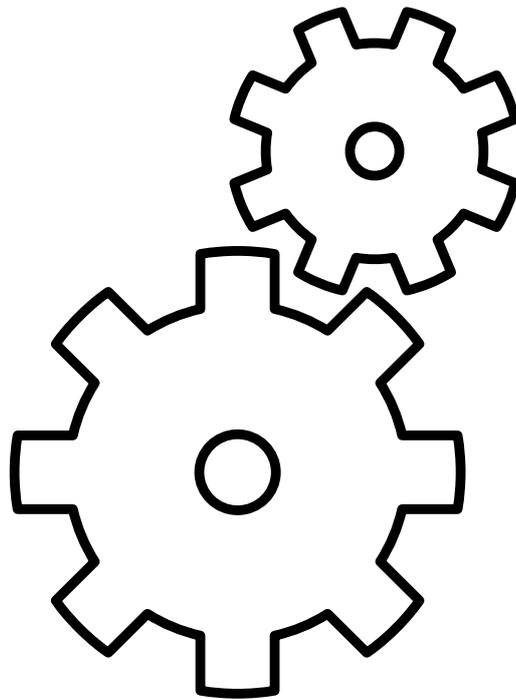


# Configuration Guide

## Pixii Offgrid connections and setup



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Revision	Date	Comment
0.1	2021-10-08	Initial
0.2	2021-11-03	Updated J1001 connections and some figures
0.3	2021-12-23	Updated doc related to AC frequency as a function of State of Charge and max power is now set to 50kW
0.4	2022-05-06	New Template

# 1 Introduction

The document is written for OEM customers that do not purchase the prewired PowerShaper cabinet but have acquired only the PixiiBox, Pixii PowerShelf and the Pixii Gateway. It is intended as a guide on how to do the electrical wiring and setup of the PixiiBox, PowerShelf and Gateway to operate in Offgrid mode.



Figure 1.1 PixiiBox



Figure 1.2 Pixii PowerShelf (3x3 pos.)



Figure 1.3 Pixii Gateway

## 2 Hardware limitations, requirements & Wiring

In Offgrid mode the maximum allowed AC power is limited to 50kW, i.e., 15 PixiiBoxes connected in star-configuration for 3-phase operation. For single-phase operation, the limit is 16.6kW with 5 PixiiBoxes. If more power is needed the load must be split in separate blocks of 50/16.6 kW.

It is of great importance that at least one PixiiBox is inserted in rack position 1, 4, 7, 10 or 13 (phase L1-N), otherwise the system won't work properly.

To be able to run in both Ongrid and Offgrid mode a grid disconnection device, typically a contactor (with the proper rating and NO contacts for the power wires), is required for preventing the grid voltage to be exposed to the PixiiBoxes during Offgrid operation. This may damage the PixiiBoxes, and correct wiring is therefore crucial! The disconnection device is also required to have a normally closed (NC) auxiliary contact that is wired to the gateway. By this the gateway may control the transitions, from Ongrid to Offgrid (and vice versa) in a safe and reliable way.

In Ongrid operation the disconnection device is closed, and the gateway will run the services set up for Ongrid mode. When the gateway is activated for Offgrid mode it will switch to Offgrid mode by quickly ramp down the power reference and then disconnect the contactor. The activation signal may either be set by an external switch, a meter or by the PowerShaper web interface, so if any of the two first methods are to be used a switch or a meter is required (Ref chapter 3.2).

Additional HW required is an emergency switch with one set of NC contacts and one set of NO contacts and in most cases some terminal fuses.

If the system is to operate only in Ongrid or Offgrid mode, the disconnection device/contacter is not needed.

Refer to the schematic drawing stated below for a complete overview of the wiring.

[1] "Hybrid OEM connection diagram", doc no 14081 (ROW option)

[2] "Hybrid OEM connection diagram AUS", doc no 14082 (AUS option)

Note! The difference in these diagrams is how the neutral connection is handled. In the first case/diagram the Neutral is connected to PE when operated in Offgrid mode, while in the second (for Australia) the Neutral in the Pixii system is connected to the Neutral of the grid in both the Ongrid and Offgrid mode. This means that an additional contactor is required for the ROW option [1].

