

- 3-PHASE POWER QUALITY ANALYZER

# 8335

## PowerPad®



### **IMPORTANT WARRANTY NOTE:**

By registering online within 30 days from the date of purchase, your warranty will be extended to 3 years

# Statement of Compliance

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

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

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

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

**Serial #:** \_\_\_\_\_

**Catalog #:** \_\_\_\_\_

**Model #:** 8335

Please fill in the appropriate date as indicated:

Date Received: \_\_\_\_\_

Date Calibration Due: \_\_\_\_\_



Chauvin Arnoux®, Inc.  
d.b.a AEMC® Instruments  
[www.aemc.com](http://www.aemc.com)



## READ CAREFULLY BEFORE USING FOR THE FIRST TIME

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

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

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

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

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



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

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

- **Only use the charger supplied with your instrument. Use of another charger may be dangerous.**
- **Only charge your instrument at temperatures between 0° and 40°C.**
- **Comply with the conditions of use defined in the operating manual.**
- **Comply with the storage conditions specified in the operating manual.**

NiMH technology allows a limited number of charge/discharge cycles depending significantly on:

- **The conditions of use.**
- **The charging conditions.**



Do not dispose of the battery pack with other solid waste. Used batteries must be entrusted to a qualified recycling company or to a company specialized in processing hazardous materials.

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


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



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



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# INTRODUCTION













### Warning

These precautions for use are imperative when using the machine. Failure to comply with these instructions may lead to electric shocks, explosions or fire.

- The operator will consult these instructions whenever the  symbol is displayed.
- If you use this instrument in a way which is not specified, the protection which it provides may be compromised, putting you in danger.
- When removing or inserting the battery and/or SD card, ensure that the measuring leads, sensors and power cord are disconnected. The unit must be disconnected and powered down.
- The unit must not be used if the “battery/SD card” housing is absent, damaged or incorrectly fitted.
- The safety of any system incorporating this instrument is the responsibility of the system assembler.
- For your safety, only use the leads and suitable accessories delivered with the instrument: they comply with the norm IEC 61010-031 (2002). When the sensors or accessories of lower voltage and/or category are connected to the unit, these lower voltages and/or categories become applicable to the entire set.
- Before using the PowerPad® always check that the leads, sensors and accessories are in perfect condition. If anything appears damaged (even partially) it must be repaired or scrapped.
- Comply with the specified environmental conditions.
- It is advisable to use individual protective safety devices when the environment in which the unit is used require them.
- This unit must be used for CAT IV installations, for voltages that do not exceed 600VAC/DC in relation to the ground (per IEC standard 61010-1) or for voltages that do not exceed 1000V for CAT III installations. Never use voltage networks or categories greater than those mentioned.
- Only use power cords and battery packs supplied by the manufacturer. They have specific security mechanisms.
- Comply with the limits of the accessory or sensor safety mechanisms. Do not keep hands close to unused terminals.
- Certain current sensors cannot be inserted and removed from bare conductors under a dangerous voltage: consult the sensor’s manual and comply with handling instructions.

## 1.1 International Electrical Symbols

	Signifies that the instrument is protected by double or reinforced insulation.
	<b>CAUTION - DANGER!</b> Read the User Manual.
	Risk of electric shock. The voltage at the parts marked with this symbol may be dangerous.
	Refers to a type A current sensor. This symbol signifies that application around and removal from HAZARDOUS LIVE conductors is permitted.
	Refers to a type B current sensor. Do not apply around or remove from HAZARDOUS LIVE conductors without additional protective means (de-energizing the circuit or wearing protective clothing suitable for high voltage work).
	Important instructions to read and understand completely.
	Important information to acknowledge.
	USB socket
	The CE marking guarantees conformity with European directives and with regulations covering EMC.
	The trash can with a line through it means that in the European Union, the product must undergo selective disposal for the recycling of electric and electronic material, in compliance with Directive WEEE 2002/96/EC.

## 1.2 Definition of Measurement Categories

**CAT IV:** Measurement category IV corresponds to measurements taken at the source of low-voltage installations.

*Example:* metering and measurements on overvoltage protection devices.

**CAT III:** Measurement category III corresponds to measurements on building installations.

*Example:* measurement on distribution panels, cabling, etc.

**CAT II:** Measurement category II corresponds to measurements taken on circuits directly connected to the installation.

*Example:* measurement for electrodomestic units, portable tools and analogue devices.

## 1.3 Receiving Your Shipment



**NOTE:** After receiving your PowerPad®, charge and discharge the instrument one or two cycles to ensure the proper level display of the battery indicator.

Make sure the contents shipped are consistent with the packing list. Notify your distributor of any missing items. If the equipment appears damaged, file a claim immediately with the carrier and notify your distributor at once. Save the damaged packing container to substantiate your claim. Do not use equipment which is damaged or appears to be damaged.

## 1.4 Ordering Information

**PowerPad® Model 8335 ..... Cat. #2136.20**  
*Includes five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 MN93-BK ..... Cat. #2136.21**  
*Includes the PowerPad® Model 8335, four MN93-BK (240A) probes, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 SR193-BK ..... Cat. #2136.22**  
*Includes the PowerPad® Model 8335, four SR193-BK (1200A) probes, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 AmpFlex® 193-24-BK (24") ..... Cat. #2136.23**  
*Includes the PowerPad® Model 8335, four 24" AmpFlex® 193-24-BK (6500A) sensors, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 AmpFlex® 193-36 (36") ..... Cat. #2136.24**  
*Includes the PowerPad® Model 8335, four 36" AmpFlex® 193-36-BK (6500A) sensors, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 MR193-BK ..... Cat. #2136.25**  
*Includes the PowerPad® Model 8335, four MR193-BK (1000AAC/1400ADC) probes, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 MN193-BK ..... Cat. #2136.26**  
*Includes the PowerPad® Model 8335, set of four MN193-BK (5A/100A) probes, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/4 MA193-10-BK ..... Cat. #2136.27**  
*Includes the PowerPad® Model 8335, set of four MA193-10-BK (1000A) probes, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*

**PowerPad® Model 8335 w/3 AmpFlex® 193-24-BK and 1 MN193-BK...Cat. #2136.28**  
*Includes the PowerPad® Model 8335, three 24" AmpFlex® 193-36-BK (6500A) sensors, one MN193-BK (5A/100A) probe, five 10 ft black voltage leads, five black alligator clips, twelve color-coded input ID markers, USB cable, NiMH battery, 110/240V power adapter with US power cord, DataView® software, extra large classic tool bag, soft carrying pouch and user manual.*



Only the SR, Ampflex® and MiniFlex® sensors are rated 600V CAT IV  
 The MN, MR and SL probes are 300V CAT IV, 600V CAT III

## 1.4.1 Accessories and Replacement Parts

Extra Large Classic Tool Bag .....	<b>Cat. #2133.73</b>
Replacement - Soft Carrying Pouch .....	<b>Cat. #2140.15</b>
5A Adapter Box (consult factory) .....	<b>Cat. #2140.17</b>
Replacement - Battery 9.6V NiMH .....	<b>Cat. #2140.19</b>
AC/DC Current Probe Model SL261* (10A-100mV/A, 100A-10mV/A, BNC) ...	<b>Cat. #1201.51</b>
* Adapter - BNC Adapter (mandatory if using an SL261 w/ the 8335).....	<b>Cat. #2140.40</b>
AC Current Probe Model MR193-BK (1000Aac/1400Adc).....	<b>Cat. #2140.28</b>
AC Current Probe Model MN93-BK (200A).....	<b>Cat. #2140.32</b>
AC Current Probe Model SR193-BK (1200A) .....	<b>Cat. #2140.33</b>
AmpFlex® Sensor 24" Model 193-24-BK (6500A) .....	<b>Cat. #2140.34</b>
AmpFlex® Sensor 36" Model 193-36-BK (6500A) .....	<b>Cat. #2140.35</b>
AC Current Probe Model MN193-BK (5A/100A) .....	<b>Cat. #2140.36</b>
MiniFlex® Sensor 10" Model MA193-10-BK (1000A).....	<b>Cat. #2140.48</b>
Replacement - Set of 5, 10 ft (3m) black leads with 5 black alligator clips .....	<b>Cat. #2140.43</b>
Lead - 1, 10 ft (3m) black lead with black alligator clip.....	<b>Cat. #2140.44</b>
Replacement - Set of 12, Color-coded Input ID Markers.....	<b>Cat. #2140.45</b>
Replacement - 5 ft USB cable ( <i>Discontinued</i> ) (Replacement part is now <b>Cat. #2136.80 Cable - 10 ft USB Type A to Type B</b> ).....	<b>Cat. #2140.46</b>
Replacement - 110/240V Power Adapter with US Power Cord .....	<b>Cat. #5000.19</b>

# PRODUCT FEATURES

## 2.1 Description

The easy-to-use, compact and shock-resistant PowerPad® Model 8335 is a three-phase power quality analyzer equipped with four current probes and five voltage inputs. It is intended for technicians and engineers to measure and carry out diagnostic work and power quality work on one, two or three phase low voltage networks.

The PowerPad's 2GB of memory is conveniently partitioned to let you store four different types of data, synchronized or independent of each other. You can store up to 50 screen snapshots, up to 210 captured transients that contain four cycles for each active input, and 10,000 alarm events from up to 40 different parameters. You can also record trend data for days, weeks or even months.

Six access buttons quickly display the following functions. Note that these functions can be accessed during a recording.

**Waveforms** – Display Volts, Amps, THD and Crest Factor by phase or for all phases. You can display all the voltage inputs on one screen, phase-to-phase or phase-to-neutral. Real-time phasor diagrams can be displayed for volts and amps, also by phase or for all phases including phase unbalance.

**Harmonics** – Display Harmonics out to the 50th for Volts, Amps and VA. Individual Harmonics are displayed as a percentage and value for Volts, Amps and VA. Harmonic direction and sequencing can also be displayed.

**Transients or Inrush Current** – Set, capture and display transients. You select the threshold and the number of transients to capture. The PowerPad® then captures four waveforms for each transient; the triggering waveform as well as one pre-triggered and two post-triggered waveforms. As many as 210 transients each consisting of 4 waveforms per channel for up to 8 channels can be captured.

**Trend Recording** – Record and display trend data at user selectable sample rates from 1/sec to 1/15 minutes and user programmable recording periods into 2GB of memory.



Recordings can only be downloaded through the USB port. Extremely long recordings will take a long time to download (> 2H per 100MB). Also, keep in mind that Microsoft® Excel is limited to 10,000 lines per spreadsheet and Access has limitations as well.

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## 2.2 Key Features

- **Voltage ratios:** 1V to 500kV / Separate or grouped configuration of channels
- **Mixed sensors:** 10mA to 60kA depending on sensor. Combine as needed. The measurements are performed simultaneously using several different current sensors
- **Transient adjustment level:** Adjustment of 1V or 1A. Separate or grouped configuration of channels
- **New languages:** In addition to the 21 existing: Japanese, Turkish, Hindi & Thai
- Measurement of TRMS voltages up to 1000Vrms AC/DC for two, three, four or five-wire systems
- Measurement of TRMS currents from 1mA to 6500Arms (sensor dependent)
- Measurement of DC current up to 1200ADc (with MR193 probe)
- Automatic probe detection and scaling
- Frequency measurement (40 to 69Hz systems)
- Direct measurement of neutral current for WYE configurations
- Record and display trend data as fast as once per second for one month for up to 25 variables. It is recommended to limit recordings to under 100MB.
- Energy assessments
- Transient detection on all V and I inputs
- Inrush current
- 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 (3 phase only)
- Measurement of harmonic angles and rates (referenced to the fundamental or RMS value) for voltage, current or power, up to 50th harmonic
- Display of harmonic sequencing and direction
- Calculation of overall harmonic distortion factors
- Real time display of Phasor diagrams including values and phase angles
- Monitoring of the average value of any parameter, calculated over a period running from 1 sec to 2 hrs
- Measurement of active, reactive and apparent power per phase and their respective sum total
- Calculation of 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, exceedance of power and harmonic thresholds)
- Detection of transients and recording of associated waveforms
- Color-coded input ID markers identify voltage and current inputs
- 2GB internal memory
- DataView® analysis software included

## 2.3 Control Functions

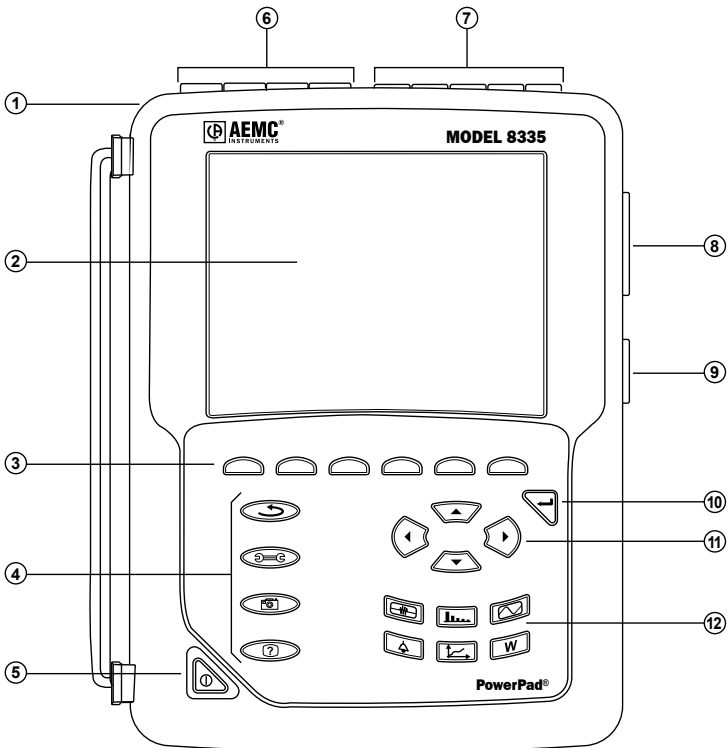


Figure 2-1

- ① Over molded protective case.
- ② Color LCD display with graphic representation of system parameters and measurements (see § 2.4).
- ③ Six (6) function buttons used to modify the display mode.
- ④ Four (4) function buttons (see § 2.5).
- ⑤ ON / OFF button.

- ⑥ Four (4) current inputs on the top of the instrument to enable the use of current sensors (MN, SR, AmpFlex®, MiniFlex®, and MR probes). It is possible to use different current probes per input voltage ratio selectable.
- ⑦ Five (5) voltage inputs (voltage ratio can be set before recording).
- ⑧ USB optically isolated output for configuring, running tests and transferring data to a PC.
- ⑨ Input for external power supply.
- ⑩ Enter button.
- ⑪ Four (4) buttons that enable movement of the cursor, browsing or the selection of data.
- ⑫ Buttons for directly accessing the 6 display modes (see § 2.5):

## 2.4 Display

Display: 320 x 240 pixels

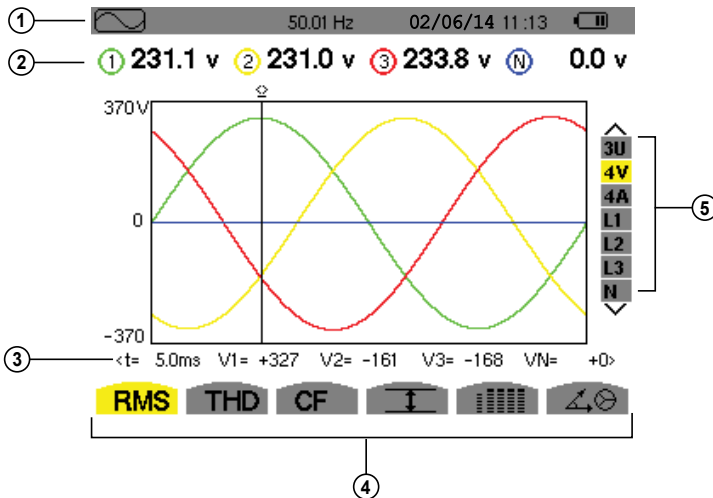




Figure 2-2

- ① Top display bar indicates:
  - Symbol of the tested mode (e.g. , ,  $W \sim$ , etc)
  - Frequency of measured signal
  - Memory capacity status bar (only available in certain modes)
  - Current date and time
  - Battery charge status (see § 8)



- 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 ◀ and ▶ buttons.
- ④ Measurement selection (refer to chart below)



Calculation of DPF, Tan, KF,  $\Phi$ , UNB, Min, Max, VAR, Harmonics, PST, and DF parameters and the frequency measurement can only be performed if voltage or current with a frequency of 40 to 70Hz is applied to the Ch1 voltage input or the A1 current input.








- ⑤ Selection of waveforms to be displayed (use the ▲ and ▼ buttons to select):
















U: Signifies phase-to-phase voltage

V: Signifies phase-to-neutral voltage




A: Displays V and A for each phase







L1, L2, L3: Refer to the phases (A,B,C)

Icon	Description
<b>RMS</b>	True RMS Measurement
<b>THD</b>	Total Harmonic Distortion
<b>CF</b>	Crest Factor
	Display of current values and their extremes
	Display all voltage and current measurements simultaneously (RMS, DC, THD, CF, PST, KF, DF)
	Fresnel diagram
<b>V</b>	Single voltage mode
<b>A</b>	Simple current mode
<b>VA</b>	Power mode
<b>U</b>	Voltage mode (phase-to-phase)
	Zoom in
	Zoom out
< >	Left/right key prompt
^ v	Up/down key prompt
<b>PF...</b>	Display of PF, DPF and Tan.
<b>W...</b>	Active power.
	Recording mode
	Recording display and selection mode

<b>OK</b>	Validation prompt
	Shutdown function in progress prompt
	Display of energy consumed
	Display of energy generated
	Screen 1 of the help function
	Screen 2 of the help function
	Screen 3 of the help function
	Screen 4 of the help function
	Screen 1 of the selected recording parameter
	Screen 2 of the selected recording parameter
	Screen 3 of the selected recording parameter
	Screen 4 of the selected recording parameter
<b>&gt;t=0&lt;</b>	Moves the cursor to transient triggering time
<b>&gt;5=-T&lt;</b>	Moves the cursor to one signal period before the transient triggering date
	Activates/deactivates the selection of the transients list display filter
	Following page screen
	Previous page screen
	Trash to delete or remove elements

## 2.5 Button Functions

Icon	Description
	<p><b>Transients or Inrush Current:</b></p> <ul style="list-style-type: none"> <li>Sets and views transient and inrush current waveforms associated with rapid changes in input</li> </ul>
	<p><b>Harmonics Mode:</b></p> <ul style="list-style-type: none"> <li>Displays the harmonics in percent and value ratios for voltage, current and power for each harmonic through the 50th</li> <li>Determines harmonic current produced by non-linear loads</li> <li>Analyzes the problems caused by harmonics according to their order (heating of neutrals, conductors, motors, etc)</li> </ul>
	<p><b>Waveforms Mode:</b></p> <ul style="list-style-type: none"> <li>Displays voltage and current waveforms or vector representation</li> <li>Identifies signal distortion signatures</li> <li>Displays of amplitude and phase unbalance for voltage and current</li> <li>Checks connections for correct phase order</li> </ul>

	<p><b>Alarm Events:</b></p> <ul style="list-style-type: none"> <li>• Provides a list of the alarms recorded according to the thresholds programmed during configuration</li> <li>• Logs interruption with half-cycle resolution</li> <li>• Determines energy consumption exceedances</li> <li>• Stores value, duration, date, time and set point for up to 4096 events</li> </ul>
	<p><b>Trend Mode:</b></p> <ul style="list-style-type: none"> <li>• Lists all recording trends and views them on the display (Urms, Vrms, Arms, etc)</li> </ul>
<p>W ~</p>	<p><b>Power / Energy:</b></p> <ul style="list-style-type: none"> <li>• Displays power levels and the associated parameters (power factor, displacement and tangent)</li> <li>• Energy monitoring</li> <li>• Four quadrant measurement to discern produced/consumed active energies and inductive/capacitive reactive energies</li> </ul>
	<p>Return to the choice of measurement view.</p>
	<p>Configure the PowerPad® (SET-UP).</p>
	<p>Take a snapshot of the current screen or access screens already stored in the memory. Record associated waveform and power measurement data.</p>
	<p>Get help on the current display functions, in the language chosen by the user.</p>

## **SPECIFICATIONS**

### **3.1 Reference Conditions**

<b>Parameter</b>	<b>Reference Conditions</b>
Ambient temperature	73°F ± 5°F (23°C ± 3°C)
Humidity (relative humidity)	[45%; 75%]
Atmospheric pressure	[860 hPa; 1060 hPa]
Phase-to-neutral voltage	[50Vrms; 1000Vrms] without DC (< 0.5%)
Standard current circuit input voltage (except AmpFlex® & MiniFlex®)	[30mVrms; 1Vrms] without DC (< 0.5%) *Anom ↔ 1Vrms 3 × *Anom ÷ 100 ↔ 30mVrms
Rogowski current circuit input voltage (Only AmpFlex® & MiniFlex®)	[11.73 mVrms; 117.3mVrms] without DC (< 0.5%) 3000 Arms ↔ 117.3mVrms to 50Hz 300 Arms ↔ 11.73mVrms to 50Hz
Frequency of electrical network	50/60Hz ± 0.1Hz
Phase shift	0° (active power and energy) 90° (reactive power and energy)
Harmonics	< 0.1%
Voltage unbalance	< 10%
Voltage ratio	1 (unity)
Current ratio	1 (unity)
Power supply	Battery only
Electric field	< 1 V.m-1
Magnetic field	< 40 A.m-1



**NOTE:** 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.

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*\*The values of Anom are provided in the next table.*

Current Sensor (excluding AmpFlex® & MiniFlex®)	Nominal RMS current ( $A_{nom}$ ) [A]
SR clamp	1000
MR clamp	1000
MN93 clamp	200
SL261 clamp (10mV/A)	100
SL261 clamp (100mV/A)	10
MN193 clamp (100A)	100
MN193 clamp (5A)	5
5 A adapter	5

## 3.2 Electrical Specifications

### Sampling Frequency (256 samples per cycle):

12.8kHz samples/sec per channel @ 50Hz

15.36kHz samples/sec per channel @ 60Hz

**Waveforms:** Displays voltages and currents

**Screen Captures:** 50 max

**Transients:** Detection and recording of transients (up to 210)

**Inrush Current:** Detection and recording of Inrush current (1 max)

**Memory:** 2GB with date and time programming

**Alarm Function:** 10,000 alarms max

### 3.2.1 Voltage Inputs

**Range for use:** 0 to 1000 Vrms AC+DC phase-to-neutral and neutral-to-earth  
0 to 2000 Vrms AC+DC phase-to-phase

(on condition of compliance with 1000 Vrms with respect to earth in CAT III)

**Input Impedance:** 969 k $\Omega$  (between phase and neutral and neutral and earth)

**Admissible Overload:** 1200 Vrms constant  
2000 Vrms for one second

### 3.2.2 Current Inputs

**Operating Range:** 0 to 1V

**Input Impedance:** 1M $\Omega$  for current probe circuit  
12.4k $\Omega$  for AmpFlex® and MiniFlex® circuit

**Overload:** 1.7V

### 3.2.3 Accuracy Specifications (excluding current probes)

Measurement		Measurement range without ratio (with unity ratio)		Resolution (with unity ratio)	Accuracy
		Min	Max		
Frequency		40 Hz	70 Hz	0.01 Hz	$\pm(0.01 \text{ Hz})$
RMS Voltage <sup>(5)</sup>	Simple	1 V	1200 V <sup>(1)</sup>	0.1 V V < 1000 V	$\pm(0.5\% + 0.2 \text{ V})$
				1 V V $\geq$ 1000 V	$\pm(0.5\% + 1 \text{ V})$
	Compound	1 V	2400 V <sup>(2)</sup>	0.1 V U < 1000 V	$\pm(0.5\% + 0.2 \text{ V})$
				1 V U $\geq$ 1000 V	$\pm(0.5\% + 1 \text{ V})$
Direct Voltage (DC) <sup>(6)</sup>	Simple	1 V	1697 V <sup>(3)</sup>	0.1 V V < 1000 V	$\pm(1\% + 0.5 \text{ V})$
				1 V V $\geq$ 1000 V	$\pm(1\% + 1 \text{ V})$
	Compound	1 V	3394 V <sup>(4)</sup>	0.1 V U < 1000 V	$\pm(1\% + 0.5 \text{ V})$
				1 V U $\geq$ 1000 V	$\pm(1\% + 1 \text{ V})$
RMS Current <sup>(5)</sup>	SR clamp MR clamp	1 A	1200 A	0.1 A A < 1000 A	$\pm(0.5\% + 0.2 \text{ A})$
				1 A A $\geq$ 1000 A	$\pm(0.5\% + 1 \text{ A})$
	MN93 clamp	0.2 A	240 A	0.1 A	$\pm(0.5\% + 0.2 \text{ A})$
	SL261 clamp (10mV/A) MN193 clamp (100A)	0.1 A	120 A	0.01 A A < 100 A	$\pm(0.5\% + 0.02 \text{ A})$
				0.1 A A $\geq$ 100 A	$\pm(0.5\% + 0.1 \text{ A})$
	SL261 clamp (100mV/A)	0.01 A	12 A	0.001 A A < 10 A	$\pm(0.5\% + 0.002 \text{ A})$
				0.01 A A $\geq$ 10 A	$\pm(0.5\% + 0.01 \text{ A})$
	MN193 clamp (5A)	0.005 A	6 A	0.001 A	$\pm(0.5\% + 0.002 \text{ A})$
AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>	10 A	6500 A	0.1 A A < 1000 A	$\pm(0.5\% + 1 \text{ A})$	
			1 A A $\geq$ 1000 A		

Direct current (DC) <sup>(6)</sup>	MR clamp	1 A	1200 A <sup>(4)</sup>	0.1 A A < 1000 A	±(1% + 1 A)
				1 A A ≥ 1000 A	
	SL261 clamp (10 mV/A)	0.1 A	169.7 A <sup>(3)</sup>	0.01 A A < 100 A	±(1% + 0.1 A)
				0.1 A A ≥ 100 A	
	SL261 clamp (100 mV/A)	0.01 A	16.97 A <sup>(3)</sup>	0.001 A A < 10 A	±(1% + 0.01 A)
				0.01 A A ≥ 10 A	
Peak factor (PF)		1	9.99	0.01	±(1% + 2 ct) CF < 4
					±(5% + 2 ct) CF ≥ 4

(1) In 1000 V<sub>RMS</sub>, CAT III, provided that the voltage between each of the terminals and earth does not exceed 1000 V<sub>RMS</sub>

(2) Two-phase (opposite phases) – same note as (1)

(3)  $1200 \times \sqrt{2} \approx 1697$ ;  $2400 \times \sqrt{2} \approx 3394$ ;  $120 \times \sqrt{2} \approx 169,7$ ;  $12 \times \sqrt{2} \approx 16,97$

(4) Limitation of the PAC clamp

(5) Total RMS value and RMS value of the fundamental

(6) DC harmonic component ( $n=0$ )

Measurement		Measurement range without ratio (with unity ratio)		Resolution (with unity ratio)	Accuracy
		Min	Max		
RMS ½ voltage	Simple	1 V	1200 V <sup>(1)</sup>	0.1 V V < 1000 V	±(0.8% + 1 V)
	Compound			1 V V ≥ 1000 V	
Peak voltage	Simple	1 V	1697 V <sup>(3)</sup>	0.1 V V < 1000 V	±(1% + 1 V)
	Compound			1 V V ≥ 1000 V	
		1 V	3394 V <sup>(3)</sup>	0.1 V U < 1000 V	±(1% + 1 V)
				1 V U ≥ 1000 V	

