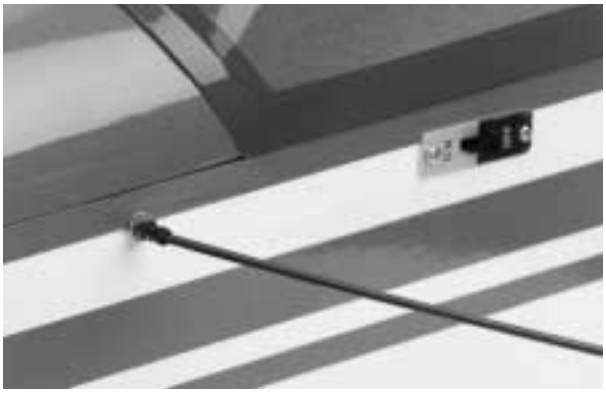
1/3 Scale Pilot (HAN8265)

Step 1. Glue a 1/3 scale pilot in the cockpit area (silicon glue works good here) and attach the instrument panel. Hangar 9 offers a sharp-looking Instrument Panel (HAN187) that replaces the decals for a more scale look.

Step 2. When satisfied with the cockpit detail, fit the canopy in place. It may be necessary to trim the edges for a perfect fit. When satisfied, glue the canopy in place using canopy glue like Pacer Formula 560. Use masking tape to hold the canopy in place while the glue dries.



Step 3. Mount the completed hatch. Use 4-40 screws with split washers and #4 washers to fasten the hatch in place.



Step 4. Apply the included decals as per the box top.

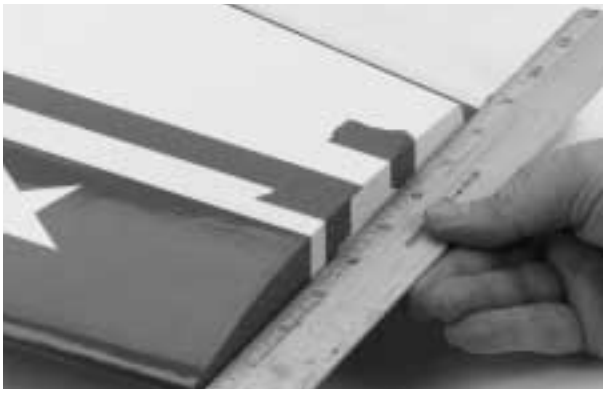
Section 14: Balancing the Model

Tools Needed

Felt-tipped pen
Ruler

Correctly balancing an aerobatic model is critical to its performance and flight characteristics. Checking the balance on giant scale models is best done with two people.

Step 1. On the top of the wing tips, measure back 4 1/2" and 5 3/4" from the leading edge and mark both places with a felt-tipped pen. This is the recommended center of gravity (C.G.) range.



Step 2. Fully assemble the model. With a helper, lift the airplane with your index fingers and find the balance point. The balance point (C.G.) should lie between the two marks on the wing tip. If not, add the necessary weight to the nose or tail to obtain the correct balance.

Section 15: Radio Setup

A 7-channel or greater computer radio is highly recommended. This allows the following features:

- Mixing the right aileron to the left aileron (flapperon mix)
- Electronically adjustable aileron differential
- Mixing the right elevator to the left elevator (dual elevator mixing)
- Independent travel and trim adjustments of each elevator half
- Mixing the right rudder servo to the left rudder servo
- Rudder to elevator mixing to correct rudder to elevator coupling
- Rudder to aileron mixing to correct rudder to aileron coupling

When using a 7-channel or greater computer radio, each servo is plugged into its own separate channel. Consult your radio manual for specific details on hookup and programming.

If using a 6-channel radio with flapperon mix, the aileron servos are each plugged into their own channels. The right aileron servo plug into the aileron socket in the receiver, while the left aileron servo plug into channel 6. With flapperon activated in the programming, this allows for independent travel adjustment of each aileron in each direction and electronic aileron differential. Consult your manual for more programming details.

With a 6-channel computer radio, it will be necessary to Y-harness the two rudder and elevator servos; a reversed elevator servo is needed to achieve the correct control direction. A servo reverser can be used here. Special attention must be taken with the rudder servos so that they don't fight each other throughout the rudder travel. This is caused by nonsymmetrical pushrod geometry from right to left. It may be necessary to rotate the arm on the servo one or two splines (most of the time toward the rear) and readjust the linkage length in order to prevent binding.

