ZES ZIMMER
Electronic Systems

PQViewer
Software for power quality analysis

User Manual

September 2003

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Regard DIN 34!

We reserve the right to implement technical changes at any time, particulary where these changes will improve the performance of the software

Contents

1 General

The software is used for the analysis of the measuring results obtained from the measuring instrument PQA450. It is able to analyse the measured data in time or frequency domain as well as to carry out the statistical analysis of the power quality parameters. The possibility to characterise voltage dips is given. The curve of recorded currents and voltages can be analysed too.

The results of analysis can be stored as ASCII-file, copied into clipboard, saved as bitmap or inserted into MS-WORD-document.

2 Hardware requirements

You need (at minimum):

- Pentium 500 MHz
- 32MB RAM
- Win 95, Win 98, Win NT, Win 2000, Win XP
- Graphic resolution 800x600
- Hard disc as required

3 Installation

The software is delivered on CD-ROM.

For installing the PQViewer you have to start the file setup.exe from the directory \PQViewer. The installation will be running automatically. If an older version of PQViewer was found on the hard-disc, it will be uninstall automatically. After uninstalling you have to start the setup.exe again to install the new version. After this the rebooting of PC is required.

4 The first steps

After you have started the PQViewer the following window appears. Here you have to enter the name of the project to be analysed.

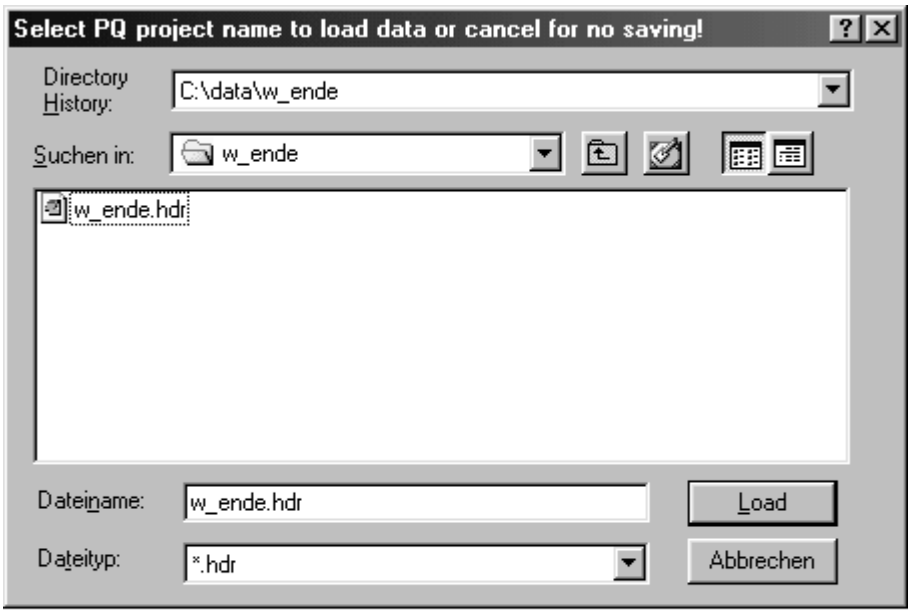


Fig. 1

If you load the project from the hard-disc drive of the NDL5 there are two options available. You are able either to copy the whole project to your hard-disc or to view the measured data directly at the NDL5 with an observation time not longer than 10 minutes. The whole project is available after copying.

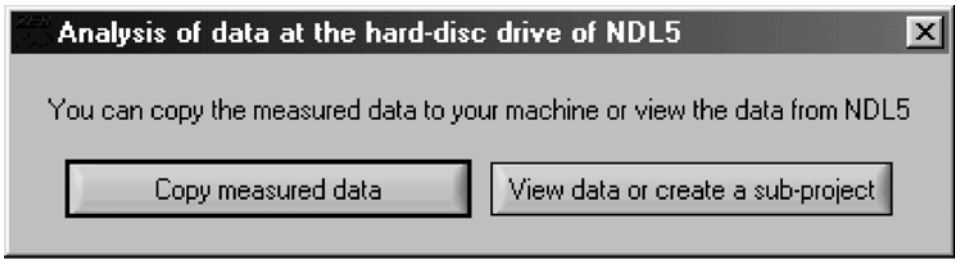


Fig. 2

There is the following window which comes into sight after loading (Fig. 3).

