Technical Information

PV Inverters

Use of PV Inverters in Off-Grid and Battery-Backup Systems in North and South America

Content

Both in off-grid systems and in the event of grid failures in battery-backup systems, grid fluctuations in the stand-alone grid are possible. This may cause severe deviations in nominal voltage and nominal frequency. Despite such fluctuations, all of the components in these systems must function without problems.

This technical information will inform you about the following topics:

- Which PV inverters you can use in off-grid systems and battery-backup systems
- Which parameters you need to set in the PV inverter
- What type of communication you need to install in battery-backup systems
- Which values the parameters of PV inverters will take in stand-alone mode
- How the output power of the PV inverter can be limited by the Frequency-Shift Power Control (FSPC) function of the Sunny Island

1 Usable PV inverters (Modified: July 2017)

PV Inverters	Off-grid system	battery-backup system	Available?
Sunny Boy (SB)			
SB 700U	✓	✖	No
SB 3000US	✓	✓	No
SB 3800-US-10	✓	✓	No
SB 4000US	✓	✓	No
SB 5000US	✓	✓	No
SB 6000US	✓	✓	No
SB 7000US	✓	✓	No
SB 8000US	✓	✓	No
SB 2000HFUS-30	✖	✖	No
SB 2500HFUS-30	✖	✖	No
SB 3000HFUS-30	✖	✖	No
SB 3000TL-US-22	✖ [1]	✓	No
SB 3800TL-US-22	✖ [1]	✓	No
SB 4000TL-US-22	✖ [1]	✓	No
SB 5000TL-US-22	✖ [1]	✓	No
SB 6000TL-US-22	✖ [1]	✓	No
SB 7000TL-US-22	✖ [1]	✓	No
SB 7700TL-US-22	✖ [1]	✓	No
SB3.0-1SP-US-40	✓	✖	Yes
SB3.8-1SP-US-40	✓	✖	Yes
SB5.0-1-SP-US-40	✓	✖	Yes
SB6.0-1-SP-US-40	✓	✖	Yes
SB7.0-1SP-US-40	✓	✖	Yes
SB7.7-1-SP-US-40	✓	✖	Yes
SB 5000TLUS-12	✓	✓	No
SB 6000TLUS-12	✓	✓	No
SB 7000TLUS-12	✓	✓	No
SB 8000TLUS-12	✓	✓	No
SB 9000TLUS-12	✓	✓	No
SB 10000TLUS-12	✓	✓	No
SB 11000TLUS-12	✓	✓	No

[1] Since 2016, no longer supported.

✓ Compatible ✖ Not compatible

PV Inverters	Off-grid system	battery-backup system	Available?
Sunny Tripower (STP)			
STP 12000TL-US-10	✖	✖	Yes
STP 15000TL-US-10	✖	✖	Yes
STP 20000TL-US-10	✖	✖	Yes
STP 24000TL-US-10	✖	✖	Yes
STP 30000TL-US-10	✖	✖	Yes

✓ Compatible ✖ Not compatible

System failures due to excessive power output of AC sources in the stand-alone grid

If the power of the AC sources (e.g. PV inverters) in off-grid systems or battery-backup systems is too high, it may cause system failures.

- Design the total nominal AC power of the PV inverters to be no more than twice as high as the nominal AC power of the Sunny Island.
- If wind power inverters feed into the stand-alone grid, design the total nominal power of the AC sources in the stand-alone grid to be no larger than the nominal AC power of the Sunny Island.
- Allow at least 100 Ah of battery capacity per 1000 W of nominal AC power from the AC sources in the stand-alone grid.

2 Configuration of PV Inverters in Off-Grid Systems

The country data set must be set to stand-alone mode in off-grid systems.

You can order PV inverters configured for stand-alone mode or you can configure existing PV inverters for stand-alone mode (see Section 4 "Communication Products for Configuring PV Inverters", page 5). During the first ten operating hours you can adjust the country data set for many PV inverters by means of rotary switches (see the manual of the PV inverter).

Setting the Country Data Set via RS485

The following table shows how the country data set must be set during configuration of the PV inverter via RS485. The parameter name and the configurable value depend on the PV inverter and the communication product in use.

Parameter name	Value
Default	**Off-Grid**
or	or
CntrySet	depending on power frequency, **OFF-Grid50** for 50 Hz power frequency or **Off-Grid60** for 60 Hz power frequency

Setting the Country Data set via Speedwire

The following table shows how the country data set must be set during configuration of the PV inverters via Speedwire. The country data set value depends on the PV inverter being used.

Parameter name	Value
Set country standard	Either **Island mode** or depending on power frequency, **Island mode 50** for 50 Hz power frequency or **Island mode 60** for 60 Hz power frequency

3 Configuration of PV Inverters in Battery-Backup Systems

In a battery-backup system, the Sunny Island is connected to the utility grid and communicates with the PV inverters via RS485. This is why the Sunny Island and each PV inverter must be equipped with an RS485 Piggy-Back or an RS485 data module. In a cluster, only the master of the Sunny Island inverters may be equipped with an RS485 Piggy-Back. In a battery-backup system, all PV inverters must be configured for backup operation (see Section 4 "Communication Products for Configuring PV Inverters", page 5).

Setting Backup Operation via RS485

The following table shows how backup operation must be set during configuration of the PV inverter via RS485. The parameter name and the configurable value depend on the PV inverter and the communication product in use.

Parameter name	Value
Backup Mode	**On all**
or	or
Op.BckOpMod	**OnAllPhs**

In battery-backup systems you operate the PV inverters with the locally typical country data set for grid-connected PV systems as per UL1741. If the parameter is set to **On all** or **OnAllPhs**, the system meets the requirements as per UL1741.

