Femtogrid Controller Box (Vestas VTC 25-002)

User Manual

Application:

Femtogrid Solar and/or Wind Optimizers in combination with DC Grid

òr AC Grid combined with non-Femtogrid inverter(s)

Contents

1. Explanation of the used symbols

For optimal use of this document we will start with the explanation of the symbols appearing in this User Manual of the Vestas VTC 25-002.

This symbol indicates a symbol.

This symbol indicates a remark that if ignored makes commissioning more difficult.

This symbol indicates a warning that if ignored may result in damage to components or possible danger for persons. Read these passages carefully.

2. Introduction

General

Thank you for purchasing this Femtogrid product and by doing so helping to make this earth greener by adding a solar and/or wind installation to our planet. Your solar or wind installation supplies energy directly suitable for a DC or an AC grid which in turn helps reducing CO_2 emission and stimulates us in our quest to switch from conventional fossil energy sources to renewable energy sources.

User group for this document

⚠️ **This product has to be installed by authorized installers. It is also necessary that the installer complies with the rules of the local grid administrator. It is strongly recommended that the installer reads this user manual carefully and keeps in mind all the safety measures, the technical connecting rules of the local grid administrator, and every other applicable rule.**

Femtogrid's solution for solar or wind installations (when using a stand-alone application of a DC grid or a stand-alone application of an AC grid together with a non-Femtogrid inverter):

Femtogrid's smart solution enhances performance, safety, reliabillity and utilization of solar and wind installations and is based on 4 (DC grid) or 5 (AC grid) component groups:

- PO310 Solar Optimizer (for each solar panel) or PO2500-UW002 Wind Optimizer (together with Safety Box) for a wind turbine (for example Anakata A018)
- Non-Femtogrid Inverter(s) when connecting to an AC grid
- VTC 25-002 Vestas Controller Box
- DC cables
- (Optional) Monitoring (wireless monitoring system) which consists of a Monitoring Box and a Monitoring Portal

Together with the solar panels (and/or the wind turbine), the fastening material, and the installation itself our system is a turnkey solution that through its innovative features has important benefits in comparison to traditionally built solar installations with the use of string architecture.

An example of an implementation on site is shown here.

3. Safety instructions

Installing Femtogrid systems

⚠️ **De installation of the % component groups (PO310 Solar Power Optimizers and/or PO2500-UW002 Wind Optimizer(s), non-Femtogrid inverter(s), VTC 25-002 Controller Box, DC cables and Monitoring Box) have to be done by authorized installers in agreement with the local and national rules (the regulations applying in the Netherlands are stated in NEN1010).**

Switching on the Controller Box

⚠️ **Do not connect the VTC 25-002 Vestas Controller Box to the power (230V AC of 400V DC) before <u>all</u> PO310 Power Optimizers (along with their solar panels) are connected in parallel and/or the PO2500-UW002 Wind Optimizer (together with the Safety Box) is connected. Voltages up to 400V can be present on the DC Grid. Do not touch the inside of the connectors.**

High voltages inside the system components

⚠️ **Do not open the PO310 Solar Power Optimizers, the PO2500-UW002 Wind Optimizer(s), the non-Femtogrid inverter(s) or the VTC 25-002 Controller Box. This is not necessary for the installation. In case of necessity it may only be done by authorized engineers. In some installations it is necessary to configure beforehand the VTC 25-002 Vestas Controller Box in Slave mode (at switched off local supply) by placement of the supplied jumpers. Only in that exceptional case it is necessary to open the Controller Box.**

Femtogrid DC bus safety warnings

⚠️ **If the Safety connection of the VTC 25-002 Vestas Controller Box(s) is disconnected all the power of the connected devices to the DC bus is switched off. In case the cables or the connectors are damaged there is a possibility to get an electrical shock.**

⚠️ **Place an endcap(s) on the non-used T-connector(s) of the DC bus cable. Otherwise penetrating water can cause your solar and/or wind installation to malfunction.**

4. Description of the purpose and working of the Controller Box

Overview:

All PO310 Solar Power Optimizers, Wind Power Optimizers and the Monitoring Box made by Femtogrid have ZigBee low power wireless communication possibilities. After the first commissioning of a solar and/or wind installation a wireless ZigBee network is being set up that makes it possible to pass through production data to the My Femtogrid portal. This monitoring of the installation enables the end user, the installer and Femtogrid to maximize both the uptime and the lifetime of the complete installation. The passing through of production data will have no influence on the electrical power generation of the solar or wind installation. For further details on how to set up a ZigBee network see the installation manual of the Monitoring Box or the manual of the Power Optimizers.

