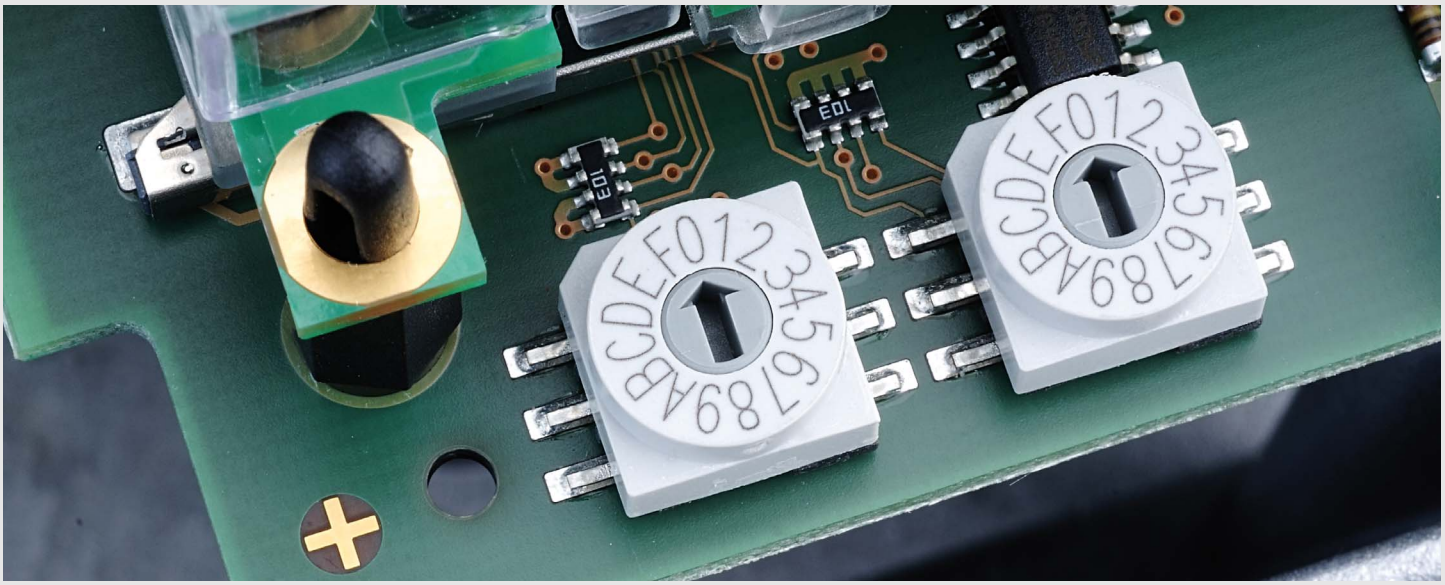
PV inverters

Use and Settings of PV Inverters for Off-grid and Backup Systems



Content

This technical information has the following content:

- Select the SMA PV inverter type best suited for use in an off-grid/backup system.
- Set the PV inverters to stand-alone grid operation to achieve optimum operation.
- You will find information on the integration of PV inverters in backup systems in accordance with the directive VDE-AR-N 4105 applicable in Germany.
- When set to stand-alone grid operation, the PV inverter can reduce its feed-in power if required to do so by the state of charge of the battery or the power requirement of the connected loads. This integrated frequency-dependent power adjustment function is called Frequency Shift Power Control (FSPC).

1 Selecting the PV Inverter

The following PV inverters can be used in off-grid/backup systems: Special requirements are applicable to PV inverters that are to be integrated into backup systems in Germany (see section).3 "PV inverter for backup systems in Germany" (page 9)

PV inverter	Off-grid system	Backup system
SB 700 / 1100 / 1200 / 1700	x	x
SB 1100LV	x	x
SB 1300TL-10 / SB 1600TL-10 / SB 2100TL	x	x
SB 2400	x	x
SB 2500	x	x*
SB 2500TLST-21 / 3000TLST-21	x	x
SB 2800i	x	x*
SB 3000	x	x*
SB 3000TL-20 / 4000TL-20 / 5000TL-20	x	x
SB 3000TL-21 / 3600TL-21 / 4000TL-21 / 5000TL-21	x	x
SB 3300	x	x
SB 3300TL / 3300TL HC / 4200TL HC / 5000TL HC		x
SB 3800	x	x
SB 4200TL Multi-String / 5000TL Multi-String		x
SB 5000TLW Multi-String		x
SMC 4600A / 5000A / 6000A	x	x
SMC 5000 / 6000	x	x
SMC 7000HV / 7000HV-11	x	x
SMC 6000TL / 7000TL / 8000TL	x	x
SMC 9000TL-10 / 10000TL-10 / 11000TL-10	x	x
SMC 9000TLRP-10 / 10000TLRP-10 / 11000TLRP-10	x	x
SWR 700 / 850(E) / 1100E		x
SWR 1100LV		x
SWR 1500		x
SWR 1700(E)		x
SWR 2000		x
SWR 2500 / 3000		x
STP 8000TL-10 / 10000TL-10 / 12000TL-10 / 15000TL-10 / 17000TL-10	x**	x**
STP 15000TLEE-10 / 20000TLEE-10	x**	x**

