RV Electrical Troubleshooting

Plus How Things Work

Plus Tips

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2/2/2021

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RV Power Systems

There are 2 separate power systems in an RV – low voltage (12 volts) and high voltage (120 volts). If the rig has 50 amp capability then it is fed with 240 volts but once inside, the 240 volts is split into 2 separate 120 volt feeds. Nothing inside is powered by 240 volts.

12 volt power is typically used for system controls, lighting, step and slide motors, furnace, etc. 120 volt power is typically used for high power items such as microwave, fridge and water heater heating elements, air conditioning, etc. 12 volt is usually protected by fuses while 120 volt power is usually protected by circuit breakers.

General Troubleshooting Tips

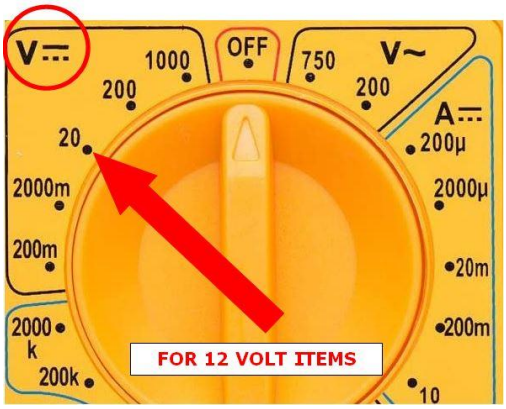
Before jumping into a situation take note of what is working and what isn't working. For example, if your 12 volt slide motor isn't working try another 12 volt device such as your lights. That will indicate whether you at least have 12 volts present. Same goes for 120 volts. If your air conditioner doesn't work see if any other 120 volt item works. If you have a microwave look at its display. Often it is lit up when 120 volts is present.

One of the first things to verify is whether the item is receiving power or not. For 120 volt items, reset its breaker even if it looks OK. Check the GFCI button too (more later). If you are unsure which breaker is the correct one simply reset them all. You won't hurt a thing. For 12 volt items check its fuse by removing it and testing with your meter in the Ohms setting.

For 120 volt items, is the problem present when connected to shore power only, generator power only, or both. Does it only happen while on the inverter?

The more info you have before jumping into the particular problem will only help your troubleshooting. Download owner, installation, or service manuals for your devices! You can try contacting Jayco to see if they will give you a wiring diagram.

Meter Settings



These are the settings for a typical test meter. If you do not have voltage selections like shown, your meter is auto-ranging meaning it will select the correct range automatically.

You just have to make sure you have selected DC (**DCV** or **V—...**) for the 12 volt systems and AC (**V~**) for the 120 volt systems. You can alter the voltage range if desired.

12 volt Power

The main power source for 12 volts is a battery or possible bank of batteries. This is commonly called the House Battery. This battery is charged via an onboard *Converter* (converts 120 volts to 12 volts) while connected to shore power or when the generator is running. Depending on the Converter model, it may be capable of charging at 40-100 amps (typically). The battery may be protected by an inline fuse or circuit breaker near the battery. Also, there may be a battery disconnect switch. If you are not getting battery voltage to anything, these are items to check.

The battery is also charged when the vehicle's engine is running, whether it is part of the rig or a tow vehicle. Typically the charge rate is lower due to wire gauge and run length.

Ground Connection - An **<u>important</u>** item to not overlook when having issues with the 12 volt power system is the ground. Typically the battery's negative terminal is connected to the metal chassis with a screw or bolt. Then 12 volt items will also be connected to the metal chassis at various other points. To complete any 12 volt circuit the current <u>must</u> flow from positive to negative. If the negative portion (ground) of the equation is missing, the circuit won't be complete and things won't work.

Chassis ground connections must be clean and tight with no corrosion. A loose connection may cause intermittent problems which may be hard to find. If the ground connection is bad at the battery side, all 12 volt items will be affected. If only certain items are affected, the individual ground for them could be bad.

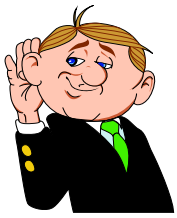
The reason ground is often overlooked is that voltage readings may be taken from metal in the area of the appliance rather than from the actual negative wire feeding the appliance. If the ground is open in the negative wire feed, you will still measure 12 volts from the positive wire to the metal chassis which will lead you into thinking that the power is OK. When troubleshooting it is always better to connect your meter's common lead to the actual negative connection on the item being tested.

Battery Disconnect Solenoid (Relay) – Your rig may contain a battery disconnect switch which controls a battery disconnect solenoid (relay). Your house battery can be disconnected during periods of storage by using this switch to remove most loads.

The Jayco owner's manual states "**Never depress the momentary battery disconnect switch for longer than 1 second. Depressing and holding the switch down will disable the battery disconnect solenoid.** Should this occur the main ground cable for the house batteries must be removed for 1 minute to re-enable the solenoid operation."

Keep this solenoid/relay in mind if you experience a complete loss of 12 volt power. If the connections to this relay aren't solid, you could experience intermittent issues.

Recommendation For Off Grid Camping – Boondockers, dry campers, whatever we wish to call ourselves, we all have at least 1 thing in common. We rely heavily on our coach battery to power many things in our rig. We don't want to lose any of our conveniences when we are "roughing it". Having your battery die at the most inopportune time is not something we want to happen.



So, what can you do to prevent this from happening? I have preached this for a long time – **you need to monitor your battery voltage!** Install an easy to view voltage display that connects to your house battery. You will then be able to tell at a glance what the current charge state of your battery is and take actions to recharge it before it gets too low. Besides, it can be entertaining to watch the display when you are bored.

The display doesn't need to be fancy. There are many available (look on Amazon for RV voltage displays) that will do exactly what you want. Many also include a reading for current being drawn. Though not necessary, a current reading will show how much power different items are pulling from your battery. Fire up an inverter and you will see just how much power these things require.

If you have a 12 volt power outlet that runs off the house battery you can use a simple plug-in monitor. A dedicated display can be installed anywhere that you can route a wire to. It is best to run a wire directly from the battery to the display so you are reading the actual battery voltage from the source which is the reading that counts. If you run a wire from the battery, install a fuse holder at the battery with a 1 amp or so fuse. This is important because if your wire gets damaged and shorts to ground, it is far better to blow a fuse than to melt the wire.

