BMFC

Introduction to RC electrics

Cliff Creese

TERMINOLOGY OF COMPONENTS

Battery = Energy source

ESC = Electronic Speed Controller

BEC = Battery Eliminator Circuit

UBEC = Universal Battery Eliminator Circuit

BASIC ELECTRICAL UNDERSTANDING

HEAT IS THE BIGGEST KILLER OF ELECTRICAL COMPONENTS

Check cooling/ventilation even on prebuilt craft

Air vent in may look good, but how can it get out.

Air flow to some component may be blocked by other

Overloading components produce heat, this applies to IC also.

Bearings and mechanical parts also effected.

SIMPLE AND NEAT WAY TO INCREASES VENTILATION

Plastic spoons

BASIC ELECTRICAL UNDERSTANDING

Volts = V (Pressure)
Amps = A (Flow)
Watts = W (Work to Do)
Resistance = R (ohms)

Ohms Law

V x A = W
W/A = V
W/V = A

1HP = 746W

Good supply of good quality knowledge

PhoenixMP On-Line Sho

E-Mail:- sales@phoenixmp.com | Telephone & Fax No. 01626 332287

Accessories
Adhesives
Batteries
Chargers and Balancers
Covering Materials
Electric Flight
Engines & Accessories
Field Equipment
General Tools
Materials
Propellers
Radio Control
Servos by Brand
Keil Kraft Kits
Stan's Kits
Stan's Mk1 Plans
Stan's EPP Plans
Aircraft Kits for Callers
Gift Vouchers
Plan Copying/Scanning Service
Special Offers - Limited Stocks
New Products

New Products

1. Futaba R617FS FASST 2.4Ghz Receiver (Ref: RR602)

Electric Flight

On-Line Shop > Electric Flight

Brushless Motors
Brushless Speed Controllers
UBECS
Plugs and Sockets
Heatshrink Tubing
Electric Flight Accessories
Glass Epoxy Motor Mounts

Gliders

Electric Flight

We recommend that you read this article on Simple Electrics if you are new into the hobby or thinking of flying electric models.

Brushless Motors

Also this article on Brushless Motors by Stan Yeo

SIMPLE ELECTRICS

By Stan Yeo

Definition of Terms
Ohms Law
Power (watts)
Selecting the Battery, Speed Controller and Motor
Brushless Motors
Electronic Speed Controller (ESC)
Electric Flight Packs
Converting IC Model to Electric
Useful Tools
Noise / Interference Suppression

a number of modellers electrics is a black art that induces a mental block

Telephone/Fax: +44 (0) 1626 332287

ic Flight | Engines | Materials | Accessories | Tools/Equipm

Modelling Magazine Articles

Stan Yeo has have written a number of articles on designing and flying slope soarers which have been published in the modelling press. Transcripts of these articles (minus diagrams) are available by clicking on the hyperlinks to the right of this page. Feel free to download these or print them out for your own pleasure. In summary the full versions are available from the following publications:

Not Published

Radio Controlled Systems
Prepare to Flap
Choosing a Slope Site
Crossed Wires
Receivers
Simple Electrics
Li-Poly Battery Failure
Batteries - The "C" Rating & Time to Charge (new)

Brushless Motors (new)
More about Chargers (new)

Radio Control Model World|

Prepare to Fly

Prepare to Land
Prepare for Slope Aerobatics
Prepare to Charge
Prepare to Design
Prepare for Lift-off
Prepare to Survive
Flying in Gales
Repairing Foam Wings
Slope Soarer Design
Foaming Experiences

Radio Control Model & Electronics|

Starting in Slope Soaring

Flying in Jersey

Silent Flight|

The EPP Revolution

| Back to top

BATTERIES

Most common Types

Nicad batteries (NiCad)
Nickel Metal Hydride batteries (NiMH)
Lithium Polymer batteries (LiPo)
Lithium Iron Phosphate and A123 (LiFePO4)

Lithium Ion (Li-ion)

Lots of advise on batteries , Most sound!

Like any fuel type the higher the amount the greater the bang.

MOST COMMONLY USED TODAY IS LIPO

CHARGING AND STORAGE

There are some pretty simple basic rules of thumb that can extend the life and performance of your batteries:

don't overcharge or run your batteries flat

don't subject batteries to extremes of heat or cold

choose an appropriate battery for the job

only use a charger designed for the type of battery you're using
never short-out a battery

never leave batteries in a fully discharged state

A neglected or mistreated battery will seldom last long and may cost you a model so try to treat them with the respect and care they deserve.

Don’t charge when hot.

Site usage :
Don’t leave in the sun.
Don’t use if below temperature (winter days left in car or on grass.

