

# Amps, Watts, Volts: The Math Can Get Confusing

By Michael and Susan Snowden

Volts x Amps=Watts

- 1) They are each a measurement of something
- 2) Amps and watts are a measurement of flow
- 3) Volts are a measurement of pressure

Think of the water system in your rig. The battery is the water pump, supplying pressure to the system in pounds per square inch (volts). The volume of water that moves through the line is measured in gallons per second (amps). When you turn on the faucet to get a glass of water it takes eight ounces to fill it (watts).

Solar panels collect electrical energy from the sun, measured in watts. This energy is transferred to the battery with a storage capacity measured in amps (volume). As volume in the battery increases so do the volts (pressure). A certain amount of electrical energy, again measured in watts, is transferred from the system to run an appliance. As this occurs the amps in the battery decrease with discharge, and then eventually so does the voltage.

Solar panels, inverters, and appliances are rated in watts because they deal directly with the collection, transference, and use of electrical energy.

Batteries and charge controllers are rated in amps because they hold and regulate a volume of electrical energy under pressure, more or less fixed around 12 volts.

Because the battery is the heart of your system, you need to understand the input and output in terms of amps. How many amps will each solar panel collect in an hour? How many amps will each appliance consume in an hour? You will need to convert the wattage to amps at a known fixed voltage using the formula  $\text{Watts} \div \text{Volts (12)} = \text{Amps}$ .

Example: our microwave requires 1500 watts of electrical energy to run  
 $1500 \text{ watts} \div 12 \text{ volts} = 125 \text{ amps per hour}$   
 $125 \text{ amps} \div 60 \text{ minutes} = 2.08 \text{ amps}$

If I run my microwave for 10 minutes I discharge 21 amps from the battery

# Marine Battery FAQ

Please select a frequently asked question from the list below.

[Proper Marine Battery Charging](#)

[Proper Marine Battery Discharging](#)

[Aren't AGM and Gel Cell Batteries tolerant to deep cycling?](#)

[Why Choose an AGM Marine Battery?](#)

[AGM ==> What is AGM and why do I need it?](#)

---

## Charging:

More batteries are damaged and prone to premature failure due to improper charging and overcharging than by any other means. If batteries are charged at a constant amperage and low voltage, charging time is significantly longer and battery capacity is effectively reduced because the battery is never completely recharged. To avoid this many individuals opt for a higher charging voltage, which accelerates the rate of charge but can ultimately harm the battery if the charge is continued for any length of time after the battery reaches capacity. The best charging solution is a multi-stage charge regulator that keeps recharging time to a minimum (higher voltage) but prevents battery damage caused by overcharging (automated charge regulation).

---

## Discharging:

Discharging marine batteries to 50% of capacity is the general rule for obtaining optimal battery life. This provides the best compromise between available energy and the number of discharge cycles a battery can provide during its lifetime. **If a marine battery is continually discharged below 50% of its capacity it leads to a shorter battery life due to sulfating (a chemical reaction inside the battery that limits the ability for it to hold a charge).**

---

## Why Choose an AGM Marine Battery?

Absorbed Glass Mat (AGM) batteries include lead plates packed between silica-glass mats, which hold electrolytes in suspension. They have no input current limitations allowing them to recharge more quickly than Flooded batteries, which typically accept about 35% of their ampere-hour rating, and Gelcells, that accept about 50%. At higher current loads AGMs also maintain usable system voltages for other high current, short duration loads as opposed to their counterparts, which become more inefficient during high current loads. AGMs also boast a longer lifespan than their counterparts, a deep-cycle flooded battery allows for 350 cycles at a 50 percent discharge level and Gelcells allow for 750 cycles whereas an AGM offers up to 1000 cycles at a 50 percent discharge level.

---

## What is AGM and why do I need it in my Marine Battery?

AGM stands for Advanced Glass Matting and is the material used in high end marine batteries to separate the lead plates. AGM also is useful as it's capillary action qualities provide abundant acid contact to the lead plates under extreme vibration, g loads, inverted installations, and more. AGM material simply allows some Marine Batteries to outperform those without due to it's ability to suspend the plates in the sulfuric acid necessary to hold, charge, and discharge marine batteries.

