Shore power transformers

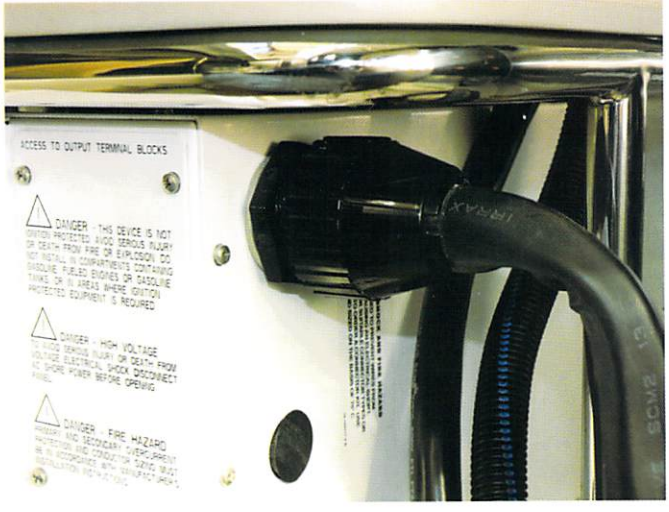
By Steve D'Antonio

Offering both safety and convenience

Shorepower transformers have been used aboard select recreational vessels for decades and of late the trend toward their use has increased, with good reason. Transformers offer users a variety of safety and convenience advantages over shore power systems that lack this valuable component.

Transformers can be wired for isolation or polarization. In either case, their greatest attribute is their ability to reduce the risk of shock and electrocution. When wired in the isolation mode, a transformer also acts as a stalwart deterrent against galvanic corrosion. The principle upon which a transformer works is simple indeed, however, there are a number of peculiarities a potential user and installer must be aware in order to ensure a safe, reliable and effective installation.

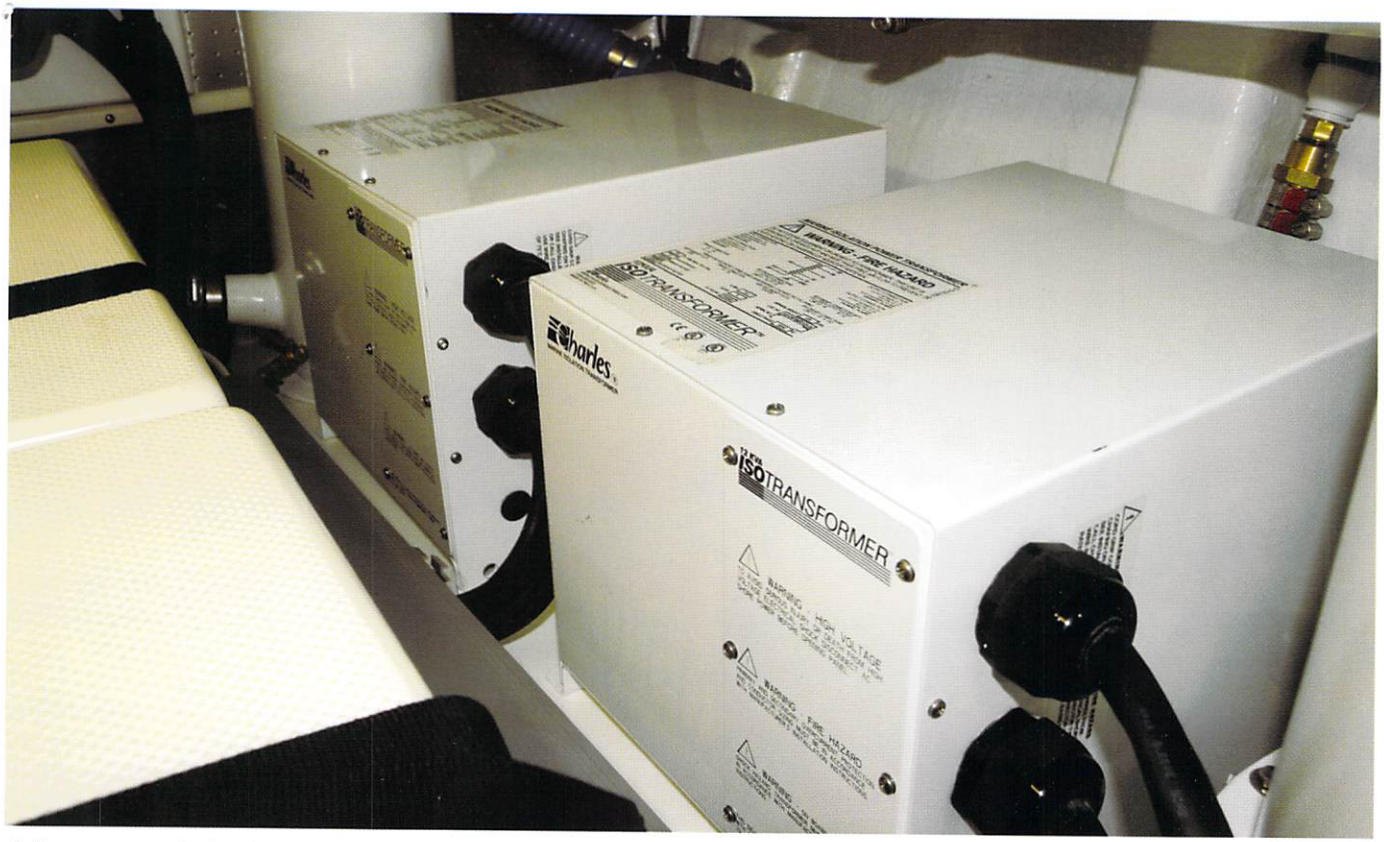
In many ways a transformer behaves much like a source of power, similar to a generator, inverter or utility company for that matter. The most important safety-related aspect of this behavior involves the path voltage takes as it's "produced" by or leaves the transformer; it seeks a return to its origin, rather than ground. The importance of this feature cannot be overemphasized. Shore power voltage, once it passes through the transformer, will only return to that transformer, either through the white neutral conductor or the green safety-grounding conductor, whether by design or in the case of a fault. Voltage that emanates from the transformer is unlikely to travel through seawater in order to seek a path to ground, thereby protecting swimmers (or someone who falls overboard while dockside).



