ePowerControl SD
User Manual

Version 2.0 (2024)

Index

1. GENERAL INFORMATION

1.1. About this manual

The purpose of this manual is to provide the users with **all the necessary information to install, configure and operate the ePowerControl SD**. It includes product information, safety instructions, as well as installation and configuration guidelines.
This document is dedicated to :

- EPC of new hybrid PV/Genset
- EPC of PV power systems on existing genset based power systems
- Anyone involved in the design, installation and maintenance of hybrid power systems

The two following symbols will help the reader navigate through the document by highlighting important information from the general text:

Warning
A Warning sign indicates a hazardous situation that could result in death or serious injury. It will often involve precautions and guidelines to avoid it.

Notes
Notes provide general information for the reader to keep in mind.

1.2. Glossary

APN address	Gateway between a GSM, GPRS, 3G or 4G mobile network and another computer network
AWG (12 wires)	American wire gauge
CT	Current Transformers detect electric current in a wire & generate a proportional signal
DHCP mode	Dynamic Host Configuration Protocol to assign IP addresses
DIN rail	Standard metal rail used for mounting industrial control equipment inside equipment racks
EMS	Energy Management System
EPC	Company that handles the Engineering, Procurement & Commissioning of projects
I/O module	Input/Output module

ICMP	Internet Control Message Protocol
LAN ports	Ports for a Local Area Network
Local NEC rules	National Electrical Code
Modbus RTU	Communication protocol to connect a supervisory computer with a remote terminal unit (RTU)
Modbus TCP	Communication protocol to connect a supervisory computer with a remote terminal unit through Ethernet with a transmission control protocol (TCP)
OCPP	Open Charge Point Protocol for communication between electric vehicle charging stations and a central management system
RS-485	Standard electrical characteristics of drivers and receivers in serial communications systems
SCADA	Supervisory control and data acquisition
SNMP	Simple Network Management Protocol (SNMP) is an Internet Standard protocol for collecting and organizing information about managed devices on IP networks and for modifying that information to change device behavior.
UDP ports	Ports for User Datagram Protocol
UPS	Uninterruptible power supply, providing emergency power to a load when the input power source or mains power fails

1.3. Legal information

The company Elum SAS, whose registered office is located at 9 rue d'Enghien - 75010 PARIS and registered with the Paris Trade and Companies Registry under number 817 860 083, integrates and distributes monitoring and control panels for photovoltaic and hybrid installations marketed under the names "ePowerLog" and "ePowerControl".

Elum controllers and data loggers are made in France. Elum guarantees they meet the french quality standards, technical criteria and quality requirements.

The English version of the document prevails if any discrepancy appears in a translated version.

1.4. Safety warnings

Please read this manual carefully before handling the ePowerControl to avoid injuries, equipment damage, or any hazards.

Elum ePowerControl products are electrical devices. The installation and operation should only be conducted by authorized personnel aware of the risks involved.

Installation of meters
Voltage-carrying parts. Risk of heart attack, burns and other injuries. Disconnect the power supply and charge the device before installing the analyzer. Protect the terminals with covers. The power meters must be installed by qualified/approved personnel.

Internet access
A stable internet access is required to perform the commissioning of ePowerControl.

Dangerous voltage
Do not touch the voltage and current terminals. Always connect grounding terminals. Do not disconnect the controller's CT terminals. Be careful to protect the unit from electrostatic discharges during the installation.

Monitoring and control features
Elum can only guarantee the monitoring and control of the site according to its product features once all of the equipment to be monitored and controlled have correctly been configured and connected to the SD controller.

Reverse Power Protection
ePowerControl is NOT an electrical protection. It does not replace an adequate protection of diesel generators against power reversal, nor a properly configured/installed protection relay, nor a properly configured/installed genset controller integrating the reverse current protection functionality. If necessary, please install protection relays against reverse power.

2. HARDWARE

This section describes the hardware of the ePowerControl SD series.

2.1. Communication ports

2.1.1. Serial ports

Two serial ports (RS232/422/485) are available on the bottom side of the controller :

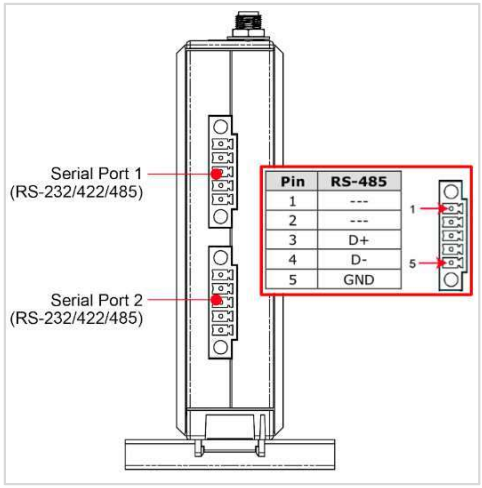


Fig. 1: ePowerControl SD bottom view

The correct identification of serial ports and pins is key to avoid communication issues.

2.1.2. Ethernet ports (LAN)

Two LAN ports are available on the front side of the controller.

However, only LAN port 1 can be used to connect to slave devices and/or to the internet.

LAN port 2 is dedicated to local configuration of the device, using eConf.

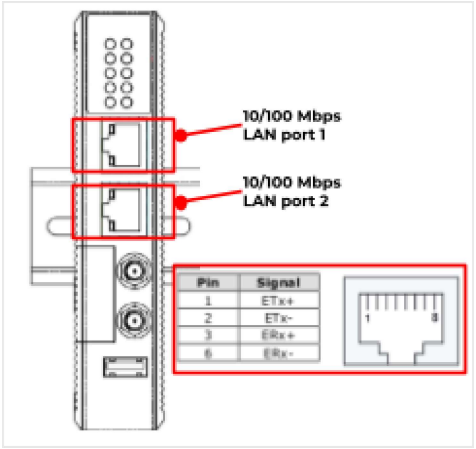


Fig. 2: ePowerControl SD front view

2.2. Led description

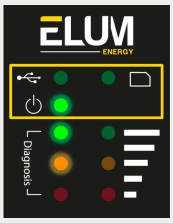
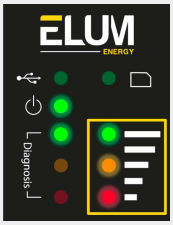
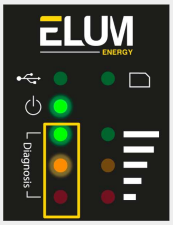
				**Diagnosis**
System LEDs 	ON	ON	ON	⚠ The device must not be turned off
	ON	- -	- -	The device is powered up
	- -	ON	- -	USB device is connected and working normally
	- -	- -	ON	SD Card inserted and working normally
Right LEDs: Network LEDs 	**Red light**	**Orange light**	**Green light**	**Diagnosis**
	Blinking	- -	- -	No internet connection
	OFF	OFF	ON	Internet access via Ethernet OK
	ON	OFF	OFF	Internet access via 3G,4G,GSM / Quality reception < 25 %
	ON	ON	OFF	Internet access via 3G, 4G, GSM / Quality reception between 25 % and 50%
	ON	ON	ON	Internet access via 3G,4G,GSM / Quality reception > 50%
Left LEDs: Diagnosis LEDs 	**Red light**	**Orange light**	**Green light**	**Diagnosis**
	Blinking	- -	- -	Local data retrieval system = inactive Connection to Elum server = inactive
	- -	- -	ON	Local data retrieval system = functioning
	- -	- -	OFF	Retrieval system and/or Local database = inactive
	ON	ON	- -	Connection to Elum server = not fully established
	OFF	ON	- -	Connection to Elum server = active
	ON	OFF	- -	Connection to Elum server = inactive

Table 1: ePowerControl SD Led description

2.3. Inputs / outputs modules

The IO modules can be connected to the SD controller via the available communication ports, in order to enable the acquisition of :

- Current input : 0~20 mA, 4~20 mA, ±20 mA
- Voltage Input :±150 mV ±500 mV ±1 V ±5 V ±10 V, 0~150mV, 0~500 mV, 0~1V, 0~5V, 0~10V
- Dry contact
- Wet Contact
- Pt100 or Pt1000 : Temperature sensors
- Current transformers input : 0-5A
- etc.

3. INSTALLATION AND CONNECTION

This section describes the steps for the ePowerControl SD installation as well as its connection with the slave devices.

3.1. Installation

Installation location
The ePowerControl enclosure is designed for indoor installations. For outdoor installations, special housing must be provided when placing the order.

Internet access
The autonomous deployment of ePowerControl as well as any maintenance intervention by Elum engineers requires a stable connection to the Internet. The enclosure must be installed in such a way that it has a reception quality at least at Edge level for wireless connection, or at least an equivalent quality on the local network for wired connection.

3.1.1. Installation of the ePowerControl SD when in kit

ePowerControl SD should be installed on a DIN rail.

To avoid the Central Computing Unit overheating, consider a 15 cm cooling area on each side of it.

3.1.2. Installation of the ePowerControl SD when in Elum casing

The manufacturer's enclosure plan can be provided by Elum upon request. To wall-mount the ePowerControl enclosure follow these steps:

- Facilitate the access to the mounting holes by removing the 4 nuts fixing the mounting plate to the enclosure
- Mount the Base station to the wall using appropriate screws and wall plugs
- Set back the mounting plate into the enclosure

3.2. Power supply

Power source
The power source supplying the controller must be taken from the load side, in order to ensure continuous power supply at all times (during both operating modes "Grid-tied mode" and on "Genset Back-up mode").

UPS
For ePowerControl SD, the use of UPS is mandatory.

3.2.1. Power supply when in kit

The power supply must deliver the following:

Input voltage	**12 to 24 VDC**
Input Current	**480 mA @ 12 VDC** **225 mA @24 VDC**
Power Consumption	**5,4 W**

Table 2: ePowerControl SD Power Supply Parameters

The power supply connector is on the top side of the device.

The shielded ground (protected ground) contact is the top contact of the 3-pin power terminal block connector as shown in the figure.

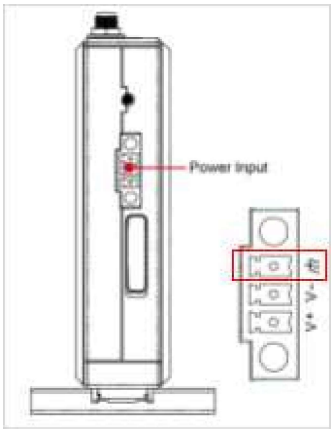


Fig. 3: Power supply connector

1. Connect the "terminal block to power jack converter" (in the package) to the Central Computing Unit DC terminal block, followed by the power adapter.
2. Connect the shielded ground wire to an appropriate grounded metal surface.

It takes about 30 seconds for the system to boot up.
Once the power supply is connected, the power LED will light up.

After 60 seconds, the operating system will be ready, and the power LED will turn solid green.
Please refer to the Led description section for more details.

3.2.2. Power supply when in Elum casing

ePowerControl SD might come in a pre-erected Elum casing. Power connectors have already been wired to a single screw terminal block on the left side of the DIN Rail.

To power up the electrical enclosure, use the screw terminal block. Allowed voltage ranges from **100 to 240 Volts AC**, and the device may use **1.30 A** maximum.

1. Connect the phase wire to the red/brown wire,
2. Connect the neutral wire to the blue wire,
3. Connect the ground wire to the green/yellow wire,
4. If a UPS was provided with the ePowerControl, connect the battery red/black wire to the transformer,
5. Close the circuit breaker, the power LED will light up.

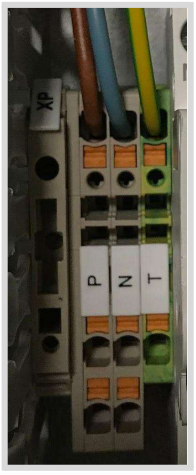


Fig. 4: Terminal block and circuit breaker overview

It takes about 30 seconds for the system to boot up.
Once the power supply is connected, the power LED will light up.
After 60 seconds, the operating system will be ready, and the power LED will turn solid green.
Please refer to the Led description section for more details.

3.3. Internet connection

ePowerControl SD offers two ways to connect to the internet.

3.3.1. Cellular internet connection

The SD controllers are equipped with a SIM card slot, and two wireless antennas connectors as shown in the figure below.

The GSM/3G kit is pre-embedded in the Central Computing Unit. A SIM card with a subscription to a valid “data” contract is needed.

To connect the device to internet through the SIM Card :

1. Turn off the SD controller.
2. Connect the two wireless antennas to the dedicated connectors (W1 and W2).
3. Open the cover of the SIM card slot with a screwdriver.
4. Insert the SIM card. You’ll hear a click.
5. Close the cover.
6. You may now turn on the controller.

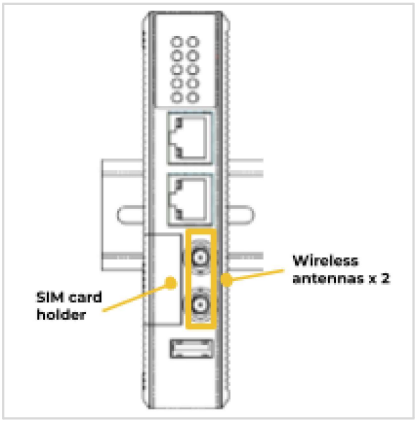


Fig. 5: Cellular internet connection accessories

The device must be turned off each time a SIM card is inserted or removed from the SIM card slot.
In case of SIM card replacement, it is necessary to perform an empty start of the device.

3.3.2. Wired internet connection

Elum devices can be connected to wired internet through the LAN port 1.
A switch can be connected to LAN port 1 if more LAN ports are needed.

In order to connect to Elum’s back end, the following outgoing ports must be open:

- ICMP
- TCP ports: 53, 80, 443, all ports from 1198 to 1210, 4505 and 4506
- UDP ports: 53, 123, 1195, all ports from 1198 to 1210.

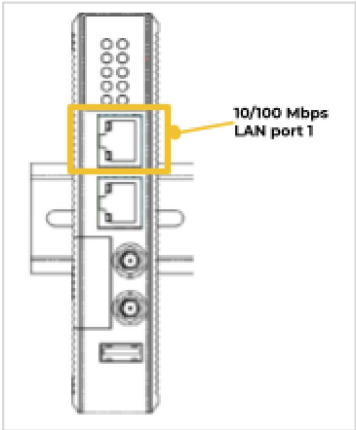


Fig. 6: Wired internet connection port

3.4. Slave devices connection

ePowerControl SD can connect to slave devices both through serial and Ethernet, using Modbus RTU and TCP protocols.
Please refer to the option relevant to your application.

For both options, it's highly recommended to use a surge protection to avoid any issues on the communication ports.

3.3.1. Communication architecture

The communication plan should be defined before proceeding to the commissioning to avoid any communication issues related to the design of the network.

The network design should take into consideration communication protocols wiring limitations and each device communication setup options.

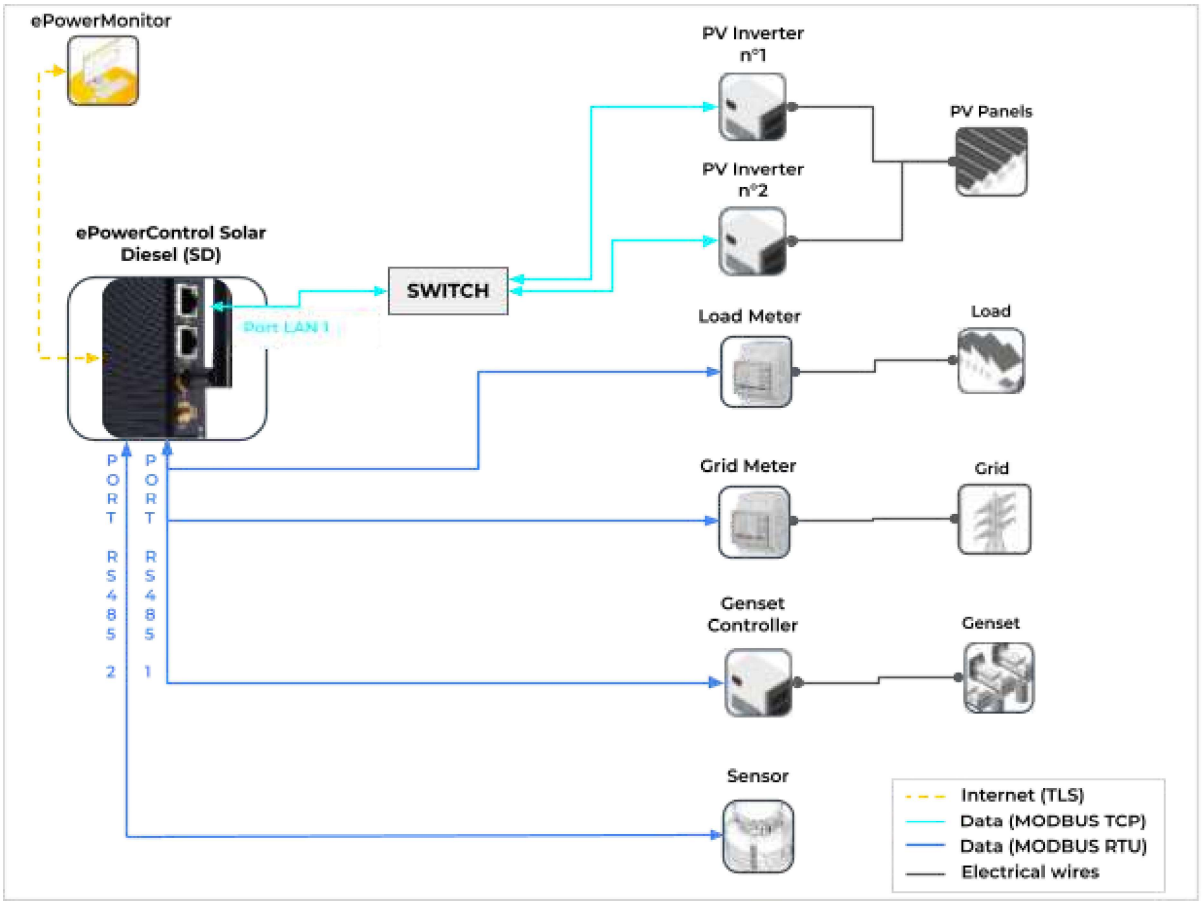


Fig. 7: Example of a communication architecture

Please note that LAN port n°2 of the Central Computing Unit cannot be used for monitoring and control purposes. It is dedicated to connecting to the Elum configuration tool (eConf).

3.3.2. RS485 Constraints: Configuring Slave ID Addresses

Please carefully follow the instructions below for a correct configuration of the slave devices IP addresses :

- Every device should have a unique slave ID
- All units connected to the same serial port should use the same communication protocol and the same parameters (Baud rate, parity, byte size and stop bits).
- The total length of the cable must not exceed 1200 m.

Example *(architecture above)*

Device	Protocol	Slave ID	Baud Rate	Byte Size	Parity	Stop Bit
Grid Meter	Modbus RTU	1	9600	8	Even	1
Load Meter		2	9600	8	Even	1
Genset Controller		3	9600	8	Even	1
Sensor		1	9600	8	Even	1

Table 3: Example of serial slave devices addressing

3.3.3. Ethernet (LAN) Constraints: Configuring IP Addresses

Please carefully follow the instructions below for a correct configuration of the slave devices IP addresses :

- Every device should have a unique IP address.
- Every device must be in the same sub-network as the Elum Explorer.
- The sub-network cannot be 192.168.4.XX, which is reserved for configuration over LAN port n°2.
- The following Subnet Mask should be configured on each device: 255.255.255.0
- The total length of the cable must not exceed 300 m.

