Solar 101, a brief introduction to Solar Power Systems…

Safety First!

12volts may not kill you, but 100amps across a ring or bracelet will cook you.

Always disconnect the **NEGATIVE CABLE** from the batteries before working on the system.

Solar connects to the coach batteries, not the chassis (front Sprinter) batter.

2 acronyms to know: **KISS** and **WAV**

KISS Keep It Simple and Safe!.. just what it says… don't try to make a basic system over complex with bells & whistles…

First and probably most important, decide what it is that you want a solar system to do for you!

if you are not familiar with basic electricity, get someone to assist you until you are…

WAV the cornerstone of any electrical system… this will be discussed later…

WATTS = AMPS times VOLTS

A Basic system.

Please note! I am going to use the Renogy diagrams, not that I am endorsing their products over any other ones, but it is the systems I am most familiar with.

I will also use Amazon as a source for kits, parts, and assorted items… just because it is, IMO, the most versatile way to get them…

A **Basic 12VDC System** consists of 3 items: a panel (or multiple panels), a controller, and a battery, and of course the interconnecting wiring…

This simple configuration is all you really need if you are looking to support only lighting and other 12Volt direct current (VDC) items in the coach..

You can purchase complete basic kits online, from sources like Amazon, Walmart, or usually the manufacturer.. here are a couple of links…

https://www.walmart.com/ip/Renogy-200W-12V-Monocrystalline-Solar-Panel-Bundle-Kit-with-30A-Charge-Controller/582359113?athbdg=L1700

https://www.amazon.com/Renogy-Monocrystalline-Negative-Controller-Connectors/dp/B00BFCNFRM/ref=sr_1_5?crid=2OXNJ7IPT3ERQ&keywords=solar+kit+for+rv+complete&qid=1642261961&sprefix=solar+kit%2Caps%2C132&sr=8-5

https://www.renogy.com/200-watt-12-volt-solar-starter-kit-w-mppt-charge-controller/

Let's do descriptions of each item in a basic kit…

Panels… this is the how you grab the power from the sun… there are different types of panels, of which the monocrystalline panels are still one of the most efficient solutions. Most "kits" have this type of panel..

(for an in-depth description of panel types go to; https://energieadvisor.org/types-of-solar-panels/)

It is important to understand that a 100watt panel will not continuously produce 100watts of power… it is dependent of the amount of direct bright sunlight that directly hits the panel… a good rule of thumb is 50% of the rating over a typical day, more in the summer, less in the winter… so if you are expecting to recharge a single 100Ahr battery from a 10% level to 100%, you would need 90Amp-hours (AHr) of energy, or 2 – 100W panels, at 50% average, producing that output for 9 hours…

The panels can be mounted to the roof of the coach by different methods, one of the least invasive (no drilling) is by the use of 3M's VHB double-sided tape..
That tape being available online… search for 3M 1 Inch Width 15 Ft Length VHB 5952 Black Water Resistant Heavy Duty Multipurpose Double Sided Tape.

Brackets are also available in different configurations.. search for "solar panel mounting brackets".

Controllers... once again, there are many manufactures of these out there..
The advantage of a kit is it will have a properly sized one for the panels that you get..

A solar charge controller is fundamentally a voltage and current controller to charge the battery and keep the battery from damaged. Generally, batteries require around 14 to 14.5V to get completely charged. 12V panels put out in the ballpark of 16 to 20VDC, so if there is no regulation the batteries will be damaged. The solar charge controllers are available with multiple features, costs, and sizes. The range of charge controllers is from 4.5A and up to 60 to 80A.

