Electric Flight

An Introduction

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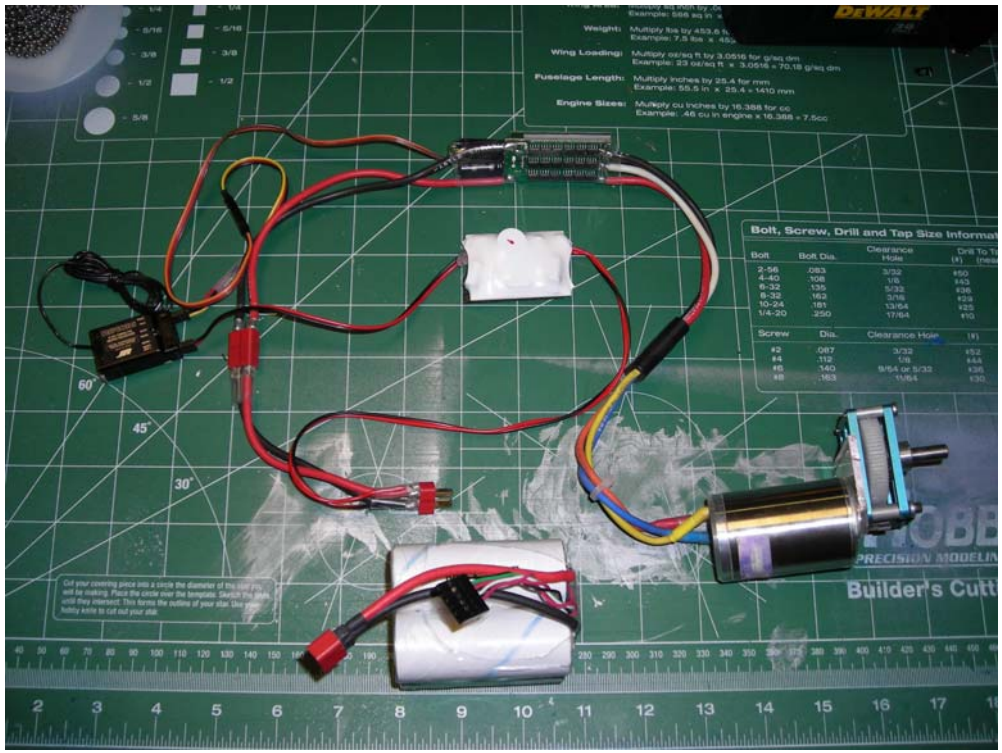
Set up for 40 size and up model airplane

Basic Electrical

- Motor (Brush or Brushless)
- Gearbox
- Electronic Speed Controller (ESC)
- Battery Elimination Circuit (BEC)
- UBEC used if battery pack provides more then 12VDC



Power – Energy per unit time

Power (Watt) = Voltage(V) * Current (Amp)

Tool – Watt Meter

- Show current consumption and voltage for wattage calculation
- Connect in series between batteries and power system

General Rules – Power

- Trainer – Approx 70+ Watts per lbs
- Sport – Approx 100+ Watts per lbs
- Pattern – Approx 120+ Watts per lbs
- 3D/Pattern – Approx 150+ Watts per lbs

General Rules – Wing Loading

- Glider – 12-17 ozs/ft^2
- Floater – Approx. 17-20 ozs/ft^2
- Semi-Symmetrical Wing – Approx. 20-27 ozs/ft^2
- Symmetrical Wing – Approx. 25-30 ozs/ft^2

(Over 30 ozs/ft^2 you are on your own)

Basic Design Rules

- Approx. 100 watt/lb
- Minimum Prop pitch speed around 2.5 times stall speed (50 mph typical)
- Wing loading 30 ozs/ft^2

