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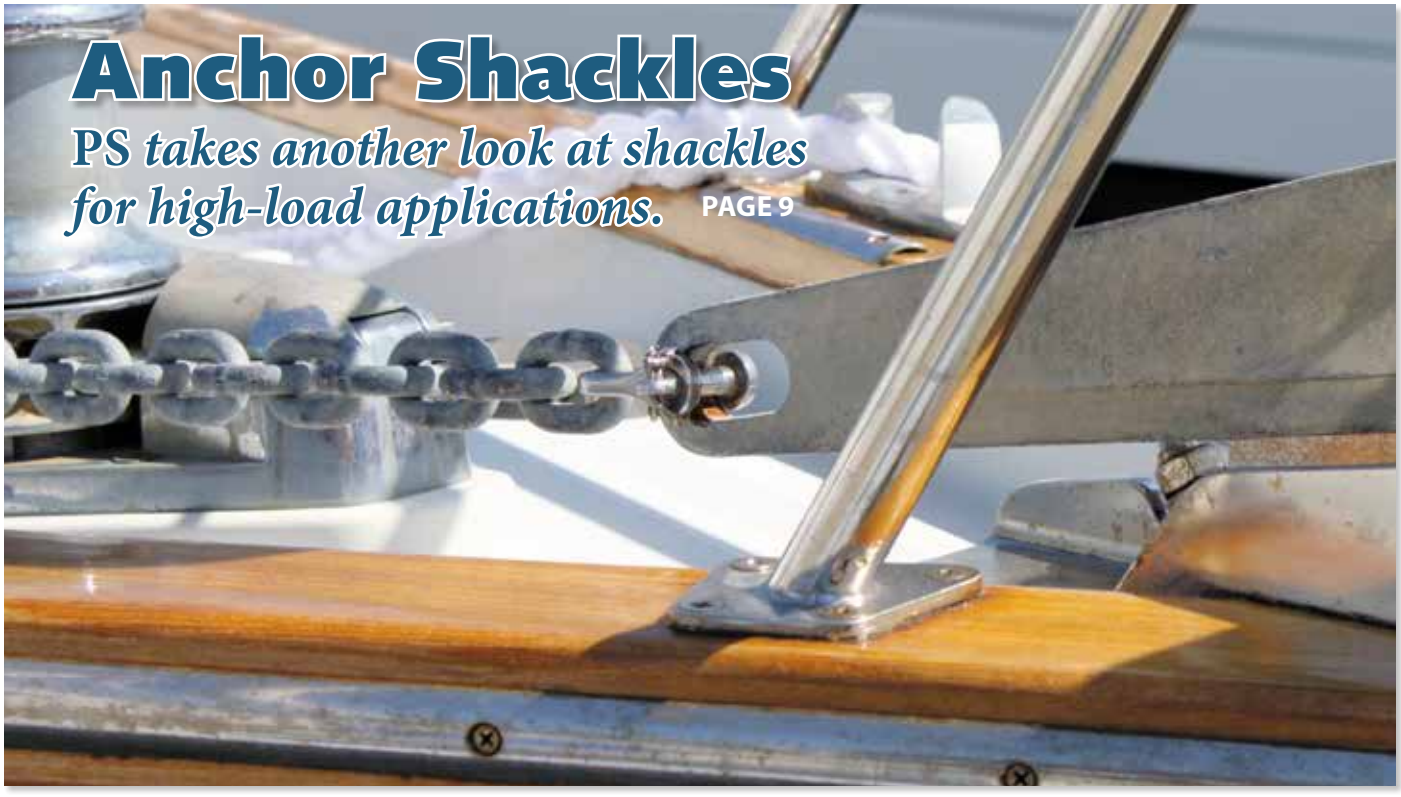
Practical Sailor™



Anchor Shackles

PS takes another look at shackles for high-load applications. PAGE 9

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ALSO IN THIS ISSUE

The test field, from left: CruzPro VAH60, Blue Sea Systems M2, Victron BMV 700, CruzPro VAH 110, and the Xantrex LinkPro. Besides technical specifications, form factor may be a deciding point in choosing a monitor. Round or square? What about depth? Our deepest unit, the LinkPro, needs four inches behind the panel. The slimmest, from Victron, needs about two inches.

