Operating Instructions

Power Quality Analyser
Topas 2000

CE

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The manufacturer reserves the right to change any information without notice.

Contents

1 About this Document

1.1 Document structure

This document consists of several chapters. Within these chapters, shoulder headings in the margin identify sections in the text focusing on the respective topic or procedure. Example:

"View details"

The text belonging to this shoulder heading informs you on how the details of a measured value can be viewed, including introductory notes, safety instructions, hints and tips, instructions on procedures, figures and tables, if any.

1.2 Signs and symbols

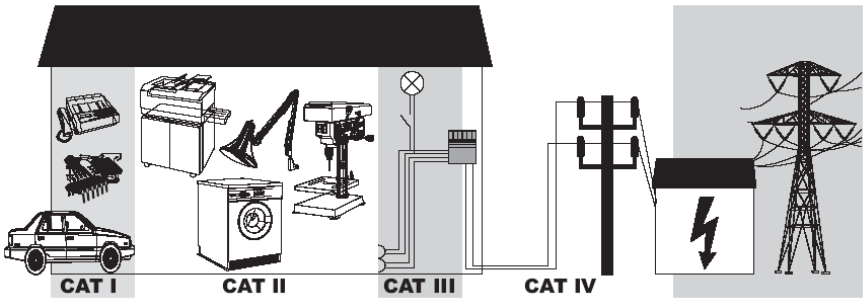
The following signs and symbols are used in this document:

Symbols

Symbol	Description
☑ ...	... identifies a requirement. This requirement must be met before you can proceed with the task described in this section of the text.
▸ ...	... identifies a mandatory action. You are requested to carry out a specified task.
▸ ... – or – ▸ ...	... identifies a mandatory action to which there is an alternative procedure. The alternative procedure is introduced with "– or –" or by a left indent.
	... identifies general information and hints. In the related section of the text, you find important information regarding a certain system feature or procedure.
	... identifies important information. The related information and instructions must always be strictly followed.
	... identifies a warning relating to a risk to life and limb from electric shock. If the instructions are not strictly adhered to, there is an inevitable risk to life and limb.
	... identifies a warning relating to a potential risk or dangerous situation. If the instructions are not adhered to, there is a risk of death, injury or damage to property.

Identification

Example to identify the locations of the different measurement categories (CAT):



Text formats

Format	Description
Detail	Names of software and operating elements, lettering on the device as well as numbers and text shown on the display are printed in italics.

2 General Safety Instructions

The design and manufacture of this 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 insure to persons and damage of property.

Protection class

The 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.

For the purpose of these instructions, all persons who are familiar with the installation, assembly, connection, inspection of connections and operation of the analyzer and who have completed training in at least one of the following areas:

- switching on/off, enabling, earthing and identification of electrical circuits and devices/systems according to the applicable safety standards
- maintenance and operation of appropriate safety gear, in accordance with the applicable safety standards
- first aid

Safe operation

- 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 "Technical data".
- During operation, ensure that circulation of air around the instrument is possible in order to prevent heat accumulation inside the housing.
- Always comply with the instructions in chapter "Transport and storage".

Proper use

- Do not use the device for any other purpose than the measuring of voltages and currents that are within the measuring ranges and categories, including voltage to earth, laid down in chapter "Technical Data".

Improper use shall void all warranty.

Warranty

- The warranty period for faultless operation is limited to 2 years from the date of purchase.
- The warranty period for accuracy is 2 years.

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 mentioned in the following documentation has to be installed in the power supply lines.

- 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.

Risks during operation

- 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 do not replace any component parts of the device.
- Damaged connecting and power leads must be repaired or replaced by an authorized service technician.
- Damaged or defective devices may only be repaired by authorized specialized technicians.

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 the IEC 61010-031/-2-032 standard and are suitable for the respective measuring voltage range.

Shutting down

- If you detect any damage to the housing, controls, power cable, connecting leads or connected devices, immediately disconnect the unit from the power supply.
- If you are in doubt as regards the safe operation of the device, immediately shut down the unit and the respective accessories, secure them against inadvertent switching on and bring them to an authorized service agent.

2.1 Safety instructions on the device housing

Mains connection

- The mains connection must conform to the following ranges/values:

Inscriptions on the instrument:

Danger! Risk of electrocution!
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 (see page 6) The voltage to earth may not exceed 300 V!

Input voltage – Measuring inputs

The measurement categorie (see page 6) 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 see chapter 11 Maintenance on page 37.

Conformity mark re. EC Low Voltage Directive 73/23/EEC and EMC directive 89/336/EEC.

Protection

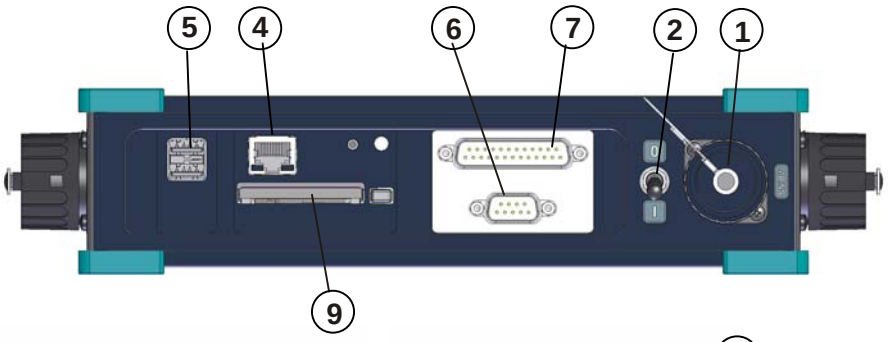
IP50

3 Design and functions

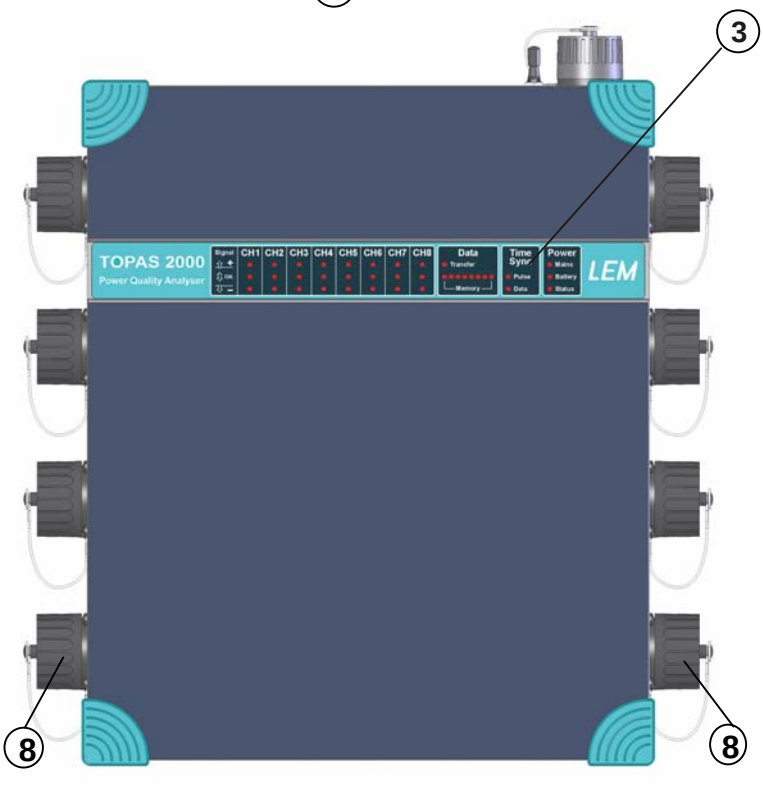
This chapter provides an overview of the terminals, ports and interfaces of the power quality analyzer, as well as a list of displays and operating devices and a brief introduction to the basic functions of the unit.

3.1 Mains connection and interfaces

Top view



Front view



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, …)
8 Analogue input connectors
9 Compact Flash card slot (future option)

Important remark:
Channels *CH1* to *CH4* are labeled like this one:

The symbol on the left side 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:

3.1.1 Functional description

① Mains connector

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

Danger! Risk of electrocution!
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 (see page 6) The voltage to earth may not exceed 300 V!

② Mains switch

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

Important remark:
The switch is secured by a mechanical feature against inadvertent activation. Lift the knob slightly before moving it to the other position.
Topas 2000 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.

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

Reboot of the Topas 2000

- Connect the Topas 2000 to mains
- Set the mains switch to the I-position
- Wait until the *Mains* LED is on
- Set the mains switch to the 0-position
- Wait until the LEDs *Mains* and *Battery* are blinking rapidly

- Within 3 second set the mains switch to I-position again, Topas 2000 will reboot, which is indicated by slowly blinking of LEDs *Mains* and *Battery*.

Maintenance of battery package

Remark:
We recommend to carry out this procedure in regular, longer time intervals to maintain the battery capacity as long as possible.

Procedure:

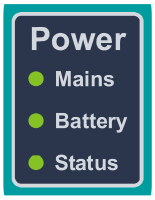
- Connect the Topas 2000 to mains
- Set the mains switch to the I-position
- Wait until the *Mains* LED is on
- Disconnect the Topas 2000 power supply
- Wait until the *Mains* LED goes off
- Set the mains switch to the 0-position
- Wait until the LEDs *Mains* and *Battery* are blinking rapidly
- Within 3 second set the mains switch to I-position again

The battery package will be discharged completely:

☑ LED *Mains* is OFF
☑ LED *Battery* is blinking 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.

③ LED indicators

LEDs in the field *Power*



Overview

Condition	LED *Mains*	LED *Battery*
Topas 2000 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
Topas 2000 reboot	Green, blinking	Blinking green, yellow, or red according to capacity
	Blinking synchronously	
Topas 2000 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: Topas 2000 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.

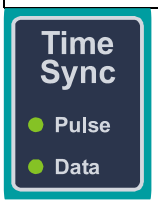
LED *Status*

This indicator gives information about status of the measurement campaign:

Condition	**LED *Status***
Topas 2000 is not yet configured for a measurement campaign	OFF
Topas 2000 configuration is in progress, Topas 2000 is not yet ready for recording data	green, blinking rapidly
Topas 2000 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,	Yellow

LEDs *Time Sync*

Topas 2000 does not record data any more	



These indicators provide information about the time synchronization of the Topas 2000.

LED *Pulse*

This LED indicates the reception of sync pulses. If Topas 2000 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*

- Yellow: no sync pulses are detected, maybe too few satellites are in the range of GPS receiver.
- Green: time string and protocol read from the GPS or DCF77 receiver are correct.
- Yellow: Correct protocol, but invalid time information
- Red: wrong protocol
- Off: No time data is received.

LEDs *Data*

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

Three LEDs are assigned to each of the eight input channels of the Topas 2000. 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 OK	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

Indications for non valid sensors

Condition	LED	LED OK	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

Remark:
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).

Wrong phase sequence

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.

Caution:
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 Topas 2000 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).

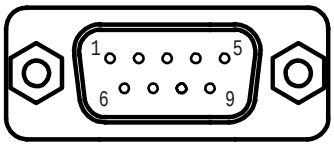
⑤ 2 USB connectors Future option! Two USB type A connectors for connection of the instrument to the USB-port of a PC. USB version V2.0 is supported. A special link cable has to be used (USB cable A-A).

⑥ Serial port *COM1* (RS232) Serial port for connection of the device to the serial port of a PC.

Default settings are:
57.600 Baud, 8 data bits, 1 stop bit, no parity

Pin assignment:

COM 1
(male pins)



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

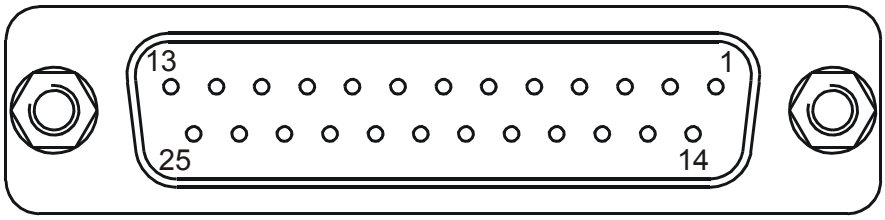
Specification of outputs / inputs:

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

Maximum load current: 5 mA

Pin assignment:

Female pins



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 galvanically insulated measurement channels
Connect only original accessories such as voltage and current sensors (clamps, LEM~flex, shunt resistors, etc.). The plug is secured by means of a bayonet mechanism.

Remark:
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.

3.2 Basic Functions

The power quality analyzer Topas 2000 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. Topas 2000 records and provides historical event data, which protective relays or protective switches have induced and how the resources have performed.

