given above using the equations from Bob Boucher's book.

Strontium 150

Cells	Amp	Volts	Watts in	Watts out	Eff
6	20	6.0	120.0	77.7	64.8%
7	25	7.2	180.0	119.4	66.3%
8	28	7.8	218.4	145.4	66.6%
10	35	9.4	329.0	221.7	67.4%

Astro FAI-05 (6 turn)

Cells	Amp	Volts	Watts in	Watts out	Eff
6	28	5.6	156.8	111.1	70.9%
7	33	6.3	207.9	148.9	71.6%
8	40	7.1	284.0	203.7	71.7%
10	51	8.1	413.1	292.7	70.9%

Conclusions:

The Hobby Lobby published test results are quite different from those I obtained. I can think of two possible reasons for this.

1) The S-150 motor takes a long time to break in. I ran mine for 5 hours and the brushes were still not completely seated. The brushes are seated better now after the motor has been flown a few dozen times. I expect that this would have an effect on the Rm constant.

2) The resistance of the batteries and harness used to drive the Hobby Lobby test was much greater than in my test. This would account for the lower than expected figures for both motors but would make the Astro appear much worse than it is because of it's much lower Rm and the higher amp draw. You can see the effect of this in my charts because the voltages on the Astro side of the chart are so much lower than those on the S-150 side for the same number of cells.

I like my S-150 and expect to use it for many years to come. But if I were to replace an Astro FAI-05 with one I would be disappointed because it runs hotter and doesn't turn the RPM. This motor is much closer to the non-FAI Astro Flight 05 (model 605) motor if the Astro Flight motor constants published are correct. The published constants are Io=2.5 which is better than the S-150 but only matters at low current draws. The Rm is 0.045 which is better than the S- 150, and the Kv is 2125 which is worse than that of the S-150 but not by much. At higher Amp draws the Astro 05 probably will turn faster than the S-150. At lower currents it should be the other way but the efficiency should always be in favor of the Astro 05 by a small margin. Some day, when I have the necessary few hours of time and a desire to do the comparison, I will run these same tests on the standard Astro 05.

I am currently using the S-150 in my Blue Curry with the Aeronaut 9.5x5 folder on 8 cells (33 amps). This combination pulls the plane around nicely. I may try the 9x6.5 or 9x7 or 10x6 or 10x7 folder on 7 cells as this draws too much current on 8 cells.

I hope this was useful to you. I know I learned a lot and would love to receive any components both positive or negative.

Thanks to Jim Martin of Hobby Lobby for permission to reprint the chart and to publish the part numbers and prices from the catalog. I also want to thank Bob Boucher for producing such a fine book.

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AI/Robotics FX-35D Electronic Speed Control

by Bernard Cawley, Jr.

from "Charge Ahead"

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By now I imagine all of you have seen, somewhere, ads for the FX-35D speed control. The ads make a rather large number of claims for the unit, including several safety features, two braking modes, two soft-start modes, the ability to charge a Rx pack in flight as an alternative to pure BEC, and "smart" overcurrent and overtemperature protection. It also has a unique three position switch (called the "sequential arming system") which allows powering up of the radio before arming the motor, eliminating the need for a separate radio system switch. It is rated for 6 to 20 cell motor battery operation, at continuous currents up to 30 amps. AI/Robotics has been kind enough to supply me with one of these units to try out. The news is good.

Physical Description

The FX-35D, as supplied, is a flat package 1 3/4 x 1 3/8 x 1/2 with 4 inch long 14 gauge silicone rubber insulated wire leads for the battery on one end of the unit and the motor leads on the other end. Also emerging from the unit on the motor lead side are three jumpers which allow selection of the BEC motor shutdown mode, throttle response setting and brake on/off. Emerging from the battery side of the controller is a 5 1/2 inch lead which ends in the "sequential arming switch" and a 3 inch lead for the receiver input. No power or receiver connectors are supplied. This package weighs 1.8 ounces. Addition of Sermos connectors and an 8 inch receiver lead (which must be

spliced into the supplied Rx lead) brings this up to 2.2 ounces ready to use.

