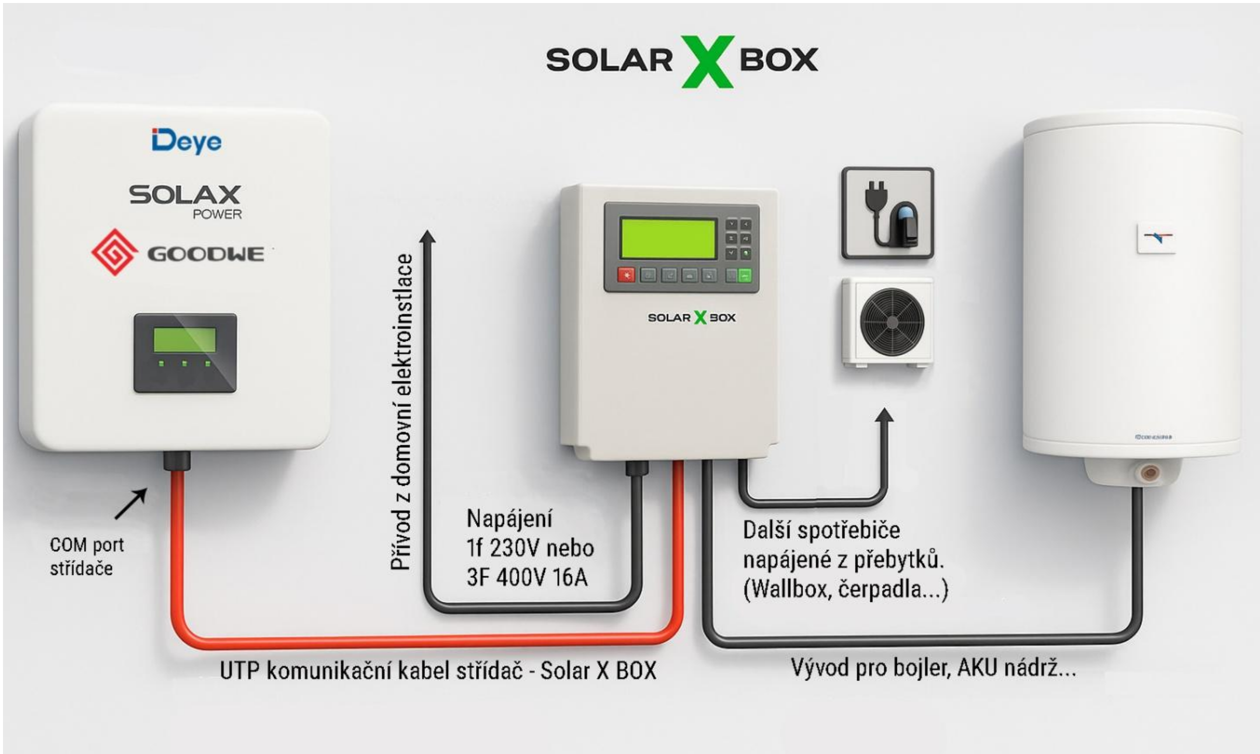
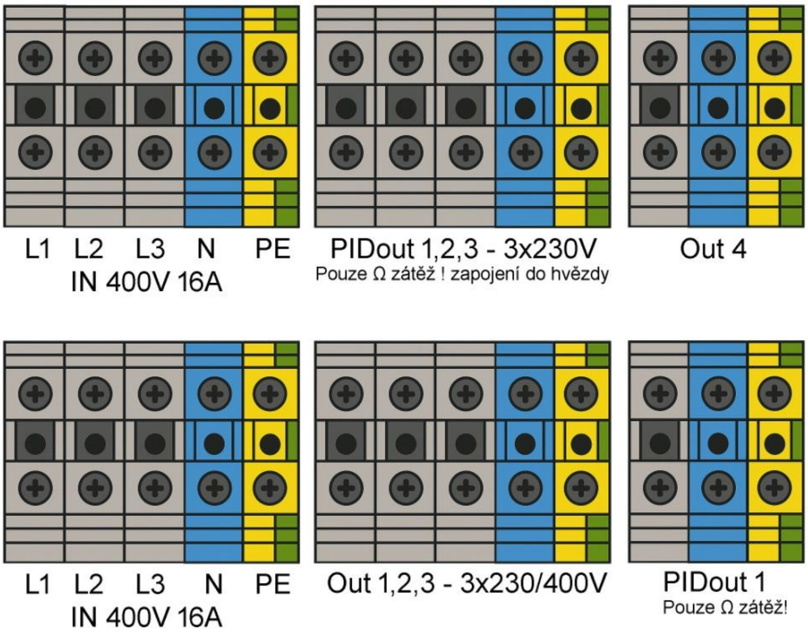
Manual



