Bob-O Schultze

Dummy loads have a bad rap and a worse name. Calling them shunt, dump, or diversion loads doesn't sound much better. Truth is, they can be pretty smart. A bit of free hot water or a few extra degrees warmth for the batteries in winter are good deals all around. It's not exactly a free lunch, but it's close.

A Diverting Experience

Using a shunt regulator to dump power when the batteries are full is the only realistic way to regulate DC hydro and wind generators. Both types of machines have to be connected to the batteries at all times to prevent unloading and overspeeding. Overspeeding a hydro plant causes serious voltage spikes and premature wear on all the moving parts. Overspeeding a wind machine can send your blades into the next county.

With automotive type alternators like the Harris Hydro, constant battery current is required to energize the field. The field windings take battery current to make the field into an electromagnet. Once the alternator is spinning, the field will energize itself. But if you take away the battery, the alternator will speed up, producing a higher voltage, which is fed back into the field, producing a higher voltage, etc. A 12 volt alternator can easily put out 120 volts. Reconnecting it to the battery would cause a serious and potentially dangerous voltage spike in the system.

Shunt Regulation

There are two types of shunt regulators. Pulse-width modulation (PWM) regulators use transistors to turn the dummy load on and off very fast. As the batteries approach the set regulation voltage, the on times or pulses get shorter than the off times. At full regulation, the charging pulse is on only long enough to keep the battery at a given voltage. Some regulators hold the batteries at that voltage for a set period of time, called the absorption phase, and then allow the batteries to come down to a lower voltage, called the float voltage.

Connect/disconnect regulators will switch the dummy load on at the regulation voltage and back off at a lower voltage. The voltage difference between on and off is called the hysteresis. I call it slam bang charging. Either type of shunt regulator will keep your batteries full and your charging sources under control. The choice of which to use can be a factor of price, convenience, opinion, and whether you are dumping the power as AC or DC.

Et Tu, PV?

Can we use shunt load regulation on a PV system as well? It is used that way in many hybrid systems such as PV/Hydro, PV/Wind, and PV/Wind/Hydro (go ahead, flaunt it!). In a system with only PV, however, I generally don't recommend it. PVs don't overspeed, so they are pretty easy to regulate. There are some very good listed series-type regulators on the market these days. A good series PWM regulator is reliable, easy, and cheaper to set up than a shunt regulator. Like anything else, there are exceptions to the rules. Call your local Wrench for help.

AC or DC?

Diverting DC power makes good sense if you don't have a lot of it. It's also the way to go if you have a small inverter or none at all. The good news is that you can use a PWM shunt regulator, which tends to get the most years out of a battery bank. The bad news is that you are severely limited in your choice of dummy loads.

High wattage, low ohmage resistors are hard to find in configurations that will divert a wattage roughly equal to your charging sources. DC water heating elements are expensive and not available to fit many water heaters. You can use AC water heating elements to dump DC, but the resistances are high, so you won't shed much power.

These elements are designed for 120 or 240 volt systems and have a high resistance. The current they can absorb decreases as you lessen the voltage (check it out with Ohm's law), and they just don't do very much

for you at 12 or 24 volts. For example, a 1,000 watt element designed for 120 volts will have a resistance of 14.4 ohms. In a 24 VDC system with a regulation voltage of 28.8 VDC, that element will only divert 2 amps. Big deal.

Shunting AC power works best if you have enough excess power to do something wonderful like provide some of your hot water. Resistive loads designed to eat 120 or 240 VAC are everywhere and inexpensive. Water heating elements and space heaters are readily available in many wattage ranges. You need to use the connect/disconnect type of regulator when switching AC loads.

Worried about your inverter being large enough to run the dummy *and* your other loads? It's a moot point. If your batteries are full enough to require regulation, you likely aren't using the inverter for anything much anyway. If you do turn on a big load, the battery voltage will soon drop enough to shut the dummy off.

The Dummy Load

The best and most reliable shunt loads are resistors. Water heating elements and space heaters are just big resistors. Light bulbs are resistors too, but I can't recommend them. Remember Murphy's Law? "Anything that can go wrong, will go wrong, and at the worst possible moment." In other words, your light bulb dummy load will burn out an hour after you leave for Christmas week at Grandma's!

