



# BATTERIES FOR HAM RADIO APPLICATIONS

AUGUST, 2020

MARTIN BUEHRING – KB4MG

# WHY LEARN ABOUT BATTERIES ?

- Batteries of all types are used in our radios and equipment. We should understand them better.
- Portable operation
  - more popular than ever (POTA, SOTA, etc) and depends on batteries
- Having the right battery for the right job is essential to your success
- Doing wrong things with batteries can be very dangerous



# BATTERY TYPES

- Primary batteries
  - Single use, like standard A,C,D, 9volt size alkaline cells
  - Not rechargeable and must be discarded
- Secondary batteries
  - Rechargeable cells with more complex chemistries and structures
  - Different recharging profiles, based on the chemistry used





# CONSIDERATIONS FOR THE RIGHT BATTERY

- Is the need for portable operation of base station backup?
- If I am operating portable, will it be close to my vehicle or a distance away?
- What are the requirements for the power I need for the period I want to operate?
- If my application is for EMCOMM, what backup considerations may I need for power shortages or complete loss of power?

# Battery Technology Comparison

Specifications	Lead-Acid	NiCd	NiMH	Li-Ion		
				Cobalt	Manganese	Phosphate
Specific energy density (Wh/kg)	30 – 50	45 – 80	60 – 120	150 – 190	100 – 135	90 – 120
Internal resistance (mΩ/V)	<8.3	17 – 33	33 – 50	21 – 42	6.6 – 20	7.6 – 15.0
Cycle life (80% discharge)	200 – 300	1,000	300 – 500	500 – 1,000	500 – 1,000	1,000 – 2,000
Fast-charge time (hrs.)	8 – 16	1 typical	2 – 4	2 – 4	1 or less	1 or less
Overcharge tolerance	High	Moderate	Low	Low	Low	Low
Self-discharge/month (room temp.)	5 – 15%	20%	30%	<5%	<5%	<5%
Cell voltage	2.0	1.2	1.2	3.6	3.8	3.3
Charge cutoff voltage (V/cell)	2.40 (2.25 float)	Full charge indicated by voltage signature	Full charge indicated by voltage signature	4.2	4.2	3.6
Discharge cutoff volts (V/cell, 1C*)	1.75	1	1	2.5 – 3.0	2.5 – 3.0	2.8
Peak load current**	5C	20C	5C	> 3C	> 30C	> 30C
Peak load current* (best result)	0.2C	1C	0.5C	<1C	< 10C	< 10C
Charge temperature	-20 – 50°C	0 – 45°C	0 – 45°C	0 – 45°C	0 – 45°C	0 – 45°C
Discharge temperature	-20 – 50°C	-20 – 65°C	-20 – 65°C	-20 – 60°C	-20 – 60°C	-20 – 60°C
Maintenance requirement	3 – 6 months (equalization)	30 – 60 days (discharge)	60 – 90 days (discharge)	None	None	None
Safety requirements	Thermally stable	Thermally stable, fuses common		Protection circuit mandatory		
Time durability				>10 years	>10 years	>10 years
In use since	1881	1950	1990	1991	1996	1999
Toxicity	High	High	Low	Low	Low	Low

Source: batteryuniversity.com. The table values are generic, specific batteries may differ.

\*\*“C” refers to battery capacity, and this unit is used when specifying charge or discharge rates. For example: 0.5C for a 100 Ah battery = 50 A.