Design Process

1. Determine the size of the model you want
2. Make sure that model will provide wing loading of less than 30 ozs/ft^2
3. Size the motor/gearbox and battery to meet the 100 watt/lb power requirement
4. Use the biggest prop diameter possible for the model
5. Use the prop that will provide pitch speed of at least 2.5 times stall speed
6. Iterate steps 3,4,5 several times until the motor is sized correctly

Batteries

- NiCd – Mostly Obsoleted
- NiMh
- LiPo
- LiMn – EMoli (Milwaukee V28)
- LiFe – A123 (DeWalt 36V nano-phosphate)

NiMh

Advantages - High current @100+ Amp capable. Quickly replaced by LiPo as LiPo becoming suitable for High Current Application

Disadvantages – High Leakage (compare to LiPo)

Typical Applications – Hot Liner

LiPo

Advantages –

- High Energy Density
- Low leakage

Mismanages –

- Volatile Chemistry (cannot be overcharged or over-discharged)
- Need Low voltage cutoff (LVC) on ESC to prevent over discharge
- Easily damaged in crash and handling
- Expensive compares to other chemistry
- Shelf Life of approx. 3 years

LiFe (A123 Dewalt)

Advantages –

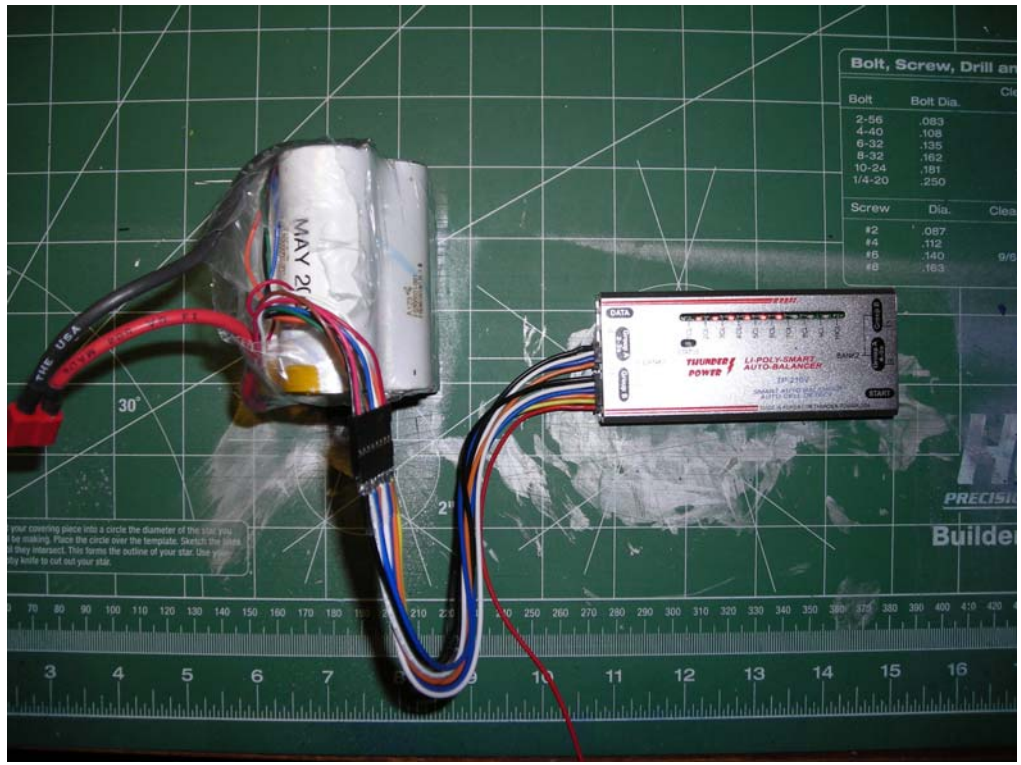
- Lithium chemistry without the LiPo safety concern.
- Can tolerate (within reason) over charge better than LiPo
- Can tolerate over discharge (within reason) without damaging the cell
- Low leakage
- Long cycle life
- Robust handling