RMS ½ current	SR clamp MR clamp	1 A	1200 A	0.1 A A < 1000 A	±(1% + 1 A)
				1 A A ≥ 1000 A	
	MN93 clamp	0.2 A	240 A	0.1 A	±(1% + 1 A)
	SL261 clamp (10mV/A) MN193 clamp (100A)	0.1 A	120 A	0.01 A A < 100 A	±(1% + 0.1 A)
				0.1 A A ≥ 100 A	
	SL261 clamp (100mV/A)	0.01 A	12 A	0.001 A A < 10 A	±(1% + 0.01 A)
0.01 A A ≥ 10 A					
MN193 clamp (5A)	0.005 A	6 A	0.001 A	±(1% + 0.01 A)	
AmpFlex® MiniFlex®	10 A	6500 A	0.1 A A < 1000 A	±(1.5% + 5 A)	
			1 A A ≥ 1000 A		
Peak Current	SR clamp MR clamp	1 A	1697 A <sup>(3)</sup>	1 A A < 1000 A	±(1% + 1 A)
				1 A A ≥ 1000 A	
	MN93 clamp	0.2 A	339.4 A <sup>(3)</sup>	0.1 A	±(1% + 1 A)
	SL261 clamp (10mV/A) MN193 clamp (100A)	0.1 A	169.7 A <sup>(3)</sup>	0.01 A A < 100 A	±(1% + 0.1 A)
				0.1 A A ≥ 100 A	
	SL261 clamp (100mV/A)	0.01 A	16.97 A <sup>(3)</sup>	0.001 A A < 10 A	±(1% + 0.01 A)
0.01 A A ≥ 10 A					
MN193 clamp (5A)	0.005 A	8.485 A <sup>(3)</sup>	0.001 A	±(1% + 0.01 A)	
AmpFlex® MiniFlex®	10 A	9192 A <sup>(3)</sup>	0.1 A A < 1000 A	±(1.5% + 5 A)	
			1 A A ≥ 1000 A		
Severity of flicker (Pst)		0	12	0.01	See the corresponding table

(1) In 1000 Vrms, CAT III, provided that the voltage between each of the terminals and earth does not exceed 1000 Vrms

(2) Two-phase (opposite phases) – same note as (1)

(3)  $1200 \times \sqrt{2} \approx 1697$ ;  $2400 \times \sqrt{2} \approx 3394$ ;  $240 \times \sqrt{2} \approx 339,4$ ;  $120 \times \sqrt{2} \approx 169,7$ ;  $12 \times \sqrt{2} \approx 16,97$ ;  $6 \times \sqrt{2} \approx 8,485$ ;  $6500 \times \sqrt{2} \approx 9192$



Measurement		Measurement range without ratio (with unity ratio)		Resolution (with unity ratio)	Accuracy
		Min	Max		
Active Power <sup>(1)</sup>	Excluding AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>	5 mW <sup>(3)</sup>	7800 kW <sup>(4)</sup>	4 digits at most <sup>(5)</sup>	$\pm(1\%)$ $\cos \Phi \geq 0.8$
	AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>				$\pm(1.5\% + 10 \text{ ct})$ $0.2 \leq \cos \Phi < 0.8$
					$\pm(1\%)$ $\cos \Phi \geq 0.8$
					$\pm(1.5\% + 10 \text{ ct})$ $0.5 \leq \cos \Phi < 0.8$
Reactive Power <sup>(2)</sup>	Excluding AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>	5 mVAR <sup>(3)</sup>	7800 kVAR <sup>(4)</sup>	4 digits at most <sup>(5)</sup>	$\pm(1\%)$ $\sin \Phi \geq 0.5$
	AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>				$\pm(1.5\% + 10 \text{ ct})$ $0.2 \leq \sin \Phi < 0.5$
					$\pm(1.5\%)$ $\sin \Phi \geq 0.5$
					$\pm(2.5\% + 20 \text{ ct})$ $0.2 \leq \sin \Phi < 0.5$
Apparent Power		5 mVA <sup>(3)</sup>	7800 kVA <sup>(4)</sup>	4 digits at most <sup>(5)</sup>	$\pm(1\%)$
Peak Factor (PF)		-1	1	0.001	$\pm(1.5\%)$ $\cos \Phi \geq 0.5$
					$\pm(1.5\% + 10 \text{ ct})$ $0.2 \leq \cos \Phi < 0.8$
Active Energy <sup>(1)</sup>	Excluding AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>	1 mWh	9,999,999 MWh <sup>(6)</sup>	7 digits at most <sup>(5)</sup>	$\pm(1\%)$ $\cos \Phi \geq 0.8$
	AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>				$\pm(1.5\%)$ $0.2 \leq \cos \Phi < 0.8$
					$\pm(1\%)$ $\cos \Phi \geq 0.8$
					$\pm(1.5\%)$ $0.5 \leq \cos \Phi < 0.8$
Reactive energy <sup>(2)</sup>	Excluding AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>	1 mVARh	9,999,999 MVARh <sup>(6)</sup>	7 digits at most <sup>(5)</sup>	$\pm(1\%)$ $\sin \Phi \geq 0.5$
	AmpFlex <sup>®</sup> MiniFlex <sup>®</sup>				$\pm(1.5\%)$ $0.2 \leq \sin \Phi < 0.5$
					$\pm(1.5\%)$ $\sin \Phi \geq 0.5$
					$\pm(2\%)$ $0.2 \leq \sin \Phi < 0.5$

<b>Apparent energy</b>	1 mVAh	9,999,999 MVAh <sup>(6)</sup>	7 digits at most <sup>(5)</sup>	±(1%)
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- (1) The stated uncertainties on the active power and energy measurements are max for  $|\cos \Phi| = 1$  and typical for the other phase differences.
- (2) The stated uncertainties on the reactive power and energy measurements are max for  $|\sin \Phi| = 1$  and typical for the other phase shifts.
- (3) With MN193 clamp (5A) or 5A adapter.
- (4) With AmpFlex® or MiniFlex®.
- (5) The resolution depends on the current sensor used and on the value to be displayed.
- (6) The energy is equivalent to more than 146 years of the associated maximum power (unity ratios).

Measurement	Measurement Range		Resolution	Accuracy
	Min	Max		
<b>Phase differences of fundamentals</b>	-179°	180°	1°	±(2°)
<b>cos Φ (DPF)</b>	-1	1	0.001	±(1°) for Φ ±(5 ct) for DPF
<b>tan F</b>	-32.77 <sup>(1)</sup>	32.77 <sup>(1)</sup>	0.001 tan Φ < 10	±(1°) for Φ
			0.01 tan Φ ≥ 10	
<b>Unbalance (UNB)</b>	0%	100%	0.1%	±(1%)

- (1)  $|\tan \Phi| = 32,767$  corresponds to  $\Phi = \pm 88.25^\circ + k \times 180^\circ$  ( $k$  being a natural number)

Measurement	Measurement Range		Resolution	Accuracy
	Min	Max		
<b>Voltage Harmonic Ratio (t)</b>	0%	1600%	0.1% $\tau < 999.9\%$	±(2.5 % + 5 ct)
			1% $\tau \geq 1000\%$	
<b>Current Harmonic Ratio (t) (excluding AmpFlex® &amp; MiniFlex®)</b>	0%	1600%	0.1% $\tau < 999.9\%$	±(2% + (n × 0.2%) + 5 ct) n ≤ 25
			1% $\tau \geq 1000\%$	±(2% + (n × 0.5%) + 5 ct) n > 25
<b>Current Harmonic Ratio (t) (AmpFlex® &amp; MiniFlex®)</b>	0%	1600%	0.1% $\tau < 999.9\%$	±(2% + (n × 0.3%) + 5 ct) n ≤ 25
			1% $\tau \geq 1000\%$	±(2% + (n × 0.6%) + 5 ct) n > 25
<b>Total Voltage Harmonic Distortion THD (THD-F)</b>	0%	999.9%	0.1%	±(2.5% + 5 ct)

Total current harmonic distortion THD (THD-F) (excluding AmpFlex® & MiniFlex®)	0%	999.9%	0.1%	$\pm(2.5\% + 5 \text{ ct})$ $\text{si } \forall n \geq 1. \tau_n \leq (100 \div n) [\%]$
				or
				$\pm(2\% + (n_{\text{max}} \times 0.2\%) + 5 \text{ ct})$ $n_{\text{max}} \leq 25$
				$\pm(2\% + (n_{\text{max}} \times 0.5\%) + 5 \text{ ct})$ $n_{\text{max}} > 25$
Total current harmonic distortion THD (THD-F) (AmpFlex® & MiniFlex®)	0%	999.9%	0.1%	$\pm(2.5\% + 5 \text{ ct})$ $\text{si } \forall n \geq 1. \tau_n \leq (100 \div n^2) [\%]$
				or
				$\pm(2\% + (n_{\text{max}} \times 0.3\%) + 5 \text{ ct})$ $n_{\text{max}} \leq 25$
				$\pm(2\% + (n_{\text{max}} \times 0.6\%) + 5 \text{ ct})$ $n_{\text{max}} > 25$
Voltage distortion factor DF (THD-R)	0%	100%	0.1%	$\pm(2.5\% + 5 \text{ ct})$
Current distortion factor DF (THD-R) (excluding AmpFlex® & MiniFlex®)	0%	100%	0.1%	$\pm(2.5\% + 5 \text{ ct})$ $\text{si } \forall n \geq 1. \tau_n \leq (100 \div n) [\%]$
				or
				$\pm(2\% + (n_{\text{max}} \times 0.2\%) + 5 \text{ ct})$ $n_{\text{max}} \leq 25$
				$\pm(2\% + (n_{\text{max}} \times 0.5\%) + 5 \text{ ct})$ $n_{\text{max}} > 25$
Current distortion factor DF (THD-R) (AmpFlex® & MiniFlex®)	0%	100%	0.1%	$\pm(2.5\% + 5 \text{ ct})$ $\text{si } \forall n \geq 1. \tau_n \leq (100 \div n^2) [\%]$
				or
				$\pm(2\% + (n_{\text{max}} \times 0.3\%) + 5 \text{ ct})$ $n_{\text{max}} \leq 25$
				$\pm(2\% + (n_{\text{max}} \times 0.6\%) + 5 \text{ ct})$ $n_{\text{max}} > 25$
K factor (KF)	1	99.99	0.01	$\pm(5\% + (n_{\text{max}} \times 0.3\%) + 5 \text{ ct})$ $n_{\text{max}} \leq 25$
				$\pm(10\% + (n_{\text{max}} \times 0.6\%) + 5 \text{ ct})$ $n_{\text{max}} > 25$
Phase shifts of harmonics (order $n \geq 2$ )	-179°	180°	1°	$\pm(1.5^\circ + 1^\circ \times (n \div 12.5))$

N.B.  $n_{\text{max}}$  is the highest order for which the harmonic ratio is non-zero.

Measurement		Measurement range (with unity ratio)		Resolution (with unity ratio)	Accuracy
		Min	Max		
RMS Harmonic Voltage (order $n \geq 2$ )	Simple	1 V	1200 V <sup>(1)</sup>	0.1 V V < 1000 V	$\pm(2.5\% + 1\text{ V})$
				1 V V $\geq$ 1000 V	
	Compound	1 V	2400 V <sup>(2)</sup>	0.1 V U < 1000 V	$\pm(2.5\% + 1\text{ V})$
				1 V U $\geq$ 1000 V	
RMS Harmonic Current (order $n \geq 2$ )	SR clamp MR clamp	1 A	1200 A	0.1 A A < 1000 A	$\pm(2\% + (n \times 0.2\%) + 1\text{ A})$ n $\leq$ 25
				1 A A $\geq$ 1000 A	$\pm(2\% + (n \times 0.5\%) + 1\text{ A})$ n > 25
	MN93 clamp	0.2 A	240 A	0.1 A	$\pm(2\% + (n \times 0.2\%) + 1\text{ A})$ n $\leq$ 25
					$\pm(2\% + (n \times 0.5\%) + 1\text{ A})$ n > 25
	SL261 clamp (10mV/A) MN193 clamp (100A)	0.1 A	120 A	0.01 A A < 100 A	$\pm(2\% + (n \times 0.2\%) + 0.1\text{ A})$ n $\leq$ 25
				0.1 A A $\geq$ 100 A	$\pm(2\% + (n \times 0.5\%) + 0.1\text{ A})$ n > 25
	SL261 clamp (100mV/A)	0.01 A	12 A	0.001 A A < 10 A	$\pm(2\% + (n \times 0.2\%) + 0.01\text{ A})$ n $\leq$ 25
				0.01 A A $\geq$ 10 A	$\pm(2\% + (n \times 0.5\%) + 0.01\text{ A})$ n > 25
	MN193 clamp (5A) 5A adapter	0.005 A	6 A	0.001 A	$\pm(2\% + (n \times 0.2\%) + 0.01\text{ A})$ n $\leq$ 25
					$\pm(2\% + (n \times 0.5\%) + 0.01\text{ A})$ n > 25
	AmpFlex® & MiniFlex®	10 A	6500 A	0.1 A A < 1000 A	$\pm(2\% + (n \times 0.3\%) + 1\text{ A} +$ $(A_{\text{FRMS}}^{(3)} \times 0.1\%))$ n $\leq$ 25
				1 A A $\geq$ 1000 A	$\pm(2\% + (n \times 0.6\%) + 1\text{ A} +$ $(A_{\text{FRMS}}^{(3)} \times 0.1\%))$ n > 25

(1) In 1000 VRMS, CAT III, provided that the voltage between each of the terminals and earth does not exceed 1000 VRMS.

(2) Two-phase (opposite phases) – same note as (1).

(3) RMS value of the fundamental.

	Max intrinsic error of the flicker severity measurement (Pst)			
Rectangular variations per minute (50% duty cycle)	120 V lamp 60 Hz network		230 V lamp 50 Hz network	
	2	Pst ∈ [1;4]	± 5%	Pst ∈ [1;4]
7	Pst ∈ [1;7]	± 5%	Pst ∈ [1;4]	± 5%
39	Pst ∈ [1;12]	± 5%	Pst ∈ [1;10]	± 5%
110	Pst ∈ [1;12]	± 5%	Pst ∈ [1;10]	± 5%
1620	Pst ∈ [1;12]	± 15%	Pst ∈ [1;10]	± 15%

Ratio	Minimum	Maximum
Voltage	100	$9,999,900 \times \sqrt{3}$
	$1000 \times \sqrt{3}$	0.1
Current <sup>(1)</sup>	1	60,000 / 1

(1) Only for the MN193 clamp (5 A) and the 5 A adapter.

Measurement		Measurement Range	
		Minimum with minimum ratio(s)	Maximum with maximum ratio(s)
RMS & RMS ½ Voltage	Simple	58 mV	207.8 GV
	Compound	58 mV	415.7 GV
Direct Voltage (DC) & Peak Voltage	Simple	58 mV	293.9 GV
	Compound	58 mV	587.9 GV
RMS & RMS ½ Current		5 mA	360.0 kA
Peak Current		5 mA	509.1 kA
Active Power		0.289 mW	74.82 PW
Reactive Power		0.289 mVAR	74.82 PVAR
Apparent Power		0.289 mVA	74.82 PVA
Active Energy		1 mWh	9,999,999 EWh <sup>(1)</sup>
Reactive Energy		1 mVARh	9,999,999 EVARh <sup>(1)</sup>
Apparent Energy		1 mVAh	9,999,999 EVAh <sup>(1)</sup>

(1) The energy corresponds to more than 15,000 years of the associated maximum power (max ratios).

### 3.2.4 Current Probe Accuracy (to be added to the PowerPad's accuracy)

Sensor errors are offset by a typical correction inside the device. This typical correction, applied to the phase and amplitude, depends on the type of sensor connected (detected automatically) and the gain in the current acquisition channel used.

The RMS current measurement error and phase error are additional errors (which must therefore be added to the device errors), indicated as influences on the calculations carried out by the analyser (powers, energies, power factors, tangents, etc.).

Sensor Type	TRMS Current	Accuracy on IRMS	Accuracy on $\phi$
<b>MR193 1000A</b>	[1A; 10A]	$\pm(1.5\% + 1A)$	N.S.
	[10A; 100A]		$\pm(2^\circ)$
	[100A; 800A]	$\pm(3\%)$	$\pm(1.5^\circ)$
	[800A; 1200A]	$\pm(5\%)$	
<b>SR193 1000A</b>	[1A; 3A]	$\pm(0.8\%)$	N.S.
	[3A; 10A]		$\pm(1^\circ)$
	[10A; 100A]	$\pm(0.3\%)$	$\pm(0.5^\circ)$
	[100A; 1200A]	$\pm(0.2\%)$	$\pm(0.3^\circ)$
<b>AmpFlex® 3000A</b>	[10A; 100A]	$\pm(3\%)$	$\pm(1^\circ)$
	[100A; 6500A]	$\pm(2\%)$	$\pm(0.5^\circ)$
<b>MiniFlex® 1000A</b>	[10A; 100A]	$\pm(3\%)$	$\pm(1^\circ)$
	[100A; 1000A]	$\pm(2\%)$	$\pm(0.5^\circ)$
<b>MN93 200A</b>	[0.5A; 2A]	$\pm(3\% + 1A)$	N.S.
	[2A; 10A]		$\pm(6^\circ)$
	[10A; 100A]	$\pm(2.5\% + 1A)$	$\pm(3^\circ)$
	[100A; 240A]	$\pm(1\% + 1A)$	$\pm(2^\circ)$
<b>MN193 100A</b>	[100mA; 300mA]	$\pm(0.7\% + 2mA)$	N.S.
	[300mA; 1A]		$\pm(1.5^\circ)$
	[1A; 120A]	$\pm(0.7\%)$	$\pm(0.7^\circ)$
<b>MN193 5A</b>	[5mA; 50mA]	$\pm(1\% + 0.1mA)$	$\pm(1.7^\circ)$
	[50mA; 500mA]	$\pm(1\%)$	$\pm(1^\circ)$
	[500mA; 6A]	$\pm(0.7\%)$	
<b>5A Adapter</b>	[5mA; 50mA]	$\pm(1\%)$	$\pm(1^\circ)$
	[50mA; 6A]	$\pm(0.5\%)$	$\pm(0^\circ)$
<b>SL261 10A (100mV/A)</b>	[0A; 10A]	$\pm(1.5\% + 50mA)$	$\pm(1^\circ)$
<b>SL261 100A (10mV/A)</b>	[0A; 40A] [40A; 100A]	$\pm(2\% + 50mA)$ $\pm(5\%)$	$\pm(0.5^\circ)$

N.S. = Not Specified

### 3.2.5 Current Probes and Sensors

When installing probes, face the arrow on the probe in the direction of the load.

Model SR193	
<b>Nominal Range</b>	1000AAC for $f \leq 1$ kHz
<b>Measurement Range</b>	1A to 1200AAC max ( $I > 1000$ A not continuously)
<b>Probe Output Signal</b>	1mVAC/AAC
<b>Maximum Clamping Diameter</b>	2" (52mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 600V CAT IV, 1000V CAT III

**NOTE:** Currents  $< 0.5$ A will be displayed as zero. Neutral current measures down to 0A.

Model MN93	
<b>Nominal Range</b>	200AAC for $f \leq 1$ kHz
<b>Measurement Range</b>	2A to 240AAC max ( $I > 200$ A not permanent)
<b>Probe Output Signal</b>	5mVAC/AAC
<b>Maximum Clamping Diameter</b>	0.8" (20mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 300V CAT IV, 600V CAT III

**NOTE:** Currents  $< 0.5$ A will be displayed as zero. Neutral current measures down to 0A.

Model MR193	
<b>Nominal Range</b>	1000AAC, 1400ADC max
<b>Measurement Range</b>	10A to 1000AAC, 10A to 1300APEAKAC+DC
<b>Probe Output Signal</b>	1mV/A
<b>Maximum Clamping Diameter</b>	One 1.6" (42mm) or two 0.98" (25.4mm) or two bus bars 1.96 x 0.19" (50 x 5mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 300V CAT IV, 600V CAT III

**NOTE:** Currents  $< 1$ AAC/DC will be displayed as zero. Neutral current measures down to 0A.

Model MN193	
<b>Nominal Range</b>	5A and 100AAC
<b>Measurement Range</b>	5A: 0.005A to 6AAC max (1A to 1200A with ratio 1000/5 selected) 100A: 0.1A to 120AAC max
<b>Probe Output Signal</b>	5A: 200mV/AAC; 100A: 10mV/AAC
<b>Maximum Clamping Diameter</b>	0.8" (20mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 300V CAT IV, 600V CAT III

The 5A range of the MN193 is designed to work with secondary current transformers.

Best accuracy is available when entering the transformer ratio (e.g. 1000/5A). When used to measure 5A direct, the resolution will be limited to 0.1A max.

**NOTE:** Currents  $< (\text{Primary} \times 5) \div (\text{Secondary} \times 1000)$  or  $< 250\text{mA}$  on the 5A range and  $< 0.2\text{A}$  on the 100A range will be displayed as zero with this probe. Power calculations will also be zeroed when the current is zeroed.

<b>AmpFlex® Sensors</b>	
<b>Nominal Range</b>	3000AAC
<b>Measurement Range</b>	10A to 6500AAC
<b>Probe Output Signal*</b>	140mVAC/3000AAC at 60Hz
<b>Sensor</b>	Length = 24" (610mm); Ø = 7.64" (190mm) Length = 36" (910mm); Ø = 11.46" (290mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 600V CAT IV, 1000V CAT III

\*Output is proportional to the amplitude and frequency of the measured current.

**NOTE:** Currents  $< 10\text{A}$  will be displayed as zero. Neutral current measures down to 0A.

<b>MiniFlex® Sensors</b>	
<b>Nominal Range</b>	1000AAC
<b>Measurement Range</b>	10A to 1000AAC
<b>Probe Output Signal*</b>	47µVAC/1000AAC at 60Hz
<b>Sensor</b>	Length = 10" (250mm); Ø = 2.75" (70mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 600V CAT IV, 1000V CAT III

\*Output is proportional to the amplitude and frequency of the measured current.

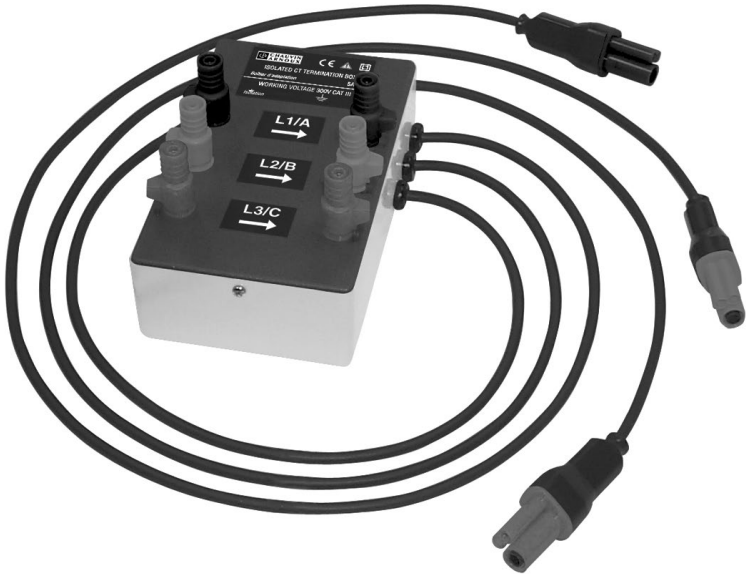
**NOTE:** Currents  $< 10\text{A}$  will be displayed as zero. Neutral current measures down to 0A.

<b>Model SL261</b>	
<b>Nominal Range</b>	10A to 100AAC
<b>Measurement Range</b>	100mV/A: 100mA to 10A peak 10mV/A: 1 to 100A peak
<b>Probe Output Signal</b>	1000mV peak max
<b>Maximum Clamping Diameter</b>	0.46" (11.8 mm)
<b>Safety</b>	EN 61010-2-032, Pollution Degree 2, 600V CAT III

**NOTE:** Currents  $< 0.5\text{A}$  will be displayed as zero. Neutral current measures down to 0A.



### 3.2.6 Three-phase 5A Adapter Box (3-Channel Use Only)



This adapter is a three-phase adapter with three 5AAC inputs L1, L2, L3 and three AC voltage outputs. All circuits are independent and isolated between input and output. The outputs are equipped with connectors to mate with the PowerPad® current channel inputs.

It facilitates automatic sensor recognition and probe ratio programming for both 1 Amp and 5 Amp output probes. Additionally, the adapter box can be used directly in series in a 5 Amp circuit.



**WARNING:** This adapter is rated EN 61010, 300V CAT III and permits the use of standard current probes with either a 1 or 5 Amp output.

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The input connections accept either  $\varnothing$  4mm male plugs or rigid leads between 1 and 2.5mm<sup>2</sup> inserted in the side hole after pressing the spring loaded connector down to expose the hole.

#### Connecting to Secondary Current Transformer (CT):



**WARNING:** Use caution when connecting to a secondary current transformer.

---

1. Short the two leads of each secondary current measurement transformer.

- Never open a secondary circuit of a CT if its primary circuit is connected to a supply voltage. In any case, disconnect the primary measurement transformer circuit from the supply network.
- Connect each CT secondary to the input of the 5A adapter in the correct order (ground on P2) and the right phase order L1, L2, L3.

### Adapter Box Specifications (add PowerPad® accuracy $\pm 0.5\% \pm 1ct$ ):

**Note:** Currents  $< (\text{Primary} \times 5) \div (\text{Secondary} \times 1000)$  will be displayed as zero on the PowerPad® with this probe.

<b>Range:</b>	5A
<b>Output / Input Ratio:</b>	0.2mV/mAAC
<b>Dimensions:</b>	6.00 x 3.74 x 3.38" (153 x 95 x 86mm)
<b>Weight:</b>	1.98 lbs (900g)
<b>Impermeability:</b>	IP50 per EN 60529 (electrical IP2X for the terminals)
<b>Electrical safety:</b>	Double Insulation, 300V CAT III Pollution Degree 2 per IEC 61010-1
<b>Operating Temperature:</b>	5° to 131°F (-15° to 55°C), 0 to 90% RH
<b>Storage Temperature:</b>	-40° to 185°F (-40° to 85°C), 0 to 90% RH
<b>Reference Conditions:</b>	73°F (23°C) $\pm 3K$ , 50 to 85% RH, 50/60Hz $\pm 2Hz$

### Current measurement according to IEC 44-1 Class 0.5

Range	5mA to 50mA	50mA to 1A	1A to 6A
Error %	0.35% + 1.5mA	0.25% + 1mA	0.25% + 0.5mA
Phase Error	0.5°	0.4°	0.33°

<b>Primary Voltage Loss:</b>	< 0.3V
<b>Permanent Overload:</b>	10A
<b>Temperature Influence:</b>	< 0.1% par 25K

Frequency Influence	65Hz to 500Hz	500Hz to 1kHz	1kHz to 5kHz
Error	0.1%	0.3%	0.5%
Phase error	0.1°	0.2°	1°

## 3.2.7 Power Supply

**AC Power** (external power supply) - 600V CAT IV; 1000V CAT III

**Operating Range:** 230VAC  $\pm 10\%$  @ 50Hz and 120VAC  $\pm 10\%$  @ 60Hz

**Max Power:** 65VA

**Battery Power** (allows use in the event of an interruption)

**Type:** 8 NiMH 4000mAh min

**Rated Voltage:** 9.6V

**Charge Time:** 5 hrs approx

**Battery Life:** 10 hrs (completely charged) approx  
35 hrs (recording in progress) approx

**Operating Temperature:** 32° to 122°F (0° to 50°C)

**Recharging Temperature:** 50° to 104°F (10° to 40°C)

**Storage Temperature:** -4 to +122°F (-20 to +50°C) for ≤ 30 days



**NOTE:** When the charger is connected, the battery starts to charge and the ON/OFF button will stay illuminated. Once the battery is charged, the instrument uses the current supplied by the power supply, without drawing from the battery.

### 3.3 Mechanical Specifications

**Dimensions:** 7.9 x 9.8 x 2.6" (200 x 250 x 67mm)

**Weight:** 4.3 lb (1950g) with batteries

**Shock and Vibration:** per EN 61010-1

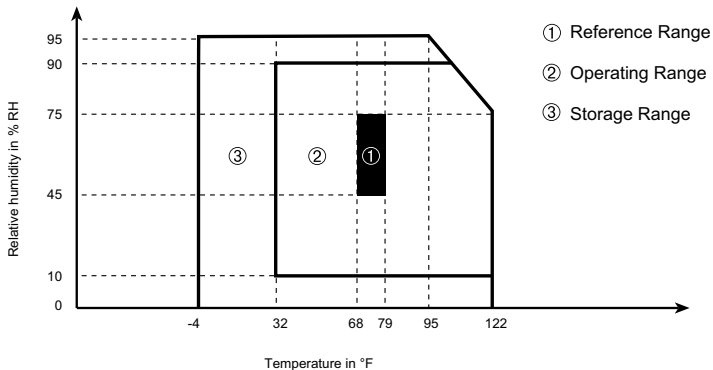
**Tightness:** IP 50 per EN 60529 (*electrical IP2X for terminals*)

### 3.4 Environmental Specifications

**Altitude:** Operating: 0 to 2000 meters (6560 ft)

Non-Operating: 0 to 10,000 meters (32800 ft)

**Temperature and % RH:**





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**WARNING:** Above 104°F (40°C) the instrument can be used only from the battery or from the battery charger with the battery removed.  
It is not recommended to use the battery and charger at the same time.

