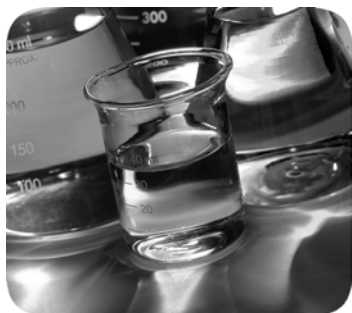**A·B** QUALITY *Allen-Bradley*

PowerPad Portable Power Monitor

Catalog Numbers 1412-PP2127, 1412-PP2137-01, 1412-PP2137-02, 1412-PP2137-03, 1412-PP2137-04, 1412-PP2137-05, 1412-PP2137-06

A·B *Allen-Bradley* • *Rockwell Software*

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation® sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

⚠	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
⚠	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
⚡	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
♨	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Added battery disposal information.	15
Updated the catalog number.	71

Notes:

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication <u>1770-4.1</u>	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, <u>http://www.ab.com</u>	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at <u>http:/www.rockwellautomation.com/literature/</u>. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

Chapter **1**

# Product Features

Description

The PowerPad portable power monitor is a three-phase power quality analyzer that is compact and shock-resistant. It is intended for technicians and engineers to measure and carry out diagnostic work on one, two, or three phase low voltage networks.

You are able to obtain instant waveforms of an electrical network's principal characteristics, and also monitor their variation over a period of time. The multi-tasking measurement system simultaneously handles all the measurement functions of the various magnitudes, detection, continuous recordings, and their display without any constraints.

The PowerPad unit has these features.

- Measurement of RMS voltages up to 480V (phase-to-neutral) or 830V (phase-to-phase) for two, three, or four-wire systems
- Measurement of RMS currents up to 6500 Arm
- Frequency measurement (40...70 Hz systems)
- Calculation of neutral current for WYE configurations
- Calculation of Crest Factors for current and voltage
- Calculation of the K Factor for transformers
- Calculation of short-term flicker for voltage
- Calculation of the phase unbalance for voltage and current (three-phase systems only)
- Measurement of harmonic angles and rates (referenced to the fundamental or RMS value) for voltage, current, or power, up to 50th harmonic
- Calculation of overall harmonic distortion factors
- Monitoring of the average value of any parameter, calculated over a period running from 5 seconds to 2 hours
- Measurement of active, reactive, and apparent power per phase and their respective sum total
- Calculation of the power factor, displacement power factor, and tangent factor
- Total power from a point in time, chosen by the operator
- Recording, time stamping, and characterization of disturbance (swells, sags, and interruptions, exceeding power and harmonic thresholds)
- Detection of transients and recording of associated waveforms

Control Features
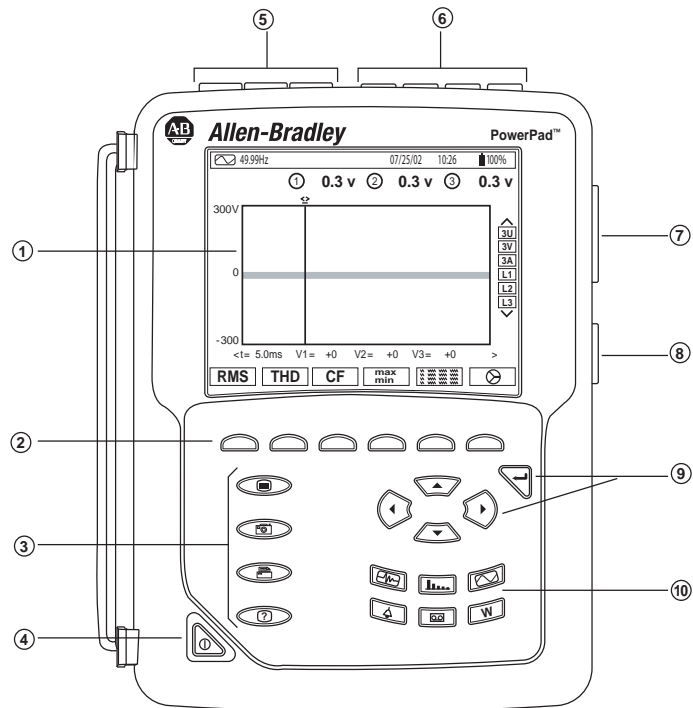
①   Color LCD display with graphic representation of system parameters and
     measurements.

②   Six function buttons used to modify the display mode.

③   Four function buttons which let you to the following:

⬛ Access the instrument setup parameters.

📷 Take a snapshot of the current screen or access screens already stored in
     the memory. Record associated waveform and power measurement
     data.

🖨 Print the measurement results on an external printer.

❓ Get help on the current display functions, in the language chosen by the
     user.

④   ON / OFF button.

⑤   Three current inputs on the top of the instrument to enable the use of
     current sensors.

⑥   Four voltage inputs.

⑦   RS-232 bidirectional optical output for transferring data to a PC
     (bidirectional).

⑧   AC Line power input.

⑨   Enter button and four buttons that enable movement of the cursor, browsing or the selection of data.

⑩   Buttons for directly accessing the six display modes at any time:

Transients (set recording or view recorded transient):

  – Displays waveforms such as, motor startup current (INRUSH) and interruptions.

Harmonics View:

  – Display of the harmonic ratios of voltage, current and power, for each harmonic through the 50th.

  – Determination of harmonic current produced by non-linear loads.

  – Analysis of the problems caused by harmonics according to their order (for example, heating of neutrals, conductors, motors).

• Waveforms View:

  – Displays voltage and current waveforms or vector representation (Phasor diagram).

  – Identification of signal distortion signatures.

  – Display of amplitude and phase unbalance for voltage and current.

  – Checking connections for correct phase order.

• Power / Energy (view or start energy monitoring):

  – Display of power levels and the associated parameters (power factor, displacement and tangent).

  – Energy monitoring.

  – Four quadrant measurement to discern produced/consumed active energies and inductive/capacitive reactive energies.

• Recording (set recording or view recorded data):

  – Time-related representation as bar charts or curves, of average power levels or of the average value of any parameter.

  – Line voltage stability check.

  – Management of power consumed and generated.

  – Monitoring of harmonic variations.

• Alarm:

  – Provides a list of the alarms recorded according to the thresholds programmed during configuration.

  – Logging of interruption with half-cycle resolution.

  – Determination of exceeding energy consumption.

Display
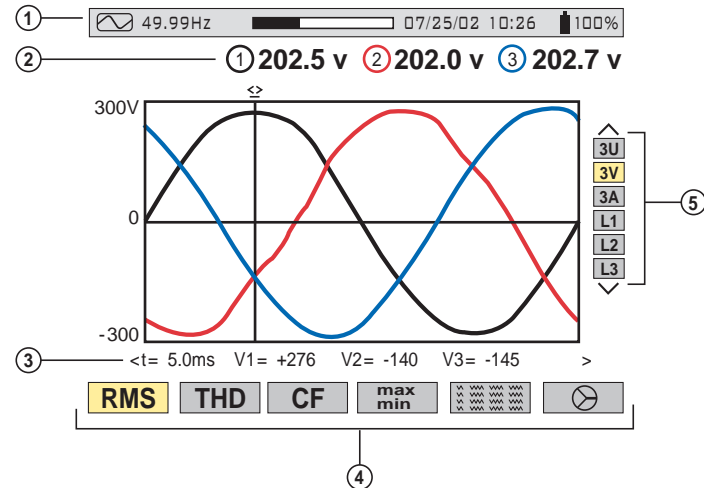
①   Top display bar indicates:
- Symbol of the tested mode (for example, ⌇, ⌇, W).
- Frequency of measured signal.
- Memory capacity status bar (only available in certain modes).
- Current date and time.
- Battery charge status.

②   Measured RMS values associated with waveforms.

③   Values of signals at an instant, **t**, at the intersection of cursor and the waveforms. The cursor can be moved along the time scale by pressing the left/right cursor buttons.

④   Measurement selection:
- RMS - True RMS Measurement.
- THD - Total Harmonic Distortion.
- CF - Crest Factor.
- max/min - Maximum and Minimum values.
- Simultaneous display of the various measurements in alphanumeric form.
- Phasor diagram.

⑤   Selection of waveforms to be displayed (use the Up/Down Cursor buttons to select):
- 3U displays the three phase-to-phase voltages U1-2, U2-3, U3-1.
- 3V displays the three phase-to-neutral voltages V1N, V2N, V3N.
- 3A displays the three phase currents.
- 4A displays the three phase currents and the neutral current.
- L1, L2 or L3 displays the voltage and current, on phase 1, 2 or 3, when selected.

TIP   Protocol:

U - Signifies phase-to-phase voltage

V - Signifies phase-to-neutral voltage

L1, L2, L3 - Refer to the phases (A, B, C, or other)

Battery Charge Status

Battery Status	Battery Indicator	Power Cord
Battery Charging •Battery capacity level relative to full charge •% of total capacity already charged (between 0 and 99%) •Battery sign and % are blinking	25%	Line cord is plugged in.
Battery Full •Battery sign and % are fixed •% of total capacity is at 100%	100%	Line cord may or may not 100% be plugged in.
Battery Discharging •Battery capacity level relative to full charge •% of the remaining capacity •Battery sign and % are fixed	25%	Line cord is not plugged in.
Battery Empty Discharging •% of total capacity reads 0% •Battery sign and % are fixed	0%	Line cord is not plugged in.
New Battery Charging •Fixed battery capacity level •Question mark showing unknown capacity level •Battery sign and % are blinking	?	Line cord is plugged in.
New Battery Discharging •Fixed battery capacity level •Question mark showing unknown capacity level •Battery sign and % are fixed	?	Line cord is not plugged in

⚠ **WARNING:** The battery may fully discharge when recording for long periods of time while not connected to a power supply. The PowerPad unit will continue to record for some time, even if below the minimum battery charge value. However, the display may not come back on, and will eventually stop saving data when the battery is too low. All data recorded will be saved.

If in the Record Mode, and the display does not come ON, do not turn the instrument OFF. Supply power to the PowerPad unit with the line cord and the display will come back ON when any button (other than ON/OFF) is pressed.

TIP   When the PowerPad unit is stopped by using the On/Off button, a confirmation is requested if the equipment is in the process of recording.

Notes:

Operation

The instrument is turned ON by pressing the green power button. The startup screen appears and indicates the instrument's software version and serial number.

If there is no AC power supply, the instrument operates on batteries. The instrument's batteries are charged when it is connected to a 120/240; 60/50Hz line.

	This product contains a sealed NiMH battery which is permanently connected and should only be removed or replaced by trained professionals.
	At the end of its life, the battery contained in this product should be collected separately from any unsorted municipal waste.
	The collection and recycling of batteries helps protect the environment and contributes to the conservation of natural resources as valuable materials are recovered.

The instrument is turned OFF by pressing the green power button. Power off confirmation is asked if the instrument is recording or detecting transients.

TIP	The current probes connected are identified at power ON only. Restart the PowerPad unit after the probe type is changed.

Instrument Configuration (Set-up Mode)

TIP	All configurations are available through the DATAVIEW software.

IMPORTANT	The instrument must be configured the first time it is used and then whenever necessary, should your needs change. The configuration is saved in the non-volatile memory when the instrument is turned OFF.

When the Parameter Setup key is pressed, these setup choices appear.

```
  ▭                              07/25/02 10:26   ▮100%

                    DATE / TIME
                    CONTRAST / BRIGHTNESS
                    COLORS
                    CALCULATION METHOD
                    ELECTRICAL HOOKUP
                    CURRENT SENSORS
                    BAUD RATE
                    RECORDING
                    ALARM
                    CLEAR MEMORY
                    LINE FREQUENCY

       [ Français ] [ English ] [ Deutsch ] [ Italiano ] [ Español ] [ Portugues ]
```
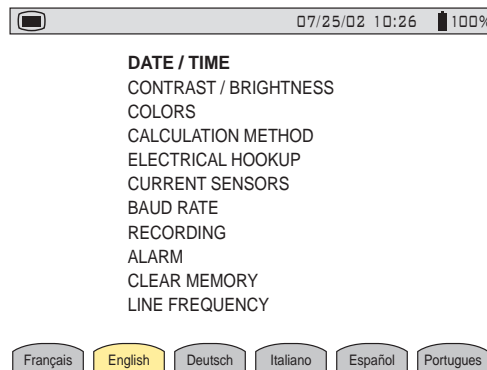
> ⚠ **ATTENTION:** When CLEAR MEMORY is selected, all configurations are deleted.

1. Choose the language by pressing the function button below the chosen language.

   Your choice remains highlighted in yellow.

2. Select the configuration settings you wish to modify, with the Up/Down Cursor buttons.

   As you scroll through the choices, they are highlighted.

3. Press Enter to modify the highlighted selection.

Date / Time

Follow these steps to changes the date and time.

1. Highlight DATE/TIME by using the Up/Down Cursor buttons, then press Enter.

2. Select the number to be modified with the Right/Left Cursor buttons (it appears in bold type).

3. Modify the value of the number selected with the Up/Down Cursor buttons.

4. Press Enter to apply the new settings.

   TIP The date and time format used is indicated at the bottom of the screen. This format can also be modified.

   - The Date format can be set to MM/DD/YYYY or DD/MM/YYYY.
   - The Time format can be set to a 12 hour clock (AM/PM) or a 24 hour clock (military - 12/24).

Contrast / Brightness

Follow these steps to adjust the contrast and brightness of the PowerPad unit.

1. Highlight CONTRAST/BRIGHTNESS with the Up/Down Cursor buttons, then press Enter.

   The setting is adjusted with the Left/Right Cursor buttons and the contrast level is indicated on the bargraph.

2. Press Enter to apply the new settings.

   The Configuration menu is once again displayed on the screen.

Colors

Follow these steps to adjust the color on the PowerPad unit screen.

1. Highlight COLORS with the Up/Down Cursor buttons, then press Enter.

   This screen appears.
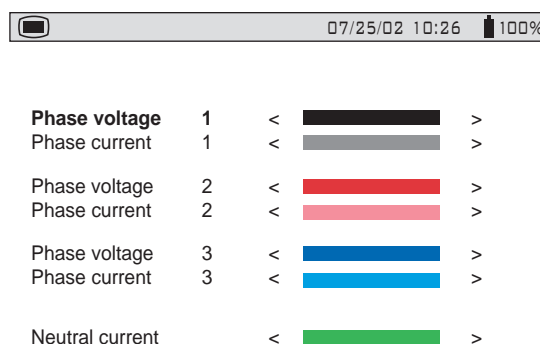
2. Choose the phase with the Up/Down Cursor buttons and the color for that phase with the Left/Right Cursor buttons.

3. Press Enter to apply the new settings.

Calculation Parameters

Follow these steps to change the calculation method of the PowerPad unit.

1. Highlight CALCULATION METHOD with the Up/Down Cursor buttons, then press Enter.

2. Select either With Harmonics or Without Harmonics with the Left/Right Cursor buttons.

3. Press Enter to apply the new settings.

   The Configuration menu is once again displayed on the screen.

Electrical Hookup (Electrical Network)

Follow these steps to select the type of power system the PowerPad unit will measure.

1. Highlight ELECTRICAL HOOKUP with the Up/Down Cursor buttons, then press Enter.

    This screen appears.
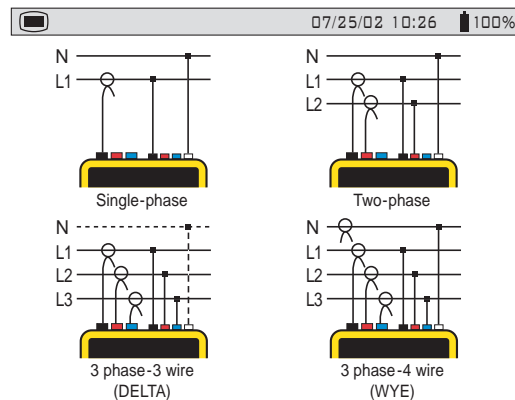
2. Choose the hookup type with the Up/Down and Left/Right Cursor buttons.

3. Press Enter to apply the new hookup selection.

    The Configuration menu is once again displayed on the screen.

Hookup Types

These are the types of power systems the PowerPad unit can measure:

- Single or two-phase: The neutral current is not measured or calculated.
- Three-phase, three-wire connection (3V, 3 A):
    - On DELTA network: Only power totals are measured. Powers per phase are displayed, but not valid.
    - On WYE network: The neutral current is not calculated. It is necessary to connect neutral (V) to obtain the power per phase.
- Three-phase, four-wire connection (4V, 3 A): The neutral current is available and its value and waveform are displayed.
    - On WYE network: Powers per phase are available.

        TIP   Neutral current is calculated, not measured, in the four-wire hookup.

⚠ **ATTENTION:** V1 must be connected in all hookups, since the display is synchronized from V1 and the network frequency measured by V1.

Table 1 - Synchronization of the Display in Waveform Mode

Display Selection (Vertical Right Menu)	Reference Channel for Synchronization
3U	U1
3V	V1
4A / 3A	A1
L1	V1
L2	V2
L3	V3

Current Sensors

Follow these steps the select the current sensor type.

1. Highlight CURRENT SENSORS with the Up/Down Cursor buttons, then press Enter.

   This screen appears.
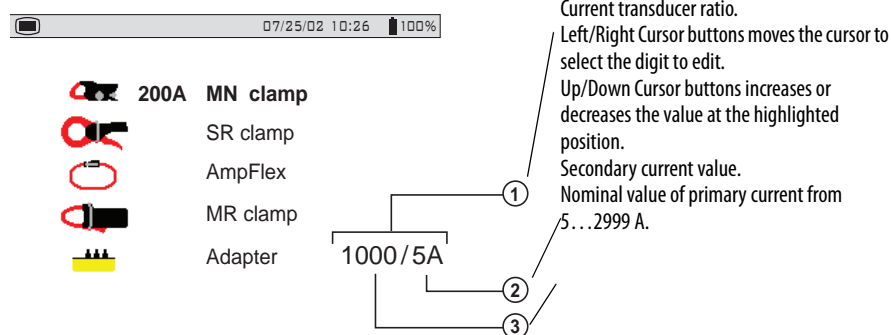
2. Choose the sensor type with the Up/Down Cursor buttons.

   The MN Clamp also requires a range selection to match your probe. The range choices are 200, 100, and 5 A. The 200 A range is used for the MN93 Probe and the 100 or 5 A range is used for the MN193 Probe.

   a. To select the proper range, first ensure that the MN Probe choice is highlighted by using the Up/Down Cursor buttons.

   b. Press the Left Cursor button to highlight the range, then press either of the Up/Down Cursor buttons to select the desired measurement range of 200, 100, or 5 A.

