**Living “Off-Grid” in Your RV – Is Solar A Feature You Need?  
Part 3: The “Golden Rules” of Solar/Electrical System Design**

Jack Mayer, [www.jackdanmayer.com](http://www.jackdanmayer.com)  
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**The Golden Rules of RV Solar and Electric**

In previous articles we covered the major electrical components used to upgrade your RV for off grid living. In this article I’ll discuss some of the factors involved in putting them together optimally, and make a recommendation on specific components of a nice system. These are my opinions based on experience and education – some of the items are based on electrical “laws” and are really not debatable, while others are best practices and people may have varying opinions. If you (or a manufacturer) follow these “rules” you will have a successful system.

Solar Panels

* Use high voltage (over 28 volts) on any but the smallest systems (small: under 350-400 watts)
* Optimal input voltages for most MPPT controllers outputting to a 12-volt battery are in the 30-40 volt range. That means high voltage panels work very well.
* Use serial/parallel connections on the panels to get higher voltage, when required. Panels must be matched (e.g. the same specifications).

Solar Controller

* Consider using an MPPT controller – the additional cost is a small percentage of the entire system. This allows for high input voltage which makes the cabling from the roof easier. An output boost in the 10%+ range is realistic.
* The controller should allow for adjustable voltage and charge times.
* Position the controller close to the battery bank.
* Make SURE the wire size to the batteries from the controller is correct. It will be bigger than what comes from the roof in most cases. You need to calculate this separately.
* Temperature compensation is NOT an option – use it. If a voltage sense line is available, use that too.
* Make sure there are fuses/breakers on input/output sides of the controller. You need to be able to isolate it.

Batteries

* Balance the system; have enough batteries for the amount of watts of panels you have.
* Rule of thumb: 1 amphour of storage for each watt of solar panel. You don’t need to obsessive about this – it is just a guideline.
* Flooded cell batteries should charge at 14.8 volts NOT at 14.4/14.6 volts that you commonly see.
* Wire the battery bank correctly: large enough wires, +/- connections on diagonal corners, equal length wire runs.
* AGM batteries have advantages, but cost much more.
* Solar alone generally will NOT bring a bank up to “full” state of charge because the system is continually in use. But it will get it very close.
* Use a battery monitor with a remote display (like a Trimetric, Link, or Magnum BMK).
* With flooded cell batteries check specific gravity at least every 6 months until you learn how your batteries charge. Equalize if required.
* A desulfator “may” be helpful. Reports vary in RV use.

Inverter

* Wiring is critical. Never less than 2/0 and usually 4/0. READ the book - there is no excuse to use a lighter wire than the inverter manufacturer requires.
* Position the inverter close to the batteries.
* Catastrophe fuse is required at the batteries.
* Remote display/control is important – use a good remote display.
* Do not use too large an inverter for your needs. It is inefficient to run an inverter way below its rating.
* The inverter charge section is critical if using AGM batteries. AGM batteries can use as large a charger as you can find.
* On flooded cells properly set the charge amperage…..C/20. (“C” is the total battery bank amperage.)
* Temperature compensation is NOT an option – use it.

Wiring

* Wire size is CRITICAL. It is the single-most common issue with installations. Use voltage/distance calculators. Then go heavier
* Manufacturers almost never provide adequate wiring. New Horizons is the only RV manufacturer I have encountered that uses proper wire sizes.
* Wire for 2% loss or less. I wire for 1% from the controller to the battery bank.
* Use quality closed-end, coated lugs, and properly attach them; use dielectric grease and adhesive heat shrink. New Horizons is one of the few manufacturers I have seen that does this.
* Fuse before/after controller; a catastrophe fuse is required at the battery bank.
* Use a combiner on roof to join the solar panel wires to the wire feeding the solar controller.
* Use distribution buss bar(s) near the battery to tie loads together (if required).
* Do not attach loads between the shunt and the battery.

Sample “Mid-size” System

People frequently ask what a good system “package” is. It is going to vary based on your electrical consumption requirements. But for most people that would like to boondock for 10+ days at a time and have “typical” electrical requirements the following system could be classed as “best of breed”. There are other components available that are quite good, and can be combined to make a comparable system. I happen to like these components, for various reasons (some of which I note here).

Inverter: I like the Magnum line of inverters. For most RVers a Magnum 2012 inverter is sufficient. This is a pure sine wave 2000 watt inverter, with a 100 amp charge section. It will run almost any microwave and all other household appliances that would normally be run on an inverter. Use the ME-ARC remote monitor.

Battery Monitor: Magnum makes a battery monitor component for their inverters. The ME-BMK will report cumulative amphours and other battery information via the ME-ARC remote display used for the inverter. That saves adding a separate display device for battery monitoring.

Solar Controller: Morningstar TriStar MPPT-60. Use the 60 even if it is not required for the number of panels you will initially use. Most people expand their systems; you want room for growth. The MPPT-60 also allows you to network the controller to your router and view solar data on your laptop. This capability is not as easily available on the MPPT-45 model. The 60 comes with a voltage sense line, and temperature compensation sensor. If you are on a budget, consider the TriStar 45 if it fits your array size requirements. But it will not be as expandable, or have the same feature set.

Battery Bank: If you can afford it, then Lifeline AGM batteries are the ultimate solution. Size the bank to your solar array size. They should be “close” in the number of watts/amphours. Three Lifeline GPL-8DL batteries will give you 765 amphours of capacity (255\*3), of which 50% (or 382 amphours) is usable. If you commonly draw them down to 25-33% of their capacity, which is what I recommend, that still gives you 255 amphours to use overnight.

If you choose not to use AGM batteries then look at Trojan T105’s. They are still expensive, but much less than AGM’s. Or, if you are doing it yourself, look at Sam’s Club flooded cell batteries. A bank of six would work well.

Solar Panels: I like the new GS100 panels that AM Solar sells. They fit places where other panels would be shaded, and they are high-efficiency panels. Although not high-voltage panels they can be combined in series/parallel if required. If doing the job yourself, look at the high voltage panels that Sun Electronics carries. You can buy “blemished” panels from them with full a warrantee at reasonable prices (well under $2 a watt).

Miscellaneous Parts: AM Solar has an excellent roof combiner with the new 4/2 Roof C-Box. MidNite Solar offers a nice breaker box with their “Baby Box Enclosure” suitable for array disconnect (to isolate the solar controller). For higher-end systems or those that like “neat installs” they also offer an E-Panel for Magnum inverters. This combines all the electrical requirements into one neat enclosure.

New Horizons offers excellent solar packages combining most of these “best of breed” components. And, since it is a custom rig you can modify the packages if you have special requirements.

I realize for those not “into” solar and electrical modifications that some of this information is just “gibberish”. But it should give you a place to start your own research. For those contemplating an installation I’m available to answer questions via email. If you are specifying a New Horizons, I can also help you with that if the standard factory packages need modification.