User Manual

ENGLISH

AEMC INSTRUMENTS

CHAUVIN ARNOUX GROUP

Power & Energy Logger

Model PEL 115

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 its published specification.

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 #: 2137.56 / 2137.58

Model #: PEL 115

Please fill in the appropriate date as indicated:

Date Received: ____________________________

Date Calibration Due: ________________________

AEMC® INSTRUMENTS
CHAUVIN ARNOUX GROUP

Chauvin Arnoux®, Inc.
d.b.a AEMC® Instruments
www.aemc.com

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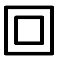
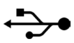
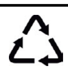
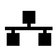
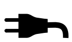
1. INTRODUCTION

Thank you for purchasing an AEMC® Instruments **Power & Energy Logger Model PEL 115**.

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
	The product has been declared recyclable.
	Indicates Important information to acknowledge
	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.
	Ethernet socket (RJ45)
	Power Source
	Ground/Earth

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/EN 61010-2-030, the leads comply with IEC/EN 61010-031 for voltages of 1000 V in measurement CAT IV and the current sensors comply with IEC/EN 61010-2-032.

Carefully read and understand all required precautions when using this instrument. Failure to comply with these safety instructions can create a risk of electric shock, fire, and explosion; resulting in destruction of the instrument, injury to the user, and damage to the facility. If the instrument is used other than as specified in this manual, the protection provided by the instrument may be impaired.

- Do not use the instrument in an explosive atmosphere or in the presence of flammable gas or smoke.
- Do not use the instrument on electrical networks with a rated voltage or category higher than those listed for the instrument.
- Respect the maximum rated voltages and currents between terminals and in relation to ground/earth.
- Do not use the instrument if it seems to be damaged, incomplete, or poorly closed.
- Before each use, check the condition of the insulation of the leads, the instrument, and all accessories. Any insulation that appears damaged (even partially) must be taken out of service for repair or disposal.
- Use leads and accessories for voltage according to IEC 61010-031 and measurement categories at least equal to those of the instrument. An accessory with a lower category reduces the category of the combined instrument/accessory combination to that of the accessory.
- Respect the environmental conditions of use listed in this manual.
- Do not modify the instrument or replace components using substitute parts. Repairs and adjustments must be performed by AEMC® Instruments.
- Use personal protection equipment when conditions require it.
- Keep hands and fingers away from unused terminals and behind the physical guard when handling the leads, test probes, and alligator clips.

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

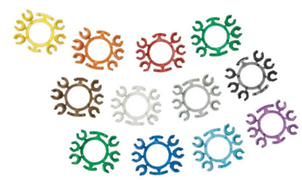
Power & Energy Logger
Model PEL 115
Cat. #2137.56 (no sensors)
Cat. #2137.58 (sensors)

(5) Black Leads - 10 ft (3 m)
(waterproof cap)
with (5) Black Alligator Clips
Cat. #2140.73
Replacement is Quantity of (1).

Extra Large Carrying Bag
with Rubber Bottom
Cat. #2133.76

Power Adapter 110/230 V
w/ US Power cord
Cat. #5000.19 (CA PA30W)

Cable - 5 ft USB
Replacement is 10 ft USB Cable
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)

USB Drive
(DataView® and User Manual)

(4) AmpFlex® Sensor 24"
Waterproof, IP67
Model 196A-24-BK
Cat. #2140.75
(Only Shipped with PEL 115
Cat. 2137.58)

Also Included:

- 9.6 V NiMH Battery (Installed)
- Measuring Instrument Safety Data Sheet (Multilingual)
- Declaration of Conformity
- Test Report
- Quick Start Guide

Set of (4) large and
(5) small
Caps (watertight)
Cat. #5000.67

1.6 ORDERING INFORMATION

Power & Energy Logger Model PEL 115 (no sensors) .... **Cat. #2137.56**
Includes extra large carrying bag with rubber bottom, (5) black leads 10 ft (3 m) (waterproof cap) with (5) black alligator clips, power adapter 110/230 V with US power cord, Cable - 5 ft USB, SD-card (8 GB), USB SD - card reader, set of (12) color input ID markers, 9.6 V NiMH battery (installed), set of (4) large and (5) small caps (watertight), quick start guide, and USB drive with DataView® software and user manual.

Power & Energy Logger Model PEL 115 (with four 196A-24-BK sensors) .... **Cat. #2137.58**
Includes extra large carrying bag with rubber bottom, (4) AmpFlex® sensors 24 in (waterproof - IP67) Model 196A-24-BK,(5) black leads 10 ft (3 m) (waterproof cap) with (5) black alligator clips, power adapter 110/230 V with US power cord, Cable - 5 ft USB, SD-card (8 GB), USB SD - card reader, set of (12) color input ID markers, 9.6 V NiMH battery (installed), set of (4) large and (5) small caps (watertight), quick start guide, and USB drive with DataView® software and user manual.

1.6.1 Accessories

Pole Mounting Kit .... **Cat. #2137.82**

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 10” Model MA193-10-BK .... **Cat. #2140.48**

MiniFlex® Sensor 14” Model MA193-14-BK .... **Cat. #2140.50**

MiniFlex® Sensor 14” Model MA196-14-BK (Waterproof, IP67) .... **Cat. #2140.79**

MiniFlex® Sensor Model MA194-24-BK.. **Cat. #2140.80**

AC/DC Current Probe Model E94... **Cat. #2140.82**

1.6.2 Replacement Parts

Extra Large Carrying Bag with Rubber Bottom .... **Cat. #2133.76**

Cable - 10 ft (3 m) USB Type A to Type B .... **Cat. #2136.80**

Replacement - (1) Set of (12) color input ID markers...................................... **Cat. #2140.45**

Lead – One 10 ft (3 m) Black Lead (Waterproof cap) (Rated 1000 V CAT IV) &
One Black Alligator Clip (Rated 1000 V CAT IV, 15 A, UL)................................. **Cat. #2140.73**

AmpFlex® Sensor 24” (Waterproof - IP67) Model 196A-24-BK .... **Cat. #2140.75**

Power adapter (replacerment) 110/230 V with US power cord .... **Cat. #5000.19**

USB SD - card reader.. **Cat. #5000.45**

Replacement - Caps (watertight) set of (4) large and (5) small............................ **Cat. #5000.67**

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

2. FEATURES

2.1 DESCRIPTION

The Power & Energy Logger Model PEL 115 is a DC, single-phase, split-phase, and three-phase (Y and Δ) power and energy logger contained within a rugged sealed housing.

The PEL 115 provides all the necessary functions and features for recording power/energy data for most (50, 60, 400) Hz and DC distribution systems worldwide. The instrument is designed to operate in 1000 V CAT IV environments for full outdoor or indoor use and is waterproof (IP67) and resistant to sunlight (UL746C F1).

The instrument measures phase-to-phase (U_{12}, U_{23}, U_{31}), phase-to-neutral (V_1, V_2, V_3) and neutral-to-ground/earth (V_{NE}) voltage up to 1000 V in measurement CAT IV, with pollution degree 4 (IEC 61010). The instrument also measures phase (I_1, I_2, I_3 and neutral (I_N) current, using a variety of external current probes/sensors.

The instrument allows for management of 17 types of connection or power distribution networks, including single-phase, split-phase, three-phase 3-wire, three-phase 4-wire, open, and DC 2-, 3- and 4-wire.

This measurement data is then used to calculate:

- Power (**W**-active power, **var**-reactive power and **VA**-apparent power)
- Energy (**VAh**-apparent energy, **Wh**-active energy at source and load and **varh**-4 quadrant reactive energy
- 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)

The instrument also has the following additional functions:

- Direct measurements of voltages up to 1000 V CAT IV.
- Direct measurements of currents from 5 mA to 12,000 A depending on the current sensors.
- Measurements of the neutral current on the 4th current terminal.
- Measurements of the voltage between earth and neutral on the 5th voltage terminal.
- Measurements of the fundamental, unbalance, and harmonic active powers.
- Measurement of current and voltage unbalances by the IEEE 1459 method.
- Voltage and current harmonics up to the 7th at 400 Hz.
- Simultaneous RMS and DC measurements on each phase.
- LCD with blue backlighting (simultaneous display of 4 quantities).
- Storage of measured and calculated values on SD or SDHC card.
- Automatic recognition of the various types of current sensor.
- Configuration of the transformation ratios for the current and voltage inputs.
- USB, LAN (Ethernet) and Wi-Fi communication.
- PEL Control Panel (distributed with the DataView® software) for data recovery, configuration, and real-time communication with a PC.
- Android application to communicate in real time and configure the PEL from a smartphone or a tablet.
- DataViewSync™ to communicate using private IP addresses.
- Sending of periodic reports by email.

2.2 FRONT PANEL

The instrument front panel interface includes LED status indicators, screens that appear on the LCD, and buttons to navigate these screens, select options, and enter data. The connectors have elastomer caps that ensure a tight seal (IP67).

Figure 1

1	QR Code
2	(7) Status Indicators
3	External Power Connector for optional power/battery charger option
4	RJ45 Ethernet Connector
5	USB Connector
6	SD-card Slot
7	LCD
8	Directional Keypad: (4) Navigation Buttons and Enter Button
9	Control Button
10	Power Button
11	Bag to stow (4) large & (5) small watertight current terminal caps

Table 1

2.3 INPUT TERMINALS

The instrument provides four current and five voltage input terminals for connecting to the electrical network under test. The tight terminal caps keep the threaded terminals waterproof (IP67) when not in use.

The instrument ships with five female **banana** voltage leads that can be screwed onto the threaded voltage terminals.

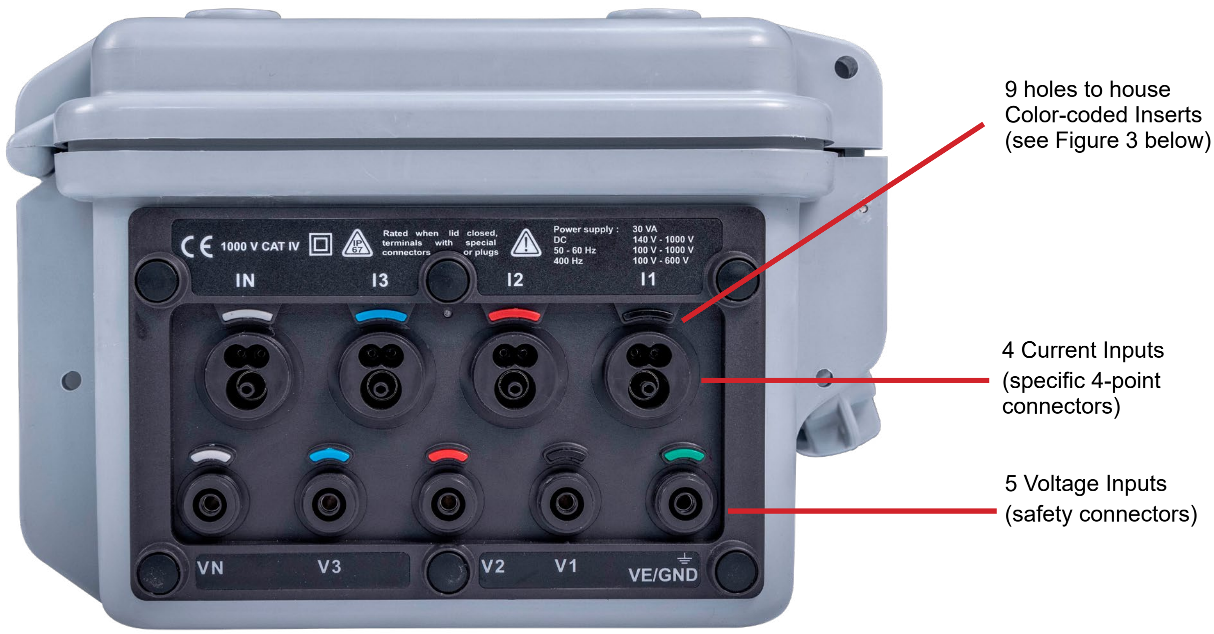


Figure 2

The number and configuration of probes and voltage leads depend on the hookup type. To help organize these connections, 12 sets of color-coded rings and inserts are supplied with your instrument. Use these ID markers to identify the leads and terminals.

- Detach the appropriate inserts and place them in the holes provided over 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 connect to the terminal.

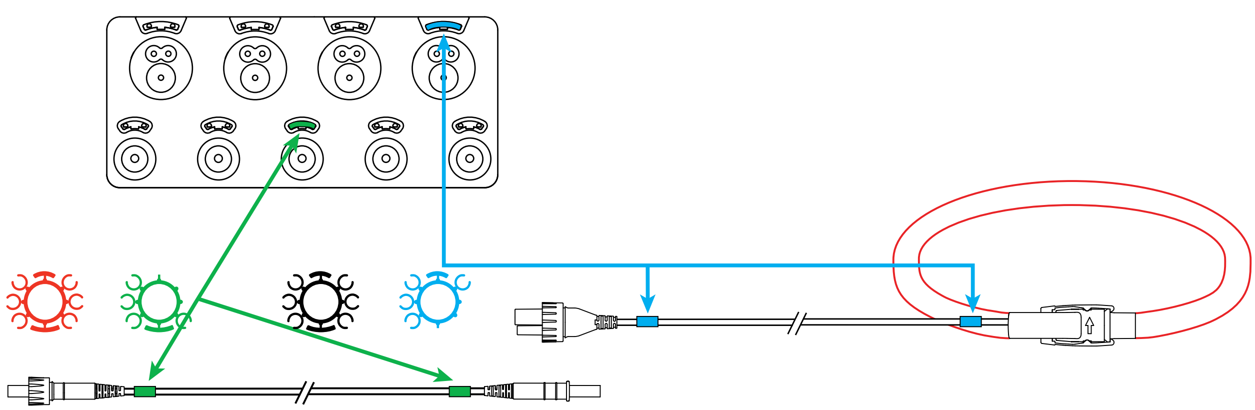


Figure 3

2.4 BUTTON FUNCTIONS

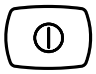
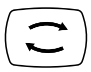
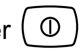
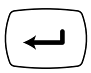
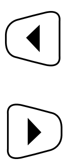
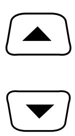
BUTTON	DESCRIPTION
	**Power:** - Turns the instrument ON or OFF when running on battery power. - The instrument cannot be turned OFF via the Power button while it is running on external AC or line input power or when a recording is in progress or pending.
	**Control (Start/Stop):** - Starts or stops a data recording session. - Enables or disables Wi-Fi. - When pressed and held down simultaneously with the Power  button for 2 sec, enables/disables the line power feature.
	**Enter:** - In Configuration Mode, selects a parameter for editing. This initiates the edit mode (the selected parameter blinks). Pressing this button again saves the modification. - In Measurement Mode, displays additional information for some measurement screens. - In Energy Mode, displays partial energy data. - In all other modes, this button is inactive.
	**Left and Right:** - Changes modes. Note that this functionality is **circular** – pressing the Right button ► while in Configuration Mode navigates to the top-level Measurement screen; pressing the Left button ◄ while in Measurement Mode goes to the top-level Configuration screen. - In edit mode, these buttons select editable parameters.
	**Up and Down:** - When editing parameters in Configuration Mode, these buttons cycle through the available options for the selected setting. - In all other modes, these buttons navigate through the individual screens.

Table 2

2.5 LCD

The Percentage of Range bargraphs indicate the percentage (0 to 100) % of full range or full load as defined by the user through the PEL Control Panel (DataView® software).

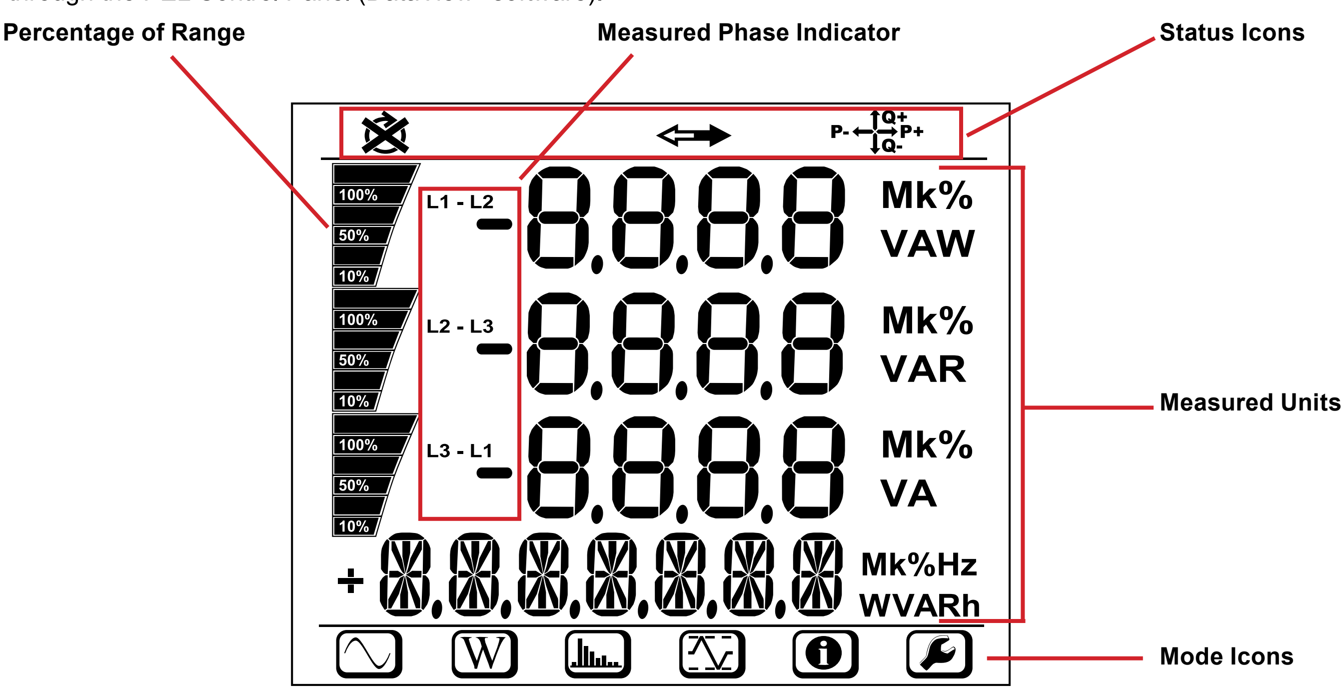


Figure 4

2.5.1 Status and Mode Icons

The status & mode icons located on the top and bottom of the display control the data and information displayed.

The table below outlines status and mode icon definitions.

STATUS ICONS	
	Indicates (1) the phase order may be incorrect, or (2) there is a missing phase. This icon only appears in Measurement Mode.
	Indicates data available for recording.
P- P+ Q+ Q-	Indicates the current power quadrant.

Table 3

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).

NOTE: When the instrument is ON and there is no user activity for approximately three minutes, the LCD automatically enters backlight Standby Mode. In this mode, measurements and recordings stay active but the LCD backlight turns OFF. To restore the backlight, press any navigation button.

MODE ICONS	
	Real-time Measurement Mode: Displays the measurement values for voltage, current, power, frequency, power factor, and tangent angle.
	Power and Energy Mode: Displays the energy values for reactive energy, apparent energy, and kilowatt hour.
	Harmonics Mode: Displays harmonics for current and voltage.
	Max Mode: Displays the maximum values for the measurement and energy values.
	Information Mode: Displays electrical hookup and other instrument-related information (these screens are read-only).
	Configuration Mode: Displays screens containing user-selectable configuration settings and options.

Table 4

2.5.2 Status Indicators

On the left side of the front panel is a vertical row of LED Indicator icons (see § 2.2, Figure 1, item 2) which provide the following information:

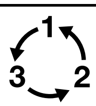
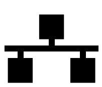
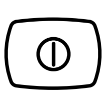
INDICATOR	COLOR	STATUS
	GREEN	**External Power** - Indicator lit green: instrument is ON and currently running on external AC power - Indicator OFF: instrument is running on battery or phase power
	ORANGE / RED	**Battery** - Indicator OFF: battery is fully charged (connected or not connected to external 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
	RED	**Phase Order** - Indicator OFF: phase rotation order correct - Indicator binking red: phase rotation order incorrect
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.
	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
	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
	GREEN / YELLOW	**Ethernet** Green Indicator - Indicator OFF: ethernet link is not activated - Indicator blinking green: ethernet link is activated Yellow Indicator - 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
REC	RED	**Recording** - Indicator OFF: not recording - Indicator blinking red: recording session programmed - Indicator lit red: recording session in progress
	GREEN / ORANGE	**Power Supply** - Indicator lit green: instrument is running on power supplied by the line voltage inputs - Indicator not lit: blinking orange: ▪ instrument is powered by the battery ▪ supply by the voltage inputs is either deactivated or the supply voltage is too low (see § 3.1.4)

Table 5

2.6 SD-CARD

NOTE: The PEL 115 is shipped with a formatted and installed SD-card ready for use.

Data recording sessions are stored on the SD-card.

The PEL 115 accepts SD, SDHC and SDXC cards, FAT32 formatted, up to a maximum 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.

To install an SD-card:

1. Locate the SD-card slot on the front panel of the instrument (see § 2.2, Figure 1, item 6) and pull open the attached protective cap marked SD.
2. Ensure that the write-protect sliding tab on the card is in the **unlock** position (towards the metal contacts).

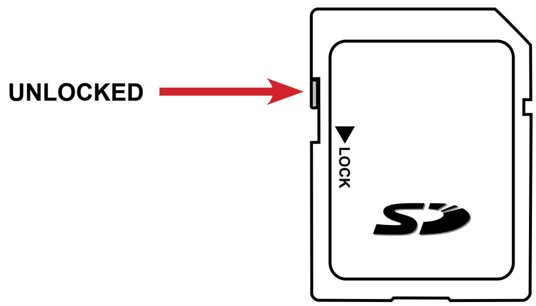


Figure 5

3. Insert the SD-card into the card slot, with the metal contacts facing up (towards the top of the instrument).
4. Press the SD-card into the card slot until it clicks into place.
5. Press the attached protective cap back onto the SD-card slot to ensure card slot is waterproof.
6. If the SD-card is not formatted, the SD LED illuminates red.
   To format the installed card, do the following:
   (a) Open the PEL Control Panel.
   (b) Click **Instrument** in the menu bar and select **Configure.**
   (c) Click **Format SD-card** in the General tab of the Configure Instrument dialog box.
   (d) Click **Yes** to confirm.

When the card is installed and ready for use, the SD LED illluminates steady green. To remove a card, press down on it until the card unclicks. It will pop up, allowing you to pull it from the slot.

3. CONFIGURATION

NOTE: Prior to changing any setup or configuration setting, ensure that no recording is active or pending.

Before using the instrument for the first time, ensure the battery is fully charged (see § 3.3) and that the instrument is ready for operation. You must also configure the instrument for the hookup type appropriate for the electrical distribution system under test.

The PEL must be configured before recording. The various steps in this configuration are:

- Set up the USB link, Ethernet link or 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 if necessary the nominal primary current of the neutral.
- Choose the aggregation period and additional recording options (aggregated and 1-s harmonics, 1-s and 200-ms trend).
- Define alarm conditions.

This configuration is done in the Configuration Mode (see § 3.6) or by using the PEL Control Panel software (see § 6). To prevent accidental modifications, the PEL cannot be configured while recording or if a recording session has been programmed.

3.1 TURNING INSTRUMENT ON AND OFF

3.1.1 Turning ON

- **On AC power or phase voltage power**, the instrument automatically turns ON when connected.
- **On battery power**, you must press the **Power** ⏻ button for > 2 sec to turn the instrument ON. The green indicator below the Power button will light. Note that the instrument will also turn ON if active voltage leads are connected.

NOTE: The battery automatically starts charging when the PEL is connected to a power or voltage source. The battery life is approximately one hour when fully charged. This enables the instrument to continue to operate if there is a brief power outage.

3.1.2 Turning OFF

When the PEL is disconnected from the power source and recording is over, the PEL turns itself off automatically after (3, 10, or 15) minutes depending on the programmed setting. Auto power-off can be disabled through the PEL Control Panel.

You cannot turn the PEL OFF while it is connected to a power source or while recording is in progress or pending. This is a precaution intended to prevent any involuntary stoppage of a recording session by the user.

First check to see whether or not a recording is scheduled or in progress (the **REC** LED is lit RED when a recording is active). If so, either stop the recording, or wait until it is finished.

The procedure for turning the instrument OFF depends upon the power source.

Then do one of the following:

- **AC power (indicated when the LED is lit):** Unplug the AC power adapter, and then press ⏻ for > 2 sec. When all LEDs light simultaneously, release ⏻.
- **Phase voltage power (indicated when ⏻ lights green):** Disconnect the voltage terminal leads from the instrument, then press ⏻ for > 2 sec and release ⏻ when all LEDs light simultaneously.
- **Battery power**: Press ⏻ for > 2 sec and release ⏻ when all LEDs light simultaneously.

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.

3.1.4 Deactivation of Supply via Voltage Inputs

Supply via the voltage inputs consumes from 10 W to 15 W. Some voltage generators cannot withstand this load. This applies to voltage calibrators and to capacitive voltage dividers. If you want to make measurements on these devices, supply to the instrument via voltage inputs must be deactivated.

To accomplish this, press the **Control** button and **Power** button simultaneously for > 2 sec. The Power button will then blink orange.

NOTE: To supply power to the instrument and charge the battery, it is necessary to use the AC power adapter included with the instrument.

3.2 POWERING INSTRUMENT

The instrument can operate on three different sources of power:

- External power provided by plugging into an AC outlet with the AC power adapter. When you connect the instrument to an AC outlet, it automatically turns ON. The instrument will always run on external AC power when plugged in, even if phase power and/or battery power are also available.
- Phase power provided through line voltage at the terminals. If AC power adapter is disconnected, the instrument runs on phase voltage power if it is available and enabled.
- Battery backup power. If neither external AC power nor phase voltage is available, the instrument runs on battery power.

3.2.1 Phase Voltage Power

Powering the instrument through phase voltage power requires no special preparation or equipment; simply connect two voltage leads to an AC power line, connect the leads to the instrument using available voltage terminals (see § 3), and unplug the external AC adapter if connected. By default, the instrument will immediately begin drawing phase power from the line.

The Power button illuminates green when the instrument is running on phase power. In this situation, the instrument cannot be turned OFF via the Power button.

Note that you cannot power the instrument from a DC network. Also note that if the AC adapter is plugged in, the instrument will use this source instead of phase power.

You can disable the phase power feature by pressing and simultaneously for 2 sec. When you do this, the button blinks red once every 2 sec, indicating the instrument cannot run on phase power.

Pressing and simultaneously for 2 sec re-enables this feature. You can also disable and enable this feature through the PEL Control Panel (see § 6).

3.3 CHARGING BATTERY

Before the first use, start by fully charging the battery. A completely discharged battery will take approximately 5 h to fully charge. The PEL 115 is equipped with a NiMH battery, which provides power in the event of a disruption in the phase power or external AC power. The battery is charged when the instrument is connected to a voltage source. However, if supply via the voltage inputs has been deactivated (see § 3.1.4), the AC power adapter must be used.

- Locate the external power connector on the front panel of the instrument and open the attached protective cap (see § 2.2, Figure 1, item 3).
- Connect the power adapter to the instrument. The instrument will turn ON. The indicator lights orange while the battery is charging and will turn off when the battery is fully charged.

