Operating Instructions

Power Analyzer
NORMA 4000
NORMA 5000

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The technical data contained in this document is subject to changes without prior notice, due to continued product development and improvements made by the manufacturer.

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 focussing 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.

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 damage to persons and property.

Protection class

The device is assigned to protection class I according to IEC 61010-1 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 the cooling vents are not obstructed.
- 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 fault free 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 is 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.
- 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.
- In the case of a direct connection to current circuits (without transformer or shunt), ensure that the circuit is protected to max. 16 A.

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 authorised service technician.
- Damaged or defective devices may only be repaired by authorised, specialised 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 61010-2-031/-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 authorised service agent.

2.1 Safety instructions on the device housing

Mains connection

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

Mains:
85...264 VAC, 47...440 Hz/ 40 VA
120...370 VDC, 40 VA

Input voltage and maintenance

The maximum input voltage for over-voltage category CAT II may not exceed 1000 V to earth (⏚).

- Do not remove the cover.
- Refer servicing to qualified personnel.

Indoor use only

- The device may only be used indoors.

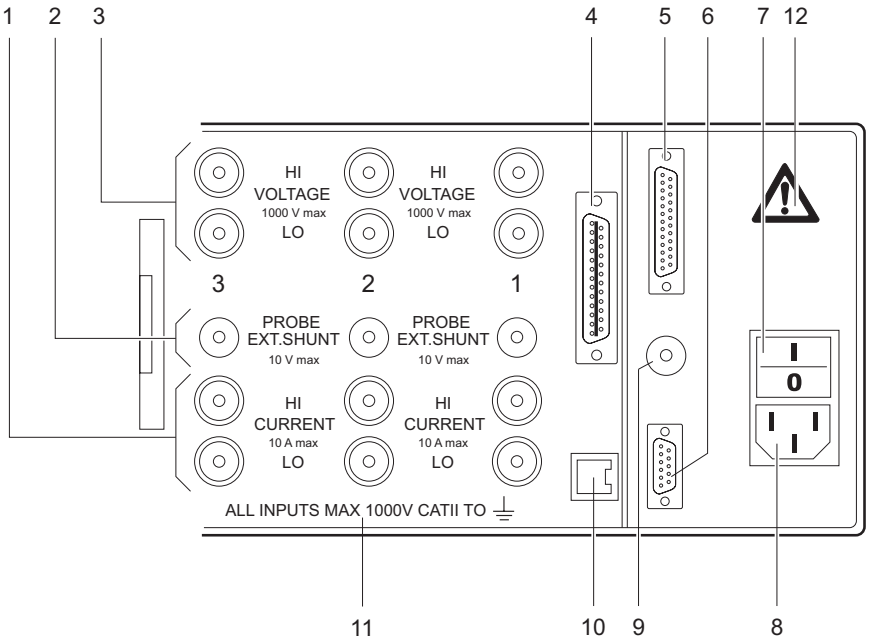
CE

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

3 Design and functions

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

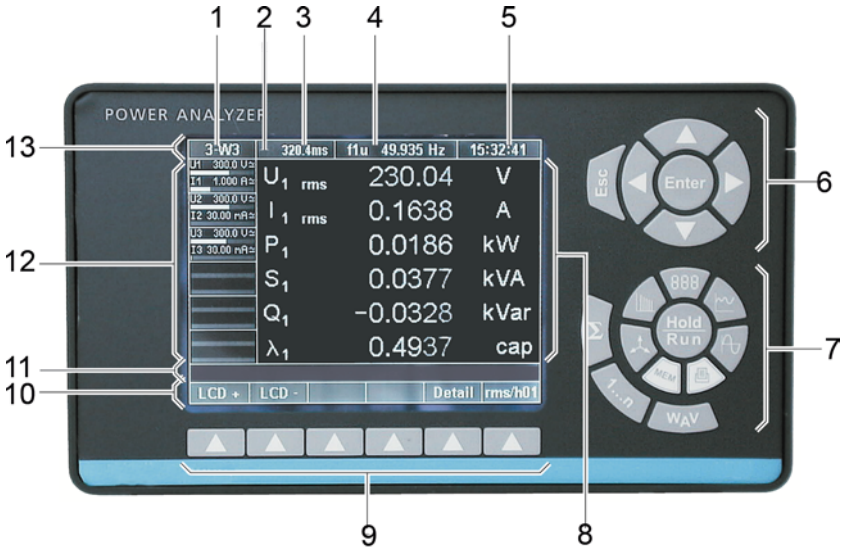
3.1 Terminals (rear of housing)



1 Measuring inputs for current (channels 1 ... 6)
HI: Conductor, positive
LO: Conductor, negative
2 Measuring inputs for shunts (channels 1 ... 6)
3 Measuring inputs for voltage (channels 1 ... 6)
HI: Conductor, positive
LO: Conductor, negative
4 IEEE488 interface (optional)
5 Port for PI1 interface
6 Serial interface (RS 232)
7 Power switch
I: ON
0: OFF
8 Mains connection
9 Input for external synchronisation signal
10 IF2 network adapter (LAN) (optional)
11 Warning regarding max. voltage to earth
12 Warning symbol; danger, observe operating instructions

3.2 Operating controls and display

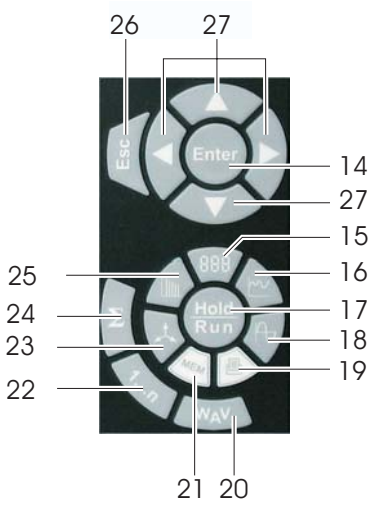
The display, operating controls and function keys are located at the front of the device. The display consists of a menu bar, a section in which the measured values and the channel settings are shown and the assignment bar for the function keys.



1 Display of configuration;
menu item *General Setup*
2 Menu item *Integration Setup / Motor-Generator Setup*
3 Measurement status / display of average time
4 Display of synchronisation source frequency;
menu item *Timing & Sync Setup*
5 Display of time;
menu item *Clock Setup*
6 Navigation keys
7 Measuring keys
8 Display for measured values
9 Function keys
10 Assignment bar for function keys
11 Information row
12 Status display for channels 1 to 6 (including measuring range, coupling and modulation bar);
menu items *Current Channel Setup* and *Voltage Channel Setup*
13 Menu bar with menu items

Status	Description
M	Memory record active
T	Wait for Trigger start condition(memory)
R	Measurement active (Run mode)
H	Measurement stopped (Hold mode)
∫	Integration of selected values active

Navigation and measuring keys



14	*Enter*: confirm; call up menu
15	Numerical display
16	Recorder
17	*Hold/Run*: start/stop measurement
18	Oscilloscope diagrams
19	Print
20	Show power, current, voltage
21	Save
22	Select channel
23	Vector display
24	Show totals of all channels
25	Frequency analysis
26	*Esc*: cancel, up one menu level
27	Cursor keys: *up/down*; *left/right*

Navigation through display

Use the navigation keys (6, page 8) and (27) to navigate through the display and the menus.
The active menu item, display or entry field in which your cursor is located is backlit.

Press *Esc* (26) to cancel an entry without saving or to go to the next higher menu level.
Press *Enter* (14) to call up a menu or to confirm an entry made in a menu.

Press the measuring keys (7, page 8) and (15) to (25) to select the display mode and the saving/output functions for measured values.

The assignment of the function keys (9, page 8) varies, depending on the current menu. The current key assignment is shown on the assignment bar (10, page 8) located above the function keys.

Overview of function keys

The assignment of the function keys varies, depending on the display or menu you have selected.

Name	Function
Default	Scale axes automatically
DELETE	Delete configuration
Detail	View details of a measured value
Freq	Set frequency analysis filter
Info…	View system information and version number of unit firmware
LCD -	Reduce brightness of display
LCD +	Increase brightness of display
lin/log	View linear/logarithmic scale
LOAD	Load configuration
mode	View table with harmonics
Offset	Adjust zero (with cursor keys)
rms/h01	View rms values or H01 fundamental
SAVE	Save configuration
Scale	Adjust scales of axes (with cursor keys)
scroll	Scroll through display
Set all	Adopt configuration or set value for all channels
tab/gra	View measured values in table/graph
U/I	Switch between voltage channel configuration and current channel configuration (in General Setup)
zoom	Adjust scales of axes (with cursor keys)
∫	View electrical work reference power or recuperated power
∫ *Clear*	Set electrical work integration to zero
∫ *Start*	Start electrical work integration
∫ *Stop*	Stop electrical work integration

3.3 Functions

The power analyzer allows for the analysis of currents from DC to several MHz. Voltage values up to 1000 V and currents up to 20 A are measured accurately, and the respective real, idle and apparent power is calculated. The limit of error is between 0.1% and 0.3%, depending on the model. For DC and AC up to a few MHz, it is not affected by the wave shape, frequency or phase position. The measuring range can be extended by connecting shunts or clamps. When extending the range using third-party shunts or clamp the extra errors due to these devices should be considered. The device caters for simultaneous measuring in up to 6 channels.

4 Startup

4.1 Checking of delivery

- Before commencing work with the analyzer, check the delivery to ensure that it is compete, using the following list and the delivery specifications:
  - 1 power analyzer
  - 1 operating manual
  - 1 mains cable
  - 1 calibration certificate
  - 1 to 6 voltage and current channel modules, according to the delivery specifications

4.2 Installation and switching on

Installation

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

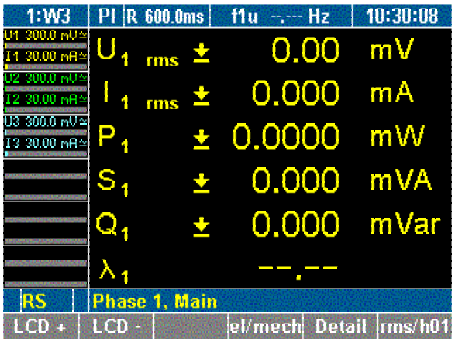
Danger! Risk of electrocution

- 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!

- Place the device onto a clean and stable surface.
- If necessary adjust the feet at the base of the unit to improve the view onto the display.

Switching device on

- Connect the device to the mains socket, using the power lead.
- Set the power switch at the rear of the housing to position "I". The device is now ready for operation. The start screen is displayed.



Switching device off

- Set the power switch at the rear of the housing to position "0".
- If the device is not to be used for a prolonged period of time, disconnect the plug from the mains socket.

5 Connection to Circuits

Danger! Risk of electrocution!

- By connecting the unit to circuits, the terminals and certain parts inside the device are live.
- In order to ensure safe operation, first connect the device to the power supply.
- If possible, open the circuit before establishing a connection to the analyzer.
- Prior to connecting the circuits, ensure that the maximum measuring voltage and max. voltage to earth (1000V CATII and 600V CATIII respectively) are not exceeded.
- Do not use leads and accessories that do not fulfil the relevant safety standards, as this could lead to serious injury or death from electric shock!

5.1 Connecting sequence

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

1. Connect the power analyzer to the mains socket.
   The analyzer is now connected to the protective earth wire.
2. Switch on the power analyzer.
3. Connect the measuring circuit as shown in the connection diagram.
   Ensure that the phase is connected to HI so that the energy flow is from HI to LO; to ensure that the measured values are indicated correctly.
4. Connect the circuit to the power supply.

5.2 Overview

The power analyzer offers the following options for connection:

Measurement	direct	with shunt	with transducer
1-phase measurement	page 13	page 14	page 15
Aron connection	page 16	page 17	page 18
3-phase measurement in 4-wire system	page 19	page 20	-

Note

When connecting a 4-channel device for electrical efficiency analysis, the 3-phase power cables for this measurement should be connected to the measuring channels 1 to 3, so that the efficiency can be calculated and displayed directly on the device.

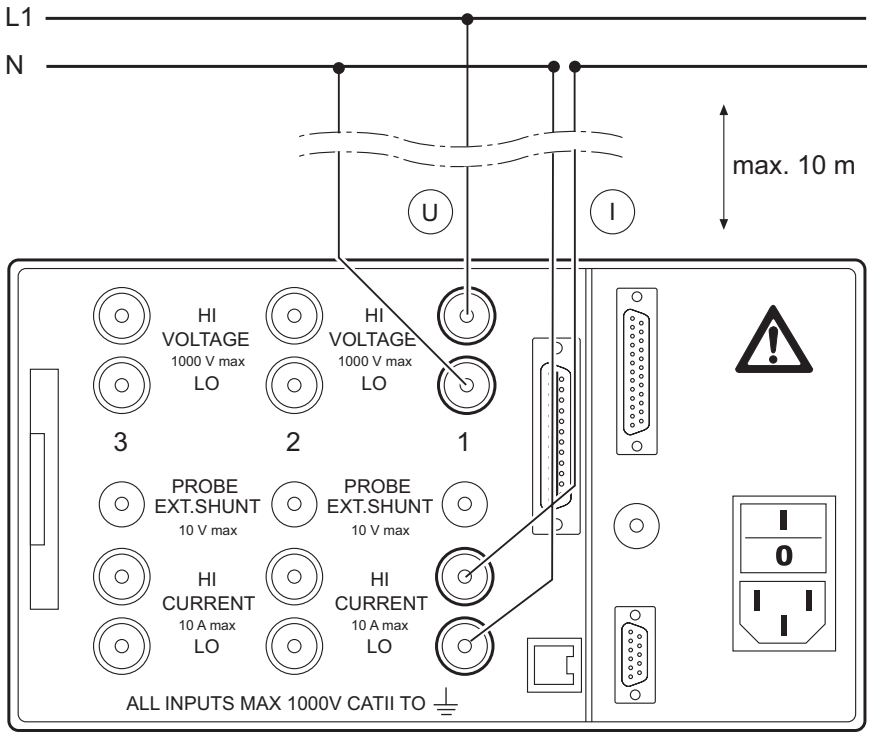
5.3 1-phase measurement

5.3.1 Direct connection

- Ensure that there is no overload at the current input of the power analyzer.
- If necessary, install appropriate fuses.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



5.3.2 With shunt

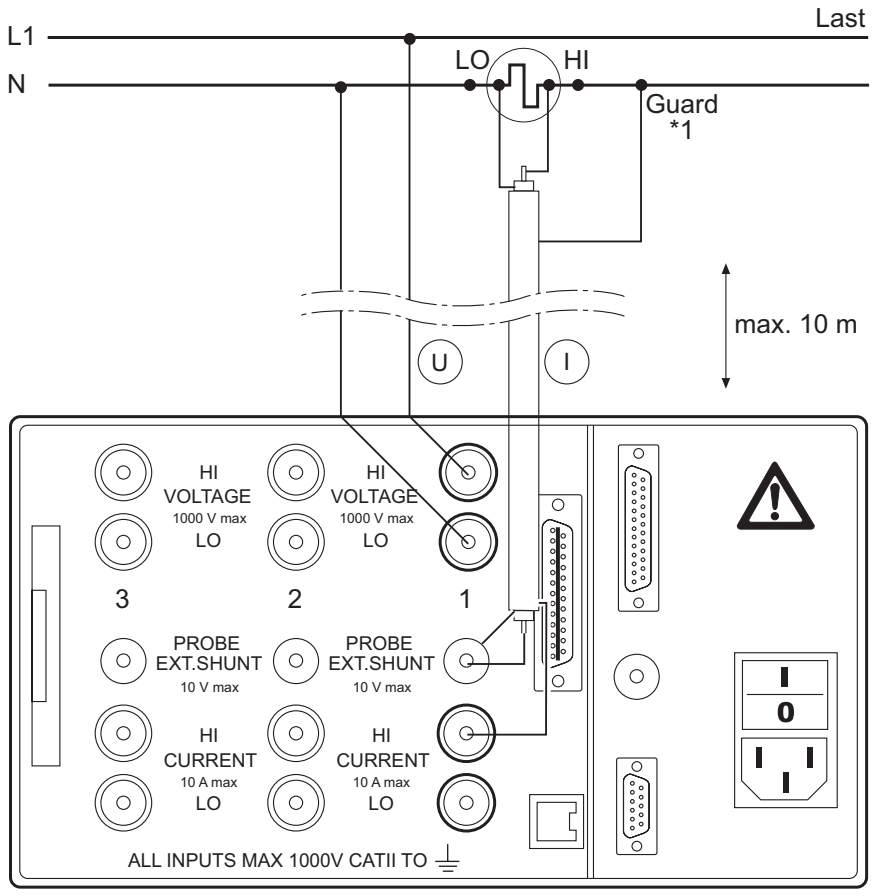
Danger! Risk of electrocution! Do not touch sense terminals!
The sense terminals at the shunts are powered with the same voltage as the power connections.
Shunts are not isolated.

- Never touch the sense terminals at the shunts.

- The connecting leads to the shunts should be as short as possible in order to prevent noise voltages.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



*1 We recommend using MCS measuring leads for triaxial shunts and MCP leads for planar shunts. Triaxial shunts are equipped with guard connectors in the plugs, while planar shuts are equipped with guard sockets.