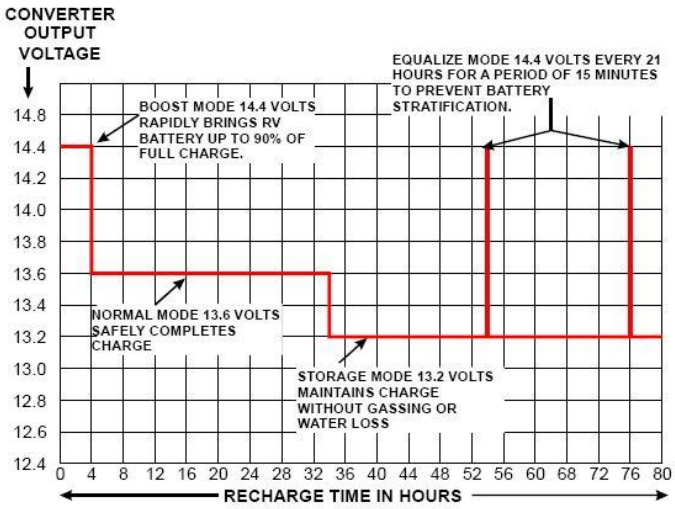
An important benefit to having a display is that you can easily verify that your Converter is charging the battery and at what level. I can personally attest to diagnosing a bad Converter. Mine was failing to go into boost mode after a year and I saw this on my display.

12 Volt Charging Troubleshooting

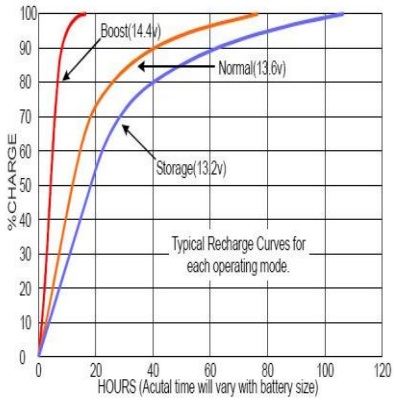
It is very easy to verify whether your house battery is charging or not. Simply put your test meter across the battery's terminals while plugged in, generator running, or engine running. The measured voltage will increase when being charged and typically will measure between mid 13s to mid 14s. If it measures in the 12s then odds are you are not charging. If the battery is extremely depleted it may take a bit to raise the reading out of the 12s. Just take before charging and after charging starts readings.

Voltage	State of Charge	Status
12.6+	100%	Normal
12.5	90%	
12.4	80%	
12.3	70%	Weakness
12.2	60%	
12.1	50%	Slow cranking
11.9	40%	No cranking
11.8	30%	
11.6	20%	
11.3	10%	
10.5	0%	Dead

A typical multi-stage converter has different charging voltages for different conditions. Here are some sample charging scenarios.



The chart below shows the amount of time it took a converter set to three different output voltages to recharge a 125AH (Amp Hour) battery after it was discharged to 10.5 volts.



A circuit breaker protects the Converter's 120 volt input. This would be something to check if you aren't charging. Also the output can be measured at the converter.

Reverse Polarity Fuses - The Converter may have external fuses on it that will blow if you connect the house battery backwards. Check those fuses if you are not getting any output.

Chassis Battery Charging From The Converter

The engine battery in a motor home, also called the chassis battery, most often is NOT charged by the Converter. On SOME newer rigs a special bi-directional relay may be present which allows the converter to charge the chassis battery.

How do you know if you are charging the chassis battery? Just put your test meter across the chassis battery and connect to shore power. If the voltage goes up, you have the bi-directional relay and the battery will charge from the converter. There is typically a minimum house battery voltage and a time delay before the relay will allow chassis battery charging.

House Battery Charging From Vehicle's Alternator

To verify that your house battery is being charged from the engine's alternator just put your test meter on the house battery and start the engine. If the voltage increases, you are charging. If no voltage increase, you will need to locate the charge relay (sometimes called solenoid). It may be mounted in the engine compartment on the firewall.

Here are 2 examples of the standard relay which is not bi-directional.

Both are troubleshot in the same manner. The 2 small terminals are the "primary" side of the relay and the 2 large terminals are the "secondary" side. When 12 volts is applied to the small terminals it energizes a heavy contact inside the assembly which connects the 2 large terminals together.

One large terminal will be connected to your chassis battery and the other large terminal will be connected to the house battery. You can easily measure each large battery

connection with your meter. Connect the black meter lead to a metal ground, bare metal, screw, whatever and then touch each large connector with your other meter lead. Each large connector should show a slightly different voltage as long as the relay isn't energized. When energized, both large terminals will read the same voltage.

If you suspect the relay is bad, first measure across the 2 small terminals with the engine running. It should read 12 volts. If it doesn't, there is a problem with the feed to those terminals. One terminal will be connected to chassis ground (metal) and the other small terminal will receive a 12 volt signal from the ignition circuitry.

If there is 12 volts across the 2 small terminals but the voltage at each large terminal is different (measured to metal vehicle ground), the relay is bad.

Inverters

If present, an Inverter is the opposite of a Converter. It takes 12 volts DC and steps it up to 120 volts AC. It does it at a cost of battery power as these things can easily suck the life out of a battery. The amount of current required on the 12 volt input side is in the neighborhood of 10 times the amount of output current on the 120 volt side. For example, if you are using 2 amps at 120 volts (240 watts) your input draw at 12 volts will be around 20 amps (240 watts). If you needed 6 amps at 120 volts (720 watts) your input draw goes way up to 60 amps (720 watts). You best have a way to recharge your battery when using an Inverter. Solar can help quite a bit.

Most often, Inverters will only supply power to certain outlets in the rig. TV outlets are commonly powered by Inverters. So how do you know what outlets your Inverter will power? Simply power up the Inverter when not connected to shore power and go around to each outlet and see if it has power. Your best friend, the test meter, will tell you right away.

The outlets that the Inverter powers are also powered by the shore power connection or your generator. This is done with a small transfer switch, which has nothing to do with the large transfer switch used with your shore power/generator feed. Some Inverters have the transfer function built in while others have the Inverter output connected to the transfer switch.

Inverter Troubleshooting

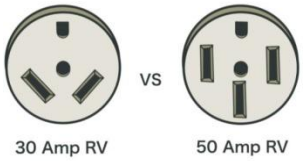
The Inverter will only operate when the 12 volt input is good so check that. The 120 volt output will likely be run through a circuit breaker in your panel. If the outlets powered by the Inverter are always dead, meaning they don't work even with shore power, check the Inverter circuit breaker.

Some Inverters may have a built-in GFCI (Ground Fault Circuit Interrupter). Look at how the 120 volt output connection is made. If a cord plugs into an outlet on the Inverter, see if there is a GFCI button in the center of the outlet.

Some Inverters may have a digital display that will show an error code when there is a problem. This is another source of good information if there is a problem.