This Vestas Controller Box is used only as a necessary complement for systems using Femtogrid solar and/or wind optimizers in case Femtogrid inverters(s) are <u>not</u> being used. These Femtogrid inverters normally supply the Safety power for the other (Femtogrid) components which now has to be supplied by the Controller Box. The Vestas Controller Box has no ZigBee functionality built in and therefore there is no need or possibility to log into a network. The picture below gives an overview of the connections and indications of the Controller Box:
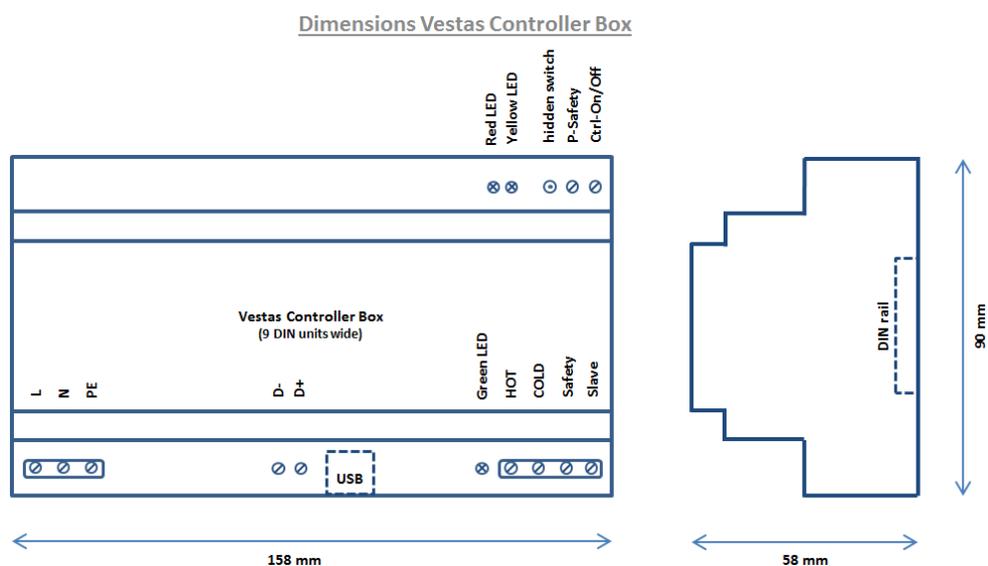
Visible are the 230VAC (L, N, PE) input connectors (front left) and the combined 48VDC output (Safety, Slave) / 400VDC sense (HOT) input connectors, all with reference to COLD, (bottom right), the control input connectors (P-Safety, Ctrl-On/Off) to be used in Slave mode (top right) and also the loop-through connectors (D-, D+) of the data lines of the USB connector (mid bottom). Also visible are three LEDs (green, yellow and red) and a hidden switch (accessible via the little hole next to the yellow LED by means of a little screwdriver or a suitable pin).

In this overview we only briefly discuss normal operation mode as is visible directly after powering on the Controller Box (configured as Master = default, meaning that both internal jumpers are not placed). See for more details the extended description which follows this. Initially the 48V Safety output voltage is being switched on and if after a short period of time the expected sensor input signals have become available (among others from the 400V DC bus but also from internal signals of

the Vestas itself) and have the right values than this output voltage remains present, which is visible from the green output LED that switches on (the yellow processor LED switches on simultaneously with the green one). The red indication LED stays off during default mode of operation. This is shown in the following time sequence diagram.

