



## Isolation Transformers: Much More Than Isolators

Steve-

*My friend said that I should have an isolation transformer. It seems to me that a galvanic isolator is much cheaper and smaller. Have isolation transformers been replaced by the new technology of galvanic isolators?*

Galvanic isolators do a good job, under ideal conditions, on just one of the many functions of an isolation transformer. If you can afford the cost, weight and space of an isolation transformer, use one. You'll be glad you did.

It is helpful to understand what an isolation transformer is, in order to understand the many different roles that it performs. A transformer consists of an input winding and an output winding, all wrapped around a heavy iron core. It converts the electrical energy on the input side into a magnetic field, which then recreates electrical energy on the output side. The input to output voltage ratio is simply a matter of the ratio of turns on the input and output windings. There is no electrically conductive path from the input to the output. Transforming this much power comes at a price: A 120/240v, 50amp isolation transformer will weigh a hundred pounds and costs about a thousand dollars. Please continue on, they are worth it!

Here are the functions of an isolation transformer, one by one:

**Galvanic isolator mode:** The boat's ground will always have a very small voltage, which is produced by the protective zincs, which are essentially small saltwater batteries. This small voltage is very important, because it protects the rest of your running gear from damaging electrolysis. For safety reasons, the boat ground must be connected to the safety ground, provided by the shore power connection. This is a problem, because this connection shorts out the protective voltage produced by your zincs. This results in accelerated zinc erosion and/or reduced protection for your running gear. A galvanic isolator allows this small voltage to exist, yet it conducts when there is a short, to cause a circuit breaker to blow rather than letting your boat's ground become electrified. An isolation transformer is considered to be an independent source, so the safety ground from the dock is not carried through it. Its output common is connected to the boat's ground instead.

**Shore power problem isolation:** Many common shore power problems are entirely eliminated by an isolation transformer. An isolation transformer corrects "Wrong polarity", which is a condition that is detected by many power panel warning lights. "Wrong polarity" usually means that the common and "hot" wires are exchanged. Polarity makes no difference on a boat with an isolation transformer. Another, more common shore power problem, is the presence of voltage on the safety ground wire. This problem can cause accelerated electrolysis damage to your boat's running gear, or even cause a safety problem. A properly wired boat, with an isolation transformer, doesn't connect the shore power safety ground to the boat's ground so the problem is entirely eliminated.

**Load Balancing Mode:** Presuming that you have 120/240v, 50amp power, you may have experienced problems with balancing your loads equally across the two 120volt lines. Nothing is more annoying than having the shore power breaker blow when you are drawing 50amps on one 120v circuit and 20amps on the other. An Isolation transformer distributes your loads perfectly across both lines. There is an extreme and infrequent result of imbalanced loads, without an isolation transformer: If the neutral gets disconnected due to corrosion, dirt, or physical damage, you can have uneven sharing of the 240 volts. Your TV wouldn't like 200 volts anymore than your air-conditioner would like 40 volts!

**Side Note on 120/240v, 50amp power:** If you are still using 120v, 30amp power, consider upgrading to 120/240v, 50amp. If you've never blown a shore breaker, seen the lights or TV dim when the air conditioner kicks on or burned a prong on a shore power plug, then maybe you don't need to change, but the rest of us should. 120/240v, 50amp power can handle 3.3 times what your old 30amp cord can handle. It's really two 120v, 50 amp circuits in one cable. Even if you don't use the 12 kilowatts that's available, it's nice to have the heavier contacts, carrying half the current. You will have far less voltage drop in the cable too. It's not much fun buying or carrying the big shore power cords, but benefits are worth it.

**Voltage Boost mode:** Once you have an isolation transformer, it is extremely simple to incorporate a low-voltage boost mode. All it takes is an extra tap on the right winding in the transformer and a switch to select it. Remember, the input to output voltage ratio is simply a matter of the input to output windings turns ratio. The extra tap just takes a few turns out of use. Voltage boost is needed at approximately half of the docks that supply 120/240volt power. It's not just a function of long, overloaded wiring that allows losses and therefore, low voltage. Low voltage is more commonly caused by the common practice of providing the two 120v circuits, by using two of three lines in a three-phase circuit. When it comes to three-phase power, 120 plus 120 doesn't equal 240!

**European Power Compatibility:** You don't have to sail to Europe to have the problem. Just sail one island past the Virgins and you have mostly European power at docks. European power is traditionally 220 volts at 50 cycles. All 120/240 isolation transformers will provide the common wire that is needed to get two 110v lines from the 220v dock power. Check to make sure that your transformer will tolerate the 50 cycles. Many are rated for 50 cycles and many more will tolerate it just fine whether rated for it or not. Most of your on-board systems will work OK on 50cycles. You should check to see what equipment could tolerate it. Most induction motor-based equipment (Air conditioners, pumps, fans) will tolerate the 50hz better if the voltage is reduced about 10 to 15 percent. Once again, another tap and switch to modify the number of turns on your transformer, will allow you to make this voltage reduction for very little cost and trouble. There are a few things like sine-wave inverter/chargers that will not tolerate 50 cycles at all.

You can deal with this exception with a switch to bypass power around your inverter and a small auxiliary battery charger.

*Stephen Sommer is a degreed Electrical Engineer with extensive experience in electrical, mechanical, refrigeration and air conditioning, systems and holds a USCG Masters license. He consults in all areas of Yacht Systems, which includes all the equipment on board yachts beyond a basic hull and motor or sails.*

*Have a systems problem or question? Ask Stephen Sommer.  
Email: [steve@boatek.com](mailto:steve@boatek.com)*