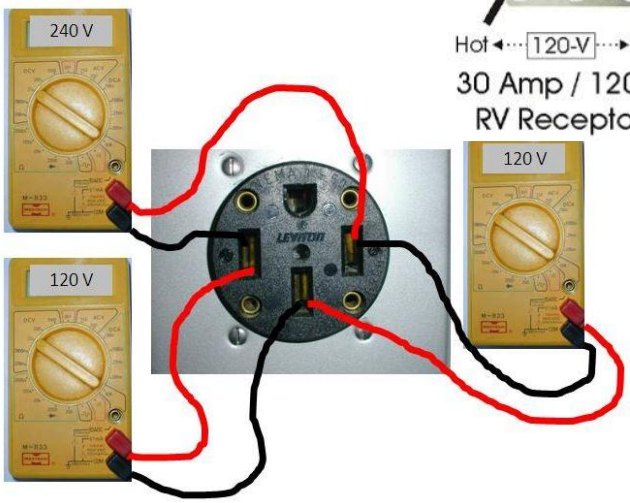
120 Volt Power

120 volt power can be supplied from either a shore power connection (plugged into an external power source) or via an onboard generator. Most common shore power connections are 30 amp and 50 amp.



30 amp service simply brings in 120 volts on heavy enough wiring in order to allow 30 amps of current flow. It is easy to test the power feed at the outlet.

50 amp service basically uses a 240 volt connection to supply 2 separate 120 volt feeds. The RV does not use 240 volts but rather uses each of the 2 legs (power lines) to feed ½ of the circuit breaker panel. This allows multiple heavy current draw devices, such as air conditioners, to run at the same time with power to spare. Each leg of the power feed is protected by a 50 amp circuit breaker therefore it can supply up to 50 amps on each leg.



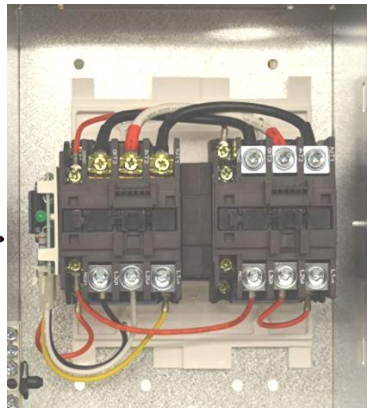
Transfer Switch

A Transfer Switch is basically a very heavy duty relay that "transfers" power from one of 2 separate power feeds. In the case of an RV, the Transfer Switch will select either the shore power feed **OR** the generator feed. Each feed is isolated from the other.

Typically the shore power will feed straight through the Transfer Switch. When power is detected on the generator feed, the relay will energize transferring the connection to the generator. Usually there is a slight time delay before the transfer takes place, possibly allowing the generator to stabilize.

Troubleshooting a Transfer Switch

There are lethal voltages inside a Transfer Switch box so it is not recommended that a novice go in there when power is applied. What you can do is **disconnect all power** and not energize the generator. This makes it safe to remove the cover.



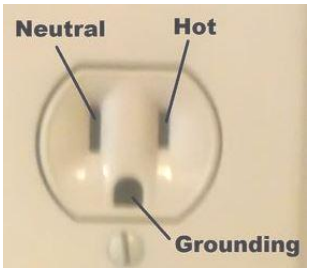
Typical problems found in a Transfer Switch are burnt or loose terminal connections. **WITH NO POWER PRESENT**, remove the cover and look for any indications of overheated (burnt) connections. Check the tightness of all screw terminal connections. Another possible problem is the relay fails to change states in which case you would probably be replacing the unit.

Testing a Power Outlet

There are some nice plug-in outlet testers out there that quickly test for the proper wiring of an electrical outlet. Your simple voltmeter can also be used to completely test an outlet.

If all you want to do is verify voltage is present, just insert your meter leads as shown. No voltage – check your circuit breakers first.

To test for proper wiring of an outlet, you simply connect your meter to other positions and check for voltage.



1. 120 volts should be between **Neutral** and **Hot**.
2. 120 volts should be between **Hot** and **Grounding**.
3. Nothing should be between **Neutral** and **Grounding**.

Possible problem scenarios:

1. 120 volts between **Neutral** and **Hot** AND 120 volts between **Neutral** and **Grounding**. This indicates an outlet that is wired backwards meaning the Neutral and Hot wire connections are reversed. This can be a dangerous situation and should be fixed.
2. No 120 volts between **Neutral** and **Hot** but 120 volts is measured between **Hot** and **Grounding**. This indicates an open Neutral to the outlet requiring further investigation as to where it is being lost.

If you have a dead outlet or multiple dead outlets, the first check would be the circuit breaker. A tripped breaker is not always obvious so it never hurts to simply turn the breaker fully off and then back on. If you don't know which breaker it is, reset them all.

There is another item that can kill power to multiple outlets. This is a Ground Fault Circuit Interrupter (GFCI) outlet that is often found in RVs. It typically will be located in either the kitchen or bathroom. One GFCI outlet in your rig will protect multiple outlets which will most often be located in areas near water. This would be the kitchen, bathroom, and possibly outside outlets.

Try pressing the red reset button on the outlet. If it was tripped, pressing the reset button will restore power as long as a problem does not still exist in any of the protected outlets. 120 volts must be available to the outlet in order for the reset button to work.

The GFCI outlet is not protecting for over current situations like a normal breaker. Instead it trips if it senses current flow to ground and it trips at a very low level. Normally there should be no current flow to ground. This is a safety feature to prevent an electrical shock if you come in contact with the hot lead and ground at the same time.

Troubleshooting Items That Have Sequence of Events

Some appliances have events that take place in a certain sequence before the unit is fully operational. For example, something may have to go through 3 steps before it is running. Step 1 must be completed before step 2 is initiated and step 2 must be completed before step 3 is initiated. Finding out which step is actually failing can help narrow down the troubleshooting to specific components.

All sequences listed are 12 volt.

Furnace Sequence

1. 12 volt turn-on signal from thermostat to control board.
2. Blower motor turns on.
3. Air flow measured by a "sail switch". Must be detected.
4. Gas valve and electric spark ignition energized.
5. Flame is detected, spark ignition is turned off, operation is complete.
6. Furnace remains on as long as 12 volt turn-on signal from the thermostat is present.

Fridge Gas Sequence

1. Control board initiates cooling cycle by monitoring inside temp via a thermistor.
2. Gas valve and electric spark ignition energized.
3. Flame is detected, spark ignition is turned off, operation is complete.
4. Cooling stays on until control board senses set temperature via the thermistor.

Water Heater (Tank Model) Gas Sequence (non pilot light models)

1. 12 volts applied to unit via an external switch.
2. Mechanical thermostat completes circuit (closes) if water temp is below its set value.
3. Control board sees thermostat closure and energizes gas valve and electric spark ignition.
4. Flame is detected, spark ignition is turned off, operation is complete.
5. Heating continues until mechanical thermostat opens when set temperature is reached.