      If the 5 A range is selected, a choice for programming the ratio is offered.

   c. To change the ratio, press the Left Cursor button to highlight the secondary value.

   d. Press either of the Up/Down Cursor buttons to toggle this value to either 1 or 5.

   e. After making this selection, press the Left Cursor button to adjust the primary value.

Each press of the Left/Right Cursor buttons moves the highlight one digit to the left or right, accordingly. Use the Up/Down Cursor buttons to change each digit position as desired. The primary range can be set between 1…2999.

3. Press Enter to apply the current sensor selection.

   The Configuration menu is once again displayed on the screen.

> **TIP** In addition to the four current probe choices, there is an adapter selection. This selection lets you use current probes that have a current output with the PowerPad unit. The ratio for these probes can be programmed with this selection. The primary current can be programmed from 5…2999 A. The secondary current can be set to 1 or 5 A. Adjustment for the ratio is performed in the same way as described on the previous page for the MN probe.

Baud Rate (Communication Rate)

Follow these steps to select the PowerPad unit's communication rate.

1. Highlight BAUD RATE with the Up/Down Cursor buttons, then press Enter.
2. Choose from the communication rate values: 2400, 4800, 7200, 9600, 19200, 38400, 57600, or 115200 with the Up/Down Cursor buttons.
3. Press Enter to apply the current sensor selection.

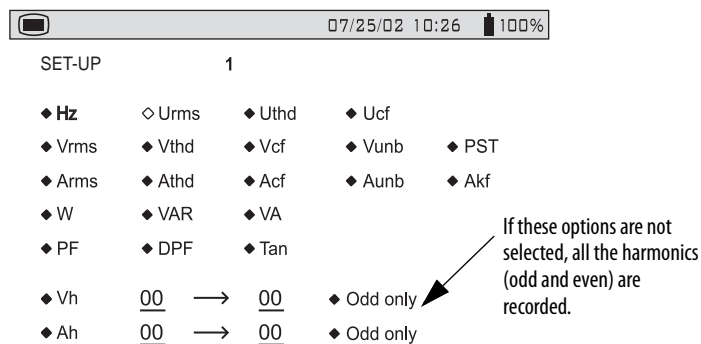   The Configuration menu is once again displayed on the screen.

> **IMPORTANT** For transfer of data between the PowerPad unit and a computer, the communication speeds must be identical on both sides.

Set Recording

Follow these steps to select which parameters the PowerPad unit records.

1. Highlight RECORDING with the Up/Down Cursor buttons, then press Enter.

   This screen appears.

   ```
   ┌─────────────────────────────────────────────┐
   │ ▣                    07/25/02 10:26  ▌100%   │
   │                                              │
   │  SET-UP              1                       │
   │                                              │
   │  ◆ Hz    ◇ Urms   ◆ Uthd   ◆ Ucf            │
   │  ◆ Vrms  ◆ Vthd   ◆ Vcf    ◆ Vunb   ◆ PST   │
   │  ◆ Arms  ◆ Athd   ◆ Acf    ◆ Aunb   ◆ Akf   │
   │  ◆ W     ◆ VAR    ◆ VA                       │
   │  ◆ PF    ◆ DPF    ◆ Tan                      │
   │  ◆ Vh    00  ⟶  00   ◆ Odd only           │
   │  ◆ Ah    00  ⟶  00   ◆ Odd only           │
   └─────────────────────────────────────────────┘
   ```

   If these options are not selected, all the harmonics (odd and even) are recorded.

   Four recording set-ups are available.

2. Choose recording configuration 1, 2, 3, or 4 with the Up/Down Cursor buttons.

3. Next, move through the choices with the Left/Right Cursor buttons and select the desired parameters with the Up/Down Cursor buttons.

   As you move through the parameters, each choice, in turn, is highlighted.

4. To activate the selected parameter for recording, use the Up/Down Cursor buttons.

   The selected parameters will have a filled in diamond shape and those not selected will have an unfilled diamond shape.

User-defined Parameters

There are two user-defined parameters at the bottom of the window. At first, they will be listed as a question mark (?). These parameters let you monitor specific, or a range, of voltage, current, or power harmonics. Follow these steps to activate these parameters.

1. Use the Left/Right Cursor buttons to select the parameter.

2. Use the Up/Down Cursor buttons to scroll through the available choices: Uh, Vh, Ah, and VAh.

3. Once the desired parameter is selected, use the Right Cursor button to move to the first modifiable field for this parameter.

   A value from 00...50 can be selected for this field.

4. Use the Up/Down Cursor buttons to select the value.

5. After selecting the desired harmonic order for the beginning value, press the Right Cursor button to move to the upper value.

Use the same process to select the upper limit.

6. Press the Right Cursor button again to move to the right and modify the last value needed to complete the definition.

Here you will choose whether to include all harmonics or only the odd harmonics.

7. Use the Up/Down Cursor buttons to make this selection.

The diamond preceding the Odd Only choice will appear filled in for selected and unfilled for not selected.

EXAMPLE   Example of a user defined choice:

Vh 02 → 15 ◆ Odd Only.

In this user defined condition, all odd voltage harmonics between the 2nd and the 15th are recorded.

---

8. Press the Enter button when you have finished selecting all the parameters to be recorded to apply the new setup.

⚠ **WARNING:** The battery may fully discharge when recording for long periods of time while not connected to a power supply. The PowerPad unit will continue to record for some time, even if below the minimum battery charge value. However, the display may not come back on, and will eventually stop saving data when the battery is too low. All data recorded will be saved.
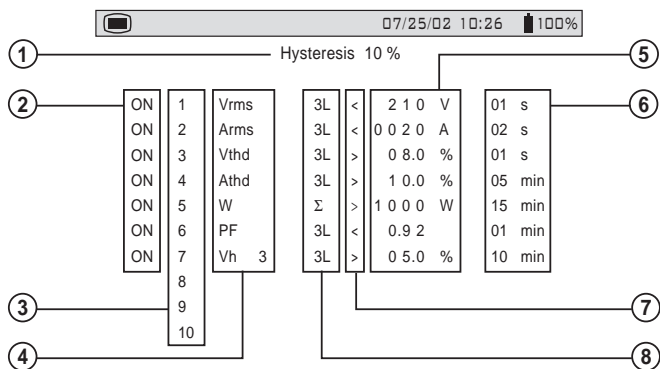
If in the Record Mode, and the display does not come ON, do not turn the instrument OFF. Supply power to the PowerPad unit with the line cord and the display will come back ON when any button (other than ON/OFF) is pressed.

Set Alarm

Follow these steps the set the alarms.

1. Highlight ALARM with the Up/Down Cursor buttons, then press Enter. This screen appears.

```
                                    07/25/02 10:26   100%
① ─────────────── Hysteresis  10 %                  ───── ⑤
②   ON │ 1  │ Vrms │ 3L │ < │ 2 1 0   V │ 01  s │   ───── ⑥
     ON │ 2  │ Arms │ 3L │ < │ 0 0 2 0  A │ 02  s │
     ON │ 3  │ Vthd │ 3L │ > │ 0 8.0   % │ 01  s │
     ON │ 4  │ Athd │ 3L │ > │ 1 0.0   % │ 05  min │
     ON │ 5  │ W    │ Σ  │ > │ 1 0 0 0  W │ 15  min │
     ON │ 6  │ PF   │ 3L │ < │ 0.9 2     │ 01  min │
     ON │ 7  │ Vh 3 │ 3L │ > │ 0 5.0   % │ 10  min │
        │ 8  │
        │ 9  │                                      ───── ⑦
③ ──────│ 10 │                                      ───── ⑧
④
```

⚠️ **ATTENTION:** A programmed alarm must be set to ON to function properly (general activation or deactivation of alarms is generated in the Alarm mode).

Modifying one or several characteristics of an alarm set to ON, automatically switches it to OFF.

①	Hysteresis Percentage (1, 2, 5, or 10%)
②	Alarm activation (ON or OFF)
③	Alarm number (1…10)
④	There are 24 parameters to choose from for alarm triggering. They are: Vrms, Urms, Arms, Vpst, Vcf, Ucf, Acf, Vumb, Aumb, Hz, Akf, Vthd, Uthd, Athd, W, VAR, VA, DPF, PF, Tan, Vh, Uh, Ah, and VAh.
⑤	Threshold value for triggering an alarm
⑥	Minimum duration from beginning threshold detection to store the alarm (from 0.01 s to 99 m)
⑦	Less than < or greater than >
⑧	Capture - – 3L: capture all phases (1, 2, or 3 depending on hookup selection) – N: neutral capture – Σ: total power capture – Σ/3: average value of 3-phase capture (S/3 for 2-phase) – 0…50 harmonic order available for harmonic event capture

Alarm Programming

Choose the parameters associated with an alarm from the available parameters (phases survey, threshold value and minimum duration filtering can be programmed).

> **TIP**   The programmed hysteresis is common to all alarms.

1. Highlight Alarm with the Up/Down Cursor buttons, then press Enter.

2. Select the modifiable field by using the Left/Right Cursor buttons.

3. Activate or adjust the threshold values by using the Up/Down Cursor buttons.

    The field to be modified is shown in bold.

4. Press Enter when you have finished setting all the alarm parameters.

> **TIP**   When the alarm is OFF, the parameters previously used are stored in memory and reappear if the alarm is selected again.

Clear Memory

When CLEAR MEMORY is selected, the following question is displayed.

> Are you sure you want to delete all the data?
>
>   Yes   No

1. Choose the answer with the Left/Right Cursor buttons.

2. Press Enter to apply your choice.

    The Configuration menu is once again displayed on the screen.

> **IMPORTANT**   When data is deleted, all detected alarms, screen snapshots, captured transient states, and all recordings are deleted.
> - The instrument configuration will return to the default setting.
> - The instrument will automatically switch itself OFF once the data has been deleted.

Line Frequency

Rated frequency of network: 50 or 60Hz

IMPORTANT	This parameter determines the correction coefficients used for calculating power and energy.

1. Highlight Line Frequency with the Up/Down Cursor buttons, then press Enter.

2. Choose the line frequency by using the Left/Right Cursor buttons.

3. Press Enter to apply your selection.

   The Configuration menu is once again displayed on the screen.

Notes:

Display Modes

The screen presentations in this section depict three-phase setups for the purpose of explaining the various choices. Your actual screens will appear differently based upon your particular set up.

Waveform Mode

Press the waveform display mode button - ⌇

RMS Voltage Measurement on a Three-phase System
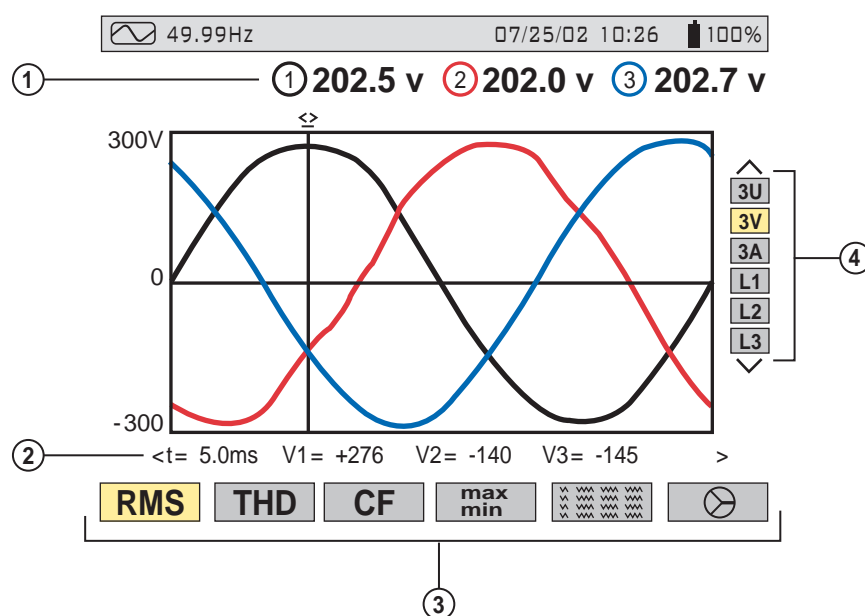
①   Values measured for each waveform, updated every second, according to the measurement type chosen with the variable function buttons. Value will be color matched to its waveform.

②   Instantaneous values of signals at time t, at the intersection of the cursor and the waveforms. The cursor is moved along the time axis with the Left/Right Cursor buttons.

③   The measurement type is selected by using one of the six variable function buttons. All of these measurements are valid in 3U, 3V, 3A, L1, L2, and L3.

④   The waveforms are selected by pressing the Up/Down Cursor buttons:

– 3U displays the three phase-phase voltages of a three-phase system

– 3V displays the three voltages of a three-phase system

– 3A displays the three phase currents of a three phase, three-wire system

IMPORTANT	The neutral current is not a direct measurement, but the resulting total of the 3 currents measured.

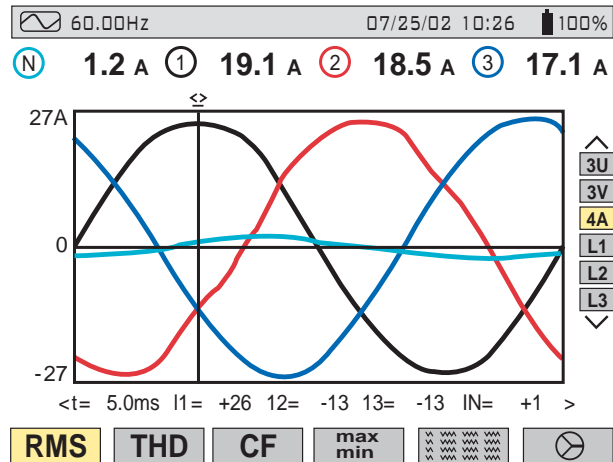– L1, L2, or L3 displays the current and voltage, on phase one, two, or three, respectively.

IMPORTANT	The choice of waveforms to be displayed, in any display mode, depends on the type of connection, see Electrical Hookup (Electrical Network) on page 18.
	• Single-phase: No choice (L1)
	• Three-phase, three-wire: 3U, 3V, 3A, L1, L2, L3
	• Two-phase: 2V, 2A, L1, L2
	• Three-phase, four-wire: 3U, 3V, 4A, L1, L2, L3

RMS Voltage Measurement on Three Phases
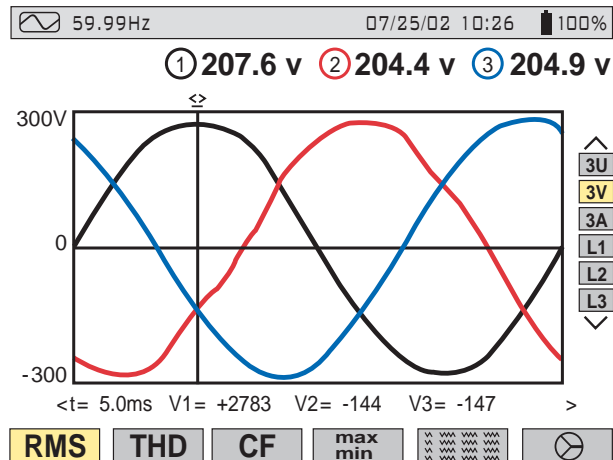
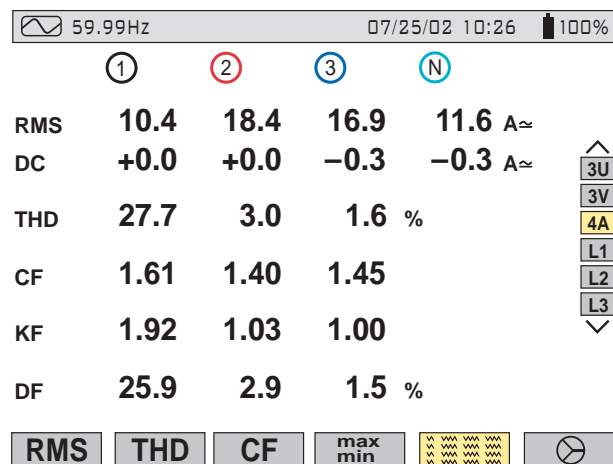## RMS Current Measurement on the Three Phases and Neutral Current on a Three-phase, Four-wire System

```
┌─────────────────────────────────────────────────────┐
│ ⌒⌒ 60.00Hz              07/25/02 10:26  ▮100%       │
│  Ⓝ   1.2 A  ①  19.1 A  ②  18.5 A  ③  17.1 A         │
│                    <>                                 │
│  27A │                                          │ ⌃   │
│      │                                          │ 3U  │
│      │                                          │ 3V  │
│      │                                          │ 4A  │
│    0 │                                          │ L1  │
│      │                                          │ L2  │
│      │                                          │ L3  │
│  -27 │                                          │ ⌄   │
│    <t= 5.0ms  I1= +26  I2= -13  I3= -13  IN= +1  >   │
│  ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐    │
│  │ RMS │ │ THD │ │ CF  │ │ max │ │≋≋≋≋│ │  ⊘  │    │
│  └─────┘ └─────┘ └─────┘ │ min │ └─────┘ └─────┘    │
│                          └─────┘                     │
└─────────────────────────────────────────────────────┘
```

Total Harmonic Distortion Measurement on One Phase

```
┌─────────────────────────────────────────────────────┐
│ ⌒⌒ 60.00Hz              07/25/02 10:26  ▮100%       │
│       ①   2.1 %  ②   3.5 %  ③   1.9 %               │
│                    <>                                 │
│ 290V │                                          │ ⌃   │
│      │                                          │ 3U  │
│      │                                          │ 3V  │
│      │                                          │ 4A  │
│    0 │                                          │ L1  │
│      │                                          │ L2  │
│      │                                          │ L3  │
│ -290 │                                          │ ⌄   │
│   <t= 5.0ms  V1= +280   V2= -144   V3= -145      >   │
│  ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐ ┌─────┐    │
│  │ RMS │ │ THD │ │ CF  │ │ max │ │≋≋≋≋│ │  ⊘  │    │
│  └─────┘ └─────┘ └─────┘ │ min │ └─────┘ └─────┘    │
│                          └─────┘                     │
└─────────────────────────────────────────────────────┘
```
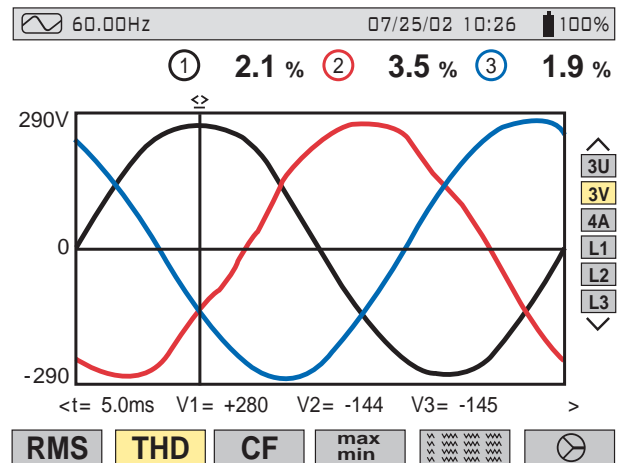
Minimum and Maximum Current Value Measurements

	①	②	③	Ⓝ	
MAX	**21.7**	**18.8**	**17.6**		A≈
AVG	**6.3**	**18.5**	**17.1**	**15.0**	A≈
MIN	**0.0**	**0.0**	**0.0**		A≈
PEAK+	**+11.4**	**+25.8**	**+24.0**		A
PEAK-	**−11.0**	**−25.8**	**−24.8**		A

(display header) 59.99Hz   07/25/02 10:26   100%

(side menu) 3U / 3V / 4A / L1 / L2 / L3

(bottom buttons) RMS | THD | CF | max min | ... | ⊘

①   Crest Factor - refreshed every 250 ms (but calculated every second)

②   Select 3V or 4 A with the Up/Down Cursor buttons to obtain the MIN, AVG, MAX, or PEAK values for current or voltage. Select L1, L2 or L3 to obtain these values for an individual phase.