WHAT IS THE BATTERY

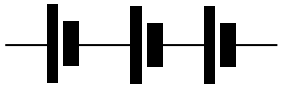
Gens Ace Lipo

Capacity 2200mAh (2.2 Ahr)

Nominal Voltage 11.1V (Consider this running load Voltage)

25C This is peak Amp rating (25x2.2= 55A)

3s1p 3 cells in series, single pack no parallel packs. Each cell 3,7v



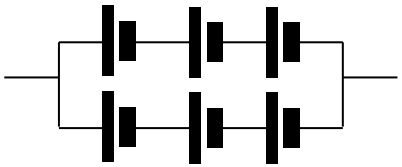
Also listed normally on the back is its charge rate, could be expressed as 1C.

So charge rate would be 1x 2.2 (2.2A or 2200mA)

C Rating is it maximum current (Amps)

Increasing C rating will not give you any more capacity,
Only peak current.

If it was stated 3S2P this would mean:



If you what more power, either.....

Get a bigger battery or put 2 in parallel

Weight is a good indicator of capacity
when comparing makes/cost.

Paying for high C rating when not needed
is a waste of money.

So what will it give you

If Loaded to 2.2A it will last an hour

If loaded to 22A it will last 10% of a hour. 6mins

If run at 55A it would last 2.4mins

i.e. 2.2 x 60 divided by 55

But always head for 10% minimum left to ensure we never over discharge the battery. I go for about 20%

Best long term storage around 11.4 - 11.8V

If a Lipo goes below 3V per Cell this is terminal for the Battery

CHARGING


Ripmax
PEAK
Mini
MIZE
LI-PO BALANCE
CHARGER
DC INPUT
Status
3S
2S
Made in China


JP·EnErG Pro
LIPRO DUAL 6
Lipo/LiIo/LiFe
NiMH/NiCd
Gel
Charge rate
Discharge rate
Memory
CHG 2
PROFESSIONAL INTELLIGENT DIGITAL AC/DC BALANCER CHARGER/DISCHARGER
DUAL AC/DC
Batt Type
Stop
Status
Start
Enter

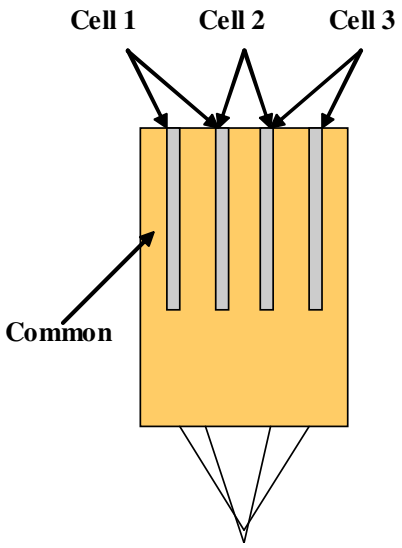
Charging

Use balanced charging. Select correct voltage and current .

Charge rate no more than that specified on battery. Usually 1C

So a 2200maHr equates to 2.2A@1C

Evan if specified 2C or 5C most people will charge at 1C to get better long term life



Balance Lead

VOLTS TO CAPACITY

A good battery should read 12.6V fully charged.

Each cell 4.2V

If Cells are not balanced total voltage will be lower, therefore less capacity.

Measure voltage at least 10 minutes after flight when pack has cooled down.
These measurements are approximate and may differ from battery to battery

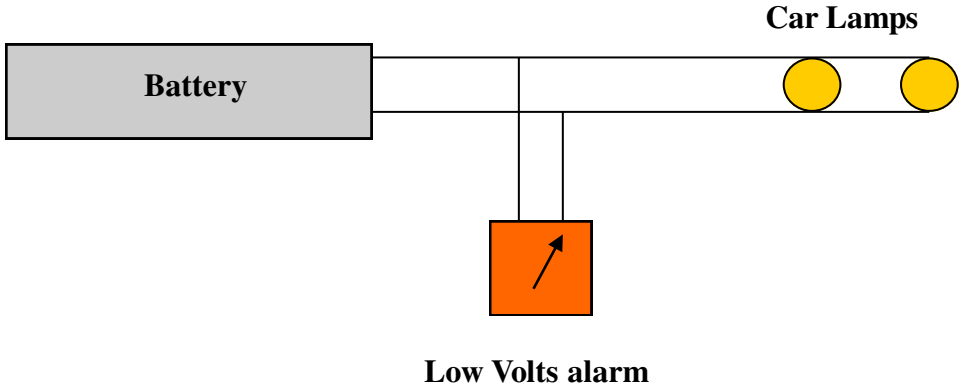
V/Cell	V-3S	%
4.20	12.60	100
4.17	12.51	98
4.13	12.39	95
4.10	12.30	92
4.07	12.21	89
4.03	12.09	86
4 .00	12.00	82
3.96	11.88	78
3.93	11.79	74
3.90	11.70	69
3.87	11.61	64
3.83	11.49	59
3.80	11.40	53
3.77	11.31	47
3.73	11.19	36
3.70	11.10	22
3.66	10.98	12

STORAGE VOLTAGE

Short term any voltage but say above 11v
Even at 12.6 O.K.

