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

LMG 450
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.

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 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.
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.

Various methods of applying current to be measured

<table>
<thead>
<tr>
<th>Device Description</th>
<th>Measured Value</th>
<th>Ch 1</th>
<th>Ch 2</th>
<th>Ch 3</th>
<th>Ch 4</th>
<th>Appropriate setting of wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td>4Ø motors</td>
<td>Power of all windings</td>
<td>Phase 1</td>
<td>Phase 2</td>
<td>Phase 3</td>
<td>Phase 4</td>
<td>4+0</td>
</tr>
<tr>
<td>High power batterie chargers (3Ø -&gt; DC)</td>
<td>Input and output power, efficiency</td>
<td>Phase 1</td>
<td>Phase 2</td>
<td>Phase 3</td>
<td>DC-Out</td>
<td>3+1 (UA Ia -&gt; U+ Ie)</td>
</tr>
<tr>
<td>Rectifier section of inverters (3Ø -&gt; DC)</td>
<td>Input power, rectifier efficiency</td>
<td>Phase 1</td>
<td>Phase 2</td>
<td>Phase 3</td>
<td>DC-Bus</td>
<td>3+1 (UA Ia -&gt; U+ Ie)</td>
</tr>
<tr>
<td>Output section of inverters (DC -&gt; 3Ø)</td>
<td>Output power, chopper efficiency</td>
<td>AC-Out 1</td>
<td>AC-Out 2</td>
<td>AC-Out 3</td>
<td>DC-Bus</td>
<td>3+1 (UA Ia -&gt; UA Ia)</td>
</tr>
<tr>
<td>1Ø -&gt; 3Ø inverter Low power motor drives</td>
<td>Input and output power, efficiency</td>
<td>AC-Out 1</td>
<td>AC-Out 2</td>
<td>AC-Out 3</td>
<td>Phase 1</td>
<td>3+1 (UA Ia -&gt; U+ Ie)</td>
</tr>
<tr>
<td>Power supplies with multiple outputs</td>
<td>Input and output power, efficiency</td>
<td>DC-Out 1</td>
<td>DC-Out 2</td>
<td>DC-Out 3</td>
<td>Phase 1</td>
<td>3+1</td>
</tr>
<tr>
<td>1Ø Transformers with multiple output windings</td>
<td>Input and output power, efficiency</td>
<td>AC-Out 1</td>
<td>AC-Out 2</td>
<td>AC-Out 3</td>
<td>AC-In</td>
<td>3+1</td>
</tr>
<tr>
<td>3Ø loads with auxiliary supplies</td>
<td>Complete input power</td>
<td>Phase 1</td>
<td>Phase 2</td>
<td>Phase 3</td>
<td>Aux. AC or DC</td>
<td>3+1 (UA Ia -&gt; UA Ia)</td>
</tr>
<tr>
<td>3Ø -&gt; 3Ø inverter High power motor drives</td>
<td>Input and output power, efficiency</td>
<td>AC-In 1</td>
<td>AC-In 2</td>
<td>AC-Out 1</td>
<td>AC-Out 2</td>
<td>2+2 (UA Ia -&gt; UA Ia)</td>
</tr>
<tr>
<td>3Ø -&gt; 1Ø AC power source</td>
<td>Input, output- and DC-Bus power, efficiency</td>
<td>AC-In 1</td>
<td>AC-In 2</td>
<td>DC-Bus</td>
<td>AC-Out</td>
<td>2+2 (UA Ia -&gt; U+ Ie)</td>
</tr>
</tbody>
</table>

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

4 independent power measuring channels

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.
**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.

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.

1. Setting of global parameters, e.g. wiring (see table at previous page)
2. Configuration of measuring inputs and synchronisation source for group A
3. Configuration of measuring inputs and synchronisation source (same as picture 2, but for group B)
4. Measuring ranges, autorange or manual, setting of scaling factors for external CT’s or VT’s (group A)
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)
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.

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

Printer and RS232 interfaces, formula editor, harmonics analysis of current and voltage for pre-compliance tests in accordance with EN61000-3-2.

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

50Hz -> f=variable, instrument for motor measurement in I* U* 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.

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.

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.

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

<table>
<thead>
<tr>
<th>Voltage measuring ranges</th>
<th>3 Phase/4 Wire</th>
<th>3 Phase/3 Wire</th>
<th>Line to Line Voltage</th>
<th>Line to Neutral/Earth</th>
</tr>
</thead>
<tbody>
<tr>
<td>66/115V</td>
<td>115V</td>
<td>66V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120V</td>
<td>120V</td>
<td>69V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>208V</td>
<td>208V</td>
<td>120V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>240V</td>
<td>240V</td>
<td>139V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400/690V</td>
<td>400V</td>
<td>230V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>480V</td>
<td>480V</td>
<td>277V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>690V</td>
<td>690V</td>
<td>289V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000V</td>
<td>1000V</td>
<td>400V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000V</td>
<td>1000V</td>
<td>578V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technical Data**

