An Auto-electricians Guide to Installing Solar - an ongoing series

Collyn's office.

The last part of this series stresses that a lot of time can be wasted seeking solar 'faults' that are in fact due to unrealistic user expectations.

It is often possible to improve an existing such system, but the starting point is always to do a quick mental guesstimate of the probable solar input and usage (as shown in a previous part of this series).

If there seems enough energy coming in, and the load is reasonable, but the system does not work as it should, then there are faults that needs fixing.

Often however the user expectations are unrealistic. The main problem tends to be not in fixing the system, but convincing the customer the work required may be extensive. It may well, for example be fixable by adding more solar capacity, but the existing wiring solar and battery cabling may not then cope with the increased current.

That one can be solved by fitting an MPPT solar regulator that accepts inputs up to 50 volts or more (many do) - and series/parallel connecting modules so the solar output is at 24 volts. This reduces current, so existing wiring now copes The MPPT function also saves 10%-14% input otherwise lost through power mismatch.

As noted in the last issue, customers may suggest increasing battery capacity but unless batteries routinely charge to 100% by midday, and discharge to about 70% remaining by (and are in reasonable condition) adding more battery capacity is counter productive. Same energy in - so adding battery capacity increases losses.

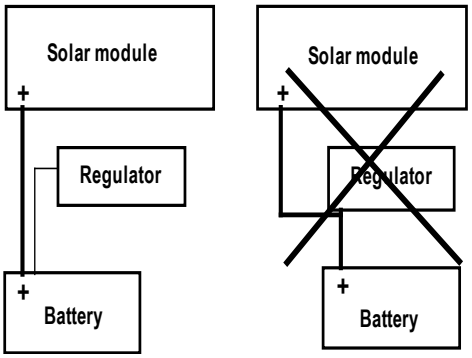
Common Solar Fault

Almost all solar regulators are switches that make and break the current flow (at high speed) such that the average current is that required for the state of the battery and/or load at the time.

They do this by sensing battery voltage and that voltage must be exactly that.

To ensure this, most good quality solar regulators have one or two dedicated reference leads that must be connected as specified.

The less than electrically astute however looks at the makers' wiring instructions and note that the lead/s appear to be in parallel with the battery leads to the regulator. They then assume the regulator makers are idiots in that their instructions show one or two apparently unnecessary leads from the battery to the regulator. So they work out ways to leave them out. One very common way, (with the Plasmatronic PL series) is shown on this page - but there are many such.



Many solar regulators take a voltage reference from Battery+ve to a BAT + reference terminal on the regulator.

Because it saves one lead, many installers both 'professional' and DIY thus connect them as shown on the right. Some regulators require a negative reference lead too. It is not uncommon to find theme leads looped via few mm of cable to the main BAT + and BAT - terminals on that regulator, thus defeating their very purpose.

*The regulator **must** know the battery voltage. The voltage part way between the solar output and the battery however is always (whilst solar charging) higher. It has to be - that's how the battery charges. Wiring incorrectly as above causes the regulator to believe the battery is more charged than it really is and drastically cuts back the charge.*

This major error is common. Checks at CMCA rallies (attracting over 1000 RVs) shows at least 20% are affected - despite makers clear warning not to do it.

The problem this causes is that the voltage reference is no longer battery voltage, but one that part way between solar output voltage and battery voltage. The further that regulator is from the batteries and closer to the solar modules, the higher will be that reference voltage.

So when there is solar input, that voltage will *always* be higher than battery voltage. This causes the regulator to assume the batteries are more charged than they are - so it cuts back the charge.

If wired that way *no* auxiliary battery may ever reach full charge, thus also shortening its life.

All rigs with solar should be checked. It's often obvious at a glance because cables are missing or in the wrong place. Or as with PL series, the Bat+ve reference terminal (it's the bottom extreme left one on the unit) has two leads there.

The only way to be 100% sure is, with the system charging, by checking voltage across those reference terminals and then directly across the battery terminals. As the reference draws virtually no current (about 0.0001 amp) there should thus be no measurable voltage difference.

This is a *surprisingly* common fault. Check after check after check shows at least one third of all PLs are installed incorrectly this way - particularly by one unfortunately major installer. So are many brands of such regulator.

Cheap voltage regulators usually have no separate provision for monitoring battery voltage. That causes them (much as with an incorrectly wired regulator) to 'see' a voltage part way between solar and that of the battery.

