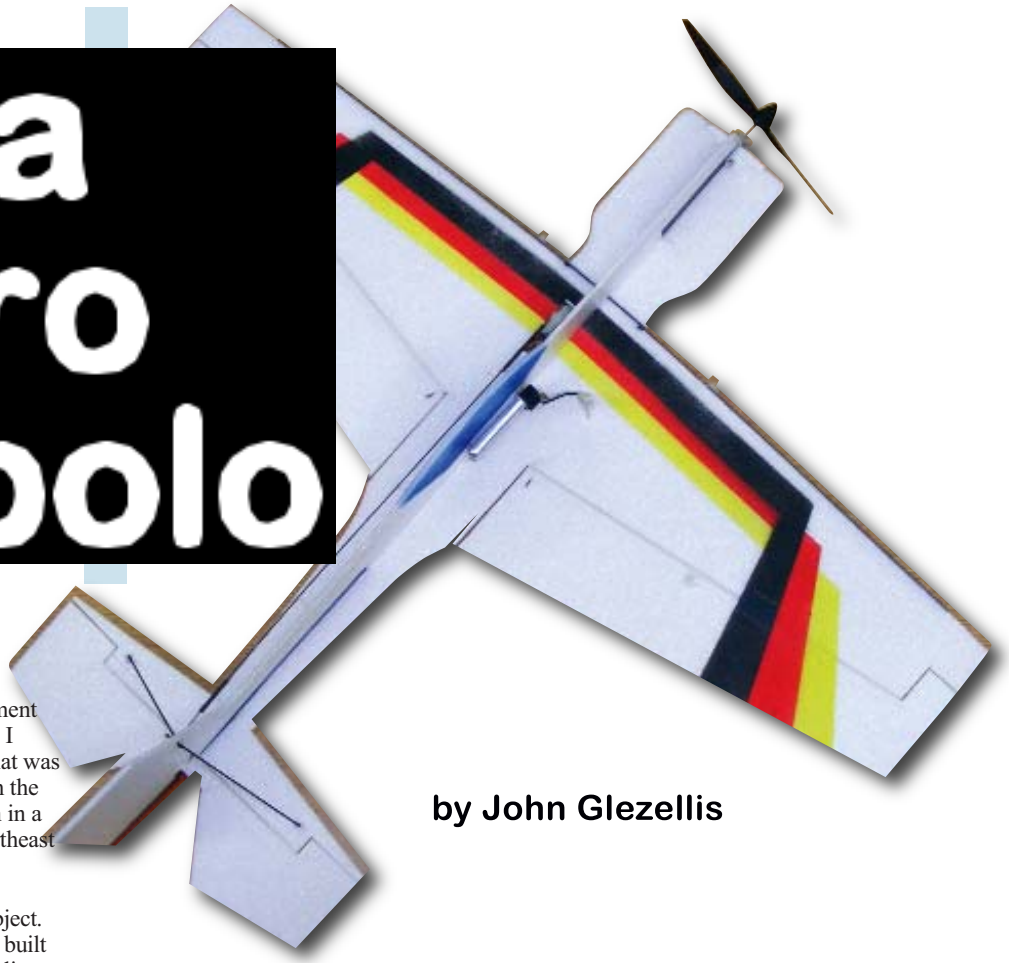
Ultra Micro Diabolo



by John Glezellis

WITH THE INCREASING development of technology for micro indoor models, I decided it was time to build a foamie that was fully 3-D capable and could be flown in the confined space of an average-size room in a home. After all, winters here in the Northeast are long.

After researching various aerobatic airframes, I chose the Diabolo as the subject. The full-scale version was designed and built in Germany. This airplane has gorgeous lines that make it unique and is capable of performing some of the most demanding maneuvers out there.

When I designed the Ultra Micro Diabolo, I made several changes to its outline to improve flight performance. I mainly added area to the wing, horizontal stabilizer, and fuselage, and I increased the size of the control surfaces.

When building a model this size, choosing the proper equipment is critical and is directly linked to its flight performance. On today's market, quite a few companies sell microservos, motors, speed controllers, etc. However, what is best for this particular aircraft?

I constructed two versions of the Diabolo. One was equipped with "standard" equipment, and the second was equipped with micro equipment from E-flite and Spektrum. Take a look at these models' specifications and how they differ.

