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Product Focus:

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Wire, Cable & Fiber Optics

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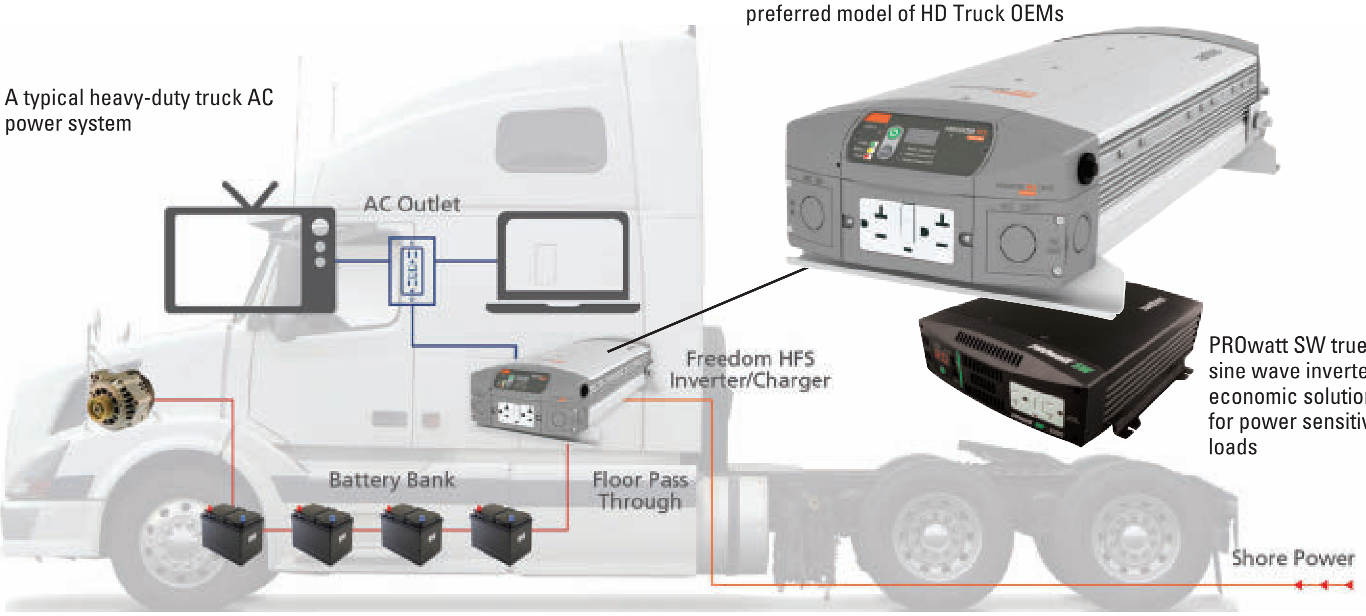
Overland Park, Kan.
Oct. 12-15

NECA
Boston, Mass.
Oct. 7-10

NSC
Anaheim, Calif.
Oct. 15-21

SCTE Cable-Tec Expo
Philadelphia, Pa.
Sept. 26-29

Freedom HFS true sine wave inverter with built-in charger—preferred model of HD Truck OEMs



A typical heavy-duty truck AC power system

PROwatt SW true sine wave inverter—economic solution for power sensitive loads

All That Power—

Where Does it Come From and how Does it get There?

By Don Wilson

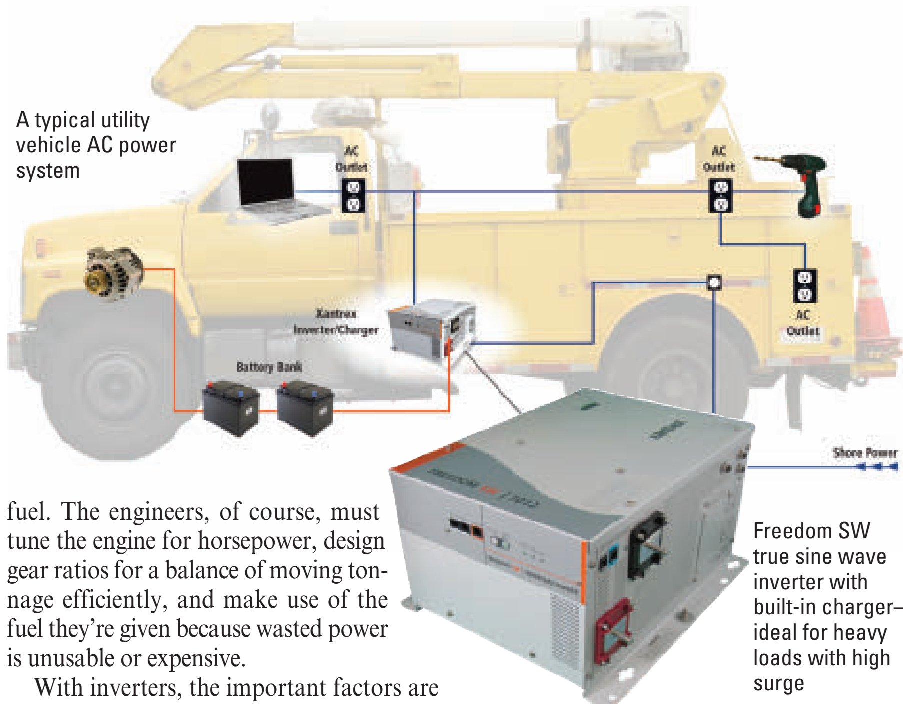
Power. It's a word that means different things to different people. For a truck manufacturer, it relates to horsepower, gear ratio and fuel. For a toolmaker, it means velocity, leverage and torque. To me, it means wattage, voltage and current. But one thing is common with everyone; it means energy—and it also means dollars.

