Airstream Tech Help Group

Howard Lefkowitz, #6077
Phil Broomall, #2654
Jim Cooper, #3056
Jamie King, #7018

This group has been established by WBCCI to help the membership with any of their technical RV problems. Examples of questions that might be of interest to many members will be published in the *Blue Beret*. We will respond directly to you, in response to your email or letter describing a problem you are having. We hope you will find this new service of value in the care and feeding of your RV. You may contact us as follows: techhelp@wbcci.org or by mail: Howard Lefkowitz, 11508 Colt Terrace, Silver Spring, MD 20902

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Solar Power

When we withdraw amp/hours from our battery vault we have to return them as soon as we have a source available. This could be shore-power, an alternator (from the tow vehicle or motorhome), a generator or a solar panel system. Solar energy is free, however, collecting and processing it is fairly expensive. Let's examine a typical system:

1. Three 130 watt solar panels which can provide 22 amps total
2. A special photovoltaic voltage regulator
3. A monitor system for voltage and current
4. Wiring harness, mounting brackets, stainless steel hardware, fuses
5. Inverter to provide 120 VAC for appliances with a transfer switch
6. Upgrading batteries (2) to AGM type
7. Upgrading the charger to computer controlled type with temperature monitor

The solar panels, regulator, monitor and all needed installation hardware can run about $2500. A 2000 watt Inverter with built in computer controlled charger can add about $1150. Installation and rewiring some of your 120 VAC outlets could easily take a day or about $700. Upgrading your batteries to two AGM Lifelines could cost $550. This represents a total expenditure of around $5000. You can skip the Inverter and just install a solar battery charger but this will still cost about $3750.

Assuming we use about 100 amp/hours in a day our solar system should be able to restore that in about 5 hours of peak sunshine. If we use most of the electricity in the evening then this should work out fine since we will have most of the second day to charge. Solar panels need sun to work not just daylight. You will have a lot more charging time in Florida in the summer than in Alaska in the winter. Your panels must be in direct sunlight all of the time which is why in critical applications moveable platforms, which can automatically track the sun, are used. No more parking under the shade trees, if you want to charge the batteries. Reference 4, illustrates the sun hours per day, high (summer) and low (winter), for major cities in the US. This provides a good guide as to how many hours of the most effective charging you will get.

Don't be fooled by the monitor system's voltage readings. You should have the monitor set for checking charge current, which reflects what is actually being put into the batteries. A minimal system, which you install yourself, keep your existing batteries, forget the inverter and provide just 7 amps charge current will run about $1000. If you limit your electric usage to just lights, TV and a laptop computer you could get by with one panel. One of the advantages of solar is you can start with a minimal system and add on over several years. If you run into several bad weather days, without sunshine, you may have to head for the campground and get a full shore power charge, anyway.

How much battery power do you need? how big a charger? how much solar power, how big an inverter? All of these questions can be answered using an amp/hour worksheet, Figure 6. This provides a list of what you want to run, how many lights you want to use and how long you will run any of the items. Check the back of the appliances or power supplies and use the wattage ratings provided by the manufacturers or if not available use Figure 6. Calculate the amp/hours you will use once you have stopped for the evening and during the night.

Even though a small toaster requires 800 watts if you only run it for 5 minutes that only requires:

I = P / E, I = 800 / 12 = 67 amps, 5/60 = 1/12 of an hour, 5.6 amp/hours.

While running a 60 watt light bulb for two hours requires 10 amp/hours, an LCD 20" TV (120 watts) running for two hours would require 20 amp/hours. Remember you are drawing the amp/hours from your 12 volt battery either directly or through an inverter.

I remember one Newfoundland Caravan where we had over two weeks of consecutive dry camping. Batteries were dropping like flies. To help the situation we spotted motorhomes among the trailers and ran their generators during the day when we were out sightseeing. For those with batteries in a deep cycle, who did not have good chargers, we collected the batteries in the morning and took them to Canadian Tire for charging during the day. One caravan member had 6 solar panels and 6 AGM batteries in his rig. One morning he stopped by to ask me to check his batteries since his rig had died during the night. Both rig batteries were completely dead, however, the AGM batteries were fine. After checking the wiring I found out that the Solar Dealer (per the owners directions) had

connected the 6 solar panels and 6 AGM batteries only to the TV and Satellite equipment. There was no connection to the rig, which is why those batteries died. So he sat there with a dead rig watching TV. You have to decide what is important to you when dry camping in order to size a Solar System.