Long term around 11.4v

Need to discharge use a charger on storage mode
or
quickly by:



Set Min 3.7v/cell 3S 11.1
Don't leave unattended, only you
can switch off discharge

Charge Safely

CHARGING STATIONS

Metal boxes lined with insulation.
Can use plasterboard

STORAGE STATION

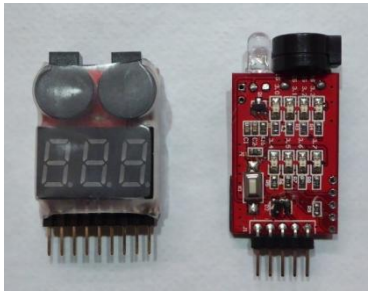
Small box on top (small batteries)

Shelf separators

IN FLIGHT BATTERY CARE

Set timers or use telemetry for battery voltage if TX will support.

Or use simple low level alarm



Or
Transmitter and receive

BEC or UBEC

Battery Eliminator Circuit
Universal Battery Eliminator Circuit

Can be stand alone or incorporated into a ESC

These are voltage converters

Will have voltage in and out rating with current rating
Can be used with IC controls

Output usually 5v or 6v

Input could be expressed as voltage or cells and cell type

Input voltage is normally From – To (Auto Detect)

ESC

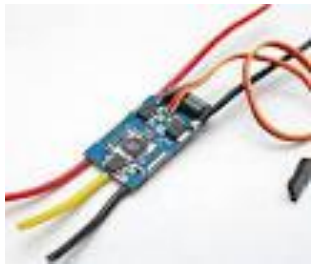
Electronic Speed Controller

Can be Brushed or Brushless motor

Can come with BEC incorporated and also Opto Controlled/Isolated

Units with BEC on earlier units and some low voltage inputs only have linear BEC

Most units now have switching BEC's These can now handle higher voltage input and Current



Typical information:

Current (A)

Voltage input 3S 2-4S 6S Voltage (V) Lipo NiMH

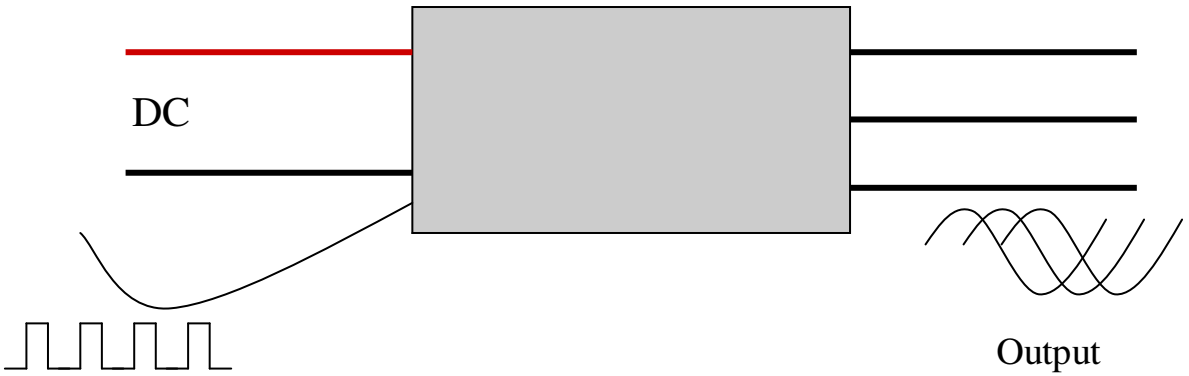
Burst (A) short time Secs ??????

BEC if fitted will have Voltage output and Maximum Current Listed

Controlled same as a servo input.