### NOTE:

The difference in these diagrams is how the neutral connection is handled. In the first case/diagram the Neutral is connected to PE when operated in Offgrid mode, while in the second (for Australia) the Neutral in the Pixii system is connected to the Neutral of the grid in both the Ongrid and Offgrid mode. This means that an additional contactor is required for the ROW option [1].

## 2.1 Powershelf wiring

The wiring of the powershelf must be done according to figure below. Cross-sections of wires should be selected based on national rules and actual load. Max AC current per PixiiBox is 16.6A long term and 20A for 1 minute. The maximum DC-current per converter is 71A. Tightening torque for the AC connections should be 1.5Nm and for the DC 5.7Nm.

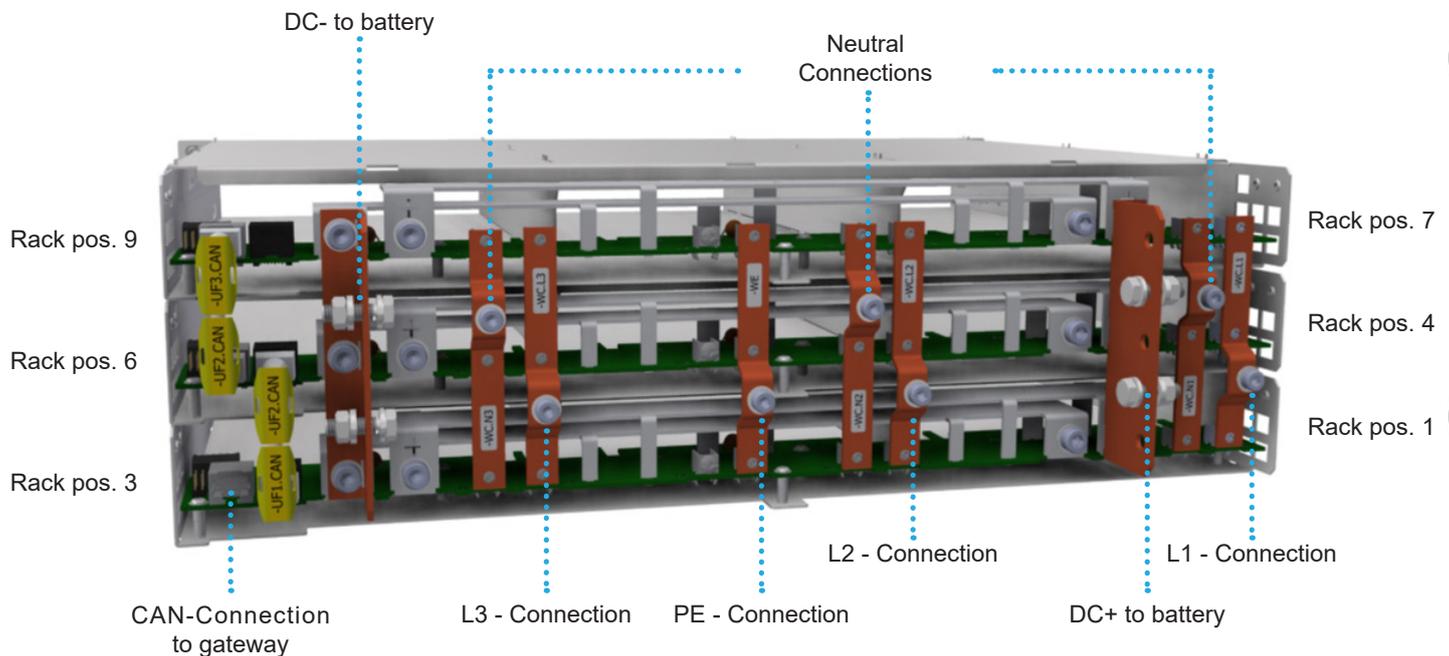


Figure 2.1 Powershelf rear view

If single-phase operation with one PowerShelf is to be used, the rack assembly may be split into 3 separate racks/shelves. For single-phase operation the connections for L1, L2 and L3 must then be connected together. To dismantle the PowerShelf into 3 racks, disconnect all the copper bars and the screw fastened metal latches on the sides of the racks. Make sure that the DIP switch (behind the CAN connector on picture above) is configured with only the leftmost switch in upper position, the remaining should be placed in the lower position. By this the PixiiBoxes will pop up in the PowerShaper web interface in position 1, 2 & 3. The terminations for the CAN and RS485 communication must also be in place, like shown on picture below. If these terminations are not in place the communication may not work.