Is it worth spending the money for a quality Solar System? If you spend most of your time in campgrounds then you won't get much use out of the solar. If you do extended dry camping in the winter and need the furnace you will probably require a generator (at least a small Honda). If you camp in the summer, particularly in the South, and want air conditioning you will need a larger generator (2500 to 3000 watts). Again, solar may not be worth the expenditure.

If you do a lot of dry camping, where generators may not be allowed, and want to spend several days at a wilderness site then a solar system could be justified. If you must have your Satellite TV in the wilderness and money is no object then solar is just the ticket. If most of your dry camping will be on caravans and it will just involve a day or two, once in a while, then a minimum solar supplement might be adequate (perhaps one panel with a minimum charger). Use the Worksheet (Figure 6) and determine your amp/hour daily needs, decide on the type of camping you will be doing, check your financial status and configure the system. Buy the largest panel you can fit on the rig and a charger that will handle 20 or 25 amps of current. Everyone I know that installed a solar system and purchased one panel eventually wanted at least a second panel and had to throw away the original10 amp charger and purchase a new one.

Solar Charge Controllers

Small, 1 to 5 watt solar panels, that provide a trickle charge for the batteries, do not need any voltage regulation. For larger solar panels the output can range from 15 to 20 volts and a charge regulator is required. This can be a conventional charger, as described above, where you set a voltage level and apply it to the battery using a four stage computer chip controlled unit.

The better solar chargers are computer chip controlled, provide the four

basic stages of charge and use a pulse width modulation technique (PWM) which is a series of charging pulses sent to the battery. The charger constantly checks the battery, hardware and environmental conditions to determines how fast to send the pulses and how long (wide) they should be.

A PWM charger provides:

1. The ability to maximize battery capacity
2. Increases the charge rate without significant battery overheating
3. Maintains high average battery capacity
4. Equalizes the different battery cells
5. Reduces heating and out-gassing which minimizes water loss
6. Automatically adjusts for battery aging
7. Self regulates for system voltage drops and temperature effects in the panels

This is a much more efficient method than just using a fixed voltage and changing the voltage level as the battery reaches a fully charged state.

For maximum efficiency, solar systems can use MPPT or Maximum Power Point Tracking chargers that are matched to the panel output voltages and the type of batteries being used. Solar panels produce about 17 or more volts of output and require battery voltages that can range from 12 to 15 volts. The MPPT chargers provide operation at the optimum power point to maximize current into the batteries, Figure 5. This takes full advantage of the 17 volt panel supply to get more charge current into the battery and provides efficiencies in the 95% range. These are more expensive but considering that they can provide 15 - 30% more power to the battery they can actually be cheaper by reducing the need for more panels.

This type of charger also uses separate voltage and temperature sensor circuits to optimize the charge current. They have switches so you can set the parameters for almost any type of deep cycle battery used in an RV. They almost always provide the four charging stages described above, in the Charger section as well as the PWM charge technique.

Solar panels produce around 17.6 volts at a specified current. A 130 watt panel will provide a maximum output of about 7.4 amps of current for a 12 volt battery. This is about 89 watts, which means you are losing 41 watts of capability when charging the battery. Figure 5 shows the peak power point at which you can best match to the 12 volt battery. If you use an MPPT charger, that operates at the peak point, it converts the panel output to 10.8 amps at 12 volts. Now you are putting an additional 3.4 amps into the battery for each panel. For a two panel system this is almost like adding a third panel, i.e. two 130 watt panels provide 14.8 amps of charge or two 130 watt panels, with an MPPT charger, provide 21.6 amps. The peak power point changes constantly with available sun light, battery condition, weather, temperature, etc. So the job of the MPPT is to monitor all of these variables and continuously adjust the operating point for the maximum output charging current.

MPPT chargers are about $600 for an 80 amp unit, $525 for a 60 amp, $380 for a 30 amp unit, $250 for a 25 amp unit and $225 for a 15 amp unit. PWM chargers are about $250 for 60 amps, $200 for 40 amps, $140 for 30 amp, $125 for 20 amps and $100 for 8 amps. Standard charge regulators run from 45-60 dollars for 8 to 16 amps. Remote digital monitor meters, which provide voltage and current measurements, can run from 40-90 dollars.

Figure 5. MPPT Optimum Power Point Charging

An MPPT charger is the most efficient and cost effective method for controlling a solar array on your RV. Further, these chargers include all of the latest technology (PWM, computer control and four stage charging) for maximizing battery efficiency, performance and extended

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life. If you plan to extend your solar system capability in the future to two, three or more panels then you should definitely consider an MPPT controller.

