

4-Channel Power Meter LMG450

Universal Meter for Motors, Power Electronics
and Energy Analysis

**Best
Accuracy
0.1%**



Cut to Half!
Active Power
0.07% rdg + 0.04% rng

General

The four-channel LMG450 power meter is another advanced product from ZES ZIMMER LMG series of precision power meters, tried and tested and with great acceptance in the market. It is designed as a universal meter for the entire field

of power electronics and network analysis. It can be used in practically all power electronics applications, in development and test systems, in quality assurance and maintenance. It is fully frequency inverter compatible.

Of course, it can also be used for measurements in motors, transformers, conventional and switched power supply units. It is also suitable for mains analysis measurements.

Easy operation thanks to colour graphics display and hotkeys for important measured values

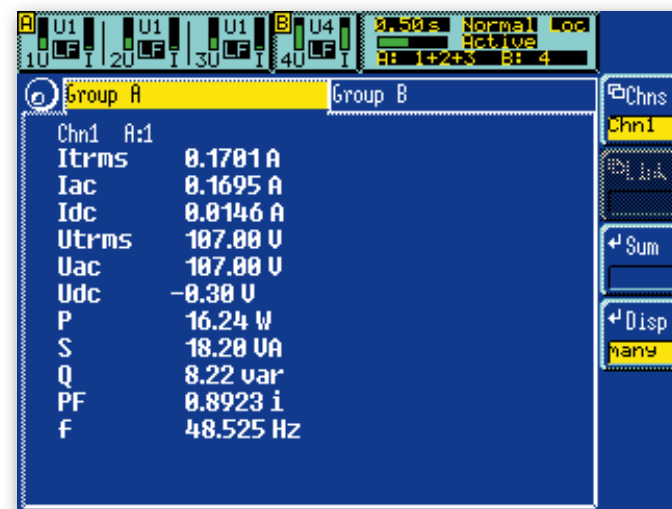
Various value tables can be called on the colour graphics display at the press of a key, either with six values in large letters, which can also be read at a glance from a greater

distance, with twelve values or with up to 40 values e.g. in range setting or in harmonics table. The graphics display allows scope and plot functions for waveform and timing diagrams, as well as xy diagrams or bar charts for the harmonics. The status bar at the top of each display menu shows the

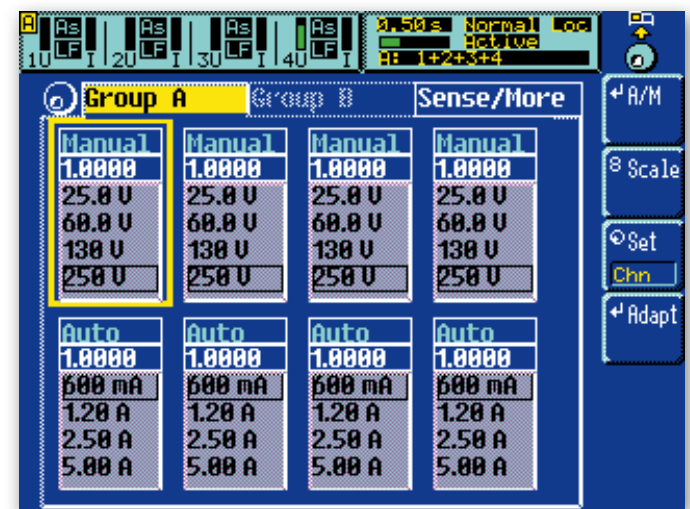
input level of the four voltage and the four current inputs – an important item of information for the quality of the measurement. The display also indicates what groups, A and B, the input channels are switched to and which signals the groups are synchronised to.



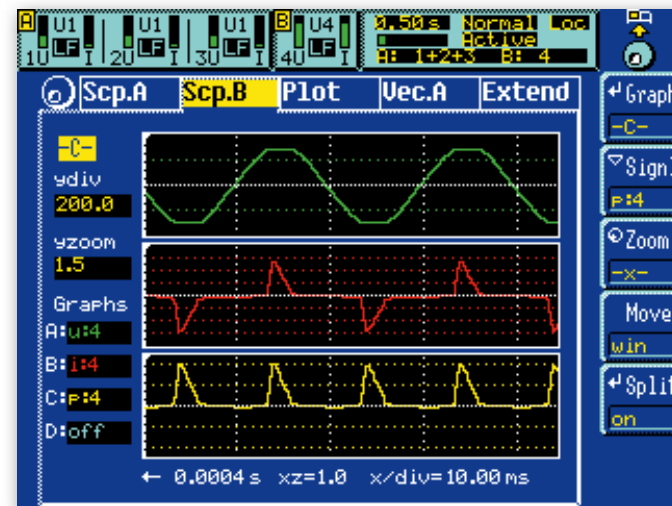
Status bar



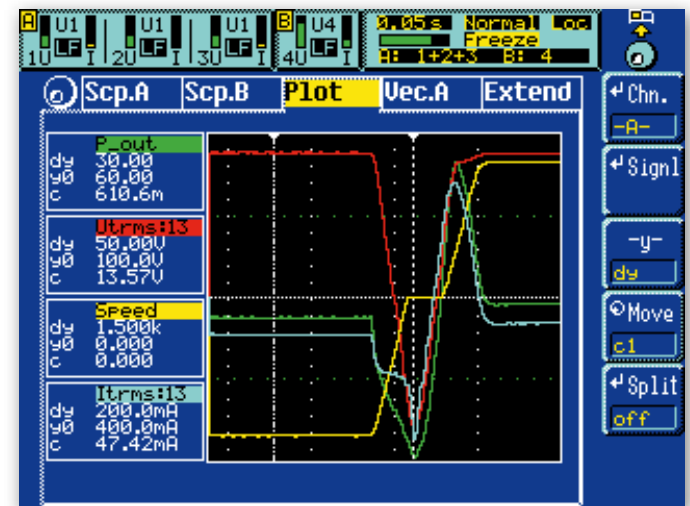
Channel 1 with 11 measuring values



Range setting and scaling



Scope function for waveform of sampling values



Plot function of calculated values

Measurement inputs

The direct measurement inputs for voltage and current have a very wide dynamic range: Eight voltage ranges from 6V to 600V, and six ranges for current from 0.6A to 16A. A further voltage input (six

ranges from 0.12V to 4V), designed for isolating current sensors, extends the current measuring range almost indefinitely. With the help of the special current clamps supplied by ZES ZIMMER and designed

for the LMG450, current can be measured during running operations, without interrupting the current path.



