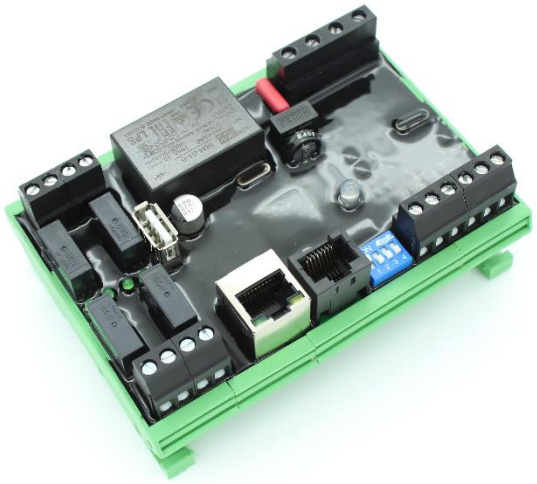
ZERO Export

“Universal ZERO export controller”



Manual
ZERO and ZEROplus

Version 1.3

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1. Introduction

Dear customer, thank you for purchasing this product. The ZERO export controller is the first controller available on the market which can control up to 10 PV inverters with ZERO export functionality. Further the ZERO can also act a general PV output controller by limiting the production.

The ZERO export controller has the following features

- Full 3 phase power measurements
- MODBUS RTU control
- MODBUS TCP control
- USB 2.0 flash drive support for data storage
- Multi-colour user LED for status information
- Integrated webserver for intuitive configuration and parametrisation

The following versions or modules are available:

- ZERO EXPORT
- MONITORING AND DATALOGGER
- POWER MANAGEMENT
- LOAD MANAGEMENT

This manual covers all versions. Version specific information is marked on version specific chapters.

Specializing in products for renewable energy, Diesel generators and hybrid power solutions, the ZERO export offers the following features standard:

- Wide range power supply input from 85 - 265 V_{AC} (50 - 60 Hz)
- Small footprint.
- Intuitive software.
- Wide temperature range of -40° – +85°.
- Industrial PUR protection coating for extra rugged environment.
- IP-68 on request.

If you have any questions or if something is unclear, you can contact us in several ways:

Per E-Mail : support@elgrispower.com

By Phone : +49 (0) 2423 9086501

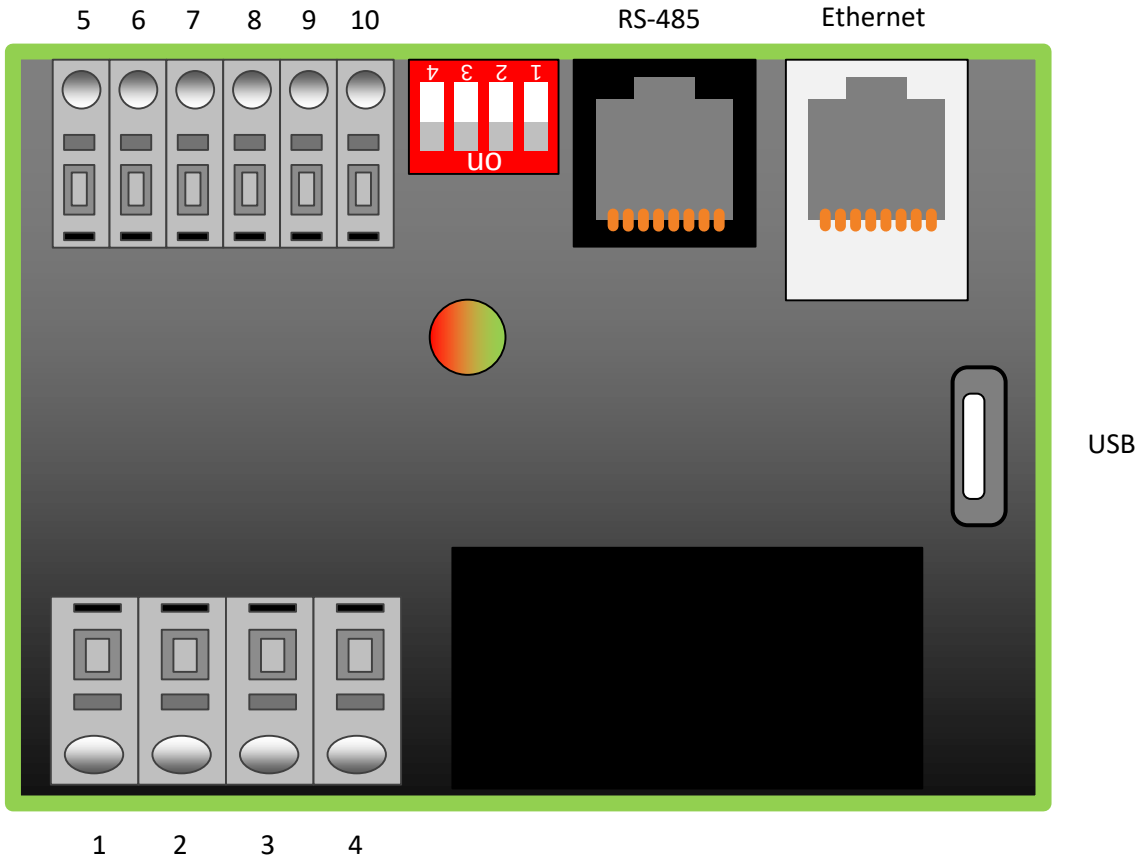
2. Installation

2.1 Safety instructions

Before installing the product in the end-installation, ensure that the device is not damages during transport and everything looks in a normal way.
All the connecting cables must not be bent or squeezed. This can result in malfunctions, short circuits and defects in the device and/or sensor connected.
Make sure that cables are not damaged when drilling or bolting in place.
The module may only be commissioned after it has been installed contact-free in a casing. This product generates high frequency. Never operate it in the vicinity of medical devices (e.g. pacemakers) and/or medical equipment (e.g. in hospitals). Look for a suitable installation site.