> **TIP**   MIN, AVG, and MAX values are measured as soon as the power is turned ON. Pressing the Enter button resets these values and begins a new update.
>
> The MAX and MIN measurements are calculated every half period (for example, every 10 ms for a 50 Hz signal). The AVG measurements are calculated every second. However, the MAX, AVG and MIN measurements are refreshed every 250 ms.

Simultaneous Display of the Different Current Measurements

(display header) 59.99Hz   07/25/02 10:26   100%

	①	②	③	Ⓝ	
RMS	**10.4**	**18.4**	**16.9**	**11.6**	A≈
DC	**+0.0**	**+0.0**	**−0.3**	**−0.3**	A≈
THD	**27.7**	**3.0**	**1.6**		%
CF	**1.61**	**1.40**	**1.45**		
KF	**1.92**	**1.03**	**1.00**		
DF	**25.9**	**2.9**	**1.5**		%

(side menu) 3U / 3V / 4A / L1 / L2 / L3

(bottom buttons) RMS | THD | CF | max min | ... | ⊘

TIP   K factor is only available for currents 4 A, 3 A, or 2 A, depending on hook up. Flicker is only available for voltages 3V or 2V, depending on hook up.

Flicker and K factor are available when either L1, L2, or L3 is selected from the choices on the right side of the screen.

The DC current will be displayed, however the values are only valid when a current probe capable of measuring DC is used. The MR193 probe is available for this purpose.

Phasor Diagram Display (Fresnal Diagram)
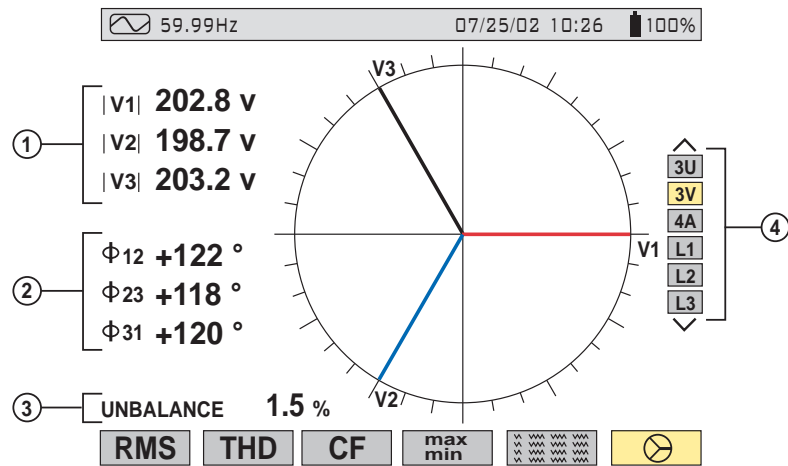
①   Absolute value of voltage or current, depending on display selection.

②   ɸ 12 corresponds to phase angle between channel 1 and 2.
ɸ 23 corresponds to phase angle between channel 2 and 3.
ɸ 31 corresponds to phase angle between channel 3 and 1.

TIP   This is valid for currents (4 A and 3 A) and for single voltage (3V). When the user chooses to look at a specific phase (L1, L2 or L3) fVA is the phase angle of V in relation to A.

③   Current or voltage unbalanced ratio.

④   Phasor diagram displays selection by voltage, current or phase.

Harmonics Mode

Press the harmonic display mode button - **Ⅱ...**

Use the function buttons to select the type of harmonic analysis:

- V - Single phase voltage analysis
- A - Current analysis
- VA - Power and direction flow analysis
- U - Phase-to-phase voltage analysis
- The Plus ⊕ and Minus ⊖ buttons let you zoom in or out, in increments of 2%, 5%, 10%, 20%, 50%, and 100%.

Single-phase and Phase-to-phase Voltage Analysis
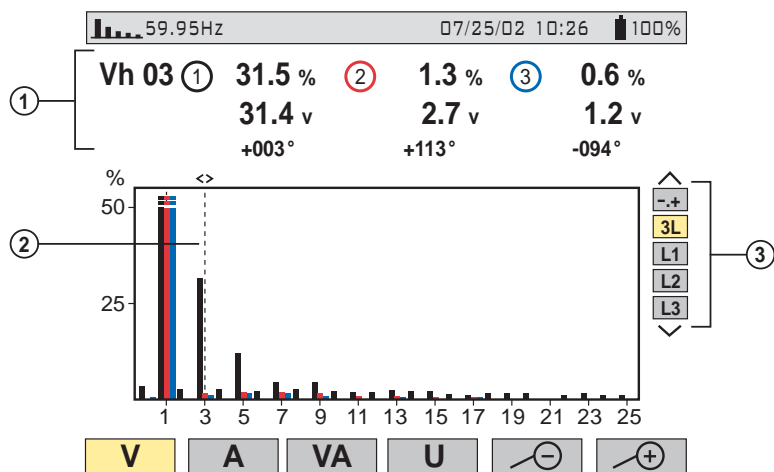
① Values measured for each phase, at cursor position (in the example shown above, the 3rd harmonic is selected and displayed).

   The information displayed is:
   - Harmonic order
   - Percentage relative to the fundamental
   - RMS value
   - Phase angle in relation to the fundamental, according to the measurement type chosen (in this example V) with the variable function buttons just below the screen.

② Cursor enables selection up to 50th harmonic, with the Left/Right Cursor buttons. As soon as the 25th harmonic is reached, the 25th to 50th range appears (0 represents the DC component).

③ Selection of expert mode -,+ is available for three-phase hookups by pressing the Up/Down Cursor buttons

   See <u>Harmonic Analysis in Expert Mode</u> on <u>page 34</u> for description.

Single-phase and Phase-to-phase Current Analysis
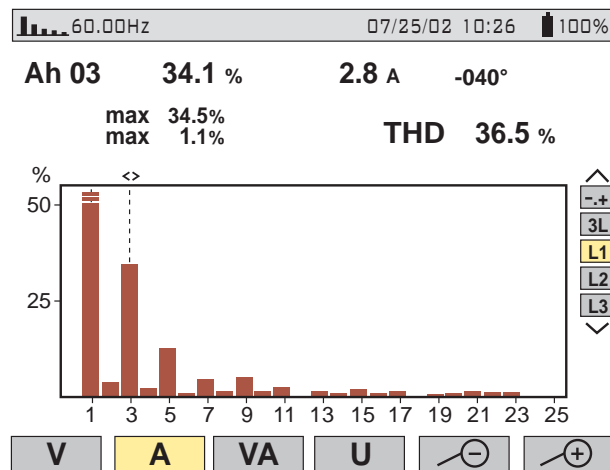
Selection of three-phase or individual phases L1, L2, and L3, displays:

- The total THD
- The MIN and MAX instantaneous values
- The parameters for the harmonic order selected by the cursor
  - Percentage in relation to the fundamental
  - RMS value and phase angle in relation to the fundamental component
- MIN, MAX instantaneous values for the selected current harmonic

> **TIP**   MIN, MAX values are reset each time the cursor position is changed.

Power and Direction Flow Analysis
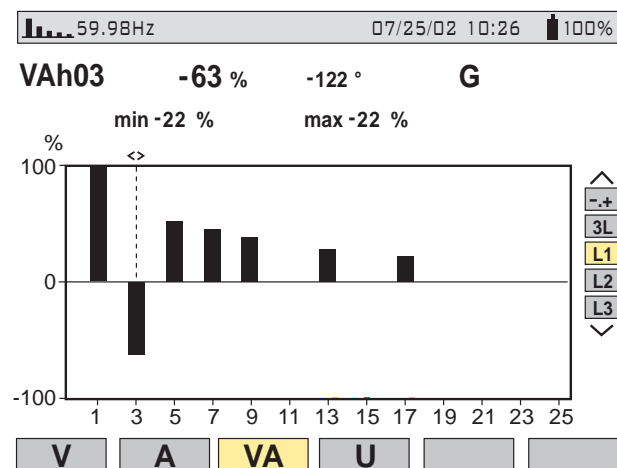
Harmonics on this screen are shown with either a positive or negative orientation.

Since the bar selected in this example is negative, it indicates that it is a harmonic from load to source.

> **TIP**   By convention, positive harmonics are from supply to load, and negative harmonics are from load to supply.

The signs are only available in harmonic power measurement.

The Power and Direction Flow Analysis example shows a power harmonic display with the 3rd harmonic highlighted by the cursor. This harmonic is generated by the load.

Harmonic Analysis in Expert Mode

Press the Up Cursor button to select -.+ and then either the V or A variable function button V or A.

This is an example of a typical display.
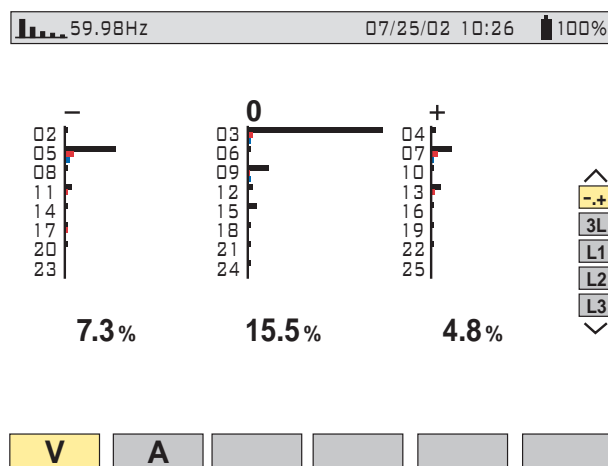
- First column: The harmonics inducing a negative sequence are displayed.
- Second column: Those inducing a zero sequence (triplens added into the neutral) are displayed.
- Third column: Those inducing a positive sequence are displayed.

Harmonic contest is useful to evaluate the influence of harmonics causing heating of the neutral or on rotating machines can be analyzed.

Power / Energy Mode

Press the power display mode button - ⋁⋁ .

This enables the PowerPad unit to do the following:

- Measurement of the real power (generated and consumed)
- Measurement of reactive power (capacitive or inductive)
- Measurement of apparent power

⋁⋁ Choice of power parameters

PF… Power factor

Ⓖ Displays the generated or consumed energy

↻ Starts energy totalization

✋ Stops energy totalization

▧ Resets the counters to zero

Starting and Stopping Energy Totalization
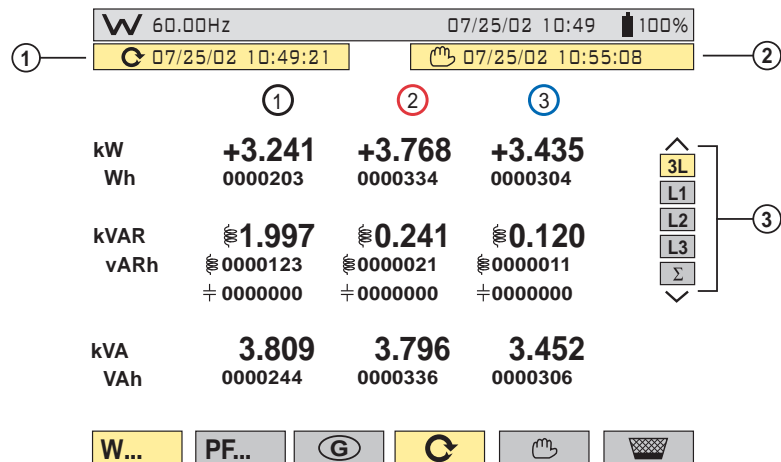
① Start date and time of energy totalization.

② Stop date and time of energy totalization.

③ Selection of the three phases (3L) or one in particular (L1, L2, L3) by pressing the Up/Down Cursor buttons. Select Σ to display total for all phases.

> **TIP** The display is automatically adjusted for a display in W, VA, VAR or kW, kVA, kVAR. It is possible to switch to other display modes without stopping the totalization.

G Button

This function key is used to display generated or consumed power, or real, reactive, and apparent energy.

This button toggles the display between generated energy (from load to supply) and consumed energy (from supply to load) each time it is pressed. When the G is highlighted (yellow background) the display shows generated energy.

PF Button

In 3L display mode, the PF (Power Factor), DPF (Displacement Power Factor [fundamental V, I, phase shift]) or Cosine φ values and the Tangent φ can be displayed by pressing the PF button.

	①	②	③
Power Factor —— **PF**	**0.634**	**0.998**	**0.995**
DPF or Cosine φ —— **DPF**	**0.742**	**0.999**	**0.999**
Tangent φ —— **Tan**	**-0.439**	**+0.050**	**+0.035**

W 50.00Hz   07/25/02 10:59   100%

3L L1 L2 L3 Σ

W...   PF...   ↻   ✋   🗑
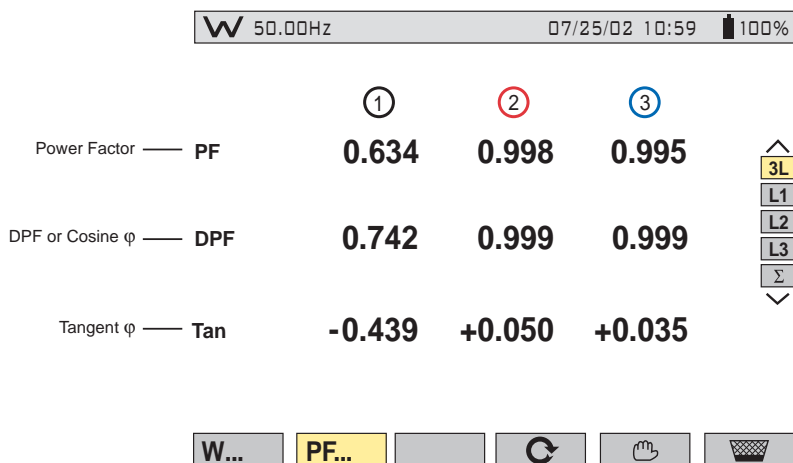
Four Quadrant Power Diagram
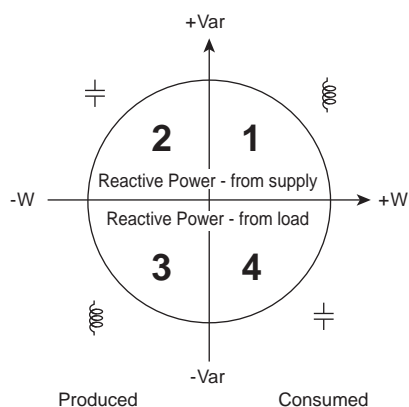
Transient Mode

Press the transient display mode button - ⟨⟋⋎⟋⟩

Transients are displayed in the form of waveforms. All channels (up to six, based upon configuration) are stored in memory for each transient. Up to 50 transients can be captured.

The function buttons have the following functions in this mode:

💾 Starts capture search programming for a new transient

✋ Stops capture search

☞ Displays a captured transient

🗑 Deletes a captured transient

```
┌────────────────────────────────────────────────────────────┐
│ ⟨⟋⋎⟋⟩                              07/25/02 10:54   ▌100%   │
├────────────────────────────────────────────────────────────┤
│                                                              │
│                SEARCH  FOR  NEW  TRANSIENTS                  │
│                                                              │
│          SLOTS  AVAILABLE              50                    │
│                                                              │
│       ┌  START           : 07/25/02 10:55                   │
│  ①    │                                                     │
│       └  END             : 07/25/02 10:55                   │
│       ┌  V   threshold   : 1 %                              │
│  ②    │                                                     │
│       └  A   threshold   : 1 %                              │
│       ┌  Number          : 1                                │
│  ③    │                                                     │
│       └  NAME            : T E S T_                         │
│                                                              │
│                                                              │
│      ┌──────┬──────┬──────┬──────┬──────┬──────┐           │
│      │      │      │      │  ☞   │  💾  │  🗑  │           │
│      └──────┴──────┴──────┴──────┴──────┴──────┘           │
└────────────────────────────────────────────────────────────┘
```

① Transient recording start and end time.

② Trigger threshold: selection of 1%, 2%, 5%, 10%, 20%, 50%, 100% for voltage and current are available.

Press the Left/Right Cursor buttons to select either V or A, then use the Up/Down Cursor buttons to modify the trigger threshold.

③ Choose a name for the session and the number of transients to be captured with the arrow buttons:

– Use the Left/Right Cursor buttons for selection of the character place (seven characters max).

– Use the Up/Down Cursor buttons for selection of the alphanumeric value.

– Press the Enter button to apply the conditions and to activate transient capture.

This table lists the capture threshold levels, based on the probe in use (for the current channels) and voltage at the different percent selections.

	Thresholds						
	100%	**50%**	**20%**	**10%**	**5%**	**2%**	**1%**
MN93	200 A	100 A	40 A	20 A	10 A	4 A	2 A
MN193 (100A)	100 A	50 A	20 A	10 A	5 A	2 A	1 A
MN193 (5A)	[(primary x 5) ÷ (secondary)] x (percent x 100)						
SR193	1000 A	500 A	200 A	100 A	50 A	20 A	10 A
AMPFLEX 193	2900 A	1400 A	580 A	290 A	140 A	58 A	29 A
MR193	1000 A	500 A	200 A	100 A	50 A	20 A	10 A
2999A Ratio Adapter	3000 A	1500 A	600 A	300 A	150 A	60 A	30 A
1A Ratio Adapter	1 A	0.5 A	0.2 A	0.1 A	0.05 A	0.02 A	0.01 A
Voltage	480V	240V	96V	48V	24V	9.6V	4.8V

Transients are detected by comparing all 256 samples on the current cycle with their counterparts from the previous cycle for each active input channel. Should any one sample deviate from its counterpart by the selected percentage value in the set up, this will be considered a transient and the data will be captured.

