User Manual
ENGLISH

AEMC® INSTRUMENTS
CHAUVIN ARNOUX GROUP

Power & Energy Logger
Models
PEL 112 & PEL 113

POWER & ENERGY LOGGERS

Measure Up
WITH AEMC INSTRUMENTS®

Chauvin Arnoux®, Inc. d.b.a AEMC® Instruments
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Statement of Compliance

Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments certifies that this instrument has been calibrated using standards and instruments traceable to international standards.

We guarantee that at the time of shipping your instrument has met the instrument's published specifications.

An NIST traceable certificate may be requested at the time of purchase, or obtained by returning the instrument to our repair and calibration facility, for a nominal charge.

The recommended calibration interval for this instrument is 12 months and begins on the date of receipt by the customer. For recalibration, please use our calibration services. Refer to our repair and calibration section at www.aemc.com/calibration.

Serial #: ____________________________

Catalog #: **2137.53, 2137.54 / 2137.63, 2137.64**

Model #: **PEL 112 / PEL 113**

Please fill in the appropriate date as indicated:

Date Received: ______________________

Date Calibration Due: __________________

AEMC® INSTRUMENTS
CHAUVIN ARNOUX GROUP

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1. INTRODUCTION

Thank you for purchasing an AEMC® Instruments **Power & Energy Logger Model PEL 112 or Model PEL 113.**

For best results from your instrument and for your safety, read the enclosed operating instructions carefully and comply with the precautions for use. Only qualified and trained operators should use this product.

1.1 INTERNATIONAL ELECTRICAL SYMBOLS

	Signifies that the instrument is protected by double or reinforced insulation.
	CAUTION - Risk of Danger! Indicates a **WARNING**. Whenever this symbol is present, the operator must refer to the user manual before operation.
	Indicates a risk of electric shock. The voltage at the parts marked with this symbol may be dangerous.
	USB socket
	SD-card
	Ethernet Socket (RJ45)
	Power supply input
	Ground/Earth
	Indicates Important information to acknowledge
	Magnetic fields can damage hard drives and medical devices.
	Refers to a type B current sensor. Application or withdrawal not authorized on conductors carrying dangerous voltages. Type B current sensor as per IEC 61010-2-032.
	The product has been declared recyclable.
	This product complies with the Low Voltage & Electromagnetic Compatibility European directives.
	In the European Union, this product is subject to a separate collection system for recycling electrical and electronic components in accordance with directive WEEE 2012/19/EU.

1.2 DEFINITION OF MEASUREMENT CATEGORIES (CAT)

CAT IV: Corresponds to measurements performed at primary electrical supply (< 1000 V).
Example: primary overcurrent protection devices, ripple control units, and meters.

CAT III: Corresponds to measurements performed in the building installation at the distribution level.
Example: hardwired equipment in fixed installation and circuit breakers.

CAT II: Corresponds to measurements performed on circuits directly connected to the electrical distribution system.
Example: measurements on household appliances and portable tools.

1.3 PRECAUTIONS FOR USE ⚠

This instrument complies with safety standard IEC 61010-2-030, the leads comply with IEC 61010-031 for voltages of 1000 V in measurement CAT III or 600 V in measurement CAT IV and the current sensors comply with IEC 61010-2-032. Failure to observe the safety instructions may result in electric shock, fire, explosion, and destruction of the instrument and of the installations.

The operator and/or the responsible authority must carefully read and clearly understand the various precautions to be taken in use. Sound knowledge and a keen awareness of electrical hazards are essential when using this instrument.

- For your safety, use only the compatible leads and accessories delivered with the instrument, which comply with IEC standard 61010-031. When sensors or accessories having a lower voltage rating and/or category are connected to the instrument, the lower voltage and/or category applies to the system so constituted.
- Before each use, check that the leads, enclosures, and accessories are in perfect condition. Any lead, sensor or accessory on which the insulation is damaged (even partially) must be repaired or scrapped.

Do not use the instrument on networks for which the voltage or category exceeds those mentioned.

- Do not use the instrument if it seems to be damaged, incomplete, or poorly closed.
- Use only the AC power adapter and battery pack supplied by the manufacturer, which include specific safety features.
- When removing and replacing the battery and/or the SD-card, make sure that the device is disconnected and turned off.
- We recommend using Personal Protection Equipment where required.
- Keep your hands away from unused terminals.
- If the instrument is wet, dry it before connecting it.
- All troubleshooting and metrological checks must be performed by authorized (competent and accredited) personnal, witht he instrument completely disconnected.

1.4 RECEIVING YOUR SHIPMENT

Upon receiving your shipment, make sure that the contents are consistent with the packing list. Notify your distributor of any missing items. If the equipment appears to be damaged, file a claim immediately with the carrier and notify your distributor at once, giving a detailed description of any damage. Save the damaged packing container to substantiate your claim.

1.5 PRODUCT PACKAGING

PRODUCT PACKAGING

Power & Energy Logger
Model PEL 112
Cat. #2137.53 / 2137.63

Power & Energy Logger
Model PEL 113
Cat. #2137.54 / 2137.64

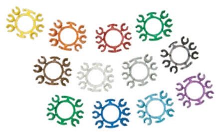
Small Classic Tool Bag
Cat. #2133.72

(4) Black Test Leads in
Cable Reeling Box
with (4) Black Alligator Clips
Cat. #2140.44
Replacement reeling box is sold separately (Qty 1)
Cat. #5000.77

Power Cord
5 ft, 115 V
Cat. #5000.14

(3) MiniFlex®
MA 193-10-BK Sensors
Cat. #2140.48
Replacement is Qty of (1)
(Only Shipped with PEL 112 Cat. #2137.53 & PEL 113 Cat. #2137.54)

Cable - USB Type A to Type B
Cat. #2136.80



(1) Set of (12) Color Input ID Markers
Cat. #2140.45

USB SD - card reader
Cat. #5000.45
SD-card (8 GB)
(Formatted & Installed)

(1) USB Drive
(DataView® and User Manual)

Also Included:

- NiMH AAA 8.4 V Rechargeable Battery Pack (Installed)
- Measuring Instrument Safety Data Sheet (Multilingual)
- Declaration of Conformity
- Safety data sheet for electrical measurment and testing probes
- Test Report
- Reeling Box User Manual
- Quick Start Guide

1.6 ORDERING INFORMATION

Power & Energy Logger Model PEL 112
(no LCD, w/ three MA193-10-BK sensors)....................................... **Cat. #2137.53**

Includes small classic tool bag, (3) MiniFlex® MA193-10-BK sensors, (4) 10 ft black test leads in cable reeling box, (4) black alligator clips, set of (12) color input ID markers, 8 GB SD-card (installed), USB SD - card reader, 5 ft USB type A to type B cable, 5 ft 115 V power cord, NiMH AAA 8.4 V battery (installed), quick start guide, and USB drive with DataView® software and user manual.

Power & Energy Logger Model PEL 113
(with LCD, w/ three MA193-10-BK sensors) .... **Cat. #2137.54**

Includes small classic tool bag, (3) MiniFlex® MA193-10-BK sensors, (4) 10 ft black test leads in cable reeling box, (4) black alligator clips, set of (12) color input ID markers, 8 GB SD-card (installed), USB SD - card reader, 5 ft USB type A to type B cable, 5 ft 115 V power cord, NiMH AAA 8.4 V battery (installed), quick start guide, and USB drive with DataView® software and user manual.

Power & Energy Logger Model PEL 112
(no LCD, no sensors) .... **Cat. #2137.63**

Includes small classic tool bag, (4) 10 ft black test leads in cable reeling box, (4) black alligator clips, set of (12) color input ID markers, 8 GB SD-card (installed), USB SD - card reader, 5 ft USB type A to type B cable, 5 ft 115 V power cord, NiMH AAA 8.4 V battery (installed), quick start guide, and USB drive with DataView® software and user manual.

Power & Energy Logger Model PEL 113
(with LCD, no sensors).. **Cat. #2137.64**

Includes small classic tool bag, (4) 10 ft black test leads in cable reeling box, (4) black alligator clips, set of (12) color input ID markers, 8 GB SD-card (installed), USB SD - card reader, 5 ft USB type A to type B cable, 5 ft 115 V power cord, NiMH AAA 8.4 V battery (installed), quick start guide, and USB drive with DataView® software and user manual.

1.6.1 Accessories

Adapter - 600 V CAT III Power to Phase Adapter	**Cat. #2137.90**
AC/DC Current Probe Model MR193-BK	**Cat. #2140.28**
AC Current Probe Model MN93-BK	**Cat. #2140.32**
AC Current Probe Model SR193-BK	**Cat. #2140.33**
AmpFlex® Sensor 24” Model 193-24-BK	**Cat. #2140.34**
AmpFlex® Sensor 36” Model 193-36-BK	**Cat. #2140.35**
AC Current Probe Model MN193-BK	**Cat. #2140.36**
MiniFlex® Sensor 14” Model MA193-14-BK	**Cat. #2140.50**
MiniFlex® Sensor 24” Model MA194-24-BK	**Cat. #2140.80**
AC/DC Current Probe Model E94	**Cat. #2140.82**

1.6.2 Replacement Parts

Small Classic Tool Bag	**Cat. #2133.72**
Cable - 10 ft (3 m) USB Type A to Type B	**Cat. #2136.80**
Battery - Replacement NiMH AAA 8.4 V	**Cat. #2137.81**
Lead - One 10 ft (3 m) Black Lead with Black Alligator Clip	**Cat. #2140.44**
Replacement - (1) Set of (12) color-coded input ID Markers	**Cat. #2140.45**
MiniFlex® Sensor 10” Model MA193-10-BK	**Cat. #2140.48**
Power Cord 115 V	**Cat. #5000.14**
USB SD-card reader	**Cat. #5000.45**
Cable reeling box for organizing leads less than 10 ft	**Cat. #5000.77**

Order Accessories and Replacement Parts Directly Online
Check our Storefront at www.aemc.com/store for availability

Dataview® Software Updates are Available at www.aemc.com

2. FEATURES

2.1 DESCRIPTION

PEL: Power and **E**nergy **L**ogger

The PEL 112 and PEL 113 are simple-to-use, single-, dual- (split-phase) and three-phase (Y, Δ) Power & Energy Loggers.

The PEL offers all the necessary functions for Power/Energy data logging for most of the (50, 60, 400) Hz and DC distribution systems worldwide, offering numerous distribution set-ups. The PEL is designed to work in 1000 V CAT III and 600 V CAT IV environments.

The PEL is compact in size and fits in many distribution panels.

The PEL provides the following measurements (or calculations):

- Direct voltage measurements up to 1000 V CAT III and 600 V CAT IV
- AC current measurements from 200 mA up to 12,000 A depending on the current sensors.
- Power measurements: VA, W and var
- Energy measurements: VAh, Wh (source, load) and varh (4 quadrants)
- Power Factor (PF), Cos φ, and Tan Φ
- Crest Factor
- Total Harmonic Distortion (THD) for voltages and currents
- Harmonics from the fundamental signal up to the 50th order for 50/60 Hz voltages and currents
- Frequency measurements
- RMS and DC measurements @ 128 samples/cycle – each phase simultaneously
- Bright triple LCD on the Model PEL 113 (3 phases shown simultaneously)
- Storage of measured and calculated values on a SD-card or SDHC-Card
- Automatic recognition of the different types of current sensors
- Configuration of current and voltage ratios with external sensors
- 17 types of supported hook-ups or electrical distribution systems
- 32 programmable alarms on the measurements
- Sends reports via email
- USB, LAN and Wi-Fi communication
- DataViewSync™ to communicate using private IP address
- DataView® Software for:
    - data download
    - viewing of measurements
    - real-time communication with a PC
    - report generation with predefined or custom templates

2.2 FRONT OF INSTRUMENT

Figure 1

Item	Designation	See §
1	Four voltage input terminals.	-
2	Three current input terminals.	-
3	Rigid molded casing over-molded with thermo-adhesive rubber.	-
4	Digital LCD displaying measured, calculated and parameterizing quantities **(PEL 113 only)**.	2.8

Item	Designation	See §
5	**PEL 112:** Two function buttons: (C) **Control** Button (D) **Power** Button **PEL 113:** Four function buttons: (A) **Enter** Button (B) **Navigation** Button (C) **Control** Button (D) **Power** Button	2.8
6	Nine LEDs for status information.	2.10
7	USB and Ethernet connectors, and SD memory card slot.	-
8	Standard (IEC C7 figure 8 terminal – non polarized) power connector for 110/250 VAC power source.	-

Table 1

2.3 BACK OF INSTRUMENT

Figure 2

Item	Designation
1	Four magnets (molded into the rubber casing).
2	Six recessed Torx® screws (for factory service use only).

Table 2

2.4 INPUT TERMINALS

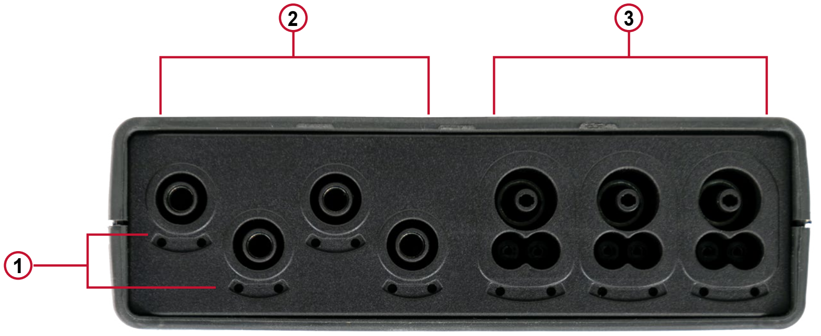


Figure 3

Item	Designation
1	Color-coded ID Marker Insertion Locations
2	Voltage Input Connectors (safety banana plug inputs)
3	Current Sensor Input Connectors

Table 3

For multiple-phase measurements, start by marking the accessories using the color-coded ID markers supplied with the device; a different color for each current terminal.

Connect the measuring leads to your PEL as follows:

- Current measurement: I1, I2, I3 4-point connectors
- Voltage measurement: V1, V2, V3 and N terminals

The measuring leads must be connected to the circuit to be monitored according to the selected hook-up diagram. Do not forget to define the voltage and current transformer's ratios when necessary (see § 4.3.6).

NOTE: Before connecting a current sensor, refer to the sensor's directions for use.

Twelve sets of color-coded rings and inserts are supplied with your PEL instrument. Use these ID markers to identify the leads and input terminals.

- Detach the appropriate inserts from the color-coded marker and place them in the holes provided under the terminals (larger inserts for current terminals, smaller inserts for voltage terminals).

■ Clip the rings of the same color to the ends of the lead you will be connecting to the terminal.

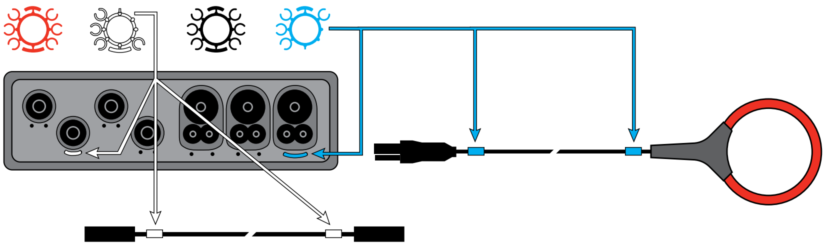


Figure 4

2.5 CONNECTIONS

Figure 5

Item	Designation	See §
1	Power Cord Connector	3.2.1
2	SD-card Slot	2.10
3	USB Connector	3.4
4	Ethernet RJ 45 Connector	3.4

Table 4

2.6 MOUNTING AND LOCATION

WARNING: Strong magnetic fields can damage hard drives and medical devices.

As a logger, the PEL is designed to be installed for an extended period of time in a utility room.

The PEL should be placed in a well-ventilated area; temperature not to exceed those specified in § 6.5.

The PEL 112 and PEL 113 can be mounted to a flat ferromagnetic vertical surface using the four molded-in magnets.

Figure 6

2.7 BUTTON FUNCTIONS

Button	Description
	Power Button: Turns the instrument ON or OFF (see § 3.2). **NOTE:** The instrument cannot be turned OFF while powered through the power cord or the phase adapter or if a recording is in progress or pending. In addition, the instrument will not turn off while connected to the PEL adapter.
	Control Button: A long press activates or deactivates the Wi-Fi link (see § 3.5). A long press starts or stops recording (see § 4.2).
	Enter Button (PEL113): In the configuration mode, serves to select a parameter to be modified (see § 4.3.6). In the measurement and power display modes, serves to display the phase angle values and partial energies (see § 4.6.1).
	Navigation Buttons (PEL113): These are used to browse the data displayed on the LCD screen.

Table 5

2.8 LCD (PEL 113)

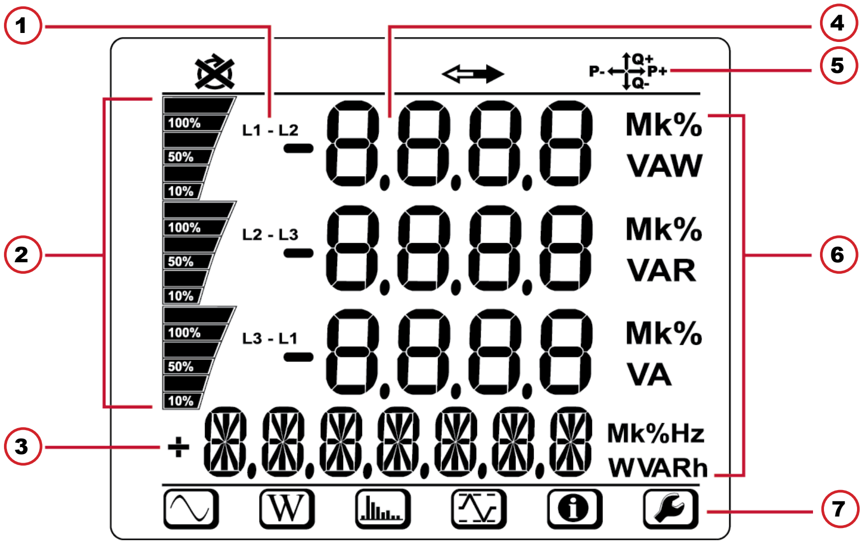


Figure 7

Item	Designation
1	Measured phase indicator.
2	Indicates percentage of the range (0 to 100) % of full range or full load as programmed into the PEL by the user through the PEL Control Panel.
3	Measurements or display page titles.
4	Measurement values.
5	Status icons.
6	Measured units
7	Mode icons

Table 6

2.8.1 Status and Mode Icons

Status and Mode indicate the Following:

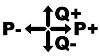
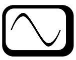
Icon	Description
	Phase Order reversal indicator or missing phase (displayed only in Real-Time Measurement Mode)
	Data are available for recording (non-display indicates possible internal problem)
	Power quadrant indicator
	Real-time Measurement Mode
	Power and Energy Mode
	Harmonics Mode
	Max Mode
	Information Mode
	Configuration Mode

Table 7

Phase Order

The phase order icon is displayed on the LCD only when Measurement Mode is selected.

The phase order is determined every second. If the phase order is incorrect, the  symbol is displayed on the LCD.

- Phase order for voltage channels only is displayed when voltages are displayed on measurement screen.
- Phase order for current channels only is displayed when currents are displayed on measurement screen.
- Phase order for voltage and current channels is displayed when the other screens are displayed.
- The source and load must be parameterized using the PEL Control Panel to define the direction of the energy (imported or exported).

2.9 STATUS INDICATORS

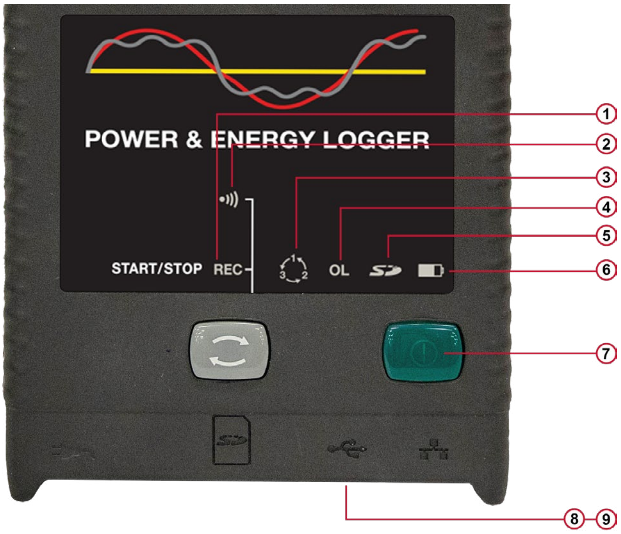


Figure 8

Item	Indicator	Color	Status
1	**REC**	Red	**Recording** - Indicator OFF: not recording - Indicator blinking red: recording session programmed - Indicator lit red: recording session in progress
2	•)))	Green	**Wi-Fi** - Indicator lit green: Wi-Fi is enabled but not currently transmitting - Indicator blinking green: Wi-Fi is enabled and transmitting - Indicator OFF: Wi-Fi is disabled
3	1 3 2	Red	**Phase Order** - Indicator OFF: phase rotation order correct - Indicator binking red: phase rotation order incorrect
4	OL	Red	- **Overload of the Measurement Range** - Indicator lit red: load is outside of limits - Indicator OFF: no input overload Note: Other conditions show OL as well. For example, no current sensors connected
5	SD	Red / Green	**SD-card** - Indicator lit red: SD-card is locked, unrecognized, or not present - Indicator blinking red: SD-card is initializing - Indicator blinking alternating red and green: SD-card is full - Indicator lit green: SD-card is present, recognized, and unlocked - Indicator blinking light green: SD-card will be full before the end of the progress or pending recording

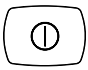
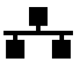
Item	Indicator	Color	Status
6		**Orange/ Red**	**Battery** - Indicator OFF: battery is fully charged (connected or not connected to external AC power) - Indicator lit orange: battery is charging - Indicator blinking orange: battery is recovering from a full discharge - Indicator blinking red: battery is low and no external AC power is connected
7		**Green**	**Power Supply** - Indicator lit green: instrument is running on power supplied by the line voltage inputs - Indicator OFF: powered by the battery
8 9		**Green/** **Yellow** (built into the connector)	**Ethernet** <u>Green Indicator</u> - Indicator OFF: ethernet link is not activated - Indicator blinking green: ethernet link is activated <u>Yellow Indicator</u> - Indicator OFF: the stack has not been initialized - Indicator blinking yellow: the stack has been initialized correctly - Indicator rapid blinking yellow: acquisition of the new IP address is complete - Indicator blinks yellow twice and stops: the IP address assigned for the DHCP server is not valid - Indicator lit yellow: ethernet link is transmitting

Table 8

2.10 SD-CARD

NOTE: The PEL 112 and PEL 113 are shipped with a formatted and installed SD-card ready for use.

