FLUKE®

1760
PQ Analyzer

Users Manual

June 2006

LIMITED WARRANTY AND LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is two years and begins on the date of shipment. Parts, product repairs, and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries, or to any product which, in Fluke's opinion, has been misused, altered, neglected, contaminated, or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available only if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's option, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to a Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center to obtain return authorization information, then send the product to that service center, with a description of the difficulty, postage and insurance prepaid (FOB Destination). Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that failure was caused by neglect, misuse, contamination, alteration, accident, or abnormal condition of operation or handling, including overvoltage failures caused by use outside the product's specified rating, or normal wear and tear of mechanical components, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

THIS WARRANTY IS BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, ARISING FROM ANY CAUSE OR THEORY.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court or other decision-maker of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
U.S.A.

Fluke Europe B.V.
P.O. Box 1186
5602 BD Eindhoven
The Netherlands

11/99

To register your product online, visit register.fluke.com

Table of Contents

List of Tables

List of Figures

Chapter 1
Introduction

About this Manual

This manual consists of several chapters.

- Introduction
- Getting Started
- Operation
- Maintenance
- Specifications
- Options and Accessories

Symbols

Table 1-1 shows the symbols used on the instrument and/or in this manual.

Table 1-1. Symbols

Symbol	Description
	Hazardous voltage.
	Important information. See manual.
	Earth ground.
	Double insulation.
	AC (Alternating Current)
	DC (Direct Current).
	Conforms to requirements of European Union.
	Canadian Standards Association is the certified body used for testing compliance to safety standards.
	Do not dispose of this product as unsorted municipal waste. Contact Fluke or a qualified recycler for disposal.
	Conforms to relevant Australian Standards.

CAT Identification

Figure 1-1 shows an example to identify the locations of different measurement categories (CAT).

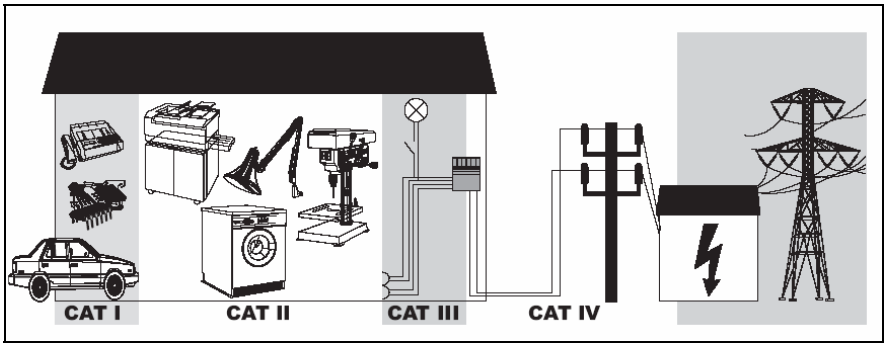


Figure 1-1. CAT

Safety Instructions

The design and manufacture of the device conform to the latest state of technology and the safety standards laid down in IEC 61010 1/2nd edition. If used improperly, there is a risk of injury to persons and damage of property.

Please read this section carefully. It will familiarize you with important safety instructions for handling your 1760 PQ Analyzer. In this manual a **Warning** identifies conditions and actions that pose hazard(s) to the user. A **Caution** identifies conditions and actions that may damage the Recorder.

Note

The 1760 PQ Analyzer is referred to as 'Recorder' through out the manual.

⚠⚠ Warnings

The Power Quality Recorder may only be used and handled by qualified personnel.

Maintenance work must be done only by qualified service personnel.

Use only specified current probes. If you use flexible current probes, wear suitable protective gloves or work on de-energized conductors.

Protect the Recorder against wetness and humidity.

To prevent electrical shock, always connect current probe test leads to the Recorder before connecting to the load.

To avoid electrical shock, do not connect the voltage measuring or power supply input to systems with higher voltages to ground (earth) than is marked on the Recorder.

To avoid damage to the Recorder, never connect the voltage measuring inputs to phase-to-phase voltages higher than defined on the voltage sensors.

To avoid damage to the Recorder, never connect the power supply voltage inputs to phase-to-phase voltages.

All these accessories must be approved for the defined overvoltage category or higher.

Use only the provided original or specified accessories.

Connect clip-on current transformers and/or Flexi Set to insulated live conductors only.

The power company side of the revenue power meter is considered a CAT IV area. To avoid electrical shock or damage to the equipment, never connect the Recorder to the power in this area.

Additional personal protective measures as required by local government agencies must be taken if the measuring sensors are installed on non-insulated live conductors.

Avoid connection from multiple channels to the same phase.

Protection Class

This device is assigned to protection class I according to IEC 61140 and is equipped with a protective earth connector.

Qualified Personnel

The device may only be operated by suitably qualified personnel. The adequate qualifications required are:

- Trained and authorized to switch on/off, ground (earth) and mark the power distribution circuits and devices in accordance with the safety standards of electrical engineering
- Training or instruction in accordance with the standards of the safety engineering in maintenance and use of appropriate safety equipment
- Training in first aid

Safe Operation

For safe operation of the Recorder:

- Ensure that all persons using the device have read and fully understood the operating manual and safety instructions.
- The device may only be used under certain ambient conditions. Ensure that the actual ambient conditions conform to the admissible conditions laid down in Chapter 6, *Technical Information*.
- During the operation, ensure that the circulation of air around the instrument is possible in order to prevent the accumulation of heat inside the housing.
- Always comply with the instructions in Chapter 2, *Transport and Storage*.

Proper Usage

Do not use the device for any other purpose other than measuring of voltages and currents that are within the measuring ranges and categories, including voltage to earth as laid down in Chapter 6, *Technical Information*.

Improper use shall void all warranty.

Electrical Connections

- Ensure that the power and connecting cables used with the device are in proper working order.
- Ensure that the protective earth connector of the power lead and the housing earth connector are connected according to the instructions to the low-resistance unit earth cable.
- Ensure that the power and connecting cables as well as all accessories used in conjunction with the device are in proper working order and clean.
- Install the device in such a way that its power cable is accessible at all times and can easily be disconnected. If this is not applicable a two pole circuit breaker with a nominal current must be installed in the power supply lines.

Risks During Operation

For connection work, do not work on your own but in teams of at least two persons.

Do not use the device if the housing or an operating element is damaged.

Ensure that the connected devices work properly.

Measurement sensors must not be connected to unfused circuits.

Connectors with locking mechanism have to be locked firmly.

Maintenance and Repairs

Do not open the housing.

Do not carry out any repairs and replace any component parts of the device.

Damaged connecting and power leads must be repaired or replaced by an authorized service technician.

Authorized, specialized technicians may only repair damaged or defective devices.

Accessories

Only use the accessories supplied with the device or specifically available as optional equipment for your model.

Ensure that any third-party accessories used in conjunction with the device conform to IEC 61010-031/-2-032 standard and are suitable for respective measuring voltage range.

Device Shutdown

If you detect any damage to the housing, controls, power cable, connecting leads or connected devices, immediately disconnect the measuring inputs of the unit and then from the power supply.

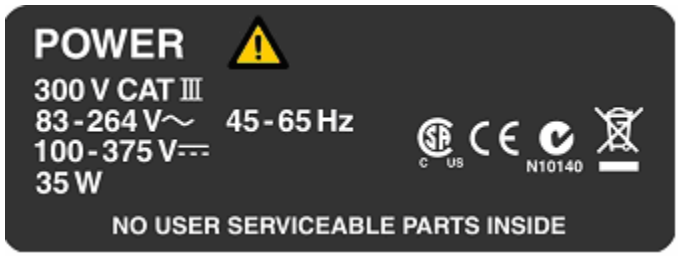
If you are in doubt as regards the safe operation of the device, immediately shutdown the unit and the respective accessories, secure them against inadvertent switching on and bring them to an authorized service agent.

Safety Instructions on Device Housing

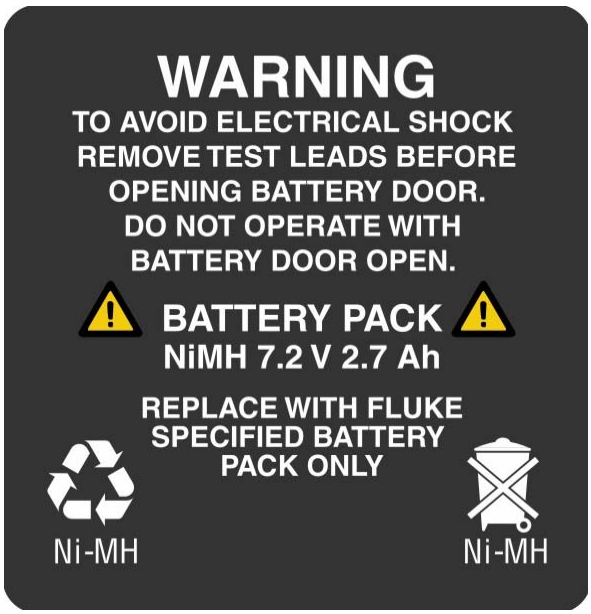
Mains Connection

The mains connection must conform to the ranges/values as inscribed on the instrument labels.

Figure 1-2 shows the instrument labels.



schild-mains.wmf



schild-akku.wmf

Figure 1-2. Instrument Labels

⚠⚠ Warning

Risk of voltage peaks in higher categories. Connect the supply cable of the device only to sections CAT I, II or III of the supply system (Refer to the 'Functional Description' section) the voltage to earth may not exceed 300 V.

Input Voltage – Measuring Inputs

The measurement category (refer to *Functional Description* section) and the max. voltage to earth of the sensors has to conform at least to the power supply system (See the inscription and the technical specifications of the accessories).

Servicing and Maintenance

- Do not remove the cover
- Refer servicing to qualified personnel
- The user can replace the accumulator package (Refer Chapter 11, *Maintenance*)

Design and Functions

This section provides an overview of the terminals, ports and interfaces of the power quality analyzer, as well as a list of displays and operating devices and a brief introduction to the basic functions of the unit.

Mains Connection and Interfaces

Figure 1-3 and Figure 1-4 show the top view and front view of the Recorder respectively.

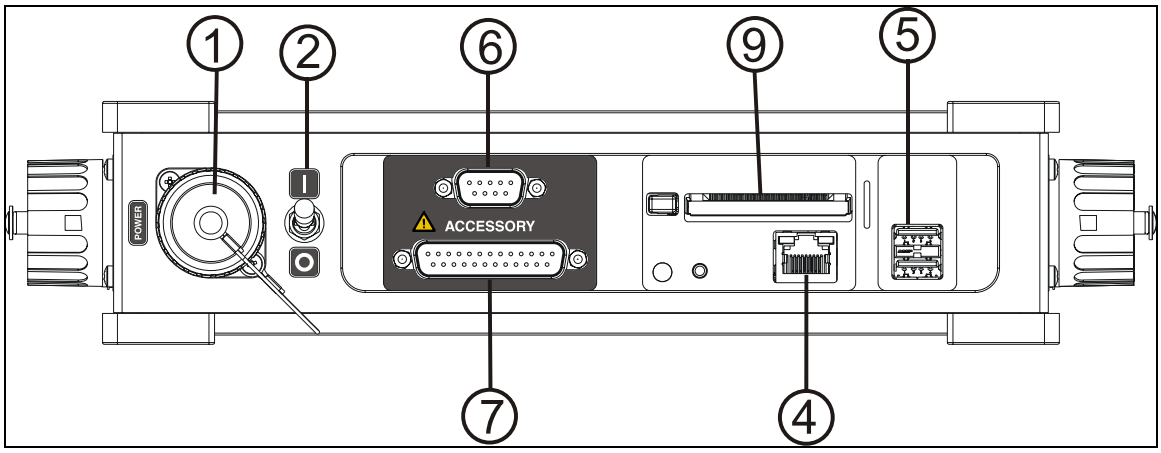
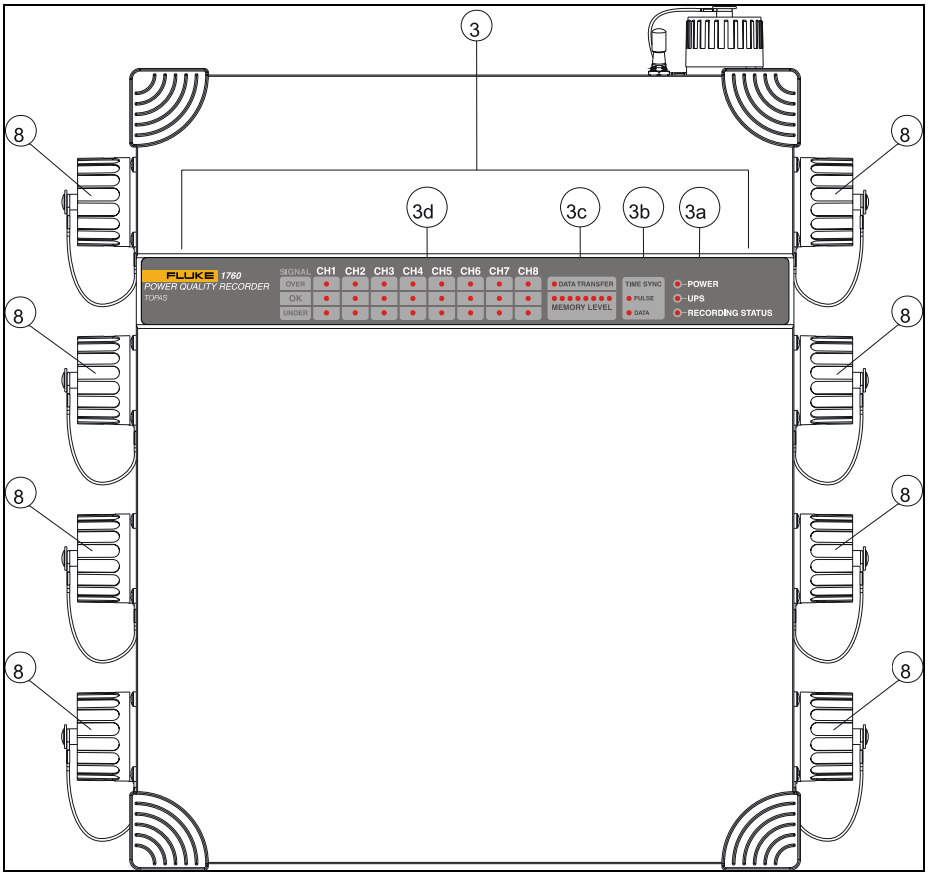


Figure 1-3. Top View



grafikview2.wmf

Figure 1-4. Front View

Table 1-2 shows the controls and indicators of the Recorder.

Table 1-2. 1760 PQ Analyzer - Controls and Indicators

Sl No.	Description
(1)	Mains connection.
(2)	Mains switch.
(3)	LED indicators.
(4)	Ethernet connector.
(5)	USB connectors type A (future option).
(6)	COM 1 – serial port (RS232).
(7)	Feature connector (GPS, DCF 77, alarms, etc).
(8)	Analogue input connectors.
(9)	Compact Flash card slot (future option).

Note

Channels ‘CH1’ to ‘CH4’ are labeled:

Schild CH1.wmf

The text TRANSIENT indicates that these channels can be equipped with a fast transient option.

Channels ‘CH5’ to ‘CH8’ cannot be used for fast transient recordings and are labeled like this:

schild ch5.wmf

Functional Description

① Mains Connector

Connect the device to 83 V – 264 V AC-47 Hz – 65 Hz or 100 V – 375 V DC, power consumption approx. 30 W.

Note

Connect the supply cable of the device only to sections CAT I, II or III of the supply system (Refer to the ‘Functional Description’ section) the voltage to earth may not exceed 300 V.

② Mains Switch

Activate the mains switch to switch the device on or off.

Note

The switch is secured by a mechanical feature against inadvertent activation. Lift the knob slightly before moving it to the other position.

Instrument can be turned on only if the mains power supply is connected and the supply voltage is within the specified range.

If the mains switch is in position I the instrument is turned on automatically as soon as an appropriate supply voltage is applied to the mains connector.

If there is no mains supply and the battery pack capacity is too low the instrument is turned off automatically.

Note

In case the internal PQ Analyze software is not working properly, put the mains switch into 0-position, the instrument will be turned off after approximately 1 minute.

Rebooting the Instrument

To reboot the instrument:

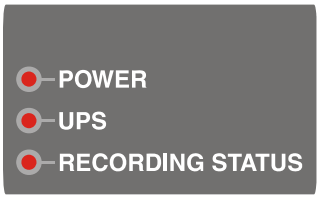
1. Connect the Instrument to mains.

2. Set the mains switch to the I-position.
3. Wait until the *Mains* LED is on.
4. Set the mains switch to the 0-position.
5. Wait until the LEDs *Mains* and *Battery* are blinking rapidly.
6. Within 3 second set the mains switch to I-position again, Instrument will reboot, which is indicated by slowly blinking of LEDs *Mains* and *Battery*.

③ LED Indicators

led-schild gesamt.wmf

LEDs in the field *Power*:



led-power.wmf

Overview

Condition	LED Mains	LED Battery
Instrument boot	Green	OFF
Mains is on, battery is not charged	Green	green, yellow, or red according to capacity
Mains is on, battery is charged	Green	Blinking green, yellow, or red according to capacity
Battery operation	OFF	green, yellow, or red according to capacity
Battery discharge mode	OFF	Blinking green, yellow, or red, Memory LEDs show “decreasing” yellow flashlight
Instrument reboot	Green, blinking	Blinking green, yellow, or red according to capacity
	Blinking synchronously	
Instrument shutdown	Green, blinking	Blinking green, yellow, or red according to capacity
	Blinking advertently	

Details

These LEDs provide information about the power supply:

LED Mains:

- Continuously green: Instrument is supplied from mains
- OFF: Supply from battery package

LED Battery:

Indicates charging state of the battery package:

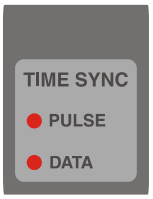
- *Green*: Battery is charged with 80 % to 100 % of nominal capacity
- *Yellow*: Energy is between 30 % and 80 %, mains independent operation is possible for more than 3 minutes
- *Red*: Energy is between 25 % and 30 % of nominal capacity. Mains independent operation is possible for less than 3 minutes
- *Flashing*: During charging the LED is blinking red, yellow, or green corresponding to charging state and turns to continuous green light when charging is complete

LED Status:

This indicator gives information about status of the measurement campaign.

Condition	LED Status
Instrument is not yet configured for a measurement campaign	OFF
Instrument configuration is in progress, Instrument is not yet ready for recording data	green, blinking rapidly
Instrument is configured for a measurement campaign, but this has not yet started	Green
Measurement campaign is active, data are recorded	Green, blinking slowly
Measurement campaign is active, data are recorded, but some memory portions are full, i. e. some virtual instruments do not record any more	Yellow, blinking slowly
Measurement campaign finished, no further campaign is programmed, data ready for upload to the PC, Instrument does not record data any more	Yellow

LEDs Time Sync:



led-timesync.wmf

These indicators provide information about the time synchronization of the Instrument.
LED Pulse:

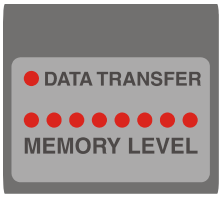
This LED indicates the reception of sync pulses. If Instrument is synchronized correctly the LED is green and turns to yellow for each pulse detected.

If external pulses are used without GPS time information the LED is off and flashes yellow for each detected sync pulse.

LED Data:

- *Green*: The Recorder is configured for time synchronization (Service menu), a time synchronization adaptor (GPS or DCF77) is connected, and the received time information is valid.
- *Yellow*: The Recorder is configured for time synchronization; a time synchronization adaptor is connected, but the received time information is not correct. Possible reasons: No satellites or time source found or adaptor still synchronizing after power on.
- *Red*: The Recorder is configured for time synchronization, but no time synchronization adaptor is connected or it is not working properly.
- *Off*: The recorder is not configured for time synchronization.

LEDs Data:



led-data.wmf

LED Transfer:

The Transfer LED indicates data transfer via external interfaces or to the Compact Flash card.

- *Off*: no data transfer
- *Blinking yellow*: data are written to the internal CF-card
- *Blinking green*: data transfer via any of the interfaces (USB, RS 232, or Ethernet)

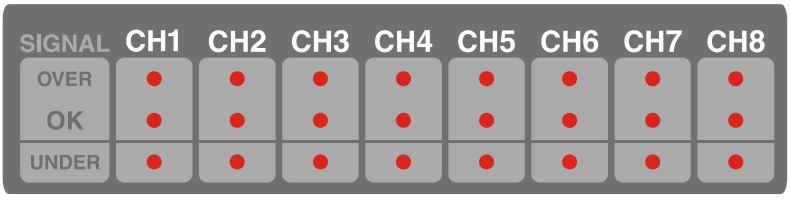
LEDs Memory:

The row of Memory LEDs indicates the amount of free/occupied measurement data memory on the Compact Flash card.

Occupied blocks are indicated by lit LEDs, 5 on the left side are green, 3 on the right side are red to indicate that the memory is soon full.

During a forced battery discharge these LEDs are flashing yellow, the number of LEDs lit represents the remaining capacity in minutes.

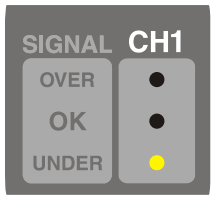
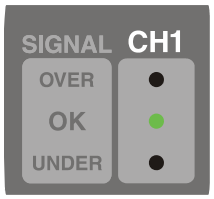
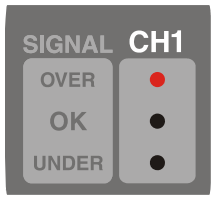
LEDs CH1 to CH8:



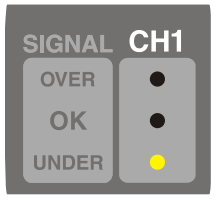
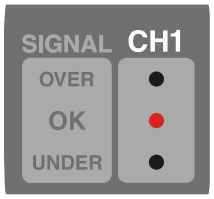
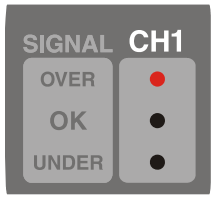
led-kanäle.wmf

Three LEDs are assigned to each of the eight input channels of the Instrument. The indicators refer to half cycle rms values of the input signal.

The following information is provided in case a valid sensor is detected.