As customary these days, the main package is shrink wrapped, with open ends which provide some possibility of cooling airflow through the unit. It is different in that the power handling components and heat sink are on one side of the circuit board, and all the rest of the components are on the other side, under the shrink wrap. At first I thought this odd, since the microprocessor and so forth are not physically protected by being mounted between the board and the heat sink plate. However, I learned from the designer that this is intended to keep the power components and the heat they generate away from the rest of the circuitry.

Mounting it would most easily be done via sticky-backed Velcro® applied to the heat shrink on the component side of the unit (not the heat sink side).

Visible through the shrink tubing is an LED which can tell you much about what the unit is "thinking" - it indicates such things as unit readiness and whether signal loss, overcurrent or thermal shutdown has occurred. (Of course, this LED is would be rather hard to see in most installations, but it is very informative during bench tests)

Included with the FX-35D is a very complete manual describing all aspects of operating and selecting the various features of the unit and how to integrate it into the power system of your plane. It also shows several wiring diagrams, has tips for splicing and soldering wires, info on connectors, and a detailed treatment of the use of Battery Eliminator Circuits and what their limitations are. This is the most complete manual I have ever seen for an electronic Speed control - it borders on information overload! Only Lofty Pursuits' manual even comes close (that one is a treatise on ESC design, among other things).

Performance Tests

After attaching the necessary connectors, I put the FX-35D in the same test setup I've been using for awhile (Airtronics receiver, servo plugged into the elevator channel of the Rx, Goldfire motor, Astro 100 ammeter/voltmeter switch harness - all mounted on a Mitch Poling style test stand). However, since the sequential arming switch (SAS) controls the radio system power, I didn't need to use the radio switch harness.

I plugged a 6cell pack into the battery inputs of the FX-35D, turned on the transmitter, then moved the SAS to the middle position. I then had control of the radio, confirmed by moving the elevator stick on the Tx, but the motor was still disarmed. After moving the SAS to the motor on position, the LED signaled that power-up calibration was underway. During this calibration it "fingerprints" the incoming signal, so it has a basis for comparison for deciding a signal is poor enough to warrant shutting the unit down. In about 2 seconds, it was ready to go. At that point, operation was just like you'd expect - smooth, linear operation from low to high, following the stick motion with a slight lag (this provides for soft start and smoothing of momentary glitches). The FX-35D is very much like Jomar units in its response - not "twitchy" like some others.

The range, which is a fixed 0.6 millisecond pulse width variation, seemed well suited to my Airtronics radio, with only a little wasted stick motion at the top of the throw. This is the same approach for range "adjustment" as is taken by the Astro 210/211, Flightec SEC-M and SEC-SP, and Lofty Pursuits LPSC-1 (as well as analog Speed controls with only one adjustment pot). It has the very real advantage of being simple, with the disadvantage of not taking full advantage of the available stick throw. Those of you with computerized transmitters can program your sticks to match - but those of us who don't - well, we can live with it.

I then proceeded to experiment with some of the safety features and conditions which has given other microprocessor throttles trouble.

Like the Astro 210 and the Jomar Mini-Max if the throttle stick is too high when the speed control is powered up, it simply refuses to start the motor. If this is the case, you simply bring the stick back to low long enough for the start-up calibration to be done and the unit then operates normally. This is a very real safety feature.

I then tried the micro-based unit's nemesis - turning the transmitter off while the motor was running. This should cause quick shutdown of the motor, and for the FX-35D that was the case, regardless of throttle position. Only once in awhile did it hesitate a moment before deciding to shut down - this is among the best of the micro-based units I've tried. In each case, when the Tx was turned back on, the unit returned to the throttle setting commanded by the position of the throttle stick on the transmitter after a couple of second delay (during which it is again "fingerprinting" the incoming signal).

Intentionally interfering with the test setup using another transmitter showed good behavior - with control being maintained at least as well as the servo on the elevator channel.