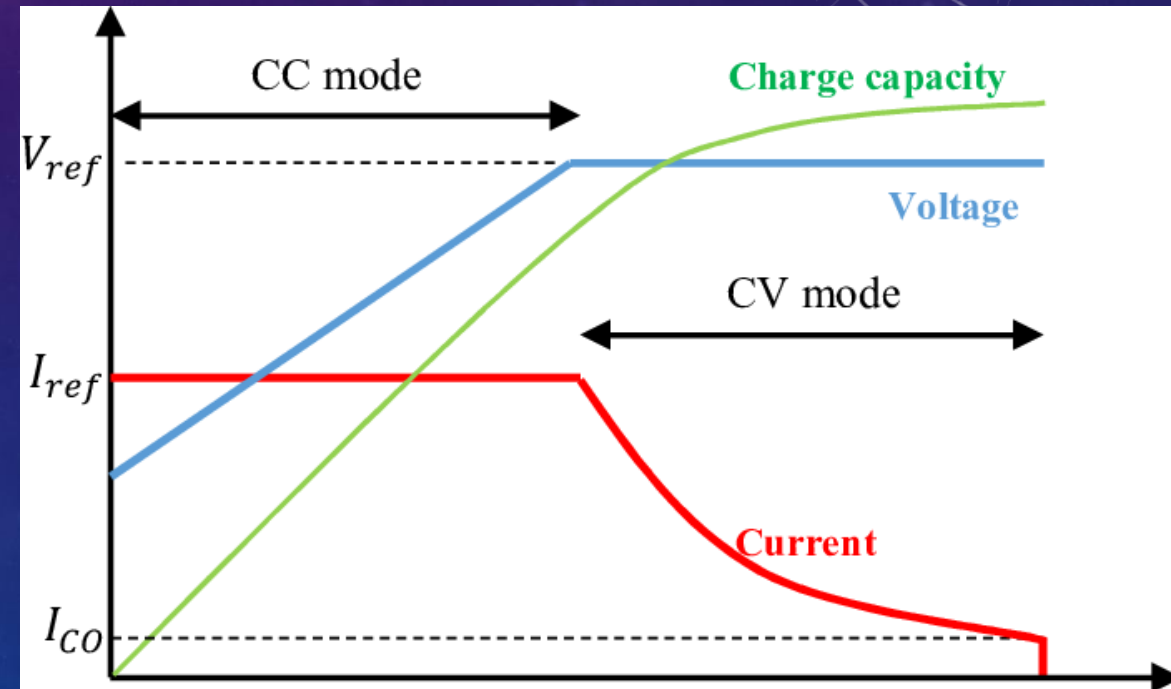
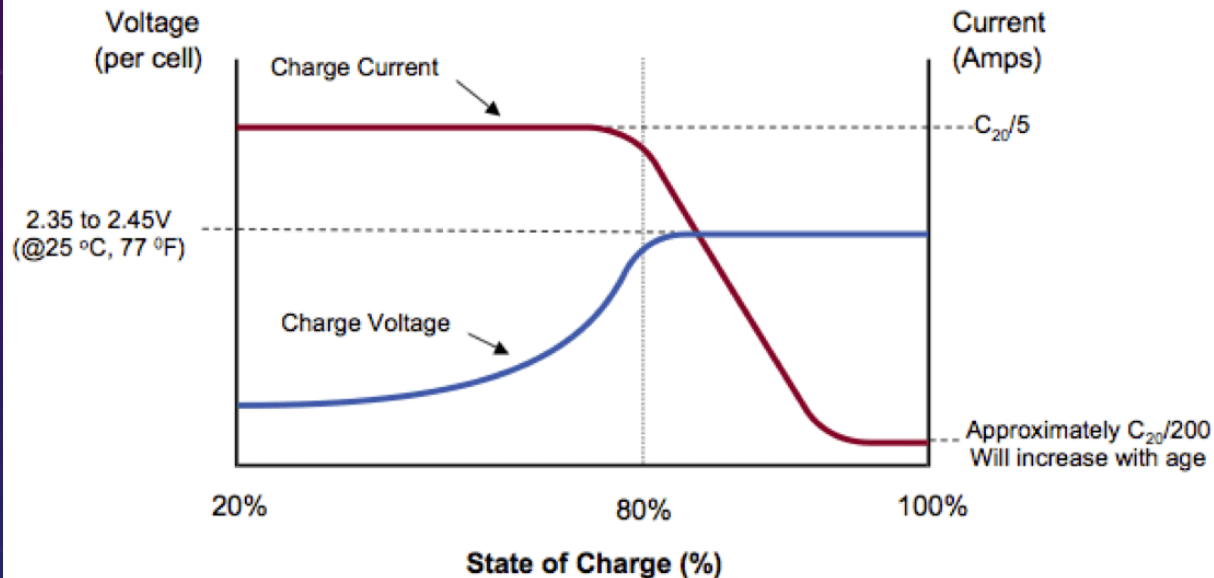
\*\*Peak load current = maximum possible momentary discharge current, which could permanently damage a battery.