Condition	 LED	 LED	 LED
Signal within nominal range	Off	Green	Off
Signal too low (dip)	Yellow	Off	Off
Signal too high (swell)	Off	Off	Yellow
Over range (ADC-overflow)	Off	Off	Flashing red
Phase sequence wrong	Off	LEDs blinking in sequence L3-L2-L1	Off

The indications for non valid sensors are:

Condition	 LED	 LED	 LED
Signal within nominal range	Off	Red	Off
Signal too low	Yellow	Red	Off
Signal too high	Off	Red	Yellow
Over range	Off	Red	Flashing red

Note

The LED OK is red if no valid sensor can be detected.

The limits for ‘Signal too low’ and ‘Signal too high’ are equal to the thresholds for voltage dips and voltage swells (e.g. ±10 % of Un).

For current inputs ‘Signal too low’ is indicated for 200 ms rms values below 10 % of the measurement range.

‘Over range’ is indicated if the input signal is outside the valid range of the analogue to digital converter (ADC, i.e. ±32.700 counts).

The phase voltages UL1, UL2, and UL3 of a three-phase system are monitored with the symmetrical components (zero, positive and negative system). If the negative system exceeds an upper threshold a wrong phase sequence condition is indicated (e.g. two lines interchanged); the associated LEDs are flashing in sequence L3-L2-L1.

Warning

The LEDs do not indicate whether there is voltage. Do not rely on the LEDs to find out whether the device under test is live or not.

④ Ethernet port

Used for connection of the Instrument to an Ethernet port of a PC, or to an Ethernet network (LAN). For a connection to an Ethernet network use the supplied Ethernet cable. For direct connection of the instrument to a PC use the cross-linked Ethernet cable (with the red plug).

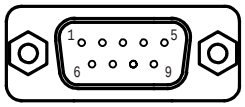
⑤ 2 USB connectors (Future option)

Two USB type A connectors for connection of the instrument to the USB-port of a PC. USB version V2.0 is supported. A special link cable has to be used (USB cable A-A).

⑥ Serial port COM1 (RS232)

Serial port for connection of the device to the serial port of a PC.

The default settings are 57.600 Baud, 8 data bits, 1 stop bit, no parity.



com_stecker.wmf

Pin assignment:

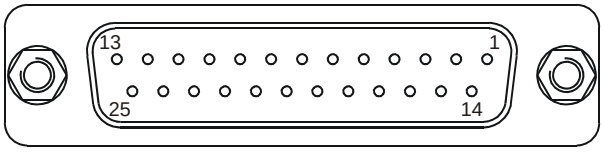
Pin	Signal	Description
1	DCD	Data Carrier Detect
2	RxD	Receive Data
3	TxD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

⑦ Feature connector

Specification of outputs / inputs:

Condition	Voltage level
Low (inactive)	0 - 0.8 V
High (active)	2.5 - 5 V

Maximum load current: 5 mA.



stecker lpt.wmf

Pin assignment:

Pin	Signal	Description
1	+15 V	Power supply voltage, max. 300 mA
2	TxD	Output, Transmit Data COM 2
3	RxD	Input, Receive Data COM 2
4	RTS	Output, Request to send COM 2
5	CTS	Input, Clear to Send COM 2
6	Service	Output, internal use
7	GND	Signal ground
8	Service	Output, internal use
9	Watchdog Pulse	Output, CPU watch dog signal
10	O1	Alarm output, reset with input RES 1
11	O2	Alarm output, reset with input RES 1
12	O3	Alarm output, reset with input RES 2
13	O4	Alarm output, reset with input RES 2
14	+5 V	Power supply voltage
15	GPS PPS+	Input for GPS time synchronization
16	GPS PPS –	Input for GPS time synchronization
17	GPS Transmit+	Input for GPS time synchronization
18	GPS Transmit-	Input for GPS time synchronization
19-23	Service	Output, internal use
24	RES1	Reset input for alarm outputs O1, O2
25	RES2	Reset input for alarm outputs O3, O4

⑧ Measurement Channels

Plugs for 8 isolated measurement channels. Connect only original accessories such as voltage and current sensors (clamps, Flexi Set, shunt resistors, etc.). The plug is secured by means of a bayonet mechanism.

Note

Inputs that are not in use must be covered with the supplied protective caps to prevent pollution.

When analyzing transients with options 2540582, 2540575 the potential to earth/ground is measured.

⑨ Compact Flash Card Future Option

Replaceable Compact Flash card for storage of measurement data.

Basic Functions

The power quality analyzer Instrument offers all functions necessary to perform network analysis, quality assurance evaluations and interference source detections. A large data memory provides a method of effecting long-term recordings. All data is saved even without connection of the instrument to an evaluation computer. No information will be lost. The recordings are the basis for detailed evaluations and analysis to assess disturbances and the mains voltage quality. Instrument records and provides historical event data, which protective relays or protective switches have induced and how the resources have performed.

Measurement Systems

The instrument combines many different measurement systems:

- Digital recording of measured data (data logger)
- Power measuring device (recording of load profiles)
- Recording of power frequency
- Power Quality Analyzer
- Fast transient recorder (optional)
- Ripple control signal analyzer

Measurements

The following measurements can be made:

- rms values with programmable averaging time
- Oscilloscope data (instantaneous value, sensing value)
- Voltage, current and power analysis
- Load and energy measurements
- Analysis current and voltage harmonics
- Fast transient analysis
- Signaling voltage, ripple control signal analysis
- Mains voltage quality analysis as per EN 50160

Chapter 2
Getting Started

Startup

Checking of Delivery

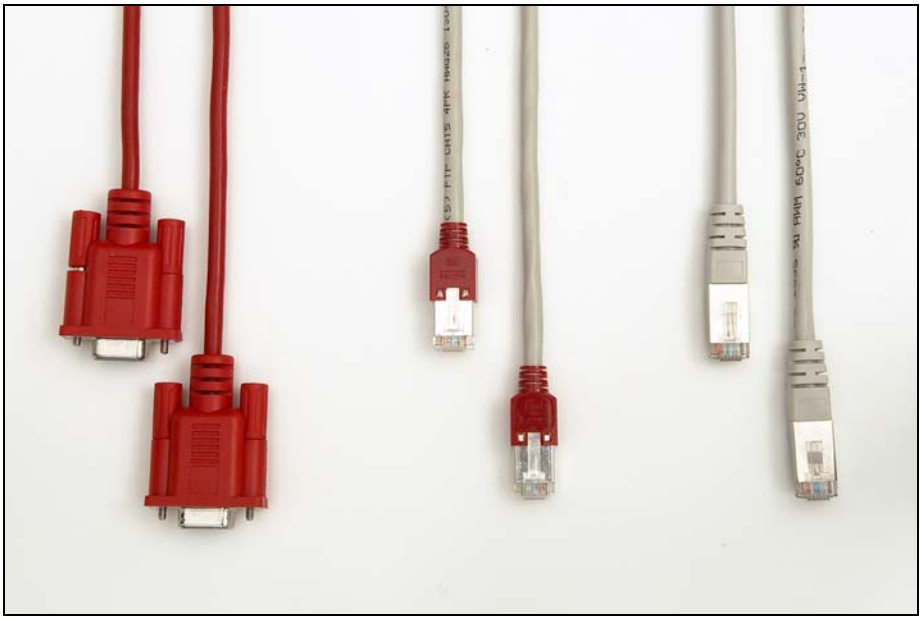
Before commencing work with the device, check the delivery to ensure that it is complete, using the following list and the delivery specifications.

- 1 Power Quality Analyzer Instrument
- 1 transient analysis card (optional, only for Fluke TR versions, like R Basic, TR INTL or TR US)
- 1 Getting Started manual
- CD-ROM with PQ Analyze application software, manuals, data sheets, and demo data
- 1 power cord for mains connection
- 1 country-specific adapter
- 1 Ethernet cable for direct PC connection
- 1 Ethernet cable for network connection
- 1 crosslink RS232 connection cable (2540608)

Optional:

- 4 voltage sensors
- 4 Flexi current sensors
- Carrying bag
- GPS receiver module

Figure 2-1 shows the communication cables.



ph_interfacecables.bmp

Figure 2-1. Communication Cables

Setup

Installation

Follow the safety instructions regarding the ambient conditions and location of the installation.

⚠ ⚠ Warning

First connect the device with the mains cable to the power supply network. Observe the specifications on the device type plate.

The device is connected to the power mains, and a number of internal components are live with dangerous voltage levels. To remain safe during the operation, the device must be equipped with a low-resistance connection to the earth. Therefore, check the mains socket and its wiring.

Connect the supply cable of the device only to the sections CAT I, II or III of the supply system. The voltage to earth may not exceed 300 V.

Switching the Device On

Switch on the power supply to the device (lift switching knob ② slightly and move to position 'I'). The LED *Mains* is lit. After approx. 40 seconds of booting, the device is ready for the operation.

Switching the Device Off

Lift switching knob ② slightly and move to position '0'. The LED *Mains* goes off after closing all the internal data files.

Note

The instrument can be only switched off after the boot process is finished (duration is approx. 40 seconds).

Transport and Storage

Transport

- Transport the device only in its original packaging
- Keep the operating manual supplied with the device for future reference
- Protect the device during the transport against heat and moisture. Do not exceed the temperature range of –20 °C to +60 °C and a maximum humidity of 85 %
- Protect the device against impacts and loads

Storage

- Keep the original packaging, as it might be required at a later stage for transport purposes or to return the device for repairs. Only the original packaging guarantees the proper protection against mechanical impacts
- Store the device in a dry room; the temperature range of –20 °C to +60 °C and a maximum humidity of 85 % may not be exceeded
  Keep the operating manual supplied with the device for future reference
- Protect the device against direct sunlight, heat, moisture and mechanical impacts.

Chapter 3
Operation

Simple Measurement – Function Check

The procedure described below allows users to familiarize themselves with the measuring functions of the instrument, while testing all basic device functions.

Installation:	Install the instruments SW PQ Analyze, see *Software manual PQ Analyze*, EO1091.
Communication:	Establish a connection to the device, using the Ethernet connection (one of the available interfaces). For detailed instructions, see *Software manual PQ Analyze*, EO1091, chapter *Software installation – Communication*.
Connect device:	Connect the device channels as described in *Connection to Circuits* section.
Configuration:	Configure the device. For detailed instructions, see *Software manual PQ Analyze*, EO1091, chapter *Operating the Software – File New*.
Measure:	Establish a connection to the device, using one of the available interfaces. See also *Software manual PQ Analyze*, EO1091, chapter *Operating the Software – Menu Transfer*. Activate ONLINE mode. For detailed instructions, refer to Operating Instructions *Software manual PQ Analyze*, EO1091, chapter *Operating the Software – Menu Transfer Menu – ONLINE* and chapter *ONLINE Mode*. Measure voltages and currents in ONLINE mode. If this is possible without problems, all *settings* are correct and all connections and sensors are working properly. Transfer the measured data from the device to the PC. For detailed instructions, see *Software manual PQ Analyze*, EO1091, chapter *Operating the Software – Menu Transfer – Download Measurement Data*. Evaluate the data according to your requirements. For detailed instructions, see *Software manual PQ Analyze*, EO1091, chapter *Operating the Software – Evaluations*.

Connections to Measuring Circuits

Warning

By connecting the unit to circuits, the terminals and certain parts inside the device are live. Utilization of leads and accessories that do not fulfill the relevant safety standards could lead to serious injury or death from electric shock.

In order to ensure safe operation:

First connect the device to protective earth and to the power supply.

Open the circuit before establishing a connection to the device. Prior to connecting the circuits, ensure that the maximum measuring voltage and the max. voltage to earth do not exceed and the category of distribution system corresponds with the inscription of the sensor 'or' meet the country specific standard.

Connecting Sequence

When connecting a circuit to Instrument, for safety reasons, proceed in the sequence outlined below:

1. Check the standard mains socket for a proper protective earth connection. Connect the instrument to the power supply socket. The PQ Recorder is now connected to the protective earth (Safety Class 1 equipment).
2. Connect the measuring circuit as shown in the connection diagrams.
3. Switch on the Instrument device.
4. Ensure that the direction of the energy flow is correct (load flow direction).

Connection Diagrams

The measuring circuit is selected by means of the *Settings/Hardware Settings* menu of the PQ Analyze software. Connect the sensors in load flow direction (observe arrows).

Table 3-1. Symbols in the Connection Diagrams

Symbol	Meaning
	Connect the Flexi current sensors in the right direction. The arrow on the Flexi must show from the network to the load.
	Red connector.
	Black connector.

Note

Use channel 'CH4' as control channel for triggering on external signals.

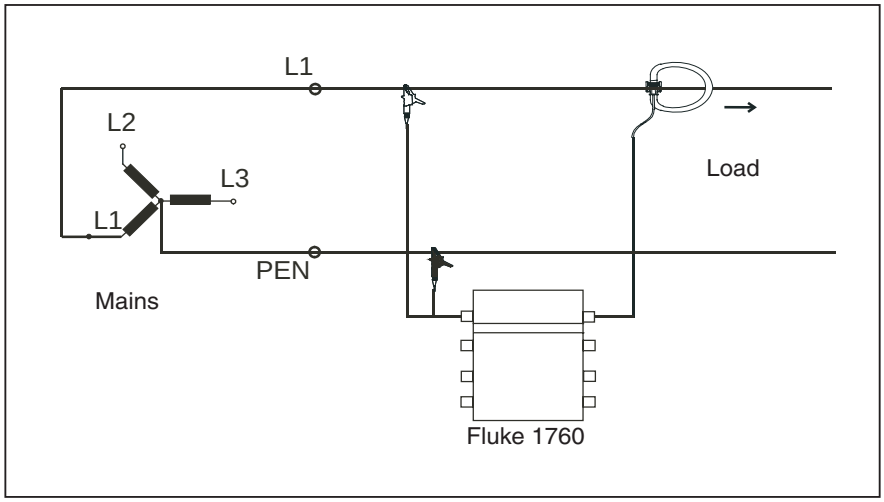
Note

Fast voltage transients are always measured between the red plug of the voltage sensor and the device ground (earth, protective conductor).

Please, note that the voltage sensors with a rated range of >100 V are equipped with the fast transient function.

1-Phase Measurement

Figure 3-1 shows the circuit diagram for 1-phase measurement.

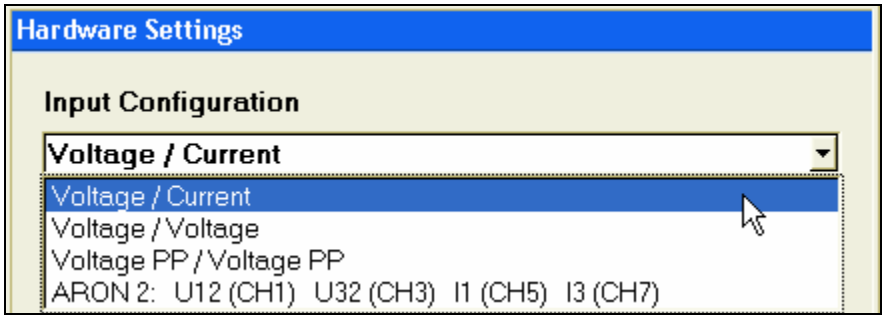


1wattm1.eps

Figure 3-1. Circuit Diagram: 1-Phase Measurement

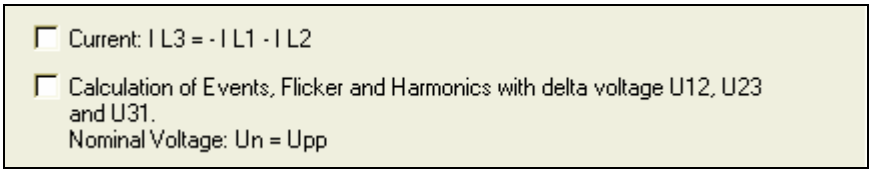
Associated PC software settings:

Connection to Single-Phase 2-Wire Network:



messsystem1 u-i.bmp

and



messsystem1 u-i-1.bmp

The option *Calculation of Events, Flicker, and Harmonics with delta voltage U12, U23 and U31* for the phase-to-phase voltages is not of relevance here.

Note

All 8 channels are measured. Please keep this in mind when assessing the power quality according to EN 50160.

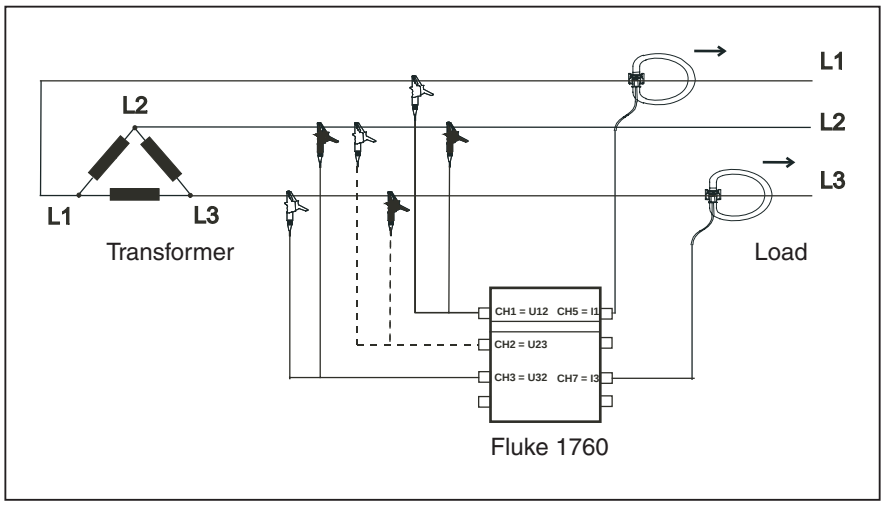
Voltage channels that are not connected therefore record continuously a power failure. Switch the channels to Off.

3-Wire Network with Two Current Sensors (ARON2 Method)

Conventional two-wattmeter method with current sensors on phases *L1* and *L3*.

The device calculates *IL2 = -IL1 – IL3*; the phase voltages are then calculated on the basis of the phase-to-phase voltages. With this method, all measured variables of the three-wattmeter method are measured. The phase and total power values are determined correctly. This method is applicable only if *I1 + I2 + I3 =0*, i.e. if there is no neutral conductor.

Figure 3-2 shows the circuit diagram for 3-wire network (Aron 2).



2wattm1-aron2.eps

Figure 3-2. Circuit Diagram: 3-Wire Network (Aron 2)

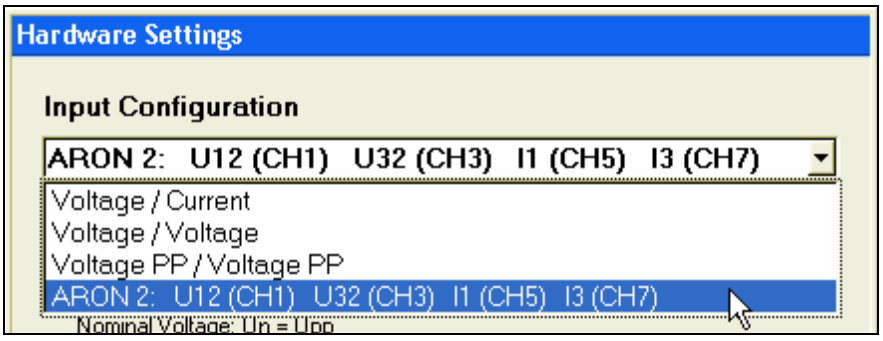
Note

The voltage sensor at channel CH2 denoted with dotted lines is only required for transient measurements; for current, voltage power measurements, no sensor is required at CH2.

Please note the channel assignment to transients:

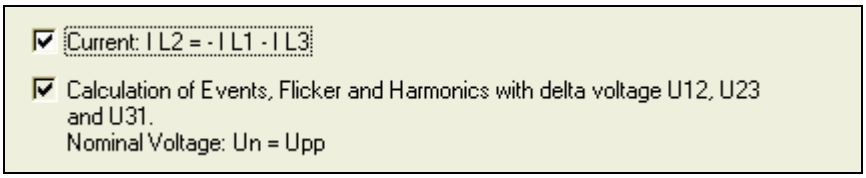
- *CH1 – measures transients of phase L3 to earth*
- *CH2 – measures transients of phase L2 to earth*
- *CH3 – measures transients of phase L1 to earth*

Associated Device Software Settings:



messsystem5 aron2.bmp

Check the respective option.



messsystem5 aron2-1.bmp

If the option *IL2 = -IL1 - IL3* is checked, the current IL2 is calculated. If this option is not checked, the current *IL2* is measured by means of a sensor at phase L2 (Instrument channel *CH6*).

Note

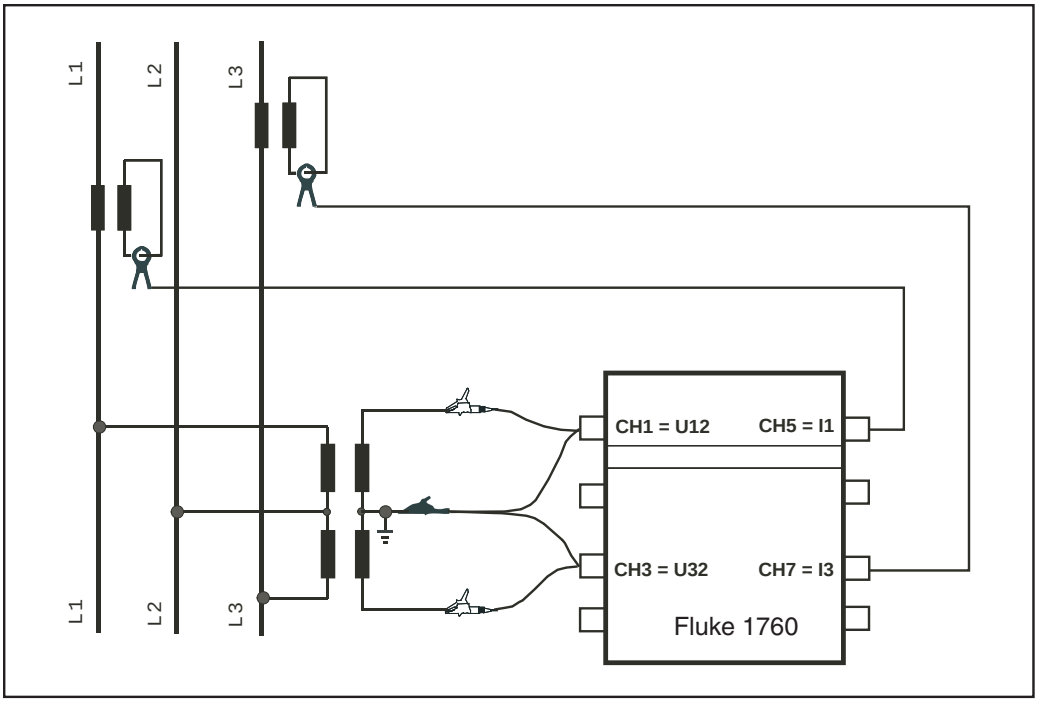
The nominal voltage has to be entered as a phase-phase voltage in the dialogue Nominal-Limit values (i.e. 400 V in a 230 V P-N-system).