2.2 Device overview

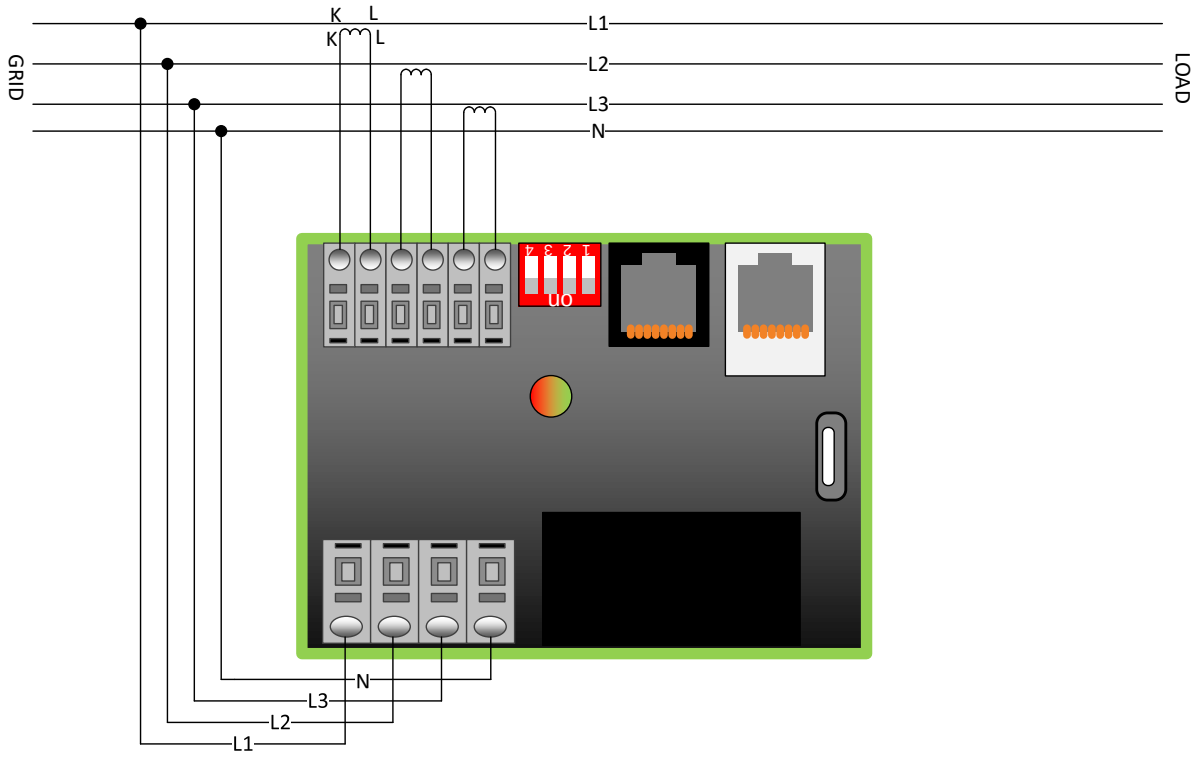
Before wiring the device, be sure that the voltage is switched off.