There are three different types of solar charge controllers, they are:

1. Simple 1 or 2 stage controls
2. PWM (pulse width modulated) – This is the type provided as original equipment(OEM) by Winnebago (WGO) for the View/Navion coaches..
3. Maximum power point tracking (MPPT)

Most all aftermarket kits use the third one, the MPPT.. These controllers combine the best working voltage and amperage provided by the solar panel and match those with the batteries. The outcome may provided 10-30% more power out of your panels versus a PWM controller. It is usually best for any solar electric systems over 200 watts.
Almost all of the newer controllers are adjustable, either automatically or thru manual methods, and should work with all the different battery types…

Once again, here are the websites for a few of the major controller manufactures..
https://www.renogy.com/rover-li-20-amp-mppt-solar-charge-controller/

https://www.victronenergy.com/solar-charge-controllers/smartsolar-mppt-75-10-75-15-100-15-100-20

as noted earlier, the controller used as OEM by WGO is made by Zamp Solar…
https://www.zampsolar.com/collections/charge-controllers
it is a PWM type unit, not an MPPT… I have included it for information only..

Batteries... This is the most controversial part of the system… The most common types used in the RV's are, FLA(flooded lead-acid), AGM(Absorbent Glass Mat) and the newest Lithium, (which is usually LiFePO4 - Lithium Iron Phosphate)

A brief summary of each;

FLA... flooded lead acid is dependable and inexpensive on a cost-per-watt base. There are few other batteries that deliver bulk power as cheaply as lead acid.. however these batteries are sensitive to the depth-of-discharge (DOD) that can be done… if you are drawing more than 50% of the energy from them, they typically last only 200 to 300 discharge/charge cycles.

They are very heavy, usually in the 70 to 80 pound range each… and are full of liquid sulfuric acid (VERY corrosive and outgases easily..) they are also subject to producing corrosion at the terminals, requiring periodic cleaning of the dried acid…
They also tend to have the water-based electrolyte evaporate over time, requiring water to be added…

The FLA is the "standard" coach batteries the WGO View and Navion's come with….

SLA, or sealed lead-acid battery, is a variation of the FLA.. but does not require water to be added… the terminals still require periodic cleaning, a messy chore.. this type has a slightly higher cost-per-watt than the FLA style…

AGM... the Absorbent Glass Mat is still a lead-acid based design that suspends the electrolyte in a specially designed glass mat. This type of battery offers several advantages to the lead acid systems, including faster charging and instant high load currents on demand. AGM works best as a mid-range battery with capacities of 30 to 100Ah… the AGM still has the disadvantage of the FLA/SLA in weight and sensitivity to DOD issues.

LFP4, or LiFePO4... lithium battery technology is not new, it has just become safer and more affordable in recent years… The key benefits are high current rating and long cycle life, besides good thermal stability, enhanced safety and tolerance if abused…

There are many sources for all of these types of batteries…
My system uses the LFP4 batteries.. here are a few suppliers…
https://www.renogy.com
https://relionbattery.com/shop/application/recreational-vehicle
https://battlebornbatteries.com

A few major advantages of these batteries is the light weight, approx. 25lbs, and a basic "install and forget" technology…

These batteries can repeatedly, 2000+ times, be discharged to 90% of their capacity and fully recharged… The statement that LFP4 batteries cannot be charged in below freezing conditions is incorrect… they can be charged, just at reduced current.. see the following information from ReLion Battery, one of the major manufactures of the LFP4 battery…

RELiON®

CHARGING INSTRUCTIONS

RELiON LITHIUM IRON PHOSPHATE ($LiFePO_4$) BATTERIES

To ensure your Lithium Iron Phosphate ($LiFePO_4$) battery provide its maximum life, follow these Charging Instructions. When charging $LiFePO_4$ make sure that you are not using a charger meant for other lithium ion chemistries, which are typically set to a higher voltage than required by $LiFePO_4$ batteries. A lead-acid battery charger can be used if the voltage settings are within the parameters of $LiFePO_4$ batteries.

Charger Inspection

Check that your charger cables are insulated and free of breakage. Charger terminal connectors should be clean and properly mate with the battery terminals to ensure a good connection and optimum conductivity.