Using a non-computer radio will require that the aileron, elevator, and rudder be Y-harnessed. Be sure to use a reversed servo (or a reverser) for one of the elevator servos. Special attention must be taken with the rudder servos so that they don't fight each other throughout the rudder travel. This is caused by non-symmetrical pushrod geometry from right to left. It may be necessary to rotate the arm on the servo one or two splines (most of the time toward the rear) and readjust the linkage length in order to prevent binding. If you've ever thought about purchasing a computer radio, now is a good time to do it!

Section 16: Control Throws

Recommended Control Throws

	Standard	3-D
Aileron	1 1/2" up 1 1/8" down (18° up 17° down)	2 1/2" up 2 1/4" down (37° up 35° down)
Elevator	1 3/8" up 1 1/2" down (16° up 16° down)	4" up 4" down (42° up 40° down)
Rudder	4 1/2" right and left (26°)	8" right and left (44°)

Section 17: Preflight at the Field

Range Test Your Radio

Step 1. Before each flying session, be sure to range check your radio. This is accomplished by turning on your transmitter with the antenna collapsed. Turn on the receiver in your airplane. With your airplane on the ground and the engine running, you should be able to walk 30 paces (approximately 100 feet) away from your airplane and still have complete control of all functions. If not, don't attempt to fly! Have your radio equipment checked out by the manufacturer.

Step 2. Double-check that all controls (aileron, elevator, rudder, and throttle) move in the correct direction.

Step 3. Be sure that your batteries are fully charged, per the instructions included with your radio.

Section 18: Setup and Flight Information by Mike McConville

Our new 1/3 Scale CAP 232 will blow away almost any pilot wanting to fly aerobatics. When designing this model, I incorporated design features and enhancements that I used in several Tournament of Champions and IMAC competitions.

Does this mean the CAP 232 is only for the serious competitor? Absolutely not! What this does mean is that the CAP is fine-tuned and tweaked to excel in both precision aerobatics and wild freestyle type 3-D, so doing any aerobatics will be easier than it has ever been.

Preflight

Before getting to the really fun stuff, flying, I'd like to reiterate some very important steps that were covered in the assembly instructions. For those of you who are veterans of large models, this is old news. But to you new comers to the world of large models, this is very important information.

While many smaller models are very tolerant of improper control linkage setups and flying techniques, large models are not. Don't let that scare you away from large models; they are truly one of the best flying experiences in RC that money can buy. However, please pay particular attention to the following areas:

Seal the aileron and elevator hinge gaps.

This should be considered part of finishing the model and is as important as installing the fuel tank or battery pack. On large aerobatic models, this is absolutely necessary. Failure to do this may very well cause control surface flutter, and on a large model, this will most likely cause a crash. Putting safety and model preservation to the side, there are several other reasons to do this on an aerobatic model. It will increase the effectiveness of the control surfaces, and the model will track more true and precise. Hinge gaps sealed? CHECK!

Maintain the proper mechanical advantage on all control surface linkages.

Same as unsealed hinge gaps, this is often the cause of flutter. Please follow the control horn and servo arm lengths recommended in this manual. Shorter arms on the servo or longer control horns on the elevator and ailerons are fine, but do not try to go the other way to increase throw. It will cause flutter on the CAP. The recommended linkage setups are more than adequate to achieve full 3-D throws. That's straight off of the prototypes. Linkages are set? CHECK!

Never attempt to make full throttle dives!

Large models perform much more like full-size aircraft than small models. If the airframe goes too fast, such as in a high throttle dive, it may fail. The CAP 232 should be flown like a full-scale CAP. Throttle management is absolutely necessary. If the nose is down, the throttle comes back. CHECK!

The Prototype Model Setup

All of the recommended settings in this manual are a result of the flight testing on the prototype CAPs. There are no secrets. If you follow the instructions and these tips, your CAP 232 will be set up just like mine.

Although a computer radio is not mandatory, it is preferable in this model. I use Exponential on all controls to soften the feel around neutral. This makes it easier to fly smooth in precision maneuvers and also makes it less likely to over-control in 3-D mode. I use the following expo values: Elevator +38% Low Rate, +70% 3-D Rate. Aileron +40% Low Rate, +55% 3-D Rate. Rudder +25% Low Rate, +50% 3-D Rate. Note that + expo values soften the neutral with JR radios. Other brand systems may require "-" (negative) expo values to soften the neutral.

