

## When to use DC Appliances

<http://www.backwoodssolar.com/learning-center/off-grid-solar-articles/when-to-use-dc-appliances-voltage-converters>

Direct Current (DC) power in certain applications makes living off-grid less costly and more luxurious. Some folks hesitate to use their battery DC power directly, fearing complexity in wiring for different voltages or believing DC requires large wires throughout the home.

Using **BOTH AC and DC**, each where most appropriate, makes a better working and less costly power system. DC is better suited for those few items that need a little power available all the time. Motion sensing outdoor lights, cord-less phones and message machines, alarm system, clock-radio and a doorbell are good examples. Turning those appliances off at night and when the house is vacant to save power just defeats their purpose.



Inverters, particularly the true-sine wave, burn 25 watts to as much as 60 watts, just internally to produce AC, even when no AC power is consumed in the home. To avoid this waste, most quality inverters can automatically shut down to "sleep" or "search" condition, using near zero battery current and ceasing to generate AC power whenever no AC appliances are used. They restart themselves automatically when any light or appliance is switched on. But if a phone message machine or clock-radio continuously uses a few watts, the inverter can never shut down and 20 to 60 watts is continuously consumed in addition to the few watts of radio or message machine power. Other appliances, like motion sensing outdoor light switches and garage door openers, when AC is off, will not be able to restart an inverter and may thereby be inoperative some of the time.

The simplest solution might be to leave the inverter locked full-on all the time, producing AC power to the home 24/7 just like a utility company. To keep the inverter on 10 extra hours at night costs 1/3 to 2/3 kilowatt hour per night, enough to power a small freezer. A good hydropower system, and larger solar power systems with unlimited sunshine and strong cash budget for extra solar modules and batteries can do that. For the rest of us, its not a good idea, especially in climates where a generator needs to supplement the battery charge in winter months. Full time true-sine wave inverter power would require at least an extra 100 watt solar module, plus extra half to one hour a day charging by generator. So we make sure the inverter can shut down to search mode at night. "Phantom load" appliances that take a trickle of power even when turned off, are manually disconnected by a switched outlet strip. Then we glance at the little neon plug-in night lights in some AC outlets that show us the inverter has indeed shut off when not actively being used.

We use battery DC to directly power those appliances that need to be available full time on minimal power consumption.

### How DC circuits are set up



Most power centers have extra circuit breakers for connecting safely to DC power from the battery. A circuit breaker or fuse on each wire is as important for DC as for AC. Square D "QO" series breakers and small breaker boxes are rated OK for low voltage DC and are sold in our catalog as well as many hardware stores. One DC outlet in each room of an otherwise AC wired home will cover most future needs. The appliances mentioned are mostly low wattage, so most DC circuits can be installed with 10 gauge standard house wire. For a DC outlet, a 240 volt AC outlet, which fits a conventional AC outlet box and outlet cover plate is legal (if you have no 240 volt circuits in the house). These have one prong turned so AC appliances cannot be plugged into DC by mistake, or vice versa. Don't use junky cigarette lighter plugs and sockets which are poor quality and do not meet building codes.

## Voltage conversion



Most small DC appliances are made for 12 volt power. Many are also available for 24 volt, particularly solar electric home appliances like ceiling fans, water pumps, and refrigerators. But consumer items like some lights, motion sensing light controllers, alarm systems and telephone equipment is usually only 12 volt.

Voltage converters in our catalog allow 12 volts to be obtained from a 24 or 48 volt battery, or for 24 volts from a 48 volt battery. These converters use negligible power when converting voltages downward. Other voltage converters can boost voltage above your battery voltage, or even double it from 12 to 24, or 48, but these are less efficient, consuming up to 20% of the power produced.

Portable radios and other devices use odd voltages between 4 to 9 volts. There are smaller adjustable voltage converters that connect to a 12 or 24 volt outlet and adjust to produce the required voltage for these items. Our catalog has some, while Radio Shack catalogs have others.

### When To Use DC Appliances and Voltage Converters

THESE PRODUCTS RUN ON SIGNIFICANTLY LESS POWER WHEN DESIGNED FOR LOW VOLTAGE DC:

- Circulating Pump for solar and hydronic loops,
- LED All-Night-Lights 1/2 to 1 watt,
- Electric Bed Warmer 50 - 60 watts rather than 200
- Evaporative House Cooler under 100 watts instead of 800+
- Rechargeable Braun Shaver charges without inverter
- Cell Phone Re-Charger auto cord works without inverter
- Flashlight Battery Recharger runs on AC or 12 volt DC.
- Electric Fence Charger for 12 volt use negligible power
- Electric Gate Opener runs from a solar module
- Water and Well Pump for most applications 12 - 48 volt

DC ceiling fans in our catalog use a lot less power for distributing home heat than AC models, though their speed is only low on 12 volts or medium on 24 volts.