# CHARGING PROFILES = DIFFERENT CHARGERS NEEDED

AGM (Sealed Lead-Acid)

Lithium Ion

## Recommended Trojan AGM Charging Profile





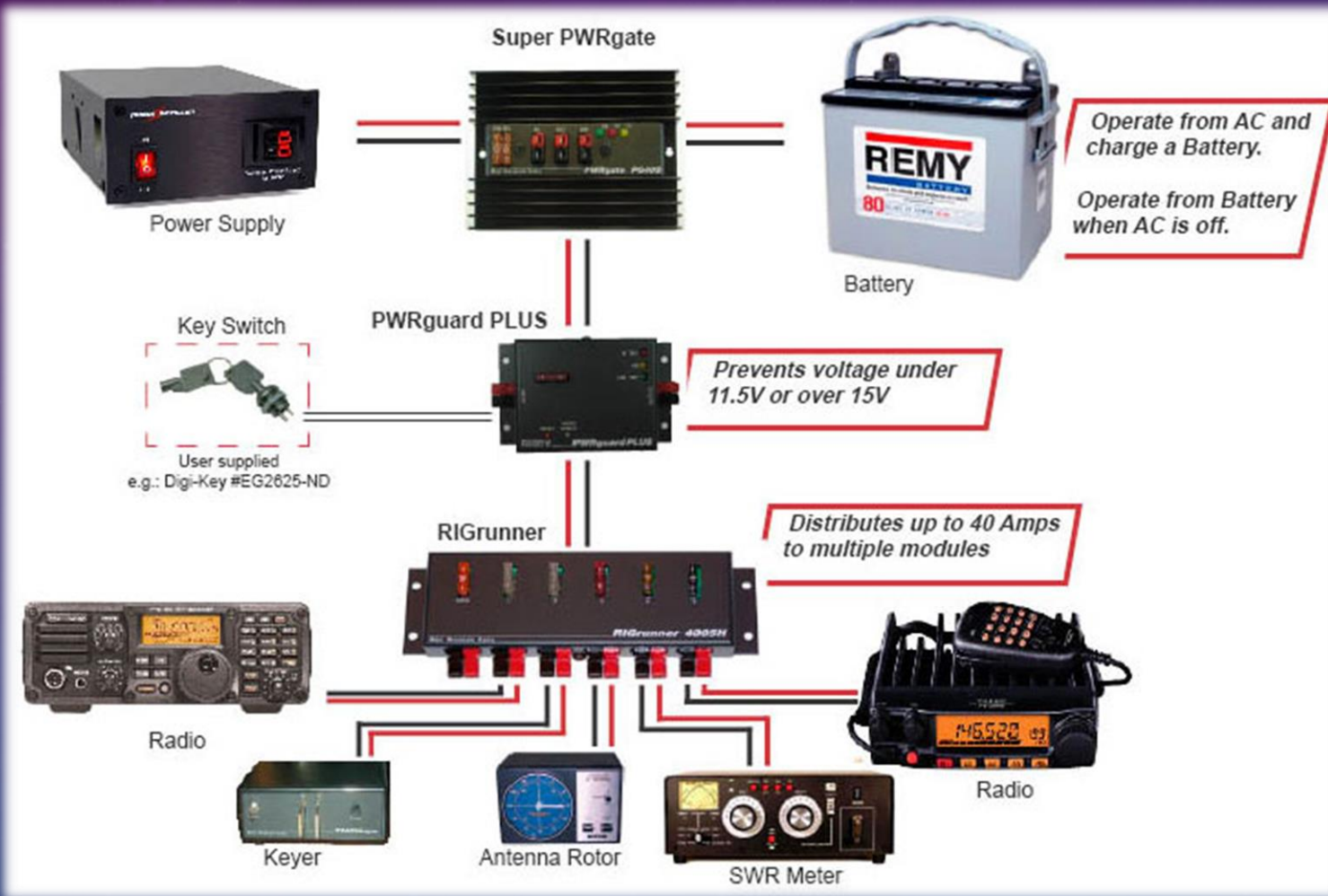
# FIXED STATION LOCATION – BACKUP SYSTEM

