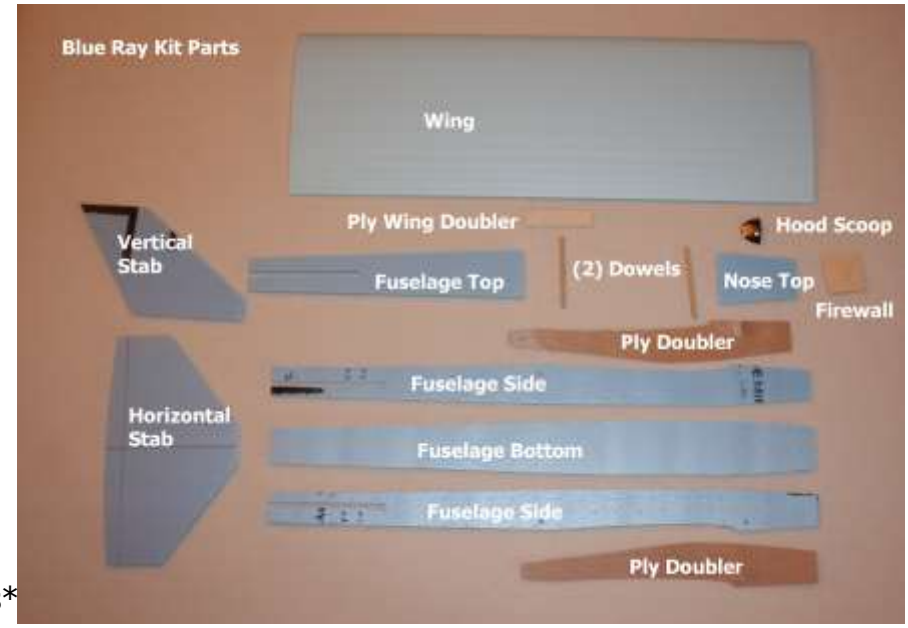
Black Hawk R/C Pilots Blue Ray November 2010
Electric Pylon Racer - original design by Tim Batt

Kit Parts List:

Qty (1) Wing
Qty (1) Ply Wing Doubler
Qty (1) Vertical Stabilizer
Qty (1) Horizontal Stabilizer
Qty (2) Fuselage Sides
Qty (1) Fuselage Bottom
Qty (1) Fuselage Top
Qty (1) Nose Top
Qty (2) Ply Fuse Doublers
Qty (1) Ply Firewall
Qty (2) Dowels
Qty (1) Plastic Hood Scoop
Qty (1) Aileron Drawing
Qty (2) Nose Doublers*
Qty (2) Rear Dowel Doublers*



* not shown in photo

Additional supplies needed to complete this kit:

- ✓ Aircraft Radio
- ✓ 4 gram (0.14 oz.) Receiver
- ✓ 22 mm stator - 1800 KV Brushless Outrunner Motor & mounting
  - – <u>REQUIRED FOR INDOOR OR OUTDOOR RACING</u>
- ✓ 20 Amp Electronic Speed Control (ESC)

- ✓ Deans Ultra Plug or JST connector to connect ESC to battery
- ✓ Li-Po Battery
    - 1000 to 1350 mAh
    - 2S (7.4 volt) – REQ'D FOR INDOOR RACING
    - 3S (11.1 volt) – for outdoor flying
    - 20C or higher recommended
    - 130 grams (4.5 oz.) maximum weight
- ✓ APC 7x5 Thin Electric Propeller (APC p/n LP07050E) – REQ'D FOR INDOOR RACING
- ✓ APC 6.5x6.5 Pylon Propeller (APC p/n LPO6565) – for outdoor flying
- ✓ Qty (3) 6 to 8 gram (0.2 to 0.3 oz) ultra-light servos
- ✓ Qty (3) micro control horns
    - Du-Bro #919 or #848 Micro Control Horns or equivalent
- ✓ Qty (3) micro control horn keepers
    - Du-Bro #849 Micro EZ Link for .032 wire
    - Du-Bro #920 Micro EZ Link for .047 wire
- ✓ .032" or .047" diameter wire
- ✓ Qty (1) 6" servo extension for the elevator servo - 32 gauge micro wire preferred
- ✓ Qty (1) "Y" harness for aileron servos or (2) 3" servo extensions if your receiver allows one aileron servo to be plugged into an alternate channel - 32 gauge micro wire preferred
- ✓ (4) #64 rubber bands
- ✓ Hinge Tape
- ✓ Velcro or double-sided tape
- ✓ 2" or 3" wide strapping tape
- ✓ 5-minute epoxy
- ✓ Foam safe CA and/or low-temp hot glue

Introduction:

The BLUE RAY is intended to be a simple-to-build club project. Micro servos, receivers and electric motors are available at very affordable prices. Now is the time to start club pylon racing!

