# EnerTEG Lite Manual

Version 1.17

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# Chapter 1. Introduction

Located at the heart of all European Data centre hubs, in the Czech Republic, our Power Distribution Units have been manufactured since 2008 using local components. CONTEG's mission is to provide reliable and easy to control power distribution. We focus on refining and perfecting PDUs to meet demands of today's Data centres, industrial facilities and any environment where reliable power distribution is critical.

Our latest innovation, PDU 5.0, embodies our commitment to excellence. Developed in collaboration with over 40 data center operators, it sets a new standard in PDU design. EnerTEG is our software for PDU 5.0. EnerTEG Lite is available as embedded software on a Controller module PDU. The EnerTEG products provide energy monitoring and control for CONTEG PDU 5.0 products. The EnerTEG user interface has been designed from the beginning to be easy to use.

Distributed monitoring and control systems have often been demonstrated to provide a better, more intelligent and more flexible way to collect and manage large amounts of data provided by current energy and sensor sources. These distributed monitoring and control systems analyse and display data from associated parts of the Data centre.

For Data centres preferring a traditional approach, the combination of a PDU with a Controller module provides a built-in solution where PDU intelligence, APIs and the web interface are embedded directly into the module. This combination runs the EnerTEG Lite version of the EnerTEG software. The PDU communicates using the Gigabit ethernet port and integrate directly with (existing) DCIMS and power management solutions in Data centres through a variety of interfaces.

The Daisychain module PDU enables easy expansion of the network via the Databus connections of a Controller module PDU. In a Databus ring configuration of up to 100 PDUs total, only one Controller module PDU is required to communicate, which saves up on IP address space.

With PDU 5.0, CONTEG provides a high quality and modular answer to the vast variety in project requirements and designs.

## 1.1. Disclaimer

While we strive to provide accurate and up-to-date information in this manual, please be aware that there may be an occasional error or inconsistency in the text or the descriptions.

# Chapter 2. Overview

EnerTEG is our Power Monitoring software for PDU 5.0. EnerTEG Lite is installed as embedded software on a Controller module PDU.

**Overview**

| Feature | EnerTEG Lite |
|---|---|
| Maximum number of PDUs in system | 100 |
| Maximum number of Databus rings supported | 1 |
| Maximum number of PDUs in one ring (single IP address) | 100 |
| Measurements refresh rate | Once/5s |
| Auto discovery of new added Databus PDUs | Yes |
| Aggregation of measurements on room/row/rack level | Yes |
| Supports CONTEG generation 2 and 3 devices | No |
| Multiple roles and permissions | Yes |
| Configurable thresholds for all measurements (warnings/alerts) | Yes |
| Dashboarding | Basic |
| Creation of reports | Basic |
| Scheduling of reports | No |
| Export of data to files or database | Yes |
| Logging and auditing | Basic |
| Back-up (configuration, log files) | Yes |
| Updating | Yes |
| PDU Communication module Compatibility | Controller module |
| Type of software | Embedded software on Controller module |
| Installation | Embedded software on Controller module |
| Scalability | Supports up to 100 PDUs and is limited to the capabilities of the Controller module hardware |
| DCIM integration | Standard integration |
| Supported protocols | HTTP/HTTPS, REST API, Modbus, Redfish, SNMP V2C & V3 (including traps), SMTP, NTP, LDAP, SSH |
| Security protocols | Strong password config, user & role management, Active Directory, LDAP/S integration, SSL/TLS 1.3, HTTPS |
| User management | Customizable roles, permissions and group management |
| Control and alerts | Configurable thresholds for all measurements on PDU and room/row/rack level |
| Threshold type | Fourfold: critical and warning thresholds, and upper and lower thresholds can be set across all PDUs / branches / outputs / inputs possible through an innovative rule-setting system, also configurable from system-wide to Data centre element level. |
| Alert notification | Optional E-mail dispatch of alerts or notifications |

| Feature | EnerTEG Lite |
|---|---|
| Real-time monitoring | All PDU measurement values |
| Inputs, branches and outlets measurements | Voltage, voltage dip and peak, current, current peak, neutral current, watts, apparant power, reactive power, energy, apparant energy, residual current, total harmonic distortion, crest factor, frequency, power factor |
| Data dashboarding | Basic |
| Data logging and reporting | Basic |
| PDU Monitoring and management | PDU 5.0 (Controller module) PDU plus up to 100 (Daisychain module) PDUs on the Databus |
| Environmental monitoring | Supports sensors for temperature, humidity |
| Backup options | Configuration, log files |
| Updating functionality | Yes |
| Report creation | Reporting of all measured values in tabular and graphical form, optionally available as an Excel download. |
| Scheduled reports | No |
| Data insight | Overviews with data of multiple PDUs, rooms, rows, racks, and also detailed views of PDU or inlet / branch & outlet specific measurements. |

# Chapter 3. Installation


*Figure 1. EnerTEG*

## 3.1. EnerTEG Lite

First check which module is attached to your PDU and if there is a DHCP server available on the network. Then follow the steps for configuration with or without DHCP server availability.

### 3.1.1. Controller module PDU without DHCP server availability

1. Connect the PDU with the Controller module to a LAN network.
2. The PDU can be reached using http://pdu5-[serial_number].local (e.g. http://pdu5-119411.local) using Link-Local address autoconfiguration and mDNS. This is supported by all operating systems such as Windows and Linux.
3. Login to the web interface on the browser with default login credentials (admin, admin).
4. To change the IP address of a Controller module to a static address, go to the general EnerTEG settings and click on Network ETH0. Set DHCP to off to start using a static IP address. Fill in the IPv4 address and a subnet prefix length. Save the changes and wait until the changes are processed.
5. Create a Data centre structure (room, row, rack) in EnerTEG (see chapter 'Data centre structure'), navigate to a rack and assign PDU(s) to the rack.

The active IPv4 address (will be a Local Link Address) can also be obtained by scanning the Controller module with the PDU Display App. Download and install the PDU Display app. Scan the PDU and retrieve the active IPv4 address to connect to the PDU.

### 3.1.2. Controller module PDU with DHCP server availability

1. Connect the PDU with the Controller module to a LAN network.
2. When the IP address is known, access the EnerTEG Lite software of the PDU by entering the IP address assigned by DHCP in a browser.
3. If the IP address is not yet known, the PDU can be reached using http://pdu5-[serial_number].local (e.g. http://pdu5-119411.local).
4. Login to the web interface on the browser with default login credentials (admin, admin).
5. To change the IP address of a Controller module to a static address, go to the general EnerTEG settings and click on Network ETH0. Set DHCP to off to start using a static IP address. Fill in the IPv4 address and a subnet prefix length. Save the changes and wait until the changes are processed.
6. Create a Data centre structure (room, row, rack) in EnerTEG (see chapter 'Data centre structure'), navigate to a rack and assign PDU(s) to the rack.

The active IPv4 address negotiated by DHCP can also be obtained by scanning the Controller module with the PDU Display App. Download and install the PDU Display app. Scan the PDU and retrieve the active IPv4 address to connect to the PDU.

## 3.2. Daisychain module PDU

A PDU with a Daisychain module can be connected to the databus of a Controller module PDU via standard network (UTP5) cables. We always recommend to connect Daisy-Chain PDUs on the databus in a closed ring situation, with both databus cabled connected. This improves performance and speed and creates a redundant communication line. The device will automatically become visible in the device list of EnerTEG via the Controller module PDU once connected. Now the Daisychain module can be assigned to a rack in EnerTEG.

## 3.3. Software updates

EnerTEG can be updated to the latest version using raucb files, which can be downloaded from https://download.conteg.com/PDU/IP-S/EnerTEG-dcem/. Make sure to download the correct update file for EnerTEG Lite. To update EnerTEG, go to the Settings → General. In the 'System update or license install' section you can select the update file there. When the raucb file is selected press the 'Start Installation' button. Now the update will start, the update progress is displayed on the progress bar. EnerTEG will reboot after the installation. After a few minutes the update will be completed.

For updating multiple Controller module PDUs, update functionality is added to the REST API. Users can make automated update scripts without installing specific tools and update hundreds of Controller module PDUs within seconds with just a single command. Detailed information can be found in the REST API documentation.

# Chapter 4. First use

## 4.1. First start

To start using EnerTEG, power up a PDU with a Controller module. The login page is displayed whenever a new user connects to EnerTEG via a browser. At the first start there is only one account (the administrator account). More accounts can be created by the administrator, each account can be assigned a role.

The administrator can login with user name “admin” and password “admin” during the first login. We strongly advise to change the password after the first time login.

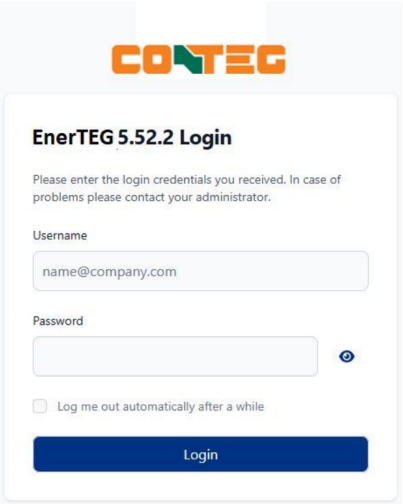



*Figure 2. Login*

## 4.2. Initial configuration

On the initial configuration, please open the settings page and validate / set the settings in EnerTEG accordingly. The Data centre structure can be set up, and Databus PDUs will be added automatically to the system.

As for certificates to function correctly and to prevent serious issues in the future, it is of vital importance that the time of EnerTEG is set via an NTP server or manually synchronized. This can be done by logging in to the web interface of EnerTEG.

1. Go to settings and open the general settings, the date and time settings can be set here.
2. There are two options; set the date and time using an NTP server or set the time from the browser. Make sure the time is correct and the settings are saved after modifying them.

Changing the time during operation should be avoided, time should be set on the first start, doing this at a later point in time can result in gaps in the history database and graphs.

# Chapter 5. Configuration

To open the application settings, click on Settings menu option.

## 5.1. General settings

The main application settings for EnerTEG.

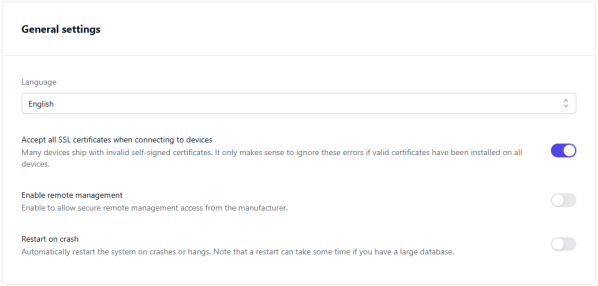



*Figure 3. General settings*

Administrators can select the language for EnerTEG, which will affect all aspects of the application. Click “Apply” to apply the new language. Many devices ship with invalid self-signed certificates, EnerTEG provides an option to accept all SSL certificates when connecting to devices. It only makes sense to ignore these errors if valid certificates have been installed on all devices.

For technical support, there is the option to enable remote management, which allows secure remote management access from the manufacturer. Also the application can restart automatically on crashes or hangs. Note that a restart can take some time if you have a large database.

### 5.1.1. System support

The system support section provides maintenance tasks for EnerTEG. Information such as the current version of EnerTEG with major, minor and patch version parameters can be viewed by the user.

An administrator can fully restart EnerTEG, it will shut down and restart the complete operating system (warm restart). No data will be lost. Also there is the option to power off, it will shut down and power off. It is safe to remove power afterwards.

When required, the software can be reset to the factory settings. This resets the EnerTEG database, deleting all data and configuration. Does not reset the configuration of connected devices. Warning: this can not be undone.

EnerTEG updates can be installed. The update file will be provided by CONTEG, and can only be installed on a EnerTEG system. When the “select file” button is clicked, the update file on the local file system must be selected. Make sure to select the correct update file for the correct EnerTEG version. It will then be uploaded to EnerTEG. After the upload process has completed, the software will update and restart, and this can take several minutes. After the update has completed, a new login will be required.

A copy of the EnerTEG logs can be downloaded for further analysis. In the event of issues during EnerTEG operation, it can be helpful to have additional information to help the analysis. The internal log files will be collected and uploaded to the download directory on the management system.

## 5.2. Web access

Access to EnerTEG is mainly done via a HTTP, or HTTPS connection from a browser. The default setup permits HTTP, but EnerTEG can also be set up for secure HTTPS connections. The default certificate supplied with EnerTEG is self-signed. Browsers may sometimes display warnings that the user can choose to ignore in order to continue using EnerTEG. This certificate can however be replaced by a user defined certificate and key.

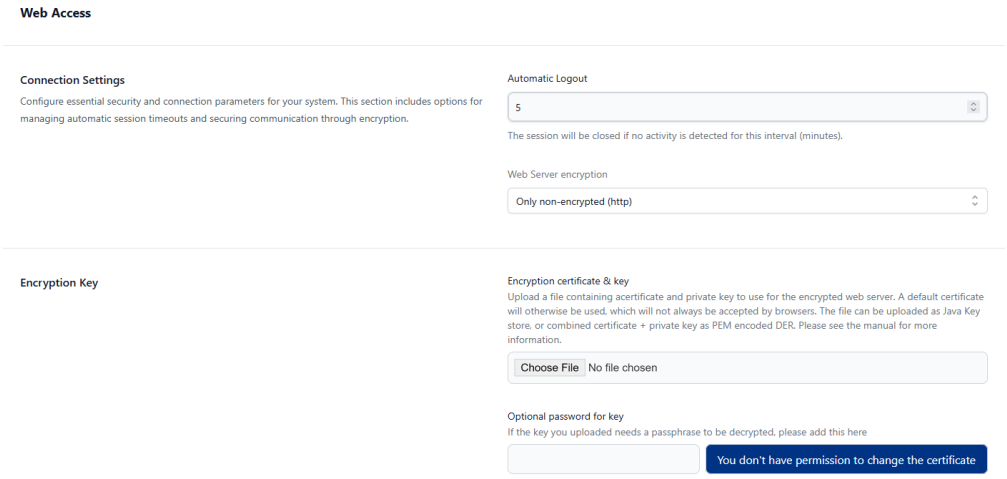



*Figure 4. Web access*

The Web Server encryption has multiple configuration options such as a non-secure Web Server. When disabled, the port 80 access (unsecure) will be blocked and redirected to the HTTPS (port 443). This effectively removes the possibility to access EnerTEG via an unsecured connection.

Another option is to use the encryption certificate & key, which means a valid certificate with its private key can be pasted into the field (this is normally a PEM file). The file must contain both the certificate and the private key are necessary to provide a secure TLS connection. Both parts should be concatenated into one file. If the certificate is invalid or the key is missing, then EnerTEG will return to using the default unsigned factory certificate. EnerTEG will require a restart before the new certificate will be activated. If the private key is protected with a password, then the password must be entered in the designated field.

The Prometheus endpoint is used to expose monitoring metrics so Prometheus can collect them. The endpoint is read-only and intended for monitoring systems, not for controlling EnerTEG. Because the metrics may reveal internal system details, there is the option to disable the endpoint. The Redfish API can also be enabled or disabled in this menu.

The browser wants to connect to the CA, but if it is in a closed network, it cannot go to an external CA for verification. By adding your own certificates, the system can be given a trusted certificate.

Certificates have a maximum lifetime. When the certificate expiry date is reached the HTTPS connection will stop working so make sure the certificate does not expire, because no more (secure) access will be possible. At the next EnerTEG restart the standard HTTP setting will be used, and the certificate can be replaced.

## 5.3. Network

The Network setting page provides the current network status information and IPv4/IPv6 connection configuration for one or more specific network interface(s) available in EnerTEG. To set a static configuration:

1. Set DHCP to off.
2. Put in the IP address.
3. Put in the correct subnet prefix length.
4. If required: set the gateway address and the DNS values.
5. Save the configuration, wait until the changes are processed. The interface is now reachable on the new static IP address.

IPv6 has additional settings such as IPv6 RA. When enabled, EnerTEG will attempt to retrieve a valid IPv6 address and default route through Router Advertisements. Note: Is not capable of retrieving DNS server information without an existing DHCPv6 server.

Enabling Local Link Addressing, EnerTEG will automatically generate an IPv6 address based on the MAC address of the interface used for local communication. Additionally LLA fallback can be enabled, which assigns a static IPv6 if IPv6 LLA fails.

## 5.4. Syslog

EnerTEG is able to export notifications to an external Syslog server of choice. When using the Syslog client, data is sent via BSD Syslog UDP/TCP. The external server should confirm to the RFC 5424 standard. This function is disabled by default, and will need to be activated with the “enable Syslog client” button. Any changes made to the settings need to be saved by clicking the “Apply” button.

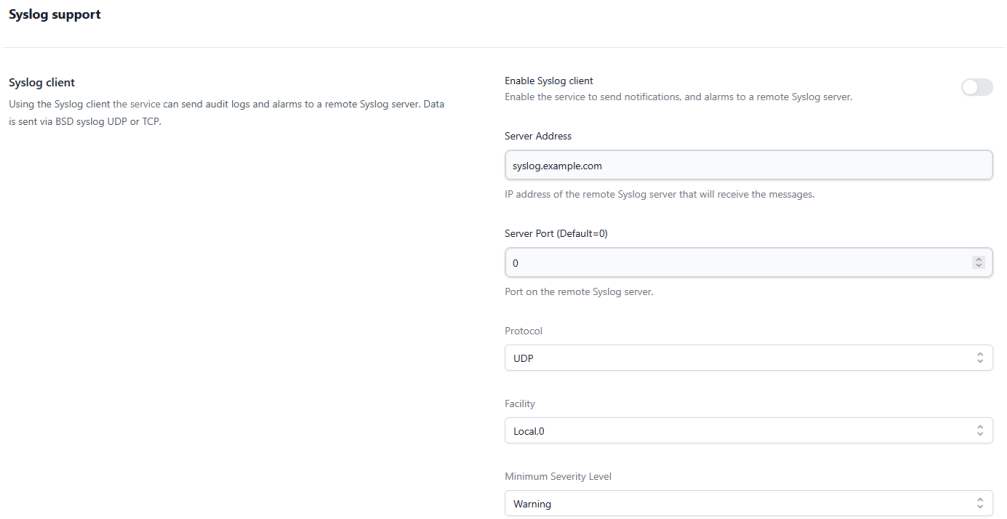



*Figure 5. Syslog*

The TCP IP name / address and port of the target Syslog server must be added when Syslog is to be used. If the remote Syslog server will be using the default port number, this field can keep the default value of 0. If this is not the case, please enter the correct value. The remote system manager can specify to which facility the Syslog entries from this EnerTEG appear. Administrators are able to select which notifications are exported. Notification messages have a severity level, these severity levels can be used to filter which messages are exported through Syslog.

# 5.5. SNMP agent

A SNMP agent can be queried via the SNMP protocol by SNMP clients. Remote SNMP browsers can access EnerTEG devices, optionally using the EnerTEG generic MIB file.