- For fixed stations
  - Standard SLA and AGM batteries are well suited for capacity and cost reasons
  - Marine batteries may be used as well and provide deep cycle capability
- Recommend you have a power gate device to switch the power during a blackout.
  - Protects your equipment and the battery
- Use Anderson Power poles on everything



West Mountain PWRgate

# POSSIBLE CONNECTIONS WITH THE BATTERY





## PORTABLE OPERATION – NEAR BY

- Similar to the fixed location recommendations
- Use a “battery box” for easy transport and safety!
- Use a power guard to protect your equipment from undervoltage (and overvoltage)
- Li-Ion works well for all field operations, and is much lighter weight
- Anderson Power Poles on everything



# PORTABLE OPERATION – LONG DISTANCE

- SOTA and POTA can be cases where weight is one of the most important considerations
- Size your battery for the current draw for your rig and the duration of operation (example will follow)
- Addition of a small foldable solar panel can extend your operating time

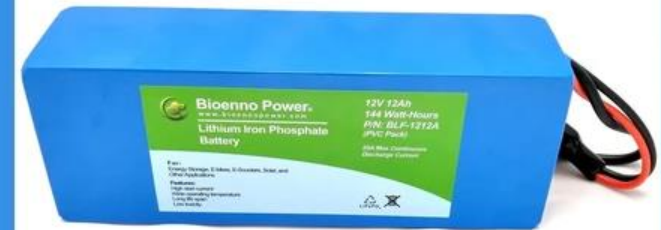
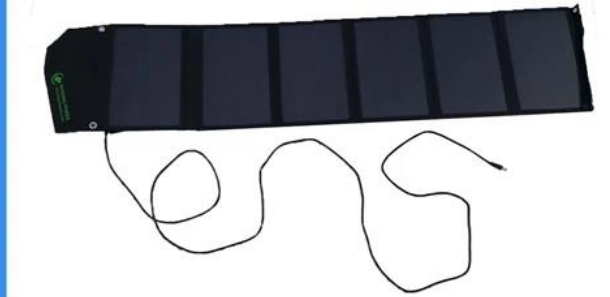
Bioenno Power BLF-1212A LiFePO4 Battery

Peak Pulse Current: 40A (2 sec.)

Max Power Delivered to Load at 12V: 240 Watts ( $12V \times 20A = 240 \text{ Watts}$ )

Dimensions:(L x W x H) 8.5 in. x 2.2 in. x 3.1 in. (215 mm x 56 mm x 79 mm)

Weight: 3.3 lbs. (1.5 kg)