Measurement systems

Topas 2000 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

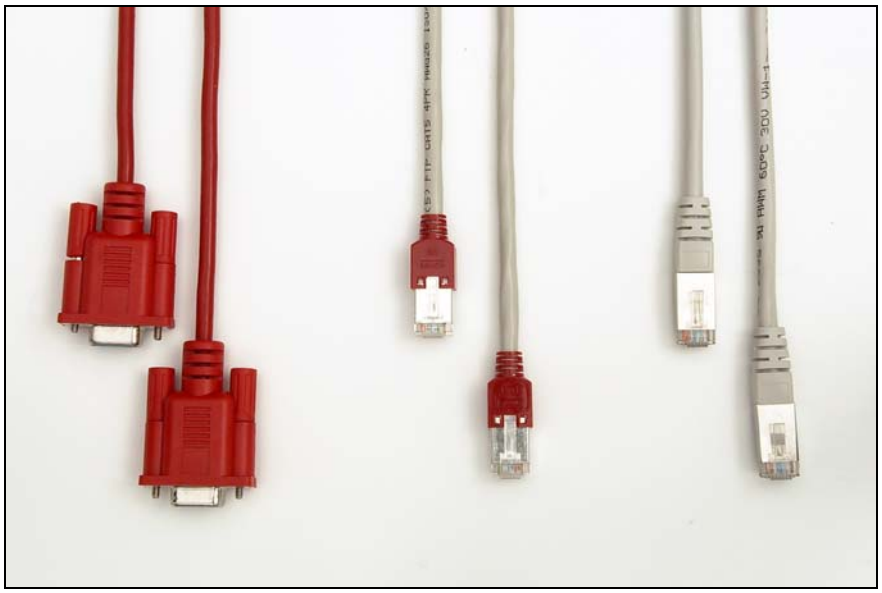
The following measurements can be made:
- rms values with programmable averaging time
- Oscilloscope data (instantaneous value, sensing value)
- Voltage, current and power analyses
- Load and energy measurements
- Analysis current and voltage harmonics
- Fast transient analysis
- Signaling voltage, ripple control signal analysis
- Mains voltage quality analysis as per EN50160

4 Startup

4.1 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 Topas 2000
  - 1 transient analysis card (optional, built in)
  - 1 operating manual Topas 2000 (EO 2000G)
  - 1 operating manual Topas Software (EO1091G)
  - 1 CD-ROM with Topas application software, manuals, data sheets, and demo data
  - 1 plug for mains connection (country-specific design)
  - 1 Ethernet cable for direct PC connection
  - 1 Ethernet cable for network connection
  - 1 crosslink RS232 connection cable (A 5505 00510)

Communication cables in delivery



4.2 Setup

Installation

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

Danger! Risk of electrocution!

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

Danger! Risk of electrocution!

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

Danger! Risk of electrocution!

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 (see page 6) The voltage to earth may not exceed 300 V!

Switching 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 operation.

Switching device off

- Lift switching knob ② slightly and move to position "0". The LED *Mains* goes off.

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

5 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 Topas software, see Operating Instructions *Topas Software*, EO1091.

Communication

Establish a connection to the device, using one of the available interfaces.
For detailed instructions, see Operating Instructions *Topas Software*, EO1091, chapter *Software installation – communication*.

Connect device

- Connect the device channels as described in chapter 6, *Connection to Circuits*.

Configuration

- Configure the device.
  For detailed instructions, see Operating Instructions *Topas Software*, EO1091, chapter *Operating the software – File new*.

Measure

- Establish a connection to the device, using one of the available interfaces.
  See also Operating Instructions *Topas Software*, EO1091, chapter *Operating the software – Menu Transfer*.

- Activate ONLINE mode.
  For detailed instructions, refer to Operating Instructions *Topas Software*, 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 Operating Instructions *Topas Software*, EO1091, chapter *Operating the software – Menu transfer – Download Measurement Data*.

- Evaluate the data according to your requirements. For detailed instructions, see Operating Instructions *Topas Software*, EO1091, chapter *Operating the software – evaluations*.

6 Connection to measuring circuits

Danger! Risk of electrocution!
By connecting the unit to circuits, the terminals and certain parts inside the device are live. Utilisation 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

6.1 Connecting sequence

When connecting a circuit to Topas 2000, for safety reasons, proceed in the sequence outlined below:

- Connect Topas 2000 to the power supply.
  The analyzer is now connected to the protective earth wire.
- Connect the measuring circuit as shown in the connection diagrams.
- Switch on the Topas 2000 device.
- Ensure that the direction of the energy flow is correct (load flow direction).

6.2 Connection diagrams

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

Remark:
Use channel *CH4* as control channel for triggering on external signals.

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

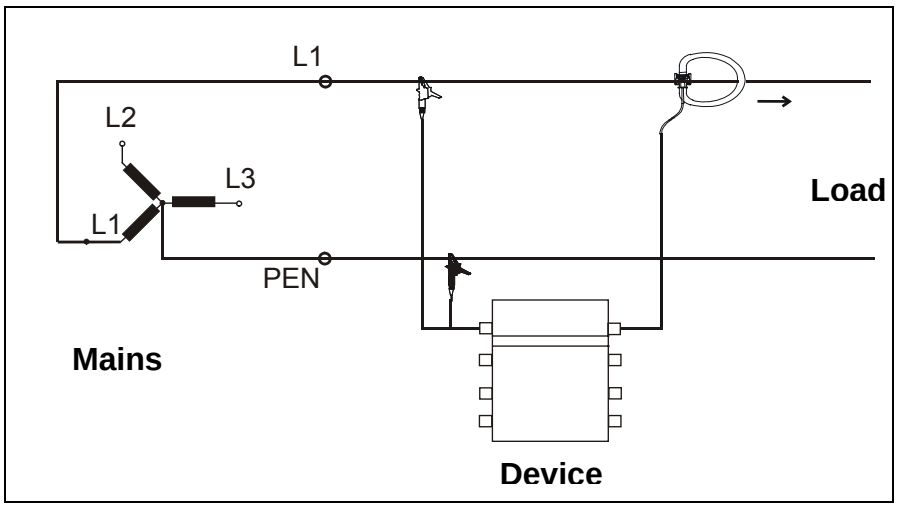
Please, note that the voltage sensors with a rated range of >100V are equipped with the fast transient function.

The following symbols are used in the connecting diagrams below:


black connector

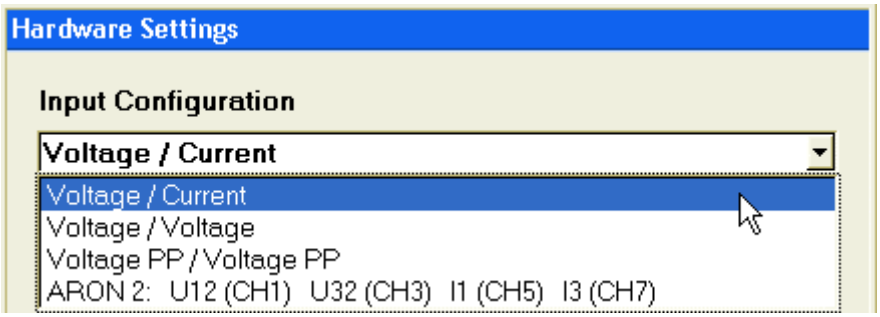

red connector

6.2.1 1-phase measurement

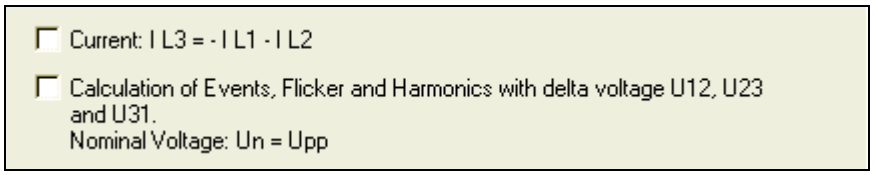


Associated PC software settings:

Connection to single-phase 2-wire network



and

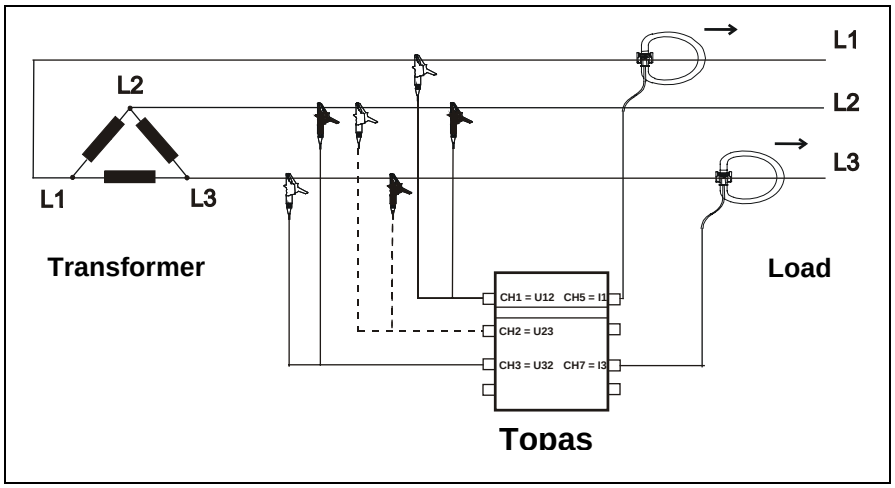


The option *Calculation of Events, Flicker, Harmonics with delta voltage U12, U23 and U31* for the phase-to-phase voltages is not of relevance here.

Important remark:
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!

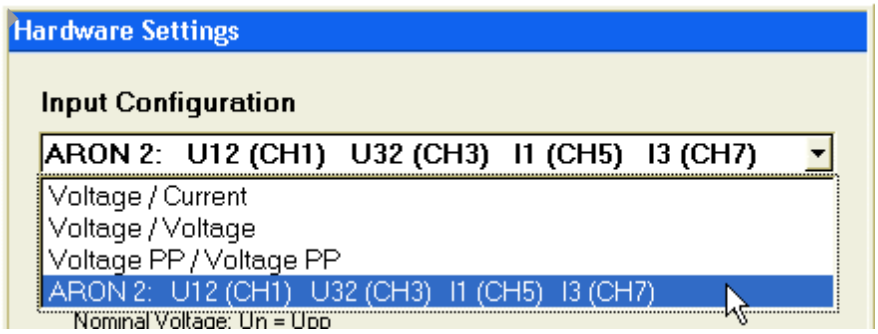
6.2.2 3-wire network with two current sensors (*ARON2* method)

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.

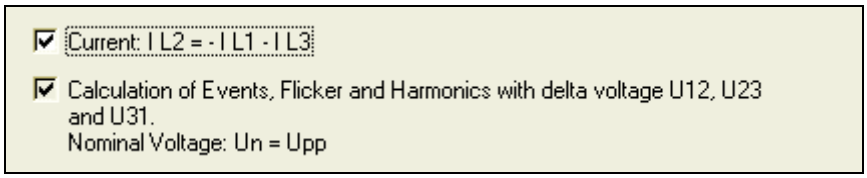


Remark:
The voltage sensor at channel CH2 denoted with dotted lines is only required for transient measurements; for current, voltage power measurements, no sensor is required at CH2!
Please note the channel assignment to transients:
CH1 – measures transients of phase L3 to earth
CH2 – measures transients of phase L2 to earth
CH3 – measures transients of phase L1 to earth

Associated device software settings



- Check the respective option:

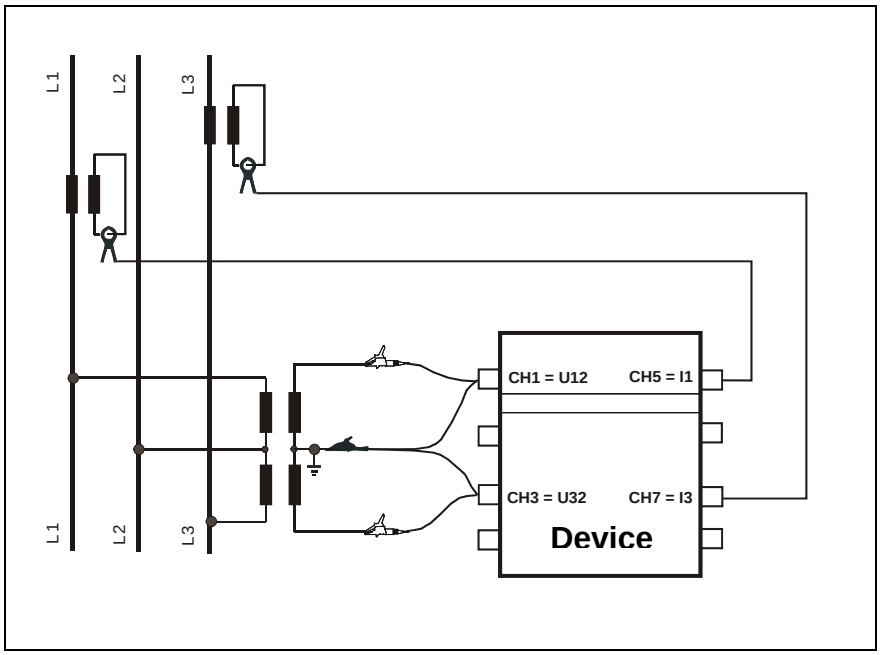


If option *IL2 = -IL1 - IL3* is checked, current IL2 is calculated. If this option is not checked, current IL2 is measured by means of a sensor at phase L2 (Topas 2000 channel CH6).