I have flown CAP 232s equipped with both JR 8101 servos and JR 8411 digital servos. While both are excellent choices for the CAP, I personally prefer the feel with the digital 8411 servos; with these servos, the model feels slightly more responsive. I use a 6V Ni-Cd battery pack for maximum speed and torque from the servos.

The prototype CAP 232s were tested on the Zenoah® G-62 and the Zenoah GT-80. With the G-62 for power, the performance was very good sport power. Vertical performance was good but not unlimited. I used a Pro-Zinger 22 x 10 prop for all testing. Even some 3-D maneuvers, such as Harriers, Blenders, and Harrier Landings were possible; anything that did not require unlimited vertical.

My favorite powerplant is the Zenoah GT-80. I use a Bolly 24 x 10 propeller, which the GT-80 turns at approximately 7000 rpm, and a preshaped and balanced Bolly 24 x 10 at 7700 rpm. Both work well, but I feel the preshaped prop has the edge in hovering maneuvers. This combination has proven to be totally unlimited and allows anything imaginable from torque rolls just a few inches off the ground to multiple vertical snaps.

I found that adequate engine cooling is very important with the GT-80 and strongly recommend adding the cowl baffles and cutting the cowl bottom hole to the size recommended in the instructions. When this was done, the performance difference was dramatic. If you aren't getting this kind of performance, take a look at the cowl and how well the GT-80 is being cooled.

Performance Tip: Drill eight 5/16" diameter holes through the internal baffle plate in the GT-80 mufflers. I drilled seven through the intake opening and one up through the exhaust stack. Just be sure to flush out all of the metal shavings from the mufflers. This little 10-minute trick will add 300 rpm to the top end.

Section 18: Setup and Flight Information by Mike McConville

Computer Radio Enhancements

A computer radio will allow you to do quite a bit of fine-tuning of the feel of the CAP 232, which will make aerobatics even easier. Below are the programming enhancements I normally use to trim out an aerobatic model.

Differential Mixing

This is a great mixing feature of many computer radios that allows you to dial in the aileron differential, which is how the roll axis of the model is set. The best method for setting this is to use the Travel Adjust (ATV) of aileron and flap channels to set the up and down movement of each aileron exactly the same. Set it to the maximum throw of 2½" (37°). Then set the differential by going to the appropriate screen in the radio and adjusting the differential value to reduce the down movement of each aileron to 2¼" (35°).

Rudder-to-Elevator and Rudder-to-Aileron Mixing

This mix is used to dial out unwanted pitch or roll caused by the rudder. The CAP has very little coupling, but dialing it out will make knife edge maneuvers easier. Use a preprogrammed mix if your radio has this feature, or if not, use a P-mix feature. Assign rudder as the master channel and elevator as the slave. Set the mixing values so when the rudder is deflected all the way in either direction on high rate, the elevator moves up 1/4".

Spoileron Mixing

This can be achieved by using either a preprogrammed elevator to flap mix or a P-mix. Assign elevator as the master channel and flap as the slave. Set the mix values so that when full up, 3-D elevator is given, both ailerons also go up 7/16" (16°). This mix helps stabilize the model in some 3-D maneuvers, such as the Elevator and Harrier.

Throttle Curve

This is normally a preprogrammed function. It can also be achieved in radios that do not have this premix but do have curve type P-mixing by mixing throttle as the master and slave channels. Then adjust the curve to get the desired throttle servo response. This is particularly useful to get an engine to "act" linear throughout the entire throttle stick movement. I also use this at times to make the throttle response less sensitive in the rpm ranges used for hovering the model. This makes altitude control easier and smoother when doing Torque Rolls.

Rates and Expos: When and Where to Use Them

I always use Expo to soften the feel of the model. On high 3-D rates I use quite a bit. The goal on 3-D rates is to get the model to feel the same around neutral as it does on low rates.

I use low rate settings for all flying except for 3-D aerobatics. For precision flying or general sport hot-dogging, the low rate throws are perfect, even for snap rolls. The only exception is rudder rates. I go to 3-D rate when doing stall turns and rolling circles, since the more rudder the better for these. When doing 3-D aerobatics, I normally flip to 3-D rates just before the maneuver. As soon as the maneuver is done, I flip back down to low rate to avoid over-controlling the model.

Let's Get Down To It

When flying aerobatics with a larger model, you will find that it will do everything just like a smaller model....only better and easier. There are just a few exceptions to how things are done. Throttle management is a must. You have to throttle back to idle when the nose is pointed down.