Monitoring Your Battery Bank

Two long-time players in energy systems charge to the top spots.

Two recent tests graphically demonstrated the importance of monitoring state of charge in a boat's batteries: "Tracking Batteries," in the May 2015 issue and "AGM Battery Test Update," in the August 2015 issue; both are available at *www.practical-sailor.com*. These tests demonstrated that a sealed battery's capacity will be reduced over time, if it's never brought back up to a full state of charge. But just how accurate are the monitors we use to gauge our batteries' states of charge?

It has been 16 years since *Practical Sailor* looked at battery monitors, so we thought it was high time to take a look at the latest offerings in this area. Certainly, for many cruising sailors, battery banks are among their most important onboard resources, and knowing when you might be running low on electrical fuel is as important as keeping track of potable water and diesel fuel.

The need for accurate monitoring is especially important when you consider that over the last decade, we have seen some important improvements in battery technology as well as other areas of onboard electrical systems. For example, LED lighting systems have finally evolved so that they not only use very few amps to provide high-quality interior light, but they also actually meet international standards, as is the case with running lights. The net result is systems that dramatically reduce the amount of power we need to keep things illuminated.

On the other hand, many cruisers now expect to have such amenities as air-conditioning and refrigeration on board—features once considered luxuries—which has increased their appetite for amps significantly, in spite of product vendors' considerable efforts to design in lower power consumption. The bottom line here is that keeping track of your batteries' states of charge is especially important for maximizing battery-cycle life. Many boat owners today can easily have several thousand dollars invested in batteries by keeping close track of their batteries' state of charge.

WHAT WE TESTED

For this report, *Practical Sailor* studied and compared monitoring systems from five different suppliers: Blue Sea Systems, CruzPro, Scad Technologies, Victron Energy, and Xantrex . Among these vendors, we looked at offerings ranging from a simple, red warning-light voltage monitor (Scad) that automatically shuts down heavy electrical loads before a dead battery occurs or turns on a generator to get a battery charger up and running when needed, to very sophisticated adjustment and profile settings (Victron) that can work well with lithium iron phosphate (LiFePO4) battery technologies. Of our test units, the Victron monitors were the only ones to even mention lithium iron technology and make a recommendation for adjusting the units' profiling to fit lithium technology and discharge/recharge regimens. It appears that the other vendors really have not tested their products with that battery chemistry in mind.

It's important for readers to understand the limitations of any battery monitoring system. These devices are quite good at monitoring amperage and voltage and keeping track of these values down to 0.1 volts in either case. But when it comes to determining state of charge or hours of use remaining, there

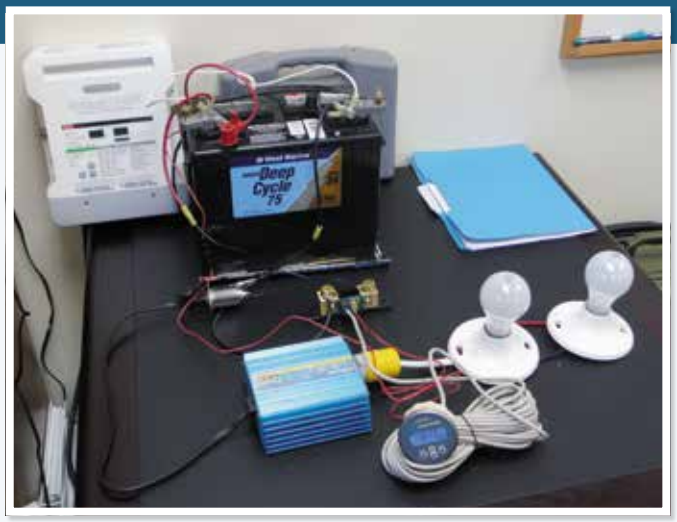
Photos by Ed Sherman

Monitoring Monitors

Our test gear comprised a ProMariner ProNautic 12-40P battery charger; West Marine-branded, flooded-cell, deep-cycle battery with a 75-amp hour rating; and two 120-volt, 70-watt incandescent light bulbs powered through a Heart 140-watt DC to AC inverter. This setup created a 12-amp DC load on the battery. We confirmed voltage and current draw using a Fluke Model 867B graphical meter and a Blue Sea Systems Model 8110-amp clamp/multimeter.