*In backup system S, SI 2012/2224: can be used from production series May 2005

**Can be used only in three-phase off-grid systems and three-phase backup systems

Sizing:

In **off-grid systems**, the nominal AC power of the PV inverter may not exceed twice the size of the nominal AC power of the off-grid inverter.

In **backup systems**, the maximum AC power of the PV inverter is limited by the Automatic Switch Box (AS-BOX).

The following table shows the nominal PV inverter power that can be connected to the corresponding AS-BOX:

Automatic Switch Box type	Nominal AC power of PV inverter
AS-BOX-S	4.6 kW at 25°C
AS-BOX-M	5.7 kW at 25°C
AS-BOX-M-20	5.7 kW at 35°C
AS-BOX-L	30 kW at 25°C
AS-BOX-L-20	28 kW at 35°C
AS-BOX-XL	110 kW at 25°C

SUNNY BACKUP-SYSTEM S

Connect no more than two PV inverters with one AS-BOX-S!

SUNNY BACKUP-SYSTEM XL

In a Sunny Backup System XL, the nominal AC power of the PV inverter may not exceed twice the size of the total nominal AC power of the backup inverter.

2 Setting to Stand-alone Grid Operation

DEFAULT SETTING

You can order all PV inverters with preset off-grid/backup parameters from SMA Solar Technology.

ACCESS PERMISSION

To change the grid-relevant parameters in the PV inverter, you need a special access permission, the SMA Grid Guard Code. To obtain this personal code, contact the SMA Service Line at the phone number +49 561 9522 399 or by e-mail at SunnyIsland.Service@SMA.de.

You will need one of the following communication devices in order to set the parameters of the PV inverter:

- Sunny Boy Control
- Sunny WebBox
- PC/laptop with Sunny Data/Sunny Data Control software and a service cable for data transmission (SMA order number: "USBPBS-11" USB service interface)
- PC/Laptop with SMA *Bluetooth*® Wireless Technology and Sunny Explorer software for PV inverters with a *Bluetooth* interface

WARNING

Danger to life due to electric shock

If the power distribution grid fails, there is a risk of backfeed in PV inverters which are configured for stand-alone grid operation.

- Only operate PV inverters configured for stand-alone grid operation in off-grid systems or backup systems.
- Comply with all local standards and guidelines applicable to off-grid systems and backup systems.
- Coordinate the parameter settings for PV inverters and off-grid inverters or backup inverters with the respective grid operator.

Set the parameters in accordance with the respective user manual of the device or software. Here, special requirements are applicable to PV inverters that are to be integrated into backup systems in Germany (see section 3 "PV inverter for backup systems in Germany" (page 9)).

2.1 Setting up the PV inverter SB xxxxTL-20 / SB xxxxTL-21 / SB xxxxTLST-21 / STP xxxxxTL-10 / STP xxxxxTLEE-10

This section describes how to set the following PV inverter types:

- SB 2500TLST-21 / 3000TLST-21
- SB 3000TL-20 / 4000TL-20 / 5000TL-20
- SB 3000TL-21 / 3600TL-21 / 4000TL-21 / 5000TL-21
- STP 8000TL-10 / 10000TL-10 / 12000TL-10 / 15000TL-10 /17000TL-10
- STP 15000TLEE-10 / 20000TLEE-10

Requirements for using PV inverters

The PV inverters must be equipped with the firmware version given in the table or higher. If this is not the case, perform a firmware update.

PV inverters	Firmware version
SB 2500TLST-21 / 3000TLST-21	2.10.25.R
SB 3000TL-20 / 4000TL-20 / 5000TL-20	3.10
SB 3000TL-21 / 3600TL-21 / 4000TL-21 / 5000TL-21	2.10.14.R
STP 8000TL-10 / 10000TL-10 / 12000TL-10 / 15000TL-10 / 17000TL-10	02.22.17
STP 15000TLEE-10 / 20000TLEE-10	2.10.11.R

Installation guide of the PV inverter

You will find instructions on how to set the aforementioned PV inverters in the supplied installation guide (see installation guide of the PV inverter in use at www.SMA-Solar.com).

