Wind power inverter

Windy Boy 3000-US/3800-US/4000-US

Addendum operating requirements

1 Notes on this addendum

1.1 Validity

This addendum does not replace the attached Sunny Boy installation guide.

- Pay attention to all operation and safety instructions listed in the Sunny Boy installation guide.
- The Sunny Boy installation guide is delivered with the Windy Boy inverter.

This addendum describes necessary confingurations for operating a Windy Boy in combination with a small wind turbine system.

This addendum is valid for the following Sunny Boy installation guides:

- Sunny Boy 3000-US
- Sunny Boy 3800-US
- Sunny Boy 4000-US

The listed types of inverters are referred to in the following as Windy Boy.

1.2 Target group

This addendum is for qualified personnel. Qualified personnel have received training and have demonstrated skills and knowledge in the construction and operation of this device. Qualified personnel are trained to deal with the dangers and hazards involved in installing electric devices.

1.3 Appropriate usage

Use the Windy Boy only in combination with a small wind turbine system having a permanet magnet generator.

Do not operate the Windy Boy without using a rectifier with overvoltage protection like the Windy Boy Protection Box.

Do not use the Windy Boy for purposes other than those described here. Alternative uses, modifications to the Windy Boy or the installation of components not expressly recommended or sold by the manufacturer void the warranty claims and operation permission.

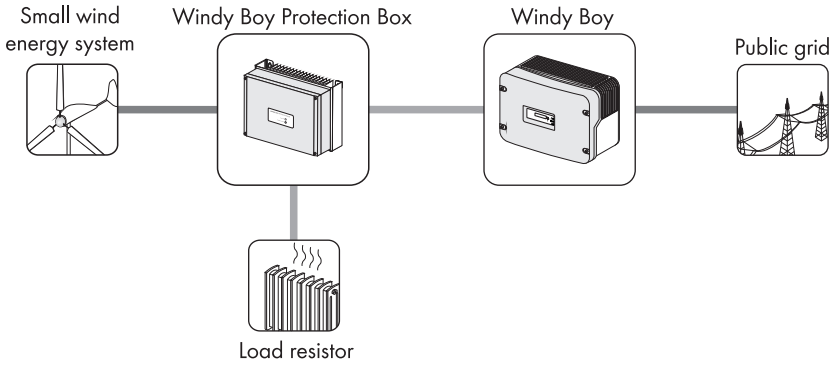


Figure 1: Concept of a wind turbine system using this Windy Boy

When designing the wind turbine system, ensure that the values comply with the permitted operating range of all components at all times.

The manufacturer of the wind turbine must have approved the turbine for use with the Windy Boy.

2 Electrical connection

2.1 Safety precautions

⚠ DANGER

Risk of electric shock due to high voltages inside the Windy Boy.

Death or serious injuries will result.

- All work on the Windy Boy must only be carried out by qualified personnel.
- All work on the Windy Boy must only be done as described in this manual.
- Pay attention to all safety instructions.

NOTICE

Electrostatic discharges possible when components are touched.

Damage to components will result.

- Follow ESD protective provisions.
- Remove existing electrostatic charges by touching a grounded metal surface (e.g. housing).

2.2 Load disconnection unit

⚠ DANGER

Risk of electric shock due to missing protective function on the line circuit breaker.

Death or serious burn injury will result.

When a generator and a consumer are connected to the same line circuit breaker, the line circuit breaker loses its protective function. The current from the inverter and the grid can add up to overcurrent which is not detected by the line circuit breaker.

- Never connect loads between the inverter and the line circuit breaker without protection.
- Always install separate fuses for loads.

NOTICE

A screw type fuse element, e.g. D system (Diazed) or D0 system (Neozed) is **not** a circuit breaker, and thus must **not** be used as a load disconnection unit. When disconnecting under load, the fuse element may be damaged or its functionality may be impaired by contact burning. It only acts as cable protection.

- Use only line circuit breakers as load disconnection units!