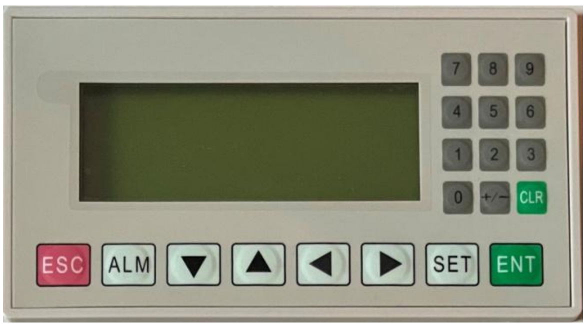
Wiring Diagram

Electrical Connection of the Box Power Supply and Appliances Powered by Surplus Energy (Examples)



According to the specific configuration of the box, it is equipped either with terminal blocks or sockets.When connected via terminals, these are labeled as shown in the diagram.
IN is the power supply input of the box — either **single-phase 230 V** or **three-phase 400 V**.
The outputs of the box are labeled according to whether they provide **continuous (PID-controlled) regulation** (*PIDout 1, 2…*) or **on/off switching** (*out 1, 2…*), and may be either **single-phase** or **three-phase 3×230 V** connected in a star configuration.
Only **resistive loads** may be connected to the continuously regulated (PID) outputs!

Control



The **up/down arrows** are used to scroll between individual screens.
The **SET** key is used to enter parameter adjustment mode. If there are multiple adjustable parameters on the screen, press **SET** repeatedly until the desired parameter starts flashing.
The **numeric keypad** is used to change parameter values.
Press **ENT** to confirm the change.

Communication Settings with Inverter or Smart Meter

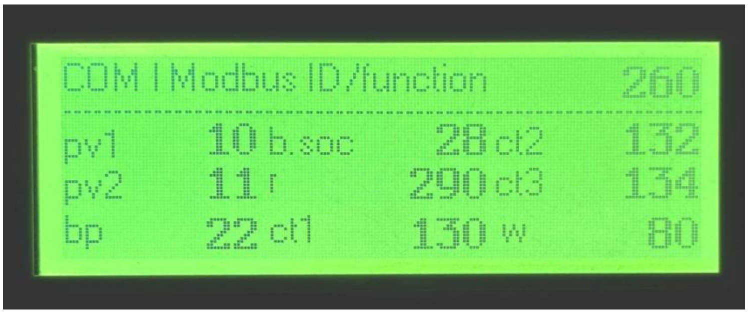
Speed and Period Settings

Solar X BOX can communicate with inverters or smart meters that support the **MODBUS RTU** protocol (most common grid-tie and hybrid inverters such as **Solax**, **GoodWe**, **Deye**, and smart meters like **Chint DTSU666**, **Chint DDSU666**, **GoodWe EM1000**, **EM3000**, etc.).

For most of these devices, the communication settings are as shown in the figure **9K7E**.
This corresponds to a baud rate of **9600 baud**, **7 data bits**, **Even parity**, and **1 stop bit**.