Water Heater (Tankless) Gas Sequence

1. Unit turned on awaiting water flow.
2. Faucet opened.
3. Water flow above minimum value detected.
4. Blower motor turns on.
5. Correct wind speed detected.
6. Gas valve and spark ignition energized.
7. Flame detected, spark ignition is turned off, operation is complete.
8. Heating continues as long as minimum water flow is present and the temp value set is not exceeded.

Furnace Troubleshooting Hints

The Furnace is a 12 volt device, not including the propane section. To operate it only needs a 12 volt power source plus a 12 volt signal from the thermostat.

The typical sequence of operation is for the thermostat to send the 12 volt turn-on signal to the Furnace. This should cause the blower motor to turn on. The blower air stream activates what is known as a "sail switch" which is a little piece of metal or plastic that moves and activates a switch when sufficient air flow is present. If the correct air flow is not detected for 30 seconds, the unit will time out in an error condition and shut down.

Provided the sail switch makes contact, the next thing to happen is the control board will energize the gas valve and initiate a high voltage spark for ignition for 7 seconds. If the flame is not sensed within the 7 seconds the control board will repeat the sequence twice more. If all 3 attempts at ignition fail, the unit will enter a lockdown mode.

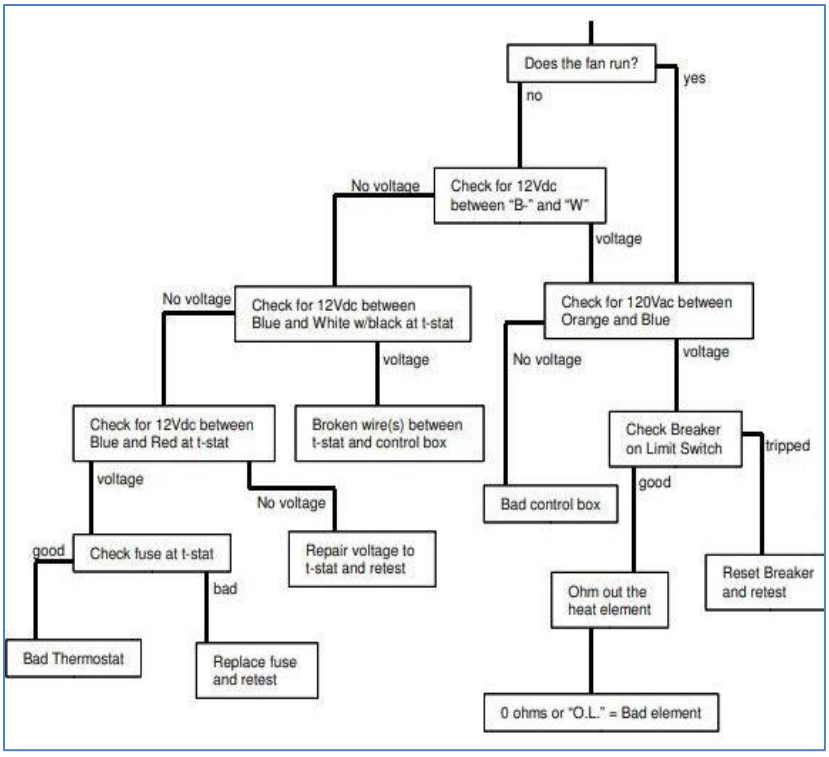
Common failures:

1. Blower operates but insufficient air flow due to blockage in the air chamber from wasp nests or other intrusions. **Clean out air chamber.**
2. Sail stuck causing sail switch to not actuate. **Free up sail (WD40 maybe).**
3. Bad sail switch. **Replace switch.**
4. Reset switch tripped (if present). **Reset the switch.**
5. Won't operate. **Check 12 volt power (don't forget ground) & thermostat signal.**

To make troubleshooting easier, download the service manual for your model.

Heat Pump Troubleshooting

If your unit includes a Heat Strip, here are some items to check if it fails to operate. Also, Heat Pumps only are good when outside temps are above a certain level.



The Jayco manual states: "On the electric setting, the heat pump will become the primary heat source as long as the interior temperature of the RV has not dropped 5° below the thermostat set point. If this occurs, the thermostat will automatically activate your gas furnace. The furnace will continue as the heat source until the thermostat set point has been satisfied. At that point, the heat pump will again become the primary heat source".

Water Heater Troubleshooting

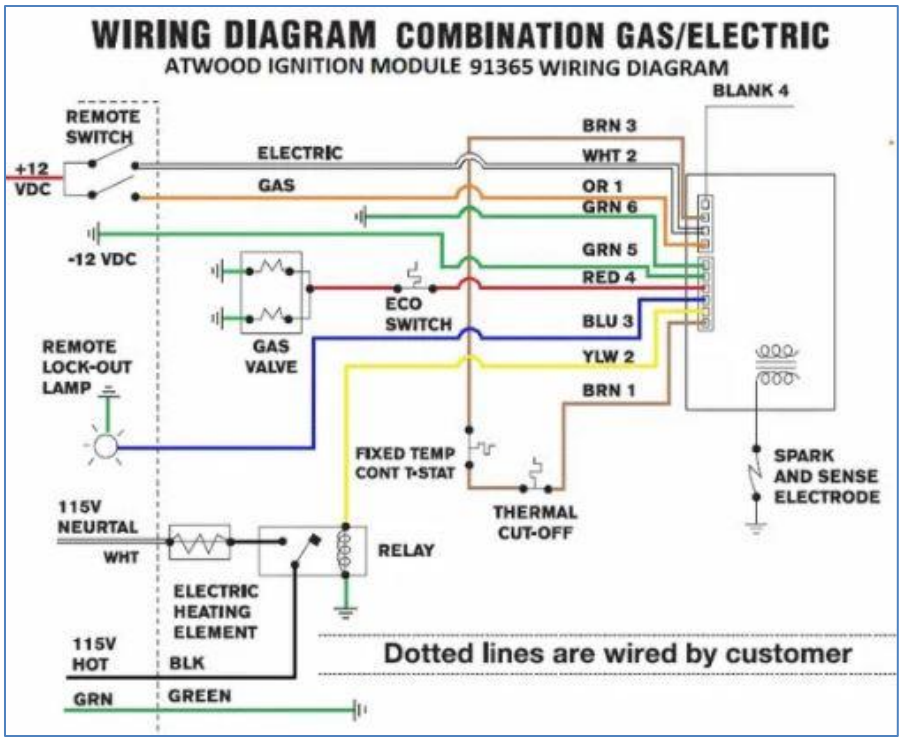
12 volts is used to control the Water Heater in both propane mode and 120 volt mode. If both modes are not working, this would be the first area to check. Check the fuse.