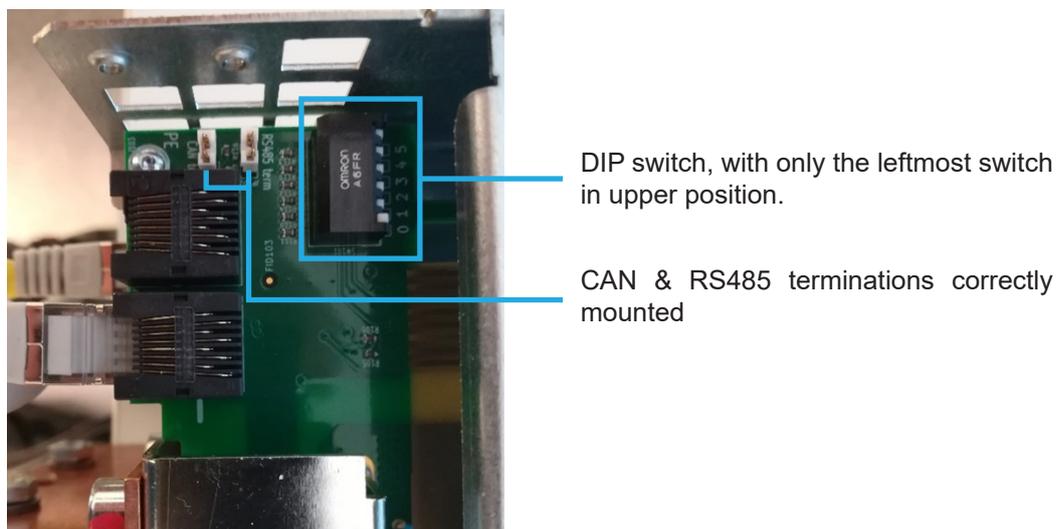


Figure 2.2 DIP-switch and terminations for com

## 2.2 Gateway wiring

The gateway is as standard configured to monitor the Pixii PowerShaper cabinet with specific batteries, fans, heaters, MCBs and so on. For an OEM customer some of this functionality may not be relevant or required. However, if a built-in functionality is not to be used it may cause an alarm or warning to become active unless some additional wiring is added.

If any of the Aux. circuit breaker, SPD, Smoke detector, main circuit breaker or door switch are not used the alarm/warning may be disabled like described below:

Function	Description	Gateway reference
Aux. circuit breaker alarm	Short the aux circuit breaker digital (Heater fuse) input to disable	J141:1 to J141:11
SPD (Surge/OV) alarm	Short the digital input for the SPD to disable	J141:2 to J141:12
Smoke detector alarm	Short the digital input for the smoke detector to disable	J141:3 to J141:13
Main circuit breaker (MCB) alarm	Short the digital input for the MCB to disable	J141:4 to J141:14
Door alarm	Short the digital input for door switch to disable	J141:5 to J141:15

If the fan (J119) or heater (J1002) functionality are not to be used, they may be skipped without further action. The same will then be the case for the temperature sensors (J139). When a fan or heater are required contact Pixii service and support team for further details.

The gateway must be powered with 48Vdc (J201) and is prepared for a redundant supply from the battery and an external power supply (like the MEAN WELL, Model: HDR-30-48) supplied from the grid. The gateway also has the possibility to monitor the battery voltage for ground fault. This requires that the positive terminal of the battery voltage is connected to J111:6 and the negative to J111:3. In addition PE must be connected to J111:2 & 7. If this function (or alarm) is to be disabled contact Pixii service and support team for further details.

The CAN connection from the power shelves is connected to the gateway at CAN1 (J115) and is required for charging and discharging power.