Snap Rolls

Just like the need to be throttle managed like a full-scale airplane, larger aerobatic airplanes need to be snapped like a full scale. Don't feel bad if this seems like a big "What are you talking about?" to you. It took me quite a while to figure this out. Let's back up to how we all learned to do a snap roll. If it's an inside (positive) snap, we pull the sticks into the corner, i.e. full up, full aileron, and full rudder in the same direction as aileron. When we want to stop snapping, we release the controls. For smaller models, this technique not only works but is normally the only way to get the model to snap. In a full-scale aerobatic plane, as well as with large models, snaps are different, particularly on the new breed of aerobatic birds like the CAP 232, which have large control surfaces.

Unloading Snaps

That's the whole trick. To start a snap roll, the same method as with a smaller model is used. Pull full up, full rudder, and aileron in the same direction. But soon as the sticks reach the corners, neutralize the elevator while keeping the rudder and ailerons at full deflection. When you do this correctly, the Extra will not get "deep" into snaps. This allows it to keep more airspeed as it exits the snap, so it stops snapping where you what it to and flies out with more air speed. You'll also find that it will be a lot easier to exit a snap heading the same direction you were when you entered the snap. It'll take a little practice to get the hang of "flying" the snaps, but I'll bet you'll see a big improvement in the quality of your flying.

CONTINUED

CAP 232 at Its Best

3-D maneuvers (in simplest terms) are maneuvers performed by an airplane that are not usually done in a normal airplane flight path. What can be done with a 3-D plane is to make it fly like no other. For example, hovering in the air nose high at a 45-degree descent, floating along in level flight, hanging on the prop, or tumble tail-over-nose in a rapid flipping motion. When you sprinkle these maneuvers together with other loops, rolls, snaps, and spins, it seems like the aerobatic options are endless.

To fly 3-D, you must have a plane that's capable. What's capable? Well, it starts with having outlandish pitch control from having huge elevators. The same applies, but not to the same extent, with rudder and ailerons. When it comes to 3-D aerobatics, our CAP 232 lives up to the CAP reputation and then some.

The Maneuvers

Let's cover the seven 3-D maneuvers where the CAP 232 really excels.

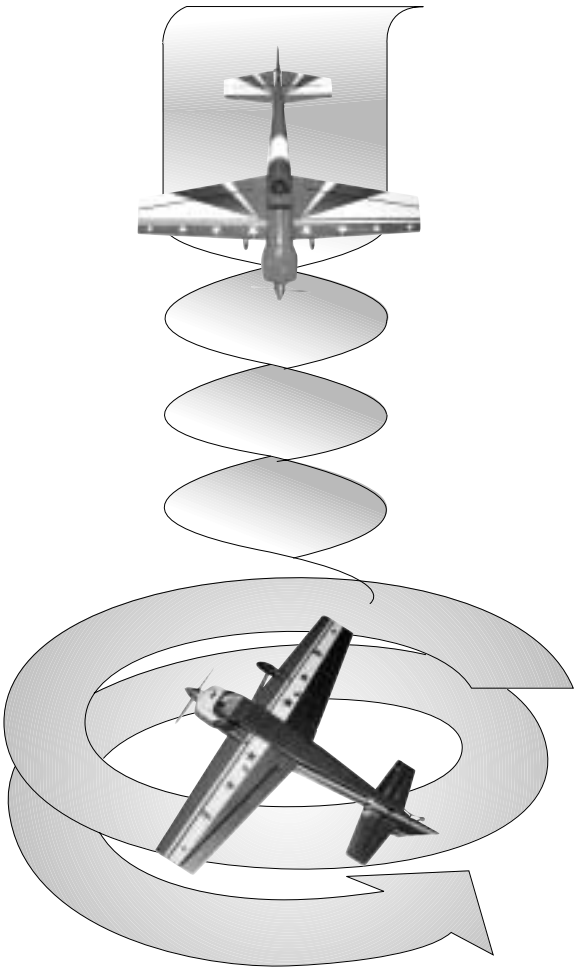
The Blender

What it is: The Blender or Panic maneuver is a vertical diving roll that virtually stops its descent as it instantaneously enters into a flat spin.

Setup: Follow the 3-D setup as described in the manual. Be sure to use Expo. Setting the CG toward the aft location will help, but I have had great results even at the forward CG location. This is a wing tester and can be extremely violent but will always generate gasps of excitement. Done correctly, the CAP 232 can handle the challenge.

