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Battery Monitors

We recommend two CruzPro units and the Link 10. For simple amps and voltage data, the Microlog is a smart lower-cost choice.

The last time we evaluated battery monitors was in 1998, so we felt it was time to revisit the current field. It was no shock to find that there are some new players, some consolidations, some dropouts, and renaming of old products in the industry—but there have been no great revelations or technological leaps.

Top, left to right: The CruzPro VAH-30, the Trimetric 2020, the CruzPro VAH110. Bottom: the Link 10 and the Microlog.

One monitor we repeat-tested was the Link 10, now sold under the Xantrex name. It has new features, and reflects some changes in capacity and programmability via software updates, which do not really affect the marine applicability. It's still the standard to beat, however.

A few of the products we tested came from companies not exclusive to the marine world, but whose products may be reasonably suited to the harsh marine environment. By this we mean circuit boards that have an encapsulating coating to prevent moisture intrusion, non-corroding cases, and corrosion-resistant hardware.

One of the most complex units we tested is oriented to home battery power grids, and would not do well if exposed to the elements. But the $155 price for a lot of functions may make worthwhile some effort to case the device to protect it. The makers of this device are interested to see what they can do to make their product more marine "hardened."

We did not test a unit this time from SALT (Sea, Air, Land Technologies). Company representatives declined to participate, saying that they were working on a new model to be available in a few months. We'll look forward to evaluating this new unit in an update feature.

What They Do

These monitors have varying capabilities, from basic, accurate measurement of volts and amps, to amp-hours, battery capacity, percent of power remaining, "time to empty," and so on. Additionally, some have programmable audio or visual alarms for such conditions as low or high voltage.

The reason for all this fancy digital paraphernalia is quite sensible—simply measuring the voltage of a battery in use is nearly worthless for giving you the amount of charge left in a battery or bank of batteries. Such a measurement is only accurate on a battery that's been resting with no load for quite a while—30 minutes for a rough read and an hour for real accuracy. It takes that long for the battery chemistry to stabilize.

If you want a real time "gas gauge" for your battery, then the only way to go is with one of these sophisticated monitors. Not only can they predict how long the battery will last at a given load, but also update in real time as you add or remove loads. They can also point out at a glance if you have a parasitic load on your batteries.

How They Do It
These monitors have a dedicated microprocessor with sophisticated algorithms programmed into them. The most significant of these formulas was originally developed by a man named Peukert, decades ago. Essentially, the Peukert equation applies correction factors to a battery discharge curve, taking a number of variables into account—primarily the discharge current value and the temperature. This is more difficult than one may think, because the discharge rates of a battery are not linear. For example, a battery may last one hour at a discharge of 30 amps. It will not last 30 minutes at 60 amps, but significantly less, primarily due to internal resistance of the battery. Peukert's equation can tell you the corrected number.

Unfortunately, while these devices can read volts and amps in a straightforward way, they need some user calibration to get the best possible accuracy in their more exotic measurements. Batteries are not identical products; there is some individual variation even with the same model battery. Add in age factors and charging efficiency factors, as well as battery type—lead acid or sealed AGM, for example—and it's easy to understand why user calibration of these devices is necessary for the accuracy one would expect.

How We Tested
This is not rocket science, but attention to detail is important to get good and fair comparisons. We used a fully charged Group 27 AGM (latest technology sealed battery) for each run. Several adjustments were required for each monitor to get amp-hour accuracy up to par.

We used a calibrated Fluke 867 graphical recording multimeter, which was also hooked to a laptop computer via a serial cable and custom software for digitally recording the values as the battery was discharged or charged. We could then select data capture intervals convenient to the test to compare real-time with the monitor we were evaluating.

We had several other ammeters and voltmeters hooked up simultaneously. This could have been done more simply, but we like to use redundant test meters as a cross check and to be sure there are no voltage drops in the temporary hook-ups. For main shunt connections we used 4-gauge starting cables from an auto parts store. For a real installation we would have looked for better quality cables, say, at a marine store. (For an explanation of what a shunt is, and what it does, see sidebar at end of article.)

We used a purely resistive source of current discharge, and ran it through a 1,000-watt sine-wave inverter, which also conveniently gave another cross check, since this high-end inverter also has a built-in digital ammeter accurate to .1 amp. We tried 2-, 25-, and 60-amp loads just to see if that influenced accuracy. It didn't.