5.3.3 With voltage and current transducer

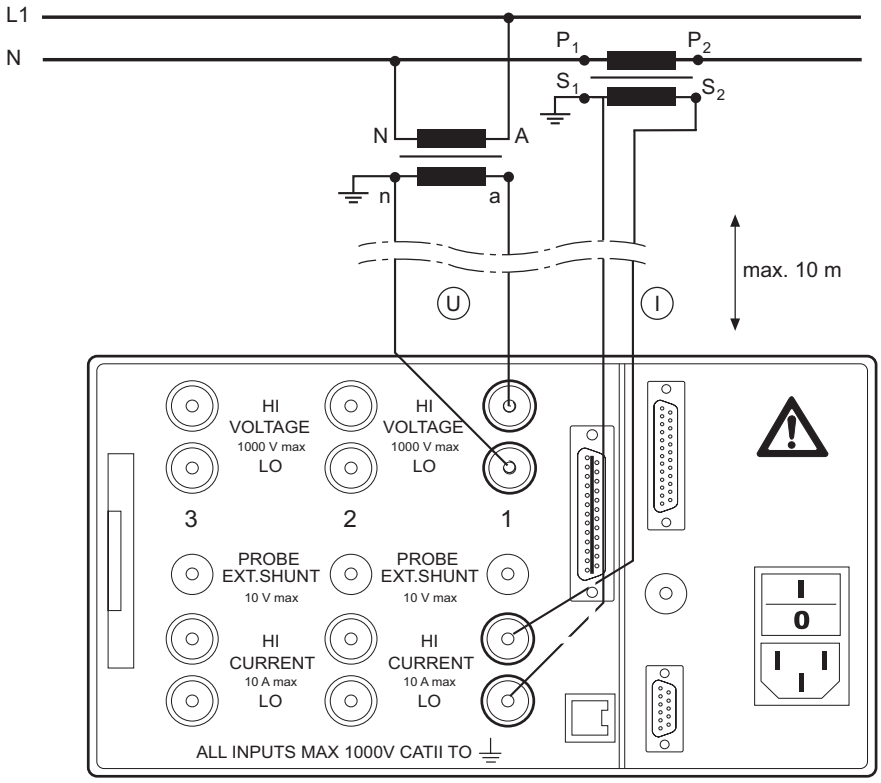
Risk of damage to transducer, due to overload!

- Check rating of transducer.

Note
When using transducers, please note that transducer errors limit the measuring bandwidth and reduce the intrinsic uncertainty.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



5.4 Aron circuit (triaxial/guard technique)

5.4.1 Direct connection

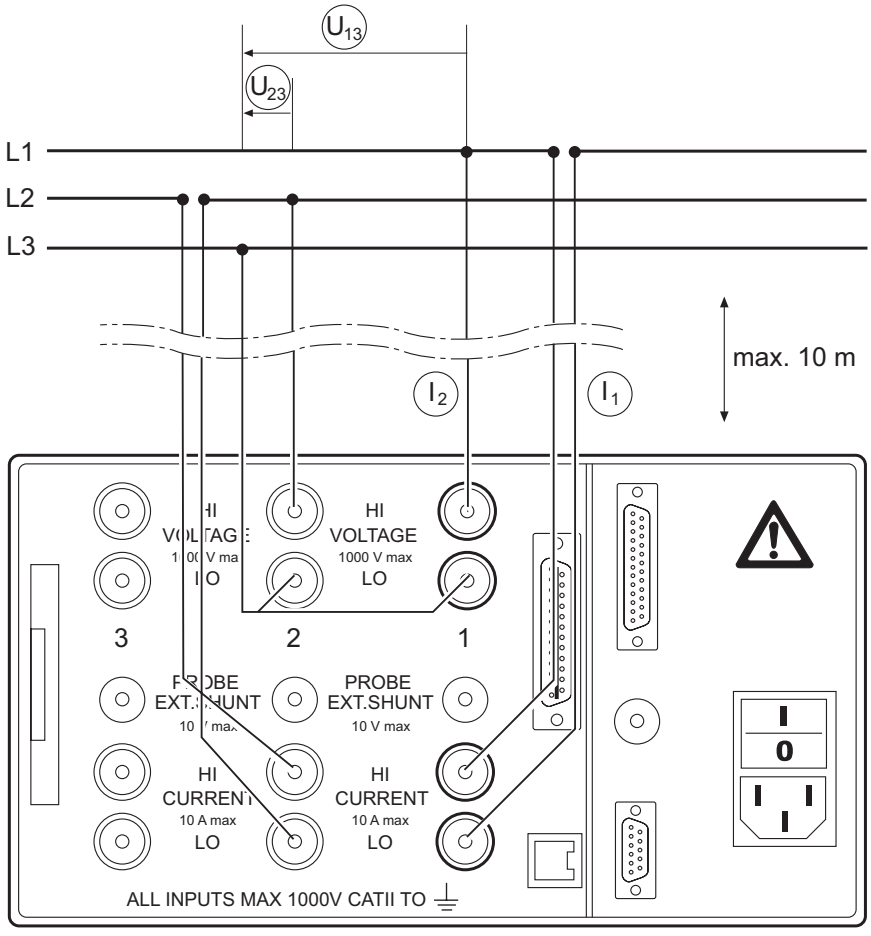
the Aron circuit is only available for 3-wire networks.
It is only required to measure two phases (currents I1 and I2 in the connection diagram), as I1+I2+I3 must be 0.

Important
In most cases, the Aron circuit is not acceptable for measurements on inverters, as there are capacitive leakage currents from the windings to the housing!

- Ensure that there is no overload at the current input of the power analyzer.
- If necessary, install appropriate fuses.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



5.4.2 With shunt

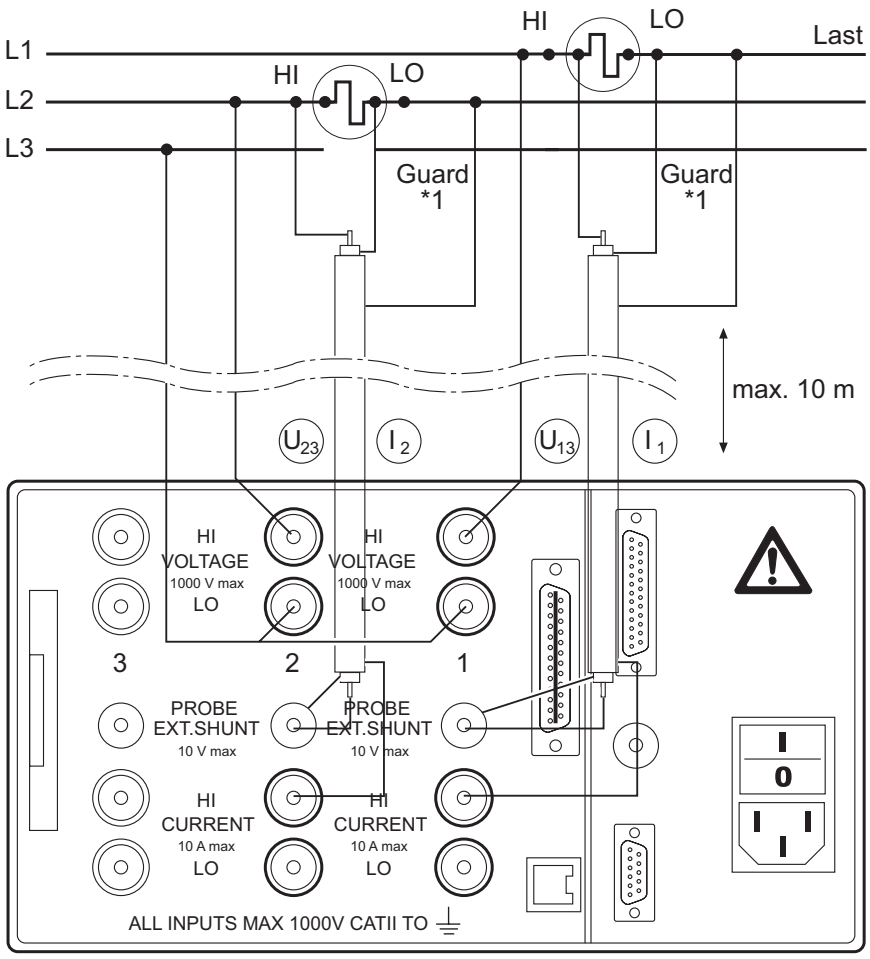
Danger! Risk of electrocution! Do not touch sense terminals!
The sense terminals at the shunts are powered with the same voltage as the power connections.
Shunts are not isolated.

- Never touch the sense terminals at the shunts.

- The connecting leads to the shunts should be as short as possible in order to prevent noise voltages.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



5.4.3 With voltage and current transducer

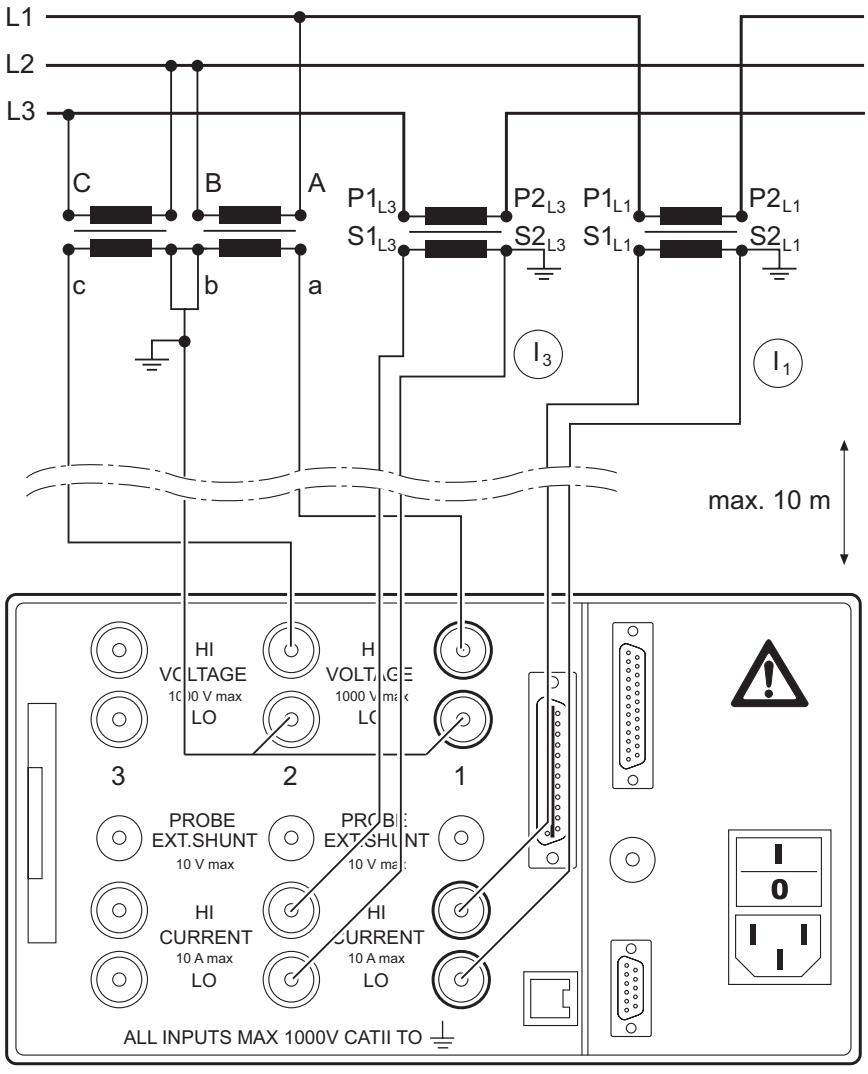
Risk of damage to transducer due to overload!

- Check rating of transducer.

Note
When using transducers, please note that transducer errors limit the measuring bandwidth and reduce the intrinsic uncertainty.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



5.5 3-phase measurement in 4-wire system

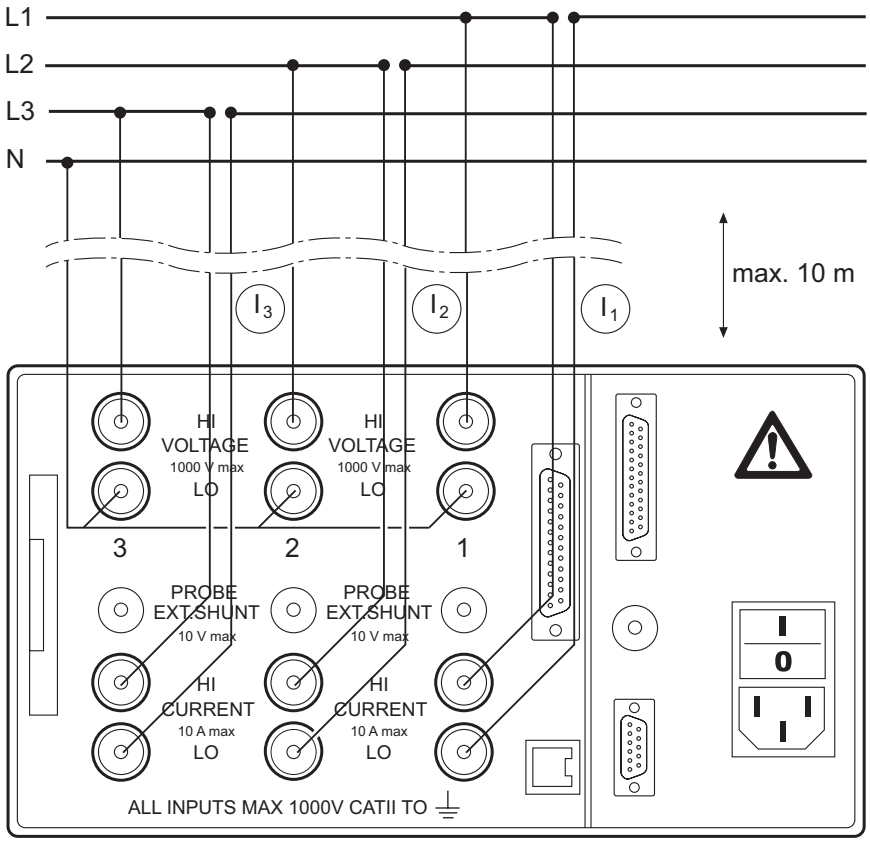
5.5.1 Direct connection

Note
3-phase measurements in 3-wire systems are only possible via a star point adapter (creates neutral point) plugged into the voltage inputs.

- Ensure that there is no overload at the current input of the power analyzer.
- If there is a potential risk of overload at the current input, incorporate a shunt or transducer into the circuit.
- If necessary, install appropriate fuses.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



5.5.2 With shunt

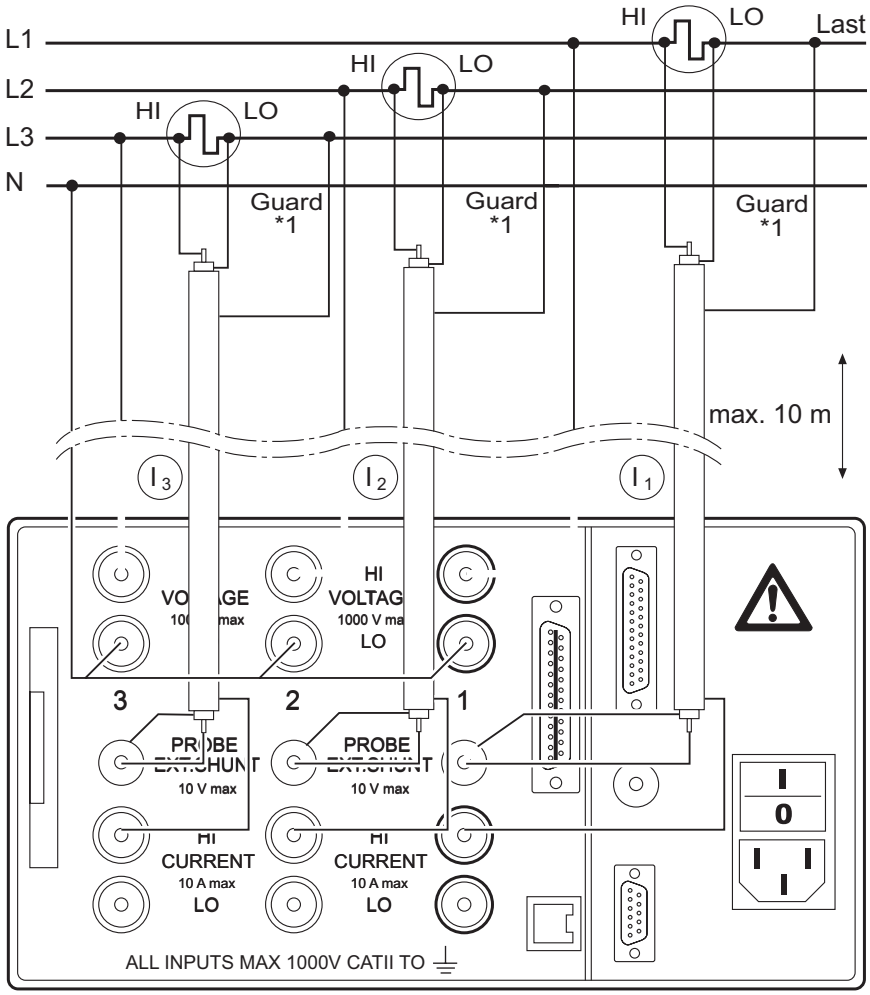
Danger! Risk of electrocution! Do not touch sense terminals!
The sense terminals at the shunts are powered with the same voltage as the power connections.
Shunts are not isolated.

- Never touch the sense terminals at the shunts.

- The connecting leads to the shunts should be as short as possible in order to prevent noise voltages.

Danger! Risk of electrocution!
Risk of injury when touching connections, internal circuits and measuring devices that are not earthed.

- Always adhere to the instructions regarding the sequence of connection (see page 12).



6 Simple Measurement

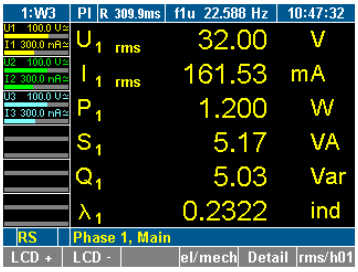
This chapter contains an introduction to the measuring procedures that can be carried out with the power analyzer, based on a simple sample measurement. The example used here is a measurement at the frequency converter with a fundamental below 100 Hz.

Connection to circuits

- Connect the outputs of the frequency converter to the current and voltage channels of the power analyzer (see chapter 5.5.1 “Direct connection”, page 19).

Configuration

- Switch on the power analyzer.



- Ensure that factory configuration 1:W3 is loaded (see chapter 7.2: "Load configuration", page 23).

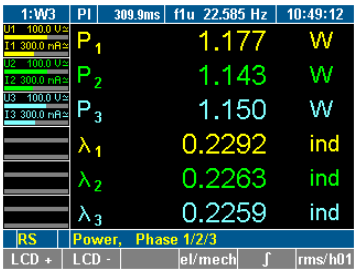
The settings of factory configuration *1:W3* are as follows:

- Low-pass filter on, set to 100 Hz
- Average time set to approx. 300 ms, depending on the measured frequency
- Synchronisation source is U1.

