VIBS 2019: PYS Presentation

Choosing the Right Battery for your Boat

By Jeff Cote

Pacific Yacht Systems Inc.

design • installation • service • support

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Passion for Boating

- Systems Design Engineer
- Owner/operator of Pacific Yacht Systems
- NMEA & ABYC certifications
- Published monthly columns
  - Pacific Yachting Magazine: Tech Talk
  - Northwest Yachting Magazine: Hot Wire
- Proud Owner: 36’ Sailboat
- Favorite BC cruising grounds are Barkley Sound and the Broughton Archipelago

About Pacific Yacht Systems Inc.

- Specialize in marine electrical and electronics
- Servicing the British Columbia and Western Canada
- Worldwide electrical design / consultation
- 2018 Recap:
  - Completed over 1000 boat projects
  - Designed / consulted on over 100 electrical projects
- Over 150 “How To” PYS Videos on YouTube
- www.pysystems.ca for schematics, design info, published articles, etc…

Marine Batteries

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Engine Batteries (AKA cranking battery)

- Used to start the engine
  - E.g. thruster
- Designed to deliver high current for short period of time
- Should be immediately recharged by engine alternator
  - NOT designed to be left uncharged for long periods
  - NOT designed for deep discharge
- Capacity measured in Cranking Amps or Cold Cranking Amps

Example: 8D Engine Flooded LA Battery

- Notice: Fill Caps

Deep Cycle Batteries

- Used to supply power to devices on boat
- Designed for deep discharge over longer time
- Capacity measured in Amp Hours (AHr)

Lead Acid Battery Choices
Two Types

- Flooded Lead Acid
  - Starter
  - Deep-Cycle
  - Dual Purpose
- Sealed Valve Regulated Lead Acid
  - Gel
  - AGM (Absorbed Glass Mat)
  - Carbon Foam AGM (i.e. Firefly)

Flooded Lead Acid Batteries

- Flooded lead acid purchase cost ($)
  - If properly maintained
- Liquid acid electrolyte
- Must use watertight battery box to contain any spilled battery acid
- Maintenance - top up with distilled water only
- Self-discharge of about 15% per month
- Practical available battery capacity about 35%
  - Bulk range: 85% to 50%
  - Example: 600 AHr battery capacity for 200 AHr useable capacity

L16 Flooded Lead Acid

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Gel Batteries

- Gel purchase cost ($$)
- Electrolyte is in gel state
- Sealed Valve Regulated: limited gassing
- No maintenance required
- CAUTION: Easy to overcharge with alternator and charger
  - Need specific gel charge profile
- Self-discharge of about 2% per month
- Practical available battery capacity about 55%
  - Bulk range: 85% to 30%
  - Example: 400 AHr battery capacity for 200 AHr useable capacity

AGM Batteries

- AGM purchase cost ($$)
- Electrolyte is in Absorbed Glass Mat (AGM)
- Sealed Valve Regulated: Limited gassing
- No maintenance required
- Self-discharge of about 2% per month
- Practical available battery capacity about 55%
  - Bulk range: 85% to 30%
  - Example: 400 AHr battery capacity for 200 AHr useable capacity

Example
16 X L16 AGM

Firefly Oasis Batteries

- Carbon foam AGM purchase cost ($$$)
- All benefits of AGM
  - Leak-proof, limited gassing, maintenance-free, faster recharge acceptance rate, limited self-discharge
- **Battery Life: 12 Times of Flooded**
  - **(FF 3600 cycles versus FLA 300 cycles at 50% DOD)**
- **No premature aging at partial state of discharge**
- 2 Sizes: Group 31 and L15+
- Practical available battery capacity about 65%
  - Bulk range: 85% to 20%
  - Example: 300 AHr battery capacity for 200 AHr useable capacity

Firefly Oasis Gr31 & L15+

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Example:
Firefly Oasis Group 31