3-Wire Network with Two Current Sensors (ARON2 Method, Open Delta Method)

The conventional two-wattmeter method with current sensors at phases L1 and L3 is frequently used in the medium voltage networks with built-in current and voltage converters.

The device calculates *IL2 = -IL1 - IL3*. The phase-to-neutral voltages are then calculated on the basis of the phase-to-phase voltages. All the measured variables required for the three-wattmeter method are thus available. Both the phase power values and the total power are determined accurately. This method is only applicable, if *I1+I2+I3 = 0*, i.e. if there is no neutral conductor.

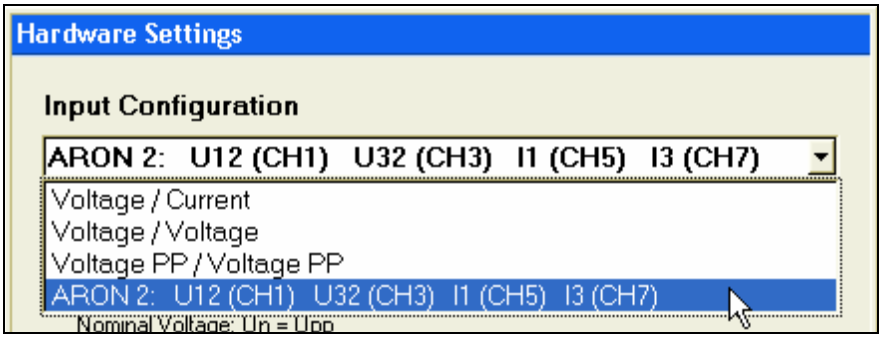
Figure 3-3 shows the circuit diagram for 3-wire network with 2 current sensors (Aron method), open delta method.



v-schaltung-3.wmf

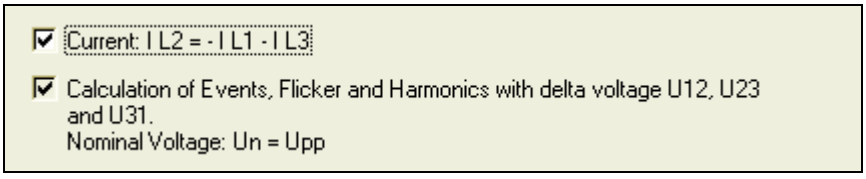
Figure 3-3. Circuit Diagram: Aron 2 Method/Open Delta Method

Associated PC Software Settings:



messsystem5 aron2.bmp

Check the respective option.



messsystem5 aron2-1.bmp

If option *IL2 = -IL1 - IL3* is checked, the current IL2 is calculated. If this option is not checked, the current IL2 is measured by means of a sensor connected to phase L2 (Instrument channel CH6).

The option *Calculation of Events, Flicker, and Harmonics with delta voltage U12, U23 and U31* is automatically on and cannot be deactivated.

Note

The nominal voltage has to be entered as a phase-phase voltage in the dialogue Nominal-Limit values (i.e. 400 V in a 230 V P-N-system).

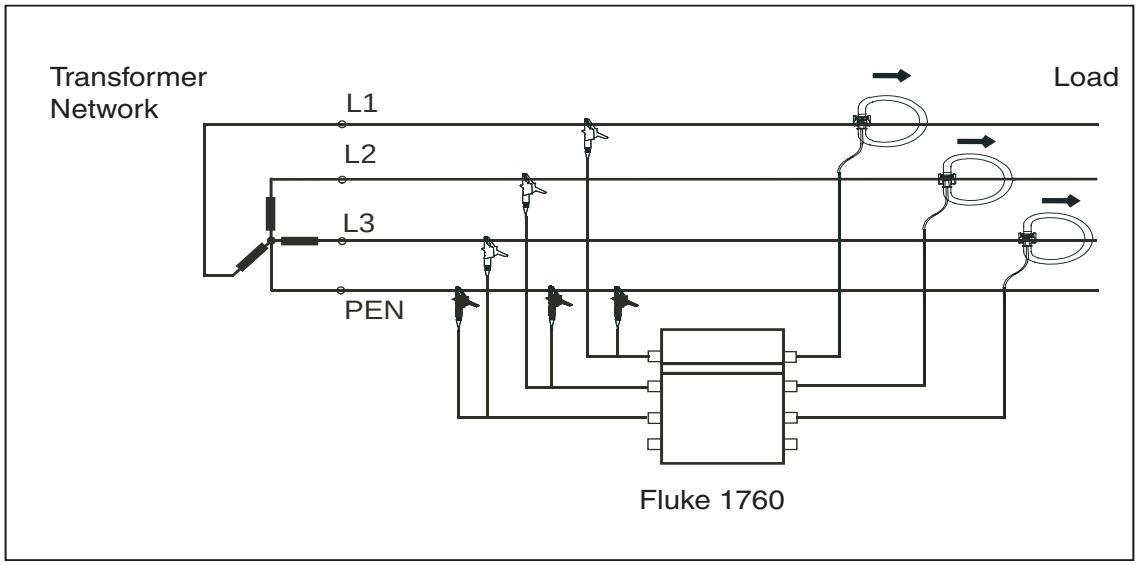
Enter the applicable transformation ratios for the current and voltage converters in the 'Hardware Settings' dialog.

As conventional current converters have an output current of 1 A or 5 A AC respectively at rated current, we recommend using current probes rather than flexible current sensors, as they provide better resolution and linearity at low currents.

4-Wire Network: 3-Wattmeter Method

This is the standard measurement configuration for three-phase networks with 3 voltage and 3 current sensors.

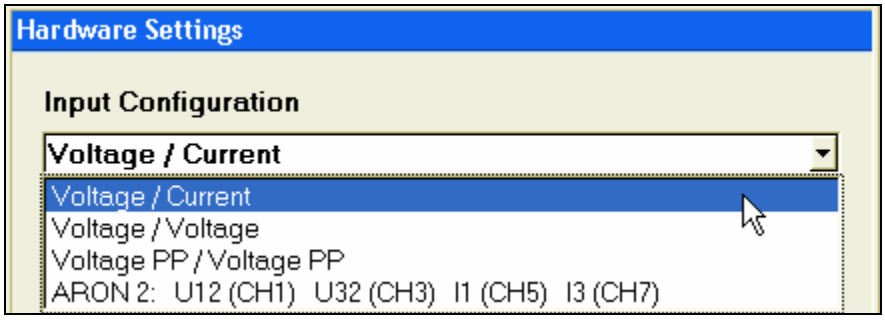
Figure 3-4 shows the circuit diagram for 4-wire network (Wye connection).



3wattm1.eps

Figure 3-4. Circuit Diagram: 4-Wire Network (Wye Connection)

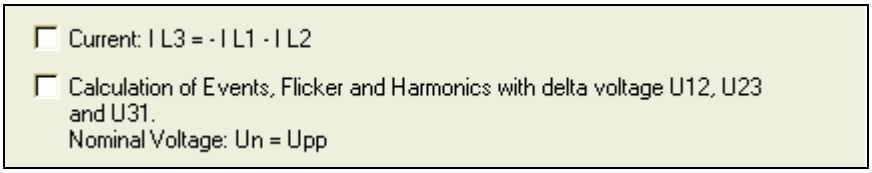
Associated PC Software Settings:



messsystem1 u-i.bmp

If required, you have the option to determine events, Flicker and Harmonics, of the phase-to-phase voltages.

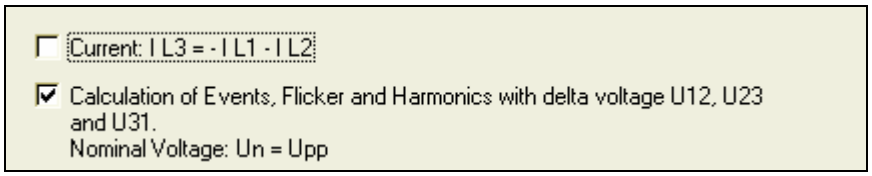
Check the respective option.



messsystem1 u-i-1.bmp

Note

If this option (calculation) is checked, you must enter the phase-to-phase voltage as the rated voltage V_N in 'Settings – Nominal / Limit values' (e.g. 400 V in the 230 V P-N network).

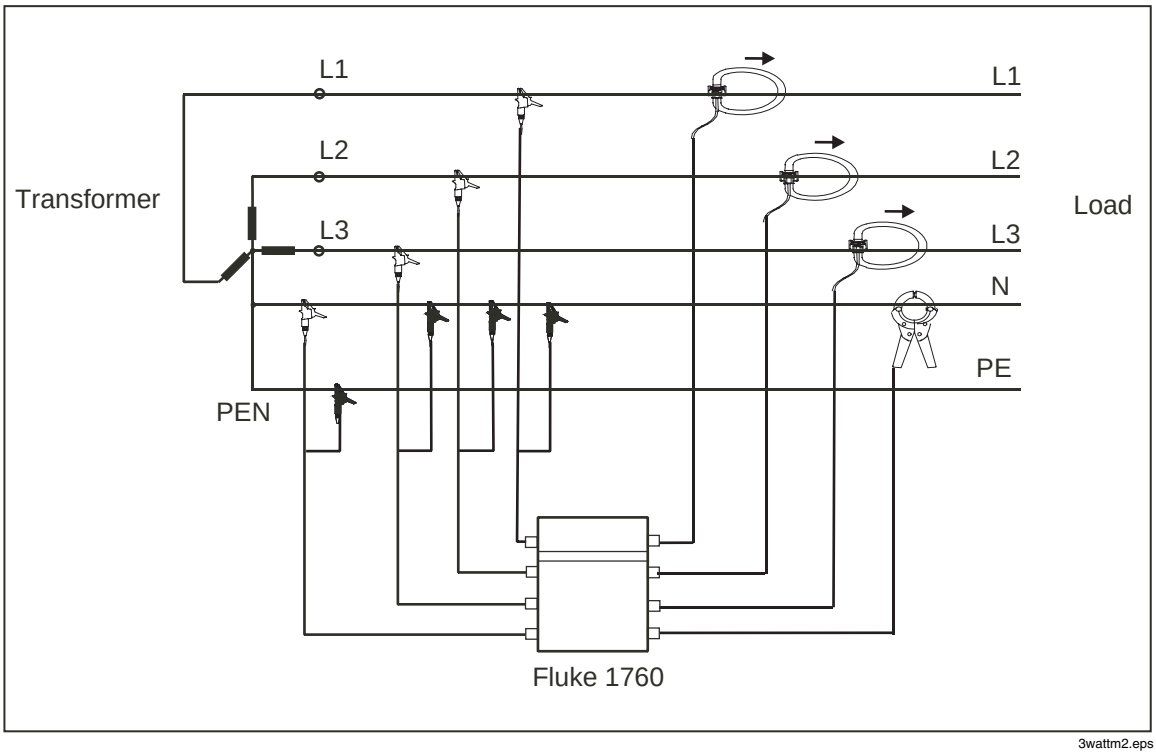


messsystem1 u-i-2.bmp

Four-Wire Network: Three-Wattmeter Method with N Conductor Voltage and N Conductor Current

This is the standard measurement configuration for three-phase networks with 4 voltage and 4 current sensors.

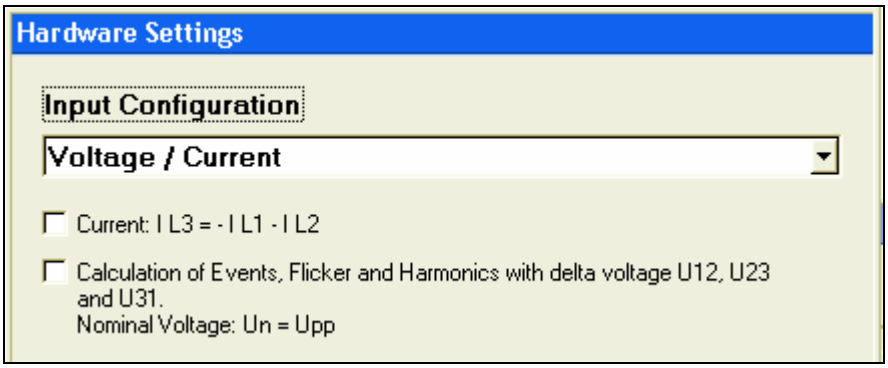
Figure 3-5 shows the circuit diagram for 4-wire network (3-wattmeter method) with N-conductor voltage and N-conductor current.



3wattm2.eps

Figure 3-5. Circuit Diagram: 4-Wire

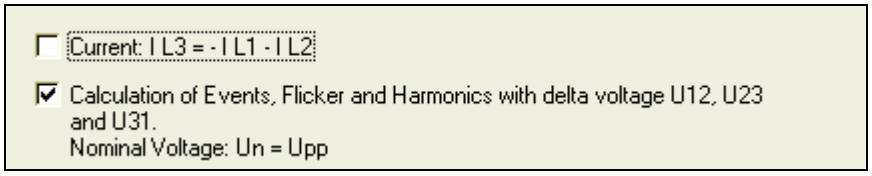
Associated PC Software Settings:



messsystem1 u-i-0.bmp

If required, you have the option to determine events, Flicker and Harmonics, of the phase-to-phase voltages.

Check the respective option.



messsystem1 u-i-2.bmp

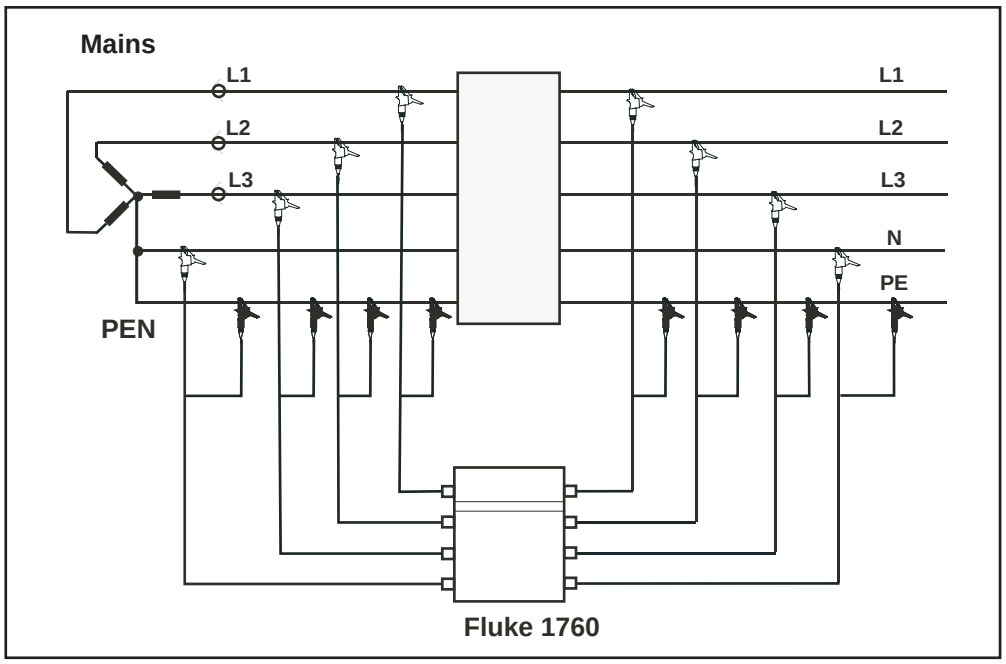
Note

If this option (Calculation) is checked, you have to enter the phase-to-phase voltage as the rated voltage V_N in 'Settings – Nominal / Limit Values' (e.g. 400 V in the 230 V P-N network).

Two Star-Connected Voltage Systems

With this method, you can determine two phase voltages and the respective N conductor voltages in two star connected three-phase systems.

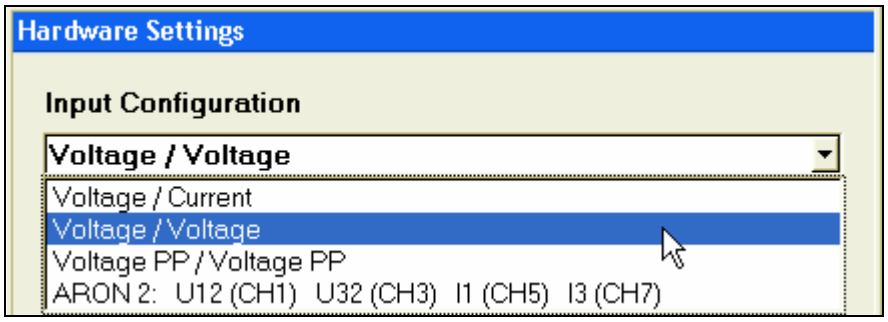
Figure 3-6 shows the circuit diagram for 2-voltage system with neutral.



system-u-u-stern.eps

Figure 3-6. Circuit Diagram: 2 Voltage System with Neutral

Associated PC Software Settings:



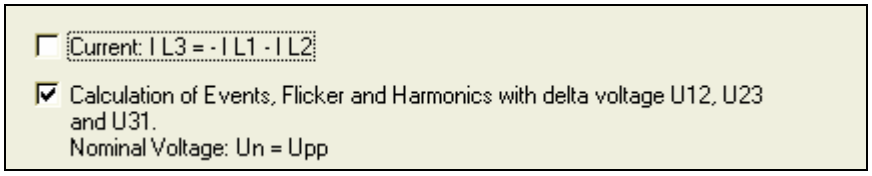
messsystem2.bmp

Note

The power quality assessment according to EN50160 can be performed for the phase voltages of system 1 and system 2 respectively; the preset limit values apply to both evaluations.

If required, you have the option to determine events, Flicker and Harmonics, of the phase-to-phase voltages.

Check the respective option.



messsystem1 u-i-2.bmp

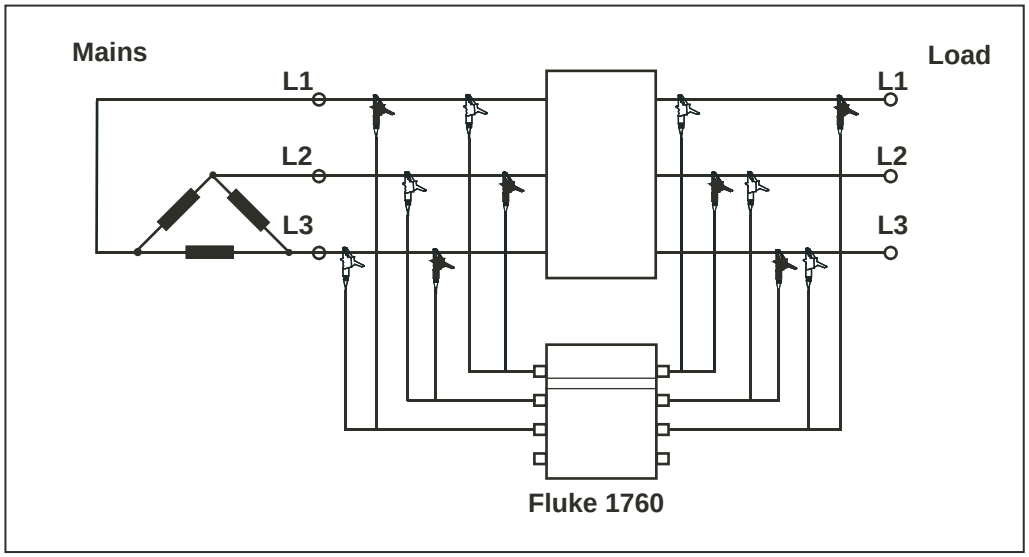
Note

If this option (Calculation) is checked, you have to enter the phase-to-phase voltage as the rated voltage V_N in 'Settings – Nominal / Limit Values' (e.g. 400 V in the 230 V P-N network).

Two Voltage Systems in Delta Configuration

This method is used to measure 3 phase-to-phase voltages in two delta-configured three-phase systems. Channels CH4 and CH8 can be used for other parameters.

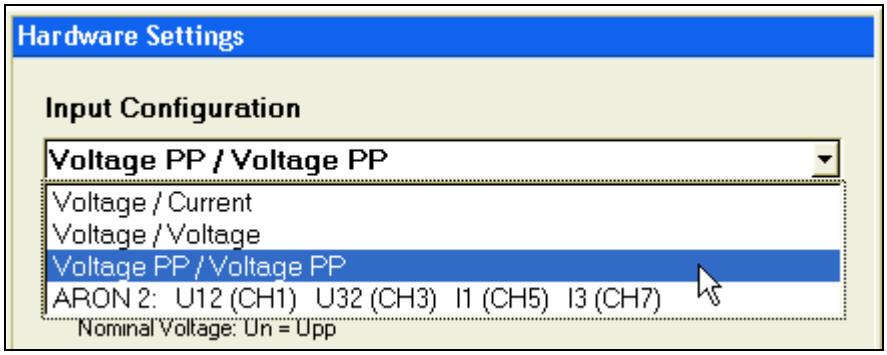
Figure 3-7 shows the circuit diagram for 2-voltage system in Delta connection.



system u-u dreieck.eps

Figure 3-7. Circuit Diagram: 2 Voltage System in Delta Connection

Associated PC Software Settings:



messsystem4.bmp

Note

The power quality assessment according to EN50160 can be performed for the phase-to-phase voltages of system 1 and system 2 respectively; the preset limit values apply to both evaluations.

We have to enter the phase-to-phase voltage as the rated voltage V_N in 'Settings – Nominal/Limit Values' (e.g. 400 V in the 230 V P-N network).

Methods of Measurement/Formulas

Signal Sampling

The device samples measurement signals at a nominal frequency of 10.24 kHz at a power frequency of 50 Hz.

The sampling frequency is synchronized to the power frequency on the reference channel CH1, the signal level has to be at least 10 % of the input range. The required PLL (Phase Locked Loop) is realized in the firmware of the instrument.

The synchronization range is according to IEC 61000-4-30 class A:

- Range for 50 Hz systems: 50 Hz ±15 % (42.5 Hz - 57.5 Hz)
- Range for 60 Hz systems: 60 Hz ±15 % (51 Hz - 69 Hz)
- Resolution: 16 ppm

Aggregations

The time aggregation of the measurement values is according to IEC 61000-4-30 class A, section 4.5 based on 10/12 cycle values (10 cycles for 50 Hz and 12 cycles for 60 Hz nominal frequency).