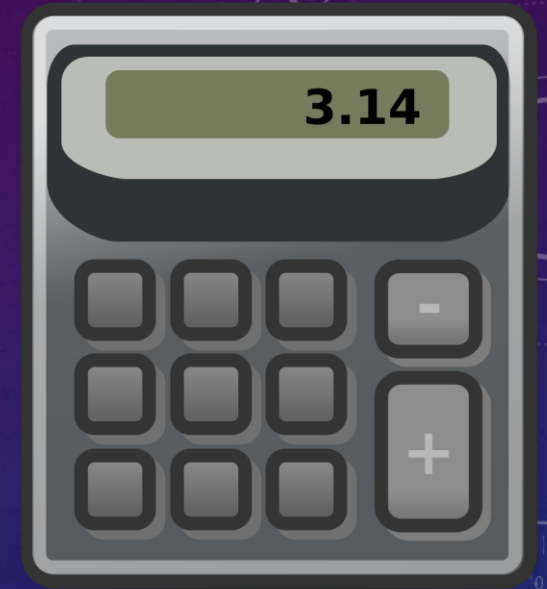


# CALCULATE WHAT YOU NEED

- Check the manual for your rig and see what the current draw is for receive and transmit
  - My ICOM 7300 is 0.9 A for receive and could be 21A on transmit. For field ops you may not run a full 100w, so this value will go down for transmit.
- The battery is rated in Ah (Amp-hours). For example, a 12Ah battery should, in theory, supply 12Amps for 1 hour straight. It is generally less than that, depending on the battery type.
  - Note some battery types do not like to be deeply discharged
- Consider the “duty cycle” of your operations and mode.
  - Assume 50% receive and transmit as worse case (1/2 the time is listening)
  - For different mode the transmit duty cycle varies the mode you use: *(ref W1RFI book on RF Exposure)*
    - CW is 40%, based on average dots and dashes
    - SSB is way less at 20% for average speech
    - Digital mode are the worst at 100% duty cycle



# HYPOTHETICAL BATTERY OPERATION



- Assume a 4 hour desired operation time or deployment
- Rig uses 0.9A on receive and 9A on transmit for about 50 Watts RF
- Assume 50% receive and 50% transmit time. For receive you will use  $0.9A \times 4 \text{ hours} \times 50\% = \mathbf{1.8Ah}$
- For transmit it is more complex. Let's assume CW operation. For transmit you must multiple the transmit current, the duty cycle of the mode, and the duty cycle of your operation
  - $9A \times 4\text{hours} \times 40\% \text{ (for CW)} \times 50\% \text{ (for operation time)} = \mathbf{7.2Ah}$
- With this scenario you need at least a battery with **9Ah** capacity.
- To be sure you are covered, add another 20% capacity.  $9Ah + 20\% = \mathbf{10.8Ah}$

# MANUFACTURES CHART

BIOENNO POWER 20/80 STANDARD DUTY CYCLE FOR MOBILE TRANSCEIVER (Compatible with all 12V Mobile Radio Transceivers)							
TRANSMIT (W)	RECEIVE (W)	TOTAL (W)	MODEL	VOLTAGE (V)	CAPACITY (AH)	CAPACITY (WH)	RUNTIME (HOURS)
5	5	5	BLF-1203W/A/AB	12	3	36	7.2
			BLF-12045W	12	4.5	54	10.8
			BLF-1206A/AB	12	6	72	14.4
			BLF-1209A/AS/WS	12	9	108	21.6
			BLF-1212A/AB/AS	12	12	144	28.8
10	5	6	BLF-1203W/A/AB	12	3	36	6
			BLF-12045W	12	4.5	54	9
			BLF-1206A/AB	12	6	72	12
			BLF-1209A/AS/WS	12	9	108	18
			BLF-1212A/AB/AS	12	12	144	24
			BLF-1215A/AS	12	15	180	30
20	5	8	BLF-1206A/AB	12	6	72	9
			BLF-1209A/AS/WS	12	9	108	13.5
			BLF-1212A/AB/AS	12	12	144	18
			BLF-1215A/AS	12	15	180	22.5
			BLF-1220A/AS	12	20	240	30
25	5	9	BLF-1206A/AB	12	6	72	8
			BLF-1209A/AS/WS	12	9	108	12
			BLF-1212A/AB/AS	12	12	144	16
			BLF-1215A/AS	12	15	180	20
			BLF-1220A/AS	12	20	240	26.7
50	5	14	BLF-1209A/AS/WS	12	9	108	7.7
			BLF-1212A/AB/AS	12	12	144	10.3
			BLF-1215A/AS	12	15	180	12.8
			BLF-1220A/AS	12	20	240	17.1

50 watts, 12Ah  
Bioenno LiFePO4  
10.3 Hours

# CAUTIONS FOR USING BATTERIES

- Use the correct wire size (gauge) for the peak current you expect
- Follow conventional color coding. Black = negative -, Red = positive +
- Take all possible precautions to never short out a battery!
- Be certain you have the correct charger for your battery type. Wrong chargers can damage a battery , or worse.
- Adding batteries in parallel can be dangerous and cause damage if not done correctly. Follow the manufactures instructions