Disadvantages –

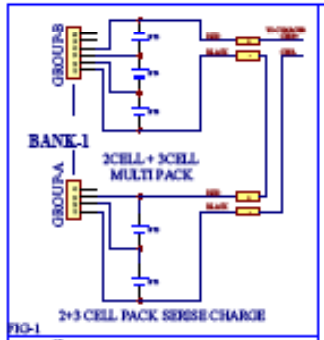
- Heavy (2.7 oz per cell)
- Low capacity

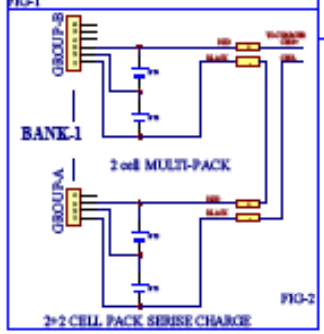
Balancing Li Chemistry Batteries

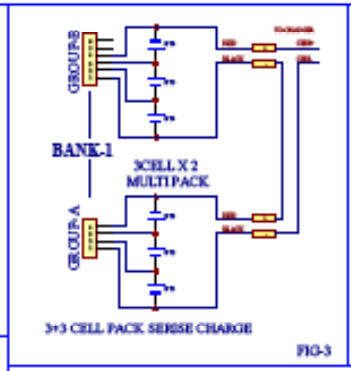
When cells in series are charged to different level, some cells may go below LVC and cause damages. Balancing is to assure all cells in series are at the same voltage level.

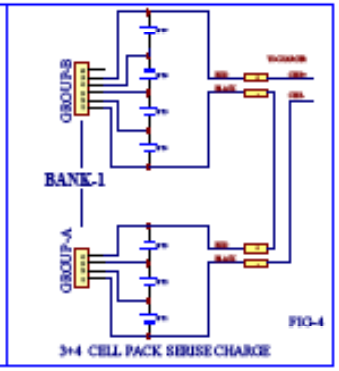


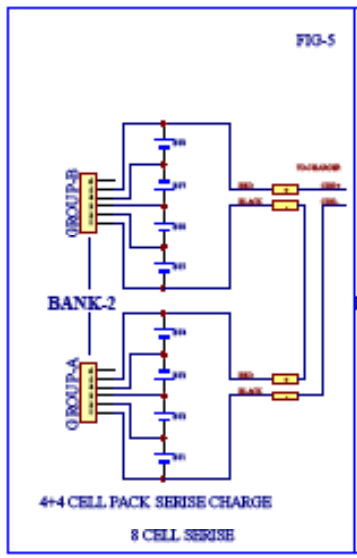
TP-210 LiPo Balancer Pack connection diagram