2.3 Pin description

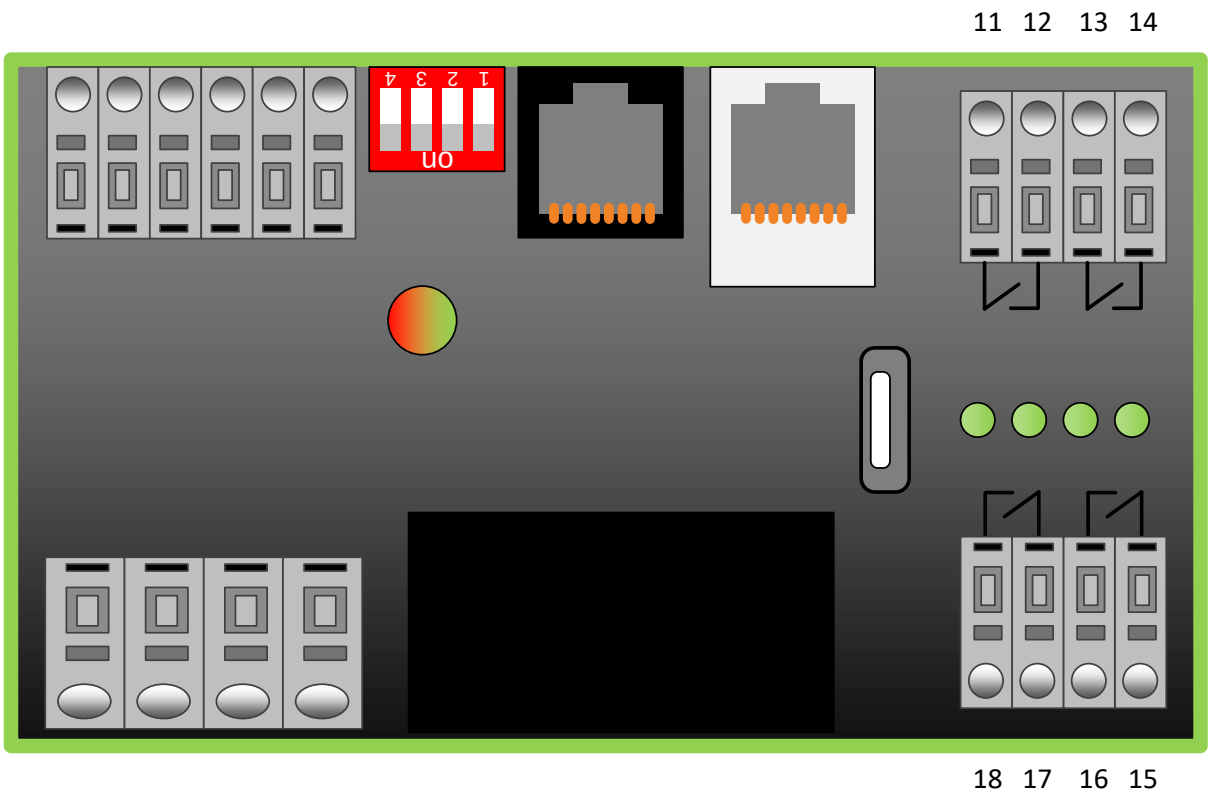
	Pin	Description	Minimum	Maximum
Voltage input	1	Phase 1 voltage input	85 Vac	250 Vac
	2	Phase 2 voltage input	85 Vac	250 Vac
	3	Phase 3 voltage input	85 Vac	250 Vac
	4	Neutral input of voltage		0 Vac
Power input	5	K input current transformer L1	0 Aac	5 Aac
	6	L input current transformer L1	0 Aac	5 Aac
	7	K input current transformer L2	0 Aac	5 Aac
	8	L input current transformer L2	0 Aac	5 Aac
	9	K input current transformer L3	0 Aac	5 Aac
	10	L input current transformer L3	0 Aac	5 Aac
Dipswitch	1	IP address selection	OFF = DHCP	ON = static
	2	System frequency	OFF = 50 Hz	ON = 60 Hz
	3	Single or Three phase	OFF = Three phase	ON = Single phase
	4	Internal use only	OFF = Default	

2.4 Wiring diagram



Please read the manual of the used inverter to check wiring scheme.
Note: Some inverters may need additional hardware

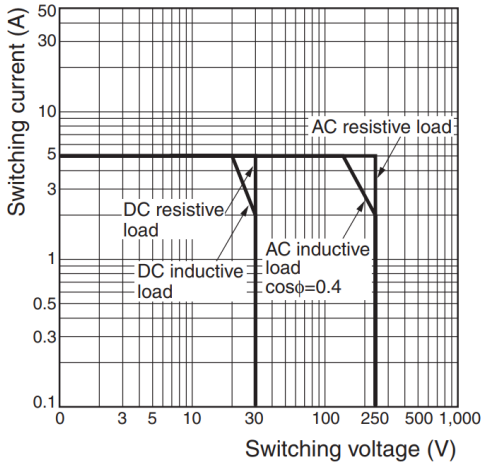
2.5 ZEROplus



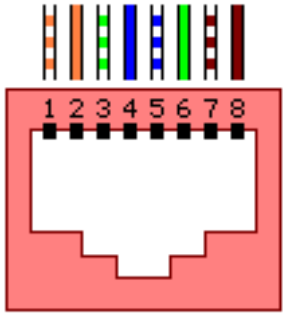
The ZEROplus is a ZERO controller equipped with 4 dry contacts to control external loads before shunting the solar output.

Channel	Pin	Electrical limit
1	11 and 12	1 A at 250 VAC, 1 A at 30 VDC, resistive load
2	13 and 14	1 A at 250 VAC, 1 A at 30 VDC, resistive load
3	15 and 16	1 A at 250 VAC, 1 A at 30 VDC, resistive load
4	17 and 18	1 A at 250 VAC, 1 A at 30 VDC, resistive load

2.5.1 Electrical rating

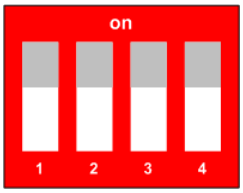


2.5 RS 485 pin out



Pin	Description
1	Not connected
2	RS-232 TX
3	RS-232 RX
4	RS-485 B (D-)
5	RS-485 A (D+)
6	GND
7	Not connected
8	Not connected

2.6 Dipswitches



Dipswitch	Description	
	OFF	ON
1	DHCP	Static IP
2	50 Hz	60 Hz
3	Three phase	Single phase
4	Not used must be OFF	

2.7 LED status

The LED on board informs the user about the internal status.

