

**Construction Article**

**THE BUG**  
**Sport Competition**  
**Hand-Launch**

**June 2001 R/C Modeler**

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By  
Carl Dowdy



**BUG**

**Designed by:**

Carl Dowdy

**TYPE AIRCRAFT**

Mosquito Class Hand Launched Glider

**WINGSPAN**

29-1/2 Inches

**WING CHORD**

5-1/2 Inches (Avg.)

**TOTAL WING AREA**

163 Sq. In.

**WING LOCATION**

Top of Fuselage

**AIRFOIL**

S3014

**WING PLANFORM**

Semi-Elliptical

**DIHEDRAL, EACH TIP**

2.56 Inches 10 degrees

**OVERALL FUSELAGE LENGTH**

24-3/4 Inches

**RADIO COMPARTMENT SIZE**

7-1/2" (L) x 1-1/4" (W) x 9/16" (H)

**STABILIZER SPAN**

11 Inches

**STABILIZER CHORD (inc. elev.)**

(V-Tail) 2-7/8" Avg.

**STABILIZER AREA**

23.6 Sq. In.

**STAB AIRFOIL SECTION**

Flat

**STABILIZER LOCATION**

Bottom of Boom

**REC. NO. OF CHANNELS**

2 (V-Tail)

**CONTROL FUNCTIONS**

Rudder and Elevator

**C.G. (from L.E.)**

2-3/4" to 2-7/8"

**ELEVATOR THROWS**

3/16" Up - 3/16" Down

**RUDDER THROWS**

1/4" Left - 1/4" Right

**SIDETHRUST**

-

**DOWNTHRUST/UPTHRUST**

-

**BASIC MATERIALS USED IN CONSTRUCTION**

Fuselage Balsa, Ply, & Carbon Fiber

Wing Balsa, Ply, & Carbon Fiber

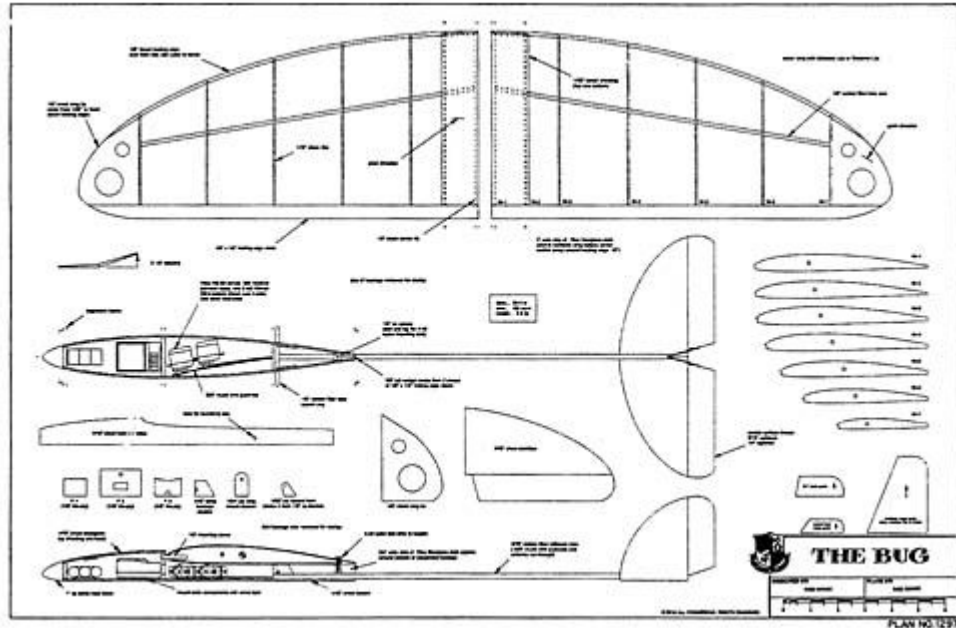
Empennage Balsa

**Wt. Ready To Fly** 3-1/2 Oz.

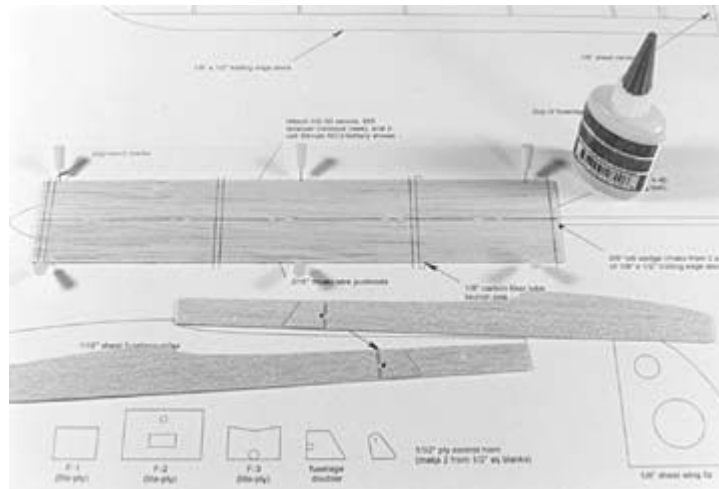
**Wing Loading** 3.09 Oz./Sq. Ft.



The Bug is a part of the Mosquito class of hand-launched radio controlled gliders. Mosquito class gliders have half the wingspan restriction of a standard hand-launch glider. That is, the span can be no more than .75 meters, or about 29.5". Full-sized hand-launched gliders have spans no larger than 1.5 meters or roughly 59". Over the last few years there have been a few all-composite kit offerings and although they are worth every penny for the handcrafted fiberglass and foam work, I thought there must be a way to get good performance out of a built-up design. It would have the side benefit of being inexpensive! The design of the Bug took place more in my computer than any other model I have built. I started with a sketch, but the wing layout, and curves of the fuselage and tail surfaces, were generated in CAD software. The airfoil templates were generated with Compufoil, adjusted for trailing edge stock, and given leading edge and spar holes. The prototype was built and flew much better than expected. The significant modifications from the original prototype to the later versions of the Bug were to increase the dihedral and reduce the fuselage cross section. It really is amazing to see how tight the Bug can thermal and how well it penetrates given its size and weight. Using off-the-shelf micro radio components available today, the Bug can be built to a 1.5 oz. empty weight and a total weight of 3.5 oz. pretty easily. That's a wing loading of 3.09 oz./sq. ft.! If you are into slope soaring, the Bug opens a whole world of sites and conditions that are otherwise not usable. So, get an order started for the carbon items and select some choice balsa at your local hobby store. Construction will take no time at all.



