ZES ZIMMER Electronic Systems

4-Channel Power Meter LMG450

Universal Meter for Motors, Power Electronics and Energy Analysis

Best Accuracy 0.1%

LMG450

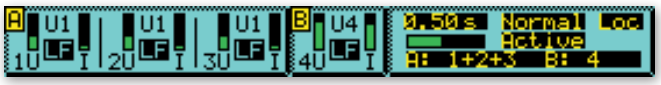
LMG450 e 02.08

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.

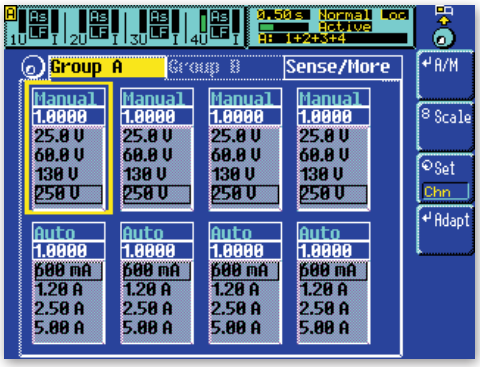
Easy operation thanks to colour graphics display and hotkeys for important measured values

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.

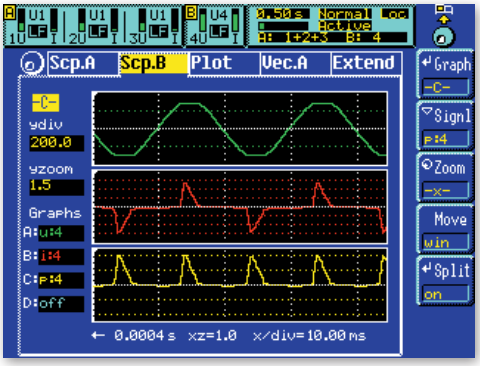


Status bar

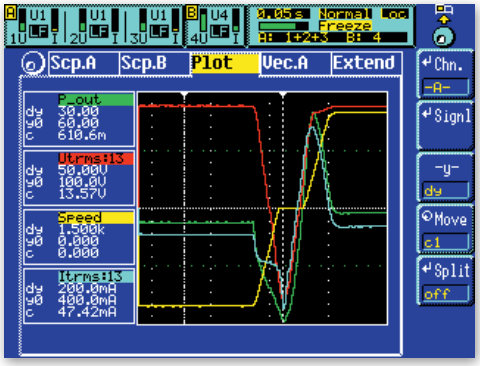
Channel 1 with 11 measuring values



Range setting and scaling



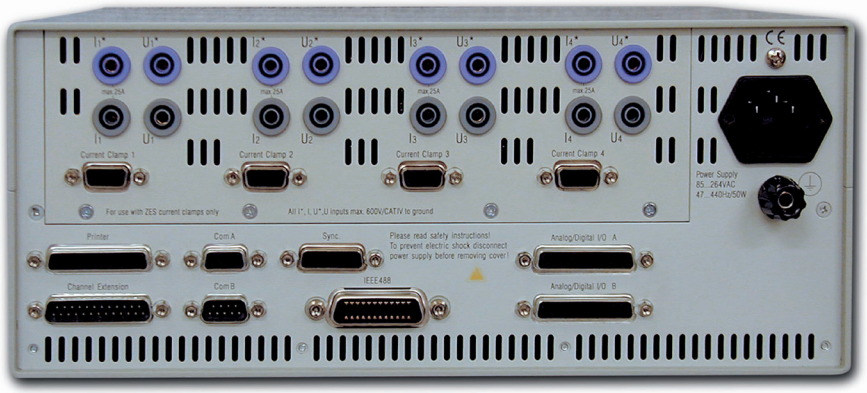
Scope function for waveform of sampling values



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

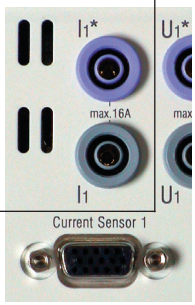
Direct measurement
0.6 ... 16A (6 Ranges)
DC ... 20 kHz

