INVERTERS

The inverter is a basic component of PV systems and it converts DC power from the batteries or in the case of grid-tie, directly from the PV array into high voltage AC power as needed. Inverters of the past were inefficient and unreliable while today's generation of inverters are very efficient (85 to 94%) and reliable.

Today, the majority, if not all of the loads in a typical remote home operate at 120 VAC from the inverter. Most stand-alone inverters produce only 120 VAC, not 120/240 VAC as in the typical utility-connected home. The reason being, once electrical heating appliances are replaced with gas appliances, there is little need for 240 VAC power. Exceptions include good-sized submersible pumps and shop tools which can either be powered by a generator, step-up transformer, or possibly justify the cost of adding a second inverter. Several utility line-tie inverters do produce 240 VAC.

Two types of stand-alone inverters predominate the market – modified sine and sine wave inverters. Modified sine wave units are less expensive per watt of power and do a good job of operating all but the most delicate appliances. Sine wave units produce power which is almost identical to the utility grid, will operate any appliance within their power range, and cost more per watt of output.

Utility-tie systems / sine wave inverters for utility interactive photovoltaic applications, provide direct conversion of solar electric energy to utility power with or without a battery storage system. These systems are designed to meet or exceed utility power company requirements and can be paralleled for any power level requirement. They are listed to UL 1741 for photovoltaic power systems.

Inverter Component Checklist

While an inverter can account for a good portion of the cost of a PV system, it is really a sub-system that requires a number of additional components. To make a safe, reliable, code compliant installation one should provide the following:

Inverter to battery cabling

Because of the high current required on low voltage circuits, this cable is large, commonly #2 to 4/0 in size. Smaller conductors than required are unsafe and will not allow the inverter to perform to its full rating.

DC input disconnect and overcurrent protection

It is important to have safe installation with a properly sized DC rated, UL listed disconnect. Typically the disconnect works in conjunction with an overcurrent protection device such as a fuse or circuit breaker. These components are usually installed in an enclosure which can also house shunts and additional equipment or circuit breakers.

Shunts

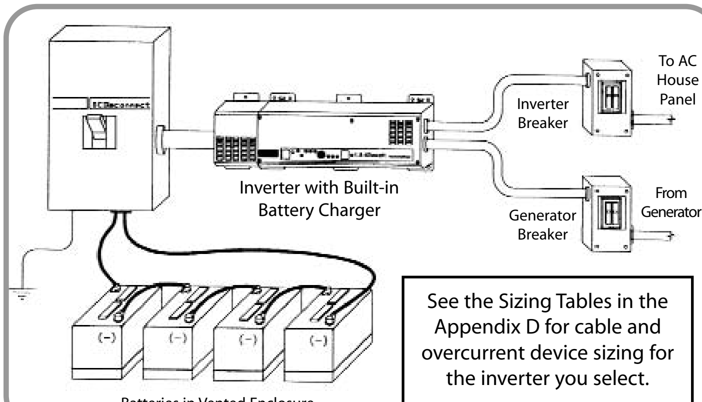
Used to read the amperage flowing between the battery and inverter, this device is installed in the negative conductor. It can easily be housed in the disconnect or its own enclosure.

AC output disconnect and overcurrent protection

If the breaker panel, which is fed from the inverter, is adjacent to the inverter, then the main breaker will serve as the inverter output disconnect and overcurrent protection.
If, however, this panel is not grouped with the inverter, then a separate unit should be installed. This also holds true for AC circuits coming into the inverter from a generator or utility source. A second breaker may be needed if these breakers are not grouped.

Inverter Sub-System Checklist

_____ Inverter to battery cabling
_____ DC disconnect and overcurrent device
_____ Inverter conduit boxes
_____ Inverter output breaker box
_____ Generator input breaker box
_____ Shunt(s) if required for monitoring



See the Sizing Tables in the Appendix D for cable and overcurrent device sizing for the inverter you select.

Built-In Battery Chargers

Most larger inverters can operate as battery chargers as well. This is easily and economically accomplished because of the design of most inverters. Inverters step up low voltage DC power and change it to 120VAC power. Battery chargers do the reverse of this.

Transfer switches are also incorporated into these Inverter / Chargers so that the AC loads can be powered directly from the generator when the battery charger is operating.