We ensured that for each product tested, our battery was at full charge, and we monitored both amp draw and voltage levels as we discharged the battery. We compared these values as we timed the constant 12-amp draw. We found that all of the units were quite accurate, but understand that this was a very controlled test using new equipment, most importantly, a new battery. The need to recalibrate this equipment as batteries age cannot be overstated, if extreme accuracy is desired.

Testers spent time analyzing the potential difficulties with installation and what the manufacturer provided to facilitate installation, including a wiring diagram and calibration instructions. It was in these areas where we found a rather broad disparity between the different manufacturers. Some units were clearly too challenging for most boat owners to install and calibrate themselves, and the units were so poorly supported that the average do-it-yourselfer would soon become frustrated. Other monitors were much easier to manage, and could be installed and calibrated by any handy boater who is capable of closely following instructions.



A Victron monitor is put through its paces. Two 70-watt light bulbs, powered through an inverter, created the load.

are many factors that can introduce some margin of error. This is something our testers had to take into account as well when they established a protocol. (See accompanying "How We Tested" for details on the testing.)

Battery chemistry and internal construction, age, temperature, and rate of discharge and recharge efficiency all play into the degree of accuracy we can expect from a battery monitor. Several of the vendors in our group have given these matters considerable attention and make recommendations to periodically synchronize or calibrate the monitor with the batteries being monitored. Victron, for example, offers an optional temperature sender to provide that data input to their monitors. Some of the vendors did not offer any guidance for calibration, presumably because calibration is limited, if at all possible.

Why does temperature matter? Monitoring battery temperature and building that data into a micro-processor that is sending out a voltage reading is useful for those seeking extreme accuracy. There is a direct correlation between temperature, current (amperage), and voltage. As batteries heat and cool due to both ambient temperature variations and electro-chemical reactions in each cell of the battery, their internal electrical resistances also vary. We know from Ohm's Law that as resistance changes (mathematically) both voltage and current will change. In the case of battery monitors that essentially present a voltage reading, monitoring temperature in real time can more accurately depict voltage, and therefore, state of charge.

Why is calibration so important? As your batteries age, a re-adjustment of the charging parameters is really quite necessary in order to maximize the accuracy of your monitor.

When selecting a monitoring system for your batteries, you may need to consider how many battery banks the system can effectively monitor. The Value Guide that accompanies this article will help with these decisions. The CruzPro VAH 110 can provide data for three separate banks of batteries, with its focus being the house bank. The Xantrex unit we tested can only handle two banks.

It is also important to understand that in most cases, the house bank is your primary concern, so complete, comprehensive analysis is provided for the house banks, but the monitoring of "auxiliary" banks (as the installation instructions will typically describe the secondary banks) will be more limited.

BLUE SEA SYSTEMS M2

The Blue Sea Systems M2 was the only monitor in our group that utilizes an extremely bright OLED (organic light emitting diode) display. This makes the display easily visible under just about all lighting conditions. The monitor includes an integrated relay that can turn loads on or off, based on the state of charge of the batteries and features a summary screen that displays pertinent information in a single screen.

Of all the units in our test field, the Blue Sea Systems installation guide was probably the simplest to follow. The M2 can work with a battery bank that has up to 5,000 amp hours of capacity and will work with 12-, 24-, 36-, or 48-volt systems. The instructions identified all of the currently available battery types as being compatible; however, they did not mention anything about LION technology.

