EN - User's manual

CHAUVIN ARNOUX

PEL 51
PEL 52

Power & Energy Logger

Measure up

Thank you for purchasing a **PEL51** or **PEL52 Power & Energy Logger**.

For best results from your device:
- **read** this user manual carefully, and
- **comply** with the precautions for use.

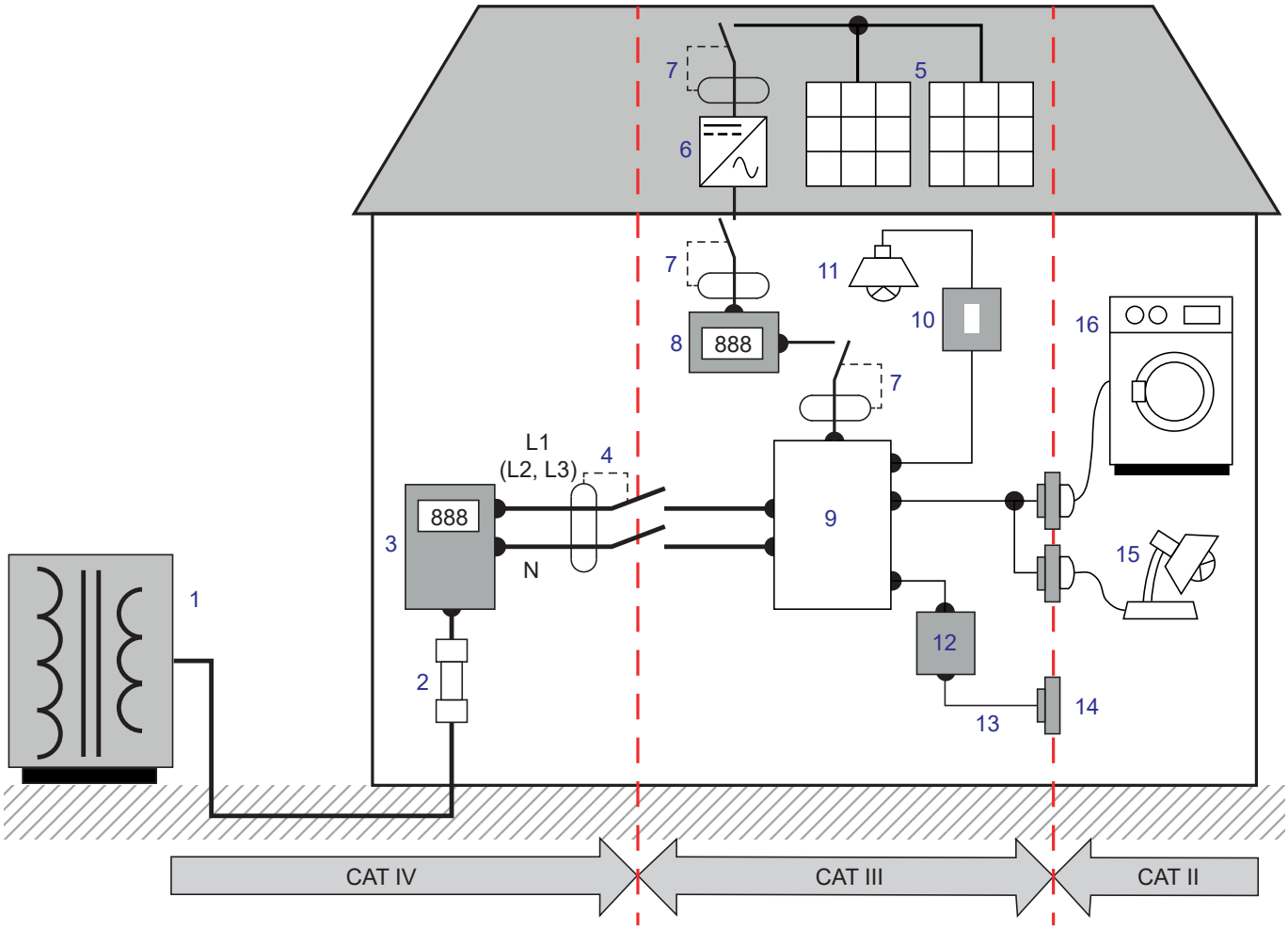
	WARNING, risk of DANGER! The operator must refer to these instructions whenever this danger symbol appears.
	Caution! Risk of electric shock. The voltage applied to parts marked with this symbol may be hazardous.
	Equipment protected by double insulation.
	Useful information or tip.
	SD card.
	Strong magnetic field.
	The product has been declared recyclable after analysis of its life cycle in accordance with the ISO 14040 standard.
	Chauvin Arnoux has adopted an Eco-Design approach in designing this appliance. Analysis of the complete lifecycle has enabled us to control and optimize the effects of the product on the environment. In particular, this appliance exceeds regulation requirements with respect to recycling and reuse.
	The CE marking indicates compliance with the European Low Voltage Directive (2014/35/EU), the Electromagnetic Compatibility Directive (2014/30/EU), the Directive on Radioelectric Equipment (2014/53/EU) and the Directive on the Restriction of Hazardous Substances (RoHS, 2011/65/EU and 2015/863/EU).
	The UKCA marking certifies that the product is compliant with the requirements that apply in the United Kingdom, in particular as regards Low-Voltage Safety, Electromagnetic Compatibility, and the Restriction of Hazardous Substances.
	The rubbish bin with a line through it indicates that, in the European Union, the product must undergo selective disposal in compliance with Directive WEEE 2012/19/EU. This equipment must not be treated as household waste.

CONTENTS

Definition of measurement categories

- Measurement category IV (CAT IV) corresponds to measurements taken at the source of low-voltage installations.
  Example: power feeds, meters and protection devices.
- Measurement category III (CAT III) corresponds to measurements on building installations.
  Example: distribution panel, circuit-breakers, stationary machines or fixed industrial devices.
- Measurement category II (CAT II) corresponds to measurements taken on circuits directly connected to low-voltage installations.
  Example: power supply to domestic appliances and portable tools.

Example to identify locations of measurement categories



1	Low voltage supply source	9	Distribution board
2	Service fuse	10	Light switch
3	Tariff meter	11	Lighting
4	Mains circuit breaker or isolator switch *	12	Junction box
5	Photovoltaic panel	13	Power socket wiring
6	UPS	14	Socket outlets
7	Circuit breaker or isolator switch	15	Plug-in lamps
8	Generation meter	16	Household appliances, portable tools

*: The mains circuit breaker or isolator switch may be installed by the service provider. If not, the demarcation point between CAT IV and CAT III is the first isolating switch in the distribution board.

PRECAUTIONS FOR USE

This device complies with safety standard IEC/EN 61010-2-30, the leads comply with IEC/EN 61010-031 and the current sensors comply with IEC/EN 61010-2-032 for voltages up to 600 V in category III.

Failure to observe the safety instructions may result in electric shock, fire, explosion, and/or destruction of the device and of the installations.

- The operator and/or the responsible authority must carefully read and clearly understand the various precautions to be taken in use. Sound knowledge and a keen awareness of electrical hazards are essential when using this device.
- Use only the leads and accessories supplied. The use of leads (or accessories) of a lower voltage or category limits the voltage or category of the combined device and leads (or accessories) to that of the leads (or accessories).
- Before each use, check the condition of the insulation on the leads, housing, and accessories. Any item of which the insulation is deteriorated (even partially) must be set aside for repair or scrapping.
- Do not use the device on networks of which the voltage or category exceeds those mentioned.
- Do not use the device if it seems to be damaged, incomplete, or poorly closed.
- When removing and inserting the SD card, make sure the device is disconnected and turned off.
- Use personal protection equipment systematically.
- When handling the leads and crocodile clips, keep your fingers behind the physical guard.
- If the device is wet, dry it before connecting it.
- All troubleshooting and metrological checks must be performed by competent and accredited personnel.

1. GETTING STARTED

1.1. DELIVERY CONDITION

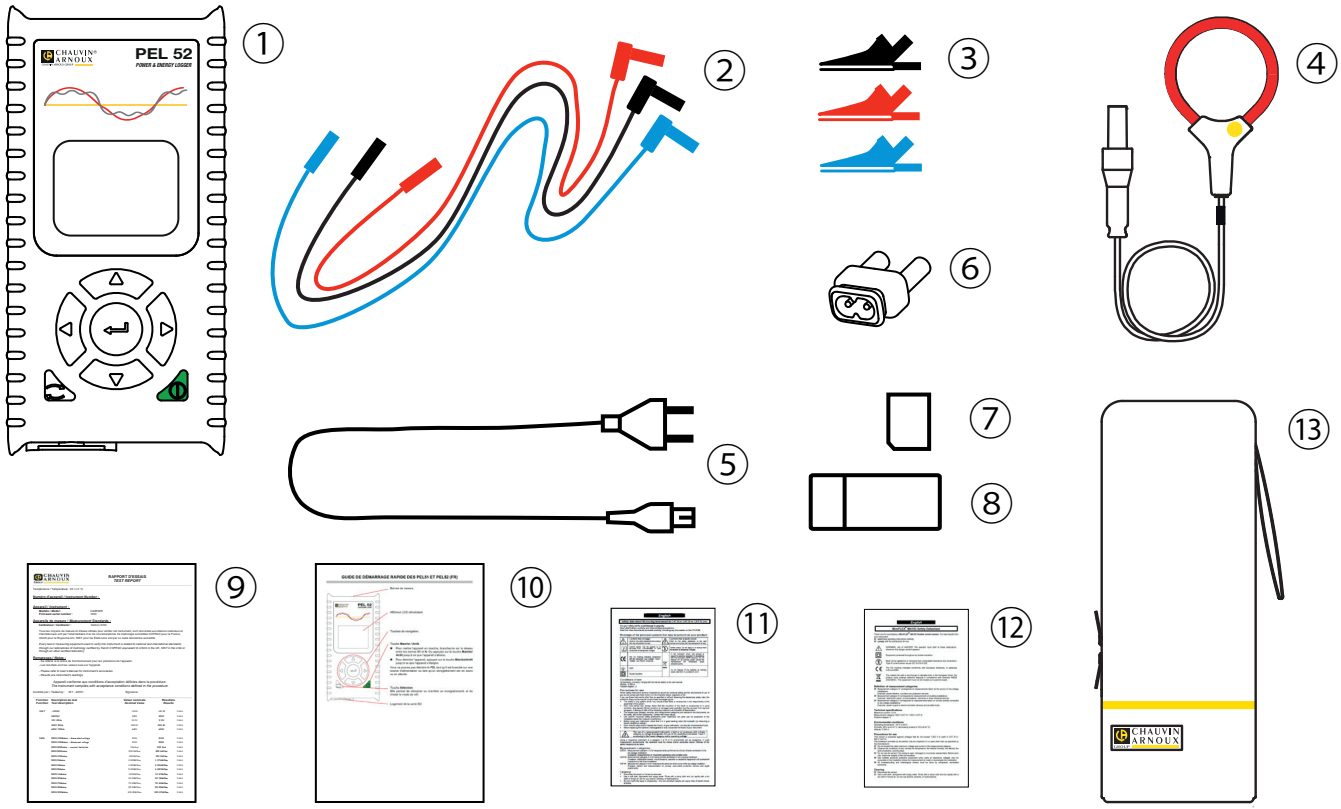


Figure 1

No.	Designation	PEL51	PEL52
①	PEL51 or PEL52	1	1
②	Safety leads, 3 m, banana-banana, straight-straight.	1 red 1 black	1 red, 1 blue, 1 black
③	Crocodile clips.	1 red 1 black	1 red, 1 blue, 1 black
④	MiniFlex MA194 250 mm current sensor.	1	0
⑤	Power cord.	1	1
⑥	C8 male / 2 banana plugs adapter	1	1
⑦	8 GB SD card (in the device).	1	1
⑧	SD card-USB adapter.	1	1
⑨	Test report.	1	1
⑩	Multilingual quick start guide.	1	1
⑪	Multilingual device safety data sheet.	1	1
⑫	Multilingual safety data sheet for current sensors and leads.	2	2
⑬	Carrying bag	1	0

Table 1

1.2. ACCESSORIES

- MiniFlex MA194 250 mm
- MiniFlex MA194 350 mm
- MiniFlex MA194 1000 mm
- MN93 clamp
- MN93A clamp
- C193 clamp
- MINI 94 clamp
- AmpFlex® A193 450 mm
- AmpFlex® A193 800 mm
- BNC adapter
- DataView software

1.3. SPARES

- 1.8m power cord
- C8 male / 2 male banana plugs
- Set of 2 safety cables, black and red, banana-banana straight-straight and 2 crocodile clips (for the PEL51).
- Set of 3 safety cables, black, red and blue, banana-banana straight-straight and 3 crocodile clips (for the PEL52).

For accessories and spares, see our website:
www.chauvin-arnoux.com

1.4. CHARGING THE BATTERY

Before first use, fully charge the battery at a temperature between 0 and 40°C.

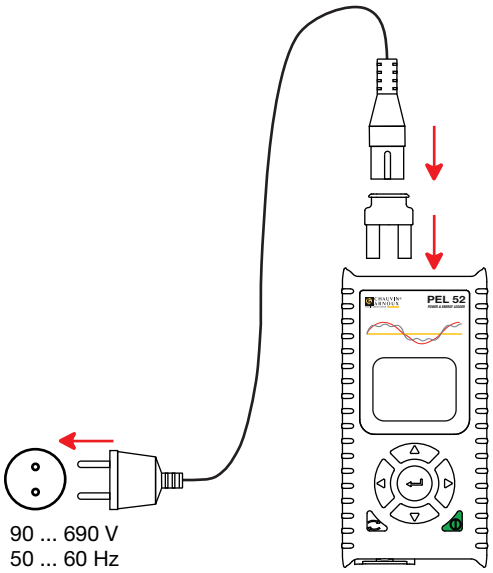


Figure 2

- Connect the C8 / banana adapter between the V1 and N terminals
- Plug the power cord into the adapter and mains power.

The device turns on.

The symbol indicates that charging is in progress. When it is on and steady, the battery is charged.

It takes about 5 hours to charge a discharged battery.

2. PRESENTATION OF THE INSTRUMENTS

2.1. DESCRIPTION

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

The PEL51 and PEL52 are easy-to-use power and energy recorders for single-phase (PEL51 and PEL52), split-phase (PEL52), two-phase (PEL52) and balanced three-phase (PEL51) systems. They have a large backlit LCD display and an SD card to store the measurements.

The PEL makes it possible to record voltage, current, power and energy on alternating current distribution grids (50 Hz or 60 Hz). It is designed to operate in 600 V category III or lower environments.

Compact, it fits into many distribution panels. Its housing is waterproof and shock resistant.

It operates on mains power and has a backup battery that recharges directly on the grid during measurements.

It allows the following measurements and calculations to be made:

- Phase-to-neutral and phase-to-phase voltage measurements (PEL52) up to 600 V.
- Current measurements up to 25,000 A with different current sensors.
- Automatic recognition of the different types of current sensors.
- Frequency measurements.
- Measurements of active power P (W), fundamental reactive power Qf (var) and apparent power S (VA) power.
- Measurements of fundamental active power Pf (W), non-active power N (var) and distorting power D (var) using the PEL Transfer application software.
- Measurements of active energy at source and load (Wh), reactive energy on 4 quadrants (varh) and apparent energy (VAh).
- Total energy meter.
- Calculation of cos φ and power factor (PF).
- Phase angle measurement.
- Calculation of aggregations of values from 1 minute to 1 hour.
- Storage of values on SD, SDHC or SDXC card.
- Communication by WiFi.
- PEL Transfer software for data recovery, configuration and communication in real time with a PC.
- Connection to DataViewSync™ (IRD server) to communicate between private networks.