Data recording sessions are stored on the SD-card.

The PEL 112 and PEL 113 accept SD, SDHC and SDXC cards, FAT32 formatted, up to a capacity of 32 GB.

If a replacement SD-card is unformatted, you will need to format it before use. It is best to format the SD-card using the PEL Control Panel, otherwise format using a PC.

- Open the elastomer cap marked .
- Press on the SD-card in the device, then withdraw it from the slot.

NOTE: Do not withdraw the SD-card if there is a recording session in progress.

- Check that the new SD-card is not locked.

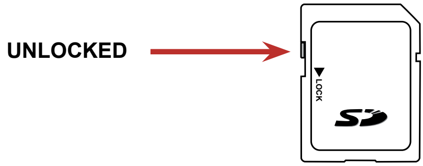


Figure 9

- Insert the new SD-card and push it in gently until seated.
- Place the protective elastomer cap back into place to ensure a waterproof seal.
- If the SD-card is unformatted, you will need to format it before use. It is best to format the SD-card using the PEL Control Panel It can also be formatted using a PC.

2.10.1 Memory Capacity

The PEL accepts SD-cards with a maximum capacity of 32 GB. This much data can require a lot of demand on a PC and a long download time (depending on the performance of the PC and connection type being used).

Furthermore, some PCs may have problems handling such a large amount of data and spreadsheets can only accept a limited amount of data.

The recording rates per day for 1 s Harmonics, 1 s Trends and Aggregated data are:

- **1 s Harmonics** = 83 MB/day
  (Do not exceed 7 days - risk of saturating the buffer)
- **1 s Trends** = 20 MB/day
  (Do not exceed 1 month - risk of saturating the buffer)
- **200 ms Trends** = ~70 MB/day
  (Do not exceed 10 days - risk of saturating the buffer)
- **Aggregated data** = 1.4 MB/day for 1 min

  For longer periods, this rate is divided by the period in minutes. For example, for an aggregation period of 10 min, the rate will be 0.14 MB/day.

We recommend managing the data on the SD-card and only recording that which is needed.

For reference purposes, a five day recording, with a 15 minute demand interval and recording 1-second data and harmonics on a 3-phase 4-wire network would consume approximately 515.5 MB of storage space. If harmonics are not needed and the recording of them is disabled, the space requirement is reduced to about ~ 100.5 MB (see § 2.9.1 for recording times).

Also, we recommend to avoid exceeding 32 recorded sessions on the SD-card.

NOTE: For recordings with harmonics or with a duration longer than one week, please use class 4 or higher SDHC cards.

Downloading over USB and Ethernet may be acceptable depending on the session size and network speed. We recommend putting the SD-card into your PC directly or with the external card reader for fastest download time.

3. CONFIGURATION

The PEL must be configured before any recording. The various steps for configuration are:

- Set up the USB link, the Ethernet link or the Wi-Fi link.
- Choose the connection according to the type of distribution network.
- Connect the current sensors.
- Define the nominal primary and secondary voltages if necessary.
- Define the nominal primary current and the nominal primary current of the neutral if necessary.
- Choose the aggregation period.

Configuration is done in the Configuration mode or by using the PEL Control Panel. For the PEL 113, this can also be done on the LCD. To prevent accidental modifications, the PEL cannot be configured while recording or if a recording session has been programmed.

IMPORTANT: The following **operation instructions** assume that the PEL has been configured by the user prior to use. The PEL can only be fully configured through the PEL Control Panel which is distributed with the DataView® software. Although on the PEL 113 some parameters (such as hookup type) can also be set through the LCD on the device itself. Please refer to § 5.2 for setup instructions using DataView, and § 4.3.6 for setup through the PEL 113 LCD.

- Following configuration, the PEL is then connected to a power supply and will turn on automatically (see § 3.3.1).
- Recording is started by pressing the **Control** button (see § 4.2).
- The PEL can be turned OFF when disconnected from the power supply and when the recording session is completed (see § 3.3.1).

3.1 TURNING THE INSTRUMENT ON/OFF

3.1.1 Turning ON

To turn the PEL ON:

- Connect the PEL to a power outlet with the AC power cord and the PEL will turn ON automatically. If it does not, press the **Power** button for > 2 sec.
- The GREEN LED under the **Power** button turns ON when the PEL is connected to a live power source.

NOTE: The batteries automatically begin charging when the PEL is connected to a live power outlet. Battery life is limited to approximately 1/2 h when the battery is fully charged, enough to cover brief power outages.

3.1.2 Turning OFF

The PEL will **NOT** turn **OFF** if it is connected to a power source, or if a recording is in progress (or pending). This is a precaution to ensure that the PEL is not accidently turned OFF when recording and to ensure that the PEL turns on when the power supply is turned back on after an outage.

To turn the PEL OFF:

- Unplug the cord from the AC power supply outlet.
- Press and hold down the **Power** button for > 2 sec until all LEDs light up, then release.
- All LEDs and the display will turn off as the PEL powers down.

3.1.3 Standby Mode

After three minutes of no user activity, the instrument automatically goes into Standby Mode. In Standby Mode the display backlight turns OFF, but the measurements continue to be displayed. The backlight will turn back ON once any Navigation button is pressed. Standby Mode cannot be disabled.

NOTE: The LCD brightness and contrast is programmed through the PEL Control Panel.

3.2 POWERING THE INSTRUMENT

3.2.1 Power Supply

The PEL is powered by standard AC power through an external C7 cord (figure-eight type, non-polarized power plug). This power cord is available in many computer or electrical supply stores. It is also referred to as a Laptop or Netbook C7 power cable. For replacement, be sure to buy the non-polarized cord. Replacement power cords are also available from the factory.

The PEL can be supplied from nominal (110 to 250) V (accepts ±10 %) 50/60 Hz to accommodate available supply voltages globally.

NOTE: Never use power cords with inadequate ratings.

- When the instrument is powered by AC power, the instrument is always ON.
- Applying AC power to the PEL turns the instrument ON if it was OFF and starts recharging the batteries automatically.
- When AC power is not present (power supply OFF or disconnected from a power supply), the instrument will run on battery power for approximately 30 minutes or less when Auto Power Off is enabled.
- The PEL has a built in Auto Power OFF, which can be set to (3 to 15) minutes or disabled through the PEL Control Panel.
- When the battery level is too low and a **Low Bat** condition occurs (the RED LED blinks twice per second), the instrument will eventually turn OFF. The PEL will start up again once it has been reconnected to a power supply.

- When the instrument is not powered by AC power, it can be turned ON with the **Power** (⏻) button).
- When the instrument is not powered by AC power and no recording is pending or in progress, it can be turned OFF with the **Power** button (see § 3.1.2).

3.3 CHARGING BATTERY

Before the first use, start by fully charging the battery at temperatures between (32 and 104) ºF (0 and 40) ºC.

NOTE: When the power is ON, the battery is charging until it is full.

- Connect the supplied power cord to the instrument and AC power.
- The device will automatically turn ON.
- The (battery) LED lights; will go out only when the battery is fully charged.
- Charging a discharged battery takes approximately 5 h.

Status Indicators (See Table 8)

- **LED OFF:** Battery full (with or without power supply).
- **Yellow LED ON/No blinks:** Battery is charging.
- **Yellow LED blinks twice per second:** Battery is recovering after a full discharge.
- **Red LED blinks twice per second:** Low battery (and no power supply)

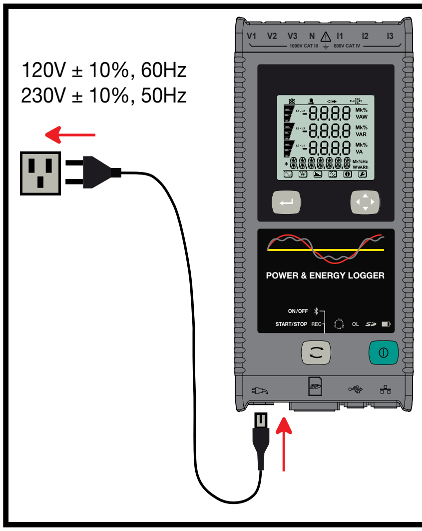


Figure 10

NOTE: After prolonged storage, the battery may be completely discharged. If so, the (battery) LED blinks twice per second. In this case, at least five charge/discharge cycles will be necessary for your battery to recover 95 % of its capacity.

3.4 CONNECTION VIA USB OR LAN VIA ETHERNET LINK

The USB and Ethernet links can be used to configure the instrument using the PEL Control Panel, to display the measurements, and to download records to the PC.

- Locate the USB or Ethernet connector on the instrument and pull open the attached protective cap (see § 2.5 Connections).
- Connect the USB cable provided or an Ethernet cable (not provided) between the instrument and the PC.

NOTE: Before connecting the USB cable, install the drivers supplied wswith the PEL Control Panel.
Connecting the USB or Ethernet cable **does not** power up the instrument or charge the battery.

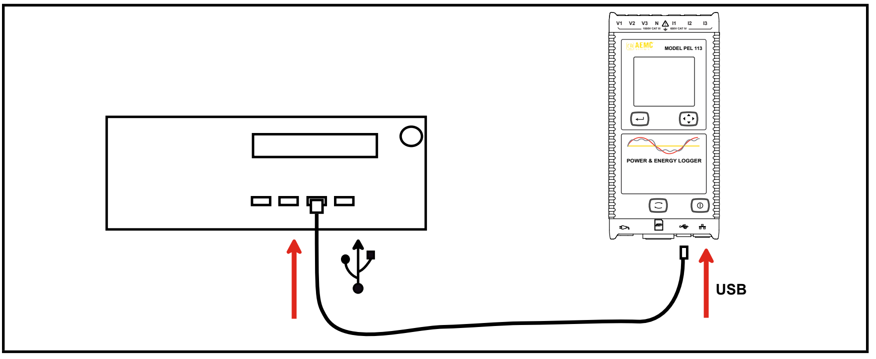


Figure 11

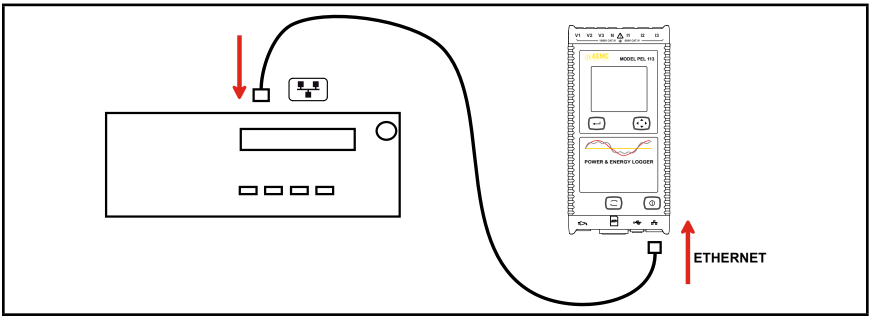


Figure 12

Then through whichever link was chosen, open the PEL Control Panel to connect to the instrument to the PC.

3.4.1 LAN Ethernet Connection to the PEL

NOTE: For the LAN Ethernet connection, the PEL has an IP address.

A LAN connection can be used to view real-time data, instrument status, configure the PEL, setup and start a recording session and download recorded sessions.

When configuring the PEL with the PEL Control Panel, if the checkbox next to **Enable DHCP** is checked in the Communication tab of the Configure Instrument dialog box, the instrument sends a request to the network DHCP server to automatically obtain an IP address.

If for any reason the DHCP server is not available, after 60 seconds the PEL Control Panel will enter auto-IP mode, using the default IP address **169.254.0.100** (the same IP address used when **Enable DHCP** is not selected). This auto-IP mode is compatible with APIPA (Automatic Private IP Addressing). A cross-over cable may be needed in auto-IP mode.

The Internet Protocol used is UDP. Port **3041** is used by default, but it can be modified in the PEL Control Panel to allow multiple PC connections to multiple PEL instruments behind a router.

NOTE: To modify network parameters it is best to use a USB connection. You can modify the network parameters while connected via a LAN Ethernet link, but once the network parameters have been modified, you will lose connection.

3.5 CONNECTION VIA WI-FI LINK

This link can be used to configure the instrument using the PEL Control Panel to view the measurements, and to download the recordings to a PC or a Windows tablet.

- Press the **Control** button and hold it down. The **REC** and •))) indicators light in turn for 3 sec each.
- Release the **Control** button while the desired function is lit.
  - If you release it while the **REC** indicator is lit, recording starts or stops.
  - If you release it while the •))) indicator is lit, Wi-Fi is enabled or disabled.

NOTE: When you press the **Control** button, if the **REC** indicator is blinking, the **Control** button is locked. The PEL Control Panel must be used to unlock the **Control** button.

The data transmitted by the device can:

- go directly to a PC connected by Wi-Fi,
- pass via DataViewSync™ hosted by AEMC® Instruments. To receive data transmission on your PC, you must enable DataViewSync™ in the PEL Control Panel and specify whether the link is via Ethernet or Wi-Fi.

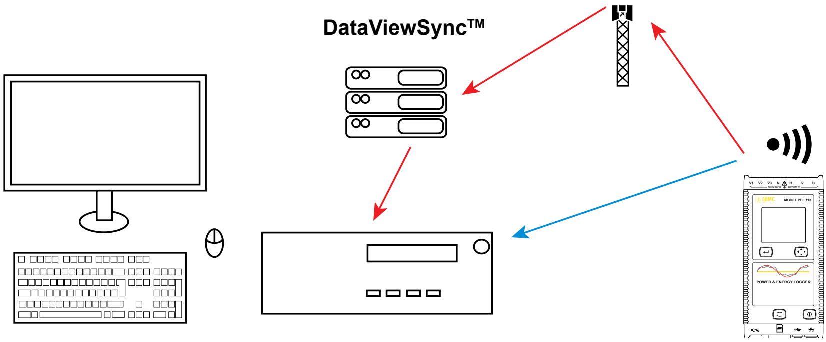


Figure 13

3.6 CONFIGURING THE INSTRUMENT

It is possible to configure some main functions directly on the instrument. For a complete configuration, use the PEL Contol Panel (see § 5).

To enter the Configuration via the instrument mode, press the ◄ or ► button until the symbol is selected. The following screen is displayed:

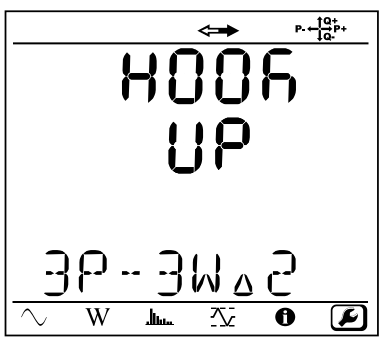


Figure 14

NOTE: If the PEL is already being configured via the PEL Control Panel, it is impossible to enter the Configuration mode in the instrument. In this case, when there is an attempt to configure it, the instrument displays **LOCK**.

After 3 minutes without pressing the **Enter** or **Navigation** button, the display returns to the measurement screen.

3.6.1 Current Sensors

Connect the current sensors to the instrument.

The current sensors are automatically detected by the instrument. It looks at the I1 terminal. If there is nothing, it looks at the I2 terminal, or the I3 terminal.

Once the sensors have been recognized, the instrument displays their transformation ratio.

NOTE: The current sensors must all be the same except for the neutral current sensor, which may be different. Otherwise, only the type of sensor connected to I1 will be used on the instrument.

3.6.2 Type of Distribution System

These are the different types of distribution systems supported by the PEL.

Designation	Distribution System
1P-2W	Single-phase, 2-wire
1P-3W	Single-phase, 3-wire
3P-3WΔ2	Three-phase, 3-wire Δ (2 current sensors)
3P-3WΔ3	Three-phase, 3-wire Δ (3 current sensors)
3P-3WΔb	Three-phase, 3-wire Δ, balanced
3P-4WY	Three-phase, 4-wire, wye
3P-4WYb	Three-phase, 4-wire, wye, balanced (voltage measurement, fixed)
3P-4WY2	Three-phase, 4-wire, wye 2½
3P-4WΔ	Three-phase, 4-wire Δ
3P-3WY2	Three-phase, 3-wire, wye (2 current sensors)
3P-3WY3	Three-phase, 3-wire, wye (3 current sensors)
3P-3WO2	Three-phase, 3-wire open Δ (2 current sensors)
3P-3WO3	Three-phase, 3-wire open Δ (3 current sensors)
3P-4WO	Three-phase, 4-wire, open Δ
dC-2W	DC 2-wire
dC-3W	DC 3-wire
dC-4W	DC 4-wire

Table 9

3.7 ALARM CONDITIONS

Alarm conditions can only be configured from the PEL Control Panel. The Alarm Conditions tab of the Configure Instrument dialog box sets parameters for alarm monitoring during recording sessions on the instrument. This tab allows you to configure up to 32 alarms. You can use the **Prev Page** and **Next Page** buttons to view alarms if you define more than 16 alarms.

NOTE: Not all fields apply to each type of alarm.

For each alarm, you can set the following:

- **Quantity** is a drop-down list of all the measured parameters for which an alarm can be set.
- **Group** identifies the group in which this quantity belongs. For example, energy quantities such as active energy load (Ep +) and source (Ep -) can be placed in either the Partial or Total group. This field does not appear for all quantity types.
- **Aggregation period** defines the time interval that measurements are aggregated over. Options are 1 s or 1 min. For some quantities, this is pre-set and cannot be changed.
- **< or >** defines the alarm trigger. Up to four types of triggers can be defined: < (less than), < = (less than or equal to), > (greater than), and > = (greater than or equal to). For example, when < is selected, an alarm triggers when the quantity falls below the defined threshold (see below).
- **%** determines whether or not the threshold is defined as a percentage of a nominal value. When you check this box, the **Nominal Value** fields appear. The first field displays the nominal (normal) value for this quantity, as defined in the Nominal Value tab. The second field defines the percentage by which the quantity must exceed or fall below this value (depending on the trigger type) to start an alarm.
- **Threshold** is the measurement that defines the alarm condition. For instance, if the trigger is < and the threshold is 60 Hz, the alarm will begin when the measurement falls below 60 Hz. The threshold can be defined as either a percentage of the nominal value (see above) or as a user-entered setting. If you check the % field, the threshold is calculated and displayed . If the % field is unchecked, you must enter the threshold. For some units of measure, a field appears allowing you to select a metric prefix (k, M, G, and so on).
- **Duration** is the number of seconds the condition must exist before it is recorded as an alarm. The duration can be set between (0 and 60) seconds.
- **Hysteresis** selects the hysteresis percentage for the quantity. Options are 1 %, 2 %, 5 % and 10 %. For example, if the trigger is < (less than), the threshold is 60 Hz, and the hysteresis is 5 %, the alarm will end when the frequency reaches 63 Hz.
- **E-mail** indicates, when the field is checked, that when the alarm starts and when the alarm ends, a report will be emailed to the defined recipients.

3.8 E-MAIL REPORT

When recording data on the PEL 112 or PEL 113, you can configure the instrument to send periodic email reports up to five users. You can also configure the instrument to send email reports when alarms occur during a recording.

Reports are only generated when the instrument is actively recording. If the recording ends before the specified report time period is reached, a partial report is sent when the recording ends.

E-Mail recipients for all reports lists the email addresses that will receive all generated reports. Up to five addresses can be entered. To enter a new name click **Add** and type the name into the address field. To remove a name, highlight it and click **Remove**. To test the validity of the addresses, press **OK** to write the addresses to the instrument. Then, re-open the Configure dialog box, open the Report tab, and click the **Test** button. A test email will be sent to each listed address.

Configure Report defines the report type and its contents. Reports can be generated when a defined alarm condition occurs, or periodically (day, week, month, or year) when a timed report is selected.