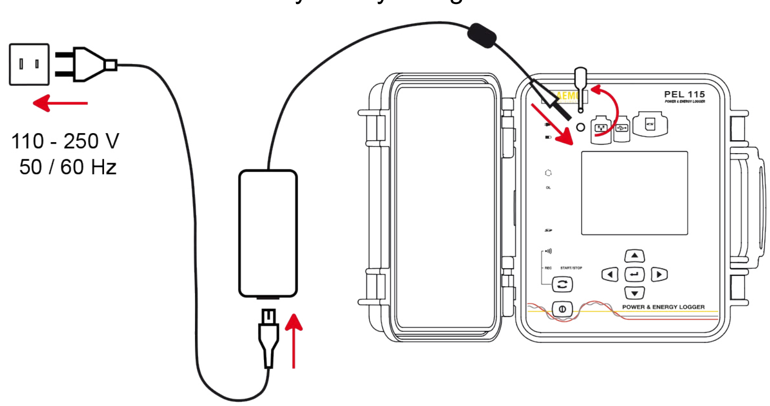


Figure 6

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 front panel of the instrument and open the attached protective cap (see § 2.2, Figure 1, items 4 and 5).
- 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 with the PEL Control Panel (see § 6)

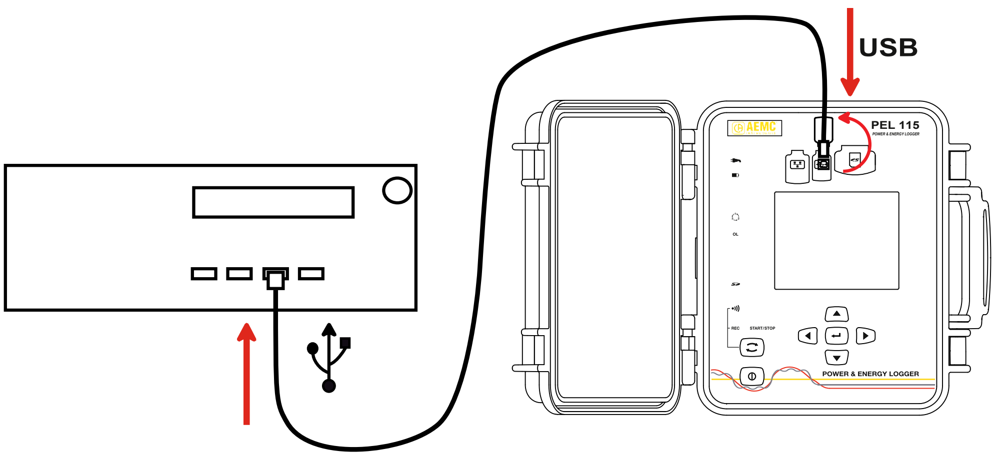


Figure 7

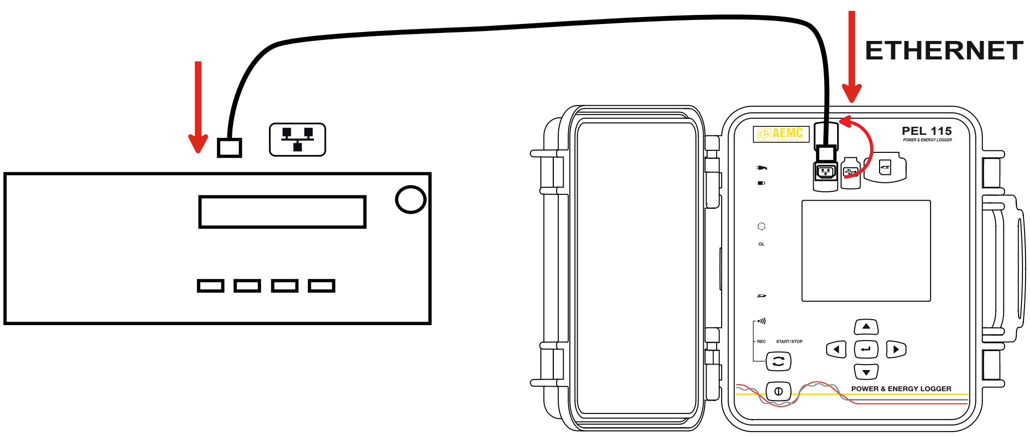


Figure 8

Then, for whichever link was chosen, open the PEL Control Panel (see § 6) to connect the instrument to the PC.

NOTE: Connecting the USB or Ethernet cable does not power up the instrument or charge the battery.

For the LAN Ethernet link, the PEL has an IP address.

When you configure the instrument with the PEL Control Panel, if the **Activate DHCP** (dynamic IP address) box is checked, the instrument sends a request to the network's DHCP server to obtain an IP address automatically.

The Internet protocol used is UDP or TCP. The port used by default is 3041. It can be modified in the PEL Control Panel so as to enable connections between the PC and several instruments behind a router.

The auto IP address mode is also available when the DHCP is selected and the DHPC server has not been detected within 60 seconds. The PEL will use **169.254.0.100** as default address. This auto IP address mode is compatible with APIPA. A crossed cable may be necessary.

NOTE: You can change the network parameters while connected via a LAN Ethernet link, but once the network parameters have been changed, you will lose connection. For this, it is better to use a USB 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 and hold down the **Control** button. The **REC** and indicators will light in turn for 3 sec each.
- Release the **Control** button while the desired function is lit.
    - If you release the **Control** button while the **REC** indicator is lit, recording will start or stop.
    - If you release the **Control** button while the indicator is lit, the Wi-Fi is activated or deactivated.

NOTE: When you press the **Control** button, if the indicator is blinking, the **Control** button is locked. You must use the PEL Control Panel to unlock the **Control** button.

The data transmitted by the device can:

- go directly to a PC connected to it by Wi-Fi, or
- pass via DataViewSync™ hosted by AEMC® Instruments

DataViewSync™ can be enabled in the PEL Control Panel. DataViewSync™ requires a LAN connection, Wi-Fi or Ethernet.

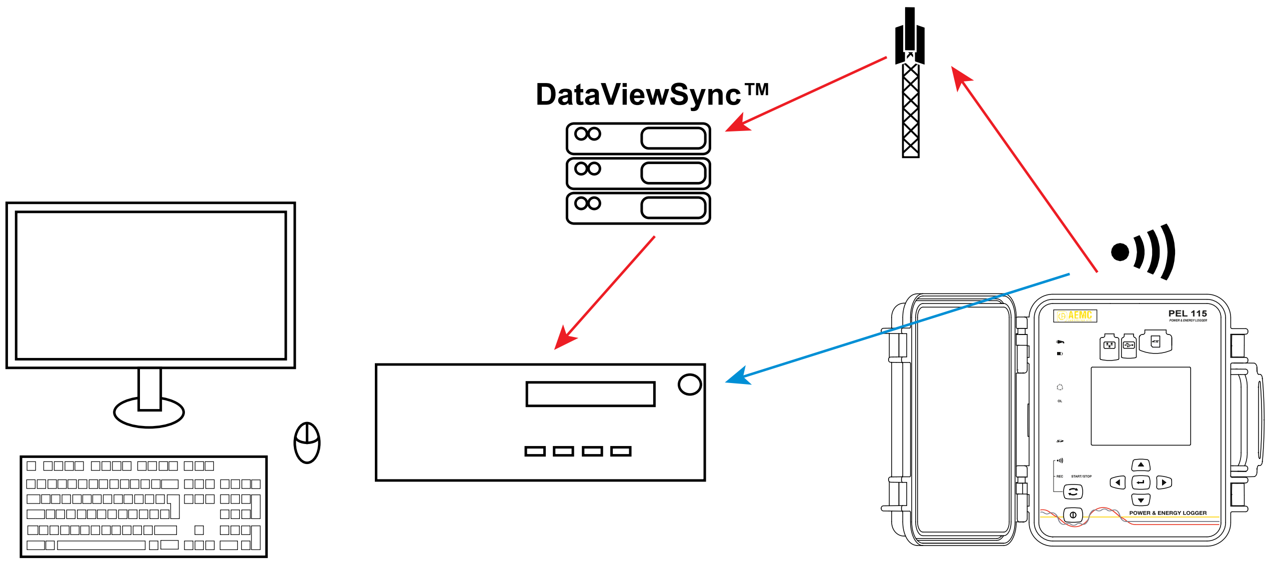


Figure 9

You can also enable and disable Wi-Fi through the PEL Control Panel. In addition, you can change the SSID (Service Set Identifier) name, and define a Wi-Fi password via the PEL Control Panel.

NOTE: The default Wi-Fi password is printed on a label placed inside the instrument's cover.

3.6 CONFIGURING THE INSTRUMENT

Before you can use the instrument for the first time, you must set a number of configuration variables. Full setup and configuration is performed through a computer running the PEL Control Panel (see § 6). This includes setting the instrument's time and date (see 6.5).

In addition, a subset of configuration settings can be performed directly on the instrument via its LCD interface, including:

- Select the hookup for the electrical distribution system under test
- Set voltage and current ratios appropriate for the connected probes or sensors
- Set the aggregation period for a recording session
- Review instrument settings, such as date and time

Before you can perform any configuration on the instrument, the Control button must be enabled. This button is enabled and disabled through the PEL Control Panel. When is disabled, Configuration Mode displays the word **LOCK**, and no configuration screens are available.

NOTE: LOCK also appears if the PEL Control Panel is actively configuring the instrument or if there is a pending or active recording.

If is disabled, enable it as follows:

1. Open the **PEL Control Panel**.
2. Ensure the instrument is connected by checking its status in the PEL Network frame. If not, reconnect it by highlighting the instrument, selecting **Instrument** in the menu bar, and clicking **Reconnect Instrument**.
3. Select the instrument, and click **Instrument** in the menu bar.
4. Select **Configure**. This displays the Configure Instrument dialog box.
5. De-select the checkbox **Lock out the Control button on the instrument front panel**.
6. Click **OK** to save the change.

Consult the PEL Control Panel Help system for assistance in completing the preceding steps.

3.6.1 Configuration Mode

Configuration Mode enables you to change several settings, including:

- Hookup type
- Primary and secondary nominal voltage
- Primary nominal phase current (available only when current sensors are connected)
- Primary nominal neutral current (available only when current sensors are connected)
- Aggregation period

To enter Configuration Mode, press either or until the Configuration icon is highlighted. Note that there are several situations that prevent you from making changes in Configuration Mode:

- The instrument is currently being configured by the PEL Control Panel.
- Local configuration is locked (disabled) through an option in the PEL Control Panel. This prevents configuration even when the instrument is disconnected from the Control Panel.
- A recording session is in progress.

If any of these situations are in effect, the word **LOCK** appears on the screen:

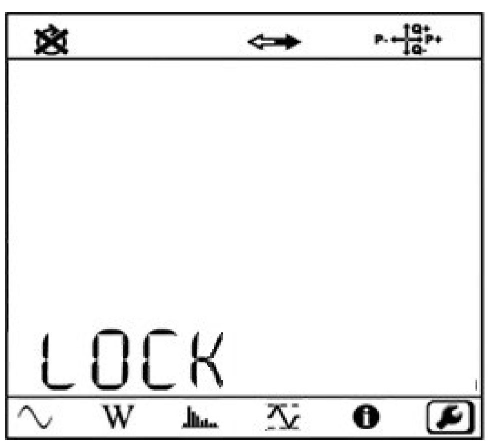


Figure 10

Otherwise, the Hookup configuration screen appears:

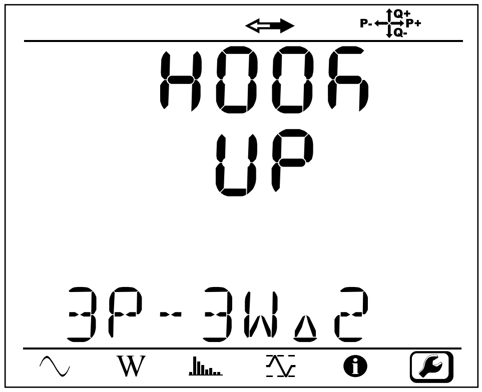


Figure 11

This is the top-level screen in Configuration Mode, and serves as the starting point for all configuration tasks. Use the and buttons to navigate through the different configuration screens.

3.6.2 Type of Distribution System

The Hookup configuration screen lets you select the type of hookup for the electrical distribution system under measurement. This selection must match the physical connection of the current probes/sensors (see § 4).

To change the hookup type, press the **Enter** button. The name of the hookup type blinks. Use the or buttons to navigate through the list to choose another available hookup type.

Designation	Distribution System
1P-2W	1-phase 2-wire
1P-3W	1-phase 3-wire (split phase)
3P-3WΔ2	3-phase 3-wire Δ (2 current probes)
3P-3WΔ3	3-phase 3-wire Δ (3 current probes)
3P-3WΔb	3-phase 3-wire Δ balanced
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-3WY2	3-phase 3-wire Y (2 current probes).
3P-3WY3	3-phase 3-wire Y (3 current probes)
3P-3WO2	3-phase 3-wire Open Δ (2 current probes)
3P-3WO3	3-phase 3-wire Open Δ (3 current probes)
3P-4WO	3-phase 4-wire Open Δ
dC-2W	DC 2-wire
dC-3W	DC 3-wire
dC-4W	DC 4-wire

Table 6

Validate your choice by pressing the **Enter** button. The hookup type stops blinking, indicating you have exited edit mode.

NOTE: This list is not cyclical; pressing while **1P-2W** is displayed, or pressing while **dC-4W** is displayed has no effect.

Press the button to go to the next screen.

3.6.3 Nominal Primary Voltage

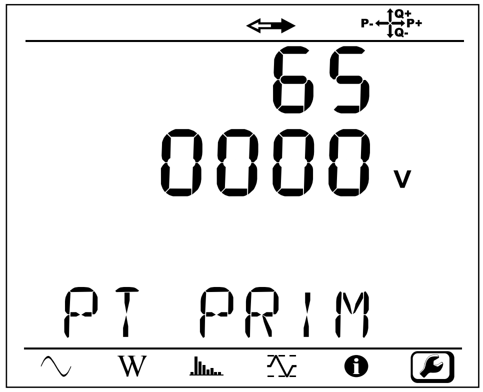


Figure 12

To change the nominal primary voltage, press the **Enter** button. Use the , , and buttons to choose the voltage, between 50 V and 650,000 V.

Validate by pressing the **Enter** button.

Press the button to go to the next screen.

3.6.4 Nominal Secondary Voltage

To change the nominal secondary voltage, press the **Enter** button. Use the , , and buttons to choose the voltage, between 50 V and 1000 V.

Validate by pressing the **Enter** button.

Press the button to go to the next screen.

3.6.5 Nominal Primary Current

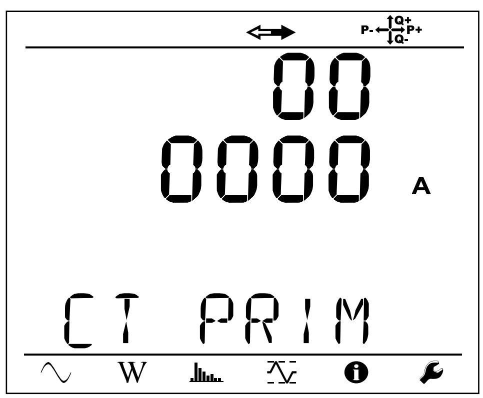


Figure 13

This screen will only be displayed if there is at least one current sensor connected to I1, I2 or I3.

Depending on the type of current sensor, MiniFlex®/AmpFlex®, MN193 5 A range, enter the nominal primary current. To do this press the **Enter** button. Use the , , and buttons to choose the current.

- AmpFlex®/MiniFlex®: 100 A, 400 A, 2000 A or 10,000 A
- MN93: automatic 200 A
- MN193 5 A range: 5 A to 25,000 A
- MN193 100 A range: automatic 100 A
- E94: 10 A or 100 A
- SR193 and MR193: automatic 1000 A

Validate the value by pressing the **Enter** button.

If a probe or sensor is connected to the instrument's neutral input terminal, pressing ▼ at the Primary Nominal Current configuration screen displays the Primary Neutral Current screen. This screen functions similarly to the Primary Nominal Current screen. Allowable values are:

- AmpFlex®/MiniFlex®: 100 A, 400 A, 2000 A or 10,000 A

3.6.5.1 Current Sensors

Connect the current sensors to the instrument.

The current sensors are automatically detected by the instrument. The instrument looks at the I_1 terminal. If there is nothing, it looks at the I_2 terminal, or the I_3 terminal. If the network chosen has a current sensor on the N terminal, it also looks at the I_N terminal.

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

Press the ▼ button to go to the next screen.

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.

3.6.6 Nominal Primary Current of the Neutral

If you connect a current sensor to the current terminal of the neutral, enter its nominal primary current following the same steps as indicated in previous § 3.6.5 Nominal Primary Current.

Press the ▼ button to go to the next screen.

3.6.7 Aggregation Period

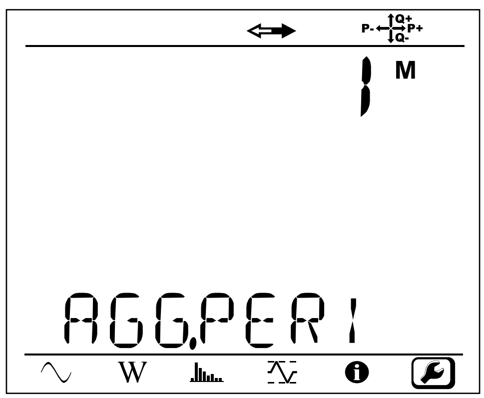


Figure 14

To change the aggregation period, press the **Enter** ↵ button. Use the ▲ and ▼ buttons to choose the value (1 to 6, 10, 12, 15, 20, 30, or 60) minutes.

Validate the value by pressing the **Enter** ↵ button.

3.7 INSTRUMENT INFORMATION

Information Mode enables you to review instrument information and settings.

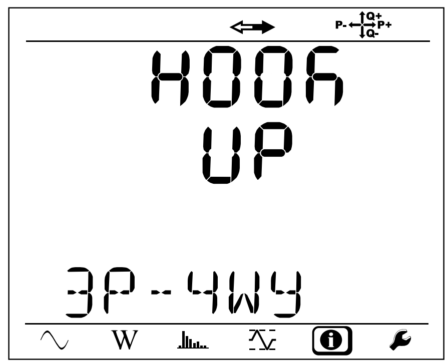
To enter Information Mode:

1. Press ◀ or ▶ until the Information icon is selected.
2. Press ▲ or ▼ to cycle through a series of read-only screens.

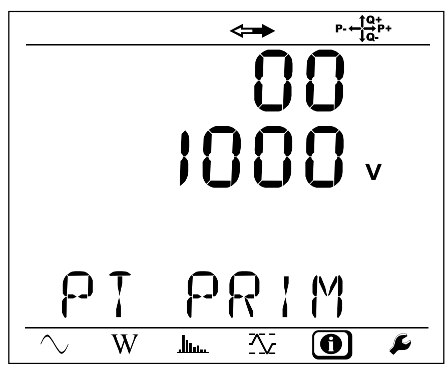
These screens display settings for the following:

- Hookup
- Primary Nominal Voltage
- Secondary Nominal Voltage
- Primary Nominal Current
- Primary Nominal Neutral Current (when available)
- Aggregation Period
- Date and Time
- LAN IP Address
- Wi-Fi IP Address
- Firmware Revision Number

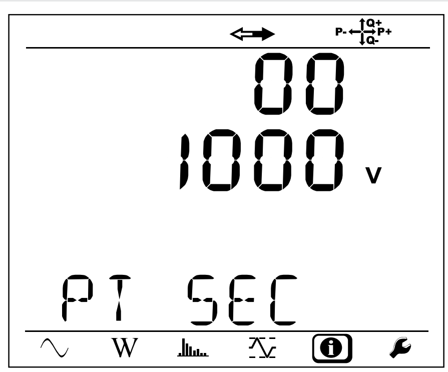
- Type of Network



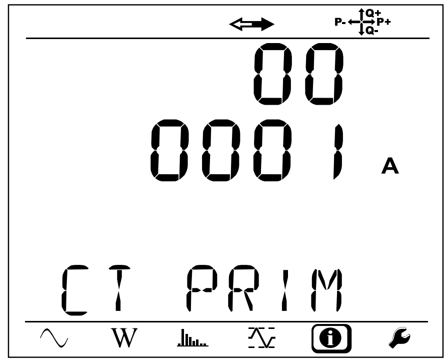
- Nominal Primary Voltage



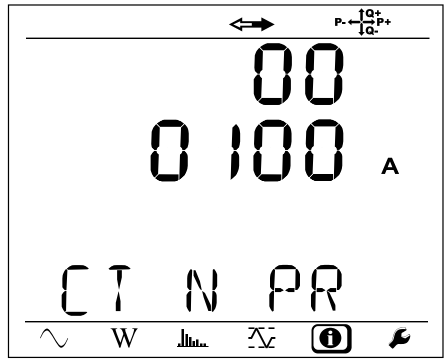
- Nominal Secondary Voltage



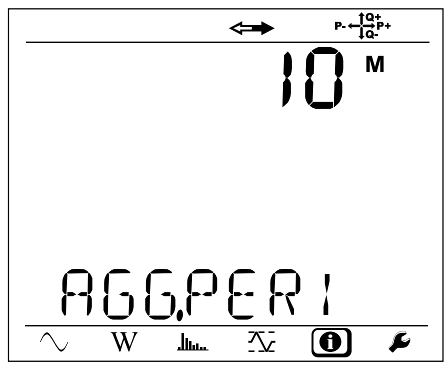
■ Nominal Primary Current



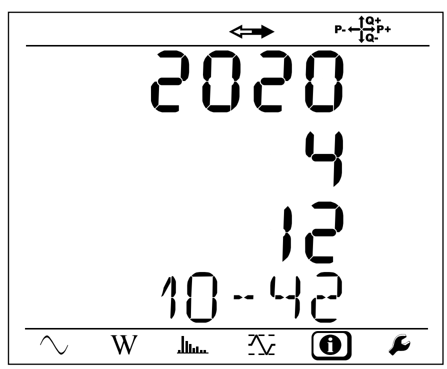
■ Nominal Primary Current of the Neutral (if a sensor is connected to the I_N terminal)



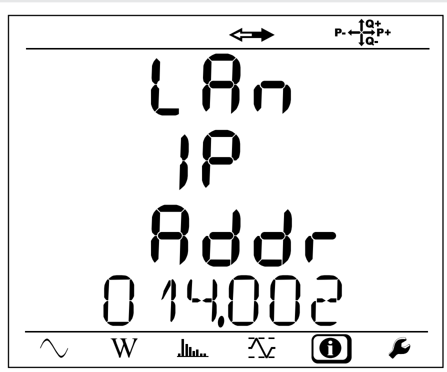
■ Aggregation Period



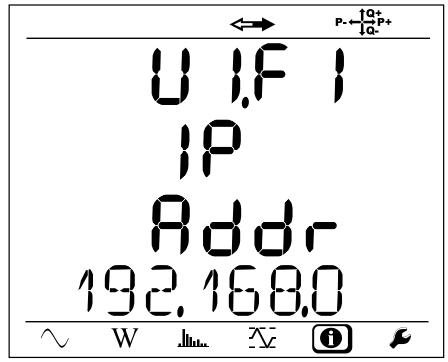
■ Date and Time



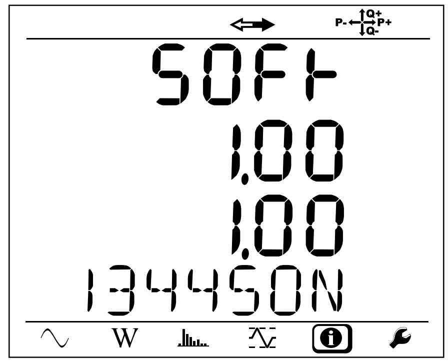
■ IP Address (scrolling)



- Wi-Fi Address (scrolling)



- Software Version
  - 1st number = software version of the DSP
  - 2nd number = software version of the microprocessor
  - Scrolling serial number (also on the QR code label glued to the inside of the cover of the PEL)



NOTE: After three minutes of no activity on the Enter button or Navigation buttons , , or , the display returns to the Measurement Screen .

3.8 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.

3.9 E-MAIL REPORT

When recording data on the PEL 115, 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. Email reports can only be enabled and configured from the PEL Control Panel.

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 and 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 and 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.

4. OPERATION

When the instrument has been configured, it is ready to use.

4.1 HOOKING UP TO THE DISTRIBUTION SYSTEM

Start by connecting the current sensors and the voltage measurement leads to your installation according to the type of distribution network. The PEL must be configured (see § 3.6) for the distribution network selected.

The PEL 115 supports 17 hookup types. For each, the following sections provide:

- **A connection diagram**. This includes a depiction of the instrument's current terminals I_1, I_2, I_3, and I_N (neutral); and voltage terminals V_1, V_2, V_3, V_N, and V_E/GND (ground/earth). The diagram also includes an illustration of how the current probes and voltage leads are connected to electrical lines, neutral, and ground.
- **An icon** showing the direction toward the load, as shown in Figure 15.
- **Instructions** for how to connect the probes and leads.

In each diagram, the top row of terminals connect current probes/sensors, the bottom row connect voltage test leads. The labels on the terminal indicate the line to which the voltage lead or current probe/sensor must be connected.
For example, I_1 connects a current probe/sensor to line 1; I_2 connects to line 2, and so on.

The following instructions assume you will use the neutral current terminal and the ground/earth voltage terminal. Use of these terminals is not strictly required; however they provide a higher level of accuracy when used.

NOTE: For measurements with a neutral, the current can be measured by a sensor or, if there is no sensor, calculated.

NOTE: When connecting to the electrical network, be sure to observe all safety precautions as stated in the documentation that accompanies the probes and sensors.

NOTE: When a recording session has ended and downloaded to a PC, it is possible to change the direction of the current (I_1, I_2, or I_3) using the PEL Control Panel. This makes it possible to correct the power calculations.

NOTE: The alligator clips can be screwed onto the voltage leads, keeping the assembly waterproof.

WARNING: ALWAYS confirm that 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.**

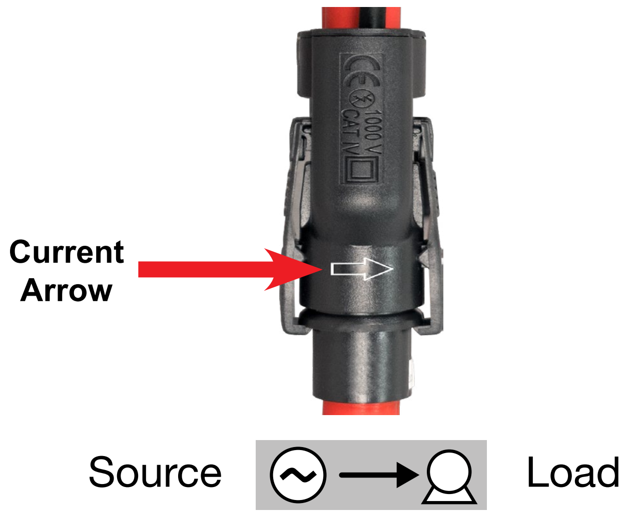


Figure 15

4.2.1 Single-Phase, 2-Wire: 1P-2W

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- I1 current sensor to the L1 phase.
- IN current sensor to the common conductor (optional on this type of network).

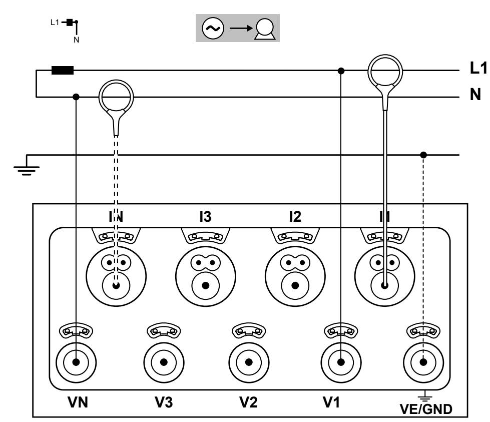


Figure 16

4.2.2 Single-Phase, 3-Wire (Split-Phase From a Center-Tap Transformer): 1P-3W

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- IN current sensor to the neutral (optional on this type of network).
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.

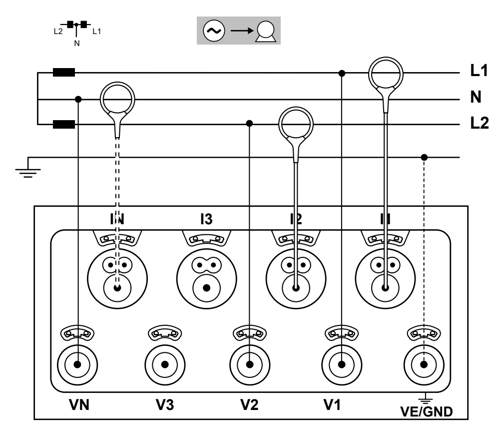


Figure 17

4.2.3. Three-Phase, 3-Wire, Δ (with 2 current probes): 3P-3WΔ2

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- I1 current sensor to the L1 phase.
- I3 current sensor to the L3 phase.

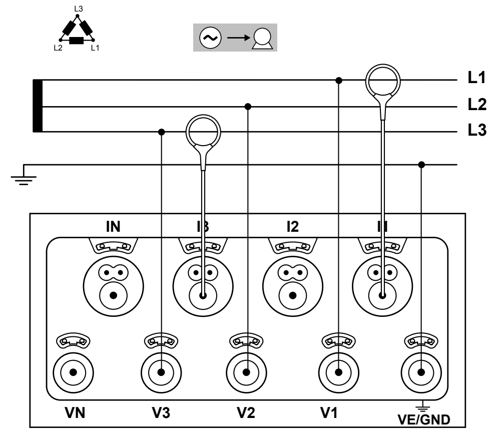


Figure 18

4.2.4 Three-Phase, 3-Wire, Δ (with 3 current probes): 3P-3WΔ3

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

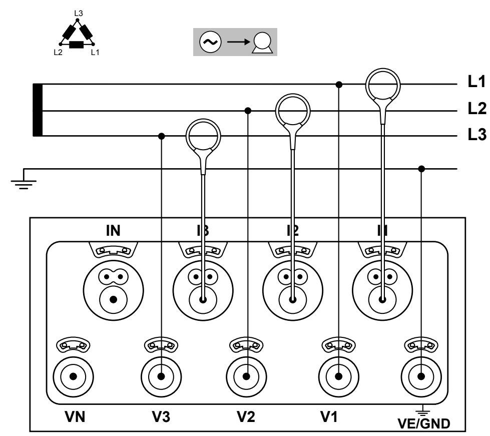


Figure 19

4.2.5 Three-Phase, 3-Wire, Open, Δ (2 current probes): 3P-3WO2

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- I1 current sensor to the L1 phase.
- I3 current sensor to the L3 phase.