Some Solar System Tips

- Select the largest panels you can mount on your rig
- One panel per battery per person with one extra (quick estimate)
- Keep the panels clean
- Clean and check all connections at least once per year
- Typical Panel voltage is 17 plus volts
- Heavy users will need 3 or 4 panels and 4 batteries
- Forget air conditioners, large microwaves and furnaces
- Consider Propane catalytic heaters and/or a 12 volt heating bed pad
- Non sinewave inverters work for computers, TVs and small appliances
- Use energy efficient lights (fluorescent, LED, halogen)
- Do a Consumption Worksheet and determine maximum amp/hours needed
- Don't forget 'sneak loads' (circuit boards, radio, pilot lights, water heater)
- Buy at least a 20 or 25 ampere charge controller (you will add panels)
- For larger Panel arrays Invest in an MPPT charge controller and remote monitor
- Make sure the proper wire size is used
- Plan for future upgrades when sizing controllers and wire size
- When your batteries need charging stay out of the shade
- After sizing solar consider needs for air conditioning, furnace, microwave
- Trade off costs and desires when considering a generator versus solar system
- Consider both acquisition and operating costs for these two approaches
- Evaluate approach based upon expected hours of usage and total investment

Figure 5. MPPT Optimum Power Point Charging

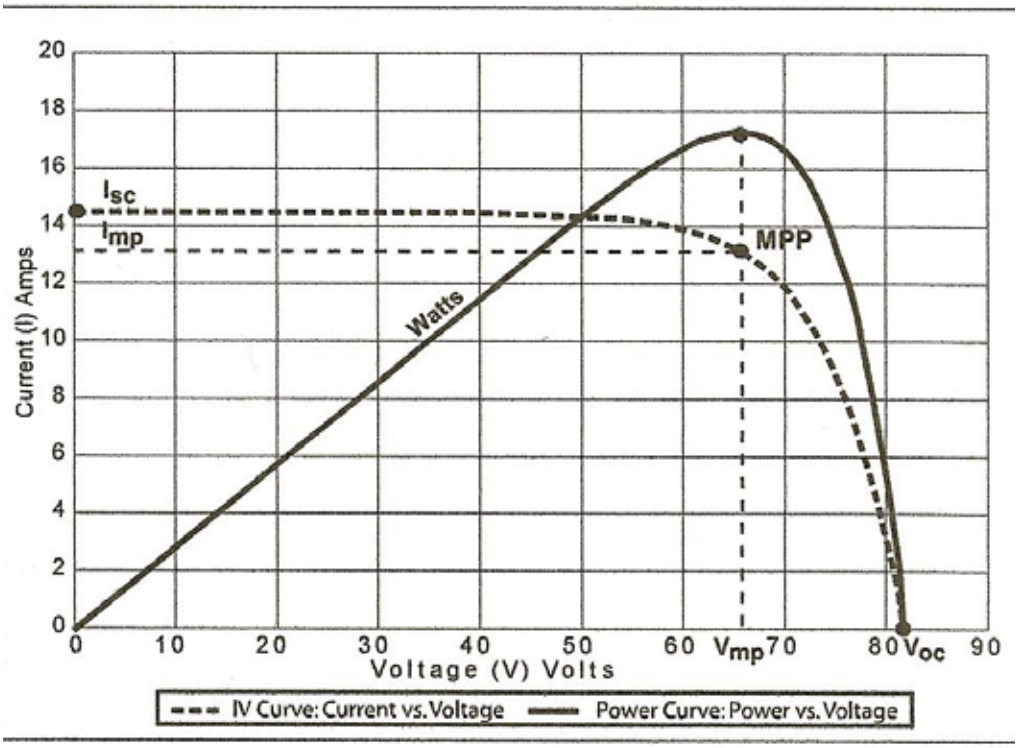

Figure 6 Worksheet for Calculating Power Required for One Day

Appliance	Watts	Amps (approx)
Lights		
bulbs	10	1
	25	2
	50	2
halogen	10	1
	20	2
fluorescent	10	1
	15	1
Entertainment		
19" Color	85	7
20" LCD	120	10
32" LCD	140	12
Satellite Rx	50	4
Stereo	40	3
Cool/Heating		
Fans	24-36	2-3
Furnace	100	8
Microwave		
small	800	67
large	1300	108
Computer	50-200	4-17
printer	50-100	4-8
Vacuum	200	17
Hair Dryer	1000	83
Water Pump	50	4
Bed warmer	24-50	2-4
Refrigerator	72	6
Toaster	800	67
Coffee Maker	1000	8