Windy Boy Protection Box

Overvoltage protection for small wind turbine systems

1 Contents

Small wind turbine systems are reliably connected to the power distribution grid or to an off-grid system via Windy Boy inverters. Windy Boy inverters operate with DC voltage on the input side, subsequently, the frequency-variable output voltage of the small wind turbine system first needs to be converted into DC voltage. In addition, in order to protect the electronics and the Windy Boy from becoming damaged, the physical properties of a small wind turbine system require overvoltage protection in the system. The following occurrences can possibly lead to overvoltage:

- Gusts of wind/storm
- Sudden relieving of the Windy Boy due to grid failure or grid synchronization
- Low energy demand in the off-grid system in case the wind energy supply is high

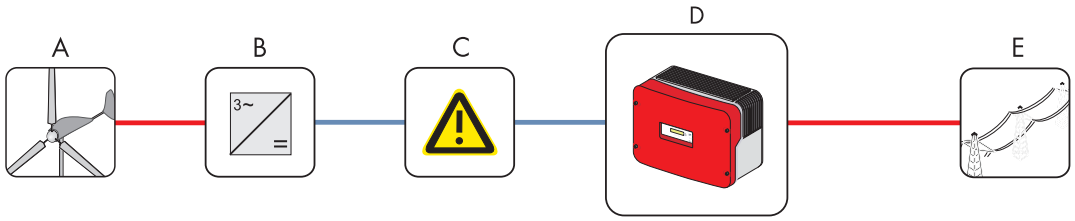
The Wind Boy Protection Box consists of a rectifier and the power electronics for protection against overvoltage. The Windy Boy Protection Box converts the variable AC voltage of a permanently excited synchronous generator of a small wind turbine system or of a water turbine into DC voltage with which it supplies the Windy Boy. The integrated overvoltage protection protects the Windy Boy's input from damages resulting from resonant voltage step-up.

In this document you will find specifications, recommended system constellations and application examples.

2 General Specification

2.1 Typical small wind turbine system

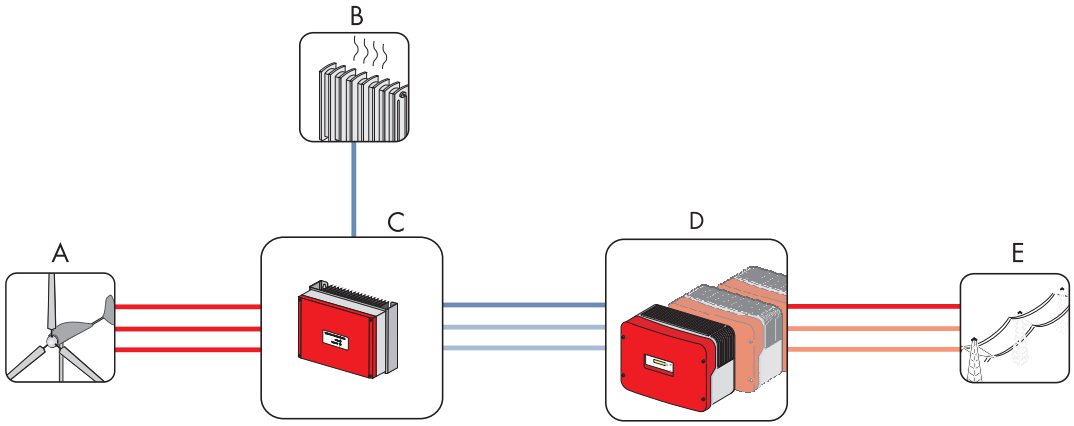
In general, a small wind turbine system in grid-parallel operation consists of the following components:



Position	Description
A	Small wind turbine system with permanent-magnet generator
B	Rectifier
C	Overvoltage Protection
D	Wind power inverter with turbine control
E	Utility Grid

2.2 Small Wind Turbine System with Components from SMA Solar Technology AG

The following pictures show the system configuration for a small wind turbine system with components from SMA Solar Technology AG:

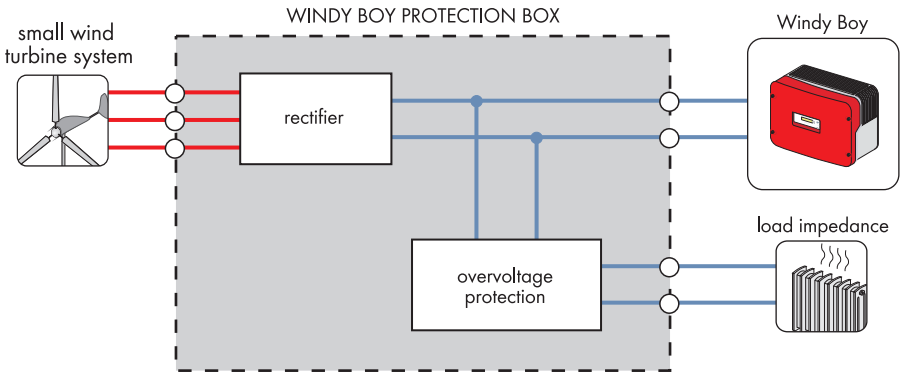


Position	Description	Function
A	Small wind turbine system	Converts the wind energy into electrical energy. Due to the variable speed of the rotor and the permanent excitation of the synchronous generator*, the AC output voltage is generally variable in terms of both frequency and amplitude. * Asynchronous generators are not suitable for operation with a Windy Boy and Windy Boy Protection Box
B	Windy Boy Protection Box	Converts the frequency-variable voltage of the small wind turbine into DC voltage and contains the electronics of the overvoltage protection. The Windy Boy functions only in combination with the load impedance. Without a load impedance, the system has no overvoltage protection.
C	Load Impedance	The load impedance is **absolutely necessary** for the loading of the small wind turbine system during overvoltage so as to reduce the speed and thus the overvoltage. The electronics of the Windy Boy Protection Box control the power flow to the resistor.
D	Windy Boy	Converts the DC voltage of the Windy Boy Protection Box into grid compliant AC voltage. The Windy Boy also includes an intelligent turbine controller for optimizing the energy yield.
E	Utility Grid	The Windy Boy feeds into the power distribution grid.

3 Product Details

The Windy Boy Protection Box is the interface between your small wind turbine system and the Windy Boy. It consists of two main components:

- Rectifier
- Intelligent overvoltage protection (requires external load impedance)

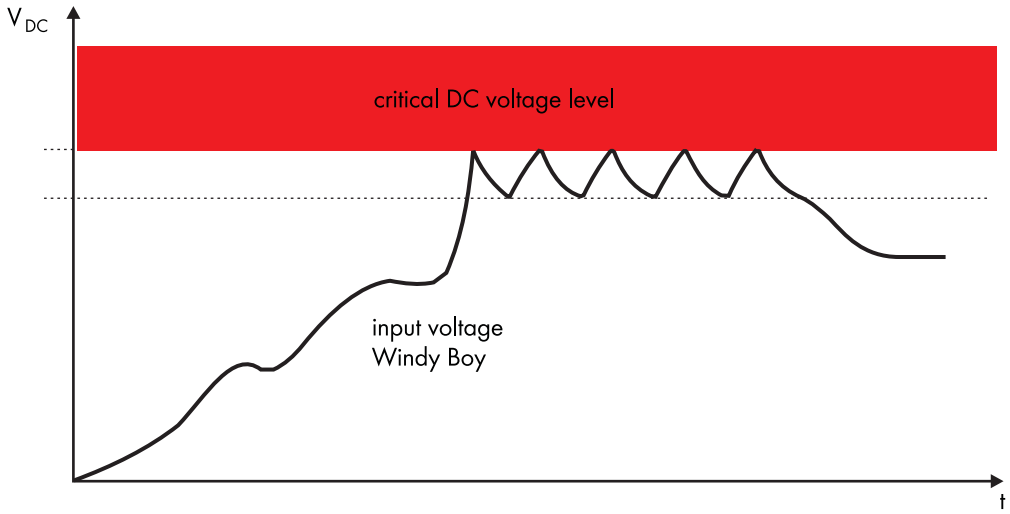


At first, a passive rectifier (B6 jumper) converts the frequency-variable AC voltage of the small wind turbine into DC voltage. The DC voltage is recorded by the installed measuring equipment. In the event a maximum DC voltage threshold is surpassed, the overvoltage protection is activated and the voltage is instantaneously limited.