When capture occurs, four cycles are recorded for each input. These include the trigger cycle, the previous cycle to the trigger and the two cycles that follow the triggered cycle. All active inputs will be captured.

Opening Previously Stored Transients

The screen below can be accessed with the retrieve button ⬌ . It displays a list transients previously stored in the memory.

```
┌─────────────────────────────────────────────────────┐
│ ⊟〜    ▬▬▬▬▬▬        07/25/02 10:56  ▮100% │
└─────────────────────────────────────────────────────┘
```
①

SELECTION OF TRANSIENT

TEST 05	**05/07/02**	**14:31:41**
TEST 04	05/07/02	14:31:41
TEST 03	05/07/02	14:31:21
TEST 02	05/07/02	14:31:04
TEST 01	05/07/02	14:31:04

②   ③

```
[    ] [    ] [    ] [ ⬌ ] [ 💾 ] [ 🗑 ]
```
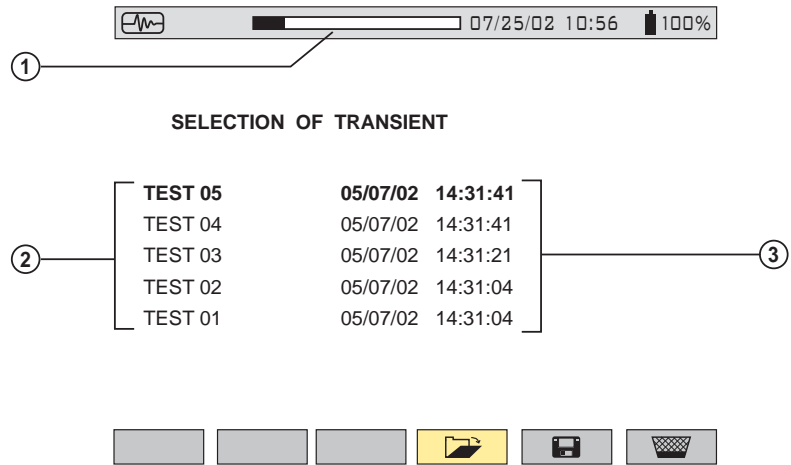
①   The status bar at the top displays the memory filled by stored transients.

②   Name and transient number (from 01…50) for each stored transient.

③   Transient recording time and date are displayed for each transient.
   – To select a transient, press the Up/Down Cursor buttons, then press Enter.
   – To delete a selected transient, press the Trash Can button 🗑, then press Enter.

Storing the Trigger

The threshold T in percent, defined as an envelope width (over and under) the last cycle of signal V or A input signal. Its width W is calculated with the nominal measurement range R for a channel (depending on the selected current sensor).

$$W = T \times R$$

EXAMPLE   Using the SR193 probe and a 2% trigger level, the width would be 1000A x 2% = 20 A. Therefore, a deviation of ±20 A will cause a transient event to be captured.

This display shows the transient selected in .

The screen displays four cycles of 256 points/cycle, with one cycle before the trigger and three cycles after.

① The waveforms to be displayed are selected by pressing on the Up/Down Cursor buttons.

- 3V displays the three phase voltages during the transient
- 4A displays the three phase currents and the neutral current during the transient
- L1, L2 or L3 displays the current and voltage on phase 1, 2, or 3

② Instant values at an instant t, in relation to the cursor, can be displayed on the time scale with the Left/Right Cursor buttons.

③ The Arrow button ⤴ returns to the transient selection screen and the Plus and Minus buttons ⊕ ⊖ change the time scale (screen display of 4, 2, or 1 periods; zoom in and zoom out) centered on the cursor, which can be moved with the Left/Right Cursor buttons.

> **TIP**   All transients captured and stored can be downloaded to a computer with the DATAVIEW software
>
> See Chapter 4 for more information about the DATAVIEW software.

Alarm Mode

Press the alarm display mode button - ⌂

TIP   The threshold values must first have been programmed in the instrument setup mode.

↻ Starts alarm capture

✋ Stops alarm capture

🗑 Deletes all stored alarms
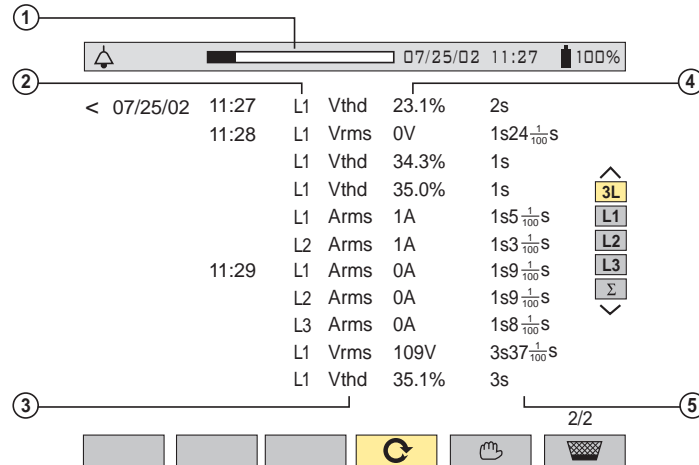
①   Alarm memory status bar (indicates available alarm storage memory)

②   Alarm target

③   Measurement parameter monitored

④   Maximum or minimum amplitude detected

⑤   Alarm duration

Use the Up/Down Cursor buttons to select an alarm.

Use the Left/Right Cursor buttons to display alarms within a period of time.

TIP   All the alarms recorded can be downloaded to a PC with the DATAVIEW software. Up to 4096 alarms can be captured.

See Chapter 4 for information on using DATAVIEW software.

IMPORTANT   The Alarm values for PF, DPF, Tan, j, W, and VAR are absolute values.

TIP   The type of connection selected in the mode has no influence on the possibilities of choices, target and monitored parameter. The user is responsible for making pertinent choices.

Record Mode

TIP   After a recording is set, the instrument will go into sleep mode (no display) to save the batteries. The recording will start as programmed. Press any button other than the On/Off button to turn On the display again.

This mode enables all the parameters previously configured in the setup mode to be recorded. Press the record display mode button ⌾⌾.

See for more information.

The variable function buttons have the following functions in this mode:

💾 Creates a new recording

➥ Opens a previous recording

🗑 Deletes recording

Save the Selected Parameters

```
┌─────────────────────────────────────────────────┐
│ ⌾⌾ │▮▭▭▭▭▭▭▭▭▭▭│ 07/25/02 10:56  ▮100% │
```

①   **NEW RECORDING**

   CONFIGURATION   : CONFIG 1

   START   : 07/25/02 10:56
② **END   : 07/25/02 10:57**
   PERIOD   : 1 min

   NAME   : T E S T
        Recording
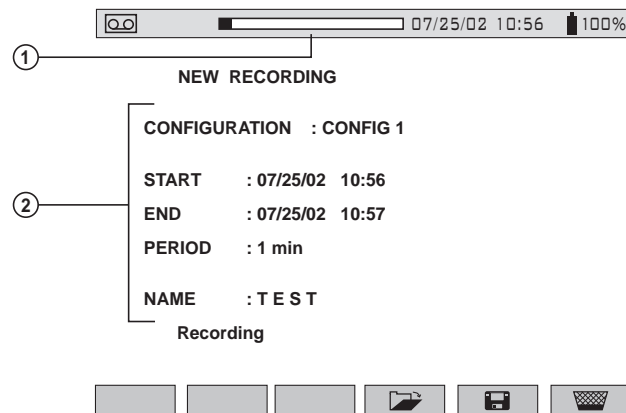
①   Recording status bar (displays remaining memory capacity).

②   Parameters - press the Left/Right Cursor buttons to select the parameters and the Up/Down Cursor buttons to modify them. An underline will appear under the selected parameter.

   – Select the configuration number to be modified with the Up/Down Cursor buttons. (CONFIG 1, 2, 3, or 4)

   – Select the dates with the Up/Down Cursor buttons.

      TIP   The dates are adjusted according to the chosen recording integration period. PERIOD does not refer to a sampling period, but rather, to an integration period (average).

   – Select a recording storage rate by using the Up/Down Cursor buttons.

      TIP   The possible storage rates are 1, 5, or 20 s; 1, 2, 5, 10, or 15 min.

   – Enter the record name with the Up/Down Cursor buttons, which scroll through the alphabet and numbers. Up to 7 characters may be entered.

   – Press Enter to save the changes.

      TIP   The PowerPad unit calculates the storage needs of the recording, and if necessary, displays the message 'Not enough memory'.

Select or Delete a Record

```
┌──┐        ████████████▒▒▒▒▒▒▒▒▒▒▒▒☐ 07/25/02 10:56   ▌100%
│○○│
└──┘


           SELECTION  OF  RECORDING


     TEST           07/25/02  17:58    > In progress
     PUMP           07/18/02  17:58    > 07/18/02  11:45
     MOTORA         07/12/02  14:41    > 07/12/02  16:40
```

[ ] [ ] [ ] [☞] [💾] [🗑]

The status bar at the top displays the memory occupied by previous records.

- To Select a Recording:

  Press the Up/Down Cursor buttons to select the recording. The current selection will appear in bold type. Press Enter to accept the selection.

- To Delete a Recording:

  Select the record to be deleted with the Up/Down Cursor buttons, press the Trash Can button 🗑 and then press Enter to delete the selection.

  > **TIP**   It is possible to display a measurement being recorded by selecting the name of the recording. To refresh the screen, press the mode buttons (caution: loss of cursor position and zoom capability will occur).

The instrument automatically makes a correction if the programmed dates and times do not match any of the following:

- the current date
- the current time
- the set storage rate

It is recommended to set multiple times:

- of 2 for 2 min
- of 5 for 5 min

> **TIP**   The instrument automatically corrects the start and end time in order to improve the readability of the time scales of the recording mode (graph representation).

Select a Graphic Display for Recorded Measurements

Recorded data can be displayed in graphic form.

Select the recording to be displayed by using the Up/Down Cursor buttons. Then, open the recording by pressing Enter.
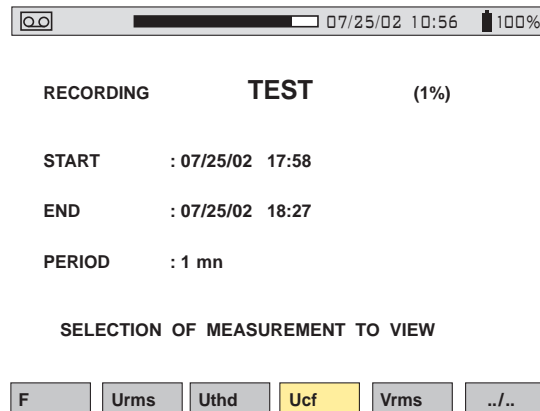
Use the function buttons to enable direct selection of the measurement to be displayed.

Pressing ../.. lets you scroll through all the measurements selected when the record was programmed.

Example When Vrms is Selected
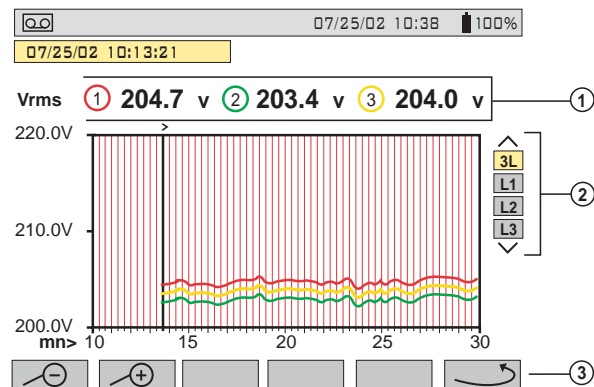
①   Display of the average voltage for each of the three voltages. Moving the cursor with the Left/Right Cursor buttons updates the values to reflect the new cursor position.

②   Selection of the three phases or each phase separately with the Up/Down Cursor buttons.

③   Returns to the screen where the measurement to be displayed is selected.

Example when L1 is Selected
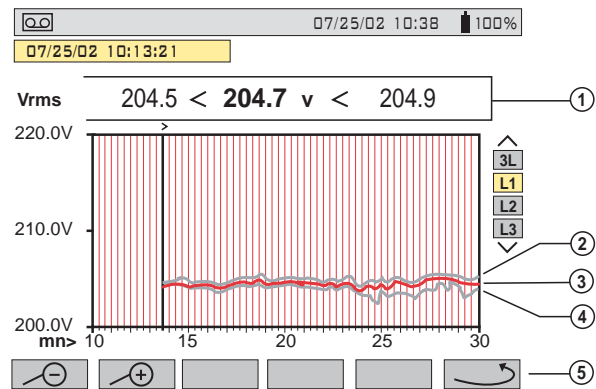
①   MIN, AVG and MAX values over the display period

②   MAX value

③   AVG value

④   MIN value

⑤   Returns to the Measurement Selection Screen

See <u>Select a Graphic Display for Recorded Measurements</u> on <u>page 44</u>.

When the display period is different from the averaging integration period:

- The average value is calculated with the sum of each integration period stored.
- The extreme values are the minimum and the maximum of an integration period during the display period selected with the cursor.

Graphic Display of Average Power

After returning to the Measurement Selection Screen use the ../.. button to view more recorded parameters, if necessary. Pressing the W button, brings up a screen similar to the following.

See .

In the example above, the display shows the average value of the real power on the phase L1. The value is updated as the cursor is moved with the Left/Right Cursor buttons.

TIP	Hold the cursor button down to switch to fast forward.

Energy Measurement for a Determined Period
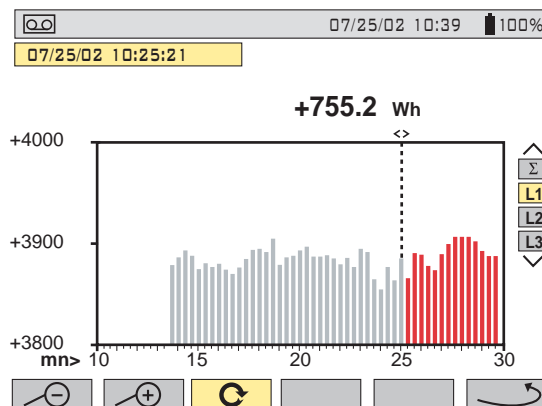
The energy over a selected period can be calculated from the average power records.

1. Move the cursor to the start time.

2. Press the Start function button ↻.

3. Move the cursor with the left and right cursor buttons to the desired end time.

4. The energy value is displayed, with end date and end time.

It is possible to make an energy measurement over several recording ranges in the 4 quadrants.

> **TIP**   All data in a recording session can be downloaded to a computer by using the DATAVIEW software.

The Plus $\oplus$ and Minus $\ominus$ buttons allow the integration period of the displayed measurement and the graph time-scale to be changed.

Display Averaging Period	Graph Scale
2 hours	over 5 days
1 hour	over 2 1/2 days
15 minutes	over 15 hours
10 minutes	over 10 hours
5 minutes	over 5 hours
1 minute	over 1 hour
20 seconds	over 20 minutes
5 seconds	over 5 minutes
1 second	over 1 minute

> **TIP**   The minimum integration period is limited by the recording period. The recording integration period of two minutes is a special case. In this case, only the following display integration periods are possible: 10 minutes, one hour, and two hours.

Save the Display

This button lets you save 12 snapshots for future recall and evaluation:

- Press the Camera button 📷 (for about 3s) to capture a snapshot of the current display.
- The Camera icon 📷 is displayed in the top left corner as soon as the operation is successful.
- This icon is replaced by the Trash Can 🗑 if there is no space left in the memory to record the display.

> **TIP**   These screens can be downloaded to a computer via the DATAVIEW software.

Open a Previously Saved Snapshot

A short press (about 1 s) on the Camera button 📷 gives access to the menu of snapshots that have been saved.

The small icon to the left of each snapshot (date and time) tells you what type of data was stored.
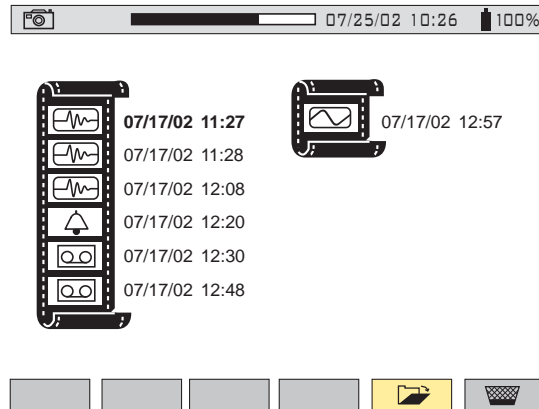
- Use the Up/Down Cursor buttons to select the snapshot.
- To display the snapshot, press the Open Folder button ☞ , then Enter.
- After reviewing the snapshot, press Enter again to return to the list of saved snapshots.
- To delete a selected snapshot, press the Trash Can button 🗑 , then press Enter.

> **TIP** The various storage spaces of the PowerPad unit are of a fixed size and are completely independent. There are four memory spaces available (alarms, snapshot, transients and recordings).

Print

The Print button 🖨 lets you print a screen directly to a dedicated printer connected to the serial port.
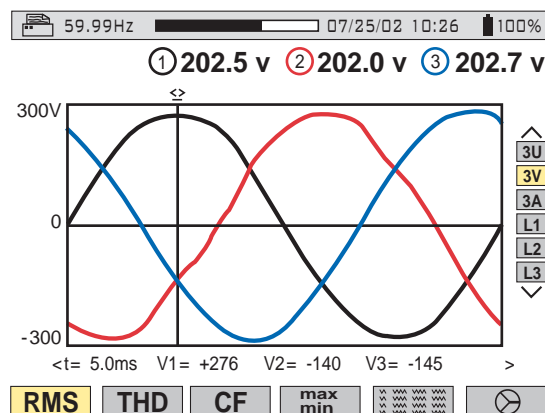
When the Print button 🖨 is pressed, the screen freezes, and the top left mode icon is replaced by the Print icon 🖨.

> **TIP** It will take a few seconds for the icon to appear. Print transmission speed is 19.2 kb.

IMPORTANT	To stop the printing in progress (for example, in the event of an error), press the Print button 🖶 once again.

The recommended printer for the PowerPad unit is the
SEIKO Model DPU414-30B.

Help

Press the Question Mark button ⑦ to obtain help for the current display mode.
To exit the Help mode, press the Question Mark button once again.

Notes:

DATAVIEW Software

Introduction

The DATAVIEW graphing and analysis program is a full function Windows based application software package.

It lets you configure and run any test or recording from the computer as you can from the instrument itself.

Additionally, it enhances the information captured for snapshots as it captures all the information to display and report waveforms, and harmonic spectrums of the data captured.

The DATAVIEW software includes several pre-defined templates for reporting and printing reports, as well as the ability for you to totally customize the reports to meet your exact needs.