Start up events/ indications in Normal mode
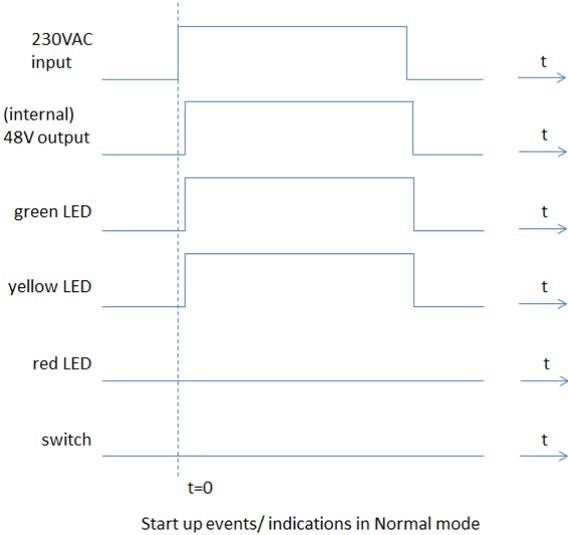
In depth description:

The Vestas Controller Box has several modes where it can be in: Normal mode versus Test mode (shorter sleep timing), Master mode versus Slave mode (or Permanent On mode), and finally Sleep mode. The actual mode will depend on the configuration of the two internal jumpers, the measured internal and external signals and the expired time in a certain condition that may occur within a mode. Master mode is the default configuration for stand-alone use and for the Master module in a larger Vestas system (see also the accompanying installation manual of the Vestas Controller Box VTC 25-002). This is the most extended mode which includes testing of certain signal conditions and signaling this via the yellow and red LED and also switching to Sleep mode when certain tested conditions are not being met (after this sleep period has ended it will retry to start up again). The Slave mode is only used for Slave module(s) in the larger Vestas systems. When in this Slave mode timing has no influence because the Slave only listens to the control by the Master. A voltage difference from as low as several Volts up to 48 VDC between the P_Safety and the Ctrl On/Off inputs is being used as control signal. The Vestas can also be configured as permanently 48VDC supply (Permanent On mode), in which case control signals and timing have no influence and the output will always be active as long as the supplying voltage at the input is present. To save energy the processor of the Vestas is most of the time in a so called 'sleep state' (this is not the same as the Sleep mode in the overall behavior of the Vestas) and wakes up shortly every 250 msec to be able to perform the necessary operations at that time. Following first is a description of the jumper setting, the hidden switch and the three LED's, after that further details about the operation of the Vestas will follow.

<u>Jumpers:</u>

For Master mode no jumpers have to be placed (this is the supplied state). For Slave mode only jumper 1 has to be set and jumper position 2 has to remain empty (control than takes place via the inputs P-Safety and Ctrl-On/Off). For the Permanent On mode (48V output always switched on independent of the state of the input signals or timing so if it were a regular 48VDC power supply) both jumper 1 and jumper 2 have to be set. The jumpers are separately packed within the packing of the Vestas.

JMP1=0, JMP2=0 : Master mode

JMP1=1, JMP2=0 : Slave mode

JMP1=1, JMP2=1 : Permanent On mode

<u>Hidden switch:</u>

If the Vestas in Master mode is in the Sleep mode and this hidden switch is being pressed for longer than 3/4 sec (but shorter than 10 sec) then an active state of the 48V output is enforced. If this switch is pressed for longer than 10 sec then a so called Power Cycle is started in which the 48V output is switched off and on 3 times in succession which causes the connected components with ZigBee-functionality to leave the ZigBee-network. This is sometimes necessary because ZigBee-components do not leave a network on their own accord once they are logged in.

If this switch is being pressed <u>during</u> the start up the Vestas will enter the Test mode instead of the Normal mode. The only difference is that the time period in Sleep mode is no longer the default 10 minutes but only 1 minute what can be handy during test runs to see if passing through the various steps is functioning properly.

Switch pressed > ¾ sec: 48VDC output enforced to on state

Switch pressed > 10 sec: Power Cycle on 48VDC output

Switch pressed < t=0 (pressed during start up): Test mode

<u>LED's:</u>

Green LED: switches on (hardwired) if the internal 48VDC signaal comes available at the output.

Yellow LED: default (no errors): switches on simultaneously with green LED (processor controlled)

      when error/indication condition exists flashing in specific rhythm:

            2x/sec: 400VDC bus error (voltage too low)

            4x/sec: external 48VDC error (externally enforced unwanted 48VDC)

            1x/8sec: Sleep mode (time period default 10 minutes)

Red LED: default: off

      continous on: Power Cycle (only during the Cycle itself)