**CONSTRUCTION**



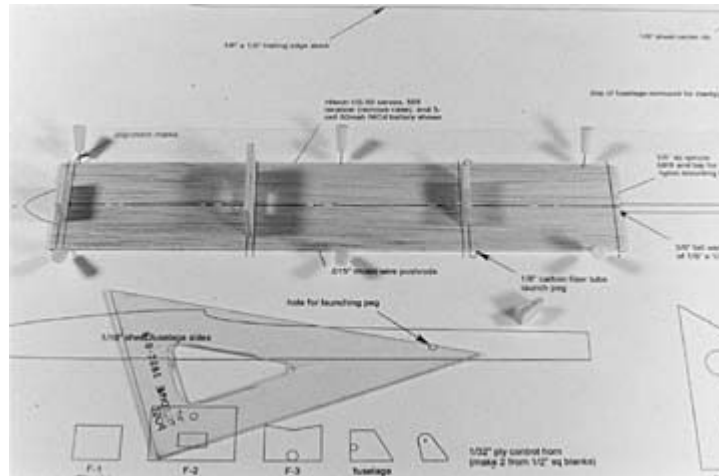
Mark centerline and former locations on fuselage bottom sheet.

**Fuselage:**

Begin construction of the fuselage by pinning a 1/16" x 2" x 11" sheet bottom to the building board using the tick marks drawn on the plans for placement. Draw in the locations of formers F-1, F-2, F-3, as well as the end of the fuselage pod. Also draw in a centerline down the length of the fuselage bottom.

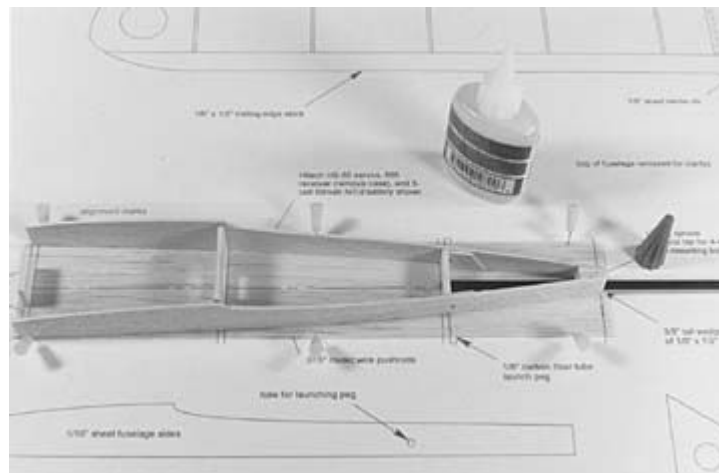
Cut (2) pieces of 3/8" long trailing edge stock and glue together, bottom side to bottom side, so that they form a wedge with a flat forward side (see plans).

Make formers F-1, F-2, and F-3 from 1/8" lite-ply. Using a drafting triangle or index card to aid alignment, glue F-1, F-2, and F-3 to the fuselage bottom, making sure that each is perpendicular to the bottom.



Formers glued in place on fuselage bottom.

Prepare the 3/16" carbon fiber tailboom by lightly sanding the bottom portion of the first 3" of the boom length to provide a better gluing surface. Test-fit the boom in place on the fuselage bottom, inserting the front end of the boom into the hole in F-3. The front end of the boom should be flush with the front side of F-3. Shim up the rear of the boom with a scrap piece of 1/16" balsa to keep the boom parallel with the fuselage bottom. Once satisfied with the placement, glue the boom to F-3 and the fuselage bottom with medium CA.



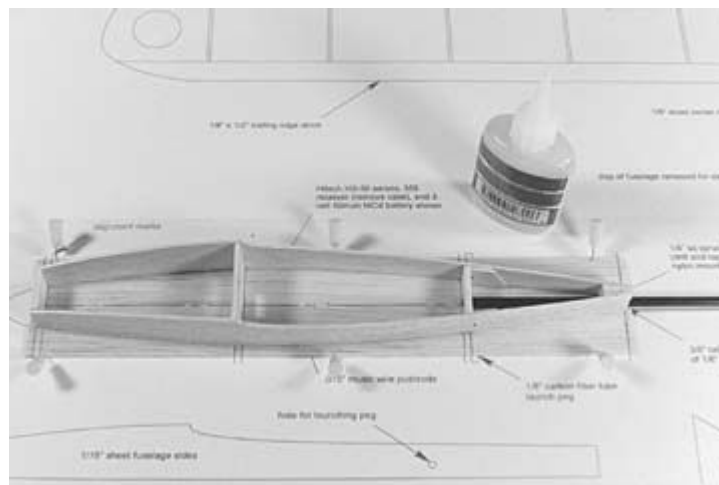
Glue sides in place starting at rear wedge and around F-3.

Make (2) fuselage doublers and (2) fuselage sides from 1/16" sheet balsa. Using the holes for the throwing peg to assist in alignment, glue the fuselage doublers to the inside of each of the sides. Glue the 3/8" long wedge of trailing edge stock that was made earlier to either the left or right fuselage side, flush with the end and top of the side (see plans). Also, you may wish to sand the fuselage sides slightly to accept the tailboom better. Wrap sandpaper

around the finger peg as a way to sand a groove in the rear of the fuselage sides.