The completed weight of the BLUE RAY is 8 to 8.5 ounces (228 to 240 grams) without a battery! The battery adds from 2.2 to 4.0 ounces (62 to 115 grams) for a total ready-to-fly weight of 10.2 to 12.5 ounces (310 to 355 grams). Typical foamy planes in this weight class do not do fly well in the wind; however the BLUE RAY handles well in a 10 mph breeze. It has good wind penetration, especially with a 3-cell battery and the throttle up.

At the UNI DOME fun-fly pylon races there is an 11 ounce (312 grams) minimum weight requirement, so there is no benefit from using high cost, ultra light weight components.

A 1000 to 1300 mAh battery is recommended for racing. A smaller battery can be used, but the flight duration is shorter and you will be under the 11 ounce minimum weight. With the recommended battery, you can get 3 two-minute heat races with a single charge. The BLUE RAY has been flown with a 1700 mAh 3-cell Li-Po battery and it still flies well, but pylon turns get to be sluggish.

If this is to be a club project, the simple fixtures shown in these instructions will make the assembly quicker and easier. If you are only building one or two airplanes, assemble the fuselage on a flat surface and use a carpenters square or right triangle to make sure the fuselage sides are perpendicular with the fuselage bottom.

The foam parts can be assembled using either hot glue, foam safe CA or 5-minute epoxy. All three work well with foam. Wood parts can be assembled with either foam safe CA or 5-minute epoxy. The firewall should only be assembled with epoxy.

Tip: To keep the aircraft weight light, mix micro-balloons with the epoxy. This will decrease the pot life of the epoxy, so work quickly or use 15-minute or longer epoxy.

Read all of the instructions before starting to assemble your BLUE RAY.

Kit Parts:

The Black Hawk R/C Pilots BLUE RAY kit includes all of the foam and wood parts including a precut foam wing. The kit has been cut from blue or pink extruded polystyrene foam insulation board that is ¼" (6 mm) thick with a plastic film on one or both sides. The plastic film should be the outside surface of most of your parts. The uncovered side is rough

If your kit has the plastic film on both sides, remove the film from any areas that will be glued together. *Tip: If you don't like printing on your plane, remove the printed film. The film does not add any appreciable strength to the aircraft structure. Tip: Rounding the leading edges of the horizontal and vertical stabilizer and the fuselage corners will require removing the plastic film from the areas to be rounded. It's easier to remove the film from the entire surface than to just trim it from the areas that are rounded.*

Radio:

Test the radio, servos, ESC and motor. If not already attached, solder male bullet connectors to the motor wires and female bullet connectors and a male power plug to the ESC wires. If using a 2.4 GHz radio system, bind the receiver to the transmitter and setup the radio for the aircraft. Connect all the servos to the radio receiver and make sure they work before installing them in the aircraft.

Fuselage:

Start the fuselage construction by gluing the plywood fuselage doublers to the inside (the side with the printing) of the fuselage side pieces. Make a RIGHT and a LEFT side! Be sure the holes for the hold-down dowels are lined up.

The nose fixture is used to assemble the front of the fuselage. Put the bottom of the fuselage into the fixture snug against the front stop and then line-up and glue one side of the fuselage while holding the side tight against the fixture. Only apply glue to the front 3½" of the fuselage (the point where the fixture ends). Repeat for the other side.

Move the partially assembled fuselage from the nose fixture to the full fuselage fixture. The front of the fuselage will not be against the bottom of the fixture. Now glue the right and then left fuselage sides to the fuselage bottom. Keep the sides tight against the fixture until the glue sets. The rear of the fuselage is easier to assemble using foam safe CA. A glue gun is hard to get into position to glue the joint as the fuselage tapers at the rear.

Foam nose and rear dowel doublers are optional. They were designed before the plywood fuselage doublers were added to the kit. Nevertheless, they still provide an increased surface area for attaching the firewall and dowels. If desired, glue the doublers in place making sure the holes for the hold-down dowels are lined up. The finished inside width in the nose is 1¼". If your battery is wider than this, you may want to cut off part of the bottom of the nose doublers to provide more space.