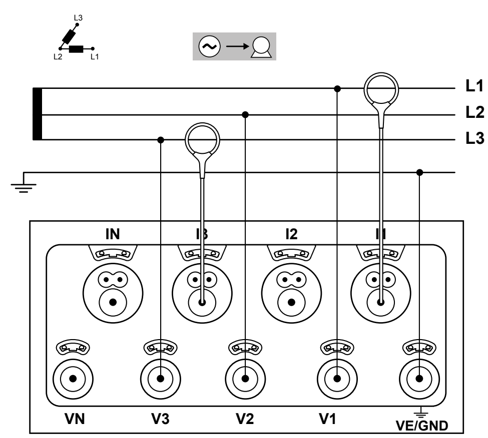


Figure 20

4.2.6 Three-Phase, 3-Wire, Open, ∆ (3 current probes): 3P-3WO3

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

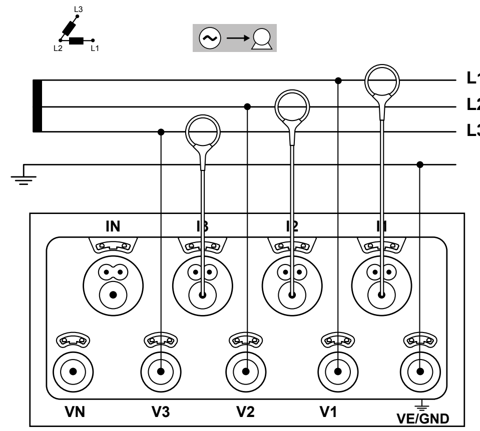


Figure 21

4.2.7 Three-Phase, 3-Wire, Y (with 2 current probes): 3P-3WY2

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- I1 current sensor to the L1 phase.
- I3 current sensor to the L3 phase.

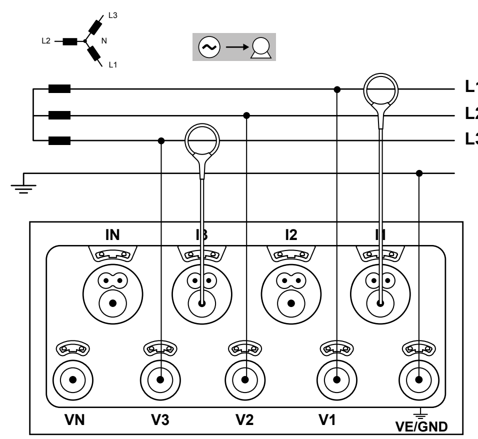


Figure 22

4.2.8 Three-Phase, 3-Wire, Y (with 3 current probes): 3P-3WY

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

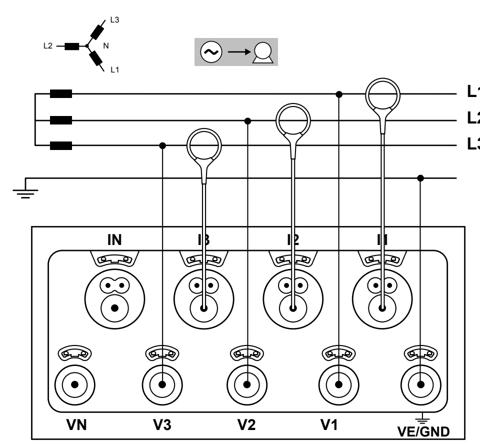


Figure 23

4.2.9 Three-Phase, 3-Wire, ∆, Balanced (with 1 current probe): 3P3W∆b

Connect:

- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- I3 current sensor to the L3 phase.

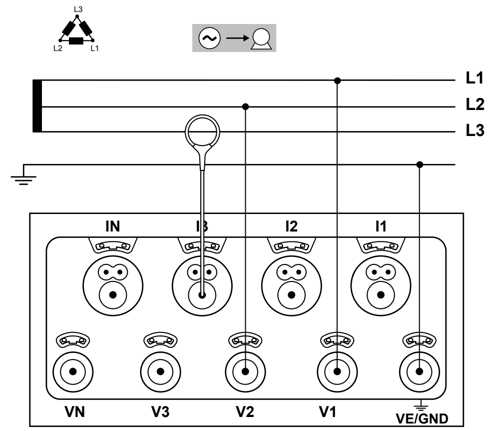


Figure 24

4.2.10 Three-Phase, 4-Wire, Y (with 4 current sensors): 3P-4WY

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- IN current sensor to the neutral.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

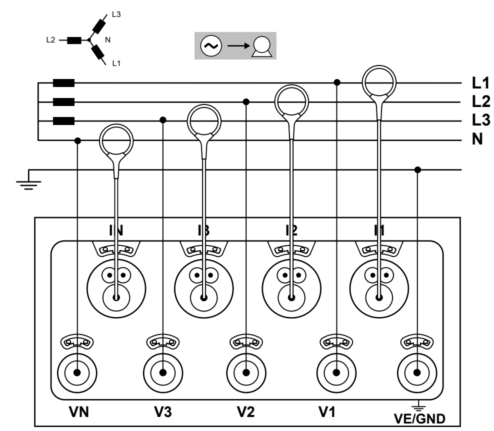


Figure 25

4.2.11 Three-Phase, 4-Wire, Y, Balanced (with 2 current probes): 3P-4WYb

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- IN current sensor to the neutral.
- I1 current sensor to the L1 phase.

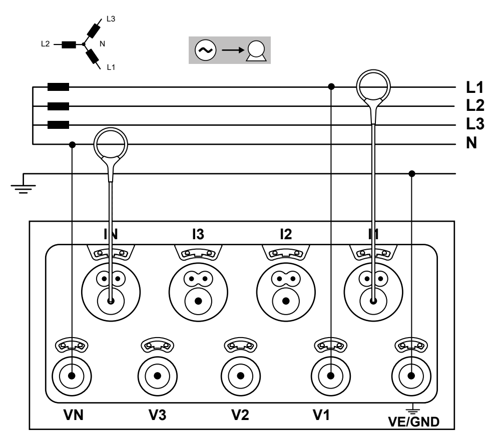


Figure 26

4.2.12 Three-Phase, 4-Wire, Y, 2½-Elements (with 4 current probes): 3P-4WY2

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V3 terminal to the L3 phase.
- IN current sensor to the neutral.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

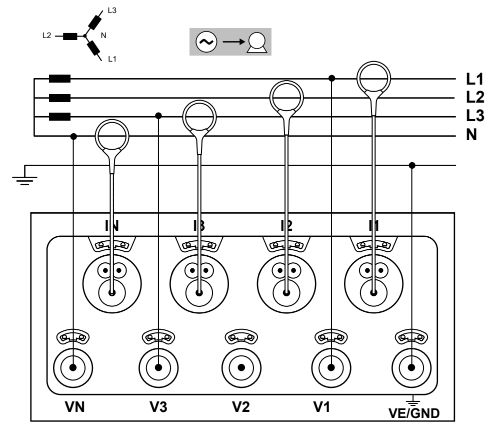


Figure 27

4.2.13 Three-Phase, 4-Wire, Δ (with 4 current probes): 3P-4WΔ

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- IN current sensor to the neutral.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

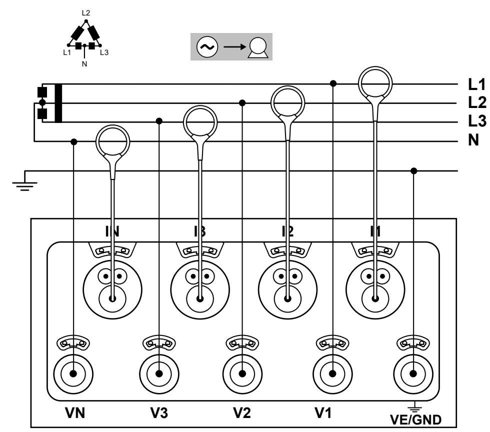


Figure 28

4.2.14 Three-Phase, 4-Wire, Open, Δ (with 4 current probes): 3P-4WO

Connect:

- N terminal to the neutral.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the L1 phase.
- V2 terminal to the L2 phase.
- V3 terminal to the L3 phase.
- IN current sensor to the neutral.
- I1 current sensor to the L1 phase.
- I2 current sensor to the L2 phase.
- I3 current sensor to the L3 phase.

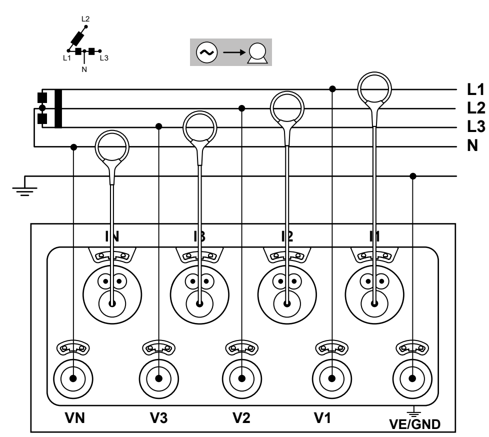


Figure 29

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.**

4.2.15 DC 2-Wire: DC-2W

Connect:

- N terminal to the common conductor.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the +1 conductor.
- IN current sensor to the common conductor.
- Current sensor I1 to the +1 conductor.

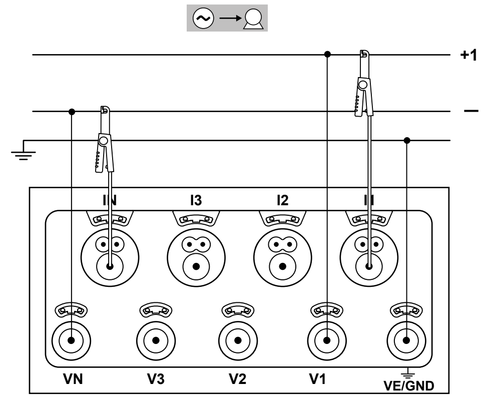


Figure 30

4.2.16 DC 3-Wire: DC-3W

Connect:

- N terminal to the common conductor.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the +1 conductor.
- V2 terminal to the +2 conductor.
- IN current sensor to the common conductor.
- Current sensor I1 to the +1 conductor.
- Current sensor I2 to the +2 conductor.

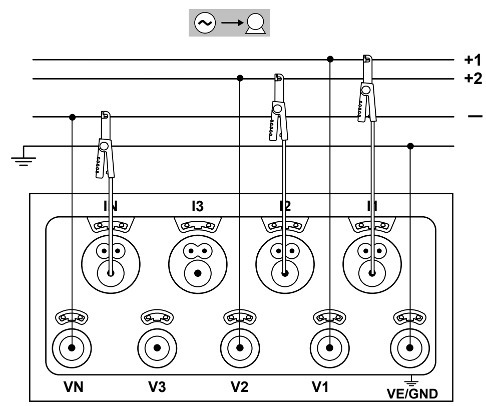


Figure 31

4.2.17 DC 4-Wire: DC-4W

Connect:

- N terminal to the common conductor.
- VE/GND terminal to the earth (optional on this type of network).
- V1 terminal to the +1 conductor.
- V2 terminal to the +2 conductor.
- V3 terminal to the +3 conductor.
- IN current sensor to the common conductor.
- Current sensor I1 to the +1 conductor.
- Current sensor I2 to the +2 conductor.
- Current sensor I3 to the +3 conductor.

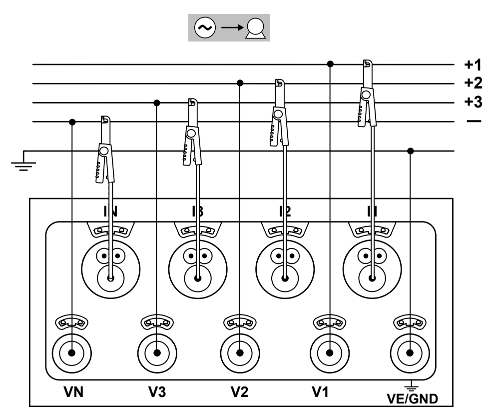


Figure 32

4.3 VIEWING DATA

The PEL 115 has four display modes, represented by the icons at the bottom of the display unit. To change from one mode to another, press the or button.

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.

ICON	DISPLAY MODE
	**Measurement Mode:** Displays real-time data currently being measured by the probes/sensors. This includes voltage, current, power, frequency, power factor, and tangent angle.
	**Energy Mode**: Displays energy use, including reactive energy, apparent energy, and kilowatt hour.
	**Harmonics Mode:** Displays harmonics for currents and voltages.
	**Maximum Mode:** Displays the maximum values for measurement and energy values.

Table 7

Press or to navigate to the desired mode. When a mode is selected, a box appears around its icon at the bottom of the display screen. Each mode provides a set of screens for viewing data. Press or to navigate through these screens. Some of these screens include additional information which you can view by pressing .

For example, several Measurement Mode screens display phase angle information when you press .
Pressing or while viewing an additional information screen returns to the previous screen.

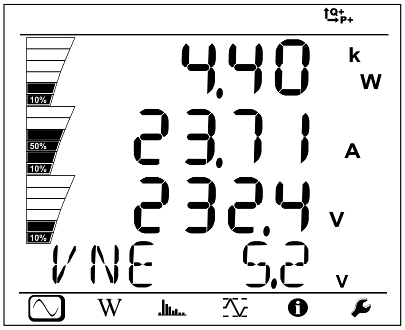
The sequence of screens, and the information each one shows, is dependent on the electrical hookup setting.

The following tables list the screens available in Measurement, Energy, Harmonics, and Maximum Modes. For each screen, the following information is displayed:

- Image of the screen.
- Title of screen, summarizing the information it displays.
- Button to push to view the screen, shown to the left of the screen shot.
- A list of the variables displayed on the screen, shown to the right of the screen image. These variables are defined in the Glossary.

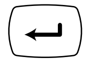
4.3.1 Measurement Mode

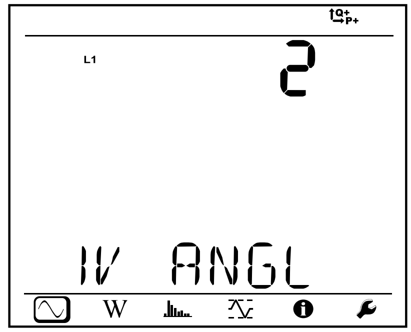
4.3.1.1 Single-Phase, 2-Wire: (1P-2W)



P
I
V
V_N

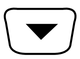
Active power/current/voltage

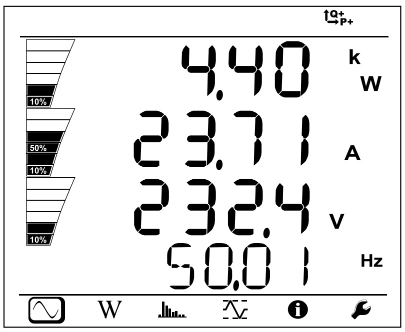




φ (I_1, V_1)

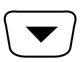
Phase Angle

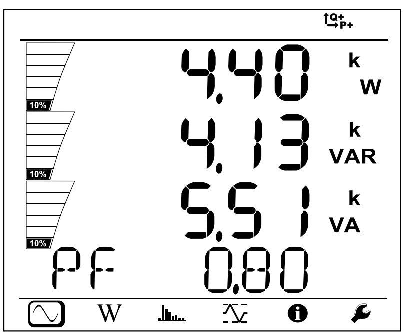




P
I
V
f

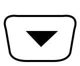
Frequency

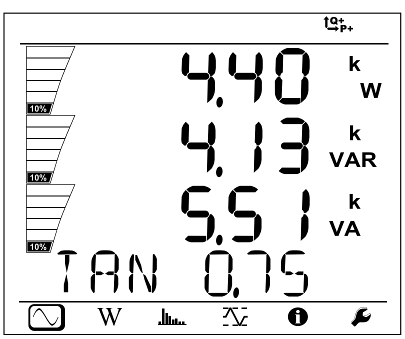




P
Q
S
PF

Power



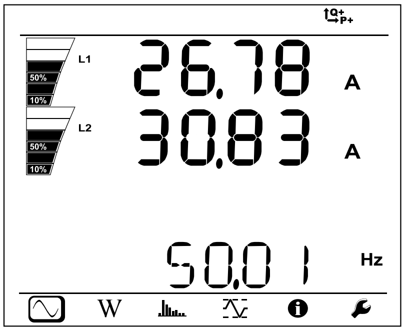


P
Q
S
tan φ

Tangent

To adjust the hook-up type, see § 3.6.2:

4.3.1.2 Split-Phase, 3-Wire: (1P-3W)

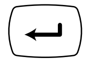


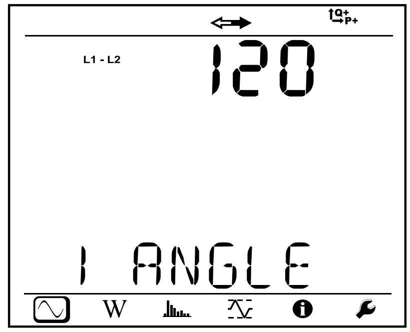
I_1

I_2

f

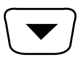
Line current/frequency

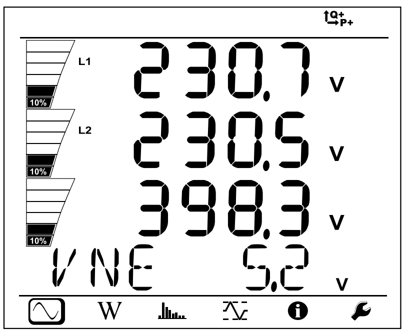




φ (I_2, I_1)

Current Phase Angle





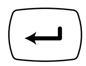
V_1

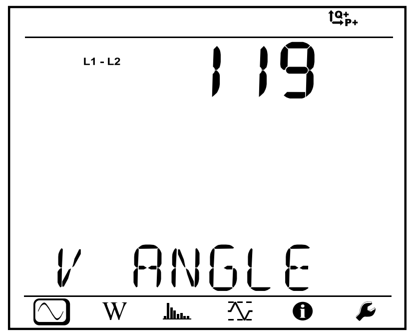
V_2

U_{12}

V_N

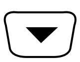
Voltage

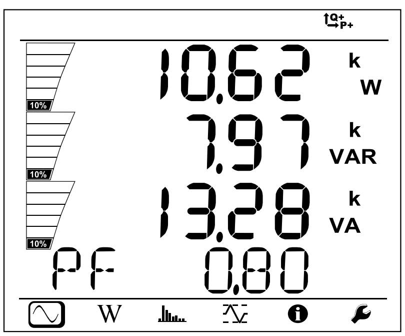




φ (V_2, V_1)

Voltage Phase Angle





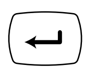
P

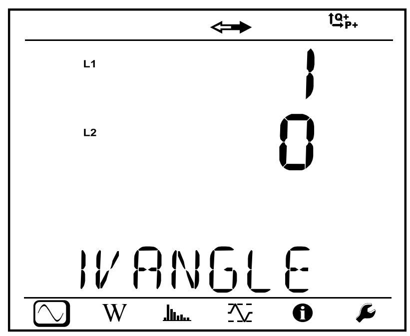
Q

S

PF

Power

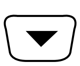


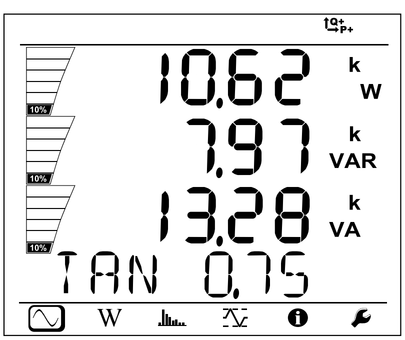


φ (I_1, V_1)

φ (I_2, V_2)

Phase angles between line currents/voltages





P

Q

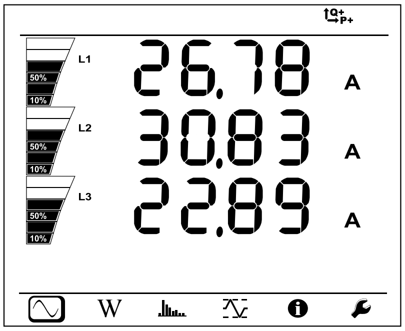
S

tan φ

Tangent

To adjust the hook-up type, see § 3.6.2:

4.3.1.3 Three-Phase, 3-Wire, Unbalanced: (3P-3WΔ2, 3P-3WΔ3, 3P-3WO2, 3P-3WO3, 3P-3WY2, 3P-3WY3)

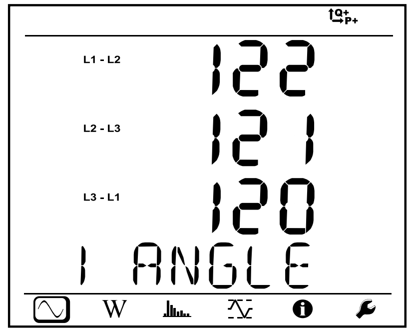


I_1

I_2

I_3

Line Current

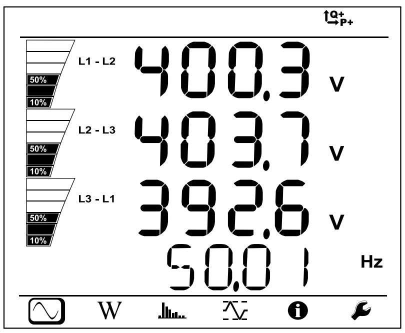


φ (I_2, I_1)

φ (I_3, I_2)

φ (I_1, I_3)

Current Phase Angle



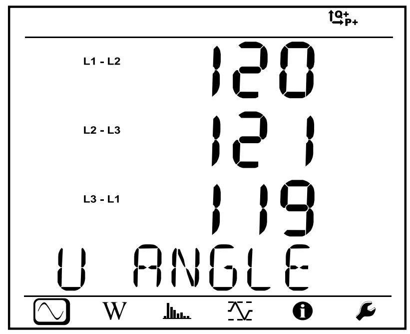
U_{12}

U_{23}

U_{31}

f

Phase voltage/frequency

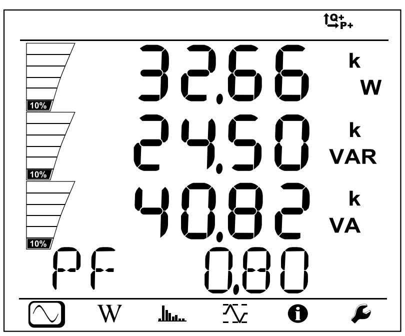


φ (U_{31}, U_{23})

φ (U_{12}, U_{31})

φ (U_{23}, U_{12})

Phase Voltage Phase Angles



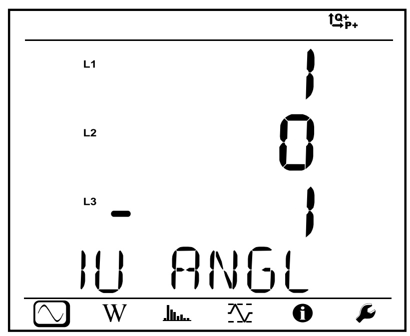
P

Q

S

PF

Power

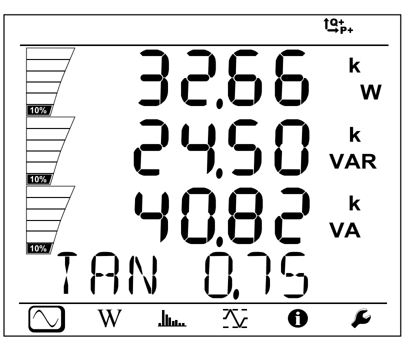


φ (I_1, U_{12})

φ (I_2, U_{23})

φ (I_3, U_{31})

Phase angles between line currents and phase voltage



P

Q

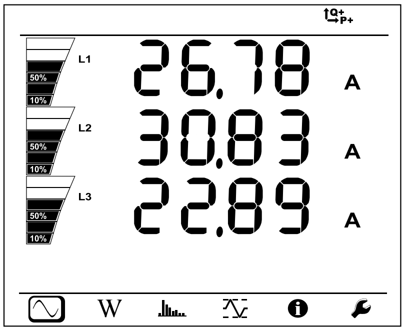
S

tan φ

Tangent

To adjust the hook-up type, see § 3.6.2.

4.3.1.4 Three-Phase, 3-Wire Δ, Balanced: (3P-3WΔb)

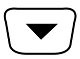


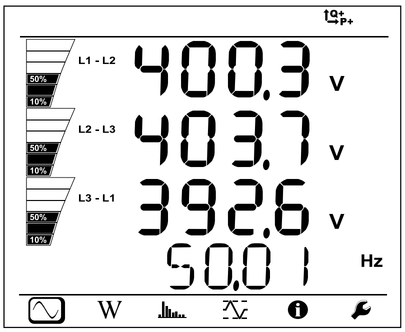
I_1

I_2

I_3

Phase voltage/frequency





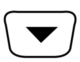
U_{12}

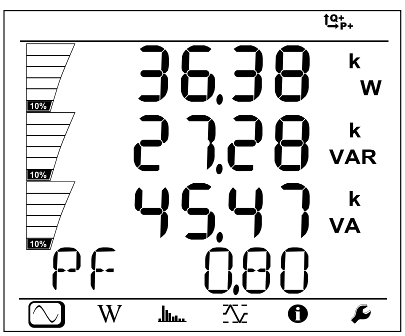
U_{23}

U_{31}

f

Phase voltage/frequency





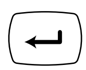
P

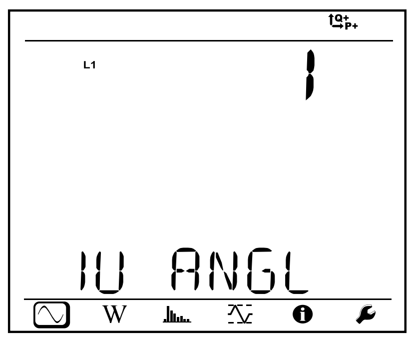
Q

S

PF

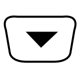
Power

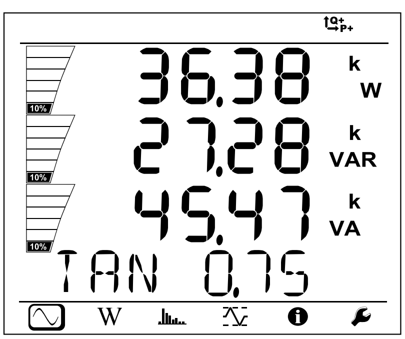




φ (I_1, U_{12})

Phase angle between line current and phase voltage





P

Q

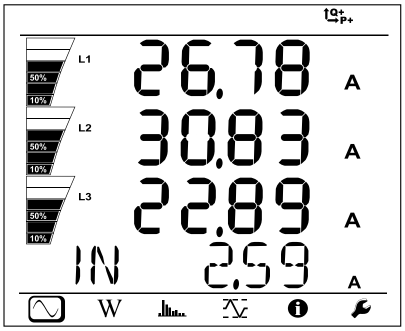
S

tan φ

Tangent

To adjust the hook-up type, see § 3.6.2.