2.2. PEL51 AND PEL52

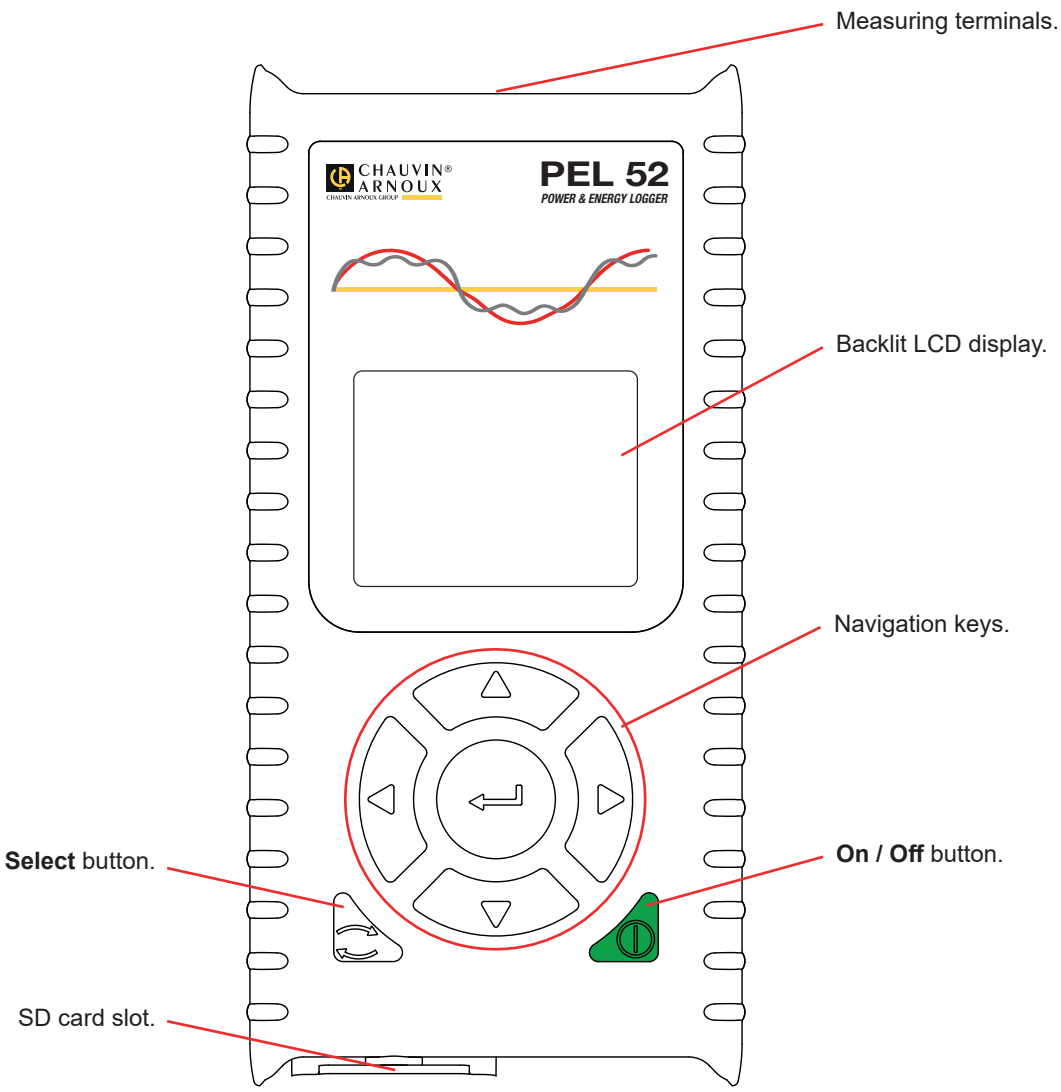


Figure 3

2.3. TERMINAL BLOCK

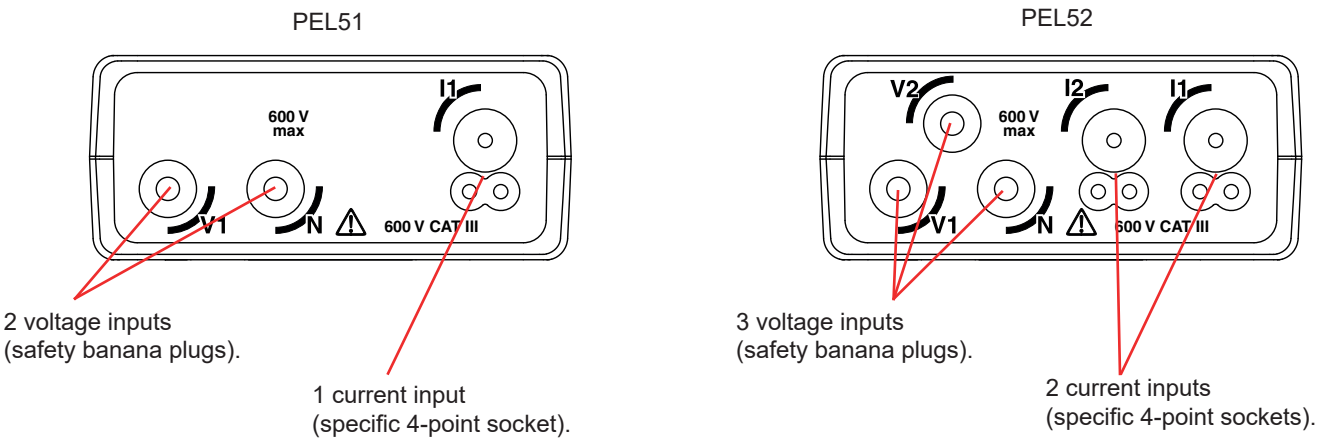
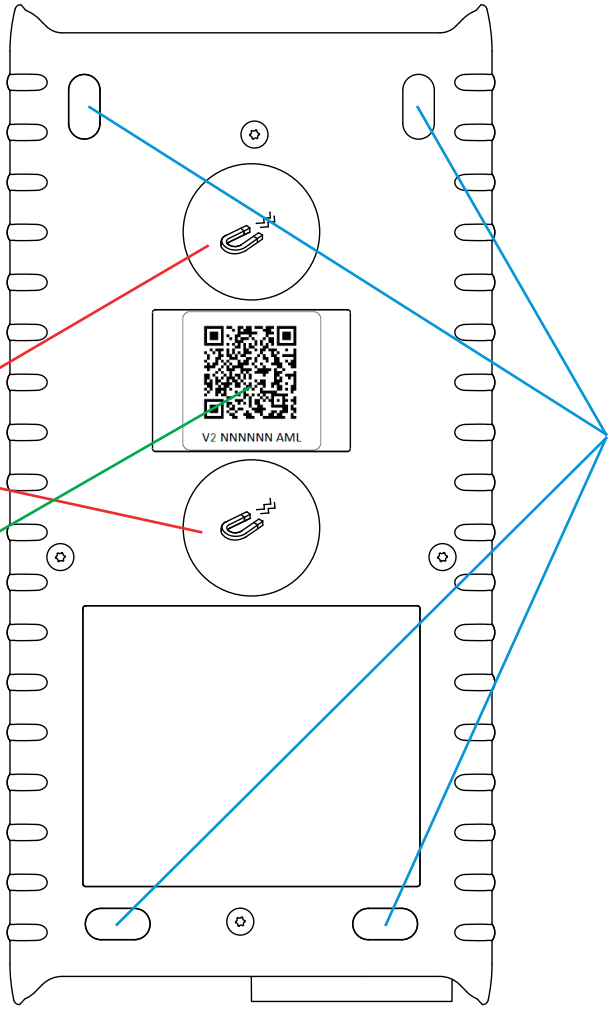


Figure 4

Before connecting a current sensor, consult its safety data sheet or its downloadable user's manual.

2.4. REAR



2 magnets.

Warranty label which also indicates the device version.
Only PEL51 version V2 or later can perform balanced three-phase measurements.

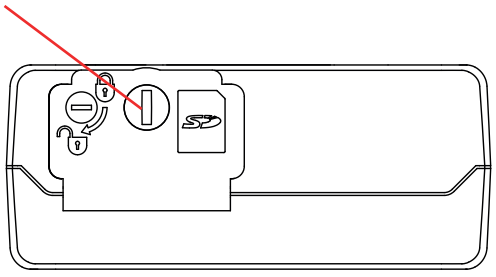
4 non-slip pads.

Figure 5

2.5. SD CARD SLOT

The PEL must not be used when the SD card slot is open.

Before opening the SD card slot, disconnect the device and turn it off.



the screw a quarter turn.
SD card slot.

To unlock the protective cap, turn

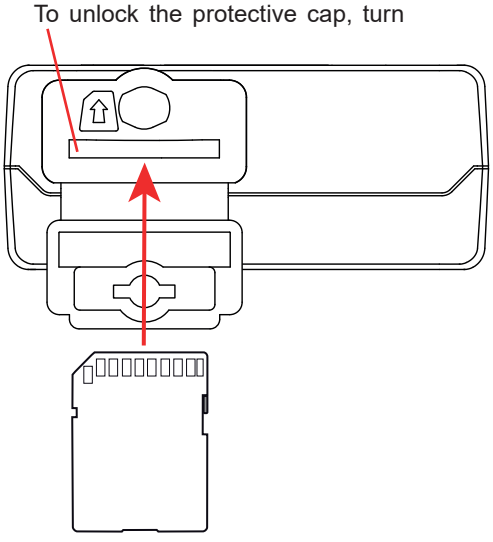


Figure 6

Open the protective cap to access the SD card.
To remove the card, press it down.
To insert the card, press it in the direction shown until you hear a "click".

2.6. MOUNTING

As a recorder, the PEL is intended to be installed for a fairly long period in a technical room.

The PEL must be placed in a well ventilated room whose temperature must not exceed the values specified in § 6.5.

The PEL can be mounted on a flat vertical ferromagnetic surface using the magnets incorporated in its housing.

The strong magnetic field of the magnets can damage your hard drives or medical devices.

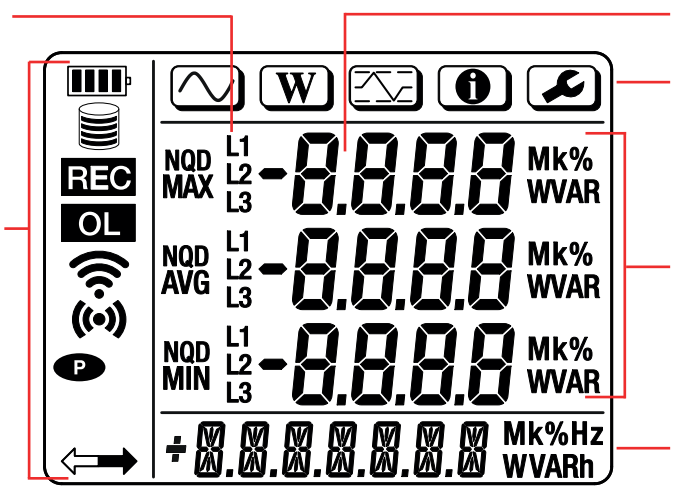
2.7. KEY FUNCTIONS

Key	Description
⏻	**On / Off button** A long press turns the device on or off. The device cannot be turned off while a recording is in progress or pending.
⟳	**Select key** It starts or stops a recording and allows WiFi mode to be chosen.
▶◀▲▼	**Navigation keys** These keys are used to configure the device and to browse the displayed data.
↵	**Enter key** In configuration mode, selects a setting to change. In measurement and power display modes, displays phase angles. In select mode, starts or stops a recording. It also allows the type of WiFi to be chosen.

Table 2

Pressing any key turns on the display backlighting for 3 minutes.

2.8. LCD DISPLAY



Phases.

Status icons.

Measured values.

Mode icons.

Units of measurement.
Information.

Figure 7

2.8.1. STATUS ICONS

Icon	Description
	Indicates battery charge status. When blinking, battery needs charging.
	Indicates memory card is full. When blinking, SD card is missing or locked.
REC	When blinking, a recording is scheduled. When on and steady, a recording is in progress.
OL	Indicates an out-of-range value that cannot be displayed. Or that the two current sensors are different (PEL52).
	Indicates active WiFi at the access point. When blinking, a transmission is in progress.
	Indicates active WiFi at the router. When blinking, a transmission is in progress.
P	Indicates the device's automatic shutdown function is disabled. It blinks when the device is operating only on the battery, i.e., when battery charging from the measuring terminals is deactivated.
	Indicates the device is being controlled remotely (by a PC, smartphone or tablet).

Table 3

2.8.2. MODE ICONS

Icon	Description
	Measurement mode (instantaneous values).
	Power and energy mode.
	Maximum mode.
	Information mode.
	Configuration mode.

Table 4

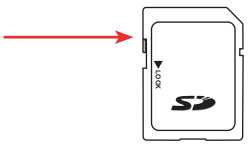
2.9. MEMORY CARD

The PEL accepts SD, SDHC and SDXC cards formatted FAT32, up to 32 GB capacity.
A 64 GB SDXC card must be formatted as 32 GB on a PC.

The PEL is delivered with a formatted SD card. If you want to install a new SD card:
- Open the elastomer cap marked SD (see § 2.5).
- Press the SD card that is in the device and then remove it.

Do not remove the SD card if there is a recording in progress.

- Check that the new SD card is not locked.
- It is preferable to format the SD card in the device using the PEL Transfer software, otherwise format it using a PC.
- Insert the new card and press it in all the way.
- Replace the elastomer protective cap.



3. OPERATION

The PEL must be configured before any recording. Configuration involves the following steps:
- Establish a WiFi connection with the PC (to use the PEL Transfer software, see § 5).
- Select the connection according to the type of distribution network.
- Connect the current sensor(s).
- Define the nominal primary current according to the current sensor used.
- Select the aggregation period.

This configuration is made in Configuration mode (see § 3.2) or with the PEL Transfer software.

In order to avoid accidental changes, the PEL cannot be configured while recording or if there is a recording pending.

3.1. TURNING THE INSTRUMENT ON AND OFF

3.1.1. TURNING ON

- Connect the PEL to the network between the **V1** and **N**, and it will turn on automatically. Otherwise, press the **On/Off** button until the device turns on**.**
- If the instrument displays **LOCK**, the selection button is locked. The PEL Transfer software (see § 5) must be used to unlock it.

The battery begins to recharge automatically when the PEL is connected to a voltage source between the **V1** and **N** terminals. Battery life is approximately one hour when fully charged. This allows the device to continue operating during brief power cuts.

3.1.2. AUTO OFF

By default, the device operates in continuous mode (P symbol displayed).

When the device is running on battery power, you can choose to have it turn off automatically after a period with no keyboard activity and no recording in progress. This time will be defined in PEL Transfer (see § 5). This saves the battery life.

3.1.3. TURNING OFF

You cannot turn the PEL off while it is connected to a power source or while a recording is in progress or pending. This is a precaution intended to prevent a recording being unintentionally stopped by the user.

To turn the PEL off:
- Disconnect the PEL.
- Press the **On/Off** button until the device turns off.

3.1.4. BATTERY OPERATION / CALIBRATION

In certain applications, such as measurements on low-output generators (calibrators, auto-transformers, voltage measurement transformers, etc.), the instrument's power supply from the mains can disturb the measurement or prevent the instrument from operating.

To operate the instrument on the battery alone, press ⟲ and ⏻ keys simultaneously.
The P symbol blinks.

Use the same combination of keys to return to using mains power. After being turned off, the instrument will restart with mains power activated.

3.2. CONFIGURING THE INSTRUMENT

Several main functions can be configured directly on the device. For full configuration, use the PEL Transfer software (see § 5) once WiFi communication has been established.

To enter Configuration mode from the device, press the ◄ or ► keys until the symbol is selected.

The following screen is displayed:

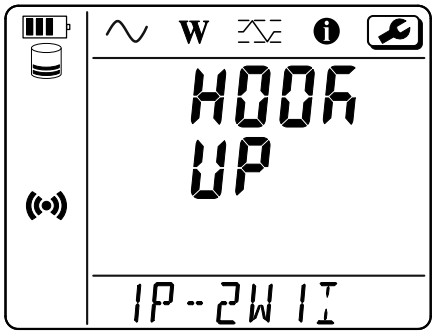


Figure 8

If the PEL is already being configured from the PEL Transfer software, it is not possible to enter Configuration mode on the device. In this case, when an attempt is made to configure it, the screen displays **LOCK**.

3.2.1. NETWORK TYPE

To change the network, press the ↵ key.

- 1P-2W1I: Single-phase 2-wire with a current sensor (PEL51 and PEL52)
- 1P-3W2I: Single-phase 3-wire (2 voltages in phase) with two current sensors (PEL52)
- 2P-3W2I: Two-phase 3-wires (2 voltages in opposite phases) with two current sensors (PEL52)
- 3P-2W1I: Balanced three-phase 2-wire (phase-to-phase voltage) with a current sensor (PEL51 V2)

3.2.2. WIFI

Press the ▼ key to go to the following screen.

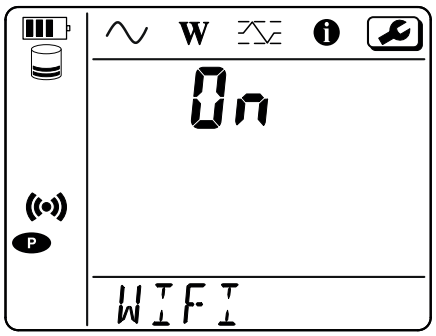


Figure 9

For the WiFi to operate, the battery must be sufficiently charged (or).

Press the ↵ key to activate or deactivate the WiFi. If the battery is too low, the device indicates it and activation is not possible.

To establish a WiFi connection

- Enable WiFi.
- This connection then lets you connect your PC to any other device such as a smartphone or a tablet. The connection procedure is detailed below.

1) WiFi access point connection procedure

The first connection must be made in WiFi access point mode.

- Press the **Select** ⟳ first. The device displays **START REC. PUSH ENTER TO START RECORDING** (Press Enter key ↵ to.
- Press the ⟳ key a second time and the device displays
  - **WIFI ST. PUSH ENTER FOR WIFI ST** (Press Enter key ↵ to start activate the WiFi router),
  - or **WIFI OFF. PUSH ENTER FOR WIFI OFF** (Press Enter key ↵ to deactivate WiFi),
  - or **WIFI AP. PUSH ENTER FOR WIFI AP** (Press Enter key ↵ activate the WiFi access point).

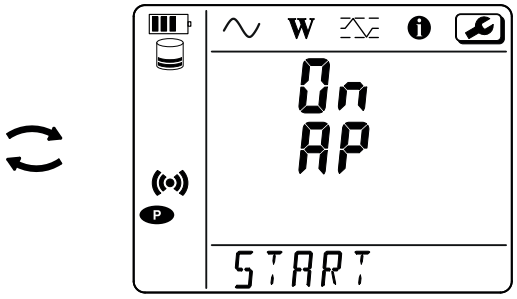


Figure 10

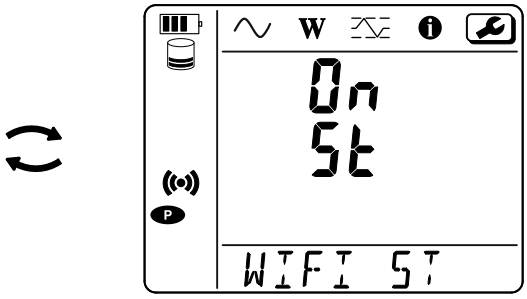


Figure 11

Change with the ↵ key to have **WIFI AP**.
Your device's IP address, shown in the information menu, is 192.168.2.1 3041 UDP.