Com period – this is the communication period in milliseconds, i.e., the speed at which the box sends requests to the inverter. At higher period values, data in the box and on the display refresh more slowly.The goal is to refresh the data as quickly as possible while avoiding communication errors. (The example in the figure was tested with **Solax X3** at a **10 ms** period.)

Slave Device Address (Inverter, Smart Meter) and MODBUS Read Function



Settings for the Modbus read type, slave address **of the inverter, and individual register reads (shown in the example for** Solax X3 Hybrid**).**

Depending on the brand and model of the inverter, there are two basic types of Modbus read commands that the **Solar X Box** uses to obtain the necessary registers for its proper operation:

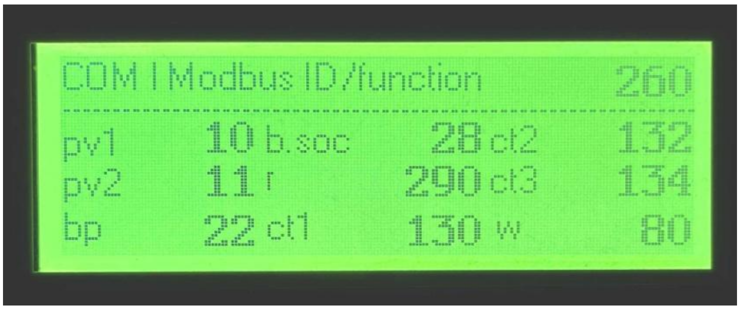
- **03 – Read Holding Registers**
- **04 – Read Input Registers**

Setting the decimal value **259** in the "Modbus ID/function" line corresponds to hexadecimal **H103** (Slave address: 1, Function code: 03 – *Read Holding Registers*, used by devices such as GoodWe EM, ET, Deye...).

Setting the decimal value **260** corresponds to hexadecimal **H104**
(Slave address: 1, Function code: 04 – *Read Input Registers*, used by devices such as Solax X3, X1...).

It is also possible to set a different slave address.
For example, if it is necessary to read input registers (function 04) from **slave address 2**, the corresponding decimal value would be **516**, which should be entered in the "Modbus ID/function" field. For converting hexadecimal values to decimal, using an **online converter** is the simplest method.

Register Addresses



Register Address Settings (as shown in the example for Solax X3)

Solar X BOX needs to read several key registers for its proper operation.
These are mainly data from the CT coils, i.e., measurements of the energy flowing to or from the house/object, and the battery SOC (if batteries are installed).

Other data are not essential for functionality and serve primarily for informational purposes. Inverter manufacturers provide **Modbus register protocols**, which are used to configure these settings.

Below is a description and examples of **register addresses** for several inverter types:

	SOLAX X3	**SOLAX X1**	**GOODWE-ET**	**DEYE SUN3F**	**DEYE SUN1F**	**GM3000**
PV1 - String 1 power	10	10	35106	672	186	
PV2 - String 2 power	11	11	35110	673	187	
bp - Battery Power	22	22	35183	590	190	
b.soc. Battery Capacity	28	28	37007	588	184	
r - Reserved	290	8	35174	541	184	
ct1 - phaseL1	130	70	36006	616	169	103
ct2 - phaseL2	132	70	36007	617	169	104
ct3 - phaseL3	134	70	36008	618	169	105
W - Energy today total	80	80	35194	529	108	

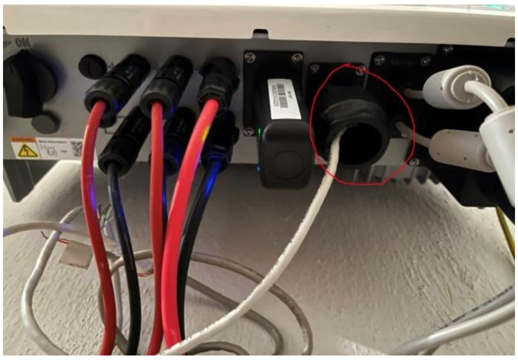
From the factory, Solar X BOX is preconfigured for common inverter types, as shown in the table.