Example (*architecture above*)

Device	Protocol	Slave IP address
Inverter n°1	Modbus TCP	192.168.3.200
Inverter n°2		192.168.3.201

Table 4: Example of ethernet slave devices addressing

3.3.4. Connecting devices through serial (Modbus RTU)

There are two serial ports (RS232/422/485) in the ePowerControl SD.

Compatible RS485 devices can be connected to serial ports of the SD Central Computing Unit using two shielded twisted pair connectors.

Please refer to the connect & config guide for more specific details on how to connect and configure your device.

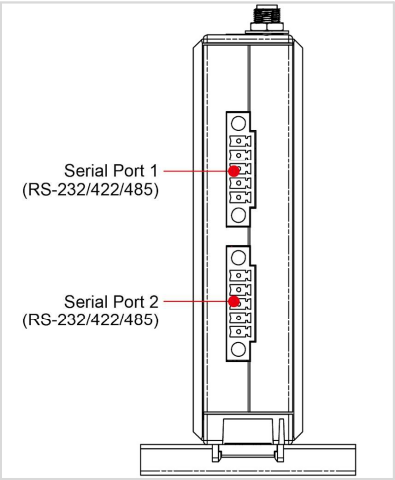


Fig. 8: Serial ports

Multiple devices can be connected to the same serial ports as shown in the following figure:

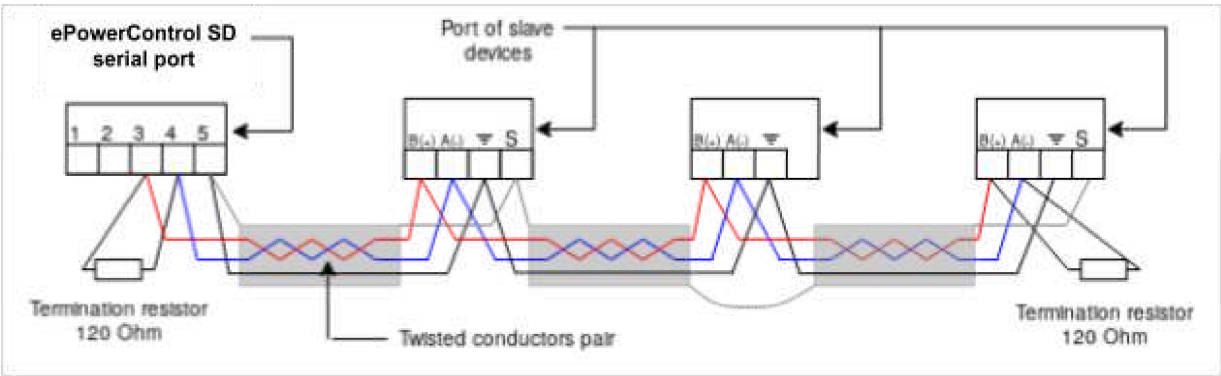


Fig. 9: Daisy-chain for RS-485 serial communication

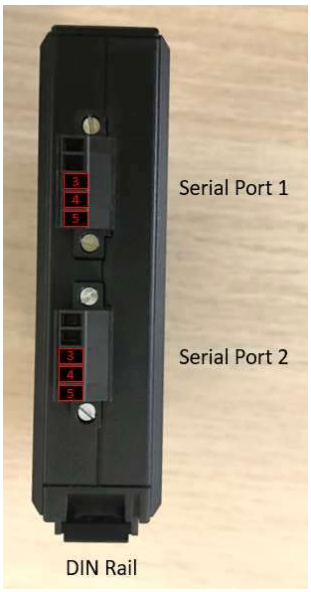
Below detailed description of the serial connection to the controller :

- **Serial ports identification**

The correct identification of the serial ports and pins is key to avoid communication issues.

A wrong wiring can damage communication ports.

Please refer to the following figures for reference :



Pin	RS-232	RS-422	RS-485
1	TXD	TXD+	---
2	RXD	TXD-	---
3	RTS	RXD+	D+
4	CTS	RXD-	D-
5	GND	GND	GND

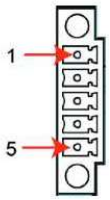


Table 5: Pins and communication port attribution

- **Wiring**

The wiring of the RS-485 serial line should be done according to the following guidelines:

1. The pin 3 of the serial port should be connected in a daisy-chain with all the dataB(+) ports on the devices to be connected.
2. The pin 4 of the serial port should be connected in a daisy-chain with all the dataA(-) ports on the devices to be connected.
3. The dataB(+) and dataA(-) should be a twisted pair of wires in order to prevent generated electromagnetic interference.
4. The pin 5 of the serial port should be connected in a daisy-chain with all the GND ports on the devices to be connected.

To facilitate the wiring and prevent errors, it is recommended to use the same color for the wires all over the installation *(example: red for all the daisy chained dataB(+) wires, blue for all the daisy chained data(-) wires and black for all the daisy chained GND wires)*.

- **Termination of data wires**

At each end of the data wires, it is important to install line termination resistors, connecting the dataB(+) and dataA(-) (as indicated in the figure 9 above).

The termination resistors impedance (usually 120 Ohm) should be compatible with the communication wire impedance .

- **Shield**

It is recommended to use shielded wires for the RS485 connections. In this instance the shield should be electrically continued throughout the serial connection, and connected to the GND wire of the RS-485 circuit at the controller (meaning pin 5).

To prevent ground loops, it must be avoided to have multiple connections of the shield to the ground. The only connection of the shield and the other wires should be at the level of the controller with the GND wire as mentioned before.

The use of unshielded data wires should be minimized to limitate eventual interferences.

- **Important notes on the RS-485 connections**

In addition, here are some major points to take into account for RS-485 connections:

- Up to 10 devices may be connected to a single port by daisy-chaining RS-485 connections.
- For each port, the total length of cable between the controller and the farthest external device may be up to 1.2 km of RS-485-compatible cable.

⚠	Failure to follow all the instructions hereinabove, including the need for termination resistors, proper grounding and shielding, will result in unreliable communication with external devices, worsened performance, and possibly equipment damage.

⚠	Shield continuity must be provided along the communication line using the dedicated third party hardware to connect, and must be grounded at a single point.

ⓘ	For lines longer than 100m, the use of a 120 Ohms termination resistance is strongly recommended. In this case, the resistance must be placed between the D+ and D- ports of the Central Computing Unit RS485 port.

3.3.5. Connecting devices through Ethernet (Modbus TCP)

LAN1 is the port dedicated to connecting the devices through Ethernet. Use a RJ45 cable to connect the LAN 1 to your device.

A switch *(optionally included in the box)* can be connected to LAN port 1 if more LAN ports are needed.

ePowerControl can communicate with Ethernet devices in Modbus TCP/IP, for monitoring and control purposes. The Ethernet devices need to be configured as slave devices. ePowerControl is the master.

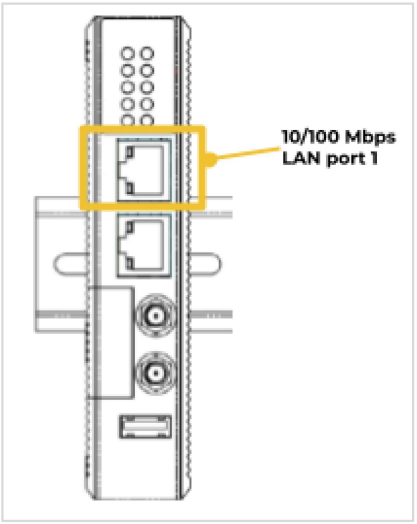


Fig. 10: Ethernet ports

3.5. Slave devices configuration

3.4.1. Configuring Solar Inverters

Some inverters may need the activation of RS485 control features. To configure your inverter, please refer to the manufacturer's instructions and to the Device Connection & Configuration Specific Instructions provided by Elum.

Elum ePowerControl communication with PV inverters must be enabled in order to :

- Control the PV inverters' active power injection,
- Data acquisition for monitoring purposes,
- Collect active power output measurements,
- Send setpoints,
- Collect accessible measurements.

The table below lists all the accessed variables.

Elum Name	Description	Max Access
W	Total active power	Read Only
WphA	Active power phase A	Read Only
WphB	Active power phase B	Read Only
WphC	Active power phase C	Read Only

VAR	Total reactive power	Read Only
VARphA	Reactive power phase A	Read Only
VARphB	Reactive power phase B	Read Only
VARphC	Reactive power phase C	Read Only
VA	Total apparent power	Read Only
VAphA	Apparent power phase A	Read Only
VAphB	Apparent power phase B	Read Only
VAphC	Apparent power phase C	Read Only
Hz	Frequency	Read Only
AphA	Current phase A	Read Only
AphB	Current phase B	Read Only
AphC	Current phase C	Read Only
PhVphA	Line voltage phase A	Read Only
PhVphB	Line voltage phase B	Read Only
PhVphC	Line voltage phase C	Read Only
Status	Solar inverter status	Read Only
Operating Mode	Solar inverter operating modes	Read Only
Alarm	Solar inverter alarms	Read Only
WSet	Solar inverter maximum active power setpoint	Read / Write

Table 6: Solar inverter variable accessed

RS1	Each inverter must allow Modbus RTU or TCP communication
RS2	Each inverter must allow active power setpoint communication via Modbus RTU or TCP

Table 7: Requirement for solar inverter

3.4.2. Configuring Genset Controllers

To configure remote communication or activate the reverse power protection on a given genset controller, please refer to the manufacturer's instructions and to the Device Connection & Configuration Specific Instructions provided by Elum.

Reverse power protection
The controller includes the minimum genset loading feature which ensures a certain level of reverse power protection, but not entirely. It's therefore important to install a Reverse power protection.

Elum ePowerControl communication with the genset must be enabled through the genset or the genset controller, in order to :

- Monitor the safe operation of the genset,
- Data acquisition for monitoring purposes,
- Collect Active power output measurements,

The table below lists all the accessed variables.

Elum Name	Description	Max Access
W	Total active power	Read Only
WphA	Active power phase A	Read Only
WphB	Active power phase B	Read Only
WphC	Active power phase C	Read Only
VAR	Total reactive power	Read Only
VARphA	Reactive power phase A	Read Only
VARphB	Reactive power phase B	Read Only
VARphC	Reactive power phase C	Read Only
VA	Total apparent power	Read Only
VAphA	Apparent power phase A	Read Only
VAphB	Apparent power phase B	Read Only
VAphC	Apparent power phase C	Read Only
Hz	Frequency	Read Only

AphA	Current phase A	Read Only
AphB	Current phase B	Read Only
AphC	Current phase C	Read Only
PhVphA	Line voltage phase A	Read Only
PhVphB	Line voltage phase B	Read Only
PhVphC	Line voltage phase C	Read Only
Status	Genset status	Read Only
Operating Mode	Genset operating modes	Read Only
Alarm	Genset alarms	Read Only

Table 8: Genset or genset controller variable accessed

RS1	The genset or the controller must allow Modbus RTU or TCP communication

Table 9: Requirement for genset or genset controller

3.4.3. Configuring Grid and Load Meters / Sensors

To configure remote communication on your power meter, please refer to the manufacturer's instructions and to the Device Connection & Configuration Specific Instructions provided by Elum.

Grid meters must be installed in order to enable the controllers to collect mandatory data from the Point of Connection (POC) between the site and the grid, to guarantee a safe operation of the installation (refer to the functional description chapter for more details).

Grid meter requirements :

- The meter must be a bidirectional one.
- The configuration of the power meter must be set (measurement type).

The power meters provided by Elum meet all those conditions and can be used with no prior configuration.

The table below lists all the accessed variables of the meters / sensors.

Elum Name	Description	Max Access
W	Total active power	Read Only

WphA	Active power phase A	Read Only
WphB	Active power phase B	Read Only
WphC	Active power phase C	Read Only
VAR	Total reactive power	Read Only
VARphA	Reactive power phase A	Read Only
VARphB	Reactive power phase B	Read Only
VARphC	Reactive power phase C	Read Only
VA	Total apparent power	Read Only
VAphA	Apparent power phase A	Read Only
VAphB	Apparent power phase B	Read Only
VAphC	Apparent power phase C	Read Only
Hz	Frequency	Read Only
AphA	Current phase A	Read Only
AphB	Current phase B	Read Only
AphC	Current phase C	Read Only
PhVphA	Line voltage phase A	Read Only
PhVphB	Line voltage phase B	Read Only
PhVphC	Line voltage phase C	Read Only

Table 10: Grid sensor variable accessed

RS1	The sensor must allow Modbus RTU or TCP communication

Table 11: Requirement for grid sensor

4. FUNCTIONAL DESCRIPTION

This section describes the functionalities,operating modes and control scenarios of the ePowerControl SD.

4.1. Operating modes

4.1.1. Grid-tied mode

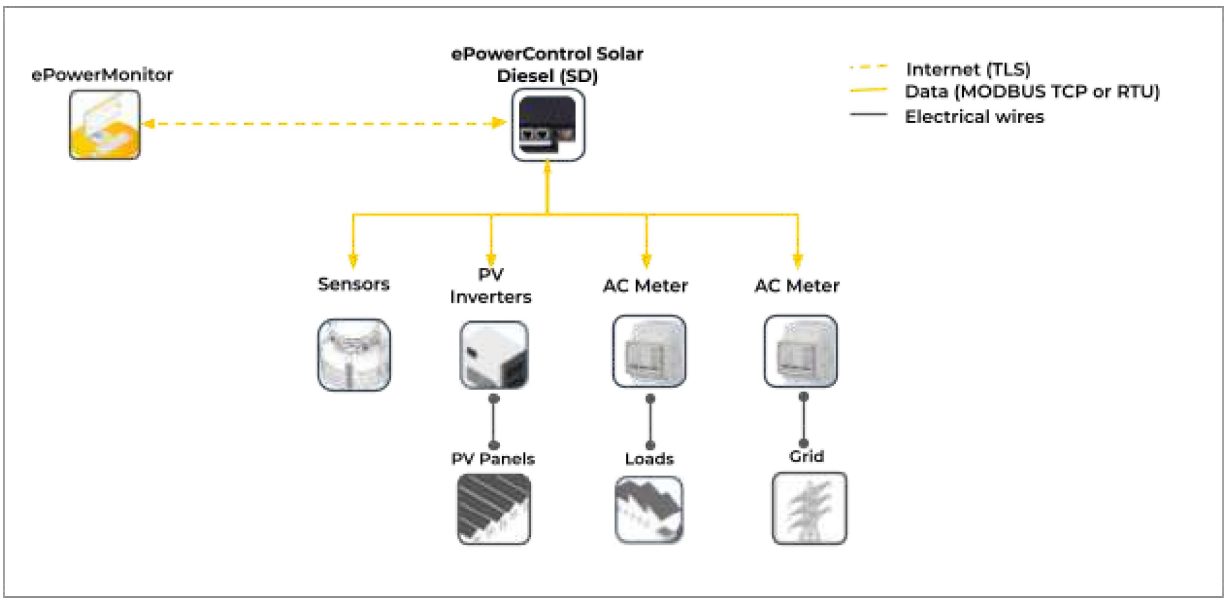


Fig. 11: Diagram of the grid-tied mode

In this mode, the installation is connected to the grid + PV.

The controller's main objective is to maximize PV production, in order to reduce the site’s grid dependence and increase its energy efficiency, while ensuring the full compliance with the grid operator’s guidelines and standards.

4.1.2. Islanded mode

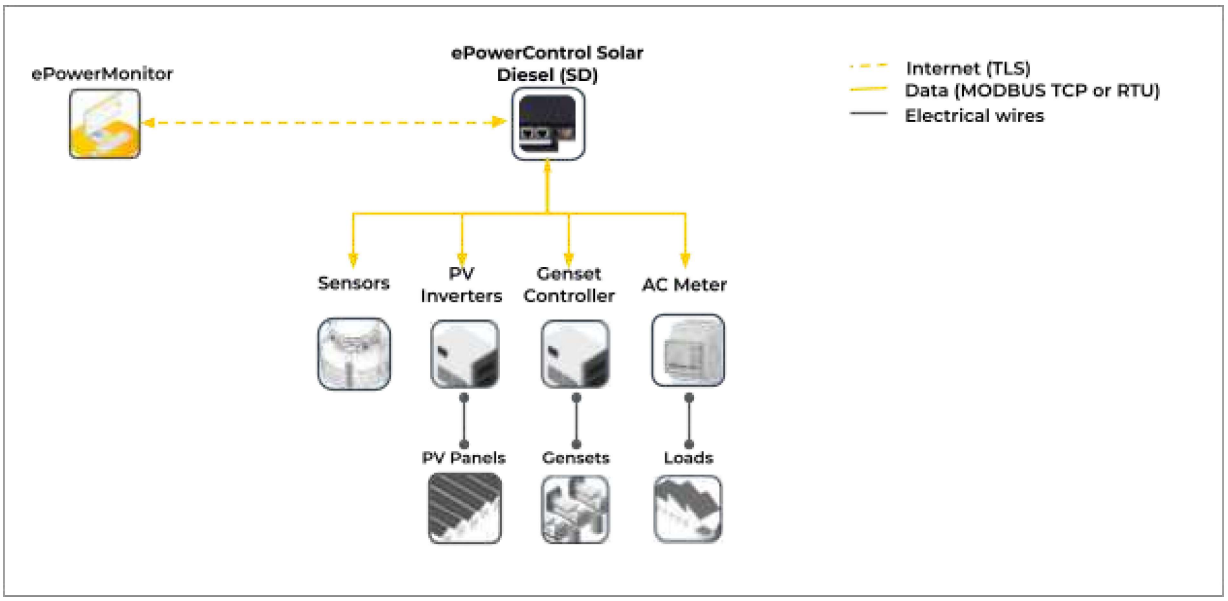


Fig. 12: Diagram of the islanded mode

In this mode, the installation is connected to Diesel Generators + PV.

ePowerControl SD's main objective in this mode is to guarantee a smooth integration of the PV plant and gensets to increase solar penetration and reduce diesel cost, while ensuring the gensets do not run below the minimum loading value, since running in light load conditions for extensive periods of time can cause irreversible damage to the gensets.