4.3.1.5 Three-Phase, 4-Wire, Unbalanced: (3P-4WY, 3P-4WY2, 3P-4WΔ, 3P-4WO)

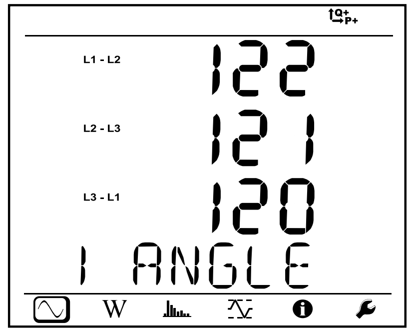


I_1

I_2

I_3

I_N



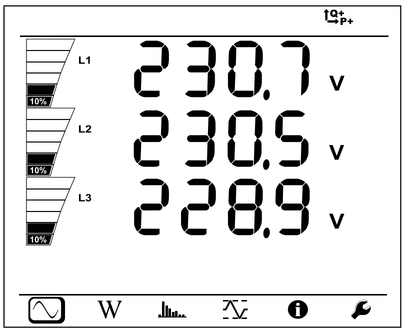
φ (I_2, I_1)

φ (I_3, I_2)

φ (I_1, I_3)

Line current

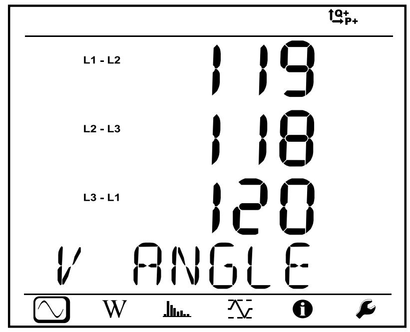
Current phase angle



V_1

V_2

V_3



φ (V_2, V_1)*

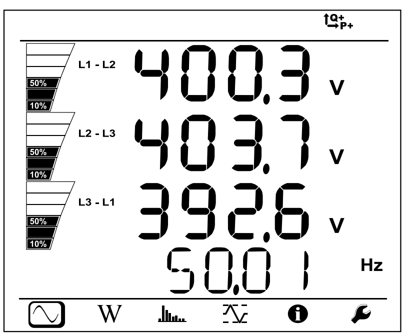
φ (V_3, V_2)*

φ (V_1, V_3)

Line voltage

Line voltage phase angles

**Not for 3P-4WΔ and 3P-4WO networks*

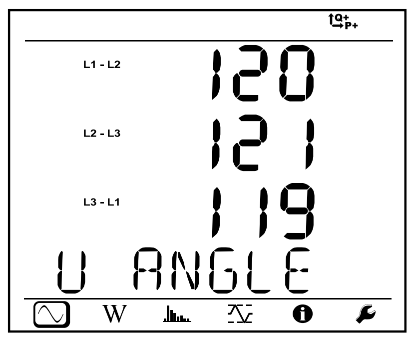


U_{12}

U_{23}

U_{31}

f



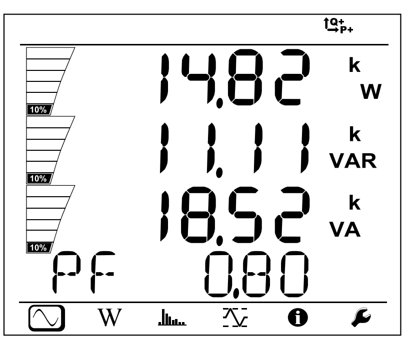
φ (U_{31}, U_{23})

φ (U_{12}, U_{31})

φ (U_{23}, U_{12})

Phase voltage/frequency

Phase angles between line currents and phase voltage

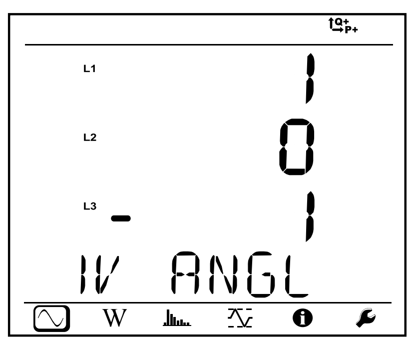


P

Q

S

PF



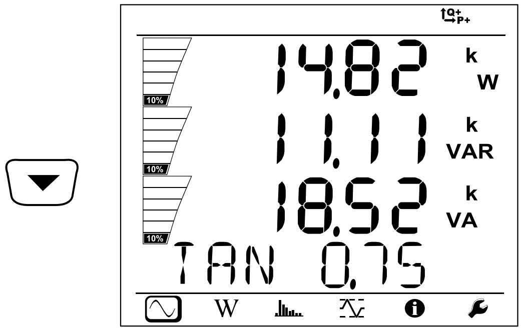
φ (I_1, V_1)

φ (I_2, V_2)

φ (I_3, V_3)

Power

Phase angles between line currents/voltage



P

Q

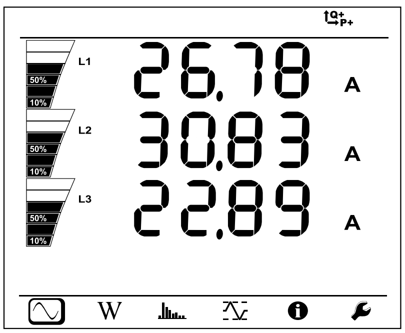
S

tan φ

Tangent

To adjust the hook-up type, see § 3.6.2.

4.3.1.6 Three-Phase, 4-Wire, Y, Balanced: (3P-4WYb)

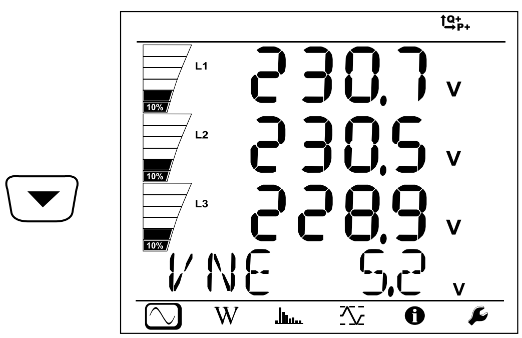


I_1

I_2

I_3

Line current



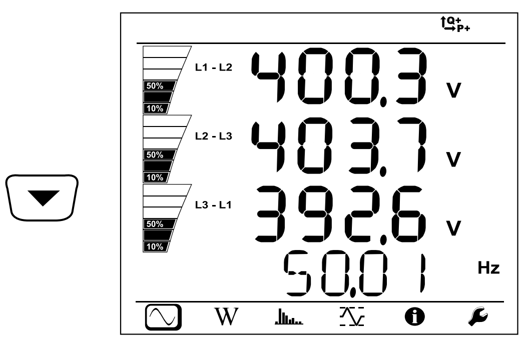
V_1

V_2

V_3

V_N

Line voltage



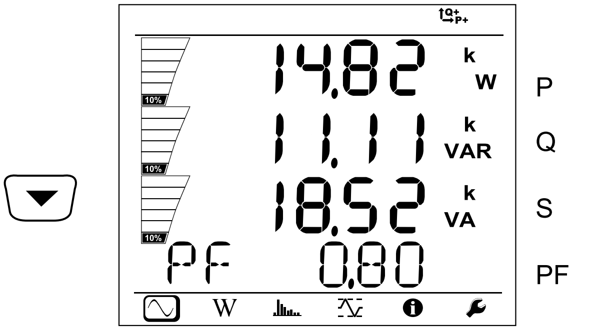
U_{12}

U_{23}

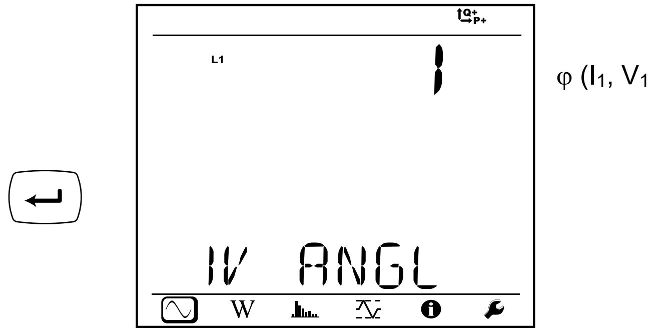
U_{31}

f

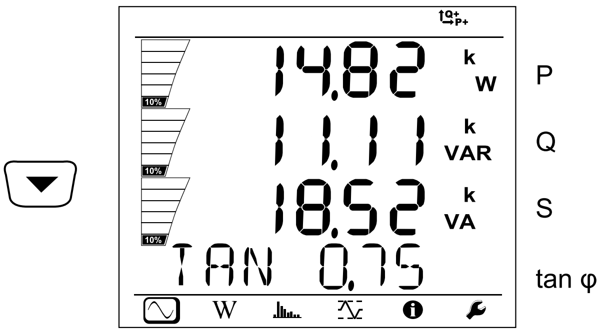
Phase voltage/frequency



Power



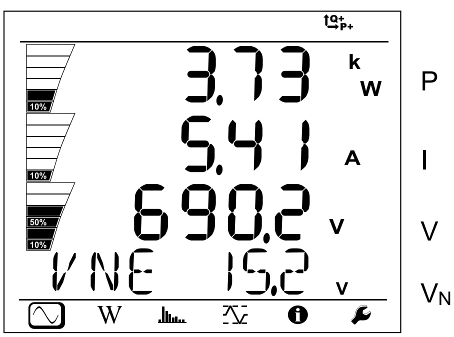
Phase angles between line current/voltage



Tangent

To adjust the hook-up type, see § 3.6.2.

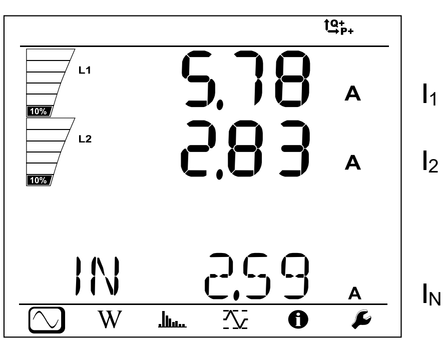
4.3.1.7 DC 2-Wire: (dC-2W)



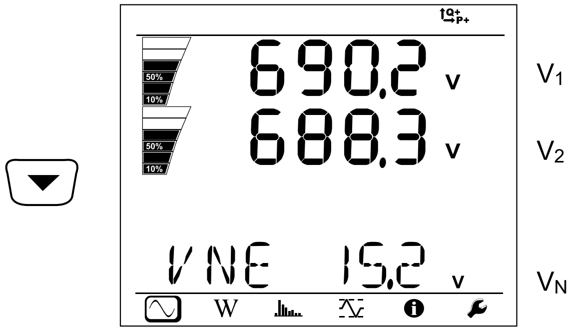
Active power/current/voltage)

To adjust the hook-up type, see § 3.6.2.

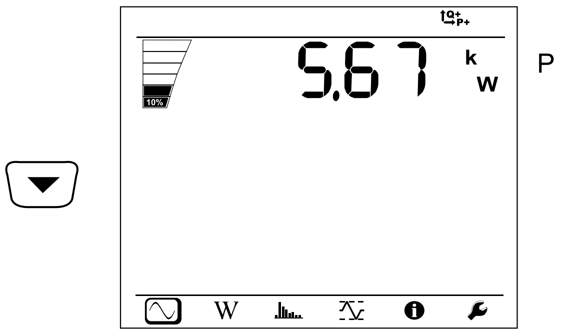
4.3.1.8 DC 3-Wire: (dC-3W)



Line current



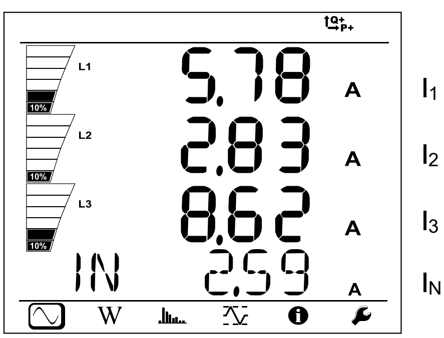
Voltage



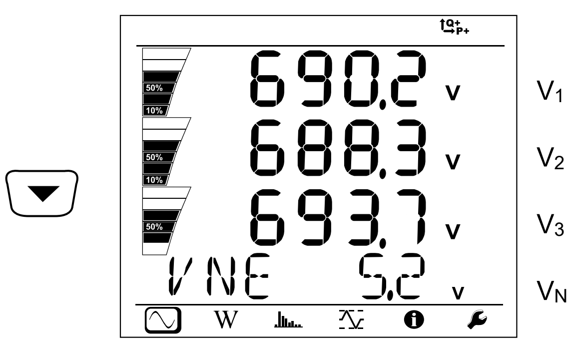
Active power

To adjust the hook-up type, see § 3.6.2.

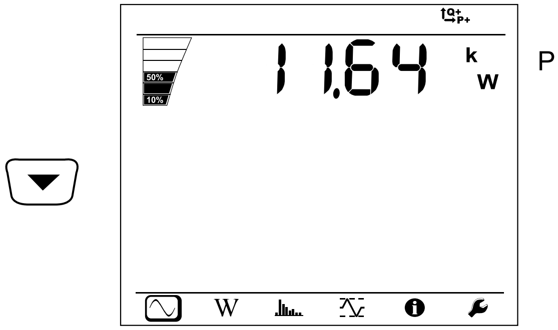
4.3.1.9 DC 4-Wire: (dC-4W)



Line current



Voltage



Active power

To adjust the hook-up type, see § 3.6.2.

4.3.2 Energy Mode (W)

Select the (W) icon to enter the Energy Mode. These screens display energy magnitudes for power flow quadrants, which per IEC 62053-23 are defined as Quadrant 1 (Inductive Import), Quadrant 2 (Capacitive Export), Quadrant 3 (Inductive Export), and Quadrant 4 (Capacitive Import).

When no current sensor is detected, the angles which include this current sensor are displayed with dashes **--------**.

When you display a screen, it shows full values for the displayed parameters. Energy measurements are time-dependent, typically with 10 or 15 minute integration or aggregation periods.

When viewing an Energy Mode screen:

Press (↵) to display partial values for energy parameters. (The word **PArt** appears on the screen when you view partial values.)

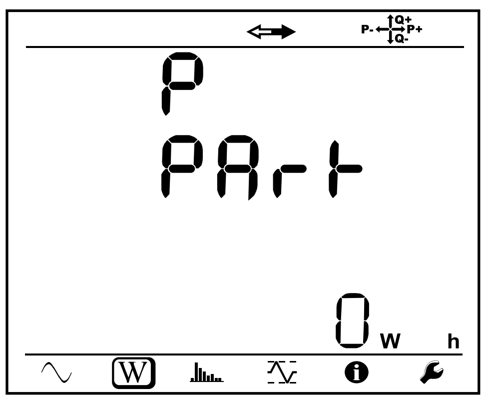


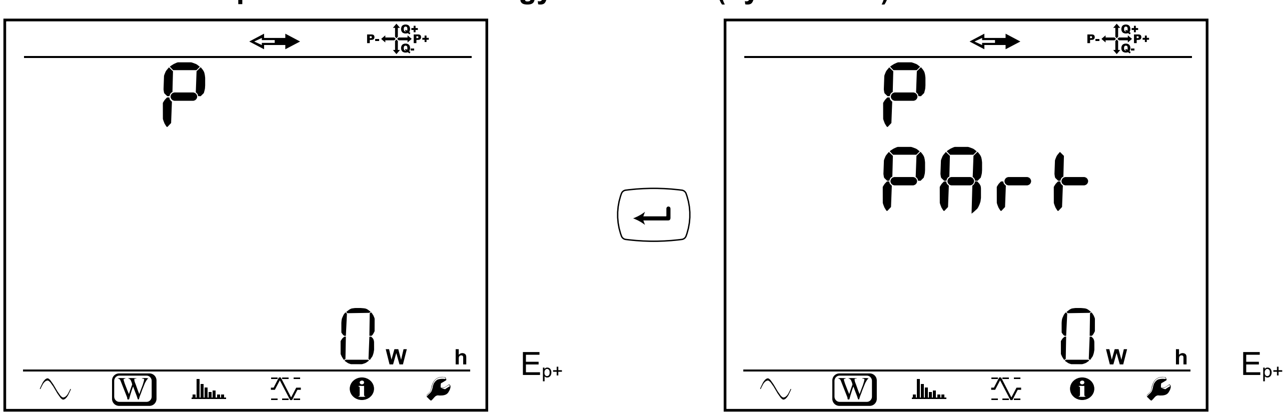
Figure 33

Press (▼) to restore the display of full values.

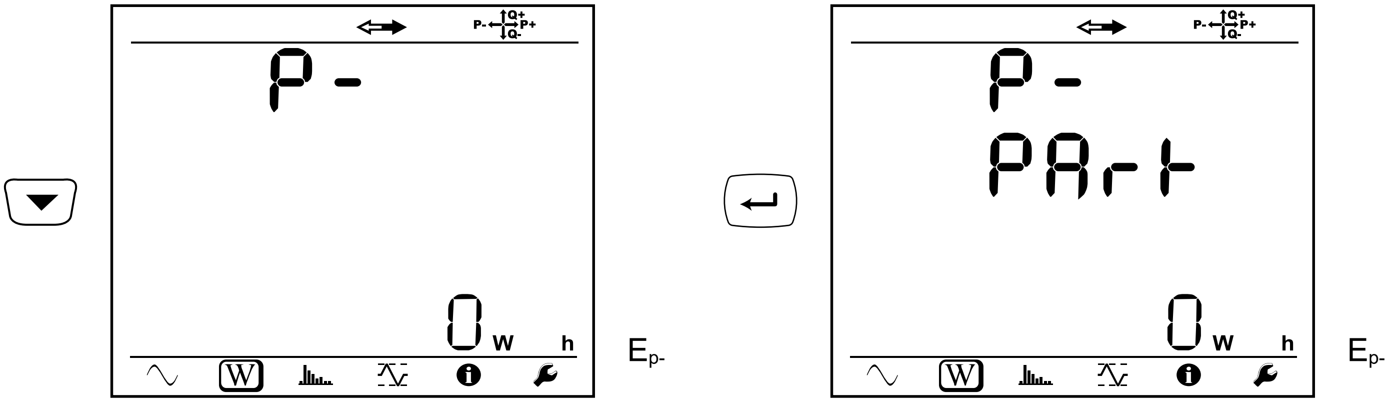
There are two sets of Energy Mode screens, one for AC hookups and one for DC.

4.3.2.1 AC Energy Screens

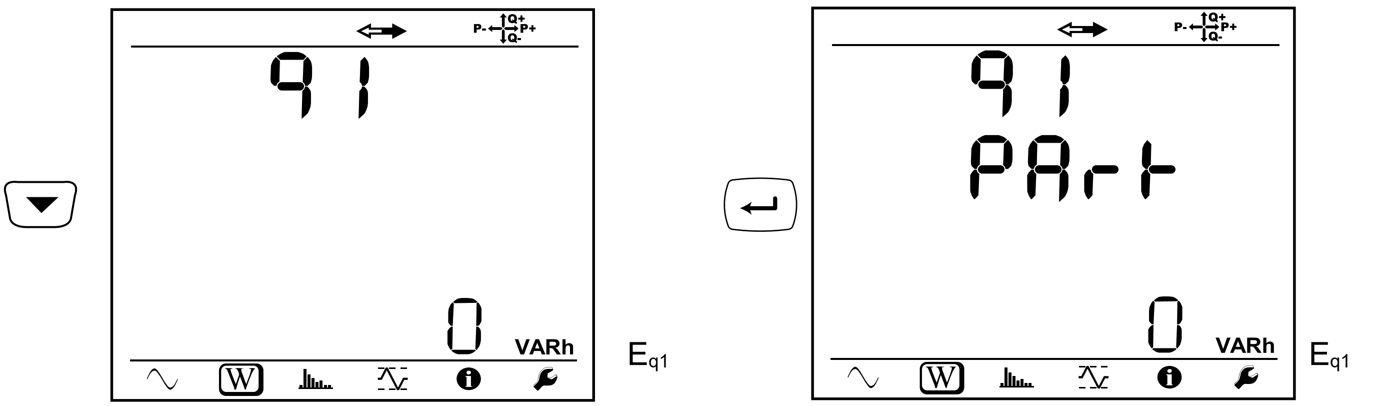
Ep+: Total active energy consumed (by the load) in kWh



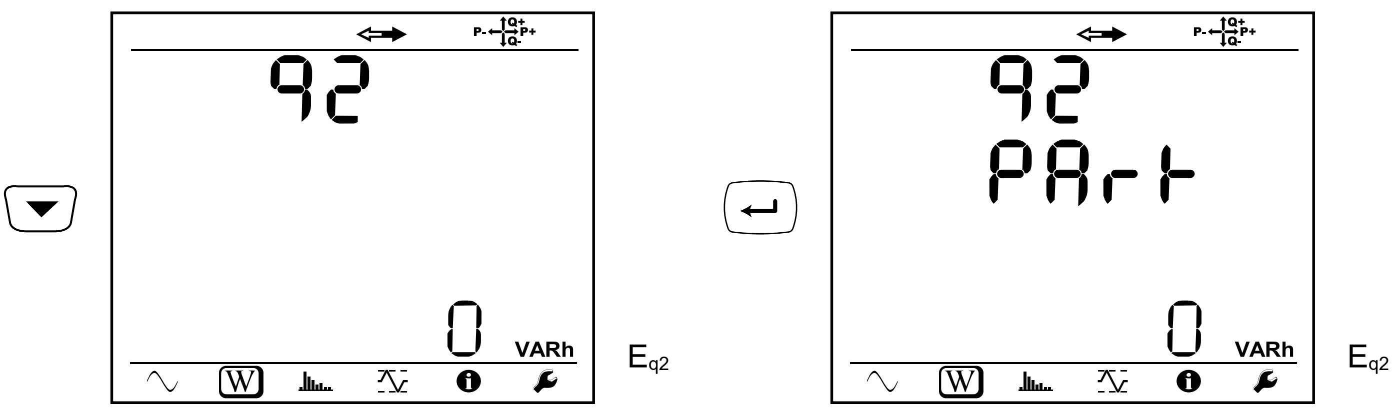
Ep-: Total active energy delivered (by the source) in kWh



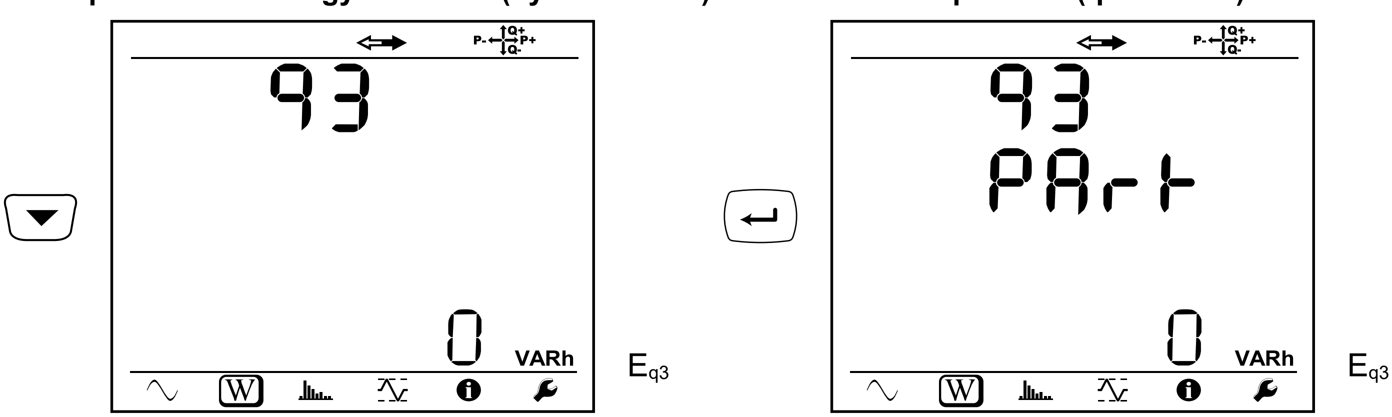
Eq1: Reactive energy consumed (by the load) in the inductive quadrant (quadrant 1) in kvarh



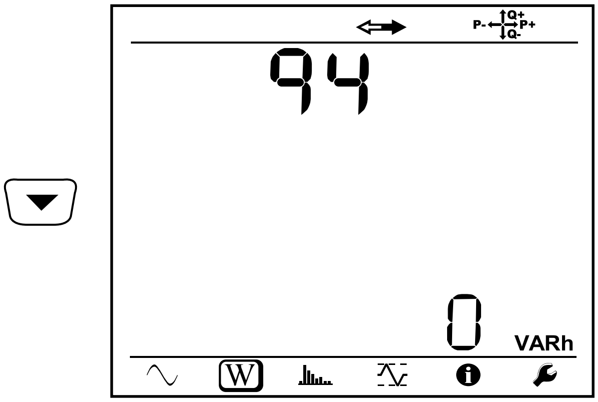
Eq2: Reactive energy delivered (by the source) in the capacitive quadrant (quadrant 2) in kvarh



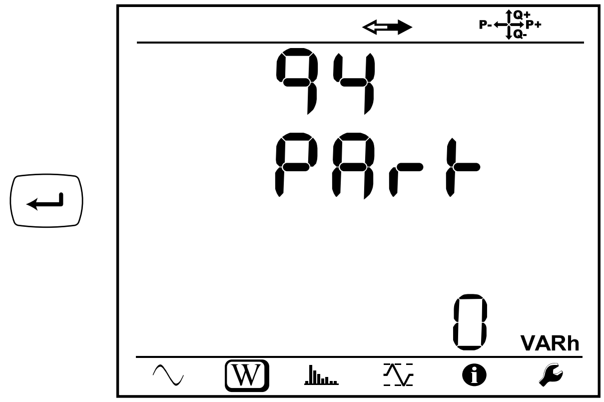
Eq3: Reactive energy delivered (by the source) in the inductive quadrant (quadrant 3) in kvarh



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

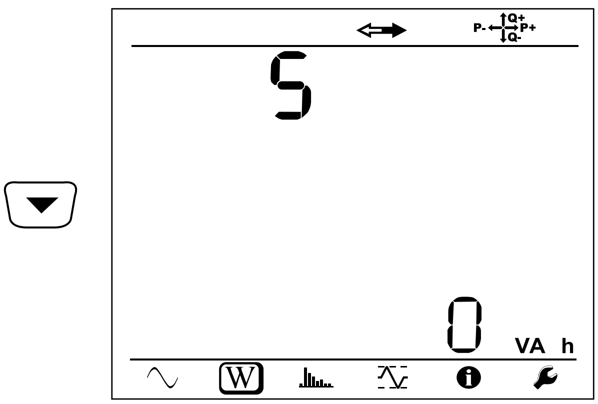


E_{q4}

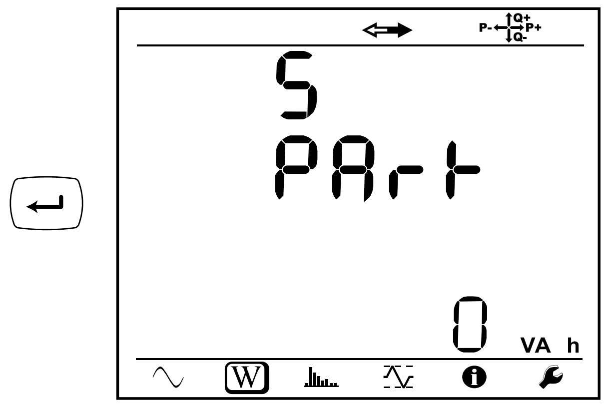


E_{q4}

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

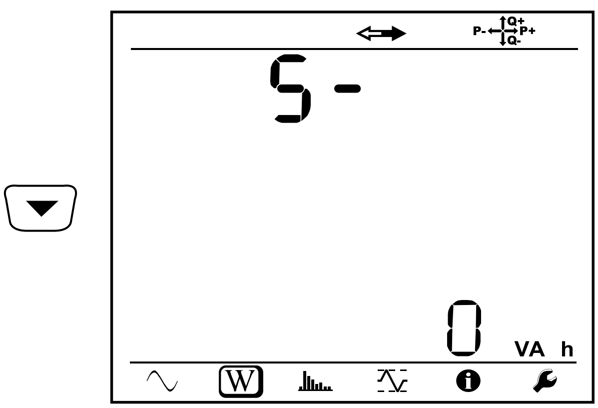


ES+

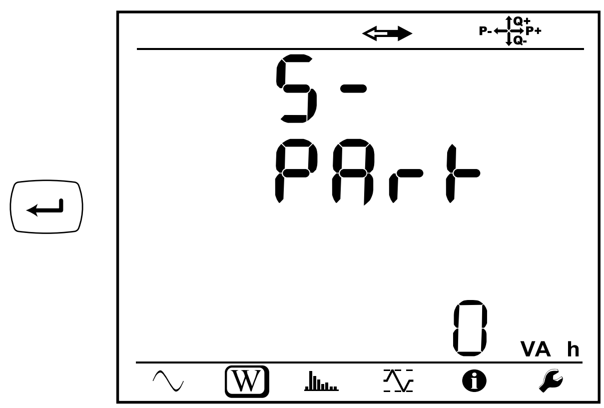


ES+

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



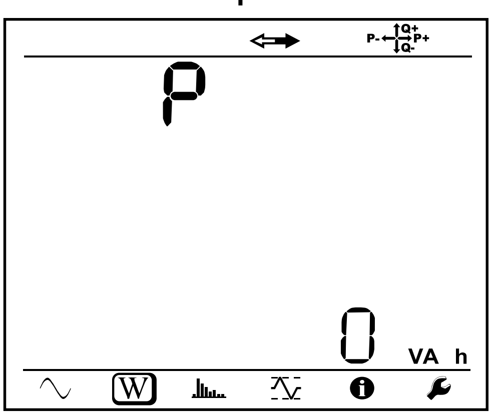
ES-



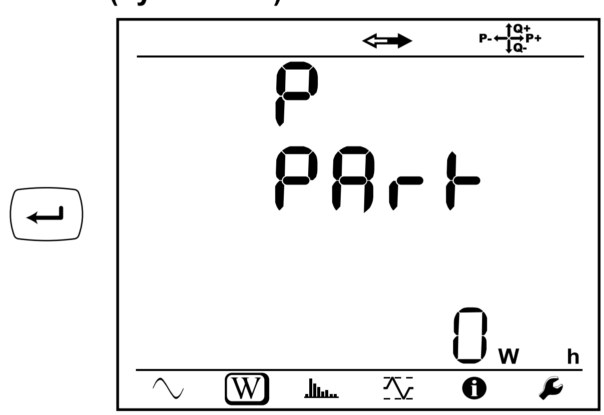
ES-

4.3.2.2 DC Energy Screens

Ep+: Total active energy consumed (by the load) in kWh

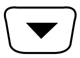
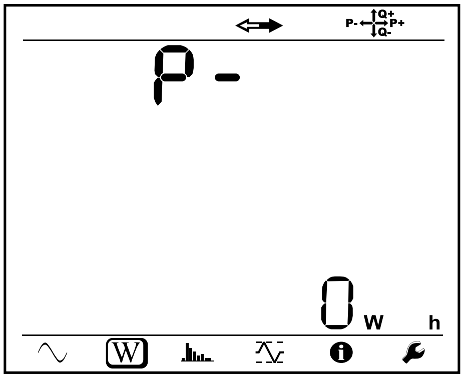


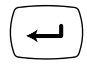
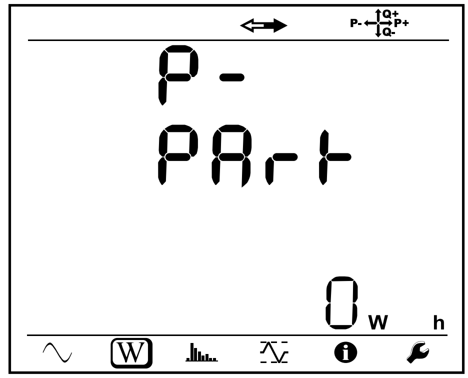
E_{p+}



E_{p+}

Ep-: Total active energy delivered (by the source) in kWh

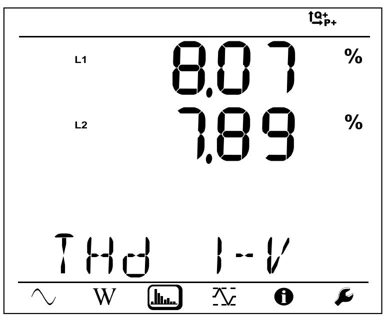
Ep- Ep-

4.3.3 Harmonics Mode

Select the icon to enter Harmonics Mode. These screens display total harmonic distortion (THD) values for AC voltage and current. There are either one or two Harmonics Mode screens, depending on hookup type.