Measuring

- Press measuring key *WAV* three times.

  The rms values for power in channels 1 ... 3 are displayed.



The numbers in subscript (e.g. U_1 or U_2) indicate the respective channel.

Note

As the power analyzer requires a complete voltage and current cycle for an accurate measurement, a full period is automatically added to the average time of 300 ms of configuration *1:W3,* and the new average time is displayed. Example: 309.9 ms at 22.585 Hz, corresponding to 7 periods.

7 Configuration

Prior to measuring, you must configure the default settings, adjust channels, measuring ranges and times and synchronise current and voltage sources.
If you wish to reapply certain settings at a later stage, you must save the configuration. You have the option to save up to 15 user-defined configurations, which are automatically assigned the names *10:USER* to *24:USER*.

Configuration *1:W3*

When first switching on the analyzer, factory configuration *1:W3* is used. This configuration is suitable for measurements with fundamentals below 100 Hz (average time 300 ms, synchronisation source U1, low-pass filter 100 Hz).

Note
You have the option to modify the settings of configuration *1:W3*. If you wish to save the new settings, you must do this in a new configuration. Default configuration *1:W3* cannot be overwritten. You may save new settings in the process or at the end of the configuration procedure. Settings that have not been saved are lost when the device is switched off or when a different configuration is loaded.

You may ...

- modify configuration 1:W3 loaded upon startup of the device,
- load an existing configuration,
- create a new configuration,
- delete or modify an existing configuration.

The power analyser features the following configuration menus:

Configuration menu	Description
General Setup	Interfaces, printer output
Timing & Sync Setup	Average time and synchronisation
Clock Setup	Date and time
Current Channel Setup	Current channels 1 … 6
Voltage Channel Setup	Voltage channels 1 … 6
Motor / Generator Setup	PI1 process interface inputs
Analog Output Setup	PI1 process interface outputs
Integration Setup	Integration function / energy

5 steps

To set up a configuration, complete the following steps:

- Call up General Setup
- Configure current and voltage channels
- Configure average time and synchronisationConfigure data transfer to printer and PCSave configuration

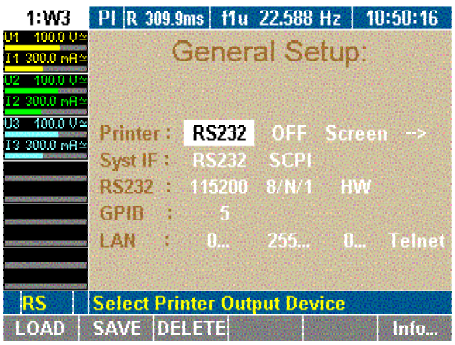
For instructions on how to configure the PI1 process interface, please refer to chapter 9: "PI1 Process Interface (optional)", page 57
For instructions on how to delete a configuration, please refer to chapter 7.10 ”Delete configuration", page 37.

7.1 Call up General Setup / Call up system information screen

Call up General Setup

☑ Analyzer is switched on; start screen is displayed.

▸ Move the cursor to menu item *General Setup* that shows the name of the currently loaded configuration and press *Enter*.
The *General Setup* menu is displayed.



Call up system information screen

☑ *General Setup* menu is displayed.

▸ Press function key F6 *Info*.
The *System Info* menu is displayed.

This screen shows the main information about the unit.

Line	Description
System	Devices type and sample rate
Phases	Type and number of equipped power phases
Options	Equipped interfaces and options
Serial	Serial number
Version	Firmware version

7.2 Load configuration

Note

If you have not set up and saved a new configuration before, you are currently working with factory configuration *1:W3*.

▸ Proceed as described in chapter 7.3: "Configure data transfer to printer and PC" 23.

Load configuration (optional)

▸ Press function key *LOAD.*
A list showing all existing configurations is displayed.

▸ Select a configuration and confirm with *Enter*.
The name of the loaded configuration, e.g. *10:USER*, is displayed in menu item *General Setup*.

To modify the loaded configuration, proceed as described below.

7.3 Configure data transfer to printer and PC

If you wish to use an internal or external printer, of if you intend to connect a PC, you must configure the parameters for the data exchange. This procedure consists of the following steps:

- Configure external printer
- Configure interface to PC
- Configure RS 232
- Configure IEEE488 device address
- Configure LAN network addresses

Note
The actual selected Interface is displayed in the Information row (see Chapter 3.2). *RS* → RS232 , *GP* → IEEE488, *EN* → Ethernet, US → USB

In the *General Setup* menu, define the following settings:

Line	Function
Printer	Configure printer
Syst IF	Configure interface to PC
RS232	Configure RS232 interface
GPIB	Configure IEEE488 device address
LAN	Configure network addresses

The device can be equipped with an IEEE 488 and/or an Ethernet interface instead of a serial RS232 interface.

Configure external printer

Settings	Description
RS232 *intern*	Print via RS232 interface on external printer or use internal printer
On key *Off*	Printer activated Printer deactivated
Screen *Num*	Print screenshot Print numerical data
1/page *3/page*	Print 1 screenshot per page Print 3 screenshots per page
PCL *EPS 9p* *EPS 24p*	PCL printer Epson 9-pin printer Epson 24-pin printer
S/W	Printing color is black/white

Note
The *PCL* setting is suitable for most inkjet printers.

- Move the cursor to the field with the value you wish to change, enter the new value and confirm with *ENTER.*
- Select the settings and confirm with *Enter*.
  The applied settings are shown in line *Printer*.

Configure interface to PC

Settings	Description
RS232 *GPIB* *USB* *LAN*	Serial interface IEEE488 interface (optional) USB2.0 interface (optional) Ethernet (LAN) interface (optional)
SCPI *D5255S* *D5255T* *D5255M*	Standard set of commands Previous set of commands (emulation) Previous set of commands (emulation) Previous set of commands (emulation)

- Move the cursor to the field with the value you wish to change, enter the new value and confirm with *ENTER.*
- Select the settings and confirm with *Enter*.
  The applied settings are shown in line *Syst IF*.

Note
A driver CD to install USB support to the PC is included in the delivery content. USB interface is installed as a virtual COM port.

Configure RS 232

Settings	Description
115200 ...1200	Baud rate of serial interface
8/N/1 …7/O/1	Data bits/parity/stop bits of the serial interface
none *HW* *XON*	Handshake (protocol) of the serial interface

Note
The factory settings of the RS232 interface are optimised for communication with a PC. We recommend adjusting the settings of the PC to suit these parameters.

Factory configuration: *115200 8/N/1 HW*

- At the connected PC, call up the Device Manager and open the dialog showing the settings for the serial port.
- Adjust these settings to those of the power analyzer.

Note
If the cable connecting the two devices is extremely long, or if the PC is unable to handle data at the set rate, you might consider adjusting the settings for the RS232 at the power analyzer to those of the PC. To do this, proceed as follows:

- Move the cursor to the first field in line *RS232*.
- Enter the settings for baud rate, data bits/parity/stop bits and handshake and confirm with *Enter*.
  The new settings are now shown in the fields of line *RS232*.
- Save the settings with *SAVE* in the desired configuration.

Configure GPIB address

The GPIB port is an IEEE488 interface. It works like an IP address in a network. The power analyzer is assigned a unique device address (numerical code) for communication on the GPIB bus. If more than one device is used simultaneously in the network, the device address can be adjusted accordingly.

- Move the cursor to the field in line *GPIB* and press *Enter*.
  A list with available addresses is displayed.
- Select an address that has not yet been assigned at the GPIB bus and confirm with *Enter*.
  The selected address is shown in line *GPIB*.

Configure Ethernet

Settings	Description
0.....	Device IP address
0.....	IP subnet mask address
0….	IP gateway address
Telnet	Protocol (fixed)

Before the Ethernet interface can be operated properly, enter the correct network addresses.

- Move the cursor to the field in line *LAN* and press *Enter*.
  A window with a numerical entry field is displayed.
- Enter the required address and confirm with *Enter*.
  The address is shown in line *LAN*.
- Save the settings with *SAVE* in the desired configuration.

Press *ESC* to leave the entry field without changing the address.

Note
The default address is 0.0.0.0 (factory settings). Addresses can only be entered in conjunction with IP network addressing (e.g. address 193.0.255.4).

Important
Network addresses are available from your network administrator.

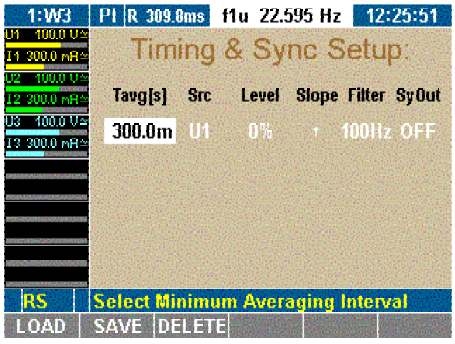
7.4 Configure average time and synchronisation

This configuration concerns important parameters required for the synchronisation of the measuring procedure. To configure these parameters, proceed as follows:

- Call up *Timing & Sync Setup*
- Enter average time
- Select synchronisation source
- Set trigger level
- Select slope direction
- Select low-pass filter
- Configure signal output

Call up Timing & Sync Setup

- Move the cursor to menu item *Timing & Sync Setup* and press *Enter*.
  The *Timing & Sync Setup* menu is displayed. The value in column *Tavg[s]* is highlighted.



In the *Timing & Sync Setup* menu, define the following settings:

Column	Settings	Description
Tavg[s]	*15 ms... 3600 s*	Minimum average time (in seconds)
Src	*U1 / I1 … U6 / I6* *ext* *Off*	Synchronisation source Fixed average time
Level	*−150 % ... +150 %*	Trigger level (in % of measuring range)
Slope	↑oder ↓	Slope direction
Filter	*10 kHz* *1k Hz* *100 Hz* *off*	Synchronisation filter (filter is not in signal path)
SyOut	*On* *Off*	Signal output enabled Signal output disabled (at *Sync Ext* output)

Set average time

The average time is a multiple of the period of the voltage of current source. The settings are automatically adjusted during measuring. Example: the average time is set to 19 ms; at a frequency of 50 Hz, it is automatically adjusted to 1 period, i.e. 20 ms.

Note

Short average times are useful, if you wish to analyse individual periods, measuring even minute interferences. With long average times (e.g. 300 ms at 50 Hz), short-term interferences are not shown.

☑ Value in column *Tavg[s]* is highlighted.

- Press *Enter*.
  A window with a numerical entry field is displayed.
- Enter the first digit of the average time and confirm with *Enter*.
  Repeat the above step for the other digits.

The measuring time is entered in seconds. For exponential powers, use the following keys on the numerical keypad:

Exponential power	Key
micro [10^{-6}]	µ
milli [10^{-3}]	m
kilo [10^{3}]	k
mega [10^{6}]	M

- Enter the exponential power and confirm with *Enter*.
- Move the cursor to the return field of the calculator and press *Enter*.
  The average time is shown in column *Tavg[s]*.
- Save the settings with *SAVE* in the desired configuration.

Select synchronisation source

The synchronisation source determines the frequency on which the analysis is based. In factory configuration *1:W3*, the synchronisation source is *U1*, as this signal tends to be reliable in most cases.
The following options are available:

- Input at device (channel 1 ... 6), current or voltage respectively (U1 ... U6, I1 ... I6)
- *Ext* for external synchronisation signal (connection to port for external synchronisation signal)
- *OFF*, if no synchronisation source is used (e.g. measuring of direct current)

Note
To measure the start-up of a machine, you might opt for an external synchronisation signal (0,2Hz to sample rate, max. 50V), as there is otherwise no signal at the beginning of the measuring procedure, and thus no measured values.

☑ Value in column *Src* is highlighted.
▸ Press *Enter*.
▸ Select a source or *OFF* and confirm with *Enter*.
The selected source or *OFF* is shown in column *Src*.
▸ Save the settings with *SAVE* in the desired configuration.

Set trigger level

The trigger level is in percentages of the measuring range, and measured from the end value of the range. In factory configuration *1:W3*, the trigger level is set to *0%*.

Note
By increasing the trigger level, the level of the average is also increased. In other words: if there are several positive slopes in the zero crossing, a higher modulated signal can be triggered.

☑ Value in column *Level* is highlighted.
▸ Press *Enter*.
▸ Enter the desired power and confirm with *Enter*.
The value is displayed in column *Level*.
▸ Save the settings with *SAVE* in the desired configuration.

Select slope direction

The value entered here determines the zero crossing at which the measurement begins, i.e. zero crossing with positive or with negative slope. In factory configuration *1:W3,* a positive slope is set. The arrow symbol "↗" indicates to a positive slope; symbol "↙" indicates a negative slope.

☑ Value in column *Slope* is highlighted.
▸ Press *Enter*.
▸ Select the desired arrow symbol and confirm with *Enter*.
The selected arrow symbol is shown in column *Slope*.
▸ Save the settings with *SAVE* in the desired configuration.

Select low-pass filter

The low-pass filter enables you to modify signals with high harmonic content (e.g. PWM) so that they are synchronised to the resulting fundamental. This ensures that all measured values refer

to this fundamental. The low-pass filter is not located in the signal path so that the input signal is not in any way interfered with.

☑ Value in column *Filter* is highlighted.
- Press *Enter*.
- Select a value or *OFF*, depending on the expected fundamental, and confirm with *Enter*.
  The entered value, or *OFF,* is shown in column *Filter*.
- Save the settings with *SAVE* in the desired configuration.

Configure signal output

☑ Value in column *SyOut* is highlighted.
- Press *Enter*.
- To activate output, select *ON*.
  – or –
  - To deactivate output, select *OFF*.
- Confirm with *Enter*.
  The entered value is shown in column *SyOut*.
- Save the settings with *SAVE* in the desired configuration.

Note
The synchronisation output is connected at the Sync-BNC plug on the backside of the unit. The output signal is a TTL pulse with 5Volt.

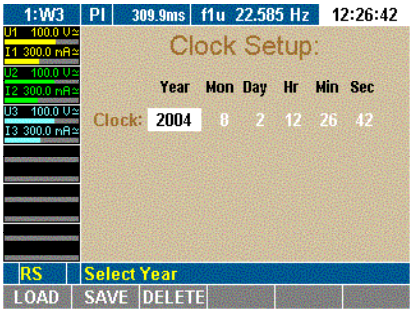
Important
The BNC can be used either as input or output. As soon as the BNC plug is switched to input (*EXT* sync source or *OFF* selected) the sync output menu is automatically switched to *OFF* (disabled).

7.5 Adjust date and time

Note
Normally, date and time must be set only once, as they do not change with different configurations.

Adjust date and time

- Move the cursor to menu item *Clock Setup* and press *Enter*.
  The *Clock Setup* menu is displayed. The value in column *Year* is highlighted.



- Press *Enter,* select a year and confirm with *Enter*.
  The selected year is displayed.
- Move the cursor to the next field and repeat the above step until the correct date and time are shown.

Menu field *Clock Setup* shows the time in hours, minutes and seconds.

7.6 Configure current and voltage channels

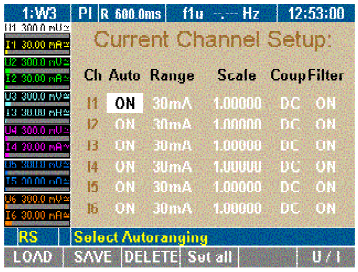
Prior to each measurement, you must configure the device inputs (channels) to be used. The following example explains the configuration procedure for current channel I1: The other current and voltage channels can be configured in the same way.

The configuration procedure consists of the following steps:

- Call up Current Channel Setup
- Configure input range
- Configure scale
- Configure coupling
- Configure anti-aliasing filter
- Call up Voltage Channel Setup

Call up Current Channel Setup

▸ Move the cursor to the status display of current channel I1 and press *Enter*.
The *Current Channel Setup* menu is displayed. The first field in column *Auto* of line *I1* is highlighted.



In the *Current Channel Setup* menu, define the following settings:

Column	Settings	Description
Ch	*I1 … I6*	Select input (channel)
Auto	*ON* *OFF*	Automatic range adjustment activated ... deactivated
Range	*30 mA ...10 A* *30 mV ... 10 V*	Measuring range (in ampere or volt)
Scale	Scale factor and A/V ratio	Scale for external probes/converters
Coup	*AC* *DC*	Coupling
Filter	*ON* *OFF*	Filter activated ... deactivated

Configure input range

You have the option to select automatic range configuration for the connected current source (*Auto*). Alternatively, you can configure the range manually (*Range*).
With automatic configuration, the analyzer determines and selected the correct range for the connected current source.

Automatic range adjustment (Auto)

☑ First field in column *Auto* is highlighted.
▸ Press *Enter*.
▸ Select *ON* and confirm with *Enter*.
The selected settings are shown in column *Auto*.

- If you wish to configure all three current channels in this way, press *Set All*.
  All channels are now set to *ON*.
- Save the settings with *SAVE* in the desired configuration.

Manual range adjustment (Range)

To manually configure the range for I1, enter the range in ampere or, if e.g. shunts are used, in volt.

☑ First field in column *Auto* is highlighted.

- Press *Enter,* select *OFF* and confirm with *Enter*.
  Automatic range adjustment is now disabled.
- Move the cursor to the value in column *Range* and press *Enter*.
- Select a value in ampere,
  – or –
  - if you use a shunt, select a value in volt.

Note
When a value in volt is entered, automatic configuration (*Auto)* is set to *Off*. Below *Scale*, option menu *A/V* is displayed.

- Confirm with *Enter*.
  The settings are shown in column *Range*. *Off* is displayed in column *Auto*.
- If you wish to configure all three current channels in this way, press *Set All*.
- Save the settings with *SAVE* in the desired configuration.

Configure scale

If you intend to use a shunt or a probe, you must adjust the scale for the output of the measuring signal.

Note
The correct parameter settings are shown on the type plate of the shunt or probe.

You can ...

- enter the transducer ratio (U over I) at the external current meters and instruct the device to calculate the final scale factor

or

- enter the scale factor at the current transducer so that the final scale factor can be calculated.