4.1.3. Back-up mode

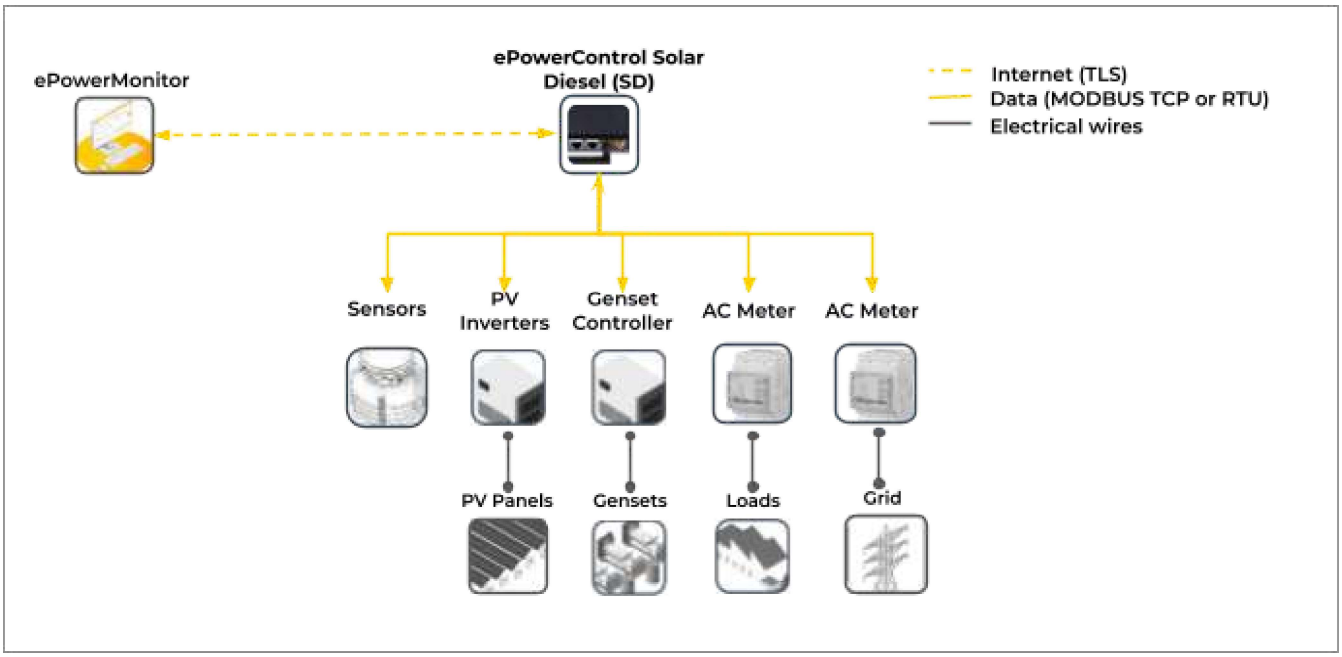


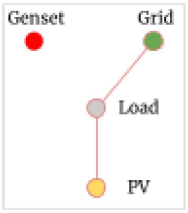
Fig. 13: Diagram of the back-up mode

In this mode, the installation is connected to the grid + Diesel Generators + PV.

ePowerControl SD's main function is to ensure the smooth integration of PV plant and diesel genset in order to increase solar penetration and reduce diesel cost.

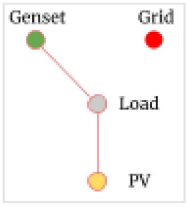
Two configurations are possible :

- **Grid-Connected mode**



In this mode, the utility grid is available and therefore the Genset plant is offline.
The grid forms the network. The PV is in grid following mode.

- **Genset Back-up mode**



In this mode, the utility grid is down and therefore the Genset plant is online.
The genset forms the network. The PV is in grid following mode.

4.2. Controller functions

This section describes all the main functions of the ePowerControl SD.

4.2.1. Feed-in management

This function is applicable in :

- Grid-tied mode
- Grid-Connected mode

The controller starts an infinite loop function, which computes and sends PV curtailment setpoints to solar inverters using Modbus write commands, as per the selected feed-in management option.

Three options are available :

- **Zero Export (default option)**

ePowerControl curtails the right amount of solar power to enable a maximum PV production, while ensuring zero export to the grid, thus avoiding penalties from the grid operator.

The controller sets the injection command (W_{MaxPV}) to be equal to the load.
This serves to reduce the power needed from the grid while preventing the power flow from reversing.

$$W_{MaxPV} = W_{Load}$$

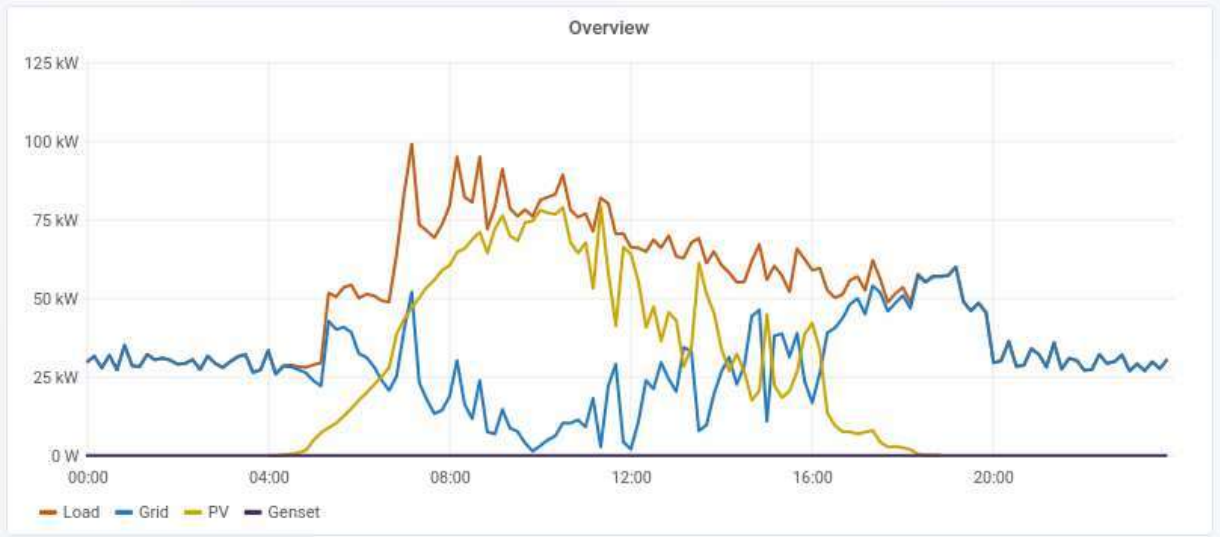


Fig. 14: Zero Export graph

- **Maximum Export**

The controller allows the export to the grid.
The operator can autonomously set the active power export target at the point of common coupling (PCC) using eConf.

The controller sets the injection command (W_{MaxPV}) to be equal to the active power export target.
This serves to reduce the power needed from the grid as well as exporting the extra production to the grid. The power flow will be reversed.

$$W_{MaxPV} = W_{active\_power\_export\_target}$$

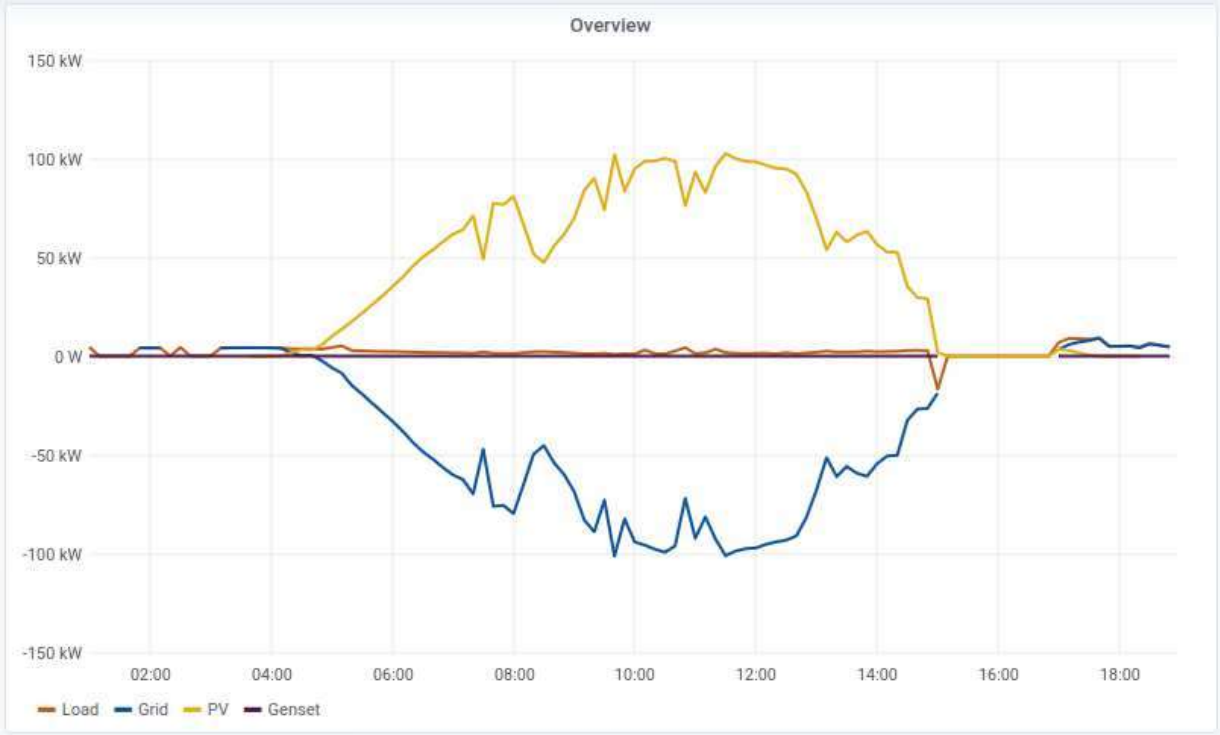


Fig. 15: Maximum Export graph

- **Minimum Import**

The controller is set to always import a minimum value from the grid. The export is forbidden.
The operator can autonomously set the active power import target at the point of common coupling (PCC) using eConf.

The controller sets the injection command (W_{MaxPV}) as per the equation below :

$$W_{MaxPV} = W_{Load} - W_{active\_power\_import\_target}$$

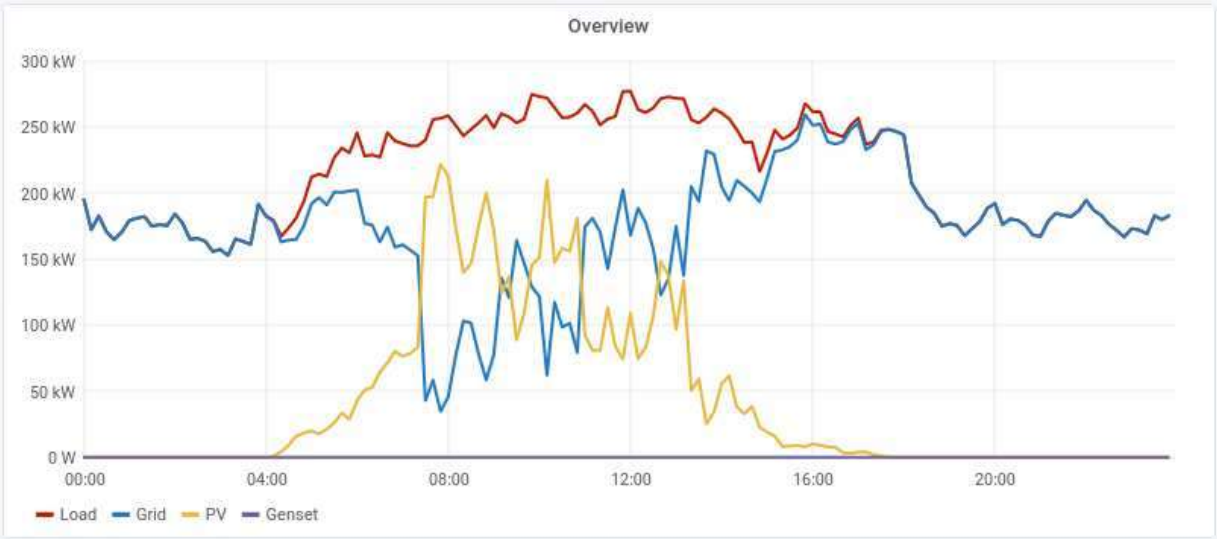


Fig. 16: Minimum Import graph

4.2.2. Genset minimum loading

This function is applicable in :

- Islanded mode
- Genset Back-up mode

The controller starts an infinite loop function, which calculates and sends PV curtailment setpoints to solar inverters using Modbus write commands, as per the description below.

The setpoints are calculated based on the power output of all the genset units, so as to make the PV to cover the load power while simultaneously allowing the gensets to produce up to their minimum loading values.

The controller sets the injection command (WMaxPV) based on the following equation:

$$W_{MaxPV} = W_{Load} - W_{Nom\_Genset\_ON} * MinLoad\%$$

Fig. 17: Genset minimum loading graph

In the case of multiple genset activated, it is assumed that active gensets are equipped with the appropriate control devices so as to share the load in proportion to their primary rated capacity.

4.2.3. Fail-safe strategy

- **Communication Errors Fail-Safe**

The fail safe mode describes the behavior of the controller when the communication with one of the critical elements composing the installation is lost, and the usual observations of the control strategy are therefore uncertain. The PV production is ramped down to 0 as long as the communication is lost, to avoid any deterioration of equipment and penalties for the site owner.

The critical elements are : PV inverters, grid meters, genset meters and genset controllers.

- **Grid injection violation fail-safe**

The controller reaction to a violation of the grid injection target can be configured in eConf.

Two options are available :

1. **Shutting down the PV production :** if the violation remains for a configurable duration.
2. **No reaction :** Disregard the violation and continue the PV production.

5. CONFIGURATION

This section describes all the main settings to configure for the ePowerControl SD. (software version: Solar control V1)

Please refer to the demo for a step by step guide on how to configure your ePowerControl SD device.

The deployment process must be done with the PV injection shut down.

5.1. eConf ACCESS

eConf is the Elum configuration tool used to configure ePowerControl and ePowerLog products.
Please refer to the eConf documentation for more information.

eConf can be accessed locally by connecting a computer to the LAN port n°2 of the SD controller.

To perform the configuration you will need the following items:

- A computer with an ethernet port
- An ethernet cable

Once the physical connection is established, open eConf by entering the following IP address 192.168.4.127 in your favorite browser URL bar.

You'll then be prompted to define a password. It is recommended to use a strong password. *(8 characters minimum, with a mix of alphabetical (upper and lowercase), numeric, and special characters).*

This password secures the access to Elum Configuration menus, and will be needed to connect to ePowerControl's Settings tab.

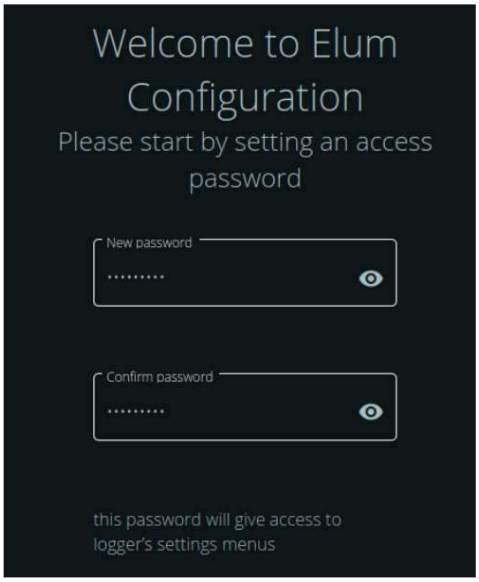


Fig. 18: eConf Password tab

To access the Elum Configuration local web page, the Ethernet port of your computer should be configured in DHCP mode.

5.2. INTERNET CONFIGURATION

ePowerControl SD offers two distinct ways to connect to the internet.

Select the interface relevant to your installation.

It is highly recommended not to skip this step, in order to enable the controller to search for software updates when applicable.

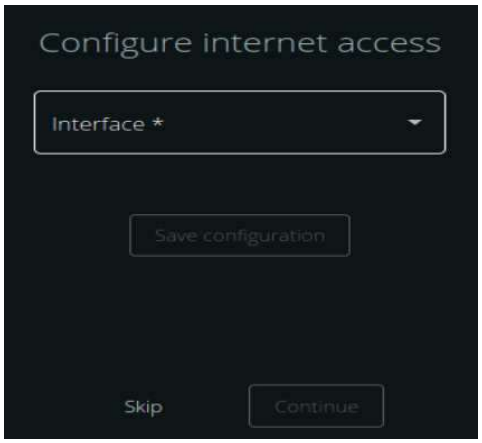


Fig. 19: eConf internet interface tab

5.2.1. Cellular internet connection

Select the "**3G Access - builtin**" option.

Enter the appropriate internet settings.

To get your SIM card PIN number, the APN address and the appropriate IDs, please refer to your service provider's documentation.

Fig. 20: eConf cellular internet configuration

5.2.2. Wired internet connection

Select the "**Wired Access - lan1**" option.

Choose "**DHCP**" for an automatic allocation of the IP address.
Or "**IP_Static**" to add the IP address and network settings manually.

Fig. 21: eConf wired internet configuration

In order to connect to Elum's back end, the following outgoing ports must be open:

- ICMP
- TCP ports: 53, 80, 443, all ports from 1198 to 1210, 4505 and 4506
- UDP ports: 53, 123, 1195, all ports from 1198 to 1210.

5.3. SOFTWARE UPDATE

It is recommended to perform a software update when applicable, in order to have access to :

- The latest version of eConf,
- The latest slave devices drivers list,
- The latest control features.

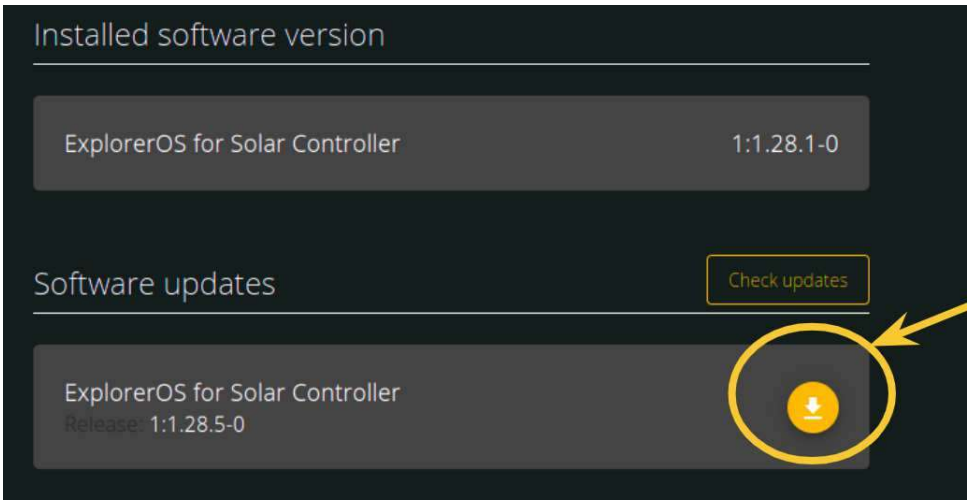


Fig. 22: eConf software update tab

⚠	The update process cannot be interrupted. Please ensure that the device remains powered up and connected to the internet to avoid any issues.
ⓘ	If a software update is performed, an automatic reboot will be performed. The previous configurations should be retaken.

5.4. SITE SETTINGS

It is important to indicate the site name and GPS coordinates, which will be used for the configuration of the ePowerMonitor dashboard.

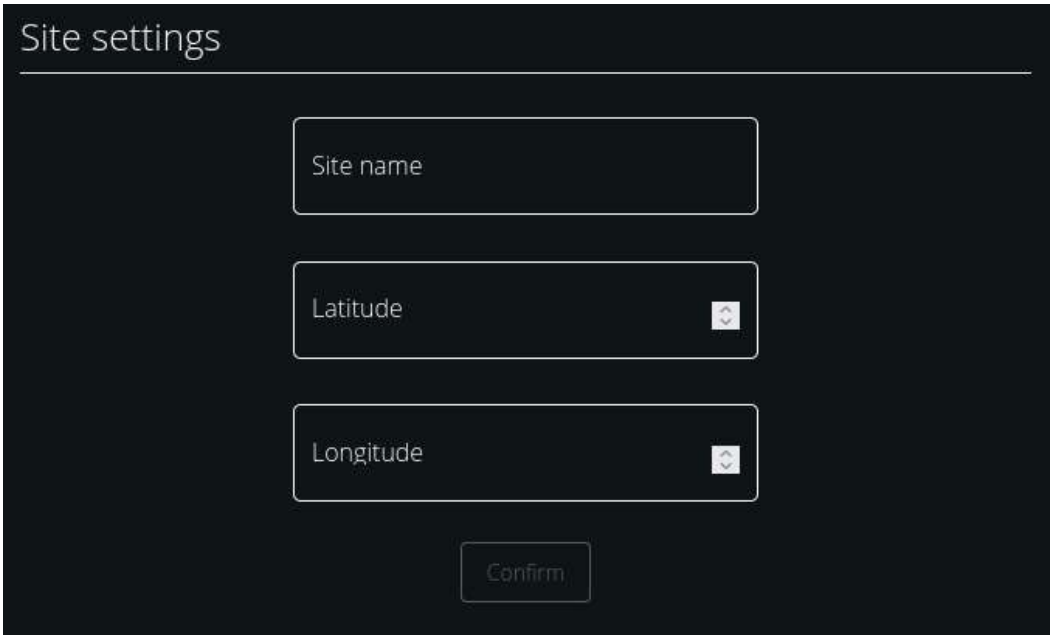


Fig. 23: eConf site settings tab

5.5. NETWORK CONFIGURATION

This section describes the configuration of the slave devices in eConf.