This chapter gives you the information you need to know to use this program. More extensive information on specific functions available in the DATAVIEW software is available in the online help system included with the software.

The DATAVIEW program supplied with the PowerPad unit, provides four main functions:
- The ability to configure the PowerPad unit from the computer.
- The ability to initiate a recording test from the computer.
- The ability to store test results and print out reports of any test.
- The ability to view and store real-time data.

Features

The DATAVIEW program has an interface for configuring and running tests with the PowerPad unit, as well as printing reports of the test results. There are many features that are available through this program. A few of the most popular are listed.

Key Features:
- Configures and displays all functions of the module
- Runs tests from your computer with a simple click and execute process
- Views and captures data in real time
- Retrieves data from the instrument's memory
- Plots graphs of recorded information that has been downloaded
- Presents reports, including your analysis in the comments section
- Stores a library of setups for different applications

- Provides consistency in testing, regardless of who performs the test

> **TIP**   For help on software instructions, use the DATAVIEW program's Help Menu, which is located on the menu bar.

Get Started

The DATAVIEW software is supplied on a CD-ROM format. The CD self-installs, prompting you along the way for any information that is needed. Insert the CD in your CD-ROM drive and follow the on-screen instructions.

Minimum Computer Requirements

- Windows 98/2000/ME/XP
- 128 MB of RAM (256MB recommended)
- 50 MB of hard disk space (200 MB recommended)
- CD-ROM drive

Connect the PowerPad unit to your Computer

The PowerPad unit is supplied with an optically isolated serial interface cable required for connecting the instrument to the computer. This cable is equipped with a 9-pin connector on one end, and an optical connector on the other end.

Follow these steps to connect the PowerPad unit to your computer.

1. Connect the optical connector end of the cable to the serial port on the side panel of the PowerPad unit.

2. Connect the 9-pin connector end of the cable, to an available serial port on your computer.

You are now ready to use the DATAVIEW program with the PowerPad unit.

Start DATAVIEW Software

Once the serial connection between the computer and the PowerPad unit has been completed, start the DATAVIEW program.

There are two ways to open and use the DATAVIEW software:

- use the PowerPad unit icon.
  - double-click the PowerPad unit icon that was created on your desktop during installation
  - DATAVIEW program opens and the Connection window appears, see
- use the DATAVIEW software icon
  - double-click on the DATAVIEW software icon that was created on your desktop during installation
  - DATAVIEW program opens and displays the DATAVIEW Quick-start window as shown on
  - click the Configure Instrument button and the Connection window appears as shown on

> **TIP**   Right-clicking on any field in a dialog box will open a Help file with detailed descriptions and instructions for that specific function.

Figure 1 - Quick-start Window
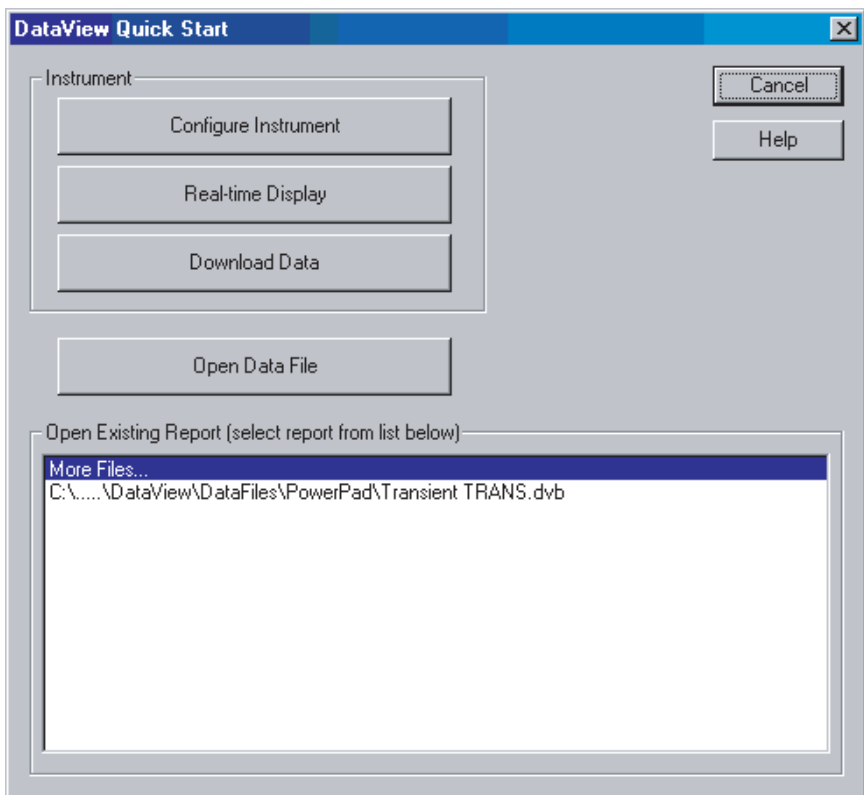
The Quick Start dialog box contains the following options:

- Configure Instrument: Opens an instrument specific control panel which displays a Configure Instrument dialog box. This dialog box lets you modify the configuration of the PowerPad unit.

- Real-time Display: Opens an instrument control panel providing real-time display of measurement data.

- Download Data: Opens an instrument control panel and begins the download of recorded data.

- Open Data File: Displays the Create View from Template dialog box letting you open an existing database by using a user customized or predefined template.

Configure the Instrument

Follow these steps to configure the instrument.

1. Click Configure Instrument from within the DATAVIEW program, or click the Configure option from the Instrument menu of the Control Panel.

   If no connection was previously established, a dialog box opens, letting you select the Communication Rate (baud rate) and the Communications Port (serial port) for communicating with the PowerPad unit.

Figure 2 - Connection Window
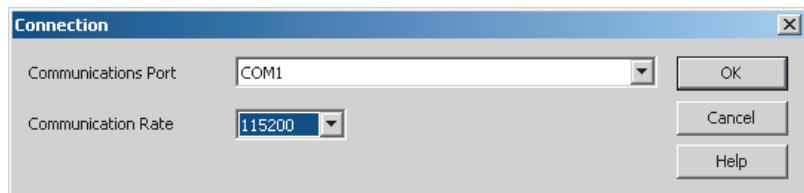
2. Click on the pull-down arrow and select the proper port.

   Make sure that the serial port displayed in the dialog box matches the port you plugged the serial cable into.

3. Select the baud rate by clicking on the pull-down arrow in the Baud Rate window and select from the available values.

   The Baud Rate needs to be set at the same rate as the module. To check the baud rate on the instrument:

   a. Turn on the PowerPad unit by pressing the green Power button.

   b. Press the Menu button ▣.

   c. Scroll down with the Down Cursor button, until you reach BAUD RATE.

   d. Press the enter button and read the baud rate.

   e. Set to read 115200.

4. Click on OK once the proper communication parameters have been specified.

IMPORTANT	The instrument must be configured for the same communications rate specified in the Connections window shown on the previous page. If it is not, then you must either select the corresponding rate or change the instrument's rate.

When a serial communication link is established, the DATAVIEW program automatically identifies the instrument that it is connected to. A status screen then appears.

Figure 3 - Status Screen
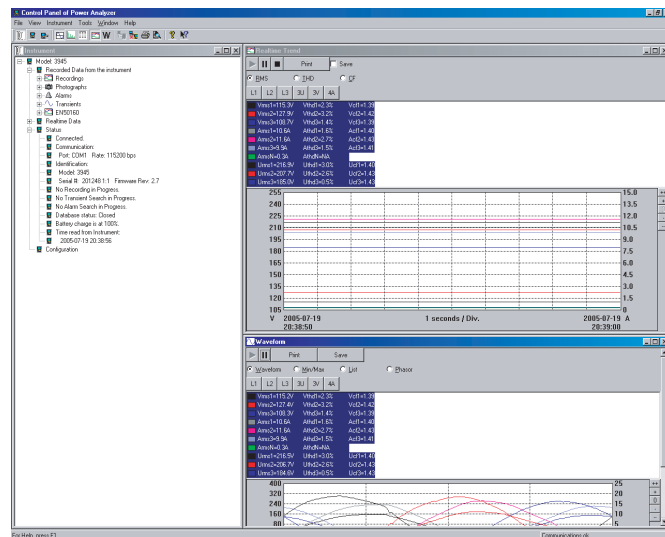
This screen shows the following:

- The status of PowerPad unit
- If the DATAVIEW software is connected to the PowerPad unit
- The communication port and speed of the connection
- The model number, serial number, and firmware revision
- If a database is open, and if so, its name, the battery charge level, whether the battery is charging or discharging, and the time on the clock
- If a recording is in progress, and when it is scheduled to end
- If a delayed recording is scheduled, and when it is scheduled to begin
- Real-time waveforms and trend information from the PowerPad unit

TIP	If the indicated items are not shown on the screen, select Restore Default Layout from the Window menu.

TIP	If the Battery charge is shown to be unknown, plug the PowerPad unit into an AC Power source. When the batter charge reaches 100%, the display should show the battery charge.

General Functions

The general function buttons appear on several DATAVIEW program setup screens.

- Re-read from PowerPad unit: Reads the current configuration of the Power-Pad attached via the serial cable.
- Save to File: Saves the current configuration. This file resides on the computer's disk drive. Saving different configuration setups can be useful for future functions and tests.
- Load from File: Retrieves a saved file from the computer's disk drive to be used in programming the PowerPad unit.
- OK: Closes the dialog box and brings up the Control Panel.
- Cancel: Exit without saving configuration.
- Apply: Programs the PowerPad unit by using the current settings without closing the window.
- Help: Opens the online Help.

Set-up Configuration

The Setup dialog box lets you configure every aspect of the module. Each field is identical to the programmable features available from the instrument's front panel itself.

Several of the functions are configured by typing the appropriate value in the field provided. Others are configured by clicking on the appropriate radio button or icon, such as, selecting the current probe.

Figure 4 - Setup Dialog Box
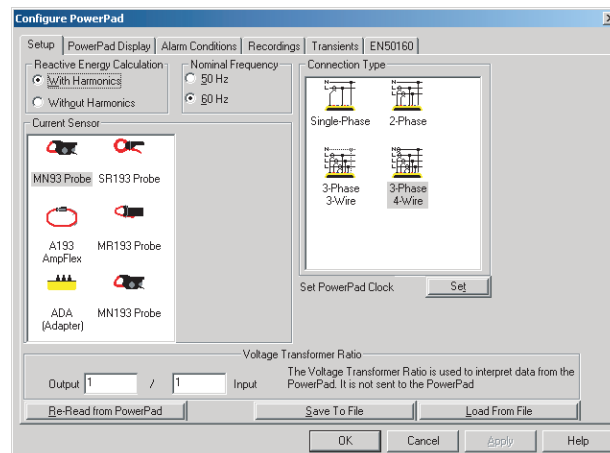
- Reactive Energy: with or without harmonics (applies to VAR calculation)
- Line Frequency: 50 or 60 Hz. This parameter determines the correction coefficients used for calculating power and energy.
- Current Sensors to be used: MN93, SR193, AmpFlex A193

- Connection Type: Single Phase, Two phase, Three-phase, three-wire Delta or Three-phase, four-wire WYE
- Voltage Transformer Ratio: Sets the scale for voltage measurement in cases where measurements are on the secondary side of a transformer and the primary value needs to be displayed.
- Set PowerPad unit Clock: Programs the computer's time and date into the configuration of the PowerPad unit.

PowerPad Unit Display Configuration

The PowerPad unit Display window lets you customize the PowerPad unit display (colors, clocks, language, and contrast).

Figure 5 - PowerPad Unit Display Window
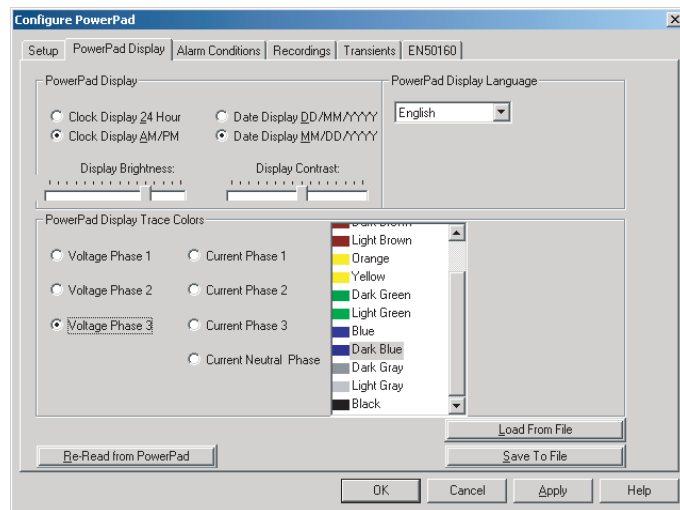
> **TIP**   For detailed instructions and descriptions for any feature in a dialog box, click on the Help Button (at lower right side of the dialog box), or right-click on the feature you want information about.

Alarm Conditions Configuration

The Alarm Conditions window lets you set up 10 alarm configurations.

Figure 6 - Alarm Conditions Window
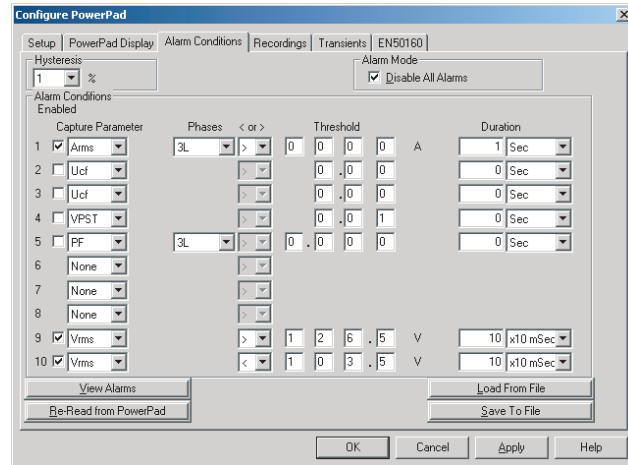
- Hysteresis: This value for alarms is set to prevent multiple recordings of an event that goes above the threshold and a certain percentage below it at times.

EXAMPLE	Alarm threshold is 100V or higher, hysteresis is 1%. When the voltage goes up to 100V, the alarm condition starts. When the voltage goes back down to 99V, the alarm condition stops.

- Disable All Alarms: When this box is checked, all alarms will be disabled even if the individual alarm enable box is checked.
- Enabled: When check box is checked, alarm is enabled.
- Capture Parameter: The Alarm will be triggered based on the value of the selected parameter.

  Choices include:
  – None: no alarm
  – Vunb: voltage unbalance
  – Vrms: voltage root mean squared
  – Aunb: current unbalance
  – Urms: voltage phase minus phase root mean squared
  – Hz: frequency
  – Akf: current K factor
  – Arms: current root mean squared
  – Vthd: voltage total harmonic distortion
  – VPST: voltage short term flicker
  – Uthd: voltage phase minus phase total harmonic distortion
  – Vcf: voltage crest factor
  – Ucf: voltage phase minus phase crest factor

> – Athd: current total harmonic distortion
>
> – W: active power
>
> – Acf: current crest factor

- Duration: The Alarm will only be recorded if the duration of the parameter meeting the threshold criteria exceeds the duration. The minimum alarm duration can be in minutes or seconds. In the case of Vrms, Urms, or Arms not using neutral current, can also be in hundredths of a second.

- Disable All Alarms: This check box prevents any alarms from being captured. Make sure this is not checked if you want to record alarms.

- View Alarms: This button lets you view a list of all the alarms already recorded and downloaded to DATAVIEW program.

> **TIP**   You can check for alarms and record at the same time.

Record Configuration

The Recording window shows the dialog box used to configure the parameters for a recording session.

Figure 7 - Recording Window
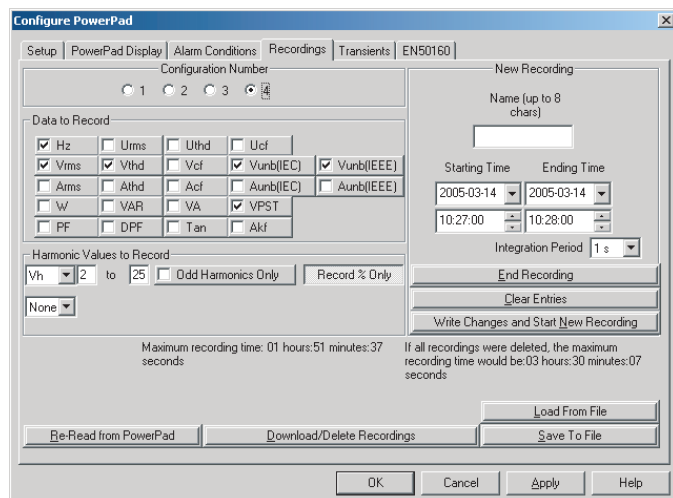
Four different configurations are available. More configurations can be saved by pressing Save to File and recalled later by pressing Load From File.

1. Check the configuration you wish to set up: 1, 2, 3, or 4.

2. Check all the parameters you wish to record by clicking on each one.

3. Configure the harmonic values to be recorded, if desired.

It is also possible to record up to 2 of 4 types of harmonic data, voltage (Vh), current (Ah), phase-to-phase voltage (Uh), and power (VAh).

For each selected harmonic data type, you can choose a range of harmonics to record from the 1st to 50th. You can further limit that range to only include odd numbers by checking the box for Odd Harmonics Only.

- End Recording: Ends any recording in progress or any future recording.
- Clear Entries: Clears the data entered in the new recording window. It does not cause any changes to the PowerPad unit.
- Write Changes and Start New Recording: Causes the PowerPad unit to schedule a new recording.

The PowerPad unit loses its scheduled memory if it is powered off before the recording begins. If it is powered off during the recording, a partial recording will usually still exist but with the first letter of its name changed to @. The start and end times requested for the recording might be adjusted by the PowerPad unit to be in even multiples of the averaging period. For instance, if an integration period of 10 minutes were requested, and the start time was 9:03, the recording might not actually begin until 9:10.

If Ok or Apply is pressed, the following screen appears.
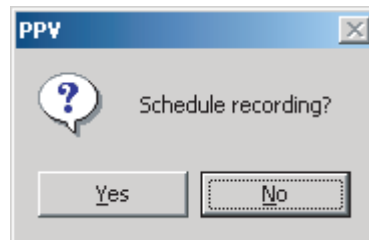
Click Yes to schedule a recording, click No to return you to the Configure dialog box without starting a recording.

Transients Configuration

The Transients window allows you to set up the criteria for capturing transients.