Standard current clamps
with current outputs >0.5A
100A ... 3000A
45Hz ... 3kHz

Compensated
ZES current clamps
1.2A ... 40A (6 Ranges)
5Hz ... 20kHz

Magneto-resistive
current transducer modules
5A ... 50A
DC ... 20KHz

4mm safety sockets
600V CAT III



HD15 sockets
for external sensors

PSU200/400/600/700
Precision current transducer
1A ... 700Apeak
DC ... 20kHz
(300kHz, bandwidth of sensor is limited by LMG450)

Standard current clamps with voltage/current (<0.5A) outputs
10A ... 200A
45Hz ... 3kHz

Hall effect transducers
5A ... 200A
DC ... 20kHz

DC/AC current clamps with voltage output
e.g. for oscilloscopes
10A ... 200A
DC ... 20kHz

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.

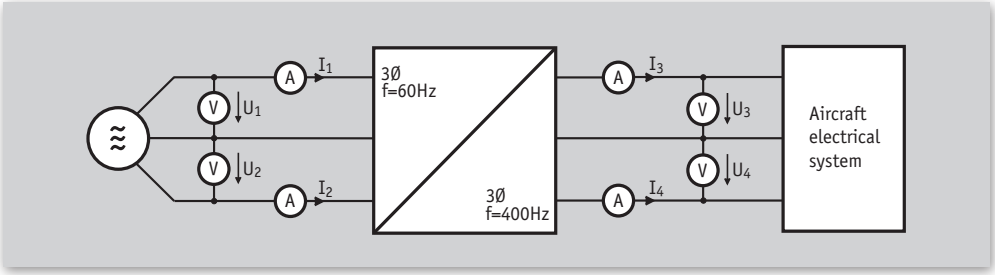
Device	Measured Value	Ch 1	Ch 2	Ch 3	Ch 4	Appropriate setting of wiring
4Ø motors	Power of all windings	Phase 1	Phase 2	Phase 3	Phase 4	4+0
High power batterie chargers (3Ø -> DC)	Input and output power, efficiency	Phase 1	Phase 2	Phase 3	DC-Out	3+1 (UΔ I* -> U* I*)
Rectifier section of inverters (3Ø -> 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 laods 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

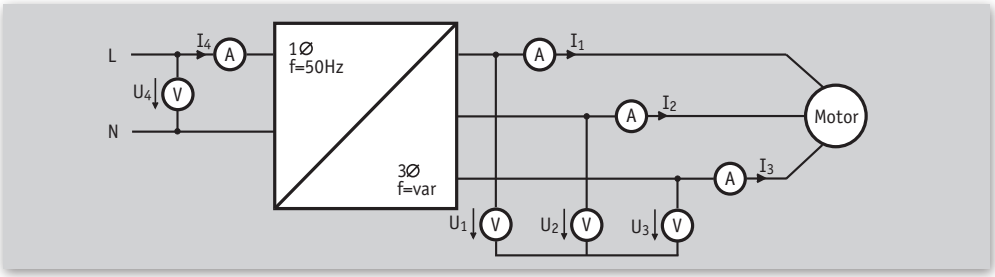
Measurement on two systems with different frequencies

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)

2 Configuration of measuring inputs and sychronisation source for group A

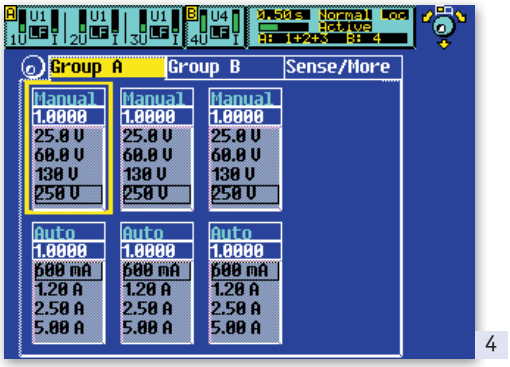
1

2

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

3

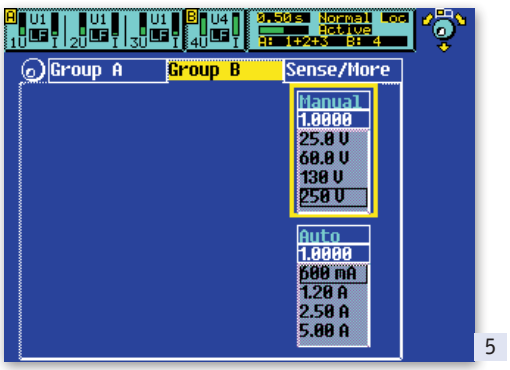
4 Measuring ranges, autorange or manual, setting of scaling factors for external CT's or VT's (group A)



