

Galvanic Isolators: An Ounce Of Prevention Is Worth A Pound Of Cure

Any boat that spends a lot of time plugged into a marina's shore-power system is susceptible to galvanic corrosion induced by neighboring boats. Every boat that plugs in is connecting to every other boat plugged into that system via the green AC grounding wire. In effect, a giant battery or *galvanic couple* is created (**figure 1**).

In **figure 2**, two boats are moored side-by-side in a marina. Each is correctly wired with the AC grounding conductor connected to the off-engine DC negative bus and to the bonding system (if installed). Metal fittings on the bottom of the boat on the left are bonded and protected by an external zinc anode; the underwater hardware on the boat on the right is not protected. The zinc on the first boat is the negative plate in our giant battery. The running gear on the second boat forms the positive plate. When both boats plug into shore power, the green AC grounding wire completes the circuit between the battery's two terminals. Galvanically generated DC current can now flow along the AC grounding wire and between the underwater metals via the electrolyte. The zinc anode – the least noble, most galvanically active metal - will corrode first. When the zinc is depleted, the next least noble metal will start to go. Boats with aluminum sterndrives are particularly vulnerable in such a scenario. As one of the least noble metals, aluminum becomes the sacrificial anode for surrounding boats with inadequate zinc protection.

Cutting or simply disconnecting the green AC grounding wire will eliminate the risk of galvanic current caused by other boats. But doing so creates a dangerous potential shock hazard for anyone onboard and for swimmers who may be nearby while the boat is plugged in. Stray AC currents as low as 5 milliamps can cause muscle seizure and drowning. *Don't cut or disconnect the green AC grounding wire; there is a better solution.*

Fortunately, the galvanic circuit created when a boat plugs into a marina's shore-power system (and the galvanic corrosion it induces) can be effectively blocked by installing a galvanic isolator (see **figure 3**). Galvanic isolators, which have one pair of diodes connected in parallel with a second pair conducting in the opposite direction, are designed to protect a boat from passing or receiving low voltage galvanic current (up to 1.2 volt) while permitting dangerous AC voltage to pass safely via the green wire to the shore ground. A galvanic isolator needs heavy-duty diodes able to carry short-circuit amperage long enough for the circuit breaker to trip. Unfortunately, some isolators lack this capability. Other isolators parallel a capacitor – an electronic component that passes AC but not DC – so that a diode failure does not disconnect the grounding wire, a potentially hazardous condition.

When shopping for a galvanic isolator, look for one that meets American Boat and Yacht Council (ABYC) standards. Ensure that the current rating of the isolator you choose is at least the same as your boat's main shore power disconnect circuit breaker. The isolator should be labeled to indicate that it has been tested by an independent laboratory (e.g., Underwriters Laboratories) for compliance with the ABYC standard. If the isolator will be installed in a compartment containing a gasoline fuel tank or a gasoline-fueled engine or generator, it must also be labeled as "Ignition Protected". All other factors being equal, galvanic isolators with a capacitor in addition to the usual diodes will perform better than an isolator with diodes alone. They will also cost two or three times more, but this

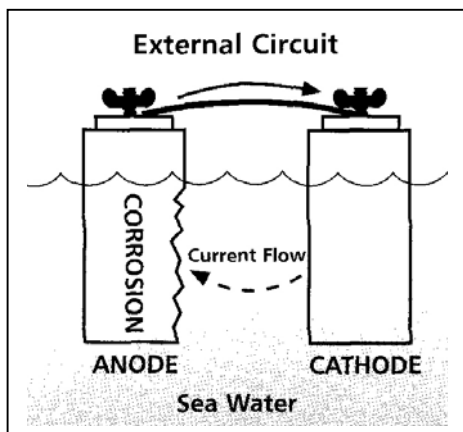
difference becomes largely insignificant when weighed against the potential costs of galvanic corrosion.

If you already have a galvanic isolator installed in your boat, check to be sure it meets the ABYC standard. If in doubt, call the isolator's manufacturer. If your isolator doesn't measure up, upgrade to one that does.