All reports include the following fields:

- Enable report enables the selected report when checked.
- Report text is a description that will be included in the selected report.
- Language selects the language in which the report is generated.
  Options are:
  - English
  - French
  - German
  - Italian
  - Spanish
- Time defines the time format in which times are displayed.
  Options are: AM/PM and 24-hours.
- Date selects the format for displaying dates.
  Options are:
  - MM/DD/YYYY
  - MM-DD-YYYY
  - DD/MM/YYYY
  - DD-MM-YYYY
  - YYYY-MM-DD

To confgure a report, select the report's tab in the Configure report field. The remaining fields depend on which type of report is selected.

Alarms displays the following fields when this tab is selected.

- **Minimum time between alarm reports** can set a minimum time between alarm emails to avoid flooding recipients' mailboxes when alarms occur repeatedly. If during this interval any additional alarm events occur, an email is sent at the end of the selected interval. Options are 10 min, 30 min, 1 hour, 6 hours, 12 hours, and 1 day.
- **Loss of power supply** generates a report when the instrument loses power.
- **Disconnection of probe** generates a report when one or more of the instrument's probes are disconnected during a recording.
- **SD-card full** generates a report when the instrument's SD-card memory becomes full before the end of the recording.
- **End of recording** generates a report when the recording comes to an end for any reason (manually stopped, reaches end time, and so on).

Timed reports options are **1 day**, **1 week**, **1 month** and **1 year**. Each timed report includes a list of check boxes for selecting/deselecting **1s**, **Aggregated**, **Partial Energy**, **Total Energy**, **Line (1,2,3)**, **Neutral** and **Total** measurements. To the right of this list are fields and buttons for selecting which parameters to include in the report.

- **Available** lists the variables that are available but not selected for the report.
- **Selected to include in the report** lists selected variables.

Between these fields are four buttons:

- **Add all** selects all available variables.
- **Add** allows you to add specific variables. Highlight them in the Available list and click **Add**. Note that you can add more than one variable at a time.
- **Remove all** deselects all variables listed in the **Selected to include in the report** field.
- **Remove** enables you to remove one or more highlighted variables from the **Selected to include in the report** field and place them in the Available field.

In addition, the 1-week report includes a field for defining the day of the week that the report will be sent. The report will be generated and mailed at midnight on the start of the selected day.

4. OPERATION

4.1 HOOKING UP TO THE DISTRIBUTION SYSTEM

This section describes how the current sensors and voltage test leads have to be connected to your installation according to its distribution system. The PEL shall also be configured for the selected distribution system.

Connect the current sensors to the instrument. The current sensors are automatically detected by the instrument. It looks at the **I1** terminal. If there is nothing, it looks at the **I2** terminal, or the **I3** terminal.

Once the sensors have been recognized, the instrument displays their transformation ratio.

NOTE: The current sensors must all be the same. Otherwise, only the type of sensor connected to I1 will be used on the instrument.

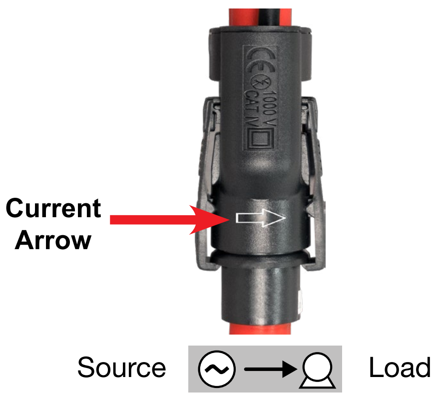


Figure 14

WARNING: ALWAYS ensure the current arrow on the current sensor points toward the load. **This ensures that the phase angle will be correct for power measurements and other measurements that depend on the phase.**

4.1.1 Single Phase 2-Wire: 1P-2W

For Single Phase 2-Wire measurements:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the current probe to the L1 phase conductor

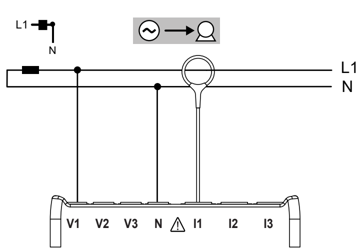
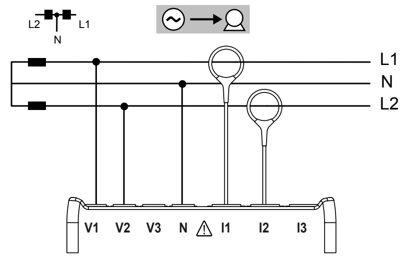


Figure 15

4.1.2 Single Phase 3-Wire (Split Phase from a Center Tap Transformer): 1P-3W



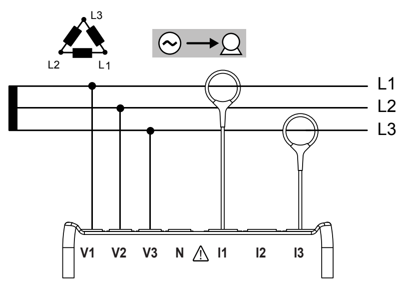
For Single Phase 3-Wire (Split Phase) measurements:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor

Figure 16

4.1.3 3-Phase 3-Wire Power Networks

4.1.3.1 3-Phase 3-Wire Δ (with 2 current sensors): 3P-3WΔ2



For 3-Phase 3-Wire Δ measurements using two current sensors:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

Figure 17

4.1.3.2 3-Phase 3-Wire ∆ (with 3 current sensors): 3P-3W∆3

For For 3-Phase 3-Wire ∆ measurements using three current sensors:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor.
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

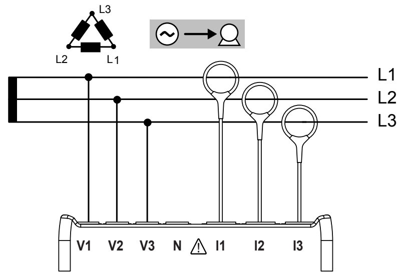


Figure 18

4.1.3.3 3-Phase 3-Wire Open ∆ (with 2 current sensors): 3P-3WO2

For 3-Phase 3-Wire Open ∆ measurements using two current sensors:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

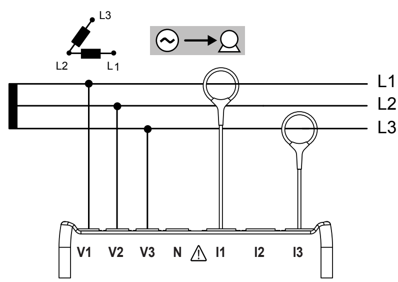


Figure 19

4.1.3.4 3-Phase 3-Wire Open ∆ (with 3 current sensors): 3P-3WO3

For 3-Phase 3-Wire Open ∆ measurements using three current sensors:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

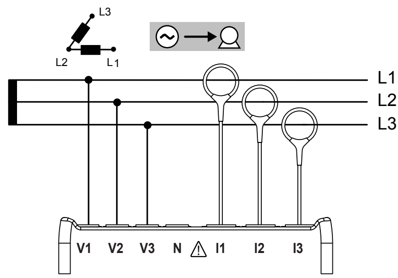


Figure 20

4.1.3.5 3-Phase 3-Wire Y (with 2 current sensors): 3P-3WY2

For 3-Phase 3-Wire Y measurements using two current sensors:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

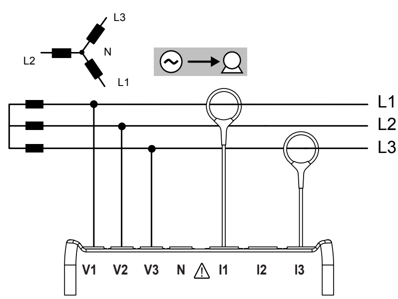


Figure 21

4.1.3.6 3-Phase 3-Wire Y (with 3 current sensors): 3P-3WY3

For 3-Phase 3-Wire Y measurements using three current sensors:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

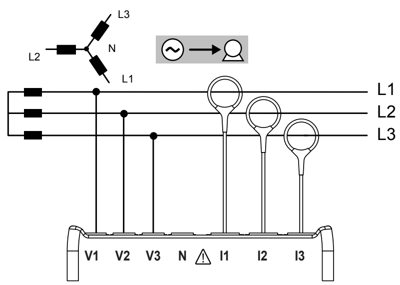


Figure 22

4.1.3.7 3-Phase 3-Wire ∆ Balanced (with 1 current sensor): 3P-3W∆B

For 3-Phase 3-Wire ∆ Balanced measurements using one current sensor:

- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

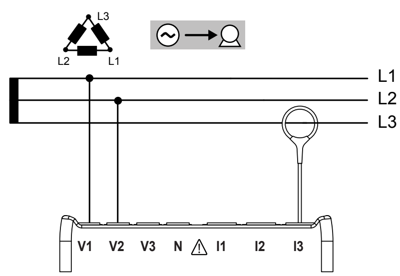


Figure 23

4.1.4 3-Phase 4-Wire Y Power Networks

4.1.4.1 3-Phase 4-Wire Y (with 3 current sensors): 3P-4WY

For 3-Phase 4-Wire Y measurements using three current sensors:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

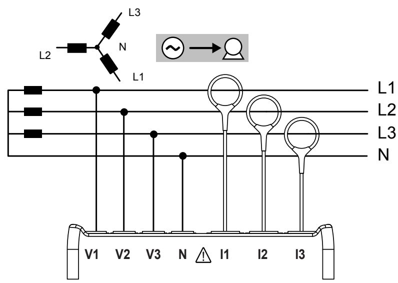


Figure 24

4.1.4.2 3-Phase 4-Wire Y Balanced: 3P-4WYB

For 3-Phase 4-Wire Balanced Y measurements using one current sensor:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal I1 current probe to the L1 phase conductor

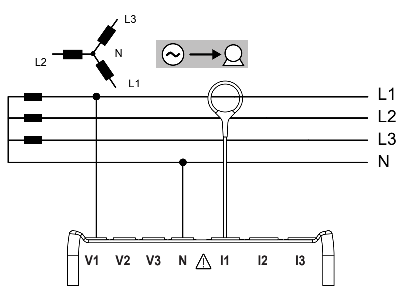


Figure 25

4.1.4.3 3-Phase 4-Wire Y 2½ Element: 3P-4WY2

For 3-Phase 4-Wire Y 2½ Element measurements and using three current sensors:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

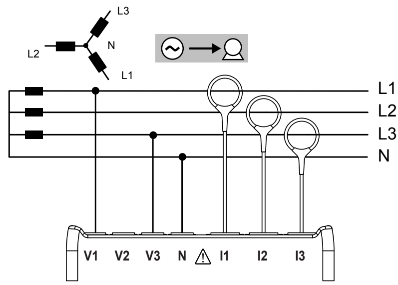


Figure 26

4.1.5 3-Phase 4-Wire Δ

High Leg configuration. No Potential Transformer (Voltage Transformer) is connected; the installation under test is supposed to be a low voltage distribution system.

4.1.5.1 3-Phase 4-Wire Δ: 3P-4WΔ

For 3-Phase 4-Wire Δ measurements and using three current sensors:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

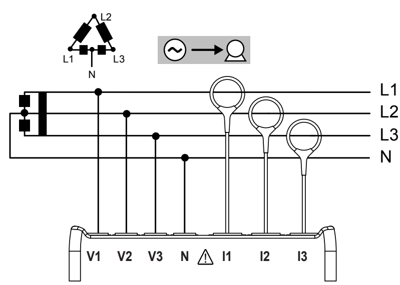


Figure 27

4.1.5.2 3-Phase 4-Wire Open ∆: 3P-4WO∆

For 3-Phase 4-Wire Open ∆ measurements and using three current sensors:

- Connect the terminal N test lead to the neutral conductor
- Connect the terminal V1 test lead to the L1 phase conductor
- Connect the terminal V2 test lead to the L2 phase conductor
- Connect the terminal V3 test lead to the L3 phase conductor
- Connect the terminal I1 current probe to the LI phase conductor
- Connect the terminal I2 current probe to the L2 phase conductor
- Connect the terminal I3 current probe to the L3 phase conductor

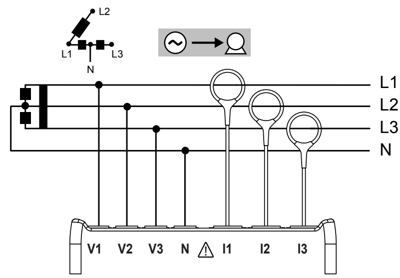


Figure 28

WARNING: ALWAYS ensure the current arrow on the current sensor points toward the load. **This ensures proper measurements for power and other sign sensitive quantities.**

4.1.6 DC Power Networks

4.1.6.1 DC 2-Wire: DC-2W

For DC 2- Wire measurements:

- Connect the terminal N test lead to the common conductor
- Connect the terminal V1 test lead to conductor +1
- Connect the terminal I1 current probe to conductor +1

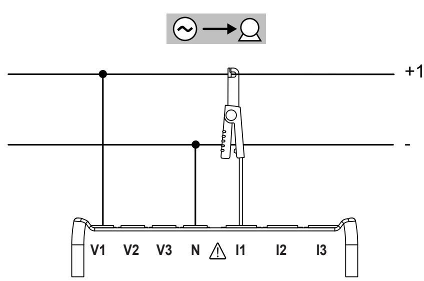


Figure 29

4.1.6.2 DC 3-Wire: DC-3W

For DC 3- Wire measurements:

- Connect the terminal N test lead to the common conductor
- Connect the terminal V1 test lead to conductor +1
- Connect the terminal V2 test lead to conductor +2
- Connect the terminal I1 current probe to conductor +1
- Connect the terminal I2 current probe to conductor +2

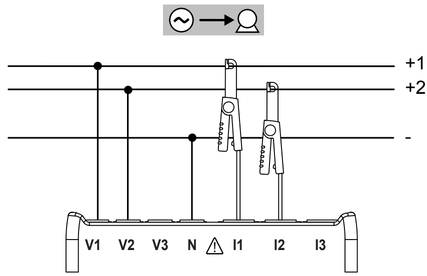


Figure 30

4.1.6.3 DC 4-Wire: DC-4W

For DC 4-Wire measurements and using three current sensors:

- Connect the terminal N test lead to the common conductor
- Connect the terminal V1 test lead to conductor +1
- Connect the terminal V2 test lead to conductor +2
- Connect the terminal V3 test lead to conductor +3
- Connect the terminal I1 current probe to conductor +1
- Connect the terminal I2 current probe to conductor +2
- Connect the terminal I3 current probe to conductor +3

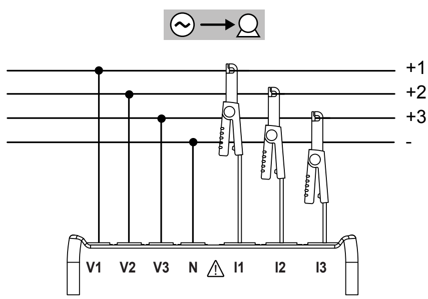


Figure 31

4.2 RECORDING DATA

Recordings are stored only on the SD-card.

To Start a Recording:

- Confirm that there is an SD-card (not locked and not full) in the PEL's SD-card slot.
- Press and hold down the **Control** button for > 2 sec. The RED **REC** indicator and indicator will light in turn for 3 sec each.
- Release the **Control** button while the RED **REC** indicator is lit. Recording starts and the RED **REC** indicator remains lit.

  Releasing the Control button during (and only during) the 3 second lighting of a particular LED, performs the associated function.

To Stop a Recording:

- Proceed in exactly the same way as starting a recording. In other words:
  - **If recording is ON:** A release while LED is lit during the 3 sec **stops** a recording.
  - **If recording is OFF:** A release while LED is lit during the 3 sec **starts** a recording.

NOTE: If the Control button **is locked** (disabled) by the PEL Control Panel, you cannot use it to start or stop a recording. Upon pressing the **Control** button while it is locked you will see the **REC** indicators blink twice, with no changes taking effect on the instrument.

T**o unlock (enable) the Control** button, you must open the PEL Control Panel on your PC and de-select the **Lock out the Control** button option in the Configure Instrument dialog box, as explained in the PEL Control Panel online Help.

4.3 MEASURED-VALUE DISPLAY MODES (PEL 113 ONLY)

The PEL 113 includes an LCD that allows you to view a variety of measurement values and set-up parameters. The display also lets you change several configuration settings.

The ◄ and ► Navigation buttons are used to scroll through the available LCD modes.

The displays are accessible as soon as the PEL is ON, but the values are zero. As soon as there is a voltage or current on the inputs, the values are updated.

Five of these modes allow you to view several types of data:

Icon	Description
	Base Measurements: Displays the measurement values V, A, Power, Frequency, Power Factor, and Tangent Angle.
W	**Energy:** Displays the energy values kWh, VAh, and varh.
	Harmonics: Displays harmonics for current and voltage.
	Max: Displays the maximum values for the measurement, energy, and harmonic values.
i	**Information:** Displays hook-up and system information.
In addition:	
	Configuration: Allows you to enter several setup parameters, described later in this section.

Table 10

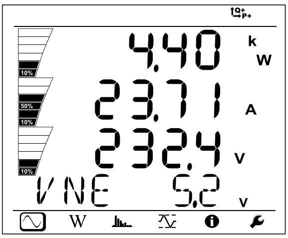
NOTE: Although the PEL 113 LCD allows you to enter a limited number of set-up values, the PEL can only be fully configured through the PEL Control Panel.

The PEL 112 can only be configured with the PEL Control Panel. For detailed instructions on configuring, recording and downloading measurements, refer to § 5.

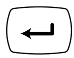
4.3.1 Measurement Mode

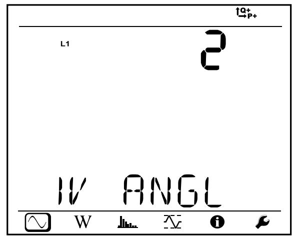
The display depends on the network configured. Press the ▼ button to go from on screen to the next.

4.3.1.1 Single-phase, 2-wire (1P-2W)



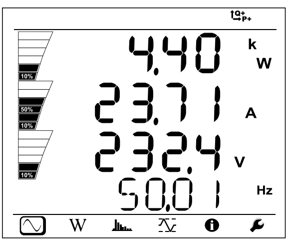
P
I
V





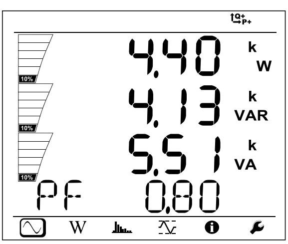
φ (I_1, V_1)

▼



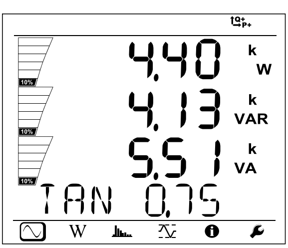
P
I
V
f

▼



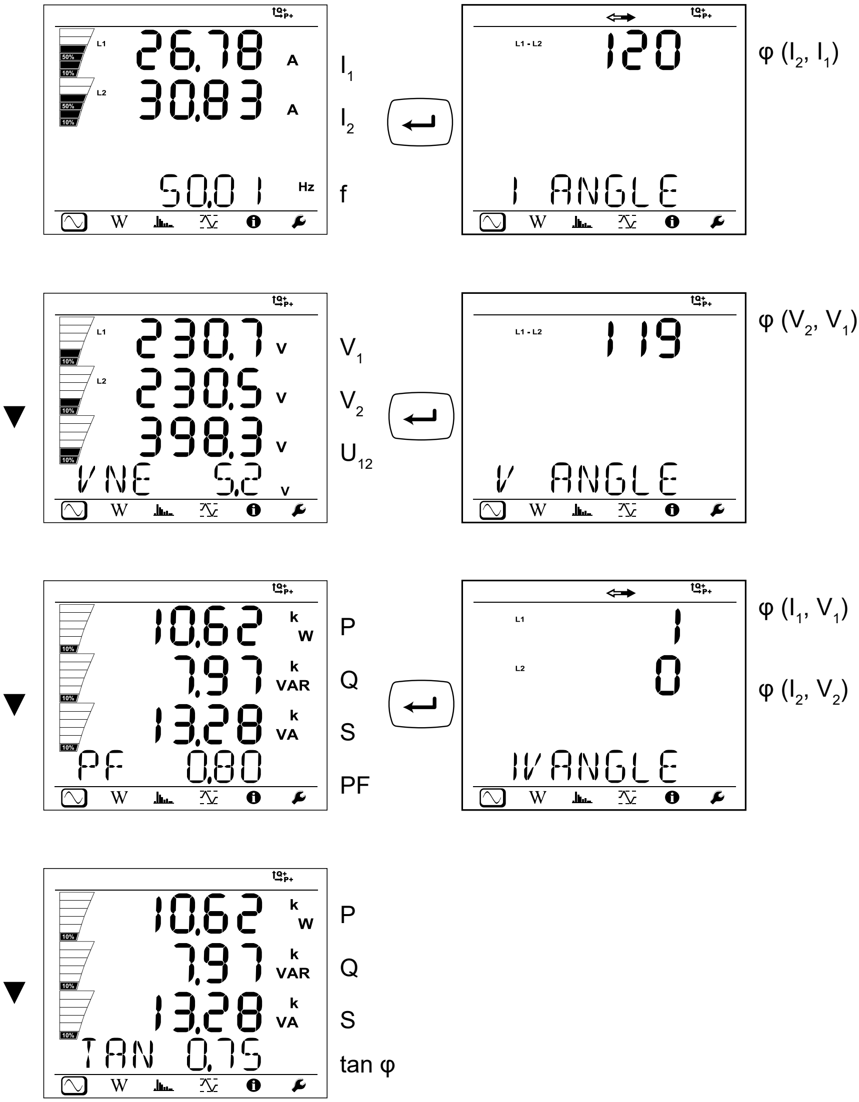
P
Q
S
PF

▼

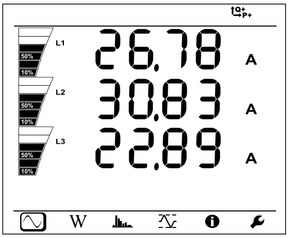


P
Q
S
tan φ

4.4.1.2 Two-phase, 3-wire (1P-3W)



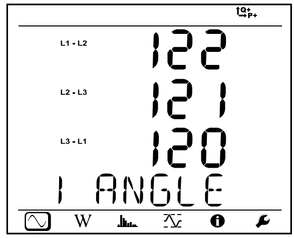
4.4.1.3 Three-phase, 3-wire, unbalanced (3P-3WΔ2, 3P-3WΔ3, 3P-3WO2, 3P-3WO3, 3P-3WY2, 3P-3WY3)