Bottom line: We liked the ease of use and the visibility of the M2, but the instructions describe only initial setup and made no mention of any synchro-

PS VALUE GUIDE BATTERY MONITORS

PRODUCT	PRICE / WARRANTY	# OF BATTERY BANKS SERVICED	MAX SHUNT/ AMP MEASUREMENT CAPACITY	MAX AMP HOUR CAPACITY	SYSTEM VOLTAGE CAPACITIES
BLUE SEA SYSTEMS M2	$305 / 5 years	3	500 amps	5,000 amp hours	12-24-48 volts
CRUZPRO VAH 60	$260 / 1 year	1	150 amps	3,000 amp hours	12-24 volts
CRUZPRO VAH 65	$302 / 1 year	3	450 amps	3,000 amp hours	12-24 volts
CRUZPRO VAH 110	$336 / 1 year	3	450 amps	3,000 amp hours	12-24 volts
SCAD LVA	$80 / N/A	1	N/A	N/A	12 volts
VICTRON BMV 700 / 5 ★	$170 / 5 years	1	500 amps	9,999 amp hours	12-24-48 volts
VICTRON BMV 702 ★	$190 / 5 years	2	500 amps	9,999 amp hours	12-24-48 volts
XANTREX LINKPRO ★	$270 / 1 year	2	600 amps	9,999 amp hours	12-24 volts

★ Best Choice ✓ Recommended $ Budget Buy

Two makers' products stood out in the battery monitor test: the Victron 700 and 702, thanks to their very precise calibration and two-bank capability, and the easy-to-install Xantrex LinkPro, which offers a desirable synchronization feature.

nization or periodic calibration requirements, so we have questions about its long-term accuracy as the batteries it's connected to age.

CRUZPRO

CruzPro sent us three different units to check out, we tested two of the three: the VAH 65 and VAH 110. We did not test the VAH 60, which is very similar to the VAH 65 unit; the essential difference is the amount of amperage each can handle. These units are limited in their voltage-handling capabilities to either 12- or 24-volt nominal systems and in battery-bank capacity up to 3,000 amp hours. The units offer NMEA 0183 interface capability, which allows you to monitor battery voltage remotely through your multi-function display (MFD) or remote display. They also have a programmable voltage alarm to alert the owner when voltage is too high or too low. Additionally, these units can be calibrated to automatically turn a battery charger on and off at user-selected points.

All of the CruzPro units offer a wide range of adjustability for altering Peukert's Exponent, the fundamental algorithm used by all of our test subjects. The problem is that the methodology involves a great deal of trial and error. The default exponent used for calculating is set at 1.25. This seemed to work well for the flooded-cell, deep-cycle battery we used during our tests, but this exponent is not the same for different battery types, and it will change as the batteries age.

The CruzPro units also offer adjustments for what they refer to as "amp-hour drift." CruzPro describes this "drift" as what happens over extended periods of time when the boat is not in use. During this period, small calibration and measurement errors accumulate and cause the meters' amp-hour value to drift away from the actual amp hours available. Again, the method to deal with this is trial and error.

Instructions are provided in the owner's manual, but they are a bit subjective (not to mention complicated), in our view. Certainly, some fiddling with the calibration will probably bring the monitor closer to its ultimate accuracy, but just remember that it will likely need readjustment as the battery ages. Our guess is that most people won't bother with these tweaks as they go along, and frankly, the documentation that comes with the product is just too vague to really be helpful. CruzPro explained that the user manuals are "short and to the point," because they have found that people tend to not actually read longer, more detailed manuals.

Bottom line: While a techie might get many hours of pleasure tinkering with the CruzPro's functions, in our opinion, this line of meters is more complicated than it needs to be for the average boater. It's complicated enough that we would recommend a professional installation in most cases.

SCAD TECHNOLOGIES

The Scad Technologies monitor we tested is basically a simple voltage alert system. It works only with 12-volt systems. The unit offers both an audible and visual alarm and is programmable for both high- and low-voltage values. Additionally, the unit can be wired to shut off a high-current load, such as a DC refrigerator, 30 seconds after the visual alert or 15 seconds after the audible alert is activated. It can also be wired to turn on a generator when the low-voltage alarm gets triggered.