There is a common theme with vehicle inverters that seems to go away when considering it—that inverters produce power. At first it seems reasonable to say "I need AC power, so I'm putting in this inverter… the bigger the inverter, the more power I can have." To the Tim Allen breed of the utility world, this makes sense—bigger equals more power. Even the box says how much power it has.

If we think about it, however, all the powerful items we use every day do not produce power. They have a power rating, but they don't produce energy as much as they convert latent energy that is already there in various forms.

For the truck manufacturer, the truck doesn't produce power—it uses energy in fuel. The engineers, of course, must tune the engine for horsepower, design gear ratios for a balance of moving tonnage efficiently, and make use of the fuel they're given because wasted power is unusable or expensive.

With inverters, the important factors are almost exclusively dependent on intended use and installation. Like the truck or the tool, under sizing or inefficient use of an inverter makes it unusable or expensive to make it work correctly.



A typical utility vehicle AC power system

Freedom SW true sine wave inverter with built-in charger—ideal for heavy loads with high surge

Most electrical-supply devices don't produce power. They convert the energy they're given to power a load, and proper sizing allows them to do that effectively. Because the load is the “work required,” let’s start with that—if you have a tool, either a 120V tool such as a drill, a battery charger for a tool, or a cell phone you use as a tool, at some point these are going to need power to be usable. So we have an inverter that can power these tools, but what size inverter should we use?

Watts are the universal measuring value for electrical energy; convert anything to watts and you can compare the consumption of a device or the available energy from a source. For this reason, inverter output is rated in watts. Loads should also be rated in watts. If there are only amps, the wattage can be figured by using watts law, which says amperage (or current) multiplied by voltage gives the wattage. Let’s say, for example, that a tool’s 20V battery pack charger charges at 3 amps. The wattage of that charger can be figured by multiplying the amperage by the voltage:

$$3 \times 20 = 60 \text{ watts}$$

Note: When calculating load, most conversion devices (such as battery chargers) lose some energy in heat. A charger is 90 percent efficient, for example, which means 10 percent of the energy is lost in heat; add 10 percent to the wattage demand. The previous example will draw 66 watts to charge at 60 watts.

Based on the previous calculation, let’s make more calculations:

- Battery charger = 66W
- Laptop = 90W
- 8A Power Drill = 960W
- That adds up to 1,116W. Because nobody makes a 1,116W inverter, a 1,500W or 1,800W would be a good fit, and you would think a 2,000W would provide overhead for unexpected loads—however, it’s not that easy.

Where Does it Come From?

Remember, the inverter is simply an energy conversion device and we must ensure it is getting the energy it needs to convert. If the DC system is 12V, that means to invert 2,000W of power, we need some 170 amps of DC power (2000W/12V = 167A)—and if a 90 percent efficiency rating is added, it’s almost 190A that’s needed.

The 190A of 12V power will come from the batteries. The batteries are the main source of DC power on the vehicle, but even the batteries don’t create energy—they store it. This means a battery needs to be able to produce some 200A for a reasonable amount of time and still be able to start the truck—which means a larger battery bank. If an auxiliary battery bank is used, however, you can take advantage of a deeper discharge and still keep the engine battery in a “ready” state.

Once the batteries are discharged, they must be re-charged. Following are a few options:

1. Install a large alternator to replenish the battery when driving the vehicle or at high idle. This can be the primary alternator for the main battery or an auxiliary if there are separate battery banks.
2. Use a generator and a charger. Many of the modern inverters, however, have built-in chargers that allow you to use generator power for heavier loads that are unrealistic to power off of the inverter, and will charge the batteries at the same time and then

allow you to shut the generator off and still use inverter power for lighter loads.

3. Use alternative energy—solar panels on an RV or a boat can be a good alternative to fuel-based chargers, but, on most utility trucks, the ladders or other equipment get in the way or damage solar panels. Alternatively, there may not be a roof to mount them.

How Does it get There?