I_1

I_2

I_3

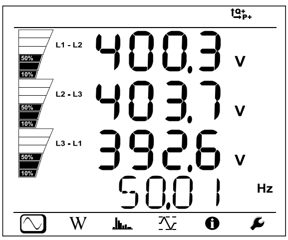


φ (I_2, I_1)

φ (I_3, I_2)

φ (I_1, I_3)

▼

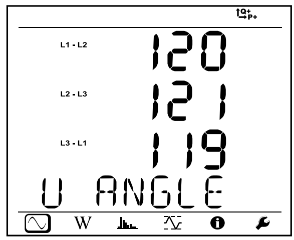


U_{12}

U_{23}

U_{31}

f

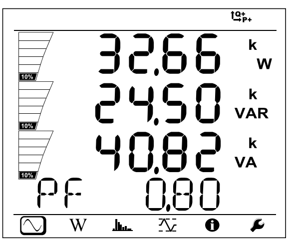


φ (U_{31}, U_{23})

φ (U_{12}, U_{31})

φ (U_{23}, U_{12})

▼

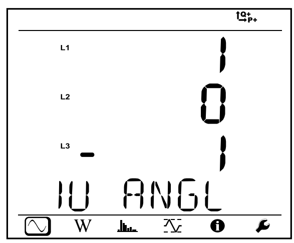


P

Q

S

PF

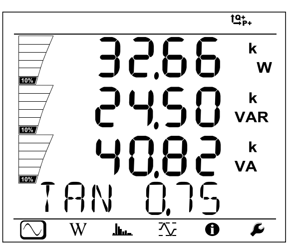


φ (I_1, U_{12})

φ (I_2, U_{23})

φ (I_3, U_{31})

▼



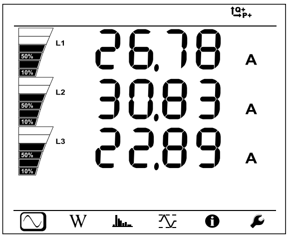
P

Q

S

tan φ

4.4.1.4 Three-phase, 3-wire ∆, balanced (3P-3W∆b)

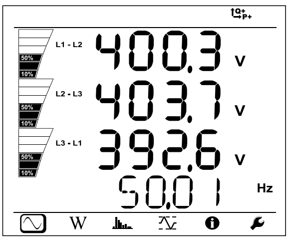


I_1

I_2

I_3

▼



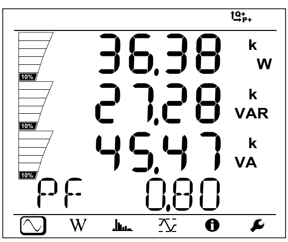
U_{12}

U_{23}

U_{31}

f

▼

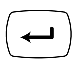


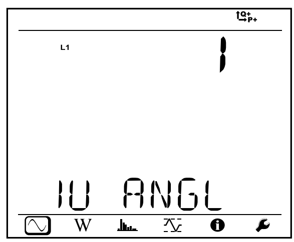
P

Q

S

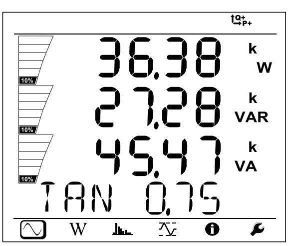
PF





φ (I_1, U_{12})

▼



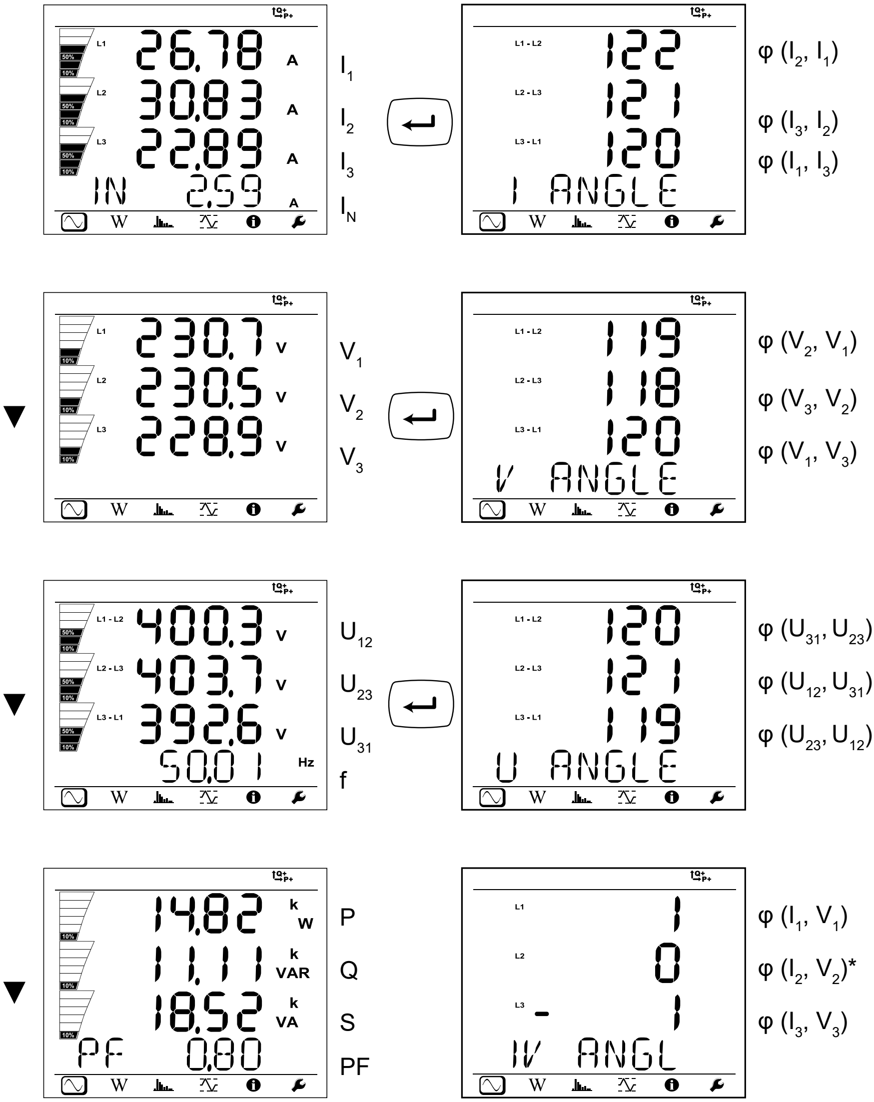
P

Q

S

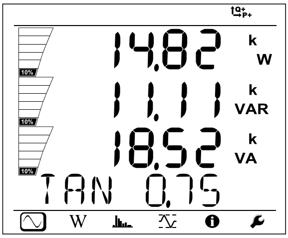
tan φ

4.4.1.5 Three-phase, 4-wire, unbalanced (3P-4WY, 3P-4WY2, 3P-4WΔ, 3P-4WO)



**: Not for 3P-4WΔ and 3P-4WO networks*

▼



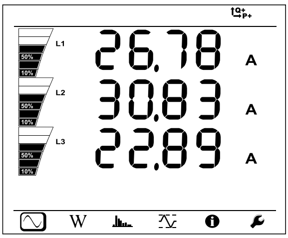
P

Q

S

tan φ

4.3.1.6 Three-phase, 4-wire, wye, balanced (3P-4WYb)

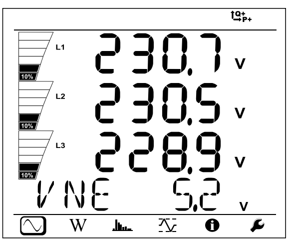


I_1

I_2

I_3

▼

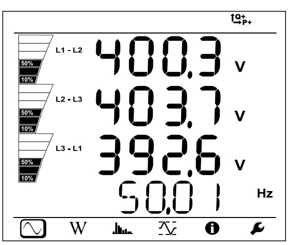


V_1

V_2

V_3

▼



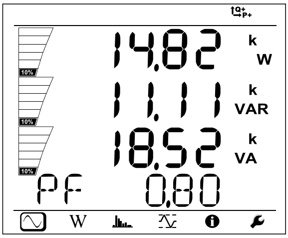
U_{12}

U_{23}

U_{31}

f

▼

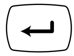


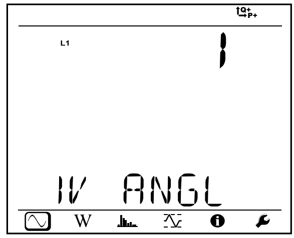
P

Q

S

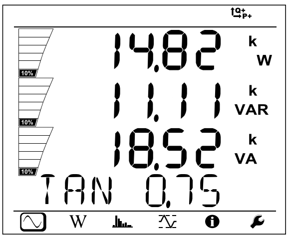
PF





φ (I_1, V_1)

▼



P

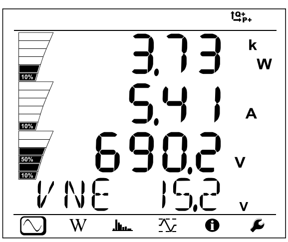
Q

S

tan φ

4.4.1.7 DC 2-wire, (dC-2W)

▼

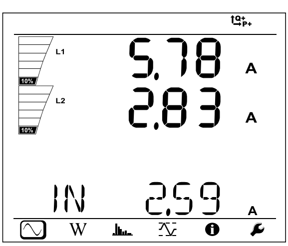


P

I

V

4.4.1.8 DC 3-wire, (dC-3W)

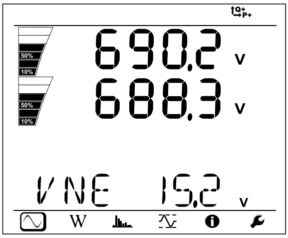


I_1

I_2

I_N

▼

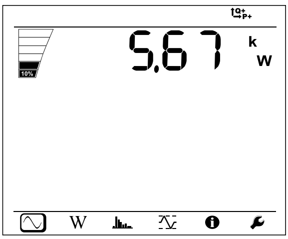


V_1

V_2

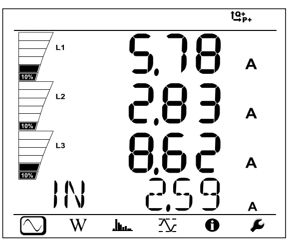
V_N

▼



P

4.3.1.9 DC 4-wire, (dC-4W)



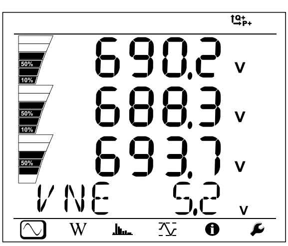
I_1

I_2

I_3

I_N

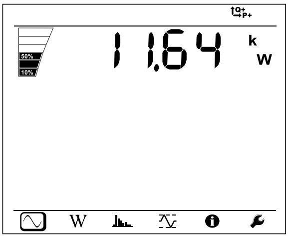
▼



V_1

V_2

V_3

▼ 

P

4.3.2 Energy Mode W

The powers displayed are the total powers. The energy depends on the duration; typically it is available at the end of (10 or 15) minutes or at the end of the aggregation period.

Press the **Enter** button for > 2 sec to obtain the powers by quadrant. The display unit indicates **PArt** to specify that the values are partial.

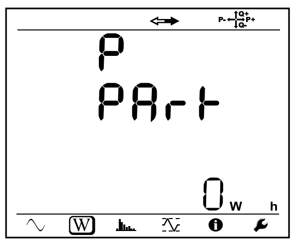


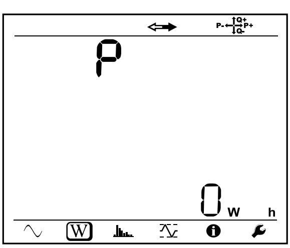
Figure 32

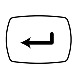
Press the ▼ button to return to display of the total powers.

The display screens for AC and DC networks are different.

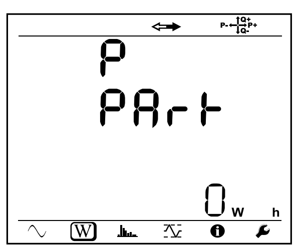
4.3.2.1 AC Networks

Ep+: Total active energy consumed (by the load) in kW·h.





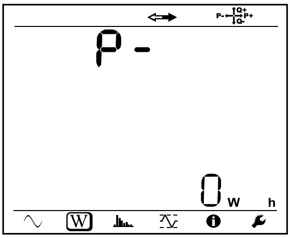
Ep+

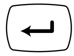


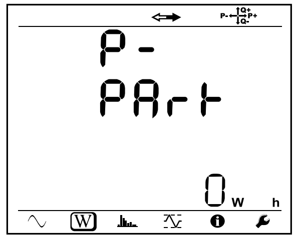
Ep+

Ep-: Total active energy delivered (by the source) in kW·h.

▼



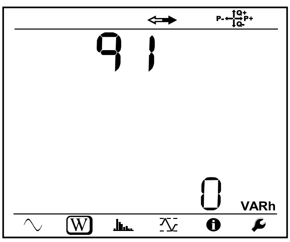


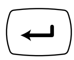


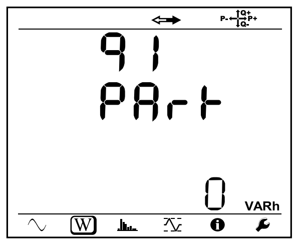
Ep- Ep-

Eq1: Reactive energy consumed (by the load) in the inductive quadrant (quadrant 1) in kvarh.

▼



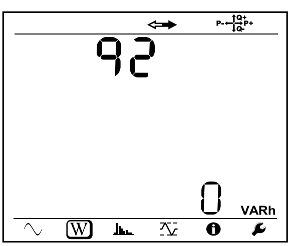


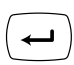


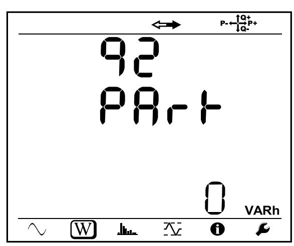
Eq1 Eq1

Eq2: Reactive energy delivered (by the source) in the capacitive quadrant (quadrant 2) in kvarh.

▼

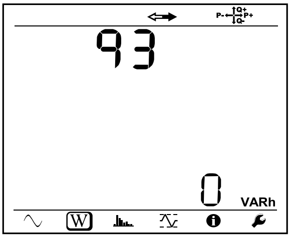




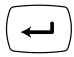


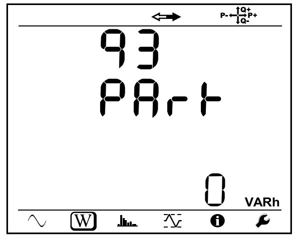
Eq2 Eq2

Eq3: Reactive energy delivered (by the source) in the inductive quadrant (quadrant 3) in kvarh.

▼ 

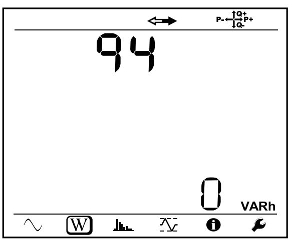
Eq3



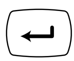


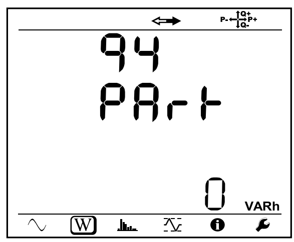
Eq3

Eq4: Reactive energy consumed (by the load) in the capacitive quadrant (quadrant 4) in kvarh.

▼ 

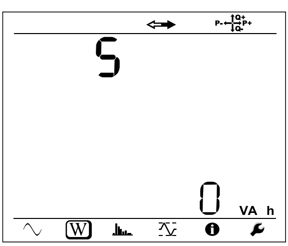
Eq4



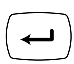


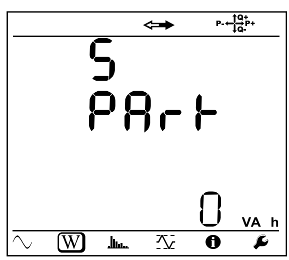
Eq4

Es+: Total apparent energy consumed (by the load) in kVAh.

▼ 

ES+

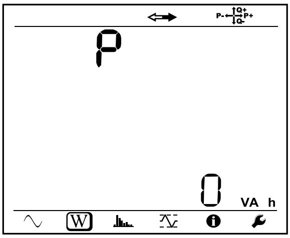




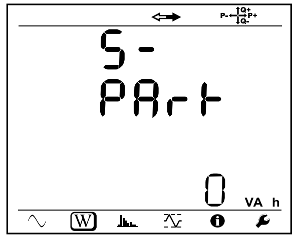
ES+

Es-: Total apparent energy delivered (by the source) in kVAh.

▼



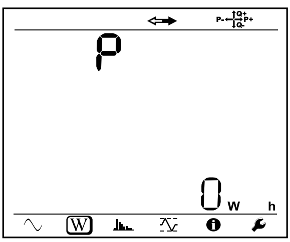
Es-



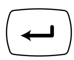
Es-

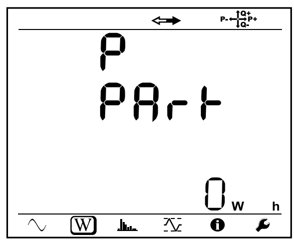
4.3.2.2 DC Networks

Ep+: Total active energy consumed (by the load) in kW·h.



Ep+

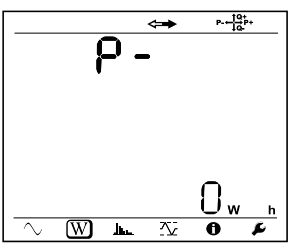




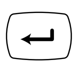
Ep+

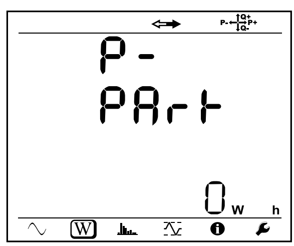
Ep-: Total active energy delivered (by the source) in kW·h.

▼



Ep-





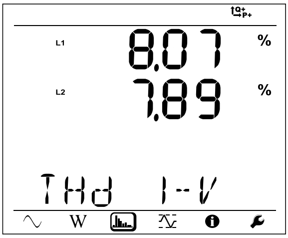
Ep-

4.3.3 Harmonics

The display depends on the network configured.

The harmonics display is not available for DC networks. The display unit indicates **DC mode no THD**.

