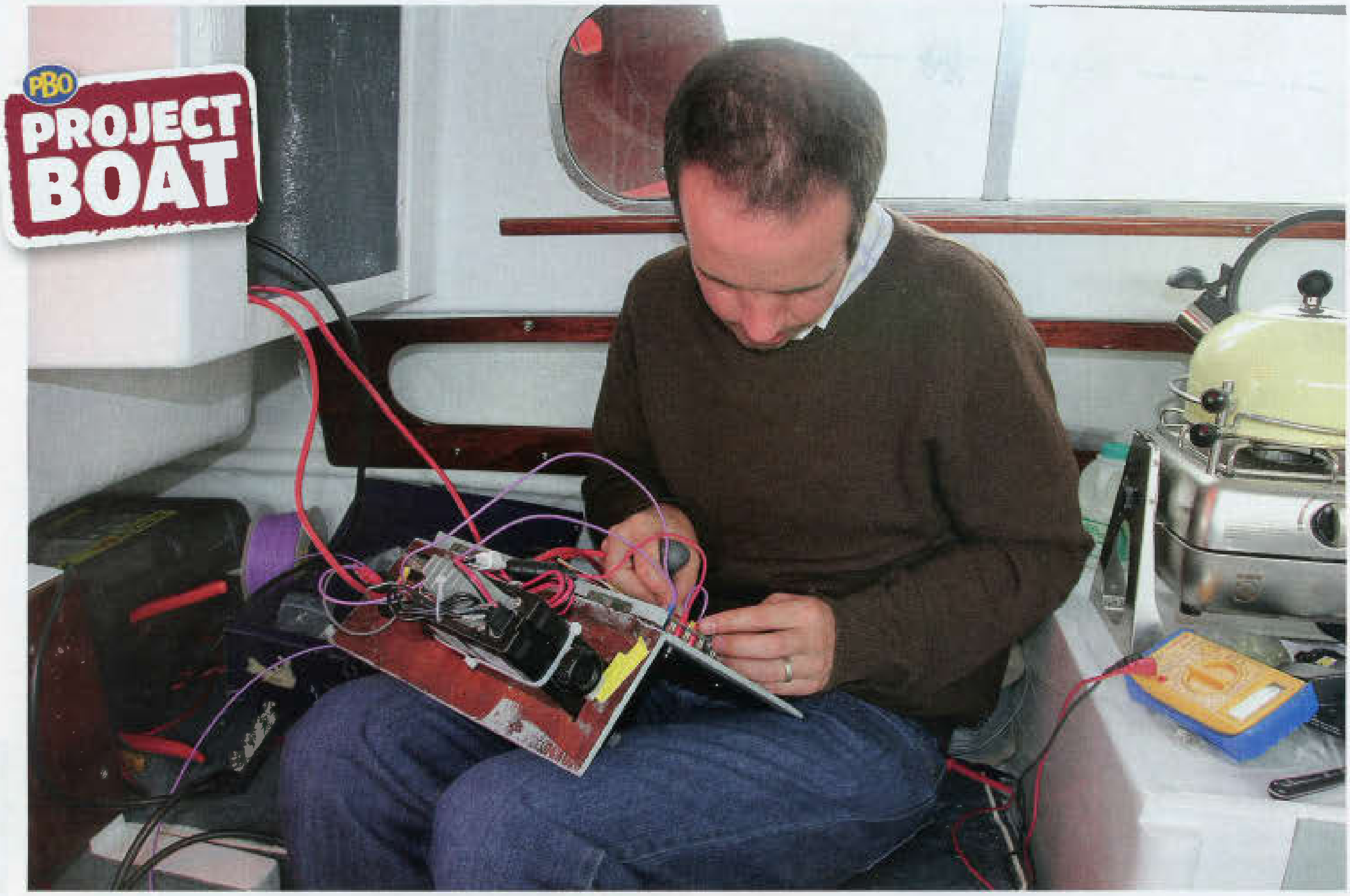


Fitting new electrics

Cables, connectors, breakers and switches are all in a day's work when rewiring a boat, as David Pugh explains

It's rare that you get the opportunity to wire a boat from scratch but, having filled all the holes and removed all previous fittings during *Hantu Biru*'s restoration, that's exactly what we needed to do.