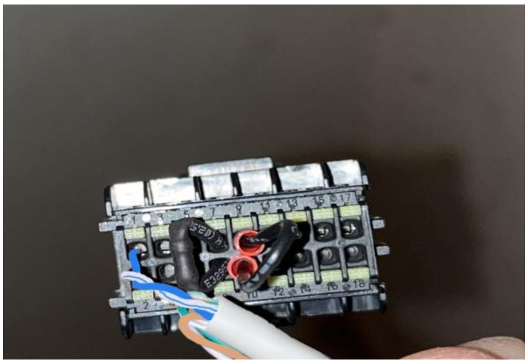
Inverter Settings and Connection

The communication output from **SxB → inverter** is a **UTP cable** with an **RJ45 connector** or **RJ45 socket**. Communication via **RS485** takes place on **pins 4 and 5** (blue and blue-white wires).

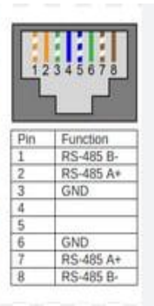
Solax – The communication cable is connected to the **RJ45 port labeled "COM"**, located on the bottom side of the inverter.
Communication settings are accessible in the inverter menu.
To open the menu, press the **Enter** key.
Navigate to **Settings** (default password: **2014**) → **Advanced Settings** → **Modbus**.
Here, **RS485**, **baud rate 9600**, and **address 1** should be set.
The connection uses a **standard UTP cable**.

GoodWe – The settings are accessible in the **PV Master** app under **Advanced Settings**.
The **Com address** must be changed from the factory default **247** to **1**.
If baud rate adjustment is available, set it to **9600**.
For GoodWe inverters, the communication cable connects to an **18-pin connector** (see photo).
Use the following wiring: **blue → PIN 1**, **blue-white → PIN 2**.
On the Solar X Box side, the **RJ45 port** follows the **standard pin configuration**.

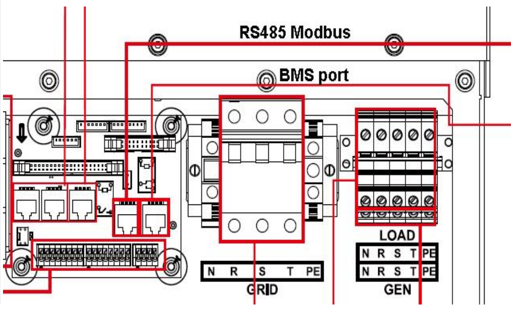




Deye – Depending on the specific inverter model, these inverters usually have a **communication port** located under the terminal cover, labeled **RS485**.Communication takes place on **pins 1 and 2** or **pins 7 and 8**.On the **Solar X Box**, communication is on **pins 4 and 5**.Therefore, it is necessary to connect the communication lines on the Deye inverter side to the correct pins (**1,2** or **7,8**).



Pin	Function
1	RS-485 B-
2	RS-485 A+
3	GND
4	
5	
6	GND
7	RS-485 A+
8	RS-485 B-



Variable Correction

Value Correction
Some inverter manufacturers use different current and power directions or various scaling (for example, a different number of decimal places).
To ensure that **Solar X Box** displays correct values and properly controls energy flow, these differences must be corrected.

This is done using the **Variable Correction** parameter, which multiplies the given value by the specified number:

- **1** = no correction (the value is used as sent by the inverter)
- **–1** = inverted sign (e.g., opposite energy flow direction)
- **–10** = adjustment of both scale and sign depending on the device type

Without proper correction settings, **Solar X Box** would be unable to correctly interpret data, and the system would not function properly.

Home screen

Here is selected information about the power plant, which, if everything is set up correctly, should be displayed immediately after connecting the power cable and communication cable to the port.