LiFePO4 Batteries

- LiFePO4 purchase cost (10 X FLA)
- Benefits
  - maintenance-free, fastest recharge acceptance rate, limited self-discharge
- **Battery Life: 12 Times of Flooded**
  - **(LiFePO4 3000 - 5000 cycles versus FLA 300 cycles at 50% DOD)**
- Large selection of battery sizes and voltages
- Holds steady voltage while discharged
- Practical available battery capacity about 80%
  - Bulk range: 100% to 20%
  - Example: 300 AHr battery capacity for 240 AHr useable capacity
- Highest energy density
  - Save space and weight

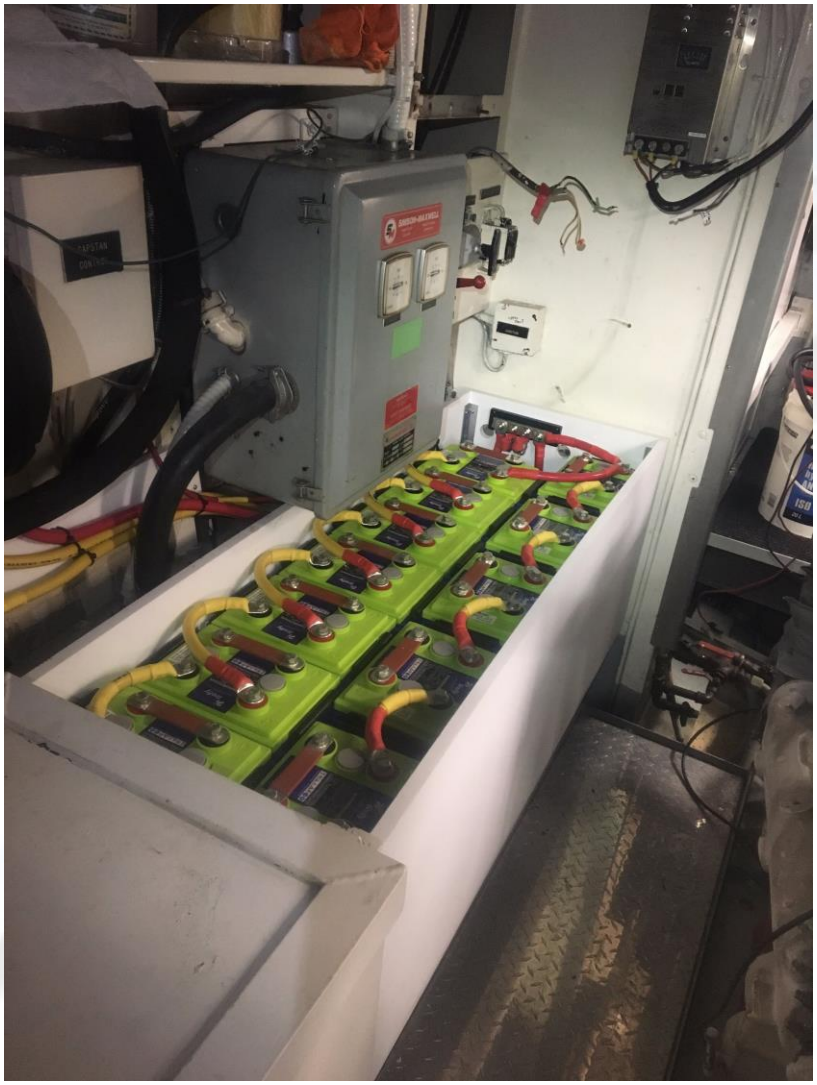
Calculate Your Power Needs

- What is your daily power need?
  - Varies depending on the season, examples:
    - Lights are run earlier in winter
    - Heating in the shoulder and winter season
- Largest DC loads
  - Refrigeration is the largest draw: 50 – 125 Amp-Hour per day
  - Inverter powering AC loads
  - DC loads from running diesel heater (especially hydronic)

Typical Daily Battery Usage

Typical daily AHr budgets	AHr
Beneteau 33	85
Catalina 36	120
Suncruiser 38	225
Grand Banks 42	175
Ocean Alexander 48	375
Meridian 580	500

Firefly L15+ Example



Sizing Battery Capacity

- Criteria to choose your battery bank
  - Daily Amp-Hour (AHr) budget
  - Estimated time between charging? How often do you charge your batteries?
    - Every ½ day
    - Every 2 days