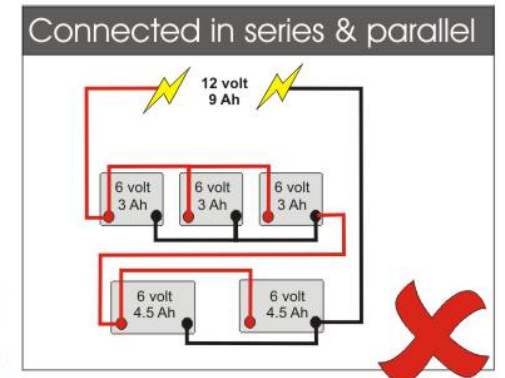
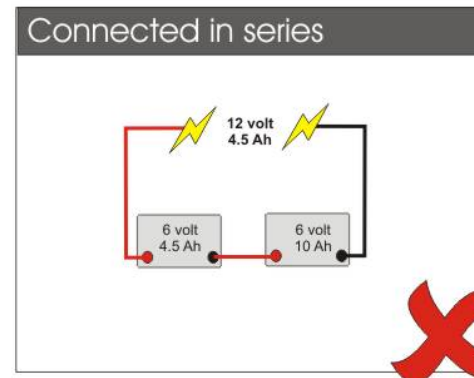
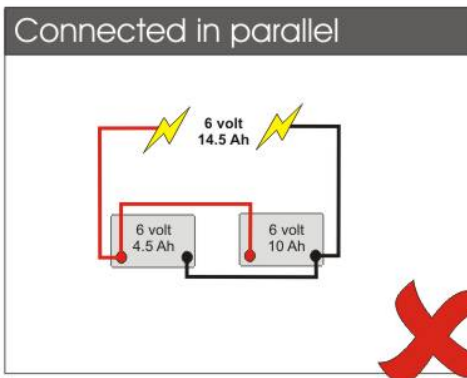
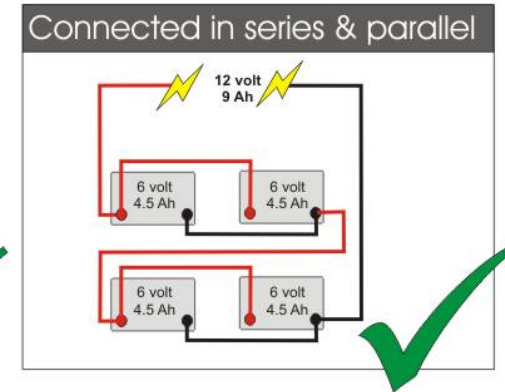
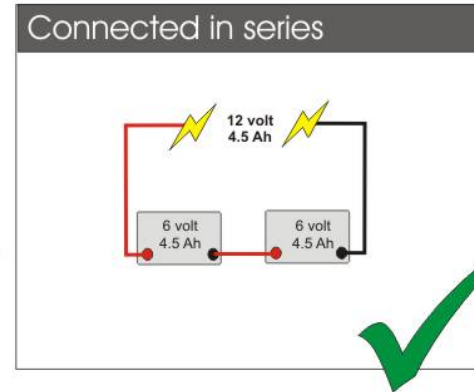
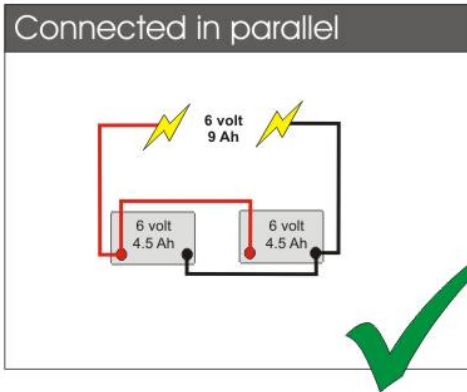


# THE DO'S & DON'TS

- Never connect batteries of different voltages!
- Never connect batteries of differing Ah ratings
- Never mix batteries of different chemistries!
- Best not to even mix batteries from different brands
- Not recommended to mix batteries of different ages
- LiFePO4 batteries may have special considerations. Check with the manufacturer