The SNMP agent is disabled by default, but can be enabled by the administrator, enabling the service to which a remote SNMP manager can poll for device data. Port 161 is the default port setting, as most SNMP devices are using the standard SNMP port. The MIB file for this agent is available for download from EnerTEG. Data from all connected devices is included in the SNMP data. Any changes need to be committed by clicking the “Apply” button.

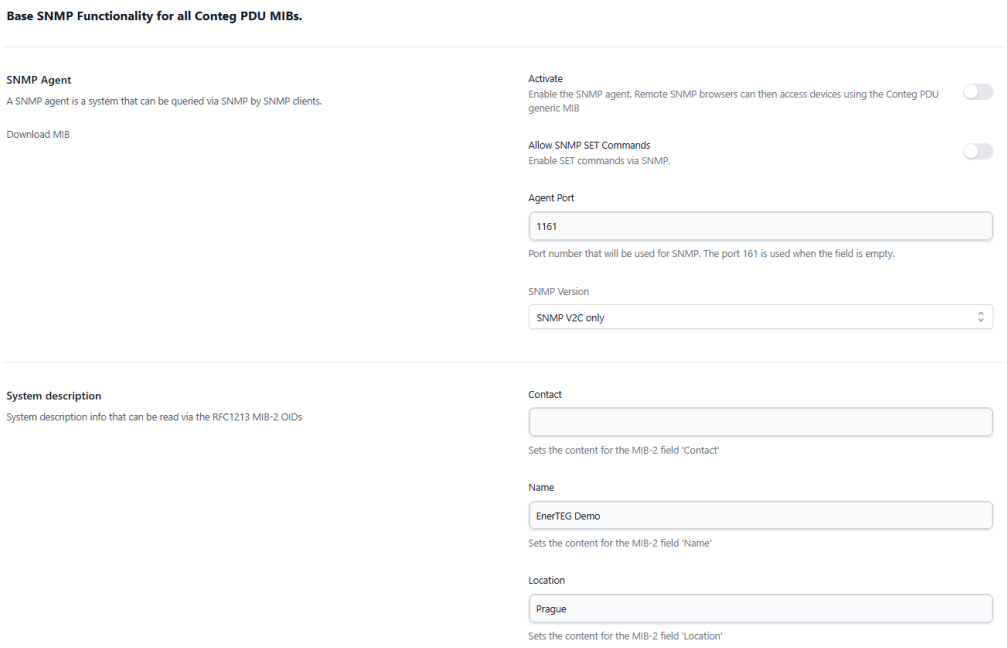



*Figure 6. SNMP Agent & System Description*

The SNMP agent can be enabled or disabled by the administrator, in addition, allowing SET commands via SNMP can also be enabled or disabled. For the SNMP agent to function correctly, a specific port number designated for SNMP could be set, but in most cases the default value can be kept (port 161 is used when the field is empty). Additionally the SNMP version should be specified, with the options V2C Only / V3 Only / V2C and V3 available.

The system description contains settings for the MIB-2 fields 'Contact', 'Name' and 'Location'.

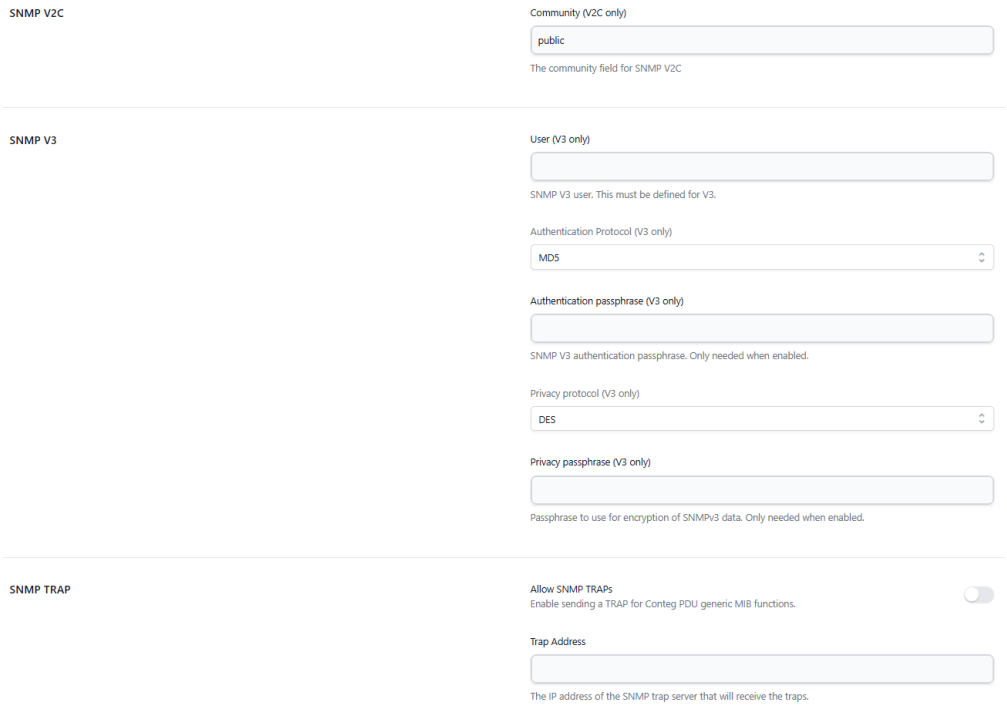



*Figure 7. SNMP V2C / SNMP V3 / SNMP TRAP*

SNMP V2C uses a community read and write password, which should be set if SNMP V2C is to be used. If SNMP V3 is to be used, more fields require setup. For example the user must be defined. Also the correct authentication protocol such as MD5 and the authentication passphrase is needed when enabled. Additionally the privacy protocol (e.g. DES) and privacy passphrase to use for encryption of SNMPv3 data should be added.

EnerTEG supports SNMP TRAPs which enables sending TRAPs for EnerTEG generic MIB functions. The TRAP address can be specified, which is the IP address of the SNMP trap server that will receive the TRAPs. The format needs to be: 'IP:Port'. When SNMPv3 traps are to be used, in addition to the authentication and privacy login data the engine id must be obtained and used by the client.

## 5.6. Modbus server

Activate the Modbus TCP server to allow Modbus clients to connect and read data. Please ensure that no unauthorized access over the network is possible, since Modbus is inherently insecure, unencrypted and without any access control. Optional: allow Modbus clients to write values to device registers (e.g., outlet control, naming). This configuration option is disabled by default. The Modbus register list can be downloaded from our website.

## 5.7. E-mail services

EnerTEG can send notifications by E-mail to a list of recipients via an external SMTP E-mail server. This function is disabled as default, but can be enabled. To minimize the number of Emails sent out, a “Delay Timer” can be defined to collect multiple notifications and send them in one Email. High severity level notifications can, however, be set to be sent immediately. Any changes need to be committed by clicking the “Apply” button. When using an internal distribution mailbox (which has no authentication to send mail), the authentication type can be set to 'None' which means that no user or password is required and a connection without authentication becomes possible.

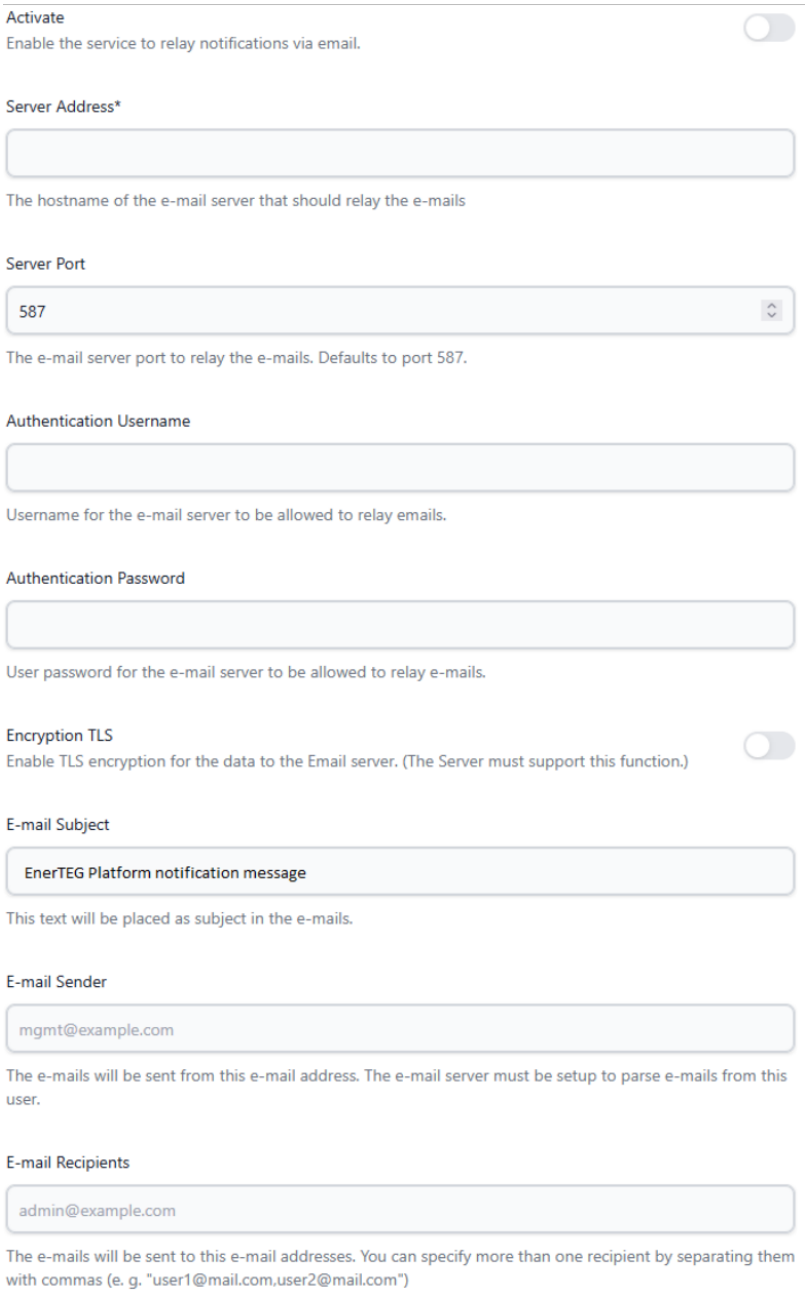



*Figure 8. E-mail services*

Enable the e-mail service to relay notifications via email. This requires the hostname and port of the e-mail server that should relay the e-mails. The port default is 587. Probably the e-mail server requires a username and password for the e-mail server to be allowed to relay emails. If the server supported this, TLS encryption for the data to the Email server can be enabled.

The mail addressing can be tweaked by setting the subject value, which will be placed as subject in the e-mails. A sender address can be supplied, e-mails will be sent from this e-mail address. The e-mail server must be setup to parse e-mails from this user. Also, multiple recipients can be supplied: The e-mails will be sent to this e-mail addresses. Administrators can specify more than one recipient by separating them with commas (e. g. "user1@mail.com,user2@mail.com").

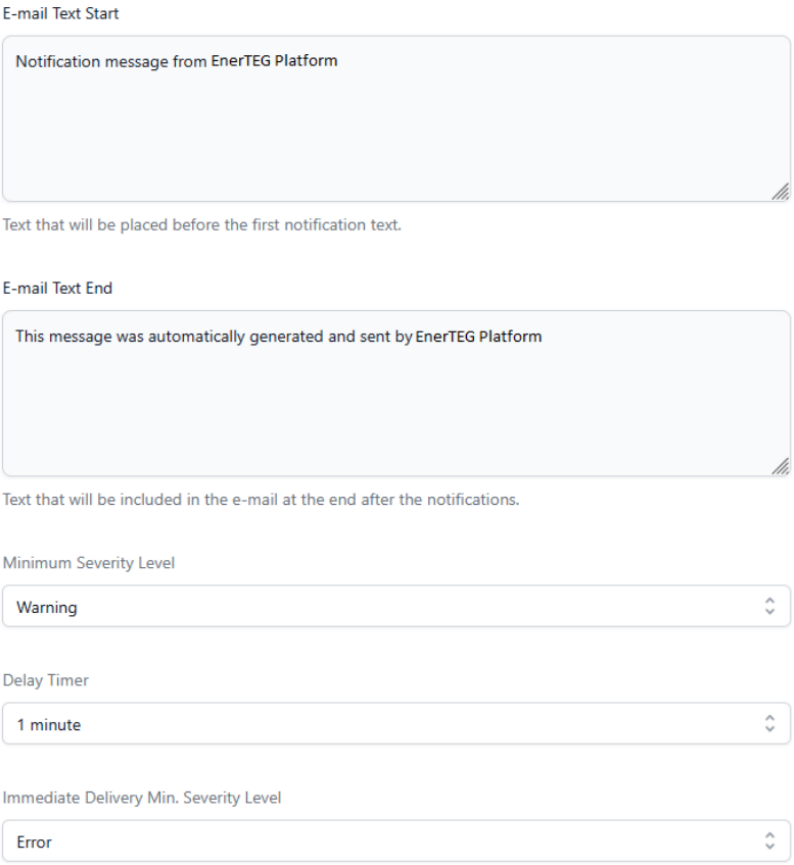



*Figure 9. E-mail services*

The mail template can be tweaked by setting the text start that will be placed before the first notification text. The end text can also be set, the end text will be included in the e-mail at the end after the notifications. Administrators can set options such as the minimum severity level threshold for sending e-mails; info, log, warning (default) or error. There is also a delay used for sending e-mails (1 min, 5 min, 15 min, 30 min, 1 hour) and the minimum severity level for which an e-mail will be send instantly can be set.

# 5.8. Audit log

These settings are for controlling the audit log.

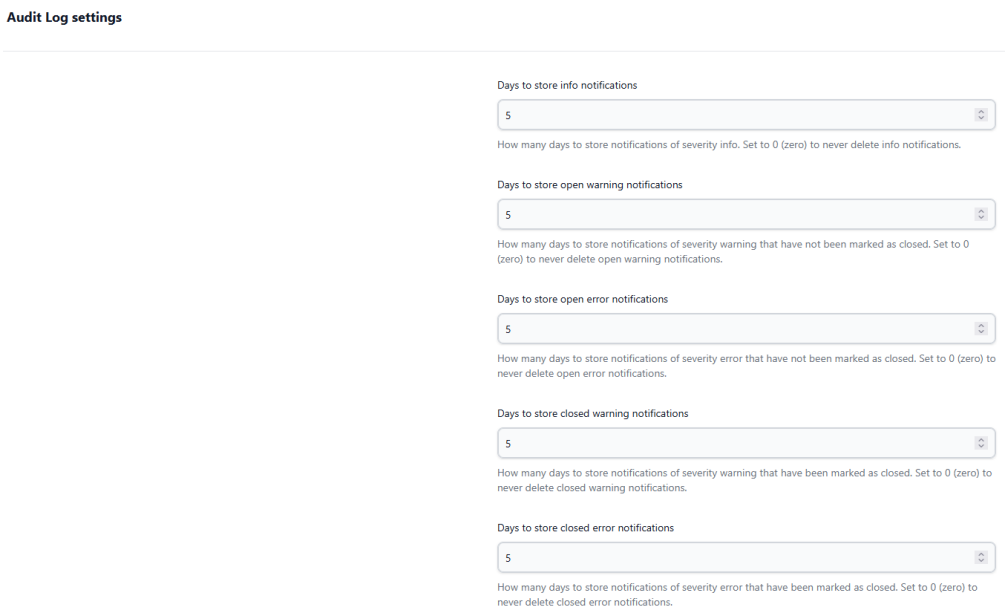



*Figure 10. Audit log*

In the audit log, there is the ability to set how many days to store notifications of severity info. Set to 0 (zero) to never delete info notifications (default = 5). This can also be done for a severity warning that have not been marked as closed. Set to 0 (zero) to never delete open warning notifications (default = 5). Open error notifications can be stored, choose how many days to store notifications of severity error that have not been marked as closed. Set to 0 (zero) to never delete open error notifications (default = 5). The same can be done for severity warnings that have been marked as closed. and notifications of severity error that have been marked as closed.

## 5.9. Authentication (user role management)

EnerTEG users can be added and removed. Roles can be assigned to users. They are allowed different access rights depending on their login attributes. These range from full rights to minimal read-only access. Users with the necessary roles can modify device and port names, switch ports and set rules and threshold values.

| Role | Access rights |
|---|---|
| admin | Read/write access to all EnerTEG functions. A user with this role has read and write access to any EnerTEG device or port. |
| readonly | Read only access to all device data. A user with this role has only read access to all devices and ports. The user cannot change any parameters, or switch any ports. |
| power | Read only access plus PDU switching. A user with this role can read any data from any device or port, and can also switch outlet ports. |
| readwrite | Read only access plus device setup. A user with this role can read any data from any device or port, and can also write new data to any device, or port - other than the switch ports. |
| poweron | Read only access. Devices can be powered on. A user with this role can read any data from any device or port, and can also switch outlet ports on. |
| poweroff | Read only access. Devices can be powered off. A user with this role can read any data from any device or port, and can also switch outlet ports off. |

There are three actions defined per user: assign roles, edit roles and delete roles.

Roles can be assigned to a local user:

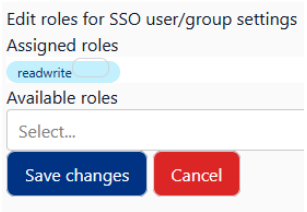



*Figure 11. Assign roles*

Existing user data can be edited:

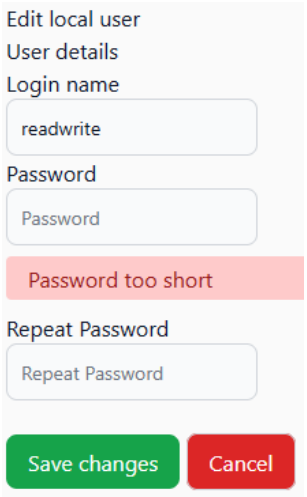



*Figure 12. Edit user*

New local users can be added to the system:

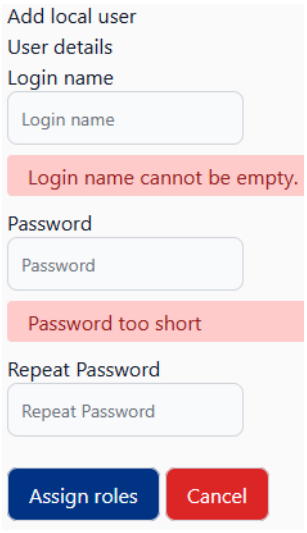



*Figure 13. Add user*

# 5.10. LDAP / Active directory

LDAP / Active Directory allows setting up a connection between the system and an LDAP or Active Directory server for authentication and user management.