Useable Battery Capacity

- At a minimum, **useable** battery capacity needs to be
  - Daily AHr budget X Estimated time between charging
  - Example: 200 AHrs X 2 days = 400 AHrs of useable battery capacity

Recap:
Lead Acid Battery Floor

BATTTERY "FLOOR"

- To balance battery cost and life, you should never deplete your lead acid batteries below the following capacity:
  - Flooded: 50%
  - AGM/GEL: 30%
  - Firefly AGM 20%
  - LiFePO4 20%

Recap:
Lead Acid Battery Ceiling

BATTERY "CEILING"

- Due **to lead acid battery** chemistry, charging above 85% of capacity (absorption stage) is time-consuming
- **LiFePO4** almost 100%

Recap:
Lead Acid Battery Capacity

USEABLE BATTERY CAPACITY

- Therefore: while cruising effective useable battery capacity is:
  - Flooded: 35% (50% to 85%)
  - AGM/GEL: 55% (30% to 85%)
  - Firefly AGM 65% (20% to 85%)
  - LiFePO4 80% (20% to 100%)

AGM vs Firefly vs Flooded Summary

	AGM	Firefly AGM	Flooded
Initial Cost	$$	$$$	$
Battery Life	1X	**4X**	1X
Useable capacity	55%	**65%**	35%
Maintenance	None	None	Regular top-off
Self-discharge	2% per month	2% per month	15% per month
Purpose	Dual	Dual	Single
Sulfation	Yes	No	Yes

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Sizing your Battery Bank

- Depending on your choice of lead acid battery, you will require the following:

Type	Useable battery capacity
Flooded	3 Times
AGM/Gel	2 Times
Firefly AGM	1.5 Times
LiFePO4	1.25 Times

Sizing your Battery Bank Examples

- Examples, if you need 200 AHr of useable battery capacity, you will require:
  - Flooded: 600 AHr
  - AGM/GEL: 400 AHr
  - Firefly AGM: 300 Ahr
  - LiFePO4: 250 Ahr

Battery Sizes and Types

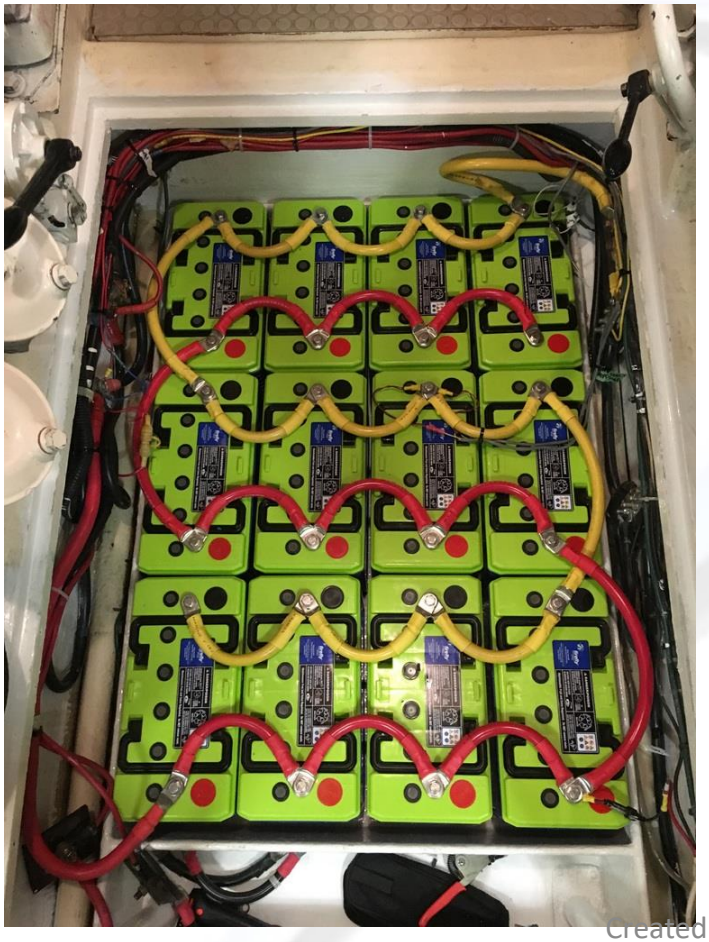
- Batteries come in all sizes
  - Group 24, Group 27, Group 31
  - 4D, 8D
  - Golf Carts
  - Slimline
  - L16