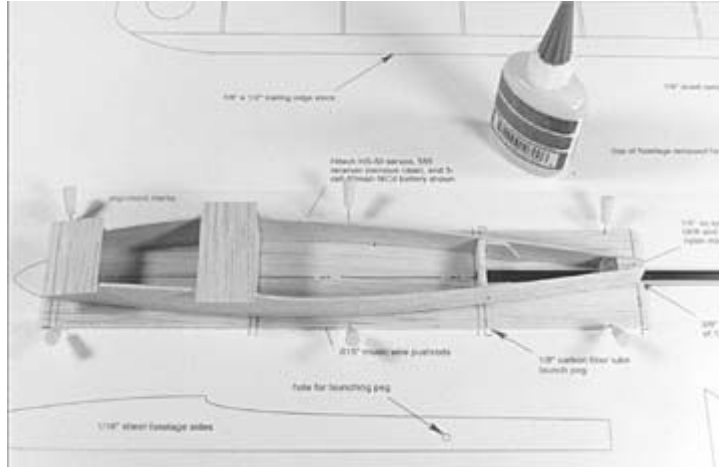
Test-fit the fuselage sides in place around the formers. The doublers should butt up along the back side of F-3. When satisfied with the placement, run glue along the sides of F-2 and F-3. Hold or pin the fuselage sides in place around F-2 and F-3, making sure to keep the bottom edges of the sides firmly against the fuselage bottom. Once dry, run glue along the sides of F-1. Hold or pin the sides to F-1, again making sure that the sides remain firmly against the fuselage bottom. Then, glue the rear end of the fuselage together by placing glue on the remaining side and bottom of the 3/8" tall wedge of trailing edge stock. Pull the fuselage sides together and hold in place over the tailboom, centered and with the sides firmly resting on the bottom sheeting.

Glue the 3/8" long 1/4" square spruce wing mount to the rear fuselage wedge with epoxy.



Fuselage sides glued around F-2 and F-1.

Make the forward fuselage sheeting and hatch from 1/16" sheet balsa, applied crossgrain. The front tab that holds the hatch in place is approximately 1/2" wide. Note that the grain runs lengthwise with the fuselage, not crossgrain. Sand the edges to match the inside of the fuselage sides, then glue in place. Use a piece of tape to hold the rear edge of the hatch down for the next step.



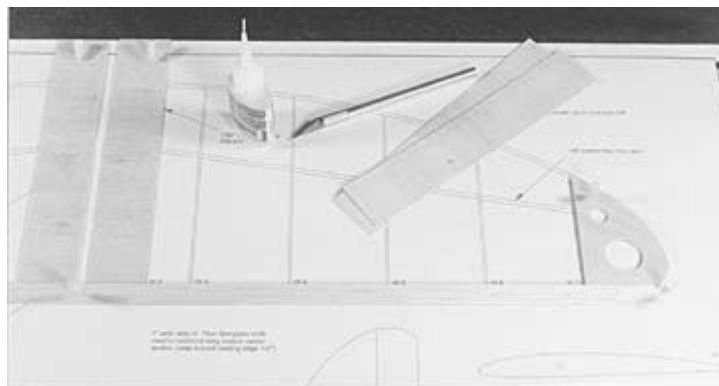
1" wide top sheeting strips in place over radio compartment.

Carefully remove the pins and lift the fuselage from the board. Trim the extra balsa from the fuselage top and bottom. Sand the top and bottom flush with the sides. Also sand the sides, top, and bottom flush with former F-1.

Glue a 1" square balsa nose block to the front of F-1. Trim the block approximately to the shape shown on the plans.

Apply a 3/4" wide strip of .75 oz. fiberglass cloth around the rear of the fuselage to strengthen the tailboom area. Start along one side, wrap under fuselage, and up other side. Use thin CA to wet out cloth once in place. Trim flush with top of fuselage sides.

Final-sand the fuselage. Slightly round the edges, complete the shaping of the nose block, and sand smooth the sides, top, and bottom. Now set the fuselage aside for later assembly and radio installation.



Trailing edge, wingtip, and bottom center sheeting pinned in place.

### Tail Surfaces:

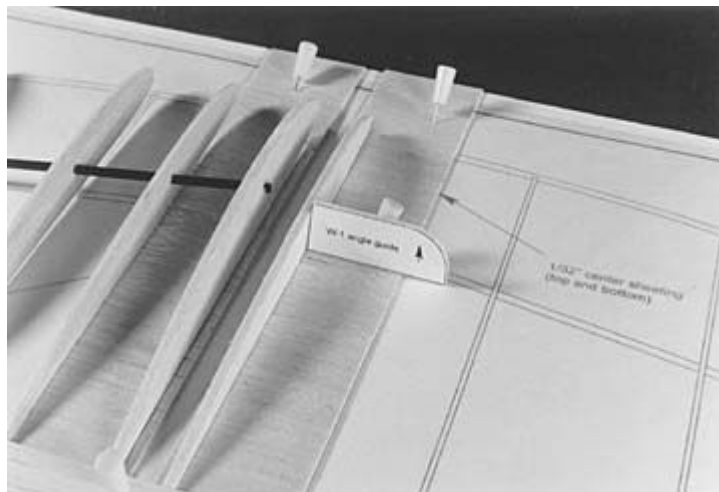
Cut (2) horizontal stabilizers and elevators from 1/16" balsa sheet. Slightly round the front edges of the stabilizers and the rear edges of the elevators. Leave the rear edge of the

stabilizers square (at the hinge line). Sand the front edge of the elevators so that the top will be flush with the stabilizer hinge line and the angle is about 30 degrees.

Cut (2) control horns from 1/32" ply and sand to shape. Use a 1" length of the 0.025" pushrod wire to carefully drill a hole in each horn for the pushrod. Do this by hand or by using an electric drill. Use a drop of thin CA glue to soak the holes for strength. Once dry, again lightly ream the holes with the pushrod wire.

Using the control horn template, glue the horns to the inside ends of each elevator. Use a small amount of baking soda to form a fillet between the horn and the top surface of each elevator. Then, use a drop or two of thin CA to soak the baking soda and reinforce the joint between the horn and elevator.