NOTE: Harmonics Mode is not available for DC Hookups. The display unit indicates **No THD in DC Mode**.

4.3.3.1 Single-Phase, 2-Wire: (1P-2W)

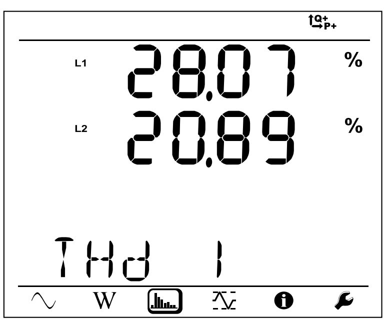


THD_I

THD_V

Total Harmonic Distortion

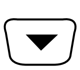
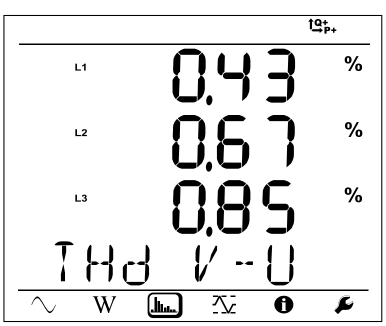
4.3.3.2 Split-Phase, 3-Wire: (1P-3W)



THD_I_1

THD_I_2

Current THD

THD_V_1

THD_V_2

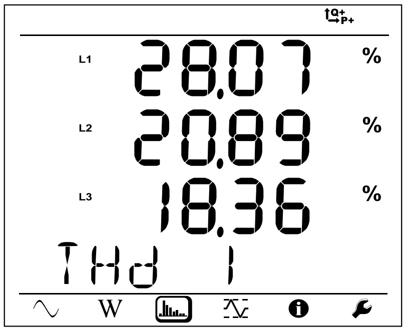
THD_U_{12}

Voltage THD

4.3.3.3 Three-Phase, 3-Wire, Unbalanced: (3P-3WΔ2, 3P-3WΔ3, 3P-3WO2, 3P-3WO3, 3P-3WY2, 3P-3WY3)

Two Harmonics Mode screens appear when the hookup setting is one of the following:

- 3P-3WΔ2 (3-phase 3-wire Δ, two probes)
- 3P-3WΔ3 (3-phase 3-wire Δ, three probes)
- 3P-3WO2 (3-phase 3-wire open Δ, two probes)
- 3P-3WO3 (3-phase 3-wire open Δ, three probes)
- 3P-3WY2 (3-phase 3-wire Y, two probes)
- 3P-3WY3 (3-phase 3-wire Y, three probes)

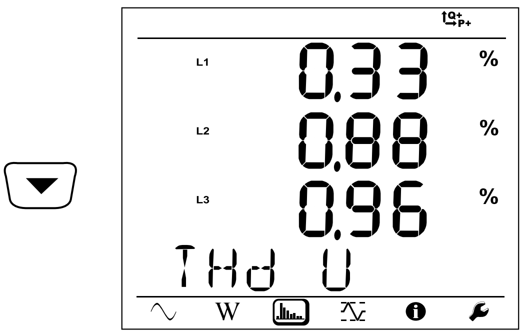


THD_I_1

THD_I_2

THD_I_3

Current THD)



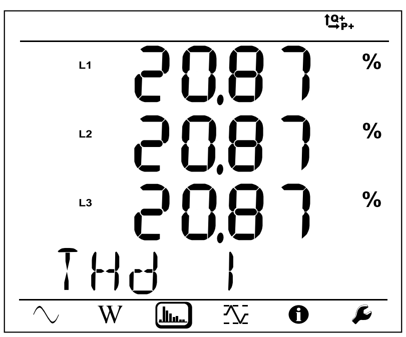
THD_U_{12}

THD_U_{23}

THD_U_{31}

Voltage THD

4.3.3.4 Three-Phase, 3-Wire, Δ, Balanced: (3P-3WΔb)

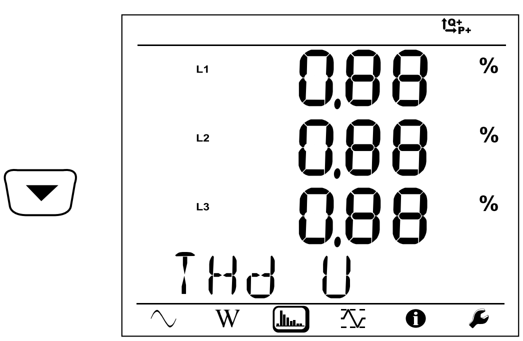


$THD\_I_1 = THD\_I_3$

$THD\_I_2 = THD\_I_3$

THD_I_3

Current THD



THD_U_{12}

$THD\_U_{23} = THD\_U_{12}$

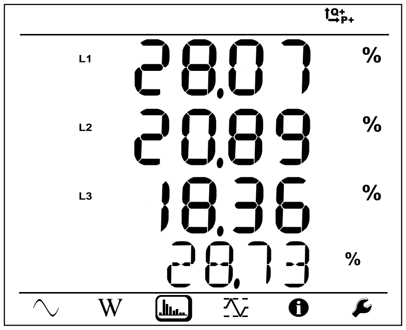
$THD\_U_{31} = THD\_U_{12}$

Voltage THD

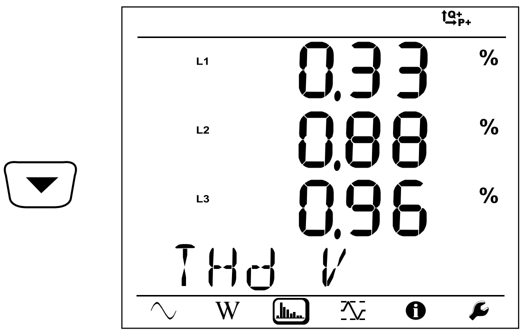
4.3.3.5 Three-Phase, 4-Wire, Unbalanced: (3P-4WY, 3P-4WY2, 3P-4WΔ, 3P-4WO)

Two Harmonics Mode screens appear when the hookup setting is one of the following:

- 3P-4WY (3-phase 4-wire Y)
- 3P-4WY2 (3-phase 4-wire Y, two probes)
- 3P-4WΔ (3-phase 4-wire Δ)
- 3P-4WO (3-phase 4-wire open Δ)

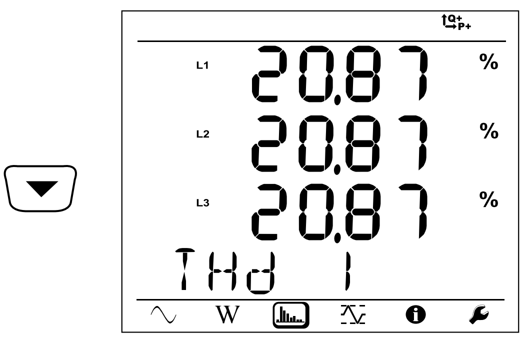


Current THD

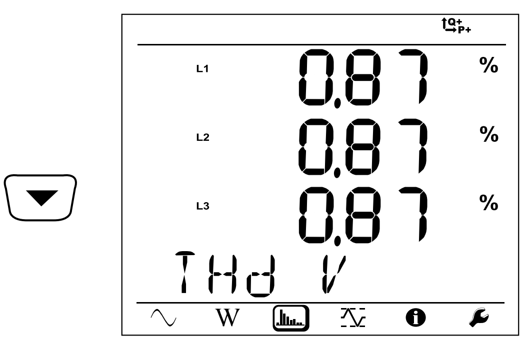


Voltage THD

4.3.3.6 Three-Phase, 4-Wire, Y, Balanced: (3P-4WYb)



Current THD



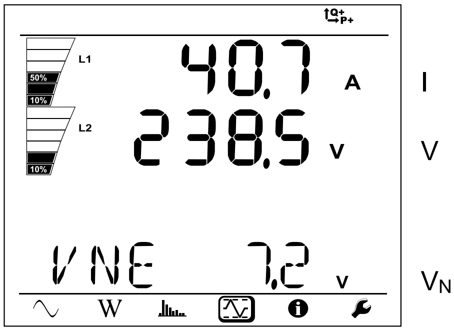
Voltage THD

4.3.4 Maximum Mode

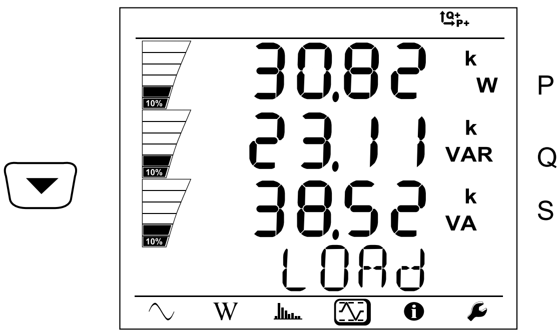
Select the icon to enter Maximum Mode. These screens display values for the maximum of the one second measurements during an aggregation period. This is reset either (1) when a new aggregation period starts, or (2) continuously, depending on how this setting is configured. You can also reset this value manually through the PEL Control Panel. When no recording is in progress, these values represent the maximum of the one second measurements since the end of the last recording.

Note that Maximum Mode is not available for DC power networks.

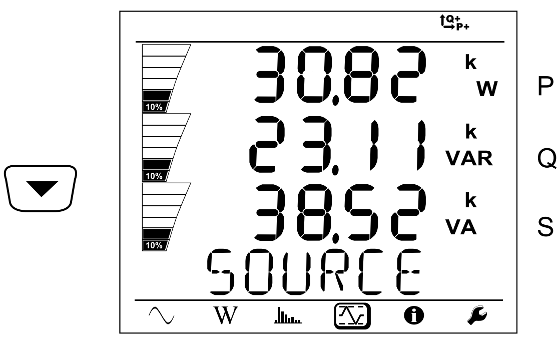
4.3.4.1 Single-Phase, 2-Wire: (1P-2W)



Maximum current/voltage

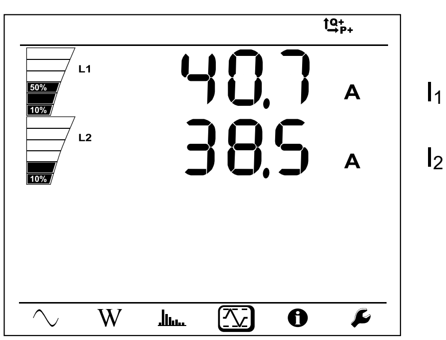


Maximum load power

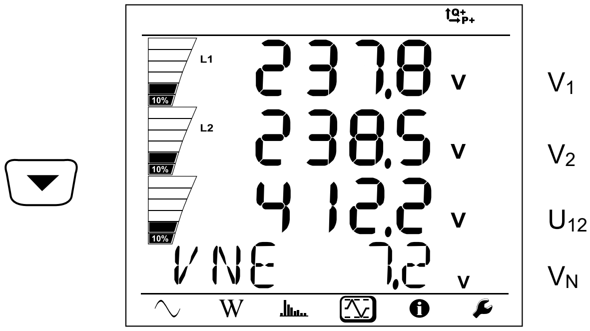


Maximum source power

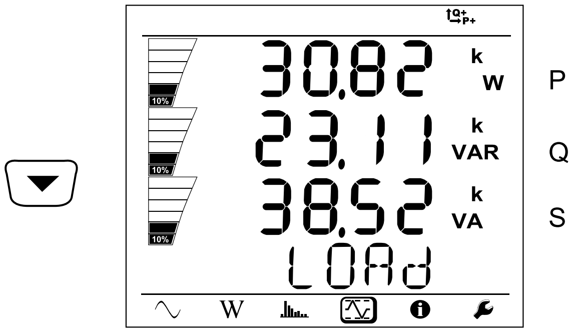
4.3.4.2 Split-Phase, 3-Wire: (1P-3W)



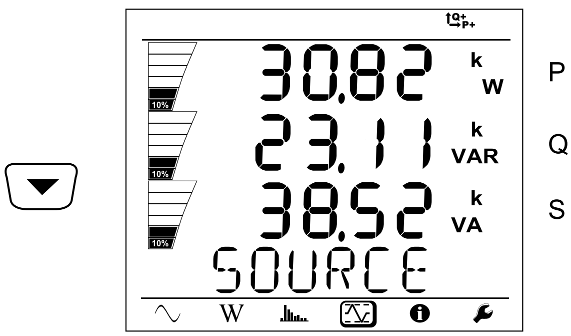
Maximum current



Maximum voltage



Maximum load power

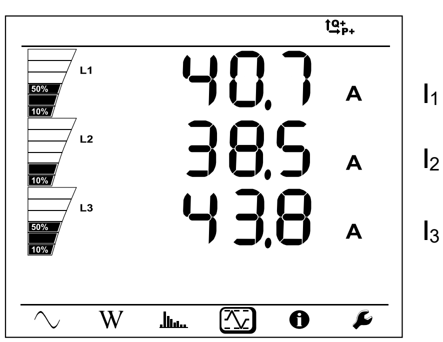


Maximum source power

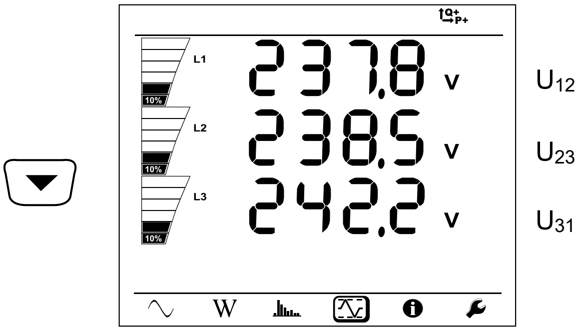
4.3.4.3 Three-Phase 3-Wire: **(3P-3WΔ2, 3P-3WΔ3, 3P-3WO2, 3P-3WO3, 3P-3WY2, 3P-3WY3, 3P-3WΔb)**

Four Maximum Mode screens appear when the hookup type is one of the following:

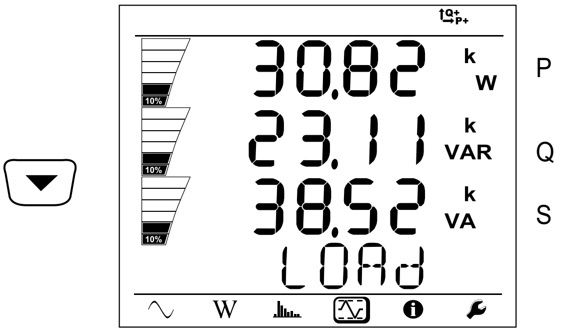
- 3P-3WΔ2 (3-phase 3-wire Δ, two probes)
- 3P-3WΔ3 (3-phase 3-wire Δ, three probes)
- 3P-3WO2 (3-phase 3-wire open Δ, two probes)
- 3P-3WO3 (3-phase 3-wire open Δ, three probes)
- 3P-3WY2 (3-phase 3-wire Y, two probes)
- 3P-3WY3 (3-phase 3-wire Y, three probes)
- 3P-3WΔb (3-phase 3-wire Δ balanced)



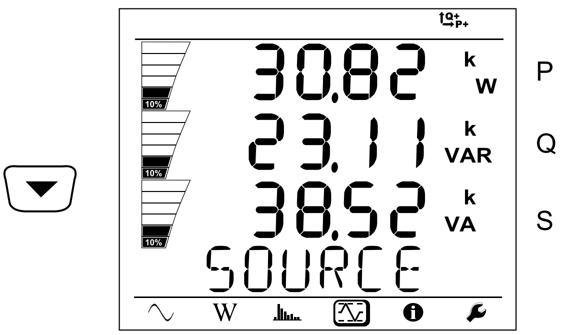
Maximum line current



Maximum line voltage



Maximum load power

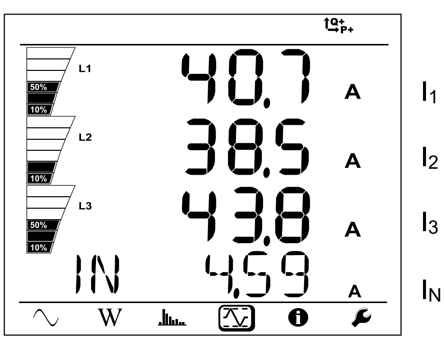


Maximum source power

4.3.4.4 Three-Phase, 4-Wire: (3P-4WY, 3P-4WY2, 3P-4WΔ, 3P-4WO, 3P-4WYb)

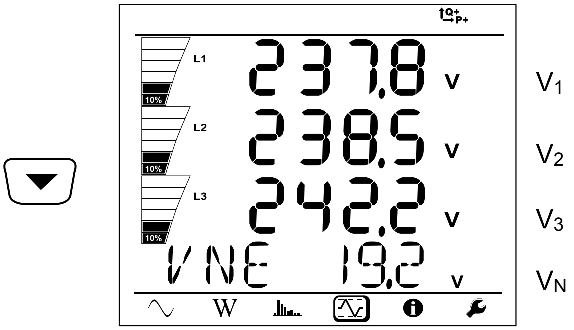
Four Maximum Mode screens appear when the hookup type is one of the following:

- 3P-4WY (3-phase 4-wire Y)
- 3P-4WY2 (3-phase 4-wire Y, two probes)
- 3P-4WΔ (3-phase 4-wire Δ)
- 3P-4WO (3-phase 4-wire open Δ)

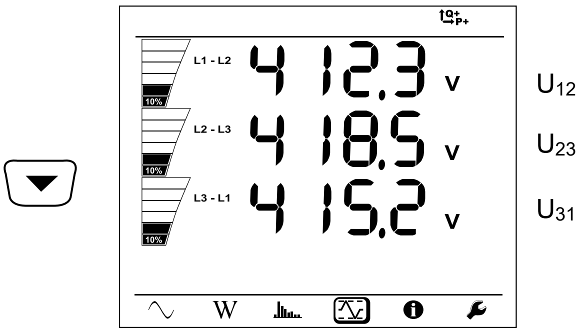


Maximum line current

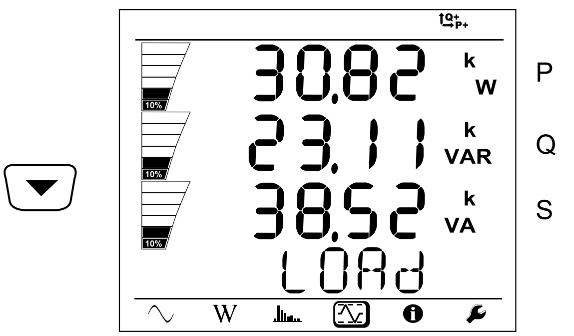
NOTE: For 3-phase, 4-wire Y balanced hookups, the maximum neutral current (I_N) is not displayed.



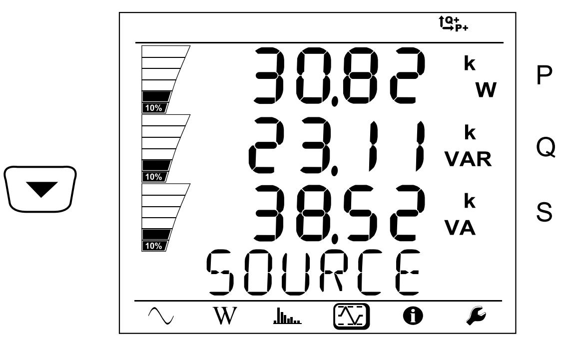
Maximum voltage



Max. phase-to-phase voltage



Maximum load power



Maximum source power

5. RECORDING DATA

The instrument can record measurement data and store the results. You can start a recording immediately, or (using the PEL Control Panel) schedule one with a defined start date/time and duration. The session can then be downloaded for viewing, analysis, and distribution.

5.1 RECORDING SESSION OVERVIEW

Recording sessions are configured through the PEL Control Panel. This provides a number of recording options, such as selecting which data to include in the recording, the demand (aggregation) period, and recording schedule. This also includes changing the instrument's date and time, if required (see § 6.5). After you complete a recording session, you can add information such as session name, the operator who conducted the recording, and the location where it took place. In addition, the PEL Control Panel enables you to download recordings and clear them from the instrument.

Typically, recording sessions are started, stopped, and scheduled through the PEL Control Panel. You can also start and stop a recording session on the instrument itself (see § 5.2). You can also set the aggregation period for a recording (see § 3.6.7).

Recording sessions are stored in the instrument's SD-card. The memory required for a recording session primarily depends upon the duration of the recording and the storage period.

5.1.1 Recording Rate

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.
- **Aggregated Harmonics** = 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.

For instance, a five-day session recording aggregated trends and harmonics with a 15 minute demand period, 1 second trends, and 1 second harmonics would consume approximately 636 MB of storage.

Example of Duration

		20 Sessions	1 Session
SD-Card 2 GB	Harmonics **1 s**, trends **1 s** and 1 min aggregated data	23 hours	19 days
	Trends **1 s** and 1 min aggregated data	4 days	12 weeks
	1 min aggregated data, included aggregated harmonics	5 weeks	2 years
	15 min aggregated data w/o aggregated harmonics	3 years	59 years
SD-Card 32 GB	Harmonics **1 s**, trends **1 s** and 1 min aggregated data	15 days	43 weeks
	Trends **1 s** and 1 min aggregated data	10 weeks	4 years
	1 min aggregated data, included aggregated harmonics	19 months	4 years (1)
	15 min aggregated data w/o aggregated harmonics	47 years	118 years (1)

Table 8

(1) Maximum size of aggregated datafile = 4 GB

NOTE: For recordings with harmonics or with a duration longer than one week, it is recommended that you use class 4 or higher SDHC cards.

5.2 STARTING AND STOPPING A RECORDING

Before starting a recording, ensure that the instrument is not currently locked (the word **LOCK** appears on the screen in Configuration Mode). The instrument cannot begin a recording when it is locked.

The instrument is locked when:

- Being configured via the PEL Control Panel.
- Disabled through an option in the PEL Control Panel (see § 3.6).
- A recording session is already in progress. Note that in this case the Control button remains active so you can stop the recording. However, you cannot start a new recording if one is in progress.

If any of these situations are in effect, take appropriate action as necessary to unlock the instrument. Then check the SD-card LED.

- **If the LED is green**, the SD-card is ready to store recordings.
- **If the LED illuminates steady red**, ensure that:
  - The SD-card is installed. If not, consult § 2.6.
  - The write-protect sliding tab on the card is in the **unlock** position (towards the metal contacts).
  - The SD-card is formatted. Formatting can be performed either through the PEL Control Panel, or through a Windows command on your computer.

  NOTE: The LED briefly blinks red when the card is initializing.
- **If the LED blinks alternately red and green**, the SD-card is full. Download any data you want to save to your computer, then erase the content of the card through the PEL Control Panel.

When the LED indicates the SD-card is ready, you can begin recording. To do this through the PEL Control Panel, follow the instructions provided in the PEL Control Panel Help system. To record through the instrument user interface, perform the following:

1. Press and hold it down until the **REC** LED lights. Then release .
2. The **REC** LED should now be lit RED, indicating a recording is in progress.
3. To stop a recording, press and hold it down until the **REC** LED lights up, then release .

To view the recording session, connect the instrument to your computer running DataView (see § 6).

6. DATAVIEW® & PEL CONTROL PANEL

DataView® enables a computer to connect to and interact with a variety of AEMC® Instruments devices, including the Model PEL 115. 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.

6.1 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 computer. 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, and double-click it to run the installation program.
3. The DataView setup screen appears.

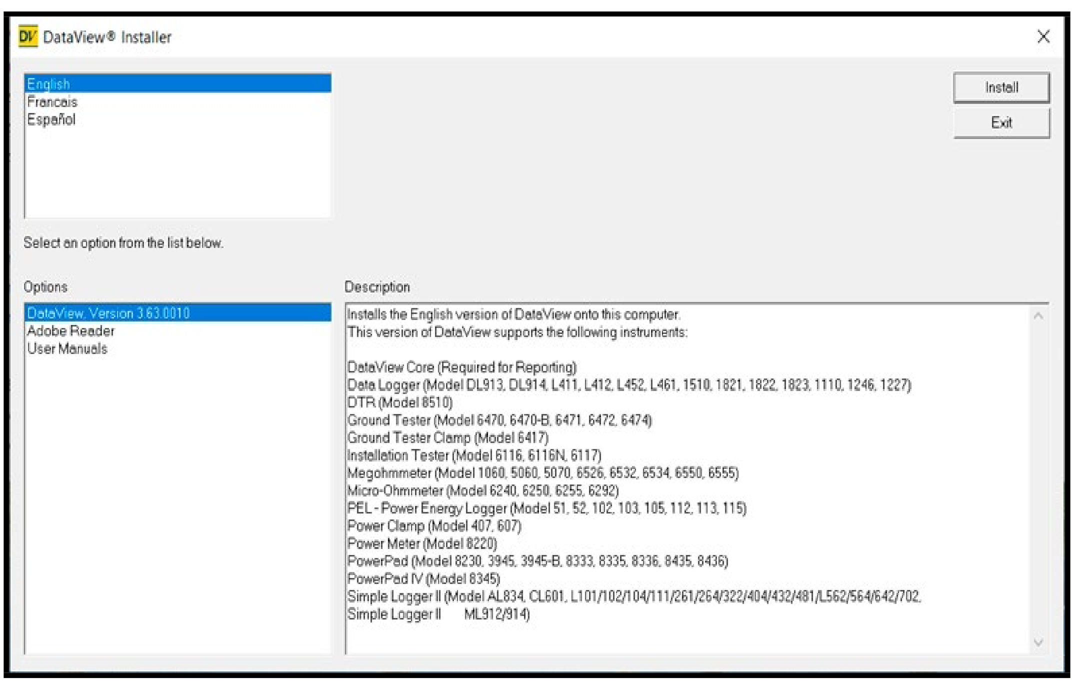


Figure 34

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 115 (see § 6.1). 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. After a few moments a screen appears asking you whether or not you want to allow the DataView Setup program to make changes to your computer. Click **OK**.
5. 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.