ESC convert D.C Voltage to a form of 3 Phase AC voltage output

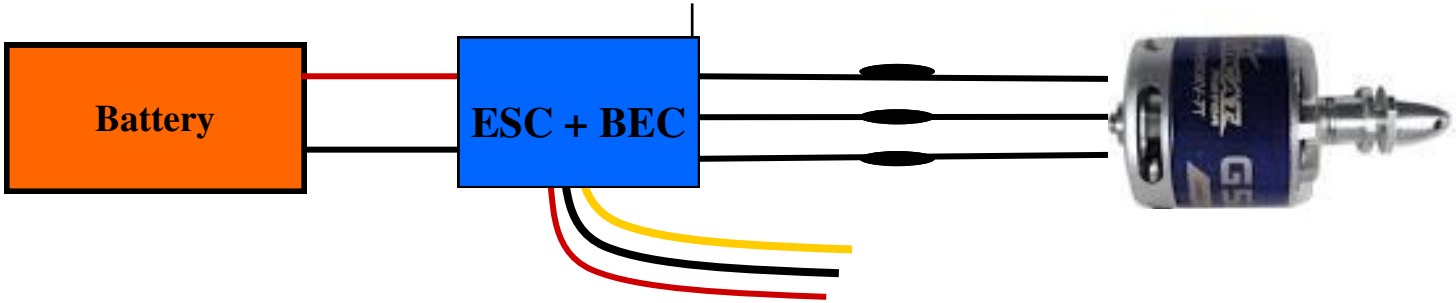
Normally rate them 20% - 30% over maximum expected current.
If expecting current 30A fit 40A



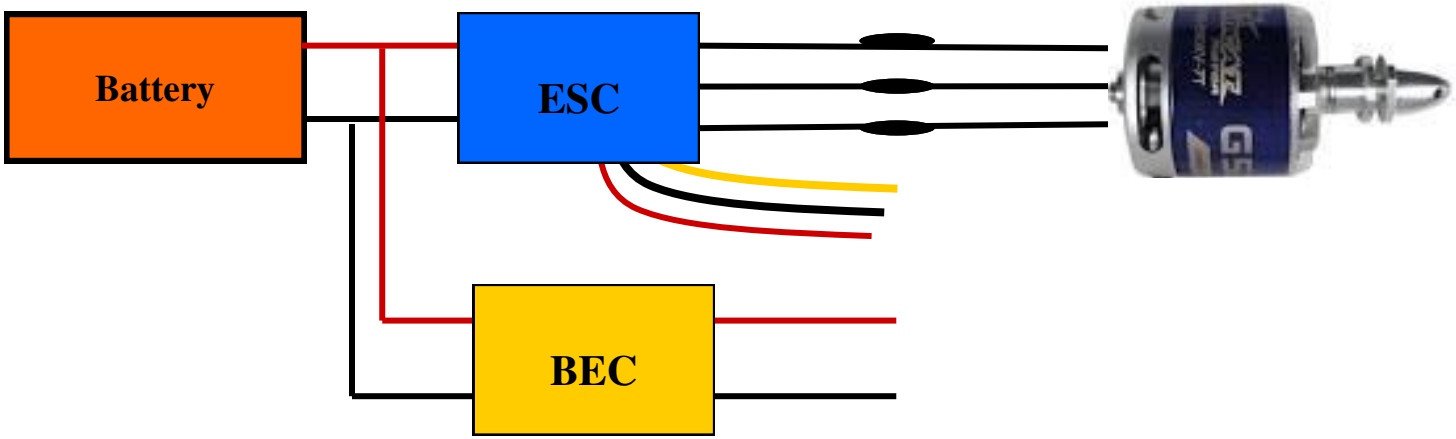
Control Signal In and
Control voltage out 5 or
6 VDC

PWM
Pulse Width Modulation

Basic Circuit ESC and Combined BEC



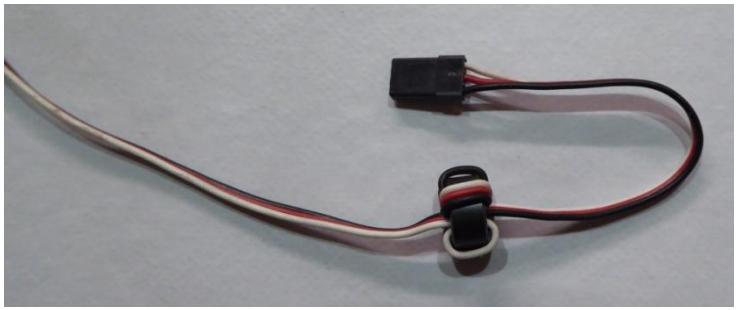
Basic Circuit ESC Separate BEC



Some ESC will have a FERRITE core on the lead this is to help prevent electronic noise generated by the ESC being transferred to other components.

On any electrical circuit if noise is suspected (jittery servo or receive) try a ferrite core.