The following time aggregations are available:

- Half cycle, full cycle, 200 ms (precisely: 10/12 cycle values), 3 s (precisely: 150/180 cycles), 10 minutes, 2 hours, Free interval (≥1 minute)
- Half cycle and full cycle values are based on the zero crossings of the fundamental
- The 10/12 cycle values are aggregated from 2.048 samples synchronized to the power frequency
- The 3 s-intervals are derived from a constant number of 30.720 samples
- The 10 minute, 2 hour and free interval values are based on the synchronized 10/12 cycle values
- The 10 minute values are synchronized to the absolute time (e.g. via GPS time sync option)

Power Frequency

For 10 s frequency values, the sample data are filtered by a 2^{nd} order IIR filter (the 3 dB cut-off frequency is 50 Hz for 50 Hz nominal frequency and 60 Hz for 60 Hz nominal frequency). Based on the filtered signal whole periods within 10 s intervals (taken from the internal real time clock) are counted by detecting the zero crossings. The frequency is calculated by dividing the number of whole periods by the duration of this number of whole periods. The time interval is derived from the timestamps generated by the hardware of the first and the last sample within the block of whole periods.

Voltage, Current rms Values, Min-/Max-Values

Half cycle rms is synchronized with the zero crossings of the fundamental component. The fundamental component zero crossing is calculated from 200 ms FFT. Half cycle rms is available as real half cycle rms and/or as full cycle rms, updated every half cycle.

The extreme values (Min-, Max-values) are derived from the half cycle rms values.

The interval values are averaged squared over the respective time interval.

FFT – Fast Fourier Transformation

FFT is calculated using an algorithm which is optimized for real input and complex output with 2.048 points. As long as the PLL controlling the sampling frequency is locked, no window function is applied. If locking cannot be established, a Hanning window is used.

The absolute value for each FFT bin can be retrieved.

Power Values, Min-/Max-Values

The sample values of voltage and current are multiplied and accumulated over the averaging time interval. The time aggregation is compatible with the norm IEC 61000-4-30 class A based on 10/12 cycle values.

For the power values 10 ms, min- and max-values are recorded during the appropriate time interval.

Active Power:

$$P = \sum_{i=0}^{N-1} V_{i,rms} * I_{i,rms} * \cos(\varphi_i)$$

V: sample of voltage

I: sample of current

i: number of sample

N: number of samples

φ_i: phase angle between V, I

Reactive Power:

$$Q = \sum_{i=0}^{N-1} V_{i,rms} * I_{i,rms} * \sin(\varphi_i)$$

V: sample of voltage

I: sample of current

i: number of sample

N: number of samples

φ_i: phase angle between V, I

Apparent Power:

$$S = \sqrt{\sum_{i=0}^{N-1} V_{i,rms}^2 * \sum_{i=0}^{N-1} I_{i,rms}^2}$$

Note

$$D_{tot}^2 \neq S_{tot}^2 + P_{tot}^2 + Q_{tot}^2$$

Power Values Total (3-Phase)

$$P_{tot} = P_1 + P_2 + P_3$$

$$Q_{tot} = Q_1 + Q_2 + Q_3$$

$$S_{tot} = S_1 + S_2 + S_3$$

The power values for each phase are available even in *ARON* circuitry (settings: ARON2). The virtual phase-neutral voltages are calculated from the phase-phase voltages which form the basis for the subsequent phase power calculations. These are used for the calculation of the 3-phase total power values.

Power Factor λ

$$\lambda = \frac{|P|}{S}$$ or as an alternative (selectable with PQ Analyze software):

$$\lambda = \frac{|P|}{S} * \frac{Q}{|Q|}$$

Using this algorithm the sign of the power factor indicates inductive or capacitive load (<0 signifies capacitive load).

$$\lambda_{tot} = \frac{|P_{tot}|}{S_{tot}}$$ or as an alternative (selectable in the PQ Analyze software):

$$\lambda_{tot} = \frac{|P_{tot}|}{S_{tot}} * \frac{Q_{tot}}{|Q_{tot}|}$$

Using this algorithm the sign of the power factor indicates inductive or capacitive load (<0 signifies capacitive load).

The selection of the formulae is done in the PQ Analyze software.

Displacement Power Factor cos φ

for Q>0:

$$\cos\varphi = \cos\left(\arctan\frac{Q}{|P|}\right)$$

$$\cos\varphi_{tot} = \cos\left(\arctan\frac{Q_{tot}}{|P_{tot}|}\right)$$

for Q≤0:

$$\cos\varphi = \cos\left(\arctan\frac{Q}{|P|} + \pi\right)$$

$$\cos\varphi_{tot} = \cos\left(\arctan\frac{Q_{tot}}{|P_{tot}|} + \pi\right)$$

Voltage Events as per EN 50160

Voltage events are detected based on 20 ms rms values updated every 10 ms. As a default, the phase-neutral voltages are monitored.

Flicker

If the option *Events, Flicker, and Harmonics of U12….* in the device settings is activated, the voltage events of the phase-to-phase voltages U12, U23, U31 are recorded.

Flicker is measured according to the methods described by the norm IEC 1000-4-15:2003-02 edition 1.1. As a default Flicker is calculated on the basis of the phase voltages. For 50 Hz or 60 Hz power systems the appropriate filter coefficients are applied. These are adapted if the mains frequency (and also the synchronized sampling

frequency) deviates more than 1 % from the nominal power frequency. The classifier consists of 1024 logarithmic classes.

If the option *Events, Flicker, and Harmonics of U12….* in the device settings is activated, the Flicker of the phase-to-phase voltages U12, U23, U31 is recorded.

Voltage and Current Harmonics

The gapless harmonic subgroups and the interharmonics centered subgroups are calculated according to IEC61000-4-7:2002 section 5.6 (no smoothing).

THD – (Total Harmonic Distortion)

The calculation utilizes the following formula: Voltage or current respectively.

$$THD = \sqrt{\frac{\sum_{n=2}^{40} V_n^2}{V_1}}$$

n: order of the harmonic.

V_1: rms value of the voltage fundamental.

Vn: rms value of the voltage harmonic with order n.

$$THD = \sqrt{\frac{\sum_{n=2}^{40} I_n^2}{I_1}}$$

n: order of the harmonic.

I_1: rms value of the current fundamental.

In: rms value of the current harmonic with order n.

TID

TID is the complete interharmonics contents of the signal. It is calculated as per EN 61000-4-7:1993 from all interharmonics spectral bins (absolute values) up to the harmonic with order 40.

THD ind

THD ind is calculated according to the formula in the norm EN61000-4-7:1993. This formula is no more part of the actual version of EN 61000-4-7 but has still importance for applications in networks with inductive loads.

$$THD_{ind} = \frac{1}{V_1}\sqrt{\sum_{n=2}^{40} \frac{V_n^2}{n}}$$

n: Order of the harmonic.

V_1: rms value of the voltage fundamental.

Vn: rms value of the voltage harmonic with order n.

THD cap

THD cap is calculated according to the formula in the norm EN61000-4-7:1993. This formula is no more part of the actual version of EN 61000-4-7 but has still importance for applications regarding reactive power compensation equipment.

$$THD_{cap} = \frac{\sqrt{\sum_{n=2}^{40} n^2 * V_n^2}}{V_1}$$

n: Order of the harmonic.

V_1: rms value of the voltage fundamental.

Vn: rms value of the voltage harmonic with order n.

Ripple Control Signals

The frequency of the ripple control signal of the local utility can be defined in the PQ Analyze software in the trigger settings dialogue. These signals are calculated from the FFT results. The FFT bin related to the signaling voltage is calculated from the rated signaling frequency and the nominal power frequency (derived from the 50 Hz or 60 Hz setting in the PQ Analyze software) using 2.048 samples per 10/12 cycle interval with 10.24 kHz sample rate. If the signaling voltage corresponds to the frequency of a FFT bin within 1 % (referred to the bin spacing), only this bin is used. Otherwise, the rms values of four neighboring FFT bins are added, giving the rms value of the signaling frequency. 200 ms and 3 s aggregations are available.

Unbalance

The unbalance (imbalance) is derived from the symmetrical components as per IEC 61000-4-30 class A section 5.7.1. based on the 10/12 cycle values of the voltage fundamentals. The symmetrical components are calculated as:

$$V_Z = \frac{1}{3}\sqrt{\left(V_1 + V_2 * \cos\varphi_{12} + V_3 * \cos\varphi_{13}\right)^2 + \left(V_2 * \sin\varphi_{12} + V_3 * \sin\varphi_{13}\right)^2}$$

$$V_P = \frac{1}{3}\sqrt{V_1 + V_2 * \cos\left(\varphi_{12} + 120^\circ\right) + V_3 * \cos\left(\varphi_{13} + 240^\circ\right)^2 + V_2 * \sin\left(\varphi_{12} + 120^\circ\right) + V_3 * \sin\left(\varphi_{13} + 240^\circ\right)^2}$$

$$V_N = \frac{1}{3}\sqrt{V_1 + V_2 * \cos\left(\varphi_{12} + 240^\circ\right) + V_2 * \cos\left(\varphi_{13} + 120^\circ\right)^2 + V_2 * \sin\left(\varphi_{12} + 240^\circ\right) + V_3 * \sin\left(\varphi_{13} + 120^\circ\right)^2}$$

V_Z, V_P, V_N	rms values of zero, positive, and negative system
V_1, V_2, V_3	rms values of the fundamentals of the phase voltages
φ_{12}, φ_{13}	phase angle between or (nominal: -120° and -240°)

Calculation of unbalance as per IEC 61000-4-30:

$$V_2 = \frac{V_N}{V_P} * 100\%$$

$$V_0 = \frac{V_Z}{V_P} * 100\%$$

V_Z: zero system

V_P: positive system

V_N: negative system

The calculation of V_0, V_2 utilizes the above formulas for V_Z, V_P, V_N or for a 3-wire system the following formulas with phase-phase voltages:

$$V_2 = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} * 100\%$$

$$\beta = \frac{V_{12,k1}^4 + V_{23,k1}^4 + V_{31,k1}^4}{\left(V_{12,k1}^2 + V_{23,k1}^2 + V_{31,k1}^2\right)^2}$$

Note

For a 3-wire network the zero system component V_z is 0 per definition.

The voltage values are averaged squared versus time, afterwards the unbalance is calculated for the time interval.

Chapter 4
Maintenance

Title **Page**

Introduction

The instrument itself is maintenance-free.

Maintenance of Battery Package

Note

We recommend carrying out a forced battery discharge in regular time intervals (no longer than 3 months) to maintain the battery capacity as long as possible.

Procedure:

1. Connect the instrument to mains.
2. Set the mains switch to the I-position.
3. Wait until the Mains LED is on.
4. Disconnect the power supply.
5. Wait until the Mains LED goes off.
6. Set the mains switch to the 0-position.
7. Wait until the LEDs Mains and Battery are flashing rapidly.
8. Within 3 second set the mains switch to I-position again.

The battery package will be discharged completely when:

- LED Mains is OFF
- LED Battery is flashing slowly
- LEDs Memory show flashing light, the number of LEDs lighting up indicates the remaining time period for discharging in minutes (e.g. 5 LEDs means that the discharging will last for appr. 5 minutes)
- Afterwards the instrument is turned off automatically

Cleaning

The device can be cleaned with an Isopropanol impregnated cloth.

⚠ Caution

Do not use abrasives or other solvents.

Replacement of Battery Pack

⚠⚠ Warning

- **Disconnect all the sensors from the instrument's input connectors**
- **Disconnect the instrument from the power supply**
- **Do not short circuit the terminals of the battery pack**
- **For replacement of the battery pack, use the original spare parts only (2540406)**

Note

 *Always adhere to the applicable statutory regulations for recycling and waste disposal.*

Procedure:

1. Locate the battery compartment on the backside of the instrument.
2. Remove the screw of the lid with a screwdriver (Pozi-drive).
3. Unlock and remove the connector cable.
4. Replace the battery pack by an original spare part (2540406) using the attached strip.
5. Connect the cable to the plug of the instrument.

Note

Note the polarity of the plug and the locking mechanism.

Decommissioning and Disposal

Shutting Down

1. Ensure that all the connected devices are switched off and disconnected from the power supply.
2. Switch off the Power Quality Analyzer.
3. Disconnect the plug from the mains socket.
4. Remove all the connected devices.
5. Secure the unit against inadvertent switching on.
6. Ensure that the operating manual is kept near the device.

Recycling and Disposal

Note

Always adhere to the applicable statutory regulations for recycling and waste disposal.

Packaging:	The following license agreements have been entered into for the disposal of the packaging: ARA license no. 1544 (Austria), DSD no. 2170305 (Germany).
Housing:	The housing is made of insulating plastics material.
Weight, Volume:	The instrument has a weight of approx. 4.900 g and a volume of approx. 4.700 cm^3.

Warranty

The warranty period for faultless operation is limited to 2 years, for the specified uncertainty of measurement is limited to 2 years from the date of purchase.

The warranty is not valid for batteries.

The warranty is only valid if accompanied with the respective invoice or receipt of payment.

Not covered by warranty are damages due to improper use, overload or operation under conditions that are outside the range of permitted ambient conditions.

Warranty covers only technical data that is specified with a tolerance range. Values or limits for which there are no tolerances specified are intended for information purposes only.

Recalibration

Fluke recommends recalibrating the device every year if the instrument is operated over the full operating temperature range. For operation between +15 °C and +35 °C the calibration period can be extended to 2 years. For an accuracy of 0.5 % for voltages and 1 % for currents, 5 years calibration period is recommended.

The device can be calibrated by the Fluke service department or any other calibration specialist.

Chapter 5
Specifications

Title **Page**

General Specifications

Intrinsic uncertainty:	Refers to reference conditions and is guaranteed for one year.
Quality system:	Developed, manufactured as per ISO 9001: 2000.
Environment Conditions:	
Operating temp. range:	0 °C - +50 °C; 32 °F - +122°F.
Working temp. range:	–20 °C - +50 °C; –4 °F - +122 °F.
Storage temp. range:	–20 °C - +60 °C; –4 °F – 140 °F.
Reference temperature:	23 °C ± 2 K; 74 °F ± 2 K.
Climatic class:	B2 (IEC 654-1), –20 °C - +50 °C; –4 °F - +122 °.
Max. operating altitude:	2000 m: max. 600 V CAT IV*.
	Power supply: 300 V CAT III.
	5000 m: max 600 V CAT III*.
	Power supply: 300 V CAT II* depending on the sensor.
Reference conditions:	Environment temp.: 23 °C ± 2 K <60 % rH; 74 °F ± 2 K <60 % rH.
	Power frequency: 50 Hz/60 Hz.
	Signal: declared input voltage Vdin.
	Averaging: 10 minute intervals.
	Warmed up instrument >3 h.
	Power supply: 100 V - 250 V ac.
Housing:	Insulated, robust plastics housing.
Electrical safety:	EN 61010-1/2nd edition, basis unit 300 V CAT III - depending on the used sensors up to 1000 V CAT III.
Test Voltages:	
Mains input - housing (earth connector):	2500 V AC in the mains input circuit before fuses. The circuitry is protected by over voltage devices behind the fuses.
Mains connection - measuring inputs:	2500 V AC.
Measuring inputs – housing:	2500 V AC.
Measuring input - measuring input:	2500 V AC.
Environmental:	Degree of pollution 2, Protection class I.
Emission:	IEC 61326-1 class B.
Immunity:	IEC 61326-1/annex A (industrial).

Display:	Fluke 1760 features LED indicators for the status of the 8 channels, phase sequence, power supply (mains or accumulator), memory usage, time synchronization, and data transfer.
Power LED:	Permanent light: normal power supply from mains. • OFF: supply via internal accumulator in case of a power failure
Channel LEDs:	3-color LEDs per channel for: • Overload condition • OK and signal level too low condition signal level in nominal range
Data memory:	2 GB Flash memory depending on model.
Memory model:	Linear.
Recording mode:	Continuous, gapless recording:
Measurement system:	4 voltages + 4 currents for 3 phases + N conductor or 8 voltages.
Interfaces:	Ethernet (100 MB/s), compatible to Windows ® 98/ME/NT/2000/XP, RS 232 for configuration.
Baud rate for RS 232:	9600 Baud – 115 kBaud.
Dimensions (H x W x D):	325 mm x 300 m x 65 mm (13 x 12 x 2.6 inch).
Weight (without accessories):	Appr. 4.9 kg (10.8 lbs).
Warranty:	2 years.
Calibration interval:	1 year recommended for Class-A, otherwise 2 years.

Signal Conditioning

Range for 50 Hz systems:	50 Hz ± 15 % (42.5 Hz - 57.5 Hz).
Range for 60 Hz systems:	60 Hz ± 15 % (51 Hz - 69 Hz).
Resolution:	16 ppm.
Sampling frequency for 50 Hz power frequency:	10.24 kHz, The sampling rate is synchronized to mains frequency.
Uncertainty for frequency measurements:	<20 ppm.
Uncertainty of internal clock:	<1 s/day.
Measurement intervals:	Aggregation of the interval values as per IEC 61000-4-30 Class-A.
Min-, Max-values:	Half cycle, e.g.: 10 ms RMS values at 50 Hz.
Transients:	Sample rate 100 kHz - 10 MHz per channel.
Harmonics:	As per IEC 61000-4-7:2002: 200 ms.

Flicker:	As per EN 61000-4-15:2003: 10 min (Pst), 2 h (Plt).

Measurement Inputs

Number of inputs:	8 galvanically isolated inputs for voltage and current measurements.
Sensor safety:	Up to 600 V CAT IV depending on sensor.
Basic safety:	300 V CAT III.
Nominal voltage (rms):	100 mV.
Range (peak value):	280 mV.
Overload capacity (rms):	1000 V, continuously.
Voltage rise rate:	Max. 15 kV/ µs.
Input resistance:	1 MΩ for instrument, 1000 V sensor 10 MΩ.
Input capacitance:	<50 pF.
Input filter:	Each channel is equipped with a passive low-pass filter, an anti-aliasing filter and a 16-bit A/D converter. All channels are sampled synchronously with a common quartz-controlled clock pulse. The filters protect against voltage transients and limit the signal rise rate, reduce high frequency components and especially the noise voltage above half the sampling rate of the A/D converter by 80 dB, thus achieving very small measuring errors in an exceptionally large amplitude range. This is also valid under extreme operating conditions like transient voltages at the output of converters.

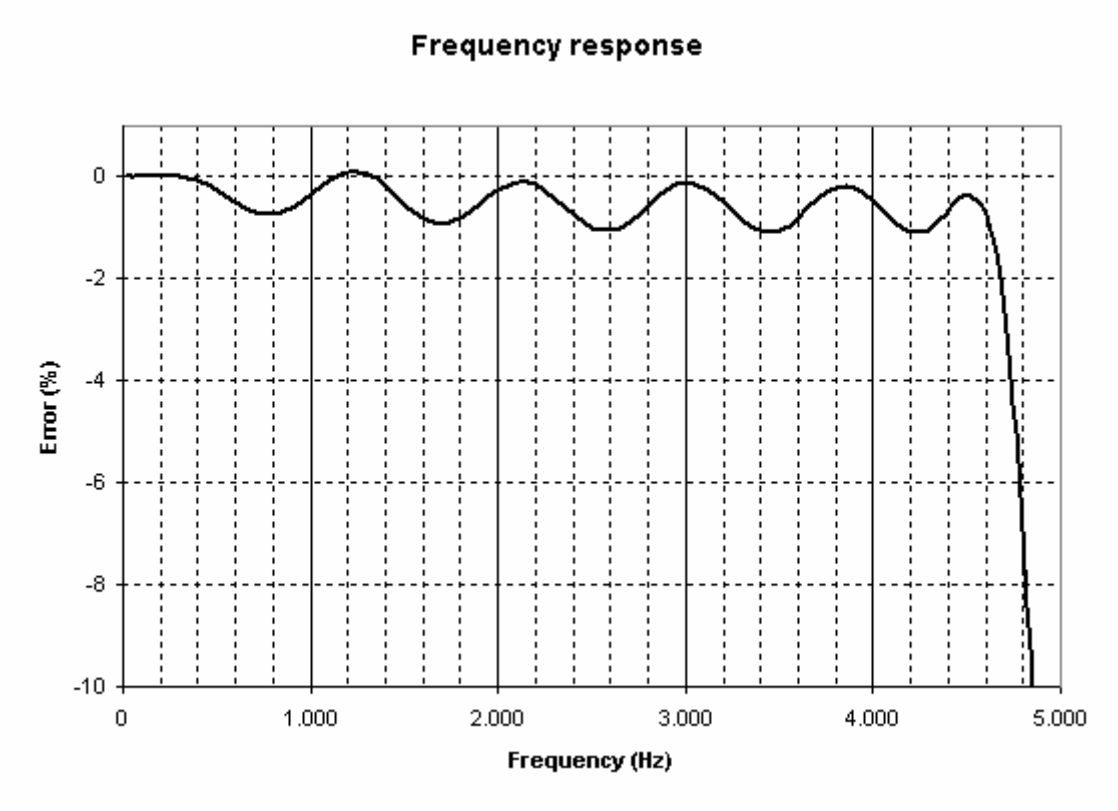
Uncertainties

Intrinsic uncertainty:	Uncertainty including the voltage sensors is in compliance with IEC 61000-4-30 Class-A. All voltage sensors are suitable for DC 5 kHz.
With Sensor 1000 V:	0.1 % at Vdin = 480 V and 600 V P-N.
With Sensor 600 V:	0.1 % at Vdin = 230 V P-N.
Intrinsic uncertainty for Harmonics:	Class I as per EN 61000-4-7:2002.
Temperature drift:	<100 ppm/K.
Aging:	<0.05 %/year.
Common mode rejection:	Instrument >100 dB at 50 Hz (e.g. shunt). With voltage sensor >70 dB at 50 Hz.
Noise:	Noise voltage, input short-circuited:<40 µV RMS 0.8 µV/√Hz.
DC:	±(0.2 % rdg + 0.1 % sensor range).

For a power frequency of 50 Hz, the sampling frequency is 10.24 kHz.