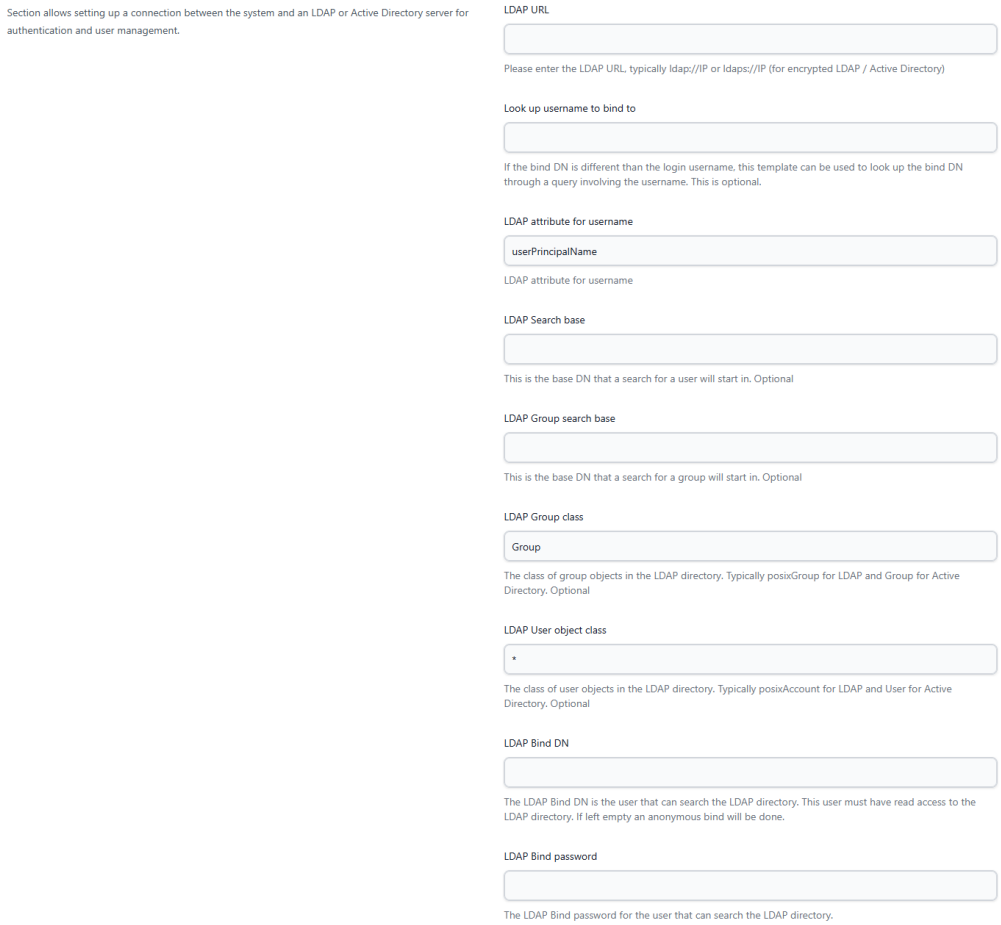



*Figure 14. LDAP / Active directory*

The LDAP URL can be entered, typically ldap://IP or ldaps://IP (for encrypted LDAP / Active Directory). For Active Directory it is recommended to use port 3269 for encrypted LDAP. If you use a self-signed certificate, please make sure to import it into the EnerTEG TLS Certificates settings. The LDAP Bind DN and password is the user that can search the LDAP directory. This user must have read access to the LDAP directory. If left empty an anonymous bind will be done.

The administrator can configure how the username is mapped from the data returned by LDAP to the username within EnerTEG. If the bind DN is different than the login username, the template can be used to look up the bind DN through a query involving the username. Typically required by LDAP but not by Active Directory. Example: (uid={0}). This is optional. The LDAP attribute of search responses will be used to determine the username. Typically set to cn. Cannot be used with a DN lookup template.

There are multiple (optional) settings such as the search base, which is the base DN that a search for a user will start in. Also the group search base, which is the base DN that a search for a group will start in. The group class of group objects in the LDAP directory can be set, this is typically posixGroup for LDAP and Group for Active Directory. Another optional setting is the class of user objects in the LDAP directory, typically posixAccount for LDAP and User for Active Directory. The LDAP Bind DN is the user that can search the LDAP directory. This user must have read access to the LDAP directory. If left empty an anonymous bind will be done. The LDAP Bind password is the password for the user that can search the LDAP directory.

## 5.11. CLI

This menu provides configuration options for the SSH CLI service which allows command line access to the system. The TCP port of the SSH server can be set. Defaults to port 22 (or 2022 for non-root installations). Also the hostname or IP address of the SSH server can be provided. If left empty or set to 0.0.0.0, the server will listen on all interfaces.

## 5.12. TLS Certificates

Multiple TLS certificates can be added to the system.

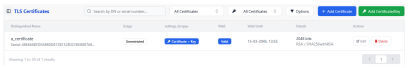


*Figure 15. TLS certificates*

It is possible to add certificates by dropping supported *.pem, *.crt or *.cer files. A usage restriction can be applied; unrestricted, LDAP connection or device access. A certificate text with PEM content only can be pasted in manually.

Additionally there is the option to add a certificate plus a key manually or via a file upload. Optionally a passphrase can be entered if the private key is encrypted. Supported formats:

- PEM: Text-based format for certificates and keys
- PKCS#12 (.pfx, .p12): Binary format containing certificate and private key
- DER: Binary format for certificates

## 5.13. RADIUS

The RADIUS configuration page contains basic settings needed for the connection between the system and a RADIUS server for authentication. Additionally the protocol and the role attribute mapping can be set.

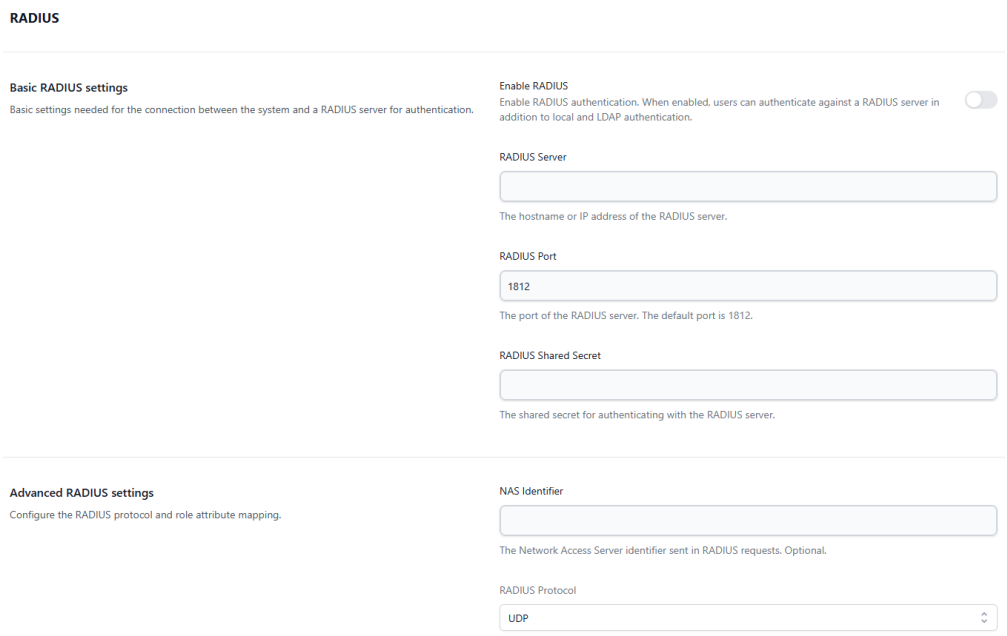



*Figure 16. RADIUS*

The RADIUS authentication can be enabled, the hostname or IP address, and the port of the RADIUS server can be set. The default RADIUS server port is 1812. For authenticating with the RADIUS server the shared secret can be set. The Network Access Server identifier sent in RADIUS requests is optional. The UDP and TCP protocol is supported for RADIUS.

# Chapter 6. Data centre structure

## 6.1. Overview

A very important EnerTEG feature is provided by the Data centre structure view functionality, which provides a way to access the energy data organised around the customer Data centre and it's structure.

Important values are displayed within the Data centre organisational units e.g a row or rack, and thresholds can be set within them. Each organisational unit has it's own dashboard. EnerTEG thus provides a very powerful customer orientated status tuned to their individual requirements.

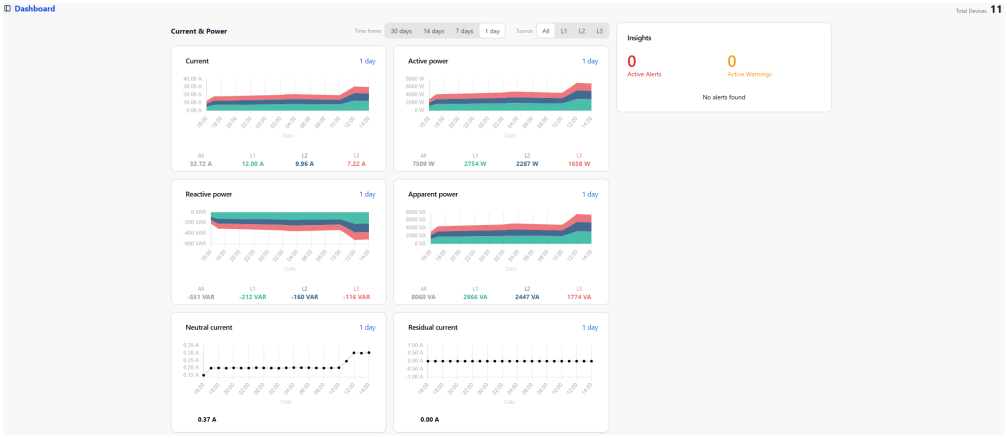



*Figure 17. Data centre overview*

The Data centre overview provides a logical power overview of the structure in a Data centre. Important energy values are displayed, and their status are made visible within the individual logical groups.

Complete or sections of racks can be switched by a EnerTEG user with the necessary access rights. The user can within this hierarchical view scroll down from the top level view into the required level, e.g. rack with it's installed rack devices.

The initial setup does not include any Data centre structure items such as rows, etc. These will need to be created after installation in EnerTEG.

## 6.2. Hierarchy explanation

The Data centre hierarchy is reflected by the elements that are available from EnerTEG. There are a couple of hierarchical options available to make a virtual representation of the Data centre which will be explained in this chapter. In the picture below is an example of a Data centre hierarchical structure fully set up.

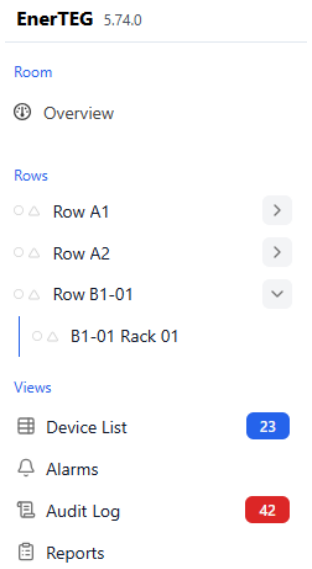



*Figure 18. Menu DC Tree*

Each structure element in the hierarchy has it's own dashboard with measurements on the level of that structure element.

### 6.2.1. Data centre

A DC item is a entry to describe a Data centre location. The top level is a room.

### 6.2.2. Row

- Display the selected row by clicking on the relevant row icon on the right side of the view.
- A Row is a logical item emulating a row of racks in a room, and will normally contain a number of racks.
- Select the row by clicking it. This will open the dashboard for that row.
- By expanding the row, the racks in the row will be displayed.

### 6.2.3. Rack

- Display the selected rack by clicking on the relevant rack icon on the right side of the view.
- A rack is a logical item emulating a rack in a row within a room, and will normally contain a number of PDUs assigned to the rack.
- Select the rack by clicking it. This will open the dashboard for that rack.

# 6.3. Data centre structure setup

In EnerTEG, a Data centre structure can be set up. Rows can be added and racks can be added. This gives users the choice to virtually create the Data centre structure and couple devices. Devices can be coupled to racks. In the device settings, the power feed can be assigned to a device.

This results in measurements on room, row and rack level each having their own dashboard. Additionally on rack level there is a device list that contains the devices present in the rack with the ability to assign and unassign devices. When a device is in a rack, the power feed which it is connected to is also displayed on rack level.

To configure the Data centre structure, the menu specially available for this task should be opened. It can be found on the lower left side of the web interface, in the settings section.

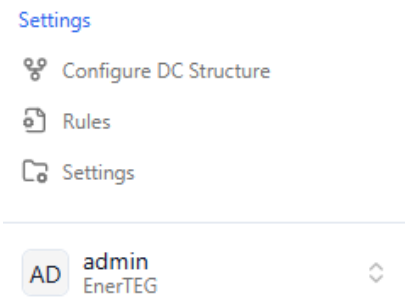



*Figure 19. Menu settings*

Click on "Configure DC structure". On a fresh installation of EnerTEG, the structure will be empty and can be set up as desired.


*Figure 20. Configure DC Structure*

**Add a structure element**

To add a Data centre structure element, click in the proper place on (example given) 'add new row'. Type in the name and click on add to add the element to the structure.

**Modify a structure element**

To modify the name of an element, click on the gear icon next to the element. The structure element name now can be changed. Should the modify action require cancellation, click on the cross icon that has become available.

**Remove a structure element**

It is also possible to remove structure elements by clicking the bin icon. After clicking on the bin once, the icon becomes red. A confirmation is required for removal. Click on the red bin icon to definitively remove the structure element.


*Figure 21. EnerTEG*

# Chapter 7. Operation

## 7.1. Managing connected PDUs

This section assumes that connections containing operational PDUs are added to the EnerTEG system and that a Data centre structure has been created.

### 7.1.1. Configure PDUs for use in EnerTEG

When PDUs are added to EnerTEG for the first time, the settings are all at default. For the search functionality and identification within EnerTEG, it works well to do a general and behaviour setup, and optionally do an input, outlet and sensor setup. Go to the device list, click on the PDU that needs configuration. Click on the configuration tab.

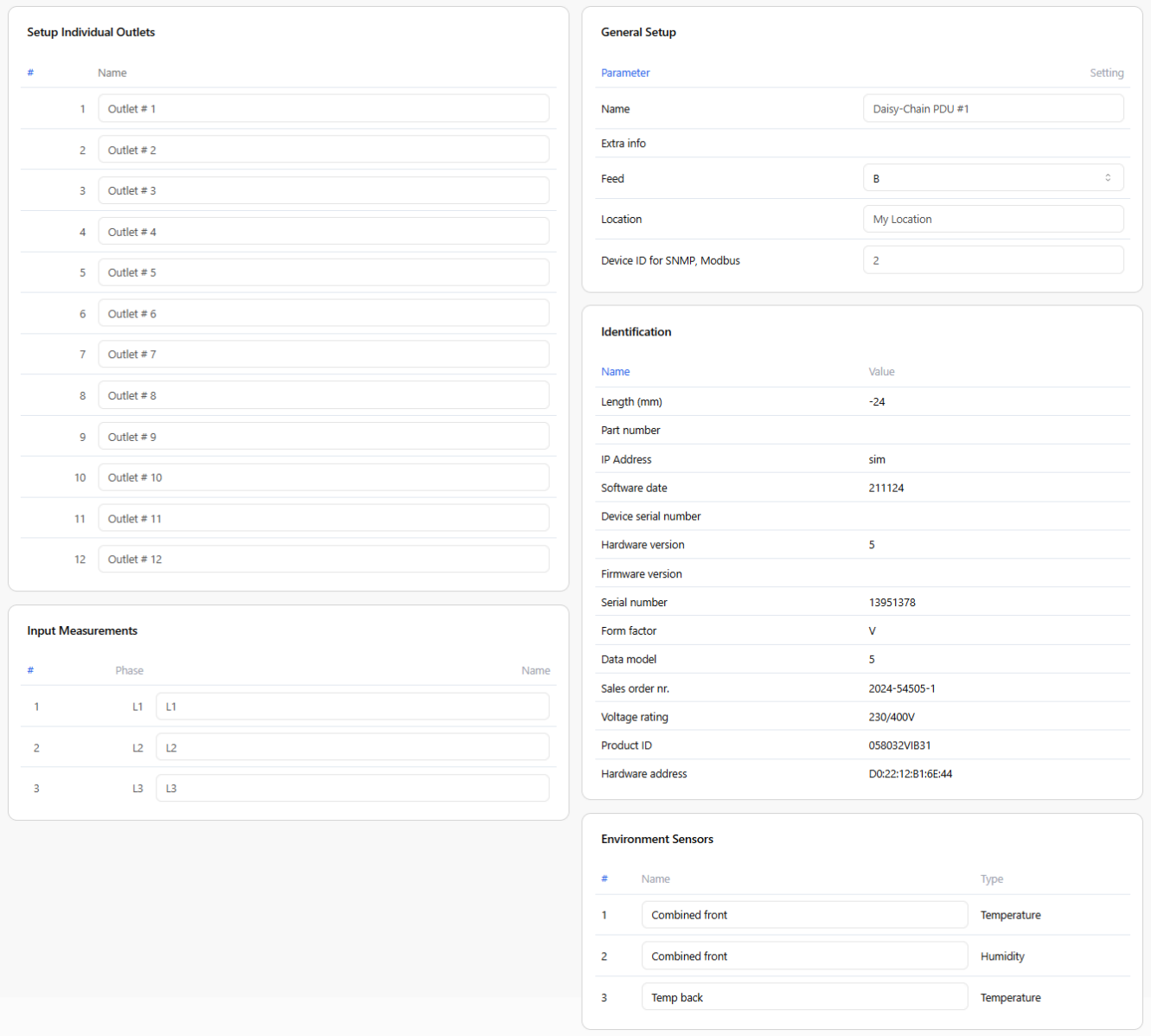



*Figure 22. PDU Settings*

1. Perform a general setup, the naming, location and extra info makes sure the PDU is easily recognized within EnerTEG. Set up which power feed the PDU is connected to (None, A, B, C or D).
2. Check if the behaviour settings are set up as desired.
3. (Optionally) name the outlets and set up the powercycle and individual outlet delay.
4. (Optionally) name the input phases.
5. (Optionally) name the environment sensors if they are connected to the PDU.

Now the PDU is fully set up and configured to be used in EnerTEG.

### 7.1.2. Optionally create device specific rules

Should EnerTEG be used in a way where a PDU requires device specific rules (they can also be set system wide), a user can set this before or after adding a device to the Data centre structure. Click on the left side of the web interface on 'Rules'. Now the rules overview opens, showing all the active rules.

1. Click on 'Create new rule'.
2. Click on 'PDUs'.
3. Click on 'One device'.
4. Select the device from the list.
5. Select the type and value of the rule.
6. If desired, further restrict the rule.
7. Enter a name for the rule.
8. Click 'Create rule and set thresholds'.

In the Rules menu, this rule can always be modified or deleted. There is also a report available for each specific rule.

### 7.1.3. Place PDUs in the Data centre structure

In this step, PDUs known in the system are added to an existing Data centre structure. If a PDU is known in the system but not part of the Data centre structure, it will show in the device list as an unassigned device.

If the user navigates to the device list, there are three filter choices: 'All devices', 'Unassigned' and 'Assigned'. If a device is assigned to the Data centre structure, it will move from unassigned to assigned. If the user wants to have an overview of all unassigned devices, the unassigned filter in the device list can be applied.