Once the wiring of the devices is done, the communication setup with devices can be started. Please ensure that the Modbus communication is enabled on all devices.

If the internet is not configured previously, it can still be configured in the network configuration panel.

5.5.1. Configuration of the communication ports

Fig. 24: Communication ports configuration tab

The list shows the available communication ports (not configured yet).

To edit the configuration of a port, click on the “edit” button. 

Select the relevant port, and enter the appropriate settings : The port settings must be the same as the ones configured on the devices connected to it.

Serial devices port :

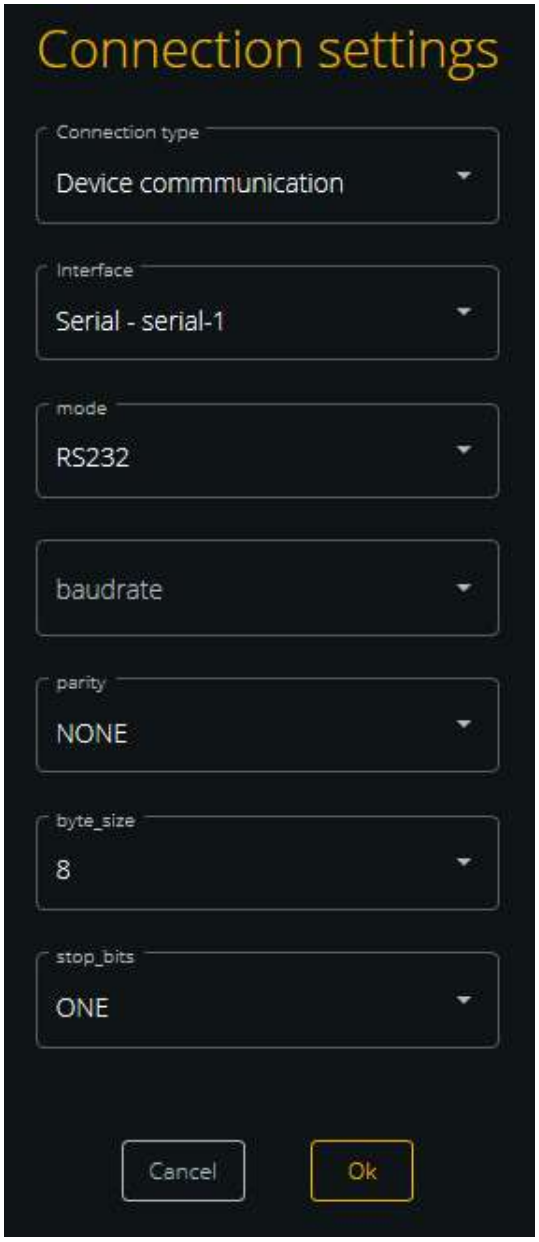


Fig. 25: Serial devices port configuration

Ethernet devices port :

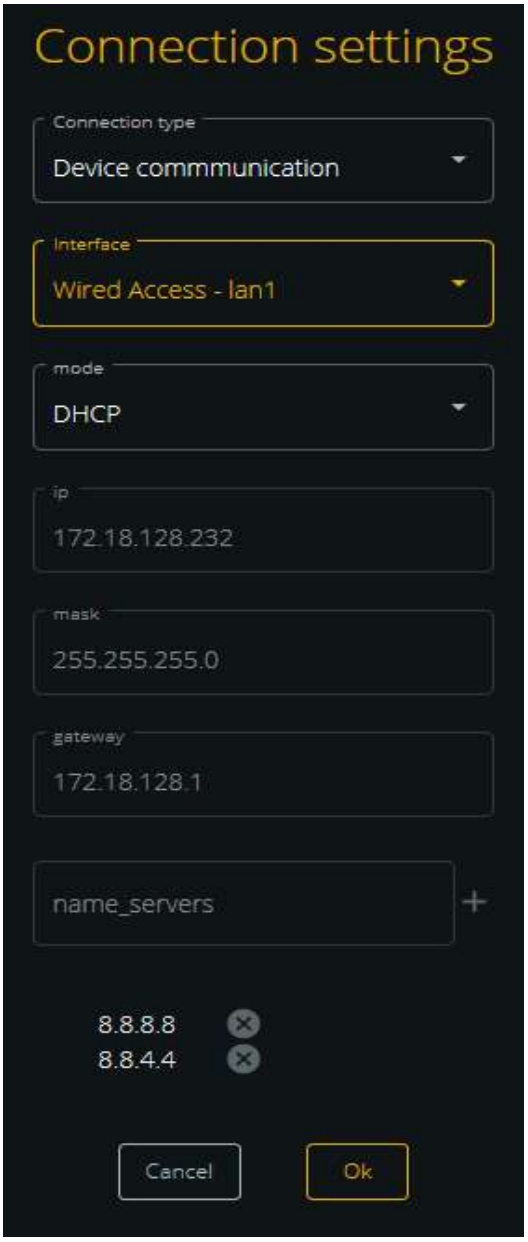


Fig. 26: Ethernet devices configuration

5.5.2. Configuration of the slave devices

In each configured port, the “ADD DEVICE” option appears as shown in the picture below.

- Click on it to start adding the devices of your site.

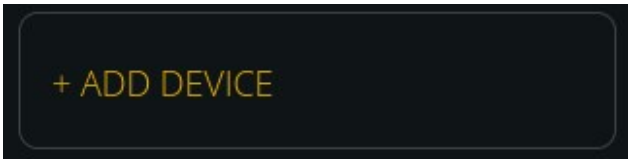


Fig. 27: Communication ports configuration tab

- Fill the boxes with the relevant information.
- Please ensure that the Modbus communication is enabled on all devices.

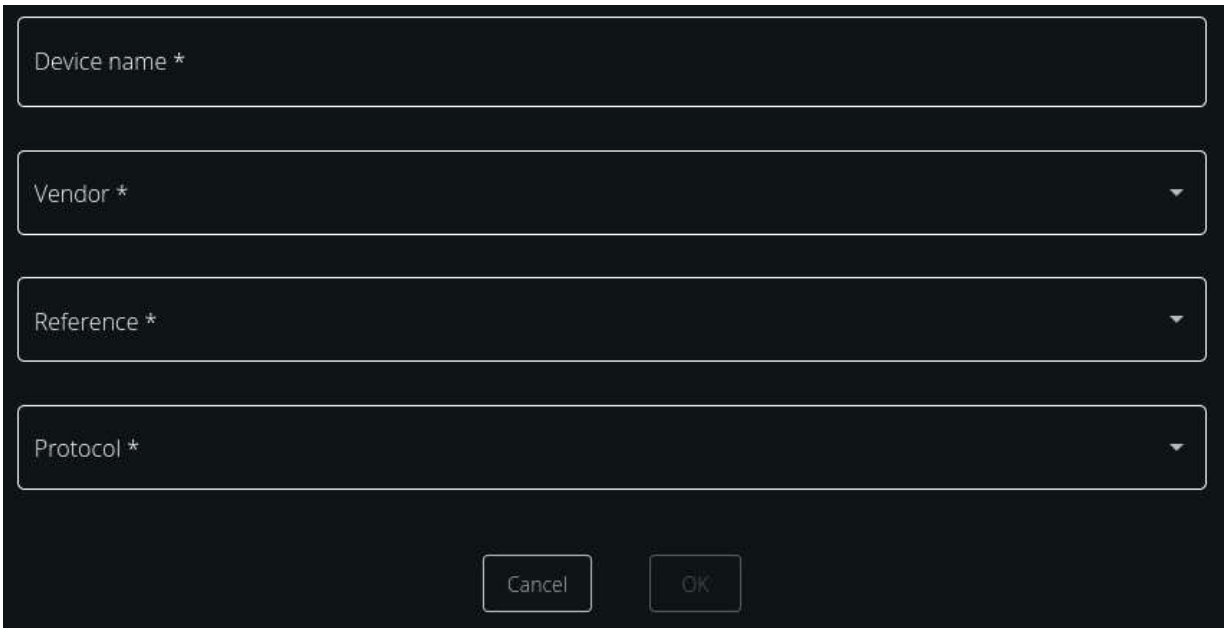


Fig. 28: Slave device configuration tab

Please contact Elum support if the device you’re trying to connect is not listed, at support@elum-energy.com.

- Modbus RTU communication parameters

- Slave_id
- Response_timeout (0.5s by default), this is maximum waiting time before receiving the first byte (i.e. before the start of transmission of the response).

- Byte_timeout (0.1s by default), this is the maximum waiting time between subsequent bytes.

- **Modbus TCP communication parameters**

- IP
- Port (502 by default)
- Slave_id
- Response_timeout (0.5s by default), this is maximum waiting time before receiving the first byte (i.e. before the start of transmission of the response).
- Byte_timeout (0.1s by default), this is the maximum waiting time between subsequent bytes.

5.5.3. Validation

There are two ways to test the connection to the devices :

- **Communication validation on the network page**

At the device level :

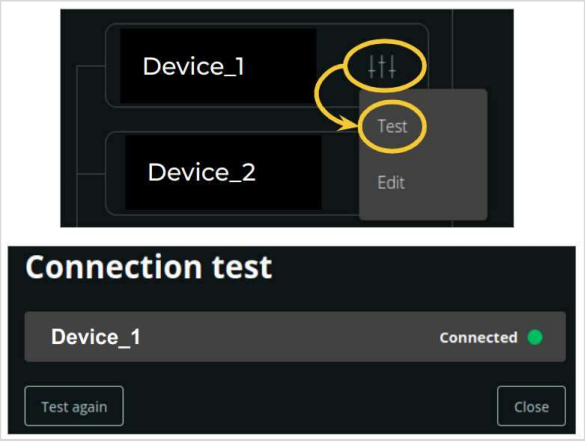


Fig. 29: Connection test at the device level

At the port level :

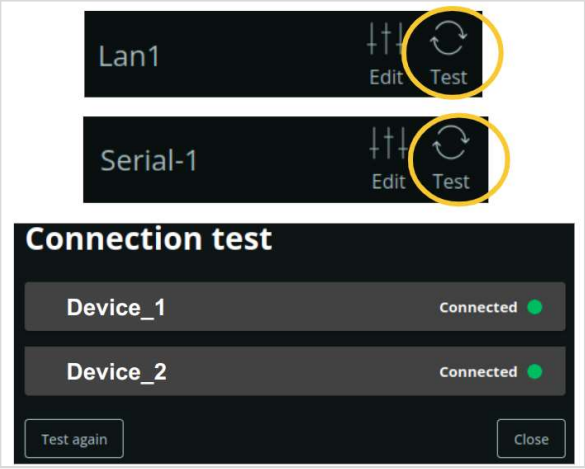
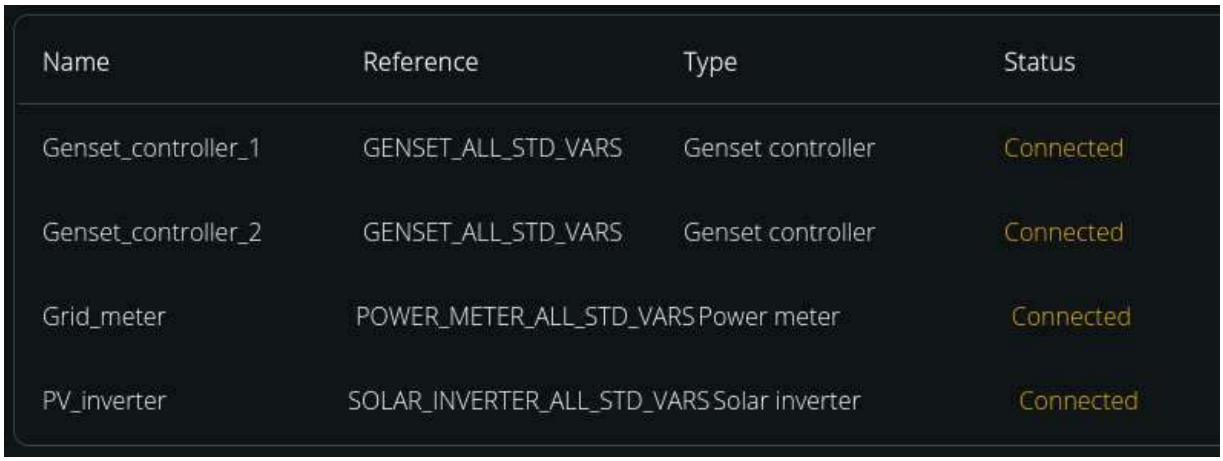


Fig. 30: Connection test at the port level

- **Communication validation on the validation page**



Name	Reference	Type	Status
Genset_controller_1	GENSET_ALL_STD_VARS	Genset controller	Connected
Genset_controller_2	GENSET_ALL_STD_VARS	Genset controller	Connected
Grid_meter	POWER_METER_ALL_STD_VARS	Power meter	Connected
PV_inverter	SOLAR_INVERTER_ALL_STD_VARS	Solar inverter	Connected

Fig. 31: Connection test on the validation page

Refer to the troubleshooting section to diagnose the “disconnected” status of a device.

In addition to the verification of the communication, the validation page allows to verify and validate the data consistency of all the connected devices.

- Observe the communication status for a relevant period of time to validate the stability of communication status of the devices.
- Press each device to check if the monitored data is consistent and relevant to your site.

Fig. 32: Device validation page

Data acquisition can only be started when the communication with all the main devices is established and stable.
Elum is not responsible for the malfunction of the monitoring and control if one or more devices is diagnosed as “Disconnected” by Elum Configuration once the commissioning is done.

5.6. DATA FORWARDING

Elum devices export data automatically to ePowerMonitor, the monitoring hypervision platform of Elum Energy.

In addition, Elum energy offers an option of exporting data to one or more third party monitoring platforms, as well as to USB devices.

Five export options are available as shown in the figure below,with the possibility to activate more than one simultaneously :

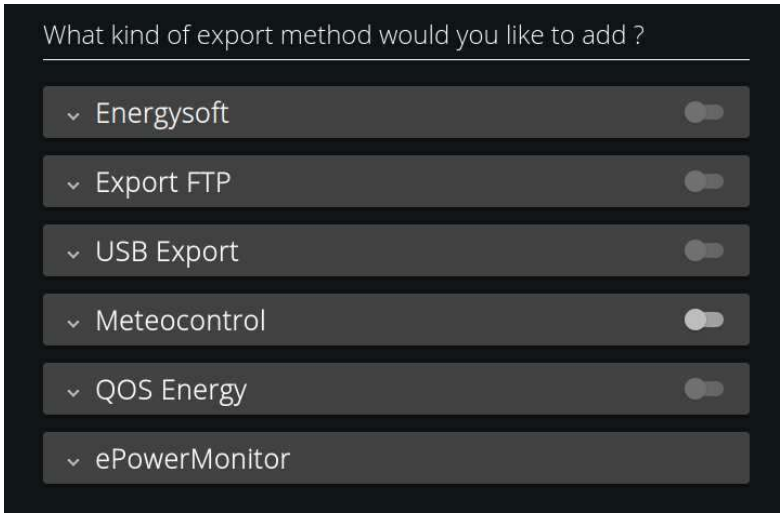


Fig. 33: eConf data forwarding tab

5.6.1. Export FTP

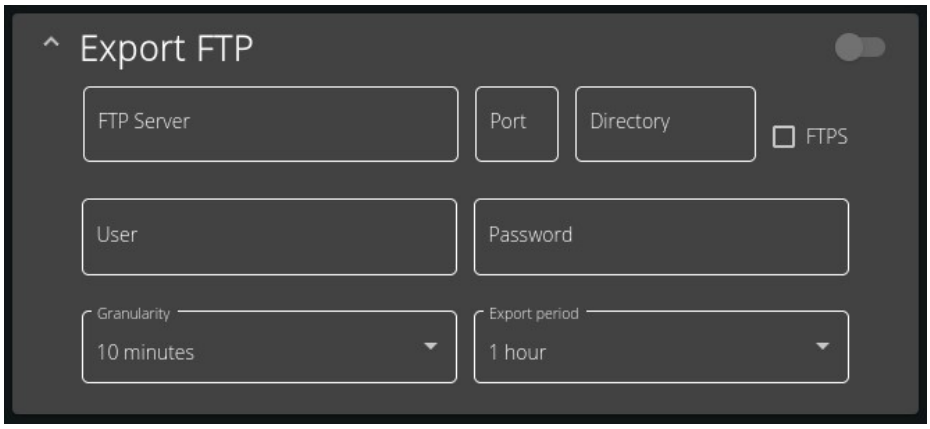


Fig. 34: FTP export configuration

FTP Push enables the data forwarding to any third party server supporting FTP protocol (internal or external) with Elum Energy data format.

- Enter the FTP server, port and directory, you want to forward your data to.
- Add your User and Password credentials to access the FTP Server indicated above.
- Indicate the granularity of the data forwarded to your FTP server.
- The export period can also be edited independently from the granularity.

5.6.2. Energy Soft

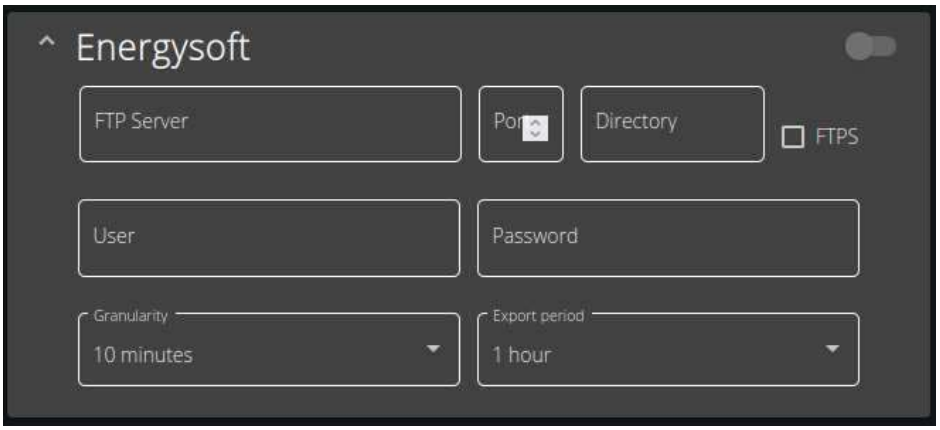


Fig. 35: Energy Soft export configuration

Energysoft is based on FTP protocol, with a different export file format than Elum standard FTP push service.

The data forwarding settings are similar for both export methods. Please refer to the section Export FTP for more information.