We also evaluated the completeness of the products, hardware included for installation, how well adapted they were to the marine environment, complexity or ease of instructions, and ease of installation. We also evaluated subjectively the human factors of how easy they are to use and what features they have as well as any programmability features. There was a great deal of variation of features, included accessories, and documentation in this group.

What We Found
As in the past, we found that these devices are capable of excellent out-of-box accuracy in the volts and amps department. In those areas where user calibration is essential for individual battery measurements, it's a function of how much effort you wish to place in calibrating and "tweaking." The reward is satisfying and very useful accuracy in all the expanded capabilities beyond volts and amps. We suspect that many of these features are unused in the "real world," and that most people just use the basic measurements.

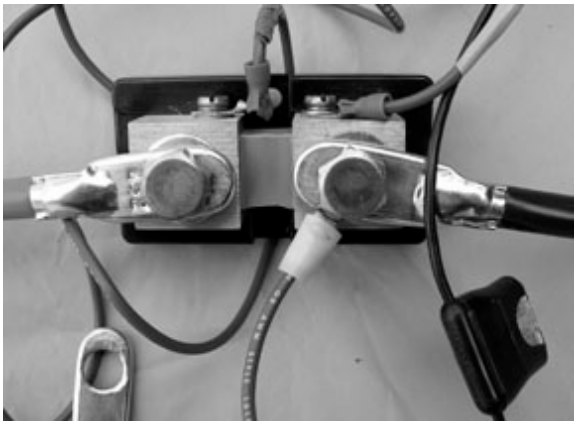
It would not be unreasonable to say these devices are as accurate (beyond volts and amps) as you wish to take the time to make them through calibration to your specific setup. Even volts and amps can be user-calibrated in most of the monitors to get .1 accuracy. Periodic monitor tweaking will also be necessary.

All the products are designed for permanent installation in the electrical system, so they take up a tiny amount of current. The value guide on the next page reflects this current draw. There are two numbers (when stated). The larger number is with the display on and the smaller with the display off or the unit in sleep mode.

All the products tested have extensive websites with all sorts of information, including downloadable user manuals so you can get a good idea ahead of time just what they do and how well they explain it. With the ease of the Internet, ordering is a snap as well, either directly from the vendor (except Xantrex) or resellers.

CruzPro
This New Zealand company has an extensive line of marine electrical products and accessories for their monitors, as well as optional remote units. (They have U.S. dealers.) The orientation of these devices is purely marine, and they are designed for the harsh environment. Functions are strictly marine-oriented.

CruzPro sent us three monitors to evaluate. All three fit in a standard size, 2-1/8" round cutout hole. Even the large VAH-110 model with a 4x4-inch face fits the same cutout, making installation and long-distance viewing a breeze. All units have LCD displays with user-selectable backlighting.



The shunt hook-up shows the use of heavy 4-gauge direct wiring and swaged lug terminals. Also, you need to add a proper-value fuse to protect the meter.

These CruzPro monitors are versatile. As shown in the value guide above, they have about everything you would need to keep tabs on any system up to three banks, depending on model. Since one shunt is supplied, only one battery or bank can have amps measured, even on the multi-bank design VAH 35 and 110 models. The NMEA output capability was unique to the test group and shows the marine orientation.

The basic product is the VAH-30, designed for one bank or house battery. It uses an included 150-amp shunt. Basically this unit displays volts, charging/discharging current (amps), and battery capacity in percent used and remaining. It allows user calibration of functions for greater accuracy. You can set high and low voltage and amp-hours-remaining audible alarms (85db built-in)—very convenient. The five backlighting choices give fine lighting level selectivity.

This featherweight unit uses no external metals to corrode other than corrosion-resistant screws under the instrument-mounting panel. All functions are accessible via the three buttons. In spite of only three pushbuttons, it was the easiest product to install, use, calibrate, and understand.

This makes up for the thin installation/user manual, in which there's just enough information to do all the calibration and use functions, but no troubleshooting section, discussion of theory, or installation hints. You get the unit, the shunt, and the instructions—all other wiring, fuses, etc. are to be furnished by the installer. This is true of all the monitors reviewed here except the Micrologic, which came with a special sense cable.