**Voltage measuring ranges**

<table>
<thead>
<tr>
<th>Nominal value /V</th>
<th>6</th>
<th>12.5</th>
<th>25</th>
<th>60</th>
<th>130</th>
<th>250</th>
<th>400</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum rms value /V</td>
<td>7.2</td>
<td>14.4</td>
<td>30</td>
<td>60</td>
<td>130</td>
<td>270</td>
<td>560</td>
<td>720</td>
</tr>
<tr>
<td>Maximum peak value for full scale /V</td>
<td>12.5</td>
<td>25</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>400</td>
<td>800</td>
<td>1600</td>
</tr>
<tr>
<td>Overload capability</td>
<td>1500V for 1s</td>
<td>1MΩ, 20µF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input impedance</td>
<td>1MΩ, 20µF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nominal value /A</th>
<th>0.6</th>
<th>1.2</th>
<th>2.5</th>
<th>5</th>
<th>10</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum rms value /A</td>
<td>1.3</td>
<td>2.6</td>
<td>5.2</td>
<td>10</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Maximum peak value for full scale /A</td>
<td>1.875</td>
<td>3.75</td>
<td>7.5</td>
<td>15</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Overload capability</td>
<td>18A permanent, 50A for 1s, 150A for 20ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input impedance</td>
<td>2mΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Measuring range selection | Automatic, manual or remotely controlled |

**Isolation**

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

**Measuring accuracy**

<table>
<thead>
<tr>
<th>Measuring accuracy</th>
<th>DC</th>
<th>3Hz..1kHz</th>
<th>45...400Hz, AC-Coupling</th>
<th>1kHz..5kHz</th>
<th>5kHz..20kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>0.2±0</td>
<td>0.1±0.1</td>
<td>0.05±0.05</td>
<td>0.2±0</td>
<td>0.3±0.4</td>
</tr>
<tr>
<td>Current (direct)</td>
<td>0.4±0.4</td>
<td>0.15±0.1</td>
<td>0.05±0.05</td>
<td>0.2±0</td>
<td>0.5±0.5</td>
</tr>
<tr>
<td>Active power (direct)</td>
<td>0.5±0.5</td>
<td>0.2±0.1</td>
<td>0.07±0.04</td>
<td>0.3±0.2</td>
<td>0.6±0.5</td>
</tr>
<tr>
<td>Active power (via ext. current transducer)</td>
<td>0.2±0.2</td>
<td>0.1±0.1</td>
<td>0.05±0.05</td>
<td>0.2±0.2</td>
<td>0.3±0.4</td>
</tr>
<tr>
<td>Active power (via ext. current transducer)</td>
<td>0.3±0.3</td>
<td>0.15±0.1</td>
<td>0.07±0.04</td>
<td>0.3±0.2</td>
<td>0.6±0.5</td>
</tr>
</tbody>
</table>

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 ≤ Iₓ ≤ I, (1±Power factor=0.75)
5. calibration interval 12 month

**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′(t)), (i′(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 pCE 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. 100Hz), 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

**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, Uin=1V, Un=0V...4V,2.5mA)
- four digital outputs to signal states and alarms (open collector, output max. 30V@100mA, output low max. 1.5V@100mA)
- one input for registration of frequency (0.1Hz...500kHz) and rotation direction of motors (Uin=1V, Un=0V...30V, 1MΩ)
- In- and outputs are isolated groupwise against each other and against the other electronics (testing voltage 5000V)
**LMG450 accessories**

**ZES ZIMMER compensated current clamps**

Nominal value / A  
- 1.25
- 2.5
- 5
- 10
- 20
- 40

Permissible rms value / A  
- 2.5
- 5
- 10
- 20
- 40
- 80

Permissible peak value for full scale / A  
- 3.75
- 7.5
- 15
- 30
- 60
- 120

Overload capability 50A for 1s

Max. cord diameter 12mm

Isolation 300V/CATIII, 600V/CATII

<table>
<thead>
<tr>
<th>Part No.</th>
<th>L45-Z06 (1 pc.)</th>
<th>L45-Z07 (Set of 4 pc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hall current sensors for range extension**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Current nominal / A</th>
<th>Current peak / A</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>L45-Z28-Hall50</td>
<td>35A</td>
<td>70A</td>
<td>Internally via HD15</td>
</tr>
<tr>
<td>L45-Z28-Hall100</td>
<td>60A</td>
<td>120A</td>
<td>by LMG450</td>
</tr>
<tr>
<td>L45-Z28-Hall200</td>
<td>120A</td>
<td>240A</td>
<td>ZES power supply</td>
</tr>
<tr>
<td>L45-Z29-Hall300</td>
<td>250A</td>
<td>500A</td>
<td>Ext. w. ZES power supply for four sensors</td>
</tr>
<tr>
<td>L45-Z29-Hall500</td>
<td>400A</td>
<td>800A</td>
<td></td>
</tr>
<tr>
<td>L45-Z29-Hall1000</td>
<td>600A</td>
<td>1200A</td>
<td></td>
</tr>
<tr>
<td>L45-Z29-Hall2000</td>
<td>1000A</td>
<td>2100A</td>
<td></td>
</tr>
</tbody>
</table>

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

Part No. SSU-4

**Adapter for 3-phase measurements**

Part No. LMG-MAX3

- 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

**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. Analyzing 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.