With one stabilizer flat on the board and the other propped up with the angle guide, bevel and glue the stabilizer halves together.



Use W-1 angle guide for center rib alignment for dihedral.

### **Wing:**

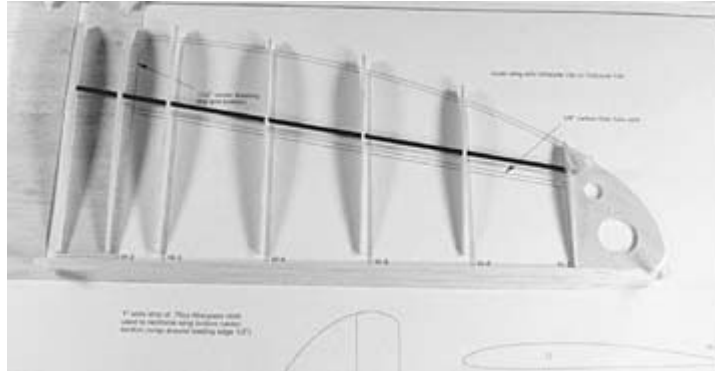
Start construction of the wing by pinning the 1/2" trailing edge stock in place over the plans. Locate a 1/8" dowel that will serve as the leading edge. Glue the (2) 1/8" sheet balsa tips to the trailing edge, pinning them in place. Shim the leading edge of the tips up with scrap 1/32" balsa so the tips will align with the dowel leading edge.

Prepare the wing center section sheeting by gluing (8) pieces of 1/32" x 1-1/2" x 4" sheet balsa together to form (4) 8" long sheets. Stack the (4) 8" sheets together and sand the sides to a straight line. Glue the 8" long bottom center sheeting to the trailing edge for each wing half.

Cut (2) W-2 through W-7 wing ribs from 1/16" balsa sheet. Cut the (2) W-1 ribs from 1/8" balsa.



Using the W-1 angle guide, test the placement of the W-1 ribs. You can improve the fit of the W-1 ribs by slightly beveling the top and bottom surfaces so that they lay flatter when angled with the guide. Glue each in place using glue only along the rear 2/3 or so of the rib bottom (up to the point where the rib curves away from the bottom sheeting).

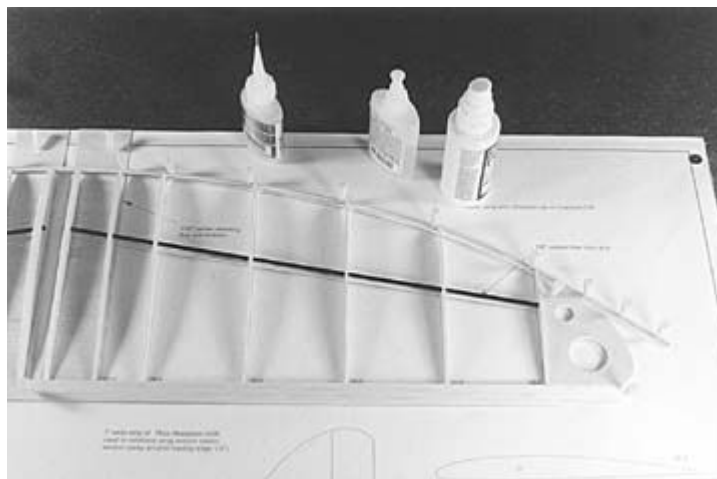


Ribs loosely in place prior to final gluing.

Glue the W-2 ribs to the center sheeting of each wing half by placing glue on the rear 2/3 of each rib bottom. The W-2 ribs are glued perpendicular to the bottom sheeting.

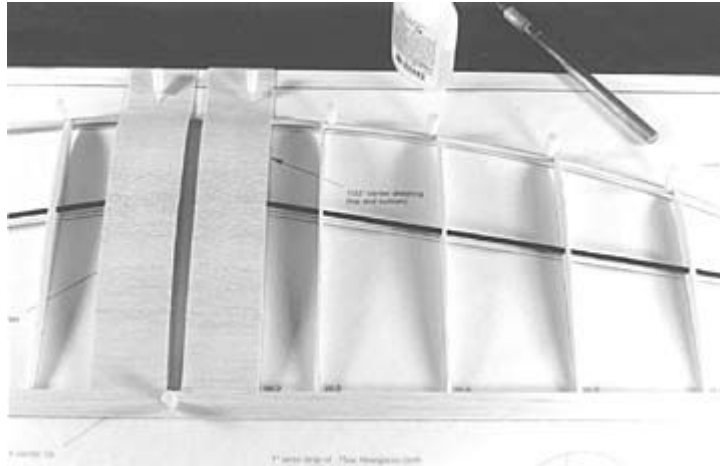
Glue the W-7 ribs in place on each wing half by gluing them to the trailing edge and also to the 1/8" sheet balsa wingtip.

Cut (2) 12-3/4" long 1/8" o.d. carbon fiber tubes for the wing spars. Use a cutoff wheel to cut the carbon fiber tubes, not a blade or razor saw! Carefully push the spar through the holes in ribs W-3 through W-6. Using the plans, roughly place the ribs along the spar at the correct locations. Then, push the center portion of the spar through W-2 and W-1 and the outer tip of the spar into W-7. You may find that it helps to have the ribs slightly inboard from their correct location until you are ready to glue them in place. Now glue each rib to the trailing edge, making sure that the rib is perpendicular to the building board and over the location drawn on the plans. Now, glue each rib to the spar using thin CA glue.



L.E. dowel glued in place. Wet front side with water to aid in bending.