---

## Aren't AGM and GELCELL Marine Batteries both Maintenance Free and tolerant to deep cycling?

**AGM Marine Batteries are desirable because they are maintenance free due to the valve-regulated and pressure-sealed design.** Like Gelcells they boast high tolerance to occasional deep discharges, excellent shock and vibration resistance, and broad operating temperatures. Here is where the similarities end, AGM Marine batteries have the advantage of being mountable in any orientation without capacity loss which Gelcells do not have. (gelcells will create air pockets and burn out the plates) AGMs also have the lowest internal resistance supporting numerous high demand loads and the fastest recharge times.

## PV (PHOTOVOLTAIC) PANELS

TYPE	GRADE	EFFICIENCY	RELATIVE COST	M/S TIP
<b>Monocrystalline</b>	solar cells are wafers cut from a perfect silicon crystal	15-18%	\$\$\$	<u>Monocrystalline panels</u> , because of their superior efficiency, are your most cost effective choice in the long term.
<b>Multicrystalline</b> (Polycrystalline)	solar cells are wafers cut from a slab of silicon cast in a mold	12-14%	\$\$	
<b>Amorphous</b> (Thin Film)	silicon is directly deposited on a surface	5-6%	\$	

PV PANELS	M/S TRANSLATION	M/S TIP
are listed and sold by Power Ratings, which is the maximum power in watts they will generate at the peak power point.	Peak power point means the sun at high noon hitting the panels under optimal conditions. There will be cloudy days.	Make sure your panels are installed so that you can raise and lower them depending on the angle of the sun at different times of the year.
Example of how you will find panels listed for sale:  SC 120 watt 16.9v 7.1 amp 58.1"x26" x 1.5" 26.1 lb	Monocrystalline panel produces 120 watts at a voltage of 16.9 and supplies 7.1 total amps per hour at peak power point. It measures 58.1 inches x 26 inches and is 1.5 " thick, weighing 26.1 pounds.	Always look at the amp rating (7.1 in this example), as this tells you how many amps you can replace in the battery in an hour when the weather circumstances are perfect. It will generally be less.
are priced by grade and watts. In March 2005, the average retail cost per watt in the U.S. was \$5.	Due to the international demand, pricing/availability varies weekly. Manufacturers have raised prices as much as 15-20% for U.S. dealers and there can be a lengthy (+3 month) wait to get them.	Times are getting tight for the dollar. Don't expect a blue light special and plan ahead.

For more info, contact Michael and Susan Snowden at [www.rvsolarenergy.com](http://www.rvsolarenergy.com) □

**Inverters** take the DC current of the battery and switches it into pulses of AC to run appliances

- classified according to how many watts of power they produce
- three types of inverters based on the kind of power they produce and how closely it resembles commercial AC

TYPE	DC TO AC	APPLICATION	AVERAGE PEAK EFFICIENCY	AVERAGE COST PER WATT
<b>Square Wave</b>	<ul style="list-style-type: none"> <li>•reverses the polarity of the DC voltage 120 times per second</li> <li>•least resembles commercial power</li> </ul>	<ul style="list-style-type: none"> <li>•power varies with voltage changes as the batteries are discharged</li> <li>•frequency can be unstable</li> <li>•produces "hum" in equipment</li> <li>•causes motors to run hotter</li> <li>•will run smaller appliances, like a blender or sewing machine</li> <li>•stereos, televisions, computers, and other frequency sensitive electronics will not accept square wave power</li> </ul>	50-70%	\$1.50
<b>Modified Sine Wave</b>	<ul style="list-style-type: none"> <li>•imitates AC by producing a stepped waveform</li> <li>•rough approximation of a true sine wave.</li> </ul>	<ul style="list-style-type: none"> <li>•can run almost all electrical appliances</li> <li>•some laser printers, fax machines, medical equipment and cordless tool rechargers may be incompatible and use could result in damage to your appliances</li> </ul>	85-95%	\$1.00 to \$1.75
<b>True Sine Wave</b>	<ul style="list-style-type: none"> <li>•most closely duplicates the sinusoidal waveform produced by the utility companies</li> </ul>	<ul style="list-style-type: none"> <li>• can run all AC appliances as long as the equipment's power requirements do not exceed the continuous and surge ratings of the inverter</li> </ul>	80-92%	\$2.50