- Connect your PC to the device's WiFi.
  In the Windows status bar, click the connection symbol.
  Select your device from the list.

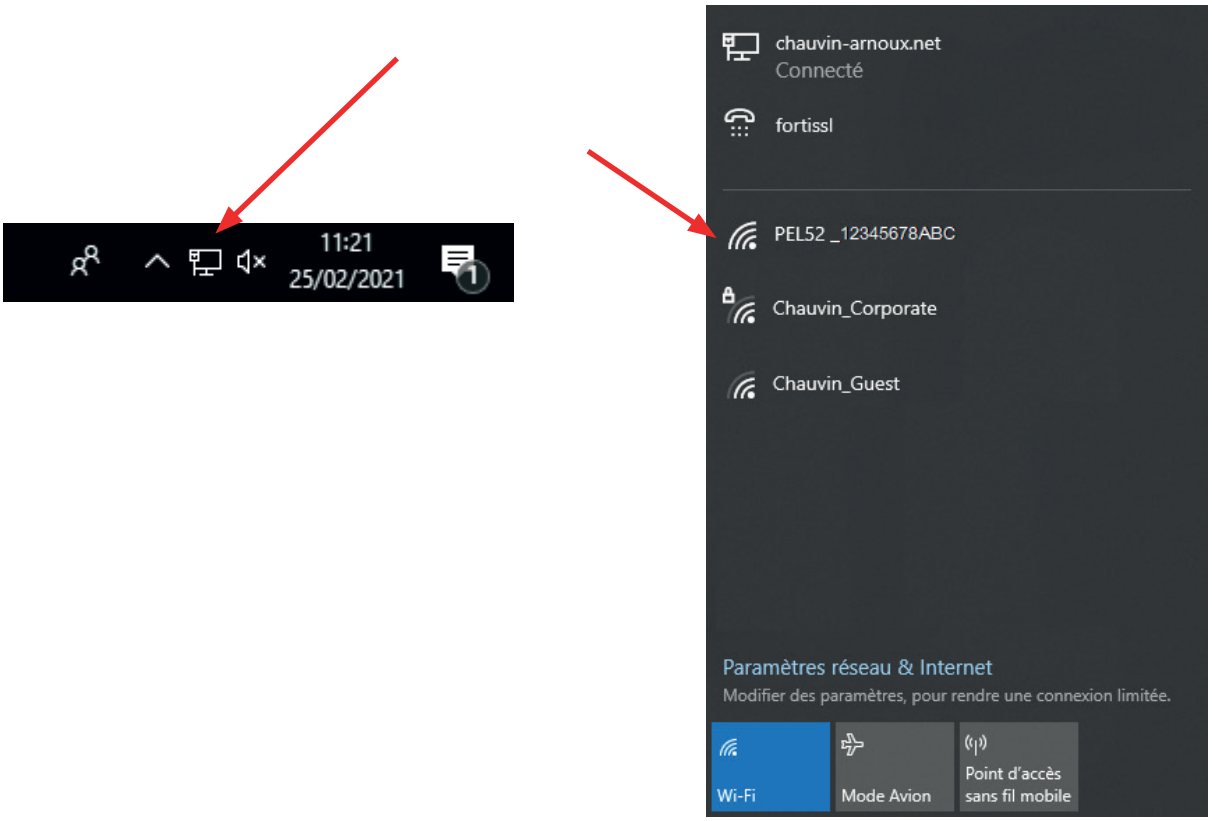


Figure 12

- Start the PEL Transfer application software (see § 5).
- Go to **Device**, **Add a device**, **PEL51 or PEL52**, to **WiFi access point**.

This connection to the PEL Transfer software lets you:
- Configure the device,
- Access real-time measurements,
- Upload the recordings,
- Change the access point SSID name and secure it with a password,

- Enter the SSID and password for a WiFi network to which the device can connect,
- Enter the DataViewSync™ (IRD server) password, allowing the device to access separate private networks.

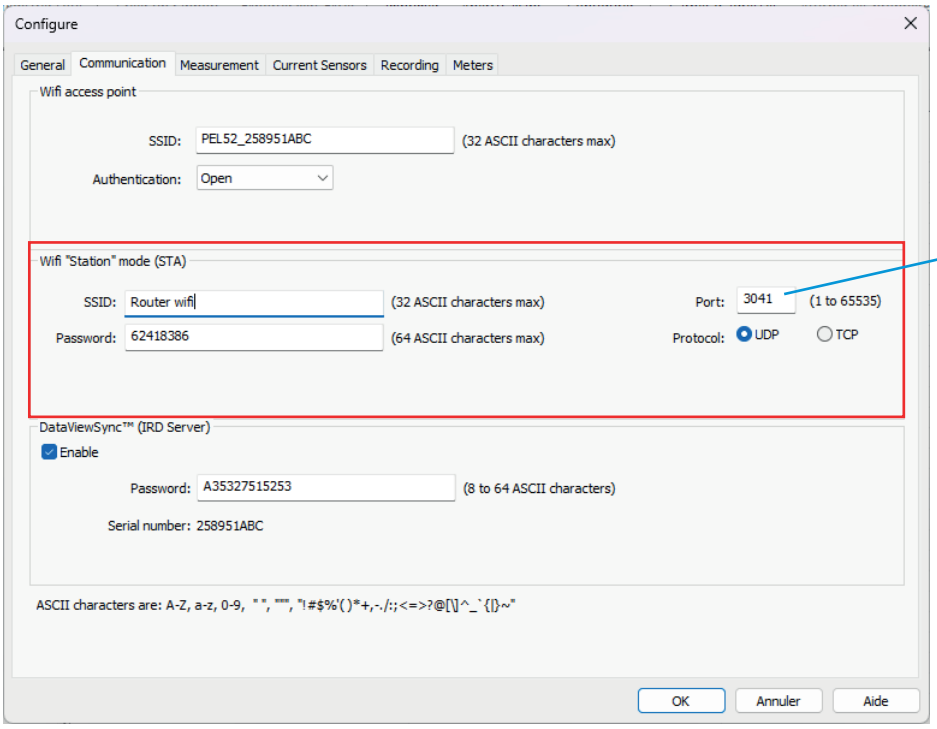
If the username and password are lost, you can reset to factory configuration (see § 3.2.5)

2) WiFi connection procedure (continued)

Once your device is connected to a WiFi access point, you can connect it to a WiFi router. This will allow you to access your device from a smartphone or tablet, or even from DataViewSync™ (IRD server) through a public or private network.

Configuration of the WiFi router connection

- In PEL Transfer, go to the Configuration menu  , **Communication** tab, and enter the network name (SSID) and password in the box **WiFi router connection**, port 3041, UDP protocol.
  The SSID is the name of the network you want to connect to. It can be the network of your smartphone or tablet in access point mode.



Port 80 is prohibited. This port is reserved for the remote user interface.

Figure 13

- Click **OK** to load the configuration into the device.
- Press twice on the **Select** button on the device, then twice on the ↵ key to switch to **WIFI ST**.
  Your device connects to this WiFi network.
  The WiFi access point connection is lost.

  Once the PEL is connected to the network, you can find its IP address in information mode.

- In PEL Transfer, change the connection  to **Ethernet (LAN or WiFi)** and enter the IP address of your device, port 3041, UDP protocol.
  This lets you connect several PELs on the same network.

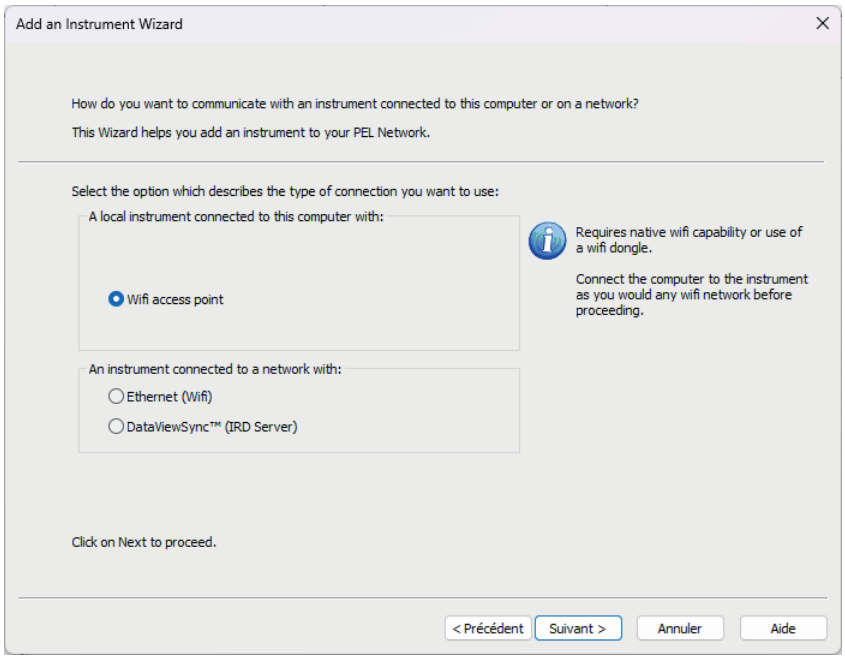


Figure 14

Configuration DataViewSync™ (IRD server) connection

- To connect the PEL to DataViewSync™, it must be in **WIFI ST** and the network to which it is connected must have internet access.
- Go to PEL Transfer, then to the Configuration menu  , **Communication** tab. Enable DataViewSync™ and enter the password that will be used to connect afterwards.

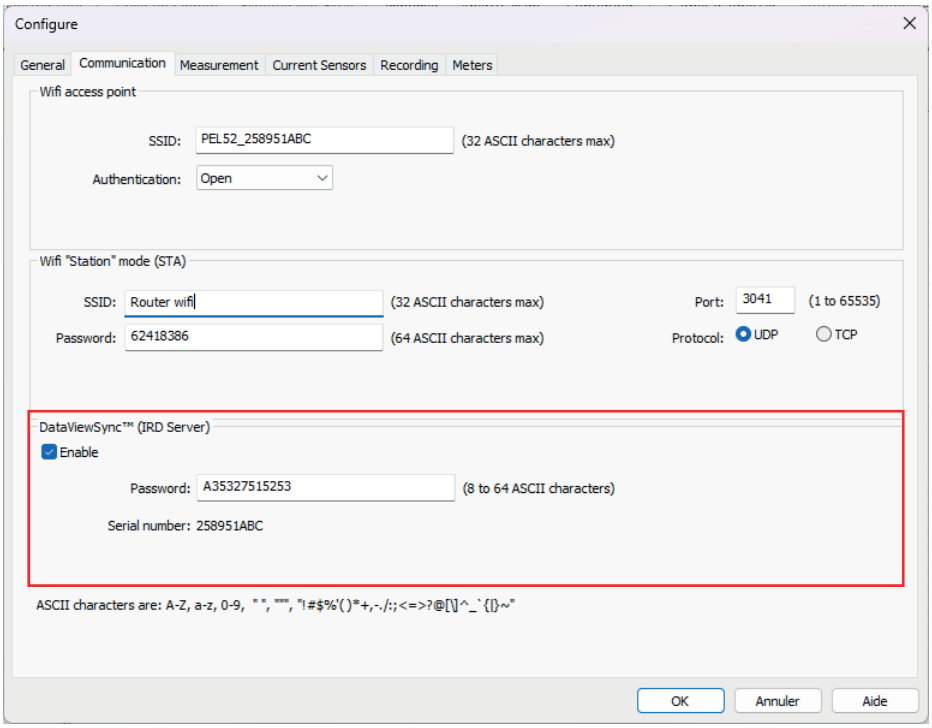


Figure 15

3.2.3. NOMINAL PRIMARY CURRENT

Connect the current sensor(s).
Press the ▼ key to go to the following screen.

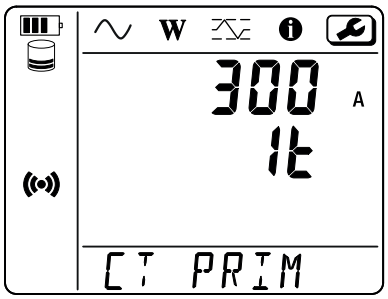


Figure 16

The current sensor is automatically detected by the device.
For the PEL52, if two current sensors are connected, they must be identical.

For AmpFlex® or MiniFlex sensors, press the ↵ key to select 300 or 3000 A.

The nominal currents of current sensors are as follows:

Sensor	Nominal current	Choice of gain	Number of turns
C193 clamp	1,000 A	✗	✗
AmpFlex® A193 MiniFlex MA194	300 or 3,000 A	✓	1, 2 or 3 to be configured in PEL Transfer
MN93A clamp 5 A calibre	5 A	to be configured in PEL Transfer	✗
MN93A clamp 100 A calibre	100 A	✗	✗
MN93 clamp	200 A	✗	✗
MINI 94 clamp	200 A	✗	✗
BNC adapter	1,000 A	to be configured in PEL Transfer	✗

Table 5

3.2.4. AGGREGATION PERIOD

Press the ▼ key to go to the following screen.

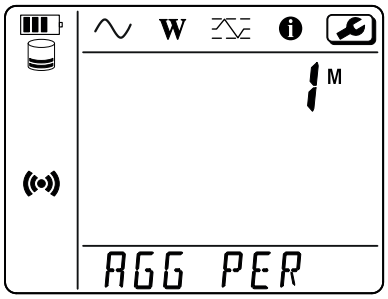


Figure 17

To change the aggregation period, press the ↵ key: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes.

3.2.5. RESET

Press the ▼ key to go to the following screen.

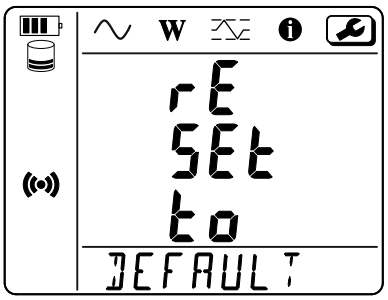


Figure 18

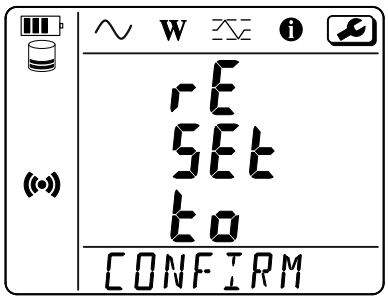


Figure 19

To reset the device to the default WiFi configuration (access point WiFi, password deleted), press the ↵ key.
The device asks for confirmation before performing the reset. Press the ↵ key to confirm and any other key to cancel.

3.3. REMOTE USER INTERFACE

The remote user interface runs on a PC, tablet or smartphone.

It enables:
- consulting the instrument's information,
- establishing a WiFi router connection,
- synchronising date and time,
- scheduling a recording.

There are several versions of the remote user interface, depending on the firmware version of your device. And these different interfaces have different functionalities.

- Enable WiFi on the instrument. The remote user interface can work with an access point WiFi link or a router WiFi link but not the DataViewSync ™ (IRD server) link.
- On the PC, tablet or smartphone, please connect to your device's WiFi network (see §3.2.2).
- In a web browser, enter http://IP_address_instrument.
  For a WiFi access point connection, enter http://192.168.2.1
  For a WiFi router connection, the address is indicated in the information menu (see §3.4).

The following screen will be displayed (which differs depending on the instrument model):

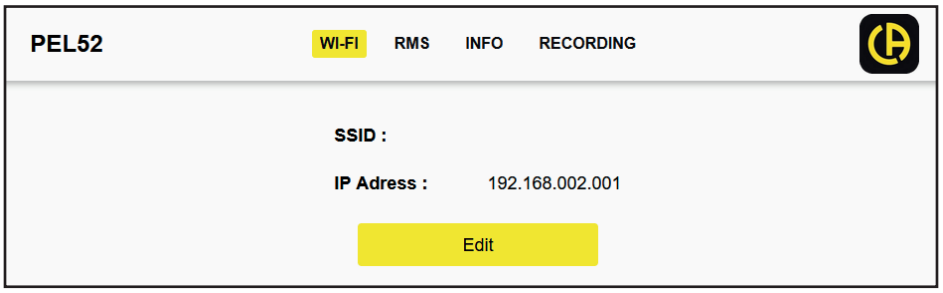


Figure 20

To enter the SSID and password, click on **Edit**.

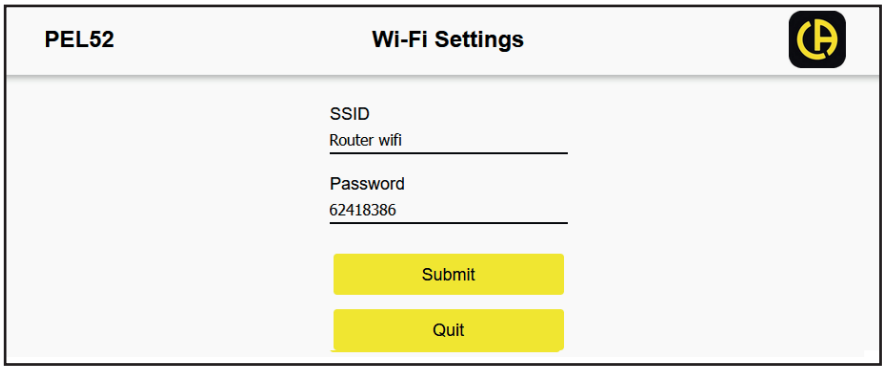


Figure 21

Fill in the fields then click on **Submit**.