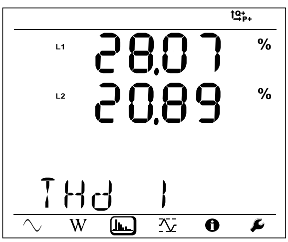
4.3.3.1 Single-phase, 2-wire (1P-2W)



I_THD

V_THD

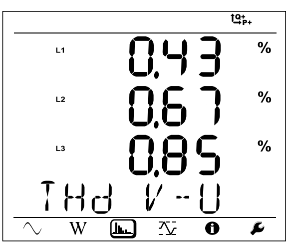
4.3.3.2 Two-phase, 3-wire (1P-3W)



I_1_THD

I_2_THD

▼

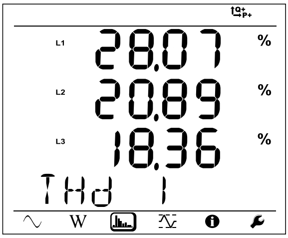


V_1_THD

V_2_THD

U_{12}_THD

4.3.3.3 Three-phase, 3-wire, unbalanced (3P-3WΔ2, 3P-3WΔ3, 3P-3WO2, 3P-3WO3, 3P-3WY2, 3P-3WY3)

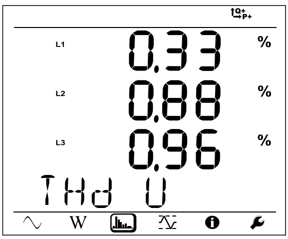


I_1_THD

I_2_THD

I_3_THD

▼

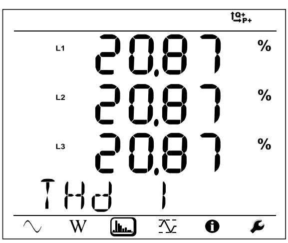


U_{12}_THD

U_{23}_THD

U_{31}_THD

4.3.3.4 Three-phase, 3-wire Δ, balanced (3P-3WΔb)

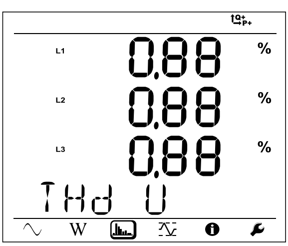


I_1_THD = I_3_THD

I_2_THD = I_3_THD

I_3_THD

▼

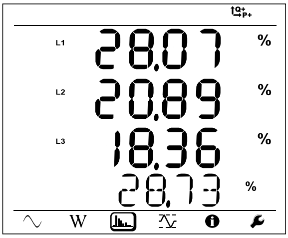


U_{12}_THD

U_{23}_THD = U_{12}_THD

U_{31}_THD = U_{12}_THD

4.3.3.5 Three-phase, 4-wire, unbalanced (3P-4WY, 3P-4WY2, 3P-4WΔ, 3P-4WO)



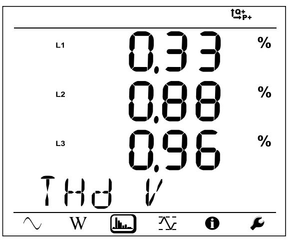
I_1_THD

I_2_THD

I_3_THD

I_N_THD

▼

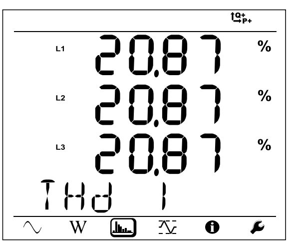


V_1_THD

V_2_THD

V_3_THD

4.3.3.6 Three-phase, 4-wire, wye, balanced (3P-4WYb)

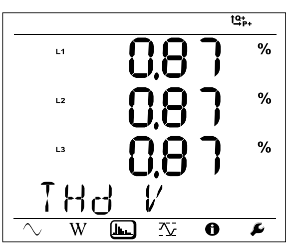


I_1_THD

I_2_THD = I_1_THD

I_3_THD = I_1_THD

▼



V_1_THD

V_2_THD = V_1_THD

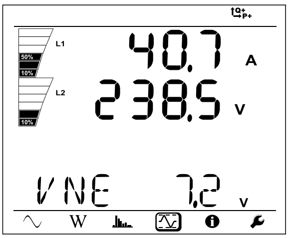
V_3_THD = V_1_THD

4.3.4 Maximum Mode

Depending on the option selected in the PEL Control Panel, these may be the maximum aggregated values of the recording in progress or of the last record, or the maximum aggregated values since the last reset.

The maximum display is not available for DC networks. The display unit indicates **DC Mode no MAX**.

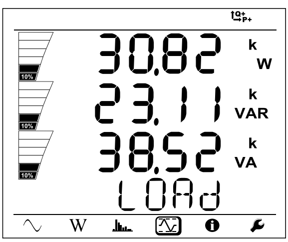
4.3.4.1 Single-phase, 2-wire (1P-2W)



I

V

▼

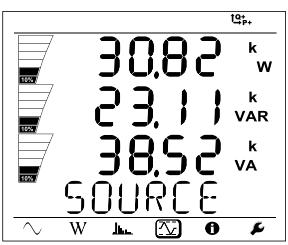


P

Q

S

▼

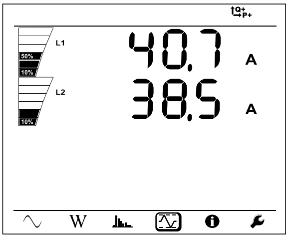


P

Q

S

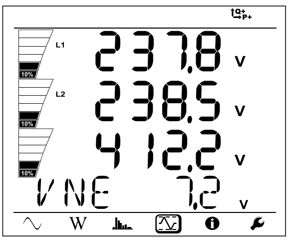
4.3.4.2 Two-phase, 3-wire (1P-3W)



I_1

I_2

▼



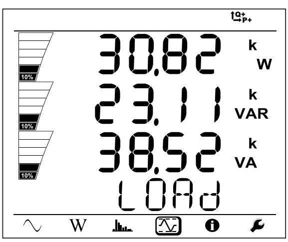
V_1

V_2

U_{12}

f

▼

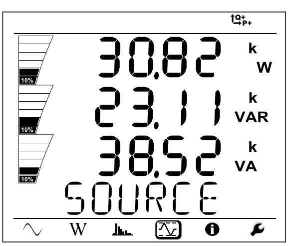


P

Q

S

▼

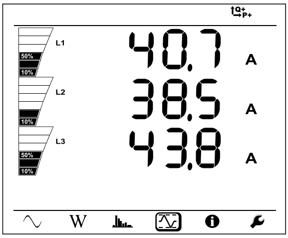


P

Q

S

4.3.4.3 Three-phase, 3-wire (3P-3WΔ2, 3P-3WΔ3, 3P-3WO2, 3P-3WO3, 3P-3WY2, 3P-3WY3, 3P-3W∆b)

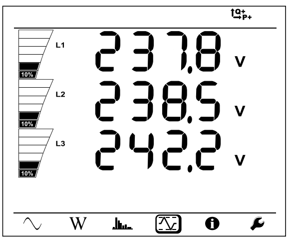


I_1

I_2

I_3

▼

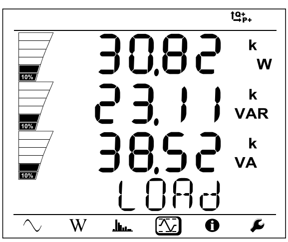


U_{12}

U_{23}

U_{31}

▼

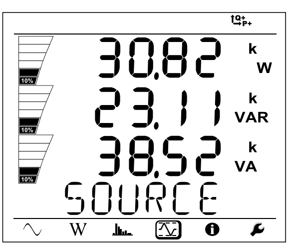


P

Q

S

▼

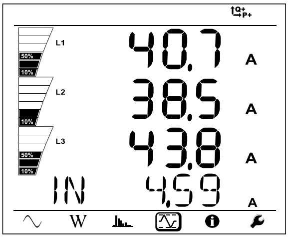


P

Q

S

4.3.4.4 Three-phase, 4-wire (3P-4WY, 3P-4WY2, 3P-4WΔ, 3P-4WO, 3P-4WYb)



I_1

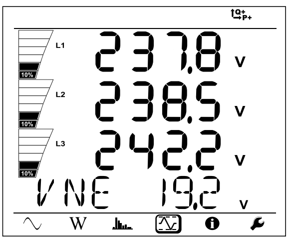
I_2

I_3

I_N

For the balanced network (3P-4WYb), I_N is not displayed.

▼



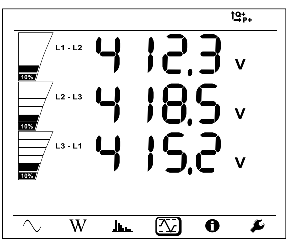
V_1

V_2

V_3

V_N

▼

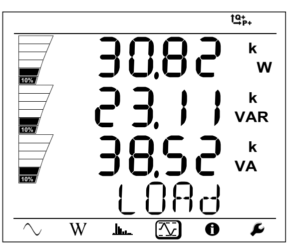


U_{12}

U_{23}

U_{31}

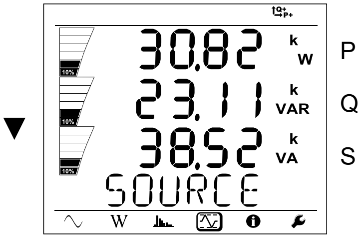
▼



P

Q

S



4.3.5 Information Display Values

This screen is disabled if three minutes elapse with no activity on the Enter or Navigation buttons. The display then returns to the Base Measurements screen.

Step	Value	Units
1	<<HOOK UP>> Distribution System Type	1P-2W = 1-phase 2-wire 1P-3W = 1-phase 3-wire 3P-3WΔ3 = 3-phase 3-wire Δ (3 current sensors) 3P-3WΔ2 = 3-phase 3-wire Δ (2 current sensors) 3P-3W02 = 3-phase 3-wire Open Δ (2 current sensors) 3P-3W03 = 3-phase 3-wire Open Δ (3 current sensors) 3P-3WΔB = 3-phase 3-wire Δ balanced 3P-3WY = 3-phase 3-wire Y (3 current sensors) 3P-3WY2 = 3-phase 3-wire Y (2 current sensors) 3P-4WY = 3-phase 4-wire Y 3P-4WYB = 3-phase 4-wire Y balanced (fixed, voltage measurement) 3P-4WY2 = 3-phase 4-wire Y 2½ 3P-4WΔ = 3-phase 4-wire Δ 3P-4WOΔ = 3-phase 4-wire Open Δ DC-2W = DC 2-wire DC-3W = DC 3-wire DC-4W = DC 4-wire
2	«PT PRIM» Primary VT	V / kV = Primary nominal voltage: 50 V to 650 kV
3	«PT SEC» Secondary VT	V = Secondary nominal voltage: (50 to 1000) V
4	«CT PRIM» Primary CT	A / kA = Primary nominal line current for the connected sensor For AmpFlex®: 100 A, 400 A, 2000 A, 10,000 A ■ For MN93A 5 A range: (5 to 25,000) A
5	«AGG.PERIOd» Aggregation period	Displays the aggregation period in minutes (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60)

Step	Value	Units
6	Year Month Day Time	Displays the date/time
7	<<IP Addr>> IP address	Scrolling IP address
8	<<Soft>> Software Version Serial Number	1st number = DSP firmware version 2nd number = Microprocessor firmware version Scrolling serial number (also on the QR code label glued to the back cover of the PEL)

Table 11

4.3.6 Configuration (PEL 113)

The Configuration mode lets you select the distribution system (hook up), voltage ratio and primary current value, primary CT value, and aggregation period on the Model PEL 113 instrument. For a complete configuration, use the PEL Control Panel (see § 5). This screen is inactive when:

- The PEL is recording (pending or in progress).
- Configuration via the DataView® PEL Control Panel is in progress.
- The button is locked through an option in the PEL Control Panel.
- Configuration is disabled by the **Control** button on the front panel.

NOTE: To avoid conflicts, when the Configuration screen is displayed, configuration through the PEL Control Panel is disabled. You also cannot start a recording session with the **Control** button while the Configuration screen is displayed. If you attempt to use the **Control** button while it is locked by the PEL Control Panel, the **REC** START/STOP light will flash twice simultaneously. The instrument will then continue its operation with no changes taking effect.

To change configuration settings on the Model PEL 113, enter the Configuration mode and do the following:

1. Scroll to the setting you want to change using the down arrow ▼ and up arrow ▲ buttons.
2. Press the **Enter** button. The displayed setting will start blinking.
3. Use the **Navigation** button to scroll through the allowable values for the setting.
4. When the desired value appears, press the **Enter** button. The setting will stop blinking.

As with the Information screen, the Configuration screen is disabled if three minutes elapse with no activity on the Enter or Navigation buttons. The display then returns to the Base Measurements screen.

Step	Value	Units
1	<<HOOK UP>> Distribution System Type	1P-2W = 1-phase 2-wire 1P-3W = 1-phase 3-wire 3P-3WΔ3 = 3-phase 3-wire Δ (3 current sensors) 3P-3WΔ2 = 3-phase 3-wire Δ (2 current sensors) 3P-3W02 = 3-phase 3-wire Open Δ (2 current sensors) 3P-3W03 = 3-phase 3-wire Open Δ (3 current sensors) 3P-3WΔB = 3-phase 3-wire Δ balanced 3P-3WY = 3-phase 3-wire Y (3 current sensors) 3P-3WY2 = 3-phase 3-wire Y (2 current sensors) 3P-4WY = 3-phase 4-wire Y 3P-4WYB = 3-phase 4-wire Y balanced (fixed, voltage measurement) 3P-4WY2 = 3-phase 4-wire Y 2½ 3P-4WΔ = 3-phase 4-wire Δ 3P-4WOΔ = 3-phase 4-wire Open Δ DC-2W = DC 2-wire DC-3W = DC 3-wire DC-4W = DC 4-wire
2	«PT PRIM» Primary VT	V / kV = Primary nominal voltage: 50 V to 650 kV
3	«PT SEC» Secondary VT	V = Secondary nominal voltage: (50 to 1000) V
4	«CT PRIM» Primary CT	Primary nominal line current for the connected sensor. For AmpFlex: 100 A, 400 A, 2000 A, 10,000 A For MN193 5 A range: (5 to 25,000) A **NOTE:** This screen does not appear if no probe is connected to the PEL 113. If you want to configure the CT PRI setting in a PEL with no probes connected, you must use the PEL Control Panel.
5	«AGG.PERIOd» Aggregation period	Displays the aggregation period in minutes (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60)

Table 12

5. DATAVIEW® & PEL CONTROL PANEL

DataView® enables a computer to connect to and interact with a variety of AEMC® Instruments devices, including the Model PEL 112 and PEL 113. As its name implies, the primary purpose of DataView is to view data that has been recorded by the instrument and display it as a report.

With DataView, you can:

- Connect the instrument to a computer. This connection can be through USB cable, LAN network, direct Ethernet connection, Wi-Fi or DataViewSync™.
- Display and analyze real-time data on the computer via a frames style interface.
- Download previously recorded data from the instrument. You will need DataView in order to view recording sessions, since these sessions cannot be displayed through the instrument's interface.
- Start, schedule, stop, and cancel a recording session.
- Configure a wide variety of instrument settings.
- Perform instrument maintenance such as formatting the SD-card and erasing its content.
- Generate reports for viewing and printing data, using standard or customizable templates.

DataView includes a core set of features used by all instruments. These features are designed for viewing data, and for opening, creating, and saving reports. DataView also includes components called **Control Panels** for interacting with the instrument. A Control Panel allows you to connect to the instrument, download data, and configure the instrument's settings. Each AEMC® Instruments product family has its own dedicated Control Panel; you select the Control Panel(s) you need during DataView installation.

For example, DataView includes the PEL Control Panel specifically designed for working with Model PEL Series instruments. The PEL Control Panel provides all the features available in the instrument's user interface, as well as many additional features.

5.1 INSTALLING DATAVIEW®

When you purchase the instrument, the product package includes a USB drive containing DataView program files. To begin installation:

1. Insert the DataView USB drive into an available USB port on your PC. If Autorun is enabled, an AutoPlay window appears on your screen. Click **Open folder to view files** to display the DataView folder. If Autorun is not enabled or allowed, use Windows Explorer to locate and open the USB drive labeled **DataView**.
2. When the DataView folder is open, find the file **Setup.exe** located in the root directory of the USB drive. Double-click the file **Setup.exe** to run the installation program.

3. The DataView setup screen appears.

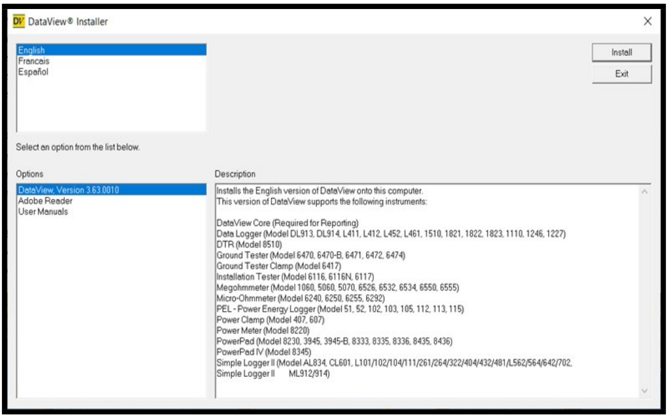


Figure 33

In the upper left corner of the screen, choose the **language version** of the Setup interface. (All Setup screens and dialogs will immediately appear in the selected language.)

In the lower left corner are the available installation options. In addition to the DataView® software, you can select **Adobe Reader**. This links to the Adobe web site where you can download the latest version of Reader. This program is required to view DataView .pdf documents. The option **Firmware Upgrades** links to the website where you can check for new firmware updates for the PEL. Finally, **User Manuals** displays a list of .pdf files contained in the USB drive that accompanies DataView. (DataView also comes with a Help system that is installed with the program files.)

To install DataView, select **DataView** in the Options list and click **Install**.

4. Select the language version of DataView you want to install (English, French, or Spanish) then click **Next**. (By default, the language selected in step 3 is highlighted.)

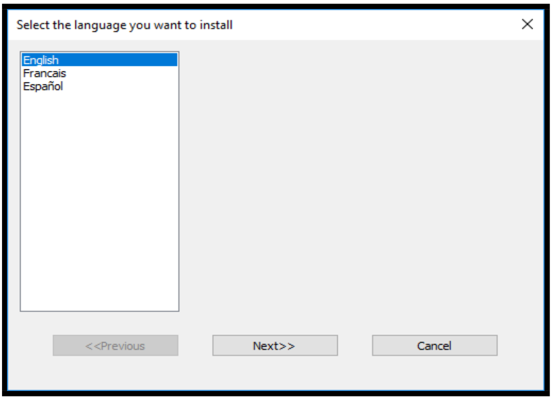


Figure 34

5. You are now prompted to select the software you want to install.

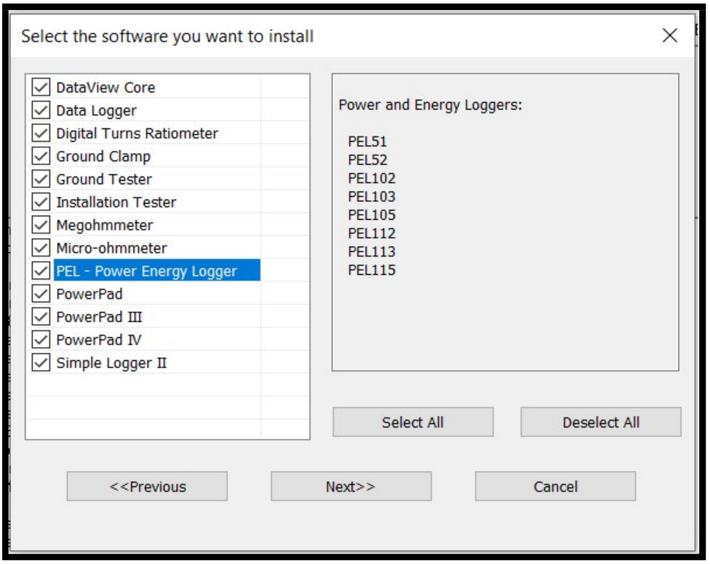


Figure 35

Each AEMC® Instruments product family has its own specially designed Control Panel. If you are performing a Complete install, by default all available Control Panels are selected (a check mark next to the Control Panel indicates it is selected). Control Panels take up disk space on the PC; so unless you have other types of AEMC® Instruments devices, we recommend that you select **Power Energy Logger** and deselect the rest. You should also check the option **DataView Core**, which is a requirement if you plan to create DataView reports.

After you finish selecting and deselecting Control Panels and/or DataView Core, click **Next**.

6. The Setup program now informs you that it is ready to install DataView. If you want to review any of your previous selections, click the **Previous** button to return to earlier screens. Otherwise, click **Install** to begin installation.

7. The InstallShield program installs the selected software. If an earlier version of the software is already installed on your PC, for each selected program the InstallShield program will:

   (a) Ask you to confirm the installation of the program. Click **Next**.
   (b) Display a status bar indicating the progress of the installation.
   (c) Inform you when the program is installed.

   Click **Finish** to install the next selected program.

   If the software is not installed (or if the installed software is the same version as the selected software), the software is installed without requesting confirmation.

   When all programs are installed, a message appears informing you of this. Click **Finish** to return to the Setup screen

8. You can now select additional Setup options to install (see step 3). When finished, click **Exit**.

9. The DataView folder now appears on your PC desktop, within which is the PEL Control Panel icon  and the icon(s) for any other Control Panel(s) you have installed.

5.2 PEL CONTROL PANEL

Clicking the DataView icon in the DataView folder on your desktop opens the core DataView program. Clicking the PEL Control Panel icon opens the PEL Control Panel:

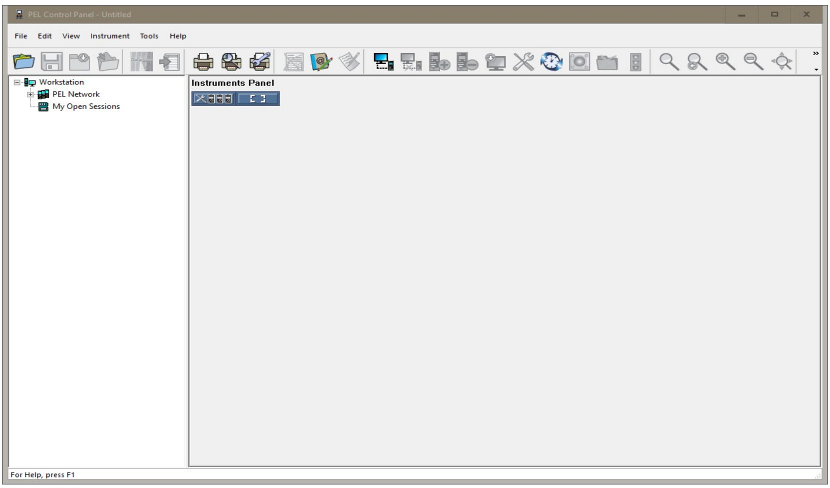


Figure 36

In general, core DataView features are for creating, viewing, editing, and storing DataView reports; while the PEL Control Panel is for connecting to, configuring, viewing measurements on, and downloading data from the instrument. You can access all DataView features through either the DataView icon or the Control Panel icon. For users who interact with PEL 100 series instruments, we recommend primarily using the PEL Control Panel. However, there are situations where using the core DataView icon may be more convenient for some users, such as when viewing multiple archived reports from different AEMC® Instruments product families.