From a reliability, performance, and economical standpoint, built-in battery chargers are the way to go.

Multi-Stage Battery Charging

A typical 12-volt lead-acid battery must be taken to approximately 14.2-14.6 VDC before it is fully charged. (For 24 volt systems double these figures for 48 volt, multiply by four.) If taken to a lesser voltage level, some of the sulfate deposits that form during discharge will remain on the battery's lead plates. Over time, these deposits will cause a 200 amp-hour battery to act more like a 100 amp-hour battery, and battery life will be shortened considerably. Once fully charged, batteries should be held at a lower float voltage to maintain their charge – typically 13.2 to 13.4 volts. Higher voltage levels will "gas" the battery and boil off electrolyte, requiring more frequent maintenance.

Most automotive battery charger designs cannot deal with the conflicting voltage requirements of the initial "bulk charge" and subsequent "float" or maintenance stage. These designs can accommodate only one charge voltage, and therefore must use a compromise setting – typically 13.8 volts. The result is a slow incomplete charge, sulfate deposit build-up, excessive gassing and reduced battery life.

The charger available in our inverters automatically cycles batteries through a proper three stage sequence (bulk, absorption and float) to assure a rapid and complete charge without excessive gassing.

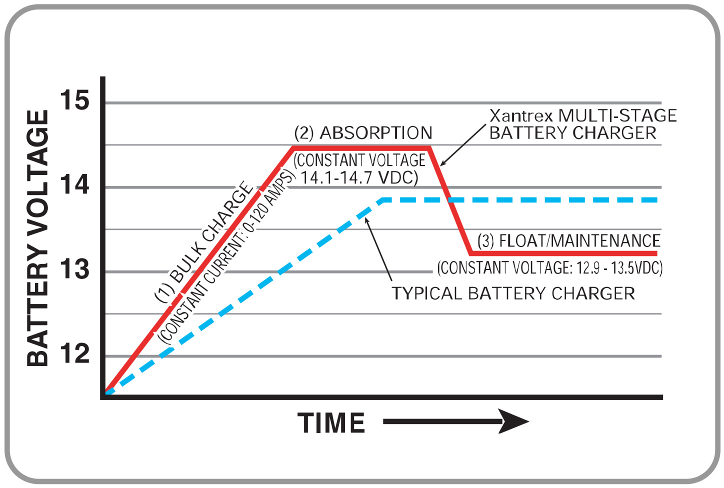
Factory battery charger settings on most inverter-charger combinations are optimal for a lead acid (liquid electrolyte) battery bank of 250-300 amp hours in a 70°F environment. If your installation varies from these conditions, you will obtain better performance from your batteries if you adjust the control settings.

The Maximum Charge Rate in amps should be set to 20-25% of the total amp-hour rating of a liquid electrolyte battery bank. For example, a 400 amp-hour bank should be charged at no more than an 80 -100 amp rate. Excessive charge rates can damage batteries and create a safety hazard.

Comparing Inverters

Inverters are compared by three factors:

- Continuous wattage rating. Hour after hour, what amount of power in watts can the inverter deliver.
- Surge Power. How much power and for how long can an inverter deliver the power needed to start motors and other loads.
- Efficiency. How efficient is the inverter at low, medium and high power draws. How much power is used at idle.



The Bulk Charge Voltage of typical liquid electrolyte lead acid batteries should be about 14.6 VDC. There is no one correct voltage for all types of batteries. Incorrect voltages will limit battery performance and useful life. Check the battery manufacturer's recommendations.

The Float Voltage setting should hold the batteries at a level high enough to maintain a full charge, but not so high as to cause excessive "gassing" which will "boil off" electrolyte. For a 12-volt liquid electrolyte battery at rest, a float voltage of 13.2-13.4 is normally appropriate; gel cells are typically maintained between 13.5 and 13.8. If the batteries are being used while in the float stage, slightly higher settings may be required.

Charge voltage guidelines used here are based on ambient temperatures of 70°F. If your batteries are not in a 70°F environment, the guidelines are not valid. Temperature Compensation automatically adjusts the voltage settings to compensate for the differences between ambient temperature and the 70°F baseline. Temperature compensation is important for all battery types, but particularly gel cell, valve-regulated types which are more sensitive to temperature.