5.6.3. QOS Energy

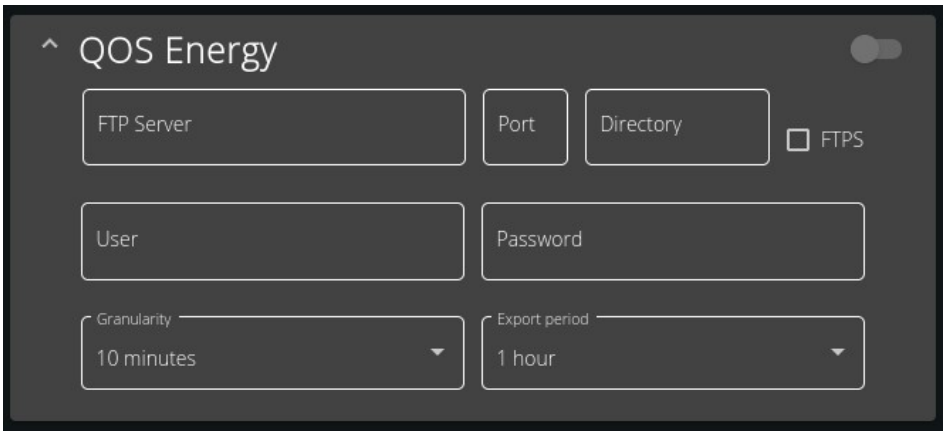


Fig. 36: QOS Energy export configuration

QOS Energy is based on FTP protocol, with a different export file format than Elum standard FTP push service.

The data forwarding settings are similar for both export methods. Please refer to the section Export FTP for more information.

5.6.4. USB Export

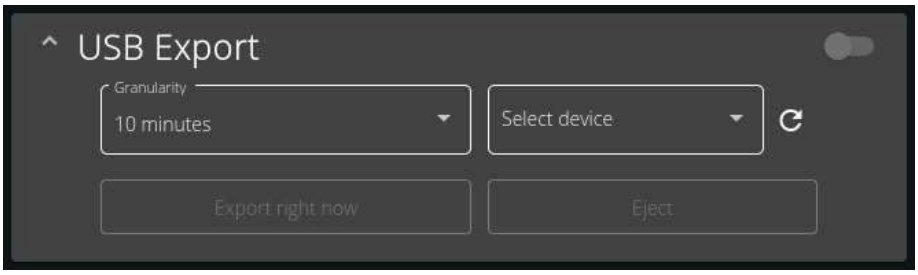


Fig. 37: USB export configuration

- Plug your USB device in the SB port of the SD controller.
- The USB device will appear in the "**Select device**" list on eConf (figure xx above). Select the USB device to forward data to.
- Indicate the granularity of the data to be forwarded. The export period is 24h, independent from the granularity. Every export happens at 00:00 UTC everyday.
- By clicking on "**Export right now**", the data of the current export period will be exported to the USB device.

The export can be done at any time. We recommend performing it right before the ejection of the USB device.

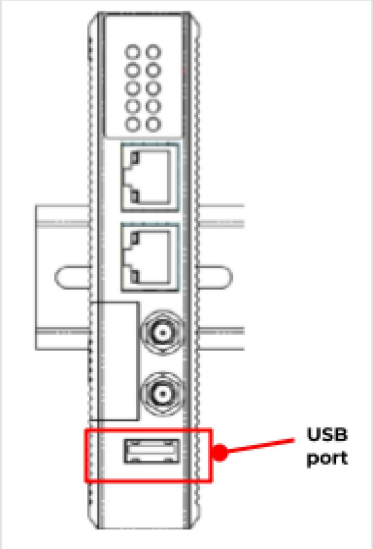


Fig. 38: ePowerControl SD USB port

To avoid any damage on your USB device, click on "Eject" before removing it from the Elum Explorer USB port.
Not ejecting the device can also cause irreversible data loss.

Recognized file systems are the following: Ext2, Ext3, Ext4, NTFS.
FAT32 is not recognized.

5.6.5. Meteocontrol

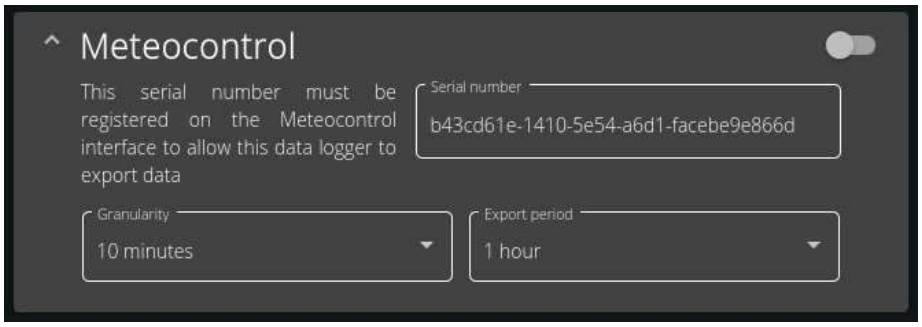


Fig. 39: Meteocontrol export configuration

- Enter the relevant serial number. (it must be registered on the Meteocontrol interface to allow the controller to export data).
- Select the granularity and Export period of your choice.

5.7. CONTROL SETTINGS

The EMS settings can be configured in the control page.

Please refer to the functional description chapter to help you navigate through the various settings and functions.

Select the relevant application to your installation from the drop-down menu, and add the relevant devices in their respective boxes.

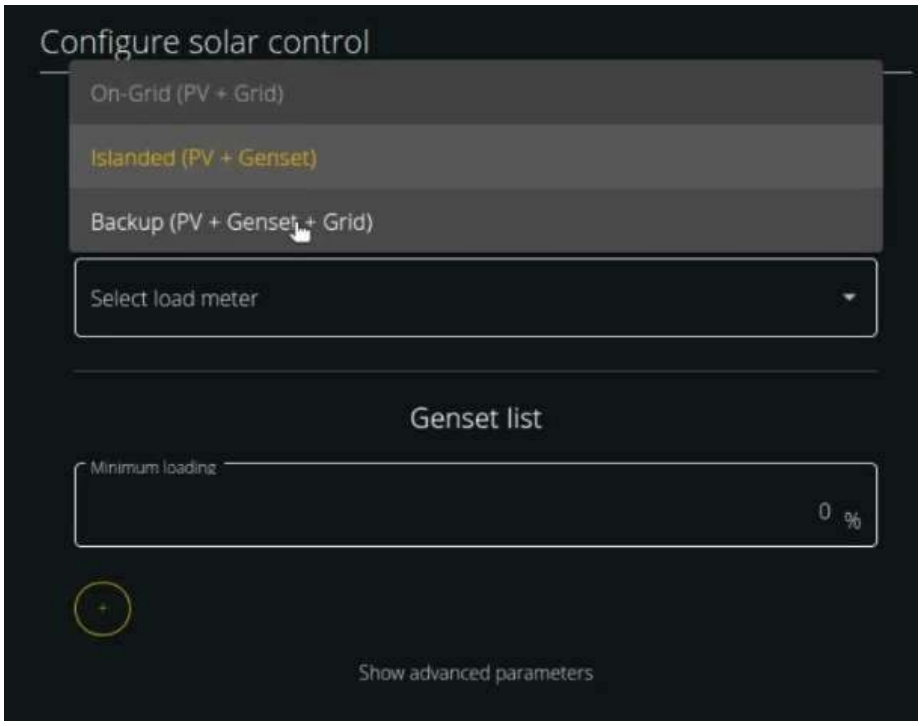


Fig. 40: EMS configuration tab

Load meter
The load power meter can be useful for the installer to proceed to some consistency check up. Nevertheless, it is not a mandatory component for the correct functioning of the ePowerControl SD.

The load meter field can remain blank.

However, if a load meter is configured, it will be considered by the EMS in the control loop as a critical device, which means that it can trigger the fail-safe mode.

5.7.1. Grid control strategy

Click on advanced settings to configure the grid control strategy. By default , it is set to “Zero Export”.

Please refer to the functional description chapter for more details on this feature.

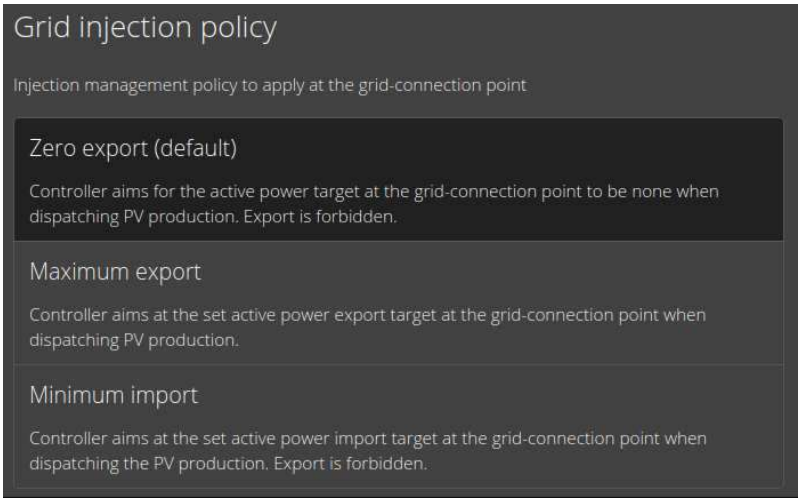


Fig. 41: Grid injection policy configuration tab

The advanced settings are pre-set by Elum.

Except for the grid control strategy, the advanced settings are intended for experienced users only. Please contact our support team before proceeding to any modification at support@elum-energy.com.

6. OPERATING THE EMS

This section describes the main eConf pages needed to operate the EMS. (software version : solar control V1)

The password is required to access the logs and the settings pages.

6.1. Overview page

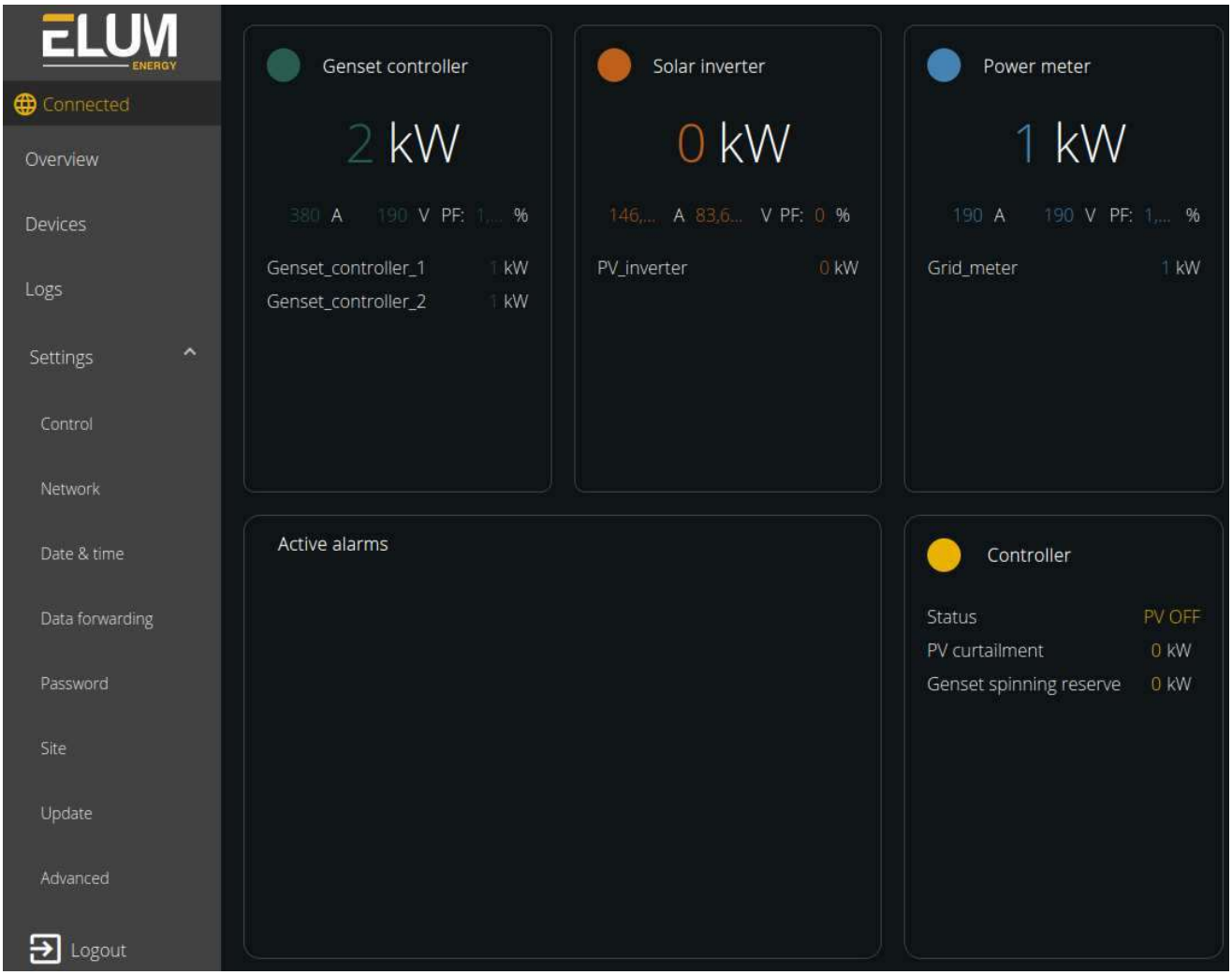


Fig. 42: eConf Overview page

The overview page enables the operator to monitor the installation KPIs locally and in real time :

- Main measurements of PV inverters, grid and gensets (active power, power factor, voltage, current),

- PV inverters setpoints sent by the controller,

- Active alarms (pre-configured in the driver of the devices),

- Status of internet connection,

- Status of the EMS,
- PV curtailment (sum of all the setpoints the controller sends to the PV inverters),
- Genset spinning reserve.(% Rated Power): Average loading of all gensets connected to the ePowerControl balanced by their nominal rated power.

6.2. Devices page

The devices page enables the operator to monitor the slave devices communication with the EMS as well as the data acquisition consistency.

The stability of the communication is required to ensure the correct behavior of the EMS, and avoid the activation of the fail safe mode, which will curtail the PV production.

Fig. 43: eConf Devices page (1/2)

Clicking on each device will open a page displaying the measurements and alarms status in real time.

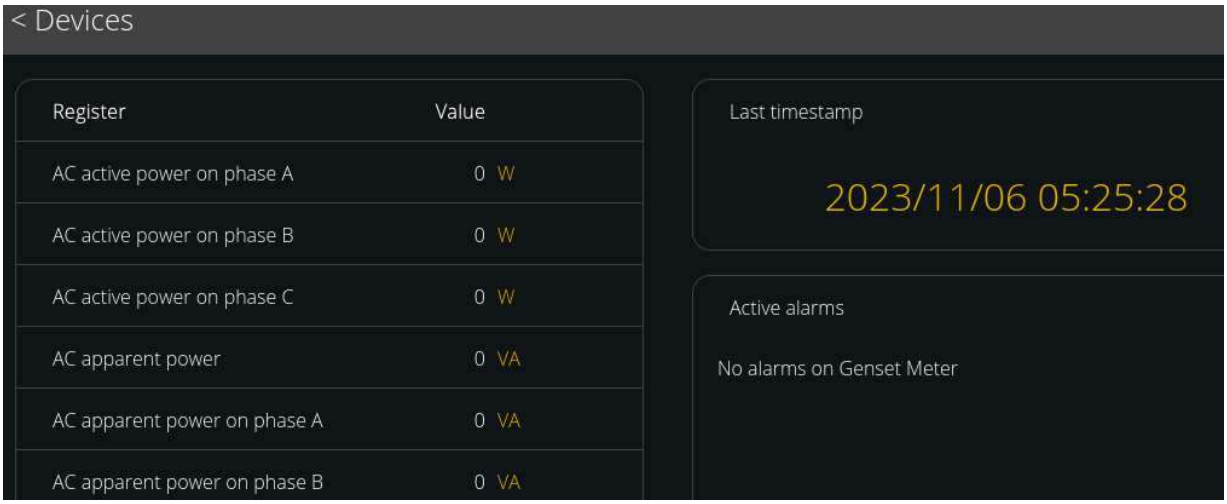


Fig. 44: eConf Devices page (2/2)

6.3. Logs page

The logs page displays all the events related to the setpoints sent by the controller to the PV inverters, as well as communication errors.

The information in this page can help diagnose issues and understand the site EMS behavior.

The logs can be downloaded.

This page is only accessible to authorized users, via password.

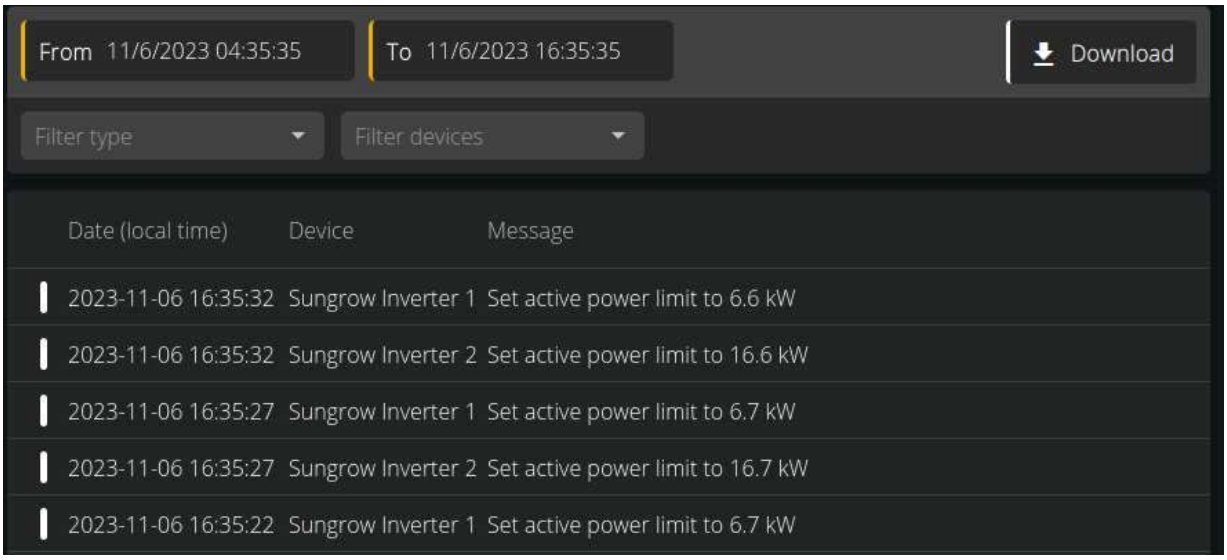


Fig. 45: eConf Logs page

6.4. Settings modification

Even after the EMS configuration, all the settings can still be modified if necessary, via the menu on the left of any eConf page.

Before making any modification, the EMS control has to be stopped.

Go to the control page, and click on the stop button:

Fig. 46: Start / Stop solar control button

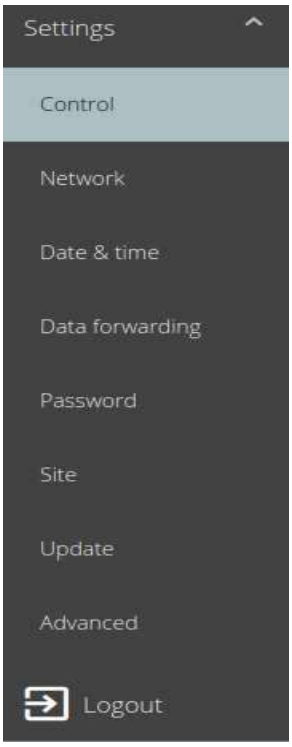


Fig. 47: Settings panel

The settings pages are only accessible to authorized users, via password.

6.5. Forgot the password ?

The password is required to access the Logs page as well as the settings menu.

If the password is forgotten, click on “Forget password” .