MOST IMPORTANT RATINGS	DESCRIPTION	M/S TRANSLATION	M/S TIP:
Output Power	rated at how much the inverter can handle before shutting down	you'll need an inverter capable of producing more than the continuous max wattage of all loads to be run at one time	don't try to cut corners with your inverter. Buy more watts than you think you will ever need.
Surge Power	rated in milliseconds, is the power that the inverter can supply for a SHORT amount of time	some appliances, like microwaves, require up to three times the running wattage to start them	if you've followed the advice above, you won't have to worry about this.
Built in Battery Charger	optional built in battery charger	higher end inverters offer this attractive feature	ideal if you intend to use a generator as a back up power supply

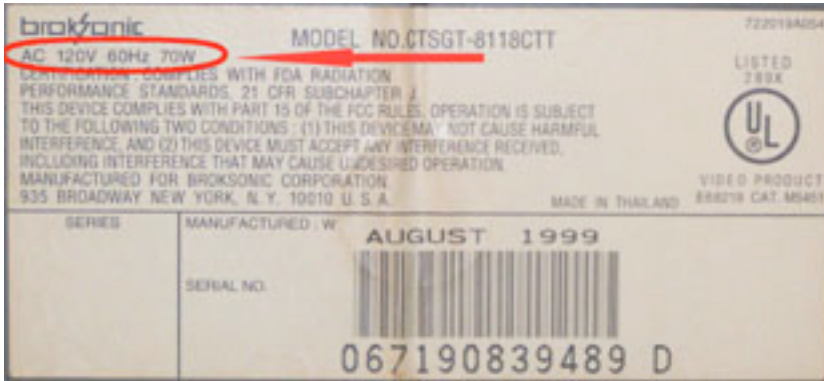
For more info, contact Michael and Susan Snowden at [www.rvsolarenergy.com](http://www.rvsolarenergy.com) □

## READING AN APPLIANCE RATING PLATE

It's there, somewhere.

- it may be a paper label
- it maybe molded plastic as a raised surface
- it may be engraved

This is what you are looking for:



Some list the rating in WATTS (as above) AC 120V 60Hz 70W

**M/S Translation:** In a 120 Volt house, this TV draws 70 Watts per hour  
(it will also use 70 watts in a 12 Volt system)

**M/S Tip:** To find the amps it will draw per hour from the battery  
in a 12V system: (Watts ÷ Volts= Amps)  
The plate tells us:  
 $70 \text{ Watts} \div 12 \text{ Volts} = 5.83$  or roughly 6 Amps/hr

It may also look like this:



This label lists the rating in Amps (as above) 120V 50-60Hz 0.4A

**M/S Translation:** In a 120 Volt house, this printer draws 0.4 amps per hour  
(BUT in a 12 Volt system it draws more...)

**M/S Tip:** First we need to determine the watts ( $\text{Amps} \times \text{Volts} = \text{Watts}$ )

The plate tells us:

$.4 \text{ Amps} \times 120 \text{ Volts} = 48 \text{ Watts}$ .

