Wind power inverter
WINDY BOY 5000-US/6000-US
WINDY BOY 7000-US/8000-US

Addendum operating requirements

1 Notes on this addendum

1.1 Validity

[i] **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 5000-US
- Sunny Boy 6000-US
- Sunny Boy 7000-US
- Sunny Boy 8000-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.
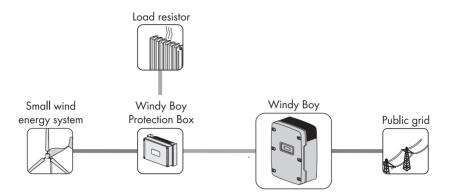
Figure 1:   Concept of a wind turbine system using this Windy Boy

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!

ℹ 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.

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E-today        0Wh
Mode       Turbine
```

Figure 2:   Operation mode display

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.

> **i**   **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 Characteristic curve function

The "Turbine" operating mode of the Windy Boy uses a programmable characteristic curve to regulate the input current depending on the generator voltage.

A characteristic of wind turbine systems is that for every rotational/wind speed there is a different optimal working point for voltage and current. This behavior is not linear.

The Windy Boy approaches this non-linearity using an approximation composed of a number of connected linear functions. These can be programmed by the user to correspond closely to the behavior of the small wind turbine system and thus provide performance adaptability.

The following illustration shows the connected linear functions of a typical characteristic curve for the Windy Boy. It shows feed-in AC power of the Windy Boy as a dependent variable of the DC input voltage. The adjustable parameters "Vpv-Start", "VdcWindStart" and "VdcWindMid", "VdcWindMax" and "Pmax" are used to adapt the power/voltage curve of the Windy Boy to the particular wind turbine system.

> [i] **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.
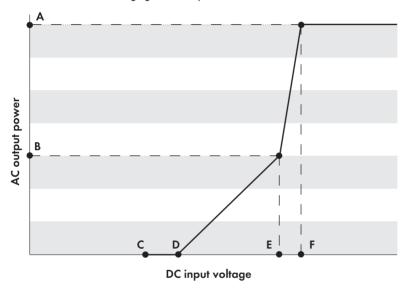

Figure 3:   Characteristic curve function

Position	Description
A	Pmax
B	P-Wind-Mid
C	Vpv-Start
D	VdcWindStart
E	VdcWindMid
F	VdcWindMax

The correct configuration of the parameters shown in the diagram is absolutely necessary to guarantee optimal performance with wind generators from different manufacturers.

The Windy Boy also has a soft-start parameter "P-Wind-Ramp". This parameter protects the mechanical components of your wind turbine system and thus contributes to a longer system life.

Other adjustments are possible to optimize the maximum performance of the Windy Boy with a particular small wind turbine system, by adjusting the regulation speed and also by setting the switch-off and switch-on times ("T-Stop", "T-Start").

3.2 Characteristic curve operation

> **i** **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.

Switch-on procedure

During the startup phase, the small wind energy system is running almost load-free. The Windy Boy only requires the power needed to supply the on-board electronics. If enough on-board power is available, this operating status is indicated by simultaneous lighting-up of the three light-emitting diodes (LEDs) on the cover.

As soon as the DC input voltage defined in the parameter "Vpv-Start" is reached, the Windy Boy begins a number of self tests, measurement processes and synchronizes with the grid. This status is indicated by a blinking green LED.

If the self tests are successfully completed, and the DC input voltage remains above the value defined in "Vpv-Start" for the time defined in "T-Start", the Windy Boy connects to the grid. This status is indicated by a continuosly lit green LED.

The inverter then switches into characteristic curve operation and regulates the input current based on the voltage of the wind turbine system. The power defined in the characteristic curve for the wind turbine system is thus fed into the grid. This status is indicated by a continuosly lit green LED.

Here you should be able to abserve that, as the inverter switches into characteristic curve operation, the small wind energy system is placed under load, i.e., the rotational speed and the DC input voltage should fall. The amount by which the input voltage decreases depends on the small wind energy system being used.

Characteristic curve operation

As soon as the DC input voltage reaches the value defined in "VdcWindStart", the Windy Boy begins feeding power into the grid. As you can see from the characteristic curve, the power fed into the grid rises with the DC input voltage.