The communication status icon is located on the top right of the main screen. If the communication with the inverter is OK, the round box is in the on state and the values on the display changeVysvětlivky -

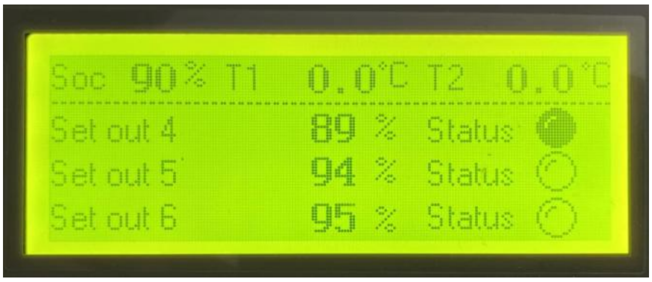
PV Power - total current power, energy produced on the panels.

Bat. SOC % - current battery charge status

Bat. P - battery performance. For Solax inverters, the charging values are positive, the discharging values are negative. It's the other way around at Goodwe.

CT L1, CT L2, CT L3 - the state of the individual measuring coils of the inverter. Minus values - how much energy flows from the network to the house. Plus values - how much energy flows from the house to the grid.

Mining settings screen by SOC. battery - cascade switching.



In the figure, the extraction is set so that output 1 turns on when the battery SOC reaches 89%, output 2 at SOC 94% and output 3 at SOC 95%.

If you want to change this setting, press SET (for body 1 - 1x, for body 2 - 2x, for body 3 - 3x), make the change with the numeric keypad and confirm with the ENT key.

The number of outputs is 3 or 6 by default and they are either on one or two screens accordingly.

Screen with setting of cut-off differentials.

Here is the switch-off difference setting of the bodies according to the SOC of the battery. The minimum can be set to 1%. It means that if, for example, output 1 turns on at 90% SOC, it will turn off only if the SOC is less than 89%

These differences are necessary to keep the miner outputs from cycling. When larger loads are connected, the SOC value may change the battery in steps within the percentage.

Boiler senzor

If the box is equipped with a temperature sensor for the battery container and the sensor is connected, it shows the temperature T1 or T2 on the display. Otherwise, zero is displayed

The attached connector is used to connect the sensor. Cable extension is best possible with shielded wires. The polarity doesn't matter. The measuring range of the sensor is approx. 0-95 degrees.

Function HDO / SPOT

If the box is equipped with the function of switching according to HDO "cheap current", it is possible to configure each of the outputs so that, if there is not enough solar energy, it will be controlled by the HDO signal and the temperature in the battery tank / boiler.

These outputs are connected to temperature control T1. The **HDO** in icon indicates whether the HDO (low current) input is active. In the picture, under the inscription - **Set HDO outputs**, there are three individual outputs. Outputs 2 and 3 are set to 0 and are controlled solely by the SOC setting. battery - excess solar energy or overflow into the grid. Output 1 is set to 1 and this means that if there is not enough solar energy and the temperature in the boiler is lower than the set minimum T1, the HDO signal will come, these outputs will switch and heat the boiler to the Min temperature. T1 (35 degrees in the picture) . Min T1+ is the switch-off difference of the output according to the temperature T1. (in the picture, the output would turn off when a temperature of 36 degrees is reached) **The HDO function, with the HDO signal, will force the corresponding outputs to switch if the temperature on the T1 sensor is lower than the set minimum.** Furthermore, it is possible to control these outputs manually in modes 0 (off) - 1 (on - works permanently as with the HDO signal) 2 - (automatic according to the HDO signal and the temperature in the boiler) **Min. T1 and Min. T1+ can be changed.**

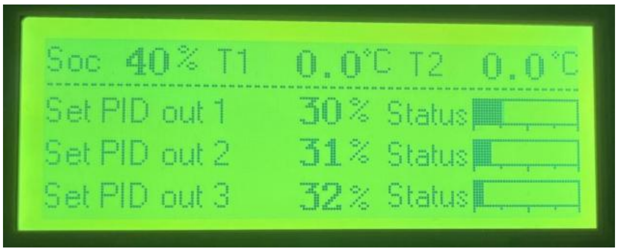
Continuously PID regulated outputs

Solar X box units can be equipped with continuously PID regulated outputs.

