



# DEMYSTIFYING YOUR MULTIMETER

Troubleshooting electrical and electronics onboard

BY JEFF COTE

PACIFIC YACHT SYSTEMS

BlueSea 8110 Mini Clamp Multimeter



First, a clarification. A voltmeter, or voltage meter, measures the potential difference (voltage) between two points in an electrical or electronic circuit. A multimeter goes beyond that to not only measure voltage but a variety of other variables such as current and resistance. There are models designed for direct current (DC) circuits, alternating current (AC) circuits or both.

Voltage is very similar to the water pressure in a garden hose. The greater the pressure (voltage), the greater the potential energy that is available. 120V is more than 24V, which is more than 12V. In a battery bank of multiple batteries, you would use voltage to determine which battery has failed or has a short.

Resistance is like kinking the garden hose and slowing the flow of current. A poor connection or corroded wire is like a kink in the hose and causes voltage drop. Excessive voltage drop may result in appliances failing, but even worse, can cause overheating of the wires and connectors.

In keeping with the hose analogy, as it relates to electrical, amps (A) for electrical is the flow rate of the water in the hose. For instance, when thinking about how much water might come from a hose, one might say the flow rate is 10 liters/second. With electricity, amps also represent the rate at which current is passing through a wire.

When troubleshooting an electrical circuit, a blown fuse or circuit breaker is a top contender for fails in a marine electrical system, but this is a good thing as fuses are designed to trip/blow when the amperage going through the fuse is exceeded. That is how fuses protect electrical circuits and, in turn, your boat. In a perfect world, all of the fuses would be at the beginning of

the circuit. However, we have worked on thousands of boats and it still amazes us how well hidden a fuse can be and how many fuses can be on one circuit. On a recent boat, there was one fuse at the beginning of the circuit, close to the battery bank, and another fuse hidden mid-way before the fridge. Without an electrical drawing or prior knowledge, your cool drinks are doomed. This is when you would use your multimeter to test along the wire run and determine, volts here, volts here, and no volts here. So what happened between those two readings?

Another great use for a multimeter is to determine how many amps something is drawing. For example, in the early days on my own sailboat I would wake up in the morning to realize that I had used almost 15 amp-hours overnight even with the fridge turned off to conserve power. I used my clamp-on multimeter to determine that the original anchor light was drawing 1.5 amps over a 10-hour period. By replacing the bulb with an economical LED, I am now drawing 0.2 amps over a 10-hour period for a total draw of two amp-hours.

**SO WHICH IS THE BEST ONE?** Like everything in the marine industry, multimeters range in price. The one we recommend for recreational boaters is the BlueSea 8110 Mini Clamp Multimeter which retails for a little over \$200. It has a large digital display and a data hold button to lock in the reading value if you are in an awkward space and can't see the screen. It includes the typical wire leads, however, the clamp allows you to measure both AC and DC current in the wire without

**T**here is nothing more frustrating than having to change your boating plans because an important piece of equipment isn't working. It is even more frustrating to return home to discover that it was a simple fuse or switch. Sometimes it is the actual appliance or equipment that has failed, however, quite often it is a connectivity issue. Boats vibrate, wires chafe, connectors come loose and saltwater causes corrosion on all of it.

During the busy months in the Pacific Northwest, we receive calls from boaters who are on the edge of cell service in Desolation and desperate to save their vacation. They really don't want to pull up anchor to look for help, and in some cases they can't. We can have a technician troubleshoot remotely but without some key pieces of information, it can be very challenging. Much of this can be avoided by simply learning how to use a multimeter.

disturbing the circuits or contacting live terminals. If you already have a multimeter onboard, confirm the options available and double-check that it has a DC amp range of at least 300 to 400 amps.

The first step is to decide what you would like to test and move the dial to that option. Notice that both the AC and DC measurement modes are marked with an A, however the symbols below are different.

Squeeze the clamp trigger to open the clamp and place a single conductor in the centre of the clamp. Allow time for the value to stabilize, then read the current on the digital display.