For further information about using the PEL Control Panel, consult the Help system that comes with the product. Access this Help by clicking the option **Help** in the PEL Control Panel's menu bar at the top of the screen.

5.3 POWER & ENERGY LOGGER (PEL) ANDROID™ APP

Another way to connect to a PEL instrument is through the Power & Energy Logger (PEL) Android app. This app, which can be downloaded free from the Google Play Store (**https://play.google.com/store/apps/details?id=com.aemc.pel&hl=en**) enables you to work with a PEL instrument from an Android mobile device.

The PEL must be connected to the Android device via a network connection or Wi-Fi direct.

The PEL app provides a substantial subset of the functionality provided by the PEL Control Panel. For example, you can view data currently being measured by the instrument in real-time. This includes the type of distribution system currently being measured, and (for AC systems) the phasor diagram appropriate for this setup. Real-time data is organized in tables of related measurements for quick navigation and reference, and updated continuously from the instrument.

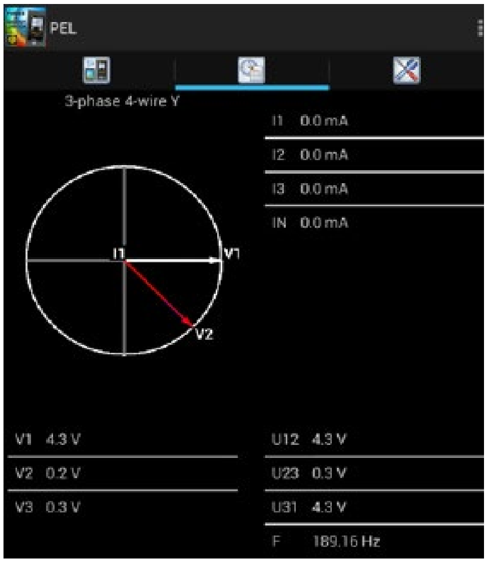


Figure 37

These data tables, which can require several pages to display, depend on the current distribution system. Different data appears for different distribution systems; the above example shows the first page of real-time data for a 3-phase 4-wire system.

You can also set parameters to schedule a recording session and specify what data will be recorded. This can be a recording that starts immediately, or at a future date and time. You can also choose which data to record. Recorded data is stored on the PEL instrument, where it can subsequently be downloaded to a PC and analyzed in detail using DataView.

In addition, you can view and/or set configuration variables on the PEL instrument. The PEL Android app enables you to review the current configuration settings on your PEL, and change these settings as required. You can change the type of distribution system being measured, voltage ratios, nominal frequency, current sensors options, communication-related settings, and other information related to the instrument and its operation.

The app is provided with a complete online Help system, which can be viewed independently at **http://www.pel100.us/help-en/index.html**. Consult this Help system for a complete description of the PEL app and all its capabilities.

6. SPECIFICATIONS

6.1 REFERENCE CONDITIONS

Parameter	Reference Conditions
Ambient Temperature	73 °F (23 °C) ± 2 °F/C
Relative Humidity	(45 to 75) % RH
Voltage	No DC component in AC, no AC component in DC (< 0.1 %)
Current	No DC component in AC, no AC component in DC (< 0.1 %)
Phase Voltage	(100 to 1000) V_{RMS}, without DC (< 0.5 %)
Input Voltage of Current Inputs (except AmpFlex®/MiniFlex®)	50 m V to 1.2 V without DC (< 0.5 %) for AC measurement, without AC (< 0.5 %) for DC measurement
Harmonics	< 0.1 %
Voltage Unbalance	0 %
Preheating	Device powered for at least 1 h
Common Mode	Neutral input and enclosure are held at earth potential
	Instrument powered on battery, USB disconnected
Magnetic Field	0 A/m AC
Electric Field	0 V/m AC

Table 13

6.2 ELECTRICAL SPECIFICATIONS

6.2.1 Voltage Inputs

Operating Range: up to 1000 V_{RMS} for phase-to-neutral voltages
up to 1000 V_{RMS} for phase-to-phase voltages

NOTE: Phase-to-neutral voltages lower than 2 V and phase-to-phase voltages lower than $2\sqrt{3}$ are zeroed.

Input Impedance: 1908 kΩ (phase-to-neutral and neutral-to-earth/ground)

Max Overload: 1100 V_{RMS}

6.2.2 Current Inputs

NOTE: Current sensor inputs are **voltage** inputs (current probes have a voltage output).

Operating Range: 0.5 mV to 1.2 V (1 V = I_{nom}) with crest factor = $\sqrt{2}$

Input Impedance: 1 MΩ (except for AmpFlex®/MiniFlex® current sensors)
12.4 kΩ (AmpFlex®/MiniFlex® current sensors)

Max Overload: 1.7 V

6.2.3 Accuracy Specifications (excluding current sensors)

6.2.3.1 Specifications @ 50/60 Hz

Quantity	Measurement Range	Intrinsic Uncertainty
Frequency (f)	(42.5 to 69) Hz	± 0.1 Hz
Phase-to-Neutral Voltage (V)	(10 to 1000) V	± 0.2 % R ± 0.2 V
Phase-to-Phase Voltage (U)	(17 to 1000) V	± 0.2 % R ± 0.4 V
Current (I) Independent of Current Sensor *	(0.2 to 120) % I_{nom}	± 0.4 % R ± 0.04 % I_{nom} **
Active Power (P)	PF = 1 V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.5 % R ± 0.005 % P_{nom}
	PF = [0.5 inductive; 0.8 capacitive] V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 1.5 % R ± 0.015 % P_{nom}
Reactive Power (Q)	Sin φ = 1 V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 1 % R ± 0.01 % Q_{nom}
	Sin φ = [0.5 inductive; 0.5 capacitive] V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 3.5 % R ± 0.03 % Q_{nom}
	Sin φ = [0.5 inductive; 0.5 capacitive] V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 1 % R ± 0.01 % Q_{nom}
	Sin φ = [0.25 inductive; 0.25 capacitive] V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 2.5 % R ± 0.025 % Q_{nom}
Apparent Power (S)	V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.5 % R ± 0.005 % S_{nom}
Power Factor (PF)	PF = [0.5 inductive; 0.5 capacitive] V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.05
	PF = [0.2 inductive; 0.2 capacitive] V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.1

Quantity	Measurement Range	Intrinsic Uncertainty
Tan Φ	Tan Φ = [√3 inductive; √3 capacitive] V = (100 to 1000) V I = (5 to 120) % Inom	± 0.02
	Tan Φ = [3.2 inductive; 3.2 capacitive] V = (100 to 1000) V I = (5 to 120) % Inom	± 0.05
Active Energy (Ep)	PF = 1 V = (100 to 1000) V I = (5 to 120) % Inom	± 0.5 % R
	PF = [0.5 inductive; 0.8 capacitive] V = (100 to 1000) V I = (5 to 120) % Inom	± 0.6 R %
Reactive Energy (Eq)	Sin φ = 1 V = (100 to 1000) V I = (5 to 120) % Inom	± 2 R %
	Sin φ = [0.5 inductive; 0.5 capacitive] V = (100 to 1000) V I = (5 to 120) % Inom	± 2 R %
	Sin φ = [0.5 inductive; 0.5 capacitive] V = (100 to 1000) V I = (5 to 120) % Inom	± 2.5 R %
	Sin φ = [0.25 inductive; 0.25 capacitive] V = (100 to 1000) V I = (5 to 120) % Inom	± 2.5 R %
Apparent Energy (Es)	V = (100 to 1000) V I = (5 to 120) % Inom	± 0.5 R %
Harmonics Number (1 to 25)	PF = 1 V = (100 to 1000) V I = (5 to 120) % Inom	± 1 R %
Total Harmonic Distortion (THD)	PF = 1 V = (100 to 1000) V I = (5 to 120) % Inom	± 1 R %

Table 14

- *Inom is the value of the measured current for a current sensor output of 1 V. See Table 17 and Table 18 for the nominal current values.*
- *Pnom and Snom are the active power and apparent power for V = 1000 V, I = Inom and PF = 1.*
- *Qnom is the reactive power for V = 1000 V, I = Inom, and Sin φ = 1.*
- ** The intrinsic uncertainty for input current (I) is specified for an isolated input voltage of 1 V = Inom. The intrinsic uncertainty of the connected current sensor should be added to this intrinsic uncertainty to determine the total intrinsic uncertainty. In the case of using sensors AmpFlex® and MiniFlex®, intrinsic uncertainty is given in Table 18.*
- *The intrinsic uncertainty for neutral current is the maximum intrinsic uncertainty on I1, I2 and I3.*
- *** Indicative maximum value of the intrinsic uncertainty. Higher uncertainties can be noted, in particular with EMI.*

6.2.3.2 Specifications @ 400 Hz

Quantity	Measurement Range	Intrinsic Uncertainty
Frequency (F)	(340 to 460) Hz	± 0.3 Hz
Phase-to-Neutral Voltage (V)	(5 to 600) V	± 0.8 % ± 0.5 V
Phase-to-Phase Voltage (U)	(10 to 600) V	± 0.8 % ± 0.5 V
Current (I) Independent of Current Sensor *	(0.2 to 120) % Inom	± 0.5 % ± 0.05 % I_{nom}
Active Power (P)	PF = 1 V = (100 to 600) V I = (5 to 120) % I_{nom}	± 2 % ± 0.2 % P_{nom} **
	PF = [0.5 inductive; 0.8 capacitive] V = (100 to 600) V I = (5 to 120) % I_{nom}	± 3 % ± 0.3 % P_{nom} **
Active Energy (Ep)	PF = 1 V = (100 to 600) V I = (5 to 120) % I_{nom}	± 2 % **

Table 15

- *Inom is the value of the measured current for a current sensor output at 50/60 Hz. See Table 17 and Table 18 for the nominal current values.*
- *Pnom is the active power for V = 600 V, I = Inom and PF = 1.*
- ** The intrinsic uncertainty for input current (I) is specified for an isolated input voltage of 1 V = Inom. The intrinsic uncertainty of the connected current sensor should be added to this intrinsic uncertainty to determine the total intrinsic uncertainty. In the case of using sensors AmpFlex® and MiniFlex®, intrinsic uncertainty is given in Table 18. The intrinsic uncertainty for neutral current is the maximum intrinsic uncertainty on I1, I2 and I3.*
- *** Indicative maximum value of the intrinsic uncertainty. Higher uncertainties can be noted, in particular with EMI.*

6.2.3.3 Specifications @ DC

Quantity	Measurement Range	Typical Intrinsic Uncertainty **
Voltage (V)	V = (10 to 1000) V	± 0.2 % R ± 0.5 V
Current (I) Independent of Current Sensor *	I = (5 to 120) % Inom	± 1 % R ± 0.3 % I_{nom}
Power (P)	V = (100 to 600) V I = (5 to 120) % I_{nom}	± 1 % R ± 0.3 % P_{nom}
Energy (Ep)	V = (100 to 600) V I = (5 to 120) % I_{nom}	± 1.5 % R

Table 16

- *Inom is the value of the measured current for a current sensor output of 1 V. See Table 17 for the nominal current values.*
- *Pnom is the power for V = 600 V and I = Inom.*
- ** The intrinsic uncertainty for input current (I) is specified for an isolated input voltage of 1 V = Inom. The intrinsic uncertainty of the connected current sensor should be added to this intrinsic uncertainty to determine the total intrinsic uncertainty. In the case of using sensors AmpFlex® and MiniFlex®, intrinsic uncertainty is given in Table 18.*
- *The intrinsic uncertainty for neutral current is the maximum intrinsic uncertainty on I1, I2 and I3.*
- *** Indicative maximum value of the intrinsic uncertainty. Higher uncertainties can be noted, in particular with EMI.*

6.2.3.4 Influence of Temperature

For V, U, I, P, Q, S, FP and E:

- 300 ppm / °C, with 5 % < I < 120 % and PF = 1
- 500 ppm / °C, with 10 % < I < 120 % and PF = 0.5 inductive
- Typical DC offset
  - V: 10 mV / °C
  - I: 30 ppm x Inom / °C

6.2.3.5 Common Mode Rejection

The common mode rejection ratio on neutral input is typically 140 dB. For example, 110 V applied on the neutral input will add 11 µV to AmpFlex®/MiniFlex® values, which is a 230 mA error at 60 Hz. A voltage of 110 V applied on the neutral input will add 11 µV to other current sensors' values, resulting in an additional error of 0.01 % I_{nom}.

6.2.3.6 Influence of Magnetic Field

For current inputs to which MiniFlex® or AmpFlex® flexible current sensors are connected: 10 mA/A/m typically at 50/60 Hz.

6.2.3.7 Accuracy

The RMS current measurement accuracy and the phase accuracy correspond to addition values (which must therefore be added to the instrument’s accuracy), indicated as influences on the calculations carried out by the instrument (powers, energies, power factors, tangents, etc.).

The following specifications are considered to be in the conditions of references of the current sensor.

Current sensors with 1 V output at I_{nom} specifications

Model	I nominal	Current (RMS or DC)	Intrinsic uncertainty at 50/60 Hz	Intrinsic uncertainty on φ at 50/60 Hz	Typical uncertainty on φ at 50/60 Hz	Typical uncertainty on φ at 400 Hz
MR193	1000 AAC 1300 ADC	(1 to 50) A	± 1.5 % ± 1 A **	-	-	
		(50 to 100) A	± 1.5 % ± 1 A	± 2.5 °	-0.9 °	
		(100 to 800) A	± 2.5 %	± 2 °	- 0.8 °	- 4.5 ° @ 100 A
		(800 to 1000) AAC (800 to 1300) ADC	± 4 %		- 0.65 °	
SR193	1000 AAC	(1 to 50) A	± 1 % **	-	-	+ 0.1 ° @ 1000 A
		(50 to 100) A	± 0.5 %	± 1 °	+ 0.25 °	
		(100 to 1200) A	± 0.3 %	± 0.7 °	+ 0.2 °	
MN93	200 AAC	(0.5 to 5) A	± 3 % ± 1 A **	-	-	-
		(5 to 40) A	± 2.5 % ± 1 A	± 5 °	+ 2 °	- 1.5 ° @ 40 A
		(40 to 100) A	± 2 % ± 1 A	± 3 °	+ 1.2 °	- 0.8 ° @ 100 A
		(100 to 240) A	± 1 % + 1 A	± 2.5 °	± 0.8 °	- 1 ° @ 200 A
MN193	100 AAC	200 mA to 5A	± 1 % ± 2 mA **	± 4 °	-	-
		(5 to 120) A	± 1 %	± 2.5 °	+ 0.75 °	- 0.5 ° @100 A
	5 AAC	(5 to 250) mA	± 1.5 % ± 0.1 mA **	-	-	-
		250 mA to 6A	± 1 %	± 5 °	+ 1.7 °	- 0.5 ° @ 5 A
E94	100 AAC/DC	50 mA to 40 A	± 4 % ± 50 mA	± 1 °	-	-
		(40 to 100) A	± 15 %	± 1 °	-	-
	10 AAC/DC	50 mA to 10 A	± 3 % ± 50 mA	± 1.5 °	-	-

Table 17

*** Indicative maximum value of the intrinsic uncertainty. Higher uncertainties can be noted, in particular, with EMI.*

AmpFlex® and MiniFlex® Specifications

Sensor Type	I nominal	Current (RMS or DC)	Intrinsic uncertainty at 50/60 Hz	Intrinsic uncertainty at 400 Hz	Intrinsic uncertainty on φ at 50/60 Hz	Typical uncertainty on φ at 400 Hz
AmpFlex® 193 *	100 AAC	200 mA to 5 A	± 1.2 % ± 50 mA**	± 2 % ± 0.1 A**	-	-
		(5 to 120) A*	± 1.2 % ± 50 mA	± 2 % ± 0.1 A	± 0.5 °	- 0.5 °
	400 AAC	(0.8 to 20) A	± 1.2 % ± 0.2 A**	± 2 % ± 0.4 A**	-	-
		(20 to 500) A*	± 1.2 % ± 0.2 A	± 2 % ± 0.4 A	± 0.5 °	- 0.5 °
	2000 AAC	(4 to 100) A	± 1.2 % ± 1 A**	± 2 % ± 2 A**	-	-
		(100 to 2400) A*	± 1.2 % ± 1 A	± 2 % ± 2 A	± 0.5 °	- 0.5 °
	10,000 AAC	(20 to 500) A	± 1.2 % ± 5 A**	±2 % ± 10 A**	-	-
		(500 to 12,000) A*	± 1.2 % ± 5 A	± 2 % ± 10 A	± 0.5 °	- 0.5 °
MiniFlex® MA193 * MA194 *	100 AAC	200 mA to 5 A	± 1 % ± 50 mA**	± 2 % ± 0.1 A**	-	-
		(5 to 120) A*	± 1 % ± 50 mA	± 2 % ± 0.1 A	± 0.5 °	- 0.5 °
	400 AAC	(0.8 to 20) A	± 1 % ± 0.2 A**	± 2 % ± 0.4 A**	-	-
		(20 to 500) A*	± 1 % ± 0.2 A	± 2 % ± 0.4 A	± 0.5 °	- 0.5 °
	2000 AAC	(4 to 100) A	± 1 % ± 1 A**	± 2 % ± 2 A**	-	-
		(100 to 2400) A*	± 1 % ± 1 A	± 2 % ± 2 A	± 0.5 °	- 0.5 °
	10,000 AAC	(20 to 500) A	± 1.2 % ± 5 A**	±2 % ± 10 A**	-	-
		(500 to 12,000) A*	± 1.2 % ± 5 A	± 2 % ± 10 A	± 0.5 °	- 0.5 °

Table 18

** The nominal ranges are reduced to (50/200/1000/5000) AAC at 400 Hz.*

*** Indicative maximum value of the intrinsic uncertainty. Higher uncertainties can be noted, in particular with EMI.*

NOTE: When no current sensor is connected, the current values are forced to zero.

Distribution system	Abbreviation	I_1	I_2	I_3
Split phase (1-phase 2-wire)	1P-2W	•	–	–
Split phase (1-phase 3-wire)	1P-3W	•	•	–
3-phase 3-wire Δ	3P-3WΔ2	•	–	•
3-phase 3-wire Open Δ	3P-3W02	•	–	•
3-phase 3-wire Y 2	3P-3WY2	•	–	•
3-phase 3-wire Δ	3P-3WΔ3	•	•	•
3-phase 3-wire Open Δ	3P-3W03	•	•	•
3-phase 3-wire Y	3P-3WY	•	•	•
3-phase 3-wire Δ balanced	3P-3WΔB	–	–	•
3-phase 4-wire Y	3P-4WY	•	•	•
3-phase 4-wire Y balanced	3P-4WYB	•	–	–
3-phase 4-wire Y 2½	3P-4WY2	•	•	•
3-phase 4-wire Δ	3P-4WΔ	•	•	•
3-phase 4-wire Open Δ	3P-4WOΔ	•	•	•
DC 2-wire	DC-2W	•	–	–
DC 3-wire	DC-3W	•	•	–
DC 4-wire	DC-4W	•	•	•

Table 19

6.3 POWER SUPPLY

AC Power (external power supply) - 600 V Overvoltage CAT III

- **Operating Range:** (110 to 250) V (± 10 %) @ DC/50/60/400 Hz
- **Max Power:** 30 VA

Battery Power

- **Type:** Rechargeable NiMH battery
- **Charge Time:** 5 h approx
- **Recharging Temperature:** (32 to 104) °F (0 to 40) °C

NOTE: Configuration data is saved for up to 5 years during a low battery condition.
When the instrument is off, the real-time clock is maintained for two weeks or longer.