LED colour	Meaning	Action
Off	No power or internal error	Contact support
	Internal Error	Contact support
	Date and time not set, no USB data logging possible	Update date and time or check internet connection for SNTP
	Standby, no inverter online	Check inverter settings
	Controller is throttling the PV	Normal operation
	Power management active	Normal operation
	Controller is not throttling PV	Normal operation

3 Commissioning

Before starting with the commissioning of the ZERO export controller all safety precautions must be taken which apply to the rules in your country and general safety rules. Never work on a system with a running generator or connected grid and short the output of the generator (when available) before working on the power system.

Only a few settings are needed to commission the ZERO export controller.

Most important is the settings of the current transformer and the setpoint for the limitation of the power.

3.1 First time power on

Follow the following steps when the system is first time being powered.

- ☞ Set the dipswitches according to the settings required. Ensure that the IP address is known when using DHCP.

- ☞ Switch off the PV inverter, disconnect the PV inverter from the system and start the controller by applying power to L1 and N in case you use a single-phase system or L1, L2 and L3 with N for three phase systems. When the ZERO export unit is working properly, the LED is blinking green or red / green flashing in case there is no internet connection, or the time server could not be reached.

- ☞ Connect to the embedded webserver by typing the default address 192.168.1.100 in a web browser. When using DHCP type the local IP address given by the DHCP server.

- ☞ On the Menu select Settings and then enable the checkbox “Advanced Settings” to adjust the CT ratio. The CT ratio is defined as 1: value. For example, when you have a CT 5:200 the value is 40.

- ☞ When the CT ratio is changed the power readings on the overview page should match the actual power. A positive value is consumption from the grid, a negative value means exporting to the grid. When this is not correct, check the wiring of K and L of the CT. Detailed readings can be got by typing 192.168.1.100/Meter

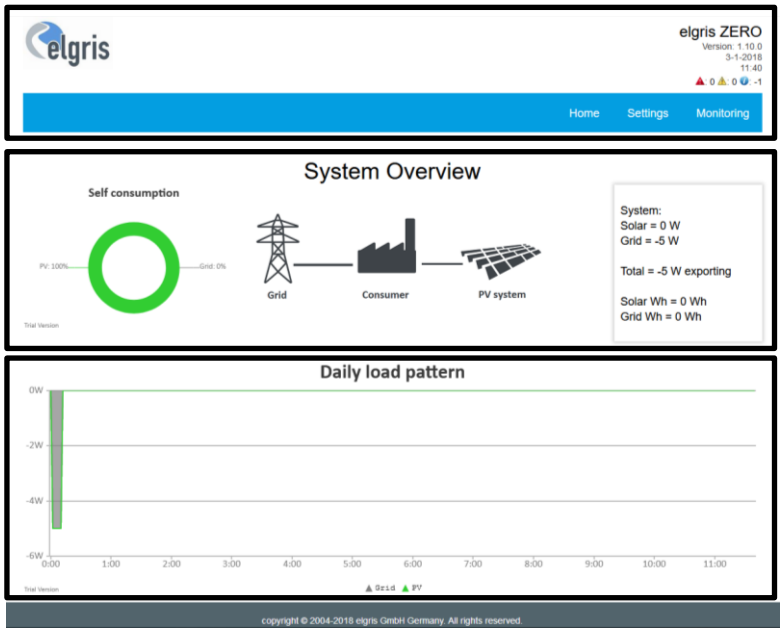
- ☞ Switch on the DC side of the PV system to commission the PV inverters. The steps to add an inverter to the system is explained on page 9.

4 Graphical User Interface

The ZERO export controller includes a webserver to adjust the system parameters and see the status of the system.

By default, the webserver can be reached by typing the IP address 192.168.1.100 in a web browser. Supported web browsers are Microsoft Edge, Google Chrome and Mozilla Firefox.

4.1 Overview



Header with status information and menu

Main area with system information

Daily chart with load and PV output

4.1.1 Header

The header on the integrated webserver gives information about the current status of the ZERO controller. Besides from the exact type it also shows the firmware version, date and time and informs the user about the status of the inverter(s).

Icon	Description
	The red icon informs about configured inverters which can not be reached by the controller. Possible causes could be wrong address, wrong wiring or not active inverter (at night)
	The warning icon informs about inverters which are configured and can be read out by the controller but are not feeding in to the grid. Possible reason could be not enough PV power available.
	The blue information icon informs the user that the configured inverters are communicating with the controller and are feeding in.

☞ Please note that not all inverters send the status information. In this case the status is ignored and only the response to the ZERO controller is considered.

4.1.2 Main area

The main area is divided into 3 parts. In the centre part, the current system layout is shown.

On the left side, the donut chart with current self-consumption informs the user about how much percent of the load is covered by the PV.

The right side includes a text box with the latest power readings and consumption from the grid as well as production from the PV.
When the controller is used in a single-phase system the grid parameters comes from L1. In case the system is configured for 3 phases, the metering data comes from the total over 3 phases.

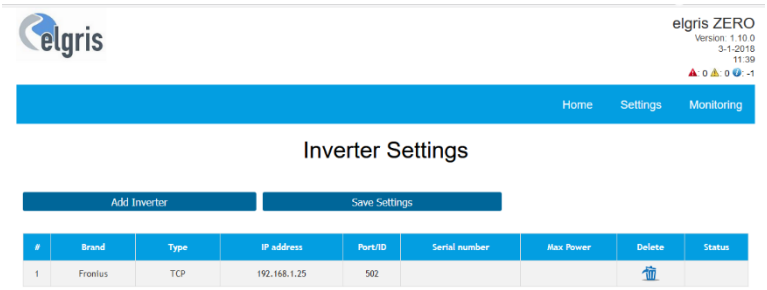
For more detailed information the /Meter command can be used.