A new page will appear with the MAC address of your controller.

Copy the MAC address and send it to our support team at support@elum-energy.com. The team will share a back-up password valid.

Use the back-up password to login to eConf, and set a new password from the Password panel.

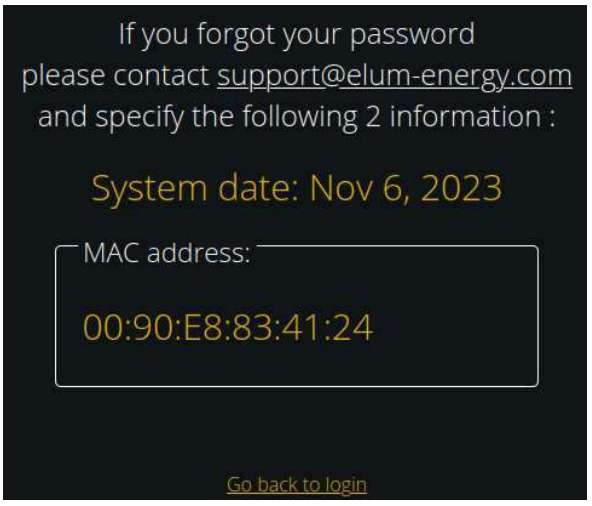


Fig. 48: MAC address page

7. EMS TESTING

This section describes the procedure to test the SD controller. (software version : solar control V1)

Notes
Results and comments should be saved in the Test Matrix for the record.

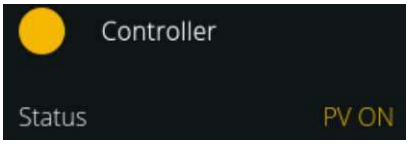
7.1. Test environment configuration

It is important to keep the computer connected to the SD controller, with eConf open and logged in at all times during the testing, in order to properly monitor the behavior.

In addition, the following points must be checked.

7.1.1. Control status

Data acquisition must have already been launched and the Control status must be displayed as “PV ON”.



7.1.2. PV injection

The PV injection must be shut down at the beginning of the test procedure.

7.1.3. Devices connection status

At this stage of the commissioning, the connection with all the devices to be monitored and controlled by the Elum controller must be established and stable. Please refer to the slave device configuration section for more details.

7.1.4. Consistency check up

eConf “Overview” and “Devices” pages display real time data. The values are automatically refreshed.

Proceed to a consistency check of the displayed data, by verifying the displayed values in eConf with those displayed in the slave devices, to validate the data acquisition and the correct configuration of the power meters.

- **Power meters consistency check**

Power meters correct installation requires a correct installation of the CTs and VTs.

- CTs and VTs must be installed on the correct bus bar/wires, corresponding to the very point of interest,
- CTs must be installed in the correct direction,
- Grid Power consumption should always be represented by a positive value,
- Load Power consumption should always be represented by a positive value,
- Genset(s) Power production should always be represented by a positive value,
- CTs and VTs must correspond phase by phase, a swap between phases will impact the cos phi measurement.

7.2. Test procedures

For each EMS application, there is a specific test procedure to follow. Please refer to the paragraph relevant to your installation :

- On-Grid (PV + Grid)
- Islanded (PV + Genset)
- Backup (PV + Genset + Grid)

Please carefully follow each and every step of the procedure described in the paragraphs below, and do not go from one step to the next unless the expected outcome is as per the procedure.

If at any step of the test procedure you have a different outcome than the expected one described in this manual, contact our support team at support@elum-energy.com.

7.2.1. On-Grid (PV + Grid)

Log into eConf and access the Control panel by clicking on "**Control**" in the **Settings** menu in the left side of the page.

➔ **Expected outcome:** The Control panel must be displayed on screen, with the settings inserted during the configuration.

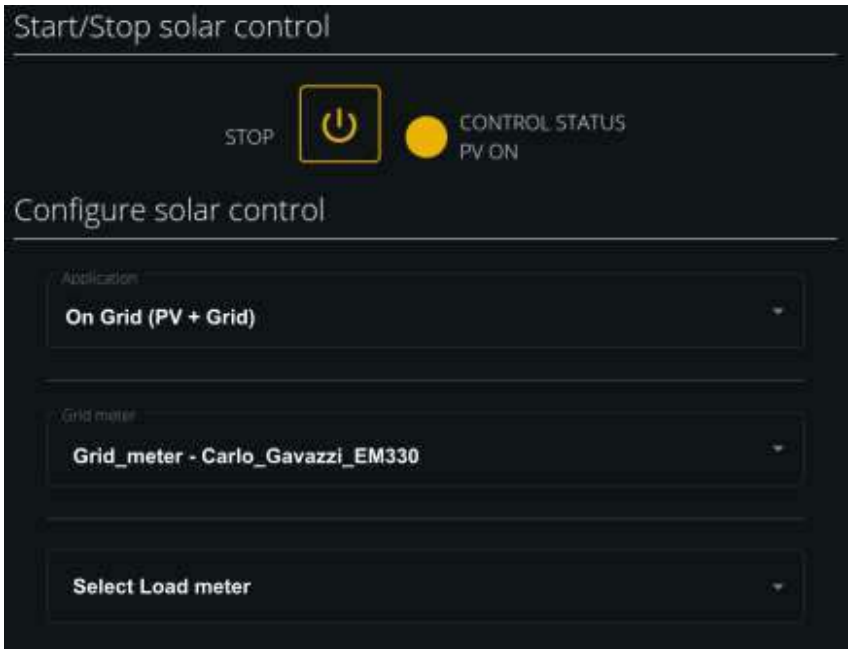


Fig. 49: eConf Control panel (PV + Grid)

Stop the EMS by clicking on start / stop button: 

➔ **Expected outcome:** The EMS control status must be "PV RAMPING-OFF" then "PV OFF".

When the EMS is stopped, the control features of the EMS are disabled and the PV inverters are curtailed to their minimum AC power output level. Datalogging features of the EMS remain active.

Start PV injection of one of the inverters.

➔ **Expected outcome:** The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.

- Repeat the step for each inverter, one inverter at a time.

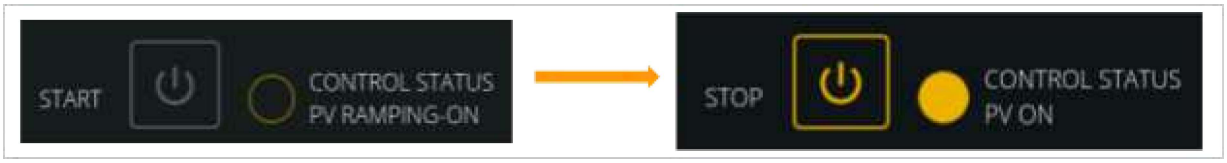
  ➔ **Expected outcome:** The AC power output of the inverter must remain below 1% of the PV inverter nominal output power, for each brand and reference of PV inverter.

- Turn on all the PV inverters.

  ➔ **Expected outcome:** The AC power output of each inverter must remain below 1% of the PV inverter nominal output power.

- Start the EMS and PV injection by clicking on start / stop button: 

  ➔ **Expected outcome n°1:** The EMS control status must first be displayed as “PV RAMPING-ON” for a few seconds and then as “PV ON”.



  ➔ **Expected outcome n°2:** PV injection should start slowly.

- Decrease the load below the nominal PV production.

  ➔ **Expected outcome:** depends on the selected grid injection policy :

  a. Zero export option : The PV production must decrease in order not to exceed the total active power of the load. The active power of the grid must be positive at all times or equal to 0.

  b. Maximum export option : The PV production must not exceed the configured active power export target. The active power of the grid will be negative when the threshold is reached.

  c. Minimum import option : The active power of the grid must be equal to the configured active power import target. The PV production must not exceed the W_{MaxPV} as defined in the following equation:

$$W_{MaxPV} = W_{Load} - W_{active\_power\_import\_target}$$

7.2.2. Islanded (PV + Genset)

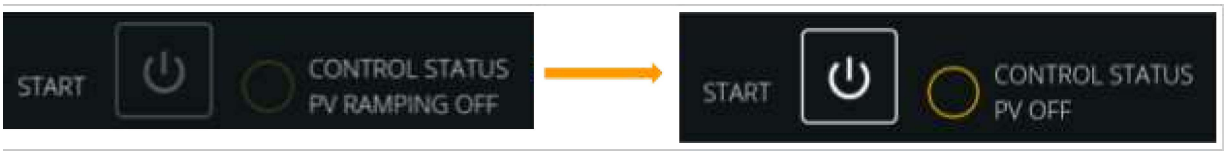
■ Log into eConf and access the Control panel by clicking on "**Control**" in the **Settings** menu in the left side of the page.

➔ **Expected outcome:** The Control panel must be displayed on screen, with the settings inserted during the configuration.

Fig. 50: eConf Control panel (PV + Genset)

■ Stop the EMS by clicking on start / stop button: 

➔ **Expected outcome:** The EMS control status must be "PV RAMPING-OFF" then "PV OFF".



When the EMS is stopped, the control features of the EMS are disabled and the PV inverters are curtailed to their minimum AC power output level. Datalogging features of the EMS remain active.

- Start PV injection of one of the inverters.

  ➔ **Expected outcome:** The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.

- Repeat the step for each inverter, one inverter at a time.

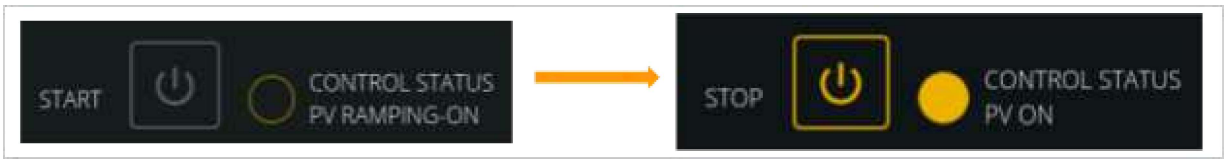
  ➔ **Expected outcome:** The AC power output of the inverter must remain below 1% of the PV inverter nominal output power, for each brand and reference of PV inverter.

- Turn on all the PV inverters.

  ➔ **Expected outcome:** The AC power output of each inverter must remain below 1% of the PV inverter nominal output power.

- Decrease the load below the minimum loading of the genset, and start the EMS and PV injection by clicking on start / stop button: 

  ➔ **Expected outcome n°1:** The EMS control status must first be displayed as “PV RAMPING-ON” for a few seconds and then as “PV ON”.



  ➔ **Expected outcome n°2:** PV production must remain stopped.

- Gradually increase the load to reach the minimum loading of the Genset.

  ➔ **Expected outcome:** PV production must remain stopped as long as the Genset is below the Minimum loading.

- Gradually increase the load to exceed the minimum loading of the Genset.

  ➔ **Expected outcome:** PV production must start. Genset production must be equal to its minimum loading value.

7.2.3. Backup (PV + Genset + Grid)

■ The plant must be in “On grid, Grid connected” configuration (gensets disconnected).

■ Log into eConf and access the Control panel by clicking on “Control” in the Settings menu in the left side of the page.

➔ **Expected outcome:** The Control panel must be displayed on screen, with the settings inserted during the configuration.

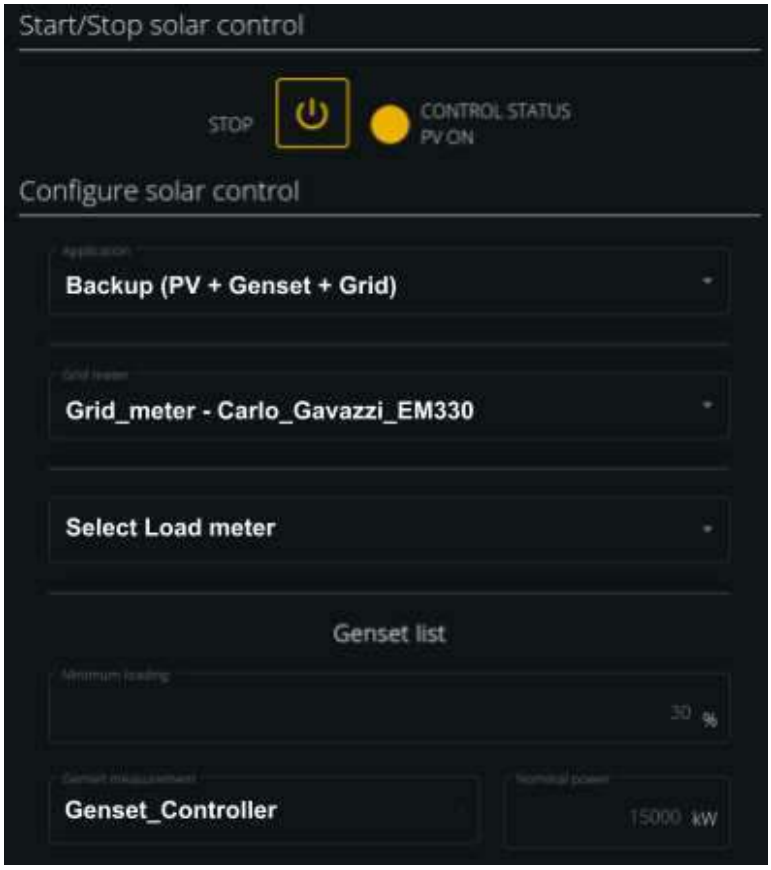
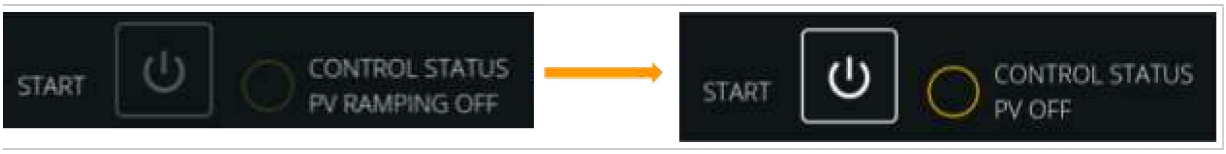


Fig. 51: eConf Control panel (PV + Genset + Grid)

■ Stop the EMS by clicking on start / stop button: 

➔ **Expected outcome n°1:** The EMS control status must be “PV RAMPING-OFF” then “PV OFF”.



➔ **Expected outcome n°2:** Genset(s) power meters monitoring values must be consistent, .i.e null.

➔ **Expected outcome n°3:** Grid power meter monitoring values must be consistent, i.e. equal to Load power meter monitoring values.

When the EMS is stopped, the control features of the EMS are disabled and the PV inverters are curtailed to their minimum AC power output level. Datalogging features of the EMS remain active.

■ Start PV injection of one of the inverters.

➔ **Expected outcome:** The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.

■ Repeat the step for each inverter, one inverter at a time.

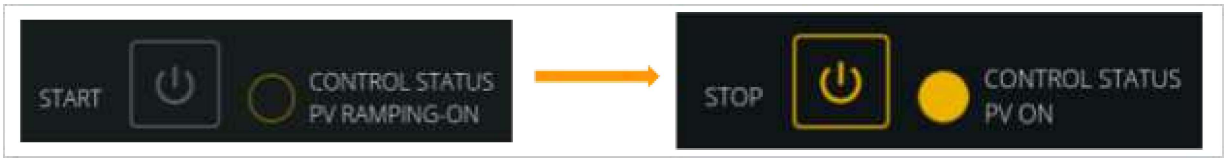
➔ **Expected outcome:** The AC power output of the inverter must remain below 1% of the PV inverter nominal output power, for each brand and reference of PV inverter.

■ Turn on all the PV inverters one by one.

➔ **Expected outcome:** The AC power output of each inverter must remain below 1% of the PV inverter nominal output power.

■ Start the EMS and PV injection by clicking on start / stop button: 

➔ **Expected outcome n°1:** The EMS control status must first be displayed as “PV RAMPING-ON” for a few seconds and then as “PV ON”.



➔ **Expected outcome n°2:** PV injection should start slowly.

■ Decrease the load below the nominal PV production.

➔ **Expected outcome:** depends on the selected grid injection policy :

a. Zero export option : The PV production must decrease in order not to exceed the total active power of the load. The active power of the grid must be positive at all times or equal to 0.

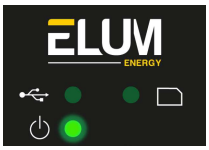
b. Maximum export option : The PV production must not exceed the configured active power export target. The active power of the grid will be negative when the threshold is reached.

c. Minimum import option : The active power of the grid must be equal to the configured active power import target. The PV production must not exceed the W_{MaxPV} as defined in the following equation:

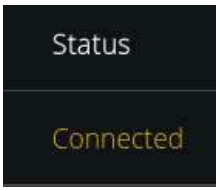
$$W_{MaxPV} = W_{Load} - W_{active\_power\_import\_target}$$

◾ Manually change the power plant from "**On grid, Grid connected**" to "**Off grid, Genset connected**" configuration, by disconnecting the grid and starting the gensets.

➔ **Expected outcome n°1:** The SD controller must remain power supplied during the transition from "On grid, Grid connected" to "Off grid, Genset connected" configuration. The transition must not impact it.



➔ **Expected outcome n°2:** Grid, Load and Genset(s) power meters must remain power supplied during the transition from "On grid, Grid connected" to "Off grid, Genset connected" configuration. The transition must not impact it.



◾ Stop the EMS by clicking on start / stop button.

➔ **Expected outcome n°1:** Genset(s) power meters monitoring values must be consistent; i.e. equal to Load power meter monitoring values.

➔ **Expected outcome n°2:** Grid power meter monitoring values must be consistent; i.e. null.

◾ Decrease the load below the minimum loading of the genset, and start the EMS and PV injection by clicking on start / stop button.

➔ **Expected outcome n°1:** The EMS control status must first be displayed as "PV RAMPING-ON" for a few seconds and then as "PV ON".

➔ **Expected outcome n°2:** PV production must remain stopped.

◾ Gradually increase the load to reach the minimum loading of the Genset.

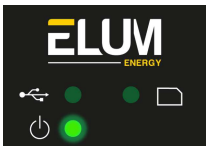
➔ **Expected outcome:** PV production must remain stopped as long as the Genset is below the Minimum loading.

◾ Gradually increase the load to exceed the minimum loading of the Genset.

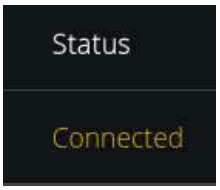
➔ **Expected outcome:** PV production must start. Genset production must be equal to its minimum loading value.

◾ Manually change the power plant from "**Off grid, Genset connected**" to "**On grid, Grid connected**" configuration, by connecting the grid and stopping the gensets.

➔ **Expected outcome n°1:** The SD controller must remain power supplied during the transition from "Off grid, Genset connected" to "On grid, Grid connected" configuration. The transition must not impact it.



➔ **Expected outcome n°2:** Grid, Load and Genset(s) power meters must remain power supplied during the transition from "Off grid, Genset connected" to "On grid, Grid connected" configuration. The transition must not impact it.



7.3. Test conclusion

The tests are considered complete when all the steps in the procedure are followed, and the expected outcomes are met and validated.

Once the tests are completed, the EMS is considered as fully commissioned.

Please make sure to properly archive the test matrix of the unit (fully completed), for future reference.

8. TROUBLESHOOTING

This section lists the most common issues faced during the installation and configuration of Elum Devices, the possible causes, and the steps to follow to solve them.