Remove the partially assembled fuselage from the fixture.

Now glue the front and rear fuselage tops to the fuselage sides. *Tip: Place the Horizontal Stab in the slots to support the rear of the fuselage sides while installing the rear top piece.* You may need to spread the sides to get a good fit with the fuselage tops. Hopefully you now have a fuselage that is straight and doesn't look like a blue banana!

Tip: Add a strip of strapping tape along the bottom of the fuselage to protect the bottom when landing on rough surfaces. The UNI Dome floor has a non-slip surface that is fairly rough.

Hood Scoop:

Next is the plastic spoon "hood scoop". Hey, this is a racer! Racers have hood scoops for a reason and this one is used to get outside air into the fuselage for cooling the ESC and battery. The kit includes a precut spoon. The picture at the right show how the hood scoop was cut from the plastic spoon. Place the hood scoop on the top of the fuselage and draw an outline of it. Remove the hood scoop and cut the air inlet hole. The rear of the fuselage is open to let out the hot air. **Do not install the scoop at this time.**

Firewall:

Sand the front fire wall area so that the front edges are even. The proper amount of firewall down-thrust is built-in, so don't sand too aggressively. Using a small drill bit or piece of wire poke holes in the edge of the foam where the firewall attaches. This really helps the bond of the firewall to the fuselage. The holes help the epoxy wick into the foam for better strength.

The firewall is a 1¾" by 1¾" square piece of ⅛" plywood. Layout the engine mount on the firewall and pilot drill for the mounting holes. Drill a ¼" hole to route the motor wires through the firewall. Glue the plywood firewall to the fuselage using 5-minute epoxy.

After the firewall epoxy has cured, sand the corners of the fuselage to round them off a bit. Try not to sand away any of the clear skin that is on the foam.

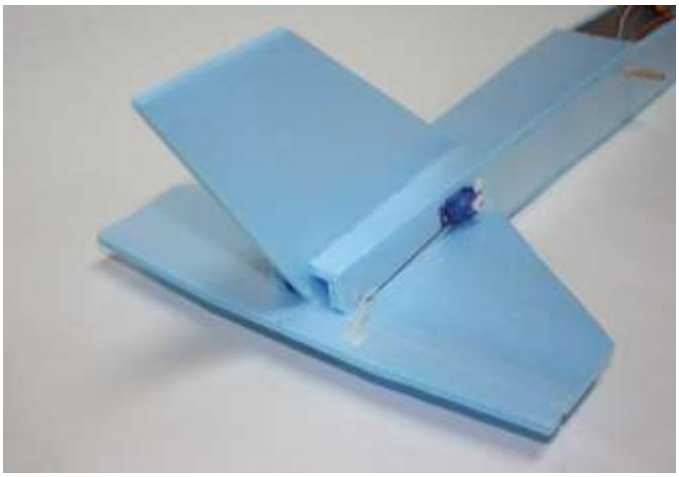
Use foam safe CA or 5-minute epoxy to install the two $^{3}/_{16}$" wood dowels for the wing hold downs. You may optionally use your own carbon fiber dowels.

Horizontal & Vertical Stabilizers:
Cut the elevator free from the horizontal stabilizer along the line drawn on the stabilizer. Cut a 45º taper into the leading edge of the elevator. You can rough cut the taper with a knife and then use a "T" bar or sanding block to sand the taper to a smooth finish. Sand the trailing edges of the elevator to a taper and round over the leading edges of the horizontal and vertical stabilizers. The leading edges of the horizontal and vertical stabilizers may be reinforced with 3" wide clear tape if desired.

Attach the elevator to the horizontal stabilizer. Hinging the elevator can be done several ways using the hinge method that you prefer. Hinge tape is an easy option. A stronger method is to join the elevator to the horizontal stabilizer with thread, but make sure that the gap is sealed with tape to prevent flutter!

The location of the elevator servo is marked on both fuselage sides. Cut out the servo opening to fit your servo, but do not install the servo at this time.

With the fuselage weighted down to the work bench place the horizontal and vertical stabilizers into the tail of the fuselage. Check that they are square with the fuselage. If needed trim the slots to adjust the alignment. Trim the rear of the fuselage to allow for full up and down movement of the elevator. Remove the vertical stab and horizontal stab from the fuselage. Using hot glue or foam safe CA, glue the vertical stab to the top of the horizontal stab. Use the centerline drawn on the top of the



horizontal stab to align the vertical stab. Use a 90º triangle or carpenter's square to make sure the vertical stab is at a 90º angle to the horizontal stab. Then glue the assembly in place in the fuselage.