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## 3.5 Safety Specifications

### Electrical Safety



EN 61010-1; 600V CAT IV\* (probe dependent - see § 3.2.5); Pollution Degree 2  
Indoor Use

**\*Warning:** The assigned voltage and measuring category of the “device + current probe” may differ from the characteristics of the device alone.

- The use of the AmpFlex®, MiniFlex® and SR probes rate the “device + probe” at **600V CAT IV** or **1000V CAT III**.
- The use of the MR193, MN93, MN193 and SL261 probes rate the “device + current probe” at **300V CAT IV** or **600V CAT III**.
- The use of the 5A adapter rates the “device + current probe” at **150V CAT IV** or **300V CAT III**.

### Electromagnetic Compatibility

Immunity: EN 61326-1:2006

- Resistance to electrostatic discharges (EN 61000-4-2)
  - 1<sup>st</sup> level : Gravity - 4 kV in contact  
Sanctions - CRITERION A
  - 2<sup>nd</sup> level : Gravity - 8 kV in the air  
Sanctions - CRITERION A
- Resistance to radiation (per EN 61000-4-3 and EN 61000-4-8)
  - Gravity: 10 V.m<sup>-1</sup>  
Sanctions: CRITERION B (THD<sub>A</sub> altered on Rogowski chain)
- Resistance to rapid transient bursts (EN 61000-4-4)
- Resistance to electric shocks (per EN 61000-4-5)
- Conducted RF interference (per EN 61000-4-6)
- Voltage interruption (per EN 61000-4-11)

*Specifications are subject to change without notice.*

# OPERATION


## 4.1 Getting Started



**NOTE:** Make sure the PowerPad® is fully charged before use.

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### Connecting:

- Start the instrument by pressing the  button.
- Configure the unit to obtain the required results and type of network (see § 4.3).
- Connect the current leads and sensors to the PowerPad®.
- Connect the ground and/or neutral lead to the network ground and/or neutral (when distributed), as well as the corresponding current sensor.
- Connect the L1 phase lead to the network L1 phase, as well as the corresponding current sensor
- Repeat the procedure for phases L2, L3 and N

**Note:** Complying with this procedure limits connection errors to a minimum and conserves time.

### Disconnecting:

- Proceed in the reverse order to connecting, always finishing by disconnecting the ground and/or neutral (when distributed)
- Disconnect the unit leads and power it down.
- Recharge the battery and recover the data registered where necessary.
- USB sockets can be used to connect the unit to any type of network.

### The following precautions for use must be complied with:

- Do not connect any voltages exceeding 1000Vrms in relation to the ground/earth.
- When connecting and disconnecting the batteries, check that measuring leads are disconnected.

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

**i** The current probes connected are identified every second. The scaling will automatically reset when a new probe is connected. When installing probes, face the arrow on the probe in the direction of the load. For the SL261 MN193 and 5A Box, the ratio needs to be programmed from the instrument menu or software.

## 4.2 Lead Connections

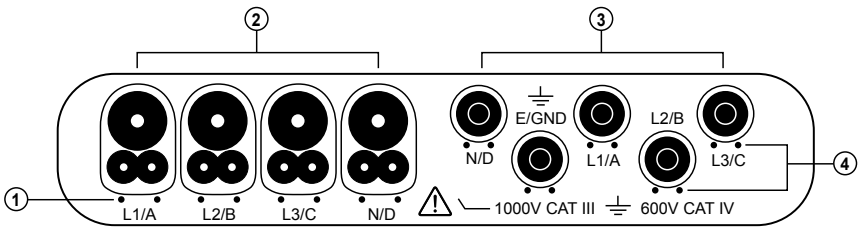



Figure 4-1


Item	Function
1	Location to plug in the current input color-coded ID markers
2	<p>Four current input connectors for current probes</p> <ul style="list-style-type: none"> <li>- <b>Current Measurement:</b> 4-point connector. Do not forget to define the transformation ratio on the 5A Adapter Box and MN193 on the 5A range. (See § 4.3.5)</li> </ul>
3	<p>Five voltage input connectors</p> <ul style="list-style-type: none"> <li>- <b>Voltage Measurement:</b> L1/A, L2/B, L3/C and N/D terminals</li> </ul>
4	Location to plug in the voltage input color-coded ID markers

Attach the color-coded input ID markers, that were shipped with the instrument, to items #1 and #4 above, to define the corresponding probe inputs and probe leads.

## 4.3 Instrument Configuration (Set-up mode)

**NOTE:** All configurations can be modified through DataView® software also.

 The instrument must be configured the first time it is used. The configuration is saved in memory when the instrument is turned OFF.

Press the  button to configure the unit. The following sub-menus appear:

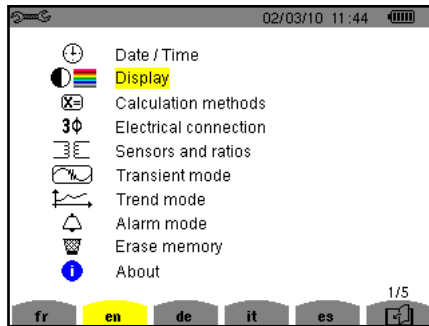





Figure 4-2

- Set the display language by pressing the yellow button corresponding to the screen language icons.
- The parameter that is ready to be configured will be highlighted in yellow. To move to a different parameter, use the ▲ and ▼ buttons.
- Press the Enter  button to select a parameter.
- Use the ◀ and ▶ buttons to change a value or setting.
- When finished, return to the Configuration menu by pressing the  button.

PARAMETER	FUNCTION
Date / Time	Sets the date and time format (see § 4.3.1)
Display	Adjusts the contrast and brightness of the display; Defines the color of the voltage and current curves (see § 4.3.2)
Calculation Methods	Determines if harmonics are used or not used in calculations of reactive quantities (power and energy) - (see § 4.3.3) <ul style="list-style-type: none"> <li>- <b>With harmonics:</b> Harmonics are taken into account when calculating reactive parameters.</li> <li>- <b>Without harmonics:</b> Only the fundamental part is used for the calculation of reactive parameters</li> </ul>
Electrical Connection	Determines the type of connection to the network (see § 4.3.4) <ul style="list-style-type: none"> <li>• Single-Phase</li> <li>• Split-Phase</li> <li>• 3-Phase 4-Wire</li> <li>• 3-Phase 5-Wire</li> </ul>

<b>Sensors &amp; Ratios</b>	Defines the type of current probe to connect (see § 4.3.5) <ul style="list-style-type: none"> <li>• MN93: 200A</li> <li>• MN193: 100A or 5A (with variable ratio)</li> <li>• SR193: 1000A</li> <li>• SL261: 10A and 100A range</li> <li>• AmpFlex® Sensors: 3000A (measures up to 6500Arms)</li> <li>• MiniFlex® Sensors: 1000A</li> <li>• MR193: 1000Aac/1200Aac</li> <li>• 5A three-phase adapter (3-channel only)</li> </ul>
<b>Transient Mode</b>	Configures the voltage and current thresholds (see § 4.3.7)
<b>Trend (Recording) Mode</b>	Selects the parameters to record (see § 4.3.8) (Up to 4 configurations)
<b>Alarm Mode</b>	Defines the parameters of an alarm (see § 4.3.9)
<b>Erase Memory</b>	Deletes configurations, alarm settings, snapshots and recordings (see § 4.3.10)
<b>About</b>	Displays the serial number, software and hardware version

### 4.3.1 Date/Time

The  parameter defines the system date and time. The display is as follows:

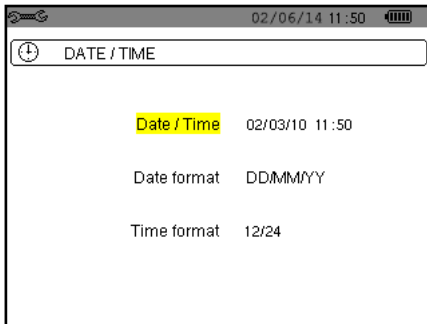







Figure 4-3

The Date/Time field is highlighted in yellow.

- To change the date/time, press the  button.
- To change a value or move from one field to another, press the  or  buttons.
- Press the  button to confirm configuration.



**NOTE: 12/24:** Display of time in 24-hour format. **AM/PM:** Display of time in 12-hour format. The time is followed by AM or PM.

To return to the *Configuration* menu, press the  button.



## 4.3.2 Display

### 4.3.2.1 Contrast/Brightness

The  menu is used to define the contrast and brightness of the display unit.

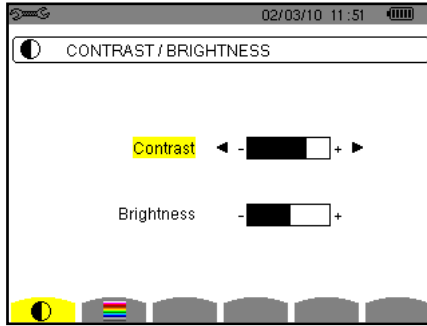




Figure 4-4

The selected field is highlighted in yellow.

- To modify the contrast, press ◀ or ▶.
- To move to the next field, press ▲ or ▼.
- To change the brightness, press ◀ or ▶.
- To return to the Configuration menu, press .

### 4.3.2.2 Colors

The  menu is used to define the colors of the voltage and current curves. The colors available are: green, dark green, yellow, orange, pink, red, brown, blue, turquoise blue, dark blue, light grey, grey, dark grey, and black.

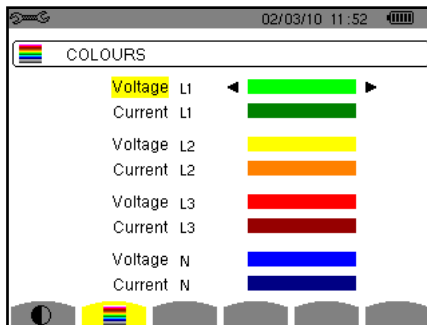


Figure 4-5

The selected field is highlighted in yellow.

- To select the color of the voltage and current curves, press ◀ or ▶.
- To move to the next field, press ▲ or ▼.
- To return to the Configuration menu, press ↶.

### 4.3.3 Calculation Methods

determines whether or not harmonics are used in calculating the reactive parameters (powers and energies).

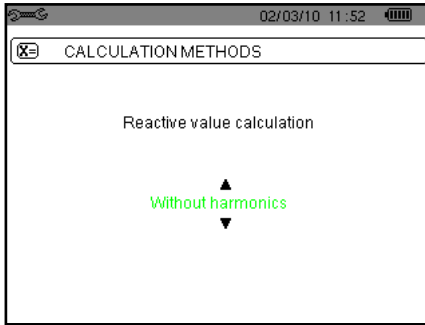



Figure 4-6

To select *With harmonics* or *Without harmonics*, press ◀ or ▶.

- *With harmonics*: Harmonics are taken into account when calculating reactive quantities.
- *Without harmonics*: Only the fundamental is used in calculations of the reactive quantities.

To confirm, press . Return to the *Configuration menu* is immediate. The parameters are applied only if confirmed.

### 4.3.4 Connection

The  $3\phi$  menu is used to define how the Model 8335 is connected, according to the type of network.

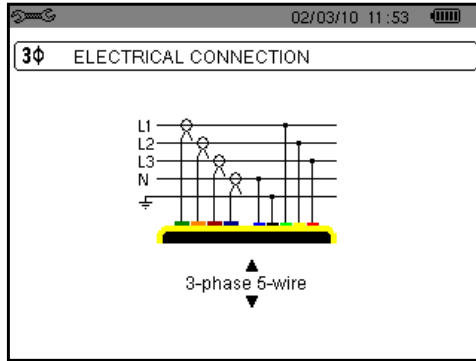


Figure 4-7

Example of the selectable electrical diagrams:

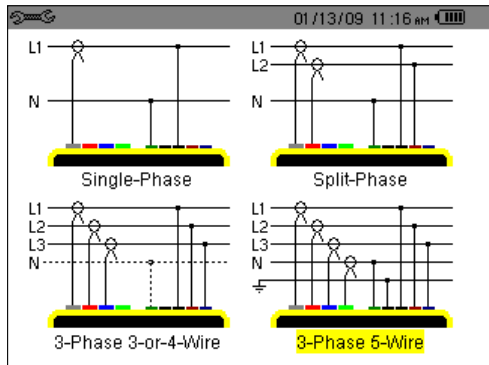




Figure 4-8

To configure the type of connection, proceed as follows:

- Select *Single-Phase*, *Split-Phase*, *3- or 4-wire Three-Phase*, or *5-wire Three-Phase* by pressing ▲ or ▼.
- Validate by pressing  (the parameters are applied only if confirmed). Return to the Configuration menu is immediate.

### 4.3.5 Sensors and Ratios

A first screen  is used to define the current sensors and ratios. It automatically displays the current sensor models detected by the device. It can also be used to define the transformation ratio (sensitivity) of certain current sensors (SL261 clamp).

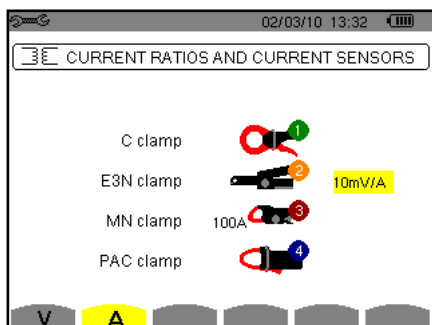










Figure 4-9

The probe choices are:


	MN93 clamp: 200A
	MN193 clamp: 100A or 5A
	SR clamp: 1000A
	AmpFlex® A193: 6500A
	MiniFlex® MA193: 6500A
	MR clamp: 1000A
	SL261 clamp: 100A (sensitivity 10mV/A)
	SL261 clamp: 10A (sensitivity 100mV/A)
	Three phase adapter: 5A

If an *MN193 clamp*, *5A range*, or an *Adapter* is used, the current ratio setting is proposed automatically. The configuration is done as follows:

- To configure the primary circuit current (1A to 60,000A) / secondary circuit current (1A, 2A, or 5A) transformation ratio, press . To select the fields, use ◀ or ▶.
- To select the values, use ▲ or ▼. Proceed in the same way for the primary and secondary circuit currents.
- To validate, press  (the parameters are applied only if confirmed).

The primary current cannot be less than the secondary current.

### 4.3.6 Voltage Ratios

A second  screen, invoked by the **V** icon, defines the voltage ratios.

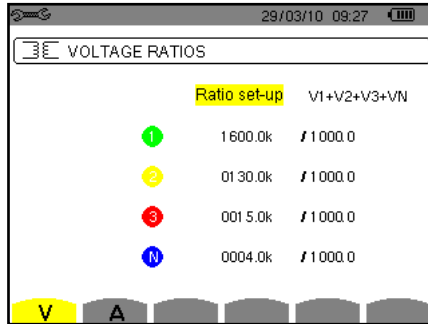







Figure 4-10

The ratios programmed may be the same in all channels, or different in some or all of them.

- To configure the ratios, press , then use the  $\blacktriangle$  or  $\blacktriangledown$  key and validate by pressing .
- To select the fields, use the  $\blacktriangleleft$  or  $\blacktriangleright$  key. To select the values, use the  $\blacktriangle$  or  $\blacktriangledown$  key. To validate, press  (the parameter must be validated to be applied).
- To return to the *Configuration* menu, press .

For the primary voltage (in kV) and the secondary voltage (in V), it is possible to specify the use of the multiplier  $1/\sqrt{3}$ . If the phase-to-neutral voltage ratios of phases 1, 2 and 3 are not identical, then all measurements and curves concerning the phase-to-phase voltages are suppressed.

## 4.3.7 Transient Mode Configuration

The  mode is used to configure the voltage and current thresholds.

### 4.3.7.1 Current Thresholds

A first screen defines the current thresholds for each current sensor recognized.

The thresholds programmed can be the same for all channels or different for some or all of them.

An example of programming of four independent thresholds:

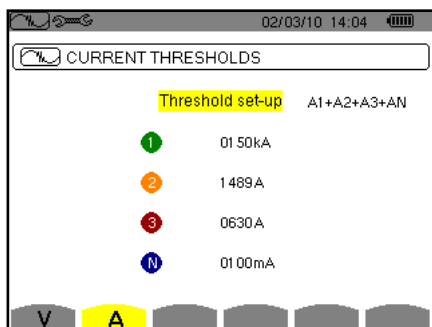















Figure 4-11

To program the current threshold for the search for a transient, proceed as follows:

- Select the *Configuration of thresholds* field, highlighted in yellow, by pressing . The arrows appear in the field.
- Use the  or  key to go from one type of configuration to another.
- Press  to validate the choice of configuration.
- Select the field of the first threshold using the  or  key. The selected field is highlighted in yellow. Press  to enter the values. The arrows appear in the field.
- Use the  or  key to increment or decrement a value and  or  to go to the next item.
- Press  to validate the programming of the threshold.

It is possible to configure the current thresholds in mA, A, or kA.

### 4.3.7.2 Voltage Thresholds

A second  screen, displayed by pressing the **V** icon, is used to define the voltage thresholds.

The thresholds programmed can be the same for all channels or different for some or all of them.

An example of programming of four independent thresholds:

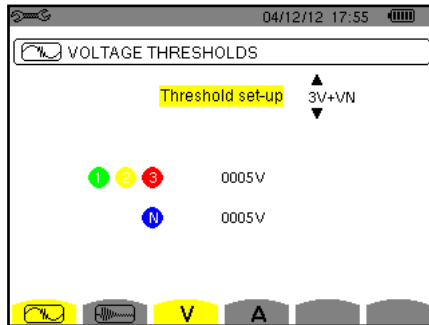






Figure 4-12


To program the voltage threshold to search for a transient, proceed as follows:

- Select the *Configuration of thresholds* field, highlighted in yellow, by pressing . The arrows appear in the field.
- Use the **▲** or **▼** key to go from one type of configuration to another.
- Press  to validate the choice of configuration.
- Select the field of the first threshold using the **▲** or **▼** key. The selected field is highlighted in yellow. Press  to enter the values. The arrows appear in the field.
- Use the **▲** or **▼** key to increment or decrement a value and **◀** or **▶** to go to the next item.
- Press  to validate the programming of the threshold. Proceed in the same way for the fields of the other thresholds.

To return to the *Configuration* screen, press .

The voltage thresholds can be configured in V or in kV.

### 4.3.8 Trend Recording Mode Configuration

The Model 8335 has a recording function key  for recording measured and calculated values (Urms, Vrms, Arms, etc.). Four independent configurations can be configured as needed.

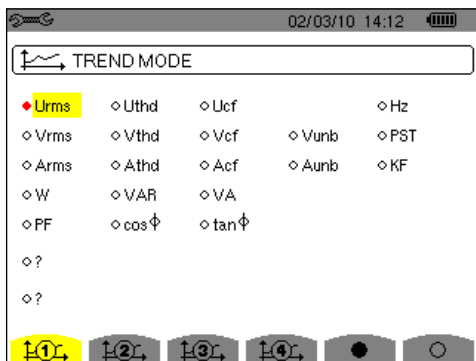









Figure 4-13

- Choose the configuration by pressing the yellow button corresponding to the icons     .
- Next, move through the choices with the ◀ and ▶ buttons and select the desired parameters with the ▲ and ▼ buttons. As you move through the parameters, each choice, in turn, will be highlighted.
- To activate the selected parameter to record, use the  button.
- The selected parameters will have a filled in  and those not selected will have an unfilled .

#### The recordable values are:






Value	Description
Urms	Phase-to-phase voltage (2φ, 3φ)
Vrms	Phase-to-neutral voltage
Arms	Phase A, B, C, N
W	Active power
PF	Power factor
Uthd	Harmonic distortion of line voltage (2φ, 3φ)
Vthd	Full harmonic distortion of phase-to-neutral voltage
Athd	Full harmonic distortion of current
VAR	Reactive power
DPF	Displacement factor
Ucf	Crest factor of phase voltage (2φ, 3φ)
Vcf	Crest factor of phase-to-neutral voltage
Acf	Crest factor of current
VA	Apparent power
Tan	Tangent



<b>Vunb</b>	Line voltage unbalance (2 $\phi$ , 3 $\phi$ )
<b>Aunb</b>	Current unbalance (2 $\phi$ , 3 $\phi$ )
<b>Hz</b>	Network frequency
<b>PST</b>	Short-term flicker
<b>KF</b>	K factor
<b>?</b>	See comment below


There are two user-defined parameters at the bottom of the window. At first, they will be listed as a question mark “?”. These parameters allow you to monitor a range of harmonics for voltage, current or power.

### To activate these parameters:

- Select the ? line you want to modify using the ▲ and ▼ buttons, then press the  button to confirm.
- Next use the ▲ and ▼ buttons to scroll through the available choices (**Uh**, **Vh**, **Ah**, and **VAh**), then press .
- Use the ► button to move to the first modifiable field for this parameter. A value from 00 to 50 may be selected using the ▲ and ▼ buttons. Press the  button to select the value.
- Press the ► button to move to the upper value. Use the same process to select the upper limit.
- Press the ► button again to move to the right to modify the last value needed to complete the definition. Here you will choose whether to include all harmonics or only the odd harmonics.
- Use the ▲ and ▼ buttons to make this selection. The diamond preceding the **Odd Only** choice will appear filled in  for selected and unfilled  for not selected.

**Example of a user defined choice:** Vh 02 → 15  Odd Only.


In this user defined condition, all odd voltage harmonics between the 2<sup>nd</sup> and the 15<sup>th</sup> will be recorded.

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



The battery may fully discharge when recording for long periods of time while not connected to a power supply. The Model 8335 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 Model 8335 with the power cord and the display will come back ON when any button (other than ON/OFF) is pressed.

### 4.3.9 Alarm Mode Configuration

The  screen defines the alarms used by the *Alarm Mode* function (see § 8). You can configure 40 different alarms.

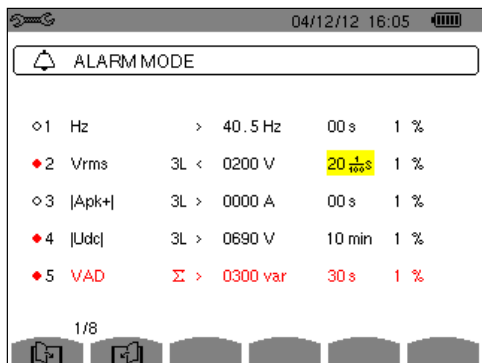






Figure 4-14

- There are five user-defined parameters. At first, they will be listed as a question mark “?” Select the line you want to modify using the ▲ and ▼ buttons, then press the  button to confirm.
- Use the ▲ and ▼ buttons to browse and select the value, then press the  button to confirm the choice.
- To navigate horizontally, use the ◀ and ▶ buttons, then confirm with . Select the values with the ▲ and ▼ buttons, then confirm with .

#### For each alarm to define, select:

- The type of alarm (Vah, Ah, Uh, Vh, Tan, PF, DPF, VA, VAR, W, Athd, Uthd, Vthd, KF, Hz, Aunb, Vunb, Vrms, Acf, Ucf, Vcf, PST, Arms, Urms and Vrms).
- The harmonics range (between 0 and 50 for Vah, Ah, Uh and Vh).
- The alarm filter (3L: 3 individually monitored phases or N: monitoring neutral or Sigma/2 or Sigma/3 or Sigma).
- The meaning of the alarm (> or < for Arms, Urms, Vrms, Hz only, otherwise the direction is unique).
- The threshold for triggering the alarm (10 possible settings of the alarm in the following cases: W, VAR and VA).
- The minimum duration for exceeding alarm validation threshold (in minutes, seconds, or for Vrms, Urms and Arms, in hundredths of seconds).
- The hysteresis value (corresponds to the percentage added or taken away from the alarm threshold chosen that will stop the alarm in the event of overrun - Value 1, 2, 5 or 10%).
- Activating the alarm (read item) or deactivating it.

- After the configuration has been completed, activate the alarm by positioning the yellow cursor in the first column on the left using the ◀ button, press ⏏. Activation is confirmed if there is a filled in ♦ to the left of the alarm.
- To display the alarm screen pages, press the yellow buttons corresponding to the 📄 and 📄 icons.

### 4.3.10 Erasing Memory

When **Erase Memory** is selected, the following screen will appear:



Figure 4-15

#### To Erase Partially:

- Select the recording from the Trend, Transient or Alarm file that you want to delete using the ▲ and ▼ buttons, then press ⏏. Validation is confirmed by the ♦ to the left of the selected parameter.
- To complete the deletion, press the yellow button corresponding to the 🗑️ icon, then press the ⏏ button to confirm.

#### To Erase All:

- Press the yellow button corresponding to the ● icon, then press ⏏. Validation is confirmed by the ♦ to the left of all parameters.
- To deselect a parameter, press the yellow button corresponding to the ○ icon.
- To complete the deletion, press the yellow button corresponding to the 🗑️ icon, then press the ⏏ button to confirm.




**WARNING:** By choosing to delete all data, **all** detected alarms, screen snapshots, captured transient states and all recordings are deleted.

To leave this screen without deleting anything, press the ↶ button.

## DISPLAY MODES

To select parameters in all modes, use the ◀▶▲▼ buttons to move to the desired parameter and use the ↵ button to confirm selections.

### 5.1 Waveform Capture Mode

Press the Waveform Display mode  button. The *Waveform Capture* screen appears with two submenus.

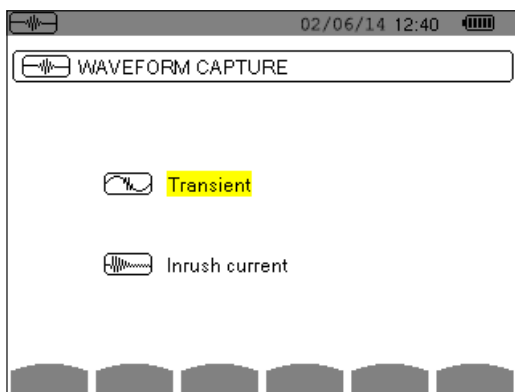


Figure 5-1

Select either the **Transient mode (§ 5.1.1)** or the **Inrush Current mode (§ 5.1.2)** using the ▲ and ▼ buttons, then confirm with ↵.

To return to the *Waveform Capture* screen, press .

#### 5.1.1 Transient Mode

This mode enables transients to be recorded, the list of recorded transients to be viewed, and if necessary, deleted. All tracks are stored in memory for each transient (regardless of the connection configuration). You can record up to 210 transients.

**NOTE:** When the Transient mode is selected, the display screen will depend on the following conditions:

if ...	then ...
no record has been made	the <i>Detection Schedule</i> screen is displayed
transients have been recorded	the <i>Recording List</i> screen is displayed

### 5.1.1.1 Programming and Starting a Search

To program the search for a transient, proceed as follows:

Select the submenu by pressing the  icon's yellow button. The *Detection Schedule* screen is displayed.

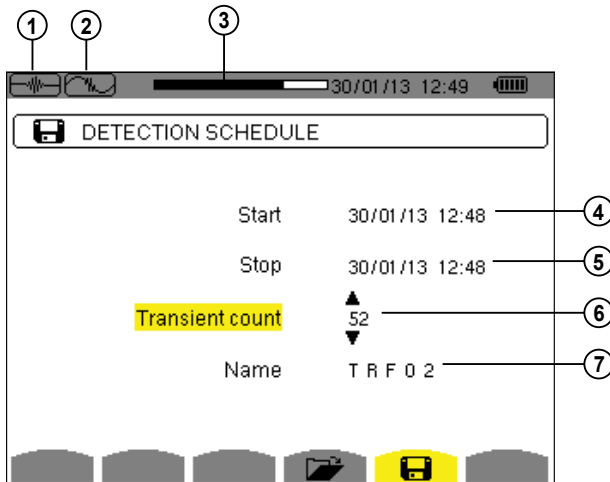



Figure 5-2

Item	Function
1	Reminder of the mode used
2	Display of sub-mode used
3	Memory indicator. Black area = used memory; White area = available memory
4	Transients search start time
5	Transients search end time
6	Number of transients
7	Name of transient

#### To Configure and Start the Programming of a Search:

1. Select and set the desired configurations for the Start/Stop date and time, the Voltage and Current threshold, Count and Series name.
2. To start programming a search between the start and end times which you have defined press the yellow button for the **OK** icon.
  - The **OK** icon disappears and the  icon appears instead.
  - When the start time is reached the message *Detection in progress* is displayed.
  - When the stop time is reached, the **OK** icon (bottom right of screen) is displayed again. It is then possible to program a new search.



Transients are recorded in relation to the voltage and/or the current in accordance with the configured activation thresholds. If an activation occurs in relation to the current, a record of the current waveform and voltage is made.