There are typically 2 thermostats controlling the heating. One is the "high temp" thermostat, which should only open if there is a problem with overheating (may have a reset button), and the regular thermostat which opens and closes to regulate the temperature. There may be a separate set of these thermostats for propane and 120 volt operation. With **no power applied** these thermostats can be measured for resistance. They should measure a dead short if the water heater is cool.

No Operation on Gas – see the *Water Heater (Tank Model) Gas Sequence* above. If there is no spark, check the spark gap. If it sparks but doesn't light, there could be no propane, air in the line, a problem with the gas valve, or a clogged jet. The gas valve is 12 volts so should be able to easily be measured.

No Operation on 120 Volts (if equipped) – If propane mode is OK but the 120 volt side is inoperable, there are 2 common failure points. The first is the relay that switches the 120 volts to the heating element. 12 volts is used to engage the relay. If you measure the 12 volt signal at the relay but the 120 volts is not being sent through, the relay is bad.

If the relay is OK the other item in the equation is the heating element. If you measure 120 volts across the heating element when it is suppose to be heating but nothing is getting warm, the heating element is open (bad). You could also try measuring the heating element's resistance with **no power applied**. It should not read open (infinity).



Typical Wiring Diagram

Foul Odor – Old water in the tank. You can try emptying and refilling the tank but that may not clean out everything. Instead, do a fresh water tank sanitization and after it has sanitized the tank, pump the water through the water heater into your holding tank. Let it sit in the water heater for a period of time (overnight maybe or longer) and then use the new clean water in your fresh water tank to flush the water heater.

Loud Roaring Noise – Usually cause by incorrect air/fuel mixture. This can be caused by something taking up residence in the burner area or tube. Make sure everything is clean and unobstructed. If that doesn't help, check the burner jet. It should be removable so pull it and look through the small hole for any blockage. If nothing wrong there, you could try adjusting the fuel/air mixture with the adjustable sleeve (if equipped). Flame should be blue rather than a yellow or orange.

Water Leaking From The Pressure Relief Valve – Here is a quote from my Suburban Water Heater manual. "You may experience water weeping or dripping from your water heater's Pressure and Temperature (P&T) Relief Valve when your water heater is operating. Water weeping or dripping from the P&T Valve does not always mean the P&T Valve is defective. As water is heated, it expands. The water system in a recreational vehicle is a closed system and does not allow for the expansion of heated water. When the pressure of the water system exceeds the relieving point of the P&T Valve, the valve will relieve the excess pressure."

No or Low Water Flow – The water heater may be equipped with a one-way check valve in either the input water connection or the output water connection. They have been known to fail causing reduced water flow. The valve is easy to replace once you get to the rear of the water heater.

Thermostat Troubleshooting (non heat pump models)

The thermostat is basically a glorified switch as it simply sends 12 volts to different wires that lead to the air conditioner and furnace. Nothing magical happening. When you have the heat function set, when the temp drops below your set temperature the thermostat just puts 12 volts on the heat line. As long as that 12 volts is on the heat line the furnace will operate, provided there is no problem with the furnace.

When in the cooling mode, when the temperature goes above your set temperature the thermostat will put 12 volts on the compressor line and the fan line. The air conditioner will remain on as long as these signals are present.

To access the wire connections you simply pop the thermostat off the wall. Most often the thermostat will snap into a bracket that is mounted on the wall. This allows easy access for taking measurements with your voltmeter. You can verify that the thermostat is receiving power by measuring across the 12 volts

Letter	Color	Function
R	red	12 volts +
C	blue	12 volts -
GL	green	high fan
GH	gray	low fan
Y	yellow	ac compressor
W	white	furnace

+ and – connections. **NOTE: The wire colors used by the installer may not match the industry standard. Use the designator letters for identification.**

If either the furnace or air conditioner is not turning on, you can measure for the 12 volt signal that is sent out to the item. Before testing make sure the thermostat is set properly and is actually calling for heating or cooling. Also, if this is an electronic thermostat there may be a built-in fuse that should be checked.

Another test is to jumper the 12 volts to the signal line. For instance, you can take a small wire and touch one end to the 12 volts + connection and the other end of the wire to the furnace connection. The furnace should start up.

Fridge Troubleshooting Hints

These hints pertain to electric/propane fridges only and not residential versions.

When troubleshooting fridge operation it is very helpful to observe what is working and what is not. The propane section operates differently than the electric side so if only one side is not working, some components can be eliminated as the source of the problem. Try to download a service manual for your model fridge as it will definitely help. It may have a flowchart to follow for troubleshooting. Also, use a wireless temp monitor to see what the actual temp is inside the fridge without having to open the door. Any wireless thermometer should work. It doesn't have to be made for a fridge.

The fridge uses 12 volts for control in both modes of operation. When in electric mode 120 volts MUST be available for operation. Verify that the fridge circuit breaker is not tripped. Odds are the fridge would not even attempt to go into electric mode if 120 volts is missing. Also, it wouldn't hurt to verify that you have a good 12 volts (from the ground wire connection) at the power connection to the fridge.

Propane side OK, electric side fails – The electric side uses a 120 volt heating element to heat the ammonia mixture that results in cooling. The heating element should probably be the first thing checked. This can be done with your test meter in one of 2 ways – voltage measurement or resistance measurement.

Once you have located the heating element's wiring, you can set your meter for resistance and place the leads across the wiring (might have to get creative on how to get to the wire inside conductor). **Very important – do not try taking a resistance measurement with any power applied to the fridge as you would probably destroy your test meter**. If the heating element reads open (infinite ohms), replace it.

The other test would be to check for 120 volts across the heating element when in the electric cooling mode. If 120 volts is measured across the heating element but yet it is not heating up, the heating element is bad.

If the heating element measures OK or the 120 volts is missing when in electric cooling mode, this could point to a board failure or, if present, a relay that the board controls that passes the 120 volts to the heating element.

Electric side OK, propane side fails – Verify that propane is available. This can be done by firing up a burner on your stove. Some items in the propane operation: spark ignition, gas valve, burner, chimney. Follow the troubleshooting flowchart in your downloaded service manual to narrow things down. You may be able to measure voltages at the various components. Also, the burner needs to be clean and any gas orifice jets open.

If the ignition has initiated a spark but yet the burner fails to ignite, there may be air in the system, no propane, gas valve problems etc. The ignition sparking tells you that the board is at least trying to light the burner.

Poor cooling propane and electric – This may be a common complaint. First off, these fridges need to be level to operate. If you are trying to operate it on a slope, it won't cool properly and you could damage the cooling system.