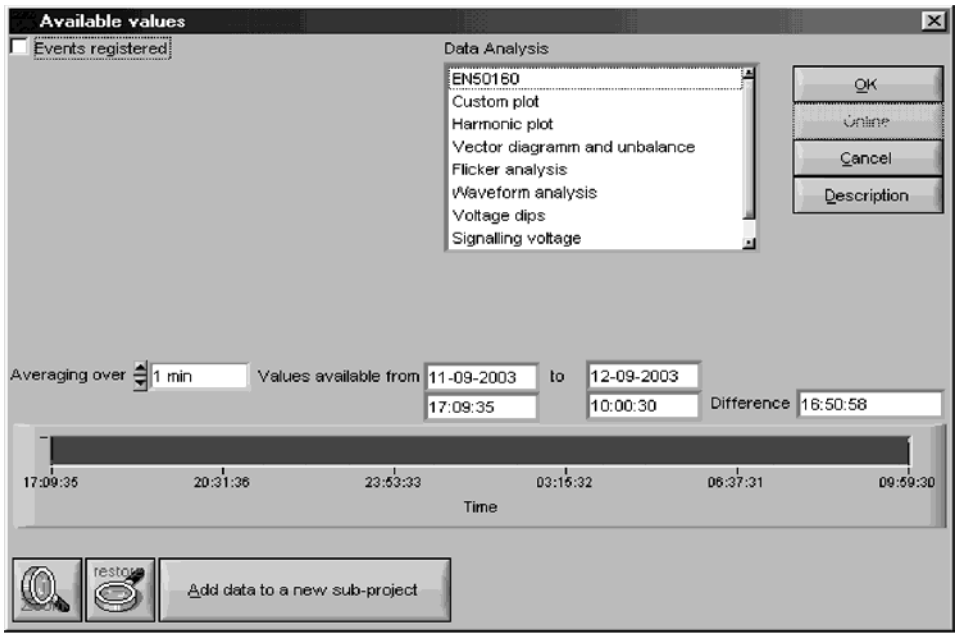


Fig. 3

You can see also a detailed description of the measurement as shown at the Fig. 4.

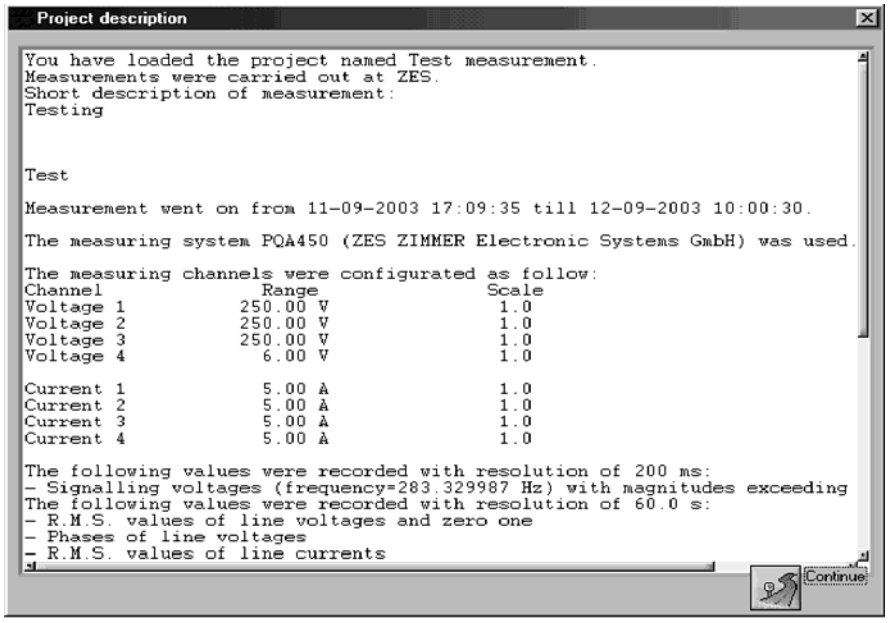


Fig. 4

You can choose the kind of analysis the observation time and the resolution in this window. If you set up the resolution of 200 ms in PQAgent, there is the possibility to evaluate the data with flexible resolution from 200ms up to 10 minutes (Fig. 5).

