

RV Systems 101

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Powering Your RV Systems

There are three ways that your RV systems are powered:

1. 12-volt DC – provided by one or more batteries on your RV, if the batteries have a charge, you will have 12-volt DC.
2. 120-volt AC – must be either plugged in to a power source (RV park power pole, generator, home) or running an inverter to make 120-volt AC from your 12-volt batteries.
3. Propane

RV Systems and Power Sources 1

High power systems only run on 120-volt AC - air conditioning, microwave, electric fireplace, some refrigerators.

Systems that need to generate a lot of heat run on propane - water heater (set to gas), furnace, stove/oven.

Systems that have lower power draw and/or need to always be available run on 12-volt DC - lights, water pump. Slide outs and leveling jacks are higher power draw but only run for short periods of time and need to always be available.

Some system can run on more than one power source, water heaters can typically run on 120-volt AC or propane, gas/electric refrigerators can run on 120-volt AC or propane. Typically, you would run both on 120-volt AC when plugged in, or propane if you are not plugged in.

RV Systems and Power Sources 2

System	12-volt DC	120-volt AC	Propane
Air Conditioning	No	Yes	No
Electric Fireplace	No	Yes	No
Furnace	Yes, for the fan	No	Yes, for the heat
Leveling Jacks	Yes	No	No
Lights	Yes	No	No
Microwave	No	Yes	No
Refrigerator - DC	Yes	No	No
Refrigerator – Gas/Electric	Yes, for controls	Yes, if set to electric	Yes, if set to gas
Refrigerator - Residential	No	Yes	No
Slide outs	Yes	No	No
Stove/oven	No	No	Yes
Water pump	Yes	No	No
Water heater	Yes, for controls	Yes, if set to electric	Yes, if set to gas

Basic Electrical Concepts

Voltage (volts): how hard electric current is trying to flow (like pressure in a plumbing system).

Current (amps): how much electric current is flowing (like water flow in a plumbing system).

Resistance (ohms): how difficult it is to push current through a material. Low resistance makes it easy for current to flow, high resistance makes it hard for current to flow.

Ohms law: $\text{current} = \text{voltage} / \text{resistance}$.

- If a material has 10 ohms of resistance, 120-volts will cause 12 amps to flow but 12-volts will only cause 1.2 amps to flow.

Power (watts): $\text{power} = \text{voltage} \times \text{current}$.

- If a system needs 1200 watts to run that is 10 amps at 120-volts and 100 amps at 12 volts.

AC and DC Electrical

Home electrical systems are Alternating Current (AC) systems. There is a ground wire (typically green), a common wire (typically white) and a hot wire (typically black).

In an AC system the voltage on the hot wire goes up and down 60 times per second (60 cycles).

To measure the voltage in an AC system a voltmeter must average the voltage by something called Root Mean Squared (RMS)

Direct Current (DC) systems have a positive wire (typically red) and a negative/ground wire (typically black).

In a DC system the voltage doesn't go up and down.

12-volt DC System Basics

If your battery(s) have a charge you will have 12-volt power available.

When you plug-in your RV, your 120-volt power panel has a converter that will charge your batteries by converting some of the 120-volt AC power to 12-volt DC power to feed into your batteries. You can also use solar arrays to charge your batteries and when you are towing your RV your tow vehicle may also charge your batteries (depends on your RV wiring).

Battery banks are described in amp hours (Ah), a 100Ah battery can in theory provide:

- 50 amps for 2 hours
- 10 amps for 10 hours.
- Etc.

As will be discussed on the next slide, most batteries can't provide their full rated Ah capacity.

RV Batteries

RV batteries are different than car batteries, a car battery must provide a lot of current for a short period of time, RV batteries provide lower amounts of current for long periods of time and are designed differently. RV batteries are known as deep cycle batteries.

Three main battery types:

1. Lead acid – inexpensive, require water to be added periodically, heavy, low power per weight/size, make hydrogen when charging, can only be discharged to about 50% without degrading them, charge quickly to about 80% and then charge slowly.
2. AGM – more expensive, sealed, do not require water to be added, heavy, low power per weight/size, almost never make hydrogen when charging, can only be discharged to about 50% without degrading them, charge quickly to about 80% and then charge slowly.
3. Lithium Iron – most expensive, do not need water to be added, light, high power per weight/size (about 3x better), never make hydrogen, can be discharged almost all the way without degrading them, last longer, charge quickly. May require the converter to be changed in your RV for optimum charging.