Now we can determine the amps it will draw per hour  
from the battery in a 12V system ( $\text{Watts} \div \text{Volts} = \text{Amps}$ )

$48 \text{ Watts} \div 12 \text{ Volts} = 4 \text{ Amps/hr}$

**For more info, contact Michael and Susan Snowden at [www.rvsolarenergy.com](http://www.rvsolarenergy.com)** □

## Average Wattage Range of Typical Appliances

120V AC Appliance	Watts per hour
Can opener	35-100
Coffee maker	800-2000
Frying pan	1300-1500
Toaster	800-1500
Rice Cooker	300-700
Crock Pot	100-350
Blender	350-700
Food Processor	120-800
Bread Maker	400-1000
Microwave	600-1800
Cell phone charger	6-20
Computer (laptop)	25-140
Computer (Desktop)	75-450
Printer (ink jet)	50-75
Printer (lazer)	600-1200
Fax (on standby/sleep)	15-45
Fax (printing)	120-350
Blow dryer	750-1875
Hot Rollers	300
Iron	1200-1500
Vacuum (upright)	200-700
Television 19"	50-160
DVD player	10
VCR	25
Receiver	100-300
Tape/CD/DVD player	25-50
Home Theater Surround Sound System	280(mini)-800

**M/S Tip:** When purchasing an appliance for use in your RV, always choose the one with the lowest wattage requirements. A watt saved is a watt you can use later. For more info, contact us at [www.rvsolarenergy.com](http://www.rvsolarenergy.com)

**Deep cycle lead acid batteries** for use in an RV are delineated by construction (how they are built):

TYPE	AVERAGE COST	EFFICIENCY RATING	AVERAGE CYCLE LIFE SPAN AT 50% DISCHARGE	RATE OF SELF DISCHARGE PER MONTH	LOSE OF ENERGY DURING CHARGE	COMMON BRANDS
<b>Wet cell (Flooded)</b>	\$1.50 per amp hour	89%	1280 Deep Cycles	10-13%	15-20% i into heat	Trojan Surrette
<b>Absorbed Glass Mat (AGM)</b>	\$1.50 per amp hour	99%	1100 Deep Cycles	1-3%	4% into heat	Lifeline Deka
<b>Gel Cell</b>	\$2.00 per amp hour	95%	400 Deep Cycles	1-3%	10-16% into heat	Universal West Marine

TYPE	PROS	CONS	M/S TIP
<b>Wet cell (Flooded)</b>	<ul style="list-style-type: none"> <li>•cheapest</li> <li>•most common</li> <li>•widely available even at Walmart</li> </ul>	<ul style="list-style-type: none"> <li>•safety equipment for handling as acid can cause burns and spill</li> <li>•need to be cleaned and watered (weekly), and equalized (monthly)</li> <li>•must be vented and shielded from sparks (mounted UPRIGHT on the exterior of your rig)</li> <li>•freeze intolerant</li> <li>•must disconnect and remove from rig when not in use to place on trickle charger device</li> </ul>	
<b>Absorbed Glass Mat (AGM)</b>	<ul style="list-style-type: none"> <li>•sealed-do not require venting so can be placed inside the coach</li> <li>•maintenance-free</li> <li>•cannot spill or leak even if the case is broken</li> <li>•can be mounted and operated in any position</li> <li>•will not freeze-can function in at -40F when fully charged</li> <li>•no need to remove from rig when not in use as long as solar panels are mostly unobstructed</li> </ul>	<ul style="list-style-type: none"> <li>•3 times the up front cost of wet cell construction</li> </ul>	<b>The "best buy" is obvious. AGM batteries are the only way to go.</b>
<b>Gel Cell</b>	<ul style="list-style-type: none"> <li>•sealed-do not require venting so can be placed inside the coach</li> <li>•maintenance-free</li> <li>•cannot spill or leak even if the case is broken</li> <li>•can be mounted and operated in any position</li> <li>•will not freeze-can function in at -20F when fully charged</li> <li>•no need to remove from rig when not in use as long as solar panels are mostly unobstructed</li> </ul>	<ul style="list-style-type: none"> <li>•4 times the up front cost of wet cell construction</li> <li>•special charging requirements-must be charged at a slower rate and at a lower voltage than wet cell or AGM. All the batteries in your bank would need to be gel cell</li> </ul>	