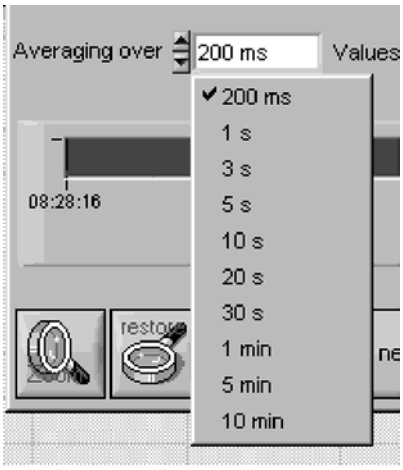


Fig. 5

On the contrary if you have measured with a resolution equal to 5 minutes, there are the resolutions of 5 minutes and 10 minutes which are available for the analysis.

You are also able to transform the data to a sub-project. The difference between a copying and a creating a sub-project will be explained follows.

By creating a sub-project you can save the data with a new resolution and a new observation time. By copying the resolution and the time of observation will be the same.

The following possibilities of data evaluation are available:

EN50160. It is a statistical evaluation of power quality factors according the European standard. This paper describes the quality of product named voltage and defines the appropriate limits for some parameters of voltage. These parameters are given in the following table:

Table 1

PQ factor	Measurand	Limit
Frequency	Average over 10 seconds	50 Hz ± 1% during 95% of a one week 50 Hz + 4% / -6% during 100% of one week
Slow voltage variations	R.m.s. value over 10 minutes	U=Un ± 10% during 95% of a one week, with Un=230 V
Rapid voltage fluctuations	Half-wave r.m.s. of voltages	$\Delta u \leq 5\%$ (up to 10% short time several times pro day). Voltage changes $\Delta u >$ 10% will be defined as a voltage dip

Flicker severity	Plt (Long-term flicker severity. The result of statistical evaluation of the instantaneous flicker level over 2 hours)	Plt ≤ 1 during 95% a week
Voltage dips	Half-wave r.m.s. values of voltage	Δu ≤ 40% t < 1 s The number of dips during 1 year n=10 till 1000. The events must be classified dependent from depth and duration.
Short-term interruptions	Half-wave r.m.s. values of voltage	n=10 till 500 during 1 year t < 1 s for 70% all events
Long-term interruptions	Half-wave r.m.s. values of voltage	n=10 till 500 during 1 year t<3 min
Slow transients	Samples	Umax = 1,5 kV
Rapid transients	Samples	Umax < 6kV
Voltage unbalance	Positive and negative components values over 10 minutes	Uneg < 0,02Upos during 95% a week
Harmonics	THD over 10 minutes	THD < 8% during 95% a week
Harmonics	R.m.s. values of harmonics up to 25^{th} over 10 minutes	Lower than limits during 95% a week

PQViewer evaluates all these parameters excepted transients and interruptions and compares them with the appropriate limits. The transients as well as voltage interruptions will be not analysed, because there are no clear limits and definitions how to estimate these factors in existing standards. However, it is possible to evaluate voltage dips and short interruptions and classify it according depth and duration. The resolution for this kind of analysis is chosen automatically. The user defined resolution don't matter.

Harmonics plot. Here you can analyse and visualise following values:

- R.m.s. values of four voltages and currents
- THD of phase voltages and currents

- Harmonics of voltages and currents (up to 40^{th})

The user defined resolution will be used.

