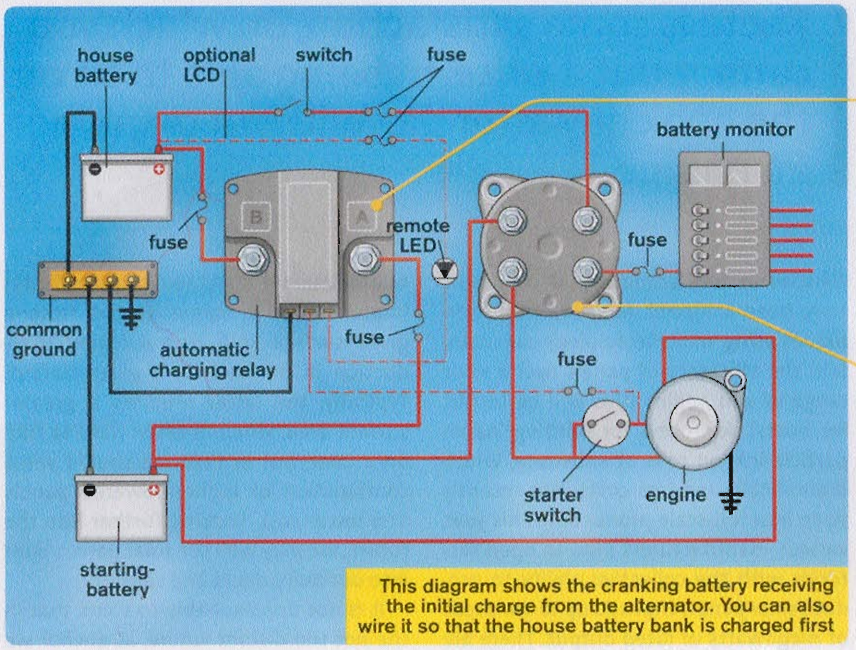


This diagram shows the cranking battery receiving the initial charge from the alternator. You can also wire it so that the house battery bank is charged first

PHOTO 1: Make sure the ACR can handle your alternator

PHOTO 2: The back side of the Dual Circuit Plus switch shows four, rather than three, studs

Simple Electrical Upgrade

A new battery management system | BY PETER NIELSEN

Our 1973 Norlin 34 project boat had been used mainly for club racing in its later years, and it showed. Among its many outdated systems was the battery-management setup. It was no worse than what I suspect can be found on many other boats of that vintage, but it would not suffice for extended cruising.

The two Group 27 90AH deep-cycle lead-acid batteries, one for house loads and one for starting, sat side-by-side under the nav-station seat. The charging cable from the 60-amp alternator went to a four-position battery switch—Off/Battery 1/ Battery 2/ Both. The battery capacity was inadequate to cope with the demands of night sailing or a weekend on the hook, and there was no way of telling the state of charge. The cables were a mess—ancient, cracked, and corroded at the terminals, not to mention mostly the same color—black, whether they were negative or positive. Basically, the electrical system was a disgrace, and I lived in fear of a fire.

Since both batteries had died last winter, I had every excuse to come up with a cost-effective solution that would bring *Ostara's* electrics into the modern world. This would involve enlarging the house bank; finding somewhere to put a dedicated starting battery; simplifying the switching; adding a battery combiner; replacing all the cables; adding a small solar panel to trickle-charge the house bank; and installing a battery monitor.

BATTERY CHOICES

My first purchase was a pair of Group 27 90Ah deep-cycle flooded lead-acid batteries. This would almost double the house-bank capacity. Why flooded? Simple economics. They were half the cost of similarly sized absorbed glass mat (AGM) batteries and a third the cost of gel-cells. If I were living aboard, I might have reconsidered, but for weekend sailing and the odd week away, flooded batteries would do fine. With regular monitoring, good winter care, and an eagle eye on the electrolyte levels, you can get a good few years out of lead-acid batteries. The combined capacity of 180 AH would be marginal for many boats, but it was adequate for *Ostara's* modest electrical draw—chartplotter, VHF, stereo. The nav lights, anchor light, and interior lights are all LEDs, which dramatically cut power consumption, and the Tacktick sailing instruments are solar-powered. There is no refrigerator.

