



3D Electrics

FOR
DUMMIES



Note: Products shown in this presentation does not constitute an endorsement.

What is Needed?

- Components in or for your Plane
 - Electric Motor
 - Speed Controller
 - Battery(s)
- Tools
 - Battery Charger
 - Lipo Bag
 - Watt Meter

Components - Motor

- Types
 - In Runner



- Lower Torque
- Used in Gear Drives or small planes
- Shaft Spins
- High RPM



Out Runner

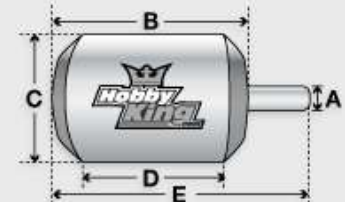
- High Torque
- Direct Drive
- Case spins
- Lower RPM than In Runners

Components - Motor

- Ratings
 - Kv (rpm/v)
 - Ex: 8880 rpm = 600KV * 14.8v
 - Ex: 13,320 rpm = 600KV * 22.2v
 - Amps – Rated as Max Efficiency
 - Ex: 38a
 - Weight – usually in grams
 - Max Voltage – check specs!



Kv (rpm/v)	600
Weight (g)	195
Max Current (A)	0
Resistance (mh)	0
Max Voltage (V)	15
Power(W)	0
Shaft A (mm)	5
Length B (mm)	50
Diameter C (mm)	43
Can Length D (mm)	27
Total Length E (mm)	70



Components – Speed Controller

- ESC – Electronic Speed Controller
 - Shown with no BEC
 - 5 amp to 200 amp



- BEC – Battery Eliminator Circuit
 - Shown ESC with BEC
 - BEC Typically 5 volts
 - ESC 5 amp to 200 amp
 - Look for the pigtail



Components - Battery

- Preferred Battery is Lithium Poly (LiPoly)
 - Commonly 3 -6 cells
 - Voltage from 11.1 v to 22.2 v
 - Rated in Mah
 - Discharge rates to 45C
 - Amps = $(C_{\text{rating}} * \text{mah})/1000$
 - Ex: 84 amps = $(30C_{\text{rating}} * 2800\text{mah})/1000$
 - Commonly comes without connectors
 - Normally has balancer leads attached
 - Price ranges from \$7.00 to \$250.00 per battery



Tools – Battery Charger

- Must be able to handle multiple cell batteries
- Must be able to charge at different rates
- Must have balanced charging capability



Tools – LiPo Bag

- Protection while charging batteries
 - Need I say more?



Tools - Wattmeter

- Use to test batteries, motors, systems
- Measures watts, volts, amps
- Check servo draw
- Check motor load
- Select correct props



Converting to Electric

■ Considerations

■ Weight

- Glow engine, full fuel tank, receiver battery, fuel lines, throttle servo
- Electric Motor, ESC w/BEC, Battery

■ Power Output

- Glow engine output vs. electric motor
- Correct prop for best thrust
 - Determine optimal thrust of different prop diameters/pitches
 - Select prop based on motor/battery loading

Testing and Calculations

- Testing

- Wattmeter and digital fish scale

- Install components

- Motor
- ESC
- Battery



- Testing Procedure

- Hook fish scale to tail of plane
- Hook Wattmeter between ESC and Battery
- Test different props, take readings of scale and wattmeter

Thrust Calculations

- Calculate Thrust Needed to Fly 3D
 - Based on Watts
 - 150 to 200 watts per pound of model weight
 - Formula: $\text{Watts} = 200 * \text{model weight}$
 - Example: $700 \text{ Watts} = 200 * 3.5 \text{ lbs}$
 - Based on Static Thrust
 - Minimum of .33 lbs static thrust per pound of model weight
 - Ideal is $> .57$ lbs static thrust per pound of model weight
 - Formula: $\text{Thrust} = .57 * \text{model weight}$
 - Example: $1.995 \text{ lbs} = .57 * 3.5 \text{ lbs}$