There is no information on proper mounting methods of wires, terminal fabrication, etc. The single basic line drawing is only adequate for those who are savvy with proper ABYC electronic installation protocols.

The VAH-35 was essentially the same, except for greater bank capacity and a 450-amp shunt.

The top-of-the-line VAH-110 has a 450-amp shunt and huge display that comes with a nice protective cover. This monitor can be programmed to work with "standard" 50mV shunts from

50 to 700 amps. The VAH-30 and VAH-35 can also be programmed with shunts from 100 to 600 amps. All were easy to use and calibrate.

The VAH-110 model also has the additional capacity to turn on a charging source when the battery reaches a certain level of discharge, and turn off the source when the battery is charged. CruzPro claims this feature is unique in this category.

Microlog
The Microlog DMM-1 represents the low-cost end. However, it's a very accurate digital volt and ammeter. The monitor appears to be sealed against the elements and the company claims to have a conformal coating on the circuit board.

There's no amp-hour readout or other exotic functions based on Peukert's equations, but the DMM-1 offers something none of the other units supplied does —dual shunts for independent measuring of amps for two batteries or banks of batteries. For example, you could set it up to measure the input from solar panels on one bank and the drain of a fridge on another bank. The shunts are rated 180 amps each continuous, 200 amps for 15 seconds, or 2,000 amps for one second. A special installation cable is provided with the shunts (not the heavy wire) that should be used for maximum amp reading accuracy.

Backlighting is a $30 option, and includes all the terminals and boots.

If you want simple and accurate accounting of amps and volts for two banks, rather than fiddling with amp-hour adjustments as on the other monitors, this is a good low-cost choice.

TriMetric 2020
This monitor is sold by Bogart Engineering in Boulder Creek, California. The unit is primarily used in off-the-grid houses and RVs, but Ralph Hiesy of Bogart Engineering asked us to consider it and see how it might be suited to use aboard boats. He is aware that the unit is not marinized and that it would need to be installed in a protected environment on a boat.

Indeed, the case is not sealed, nor does the circuit board appear to have any type of conformal protective coating. The device face is aluminum, but the mounting box has open areas.

Assuming that the monitor was mounted in a place and in a way that water couldn't get to it, our only concern would be its ability to resist corrosion from salt-air exposure.

There are a number of additional functions built in to this monitor beyond normal marine needs. They are conveniently accessed in a second tier of functions, if desired.

If the CruzPro products represent a minimalist approach to instructions, the TriMetric is at the other end of the scale. It has an extensive technical manual, definitions, theory, some troubleshooting tips, diagrams, and even more on the website. It's a bit complex, but manageable, and it's always better to have too much information available than too little.

The basic functions of volts, amps, and percent of battery charge are there, as are amp-hours from full, days since charged, days since equalized, cumulative amp-hours since installation, maximum voltage, and minimum voltage. All functions are discussed in some detail and theory of operation, but there's limited information on installation issues, and nothing about boat installation.

Alarms are limited to visual only. There are user customization functions to increase system accuracy. This device is more of a battery bank system manager than the other monitors. The display may be shut off to conserve the already low installation drain (30ma with display on, 16ma with display off).

The unit comes with the mounting box, electronic display, and shunt. Additional installation accessories such as a smaller-capacity shunt, lighting protection, wiring installation cable, or an adapter that allows use in 48-volt systems, are available as optional items.

Link 10
There are a series of venerable Link devices designed for single batteries (Link 10), dual banks

(Link 20) or to interface with battery chargers (Link 1000 and 2000). This series has been around for a number of years.

The latest version of the Link 10 we tested has some additional finer calibration capability, such as for smaller-capacity batteries as well as high-voltage capabilities to 500 volts. These are geared to other functions such as electric vehicle battery monitoring. Marine-wise, the Link 10 is pretty much the same as before, which is to say it has extensive functionality and adjustability. Most of the features can be turned on or off, such as auto-scan, sleep mode, display lockout etc.—more adjustability than any other model.

It has the most choices in the important "remaining battery time" function, which helps to get more accurate projections of how much time remains in your battery bank. You can choose from several averaging functions, no averaging, or percent remaining. Others only give percent or amp-hours remaining, which is only accurate if the load is constant. However, nothing will help accuracy if the battery loads constantly vary significantly.