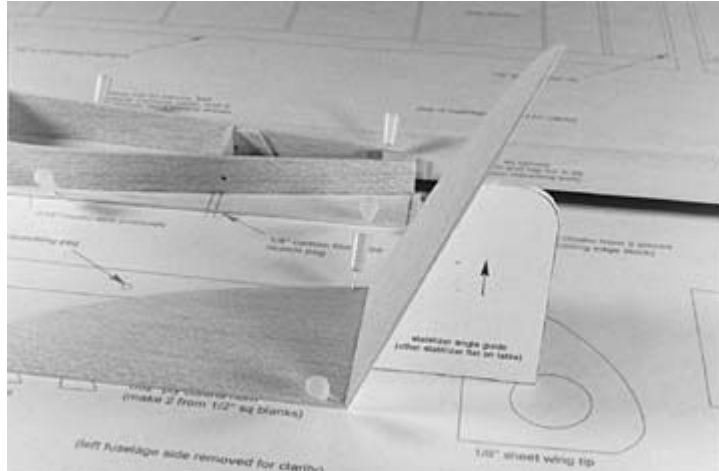
Prepare the leading edge dowel for assembly by wetting the front side with water to make bending it easier. Glue the leading edge dowel to the W-1 and W-2 ribs on both wing halves. Medium CA works best. Using your fingers, hold the leading edge to the ribs until the glue cures. Next, put glue on ribs W-3, W-4, and W-5, one wing half at a time. Wrap the leading edge around W-3 through W-5 and hold or pin in place until the glue cures. Repeat for the other wing half. Use 5-minute epoxy to glue leading edge to the 1/8" sheet wingtip and medium CA on W-6. Pin, hold, and/or tape the leading edge dowel to the wingtip until the epoxy is fully cured. Repeat for the other wing half.



Top sheeting being glued in place.

Next, glue the top sheeting in place using medium CA or aliphatic glue (Sig-Bond, Titebond, etc.). Start by gluing the sheeting to the trailing edge and to the rear portion of the W-1 and W-2 ribs. Then, carefully pull the sheeting up a bit and run glue along the rest of the rib tops. Press the sheeting down across the rib tops until the glue is cured. Last, glue the sheeting down to the leading edge dowel and into the joint between the ribs and the dowel. Repeat these steps for the other wing half.

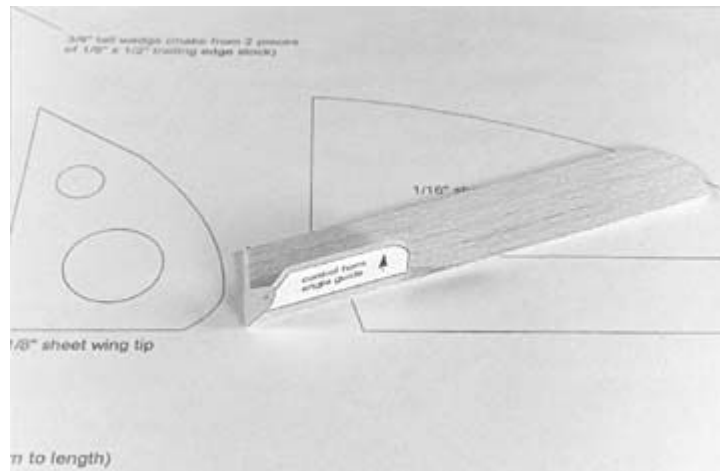
Remove the wing halves from the building board. Complete the center section sheeting by gluing the remaining portion of the bottom sheeting to the W-1 and W-2 ribs, and to the leading edge dowel. Reinforce the rib-to-trailing edge joints with fillets of medium CA.



Use stabilizer angle guide to set V-Tail dihedral.

Sand the excess center section sheeting flush with the end of the W-1 ribs and the leading edge. Trim the excess trailing edge and leading edge dowel as indicated on the plans and sand to the final outline.

The wing halves are glued together with 5-minute epoxy. Test-fit with one wing half pinned to the building board and the other half elevated to 5-1/8" under the wingtip. If the measurement is off more than 1/8" either way, use a sanding block to carefully adjust the bevel on the center ribs until correct. Then, glue the halves together with epoxy.

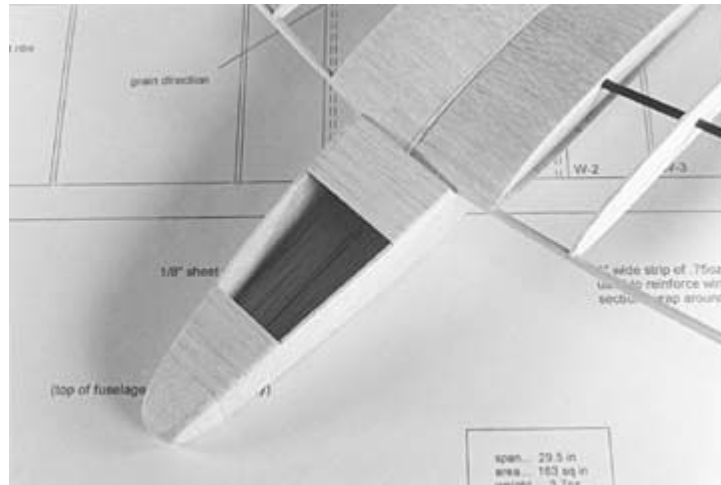


Control horn angle guide used to set tilt.  
Use baking soda and CA to make fillet for strength.

The wing center joint is reinforced with a 1" wide strip of .75 oz. fiberglass cloth. The fiberglass strip should run along the entire bottom of the wing joint and around the leading edge of the wing for 1/2". Apply the fiberglass strip with thinned aliphatic glue or thin CA. The recommended method is to use 3M-77 spray adhesive and thin CA. Start by cutting a 9" long 1" wide strip of fiberglass. Lay the strip on a piece of newspaper and spray a very light mist of 3M-77 spray adhesive on one side only. Apply the strip to the underside of the wing joint and wrap around the leading edge. Trim the strip on the top of the wing to about

1/2" of the leading edge and to the trailing edge on the underside. Once the fiberglass reinforcement is nicely in place, soak it with thin CA until the strip is wetted out. Apply only as much as is needed (drop by drop) to just wet out the glass. Once cured, final-sand the reinforcement.