Her original installation was simple to say the least: three cabin lights, navigation lights, and power to a combined log and volt meter.

There was no breaker panel and precious few switches or fuses; a large toggle switch controlled the nav lights and everything else was switched from an isolator in the engine compartment. The cabin lights had their own switches, integrated into their housings.

Apart from the cabin lights, everything had suffered from water damage, so complete replacement was our only option.

Modern life demands more from an electrical system than the original would have afforded, but nevertheless we wanted to keep it as simple as possible.

Choosing components

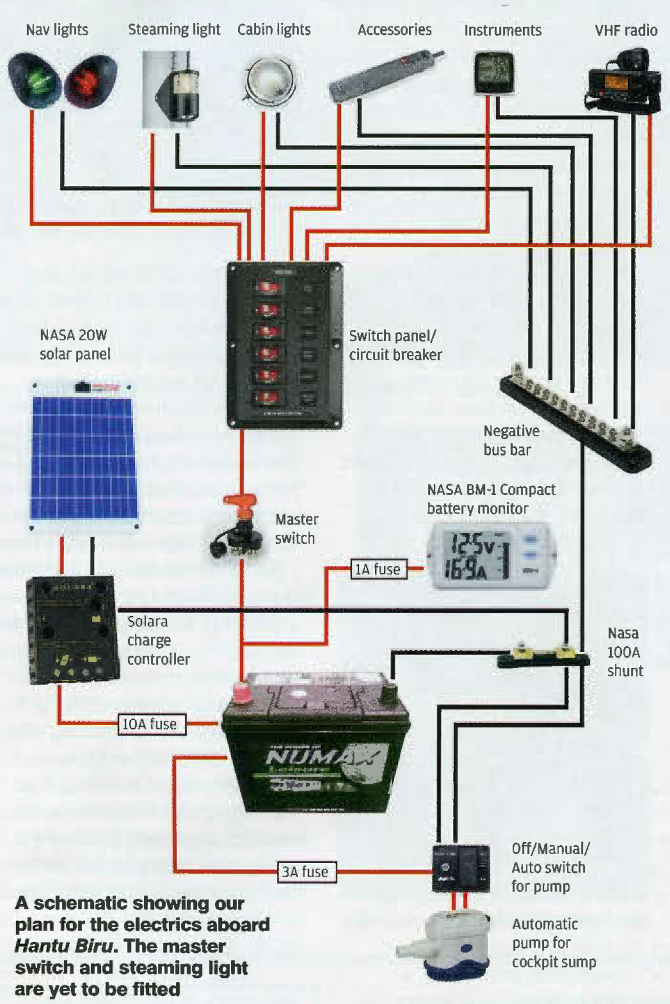
The centre of our system, we decided, would be a six-breaker panel from Blue Sea Systems. We had chosen the port cabin bulkhead locker as the location for the bulk of the wiring, and the panel would fit the locker door neatly. Using breakers removes the need for separate fuses and their additional wiring.

At the heart of *Hantu Biru*'s electrics is a six-breaker panel (left) from Blue Sea Systems. The other instrument is a NASA BM-1 Compact battery monitor

For the navigation lights we chose some LED units from Osculati at a fraction of the cost of most other manufacturers' offerings – ours came from our local chandlery, Piplers of Poole.

Although LEDs are more expensive than incandescents, their lower power consumption and long life makes them an obvious choice when installing from scratch. Their low current also means you can use lighter-gauge cable to connect them, keeping down cost and weight. Unfortunately, we couldn't find a matching stern light, so we

Plan for *Hantu Biru* wiring



A schematic showing our plan for the electrics aboard *Hantu Biru*. The master switch and steaming light are yet to be fitted

We installed two auxiliary sockets – a 12V cigar lighter-type socket and a dual USB charging point for mobile phones and other devices

chose a standard incandescent unit and fitted an LED bulb.

As the original 1960s vintage cabin lights were still in reasonable order we decided to clean them up and reuse them. They are currently still fitted with the original incandescent bulbs, but we plan to fit LED bulbs in the future.