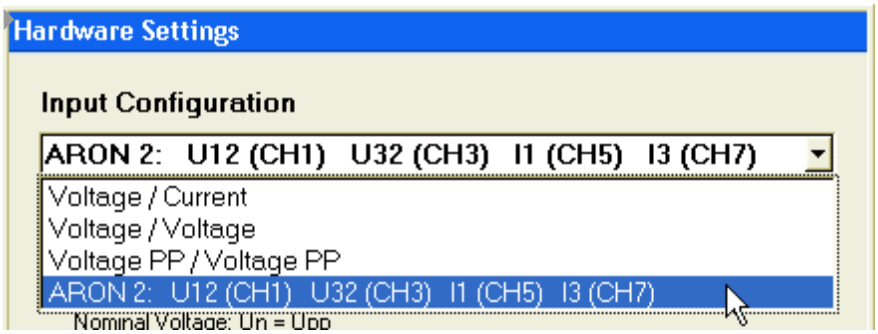
Important remark:
The nominal voltage has to be entered as a phase-phase voltage in the dialogue Nominal-Limit values (i.e. 400 V in a 230 V P-N-system).

6.2.3 3-wire network with two current sensors (*ARON2* method, *open delta* method)

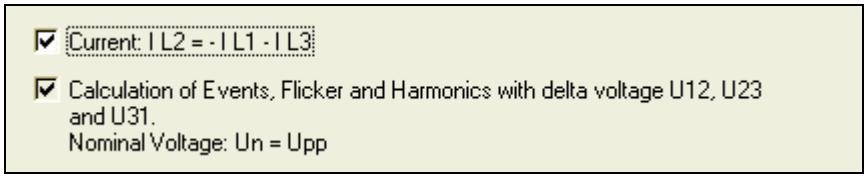
Conventional two-wattmeter method with current sensors at phases L1 and L3, frequently used in medium voltage networks with built-in current and voltage converters.
The device calculates IL2 = -IL1 - IL3; the phase-to-neutral voltages are then calculated on the basis of the phase-to-phase voltages. All 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.



Associated PC software settings



- Check the respective option:



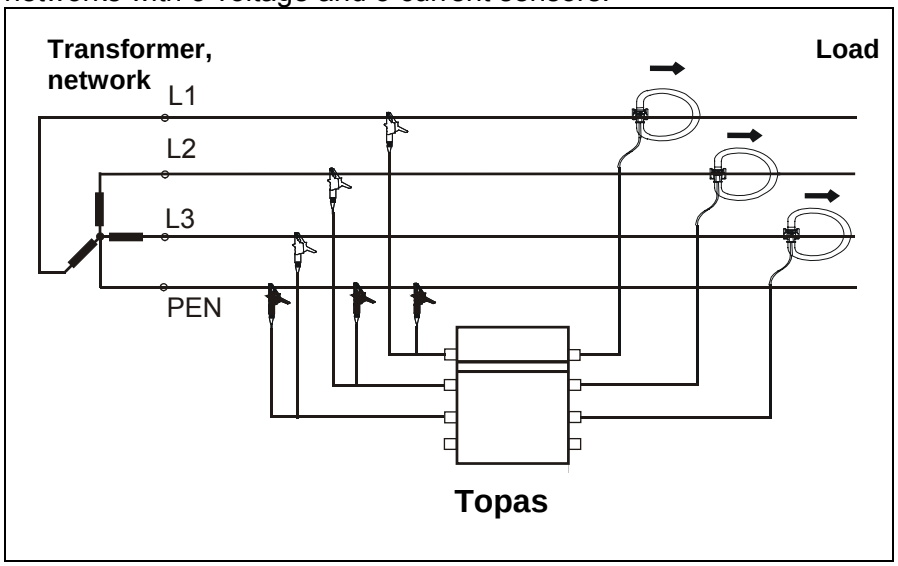
If option *IL2 = -IL1 - IL3* is checked, current IL2 is calculated. If this option is not checked, current IL2 is measured by means of a sensor connected to phase L2 (Topas 2000 channel CH6).
The option *Calculation of Events, Flicker, Harmonics with delta voltage U12, U23 and U31* is automatically on and cannot be deactivated.

Important remark:
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).

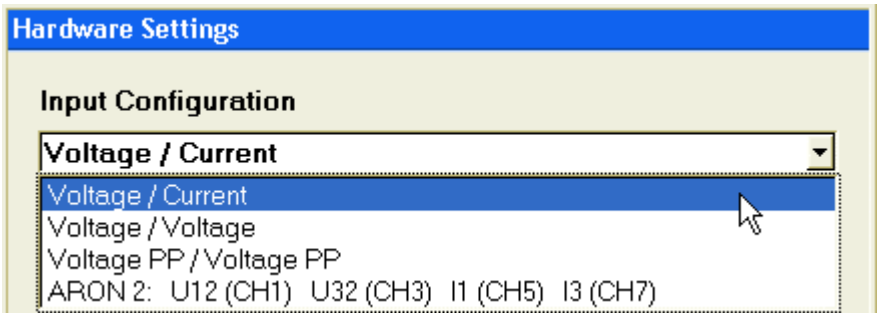
Enter the applicable transformation ratios for the current and voltage converters in the *Hardware Settings* dialog.
As conventional current converters have an output current of 1 A or 5 A AC respectively at rated current, we recommend using current probes rather than flexible current sensors, as they provide better resolution and linearity at low currents.

6.2.4 4-wire network: 3-wattmeter method

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

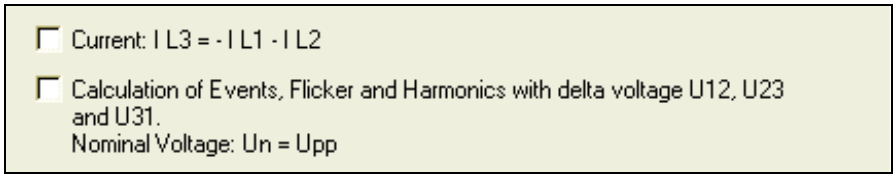


Associated PC software settings



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

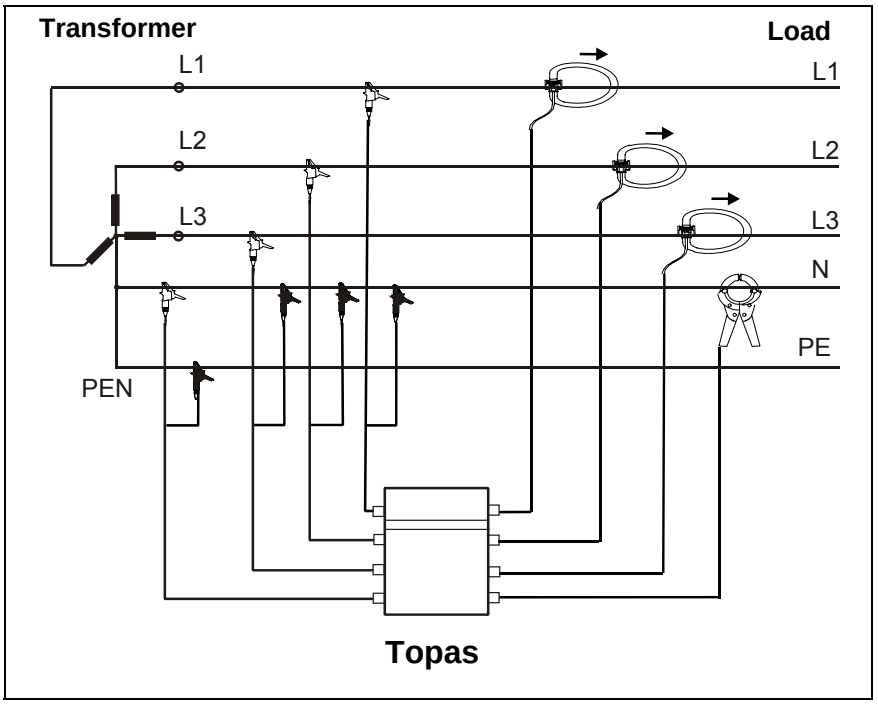
- Check the respective option:



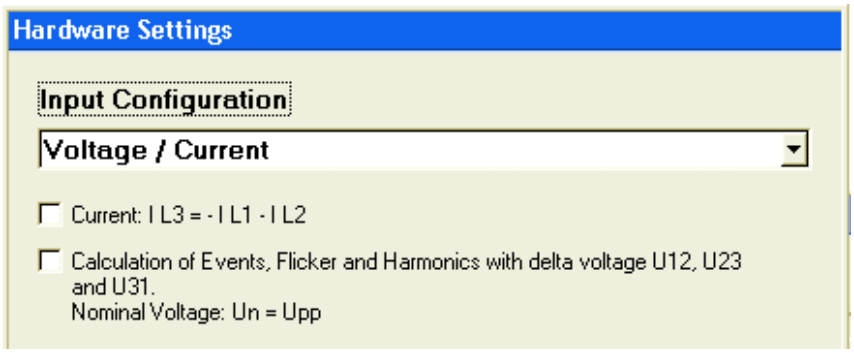
Important remark:
If this option is checked, you must enter the phase-to-phase voltage as the rated voltage Un in *Settings – Nominal / Limit values* (e.g. 400 V in the 230 V P-N network).

6.2.5 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.

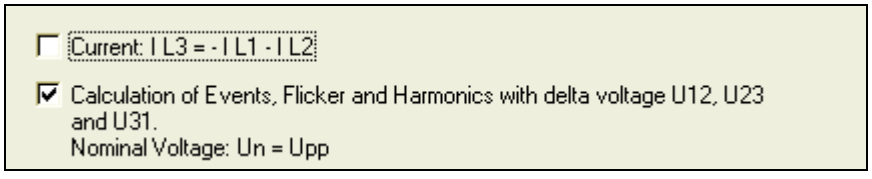


Associated PC software settings



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

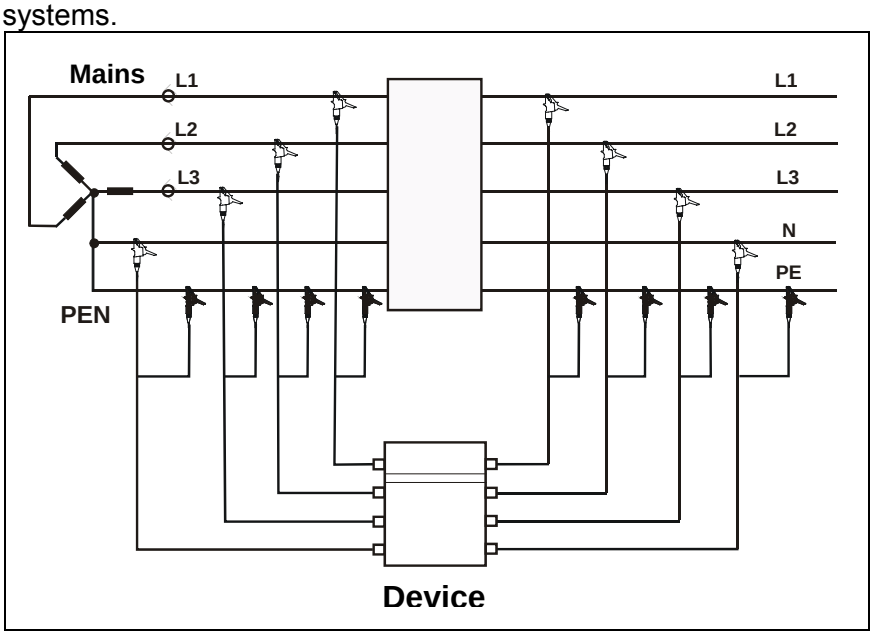
- Check the respective option:



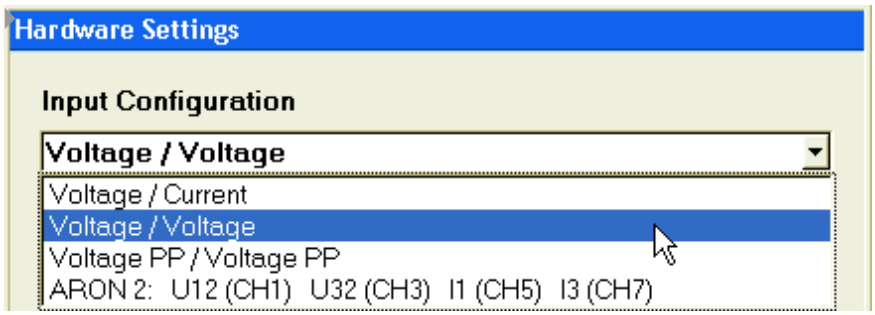
Important remark:
If this option is checked, you have to enter the phase-to-phase voltage as the rated voltage Un in *Settings – Nominal / Limit Values* (e.g. 400 V in the 230 V P-N network).

6.2.6 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.