How to do it: Start from about 400-500 feet straight and level, chop throttle, and push the nose straight down. As soon as the model is diving straight down at low throttle, add full left aileron. Let the model compete two or three rolls and then quickly transition the sticks to an inverted snap roll position (left aileron, right rudder, down elevator) all at the same time. As soon as the CAP enters a spin, quickly neutralize the ailerons while holding full right rudder and down elevator. If you do it right, the airplane will instantly transition from a left roll to a flat spin in the same direction, and the decent will all but stop.

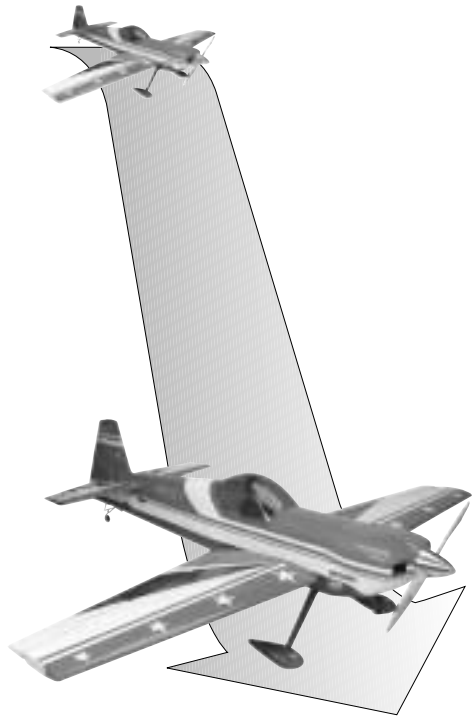
The Blender



Tip: Add full throttle just after the spin goes flat. That'll keep fuel going to the engine, make the rotation speed high, and help stop the vertical decent.

Recovery: Simply release rudder and hold just a little down elevator. The model will stop rotating and begin to fly out. As it gains airspeed, roll back to upright. Since you're in 3-D mode, make sure you don't do anything abrupt, or you'll stall again.

Section 18: Setup and Flight Information by Mike McConville



The Elevator

The Elevator

What it is: The plane drops vertically while in a nose high attitude. Depending on the head wind conditions, the model will drop anywhere from about a 45° angle in calm conditions to vertical or even a little backwards in more windy conditions. Throttle is used to determine rate of descent and the nose high attitude of the model.

Setup: Same as the Blender, except flip the switch to turn on the spoilerons. This will help to keep the CAP 232 from teetering back and forth.

How to do it: At near stall airspeed up high, slowly feed in up elevator until you have the full 3-D rate up in it. With low throttle, the CAP 232 will fall like a rock. To guide it around, use the rudder, not ailerons. Just keep the wings level. Add power to change the attitude of your CAP 232.

Trickiest part: Aside from steering it with the rudder, you'll quickly see that this maneuver is a matter of juggling the throttle and rudder to get the plane to go where you want it to go.

Recovery: Basic recovering-add full power, flip to normal rate elevator, and fly out.

Advanced recovery: Take the elevator all the way to the ground, adding some power before it touches down to slow the decent and transition into a Harrier and land.

OR

Add power to get the nose to rise to vertical and transition into a Torque Roll. Elevator down from a hundred feet down to 20 feet (or less) and power up into a Torque Roll. Ooh!!

Worst way to mess up: Let your direction control (rudder) get away from you after starting too low-you could snap it right into the ground. Ouch!

The Harrier

What it is: It is very slow forward flight in a very nose high (about 45°) attitude.

Setup: Same as the Elevator, and the raised ailerons help in this maneuver even more.

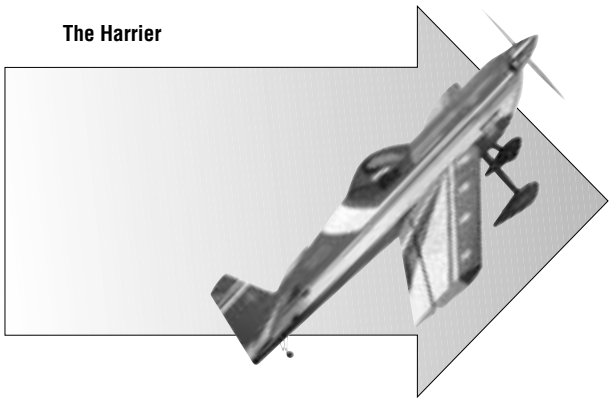
How to do it: Start by entering an Elevator maneuver. Let the Extra drop a small amount, then slowly add power until the vertical decent stops and the model begins to fly forward with the nose very high, all the while your holding full up elevator (on 3-D rate). Juggle the power to control the attitude and forward speed of the model. In a head wind, you may also have to juggle the elevator some to keep the model from pitching up to a vertical attitude. Use the rudder to steer the model around in the Harrier attitude. Try to use the ailerons very little, as they will cause the model to wobble side to side.