The forecabin light was beyond repair, so we fitted a wired-in push on-off LED unit, also from Piplers.

Pump out the volume

The main bilge is cleared by a manual pump, but the cockpit is drained using a Rule 500 automatic pump under the cockpit grating.

The pump was chosen owing to its relatively small footprint and high capacity – and also because I have the same pump in the same position on my own boat and know it works well.

Other users of power are the VHF, log/echo sounder, plotter and compass light – more on these next month.

We also opted to install two auxiliary sockets from Blue Sea Systems, namely a 12V cigar lighter-type socket and a dual USB charging point for mobile phones.

As the boat currently has no inboard engine we decided to see if we could manage our power requirements with solar energy. We chose a 20W semi-flexible panel from NASA Marine, which looks good at a competitive price. The battery is a 75Ah deep cycle model from Numax, and we keep an eye on the voltage and charge-discharge current with a BM-1 Compact battery monitor, also from NASA.

Specifying cables

With any electrical installation, it's essential to make sure your cables are up to the job. For boats, we have the added complication of the marine environment, so wherever possible choose tinned wire to guard against corrosion, and with as many strands as possible for extra flexibility and resistance to fatigue.

The other major consideration is cable size. In the best case, undersized wiring will result in unacceptable voltage drop; in the worst case it's a fire hazard. The appropriate cable can often be thicker then you think, so it's worth doing the maths. You can do it yourself from first principles (see panel below), or trust an online calculator. I found the one here straightforward: www.bulkwire.com/wireresistance.asp

With either method, to work out the correct size of cable you need to know the length of the cable run and the current it needs to supply.

A classic application where cables are often underspecified is when fitting a masthead tricolour. An incandescent bulb in this application will probably be 25W, drawing 2.1A at 12V. For a 12m cable run (24m in total, there and back) the calculations give 2mm² wire, but as the nearest standard size is 2.5mm² you end up with quite a chunky cable – a single insulated core will be around 3.5mm thick. Most boats' mast wiring is nothing like this size!

By comparison, an LED tricolour drawing 200mA only needs 0.5mm² wire – lighter, cheaper and easier to handle. For that reason, we'll be fitting an LED tricolour to *Hantu Biru*.

The original 1960s cabin lights were good enough to reuse

A simple push on-off LED unit illuminates the forward cabin

Calculating cable size

For a standard masthead tricolour with a 25W incandescent bulb and a 12m cable run:

- A 25W bulb at 12V draws current $I=P/V=25/12=2.1$A.
- The total wire length, l, is from battery positive to battery negative: 24m.
- An acceptable voltage drop is usually reckoned to be between 3% and 4%, or 0.36V to 0.48V at 12V. We'll use a middle value of 0.42V.
- Total acceptable cable resistance is therefore $R=V/I=0.42/2.1=0.2\Omega$.
- Copper has a resistivity (ρ) of $1.68\text{x}10^{-8}\Omega$m, so the required cross sectional area is $A=\rho l/R=(1.68\text{x}10^{-8}\text{x}\ 24)/0.2=2\text{x}10^{-6}\text{m}^2 = 2\text{mm}^2$.

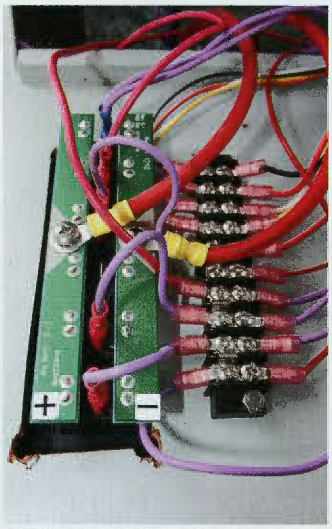
Wiring a breaker panel...

Using a pre-built breaker panel immediately helps to reduce wiring, as it allows you to take a single positive feed from the battery switch to the panel: the panel itself then splits the feed to the switches.

Our panel also has a negative connection, but this only exists to power the switch lamps.

The output from each breaker is taken from individual ¼in spade terminals.