3.1 Overvoltage Protection

If the Windy Boy reaches a critical input voltage level, the small wind turbine system will be additionally charged with the load impedance. The input voltage is immediately limited to the permissible value.

The load impedance is deactivated when the lower preset voltage value is reached again. If the voltage increases again, this process will be repeated. If the voltage decreases and generally remains below the critical threshold, the overvoltage protection remains inactive (see figure).



The voltage thresholds depend on the respective type of Windy Boy Protection Box. The input voltage of the Windy Boy inverters will be limited by connecting the load impedance.

- Windy Boy Protection Box 400 limited as of 360 V_{DC}
- Windy Boy Protection Box 500 limited as of 460 V_{DC}
- Windy Boy Protection Box 600 limited as of 560 V_{DC}

3.2 Load Impedance

A properly-sized load impedance which is connected to the Windy Boy Protection Box is indispensable for the functionality of the overvoltage protection. The load impedance serves as additional load of the small wind turbine system and converts the excess electrical energy into heat. The load impedance must be designed to handle a permanent load of the small wind turbine system. An optimally-adjusted load impedance can be ordered from SMA Solar Technology AG.

The load impedance is specifically adapted to the requirements of the overall system. Other resistors in form of fan heaters, heating elements, rotating loads are **not suitable** for the use with the Windy Boy Protection Box.

Destruction of the Windy Boy

In case an unsuitable load impedance is connected, the function of the overvoltage protecting is interfered, it is possible that the Windy Boy or the impedance load will be destroyed.

The load impedance must meet the following requirements:

- DC nominal voltage of 600 V.
- The resistance value at 25 °C surface temperature amounts to approx. 30 ohm.
- The resistance value at 80 °C surface temperature amounts to approx. 42 ohm.
- Continuous nominal power amounts to 7 000 W.

4 Application examples

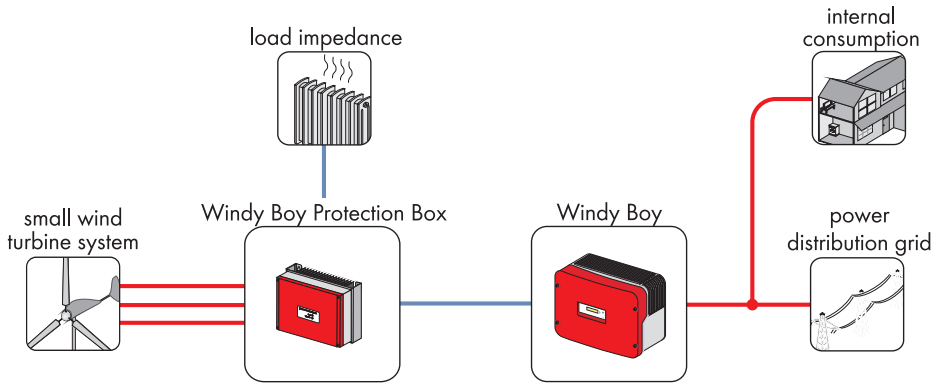
Deterioration of the energy yield

The compatibility of the small wind turbine system and the Windy Boy must be checked separately. It is essential to make sure that the DC output voltage of the small wind turbine system is compatible with the operational voltage of the Windy Boy.

Destruction of the Windy Boy Protection Box

As a matter of principle, the Windy Boy Protection Box must not be connected in parallel on the DC side!

