SOLAR STIK™

SOLAR STIK™ INVERTER SCHOOL

NOTE: IT IS RECOMMENDED THAT THE READER REVIEW THE **SOLAR STIK™ SOLAR SCHOOL** BEFORE READING THIS SECTION.

INTRODUCTION

Battery-based DC (12-volt) electrical systems are more common as our society is increasingly "mobile" in cars, RVs and boats. Also, many new AC appliances have “Energy Star” ratings, operate more efficiently and use less power. This increases the potential to operate such home AC appliances from a DC power source. To accomplish this conversion of power a DC to AC Power Inverter is used.

Power inverters of all shapes and sizes are available in places ranging from your local drug & automotive stores, to big retail chain outlets.

Most appliances will require a certain type of inverter and waveform, but because of a flood of power inverters in the marketplace, the consumer can be overwhelmed when choosing an inverter.

This section helps you understand how to select the correct inverter for a particular appliance or appliances. This section also explains why certain inverters cost more than others. These principals can apply to all makes of Inverters whether they are purchased from Solar Stik™, or not.

It is important to remember that the Solar Stik™ System is a portable DC (solar & battery) system, and the basic operating Voltage is 12 Volts DC (Direct Current).

CHOOSING THE APPROPRIATE INVERTER

There are some distinct differences between types of inverters. Typically, a person will NOT shop for an inverter based on its physical size, but rather its power (Watts) handling ability and the type of output (Sine-Wave or Modified Sine-Wave).

If a person is shopping for an inverter based on its physical size (to accommodate for available storage or installation space), then the user MIGHT be restricted to using an inverter that has less than the required output or the least favorable waveform type (...more on that below).

12 Volt power Inverters range in output from 20 to as much as 10,000 Watts. Also, many inverters have additional features such as incorporated battery chargers, transfer switches, and more. These higher wattage output inverters are usually installed in a "fixed" location, like a boat, an RV or even a residential building that may have a roof-mounted solar panel. Most mobile applications for inverters usually require less than 5000 Watts.

The following discussion applies to inverters in mobile or portable applications.

There are three categories of portable DC to AC inverters:

- Low Wattage - less than 200 Watts Power output
- Medium Wattage - between 200 and 800 Watts Power output
- High Wattage - Greater than 800 Watts Power output

Choosing an inverter for any specific application should be based on two factors:

- POWER CONSUMPTION (Watts or Amps used by the appliance)
- TYPE OF APPLIANCE (sensitive electronics, motors, lights, etc.)

Inverter "Continuous" versus "Peak Surge" Wattage Ratings:

Inverters are usually rated in Continuous Power and sometimes in Peak-Surge Power.

Continuous Power is the total WATTS the inverter can deliver continuously, while Peak-Surge Power is the amount of momentary Power that the inverter can provide when equipment or an appliance starts up. For example, induction motors often found in such devices as refrigerators, freezers, pumps, etc. may well have a momentary start up peak-surge of up to 800% of the appliance's power rating.

Some inverters have no Peak Surge rating stated because they have a “Soft Start” feature. Soft start gradually ramps up output Voltage, thereby, avoiding a momentary peak surge on startup of appliances.

DETERMINING AN APPLIANCE'S POWER CONSUMPTION:

Selecting the best inverter to suit the appliance starts with finding the operating Watts by referring to the specification plate on that appliance. You can also find this information in the appliance manual, the appliance supplier or on the internet. You need to know both the continuous rating in either Watts or Amps, and the peak-surge rating in either Watts or Amps.

Without the appliance power information, any further calculation to determine the correct inverter for the application is not possible. There are low cost plug-in meters that will directly read AC appliance power consumption in Watts.

The Solar Stik™ System operates at 12 Volts DC, so we can convert either Watts (P) to Amps (A) or Amps (A) to Watts (P) by using the following formulas.

A = P / V (Amps = Watts /12)

P = V x A (12 x Amps = Watts)

Once the power requirements for the appliance/system have been determined, then an inverter can be selected for use with that appliance/system.

TIP: It is always advisable to build in a safety factor by overrating an appliance's Continuous Power rating by 20 - 25%.

For example, if an appliance continuously draws 240 Watts, then an inverter with a rating of 300-Watts continuous output should be selected.