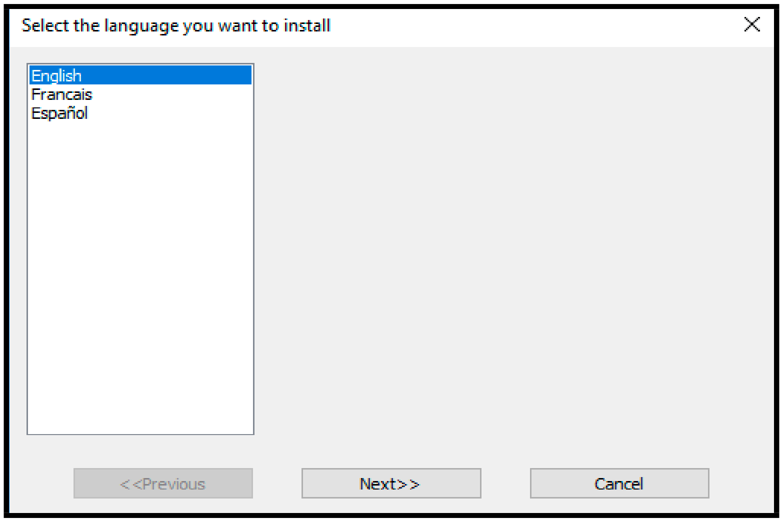


Figure 35

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

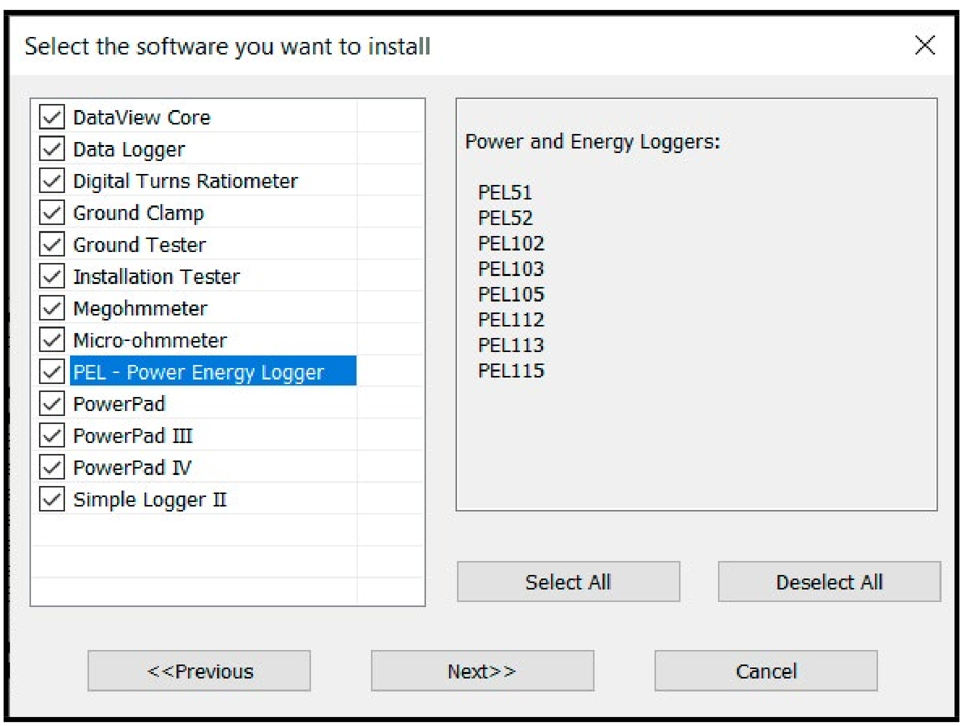


Figure 36

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 computer; 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**.

7. 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.
8. The InstallShield program installs the selected software. If an earlier version of the software is already installed on your computer, for each selected program the InstallShield program will:
   - Ask you to confirm the installation of the program. Click **Next**.
   - Display a status bar indicating the progress of the installation.
   - 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.
9. You can now select additional Setup options to install (see step 3 above). When finished, click **Exit**.
10. The DataView folder now appears on your computer desktop, within which is the PEL Control Panel icon and the icon(s) for any other Control Panel(s) you have installed.

6.2 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:

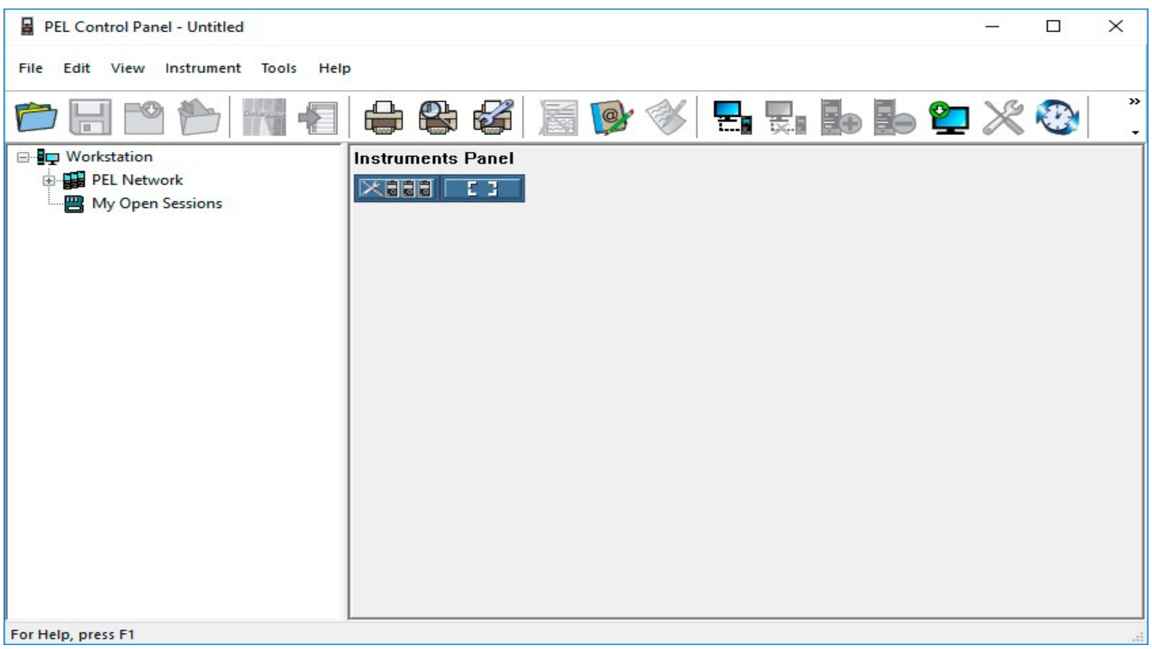


Figure 37

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.

6.3 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. Android is a platform for **touch screen** mobile devices such as tablets and smartphones. Introduced in 2007, Android has grown to become the most popular mobile operating system in the world, with over one billion devices sold globally.

The PEL must be connected to a LAN network in order for the instrument to communicate with the PEL app via Wi-Fi.

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 phaser 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.

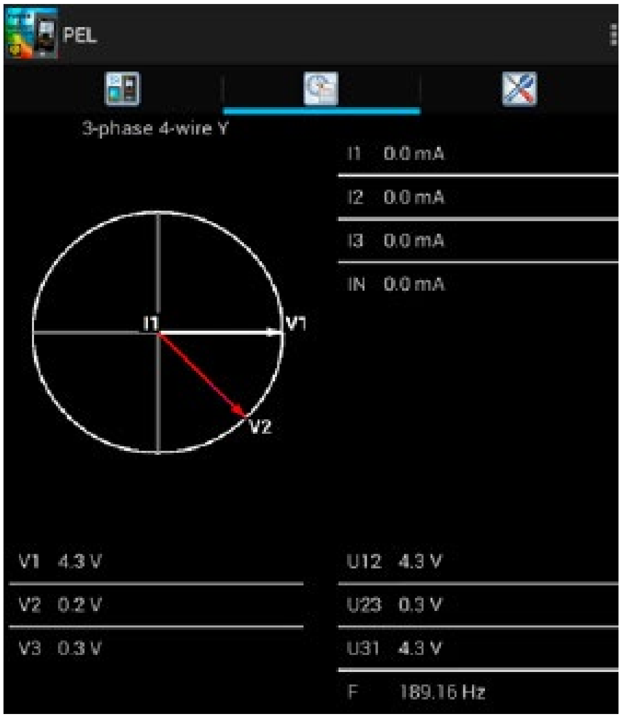


Figure 38

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 personal computer 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.

6.4 CONNECTING TO THE COMPUTER

Before you can use the PEL Control Panel to communicate with your instrument, you must establish a connection between the instrument and the computer. There are five types of connections available:

- USB cable connection
- Wi-Fi direct connection
- Ethernet point-to-point cable connection
- Network connection via LAN or Wi-Fi
- Network connection via DataViewSync®

To begin, ensure that you have installed DataView with the PEL Control Panel. Also ensure that the required communication and connection drivers are installed on your computer. These drivers are installed as part of the DataView installation process.

After the instrument is successfully connected, consult the PEL Control Panel Help system for instructions about viewing real-time data on the instrument, downloading and viewing recorded sessions, creating DataView reports from the downloaded data, and configuring the instrument.

6.4.1 Connection by USB or LAN Ethernet Link

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

- Pull back the elastomer cap that protects the connector.
- 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 with the PEL Control Panel software (see § 6.1)

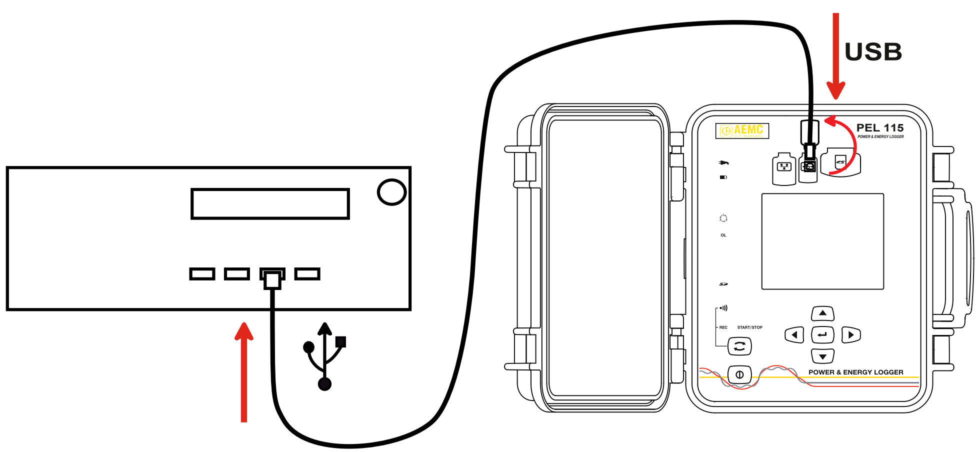


Figure 39

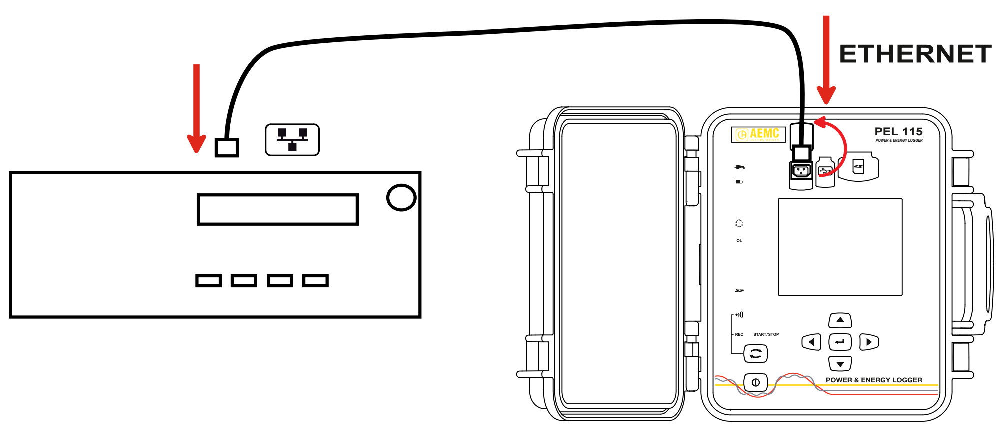


Figure 40

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

NOTE: Connecting the USB or Ethernet cable does not power up the instrument or charge the battery.

For the LAN Ethernet link, the PEL has an IP address.

When you configure the instrument with the PEL Control Panel software, if the **Activate DHCP** (dynamic IP address) box is checked, the instrument sends a request to the network's DHCP server to obtain an IP address automatically.

The Internet protocol used is UDP or TCP. The port used by default is 3041. It can be modified in PEL Control Panel so as to enable connections between the PC and several instruments behind a router.

The auto IP address mode is also available when the DHCP is selected and the DHPC server has not been detected within 60 seconds. The PEL will use 169.254.0.100 as default address. This auto IP address mode is compatible with APIPA. A crossed cable may be necessary.

NOTE: You can change the network parameters while connected via an LAN Ethernet link, but once the network parameters have been changed, you will lose connection. For this, it is better to use a USB connection.

6.4.2 Connection by Wi-Fi Link

This link can be used to configure the instrument using the PEL Control Panel, to view measurements and to download the recordings to a PC or 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, the Wi-Fi is activated or deactivated.

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 can be transmitted by the instrument to a PC through Wi-Fi Link in different ways:

- **Wi-Fi access point (AP):** Connecting the instrument directly to the computer.
- **W-Fi station mode (STA):** Connecting the instrument to the same Wi-Fi network to which the PC is connected.
- **DataViewSync™:** Connecting the instrument to DataViewSync™ (hosted by AEMC® Instruments) to communicate with a PC on a different network.

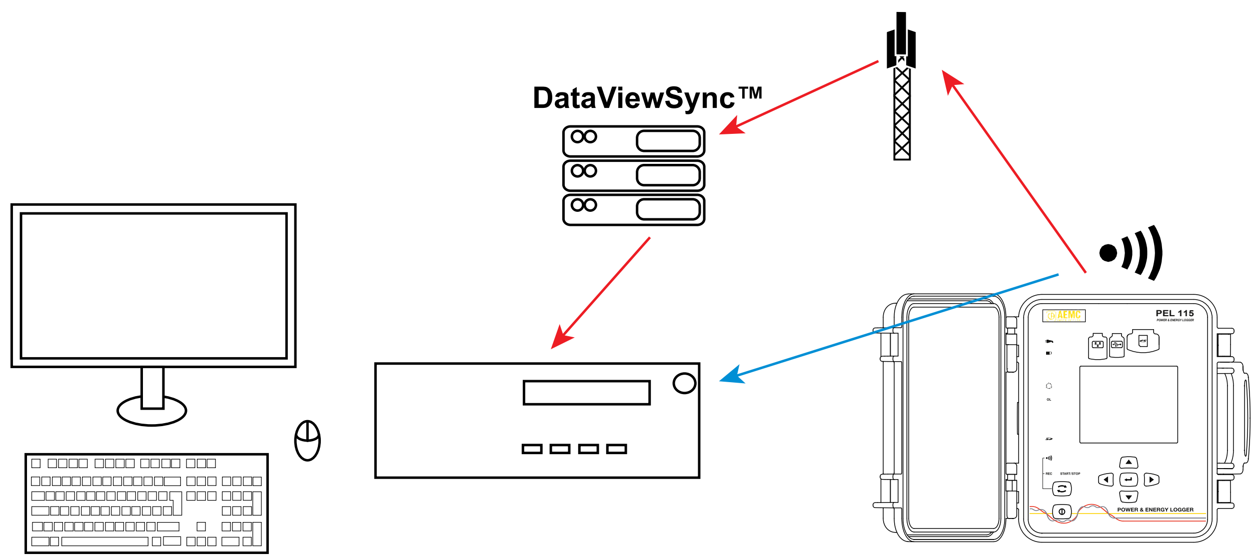


Figure 41

6.4.3 Network via DataViewSync™

DataViewSync™ allows you to connect your computer to instruments on different networks. You must first connect the instrument to a network that can access the internet via Ethernet or Wi-Fi. If you need assistance with this please, consult your network administrator. When this connection is established, open the PEL Control Panel. Then do the following:

1. In the menu bar at the top of the screen, select Instrument.
2. In the drop-down menu that appears, click the option Add an Instrument.
3. Select DataViewSync™ as the connection type, and complete the Add and Instrument dialog. If you need assistance, press the **Help** button.

To receive the data on your PC, you must enable DataViewSync™ in the PEL Control Panel and specify whether the link is via Ethernet or Wi-Fi.

6.5 SETTING DATE AND TIME

As explained in § 3.6, you can view the instrument's date and time in Information Mode, but you cannot change this information through the instrument's interface. To change the instrument's date/time, open the PEL Control Panel and do the following:

1. Ensure that the instrument is connected by checking its status in the PEL Network frame (a green check mark appears next to its name). If not, reconnect it by highlighting the instrument, selecting Instrument in the menu bar, and clicking Reconnect Instrument.
2. Select the Instrument, and click Instrument in the menu bar.
3. Select Configure. This displays the Configure Instrument dialog box.
4. Click the **Set Clock** button. This displays a dialog for setting the date and time on the instrument.
5. You can synchronize the instrument's clock with the computer's clock, or use the Date and Time fields to select another date and time.
6. Click OK to save the change.

7. SPECIFICATIONS

7.1 REFERENCE CONDITIONS

Parameter	Reference Conditions
Ambient Temperature	23 °C ± 2 °C (73 °F ± 3.6 °F)
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 %)
Distribution System Frequency	50 Hz ± 0.1 Hz and 60 Hz ± 0.1 Hz
Current-to-Voltage Phase	0° (active power) and 90° (reactive power)
Harmonics	< 0.1 %
Voltage Unbalance	0 %
Internal Temperature	Warm up: 1 h
Common Mode	The instrument is powered by battery, the USB is disconnected. Neutral input and enclosure are at Earth potential.
	PEL 115 powered on battery, USB disconnected
Magnetic Field	0 A/m AC
Electric Field	0 V/m AC

Table 9

7.2 ELECTRICAL SPECIFICATIONS

7.2.1 Voltage Inputs

- **Operating range**: Up to 1000 VRMS FOR phase-neutral voltages, voltages between phases, from (42.5 to 69) Hz (600 VRMS FROM 340 Hz TO 460 Hz) AND UP TO 1000 VDC.

NOTE: Phase-to-neutral voltages lower than 2 V and phase-to-phase voltages lower than (2 x √3) V are zeroed.

- **Input impedance**: 1908 kΩ (phase-to-neutral and neutral-to-ground)
- **Max permanent overload**: 1100 VRMS

7.2.2 Current Inputs

NOTE: The outputs of the current sensors are voltages.

- **Operating range**: 5 μV to 1.2 V (1 V = I_{nom}) with a crest factor = √2 @ 1.2 I_{nom}
- **Input impedance**: 1 MΩ (standard current input), 12.4 kΩ (AmpFlex®/MiniFlex® current input).
  The AmpFlex®/MiniFlex® configuration switches the current input onto an integrating circuit.
- **Max overload**: 1.7 V

7.2.3 Measurement Ranges

7.2.3.1 Measurement Specifications at 50/60 Hz

Quantities	Unit	Measurement Range	Accuracy
Frequency (f)	Hz	(42.5 to 69) Hz	± 0.1 Hz
Phase-to-Neutral voltage (V)	V	(10 to 1000) V	± 0.2 % R ± 0.2 V
Neutral-to-Ground/Earth voltage (V_{PE})	V	(10 to 1000) V	± 0.2 % R ± 0.2 V
Phase-to-Phase voltage (U)	V	(17 to 1000) V	± 0.2 % R ± 0.4 V
Current (I)	A	(0.2 to 120) % I_{nom}	± 0.4 % R ± 0.04 % I_{nom}
Neutral Current (I_N)	A	(0.2 to 120) % I_{nom}	± 0.4 % R ± 0.04 % I_{nom}
Active Power (P)	W	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)	var	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 10) % I_{nom}	± 3.5 % R ± 0.03 % Q_{nom}
		Sin φ = 0.5 inductive 0.5 capacitive V = (100 to 1000) V I = (10 to 120) % I_{nom}	± 1 % R ± 0.01 % Q_{nom}
		Sin φ = 0.25 inductive 0.25 capacitive V = (100 to 1000) V I = (10 to 120) % I_{nom}	± 2.5 % R ± 0.025 % Q_{nom}
Apparent power (S)	VA	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
Tan Φ	-	tan Φ = $\sqrt{3}$ inductive $\sqrt{3}$ capacitive V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.02
		tan Φ = 3.2 inductive 3.2 capacitive V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.05
Active Energy (E_p)	Wh	PF = 1 V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.5 % R
		PF = 0.5 inductive 0.8 capacitive V = (100 to 1000) V I = (10 to 120) % I_{nom}	± 0.6 % R
Reactive energy (E_q)	varh	Sin φ = 1 V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 2 % R
		Sin φ = 0.5 inductive 0.5 capacitive V = (100 to 1000) V I = (5 to 10) % I_{nom}	± 2.5 % R
		Sin φ = 0.5 inductive 0.5 capacitive V = (100 to 1000) V I = (10 to 120) % I_{nom}	± 2 % R

Quantities	Unit	Measurement Range	Accuracy
Apparent energy (Es)	VAh	V = (100 to 1000) V I = (5 to 120) % I_{nom}	± 0.5 % R
Fundamental Harmonic Distortion Rate (THDF)	%f	PF = 1 V = (100 to 1000) V I = (10 to 120) % I_{nom}	± 1 % R

Table 10

In the preceding table:

- *I_{nom} is the measured current when the output from the current sensor is 1 V.*
- *P_{nom} and S_{nom} are the active and apparent powers for V = 1000 V, I = I_{nom}, and PF = 1.*
- *Q_{nom} is the reactive power for V = 1000 V, I = I_{nom}, and sin φ = 1.*
- *The uncertainty for input current is specified for an isolated voltage input of 1 V, corresponding to I_{nom}. The uncertainty of the current sensor used must be added to it to determine the total uncertainty of the measurement system. With the AmpFlex® and MiniFlex® current sensors, the uncertainty given in Table 14 (AmpFlex® and MiniFlex® Specifications) must be used.*
- *The uncertainty for neutral current I_N is the sum of the uncertainties on I_1, I_2, and I_3.*

7.2.3.2 Measurement Specifications at 400 Hz

Quantity	Unit	Measurement range	Accuracy
Frequency (F)	Hz	(340 to 460) Hz	± 0.3 Hz
Phase-to-Neutral voltage (V)	V	(5 to 600) V	± 0.8 % R + 0.5 V
Neutral-to-Ground/Earth voltage (V_{PE})	V	(5 to 600) V	± 0.8 % R + 0.5 V
Phase-to-Phase voltage (U)	V	(10 to 600) V	± 0.8 % R + 0.5 V
Current (I)	A	(0.2 to 120) % I_{nom}	± 0.5 % R + 0.05 % I_{nom}
Neutral current (I_N)	A	(0.2 to 120) % I_{nom}	± 0.5 % R + 0.05 % I_{nom}
Active Power (P)	kW	PF = 1 V = (100 to 600) V I = (5 to 120) % I_{nom}	± 2 % R + 0.2 % P_{nom} [1]
		PF = 0.5 inductive 0.8 capacitive V = (100 to 600) V I = (5 to 120) % I_{nom}	± 3 % R + 0.3 % P_{nom} [1]
Active Energy (E_P)	kWh	PF = 1 V = (100 to 600) V I = (5 to 120) % I_{nom}	± 2 % R

Table 11

In the preceding table:

- *R = Reading (displayed value).*
- *I_{nom} is the value of the measured current for a current probe output of 1 V.*
- *P_{nom} is the Active Power for V = 600 V, I = I_{nom}, and PF = 1.*
- *The uncertainty for input current (I) is specified for an isolated input voltage of 1 V = I_{nom}. The accuracy of the connected current probe should be added to this uncertainty to determine the total uncertainty. For MiniFlex® and AmpFlex® probes, the uncertainty of current input (I) is not specified.*
- *The uncertainty for neutral current I_N is the sum of the uncertainties on I_1, I_2, and I_3.*
- *For AmpFlex®/MiniFlex®, IMAX is limited to 60 % I_{nom} at 50/60 Hz, due to the higher sensitivity.*
- *1 = indicative value.*

7.2.3.3 Measurement Specifications for DC

Quantity	Unit	Measurement range	Accuracy
Voltage (V)	V	V = (10 to 1000) V	± 0.2 % R ± 0.5 V
Common to Ground/ Earth voltage (V_{PE})	V	V = (10 to 1000) V	± 0.2 % R ± 0.5 V
Current (I)	A	I = (5 to 120) % I_{nom}	± 1 % R ± 0.3 % I_{nom}
Common current (I_N)	A	I = (5 to 120) % I_{nom}	± 1 % R ± 0.3 % I_{nom}
Power (P)	kW	V = (100 to 600) V I = (5 to 120) % I_{nom}	± 1 % R ± 0.3 % P_{nom}
Energy (E_P)	kWh	V = (100 to 600) V I = (5 to 120) % I_{nom}	± 1.5 % R

Table 12

In the preceding table:

- *R = Reading (displayed value).*
- *I_{nom} is the value of the measured current for a current probe output of 1 V.*
- *P_{nom} is the Active Power for V = 600 V and I = I_{nom}.*
- *The uncertainty for input current (I) is specified for an isolated input voltage of 1 V = I_{nom}. The accuracy of the connected current probe should be added to this uncertainty to determine the total uncertainty.*
- *The uncertainty for neutral current I_N is the sum of the uncertainties on I_1, I_2, and I_3.*

7.2.3.4 Influence of Temperature

For V, U, I, P, Q, S, and energies:

- 300 ppm/°C, with 5 % < I < 120 % and PF=1
- 500 ppm/°C, with 10 % < I < 120 % and PF= 0.5 inductive

DC offset (V and I):

- 10 mV/°C typical
- 30 ppm x I_{nom}/°C typical

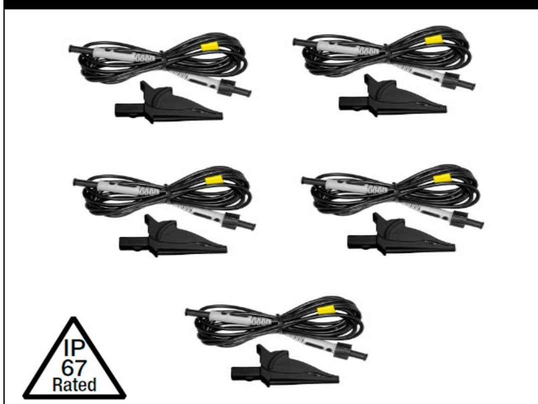
7.2.3.5 Influence of the Magnetic Field

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

7.2.3.6 Voltage Test Leads

Voltage Test Leads

The PEL 115 ships with five black test leads and black alligator clips.

Voltage Test Lead and Alligator Clip	
	**Length:** Approximately 10 ft (3 m) **Rating:** 1000 V CAT IV, 15 A

Each lead includes a waterproof cap that screws into the instrument's threaded voltage terminals to ensure a waterproof (IP67) connection. It may be possible to use other test leads with the instrument. However, only leads that screw into the voltage terminals can provide IP67 performance.

7.2.4 Current Sensors

7.2.4.1 Precautions for Use

⚠ **WARNING:** Refer to the safety sheet or user manual that was supplied with your current sensors for more information.

Current clamps and flexible current sensors make it possible to measure the current flowing in a cable by breaking the circuit. They also isolate the user from the dangerous voltages in the circuit.

Which current sensor to use will depend on the current to be measured and the diameter of the cables.

When you install current sensors, have the arrow on the sensor point toward the load.

Only the AmpFlex® 196A current sensor, the MiniFlex® MA196 current sensor and the lockable voltage leads ensure tightness (IP67 when instrument is closed).

7.2.4.2 Specifications

The measurement ranges are those of the current sensors. These are sometimes different from those of the PEL.

The following table provides measurement specifications for supported sensors and probes. For detailed sensor/probe specifications refer to the user manual provided with the current sensor.