Press the second button to view the measurements:

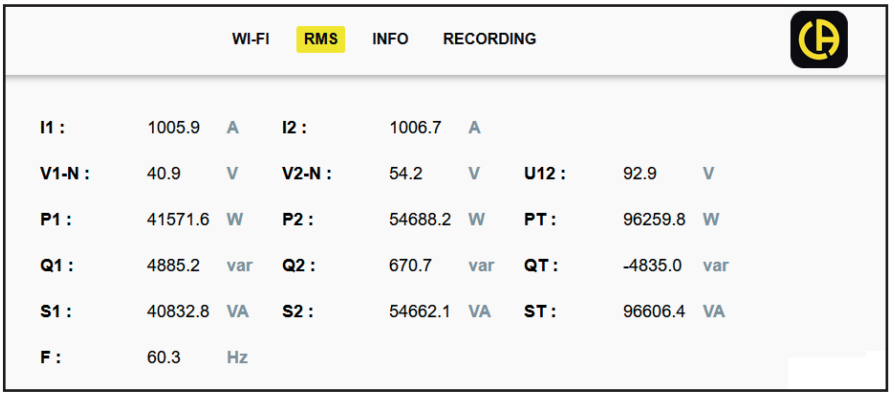


Figure 22

Press the third button to view the instrument's information:

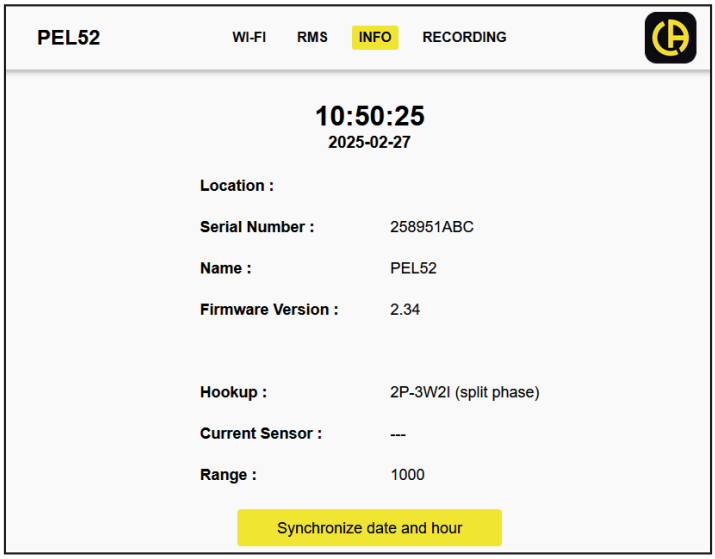
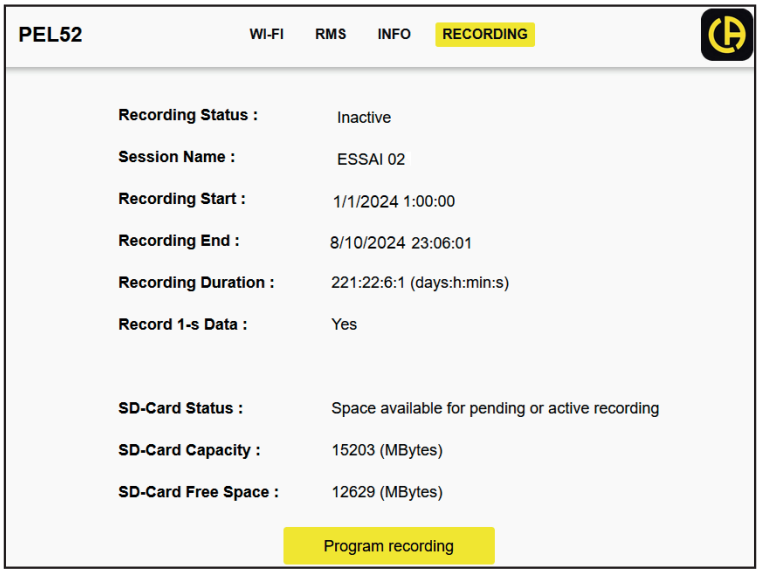


Figure 23

Press **Synchronize date and time** to synchronise your instrument's date and time with your PC, tablet or smartphone.

Press the fourth button to view information about the current recording or the last recording made.



Recording Status
Session Name
Start of recording
End of recording

Recording duration
Recording the '1s' data

SD card status

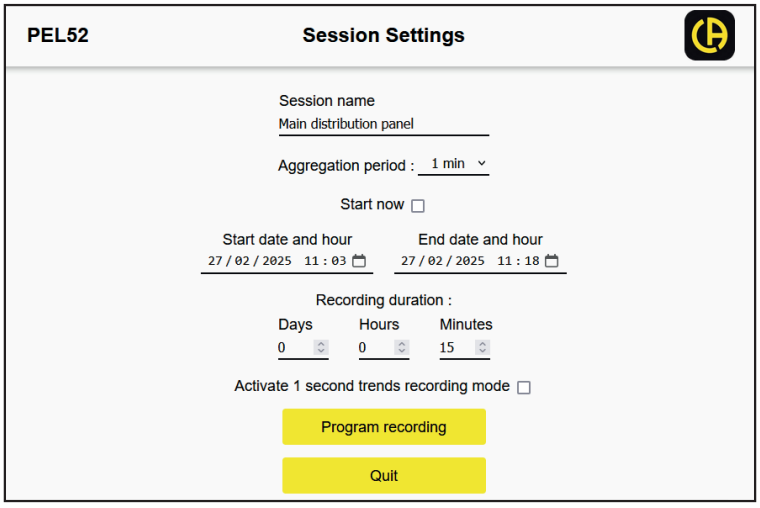
SD card capacity

Free space on SD card

Schedule a recording.

Figure 24

Press **Program recording** to program a recording.



Session Name

Aggregation period

Start now

Start date and time
End date and time

Recording duration
Days Hours Minutes
Activate '1s' data recording
Start recording

Quit

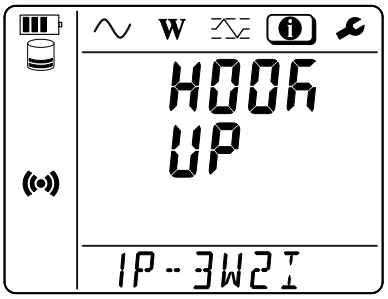
Figure 25

3.4. INFORMATION

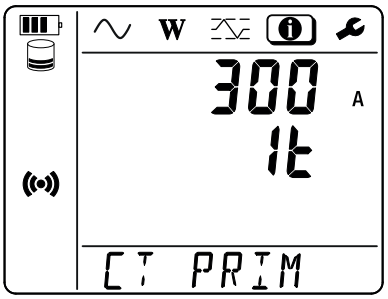
To enter Information mode, press the ◄ or ► keys until the symbol is selected.

Using the ▲ and ▼ keys, scroll through the device information:

- Type of network

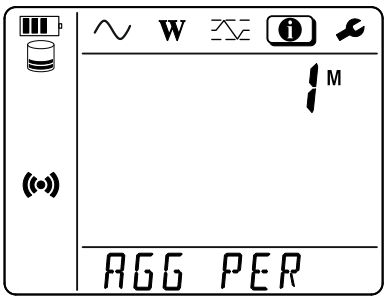


- Nominal primary current and number of turns: 1t, 2t or 3t (to be defined via PEL Transfer for Flex type current sensors)

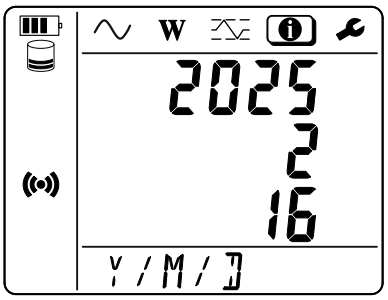


  - C193 clamp: 1,000 A
  - AmpFlex® or MiniFlex: 300 or 3,000 A
  - MN93A clamp 5 A calibre: 5 A modifiable
  - MN93A clamp 100 A calibre: 100 A
  - MN93 clamp: 200 A
  - Mini 94 clamp: 200 A
  - BNC adapter: 1,000 A modifiable

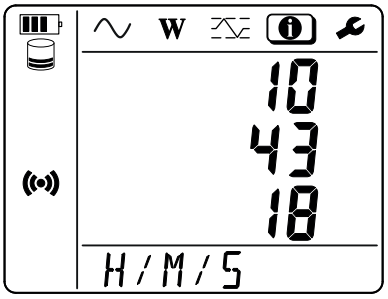
- Aggregation period



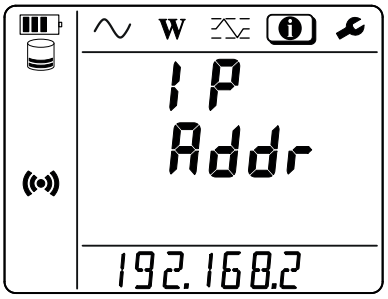
- Date
  Year, month, day



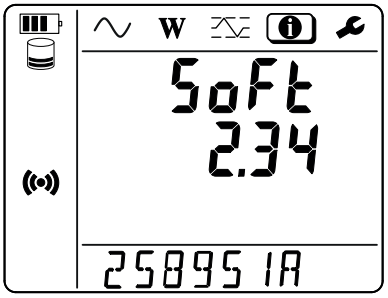
- Time
  Hour, minute, second



- IP address (scrolling)



- Software version and scrolling serial number,



4. USE

Once the device has been configured, it is ready for use.

4.1. DISTRIBUTION NETWORKS AND CONNECTIONS OF THE PEL

Connect the current sensors and voltage measurement leads on your installation according to the type of distribution network.

Source  Load

Always check that the arrow on the current sensor is pointing towards the load. In this way the phase angle will be correct for power measurements and other phase dependent measurements. Otherwise, the PEL Transfer software allows the phase of a current sensor to be reversed under certain conditions.

4.1.1. SINGLE-PHASE 2-WIRE: 1P-2W1I (PEL51 AND PEL52)

For single-phase 2-wire measurements:

- Connect the N measuring lead to the neutral conductor.
- Connect the V1 measuring lead to the L1 phase conductor.
- Connect the I1 current sensor to the L1 phase conductor.

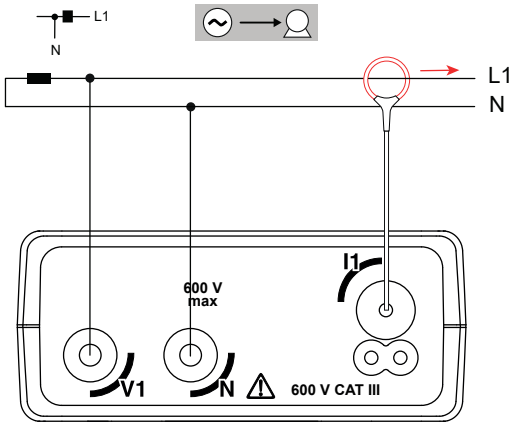


Figure 26

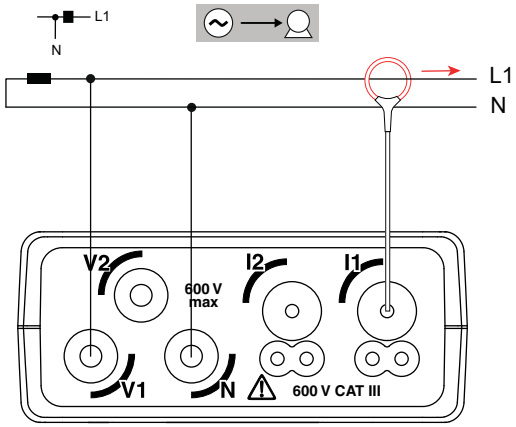


Figure 27

4.1.2. SINGLE-PHASE 3-WIRE 2-CURRENTS: 1P-3W2I (PEL52)

For single-phase 3-wire measurements with 2 current sensors:

- Connect the N measuring lead to the neutral conductor.
- Connect the V1 measuring lead to the L1-I1 phase conductor.
- Connect the V2 measuring lead to the L1-I2 phase conductor.
- Connect the I1 current sensor to the L1-I1 phase conductor.
- Connect the I2 current sensor to the L1-I2 phase conductor.

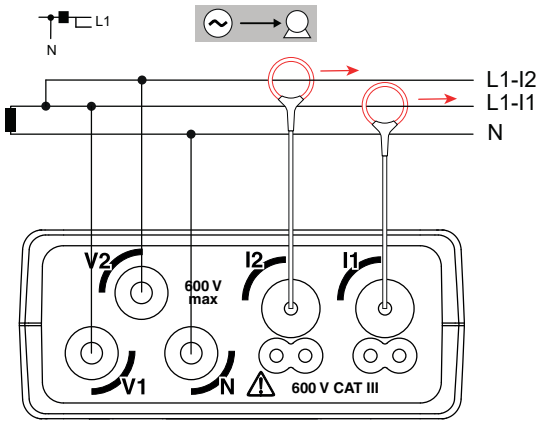


Figure 28

4.1.3. SPLIT-PHASE 3-WIRE 2 CURRENTS AND TWO-PHASE 3-WIRE (TWO-PHASE FROM A MID-TAP TRANSFORMER): 2P-3W2I (PEL52)

For two-phase 3-wire measurements with 2 current sensors:

- Connect the N measuring lead to the neutral conductor.
- Connect the V1 measuring lead to the L1 phase conductor.
- Connect the V2 measuring lead to the L2 phase conductor.
- Connect the I1 current sensor to the L1 phase conductor.
- Connect the I2 current sensor to the L2 phase conductor.

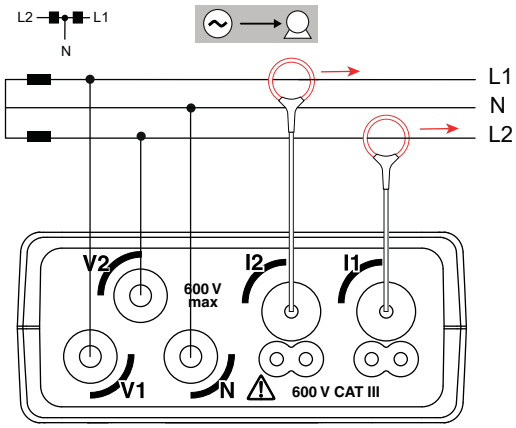


Figure 29

4.1.4. THREE-PHASE BALANCED 2-WIRE 1 CURRENT: 3P-2W1I (PEL51 V2)

For three-phase 2-wire measurements with 1 current sensor:

- Connect the V1 measuring lead to the L1 phase conductor.
- Connect the N measuring lead to the L2 phase conductor.
- Connect the I1 current sensor to the L3 phase conductor.

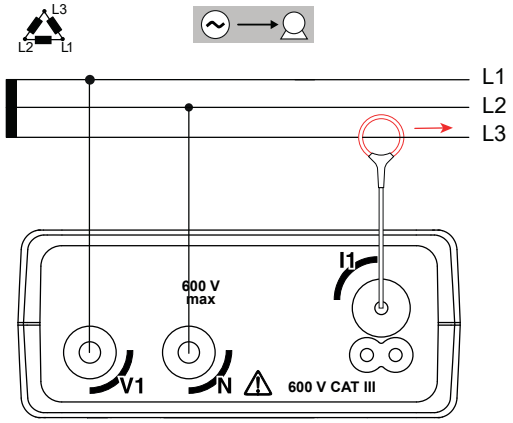


Figure 30

4.2. RECORDING

To start a recording:

- Check that there is an SD card in the PEL (not locked and with sufficient space).
- Press the **Select** key first. The device displays **START REC. PUSH ENTER TO START RECORDING** (Press Enter key ↵ to start recording). If it displays **INSERT SD CARD**, there is no SD card in the device. If it displays **SD CARD WRITE PROTECT**, it is locked. In either case, recordings cannot be made.
- Confirm with the ↵ key. The REC symbol blinks.

To stop recording, press the **Select** key. The device displays **STOP REC. PUSH ENTER TO STOP RECORDING** (Press Enter key ↵ to stop recording) The REC symbol disappears.

Recordings can be managed from PEL Transfer (see § 5).

While recording, the device configuration cannot be modified. To enable or disable WiFi, press the **Select** key twice, then the ↵ key to choose **WIFI AP**, **WIFI ST** or no WiFi.