The gateway supports communication with several different battery brands and technologies. Contact Pixii service and support team for details on which batteries that are supported and how to connect them to the gateway. If batteries without BMS are to be used select the option 'NO BMS' in the Menu > Battery > Standard settings. Make then sure that the battery settings reflect the number of Pixiiboxes and batteries, so that no unexpected behaviour occur.

For battery systems like this it is recommended to also include an E-switch (QA6) that disconnects the grid and ceases the current flow to/from the battery (both in Ongrid and Offgrid mode) in case of an emergency. The feedback for this switch is connected to the gateway on connector J141:7&17.

The NC contact set on the disconnection device (QA4-contactor in drawings) is connected to the gateway on connector J136:6&16, and the key-switch (optional, ref chapter "3.2 Offgrid mode settings" on page 12) is connected to same connector on pin 7&17.

The gateway controls the disconnection device by a relay output (J1001:4&5) and is important for a safe and reliable transfer between Ongrid and Offgrid.

Finally, if automatic transfer from Ongrid to Offgrid is to be used an external meter is required. Ref. Chapter "3.2.2 Activation by AC voltage" on page 13 for more details.

## 3 Offgrid system configuration

The Offgrid configuration is done through the PowerShaper web interface. There are two Offgrid menus for doing the setup:

1. For setting the parameters like voltage, frequency and maximum current: 'Offgrid settings' menu.
2. For setting the criteria for going from Ongrid to Offgrid: 'Offgrid mode settings'.

### 3.1 Offgrid settings

In the PowerShaper web interface, select Menu > System > Offgrid settings

**NOTE:**

Access level of installer (20) or higher is required to access this setting.

If this is the first time this page is opened it will look like this:

Figure 3.1 Offgrid settings

The first thing to select is the Offgrid profile, and you now have two options (to enable the Offgrid mode):

1. Offgrid three-phase
2. Offgrid single-phase one shelf

Select 1) if you are going to run the system in 3-phase mode or with up to 5x3 position PowerShelf

Select 2) if you are going to run the system in single-phase mode with one shelf/rack

The settings menu should then look like this:

### Offgrid Settings

Offgrid mode: Deactivated

Profile: Offgrid three-phase ▾

Description:

Cancel changes
Apply changes
Unit: All ▾

Offgrid			
Num	Item	Value	Unit
0	crc	2855	–
1	version	0	–
2	Offgrid profile	2	–
3	Nominal voltage	230.0	Vrms
4	Nominal frequency	50.00	Hz
5	Max AC current	16.60	A
6	Max AC apparent power	4400	VA
7	Virtual voltage droop control.	0.10	ohm
8	Virtual frequency droop control.	0.00	ohm
9	Ramp up time	2300	ms
10	Max. over load time (long terms)	59	s
11	Microgrid frequency power derate SoC start	80.0	%
12	Microgrid frequency power derate SoC end	90.0	%
13	Max. over current (long terms)	20.00	A
14	Off-grid configuration	0	–
15	Microgrid frequency power derate freq end	53.00	Hz
16	Minimum voltage at overload before stop	85	%
17	Off-grid Vac min trip time	5000	ms
18	Maximum voltage before stop	120	%
19	Off-grid Vac max trip time	200	ms
21	Minimum restart time	90	s
22	Maximum restart attempts	3	–

Figure 3.2 Offgrid parameters

The only difference in this table for the two mentioned options will be the crc and the offgrid profile number. Table 2 briefly explains these parameters.

Num.	Name	Description	Default value
0	crc	Only for internal use	NA
1	version	Offgrid table version. Only for internal use.	0
2	Offgrid profile	Deactivated = 1 3-phase operation = 2 Single phase operation = 3	
3	Nominal voltage	This is the actual output voltage that you will have in Offgrid mode. May be set between 190V and 250V.	230V
4	Nominal frequency	This is the actual output frequency that you will have in Offgrid mode. May be set between 40Hz and 70Hz. It will also be the frequency starting point when operated in Microgrid mode (See Ch. 3.3.2)	50Hz
5	Max AC current	The maximum AC current that the PixiiBox may deliver on long terms. May be set between 14A and 20A. It is not recommended to increase this value beyond 16.6A unless better cooling is provided (low ambient temperature).	16.6A