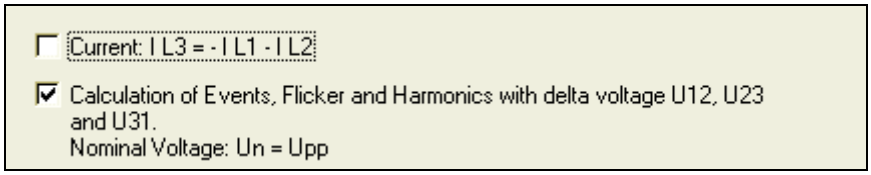
Associated PC software settings



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

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

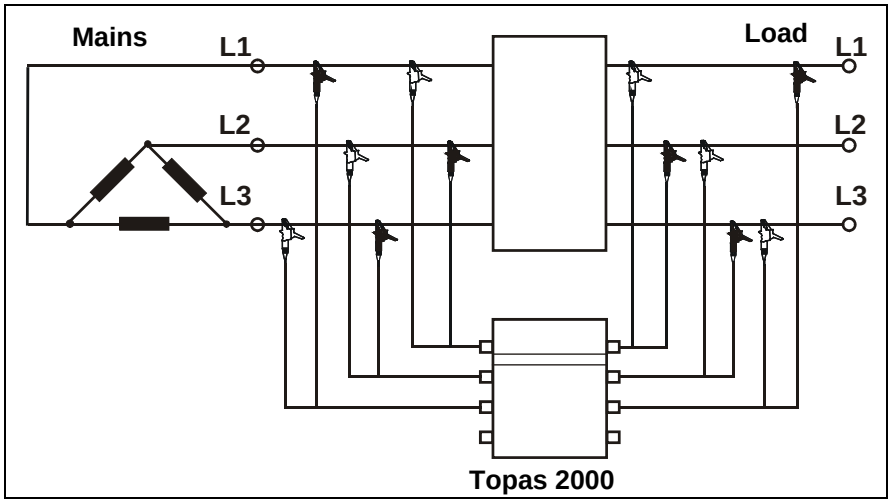
- Check the respective option:



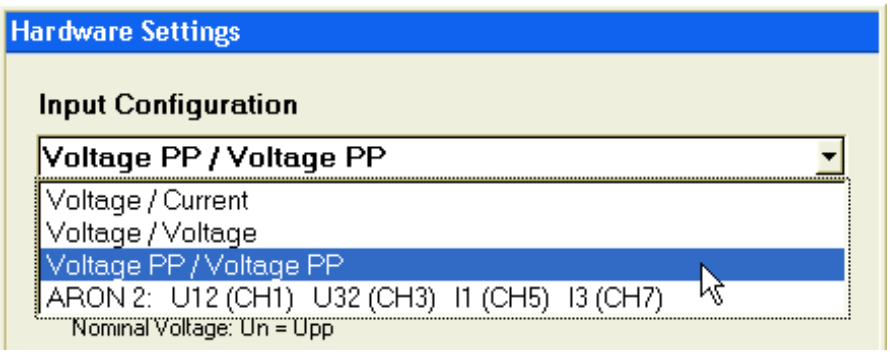
Important remark:
If this option is checked, you have to enter the phase-to-phase voltage as the rated voltage Un in "*Settings – Nominal / Limit Values*" (e.g. 400 V in the 230 V P-N network).

6.2.7 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.



Associated PC software settings



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

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

7 Methods of measurement / Formulars

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 reference channel CH1, the signal level has to be at least 10 % of 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 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 3dB 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 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 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 are synchronized with 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 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 10/12cycle values.
For the power values 10 ms min- and max-values are recorded during the appropriate time interval.

Active power

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

U sample of voltage
I sample of current
i number of sample
N number of samples
φ_i phase angle between U, I

Reactive power

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

U sample of voltage
I sample of current
i number of sample
N number of samples
φ_i phase angle between U, I

Apparent power

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

Distortion power

$$D = \sqrt{S^2 - P^2 - Q^2}$$

Important remark:

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

Power values total (3-phase)

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

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

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

$$D_{tot} = D_1 + D_2 + D_3$$

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 in the Topas 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 Topas 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 Topas software.

Displacement power factor COS φ

for Q>0: $$\cos\varphi = \cos(\arctan\frac{Q}{|P|})$$

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

for Q<=0: $$\cos\varphi = \cos(\arctan\frac{Q}{|P|} + \pi)$$

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

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 option *Events, Flicker, Harmonics of U12….* in the device settings is activated, 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 option *Events, Flicker, 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:

$$THD = \frac{\sqrt{\sum_{n=2}^{40} U_n^2}}{U_1}$$

n … order of the harmonic

U1 … rms value of the voltage fundamental
Un … rms value of the voltage harmonic with order n

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

n … order of the harmonic

I1 … 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.

$$THD_{ind} = \frac{1}{U_1}\sqrt{\sum_{n=2}^{40} \frac{U_n^2}{n}}$$

n … Order of the harmonic

U1 …rms value of the voltage fundamental
Un …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.

$$THD_{cap} = \frac{\sqrt{\sum_{n=2}^{40} n^2 * U_n^2}}{U_1}$$

n … Order of the harmonic

U1 …rms value of the voltage fundamental
Un …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 Topas software in the trigger settings dialogue. These signals are calculated from 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 Topas 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:

$$U_Z = \frac{1}{3}\sqrt{(U_1 + U_2 * \cos\varphi_{12} + U_3 * \cos\varphi_{13})^2 + (U_2 * \sin\varphi_{12} + U_3 * \sin\varphi_{13})^2}$$

$$U_P = \frac{1}{3}\sqrt{(U_1 + U_2 * \cos(\varphi_{12} + 120°) + U_3 * \cos(\varphi_{13} + 240°)^2 + (U_2 * \sin(\varphi_{12} + 120°) + U_3 * \sin(\varphi_{13} + 240°)^2}$$

$$U_N = \frac{1}{3}\sqrt{(U_1 + U_2 * \cos(\varphi_{12} + 240°) + U_3 * \cos(\varphi_{13} + 120°)^2 + (U_2 * \sin(\varphi_{12} + 240°) + U_3 * \sin(\varphi_{13} + 120°)^2}$$

U_Z, U_P, U_N	rms values of zero, positive, and negative system
U_1, U_2, U_3	rms values of the fundamentals of the phase voltages
φ_{12}, φ_{13}	phase angle between $\vec{U}_1, \vec{U}_2$ or $\vec{U}_{1,h1}, \vec{U}_{3,h1}$ (nominal: -120° and -240°)

Calculation of unbalance as per IEC 61000-4-30

$$u_2 = \frac{U_N}{U_P} * 100\% \qquad u_0 = \frac{U_Z}{U_P} * 100\%$$

U_Z .. zero system, U_P .. positive system, U_N .. negative system

The calculation of u_0, u_2 utilizes the above formulas for U_Z, U_P, U_N or for a 3-wire system the following formulas with phase-phase voltages:

$$u_2 = \sqrt{\frac{1-\sqrt{3-6\beta}}{1+\sqrt{3-6\beta}}} * 100\% \quad \beta = \frac{U_{12,h1}^4 + U_{23,h1}^4 + U_{31,h1}^4}{(U_{12,h1}^2 + U_{23,h1}^2 + U_{31,h1}^2)^2}$$

Remark:
For a 3-wire network the zero system component Uz is 0 per definition!
The voltage values are averaged squared versus time, afterwards the unbalance is calculated for the time interval.

8 Transport and Storage

8.1 Transport

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

8.2 Storage

- Keep 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 proper protection against mechanical impacts**.**
- Store the device in a dry room; the temperature range of -20°C to +60°C and 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.

9 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.

10 Recalibration

LEM 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 LEM service department or any other calibration specialist.

11 Maintenance

11.1 Maintenance

- The device is maintenance-free.

11.2 Cleaning

- The device can be cleaned with an Isopropanol impregnated cloth.

Important remark:
Do not use abrasives or other solvents.

11.3 Replacement of battery pack

Attention!
- Disconnect all sensors from the instrument's input connectors!
- Disconnect the instrument form the power supply!
- Do not short circuit the terminals of the battery pack!

Important remark:
- For replacement of the battery pack use original spare parts only (2540406).

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

Procedure:

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

Important remark:
Note the polarity of the plug and the locking mechanism!

12 Decommissioning and Disposal

12.1 Shutting down

- Ensure that all connected devices are switched off and disconnected from the power supply.
- Switch off the power quality analyzer.
- Disconnect the plug from the mains socket.
- Remove all connected devices.
- Secure the unit against inadvertent switching on.
- Ensure that the operating manual is kept near the device.

12.2 Recycling and disposal

Important remark:

- 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.

13 Technical Data

13.1 General technical data

Intrinsic error (instrument including sensor A6805 02002)	0.1% as per IEC 61000-4-30 class A
Measurement system	4 voltages + 4 currents for 3 phases + N conductor or 8 voltages
Recording mode	Continuous, gapless recording
Interfaces	Ethernet, 2x USB V2.0 Type A, RS232, external modem
Housing	Insulated plastic housing
Weight	approx. 4.9 kg
Dimensions (H, W, D)	325 mm, 300 mm , 65 mm
Display	LED indicators for power supply, analogue inputs
Mains connection	83 ... 264 V AC, 45 ... 65 Hz, DC: 100 ... 375 V, 300 V CAT III
Backup battery	Type: NIMH Voltage: 7.2 V Capacity: 2.7 Ah
Measuring terminals	1 plug adapter per channel; mechanically lockable

Ambient conditions

Operating temperature range	+0 ... +50°C
Storage temperature range	-20 ... +60°C
Humidity	According to B3 of IEC 654-1

13.2 Specification

Measuring input without sensor

Sampling frequency: 10.24 kHz for 50 Hz power frequency
Input resistance: approx. 4.7 MOhm
Safety: 300 V CAT III
Noise: <20µV for short circuited input
0.4µV/√Hz

U nominal	U max (for CF<2)	U peak
0.1 V	0.2 V	0.28 V

Intrinsic error

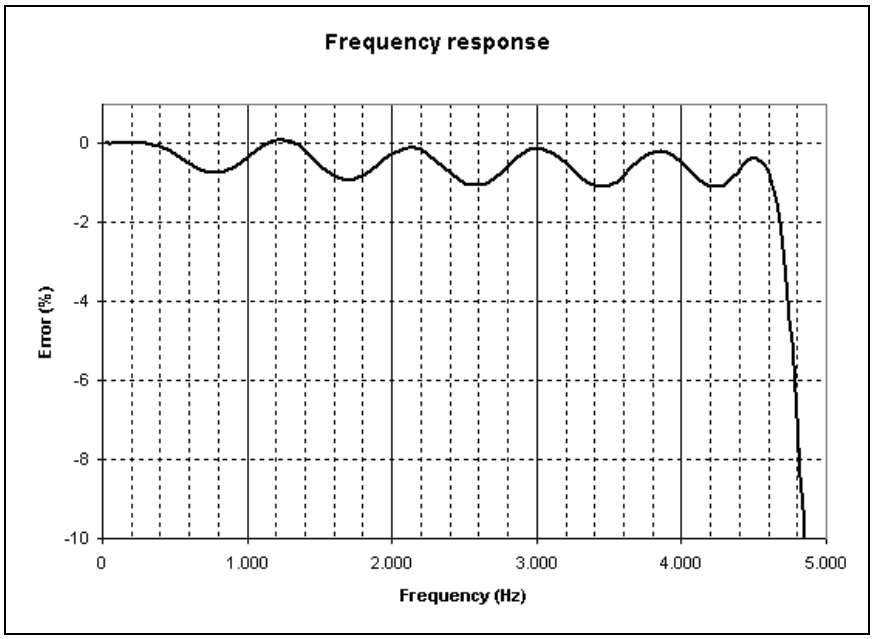
Frequency	Signal level	Uncertainty in % of m. v.
50 Hz	100 %	<0.1 %
50 Hz	>1 %	<0.5 %
<4.600 Hz	100 %	<1 %
<4.600 Hz	>1 %	<1.2 %

This data is valid for 10 min average values and the following reference conditions:

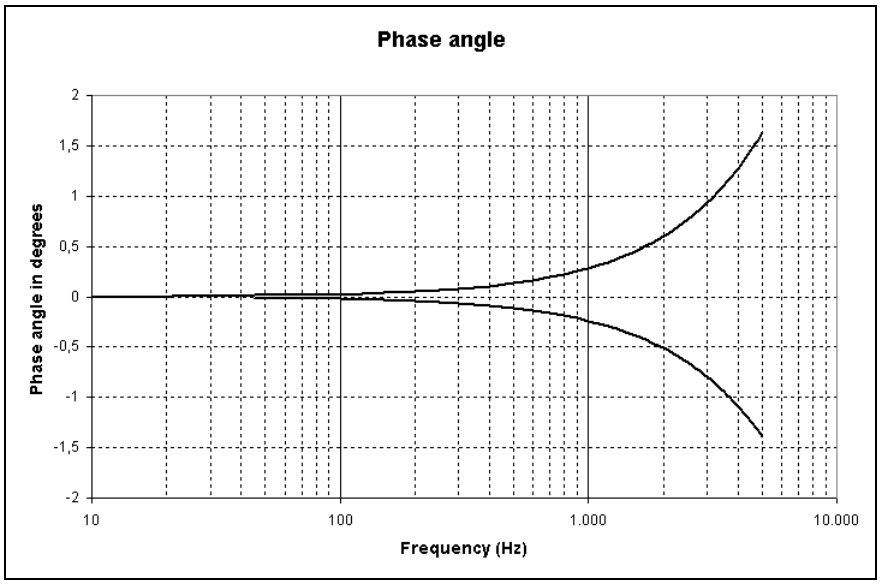
☑ Ambient temperature 23° C ±2 K, power frequency 50 Hz, instrument warmed-up.