I chose to take short links from these to a bigger, screw terminal block, mounted adjacent to the panel. These neat devices have bridging pieces to allow you to connect as many sections together as necessary, allowing you to, for example, have separate terminals for port, starboard and stern lights, all switched from the same switch. The use of ring crimps and screw terminals is much more resistant to vibration and fatigue than even the best quality choc-block.



Screw terminals offer good resistance to vibration and fatigue

All the negatives are taken to a common bus bar. We chose a seven-terminal bar, mounted just below the switch panel, but in retrospect I would have used a bigger bar. Even with only six switches you end up with a lot of cables to terminate.

All the negatives are taken to a common bus bar

... navigation lights

We mounted the port and starboard LED navigation lights directly to the cabin sides in the same position as the originals. This has the advantage that the wiring for the port lamp exits straight into the locker with the panel.

The stern light was more complicated. As *Hantu Biru* has no pushpit, options were limited – the original was mounted on a short bumkin as part of the self-steering system. In most of the possible locations the light would have been obscured by the rudder stock or tiller at some point; the only way to avoid this was to mount it above the tiller, making the only possible location the traveller horse.

Nav lights, mounted to cabin sides

Stern light, mounted above the tiller

Because the traveller car only contacts the top and bottom faces of the traveller rails, we realised that by welding a plate to the side of the aft rail we could have a stern light bracket that would not foul the traveller. Dave at Poole's Midas Manufacturing did the honours with a neat L-shaped bracket the exact size of the lamp, complete with a cable hole.

We then drilled the traveller tube to accept the cable, entering adjacent to the lamp and exiting at the port end of the traveller. Drilling into the side of stainless tube is a good way to break drills – our technique was to centre-punch it, clamp it firmly and drill it on a press with plenty of cutting fluid.

Dressing with a needle file and inserting grommets finished the holes, and I threaded the cable once the traveller was bolted back to the boat.

... and the bilge pump

The cockpit in *Hantu Biru* was originally set up to self-drain, with large-bore hoses straight down to underwater skin fittings. However, as the cockpit floor is virtually on the waterline, we suspected that wet feet would be inevitable.

My own boat, a Contessa 26, has a similar problem, and after several false starts my brother and I came up with a workable solution to keep the cockpit dry – we built a sump in the cockpit. Rather than start from scratch, we copied it for *Hantu Biru*.

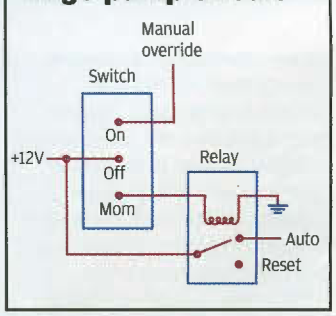
***Hantu Biru*'s original cockpit had drains – and an enormous hole!**

The cockpit floor (which we replaced earlier in the project, see PBO Summer 2013) is moulded with a sump in the middle. The top is almost the full width of the cockpit to catch water even when heeled, but the bottom is only just bigger than the footprint of a Rule 500 bilge pump. When the water rises about halfway up the side of the pump, it turns on automatically and throws it out again through a skin fitting in the transom.

This system works well by and large, the only problem under normal circumstances being that the pump take a long time to switch off if slime has collected on the sensor. It's a good idea to wipe it clean every few weeks. However, if sailing in splashy conditions the sensor can be triggered before the pump has switched off, keeping it running continuously with insufficient water to pump. The only way to reset it is to turn it off and then back on again.

We built a simple circuit to make that easy to achieve, without risking leaving the pump permanently switched off. Using an on-off-momentary Carling switch and a relay, we now have switch positions to feed power to the manual override wire on the pump, causing it to run continuously, an automatic position and a momentary position which cuts all power to the pump while pressed, causing it to reset. The relay coil is only ever powered when the switch is held down, so normally draws no current.

Bilge pump circuit



We built a sump in the cockpit floor with an automatic pump

Installing a solar panel

The sliding hatch proved to be the best location for our solar panel

Siting a solar panel on *Hantu Biru* was tricky. She doesn't have much of a foredeck, and most deck areas are subject to foot traffic. Although the NASA panel will tolerate being stood upon, it's still a good idea to keep solar panels and feet apart as much as possible.