4.1.3 Daily chart

On the bottom of the main page the daily chart is located. This chart gives an historical overview of the load (single or three phase) and PV.

The chart is only updated on page load. To update the chart, the page needs to be refreshed.

4.2 Inverter settings



After selecting the brand of the inverter which needs to be controlled, the type of communication needs to be selected. Not all communication options are available for all inverters. Please refer to the inverter support list on the website www.elgrispower.com

When selecting TCP as communication, the IP address and MODBUS TCP port (Default 502) must be adjusted. When selecting RS 485 for communication, the MODBUS slave ID must be set and the serial port settings must match the inverter settings.

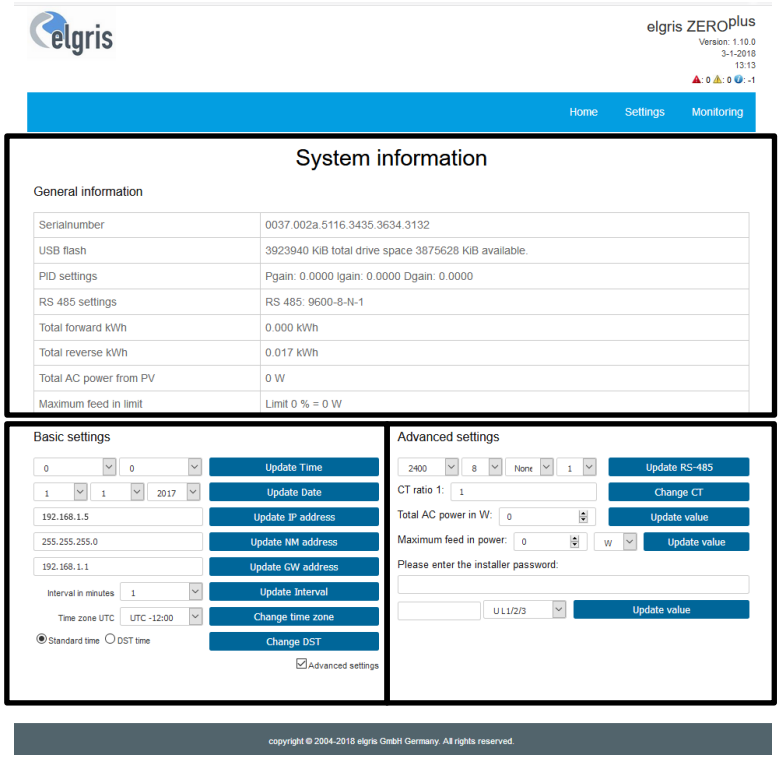
It is possible to have inverters with TCP and RTU within the same table.

When all settings are correct, they can be sent to the controller by pressing “Save settings”. Up to ten inverters can be programmed by pressing “Add Inverter”.

To delete an inverter the Delete can be pressed. First after pressing “Save Settings” the table is sent the controller and stored. To undo changed, the page can be refreshed without pressing “Save Settings”

- ☞ Every “Save settings” will reset the controller to zero and all daily values are lost.

4.3 System settings



Status information and settings for information

Basic settings like IP address and date / time

Advanced settings for RS 485 bus and control parameters

On the settings page the main settings and parameters can be changed. To enable the advanced settings, the checkbox must be selected.

4.3.1 Change the static IP settings

To change the static IP settings the IP address, Network Mask and Gateway needs to be set. Start with the IP address by typing the new address in the text field and press “Update IP Address”. The controller will store the IP address and returns to the settings page. Proceed with the Netmask and gateway.

When all three settings are correct, the controller can be restarted with a power cycle to enable the updated IP address settings.

Make sure that the new IP address is stored, otherwise the controller will not be accessible.

4.3.2 Change the time zone

When the controller has an active internet connection, the time is automatically synchronized. To adjust the time with the local time zone please select the time difference from GMT and press “Change time zone”. The DST can be used in case of daylight-saving time or not.

The controller needs to be restarted with a power cycle to update the time

4.3.3 Setting the serial baud rate

The serial port is only used in case one inverter with RS-485 is configured in the inverter table. The speed must match the speed of the inverter. Further the number of bits and stop bits must be identical.

- ☞ The parity is also defined as one bit. This means that when the parity is active (either even or odd) the number of bits must be increased with 1. For example, 8 bits with even parity means 9 bits.

4.3.4 Broadcast

The broadcast function is only used for the setpoint to send the calculated setpoint to all configured inverters at the same time. This is an important setting when there are more than 1 inverter in the table.

When there are different communication channels (TCP and RTU) within the inverter table, the setpoint is send in 2 commands, both using broadcast.

- ☞ Even when there are different inverters in terms of power within 1 configuration the broadcast can be used but the absolute power output will be different depending on the difference in power.

4.3.5 SMA Smart Meter

When this setting is enabled the ZERO controller send the metering data with the SMA protocol to the inverters. This function can only be used when there are SMA inverters handling the requests. When there are no SMA inverters in the inverter table, or when this capability is not needed it can be disabled.

4.3.6 SMA turbo

The SMA Smart Meter protocol data can be send at 2 times the normal speed to increase the control speed for SMA inverters.