This can only be overcome by relocating it close to the batteries - or running extra-heavy leads from the battery to the regulator. But *not* from the regulator to the solar array.

Checking Solar Output

It is also worth checking that solar module output is as it should be. This needs both voltage and current checks.

The latter needs a considerable level of faith for those who mainly work with batteries as it requires totally shorting the modules's output.

Doing this is totally acceptable because unlike batteries, solar modules put out a more or less constant current and care not if that is open circuit, on load or short circuited. It is thus 100% safe - and is how their output is checked.

If you have a ammeter that reads up to the expected current output (very few do) you simply connect that ammeter *directly across their output.* The alternatives are to use a shunt in series with a dead short, or (but less accurately) by using a clamp ammeter around the shorted cable.

It's not *quite* that simple because the modules must be in full sun, and when you short them out, the resultant spark may burn the end off your meter probe.

First tie a blanket firmly over the modules, and only *then* connect the meter leads directly across the modules - via a suitable connector - and then remove the blankets. Do the same when reconnecting.

The current you should expect to find is the wattage divided by 17 for 12 volt systems and 34 for 24 volt systems (i.e. not the 12 or 24 you may have thought).

This is because makers rate the products at that combination of volts and amps which gives the highest result (in watts). That is almost always around 17 volts.

The output of a '120 watt' module is thus typically 8.4 amps at 17 amps, not 10 amp at 12 volts. (But both are still 120 watts).

This is often hard to explain to customers who understand electricity, but not the curious marketing practices of the solar module industry.

If a customer argues about this, refer them to the data panel that most modules have on their rear. That will confirm the above - that typical output in typical usage is about 71% of that claimed. This is also clear in the data sheets - but in language that auto electricians understand, but far from all owners.

As noted earlier, an MPPT's volt/amp juggling can reduce that loss by a typical daily 12.5% (not the 30% often claimed). But it's still way off the wattage that most buyers thought they'd paid for.

Under/over Charging

It is my general experience from feedback (from my now over 135,000 book buyers) that almost all believe that batteries are wrecked by overcharging. The reality is the opposite, plus ongoing close to fully discharging that results in damaging sulphation.

Unless most issues are addressed and fixed, customer with overloaded systems are best sold cheaper deep-cycle traction or golf cart batteries (such as those made by Trojan). This is because no battery *including AGMs and gel cells* will withstand that treatment for long.

Lithium based batteries cope better with such usage, and also offer four times the energy stored for the same size and weight - but are four times the price. They not yet in common RV use so are covered only briefly here.

If you meet one, treat it as a normal battery, except for one main difference. A lithium cell produces an almost constant 3.6 volts. A 12 volt lithium battery thus has four cells producing an almost constant 14.4 volts.

Its state of charge cannot be assessed by measuring its voltage. It suddenly drops to 1.0 volt or so just before fully discharged. Some include a way of disconnecting the load when they fall below 20% charge.

The only reliable way to know their charge is via an energy monitor.

These work much as a business tracks money. Count what comes in and subtract what goes out plus internal losses. The result is more or less what you have left. They will be covered in a later part.

Mains Voltage

No licence is needed to do electrical work that does not exceed 50 volts alternating current, nor 120 volts direct current. Anything above that must be done by a licensed electrician.

There are however known problems in this area. The requirements for RVs are set out in Standard (AS/NZS 3001:2008) and are substantially different from domestic practice, but not all RVs (especially imported fifth wheelers) made or modified since 2008 appear to be compliant with this Standard.

The issues are not covered in this series, but the forthcoming book based on it will cover the main requirements so that auto electricians can bring such issues to the owner's notice. (If interested see under 'Articles' on my main website: www.caravanandmotorhomebooks.com).

From hereon, this series will show how solar installation should really be done.

Learning More Right Now

For those seeking to know more right now, please see our Auto-electricians' Offer for the (August 2012) released 3rd Edition of *Solar That Really Works.*

As some companies are buying a copy for each of their staff, so we provide for an additional 10% discount for three or more. (We also extend this to buyers who may wish to group to place a single such order).

We also provide a special price for TAFE Institutes seeking to buy in bulk, and also to any company wishing to stock and resell the book to customers.

The content of this current series will later be expanded and produced in print and eBook format.

Previous parts of this series can be accessed on-line at www.aaen.com.au