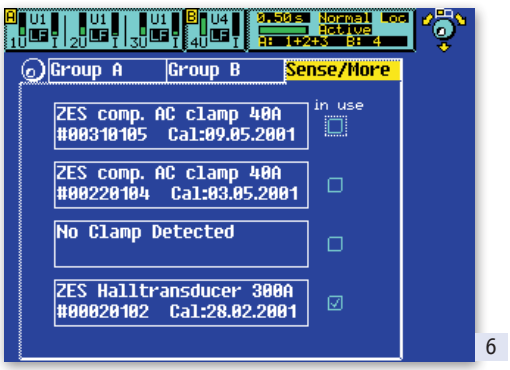
4

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

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



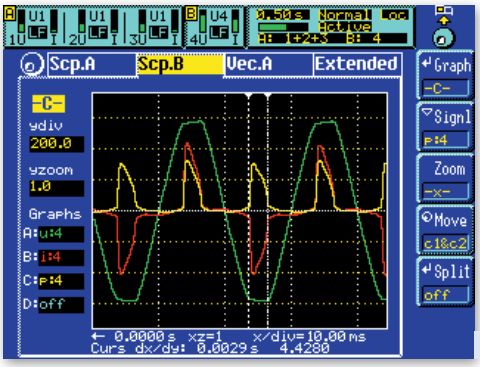
5



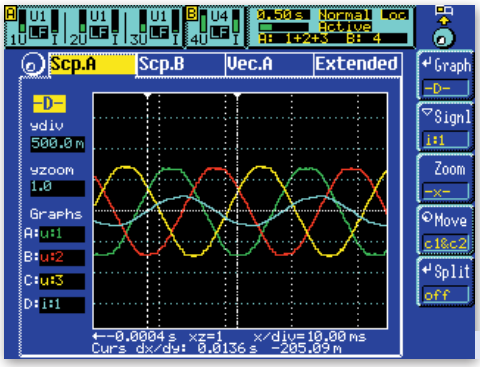
6

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



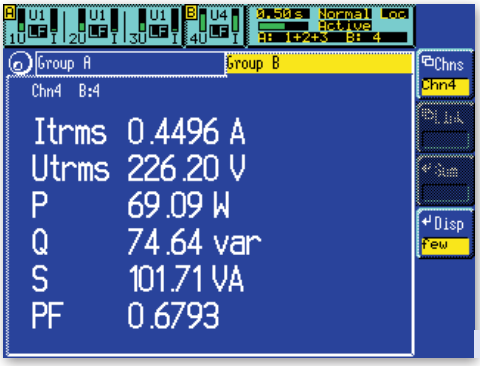
7



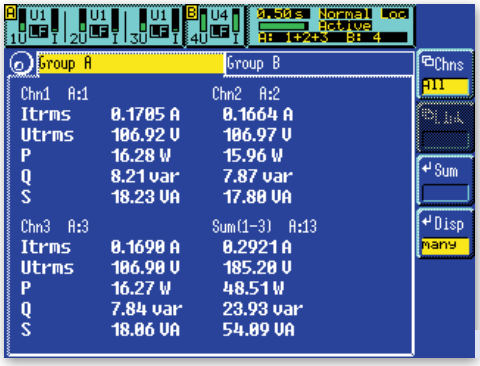
8

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)