Flying Time Calculations

- Calculating Flying Time
 - Flying Time in minutes = (Battery mah / 1000 / amps draw on motor) * 60
 - Flying Time = (mah/1000/amps) * 60
 - Ex: 11.5 min. = (5000/1000/26) * 60

Example #1

- Plane: Katana
 - Weight: 3 lb. 10 oz. (3.625 lbs.)
 - Required Watts: 725 Watts = $200 * 3.625$ lbs.
 - Required Static Thrust: 2.067 lbs. = $.57 * 3.625$ lbs.
 - Motor: Turnigy 4250-600
 - Max Efficiency (Amps): 38 amps
 - Max Watts: $562 \text{ w} = 14.8 \text{ v} * 38 \text{ a}$
 - Max Rpm: $8880 \text{ rpm} = 600 * 14.8$
 - Battery: Mystery 2800 mah, 14.8 v 4S, 30C
 - ESC: Aeolian 50 amp w/5 v, 2 a BEC
 - Desired Flying Time: 6 to 8 minutes at full throttle



Example #1 Readings

- Plane: Katana, 3lb. 8 oz.
 - Actual Readings using Wattmeter and Scale

Readings																	
Prop								Battery Rating			Motor			Calculations			
Dia.	Pitch	Amps	Volts	Watts	Thrust			Volts	MA	Rating	KV	Max. Load	Max. Efficiency	Required Watts	Required Thrust	Flight Time	RPM
11 X	5.5	21	14.3	328	2 lb.	4 oz.	1022 gr.	14.8	2800	30	600	43	38	700	1.995	8.00	8580
11 X	7	23	14.6	330	2 lb.	10 oz.	1192 gr.	14.8	2800	30	600	43	38	700	1.995	7.30	8760
11 X	8.5	27	14.2	380	2 lb.	7 oz.	1107 gr.	14.8	2800	30	600	43	38	700	1.995	6.22	8520
11 X	10	29	14.0	400	2 lb.	10 oz.	1192 gr.	14.8	2800	30	600	43	38	700	1.995	5.79	8400
12 X	6	25	14.3	380	3 lb.	5 oz.	1504 gr.	14.8	2800	30	600	43	38	700	1.995	6.72	8580
12 X	8	27.8	14.4	385	3 lb.	8 oz.	1589 gr.	14.8	2800	30	600	43	38	700	1.995	6.04	8640
12 X	10	46	14.0	505	3 lb.	4 oz.	1476 gr.	14.8	2800	30	600	43	38	700	1.995	3.65	8400
12 X	12	44	13.6	615	2 lb.	13 oz.	1277 gr.	14.8	2800	30	600	43	38	700	1.995	3.82	8160
13 X	6.5	28	14.4	420	4 lb.	1 oz.	1844 gr.	14.8	2800	30	600	43	38	700	1.995	6.00	8640
13 X	8	33	14.9	485	4 lb.	5 oz.	1958 gr.	14.8	2800	30	600	43	38	700	1.995	5.09	8940
13 X	10	43	14.8	585	3 lb.	12 oz.	1703 gr.	14.8	2800	30	600	43	38	700	1.995	3.91	8880
14 X	7	33	14.2	485	4 lb.	7 oz.	2015 gr.	14.8	2800	30	600	43	38	700	1.995	5.09	8520
14 X	8.5	41	13.8	580	4 lb.	12 oz.	2157 gr.	14.8	2800	30	600	43	38	700	1.995	4.10	8280
14 X	10	36	12.5	460	4 lb.	2 oz.	1873 gr.	14.8	2800	30	600	43	38	700	1.995	4.67	7500
14 X	12	52	12.8	620	3 lb.	13 oz.	1731 gr.	14.8	2800	30	600	43	38	700	1.995	3.23	7680

Example #2



- Plane: Velox Revolution
 - Weight: 6 lb. 8 oz. (6.5 lbs.)
 - Required Watts: 1300 Watts = $200 * 6.5$ lbs.
 - Required Static Thrust: 3.70 lbs. = $.57 * 6.5$ lbs.
 - Motor: Turnigy 5065A-400
 - Max Efficiency (Amps): 56 amps
 - Max Watts: 828 w = 14.8 v * 56a
 - Max Rpm: 5920 rpm = $400 * 14.8$
 - Battery: Turnigy 5000 mah, 14.8 v 4S, 40C
 - ESC: Turnigy 80 amp w/5 v, 2 a BEC
 - Desired Flying Time: 6 to 8 minutes at full throttle