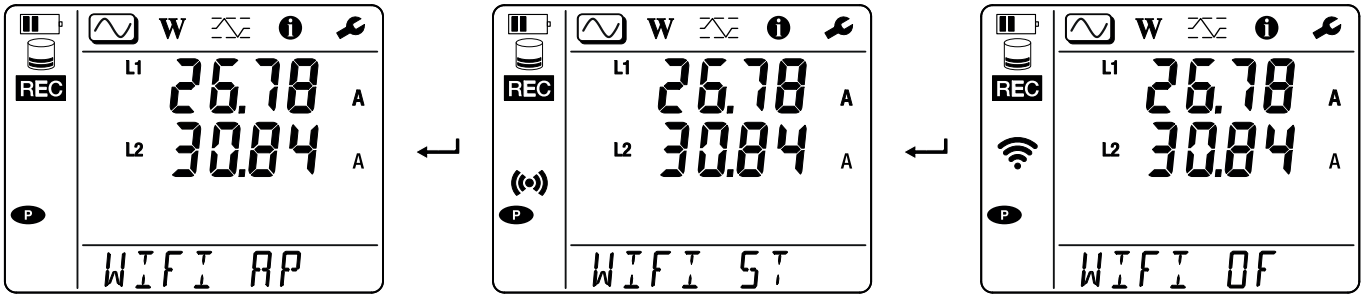


Figure 31

4.3. MEASURED VALUE DISPLAY MODES

The PEL has 3 measurement display modes, , W and , represented by the icons at the top of the display. To switch from one mode to another, use the ◄ or ► keys.

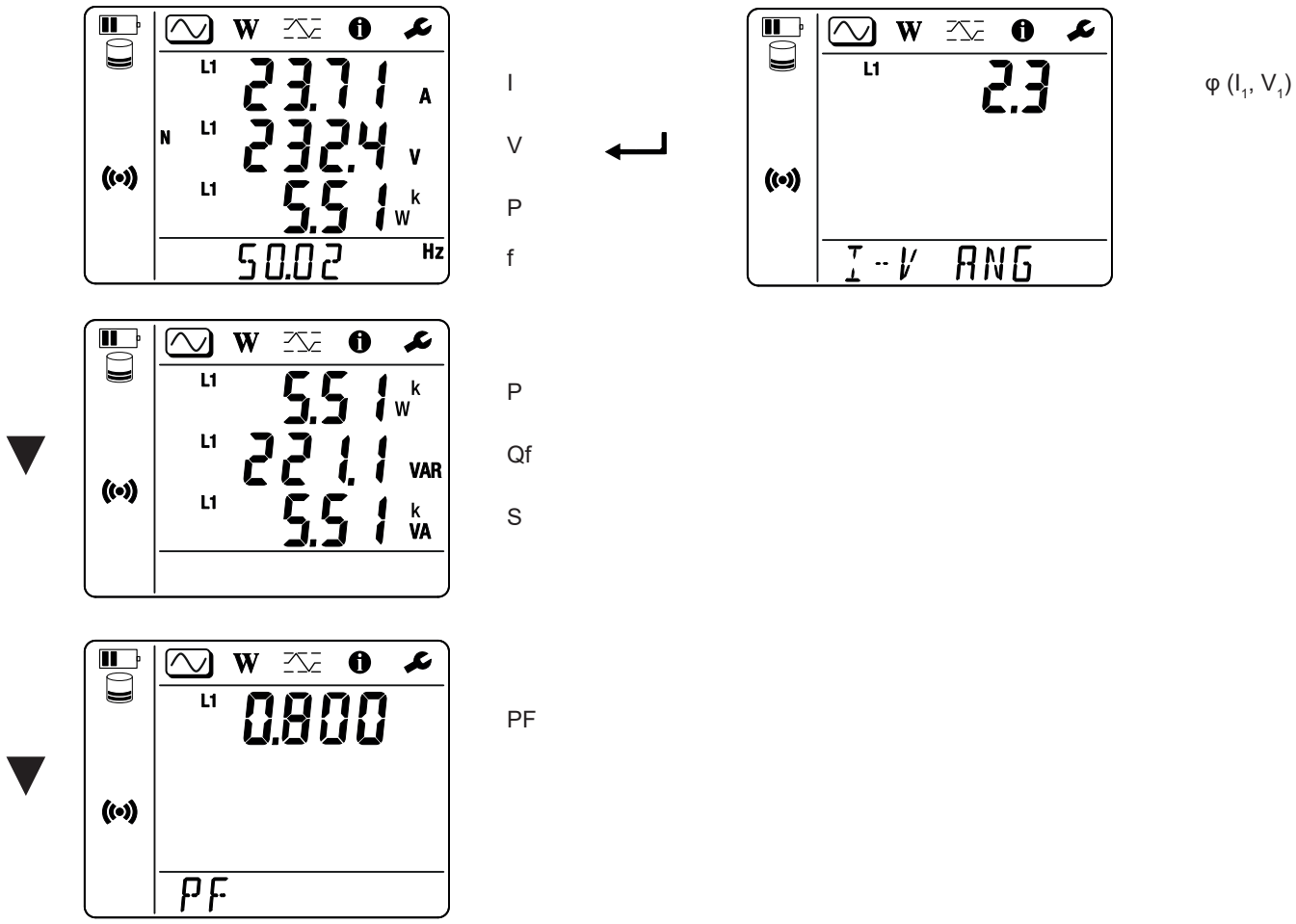
The displays can be accessed as soon as the PEL is turned on but the values are at zero. As soon as voltage or current is present at the inputs, the values are updated.

4.3.1. MEASUREMENT MODE

This mode displays the instantaneous values: voltage (V), current (I), active power (P), fundamental reactive power (Qf), apparent power (S), frequency (f), power factor (PF), phase shift (φ).

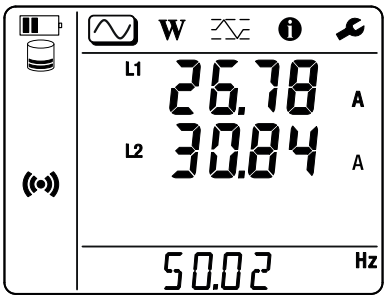
The display depends on the configured network. Press the ▼ key to switch from one screen to the next.

Single-phase 2-wire (1P-2W1I) (PEL51 and PEL52)



If the current sensor is not detected, all the quantities that depend on the current (current, angle, powers, PF) are undefined (displays - - - -).

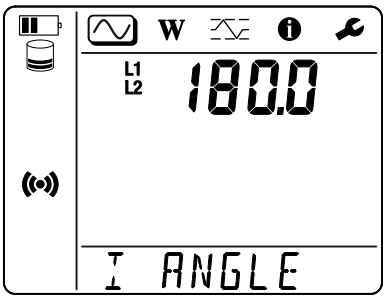
Single-phase 3-wire 2-currents (1P-3W2I) and two-phase 3-wire (2P-3W2I) (PEL52)



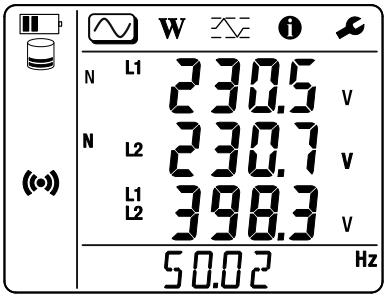
I_1

I_2

f



$\varphi (I_2, I_1)$

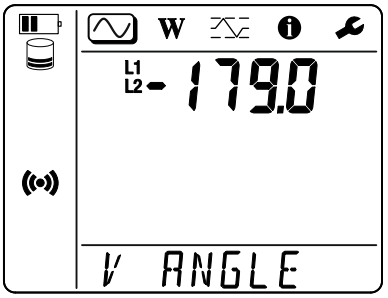


V_1

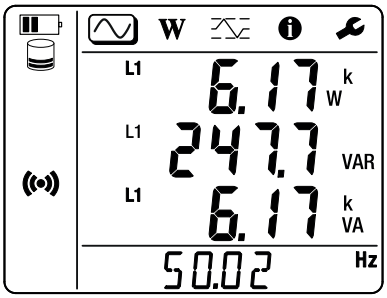
V_2

U_{12}

f



$\varphi (V_2, V_1)$

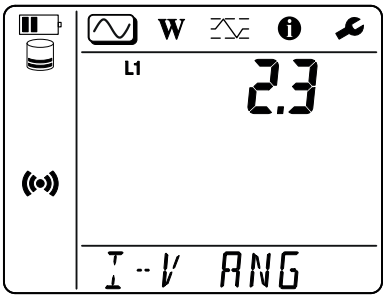


P

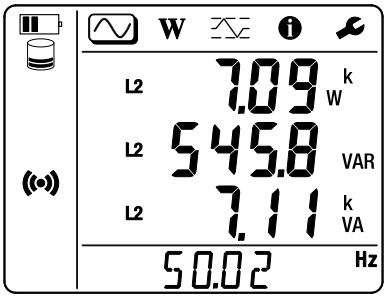
Qf

S

f



$\varphi (I_1, V_1)$

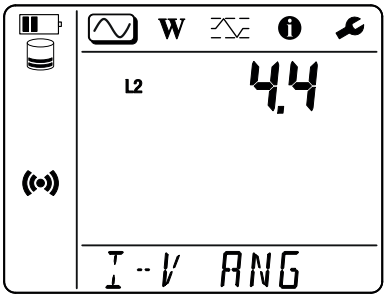


P

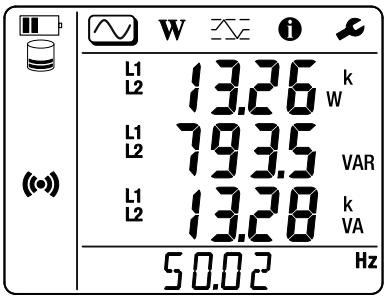
Qf

S

f



$\varphi (I_2, V_2)$

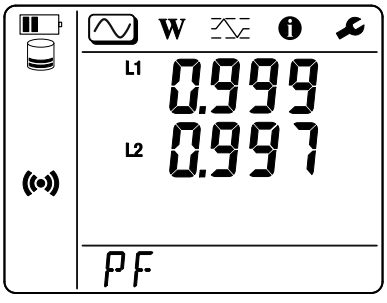


P

Qf

S

Sum of powers on L1 and L2.

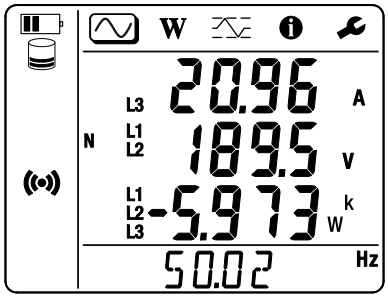


PF_1

PF_2

If a current sensor is not detected, all the quantities that depend on this current (current, angle, powers, PF) are undefined (displays - - - -).

Three-phase balanced 2-wire 1 current (3P-2W1I) (PEL51 V2)

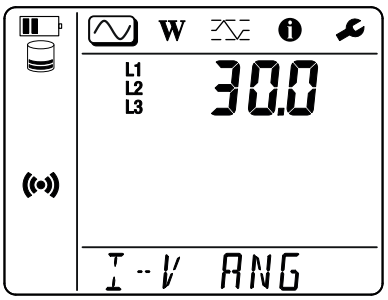


I

U_{12}

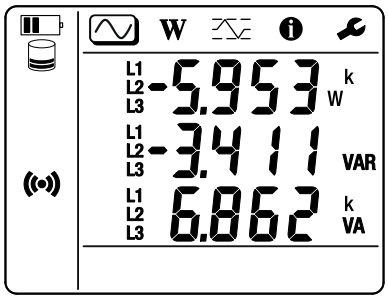
P

f



φ (I_1, V_1)

▼

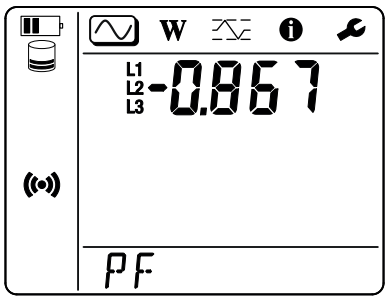


P

Qf

S

▼



PF

4.3.2. ENERGY MODE

This mode displays the energy: active energy (Wh), reactive energy (varh), apparent energy (VAh).

The energies displayed are the total energies, of the source or of the load. The energy depends on the duration.

Press the ▼ key to switch from one screen to the next. You will scroll successively:
- Ep+: Total active energy supplied (by the source) in Wh
- Ep-: Total active energy consumed (by the load) in Wh
- Eq1: Reactive energy consumed (by the load) in the inductive quadrant (quadrant 1) in varh.
- Eq2: Reactive energy supplied (by the source) in the capacitive quadrant (quadrant 2) in varh.
- Eq3: Reactive energy supplied (by the source) in the inductive quadrant (quadrant 3) in varh.
- Eq4: Reactive energy consumed (by the load) in the capacitive quadrant (quadrant 4) in varh.
- Es+: Total apparent energy supplied (by the source) in VAh
- Es-: Total apparent energy consumed (by the load) in VAh

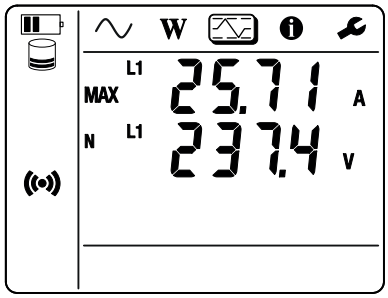
The device does not display the "h" symbol. Therefore you will see "W" for "Wh".

4.3.3. MAXIMUM MODE

This mode displays the maximum values: maximum aggregated values of measurements and energy.

Depending on the option selected in PEL Transfer, these may be the maximum aggregated values for the recording in progress or the maximum aggregated values of the last recording, or the maximum aggregated values since the last reset to zero.

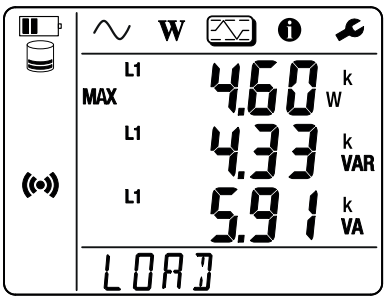
Single-phase 2-wire (1P-2W1I)



I_1

V_1

▼

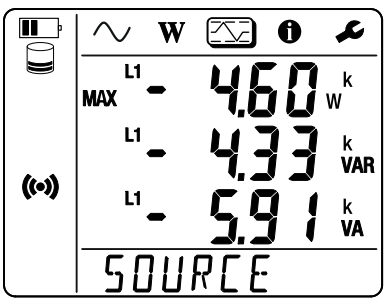


P

Qf

S

▼

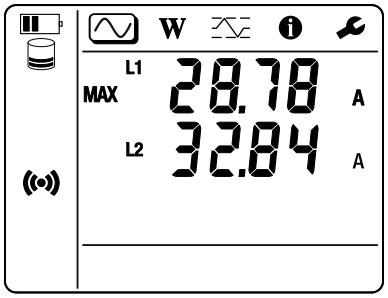


P

Qf

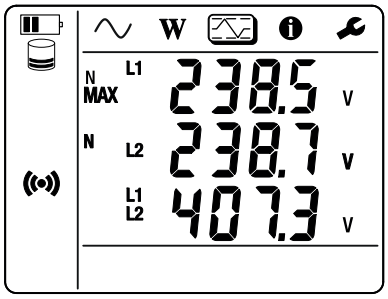
S

Single-phase 3-wire 2-currents (1P-3W2I) and two-phase 3-wire (2P-3W2I) (PEL52)



I_1

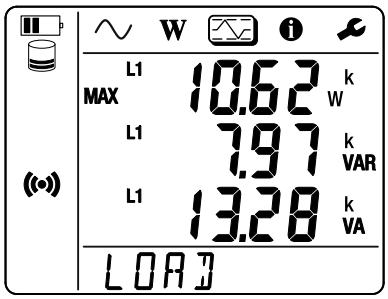
I_2



V_1

V_2

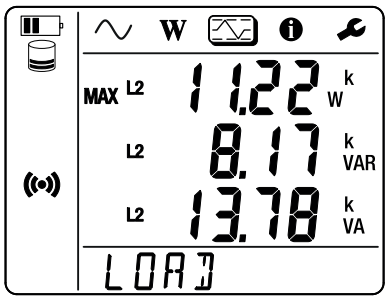
U_{12}



P_1

Qf_1

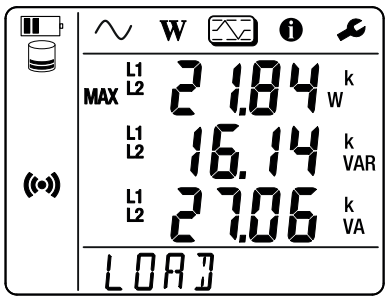
S_1



P_2

Qf_2

S_2

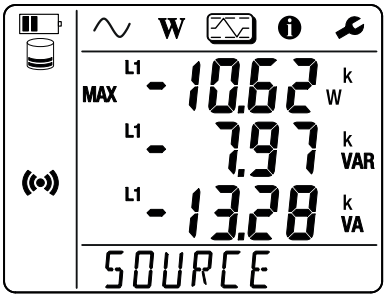


P

Qf

S

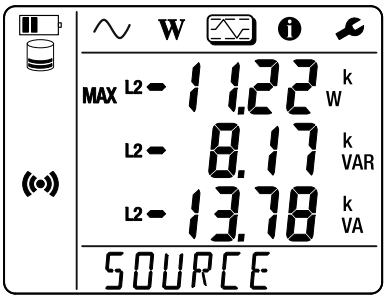
Sum of powers on the load on L1 and L2.



