

2016 Singlehanded TransPac Seminar on Power Management

The Scottish CPA's Guide to Cheap Boat Wiring

Bob Johnston, SHTP Class of 2006

J/92 “Ragtime!”



Hanalei Bay (2006 SHTP)



Yanmar 1GM10 (9 h.p.)



Typical 1-2-Both-Off Rotary Battery Switch

“Make before break”

Must combine (All/Both) for charging from alternator, then remember to isolate one battery after charging

Effectively uses only half your house bank (if two deep-cycles), since one battery is always isolated



Rags' Main Fuse Panel (Wow)



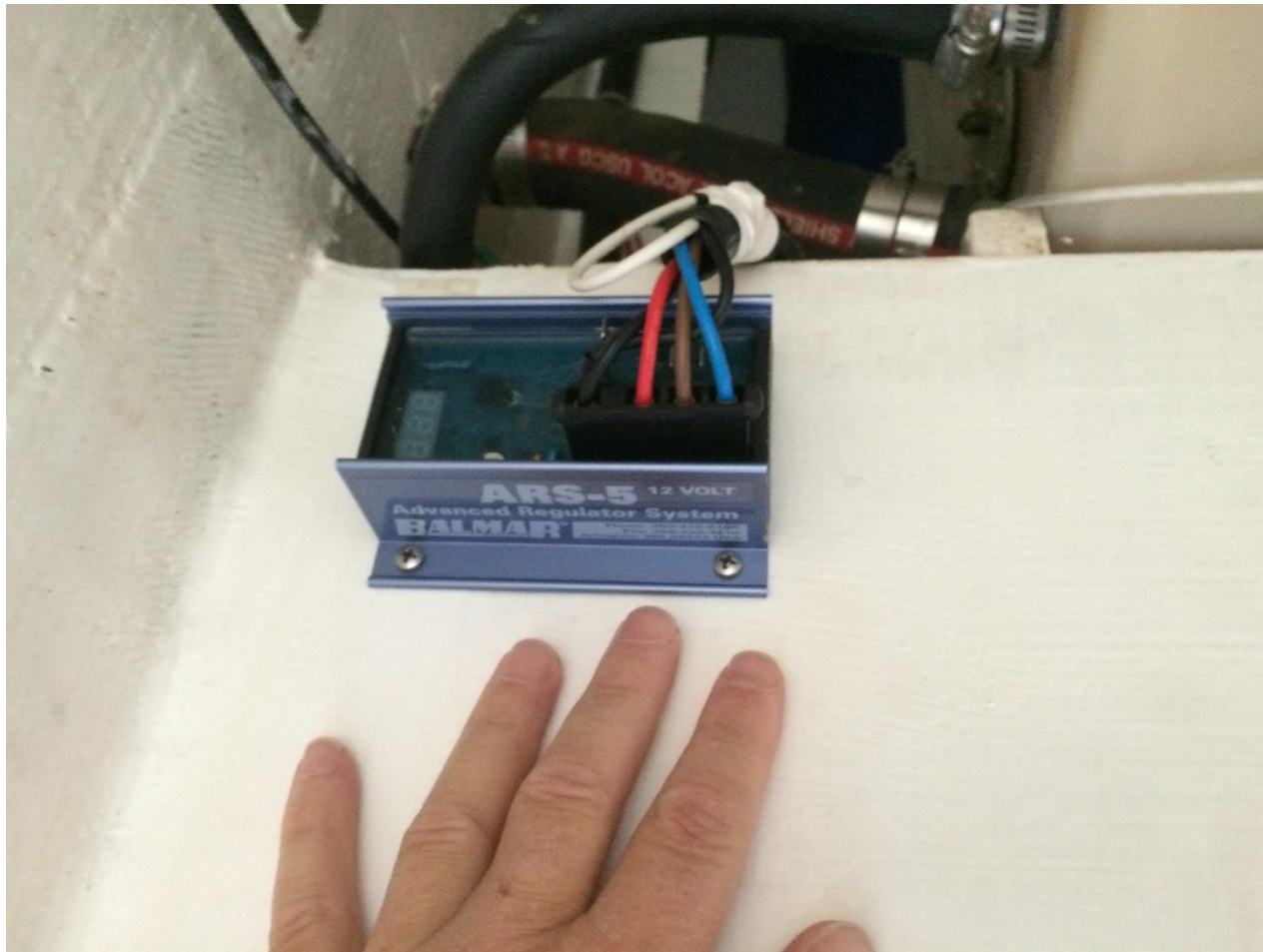
Alternator w/field wire



External alternator regulator



Regulator installed on Rags



Battery isolator switch/ACR Kit



Battery Monitor (Victron BMV-700/702)