Attach the 6" servo extension to the elevator servo. Route the servo extension through the fuselage and hot glue the elevator servo in place.

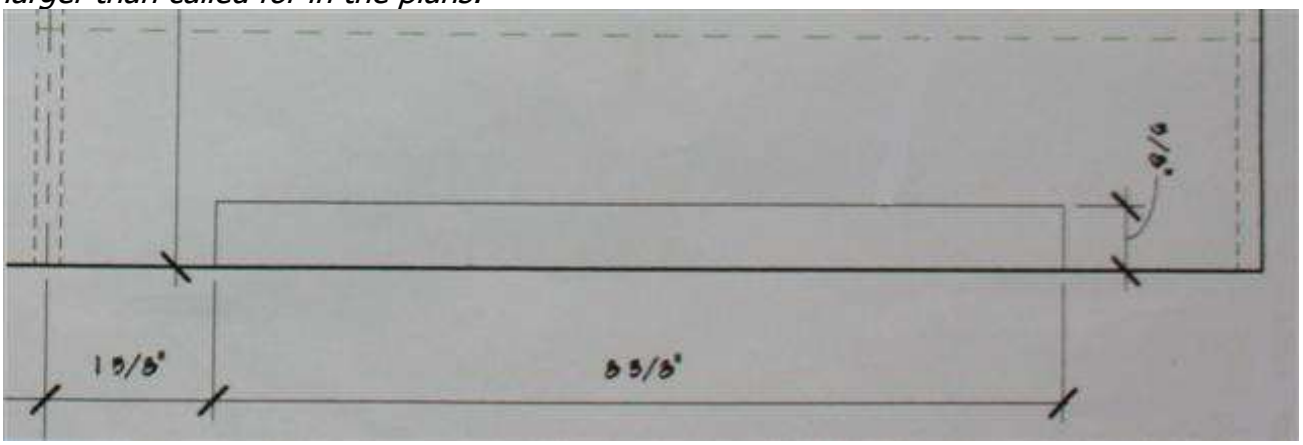
Glue the elevator control horn in place and connect it to the servo arm with either .032 or .042 diameter wire with a "Z" bend at the servo end and a keeper at the elevator end.

Wing:

Before working on the wing, make sure you have correctly identified the top side of the wing.

Attach a strip of strapping tape along the top of the wing approximately 2¼" behind the leading edge of the wing. Attach a strip of 2" or 3" wide clear tape over the length of the leading edge.

Cut out the aileron as shown with the inner edge 1⅝" out from the wing centerline. The ailerons are 8⅜" long by ⅝" wide. If you choose to use balsa ailerons (not supplied), adjust the width dimension to fit. Sand the area of the wing where the ailerons were cut out to clean up the foam. Cut and sand a 45º taper in the leading edge of each aileron. *Tip: These ailerons are very effective. Do not make them any larger than called for in the plans.*



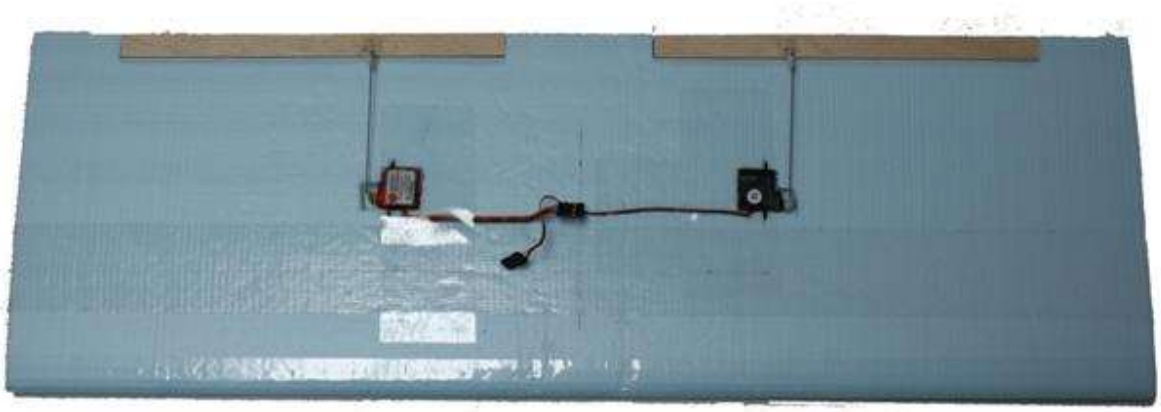
Locate the aileron servo locations on the bottom of the wing. The pushrods are 3" out from the wing centerline with the servo horn about 4½" from the trailing edge. Mark the servo locations on the wing. Use tape on a knife blade as a depth gauge and make several closely spaced cuts along the length of the servo location. Use a knife to pry out the foam from the servo locations. Check to make sure your servo arms are centered and move in the right directions. Hot glue the servos into position. Make narrow slits in the wing between the servo and the centerline of the wing. Push the servo wires into the slit, and then tape over the wires. This will prevent the servo wires