8.1. Communication issues

The following table describes the different communication cases:

Issue	Possible causes	Steps to follow
Serial Communication issues		
Communication with the Serial device cannot be established	- Modbus communication not enabled on slave device - Improper RS485 wiring	• Check the port and device communication settings both on eConf and the device itself. • Ensure the Modbus communication is enabled on the devices if applicable. • Ensure the RS485 wires are shielded twisted pairs. • Check the connectivity of the RS485 wires. • Ensure the RS485 cables are correctly inserted and fixed in the pins. • Check that the RS485 cables are correctly stripped and protected by the sheathing to the pins. • Check that the distance for serial communication is less than 1000m. • Add a termination resistance (120 Ohm) on each end of the RS485 line. Please *refer to the Device Connection & Configuration document, for specific instructions.*
Communication with the Serial device is intermittent	- Neglected RS485 wiring	
Ethernet Communication issues		
Communication with the device through Ethernet cannot be established	- Modbus communication not enabled on slave device	• Check the port and device communication settings both on eConf and the device itself. • Ensure the Modbus communication is

Communication with the device through Ethernet is intermittent	- IP address conflict	enabled on the devices if applicable. • Ensure no IP address is used more than once. Please *refer to the Device Connection & Configuration document, for specific instructions.*
Internet Communication issues		
Local internet access fails	Local internet network configuration invalid	• Please refer to the note on step 3, for wired internet connection configuration.
Wireless internet network fails	SIM card contract invalid	• The GSM/3G kit is pre-embedded in the Central Computing Unit. You also need a SIM card with a subscription to a valid "data" contract. Please refer to paragraph 2.1. Option A for more details.

Table 12: Communication issues

Communication establishment errors

Status name	What happened ?	What to do ?	
		Serial	Ethernet
OK	A command was successfully sent to the device, an answer was sent back and successfully received by the controller, and the data shows no inconsistency	Nothing	Nothing

Unreachable	A command was successfully sent to the device but no answer was received in return	• Check that communication parameters are correct (baud rate, etc). • Check that the slave address matches. • Check wiring and power (for detailed instructions please refer to *the Device connection & configuration guide*) • Check for reversed polarity on RS485 lines. If uncertain, just try swapping them. • Check to see that slave device is enabled for Modbus communication (for detailed instruction please refer to *the Device connection & configuration guide*)	• Check that communication parameters are correct (Subnet Mask, Gateway, ...) • Check that the IP address matches • Check wiring and power (for detailed instructions please refer to *the Device connection & configuration guide*) • Check to see that slave device is enabled for Modbus communication (for detailed instruction please refer to *the Device connection & configuration guide*)
CRC Error	A command was successfully sent to the device, an answer was successfully received from the device, but the answer is inconsistent	• Check baud rate • Check wiring – if everything else is correct, CRC errors mean noise on the line. • Check for reversed polarity on RS485 lines. Reversed polarity often looks like just noise.	*Not applicable*

Protocol error	A command was successfully sent to the device, an answer was successfully received from the device, but the answer is an error	• Check that device reference you picked in the device connection settings menu matches the actual device reference • If the problem persists, please contact Elum support	• Check that device reference you picked in the device connection settings menu matches the actual device reference • If the problem persists, please contact Elum support
Error	Elum controller went through an unexpected error during the connection test process and is unable to give a valid connection status	Please retry. If the problem persists, please contact Elum support	Please retry. If the problem persists, please contact Elum support

Table 13: Communication establishment errors

8.2. Reboot / Start issues

Issue	Possible causes	Steps to follow
Elum Controller reboots when switching from “On grid - Grid connected mode” and to “Off grid - Genset connected mode”.	- Unstable power source - Incorrect UPS wiring	• The power source supplying the Datalogger / Controller must be taken from the load side, to ensure a continuous power supply constantly. • If a UPS is used, the power source of the UPS must follow the same rule as above. *For ePowerControl SD the use of a UPS is mandatory.*
Elum Controller reboots when switching from “Off grid - Genset		

connected mode" to "On grid - Grid connected mode".		

Table 14: Reboot / Start issues

8.3. Reverse power protection issues

Issue	Possible causes	Steps to follow
Wrong breaker control	- Missing Reverse power protection relay - Incorrect configuration of the Reverse power protection relay	ePower Control is NOT an electrical protection. It does not replace an adequate protection of diesel generators against power reversal. Please install a dedicated Reverse power protection relay, or a genset controller integrating the reverse current protection function. Please refer to the manufacturer documentation for proper configuration of the relay.
Breaker control fails		

Table 15: Reverse power protection issues

8.4. Power meter reading issues

Issue	Possible causes	Steps to follow
Power meter monitoring values are incorrect	Incorrect Power meter VTs/CTs ratios	• CT ratio: Can be obtained by dividing the primary current by the secondary current. • VT ratio : Can be obtained by dividing the primary voltage by the secondary voltage.
Cos phi is incorrect, All the other power meter monitoring	Incorrect Power meters VTs/CTs wiring	• Rearrange CTs and VTs wiring by respecting phases order.

values are correct		
Power meter monitoring values signs are incorrect	Negative power monitoring not enabled on grid meter	• The meter must be a bidirectional one. • Check the configuration of the power meter (measurement type). • Check the CTs installation, which must match the current direction. *Please refer to the manufacturer documentation for proper configuration of the relay.*

Table 16: Power meter reading issues

Appendix 01 : Installation of Carlo Gavazzi meter

Safety Warning

⚠	Please follow the installation instructions in this manual for wiring diagram and proper selection of CTs. To reduce the risk of electric shock: - Do not connect the device to a circuit operating at > 277 Vrms to neutral. - Always open or disconnect circuits from Power Distribution System of building before installing or servicing the unit or attached current transformers

Materials required

The installation and wiring of an AC Meter | 5A provided by Elum requires:

- Per phase: Use of proper smallest available breakers or rated fuse taps for the installation per local NEC rules. Usually 15A circuit breaker or single multipole breaker depending on phases used.
- Black, red, and white stranded AWG 12 wire; length depending on installation location. Thermal resistance to at least 75 C. Blue wire is needed in addition for 3-phase installations. Use wire that has an insulation rating greater than the max voltage inside the panel.
  Note: wire colors may vary based on country and electrical service. Blue wire is needed in addition for 3-phase installations.
- Electrical tape
- Conduit and couplings as needed
- Mounting and wire organization hardware as needed
- If installed outside, appropriately rated enclosure

Installation location

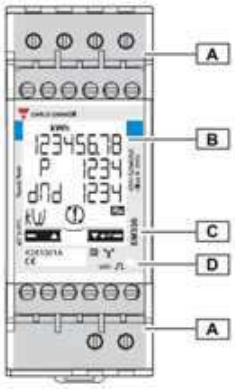
The power meter must be installed near the low voltage distribution where there is easy access to the grid, load and genset connections. A 10 A circuit-breaker shall be included (one per phase) in close proximity of the device and within easy reach of the operator. The breakers shall be marked as the disconnecting device for the power meter. The power meter is a listed device and must be installed inside a suitable enclosure. The enclosure of the power meter must be rated according to the environment it is used in. For example, outdoor installations require an outdoor-rated

enclosure. Select an installation location that is not exposed to direct sunlight of the elements.

1. Wiring an AC Meter | 5A provided by Elum

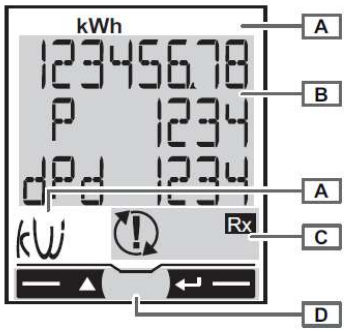
Only connect authorized 5A CTs to the CT inputs of the device.

1.1. Device overview



Area	Description
A	Current and communication connection terminals
B	Backlit LCD display with sensitive touch screen areas
C	Model, feature summary and serial number
D	LED: • blinking red: pulse weight proportionate to the TA and TV ratio result, • orange on: total active power negative. Control only run if the imported and exported energies are measured separately (**Measure** = b).

Fig. 1: View of the EM330-DIN.AV5.3.H.S1.X, Carlo Gavazzi



Area	Description
A	Unit of measure area
B	Specific section information area
C	Signal area: • : incorrect voltage connections • : incorrect current connections • Rx: version S1 only. Modbus command correctly received. • Tx: version S1 only. Modbus command correctly sent to master.
D	Command area

Fig. 2: View of the EM330-DIN.AV5.3.H.S1.X, Carlo Gavazzi LCD screen

1.2. Installation steps

1. Install the breaker(s) in the power-distribution panel so that they provide access to all phases.
2. Open the breakers so there is no power on the breaker contacts.
3. Mount the power meter inside a suitable enclosure near the power distribution panel.
4. Proceed to the wiring of the power meter and CTs according to the wiring diagram corresponding to the site system layout. For a three-phase system current, 4-wire, unbalanced load and three current transformers the wiring should be as described below. Ensure that the stickers on the CTs point towards what is being measured. If it is necessary to shorten or lengthen the CT wires, ensure that the CT wires are properly connected.

The main voltage must not exceed 400V, and the CTs must always have 5A secondary current.

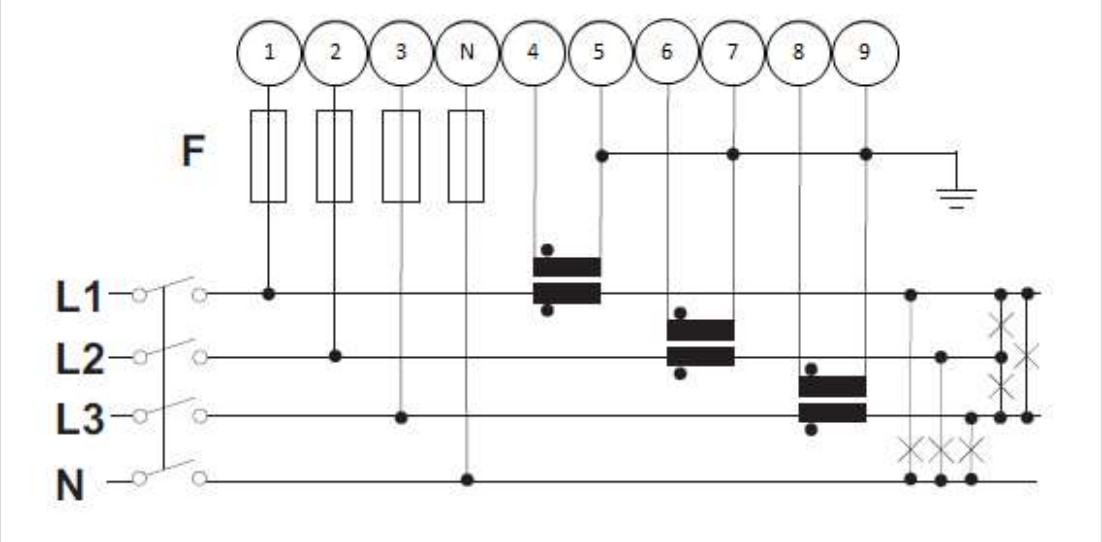


Fig. 3: Example of the EM330-DIN.AV5.3.H.S1.X, Carlo Gavazzi connection diagram for a three-phase system of the system, 4 wires, unbalanced load and three current transformers (CT) and three voltage transformers (VT)

5. Proceed to the power supply wiring of the power meter as described below.

The power supply should be 90-260 V AC/DC.

The auxiliary power supply on the meter enables it to always be powered up whether the plant is operating on grid or on gensets. Power meters monitoring the grid, the load or gensets should always be powered up. One of those power meters being suddenly turned off would turn the ePowerControl into a fail safe mode, curtailing PV production.

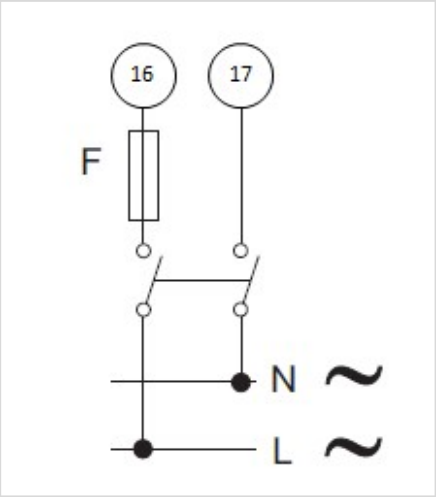


Fig. 4: Connecting the power supply to the EM330-DIN.AV5.3.H.S1.X, Carlo Gavazzi

6. Close the newly installed breakers. This should cause the power meter to power up, within a few seconds the screen should light up and display the measurement page.

7. You can now proceed to the parameter setup of the power meter:

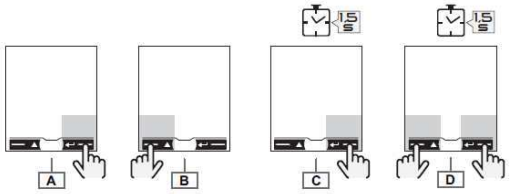
- **SYStEM**, System type: To be set according to the site design.
- **Ct rAtIo**, Current transformer ratio: To be set according to the CTs used with the power meter. You can obtain this ratio by dividing the primary current by the secondary current.
  As an example, when using 200 A to 5 A CTs, the ratio should be set to 40.
- **Vt rAtIo**, Voltage transformer ratio: To be set according to the VTs used with the power meter. You can obtain this ratio by dividing the primary voltage by the secondary voltage.
  As an example, when installing the power meter using no VTs, the ratio should be set to 1.
- **MEASurE**, Measurement type: To be set to “b”
- **AddrESS**, Modbus address: To be set according to your ID plan

The result of the ratio between the current and voltage transformers must be under 1054.

It is critical that the measurement type was correctly set up to “b” for the zero export control feature. If the ePowerMeter was not correctly set up, Elum cannot guarantee any reliability on the zero export feature and will not be taken responsible if some energy is exported to the grid.

Instructions to use the power meter and navigate through the different menus:

Measurement pages displayed by default when turned on. Pages are characterized by the reference unit of measure. The initial measurement page set is displayed after 120 s of disuse.



Commands

Navigation

Operation	Command
View the next page	A
View the previous page	B
Open the programming section	C
Exit the programming section	C (page End)
Open the information section	D
Exit the information section	D

Parameter settings

Operation	Command
Increase a parameter value	A
View the next value option	A
Decrease a parameter value	B
View the previous value option	B
Confirm a value	C
Open the parameter settings page	C

Parameters description

Page	Code	Description	Values
PASS	**P1**	Enter current password	Current password. 0000 default password.
nPASS	**P2**	Change password	Four digits (0000–9999)
SYStEM	**P3**	System type	**3Pn**: three phase system, 4-wire/ **3P**: three-phase system, 3-wire/ **2P**: two-phase system, 3-wire
Ct rAtIo	**P4**	Current transformer ratio (TA)	1–1000 *
Vt rAtIo	**P5**	Voltage transformer ratio (TV)	1–1000 *
		*NOTE *: the result of the ratio between the current and voltage transformers must be under 1054 for **AV5** analyzers and under 3148 for **AV6**.*	
MEASurE	**P6**	Measurement type	**A** : *easy connection* , measures total energy without considering the direction/ **b** : separately measures imported and exported energy
InStALL	**P7**	Connection check	**On**: enabled/ **Off**: disabled
P int	**P8**	Average power calculation interval (minutes)	1–30
MOdE	**P9**	Display mode	**Full** : complete mode/ **Easy** : reduced mode. Measurements not displayed are still sent via serial port.
tArIFF	**P10**	Tariff management	**On**: enabled/ **Off**: disabled
HoME	**P11**	Measurement page displayed when turned on and after 120 seconds of disuse	For full display mode (**Mode** = Full): 0–19 For reduced display mode (**Mode** = Easy): 0–3, 6, 7, 10/11, 18 To learn the page code *see "**Measurement (Fig. 16)**" on page 7.*
rESET	**P17**	Enable energy tariff, maximum requested power and partial active and reactive energy reset (the latter only sent via serial port)	**No**: cancel reset/ **Yes**: enable reset
End	**P18**	Return to the initial measurement page	–

AddrESS	**P14**	Modbus address	1–247
bAUd	**P15**	Baud rate (kbps)	**9.6/ 19.2/ 38.4/ 57.6/ 115.2**
PArITY	**P16**	Parity	**Even/ No**
STOP bit	**P16–2**	Only if no parity. Stop bit.	**1/ 2**

8. Proceed to the communication wiring of the power meter as described below. Connect the ePowerMeter using a shielded twisted pair RS485 connector to one of the serial ports of the Central Computing Unit using a Cat 5 cable.

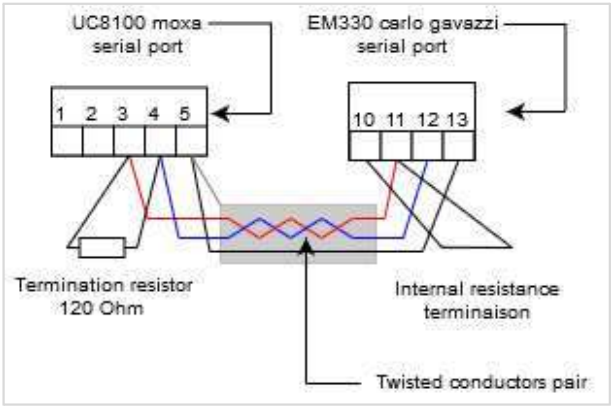


Fig. 5: Connecting a single EM330-DIN.AV5.3.H.S1.X, Carlo Gavazzi

Additional ePowerMeters with RS485 are connected in parallel. The serial output must only be terminated on the last network device connecting terminals B+ and T.
For connections longer than 1000 m or networks with more than 160 instruments, use a signal repeater.