Bandwidth

Frequency Response:

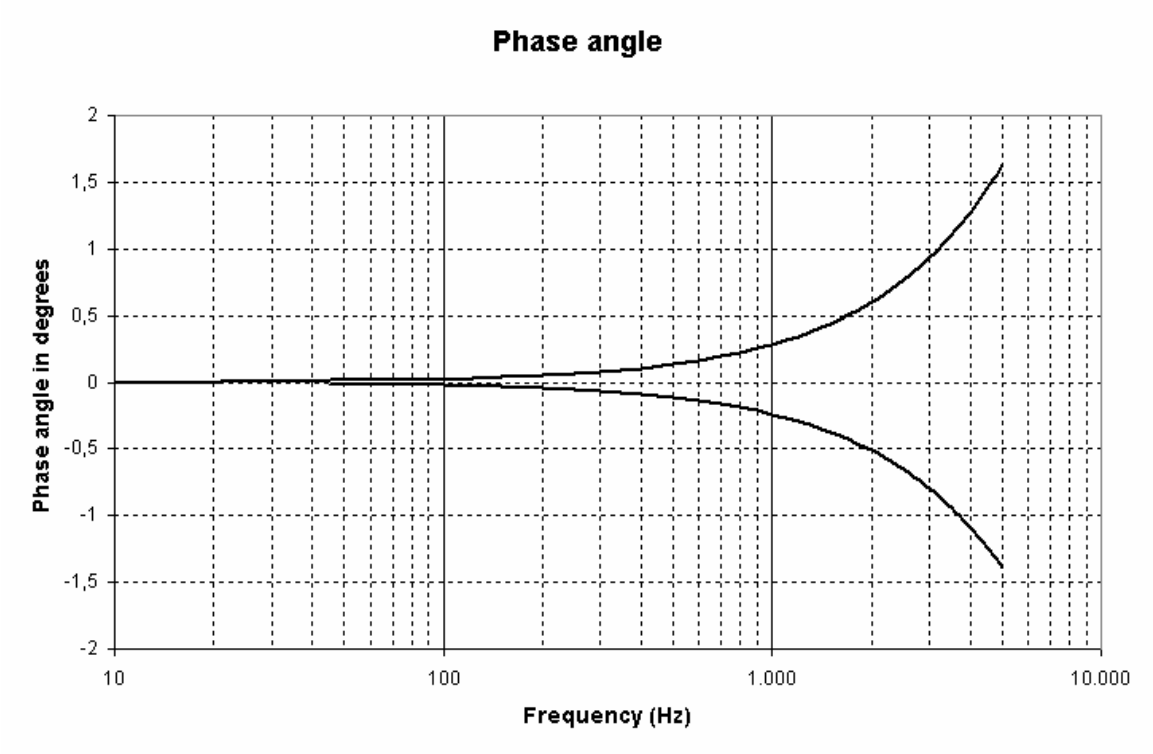


frequency response.bmp

Fluke 1760 effects measurements with precisely defined frequency response. Between the 3 dB limit frequency at 0.45-fold sampling frequency and the 1.2 higher frequency the magnitude falls 80 dB below the A/D converter‘s resolution. Particular attention is paid to the identical phase responses of the analog inputs in order to avoid errors during the power measurement.

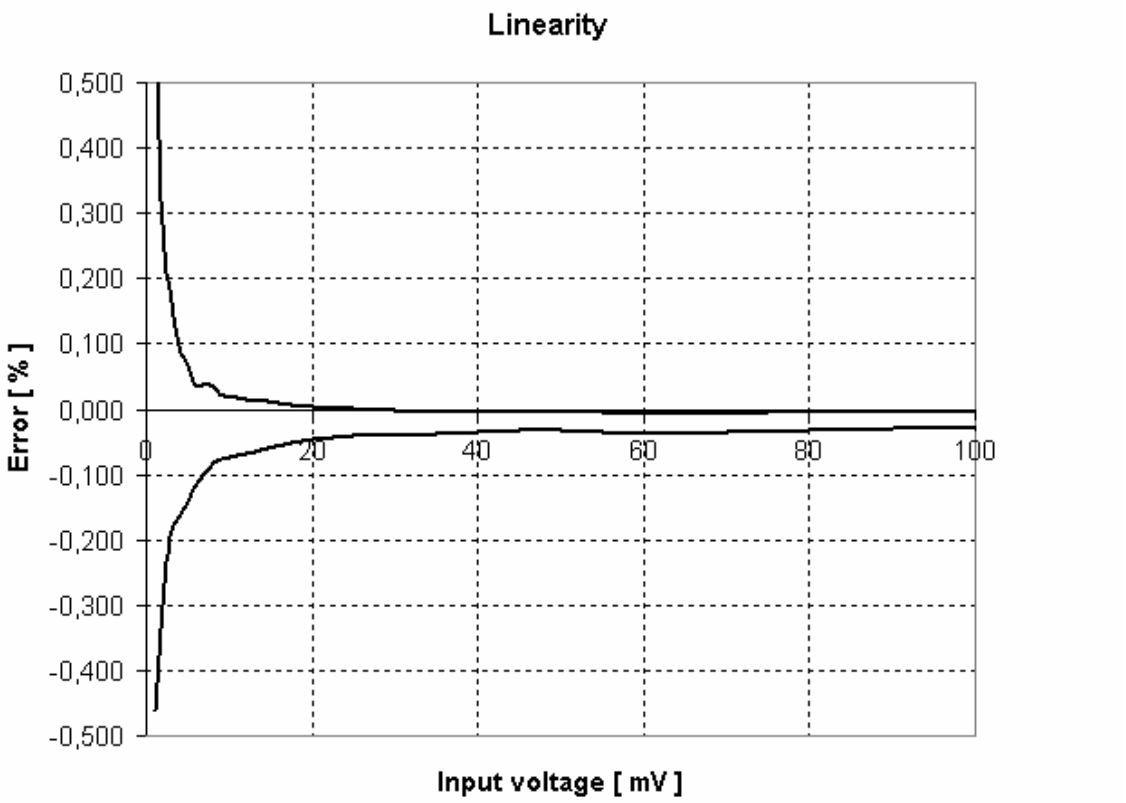
Phase Angle

Phase Angle of Analog Channels:



phase angle.bmp

Linearity



linearity.bmp

Data Memory

- *Measurement data memory*: 2 GB Flash memory
- *Memory model*: linear
- *Data retention time*: unlimited

Configuration Memory

The current settings can be stored as configuration files on the hard disk of the PC and/or in non-volatile data storage memory of the device.

Interfaces

RS 232: Future option.

RS 232 interface for firmware upload and data exchange with PC.

External modem is possible.

LAN: Ethernet 100 MBit/s.

USB: Future option.

2 connectors of type A, USB V2.0.

Circuit Diagram

Overview:

Figure 6-1 shows the circuit diagram for the 1760.

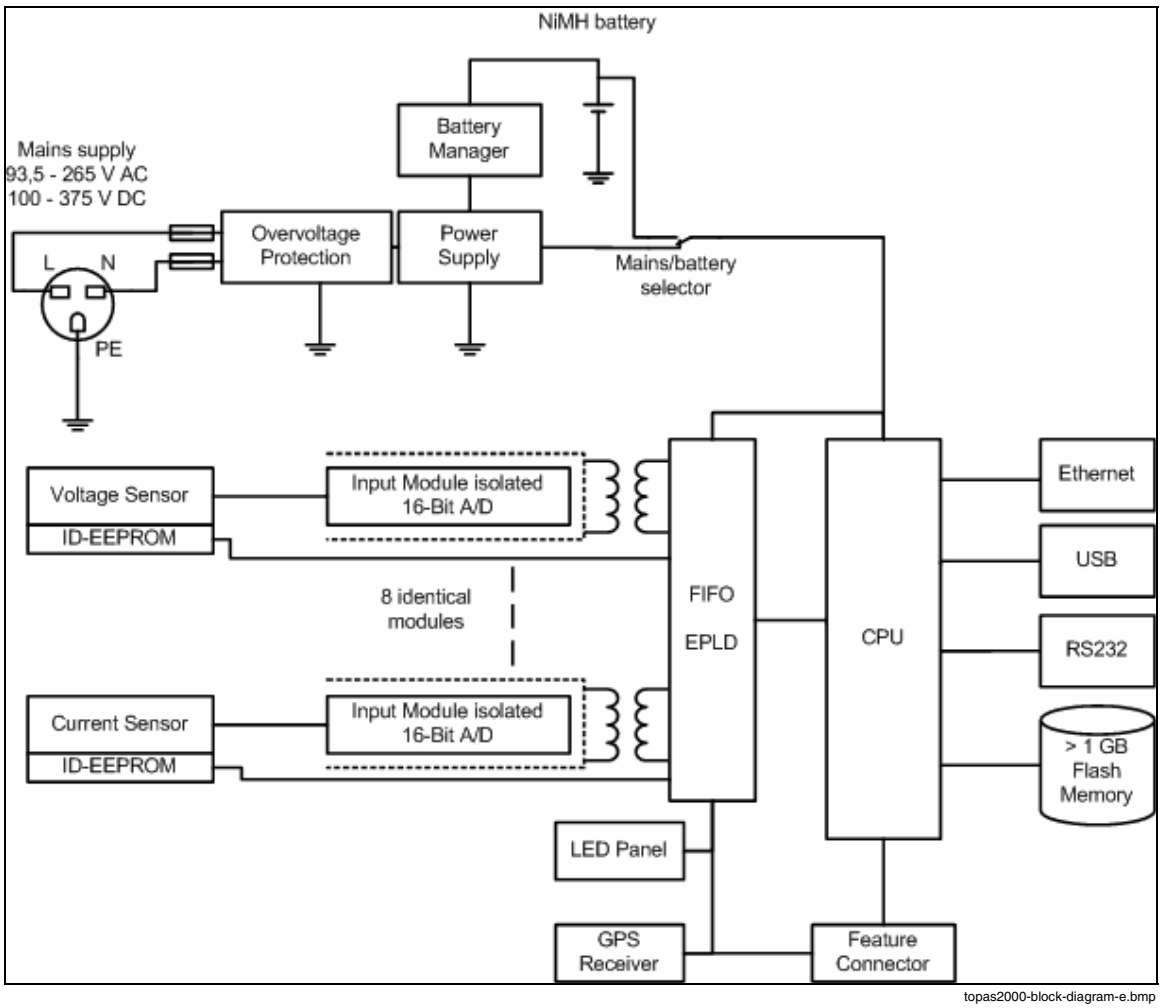


Figure 5-1. Circuit Diagram

Chapter 6
Options and Accessories

Title **Page**

Instruments

Product	Description/technical specifications	Product- No.
Fluke 1760 Basic without fast transient without voltage and current sensors	**Power Quality Recorder/Analyzer** 8 channels (4 voltages/4 currents or 8 voltages) **Interfaces:** Ethernet 1 Ethernet cable for network connection 1 crosslink Ethernet cable for direct PC connection **Memory:** 2 GB Flash memory **CDROM:** PQ Analyze software and SW manual, operators guide on CDROM 1 mains cable, county specific adapter 1 Getting Started Manual 1 carrying bag	2540384
Fluke 1760TR Basic with fast transient, without voltage and current sensors	The Fluke 1760 TR Basic includes all of the items in the Fluke 1760 Basic unit, plus. **Fast transient analysis** up to 10 MHz	2540391
Fluke-1760 INTL **Fluke-1760 US** without fast transient, with voltage and current sensors	**The Fluke 1760** includes all of the items in the Fluke 1760 Basic unit, plus. **INTL:** 4 voltage probes 600 V **US:** 4 voltage probes 1000 V 4 flexible current probes 1000 A/200 A **GPS time** sync receiver	
Fluke-1760TR INTL **Fluke-1760TR US** with fast transient, with voltage and current sensors	**The Fluke 1760 TR** includes all of the items in the Fluke 1760 unit, plus. **Fast transient analysis** up to 10 MHz	

Accessories

The voltage probes for various ranges between 100 mV and 1000 V are available for the instrument.

The current sensors for direct current measurement (shunts) are available between 20 mA and 5 A.

The passive current clamps (ac only) are available in ranges with 1 A up to 1000 A, 2 ranges can be selected in the PQ Analyze software.

The flexible current sensors (Flexi Set) are available for ranges between 100 A and 6000 A ac; 2 ranges can be selected in the PQ Analyze software.

All probes contain a memory for calibration factors, sensor identity, and serial number which is read automatically by the instrument. Ranges can be selected in the PQ Analyze software.

Other measuring transducers can be used in front of these standard sensors.

Standard Voltage Probes for AC and DC

Temperature coefficient: 100 ppm/K

Aging: <0.05 %/year

All voltage sensors are suitable for DC: 5 kHz

Model No Product No	Type	Range rms	V_{nom}	$V_{max.}$ contin.	Fast Transient Range $V_{p<1\ ms}$	Operating Voltage Category
TPS VOLTPROBE 10 V PN 2540636	VOLTAGE PROBES 10 V	0.1 – 17 V	10 V	100 V	-	150 V CAT IV
TPS VOLTPROBE 100 V PN 2540624	VOLTAGE PROBES 100 V	1 – 170 V	100 V	1000 V	6000	600 V CAT IV
TPS VOLTPROBE 400 V PN 2540660	VOLTAGE PROBES 400 V	4 – 680 V	400 V	1000 V	6000	600 V CAT IV
TPS VOLTPROBE 750 V PN 2540703	VOLTAGE PROBE 400 V/750 V PEAK	4 – 680 V	400 V	1000 V	5 - 750	600 V CAT IV
TPS VOLTPROBE 600 V PN 2540697	VOLTAGE PROBES 600 V	10 – 1000 V	600 V	1000 V	6000	600 V CAT IV
TPS VOLTPROBE 1 KV PN 2540649	VOLTAGE PROBE 1000 V	10 - 1700 V	1000 V	2000 V	6000	600 V CAT IV

Product No.	Input Resistance[1)]	Intrinsic Error	Safety
2540636	16 kOhm	0.15 %	300 V CAT II
2540624	2 MOhm	0.15 %	600 V CAT III
2540660 Vdin = 230 V	2 MOhm	0.15 %	600 V CAT III
25406602) Vdin = 230 V	2 MOhm	5 %	600 V CAT III
2540703	4 MOhm	0.2 %	600 V CAT III
25407032)	2 MOhm	5 %	600 V CAT III
2540697	2 MOhm	0.15 %	600 V CAT III
2540649	19 MOhm	0.15 %	600 V CAT IV
1): Input resistance between red and black connector. 2): For transient range.			

Order No.	Trans. Range $V_{p<1ms}$	$U_{nominal}$	Effective Range	U_{max} continuous
2540636	-	10 V	0,1…17 V	100 V
2540624	6000	100 V	1…170 V	1000 V
2540660	6000	400 V	4…680 V	1000 V
2540703	5...750	400 V	4…680 V	1000 V
2540697	6000	600 V	10…1000 V	1000 V
2540649	6000	1000 V	10…1700 V	2000 V

Flexible Current Probes for AC

Model No. Product No	Type	Range Selec-table Per Software	Peak Current for Sinusoidal Currents	Uncer-tainty	Frequency Range	Operating Voltage	Phase Error	Diameter
TPS Flex 18 PN 2540477	Flexible Current Probe	1 A – 100 A 5 A – 500 A	240 A 1350 A	1 %	45 Hz – 3.0 kHz	300 V CAT IV	0.5 °	45 cm (18 inch) length 2 m cable
TPS Flex 24 PN 2540489	Flexible Current Probe	2 A – 200 A 10 A – 1000 A	480 A 2700 A	1 %	45 Hz – 3.0 kHz	600 V CAT IV	0.5 °	61 cm (24 inch) length 2 m cable
TPS Flex 36 PN 2540492	Flexible Current Probe	30 A – 3000 A 60 A – 6000 A	10 kA 19 kA	1 %	45 Hz – 3.0 kHz	300 V CAT IV	0.5 °	91 cm (36 inch) length 4 m cable

Current Probes for AC Currents

Model No. Product No	Type	Range Selectable	Peak Current for Sinusoidal Currents	Uncertainty	Frequency Range	Operating voltage	Phase error	Jaw Opening
TPS CLAMP 10 A/1 A PN 2540445	CLIP-ON CURRENT TRANSFORMER	0.01 A – 1 A 0.1 A – 10 A	3.7 A 37 A	0.5 %	40 Hz – 10 kHz	300 V CAT IV	0.5 °	conductor cross-section 15 mm, (0.6 inch) 2 m cable
TPS CLAMP 50 A/5 A PN 2540461	CLIP-ON CURRENT TRANSFORMER	0.05 A – 5 A 0.5 A – 50 A	18 A 180 A	0.5 %	40 Hz – 10 kHz	300 V CAT IV	0.5 °	conductor cross-section 15 mm, (0.6 inch) 2 m cable
TPS CLAMP 200 A/20 A PN 2540450	CLIP-ON CURRENT TRANSFORMER	0.2 A – 20 A 2 A – 200 A	74 A 300 A	0.5 %	40 Hz – 10 kHz	300 V CAT IV	0.5 °	conductor cross-section 15 mm, (0.6 inch) 2 m cable

Shunt Resistors for AC and DC Currents

Model No. Product No	Type	Range	Peak Current for Sinusoidal Currents	Uncertainty	Frequency Range	Operating Voltage	Phase Error
TPS SHUNT 20 MA PN 2540553	SHUNT 20 mA	0 – 55 mA	77.8 mA Imax=1.5 A	0.2 %	DC 3.0 kHz	300 V CAT II	0.1 °
TPS SHUNT 5 A PN 2540566	SHUNT 5 A	0 – 10 A	21.9 A Imax=10 A	0.2 %	DC 3.0 kHz	300 V CAT II	0.1 °

Errors in % of measuring range at 23 °C ± 2 K, for 48 – 65 Hz.

Phase angle error at nominal current.

I_{max} maximum current without time limit.

Other Accessories

Product	Description/technical specifications	Product- No.
Transport case	For Instrument and accessories	2540414
Safety adapter	With quick-break fuse of 100 kA circuit-breaking capacity	2540530
2 A quick-break fuse	With 100 kA circuit-breaking capacity	2540509
Battery pack	Replacement battery pack	2540406

Current Clamp 1 A/10 A AC

This current probe has been designed for non intrusive, accurate measurements of small AC currents. Using latest technologies (internal memory for calibration data) provides current ranges from 0.01 A up to 10 A. The measurement range can be selected in the PQ Analyze software: *IAC1* or *IAC10*.

Electrical Characteristics

Nominal current In:	1 A/10 A AC rms
Measuring ranges:	0.01 A – 1 A or 0.1 A – 10 A
Crest factor:	< 3
Peak current:	3.7 A/37 A
Overload:	Up to 100 A rms
Conductor position influence:	< 0.5 % of range for 50/60 Hz
Error due to adjacent conductor:	≤ 15 mA/A for 50 Hz
Phase error (to reference conditions):	< ±0.5 degrees
Frequency range (clamp without the instrument):	40 Hz – 10 kHz (–3 dB)
Temperature coefficient:	0.015 % of range/ °C
Safety:	600 V CAT IV, class C sensor pollution degree 2

General Characteristics

Maximum conductor size:	*Diameter:* 15 mm. *Bus bar:* 15 x 17 mm
Cable length:	2 m
Operating temperature range:	–10 °C - +55 °C
Storage temperature range:	–20 - +70 °C
Operating humidity:	15 % - 85 % (non-condensing)
Weight (per clamp):	220 g
Order-number:	2540445

Reference Conditions

Environment temperature range:	+18 °C to +26 °C
Humidity:	20 to 75 % rh
Current:	Sinusoidal waveform with 48 to 65 Hz
Distortion factor:	<1 %, no DC component, stray field <40 A/m, conductor centered within the clamp jaws

Safety Standards

- IEC/EN 61010-1: 2001
- IEC/EN 61010-2-032
- IEC/EN 61010-2-031

EMC Standards

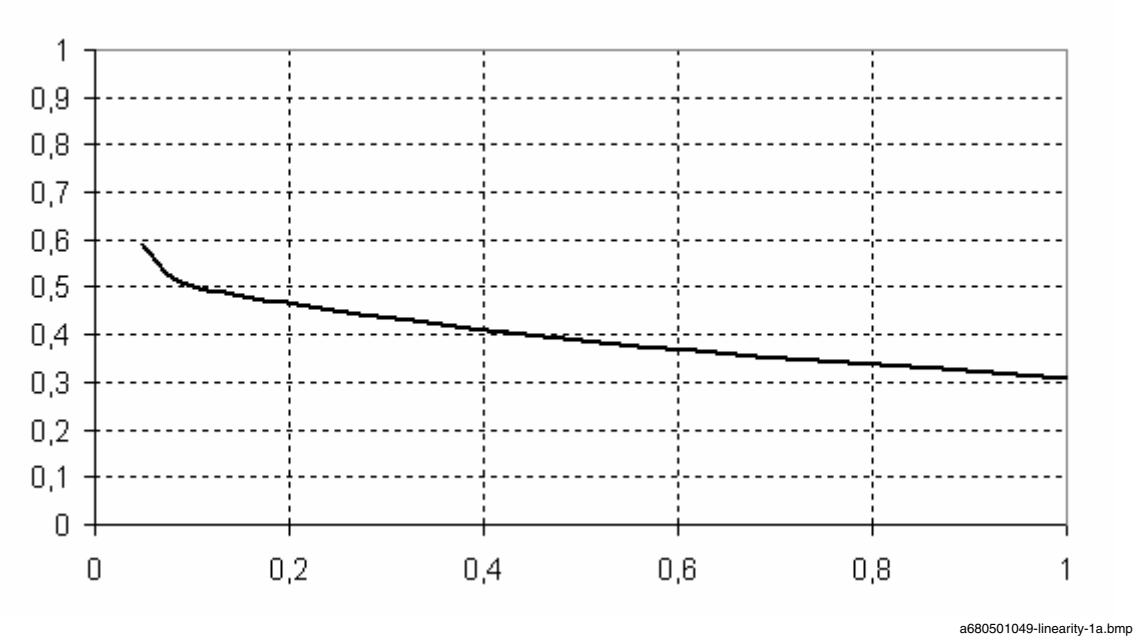
EN 61326 –1: 1997/A1: 1998.