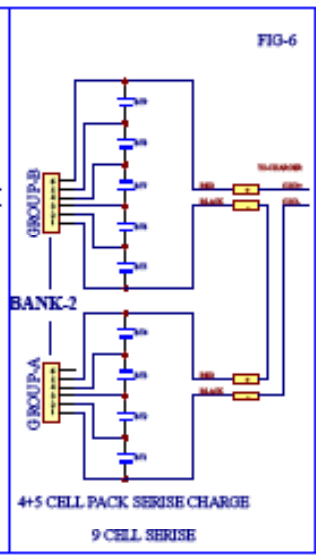


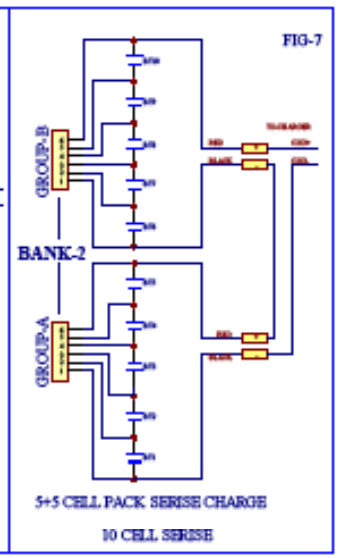












A123


RECYCLE ME