4.1 Single-phase power supply line



In accordance with the figure illustrated above, the following constellation can be installed for the single-phase power supply line of a small wind turbine system:

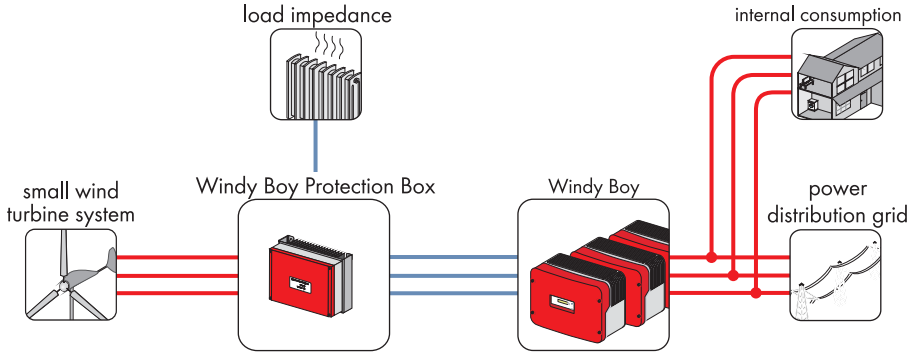
Small Wind Turbine - System	Windy Boy
1 x small wind turbine system (max. 3.5 kW) **1 x WBP-Box 400-11** 1 x load impedance	1 x Windy Boy 1200 or 1 x Windy Boy 1700
1 x small wind turbine system (max. 5 kW) **1 x WBP-Box 500-11** 1 x load impedance	1 x Windy Boy 3300 or 1 x Windy Boy 3800 or 1 x Windy Boy 3600TL or 1 x Windy Boy 5000TL
1 x small wind turbine system (max. 7 kW) **1 x WBP-Box 600-11** 1 x load impedance	1 x Windy Boy 2500 or 1 x Windy Boy 3000 or 1 x Windy Boy 5000A or 1 x Windy Boy 6000A

4.2 Two or three-phase power supply line

Three-phase connection of a small wind turbine system is either logical or mandatory for diverse grids, in different countries as well as for off-grid systems. The Windy Boy Protection Box offers the possibility to connect up to three Windy Boy inverters. If this is the case, the Windy Boy inverters can be operated in parallel.

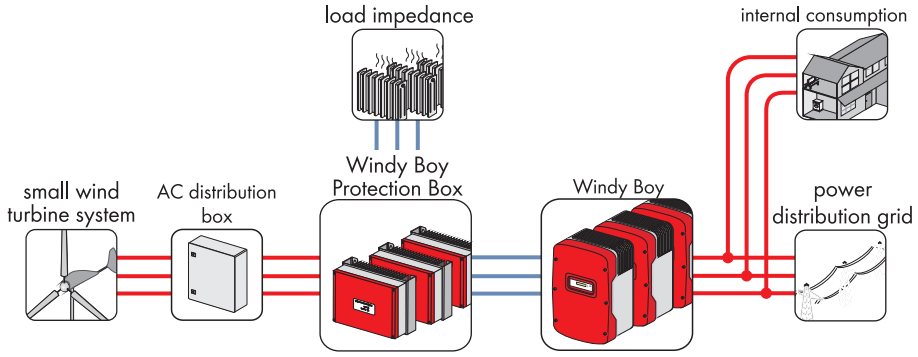
The following constellation can be installed for the three-phase power supply line of a small wind turbine system:

Small Wind Turbine System with an Output of up to 7 kW



Small Wind Turbine - System	Windy Boy
1 x small wind turbine system (max. 3.5 kW) **1 x WBP-Box 400-11** 1 x load impedance	3 x Windy Boy 1200 or 3 x Windy Boy 1700
1 x small wind turbine system (max. 5 kW) **1 x WBP-Box 500-11** 1 x load impedance	3 x Windy Boy 3300 or 3 x Windy Boy 3800
1 x small wind turbine system (max. 7 kW) **1 x WBP-Box 600-11** 1 x load impedance	3 x Windy Boy 2500 or 3 x Windy Boy 3000 or 3 x Windy Boy 5000A or 3 x Windy Boy 6000A

Small Wind Turbine System with an Output between 10 kW and 25 kW



As in the last section, possible constellations are illustrated for the three-phase power supply line of small wind turbine systems with a capacity exceeding 10 kW. It is possible to operate several Windy Box Protection Boxes in parallel.