LMG450 – rear view

Compensated current clamp
Part No. L45-Z06

A special current measuring device is the compensated current clamp by ZES ZIMMER. It features electronic compensation of amplitude and delay errors. Even at low current levels of 1A to 40A, measurement is exact in the frequency range from 5Hz to 20kHz. Due to its high dynamic common-mode rejection, this current clamp is also very suitable for carrying out measurements at the frequency inverter output.



Compensated current clamp L45-Z06

Various methods of applying current to be measured

| | | |
|---|---|---|
| <p>Direct measurement 0.6 ... 16A (6 Ranges) DC ... 20 kHz</p> | <p>4mm safety sockets 600V CAT III</p> | <p>PSU200/400/600/700 Precision current transducer 1A ... 700A_{peak} DC ... 20kHz (300kHz, bandwidth of sensor is limited by LMG450)</p> |
| <p>Standard current clamps with current outputs >0.5A 100A ... 3000A 45Hz ... 3kHz</p> | | <p>Standard current clamps with voltage/current (<0.5A) outputs 10A ... 200A 45Hz ... 3kHz</p> |
| <p>Compensated ZES current clamps 1.2A ... 40A (6 Ranges) 5Hz ... 20kHz</p> | <p>HD15 sockets for external sensors</p> | <p>Hall effect transducers 5A ... 200A DC ... 20kHz</p> |
| <p>Magneto-resistive current transducer modules 5A ... 50A DC ... 20kHz</p> | | <p>DC/AC current clamps with voltage output e.g. for oscilloscopes 10A ... 200A DC ... 20kHz</p> |

4 independent power measuring channels

| Ch 1 | Ch 2 | Ch 3 | Ch 4 |
|-----------------------|-------|--------------|-------|
| 4Ø 4W / 4Ø 5W | | | |
| 1Ø 2W | 1Ø 2W | 1Ø 2W | 1Ø 2W |
| 3Ø 3W / 3Ø 4W / 4Ø 4W | | | 1Ø 2W |
| 3Ø 3W (Aron) | | 3Ø 3W (Aron) | |
| 3Ø 3W (Aron) | | 1Ø 2W | 1Ø 2W |

The current and voltage paths of the four power measuring channels are all isolated from each other and from earth. This allows a high degree of measuring freedom in many different power measurement applications. The adjacent table shows various types of wirings for grouped and individual measurement channels. The table also assigns application examples for the respective types of wiring. Power measurement channels 1 and 4 can each be synchronised to their input signals (fundamental waves etc.) independent of each other. Channels 1 and 4 are then the synchronisation references for the other channels contained in groups A and B. This is a very useful method for carrying out efficiency measurements for equipment where the input and output have different frequencies, for example a 3-phase frequency inverter with single-phase mains supply.

| Device | Measured Value | Ch 1 | Ch 2 | Ch 3 | Ch 4 | Appropriate setting of wiring |
|---|--|----------|----------|----------|---------------|-------------------------------|
| 4Ø motors | Power of all windings | Phase 1 | Phase 2 | Phase 3 | Phase 4 | 4+0 |
| High power batterie chargers (3Ø -> DC) | Input and output power, efficiency | Phase 1 | Phase 2 | Phase 3 | DC-Out | 3+1 (UΔ I* -> U* I*) |
| Rectifier section of inverters (3Ø -> DC) | Input power, rectifier efficiency | Phase 1 | Phase 2 | Phase 3 | DC-Bus | 3+1 (UΔ I* -> U* I*) |
| Output section of inverters (DC -> 3Ø) | Output power, chopper efficiency | AC-Out 1 | AC-Out 2 | AC-Out 3 | DC-Bus | 3+1 (UΔ I* -> UΔ IΔ) |
| 1Ø -> 3Ø inverter Low power motor drives | Input and output power, efficiency | AC-Out 1 | AC-Out 2 | AC-Out 3 | Phase 1 | 3+1 (UΔ I* -> U* I*) |
| Power supplies with multiple outputs | Input and output power, efficiency | DC-Out 1 | DC-Out 2 | DC-Out 3 | Phase 1 | 3 +1 |
| 1Ø Transformers with multiple output windings | Input and output power, efficiency | AC-Out 1 | AC-Out 2 | AC-Out 3 | AC-In | 3+1 |
| 3Ø loads with auxiliary supplies | Complete input power | Phase 1 | Phase 2 | Phase 3 | Aux. AC or DC | 3+1 (UΔ I* -> UΔ IΔ) |
| 3Ø -> 3Ø inverter High power motor drives | Input and output power, efficiency | AC-In 1 | AC-In 2 | AC-Out 1 | AC-Out 2 | 2+2 (UΔ I* -> UΔ IΔ) |
| 3Ø -> 1Ø AC power source | Input-, output- and DC-Bus power, efficiency | AC-In 1 | AC-In 2 | DC-Bus | AC-Out | 2+2 (UΔ I* -> U* I*) |

Wiring settings in () are featured by option „Star-Delta Conversion“

Group A

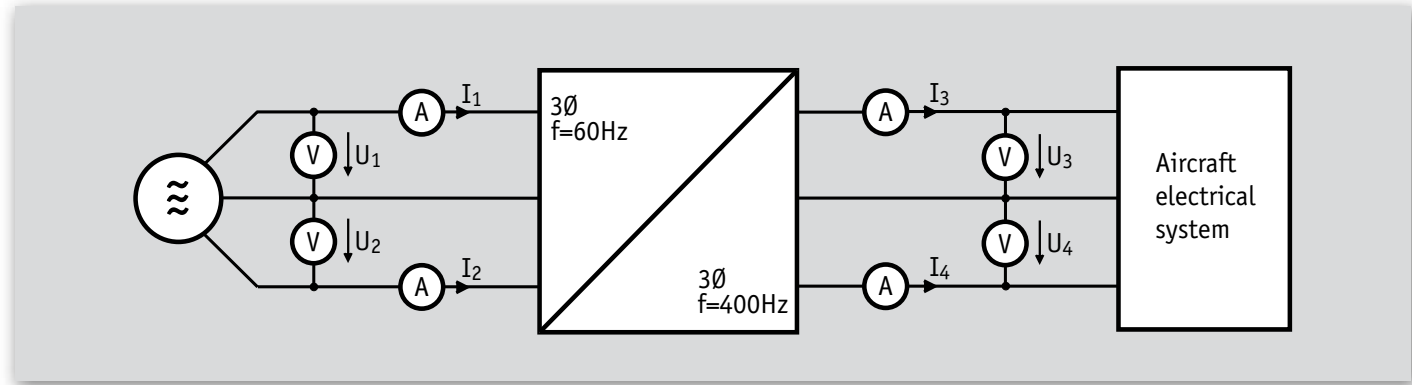
Group B

Measurement on two systems with different frequencies

In wiring A:1+2 B:3+4, the ARON circuit is two times used. The block diagram shows that

only one LMG450 is needed for complete measurement. Generally frequency converters

for speed variable drives or frequency conversion have no neutral on input or output.