What is PID control? It is a continuous / continuous regulation, where the power is sent to the coils continuously in the range of 0-100%. The principle of PID is the continuous comparison of the measured values with the required ones and the automatic adaptation of the controller to the given conditions. It is possible to achieve not only a short regulation time, but also a high accuracy without permanent regulation deviation.

The basis of PID control are three components - proportional **P**, Integral **I** and Derivative **D**

With continuous regulation, the power is sent to individual outputs smoothly, without step changes, as is the case with two-state outputs 0/1 (0/100%).



Outputs 1-3 - general settings according to SOC value. battery + output status

Set PID out 1,2,3 (can be changed with the SET key) - setting from which SOC value. battery, the regulator starts sending power to individual outputs. **The regulator can send power to the outputs even if the set battery charge is not reached, at the moment when there is an overflow of energy towards the network and it depends on the difference between the SOC. measured and set, on the setting of the GRID+ parameter (see the detailed setting of the PID output) and on the size of this flow. Further, see wattrouter mode settings. "Wattrouter Mode" section.**

Status - graphical representation of the size of the sent power 0-100%.

The regulator starts sending power to the heating coils if the battery is charged above the **Bat. set.** value a hundred or according to the settings, if there is an overflow of energy towards the distribution network, according to the settings of the Grid + parameter. **Thanks to this, smooth regulation is also a solution for battery-free systems. Continuous regulation, on the other hand, will reduce the output if the sum of the outputs of all appliances in the house exceeds the capabilities of the power plant and the values from the coils / smart meter of the inverter reach negative values. This depends on the setting of the Grid parameter.** In this way, management is achieved only with excess energy.

Detailed PID control setting

Output 1 - detailed setting of PID regulation of output No. 1

PIDout1 - percentage value of the power that the controller sends to the spiral at output 1.

CT - is the current value - **the sum of the values from the measuring coils L1, L2, L3 (R, S, T)** or the smart meter of the inverter. It is therefore the total power delivered from or to the distribution network.

Bat. SOC. - the current value of the battery capacity.

Bat.P - battery power. Positive values mean battery charging, negative values mean battery discharging.

Bat. set. - setting from which SOC value. battery, the regulator will start sending power to the coil, assuming the CT coils are at or near 0.

Grid - a Grid + coefficient of influence of the measured values from the CT coils / smart meter of the inverter on the controller.

Grid - determines the sensitivity to withdrawal from the network and adjusts the power sent to the coils so that there is no withdrawal from the network when the water is heated from surpluses, if the power plant cannot satisfy the current consumption in the house.

Grid + determines the sensitivity of the controller to overflows into the grid.

Grid - and Grid + settings: the setting range is 1-32000

1=maximum sensitivity and influence on the controller.

1 and above reducing the sensitivity of the influence of CT coil values on the regulator. When set to high values, the controller will no longer take into account the values from the CT coils and will only regulate based on SOC. battery

We recommend setting the Grid - and Grid + parameters to values of around 40-60 for a system without switched on overflows to the network. Excessive sensitivity to CT values can cause unwanted oscillation of the outputs. For systems with overflows enabled, it may be desirable to set Grid + higher so that the controller makes changes to the outputs more slowly and smoothly.

Bkoef - the degree of influence of battery discharge on the controller. It indicates the sensitivity of the controller to the battery discharge power. **The setting range is 0 to -30000.**

0 = battery influence off, (in this seting the controller will extract surpluses only based on the difference between BAT. SOC and BAT set, or when overflowing into the network)

-1 = maximum sensitivity, moving further towards minus values, the sensitivity decreases and the controller allows more power to be taken from the battery.