Bottom line: Essentially, this is an inexpensive backup monitor, or an energy-saving switch to preserve battery state.

VICTRON ENERGY

Victron sent us two similar units, the BMV 700 and the BMV 702, which adds features like battery temperature monitoring, basic monitoring of an auxiliary battery, and monitoring of mid-point voltage on larger battery banks.

The comprehensive owner's manual does a good job explaining the monitors' limitations and the variability in battery monitoring systems in general. It also discusses the Victron monitor's programmable functions that help to ensure a higher degree of accuracy. Programmable functions include battery capacity, charged voltage, tail current (a percentage of the battery capacity), charged detection time, Peukert's exponent, charge efficiency factor, cur-

In Search of Accuracy

The degree of accuracy we can expect from a battery monitor depends on a number of factors: battery type, age, rate of discharge, and recharge efficiency, to name a few.

Several of the vendors in our test group recommend that you carry out periodic calibration in order to ensure that the readings are accurate. Victron's monitors, for example, can be programmed for a range of scenarios. Other makers offer very little guidance on calibration.

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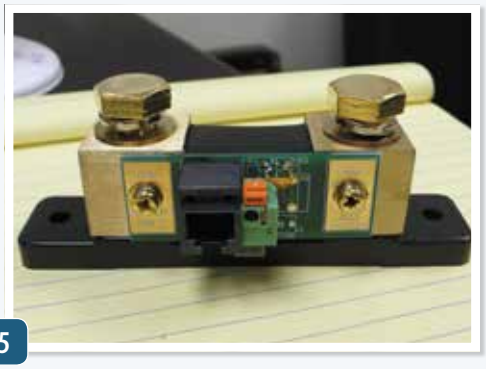
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1. The Victron units were the most compact and will require very little behind-panel depth for installation.

2. The Xantrex LinkPro offers a temperature monitor sensor option, which we feel is an important addition to enhance accuracy of readings over time.

3. The CruzPro display is large, and the data is in large font. This will make it quite useful for those needing to check the screen from a distance.

4. The Blue Sea Systems LED display will be crystal clear even in the brightest sunlight. In terms of display, it was very well suited for being mounted in the cockpit.

5. The Victron shunt was the only one in our group that supplied a CAT 5 cable to connect the really fine-gauge wires linking the shunt to the instrument display. This simplified installation considerably.

rent threshold, time-to-go averaging period, zero current calibration, and a synchronization function. All of these functions are explained in great detail in the owner's manual with help provided in making initial decisions based on the battery technology in use.

These units have the highest capacity of all the units we tested except the Xantrex LinkPro and can be used to monitor a battery bank with up to 9,999 amp hours of capacity. They can work with 12-, 24-, or 48-volt systems. The BMV units also store history data, which can be used later to evaluate usage patterns and battery health, as well as help in tweaking as the batteries age.

In all, we liked the documentation provided with the Victron energy units over all of the other products in our test group. The fact that the units come with a CAT 5 cable to connect the gauge to the shunt helps to significantly reduce the chance of making a potentially damaging error during installation. Basically, all of the wiring needed to install the unit that is not a part of the boat is provided with the kit.

Finally, the Victron monitors were the only units in our test group to provide information on using them with LION batteries.

Bottom line: The Victron BMV monitors earned the Best Choice pick. They will hold particular appeal to owners with high-capacity battery banks who are leaning toward Lithium Ion. If you're a savvy do-it-yourselfer, the BMVs lend themselves to DIY installation.

XANTREX

The Xantrex LinkPro we tested is quite feature-rich. The voltage limits are for 12- and 24-volt systems only, which cover most applications. Its amp-hour range goes to 9,999 like the Victron units, so connecting to large battery banks will not be an issue. The unit can be equipped with an optional temperature sensor like the Victron BMV 702 model, which we would always recommend as one more data point to improve overall accuracy.

Also like the Victron units, the Link-

We used a brand new lead-acid battery for testing. While hardly mimicking the real world, this allowed for a more controlled comparison.