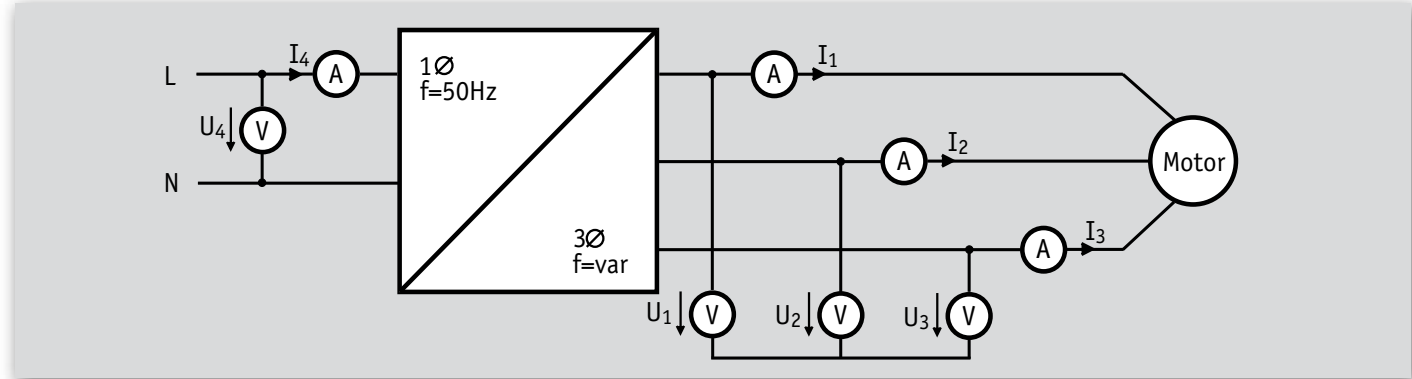


60Hz -> 400Hz

The following block diagram applies wiring A:1+2+3 B:4 and is typical for a low power speed

variable drive. This example is used to explain the settings and displays of the LMG450.

The screenshots were made with the free software BMP2PC from ZES ZIMMER.



