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## **Split Phase 120/208VAC Shore Power and the MS400's Isolation Transformer**

*Your Charles Isolation Transformer is also capable of becoming a "Boost" Transformer with a simple modification. Here's how...*

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## **The Split Phase 120/208VAC shore power problem.**

Some marinas provide shore power that, while great for commercial businesses, is improper for boats, typically causing "brown out" conditions. It is called "Split phase 120/208 volt" power. The normal power for boats is the same 120/240 volt single-phase power you find in your house.

This shore power problem is not limited to MS400 owners. It applies to any boat that has 240VAC equipment such as air conditioners and pumps. On 120/208VAC shore power this 240VAC equipment only sees 208VAC at best and usually less, maybe as low as 192VAC or lower. If the 240VAC equipment doesn't refuse to run on this low voltage, this "brown out" condition may not cause immediately damage or failure but the increase in current draw and heat generated can shorten the life of such equipment.

Most boats do not have isolation transformers. On 120/208VAC shore power the 120VAC equipment on these boats sees a normal voltage and is not at risk. If the AC breaker panel only has a 120VAC voltmeter it will show that the 120VAC shore power is OK, however the boat owner is unaware that the boat's 240VAC equipment is seeing brownout voltages.

For a thorough explanation of the Split phase 120/208VAC problem see the excellent article by Jim Healy titled "Why Boaters Get 208V AC Power In Some Marinas" (Just Google the title)

The problem is also mentioned in the February 2013 issue of Yachting Magazine titled "Boat Bots: Automate or upgrade your boat's electrical system" by Vincent Daniello.

## **The Bad News/Good News for MS400s.**



My 2005 MS400 came from Mainship equipped with a Charles 93-IXFMR12IIA Isolation Transformer. It is located behind the upper back plywood panel in the guest stateroom hanging locker. It isolates the MS400's AC system from the shore power AC. This prevents electrical leakage from the dock or other boats from causing corrosion on the MS400. It does this by creating a virtual 240VAC system on the boat including its own neutral and ground leads that are

not connected to the shore power neutral and ground. This not only prevents corrosion problems but also protects against 120/240VAC shore power that has problems with its neutral lead and/or load imbalance and over/under voltage on its two 120VAC leads. These are important benefits being provided by this \$2,000 isolation transformer.



The Charles isolation transformer expects to see 240VAC shore power and divides that in half to create the two 120VAC leads on the boat. That is the voltage we see on our AC breaker panel's voltmeter for L1/L2. Unfortunately, when the shore power is 120/208VAC then the Charles isolation transformer splits the 208VAC in half creating only 104VAC for the boat's 120VAC equipment. The shore power is probably less than 208VAC to begin with so the two 120VAC leads on the boat will be closer to 100VAC. Without the isolation transformer our 120VAC equipment would be OK and only our 240VAC equipment

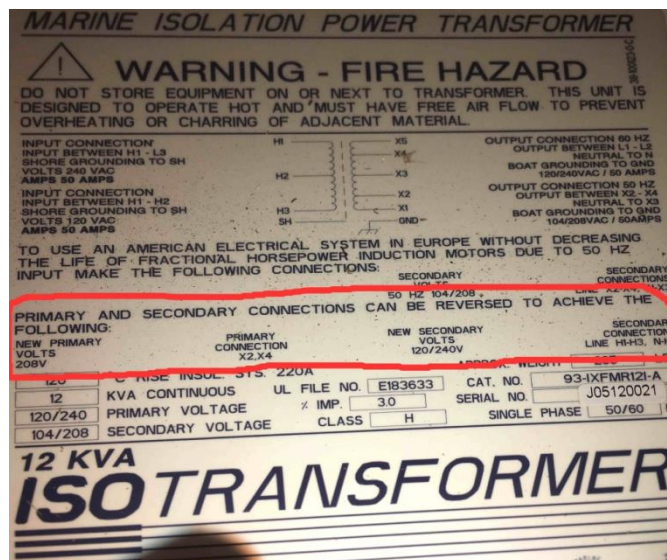
would be affected. **With the isolation transformer both our 120VAC and 240VAC equipment see brownout conditions.**

I have been at 10 marinas in Florida with my MS400 this season and encountered 120/208VAC at three of them. I saw 103, 102 and 99 volts on my AC breaker panel's voltmeter at these marinas. I went to a different marina rather than subject my air conditioners to less than 200 volts when they are expecting 240 volts. The worst part of this is that we really looked forward to our planned stay at the third marina but ended up with a wasted day and a complete change in plans and reservations.

After the third encounter I began researching the issue. It turns out that our Charles 93-IXFMR12i-A Isolation Transformer is also capable of being a "boost" transformer that will boost voltages by 15% while continuing to provide the isolation benefits. All that is needed is to change the way the transformer is wired and add a couple of lockout breakers. This allows us to use "normal" mode when we have 120/240VAC shore power and use "boost" mode when we have 120/208VAC shore power. (208 boosted by 15% is 239.2) This eliminates any concern over which type a power a marina has. The person you would talk to at the marina prior to your visit to ask what kind of power they have probably doesn't know anyway.

The following describes how to make this simple modification. It wasn't simple to research, but once educated it is simple to do.

## Enabling the Transformer's "Boost" Feature



Our first clue was on the transformer's data label. It said the primary and secondary connections could be reversed to boost 208V to 120/240V.