1-800-8-BATTERY
DEWALT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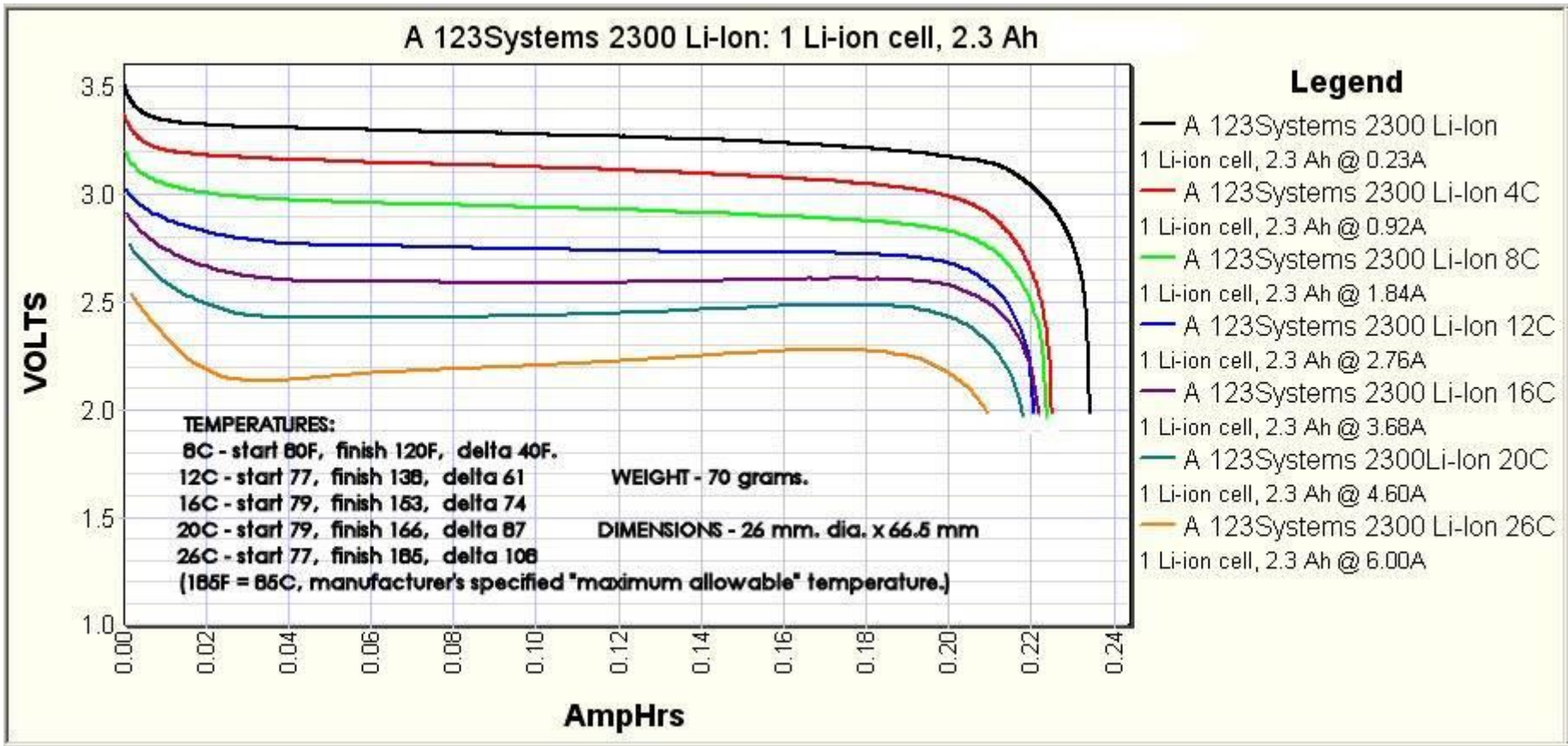