- All battery sizes come in different lead acid types:
  - Flooded , AGM, Firefly AGM, Gel
- Flooded batteries are built specifically for a purpose
  - Starter
  - Deep cycle
  - Dual purpose

Ideal Charge Rate for Batteries

- Importance of sizing **minimum** charge rate to battery size
  - **Minimum: ~ 10% of capacity**
- Reduce your charging time by increasing your charge rate
  - **Maximum: ~ 25% of capacity (AGM/Gel: ~ 40%)**
  - How often to you want to run genset/engine per day?

Battery Install
Firefly Examples

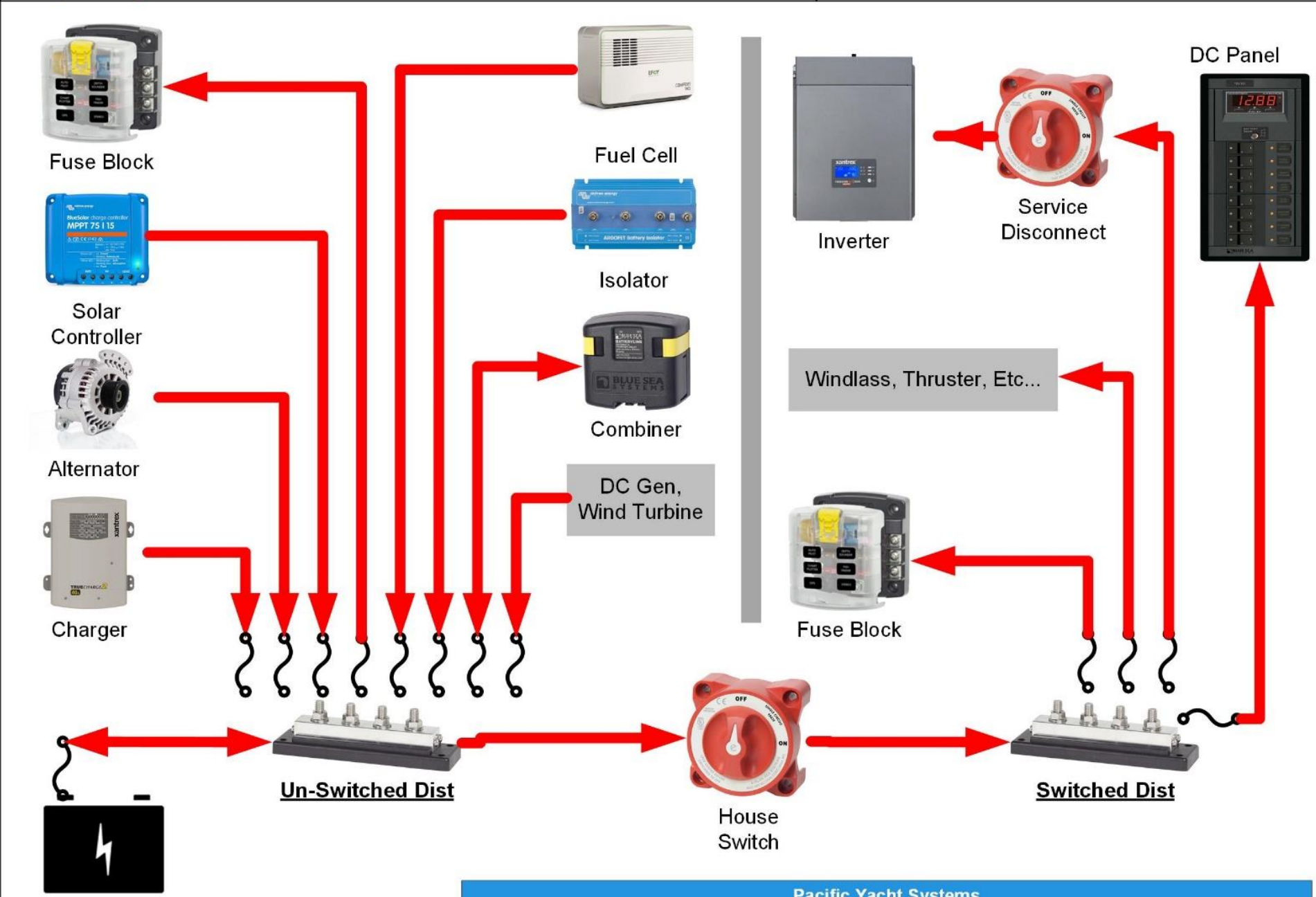


Battery Install
Secured & Contained

Different Charge Methods

- Ways to create power
  - Charger(s)
  - Alternator(s)
  - Methanol Fuel Cell
  - Solar
  - DC Genset
  - Wind Turbine

Conceptual Diagram – DC Overview



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Smart Battery Charger

- Charges batteries from AC shore-power
- **Reduce** the charge time
- Choose the right charge curve
  - Flooded, AGM, Gel, Custom
- Three-phase smart charge cycle:
  - Bulk, Absorption, Float
- Right rate of charge for extended battery life
  - Minimize sulfation

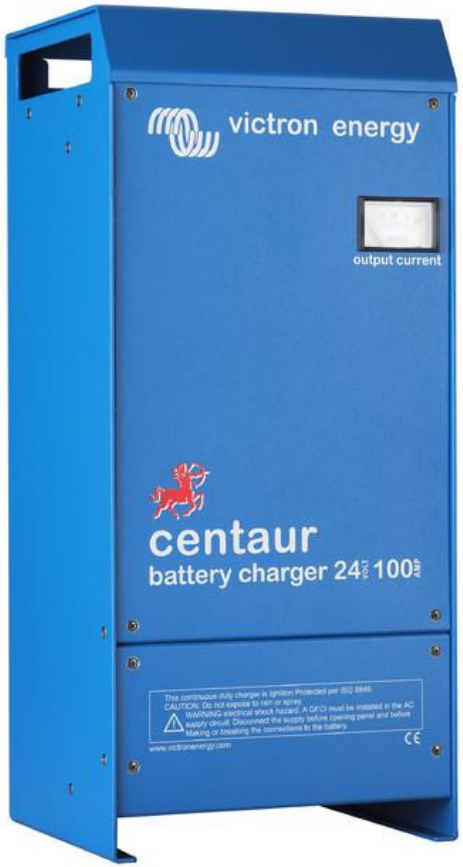
Old vs New Chargers

- Ferroresonant vs Smart Charger

	Ferroresonant	Smart Charger
Rate of charge	Half rated output	Full rated output
Charge curve	Simple	3 stage
Overcharging	Yes - Trickle	No - Float
Battery type settings	Flooded	Flooded, AGM, Gel
Temperature - compensated	No	Yes
Looks	Ugly	Pretty
Weight	Heavy	Light

Smart Charger Application - Multiple Units

- Reduce genset runtime by adding 2nd or 3rd charger in parallel
  - E.g. 1 hour morning and evening
- Charge at the right rate
- Min and Max Charge Rate
  - Flooded: 10% to 25%
  - AGM: 10% to 40%



Questions?

Connect with PYS

- PYS Electrical Orientation for your boat
  - 90 mins: Batteries, DC distribution, charger, alternator, inverter
- PYS Design Services for DIYers
  - Electrical system designed by PYS (collaborative and to marine code)
  - Installed by yourself or other outfit
- Pacific Yachting magazine - Monthly Tech Talk Column
- Northwest Yachting – Monthly Hot Wire Column
- YouTube – 500K Views
- www.pysystems.ca 1000s of articles
- Monthly email newsletter

Pacific Yacht Systems

marine electronics & electrical

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