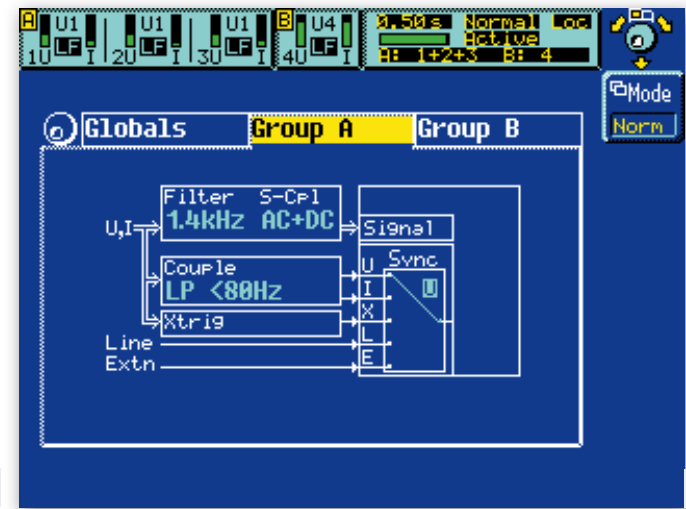
50Hz -> f=variable

1 Setting of global parameters, e.g. wiring (see table at previous page)



1

2 Configuration of measuring inputs and synchronisation source for group A



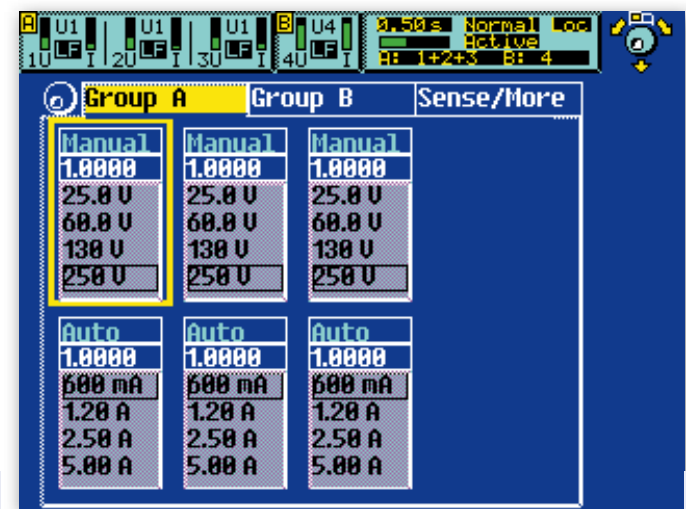
2

3 Configuration of measuring inputs and synchronisation source (same as picture 2, but for group B)



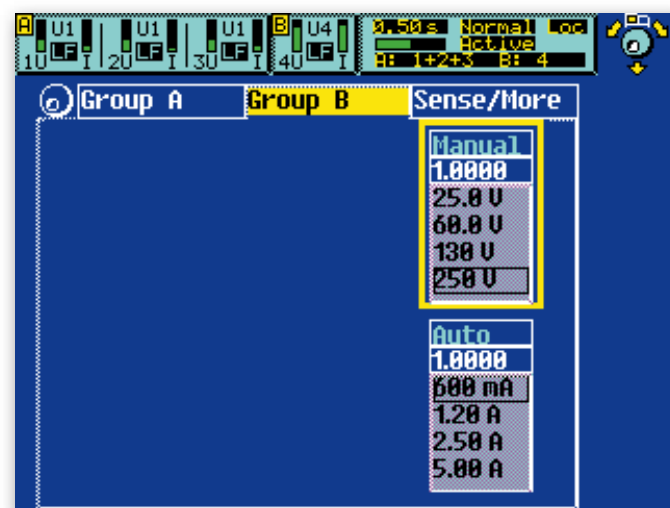
3

4 Measuring ranges, autorange or manual, setting of scaling factors for external CT's or VT's (group A)



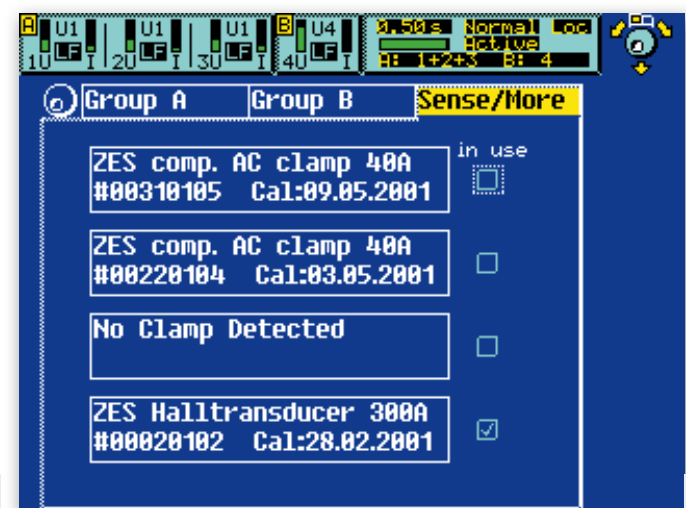
4

5 Measuring ranges, autorange or manual, setting of scaling factors for external CT's or VT's (group B)



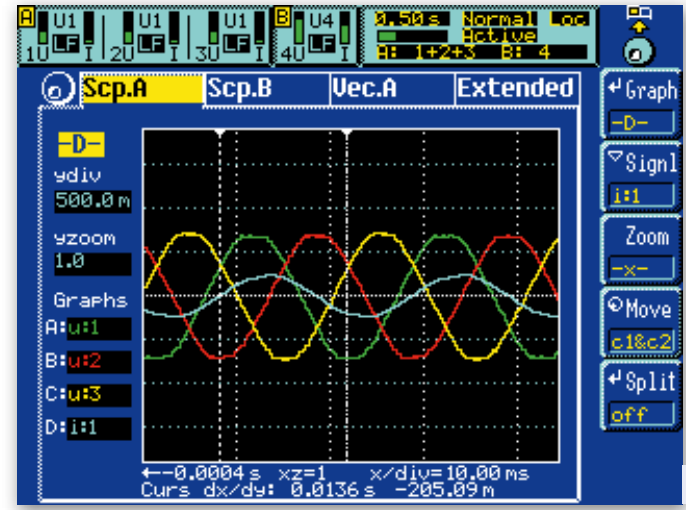
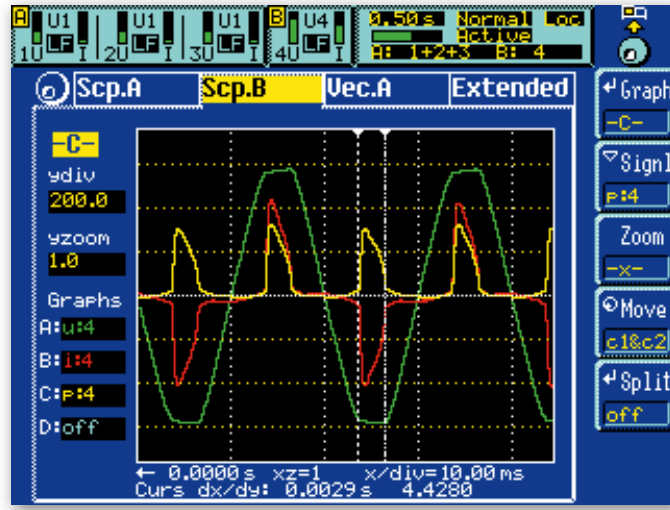
5

6 Display of different plugged external current sensor devices from ZES ZIMMER, here the bottom one is in use (enabled)



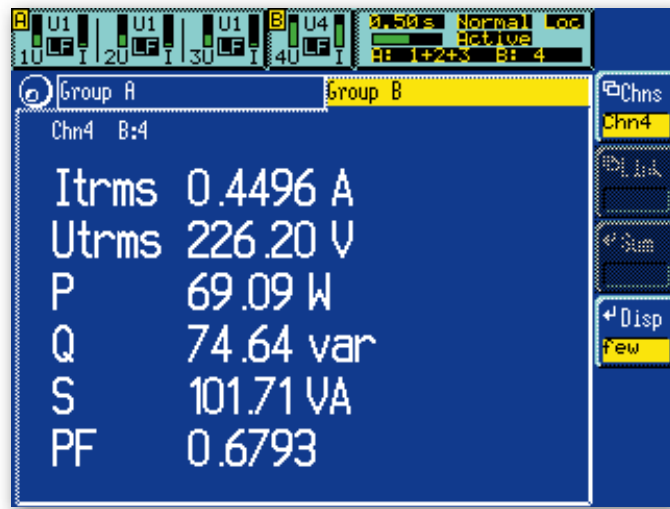
6

7 Scope of power (yellow), current (red) and voltage (green) of the frequency converter single phase input



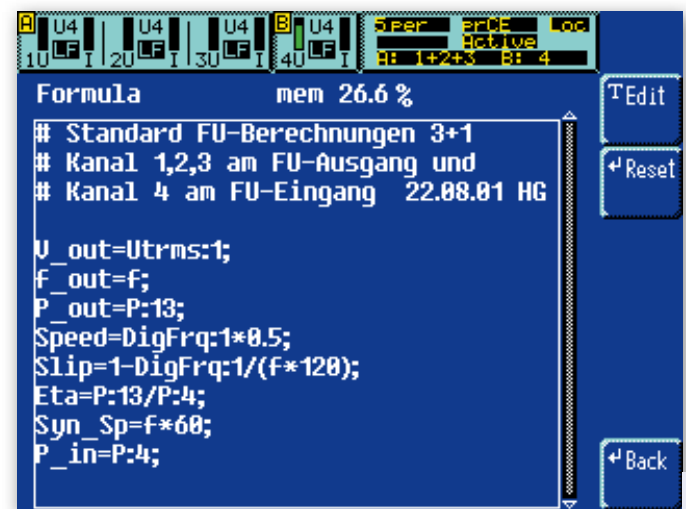
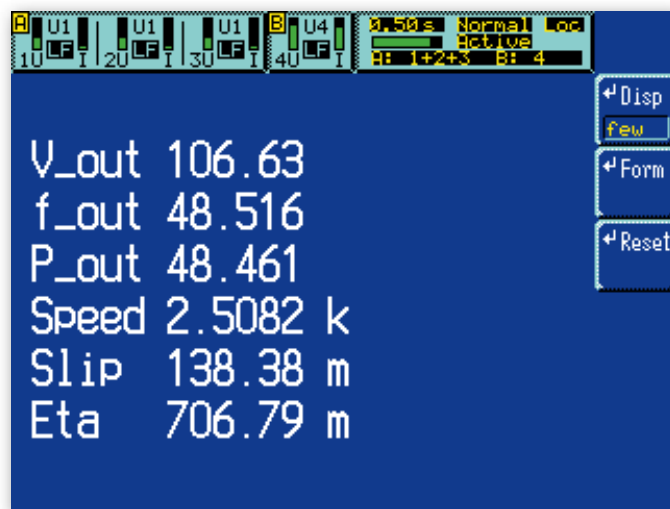
8 Scope display of the low pass filtered 3Ø output, the chopper frequency is no more contained because of being outside the filtered range