Example #2 Readings

- Plane: Velox Revolution, 6lb. 8 oz.
 - Actual Readings using Wattmeter and Scale

Readings																	
Prop					Thrust			Battery Rating			Motor			Calculations			
Dia.	Pitch	Amps	Volts	Watts				Volts	MA	C Rating	KV	Max. Load	Max. Efficiency	Required Watts	Required Thrust	Flight Time	RPM
15 X	6	19	16.0	300	3 lb.	9 oz.	1617 gr.	14.8	5000	40	400	60	56	1300	3.705	15.79	6400
15 X	8	23	15.8	375	4 lb.	3 oz.	1901 gr.	14.8	5000	40	400	60	56	1300	3.705	13.04	6320
15 X	10	27	15.7	430	4 lb.	6 oz.	1986 gr.	14.8	5000	40	400	60	56	1300	3.705	11.11	6280
16 X	8	52	15.7	520	5 lb.	6 oz.	2440 gr.	14.8	5000	40	400	60	56	1300	3.705	5.77	6280
16 X	10	33	15.6	520	5 lb.	5 oz.	2412 gr.	14.8	5000	40	400	60	56	1300	3.705	9.09	6240
16 X	12	45	15.3	645	5 lb.	7 oz.	2469 gr.	14.8	5000	40	400	60	56	1300	3.705	6.67	6120
17 X	8	37	15.3	550	6 lb.	5 oz.	2866 gr.	14.8	5000	40	400	60	56	1300	3.705	8.11	6120
17 X	10	43	15.0	600	6 lb.	9 oz.	2979 gr.	14.8	5000	40	400	60	56	1300	3.705	6.98	6000
17 X	12	50	15.0	750	5 lb.	3 oz.	2355 gr.	14.8	5000	40	400	60	56	1300	3.705	6.00	6000

Example #2 Readings

- Plane: Velox Revolution, 6lb. 8 oz.
 - Actual Readings using Wattmeter and Scale
 - Battery changed to a 5000mah 22.2V 6S 40C

Readings																	
Prop						Thrust		Battery Rating			Motor			Calculations			
Dia.	Pitch	Amps	Volts	Watts			Volts	MA	C Rating	KV	Max. Load	Max. Efficiency	Required Watts	Required Thrust	Flight Time	RPM	
15 X	6	32	22.2	700	6 lb.	12 oz.	3065 gr.	14.8	5000	40	400	60	56	1300	3.705	9.38	8880
15 X	8	41	22.0	900	7 lb.	10 oz.	3462 gr.	14.8	5000	40	400	60	56	1300	3.705	7.32	8800
15 X	10	47	22.8	1080	7 lb.	12 oz.	3519 gr.	14.8	5000	40	400	60	56	1300	3.705	6.38	9120
16 X	8	52	21.8	1220	9 lb.	10 oz.	4370 gr.	14.8	5000	40	400	60	56	1300	3.705	5.77	8720
16 X	10	51	21.8	1120	9 lb.	5 oz.	4228 gr.	14.8	5000	40	400	60	56	1300	3.705	5.88	8720
16 X	12	75	21.0	1540	8 lb.	7 oz.	3831 gr.	14.8	5000	40	400	60	56	1300	3.705	4.00	8400
17 X	8	63	21.2	1320	10 lb.	13 oz.	4909 gr.	14.8	5000	40	400	60	56	1300	3.705	4.76	8480
17 X	10	66	21.2	1370	11 lb.	2 oz.	5051 gr.	14.8	5000	40	400	60	56	1300	3.705	4.55	8480
17 X	12	NA						14.8	5000	40	400	60	56	1300	3.705		

Putting it All Together



- After Testing

Go Fly!

Thank you!