4.3.7 VT value

The VT value is for a voltage transformer can has a 1-digit accuracy. When there is no voltage transformer this value must be 1,0.

4.3.8 CT value

The CT value is for the current transformer ratio and is defined as 1: value. For example for 5:200 CT the CT value is 40. To measure the secondary current directly, the CT value can be set to 1.

- ☞ The CT and VT values can be used to compensate for any losses within the circuit. Detailed power metering data can be obtained by using the /Meter URL.

4.3.9 Setpoint

The setpoint is used the calculate the operating point of the inverters depending on the load and PV production.

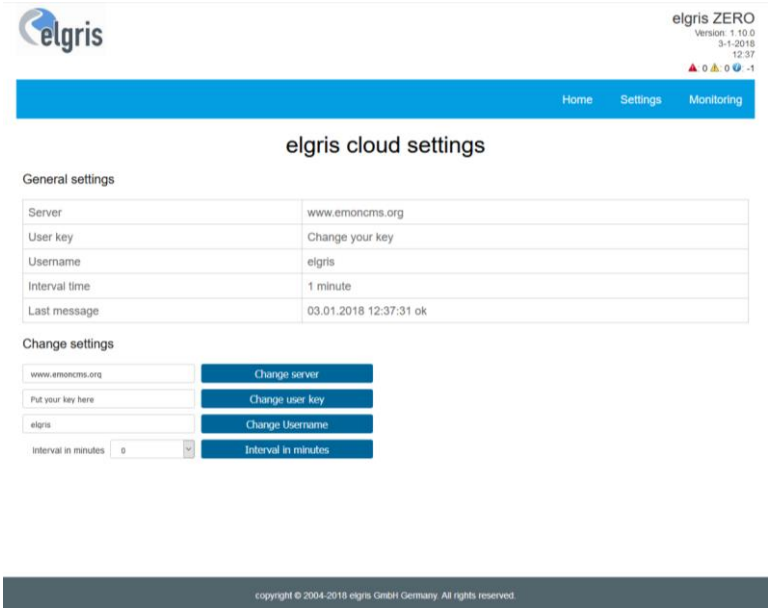
There are different ways to set the setpoint. The main criteria is if the ZERO controller is connected to a single phase installation or PV inverter or a three phases system.

In all cases the % setpoint is not taken for the control setpoint itself, but only for selecting of the actual value. Ensures to set the correct level with the W setpoint.

Dipswitch 3	Setpoint in %	Setpoint in W	Description
ON	-	-	When dipswitch 3 is on, the controller used L1 for control. There are no special settings.
OFF	-	-	With dipswitch 3 OFF, three phases mode is selected. There are 2 options now. Either the controller takes the lowest phase out of L1, L2 or L3 or it takes the sum (total power).
OFF	Not equal 70%	User setting	When the setpoint is not equal to 70%, the lowest phase is taken.
OFF	70% then W	User setting	When the setpoint is first set to 70% and then the requested W is set, the controller takes the total power for control. This is called EEG mode.

☞ To select between the total power or lowest phase, first the setpoint in % must be set to 70% for all phases or 0% for lowest phase. As the second step the wanted setpoint can be set with the W setpoint.

4.4 elgris cloud



With the elgris cloud you can store data on the open source platform emonCMS. This enables the user to have a cloud solution where all data can be visualised and transferred on other mediums.

The emonCMS software can run on the open source server, a self-hosted server or local server like Raspberry PI.

elgris is offering the hosting under ecloud.elgris.de as a service. More information can be found in the eCloud manual.

To start logging, you must fill out the server address with its hostname, the user key for security and optional a user name when you want to log more data under the same account.
With the interval time you can set the time between each update interval. By setting the time to zero, the data logging to the remote sever stops.

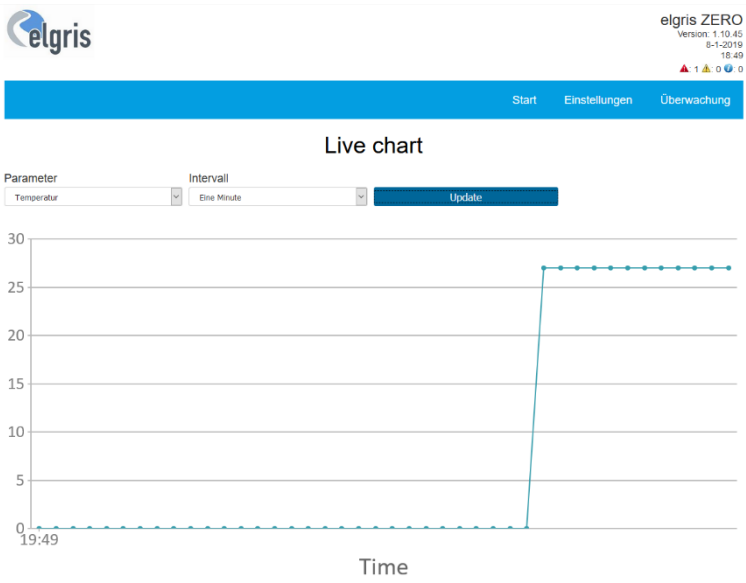
The response of the communication is displayed as last messages. When everything is working fine, the message ”Ok” will be displayed here.

4.5 Live chart

The live chart shows the selected channel data with a one second interval over a fixed time window. The user can select a one, fife or fifteen minutes windows.