9 Large display with six important values of the frequency converter input, measured in group B



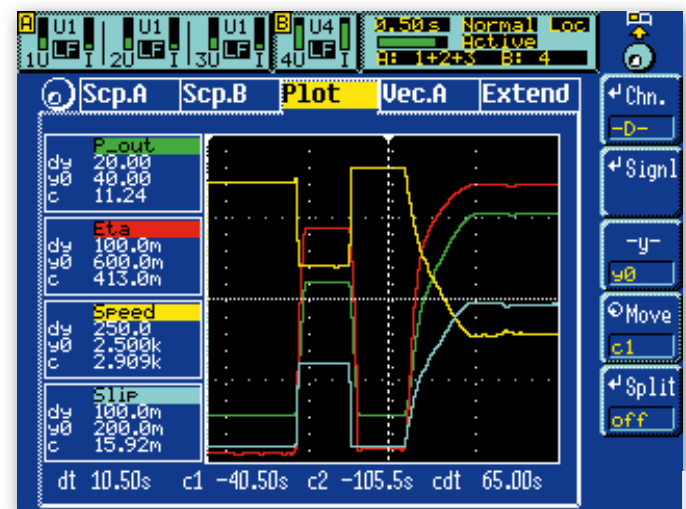
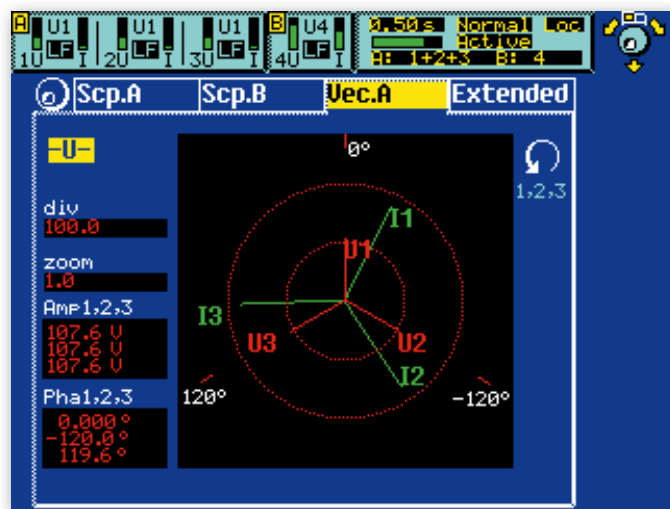
10 Phase values and summing values of the frequency converter 3Ø output gives a quick overview (group A)

11 Efficiency, slip, speed and other interesting values calculated by user defined formulas



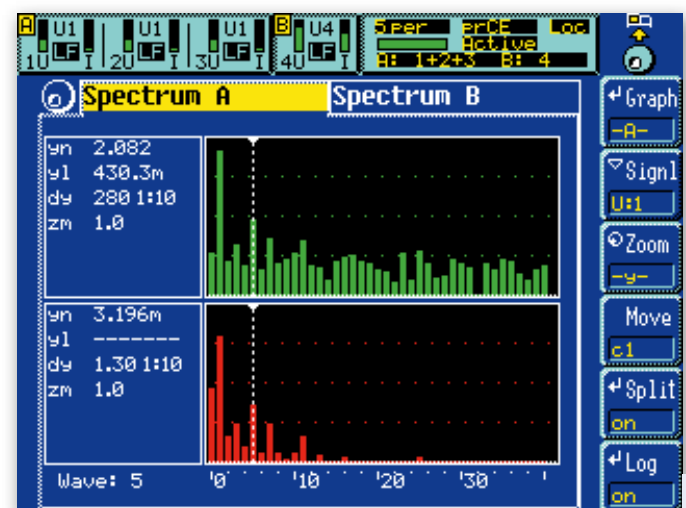
12 The formula editor provides the individual calculations shown in picture 11

13 Vector display of 3Ø systems immediately checks the phase sequence and shows phase interchanges



14 Plot display works like a strip chart recorder and can plot all measured or formula calculated values

15 Harmonic analysis conform to CE standards (precompliance tests)



16 Frequency spectrum for current, voltage (as bar chart), with CE-limits, linear or logarithmic

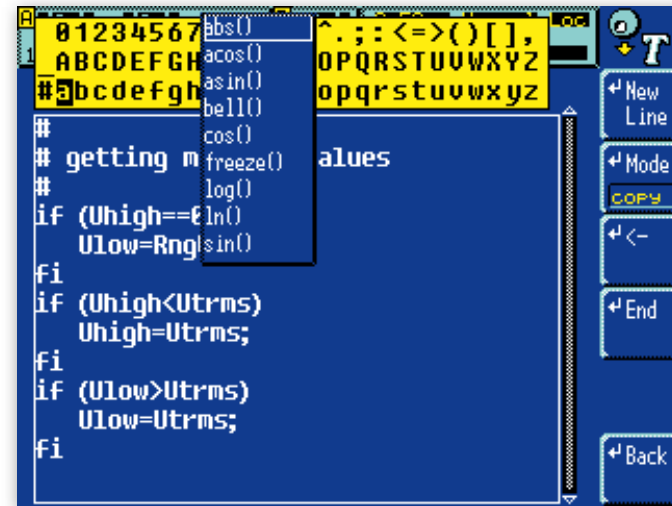
All necessary functions in the basic device:

- Printer interface
- RS232 interface
- Formula editor
- Harmonics analysis for CE pre-compliance