In accordance with the figure illustrated above, the following constellation can be installed for the three-phase power supply line of a small wind turbine system:

Small Wind Turbine System (10 kW)

Small Wind Turbine - System	Windy Boy
1 x small wind turbine system (10 kW) **3 x WBP-Box 500-11** 3 x load impedance	3 x Windy Boy 3300 or 3 x Windy Boy 3800
1 x small wind turbine system (10 kW) **2 x WBP-Box 600-11** 2 x load resistors	2 x Windy Boy 5000A or 2 x Windy Boy 6000A

Small Wind Turbine System (15 kW)

Small Wind Turbine - System	Windy Boy
1 x small wind turbine system (15 kW) **3 x WBP-Box 600-11** 3 x load impedance	3 x Windy Boy 5000A or 3 x Windy Boy 6000A

Small Wind Turbine System (20 kW)

Small Wind Turbine - System	Windy Boy
1 x small wind turbine system (20 kW) **3 x WBP-Box 600-11** 3 x load impedance	4 x Windy Boy 5000A or 3 - 4 x Windy Boy 6000A

Small Wind Turbine System (25 kW)

Small Wind Turbine - System	Windy Boy
1 x small wind turbine system (25 kW) **4 x WBP-Box 600-11** 4 x load impedance	5 x Windy Boy 5000A or 4 - 5 x Windy Boy 6000A

5 Setting the Windy Boy

Since the Windy Boy Protection Box additionally charges the small wind turbine system with a load impedance after exceeding a certain preset DC voltage (see section 3.1) the Windy Boy must be configured accordingly. Greatest performance can be expected if the Windy Boy charges the small wind turbine system with maximum output before the switching voltage is reached. You need to adjust the following parameters of the Windy Boy:

- "Wind_a0" ... "Wind_a3" or

  "Power characteristic curves coefficient for Udc^0" ... "Power characteristic curves coefficient for Udc^3"

- "Pmax" or "Currently set active power limit"

Thermal Destruction of a Small Wind Turbine System

In case of a maximum voltage value of the polynomial characteristic "Pmax" may not exceed a maximum performance value recommended by the producer of the small wind turbine system. Too high Pmax values lead to excessive generator currents and destroy the generator. Please ask the producer and read the documentation of the small wind turbine system.

Setting of WBP-Box 400-11

"Wind_a0" ... "Wind_a3" or "Power characteristic curves coefficient for Udc^0" ... "Power characteristic curves coefficient for Udc^3"	Set the maximum voltage level of the polynomial characteristic curve below 360 V.
"Pmax" or "Currently set active power limit"	Setting the power provided by the small wind turbine at approx. 360 V. Take note of the manufacturer's recommendations.

Setting of the WBP-Box 500-11

"Wind_a0" ... "Wind_a3" or "Power characteristic curves coefficient for Udc^0" ... "Power characteristic curves coefficient for Udc^3"	Set the maximum voltage level of the polynomial characteristic curve below 460 V.
"Pmax" or "Currently set active power limit"	Setting the power, provided by the small wind turbine at approx 460 V. Take note of the manufacturer's recommendations.

Setting of the WBP-Box 600-11

"Wind_a0" ... "Wind_a3" or "Power characteristic curves coefficient for Udc^0" ... "Power characteristic curves coefficient for Udc^3"	Set the maximum voltage level of the polynomial characteristic curve below 560 V.
"Pmax" or "Currently set active power limit"	Setting the power, provided by the small wind turbine at approx 560 V. Take note of the manufacturer's recommendations.