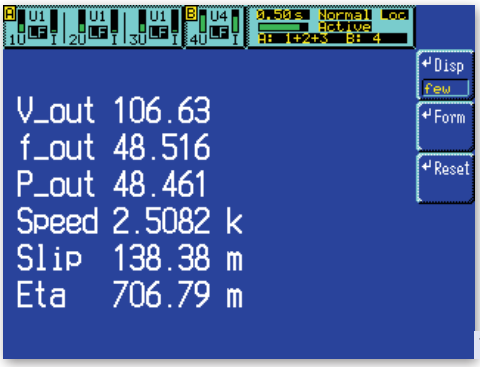
9



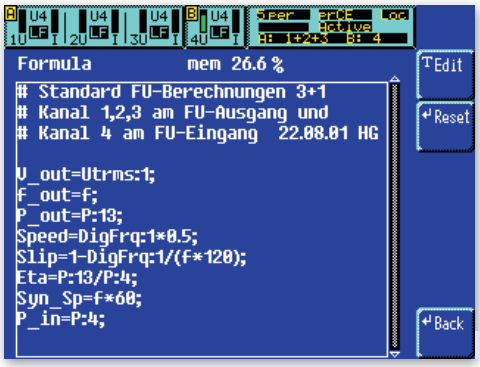
10

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



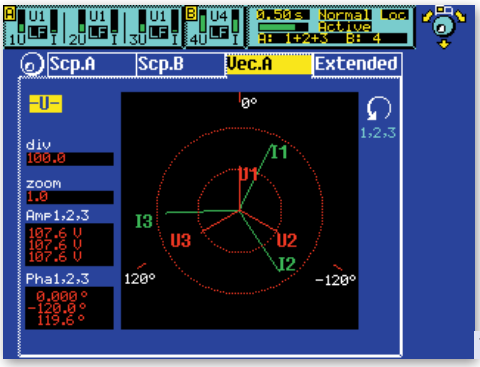
11



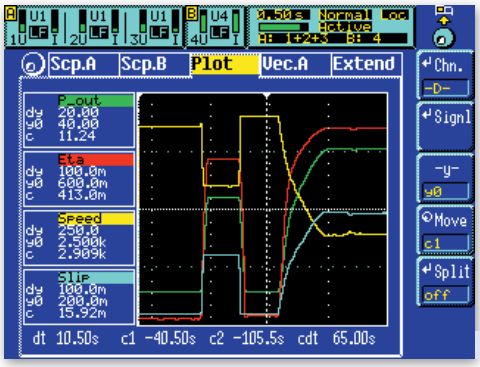
12

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



13

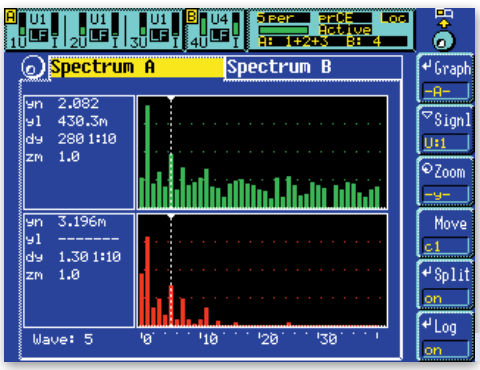


14

15 Harmonic analysis conform to CE standards (precompliance tests)

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

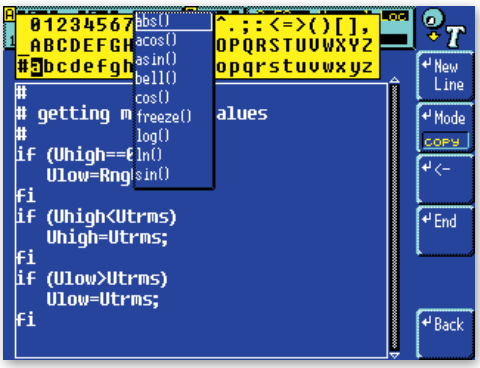
15



16

All necessary functions in the basic device:
- **Printer interface**
- **RS232 interface**
- **Formula editor**
- **Harmonics analysis for CE pre-compliance**

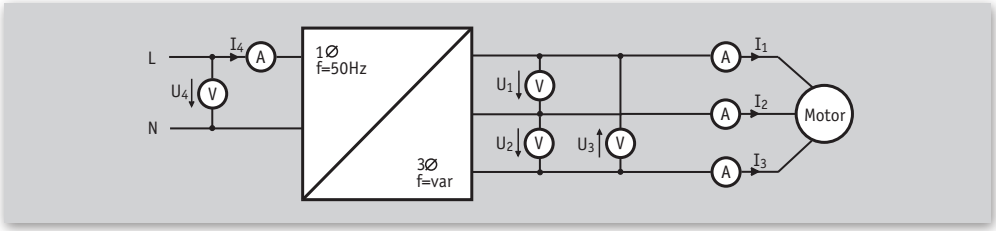
All necessary functions are included in the basic device at reasonable price. Printer and RS232 interfaces, formula editor, harmonics analysis of current and voltage for pre-compliance tests in accordance with EN61000-3-2.