⚠ Warning

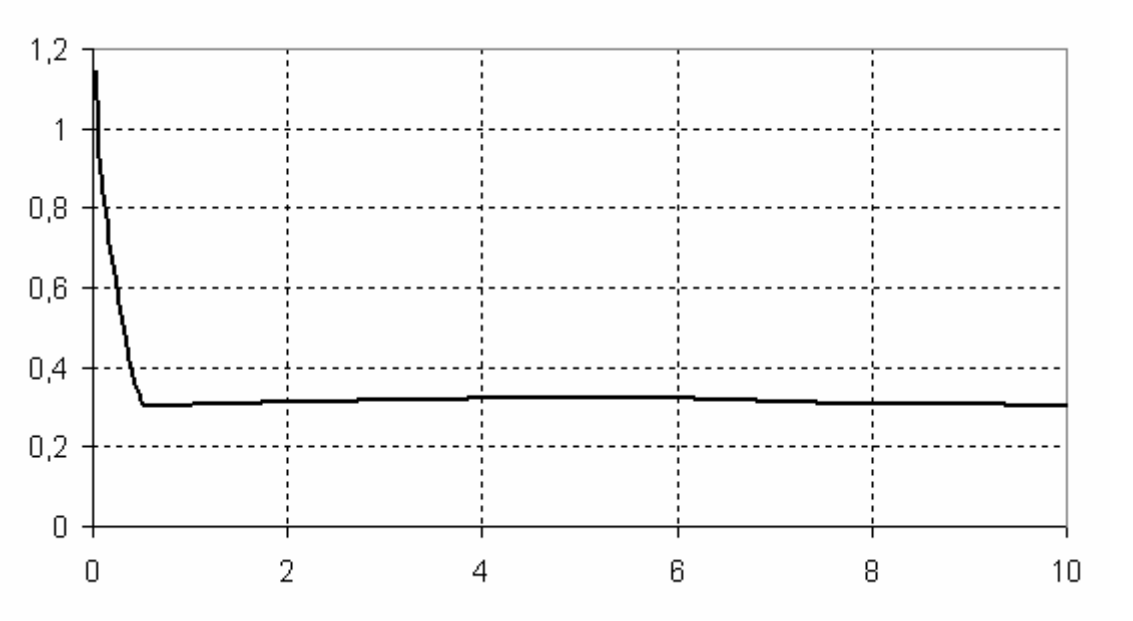
Utilize the clamps only on insulated conductors, max. 600 V r.m.s. or DC to ground and frequencies below 1 kHz.

Accuracy (Typical, for 50/60 Hz)

Linearity, error in % of measured value, primary current in A:

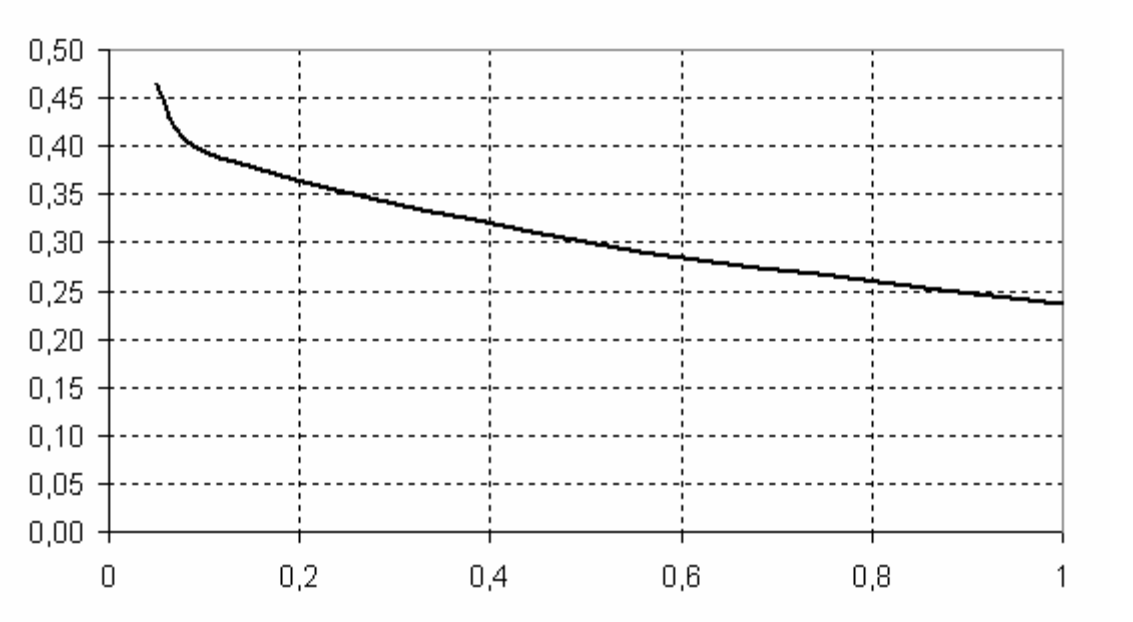


a680501049-linearity-1a.bmp

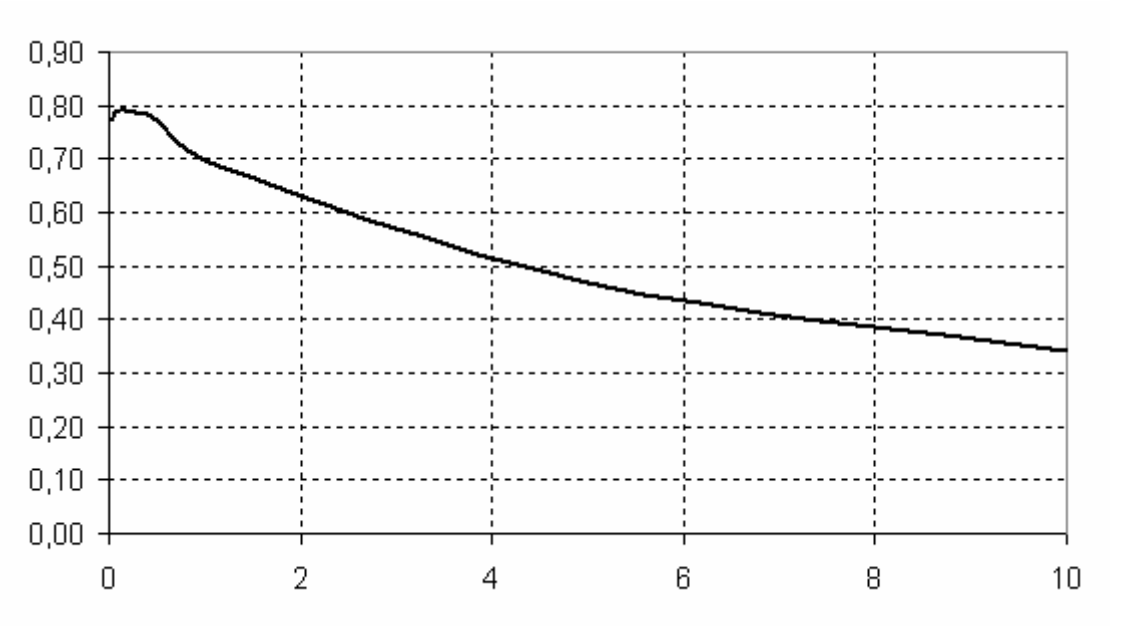


a680501049-linearity-10a.bmp

Phase angle in degrees, primary current in A:

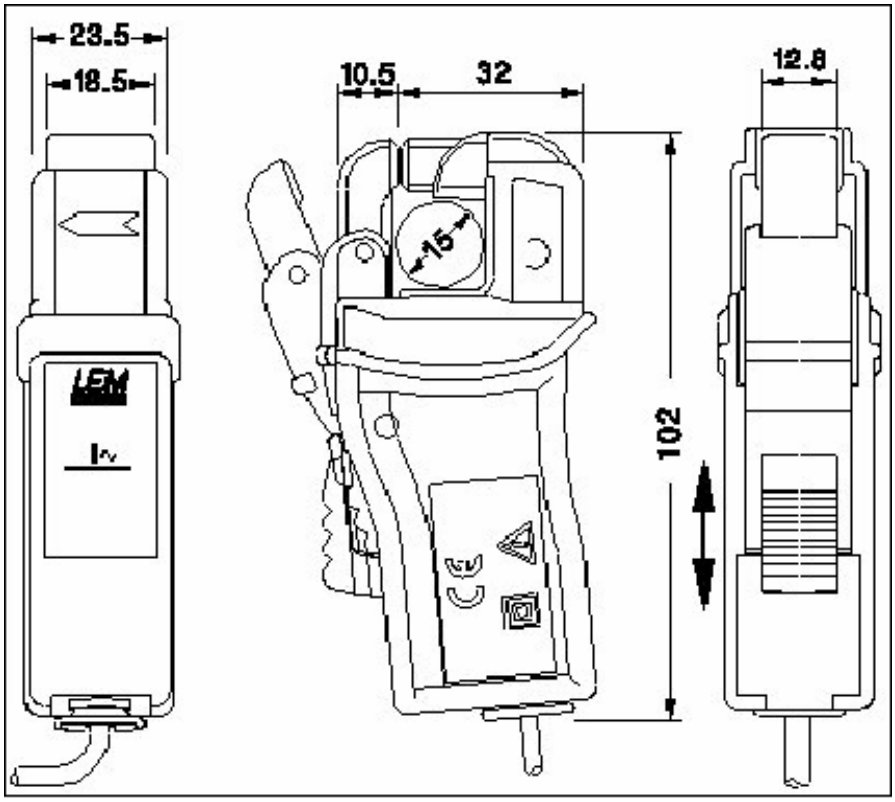


a680501049-phase-1a.bmp



a680501049-phase-10a.bmp

Dimensions (in mm):



small clamp-dimensions.bmp

Current Clamp 5 A/50 A AC

This current probe has been designed for non intrusive, accurate measurements of small AC currents. Using the latest technologies (internal memory for calibration data) provides current ranges from 0.05 A up to 50 A. The measurement range can be selected in the PQ Analyze software: *IAC5* or *IAC50*.

Electrical Characteristics

Nominal current In:	5 A/50 A AC rms
Measuring ranges:	0.05 A – 5 A or 0.5 A – 50 A
Crest factor:	< 3
Peak current:	18 A, 180 A
Overload:	Up to 200 A rms
Conductor position influence:	< 0.5 % of range at 50/60 Hz
Error due to adjacent conductor:	≤ 15 mA/A at 50 Hz
Phase error (to reference conditions):	< ±0.5 degrees
Frequency range (clamp without the instrument):	40 Hz – 10 kHz (–3 dB)
Temperature coefficient:	0.015 % of range/ °C
Safety:	600 V AC CAT III, class C sensor, pollution degree 2

General Characteristics

Maximum conductor size:	*Diameter:* 15 mm. *Bus bar:* 15 x 17 mm
Cable length:	2 m
Operating temperature range:	–10 °C - +55 °C
Storage temperature range:	–20 - +70 °C
Operating humidity:	15 % - 85 % (non-condensing)
Weight (per clamp):	Approx. 220 g
Order-number:	2540461

Reference Conditions

Environment temperature range:	+18 °C to +26 °C
Humidity:	20 to 75 % rh
Current:	Sinusoidal waveform, with 48 to 65 Hz
Distortion factor:	< 1 %, no DC component, stray field < 40 A/m, conductor centered within the clamp jaws

Safety Standards

- IEC/EN 61010-1: 2001
- IEC/EN 61010-2-032
- IEC/EN 61010-2-031

EMC Standards

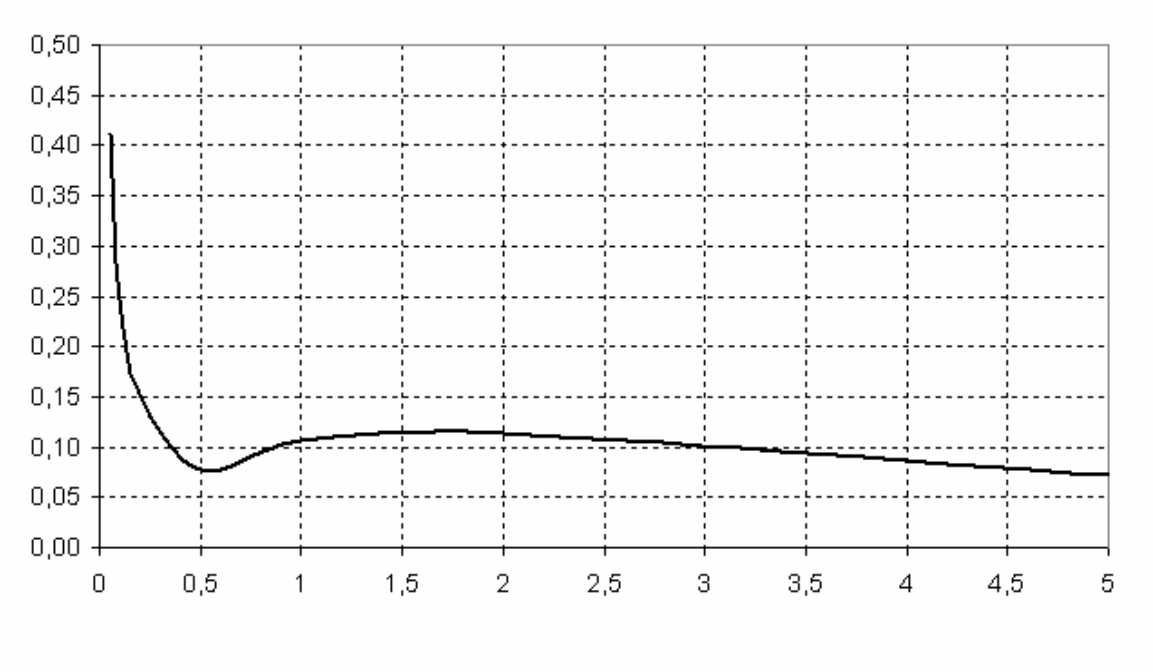
EN 61326 –1: 1997/A1: 1998.

⚠ Warning

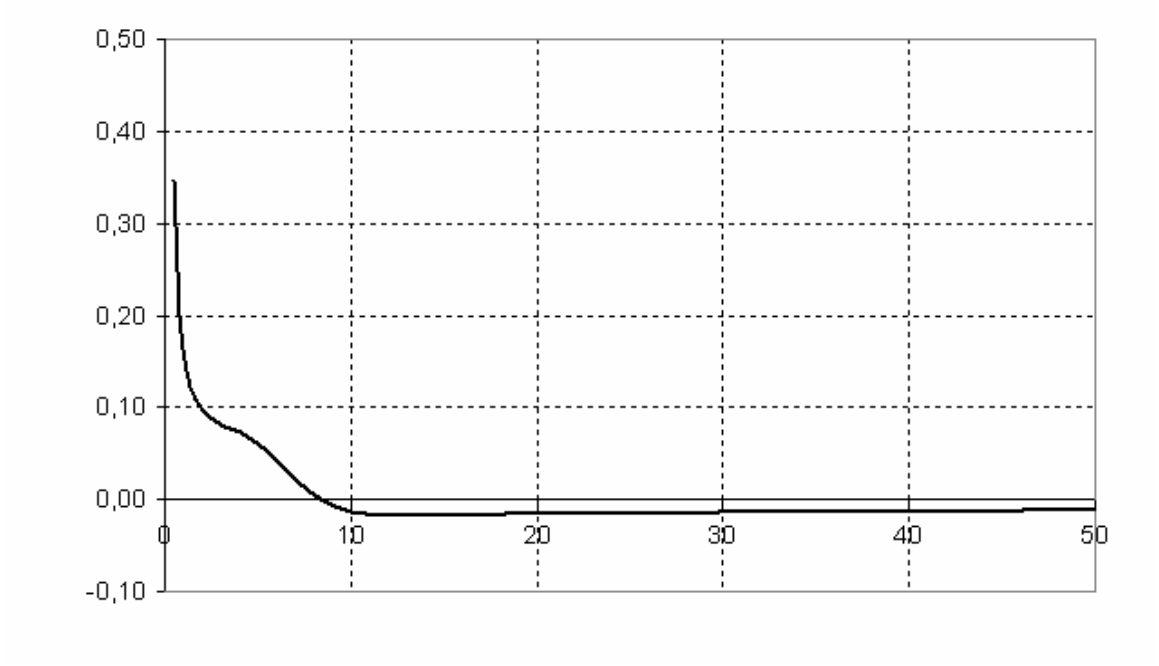
Utilize the clamps only on insulated conductors, max. 600 V r.m.s. or DC to ground and frequencies below 1 kHz.

Accuracy (Typical, for 50/60 Hz)

Linearity, error in % of measured value, primary current in A:

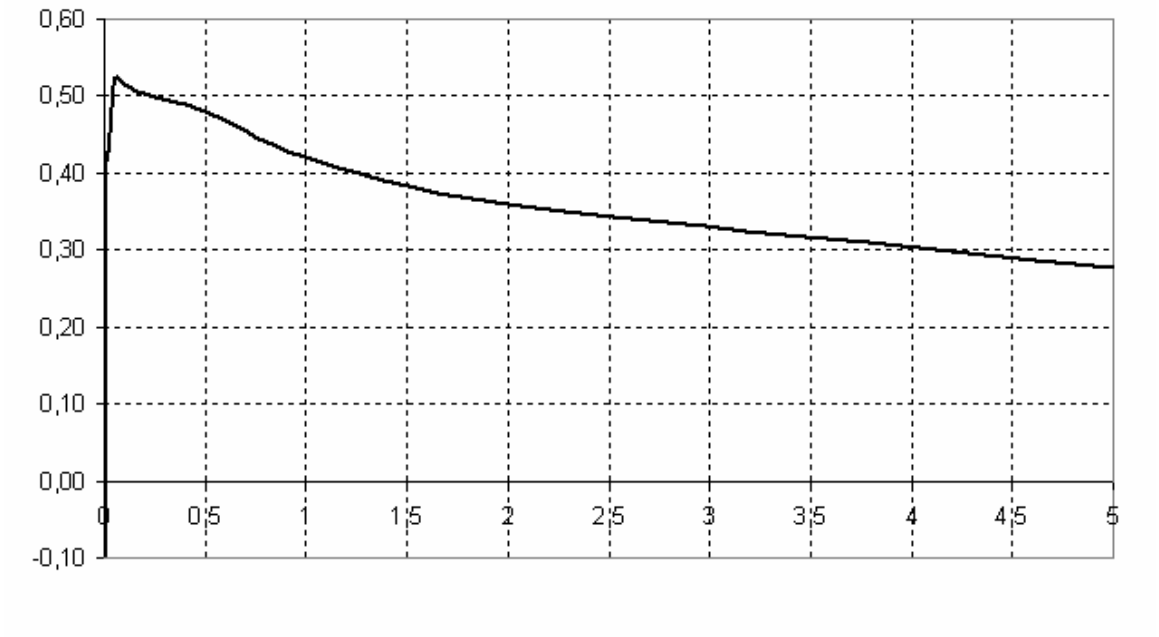


a680501048-linearity-5a.bmp

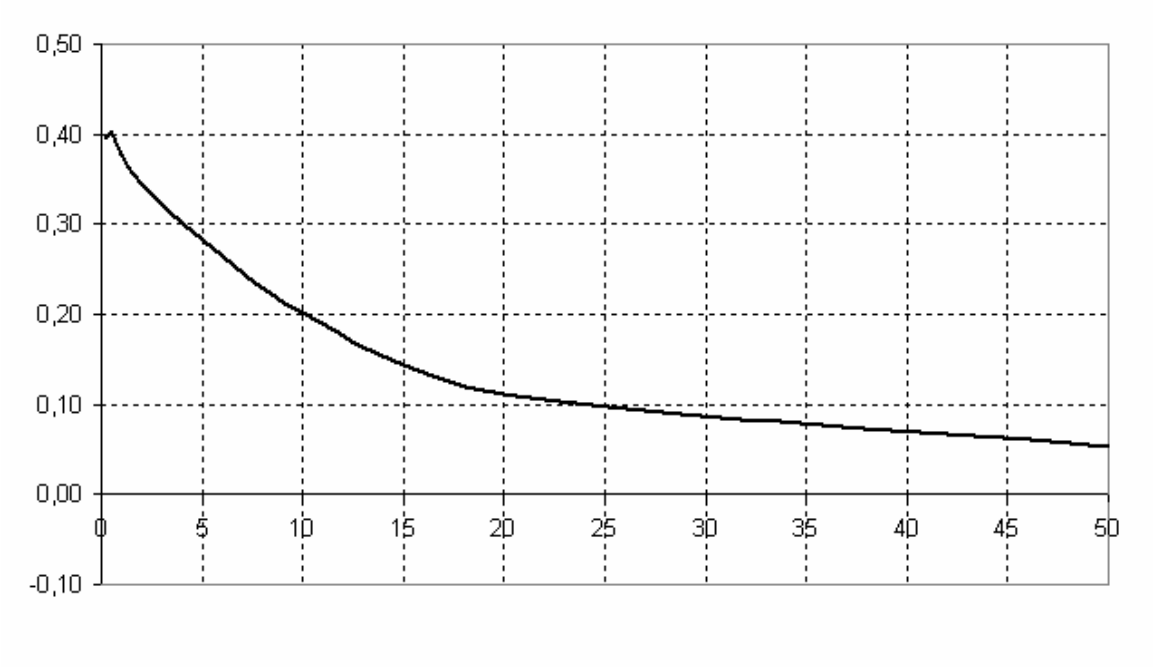


a680501048-linearity-50a.bmp

Phase angle in degrees, primary current in A:



a680501048-phase-5a.bmp



a680501048-phase-50a.bmp

Dimensions: See 2540445.

Current Clamp 20 A/200 A AC

This current probe has been designed for non intrusive, accurate measurements of small AC currents. Using the latest technologies (internal memory for calibration data) provides current ranges from 0.2 A up to 200 A. The measurement range can be selected in the PQ Analyze software: *IAC20* or *IAC200*.