from being pinched by the fuselage side doublers. *Tip: You may prefer to notch the fuselage sides and doublers to provide clearance for the aileron servo wires instead of slitting the wing.*

Make two 1½"x½" light ply doublers (material not supplied). Glue one doubler on each aileron where the aileron control horn will be attached. (We've discovered that attaching the aileron control horn directly to the foam aileron without a doubler will result in a joint failure due to the aerodynamic load on the aileron. Adding the doublers strengthens this connection.) Install the ailerons using your favorite hinge method. Again, use sealing tape to seal the hinge area.

Drill holes for the aileron control horns and glue them in place. Connect the control horns to the servo arms with either .032 or .042 diameter wire with a "Z" bend at the servo end and a keeper at the aileron end. *Tip: There are several ways to make the servo arm to aileron horn linkage. Another method is to make two wires with a "Z" bend at the end of each wire. Install one wire on the servo arm and the other wire on the aileron horn. Put a one-inch section of heat shrink tubing over both wires. Trim the wires to length so that the wires have about an inch of overlap. Shrink the tubing and then infuse CA glue into the joint.)*

Attach a strip of strapping tape along the bottom of the wing approximately 2¼" behind the leading edge of the wing.



The wing will use four #64 rubber bands for wing mounting. (#64 Rubber bands are available at any office supply store.) Glue the supplied $^{1}/_{16}$" X ¾" X 3" ply wing doubler to the top of the trailing edge of the wing to prevent the rubber bands from crushing the trailing edge of the wing. Again, those of you who prefer carbon fiber may substitute flat carbon fiber for the ply in this location. *Tip: Install the rubber bands from the rear forward to avoid catching the bands on the ends of the aileron.*

Motor Installation:

Install the motor mount to the motor. Mount the motor to the firewall using #2 servo mounting screws. Connect the motor wires to the ESC. You can use forceps through the air intake hole to connect

the bullet connectors. Check to see that the motor is turning in the correct direction. If not, switch any two of the motor wires connecting the ESC. The ESC can be mounted with double-sided tape or Velcro to the inside of the fuselage bottom. *Tip: Whenever you attach double-sided tape or Velcro to foam put a thin coat of 5-minute epoxy on the foam and let it thoroughly cure before attaching the tape or Velcro.*

Tip: The smooth, flat side of the ESC is the heat sink. Attach the Velcro or tape to the other side.

Glue the hood scoop in place.

Radio installation:

Attach the receiver near the rear of the wing opening with Velcro or double-sided tape. The ailerons can be wired with a 3" micro wire "Y" connector or if your receiver allows for direct connection of the ailerons to the receiver, use two 3" servo extensions. The removable wing provides access to the battery so make sure you have enough slack in the aileron wires to allow the battery to be installed and removed.

Setup:

The CG is located 2 ⅝" from the leading edge of the wing. The battery is mounted slightly forward of the CG so you can use just about any weight battery without affecting the CG too much. Loosely locate the battery in the fuselage, install the wing and check the CG. When you've determined the correct battery location, mark the location on the inside of the fuselage and install the battery with Velcro. The battery can be moved slightly forward or back to fine tune the CG.

A 2-cell Li-Po 1000 to 1300 mAh 20C battery is recommended for the average RC pilot. This will give you plenty of performance while keeping the speed down. For those of you hot shot pilots, use a 3-cell 1000 to 1300 mAh 20C Li-Po and be ready! This little guy screams!

A 1000 mAh 15C battery is lighter and therefore a better choice for all out performance, but the heavier batteries have the added advantage of not pushing the Li-Po batteries to their limits.