Battery Bank Sizing

Most RVs will come with a single lead-acid battery of around 75 amp-hours in capacity.

That is sufficient to run your lights, water pump, fans for around one day. It is not enough if you use an inverter or have any other high-power draws and you must recharge the battery every day.

For longer run times or higher use you can get a bigger/high-capacity battery or hook multiple batteries in parallel.

If you hook batteries together so the positive terminals are connected and the negative terminals are connected that is called parallel, and you will increase the Ah capacity at the same voltage. The batteries should be identical.

If you connect to the positive terminal of one battery and then connect the negative terminal of that battery to the positive terminal of a second battery and then connect to the negative terminal of the second battery that is called series. Series connections double the voltage and are generally not used because your systems are designed for a specific voltage.

120-volt AC System Basics

As previously mentioned, 120-volt AC is only available if the RV is plugged into a power pole, house or generator, or an inverter is making 120-volt AC power from the 12-volt DC system.

120-volt AC systems in campers typically have either a 30-amp or a 50-amp connection.

30-amp – a 3 prong plug provides a ground, a common and one hot connection that can provide up to 30-amps of current.

- A 30-amp connection can typically only support one air conditioner.

50-amp – a 4 prong plug provides a ground, a common and two hot connections that can provide 50-amps each, a 50-amp connection can provide up to 100-amps.

- A 50-amp connection can support two or more air conditioners.
- In the RV power panel, there will be two – 50-amp breakers and the 120-volt AC loads will be divided between them. For example, there might be a 20-amp circuit for an air conditioner on each of the 50-amp legs, one leg might have a 15-amp circuit for the water heater, another leg might have a 15-amp circuit for the fireplace, etc.

Plugging In Your RV

If you have a 50-amp connection and you are at a campground with 50-amp hook ups, you simply plug in your 4-prong power cord.

If the campground only has 30-amp hookups you can connect to that with an adapter, but you must be careful not to run too many things at once and overload the circuit tripping the circuit breaker (for example don't run more than one air conditioner).

Because a 50-amp circuit has two hot wires and a 30-amp circuit only has one, you need to use something called a dog-bone that splits the 30-amp feed into two feeds to connect. If you don't use a dog bone only half the circuits in your RV will be powered up.

You can also get a 30-amp to 20-amp adapter to plug into a regular home outlet. This will let you charge your camper batteries but not run an air conditioner.

Inverters

An inverter can take 12-volt DC and convert it to 120-volt AC.

Inverters are not 100% efficient and you lose some power during the conversion process, typically less than 10% is lost.

Inverters can be pure sinewave, modified sinewave or some other output type. Pure sinewave is best so that your systems run well, and they will run more efficiently than on a modified sinewave.

Inverters can be very hard on your battery bank, if you are drawing 1200-watts of 120-volt AC from an inverter, the draw on your batteries will be over 100-amps after accounting for efficiency. You will likely need more than one battery in your battery bank to support that much power draw.

A 2000-watt inverter can generally supply the needs of an RV if you don't try to run an air conditioner.

Propane System Basics

Your propane system will have one or more propane tanks that are connected to a regulator.

The propane in the tanks is too high pressure for your appliances so the regulator reduces the pressure to a specific value to feed out to your appliances.

Propane can explode if it accumulates somewhere and ignites, your RV should have a propane detector near the floor (propane is heavier than air).

Anytime you change propane tanks you should check for leaks.

If you smell gas in your RV shut off your propane tanks and leaves the RV until the propane has dissipated. Don't use the propane until the source of the leak is found and fixed.

After changing propane tanks, or if your system hasn't been run in a while, you can light the stove burners to flush any air out of the system. A refrigerator on propane may not start if there is air in the system.

Propane on the Road

From a safety perspective, ideally you would shut off the valve at your propane tanks while travelling but this isn't always practical.

If you need to run your refrigerator on propane while travelling, you can legally do so except in certain tunnels or on ferry boats.