Autonomy

- 30 minutes minimum with no Wi-Fi

6.4 MECHANICAL SPECIFICATIONS

Dimensions: (10.08 x 4.92 x 1.46) in (256 x 125 x 37) mm

With Voltage and Current Leads: (10.08 x 4.92 x 10.08) in (256 x 125 x 256) mm

Weight: < 1 kg

Drop Test: 1 m in the most severe position without permanent mechanical damage and functional deterioration

Degrees of Protection: Provided by enclosure (IP code) according to IEC 60529
IP 54 instrument not connected (de-energized) / not including the terminals
IP20 instrument connected (operating)

6.5 ENVIRONMENTAL SPECIFICATIONS

Temperature and Relative Humidity:

1 =	**Reference Temperature:**	(68 to 78.8) °F (20 to 26) °C from (45 to 75) % RH
1+2 =	**Operating Temperature:**	
	PEL 112:	(-4 to 108.5) °F (-20 to 42.5) °C from (10 to 85) % RH (-4 to 122) °F (-20 to 50) °C from (10 to 75) % RH
	PEL 113:	(32 to 108.5) °F (0 to 42.5) °C from (10 to 85) % RH (32 to 122) °F (0 to 50) °C from (10 to 75) % RH

Maximum operating range when battery charging: 104 °F / 40 °C from (10 to 85) % RH

3 =	**Storage Temperature (w/ battery):**	(-4 to 95) °F (-20 to 35) °C from (0 to 95) % RH (-4 to 158) °F (-20 to 70) °C from (0 to 75) % RH

Recommended long-term storage temperature for battery: (41 to 77) °F (5 to 25) °C

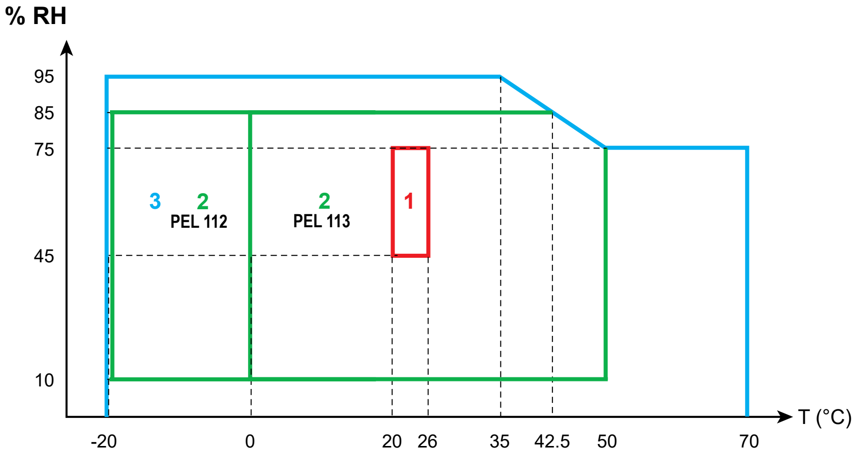


Figure 38

Recharging Temperature: N/A

Altitude: Operating: (0 to 2000) m (6560 ft)

Non-Operating: (0 to 10,000) m (32,800 ft)

6.6 SAFETY SPECIFICATIONS

Electrical Safety

The instrument complies with IEC/EN 61010-2-030 for the following:

- Measurement inputs and enclosure: 600 V CAT IV / 1000 V CAT III, Pollution Degree 2
- Power supply: 600 V overvoltage CAT III, Pollution Degree 2

Conforms to UL Std. UL 61010-1
Conforms to UL Std. UL 61010-2-030
Cert. to CAN/CSA Std. C22.2 No. 61010-1
Cert. to CSA Std. C22.2#61010-2-030

The current sensors comply with IEC 61010-2-032

The test leads and alligator clips comply with IEC 61010-031

6.7 ELECTROMAGNETIC COMPATIBILITY

- Emissions and immunity in an industrial setting compliant with IEC 61326-1 (with an influence of 0.5 % typical of the full scale

Specifications are subject to change without notice.

6.7.1 Radio Emission

The devices are compliant with the 2014/53/EU RED directive and FCC Regulations.

Wi-Fi: FCC certification QOQWF121

7. MAINTENANCE

7.1 BATTERY

Your instrument is equipped with a NiMH battery. This technology offers several advantages:

- Long battery charge life for a limited volume and weight.
- Possibility of quickly recharging your battery.
- Significantly reduced memory effect: you can recharge your battery even if it is not fully discharged.
- Respect for the environment: no pollutant materials such as lead or cadmium, in compliance with the applicable regulations.

After prolonged storage, the battery may be completely discharged. If so, it must be completely recharged.

Your instrument may not function during part of this recharging operation.

Full recharging of a completely discharged battery may take several hours.

NOTE: In this case, at least 5 charge/discharge cycles will be necessary for your battery to recover 95 % of its capacity.

To make the best possible use of your battery and extend its effective service life:

- Only charge your instrument at temperatures between:
  - **PEL 112**: (-20 to 40) °C (-4 to 104) °F
  - **PEL 113**: (0 to 40) °C (32 to 104) °F
- Comply with the conditions of use defined in the operating manual.
- Comply with the storage conditions specified in the operating manual.

NOTE: Before first use, charge and discharge the instrument one or two cycles to ensure the proper level display of the battery indicator.

If you are unsure about changing the battery, we recommend having this done at our Service Center as part of the PEL instrument's regular maintenance.

7.2 CLEANING

WARNING: Disconnect the instrument from any source of electricity.

The instrument should be cleaned periodically to keep the LCD clear and prevent the buildup of dirt and grease around the instrument's buttons.

- Turn the instrument OFF.
- Clean the body of the instrument with a damp and soapy cloth.
- Do not submerge the instrument in water.
- Do not use alcohol, solvents, or hydrocarbons.

7.3 UPDATING THE FIRMWARE

The PEL 112 and PEL 113 firmware controls the features and functionality of the instrument. AEMC® Instruments provides firmware updates free of charge to download through our DataView® PEL Control Panel software.

⚠ **WARNING: Updating the firmware could reset the configuration and cause loss of stored data. As a precaution, save the stored data to a PC before updating the firmware.**

To update the firmware, your PC must be running DataView with the PEL Control Panel (V2.9.16216 or later).

1. Power ON the instrument using external power, to ensure the instrument remains ON throughout the update procedure. Also ensure that the battery is at least 50 % charged. **Do not perform an update with the instrument running on battery power, or with low battery charge. If the instrument turns OFF while firmware updating is in progress, it could become inoperative. External power with a sufficiently charged battery for backup helps minimize the risk of power interruptions during updating.**
2. Connect the PEL instrument to the PC using the USB cable.
3. Launch the PEL Control Panel.
4. Ensure the instrument is listed in the PEL Network navigation tree. If it is, skip this step and go to step 5 below. If not, click **Instrument** in the menu bar and select **Add an Instrument**, then connect the instrument using the Add an Instrument Wizard. (Press F1 if you need assistance.)
5. Ensure the instrument is listed with a green check next to its name, indicating it is connected. If not, select the instrument and click **Instrument** > **Reconnect Instrument**. When the instrument is connected, select it.
6. By default, the PEL Control Panel automatically checks the connected instrument's firmware. If it is out of date, the Firmware Update dialog box appears, listing the instrument and any others running out-of-date firmware. Click **Update** (or **Select All** to update multiple instruments). This displays the Firmware Upgrade dialog box listing the latest firmware revisions for the PEL DSP and microprocessor; proceed as instructed in Step 7 below.

   If the PEL Control Panel option **Check automatically for new firmware for connected instruments upon start of program** has been previously de-selected, the automatic firmware check does not occur. In this case, click **Instrument** in the menu bar. This includes the option **Firmware Upgrade**. If the selected instrument is running the latest firmware, this option is grayed out and inactive. If the instrument is not running the latest firmware, click Firmware Upgrade to display the Firmware Upgrade dialog box.
7. Click the **Start** button to begin the update. During this process, status bars display the progress of the DSP and microprocessor firmware updates. (Note that if only one of these requires updating, only its status bar appears.)
8. When the firmware update is complete, click the **Close** button to exit.

7.4 REPAIR AND CALIBRATION

To ensure that your instrument meets factory specifications, we recommend that it be sent back to our factory Service Center at one-year intervals for recalibration or as required by other standards or internal procedures.

For instrument repair and calibration:

You must contact our Service Center for a Customer Service Authorization Number (CSA#). Send an email to repair@aemc.com requesting a CSA#, you will be provided a CSA Form and other required paperwork along with the next steps to complete the request. Then return the instrument along with the signed CSA Form. This will ensure that when your instrument arrives, it will be tracked and processed promptly. Please write the CSA# on the outside of the shipping container. If the instrument is returned for calibration, we need to know if you want a standard calibration or a calibration traceable to N.I.S.T. (includes calibration certificate plus recorded calibration data).

Ship To: Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments
15 Faraday Drive ▪ Dover, NH 03820 USA
Phone: (800) 945-2362 (Ext. 360) / (603) 749-6434 (Ext. 360)
E-mail: repair@aemc.com

(Or contact your authorized distributor.)

Contact us for the costs for repair, standard calibration, and calibration traceable to N.I.S.T.

NOTE: You must obtain a CSA# before returning any instrument.

7.5 TECHNICAL ASSISTANCE

If you are experiencing any technical problems or require any assistance with the proper operation or application of your instrument, please call or e-mail our technical support team:

Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments
Phone: (800) 343-1391 (Ext. 351)
E-mail: techsupport@aemc.com
www.aemc.com

7.6 LIMITED WARRANTY

The instrument is warrantied to the owner for a period of two years from the date of original purchase against defects in manufacture. This limited warranty is given by AEMC® Instruments, not by the distributor from whom it was purchased. This warranty is void if the unit has been tampered with, abused, or if the defect is related to service not performed by AEMC® Instruments.

Full warranty coverage and product registration is available on our website at www.aemc.com/warranty.html

Please print the online Warranty Coverage Information for your records.

What AEMC® Instruments will do:

If a malfunction occurs within the warranty period, you may return the instrument to us for repair, provided we have your warranty registration information on file or a proof of purchase. AEMC® Instruments will repair or replace the faulty material at our discretion.

REGISTER ONLINE AT: www.aemc.com/warranty.html

7.6.1 Warranty Repairs

What you must do to return an Instrument for Warranty Repair:

First, send an email to repair@aemc.com requesting a Customer Service Authorization Number (CSA#) from our Service Department. You will be provided a CSA Form and other required paperwork along with the next steps to complete the request. Then return the instrument along with the signed CSA Form. Please write the CSA# on the outside of the shipping container. Return the instrument, postage or shipment prepaid to:

Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments
15 Faraday Drive, Dover, NH 03820 USA
Phone: (800) 945-2362 (Ext. 360)
(603) 749-6434 (Ext. 360)
E-mail: repair@aemc.com

Caution: To protect yourself against in-transit loss, we recommend that you insure your returned material.

NOTE: You must obtain a CSA# before returning any instrument.

8. APPENDIX A

8.1 MEASUREMENTS

8.1.1 Definition

Calculations are done according to IEC 61557-12 and IEC 61010-4-30.

Geometric representation of active and reactive power:

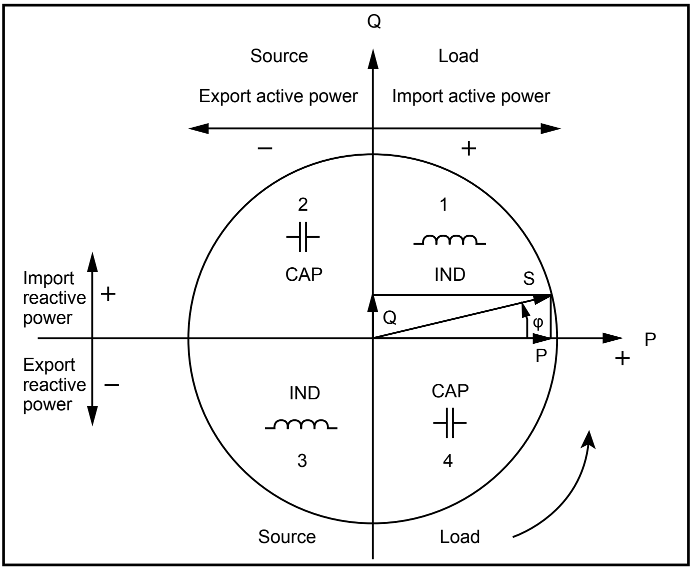


Figure 39

Diagram in accordance with clauses 12 and 14 of IEC 60375.

Reference of this diagram is the current vector (fixed on right-hand line).

The voltage vector V varies its direction according to the phase angle φ.

The phase angle φ between voltage V and current I is taken to be positive in the mathematical sense (counter-clockwise).

8.2 SAMPLING

8.2.1 Sampling Period

Depends on main frequency: (50, 60 or 400) Hz

- Main frequency f = 50 Hz
  - Inside (42.5 to 57.5) Hz (50 Hz ±15 %), sampling period is locked to main frequency.

    128 samples are available for each main cycle.
  - Outside (42.5 to 57.5) Hz, sampling period is (128*50) Hz.

- Main frequency f = 60 Hz
  - Inside (51 to 69) Hz (60 Hz ±15 %), sampling period is locked to main frequency.

    128 samples are available for each main cycle.
  - Outside (51 to 69 Hz), sampling period is (128*60) Hz.
- Main frequency f = 400 Hz
  - Inside (340 to 460) Hz (400 Hz ±15 %), sampling period is locked to main frequency.

    16 samples are available for each main cycle.
  - Outside (340 to 460) Hz, sampling period is 16*400 Hz.

DC is not a frequency parameter for sampling. A pure DC measured signal is considered to be outside the frequency ranges. Then, the sampling frequency is, according to the preselected main frequency, 6.4 kHz (50/400 Hz) or 7.68 kHz (60 Hz).

8.2.2 Locking of Sampling Frequency

- By default, sampling frequency is locked on V1
- If V1 is missing, sampling frequency tries to lock to V2, then V3, I1, I2 and I3

8.2.3 AC/DC

The PEL performs AC and DC measurements for alternative current and/or direct current distribution systems. Selection of AC or DC is done by the user.

AC + DC values are not available with PEL.

NOTE: AC+DC values could be calculated after download using the DataView® software.

8.2.4 Measurement of Neutral Current

For the PEL 112 and PEL 113, neutral current is calculated according to the distribution system.

8.2.5 200 mS Quantities

The instrument calculates the following quantities every 200 ms on the basis of measurements on 10 periods for 50 Hz, 12 periods for 60 Hz, and 80 periods for 400 Hz.

The **200 ms** quantities are used for:

- the trends on the **1 s** quantities
- the aggregation of the values for the **1 s** quantities (see § 8.2.6).

All of the **200 ms** quantities can be recorded on the SD-card during the recording session.

8.2.6 1-Second Quantities

The instrument calculates the following quantities every second.

The **1-second** quantities are used for:

■ Real time values

■ **1-second** trends

■ Aggregation of values for **aggregated** trends (see § 8.2.7)

■ Min and max determination for **aggregated** trends

All **1-second** quantities, when selected on the recording configuration through the PEL Control Panel are saved on the SD-card, during the recording session.

They can be displayed in the PEL Control Panel (see § 5.2).

8.2.7 Aggregation

An aggregated quantity is a value calculated for a defined period.

Aggregation periods always start on rounded hours/minutes. Aggregation period is the same for all quantities. The period is one of the following:
(1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 and 60) min.

All aggregated quantities are saved on the SD-card, during the recording session. They can be displayed in the PEL Control Panel (see § 5.2).

8.2.8 MIN / MAX

The Min and Max are the minimum and maximum 1-second values observed during the aggregation period. They are recorded with their dates and times. The Max of some aggregated values are displayed directly on the instrument.

8.2.9 Energy Calculations

Energies are calculated every second.

The **Total** energy is the demand during the recording session.

The **Partial** energy can be determined during an integration period with the following values: 1 h, 1 d, 1 wk, 1 mo. The partial energy index is available only in real-time. It is not recorded.

However, the **Tota**l energy is available with the recording session data.

NOTE: N is the number of **1-second** values for the considered aggregation period (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60) min.

8.3 SUPPORTED ELECTRICAL NETWORKS

The following types of distribution systems are supported:

- V1, V2, V3 are the line-to-neutral voltages of the installation under test
- [V1=VL1-N; V2=VL2-N; V3=VL3-N]
- Low caps v1, v2, v3 are used for time values
- U12, U23, U31 are the line-to-line voltages of the installation under test
- Low caps are used for time values [u12 = v1-v2; u23= v2-v3, u31=v3-v1]
- I1, I2, I3 are the currents flowing in the line conductors of the installation under test
- Low caps i1, i2, i3 are used for time values

Distribution System	Abbreviation	Comments	Reference Diagram
Single phase (1-Phase 2-Wire)	1P-2W	Voltage measurements are performed between L1 and N. Current measurements are performed on L1 conductor.	§ 4.1.1
Split phase (1-Phase 3-Wire)	1P-3W	Voltage measurements are performed between L1, L2 and N. Current measurements are performed on L1 and L2 conductors. Neutral current is calculated: iN = i1 + i2	§ 4.1.2
3-Phase 3-Wire Δ (2 current sensors)	3P-3WΔ2	Power measurement method is based on 3 wattmeters method with virtual neutral. Voltage measurements are performed between L1, L2 and L3. Current measurements are performed on L1 and L3 conductors. I2 current is calculated (no current sensor connected on L2): i2 = - i1 - i3 Neutral is not available for current and voltage measurement	§ 4.1.3.1
3-Phase 3-Wire Open-Δ (2 current sensors)	3P-3WO2		§4.1.3.3
3-Phase 3-Wire Y (2 current sensors)	3P-3WY2		§ 4.1.3.5
3-Phase 3-Wire Δ	3P-3WΔ3	Power measurement method is based on 3 wattmeters method with virtual neutral. Voltage measurements are performed between L1, L2 and L3. Current measurements are performed on L1, L2 and L3 conductors. Neutral is not available for current and voltage measurement	§ 4.1.3.2
3-Phase 3-Wire Open-Δ	3P-3WO3		§ 4.1.3.4
3-Phase 3-Wire Y	3P-3WY3		§ 4.1.3.6

Distribution System	Abbreviation	Comments	Reference Diagram
3-Phase 3-Wire Δ balanced	3P-3WΔB	Power measurement is based on 1 wattmeter method. Voltage measurements are performed between L1 and L2. Current measurements are performed on L3 conductor. U23 = U31 = U12. I1 = I2 = I3	§ 4.1.3.7
3-Phase 4-Wire Y	3P-4WY	Power measurement method is based on 3 wattmeters method with neutral. Voltage measurements are performed between L1, L2 and L3. Current measurements are performed on L1, L2 and L3 conductors. Neutral current is calculated: iN = i1 + i2 + i3.	§ 4.1.4.1
3-Phase 4-Wire Y balanced	3P-4WYB	Power measurement is based on single phase wattmeter method. Voltage measurements are performed between L1 and N. Current measurements are performed on L1 conductor. V1 = V2 = V3 U23 = U31 = U12= V1 x √3. I1 = I2 = I3	§ 4.1.4.2
3-Phase 4-Wire Y 2½	3P-4WY2	This method is named 2½ element method. Power measurement method is based on 3 wattmeters method with virtual neutral. Voltage measurements are performed between L1, L3 and N. V2 is calculated: v2 = - v1 - v3, u12 = 2·v1 + v3, u23= - v1 - 2·v3. It supposes that V2 is balanced. Current measurements are performed on L1, L2 and L3 conductors. Neutral current is calculated: iN = i1 + i2 + i3	§ 4.1.4.3

Distribution System	Abbreviation	Comments	Reference Diagram
3-Phase 4-Wire Δ	3P-4WΔ	Power measurement method is based on 3 wattmeters method with neutral, but no power information for each phase is available. Voltage measurements are performed between L1, L2 and L3. Current measurements are performed on L1, L2 and L3 conductors. Neutral current is calculated only for a transformer branch:iN = i1 + i2	§ 4.1.5.1
3-Phase 4-Wire Open-Δ	3P-4WOΔ		§ 4.1.5.2
DC 2-Wire	DC-2W	Voltage measurements are performed between L1 and N. Current measurements are performed on L1 conductor.	§ 4.1.6.1
DC 3-Wire	DC-3W	Voltage measurements are performed between L1, L2 and N. Current measurements are performed on L1 and L2 conductors. Negative (return) current is calculated : iN = i1 + i2	§ 4.1.6.2
DC 4-Wire	DC-4W	Voltage measurements are performed between L1, L2, L3 and N. Current measurements are performed on L1, L2 and L3 conductors. Negative (return) current is calculated : iN = i1 + i2 + i3	§ 4.1.6.3

Table 20

8.4 PHASE ORDER

Every second, the PEL determines the phase order. If the phase order is incorrect, the RED Phase Order indicator on the PEL front panel blinks (see § 2.10). In addition, on the PEL 113, the Phase Order Incorrect icon appears on the LCD screen.

Setting the correct phase order for a distribution system requires that the current phase order, voltage phase order, and current vs voltage phase order for that distribution system are all correct. Note that:

- Phase order for voltage channels only is displayed when voltages are displayed on the LCD screen. The voltage phase order is derived from the FFT analysis.
- Phase order for current channels only is displayed when currents are displayed.
- Phase order for voltage and current channels is displayed when the other screens are displayed.

- Load or Source is set by the PEL Control Panel.
- In some distribution systems (such as DC) the phase order does not apply in every instance.

The following three tables show information for each distribution system for setting the correct current phase order, voltage phase order, and current vs voltage phase order respectively.