Figure 8 - Transients Window
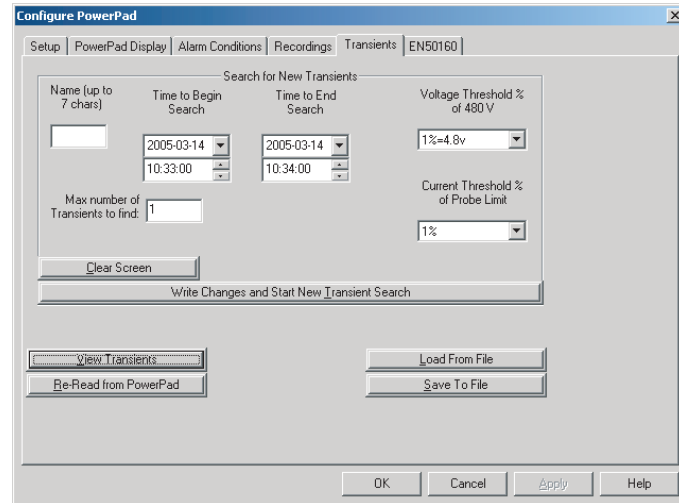
1. Type a name for the session, up to seven characters.

2. Select the date and time to end the search for transients.

3. Select the percent deviation for voltage and current transients.

   The choices available from the drop down window are 1, 2, 5, 10, 20, 50, and 100% of the full scale range of measurement.

   for detailed information on these values.

4. Select the maximum number of transients to capture (from 1...50).
   - Clear Screen: Clears the fields that were already entered for a new transient search. This button doesn't cause any changes on the PowerPad unit.
   - Write Changes and Start New Transient Search: Initiates searching from new transients when the OK or Apply button is pressed.
   - View Transients: View the PowerPad unit's stored transients. Download and delete transients options are also available.

EN50160 Configuration

The EN50160 standard defines limiting values and permissible variations of the voltage quality for the European Community. It defines which parameters are relevant, and how are they measured. Continuous or random sampling control of the voltage quality provides the supplier of electric energy with a reliable basis when dealing with network problems, and it contributes to quality assurance.

The purpose of the EN50160 standard Voltage characteristics of electricity supplied by public distribution systems is to specify the characteristics of the supply voltage with regard to the course of the curve, the voltage level, the frequency, and symmetry of the 3-phase network at the interconnecting point to the customer. The goal is to determine limiting values for regular operating conditions.

However, facility defects may lead to major disturbances in the electricity distribution supply network. Accordingly, the standard establishes these values as limiting values, which are not allowed to be exceeded on the high or low side during 95% of the controlled period typically one week.

Figure 9 - EN50160 Configuration Window
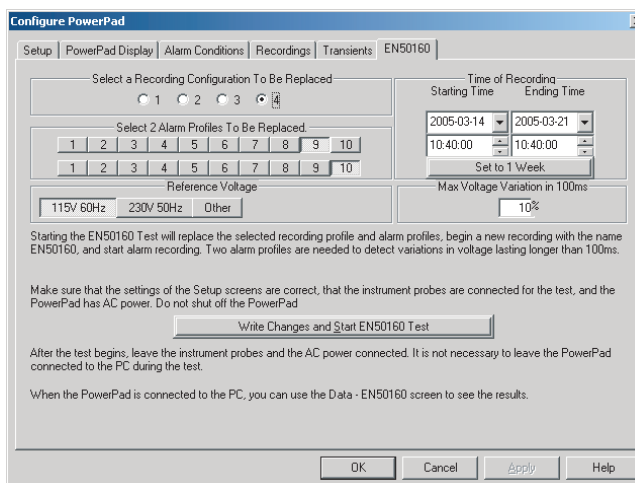
Configure and start an EN50160 test of line quality. It is recommended that a brief test of 10 minutes or longer be done first, to verify the connections and parameters of the test are correct. Only then should the 1-week test be done.

If neither of the voltage profiles are chosen, a field appears to enter the nominal voltage. The frequency is not asked for, since it will be asked for when the test result is downloaded.

Follow the instructions in the dialog box to setup and run this special test. Press Help for further instructions.

Run the Test

After configuring the instrument, press OK. The status window will display if a recording is ready to start.

Download: Retrieves data from the memory of the PowerPad unit for storage in the computer.

TIP   Always use the EN50160 data screen when downloading an EN50160 recording, NOT the recording screen.

Real-time Windows

When your setup is completed, you can display different views on the screen of real time data and waveforms.

Waveform, Harmonic Bar and Harmonic Text

Figure 10 - Real-time Data
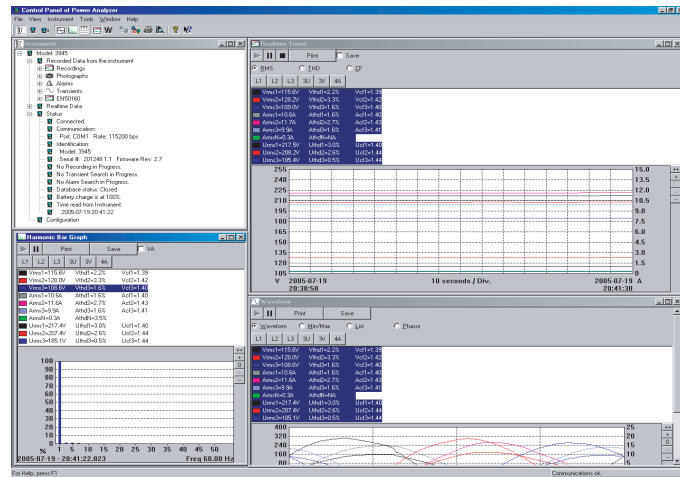
On each screen, you can:

- Select the type of data to see
- Stop the update with the Hold function
- Print the screen selected
- Save it to disk.

Download Data to Database

From the Instrument menu, select data to download the data recorded to the PowerPad unit.

1. Select the data you want to Download by clicking on the desired tab (Recordings, Photographs, Alarms, Transients, Power/Energy, EN50160), then clicking on the file name.

2. Select Download to Database (this may take few minutes).

3. Type a name for the file downloaded and click OK.

The following are examples of each tab listed in the display window.

Photographs
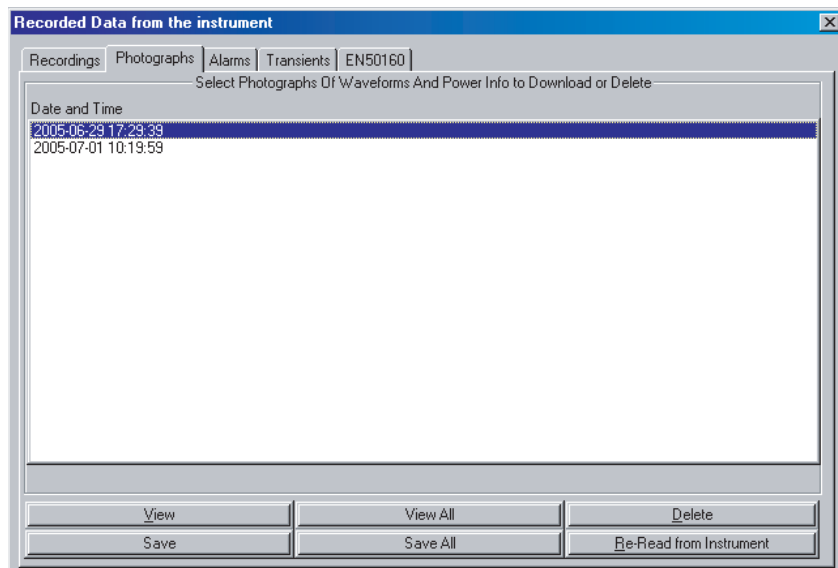
The Photographs window displays a list of photographs taken on the PowerPad unit. It shows the date and time when the camera button was pressed.

When Download to Database is selected, it shows the waveforms, power data, and Bitmap image of the PowerPad unit screen from the time the camera button was pressed.

> **TIP**   Snapshots can only be initiated by using the Camera button 📷 on the PowerPad unit itself, not by DATAVIEW.

Alarms
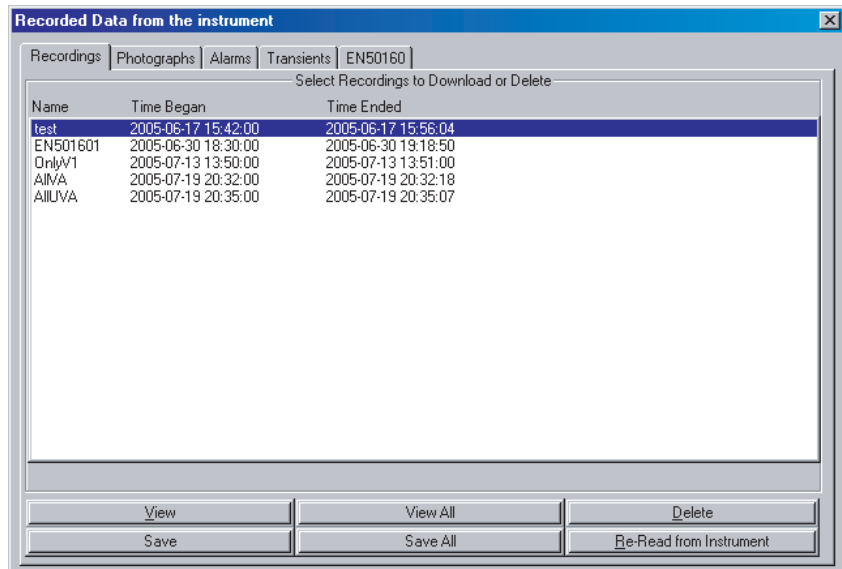
The Alarms window displays a list of alarms recorded on the PowerPad unit. A subset of the list, can be viewed by the phase of the triggering event.

Alarms can be selected and downloaded to a database. The downloaded alarms contain no more information than is shown in the screen display.

Alarm Phase: Lets you select which type of alarms to display (either all, those that were triggered by an event in phase 1, 2, or 3, neutral phase, or an event that involved multiple phases or no phase, such as frequency).

Transigents
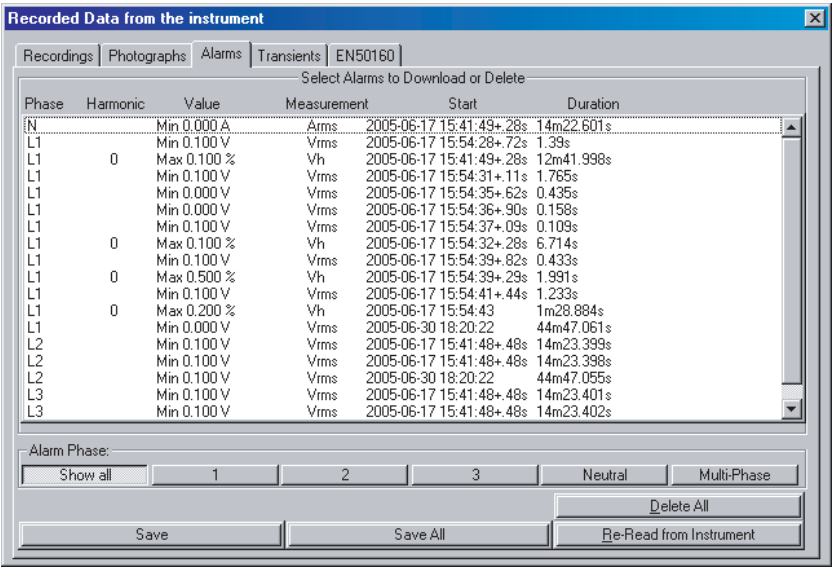
The Transients window displays transients stored on the PowerPad unit. It shows the number and name of the recording, and the time it began and ended.

The selected transients can either be downloaded or deleted.

The downloaded result contains four waveforms. The triggering event is contained in the second waveform, and within the first 32 samples of the 256-sample waveform

Power/Energy
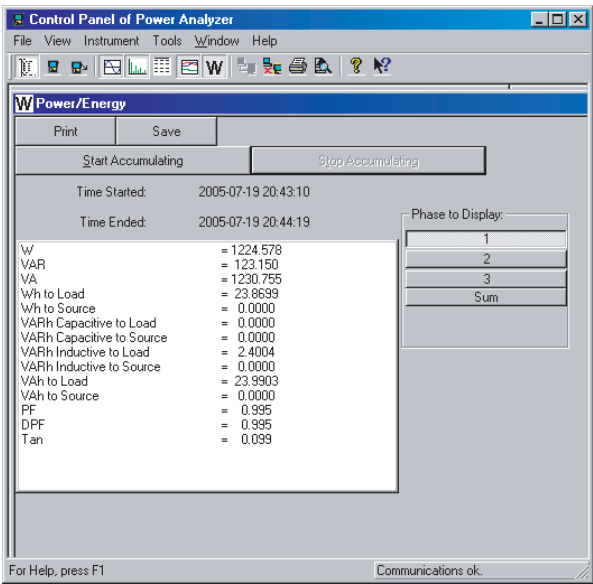
The Power/Energy window displays accumulated power and energy data. Accumulated energy data can be started or stopped, and the results can be download to a database, and viewed on the screen, selected by phase.

> **TIP**   The data for all available phases are downloaded to a database, not just that shown on the screen.

EN50160
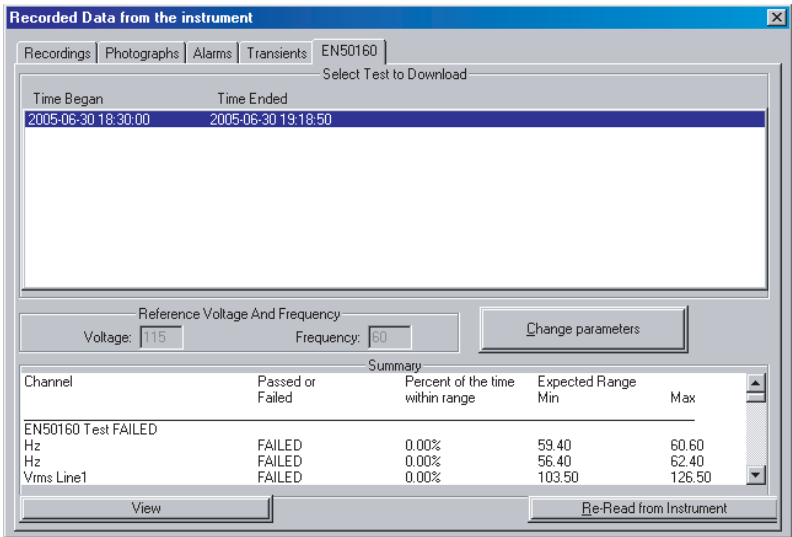
The EN50160 window displays recorded tests that can be downloaded and analyzed.

The summary window shows the results after all the data has been downloaded to a database. It displays the name, percent of the 10-minute periods that it has been out of range, followed by the range it needed to be within.

Session Properties

After downloading the data that is selected, the Session Properties window opens, which consists of the following:

- Operator Information: Information associated with the person and company conducting the test.

- Site Information: Information about the site itself.

- Comments: A place where information can be typed, such as, further descriptive analysis of the test, the test results, or reasons for running the test.

- Make Default: Saves the operator information into memory so that it will automatically appear the next time. This will save time on future tests.

1. After filling in the appropriate information, close the Session Properties dialog box by clicking on the X at the top right corner.

   You are then asked if you want to open the database just downloaded.

2. Click Yes, which opens a dialog box labeled Create View from Template.

3. In the Groups window of this dialog box, click on PowerPad unit and in the Templates window click on PowerPad unit Summary Report.

   In Step 2: Specify Database window, the file you just saved and named should be visible.

4. If this is the file you wish to generate a report from, click OK.

   The report is now available on the screen including graph, individual data points, and all statistical data.

5. To print this report, either click on the Print icon or click on the File from the top menu and then Print.

This completes the process of configuring, running, retrieving data, and printing a report by using DATAVIEW software with your module. In addition to the pre-designed report templates, DATAVIEW software lets you totally configure reports to your needs. Refer to the DATAVIEW Program Manual on the CD-ROM, containing the DATAVIEW program, for complete details, or use the HELP file on Templates to learn more about templates.

Maintenance

Use only factory specified replacement parts. Rockwell Automation is not held responsible for any accident, incident, or malfunction following a repair done other than by its service center or by an approved repair center.

Recharging and Changing the Battery

The battery is automatically charged when the unit is connected to AC power.

> ⚠️ **WARNING:**
>
> - When changing the battery, it must be de-energized, the equipment turned off, and there must be a delay of at least one minute without the battery being connected.
> - Do not expose the battery to heat exceeding 100 °C (212 °F).
> - Do not short-circuit the battery terminals.

Cleaning

> **IMPORTANT**   Disconnect the instrument from any source of electricity.

- Use a soft cloth, lightly dampened with soapy water
- Wipe with a damp cloth and then dry with a dry cloth
- Do not splash water directly on the clamp
- Do not use alcohol, solvents or hydrocarbons

Notes:

Catalog Number Explanation

Available PowerPad Units and Accessories

Table 2 - Catalogs

Cat. No.	Description
1412-PP2127	PowerPad portable power monitor

Table 3 - Probe selection (one selection is required)

Cat. No.	Description
1412-PP2137-01	Set of three probes (240 A)
1412-PP2137-02	Set of three probes (1200 A)
1412-PP2137-03	Set of three 24-inch probes (6500 A)
1412-PP2137-04	Set of three 36-inch probes (6500 A)
1412-PP2137-05	One probe (1000 A ac/1400 A dc)
1412-PP2137-06	Set of three probes (6 A/120 A)

Notes:

Specifications

Reference Conditions

Attribute	Reference Conditions
Ambient temperature	23 °C ± 3 °C (73 °F ± 5 °F)
Humidity	45%
Atmospheric pressure	25.4" Hg … 31.3" Hg (860 … 1060 hPa)
Phase voltage	230V rms and 110V rms ±2% without dc
Clamp current circuit input voltage	0.03V to 1V rms without DC (< 0.5%)
AMPFLEX current circuit input voltage	11.8mV … 118mVrms without DC (< 0.5%)
Frequency of electricity network	50 and 60 Hz ± 0.1 Hz
V/I phase shift	0° active power / 90° reactive power
Harmonics	< 0.1 %

The uncertainties given for power and energy measurements are maximum for Cos φ = 1 or Sin φ = 1 and are typical for the other phase shifts.

TIP The symbol U will be used throughout this manual and in the instrument to refer to phase-to-phase voltage measurement.

The symbol V will be used for phase-to-neutral voltage measurement.

