ZES ZIMMER Electronic Systems

Power Quality Analyser PQA 450

Disturbance Analysis, Long Time Recording
EN50160-Power Quality

PQA 450

PQA450 e 11.02

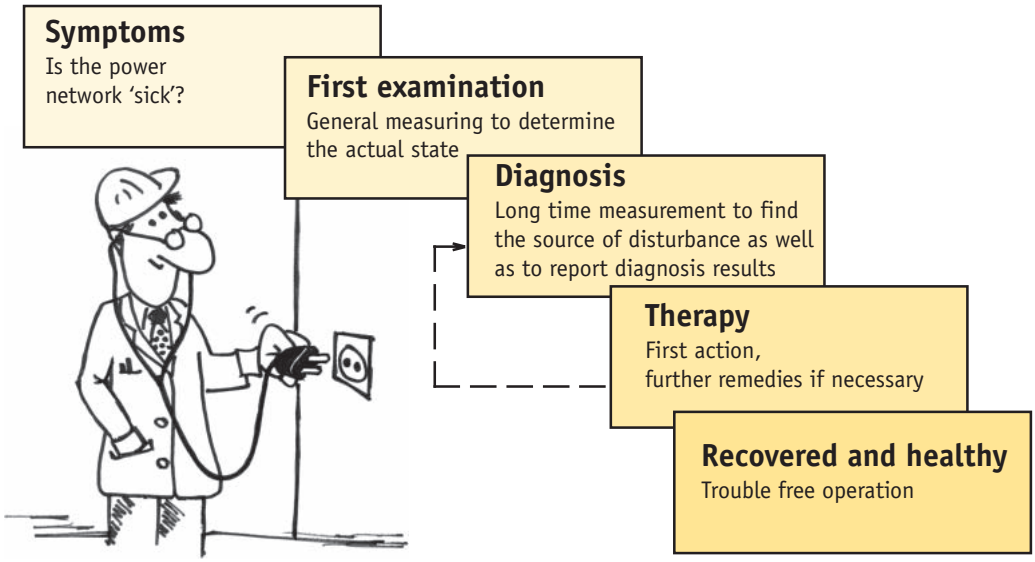
General

Today power quality is heavily impacted by interferences into the mains caused by loads with non-linear current-voltage-characteristics as well as by loads in non steady operation. On the other hand modern industrial productions like semiconductors and automotive require a very good power quality and stability. The analysis of the power quality is necessary.
For this assignment ZES ZIMMER has developed and released the power quality analysing system PQA450. Its base is the universal 4-channel power meter LMG450 that is extended by the long term net data logger NDL5. The NDL5 controls the measuring and stores the data.
It can be configured via usual networks and the data can also be transferred. The PQA evaluation software is used for the comfortable display and protocolling.

Special features

- Checks the correct connection to the supply mains by using the LMG450 display
- Continuous display of the recent measuring values
- Measures without interrupting the secondary circuit of a current transformer by using the compensated ZES ZIMMER current clamp. Highest accuracy, also at small currents
- Monitors current, voltage and power simultaneously to determine the reason of disturbances
- Power quality according EN50160
- Additional analysis in time and frequency domain. Statistical analysis of the measuring results
- Configuration and data transfer via serial interface or via ethernet (LAN/WAN)

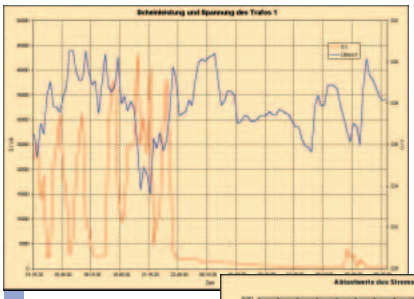
Steps to a successful disturbance analysis