As soon as the DC input voltage reaches the value defined by the parameter <UdcWindMid>, the output power corresponds to the value defined by <P-Wind-Mid>. If the voltage continues to increase, the power rises according to the voltage/power curve. To emulate the typical behavior of an actual wind turbine system, after <P-Wind-Mid> the curve is steeper than before <P-WindMid>.

As soon as the DC input voltage reaches the value defined in the parameter "VdcWindMax", the Windy Boy feeds the grid with the maximum possible power. If the input voltage continues to rise, the Windy Boy continues to feed the grid at maximum power. The maximum power reflects the maximum AC power of the Windy Boy, but this can be reduced using the "Pmax" parameter.

The characteristic curve ends at the maximum permissible input voltage of the Windy Boy, which must never be exceeded. Do not operate the Windy Boy without using a rectifier with overvoltage protection like the Windy Boy Protection Box.

Shutdown

If the wind strength is so low that the DC input voltage falls below the minimum voltage of the operating range „Turbine Mode", then theWindy Boy ceases feeding power into the grid for the period defined in "T-Stop".

If the DC input voltage increases again, then the "T-Stop" timer is deleted and the Windy Boy will operate according to the characteristic curve again.

If the DC input voltage remains below the minimum voltage of the operating range „Turbine Mode" for the time defined in "T-Stop" then the Windy Boy switches off.

If the DC input voltage is no longer sufficient to supply the on-board electronics, then the Windy Boy switches off immediately.

After the switch-off, the whole process begins anew.

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.

ℹ **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.

ℹ **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.
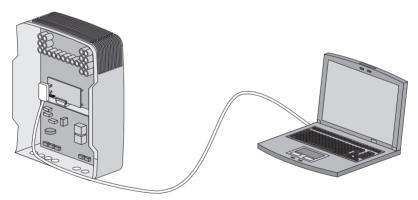

Figure 4:   Connection to PC (example)

Ensure that the operating mode "Turbine" is activated.

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E-today      0Wh
Mode     Turbine
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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 Sunny Data Control software on your PC, which is available from the download area at www.SMA-America.com. The Sunny Data Control software is a PC program for direct monitoring and configuration of your Windy Boy, which also allows visualization and logging of various system parameters.

3.3.1 General Example Settings

$\boxed{i}$ **The following example represents a starting point for the operation with a wind generator.**

Contact the manufacturer of your wind generator for information on its typical properties (voltage/power characteristic).

- "Vpv-Start" is set approximately to its minimum:

  This results in early activation of the Windy Boy.

- "VdcWindStart" is set to the lower limit of the Windy Boy's input voltage range:

  This results in early grid feeding.

- "P-Wind-Mid" is set to approximately $^1/_5$ of the Windy Boy's maximum AC power.

- "VdcWindMid" is set in the lower third of the voltage range between "VdcWindStart" and "VdcWindMax":

  The selection of this point divides the curve into a weak and a strong wind range, and is decisive for optimal adjustment of output according to your wind turbine. It is to be noted that the curve is flat in the weak wind range, and climbs more steeply in the strong wind range. The flat curve in the weak wind range prevents the wind turbine from "braking" due to excessive power extraction, and thus provides good startup properties.

  The steeper curve section causes a strong increase in power extraction upon higher DC input voltages. This behavior corresponds to typical wind turbine properties.

- "VdcWindMax" is set to the rated voltage of the turbine that has the maximum power:

  Once the properties of the wind turbine are known, reduction of the "VdcWindMax" parameter may be advisable, in order to extract the maximum power from the wind turbine even at low DC input voltages (low wind speeds). The second curve section then increases more steeply.

- "Pmax" is set to the wind turbine's maximum output power:

  This allows the Windy Boy's maximum AC power to be optimally adjusted to the wind turbine used. This prevents the generator from being overloaded by excessive power extraction.

- "T-Stop":

  "T-Stop" defines the deactivation delay, befor the Windy Boy disconects from the grid, if the DC input voltage is below the feed-in conditions.

- "T-Start":

  This shortens the period waited before activation (please observe the regulations of the local energy supplier).
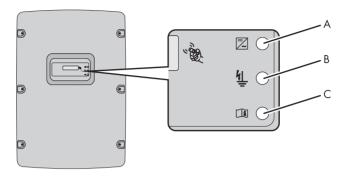
4   Commissioning

Figure 5:   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.

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