I also bought a Group 24 starting battery, along with a battery box. I had to make room for the second house battery under the nav seat, which meant the starting battery had to be relocated.

SWITCHING QUESTIONS

The most common way of switching between two battery banks is the Off/1/2/Both four-position selector switch. Switch to "1," and the house bank draws from that battery, and only that battery is charged while the engine is running. In the "2" position, house loads are drawn from the #2 battery, which is also the only one charged. "Both" combines the batteries for charging and also for discharging. This is where you can come unstuck; you quite properly select "Both" for starting the engine and to charge both batteries when running under power, only to forget to switch over to your house battery when the engine is cut. Next morning, you realize you've drawn down both batteries to the point where there's not enough juice between them to start the engine.

Because we often sail with children and novices and wanted to eliminate any possibility of confusion, I decided to make the charging system idiotproof—well, foolproof at least. As the first step I bought a Blue Sea Systems Dual Circuit Plus battery switch. This switch isolates

PHOTOS BY PETER NIELSEN; ILLUSTRATION BY KIM DOWNING

Installation

→ Since the existing system was patently not to ABYC guidelines, I wanted to make sure the new one was. Insurance companies want regular surveys of "classic" (i.e., old fiberglass) boats, with an emphasis on mechanical and electrical systems meeting ABYC standards. Unfortunately, compliance comes at a price. Unless you pony up $250 for ABYC membership, a copy of Standard E-11—AC and DC Systems on Boats—will set you back $195, but unless you're installing your own AC shore-power system I see no reason to get the checkbook out. Skinflints will be pleased to know that much of the essential information can be found for free on the Blue Sea Systems Web site **(www.bluesea.com).** Nigel Calder's Boatowner's Mechanical and Electrical Handbook is much more detailed and is an essential companion for anyone who does his own electrical work. The Coast Guard has federal requirements on its Web site **(uscgboating.org).**

house and starting battery circuits. Switch to "on," and current goes from start battery to start circuit only, and from house battery to house circuit only. You cannot mistakenly run down the start battery. If you need to combine both banks for starting, just switch to "combine."

BATTERY COMBINERS

The three-way Dual Circuit Plus is simpler than the four-position switch, but you still have to remember to switch to "combine" so that both batteries are charged when the engine is running, and back to "on" when the engine's off, which means there is still room for confusion. I wanted more of a set-and-forget system, so I decided to add a battery combiner. Also called automatic charging relays (ACR) or voltage sensitive relays (VSR), these devices connect two or more battery banks together when charging and isolate them when charging stops.

Don't confuse ACRs with battery isolators. These contain silicon diodes that let current flow only one way; the current can flow from the alternator to the batteries, but not from one battery to another or back to the alternator. This means you can't accidentally run both batteries down, which is good, but there is a sizable voltage drop across the diodes—up to 0.7 volt—that can leave your batteries undercharged.

You can overcome this by installing a "smart" regulator that senses the undercharging and compensates for it, but this would be a whole other project, so I decided to follow the path of least resistance (pardon the pun). An ACR contains a relay that closes when one battery reaches its peak charge, allowing charging current to also flow to the second battery. When charging stops the relay opens again, isolating the batteries. There is no voltage drop.

There are several makes of ACR on the market, some more expensive than others, and some with more functions than others. I chose a Blue Sea 7610-SI Series unit **(Photo 1)**, which supports alternators up to 120 amps and can cope with temporary immersion, always a handy attribute for marine electrics. The combination of the new switch and the ACR meant that I would merely have to turn the switch to the "on" position, and both banks would be charged according to their needs. When the engine was switched off, I could leave the switch in the "on" position in the knowledge that I was using current only from the house bank. It would no longer be possible to flatten the starting bank accidentally.