Trickiest part: Keeping up with the model if it begins to wobble.

Recovery: Simply add full power and reduce elevator to transition into normal forward flight.

Advanced recovery: After you get the hang of flying around in the Harrier, juggle the throttle to slowly lose altitude and do a Harrier landing. The model will land on the rear of the rudder first, then add a little power so it doesn't smack the landing gear too hard.

The Harrier



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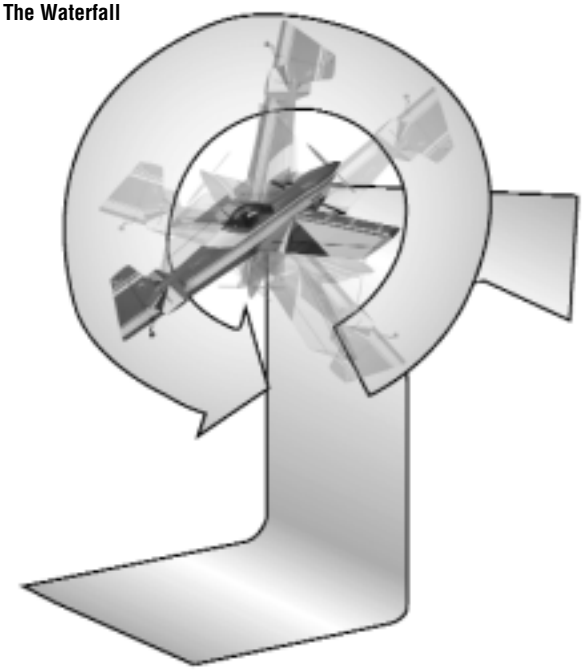
The Waterfall



The Waterfall

What it is: This maneuver is a continuous tail-over-nose descending flip. It is not a loop, but the aircraft actually flops around its canopy.

Setup: Again, this is the critical component is having the 3-D elevator. The aft CG helps this the most.

How to do it: Start relatively high. At low throttle, gradually pull the nose up until its near vertical. Just before it stalls, add full down and, at the same time, add full power. You have to continuously "fly" the rudder and ailerons to keep the model flipping over in a straight line. To do consecutive Waterfalls, continue to hold full down and to "fly" rudder and ailerons and chop the throttle as the nose comes back up to vertical, then add full power as it flips straight down.

Trickiest part: No doubt here, it's flying the rudder and aileron correctly. You have to fly the rudder and ailerons and make constant corrections. The amount you add will vary. If you do not do this, the model will fall off into a knife edge spin

Recovery: Just neutralize the elevator and the CAP will quit flipping, but expect some over-rotation, so practice high until you get the feel of it. Fly out straight and level or stop the rotation while pointed vertical and go into a Torque Roll.

Worst way to mess up: Take it down too low, over-control your elevator on recovery, and snap into the ground. To avoid this, simply change rates on your elevator to normal travel.

The Torque Roll

What it is: The CAP "hovers" vertically in place, rotating left around its roll axis.

Setup: Full 3-D throws in elevator and rudder are a must. An aft CG helps a little. Also gyros provide the best aid to stabilize the aircraft. They won't do the maneuver for you but they'll help. I found them a fantastic tool in learning to torque roll, kind of like training wheels. A few years ago gyros made a big difference for me, now I don't use them anymore. You'll need to use the Zenoah® GT-80 or an engine that will give you unlimited vertical before you try this one.

How to do it: Fly low along the ground at low throttle and gently add power with up elevator to bring the model into a vertical position. Add throttle to keep the nose pointed up and make corrections with rudder and elevator to keep things straight. If the model hovers but won't start rolling left, quickly blip the throttle up and down. The torque change will usually get it going.