2.2 Setting up PV inverters SB xxxxTL /SB xxxxTL HC / SB xxxxTL Multi-String / SB 5000TLW Multi-String for backup systems

This section describes how to set the following PV inverter types:

- SB 3300TL / 3300TL HC / SB 4200TL HC / SB 5000TL HC
- SB 4200TL Multi-String / 5000TL Multi-String
- SB 5000TLW Multi-String

Manually set the inverter types to back-up operation. For this, you need the SMA Grid Guard Code.

Set the parameters given in the table below to the specified values.

No.	Parameters	Unit	Value
1	I-NiTest	mA	Off (MSD = 0)
4	Fac-delta– Lower range in which the Sunny Boy is active, relative to f_0	Hz	–4.5 (starting from the base frequency f_0)
5	Fac-delta + Upper range in which the Sunny Boy is active relative to f_0	Hz	+1.5 (starting from the base frequency f_0)
6	dFac-Max Max. rate of change	Hz/s	4

2.3 Setting further PV inverter types

This section describes how to set the following PV inverter types:

- SB 700
- SB 1100 / 1200 / 1700
- SB 1100LV
- SB 1300TL-10 / SB 1600TL-10 / SB 2100TL
- SB 2400
- SB 2500
- SB 2800i
- SB 3000
- SB 3300
- SB 3800
- SMC 4600A / 5000A / 6000A
- SMC 5000 / 6000
- SMC 7000HV / 7000HV-11
- SMC 6000TL / 7000TL / 8000TL
- SMC 9000TL / 10000TL / 11000TL
- SMC 9000TLRP-10 / 10000TLRP-10 / 11000TLRP-10
- SWR 700 / 850(E) / 1100E
- SWR 1100LV
- SWR 1500
- SWR 1700(E)
- SWR 2000
- SWR 2500 / 3000

These inverter types can be changed to off-grid/backup operation by setting the "Default" parameter to "OFF-Grid". For this, you need the SMA Grid Guard Code.

The PV inverters SB 1300TL-10 / SB 1600TL-10 / SB 2100TL must be equipped with firmware version 4.22 or higher. If this is not the case, perform a firmware update.

The "OFF-Grid" parameter setting automatically sets the Sunny Boy parameters to the values listed in the following table:

No.	Parameters	Unit	Value
1	I-NiTest	mA	Off (MSD = 0)
2	Uac-Min	V	180
3	Uac-Max	V	260
4	Fac-delta– Lower range in which the Sunny Boy is active, relative to f_0	Hz	–4.5 (starting from the base frequency f_0)
5	Fac-delta + Upper range in which the Sunny Boy is active relative to f_0	Hz	+4.5 (starting from the base frequency f_0)
6	dFac-Max Max. rate of change	Hz/s	4
7	Fac-start delta Frequency increase relative to f_0, at which point the power adjustment via frequency begins.	Hz	1 (starting from the base frequency f_0)
8	Fac-limit delta Frequency increase relative to f_0, at which point the power adjustment via frequency ends. The output power of the Sunny Boy at this point is 0 W.	Hz	2 (starting from the base frequency f_0)

3 PV inverter for backup systems in Germany

When integrating PV inverters in backup systems in accordance with the directive VDE-AR-N 4105 applicable in Germany, there are 2 differing cases to be aware of:

- Backup systems with PV plants that were commissioned on or before 2011-12-31
- Backup systems with PV plants that were commissioned on or after 2012-01-01

Setting PV inverters that were installed on or before 2011-12-31

PV plants commissioned on or before 2011-12-31 must not satisfy the requirements of the VDE-AR-N 4105 directive. Set the country data set of the PV inverters to "OFF-Grid" (see section 2 "Setting to Stand-alone Grid Operation" (page 4)).

If the PV inverter is suitable for use in backup systems without limitations according to VDE-AR-N 4105 and is already set to the country data set for the VDE-AR-N 4105 directive, you can leave this country data set in place. You will find a list of PV inverters suitable for use in backup systems without limitations according to VDE-AR-N 4105 in the technical description "Anpassungen für VDE-Richtlinie VDE-AR-N 4105 für Sunny Backup 5000 / 2200" at www.SMA-Solar.com.