Fleming uses only Marine UL Listed Isolation Transformers

The transformer is able to achieve this through the principal of inductance. In brief, shore power voltage travels from the dock, through the shore power cable or cables (one transformer is required for each shore power inlet), and on to the boat's shore power inlet. However, instead of going from there to the vessel's shore power circuit breaker panel, the isolation transformer is inserted into the circuit first. The incoming AC power travels through the primary or input winding of the transformer and back to shore. That's as close as the dockside shore power ever gets to the boat's electrical system. Electricity is induced on the transformer's secondary or boat side winding, there is no direct connection. This arrangement eliminates the possibility of reverse polarity (it's telling that vessels equipped with transformers are exempt from ABYC's reverse polarity indicator requirement), while significantly reducing the possibility of electrocuting a person in the water. Regardless of this protection, even where vessels are equipped with transformers, under no circumstances should people swim around vessels that are plugged in to shore power.

There's a price to be paid for the benefits offered by transformers. The average 30-amp unit may measure roughly a cubic foot and weigh sixty pounds, with 50 amp units measuring twice that size and over 100 lbs. Additionally, transformers must be provided with appropriate ventilation. Ideally, all shore power transformers should carry a marine UL listing (while most industrial transformers are UL Listed, few carry the "Marine" prefix), as well as full adherence to ABYC's (American Boat and Yacht Council) standards for transformers, found in section E-11.



Fully encapsulated isolation transformer and full current carrying shield per ABYC E-11

Isolation vs. Polarization

When wiring a transformer, the installer will have a choice, either isolation or polarization. The distinctions that exist between isolation transformers and polarization transformers are few; however, they are important none the less. It's important that you understand these differences if the vessel you own or may own in the future is equipped with a transformer, or if you are considering having one installed.

The primary difference between the polarization transformer and the isolation transformer is the manner in which the polarization transformer's connection to shore side ground is established, it is essentially a conventional connection between ground ashore and ground aboard; no galvanic (corrosion) isolation is afforded and thus polarization transformer installations must also include a galvanic isolator in order prevent corrosion. Conversely, potentially damaging galvanic current that normally would be allowed to come aboard via the green grounding conductor in the shore power cable is thwarted by the isolation transformer because there is no longer any direct connection to shore side ground or current carrying conductors.