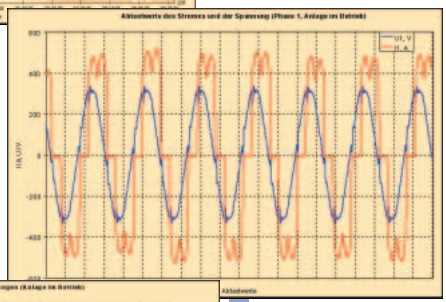
Examples for disturbance analysis

Example 1:
Break down of a computer network

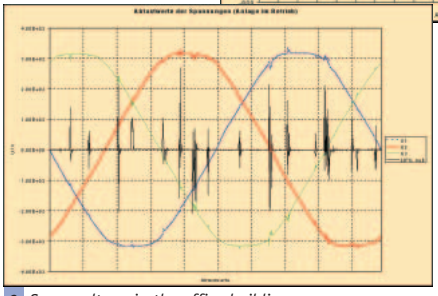
In the office building of an industrial plant a computer network has been installed. While a motor (powered by an inverter with a rectifier) getting sudden load changes distortions occured in the computer network. The office building was fed from the same transformer as the rectifier. The nominal power of the transformer (20kV/0.4kV) was 630kVA, the rectifier power was about 210kVA. The measurements of the power distribution utility indicated, that the performance of the motor was corresponding with high flicker values. The measuring time for this result was one week. However, it didn't help to find the reason of the distortions, because only the 10 minute results and the statistics had been available.
To find the reason of the distortion a measurement with the power quality analyser PQA450 was performed. The measurement for only one day was done during the working times as well as the standby times.
The power consumption of the rectifier and the output voltage of a second transformer showed voltage fluctuations during the working time (picture 1).
The voltage fluctuations on the output of the second transformer were about tenfold smaller. By this it was proven, that the distortions were caused by the rectifier.
The trigger level was not known in advance. So the manual trigger, especially developed for such cases, was used. The measured waveforms brought following results:
The two possible reasons for the distortions were defined:
- Voltage fluctuations
- Voltage notches (picture 2).



1 Power consumption of rectifier correlates with the voltage fluctuations



2 Voltage and current in the switchgear, you see the commutating notches



3 Same voltage in the office building

The waveform of the line voltage as well as the neutral voltage in the office during the working times are different from the voltage in the switchgear. The neutral voltage has had voltage peaks up to 25V (picture 3).
An exact analysis of the system showed, that the earth conductor was installed in a faulty way. After the repair the distortions in the computer network vanished.

Result: The common long time data loggers – with all their statistical values – after one week showed only, that the flicker values were high. The source of the distortion couldn't be found.

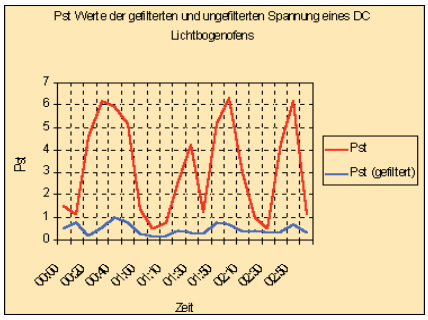
The usage of the PQA450 with the possibility to measure directly reduced the measuring time to one day. The distortion source was found.

Example 2:

Problems in a residential area close to an industrial area

While operating a DC arc furnace in a steelwork high flicker levels were detected. The ratio of installed load to short circuit capability (5000MVA) was very small. Thus such an effect was rather unexpected. For finding the reason the PQA450 was used.
While measuring for 3 hours, a correlation between flicker and power consumption was detected. So it was clear, that this specific furnace caused the problems. The maximum power was 130MVA. So a P_{st} value of just about 0.8 was expected.

To find the real reason a measurement was started to find the flicker caused by interharmonics. For this the flicker values of the entire and of the filtered signal (low pass filter with cut-off frequency 60Hz) were measured. The results showed, that the flicker by voltage fluctuations was very low and corresponded to the calculated values.
Picture 4 shows the filtered and unfiltered flicker values.
A further measurement (flicker with 60Hz and 175Hz filter at the same time) for 3 hours has proofed, that the flicker was caused by interharmonics in the range of the 3rd harmonic. The calculation of the impedance vs. frequency of the net showed a resonance at 162Hz. The current into an arc furnace usually contains big interharmonics. The resonance amplified the interharmonics and caused a 12Hz flicker (=162Hz-150Hz). By a small change in the already installed filter (an additional resistor) the flicker values became below the limits.
Result: This additional resistor was very cheap compared to a compensation unit or a new transformer. Required time: 6 hours for measurement, 4 hours for evaluation.



4 Arc furnace: Flicker is caused by interharmonics

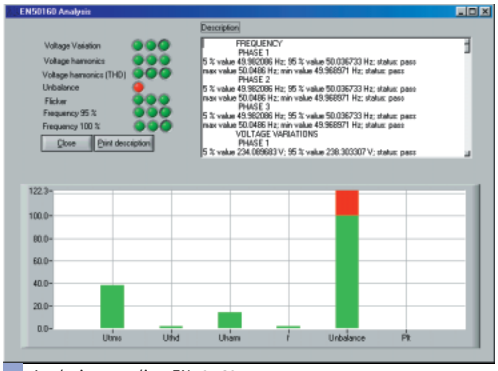
PQAgent software

The software PQAgent operates under Windows (95 to 2000) and is used to configure the measuring device and to evaluate the results.
Following parameters can be measured at the same time:

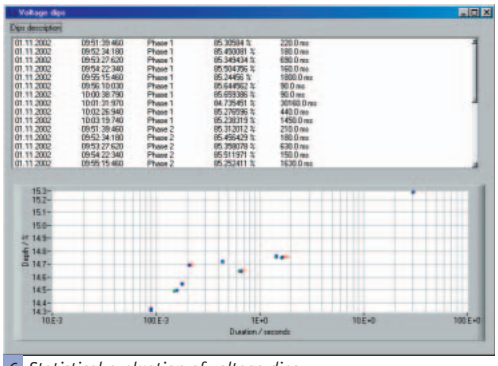
- TRMS value and phase of voltage and current (4 x voltage, 4 x current)
- Harmonics of voltage and current
- Active, reactive and apparent power
- Power factor
- Short term and long term flicker (the duration for P_{st} is adjustable)
- Unbalance, positive/ negative/zero components of voltages
- Half wave TRMS values of the voltage
- Voltage interruptions
- Mains signaling
- Transients up to 1.5kV with sampling frequency 50kHz
  All values can be stored continuously or event triggered. The resolution is adjustable from 200ms up to 15 minutes.

To trigger an event you can use all measured values or external digital signals.
Also a manual trigger is available. The sampling values of voltage and current can also be used.
The evaluation can be started while the measurement is running and has not to be interrupted. The user has access to following values:

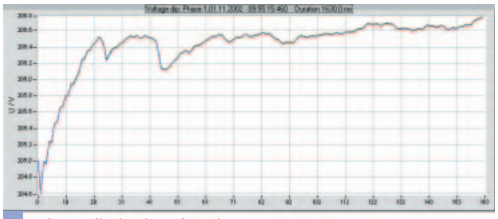
- Statistical analysis according EN50160 (picture 5)
- Analysis of harmonics in time and frequency domain
- Analysis of all values in time domain
- Statistic and regression analysis
- Flicker analysis (also flicker of interharmonics)
- Analysis of voltage interruptions (pictures 6 and 7)
- Automatic test report generation



5 Analysis according EN50160



6 Statistical evaluation of voltage dips



7 Voltage dip in time domain

Power Meter LMG450 – 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, manually or remotely controlled

Measuring accuracy

45...65Hz, AC-Coupling	Measuring accuracy	± (% of measuring value + % of measuring range)			
		DC	1Hz..1kHz	1kHz..5kHz	5kHz...20kHz
0.05+0.05	Voltage	0.2+0.2	0.1+0.1	0.2+0.2	0.3+0.4
0.05+0.05	Current (direct)	0.4+0.4	0.15+0.1	0.2+0.2	0.5+0.5
0.07+0.08	Active power (direct)	0.5+0.5	0.2+0.1	0.3+0.2	0.6+0.5
0.05+0.05	Current (via ext. current transducer)	0.2+0.2	0.1+0.1	0.2+0.2	0.3+0.4
0.07+0.08	Active power (via ext. current transducer)	0.3+0.3	0.15+0.1	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. $S = I * U$, $\Delta S/S = \Delta I/I + \Delta U/U$)

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): 4 analog inputs for registration of process magnitudes (16Bit, ±10V, 1kHz) 4 analog outputs for output of readings or measured magnitudes (16Bit, ±10V, 100kHz) 4 digital inputs for registration of states (1kHz, U_{LOW}<1V, U_{HIGH}=4...60V/2.5mA) 4 digital outputs to signal states and alarms (open collector, output high max. 30V@100µA, output low max. 1.5V@100mA) 1 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 insulated groupwise against each other and against the other electronics (testing voltage 500V)

Other data	
Dimensions, Weight	Bench case: W 320mm x H 147mm x D 307mm, 19"-chassis: 84PU, 3HU, D 307mm / about 6.5kg each
Protection class	EN61010 (IEC1010, VDE0411), protection class I, overvoltage category III
Electromagnetic compatibility	EN50081, EN50082
Protection/Operating-/Storage temperature	IP20 in accordance to DIN40050 / 0...40°C / -20...50°C
Climatic class	KYG in accordance to DIN40040
Power supply	85...264V, 47...440Hz, about 45W

Further data see LMG450 data sheet

Network Data Logger NDL5 – Technical Data

Capacity	Hard Disk 20 GB or more
Power supply fail	Instruments runs for >5s including the connected LMG
Display	LCD, 2x20 characters, background light, for status informations
Interfaces	RS232, LAN, Modem (ISDN and POTS)

Other data	
Dimensions/Weight	Desktop: W 320mm x H 59mm x D 307mm, 19" plug in: 1HU, D 307mm / about 2kg each
Protection class	EN61010 (IEC1010, VDE0411), protection class I, overvoltage category III
Electromagnetic compatibility	EN50081, EN50082
Protection/Operating-/Storage temperature	IP20 acc. DIN40050 / 0...40°C / -20...50°C
Climatic class	KYG nach DIN40040
Power supply	85...264V, 47...440Hz, about 15W, max. 90 W with connected LMG

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