You need to determine if it is trying to cool, meaning the burner is on or the electric element is receiving voltage. This is important because it will point you in the right direction. The easiest way to see if it is trying to cool is to operate in propane mode and look for a flame. If the flame is present, it is trying to cool. No flame may mean the fridge thinks it has reached the desired temperature and has cycled off.

Trying to cool – If your fridge is trying to cool but not working very well you may have a buildup of heat in the rear of the fridge. Many fridges have built-in exhaust fan(s) at the top that come on when excess heat is detected. These fan(s) pull air in from the bottom and exhaust it out the top and are typically controlled by a thermal switch. There have been a number of instances where these fans have failed. If you have downloaded a service manual for your model it should indicate whether you have these fan(s) or not. It also may have a troubleshooting flowchart for poor cooling. If you can get to your thermal switch you can jumper it to see if the fan(s) come on. These fans operate on 12 volts.


Thermal Switch

When cooling on gas the flame should look clean and stable. Problems can result if the burner or flue is clogged/dirty. When cooling on AC some fridges may have 2 heating elements and one may be bad. The service manual will give information on this.

If you see a frost buildup on the rear tubing it may indicate an ammonia blockage. Try tapping the tubing with a block of wood to clear the blockage. There have been reports that this has solved the problem and the fridge returned to normal cooling.

If everything appears normal there may be one last thing to try. It is called "burping the fridge". Apparently it is a procedure to get rid of possible bubbles in the ammonia. I am totally unfamiliar with this but wanted to include it in this troubleshooting section. For information on burping the fridge, do a Google search for "Burping RV Fridge".

Not trying to cool – If your fridge has cycled off, meaning it thinks it has reached the temp you have set, you may have a problem with a thermistor. This is the electronic device, often attached to the fins inside the fridge, that senses the inside temperature. The control board reads the thermistor's resistance and turns off cooling at a certain reading. If the thermistor is bad it may cause the board to shut off cooling before it should.

Thermal Switch

Tips to help cooling – If your unit does not have a fan in the rear to pull air up and out the upper vent, you can install one. If you can't mount it up high, install it at the bottom and have it push the air up. It can only help. If you install one I recommend putting a fuse in the 12 volt positive line to prevent any problems. Also, connect a thermal switch in series with the either the 12 volt power feed or the ground feed to the fan. You can use worm gear clamps to secure the thermal switch to the cooling coils. A switch value of 130° or so would cause the fan to only operate when the fridge is in a cooling mode and creating heat.

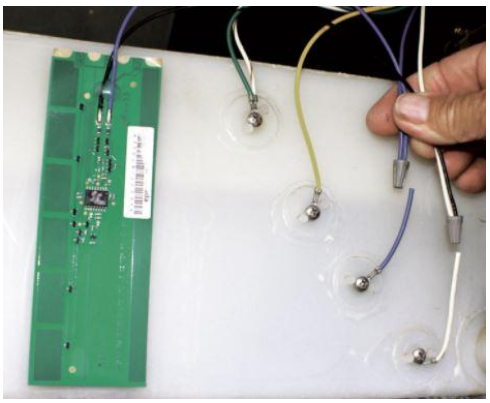
Circulating the air inside the fridge is also very beneficial. This helps even out the temp so you don't get areas that freeze things while other areas are a tad warmer. A couple of small fans secured to the inside cooling fins works pretty well.

You don't need a whole lot of air movement. I put in a pair of 60mm fans that are quiet and move just enough air. Currently these are USB fans that I power off a brick inside the fridge just because I wanted to test the size and airflow before committing to 12 volt powered ones. I will be changing these out when I get around to it. Apparently you can get 12 volt power by running a small wire through the drain hose (in tray below coils) to the back of the fridge. Some RVers have tapped into power that goes to the door, the door light switch, or the power to the light. You just need to find a source of constant 12 volt power when the door is closed. Ground may be available on the cooling fins.

Another common tip is to load the fridge with food that is already cold. If you fill it with warm food the cooling system will have to work very hard to cool down and take longer than usual. Cool the empty fridge overnight or longer before loading.

Make sure all users are aware to not stand there with the door open any longer than necessary. In and out as quick as possible. Kids are notorious for standing in front of an open fridge trying to figure out what they want.

Fresh Water/Holding Tank Sensors



SeeLevel II Sensor Pad (green) Next To Old Sensors

By far the most common problem with holding tank sensors is crud on the actual sensors in the tank. These sensors are basically just a little metal probe stuck through the side of the tank. Think of them as screws protruding into the tank that sense liquid because liquid has resistance to it and this resistance is measured between the lowest probe and others higher up in the tank. Not extremely high tech.

If any sensors remain on after the tank has been emptied, odds are something has stuck to the sensor that remains lit. The course of action is to flush, flush, and flush

the tank. The cleaner the tank is the less chance of sensor problems there is. Google RV tank cleaning for information on different methods for getting the sensors clean.

The sensors connect through wires to a little circuit board with LEDs that light up indicating the level. The boards and LEDs rarely are the problem. Wires have been known to break off the actual sensor so this is something to look at if a sensor is not detecting levels.

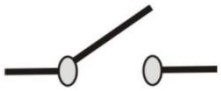
If you get tired of dealing with these sensors, there is an alternative. One outstanding option is to install the *SeeLevel II* system. This system uses a sensor array that sticks on the <u>outside</u> of the tank which totally eliminates the crud on sensor problem. I personally installed this system on my tanks and couldn't be happier. It is far more accurate than the old method as it measures in tank percentages rather than in thirds.

SeeLevel II Display

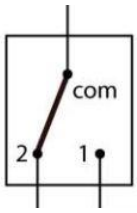
How To Test A Switch

Switches control many things in an RV. They all, except for 3 way switches, operate the same way. This includes 12 volt switches, 120 volt switches, and micro switches, such as a sail switch in a furnace.

The switch is either on or off, there is no in-between mode.


Symbol of SPST Switch

The switch may have 2 or 3 terminals unless it is a "double pole" switch which has 2 separate sets of contacts. If there are 3 terminals, one will be labeled "Com" which means common, the others may be labeled NO (normally open) and NC (normally closed). Test measurements will be made from the common terminal to one of the other terminals. These types of switches connect the common terminal to one of the other 2 terminals (not at the same time) depending on the switch position.



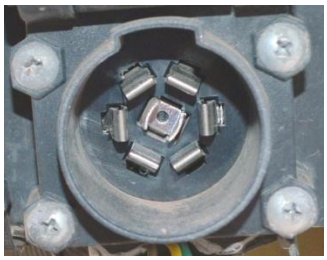
Testing a switch is very easy and can be done in one of two ways:

Voltage testing – An "open" switch will read full supply voltage meaning 12 volts for a 12 volt system and 120 volts for the 120 volt system across its contacts if there is a load connected in the circuit. A "closed" switch will read zero volts. If you read a voltage in the closed position, the switch is resistive and should be replaced.