Wrap wire around 3 or 4 times



ESC TYPICAL CONTROLS

Can be change via Transmitter or Programme card

All will have default setting in instruction manual

1.User programmable brake setting (recommend using brake for only folding props applications)

2.User programmable battery type(LiPo, NiCd or NiMH)

3.User programmable low voltage cut off setting

4.User programmable factory default setup restore

5.User programmable timing settings (to enhance ESC efficiency and smoothness)

6.User programmable soft acceleration start ups (for delicate gearbox and helicopter applications)

7.User programmable governor mode(for helicopter applications)

8.User programmable motor rotation(clockwise\counter clockwise)

9.User programmable switching frequency

10.User programmable Low voltage cut off type (power reduction or immediate shutdown)

TRANSMITTER

·**Phrases 2 Programming**

After 3 seconds, the controller will start beeping a sequence of tones – a musical tone followed by one or more beeps. Each sequence represents a parameter that you can program and is repeated 3 times. The parameters are:

♪—

Music Tone + 1

Beep

Options 1. Cell Type and No. of Cells

♪— —

Music Tone + 2

Beeps

Options 2. Throttle Setting

♪— — —

Music Tone + 3

Beeps

Options 3. Brake Setting

♪— — — —

Music Tone + 4

Beeps

Options 4. Direction and Cutoff Type

♪— — — — —

Music Tone + 5

Beeps

Options 5. Timing Mode

♪— — — — — — -

Music Tone + 6

Beeps

Option 2. Throttle Setting ♪— —

•• — 2 Short + 1 Long Auto Throttle Range *

•• — — 2 Short + 2 Long 1.1ms to 1.8ms

•• — — — 2 Short + 3 Long Hard Acc*

•• — — — — 2 Short + 4 Long Soft Acc

Option 3. Brake Setting ♪— — —

••• — 3 Short + 1 Long No Brake

••• — — 3 Short + 2 Long Soft Brake*

••• — — — 3 Short + 3 Long Medium Brake

••• — — — — 3 Short + 4 Long Hard Brake

Option 4. Direction and Cutoff Type

♪— — — —

•••• — 4 Short + 1 Long Clockwise Rotation *

•••• — — 4 Short + 2 Long Counterclockwise Rotation

•••• — — — 4 Short + 3 Long Soft Cutoff

•••• — — — — 4 Short + 4 Long Hard Cutoff *

Option 5. Timing Mode Setting

♪— — — — —

••••• — 5 Short + 1 Long 1º - For 2-4 Pole Inrunner Motors *

••••• — — 5 Short + 2 Long 7º - For 6-8 Pole Motors

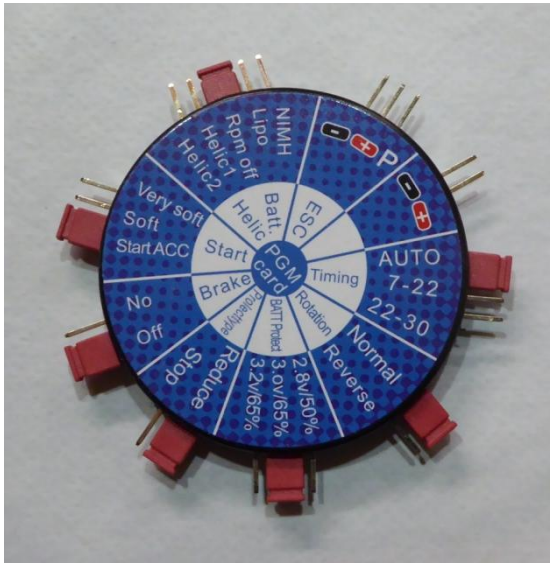
••••• — — — 5 Short + 3 Long 15º- For 10-14 Pole Outrunner Motors

••••• — — — — 5 Short + 4 Long 30º - For 10-14 Pole High-RPM Outrunner Motors

PROGRAMME CARD

Easy way

Different types
Each are for there own group of ESC’s



Select the setting you want, connect a motor + ESC and supply and setting are transferred. Simple

ESC low voltage cut off setting

Where this is present' normally supplied to either reduce motor power output or shut off motor at a percentage of input voltage

Lets assume it has a cut out to protect over discharging a battery at 3,2Volts per cell (73%). With a full battery (3S) 12.6V reduced motor power output or shut off motor will occur at around 9.6V or 73% Discharge **Just safe!**

If we disconnect the battery between flights or start off on not a fully charged Battery what will happen. The cut off will still be 73% discharge.

BUT!!!!!!

If the Voltage at start is now 11.8V the cut off will be 8.6V

One Duff Battery and possible other damage

MOTORS

Two common types

Brushed or Brushless

Brushed Type now mainly in Cars

Brushless mainly Aircraft

These fall into two common groups Inrunner and Outrunner

and

Brushless Outrunner is now far the most Common in flying

These are generally more flexible in use and produce more torque

Outrunner.....Outside of motor rotates and contains magnets (shown above)

Inrunner .....Centre rotates and contains magnets(usually less)

More power can be produced by design.

Motor is better balanced as rotating case and magnets are easier to manufacture to tolerance as opposed to magnets on a rotating core and less likely to come loose.

Some motors better efficiency than others. 72 - 82% Typical

Outrunner v Inrunner

Outrunners

- Low RPM's, high torque
- Less efficient than inrunners
- No gearbox required
- Narrow prop selection
- Silent

Inrunners

- High RPM's, low torque
- More efficient than outrunners
- Require a gearbox
- Wide prop selection
- Noisy

MOTOR FAILURES

Mechanical: Usually bent shafts. I try to buy where possible motors with 5mm shafts.