Measurement Specifications for Supported Probes and Sensors		
Model	**Nominal Range**	**Measurement Range**
AmpFlex® Sensor Model 196A (waterproof, IP67)	(100, 400, 2000, 10,000) A_{AC}	200 mA to 12,000 A_{AC}
AmpFlex® Sensor Model 193	(100, 400, 2000, 10,000) A_{AC}	200 mA to 12,000 A_{AC}
MiniFlex® Current Probe MA193	(100, 400, 2000, 10,000) A_{AC}	200 mA to 12,000 A_{AC}
MiniFlex® Sensor Model MA196 (waterproof, IP67)	(100, 400, 2000) A_{AC}	200 mA to 2400 A_{AC}
MiniFlex® Sensor Model MA194	(100, 400, 2000, 10,000) A_{AC}	200 mA to 12,000 A_{AC}
AC/DC Current Probe Model MR193-BK	1000 A_{AC} 1300 A_{DC}	(1 to 1000) A_{AC}, (1 to 1300) A_{peak} AC+DC
AC Current Probe Model SR193-BK	1000 A_{AC}	(1 to 1200) A_{AC} max (I >1000 A for 5 min at most
AC Current Probe Model MN93-BK	200 A_{AC}	0.5 at 240 A_{AC} max (I >200 A not permanent)
AC Current Probe Model MN193-BK	5 A and 100 A_{AC}	5 A: (0.005 to 6) A_{AC} max 100 A: (0.2 to 120) A_{AC} max
AC/DC Current Probe Model E94	10 $A_{AC/DC}$ and 100 $A_{AC/DC}$	10 A: 50 mA to 10 A_{AC} 100 A: 50 mA to 100 A_{AC}

Table 13

7.2.4.3 AmpFlex® 196A or AmpFlex® 193

To connect the flexible sensor to the electrical network under measurement, do the following:

1. Connect the sensor lead onto the appropriate current terminal. Which terminal to use depends on the hookup type, as explained later in this section. When using the AmpFlex® 196A-24-BK sensor, be sure to screw the lead onto the threaded terminal to ensure a waterproof (IP67) operation.
2. Open the sensor by pressing on both sides of the release levers of the coupling and pulling out the end.
3. Open sensor then wrap it around the electrical coil to be measured (only one conductor per coil).
4. Close the sensor by inserting the end back into the coupling. You must hear a **click**. For better measurement quality, center the conductor in the coil and keep the coil as circular as possible.
5. To disconnect the sensor, open it and withdraw it from the conductor. Then disconnect the current sensor from the instrument.

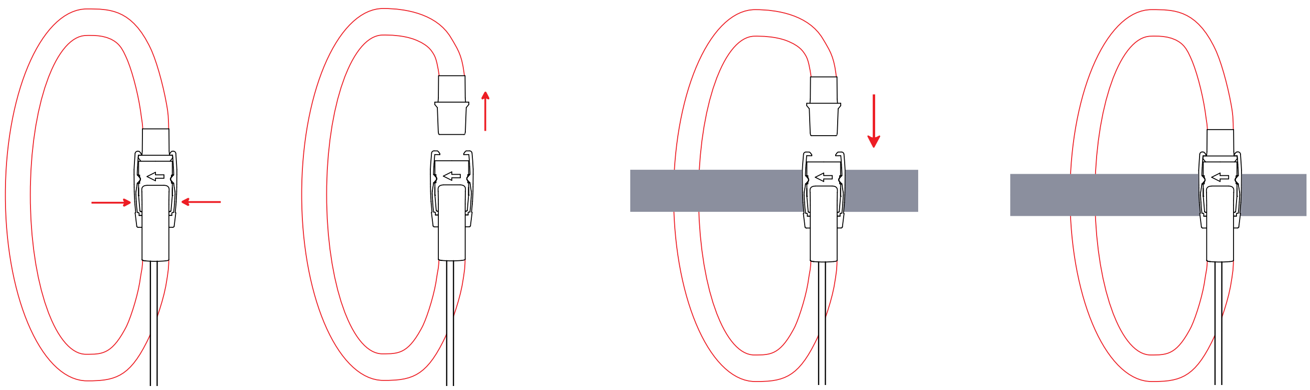


Figure 42

This is the basic connection procedure for flexible loop sensors/probes. Clamp-on sensors/probes require a similar connection process.

7.2.4.4 AmpFlex® & MiniFlex® Probe and Sensor Accuracy

Current Sensors with 1 V Output at Full Range

The following current probe uncertainties do not include instrument uncertainties. The numbers listed below should be added to the uncertainties listed in Tables 10, 11 and 12 to calculate total uncertainty when using the instrument with a specific probe.

Model	I Nominal of the Range	Measurement Current Range	Accuracy	Maximum Phase Error @ 50/60 Hz	Typical Phase Error @ 50/60 Hz	Typical Phase Error @ 400 Hz
MR193 Clamp	1000 AAC/DC	(1 to 50) A	± 1.5 % R + 1 A		-	
		(50 to 100) A	± 1.5 % R + 1 A	± 2.5 %	- 0.9°	- 4.5° @ 100 A
		(100 to 800) A	± 2.5 % R	± 2 %	- 0.8°	
		(800 to 1000) A	± 4 % R	± 2 %	- 0.65°	
SR193 Clamp	1000 AAC	(1 to 50) A	± 1 % R	-	-	-
		(50 to 100) A	± 0.5 % R	± 1°	+0.25°	+0.1° @ 1000 A
		(100 to 1200) A	± 0.3 % R	± 0.7°	+0.2°	
MN93 Clamp	200 AAC	(0.5 to 5) A	± 3 % R + 1 A	-	-	-
		(5 to 40) A	± 2.5 % R + 1 A	± 5°	± 2°	-1.5° @ 40 A
		(40 to 100) A	± 2 % R + 1 A	± 3°	± 1.2°	-0.8° @ 100 A
		(100 to 240) A	± 1 % R + 1 A	± 2.5°	± 0.8°	-1° @ 200 A

Model	I Nominal of the Range	Measurement Current Range	Accuracy	Maximum Phase Error @ 50/60 Hz	Typical Phase Error @ 50/60 Hz	Typical Phase Error @ 400 Hz
MN193 Clamp	100 A_{AC}	200 mA to 5 A	± 1 % R + 2 mA	± 4º	-	-
		(5 to 120) A	± 1 % R	± 2.5º	+ 0.75º	-0.5º @ 100 A
	5 A_{AC}	(5 to 250) mA	± 1.5 % R + 0.1 mA	-	-	-
		250 mA to 6 A	± 1 % R	± 5º	+ 1.7º	-0.5º @ 5 A
E94 Clamp	100 $A_{AC/DC}$	50 mA to 40 A	± 4 % R + 50 mA	± 1º	-	-
		(40 to 100) A	± 15 % R	± 1º	-	-
	10 $A_{AC/DC}$	50 mA to 10 A	± 3 % R + 50 mA	± 1.5º	-	-

Table 14

7.2.4.5 AmpFlex® and MiniFlex® Specifications

The following AmpFlex®/MiniFlex® accuracies include instrument accuracy for AC current values. To calculate accuracy for power/energies and other quantities, the following accuracies must be added to the accuracy for the instrument listed in Tables 10, 11, and 12.

Probe	I Nominal of the Range	Measurement Current Range	Accuracy @ 50/60 Hz	Accuracy @ 400 Hz	Maximum Phase Error @ 50/60 Hz	Typical Phase Error @ 50/60 Hz	Typical Phase Error @ 400 Hz
AmpFlex® 196A 193	100 A_{AC}	200 mA to 5 A	± 1.2 % R + 50 mA	± 2 % R + 0.1 A	-	-	-
		(5 to 120) A*			± 0.5°	0º	- 0.5°
	400 A_{AC}	(0.8 to 20) A	± 1.2 % R + 0.2 A	± 2 % R + 0.4 A	-	-	-
		(20 to 500) A*			± 0.5°	0°	- 0.5°
	2000 A_{AC}	(4 to 100) A*	± 1.2 % R+ 1 A	± 2 % R ± 2 A	-	-	-
		(100 to 2400) A*			± 0.5°	0°	- 0.5°
	10,000 A_{AC}	(20 to 500) A	± 1.2 % R + 5 A	± 2 % R + 10 A	-	-	-
		(500 to 12,000) A*			± 0.5°	0°	- 0.5°
MiniFlex® MA196 MA194	100 A_{AC}	200 mA to 5 A	± 1 % R + 50 mA	± 2 % R + 0.1 A	-	-	-
		(5 to 120) A*			± 0.5°	0°	- 0.5°
	400 A_{AC}	(0.8 to 20) A	± 1 % R + 0.2 A	± 2 % R + 0.4 A	-	-	-
		(20 to 500) A*			± 0.5°	0°	- 0.5°
	2000 A_{AC}	(4 to 100) A*	± 1 % R + 1 A	± 2 % R ± 2 A	-	-	-
		(100 to 2400) A*			± 0.5°	0°	- 0.5°
	10,000 A_{AC}	(20 to 500) A*	± 1 % R + 1 A	± 2 % R ± 2 A	-	-	-
		(500 to 12,000) A*			± 0.5°		- 0.5°

Table 15

**The high range value is reduced by 50 % when used at 400 Hz.*

Limitations of the AmpFlex® and MiniFlex®

Like all Rogowski sensors, the AmpFlex® and MiniFlex® have output voltage that is proportional to the frequency. A high current at high frequency can saturate the instrument's current input.

7.4 COMMUNICATION

7.4.1 USB

- USB 2.0
- Type B connector

7.4.2 Network

- RJ 45 connector with two integrated LEDs
- 100 Base T Ethernet

7.4.3 Wi-Fi

- 2.4 GHz band IEEE 802.11 B/G/N radio
- TX power: +17 dBm
- Rx sensitivity: -97 dBm
- Rate: 72.2 MB/s max
- Security: WPA/WPA2
- Client (STA) mode support
- Access Point (AP) mode support for up to five clients

7.5 POWER CONSUMPTION

- Phase power via voltage measurement terminals.
- Range of Operation:
  - (100 to 1000) V (± 10 %) @ (42.5 to 69) Hz
  - (100 to 600) V (± 10 %) @ (340 to 460) Hz
  - (140 to 1000) V in DC
- Maximum power: 30 VA
- Battery:
  - Type: Rechargeable NiMH battery
  - Weight: Approximately 7.05 oz (200 g)
  - Number of charging/discharging cycles: >1000
  - Charging time: Approximately 5 h
  - Maximum operating range when battery charging: (-4 to 104) °F (-20 to 40) °C
  - Life between charges: Provides approximately 1 h standalone operation without Wi-Fi activated.
  - Battery is designed to last through at least 1000 charge-discharge cycles over two years.
- External AC power input: 15 V_{DC}.

NOTE: When the instrument is powered down, the internal clock is maintained for 20 days.

7.6 MECHANICAL SPECIFICATIONS

- Weight: approximately 8.8 lb (4 kg)
- Dimensions:
  Length: 10.63 in (270 mm) With leads: 12.6 in (320 mm)
  Width: 9.65 in (245 mm)
  Height: 7.09 in (180 mm)
- Drop test:
  - Approximately 8 in (20 cm) in the most severe position without permanent mechanical damage and functional deterioration.
  - 3.28 ft (1 m) in its packaging.

- Degrees of protection provided by enclosure (IP code) according to IEC 60529:
  - IP67 (waterproof) when the cover of the instrument is closed, the voltage leads are screwed tight and the leads of the AmpFlex® 196A connectors are screwed tight.
  - IP54: when the cover is open, the instrument is in a horizontal position, and the terminal plugs are in place.
  - IP40: when the cover is open, the instrument is in a horizontal position, and the terminal plugs are not in place.
- LCD: (4.2 x 3.3) in (106.7 x 83.82) mm
- Resistance to sunlight: Complies with the sunlight, UV, and water resistance requirements of UL 746C (F1).

7.7 ENVIRONMENTAL CONDITIONS

The instrument must be used in the following environmental conditions.

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: (-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

3 = Storage Temperature (w/ battery): (-40 to 95) °F (-40 to 35) °C from (0 to 95) % RH
(-40 to 158) °F (-40 to 70) °C from (0 to 75) % RH

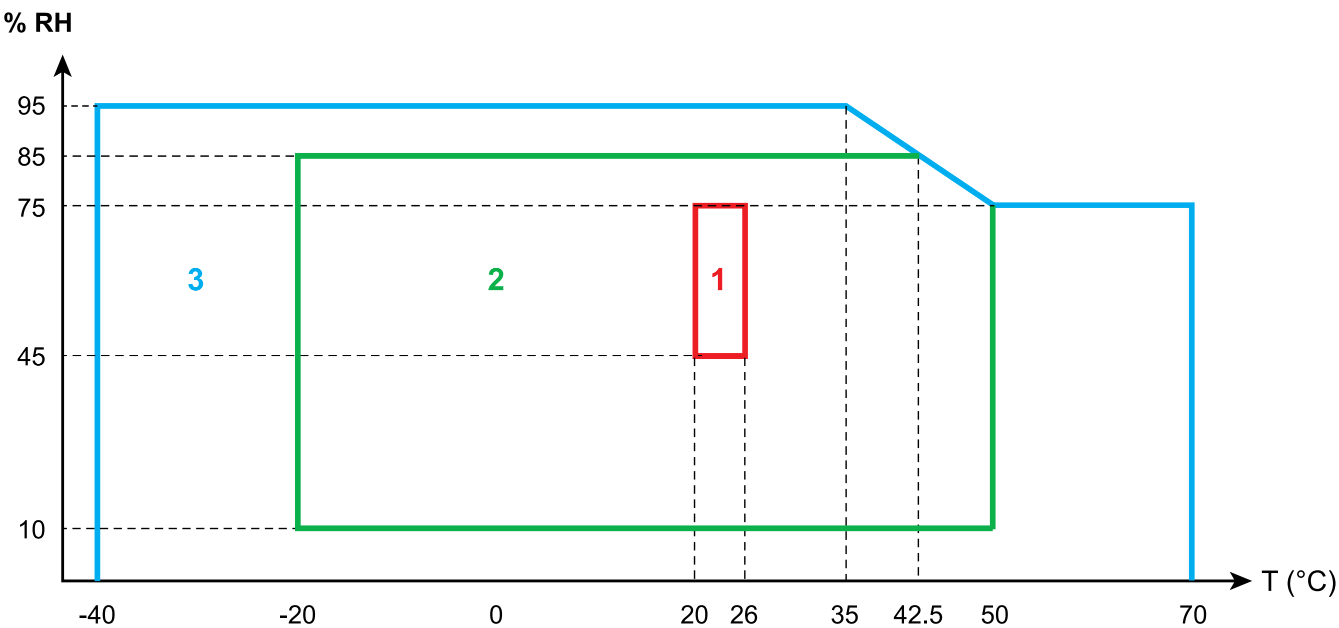


Figure 43

Indoor and outdoor use

Operating Altitude: < 6562 ft < 2000 m

Storage Altitude: < 32,808 ft < 10,000 m

Degree of Pollution: 3 with cover open / 4 with cover closed

7.8 ELECTRICAL SAFETY

The instruments are compliant with standard IEC/EN 61010-2-030:

- Measurement inputs and enclosure: 1000 V overvoltage CAT IV, degree of pollution 3 (4 with instrument closed)
- Power supply: 1000 V overvoltage CAT IV, pollution degree 2

The current probes are compliant with IEC/EN 61010-2-032.

The test leads and alligator clips are compliant with IEC/EN 61010-031.

NOTE: The overall rated voltage and the measurement category of the instrument/probe system may be reduced depending on the current probe type or other accessories.

The instrument is protected internally by 1000 V fuses against excessive current being drawn from the phase power supply due to faulty equipment or transient overvoltages. These fuses can only be replaced by authorized AEMC® Instruments service personnel.

7.9 ELECTROMAGNETIC COMPATIBILITY

- Immunity: Compliant with IEC/EN 61326-1. Immunity test requirements are for equipment intended for use in industrial locations.
- With MiniFlex® and AmpFlex® probes, the typical influence is 0.5 % of full scale with a maximum of 5 A.

7.10 RADIO EMISSION

The device is compliant with the 2014/53/EU RED directive and FCC Regulations. Wi-Fi: FCC certification QOQWF121

7.11 MEMORY CARD

The PEL 115 accepts FAT32 formatted SD and SDHC cards and SDXC cards up to a capacity of 32 GB. The SDXC cards must be formatted in the instrument.

Number of insertions and withdrawals: 1000.

The transfer of a large quantity of data may take a long time. Moreover, some computers may have difficulty processing such large quantities of information, and spread sheets accept only a limited quantity of data.

We recommend optimizing the data on the SD-card and recording only the necessary measurements. Recording sessions are stored in the instrument's SD-card. The memory required for a recording session primarily depends upon the duration of the recording and the storage period. Recording rates for the different types of session data are as follows:

- 200 ms trends: ~70 MB per day
- 1 second harmonics: 83 MB per day.
- 1 second trends: 20 MB per day.
- Aggregated trend: 1.4 MB per day for 1 minute periods.
- For longer periods, this rate is divided by the period in minutes. For example, for an aggregation period of 10 minutes, the rate will be 0.14 MB per day; for 15 minute periods this is 0.113 MB per day, and so on.
- Aggregated harmonics: 1.4 MB per day for 1 minute periods. (For longer periods, use the same formula described above for aggregated trend data.) For instance, a five-day session recording aggregated trends and harmonics with a 15 minute demand period, 1 second trends, and 1 second harmonics would consume approximately 636 MB of storage. The maximum recording times for a single session on an instrument are:
- 21 days when recording 200 ms trends and 1 minute aggregated data (trend and harmonics).
- One month when recording 1 minute aggregated data, 1 second trends, and 1 second harmonics.
- 15 weeks when recording 1 minute aggregated data and 1 second trend data but not harmonics.
- Three years when recording only 1 minute aggregated data (including aggregated harmonics).
- Multiple years when recording only 15 minute aggregated data (without aggregated harmonics).

Do not exceed 32 records on the SD-card.

For records that are long (duration greater than one week) or include the harmonics, use class 4 or higher SDHC cards.

Do not use the Wi-Fi link to download large records as it would take too long. If no other link is possible, do not include 1 s data and harmonics when configuring the recording. Without these, a 30-day record occupies only 2.5 MB.

On the other hand, downloading by USB or Ethernet link can be acceptable, depending on the length of the record and the transmission rate.

To transfer the data more rapidly, use the SD-card/USB SD-card reader.

8. MAINTENANCE

There are several routine maintenance tasks you should perform periodically to ensure optimal operation of your instrument.

Instrument maintenance tasks include:

- Erasing and upgrading the SD-card
- Upgrading to the latest firmware revision
- Maintaining the batteries
- Cleaning the instrument

The following sections explain how to perform these tasks.

8.1 ERASING AND UPGRADING MEMORY

When the SD-card SD LED either (1) blinks alternately red and green, or (2) blinks green once per second, the SD-card is either full or does not have enough remaining space to store the scheduled or in-progress recording session. In either case, you must erase the SD-card to ensure sufficient storage capacity for future recordings. This is done via an option in the PEL Control Panel.

NOTE: Erasing the SD-card deletes all the records stored in memory. To save one or more recording sessions, you must download the session(s) to the computer.

You can remove the SD-card that comes with the instrument and replace it with an SD-card with more storage but not > 32 GB.

To do this:

1. Remove the existing SD-card from the instrument by pressing down and then releasing it. The card will pop up, allowing you to pull it from the card slot.
2. Check the replacement card to ensure its write-protect sliding tab is in the **unlock** position (towards the metal contacts).
3. Insert the SD-card into the slot, with the metal contacts facing towards the top of the card.
4. Press the SD-card into the slot until it clicks in place.
5. If necessary, format the card by connecting the instrument to a computer running the PEL Control Panel and selecting the Format SD-card option.

When the new card is ready for storing recordings; the SD LED illuminates steady green.

8.2 UPGRADING FIRMWARE

The PEL 115 firmware controls the features and functionality of the instrument. AEMC® Instruments provides firmware updates free of charge to download through our PEL Control Panel software.

NOTE: Updating the firmware could reset the configuration and causes loss of stored data. As a precaution, save the stored data to a computer before updating the firmware.

To update the firmware, your computer 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 computer using any connection other than DataViewSync™ or Wi-Fi.
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, if the computer has internet access, 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.

8.3 BATTERY MAINTENANCE

The instrument is equipped with a NiMH battery, which provides approximately 1 hour of power. After prolonged storage, the battery may be completely discharged. If so, it must be completely charged. This requires approximately 5 h (see § 3.3.).

To make the best possible use of your battery and extend its effective service life comply with the instrument usage and storage conditions defined in § 7.7.

NOTE: You cannot change the battery. This must be done at an authorized AEMC® Instruments Service Center as part of the instrument's regular maintenance.

8.4 CLEANING THE INSTRUMENT

CAUTION! Risk of Electric Shock
Before cleaning, disconnect all input(s) to prevent possible electric shock.

The instrument should be cleaned periodically. This keeps the LCD clear and easily viewable, and also prevents dirt and grease buildup around the instrument's buttons and input terminals.

- Disconnect all inputs.
- The body of the instrument should be cleaned with a clean, damp and soapy cloth.
- Do not submerge the instrument in water.
- Do not use solvent.

8.5 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.

8.6 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

8.7 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

8.7.1 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.

9. TROUBLESHOOTING

This section describes how to correct several potential issues you may encounter. These include:

- The instrument does not turn ON when you press the **Power** button.
- The instrument turns ON but does not function.
- You cannot configure settings through the instrument's front panel interface.
- You cannot start a recording session.
- Recording sessions end before the specified end date and time.
- You cannot connect to a computer.
- The instrument does not turn OFF when you press .

The following sections explain some of the possible causes for these issues and how you can address them. If you perform these troubleshooting actions but the issue still persists, or if you encounter a problem not covered in this section, please contact AEMC® Instruments Technical Support.

9.1 INSTRUMENT DOES NOT TURN ON

The most common cause of failure to power ON is a completely discharged battery. Connect the instrument to an external power source, either external AC power or phase power. The instrument should immediately turn ON, and the Battery LED should illuminate orange and blink indicating the battery is recovering from a full discharge.

If the instrument does not turn ON when connected to external power, contact AEMC® Instruments Technical Support.

9.2 INSTRUMENT TURNS ON BUT DOES NOT FUNCTION

If the instrument has been stored in a cold and damp environment, condensation may form inside. This can short internal circuitry, preventing the instrument from operating normally. In this case, turn OFF the instrument and place it in a warm, dry environment for several hours. Then turn the instrument ON and try navigating through the screen interface to determine whether or not it has been restored to normal functionality.

9.3 CANNOT CONFIGURE THE INSTRUMENT

Several conditions may cause some or all configuration options to appear disabled, or function in unexpected ways. For example, when the instrument is locked or when it is recording data, none of the Configuration Mode options is enabled. Instead, the word **LOCK** appears on the LCD when you enter Configuration Mode.

The instrument is locked when it is being configured through the PEL Control Panel Configure Instrument dialog box. It can also be locked through a configuration option in the PEL Control Panel. When this option is enabled, the instrument remains locked even when disconnected from the computer.

To return local control to the instrument, ensure that the **Lock out the Control button on the instrument front panel** option in the PEL Control Panel is unchecked (see § 3.6). Then disconnect the instrument from the PEL Control Panel. If the instrument remains locked, check whether or not a recording is in progress. (The **REC** LED is lit RED when a recording is active.) If so, either stop the recording or wait until it completes (see § 5.2).

If some configuration screens are active, while others are inactive (or don't appear at all), you may have the wrong hookup type selected. Hookup settings can affect which configuration screens are available. In this case, enter Information Mode and ensure the appropriate hookup type is selected.

9.4 RECORDING SESSIONS DO NOT START

If you attempt to start a recording either by pressing or via the PEL Control Panel and the session does not start, check whether or not a recording is already in progress on the instrument (the **REC** LED is lit RED). To start a new recording, either wait for the in-progress recording to finish, or stop the recording.

Also check that the SD-card is installed, operational, and has sufficient space to save the recording. If the SD LED illuminates red, it is write-protected, not installed, or not recognized. If it blinks alternately red and green, it is full. If it blinks green once per second, it does not have enough space for the recording you are attempting to start.

Another condition that could prevent a recording session from starting is if the start and/or end times and dates are configured incorrectly, such as a stop date/time that has already passed. If the instrument has sufficient memory for the recording but it still will not start, check the recording's start and stop times/dates to ensure they are configured properly.

See § 5.2 for information about configuring a recording session.

9.5 RECORDING SESSIONS END PREMATURELY

If a recording session terminates before its scheduled stop time, a likely cause is that the SD-card memory has become full. When this happens, the SD LED illuminates red. Download any data you want to save, then erase the contents of the SD-card through the PEL Control Panel (see § 8.1).

9.6 CANNOT CONNECT TO A COMPUTER

If you cannot connect the computer via Wi-Fi, ensure that the communication protocol through which you are attempting to connect is enabled. Check the appropriate LED: •))) for Wi-Fi. If it is OFF (indicating the protocol is disabled) enable it (see § 3.5) for instructions.

If you are attempting to connect via USB or point-to-point Ethernet, ensure that the cable is securely connected to both the instrument and the computer. If the connections are secure, close the PEL Control Panel, disconnect the cable, wait a few seconds, then reconnect the cable. This resets the connection with the computer.

Also check the Communication settings in the PEL Control Panel, as explained in the PEL Control Panel Help system.

9.7 CANNOT TURN OFF THE INSTRUMENT

The Power button is disabled if a recording is active or pending. In addition, you cannot turn OFF the instrument if it is operating on external AC or phase power. Disconnect the power source, hold down the **Power** button until all the instrument's LEDs light up, then release to turn OFF the instrument.

APPENDIX A: THEORY OF OPERATION

The instrument calculates measurements in accordance with IEC 61557-12 and IEC 61010-4-30. The following is a graphic representation of active and reactive power, in accordance with clauses 12 and 14 of IEC 60375.

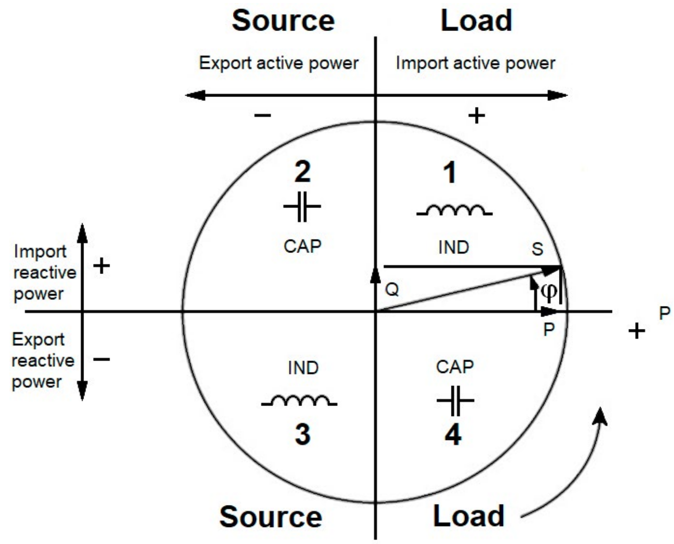


Figure 44

In this diagram:

- The current vector is fixed on the right-hand line.
- The voltage vector V varies direction according to the phase angle φ.
- The phase angle φ between voltage V and current I is considered mathematically positive (counter-clockwise).

A.1 Sampling

The sampling period is calculated every second, and varies according to the line frequency (50, 60, or 400) Hz.

50 Hz:

- (42.5 to 57.5) Hz (50 Hz ± 15 %), sampling period is locked to the main frequency. There are 128 samples available for each main cycle.
- Outside (42.5 to 57.5) Hz, sampling period is (128 x 50) Hz.

60 Hz:

- (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 x 60) Hz.

400 Hz:

- (340 to 460) Hz (400 Hz ± 15 %), sampling period is locked to main frequency. For each main cycle, 16 samples are available.
- Outside (340 to 460) Hz, sampling period is (16 x 400) Hz.

Note that DC is not a frequency parameter for sampling. A pure DC measured signal is considered to be outside the frequency ranges. In this case the sampling frequency for a pure DC signal is, according to the preselected main frequency, 6.4 kHz 312 (50 Hz/400 Hz) or 7.68 kHz (60 Hz). By default, sampling frequency is locked on V_1. If V_1 is missing, the instrument attempts to lock sampling frequency V_2, then V_3, I_1, I_2, and I_3.

A.1.1 Locking the Sampling Frequency

By default, the sampling frequency is locked to V_1. If V_1 is missing, the instrument attempts to lock to V_2, then to V_3, I_1, I_2, and I_3.

A.1.2 AC/DC

The PEL 115 makes AC and DC measurements for AC and DC distribution networks. AC or DC is selected by the user.

The AC + DC values are available via the PEL Control Panel.

A.1.3 Neutral Current Measurement

Depending on the distribution network, if there is no current sensor on the IN terminal, the neutral current is calculated.

A.1.4 200 ms Quantities

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

- Trends on the **1 s** quantities
- Aggregation of the values for the **1 s** quantities (see § A.1.6)

All **200 ms** quantities can be recorded on the SD-card during the recording session. They can be displayed in the PEL Control Panel.

A.1.5 1 s Quantities (one second)

The instrument calculates the following quantities every second based on measurements of 50 periods for 50 Hz, 60 periods for 60 Hz, and 400 periods for 400 Hz. The **1 s** quantities are used for:

- Real-time values
- Trends
- Aggregation of the values for the aggregated quantities (see § A.1.6)
- Determination of the values and maximum/minimum for the values of the aggregated trends

All **1 s** quantities can be recorded on the SD-card during the recording session. They can be displayed in the PEL Control Panel.