The best resistor for a shunt load is a water heating element. Who doesn't use hot water? These are available in both 120 and 240 VAC models from 1,000 to 4,500 watts. Sometimes a 240 VAC element fed 120 VAC will be just right for your diversion. Hey, it's just a resistor! My system uses a 4,500 watt 240 VAC element fed 120 VAC from the inverter. It eats about 1,075 watts, just right for shunting my Whisper 1000 wind genny.

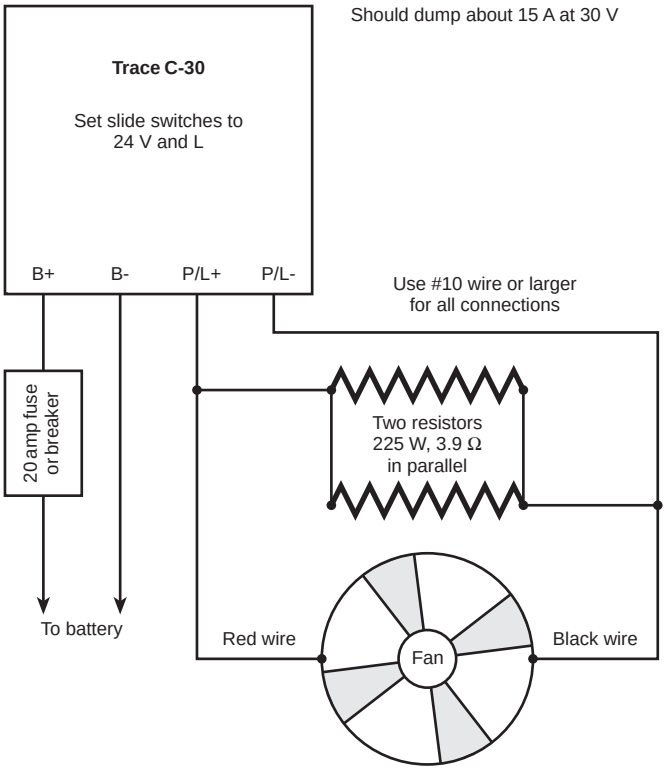
Danger, Will Robinson!

With a large charging source you may heat too much water! Run your element through a thermostat and make sure your temperature and pressure (T&P) valve works. I like to set up a second voltage sensing switch and a space heater in case the water gets too hot and the thermostat cuts the power. Setting your regulation point 0.1 to 0.2 VDC higher on the second regulator works fairly well.

Shunting DC

Shunting DC is straightforward. You need a voltage sensing switch (VSS) and a dummy load capable of dumping the full output of the charging source without burning up. Use Ohm's law to calculate the resistance and the power-handling capability of the dummy.

Shunting to DC loads with a Trace C-30



For example, say we need to divert 10 amps from a hydro plant charging a 24 volt battery system. First, choose your regulation point. Let's assume 28.8 volts. We use the formula:

$$R = E \div I$$

where R is resistance in ohms, E is potential in volts, and I is current in amps. This yields 28.8 V ÷ 10 A, or 2.88 Ω, in our system.

To figure the wattage value for our resistor, use the formula:

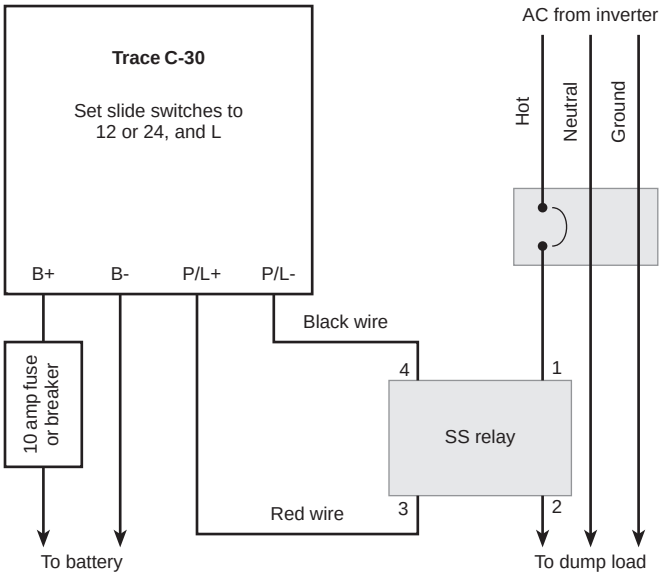
$$P = E \times I$$

where P is power in watts, E is potential in volts, and I is current in amps. So 28.8 V x 10 A = 288 W. We need at least a 288 watt resistor with a resistance of 2.88 Ω. The voltage sensing switch can be either a PWM type such as the Trace C-40 or AEE's Enermaxer, or a slam bang like the Trace C-30, Photron Simple Switch, or a homebrew.