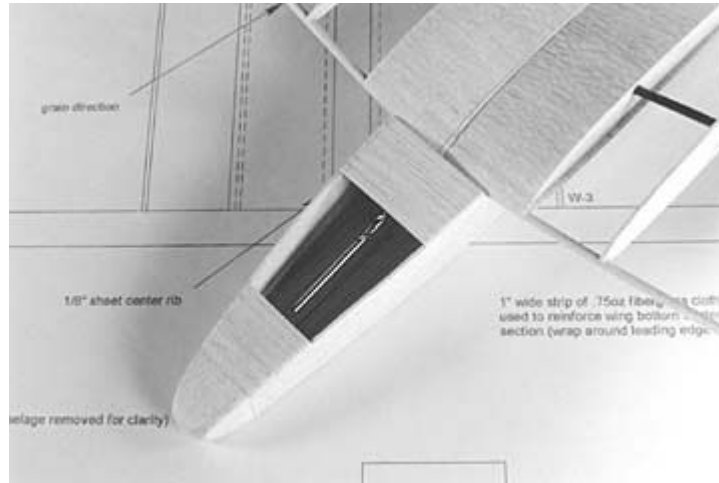
Cut and sand the 1/64" plywood wing bolt reinforcement as shown on the plans and glue in place. Lightly bend the plate lengthwise so that it more closely matches the wing center section.



Completed airframe showing radio compartment.

### **Final Assembly:**

The wing is secured to the fuselage with a 1/8" dowel at the leading edge and a 4-40 nylon bolt at the trailing edge. Use a 1/8" drill bit by hand to begin drilling through the hole in F-2 and into the leading edge of the wing. Once the beginning of the hole has been made through the fiberglass reinforcement and into the leading edge dowel, you can remove the wing and continue either by hand or carefully with a power drill. Shake out any chips from inside of the center section. The mounting dowel should be inserted into the wing center section approximately 3/4" and stick out from the leading edge about 1/4". Glue in place with epoxy. Round the end of the mounting dowel with sandpaper to make it easier to insert into F-2. The fit should be snug with no play.

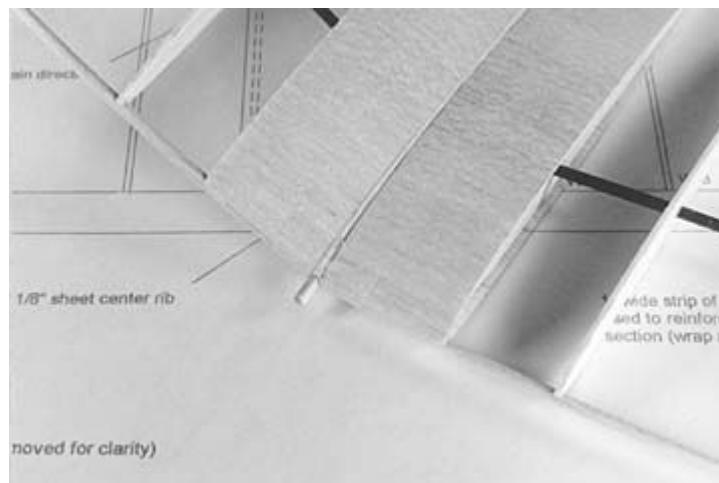


Mark and drill for wing dowel through F-2 into wing L.E.

With the wing in place, mark the location of the hole for the 4-40 nylon wing bolt on the 1/64" plywood plate. Carefully drill through the wing and into the spruce mounting block, taking care not to drill into the carbon fiber tailboom. Tap the spruce block for the 4-40 bolt. Soak the threads of the mounting block with a few drops of thin CA and again re-tap when dry. This will reinforce the threads.

Lightly sand the bottom surfaces of the tailboom where it will come in contact with the tail surfaces. Note that the rear edge of the assembled tail surfaces does not end up flush with the end of the tailboom. With the wing mounted to the fuselage and the model resting on the building table, test-fit the V-tail in place under the tailboom. Adjust the model so that the measurement under each wingtip is equal. Then adjust the V-tail so that the measurement under each tail surface tip is equal. When aligned, glue the V-tail in place.

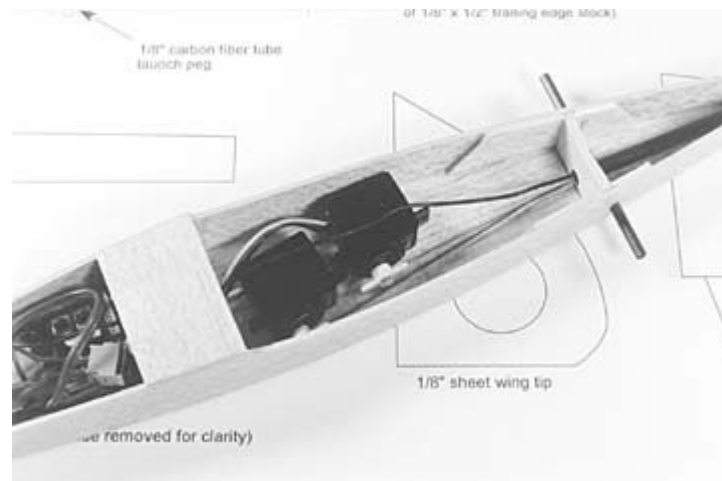
Finally, test-fit and glue the 1/8" carbon fiber launch peg into place through the fuselage sides using thin CA.



Wing close-up showing mounting dowel.

## Covering And Finishing:

The goal when building a Bug is to keep the completed weight as light as possible. This is done primarily by selecting lightweight radio control components and by keeping the covering and finish light. The recommended covering is either Ultracote Lite or Oracover Lite. They are essentially identical and come in similar colors. Only cover the wing with this covering. Do not cover the fuselage and tail surfaces.

