AC-coupling and the Factor 1.0 rule

1. Introduction to the AC-Coupling concept

Already familiar with the concepts of AC-coupling and regulating PV inverter output power by frequency shifting? Skip to the factor 1.0 rule.

1.1 What is AC-coupling?

In an AC-coupled system, a grid-tied PV inverter is connected to the output of a Multi, Inverter or Quattro. PV power is first used to power the loads, then to charge the battery, and any excess PV power can be fed back to the grid.

When the Multi or Quattro is connected to the grid, this excess PV inverter power will automatically be fed back to the grid.

When the Multi or Quattro is operating in inverter-mode, disconnected from its AC input, it will create a local grid: a micro-grid. The PV Inverter will accept this micro-grid and will therefore operate even during a black-out. The PV power can even be used to charge the batteries: when there is more PV power available than used by the loads, the power will automatically run through the inverter in reverse direction and charge the batteries. It is necessary to regulate that power to prevent overcharging the batteries as well as overloading the inverter/charger. This is where 'frequency shifting' comes in to the picture, see next section.

Highlights:

- AC-coupling is available in single-phase, split-phase and also three-phase systems.
- Victron Multis and Quattros can prevent feeding back PV power to grid.
- Systems with only a grid-tied PV inverter will fail when there is a grid black-out. A micro-grid system will continue to operate, and even keep using solar power.
- It is also possible to run a AC-coupled micro-grid on a generator
- Most brands of PV inverters can be used for these systems, they need to be setup to support frequency shifting, often called the island-mode or micro-grid mode. For Fronius settings, see AC-coupled PV with Fronius PV Inverters.
- If power will be fed back into the grid an anti-islanding device may have to be added to the system, depending on local regulations.

1.2 What is frequency shifting?

Frequency shifting is the ability to change the output frequency of a VE.Bus product like the MultiPlus or Quattro to regulate the production of energy of AC-coupled generators. In most cases this will be a grid connected inverter powered by solar or wind. These grid-tie inverters need to be regulated also see chapter 'Example & background'.

How can a VE.Bus product configured to frequency shift?

Several options:

1. ESS Assistant
2. Self-consumption Hub-2 v3 assistant
3. PV Inverter support Assistant
4. (deprecated) Hub-4 Assistant in combination with the PV Inverter support Assistant
5. Use the Inverter period time settings on the Virtual switch tab.

2. The 1.0 rule: Max PV power must be equal or less than the VA rating of the Multi

2.1 Rule definition

In both grid-connected and off-grid systems with PV inverters installed on the output of a Multi, Inverter or Quattro, there is a maximum of PV power that can be installed. This limit is called the factor 1.0 rule: 3.000 VA Multi = 3.000 Wp installed solar power. So for a 8.000 VA Quattro the maximum is 8.000 Wp, for two paralleled 8000 VA Quattros the maximum is 16.000 Wp, etcetera.

2.2 Example and background

To understand the background, consider the following situation: the PV inverter is at full power, supplying a big load. The Multi is in inverter mode. Then, suddenly and at once, this load is switched off. At that moment the PV inverter will continue operating at full power until the AC frequency has been increased. Increasing this frequency will take a very short time, but during that time all power will be directed into the batteries as there is no other place for it to go. This causes the following:

- When batteries are (nearly) full, the battery voltage will spike, possibly causing the Multi to switch off in DC over-voltage alarm.
- The same spike will cause the AC output voltage of the Multi to spike, as these two are directly related, and when the spike on the battery voltage is high and fast enough, the Multi can never regulate its PWMs down fast enough to prevent the spike on AC. This spike can damage the PV inverter, the Multi and also any connected loads and other equipment.
- Another problem is that the Multi starts charge current protection.
- In the best case it might switch the grid inverter off immediately by setting the AC frequency to the disconnect frequency as configured in the assistant.

It is no problem to overpower the grid inverter by installing more solar panels. Some people do this to increase the generated solar power in winter time or rainy weather. Refer to the PV Inverter datasheet to maximum allowed installed PV power. Two times the inverter nameplate rating or even more is not uncommon!

2.3 Charge current limit

Another question frequently asked is how can this factor be 1.0? Since the charger inside a 3000 VA Multi is not 3000 VA but closer to 2000 VA? The explanation lies in the fact that it will regulate . In other words: when there is too much power coming in, causing the charge current to exceed the limit, it will increase the output frequency again and will keep regulating the AC output frequency to charge with the limit.

An example, a 3000 VA Multi, with 3000 W of solar power coming out of a PV inverter:

1. When the Multi is connected to the grid, all 3000 W can be fed back to the grid through the Multi, no problem.
2. In case the Multi is not connected to the grid, the 3000 Wp is more than the charger in a Multi 3000 VA can handle. The charger is around 2000 W. Therefore the grid inverter assistant will automatically increase the frequency to reduce the output of the grid inverter, to match maximum charge current.

2.4 Should you look at the total PV array, or the PV inverter rating?

The mentioned 3000 Wp and 8000 Wp is the Watt-peak which can be expected from the solar system. So for a oversized PV array, where the total Watt-peak installed PV panels exceeds the power of the PV Inverter, you take the Wp from the inverter. For example 7000 Wp of solar panels installed, with an 6000 Watt PV grid inverter, the figure to be used in the calculations is 6000 Wp.

And for an undersized PV array, where the total Wp of installed PV panels is less than the installed PV grid inverter, you use the Wp from the PV panels in your calculation.

3. Minimum battery capacity

Besides the relation between installed PV Power and the inverter/charger VA rating, it is also important to have a sufficiently sized battery. The minimum battery capacity depends on the type of battery, lead or lithium.

Note that, besides the minimum battery capacity, the mentioned sizes are often also the most economical battery size. In case used for self-consumption purposes that is. In case the goal is to increase autonomy, of course installing a large battery increases the system autonomy in case of a grid failure.

3.1 Lead batteries

1 kWp installed PV power requires:

- 100 Ah accubank 48 Vdc
- 200 Ah accubank 24 Vdc
- 400 Ah accubank 12 Vdc

3.2 Lithium batteries

1,5 kWp installed PV power requires:

- 100 Ah accubank 48 Vdc

- 200 Ah accubank 24 Vdc
- 400 Ah accubank 12 Vdc

DISQUS

~~DISQUS~~