ZES ZIMMER Electronic Systems

Network Capable Autonomous Data Logger

for Long-Term Data Recording with Precision Power Meters LMG500/LMG450/LMG95

- Long-term behaviour of variable loads and power supply systems
- Disturbance detection and analysis
- Interaction between customer and supply mains

LMG500
0.03%, 10MHz, modular for 1 to 8 power channels

LMG450
0.1%, compact with 4 power channels

LMG95
0.03%, precise up to 500kHz, monophase

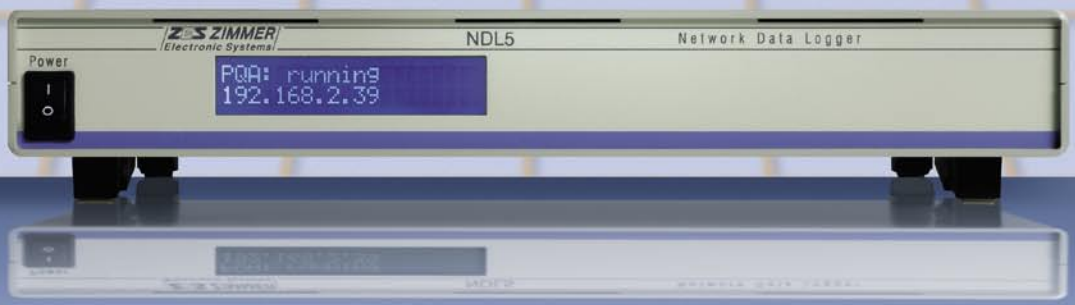
PQA

„Ready To Run"- software for net analysis and disturbance detection

TERM-L5

Configuration, selection of measuring values at customer specific jobs

NDL5 – Autonomous data recording of LMG measuring values, configuration and monitoring over Ethernet



NDL5

Precision Power Measuring and Long-Term Recording

ZES ZIMMER Precision Power Analyser of LMG500/450/95 series are approved and manifold used for product optimization, efficiency improvement, quality assurance, etc.

Magnitude and phase of current, voltage and power must be measured exactly within a wide frequency range and at very low power factors.

LMGs are used at the following measurements:

Example: NDL5 in combination with Precision Power Meter LMG450

1. Components (e.g. ferrite cores)

2. Devices (e.g. motors, inverters, lamps)

3. Installations and parts of them, also at power grids to identify their parameters

4. CE mark tests on devices which are supplied by a power source (to simulate an ideal power network), to investigate the feedback of harmonics and flicker (load variation)

5. Interaction of network ***and*** appliance. Especially the detection and the analysis of interactions between network and appliance are necessary for robustness, reliability and to evaluate the sufficient design of installation and its parts.

An usual power quality analyser won't be helpful in this case!

Precision power measuring in combination with long term data recording with configuration, control and analysing software is required.

ZES ZIMMER provides all the key building blocks:

- Established LMG precision power analysers
- Autonomous, configurable network data logger
- Software to combine LMG and data logger as one unit:

PQA450 „Ready to Run"-software for power quality and disturbance analysis

TERM-L5 Software to get full benefit of all measuring potential of the LMG, configuration and selection of the required values for specific application.

Software to Control, Configure and Evaluate

	PQA	TERM-L5
Special features	• Dedicated for LMG500/LMG450 • Software especially designed for power quality and network analysis • Simple configuring of the measurement in a few steps • Built-in tools for data analysis and visualisation	• Configuration of the measurement using all features of the measuring instruments LMG500/LMG450/LMG95 • Individual configuration of the measurement by customer, according to particular tasks • Minimisation of the volume of analysed data
Measured values	Simultaneous logging of following measured values: • r.m.s. values and phase angles of voltages and currents (4 x voltage, 4 x current) • Harmonics of currents and voltages • Active, reactive and apparent powers • Power factors • Flicker (Pst and Plt) • Unbalance, positive, negative and zero component of voltage • Half-wave r.m.s. values of voltage (10ms for 50Hz) • Ripple control signals • Transients up to 1,5kV with sampling frequency up to 3MHz (LMG500) or 50kHz (LMG450)	• Selectable measured values • All measured values of the chosen measuring mode available
Recording modes	• Continuous and event controlled recording of all measured values • Resolution in time domain from 200ms to 15min • Measured values and external control signals as trigger thresholds for events	• Continuous logging with adjustable resolution in time domain from 50ms to 1 hour • Programmable start and stop of the measurement as well as by digital inputs • Segmented storing into files with an adjustable size
Access to measuring data	• During and after the measurement	• During and after the measurement

To be continued on next page...