Vector diagram and unbalance. There are following values available:

- R.m.s. values of four voltages and currents
- Phase angles of voltages and currents
- Positive, negative and zero components of voltage
- Unbalance factor
- Frequency

Flicker analysis. It is possible to present and analyse the following flicker-relevant values

- R.m.s. values of four voltages and currents
- Fluctuations of the r.m.s. values of currents and voltages
- Active, reactive and apparent power as well as their fluctuations
- Pst values of four voltages
- Power factors

The resolution for all values is user defined. The resolution for Pst values corresponds with short-term duration entered in the PQAgent.

Waveform analysis. The waveforms of voltages and (or) currents which were saved during measurement can be analysed in this section. The sampling frequency used could be set up only before measurement was starting and can't be changed in PQView.

Voltage dips. The evaluation of voltage dips and swells is possible in this analysis task. The program uses the half-wave values of voltages to estimate the dips and swells. The resolution equals 10ms and can't be changed.

Signalling voltages. The signalling voltages which were transmitted by a utility to control the energy counters and lighting equipment will be shown as a set of events. You can visualise it in time domain as a telegram with a resolution of 200ms.

Analogue- and digital inputs. If your LMG450 is equipped with an I/O Card you can use an additional analogue and digital inputs to record non-electrical and control signals. You can analyse them in this section. The resolution equals 200ms.

5 Switching between the analysis tasks

There are two ways to jump from one task to another:

1. You can choose the new task from the window “Available values”. You can activate this window from menu point “analysis task->Change analysis task>. You can change also the resolution and the boards of the observation window.

2. Direct switching from the main window. There is a list “Analysis mode” in the main window. You can change the analysis task by using this field. The resolution and the observation window will stay the same.

6 Evaluating the measured data vs. loading the pre-compiled data

While evaluating the measured data the original values will be first prepared and saved as a pre-compiled file in order to make the visualisation faster. While analysing the data again you will be asked which data are you going to analyse (Fig. 6)

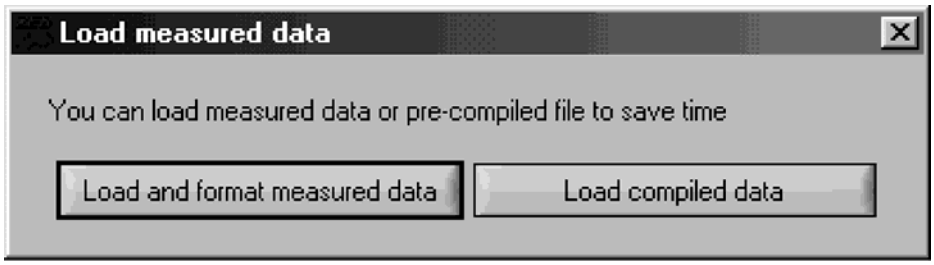


Fig. 6

The option “Load and format measured data” allows you the analysis of the original data. The second options causes the repeat analysis of previous evaluated data.

7 EN50160

While solving this analysis task the following values will be evaluated:

Tabelle 2

Factor	Resolution
R.m.s. values of the phase voltages	10 minutes
R.m.s. values of harmonics (2 till 25th) of the phase voltages	10 minutes
THD's of the phase voltages	10 minutes
Phase angles, positive, negative and zero components of voltage as well as the unbalance factor	10 minutes
Long-term flicker severity	2 hours
Frequency	10 seconds

After evaluating you can see the window as shown at Fig. 7. You can find the graphical presentation as well as the short text description of the test results.