Bandwidth

For a power frequency of 50 Hz the sampling frequency is 10.24 kHz.
Frequency response:

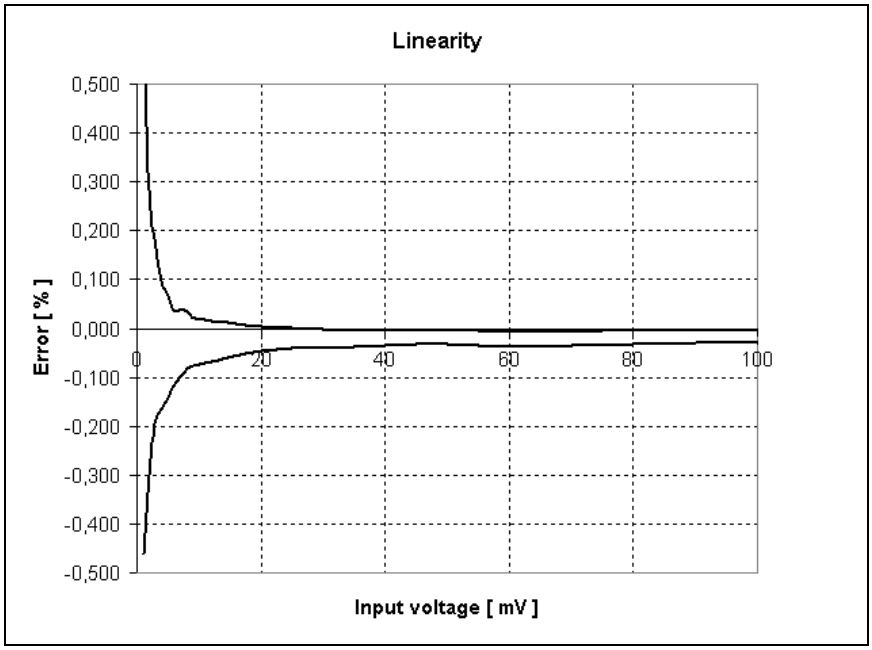


Phase angle:



Linearity

For a power frequency of 50 Hz the sample frequency is 10.24 kHz, the linearity error is:



Data memory

Measurement data memory 1 GB Flash memory (optional 2 GB)
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 will be available soon
RS 232 interface for firmware upload and data exchange with PC.
External modem is possible

LAN Ethernet 100 MBit/s

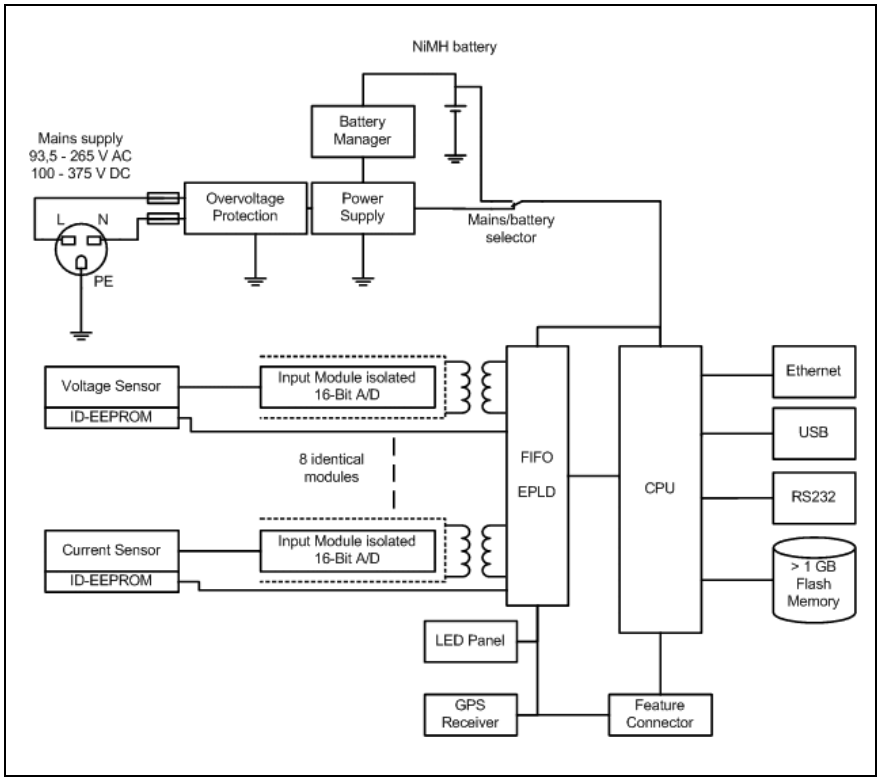
USB will be available soon
2 connectors of type A, USB V2.0

Standards

Electrical safety	
EN 61010-1 basis unit 300 V CAT III - depending on the used sensors up to 1000 V CATIII	Degree of pollution 2, Protection class I
Electromagnetic compatibility	
Emission	IEC 61326-1 class B
Immunity	IEC 61326-1 / annex A (industrial)
Max. input signal	
for voltage inputs	see specification of voltage sensor
for current inputs	see specification of current sensor
Test voltages	
Mains input - housing (earth connector)	2500 V AC in the mains input circuit before fuses. 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

13.3 Block diagram

Overview



14 Accessories

14.1 Sensors – technical specification

Voltage probes for various ranges between 100 mV and 1000 V are available for Topas 2000.
Current sensors for direct current measurement (shunts) are available between 20 mA and 5 A.
Passive current clamps (AC only) are available in ranges with 1 A up to 1000 A, 2 ranges can be selected in the Topas software.
Flexible current sensors (LEM~flex) are available for ranges between 100 A and 6000 A AC, 2 ranges can be selected in the Topas software.
All probes contain a memory for calibration factors, sensor identity, and serial number which is read automatically by Topas 2000.
Ranges can be selected in the Topas software.
Other measuring transducers can be used in front of these standard sensors.

14.1.1 Voltage sensors

Temperature coefficient: 100 ppm / K
Aging: <0.05 % / year
All voltage sensors are suitable for DC ... 5 kHz.

Order number	Trans. Range $V_{p<1ms}$	U_{nom}	Range rms	U_{max} contin.
2540613	-	0.1 V	0.01…0.2 V	100 V
2540651	-	1 V	0.01…1.7 V	100 V
2540685	-	5 V	0.05…8.5 V	100 V
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
2540672	6000	480 V	5…820 V	1000 V
2540697	6000	600 V	10…1000 V	1000 V
2540649	6000	1000 V	10…1700 V	2000 V

Order number	Input resistance[1)]	Intrinsic error	Safety
2540613	1 MOhm	-	300 V CAT II
2540651	16 kOhm	0.15 %	300 V CAT II
2540685	16 kOhm	0.15 %	300 V CAT II
2540636	16 kOhm	0.15 %	300 V CAT II
2540624	2 MOhm	0.15 %	600 V CAT III

2540660 U_{din} = 230 V	2 MOhm	0.15 %	600 V CAT III
2540660[2)] U_{din} = 230 V	2 MOhm	5 %	600 V CAT III
2540703	4 MOhm	0.2 %	600 V CAT III
2540703[2)]	2 MOhm	5 %	600 V CAT III
2540672	2 MOhm	0.15 %	600 V CAT III
2540697	2 MOhm	0.15 %	600 V CAT III
2540649	4 MOhm	0.15 %	600 V CAT IV

1) input resistance between red and black connector

2) for transient range

14.1.2 Current sensors - overview

Sensor type	ranges	Peak current[3)]	error	Frequency range	Phase error	operating voltage
Clip-on current transformers for AC current						
1 A / 10 A 2540445	0.01 A ...1 A 0.1 A ...10 A	3.7 A 37 A	0.5 %	40 Hz… 10 kHz	0.5°	600 V CAT III
5 A / 50 A 2540461	0.05 A …5 A 0.5 A...50 A	18 A 180 A	0.5 %	40 Hz... 10 kHz	0.5°	600 V CAT III
20 A / 200 A 2540450	0.2 A...20 A 2 A...200 A	74 A 300 A	0.5 %	40 Hz... 10 kHz	0.5°	600 V CAT III
100 A / 1000 A 2540438	1 A…100 A 10 A…1200 A	370 A 1700 A	0.5 %	40 Hz... 10 kHz	0.5°	600 V CAT III
LEM~flex for AC current						
100 A / 500 A 2540477	1 A...100 A. 5 A…500 A	240 A 1350 A	1%	45 Hz... 3.0 kHz	0.5°	600 V CAT III
200 A / 1000 A 2540489	2 A...200 A 10 A…1000 A	480 A 2700 A	1%	45 Hz... 3.0 kHz	0.5°	600 V CAT III
3000 A / 6000 A 2540492	30A…3000A 60 A…6000 A	10 kA 19 kA	1%	45 Hz... 3.0 kHz	0.5°	600 V CAT III

Shunts for AC and DC currents [4]						
20 mA 2540553	0…55 mA	77,8 mA I_{max}=1,5A	0.2 %	DC... 3.0 kHz	0.1°	300 V CAT II
1 A 2540548	0…2.8 A	4,0 A I_{max}=6,5 A	0.2 %	DC... 3.0 kHz	0.1°	300 V CAT II
5 A 2540566	0…10 A	21,9 A I_{max}=10 A	0.2 %	DC... 3.0 kHz	0.1°	300 V CAT II

Errors in % of measuring range at 23° C ±2K, for 48…65 Hz
Phase angle error at nominal current

3) for sinusoidal currents

4) I_{max} maximum current without time limit

14.1.3 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 Topas software: *IAC1* or *IAC10*.

Electrical characteristics	Nominal current In:	1 A / 10 A AC r.m.s
	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 r.m.s.
	Conductor position influence:	< 0.5 % of range for 50 / 60Hz
	Error due to adjacent conductor:	≤ 15 mA / A for 50Hz
	Phase error (to reference conditions):	< ±0.5 degrees
	Frequency range (clamp without 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 17mm
	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, relative Humidity: 20 to 75 % r.h., 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/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

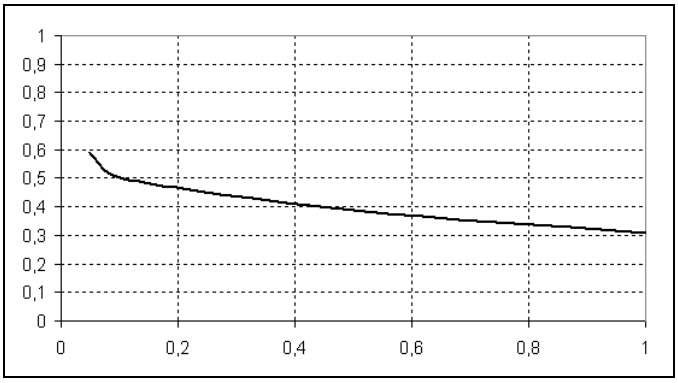
Danger! Risk of electrocution!

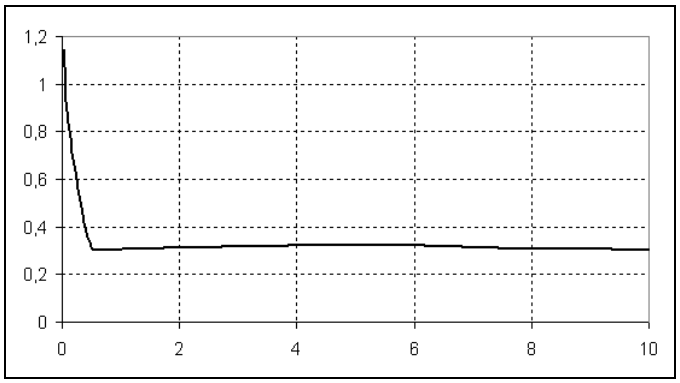
Risk of voltage peaks in higher categories.