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

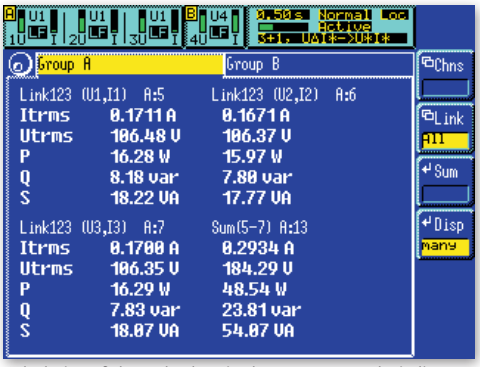
Program example for the monitoring of overvoltage and undervoltage

Options
- **Star-Delta Conversion**
  Part No. L45-06

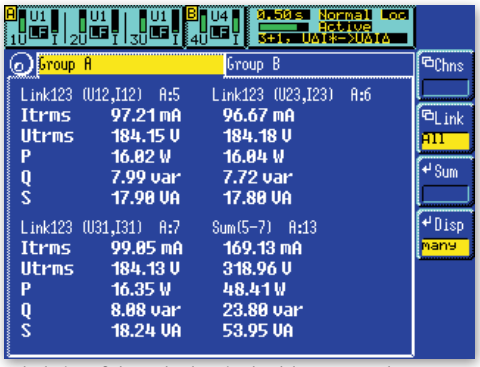


50Hz -> f=variable, instrument for motor measurement in I UΔ wiring*

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 intelligent 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.



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



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/CAT III

Voltage measuring ranges for external isolated current transduceers

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+0.08	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+0.08	0.3+0.2	0.6+0.5

Accuracies based on:
1. sinusoidal voltage and current
2. ambient temperature 23 °C
3. warm up time 1h
4. definition of power range as the product of current and voltage range, $0 \le |\lambda| \le 1$, (λ=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/CAT III, 600V/CATII					

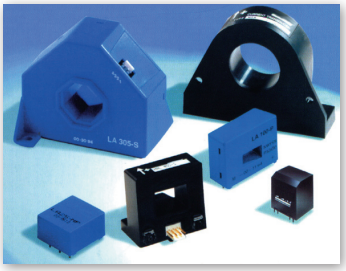
Part No.
L45-Z06 (1 pc.)
L45-Z07 (Set of 4 pc.)

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 nominal	trms	peak	Supply
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

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

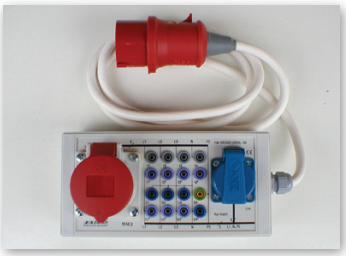


Power supply unit for up to 4 Sensors
Part No. SSU-4

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/CAT III



Longtime Data Logging NDL5
Part No. NDL5

Longtime-data logging to harddisk for LMG450/LMG95
Communication via Internet/Ethernet, even when recording

LMG450 application software
Product name (Part No.)

LVDRV-L45 Driver for LMG450 under LAB-View 5.1.1 for RS232 as well as IEEE488 interface, with programming samples

LWINDRV-L45 Driver for LMG450 under LAB Widows/CVI for RS232 as well as IEEE488 interface, with programming samples

LMGControl Individual configuration of measurement using all features of the LMG450, spectral analysis, remote of LMG450. Storage in MS Excel format possible

BMP2PC Bitmap transfer from LMG450/LMG95 to PC via RS232, downloaded screens can be processed and scaled in Windows. Free download from the website www.zes.com

ZES ZIMMER Electronic Systems

ZES ZIMMER Electronic Systems GmbH
Tabaksmühlenweg 30, D-61440 Oberursel/Ts.
Tel. ++49 6171 628750 Fax ++49 6171 52086
http://www.zes.com e-mail: sales@zes.com