	PQA	TERM-L5
Evaluation	• Analysis of the results according to EN50160 • Analysis of the harmonics in time and frequency domain • Evaluation of flicker with representation of the flicker relevant signals (currents, power components as well as their changes) • Unbalance analysis and representation of the positive, negative and zero sequences • Analysis of the voltage dips and swells with an adjustable reference voltage and threshold • Statistic and regression analysis as well as automatic computation of planning and emission levels	• Data analysis with common programs (MSExcel, Matlab etc..) • Representation of the waveforms of currents, voltages and powers • Time plot of half wave r.m.s. values of voltages, currents and powers • Inrush currents and corresponding changes of supply voltages • Determination of the origin of harmonics by measurement of 100 harmonics inclusive phase angles, active, reactive and apparent power • Evaluation of sub- and interharmonics • Analysis of DC signals, for example in the DC link of a variable frequency drive, for the investigation of immunity and controlling capabilities • Representation of the r.m.s values with an averaging time of 50ms for the analysis of rapid processes in the network
Data export	• Export of all measured values in ASCII format • Export possibilities of all tables and figures • Easy creation of measuring reports	• Measured values, stored in ASCII, are available for data transfer
PC-Operation without NDL5	Benefits: • Small budget Drawbacks: • Leaving alone notebook for days or weeks, risk of theft! • No battery backup of measurement while mains failure	
		• Step by step logging, manual control of data recording • Graphical display, measuring values presentable in six plot windows • Spectrum calculation of recorded sample values, bandwidth adjustable up to the half of the recording rate • Trigger controlled recording and presentation of sample values in normal measuring mode

Application

Nowadays, the photovoltaics is a rapidly expanding technology with growing application fields. At the same time, solar cells, inverters as well as control circuits are still under development to reach the best possible efficiency, stability and electromagnetic compatibility.
While monitoring the operation of grid connected photovoltaic systems, current, voltage and power at the output of a solar cell should be measured together with parameters at the grid side. The main purpose of the monitoring is to estimate the daily changes of efficiency and other operational parameters as well as their dependency on the sunlight intensity and the grid conditions.

There are some issues challenging the instrumentation:

- Simultaneous measurement of DC and AC signals together with AC harmonics
- Long term recording of the results over several days or weeks
- Small time period, for instance 1 s or smaller

This problem can be easily solved by application of a Precision Power Meter LMG450, an Autonomous Data Logger NDL5 and an user-friendly software TERM-L5.

Why LMG450? In opposite to most power quality analysers, it allows simultaneous measurement in both AC and DC circuits. Four input channels can be independently configured regarding filtering and synchronisation. Three of them can be used to measure currents, voltages and power at the grid side. The fourth one estimates the current, voltage and power at the output of the solar cell. The accuracy of 0.1% and capability to measure harmonics are important preconditions to estimate efficiency as well as its dependency on the power quality issues.

Why NDL5?
While monitoring the photovoltaic system it is important

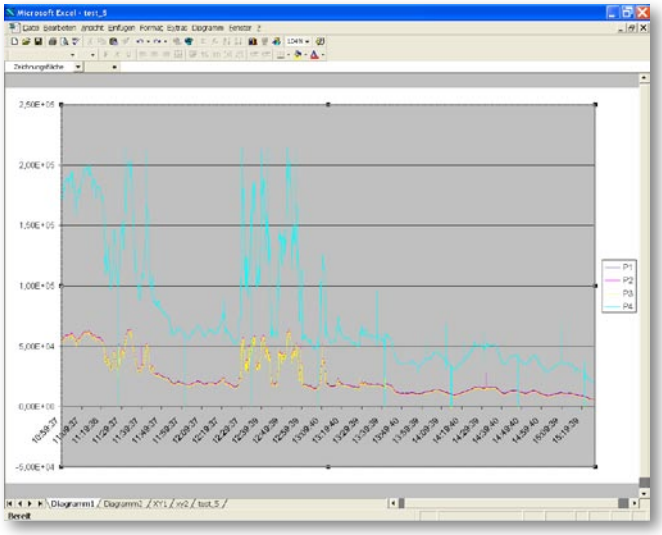


Fig. 1 Reliable determination of efficiency through simultaneous detection of solar DC input power and delivered to mains output power

to have a meaningful amount of data to process them statistically or to apply the regression analysis. With NDL5 it is possible to store, for instance, 300 values over 1 month, using a time period of 1s. Additionally the NDL5 is more secure from stealing than a usual PC or notebook. The built-in UPS supplies both LMG450 and NDL5 during interruptions of the supply voltage up to 15 minutes. The measured data are available via Ethernet also during measurement.

Power quality of solar plants

Why TERM-L5?

While configuring the measurement the user defines individually, which values are to be logged and what time period to be applied – Optimization of analysis from the very beginning.

The figures illustrate the results of the power measurement on a 300 kW photovoltaic system. This measurement was carried out by means of a LMG450, NDL5 and TERM-L5. Fig. 1 shows the almost identical power profiles of the solar cell and at the grid side. The leaps of the output power from one phase completely correspond with the leaps of input power. Fig. 2 represents the regression analysis of measured values. We notice an almost linear dependency between input and output regardless weather conditions. Therefore the steady state operation of an inverter is correct. However, there are some points outside the regression line. The exact reason of abnormal values (operational changing at the grid side or sporadic failures of the photovoltaic appliance) should be investigated separately.