### 5.1.1.2 Stopping a Search

The search can be manually stopped before the end time and date by pressing the icon's yellow button. The **OK** icon will reappear in the same location.

### 5.1.1.3 Displaying a Transient

To display the recorded transient, proceed as follows:

1. Select the submenu by pressing the icon's yellow button. The *Transient List* screen is displayed.

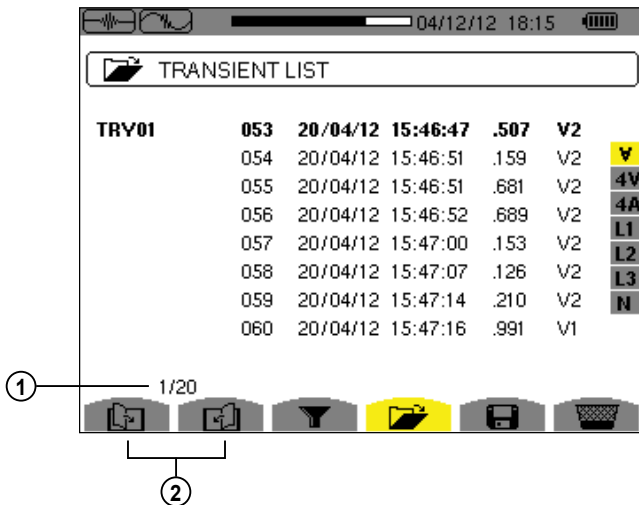


Figure 5-3

Item	Function
1	The displayed value indicates the page number and the number of pages.
2	These icons let you browse through the previous and next screens. Press the yellow buttons corresponding to these icons to display the pages.

2. Select the line of the transient to be displayed. The selected field appears in bold text. The screen displays the transients in the form of graphs.

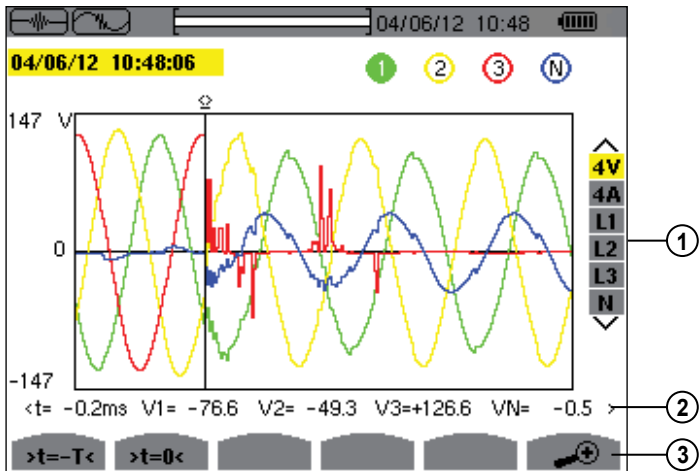


Figure 5-4

Item	Function
1	Selection of graphs to be displayed - <b>4V</b> : displays the 4 single voltages during the transient (here in a 5-wire tri-phase connection) - <b>4A</b> : displays the 3 currents and the neutral current during the transient - <b>L1, L2 or L3</b> : displays the current and the single voltage successively in relation to phases 1, 2 and 3 - <b>N</b> : displays neutral
2	Instantaneous value of the signals according to the position of the cursor on the scale. To move the cursor use the ▲ and ▼ buttons.
3	🔍: Zoom In - To zoom in press the yellow keypad key for the icon.

3. To return to the *Transient List* screen, press ↶.


#### 5.1.1.4 Deleting a Transient

From the *Transient List* screen (see § 5.5.3), press the 🗑️ icon's yellow button. Select the transient to be deleted using the ▲ and ▼ buttons, then press the ↵ symbol.

To leave this screen without deleting, press any of the Mode buttons on the PowerPad®.

To return to the *Waveform Capture* screen, press ↶.

## 5.1.2 Inrush Current Mode


The  mode is used to capture (record) inrush currents and to view and delete the recordings. In capture display mode, two sub-menus **RMS** and **PEAK** are available. Only a single current inrush capture is kept in memory.

**NOTE:** When Inrush Current mode is selected the display screen will depend on the following conditions:

if ...	then ...
no capture has been made	the <i>Capture Schedule</i> screen is displayed
captures have been made	the <i>Capture Parameters</i> screen is displayed

### 5.1.2.1 Programming a Capture

To program the capture of an inrush current, proceed as follows:

1. Select the sub-menu by pressing the  icon's yellow button. The *Capture Schedule* screen is displayed.

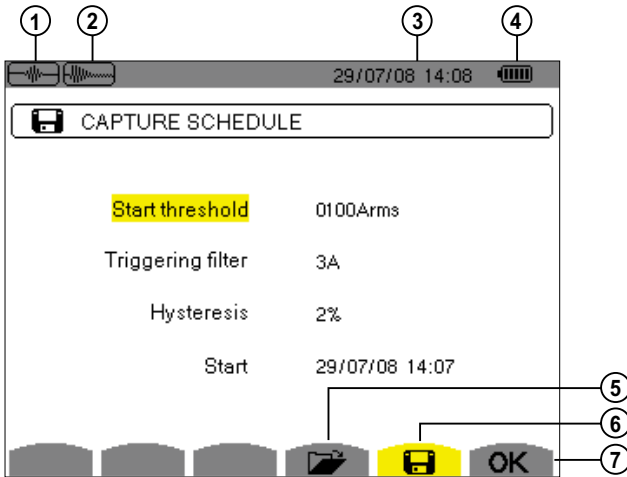





Figure 5-5

Item	Function
1	Reminder of the mode used
2	Display of sub-mode used
3	Current date and time
4	Battery charge level
5	Displays the parameters of the capture
6	Programs the capture
7	<b>OK:</b> confirms programming of a capture  : deletes a capture (this icon is displayed if a capture has been made)



2. Select the **Start threshold** field using the ▲ and ▼ buttons. The selected field is highlighted in yellow. Press  to enter the type of values.  
Use the ▲ and ▼ buttons to increase or decrease a value and press ◀ and ▶ buttons to switch to the next value field.


3. Press  to confirm programming of the activation threshold.

Proceed in the same manner for the **Triggering filter**, **Hysteresis** and **Start** fields.

**Note:** For more information on the hysteresis, refer to Appendix A: Mathematical Formulas.

### 5.1.2.2 Starting a Capture

To start the capture at the defined start date and time defined previously, press the yellow button corresponding to the **OK** icon.

- The **OK** icon disappears and the  icon appears instead.
- When the activation conditions are met and the start time is reached, the message *Capture pending* is displayed and the memory indicator appears at the top of the screen.



- The indicator is displayed **only** during the capture and disappears when the capture is completed.
- If the capture is completed with a stop event or if the memory is full, the capture stops automatically. The *Capture Schedule* screen with the **OK** icon (bottom right of screen) is displayed again.




The PowerPad® can keep only a single current waveform capture in memory. If you wish to make another capture, delete the previous one first.

---


To return to the *Waveform Capture* screen, press .

### 5.1.2.3 Manually Stopping a Capture

The capture can be manually stopped by pressing the  icon's yellow button. The **OK** icon will reappear in the same location.

### 5.1.2.4 Displaying the Parameters of a Capture

To display the parameters of a capture, proceed as follows:

1. Select the sub-menu by pressing the  icon's yellow button. The *Capture Parameters* screen is displayed.

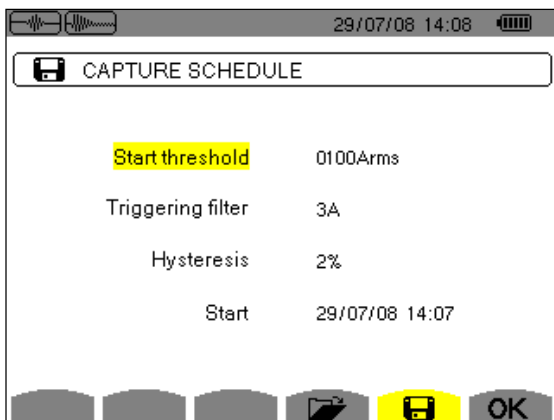


Figure 5-6

Choose the type of display, **RMS** or **PEAK**, by pressing the yellow key corresponding to the icon. The Model 8335 displays curves on which you can move the time cursor and zoom in and out.

#### In the **PEAK** display, the available information is:

- The instantaneous current and voltage at the time indicated by the cursor (in a “waveform” representation).
- The maximum instantaneous current and voltage in the half-cycle indicated by the cursor (in an “envelope” representation).
- The maximum instantaneous absolute value of the current and voltage (over the entire capture).

#### In the **RMS** display, the available information is:

- The instantaneous frequency at the time indicated by the cursor.
- The minimum, mean, and maximum instantaneous values of the frequency over the entire capture.
- The RMS current and voltage in the half-cycle (or lobe) on which the cursor is positioned.
- The maximum half-cycle RMS current and voltage (over the entire capture).



A voltage must be present on the phase before the motor start-up for a stable and correct frequency control.

### 5.1.3 True RMS Current and Voltage

The **RMS** mode displays the record of the trend of the true half-cycle RMS current and voltage and the frequency trend curve.

#### 5.1.3.1 RMS Display Screen (3A)

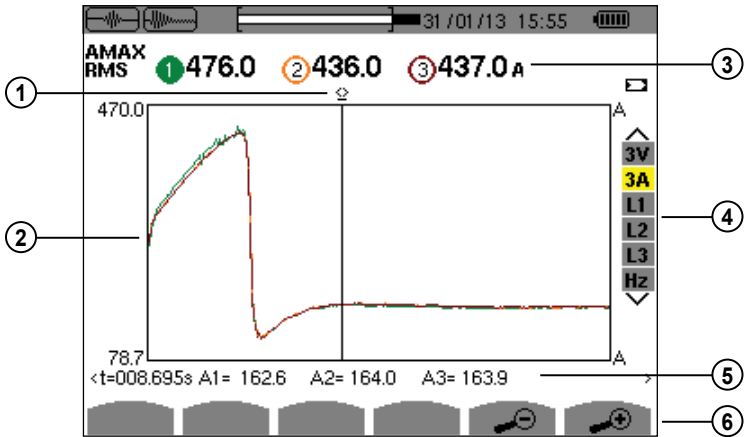


Figure 5-7

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Scale of values in amperes
3	<ul style="list-style-type: none"> <li>- Maximum half-period RMS value of the inrush current capture</li> <li>- Indicator of number attributed to the displayed curve</li> <li>- Value of the measured current</li> </ul>
4	Selection of curves to be displayed: <ul style="list-style-type: none"> <li>- 3V: displays the 3 voltages during the inrush current capture</li> <li>- 3A: displays the 3 currents during the inrush current capture</li> <li>- L1, L2, L3: display the current and voltage in phases 1, 2, and 3, respectively</li> <li>- Hz: displays the evolution of the network frequency vs time</li> </ul>
5	<ul style="list-style-type: none"> <li>- t: relative time position of the cursor (t = 0 corresponds to the start of the inrush capture)</li> <li>- A1, A2, A3: RMS values of currents 1, 2 and 3 at the position of the cursor</li> </ul>
6	<ul style="list-style-type: none"> <li>◀ : Zoom Out - press the yellow key on the keypad corresponding to the icon</li> <li>▶ : Zoom In - press the yellow key on the keypad corresponding to the icon</li> </ul>

### 5.1.3.2 RMS Display Screen (L1)

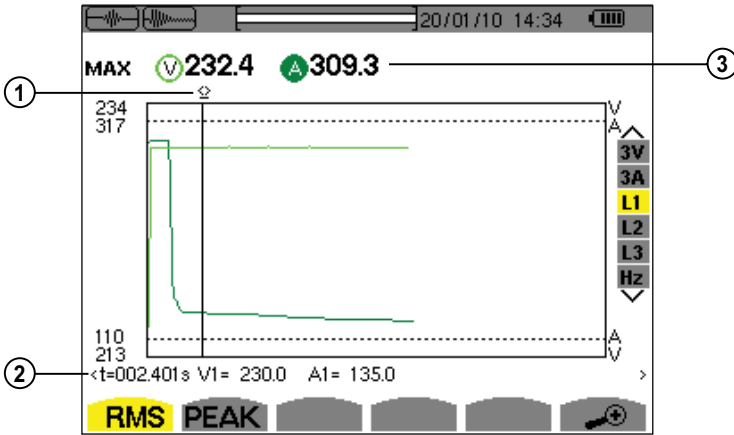


Figure 5-8

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	<ul style="list-style-type: none"> <li>- t: relative time position of the cursor (t = 0 corresponds to the start of the inrush capture)</li> <li>- V1: RMS value of voltage 1 in the half-cycle at the position of the cursor</li> <li>- A1: RMS value of current 1 in the half-cycle at the position of the cursor</li> </ul>
3	<ul style="list-style-type: none"> <li>- MAX: maximum half-cycle RMS value of the inrush current capture</li> <li>- V: measured voltage</li> <li>- A: measured current</li> </ul>

**NOTE:** Filters L2 and L3 display the trend of the true half-cycle RMS current and voltage of phases 2 and 3. The screen is identical to the one displayed for filter L1.

## 5.1.4 Instantaneous Inrush Current

The **PEAK** mode is used to display the envelopes and waveforms of the inrush current capture.

### 5.1.4.1 PEAK Display Screen (4A)

The **PEAK** display of an inrush current capture provides two possible types: Envelope and Waveform.

Switching between the two types is automatic, and is determined by the zoom. In the case shown, there is enough zoom in to force the waveform type of representation. The display filters along the right edge of the screen depend on the type of representation, and on the zoom.

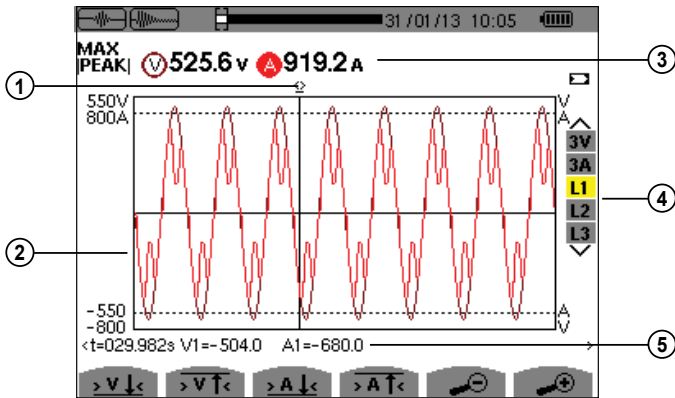


Figure 5-9

Item	Function
1	Instantaneous value cursor; change values with the ◀ and ▶ buttons
2	Scale of values in amperes
3	<ul style="list-style-type: none"> <li>- <b>AMAX</b>: absolute value</li> <li>- Indicator of number attributed to the displayed curve</li> <li>- Value of the measured current</li> </ul>
4	Selection of curves to be displayed: <ul style="list-style-type: none"> <li>- <b>4V</b>: displays the 4 voltages during the inrush current capture</li> <li>- <b>4A</b>: displays the 4 currents during the inrush current capture</li> <li>- <b>L1, L2, L3</b>: display the current and voltage in phases 1, 2, and 3, respectively</li> <li>- <b>N</b>: displays the neutral current and neutral voltage during the inrush current capture</li> </ul>
5	<ul style="list-style-type: none"> <li>- <b>t</b>: relative time position of the cursor (t = 0 corresponds to the start of the inrush capture)</li> <li>- <b>A1, A2, A3</b>: instantaneous values of currents 1, 2 and 3 at the position of the cursor</li> </ul>

### 5.1.4.2 PEAK Display Screen (A1)

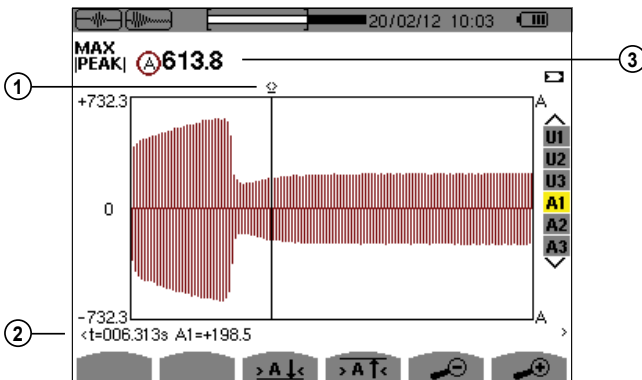


Figure 5-10



Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	- <b>t</b> : relative time position of the cursor (t = 0 corresponds to the start of the inrush capture) - <b>A1</b> : maximum instantaneous current of the half-cycle identified by the cursor
3	- <b>AMAX</b> : maximum instantaneous absolute value of the inrush current capture

**NOTE:** Filters A2 and A3 display the record of the current envelope of phases 2 and 3. The screen is identical to the one displayed for filter A1.

## 5.2 Harmonics Mode

Press the Harmonic Display mode button - .

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

<p><b>V</b> - Phase-to-neutral voltage analysis</p> <p><b>A</b> - Harmonics of the current analysis</p> <p><b>VA</b> - Apparent power of the harmonics analysis</p> <p><b>U</b> - Phase-to-phase voltage analysis</p> <p>The  and  buttons allow the user to zoom in or out, in increments of 2%, 5%, 10%, 20%, 50% and 100%.</p>
---

### 5.2.1 Phase-to-Neutral Voltage

The **V** sub-menu displays the harmonics of the phase-to-neutral voltage.

**NOTE:** The choice of curves to be displayed depends on the type of connection (see § 4.3.4):

- Single-phase: no choice (L1)
- Split-phase: 2L, L1, L2
- Three-phase, 3-, 4-, or 5-wire: 3L, L1, L2, L3, -, +

The screen snapshots shown in this section as examples were obtained with a three-phase connection. This observation also applies to the other sub-menus.

### 5.2.1.1 Phase-to-Neutral Harmonics Display Screen (3L)

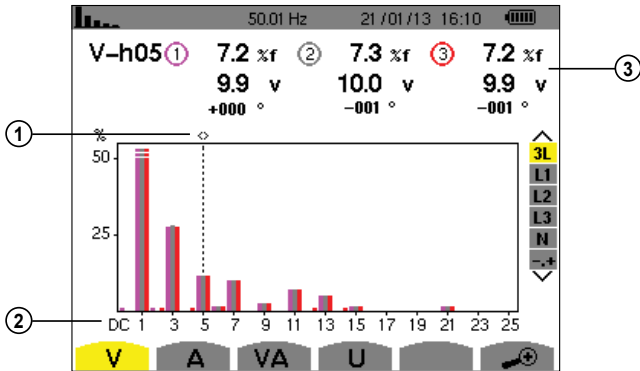


Figure 5-11

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1) - DC: DC component - 1 to 25: harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears
3	- Vh 05: harmonic number - %: ratio of the harmonic to the fundamental - V: RMS voltage of the harmonic in question - +000°: phase shift with respect to the fundamental (order 1)

Display in expert mode **-.+** (on the right-hand side) is available for 3-Phase hook-ups by pressing the ▲ and ▼ buttons.

### 5.2.1.2 Phase Voltage Harmonics Display Screen (L1)

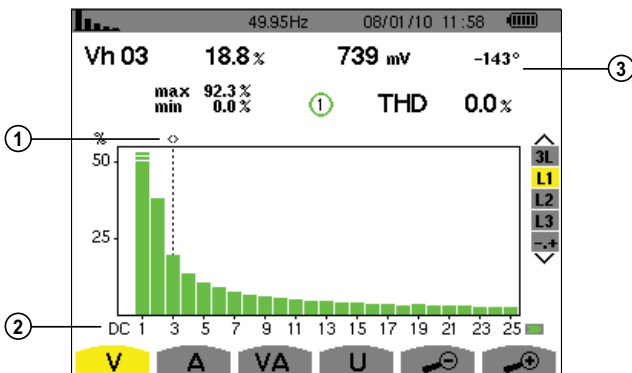



Figure 5-12

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1) <b>DC</b> : DC component <b>1 to 25</b> : harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears  : indicator of the presence of non-zero harmonics of order higher than 25
3	<b>Vh 03</b> : harmonic number <b>%</b> : ratio of the harmonic to the fundamental <b>V</b> : RMS voltage of the harmonic in question <b>+000°</b> : phase shift with respect to the fundamental (order 1) <b>max – min</b> : maximum and minimum levels of the harmonic in question (reset when the harmonic number is changed or the ↵ key is pressed) <b>THD</b> : total harmonic distortion

**NOTE:** Filters L2 and L3 display the harmonics of the phase-to-neutral voltage for phases 2 and 3, respectively. The screen is identical to the one displayed for filter L1.

## 5.2.2 Current

The **A** sub-menu displays the harmonics of the current.

### 5.2.2.1 Current Harmonics Display Screen (3L)

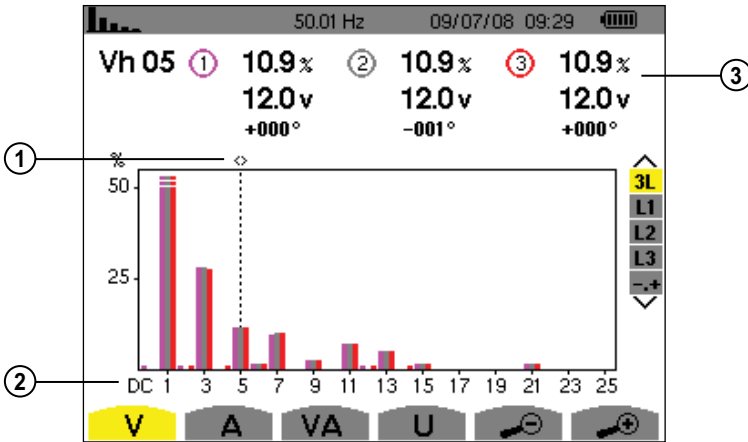


Figure 5-13



Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1) <b>DC</b> : DC component <b>1 to 25</b> : harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears
3	<b>Ah 05</b> : harmonic number <b>%</b> : ratio of the harmonic to the fundamental <b>A</b> : RMS current of the harmonic in question <b>+000°</b> : phase shift with respect to the fundamental (order 1)

### 5.2.2.2 Current Harmonics Display Screen (L1)

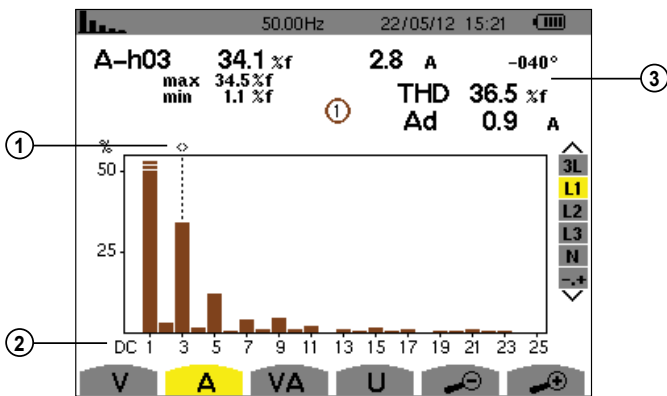


Figure 5-14

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1) <b>DC</b> : DC component <b>1 to 25</b> : harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears <span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span> : indicator of the presence of non-zero harmonics of order higher than 25
3	<b>Ah 03</b> : harmonic number <b>%</b> : ratio of the harmonic to the fundamental <b>A</b> : RMS current of the harmonic in question <b>+000°</b> : phase shift with respect to the fundamental (order 1) <b>max – min</b> : maximum and minimum levels of the harmonic in question (reset when the harmonic number is changed or the ◀ button is pressed) <b>THD</b> : total harmonic distortion

**NOTE:** Filters L2 and L3 display the current harmonics of phases 2 and 3, respectively. The screen is identical to the one displayed for filter L1.

## 5.2.3 Apparent Power

The VA sub-menu displays the harmonics of the apparent power.

### 5.2.3.1 Apparent Power Harmonics Display Screen (3L)

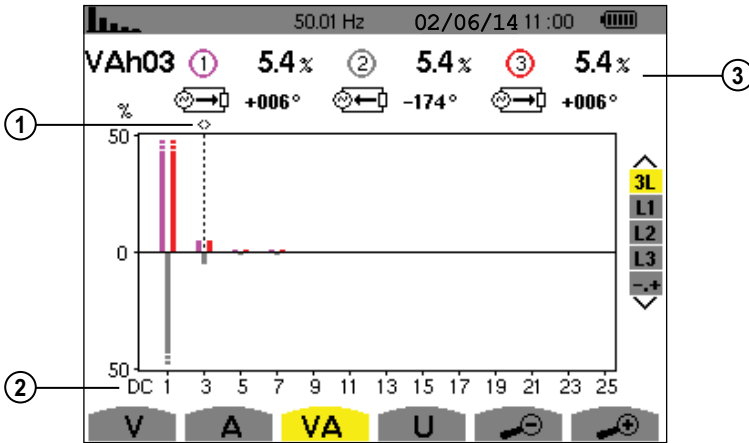


Figure 5-15

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1) - DC: DC component - 1 to 25: harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears
3	- VAh 03: harmonic number - %: ratio of the harmonic to the fundamental - +000°: phase shift of the voltage harmonic with respect to the current harmonic for the order in question ◀→: Indicator of energy generated for this harmonic →: Indicator of energy consumed for this harmonic

### 5.2.3.2 Apparent Power Harmonics Display Screen (L1)

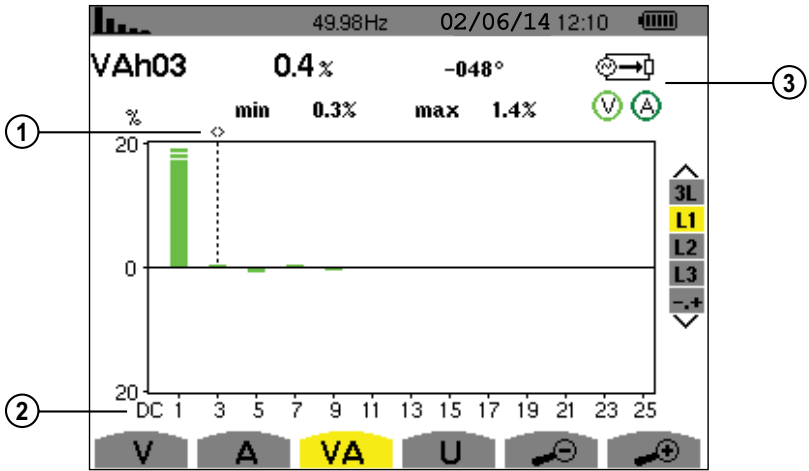


Figure 5-16

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	<p>The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1)</p> <p>- DC: DC component</p> <p>- 1 to 25: harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears</p> <p>↻: Indicator of energy consumed for this harmonic</p>
3	<p>- VAh 03: harmonic number</p> <p>-%: ratio of the harmonic to the fundamental</p> <p>+000°: phase shift of the voltage harmonic with respect to the current harmonic for the order in question</p> <p>max – min: maximum and minimum levels of the harmonic in question (reset when the harmonic number is changed or the ↻ key is pressed)</p>

**NOTE:** Filters L2 and L3 display the apparent power of the harmonics for phases 2 and 3, respectively. The screen is identical to the one displayed for filter L1.

## 5.2.4 Phase-to-Phase Voltage

The U sub-menu is available only for three-phase connections, when the voltage ratios of phases 1, 2, and 3 are equal. This sub-menu displays the harmonics of the phase-to-phase voltage.