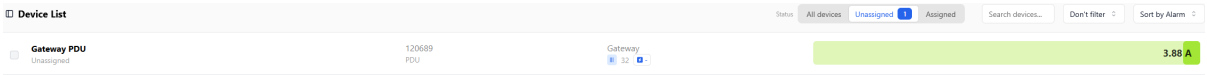



*Figure 23. Unassigned devices*

If an unassigned PDU is situated in for example rack 4, row 3 in a room, the user can navigate in the left menu of the EnerTEG web interface to the virtual representation of that rack if the Data centre structure is set up correct. If the user clicks on that rack, and the dashboard page for that rack will appear. There will be a section called 'Devices in this rack'. If the 'Assign device to rack' is clicked, a device list appears and the user can select the PDU that is in this particular rack by clicking on 'Assign'.

Should a PDU be replaced or removed, or if the user assign an incorrect PDU to a rack; a device can also be unassigned in the rack view to correct this.

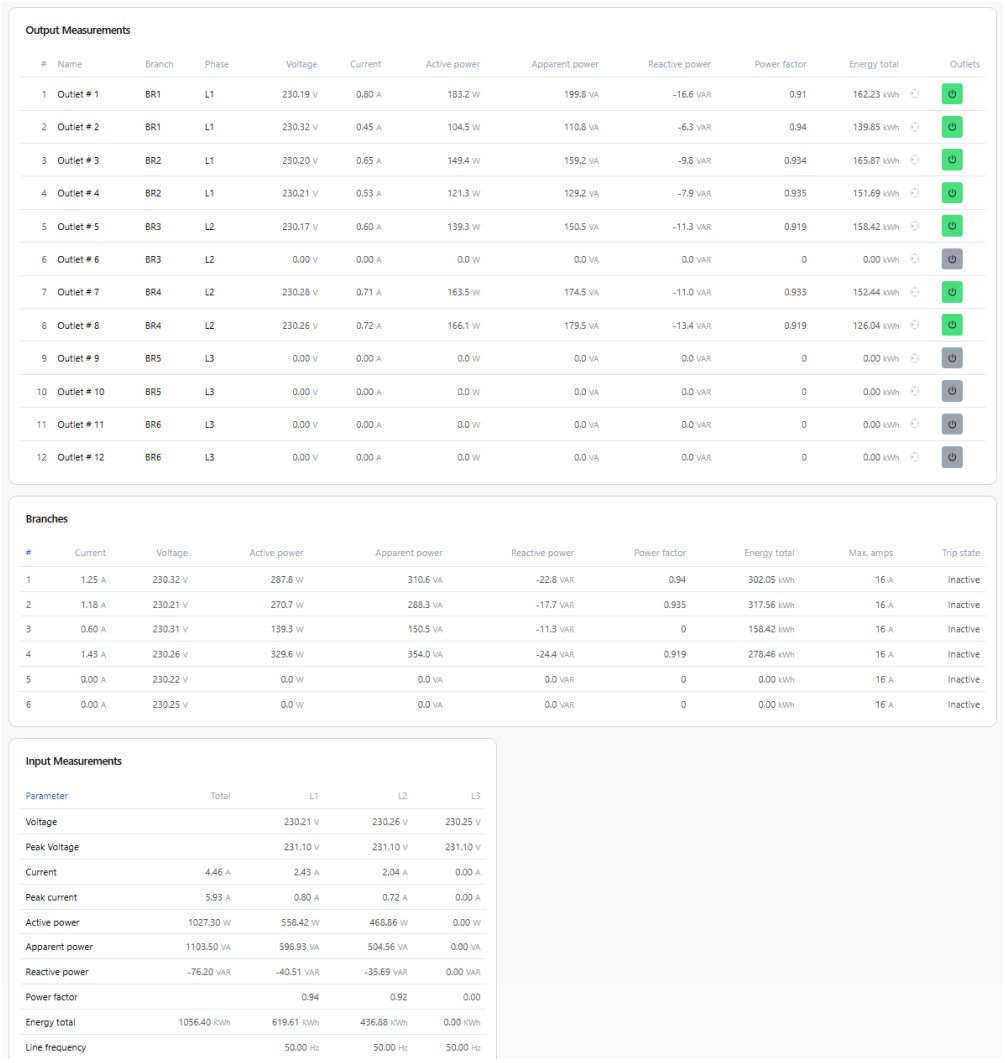
# 7.2. Measurement monitoring

There are different views for measurements in EnerTEG. There are multiple measurements or inputs, branches, outlets, totals and sensors per device in overview but also detailed measurement views of this data. Combined measurements of PDUs in Data centre structure elements can also be viewed. This chapter goes into detail on how to view these measurements and where to find them.

## 7.2.1. Per device

To view the measurements per device, first navigate to the device list menu. The device list itself shows the total load on the PDU compared to the maximum load it is rated to handle.

Now an individual PDU can be selected. If the user clicks on a PDU, the device view will load. By default, the information page of that PDU will be shown, which also contains the PDU measurements.



**Output Measurements**

| # | Name | Branch | Phase | Voltage | Current | Active power | Apparent power | Reactive power | Power factor | Energy total | Outlets |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Outlet # 1 | BR1 | L1 | 230.19 V | 0.80 A | 183.2 W | 199.8 VA | -16.6 VAR | 0.91 | 162.23 kWh | |
| 2 | Outlet # 2 | BR1 | L1 | 230.32 V | 0.45 A | 104.5 W | 110.8 VA | -6.3 VAR | 0.94 | 139.85 kWh | |
| 3 | Outlet # 3 | BR2 | L1 | 230.20 V | 0.65 A | 149.4 W | 159.2 VA | -9.8 VAR | 0.934 | 165.87 kWh | |
| 4 | Outlet # 4 | BR2 | L1 | 230.21 V | 0.53 A | 121.3 W | 129.2 VA | -7.9 VAR | 0.935 | 151.69 kWh | |
| 5 | Outlet # 5 | BR3 | L2 | 230.17 V | 0.60 A | 139.3 W | 150.5 VA | -11.3 VAR | 0.919 | 158.42 kWh | |
| 6 | Outlet # 6 | BR3 | L2 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 7 | Outlet # 7 | BR4 | L2 | 230.28 V | 0.71 A | 163.5 W | 174.5 VA | -11.0 VAR | 0.933 | 152.44 kWh | |
| 8 | Outlet # 8 | BR4 | L2 | 230.26 V | 0.72 A | 166.1 W | 179.5 VA | -13.4 VAR | 0.919 | 126.04 kWh | |
| 9 | Outlet # 9 | BR5 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 10 | Outlet # 10 | BR5 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 11 | Outlet # 11 | BR6 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 12 | Outlet # 12 | BR6 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |

**Branches**

| # | Current | Voltage | Active power | Apparent power | Reactive power | Power factor | Energy total | Max. amps | Trip state |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.25 A | 230.32 V | 287.8 W | 310.6 VA | -22.8 VAR | 0.94 | 302.05 kWh | 16 A | Inactive |
| 2 | 1.18 A | 230.21 V | 270.7 W | 288.3 VA | -17.7 VAR | 0.935 | 317.56 kWh | 16 A | Inactive |
| 3 | 0.60 A | 230.31 V | 139.3 W | 150.5 VA | -11.3 VAR | 0 | 158.42 kWh | 16 A | Inactive |
| 4 | 1.43 A | 230.26 V | 329.6 W | 354.0 VA | -24.4 VAR | 0.919 | 278.46 kWh | 16 A | Inactive |
| 5 | 0.00 A | 230.22 V | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | 16 A | Inactive |
| 6 | 0.00 A | 230.25 V | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | 16 A | Inactive |

**Input Measurements**

| Parameter | Total | L1 | L2 | L3 |
|---|---|---|---|---|
| Voltage | | 230.21 V | 230.26 V | 230.25 V |
| Peak Voltage | | 231.10 V | 231.10 V | 231.10 V |
| Current | 4.46 A | 2.43 A | 2.04 A | 0.00 A |
| Peak current | 5.93 A | 0.80 A | 0.72 A | 0.00 A |
| Active power | 1027.30 W | 558.42 W | 468.86 W | 0.00 W |
| Apparent power | 1103.50 VA | 598.93 VA | 504.56 VA | 0.00 VA |
| Reactive power | -76.20 VAR | -40.51 VAR | -35.69 VAR | 0.00 VAR |
| Power factor | | 0.94 | 0.92 | 0.00 |
| Energy total | 1056.40 kWh | 619.61 kWh | 436.88 kWh | 0.00 kWh |
| Line frequency | | 50.00 Hz | 50.00 Hz | 50.00 Hz |

*Figure 24. PDU Measurements*

The top table on the information tab contains the outlet measurements.

- For each outlet, it is displayed to which branch and which input it belongs.
- Per outlet that is displayed in the table, there is a name, apparent energy, peak current, energy total, apparent power, reactive power, power factor, crest factor, voltage, active power, current, outlet type and state value available.
- The outlet type is displayed as a symbol.
- The outlet state can be on or off, and if switchable, switched to the opposite state by clicking on the button.

Below the outlet measurement table is the branch measurement tab with similar measurements available if the PDU supports this. The outlet and branch measurements are displayed in real time. There is also the input measurements table. This table contais multiple parameters such as voltage, peak voltage, current, peak current, active power, apparent power, reactive power, power factor, energy total, line frequency, neutral current and residual current. There parameters are available as total, and for the available input phases. The input measurements are displayed real time.

Only PDUs that are configured with measuring capabilities will show the measurements according to it's configuration.

## 7.2.2. Detailed measurements per device

For all individual PDU measurements, there is a detailed measurement feature available with measurement data over time.

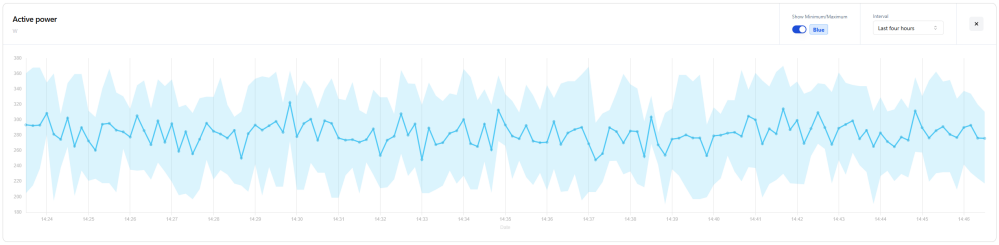



*Figure 25. Detailed measurements*

The detailed view for PDU measurements can be opened by clicking on a specific measurement in the input or outlet measurement tables.

For each detail view, the minimum and maximum values can optionally be set to on or off. This means the minimum and maximum value on that timespan can be viewed also. The graph interval can be set to real time, last four hours, last three days, last week, last month and last year.

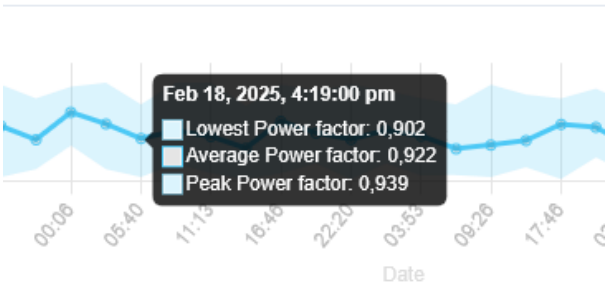



*Figure 26. Pop-up with details*

When hovering over the graph, a detail pop-up will be available with details and the exact measurement values for the point in time.

## 7.2.3. Data centre structure measurement view

This chapter described how measurements for different Data centre structure elements can be viewed. There are measurement views available per room, per row and per rack (only if they are created in the Data centre structure). The measurements per Data centre structure element are available in the current & power section of the chosen Data centre structure element.

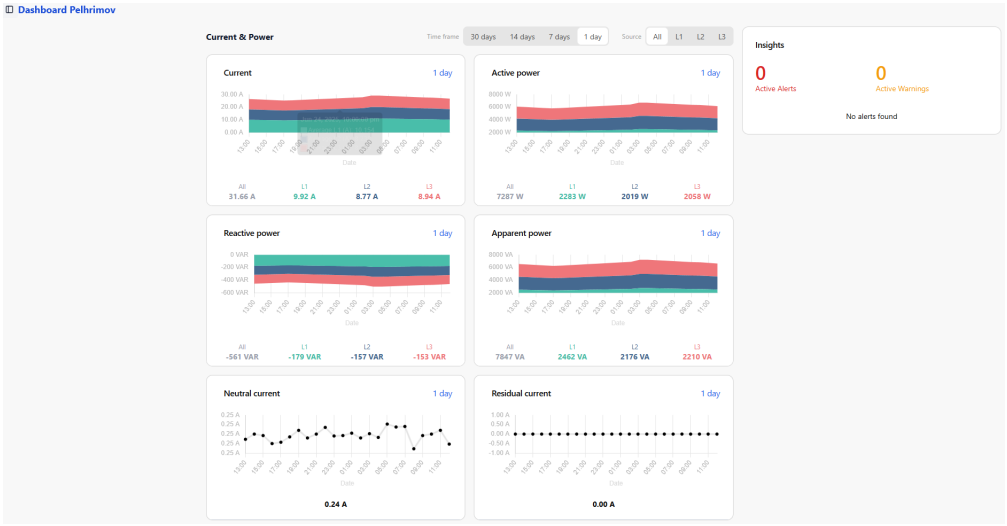



*Figure 27. Room dashboard*

There are graphs for current, active power, residual current, apparent power, neutral current and reactive power available. The time frame can be selected for these graphs, there are options for 1, 7, 14 and 30 days. Also the source of the measurement data over time can be selected, which is 'all', or per individual phase.

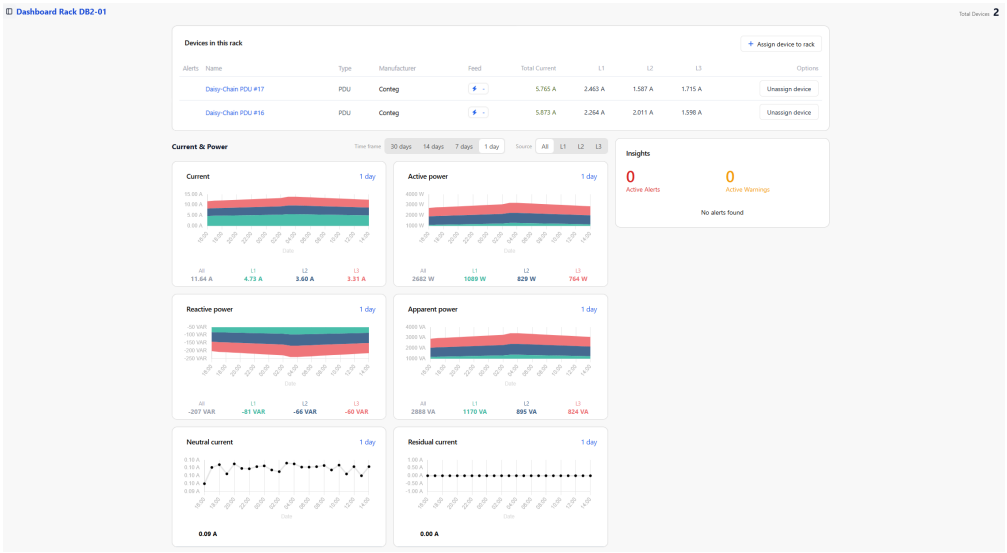



*Figure 28. Rack dashboard*

The rack view is a bit different in comparison to the view of a room or row. Next to the current & power measurement section described in this chapter, the rack page also contains a section of all devices in the rack. For these devices assigned to the rack, the total current and the current per phase is available as measurement.

## 7.2.4. Feed perspective

For the electricity network it is important the phases are in balance, but for the datacenter the load on e.g. an A- and B-feed could be equally important. Users would want to know what happens if a feed fails or see when one feed needs to go down for maintenance. EnerTEG provides a feed perspective view on Data centre, room, row and rack level so users can quickly see if all feeds are arranged as expected.

How to couple devices to a feed:

1. To achieve the coupling of PDUs to a feed succesfully, the Data centre structure should be setup first. This can be done in the 'Configure DC Structure' menu.
2. When the Data centre structure is complete, the PDUs that are present in the device list can now be coupled to the racks that are defined in the Data centre structure. This can be done by clicking on a rack and then select 'Assign device to rack'.
3. Click on the PDU that was added to the rack and click on the 'configuration' tab.
4. Select the feed this PDU is coupled to (A, B, C or D).

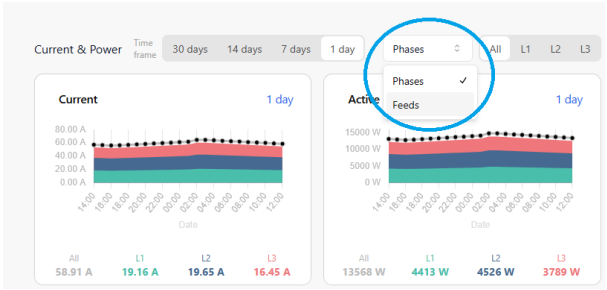



*Figure 29. Feed selection*

To select the feed perspective, navigate to a Data centre, room, row or rack within the Data centre structure and select the feed perspective instead of the phase pserspective.

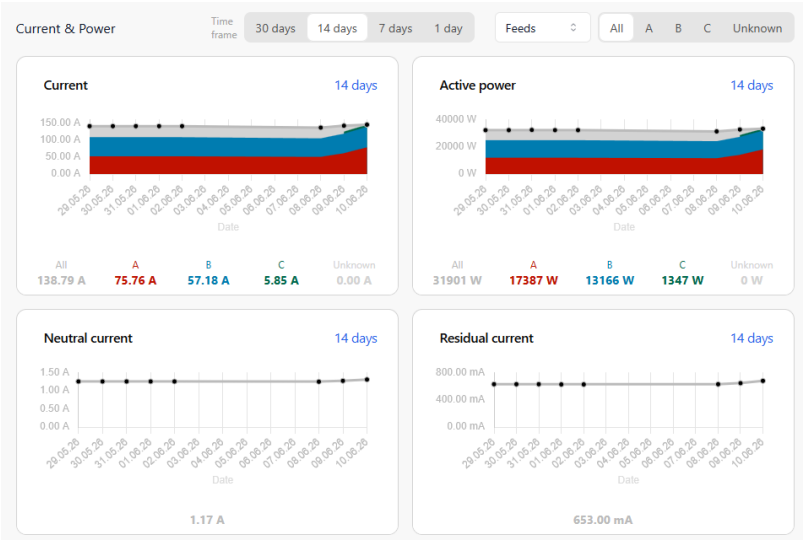



*Figure 30. Feed overview*

Now the view of the feed perspective for the selected Data centre structure element can be seen. Note that it can take some time for the graphs to show information after the feed perspective has been set up.

# 7.3. Powering on/off outlets

The EnerTEG is able to switch outlets on devices that support outlet switching. The typical way to switch the outlet of an device is to go to the 'Device list' and to click on the device of which the outlets needs to be switched.