The live chart data is not stored and only displayed on the chart. When the page is refreshed, or the channel is changed, the chart is cleared.

☞ To compare multiple channel, the live chart page can be open multiple times. It is advised not to open a maximum of 2 browser tabs.

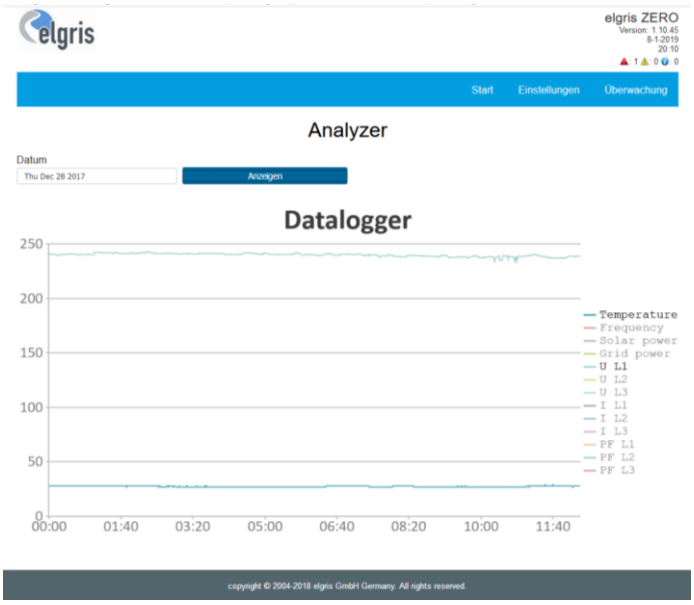


4.6 Data logger

The data logger uses the data stored on the installed USB flash drive. When there is no flash drive available, the data logger will not show any data and return an error.

Select the date to display and press “Shown”

In the list on the right side, the requested channel can be selected.



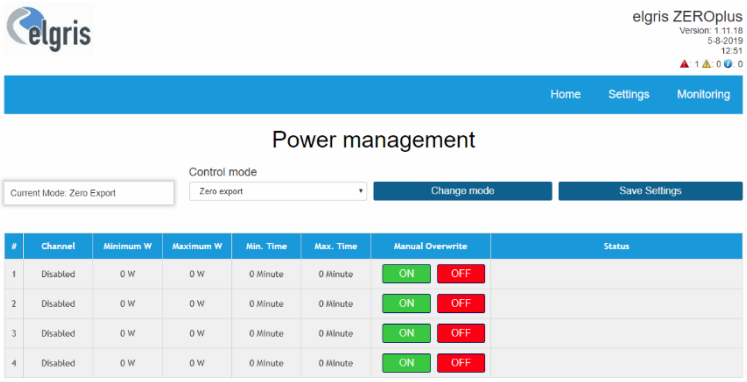
4.7 Performance

On the performance page the daily produced PV energy is displayed together with the AC consumption in a bar graph. The data is taken from the USB flash drive and at least 2 full days of data logging needs to be available.

Select the requested period and press “Show”

4.8 ZEROplus

The elgris ZEROplus can control 4 dry contacts based on the internal measurements for the active power on all phases, phase 1, 2 or 3. When a supported PV inverter is connected to the system, the actual output of that inverter or the sum of all inverters can be used as a control input as well.



- ☞ To enable the power management, the control mode must be set to “Power Management”. Press the button “Change mode” to update the control mode before setting the rest of the parameters.
- ☞ Select the input channel for the desired output
- ☞ Set the minimum load to trigger the dry contact
- ☞ Set the maximum load to trigger the dry contact (future function)
- ☞ Set the minimum time the dry contact should be active to prevent the output from instability
- ☞ Set the maximum time in case the load requires this (future function)
- ☞ Repeat the above steps or press “Save settings” to store the settings permanently

The output control becomes directly active and as soon as one threshold level is trigger, the corresponding output is set or reset.

By default, the output is active closed and open when not triggered. To inverter this signal an external relay or similar device is needed.

Example: The dry contact should become active when the total export to the grid is more than 1500 W to switch on a water heater with 1,500 W and should remain on for at least 10 minutes:

#	Channel	Minimum W	Maximum W	Min. Time	Max. Time	Manual Overwrite	Status
1	AC Total	-1500 W	0 W	10 Minutes	0 Minute	ON OFF	

The manual overwrite will switch on the output directly and remains active unless OFF is pressed, whereby the status will inform about the current mode. (future version)

Please note that the dry contact output can only switch a limited amount of power and must never be used to switch a load direct.

5 Adjusting the PID settings

The elgris ZERO controller has a real time PID controller to adjust the amount of PV power within the system. By setting one value to zero, P, PI or PID controllers can be set. For standard applications, the PI controller is a good starting point.

The PID controller takes the current power value (single or three phase) as current value and the setpoint as desired value.

The settings for P, I and D can be changed according to the application. Please note the following:

- ☞ The P value is the proportional gain of the error between setpoint and current value. The higher the P value, the more the controller will react to a change of load.
  When the solar system over reacts on load changes, the P factor is too high. The other way around, when the response is not high enough, the P factor is too small.
- ☞ The I value is the integrated value of the past error over time. The longer and error exist, the more the I part will affect the output.
  When the reaction time on a load change is too slow, the I factor is too low. Opposite, when the system is unstable (oscillating around a value) the I factor is too high.
- ☞ The D value is for future trends. When there are big load changes in a very small time interval this can be compensated by adding some D factor. The D factor only has influence on load changes and not in a steady system.
- ☞ The values entered on the settings page are divided by 1000.