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

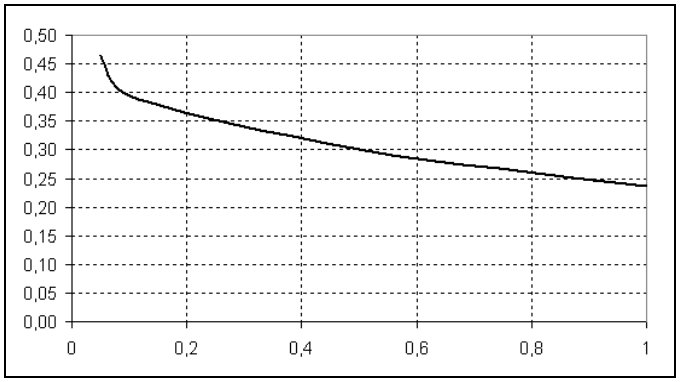
Accuracy (typical, for 50 / 60 Hz)

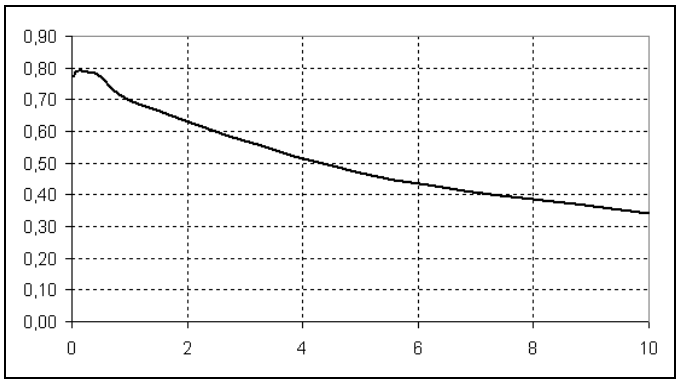
Linearity, error in % of measured value, primary current in A



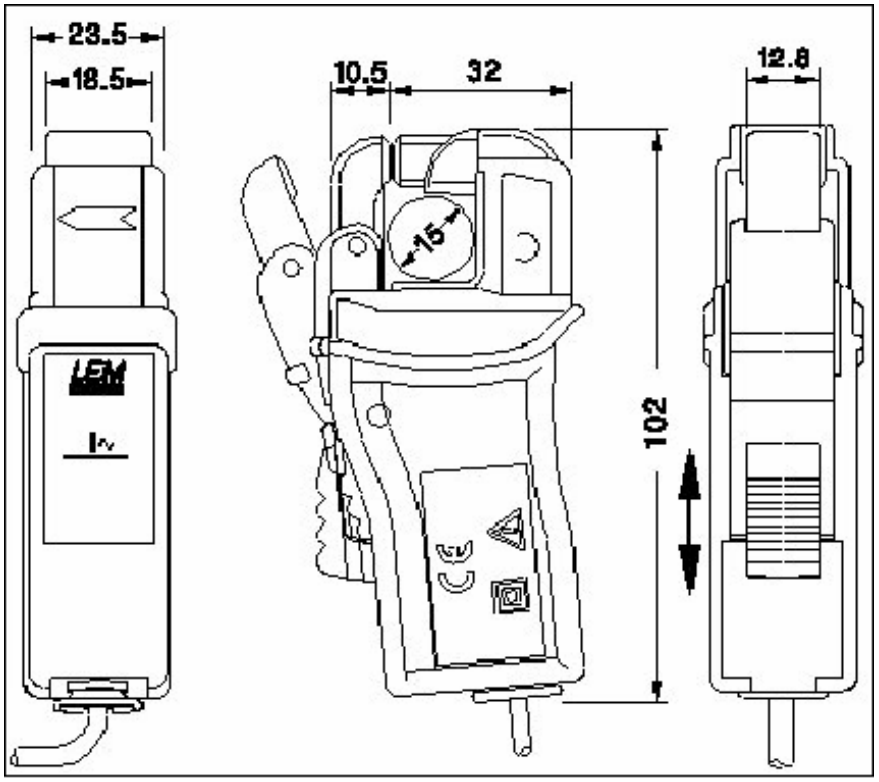


Phase angle in degrees, primary current in A





Dimensions (in mm)



14.1.4 Current clamp 5 A / 50 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 0.05 A up to 50 A. The measurement range can be selected in the Topas software: *IAC5* or *IAC50*.

Electrical characteristics	Nominal current In:	5 A / 50 A AC r.m.s.
	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 r.m.s.
	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 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 % 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/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

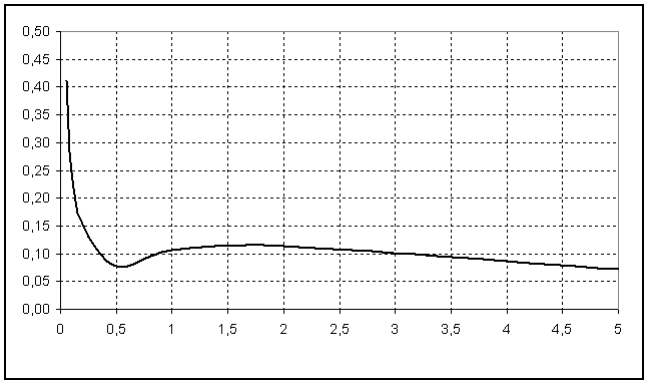
Danger! Risk of electrocution!

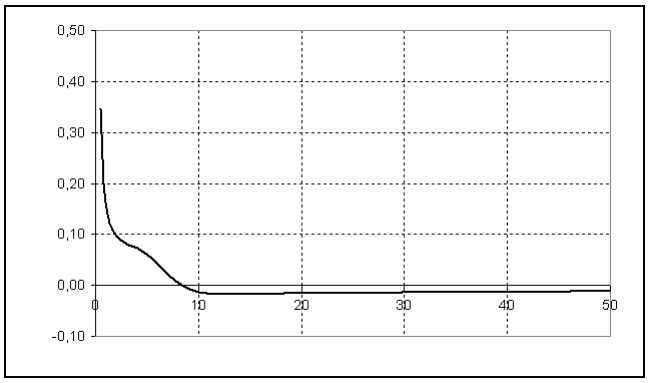
Risk of voltage peaks in higher categories.

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

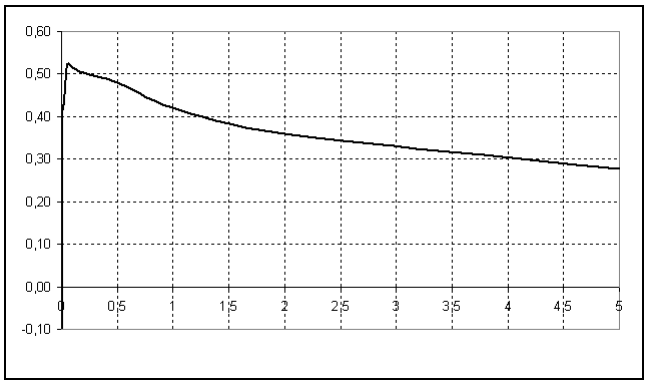
Accuracy (typical, for 50 / 60 Hz)

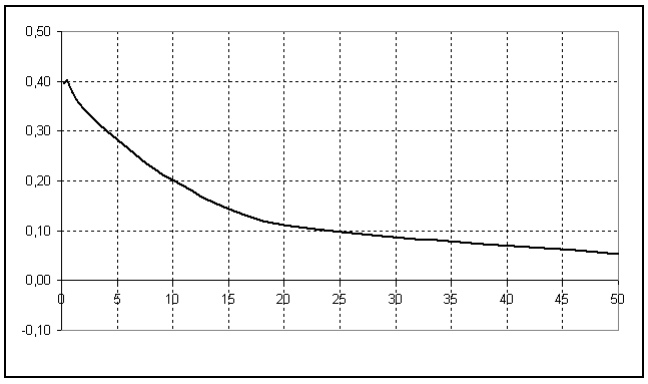
Linearity, error in % of measured value, primary current in A





Phase angle in degrees, primary current in A





Dimensions See 2540445

14.1.5 Current clamp 20 A / 200 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 0.2 A up to 200 A. The measurement range can be selected in the Topas software: *IAC20* or *IAC200*.

Electrical characteristics	Nominal current In:	20 A, 200 A AC r.m.s.
	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 r.m.s.
	Conductor position influence:	< 0.5 % of range for 50/60 Hz
	Error due to adjacent conductor:	≤ 15 mA / A for 50Hz
	Phase error (to reference conditions):	< ±0.5 degrees
	Frequency (clamp without 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/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

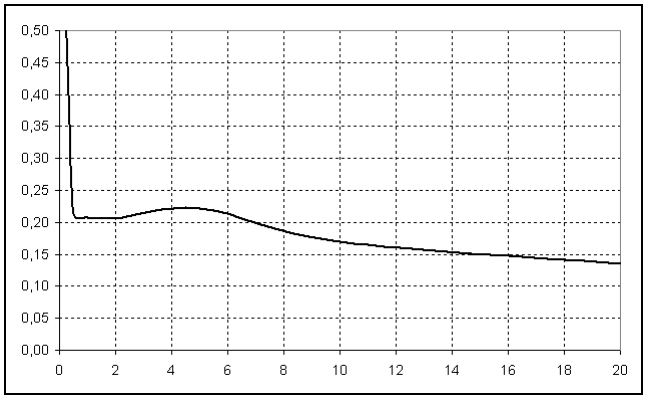
Danger! Risk of electrocution!

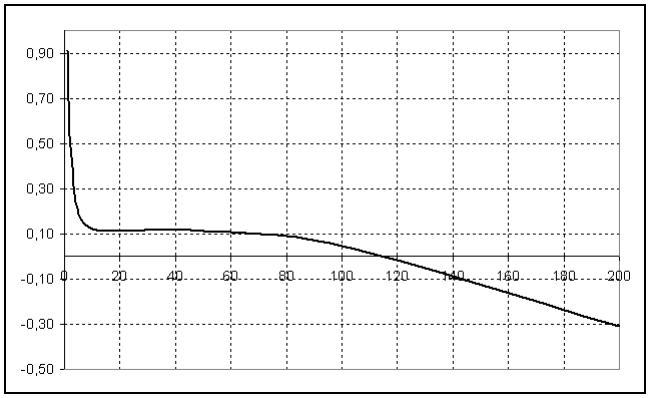
Risk of voltage peaks in higher categories.

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

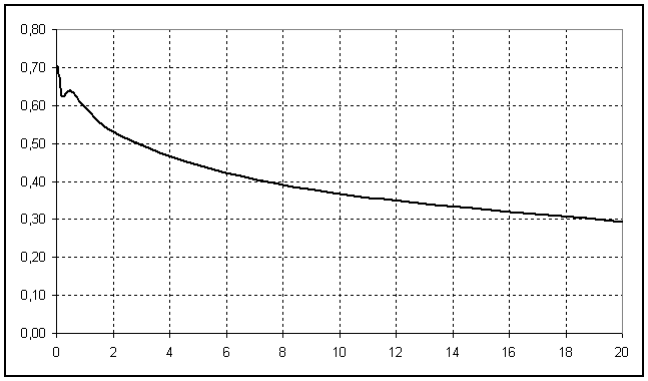
Accuracy (typical, for 50 / 60 Hz)

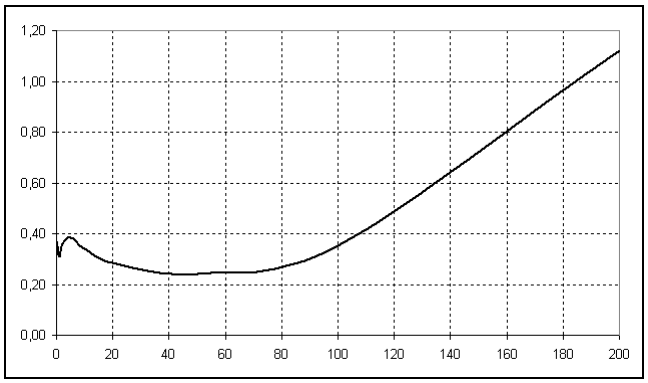
Linearity, error in % of measured value, primary current in A





Phase angle in degrees, primary current in A





Dimensions See 2540445

14.1.6 Current clamp 100 A / 1000 A AC

This current probe has been designed for non intrusive, accurate AC current measurements. Using latest technologies (internal memory for calibration data) provides current ranges from 1 A up to 1000 A AC. The measurement range can be selected in the Topas software: *IAC100* or *IAC1000*.

Electrical characteristics	Nominal current In:	100 A, 1000 A AC r.m.s.
	Measuring ranges:	1 A … 100 A or 10 A … 1000 A AC
	Crest factor:	< 2
	Peak current:	370 A, 1700 A
	Overload:	up to 1500 A r.m.s. max. 1 h., duty cycle <33 %
	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 instrument):	40 Hz … 10 kHz (- 3 dB)
	Temperature coefficient:	0.015 % of range / °C
	Safety:	600 V CAT III, class A sensor pollution degree 2
General characteristics	Maximum conductor size:	54 mm diameter
	Cable length:	2 m
	Operating temperature:	-10° C … +55° C
	Storage temperature:	-20 … +70° C
	Operating humidity:	15 % … 85 % (no condensing)
	Weight (per clamp):	approx. 700 g
	Order-Number:	A6805 01052
Reference conditions:	Environment temperature range: +18° C to +26° C, humidity: 20 to 75 %r.h., current: sinusoidal waveform, 48 to 65 Hz, distortion factor: < 1 %, no DC component < 40 A/m, conductor centered within the clamp jaws.	
Safety standards	IEC/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

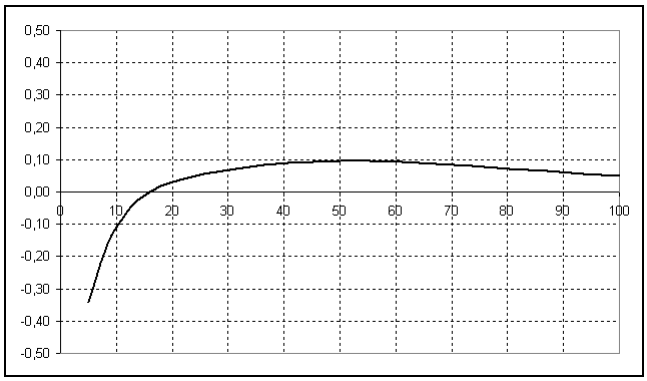
Danger! Risk of electrocution!