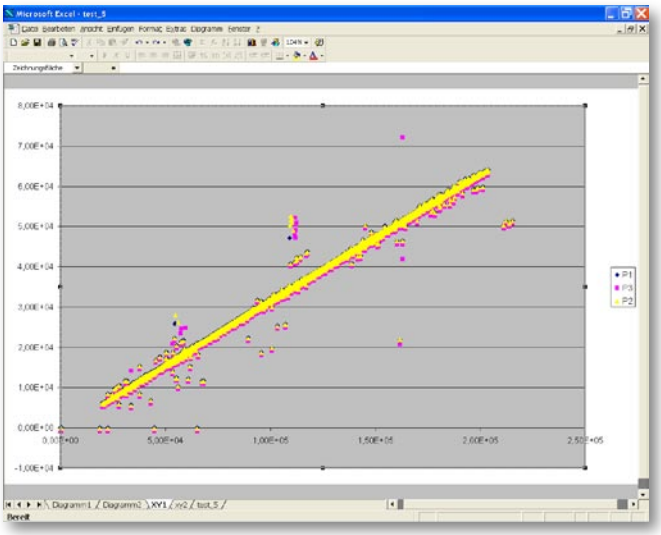
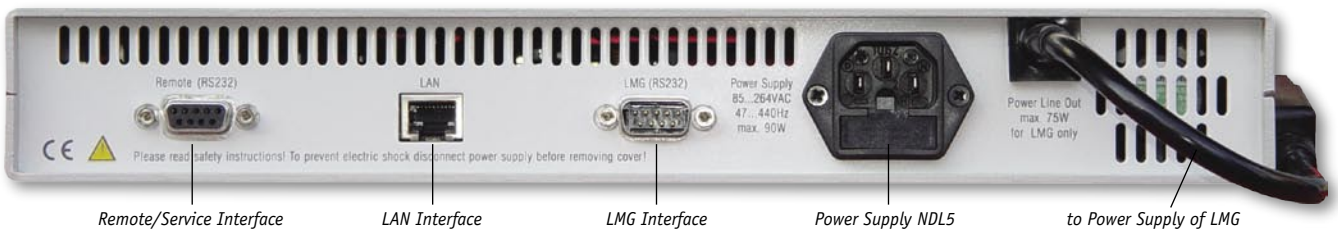


Fig. 2 Regression analysis of in- and output power to determine functionality

Technical Data of NDL5	
Specified meters for NDL5 long-term recording	ZES ZIMMER Precision Power Meters LMG500/LMG450/LMG95
Data memory	Harddisk, min. 20GB, 4kB segmentation, block by block transmission and analysis also while measuring
Recording duration	PQA $t_{max} \approx \frac{t_{Av}}{0{,}2s} \cdot 25d$ t_{max} = maximum recording duration in days t_{Av} = time period in seconds Example: By PQA measuring with 200ms time period (t_{Av}) there follows a recording duration of 25 days (t_{max}) TERM-L5 $t_{max} \geq \frac{t_{Cyc}}{A_{Mg}} \cdot 10^4$ t_{max} = maximum recording duration in days t_{Cyc} = cycle time in seconds, A_{Mg} = number of meas. values Normal meas. mode: max. 1500 meas. values per second Other measuring modes: max. 300 meas. values per cycle Example: By 20 meas. values (A_{Mg}) and 500ms cycle time (t_{Cyc}) there follows a recording duration of 275 days (t_{max})
Interfaces	1.) LAN (10/100 Base-T) for configuration of measurement and data request (also while operation) 2.) RS232 (remote/service interface) for setting of IP-address and subnet-mask 3.) RS232 (LMG interface) for data transfer between NDL5 and LMG
Operation time while power failure (UPS)	10...15 minutes depending on LMG-type, accu pack NiCd, 4800mAh, 7,2V, longlife
Supply of LMG	20cm cable with inlet connector (fixed at NDL5)
Display	LCD display dot matrix, blue/white, 2 rows a 20 digits, digit dimensions 2,4 x 4,7mm, backlighted, status display („run“, „idle“, „logging“), IP-Address, UPS status (charge operation, power failure, capacity)
Power switch	On-/off switch of supply as well as start/stop of measuring according to stored configuration
Accessories included	Ethernet crossover cable 1m, standard Ethernet cable 1m, RS232 cable (NDL5 to LMG), manual
Dimensions/weight desktop case Dimensions/weight 19“-cassette	W 320mm x H 59mm x D 307mm / 4kg (screw mounting at bottom of LMG450 possible) W 84HP x H 1U x D 307mm / 4,2kg
Protection class	EN61010 (IEC61010, VDE0411), protection class I
Electromagnetic compatibility	EN50081, EN50082
Protection system	IP20 in accordance with DIN40050
Operating/storage temperature/climatic	0...40° / -20°...50° / KYG in accordance with DIN40040
Power supply	85...264V, 47...440Hz, typ. 20W, max. 74W additional power consumption af conncted LMG



Remote/Service Interface *LAN Interface* *LMG Interface* *Power Supply NDL5* *to Power Supply of LMG*

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