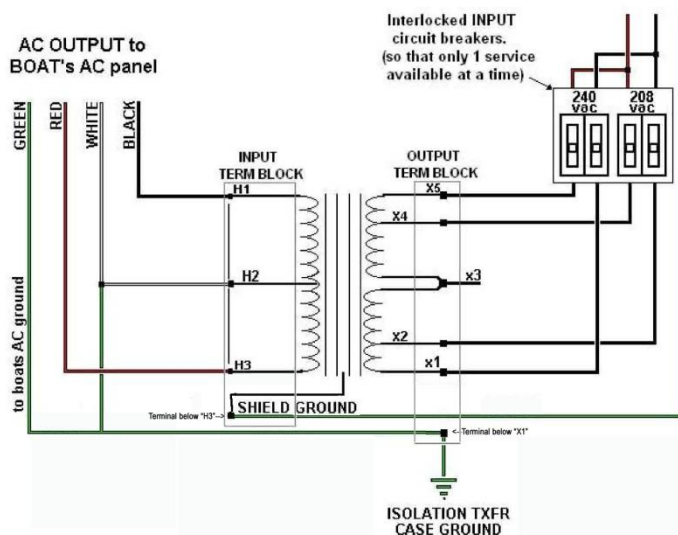
My marine master electrician, Rick Flynn of Apollo Marine Solutions called Charles and spoke with a technician who confirmed the feature.

5/19/2016 93-IXFMR12-A reverse wired for manual boost & noboost.JPG  
6/15/2016 After consultation with a Charles technician this diagram was field edited to show that ground connections are not reversed.

### 12i wired for manual Boost & NoBoost

\*\* Note that the transformer is wired in reverse of typical installation. (Ground connections are NOT reversed.)

AC INPUT from SHOREPOWER



**\*\* Using taps X2 & X4 as an input will create a 15% boost. If a source greater than 225vac is applied to these taps, hazardous voltage levels will be present. (260+ vac)**

<https://mail.google.com/mail/u/0/#inbox/154c3405197e8fd0?projector=1>

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The Charles technician provided the above wiring diagram to explain how to enable the boost function. The AC input and output are reversed. During

installation we again spoke with Charles to clarify that the ground leads are NOT to be reversed and the diagram was edited to make this clear.



A different pair of terminals are used if the input voltage is 208V rather than the terminals used when the input voltage is 240V. See the wiring diagram. Only one set of input terminals can be used at a time so a pair of interlocked breakers are used to switch the input from one set of transformer terminals to the other.

These breakers must be rated to handle the full 50 amp shore power. After conversations with the techs at Charles and Blue Sea Systems we chose to use Blue Sea's C-Series 50A breakers that have a 5,000 amp interrupt rating (AIC). We had Blue Sea custom configure and label a panel for us. Contact Rick Flynn for more

information.

The plywood backing of the hanging locker is too thin to support the breaker panel.



We added a piece of 5/8" plywood about half the width of the hanging locker and tall enough for the breaker panel. We then cut the locker's back panel to fit around the thicker plywood. By positioning the new board in the upper right corner of the hanging locker the existing cables could reach the breakers and new additional cable runs would be very short.

We used the cutout template provided by Blue Sea to cut the hole for the breakers a little to the left side of our new mounting board. This left room for mounting a small ground leads bus bar on the back side of the mounting board to the right of the breakers to make wiring easier.





We used a label tape gun to add a few labels to make operation clear. We turned OFF all branch breakers in the AC panel and then applied normal 240V shore power. With the Isolation/Boost Transformer Breaker Panel's "Normal No Boost" 240V breaker ON we saw approximately 117V at the AC panel's voltmeter.



For testing purposes only: With the Isolation/Boost Transformer Breaker Panel's "15% Boost" 208V breaker turned ON we saw approximately 135V at the AC panel's voltmeter. ( $117 + 15\% = 134.6$ ) If we boost 208V shore power by 15% we would see  $208 + 15\% = 239 / 2 = 119.5$  on the voltmeter.



We added a label to the main AC breaker panel to inform those unfamiliar of the existence and location of the Isolation/Boost Transformer breaker panel.

The procedure when entering a marina with unknown shore power is now:

1. Turn off all branch breakers in the main AC panel.
2. Be sure the Isolation/Boost Transformer breaker panel is set the "Normal No-Boost 240VAC" mode.
3. Connect to shore power and turn on.
4. Read the voltmeter in the main AC panel. If it shows 110 to 130 volts then all is good.

5. If the voltmeter reads less than 110 volts then switch the Isolation/Boost Transformer breaker panel to the "15% Boost 208VAC" mode.

## Summary

Most boats our size with 240VAC equipment do not have an isolation transformer. Most of the owners of these boats are oblivious to the "brown out" conditions their 240V equipment suffers when in marinas with 120/208VAC power. Mainship provided an expensive, high-quality upgrade in our MS400s to provide the "Isolation" benefit. However, the transformer causes brown out conditions to both our 120VAC and 240VAC equipment and Mainship did not enable it's "Boost" capability for us. This Charles transformer stands ready to also serve as a "Boost" transformer if you just enable that feature as I did.

Now I don't need to worry about what kind of power a marina has. I can boost it if necessary with the simple flip of a switch. This will also be useful if the marina's voltage is dropping too low due to extra air conditioner loads at the dock in the peak heat of summer. No more diversions to unplanned marinas. And, the electrical equipment on my boat will be much happier and enjoy longer lives.

The cost of this modification was approximately \$350 for parts and \$250 for labor. You may be able to find suitable breaker/switches at lower cost.

For more information contact:

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