Shunting AC with Trace SW Inverters

The Trace SW series inverters have three small voltage-controlled relays built in. Use them to control the coil of a larger relay capable of handling the current you need to dump. I prefer a solid-state relay such as Continental Industries S505-0SJ625-009. It has a

Shunting to AC loads with a Trace C-30



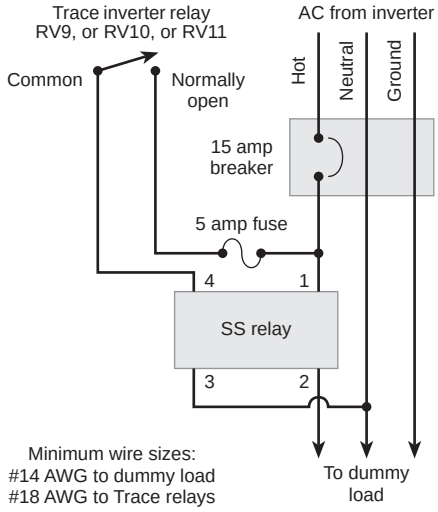
control rated from 90 to 280 VAC and contacts rated at 25 A from 24 to 330 VAC. That's plenty of range and headroom. See the schematic for details.

Shunting AC with Other Inverters

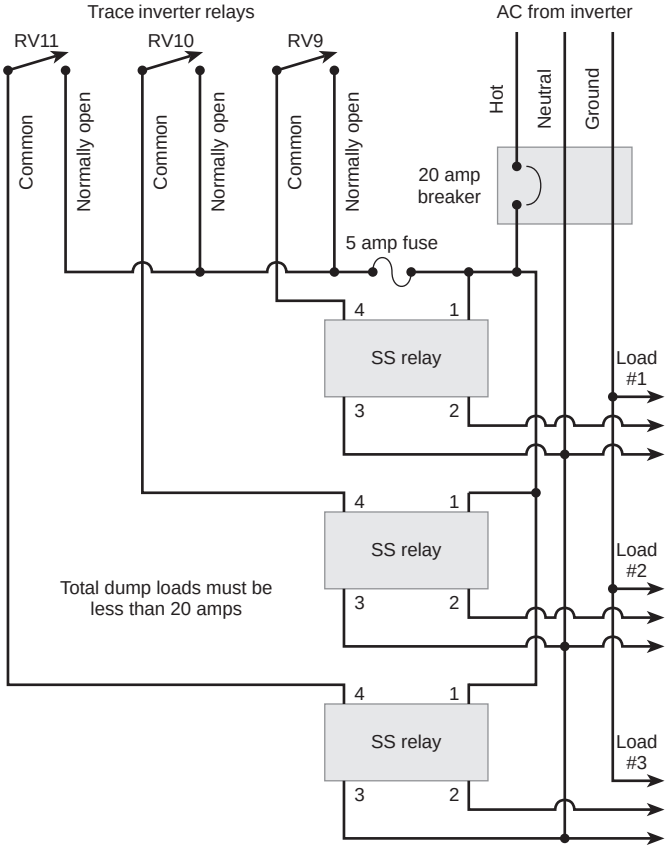
This works the same as shunting with the Trace SW, except that you'll need an external VSS and a relay with a DC-rated coil. If you want to use a solid-state relay, Continental makes the S505-0SJ625-000. It has the same 25 A and AC voltage rating on the contacts, but the control is 3 to 32 VDC. Your favorite renewable energy dealer can get these relays for you.

Any relay, and its wiring, needs to be mounted in a UL approved enclosure. The solid-state relays need to be mounted on a heat sink as well. I've found that mounting them directly to the back of a 6 by 6 by 4 inch

Shunting to AC loads with a Trace SW Inverter



Shunting to Multiple AC loads with a Trace SW Inverter



(15 x 15 x 10 cm) metal enclosure with heat sink grease works okay up to about 10 A at 120 VAC. If your load is more than that, you must heatsink and allow for heat dissipation.

It's a Wrap

Deciding which type of regulation is the best for your system isn't a trivial decision. Nor is it often cut and dried. My advice? Talk it over with your favorite Wrench. Support your local talent.

Access

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