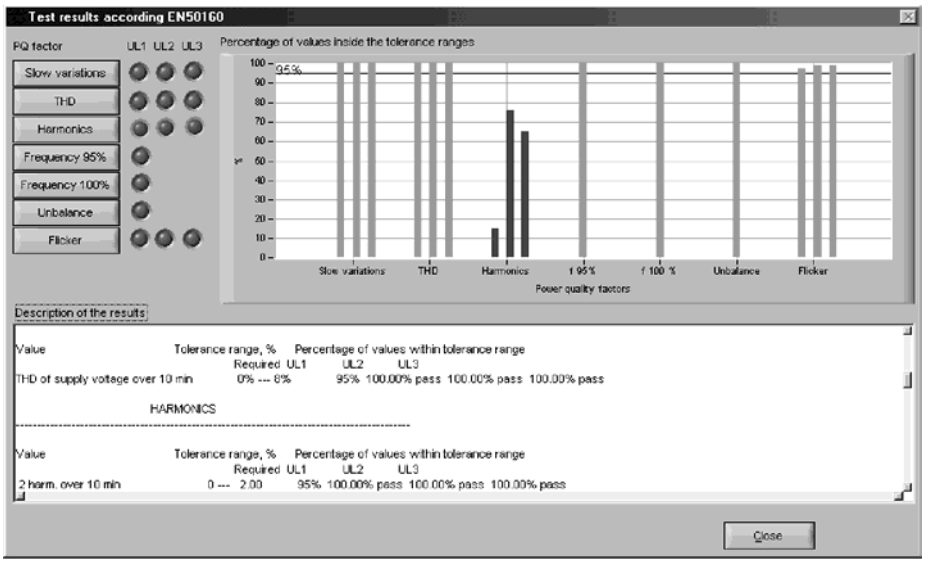


Fig. 7

At the left side you can see the test results for each power quality factor evaluated. Green indicator means the result was „pass", the red one shows the result „fail". The bar plot shows the percentage of measured values inside the tolerance ranges. The percentage which is smaller than 95% is presented with red colour and means „fail".

A detailed description can be found in the field “Description of the results”. The user is able to show it, to export it into an ASCII file as well as to print it directly. The picture can be saved as a bitmap, placed in the clipboard or printed. This window gives the user only general information about test results. You can see the results for each factor in details by pushing the button with appropriate name left from the result indicators. After pushing it, the following window will be visible (Fig. 8)

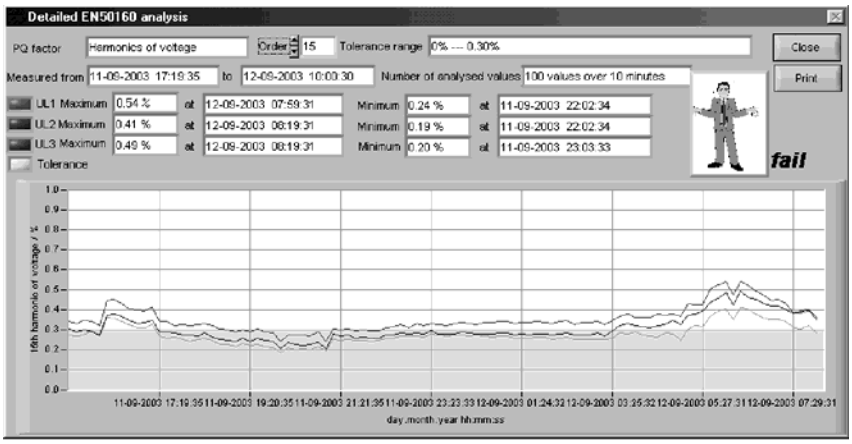


Fig. 8

You can find there the following data:

- Observation time
- Resolution
- Number of measured values
- Minimum and maximum values

The plot shows you the evaluated factor in the time domain as well as the tolerance range which is presented with yellow. You can take from this plot, for example, the information when the analysed value was outside the tolerance and how long it was. If more than 95% of values were outside the result becomes “fail”. If you analyse the harmonics, you can change the order in the “Order” field.

8 Harmonics plot

After choosing this analysis mode first of all the original data will be prepared. It could take some time into account. The duration of the data preparation depends on the computer power, observation time and resolution.

After preparation of the original data you can see the bar plot of harmonics as shown at the Fig. 9. The user can switch between voltage and current and between the phases. It is also possible to present harmonics for each time. You can change the actual time by means of the upper time slider.