It's important to note that it is virtually impossible to determine whether a transformer is wired in polarization or isolation mode by casual visual inspection, the identical transformer may be wired either way in full compliance with ABYC and manufacturer guidelines during installation. Only a careful inspection of the actual wiring connections and/or by using a multi-meter can this be determined for certain.

This distinction between polarization and isolation also represents a marked difference between the isolation transformer and the galvanic isolator. Where the galvanic isolator attempts to block DC current (nearly all galvanic corrosion is DC in nature) from coming aboard, up to a given threshold, the isolation transformer severs this connection altogether. It's as thorough an electrical separation as can be achieved under these circumstances.

The on board AC safety, green grounding conductor originates at the secondary winding of the isolation transformer. As a result, shore side grounds and the boat's ground have nothing in common, which eliminates the potential for "foreign" (that which originates off the boat) galvanic and stray current corrosion. Stray and galvanic current corrosion, which originates domestically, that is aboard your own boat, are still potentially destructive and not prevented or reduced by the isolation transformer, galvanic isolator or any other device except a proper bonding system and general ABYC compliant wiring procedures.

With the installation of the isolation transformer, all onboard bonding, DC grounds and AC safety grounds remain unchanged, provided they previously met the ABYC standards.

F55 Shorepower equipment, includes voltage boost feature

Whichever product you may use, ensure that carries a UL Marine, ABYC approval and that the installation instructions are followed to the letter. If this is not done, the expense and benefits, and safety, of the isolation transformer may be negated.

Additionally, because the transformer's enclosure cannot be connected to both shore and vessel grounds, this would eliminate its isolation and corrosion effectiveness, absolute attention to detail must be observed when installing AC wiring through the transformer's steel case. Properly configured, proprietary and preferably non-metallic strain relief fittings must be used in order to eliminate the possibility of chafe or contact between an energized conductor and the unit's metal housing.

In accordance with ABYC recommendations, primary input cabling must also be equipped with over-current protection, typically a circuit breaker that embodies ground fault protection, commonly referred to as an Equipment Leakage Circuit Interrupter or ELCI. These are an amalgamation of a circuit breaker and a GFCI receptacle, offering ground fault and over-current protection to the transformer's primary circuit installation. It's important to note that because of their necessary high trip threshold (typically 30 milliamps, compared to a conventional GFCI's 5 milliamps) ELCIs are officially designated for protection of equipment alone, rather than people. Additionally, an ELCI installed on the primary circuit of a transformer will provide no fault/leakage protection for the transformer's secondary or output circuit and thus the remainder of the vessel. While it's not currently recommended in ABYC standards, in order to take advantage of protection on this circuit an ELCI would have to be installed on the transformer secondary wiring as well. Input and output breakers are required in both locations in any event. Thus, the double ELCI approach is desirable in that it affords the greatest leakage fault protection for the entire transformer-equipped shore power system.

Polarization transformers, on the other hand, maintain the shore side ground connection. While polarization transformers ensure correct onboard polarity in the event of a dockside fault, they will do little if anything to prevent corrosion because the shore side ground remains intact. If you have one of these, you are protected from dangerous reverse polarity scenarios as well as water borne return paths and the resultant possible swimmer electrocution. However, on their own they will do nothing to prevent shore-induced corrosion.

Advocates of their use point out that they are safer because their metal enclosures are connected to shore as well as the vessel's grounding system, and when used with a galvanic isolator they too provide a measure of shore induced corrosion protection (up to 1.2 volts of blocking voltage). It's worth noting that any ABYC/UL compliant isolation transformer may, at the discretion of the installer or vessel owner, be installed in either the isolation or polarization mode depending upon the ground connections. In either case, the installation must meet current ABYC guidelines and manufacturer recommended installation schematics, of which there are several options. In either case, ELCIs should be used on the primary or input side as well as the secondary or output side of the unit's wiring in order to afford the greatest degree of ground fault protection to the transformer as well as the entire vessel's AC electrical system.

A limited number of isolation transformer manufacturers produce units appropriate for the recreational cruising or commercial vessel (and still fewer produce units that are compliant with UL Marine standards). Whichever product you may use, ensure that carries a UL Marine and ABYC approval and that the installation instructions are followed to the letter. If this is not done, the expense and benefits, as well as safety, of the isolation transformer may be negated. AC shore power wiring, unless you are trained and experienced, should be left to the pros, preferably an ABYC certified marine electrician.