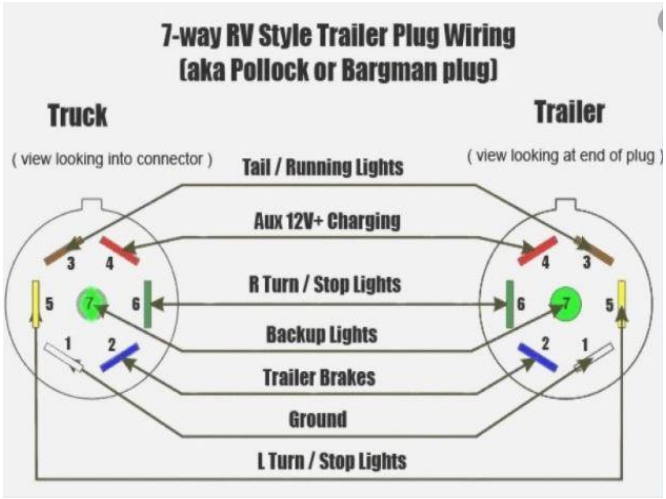
Resistance testing – If you want to test a switch using an ohm meter, you **<u>MUST</u>** remove all voltage. Trying to measure resistance with any voltage present can damage the test meter.

To properly measure a switch for resistance it should be removed from the circuit meaning you should disconnect the wires. At the very least you should disconnect one wire. The reason for this is that your meter could be measuring resistance that is in the circuit. Breaking the circuit open will eliminate external items from affecting your measurement. A "closed" switch will read zero ohms and an "open" switch will read infinite ohms. If a closed switch measures some resistance it is bad and should be replaced.

Testing a Trailer Connector

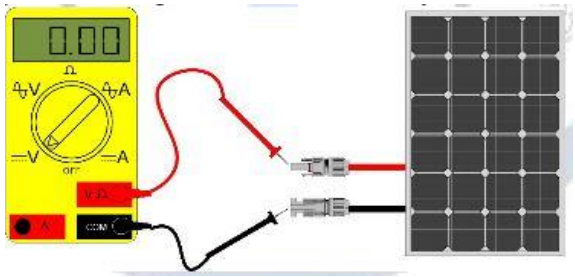


If you have problems with towed things not lighting properly you can measure the 12 volts going out. Another test for the actual towed item is to send 12 volts to it by connecting a battery or battery charger to the appropriate pins. Don't forget the ground connection.

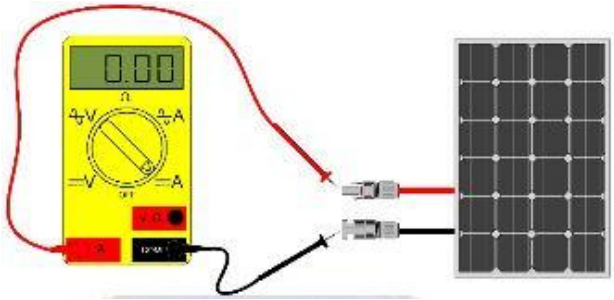


Testing a Solar Panel

Want to know what your solar panel is putting out? You can verify the panel by using your voltmeter to measure the output voltage **and** output current. *Windy Nation*, a solar panel distributor, published a method for troubleshooting a solar panel. It is best to test one panel at a time so as not to exceed the current measuring capability of your meter. Besides, if you have multiple panels connected, it is hard to know which one is working and which one is not. Look up the panel specs prior to taking the measurement.



Test 1 Output Voltage – Set the meter to measure DC Volts (20 volt scale). Disconnect the solar panel completely from the battery and regulator. While the solar panel is directly in the sunlight, measure the voltage by connecting the negative (COM) test lead from the multimeter to the negative MC4 connector and the positive test lead on the multimeter to the positive MC4 connector.



Test 2 Output Current (short circuit) - Set the meter to measure DC Amps (10 amps) and plug the leads into the correct connector for measuring current. This will be a separate connector that you probably never have used. Disconnect the solar panel completely from the battery and

regulator. While the solar panel is directly in the sunlight, measure the amps directly at the positive and negative MC4 connectors by connecting the negative (COM) test lead from the multimeter to the negative MC4 connector and the positive test lead on the multimeter to the positive MC4 connector.

The published specs for a Windy Nation 100 watt panel are shown. Don't expect to measure the maximum shown. These readings are for new panels in a lot of sunlight directly overhead.

windynation
clean | power to the people

100W Polycrystalline Photovoltaic Solar Panel

Part #:	SOL-100P-01
Maximum Power (Pmax):	100 Watts
Open Circuit Voltage (Voc):	21.60 Volts
Short Circuit Current (Isc):	6.32 Amps
Max Power Voltage (Vpm):	17.4 Volts
Max Power Current (Imp):	5.75 Amps
Max System Voltage:	1000 VDC (600 VDC UL)

Onan Generator Tips

1. Exercise the generator once a month for an hour or two under ½ load to prevent carburetor problems. Old fuel or varnish buildup in the carb is a common issue that will cause it to run rough or fail to start.
2. Before cranking, prime the fuel pump for 20 seconds by holding the start/stop switch in the **Stop** position.
3. Maintain correct oil level as there may be a low oil level shut down.
4. Look at control switch on the generator for blinking error codes if there is a problem.

Energy Management System – How It Works

You always wondered how your Energy Management System worked (OK, maybe you haven't). Here is some info that explains this nice feature.

If you are fortunate to have an automatic energy management system, you are in good shape. So, just what does this thing do? It eliminates the need for you to manually turn items off so as to not overload the system's current capability causing a circuit breaker to trip.

You have a number of high-power 120 volt appliances in your rig so you are able to properly "rough it". Unfortunately you can't run everything all at once especially if you only have 30 amp service. If you have 50 amp service you may be able to run everything at once, you lucky campers!