5.1 Manual tuning

If the system must remain online, one tuning method is to first set I and D values to zero. Increase the P until the output of the loop oscillates, then the P should be set to approximately half of that value for a "quarter amplitude decay" type response. Then increase I until any offset is corrected in enough time for the process. However, too much I will cause instability.
Finally, increase D, if required, until the loop is acceptably quick to reach its reference after a load disturbance. However, too much D will cause excessive response and overshoot. A fast PID loop tuning usually overshoots slightly to reach the setpoint more quickly; however, some systems cannot accept overshoot, in which case an overdamped closed-loop system is required, which will require a P setting significantly less than half that of the P setting that was causing oscillation.

Parameter	Rise time	Overshoot	Settling time	Steady-state error	Stability
P	Decrease	Increase	Small change	Decrease	Degrade
I	Decrease	Increase	Increase	Eliminate	Degrade
D	Minor change	Decrease	Decrease	No effect in theory	Improve if small

5.2 Ziegler–Nichols method

As in the method above, the I and D gains are first set to zero. The proportional gain is increased until it reaches the ultimate gain, Ku, at which the output of the loop starts to oscillate. Ku and the oscillation period Tu are used to set the gains as follows:

Control type	P value	I value	D value
P	0,50 * Ku	-	-
PI	0,45 * Ku	0,54 * Ku / Tu	-
PID	0,60 * Ku	1,20 * Ku / Tu	3 * Ku * Tu / 40

6 Firmware update

6.1. Introduction

This document describes how to upgrade the firmware in the elgris controller. Please read every step carefully. Not following this document could permanently damage the device.

☞ Please ensure that the power supply is stable. When the power is interrupted during the upgrade process, the controller could be damaged.

☞ Only upgrade from a local location. Although the Ethernet protocol also can be used from remote, it is advised not to do this due to delays in the transmission.

6.2 Connecting with the controller

The standard IP address of the controller is 192.168.1.100. When another address is used, please replace the IP address with the correct address.

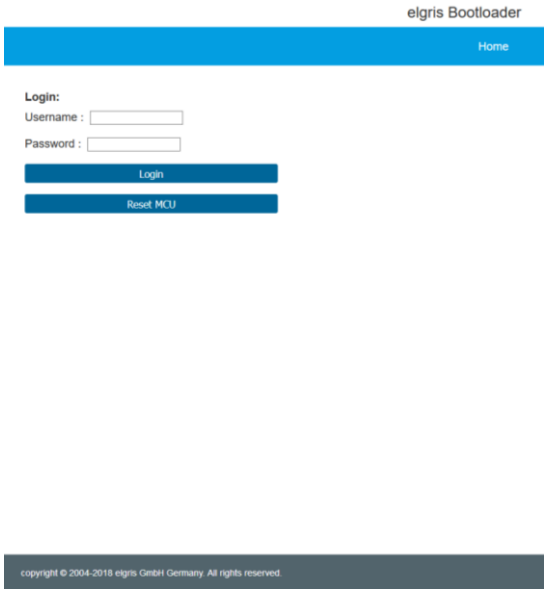
Open the overview of the controller by opening http://192.168.1.100
When the overview screen appears, the connection is working, and you can proceed with the next step.

☞ Close all browsers windows and make sure no other connection with the controller is active. This will interfere with the bootloader and can permanently damage the controller.

6.3 Start of the boot loader

The boot loader can be started by opening http://192.168.1.100/Bootloader
After pressing Enter, the boot loader will be started and the connection gives a time out.

Wait around 15 seconds and go back to the start http://192.168.1.100
Now the boot loader screen will be shown:

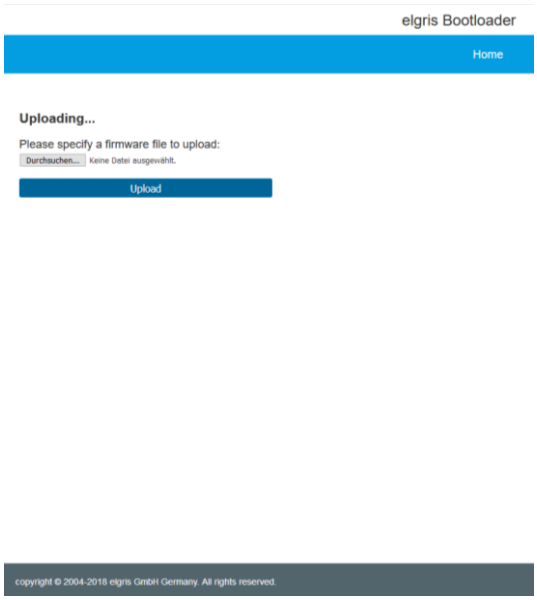


6.4 Login

To login use the credentials which come with the new firmware

6.5 Select new firmware

Press “Choose” to select the new firmware file and press “Upload”



6.6 Reset the controller

After successful updating of the firmware the following screen is shown. To activate the new firmware press “Reset controller”.

☞ Other ways of resetting the controller will permanently damage the controller.