### 5.2.4.1 Phase-to-Phase Voltage Harmonics Display Screen (3L)

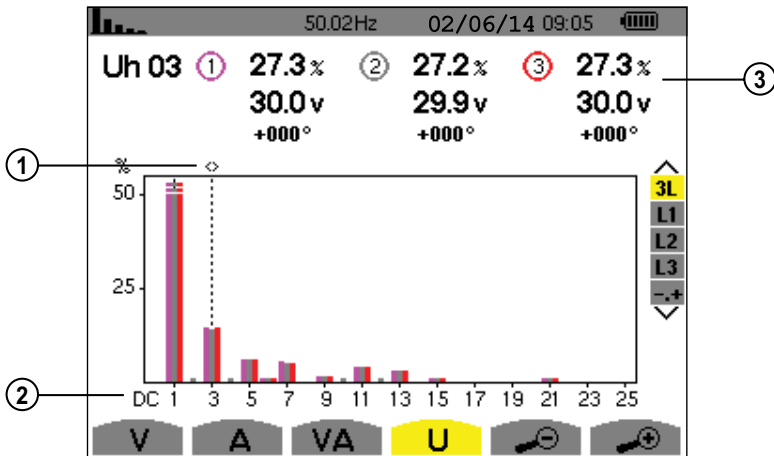


Figure 5-17

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1) - DC: DC component - 1 to 25: harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears
3	- Uh 03: harmonic number - %: ratio of the harmonic to the fundamental - V: RMS voltage of the harmonic in question - +000°: phase shift with respect to the fundamental (order 1)

### 5.2.4.2 Phase-to-Phase Voltage Display Screen (L1)

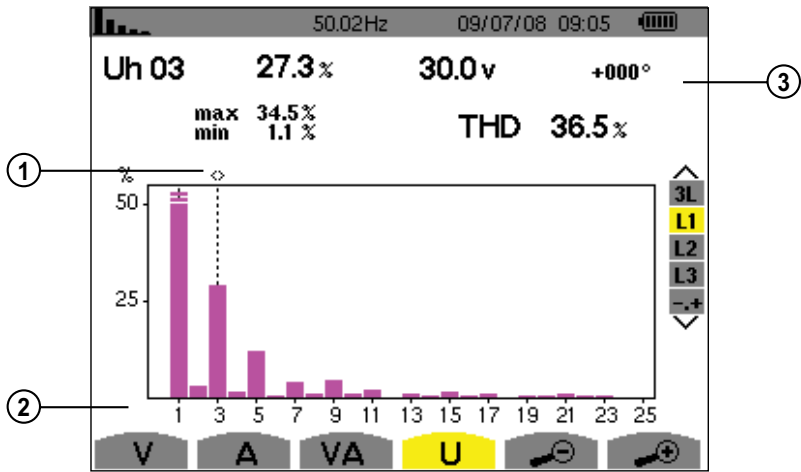


Figure 5-18

Item	Function
1	Harmonic selection cursor; change values with the cursor using the ◀ and ▶ buttons
2	<p>The horizontal axis indicates the orders of the harmonics (odd marking). Display of the level of the harmonics as a percentage of the fundamental (order 1)</p> <ul style="list-style-type: none"> <li>- DC: DC component</li> <li>- 1 to 25: harmonics of order 1 to 25; when the cursor exceeds order 25, order 26 to 50 appears</li> <li>- <span style="background-color: yellow;">■</span>: indicator of the presence of non-zero harmonics of order higher than 25</li> </ul>
3	<ul style="list-style-type: none"> <li>- U<sub>h</sub> 03: harmonic number</li> <li>-%: ratio of the harmonic to the fundamental</li> <li>V: RMS voltage of the harmonic in question</li> <li>+000°: phase shift with respect to the fundamental (order 1)</li> <li>max – min: maximum and minimum levels of the harmonic in question (reset when the harmonic number is changed or the ↵ key is pressed)</li> <li>THD: total harmonic distortion</li> </ul>

**NOTE:** Filters L2 and L3 display the harmonics of the phase-to-neutral voltage for phases 2 and 3, respectively. The screen is identical to the one displayed for filter L1.

## 5.2.5 Harmonic Analysis in Expert Mode

The -,+ mode is available with a 3-Phase connection only. It is used to display the influence of the harmonics on the heating of the neutral and on rotating machines. Press on the ▲ ▼ buttons to select “-,+” and then either the V or A sub-menu.

**Example of a typical display:**

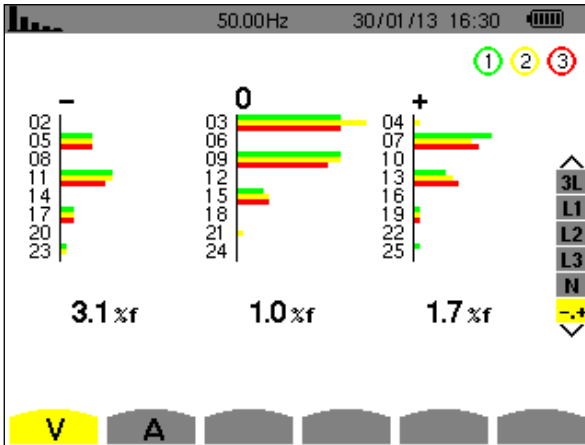


Figure 5-19

- **Column One:** The harmonics inducing a negative sequence.
- **Column Two:** Those inducing a zero sequence (triplens added into the neutral).
- **Column Three:** Those inducing a positive sequence.

## 5.3 Waveform Mode

This mode displays the current and voltage curves, along with the values measured and those calculated from the voltages and currents (except for power, energy and harmonics).

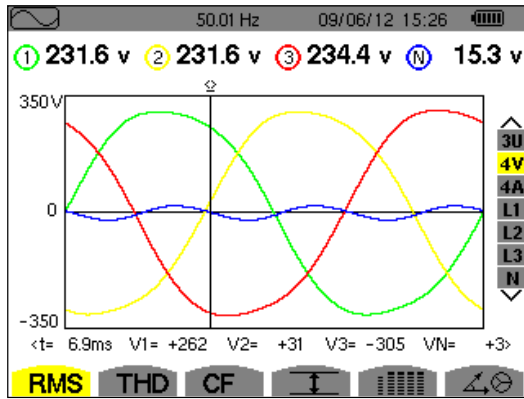





Figure 5-20




Item	Measurement Type
<b>RMS</b>	Measurement of the true RMS value
<b>THD</b>	Measurement of total harmonic distortion
<b>CF</b>	Measurement of the peak factor
	Display of min/max RMS and peak values (see § 5.3.4)
	Simultaneous display of voltage and current measurements (see § 5.3.5)
	Display of Fresnel diagram of signals (see § 5.3.6)

### 5.3.1 RMS Measurement

This sub-menu displays the waveforms over a period of the measured signals and the true effective values of the voltage and the current.



The choice of graphs to be displayed depends on the type of electrical connection that was set up during the configuration (see § 4.3.4).

- Single-phase: no choice (L1)
- Two-phase: 2V, 2A, L1, L2
- Tri-phase 3 or 4 wires: 3U, 3V, 3A, L1, L2, L3
- Tri-phase 5 wires:
  - For **THD**, **CF** and  : 3U, 3V, 3A, L1, L2 and L3
  - For **RMS**,  and  : 3U, 4V, 4A, L1, L2, L3 and N

The screen captures shown in this section are examples of those obtained with a 3-Phase 5-Wire connection.

### 5.3.1.1 RMS Display Screen (3U)

This screen displays the three phase-to-neutral voltages of a 3-phase system when the voltage ratios of phases 1, 2, and 3 are equal.

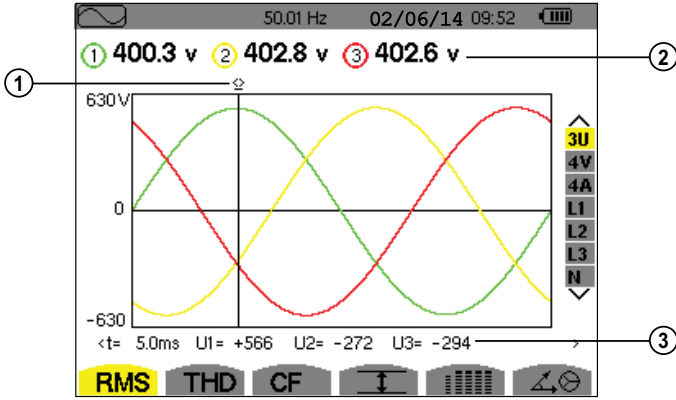


Figure 5-21

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	RMS phase-to-phase voltages
3	Instantaneous value of the signals at the intersection of the cursor and the curves <b>t</b> : time relative to the start of the period (expressed in milliseconds) <b>U1</b> : instantaneous phase-to-phase voltage between phases 1 and 2 ( $U_{12}$ ) <b>U2</b> : instantaneous phase-to-phase voltage between phases 2 and 3 ( $U_{23}$ ) <b>U3</b> : instantaneous phase-to-phase voltage between phases 3 and 1 ( $U_{31}$ )



### 5.3.1.2 RMS Display Screen (4V)

This screen displays the three phase-to-neutral voltages and the neutral-to-earth voltage of a 3-phase system.

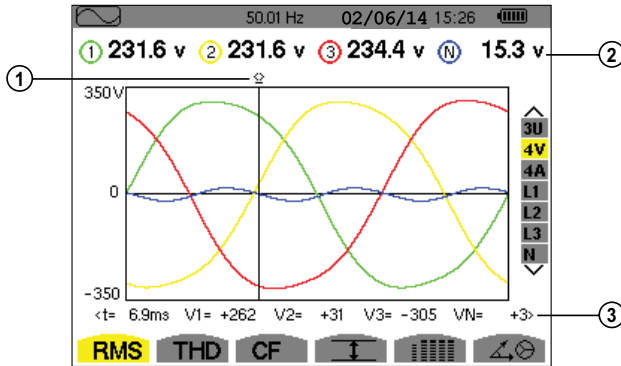


Figure 5-22

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Effective phase-to-neutral voltages
3	Instantaneous value of the signals at the intersection of the cursor and the curves t: time relative to the start of the period (expressed in milliseconds) V1: instantaneous phase-to-neutral voltage of curve 1 V2: instantaneous phase-to-neutral voltage of curve 2 V3: instantaneous phase-to-neutral voltage of curve 3 VN: instantaneous neutral voltage

### 5.3.1.3 RMS Display Screen (4A)

This screen displays the three phase currents and the neutral current of a 3-phase system.

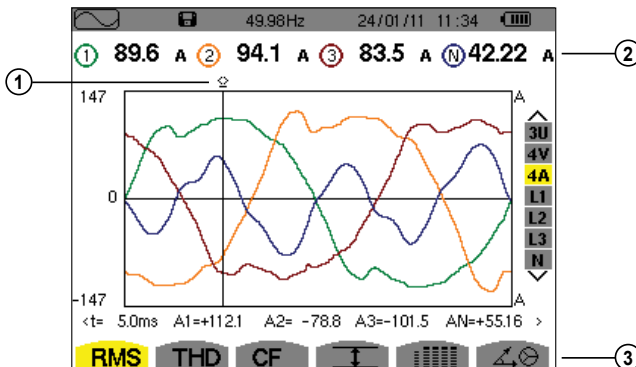


Figure 5-23

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	RMS currents
3	Instantaneous value of the signals at the intersection of the cursor and the curves <b>t</b> : time relative to the start of the period (expressed in milliseconds) <b>A1</b> : instantaneous current of phase 1 <b>A2</b> : instantaneous current of phase 2 <b>A3</b> : instantaneous current of phase 3 <b>AN</b> : instantaneous neutral voltage

### 5.3.1.4 RMS Display Screen (Neutral)

This screen displays the neutral voltage relative to earth and the neutral current.

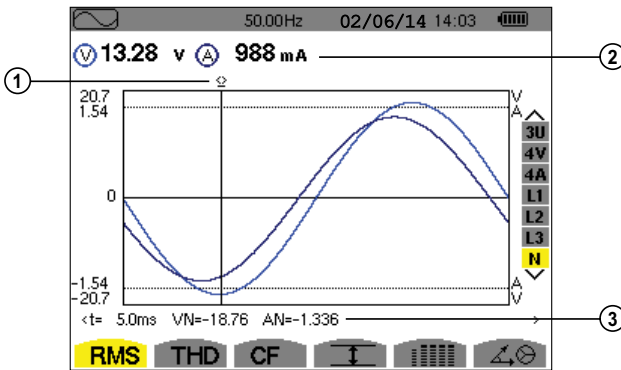


Figure 5-24

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Effective values of currents
3	Instantaneous value of the signals at the intersection of the cursor and the graphs <b>t</b> : time relative to the start of the period (expressed in milliseconds) <b>VN</b> : instantaneous neutral voltage <b>AN</b> : instantaneous neutral current

## 5.3.2 THD Measurement of Total Harmonic Distortion

The **THD** sub-menu displays the waveforms over a period of the measured signals and the total harmonic distortion rates for voltage and current.

### 5.3.2.1 THD Display Screen (3U)

This screen displays the phase-to-phase voltage waveforms for one period and the total harmonic distortion values.

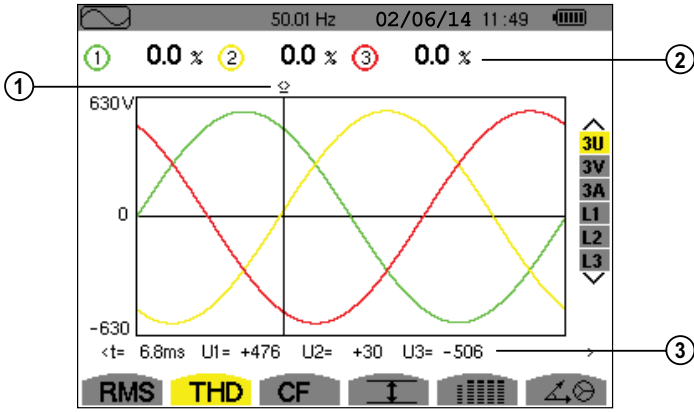


Figure 5-25

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Harmonic distortion rate for each curve
3	Instantaneous value of the signals at the intersection of the cursor and the curves <b>t</b> : time relative to the start of the period (expressed in milliseconds) <b>U1</b> : instantaneous phase-to-phase voltage between phases 1 and 2 ( $U_{12}$ ) <b>U2</b> : instantaneous phase-to-phase voltage between phases 2 and 3 ( $U_{23}$ ) <b>U3</b> : instantaneous phase-to-phase voltage between phases 3 and 1 ( $U_{31}$ )

### 5.3.2.2 THD Display Screen (3V)

This screen displays the phase-to-neutral voltage waveforms for one period and the total harmonic distortion values.

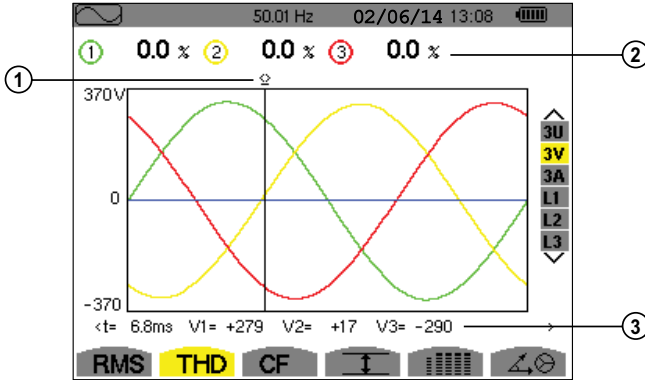


Figure 5-26

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Harmonic distortion rate for each curve
3	Instantaneous value of the signals at the intersection of the cursor and the curves <b>t</b> : time relative to the start of the period (expressed in milliseconds) <b>V1</b> : instantaneous phase-to-neutral voltage of curve 1 <b>V2</b> : instantaneous phase-to-neutral voltage of curve 2 <b>V3</b> : instantaneous phase-to-neutral voltage of curve 3

### 5.3.2.3 THD Display Screen (3A)

This screen displays the phase current waveforms for one period and the total harmonic distortion values.

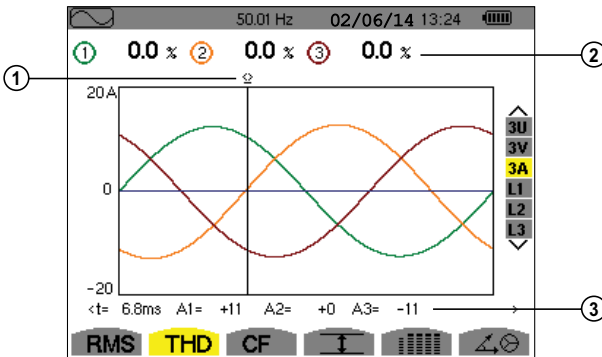


Figure 5-27

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Harmonic distortion rate for each curve
3	Instantaneous value of the signals at the intersection of the cursor and the curves <b>t:</b> time relative to the start of the period (expressed in milliseconds) <b>A1:</b> instantaneous current of phase 1 <b>A2:</b> instantaneous current of phase 2 <b>A3:</b> instantaneous current of phase 3

**Note:** Filters L1, L2, and L3 display the total current and voltage harmonic distortion for phases 1, 2, and 3, respectively.

### 5.3.3 Measurement of the Peak Factor (CF)

The **CF** sub-menu displays the waveforms of the signals measured over one period and the voltage and current peak factors.

#### 5.3.3.1 CF Display Screen (3U)

This screen displays the phase-to-phase voltage waveforms of one period and the peak factors.

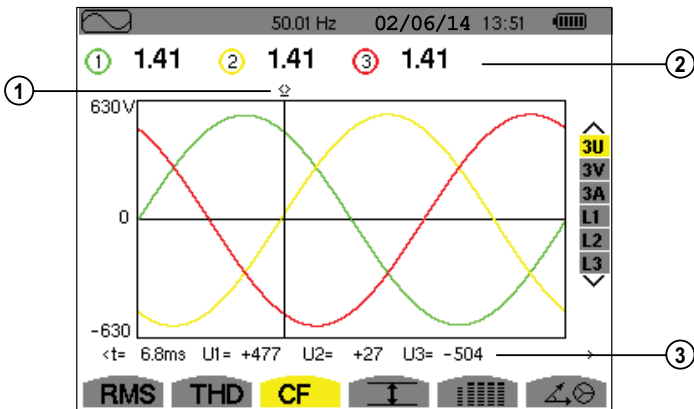


Figure 5-28

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Peak factor for each curve
3	Instantaneous value of the signals at the intersection of the cursor and the graphs <b>t:</b> time relative to the start of the period (expressed in milliseconds) <b>U1:</b> instantaneous voltage peak factor between phases 1 and 2 ( $U_{12}$ ) <b>U2:</b> instantaneous voltage peak factor between phases 2 and 3 ( $U_{23}$ ) <b>U3:</b> instantaneous voltage peak factor between phases 3 and 1 ( $U_{31}$ )

### 5.3.3.2 CF Display Screen (3V)

This screen displays the phase-to-neutral voltage waveforms of one period and the peak factors.

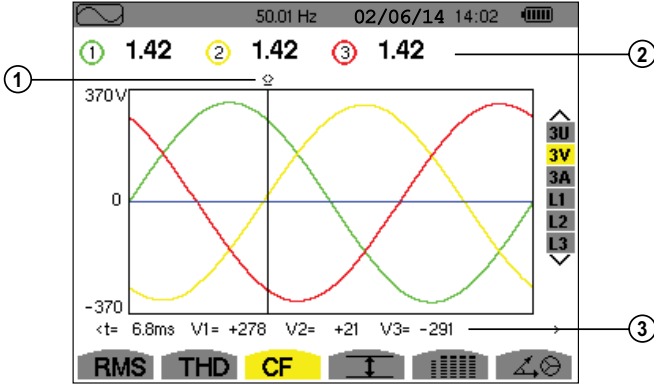


Figure 5-29

Item	Function
1	Instantaneous value cursor; change values with the ◀ and ▶ buttons
2	Peak factor for each curve
3	Instantaneous value of the signals at the intersection of the cursor and the curves t: time relative to the start of the period (expressed in milliseconds) V1: instantaneous phase-to-neutral voltage of phase 1 V2: instantaneous phase-to-neutral voltage of phase 2 V3: instantaneous phase-to-neutral voltage of phase 3

### 5.3.3.3 CF Display Screen (3A)

This screen displays the current waveforms of one period and the peak factors.

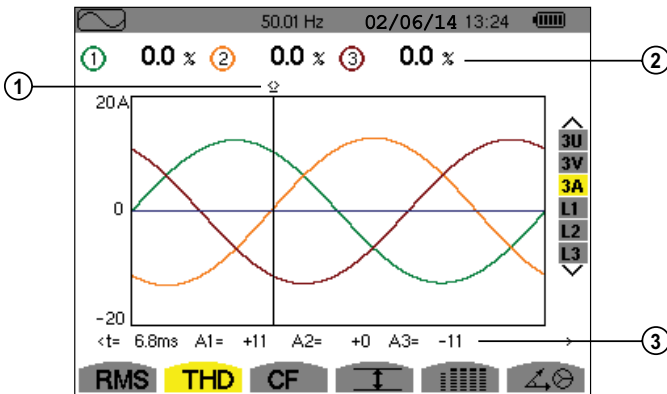


Figure 5-30

Item	Function
1	Instantaneous value cursor; change values with the cursor using the ◀ and ▶ buttons
2	Peak factor for each curve
3	Instantaneous value of the signals at the intersection of the cursor and the graphs t: time relative to the start of the period (expressed in milliseconds) <b>A1:</b> instantaneous current of phase 1 <b>A2:</b> instantaneous current of phase 2 <b>A3:</b> instantaneous current of phase 3

**Note:** L1, L2 and L3 display the peak factors of the current and of the voltage respectively for phases 1, 2 and 3.

### 5.3.4 Measurement of Min, Max, Average, Voltage and Current Values

This sub-menu displays the RMS, maximum, minimum and average values for voltage and current, together with those for the instantaneous positive and negative voltage and current peaks.



**NOTE:** The display screen varies depending on which value is selected.

**3U:** Displays the one-second mean and half-cycle maximum and minimum RMS values and the instantaneous positive and negative phase-to-phase voltage peaks.

**4V:** Displays the one-second mean and half-cycle maximum and minimum RMS values and the instantaneous positive and negative peaks of the phase-to-neutral voltages and of the neutral.

**4A:** Displays the one-second mean and half-cycle maximum and minimum RMS values and the positive and negative instantaneous peak values of the phase and neutral currents.

**L1/L2/L3:** Displays the one-second mean and half-cycle maximum and minimum RMS values and the instantaneous positive and negative peaks of the phase-to-neutral voltage and of the current of phase 1.

**N:** Displays the RMS values and the positive and negative instantaneous peaks of the neutral relative to earth.

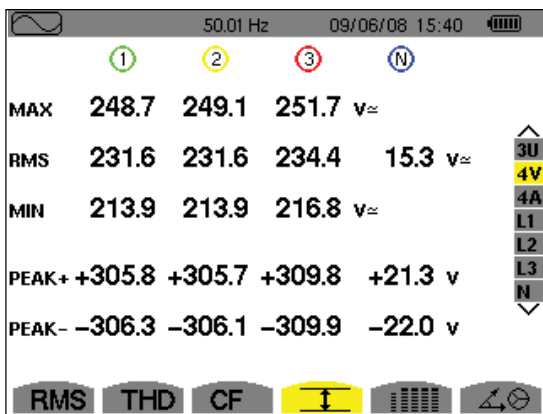





Figure 5-31

The columns display the values relative to each voltage, current or neutral graph.


Item	Function
MAX	Maximum RMS value of the voltage or current from powering of the PowerPad® or from the last time the  button is pressed.
RMS	True effective value of voltage or current
MIN	Minimum RMS value of the voltage or current from powering of the PowerPad® or from the last time the  button is pressed.
PEAK+	Maximum peak value of the voltage or current
PEAK-	Minimum peak value of the voltage or current

**NOTE:** The Max and Min RMS measurements are calculated every half-period (e.g. every 10ms for a signal at 50Hz). The measurements are refreshed every 250ms.

To reset the MIN and MAX on the display, press the  key.

### 5.3.5 Simultaneous Display

This sub-menu displays all the voltage and current measurements (RMS, DC, THD, DF, CF, PST, KF).

 **NOTE:** The display screen varies depending on which value is selected.

**3U:** Displays the RMS, DC, THD, DF, and CF values of the phase-to-phase voltages.

**4V:** Displays the RMS, DC, THD, DF, CF and PST values of the phase-to-neutral voltages and of the neutral.



**4A:** Displays the RMS, DC, THD, DF, CF, and KF values of the phase and neutral currents.

**L1/L2/L3:** Displays the RMS, THD, DF, and CF values of the phase-to-neutral voltage and of the current, the DC and PST parameters of the phase-to-neutral voltage, and the DC value (if the current sensor allows) and KF of the current for phase 1.

**N:** Displays the RMS voltage and current of the neutral, the DC component of the neutral voltage, and (if the current sensor allows) the DC component of the neutral current.

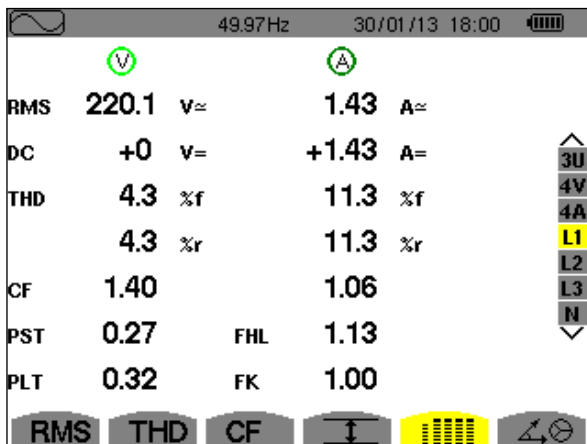


Figure 5-32

Item	Function
<b>RMS</b>	True effective value of voltage or current
<b>DC</b>	Direct component
<b>THD</b>	Total harmonic distortion rate
<b>DF</b>	Distortion factor
<b>CF</b>	Peak factor calculated in relation to the displayed waveform
<b>PST</b>	Short-term flicker (over 10 minutes)
<b>KF</b>	K factor - Oversizing of transformer relative to harmonics

**NOTE:** L2 and L3 give information concerning simultaneous display of the current and of the voltage respectively for phases 2 and 3.

### 5.3.6 Display of Fresnel Diagram

This sub-menu displays the absolute values of the voltages and currents at the fundamental frequency, the phase displacement of the voltages relative to the currents and the unbalances of the voltages and currents.



**NOTE:** The display screen varies depending on which value is selected.

**3U:** Displays a vector representation of the fundamentals of the phase-to-phase voltages and of the currents. It indicates their associated quantities (modulus and phase of the phase-to-phase voltage vectors) and the voltage unbalance. The reference vector of the representation (at 3 o'clock) is U1.

**3V:** Displays a vector representation of the fundamentals of the phase-to-neutral voltages and of the currents. It indicates their associated quantities (modulus and phase of the phase-to-neutral voltage vectors) and the voltage unbalance. The reference vector of the representation (at 3 o'clock) is V1.

**3A:** Displays a vector representation of the fundamentals of the phase-to-neutral voltages and of the currents. It indicates their associated quantities (modulus and phase of the current vectors) and the current unbalance. The reference vector of the representation (at 3 o'clock) is A1.

**L1/L2/L3:** Displays a vector representation of the fundamentals of the phase-to-neutral voltages and the currents of one phase. It indicates their associated quantities (modulus and phase of the current and phase-to-neutral voltage vectors). The reference vector of the representation (at 3 o'clock) is the current vector.

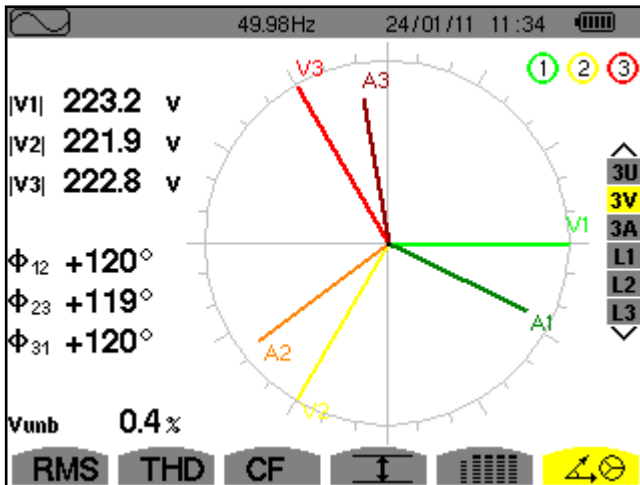


Figure 5-33

Item	Function
U1, U2, U3	Absolute values of the voltages at fundamental frequency
V1, V2, V3	Absolute values of the voltages at fundamental frequency
A1, A2, A3	Absolute values of the current at fundamental frequency
$\phi_{12}$	Phase displacement of phase 1 relative to phase 2
$\phi_{23}$	Phase displacement of phase 2 relative to phase 3
$\phi_{31}$	Phase displacement of phase 3 relative to phase 1
$\phi_{VA}$	Phase displacement of voltage (V) relative to current (A)
Unb	Unbalance of line voltages

**NOTE:** L2 and L3 display vector representations of the fundamentals of the phase-to-neutral voltages and the currents of phases 2 and 3, respectively. They indicate their associated quantities (modulus and phase of the current and phase-to-neutral voltage vectors of phases 2 and 3, respectively). The reference vector of the representation (at 3 o'clock) is the current vector (A2 and A3, respectively).