Bearings sometime after a bump.

Electrical: Nearly always due to over temperature.

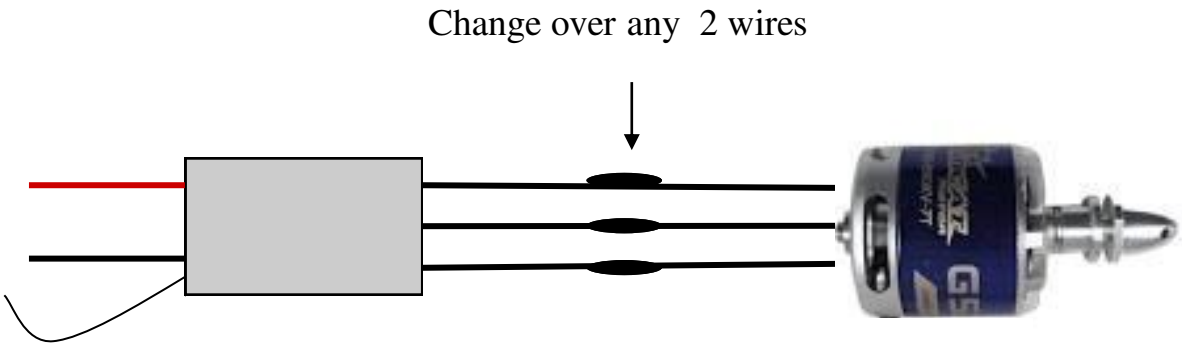
Reasons:

Over powering.

Over temperature due to lack of cooling.

Heat weakens magnet in turn producing more heat,
Can lead to very quick burn out.

Reversing a Motor



Some ESC’s also can reverse direction electronically

SIZING

Information is getting better

You get some but also some contradiction

A motor given as 2840 is likely to be case size, the bigger the size the more power.

If you look at power rating this could be nominal peak or made up you can see this if weight is given.

You cannot get a quart out of a pint pot!!!!

You get information? operates on 3 or 4 S ?

O.K for 9x6 to 13x7 props

It's a 400 or 450 motor

WHAT WE ARE AFTER

The kV is expressed as revolutions per volt applied So a 1400kV motor will rotate at 1400 rpm @ 1V and 14000rpm @ 10V offload.
 Assume 3S nominal voltage 11,1 + 15540 RPM no load.
We have to understand this will be lower on Load expect around -10%

Max Current (A)
Power (W)
Voltage V May be giver as 3-4s not really import in most cases

Expected prop size performance
9x6 200W?
11x7 350W?

Weight

Key Bits
Power, Current and if correct prop data.

What we might assume from data

3 – 4S Any other data could be for operating on either voltage

Prop 9x6 - 11x4 Possible 9x6 on 4S 11x4 on 3 S

Power 340W could be anything

If we have current (A) Say 30A this will be the maximum

So 30A x 3S 11.1 V = 333W Near enough!
If 30A x 4S 14.8 this would be 444W So Wattage based on 3S

<u>This is why if scratch building you need a Wattmeter</u>

We could also run this motor on 6S, it would need to be a very small prop sized to stay within wattage. It would scream and we would need to find a prop capable of the RPM to remain safe.

MOTOR ARE VERY FLEXIBLE

What Prop size, is a case of how noisy or what size looks good on a given plane and will it produce enough power.

Big prop vintage planes?

We can get more loading (W) buy increasing prop diameter or ratio or altering the applied voltage.

We can get the reverse if we go the other way.

We can also reduce the speed RPM by loading or reducing voltage.

We don't have to use all the power we may just need the weight up front (Scale Models).

We can use it to Pull or Push a plane we can use a CW or CCW Prop

Do we what Speed or Torque or both.

You can change bearing and shafts.

Wattmeter

This one can measure: Volts, Amps running and peak, Watts, RPM
Voltage each cell, battery tester, Servo Tester and more.

WATTMETER BENCH SET UPS

On static bench running it is the same as a I.C. engine the loading will be 10-15% higher.

So maximum bench set readings for Power or Current can be higher as this will reduce when moving through the air.

PROP SELECTION AND TYPES

Their limit is their structural strength, running them at higher RPM risks losing a blade.