Model	*First Diabolo*	*Second Diabolo*
Motor	C05 brushless	8.5mm coreless brushed
ESC	XP-7a	Built into receiver unit
Servos	Three 2.5g	Two 1.5g long-throw linear, as receiver has two others built in.
Battery	Two-cell, 200 mAh Li-Poly	One-cell, 150 mAh Li-Poly
Ready-to-Fly Weight	1.8 ounces	1.2 ounces

The second Diabolo is a fair amount lighter. It might not seem to be much, but $^{6}/_{10}$ ounce is crucial for a model this size and changes flight performance for the better.

Enough of that; let's get started.

Look thoroughly at the plans, and note the materials list and equipment recommendations. With everything at hand, building your Ultra Micro Diabolo will go surprisingly quickly.

Make a copy of the plans. You can use the copy as a template for cutting all of the components from 3mm Depron foam, and the original plans will remain intact. Ask the AMA Plans Service about the substantial cost savings of ordering a second copy with your order.

After you have chosen a flat work area, lay down a cutting mat, place a piece of Depron foam on it, and cut away. You might find it beneficial to tape the plans over the Depron when cutting each piece, to ensure that the plans will not move after each cut.

Because of the relatively small size of this model, the wing, horizontal fuselage (cruciform), and horizontal stabilizer can be cut out as one piece of Depron. Always use a ruler and a sharp #11 X-Acto blade when making straight cuts.

I advise you to use waxed paper so you don't adhere the foam components to your building surface. And don't forget to use foam-safe CA glue.

CONSTRUCTION

Once you have cut all of the parts, it's time to hinge the control surfaces. I "top-hinge" my aerobatic models that are fabricated from Depron.

On the Ultra Micro Diabolo, it's convenient that you can do all of the hinging at once. To do so, either sand the bottom LE of the aileron or use a ruler and a sharp #11 X-Acto blade.

For the latter, position the ruler roughly $^{1}/_{4}$ inch away from the LE of the surface. Position the X-Acto blade at an angle so that it comes in contact with the ruler and the top of the control surface at the LE, and cut away. Follow this process for both ailerons and the elevator.

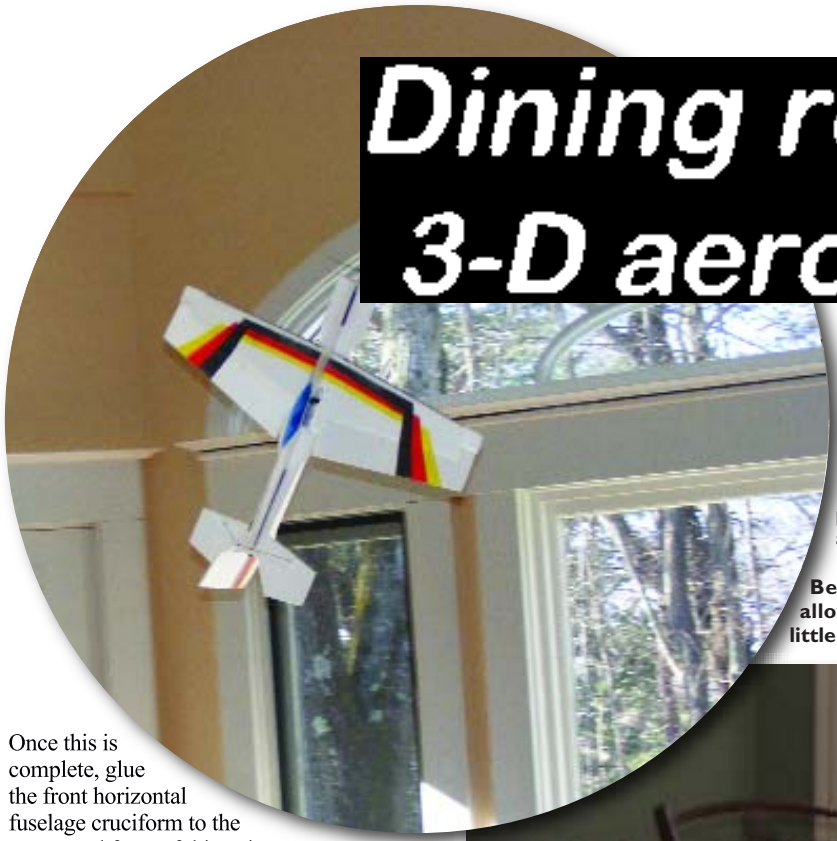
Once you are satisfied with the bevel, place the control surface in position and apply hinge tape centered over the control and flying surfaces.