Pro provides a history menu, which testers really liked. The data it provides can help boat owners analyze their onboard electrical habits, both good and bad. A unique feature with this model is the ability to auto-synchronize with the connected batteries. This synchronization function helps to eliminate the need for tweaking adjustments as the battery ages and will go a long way toward ensuring that battery maximum cycle life is achieved.

Bottom line: Also a Best Choice pick, the LinkPro is one of the most popular battery monitors on the market for good reason. The synchronization feature is especially helpful for the non-techie.

CONCLUSION

After spending a month working with these units and really digging into all of their features and setup requirements, we came up with two winners: the Victron Energy BMV monitors and the Xantrex LinkPro monitor. These monitors offer the highest level of sophistication available today, and we feel they will do the best job in ensuring that you can maximize your onboard battery investment.

For further tips on installing a battery monitor, *Practical Sailor* contributor Rod Collins of Compass Marine, who carried out the *PS*'s 2015 battery tests, has an illustrated guide on his website: *http://www.pbase.com/mainecruising/battery_monitor.*

CONTACTS

BLUE SEA SYSTEMS, 360/738-8230, www.bluesea.com

CRUZ PRO, www.cruzpro.com

SCAD TECHNOLOGIES, 336/793-2003, www.scadtech.com

VICTRON ENERGY, www.victronenergy.com

XANTREX, 800/670-0707, www.xantrex.com

SHACKLES *Continued from page 13*

ue, consumers deserve to get an accurate number for rated strength.

Even more concerning is the West Marine shackle. This is shackle has all the appearance of a good product. It is embossed with the load rating and sold through a reputable merchant. But if we respect the warnings about side-loading (a reduction of 50-percent strength, or more), this shackle is unfit for service in the anchor rode, in our opinion. We contacted West Marine with our findings. At presstime, West Marine was working with Fasco, the shackle supplier, to conduct further testing. We look forward to their findings.

To their credit, West Marine has been very supportive of our testing program. They have also been very responsive when we've raised red flags. When *PS* discovered that Rocna (under its former manufacturer, not CMP) was misrepresenting the materials used in its anchor shank, West Marine was the only major retailer to set up an exchange program. We expect that the company again will do the right thing. In our opinion, this shackle should not be marketed as a ground-tackle accessory until other independent testing proves it is up to the task.

The take away bit of wisdom here is that if you are looking for an anchor shackles, specify Grade B shackles from Peerless (Peerlift, Grade B), Crosby (G209 A), and Campbell (Grade B). These shackles are all proof tested by their manufacturers, and we've found no reason not to have faith in them. (CMP also proof tests its shackles, so we were somewhat surprised at our findings.) Although we did not test the Peerless shackle in the 3/8-inch size, other Peerless shackles have performed well in our tests. We will be answering the question of strength once and for all soon, when we put it on the test bench.

For lower-load situations, CMP's yellow-pin Titan shackles are fine—they performed well over specification—but not so well as to recommend them over Peerless, Crosby, and Campbell Grade B shackles for anything but moderate-load service above the waterline.

For those who are dead-set on converting to G70 chain, the Omega shackles look promising. Until it is manufacturer-approved, though, we can't endorse its use for such a critical application.

If you have a shackle story to share—good or bad—let us know at practicalsailor@belvoir.com.

CONTACTS

CAMPBELL, 800/688-8949, www.campbellchainandfittings.com

CMP / TITAN, www.titanmarineproducts.com

CROSBY, 918/834-4611, www.thecrosbygroup.com

CROMOX, www.cromox.eu

HARKEN, www.harken.com

PEERLESS, 800/873-1916 www.peerlesschain.com

PETERSEN, www.petersen-stainless.co.uk

SUNCOR, 508/732-9191 www.suncorstainless.com

TECNI, www.tecni-lift.co.uk

WEST MARINE, 800/262-8464 www.westmarine.com

WICHARD, 401/683-5055 www.wichard.com

VAN BEEST, www.vanbeest.com