When a PDU is clicked, the website goes to the web page for individual PDU data and lands on the 'Information' page. The information page contains the input and output measurements.

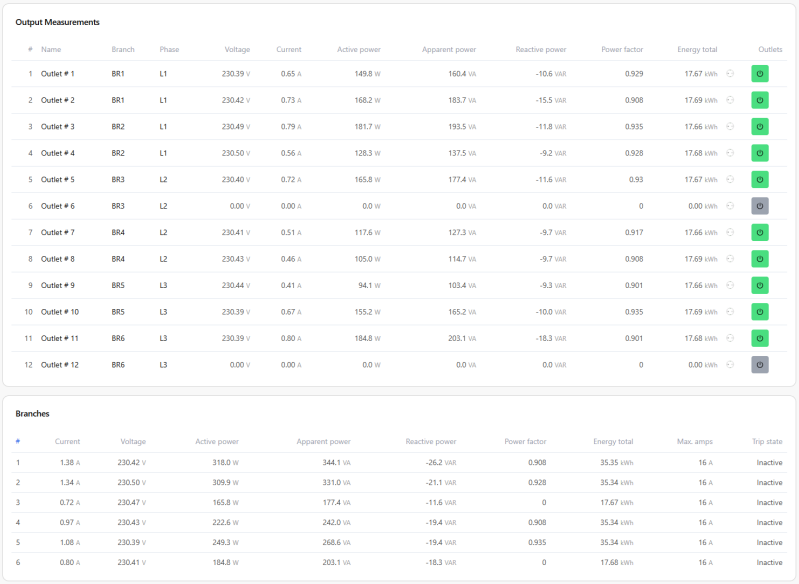



*Figure 31. Outlet measurements section*

If outlet switching is supported on the PDU, the user will see a state button for each outlet in the output measurements section. These icons are clickable. If the icon is green, the outlet is currently powered. If the icon is grey, the outlet is not powered.

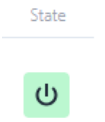



*Figure 32. Outlet state icon*

When the state icon is clicked, the outlet switch menu appears. If so desired, the outlet can be switched to on or off depending on the current state of the outlet.

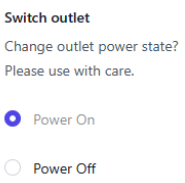



*Figure 33. Switch outlet menu*

When the outlet is powered on or off, the icon should change and the outlet will switch accordingly. If the PDU is measured, the measurements should appear of disappear depending on the switch choice.

## 7.4. PDU firmware updates

With each version of EnerTEG, firmware updates for PDU modules are included. EnerTEG is able to update the firmware of the PDUs automatically in the background. It is not possible for a user to manually trigger a firmware update, this is done by EnerTEG. Updating the PDU firmware is done through updating the EnerTEG, which can be done by the user in the EnerTEG Settings.

During the firmware update of a PDU, the LED ring becomes blue. When a firmware update is done, the LED ring of the PDU will become green again.

In case EnerTEG finds PDUs with an older version that it has internally available, first the Controller module PDU is updated. After the update has succeeded, EnerTEG is done updating. The Controller module PDU will take further responsibility of updating all PDUs that are daisy-chained via the Databus.

## 7.5. PUE

The Power Usage Effectiveness measures how efficiently electricity is used. It is calculated by dividing the total facility energy by the IT equipment energy.

A PUE of:

- 1.0 would be theoretically a perfect value.
- 1.2–1.6 is considered efficient.
- 2.0 means that as much power is used for overhead as for IT equipment, which would be inefficient.

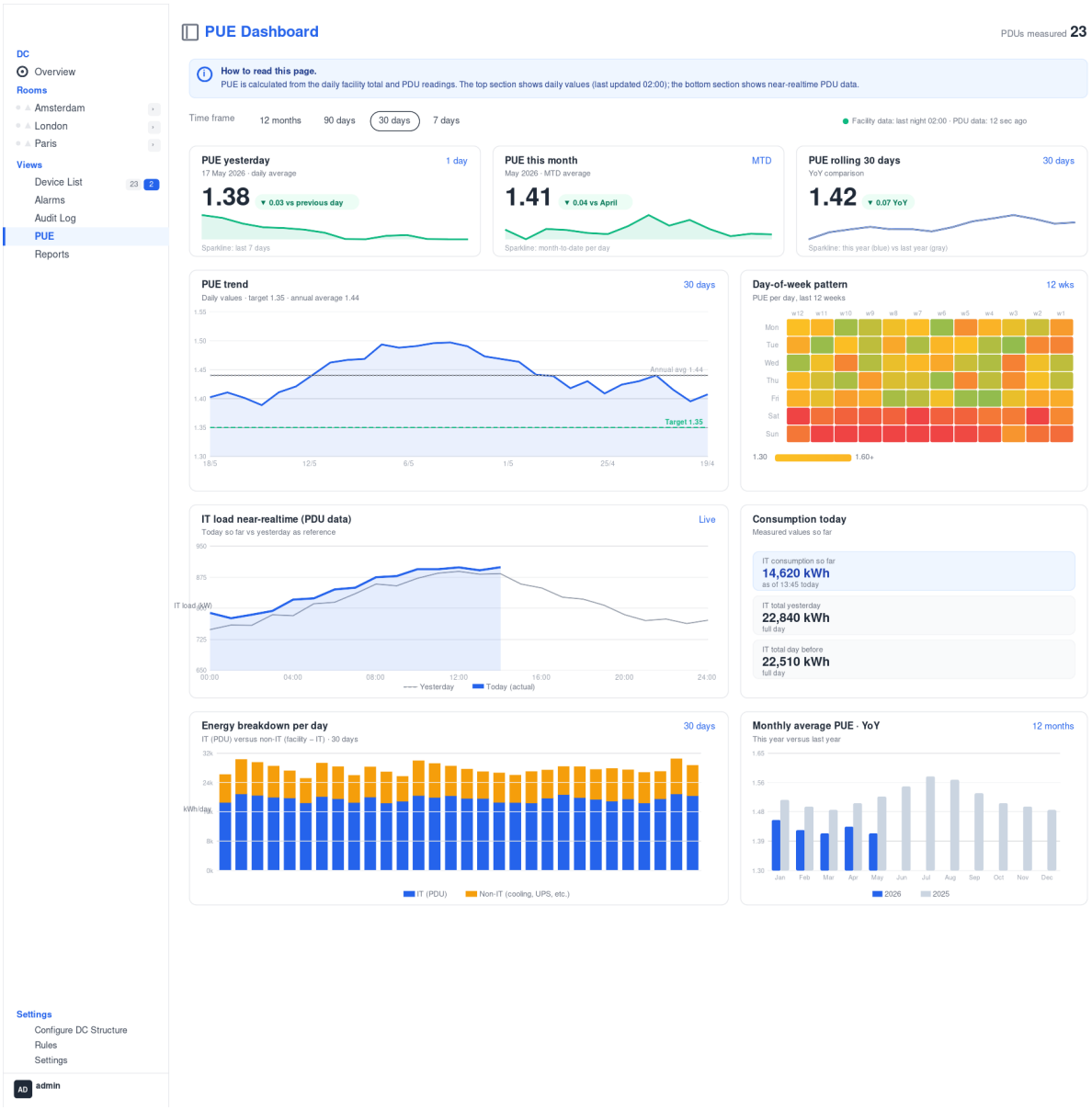



*Figure 34. PUE*

PUE is calculated over a defined period, such as monthly or annually, using energy values in kWh rather than a single instantaneous power reading. PUE warnings and alerts appear also in the combined insights panel on the DC Dashboard, allowing operations teams to view all notifications in one place.

Additionally the REST API of EnerTEG provides the functionality to GET, POST and DELETE a PUE Datacenter record. This means that a total kWh figure for PUE can be set from an external source.

## 7.5.1. PUE tiles

Three KPI tiles are displayed side by side, each showing a large value, a delta indicator, and a sparkline:

- PUE yesterday - the most recent confirmed value, including the change compared with the previous day.
- PUE this month (MTD) - the average up to the current day, including the change compared with the previous month.
- PUE rolling 30 days - a smoothed trend including a year-over-year delta for management reporting.

### PUE trend

A large line chart on the left shows the daily PUE, with a selectable period of 7 days, 30 days, 90 days, or 12 months. Two reference lines provide context: the design target, shown as a dashed teal line, and the annual average, shown as a dashed grey line. For monthly or yearly views, the chart switches to monthly averages with a

narrow band showing the minimum and maximum values within each month.

**Day-of-week pattern**

A mapping shows the day of the week on the vertical axis and the week number on the horizontal axis for the past 12 weeks. The colour intensity represents the PUE value. It reveals patterns within the week that may not be visible in a daily trend line, such as consistently poorer PUE values during weekends due to lower IT load.

**Near-real-time IT load**

A line chart shows the IT load in kW and is updated every 10 minutes. It contains two series: yesterday's values as a dashed grey reference line and today's values up to the current time. This allows the user to immediately see whether today's load is below, in line with, or above yesterday's profile.

**Consumption**

Three statistic tiles show measured values only:

- "IT consumption so far" for today.
- "IT total yesterday".
- "IT total day before".

A deliberate design choice was made not to show a projected daily total. EnerTEG only displays data that is already known. Forecasts based on trends are kept outside the dashboard to prevent confusion. It is therefore called "IT load", rather than "live PUE". It highlights one of EnerTEG's strengths, namely PDU-level granularity, without suggesting that the PUE value itself is calculated in real time.

**Energy breakdown per day**

A stacked bar chart shows the daily energy consumption over a period of 30 days. IT consumption is shown in blue, while non-IT consumption, calculated as the total facility consumption minus the IT consumption, is shown in amber. If the blue section remains stable while the amber section increases, the user can see that potential efficiency improvements should be made on the non-IT side, such as cooling or UPS losses. The Y-axis is in "kWh/day".

**Monthly average PUE - YoY**

A grouped bar chart compares the average monthly PUE for the current year with the previous year.

## 7.5.2. PUE on the DC Dashboard

The existing DC Dashboard page includes two PUE sections at the top: "PUE yesterday" with a seven-day sparkline, and "Energy breakdown per day" covering a period of 14 days.

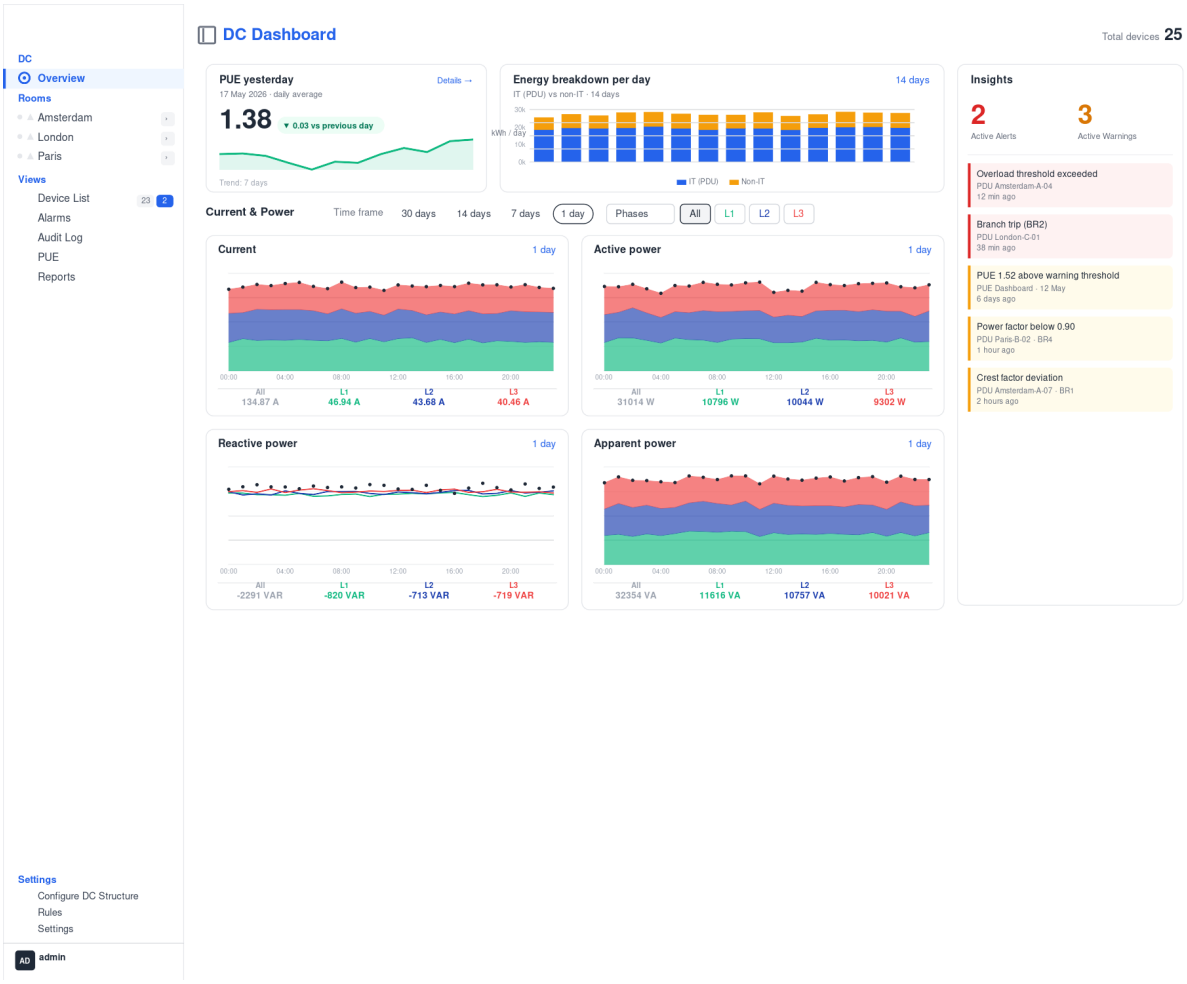



*Figure 35. PUE DC Dashboard*

The PUE sections at the top act as entry points to the full PUE Dashboard page. If no PUE data is available, these two sections are replaced with a single section containing an "Energy per day" bar chart covering a period of 30 days.

# Chapter 8. Device view

EnerTEG can collect data from multiple energy and sensoric measuring devices and stores this data long-term. This allows visualization of the data in both tabular form and visualized as charts. PDUs all have ports, measurements and settings which are intelligently monitored and can in some cases be controlled. All devices that are connected to EnerTEG can be found in the device list.

Devices will be automatically detected when connected to the Databus of the Controller module which is running EnerTEG Lite.

As devices are found, they will appear in the device list, this can take a short time depending on device connection speed. The contents are then continuously monitored and updated in the available interfaces by EnerTEG. It should not be required to refresh the view from the browser to receive new data, this should update automatically.

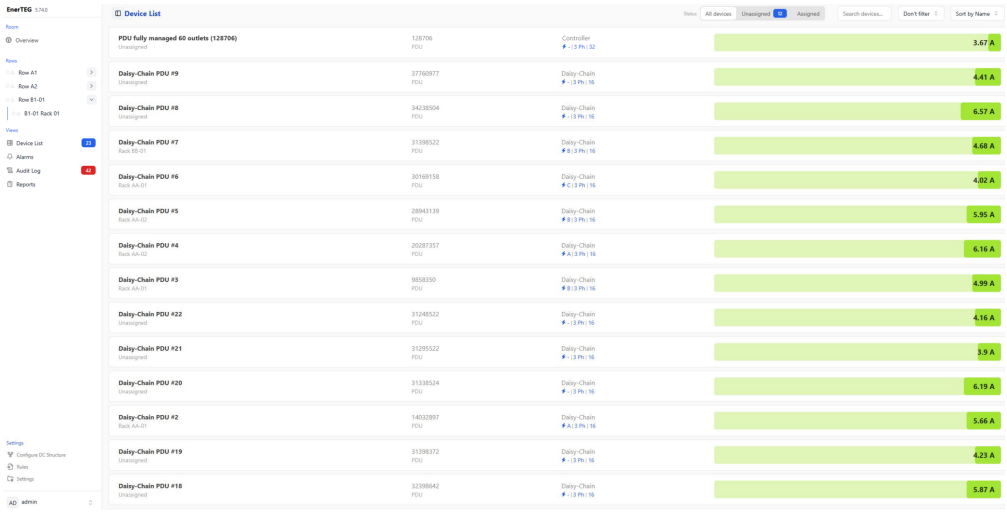



*Figure 36. Device list*

Devices with an alarm status are shown at the top of the list, and are colored so they can easily be recognized. Depending on the device type the maximum value is displayed with both a slider and a value. The value unit will depend on the device type.

- The total current per PDU will be displayed.
- The device type, the number of outlets and the feed to which the PDU connects to is displayed.

The search field at the top left of the view provides the means to search for device, port or chain names. When an entry is selected, the relevant page and entry will be displayed. There is also a filter box in which the user can filter between all devices, unassigned devices and assigned devices. An unassigned device is not yet added to the Data centre structure. A sorting function can be used to sort devices on alarm, name, type or daisy chain.

# 8.1. Databus status indication

When Daisychain module PDUs are connected to a Controller module PDU, the device list will show a visualisation of the Databus ring connection.