Detailed information

Detailed information and sample designs of a line circuit breaker can be found in the Technical Information "Line circuit breaker" in the download section of www.SMA-America.com.

2.3 Connecting the turbine to the rectifier

NOTICE

Destruction of the inverter by overvoltage.

If the voltage of the small wind turbine system exceeds the maximum input voltage of the inverter, it can be destroyed by the overvoltage. All warranty claims become void.

- Install overvoltage protection, e.g. Windy Boy Protection Box, between the small wind turbine system and the inverter.

For proper connection refer to the installion guides of the wind turbine system and the attached Sunny Boy installation guide.

2.4 Connecting the rectifier to the Windy Boy

For proper connection refer to the attached installion guide of the Sunny Boy and the rectifier.

3 Turbine operation

The Windy Boy is a single phase inverter that converts DC current into AC current and feeds the energy generated by a wind turbine system into an existing power supply system.

The Windy Boy inverter has a special operating mode for wind generators (see figure below). That allows performance adjustment to the characteristic curves for generators of many different manufacturers. In this way maximum yields can be obtained from your wind turbine system.

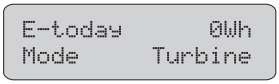


Figure 2: Display operation mode

The mechanical power of the wind turbine is delivered to the Windy Boy in the form of a direct, rotational-speed variable DC voltage (RPM) and current intensity (torque).

Most small wind turbine systems have a permanent magnet generator. For converting the variable frequency AC generator voltage into DC current a rectifier like the Windy Boy Protection Box is needed.

If a different operation mode is displayed:

- Activate the operating mode "Turbine" by using Sunny Data Control.
- If problems occur contact the SMA Serviceline.

3.1 Polynomial characteristic curve

The operation mode "Turbine" of the inverter uses a programmable output characteristic curve (output and voltage curve) to regulate the input current depending on the generator voltage.

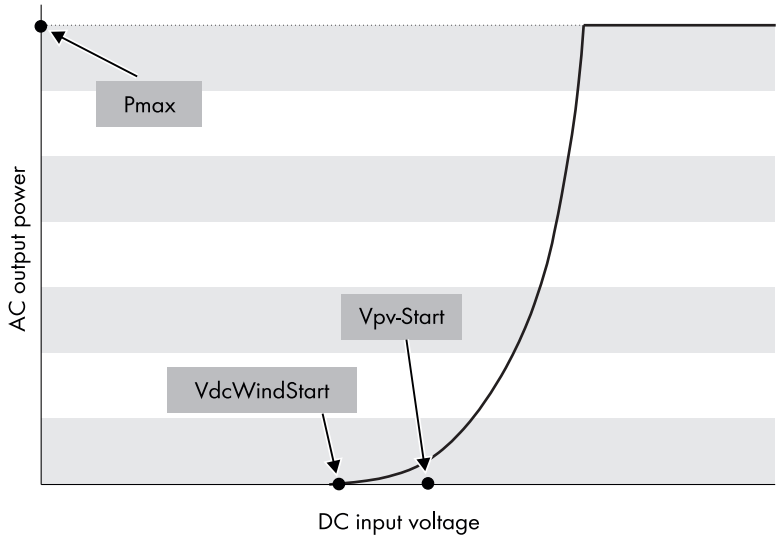
The polynomial characteristic curve is a programmable power curve depending on the DC input voltage. By adapting the default polynomial characteristic curve to the small wind turbine system being used, you can optimize the energy output of the small wind turbine system.