PV inverters without backup operation

For PV inverters without backup operation, the country data set must be set to the locally typical value for grid-tie PV systems as per UL1741. The PV inverter is then configured for operation on the utility grid. In the event of a utility grid failure, the Sunny Island is unable to derate the PV inverters by means of Frequency-Shift Power Control (FSPC). If there is an excessive supply of energy, the PV inverters will switch off.

4 Communication Products for Configuring PV Inverters

SMA Grid Guard code required to change grid-relevant parameters

To change grid-relevant parameters in the PV inverter after ten operating hours, you will need the SMA Grid Guard code.

- Select a communication product corresponding to the type of communication and the PV inverter used.
- Apply for an SMA Grid Guard code to change grid-relevant parameters (for an application for the SMA Grid Guard code, see the certificate "Application for SMA Grid Guard Code" at www.SMA-Solar.com).

PV Inverters with RS485

You can configure PV inverters with RS485 using the following communication products:

- Sunny WebBox
- Sunny Boy Control
- Computer with Sunny Data/Sunny Data Control software

  For PV inverters without RS485 Piggy-Back or RS485 data module, you will also need a service cable for data transmission (USB Service Interface, SMA order number: USBPBS).

PV Inverters with Speedwire

You can configure PV inverters with Speedwire using the following communication products:

- Sunny Explorer
- SMA Cluster Controller

5 Parameter Values in Stand-Alone Mode

The **OFF Grid** setting for the **Default** parameter affects the following parameters of the PV inverter that communicates via RS485.

Parameters	Unit	Value
Test current	mA	Off (MSD=0)
Vac.Min	V	–50% $V_{AC\ Nom}$*
Vac.Max	V	+20% $V_{AC\ Nom}$*
Fac-delta– Lower range in which the Sunny Boy is active relative to f_0	Hz	-4.5 (starting from base frequency f_0)
Fac-max+ Upper range, where the Sunny Boy is active, based on f_0	Hz	+4.5 (starting from base frequency f_0)
dFac-Max Max. rate of change	Hz	5
Fac-start delta Frequency increase in relation to f_0, at which point the power adjustment via frequency begins	Hz	1 (starting from base frequency f_0)
Fac-Limit delta Frequency increase based on f_0, where the power control via frequency ends. The power of the Sunny Boy at this point is 0 W.	Hz	2 (starting from base frequency f_0)

* $V_{AC\ Nom}$ = 208 V/240 V/277 V

6 Frequency Shift Power Control (FSPC)

If PV inverters are connected on the AC side in off-grid operation or back-up operation, the Sunny Island must be able to limit their output power. This situation can occur, for example, when the battery of the Sunny Island is fully charged and the PV power available from the PV array exceeds the power required by the connected loads.

To prevent the excess energy from overcharging the battery, the Sunny Island recognizes this situation and changes the frequency at the AC output. This frequency change is monitored by the PV inverter. As soon as the power frequency increases beyond the value specified by **Fac-Start delta**, the PV inverter limits its power accordingly.

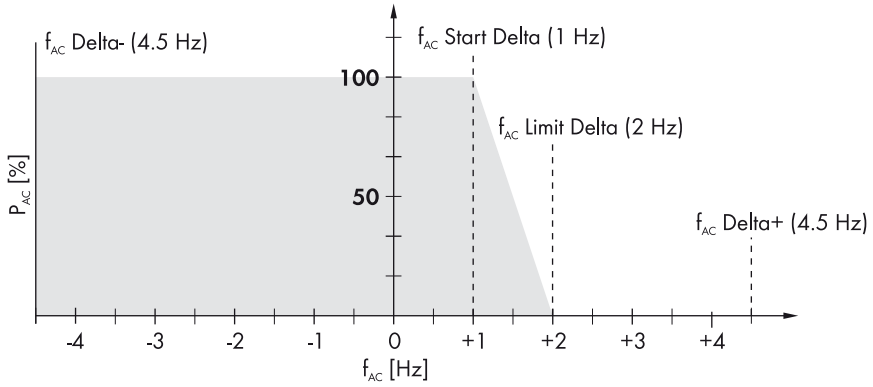

Figure 1: Operating principle of FSPC

The terms used have the following meanings:

- $\mathbf{f}_{AC}$ refers to the base frequency of the stand-alone grid (here 60 Hz).
- $\mathbf{f}_{AC}$ **Delta-** and $\mathbf{f}_{AC}$ **Delta+** are the maximum ranges relative to $\mathbf{f}_{AC}$ in which the PV inverter is active.
- fAC **Start Delta** is the frequency increase relative to fAC at which frequency-based power control begins.
- $\mathbf{f}_{AC}$ **Limit Delta** is the frequency increase relative to $\mathbf{f}_{AC}$ at which frequency-based power control ends. The power of the PV inverter at this point is 0 W.

If the limits $\mathbf{f}_{AC}$ **Delta-** or $\mathbf{f}_{AC}$ **Delta+** are exceeded, the PV inverters disconnect from the utility grid.

When an external energy source, (e.g. a diesel generator) is operating in the stand-alone grid, this external energy source determines the frequency and the PV inverters set to off-grid operation react to certain frequency changes brought about by the external energy source.

When diesel generators are used as external energy sources, the output voltage frequency under load is 60 Hz. For this reason, in most cases the PV inverters will deliver their entire power to the stand-alone grid, even when the diesel generator is in operation.

If the current battery voltage is greater than the battery voltage setpoint and the stand-alone grid is also to be synchronized with an external energy source, the Sunny Island temporarily increases the frequency and the PV inverters disconnect via frequency shutdown (overfrequency). Afterwards, the Sunny Island synchronizes with the external energy source.