The UNI Dome fun-fly pylon races have an 11 ounce ready-to-fly minimum weight requirement for the 2-cell class races. Weigh your airplane on a postal scale and add weight to bring it up to the minimum. *Tip: Before adding lead weight, consider adding additional reinforcement tape to the wing and bottom of the fuselage.*

Set your radio up for these control throws.

Elevator Up & Down – ⅜" with 30% exponential

Aileron Up & Down – $^{3}/_{16}$" with 50% exponential

Test Flight:
The BLUE RAY can be easily hand launched. Advance the throttle to "full throttle" and lightly toss the airplane into the wind. The climb out will be quick so be ready to throttle back to keep the BLUE RAY in sight. Climb to a two mistakes high altitude and trim the airplane. *Tip: If using a 3-cell battery, launch the airplane at half-throttle until you get a feel for the BLUE RAY. Then advance the throttle and have a blast!*

Use this first flight to get comfortable with the control rates and take mental notes of more or less exponential rates. The control sensitivity follows the airspeed in that they are nice and easy at slow speeds but get pretty quick at full throttle.

Even though the BLUE RAY is very light weight, it can easily handle winds over 10 mph. Landings are actually very slow. "Dead Stick" landings are easy or you can keep a little throttle "on" with a nose high attitude until just before touch-down.

Optional Modifications:
The Blue Ray can be built with a single aileron servo and torque tubes. The double servo arrangement is shown in the instructions because it's easy to install.

The Du-Bro micro control horns and keepers are inexpensive and easy to install, but other brands or even home-made control horns and keepers can be used.

The original Blue Ray design had the aileron servos in a "stand up" position in the wing. The "lay down" position is shown in the instructions because it gives more clearance between the bottom of the servo and the top of the wing.

The foam ailerons may seem to be "floppy", especially at the outer ends of the ailerons. They are still quite effective. You may prefer to stiffen them with a carbon fiber strip along the top of the ailerons.

While 6 gram servos are recommended especially for the elevator servo, 9 gram servos can be used for the aileron servos without affecting the CG location or flying performance.

A good method of attaching the control surfaces is to use double-sided tape in an "X" pattern. Start with a strip of tape on the top of the stabilizer and crossover to the underside of the elevator with the first strip. The next strip is reversed. Start on the bottom of the stabilizer and crossover to the top of the elevator. Repeat the process until you have "X" strips at both ends of the stab/elevator assembly and on both sides next to the fuselage. Finish up by putting hinge tape along the top of the hinge to seal the entire length of the hinge. Do the same for the wing/aileron assembly.

When you are not participating in a class event, you may find other motor, propeller and battery combinations that provide better performance.

The BLUE RAY is a capable aerobatic airplane. A rudder servo could be added to make it a full-house setup. This will add weight and provide no real advantage in pylon racing. If you want a hot sport flyer, add the rudder servo. Make the rudder about ¾"

wide, cut from the vertical stabilizer as the ailerons were done. Mount the rudder servo on the fuselage top next to the vertical stabilizer. You may need to add some nose weight to get the CG in the proper location.

Conclusion:
This kit is intended for class racing where piloting skill determines the outcome more than the airplane. The motor and propeller selections were made to provide good performance for indoor pylon racing at a low cost. We hope you like flying your Blue Ray Racer as much as we liked flying ours.

Stats:

Finished weight without battery is 8 to 8.5 ounces (228 to 240grams)
Battery weight for 2-cell 1000 to 1300 mAh Li-Po is 2.2 to 3.0 ounces (62 to 85 grams)
Battery weight for 3-cell 1000 to 1300 mAh Li-Po is 3.0 to 3.8 ounces (85 to 110 grams)

Total flying weight:
w/ 2 cell Li-Po = 10.2 to 11.5 ounces – 290 to 325 grams
w/ 3 cell Li-Po = 11.0 to 12.3 ounces – 312 to 350 grams

Wing Span: 24 inches
Wing Area: 174 square inches
Wing loading: 8½ to 10¼ oz / sq ft
Airfoil: Semi Symmetrical
Total Length: 28 inches

Motors:
For competition a 22 mm stator diameter and 1820 KV maximum outrunner motor is required. See the web page for a list of potential motor suppliers. For non-completive flying, a larger diameter motor has more torque and will fly faster. Just be careful not to add too much weight with a larger motor.