To optimally adapt the polynomial characteristic curve of the inverter to the wind turbine system being used, you can change the following parameters on the PC with the Windy Boy Setup Tool version 1.0.6 or Sunny Data Control (www.SMA-America.com). Before changing the curve parameters, consult the manufacturer of the wind turbine system for its typical characteristics:

Parameter	Description
Vpv-Start	This value defines the grid connection voltage. As soon as the DC input voltage of the inverter reaches the voltage set here, the grid monitoring of the inverter starts up. When this occurs, the inverter carries out various self-tests, measurement processes and grid synchronization. When the tests are successfully completed and the DC input voltage for the time "T-Start" rises above "Vpv-Start", the inverter connects to the grid.
VdcWindStart	This value defines the starting point of the output characteristic curve. When the DC input voltage reaches this value after grid synchronization, the inverter using the output characteristic curve, starts with the load of the wind turbine and feeds into the grid.
Wind_a_0	This value serves to internally calculate the output characteristic curve. By the following formula: $P(U)= a_0 + a_1 \times U + a_2 \times U^2 + a_3 \times U^3$
Wind_a_1	
Wind_a_2	
Wind_a_3	
Pmax	This value defines the maximum AC output power of the inverter. The inverter feeds the maximum power that has been set here into the grid. Should the wind turbine system however produce more power than "Pmax", this surplus power must be purged accordingly. Otherwise, there is a risk that the inverter will be damaged by overvoltage.
P-Wind-Ramp	This value defines the target startup of the wind turbine system. Only after connecting the inverter to the grid, the wind turbine system is not rapidly charged but using a configurable ramp.
KP-Wind-Ramp	This value defines the control speed of the power characteristic curve. The inverter reacts to changes in the DC input voltage by adjusting its output power using the power characteristic curve. The higher this parameter is set, the larger the power jump in response to the changes in the DC input voltage. Values that are too high lead to vacillations and instability in the system. Values that are too low delay the optimal load of the turbine and thereby reduce the yield.

Parameter	Description
KI-Wind-Ramp	This value defines the control speed of the power characteristic curve. The inverter reacts to changes in the DC input voltage by adjusting its output power using the power characteristic curve. The higher this parameter is set, the quicker the inverter regulates the output difference in response to changes in DC input voltage. Values that are too high lead to vacillations and instability in the system. Values that are too low delay the optimal load of the turbine and thereby reduce the optimal yield.
T-Stop	This value defines the time in which the inverter remains connected to the grid despite low input voltage. When the DC input voltage exceeds the minimum DC voltage, the inverter remains on the grid for the time "T-Stop" , but does not feed in any power. During this time, it receives its own power from the AC grid. When the DC input voltage exceeds the minimum DC input voltage in that time, the inverter feeds the power directly into the grid. No grid synchronization is required.
T-Start	This value defines the waiting time of the inverter, before it connects to the grid. When the tests are successfully completed and the DC input voltage rises above the configured time "Vpv-Start", the inverter connects to the grid. This value is prescribed by country-specific standards and may only be changed with the permission of SMA Solar Technology.

The inverter regulates its output power according to the generator voltage. The following illustration shows the function of a typical polynomial characteristic curve. Here, the fed-in AC power is shown according to the DC input voltage of the inverter.



3.2 Characteristic curve operation

Characteristic curve operation

The characteristic curve of the Windy Boy only approximates the actual characteristics of a real small wind energy system. Consult the manufacturer of your wind generator for its typical characteristics before changing the curve parameters.

Startup Procedure

If the inverter has enough voltage and power, the startup process is displayed by means of simultaneous lighting of the three LEDs on the inverter.

As soon as the DC input voltage defined in the parameter "Vpv-Start" is reached, the inverter starts a number of self-tests and measurement processes and synchronizes with the grid. This operating mode is indicated by means of the green LED blinking on the inverter.

When the tests are successfully completed and the DC input voltage is above "Vpv-Start", for the time configured in "T-Start", the inverter connects to the grid and the green LED lights up. The inverter then switches to characteristic curve operation, and regulates the input current according to the generator voltage.

Characteristic Curve Operation

After the startup procedure, the inverter switches to characteristic curve operation, and regulates the input current according to the generator voltage.

The inverter then begins to put a load on the wind turbine system and then according to the present input voltage, takes power from the wind turbine system and feeds it into the grid. The maximum power corresponds to the maximum AC power of the inverter. However, it can be reduced using the "Pmax" parameter.

