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TECHNICAL REPORT

MORE CONTROLLERS ON A BATTERY
BATTERY CHARGE LIMITATIONS

Photovoltaic panels can be wired in series or in parallel. In the first case only panels with the same current can be connected and the final current remains the same of the single panels, while the output voltage results in the sum of the panels voltages. In the second case the currents sum up while the voltage remains **the same**. Only panels with the same output voltage can be connected in parallel.

Both series and parallel wiring suffer from some problems. Series connection is quite sensitive to shading and different panels orientation, while parallel connection resolves the shading problem but leads to a rarely optimal match with the MPPT algorithm in controllers. Moreover parallel wiring needs blocking diodes which produce a small power loss and make the installation more complex.

The best way to harvest all the possible energy from photovoltaic panels is to pair any single panel to a proper MPPT controller. In this way all the panels are independent and each one is working at its best.

If this is the case, the result is two or more controllers connected to the battery, and this can be done in the simplest way, connecting all of them in parallel. That is surely possible since every controller is protected from reverse current and thus acts as an isolated one. We need nevertheless to add some considerations.

Any battery is charged in different steps, depending on its kind. Let's focus on the initial and final steps. When the battery is discharged the controller sets its output voltage slightly higher than the battery voltage and controls only the current flow to avoid an overly strong current (in the case of solar charging the current is actually limited by the panel itself). When the battery is close to be charged, the current is further limited, to reach smoothly the charged state and avoid overcharging.

We can thus say that the maximum current flow through the controller is dictated by the battery status and not only by the photovoltaic panel.

This is an important issue when two or more controllers are wired to the same battery because it can happen to observe that the current of a single controller is reduced when a second controller is connected. This is not a sign that controllers are influencing negatively one another, but only the result of a current limitation due to approaching the charged state of the battery. As an example let us consider a 12 volt battery close to be charged (close to 14 V) and a single controller. By using a 100 W panel, in full sun we should expect a current of about 7 A ((100 W / 14 V), while we read only 4 A (due to charged status). If we add a second controller (and a second panel), we will realize that the total current will remain the same (4 A) being limited by the battery and thus any controller will now show only a 2 A current intensity. The exceeding energy is not wasted somewhere, it is simply not produced, inhibited by the controllers which "know" how much current they can supply to the battery.

A similar phenomenon could actually occur even if the battery is far from being charged. This is related to a more general current limitation that depends on the kind of battery considered. It exists in fact a maximum charging current, usually proportional to the battery size. This MAX value is shown on the battery or on the data sheet, and is often expressed as CA/N where N is a number and CA means battery capacity. If, for example, we have a 100 Ah battery and we read CA/5, it means that the maximum current is limited to 100/5 = 20 A. That is usually a quite large number and thus this limitation can be important only if the system has not been sized properly (too many panels compared to the battery size).

To show that two controllers are not influencing each other, we performed a test by using two SP100 and two Western WRM15 controllers (in a winter almost sunny day). First of all the two panels have been checked by connecting one of them to the same controller, and then both of them in series. The power is doubled as expected. Then parallel connection of the two controllers (each one with a single panel) and the effect of disconnecting one of the two controllers are observed.
We used a 45Ah sealed lead battery. The battery was low, in order to avoid any current limitation. The tests have been performed with and without load.

First test

Panels series connection

WRM15 + one SP100



Instantaneous power is 17 V x 3.6 A = 61.2 W

WRM15 + two series connected SP100 on one controller



Instantaneous power is 35.2 V x 3.2 A = 112.7 W

As expected, doubling the panels we double the power.

Second test

Controllers parallel connection

Both WRM15 connected to one SP100 and both controllers connected to the battery

Controller 1)



Controller 2)



Controller 2 is then disconnected

Controller 1)



No important changes are measured. Without current limitation by the battery, a single panel produces half the energy of two panels together.

This last test has been repeated with a 100 W load on the battery, and again no anomaly has been measured.

CONCLUSIONS

Connecting more controllers on the same battery does not produce any problems, the current of one is not limited by the presence of others. The only current limitations can be due to the state of charge of the battery or to a wrong sized system (too much solar power on a small battery). Such a limitation does not depend on the electrical architecture, i.e. more panels on a single controller or more controllers on the same battery.

The best solution remains to use a controller for each panel, in order to minimize shading effects and optimize the energy harvesting with independent MPPTs.