Charging Guidelines

When to Charge your $LiFePO_4$ Battery

If $LiFePO_4$ batteries are not fully discharged, they do not need to be charged after each use. $LiFePO_4$ batteries do not get damaged when left in a partial state of charge (PSOC). You can charge your $LiFePO_4$ batteries after each use or when they have been discharged up to 80% (20% SOC). If the Battery Management System (BMS) disconnects the battery due to low voltage, at 100% depth of discharge, remove the load to reconnect the battery circuit and charge immediately. Please note that we recommend storing batteries at 50% state of charge (SOC) to minimize irreversible capacity loss.

Charging Temperature

$LiFePO_4$ batteries can safely charge between -20°C to 55°C (-4°F to 131°F). However, at temperatures below 0°C (32°F) the charge current must be reduced, until the temperature is >0°C (32°F), as follows:

1. 0°C to -10°C (32°F to 14°F) charge at 0.1C (10% of the battery capacity)
2. -10°C to -20°C (14°F to -4°F) charge at 0.05C (5% of the battery capacity)

$LiFePO_4$ batteries do not require temperature compensation for voltage when charging at hot or cold temperatures.

All Relion $LiFePO_4$ come with a BMS that protects the battery from over-temperature. If the BMS disconnects due to high temperature, wait until the temperature reduces and the BMS reconnects the battery circuit before using or charging the battery. Please refer to your battery data sheet for the BMS high temperature cut-off value.

Battery summary... I have LFP4 batteries in my coach.. they were purchased 6+ years ago and still recharge to 100% after 1000+ cycles…

If you plan to do any boondocking, IMO, the LFP4 battery is a must.. the cost up front is still a bit steep, but they will probably be the last set of batteries you will buy for the coach.. the trade off of weight and maintenance, and basically carefree, is worth it…

Mounting and Routing cables, etc.... unfortunately, there is no straight forward set of instructions to do this… you MUST be comfortable working on the roof of your rv, and knowledgeable of it's internal passages and hidden spaces to run the wires and make connections… if you are not, let a professional do the install…

WAV, or WATTS = AMPS times VOLTS...

This is the basic formula you will be following to determine what you need in a system. Any system you put together must be able to meet the needs of the loading you want to support. This will become more important when you start to consider batteries in your system.

This is where you ask yourself what is it I want/need solar for? The energy is free, but your system must be able to store and deliver power for you.. Bob Kelly made a table up of power requirements for the typical items in the V/N's… it is a great reference to start with. It can be found in it's entirety at https://www.viewnavionmotorhomes.com/documents-information/coach/solar-use-calculator-worksheet/

An simple example would be a 12VDC fan, like https://www.roadtrucker.com/12-volt-appliance/12-volt-quick-clip-multi-mount-oscillating-fan.htm that draws 15watts, continously... That would be (15watts/12VDC=1.25amps)

If your battery s a SLA or FLA, you probably don't want to go below 40% of DOD, so assuming you have a 100AHr battery, the usable power is actually 60AHr… so you can run the fan for approximately 48 hours..