6	Max AC apparent power	Maximum AC apparent power that the PixiiBox will supply for a period of time, specified by parameter num. 10. May be set between 100 and 4400VA.	4400VA
7	Virtual voltage droop control	Droop resistor is used for current sharing among paralleled PixiiBoxes. Load voltage drop may be calculated as: Voltage drop = droop resistor * actual AC current.	0.1ohm
8	Virtual frequency droop control	Currently not in use	0.0ohm
9	Ramp up time	Time from 0V to nominal voltage at start-up.	2300ms
10	Max overload time (long terms)	The amount of time that the PixiiBox may be overloaded long terms. Ref parameter num. 6 & 13. May be set between 0 and 60 sec.	59s
11	Microgrid frequency power derate SoC start	This is the Battery SoC level where the PixiiBoxes will start to increase the AC frequency.	80%
12	Microgrid frequency power derate SoC end	This is the Battery SoC level where the PixiiBoxes will stop to increase the AC frequency.	90%
13	Max overload current (long terms)	The max AC current that the PixiiBox may be overloaded long terms. Ref parameter num. 10. May be set between 20.0 and 30.0. It is not recommended to increase this value beyond 20.0A unless better cooling is provided (low ambient temperature).	20.0A
14	Off_grid configuration	This parameter defines whether: <ul style="list-style-type: none"> <li>All PixiiBoxes should trip if overloaded on one phase or only the PixiiBoxes connected to the affected phase should trip.</li> <li>The microgrid mode is enabled or disabled.</li> </ul> How to set this parameter is described in chapter 3.1.1	0
15	Microgrid frequency power derate freq end	It will be the frequency end point when operated in Microgrid mode.	53.0Hz
16	Minimum voltage at overload before stop	Minimum voltage level where the PixiiBoxes will stop feeding power at overload. If set to 85% at default nominal voltage it will stop at $0.85 \times 230$ . Parameter 17 will define the overload time. Parameter 21 will define the time until the unit is restarted, and parameter 22 will set the number of restart attempts until it shuts down (without restarting).	85%
17	Off-grid Vac min trip time	Trip time for minimum voltage violation at overload before stop. Ref parameter num. 16.	5000ms
18	Maximum voltage before stop	Maximum voltage level where PixiiBoxes will stop feeding power. If set to 120% at default nominal voltage it will stop at $1.20 \times 230$ . Parameter 19 sets the trip time. Parameter 21 will define the time until the unit is restarted, and parameter 22 will set the number of restart attempts until it shuts down (without restarting).	120%
19	Off-grid Vac max trip time	Trip time for a violation of maximum voltage before stop. Ref parameter num. 18.	200ms
21	Minimum restart time	Delay prior to restart PixiiBoxes after being overloaded and tripped because of low or high AC voltage. Ref parameter num. 16 & 18.	90s
22	Maximum restart attempts	Maximum restart attempts in a row if overloaded or high AC voltage. Ref parameter num. 16 & 18.	3

When the settings are set the Offgrid mode must be activated and saved (Apply changes)

## Offgrid Settings

Offgrid mode: Activated

Profile: Offgrid three-phase ▾

Description:

Cancel changes
Apply changes
Unit: All ▾

Figure 3.3 Offgrid mode set and activated, here for 3-phase operation

### 3.1.1 Offgrid configuration

By setting the value of the Off\_grid configuration parameter the system behaviour (or mode) may be altered. The possible combinations (for now) are described in the table below:

Description	Default value
All PixiiBoxes will trip if overloaded on one phase. Microgrid mode is disabled. This is the default setting.	0
Only the Pixiiboxes connected to the overloaded phase will trip. Microgrid mode is disabled.	1
All PixiiBoxes will trip if overloaded on one phase. Microgrid mode is enabled.	2
Only the Pixiiboxes connected to the overloaded phase will trip. Microgrid mode is enabled.	3

Figure 3.4 Off\_grid configuration settings

### 3.1.2 Microgrid mode

The Pixiiboxes in Microgrid mode may handle power flow both in discharge mode and charge mode. This feature makes it possible to parallel the battery system with Solar Inverter(s). To prevent the Solar Inverter from overcharging the battery it must have the capability to derate the AC power dependent on the frequency. The settings in the Pixii Gateway may be adjusted by the parameters 4, 11, 12 & 15 and the Solar Inverter settings (Power as a function of frequency) must be aligned with these. The default settings in the Pixii Gateway will program the pixiiboxes to adjust the frequency according to figure below.