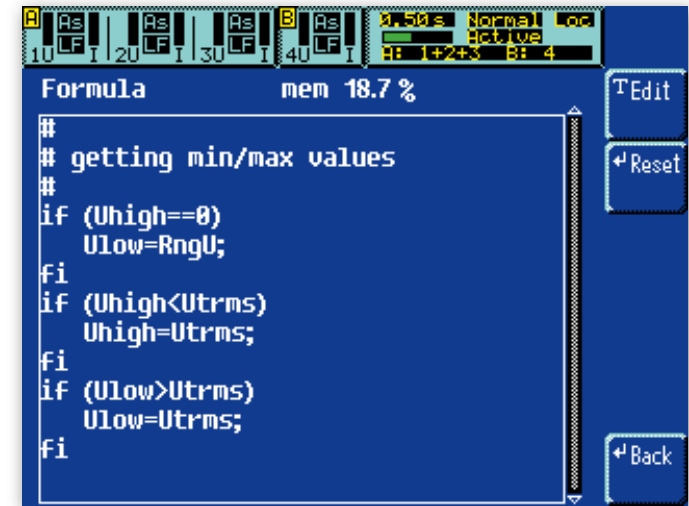
All necessary functions are included in the basic device at reasonable price.

Printer and RS232 interfaces, formula editor, harmonics analysis of current and voltage

for pre-compliance tests in accordance with EN61000-3-2.



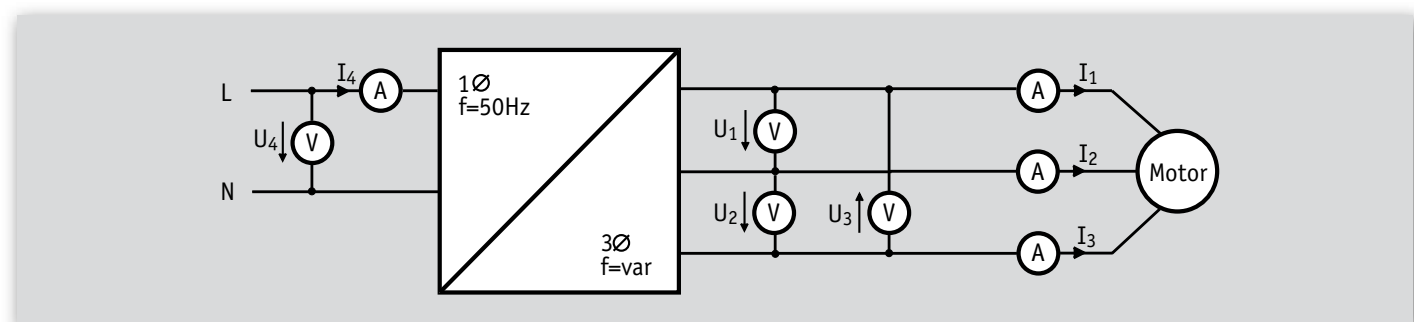
Formula editor: the window shows the available mathematical formulae, functions and logical conditions



Program example for the monitoring of overvoltage and undervoltage

Options

- Star-Delta Conversion
Part No. L45-06



50Hz -> f=variable, instrument for motor measurement in I* UΔ wiring

For detailed test and evaluation of 3Ø motors the electrical quantities for each winding phase is needed. In some cases you have access to the motor terminal block with start and end of all three windings. Then you can measure all what you need. But in most cases the motor has only three terminals

and the internal star point or the delta winding as to measure its current is not accessible. Also far away from the motor you have only the three wires. With the option star-delta conversion you have the capability to calculate the not accessible values (e.g. voltages, currents, power, harmonics). This intelli-

gent solution with an additional DSP works well at all waveforms and every unbalance of mains and load. Simply connect the voltage paths in delta and click the current clamps around the wires. Select the internal connection of your load and press the „Link“ softkey.

| Group A | | Group B | |
|---------------------|---------------------|---------|--|
| Link123 (U1,I1) A:5 | Link123 (U2,I2) A:6 | | |
| Itrms 0.1711 A | 0.1671 A | | |
| Utrms 106.48 U | 106.37 U | | |
| P 16.28 W | 15.97 W | | |
| Q 8.18 var | 7.88 var | | |
| S 18.22 VA | 17.77 VA | | |
| Link123 (U3,I3) A:7 | Sum(5-7) A:13 | | |
| Itrms 0.1700 A | 0.2934 A | | |
| Utrms 106.35 U | 184.29 U | | |
| P 16.29 W | 48.54 W | | |
| Q 7.83 var | 23.81 var | | |
| S 18.07 VA | 54.07 VA | | |

Calculation of the real values in the star connected winding phases (wiring: 3+1, UΔ I* -> U* I*)

| Group A | | Group B | |
|-----------------------|-----------------------|---------|--|
| Link123 (U12,I12) A:5 | Link123 (U23,I23) A:6 | | |
| Itrms 97.21 mA | 96.67 mA | | |
| Utrms 184.15 U | 184.18 U | | |
| P 16.02 W | 16.04 W | | |
| Q 7.99 var | 7.72 var | | |
| S 17.98 VA | 17.88 VA | | |
| Link123 (U31,I31) A:7 | Sum(5-7) A:13 | | |
| Itrms 99.05 mA | 169.13 mA | | |
| Utrms 184.13 U | 318.96 U | | |
| P 16.35 W | 48.41 W | | |
| Q 8.08 var | 23.88 var | | |
| S 18.24 VA | 53.95 VA | | |

Calculation of the real values in the delta connected winding phases (wiring: 3+1, UΔ I* -> UΔ IΔ)

Further options:

IEEE488 interface

(Part No. L45-01)
Interpretation of the complete SCPI, as well as the LMG450 specific command set. The data transfer yields up to 1Mbyte/sec.

Disk or memory card

(Part No. L45-02F or L45-02)
The two memory media, disk or memory card, can be used as required. They serve to record measured and sampled values and to save and recall device settings (setups).

Flicker meter

(Part No. L45-04)
Compliant to EN61000-4-15. The evaluation of the voltage fluctuations by currents up to 16A compliant to EN61000-3-3, by currents up to 75A compliant to EN61000-3-11.

Process signal interfaces, digital and analog inputs and outputs

(Part No. L45-03)
To monitor further process magnitudes like revolution, torque etc. With assistance of the formula editor efficiency

and other magnitudes can be deduced and be applied as control parameters.

Harmonics up to 99th from U, I and P

(Part No. L45-08)
The harmonics up to 99th option can be used to analyse current, voltage and power related to the fundamental ranging from 1Hz to 1.2kHz. It is possible to detect interharmonics by a selectable division factor giving a new fundamental as reference.