Keeps you aware of your power system:

Voltage

Amps + (charging) or – (using)

Ah Consumed

State of Charge

Time to go

Power consumption in Watts

Great for preparing your load chart

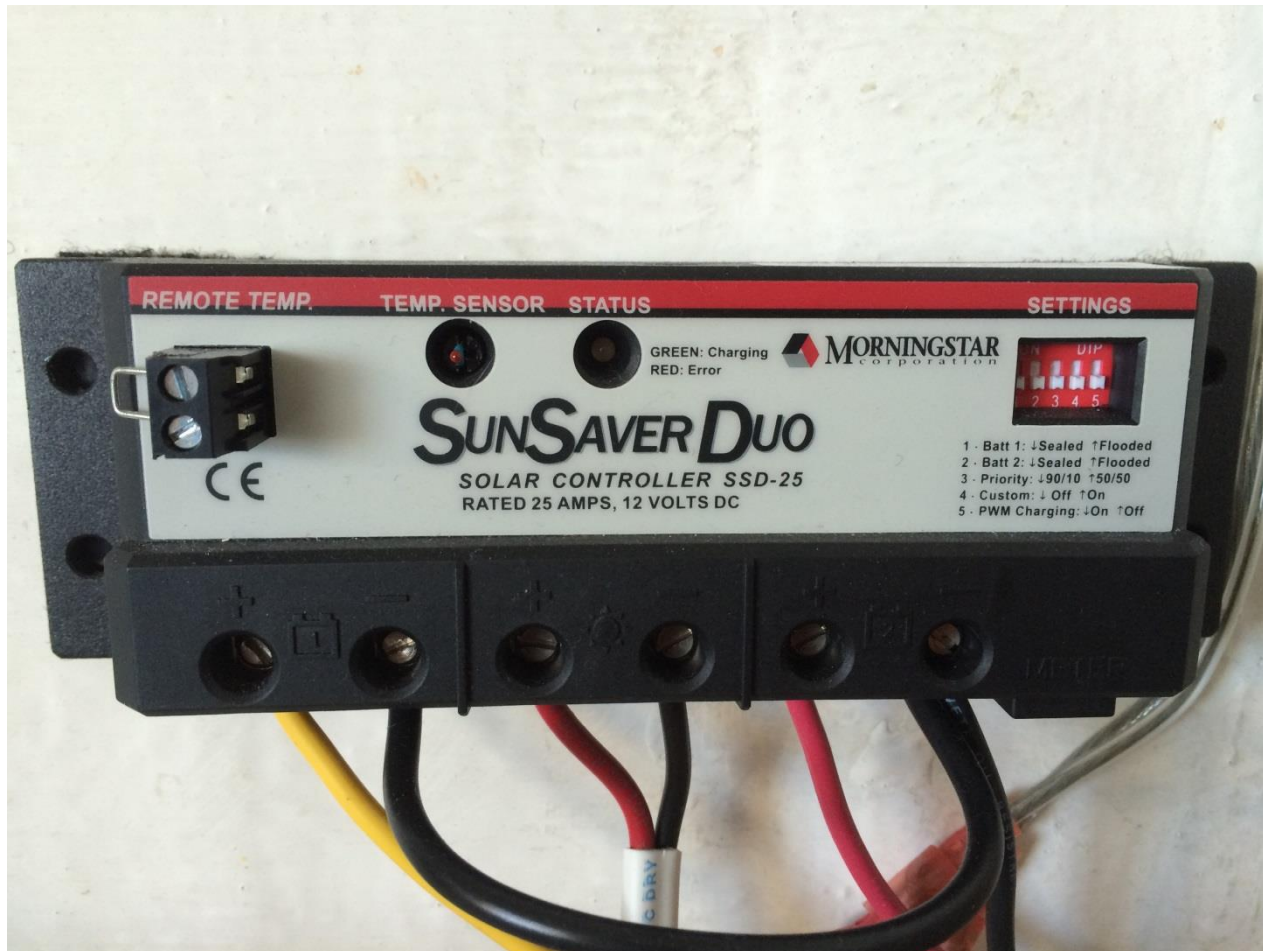
This one is pretty accurate and sells for about \$160 on Ebay.