MONITORING BATTERIES

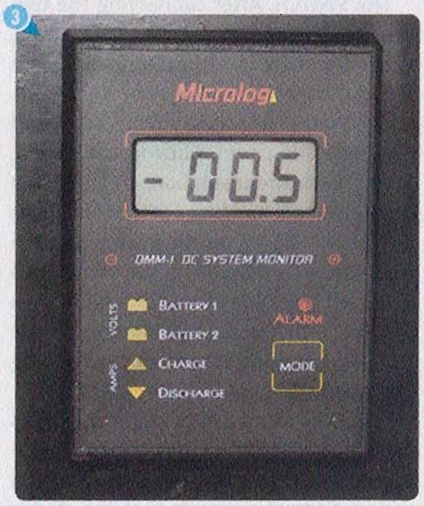
It was difficult to choose a battery monitor. There are many on the market, from the simple analog type with its moving needle to the sophisticated microprocessor-controlled units from companies like Link and Xantrex, which have a multitude of functions and can cost hundreds of dollars. With my simple system I couldn't see the need for anything too complex; all I wanted to know was the state of charge of each bank and how much current was flowing into or out of the batteries.

In the end I decided on a Microlog DMM-1 **(Photo 3)**, a Canadian-made unit that measures battery voltage on both banks and lets you know in amps how much current is going into or out of them. You can switch through four modes to display (1) the voltage of the first battery; (2) the voltage of the second battery; (3) charging current in amps; (4) total current drain in amps. It has alarms for both low and high voltage (handy to know if you're cooking your batteries) and looked like a simple, cost-effective solution.

THE PROJECT

On older, skinnier boats, it can be difficult to find room even for something as small as a battery. You want to keep cable runs between alternator and battery as short as possible to avoid voltage drop, and locate the battery where it can be secured firmly against movement. A battery box that will contain acid spills and also protect the terminals against a possible short circuit is a sound investment. In order to avoid an overlong cable run from battery to switch, I had to sacrifice a bit of valuable stowage space and locate the starter battery alongside the quarterberth.

There was nothing worth keeping, so I started the project by removing the old batteries, cables, and switches. I consulted a voltage-drop table and found that for my installation, with an 80-amp alternator and a maximum cable run of just over 6



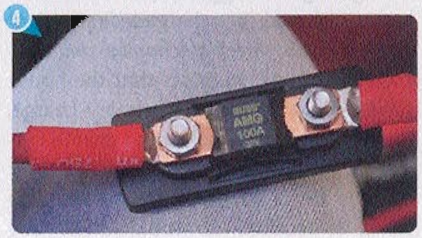


PHOTO 3: The Micrologic DC monitor is no more sophisticated than it needs to be for a simple two-bank system

PHOTO 4: Make sure all cables that carry charging current have overload protection

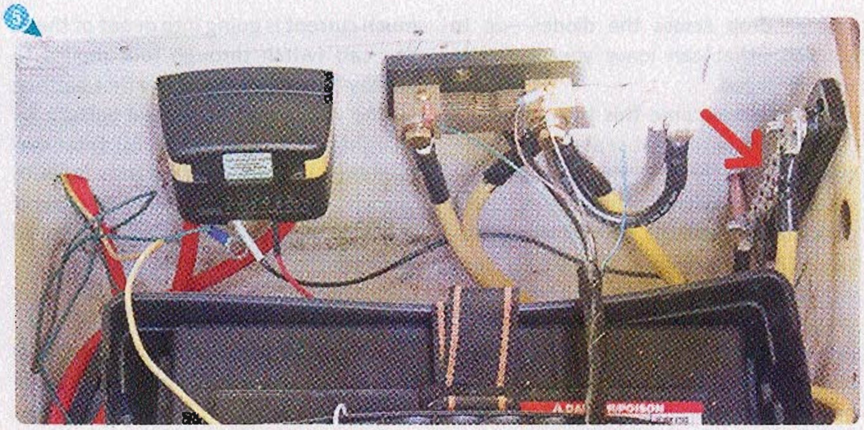


PHOTO 5: I led all negative cables to the busbar (upper right), and connected it to the engine block

feet, AWG 4 battery cable would be more than adequate. I calculated that I would need 21 feet each of positive and negative cable, and some of the prices quoted for marine-grade tinned-wire cable made my eyes water. I ordered the cable, terminals, heat-shrink covering, and a crimping tool from Genuinedealz.com, the online store that offered the best deal at the time.

I suffered momentary brain fade once I had all parts in hand and was ready to begin. What to do first? I decided to complete each aspect of the installation before moving on to the next.