Transients

(Part No. L45-05)
The transients option detects peaks and dips up to a resolution of 20µsec, scanning taking place at 50kHz.

Torque determination

(Part No. L45-016)
Precision Power Meter Series LMG calculates torque and speed of three-phase asynchronous motors from motor current and voltage without torque measuring shaft.

Dimensioning of insulation for all standard low voltages

The measurement inputs are dimensioned for 600V/CAT III, with option L45-015 up to 1000V. This makes it possible to measure in all standard 3-phase low voltage networks. The adjacent table shows that the voltage "Line to Neutral/Earth" is always less than 600V.

| 3 Phase/ 4 Wire | 3 Phase/ 3 Wire | Line to Line Voltage | Line to Neutral/Earth |
|--------------------|--------------------|-------------------------|--------------------------|
| 66/115V | | 115V | 66V |
| | 120V | 120V | 69V |
| 120/208V | | 208V | 120V |
| | 240V | 240V | 139V |
| 230/400V | | 400V | 230V |
| 277/480V | | 480V | 277V |
| | 500V | 500V | 289V |
| 400/690V | | 690V | 400V |
| | 1000V | 1000V | 578V |

Technical Data

Voltage measuring ranges

| | | | | | | | | |
|--------------------------------------|--------------|------|----|-----|-----|-----|-----|------|
| Nominal value /V | 6 | 12.5 | 25 | 60 | 130 | 250 | 400 | 600 |
| Maximum trms value /V | 7.2 | 14.4 | 30 | 60 | 130 | 270 | 560 | 720 |
| Maximum peak value for full scale /V | 12.5 | 25 | 50 | 100 | 200 | 400 | 800 | 1600 |
| Overload capability | 1500V for 1s | | | | | | | |
| Input impedance | 1MΩ, 20pF | | | | | | | |

Current measuring ranges

| | | | | | | |
|--------------------------------------|--|------|-----|----|----|----|
| Nominal value /A | 0.6 | 1.2 | 2.5 | 5 | 10 | 16 |
| Maximum trms value /A | 1.3 | 2.6 | 5.2 | 10 | 18 | 18 |
| Maximum peak value for full scale /A | 1.875 | 3.75 | 7.5 | 15 | 30 | 60 |
| Overload capability | 18A permanent, 50A for 1s, 150A for 20ms | | | | | |
| Input impedance | 2mΩ | | | | | |

Isolation

All direct current and voltage inputs of power measuring channels against each other and against earth isolated, max. 600V/CATIII

Voltage measuring ranges for external isolated current transducers

| | | | | | | |
|--------------------------------------|-------------|------|-----|-----|-----|---|
| Nominal value /V | 0.12 | 0.25 | 0.5 | 1 | 2 | 4 |
| Maximum trms value /V | 0.15 | 0.3 | 0.6 | 1.2 | 2.5 | 5 |
| Maximum peak value for full scale /V | 0.25 | 0.5 | 1 | 2 | 4 | 8 |
| Overload capability | 250V for 1s | | | | | |
| Input impedance | 100kΩ, 10pF | | | | | |

Measuring range selection

Automatic, manual or remotely controlled

Measuring accuracy

| Measuring accuracy | ± (% of measuring value + % of measuring range) | | | | |
|--|---|-----------|------------------------|------------|--------------|
| | DC | 1Hz..1kHz | 45...65Hz, AC-Coupling | 1kHz..5kHz | 5kHz...20kHz |
| Voltage | 0.2+0.2 | 0.1+0.1 | 0.05+0.05 | 0.2+0.2 | 0.3+0.4 |
| Current (direct) | 0.4+0.4 | 0.15+0.1 | 0.05+0.05 | 0.2+0.2 | 0.5+0.5 |
| Active power (direct) | 0.5+0.5 | 0.2+0.1 | 0.07+0.04 | 0.3+0.2 | 0.6+0.5 |
| Current (via ext. current transducer) | 0.2+0.2 | 0.1+0.1 | 0.05+0.05 | 0.2+0.2 | 0.3+0.4 |
| Active power (via ext. current transducer) | 0.3+0.3 | 0.15+0.1 | 0.07+0.04 | 0.3+0.2 | 0.6+0.5 |

Accuracies based on:

1. sinusoidal voltage and current
2. ambient temperature (23 ± 3) °C
3. warm up time 1h
4. definition of power range as the product of current and voltage range, $0 \leq |\lambda| \leq 1$, ($\lambda = \text{Power factor} = P/S$)
5. calibration interval 12 month

Other values

All other values are derived from the current, voltage and active power values. Accuracies for derived values depend on the functional relationship (e.g. $S = I * U$, $\Delta S/S = \Delta I/I + \Delta U/U$)

Synchronization

The measurement is synchronized on the signals period. There is a choice to determine the period from $u(t)$, $i(t)$, $p(t)$, further $u^2(t)$, $i^2(t)$ by using a settable filter. By this very stable readings are achieved, even at signals of pulse width modulated frequency inverter and amplitude modulated electronic ballast, synchronization also with external signal or „Line“

Scope function

Graphical representation of sampled values over the time

Plot function

Time diagram of max. four readings, minimal resolution 50ms

Harmonic analysis prCE Harm

Measuring of current and voltage according to EN61000-4-7 with evaluation according to EN61000-3-2 (Pre-compliance)

Harmonic analysis Harm100

Analysis of current, voltage and power up to 99th harmonics (max. 10kHz), in total 100 harmonics, when including DC part. Fundamental in the range from 1Hz to 1.2kHz. By selectable integer divider (1...50) a new reference fundamental can be created as to detect interharmonics.