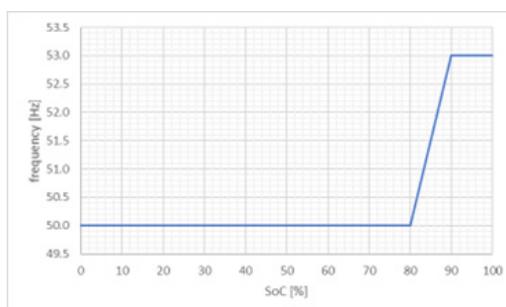


Figure 3.5 Frequency as a function of battery State of Charge

The microgrid mode is by default disabled. How to enable it is described in chapter “3.1.1 Offgrid configuration”.

## 3.2 Offgrid mode settings

After the Offgrid settings has been set and activated the method of going from Ongrid to Offgrid must be selected. For now, four different ways has been implemented:

1. By activation of a key-switch (other switches may also be used).
2. By reading AC voltage from a meter (a supported meter with Modbus com is required).
3. By reading AC voltage from a meter and by activating a soft switch in the web interface.
4. By activation of a soft switch in the web interface

The fifth option, OEM mode, is currently not supported.

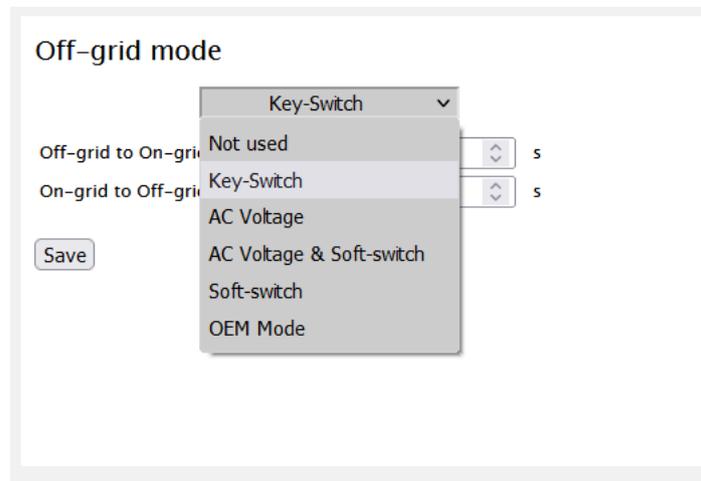


Figure 3.6 Off-grid mode settings

The required hardware must be connected and wired as described in chapter “2 Hardware limitations, requirements & Wiring” on page 5.

Access level for the Offgrid mode settings is installer (20).

### 3.2.1 Activation by Key-switch

The activation by key-switch requires an external switch with normally open (NO) contacts. A cable (recommended minimum cross-section 2x1mm<sup>2</sup>) must be routed from the switch to the gateway. Connection point at the gateway is J136:7 and J136:17. The off-grid mode is activated when the NO contact is shorted.

Off-grid mode

Key-Switch

Off-grid to On-grid switchover time: 10 s

On-grid to Off-grid switchover time: 10 s

Save

Figure 3.7 Key-switch method

As soon as the gateway detects that the switch has been shorted it will start the transition from Ongrid to Offgrid. During this transition the gateway will stop the power from the PixiiBoxes and disconnect the grid (by the contactor). The duration of this transition may be controlled by the parameter: 'On-grid to Off-grid switchover time' as indicated on the figure above. The default setting is 10 second, but the interval of 2 sec to 120 sec may be used. With a switchover time of 2 second the total time of transition will be approximately 10 seconds.

If the key-switch is opened, the gateway will initiate a transition back to Ongrid mode. The duration is controlled by the parameter: 'Off-grid to On-grid switchover time' with the same default setting and interval as above. The transition time back to Ongrid also depends on the grid settings used (Menu > System > Grid Settings), so the minimum re-connection time may be longer than 10 seconds.