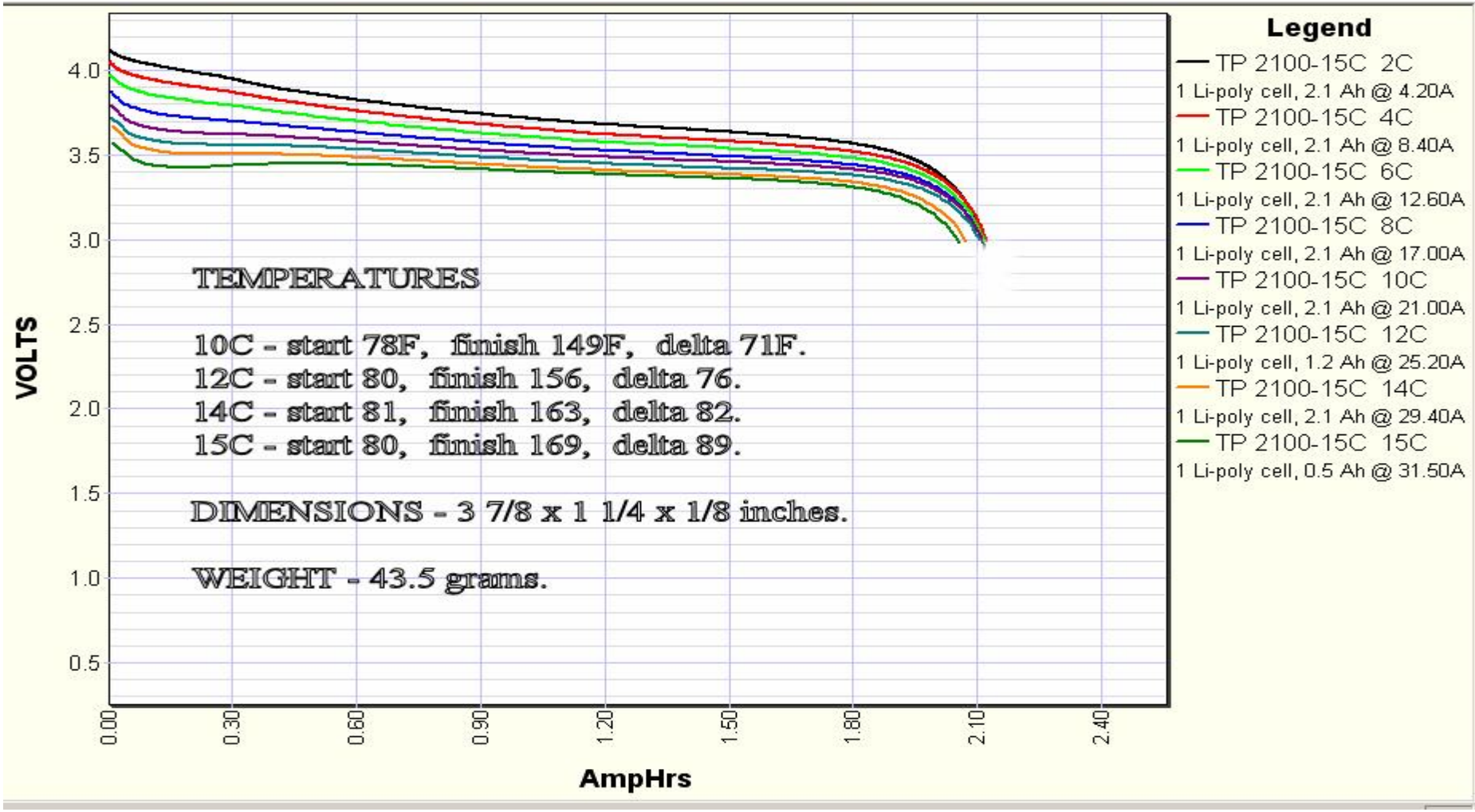
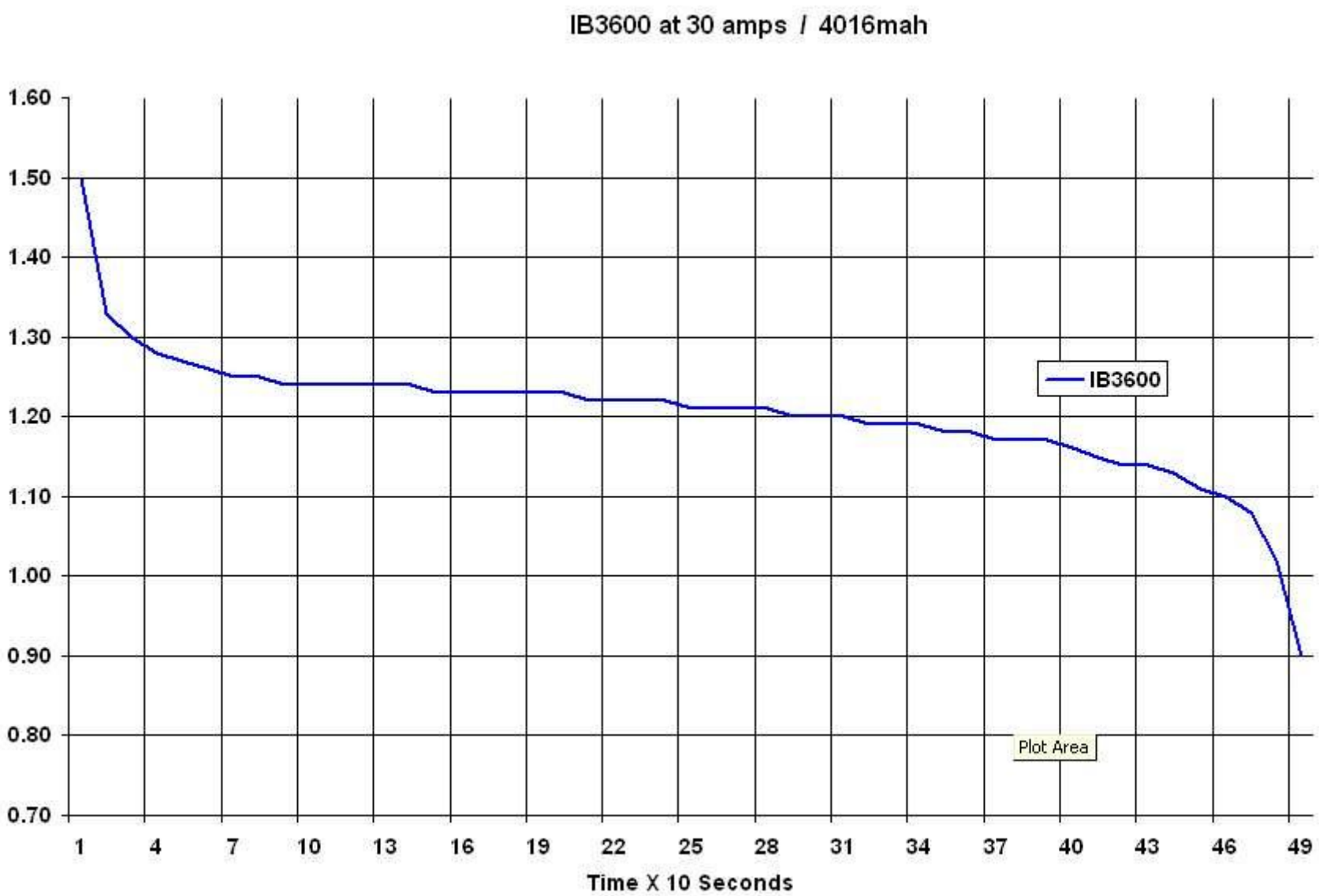
1-800-8-BATTERY
DEWALT