The parameters of the formula must be entered as follows:

- scale factor x transducer ratio

whereby

- scale factor: generally "1.0000" (one)
- transducer ratio: current (in ampere) to voltage (in volt)

Important
If you select *Set all* to apply the configuration to all channels, only the scale factor is transferred. If shunt values U/I are entered, the scale factor is always 1, and *Set all* is not available. If probes are used, it is generally easier to enter the transducer ratio, and *Set all* is thus not recommended.

- Move the cursor to the value in column *Scale* and press *Enter*.
  A dialog window showing the scale formula is displayed.
- Select a value for each parameter and confirm with *Enter*.
  The settings are shown in column *Scale*.
- Save the settings with *SAVE* in the desired configuration.

Configure coupling

By configuring the coupling, you determine the current you wish to analyse. Select *AC* to analyse alternating currents; select *DC* to analyse direct and alternating current.

- Move the cursor to the field in column *Coup* and press *Enter*.
  The options *AC* and *DC* are displayed.
- Select *AC* or *DC* and confirm with *Enter*.
  The settings are shown in column *Coup*.
- If you wish to configure all three current channels in this way, press *Set All*.
- Save the settings with *SAVE* in the desired configuration.

Configure filter

The anti-aliasing filter is located in the measuring channel. It is a prerequisite for the correct analysis of FFT data. The default configuration is *ON*. The anti-aliasing filter has a cut-off frequency of 1/10 of the sampling frequency. At half the sampling frequency, no signal reaches the A/D converter.

Note
For broadband numerical measurements in lighting technology, set the filter to *OFF*.
If measurements at high frequency are made without filter, it is not possible to correctly analyse the signals, due to aliasing. Please refer to chapter 7.11 ”Undersampling / Aliasing” page 37

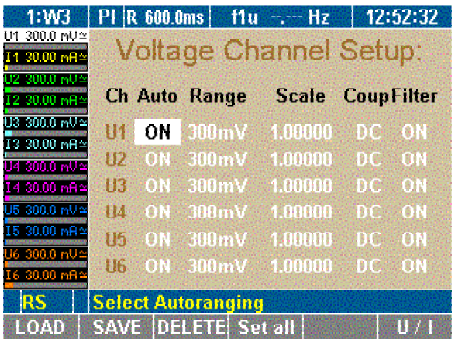
- Move the cursor to the value in column *Level* and press *Enter*.
  The options *AC* and *DC* are displayed.
- Select the desired value and confirm with *Enter*.
  The entered value is shown in column *Level*.
- If you wish to configure all three current channels in this way, press *Set All*.
- Save the settings with *SAVE* in the desired configuration.

Call up Voltage Channel Setup

☑ Call up *Current Channel Setup*.

Note
To configure the voltage channels, proceed as described for the current channels.

▸ Press function key *U/I*.
The *Voltage Channel Setup* menu is displayed.



▸ Configure voltage channels 1 to 6.

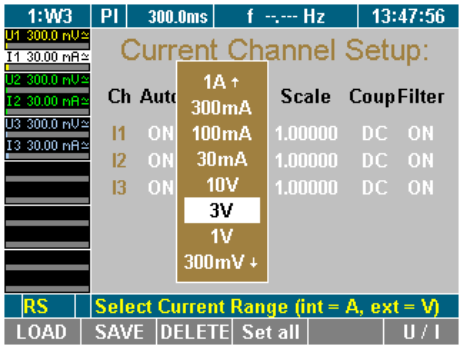
7.7 Switch current input to external input (BNC)

If you want to use an external shunt or probe you have to change the current input from direct measurement to the BNC input. This has to be done in the *Current Channel Setup* menu.

This procedure consists of the following steps:
- Call up Current Channel Setup
- Switch input
- Configure input range
- Configure scale

Switch Current input

☑ First filed in column *Range* is highlighted.
▸ Press *Enter*, select a voltage range (e.g. *3V*) and confirm with *Enter*.



▸ If you wish to configure all three current channels in this way press *Set All*.
▸ Save the settings with *SAVE* in the desired configuration.
The current input is now changed to the external BNC input.

Configure auto-range selection

☑ First filed in column *Auto* is highlighted.
▸ Press *Enter*, select *ON* and confirm with *Enter*.
▸ If you wish to configure all three current channels in this way press *Set All*.
▸ Save the settings with *SAVE* in the desired configuration.

Auto range is now enabled.

Configure scale

If you intend to use a shunt or a probe, you must adjust the scale for the output of the measuring signal.

Note
The correct parameter settings are shown on the type plate of the shunt or probe.

You can ...
- enter the transducer ratio (U over I) at the external current meters and instruct the device to calculate the final scale factor

or
- enter the scale factor at the current transducer so that the final scale factor can be calculated.

The parameters of the formula must be entered as follows:
- scale factor x transducer ratio

whereby
- scale factor: generally "1.0000" (one)
- transducer ratio: current (in ampere) to voltage (in volt)

Important
If you select *Set all* to apply the configuration to all channels, only the scale factor is transferred. If shunt values U/I are entered, the scale factor is always 1, and *Set all* is not available. If probes are used, it is generally easier to enter the transducer ratio, and *Set all* is thus not recommended.

- Move the cursor to the value in column *Scale* and press *Enter*.

  A dialog window showing the scale formula is displayed.
- Select a value for each parameter and confirm with *Enter*.

  The settings are shown in column *Scale*.

- Save the settings with *SAVE* in the desired configuration.

7.8 Integration function configuration

This configuration concern important parameters required for the calculation of integrated values over time.

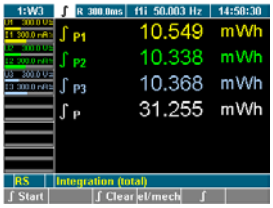
Note
You can select up to six different integration parameter (values) out of a list. Active power P1 to P3 and the sum power are preselected.

Call up Integration Setup

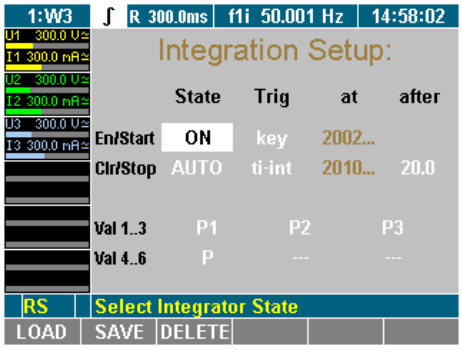
☑ Analyzer is switched on; start screen is displayed.

- Press function key *WAV*.

  The integration symbol is displayed in the assignment bar for function keys.



- Press the function key ∫.
  Integration symbol is displayed in the menu bar.
- Move Cursor to ∫ display and press *Enter*.
  The *Integration Setup* menu is displayed.



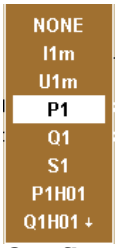
In the *Integration Setup* menu, define the following settings:

Line	Function
En/Start	Enable integration function/ set start conditions
Clr/Stop	Configure data reset / set stop conditions
Val 1..3	Select first three values
Val 4..6	Select next three values

☑ Menu *Integration Setup* is displayed on the screen

Select integration value

- Select with the cursor in line *Val 1..3* or *Val 4..6* a value and confirm with *Enter* .
  A dialog window showing the selectable values is displayed.
- Move the Cursor in the window to the wanted value and confirm with *Enter*.
  The parameter is now shown on the display
- Configure the other values accordingly
- Save the settings with *SAVE* in the desired configuration.



Configure status

In this menu you can enable / disable the integration function. Also the way of clearing the values can be configured. This is done in the *Integration Setup* menu at column *State*.

Line	Settings	Description
En	*ON* *OFF*	Integration function active Integration function inactive
Clr	*MAN* *AUTO*	Clear manual Auto clear at start

☑ Menu *Integration Setup*, first field column *State* is highlighted

- Press *Enter*, select *ON* and confirm with *Enter*.
  The integrations function is now enabled . If you want to disable it, select *OFF* and confirm with *Enter*
- Save the settings with *SAVE* in the desired configuration.

Note
The integration function is enabled (*ON*) in the factory configuration *1:W3* .

☑ Menu *Integration Setup*, second field column *State* is highlighted

- Press *Enter*, select *AUTO* and confirm with *Enter*.
  Clear values at start is now enabled. If you want to change it, select *MAN* and confirm with *Enter*
- Save the settings with *SAVE* in the desired configuration.

Note
In the factory configuration *1:W3* the function clear manual (*MAN*) is preselected.

Configure start

You can select different start conditions:

Column	Settings	description
Trig	*remote* *time* *key*	Start via Interface command Start on date and time Start when key pressed (Key *F1*)
at	*-Date-*	Start time(only active at *Trig time*)
after	*-*	No function

☑ Menu *Integration Setup*, first field column *Trig* is highlighted

- Press *Enter*, select start condition and confirm with *Enter*.
  Start condition is now set. If you have selected a time to start (*time*) enter the time in the column *at*. Proceed as described below:

☑ Menu *Integration Setup*, first field column *at* is highlighted

- Press *Enter*, select year, month, day, hour minute and seconds with the cursors and confirm with *Enter*.
  Start time is now set.
- Save the settings with *SAVE* in the desired configuration.

Note
Date and time for start is taken from the clock in the unit. Please control date and time of the unit before you start the integration calculation (7.5“Adjust date and time” page 29).

Configure stop

You can select different stop conditions:

Column	Settings	Description
Trig	*remote* *time* *key* *ti-int*	Stop via Interface command Stop at date and time Stop when key pressed (Key *F2*) Stop after time window
at	*-Date-*	Stop on date and time (only active at *Trig time*)
after	*-time-*	Integrations time window in sec. ((only active at *Trig ti-int*)

☑ Menu *Integration Setup*, second field column *Trig* markiert

▸ Press *Enter*, select stop condition and confirm with *Enter*.
Stop condition is now set. If you have selected a time to start (*time*) enter the time in the column *at*. Proceed as described below:

☑ Menu *Integration Setup*, first field column *at* is highlighted

▸ Press *Enter*, select year, month, day, hour minute and seconds with the cursors and confirm with *Enter*.
Stop time is now set. If you have an integration time window selected (*ti-int*) proceed as follow:

☑ Menu *Integration Setup*, second field column *after* is highlighted

▸ Press *Enter*, select time with the cursors and confirm with *Enter*.
Stop time is now set.
▸ Save the settings with *SAVE* in the desired configurationPress

7.9 Save configuration

☑ A configuration menu is displayed on the screen (for a list of configuration menus, refer to page 22).
▸ Press function key *SAVE.*
A list showing all existing configurations is displayed.
▸ Select a configuration (e.g. *10:USER*) and confirm with *Enter*.
The configuration is now being saved with the new name. The name of the new configuration, e.g. *10:USER*, is displayed in the menu item.

At the next startup of the device, the last saved and loaded configuration is applied by default.

7.10 Delete configuration

☑ A configuration menu is displayed on the screen (for a list of configuration menus, refer to page 22).
▸ Press function key *DELETE.*
A list showing all existing configurations is displayed.
▸ Select a configuration (e.g. *10:USER*) and confirm with *Enter*.
The configuration is now being deleted.
▸ Press *Enter* or *Esc* to return to the previous screen.

7.11 Undersampling / Aliasing

If you want to make signal analyses like DSO (scope) or harmonic analyses (FFT) with a digital sampling procedures you need to take care about Shannon's sampling theorem which says: "The sample frequency must be minimum double than the highest signal frequency". If you do not keep this rule you will get results (frequencies or waveforms) that do not exist in truth (=Aliasing).

If you want to measure a numeric time based mean values like rms, rectified mean, mean…you do not need to take care about Shannon's theorem. For the precision of the results only the number of samples is important, not the sampling frequency (average time >> cycle duration). But you have to consider that the sampling signal must be statistical independent, that means the sampling frequency must not be close or a multiple of the signal frequency.

Note
To work in the "undersampling mode" the anti-aliasing filter has to be turned *OFF* at the current and voltage channel (see chapter 7.6 "Configure current and voltage channels" page: 30).

8 Measuring process

The power analyzer is designed for the measuring of currents and voltages through up to three different channels. It calculates rms values, real, apparent and idle power and other derived values. The accuracy is thereby not affected by the wave form, frequency or phase shift. Harmonics are output to maximum half the sampling frequency.

You have the option to apply the default settings or a user-defined configuration. If you wish to use a user-defined configuration, you must first define and save the respective settings and then load the relevant configuration (see chapter 7: "Configuration", page 22).

The power analyzer begins to measure as soon as the measuring arrangement is set up and the device is switched on.

8.1 Prior to measuring

☑ Connect power analyzer to the mains socket.

- Check the measuring connections at the power analyzer.
- Switch on the power analyzer.

Measuring with default configuration

If you want to complete an analysis using the default configuration, no additional steps are required.

- Ensure that the factory configuration is loaded (see chapter 7.2: "Load configuration", page 23).

Measuring with user-defined configuration

If you want to complete an analysis using a user-defined configuration, load the respective configuration see chapter 7 "Configuration", page 22).

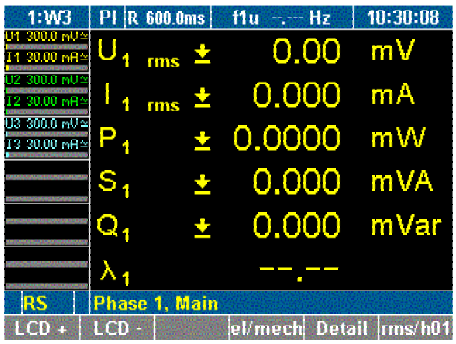
Important
If you want to measure with external shunt or probe please make sure that there is no signal connected at the direct current inputs. Signals on both inputs (external- and direct current input) can damage the measurement unit.

8.2 Measure voltage, current and power

8.2.1 View the measured values for the individual channels

View the values of one channel

After switching on the power analyzer, the display shows the numerical values measured in channel 1.



Display	Description
$U_{1\ rms}$	rms voltage value
$I_{1\ rms}$	rms current value
P_1	Real power
S_1	Apparent power
Q_1	Idle power
λ_1	Power factor lambda (*cap.* or *ind.*)

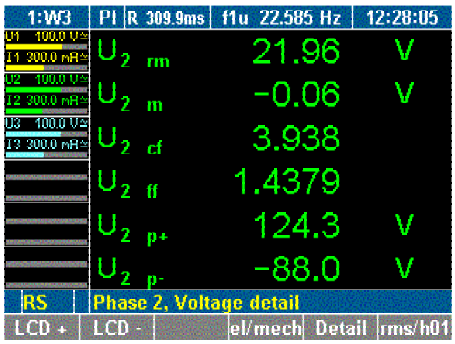
- Press measuring keys 1...n to view the values of the respective channels.

View detailed values of one channel

You have the option to view detailed data regarding the measured values of a channel.

- Press measuring keys *1...n* to view the measured values of the respective channel.
- Press function key *Detail.*

  Details regarding the voltage values, e.g. for channel 2, are shown.

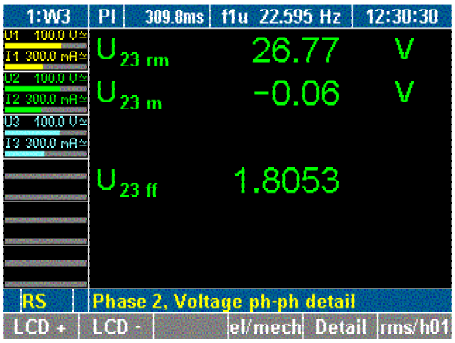


Display	Description
$U_{2\ rm}$	Rectified mean value
$U_{2\ m}$	Mean value
$U_{2\ cf}$	Crest factor
$U_{2\ ff}$	Form factor
$U_{2\ p+}$	Positive peak value
$U_{2\ p-}$	Negative peak value

- Press function key *Detail* again.
  Details regarding the current values are displayed. The equivalent parameters to those shown above for voltage are displayed.
- Press function key *Detail* again.
  Details regarding the power values, e.g. for channel 2, are shown.

Display	Description
P_2	Power
P_{c2}	Corrected power
Z_2	Apparent impedance
φ_2	Angle between U2 and I2

- Press function key *Detail* again.
  Details regarding the measured values for phase-to-phase voltage are displayed.



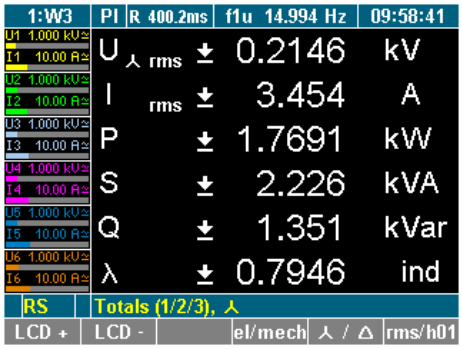
- To return to the measured values for channel 2, press function key *Detail* again.

8.2.2 View totals of all measured values

View totals

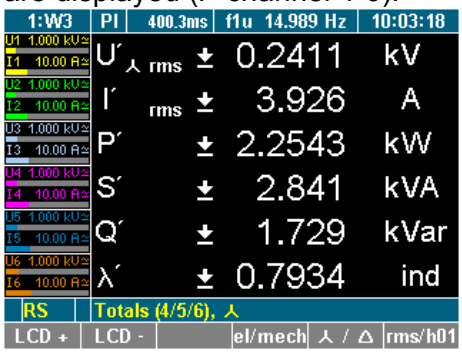
- Press measuring key Σ.

  The totals of the measured values of the first three channels are displayed (channel 1-3).



- Press measuring key Σ again

The totals of the measured values of the second three channels are displayed (P channel 4-6).



View efficiency

- Press measuring key Σ three times (or again)

The efficiency and the total active power are displayed.