The vast majority of galvanic isolators currently installed in boats give no visual indication of diode failure. It is, therefore, critically important to periodically check isolator function using a circuit tester or multimeter. Refer to the owners manual for information on testing your galvanic isolator, or to references like Nigel Calder's *Boatowners Mechanical and Electrical Manual* or *Powerboater's Guide to Electrical Systems* by Ed Sherman. In July 2001, ABYC updated its galvanic isolator standard and recommended that isolators, manufactured or installed after July 31, 2002, be equipped with an integral or external operational status monitoring and alarm system mounted in a location readily apparent to the boat's operator. This system would provide an audible or visible indication of the shorted or open condition of any diode, failure to block galvanic current at 1.2 volts DC, continuity of the shore grounding circuit, and operation of the status monitoring device. Galvanic isolators that meet ABYC's new standard are already available in the marketplace.

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Figure 1 - Galvanic corrosion occurs whenever two different metals are in electrical contact, either directly or via an external conductor, *and* immersed in a liquid conductor of electricity (electrolyte). This electrical coupling of dissimilar metals in an electrolyte is called a *galvanic couple*. In the resultant electrochemical reaction, the flow of ions from the anode to the cathode through the electrolyte causes the less noble metal, the *anode*, to corrode. The more noble metal, the *cathode*, is protected. (*Seaworthy*, BoatUS, April 2001)



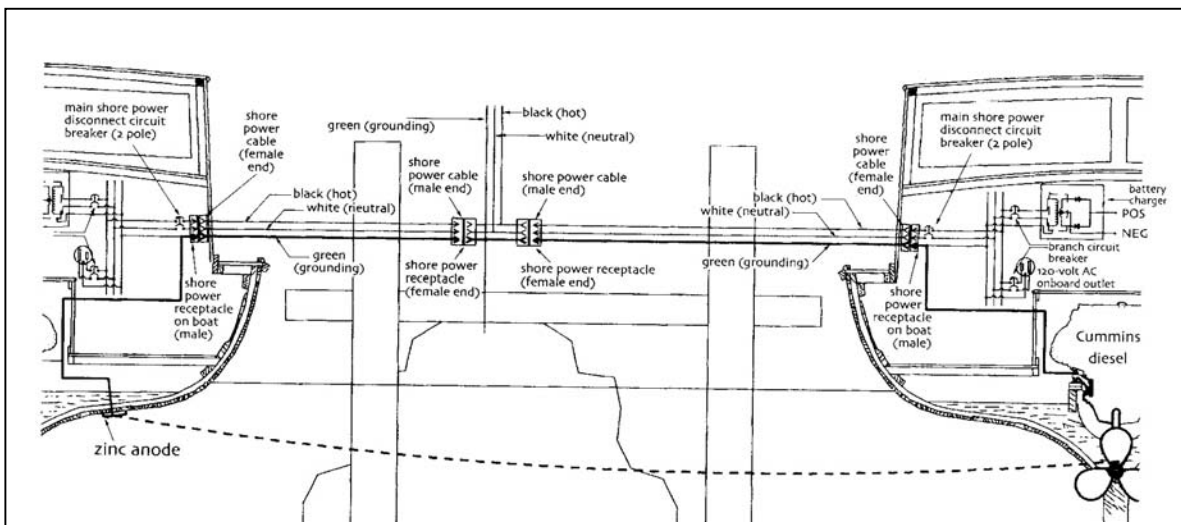


Fig. 2 – When boats plug into a marina’s shore-power system, the green AC grounding wire is the external conductor in a giant galvanic couple. Galvanically generated DC current will then flow along the AC grounding wire and between the underwater metals via the electrolyte. The zinc anode – the least noble, most galvanically active metal - will corrode first. When the zinc is depleted, the next least noble metal will start to go. (*The Boatowner’s Guide to Corrosion* by Everett Collier)