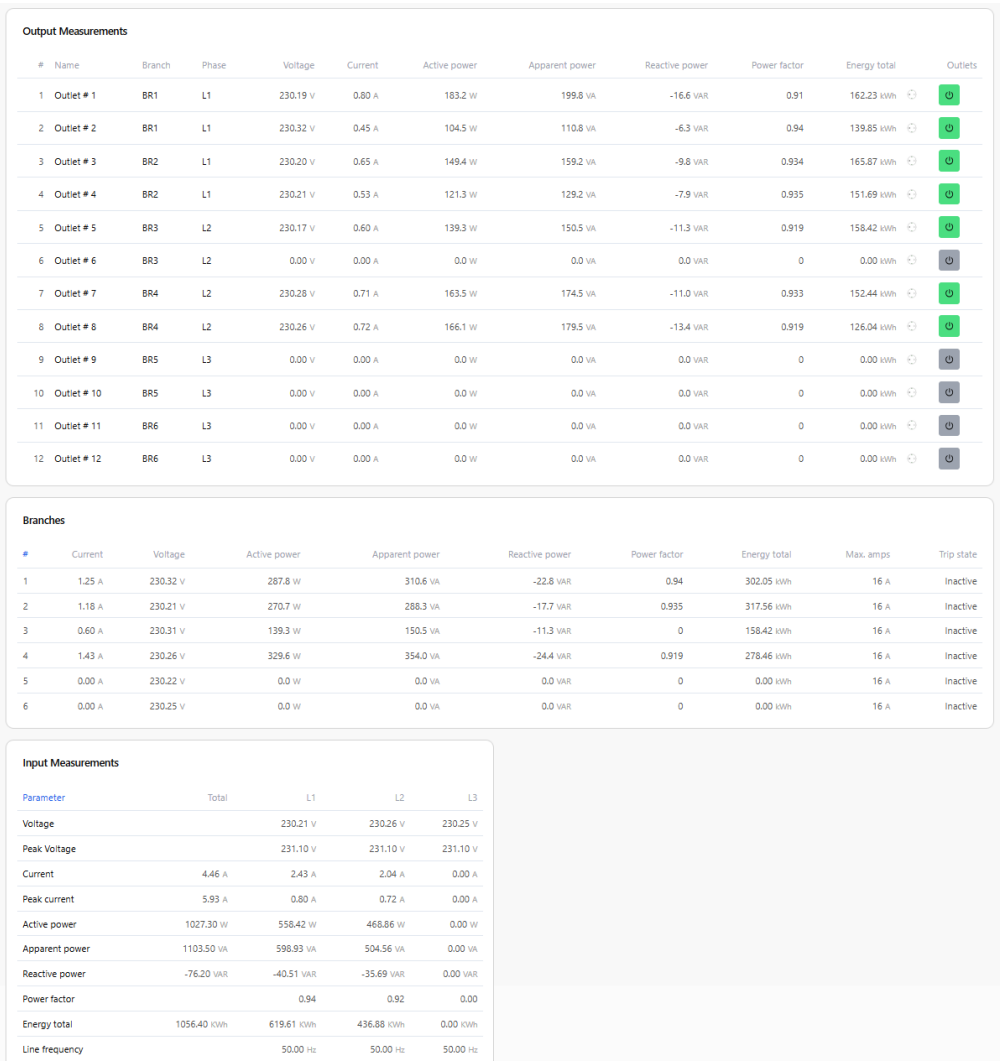

*Figure 37. Databus visualisation*

For instance if a connection is broken or disconnected and the Databus ring becomes open, EnerTEG is able to determine the exact break location. The break location will be visible in the device list. When a break location appears the cause may originate in one of the devices on either end of the break location, loose / defect connectors or a wiring defect in the cable.


*Figure 38. Open Databus ring*

# 8.2. Detail view

To look at a device in detail, the detail view of the device can be selected by clicking on it - the detail view for this device will then be opened. This view provides monitoring for a specific device in the “information” tab. The device settings can also be managed, if user authorisation permits it, by selecting the “configuration” tab at the top right of the view. Any configuration changes made, will be exported back to the device (if supported, such as in PDU 5.0), so that the device status always reflects the status of the values within the device itself.



**Output Measurements**

| # | Name | Branch | Phase | Voltage | Current | Active power | Apparent power | Reactive power | Power factor | Energy total | Outlets |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Outlet # 1 | BR1 | L1 | 230.19 V | 0.80 A | 183.2 W | 199.8 VA | -16.6 VAR | 0.91 | 162.23 kWh | |
| 2 | Outlet # 2 | BR1 | L1 | 230.32 V | 0.45 A | 104.5 W | 110.8 VA | -6.3 VAR | 0.94 | 139.85 kWh | |
| 3 | Outlet # 3 | BR2 | L1 | 230.20 V | 0.65 A | 149.4 W | 159.2 VA | -9.8 VAR | 0.934 | 165.87 kWh | |
| 4 | Outlet # 4 | BR2 | L1 | 230.21 V | 0.53 A | 121.3 W | 129.2 VA | -7.9 VAR | 0.935 | 151.69 kWh | |
| 5 | Outlet # 5 | BR3 | L2 | 230.17 V | 0.60 A | 139.3 W | 150.5 VA | -11.3 VAR | 0.919 | 158.42 kWh | |
| 6 | Outlet # 6 | BR3 | L2 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 7 | Outlet # 7 | BR4 | L2 | 230.28 V | 0.71 A | 163.5 W | 174.5 VA | -11.0 VAR | 0.933 | 152.44 kWh | |
| 8 | Outlet # 8 | BR4 | L2 | 230.26 V | 0.72 A | 166.1 W | 179.5 VA | -13.4 VAR | 0.919 | 126.04 kWh | |
| 9 | Outlet # 9 | BR5 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 10 | Outlet # 10 | BR5 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 11 | Outlet # 11 | BR6 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 12 | Outlet # 12 | BR6 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |

**Branches**

| # | Current | Voltage | Active power | Apparent power | Reactive power | Power factor | Energy total | Max. amps | Trip state |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.25 A | 230.32 V | 287.8 W | 310.6 VA | -22.8 VAR | 0.94 | 302.05 kWh | 16 A | Inactive |
| 2 | 1.18 A | 230.21 V | 270.7 W | 288.3 VA | -17.7 VAR | 0.935 | 317.56 kWh | 16 A | Inactive |
| 3 | 0.60 A | 230.31 V | 139.3 W | 150.5 VA | -11.3 VAR | 0 | 158.42 kWh | 16 A | Inactive |
| 4 | 1.43 A | 230.26 V | 329.6 W | 354.0 VA | -24.4 VAR | 0.919 | 278.46 kWh | 16 A | Inactive |
| 5 | 0.00 A | 230.22 V | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | 16 A | Inactive |
| 6 | 0.00 A | 230.25 V | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | 16 A | Inactive |

**Input Measurements**

| Parameter | Total | L1 | L2 | L3 |
|---|---|---|---|---|
| Voltage | | 230.21 V | 230.26 V | 230.25 V |
| Peak Voltage | | 231.10 V | 231.10 V | 231.10 V |
| Current | 4.46 A | 2.43 A | 2.04 A | 0.00 A |
| Peak current | 5.93 A | 0.80 A | 0.72 A | 0.00 A |
| Active power | 1027.30 W | 558.42 W | 468.86 W | 0.00 W |
| Apparent power | 1103.50 VA | 598.93 VA | 504.56 VA | 0.00 VA |
| Reactive power | -76.20 VAR | -40.51 VAR | -35.69 VAR | 0.00 VAR |
| Power factor | | 0.94 | 0.92 | 0.00 |
| Energy total | 1056.40 kWh | 619.61 kWh | 436.88 kWh | 0.00 kWh |
| Line frequency | | 50.00 Hz | 50.00 Hz | 50.00 Hz |

*Figure 39. Detail view*

The data that is available in this view will adapt to the device which is being displayed. In most cases, the data will be extracted dynamically from the device, and the displayed will arrive real time depending on the speed of the device. This data will automatically be collected within EnerTEG memory in 5 second blocks with a maximum, minimum and average calculated for each entry. These blocks are eventually stored on the internal database, which forms the basis of charts that can be viewed by clicking on a relevant measurement value. Historical data will later be changed into hourly and daily blocks, to provide real long term information.

The data is written out from memory to storage at 5 minute intervals, so charting data for a device becomes available after several minutes.

# 8.3. Input/outlet/branch/total power measurements

The “Input Measurements” table will only be displayed for PDUs that provide measurement per input. The values displayed will depend on the PDU type, and are extracted dynamically during runtime - any changes are marked by flashes. If thresholds have been set then an icon can be seen next to the relevant value. When the threshold is exceeded, an alarm will be raised the entry color will be changed and then is then also visible on the Overview page.

**Input Measurements**

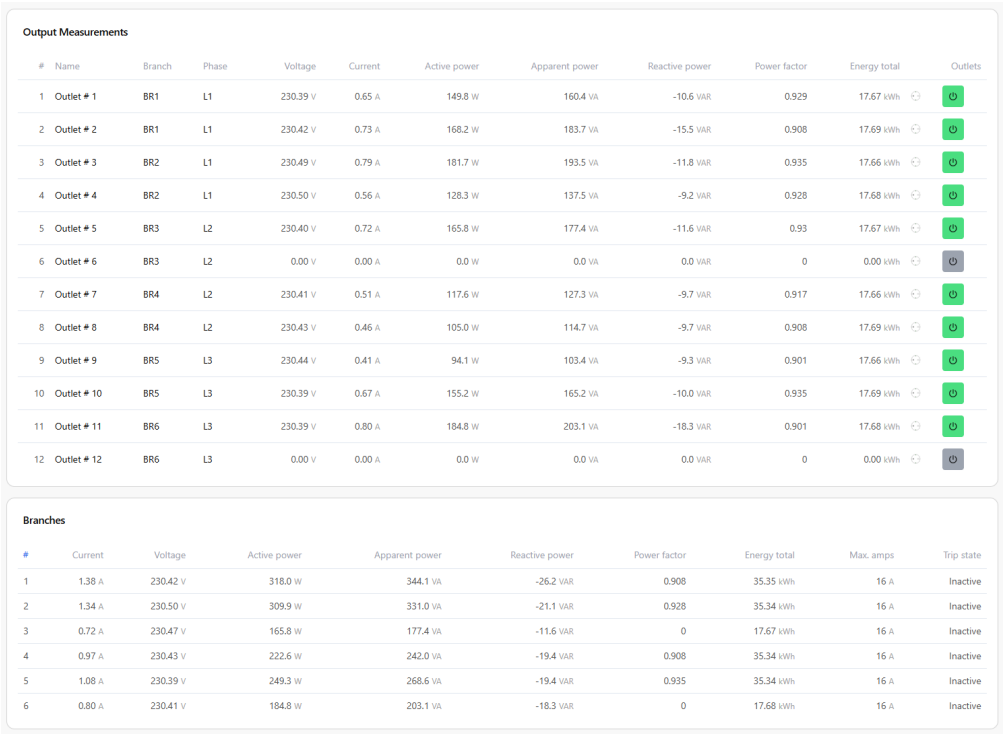
| Parameter | Total | L1 | L2 | L3 |
|---|---|---|---|---|
| Voltage | 220.96 V | 221.02 V | 221.04 V | 220.83 V |
| Min voltage | – | 218.68 V | 218.32 V | 218.37 V |
| Max voltage | – | 234.47 V | 234.33 V | 234.14 V |
| Current | 3.10 A | 3.10 A | 0.00 A | 0.00 A |
| Peak current | 3.18 A | 3.14 A | 3.18 A | 0.00 A |
| Crest factor | – | 1.68 | 1.40 | 1.40 |
| Total harmonic distortion | – | 29.00 % | 0.00 % | 0.00 % |
| Active power | 647.31 W | 647.31 W | 0.00 W | 0.00 W |
| Apparent power | – | 685.61 VA | 0.00 VA | 0.00 VA |
| Reactive power | – | -225.94 VAR | 0.00 VAR | 0.00 VAR |
| Power factor | – | 0.94 | 1.00 | 1.00 |
| Energy total | 0.19 KWh | 0.08 KWh | 0.06 KWh | 0.05 KWh |
| Energy subtotal 16 Jun 2026, 10:22 | 0.19 KWh | 0.08 KWh | 0.06 KWh | 0.05 KWh |
| Line frequency | 50.00 Hz | 50.00 Hz | 50.00 Hz | 50.01 Hz |
| Neutral current | 3.14 A | – | – | – |

*Figure 40. Input measurements*

The input table is only available for PDUs with measured inputs. Click on individual measurements to open the detail view.

There are multiple measurement parameters available: voltage, peak voltage, current, peak current, active power, apparent power, reactive power, power factor, energy total, line frequency, neutral current, residual current.

Outlet measurements are only available for PDUs with measurable outlets. Depending on the PDU, various field values such as the outlet name can be changed. It may take a few seconds before the PDU reacts and responds to the new configuration. Click on individual measurement values to open the detail view for that measurement.



Output Measurements

| # | Name | Branch | Phase | Voltage | Current | Active power | Apparent power | Reactive power | Power factor | Energy total | Outlets |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Outlet # 1 | BR1 | L1 | 230.39 V | 0.65 A | 149.8 W | 160.4 VA | -10.6 VAR | 0.929 | 17.67 kWh | |
| 2 | Outlet # 2 | BR1 | L1 | 230.42 V | 0.73 A | 168.2 W | 183.7 VA | -15.5 VAR | 0.908 | 17.69 kWh | |
| 3 | Outlet # 3 | BR2 | L1 | 230.49 V | 0.79 A | 181.7 W | 193.5 VA | -11.8 VAR | 0.935 | 17.66 kWh | |
| 4 | Outlet # 4 | BR2 | L1 | 230.50 V | 0.56 A | 128.3 W | 137.5 VA | -9.2 VAR | 0.928 | 17.68 kWh | |
| 5 | Outlet # 5 | BR3 | L2 | 230.40 V | 0.72 A | 165.8 W | 177.4 VA | -11.6 VAR | 0.93 | 17.67 kWh | |
| 6 | Outlet # 6 | BR3 | L2 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |
| 7 | Outlet # 7 | BR4 | L2 | 230.41 V | 0.51 A | 117.6 W | 127.3 VA | -9.7 VAR | 0.917 | 17.66 kWh | |
| 8 | Outlet # 8 | BR4 | L2 | 230.43 V | 0.46 A | 105.0 W | 114.7 VA | -9.7 VAR | 0.908 | 17.69 kWh | |
| 9 | Outlet # 9 | BR5 | L3 | 230.44 V | 0.41 A | 94.1 W | 103.4 VA | -9.3 VAR | 0.901 | 17.66 kWh | |
| 10 | Outlet # 10 | BR5 | L3 | 230.39 V | 0.67 A | 155.2 W | 165.2 VA | -10.0 VAR | 0.935 | 17.69 kWh | |
| 11 | Outlet # 11 | BR6 | L3 | 230.39 V | 0.80 A | 184.8 W | 203.1 VA | -18.3 VAR | 0.901 | 17.68 kWh | |
| 12 | Outlet # 12 | BR6 | L3 | 0.00 V | 0.00 A | 0.0 W | 0.0 VA | 0.0 VAR | 0 | 0.00 kWh | |

Branches

| # | Current | Voltage | Active power | Apparent power | Reactive power | Power factor | Energy total | Max. amps | Trip state |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.38 A | 230.42 V | 318.0 W | 344.1 VA | -26.2 VAR | 0.908 | 35.35 kWh | 16 A | Inactive |
| 2 | 1.34 A | 230.50 V | 309.9 W | 331.0 VA | -21.1 VAR | 0.928 | 35.34 kWh | 16 A | Inactive |
| 3 | 0.72 A | 230.47 V | 165.8 W | 177.4 VA | -11.6 VAR | 0 | 17.67 kWh | 16 A | Inactive |
| 4 | 0.97 A | 230.43 V | 222.6 W | 242.0 VA | -19.4 VAR | 0.908 | 35.34 kWh | 16 A | Inactive |
| 5 | 1.08 A | 230.39 V | 249.3 W | 268.6 VA | -19.4 VAR | 0.935 | 35.34 kWh | 16 A | Inactive |
| 6 | 0.80 A | 230.41 V | 184.8 W | 203.1 VA | -18.3 VAR | 0 | 17.68 kWh | 16 A | Inactive |

*Figure 41. Outlet measurements*

Per outlet that is displayed in the table, there is a name, apparent energy, peak current, energy total, apparent power, reactive power, power factor, crest factor, voltage, active power, current, outlet type and state value available.

The functionality to switch an outlet will only be displayed for PDUs that provide outlet switching. The displayed outlet statuses are extracted dynamically during runtime from the PDU. Authorised users can toggle the switch status of a outlet by first clicking the outlet to “unlock” the switching functionality and then toggling the power state in the pop-up window. It may take several seconds for the PDU to react to the toggle command.

The total measurements for a PDU can be found in the input measurements table. The totals are the calculated values (in the PDU) for all phases, which include: current, peak current, active power, apparent power, reactive power, energy total, neutral current.

# 8.4. Power quality

Voltage transients are events with a very short duration, starting at one microsecond. Swells are peaks (above 110% of nominal) with a longer duration, generally from 1ms to 500ms. Our PDU is able to measure these from about 10ms (half cycle) scale. The PDU is also about to detect current peaks.

Crest factor, total harmonic distortion, and the power factor all describe non-linear current, but from a different perspective. The crest factor is the ratio between the peak value and the RMS value of an alternating current or voltage. This is ured for determining cable loading, UPS sizing and neutral conductor current. The total harmonic distortion measures in the frequency domain, the share of harmonics in power which is relevant for determining signal quality and filter sizing. The power factor measures the ratio of active to apparent power which is relevant for energy costs, determining cabling losses and reactive current.

The PDU could be equipped with per-phase crest factor measurement using static rotation at 50 Hz. A combined measurement would conceal a phase-specific cause, a static rotation measurement can also distinct between a homogeneous problems or a severe imbalance. The neutral current can be estimated from per-phase CF data; with a combined measurement this information is lost. In a data centre the three phases are almost never equally loaded. The problems that crest factor monitoring in a data centre aims to detect are structural in nature and develop over seconds to minutes; a 60 ms latency as a result of static rotation per-phase measurements is therefore more than adequate.

The power quality measurements are not a substitute for specialised power quality analysis. In case of persistent deviations or serious power quality problems, a certified power quality analyser should be used for definitive diagnosis.

**Input measurements**

Total harmonic distortion, crest factor, peak current, min voltage, max voltage, energy subtotal

**Input Measurements**

| Parameter | Total | L1 | L2 | L3 |
|---|---|---|---|---|
| Voltage | 220.96 V | 221.02 V | 221.04 V | 220.83 V |
| Min voltage | – | 218.68 V | 218.32 V | 218.37 V |
| Max voltage | – | 234.47 V | 234.33 V | 234.14 V |
| Current | 3.10 A | 3.10 A | 0.00 A | 0.00 A |
| Peak current | 3.18 A | 3.14 A | 3.18 A | 0.00 A |
| Crest factor | – | 1.68 | 1.40 | 1.40 |
| Total harmonic distortion | – | 29.00 % | 0.00 % | 0.00 % |
| Active power | 647.31 W | 647.31 W | 0.00 W | 0.00 W |
| Apparent power | – | 685.61 VA | 0.00 VA | 0.00 VA |
| Reactive power | – | -225.94 VAR | 0.00 VAR | 0.00 VAR |
| Power factor | – | 0.94 | 1.00 | 1.00 |
| Energy total | 0.19 KWh | 0.08 KWh | 0.06 KWh | 0.05 KWh |
| Energy subtotal<br>16 Jun 2026, 10:22 | 0.19 KWh | 0.08 KWh | 0.06 KWh | 0.05 KWh |
| Line frequency | 50.00 Hz | 50.00 Hz | 50.00 Hz | 50.01 Hz |
| Neutral current | 3.14 A | – | – | – |

*Figure 42. Input power quality*

- Row for the energy subtotal, shows date/time of last reset when hovering over.
- Row for crest factor.

Rows for peak values for peak current and min/max voltage: showing timestamp of peak and when last reset when hovering over.

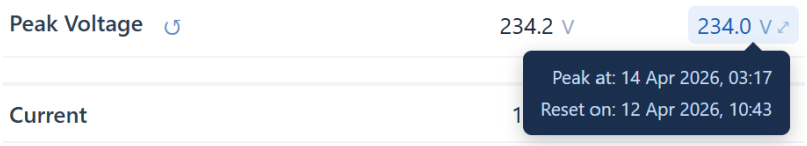



*Figure 43. Power quality details*

Peaks and energy subtotal have reset option (refresh icon) - a reset of these values is only possible when logged in as administrator.