Flicker measuring

Flicker Meter according to EN61000-4-15 with evaluation according to EN61000-3-3

Transients – monitoring and storing

Storing and graphical displaying of transients with a resolution of 20μs. Storing depth is 1.4 Millions sample values/channel, selectable recording duration from 0.05 to 60 seconds. Adjustable pre-trigger, different possibilities of triggering

Computer interfaces

Interfaces: **RS232** and **IEEE488.2**, only one interface can be used at the same time
 Remote control: All functions can be remote controlled, keyboard lock for measuring parameters available
 Output data: Output of all readable data, data formats equal for all interface types, SCPI command set
 Transfer rate: RS232: max.115200 Baud, IEEE488.2: max. 1MByte/sec

Printer interface

Parallel PC-Printer interface with 25-pin SUB-D socket for printing measuring values, tables, graphics to matrix, inkjet or laser printers

Processing signal interface

25 pin SUB-D socket with (The option processing signal interface can be built in twice):

- four analog inputs for registration of process magnitudes (16Bit, ±10V, 1kHz)
- four analog outputs for output of readings or measured magnitudes (16Bit, ±10V, 100kHz)
- four digital inputs for registration of states (1kHz, $U_{LOW} < 1V$, $U_{HIGH} = 4...60V/2.5mA$)
- four digital outputs to signal states and alarms (open collector, output high max. 30V@100μA, output low max. 1.5V@100mA)
- one input for registration of frequency (0.1Hz...500kHz) and rotation direction of motors ($U_{LOW} < 1V$, $U_{HIGH} = 4...10V$, 1MΩ)

In- and outputs are isolated groupwise against each other and against the other electronics (testing voltage 500V)

Other data

| | |
|-------------------------------|--|
| Display | STN colour display, 320 x 240 pixel, 5,7" |
| Dimensions | - Bench case, W 320mm x H 147mm x D 307mm - 19"-chassis, 84PU, 3HU, D 307mm |
| Weight | about 6,5kg |
| Protection class | EN61010 (IEC1010, VDE0411), protection class I, overvoltage category III |
| Electromagnetic compatibility | EN50081, EN50082 |
| Protection system | IP20 in accordance to DIN40050 |
| Operating/storage temperature | 0...40°C, -20...50°C |
| Climatic class | KYG in accordance to DIN40040 |
| Power supply | 85...264V, 47...440Hz, about 45W |

LMG450 accessories**ZES ZIMMER compensated current clamps**

| | | | | | | |
|--|-------------------------|-----|----|----|----|-----|
| Nominal value /A | 1.25 | 2.5 | 5 | 10 | 20 | 40 |
| Permissible trms value /A | 2.5 | 5.0 | 10 | 20 | 40 | 80 |
| Permissible peak value for full scale /A | 3.75 | 7.5 | 15 | 30 | 60 | 120 |
| Overload capability | 500A for 1s | | | | | |
| Max. cord diameter | 12mm | | | | | |
| Isolation | 300V/CATIII, 600V/CATII | | | | | |

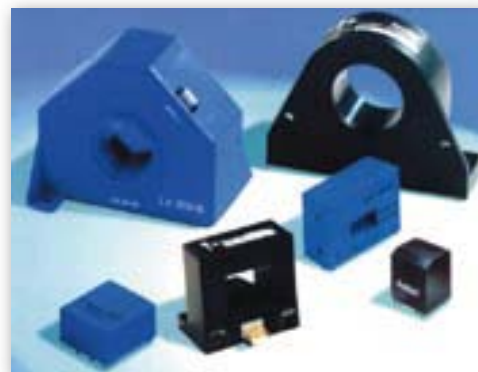


Part No.
L45-Z06 (1 pc.)
L45-Z07 (Set of 4 pc.)

| Measuring accuracy of clamp | Current: ± (% of measuring value + % of measuring range) / Phase: degrees | | | | | |
|-----------------------------|---|-------------|-------------|-------------|--------------|---------------|
| | 1Hz...10Hz | 10Hz...45Hz | 45Hz...1kHz | 1kHz...5kHz | 5kHz...20kHz | 20kHz...50kHz |
| Current | 1.5+0.25 | 0.4+0.15 | 0.15+0.05 | 0.3+0.15 | 1.0+0.25 | 4.0+0.5 |
| Phase | 6 | 3 | 0.5 | 2 | 6 | 20 |

Hall current sensors for range extension

| Part No. | Current | | | Supply | Current transducers with Hall effect sensors for range extension of LMG450, DC...20kHz, accuracy class 0,5 connected to LMG450 via HD15 sensor input, incorporated EEPROM for scaling and adjustment data as well as data for automatically setting of appropriate current range |
|------------------|---------|-------|-------|----------------------|--|
| | nominal | trms | peak | | |
| L45-Z28-Hall50 | 35A | 50A | 70A | Internally | |
| L45-Z28-Hall100 | 60A | 100A | 120A | by LMG450 | |
| L45-Z28-Hall200 | 120A | 200A | 240A | via HD15 | |
| L45-Z29-Hall300 | 250A | 300A | 500A | Externally e.g. with | |
| L45-Z29-Hall500 | 400A | 500A | 800A | ZES power supply for | |
| L45-Z29-Hall1000 | 600A | 1000A | 1200A | up to four sensors | |
| L45-Z29-Hall2000 | 1000A | 2000A | 2100A | Part No. SSU-4 | |

**Power supply unit for up to 4 Sensors**

Part No. SSU-4 Power supply unit for up to 4 Sensors for L45-Z29 and PSU-600 series, device fitting under LMG450/95, design equal to NDL5 (see below)

Adapter for 3-phase measurements

Part No. LMG-MAK3

- CEE-Plug, 5 pins, 16A, 2m supply cord
- CEE-Socket, 5 pins, 16A, for EUT
- Socket for supplying the meter LMG450
- 4mm safety sockets, measuring access to current and voltage
- Safety acc. IEC61010: 300V/CATIII

**RS232 - Ethernet - converter, 10/100mbit**

Part No. L45-Z318

External adaptor, all connectors will fixed at the LMG, supply by LMG

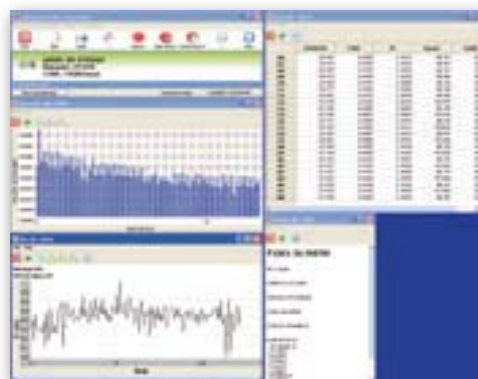
**PC Software**

Order no. LMG-CONTROL-B

PC software for data transfer, configuration and visualisation, Modular design, saves and loads device configurations. Interactive mode to set up the measurements. Recording and storage adds timestamps with accuracy in the range of milliseconds. Analysing modules for different applications. Basic version is free of cost.

Order no. LMG-CONTROL-WA

Additional module for LMG-CONTROL, logging and analysis of all sampling values of the LMG, harmonic analysis up to 1MHz, frameanalyser, logging of transients.



Subject to technical changes, especially to improve the product, at any time without prior notification.