**REVERSE POLARITY** is when the hot and neutral connections are wired backwards. You may have noticed that you have a Reverse Polarity Indicator (RPI) on your main AC electrical panel. When you

are plugged into shore power, this verifies that the outlet on the dock is wired correctly. Reverse polarity on the dock or on your own boat energizes the neutral ground and can create a potential electrical shock hazard. ABYC requires that you have a double pole main breaker or a single pole with a polarity indicator. If you don't have a polarity indicator, get one. If you aren't sure, check your AC panel the next time you are at your boat.

Here's a good example of reverse polarity on the DC circuit, a downrigger or prawn puller wired backwards, to a 12V battery, will turn in the opposite direction.

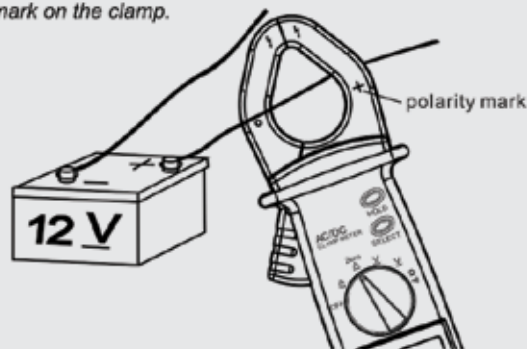
**CONTINUITY** exists when two points in an electrical pathway have a continuous connection. This is used to find breaks in circuits, faulty fuses or solder joints. Ensure that whatever you are testing is disconnected from a power

## MEASURING DC CURRENT POLARITY

**Range:** 40A – 400A (2 ranges; will change automatically)

1. Turn the function switch knob to **A** Zero.
2. Squeeze the clamp trigger to open the clamp. Place a single conductor in the centre of the clamp, as shown in the drawing.
3. Allow time for the value to stabilize, then read the DC current measurement on the LCD.
4. When finished, turn the meter OFF.

**Note:** If **■** symbol displays, it means that the direction of current flow in the conductor is opposite to the polarity mark on the clamp.



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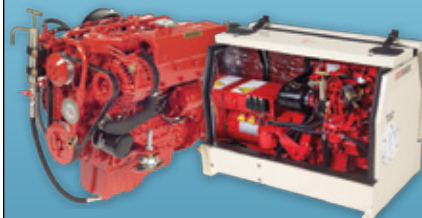


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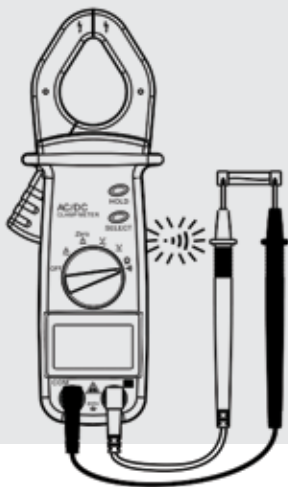
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## CONTINUITY CHECK

1. Turn the function switch knob to  $\Omega$  (••) and press the SELECT key until the •• symbol displays on the LCD.
2. Plug the black test lead into the COM terminal and the red test lead into the  $\oplus$  terminal.
3. Apply the test leads to the circuit to be tested. If the circuit is continuous or has a resistance of  $< 50\Omega$  ( $\pm 25\Omega$ ), the beeper will sound.
4. When finished, turn the meter OFF.




source. To start, switch the multimeter to the ohm symbol and (as a test) touch the red and black leads together, you should hear a beep and see a number close to zero on the display. This confirms that you have continuity. Now, choose the item you would like to test and place one probe on either side. If you do not hear a beep and the display reads 1 or OL (open loop), then you do not have continuity and hence the circuit is open or broken.

A multimeter can also be used to test AC electrical (such as outlets) but we recommend leaving that to the professionals. Home Depot sells a non-contact AC voltage detector for \$17; they also carry a Ground Fault Circuit Interrupt (GFCI) tester that simply plugs into the outlet for \$23. We recommend having both of these on your boat.

The topic of marine electri-



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cal can be overwhelming, we get that. Using a multimeter and taking the time to understand the basics on your boat can go a long way in helping when things aren't working. With that in mind, we have created a basic tutorial on the Pacific Yacht Systems YouTube channel titled "PYS BSS 8110 Multimeter Tutorial," which can also be found on our website at [pysystems.ca](http://pysystems.ca) 

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