DETERMINING AN APPLIANCES PEAK/SURGE LOAD:

When determining the Peak-Surge load of an appliance, take the rated Power consumption and multiply it by three:

"Peak-Surge Power" = 3 x P

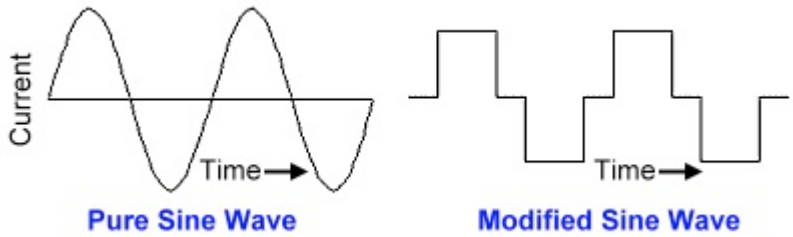
For example, if an appliance is rated for 300-Watts continuous usage, then it is reasonable that the start-up load may be 900 Watts.

There are a few notable types of appliances that require very high peak startup power. For example:

- Ordinary incandescent lamps and quartz halogen lamps need as much as 10 times the start up Wattage as operating Wattage. Pumps or compressors that are under full load can require as much as 8 times the start up Wattage or current as operating Wattage. This is sometimes labeled as “locked rotor” current.

CHOOSING THE CORRECT INVERTER WAVE-FORM

Inverters are classified as producing either Pure Sine-Wave output or Modified Sine-Wave output. The output wave-forms are shown in the following drawings:



The Advantages and Disadvantages of using a Pure Sine-Wave Inverter (also referred to as "Sinusoidal"):

A pure Sine-Wave, which is commercially produced by rotating machinery (a generator), is the type of wave form provided by electric utility companies. This type of power is available anywhere an outlet is tied to the power grid (such as in homes or business). A pure Sine-Wave Inverter reproduces this waveform through the use of advanced internal circuitry.

Sine Wave Inverter Advantages:

- Pure Sine-Wave output is the most compatible AC power from an inverter, and it is the best waveform for ALL AC electrical appliances.
- Pure Sine-Wave output eliminates interference, noise, and overheating.
- Reduces audible and electrical noise in fans, fluorescent lights, electronics gear and magnetic circuit breakers.
- Prevents crashes in computers, unreadable print-outs, and glitches and noise in monitoring equipment.
- It can be efficiently electronically protected from overload, over Voltage, under Voltage, and over temperature conditions.
- Inductive loads like microwave ovens and variable-speed motors operate properly, quieter and cooler. Some appliances will not produce full output if they do not use Sine-Wave power.
- Some appliances, such as variable speed drills and bread makers, will not work properly without Sine-Wave power.

Sine Wave Inverter Disadvantages:

- More expensive than non Sine Wave power inverters.
- Physically larger than their non Sine Wave counterparts.

A MODIFIED SINE-WAVE INVERTER (ALSO REFERRED TO AS "NON-SINUSOIDAL" OR "STEP-WAVE"):

The Modified Sine-Wave Inverter is much different from a pure Sine-Wave Power inverter because the waveform output is in more of a "stepped" shape.

AC Appliances are not specifically designed to work with this type of inverter waveform output, although many appliances will work properly with a Modified Sine-Wave Inverter. The result is that some appliances take more power to operate some appliances with a Modified Sine-Wave Inverter, thereby reducing the efficiency of the entire electrical system. Some appliances may not work correctly.

For example, some fluorescent lighting may not get as bright, or they may make buzzing noises. Also, certain appliances with digital clocks or electronic timers may work improperly with this type of inverter because the waves are rougher and cause extra "noise" to be created in the circuitry. Further, some appliances that use electronic controls will not be able to vary speed or temperature when using Modified Sine-Wave power. Some appliance motors may produce more heat and burn out when they are operating.

The following appliances may experience problems when operated from Modified Sine-wave inverters:

- Electronic Equipment, Sound Systems, wall-mounted lamp dimmers, Corded power tools that have variable speed controls, some battery chargers for cordless tools, devices that have speed/microprocessor controls, medical equipment, & lamp dimmers, transformerless photographic flash power supplies.

Modified Sine Wave Inverter Advantages:

- Substantially less expensive than the pure Sine-Wave Inverters (can be a good thing)
- Readily available - they are the most commonly used and found in the marketplace. (In fact, it can sometimes be difficult to find other than Modified Sine-Wave Inverters.)
- Smaller in physical size for the same power output as its Sine-Wave counterpart.

Modified Sine Wave Inverter Disadvantages:

- Lower quality construction (it can be a bad thing)
- Not compatible with all AC appliances

PROPER INVERTER CONNECTION

Regardless of the type of inverter you select, you will need to make proper connections.

Low Wattage inverters (usually less than 200 Watts) often come equipped with a 12 Volt DC Plug, and may be plugged into any 12 Volt DC socket (cigarette lighter-style).

Medium Wattage inverters (200 – 800 watts) are often supplied with DC cables that must be connected directly to a battery.