Electrical Specifications

Sampling Frequency (256 samples per cycle):

- 12.8 kHz samples/sec per channel @ 50 Hz
- 15.36 kHz samples/sec per channel @ 60 Hz
- Memory Size: 4MB

Voltage Inputs

Attribute	1412-PP2127
Operating Range	Phase-phase - 960V rms ac/DC Phase-neutral - 480V rms ac/dc
Input Impedance	340 kΩ between phase and neutral
Overload	1.2Vn permanently; 2Vn for 1 sec (Vn = nominal voltage)

Current Inputs

Attribute	1412-PP2127
Operating Range	0…1V
Input Impedance	100 kΩ for current probe circuit and 12.4 kΩ for AMPFLEX circuit
Overload	1.7V

Accuracy Specifications (excluding current probes)

Table 4 - Accuracy Specifications 1412-PP2127

Function	Range	Display Resolution	Accuracy
Frequency	40 … 69 Hz	0.01 Hz	±0.01 Hz
Single phase RMS voltages (Vrms, Vdem)	15 … 480V	0.1V	±0.5% ± 2 cts
Phase-to-phase RMS voltages (Urms, Udem)	15 … 960V	0.1V	±0.5% ± 2 cts
DC voltage component	15 … 680V	0.1V	±1 % ± 5 cts
Single phase peak voltages (Vpp, Vpm)	15… 680V	0.1V	±1 % ± 5 cts
Phase-to-phase peak voltages (Upp, Upm)	15… 1360V	0.1V if I < 1000 V 1 V if I ≥ 1000 V	±1 % ± 5 cts
Current probe (Arms, Adem)	I nom/1000 … 1.2 I nom	0.1 A if I < 1000 A 1 A if I ≥ 1000 A	±0.5% ± 2 cts
AMPFLEX (Arms, Adem)	10 A … 6500 A	0.1 A if I < 1000 A 1 A if I ≥ 1000 A	±0.5% ± 1 A
DC current (MR193)	1 A … 140 A	0.1 A if I < 1000 A 1 A if I ≥ 1000 A	±(1% + 1 A)
Peak Current (App, Apm)	0 … 1.7 x I nom	0.1 A if I < 1000 A 1 A if I ≥ 1000 A	±(1% + 1 A)
Peak Current (AMPFLEX)	10 … 9190 A	0.1 A if I < 1000 A 1 A if I ≥ 1000 A	±(1% + 1 A)
Crest Factor (Vcf, Ucf, Acf)	1.00 … 9.99	0.01	±1 % ± 2 cts
Real Power (W) Clamp-on and AMPFLEX Clamp-on AMPFLEX	0W … 9999 kW Cos φ ≥ 0.8 Cos φ 0.2 … < 0.8 Cos φ 0.5 … < 0.8	4 digits (10000 cts)	±1 % ± 1 ct ±1.5% ± 10 cts ±1.5% ± 10 cts

Reactive Power (VAR)
    Clamp-on and AMPFLEX
    Clamp-on
    AMPFLEX
	0 W … 9999 kW
	Sin φ ≥0.5
	Cos φ 0.2 … < 0.8
	Cos φ 0.5 … < 0.8
		4 digits
		(10000 cts)
			±1 % ± 1 ct
			±1.5% ± 10 cts
			±1.5% ± 10 cts

Table 4 - Accuracy Specifications 1412-PP2127

Function	Range	Display Resolution	Accuracy
Apparent Power (VA)	0VA … 9999 kVA	4 digits	±1 % ± 1 ct
Power Factor (PF, DPF)	-1.000 … 1.000 Cos φ ≥ 0.5 Cos φ 0.2 … < 0.5	0.001	 ±1.5% ± 1 ct ±1.5% ± 1 ct
Tangent (Tan) for VA ≥ 50VA	-32.76 … 32.76	0.001 Tan φ < 10 0.01 Tan φ < 10	±1 ° on φ ±1° on φ
Active Energy (Wh) Clamp-on and AMPFLEX Clamp-on AMPFLEX	0 Wh … 9999 MWh Cos φ ≥ 0.8 Cos φ 0.2 … < 0.8 Cos φ 0.5 … < 0.8	4 digits (10000 cts)	 ±1 % ± 1 ct ±1.5% ± 1 ct ±1.5% ± 1 ct
Reactive Energy (VARh) Clamp-on	0 VARh … 9999 MVARh Sin φ ≥ 0.5 Sin φ 0.2 … < 0.5	4 digits	 ±1.5% ± 1 ct ±2.5% ± 1 ct
Reactive Energy (VARh) AMPFLEX	0 VARh … 9999 MVARh Sin φ ≥ 0.5 Sin φ 0.2 … < 0.5	4 digits	 ±1.5% ± 1 ct ±2.5% ± 1 ct
Apparent Energy (Vah)	0 VAh … 9999 MVAh	4 digits	±1 % ± 1 ct
Unbalance (Vunb, Aunb) three phase supply	0% … 100%	0.1 %	±1 % ± 1 ct
Phase angle φ (V/I; I/I; V/V)	-179° … +180°	1°	± 2°
Harmonics ratios F = 40…69 Hz (Vrms > 50 V) (rms > I nom/100)	0%… 999% 1…50th harmonic	0.1 %	± 1 % + 5 cts
Harmonics angles F = 40…69 Hz (Vrms > 50 V) (rms > I max/100)	-179° … +180° 1 … 25 26 … 50	1°	± 3° ± 10°
Total harmonics distortion (Vthd, Athd, Uthd)	0% … 999% 50th harmonic	0.1 %	±1 % + 5 cts
Current K factor (Akf)	1 … 99.99	0.01	±5% ± 1ct
Voltage flicker (Vflk)	0.00 … 9.99	0.01	not specified

IMPORTANT	Vdem, Adem and Udem = Values measured on half cycle (allow to get a measurement with positive and negative values). Vpm, Upm and Apm = Peak values min.

Nominal Range of Use

Attribute	1412-PP2127
Frequency	40 … 69 Hz
Harmonics	THD (I) - 0 … 40% THD (U) - 0 … 20%
Magnetic Field	< 40.0 A/m (Earth's magnetic field)
Electrical Field	< 3 V/m
Relative Humidity	10 … 90% without condensation

Power Supply

Attribute	1412-PP2127
AC Power (internal power supply)	
Operating Range	230V AC ± 20% and 110V AC ± 20%
Max Power	30VA
Battery Power Supply (allows use if power is interrupted)	
Type	NiMH 3800 mAh
Output	4-wire (2 for temperature probe)
Raged Voltage	9.6V
Charge Time	3 hours 30 minutes (approximately)
Battery Life	> 8 hours with display on ≤ 35 hours with display off (recording mode)
Operating Temperature	0 … 50 ℃ (32 … 122 ℉)
Recharging Temperature	10 … 40 ℃ (50 … 104 ℉)
Storage Temperature	-20 … 50 ℃ (-4 … 122 ℉) for ≤ 30 days

IMPORTANT	The battery starts to charge when the power cord is connected. When the battery is charged, the instrument uses the current supplied by the power supply, without drawing from the battery.

Mechanical Specifications

Attribute	1412-PP2127
Dimensions	240 x 180 x 55 mm (9.5 x 7.0 x 2.0 in.)
Weight	2.1 kg (4.6 lb)
Altitude, Operating	0 . . . 2000 m (6560 ft)
Altitude, Non-Operating	0 . . . 10,000 m (32,800 ft)

Figure 11 - Temperature and % RH
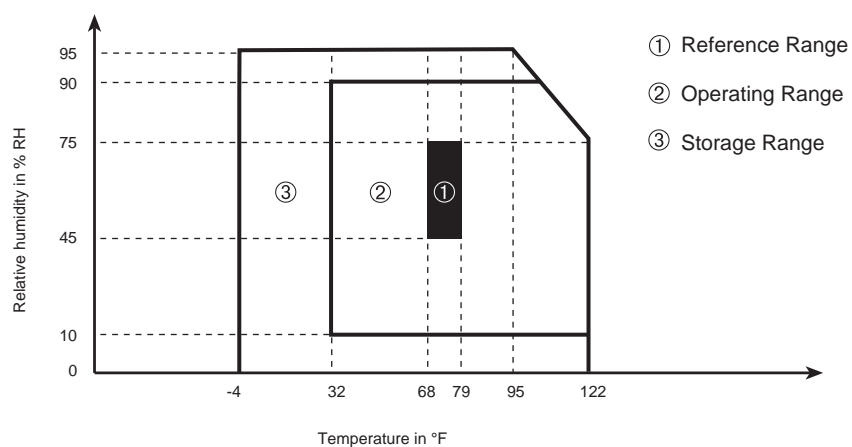
Safety Specifications

Attribute	1412-PP2127
Electrical Safety (per EN 61010-1)	Double insulation 600V rms, Category IV, Pollution Degree 2
Electromagnetic Compatibility	
Immunity and Emission	EN 61236-1 amendment 1
Electrostatic Discharges	IEC 1000-4-2
Radiation Field Resistance	IEC 1000-4-3
Fast Transients Resistance	IEC 1000-4-4
Electric Shock Resistance	IEC 1000-4-5
Conducted RF Interference	IEC 1000-4-6
Mechanical Protection	
Shock and Vibration	EN 61010-1
IP 50	EN 60529 (electrical IP2X for the terminals)

1200 Amp AC Current Probe (Base Unit Accuracy Included)

Attribute	1412-PP2137-02
Nominal Range	1000 A AC for f ≤ 1 kHz
Measurement Range	3 A … 1200 A AC max (I > 1000 A not continuously)[1]
Probe Output Signal	1 mV AC/A AC
Maximum Clamping Diameter	52 mm (2 in.)
Safety	EN 61010-2-032, 600V, Category IV, Pollution Degree 2

(1)   Currents < 0.5 A are displayed as zero on the PowerPad unit with this probe.

Attribute	1412-PP2137-02
Ambient temperature	23 °C (73 °F) ± 3 °C (5 °F)
Humidity	20 … 75% of RH
Frequency	48 … 65 Hz
Distortion factor	< 1% no DC current
Magnetic field of external origin	< 40 A/m (earth's magnetic field)

Primary current (A ac)	3 … 10 A	10 … 100 A	100 … 1200 A
Accuracy (% of the output signal)	≤ 0.8% ± 1 ct	≤ 0.3% ± 1 ct	≤ 0.2% ± 1 ct
Phase shift (°)	≤ 1°	≤ 0.5°	≤ 0.3°

Table 5 - Factors Affecting Accuracy (% of the output signal)[1]

Conditions	Range	Error
Temperature	-10…50 °C (14 …122 °F)	≤ 200 ppm/°C or 0.2% per 10 °C
Relative humidity	10…90%	< 0.1%
Frequency	30…48 Hz 65…1000 Hz 1…5 kHz	< 0.5% < 1% < 2%
Position of the cable in the jaws	-	< 0.1% at ≤ 400 Hz
Adjacent conductor carrying a 60 Hz AC current	Conductor in contact with the sensor	≤ 0.5 mA/A
Crest factor distortion	≤ 6 and current ≤ 3000 A peak	< 1%
Current distortion, dc	≤ 15 A DC on the nominal AC current	< 1%

(1) Overload: Frequency derating beyond 1 kHz - I max ≤ 1000 A x 1/f (in kHz).

240 Amp AC Current Probe (Base Unit accuracy included)

Attribute	1412-PP2137-01
Nominal Range	200 A AC for f ≤ 1 kHz
Measurement Range	2…240 A AC max (I > 200 A not permanent)[1]
Probe Output Signal	5 mV AC / A AC
Maximum Clamping Diameter	20 mm (0.8 in.)
Safety	EN 61010-2-032, 600 V, Category III and/or 300V, Catergory IV, Pollution Degree 2

(1) Currents < 0.5 A will be displayed as zero on the PowerPad unit with this probe.

Attribute	1412-PP2137-01
Ambient temperature	23 °C (73 °F) ± 3 °C (5 °F)
Humidity	20 … 75% of RH
Frequency	48 … 65 Hz
Distortion factor	< 1% no DC current
Magnetic field of external origin	< 40 A/m (earth's magnetic field)

Primary current (A ac)	2 … 10 A	10 … 100 A	100 … 240 A
Accuracy (% of the output signal)	≤ 3% ± 1ct	≤ 2.5% ± 1ct	≤ 1% ± 1ct
Phase shift (°)	≤ 6°	≤ 3°	≤ 2°

Table 6 - Factors Affecting Accuracy (% of the Output Signal)[1]

Conditions	Range	Error
Temperature	-10… 50 °C (14… 122 °F)	≤ 150 ppm/K or 0.15% per 10K
Relative humidity	10 … 90%	< 0.2%
Frequency response	40 Hz … 10 kHz	40 Hz … 1 kHz: < 3% 1 … 10 kHz: < 12 %
Position of the cable in the jaws	-	< 0.5% to 50/60Hz
Adjacent conductor carrying a 60 Hz AC current	Conductor in contact with the sensor	≤ 15 mA/A
Current distortion, dc	< 20 A DC on the nominal AC current	< 5%
Crest factor distortion	≤ 3 and peak current = 200 A	≤ 3%

(1)   Overload: Frequency derating beyond 1 kHz - I max ≤ 1000 A x 1/f (in kHz)

6500 Amp AC Current Probe (Base Unit Accuracy Included)

Attribute	1412-PP2137-03
Nominal Range	3000 A AC
Measurement Range	10 A… 6500 A AC max[1]
Probe Output Signal	140 mV ac/3000 A AC at 50 Hz[2]
Sensor	Length = 610 mm (24 in.); Ø = 190 mm (7.64 in.) Length = 910 mm (36 in.); Ø = 290 mm (11.46 in.)
Safety	EN 61010-1 and 2, 600 V, Category IV and/or 1000 V, Category III, Pollution Degree 2

(1)   Currents below 9 A will be displayed as zero on the PowerPad unit with this probe.

(2)   Output is proportional to the amplitude and frequency of the measured current.

Attribute	1412-PP2137-03
Ambient temperature	64 … 82 °F (18 … 28 °C)
Humidity	20 … 75% of RH
Position of conductor in the sensor	Centered
Continuous magnetic field	< 40 A/m (earth's magnetic field)
External alternative magnetic field	None present
External electric field	None present
Frequency	10…100 Hz
Type of signal measured	Sinusoidal

Table 7 - Accuracy

Primary Current (A ac)	10…100 A	100…6500 A
Accuracy (% of the output signal)	≤ 3% ± 1 ct	≤ 2%
Phase Shift (°)	≤ 0.5°	≤ 0.5°

Table 8 - Factors Affecting Accuracy (% of the Output Signal)

Conditions	Range	Error
Temperature	-20…60 °C (-4…140 °F)	0.2% per 10 °C
Relative humidity	10 … 90% RH	0.5%
Frequency response	10 Hz…20 kHz	0.5%
Position of conductor in clamp	Any position on internal perimeter of the undeformed sensor	2% (4% near latching system)
Adjacent conductor carrying an AC current	Conductor in contact with the sensor	1% (2% near latching system)

6/120 Amp AC Current Probe (Base Unit Accuracy Included)

The 5 A range of the probe is designed to work with secondary current transformers. Best accuracy is available when entering the transformer ratio (for example, 1000/5 A). When used to measure 5 A direct, the resolution is limited to 0.1 A max.

Attribute	1412-PP2137-06
Nominal Range	5 A and 100 A AC
Measurement Range	5 A: 0.005…6 A AC max (1…1200 A with ratio 1000/5 selected) 100 A: 0.1…120 A AC max[1]
Probe Output Signal	5 A: 200 mV/A AC; 100 A: 10 mV/A AC
Maximum Clamping Diameter	20 mm (0.8 in.)
Safety	NF EN 61010-2-032, 600V, Category III and/or 300V Cat IV, Pollution Degree 2

(1) Currents < (Primary x 5) + (Secondary x 1000) on the 5 A range and < 0.2 A on the 100 A range is displayed as zero on the PowerPad unit with this probe.

Attribute	1412-PP2137-06
Ambient temperature	23 °C (73 °F) ± 3 °C(5 °F)
Humidity	20 … 75% of RH
Frequency	48 … 65 Hz
Distortion factor	< 1% without superimposed DC current
Magnetic field of external origin	< 40 A/m (earth's magnetic field)

Table 9 - Accuracy Specifications - Range 10 mV/A (1 V at 100 A rms)[1]

Primary current (in A ac)	0.1 … 1 A	1 … 120 A
Accuracy (% of the output signal)	≤ 1% ± 2 ct	≤ 1% ± 1 ct
Phase shift (°)	≤ 1.5°	≤ 1°

(1)   Overload: 120 A continuous.

Primary current (in A ac) Probe Output	1…10 A 5…50 mA	10…100 A 0.05…0.5 A	100…1200 A 0.5…6 A
Accuracy (% of the output signal)	≤ 1.5% ± 1 ct	≤ 1.5% ± 1 ct	≤ 1% ± 1 ct
Phase shift (°)	≤ 1.7°	≤ 1°	≤ 1°

Table 10 - Factors Affecting Accuracy (% of the Output Signal)

Conditions	Range	Error
Ambient temperature	-10…55 ℃ (14…131 ℉)	≤ 200 ppm/K or 0.2% per 10K
Relative humidity	10…35 ℃ 85% (50…95 ℉)	< 0.2%
Frequency response	40 Hz…3 kHz	40 Hz… kHz:< 0.7% 1…3 kHz: < 2 %
Position of the cable in the jaws	-	< 0.5% to 50/60Hz
Adjacent conductor carrying a 60 Hz AC current	Conductor in contact with the sensor	≤ 15 mA/A

1000 Amp AC and 1400 Amp DC Current Probe (Base Unit Accuracy Included)

Attribute	1412-PP2137-05
Nominal Range	1000 A AC 1400 A DC max
Measurement Range	10…1000 A AC max, 10…1300 A peak AC + DC[1]
Probe Output Signal	1 mV/A
Maximum Cable Diameter	One 42 mm (1.6 in.) or two 25.4 mm (0.98 in.) or two bus bars 50 x 5 mm (1.96 x 0.19 in.)
Safety	EN 61010-2, 600 V, Category III and/or 300V Cat IV, Pollution Degree 2

(1) Currents < 1 A AC/DC will be displayed as zero on the PowerPad unit with this probe.