Electrical Characteristics

Nominal current In:	20 A, 200 A AC rms
Measuring ranges:	0.2 A – 20 A or 2 A – 200 A
Crest factor:	< 3
Peak current:	74 A, 300 A
Overload:	Up to 300 A rms
Conductor position influence:	< 0.5 % of range for 50/60 Hz
Error due to adjacent conductor:	≤15 mA/A for 50 Hz
Phase error (to reference conditions):	< ±0.5 degrees
Frequency (clamp without the instrument):	40 Hz – 10 kHz (–3 dB)
Temperature coefficient:	0.015 % of range/ °C
Safety:	600 V CAT III, class C sensor pollution degree 2

General Characteristics

Maximum conductor size:	*Diameter:* 15 mm *Bus bar:* 15 x 17 mm
Cable length:	2 m
Operating temperature range:	–10 °C - +55 °C
Storage temperature range:	–20 - +70 °C
Operating humidity:	15 % - 85 % (non-condensing)
Weight (per clamp):	Approx. 220 g
Order-number:	2540450

Reference Conditions

Environment temperature range:	+18 °C to +26 °C.
Humidity:	20 up to 75 % r.h.
Current:	Sinusoidal waveform with 48 to 65 Hz.
Distortion factor:	< 1 %, no DC component, stray field < 40 A/m, conductor centered within the clamp jaws

Safety Standards

- IEC/EN 61010-1: 2001
- IEC/EN 61010-2-032
- IEC/EN 61010-2-031

EMC Standards

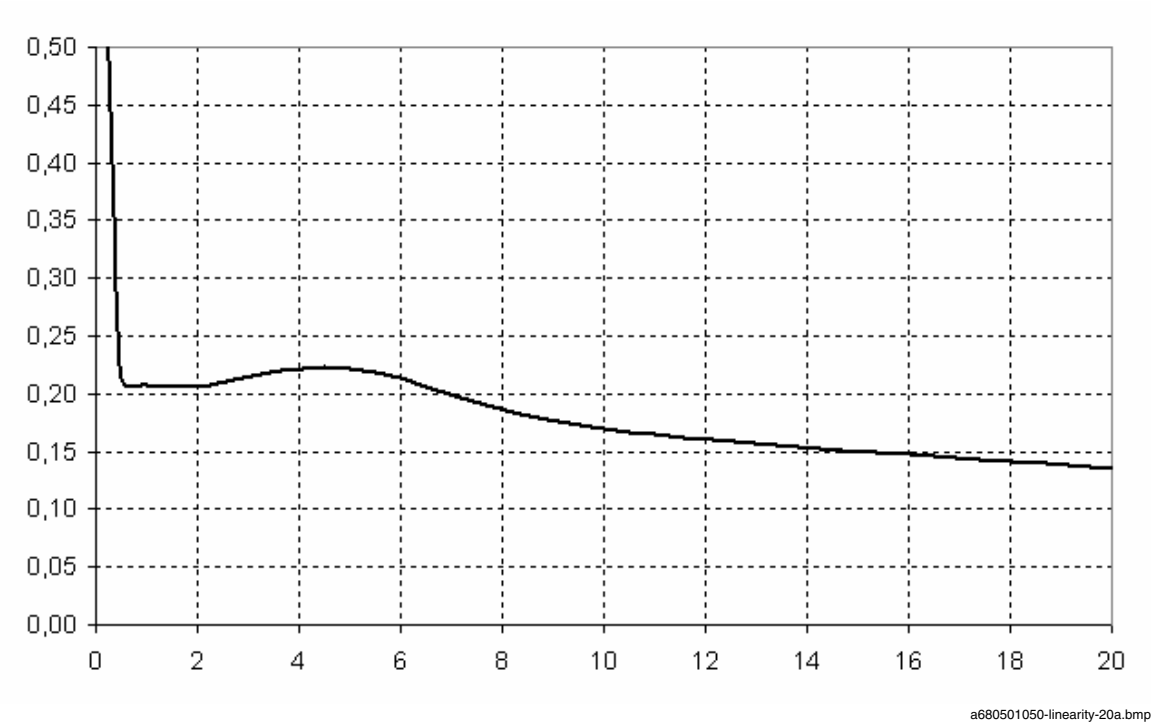
EN 61326 –1: 1997/A1: 1998.

⚠ Warning

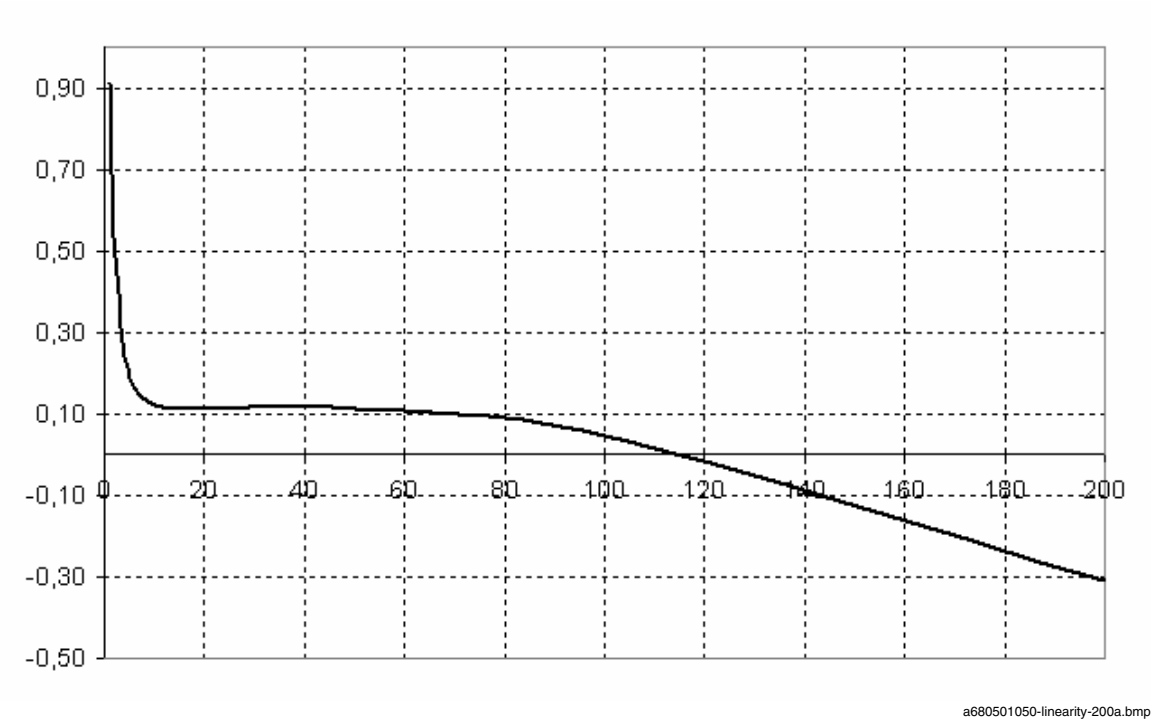
Utilize the clamps only on insulated conductors, max. 600 V r.m.s. or DC to ground and frequencies below 1 kHz.

Accuracy (Typical, for 50/60 Hz)

Linearity, error in % of measured value, primary current in A:

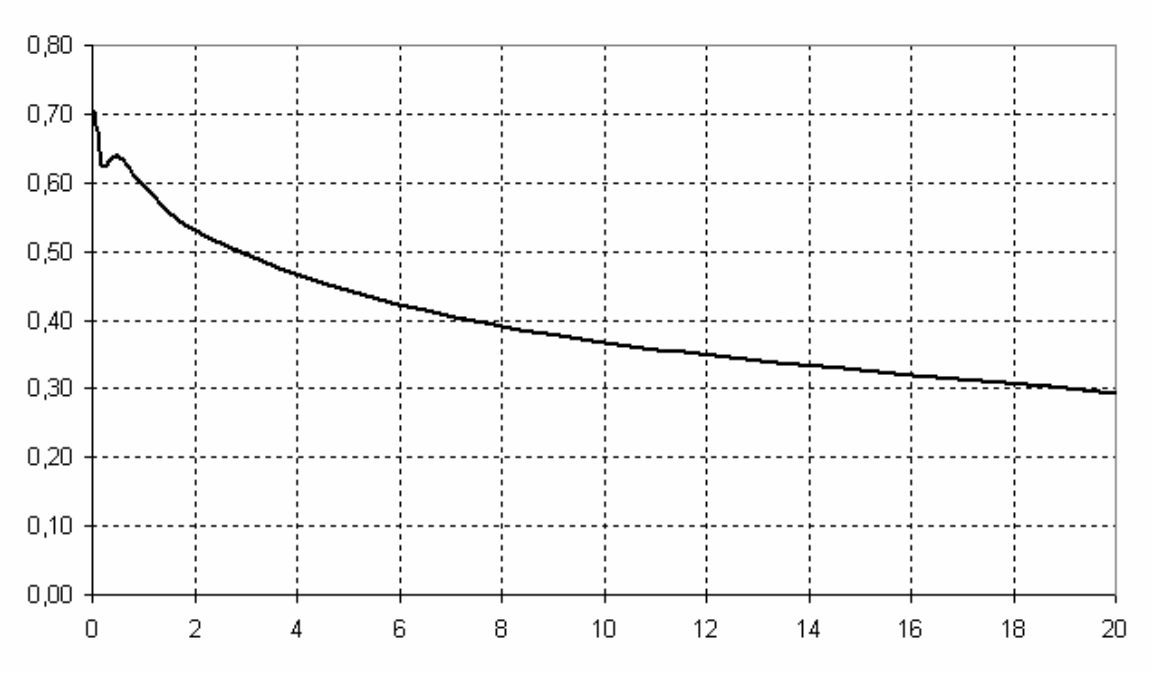


a680501050-linearity-20a.bmp

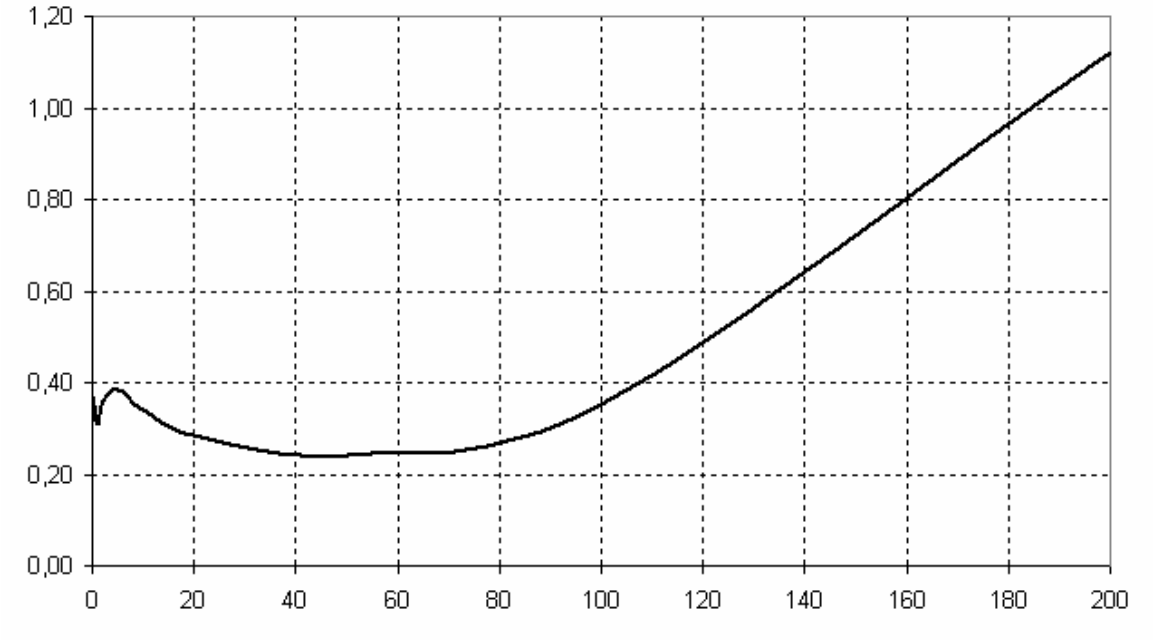


a680501050-linearity-200a.bmp

Phase angle in degrees, primary current in A:



a680501050-phase-20a.bmp



a680501050-phase-200a.bmp

Dimensions: See 2540445.

Flexi Current Sensor 100 A/500 A

This current probe has been designed for non intrusive, accurate AC current measurements. Using the latest technologies (internal memory for calibration data) provides current measurements between 1 A and 500 A. The measurement range can be selected in the PQ Analyze software: *IAC100* or *IAC500*.

Electrical Characteristics

Nominal current In:	100 A, 500 A AC rms
Measuring ranges:	1 A – 100 A or 5 A – 500 A AC
Peak current:	240 A, 1350 A
Overload capacity:	Up to 2000 A rms
Intrinsic error:	< ±1 % of mv
Linearity (10 % - 100 % of In):	±0.2 % of In.
Conductor position influence:	< ±2 % of mv, distance to measuring head >30 mm
Error due to adjacent conductor:	≤ ±2 A (Iext = 500 A, distance to head >200 mm)
Phase error (to reference conditions):	< ± 0.5 degrees
Temperature coefficient:	0.005 % of range/ °C
Safety:	600 V CAT IV, class B sensor pollution degree 2

General Specification

Cable length:	2 m
Length of measuring head:	45 cm (18 inch)
Operating temperature range:	–10 °C - +70 °C
Storage temperature range:	–20 °C - +90 °C
Operating humidity:	10 % - 80 % (non-condensing)
Weight:	Approx. 0.3 kg
Order-number:	2540477

Reference Conditions

Environment temperature range:	+18 °C to +26 °C
Humidity:	20 – 75 % rh
Current:	Nominal value In, sinusoidal waveform, 48 – 65 Hz
Distortion factor:	< 1 %. No DC component, stray field < 40 A/m, conductor centered within the Flexi current sensor

Safety Standards

- IEC/EN 61010-1: 2001
- IEC/EN 61010-2-032
- IEC/EN 61010-2-031

EMC Standards

EN 61326 –1: 1997/A1: 1998.

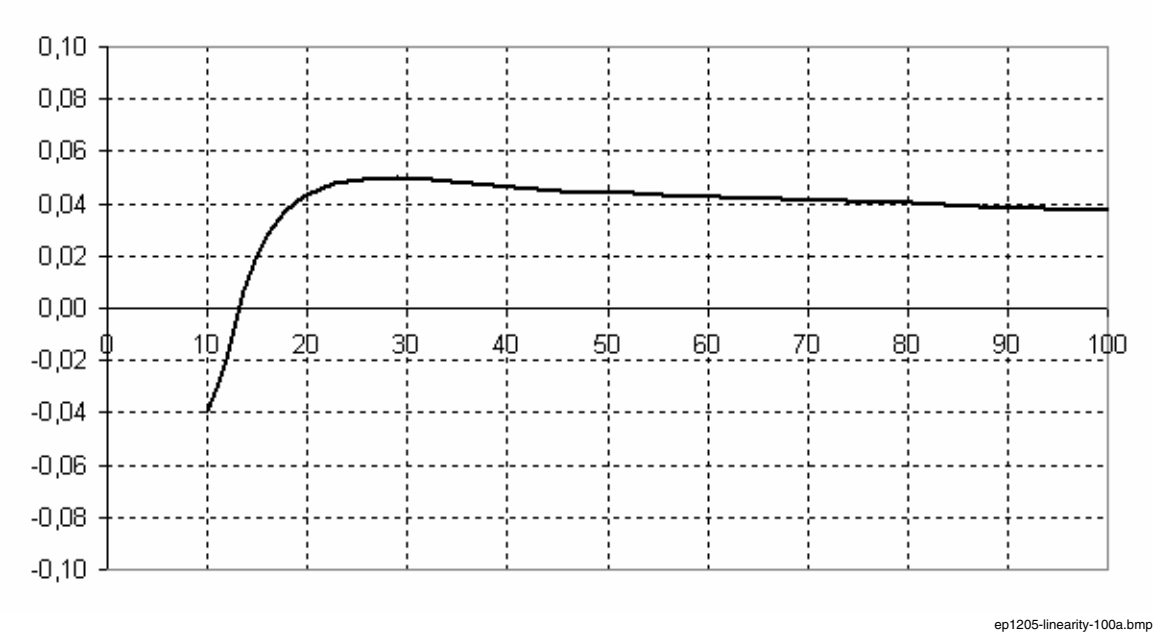
⚠ Warning

Wear high voltage protection gloves, and switch off the conductors and ensure that the potential is zero.

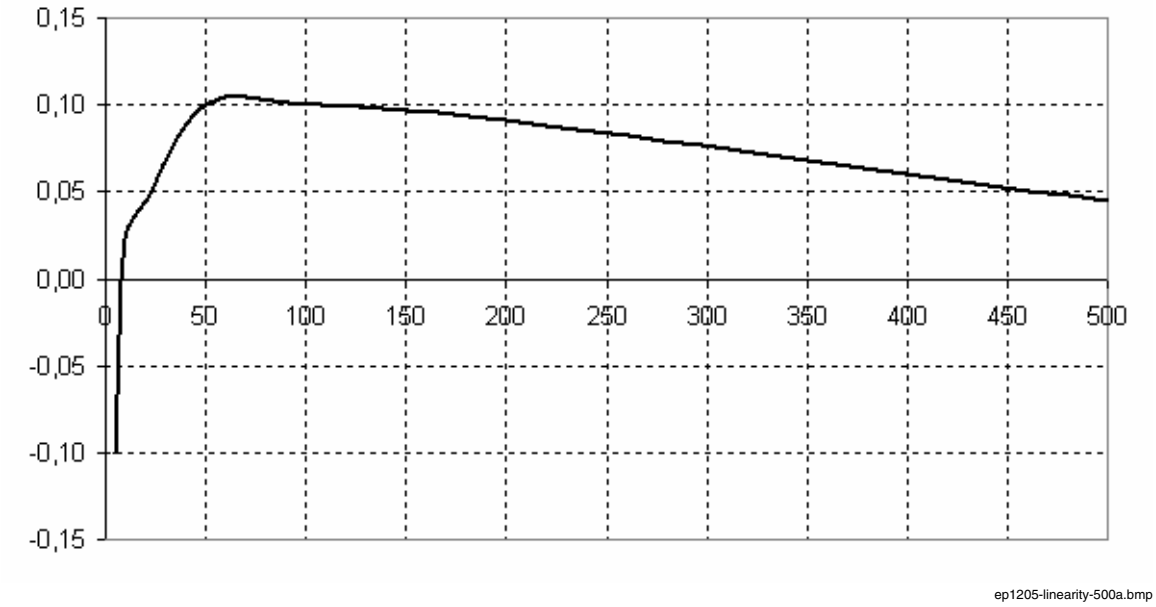
Utilize the Flexi current sensor only at 600 V rms or dc to ground and frequencies below 1 kHz.

Accuracy (Typical, for 50/60 Hz)

Linearity, error in % of measured value, primary current in A:

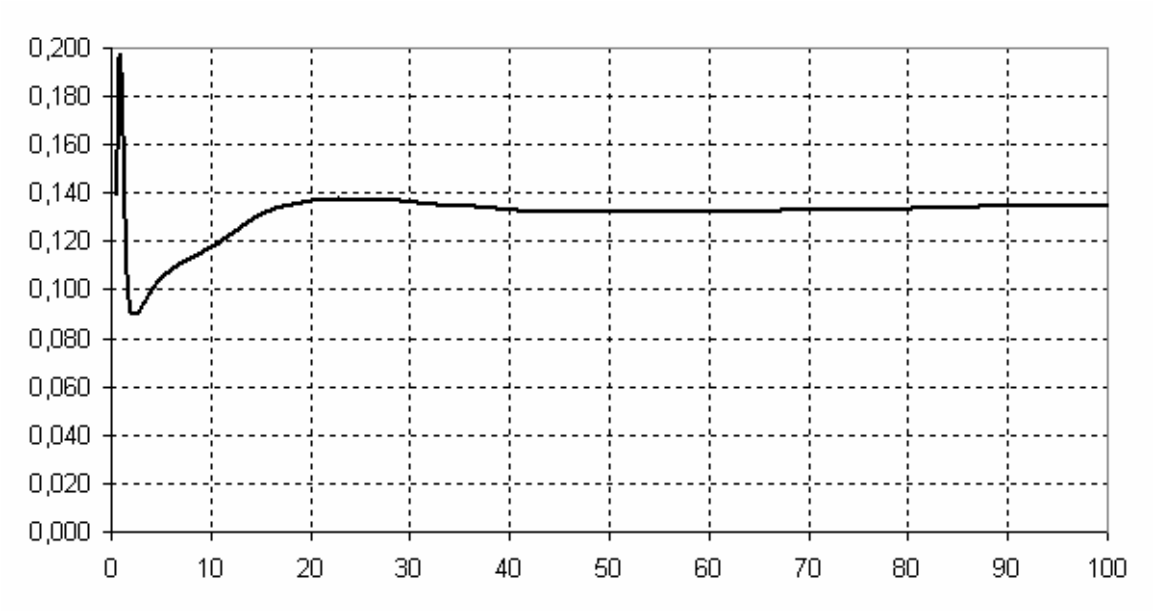


ep1205-linearity-100a.bmp

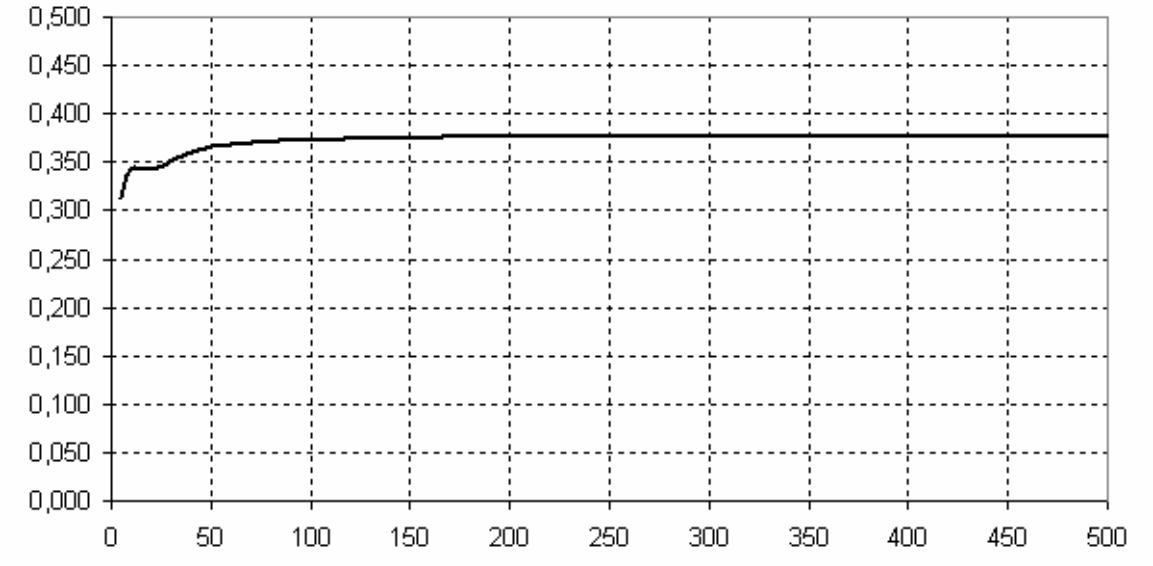


ep1205-linearity-500a.bmp

Phase angle in degrees, primary current in A:



ep1205-phase-100a.bmp



ep1205-phase-500a.bmp

Flexi Current Sensor 200 A/1000 A

This current probe has been designed for non intrusive, accurate ac current measurements. Using the latest technologies (internal memory for calibration data) provides current measurements between 2 A and 1000 A. The measurement range can be selected in the PQ Analyze software: *IAC200* or *IAC1000*.