### 3.2.2 Activation by AC voltage

With the Activation by AC voltage method it is required to have a meter communicating, over RS485, with the gateway. Refer to the document: 'Pixii PowerShaper Meter setup' for instructions on how to do the setup and what kind of brands that are supported.

Off-grid mode

AC Voltage

Vmax: 250 Vrms

Vmin: 180 Vrms

Off-grid to On-grid switchover time: 10 s

On-grid to Off-grid switchover time: 10 s

Save

Figure 3.8 AC voltage method

The gateway will then decide on whether the PixiiBoxes will run in Ongrid or Offgrid mode based on the voltages measured by the meter. If the AC voltage measured is outside the range set by Vmax and Vmin (ref figure above) the Offgrid mode will be initiated. The time delays are set in same way as for the key switch (and the valid interval is the same).

**NOTE:**

That the voltage set here in Offgrid mode should be coordinated with the grid settings used for Ongrid mode.

The AC meter is powered from the grid so during grid blackouts the communication with the gateway will stop. This means, if the communication with the meter is lost and the main circuit breaker has not tripped the gateway will interpret this as a signal to initiate Offgrid mode. If the main circuit breaker has tripped this is interpreted as the Pixii system has a fault, and the Offgrid mode is not initiated. When the meter is again having stable voltage readings the system will return to Ongrid mode.

### 3.2.3 Activation by AC voltage & Soft-Switch

In this case the functionality of the AC voltage measurement is combined with a software switch in the web interface (Ref red button indicating Ongrid in figure below). If the voltage measurements are outside the set voltage window, the Offgrid mode will be initiated when the button is pushed. The active mode is indicated by the button.

Figure 3.9 AC voltage and Soft-switch method

The transfer time is controlled in a similar manner as described in two previous sections. During transfer periods the switch will be yellow, while in Offgrid it will be green.

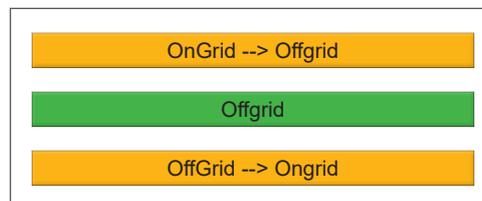
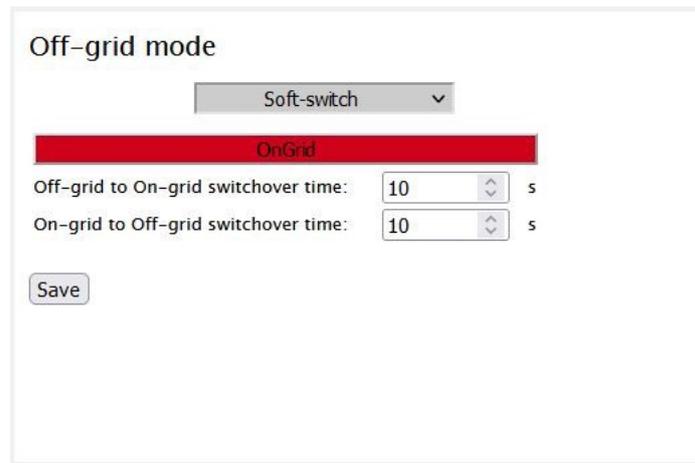


Figure 3.10 Switch animations during transitions and Offgrid

If the automatic transfer to off-grid selection has been ticked off, the transfer to Offgrid will go automatically based on AC voltage only. It will be the same for the other option back to Ongrid. If both options are ticked off it will behave as described in chapter “3.2.2 Activation by AC voltage” on page 13 except that it will not care about the status of the main circuit breaker.

### 3.2.4 Activation by Soft-Switch

With the selection of Soft-Switch method the transfer to On or Offgrid is completely controlled by the web interface through the Soft-Switch.



The screenshot shows a web interface for configuring the 'Off-grid mode'. At the top, there is a dropdown menu set to 'Soft-switch'. Below this is a red bar with the text 'OnGrid'. Underneath the bar, there are two input fields for switchover times, both set to '10' seconds. The first is 'Off-grid to On-grid switchover time:' and the second is 'On-grid to Off-grid switchover time:'. A 'Save' button is located at the bottom left of the configuration area.