Automatic Charging Relay and Battery Monitor on Rags



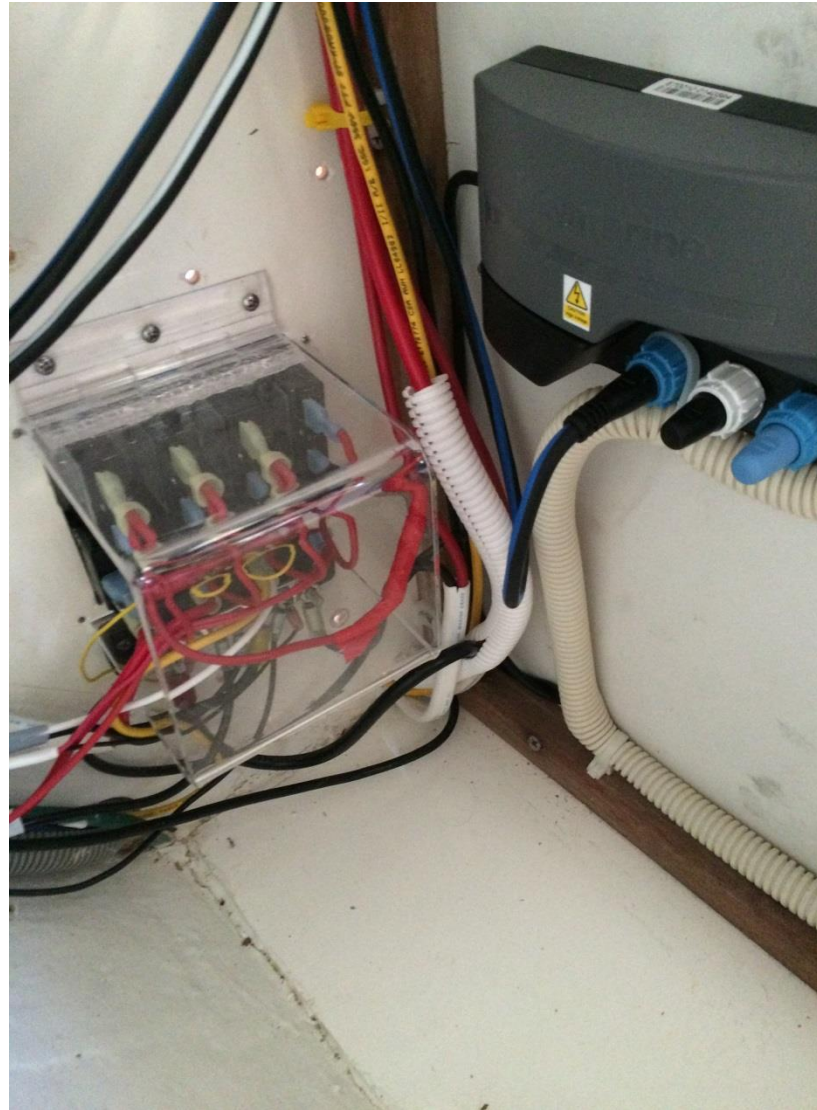
Rags' Solar Charge Controller



Rags' Auxiliary DC Panel



Aux DC Panel - rear w/cover



Rags' AC System



Take spare fuses (labeled)



Power requirements per the SHTP Race Rules and Conditions

- 4.01 All equipment required (*incl. electrical*) shall function properly and be of a type, size and capacity suitable and adequate for (*sailing solo to Hawaii*)**
- 4.02 Heavy items such as batteries . . . shall be securely fastened**
- 4.10 A permanently installed 25-watt VHF radio**
- 4.18 Fixed mount electronic depth sounder**
- 4.26 A second bilge pump, which may be manual or electric**
- 4.30 Navigation lights as required by the COLREGS**
- 4.30 All yachts shall have a masthead tricolor light or a strobe able to be hoisted**
- 4.31 A minimum of two batteries with a combined capacity of at least 120 Ah**