THE SWITCH. After connecting the two 90-amp batteries in parallel, I measured, cut, and installed the positive cables from the alternator to the house battery bank, and from there to the battery switch and the domestic panel. Cutting the cables, paring back the insulation, crimping the terminals on, adding protective heat shrink, and wiring up the switch cost me most of an afternoon, a set of skinned knuckles, and several explosions of temper. I re-used the 0 AWG charging cable from alternator to battery, but everything else was new.

THE ACR. Next, I mounted the ACR as close as practicable to the batteries, inside the battery compartment. The Blue Sea wiring diagram suggests that the starter battery should be charged first. Nigel Calder's *Boatowner's Mechanical and Electrical Handbook* suggests that the house bank should receive the primary charge, rather than have unregulated charge current running through the smaller starter battery. On a low-capacity system like mine, I doubted it would make any difference. I ran a cable from the starter battery side of the switch to the A terminal of the ACR. From the B terminal, I ran a cable to the house side of the switch. ABYC standards require overcurrent protection in positive DC cables, so I added 100-amp fuses to the cables between the switch and the ACR **(Photo 4)**. Following instructions, I wired up a small LED light to tell me when the batteries were combined.

NEGATIVE CIRCUIT. It's a good (and tidy) idea to have a common grounding point near the batteries **(Photo 5)**. I installed a busbar in the battery compartment and took all the DC negatives to it, including the negative return for the ACR. Then I ran a single grounding cable down to the engine block. The AC ground should also be connected to this negative busbar.

BATTERY MONITOR. The DMM-1 came with a dual shunt, which is necessary to measure amps instead of just volts. It had to be wired into the negative return from the battery banks where it measures all incoming and outgoing current **(Photo 6)**. Smaller sensing wires had to be run from the shunt to the various battery banks and to the display, which I mounted above the switch panel. The instructions had seemed confusing to me, but it all became clear once I started. The negative cables from the two battery banks went to the central terminal on the shunt; the negative cable from the switch panel went to the right-hand terminal; and the left-hand terminal was connected to the main grounding busbar.

SOLAR PANEL. The small Sunsei solar panels sold by West Marine looked like an economical way to keep the batteries trickle-charged. I wired one of the 7.5-watt panels directly to the house bank and took its negative to the common grounding busbar so that the DMM-1 could measure the charging current. It's topped out at a 0.2 amp charge and has helped keep the batteries in good order during the summer.

HOW IT ALL WORKED

Apart from checking the electrolyte level in the house batteries (the cranking battery is sealed), I didn't have to think about the charging system all summer. Voltage in either battery bank never dropped below 12.6 volts between charges. The ACR, which lets the house bank be charged only after the starter battery reaches full charge, obviously does its job well. All I have to do is turn the switch to "on" when I get to the boat and "off" when I leave—which is exactly what I wanted.

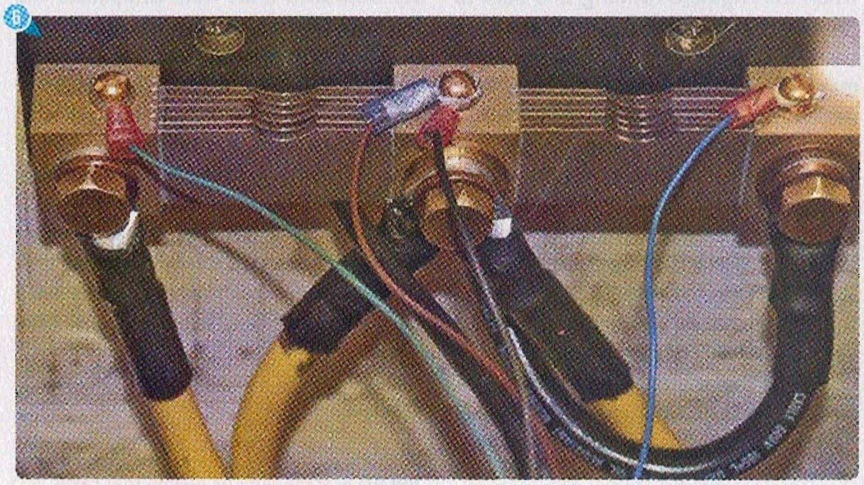


PHOTO 6: The shunt for the battery monitor measures incoming and outgoing current