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By Stephen Sommer

Voltage Loss in A 12 Volt Refrigeration Unit

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Last Fall I had a 12 volt refrigeration system installed and recently it seems to only work at night. Someone told me that the compressor might be shutting down because it's not getting enough power and maybe the wire size is too small. Is this possible and how can I find out without hiring a refrigeration specialist?

First, check to make sure that you have good cooling air (or water) flow through your condenser, lack of which will certainly cause a shutdown, and is all the more likely when it's hot outside. If that's OK, continue on.

I suspect that your problem is low voltage at the input to the Adler Barbour control unit. It's easy to suspect this because it is so common to have these wired with long and small gauge wires. In your case, the fact that it runs OK at night supports this. First, at night the air (or water) cooling the condenser is cooler, so the compressor will see a lower pressure head and draw less current (amps) which will reduce the voltage loss in the wires. Second, if the batteries are cooler at night, the voltage will be slightly higher. Third, if you have a smart battery charger with temperature sensor, it will charge at a slightly higher voltage, when it's cooler.

The relevant place to check for low voltage is at the input terminals of the unit, while it is operating. You might have to measure it during nighttime conditions and just assume it's a bit worse during the daytime. Then, look up the minimum acceptable voltage in the specifications that came with your unit. The number is probably 10.5 volts. If your voltage is low, continue on.

Your problem with your fridge is the oldest problem in 12-volt systems. The low voltage is a problem in two ways. I'll explain. A refrigeration compressor requires about 60 watts. Watts is equal to volts times amps. In a similar size household fridge you could get the 60 watts with 1/2 amp and 120 volts. With 120 volts you could probably lose 5 or 10 volts to wiring losses and not notice it. In your boat though, you need 5 amps at 12 volts, and you can tolerate 1/2 or maybe one volt loss in wires. You are running 10 times as many amps and have one tenth the tolerance for losses, which means you need very heavy wires.

If you want to figure out the required wire size analytically, here are a few rules of thumb: Determine the loss budget for the wire in question. Remember that all series losses add up, and both positive and negative count. For example, if your minimum operating, under load, battery voltage is 11.5 volts, and your fridge requires a minimum of 10.5 volts, then you have 1.0 volt for all losses. If your circuit breaker output, under load, is .5 volts less than the battery voltage, then you only have .5 volts for loss. A good rule of thumb to remember is: 10-gauge wire has .001 volt of loss for every foot and every amp. For example, a 20 foot 10 gauge wire with 5 amps going through it will have 20feet x 5amps = .100 volt of loss. If it's a pair of wires, that's .2 volts. Another rule of thumb: For every three gauges of increase, the loss is twice as great. So, 16-gauge wire has .004 volts loss per foot, per amp. So if this 20-foot wire pair was 16 gauge the loss would be .8 volts.

Your new wiring might not be the only problem. To avoid other problems, the installation instructions for the fridge probably says to connect directly to the battery. Direct connections to the battery are a very bad idea. Properly, there should be only one heavy wire on each battery terminal. The single heavy wires should go directly to the main disconnect switch and to the shunt for your battery monitor and then to buss bars for distribution. The circuit breaker for the fridge can be in the central distribution panel, if you are confident that the wiring is heavy and short. The circuit breaker should be as high a rating as is permissible by the fridge installation instructions and the wiring used. The reason for this is that a breaker, near it's rated current, will be getting warm and allow a significant voltage drop. It goes without saying that connections and crimps along the way should be scrutinized

For only $20 you can buy a digital voltmeter that will measure voltages as little as .0001volt. You can use it to see the loss of every foot of wire, crimp connection, circuit breaker, switch and screw terminal. Just remember, that all systems have to be operating to measure losses. If the losses are too high, and the fridge won't run, just use an incandescent 12-volt work light as a load of similar wattage, while you are finding the problem.

Happy Hunting!

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