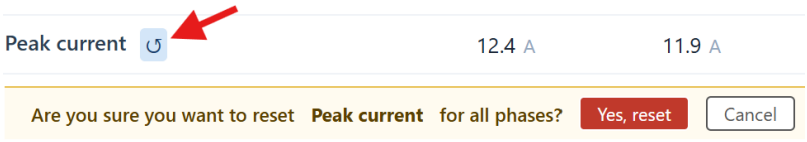
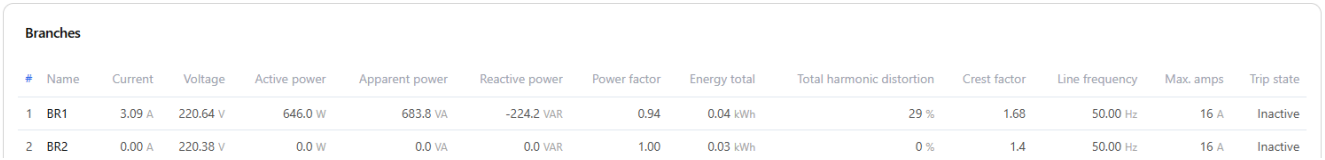



*Figure 44. Reset values*

### Branch measurements

Total harmonic distortion, crest factor only

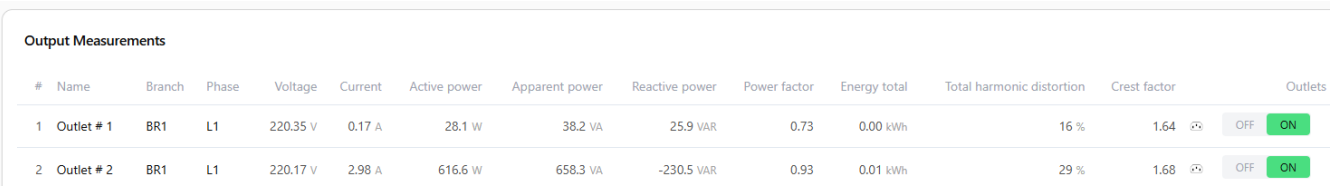

Branches

| # | Name | Current | Voltage | Active power | Apparent power | Reactive power | Power factor | Energy total | Total harmonic distortion | Crest factor | Line frequency | Max. amps | Trip state |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | BR1 | 3.09 A | 220.64 V | 646.0 W | 683.8 VA | -224.2 VAR | 0.94 | 0.04 kWh | 29 % | 1.68 | 50.00 Hz | 16 A | Inactive |
| 2 | BR2 | 0.00 A | 220.38 V | 0.0 W | 0.0 VA | 0.0 VAR | 1.00 | 0.03 kWh | 0 % | 1.4 | 50.00 Hz | 16 A | Inactive |

*Figure 45. Branch power quality*

### Output measurements

Total harmonic distortion, crest factor only

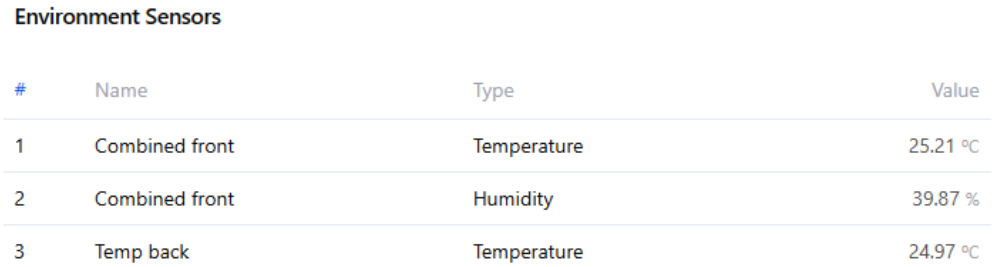

Output Measurements

| # | Name | Branch | Phase | Voltage | Current | Active power | Apparent power | Reactive power | Power factor | Energy total | Total harmonic distortion | Crest factor | Outlets |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Outlet # 1 | BR1 | L1 | 220.35 V | 0.17 A | 28.1 W | 38.2 VA | 25.9 VAR | 0.73 | 0.00 kWh | 16 % | 1.64 | OFF ON |
| 2 | Outlet # 2 | BR1 | L1 | 220.17 V | 2.98 A | 616.6 W | 658.3 VA | -230.5 VAR | 0.93 | 0.01 kWh | 29 % | 1.68 | OFF ON |

*Figure 46. Output power quality*

## 8.5. Sensor measurements

Sensors connected to the PDU will be listed in the “Environment Sensors” table. EnerTEG will attempt to identify the attached sensor type, but this is not always possible. The values displayed will depend on the sensor type, and are extracted dynamically during runtime - any changes are marked by flashes.



**Environment Sensors**

| # | Name | Type | Value |
|---|---|---|---|
| 1 | Combined front | Temperature | 25.21 °C |
| 2 | Combined front | Humidity | 39.87 % |
| 3 | Temp back | Temperature | 24.97 °C |

*Figure 47. Environment sensors*

If thresholds have been set then an icon can be seen next to the relevant value. When the threshold is exceeded, an alarm will be raised the entry color will be changed and then is then also visible on the Overview page. Depending on the PDU, various field values can be changed. It can take several seconds before the PDU reacts and responds to the new configuration.

Should a sensor be disconnected from a PDU, it needs to be manually removed from the Configuration menu. The remove sensor option will only be available when a known sensor in a PDU is disconnected.

This table is only available when sensors are active on the device.

## 8.6. Detailed measurement charts

As briefly described in the Operation chapter, a measurement value of a PDU can be clicked which leads to a detail view pop-up. All device data points are collected and processed for the charts. The relevant data point needs to be selected, and its chart will be opened. All charts can be zoomed by using the mouse. The measuring interval can be selected at the top of the chart in the resolution of last four hours, last three days, last week, last month or last year.

## 8.7. PDU identification

Information provided by the PDU. These values cannot be modified as these are read only values.

# 8.8. PDU configuration

This table shows the static data for inputs, branches, outlets and sensors provided by the device. Some of these parameters can be changed in Configuration mode. Changing these parameters makes them easily recognizable when an alert is triggered or a rule is made in EnerTEG. For inputs, branches, outlets and sensors, their name can be set. For outlets, there are also fields for setting the individual outlet delay and the power cycle delay. These outlet specific delays will be used by EnerTEG if an power cycle is triggered or when the outlet delay is used depending on the setting of the power-up mode of the PDU on a power failure.

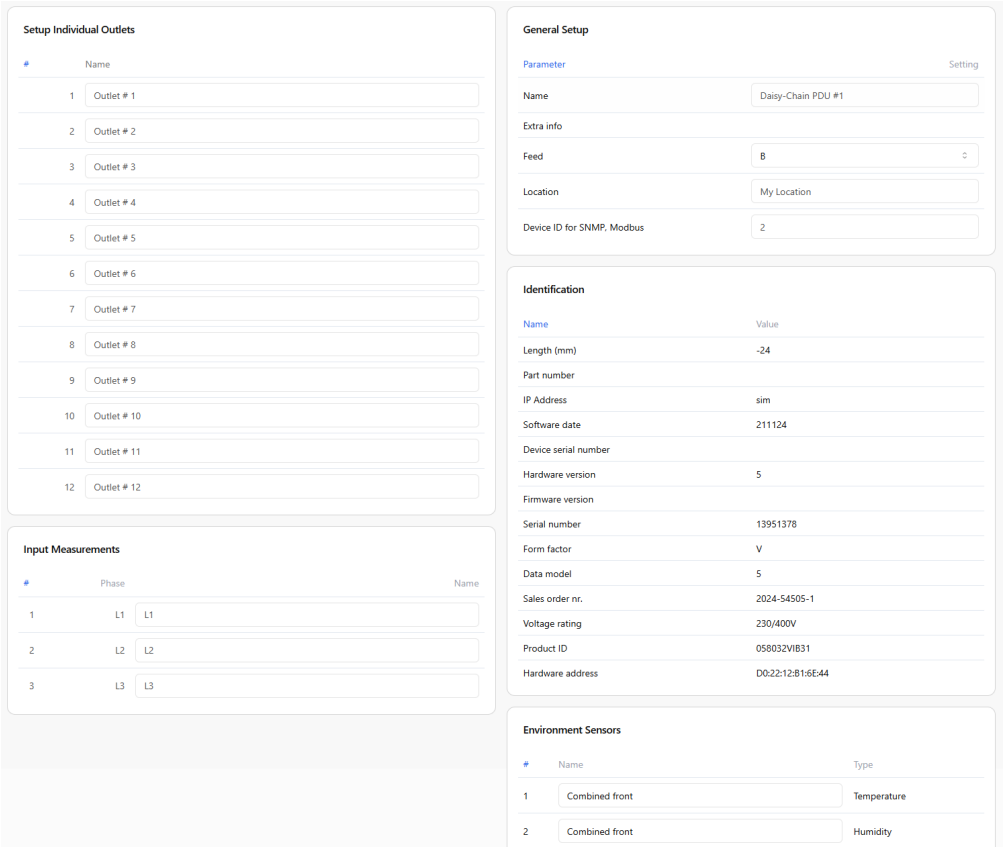



*Figure 48. Device configuration*

The device configuration is split into three sections; behaviour, diagnostics and the general setup. In the general setup, the “name”, “extra Info”, “location” and power feed information fields can be set. If the device supports these functions, then EnerTEG will export the changed data, otherwise it is only stored locally. The behaviour settings for each individual PDU are also stored in the PDU. The fixed outlet delay contains the value for delay time between two switch actions in milliseconds If a PDU is equipped with switchable outlets, the option to set the power up/down behaviour of outlets on power loss can be configured. The following options are available:

- Off, no switching on power up; At a power loss all outlets are switched off. At power up, all outlets are kept in the off state. This results in the PDU booting up while any power draw on connected devices is prevented.
- Same state as on power down, use fixed outlet delay; At power loss all outlets are switched off. At power up, all the outlets are set one by one to their last known state by respecting the fixed outlet delay.
- Same state as on power down, use individual outlet delay; At power loss, all outlets are switched off. At power up, all the outlets are set to their last known state by respecting the individual outlet delay
- Always on, no switching on power down; In this mode outlets are not switched in case of a power loss, they will be in the exact same state at power on as they were before the power loss.

Device ID: This value is used to address the PDU via the EnerTEG APIs and are automatically assigned by EnerTEG, they are not manually configurable.

- Power Loss: After the PDU boots up again after the power loss, it is guaranteed the Device ID stays the same as before.
- When a Communication module is replaced, it is guaranteed the Device ID stays the same as before.
- When a PDU is replaced, the new PDU is a different PDU and therefore the device ID will be different. When the PDU is detected by EnerTEG it will receive a new Device ID.


*Figure 49. NFC scan functionality*

The NFC scan functionality is enabled by default, but could be set to disabled for increased security. Note that the setting is per PDU and is also the only location where this setting can be changed.

# Chapter 9. Alerts & rules

## 9.1. Overview

EnerTEG includes a very powerful concept to actively mark events from connected PDUs or Data centre structure items, e.g. a room, row or rack via alerts, coloring, notifications and e-mail. The concept is built around creating rules for these items or devices, these can all be created and modified within EnerTEG.

- The Rules menu in the Settings section of the main web interface can be used to create and modify rules.
- The Open Alarms page shows PDU or Data centre structure element alarms, these are instances of thresholds set within a rule that are or were exceeded.

Rules will generally be inserted by the admin, who enters simple commands to initiate events that get triggered when PDU or Data centre structure measurement values change over or below thresholds set by the admin. The events generated by these rules will then be visible on the open alarms page, logged in the audit log, and also included in e-mails and SYSLOG entries if these have been set up. This give multiple options to receive immediate information over data changes, not only from individual measurements on one PDU but possibly from a combination of devices which have a logical dependency on each other. Color coding for all displayed elements immediately shows their status, and therefore any changes are shown immediately based on the rules that are set.

Entries at all levels within EnerTEG are displayed with the most important information inserted and with a background color that reflects their current entity, PDU or measurement status. If multiple statuses are detected within EnerTEG, then the color with the highest priority will be displayed. In the Data centre structure dashboards, the alert will escalate up through the logical levels and be displayed at all levels above the cause and will be mentioned in the insight section of these dashboards.

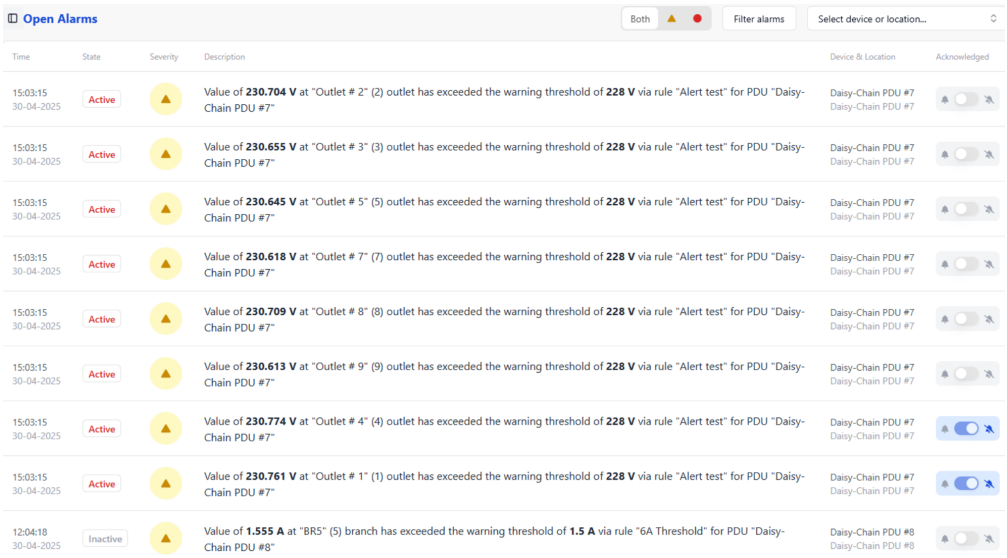



*Figure 50. Open alerts*

Alerts have a time and date of occurence, a state, severity, description, origin (device), location and an acknowledgement state. The selection box on the open alarms page can be used to display all alarms, only warnings or alerts. There is a filter for acknowledged active alarms, acknowledged inactive alarms, unacknowledged active alarms and unacknowledged inactive alarms.

An alert can be active or inactive which indicates if the threshold in the rule is still being exceeded or not. A user can have the alert unacknowledged (this is the initial state of an alarm) or acknowledged. Acknowledging an alert requires a user action which can be performed on the open alarms page.

In general, the color coding throughout EnerTEG provides a very simple way to have an immediate overview of changes or issues. In most cases a change of status will also cause a notification, which, depending on EnerTEG settings will export an email, or SYSLOG entry.

| Color | Description |
|---|---|
| Red | EnerTEG has detected a value in a critical state. |
| Yellow | EnerTEG had detected a value in a warning state. |
| Green | Device or entity ok. No rules exceeded. |

## 9.2. Creating general rules

Rules can be created and modified via the rules page in the settings section. A rule sets an lower warning, upper warning, lower critical or upper critical threshold for a chosen measurement type in all PDUs, a specific PDU, a type of PDU or a Data centre structure element. When a rule is exceeded it will become a warning when the upper or lower warning threshold is exceeded and an alert when the upper or lower critical threshold is exceeded. The rule status is always escalated up through the levels, to provide an immediate overview of PDU specific (measurement) issues or issues within Data centre structure elements such as a room, a row or a rack.

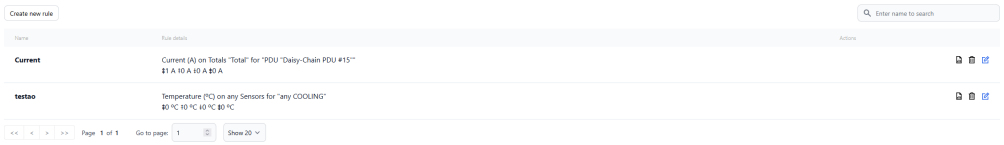



*Figure 51. Rules*

Rules can be created to match a large number of devices, or specifically for e.g. a single outlet on a specific PDU.

Rules for a large number of devices will generally be thought of as a template, and will be overruled by a more specific matching rule. This allows EnerTEG administrators to create basic rules for all or part of the Data centre item, and then focus on specific rules for special cases

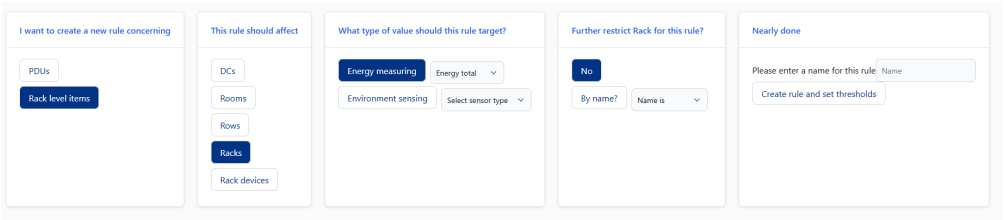



*Figure 52. Rule creation*

Rules can be created for Data centre structure elements (room, rows and racks), for all PDUs, a single PDU or a type of PDU. Ther user can select the measurement and even further restrict the rule. A rule requires a name and the setting of the thresholds before it can be created.

# 9.3. Creating state rules

By setting state rules for all or specific PDUs the user can define alarms or warnings on state changes of breakers, outlets or digital sensors (e.g. when a cabinet door is opened). These alarms and warnings make it easier to integrate PDUs with external monitoring systems that monitor state changes.

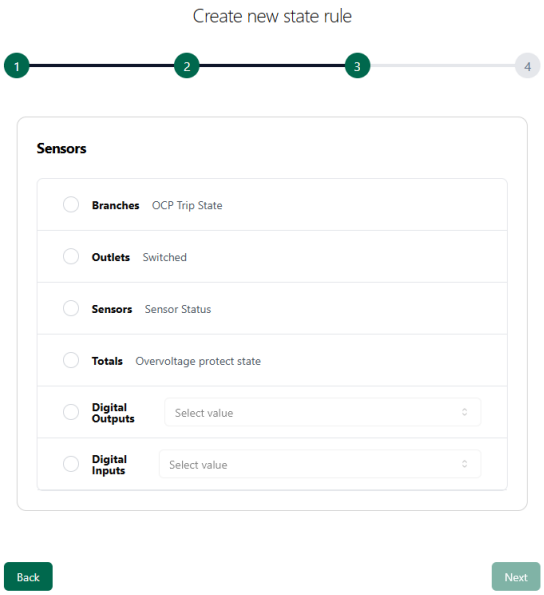



*Figure 53. State rules*

It is possible to set state rules for all PDUs, a PDU or a selection of PDUs on:

- The OCP trip state on branch level
- Switched state change on outlet level
- Sensor status on sensor level
- Overvoltage protect state on total level
- Digital output state
- Digital input state

The PDUs must be built to specification and/or be equipped with the correct sensor to have the actual hardware capabilities for using these state rules.