P_1

Qf_1

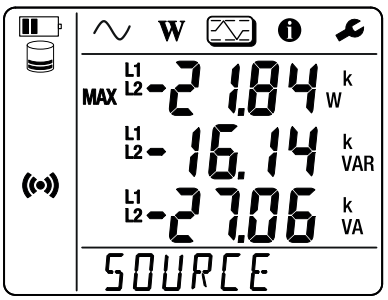
S_1



P_2

Qf_2

S_2



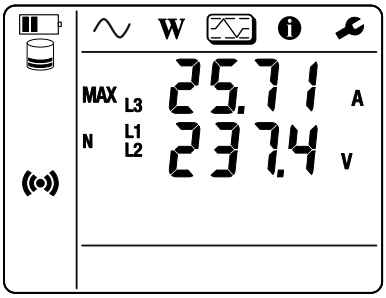
P

Qf

S

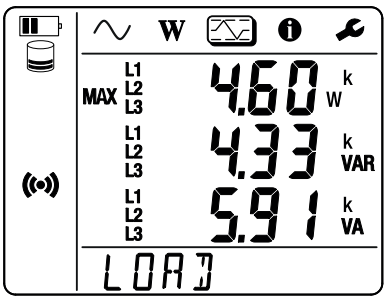
Sum of powers on the source on L1 and L2.

Three-phase balanced 2-wire 1 current (3P-2W1I) (PEL51 V2)



I_3

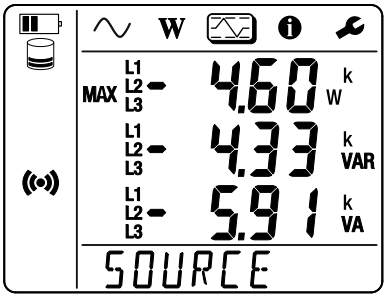
U_{12}



P

Qf

S



P

Qf

S

5. SOFTWARE AND APPLICATION

5.1. PEL TRANSFER SOFTWARE

5.1.1. FUNCTIONS

The PEL Transfer software lets you:

- Connect the device to the PC by WiFi.
- Configure the device: give the device a name, set the automatic power-off delay, choose the refresh rate for the maximum values, lock the device's **Select key**, prevent battery charging during measurement, set a device configuration password, set date and time, format the SD card, etc.
  When the instrument is turned off, the **Select key** lock is lost as well as the block preventing power supply through the measurement terminals.
- Configure communication between the device, PC and network.
- Configure measurement: choose the distribution network.
- Configure the current sensors: the transformation ratio and number of turns, if necessary.
- Configure recordings: choose their names, duration, start and end date, aggregation period.
- Reset the energy meters to zero.

PEL Transfer software also allows recordings to be opened, uploaded to the PC and exported to a spreadsheet, as well displaying the corresponding curves and creating and printing reports.

It also allows the firmware of the device to be updated when a new update is available.

5.1.2. INSTALLING PEL TRANSFER

1. Download the latest version of PEL Transfer from our website.
www.chauvin-arnoux.com

Go to the **Support** section and search for **PEL Transfer**.
Download the software to your PC.
Launch **setup.exe**. Then follow the installation instructions.

You must have administrator rights on your PC to install the PEL Transfer software.

2. A warning message similar to the one below appears. Click **OK**.
There is no USB connection on the PEL 51 and 52, so ignore this automatic message which applies to other devices in the PEL range.

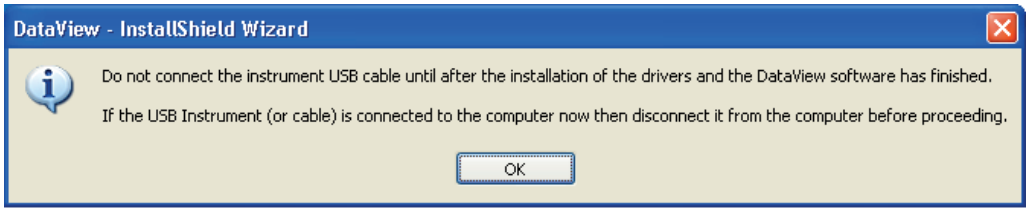


Figure 32

Installing the drivers may take some time. Windows may even indicate that the program is not responding, although it is still running. Wait until it is finished.

3. When driver installation is finished, the dialogue box **Installation successful** is displayed. Click **OK**.

4. The **Install Shield Wizard completed** window then displays. Click **Finish**.

5. If necessary, restart the computer.

A shortcut has been added to your desktop  or in the DataView directory.

You can now open PEL Transfer and connect your PEL to the computer.

For background information on using PEL Transfer, see the software Help.

5.2. PEL APPLICATION

The Android application provides some of the functions of the PEL Transfer software.
It enables you to connect to your instrument remotely.

Find the application by typing PEL Chauvin Arnoux.
Install the application on your smartphone or tablet.

PEL

The application has 3 tabs.

 is used to connect the instrument on DataViewSync™ (IRD server). Enter the serial number of the PEL (see §3.4) and the password (this information is available in PEL Transfer). Then connect.

 is used to display the measurements in the form of a Fresnel diagram.
Drag the screen to the left to see the voltage, current, power, and energy values, etc.

 is used to:

- Configure the records: choose their names, their duration, their start and end dates, the aggregation period, whether or not the “1s” values are recorded.
- Configure the measurement: choose the distribution network, the primary current and the aggregation period.
- Configure communication between the instrument and the smartphone or tablet.
- Configure the instrument: set the date and time, format the SD card, and lock or unlock the **Selection** key.

6. TECHNICAL SPECIFICATIONS

6.1. REFERENCE CONDITIONS

Parameter	Reference conditions
Ambient temperature	23 ± 2 °C
Relative humidity	45 to 75% RH
Voltage	No DC component
Current	No DC component
Network frequency	50 Hz ± 0.1 Hz and 60 Hz ± 0.1 Hz
Harmonics	< 0.1%
Preheating	The device must have been powered up for at least one hour.
Common mode	The neutral input and the casing are grounded.
	The device is powered by the battery.
Magnetic field	0 A/m AC
Electrical field	0 V/m AC

Table 6

6.2. ELECTRICAL PROPERTIES

Uncertainties are expressed in % of reading (R) and an offset:
± (a % R + b)

6.2.1. VOLTAGE INPUTS

Operating range up to 600 VRMS for phase-neutral voltages and 1200 VRMS for phase-phase voltages from 45 to 65 Hz.

Phase-to-neutral voltages less than 2 V and phase-to-phase voltages less than 3.4 V are set to zero.

Input impedance 903 kΩ when the device is running on battery.
When the device is powered by the voltage at the terminals, the impedance on L1 is dynamic and the current source must be able to deliver up to 100 mA at 90 V and 500 mA at 660 V.

Sustained overload 660 V.

Above 690 V, the device displays the **OL** symbol.

6.2.2. CURRENT INPUTS

The outputs from current sensors are voltages.

Operating range 0.5 mV to 1.7 Vpeak

Peak factor $\sqrt{2}$ except AmpFlex® / MiniFlex current sensors see Table 16.

Input impedance 1 MΩ (except AmpFlex® / MiniFlex current sensors)
12.4 kΩ (AmpFlex® / MiniFlex current sensors)

Maximum overload 1.7 V

6.2.3. INTRINSIC UNCERTAINTY (EXCLUDING CURRENT SENSORS)

With:
- R: displayed value.
- I_{nom}: nominal current of the current sensor for an output of 1 V, see Table 15 and Table 16.
- P_{nom} and S_{nom}: active and apparent power for V = 230 V, I = Inom and PF = 1.
- Qf_{nom}: reactive power for V = 230 V, I = Inom and sin φ = 0.5.

6.2.3.1. Specifications of the PEL

Quantities	Measurement range	Intrinsic uncertainty
Frequency (f)	[45 Hz; 65 Hz]	± 0.1 Hz
Phase-neutral voltage (V_1, V_2)	[10 V; 660 V]	± 0.2% R ± 0.2 V
Phase-phase voltage (U_{12}) (PEL52 only)	[20 V; 1200 V]	± 0.2% R ± 0.4 V
Current (I_1, I_2)	[0.2% I_{nom}; 120% I_{nom}]	± 0.2% R ± 0.02% I_{nom} (1)
Active power (P_1, P_2, P_T) kW	PF = 1 V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.3% R ± 0.003% P_{nom} (2)
	PF = [0.5 inductive; 0.8 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.7% R ± 0.007% P_{nom} (2)
Reactive power (Qf_1, Qf_2, Qf_T) kvar	Sin φ = [0.8 inductive; 0.6 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 10% I_{nom}]	± 2% R ± 0.02% Qf_{nom} (2)
	Sin φ = [0.8 inductive; 0.6 capacitive] V = [100 V; 660 V] I = [10% I_{nom}; 120% I_{nom}]	± 1% R ± 0.01% Qf_{nom} (2)
Apparent power (S_1, S_2, S_T) kVA	V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.3% R ± 0.003% S_{nom}
Power factor (PF_1, PF_2, PF_T)	PF = [0.5 inductive; 0.5 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.02 (2)
	PF = [0.2 inductive; 0.2 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.05 (2)
Cos φ (Cos $φ_1$, Cos $φ_2$, Cos $φ_T$)	Cos φ = [0.5 inductive; 0.5 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.05 (2)
	Cos φ = [0.2 inductive; 0.2 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.1 (2)
Active energy (Ep_1, Ep_2, Ep_T) kWh	PF = 1 V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.5% R (2)
	PF = [0.5 inductive; 0.8 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.6% R (2)
Reactive energy (Eq_1, Eq_2, Eq_T) kvarh	Sin φ = [0.8 inductive; 0.6 capacitive] V = [100 V; 660 V] I = [5% I_{nom}; 10% I_{nom}]	± 2.5% R (2)
	Sin φ = [0.8 inductive; 0.6 capacitive] V = [100 V; 660 V] I = [10% I_{nom}; 120% I_{nom}]	± 1.5% R (2)
Apparent energy (Es_1, Es_2, Es_T) kVAh	V = [100 V; 660 V] I = [5% I_{nom}; 120% I_{nom}]	± 0.5% R

Table 7

1: The uncertainty is specified for an output voltage of 1 V (Inom). The uncertainty of the current sensor must be added to obtain the total uncertainty (see Table 15). In the case of the AmpFlex® and MiniFlex sensors, the total uncertainty is indicated in Table 16.
2: The uncertainties are defined for the load, inductive for quadrant 1 and capacitive for quadrant 4. The same uncertainties apply to the source for the quadrants concerned.

Internal clock: ± 20 ppm

6.2.4. CURRENT SENSORS

6.2.4.1. Precautions for use

Refer to the safety data sheet provided or the downloadable user manual.

Current clamps and flexible current sensors are used to measure the current flowing in a cable without opening the circuit. They also isolate the user from dangerous voltages present in the circuit.

The choice of the current sensor to use depends on the current to be measured and the diameter of the cables.
When installing current sensors, point the arrow on the sensor towards the load.

When a current sensor is not connected, the device displays - - - -.

6.2.4.2. Characteristics

The measurement ranges are those of the current sensors. Sometimes they may differ from the ranges measurable by the PEL.

a) MiniFlex MA194

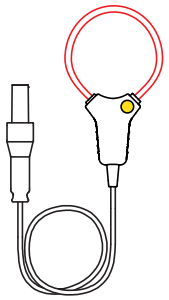
MiniFlex MA194		
Nominal range	300 / 3,000 Aac	
Measurement range	0.4 to 360 Aac for the 300 A range 2 to 3,600 Aac for the 3,000 A range	
Maximum clamping diameter	Length = 250 mm; Ø = 70 mm Length = 350 mm; Ø = 100 mm Length = 1000 mm; Ø = 320 mm	
Influence of the conductor's position in the sensor	≤ 2.5 %	
Influence of an adjacent conductor carrying an AC current	> 40 dB typical at 50/60 Hz for a conductor in contact with the sensor and > 33 dB near the latching mechanism	
Safety	IEC/EN 61010-2-032, pollution degree 2, 600 V category IV, 1000 V category III	

Table 8

Remark: Currents < 0.4 A for the 300 A range and < 2 A for the 3,000 A range are set to zero.

b) AmpFlex® A193

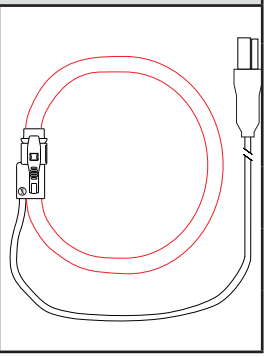
AmpFlex® A193		
Nominal range	300 / 3,000 Aac	
Measurement range	0.4 to 360 Aac for the 300 A range 2 to 3,600 Aac for the 3,000 A range	
Maximum clamping diameter (depending on the model)	Length = 450 mm; Ø = 120 mm Length = 800 mm; Ø = 235 mm	
Influence of the conductor's position in the sensor	≤ 2 % everywhere and ≤ 4 % near the latching mechanism	
Influence of an adjacent conductor carrying an AC current	> 40 dB typical at 50/60 Hz everywhere and > 33 dB near the latching mechanism	
Safety	IEC/EN 61010-2-032, pollution degree 2, 600 V category IV, 1000 V category III	

Table 9

Remark: Currents < 0.4 A for the 300 A range and < 2 A for the 3,000 A range are set to zero.

c) C193 clamp

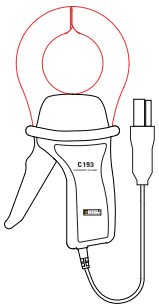
C193 clamp		
Nominal range	1000 Aac for f ≤1 kHz	
Measurement range	0.5 to 1200 Aac (I >1000 A for 5 minutes maximum)	
Maximum clamping diameter	52 mm	
Influence of the conductor's position in the clamp	< 0.1% from DC to 440 Hz	
Influence of an adjacent conductor carrying an AC current	> 40 dB typical at 50/60 Hz	
Safety	IEC/EN 61010-2-032, pollution degree 2, 600 V category IV, 1000 V category III	

Table 10

Remark: Currents < 0.5 A are set to zero.

d) MN93 clamp

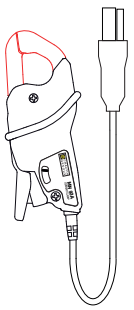
MN93 clamp		
Nominal range	200 Aac for f ≤1 kHz	
Measurement range	0.1 to 240 Aac max (I >200 A non-continuous)	
Maximum clamping diameter	20 mm	
Influence of the conductor's position in the clamp	< 0.5%, at 50/60 Hz	
Influence of an adjacent conductor carrying an AC current	> 35 dB typical at 50/60 Hz	
Safety	IEC/EN 61010-2-032, pollution degree 2, 300 V category IV, 600 V category III	

Table 11

Remark: Currents < 0.1 A are set to zero.

e) MN93A clamp

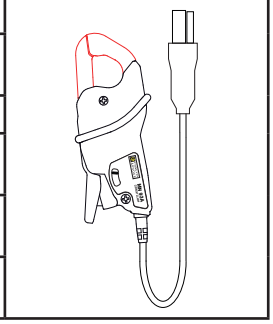
MN93A clamp		
Nominal range	5 and 100 Aac	
Measurement range	2.5 mA to 6 Aac for the 5 A range 0.05 to 120 Aac for the 100 A range	
Maximum clamping diameter	20 mm	
Influence of the conductor's position in the clamp	< 0.5%, at 50/60 Hz	
Influence of an adjacent conductor carrying an AC current	> 35 dB typical at 50/60 Hz	
Safety	IEC/EN 61010-2-032, pollution degree 2, 300 V category IV, 600 V category III	

Table 12

The 5 A range of MN93A clamps is suitable for measuring the secondary currents of current transformers.

Remark: Currents < 2,5 mA for the 5 A range and < 50 mA for the 100 A range are set to zero.

f) MINI 94 clamp

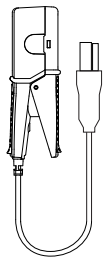
MINI 94 clamp		
Nominal range	200 Aac	
Measurement range	50 A to 240 Aac	
Maximum clamping diameter	16 mm	
Influence of the conductor's position in the clamp	< 0.08%, at 50/60 Hz	
Influence of an adjacent conductor carrying an AC current	> 45 dB typical at 50/60 Hz	
Safety	IEC/EN 61010-2-032, pollution degree 2, 300 V category IV, 600 V category III	

Table 13

Remark: Currents < 50 A are set to zero.

g) Current sensor thresholds

Sensor	Nominal current	Number of turns	Display threshold
C193 clamp	1000 A		0.50 A
AmpFlex® A193 MiniFlex MA194	300 A	1 turn	0.40 A
		2 turns	0.20 A
		3 turns	0.15 A
	3,000 A	1 turn	2 A
		2 turns	1 A
		3 turns	0.7 A
MN93A clamp	5 A		2.5 mA
	100 A		50 mA
MN93 clamp	200 A		0.1 A
MINI 94 clamp	200 A		50 mA
BNC adapter	1000 A (1 mV/A calibre)		0 A (no threshold)

Table 14

6.2.4.3. Intrinsic uncertainty

The intrinsic uncertainties of the current and phase measurements must be added to the intrinsic uncertainties of the instrument for the quantity concerned: power, energies, power factors, etc.

The following characteristics are given for the reference conditions of the current sensors.