On the Link 10, the deepest discharge function and average discharge function can help determine a battery's projected life, or whether a larger bank is necessary or a different charging schedule is needed.

The Link 10 doesn't have NMEA functions, but does have an optional serial and/or external temperature connection. It also doesn't have audible alarms except as a pre-buy option. It does have the easiest to understand and use manual, and even a little troubleshooting.

If you decide on this monitor, you would be well-served also to buy the optional wiring kit of twisted-pair wire, enclosed in a jacket.

Summary
In our opinion, none of these devices has adequate information for a person inexperienced with low-voltage electronics installations to do a good job—at least with the shunt installation. The Link 10 and TriMetric come closest, but even the information-rich TriMetric manual had little in the way of specific installation directions, and in fact, the manual recommends professional installation.

It would seem that all the monitor vendors assume these units will be professionally installed.

The Link 10 from Xantrex offers a lot of adjustabilty if you want to go beyond the basics.

We don't want to overstate the level of difficulty here—there aren't that many wires and connections—but high-current shunts and #4 wire are nothing to trifle with. You can cause bum instrument readings at least, or electrical system- wide malfunctions. Much heat can be generated with only minor wiring termination errors, causing resistance. Most likely of all is a quick corrosion problem due to improper lug terminal installation techniques and materials.

Large terminals should be swaged on with a very expensive professional device or purchased made-up. Hammer-type lug "mounters" are inadequate and should be avoided—we have tried them all. They will work in the short run but tend to fail by corrosion in a marine environment. They also don't "fuse" to the wires the same way a swaged terminal does—lots of micro air spaces are left between the wires and terminal sides, which attracts corrosion.

Performance-wise, all these instruments did what they said they would. All took some monitor tweaking and re-tweaking to get battery-measuring functions working accurately.

Plan on purchasing extra all the additional wiring, terminals, fuses, wire mounting accessories, etc. since all but the Micrologic supply only shunts and monitors.

Be sure to use twisted-pair wiring when called for. The vendors generally offered optional wiring

installation kits. The distance between the batteries and the monitor is no problem since only thin (twisted pair) wire is needed.

Bottom Line
For us it's a toss-up between the CruzPro 35 or 110 units and the Link 10. The particular functionality you're after is the deciding factor, since they have slightly different feature sets. The CruzPro VAH 30 and 35 instrument faces are also available in a square form in addition to round.

If you want NMEA connectivity, remote additional units, or audible alarms, the CruzPro monitors are the choice. If you want a whole suite of coordinated-appearing instruments, CruzPro can supply that. If you want a big visual display—then again, the CruzPro 110 is the one. It has the additional charger turn-on capability as well.

The CruzPro units carry LCD displays, which generally do not work well in below-freezing environments, but have lower power drain with the backlighting off. If you need or prefer an LED display, then the Link series will be better.

The Link 10 has been around for years and is one of the few survivors you will find in all the catalogs. This is partly because of marketing, but also because it has lots of flexibility and adjustability of virtually every measuring and display parameter. No other unit has as many, but the CruzPro has a good set of adjustments as well.

The Link 10 is a good choice if you are a detail person and like to adjust the instrument to the n-th degree. It potentially can be made more accurate than any other, but will require constant tweaking as the banks age to keep up that accuracy. For multi-banks, go with the Link 20. The display numbers are small but bright LEDs, and the constantly visible charge status display is handy for at-a-glance charge status.

If you want simplicity of volts and amps only, and low cost, then the Microlog is the choice. The dual shunts were unique in the group to measure amps in two separate batteries or banks.This is a very attractive feature.

The TriMetric offers accuracy, sophistication, user-friendliness, and an excellent manual—all for an attractive price—but at present its land orientation makes us wary. The big draw is bang for the buck, but plan on installing it in a water-resistant case. Heat should be no issue.

Also With This Article
"Value Guide: Battery Monitors"
"How They Do It"

Contacts
• Bogart Engineering (TriMetric), 831/338-0616, www.bogartengineering.com
• CruzPro, 64-9-838-3331, www.cruzpro.com
• Microlog, 450/664-2664, www.micromediaplus.com
• Xantrex (Link series) 800/670-0707, www.xantrex.com