Electrical Characteristics

Nominal current In:	200 A, 1000 A AC rms
Measuring ranges:	2 A – 200 A or 10 A – 1000 A ac
Peak current:	480 A, 2700 A
Overload capacity:	Up to 2000 A rms
Intrinsic error:	< ±1 % of mv
Linearity (10 % - 100 % of In):	±0.2 % of In
Conductor position influence:	< ±2 % of mv, distance to measuring head >30 mm
Error due to adjacent conductor:	≤ ±2 A (Iext = 500 A, distance to head >200 mm)
Phase error (to reference conditions):	< ± 0.5 degrees
Temperature coefficient:	0.005 % of range/ °C
Safety:	600 V CAT IV, class B sensor pollution degree 2

General Specifications

Cable length:	2 m
Length of measuring head:	61 cm (24 inch)
Operating temperature range:	–10 °C - +70 °C
Storage temperature range:	–20 °C - +90 °C
Operating humidity:	10 % - 80 % (non condensing)
Weight:	Approx. 0.3 kg
Order-number:	2540489

Reference Conditions

Environment temperature range:	+18 °C to +26 °C
Humidity:	20 – 75 %
Current:	Nominal value In, sinusoidal waveform, 48 – 65 Hz
Distortion factor:	< 1 %. No DC stray field <40 A/m, conductor centered within the Flexi current sensor

Safety Standards

- IEC/EN 61010-1: 2001
- IEC/EN 61010-2-032
- IEC/EN 61010-2-031

EMC Standards

EN 61326 –1: 1997/A1: 1998.

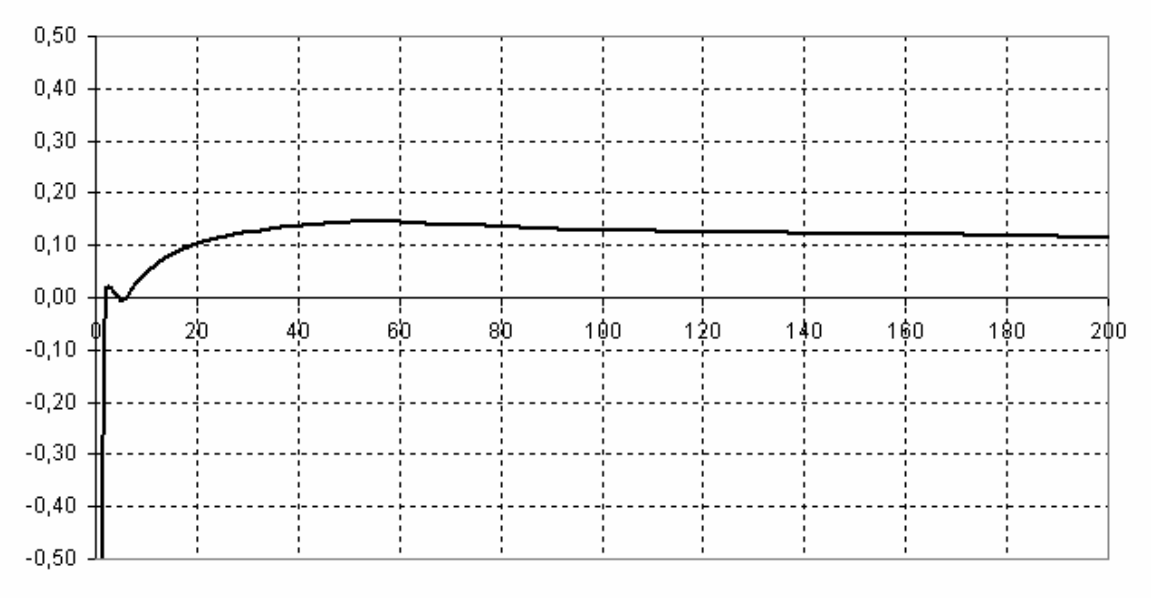
⚠ Warning

Wear high voltage protection gloves, switch off conductors and ensure that the potential is zero.

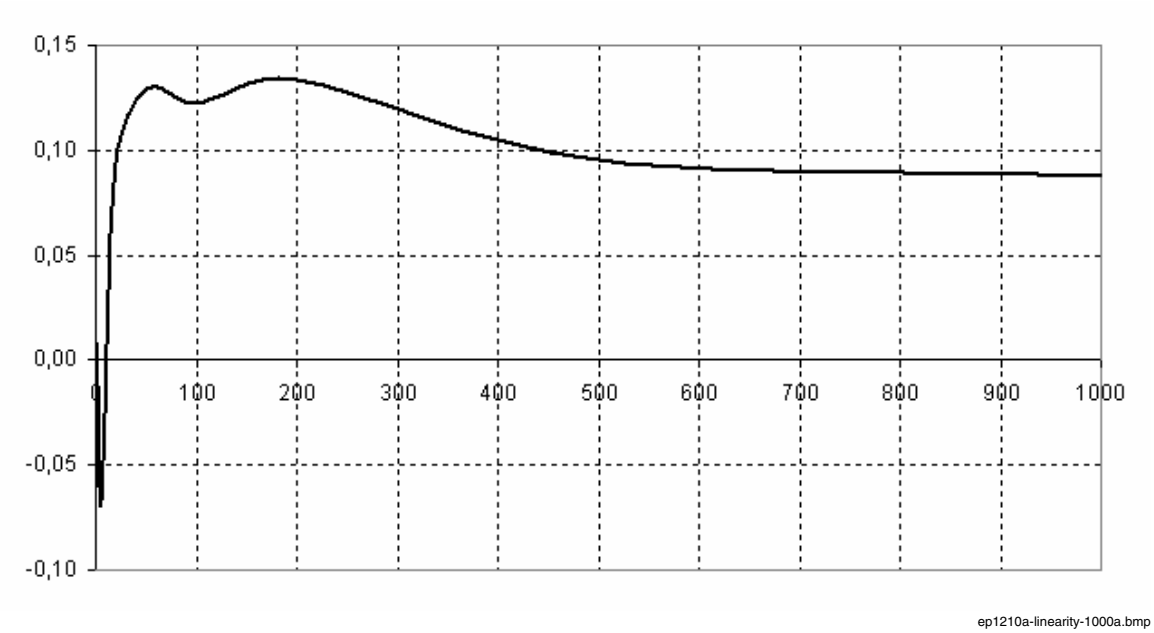
Utilize the Flexi current sensor only at 600 V rms or dc to ground and frequencies below 1 kHz.

Accuracy (Typical, for 50/60 Hz)

Linearity, error in % of measured value, primary current in A:

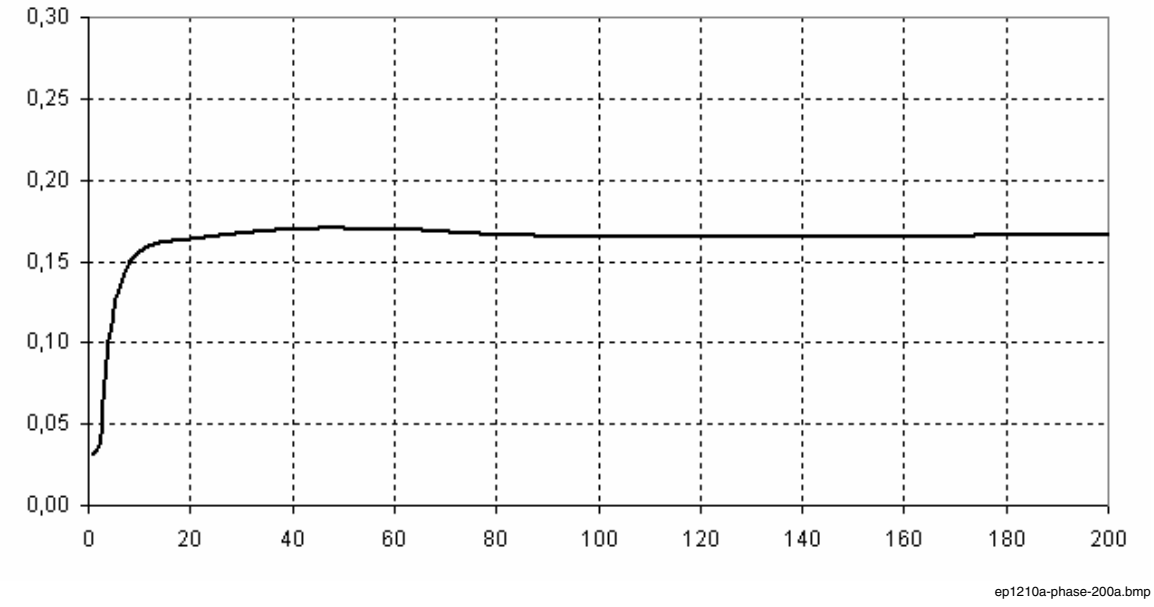


ep1210a-linearity-200a.bmp

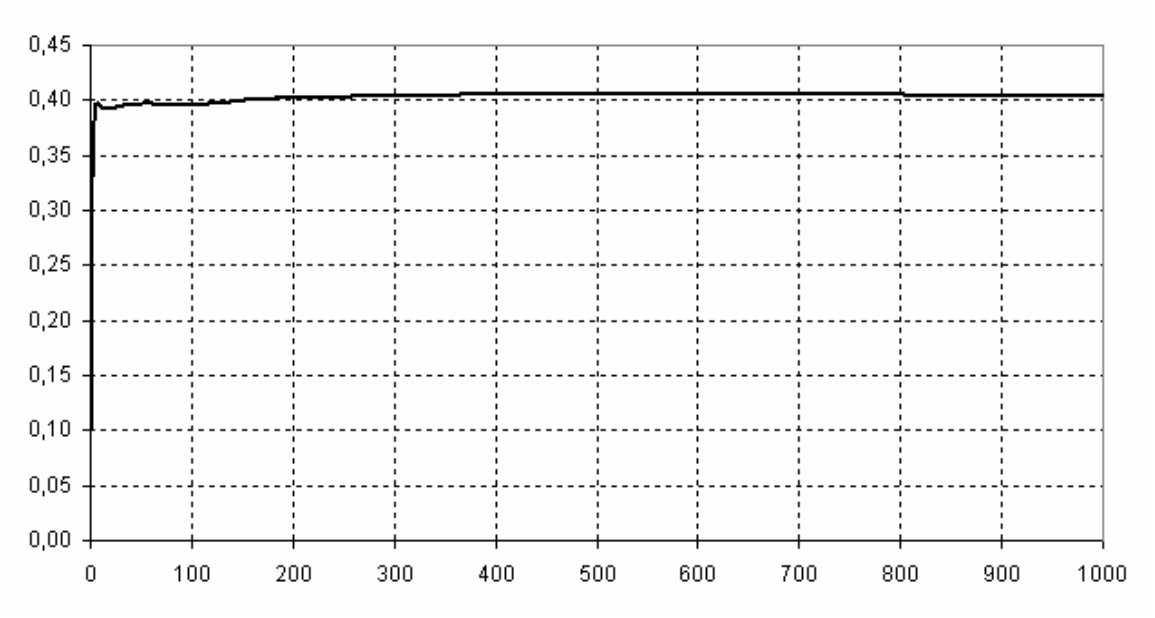


ep1210a-linearity-1000a.bmp

Phase angle in degrees, primary current in A:



ep1210a-phase-200a.bmp



ep1210a-phase-1000a.bmp

Flexi Current Sensor 3000 A/6000 A

This current probe has been designed for non intrusive, accurate ac current measurements. Using the latest technologies (internal memory for calibration data) provides current measurements between 30 A and 6000 A. The measurement range can be selected in the PQ Analyze software: *IAC3000* or *IAC6000*.

Electrical Characteristics

Nominal current In:	3000 A, 6000 A AC rms
Measuring ranges:	30 A … 3000 A or 60 A … 6000 A AC
Peak current:	10 kA, 19 kA
Overload capacity:	up to 19 kA rms
Intrinsic error:	< ±2 % of mv
Linearity (10 % - 100 % of In):	±0.2 % of In
Conductor position influence:	< ±2 % of m.v, distance to measuring head >30 mm
Error due to adjacent conductor:	≤ ±2 A (Iext = 500 A, distance to head >200 mm)
Phase error (to reference conditions):	< ± 0.5 degrees
Temperature coefficient:	0.005 % of range/ °C
Safety:	600 V CAT IV, class B sensor pollution degree 2

General Characteristics

Cable length:	4 m
Length of measuring head:	91 cm (36 inch)
Operating temperature range:	–10 °C - +70 °C
Storage temperature range:	–20 °C - +90 °C
Operating humidity:	10 % - 80 % (non condensing)
Weight:	Approx. 0.4 kg
Order-number:	2540492

Reference Conditions

Environment temperature range:	+18 °C to +26 °C
Humidity:	20 – 75 %
Current:	Nominal value In, sinusoidal waveform, 48 – 65 Hz
Distortion factor:	<1 %. Stray field <40 A/m, conductor centered within the Flexi current sensor

Safety Standards

- IEC/EN 61010-1: 2001
- IEC/EN 61010-2-032
- IEC/EN 61010-2-031

EMC Standards

EN 61326 –1: 1997/A1: 1998

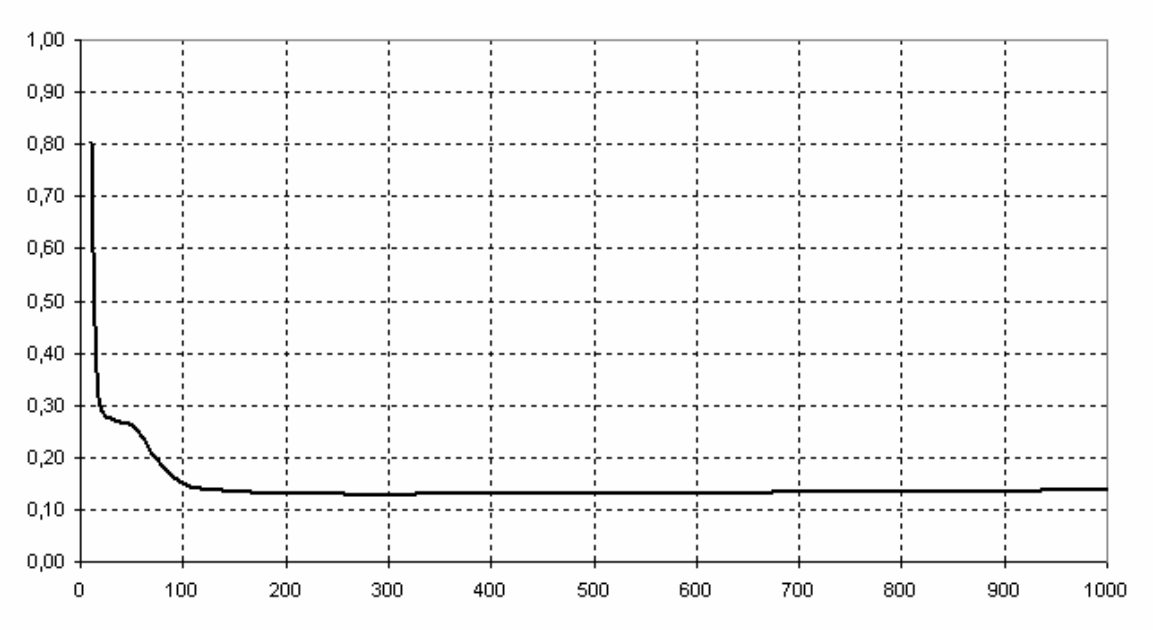
⚠ Warning

To avoid injury, wear high voltage protection gloves, switch off conductors and ensure that the potential is zero.

Utilize the Flexi current sensor only at 600 V rms or dc to ground and frequencies below 1 kHz.

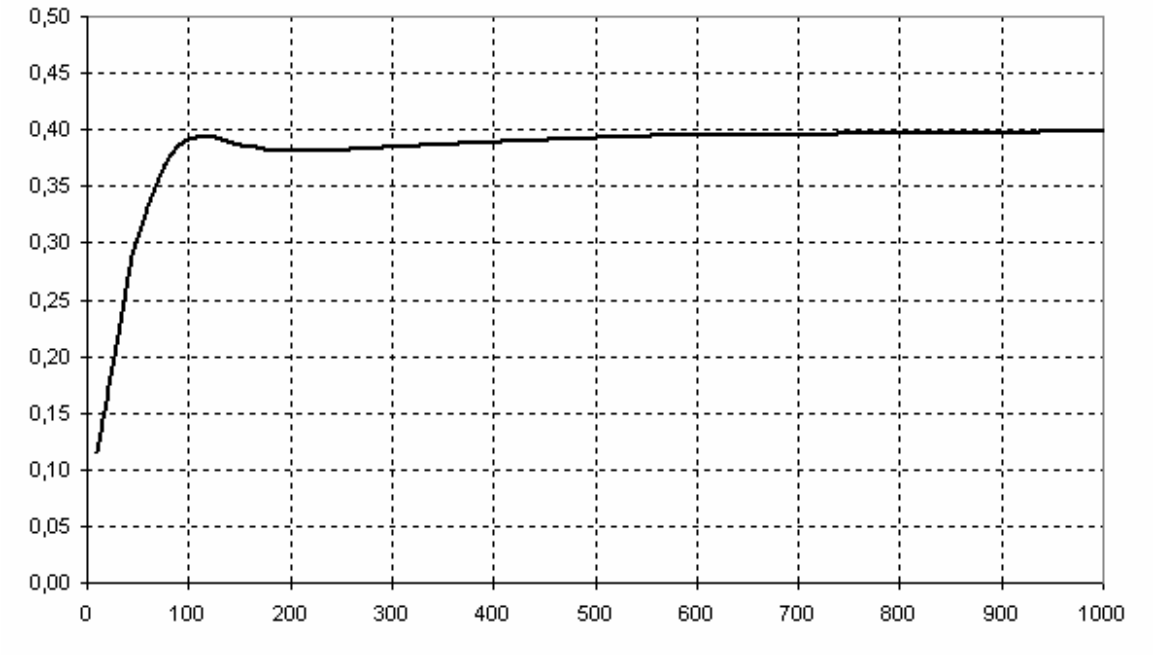
Accuracy (Typical, for 50/60 Hz)

Linearity, error in % of measured value, primary current in A:



ep1360a-linearity.bmp

Phase angle in degrees, primary current in A:



ep1360a-phase.bmp

Options

GPS-Time Synchronization – 2539223

This option consists of a GPS-receiver module including GPS antenna, and a 5 m connection cable for the Instrument 25-pole feature connector (on top of the instrument).

Note

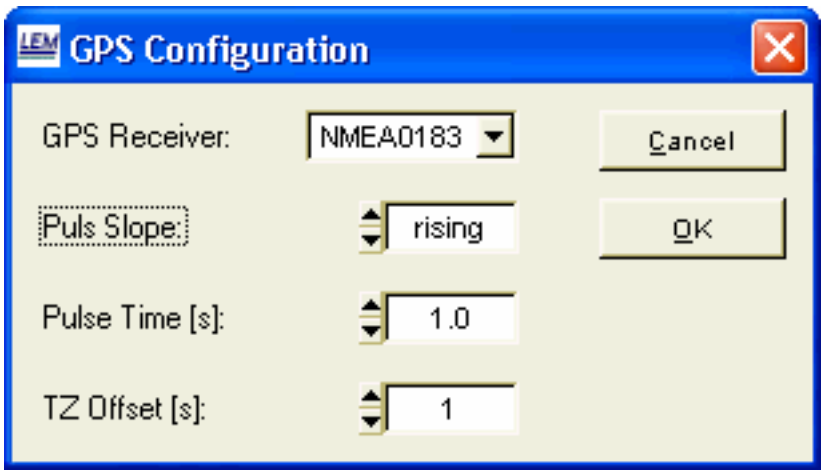
For optimal performance the GPS receiver should be placed in a location where at least 4 satellites are within the receiving are; concrete, metal construction elements, roofs will damp the satellite signals to an insufficient level. An extension cable with 10 m length is available.

Technical Specification

Dimensions:	Diameter 61 mm (2.4 inch).
	Height: 19.5 mm (0.77 inch).
Weight:	Appr. 190 g.
Cable length:	5 m.
Mounting:	Integrated magnetic base.
Case:	Polycarbonate thermoplastic.
Protection:	IPX7 as per IEC 60529.
Operating temp. range:	–30 °C - +80 °C.
Storage temp. range:	–40 °C - +90 °C.
Power consumption:	0.3 W typ.
Sensitivity:	–165 dBW.
Acquisition time:	*Cold start*: 45 s.
	Warm start: 15 s.
	Re-acquisition: 2 s.
Protocol:	NMEA 0183 V2.0, or V2.30.
	UTC (Coordinated Universal Time).
	PPS (pulse per second), rising edge.
Satellites:	Tracking of up to 12 satellites continuously.
Time accuracy:	Better than ±1 µs at rising edge of pulse.
Memory:	Non volatile memory for storage of configuration data.

Procedure:

1. Run the PQ Analyze software and open menu *Service – GPS Configuration*.



garmin-sttiings.bmp

2. Put the GPS receiver in a location with clear view to the sky.
3. Connect the GPS-receiver to the Instrument 25-pole feature connector on top.
4. Power on the Instrument. The instrument checks if there are NMEA data available. If *yes* it waits max. 5 min for synchronization pulses from the GPS receiver. Otherwise, the internal time is taken for measurements.
5. The *Pulse* LED on the Instrument will start to blink at the reception of synchronization pulses. For LED functions see LEDs *Time Sync*.

Handling of Date/Time in the Instrument

There are two ways for changing date/time:

- *Hard change*: Date/time (used for timestamps of measurement values) are set to the actual time immediately
- *Smooth change*: Measurement date/time are slowed or accelerated a little bit until they reach the actual time

Changing Date/Time: No Measurement is Active

When no measurement is running, then time changes by GPS or software are always done immediately.

Changing Date/Time during a Measurement

During a measurement only smooth time changes can be done.

When the GPS signal becomes available during a measurement, then the *system time* is set immediately and the measurement time adapts slowly (±0.01 %) to the new system time. This provides a correction of max. 8.64 seconds per day. The error for the power frequency measurement is <0.005 Hz at 50 Hz and <0.006 Hz at 60 Hz (IEC61000-4-30 5.1.2 requires that the measurement uncertainty never exceeds ±0.01 Hz).

If the user wants to adjust date/time of the instrument via the software then he gets the following selection menu:

- Smooth time adaptation
- Hard time change (the measurement will be stopped)

Index