Shutdown Procedure

If the wind strength is so low that the DC input voltage falls below the minimum voltage of the operating range „Turbine Mode“, the inverter ceases feeding power into the mains grid for the period defined in "T-Stop". When the DC input voltage increases again, the inverter switches back to characteristic curve operation.

If the DC input voltage for the time set in "T-Stop" falls below the minimum voltage of the operating range „Turbine Mode“, the inverter will switch off.

If the DC input voltage is no longer sufficient to supply the on-board electronics with power, the inverter deactivates immediately.

3.3 Changing the power characteristic curve

⚠ DANGER

The USB service interface can only be used by opening the Windy Boy.

- Observe the safety instructions in the operating and installation manuals for your Windy Boy.

Requirement the power characteristic curve

In order to configure the Windy Boy, a DC input voltage - the minimum open-circuit voltage for activating the operating mode "Turbine" - is needed. In addition, the Windy Boy must be connected to the grid voltage.

Not suitable for permanent installation

Once you have finished setting the parameters, the service interface must be removed and the Windy Boy must be closed. The connection is therefore not suitable for permanent installation.

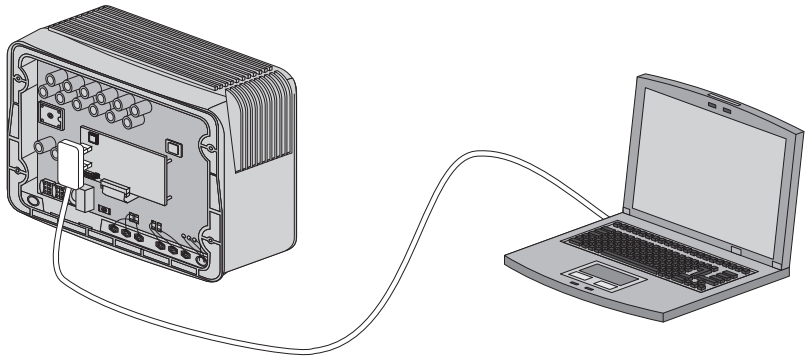
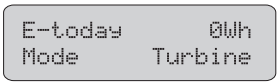


Figure 3: Connection to PC (example)

Ensure that the operating mode "Turbine" is activated.



In addition to the communications possibilities described in the attached Sunny Boy installation guide, you can also implement a simple parameter setting using an optional "USB service interface". This special cable allows communication between a PC and a single Windy Boy.

You need to install the Windy Boy Setup Tool version 1.0.6 or Sunny Data Control software on your PC, which is available from the download area at www.SMA-America.com. The Windy Boy Setup Tool and the Sunny Data Control software are PC programs for direct monitoring and configuration of your Windy Boy, which also allow visualization and logging of various system parameters.

4 Commissioning

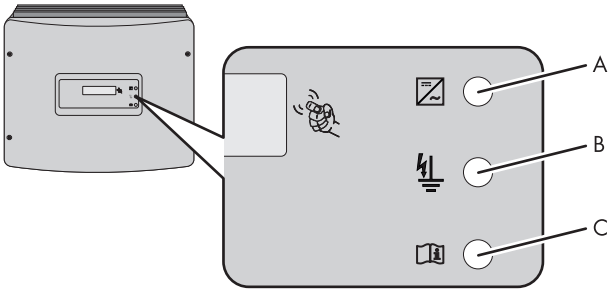


Figure 4: Display and LED

Object	Description	Explanation
A	Green LED	Operation
B	Red LED	Ground fault
C	Yellow LED	Disturbance

1. Check the following requirements before commissioning:
   - Correct mounting and correct connection of the inverter.
   - Correct layout of the line circuit breaker.
   - Correct grounding of the small wind turbine system according to the manufacturer's instructions.
   - Rectifier and overvoltage protection (e.g. Windy Boy Protection Box) between the small wind turbine system and the inverter have been installed.
2. Commission the small wind turbine system according to the instructions of the manufacturer.
   ☑ The green LED glows or blinks: commissioning has been successful.

   or

   ☑ The red or yellow LED glows or blinks: an error has occurred.