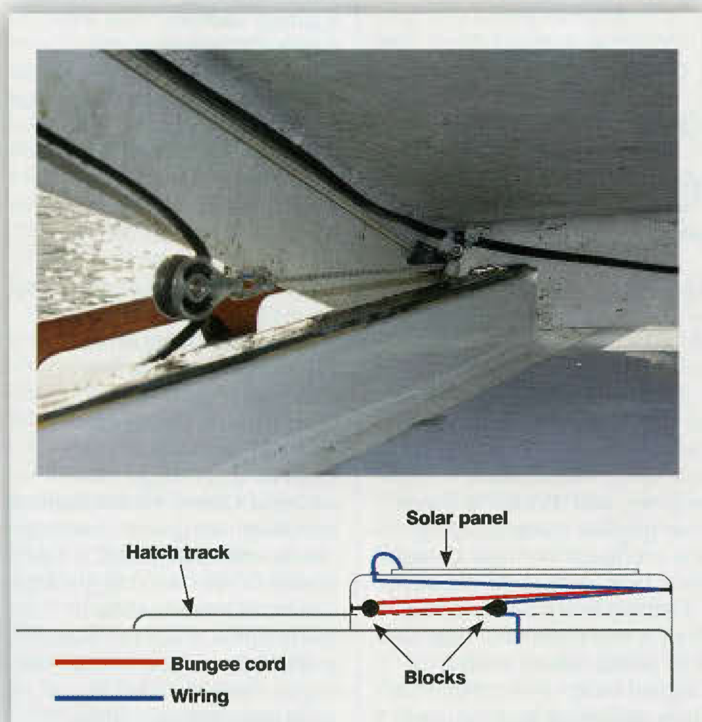
Eventually, we concluded that the sliding hatch was the best location. It gets good light, has only a gentle curve – easily within the tolerance of our semi-flexible panel – and receives virtually no foot traffic. It has one major drawback, however: because it slides, the cable couldn't simply pass through a deck gland.

Our solution was to devise a system to take up the slack cable, built into the side of the hatch. There's a gap about an inch wide, so we decided to use some bungee cord and a small block to take up a bight of cable as the hatch slides backwards or forwards.

Siting a solar panel on a sliding hatch required ingenious wiring

The idea works in principle, but in practice we found the short length of bungee under the hatch wouldn't stretch far enough, so we added another block to allow us to use a longer length of bungee.

The panel is powerful enough that it could potentially overcharge the battery, so we wired it via a simple Solara charge controller, which disconnects the panel when the battery is fully charged.



The battery monitor tells us the battery voltage and how much charge the solar panel is putting into the battery

Battery monitor

To keep track of how much power we use, and how much charge the solar panel is delivering, we installed a NASA BM-1 Compact battery monitor.

This can be used to track the charge state of your battery, but we leave it displaying voltage and current. It's reassuring to see current flowing back in from the solar panel: on even quite a dull day you can see 100mA, and in sunshine we get 500mA or sometimes more. Not huge numbers, but over the course of the season the panel has kept the battery fully topped up.

The monitor tracks voltage with a positive wire to the battery, and current with two additional wires to either end of a shunt, wired straight to the battery negative. This is mounted as close as possible to the battery – in our case, bolted to the side of the battery box – and all other negative connections go through the shunt so that it handles the entire current usage of the boat.

As the shunt has a known resistance, the battery monitor can calculate the current flowing into or out of the battery by measuring the voltage across the shunt.

The battery monitor has its own, fused power feed from the battery, and is left on permanently.

The shunt is fixed to the side of the battery box

Conclusion

The eagle-eyed among you will have spotted that there is no mention of mast wiring, or a main battery switch. We'll be fitting both of these over the winter, to power a tricolour and steaming light, and to give us a master switch for the electrics.

Once we install *Hantu Biru*'s inboard engine we'll have some serious charging capacity from the alternator, and will be able to work out the final location for the battery and hence the master switch.

We may also opt for a separate starter battery, which will then demand some kind of split charging system.

Hantu Biru's electrics are very much a work in progress, but what we have at the moment is simple and effective. Watch this space for more!

NEXT MONTH

Installing a VHF radio, log/echo sounder, plotter and compass light