Typical Discharge graph for A123 (courtesy RD Blakeslee @ ezonemag.com)



Typical Discharge graph of LiPo (Courtesy RD Blakeslee @ ezonemag.com




IB3600 at 30 amps / 4016mah
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
Time X 10 Seconds
IB3600
Plot Area

	NiMh	LiPo	LiFe (A123)
Current Limit	100C +	20C	20C
Charge mechanism	Constant current	Constant voltage Current limited	Constant voltage Current limited
Charge Termination	Peak Detection	Voltage reaches 4.2V per cell	Voltage reaches 3.6V per cell
Cycle life	150	150	1000
Energy Density	Med	High	Med
Usable Cap.	80%	80%	95%
Leakage after charge	10% first day 15-20% first week	1-2% first month	1-2% first month
Discharge	No low limit but should not completely discharged	3.2V per cell Open circuit	2.5V per cell Open circuit

Typical data 4300 mah pack @ 10V measured @ 10C (43 Amp) (High current Low voltage)

	NiMh	Lipo	LiFe (A123)
Configuration	10 cells	3S	4S2P
Typical Wt.	20 ozs	8 ozs	22 ozs
Typical Cost	$60	$140	$100
Actual Example Package	IB4200	TP4300	A123 from Dewalt 36V pack
Actual Voltage Under Load	11V	10V	10.5V
Actual Usable Capacity	3900 mah	3900 mah	4500 mah

Typical data 2300 mah pack @ 20V measured @ 15C (30 Amp) (Low current High voltage)

	NiMh	Lipo	LiFe (A123)
Configuration	20 cells	6S	7S1P
Typical Wt.	30 ozs	14 ozs	20 ozs
Typical Cost	$120	$140	$90
Actual Example Package	GP2200	TP2100	A123 from Dewalt 36V pack
Actual Voltage Under Load	21V	20V	19V
Actual Usable Capacity	1900 mah	1900 mah	2300 mah

Motor

- Brush-
  - Good Brush motor almost as efficient as Brushless especially at part throttle.
- Brushless
  - In-Runner
    - In general believe to be more efficient than Out-Runner
    - Need gearbox
    - Usually more expensive than Out-Runner
  - Out-Runner
    - Lower cost to manufacture then In-Runner
    - No gearbox needed

Gear Box

- Let motor run at the most efficiently
- For In-runner but applicable for out-runner