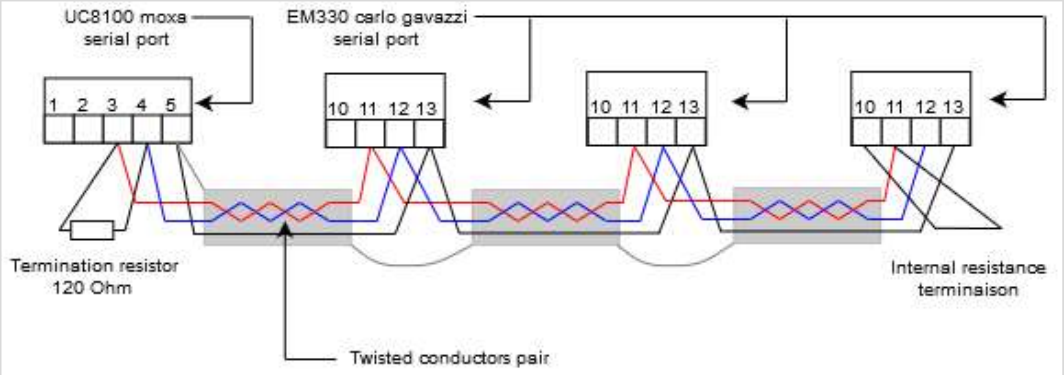


Fig. 6: Connecting several EM330-DIN.AV5.3.H.S1.X, Carlo Gavazzi in parallel

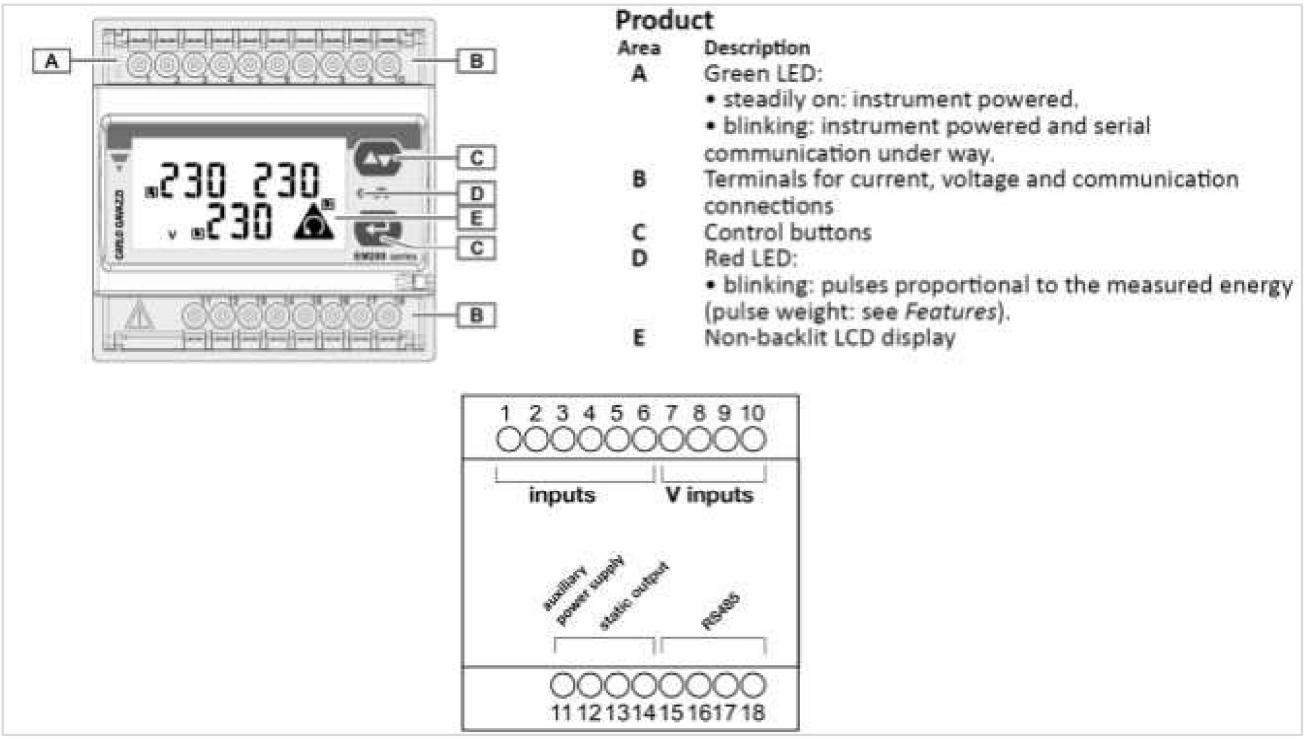
The continuity of the shielding must be ensured throughout the communication cable, and the ground must be connected at a single point. The total length of the cable must not exceed 1200m.

9. Label the newly installed breakers as “ePower Meter Disconnect” so the customer can readily find them if it becomes necessary to power-cycle or turn off the device for any reason.

2. Wiring an AC Meter | 333mV provided by Elum

Only connect authorized 333mV CTs to the CT inputs of the device.

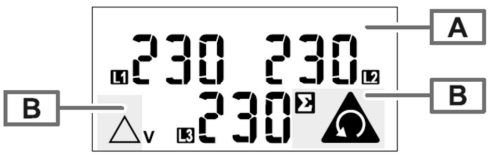
2.1. Device overview



Product

Area	Description
A	Green LED: • steadily on: instrument powered. • blinking: instrument powered and serial communication under way.
B	Terminals for current, voltage and communication connections
C	Control buttons
D	Red LED: • blinking: pulses proportional to the measured energy (pulse weight: see *Features*).
E	Non-backlit LCD display

Fig. 7: View of the EM210-72D.MV5.3.X.OS.X, Carlo Gavazzi



Display

Area	Description
A	Measuring unit area
B	Indication area:
	Incorrect phase sequence.
	Displayed line voltages .
	Displayed system values.

Fig. 8: View of the EM210-72D.MV5.3.X.OS.X, Carlo Gavazzi LCD screen

2.2. Installation steps

1. Install the breaker(s) in the power-distribution panel so that they provide access to all phases.
2. Open the breakers so there is no power on the breaker contacts.
3. Mount the power meter inside a suitable enclosure near the power distribution panel.
4. Proceed to the wiring of the power meter and CTs according to the wiring diagram corresponding to the site system layout. For a three-phase system current, 4-wire, unbalanced load and three current transformers the wiring should be as described below. Ensure that the stickers on the CTs point towards what is being measured. If it is necessary to shorten or lengthen the CT wires, ensure that the CT wires are properly connected.

The main voltage must not exceed 400V, and the CTs must always have 333 mV output.

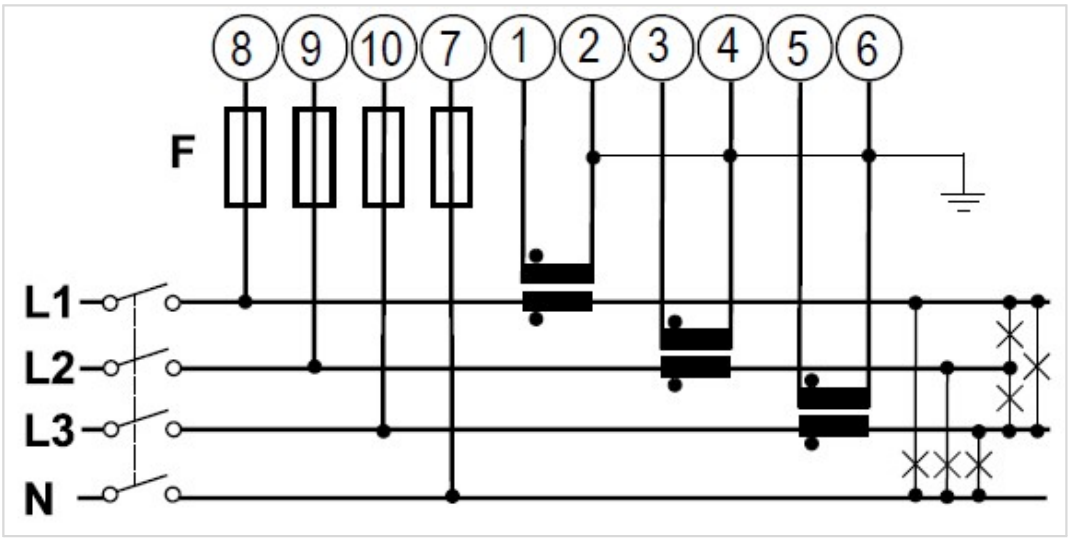


Fig. 9: Example of the EM210-72D.MV5.3.X.OS.X, Carlo Gavazzi connection diagram for a three-phase system of the system, 4 wires, unbalanced load and three current transformers (CT) and three voltage transformers (VT)

5. Proceed to the power supply wiring of the power meter as described below.

The power supply should be 65-400 V AC, 50 Hz

The auxiliary power supply on the meter enables it to always be powered up whether the plant is operating on grid or on gensets. Power meters monitoring the grid, the load or gensets should always be powered up. One of those power meters being suddenly turned off would turn the ePowerControl into a fail safe mode, curtailing PV production.

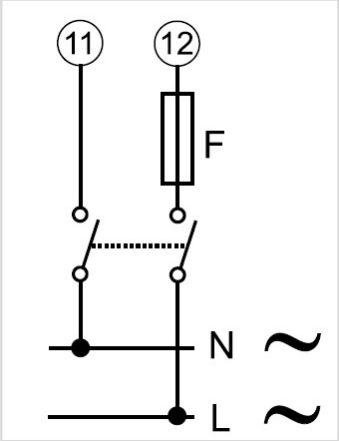


Fig. 10: Connecting the power supply to the EM210-72D.MV5.3.X.OS.X, Carlo Gavazzi

6. Close the newly installed breakers. This should cause the power meter to power up, within a few seconds the screen should light up and display the measurement page.

7. You can now proceed to the parameter setup of the power meter:

- **SYS**, System type: To be set according to the site design.
- **SEnSOr** , CT type: To be set according to the CTs used with the power meter. As an example, when installing the power meter with Rogowski coil CTs, the type should be set to roG.
- **Ct Prin**, Current transformer maximum current input: To be set according to the CTs used with the power meter. As an example, when installing the power meter with Rogowski coil 4000A, the type should be set to 4,00k.
- **Vt rAtIo**, Voltage transformer ratio: To be set according to the VTs used with the ePowerMeter. You can obtain this ratio by dividing the primary voltage by the secondary voltage. As an example, when installing the power meter using no VTs, the ratio should be set to 1.
- **APPLiC**, Measurement application: To be set to “E”.
- **AddrESS**, Modbus address: To be set according to your ID plan.

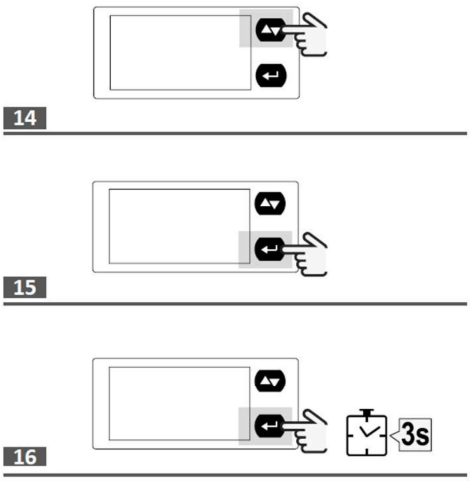
The result of the ratio between the current and voltage transformers must be under 1054.

It is critical that the measurement application was correctly set up to “E” for the zero export control feature. If the ePowerMeter was not correctly set up, Elum

cannot guarantee any reliability on the zero export feature and will not be taken responsible if some energy is exported to the grid.

Instructions to use the power meter and navigate through the different menus.

Measurement pages displayed by default when turned on. Pages are characterized by the reference unit of measure. The initial measurement page set is displayed after 120 s of disuse.



Controls (Fig. 14 – Fig. 16)

Navigation

Operation	Control
Display the next measurements page	**Fig. 14**
Open the Information menu	**Fig. 15**
Display the next information page	**Fig. 15**
Exit the information menu	**Fig. 14**
Enter the parameters menu	**Fig. 16**
Exit the parameters menu (the information menu will be displayed)	**Fig. 16** (page **End**)

Parameter setting

Operation	Control
Access the page to set a parameter	**Fig. 15**
Switch from increase mode (**C** icon) to decrease mode (**-C** icon)	**Fig. 15**
Increase the value of a parameter/display the next option (**C** icon)	**Fig. 14**
Decrease the value of a parameter/display the previous option (**-C** icon)	**Fig. 14**
Confirm a value	**Fig. 16**

NOTE: hold it pressed for at least 2.5 s.

8. Proceed to the communication wiring of the power meter as described below. Connect the ePowerMeter using a shielded twisted pair RS485 connector to one of the serial ports of the Central Computing Unit using a Cat 5 cable.

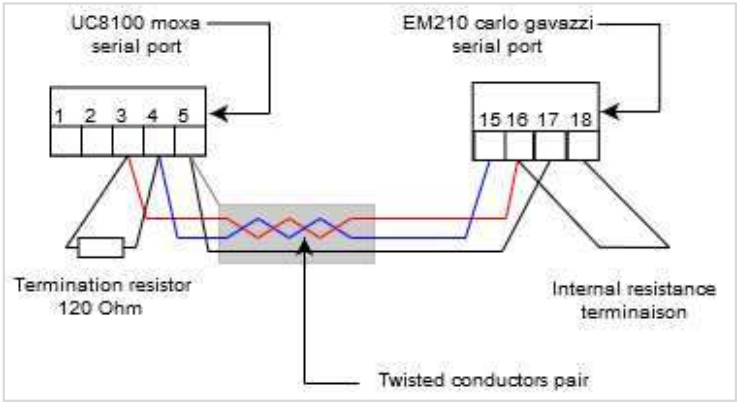


Fig. 11: Connecting a single EM210-72D.MV5.3.X.OS.X, Carlo Gavazzi

Additional ePowerMeters with RS485 are connected in parallel. The serial output must only be terminated on the last network device connecting terminals B+ and T. For connections longer than 1000 m or networks with more than 160 instruments, use a signal repeater.

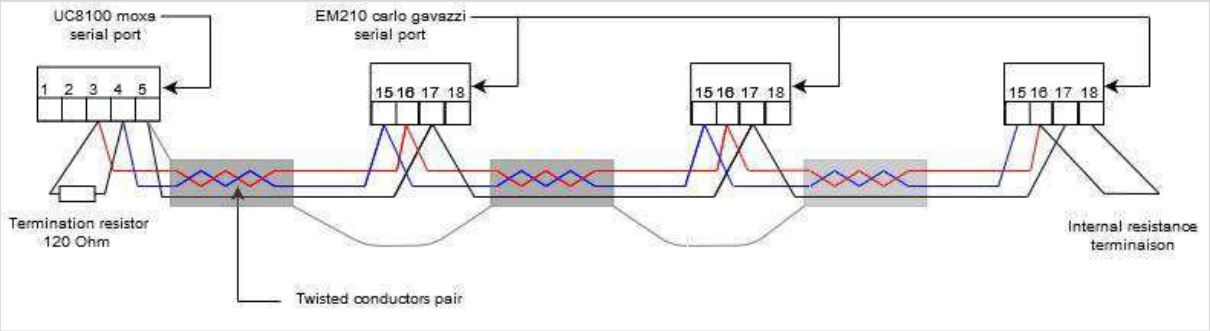


Fig. 12: Connecting several EM210-72D.MV5.3.X.OS.X, Carlo Gavazzi in parallel

The continuity of the shielding must be ensured throughout the communication cable, and the ground must be connected at a single point. The total length of the cable must not exceed 1200m.

9. Label the newly installed breakers as “ePower Meter Disconnect” so the customer can readily find them if it becomes necessary to power-cycle or turn off the device for any reason.

Appendix 02 : TEST MATRIX

1. On-Grid (PV + Grid application) test matrix

N°	Steps	Expected outcome	Observed outcome
1	Log into eConf and access the Control panel	The Control panel must be displayed on screen.	
2	Stop the EMS by clicking on the EMS On/Off Button	The EMS control status must be “PV RAMPING-OFF” then “PV OFF”.	
3	Start PV injection of one of the inverters	The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.	
4	Repeat the step for each inverter, one inverter at a time.	The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.	
5	Turn on all the PV inverters one by one.	The AC power output of each inverter must remain below 1% of the PV inverter nominal output power.	
6	Start the EMS by clicking on the EMS On/Off Button	The EMS control status must first be displayed as “PV RAMPING-ON” for a few seconds and then as “PV ON”.	
		PV injection should start slowly	
7	Decrease the load below the nominal PV production. *(test*	**Zero export option :** The PV production must decrease in	

	the option relevant to your installation)	order not to exceed the total active power of the load. The active power of the grid must be positive at all times or equal to 0.	
		Maximum export option : The PV production must not exceed the configured active power export target. The active power of the grid will be negative when the threshold is reached.	
		Minimum import option : The active power of the grid must be equal to the configured active power import target. The PV production must not exceed the W_{MaxPV} as defined in the following equation: $W_{MaxPV} = W_{Load} - W_{P\_import\_target}$	

2. Islanded (PV + Genset) test matrix

N°	Steps	Expected outcome	Observed outcome
1	Log into eConf and access the Control panel	The Control panel must be displayed on screen.	
2	Stop the EMS by clicking on the EMS On/Off Button	The EMS control status must be “PV RAMPING-OFF” then “PV OFF”.	
3	Start PV injection of one of the inverters.	The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.	
4	Repeat the step for each inverter, one inverter at a time.	The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.	
5	Turn on all the PV inverters one by one.	The AC power output of each inverter must remain below 1% of the PV inverter nominal output power.	
6	Start the EMS by clicking on the EMS On/Off Button	The EMS control status must first be displayed as “PV RAMPING-ON” for a few seconds and then as “PV ON”.	
		PV injection should start slowly	
7	Decrease the load below the minimum loading of the genset, and start the EMS and PV injection by clicking on start	The EMS control status must first be displayed as “PV RAMPING-ON” for a few seconds and then as “PV ON”	

	/ stop button *(mention the minimum loading %)*	PV production must remain stopped	
8	Gradually increase the load to reach the minimum loading of the Genset.	PV production must remain stopped as long as the Genset is below the Minimum loading.	
9	Gradually increase the load to exceed the minimum loading of the Genset.	PV production must start. Genset production must be equal to its minimum loading value.	

3. Backup (PV + Genset + Grid) test matrix

N°	Steps	Expected outcome	Observed outcome
A	**"On grid, Grid connected" configuration (gensets disconnected)**		
1	Log into eConf and access the Control panel	The Control panel must be displayed on screen.	
2	Stop the EMS by clicking on the EMS On/Off Button	The EMS control status must be "PV RAMPING-OFF" then "PV OFF".	
		Genset(s) power meters monitoring values must be consistent, .i.e null.	
		Grid power meter monitoring values must be consistent, i.e. equal to Load power meter monitoring values.	
3	Start PV injection of one of the inverters.	The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.	
4	Repeat the step for each inverter, one inverter at a time.	The AC power output of the inverter must remain below 1% of the PV inverter nominal output power.	
5	Turn on all the PV inverters one by one.	The AC power output of each inverter must remain below 1% of the PV inverter nominal output power.	

6	Start the EMS by clicking on the EMS On/Off Button	The EMS control status must first be displayed as "PV RAMPING-ON" for a few seconds and then as "PV ON".	
		PV injection should start slowly	
7	Decrease the load below the nominal PV production. *(test the option relevant to your installation)*	**Zero export option :** The PV production must decrease in order not to exceed the total active power of the load. The active power of the grid must be positive at all times or equal to 0.	
		Maximum export option : The PV production must not exceed the configured active power export target. The active power of the grid will be negative when the threshold is reached.	
		Minimum import option : The active power of the grid must be equal to the configured active power import target. The PV production must not exceed the W_{MaxPV} as defined in the following equation: $W_{MaxPV} = W_{Load} - W_{P\_import\_target}$	
B	**"Off grid, Genset connected" configuration**		
8	Manually change the power plant from "On grid, Grid connected" to "Off grid, Genset	The SD controller must remain power supplied during the transition from "On grid, Grid connected" to "Off grid, Genset	

	connected" configuration, by disconnecting the grid and starting the gensets.	connected" configuration. The transition must not impact it.	
		Grid, Load and Genset(s) power meters must remain power supplied during the transition from "On grid, Grid connected" to "Off grid, Genset connected" configuration. The transition must not impact it.	
9	Stop the EMS by clicking on start / stop button.	Genset(s) power meters monitoring values must be consistent; i.e. equal to Load power meter monitoring values.	
		Grid power meter monitoring values must be consistent; i.e. null.	
10	Decrease the load below the minimum loading of the genset, and start the EMS and PV injection by clicking on start / stop button. *(mention the minimum loading %)*	The EMS control status must first be displayed as "PV RAMPING-ON" for a few seconds and then as "PV ON".	
		PV production must remain stopped.	
11	Gradually increase the load to reach the minimum loading of the Genset.	PV production must remain stopped as long as the Genset is below the Minimum loading.	
12	Gradually increase the load to exceed the minimum loading of the Genset.	PV production must start. Genset production must be equal to its minimum loading value.	
13	Manually change the power plant from "Off grid, Genset	The SD controller must remain power supplied during the transition from "Off grid, Genset	

	connected" to "On grid, Grid connected" configuration, by connecting the grid and stopping the gensets.	connected" to "On grid, Grid connected" configuration. The transition must not impact it.	
		Grid, Load and Genset(s) power meters must remain power supplied during the transition from "Off grid, Genset connected" to "On grid, Grid connected" configuration. The transition must not impact it.	