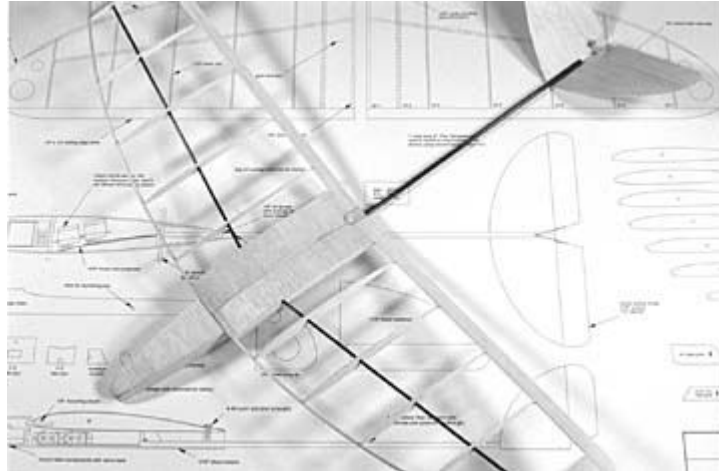


Radio installation in second prototype.  
Components mounted with servo tape.

The tail surfaces and fuselage can be finished with either a few light coats of dope or water-based polyurethane. The polyurethane method is "borrowed" from DJ Aerotech. Colored polyurethane can be made by mixing in any color you like of acrylic paint such as Testors Model Master in an 8:1 to 10:1 ratio of polyurethane to paint. The colors can be made to nicely match the transparent colors of the coverings. Apply the polyurethane with a folded paper towel. Apply the coats very lightly, let dry completely, and fine sand between coats. The object is to just barely seal the wood with each coat, not to obtain a smooth glossy finish.

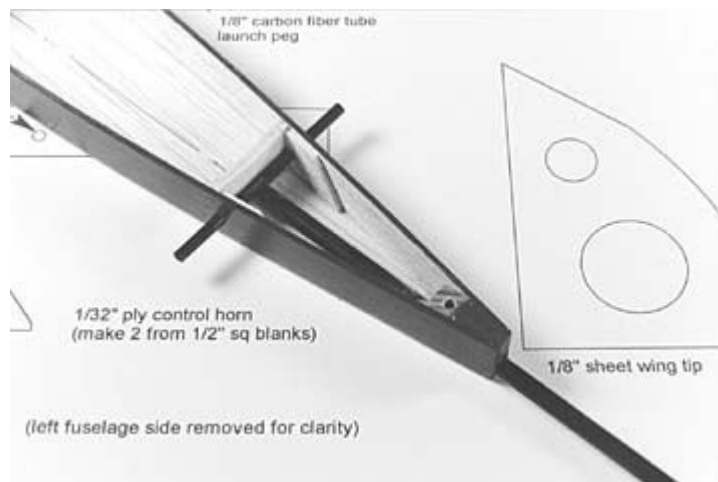
## Radio Installation:

Make a Z-bend at one end of each 0.025" dia. music wire pushrod. Bend each pushrod up and out as shown on the plans. Note that the end of the Z-bend is on the outside of each control horn. Use a couple of small pieces of tape to temporarily mount the elevators in place with the pushrods connected to the control horns and running through the tailboom.



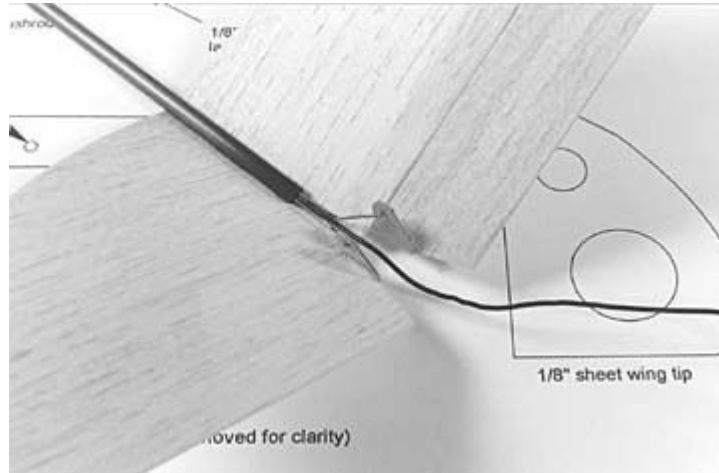
Completed airframe ready for covering and finish.

The servos are mounted using double-sided sticky servo tape. First put a light coat of thin CA on the fuselage bottom (a drop or two at a time), where the servos are to go, to seal the wood and provide a smooth mounting surface. Then place the servo tape on the servos, leaving the backing on the opposite side until later. Bend the pushrods slightly so that they curve to approximately where the servo arms will be. Avoid any binding between the pushrods. Before bending the final Z-bends for the servo arms, it may help to bend a small V-shaped kink in each pushrod to allow you to fine-tune the total length of the pushrods for surface adjustments.



Carbon fiber throwing peg behind F-3 and above tailboom.

Remove the temporary tape from the elevators and remove them from the Z-bends. Apply a length of 1/2" or 3/4" Scotch 600 tape (found at most office supply stores) to each elevator, with half the width on the elevator side of the hinge line. Again insert the Z-bends through the control horns and tape the elevators to the stabilizers. A tip in getting the right gap between elevator and stabilizer is to bend the elevator to its full down travel and then adhere the tape to the stabilizer. When returned to neutral, the elevator will have a small gap between it and the stabilizer.



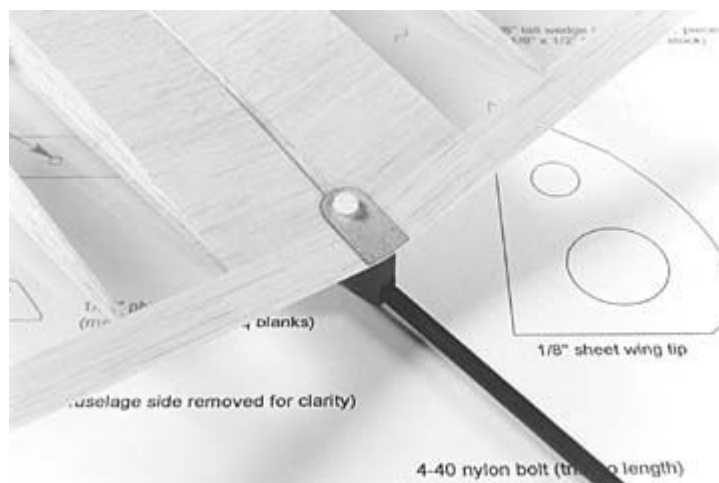
Pushrods and antenna route through tailboom.