## 5.4 Alarm Mode

This mode detects the type of alarm that you wish to monitor (Vah, Ah, Uh, Vh, Tan, PF, DPF, VA, VAR, W, Athd, Uthd, Vthd, KF, Hz, Aunb, Vunb, Vrms, Acf, Ucf, Vcf, PST, Arms Urms and Vrms – see Appendix B: Glossary of Terms).








All alarms recorded can be downloaded to a PC with DataView® software (see § 7). Up to 10,000 alarms can be captured.

### 5.4.1 Programming an Alarm


1. Press the Alarm mode button . The *Detection Schedule* screen will appear.





Figure 5-34

Item	Measurement Type
	Configures alarms
	Displays alarm log
	Programs an alarm
<b>OK</b>	Validates the programming of an alarm (after <b>OK</b> is selected, the  icon appears)
	Manually stops an alarm that is in progress



---

 To program/display alarms, they must first be configured (see § 4.3.9)


---

2. With the start field highlighted in yellow, press  to enter the date and time.
3. Use the ▲ and ▼ buttons to increase or decrease the value. Use the ◀ and ▶ buttons to move to the next parameter.
4. When completed, confirm the Start alarm schedule with .
5. Use the ▼ button to set the Stop alarm settings, then repeat the previous steps.

## 5.4.2 Starting an Alarm


1. Press the **OK** icon's yellow button to launch the alarm campaign between the start and end times that you specified.
2. The **OK** icon disappears and the  icon appears instead.
3. The *Campaign on standby* message is displayed while awaiting start time and the  icon blinks on the screen's top display bar.
4. The *Campaign running* message is displayed when start time begins.
5. The *Campaign schedule* screen with the **OK** icon (bottom right-hand side of the screen) are displayed when the end time is reached. You can then program a new alarm campaign.

## 5.4.3 Manually Stopping an Alarm

An alarm can be manually stopped before the Stop date and time by pressing the  icon's yellow button. The **OK** icon will reappear in the same location.

## 5.4.4 Displaying an Alarm Log

Press the  icon's yellow button to view the alarm log. The log can contain a maximum of 10,920 alarms.

**NOTE:** The type of connection selected in the configuration mode  does not affect the possibilities of alarm filter choice and monitored parameter. Users are responsible for these choices.

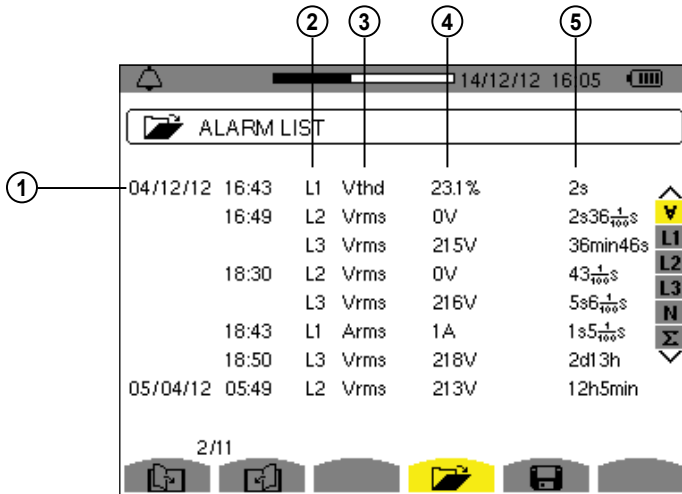





Figure 5-35

Item	Function
1	Alarm date and time
2	Alarm filter
3	Monitored parameter (Vrms, etc.)
4	Amplitude (min or max)
5	Alarm duration


## 5.4.5 Deleting an Alarm Log


1. Press the  icon's yellow button
2. Select the alarm to be deleted using the ▲ or ▼ button, then press the  button to confirm deletion.


To leave this screen without deleting any alarm, press the  button.

## 5.5 Trend Mode

### 5.5.1 Programming and Starting a Recording

 **NOTE:** The ON/OFF light will blink when the recording is in progress. When the recording is done, the ON/OFF light will turn off. You will need to press it again to restart the instrument.

This mode enables all the parameters previously configured in the Configuration mode  to be recorded (see § 4.3).

1. Press the Trend mode button - .

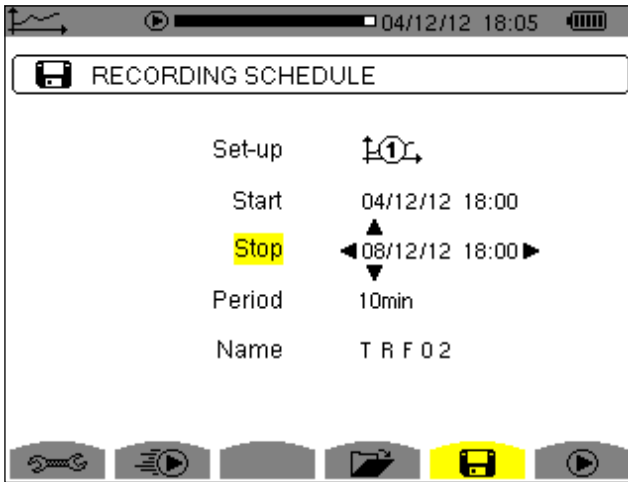




Figure 5-36


2. Select the Configuration that was previously set-up (see § 4.3) by using the ▲ or ▼ button to highlight **Set-up**, then press the ▽ button.
3. Use the ▲ or ▼ button to choose Configuration 1, 2 3 or 4, then press ▽.
4. Select the Start field using the ▼ button. Press ▽ to select the date and time field, then use the appropriate arrow buttons to change the date and time. Press ▽ when finished.
5. Using the same method as steps 1, 2 and 3, use the arrow buttons and the ▽ button to change the values for Stop, Period and Name.
6. Press the **OK** icon's yellow button to begin recording between your specified start and end times. The **OK** icon disappears and the icon  appears.

7. The *Recording on Standby* message is displayed and the icon blinks on the top display bar. Once the start time has been reached, the Recording running message is displayed.
8. When the recording is finished, the *Programming a recording* screen will appear and the **OK** icon reappears.

## 5.5.2 Manually Stopping a Recording

An alarm can be manually stopped by pressing the  icon's yellow button. The **OK** icon will reappear in the same location.

## 5.5.3 Displaying the Recording List

Press the  icon's yellow button to view the recording list.

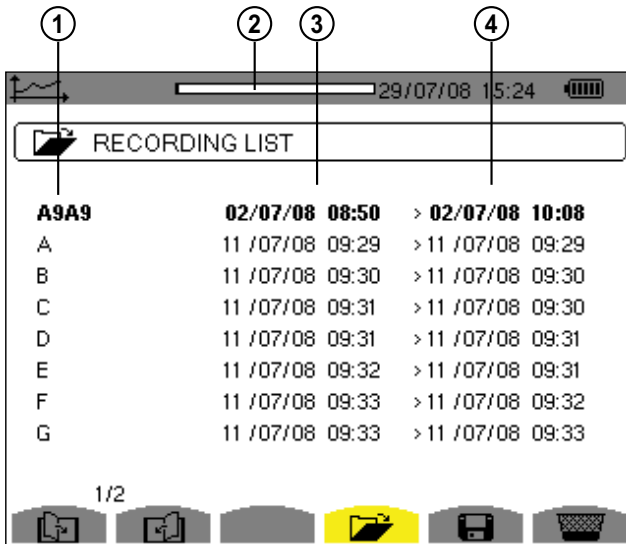





Figure 5-37

Item	Function
1	Recording name
2	Memory usage
3	Recording start time
4	Recording end time

## 5.5.4 Deleting a Recording

1. Press the  icon's yellow button
2. Select the recording to be deleted using the ▲ or ▼ button, then press the  button to confirm deletion.

To leave this screen without deleting any alarm, press the  button.

## 5.6 Power and Energy Mode $W \sim$

This sub-menu displays the measurements for power and energy.



**NOTE:** The display screen varies depending on which value is selected.

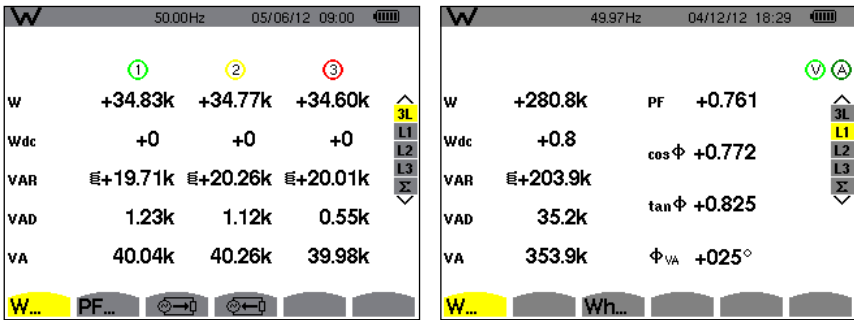











Figure 5-38



Item	Function
W	Display of power
PF	Display of power factor (Note: the display screen for the PF... button is only available for the 3L filter)
	Display of energy consumed (active, reactive and apparent power)
	Display of energy generated (active, reactive and apparent power)
	Starts the measurement
	Resets the energy value to zero
	Stops the measurement
Σ	Display of sum of values
$\bar{X}$	Display of mean of values
tan Φ	Tangent of the phase shift of the voltage with respect to the current
cos Φ	Cosine of the phase shift of the voltage with respect to the current (DPF - displacement factor)
Φ <sub>VA</sub>	Phase shift of phase-to-neutral voltage with respect to current




<b>Wh</b>	Active energy consumed
<b>VAR</b>	Reactive power:  - Inductive  - Capacitive
<b>VARh</b>	Reactive energy consumed:  - Inductive  - Capacitive
<b>VA</b>	Apparent power
<b>VAh</b>	Apparent energy consumed

**NOTE:** Filters L2 and L3 display the same information for phases 2 & 3.



## 5.6.1 Starting and Stopping Energy Measurements

- To start a measurement, press the  icon's yellow button. The date and time at which the measuring starts will appear in the upper left-hand corner of the screen.
- To stop the measurement, press the  icon's yellow button. The date and time at which the measuring stops will appear in the upper right hand corner of the screen.



**NOTE:** Stopping the metering is not definitive. It can be resumed by pressing the  icon again. All of energy meters resume totalizing.

## 5.6.2 Resetting the Energy Measurement





To reset the measurement, press the  icon's yellow button, then  to confirm. All energy values (consumed and generated) are reset.



**NOTE:** Refer to the 4-quadrant power diagram in APPENDIX A.

## 5.7 Snapshot Mode


This button allows 50 snapshots to be saved for future recall and evaluation.

- Press the  button (for about 3s) to capture the current display.
- The  icon is displayed in the top left corner as soon as the operation is successful.
- This icon is replaced by  if there is no space left in the memory to record the display.
- The snapshot will record all measurements present at the input of the meter when you press the  button.



These screens can be downloaded to a computer using DataView®

### 5.7.1 Opening a Previously Saved Snapshot

- A **short press** (about 1s) on the  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.

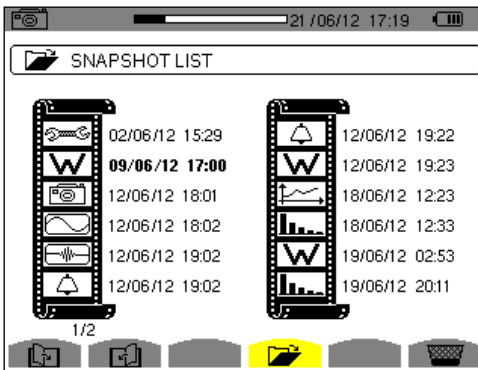







Figure 5-39


- Use the ▲ or ▼ buttons to select the snapshot.
- To display the snapshot, press the  button, then the  button.
- After reviewing the snapshot, press the  button again to return to the list of saved snapshots.



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


## 5.7.2 Deleting a Snapshot

1. Press the  icon's yellow button
2. Select the snapshot to be deleted using the ▲ or ▼ button, then press the  button to confirm deletion.

To leave this screen without deleting any alarm, press the  button.

## 5.8 Help

Press this button to obtain help for the current display mode.

To exit the Help mode, press the  button once again.

# DATAVIEW® SOFTWARE

## 6.1 Installing DataView®



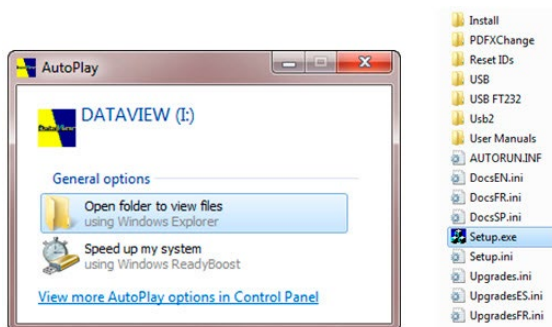
**DO NOT CONNECT THE INSTRUMENT TO THE PC BEFORE INSTALLING THE SOFTWARE AND DRIVERS.**

**NOTE:** When installing, the user must have Administrative access rights during the installation. The users access rights can be changed after the installation is complete.

DataView® must be reinstalled for each user in a multi-user system.

### USB Flash Drive Install

1. Insert the USB stick into an available USB port (wait for driver to be installed).
2. If Autorun is enabled then an AutoPlay window should appear as shown.



**NOTE:** If Autorun is disabled, it will be necessary to open Windows Explorer, then locate and open the USB stick drive labeled “DataView” to view the files on the drive.

3. In the AutoPlay window, select **Open Folder to view Files**.
4. Double-click on **Setup.exe** from the opened folder view to launch the Data-View setup program.



**NOTE:** If installing onto a Vista based computer the **User Account Control** dialog box will be displayed. Select the **Allow** option to proceed.

5. A **Set-up** window, similar to the one below, will appear.

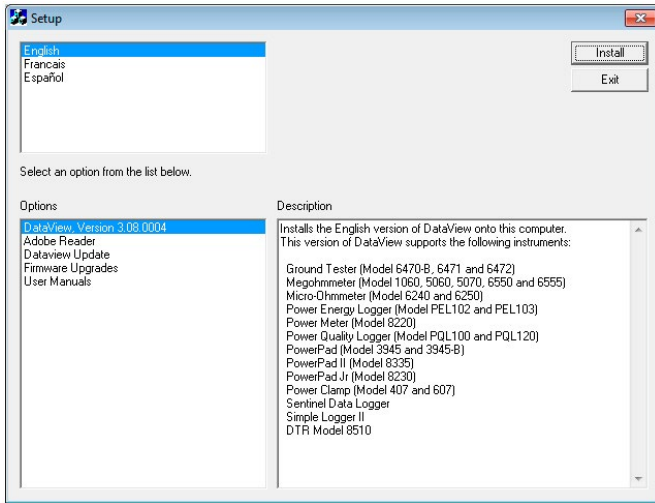


Figure 6-1

There are several different options to choose from. Some options<sup>(\*)</sup> require an internet connection.

- **DataView, Version x.xx.xxxx** - Installs DataView® onto the PC.
- **\*Adobe Reader** - Links to the Adobe® website to download the most recent version of Adobe® Reader to the computer. *Adobe® Reader is required for viewing PDF documents supplied with DataView®.*
- **\*DataView Updates** - Links to the online DataView® software updates to check for new software version releases.
- **\*Firmware Upgrades** - Links to the online firmware updates to check for new firmware version releases.
- **Documents** - Shows a list of instrument related documents that you can view. Adobe® Reader is required for viewing PDF documents supplied with DataView®.

6. **DataView, Version x.xx.xxxx** option should be selected by default. Select the desired language and then click on **Install**.
7. The **Installation Wizard** window will appear. Click **Next**.
8. To proceed, accept the terms of the license agreement and click **Next**.
9. In the **Customer Information** window, enter a Name and Company, then click **Next**.
10. In the **Setup Type** window that appears, select the “**Complete**” radio button option, then click **Next**.
11. In the **Select Features** window that appears, select the instrument’s control panel that you want to install, then click **Next**.



**NOTE:** The **PDF-XChange** option must be selected to be able to generate PDF reports from within DataView®.

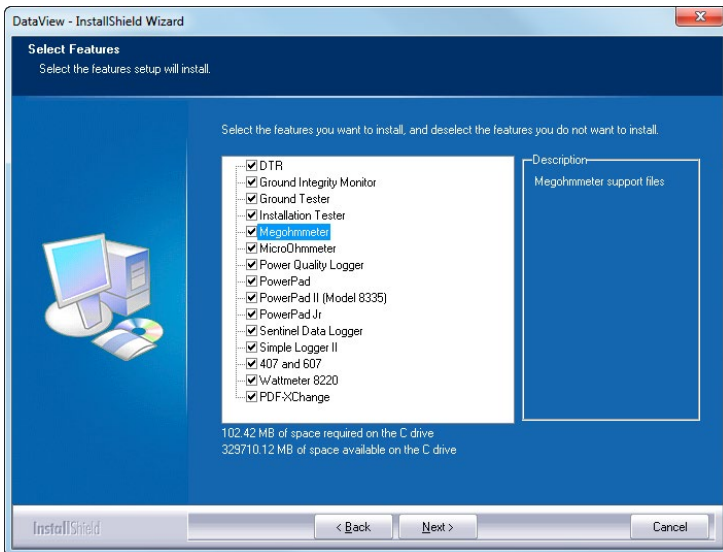


Figure 6-2

12. In the **Ready to Install the Program** window, click on **Install**.
13. If the instrument selected for installation requires the use of a USB port, a warning box will appear, similar to Figure 6-3. Click **OK**.

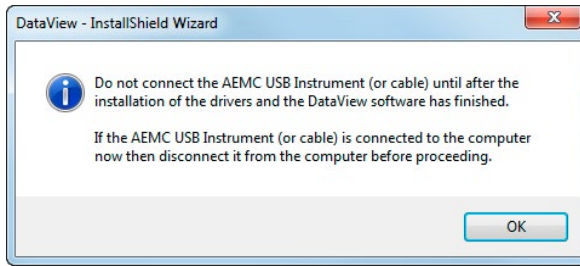


Figure 6-3



**NOTE:** The installation of the drivers may take a few moments. Windows may even indicate that it is not responding, however it is running. Please wait for it to finish.

---

14. When the drivers are finished installing, the **Installation Successful** dialog box will appear. Click on **OK**.
  15. Next, the **Installation Wizard Complete** window will appear. Click on **Finish**.
  16. A **Question** dialog box appears next. Click **Yes** to read the procedure for connecting the instrument to the USB port on the computer.
- 



**NOTE:** The Set-up window remains open. You may now select another option to download (e.g. Adobe® Reader), or close the window.

---

17. **Restart** your computer, then connect the instrument to the USB port on the computer.
18. Once connected, the **Found New Hardware** dialog box will appear. Windows will complete the driver installation process automatically.

Shortcuts for DataView® and each instrument control panel selected during the installation process have been added to your desktop.

---



**NOTE:** If you connected your instrument to the computer before installing the software and drivers, you may need to use the **Add/Remove Hardware** utility to remove the instrument driver before repeating the process.

---

## 6.2 Connecting the PowerPad® to your Computer

The PowerPad® is supplied with a USB cable required for connecting the instrument to the computer.

To connect the PowerPad® to your computer:

1. Connect USB cable to the port on the side panel of the PowerPad®.
2. Connect the other end of the USB cable to a USB port on your computer.
3. Turn the PowerPad® on (for the Control Panel to work, the PowerPad® must be on at all times when in use).

You are now ready to use the DataView® software with the PowerPad®.

## 6.3 Opening the Control Panel

To open the Power Analyzer Control Panel:

- Double-click the **PowerPad** Icon that was created during installation, located on the desktop.
- The **Connection** window will appear (see Figure 6-4).

Once the communication link is established, DataView® will automatically identify the instrument that it is connected to.

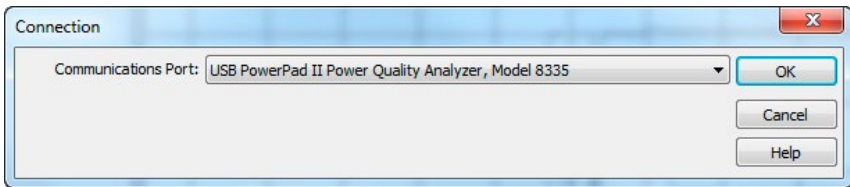


Figure 6-4

- Make sure the communications port displayed in the dialog box matches the instrument you plugged the USB cable into. If the correct port is not selected, click on the drop-down menu to select it.



For detailed instructions and descriptions for any feature in a dialog box, click on the **Help Button**, or **right-click on the feature** you want information about.

---



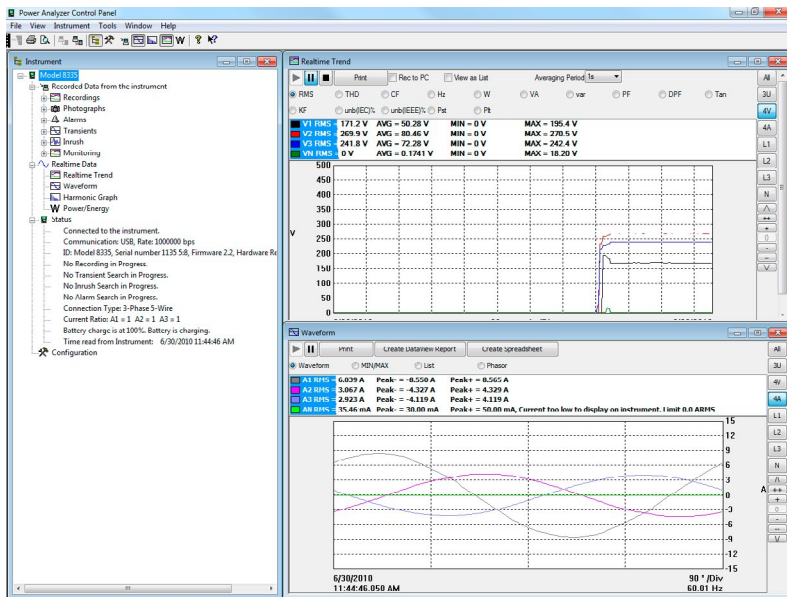


Figure 6-5

The Control Panel displays:

- Recorded Data from the instrument
- Realtime Data
- Connection status
- The communications port and speed of the connection
- The model number, serial number, firmware and hardware revision
- 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
- Connection type (Electrical Hookup)

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



If the battery charge is shown to be unknown, plug the PowerPad® into AC Power. When it reaches 100% charge, the display should again be able to show the battery charge.

## 6.4 Common Functions

The buttons described below appear on several DataView® Setup Screens.

- **Re-Read from Instrument:** Reads the current configuration of the PowerPad® attached via the serial cable.
- **Save to File:** Saves the current configuration. This file will reside 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®.
- **OK:** Closes the dialog box while saving the current configuration and returns to the Control Panel.
- **Cancel:** Exit without saving configuration.
- **Apply:** Programs the PowerPad® using the current settings without closing the window.
- **Help:** Opens the online Help.

## 6.5 Configuring the Instrument

The Configure dialog box lets you configure every aspect of the PowerPad®. 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.

To configure the instrument, go to **Instrument > Configure** or select **Configuration** from the Instrument Tree.

## 6.5.1 Setup

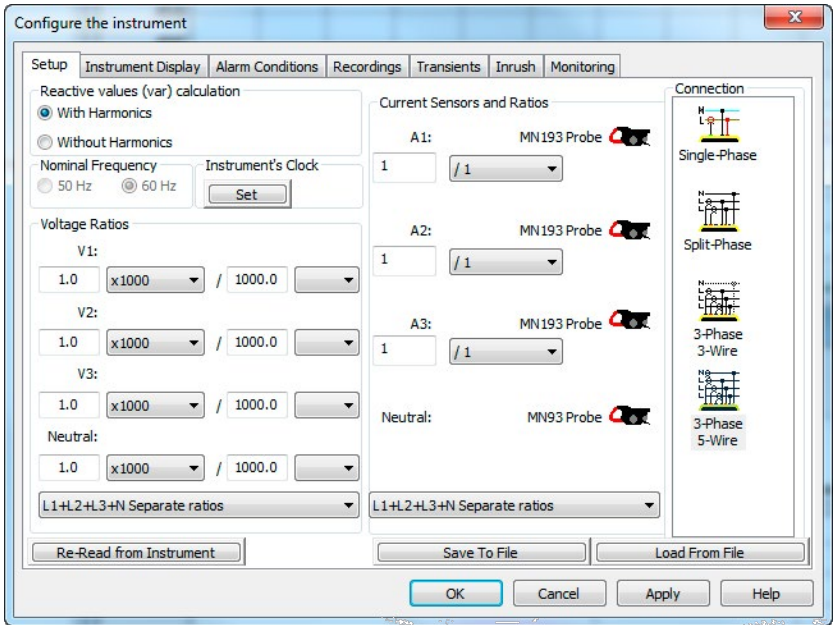


Figure 6-6

- **Reactive Values Calculation:** With or without harmonics. Applies to VAR calculation.
- **Nominal Frequency:** 50 or 60Hz. This parameter determines the correction coefficients used for calculating power and energy.
- **Current Sensor:** MN93, MN193, SR193, MR193, A193, SL261 AmpFlex®, MiniFlex® or ADA Adapter (used to accept probes with other ratios or a direct 1 Amp or 5 Amp input)
- **Connection Type:** Single-Phase, Two-Phase (Split Phase), 3-Phase 3 wire or 3-Phase 5 wire.
- **Set Instrument's Clock:** Resets the time and date on the PowerPad® to that of the computer or a desired setting.
- **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.

## 6.5.2 Instrument Display

The Instrument Display tab allows you to customize the display (colors, clock, language and contrast).

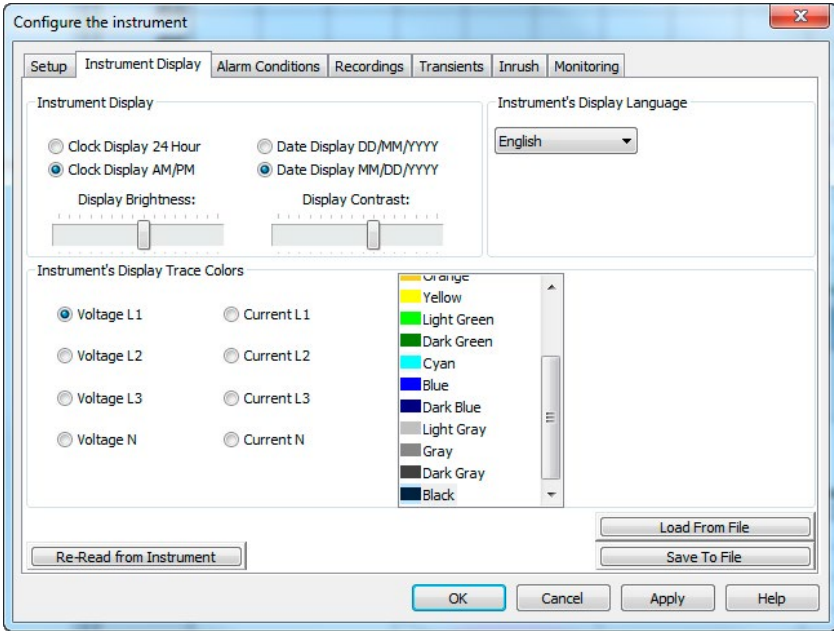


Figure 6-7



**NOTE:** For detailed instructions and descriptions for any feature in a dialog box, click on the **Help Button** (lower right-side of the dialog box), or **right-click on the feature** you want information about.

## 6.5.3 Alarm Conditions Configuration

The Alarm Conditions tab allows you to set up 40 alarm configurations.

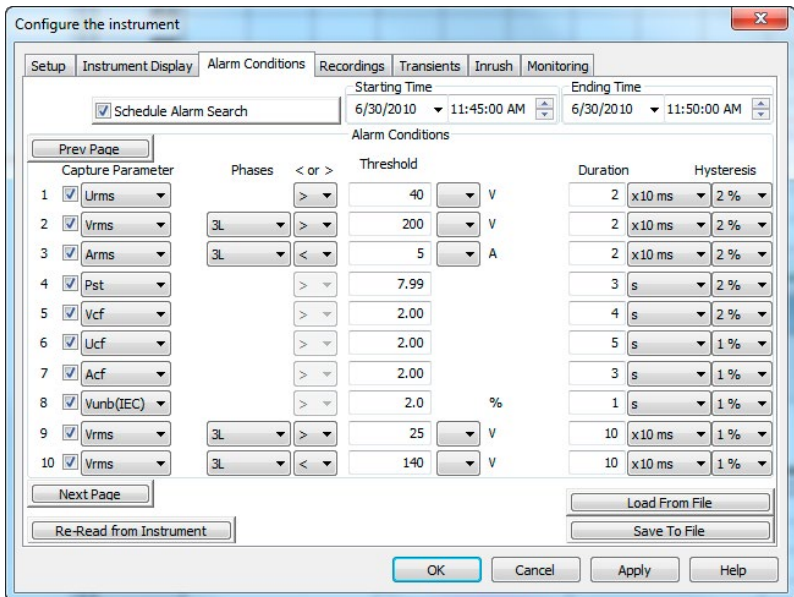


Figure 6-8

- **Schedule Alarm Search:** Check this box to activate the alarms, and set a starting and ending time and date to assign the time period during which the alarms will be active.
- **Prev Page & Next Page:** Move between the 4 pages of alarms with 10 alarms per page.
- **Capture Parameter:** The Alarm will be triggered based on the value of the selected parameter.