Power requirements per the SHTP Race Rules and Conditions - continued

- 4.32 A means of charging the batteries at sea at a rate that will allow the running lights to be used from sunset to sunrise each day**
 - 4.33 An energy budget that details all the storage, sources and uses of electricity**
 - 4.35 Equipment to communicate your position to the Race Committee . . . though a single sideband (SSB) radio transceiver is not required, it is highly recommended**
 - 4.38 A depth sounder**
 - 4.39 A knotmeter or log**
 - 4.45 Automatic Identification System (AIS) receiver or radar with perimeter alarm**
-

17.01 (Penalties) A yacht failing to comply with the position reporting requirements shall receive a 60-minute penalty added to the yacht's corrected time for each calendar day the yacht fails to comply.

Marine Batteries: Types (applications)

- **Starting**
 - High amps for short periods (then quickly recharged)
- **Deep-Cycle**
 - Can be heavily discharged repeatedly (but taking much longer to recharge)
- **Dual-Purpose**
 - Lower storage capacity than deep-cycle batteries of the same size. Not a good compromise for our needs.

Marine Batteries: Chemistry

- **Flooded**
 - Not sealed, must vent hydrogen (explosive) and can spill, must inspect and top off electrolyte, 6-7% per mo. self-discharge.
- **Gel – Sealed (spillproof)**
 - Highest number of lifetime charging cycles, more sensitive to proper charging than AGM's, 3% self-discharge.
- **AGM – Sealed (spillproof)**
 - More shock/vibration tolerance, lower internal resistance/better charge acceptance, 3% self-discharge.
- **TPPL and Lithium**
 - Can accept high charging amperage for much quicker charging, can be deeply discharged (>80%), monitoring system adds complexity and cost.

Marine Batteries: Key Tips

Don't mix chemistries – each chemistry charges differently

Don't mix ages or sizes in one bank – the weaker battery will shorten the life of the stronger battery

A large (200A) battery bank fuse may well save your boat. Mount within 7" of your battery. This Blue Sea fuse holder mounts right on the battery >



Your battery bank as a bucket



100% “Full” with solar, hydro, etc.

85% “Full” with alternator

50% “Empty” (mid-capacity rule)

<50% “Empty” (shortens batt. life)

Engine as your primary charger

- Clean tank and fuel
- Fuel filter elements – primary and secondary
- Tighten fittings, replace crush washers
- Know how to bleed air out of fuel system
- Carry spare alternator belt(s), bolts, tools/bar
- Check condition and alignment of alt. bracket
- Condition of wires to battery switch (etc.)
- Protect engine switch panel from water
- Increase throttle above idle to charge

Types of Solar Panels

1) Poly (or multi) crystalline – best output

Ex: Kyocera KC40T: 43W/17.4V/2.48A

Best if adjustable to face sun/avoid shadow

2) Amorphic (flexible) – Need 2X surface area
but tolerate minor shading (rigging, etc.)

Ex: PowerFilm R42: 42W/15.4V/2.7A

3) Semi-Flexible (Ex: Solbian brand) – lighter
than rigid panels but similar output - \$\$\$

Types of solar charge controllers

- **Shunt/1 or 2 stage:** Uses relays or shunt transistors to control voltage in one or two steps. These short or disconnect the solar panel unless the voltage is within its charging band, making it inefficient for keeping your battery bank “topped off.”
- **PWM/3 stage** (Pulse Width Modulation): Industry standard for smaller panels. Best alternative to MPPT but doesn't convert excess voltage.
- **Maximum Power Point Tracking** (MPPT): Highly efficient in colder conditions and with larger arrays. Converts excess voltage into additional current. The only brand of MPPT available for smaller panels (below 150W) is Genasun.

SunForce 400 Watt Wind Turbine

Blades: Carbon fiber for low wind noise

Body material: Cast aluminum

“High wind over speed Technology”

Fully integrated regulator automatically shuts down when the batteries are charged to minimize wear.

Maintenance-free: (2) Moving Parts

3 Year Warranty

Max Power up to 400 Watts or 27 Amps

“In ideal conditions” (*i.e. lots of wind!*)

Completely weatherproof

Tower kit sold separately (adds ~ \$500)

Powder-coated for marine applications

Dimensions: 27" L x 15" W x 9" H

Weight: 19 lbs (plus mast, hdw, etc.)