Characteristics of current sensors which have an output of 1 V at Inom

Current sensor	I nominal	Current (RMS or DC)	Intrinsic uncertainty at 50/60 Hz	Intrinsic uncertainty on φ at 50/60 Hz	Typical uncertainty on φ at 50/60 Hz	Resolution
C193 clamp	1000 Aac	[1 A; 50 A]	± 1% R	-	-	10 mA
		[50 A; 100 A]	± 0.5% R	± 1°	+ 0.25°	
		[100 A; 1200 A]	± 0.3% R	± 0.7°	+ 0.2°	
MN93 clamp	200 Aac	[0.5 A; 5 A]	± 3% R ± 1 A	-	-	1 mA
		[5 A; 40 A]	± 2.5% R ± 1 A	± 5°	+ 2°	
		[40 A; 100 A]	± 2% R ± 1 A	± 3°	+ 1.2°	
		[100 A; 240 A]	± 1% R + 1 A	± 2.5°	± 0.8°	
MN93A clamp	100 Aac	[200 mA; 5 A]	± 1% R ± 2 mA	± 4°	-	1 mA
		[5 A; 120 A]	± 1% R	± 2.5°	+ 0.75°	
	5 Aac	[5 mA; 250 mA]	± 1.5% R ± 0.1 mA	-	-	1 mA
		[250 mA; 6 A]	± 1% R	± 5°	+ 1.7°	
MINI 94 clamp	200 Aac	[0.05 A; 10 A]	± 0.2% R ± 20 mA	± 1°	± 0.2°	1 mA
		[10 A; 240 A]		± 0.2°	± 0.1°	
BNC adapter	The nominal range of the input voltage of the BNC adaptor is 1 V. Refer to the specifications of the current sensors.					

Table 15

AmpFlex® and MiniFlex characteristics

Current sensor	I nominal	Current (RMS or DC)	Intrinsic uncertainty at 50/60 Hz	Intrinsic uncertainty on φ at 50/60 Hz	Typical uncertainty on φ at 50/60 Hz	Resolution
AmpFlex® A193	300 Aac	[0.5 A; 10 A]	± 1.2% R ± 0.2 A	-	-	10 mA
		[10 A; 360 A]		± 0.5°	0°	
	3,000 Aac	[1 A; 100 A]	± 1.2% R ± 1 A	-	-	100 mA
		[100 A; 3,600 A]		± 0.5°	0°	
MiniFlex MA194	300 Aac	[0.5 A; 10 A]	± 1% R ± 0.2 A	-	-	10 mA
		[10 A; 360 A]		± 0.5°	0°	
	3,000 Aac	[1 A; 100 A]	± 1 % R ± 1 A	-	-	100 mA
		[100 A; 3,600 A]		± 0.5°	0°	

Table 16

Crest factor:
- 2.8 to 360 A on the 300 A calibre.
- 1.7 to 3,600 A on the 3,000 A calibre.

AmpFlex® and MiniFlex limitation
Like all Rogowski sensors, the output voltage of AmpFlex® and MiniFlex is proportionate to the frequency.High current at high frequency can saturate the current input of devices.

To avoid saturation, the following condition must be respected:

$$\sum_{n=1}^{n=\infty} [n.\ I_n] < I_{nom}$$

Where I_{nom} is the range of the current sensor
n is the harmonic order
I_n is the current value for the harmonic of order n

For example, the input current range of a potentiometer should be 5 times less than the current range selected on the device.

This requirement does not take into account the limitation of the bandwidth of the device, which can lead to other errors.

6.3. VARIATION IN THE FIELD OF USE

6.3.1. GENERAL

Internal clock drift: ± 5 ppm/year at 25 ± 3°C

6.3.2. TEMPERATURE

V_1, V_2: 50 ppm/°C typical
I_1, I_2, I_3: 150 ppm/°C typical, for 5% I_{nom} < I < 120% I_{nom}
Internal clock: 10 ppm/°C

6.3.3. HUMIDITY

Range of influence: 30 to 75 %RH at 50°C / 85 %RH at 23°C excluding condensation
The influence is indicated for the instrument with the current sensors.
V_1, V_2: ± 2%
I_1, I_2, I_3 (1% I_{nom} ≤ I ≤ 10% I_{nom}): 5%
(10% I_{nom} < I ≤ 120% I_{nom}): 4%

6.3.4. CONTINUOUS COMPONENT

Range of influence: ± 100 VDC
Quantities influenced: V_1, V_2
Rejection: > 160 dB

6.3.5. FREQUENCY

Range of influence: 45 Hz to 65 Hz, - 60° ≤ φ ≤ +60°
Quantities influenced: V_1, V_2, I_1, I_2, I_3, P_1, P_2
Influence: 0.1 %/Hz

6.3.6. BANDWIDTH

Range of influence: 100 Hz to 5 kHz (harmonics)
Presence of the fundamental at 50/60 Hz (THD = 50%)
V_1, V_2: 0.5% @ 2.1 kHz / -3 dB @ 5 kHz
I_1, I_2, I_3 (direct input, excluding AmpFlex® and MiniFlex): 0.5% @ 1.75 kHz / -3 dB @ 5 kHz
P_1, P_2: 0.5% @ 1.25 kHz / -3 dB @ 3.5 kHz

6.3.7. DISTURBED SIGNALS

The following signal bandwidth is 6 kHz, 5% I_{nom} < I ≤ 50% I_{nom}.

Signal type	Sensor	Typical influence
Phase cut-off potentiometer	MN93A clamp	< 1%
	MiniFlex MA194	< 3%
Square	MN93A clamp	< 1%
	MiniFlex MA194	< 3%

Bridge rectifiers have a waveform that is not supported by the PEL51/52.

6.4. POWER SUPPLY

Mains power supply (between terminals V1 and N)

- Operating range: 90 V - 600 V
  DC voltage of 100 V or more will prevent the operation of the mains power supply.
- Power: 3 to 5 W depending on input voltage.
- Current: at 90 VAC, 100 mApeak and 17 mARMS.Inrush current: 1.9 Apeak
  at 600 VAC, 500 mApeak and 0.026 mARMS. Inrush current: 5.3 Apeak

Battery

- 2 NiMH rechargeable elements type AAA 750 mAh
- Battery mass: about 25 g
- Charging time: approx. 5 hours
- Charging temperature: 0 to 45 °C
- Battery life with active WiFi: 1 hr minimum, 3 hrs typical

When power is off, the real time clock is retained for more than 20 days.

6.5. ENVIRONMENTAL CHARACTERISTICS

- **Temperature and relative humidity**

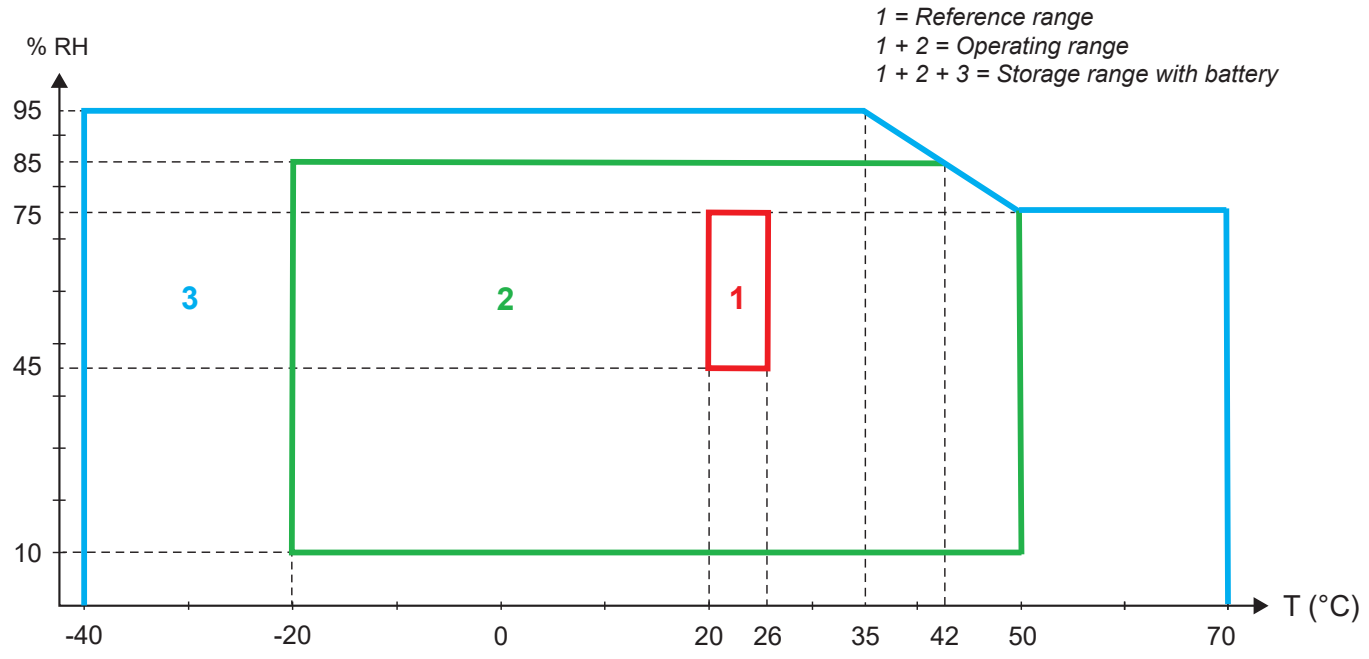


Figure 33

- For indoor use.
- **Altitude**
  - Operating: 0 to 2,000 m;
  - Storage: 0 to 10,000 m

6.6. WIFI

2.4 GHz IEEE 802.11 b/g/n band
Tx power: +15.1 dBm
Rx sensitivity: -96.3 dBm
Security: open / WPA2

6.7. MECHANICAL CHARACTERISTICS

- **Dimensions:** 180 × 88 × 37 mm
- **Mass:** Approx. 400 g
- **Degree of protection:** provided by the enclosure according to IEC 60529,
  IP 54 when the device is not connected
  IP 20 when the device is connected

6.8. ELECTRICAL SAFETY

The devices comply with IEC/EN 61010-2-030 for a voltage of 600 V measurement category III pollution degree 2.

The devices comply with BS EN 62749 for EMF.

Battery load between terminals **V1** and **N**: 600 V surge category III, pollution degree 2.
The test leads and crocodile clips comply with standard IEC/EN 61010-031.

6.9. ELECTROMAGNETIC COMPATIBILITY

Emissions and immunity in industrial environment compatible with IEC/EN 61326-1.

With the AmpFlex® and MiniFlex, the typical influence on the measurement is 0.5% of full scale with a maximum of 5 A.

6.10. RADIO EMISSION

The devices comply with the RED Directive 2014/53/EU and FCC regulations.
FCC certification number for the WiFi: FCC QOQWF121

6.11. MEMORY CARD

The instrument contains a micro-SD card with a capacity of 8 GB formatted FAT32. This card allows recording for 100 years, but the number of recording sessions is limited.

The memory symbol on the display indicates that it is full:

-  : number of sessions ≤ 50,
-  : number of sessions > 50,
-  : number of sessions > 100,
- : number of sessions > 150,
-  : number of sessions = 200,

Recording sessions can be downloaded and/or deleted individually via the PEL Transfer application software.

Transferring a large amount of data from the SD card to a PC can take a long time. In addition, some computers can have difficulty processing such amounts of information and spreadsheets only accept a limited amount of data.

To transfer data faster, use the SD/USB card adapter.

The maximum size of a recording is 4 GB and its duration is unlimited (> 100 years).

7. MAINTENANCE

Except for the batteries, the device contains no parts that can be replaced by personnel who have not been specially trained and accredited. Any unauthorized work or any part replacement with equivalents may seriously compromise safety.

7.1. CLEANING

Disconnect all connections from the device.

Use a soft cloth, moistened with soapy water. Rinse with a damp cloth and dry quickly with a dry cloth or forced air. Do not use alcohol, solvents, or hydrocarbons.

Do not use the device if the terminals or the keyboard are wet. Dry it first.

For the current sensors:

- Ensure that no foreign body interferes with the current sensor latching mechanism.
- Keep the air gaps of the clamp completely clean. Do not spray water directly on the clamps.

7.2. BATTERY

The device is equipped with a NiMH battery. This technology has several advantages:

- Long battery life for a limited volume and weight;
- Significantly reduced memory effect. You can recharge the battery even if it is not completely discharged;
- Environmentally friendly. No polluting material such as lead or cadmium, in accordance with applicable regulations.

The battery may be completely discharged after prolonged storage. In this case, it must be fully recharged. The device may not work during part of the charging. Recharging a completely discharged battery may take several hours.

In this case, at least 5 charge/discharge cycles will be necessary for the battery to regain 95% of its capacity. Refer to the battery data sheet delivered with the device.

To optimise the use of your battery and extend its effective life:

- Charge the device only at temperatures between 0 and 45 °C.
- Comply with the conditions for use.
- Comply with the conditions for storage.

7.3. UPDATING FIRMWARE

To make sure that it provides the best possible service in terms of performance and technical developments, Chauvin Arnoux offers the opportunity to update the firmware of this instrument.

Updating firmware may reset the configuration to zero and cause loss of the date and recorded data. As a precaution, back up the data in memory on a PC before updating.

Our site:
www.chauvin-arnoux.com

Then go to the **Support** section then **Download our software** then do a search for **PEL51** or **PEL52**.

- Download the zip file that contains the new firmware and the FlashUp installation utility.
- Connect the instrument to your PC via WiFi.
- Unzip the zip file.
- Launch **FlashUp.exe**.

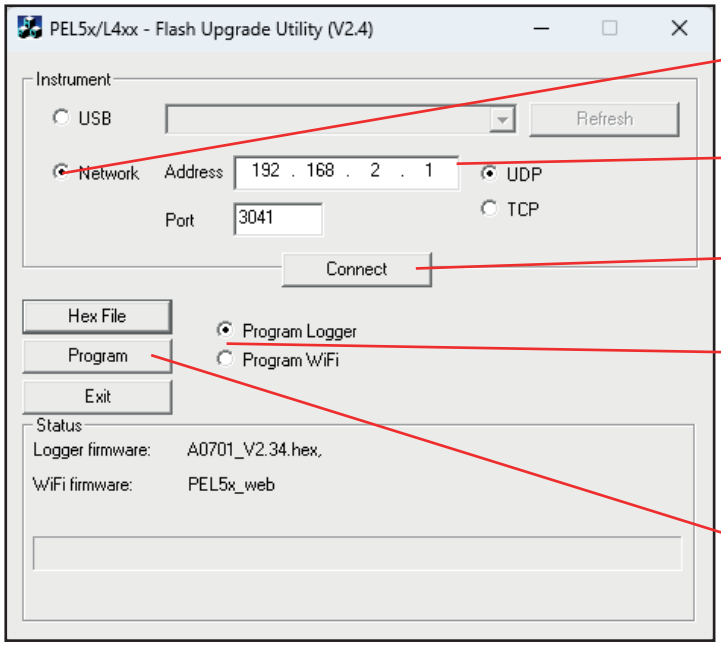


Figure 34

- Tick the **Network** box.
- Enter the IP address of your instrument.
- Click on **Connect** to connect your instrument.
- The firmware is made up of 2 parts: **Program Logger** and **Program WiFi**. Select one of the two and run the update. When it is finished, select the other and run the update again.
- Click **Program**. Writing the firmware takes about 5 minutes. The window shows the progress. The device displays **FLASHUP**.

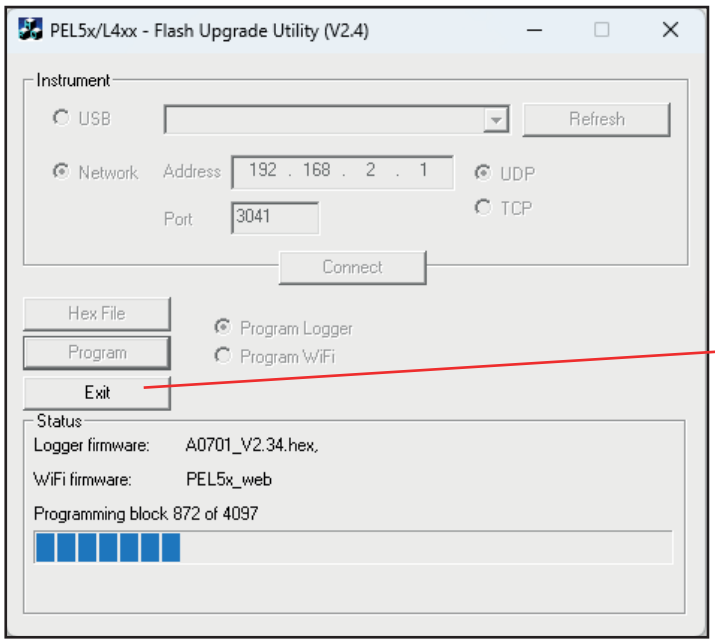


Figure 35

- When writing is finished, click **Exit** - the FlashUp window closes. Switch off the instrument and then on again.

7.4. FORMATTING THE SD CARD

If, when you press the **Select** ⟲ key to start a recording, the instrument displays **SD CARD ERROR**, the SD card of the instrument has encountered a problem.

If this occurs, connect your instrument to the PEL Transfer application software. In the configuration function, you can then format the SD card.

If this does not solve the problem, you will need to replace the SD card (see § 2.5).

⚠ Disconnect all connections to the instrument before opening the SD card slot.

7.5. MESSAGES

The main messages concern WiFi.