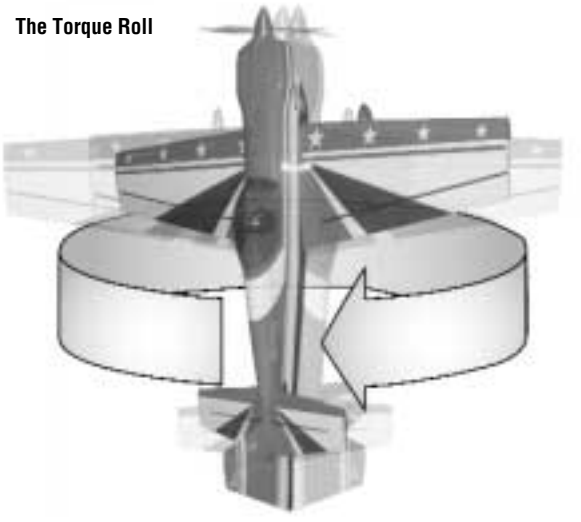
Trickiest part: Recognizing your correction when the model's belly is toward you.

Tip: Think push the rudder toward the low wing when the belly is toward you. You have to be fast with throttle corrections. Add bursts of power, along with rudder/elevator corrections. If you simply hold full throttle, you'll climb out of the maneuver.

Recovery: Fly out at full throttle.

Worst way to mess up: Have an unreliable engine. Torque Rolls are tough on engines because there's only prop-induced airflow over the cylinders. I'd really recommend putting the baffling in the cowl if you are running a twin cylinder engine and plan on doing Torque Rolls.

The Torque Roll



Section 18: Setup and Flight Information by Mike McConville

CONTINUED

The Parachute

What it is: The Parachute is a vertical dive that instantly decelerates in its descent as it instantaneously corners into an Elevator.

Setup: Same as the Elevator, and the raised ailerons help in this maneuver too.

How to do it: Start from about 400-500 feet straight and level, chop throttle, and push the nose straight down. As soon as the model is diving straight down at low throttle, add full up elevator. If you do it right, the CAP will instantly transition from a vertical dive to an Elevator.

Tip: Add a little throttle just after transition to an Elevator. That'll keep fuel going to the engine and keep it from quitting.

Recovery: Simply add full power and reduce elevator to transition into normal forward flight.

Advanced recovery: Juggle the throttle to slowly lose altitude and do a Harrier landing. The model will land on the rear of the rudder first, then add a little power so it doesn't smack the landing gear too hard.

Worst way to mess up: To build up too much speed. This maneuver has huge "WOW" factor, but just like a Blender, too much speed and it over stresses the wing. Watch the speed.

The Parachute

The Wall

What it is: The Wall is a Parachute turned on end. The model starts in normal level flight and suddenly corners nose up 90°, as if it hit a wall.

Setup: Same as the Elevator, and the raised ailerons help in this maneuver too.

How to do it: Start from about 100 feet straight and level, chop throttle, and as the model begins to slow down, quickly pull full up elevator. When the CAP corners to vertical, add full power and release the up elevator.

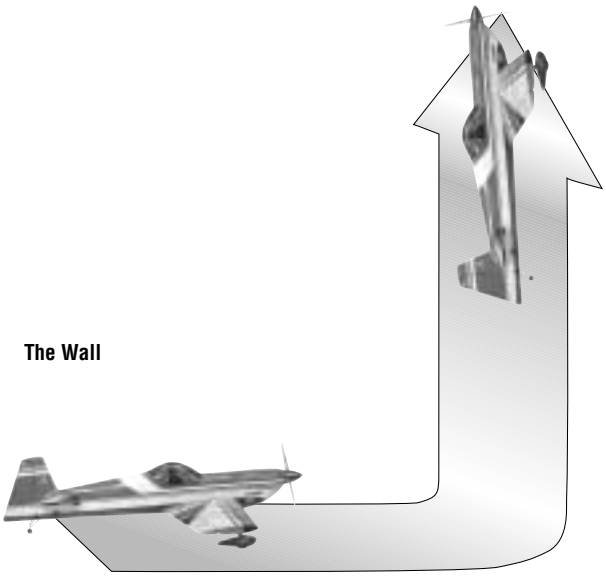
Tip: Start a low speed and add power at the same time that you begin to pull full up elevator.

Recovery: Simply release the elevator, go to full throttle, and fly out upward.

Advanced recovery: Juggle the throttle to sustain a hover and transition into a Torque Roll.

Worst way to mess up: Don't get the throttle in quickly enough and the model falls backward.

Great combo: This has become one of my favorites to do with the CAP. Takeoff normally, but as soon as the CAP is airborne, chop the throttle and do the Wall, then transition into a Torque Roll over the runway. Practice all of this stuff up high before you try that.



The Wall

I hope you enjoy your CAP 232 as much as I do!

Happy Landings!