When hinging the rudder, it's easier to maintain alignment of the rudder hinge line while the upper and lower vertical fuselage parts are attached. Cut away the rudder and cut out only the area where the horizontal stabilizer will go. Hinge the rudder as described and cut apart the upper and lower fuselage parts, which will remain linked and properly spaced with the rudder hinge.

After you have hinged all of the components, cut the front fuselage horizontal cruciform free from the wing LE. Once that is done, cut a piece of .08mm x 3mm carbon fiber so it measures the length of the wingspan.

Lay the wing on a flat surface, and glue the carbon strip to the wing LE. The carbon will bend at the center to follow the LE sweep.

Dining room-size 3-D aerobatic fun



Left: Once a pilot gets comfortable with this model's flight characteristics, smaller indoor spaces become an opportunity to enjoy it. Hovering is possible with a freshly charged battery. This airplane will accelerate slowly out of a hover.

Below: The generous amount of fuselage side area allows maneuvers such as knife-edge flight to require little rudder input.

Once this is complete, glue the front horizontal fuselage cruciform to the center and front of this strip.

If you decide that you want to paint your Diabolo, it is best to do so at this time. If you are using an airbrush, you can employ craft paint (which is used for T-shirts, etc.) or any other paint that is compatible with foam.

When choosing a color scheme, I use card stock to make paper templates of the components that are to be painted. Then I draw the scheme on the templates and use an X-Acto blade to cut out each color that is to be painted.

If you do this, use a few ounces of weight to hold the template in position over the component that is to be painted and spray away. Remember that patience is a virtue.

Equipment Installation: Before you proceed, decide what electronic equipment you want to put in your little model. As I described, I tested two setups.

Because of weight, I recommend that you consider using Spektrum-brand (or similar) electronics. This build applies to using Spektrum equipment. If you decide on a different brand, you might have to modify the equipment installation process on your Diabolo because it will differ from the plans.

Make the appropriate cutout in the wing for the Spektrum AR6400L receiver unit. Once you have completed that, you can glue the horizontal cruciform assembly (the horizontal fuselage pieces, wing, and horizontal stabilizer) to the vertical fuselage piece. Use an 18-inch ruler to ensure that the vertical fuselage is properly aligned and a plastic 90° triangle to make sure that the fuselage components are perpendicular to one another.

Once you have completed the assembly process, add the tail bracing made from .040 carbon rod. This will ensure that the horizontal stabilizer will not flex in flight.

It is time to install the landing gear legs and the wheel pants. To do so, cut two pieces of .040 carbon rod that measure $4^{1}/_{4}$ inches in length. Use sandpaper to sharpen one end of each rod.

The plans show where the rods will penetrate both the fuselage side and the wing. Insert the rods through these locations. Once you are satisfied with the height of the model (and make sure it is level), put a few drops of odorless CA where the carbon makes contact with the Depron foam.

The plans show the wheel pants and wheels as one piece. When you cut the wheel pants, you should have also cut a "half wheel" to visually simulate a wheel.

This is the lightest method I've found to create wheel pants for a model this size. I usually paint the "wheel" so it looks as real as possible.

If you are using this technique, push the carbon-fiber ends through the wheel pant, in the same manner for both. Make sure they are mounted in the same fashion, and glue them in place.

Insert the motor into the plastic gearbox. Then insert the entire assembly onto the front of the airplane. It may be necessary to trim the front of the aircraft to accept the gearbox frame.

Once the fit is perfect and the motor is properly aligned, you can glue in the gearbox frame with odorless CA. Last, thread the propeller onto the shaft and use CA to glue the rubber spinner to the front of the propeller.

Install the AR6400L receiver unit and the two wing servos using double-stick servo tape. Cut a small piece of servo tape that is slightly smaller than each servo, and place it on the underside of the servo. Position the servos according to the plans and properly secure them.

Regarding the AR6400L, cut two strands of servo tape (measuring $^{1}/_{4}$ x $^{3}/_{4}$) and secure them lengthwise on the top and bottom of the underside of the unit. Then secure the AR6400L in place.

When I installed my unit, I plugged the motor wires to the receiver and ran them on the underside of the receiver between the two strands of servo tape. Doing so ensured a clean installation with respect to wiring.