Attribute	1412-PP2137-05
Ambient temperature	18…28 °C (64…82 °F)
Humidity	20…75% of RH
Battery voltage	9V ±0.1V
Position of conductor in the sensor	Centered
Magnetic field	DC magnetic field
External magnetic field, ac	None
External electric field	None
Frequency	≤ 65 Hz
Type of signal measured	Sinusoidal

Attribute	1412-PP2137-05		
Primary current	10…100 A	100…800 A	800…1000 A AC 800…1300 A Peak
Accuracy	≤ 1.5% + 1 ct	≤ 3% + 1ct	≤ 5% + 1 ct
Primary current	10…100 A	100…1000 A	-
Phase angle	≤ 2.0°	≤ 15°	-

Table 11 - Factors Affecting Accuracy (% of the Output Signal)

Conditions	Range	Error
Temperature	18…28 °C (64…82 °F)	Zero: ≤ 2 A/°C Scale: ≤ 300 ppm/°C or 0.3%/10 °C
Relative humidity	10 … 90%	0.5% of Reading
Battery voltage[1] [2]	6.5 … 10 V	≤
Position of a 20 mm Ø 20 conductor	DC at 440 Hz DC at 1 Hz DC at 2 Hz DC at 5 Hz	< 0.5% of Reading < 1 % of Reading < 3% of Reading < 10% of Reading
Live adjacent conductor	50 and 60 Hz	< 10 mA/AAC (1 in from clamp)
External field	400 A/m	< 1.3 A

Table 11 - Factors Affecting Accuracy (% of the Output Signal)

Conditions	Range	Error
Rejection in common mode (ac)	50…400 Hz	> 65 dB
Remanence in DC	+1300 A DC at -1300 A DC	< 4 mA/A
Frequency of the measurement signal	65…440 Hz 440 Hz…1 kHz 1 kHz…10 kHz	-2% -5% -4dB

(1)   Battery: 9V alkaline (NCDA 1604 A, 6LR61).

(2)   Battery Life: Approximately 120 hr with alkaline.

Mathematical Formulas For Various Parameters

Half-period Voltage and Current RMS Values

$$\text{Vdem}[i] = \sqrt{\frac{2}{NSHC} \cdot \sum_{n:Zero}^{Next\ Zero} V[i][n]^2}$$ Single rms voltage half-period i + 1 phase

$$\text{Udem}[i] = \sqrt{\frac{2}{NSHC} \cdot \sum_{n:Zero}^{Next\ Zero} U[i][n]^2}$$ Compound rms voltage half-period i + 1 phase

$$\text{Adem}[i] = \sqrt{\frac{2}{NSHC} \cdot \sum_{n:Zero}^{Next\ Zero} A[i][n]^2}$$ Rms current half-period i + 1 phase

- NSHC: number of samples per half cycle (between two consecutive zeros)
- n: sample (0; 255)
- i: phase (0; 1; 2)

MIN / MAX Values for Voltage and Current

Vmax[i]=max (Vdem[i]), Vmin[i]=min (Vdem[i]), Vavg=1/6000 Σ Vdem[i]

Umax[i]=max (Udem[i]), Umin[i]=min (Udem[i]), Aavg=1/6000 Σ Adem[i]

Amax[i]=max (Adem[i]), Amin[i]=min (Adem[i]) (Avg calculation on 1s)

Peak Values for Voltage and Current

These values are updated on each waveform refresh.

Vpp[i]=max (V[i][n]), Vpm[i]=min (V[i][n]), n $\in$ [0..NSC-1]

Upp[i]=max (U[i][n]), Upm[i]=min (U[i][n]), n $\in$ [0..NSC-1]

App[i]=max (A[i][n]), Apm[i]=min (V[i][n]), n $\in$ [0..NSC-1]

NSC: number of samples per cycle

Peak Factors for Current and Voltage

$$\mathrm{Vcf}[i] = \frac{\max(\mathrm{Vpp}[i], \mathrm{Vpm}[i])}{\sqrt{\dfrac{1}{NSC} \cdot \displaystyle\sum_{n=0}^{NSC-1} V[i][n]^2}} \quad \text{Peak factor single voltage i + 1 phase}$$

$$\mathrm{Ucf}[i] = \frac{\max(\mathrm{Upp}[i], \mathrm{Upm}[i])}{\sqrt{\dfrac{1}{NSC} \cdot \displaystyle\sum_{n=0}^{NSC-1} U[i][n]^2}} \quad \text{Peak factor phase-phase voltage i + 1 phase}$$

$$\mathrm{Acf}[i] = \frac{\max(\mathrm{App}[i], \mathrm{Apm}[i])}{\sqrt{\dfrac{1}{NSC} \cdot \displaystyle\sum_{n=0}^{NSC-1} A[i][n]^2}} \quad \text{Peak factor current i + 1 phase}$$

One Second RMS Values for Voltage and Current

$$\mathrm{Vrms}[i] = \sqrt{\dfrac{1}{NSS} \cdot \displaystyle\sum_{n=0}^{NSS-1} V[i][n]^2} \quad \text{Single rms voltage i + 1 phase}$$

$$\mathrm{Urms}[i] = \sqrt{\dfrac{1}{NSS} \cdot \displaystyle\sum_{n=0}^{NSS-1} U[i][n]^2} \quad \text{Compound rms voltage i + 1 phase}$$

$$\mathrm{Arms}[i] = \sqrt{\dfrac{1}{NSS} \cdot \displaystyle\sum_{n=0}^{NSS-1} A[i][n]^2} \quad \text{Rms current i + 1 phase}$$

NSS: number of samples in one second (multiple of NSC).

Voltage and Current Unbalance

$$V_+ = \frac{1}{3}(\mathrm{VF}[0] + a \cdot \mathrm{VF}[1] + a^2 \cdot \mathrm{VF}[2]) \quad \text{Direct voltage (complex notation } a = e^{j\frac{2\pi}{3}})$$

$$V_- = \frac{1}{3}(\mathrm{VF}[0] + a^2 \cdot \mathrm{VF}[1] + a \cdot \mathrm{VF}[2]) \quad \text{Reverse voltage}$$

$$\mathrm{Vunb} = \frac{|\mathrm{Vrms}_-|}{|\mathrm{Vrms}_+|}, \quad \mathrm{Aunb} = \frac{|\mathrm{Arms}_-|}{|\mathrm{Arms}_+|}$$

THD Calculation

$$Vthd[i] = \frac{\sqrt{\sum_{n=2}^{50} Vharm[i][n]^2}}{Vharm[i][1]} \ , \qquad Uthd[i] = \frac{\sqrt{\sum_{n=2}^{50} Uharm[i][n]^2}}{Uharm[i][1]} \ , \qquad Athd[i] = \frac{\sqrt{\sum_{n=2}^{50} Aharm[i][n]^2}}{Aharm[i][1]}$$

- i: phase (0, 1, 2)
- n: range (2 to 50)

Calculation of Harmonic Bins

Harmonic bins are calculated by FFT with 16 bit resolution (1024 samples on 4 cycles) without windowing (IEC 1000-4-7). From real and imaginary components, each bin ratio is calculated on each phase Vharm [3][51], Uharm [3][51] and Aharm [3][51] in proportion to the fundamental value and the phase angles Vph [3][51], Uph [3][51] and Aph [3][51] between each bin and the fundamental.

This calculation is accomplished by using the following principle:

module in %: $mod_k = \dfrac{c_k}{c_1} \times 100$ $\qquad$ angle in degree: $\varphi_k = \arctan\left(\dfrac{a_k}{b_k}\right)$

$$\text{with} \ \begin{cases} c_k = |b_k + ja_k| = \sqrt{a_k^2 + b_k^2} \\[2mm] b_k = \dfrac{1}{512} \sum_{s=0}^{1024} F_s \times \sin\left(\dfrac{k\pi}{512} s + \varphi_k\right) \\[2mm] a_k = \dfrac{1}{512} \sum_{s=0}^{1024} F_s \times \cos\left(\dfrac{k\pi}{512} s + \varphi_k\right) \\[2mm] c_0 = \dfrac{1}{1024} \sum_{s=0}^{1024} F_s \end{cases}$$

- c_k: amplitude of the component with a frequency of $f_k = \dfrac{k}{4} f_1$
- F_s: sampled signal
- c_0: DC component
- k: ordinal number (spectral bin)

Distortion Factor Calculation (DF)

Two global values giving the relative quantity of harmonics are computed: the THD in proportion to the fundamental and the DF in proportion to the RMS value.

$$\text{Vthd[i]} = \frac{\sqrt{\sum_{n=2}^{50} Vharm[i][n]^2}}{Vharm[i][1]} \,,\; \text{Uthd[i]} = \frac{\sqrt{\sum_{n=2}^{50} Uharm[i][n]^2}}{Uharm[i][1]} \,,\; \text{Athd[i]} = \frac{\sqrt{\sum_{n=2}^{50} Aharm[i][n]^2}}{Aharm[i][1]}$$

$$\text{Vdf[i]} = \frac{\sqrt{\frac{1}{2}\sum_{n=2}^{50} Vharm[i][n]^2}}{Vrms[i]} \,,\; \text{Udf[i]} = \frac{\sqrt{\frac{1}{2}\sum_{n=2}^{50} Uharm[i][n]^2}}{Urms[i]} \,,\; \text{Adf[i]} = \frac{\sqrt{\frac{1}{2}\sum_{n=2}^{50} Aharm[i][n]^2}}{Arms[i]}$$

Multiplying the voltage harmonic factor with the current harmonics factor gives the power harmonic factor. Differentiating voltage harmonic phase angle with current harmonic phase angle gives power harmonic phase angle.

- VAharm [3][51]
- VAph [3][51]

K Factor

$$\text{Akf}\,[i] = \frac{\sum_{n=1}^{n=50} n^2 Aharm[i][n]^2}{\sum_{n=1}^{n=50} Aharm[i][n]^2} \quad \text{K factor for the i + 1 phase}$$

Different Power Levels 1 Sec

$$W[i] = \frac{1}{NSS}\sum_{n=0}^{NSS-1} V[i][n] \cdot A[i][n] \quad \text{Active power i + 1 phase}$$

$$VA[i] = Vrms[i] \cdot Arms[i] \quad \text{Apparent power i + 1 phase}$$

$$VAR[i] = \frac{1}{NSS}\sum_{n=0}^{NSS-1} VF\,[i][n - NSS/4]\cdot AF\,[i][n] \quad \text{Reactive power i + 1 phase}$$

$$\text{ou } VAR[i] = \sqrt{VA[i]^2 - W[i]^2} \quad \text{if computation method is with harmonics}$$

$$W[3] = W[0] + W[1] + W[2] \text{ - Total Active Power}$$

$$VA[3] = VA[0] + VA[1] + VA[2] \text{ - Total Apparent Power}$$

$$VAR[3] = VAR[0] + VAR[1] + VAR[2] \text{ - Total Reactive Power}$$

Ratios

$$PF[i] = \frac{W[i]}{VA[i]} \quad i + 1 \text{ phase power factor}$$

$$DPF[i] = \cos(\phi[i]) \quad i + 1 \text{ phase displacement factor}$$

$$Tan[i] = \tan(\phi[i]) \quad i + 1 \text{ phase tangent}$$

$$\cos(\phi[i]) = \frac{\sum_{n=0}^{NSS-1} VF[i][n] \cdot AF[i][n]}{\sqrt{\sum_{n=0}^{NSS-1} VF[i][n]^2} \sqrt{\sum_{n=0}^{NSS-1} AF[i][n]^2}} \quad \begin{array}{l}\text{Cosine angle between voltage} \\ \text{fundamental and i + 1 phase current}\end{array}$$

$$PF[3] = \frac{PF[0] + PF[1] + PF[2]}{3} \qquad \text{Total power factor}$$

$$DPF[3] = \frac{DPF[0] + DPF[1] + DPF[2]}{3} \quad \text{Total shift factor}$$

$$Tan[3] = \frac{Tan[0] + Tan[1] + Tan[2]}{3} \quad \text{Total tangent}$$

Various Types of Energy

$$Wh[0][i] = \sum_{Tint} \frac{W[i]}{3600} \quad \text{Active energy consumed phase i + 1}$$

$$VAh[0][i] = \sum_{Tint} \frac{VA[i]}{3600} \quad \text{Apparent energy consumed phase i + 1}$$

$$VARhL[0][i] = \sum_{Tint} \frac{VAR[i]}{3600} \text{ for } VAR[i] \geq 0 \quad \text{Reactive inductive energy consumed phase i + 1}$$

$$VARhC[0][i] = \sum_{Tint} \frac{-VAR[i]}{3600} \text{ for } VAR[i] \leq 0 \quad \text{Reactive capacitive energy consumed phase i + 1}$$

Total active energy consumed:
Wh[0][3] = Wh[0][0] + Wh[0][1] + Wh[0][2]

Total apparent energy consumed:
VAh[0][3] = VAh[0][0] + VAh[0][1] + VAh[0][2]

Total reactive capacitive energy consumed:
VARhC[0][3] = VARhC[0][0] + VARhC[0][1] + VARhC[0][2]

Total reactive inductive energy consumed:
VARhL[0][3] = VARhL[0][0] + VARhL[0][1] + VARhL[0][2]

$$Wh[1][i] = \sum_{Tint} \frac{W[i]}{3600} \quad \text{Active energy consumed phase i + 1}$$

$$VAh[1][i] = \sum_{Tint} \frac{VA[i]}{3600} \quad \text{Active energy consumed phase i + 1}$$

$$VARhL[1][i] = \sum_{Tint} \frac{-VAR[i]}{3600} \text{ for } VAR[i] \leq 0 \quad \text{Reactive inductive energy consumed phase i + 1}$$

$$VARhC[1][i] = \sum_{Tint} \frac{VAR[i]}{3600} \text{ for } VAR[i] \geq 0 \quad \text{Reactive capacitive energy consumed phase i + 1}$$

Total active energy consumed:
Wh[1][3] = Wh[1][0] + Wh[1][1] + Wh[1][2]

Total apparent energy consumed:
VAh[1][3] = VAh[1][0] + VAh[1][1] + VAh[1][2]

Total reactive capacitive energy consumed:
VARhC[1][3] = VARhC[1][0] + VARhC[1][1] + VARhC[1][2]

Total reactive inductive energy consumed:
VARhL[1][3] = VARhL[1][0] + VARhL[1][1] + VARhL[1][2]

Hysteresis

Hysteresis is a filtering principle, often used after the threshold detection has occurred. A correct setting of hysteresis value will avoid repeated triggering when the measure is varying close to the threshold.

The event detection is activated when the measure is going over the threshold but it can only be deactivated if the measure goes under the threshold minus the value of the hysteresis.

The default hysteresis value is 2% of the reference voltage but it may be set in the range of (1%, 5%) depending on the voltage stability of the system.

Swell Detection

Hysteresis = 2% Uref

Threshold of swell = 100% Uref

Level to go back = 100% - 2% = 98% Uref

Swell duration
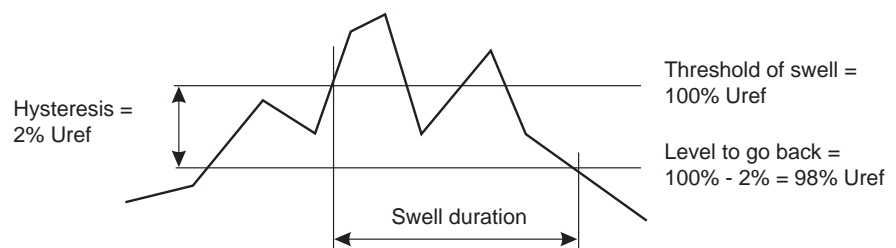
Sag of Interruption Detection

Duration

Hysteresis =
2% Uref

Level to go back =
(100% + 2%)Uref

Threshold = 102% Uref
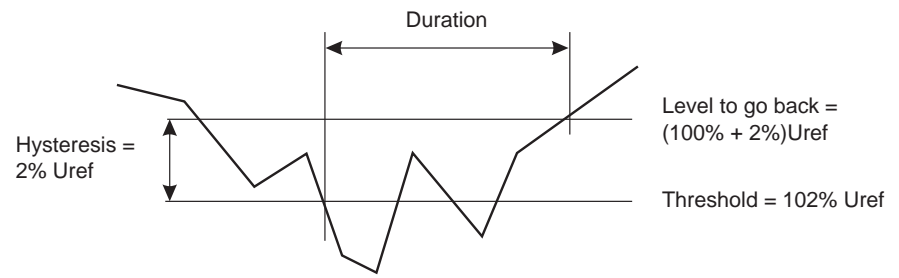
Notes:

These are terms and symbols used throughout the manual.

Symbol	Definition
F	Frequency
Vrms	Volts rms
Arms	Amps rms
W	Watts (Real Power)
PF	Power Factor
Urms	Volts (phase-to-phase rms)
Vthd	Volts total harmonic distortion
Athd	Amps total harmonic distortion
VARS	VARS (Reactive Power)
DPF	Displacement Power Factor
Uthd	Volts total harmonic distortion (phase-to-phase)
Vcf	Volts Crest Factor
Acf	Amps Crest Factor
VA	Volt-Amps (Apparent Power)
Tan	Tangent (Volt-Amp)
Ucf	Volts Crest Factor (phase-to-phase)
Vunb	Volts Unbalanced
Aunb	Amps Unbalanced
PST	Short term Flicker
Akf	K Factor
Vh	Harmonic Volt
Ah	Harmonic Amps
3L	Capture of each 3 phases
N	Neutral current (calculated)
Σ	Sum of three-phase power capture
Σ/3	Average value of three-phase capture
3U	Three Phases of Voltage (phase-to-phase)
3V	Three Phases of Voltage (phase-to-neutral)
3A	Three Phases of Current
4A	Three Phases of Current including derived neutral current
L1	Phase one of voltage (phase-to-neutral) plus current

Symbol	Definition
L2	Phase two of voltage (phase-to-neutral) plus current
L3	Phase three of voltage (phase-to-neutral) plus current
	Up/Down buttons
	Enter button
◆	Parameter Selected for Recording
◇	Parameter Not Selected for Recording
	Left/Right Selection buttons
	Right Selection button
	Left Selection button
	Warning
	Double or Reinforced Insulation
	Danger - Risk of Electric Shock
	Transients Mode
	Harmonics Mode
	Harmonic Analysis
	Waveforms Mode
W	Power/Energy Mode
	Recording Mode
	Alarm Mode

Symbol	Definition
■	Set Up Mode
📷	Snapshot Capture
🖨	Direct Print
?	Help
▦	Tabular Display Of Measurements
⊗	Phasor diagram Display
25%	Battery Charging or Discharging
100%	Battery Full
0%	Battery Empty Discharging
?	New Battery Discharging
◔	Power On / Off
⊲	Validate the Setting
W...	Power Parameters
PF...	Power Factor
G	Displays Generated or Consumed Energy
↻	Starts Energy Accumulation
✋	Stops Current Activity
▨	Resets Counter to Zero
G	Displays each type of Energy (real, reactive, apparent)

Symbol	Definition
💾	Starts Capture or Recording Search
🗀	Displays a captured transient
🗑	Deletes a captured transient
↩	Returns to the transient selection screen
🔍⊕	Zoom In
🔍⊖	Zoom Out
📷	Saving
📷	Opening a Saved Display

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support, you can find technical manuals, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools. You can also visit our Knowledgebase at http://www.rockwellautomation.com/knowledgebase for FAQs, technical information, support chat and forums, software updates, and to sign up for product notification updates.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect℠ support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.