Mike McConville

AMA National Model Aircraft Safety Code

Effective January 1, 2001

Model flying must be in accordance with this code in order for AMA Liability Protection to apply.

General

1. I will not fly my model aircraft in sanctioned events, air shows, or model flying demonstrations until it has been proven airworthy by having been successfully flight tested previously.

2. I will not fly my model higher than approximately 400 feet within 3 miles of an airport without notifying the airport operator. I will give right-of-way 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.

4. At all flying sites a straight or curved line(s) must be established, in front of which all flying takes place and the other side designated for spectators. Only personnel involved with flying the aircraft are allowed in front of the flight line. Flying over the spectator side of the line is prohibited, unless beyond the control of the pilot(s). In any case, the maximum permissible takeoff weight of the models with fuel is 55 pounds.

5. At air shows or model flying demonstrations, a single straight line must be established, one side of which is for flying and the other side designated for spectators. Only those persons accredited by the contest director or other appropriate officials as necessary for flight operations or having duties or functions relating to the conduct of the show or demonstration are to be permitted on the flying side of the line. The only exceptions which may be permitted to the single straight line requirements, under special circumstances involving consideration of site conditions and model size, weight, speed, and power, must be jointly approved by the AMA President and the Executive Director.

6. Under all circumstances, if my model weights over 20 pounds, I will fly it in accordance with paragraph 5 of this section of the AMA Safety Code.

7. I will not fly my model unless it is identified with my name and address or AMA number on or in the model. (This does not apply to models while being flown indoors.)

8. I will not operate models with metal-bladed propellers or with gaseous boosts, in which gases other than air enter their internal combustion engine(s); nor will I operate models with extremely hazardous fuels, such as those containing tetranitromethane or hydrazine.

9. I will not operate models with pyrotechnics (any device that explodes, burns, or propels a projectile of any kind) including, but not limited to, rockets, explosive bombs dropped from models, smoke bombs, all explosive gases (such as hydrogen-filled balloons), or ground-mounted devices launching a projectile. The only exceptions permitted are rockets flown in accordance with the National Model Rocketry Safety Code or those permanently attached (as per JATO use); also those items authorized for Air Show Team use as defined by AST Advisory Committee (document available from AMA HQ). Models using rocket motors as a primary means of propulsion are limited to a maximum weight of 3.3 pounds and a G series motor. (A model aircraft is defined as an aircraft with or without an engine, not able to carry a human being.)

10. I will not operate any turbo jet engine (axial or centrifugal flow) unless I have obtained a special waiver for such specific operations from the AMA President and Executive Director, and I will abide by any restriction(s) imposed for such operation by them. (This does not apply to ducted fan models using piston engines or electric motors.)

11. I will not consume alcoholic beverages prior to nor during participation in any model operations.

Radio Control

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

2. I will not fly my model aircraft near spectators until I become a qualified flier, unless assisted by an experienced helper.

3. I will perform my initial turn after takeoff away from the pit or spectator areas, and I will not thereafter fly over pit or spectator areas, unless beyond by control.

4. I will operate my model using only radio control frequencies currently allowed by the Federal Communications Commission. (Only properly licensed amateurs are authorized to operate equipment on Amateur Band frequencies.)

5. I will not knowingly operate an R/C system within 3 miles of a pre-existing model club flying site without a frequency-sharing agreement with that club.

6. Models flown in air-to-air combat are limited to maximum total engine displacement of .30 cubic inches and a maximum dry weight prior to flying of 4 pounds.

7. An RC racing event, whether or not an AMA Rule Book event, is one in which model aircraft compete in flight over a prescribed course with the objective of finishing the course faster to determine the winner.

AMA National Model Aircraft Safety Code

Effective January 1, 2001

ORGANIZED RC RACING EVENT

A. In every organized racing event in which contestants, callers, and officials are on the course:

1. All officials, callers and contestants must properly wear helmets which are OSHA, DOT, ANSI, SNELL, or NOCSAE approved or comparable standard while on the race course.

2. All officials must be off the course except for the starter and his/her assistant.

3. "On the course" is defined as any area beyond the pilot/staging area where actual flying takes place.

B. I will not fly my model aircraft in any organized racing event which does not comply with paragraph A above or which allows models over 20 pounds unless that competition event is AMA sanctioned.

Note: Refer to AMA Headquarters for Free Flight, Control Line, boat, car and rocket safety codes. ACADEMY OF MODEL AERONAUTICS, 5161 EAST MEMORIAL DRIVE, MUNCIE, INDIANA 47302-9252

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