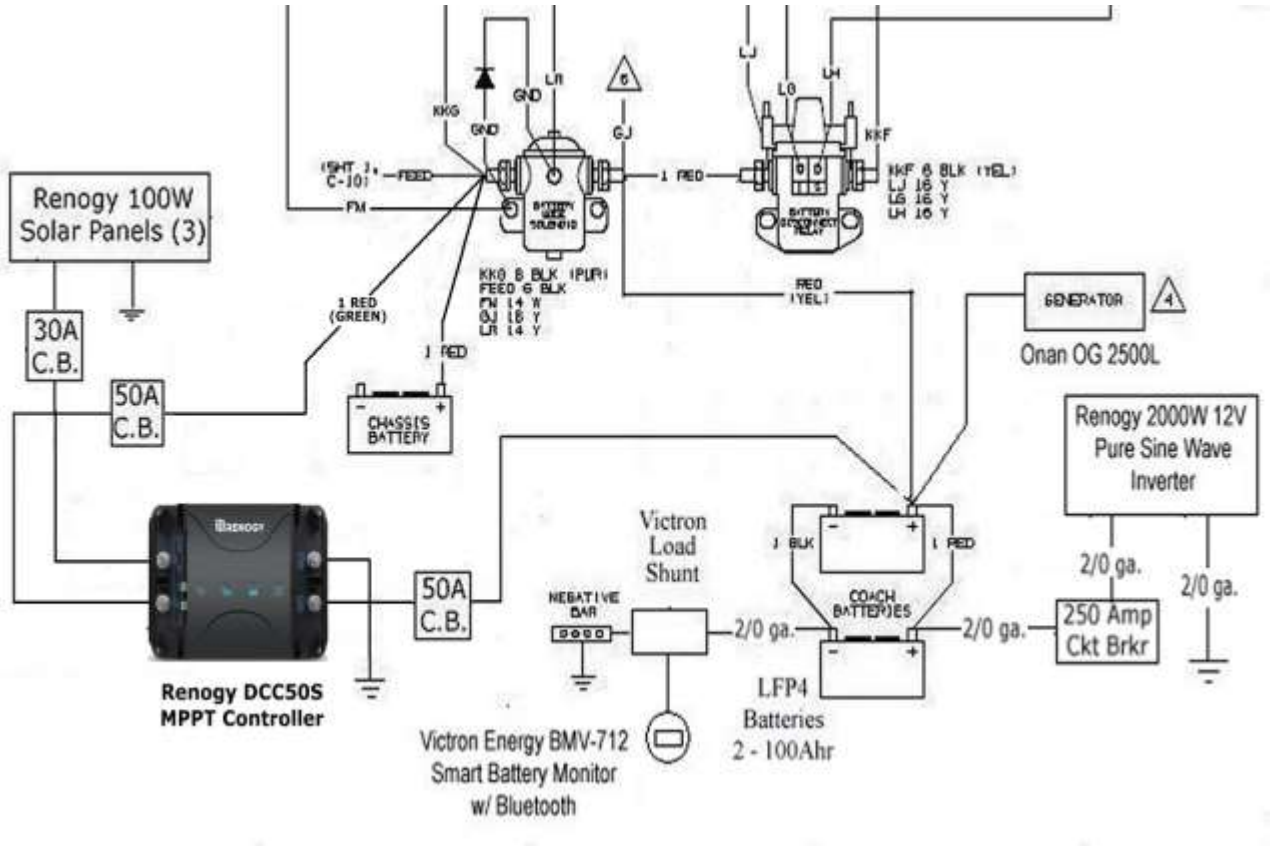
If you are using a 100Ahr LFP4 battery (90%usable), then you could run this fan for about 72 hours.. a 30% increase in usable power…

You can use an inverter to run a standard fan, but you need to do some additional calculations to determine the power necessary…

A classic example of this is a small 120VAC 1000Watt heater… 1000w = 120VAC x 8.33amps… but to get the 120VAC you have to use an **inverter** to change the 12VDC of the battery to 120VAC.. assuming the inverter has no loss the same heater would add a multiplier of 10 to the amperage requirement (120VAC/12VDC =10) then that heater would require almost **84amps** to run! So your 100Ahr LFP4 battery would last for about 1 hour, and the SLA about 40 minutes…

Why is this important? The equations are what you need to use to determine how much battery and solar power you will need in your system.

Just for informational purposes, here is the diagram of my 300watt, 200AHr, LFP4 based solar system install in my 2008 Navion.



I prefer the Reogny DCC50S controller as it has features to use the different types of batteries, and also keep the chassis (Sprinter) battery charged when not in use.
It also provides current limiting 0f 25amps from the alternator for charging while driving.

I also have a converter, the device that provides 12VDC to the coach lights and appliances, model PD4645. That converter is configured to charge the LFP4 batteries to the proper levels.

There is a smaller amperage version, DCC30S, available that has the same features.