Muffin fans in our catalog are small 12 and 24 volt computer style fans that make a personal desk fan or improve wood stove and gas heater air flow at 3 to 9 watts. less air but far less power than AC fans would need.

A Notebook computer can be charged on much less power with a 12 volt car cord, available from Lind Electronics. They have a cord and converter for every model at 800-659-5956 or [www.lindelectronics.com](http://www.lindelectronics.com). Notebooks use much less power than standard computers, and with addition of an external keyboard can be just as functional.

Consumer audio equipment with "Wall wart cube" adapter on the cord, common on cordless phones, message machines, boom box stereos, and some flashlight battery rechargers just convert the AC power to low voltage DC which those appliances actually run on. But running an inverter full time to convert battery DC to 120 volt AC power, so those appliances can convert it back to low voltage DC makes little sense, and wastes a great deal of energy. Many of these items can be modified to work directly on your DC voltage.

12/24 VOLT DC refrigerators & chest freezers in our catalog offer energy savings and security, by needing no inverter to function. However the most efficient AC refrigerators and freezers have more

powerful compressors and shorter running times. A select few AC units are nearly as efficient as DC units. The AC power Conserv freezer in our catalog, is just as efficient as the DC units.

Inside lights can be either DC powered or AC powered. AC 120 volt lighting is usually easier to get and lower cost, more practical for most solar homes. DC lighting is best in very small cabins, also in any battery rooms because you may need to work on wiring with the AC power off. DC lighting can be advantageous on a single reading light used long hours when no other power is being used. This avoids power drain of the inverter to run just that one light.

New LED white light bulbs can be left on all the time using one single watt or less. We supply 12 volt screw-in LED bulbs in several brightness levels. There will be more white LED lighting products in the future. These save off-grid energy only by operating on DC power so the inverter can be off. Decorative strings of LED lights also make good nightlights, but only DC powered LED strings can be continuous nightlights without wasting power.

Water Pump of positive displacement design rather than centrifugal always uses much less power. Even centrifugal units with DC powered motor use less and require no large starting surge or inverter.

### **THE FOLLOWING PRODUCTS FOR DC POWER DO JOBS THAT CANNOT BE POWERED BY AC, IF THE AC POWER IS NOT TO BE ON CONTINUOUSLY:**

**Cordless phone & Phone message machines** same the same energy described for consumer electronics, plus they still operate when inverter is off. Backwoods catalog has selected cordless and message phones set up to operate on 12 volt power.

**Motion Sensing Light Control** operating on 12 volt dc is on duty full time with about 1 watt used when idle. It can operate 12 volt yard lighting directly. With the addition of a relay, it can turn on larger AC lights that do start up the inverter. A 12 volt RAB motion light control is available in our catalog. It is on duty all dark hours whether inverter is on or off. AC motion light controls cannot start the inverter up.

**Doorbell** usually powered 24 volts AC through a transformer is a constant trickle of power. But standard mechanical doorbells will operate from 12 volts DC, and use power only while the button is pressed.

**Alarm systems** available at Radio Shack and elsewhere usually have a 12 volt backup connection so they will operate during power failures. Connected to your 12 volt DC power, these will operate continuously with little power used.

**7-day Programable appliance timers** in our catalog are made for 12 or 24 volt power. Because they use minuscule current and are unaffected by whether AC power is on or off, these always keep their time setting and program memory. These timers control either DC or AC appliances to make your stereo into a wake-up clock-radio, disconnect the phone during sleeping hours, or operate a water pump unattended.

**Garage Door Openers** are phantom loads, using power 24 hours a day to keep their remote control receiver awake. The trick to live with these energy wasters is to install a 12 volt RAB motion detector outside the garage. When it senses a person or car, it activates a 12 volt relay that connects AC power to the garage door opener and to a light bulb. This causes the inverter to start up and the door operator then operates normally, with no modifications to the unit. The Rab motion sensor contains a timer adjustable from minutes to half an hour, after which power to the garage door opener cuts off again. Inside the garage, a windup light switch timer wired parallel to the same relay contacts allows a manual start to leave from inside the garage.