Note

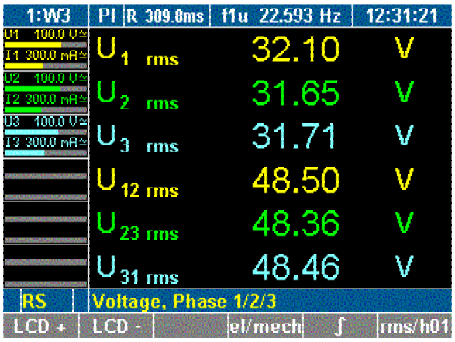
The efficiency screen and totals channels 4-6 screen only appear if there are 4 to 6 power phases equipped

8.2.3 Compare measured values

Compare measured values

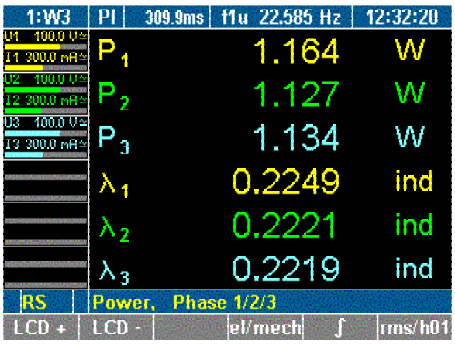
You have the option to compare the values measured at the different channels, e.g. all voltages measured at all channels. When pressing measuring key WAV, the comparative display switches from voltage to current and power, showing the respective values of all three channels.

- Press measuring key *WAV*.
  The measured voltages and phase-to-phase voltages are displayed.



Display	Description
$U_{1\,rms}$ ... $U_{3\,rms}$	rms voltage at channels 1 to 3
$U_{12\,rms}$ ... $U_{31\,rms}$	Phase-to-phase voltage at channels 1/2, 2/3 and 3/1

- Press key *WAV* again.
  The measured current values *I1* to *I3* for the three channels are displayed.
- Press key *WAV* again.
  The power and power factor values are displayed.



Display	Description
P_1 ... P_3	Power at channels 1 to 3
λ_1 ... λ_3	Power factors at channels 1 to 3

To select channels 4 to 6, repeatedly press key WAV.

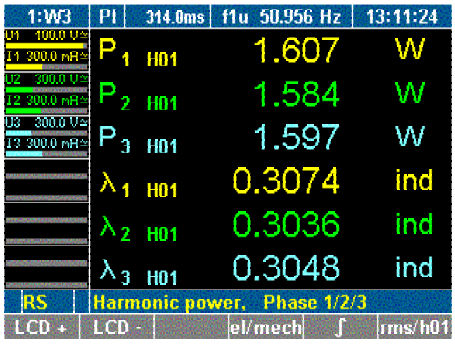
8.2.4 View fundamentals

View fundamentals

For each measured value, the power analyzer calculates the fundamental by means of Fourier transformation (DFT).

- Press measuring keys ∑ or *1...n* and *WAV* to call up the desired values, e.g. power at channels 1 to 3.
- Press function key *rms/h01.*

  The power of the fundamentals is displayed.



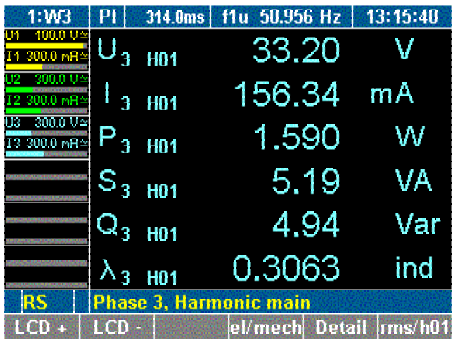
- To return to the power values, press function key *rms/h01* again.

View details of fundamentals

You have the option to view detailed data regarding a fundamental, such as voltage, current, power and phase-to-phase voltage.

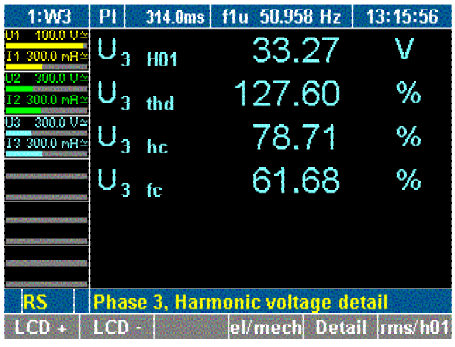
- Press measuring keys ∑ or *1...n* and *WAV* to call up the desired values, e.g. values measured at channels 3.
- Press function key *rms/h01.*

  Detailed measured values in connection with the fundamentals at channel 3 are shown.



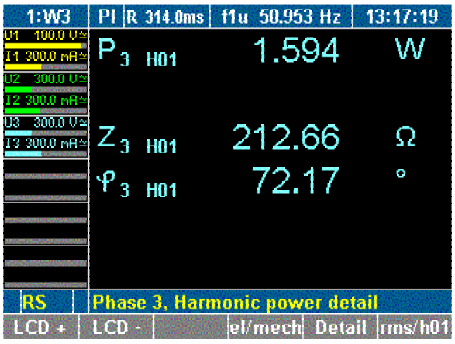
- Press function key *Detail.*

  Details of the voltage of the fundamental at channel 3 are shown.



Display	Description
$U_{2\ H01}$	rms value of fundamental
$U_{2\ thd}$	Total harmonic distortion (according to IEC)
$U_{2\ hc}$	Harmonic content (according to DIN)
$U_{2\ fc}$	Fundamental content

- Press function key *Detail* twice.
  Details of the power of the fundamental at channel 3 are shown.



Display	Description
$P_{2\ H01}$	Power of fundamental
$Z_{2\ H01}$	Apparent impedance of fundamental
$\varphi_{2\ H01}$	Angle between U3 and I3 of fundamental

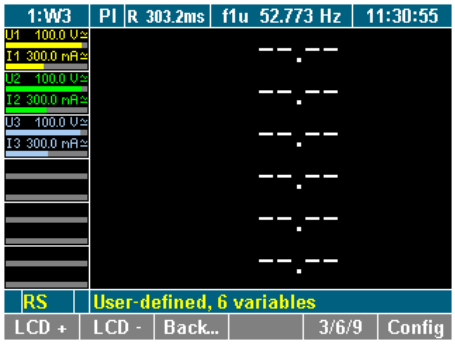
- To return to the display of the fundamentals for channel 3, press function key *Detail* twice.
- To return to the measured values for channel 3, press function key *rms/h01* again.

8.2.5 User defined screen view

In this menu you can configure your own defined numeric screen. Furthermore you can change this user defined screen to get 3, 6 or even 9 values displayed on one screen.

View user defined screen

- Press function key *User*
  The display shows the user defined screen.



Note
If you enter the user defined screen the first time it is empty, showing dashes. In all other cases it shows the last saved configuration or the recently selected values.

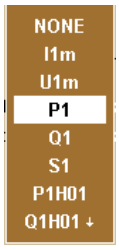
Select numeric values

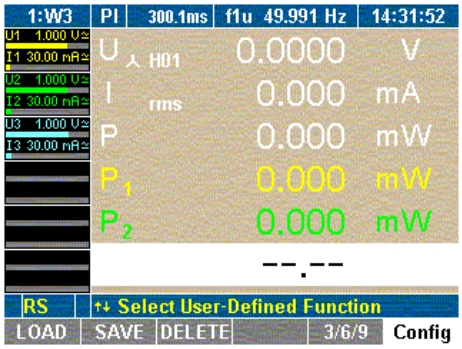
You can select values out of list of more than 450 variables depending with how many channels the unit has equipped.

- Press function key *Config*

The configuration menu is shown.

- Select desired row with the Cursor and confirm with *Enter*.
  A dialog window showing the selectable values is displayed
- Select desired values with the cursor (*up/down* and *left/right*) and confirm with *Enter*.
  The selected values are shown on the display.
  Repeat until all desired values are on the display screen
- Press *Esc* to leave the configuration menu





Note
You can configure and display up to nine variables (values). Please change the user defined display size (see “Change user defined display size” below) to configure all nine values.

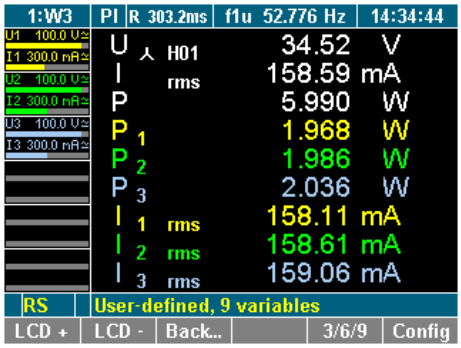
Change user defined display size

You can change the size of the numeric display in the user defined screen. You can select between three sizes:

size	description
3	3 numeric values, double size
6	6 numeric values, common size (7mm)
9	9 numeric values, with size 5mm

- Press function key *3/6/9*

User defined values are shown in desired size .



Note
The changing of the display size is done in a loop, every time you press the function key *3/6/9*.
You can change the size in the configuration menu and also in the measurement menu.

Save user defined screen

- Save the settings with *SAVE* in the desired configuration

See details about saving a configuration in chapter 7.9 Save configuration

Back to common numeric screen

- Press function keys *Back...* or *Esc*

The recently used numeric screen is shown.

8.3 Change view mode

After having selected a channel and the relevant measured values, you have the option to change to different view modes where the parameters are shown in the form of numerical values, vector graphs or oscilloscope graphs.

8.3.1 Numerical display

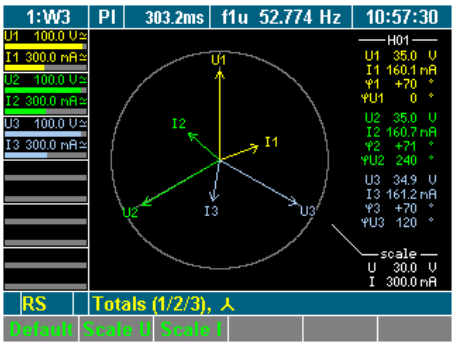
For details regarding the numerical display of measured values, refer to chapter 8.2 "Measure voltage, current and power", page 40

8.3.2 Vector graphs

Up to 6 signals of the H01 fundamentals can be viewed as vector graphs.
The vector graphs show voltage and current with amplitude and phase shift, and allow fro the fast assessment of signals and detection of errors in the connections.

View vector graphs

- Press measuring keys ∑ or *1...n* and *WAV* to call up the desired values, e.g. values measured at *WAV power*.
- Press measuring key *Vector graphs*.
  The measured values are shown in the form of vector graphs.



Display	Description
φ1 ... φ3	Phase angle between U and I
φU1	... reference point (always = 0)
φU2	Angle between U2 and U1
φU3	Angle between U3 and U1
scale	Range (reference value for the diameter of the outer circle)

- To view a different channel or different measured values in vector graph form, press measuring keys *∑* or *1...n* and *WAV.*

Adjust scale

The scale of the vector in the vector diagram can de zoomed.

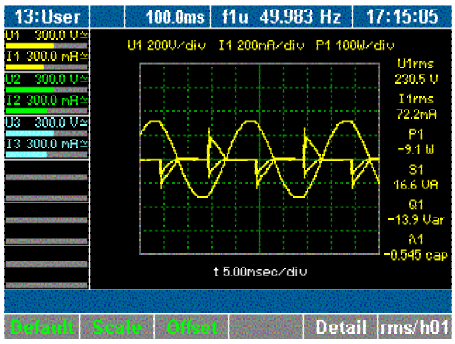
- To automatically optimise the scale of the graph, press function key *Default*.
  The scale is set to the measurement range.
- To change the scale of the axes, press function key *Scale U* or *Scale I*.
- Adjust the scale, using the cursor keys *up* / *down* press *Enter* to confirm or *Esc* to exit. *I*.

8.3.3 Oscilloscope curves

The digital oscilloscope function (DSO) allows for display of signals in curves, so that signal distortions can be quickly detected.

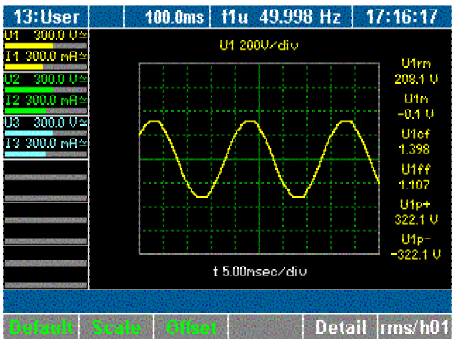
View oscilloscope display

- Press measuring keys *∑* or *1...n* and *WAV* to call up the desired values, e.g. values measured at channels 1.
- Press measuring key *Oscilloscope curves*.
  The measured values are shown in the form of oscilloscope curves.



- To view the details regarding a measured value, press function key *Detail*.

  The display shows the measured voltage.



- To view a different measure parameter, press function key *Detail* again.
- To return to an overview of all measured values for channel 1 in oscilloscope format, press function key *Detail* again.
- To view a different channel or different measured values in oscilloscope graph form, press measuring keys ∑or *1...n* and *WAV.*

Adjust axial scale

The oscilloscope display can be optimised in a number of ways.

- To automatically optimise the scale of the graph, press function key *Default*.
  The scale is set to steps of 5 ms.
- To change the scale of the axes, press function key *Scale*.
  Adjust the scale, using the cursor keys as described below:

Cursor key	Function
left, right	Adjust scale of time axis
up, down	Adjust scale of amplitude axis
Enter	Confirm settings
Esc	Exit scale mode

- Adjust the scale of the axes, using the cursor keys, and press *Enter* and *Esc*.
  The oscilloscope display with the adjusted axes is shown.

Adjust zero

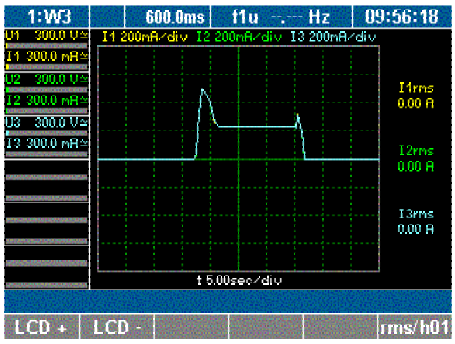
- Press function key *Offset.*
- Adjust the zero point by using the cursor keys and confirm with *Enter*.
  The oscilloscope display with the adjusted zero point is shown.

8.3.4 Recorder view

The recorder allows you to monitor measured values, by recording the mean measured values over time. This function is particularly useful for the detection of trends and amplitude variations. The actual graph depends on the configured range and average time (see chapter 7.1 "Call up General Setup", page 23). Prominent variations in the graph indicate errors in the measuring system.

View recorder

- Press measuring keys ∑or *1...n* and *WAV* to call up the desired values, e.g. current measured at channels 1 to 3.
- Press measuring key *Recorder*.
  The display shows a recording of the measured values.

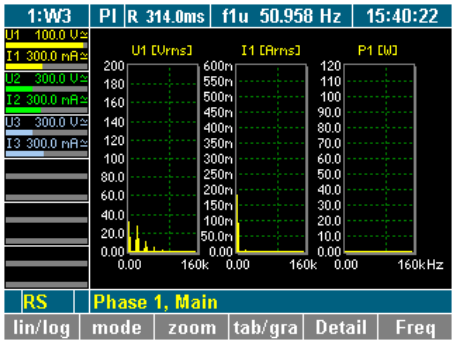


- drücken Sie nochmals die Funktionstaste *rms/h01*.

8.4 Fast Fourier analysis

Fast Fourier transformation (FFT) allows for the analysis of the individual frequency components of a signal. The harmonics may be viewed in graphical or tabluar format as percentages of fundamental H01.

- Press measuring keys *1...n* to call up the desired values, e.g. values measured at channels 1.
- Press measuring key *Fast Fourier analysis*.
  The frequency analysis is shown.



The following function keys are available:

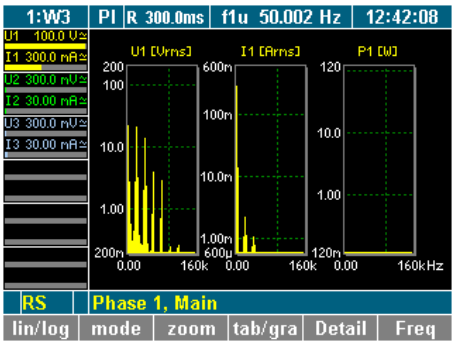
Function key	Description
lin/log	Switch between linear and logarithmic Y axis
mode	View harmonics
zoom	Shift X axis
tab/gra	Switch between table and graphic display
Detail	Switch between U, I and P of one phase; switch between displays of 1 or 3 values
Freq	Select frequency range

8.4.1 FFT mode

Adjust scale

You have the option choose between a linear or logarithmic Y-axis. By using the cursor keys, you can adjust the positions of the axes.

- Press function key *lin/log.*
  The scale of the graph changes from linear to logarithmic or vice versa (here: change to logarithmic).



- To change the scale of the axes, press function key *Zoom*.

Adjust the scale, using the cursor keys:

Cursor key	Function
left, right	Shift frequency axis
up, down	Change frequency
Enter	Confirm settings
Esc	Exit scale mode

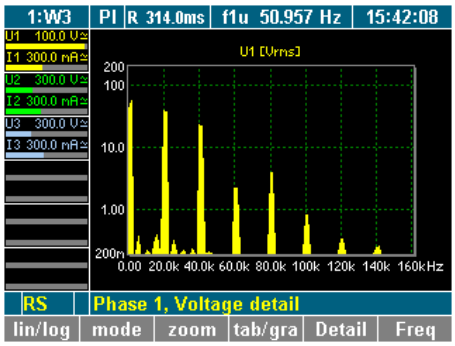
- Adjust the scale of the axes, using the cursor keys, and press *Enter* and *Esc*.

The graph with the adjusted axes is shown.

View details of a measured value

- Press function key *Detail.*

The details of measured value U1 (voltage) are displayed.



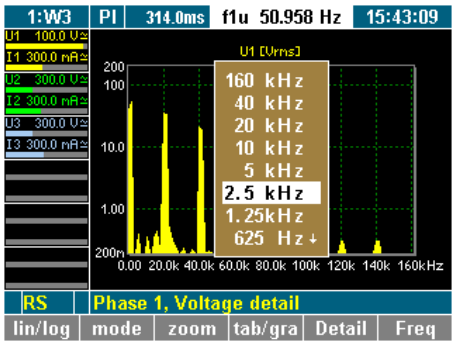
- Press function key *Detail* again.
  The details of measured value I1 (current) are displayed.
- Press function key *Detail* again.
  The details of measured value P1 (power) are displayed.
- To return to the overview of measured values of the selected channel, press function key *Detail* again.