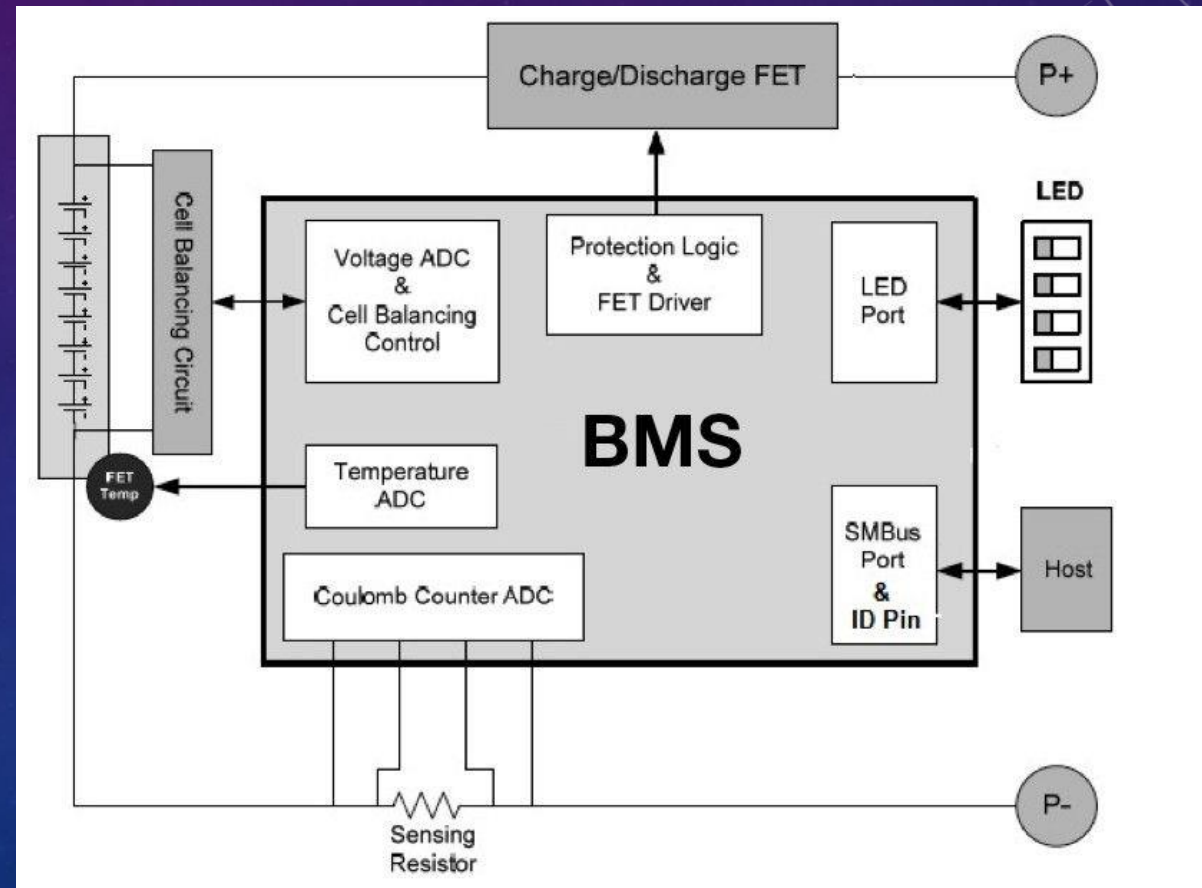
## The BatteryGuy.com Knowledge Base

Results of wiring batteries in parallel and series



# LITHIUM BATTERIES MUST HAVE A BMS

- Lithium batteries have special considerations for:
  - Charging
  - Excessive discharge
  - Cell balancing
  - Over temperature





# CONCLUSIONS

- Consider what you need your battery to do and chose the type and capacity accordingly
- Use the recharger that the manufacturer recommends. You can avoid damaging the battery, or worse
- Isolate your battery from your expensive radio equipment with a proper protection device for voltage and current.
- Always exercise safety measures and don't violate the basic rules
- Batteries are a great thing for the amateur radio operator, but we have to understand them better than most people