Excessive sensitivity to the power values from the battery can cause unwanted oscillation of the outputs. It is recommended to stay with values between -30-100

Example 1 : If BAT SOC. measured 90% and BAT set required 89% - (so the regulator will want to extract excess energy from the battery), the Grid setting - will be 40, then after crossing the -40W limit of power from the grid, the regulator will stop, after crossing the -80W limit it will start to decrease and the rate of power draw on the spiral will be proportional to the amount of power gain from the network. (for example, a cloud comes or several appliances in the house are switched on at the same time and the power plant cannot detect this change).

Example 2: By setting Grid + to low values, the result is an increase in the sensitivity of the regulator to overflows. The regulator will then have minimal regard for how charged the battery is and can send power to the coils well before the battery charge reaches the BAT SET value. These overflows are often generated by the inverter before the battery is charged, and this can be caused by limiting the maximum charging current of the battery, which is below what the panels can produce.

Operation without batteries

If overflows are enabled, set the parameters of individual BAT outputs. SET. (same as SET PID OUT) to 0. The controller will start modulating (gradually adding) power, only according to the size of the flow to the network.

If overflows are disabled, set BAT. SET to -1. This setting ensures that the regulator tries to add power permanently even without overflow with respect to the values from the CT coils. If the values from the CT coils fall below the Grid setting - it waits to see if the inverter catches up with the deficit. If so, it will start adding again. If not, it will take away. The result is that the regulator will sensitively force the inverter to produce when the sun is shining, and when a cloud comes or the consumption in the house increases, the output will go down so that it does not heat the water from the network.

PID parameters

These parameters influence the behavior of the controller as a whole. It changes his behavior, mainly the speed of reactions as to the difference between BAT SOC. and BAT SET. so on values from CT coils.

P - Is the proportional component of the regulator. This is a simple amplifier. The action variable is directly proportional to the control deviation. **The higher the value of P, the more robust the controller will react to the deviation of the desired SOC. from the current SOC. battery and for changes in the values of the measuring coils / smart meter.**

I - regulator, is such a regulator where the action quantity is directly proportional to the integral of the regulation deviation. In other words, the integration takes into account the time during which the controller is outside the desired value and tries to gradually add or subtract it so that the deviation is as low as possible. **Higher setting values = faster controller response to SOC changes. and CT coil values. Lower values = slower response.**

D - controller, is such a controller where the action variable is directly proportional to the derivative of the control deviation. D setting improves the dynamic properties of the controller and the controller "damps".

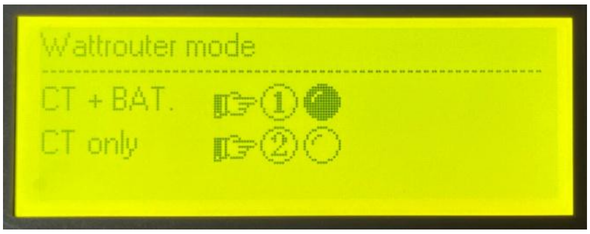
LO a HI -

parameters LO and HI are the lower and upper limits of the controller's performance. For example, if you set LO to 10% and HI to 50%, the controller will always go to the corresponding output at a minimum of 10% and a maximum of 50%. If you set both parameters to 50%, the controller will permanently deliver half the power to that output. If you set both parameters to 0%, this controller output will be permanently switched off. With this setting, the outputs can also be controlled manually.

Everything is set from the factory. If you want to change the settings, do it gradually and sensitively and always make a note of the default settings.

By combining correctly set parameters, the controller can be used for systems with enabled or disabled supply to the network with batteries or without batteries.

Wattrouter mode



Wattrouter mode selection is available for versions with PID regulation and is only valid for continuously regulated outputs.

1 - CT + Bat. the mode works in such a way that the wattrouter takes into account the amount of flow to the network (if it is enabled on the inverter) and the state of battery charge. This mode is used for power plants without permitted overflows into the distribution network.

2 - CT only mode sends power outputs only based on flow to the network. With this setting, the parameters Grid+ and Grid - represent watts. This mode may be more advantageous for power plants with permitted overflows into the distribution network.