Set frequency range

The default frequency range is set to maximum half of the sampling frequency.

Important
For signals with a lower frequency (e.g. 10 Hz), the frequency range must be adjusted, as measurements would otherwise be inaccurate.

- Press function key *Freq.*
  A list of possible values is displayed.

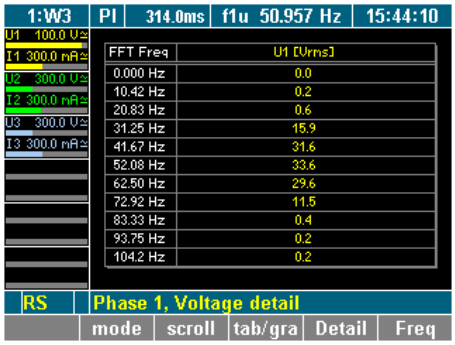


- Select a value, using the cursor keys, and press *Enter*.
  The frequency analysis is carried out up to the selected value, and the result is displayed.

Change view mode

You have the option to view individual measured values or a group of up to three values (e.g. all measured values of channel 1) in graphic or table format. By default, the measured values are shown in graphic format.

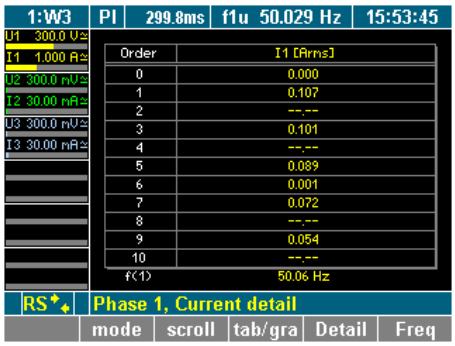
- Press function key *tab/gra.*
  The raw data is now shown in a table (here: voltage on channel 1).



8.4.2 Harmonic Order mode

View harmonics

- Press function key *mode* to call up a table showing the harmonics.



The table shows the integer harmonics (here: voltages of the individual harmonics on channel 1).

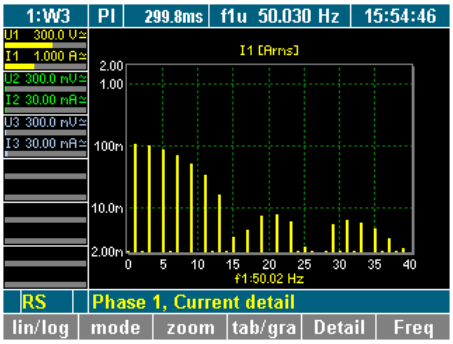
Display	Description
Order 0	DC content
Order 1	Fundamental
Order 2	2 x fundamental frequency
Order 3	3 x fundamental frequency
Order ...	n x fundamental frequency

- Press function key *scroll* to enable scrolling and paging through the table.

  To scroll and page, use the cursor keys:

Cursor key	Function
left, right	Page through table (screen by screen)
up, down	Scroll through table (line by line)
Enter	Confirm view and exit scale mode
Esc	Exit scale mode

- When you have reached the table section you wish to study in more detail, press *Enter* or *Esc*.
  The selected table section is now displayed.
- To change to a graphic display of the harmonics, press function key *tab/gra*.



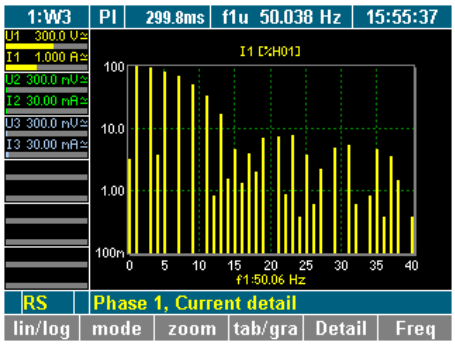
8.4.3 Harmonic Order mode related to fundamental in %

View spectrum relative to H01

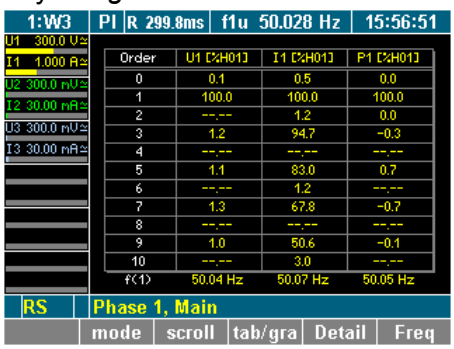
The harmonic spectrum can be viewed in percentages of fundamental H01.

Note
This view is important for the analysis of the input signal.

- Press function key *mode.*



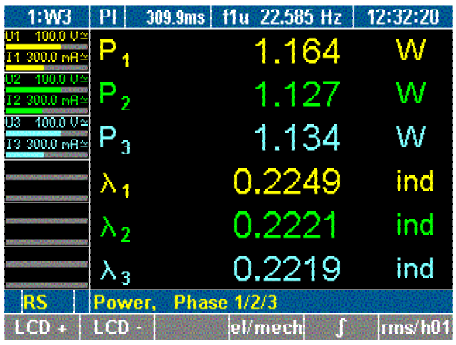
- To change to the table view of the spectrum, press function key *tab/gra*.



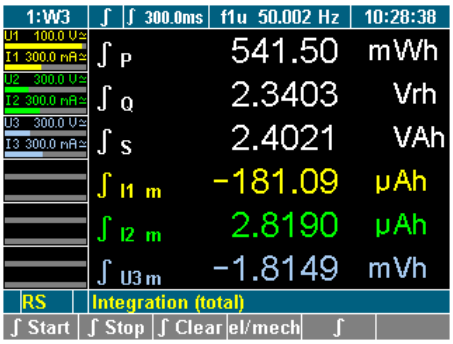
8.5 Integration function / electrical work

For the calculation of integrated values the values are measured over time. You can configure up to six independent values (Um, Im, S, P, Q) for the calculation.

- Press measuring key *WAV*.
  A key for the calculation of the electrical work is shown in the assignment bar for function keys.

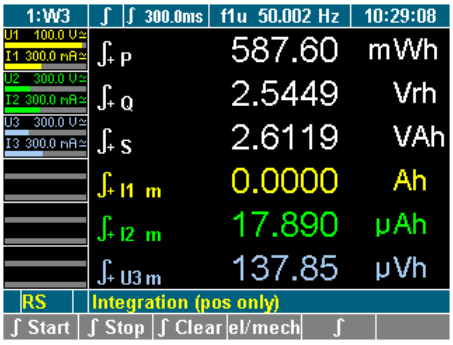


- Press function key ∫.
  The assignment bar shows the functions used for the calculation.

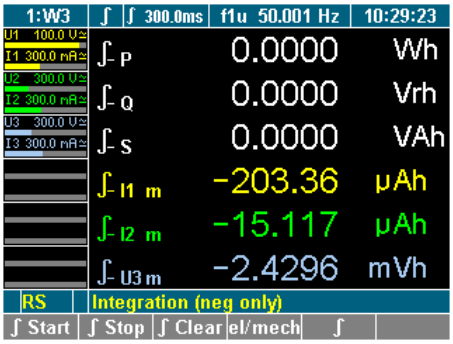


Function key	Function
∫ *Start*	Start measurement (integration)
∫ *Stop*	Stop measurement (integration)
∫ *Clear*	Reset measurement (integration) to zero
∫	Change to display of measured values

- Press function key ∫ *Start* to start the measuring process.
- Press function key ∫ *Stop* to stop the measuring process.
  The totals of the reference power are shown.



- Press function key ∫.
  The totals of the output power are shown.



- To return to the overview of measured values for the selected channel, press function key ∫ again.

8.6 Save and print measurements

8.6.1 Save measurements

You have the option to save the sampling values or measurements for later offline analyses, e.g. FFT, average startup currents or transient processes.

Note
Measuring key *Storage* works only in conjunction with PowerView Storage or NormaX software.

For more details, please refer to the user manuals of the respective software product.

8.6.2 Print measurements

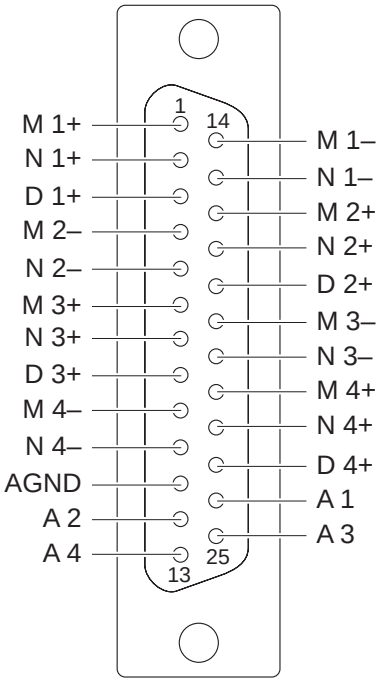
☑ Check whether a printer is connected.
☑ Ensure that the interface is properly configured (see chapter 7.3: "Configure data transfer to printer and PC", page 23.)
▸ Press measuring key *Print*.
The measured values are printed.

9 PI1 Process Interface (optional)

The PI1 interface allows you to simultaneously analyse the electrical and mechanical power of up to 4 motors (generators). The torque and rotational speed are thereby measured as analog signals or via frequency inputs.

9.1 Pin assignment

The PI1 is located on the rear panel of the power analyzer (see chapter 3 "Design and functions", page 7).



Pin	Assignment
M1+...M4+ *M1-...M4-*	4 inputs for torque; configurable for analog or digital signals
N1+...N4+ *N1-...N4-*	4 inputs for rotational speed; configurable for analog or digital signals
D1+...D4+	4 inputs for sense of rotation; only for motor analyses with digital speed inputs; corresponding inputs, e.g. N1/D1 share a LO port
AGND	Input of analog ground
A1...A4	4 analog outputs

9.2 Measured values

Torque

The torque is measured by means of a force transducer or torque measuring shaft with a ± 10V DC output or a frequency output.

Rotational speed

The speed is measured by means of an incremental encoder with TTl or AC output; alternatively, an analog signal, e.g. from a speedometer might be used.

Sense of direction

The sense of direction is detected by means of a permanent signal (L = sense of direction positive, H = sense of direction negative); alternatively, it might be determined using an incremental encoder. In this case, the following applies: if the signal is leading, the sense of direction is positive; if the signal is lagging, the sense of direction is negative.

9.3 Configuring PI1

Prior to starting the measuring process, the torque sensor and the speed sensor must be configured. To configure the process interface, select menu *Motor / Generator Setup*. The configuration procedure consists of the following steps:

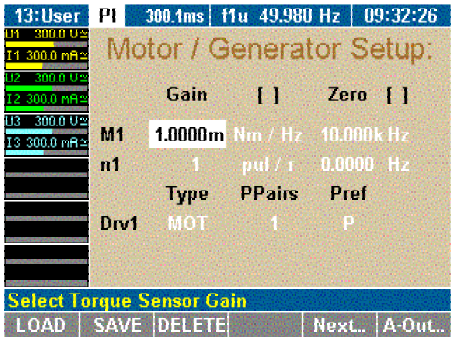
- Call up Motor / Generator Setup
- Select motor
- Configure torque sensor
- Configure speed sensor
- Configure other motors
- Configure analog outputs

Call up Motor / Generator Setup

☑ The device must be equipped with a PI1 process interface.
☑ Menu item *PI* must be shown in the menu bar

If the analyzer is equipped with a process interface, menu item PI is shown automatically in the menu.

▸ Move the cursor to menu item *PI* and press *Enter*.
Menu *Motor / Generator Setup* is displayed, showing the settings for motor 1 (*M1*).



Adjust the settings as follows:

Line	Description
M1	Configure torque measurement (input, slope and zero) for each motor
n1	Configure speed measurement (speed sensor)
Drv1	Set type (*Type*), pole pairs (*PPairs*) and reference power (*Pref*)

▸ If you have already saved a configuration that suits the measuring layout: press function key *LOAD*, select this configuration and confirm with *Enter*.
▸ Adjust configuration as described below.

Select motor

- To configure the system for motor 1, go to "Configure torque sensor"

  – or –

  - To configure another motor, press *Next ...* until the respective motor code (*M2*, *M3* or *M4*) is displayed.

Configure torque sensor

The torque can be measured by means of force transducers or a torque-measuring shaft. The signal is transferred via a ± 10V AC output or a frequency output. In line *M..* (e.g. for motor 1: *M1*), adjust the following settings:

Column	Settings	Description
Gain	*1...*	Slope
Unit	*Nm/Hz* *Nm/V*	Depending on force transducer or sensing shaft type
Zero	*1...*	Voltage or frequency corresponding to speed = 0
Unit	*Hz*, *V*	Unit for zero, depending on sensor type

- Move the cursor to a field in line *M1* and press *Enter*.
  A list of possible options is displayed.
- Select a value and confirm with *Enter*.
  The value is now shown in the display field.

Configure speed sensor

Possible speed sensors are: Incremental encoder (measuring with TTL / AC output) or an analog signal. In line *n..* (e.g. for motor 1: *n1*), adjust the settings as follows:

Column	Settings	Description
Gain	*1 ...*	Slope
Unit	*pul/r* *rpm/V*	Pulses per revolution Revolutions per volt
Zero	*1 ...*	Voltage or frequency corresponding to speed = 0
Unit	*Hz*, *V*	Unit for zero, depending on sensor type

- Move the cursor to a field in line *n1* and press *Enter*.
  A list of possible options is displayed.
- Select a value and confirm with *Enter*.
  The value is now shown in the display field.

Configure motor or generator

The analyzer can be used for the analysis of both motors and generators. To configure the device, adjust the settings in line *Drv1* (for motor 1):

Column	Settings	Description
Type	*MOT* *GEN*	Motor Generator
PPairs	*1 ... 999*	Number of pole pairs
Pref	*P ... P3*	Reference power for efficiency calculation

- Move the cursor to the field in line *Drv1* and press *Enter*.
  A list of possible options is displayed.
- Select a value and confirm with *Enter*.
  The value is now shown in the display field.
- Save the configuration for the motor by pressing *SAVE*.

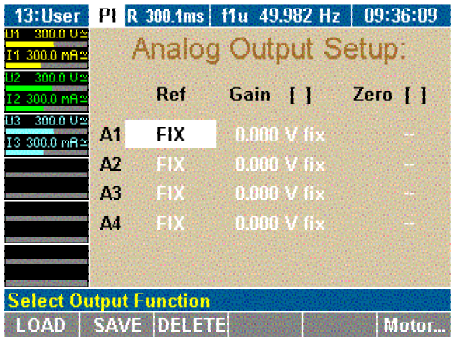
Configure other motors

- Press function key *Next....*
  The settings for motor 2 are displayed.
- Adjust settings for motors 2 to 4, following the above instructions for motor 1.
- Save the configurations for the motors by pressing *SAVE*.

Configure analog output

The 4 analog outputs (A1...A4) can be used to output the measured, calculated or averaged values or to transfer them to an external device for further processing. By default, the analog outputs are configured as voltage output for ±10 V. In order to output higher voltages, you must enter the relevant transducer ratio, e.g. 10 mV/V for a measured voltage of 220 V and an output of 2.2 V.

- Press function key *A-Out.*
  The *Analog Output Setup* menu is displayed.



Adjust the settings as follows:

Column	Settings	Description
Ref	*FIX* *U1, M1, P_{M1} ...*	Fixed DC voltage, or selection from available average measured values
Gain	*1...*	Transducer ratio or fixed value (-10.3 V to +10.3 V)
Column	**Settings**	**Description**
Unit	*V/A, V/V, V/Ohm, V/Hz* (depending no selected *Ref)*	e.g. 10 mV/V, i.e. 10 mV at the output correspond to 1 V of the measured value
Zero	*1...*	Set zero/offset
Unit	*A, W, V, Hz, Ohm*	Unit for zero, depending on selected *Ref*

- Move the cursor to a field in line *A1* and press *Enter*.
  A list of possible options is displayed.
- Select a value and confirm with *Enter*.
  The value is now shown in the display field.
- Configure analog outputs *A2* to *A4* accordingly.

9.4 Measuring with PI1

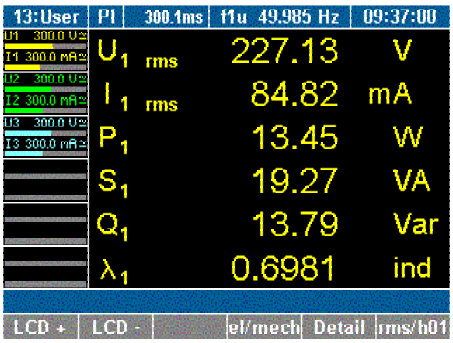
Torque, rotational speed and mechanical power are measured in real-time and averaged. They are combined with the measured electrical values so that slip and mechanical efficiency can be calculated.

☑ The device must be equipped with a PI1 process interface
☑ Menu item *PI* must be shown in the menu bar

If the analyzer is equipped with a process interface, menu item PI is shown automatically in the menu.

View measured electric values

▸ Press the measuring key for numerical display.
The measured values of channel 1 are shown.



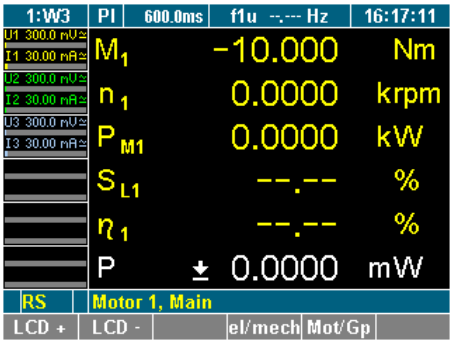
Display	Description
$U_{1\,rms}$	rms voltage value
$I_{1\,rms}$	rms current value
P_1	Real power
S_1	Apparent power
Q_1	Idle power
λ_1	Power factor

▸ Press measuring keys *1...n* to view the values of the respective channels.

▸ Press function key *el/mech.*

View mechanical values

The measured values of motor 1 are shown.