# 9.4. Threshold levels

Rules are given names to help identify them and their purpose. Each rule requires the definition of one or more thresholds.


*Figure 54. Rule thresholds*

- Critical above: Value measured greater then this value will cause a Critical threshold state to be detected. The PDU(s) or Data centre structure item will be marked in red and a notification created.
- Critical above toggle: Enable or disable the Critical above threshold detection.
- Warning above: Value measured greater then this value will cause a warning threshold state to be detected. The PDU(s) or Data centre item will be marked in brown and a notification created.
- Warning above toggle: Enable or disable the Warn above threshold detection.
- Warning below: Value measured below this value will cause a Warning threshold state to be detected. The PDU(s) or Data centre item will be marked in brown and a notification created.
- Warn below toggle: Enable or disable the Warn below threshold detection.
- Critical below: Value measured below this value will cause a critical threshold state to be detected. The PDU(s) or Data centre item will be marked in red and a notification created.
- Critical below toggle: Enable or disable the Critical below threshold detection.

# Chapter 10. Audit log

EnerTEG includes an advanced audit architecture. EnerTEG also displays the list of audit logs, which are in some cases information such as PDUs that are added or user logins, but also include the alarms. Users with the necessary access rights can add comments to the logs, track the state of actions taken to fix issues and directly access information on devices linked to the alarm.

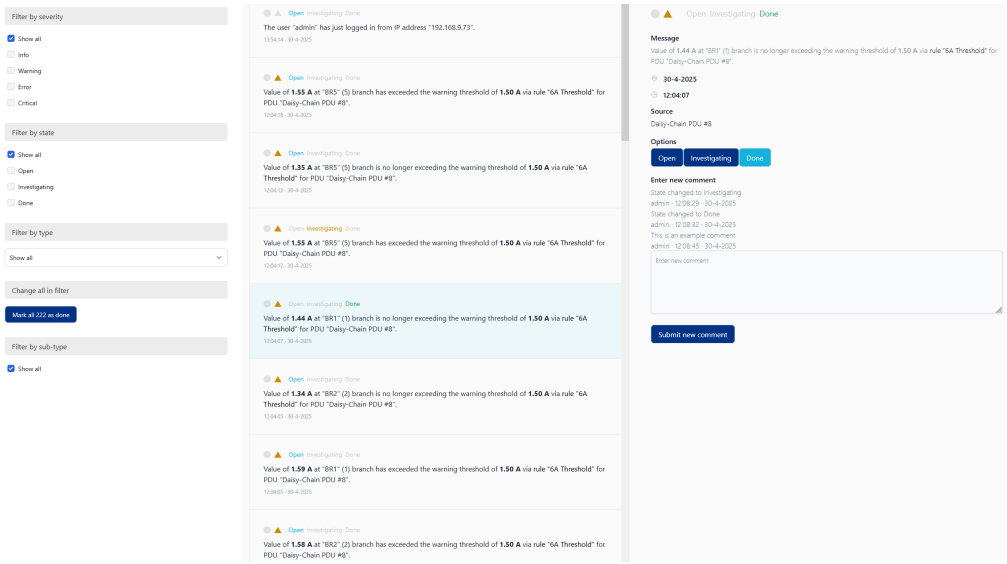



*Figure 55. Audit*

The audit log lists all the EnerTEG internal events, and their severity. These events can also be sent via E-mail or SYSLOG if required (see “Settings”). The view is in three vertical parts.

- The left section provides various filter mechanisms to select which logs are displayed. The logs can be filtered depending on their severity, or their state.
- The middle section displays a vertical scrolled list of logs. The list will be split into pages when the page limit is reached, the pages can be selected by buttons at the bottom of the view. – The severity is on the top left of each entry. The entry color will depend on the severity level. A detailed entry will be displayed on the right side if clicked. – The possible states are listed below, and can be changed by using the buttons in the detail section of the view. – The associated text for this log. – The date when the log was created.
- The right section is a detailed view of the selected log. The selected log state can be modified within this view, and also comments can be entered. This information will be stored with the log entry.

## 10.1. Severity

Every notification is generated with a predefined severity level. This level cannot be changed. The severity for a log entry is listed as part of the title. The available severity levels are listed below:

| Severity | Description |
|---|---|
| Debug | Only in debug mode. Development only. |
| Log | Very low information only. |
| Info | Information only. |
| Warning | Warning level, not a critical error. |
| Error | Error level. |
| Always | Always logged. |

## 10.2. State

Every notification has a current state. The state is generated in an “open” state, this can be changed for high severity notifications. State changes are also listed in the notification comment field. The available states are listed below:

| State | Description |
|---|---|
| Open | This is the initial state for any newly created Notification. |
| Investigating | This state can be selected by the “investigating” button. |
| Done | This can be selected by the “done” button. |

# Chapter 11. Remote monitoring

## 11.1. CLI

The CLI is available for EnerTEG Lite on a Controller module PDU via SSH. The functionality is enabled by default, but can be configured in the CLI menu in the settings of EnerTEG. The command line interface has been modelled on the semantics of a UNIX shell, making it familiar to many administrators.

The CLI interface is primarily intended for performing configuration tasks without using the web interface, or possibly automated configuration via scripting.

Login on the CLI via console: Open the console in the Virtual Machine and type in username and password. Login on the CLI via SSH: 'ssh <account_name>@<ip_address>' and then fill in the password for that user account. The account name and the IP address are parameters that must be filled in with valid data from the customer environment. Please note that after a software update to a newer version of EnerTEG has been completed, the SSH key for access to the CLI will be changed.

The 'tab' key will often offer autocomplete. The arrow keys allow access to the command history. All measurement data, PDU configuration settings and system settings are reachable through 'topics'. Topics can be viewed as folders with subfolders and only one single _data file inside.

The following commands can also be queried on the system by typing 'help'. Help shows a list of commands, modelled to Unix commands.

### 11.1.1. Commands

**Navigation**

| Command | Description |
|---|---|
| pwd | Show current path |
| cd <path> | Change path (support for relative and absolute paths) |
| ls <path> | List contents (subtopics/ and _data if present) |
| cat <(path)_data> | Get JSON contents of path or _data file |
| edit <_data> | Edit _data file in a VIM like editor. Use ':wq' to save, ':q' to quit in the editor |
| put <key_1="a_value"> <key_2=true> | Edit the value of a key in the _data file |

**Network**

| Command | Description |
|---|---|
| ping <hostname or ip> | Ping a server using a hostname or an IP address |
| network status (optional <eth0>) | Show the status of all network interfaces or a specific network interface |
| network config (example <eth0>) | Configure a network interface |
| network list | List all network interfaces |

**User**

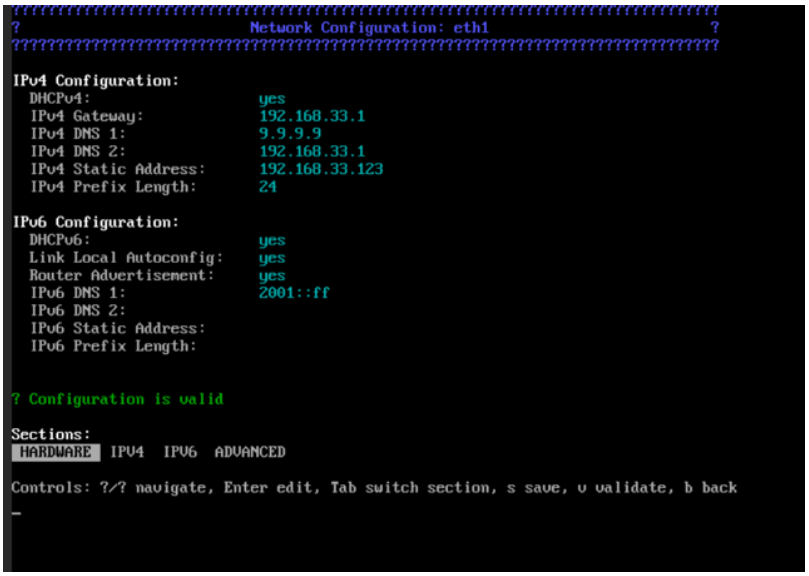
| Command | Description |
|---|---|
| whoami | Show detailed user information |
| users | Show currently logged users |
| format <text or json> | Set output format |

| Command | Description |
|---|---|
| help | Help shows a list of available commands, modelled to UNIX commands |
| clear | Clear the terminal session |
| exit | Terminate |

## 11.1.2. Network configuration

- To view a network, type e.g. ‘network status eth0’ to obtain the network status from the first network adapter available.
- To configure the network settings, type e.g. ‘network config eth0’ to change the network settings of the first network adapter available.


The network configuration configures the ethernet interface and is displayed as a menu-style. Values are sorted in sections, which consist of HARDWARE. IPV4, IPV6 and ADVANCED. Use the Tab key to switch between sections. Press enter to edit a value. After a value has been edited, the settings can be validated by pressing the ‘v’ key. After validation, the new settings can be saved by pressing ‘s’. To exit, press ‘b’




## 11.1.3. System configuration

The main items in the system can be accessed by using ‘ls’ in the root folder.


To access the system configuration, navigate to config and use ‘ls’ again to view all system configuration items.

```
telnet:admin:config> ls
auth/                   backup/                 backup_settings/
cli/                    core/                   devices/
email/                  hostname/               http_server/
modbus/                 network/                notifications/
snmp_agent/             sppdu5/                 sql_export/
syslog/                 time/
```

These folders can then be further navigated, and also viewed using the 'ls' command and opened by using the cat _data command.

### 11.1.4. Reading PDU data

The CLI interface is not intended for reading measurement data. For this purpose SNMP, Modbus, REST API, or the Redfish API can be used. So measurement data is displayed in the CLI, but the correct interfaces must be used for monitoring.

```
Changed to: /sensor
telnet:admin:sensor> ls
_data                   1ea94/                  1f669/
1f6c1/                  driver_system/
telnet:admin:sensor>
```

- PDU data can be accessed from the sensor directory
- PDU serial numbers are displayed in hexadecimal, an easy way to identify them is to copy them from the URL bar in the browser when the PDU is selected in the device list.

http://192.168.9.139/devices/1f6c1/config

To obtain basic PDU information:

```
telnet:admin:sensor> cd 1f6c1
Changed to: /sensor/1f6c1
telnet:admin:sensor/1f6c1> cat _data
Getting data from: sensor/1f6c1
{
  "ts" : 1762512213984,
  "name" : "Gateway PDU",
  "rating" : 16,
  "phases" : 3,
  "state" : "RUNNING",
  "type" : "PDU",
  "location" : "My Location",
  "tpl" : "SpPdu5",
  "url" : "sppdu5|http://s:xxx@192.168.9.47/",
  "vendor" : "Schleifenbauer",
  "groupId" : null,
  "shepherdId" : "000c290af33b",
  "unit" : "AMPERE",
  "max" : 48.0,
  "serial" : "128705",
  "connection" : "Gateway",
  "id" : 6,
  "a" : null,
  "w" : null
}
```

Measurements can be accessed by using the ‘ls’ command in the hexadecimal PDU folder

- t = totals
- i = inlets
- o = outlets
- s = sensors
- status = PDU status data
- config = PDU configuration data
- misc = other PDU data

These folders can then be further navigated, and also viewed using the ‘ls’ command and opened by using the cat _data command.

### 11.1.5. Changing configuration data

The 'PUT' command can be used to make changes to the EnerTEG configuration. Incorrect changes may cause EnerTEG to stop working. With the exception of configuring the network settings, we strongly recommend that configuration changes are performed via the web interface. Can be used for scripting purposes, but is to be used with extreme caution.

In this example, the SNMP functionality in EnerTEG is enabled via the CLI. Note that the goal of this example is to show how to change a configuration parameter, not to get SNMP fully functioning.

```
telnet:admin:> cd config/snmp_agent
Changed to: /config/snmp_agent
telnet:admin:config/snmp_agent> put enabled="enabled"
Value at config/snmp_agent updated successfully.
telnet:admin:config/snmp_agent> cat _data
Getting data from: config/snmp_agent
{
  "ts" : 1763369306162,
  "v" : {
    "agentAddress" : "0.0.0.0",
    "snmpLocation" : "",
    "enabledTrap" : "enabled",
    "snmpContact" : "",
    "v3PasswordAuth" : "set",
    "snmpVersion" : "snmpV2C",
    "enabledWrite" : "disabled",
    "v2cCommunity" : "public",
    "v3PasswordPriv" : "set",
    "v3ProtocolAuth" : "MD5",
    "snmpName" : "",
    "enabled" : "enabled",
    "genericMibEnabledSet" : "disabled",
    "serverTrapPort" : "162",
    "v3User" : "",
    "agentPort" : "161",
    "v3ProtocolPriv" : "DES",
    "serverTrapAddress" : "192.168.9.22"
  },
  "new" : null
}
```

Navigate to the folder of the correct configuration entry, which in this case is the snmp_agent. The snmp_agent is present in the config folder. Now enable the SNMP functionality by using put enabled=”enabled”. SNMP is now enabled, the response was that the configuration parameter was updated successfully. This example also has a ‘cat _data’ command included so the actual change can be observed. More changes to the SNMP configuration can be made this way to get SNMP fully configured.

## 11.2. SNMP

Simple Network Management Protocol (SNMP) is an Internet Standard protocol for collecting, modifying and organizing information about managed devices on IP networks. The supported versions in EnerTEG, SNMPv2c and SNMPv3, feature improvements in performance, flexibility and security.

The variables accessible via SNMP are organized in hierarchies. SNMP itself does not define which variables a managed system should offer. Rather, SNMP uses an extensible design which allows applications to define their own hierarchies. These hierarchies are described as a management information base (MIB). SNMP operates in the application layer of the Internet protocol. All SNMP messages are transported via User Datagram Protocol (UDP). A default configured SNMP agent receives requests on UDP port 161. The manager may send requests from any available source port to port 161 in the agent.

### 11.2.1. Specification

In principle, SNMP is an interface to read and write registers of the EnerTEG software and the CONTEG PDU. It can also be used to switch outlets. Reading or writing a register using SNMP requires knowledge of the OID structure provides this functionality, which is collected in a MIB file. This MIB file can be downloaded from the SNMP agent menu in EnerTEG.

### 11.2.2. Configuration

To configure the remote management of EnerTEG via SNMP, the setup of an SNMP agent is required within EnerTEG. The required knowledge of setting up an SNMP agent is described in SNMP Agent section of the Configuration chapter of this manual.

Should a Data centre structure not exist yet and the PDU is not assigned, it’s still possible to add the PDU to an SNMP monitoring tool.

### 11.2.3. Examples

The MIB file (SNMP OID translation table, used for reference) can be loaded easily into various software so it's possible to navigate with readable object names. It is easy to take the OIDs from the MIB browser and insert them in a DCIM mapping file or for example a Python script. There is also the option to download and install an SNMP tool to make sure the connection is valid first, there are multiple useful tools for exploring the SNMP environment.

1. Launch the SNMP tool / MIB Browser.
2. Go to the settings and make sure the Agent Port is set to the correct port (default: 161),
3. In case of SNMP v2c, set the read community to the read community in EnerTEG (default = "public") and the write Community to the correct one (default = "private") after selecting the correct SNMP version.
4. In case of SNMP v3 this is different, in addition to a username and password, the authentication protocol and the privacy protocol must be set accordingly to the settings in EnerTEG.
5. Create an agent using the settings above. Make sure the IP Address of the EnerTEG Platform instance of the EnerTEG Lite on a Controller module PDU is filled in.
6. Make sure the Agent IP is set correctly. Otherwise set this IP address to the correct value and check if the IP is still valid.
7. Download the PDU MIB file from the SNMP agent menu in EnerTEG.
8. Load the MIB file into the software.
9. Now use the application to navigate through different PDU registers values using SNMP and retrieve or write values.
10. Make sure the proper request method is used to read or write the register.
11. To get the all values (also of multiple PDUs if on Databus), perform a "Walk".
12. Some application include a section for receiving traps. Make sure the correct trap port is used and it is enabled in EnerTEG.

While in other SNMP communication, the manager actively requests information from the agent, traps provide the option to send alarms from the agent (EnerTEG) to the manager without being explicitly requested. SNMP traps enables a Controller module PDU with EnerTEG Lite or an EnerTEG Platform instance to notify the management station of significant events by way of an unsolicited SNMP message. Destination addressing for traps is determined in an application-specific manner typically through trap configuration variables in the MIB file.

A walk can also be initiated from a command line:

- snmpwalk -v3 -u user -l authPriv -a auth_protocol -A auth_password -x priv_protocol -X priv_password ip_address:port_nr oid
- snmpwalk -v2c -c community_password ip_address:port_nr oid

## 11.3. Modbus

The Modbus API can be used for reading PDU values and also for switching outlets.

As Modbus communication is unsecured, make sure that the environment is suitable before enabling Modbus.

### 11.3.1. Register list

The CONTEG EnerTEG Modbus implementation uses Modbus TCP/IP to read values from PDU registers. This is a Modbus variant used for communications over TCP/IP networks, connecting over a port (default 502). Modbus provides the possibility to address all devices known in the device list in EnerTEG, but keep in mind that due to the 8-bit addressing the Modbus connection can contain a maximum of 247 device IDs.

The Modbus register list can be downloaded from: https://download.conteg.com/PDU/IP-S/EnerTEG-dcem/

### 11.3.2. Modbus API Technical Documentation

The Modbus API technical documentation is available from https://download.conteg.com/PDU/IP-S/EnerTEG-dcem/ and provides the API documentation, including the technical specification and usage examples for reading out actual PDU values.

## 11.4. Redfish API

The Redfish API is an open, standardized JSON-based RESTful API designed for managing and monitoring. It can also be used to switch outlets. It can also be accessed via HTTPS and provides a standardized schema/model describing hardware components. There is roles and permissions support for admin, operator, and read-only users.

The Redfish API technical documentation is available from https://download.conteg.com/PDU/IP-S/EnerTEG-dcem/ and provides the API documentation, including the technical specification and usage examples for reading out actual PDU values.

To make use of the Redfish API, it needs to be enabled in the general settings of the power management system. To enable the Redfish service, log in to the web interface of the power management system and navigate to the general settings, then go to: Web Server Settings → Redfish API. Make sure the Redfish API is set to 'Enabled' and save the changes.

## 11.5. REST API

The REST API is available in our monitoring software for custom implementation and scripting, including outlet switching. The REST API can be used for retrieving device data but should first be enabled in the monitoring software before use.

The REST API technical documentation is available from https://download.conteg.com/PDU/IP-S/EnerTEG-dcem/ and provides the API documentation, including the technical specification and usage examples for reading out actual PDU values.

Many chapters in the technical documentation provide Curl examples, but any program that can transfer data over HTTP/HTTPS can be used.

# Chapter 12. Technical support and warranty

## 12.1. Technical support

Please contact us in case there are questions regarding our products:

T: +420565300358
E-mail: presales@conteg.com
Website: https://www.conteg.com/

## 12.2. End User Licence Agreement

The End User Licence Agreement can be found at: https://www.conteg.com/general-business-terms-and-conditions