While wattage is the number one factor to consider and takes the most time, there are two other facets of electrical power to consider: voltage and resistance.

We accept that wattage is the calculation of usable energy, but good voltage is necessary to use that energy effectively. For an inverter, DC voltage is critical. While a 2,000W inverter will power a 2,000W load in ideal conditions, during low DC voltage scenarios it may only be able to power at 1,900W or lower. In addition, many inverters manufactured by Xantrex have an adjustable low voltage cutoff, which means technicians can decide and program the voltage to turn off because of low DC voltage. While 10.5 volts might make sense for an installation with an auxiliary battery bank, if the inverter it connected to the main battery that starts the vehicle's engine, 10.5 is too low. While 12.1 volts may be appropriate for a low-voltage cutoff on a main battery, with high loads and voltage drop across the DC cable run, it may turn off prematurely. It's critical the DC voltage be kept as high as possible to maintain the expected energy conversion. This means reducing the electrical resistance between the DC source (batteries) and the inverter.

There are two main factors that influence resistance.

1. Wire size—smaller wires will resist higher currents than larger wires. This induces a voltage-drop over the length of the wire and can make a fully charged battery seem like a discharged battery to the inverter, affecting its performance. Keep the wires thick and reduce that resistance.
2. Wire length—even a properly sized wire will resist current flow if it's very long. When going longer distances (more than five to six feet), feel free to size your wire up one size. This minor cost increase will lessen the voltage drop and allow the inverter to use the DC at a higher voltage under heavy loads, improving its performance.

How is it Controlled?

Some inverters, such as the Xantrex Freedom SW line, do not come with a controller. Instead, a technician can choose whether to use the simple on/off remote or the more complete System Control Panel (SCP). While the SCP has options for custom programming of many parameters, including low voltage disconnect, AC voltage qualification, stacking, etc.—and is valuable for programming an initial installation—it may be too much information or too complicated for some operators. The on/off remote is easy to use, has a built-in 12V lock-out feature that can enable the inverter only when 12V is available (ignition or safety switch), and it has no programming capabilities.

Other models such as the Xantrex Freedom Xi inverter or Freedom HFS inverter/

charger have fewer adjustable parameters and a simpler controller than the SCP (included with the inverter); it also includes built-in 12V lock-out with no extra hardware to buy. It also has 12V operation for installations that prefer a simple switch to control the inverter rather than the remote panel—and the panel can be left on the inverter rather than remotely mounted.

If the need is for a straight inverter that can be controlled by a simple on/off switch, the Xantrex PROwatt SW true sine wave has an onboard on/off soft button and display panel for input voltage and output power reading. It can also be controlled by an external on/off switch that can be mounted near the dashboard or other location.

Power Doesn't Always Work When and Where it's Wanted

Everyone has heard about or experienced a truck that won't start. Maybe it's out of fuel or maybe the lights were left on and the battery is dead. If the inverter doesn't work, it may not be the inverter's fault. Following are the most common reasons for a non-functioning inverter:

1. **Input Voltage:** When troubleshooting a vehicle with the symptom "cranks, but won't start," the first step is to check for fuel in the tank, and next is to check for fuel pressure at injectors. Likewise, when troubleshooting an electrical device, check it's input. For an inverter, that would be the DC voltage. Check it at the battery first, then at the inverter's DC input terminals. For a charger, check the AC voltage at the plug first, then at the charger's AC input wires.

2. **Voltage Out of Range:** Next, check the voltage range and compare it to the measured voltage. You may be dealing with a setting that doesn't match what you're giving it.

3. **Temperature:** Many of our products are asked to work where the temperature is high, and that's why many inverters and inverter/chargers have a high temperature tolerance. Even that, however, has limits. Make sure the hardware has room to breathe and is as cool as possible. The Freedom SW 3012, for example, offers full 3 KW output from –4 F to 104 F. The output de-rates to 2.6 KW at 140 F, although that high operating temperature is an extreme scenario.

4. **Safety lockouts:** This is broad, but with ignition lockout features, such as on the Freedom HFS or InvStdBy (Inverter Standby) mode in the Freedom SW, the hardware may simply be locked out because of the installation options or an accidental programming mistake. Check for intended operation.

Power. While it has different meanings to different people, it's what makes things work. To get the most of the available power, whether it's a vehicle, a tool or an electrical device, follow the power path from the beginning (fuel, solar, human) to the end, and focus on allowing the energy to get from the source to the function in the most efficient way. Energy lost because of inefficiency, or lost time, is really just lost dollars. **UP**

About the author: Don Wilson has worked in technical capacities in the automotive/truck, RV and marine fields and for the military since 1989 and has extensive experience in designing and troubleshooting onboard electrical systems. A former customer service manager dealing with electronic issues, Wilson currently serves as a technical instructor for the RV industry's RVIA Trouble Shooters Clinics and is a full-time sales application specialist for Xantrex brand at Schneider Electric.