Other features

The FX-35D has some self-protective features which other units I've tried don't have. One is an over-

temperature shutdown mode (if it gets too hot it kills the motor, waits awhile, then if it's cool enough powers up again). The other is an overcurrent shutdown - if current goes over 75A it shuts the motor down until you reset it by powering down the system. This will also protect it in the case of shorted outputs.

I did not test the overtemperature shutdown, but I did try the overcurrent shutdown. I verified that it will shut itself down safely if the outputs are shorted together. I also tried a test suggested by the manufacturer - that of putting a fuse across the unit instead of a motor. I found that if you advance the throttle quickly it will, indeed, shut itself down before a 30A fuse blows. If you bring the throttle up slowly, the fuse does blow. Still, this is a surprising demonstration of the speed of the overcurrent protection.

As shipped, the FX-35D has a brake (which can be disabled by cutting one of the jumper wires). This brake seems to be less abrupt in its action than on the Flightec SEC-SP/M. It comes on smoothly (again, more like the Jomar MiniMax), then drops out.

In prior issues I mentioned that I really liked the motor cutoff method used in the Flightec SEC-SP/M family of controls in that it shuts the motor down when the power battery is getting low, but returns control of the motor to you after a short delay so that you can stretch approaches or whatever. Since I've been flying a SEC-SP in my trusty ol' Elf 1-20E, I've really come to appreciate this approach (though the delay sometimes can be inconvenient). The FX-35D's default motor cutoff method is very similar, except that it returns control to you virtually immediately - which I think could be even better. The FX-35D also has another mode (selected by cutting a jumper wire) that reduces, but does not cut off, power progressively. I haven't tested that yet - good for 7 cell battery allotment events, perhaps.

The battery eliminator circuit does the usual job (with the added capability afforded by the sequential arming switch mentioned above). It can also be disabled (and should be if you are using more than a 10 cell motor pack). A third option is the "in flight charger" which allows the BEC circuitry to help keep a regular receiver battery charged by kicking in some current when the Rx battery falls below 4.8V under load. All three options - BEC, in flight charger or no BEC operation can take advantage of the sequential arming switch if you wire your system as described in the manual.

There is much more to tell - more than I have space to write about. Therefore, through arrangement with AI/Robotics, PSEMF members will each be mailed a copy of the instruction manual at about the same time you receive this issue. (I've also sent the Ampeer mailing list to AI/Robotics - hopefully, all of you will also receive this very interesting manual. km)

All in all, this is quite an impressive unit, and with a street price below $90 it represents a good value if you have need of even a few of the features it offers. I am especially taken with the sequential arming system (which, the manual notes, is patent pending) as it simplifies wiring the inside of the airplane quite a bit, as well as operation of it. I have added it to my current list of recommended microprocessor-based speed controls along with the EMS/Jomar MiniMax95, the Astro Flight 210, the Ace S72635 and Flightec SEC-SP. It is one of the larger and heavier units in that group, and so is perhaps not suitable for Speed 400 type planes (where the MiniMax would do very well, for example). However, I understand that Al/Robotics is working on a unit to fill that market niche, as well as a higher power handling unit to compete with the big guns - the Jomar

The Howell Meet

On May 20 the Livingston County R/C Club hosted their annual Electric Fly. As usual Keith Clark, CD, had everything very well organized and his crew of club members, including Keith's lovely wife made everything run very smoothly.

Beautiful Jenny and Old Timer seen at Howell, but couldn't fly because of the high winds.

Unfortuately, the weather was not quite ideal. Although it was a lovely spring day, the winds blew hard, too hard. They were 25 mph, gusting to over 35 mph. It was impossible for me to keep my hat on while flying! This didn't stop fliers from flying, but did limit the selection of aircraft flown. There were several mishaps because of the wind, which was of course a cross wind. I managed to bang up the Senior Skyvolt pretty badly. I had had three very good flights in the heavy winds and was getting quite cocky on my ability to handle the wind. On the fourth takeoff, the wind flipped the plane just as it lifted off causing severe damage to the nose, tail, wing and top of the fuselage. That's what happens