APC Suggested RPM Limits:

1.Glow Engine and Speed 400 Electric Props Maximum RPM=190,000/prop diameter (inches)

2.Thin Electrics and Folding Electric Props - Maximum RPM=145,000/prop diameter (inches)

3.Slow Flyer props - Maximum RPM=65,000/prop diameter (inches)

4.Racing Props 8.75 N,W and 8.8 series 40 Pylon props - Maximum RPM=225,000/Prop diameter (inches)

For example, a 10" Slow Fly prop should be limited to 65,000/10 = 6500RPM

ANOLOG OR DIGITAL SERVOS

Signal and motor normally same

Digital quicker response on small movements, bigger price

PWM changed inside to give frequency response and more initial torque, so initially quicker response?

Fingers are slow for speed, digital would be best for reducing dead band and for gyro control?

Ripmax New Power XL-09HMB Servo

Specifications:

- Weight: 11g
- Torque (6.0v): 3.5kg
- Torque (4.8v): 3.0kg
- Speed (6.0v): 0.10 secs 60deg
- Speed (4.8v): 0.12 secs 60deg
- Gear Type: Metal
- Dimensions: 23.2 x 12 x 24.8mm
- Bearings: Ballrace
- Voltage Range: 4.8v – 6.0v

Identical to the regular 09HMB version but with real, digital holding power.

- Weight: 11g
- Bearings: Ballrace
- Dimensions: 23.2 x 12 x 24.8mm
- Gear Type: Metal
- Speed (4.8v): 0.12 secs 60deg
- Speed (6.0v): 0.10 secs 60deg
- Torque (4.8v): 3kg.cm

Need A Power Cheap Switch To Control Light Or Other Component

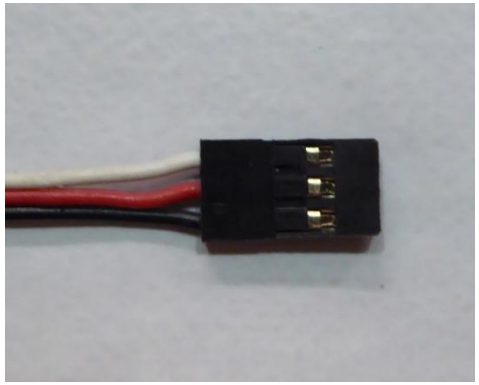
Use a servo, disconnect the motor output is 5 or 6v

Current : as rating of servo. Need a high current connect to a relay.

Switch it via a normal channel.

Servo size. i.c. big for vibration not just load?

Connector only good for 3A and come from electronic industry.



My thinking, if I think I need a 3kg servo at 1:1 cm ratio, would the control surface support 3 X 1kg bags of sugar without breaking.

HOW MUCH POWER DO I NEED

How much power do we need?

The simplest approach to figuring power systems in electrics is input watts per pound of "all up" airplane weight. The following guidelines were developed before brushless motors were common but it seems to hold pretty well so we will use it regardless of what kind of motor is being used.

25 W/lb = minimum for level flight, with a reasonably clean plane.
50 W/lb = Trainer/Casual/scale flying
75 W/lb = Sport flying and sport aerobatics
100 W/lb = aggressive aerobatics and mild 3D, effortless loops from level flight.
150 W/lb = all out performance.
200 W/lb = Unlimited high-speed vertical flight.

There's a slight addition to that:
For 3D flight you need thrust as well as power. Ideally at least 1.5 times the AUW

For a ducted fan you need something like 1.5 to twice the power of a prop, because ducted fans don't work well at low speeds.

Deltas really need at least thrust equal to their weight, or you can get 'stuck' with the nose up at low altitude with no way to gain speed.

Gliders obviously don't need any power :-)