Cost: About \$500 at Defender (plus mast)



Watt & Sea Hydrogenerator

Cruising 300 model includes:
Hydrogenerator 300W (fixed
blades), Converter 12/24V
auto-detected, Three-blade
propeller (240mm), Lifting
bracket with cam-cleat,
Fastening kit for transom
\$3,840

610mm (24") Weight: 17.2#

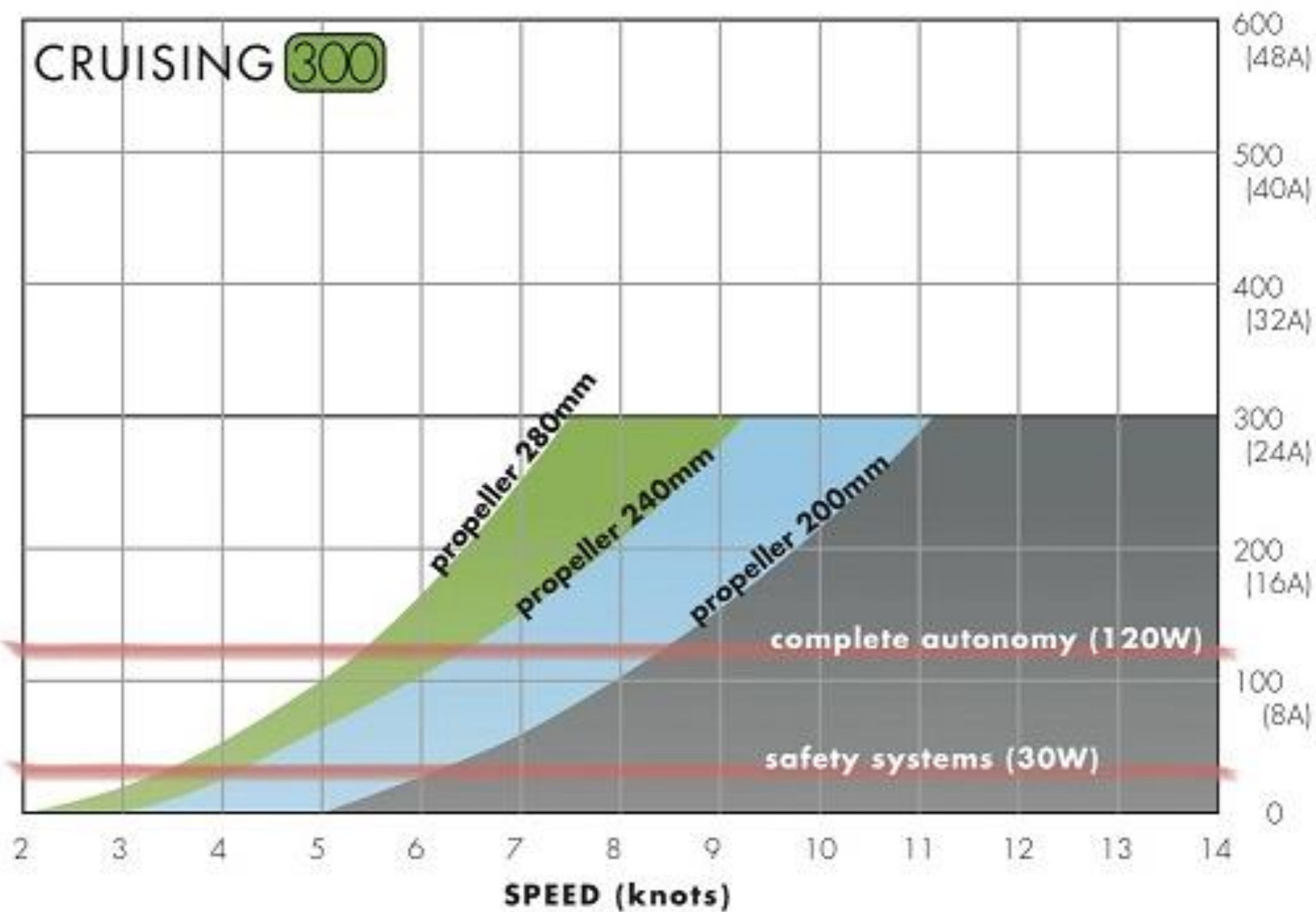
970mm (38") Weight: 18.9#

Bruce Schwab:

