# ELECTRIC FLIGHT SYSTEMS

## Part I
## SYSTEMS COMPONENTS

# . . . But first a few important electrical concepts

***'The hydraulic analogy'***

- **Volts**
  - Think of volts as being similar to water pressure.
- **Amps**
  - Think of amps as being similar to water volume.
- **Watts**

  Volts X Amps = Watts

# Basic components of an electric flight system

- Motor
- Electronic Speed control
- Batteries
- Propeller or ducted fan

# Brushless Motors

- **Two basic types:**
  - **Inrunner and outrunner**

# Inrunner motors


- Magnets mounted on shaft and spin inside can
- Better in tight spaces
- Typically higher RPMs – smaller props/EDF
- Typically more efficient
- Typically more expensive
- Can be mated to gearbox to change kv

# Outrunner motors


- Magnets on can – outer case spins around shaft
- More torque – larger props
- Fixed kv
- Typically lower RPM
- Typically less efficient
- Typically less expensive
- More popular right now

# MOTOR RATINGS

- KV
  - Unloaded rpm/volt
    - Example: 1000kv @ 11.1v = 11,100 rpm w/ no propeller
    - The actual rpms drop as you load up with prop
  - Relative KV numbers more important than actual number
    - A higher KV motor will spin faster than a lower kv motor on the same voltage and will either take a smaller prop or will draw more amps on the same prop.
- Maximum Amps  Maximum Volts
- Maximum Watts  Io (internal resistance)

# ESC
# Electronic Speed Control


- chops up current to act as a throttle

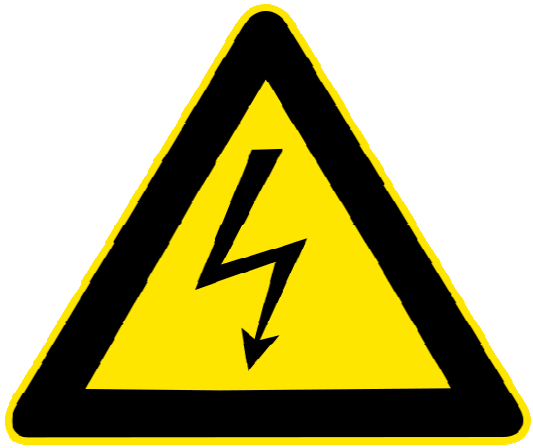
- Typical components
  - Battery leads one side - motor leads on other
  - 'Throttle' plug to receiver
  - BEC (Battery Elimination Circuit) on circuit board

# ESC Ratings

- **Amps**
  - **plan to use max 75% of rated amp capacity or plan provide good cooling airflow**
- **Volts (cell count)**
- **BEC – linear, switching, opto**

# Common ESC Misconceptions

- I can use the transmitter throttle end-points to keep the system within its amp limits
- The ESC works hardest and generates most heat at full throttle



# BEC

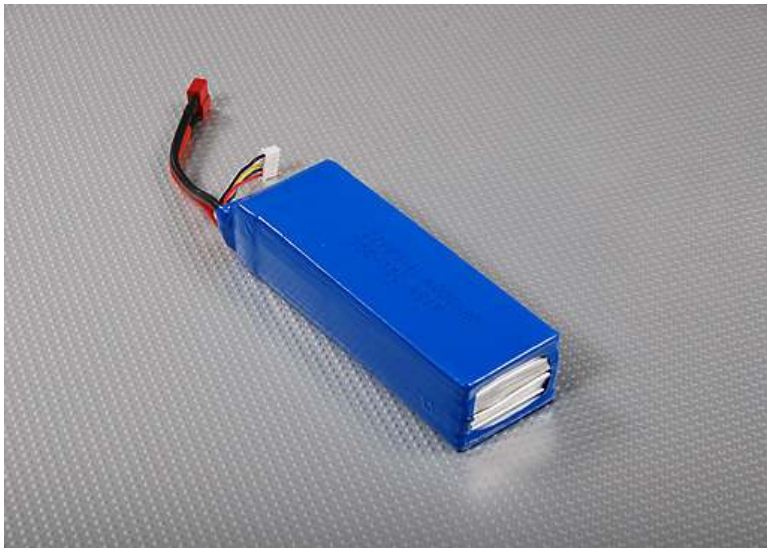
- **Steps-down voltage of main battery to power receiver & servos**
  - **Replaces receiver pack**
- **Can be built-in to an ESC or external**
- **Rated by volts-in and amps/volts out**