Figure 3.11 Soft-Switch method

The switchover times and the colour of the switch will be as described in previous sections.

## 4 Troubleshooting

There may be several reasons for why the Offgrid mode is not started. The most common are:

- The Offgrid mode is not activated
- The emergency stop switch is activated
- The feedback from the AC disconnect device/contactor is missing
- There is no PixiiBox inserted in position 1 (4 or 7, i.e. connected in phase L1)
- Battery settings are not correct

## 5 Web Interface in Offgrid mode

When running the Offgrid mode the active Service will be: Off Grid. There will be no source/On grid converters and the grid voltages will appear as 0V. The power flow will be as shown in the animation, from the battery to the loads: 965W. In rack view the T-P2 (Port 2) will state that the PixiiBox is in off-grid mode.



Figure 5.1 Web Interface

Vdc	54.76	Vac	229.50	Status	Norm
Pdc	-1002.1	Pac	-975.0	T_P1	Battery
Idc	-18.3	Iac	4.3	T_P2	Off-grid
VdcL	438.0	Sac	976.0	F dir	OUT
T In	30.0	Freq	50.00		
TOut	35.0	C opt	1		

Figure 5.2 Rack view

When running one shelf in single phase mode the Pixiiboxes will be sharing the power on a horizontal basis (Pixiiibox 1,2 & 3 are all connected to L1 & N), while with the PowerShelf (3x3 pos.) the power is shared vertically (Pixiiibox 1, 4 & 7 are connected to L1).

1	Vdc	53.47	Vac	229.70	Status	Norm	Vdc	53.47	Vac	229.70	Status	Norm	Vdc	53.43	Vac	229.70	Status	Norm			
	Pdc	-668.4	Pac	-641.0	T_P1	Battery	Pdc	-668.4	Pac	-640.0	T_P1	Battery	Pdc	-651.8	Pac	-633.0	T_P1	Battery			
	Idc	-12.5	Iac	2.8	T_P2	Off-grid	Idc	-12.5	Iac	2.8	T_P2	Off-grid	Idc	-12.2	Iac	2.8	T_P2	Off-grid			
	VdcL	428.1	Sac	642.0	F dir	OUT	VdcL	427.3	Sac	652.0	F dir	OUT	VdcL	427.2	Sac	635.0	F dir	OUT			
	T In	32.0	Freq	50.00	pixiiibox			T In	32.0	Freq	50.00	pixiiibox			T In	32.0	Freq	50.00	pixiiibox		
	TOut	38.0	C opt	1	-----			TOut	36.0	C opt	1	-----			TOut	36.0	C opt	1	-----		

Figure 5.3 Rack view with 3 Pixiiboxes (here in single-phase operation with one shelf)

1	Vdc	53.10	Vac	226.70	Status	Norm	Vdc	53.08	Vac	228.30	Status	Norm	Vdc	53.04	Vac	229.90	Status	Norm			
	Pdc	-1885.0	Pac	-1843.0	T_P1	Battery	Pdc	-966.1	Pac	-939.0	T_P1	Battery	Pdc	-58.3	Pac	-30.0	T_P1	Battery			
	Idc	-35.5	Iac	8.1	T_P2	Off-grid	Idc	-18.2	Iac	4.1	T_P2	Off-grid	Idc	-1.1	Iac	0.1	T_P2	Off-grid			
	VdcL	424.6	Sac	1846.0	F dir	OUT	VdcL	424.6	Sac	941.0	F dir	OUT	VdcL	420.2	Sac	34.0	F dir	OUT			
	T In	32.0	Freq	50.00	pixiiibox			T In	33.0	Freq	50.00	pixiiibox			T In	33.0	Freq	50.00	pixiiibox		
	TOut	40.0	C opt	1	-----			TOut	39.0	C opt	1	-----			TOut	38.0	C opt	1	-----		

Figure 5.4 Rack view with 3 Pixiiboxes (here in three-phase operation with one shelf)





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**PIXII**