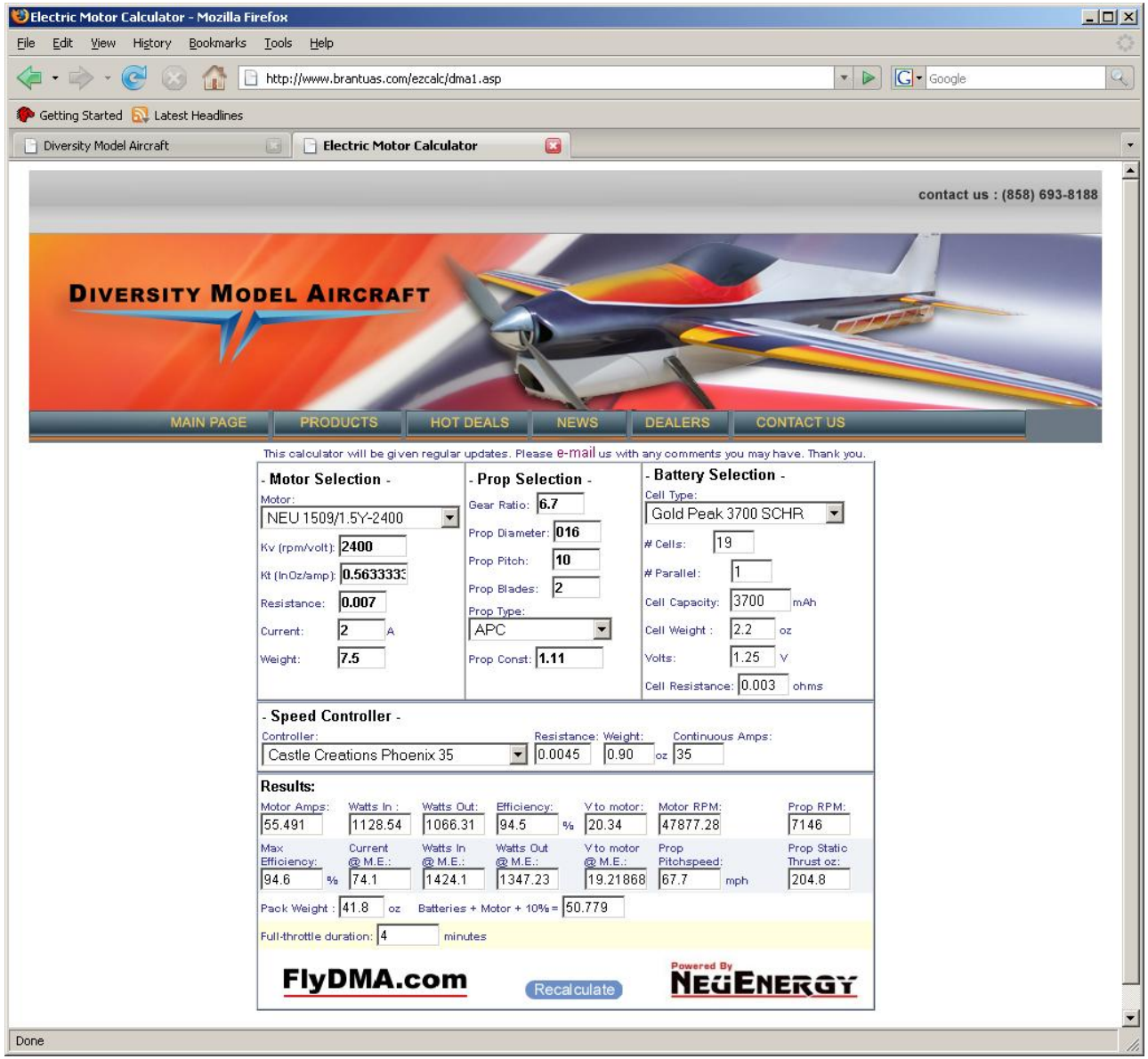
Sizing of Motor

(An Art rather than Science)

- Use one of the motor performance program such as ECalc or MotorCalc
- Use Web calculator such as PCalc

The calculation is only an estimate and you need to use the Watt meter, Tech to get a real picture of your motor

Usually, the Kv and the size of the motor will give you a rough idea



Know your motor

- Kv
- RPM
- Prop
- Number of Cell
- Static Current draw

Venus 40

Wt : 5 lbs 15 oz

Battery : A123 7S1P

Prop : APCE 14x8.5

RPM : 7050

Static Current : 27 amp

Duration : 8 minutes

Input Power : 513 Watt

Statistic : 87 Watt/lb, 24 ozs/ft^2

Hobby Lobby Senior Telemaster

Wt : 11 lbs 12 oz

Battery : EMoli 6S2P

Prop : APCE 16x10

RPM : 6500

Static Current : 46 amp

Duration : 12 minutes

Input Power : 897 Watt

Statistic : 76 Watt/lb, 20.35 ozs/ft^2

Hobbico Twinstar

Wt : 6 lbs

Battery : A234 4S1P x 2

Prop : MA 3 blade 9x7

RPM : Not measured

Static Current : 35 amp

Duration : 8 minutes

Input Power : 330x2 Watt

Statistic : 110 Watt/lb, 25 ozs/ft^2