12V Wiring for Yachts

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2 Abstract

The HowTo is based on a 47 ft Vagabond 47. It does not cover wiring diagrams and details of charging and discharging layouts. This is the content of another HowTo which is in progress. The target is to describe a wiring infrastructure that will last as long as possible in spite of the extended corrosion on marine vessels.

For the electricians among the audience. I am NOT an electrician, so make your buh buh's. This short essay shall be a simple guide as "good – not best – practice for novices"

3 Slogans

"Keep it simple!"
"It can't break if you don't have it"

4 General Layout

It is not a problem to run cables through the bilge if one can not avoid it. What you should avoid in any case are connectors in the bilge. Try to set outlets and connectors as high as possible. Best would be a 40mm wastewater tube (cheap) running around the boats interior just besides the deck and hull connection.

Why not 24/36/48V ? Well, it is said that 12V is most common amongst other currencies and I am sure you want to get spares all over the world.

5 Batteries

I consider the minimum of 1 x 225 Ah for the engine (75Ah is enough but a security risk) an 3x 225 Ah house batteries.

5.1 Battery Types

My choice were simple lead acid (AGM) truck batteries as I do not see much more revenue with gel or others. The main problem is that you have to recharge your batteries. With the above mentioned configuration I have only a capacity of about 120 Ah (from 13,8 to 11,3V) and the 2,6 m² solar panel gives me 6-10 Ah/hr which is enough if one tries to keep the usage at its minimum.

The conclusion is: the more capacity you have the more you have to recharge and I think the boats system shall be independent as much as possible.

5.2 Battery Mounting

My decision was to fit the batteries right beside the companionway and to stow one above the other in an solid rack and locker. Reason is that I can switch every battery independently off the net in case I am making water. The last battery is about 5 ft above the floor. This enables me to have electricity until it is time to go!

5.3 Battery Banks

The best way to build the charging side is to use something like Victron Cyrix-ct and on the consumer side one should use battery isolators to disable current flows between the batteries.

6 Wiring

6.1 Standards

Yes it is a good idea to use marine standardized wires (expensive). The fortune of living in the US is that common standard is copper-TINNED wires. They are perfect. In Europe only copper wires are common so one has to search a lot to find cheaper equivalents but finally he will end up with Lloyd's certified stuff.

Dimensions > 10mm² (AWG 7) have to be copper only (just a cost/average factor). The important thing is correct fitting of the cable shoes and the perfect sealing with shrink hoses and fluid tape.

6.2 Sizes

Bowthruster	6000 W	95mm²	AWG 3/0 or 4/0
Windlass	1600 W	50mm²	AWG 0
Starter	1000 W max	50mm²	AWG 0
House total 210A!	2500 W max	50mm²	AWG 0 better 2x50mm²
Bilgepumps upto	250 W	2,5mm²	AWG 13

It is not necessary but I decided to stay at least with 2,5mm² and 4mm² AWG 13 and 11. Don't forget we have only 12V and the resistance is high.

6.3 Formula

$$mm^2 = \frac{(2 \times \text{length in meters}) \times \text{Amps}}{56 \times 0{,}2 \text{ Voltage drop}}$$

Why 2x length? There is a way forward + and a way back – UNFORTUNATELY.

6.4 Colours

I would not deny the worthiness of colouring but it is an extra cost factor and in fact it is not necessary if one uses red and black for +/-

My decision was red/black and blue black or black/black > 50mm² as I did not get red wires of this size but it is well documented.

6.5 Marking

Using just black and red wire colours it is a good idea and to number each wire circuit with specific letters and or numbers too. For example:

<100	interior: lights, fridge, pumps, USB Charging, 12V outlets etc.
<200	navigation, all including autopilot, radar, transceivers…
<300	engine
+900	everything that is connected directly to the battery(ies) like bilge pumps

Or Ix, Nx, Ex, Dx… YOU name it and write your own documentation.

How to do this? Print out your letters or number with an ordinary printer on usual paper, cut it and glue it – just to fix it a little – on the wire. Then apply the shrink hose.