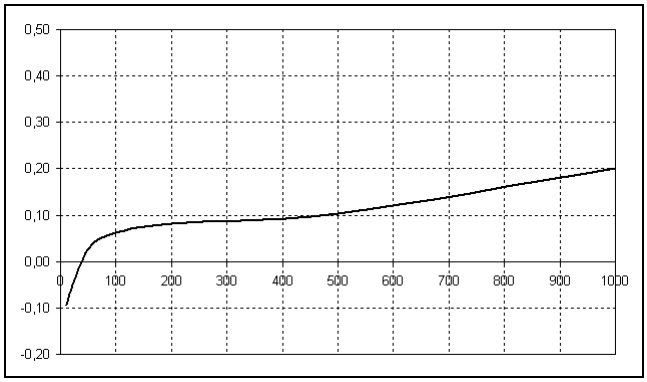
Risk of voltage peaks in higher categories.

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

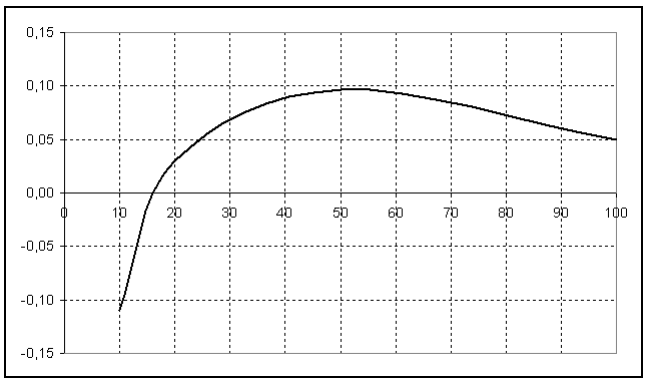
Accuracy (typical, for 50 / 60 Hz)

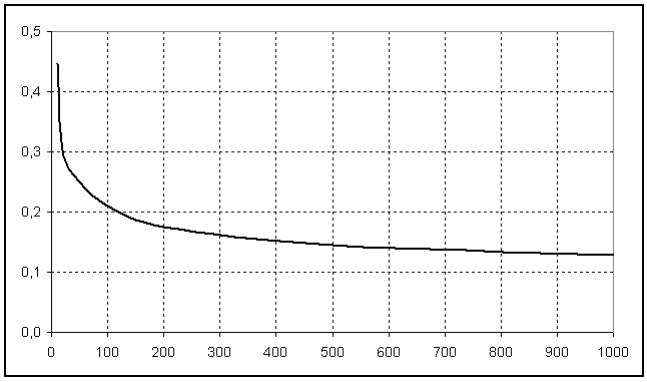
Linearity, error in % of measured value, primary current in A



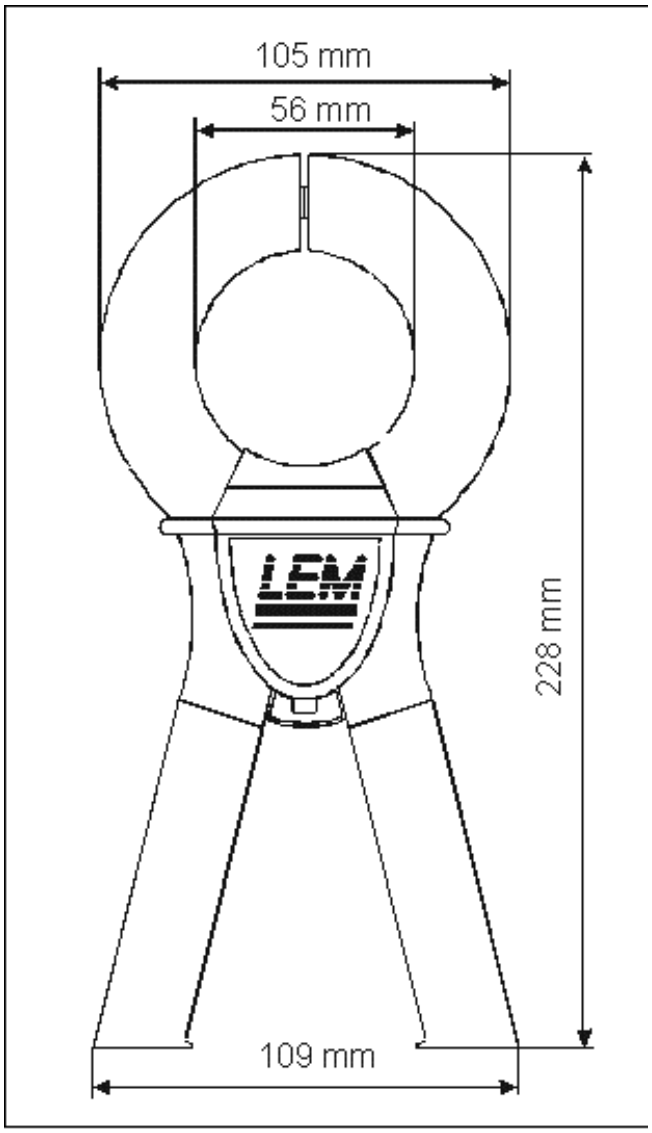


Phase angle in degrees, primary current in A





Dimensions (in mm)



14.1.7 LEM~flex 100 A / 500 A

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

Electrical characteristics	Nominal current In:	100 A, 500 A AC r.m.s.
	Measuring ranges:	1 A …100 A or 5 A …500 A AC
	Peak current:	240 A, 1350 A
	Overload capacity:	up to 2000 A r.m.s.
	Intrinsic error:	< ±1 % of m. v.
	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 III, 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 % r.h.
	Current: nominal value In, sinusoidal waveform, 48 … 65 Hz, distortion factor: < 1 %. No DC component, stray field < 40 A/m, conductor centered within the LEM~flex.	
Safety standards	IEC/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

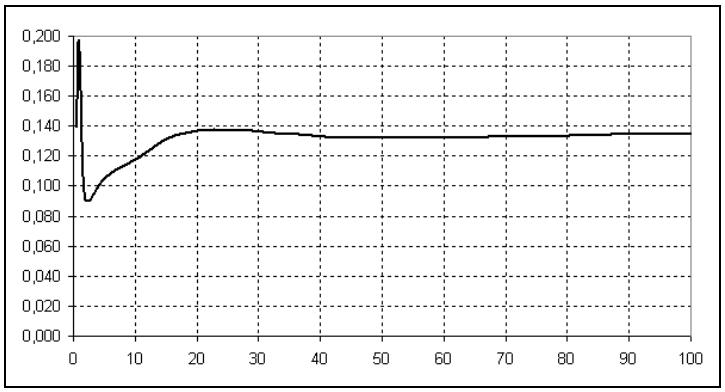
Danger! Risk of electrocution!

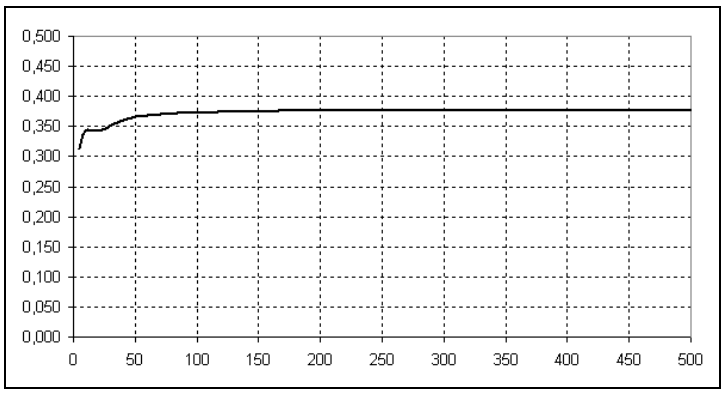
Risk of voltage peaks in higher categories.

- Wear electrician gloves, switch off conductors and ensure that the potential is zero.
- Utilise the LEM~flex only at 600 V r.m.s. or DC to ground and frequencies below 1 kHz.

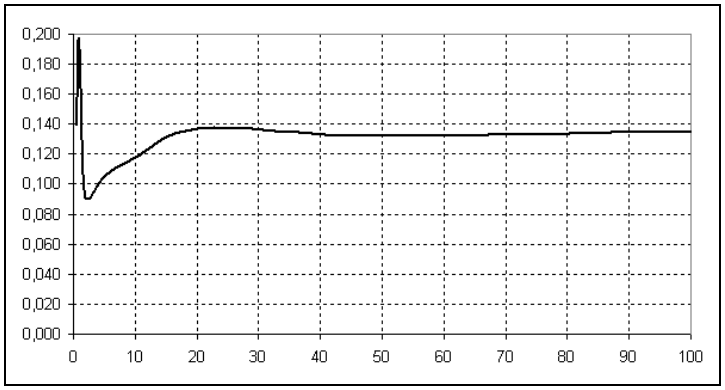
Accuracy (typical, for 50 / 60 Hz)

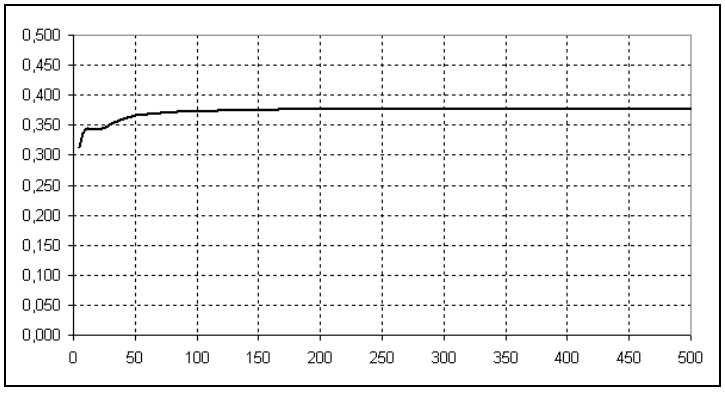
Linearity, error in % of measured value, primary current in A





Phase angle in degrees, primary current in A





14.1.8 LEM~flex 200 A / 1000 A

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

Electrical characteristics	Nominal current In:	200 A, 1000 A AC r.m.s.
	Measuring ranges:	2 A..200 A or 10 A..1000 A AC
	Peak current:	480 A, 2700 A
	Overload capacity:	up to 2000 A r.m.s.
	Intrinsic error:	< ±1 % of m. v.
	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 III, 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 LEM~flex.	
Safety standards	IEC/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

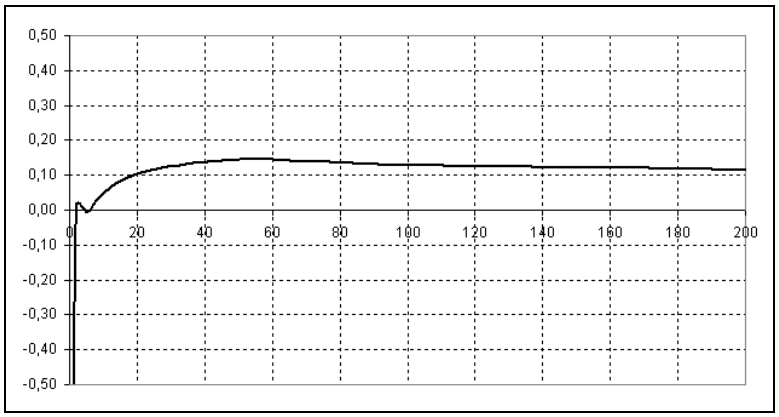
Danger! Risk of electrocution!

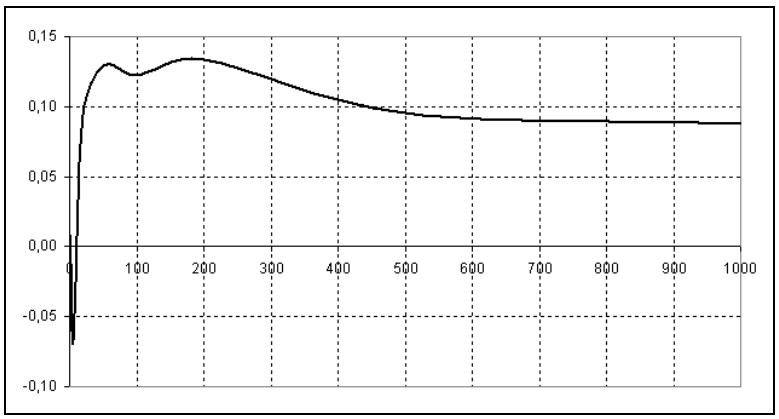
Risk of voltage peaks in higher categories.