Now, remove the backing from the servo tape and mount the servos in place. Try to keep the elevators as close to neutral as possible during this process. Use your transmitter trims or the small kinks in the pushrods to make any corrections.

Mount the receiver and battery pack using the same method. Apply thin CA to the fuselage bottom and use servo tape to mount the receiver and battery pack in the forward bay. Run the antenna wire through the hole in F-2 and through the tailboom. Enough antenna should extend from the tailboom to provide good signal reception. If not, route the antenna outside the tailboom.

One final note on radio installation and selection. All of my Bugs have used a Hitec 555 receiver, without its case, and two HS-50 servos. This combination is one of the very few that will work properly with a 3-cell receiver pack. I limit my flying to about 25-30 minutes before recharging with my trusty Sirius Charge 100 peak charger:

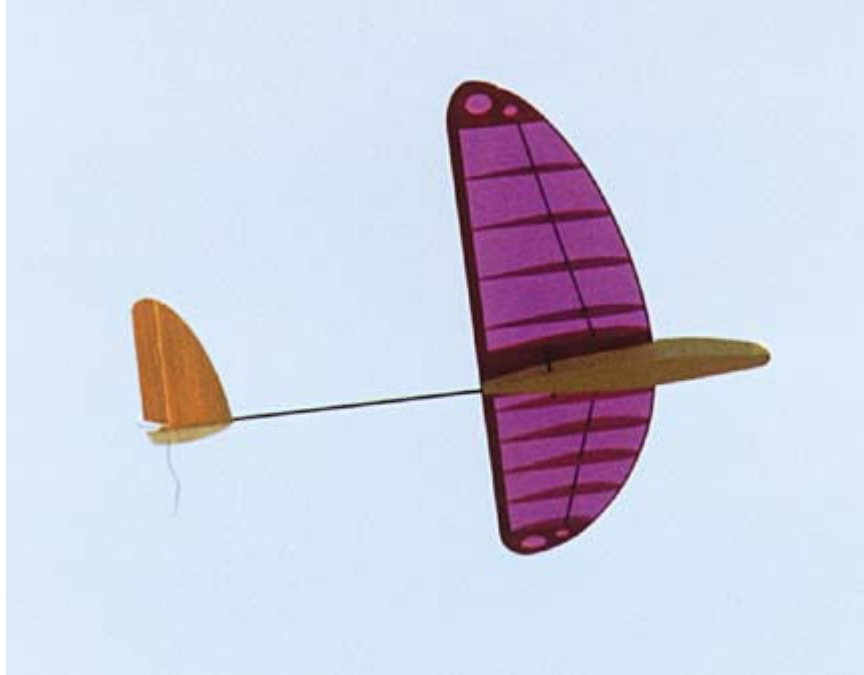
[www.siriuselectronics.com](http://www.siriuselectronics.com)





Wing mount shows 1/64" ply doubler and 4-40 nylon mounting bolt.

If you are using any other radio components or have any doubts about the duration of your set-up, do what I do. Charge your plane, plop in front of the TV, and wiggle the sticks until stuff stops moving! Set your maximum flight time to a safe amount below that duration.



All in-flight photos by Debbie Dowdy.

### **Trimming And Flying:**

Before flying your Bug, first verify that the Center of Gravity is 2-3/4" to 2-7/8" back from the leading edge. The fuselage should hang level with the plane suspended from under the wing at this location. Also check that the elevators are at neutral and work correctly as V-tails. That is, they should both go up with up elevator and both go right with right rudder. Also check that they have the correct amount of throw, 3/16" up/down with just elevator and 1/4" right/left with just rudder - more/less depending on your preferences.

The Bug wing is stiff even with its minimal structure, but you should still check to see that there were no warps created during construction or during covering. This is accomplished by laying the wing upside down on a pillow and laying spare balsa sticks across the center section and the W-7 ribs. Looking across the wing from tip to tip you should be able to detect any warps. Remove these by re-heating the covering and removing the warps.

Now to the field! Test glide your Bug by giving it a firm push forward, slightly nose down. Check that the glide is straight and not stalling. Do this several times and adjust the transmitter trims or balance if necessary. Once satisfied with the glide, give your Bug a firm toss at a shallow angle (approximately 10-20 degrees above the horizon) and check to see if it zooms up too much or not enough. With the correct construction, Center of

Gravity, and elevator trim, your Bug should very slightly climb up during the launch and you should be launching at 30-40 degrees. Note that at this angle you will need to use a sharp down elevator input just before it reaches its peak in order to avoid a stall. Take care not to grip the launching peg too much with the first joints of your fingers. The pads of your fingertips should rest on the peg to avoid hooking the peg and pulling down too hard during launch (done to extreme, this could damage the Bug wing).

Most of all, have fun. The Bug is small enough to keep in the car all the time and fly anywhere. Even the smallest hills or embankments become slope soaring sites. Even the lightest thermal lift is enough for the Bug. It turns very tightly and can stay in the strongest part of a forming thermal. Your flying will improve quickly because you can see your mistakes and your improvements up close. Now you've got the Mosquito Bug!

Carbon fiber purchased from: Composite Structure Technologies. Web site:

<http://www/cstsales.com>

Phone (661) 822-4162, fax (661) 822-4121. P.O. box 622 Tehachapi, CA 92581. Electronic Mail Sales and Information:

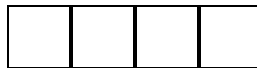
[info@cstsales.com](mailto:info@cstsales.com)

Wing Spar part No: T512, Tailboom Part No: T515, .75 oz. Fiberglass, Part No. G0106038.

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