The trick is: Paper will burn but it needs oxygen. While the hose is shrinking the temperature is not high enough and when the hose is tight enough the paper will not get oxygen any more

7 What I use and what I do not use

Well yes I confess! It is archaic! BUT remember electric/electronic you don't have can't brake! Think of the corrosion and temperature change requirements and you end up with Eyelet Connectors.

It is widely agreed that eyelet (ring) connectors on terminals are most resistant against loosing contact due to temperature changes. They should be carefully sealed with transparent shrink hoses with glue inside.

- ✓ Transparency to see your numbers
- ✓ and to see possible corrosion.
- ✓ the glue to get it absolutely tight.

Once the connector is screwed finally on the terminal it should be sealed with fluid tape.

8 Tools

For the very big connectors >= 16mm² you should borrow this pair of tongs.

If you want buy it expect about 1200 USD – You won't need it later on.

For the small connectors up to 10mm² try to buy something like this

Be very careful what you buy as the right tools are very important. I have a punch marker I made at school. It is 40 years old and I did not have to grind it since!

Wire cutter – this solution is the best from 1mm² to 95mm² (tested)

9 Parts

Reading the HowTo I am sure mentioned that a lot of things look perfect and one should suggest that as the years go by some technical efforts have been made.

Well yes, sure, nobody will deny it. BUT do you have proof of it? Can you dismount every electronic part and check the materials used? I can and will not say modern technique is scrap but I say I want to be able to check if it is good or not and that brings me down to archaic layouts according to the slogans. I want things fool-proof and I want an electric implementation that will survive a turnaround just by spray-washing it with fresh water and letting it dry by air.

9.1 Connectors

In general you should not use connectors that are only pressed on the counterpart somehow. We face temperatures from at least -10 to 60 C and every material will shrink and grow.

before and after

9.2 Switches

For example carling switches. They claim to be water proof and yes I am sure they are. But look at the backside! Ok no discussion if you use them on deck you have to have a waterproof switch which the switch in Pic2 is not and the preservatives for this switch are definitively not what I like. What I would do with the Backside of the carling switches: I would solder wire on the connectors and seal the whole thing with hot glue. In fact we can not find a way around plug connectors as the industry ignores our needs consequently. It is far more expensive to make screw terminals that simple plug connectors.

9.3 Fuses

Yes I really like the fuses, best automatic inserts, and fuse holders in Pic1. For a motorhome, car or truck but not on my boat. What I want are fuses that I can get everywhere around the globe. Therefore I decided to uses d=5mm up to 15A (The smaller ones) and d=6mm >15A as the smaller ones are only up to 15Amps.

In fact you can buy the glass fuses in every electric and electronic shop – everywhere.

9.4 Fuse dimensioning

Check your manuals of every unit you use and insert the fuses as said. Keep the difference between recommended values and the fuses you use as small as possible. When your installation is finished measure out the maximum load again and, if required, change some wires. I started with 63Amps on the house fusing and ended up with 220Amps at full load. I had to change the wire from the battery to the main panel from 50mm² to 95 mm² to keep the loss under 0,2Volts. So be careful calculating your loads.

9.5 Diodes

And rather quick we slide in the electronic part. In fact it makes no sense to use bulbs any more and the 12V LED's are perfect sealed, long life an as log as you seal the wires tight – no problem at all.

9.6 Terminal Blocks

As shown, everything that does not fit tight when screwed together is not what you want.

9.7 Soldering

In fact it is better to stay off soldering in marine environments but one won't come around without it. Once I was informed that the soldering tin shall be a special one that has a different consistency. Well I do not care about this and seal everything with shrink hoses and fluid tape.

10 Conclusion

Avoid electronics as far as possible. Oversize your wires, the bigger the less resistance you have. Always screw your connections with eyelet connectors. Use shrink hoses and seal everything with fluid tape. Connect your minus to the scarifying anode to have corrosion protection.

Coming soon: HowTo – 12V Installation Scheme and Diagrams for Yachts

comments welcome!