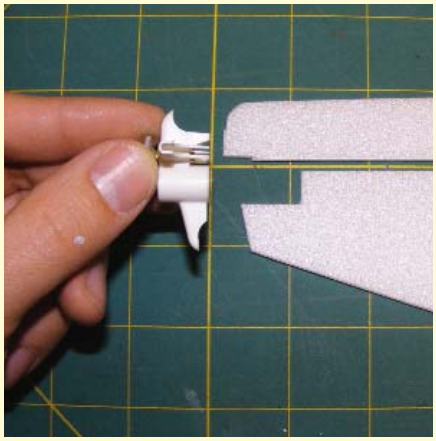
The pushrods on my model measure $10^{1}/_{8}$ inches for both the rudder and the elevator. If you purchased the pushrod set (for the E-flite

Photos by the author

Above: To create hinge bevels, use a ruler and a sharp #11 X-Acto blade. Hold the knife at a 45° angle and pull it slowly through the material.

Left: All of the components have been cut from 3mm Depron and the rudder has been hinged. Use an 18-inch metal ruler and a sharp #11 X-Acto blade for clean edges.

Hinge tape, available from Du-Bro, is used before assembling the two main airplane sections. The gap between the upper and lower fuselage halves is critical.



The E-flite 4-Site gearbox is designed to interlock with the front of the Diabolo. Make necessary corrections to ensure a perfect fit and 0° of up/down thrust as well as right thrust.

Micro 4-Site), you have the necessary materials to make and complete this assembly.

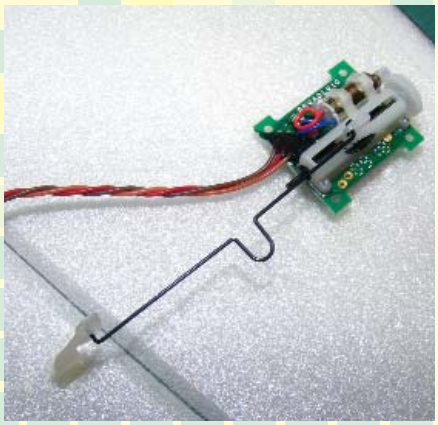
To start, glue one of the wires with a Z-bend already shaped to the front of the carbon rod. Slide a piece of heat-shrink tubing over this assembly and use a heat gun to shrink the tubing. Repeat this step for the second pushrod.

If you purchased the hardware set for the Micro 4-Site, you will notice four pushrod supports. Two are shorter in height than the other two.

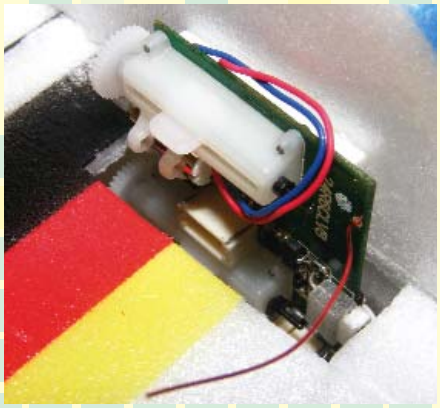
The shorter supports are for the elevator pushrod, and they will be secured to the bottom of the horizontal fuselage cruciform. The longer supports will be glued on the left side of the vertical fuselage cruciform. The plans estimate these locations.

After you insert the rudder pushrod through two supports, push a piece of heat-shrink tubing over this rod as well. Then glue another piece of music wire (included in the pushrod-set package) to the carbon rod.

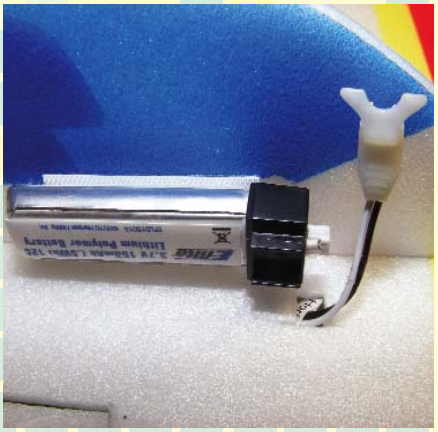
When the glue sets, push the heat-shrink tubing over this area and shrink it in place with a heat gun. Then see where the rudder



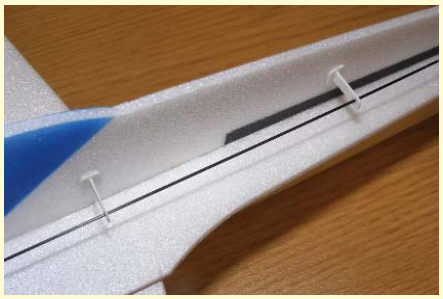
The aileron servo is attached to the control horn via a pushrod that is included with the pushrod set from the Micro 4-Site. Servo tape holds the linear servo in place.