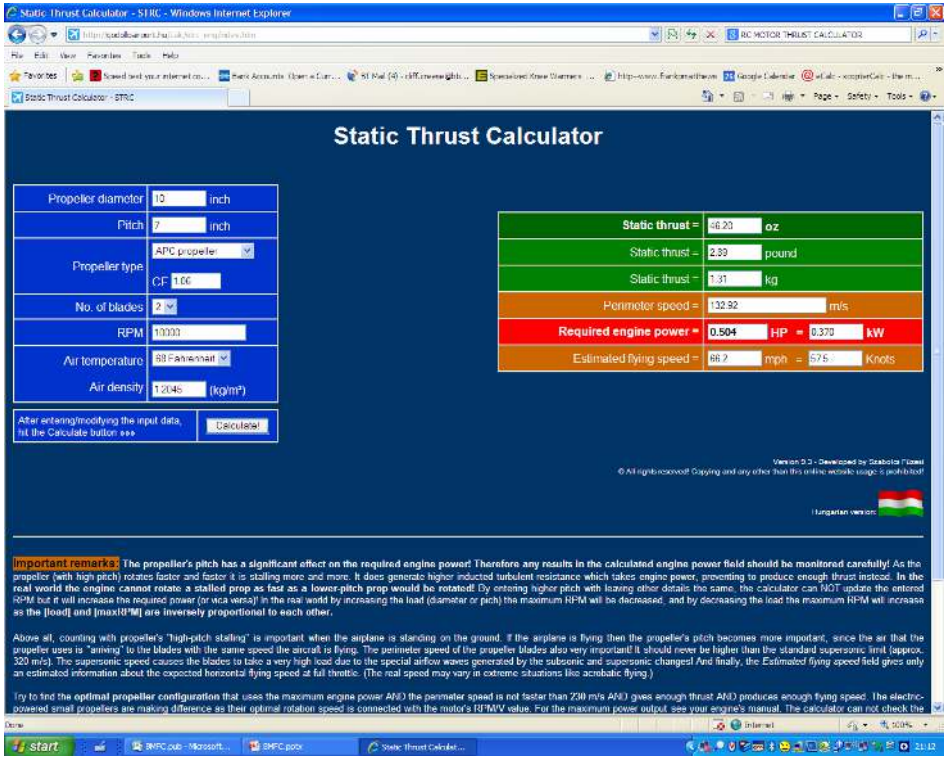
ON LINE CALCULATORS

calculators for everything

Motor powers to weight, thrust, prop size, battery capacity required, esc etc

MASSES

CHECK SEVERAL



Typical of standard 1200mm foam models

Propeller diameter	10 inch
Pitch	7 inch
Propeller type	APC propeller CF 1.06
No. of blades	2
RPM	10000
Air temperature	68 Fahrenheit
Air density	1.2045 (kg/m³)
After entering/modifying the input data, hit the Calculate button »»»	Calculate!

Static thrust =	46.20 **oz**
Static thrust =	2.89 pound
Static thrust =	1.31 kg
Perimeter speed =	132.92 m/s
Required engine power =	**0.504 HP = 0.370 kW**
Estimated flying speed =	66.2 mph = 57.5 Knots

Hard to compare i.c. to electric motor sizes

Not all 1600cc car engines perform the same!

⚠ Which electric motor is equal to what glow engine?

Q) How do you tell which Electric Motor is equal to what Glow Engine?
A) One of the biggest confusions for most people selecting an electric motor is, "What is a watt?" The glow guys are used to horsepower and electric power systems are measured in watts.

(1 hp = 746 watts or about 750 watts)

Don't go by the max rating for HP that engine manufacturers publish. That is a MAX figure and very seldom is an engine for sport use operated at that figure. The h.p. drops off quite a bit when the RPM is not at the rated figure which is usually around 16,000 RPM's or greater.

Glow Engines vs. Electric Motors

1. ♠ **.20-size glow engine / 300w electric motor**
2. ♠ **(OS Max 0.20 engine develops 0.4 hp = 300w electric motor (AXI 2820))**
3. ♠ **.35-size glow engine / 500w electric motor**
4. ♠ **(Fox 0.35 stunt engine develops 0.7 hp = 522w electric motor)(AXI 2826)**
5. ♠ **.40-size glow engine develops 1.0 hp = 750w electric motor (AXI 2826 or 4120)**
6. ♠ **.60-size glow engine develops 1.3 hp = 975w electric motor (AXI 4120 or 4130)**
7. ♠ **.90-size glow engine develops 1.6 hp = 1200w electric motor (AXI 5320 or 4130)**
8. ♠ **1.20-size glow engine develops 3.0 hp = 2250w electric motor (AXI 5330)**
9. ♠ **DA-50 develops 5.0 hp = 3750w electric motor (AXI 5330)**
10. ♠ **DA-100 develops 9.8 hp = 7311w electric motor (Double AXI 5330)**

See E-flite Park 400 and Power 60 series that mimic replacement sizes for old brushed motors and glow engines.
http://www.gregcovey.com/Glow_Conversions_Made_Easy.htm

Himax Brushless Motors

HC50 Outrunner 800-1500 Watts HC50 - These motors are for large models weighing 6-8Lb for 3-D flight, 8-15Lb for aerobatic flight and 10-20Lb for leisure flight.
• **Gas equivalent - .46 - .90**

HC63 Outrunner 1700-2200 Watts HC63 - These motors are for large models weighing 10-12Lb for 3-D flight, 17-22Lb for aerobatic flight and 22-30Lb for leisure flight.
• **Gas equivalent - 1.20 - 1.80**

http://www.maxxprod.com/mpi/mpi-2601.html

Chart to ele to Ic

Engines give different power to CC depending on type/make

Motors less so

Most 3s 2200 fly 1.5kg /3lbs to 2.5kg/ 5 Lbs all up weight planes.

RUNNING HIGHER VOLTS BY DESIGN

Small cables, smaller esc, smaller lighter motors etc.

Planes have less all up weight, cheaper to make more profit margin!!!

Alternately put a bigger battery in and fly a bigger or heavier plane, you pay the price of the battery, the manufacturer is selling a cheap plane.