### Choices include:

**None:** no alarm

**Vrms:** voltage root mean squared

**Urms:** voltage phase minus phase root mean squared

**Arms:** current root mean squared

**VPST:** voltage short term flicker

**Vcf:** voltage crest factor

**Ucf:** voltage phase minus phase crest factor

**Acf:** current crest factor

**Vunb:** voltage unbalance

**Aunb:** current unbalance

**Hz:** frequency

**Akf:** current K factor

**Vthd:** voltage total harmonic distortion

**Uthd:** voltage phase minus phase total harmonic distortion

**Athd:** current total harmonic distortion

**W:** active power

- **Harmonic Number:** For alarm parameters, Vh, Ah, Uh, and VAh, selects which harmonic number is being used as an alarm condition. For example, Vh with a harmonic number of 2, will only look at Voltage phase to neutral, harmonic 2.
- **Phases:** Some alarm conditions have a phase selection. W, VAR, and VA, have a choice of "3L" (each individual phase), or "Sum" which is the sum of phases. DPF, PF, and TAN have the choice of "3L" (each individual phase), or "Mean" which is the mean of phases.
- **Threshold:** The value that must be reached to start an alarm. For ">" alarms, the value or higher must be reached, for "<" alarms, the value or lower must be reached.
- **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. For Vrms, Urms, and Arms, it can be useful to set a duration of 0 seconds. In that case an event as short as a half cycle can be detected (8 milliseconds at 60Hz). For all other parameters, the minimum duration that can be detected is 1 second.
- **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 100 Volts or higher, hysteresis is 1%. When the voltage goes up to 100V, the alarm condition starts. When it goes back down to 99V, the alarm condition stops.

---

**NOTE:** You can configure alarms, recordings, inrush, and transient searches while testing is in progress.

## 6.5.4 Recordings Configuration

The Recordings tab shows the parameters for a recording session.

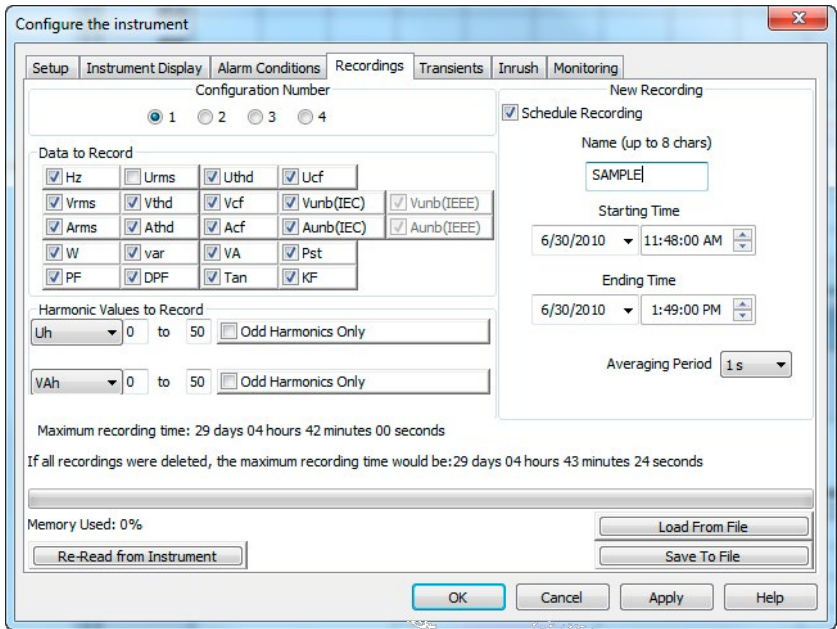


Figure 6-9

Four different configurations are available. More configurations can be saved by pressing **“Save to File”** and recalled later by pressing **“Load From File”**.

1. Select the configuration to set up: 1, 2, 3 or 4.
2. Check the box for each parameter desired in the **“Data to Record”** section.
3. Configure the harmonic values to be recorded, if desired.  
It is 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”**.
4. Check the box next to **“Schedule Recording”** to activate the recording function. Choose a starting and ending time to assign a time period for the recording to run. Enter a name for the recording (up to 8 characters), if desired.
5. Choose an **“Averaging Period”** for the recording, which sets how often the recording updates while it is running.



The PowerPad® loses its scheduled recording 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® to be in even multiples of the averaging period. For instance, if an integration period of 10 minutes was requested, and the start time was 9:03, the recording might not actually begin until 9:10.

## 6.5.5 Transients

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

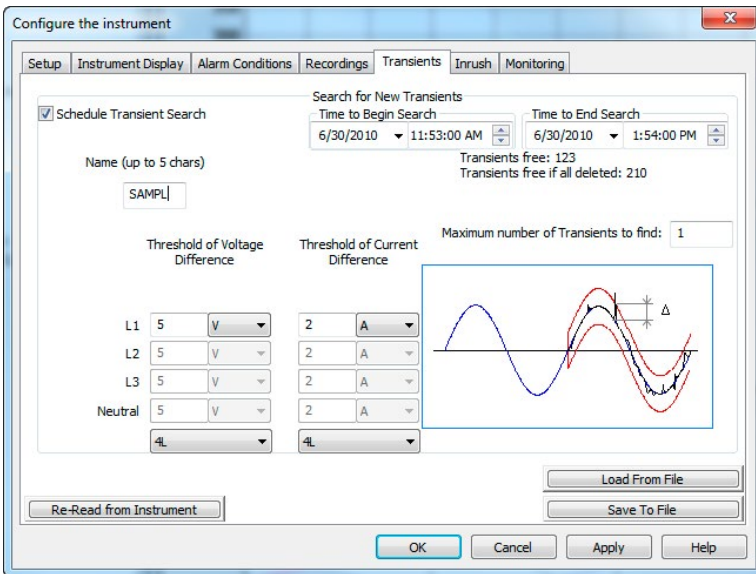


Figure 6-10

1. Click the check box next to “**Schedule Transient Search**” to activate the transient search function.
2. Type a name for the session, up to five characters.
3. Select the date and time to begin and end the search for transients.
4. Select the percent deviation for voltage and current transients. The choices available from the drop-down menu are 1, 2, 5, 10, 20, 50 and 100% of the full scale range of measurement.
5. Select the maximum number of transients to capture (from 1 to 210).



## 6.5.6 Inrush

The Inrush tab shows the dialog box used to configure the parameters for an Inrush search.

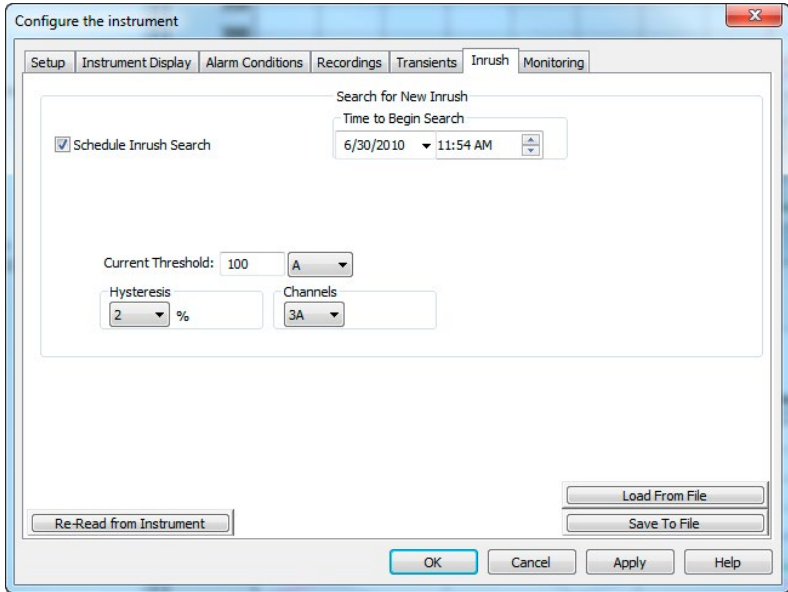


Figure 6-11

1. Click the check box next to **Schedule Inrush Search** to activate the function.
2. Set a time and date for the search to begin.
3. Assign a **Current Threshold** in Amps, to trigger the inrush recording.
4. Select the **Channel** to run the Inrush search on. The search can be performed on one of the three current channels (A1, A2, A3) or all three (3A).
5. Select a **Hysteresis** percentage.

## 6.5.7 Monitoring

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 to the customer of the supply voltage with regard to the curve, the voltage level, the frequency and symmetry of the three phase-network at the interconnecting point. 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.

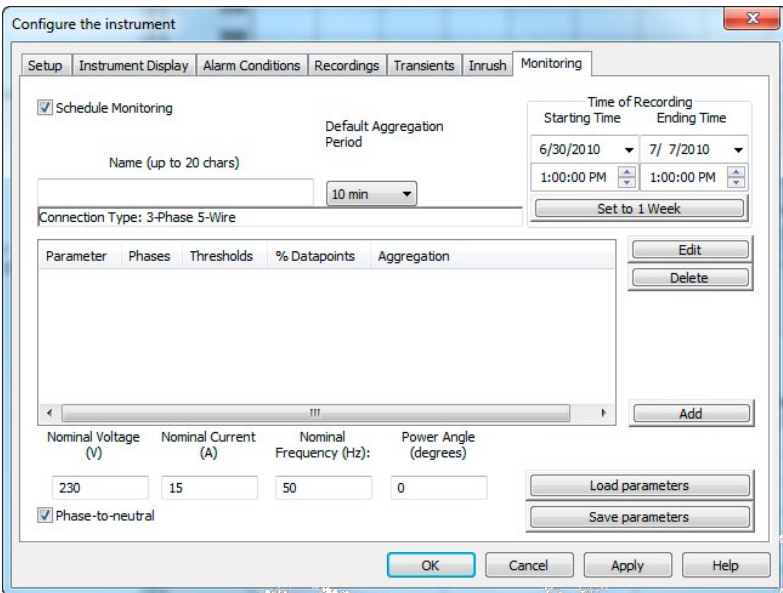


Figure 6-12

Configure and start an EN50160 test of line quality. Note that it is recommended that a brief test of 10 minutes or shorter be done first, to verify that 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 set up and run this special test. Press the Help button for further instructions.

## 6.5.8 Running the Test

After configuring the instrument, press “OK”. The status window will display if a recording is ready to start. Select “Yes” to run the scheduled testing, select “No” to close the Configure dialog box and cancel the testing.

## 6.6 Real-time Windows

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

### 6.6.1 Waveform and Harmonic Graph

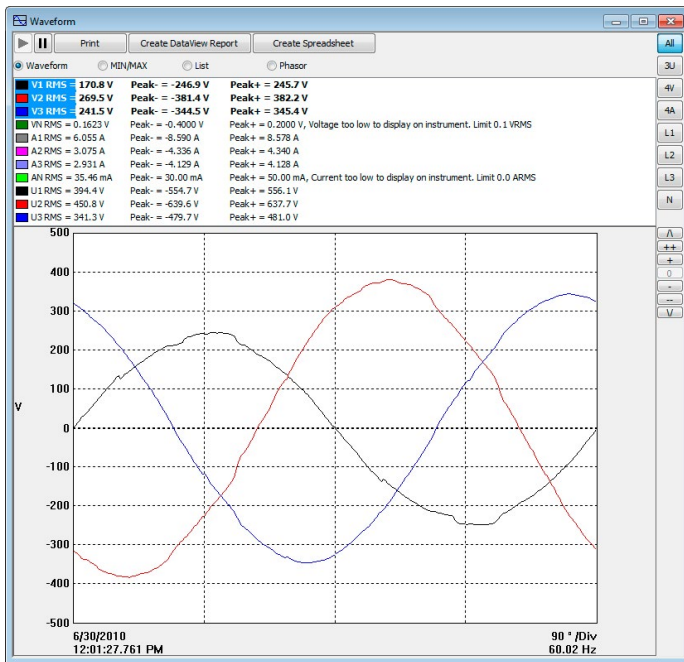


Figure 6-13

- Select the type of data to see.
- Stop the update with the Hold (Pause) button. Resume with the Start (Play) button.
- Print the screen selected.
- Save the data by choosing either **Create DataView Report** to view the data in a DataView® report or **Create Spreadsheet** to view in a Spreadsheet program (e.g. Microsoft® Excel).

## 6.6.2 Power/Energy

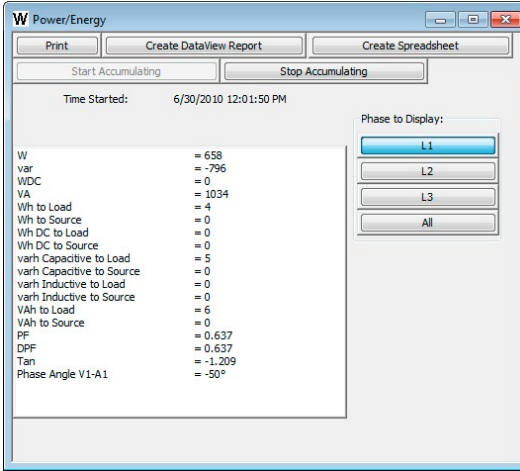


Figure 6-14

The Power/Energy window displays accumulated power and energy data.

Accumulated energy data can be started or stopped and the results can be downloaded to a database and viewed on the screen, selected by phase.



The data for all available phases are downloaded to a database or spreadsheet, not just what is shown on the screen.

## 6.6.3 Trend

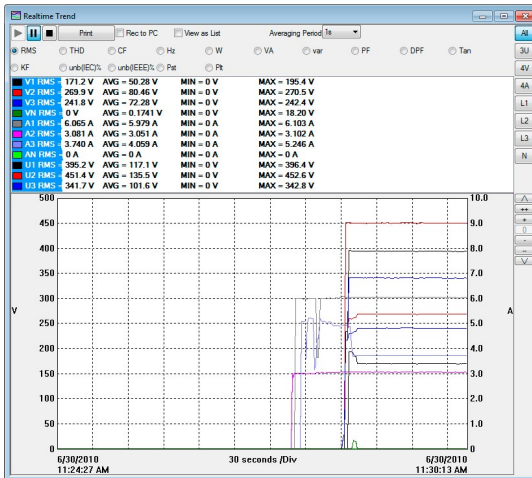


Figure 6-15

Shows a real-time trend of data from the PowerPad®. The data is an average of waveforms downloaded to the PC whose scale adjusts constantly to fit all the data it has received.

## 6.7 Downloading Data

To download recorded data, go to **Instrument > Recorded Data**, recorded data can also be found from the Instrument tree view. Expand the sections under **“Recorded Data from the Instrument”** then click on a line that describes the desired recorded data. It will bring up a window with a graph of the data.

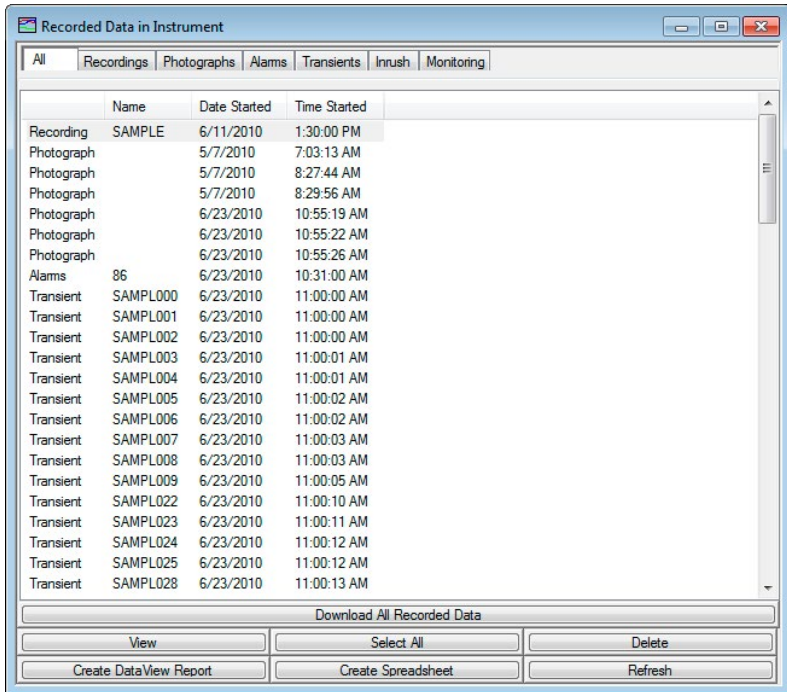


Figure 6-16

- Select the data you want to download by clicking on the desired tab (Recordings, Photographs, etc.), then clicking on the file name.
- You can choose to view the data in three different ways:
  - **“Create DataView Report”** inserts the data into a DataView® report which can then be viewed, modified and saved.
  - **“Create Spreadsheet”** saves the data in a Microsoft® Excel spreadsheet (.csv file) which can then be viewed, modified and saved.
  - **“View”** opens up a window with a graph of the data where the user can select to **“Print”**, **“Create DataView Report”**, and **“Create Spreadsheet”**.

- From the “**Recorded Data**” window it is possible to delete files stored on the PowerPad® using the “**Delete**” button
- The “**Download All Recorded Data**” button allows the user to download and save all the files on the PowerPad® for later viewing and analysis.
- Recorded data can also be found from the Instrument tree view. Expand the sections under “**Recorded Data from the Instrument**” then click on a line that describes the desired recorded data. It will bring up a window with a graph of the data.

### **Recordings:**

The Recording tab displays a list of recordings within the PowerPad®.

These recordings can be selected and downloaded to a database.

### **Photographs:**

The Photographs tab displays a list of photographs (snapshots), with the date and time, taken when the camera button was pressed.

When “**View**” is selected, it shows the waveforms, power data and Bitmap image of the PowerPad® screen from the time the camera button was pressed.



Snapshots can only be initiated using the camera button on the PowerPad® itself, not by DataView®.

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### **Alarms:**

The Alarms tab displays the alarm search that was recorded to the PowerPad®. Details on the alarm search are available by clicking on the desired alarm set, which opens up an alarm window with the searches details. Alarm search data can be selected and downloaded to a Spreadsheet or a DataView® Report by clicking the corresponding buttons.

### **Transients:**

The Transients tab displays transients stored on the PowerPad®. It shows the number and name of the recording, and the time it began and ended. The selected transient(s) can either be downloaded or deleted.

The downloaded result contains many waveforms. Use the controls “><” and “<>” located at the lower right corner of the window, to zoom in or out of the data.

These controls are available in every graph from recorded data.

There is also a checkbox, “**View As List**”, which can be used to show the value of every datapoint.

**Inrush:**

The Inrush tab displays recorded Inrush data that is stored on the PowerPad®.

**Monitoring:**

The Monitoring tab displays recorded tests that can be downloaded and analyzed.

After selecting a recording and clicking “**View**”, the summary window appears showing 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.

## 6.8 Saving Real-time Measurements

Real-time data received from an instrument can be saved directly into a recording session database. This differs from the process of downloading and saving recorded data in that the measurements are stored on the computer as the instrument measures them. These measurements are not necessarily being stored within the instrument. However, the instrument may be configured to record at the same time real-time measurements are being received from the instrument. In which case, two copies of the measurements will be stored. One copy is stored on the local computer and the other in memory within the instrument.

**To Save a Real-time Measurement:**

1. From the Realtime Trend window, check the “**Rec to PC**” checkbox.
2. In the Save As dialog box that appears, specify the type of file to save in the “**Save as Type**” field. The choices are .dvb (DataView database), .xls (Excel spreadsheet), or .csv (Comma Separated File). Specify the name of the file by typing it into the File name field, select the desired location to save the file, then click Save to save the file.
3. When the “**Rec to PC**” option is unchecked the file can be opened by selecting “**Yes**” from the View Saved File dialog box.

To edit the Session Properties, return to the Power Analyzer Control Panel and select **File > Edit Session Properties**.

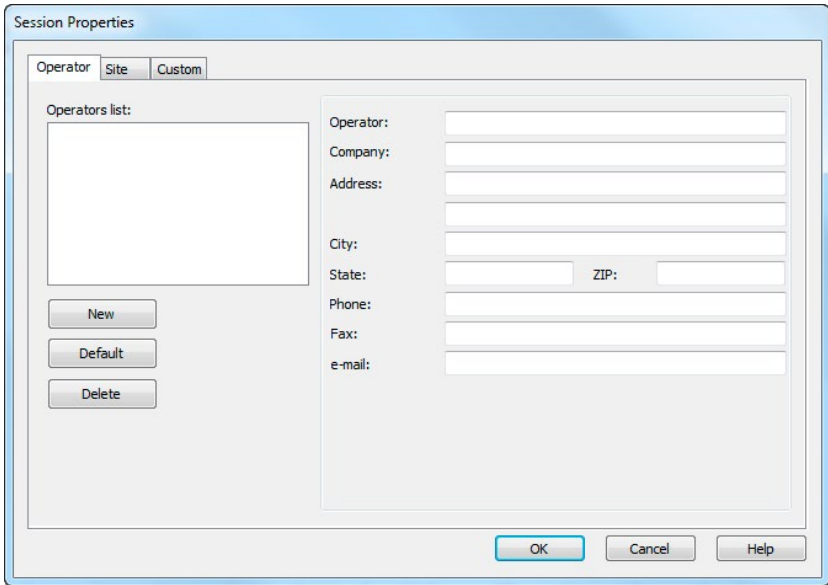


Figure 6-17

The Session Properties dialog box allows you to specify the Operator, Site and Custom parameters that are to be saved with recorded data. These parameters are used when generating reports.

The Operator and Site tabs allow you to maintain lists of operators and sites, saving you time when specifying parameters for reports.

On the left of the Operator and Site tabs is the list of previously defined Operators and Sites. On the right of the Operator and Site tabs is the individual parameters that will be saved in an associated database. Only a single set of operator and site fields are saved in the recording database.

The Custom tab contains a list of user defined parameters. Along side each user defined parameter is a check box. Items that are checked will be added to an associated database. Only a single set of Custom parameters can be maintained (unlike the Operator and Site lists). The Custom tab allows you to specify any user defined parameters (in addition to the comments field of the Site tab) that are to be used in displaying a report.



In addition to the pre-designed report templates, DataView® allows you to totally configure reports to your needs. **Refer to the DataView® HELP file on “Templates” to learn more about templates.**

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## **MAINTENANCE**

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



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

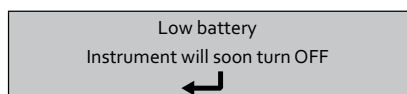
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### **7.1 Battery Indicator**

The number of bars in the battery icon located in the upper right of the screen shows the battery level.

<b>Icon</b>	<b>Battery Charge Status</b>
	Battery charged
	Low battery
	Battery charging
	The PowerPad® is being powered by the power cord

When the capacity of the battery is too low, the following message is displayed:



Press to confirm. The PowerPad® will shut off after one minute if you do not connect the PowerPad® to the power cord.



The battery may fully discharge when recording for long periods of time while not connected to a power supply. The PowerPad® 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. During the recording, the ON/OFF button will blink. If the light is not blinking, the recording has stopped and the data has been saved. Do not turn the instrument OFF. Supply power to the PowerPad® with the power cord and press the ON/OFF button.

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## 7.2 Recharging the Battery

Battery life is 10 hours when the battery is completely charged and no recording is in progress. Battery life is approximately 35 hours when recording and the display is off.

The batteries automatically begin recharging when the PowerPad® is connected to the AC power supply. Only use the supplied AC power supply to recharge the batteries of the PowerPad®. It will take about 5 hours to fully charge completely drained batteries. The batteries will not be depleted when the unit is connected to the power supply.



The instrument will not recharge if the message “Instrument will soon turn OFF” is displayed on the screen. The Enter button must be pressed or the instrument must be turned OFF before recharging will start.

---

## 7.3 Changing the Battery



### **WARNING:**

- When changing the battery, disconnect all instrument inputs and turn the equipment off. There must be a delay of at least one minute without the battery being connected.
- Do not expose the battery to heat exceeding 212°F (100°C)
- Do not short-circuit the battery terminals

To change the battery, disconnect from any input and make sure the instrument is turned off.

With a coin, remove back panel and replace with a 9.6V NiMH factory supplied battery pack.

**NOTE:** The memory card is accessible when the battery is removed from the compartment.

## 7.4 Cleaning



Disconnect the instrument from any source of electricity.

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- 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

## APPENDIX A

### MATHEMATICAL FORMULAS FOR VARIOUS PARAMETERS

**NOTE the following abbreviations used in this section:**

**NSHC** = number of samples per half cycle (between two consecutive zeros)

**NSC** = number of samples per cycle

**NSS** = number of samples in a second (multiple of NSC)

**V** = voltage phase to neutral

**U** = voltage phase to phase

#### **RMS values of half-cycle voltage and current (excluding neutral)**

Half-cycle RMS phase-to-neutral voltage of phase (i+1) with i  $\in [0; 2]$ .

$$V_{\text{half}}[i] = \sqrt{\frac{1}{NSHC} \cdot \sum_{n=Zero}^{(Next\ Zero)-1} V[i][n]^2}$$

Half-cycle RMS phase-to-phase voltage of phase (i+1) with i  $\in [0; 2]$ .

$$U_{\text{half}}[i] = \sqrt{\frac{1}{NSHC} \cdot \sum_{n=Zero}^{(Next\ Zero)-1} U[i][n]^2}$$

Half-cycle RMS current of phase (i+1) with i  $\in [0; 2]$ .

$$A_{\text{half}}[i] = \sqrt{\frac{1}{NSHC} \cdot \sum_{n=Zero}^{(Next\ Zero)-1} A[i][n]^2}$$


To avoid missing any fault, these values are calculated for each half-cycle.

## Minimum and Maximum half-cycle RMS values (excluding neutral)

Min and max RMS phase-to-neutral voltages of phase (i+1) with  $i \in [0 ; 2]$ .  
 $V_{\max}[i] = \max(V_{\text{half}}[i])$ ,  $V_{\min}[i] = \min(V_{\text{half}}[i])$

Min and max RMS phase-to-phase voltages of phase (i+1) with  $i \in [0 ; 2]$ .  
 $U_{\max}[i] = \max(U_{\text{half}}[i])$ ,  $U_{\min}[i] = \min(U_{\text{half}}[i])$

Min and max RMS currents of phase (i+1) with  $i \in [0 ; 2]$ .  
 $A_{\max}[i] = \max(A_{\text{half}}[i])$ ,  $A_{\min}[i] = \min(A_{\text{half}}[i])$

**NOTE:** The duration of the evaluation is left to the user's discretion (reset by pressing the  key).

## Short-term flicker – 10 minute (excluding neutral)

Method based on the IEC 61000-4-15 standard.

The input values are half-cycle phase-to-neutral voltages. Blocks 3 and 4 are created digitally. The classifier of block 5 has 128 levels.

The value  $V_{\text{flk}}[i]$  is updated every 10 minutes (phase (i+1) with  $i \in [0 ; 2]$ ).