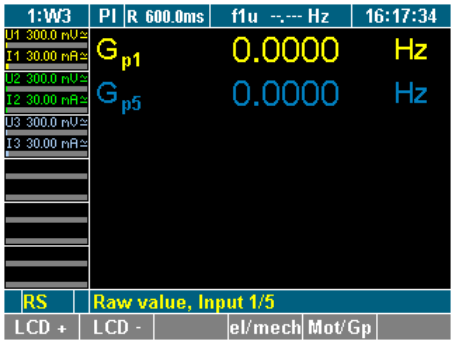
▸ Press measuring keys *1...n* to view the values of the respective inputs.

Display	Description
M_1	Torque of motor 1
n_1	Speed of motor 1
P_{M1}	Mechanical power of motor 1
S_{L1}	Slip of motor 1
η_1	Efficiency of motor 1
P	Electrical reference power, depending on configuration

View raw values

Raw values are unscaled values measured in a channel.

- Press function key *Mot/Gp*.
  The measured value of motor 1 is shown.

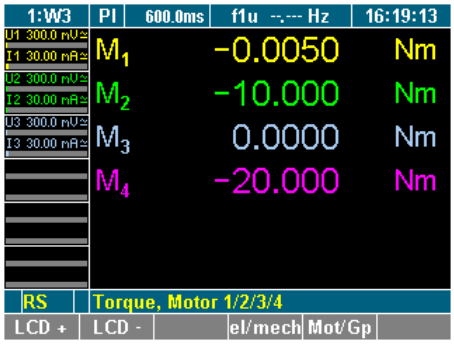


- Press measuring keys *1...n* to view the values of the respective inputs.

Display	Description
*G*p1	Torque of motor 1
*G*p2 ...	Torque of motor 2
*G*p5	Speed of motor 1
*G*p6 ...	Speed of motor 2

View all torques

- Press measuring key *WAV*.
  The torques of motors 1 to 4 are shown.



- Press key *WAV* again.

View all speeds

The rotational speeds of motors 1 to 4 are shown.

9.5 PI1 - technical data

9.5.1 8 inputs (analog/digital)

Each differential input can be configured individually as an analog or a digital input.

Input configured as analog input

Parameter	Voltage
Range	±10 V nominal (saturation region approx. +2 %)
Max. input voltage	±50 Vrms
Max. common mode voltage to ground	±10 V (without additional error)
	±25 V (without limitation by protective components)
Uncertainty of measurement	±(0.1 % of AVG+ 0.08 % of AVGR)

Input configured as digital input

Parameter	Frequency
Measuring signal	TTL-compatible or AC (switching threshold approx. +1.5 V ±0.5 V hysteresis)
Range	0.5 Hz ... 500 kHz *[1]
Max. input voltage	±50 Vrms
Max. common mode voltage to ground	±25 V
Uncertainty of measurement	±0.025 % of AVG

9.5.2 4 digital inputs for the detection of the sense of rotation

Inputs for the detection of the sense of rotation are only used for motors and in conjunction with the corresponding digital speed inputs.

*[1] The number of pulses per revolution must be synchronised with the rotational speed of the motor in such a way that the maximum measuring frequency is not exceeded. On the other hand, ensure that the resolution is sufficient to measure the frequency at low motor speeds.

9.5.3 4 outputs (analog)

Output voltage	max. ± 10.3 V; max. load 5 mA, short-circuit protected, shared LO connection to ground potential
Allowable external voltage	max. 50 Vrms at HI input
Additional error	± (0.15 % of AVG + 0.05 % of FV), final value FV = 10 V
Temperature coefficient	< 0.2 x fault limit/K
Output rate	corresponds to current average time
Resolution	approx. ± 8000 counts for ± 10 V, 1 count ≈ 1.25 mV
Rise time	10...90 %: approx. 10 ms
Response time	to ± 0.2 %: 25 ms
	to ± 1.0 %: approx. 20 ms

10 Formulas

10.1 Direct current

Resistance: $R = U / I$

Power (P): $P = U \cdot I$

10.2 Alternating current

Typical values for 230-V AC grid (50 Hz):

U_p	= 325 V	Periodic time t = 0.02 seconds
U_{rms}	= 230 V	(= 0.707 * Up
U_{gw}	= U_{rm} = 207 V	(= 0.637 * Up

Arithmetic mean: $U_m = \frac{1}{T}\int_0^T u\,dt$ (pure AC sine = 0)

RMS value: $U_{rms} = \sqrt{(1/T \int_0^T u^2 dt)}$

Rectified mean value: $U_{rm} = \frac{1}{T}\int_0^T /u/\,dt$

Crest factor: $cf = U_p / U_{rms}$

Form factor: $ff = U_{rms} / U_{rm}$

Rectified mean value corrected: $U_{rmc} = (U_{rm} \cdot 1{,}1107) = U_{rm} \cdot \pi / 2 \cdot \sqrt{2}$

Active power: $P = \frac{1}{T}\int_0^T (u \cdot i)\,dt$

Apparent power: $S = U \cdot I$

Reactive power: $Q = \sqrt{(S^2 - P^2)}$ (+...inductive, -...capacitive)

Power factor: $\lambda = P / S \rightarrow \cos\varphi \cdot g$ $\lambda_{H01} = (\cos\varphi) = P_{H01} / S_{H01}$

Apparent impedance: $Z = S / I_{rms}^{\ 2}$

Active energy: $W = \int (u \cdot i) dt$

Voltage phase to phase: $U_{12rms} = \sqrt{1/T \int_0^T (U_{x(t)} - U_{y(t)})^2 dt}$

Power corrected: $P_{cx} = \frac{P}{0{,}5 + 0{,}5 \cdot (\frac{U_{rms}}{U_{rm} \cdot 1{,}1107})^2}$ x = 1...6

10.3 Fundamental and harmonics

Harmonic content (according to DIN): $U_{hc} = k = \frac{\sqrt{(U_{H2}{}^2 + U_{H3}{}^2 + ... + U_{Hn}{}^2)}}{\sqrt{(U_{H1}{}^2 + U_{H2}{}^2 + ... + U_{Hn}{}^2)}} = \frac{\sqrt{U_{rms}{}^2 - U_{H01}{}^2}}{U_{rms}}$

Harmonic distortion (according to IEC): $U_{thd} = \frac{\sqrt{(U_{H2}{}^2 + U_{H3}{}^2 + ... + U_{Hn}{}^2)}}{U_{H01}} = \frac{\sqrt{U_{rms}{}^2 - U_{H01}{}^2}}{U_{H01}}$

Fundamental content: $I_{fc} = \frac{I_{H01}}{I_{rms}} \qquad \Rightarrow k^2 + fc^2 = 1$

10.4 Frequency analysis

Fourier transformation: $F(t) = \int_0^\infty [C(\omega) \cdot \cos(\omega t) + S(\omega) \cdot \sin(\omega t)] d\omega$

$C(\omega)$ Amplitude of cosine wave

$S(\omega)$ Amplitude of sine wave

The coherence with f(p) results in:

$f(p) = \pi \times [C(\omega) - jS(\omega)]$

amplitude spectrum: $F(\omega) = \sqrt{(C(\omega)^2 + S(\omega)^2)}$

phase angular: $\tan \varphi(\omega) = \frac{C(\omega)}{S(\omega)}$

10.5 Uncertainty of measurement

Uncertainty of measurement - power: $M_P = \frac{2}{\sqrt{3}} \times \sqrt{M_U{}^2 + M_I{}^2 + M_W^2}$

M_U Uncertainty of measurement - voltage

M_I Uncertainty of measurement - current

M_W Uncertainty of measurement - angle

11 Transport and Storage

11.1 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 + 50 °C and max. humidity of 85%.
- Protect the device against impacts and loads.

11.2 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 + 50 °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.

12 Warranty

- The warranty period for faultless operation and compliance with the specified uncertainty of measurement is limited to 2 years from the date of purchase.
- Damage due to improper use, overload or operation under conditions that are outside the range of permitted ambient conditions are not covered by the warranty.
- 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.

13 Recalibration

- The manufactorer recommends recalibrating the device every 2 years. The device can be calibrated by the manufactorer service department or any other calibration specialist.

14 Maintenance

- Ensure that the ventilation slots are not blocked. Otherwise, the device is maintenance-free.

15 Decommissioning and Disposal

15.1 Shutting down

- Ensure that all connected devices are switched off and disconnected from the power supply.
- Switch off the power 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.

15.2 Recycling and disposal

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

15.3 Packaging

- The following licence agreements have been entered into for the disposal of the packaging: ARA licence no. 1544 (Austria), DSD no. 2170305 (Germany).

15.4 Housing

- The housing is made in metal and can be recycled.

15.5 Electronic components

- The electronic components including the power adapter, filter, plug-in modules and wires have a weight of approx. 1500 g and a volume of approx. 3000 cm^3.

16 Technical Data

16.1 Technical data NORMA 4000

General technical data

Compact system	With 1 to 3 phases
	Continuous averages
Interface	Compatible to D5255
Housing	Metal housing
Weight	approx. 5 kg
Dimensions (W,H,D)	237 mm, 150 mm (3HU), 315 mm
Display	5.7“, 320 x 240 pixel; background illumination and contrast adjustable
Operation	Membrane keyboard, with cursor, function keys and direct functions
Mains connection	85 ... 264 V AC, 47 ... 440 Hz, DC 120 ... 370 V, approx. 40 VA Euro plug with switch
Measuring terminals	4 mm guard sockets, 2 each per input; or screw terminals external shunt connection via BNC socket

Ambient conditions

Operating temperature range	+5 ... +35 °C
Storage temperature range	−20 ... +50 °C
Climatic class	B2 (according to IEC 60654-1)
Relative humidity	max. 85 %, noncondensing

Specifications

Voltage

8 measuring range for U	0.3 – 1 – 3 – 10 – 30 – 100 – 300 – 1000 V
U_{peak}	2 x measuring range
Input impedance	2 Mohm // 20 pF
Common mode rejection	120 dB at 100 kHz

Current

6 measuring ranges for I direct (10A)	30 – 100 mA – 0.3 – 1 – 3 – 10 A
6 measuring ranges for I direct (20A)	60 – 200 mA – 0.6 – 2 – 6 – 2 A
I_{peak}	2 x range
Input impedance with integrated shunts (10A)	
Ranges	30, 100 mA: 1 ohm
	0.3, 1 A: 0.1 ohm
	3, 10 A: 0.01 ohm
Input impedance with integrated shunts (20A)	
Ranges	6, 20 mA: 0.5 ohm
	0.6, 2A: 0.05 ohm
	6, 2 A: 0.005 ohm
Measuring connection for shunt or probe	
BNC socket	100 kOhm // 30pF
Ranges	30 – 100mV – 0.3 – 1 – 3 – 10 V
Overload	max. 20 V_{eff}
Common mode rejection	120 dB at 100 kHz

Limit of error

Power phase	PP30	PP40	PP42	PP50	PP51	PP52	PP54
Limit of error	U	U	U	U	U	U	U
reading	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%	0,05%
range	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%	0,05%
Limit of error	I	I	I	I	I	I	I
reading	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%	0,05%
range	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%	0,05%

This data is valid for averages and the following reference conditions:

- Ambient temperature 23 +- 0.5 °C, frequency 50 Hz, heat-up time of minimum 1 hour and incoming measuring signal.

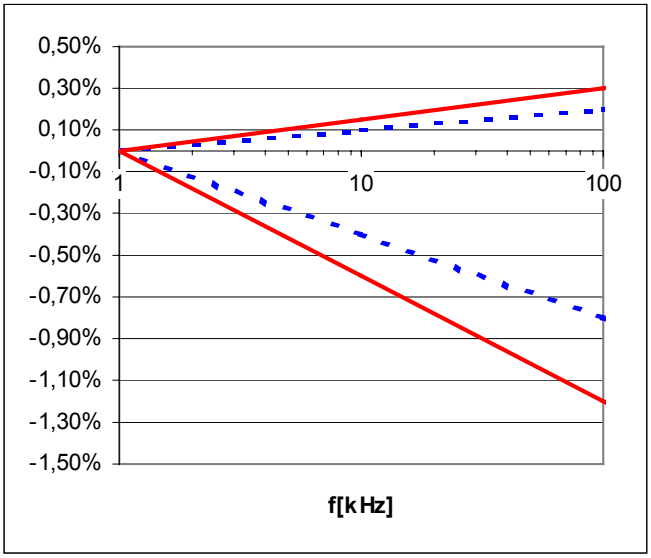
Sample rate

Power Phase	PP30	PP40	PP42	PP50	PP51	PP52	PP54
Sample rate	102kHz	341kHz	341kHz	1MHz	1MHz	341kHz	341kHz

Bandwidth

Bandwidth	U direct	I via BNC	I direct measured
PP30	1 MHz	1 MHz	0,3 MHz
PP40	3 MHz	3 MHz	1 MHz
PP42	3 MHz	3 MHz	0,5 MHz
PP50	10 MHz	10 MHz	1 MHz
PP51	3 MHz	3 MHz	1 MHz
PP52	3 MHz	3 MHz	0,5 MHz
PP54	3 MHz	3 MHz	1 MHz

Diagram Bandwidth (limit of error) Power Phase PP40



For accurate measurements, harmonics over 1 MHz may reach maximum half of the range.

Angle error

Power phase PP30	between U and I_{BNC}	between U and I_{direct}
Angle error	0,1° + 0,1° /kHz	0,1° + 0,1° /kHz
All other power phases		
Angle error	0,005° + 0,005° /kHz	0,025° + 0,015° /kHz

Frequency and synchronisation

Range	0.2Hz ... Sample rate (102kHz / 341kHz / 1MHz)
Measurement error	±0.01% rdg
Channel selection	all channels U/I, or external input
Low-pass filter	optionally integratable, with 3 different limit frequencies
External Sync-input	Max. 50V, 0,2Hz to sample rate
Sync-output	Pulsed TTL signal 5V

Data memory

Measured data memory	approx. 4 MB

Configuration memory

The current instrument settings can be stored as configurations in a non-volatile memory for subsequent reloading. Changes that are not saved in a configuration are lost when the device is switched off. Up to 15 user-defined configurations can be permanently stored under predefined names.

Interfaces

RS 232	RS 232 interface for firmware upload and data exchange with PC; the device can be connected to a printer through an external adapter
GPIB	IEEE 488.2 / 1 MBit/s
LAN	Ethernet / 10 MBits/s or 100 MBits/s
USB	USB 2.0

Standards

Electrical safety	
EN 61010-1/ 2. edition 1000V CAT II (600V CAT III)	Degree of pollution 2, Protection class I
EN 61558	for transformer
EN 61010-2-031/032	for accessories
Electromagnetic compatibility	
Emission	IEC 61326-1, EN 50081-1, EN 55011 class B
Immunity	IEC 61326-1 / annex A (industrial), EN 50082-1
Max. input voltage	
for voltage inputs	Range 1000 V_{eff}, 2 kV_{peak}
for current inputs	Range 10 A_{eff}, 20 A_{peak}
Test voltages	
Mains input housing (earth connector)	1.5 KV a.c.
Mains connection measuring inputs	5.4 kV a.c.
Measuring inputs housing	3.3 kV a.c.
Measuring input measuring input	5.4 kV

16.2 Technical data NORMA 5000

General technical data

Compact system	With 1 to 6 phases
	Continuous averages
Interface	Compatible to D5255
Housing	Metal housing
Weight	approx. 7 kg
Dimensions (W,H,D)	447 mm, 150 mm (3HU), 315 mm
Display	5.7“, 320 x 240 pixel; background illumination and contrast adjustable
Operation	Membrane keyboard, with cursor, function keys and direct functions
Mains connection	85 ... 264 V AC, 47.. 440Hz, DC 120 ... 370 V, approx. 40 VA Euro plug with switch
Measuring terminals	4 mm guard sockets, 2 each per input; or screw terminals external shunt connection via BNC socket

Ambient conditions

Operating temperature range	+5 ... +35 °C
Storage temperature range	−20 ... +50 °C
Climatic class	B2 (according to IEC 60654-1)
Relative humidity	max. 85 %, noncondensing

Specifications

Voltage

8 measuring range for U	0.3 – 1 – 3 – 10 – 30 – 100 – 300 – 1000 V
U_{peak}	2 x measuring range
Input impedance	2 Mohm // 20 pF
Common mode rejection	120 dB at 100 kHz

Current

6 measuring ranges for I direct (10A)	30 – 100 mA – 0.3 – 1 – 3 – 10 A
6 measuring ranges for I direct (20A)	60 – 200 mA – 0.6 – 2 – 6 – 20 A
I_{peak}	2 x measuring range
Input impedance with integrated shunts (10A)	
Ranges	30, 100 mA: 1 ohm
	0.3, 1 A: 0.1 ohm
	3, 10 A: 0.01 ohm
Input impedance with integrated shunts (20A)	
Ranges	60, 200 mA: 0.5 ohm
	0.6, 2 A: 0.05 ohm
	6, 20 A: 0.005 ohm
Measuring connection for shunt or probe	
BNC socket	100 kOhm // 30pF
Ranges	30 – 100mV – 0.3 – 1 – 3 – 10 V
Overload (bar)	max. 20 V_{eff}
Common mode rejection	120 dB at 100 kHz

Limit of error

Power phase	PP30	PP40	PP42	PP50	PP51	PP52
Limit of error	U	U	U	U	U	U
reading	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%
range	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%
Limit of error	I	I	I	I	I	I
reading	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%
range	0,15%	0,10%	0,10%	0,05%	0,05%	0,05%

This data is valid for averages and the following reference conditions:

- Ambient temperature 23 +- 0.5 °C, frequency 50 Hz, heat-up time of minimum 1 hour and incoming measuring signal.