8.5 CURRENT PHASE ORDER

Distribution System	Abbreviation	Current Phase Order	Comments
Single phase (1-Phase 2-Wire)	1P-2W	No	
Split phase (1-Phase 3-Wire)	1P -3W	Yes	ϕ (I2, I1) = 180° ± 30°
3-Phase 3-Wire Δ [2 current sensors]	3P-3WΔ2	Yes	ϕ (I1, I3) = 120° ± 30° No I2 current sensors
3-Phase 3-Wire Open-Δ [2 current sensors]	3P-3WO2		
3-Phase 3-Wire Y [2 current sensors]	3P-3WY2		
3-Phase 3-Wire Δ	3P-3WΔ3	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 3-Wire Open-Δ	3P-3WO3		
3-Phase 3-Wire Y	3P-3WY3		
3-Phase 3-Wire Δ balanced	3P-3WΔB	No	
3-Phase 4-Wire Y	3P-4WY	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Y balanced	3P-4WYB	No	
3-Phase 4-Wire Y 2½	3P-4WY2	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Δ	3P-4WΔ	Yes	[ϕ (I1, I3), ϕ (I3, I2), ϕ (I2, I1)] = 120° ± 30°
3-Phase 4-Wire Open-Δ	3P-4WOΔ		
DC 2-Wire	DC-2W	No	
DC 3-Wire	DC-3W	No	
DC 4-Wire	DC-4W	No	

Table 21

8.6 VOLTAGE PHASE ORDER

Distribution System	Abbreviation	Current Phase Order	Comments
Single phase (1-Phase 2-Wire)	1P-2W	No	
Split phase (1-Phase 3-Wire)	1P -3W	Yes	ϕ (V2, V1) = 180° ± 10°
3-Phase 3-Wire Δ [2 current sensors]	3P-3WΔ2	Yes (on U)	[ϕ (U12, U31), ϕ (U31, U23), ϕ (U23, U12)] = 120° ± 10°
3-Phase 3-Wire Open-Δ [2 current sensors]	3P-3WO2		
3-Phase 3-Wire Y [2 current sensors]	3P-3WY2		
3-Phase 3-Wire Δ	3P-3WΔ3		
3-Phase 3-Wire Open-Δ	3P-3WO3		
3-Phase 3-Wire Y	3P-3WY3		
3-Phase 3-Wire Δ balanced	3P-3WΔB	No	
3-Phase 4-Wire Y	3P-4WY	Yes (on V)	[ϕ (V1, V3), ϕ (V3, V2), ϕ (V2, V1)] = 120° ± 10°
3-Phase 4-Wire Y balanced	3P-4WYB	No	
3-Phase 4-Wire Y 2½	3P-4WY2	Yes (on V)	ϕ (V1, V3) = 120° ± 10° No V2
3-Phase 4-Wire Δ	3P-4WΔ	Yes (on U)	ϕ (V1, V3) = 180° ± 10° [ϕ (U12, U31), ϕ (U31, U23), ϕ (U23, U12)] = 120° ± 10°
3-Phase 4-Wire Open-Δ	3P-4WOΔ		
DC 2-Wire	DC-2W	No	
DC 3-Wire	DC-3W	No	
DC 4-Wire	DC-4W	No	

Table 22

8.7 CURRENT VS VOLTAGE PHASE ORDER

Distribution System	Abbreviation	Current Phase Order	Comments
Single phase (1-Phase 2-Wire)	1P-2W	Yes	ϕ (I1, V1) = 0° ± 60° for load ϕ (I1, V1) = 180° ± 60° for source
Split phase (1-Phase 3-Wire)	1P -3W	Yes	[ϕ (I1, V1), ϕ (I2, V2)] = 0° ± 60° for load [ϕ (I1, V1), ϕ (I2, V2)] = 180° ± 60° for source
3-Phase 3-Wire Δ [2 current sensors]	3P-3WΔ2	Yes	[ϕ (I1, U12), ϕ (I3, U31)] = 30° ± 60° for load [ϕ (I1, U12), ϕ (I3, U31)] = 210° ± 60° for source No I2 current sensor
3-Phase 3-Wire Open-Δ [2 current sensors]	3P-3WO2		
3-Phase 3-Wire Y [2 current sensors]	3P-3WY2		
3-Phase 3-Wire Δ	3P-3WΔ3	Yes	[ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 30° ± 60° for load [ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 210° ± 60° for source
3-Phase 3-Wire Open-Δ	3P-3WO3		
3-Phase 3-Wire Y	3P-3WY3		
3-Phase 3-Wire Δ balanced	3P-3WΔB	Yes	ϕ (I3, U12) = 90° ± 60° for load ϕ (I3, U12) = 270° ± 60° for source
3-Phase 4-Wire Y	3P-4WY	Yes	[ϕ (I1, V1), ϕ (I2, V2), ϕ (I3, V3)] = 0° ± 60° for load [ϕ (I1, V1), ϕ (I2, V2), ϕ (I3, V3)] = 180° ± 60° for source
3-Phase 4-Wire Y balanced	3P-4WYB	Yes	ϕ (I1, V1) = 0° ± 60° for load ϕ (I1, V1) = 180° ± 60° for source
3-Phase 4-Wire Y 2½	3P-4WY2	Yes	[ϕ (I1, V1), ϕ (I3, V3)] = 0° ± 60° for load [ϕ (I1, V1), ϕ (I3, V3)] = 180° ± 60° for source No V2
3-Phase 4-Wire Δ	3P-4WΔ	Yes	[ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 30° ± 60° for load [ϕ (I1, U12), ϕ (I2, U23), ϕ (I3, U31)] = 210° ± 60° for source
3-Phase 4-Wire Open-Δ	3P-4WOΔ		
DC 2-Wire	DC-2W	No	
DC 3-Wire	DC-3W	No	
DC 4-Wire	DC-4W	No	

Table 23

8.8 QUANTITIES ACCORDING TO THE SUPPLY SYSTEMS

8.8.1 1P-2W, 1P-3W, 3P-3W (∆2, O2, Y2), 3P-3W (∆3, O3, Y3), 3P-3W∆B

● = YES

Quantities		1P-2W	1P-3W	3P-3W∆2 3P-3WO2 3P-3WY2	3P-3W∆3 3P-3WO3 3P-3WY3	3P-3W∆B
V_1	RMS	●	●			
V_2	RMS		●			
V_3	RMS					
V_1	DC					
V_2	DC					
V_3	DC					
U_{12}	RMS		●	●	●	●
U_{23}	RMS			●	●	●(1)
U_{31}	RMS			●	●	●(1)
I_1	RMS	●	●	●	●	●
I_2	RMS		●	●(2)	●	●(1)
I_3	RMS			●	●	●(1)
I_N	RMS		●(5)			
I_1	DC					
I_2	DC					
I_3	DC					
I_N	DC					
$V1_{CF}$		●	●			
$V2_{CF}$			●			
$V3_{CF}$						
$I1_{CF}$		●	●	●	●	●
$I2_{CF}$			●	●(2)	●	●(1)
$I3_{CF}$				●	●	●
u_2				●	●	●(4)
F		●	●	●	●	●
P_1		●	●			
P_2			●			
P_3						
P_T			●	●	●	●
P_1	Source	●	●			

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔB
P_2	Source		●			
P_3	Source					
P_T	Source		●	●	●	●
P_1	Load	●	●			
P_2	Load		●			
P_3	Load					
P_T	Load		●	●	●	●
Q_1		●	●			
Q_2			●			
Q_3						
Q_T			●	●	●	●
Q_1	Source	●	●			
Q_2	Source		●			
Q_3	Source					
Q_T	Source		●	●	●	●
Q_1	Load	●	●			
Q_2	Load		●			
Q_3	Load					
Q_T	Load		●	●	●	●
S_1		●	●			
S_2			●			
S_3						
S_T			●	●	●	●
PF_1		●	●			
PF_2			●			
PF_3						
PF_T			●	●	●	●
PF_1	Source	●	●			
PF_2	Source		●			
PF_3	Source					
PF_T	Source		●	●	●	●
PF_1	Load	●	●			
PF_2	Load		●			
PF_3	Load					

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔB
PF_T	Load		●	●	●	●
Cos φ_1		●	●			
Cos φ_2			●			
Cos φ_3						
Cos φ_T			●	●	●	●
Cos φ_1	Source	●	●			
Cos φ_2	Source		●			
Cos φ_3	Source					
Cos φ_M	Source		●	●	●	●
Cos φ_1	Load	●	●			
Cos φ_2	Load		●			
Cos φ_3	Load					
Cos φ_T	Load		●	●	●	●(3)
TAN Φ		●	●	●	●	●(3)
TAN Φ	Source	●	●	●	●	●(3)
TAN Φ	Load	●	●	●	●	●(3)
Hi_V_1	i=1 to 50 (6)	●	●			
Hi_V_2			●			
Hi_V_3						
Hi_U_{12}	i=1 to 50 (6)		●	●	●	●
Hi_U_{23}				●	●	●(1)
Hi_U_{31}				●	●	●(1)
Hi_I_1	i=1 to 50 (6)	●	●	●	●	●
Hi_I_2			●	●(2)	●	●(1)
Hi_I_3				●	●	●(1)
Hi_I_N			●(2)			
THD_V_1		●	●			
THD_V_2			●			
THD_V_3						
THD_U_{12}			●	●	●	●
$THD\ \_U_{23}$				●	●	●(1)
$THD\ \_U_{23}$				●	●	●(1)
THD_I_1		●	●	●	●	●
THD_I_2			●	●(2)	●	●(1)
THD_I_3				●	●	●(1)

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔB
THD_I_N			●(2)			
V_1 Angle		●	●			
V_2 Angle			●			
V_3 Angle						
U_{12} Angle			●	●	●	●
U_{23} Angle				●	●	●(1)
U_{31} Angle				●	●	●(1)
I_1 Angle		●	●	●	●	●
I_2 Angle			●	●(2)	●	●(1)
I_3 Angle				●	●	●(1)

Table 24

(3) Not a significant value

(4) Always = 0

(5) Calculated

6) Order 7 for 400 Hz

8.8.2 3P-4WY, 3P-4WYB, 3P-4WY2, 3P-4WΔ/3P-4WOΔ

●	= YES

Quantities		3P-4WY	3P-4WYB	3P-4WY2	3P-4WΔ 3P-4WOΔ
V_1	RMS	●	●	●	●
V_2	RMS	●	●(1)	●(1)	●
V_3	RMS	●	●(1)	●	●
V_1	DC				
V_2	DC				
V_3	DC				
U_{12}	RMS	●	●(1)	●(1)	●
U_{23}	RMS	●	●(1)	●(1)	●
U_{31}	RMS	●	●(1)	●	●
I_1	RMS	●	●	●	●
I_2	RMS	●	●(1)	●	●
I_3	RMS	●	●(1)	●	●
I_N	RMS	●(5)	●(1)	●(5)	●(5)
I_1	DC				
I_2	DC				
I_3	DC				
I_N	DC				

Quantities		3P-4WY	3P-4WYB	3P-4WY2	3P-4WΔ 3P-4WOΔ
$V1_{CF}$		●	●	●	●
$V2_{CF}$		●	●(1)	●	●
$V3_{CF}$		●	●(1)	●	●
$I1_{CF}$		●	●	●	●
$I2_{CF}$		●	●(1)	●	●
$I3_{CF}$		●	●(1)	●	●
u_2		●	●(4)	●(4)	●(3)
F		●	●	●	●
P_1		●	●	●	●
P_2		●	●(1)	●(1)	●(3)
P_3		●	●(1)	●	●
P_T		●	●(1)	●	●
P_1	Source	●	●	●	●
P_2	Source	●	●(1)	●(1)	●(3)
P_3	Source	●	●(1)	●	●
P_T	Source	●	●(1)	●	●
P_1	Load	●	●	●	●
P_2	Load	●	●(1)	●(1)	●(3)
P_3	Load	●	●(1)	●	●
P_T	Load	●	●(1)	●	●
Q_1		●	●	●	●
Q_2		●	●(1)	●(1)	●(3)
Q_3		●	●(1)	●	●
Q_T		●	●(1)	●	●
Q_1	Source	●	●	●	●
Q_2	Source	●	●(1)	●(1)	●(3)
Q_3	Source	●	●(1)	●	●
Q_T	Source	●	●(1)	●	●
Q_1	Load	●	●	●	●
Q_2	Load	●	●(1)	●(1)	●(3)
Q_3	Load	●	●(1)	●	●
Q_T	Load	●	●(1)	●	●
S_1		●	●	●	●
S_2		●	●(1)	●(1)	●(3)
S_3		●	●(1)	●	●
S_T		●	●(1)	●	●
PF_1		●	●	●	●

Quantities		3P-4WY	3P-4WYB	3P-4WY2	3P-4WΔ 3P-4WOΔ
PF_2		●	●(1)	●(1)	●(3)
PF_3		●	●(1)	●	●
PF_T		●	●(1)	●	●
PF_1	Source	●	●	●	●
PF_2	Source	●	●(1)	●(1)	●(3)
PF_3	Source	●	●(1)	●	●
PF_T	Source	●	●(1)	●	●
PF_1	Load	●	●	●	●
PF_2	Load	●	●(1)	●(1)	●(3)
PF_3	Load	●	●(1)	●	●
PF_T	Load	●	●(1)	●	●
Cos φ_1		●	●	●	●
Cos φ_2		●	●(1)	●(1)	●(3)
Cos φ_3		●	●(1)	●	●
Cos φ_T		●	●(1)	●	●
Cos φ_1	Source	●	●	●	●
Cos φ_2	Source	●	●(1)	●(1)	●(3)
Cos φ_3	Source	●	●(1)	●	●
Cos φ_M	Source	●	●(1)	●	●
Cos φ_1	Load	●	●	●	●
Cos φ_2	Load	●	●(1)	●(1)	●(3)
Cos φ_3	Load	●	●(1)	●	●
Cos φ_T	Load	●	●(1)	●	●
TAN Φ		●	●	●(1)	●(3)
TAN Φ	Source	●	●	●	●
TAN Φ	Load	●	●	●	●
Hi_V_1	i=1 to 50 (6)	●	●	●	●
Hi_V_2		●	●(1)	●	●(3)
Hi_V_3		●	●(1)	●	●
Hi_U_{12}	i=1 to 50 (6)	●	●(1)	●(1)	●
Hi_U_{23}		●	●(1)	●(1)	●
Hi_U_{31}		●	●(1)	●	●
Hi_I_1	i=1 to 50 (6)	●	●	●	●
Hi_I_2		●	●(1)	●	●
Hi_I_3		●	●(1)	●	●
Hi_I_N		●(2)	●(1)	●(2)	●(2)
THD_V_1		●	●	●	●
THD_V_2		●	●(1)	●	●(3)

Quantities		3P-4WY	3P-4WYB	3P-4WY2	3P-4WΔ 3P-4WOΔ
THD_V_3		●	●(1)	●	●
THD_U_{12}		●	●(1)	●(1)	●
THD _U_{23}		●	●(1)	●(1)	●
THD _U_{23}		●	●(1)	●	●
THD_I_1		●	●	●	●
THD_I_2		●	●(1)	●	●
THD_I_3		●	●(1)	●	●
THD_I_N		●(2)	●(1)	●(2)	●(2)
V_1 Angle		●	●	●	●
V_2 Angle		●	●(1)	●(1)	●(3)
V_3 Angle		●	●(1)	●	●
U_{12} Angle		●	●(1)	●(1)	●
U_{23} Angle		●	●(1)	●(1)	●
U_{31} Angle		●	●(1)	●	●
I_1 Angle		●	●	●	●
I_2 Angle		●	●(1)	●	●
I_3 Angle		●	●(1)	●	●

Table 25

(3) Not a significant value

(4) Always = 0

(5) Calculated

6) Order 7 for 400 Hz

8.8.3 DC-2W, DC-3W, DC-4W

●	**= YES**

Quantities		DC-2W	DC-3W	DC-4W
V_1	RMS			
V_2	RMS			
V_3	RMS			
V_1	DC	●	●	●
V_2	DC		●	●
V_3	DC			●
U_{12}	RMS			
U_{23}	RMS			
U_{31}	RMS			

Quantities		DC-2W	DC-3W	DC-4W
I_1	RMS			
I_2	RMS			
I_3	RMS			
I_N	RMS			
I_1	DC	●	●	●
I_2	DC		●	●
I_3	DC			●
I_N	DC		●(5)	●(5)
$V1_{CF}$				
$V2_{CF}$				
$V3_{CF}$				
$I1_{CF}$				
$I2_{CF}$				
$I3_{CF}$				
u_2				
F				
P_1		●	●	●
P_2			●	●
P_3				●
P_T			●	●
P_1	Source	●	●	●
P_2	Source		●	●
P_3	Source			●
P_T	Source		●	●
P_1	Load	●	●	●
P_2	Load		●	●
P_3	Load			●
P_T	Load		●	●
Q_1				
Q_2				
Q_3				
Q_T				
Q_1	Source			
Q_2	Source			
Q_3	Source			

Quantities		DC-2W	DC-3W	DC-4W
Q_T	Source			
Q_1	Load			
Q_2	Load			
Q_3	Load			
Q_T	Load			
S_1				
S_2				
S_3				
S_T				
PF_1				
PF_2				
PF_3				
PF_T				
PF_1	Source			
PF_2	Source			
PF_3	Source			
PF_T	Source			
PF_1	Load			
PF_2	Load			
PF_3	Load			
PF_T	Load			
Cos φ_1				
Cos φ_2				
Cos φ_3				
Cos φ_T				
Cos φ_1	Source			
Cos φ_2	Source			
Cos φ_3	Source			
Cos φ_M	Source			
Cos φ_1	Load			
Cos φ_2	Load			
Cos φ_3	Load			
Cos φ_T	Load			
TAN Φ				
TAN Φ	Source			

Quantities		DC-2W	DC-3W	DC-4W
TAN Φ	Load			
Hi_V_1	i=1 to 50 (6)			
Hi_V_2				
Hi_V_3				
Hi_U_{12}	i=1 to 50 (6)			
Hi_U_{23}				
Hi_U_{31}				
Hi_I_1	i=1 to 50 (6)			
Hi_I_2				
Hi_I_3				
Hi_I_N				
THD_V_1				
THD_V_2				
THD_V_3				
THD_U_{12}				
$THD\ \_U_{23}$				
$THD\ \_U_{23}$				
THD_I_1				
THD_I_2				
THD_I_3				
THD_I_N				
V_1 Angle				
V_2 Angle				
V_3 Angle				
U_{12} Angle				
U_{23} Angle				
U_{31} Angle				
I_1 Angle				
I_2 Angle				
I_3 Angle				

Table 26

(3) Not a significant value

(4) Always = 0

(5) Calculated

6) Order 7 for 400 Hz

9. GLOSSARY OF TERMS

Symbol or Terminology	Description
≂	AC and DC components.
∼	AC component only.
═	DC component only.
	Inductive phase shift.
	Capacitive phase shift.
°	Degree.
%	Percentage.
CF	Crest factor (Peak Factor) in current or voltage: ratio of the peak value of a signal to the RMS value.
Cos φ	Cosine of the phase shift of the fundamental voltage with respect to the fundamental current.
DC	DC component (current or voltage)
DataViewSync™	By enabling DataViewSync™ in the PEL Control Panel, data transmitted by your device can be received on your PC by passing via DataViewSync™. DataViewSync™ is hosted by AEMC® Instruments.
Ep	Abbreviation for active energy.
Eq	Abbreviation for reactive energy.
Es	Abbreviation for apparent energy.
Frequency	Number of full voltage or current cycles in one second.
Fundamental Component	Component at the fundamental frequency.
Harmonics	In electrical systems, voltages and currents at frequencies that are multiples of the fundamental frequency.
Hz	Frequency of network studied.
I	Abbreviation for current.
I-CF	Crest (peak) factor of current.
I-THD	Total harmonic distortion of current.
Ix-Hh	Current value or percentage for harmonic order n.
L	Phase (Line).
MAX	Maximum value
Measurement Method	All measurement methods associated to an individual measurement.
MIN	Minimum value
Nominal Voltage	Reference voltage of a network.
Order of a Harmonic	Ratio of the frequency of the harmonic to the fundamental frequency; a whole number.

Symbol or Terminology	Description
P	Abbreviation for active power.
PF	Power Factor: ratio of active power to apparent power.
Phase	Temporal relationship between current and voltage in alternating current circuits.
Q	Abbreviation for reactive power.
RMS	RMS (Root Mean Square) value of current or voltage. Square root of the mean of the squares of the instantaneous values of a quantity during a specified interval.
S	Abbreviation for apparent power.
Tan Φ	Ratio between reactive power and active power.
THD	Total Harmonic Distortion. The total harmonic distortion describes the proportion of the harmonics of a signal with respect to the fundamental RMS value (%f).
U	Phase-to-phase voltage
u2	Phase-to-neutral voltage unbalance
U-CF	Phase-to-phase voltage crest factor
Uh	Phase-to-phase voltage harmonic
Unbalance in voltage in a polyphased electrical power network	Status where efficient values for voltages between conductors (fundamental component) and/or differences in phase between successive conductors are not equal.
Ux-Hn	Phase-to-phase voltage value or percentage for harmonic order n.
Uxy-THD	Total phase-to-phase voltage harmonic distortion.
V	Abbreviation for phase-to-neutral voltage or the unit **volt**.
V-CF	Voltage crest (peak) factor.
VA	Apparent power unit (Volt - Ampere).
var	Reactive power unit.
varh	Reactive energy unit.
V-THD	Voltage crest (peak) factor.
Vh	Phase-to-neutral voltage harmonic.
V	True RMS phase-to-neutral voltage.
V-THD	Total harmonic distortion of phase-to-neutral voltage.
Vunb	Phase-to-neutral voltage unbalance.
Vx-Hn	Phase-to-neutral voltage value or percentage for harmonic order n.
W	Active power unit (Watt).
W·h	Active energy unit (Watt - hour).

Table 27

9.1 PREFIXES OF INTERNATIONAL SYSTEM (SI) UNITS

Prefix	Symbol	Multiplies by
milli	m	10^{-3}
kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}

Table 28

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