Setting PV inverters that were installed on or after 2012-01-01

PV plants commissioned on or after 2012-01-01 must satisfy the requirements of the VDE-AR-N 4105 directive. The PV inverters must remain set to the country data set "VDE-AR-N-4105", "VDE-AR-N-4105-MP" or "VDE-AR-N-4105-HP". The PV inverters may not be set to "OFF-Grid".

Currently, not all SMA Solar Technology AG PV inverters can work in a backup system with the country data set for the VDE-AR-N 4105 directive without the following limitations: An electricity grid black-out can lead to the inverter feeding-in only limited current during the black-out.

You will find a list of PV inverters that function without these limitations in the technical description "Anpassungen für VDE-Richtlinie VDE-AR-N 4105 für Sunny Backup 5000 / 2200" at www.SMA-Solar.com.

4 Frequency Shift Power Control (FSPC)

If PV inverters are connected to the AC side in off-grid/backup operation, the off-grid/backup inverter must be able to limit their output power. This kind of situation arises, for example, when the battery of the off-grid/backup inverter is fully charged and the (solar) power available from the PV plant exceeds the power required by the connected loads.

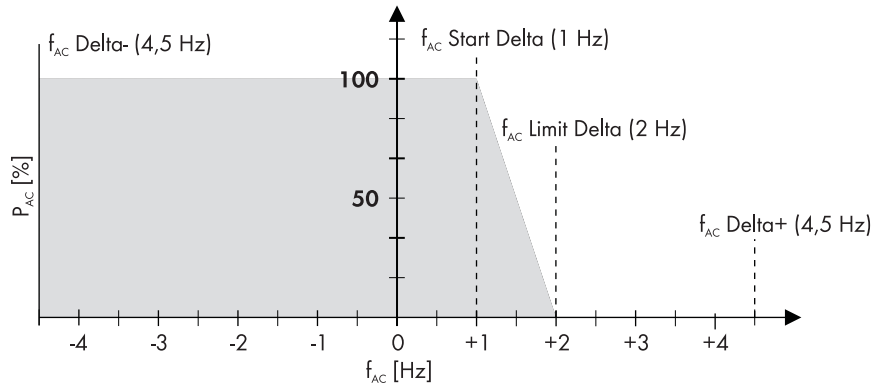
In order to prevent the excess energy from overcharging the battery, the off-grid/backup inverter detects this situation and changes the frequency at the AC output. This frequency change is analyzed by the PV inverter. As soon as the power frequency increases beyond the value specified by "f_{AC} Start Delta", the PV inverter limits its output power accordingly.

NO FREQUENCY CONTROL

The inverter types SB 2100TL / SB 3300TL / SB 3300TL HC / SB 4200TL Multi-String /SB 4200TL HC / SB 5000TL Multi-String / SB 5000TL HC / SB 5000TLW Multi-String as well as older models from the SWR production series **do not support** Frequency Shift Power Control.

If the present battery voltage (V_{Batt}) is greater than the nominal battery voltage ($V_{Batt\ soll}$), the affected Sunny Boys disconnect from the existing stand-alone grid/backup grid. They cannot reconnect until the battery has been discharged by at least 5%.

This function is shown in the following figure:



The data in the above figure have the following meanings:

- f_{AC} refers to the base frequency of the stand-alone grid (here 50 Hz).
- f_{AC} Delta– and f_{AC} Delta+ relative to f_{AC} refers to the maximum range in which the PV inverter is active.
- f_{AC} Start Delta refers to the frequency increase relative to f_{AC}, at which point the power adjustment via frequency begins.
- f_{AC} Limit Delta refers to the frequency increase relative to f_0, at which point the power adjustment via frequency ends. The output power of the PV inverter at this point is 0 W.

If the value falls below f_{AC} Delta– or exceeds f_{AC} Delta+, the PV inverters disconnect from the off-grid/backup system.

FREQUENCY CONTROL OF THE PV INVERTERS

The off-grid/backup inverter increases the frequency momentarily when it needs to synchronize itself to the power distribution grid and the present battery voltage (V_{Batt}) is greater than the nominal battery voltage ($V_{Batt\ soll}$).

In this way, it disconnects the PV inverter via this frequency control (overfrequency) and then synchronizes itself to the external source.

The PV inverters reconnect automatically as soon as the power frequency falls within the limiting values again.

When Frequency Shift Power Control is activated and the diesel generator in the off-grid/backup grid is in operation, the diesel generator determines the frequency, and the PV inverters react to certain changes in the diesel generator frequency. In most cases, diesel generators operate at 50 Hz when operating under load. For this reason, in most cases the PV inverters will deliver their entire power to the stand-alone grid/backup grid, even when the generator is in operation.