AP CONFIG TCPIP FAILED	AP Mode: TCP/IP configuration failed
AP DHCP SERVER FAILED	AP Mode: Failed to start DHCP server
AP MODE START FAILED	AP Mode: Failed to start AP mode
AP POWER MODE FAILED	AP mode: Max power saving mode configuration failed
AP SCAN FAILED	AP Mode: Network scan failed
AP SET PASSWORD FAILED	AP Mode: Failed to set AP mode password
AP UDP SERVER FAILED	AP Mode: Failed to start UDP server
AP TCP SERVER FAILED	AP Mode: Failed to start TCP server
CONFIG AP	Configures the module for operation as an access point
CONFIG DHCP	Configures the modules for the DHCP server
CONFIG HTTP SERVER	Configures the modules for the HTTP server
CONFIG ST	Configures the module for ST mode (router)
CONFIG TCP	Configures TCP settings
CONFIG TCP SERVER	Configures the TCP server settings
CONFIG TCPIP	Configures the TCP/IP settings
CONFIG UDP/TCP SERVER	Configures the modules for UDP/TCP server
CONFIG UDP SERVER	Configures the UDP server settings
CONNECT SSID	Connection to an SSID server
DISABLED	Disabled by user
FLASHING WiFi MODULE	Programming the WiFi module
HTTP SERVER FAILED	Failed to start HTTP server
INIT FAILURE	Initialisation failed
NO CONFIG TCPIP RSP	STA mode: No TCP/IP response configuration
NO CONFIG TCPIP EVT	STA mode: No TCP/IP event configuration
NO GET MAC EVT	No response from MAC event
NO GET MAC EVT	No response from MAC address
NO HELLO RSP	No Hello response
NO OP MODE RSP	No response to set operating mode (STA or AP)
NO POWER MODE RSP	STA mode: No response to set maximum power saving mode
NO RADIO ON EVT	STA mode: No response to Radio On event
NO RADIO ON RSP	STA mode: No radio activation response
NO RESPONSE	Module did not respond to hard reset
NO SET MAC RSP	No response to setting MAC address
NO SET PASSWORD RSP	STA mode: No response to setting WiFi password
NO SYNC RSP	No sync response
POWER ON	Powering up the module
POWER MODE AP	Set power mode for WiFi AP operation
POWER MODE ST	Set power mode for ST WiFi operation
RADIO ON	Activation of the radio in the module
RADIO ON AP	Activate radio
RADIO ON FAILED	AP Mode: Radio Power On failed
RESETTING MODULE	Resetting the module
SET 80211 MODE	Set 802.11 operating mode
SET 80211 MODE FAILED	Failed to set 802.11 operating mode
SET AP MODE FAILED	AP Mode: Failed to set AP mode
SET AP PASSWORD	Set AP mode password
SET PASSWORD	Set password to use when connecting to an existing SSID
SETTING BPS RATE	Set the BPS of the module
SETTING OPERATING MODE	Setting the module operating mode
SSID SCAN AP	Scan SSID
SSID ERROR	Failed to connect to specified SSID
START AP SERVER	Start the server in AP mode
START TCP AP SERVER	Start the TCP server for operation in AP mode
START TCP SERVER FAILED	STA Mode: Failed to start TCP server
START UDP AP SERVER	Start the UDP server for operation in AP mode
START UDP SERVER FAILED	STA Mode: Failed to start UDP server
START UDP/TCP AP SERVER	Start UDP/TCP servers in APs mode
VALIDATE FAILED	Validation failed
VALIDATING MAC	Checking the validity of the MAC address
WAITING FOR BOOT EVENT	Waiting for the module to send a boot event message
WAIT FOR HELLO MSG	Waiting for module greeting
WAITING FOR SYNC	Waiting for module synchronisation messages

8. WARRANTY

Except as otherwise stated, our warranty is valid for **24 months** starting from the date on which the equipment was sold. The extract from our General Terms of Sale is available on our website.
www.chauvin-arnoux.com/en/general-terms-of-sale

The warranty does not apply in the following cases:

- Improper use of the device or use with incompatible equipment;
- Modifications to the device without the explicit authorisation of the manufacturer's technical department;
- Work performed on the device by a person not approved by the manufacturer;
- Adaptation to a particular application not anticipated in the definition of the device or not indicated in the user manual;
- Damage caused by shocks, falls or floods.

9. APPENDIX

9.1. MEASUREMENTS

9.1.1. DEFINITION

Geometric representation of active and reactive powers:

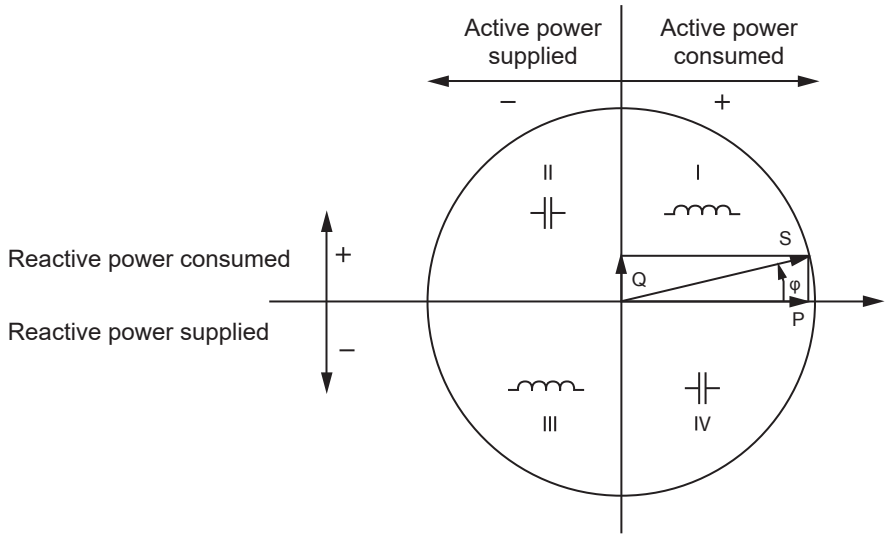


Figure 36

The reference of this diagram is the current vector (fixed on the right-hand part of the axis).
The voltage vector V varies in its direction as a function of the phase angle φ.
The phase angle φ, between voltage V and current I, is considered positive in the mathematical sense of the term (counterclockwise).

9.1.2. SAMPLING

9.1.2.1. "1 s" (one second) quantities

The device calculates the following quantities every second on the basis of measurements over a cycle, according to § 9.2.
"1 s" quantities are used for:

- real-time values
- trends over 1 second
- aggregation of values for "aggregated" trends
- determination of minimum and maximum values for the values of "aggregated" trends

All "1 s" quantities can be recorded on the SD card during the recording session.

9.1.2.2. Aggregation

An aggregated quantity is a value calculated over a period defined according to the formulas indicated in Table 18.

The aggregation period always begins at the start of an hour or a minute. The aggregation period is the same for all quantities. The following periods are possible: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 and 60 min.

All aggregated quantities are recorded on the SD card during the recording session. They can be displayed in PEL Transfer.

9.1.2.3. Minimum and maximum

Min and Max are the minimum and maximum values of the "1 s" quantities for the aggregation period considered. They are recorded with their dates and times. The Max values of certain aggregated values are displayed directly on the device.

9.1.2.4. Calculation of energies

Energies are calculated every second.
Total energies are available with the data of the recorded session.

9.2. MEASUREMENT FORMULAS

Quantities	Formulas	Comments
AC RMS phase-neutral voltage (V_L)	$V_L[1s] = \sqrt{\frac{1}{N} \times \sum_{1}^{N} v_L^2}$	vL = v1 or v2 incremental sample N = number of samples
AC RMS phase-phase voltage (U_L)	$U_{ab}[1s] = \sqrt{\frac{1}{N} \times \sum_{1}^{N} u_{ab}^2}$	Uab = u_{12} incremental sample N = number of samples
AC RMS current (I_L)	$I_L[1s] = \sqrt{\frac{1}{N} \times \sum_{1}^{N} i_L^2}$	iL = i1, i2 or i3 incremental sample N = number of samples
Active power (P_L)	$P_L[1s] = \frac{1}{N} \times \sum_{1}^{N} (v_L \times i_L)$	L = I1, I2 or I3 incremental sample N = number of samples P_T[1s]= P_1[1s] + P_2[1s] + P_3[1s]

Table 17

9.3. AGGREGATION

Aggregated quantities are calculated for a defined period according to the following formulas based on "1 s" values. Aggregation can be calculated by arithmetic average, quadratic average or other methods.

Quantities	Formula
Phase-neutral voltage (V_L) (RMS)	$V_L[agg] = \sqrt{\frac{1}{N} \times \sum_{x=0}^{N-1} {V_L}^2[1s]_x}$ L = 1 or 2
Phase-phase voltage (U_{ab}) (RMS)	$U_{ab}[agg] = \sqrt{\frac{1}{N} \times \sum_{x=0}^{N-1} U_{ab}^2\ [1s]_x}$ ab = 12
Current (I_L) (RMS)	$I_L[agg] = \sqrt{\frac{1}{N} \times \sum_{x=0}^{N-1} I_L^2\ [1s]_x}$ L = 1, 2 or 3
Frequency (F_L)	$F[agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} F\ [1s]_x$
Active power (P_L)	$P_L\ [agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} P_L\ [1s]_x$ L = 1, 2 or T
Reactive power (Qf_L)	$Qf_L\ [agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} Qf_L\ [1s]_x$ L = 1, 2 or T
Apparent power (S_L)	$S_L[agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} S_L[1s]_x$ L = 1, 2 or T
Source power factor with the associated quadrant (PF_{SL})	$PF_{SL}[agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} PF_{SL}\ [1s]_x$ L = 1, 2 or T
Load power factor with the associated quadrant (PF_{LL})	$PF_{LL}\ [agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} PF_{LL}\ [1s]_x$ L = 1, 2 or T
Cos (φ)$_S$ of the source with the associated quadrant	$\mathrm{Cos}(\varphi_L)_S[agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} \mathrm{Cos}(\varphi_L)_S\ [1s]_x$ L = 1, 2 or T

Quantities	Formula
Cos $(\varphi)_L$ of the load with the associated quadrant	$\mathrm{Cos}(\varphi_L)_L[agg] = \frac{1}{N} \times \sum_{x=0}^{N-1} \mathrm{Cos}(\varphi_L)_L[1s]_x$ L = 1, 2 or T

Table 18

N is the number of "1 s" values for the aggregation period considered (1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes).

9.4. SUPPORTED ELECTRICAL NETWORKS

The following types of distribution networks are supported:

- V1, V2 are the phase-neutral voltages of the installation measured. [V1=VL1-N; V2=VL2-N].
- The lower case letters v1, v2 denote the sampled values.
- U12 is the voltage between phases of the installation measured.
- Lower case letters denote the sampled values [u12 = v1-v2].
- I1, I2, I3 are the currents flowing in the phase conductors of the installation measured.
- The lower case letters i1, i2, i3 denote the sampled values.

Distribution network	Abbreviation	Comments	Reference diagram
PEL51 and PEL52 Single phase (single phase 2-wire 1 current)	1P- 2W1I	Voltage is measured between L1 and N. Current is measured on conductor L1.	see § 4.1.1
PEL52 Single phase (single phase 3-wire 2 currents)	1P- 3W2I	Voltage is measured between L1 and N. Current is measured on conductors L1 and L2.	see § 4.1.2
PEL52 Two-phase or split-phase (split-phase single phase 3-wire)	2P-3W2I	Voltage is measured between L1, L2 and N. Current is measured on conductors L1 and L2.	see § 4.1.3
PEL51 V2 Three-phase (three-phase balanced 2-wire 1 current)	3P-2W1I	Voltage is measured between L1 and L2. Current is measured on conductor L3.	see § 4.1.4

Table 19

9.5. VALUES AVAILABLE

●	available on the instrument and in PEL Transfer
○	available in PEL Transfer
	not available

Quantities	Symbol	Real-time value 1s	Trend value 1s	Max value	Trend value aggregated	Min/Max 1s aggregated
Phase-neutral voltage	V_1, V_2	●	○	●	○	○
Phase-phase voltage	U_{12}	●	○	●	○	○
Current	I_1, I_2, I_3	●	○	●	○	○
Frequency	f	●	○		○	○
Active power	P_1, P_2, P_T	●	○		○	
Active power on the source	P_1, P_2, P_T			●	○	○ (1)
Active power on the load	P_1, P_2, P_T			●	○	○ (1)
Fundamental active power	Pf_1, Pf_2, Pf_T	○	○		○	
Fundamental active power on the source	Pf_1, Pf_2, Pf_T				○	
Fundamental active power on the load	Pf_1, Pf_2, Pf_T				○	
Reactive power	Qf_1, Qf_2, Qf_T	●	○		○	
Reactive power on the source	Qf_1, Qf_2, Qf_T			●	○	○ (1)
Reactive power on the load	Qf_1, Qf_2, Qf_T			●	○	○ (1)
Apparent power	S_1, S_2, S_T	●	○		○	○ (1)
Apparent power on the source	S_1, S_2, S_T			●	○	
Apparent power on the load	S_1, S_2, S_T			●	○	
Non-active power	N_1, N_2, N_T	○	○		○	
Distorting power	D_1, D_2, D_T	○	○		○	
Power factor	PF_1, PF_2, PF_T	●	○			
Power factor on the source	PF_1, PF_2, PF_T				○	
Power factor on the load	PF_1, PF_2, PF_T				○	
Cos φ	$\cos\varphi_1, \cos\varphi_2, \cos\varphi_T$	○	○			
Cos φ on the source	$\cos\varphi_1, \cos\varphi_2, \cos\varphi_T$				○	
Cos φ on the load	$\cos\varphi_1, \cos\varphi_2, \cos\varphi_T$				○	
Total active energy on the source	Ep_T	●	○			
Total active energy on the load	Ep_T	●	○			
Reactive energy on quadrant 1	Eq_T	●	○			
Reactive energy on quadrant 2	Eq_T	●	○			
Reactive energy on quadrant 3	Eq_T	●	○			
Reactive energy on quadrant 4	Eq_T	●	○			

Quantities	Symbol	Real-time value 1s	Trend value 1s	Max value	Trend value aggregated	Min/Max 1s aggregated
Apparent energy on the source	Es_T	●	○			
Apparent energy on the load	Es_T	●	○			
Φ (I_2, I_1)		●				
Φ (V_2, V_1)		●				
Φ (I_1, V_1)		●				
Φ (I_2, V_2)		●				
Φ (I_3, U_{12})		○				

Table 20

(1) No minimum value for P_1, P_2, P_T, Qf_1, Qf_2, Qf_T

9.6. VALUES AVAILABLE

The following quantities are available in the instrument or in PEL Transfer.

●	available on the instrument and in PEL Transfer
○	available in PEL Transfer
	not available

Quantities	PEL51 and PEL52 1P-2W1I	PEL52 1P-3W2I and 2P-3W2I	PEL51 3P-2W1I
V_1	●	●	
V_2		●	
U_{12}		●	●
I_1	●	●	
I_2		●	
I_3			●
f	●	●	
P_1	●	●	
P_2		●	
P_T	● (1)	●	●
Pf_1	○	○	
Pf_2		○	
Pf_T	○	○	○
Qf_1	●	●	
Qf_2		●	
Qf_T	● (1)	●	●
S_1	●	●	
S_2		●	
S_T	● (1)	●	●
N_1	○	○	
N_2		○	
N_T	○	○	○
D_1	○	○	
D_2		○	
D_T	○	○	○
PF_1	●	●	
PF_2		●	
PF_T	● (1)	●	●

Quantities	PEL51 and PEL52 1P-2W1I	PEL52 1P-3W2I and 2P-3W2I	PEL51 3P-2W1I
Cos φ_1	○	○	
Cos φ_2		○	
Cos φ_T	○	○	○
Ep_T source	●	●	
Ep_T load	●	●	●
Eq_T quadrant 1	●	●	●
Eq_T quadrant 2	●	●	●
Eq_T quadrant 3	●	●	●
Eq_T quadrant 4	●	●	●
Es_T source	●	●	●
Es_T load	●	●	●
Φ (I_1, I_2)		●	
Φ (V_1, V_2)		●	
Φ (I_1, V_1)	●	●	●
Φ (I_2, V_2)		●	
Φ (I_3, U_{12})			○

Table 21

(1) $P_1 = P_T$, $Pf_1 = Pf_T$, $Qf_1 = Qf_T$, $N_1 = N_T$, $D_1 = D_T$, $S_1 = S_T$, $PF_1 = PF_T$, Cos φ_1 = Cos φ_T

9.7. GLOSSARY

φ Phase offset of the voltage relative to the current.
° Degree.
% Percentage.
A Ampere (current unit).
AC Alternative component (current or voltage).
Aggregation Different averages defined at § 9.3.
cos φ Cosine of the phase shift of the voltage with respect to the current.
DataViewSync™ (IRD server): Internet Relay Device server. Server that relays data between the recorder and a PC.
DC DC component (current or voltage).
Ep Active energy.
Eq Reactive energy.
Es Apparent energy.
Frequency Number of full cycles of voltage or current per second.
Hz Hertz (unit of frequency).
I Symbol for current.
L Phase of a multiphase network.
MAX Maximum value.
MIN Minimum value.
P Active power.
PF Power Factor: Ratio of active power to apparent power.
Phase Temporal relationship between current and voltage in alternating current circuits.
Qf Fundamental reactive power.
RMS RMS (Root Mean Square) average quadratic value of the current or voltage. Square root of the average of the squares of instantaneous values of a quantity during a specified interval.
S Apparent power.
Nominal voltage: Nominal voltage of a network.
U Voltage between two phases.
V Phase-neutral voltage or Volt (unit of voltage).
VA Unit of apparent power (Volt x Ampere).
var Unit of reactive power.
varh Unit of reactive energy.
W Unit of active power (Watt).
Wh Unit of active energy (Watt x hours).

Prefixes of units of the International System (SI)

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

Table 22

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