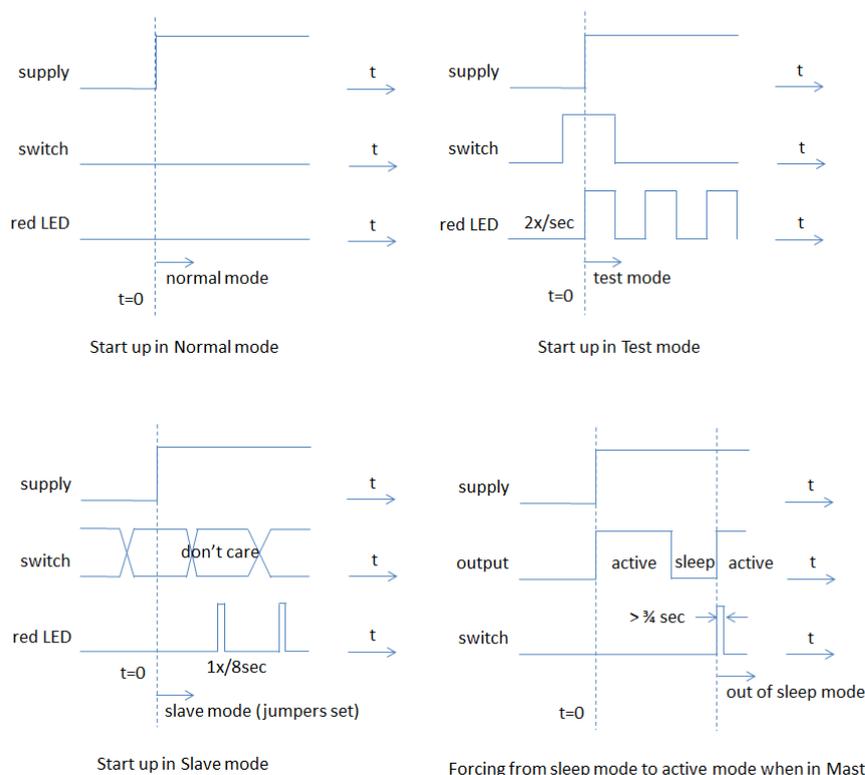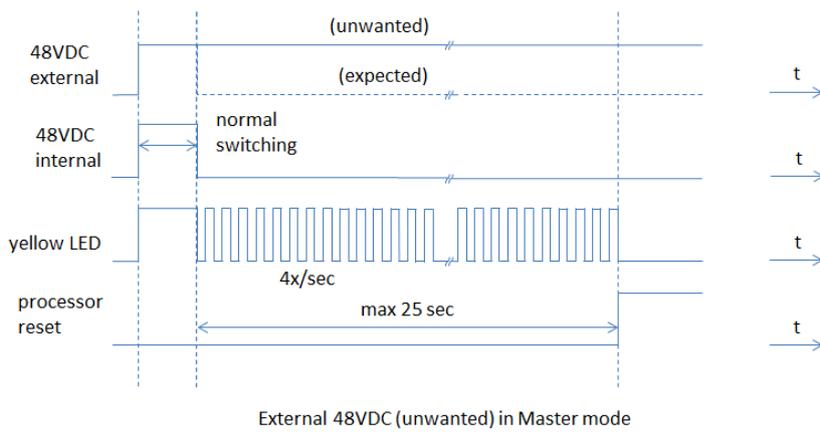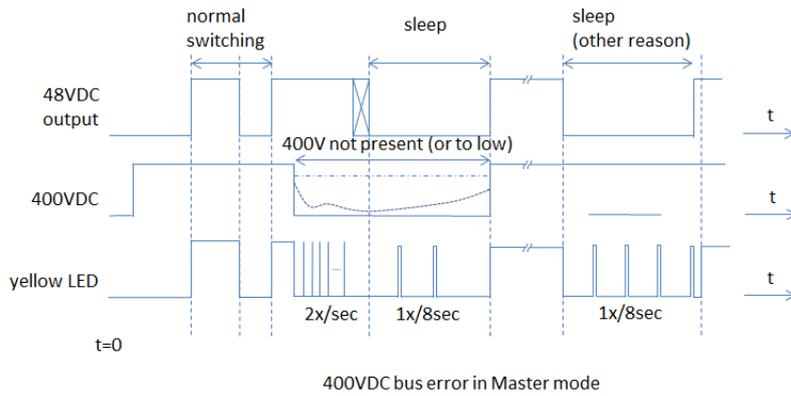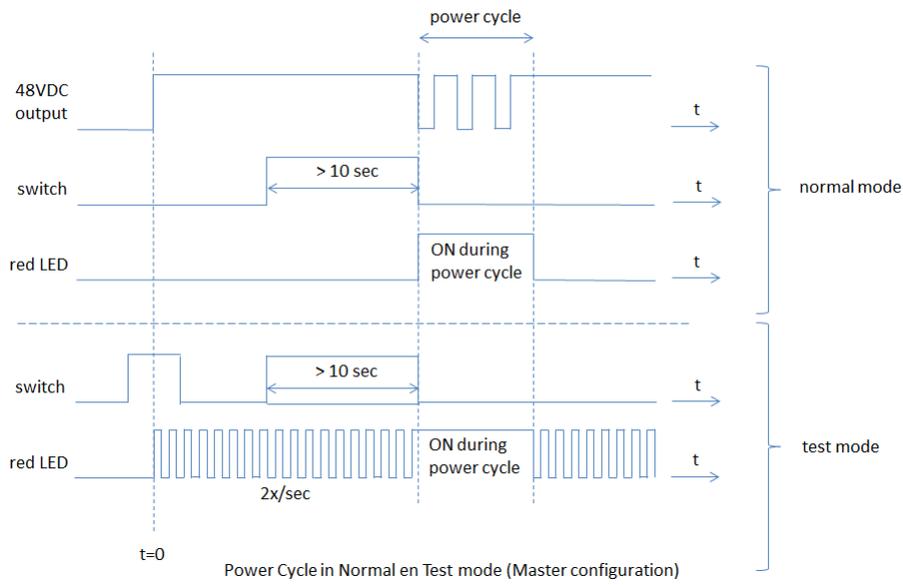   when error/indication condition exists flashing in specific rhythm:

2x/sec: Test mode

1x/8sec: Slave mode

As the (Master) Vestas takes over a part of the functionality of the now not present Femtogrid Inverter it will have to take care of the coordination of the complete solar and/or wind optimizer system. Initially after start up the 48V (Safety signal) is being switched on and then the built up of the 400V on the DC-bus (by the optimizers) is being tested. When this bus voltage is lower than 329V it indicates a bus error which is shown by flashing the yellow LED (2x/sec), if this condition lasts longer than 30 sec (after start up initially 60 sec) than the Vestas switches to Sleep mode for a duration of 10 min after which it returns to testing this bus voltage. Has this bus voltage of 400VDC finally become stable than it will be converted by the (non-Femtogrid) inverter to 230VAC for supplying power to the (public) AC-grid. In a larger system consisting of several Vestas modules (Master and one or more Slaves) it is possible that due to a fault a condition can occur whereby the Master wants to remove the 48V signal from the output but that nevertheless the signal remains present because for instance a Slave does not switch off along with the Master (in case several Vestas modules are switched in parallel) and keeps its 48V voltage enforced on this combined output. This condition is indicated by flashing the yellow LED (4x/sec). Because this is an (as seen from the Master) external hardware error which causes the system not to operate properly, it will have to be solved manually first, so after a maximum of 25 sec the Master Vestas is reset.

Time sequence diagrams:

For clarification some time sequence diagrams follow which show the different conditions:

Start up in Normal mode

Start up in Test mode

Start up in Slave mode

Forcing from sleep mode to active mode when in Master mode

power cycle

48VDC output

switch   > 10 sec

red LED   ON during power cycle

normal mode

switch   > 10 sec

red LED   ON during power cycle   2x/sec

test mode

t=0

Power Cycle in Normal en Test mode (Master configuration)

normal switching   sleep   sleep (other reason)

48VDC output

400V not present (or to low)

400VDC

yellow LED   2x/sec   1x/8sec   1x/8sec

t=0

400VDC bus error in Master mode

(unwanted)

48VDC external

(expected)

48VDC internal   normal switching

yellow LED   4x/sec

processor reset   max 25 sec

External 48VDC (unwanted) in Master mode

5. Installation

To install this Vestas Controller Box use the accompanying Vestas VTC 25-002 Installation manual.

6. Technical specifications

The technical specifications of the Vestas Controller Box are stated in the accompanying Vestas VTC 25-002 Datasheet.

7. Practical hints

To be added later.

8. Company information

Femtogrid Energy Solutions BV

Oosteinderweg 127C

1432 AH Aalsmeer

The Netherlands

+31 (0)85 0444 004

info@femtogrid.com

www.femtogrid.com