- Wear electrician gloves, switch off conductors and ensure that the potential is zero.
- Utilise the LEM~flex only at 600 V r.m.s. or DC to ground and frequencies below 1 kHz.

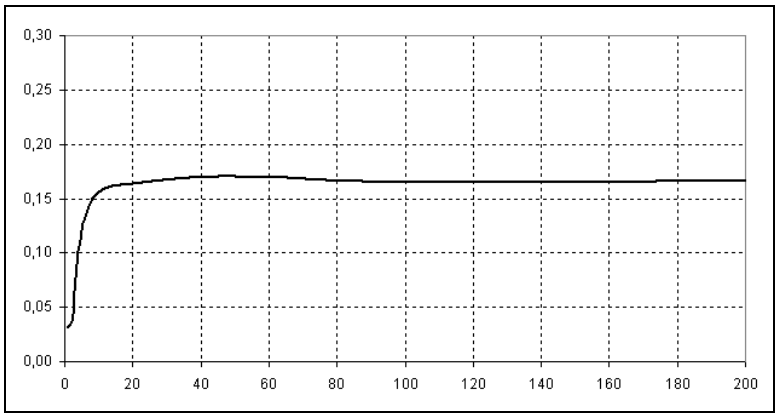
Accuracy (typical, for 50 / 60 Hz)

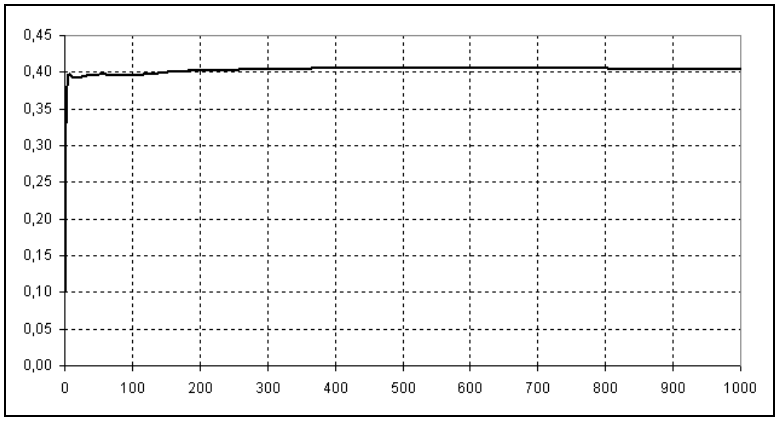
Linearity, error in % of measured value, primary current in A





Phase angle in degrees, primary current in A





14.1.9 LEM~flex 3000 A / 6000 A

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

Electrical characteristics	Nominal current In:	3000 A, 6000 A AC r.m.s.
	Measuring ranges:	30 A … 3000 A or 60 A … 6000 A AC
	Peak current:	10 kA, 19 kA
	Overload capacity:	up to 19 kA r.m.s.
	Intrinsic error:	< ±2 % of m. v.
	Linearity (10 % … 100 % of In):	±0.2 % of In
	Conductor position influence:	< ±2 % of m. v. for distance to measuring head >30 mm
	Error due to adjacent conductor:	≤ ±2 A for Iext = 500 A, distance to measuring head >200 mm
	Phase error (to reference conditions):	< ± 0.5 degrees
	Temperature coefficient:	0.005 % of range / °C
	Safety:	600 V AC CAT III, 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, relative humidity: 20 … 75 %.
	Current: nominal value In, sinusoidal waveform, 48 … 65 Hz, distortion factor: < 1 %. stray field < 40 A/m conductor centered within LEM~flex	
Safety standards	IEC/EN61010-1: 2001 IEC/EN61010-2-032 IEC/EN61010-2-031	
EMC standards	EN 61326 –1: 1997/A1: 1998	

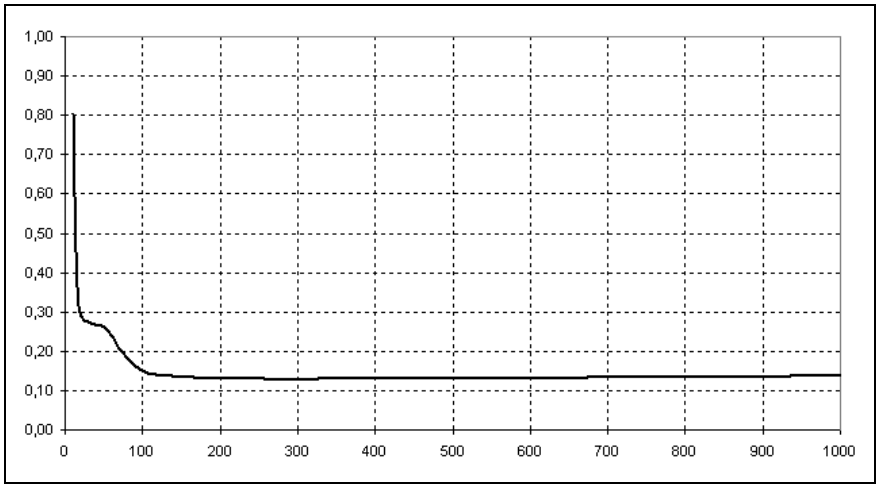
Danger! Risk of electrocution!

Risk of voltage peaks in higher categories.

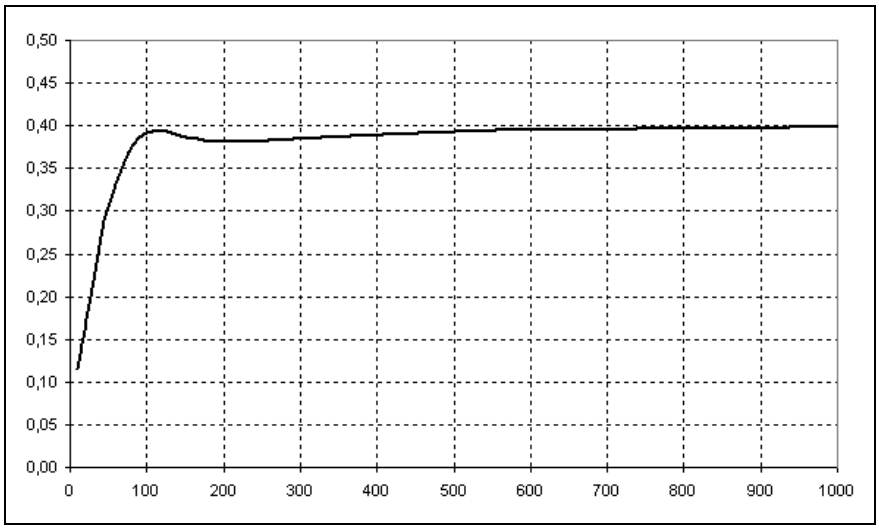
- Wear electrician gloves, switch off conductors and ensure that the potential is zero.
- Utilise the LEM~flex only at 600 V r.m.s. or DC to ground and frequencies below 1 kHz.

Accuracy (typical, for 50 / 60 Hz)

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



Phase angle in degrees, primary current in A



15 Options

15.1 GPS-Time synchronization – 2539223

This option consists of a GPS-receiver module incl. GPS antenna, and a 5 m connection cable for the Topas 2000 25-pole feature connector (on top of the instrument):

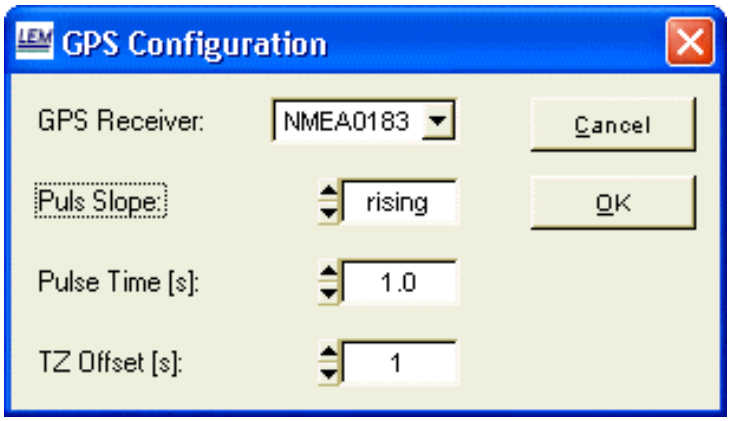
Important remark:
For optimal performance the GPS receiver shall be placed in a location where at least 4 satellites are within the receiving area, concrete, metal construction elements, roofs will damp the satellite signals to an insufficient level.
An extension cable with 10 m length is available.

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 ±1µs at rising edge of pulse
Memory:	non volatile memory for storage of configuration data

Procedure

- Run the Topas software and open menu *Service – GPS Configuration*:



- Put the GPS receiver in a location with clear view to the sky
- Connect the GPS-receiver to the Topas 2000 25-pole feature connector on top.
- Power on the Topas 2000. Topas 2000 checks if there are NMEA data available. If yes it waits max. 5 min for synchronization pulses from the GPS receiver. If not the internal time is taken for measurements.
- The *Pulse* LED on the Topas 2000 will start to blink at the reception of synchronization pulses. For LED functions see *LEDs Time Sync* on page 14.

Handling of date/time in Topas 2000

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 +/-0.01Hz).

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)

16 Equipment and accessories

16.1 Devices

Devices

Product	Description/technical specifications	Product- No.
Topas 2000	**Topas 2000 Power Quality Analyzer** 8 channels (4 voltages / 4 currents or 8 voltages) **Interfaces:** Ethernet **Memory:** 1 GB flash memory	2540384
Topas 2000	**Topas 2000 comprehensive set.** Like EP 2000 A including options: Trigger functions, EN50160+ ripple control signal analysis Transient analysis 10 Ms/s 2 GB flash memory, transport case	2540391

Options

Product	Description/technical specifications	Product- No.
Trigger functions	Manual trigger settings for 4 voltage channels and 4 current channels, or 8 voltage channels; harmonics, THD	2540608
EN50160	Power Quality Analysis as per EN50160 incl. option ripple control signal analysis	2540527
Transient analysis 500 kHz	Analysis of 4 voltage-channels, sampling rate: 100 kHz – 500 kHz, Voltage range: 6 kV	2540582
Transient analysis 10 MHz	Analysis of 4 voltage-channels, sampling rate: 100 kHz - 10 MHz, Voltage range : 6 kV	2540575
Transient upgrade	Upgrade of an existing 500 kHz transient option to a 10 MHz transient option	2540594
2 GB Memory	2 GB flash memory instead of 1 GB	2540423
GPS	GPS time synchronization	2539223

16.2 Accessories

Accessories

Product	Description/technical specifications	Product- No.
Voltage sensors for AC and DC		
0.1 V	Measuring range: 0.1 V	2540613
1 V	Measuring range: 1 V	2540651
5 V	Measuring range: 5 V	2540685
10 V	Measuring range: 10 V	2540636
100 V	Measuring range: 100 V, transients: 6000 V	2540624
400 V	Measuring range: 4-680 V, 1000 V peak, transients: 6000 V	2540660
400 V / 750 V peak	Measuring range: 400 V, transients: 750 V	2540703
480 V	Measuring range: 600 V, transients: 6000 V	2540672
600 V	Measuring range: 830 V max. 600V to earth, transients: 6000 V	2540697
1000 V	Measuring range: 1000 V, max. 1000V to earth, transients: 6000 V 1000V CAT III, 600V CAT IV	2540649
Flexible current sensors for AC currents - LEM~flex		
500 A / 100 A	Measuring range: 500 A / 100 A software-selectable, head circumference: 45 cm (18 inch), 2 m cable	2540477
1000 A / 200 A	Measuring range: 1000 A / 200 A software-selectable, head circumference: 61 cm (24 inch), 2 m cable	2540489
6000 A / 3000 A	Measuring range: 6000 A / 3000 A software-selectable, head circumference: 91 cm (36 inch), 4 m cable	2540492
Current probes for AC currents		
10 A / 1 A	Measuring range: 10 A / 1 A, software-selectable, max. conductor cross-section 15 mm, 2 m cable	2540445
50 A / 5 A	Measuring range: 50 A / 5 A, software-selectable, max. conductor cross-section 15 mm, 2 m cable	2540461
200 A / 20 A	Measuring range: 200 A / 20 A, software-selectable, max. conductor cross-section 15 mm, 2 m cable	2540450
1000 A / 100 A	Measuring range: 1000 A / 100 A, software-selectable, max. conductor cross-section 54 mm, 2 m cable	2540438
Shunt resistors for AC and DC currents		
20 mA	Measuring range: 20 mA	2540553
1 A	Measuring range: 1 A	2540548
5 A	Measuring range: 5 A	2540566

Product	Description/technical specifications	Product- No.
Other accessories		
Transport case	for Topas 2000 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

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