A.1.6 Aggregation

An aggregated quantity is a value calculated for a defined period. Aggregation periods always start on rounded hours/minutes. The period is one of the following: (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60) minutes.

All aggregated quantities and 200 ms and 1 s quantities, are saved on the SD-card during the recording session. They can be displayed in the PEL Control Panel.

A.1.7 Minimum and Maximum

The Min and Max are the minimum and maximum 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.

A.1.8 Energy Calculations

Energies are calculated every second. Total energy is the demand during the recording session. Partial energy can be determined for one of the following integration periods: 1 h, 1 d, 1 wk, or 1 mo. The partial energy index is available only in real time. It is not recorded.

Note that total energies are available with the data of the recorded session.

A.2 Phase Order

Every second, the instrument determines the phase order. If the phase order does not meet the criteria listed in the tables below, the red Phase Order LED blinks. In addition, the Phase Order icon appears on the LCD.

To ensure proper phase order, the current phase order, voltage phase order, and current vs voltage phase order for that hookup must all be correct. Note that:

- Phase order for voltage channels is only displayed when voltages are displayed on the LCD.
- 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 hookups (such as DC) the phase order does not always apply.

The following tables list the measurement ranges that ensure correct current phase order, voltage phase order, and current vs voltage phase order respectively.

A.2.1 Current Phase Order

Hookup	Current Phase Order	Range
1P-2W (1-Phase 2-Wire)	No	
1P -3W (1-Phase 3-Wire)	Yes	φ (I_2, I_1) = 180° ± 30°
3P-3WΔ2 (3-Phase 3-Wire Δ, 2 current probes)	Yes	φ (I_1, I_3) = 120° ± 30° No I_2 current probes
3P-3WO2 (3-Phase 3-Wire Open Δ, 2 current probes)		
3P-3WY2 (3-Phase 3-Wire Y, 2 current probes)		
3P-3WΔ3 (3-Phase 3-Wire Δ, 3 current probes)	Yes	[φ (I_1, I_3), φ (I_3, I_2), φ (I_2, I_1)] = 120° ± 30°
3P-3WO3 (3-Phase 3-Wire Open Δ, 3 current probes)		
3P-3WY3 (3-Phase 3-Wire Y, 3 current probes)		
3P-3WΔb (3-Phase 3-Wire Δ balanced)	No	
3P-4WY (3-Phase 4-Wire Y)	Yes	[φ (I_1, I_3), φ (I_3, I_2), φ (I_2, I_1)] = 120° ± 30°
3P-4WYb (3-Phase 4-Wire Y balanced)	No	
3P-4WY2 (3-Phase 4-Wire Y 2½)	Yes	[φ (I_1, I_3), φ (I_3, I_2), φ (I_2, I_1)] = 120° ± 30°
3P-4WΔ (3-Phase 4-Wire Δ)	Yes	[φ (I_1, I_3), φ (I_3, I_2), φ (I_2, I_1)] = 120° ± 30°
3P-4WOΔ (3-Phase 4-Wire Open Δ)		
DC-2W (DC 2-Wire)	No	
DC-3W (DC 3-Wire)	No	
DC-4W (DC 4-Wire)	No	

Table 16

A.2.2 Voltage Phase Order

Hookup	Voltage Phase Order	Range
1P-2W (1-Phase 2-Wire)	No	
1P -3W (1-Phase 3-Wire)	Yes	φ (V_2, V_1) = 180° ± 10°
3P-3WΔ2 (3-Phase 3-Wire Δ, 2 current probes)	Yes (on U)	[φ (U_{12}, U_{31}), φ (U_{31}, U_{23}), φ (U_{23}, U_{12})] = 120° ± 10°
3P-3WO2 (3-Phase 3-Wire Open Δ, 2 current probes)		
3P-3WY2 (3-Phase 3-Wire Y, 2 current probes)		
3P-3WΔ3 (3-Phase 3-Wire Δ, 3 current probes)		
3P-3WO3 (3-Phase 3-Wire Open Δ, 3 current probes)		
3P-3WY3 (3-Phase 3-Wire Y, 3 current probes)		
3P-3WΔb (3-Phase 3-Wire Δ balanced)	No	
3P-4WY (3-Phase 4-Wire Y)	Yes (on V)	[φ (V_1, V_3), φ (V_3, V_2), φ (V_2, V_1)] = 120° ± 10°
3P-4WYb (3-Phase 4-Wire Y balanced)	No	
3P-4WY2 (3-Phase 4-Wire Y 2½)	Yes (on V)	φ (V_1, V_3) = 120° ± 10° No V_2
3P-4WΔ (3-Phase 4-Wire Δ)	Yes (on U)	ϕ φ (V_1, V_3) = 180° ± 10° [φ (U_{12}, U_{31}), φ (U_{31}, U_{23}), φ (U_{23}, U_{12})] = 120° ± 10°
3P-4WOΔ (3-Phase 4-Wire Open Δ)		
DC-2W (DC 2-Wire)	No	
DC-3W (DC 3-Wire)	No	
DC-4W (DC 4-Wire)	No	

Table 17

A.2.3 Current vs Voltage Phase Order

Hookup	Current vs Voltage Phase Order	Range
1P-2W (1-Phase 2-Wire)	Yes	φ (I_1, V_1) = 0° ± 60° for load φ (I_1, V_1) = 180° ± 60° for source
1P -3W (1-Phase 3-Wire)	Yes	[φ (I_1, V_1), φ (I_2, V_2)] = 0° ± 60° for load [φ (I_1, V_1), φ (I_2, V_2)] = 180° ± 60° for source
3P-3WΔ2 (3-Phase 3-Wire Δ, 2 current probes)	Yes	[φ (I_1, U_{12}), φ (I_3, U_{31})] = 30° ± 60° for load [φ (I_1, U_{12}), φ (I_3, U_{31})] = 210° ± 60° for source No I_2 current probes
3P-3WO2 (3-Phase 3-Wire Open Δ, 2 current probes)		
3P-3WY2 (3-Phase 3-Wire Y, 2 current probes)		
3P-3WΔ3 (3-Phase 3-Wire Δ, 3 current probes)	Yes	[φ (I_1, U_{12}), φ (I_2, U_{23}), φ (I_3, U_{31})] = 30° ± 60° for load [φ (I_1, U_{12}), φ (I_2, U_{23}), φ (I_3, U_{31})] = 210° ± 60° for source
3P-3WO3 (3-Phase 3-Wire Open Δ, 3 current probes)		
3P-3WY3 (3-Phase 3-Wire Y, 3 current probes)		
3P-3WΔb (3-Phase 3-Wire Δ balanced)	Yes	φ (I_3, U_{12}) = 90° ± 60° for load φ (I_3, U_{12}) = 270° ± 60° for source
3P-4WY (3-Phase 4-Wire Y)	Yes	[φ (I_1, V_1), φ (I_2, V_2), φ (I_3, V_3)] = 0° ± 60° for load [φ (I_1, V_1), φ (I_2, V_2), φ (I_3, V_3)] = 180° ± 60° for source
3P-4WYb (3-Phase 4-Wire Y balanced)	Yes	φ (I_1, V_1) = 0° ± 60° for load φ (I_1, V_1) = 180° ± 60° for source
3P-4WY2 (3-Phase 4-Wire Y 2½)	Yes	[φ (I_1, V_1), φ (I_3, V_3)] = 0° ± 60° for load [φ (I_1, V_1), φ (I_3, V_3)] = 180° ± 60° for source No V_2
3P-4WΔ (3-Phase 4-Wire Δ)	Yes	[φ (I_1, U_{12}), φ (I_2, U_{23}), φ (I_3, U_{31})] = 30° ± 60° for load [φ (I_1, U_{12}), φ (I_2, U_{23}), φ (I_3, U_{31})] = 210° ± 60° for source
3P-4WOΔ (3-Phase 4-Wire Open Δ)		
DC-2W (DC 2-Wire)	No	
DC-3W (DC 3-Wire)	No	
DC-4W (DC 4-Wire)	No	

Table 18

APPENDIX B: MEASUREMENT QUANTITIES

The following table lists all quantities measured or calculated by the instrument, organized by hookup type. Circles indicate that the quantity is measured for the hookup.

For example, the first quantity listed in the table is V_1 (line 1 voltage). Circles in the 1P-2W and 1P-3W columns indicate V_1 is measured for single-phase 2-wire and single-phase 3-wire hookups. The absence of a circle in the 3P-3WΔb column indicates V_1 is not measured for 3-phase 3-wire Δ balanced hookups.

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
V_1	AC RMS	●	●				●	●	●	●			
V_2	AC RMS		●				●	● $=V_1$	●(10)	●			
V_3	AC RMS						●	● $=V_1$	●	●			
V_N	AC RMS	●	●				●	●	●	●			
V_1	DC										●	●	●
V_2	DC											●	●
V_3	DC												●
V_N	DC	●	●				●	●	●	●	●	●	●
V_1	AC+DC RMS	●	●				●	●	●	●			
V_2	AC+DC RMS		●				●	●(1)	●(10)	●			
V_3	AC+DC RMS						●	●(1)	●	●			
V_N	AC+DC RMS	●	●				●	●	●	●			
U_{12}	AC RMS		●	●	●	●	●	●(1)	●(10)	●			
U_{23}	AC RMS			●	●	●(1)	●	●(1)	●(10)	●			
U_{31}	AC RMS			●	●	●(1)	●	●(1)	●	●			
I_1	AC RMS	●	●	●	●	●(1)	●	●	●	●			
I_2	AC RMS		●	●(2)	●	●(1)	●	●(1)	●	●			
I_3	AC RMS			●	●	●	●	●(1)	●	●			

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
I_N	AC RMS		●				● (11)	●	●	●			
I_1	AC+DC RMS	●	●	●	●	● (1)	●	●	●	●			
I_2	AC+DC RMS		●	● (2)	●	● (1)	●	● (1)	●	●			
I_3	AC+DC RMS			●	●	●	●	● (1)	●	●			
I_N	AC+DC RMS		●				●	●	●	●			
I_1	DC										●	●	●
I_2	DC											●	●
I_3	DC												●
I_N	DC											●	●
V_{1CF}		●	●				●	●	●	●			
V_{2CF}			●				●	● (1)	● (10)	●			
V_{3CF}							●	● (1)	●	●			
I_{1CF}		●	●	●	●	●	●	●	●	●			
I_{2CF}			●	● (2)	●	● (1)	●	● (1)	●	●			
I_{3CF}				●	●	● (1)	●	● (1)	●	●			
V_+				●	●	●	●	●	● (10)				
V_-				●	●	● (4)	●	● (4)	● (10)				
V_0				●	●	● (4)	●	● (4)	● (10)				
I_+				●	●	●	●	●	●				
I_-				●	●	● (4)	●	● (4)	●				
I_0				●	●	● (4)	●	● (4)	●				
U_0				●	●	● (4)	●	● (4)	● (4)	● (3)			

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
U_2				●	●	●(4)	●	●(4)	●(4)	●(3)			
I_0				●	●	●(4)	●	●(4)	●	●(3)			
I_2				●	●	●(4)	●	●(4)	●	●(3)			
F		●	●	●	●	●	●	●	●	●			
P_1	AC	●	●				●	●	●	●			
P_2	AC		●				●	●(1)	●(10)	●			
P_3	AC						●	●(1)	●	●			
P_T	AC	●(7)	●	●	●	●	●	●(1)	●	●			
P_1	DC										●	●	●
P_2	DC											●	●
P_3	DC												●
P_T	DC										●(7)	●	●
P_1	AC+DC	●	●				●	●	●	●			
P_2	AC+DC		●				●	●(1)	●(10)	●			
P_3	AC+DC						●	●(1)	●	●			
P_T	AC+DC	●(7)	●	●	●	●	●	●(1)	●	●			
P_{F1}		●	●				●	●	●	●			
P_{F2}			●				●	●(1)	●(10)	●			
P_{F3}							●	●(1)	●	●			
P_{FT}		●(7)	●	●	●	●	●	●(1)	●	●			
P_+				●	●	●	●	●(1)	●				
P_U				●	●	●(4)	●	●(4)	●				

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
P_H		●	●	●	●	●	●	●	●				
Q_1		●	●				●	●	●	●			
Q_2			●				●	●(1)	●(10)	●			
Q_3							●	●(1)	●	●			
Q_T		●(7)	●	●	●	●	●	●(1)	●	●			
S_1	AC	●	●				●	●	●	●			
S_2	AC		●				●	●(1)	●(10)	●			
S_3	AC						●	●(1)	●	●			
S_T	AC	●(7)	●	●	●	●	●	●(1)	●	●			
S_1	AC+DC	●	●				●	●	●	●			
S_2	AC+DC		●				●	●(1)	●(10)	●			
S_3	AC+DC						●	●(1)	●	●			
S_T	AC+DC	●(7)	●	●	●	●	●	●(1)	●	●			
S_{F1}		●	●				●	●	●	●			
S_{F2}			●				●	●(1)	●(10)	●			
S_{F3}							●	●(1)	●	●			
S_{FT}		●(7)	●	●	●	●	●	●(1)	●	●			
N_1	AC	●	●				●	●	●	●			
N_2	AC		●				●	●(1)	●(10)	●			
N_3	AC						●	●(1)	●	●			
N_T	AC	●(7)	●	●	●	●	●	●(1)	●	●			
N_1	AC+DC	●	●				●	●	●	●			

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
N_2	AC+DC		●				●	●(1)	●(10)	●			
N_3	AC+DC						●	●(1)	●	●			
N_T	AC+DC	●(7)	●	●	●	●	●	●(1)	●	●			
D_1	AC	●	●				●	●	●	●			
D_2	AC		●				●	●(1)	●(10)	●			
D_3	AC						●	●(1)	●	●			
D_T	AC	●(7)	●	●	●	●	●	●(1)	●	●			
D_1	AC+DC	●	●				●	●	●	●			
D_2	AC+DC		●				●	●(1)	●(10)	●			
D_3	AC+DC						●	●(1)	●	●			
D_T	AC+DC	●(7)	●	●	●	●	●	●(1)	●	●			
PF_1		●	●				●	●	●	●			
PF_2			●				●	●(1)	●(10)	●			
PF_3							●	●(1)	●	●			
PF_T		●(7)	●	●	●	●	●	●(1)	●	●			
Cos φ_1		●	●				●	●	●	●			
Cos φ_2			●				●	●(1)	●(10)	●			
Cos φ_3							●	●(1)	●	●			
Cos φ_T		●(7)	●	●	●	●	●	●(1)	●	●			
TAN φ		●	●	●	●	●(3)	●	●	●(10)	●			

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
V_1-Hi	i=1 to 50[6] %f	●	●				●	●	●	●			
V_2-Hi			●				●	●[1]	●[10]	●			
V_3-Hi							●	●[1]	●	●			
U_{12}-Hi	i=1 to 50[6] %f		●	●	●	●	●	●[1]	●[10]	●			
U_{23}-Hi				●	●	●[1]	●	●[1]	●[10]	●			
U_{31}-Hi				●	●	●[1]	●	●[1]	●	●			
I_1-Hi	i=1 to 50[6] %f	●	●	●	●	●[1]	●	●	●	●			
I_2-Hi			●	●[2]	●	●[1]	●	●[1]	●	●			
I_3-Hi				●	●	●	●	●[1]	●	●			
I_N-Hi			●[2]				●[11]	●[4]	●[2]	●[2]			
V_1-Hi	i=1 to 50[6] RMS	●	●				●	●	●	●			
V_2-Hi			●				●	●[1]	●[10]	●			
V_3-Hi							●	●[1]	●	●			
U_{12}-Hi	i=1 to 50[6] RMS		●	●	●	●	●	●[1]	●[10]	●			
U_{23}-Hi				●	●	●[1]	●	●[1]	●[10]	●			
U_{31}-Hi				●	●	●[1]	●	●[1]	●	●			
I_1-Hi	i=1 to 50[6] RMS	●	●	●	●	●[1]	●	●	●	●			
I_2-Hi			●	●[2]	●	●[1]	●	●[1]	●	●			
I_3-Hi				●	●	●	●	●[1]	●	●			
I_N-Hi			●[2]				●[11]	●[4]	●[2]	●[2]			
V_1-THD	%f	●	●				●	●	●	●			
V_2-THD	%f		●				●	●[1]	●[10]	●			

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
V_3-THD	%f						●	●(1)	●	●			
U_{12}-THD	%f		●	●	●	●	●	●(1)	●(10)	●			
U_{23}-THD	%f			●	●	●(1)	●	●(1)	●(10)	●			
U_{31}-THD	%f			●	●	●(1)	●	●(1)	●	●			
I_1-THD	%f	●	●	●	●	●(1)	●	●	●	●			
I_2-THD	%f		●	●(2)	●	●(1)	●	●(1)	●	●			
I_3-THD	%f			●	●	●	●	●(1)	●	●			
I_N-THD	%f		●(2)				●(11)	●(4)	●(2)	●(2)			
Phase order	I		●	●	●		●		●	●			
	V		●	●	●		●		●	●			
	I, V	●	●	●	●	●	●	●	●	●			
$\varphi(V_2, V_1)$			●				●	●(9)					
$\varphi(V_3, V_2)$							●	●(9)					
$\varphi(V_1, V_3)$							●	●(9)	●	●			
$\varphi(U_{23}, U_{12})$				●	●	●(9)	●	●(9)		●			
$\varphi(U_{12}, U_{31})$				●	●	●(9)	●	●(9)		●			
$\varphi(U_{31}, U_{23})$				●	●	●(9)	●	●(9)		●			
$\varphi(I_2, I_1)$			●		●	●(9)	●	●(9)	●	●			
$\varphi(I_3, I_2)$					●	●(9)	●	●(9)	●	●			
$\varphi(I_1, I_3)$				●	●	●(9)	●	●(9)	●	●			
$\varphi(I_1, V_1)$		●	●			●(8)	●	●	●	●			
$\varphi(I_2, V_2)$			●				●	● $=\varphi(I_1, V_1)$					

Quantities		1P-2W	1P-3W	3P-3WΔ2 3P-3WO2 3P-3WY2	3P-3WΔ3 3P-3WO3 3P-3WY3	3P-3WΔb	3P-4WY	3P-4WYb	3P-4WY2	3P-4WΔ 3P-4WOΔ	DC-2W	DC-3W	DC-4W
$\varphi(I_3, V_3)$							●	● $=\varphi(I_1, V_1)$	●	●			
E_{PT}	Source AC	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{PT}	Load AC	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{QT}	Quad 1	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{QT}	Quad 2	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{QT}	Quad 3	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{QT}	Quad 4	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{ST}	Source	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{ST}	Load	●	●	●	●	●	●	●	●	●	● (5)	● (5)	● (5)
E_{PT}	Source DC	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	●	●	●
E_{PT}	Load DC	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	● (5)	●	●	●

Table 19

● Available

(1) Extrapolated

(2) Calculated

(3) Not a real quantity

(4) Always = 0

(5) AC+DC when selected

(6) Rank 7 for 400 Hz

(7) $P_1 = P_T$, $Q_1 = Q_T$, $N_1 = N_T$, $D_1 = D_T$, $S_1 = S_T$, $PF_1 = PF_T$, $\cos \varphi_1 = \cos \varphi_T$, $PF_1 = PF_T$

(8) $\varphi (I_3, U_{12})$

(9) Always = 120°

(10) Interpolated

(11) Calculated or measured if a current sensor is connected

APPENDIX C: POLE MOUNTING

Accessory brackets (Cat. #2137.82) enable you to mount the Model PEL 115 on a utility pole or similar structure.

Figure 45

To mount the instrument on a pole, turn it OFF and detach all leads and other connections. Then do the following:

1. Slide the brackets onto the bottom of the instrument.

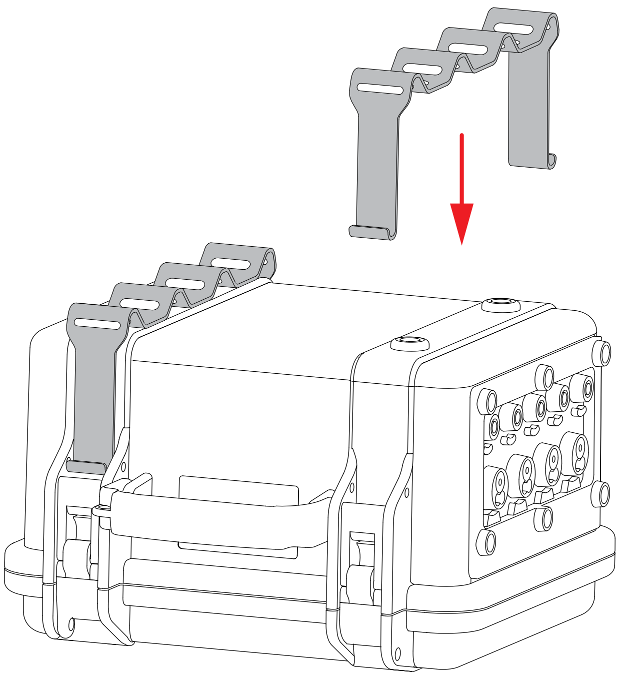


Figure 46

2. Attach the bracket by inserting the four connecting pins into the holes in the instrument case.

3. Insert the four clips into the holes in the pins.

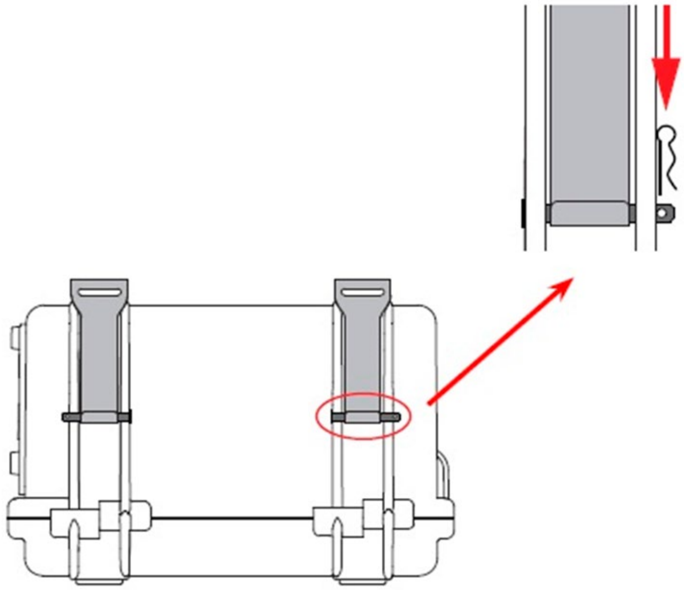


Figure 47

4. Run two straps (not included) through the slots in the brackets. These slots are (1 x 0.157) in (25.4 x 4) mm.
5. Position the instrument on the pole, and attach it by fastening the straps.

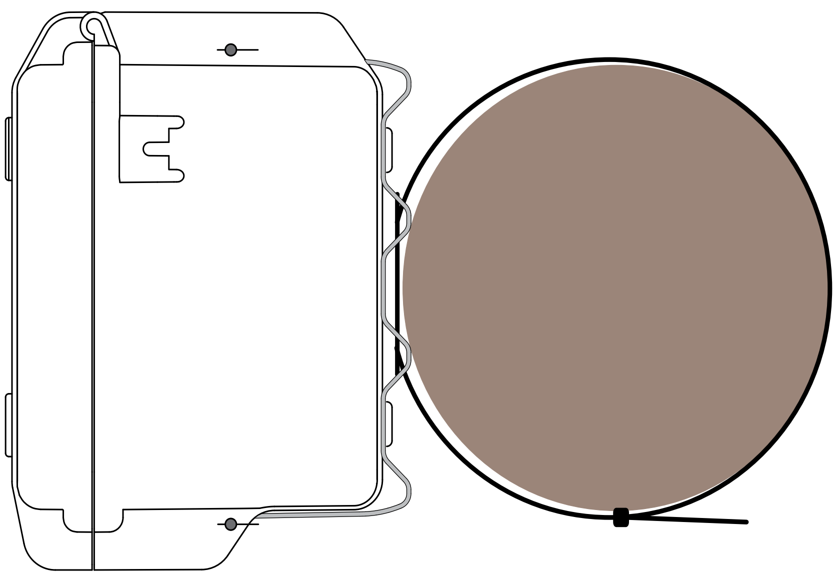


Figure 48

GLOSSARY

Symbol/Term	Definition
φ	Phase angle. For example: φ (I_1, I_2) is the phase angle between line 1 current and line 2 current. φ (I_1, V_1) is the phase angle between line 1 current and line 1 voltage. φ (U_{31}, U_{23}) is the phase angle between phase 3-to-phase 1 voltage and phase 2-to-phase 3 voltage. φ (V_1, V_2) is the phase angle between line 1 voltage and line 2 voltage.
A (Amps or Amperes)	Unit of measure for current. For example: A_{AC} is AC current. A_{DC} is DC current.
AC	Alternating current.
CF	Crest factor in current or voltage. This is the ratio of the Peak value of a signal to the RMS value (Peak/RMS).
Cos φ	Cosine of the phase shift of the fundamental voltage with respect to the fundamental current.
DC	Direct current.
DataViewSync™	DataViewSync™ is hosted by AEMC® Instruments and allows you to connect your computer to instruments on different networks. Data transmitted by the device can pass via DataViewSync™.
E	Energy. For example: E_P is active energy. E_{P+} is consumed active energy. E_{P-} is generated active energy. E_Q is reactive energy. E_S is apparent energy. E_{S+} is consumed apparent energy. E_{S-} is generated apparent energy.
F (Frequency)	Number of AC voltage or current cycles in one second, measured in Hertz (Hz).
Fundamental Frequency	Primary frequency of the AC electrical network, typically (50, 60, or 400) Hz.
Harmonics	Voltages and currents at frequencies that are multiples of the fundamental frequency. Harmonics distort the fundamental waveform and can affect the performance of electrical equipment and components.
Harmonic Order	Ratio of the frequency of the harmonic to the fundamental frequency; expressed as a whole number. For example, in a 60 Hz system the 1st harmonic order = 60 Hz, 3rd order = 180 Hz, 5th order = 300 Hz, and so on.
Hz (Hertz)	Unit of measurement for frequency, representing the number of cycles per second. For example, 60 Hz equals 60 cycles per second.
I	Current. For example: I_1 is line 1 current. I_N is neutral current. I-CF crest factor of current (Peak/RMS). I-THD total harmonic distortion of current.
L	Line (phase). For example, L_1 is line 1 or phase 1.
MAX	Maximum value. Typically, this represents the maximum measurement during a specified time interval.

Symbol/Term	Definition
MIN	Minimum value.
Nominal Voltage	Reference voltage of the electrical network.
P	Active power (W).
PF (Power Factor)	Ratio of active power to apparent power (W/VA).
Phase	Temporal relationship between current and voltage in AC circuits.
Q	Reactive power (var).
RMS (Root Mean Square)	Square root of the mean of the squares of the instantaneous current or voltage values during a specified interval.
S	Apparent power (VA).
TAN	Tangent of the phase angle between current and voltage.
Tan φ	Ratio between reactive power and active power (var/W).
THD (Total Harmonic Distortion)	Ratio between the sum of all harmonic RMS values and the electrical network's fundamental RMS, expressed as a percentage of the fundamental. For example: THD_I is total harmonic distortion for current. THD_I_1 is total harmonic distortion for phase 1 current. THD_V is total harmonic distortion for voltage. THD_V_1 is total harmonic distortion for phase 1 voltage. THD_U_{12} is total harmonic distortion for voltage between phase 1 and phase 2.
u2	Phase-to-neutral voltage unbalance
U	Phase-to-phase voltage. For example: U_{12} is phase 1 to phase 2 voltage. U_1-H_n is phase-to-phase voltage value or percentage for harmonic rank n. U_{12}-THD is total phase 1-to-phase 2 voltage harmonic distortion. U-CF is phase-to-phase voltage crest factor. Uh is phase-to-phase voltage harmonic.
V	Voltage. For example: V_1 is line 1 voltage. V_{AC} is AC voltage. V-CF is voltage crest (peak) factor. V_{DC} is DC voltage. V_N is neutral voltage. V-THD is total harmonic distortion of phase-to-neutral voltage. V_{UNB} is phase-to-neutral voltage unbalance, expressed in percent.
VA	Apparent power, expressed in volt-amperes.
var	Reactive power, expressed in volt-amperes.
varh	Reactive energy, expressed in volt-amperes.
Vh	Phase-to-neutral voltage harmonic.
VNE	Voltage at neutral (V_N)
W (Watt)	Unit of measure for power.

Table 20

NOTES:

NOTES:

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99-MAN 100621 v01

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