## Peak Values (neutral except $U_{\text{pp}}$ and $U_{\text{pm}}$ – over 250ms)

Positive and negative phase-to-neutral peak voltages of phase (i+1) with  $i \in [0 ; 3]$   
 $V_{\text{pp}}[i] = \max(V[i][n])$ ,  $V_{\text{pm}}[i] = \min(V[i][n])$ ,  $n \in [0..NSC-1]$

Positive and negative phase-to-phase peak voltages of phase (i+1) with  $i \in [0 ; 2]$   
 $U_{\text{pp}}[i] = \max(U[i][n])$ ,  $U_{\text{pm}}[i] = \min(U[i][n])$ ,  $n \in [0..NSC-1]$

Positive and negative peak currents of phase (i+1) with  $i \in [0 ; 3]$   
 $A_{\text{pp}}[i] = \max(A[i][n])$ ,  $A_{\text{pm}}[i] = \min(A[i][n])$ ,  $n \in [0..NSC-1]$

## Peak Factors (excluding neutral – over 250ms)

Peak factor of phase-to-neutral voltage of phase (i+1) with  $i \in [0 ; 2]$

$$V_{cf}[i] = \frac{\max(V_{pp}[i], V_{pm}[i])}{\sqrt{\frac{1}{NSC} \cdot \sum_{n=0}^{NSC-1} V[i][n]^2}}$$

Peak factor of phase-to-phase voltage of phase (i+1) with  $i \in [0 ; 2]$

$$U_{cf}[i] = \frac{\max(U_{pp}[i], U_{pm}[i])}{\sqrt{\frac{1}{NSC} \cdot \sum_{n=0}^{NSC-1} U[i][n]^2}}$$

Peak factor of current of phase (i+1) with  $i \in [0 ; 2]$

$$A_{cf}[i] = \frac{\max(A_{pp}[i], A_{pm}[i])}{\sqrt{\frac{1}{NSC} \cdot \sum_{n=0}^{NSC-1} A[i][n]^2}}$$

## RMS Values

(neutral except URMS - over one second)

RMS phase-to-neutral voltage of phase (i+1) with  $i \in [0 ; 3]$  ( $i = 3 \Leftrightarrow$  neutral-to-earth voltage).

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

RMS phase-to-phase voltage of phase (i+1) with  $i \in [0 ; 2]$ .

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

RMS current of phase (i+1) with  $i \in [0 ; 3]$  ( $i = 3 \Leftrightarrow$  neutral current).

$$A_{rms}[i] = \sqrt{\frac{1}{NSS} \cdot \sum_{n=0}^{NSS-1} A[i][n]^2} \quad \text{Rms current } i + 1 \text{ phase}$$

## Voltage and Current Unbalance (three-phase connection - over one second)

These are calculated from the filtered RMS vector values (over one second)  $V_{Frms}[i]$  and  $A_{Frms}[i]$  (ideally the fundamental vectors of the signals).

**NOTE:** The operations are vector operations in complex notation with

Forward phase-to-neutral voltage (vector)

$$V_{rms+} = \frac{1}{3}(V_{Frms}[0] + a \cdot V_{Frms}[1] + a^2 \cdot V_{Frms}[2])$$

Reverse phase-to-neutral voltage (vector)

$$V_{rms-} = \frac{1}{3}(V_{Frms}[0] + a^2 \cdot V_{Frms}[1] + a \cdot V_{Frms}[2])$$

Phase-to-neutral voltage unbalance (vector)

$$V_{unb} = \frac{|V_{rms-}|}{|V_{rms+}|}$$

Forward current (vector)

$$A_{rms+} = \frac{1}{3}(A_{Frms}[0] + a \cdot A_{Frms}[1] + a^2 \cdot A_{Frms}[2])$$

Reverse current (vector)

$$A_{rms-} = \frac{1}{3}(A_{Frms}[0] + a^2 \cdot A_{Frms}[1] + a \cdot A_{Frms}[2])$$

Current unbalance (vector)

$$A_{unb} = \frac{|A_{rms-}|}{|A_{rms+}|}$$

# Harmonic Calculations

(excluding neutral – over 4 consecutive periods every second)

Harmonic bins are calculated by FFT with 16 bit resolution (1024 samples on 4 cycles) without windowing (IEC 1000-4-7). From the real parts  $b_k$  and the imaginary parts  $a_k$ , the harmonic factor is calculated for each order ( $j$ ) and for each phase ( $i$ ) ( $V_{harm}[i][j]$ ,  $U_{harm}[i][j]$ , and  $A_{harm}[i][j]$ ) with respect to the fundamental and the angles  $V_{ph}[i][j]$ ,  $U_{ph}[i][j]$ , and  $A_{ph}[i][j]$  with respect to the fundamental.

This calculation is accomplished using the following principle:

The factor in percent [%]  $\Leftrightarrow \tau_k = \frac{c_k}{c_4} \cdot 100$

The angle in degrees [°]  $\Leftrightarrow \varphi_k = \arctan\left(\frac{a_k}{b_k}\right) - \varphi_4$

$$\text{with } \begin{cases} c_k = |b_k + j a_k| = \sqrt{a_k^2 + b_k^2} \\ b_k = \frac{1}{512} \sum_{s=0}^{1024} F_s \cdot \sin\left(\frac{k\pi}{512} s + \varphi_k\right) \\ a_k = \frac{1}{512} \sum_{s=0}^{1024} F_s \cdot \cos\left(\frac{k\pi}{512} s + \varphi_k\right) \\ c_0 = \frac{1}{1024} \sum_{s=0}^{1024} F_s \end{cases}$$

$c_k$  is the amplitude of the component of order  $j = \frac{k}{4}$  with a frequency  $f_k = \frac{k}{4} f_4$

$F_s$  is the sampled signal at the fundamental frequency

$c_0$  is the DC component

$k$  is the index of the spectral spike - the order of the harmonic component is  $j = \frac{k}{4}$

**NOTE:** The power harmonic factors are calculated by multiplying the phase-to-neutral voltage harmonic factors by the current harmonic factors. The power harmonic angles ( $V_{Aharm}[i][j]$  and  $V_{Aph}[i][j]$ ) are calculated by differentiating the phase-to-neutral voltage harmonic angles with the current harmonic angles.

## Harmonic Distortions

(excluding neutral – over 4 consecutive cycles every second)

Two global values giving the relative quantity of harmonics are calculated: the THD as a proportion of the fundamental (“THD-F”) and the DF as a proportion of the RMS value (“THD-R”).

Total harmonic distortion of phase (i+1) with  $i \in [0 ; 2]$  (THD or THD-F).

$$V_{thd}[i] = \frac{\sqrt{\sum_{n=2}^{50} V_{harm}[i][n]^2}}{V_{harm}[i][1]}, \quad U_{thd}[i] = \frac{\sqrt{\sum_{n=2}^{50} U_{harm}[i][n]^2}}{U_{harm}[i][1]}, \quad A_{thd}[i] = \frac{\sqrt{\sum_{n=2}^{50} A_{harm}[i][n]^2}}{A_{harm}[i][1]}$$

Distortion factors of phase (i+1) with  $i \in [0 ; 2]$  (DF or THD-R).

$$V_{df}[i] = \frac{\sqrt{\sum_{n=2}^{50} V_{harm}[i][n]^2}}{\sqrt{\sum_{n=1}^{50} V_{harm}[i][n]^2}}, \quad U_{df}[i] = \frac{\sqrt{\sum_{n=2}^{50} U_{harm}[i][n]^2}}{\sqrt{\sum_{n=1}^{50} U_{harm}[i][n]^2}}, \quad A_{df}[i] = \frac{\sqrt{\sum_{n=2}^{50} A_{harm}[i][n]^2}}{\sqrt{\sum_{n=1}^{50} A_{harm}[i][n]^2}}$$

## K factor

(excluding neutral – over 4 consecutive cycles every second)

K factor for phase (i+1) with  $i \in [0 ; 2]$ .

$$A_{kf}[i] = \frac{\sum_{n=1}^{n=50} n^2 \cdot A_{harm}[i][n]^2}{\sum_{n=1}^{n=50} A_{harm}[i][n]^2}$$



## Sequence harmonics

(over 3 × (4 consecutive cycles) every second)

Negative-sequence harmonics

$$V_{\text{harm}_-} = \frac{1}{3} \sum_{i=0}^2 \frac{\sum_{j=0}^7 V_{\text{harm}}[i][3j+2]}{V_{\text{harm}}[i][1]}, \quad A_{\text{harm}_-} = \frac{1}{3} \sum_{i=0}^2 \frac{\sum_{j=0}^7 A_{\text{harm}}[i][3j+2]}{A_{\text{harm}}[i][1]}$$

Zero-sequence harmonics

$$V_{\text{harm}_0} = \frac{1}{3} \sum_{i=0}^2 \frac{\sum_{j=0}^7 V_{\text{harm}}[i][3j+3]}{V_{\text{harm}}[i][1]}, \quad A_{\text{harm}_0} = \frac{1}{3} \sum_{i=0}^2 \frac{\sum_{j=0}^7 A_{\text{harm}}[i][3j+3]}{A_{\text{harm}}[i][1]}$$

Positive -sequence harmonics

$$V_{\text{harm}_+} = \frac{1}{3} \sum_{i=0}^2 \frac{\sum_{j=0}^7 V_{\text{harm}}[i][3j+4]}{V_{\text{harm}}[i][1]}, \quad A_{\text{harm}_+} = \frac{1}{3} \sum_{i=0}^2 \frac{\sum_{j=0}^7 A_{\text{harm}}[i][3j+4]}{A_{\text{harm}}[i][1]}$$

## Powers

(excluding neutral – over one second)

**NSS** = number of samples in a second

Active power of phase (i+1) with  $i \in [0 ; 2]$ .

$$W[i] = \frac{1}{NSS} \cdot \sum_{n=0}^{NSS-1} V[i][n] \cdot A[i][n]$$

Apparent power of phase (i+1) with  $i \in [0 ; 2]$ .

$$VA[i] = V_{\text{rms}}[i] \cdot A_{\text{rms}}[i]$$

Reactive power (without harmonics) of phase (i+1) with  $i \in [0 ; 2]$ .

$$VAR[i] = \frac{1}{NSS} \cdot \sum_{n=0}^{NSS-1} VF[i][n - \frac{NSC}{4}] \cdot AF[i][n]$$

Reactive power (with harmonics) of phase (i+1) with  $i \in [0 ; 2]$ .

$$VAR[i] = \sqrt{VA[i]^2 - W[i]^2}$$

Reactive powers are calculated using the filtered signals (without harmonics) – VF[i][j] and AF[i][j] - in accordance with EDF (French national electricity company) rules or from the apparent and active powers (with harmonics). The choice of calculation is left up to the user.

Total active power

$$W[3] = W[0] + W[1] + W[2]$$

Total apparent power

$$VA[3] = VA[0] + VA[1] + VA[2]$$

Total reactive power

$$VAR[3] = VAR[0] + VAR[1] + VAR[2]$$

## Power ratios

(excluding neutral – over one second)

**NSS** = number of samples in a second

Power Factor of phase (i+1) with  $i \in [0 ; 2]$ .

$$PF[i] = \frac{W[i]}{VA[i]}$$

Displacement Power factor of phase (i + 1) or cosine of the angle of the phase-to-neutral voltage fundamental of phase (i+1) with respect to the current fundamental of phase (i+1) with  $i \in [0 ; 2]$ .

$$DPF[i] = \cos(\phi[i]) = \frac{\sum_{n=0}^{NechSec-1} VF[i][n] \cdot AF[i][n]}{\sqrt{\sum_{n=0}^{NechSec-1} VF[i][n]^2} \cdot \sqrt{\sum_{n=0}^{NechSec-1} AF[i][n]^2}}$$

Tangent of phase (i + 1) or tangent of the angle of the phase-to-neutral voltage fundamental of phase (i+1) with respect to the current fundamental of phase (i+1) with  $i \in [0 ; 2]$ .

$$Tan[i] = \tan(\phi[i]) = \frac{\sum_{n=0}^{NechSec-1} VF[i][n - \frac{NechPer}{4}] \cdot AF[i][n]}{\sum_{n=0}^{NechSec-1} VF[i][n] \cdot AF[i][n]}$$

Total power factor

$$PF[3] = \frac{|PF[0]| + |PF[1]| + |PF[2]|}{3}$$

Total displacement power factor

$$DPF[3] = \frac{|DPF[0]| + |DPF[1]| + |DPF[2]|}{3}$$

Total tangent

$$Tan[3] = \frac{|Tan[0]| + |Tan[1]| + |Tan[2]|}{3}$$

## Energies (excluding neutral – over Tint with refresh every second)

Tint is the power integration time in energy calculations; the beginning and end of this period are user-controlled.

### Case 1: consumed energies ( $W[i] \geq 0$ )

Consumed active energy of phase (i+1) with  $i \in [0 ; 2]$ .

$$Wh[0][i] = \sum_{Tint} \frac{W[i]}{3600}$$

Consumed apparent energy of phase (i+1) with  $i \in [0 ; 2]$ .

$$VAh[0][i] = \sum_{Tint} \frac{VA[i]}{3600}$$

Consumed inductive reactive energy of phase (i+1) with  $i \in [0 ; 2]$ .

$$VARhL[0][i] = \sum_{Tint} \frac{VAR[i]}{3600} \text{ with } VAR[i] \geq 0$$

Consumed capacitive reactive energy of phase (i+1) with  $i \in [0 ; 2]$ .

$$VARhC[0][i] = \sum_{Tint} \frac{-VAR[i]}{3600} \text{ with } VAR[i] < 0$$

Total consumed active energy

$$Wh[0][3] = Wh[0][0] + Wh[0][1] + Wh[0][2]$$

Total consumed apparent energy

$$VAh[0][3] = VAh[0][0] + VAh[0][1] + VAh[0][2]$$

Total consumed capacitive reactive energy

$$VARhC[0][3] = VARhC[0][0] + VARhC[0][1] + VARhC[0][2]$$

Total consumed reactive inductive energy

$$VARhL[0][3] = VARhL[0][0] + VARhL[0][1] + VARhL[0][2]$$

## Case 2: generated energies ( $W[i] < 0$ )

Generated active energy of phase  $i + 1$ .

$$Wh[1][i] = \sum_{T_{int}} \frac{W[i]}{3600}$$

Generated apparent energy of phase  $(i+1)$  with  $i \in [0 ; 2]$ .

$$VAh[1][i] = \sum_{T_{int}} \frac{VA[i]}{3600}$$

Generated inductive reactive energy of phase  $(i+1)$  with  $i \in [0 ; 2]$ .

$$VARhL[1][i] = \sum_{T_{int}} \frac{-VAR[i]}{3600} \text{ with } VAR[i] < 0$$

Generated capacitive reactive energy of phase  $(i+1)$  with  $i \in [0 ; 2]$ .

$$VARhC[1][i] = \sum_{T_{int}} \frac{VAR[i]}{3600} \text{ with } VAR[i] \geq 0$$

Total generated active energy

$$Wh[1][3] = Wh[1][0] + Wh[1][1] + Wh[1][2]$$

Total generated apparent energy

$$VAh[1][3] = VAh[1][0] + VAh[1][1] + VAh[1][2]$$

Total generated capacitive reactive energy

$$VARhC[1][3] = VARhC[1][0] + VARhC[1][1] + VARhC[1][2]$$

Total generated inductive reactive energy

$$VARhL[1][3] = VARhL[1][0] + VARhL[1][1] + VARhL[1][2]$$

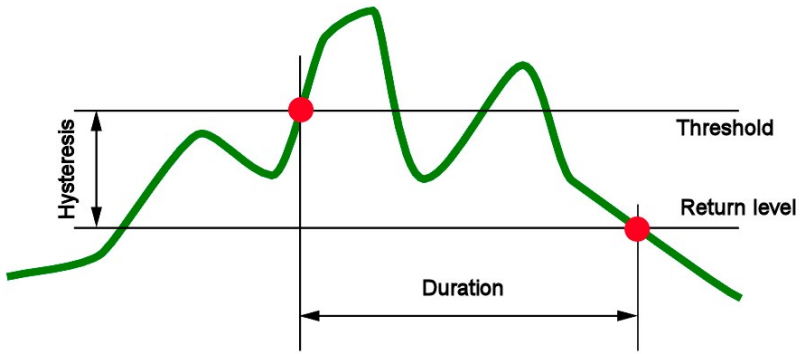
# Hysteresis

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.

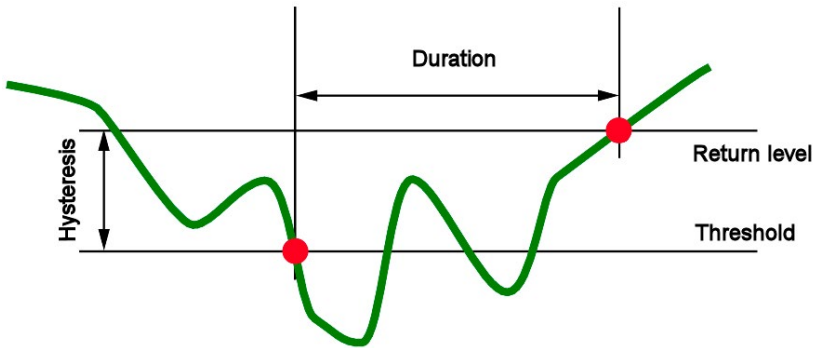
The event detection is activated when the measure is going over the threshold but it can only be deactivated if the measure goes under the threshold minus the value of the hysteresis.

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 on the system.

## Alarm for high voltage RMS (Swell Detection)



## Alarm for low voltage RMS (Sag or Interruption Detection)



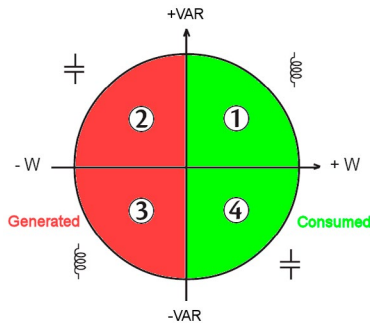
# Minimum scale values for waveforms and minimum RMS values

Type	Min scale value [waveform mode]
Phase-to-neutral and phase-to-phase voltages	8V
AmpFlex® & MiniFlex®	90A
SR193	8A
MR193	8A
MN93	2A
SL261 (10mV/A)	0.8A
SL261 (100mV/A)	0.08A
MN193 (100A)	0.8A
MN193 (5A)	0.04A <sup>(1)</sup>
5A Adaptor	0.04A <sup>(1)</sup>

<sup>(1)</sup> Value to be multiplied by the ratio in effect (if not unity).

## Four-Quadrant Diagram

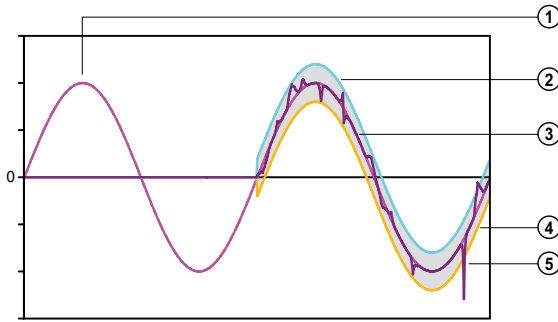
This diagram is used as part of measuring power and energy (see § 5.6)



## Mechanism for triggering transient sensors

The sample rate is a constant value equivalent to 256 samples per cycle. When a transient search is launched, each sample is compared to the sample from the preceding cycle. The preceding cycle matches the middle of the tube; it is used as a reference. As soon as a sample leaves the tube, the trigger event comes; representation of the transient is then captured by the PowerPad®. The cycle preceding the event and the three following cycles are saved to memory.

Here is a graphical representation of the transient capture trigger mechanism:



Item	Function
1	Reference period
2	Top of envelope
3	Cycle monitored
4	Bottom of envelope
5	Triggering event

## Capture Conditions in Inrush Current Mode

**Reminder:** Captures depend on the trigger event and a stop event. If the capture ends with a stop event or if the recording memory of the PowerPad® is full, the capture stops automatically.

The stop threshold for capture is calculated as follows:

$$[\text{Stop threshold [A]}] = [\text{Start threshold [A]}] \times (100 - [\text{Stop hysteresis [\%]}]) \div 100$$

Here are the conditions for triggering and stopping capture:

Triggering filter type	Start and end conditions
A1	Start condition $\Leftrightarrow$ [A1 half-period RMS value] > [Start threshold] Stop condition $\Leftrightarrow$ [A1 half-period RMS value] < [Stop threshold]
A2	Start condition $\Leftrightarrow$ [A2 half-period RMS value] > [Start threshold] Stop condition $\Leftrightarrow$ [A2 half-period RMS value] < [Stop threshold]

## APPENDIX B

### GLOSSARY OF TERMS

**Ampere:** unit of electrical current intensity (A symbol).

**Bandwidth:** frequency range on which an instrument supplies a precise measurement.

**Channel and phase:** a measurement channel corresponds to a difference in potential between two conductors. A phase is a single conductor. In polyphased systems, a measurement channel may be between two phases, or between a phase and neutral, or between a phase and earth, or between neutral and earth.

**Cut:** reduction in voltage at a point in the electrical power network below the cut threshold.

**Dip threshold:** specific voltage value to detect the start and end of a voltage dip.

**Distortion factor (DF - Distortion Factor):** ratio of the harmonics of a signal to the whole signal without the DC or bias component (THD-R).

**Harmonics level** whole number equal to the relationship between the frequency of the harmonic and the fundamental frequency.

**Imbalance in voltage in a polyphased electrical power network:** status where efficient values for voltages between conductors (fundamental component) and/or differences in phase between successive conductors are not equal.

**Factor K:** number based on the contents of a harmonic of a charge current that determines the maximum load on a source of energy. The K factor calculated by the PowerPad® is measured and compared with the one specified by the transformer manufacturer. It gives the percentage of “harmonics load” of the transformer.

**Flicker:** The visual effect produced by the variation in electrical voltage.

**Frequency:** number of full voltage cycles produced in one second.

**Fundamental component:** component whose frequency is the fundamental frequency.

**Harmonics:** voltage and current existing in electrical material at frequencies that are multiples of the fundamental frequency.

**Hysteresis:** difference in amplitude between threshold incoming and outgoing values.

**K factor:** used to quantify the effect of a load on a transformer.



**Measurement method:** all measurement methods associated to an individual measurement.

**Nominal voltage:** voltage by which a network is named or identified.

**Order of a harmonic:** ratio of the frequency of the harmonic to the fundamental frequency; a whole number.

**Passband:** range of frequencies in which the response of a device exceeds some specified minimum.

**Peak:** maximum (+) or minimum (-) peak value of the signal.

**Peak factor:** relation between the peak value and efficient value of the current.

**Phase:** temporal relationship between current and voltage in alternating current circuits.

**Phase and route:** a measurement route corresponds to a difference in potential between two conductors. A phase is a simple conductor. In polyphased systems, a measurement route can be between two phases or a phase and neutral or a phase and earth or neutral and earth.

**Phase displacement factor:** relationship between the active power and apparent power of the fundamental component.

**Power displacement factor:** expresses the difference between the apparent and active power when and only when the relationship of the voltage phase and current to the fundamental is taken into account.

**Power factor:** relationship between active and apparent power.

**PST:** (*Short term perception*). Calculation of flicker over a ten minute cycle.

**PLT:** (*Long term perception*). Calculation of flicker over a two-hour cycle.

**RMS:** Root Mean Square. Efficient value of a current or voltage.

**Temporary surge at industrial frequency:** temporary increase in the voltage amplitude at a point in the electrical power network above a given threshold.

**THD:** Total Harmonic Distortion. The rate of total harmonic distortion gives the influence of harmonic components in a signal.

**Voltage dip:** temporary reduction in the voltage amplitude at a point in the electrical power network below a given threshold.

**UNB:** Voltage unbalance in a polyphased electric power network; state in which the RMS voltages between conductors and/or the phase differences between successive conductors are not all equal.

**Watt:** unit of measurement for power (W symbol).

# SYMBOLS & ABBREVIATIONS

Meanings of the symbols and abbreviations used:

Symbol	Designation
$\simeq$	AC and DC components.
$\sim$	AC component only.
$\equiv$	DC component only.
$\Phi$	Phase shift of phase-to-neutral voltage with respect to phase-to-neutral current.
$\overset{\sim}{\text{L}}$	Inductive phase shift.
$\overset{\sim}{\text{C}}$	Capacitive phase shift.
$^{\circ}$	Degree.
$-.+$	Expert mode.
$  \quad  $	Absolute value.
$\Sigma$	Sum of values.
$\bar{x}$	Mean value (arithmetic mean).
<b>L</b>	Phase (Line).
<b>%</b>	Percentage.
$\Phi_{VA}$	Phase shift of voltage with respect to current.
<b>A</b>	Current; also Ampere (unit).
<b>Acf</b>	Crest (peak) factor of current.
<b>Ah</b>	Current harmonic.
<b>Akf</b>	K Factor of current (for transformers).
<b>Arms</b>	True RMS current.
<b>Athd</b>	Total harmonic distortion of current.
<b>Aunb</b>	Current unbalance.
<b>AVG</b>	Mean value (arithmetic mean).
<b>CF</b>	Peak factor (current or voltage).
<b>cos <math>\Phi</math></b>	Cosine of the phase shift of voltage with respect to current (DPF)
<b>DC</b>	DC component (current or voltage).
<b>DF</b>	Distortion factor (THD-R)
<b>DPF</b>	Displacement factor (cos F).
<b>Hz</b>	Frequency of network studied.
<b>KF</b>	See Akf.
<b>MAX</b>	Maximum value.

<b>Symbol</b>	<b>Designation</b>
<b>MIN</b>	Minimum value
<b>ms</b>	Millisecond (unit)
<b>PEAK or PK</b>	Maximum (+) or minimum (-) peak instantaneous value of the signal
<b>PF</b>	Power factor
<b>PST</b>	Short-term flicker
<b>RMS</b>	True RMS value (current or voltage)
<b>t</b>	Relative date of time cursor
<b>tan <math>\Phi</math></b>	Tangent of the phase shift of voltage with respect to current
<b>THD</b>	Total harmonic distortion (THD-F)
<b>U</b>	Phase-to-Phase voltage
<b>Ucf</b>	Phase-to-Phase voltage crest factor
<b>Uh</b>	Phase-to-phase voltage harmonic
<b>Urms</b>	True RMS phase-to-phase voltage
<b>Uthd</b>	Total phase-to-phase voltage harmonic distortion
<b>Uunb</b>	Phase-to-phase voltage unbalance
<b>V</b>	Phase-to-neutral voltage; also Volt (unit)
<b>VA</b>	Apparent power
<b>VAh</b>	Apparent energy; also apparent harmonic power
<b>VAR</b>	Reactive power
<b>VARh</b>	Reactive energy
<b>Vcf</b>	Voltage crest (peak) factor
<b>Vh</b>	Phase-to-neutral voltage harmonic
<b>Vrms</b>	True RMS phase-to-neutral voltage
<b>Vthd</b>	Total harmonic distortion of phase-to-neutral voltage
<b>Vunb</b>	Voltage unbalance
<b>W</b>	Active power
<b>Wh</b>	Active energy

### Prefixes of International System (SI) units

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

## Repair and Calibration

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

### **For instrument repair and calibration:**

You must contact our Service Center for a Customer Service Authorization Number (CSA#). This will ensure that when your instrument arrives, it will be tracked and processed promptly. Please write the CSA# on the outside of the shipping container. If the instrument is returned for calibration, we need to know if you want a standard calibration, or a calibration traceable to N.I.S.T. (Includes calibration certificate plus recorded calibration data).

**Ship To:** Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments  
15 Faraday Drive  
Dover, NH 03820 USA  
Phone: (800) 945-2362 (Ext. 360)  
(603) 749-6434 (Ext. 360)  
Fax: (603) 742-2346 or (603) 749-6309  
E-mail: [repair@aemc.com](mailto:repair@aemc.com)

(Or contact your authorized distributor)

Costs for repair, standard calibration, and calibration traceable to N.I.S.T. are available.

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

## Technical and Sales Assistance

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

**Contact:** Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments  
Phone: (800) 945-2362 (Ext. 351)  
(603) 749-6434 (Ext. 351)  
Fax: (603) 742-2246  
E-mail: [techsupport@aemc.com](mailto:techsupport@aemc.com)

## Limited Warranty

The PowerPad® Model 8335 is warranted to the owner for a period of two years from the date of original purchase against defects in manufacture. This limited warranty is given by AEMC® Instruments, not by the distributor from whom it was purchased. This warranty is void if the unit has been tampered with, abused or if the defect is related to service not performed by AEMC® Instruments.

Full warranty coverage and product registration is available on our website at [www.aemc.com/warranty.html](http://www.aemc.com/warranty.html).

### **IMPORTANT WARRANTY NOTE:**

By registering online within 30 days from the date of purchase, your warranty will be extended to 3 years

Please print the online Warranty Coverage Information for your records.

### **What AEMC® Instruments will do:**

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

## Warranty Repairs

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

First, request a Customer Service Authorization Number (CSA#) by phone or by fax from our Service Department (see address below), then return the instrument along with the signed CSA Form. Please write the CSA# on the outside of the shipping container. Return the instrument, postage or shipment pre-paid to:

**Ship To:** Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments  
15 Faraday Drive • Dover, NH 03820 USA  
Phone: (800) 945-2362 (Ext. 360)  
(603) 749-6434 (Ext. 360)  
Fax: (603) 742-2346 or (603) 749-6309  
E-mail: [repair@aemc.com](mailto:repair@aemc.com)

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

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

**NOTES:**

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