Renewable Energy Terms

Series—Linked Together in One Electrical Path

Ian Woofenden

Derivation: From Latin serere, *to join, link together.*

Did you have one of those wooden train sets when you were a kid? Remember how all the cars lined up and linked to each other? Either they had a hook on one car and an eye on the next, magnets, or some sort of interlock. The train cars were lined up in *series,* one after the other. The front end of one car was connected to the back end of the next. When you pulled on the engine, all the cars came along with it.

Series circuits in electricity are similar. All the elements in the circuit are in one line, and anything that happens to one element happens to them all.

A flashlight is a common example of a series circuit. When you load the batteries in, you put them all in the same way on top of each other. So the positive end of one battery connects to the negative end of the next one. The flow of electrons goes through all the batteries, through the switch, and through the bulb. It's a single loop.

When you're adding energy sources or loads in series, the individual voltages add up. If your super-duper flashlight holds six 1.5 volt D-cells, you're packing a 9 volt flashlight.

In renewable energy (RE) systems, we see series circuits in several places. Photovoltaic (PV) panels generally come in a 12 volt nominal configuration. So if your system voltage is 24 or 48 volts, you'll have to wire the PVs in series strings. Two 12 volt panels will give you a nominal voltage of 24 volts. Four will give you 48 volts. (Remember that you're just changing the electrical "pressure" (voltage), and that the total energy (watt-hours) is not affected.)

In order to create a battery bank of a given voltage, sets of batteries are wired in series strings. Common batteries that are frequently used in RE systems (such as the L-16 and T-105) come in a 6 volt configuration. So you will need two of them in series for a 12 volt system, four for a 24 volt system, and eight for a 48 volt system.

In your house wiring, a switch and its loads are always wired in series. In order for the switch to be effective, all the electrons have to flow through one path that includes the switch and the loads.

You'll rarely find two loads wired in series. We used to see Christmas tree lights that were wired this way. When one bulb went out, it acted like a switch, shutting down the whole string of lights. Some inexpensive burglar alarms use circuts with many switches connected in series. When the bad guy or your brother-in-law breaks the window to get in, it opens one of the switches and sets off the alarm.

Wiring PVs and batteries in series is similar to the circuit in your flashlight. The positive terminal of one panel or battery is wired to the negative terminal of the next one in line. You tap your main negative for the system off one end of the string, and your main positive off the other end.

Other RE system components are also wired in series. Switches, fuses, breakers, ammeters, blocking diodes, and other things that control or monitor electron flow are all wired inline with the circuit, not outside it. For the circuit to work, each component has to allow electrons to flow. And if you use your multimeter to check current in a circuit (make sure it's well within the meter's range), you'll have to open the circuit and put the meter in series with it.

Since the electrons have to flow through all the components and the wiring in a series circuit, you can see how important it is to have adequately sized wiring and strong connections. A poor connection or undersized wire between two components can set up a resistance that will rob you of energy. And a failed connection can shut down your system altogether.

Next time I'll talk about parallel circuits, but here's a little preview. Most of the circuits in your home are wired in parallel with each other. If they were all in one series loop, you could only have everything on or everything off. This would make energy conservation—and life—rather difficult.

Access
Ian Woofenden, PO Box 1001, Anacortes, WA 98221
Fax: 360-293-7034 • ian.woofenden@homepower.com