OceanPlanetEnergy.com



CRUISING **300**



EFOY Fuel Cell

80Ah/40W/3.3A Weighs 15.7#

\$ 3,500

140Ah/72W/6.0A Weighs 17.4#

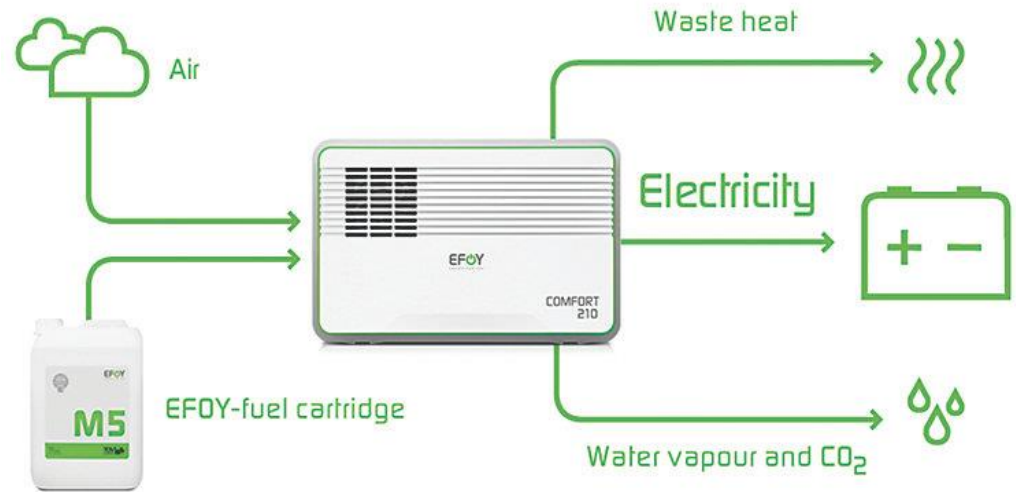
\$ 5,000

210Ah/105W/8.8A Weighs 18.7#

\$ 7,000

Methanol cartridge Weighs 18.5#

\$ 80



Electrical Budget (see Excel Spreadsheet)

Blue Sea Wiring Sizing Chart

U.S. Coast Guard regulation requires all ungrounded current carrying conductors (except the starting circuit) to be protected with a circuit breaker or a fuse.

CIRCUIT TYPE			CURRENT FLOW IN AMPS															
10% VOLTAGE DROP	Non Critical	3% VOLTAGE DROP Critical	5A	10A	15A	20A	25A	30A	40A	50A	60A	70A	80A	90A	100A	120A	150A	200A
CIRCUIT LENGTH	0 to 20 ft	0 to 6 ft	16 AWG	16 AWG	14 AWG	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	1 AWG	2 0 AWG
	30 ft	10 ft	16 AWG	14 AWG	12 AWG	12 AWG	10 AWG	10 AWG	8 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	1 AWG	2 0 AWG
	50 ft	15 ft	16 AWG	12 AWG	10 AWG	10 AWG	8 AWG	8 AWG	6 AWG	4 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	0 AWG	2 0 AWG
	65 ft	20 ft	14 AWG	10 AWG	10 AWG	8 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG
	80 ft	25 ft	12 AWG	10 AWG	8 AWG	6 AWG	6 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG
	100 ft	30 ft	12 AWG	8 AWG	6 AWG	6 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	0 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG
	130 ft	40 ft	10 AWG	8 AWG	6 AWG	4 AWG	4 AWG	2 AWG	2 AWG	1 AWG	1 AWG	0 AWG	0 AWG	2 0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG
	165 ft	50 ft	10 AWG	6 AWG	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	0 AWG	2 0 AWG	3 0 AWG	3 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
	200 ft	60 ft	8 AWG	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		70 ft	8 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		80 ft	8 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		90 ft	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		100 ft	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		110 ft	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		120 ft	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG
		130 ft	6 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG

Although this process uses information from ABYC E-11 to recommend wire size and circuit protection, it may not cover all of the unique characteristics that may exist on a boat. If you have specific questions about your installation please consult an ABYC certified installer.