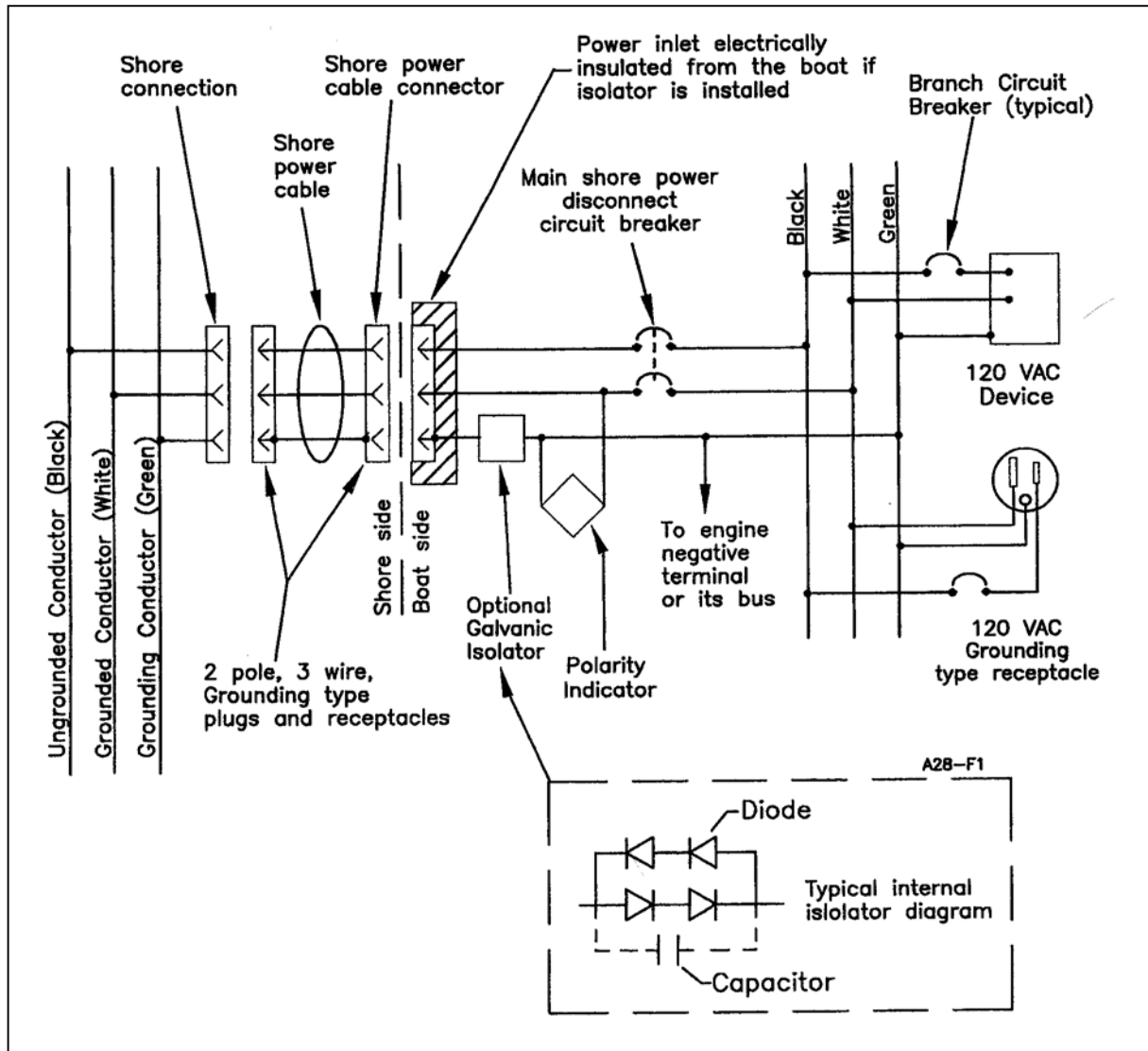


Fig. 3 - If a galvanic isolator is installed, ABYC standards require that it be placed in series in the incoming AC grounding wire immediately downstream of the shore-power inlet. If your boat has two shore-power inlets, you will need two separate galvanic isolators – one for each inlet. It is important that an isolator be installed in a ventilated, dry, and accessible location. (ABYC A-28)