You also need to shut off the refrigerator whenever you are fueling up your vehicle because the refrigerator has a flame that could ignite the fumes from fueling. Basically, you need to stop before you pull up to the pump, shut off the refrigerator, pull up to the pump, fuel up, pull away from the pump and restart the refrigerator. It isn't ideal but I have done this on some long trips before and it isn't that much extra work. You just must make sure you don't forget to turn the refrigerator back on. I had an index card that said refrigerator off that I would put in the center console when it was off.

In my current fifth wheel I have a 400 Ah battery bank and 800 watts of solar with an inverter, during daytime travel I can run the refrigerator off the inverter and the solar keeps the batteries charged. This allows me to travel with propane shut off.

Fresh Water System

The Fresh water system on an RV will typically include a freshwater tank, a water pump to pump the water from the tank to the fixtures and a water heater for hot water.

If you are on hookups, you can also hook up a water hose and use the hose pressure for the RV without running the pump or even filling the water tank.

RV water system have vents and are open to the air, they should be sanitized at the start of the season and every three or four months after.

We have a 75-gallon water tank and get around 4 or 5 days out of a tank, but we aren't very careful about water use. If we are more conservative with water, a week is likely possible.

If possible empty your tanks before driving with your RV. Some effluent in the tank is OK but your RV may not be designed to drive with full tanks (this may surprise you, but tanks have fallen out of the bottom of RVs before plus the weight can unbalance your RV).

Black Water System 1

RV toilets drain to a black water holding tank. The drain from the toilets to the tank is typically gravity fed through a 3" pipe. There is also a valve on the tank and a 3" pipe that runs to the side of the RV to drain the tank when needed.

Black water holding tanks vary in size, our RV has a 50-gallon tank, and we generally get 2-weeks out of that tank for 2 adults.

Your tank should have several gallons of water and tank treatment added before use, I have had good luck with happy camper treatment.

Only RV quick dissolving toilet paper should be used.

When flushing solids, use plenty of water.

Black Water System 2

Never let solid wastes dry in the tank. If you are hooked up to a sewer system, leave the black tank valve closed until the tank fills up, then open the valve to empty the tank, close the valve, add water and tank treatment and use the system with the valve closed until it fill up again.

It is OK to completely drain the tank when you are leaving the campground. Most black water tanks also have a water inlet to flush out the tank when dumping it.

To clean out your drainpipe and hose dump your black tank first and then your gray tank(s) so the grey water washes everything out. When camping on hook ups you can close your gray tank valves for the last day to build up water to flush out the system.

If possible empty your tanks before driving with your RV. Some effluent in the tank is OK but your RV may not be designed to drive with full tanks.

Gray Water System

Gray water is water from your sinks, shower and washer dryer if so equipped. Basically, any wastewater that isn't from the toilet.

Most RVs have separate Gray and Black water storage tanks.

In some places you can run gray water out onto the ground but in many other places you can't so check with local authorities.

When you are on hook ups it is fine to just leave your gray valve(s) open to the sewer.

Some RVs have one gray tank, some like our have one for the bathroom and one for the kitchen.

We have 35 gallons for the kitchen and 50 gallons for the bathroom and get 4 to 5 days out of that, but we aren't very careful about water use. I would expect a week with more careful water use would be reasonable.

If possible empty your tanks before driving with your RV. Some effluent in the tank is OK but your RV may not be designed to drive with full tanks.

RV Leveling

For personal comfort and for your systems to work correctly your RV needs to be level.

If you have a pop-up or travel trailer you generally level the RV by placing blocks under the wheels and raising or lowering the front jack. The corner jacks on the RV are for stabilizing it only and are put down after it is already level.

For fifth wheels and most drivable RVs there are leveling jacks that will automatically level the RV if the ground isn't too far out of level. If the ground is too far out of level, you may need to put blocks under the leveling jacks.

Slides

Many RVs have slides that open when you are stopped to provide additional living space.

Slides run on 12-volt DC.

It is important to always either fully open or fully close the slides, walking in a partially open slide can damage it.

Schwintek slides track revolutions of the motor to decide if they are all the way open or closed when you activate the slide, it is important to hold the button for several seconds after it is all the way in or all the way out, so the system doesn't get confused. This only applies to Schwintek slides.

If you have Rack and Pinion slides you hold the button down until you hear a clicking noise to indicate it is all the way in or out.