Servo tape is also used to attach the Spektrum AR6400 control module to the fuselage. Locations on the plans assure that the stock radio wiring works without extensions.

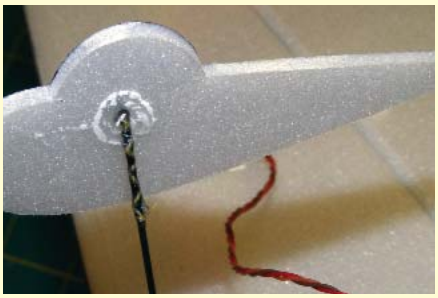


Once the proper CG is located, attach the single-cell, 150 mAh battery in place with the included hook-and-loop material.



Shown are two supports for the rudder pushrod. Those for the elevator are located below. These supports are included with the 4-Site pushrod hardware kit.

After the motor gearbox is glued in place, install the propeller and spinner. The propeller threads in place, and the included rubber spinner is glued to the front of the propeller with CA.



The wheel and wheel pant are one unit, made from 3mm Depron. It's simple to do and is durable because of the Diabolo's light flying weight.

control horn will mount and make the necessary Z-bend in the wire, if need be.

Insert one end of the pushrod in the servo arm (located on the receiver unit) and the other end on the rudder control horn. Glue the control horn keeper on the opposite side of the rudder. Adhere the two supports in place after making a small cut so that they can each be inserted in the fuselage side.

Repeat the same process for the elevator pushrod. However, when gluing in the supports for the elevator, you will need to glue them on the underside of the horizontal cruciform.

The aileron pushrods are also included in this hardware package. Attach one end of the pushrod to the servo and the other end to a control horn. Determine where the control horn will be secured, and make a small cut so that the control horn can be inserted through it. Install the small control horn keeper in place and apply a drop of odorless CA on the top of the wing. This completes the build.

CG and Rate Settings: The CG should be $1^{10}/_{16}$-$1^{15}/_{16}$ inches behind the LE of the wing at the root, depending on personal preference. I have found that the original rearmost CG is great for 3-D, but the airplane can lock in better to perform sequence-style flight with the more nose-heavy setup. Once you find this CG, use Velcro to secure the battery pack in place.

Programming this model is relatively easy. If using the Spektrum 6400L unit, both aileron servos plug into ports on the receiver that activate automatically—no mix required. Regardless, once all the servos are centered, I recommend that you use the rates and exponential settings shown on the plans.

I wish you much success with your Ultra Micro Diabolo, and I hope you enjoy the construction process and its flight performance.

Once you fly this model, you will probably notice that it's neutral and extremely predictable. But please remember that weight is critical—especially on an airplane this size.

Try to keep this model light, to obtain a ready-to-fly weight of 1.2-1.3 ounces. It has a fairly wide aerobatic flight envelope, and because of its petite size, it is sure to turn heads at the local indoor flying event, or maybe in your home when the sunroom is unoccupied. *MA*

John Glezellis
jglezellis@comcast.net

Sources:

2DogRC
(800) 517-3810
www.2dogrc.com

Du-Bro
(800) 848-9411
www.dubro.com

E-flite
(800) 338-4639
www.e-fliterc.com

JR Radio
(800) 338-4639
www.jrradios.com

Midwest Products
(800) 348-3497
www.midwestproducts.com

Spektrum RC
(800) 338-4639
www.spektrumrc.com

Zap
(863) 607-6611
www.franktiano.com

Ultra Micro Diabolo

Type: RC semiscale micro aerobatic

Skill level: Intermediate

Wingspan: 19 inches

Wing area: 80.75 square inches

Length: 17.356 inches

Weight: 1.2-1.8 ounces

Recommended power system: E-flite Ultra Micro 4-Site motor and battery

Construction: 3mm Depron, carbon fiber

Finish: Builder's choice of paint, sticker, or permanent marker

Radio: Spektrum AR6400 six-channel receiver/ESC/servo system

John designed the Ultra Micro Diabolo for fun 3-D flying, but he also found that with a forward CG, it is also good for precision flying.

Full-Size Plans Available—see page 167