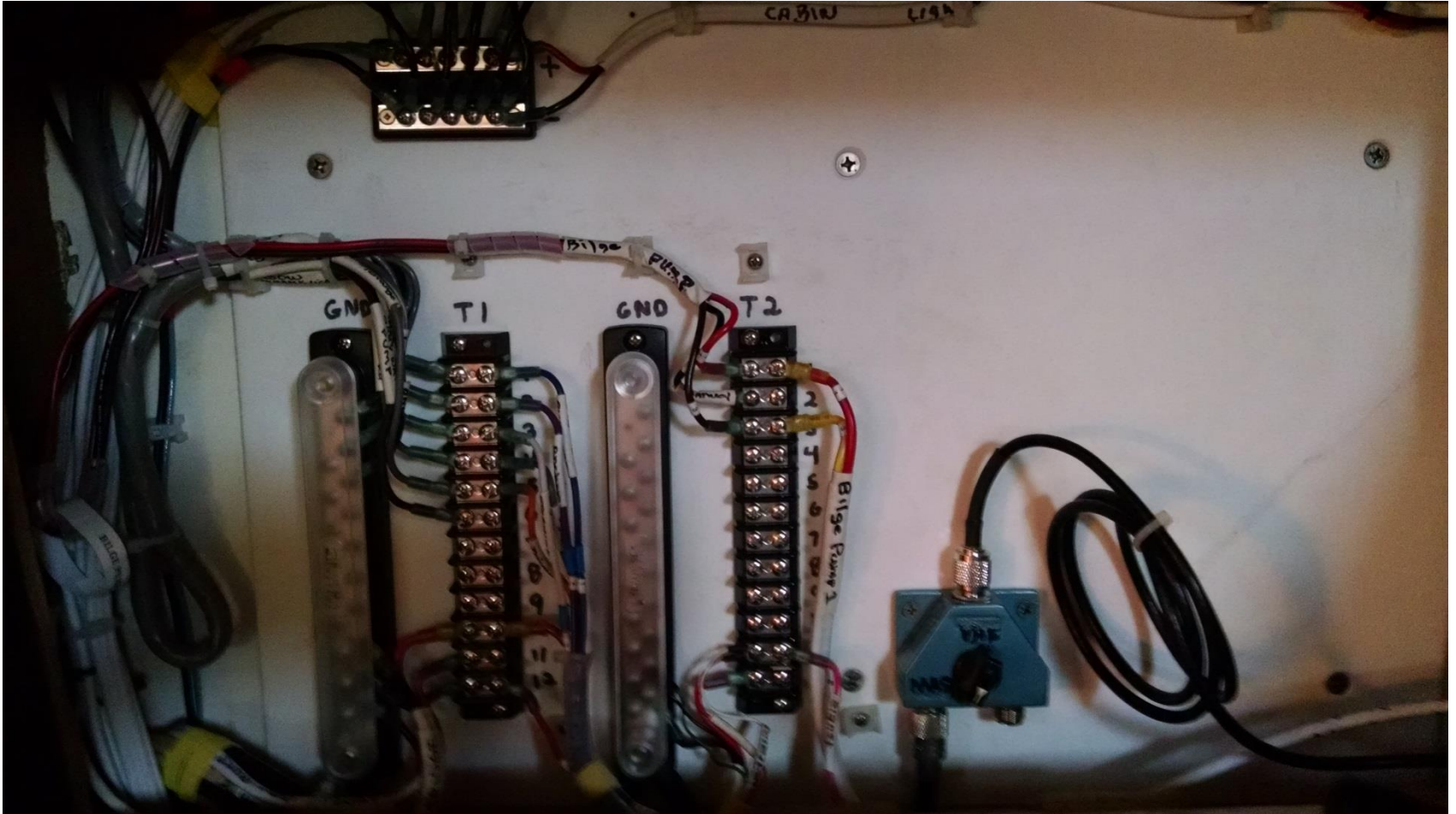
Kynntana's DC Panel



Kynntana's AC Panel



Kynntana – Wiring



Kynntana – High-Wattage Panel



Kynntana's Nav Station