# BEC types

- Linear
  - More heat
  - fewer servos
  - Cheaper
- Switching
  - little heat
  - more servos
  - more interference (if not shielded)
  - More expensive

# Lithium Polymer (LiPo) Batteries

- **Components:**
  - **Cells**
  - **Main power leads**
  - **Balance tap**
    - **Allows charge / discharge of each individual cell**
  - **Shrink wrap**



# (LiPo) Battery Ratings

- **Voltage**
  - **3.7v per cell resting voltage**
  - **4.2v per cell @ full charge**
  - **3.0v per cell @ full discharge**
  - **"S" = the # of cells in series**
    - **Adding cells in series increases the voltage**
  - **"P" = the number of cells in parallel**
    - **Adding cells in parallel increases the Mah**
  - **Example: 3s2p = 3 cells in series x 2 in parallel for 6 cells total.**

# LiPo Battery Ratings - continued

- Mah = milliamp hour capacity
- “C” rating = how fast can the battery release its energy.
  - 1C means the battery can release its total mah of energy in 1 hour.
  - A 30C battery could release its total mah in 1/30 of an hour (2 minutes).

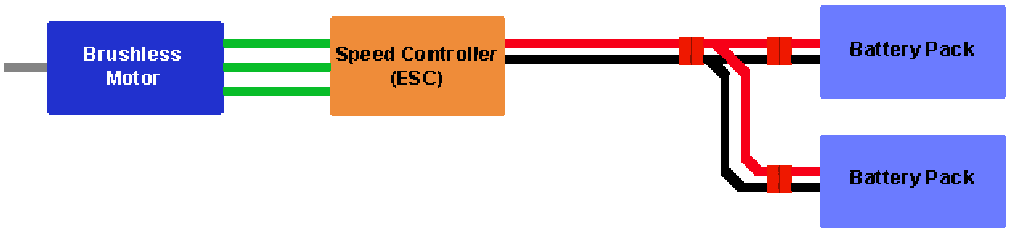
# LiPo Battery Ratings - continued

- "C" rating tells you how many amps you can safely draw from the battery.
  - "C" ratings typically given as 'Continuous" and "Burst"
- C rating X (Mah/1000) = permissible amp draw

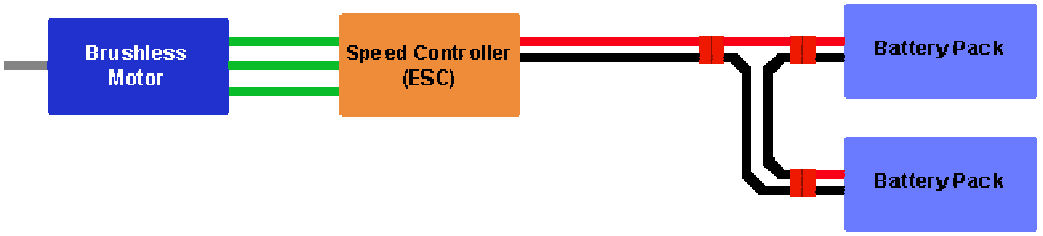
**EXAMPLE:** You can draw 27 amps from a 20C 1350mah battery. 20x(1350/1000) = 27

# Combining LiPo Packs

- Packs can be joined in parallel to increase Mah capacity




- Packs can be joined in series to increase voltage



# Stay Tuned . . .

- **Part II will cover how to select the correct components for your aircraft.**