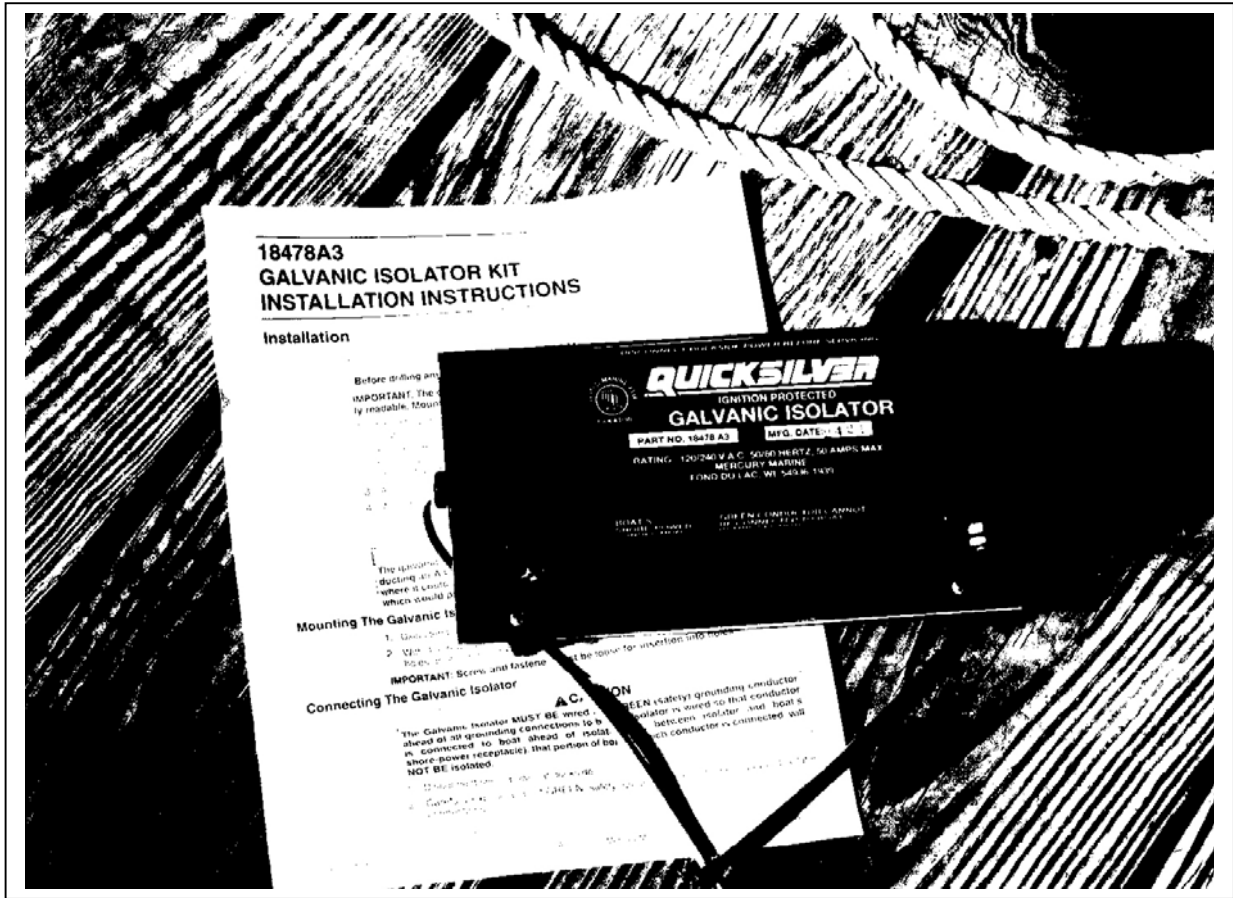


Fig. 4 – This Mercury Marine Quicksilver galvanic isolator is UL listed and ignition protected, with a current rating of 60 amps. It uses a capacitor – which passes AC but not DC – so that a diode failure does not disconnect the grounding wire, a potentially lethal condition (S. Canfield).