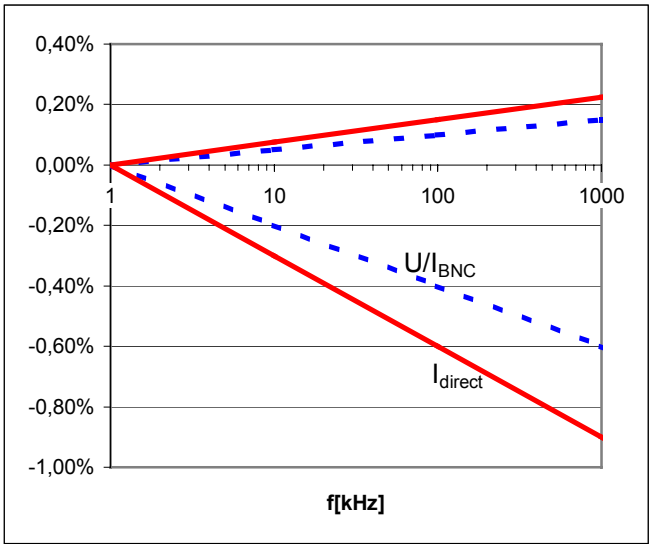
Sample rate

Power Phase	PP30	PP40	PP42	PP50	PP51	PP52	PP54
Sample rate	102kHz	341kHz	341kHz	1MHz	1MHz	341kHz	341kHz

Bandwidth

Bandwidth	U direct	I via BNC	I direct measured
PP30	1 MHz	1 MHz	0,3 MHz
PP40	3 MHz	3 MHz	1 MHz
PP42	3 MHz	3 MHz	0,5 MHz
PP50	10 MHz	10 MHz	1 MHz
PP51	3 MHz	3 MHz	1 MHz
PP52	3 MHz	3 MHz	0,5 MHz
PP54	3 MHz	3 MHz	1 MHz

Diagram Bandwidth (limit of error) Power Phase PP50:



Angle error

For accurate measurements, harmonics over 1 MHz may reach maximum half of the range.

Power phase PP30	between U and I_{BNC}	between U and I_{direct}
Angle error	0,1° + 0,1° /kHz	0,1° + 0,1° /kHz
All other power phases		
Angle error	0,005° + 0,005° /kHz	0,025° + 0,015° /kHz

Frequency and synchronisation

Range	0.2Hz ... Sample rate (102kHz / 341kHz / 1MHz)
Measurement error	±0.01% rdg
Channel selection	all channels U/I, or external input
Low-pass filter	optionally integratable, with 3 different limit frequencies
External Sync-input	Max. 50V, 0,2Hz to sample rate
Sync-output	Pulsed TTL signal 5V

Data memory

Measured data memory	approx. 4 MB

Configuration memory

The current instrument settings can be stored as configurations in a non-volatile memory for subsequent reloading. Changes that are not saved in a configuration are lost when the device is switched off. Up to 15 user-defined configurations can be permanently stored under predefined names.

Interfaces

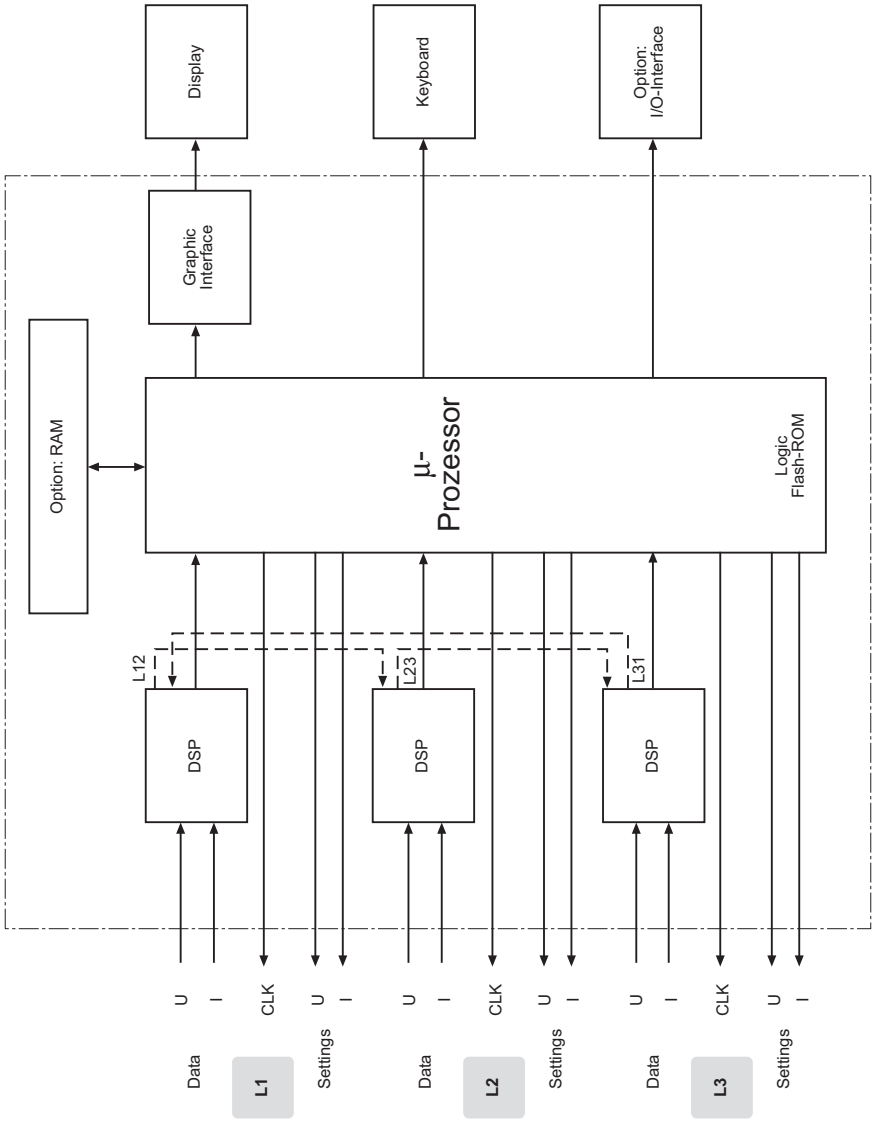
RS 232	RS 232 interface for firmware upload and data exchange with PC; the device can be connected to a printer through an external adapter
GPIB	IEEE 488.2 / 1 MBit/s
LAN	Ethernet / 10 MBits/s or 100 MBits/s
USB	USB2.0

Standards

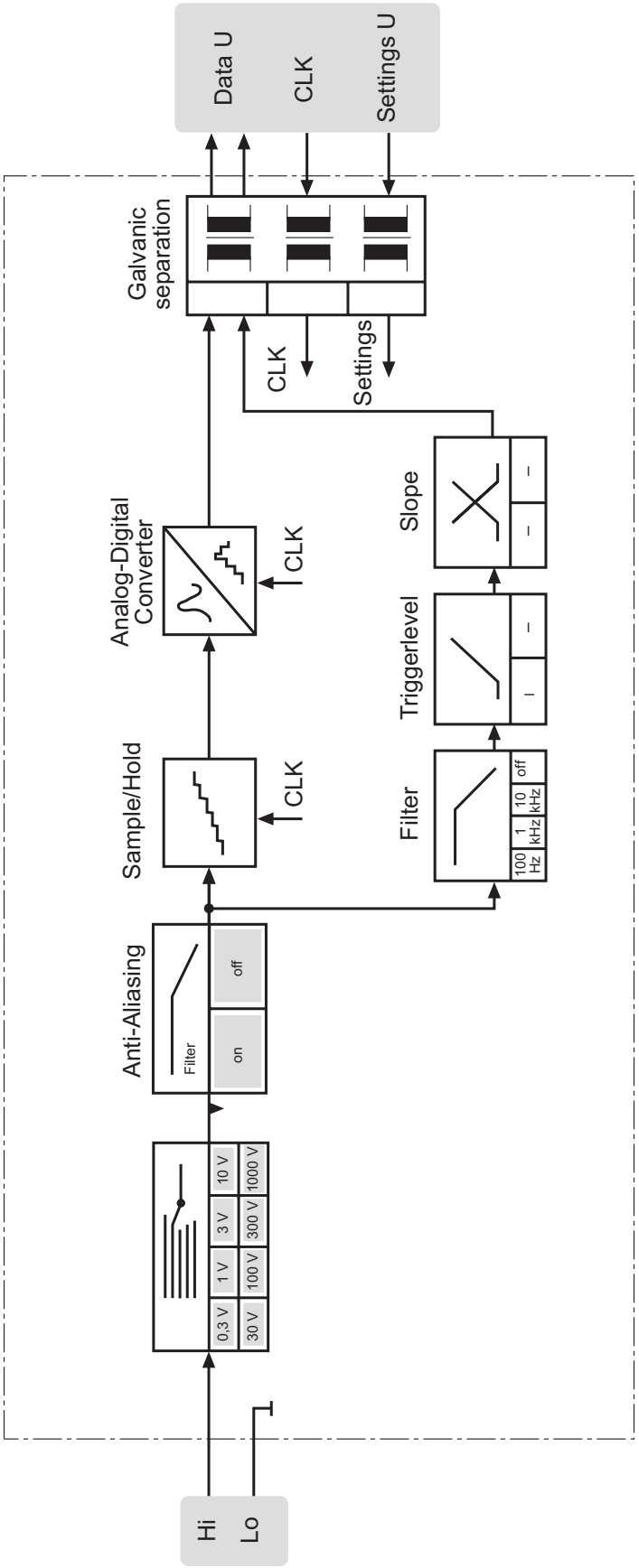
Electrical safety	
EN 61010-1/ 2. edition 1000V CAT II (600V CAT III)	Degree of pollution 2, Protection class I
EN 61558	for transformer
EN 61010-2-031/032	for accessories
Electromagnetic compatibility	
Emission	IEC 61326-1, EN 50081-1, EN 55011 class B
Immunity	IEC 61326-1 / annex A (industrial), EN 50082-1
Max. input voltage	
for voltage inputs	Range 1000 V_{eff}, 2 kV_{peak}
for current inputs	Range 10 A_{eff}, 20 A_{peak}
Test voltages	
Mains input housing (earth connector)	1.5 KV a.c.
Mains connection measuring inputs	5.4 kV a.c.
Measuring inputs housing	3.3 kV a.c.
Measuring input measuring input	5.4 kV

16.3 Block diagrams

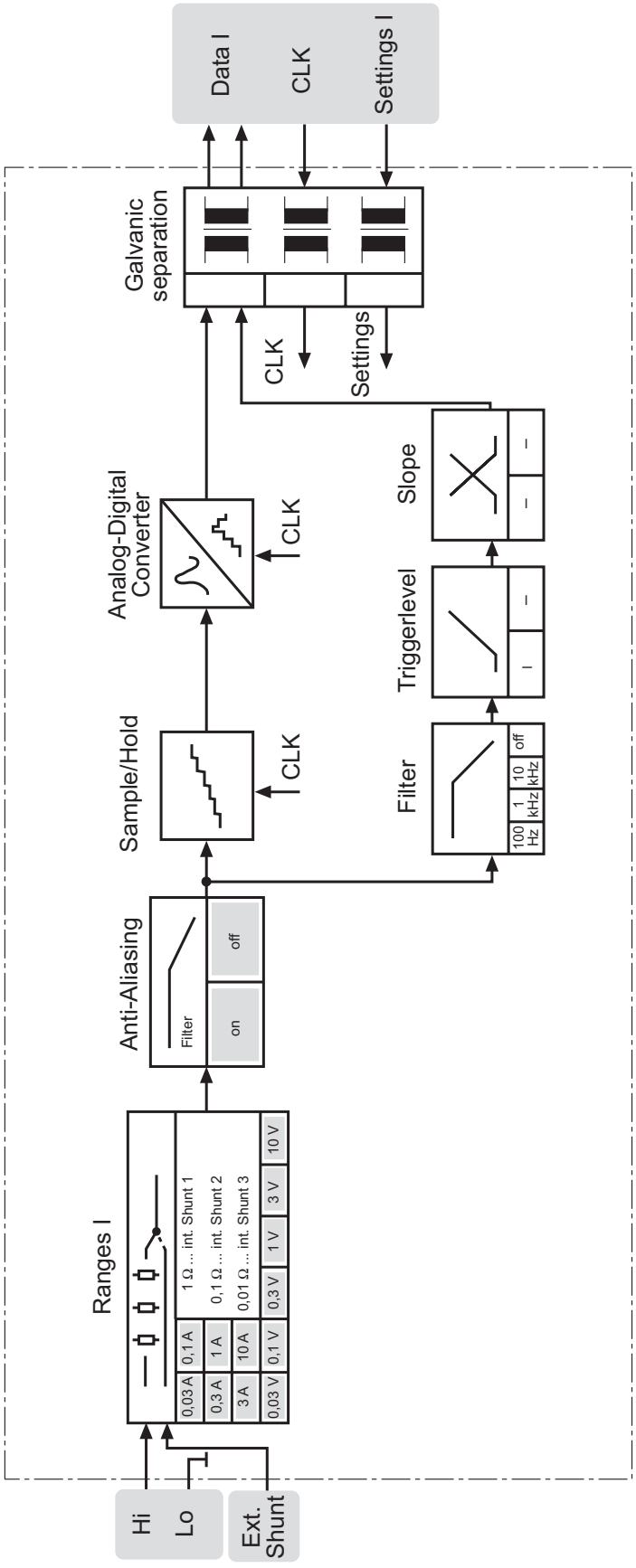
Overview



Voltage channels



Current channels



17 Service and Accessories

17.1 Instrument

Analyzer

Product	Description/technical specifications	Prod. no.
NORMA 4000 BU 43	Basic unit 2/3 19“, with power adapter, 5.7" colour display, back lighted RS 232 interface for firmware upload, catering for 3 power phases and optional extensions	EA 1430 Z
NORMA 5000 BU 56	Basic unit 19“, with power adapter, 5.7" colour display, back lighted RS 232 interface for firmware upload, catering for 6 power phases and optional extensions	EA 1560 Z
PP 30	Power phase for voltage, current (10A) and power measurement, bandwidth 1 MHz, sampling rate 102kHz limit of error ±0.15% measured value and ±0.15% range	EA 1300 Z
PP 40	Power phase for voltage, current (10A) and power measurement, bandwidth 3 MHz, sampling rate 1/3 MHz limit of error ±0.1% measured value and ±0.1% range	EA 1400 Z
PP 42	Power phase for voltage, current (20A) and power measurement, bandwidth 3 MHz, sampling rate 1/3 MHz limit of error ±0.1% measured value and ±0.1% range	EA 1420 Z
PP 50	Power phase for voltage, current (10A) and power measurement, bandwidth 10 MHz, sampling rate 1 MHz limit of error ±0.05% measured value and ±0.05% range	EA 1500 Z
PP 52	Power phase for voltage, current (20A) and power measurement, bandwidth 3 MHz, sampling rate 1/3 MHz limit of error ±0.05% measured value and ±0.05% range	EA 1520 Z
PP 54	Power phase for voltage, current (10A) and power measurement, bandwidth 3 MHz, sampling rate 1/3 MHz limit of error ±0.05% measured value and ±0.05% range	EA 1540 Z

Optional equipment

Product	Description/technical specifications	Prod. no.
IF3 interface USB	USB2.0 and Ethernet	EA 1001 Z
IF2 interface IEEE488	IEEE 488 and Ethernet	EA 1002 Z
PI1 process interface	8 analog/pulse inputs, 4 analog outputs	EA 1003 Z
Internal printer	Thermal printer for NORMA 5000	EA 1006 Z
PC printer cable	RS-232 Centronics, 1.8 m	EA 1007 Z
Additional memory	128 MB additional memory for NORMA 5000	EA 1010 Z
Rs232 cable	1,5m length 1:1 connected	EA 1011Z
LAN cable	2m length, crossed	EA 1012Z
USB cable	1,5m length, A to B plug	EA 1013Z

17.2 Accessories

Accessories

Product	Description/technical specifications	Prod. no.
MC1	Measuring lead set for power phase, cable length 1.5 m	EA 1030 Z
Planar Shunt 32	32 A 10 mohm 0-1 MHz	EA 1032 Z
Shunt 100	Scale 30 A / approx. 30 mV,	A641401100
Shunt 300	300 A, 0.2 mohm 0-1 MHz	EA 1033 Z
Shunt 1000	1000 A, 0.1 mohm 0-0.5 MHz	EA 1034 Z
Shunt 1500	1500 A, 0.1 mohm 0-0.2 MHz	EA 1035 Z
Shunt 450	450 A, increased measuring voltage 0.5 mohm 0-0.5 MHz	EA 1036 Z
MCP	Measuring lead for planar shunt, 1.5 m	EA 1038 Z
MCS	Measuring lead for shunt, 1.5 m	EA 1039 Z
IT 150-S	Transducer 150 A / 0.2 A DC … 100kHz	EA 1045 Z
IT 600-S	Transducer 600 A / 0.4 A DC ... 100 kHz	EA 1046 Z
LT 3	Power unit for up to 3 IT transducers	EA 1047 Z
RR 3030	Lemflex 30/300/3000A with BNC plug 10 Hz-50 kHz	EA 1051 Z
Probe PR1235X	Passive probe 1000 / 1 A 30 Hz ... 10 kHz	EA 1052 Z
Probe PR201 ACI	Passive probe 200 / 0,2 A 40 Hz ... 10 kHz	EA 1053Z
SP	3-phase star point adapter	EA 1059 Z
Bag	Carrier bag for NORMA 4000	EA 1060 Z

Software

Product	Description/technical specifications	Prod. no.
PowerVIEW Basic	Basic PC software package for numerical display	EA 1090 Z
PowerVIEW Motor	Plug-in "Motor" supports the motor process interface	EA 1091 Z
PowerVIEW Storage	Plug-in "Storage" Data memory functions, DSO	EA 1092 Z
PowerVIEW Harmonic	Plug-in "Harmonic" (FFT, Harmonic analysis)	EA 1093 Z
PowerVIEW Developer	Software package for the design of customer applications; training and support are available on request	EA 1094 Z

17.3 Service

General

- The power analyzer may only be serviced by specialised service workshops authorised by LEM Norma.

Service

Product	Description/technical specifications	Prod. no.
Cal BU	Recalibration of the first power phase of the analyzer, including LNO test report	EA 1071 Z
Cal PP	Recalibration of each of the other power phases, including LNO test report	EA 1072 Z
Cal 500	Recalibration of a shunt of up to 500A	EA 1075 Z
Cal 1500	Recalibration of a shunt of up to 1500A	EA 1076 Z

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