Higher Wattage inverters (800 Watts and over) usually require larger cables that are typically not supplied by the inverter manufacturer**. It is the responsibility of the installer or owner to purchase the correct size (gauge) and length according to the information supplied in the Inverter Manual.

**NOTE: The Solar Stik™ Inverter Paks come pre-equipped with the proper cables for connection to a Power Pak.

If using a high Wattage inverter purchased from a retailer, it will probably be necessary to purchase inverter-to-battery connection cables. There is a general rule to remember:

The connection cable size depends on the distance between battery and the amount of maximum current draw the inverter will require from the battery. It is good practice use the thickest gauge wire available, in the shortest length practical.

If a less than adequate cable is used, it may cause the inverter to sense that the DC voltage is low and will simply shut down. Incorect size cables can overheat and they can even cause fires. If you are unsure about the proper cable size, please consult a qualified individual.

THE INVERTER'S POWER SOURCE... THE BATTERY

12 Volt batteries are rated in the amount of energy that they can store.

For example, Deep-Cycle batteries are rated in Amp-hours (the amount of Amps it can provide for a given period of time). Deep Cycle batteries are designed to supply power for a long period of time and tolerate repeated discharge and charge cycles.

Vehicle batteries, also known as starting batteries, are often rated in Cold Cranking Amps. These batteries are designed to supply short-duration bursts of power (like starting a fuel-driven car). After an engine starts, an alternator quickly replaces energy that was used during the engine start. Engine starting batteries are not suited for deep-cycle use, as they will have reduced life if not immediately charged after engine start.

Low Wattage Inverters:

Deep-cycle batteries like the ones employed in the Solar Stik™ Power Pak easily handle light duty inverters. Most vehicle starting batteries will support a low Wattage inverter for 30 to 60 minutes. Actual operating time will vary depending on the age and condition of the battery, and the AC appliance powered by the inverter. If you use a light duty inverter that is powered through a DC accessory socket, and the vehicle engine is turned off, you should periodically run the engine for 15 minutes to recharge the battery.

Medium-High Wattage Inverters:

It is strongly recommended that only deep-cycle batteries be used for any inverter with a continuous output of 200 Watts or greater. This will ensure that you have several hundred complete charge/discharge cycles. If you use a normal vehicle starting battery to support a heavy-duty inverter, it will quickly fail after repeated charge/discharge cycles (starting batteries are not designed to do this type of work).

When the inverter operates "power-hungry" appliances with continuous loads for extended periods, it will drain the battery to the point where the battery has insufficient energy to support the inverter. In these cases, it's a good idea to have extra deep-cycle batteries (extra battery capacity such as the Expander Pak) to extend the appliance operating time.

PROPER PLANNING is important when considering battery capacity. All power inverters have a low-battery alarm that sounds when the battery Voltage becomes low, and all have a low-Voltage shut-down that prevents damage to the battery should the voltage drop below 10.5 Volts. If the battery capacity is insufficient for the load size, the batteries will rapidly discharge and the user will have to deal with unexpected shutdown.

KEEPING THE BATTERIES CHARGED AT ALL TIMES should be the focus for the user. This will ensure that there is always enough stored energy to meet the appliance demands. There are many methods to achieve this, but the simplest is:
If you are not using the appliance, turn it off.

The Solar Stik™ System was designed for continuous inverter operation from the Power Pak. Inverters convert power, so if a connected AC appliance is turned off, the inverter draws proportionally less power from the Power Pak battery. This lowered inverter output allows for "recharge time". Power from the Pak can be used by the inverter/appliance whenever it is needed; even while the Solar Stik™ solar generator is connected and charging.

INVERTER OPERATION TIME (RUN-TIME)

Inverters will continue to operate as long as there is sufficient battery power available. A battery's "Voltage" is a direct indication of its state of charge.

For example, a 12 Volt battery that has a static (no-load, no charge) Voltage of 13.2 is considered 100% charged. A 12 Volt battery that has a static Voltage of 10.5 is considered "dead". The Voltage range in between these upper and lower voltage values is used to determine the battery's state of charge.

The Amp-hour capacity of a deep cycle battery and the load connected to it will determine the actual appliance run time. (Please visit the Solar School section for more information about figuring our Loads and Run-times.)

EDUCATIONAL MATERIALS AVAILABLE FOR DOWNLOAD FROM
WWW.SOLARSTIK.COM:

SOLAR SCHOOL – the basics of a DC electrical system

BATTERY SCHOOL – all about lead-acid batteries

A SYNOPSIS OF THE SOLAR STIK™ – how the Solar Stik™ works

FREQUENTLY ASKED QUESTIONS – all about the system & how it operates