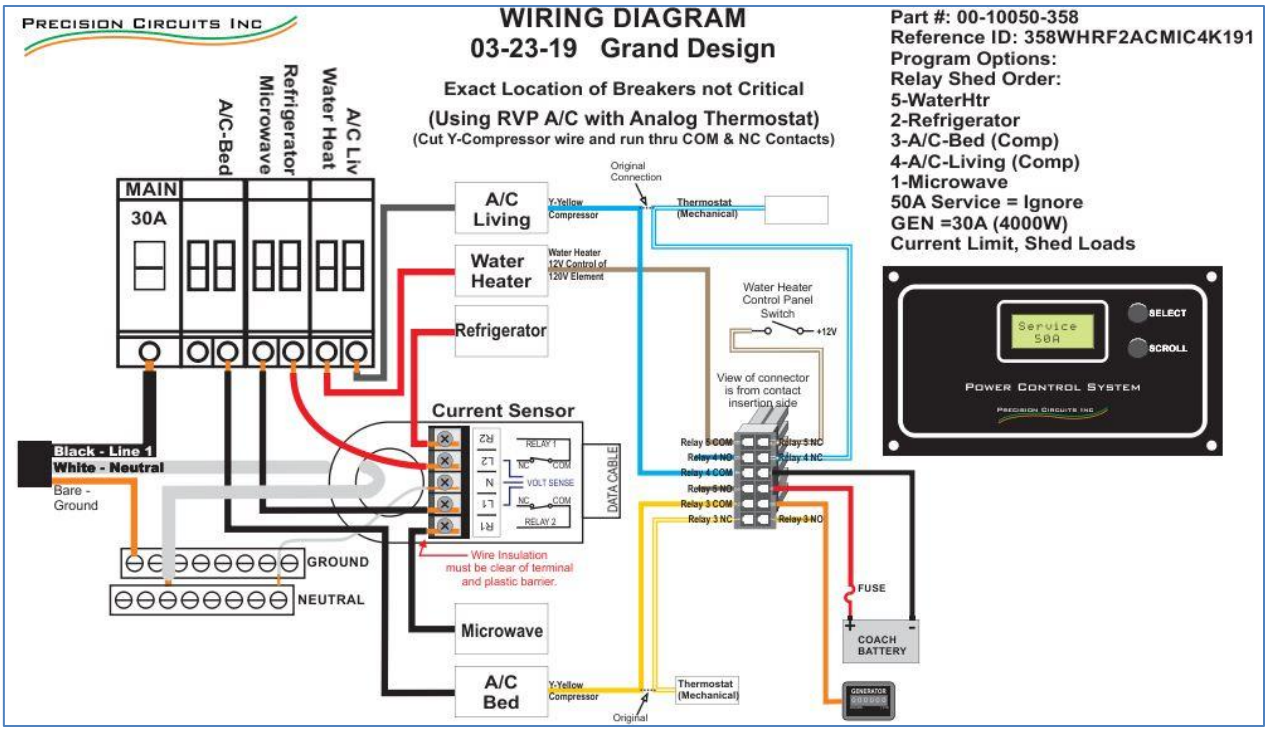
So, for 30 amp service you can pull a max of 30 amps before things get interesting. If you ever watched the display it will indicate how many amps you are pulling. If you are running 2 air conditioners you will probably be pulling 20-25 amps. Now all of a sudden someone wants to heat a Hot Pocket in the microwave. What do you do?

You don't have to do anything. When the energy management system sees the additional load it will cycle off one or more attached appliances. This may cause the bedroom air conditioner compressor to automatically shut down while the microwave is running. Once the microwave is done the compressor will be allowed to operate as usual.

The energy management system has a set sequence where is "sheds" power loads as needed. Items connected that it may monitor and manage are: electric water heater, air conditioners, microwave, and fridge.

Important note – if you are operating your water heater off 120 volts it will limit the other items that can operate. You can switch the water heater to propane mode to eliminate it from the equation and still allow full hot water capability. Otherwise it may be turned off while other items are being used. Also, keep in mind that items will be shed if you fire up a coffee pot or electric skillet.

The sequence of power cut offs, according to the manufacturer info is: Water heater, Fridge (will probably revert to propane mode), Bedroom AC (fan stays running), Living room AC, Microwave.



Propane Problems

If you have no or poor propane flow to your propane devices, try the following. There may be a check valve in the propane tank that may be tripped. This valve is a safety device to prevent rapid propane flow if a hose were to break. There have be cases where the valve tripped if the propane valve was opened very quickly.

Try resetting the check valve. Close the propane valve and then bleed the line by firing up a stove burner. Shut off the stove and then slowly open the propane valve. Relight the stove to bleed the line and see if you have full propane flow.

Service/Owner Manual Links

Here are some links to sites where service manuals or owner's manuals can be downloaded.

Jayco Owner Manuals
https://www.jayco.com/owner/manuals/

Norcold Refrigerators
https://norcold.com/product-manuals/

Coleman AC
https://www.airxcel.com/rv/coleman-mach/service-support/document-library

Onan Generators
https://www.cummins.com/rv-generator-manuals

Progressive Dynamics Converters, Transfer Switches, Inverters, Power Panels
https://www.progressivedyn.com/support-manuals-troubleshooting-guides/

Suburban Furnaces, Stoves, Water Heaters (site under construction)
https://www.airxcel.com/rv/suburban/service-support/document-library

Furrion Electronics
https://furrion.com/pages/downloads

Equalizer Systems Leveling Systems
https://equalizersystems.com/service-and-support/

Precision Circuits Energy Management Control System
http://precisioncircuitsinc.com/category/energy-management-120v/

Kwikee Electric Steps
https://www.rvtechlibrary.com/exterior/kwikee_svc_manual.pdf

Girard Tankless Water Heater
https://www.girardgroupcompanies.com/storage/app/public/brochure/GSWH-1-24-ENG-694.pdf

Ford Auto Parts (RockAuto.com) (good spot to see what parts are available for the E350/E450 chassis)
https://www.rockauto.com/en/catalog/ford

Bauer Keyless Entry (one model of keyless entry)
https://bauerproducts.com/wp-content/uploads/2019/11/Bauer-NE-Instructions-23-Mar-15.pdf

Inverter Amp Draw Calculator
https://www.batterystuff.com/kb/tools/dc-to-ac-amperage-conversion-run-through-an-inverter.html

Summary

Hopefully these troubleshooting hints will give you some places to look when a problem develops. This is not a complete troubleshooting guide but does list some common failure items. If you elect to try diagnosing any problem, be sure to exercise caution. Typically you won't hurt yourself with the 12 volt systems but when working around 120 volts, if you are not careful you could get seriously hurt. When in doubt, leave it to a professional.

This is Part 2 of a 2 part series. The first article gives instructions for first time test meter users.

Version 2 Document Changes

1. New title page.
2. Add Table of Contents.
3. Add ground connection info to 12 volt power section.
4. Add owner/service manual links.
5. Add heat pump troubleshooting.
6. Add tank sensor info.
7. Add battery disconnect info.
8. Add battery display info.
9. Add Sequence of Operation section.
10. Add Onan tips.
11. Add water heater troubleshooting.
12. Add propane problems.
13. Add energy management system operation.