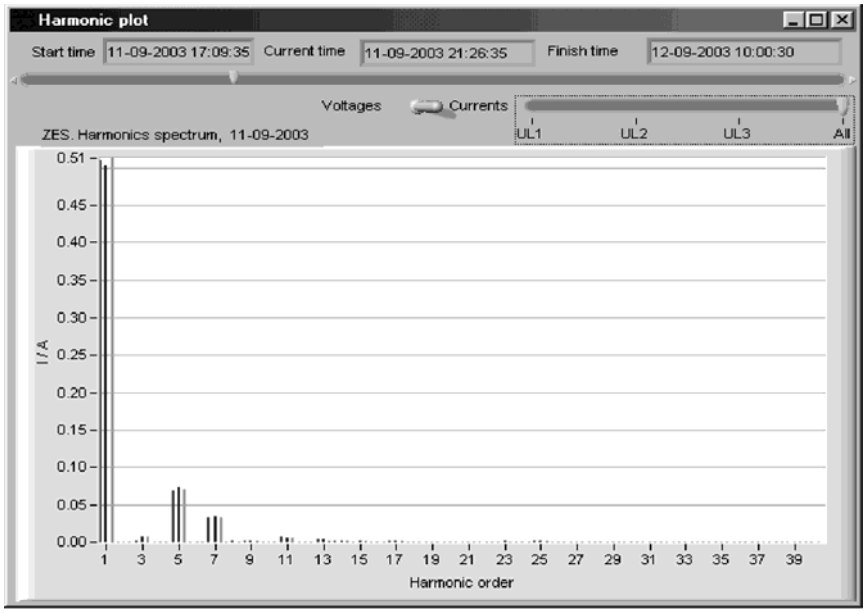


Fig. 9

The main window is presented at the Fig. 10

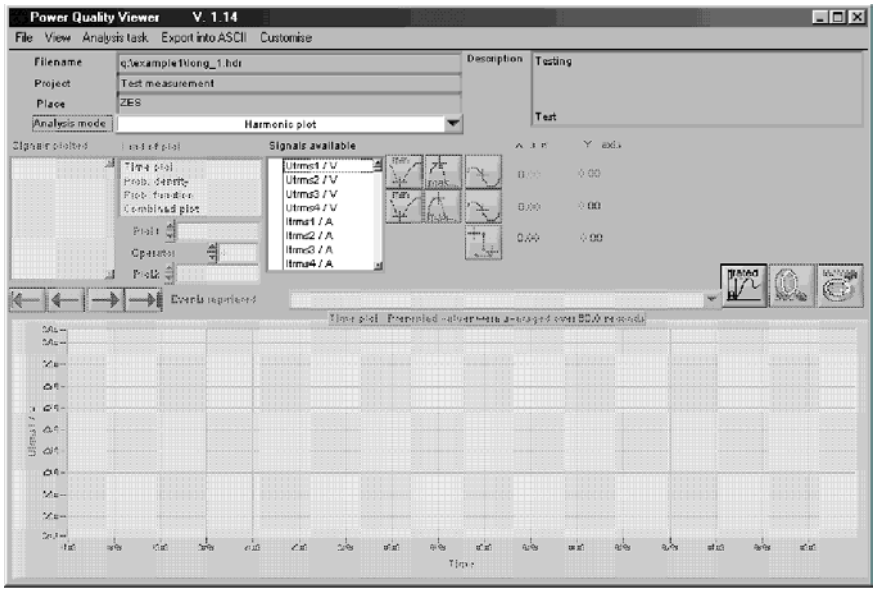


Fig. 10

The user has to check the item to be plotted in the field “Signals available”. The marked signal will be presented (Fig. 11).

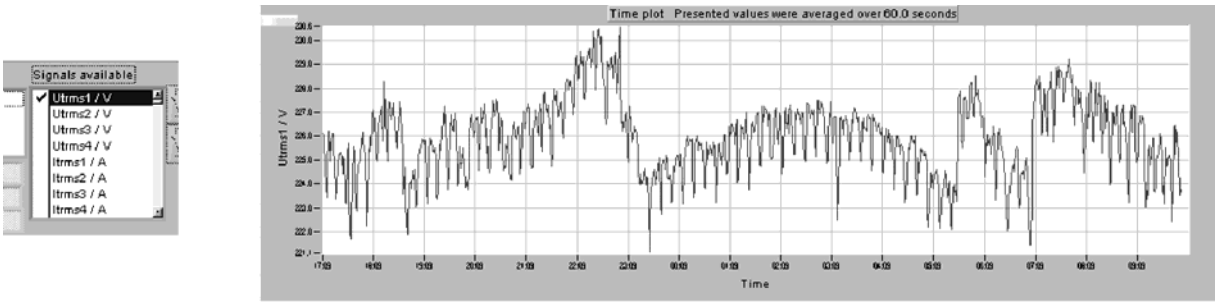


Fig. 11

The kind of visualisation can be changed in the field „Kind of plot“. There are following styles available:

- Time plot
- Probability density
- Probability function
- Combined plot (the combinations of two signals)

A time plot is a simple presentation in the time domain. The X-axis contains the time and the Y-axis shows the value to be presented. By choosing “Probability density” a histogram will be built (Fig. 12).

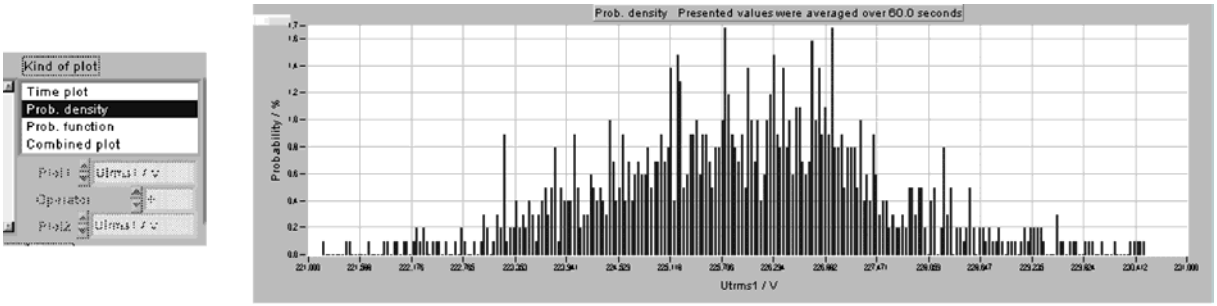


Fig. 12

The whole range of an analysed value will be divided into a number of steps. The number of steps depends on the number of analysed values. Each step will be presented on the X-axis with its averaged value. The Y-axis contains the probability that the measured values belongs to this interval. In order to obtain the information about statistical parameters of the analysed signal it is recommended to built the probability function which is shown at the Fig. 13. The X-axis presents the values of the analysed signal and the X-axis shows the probability that the measured value was smaller than the appropriate value from X-axis.

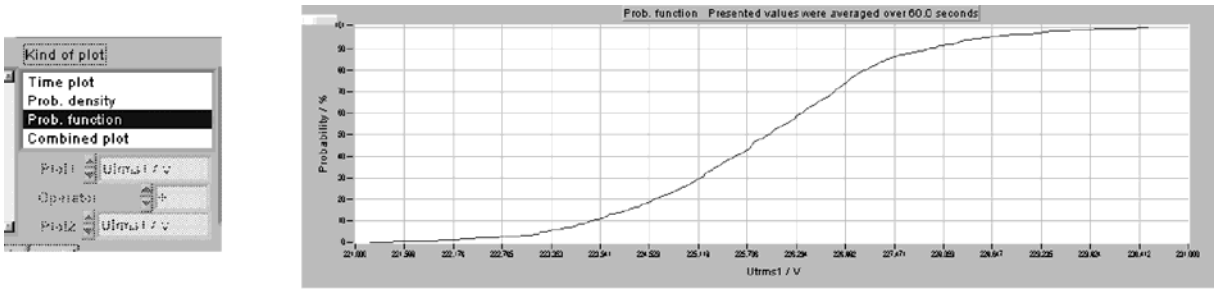


Fig. 13

The option “Combined plot” allows the combination of two signals (sum, difference, product and ratio) to be plotted over time. The user has to choose the needed operation from the field “Operator” and the signals to be analysed – from the fields “Plot1” and “Plot2”.

Additionally the possibility to present one signal versus the another one is given. The result is shown at the Fig. 14. This tools makes the regression analysis easy.

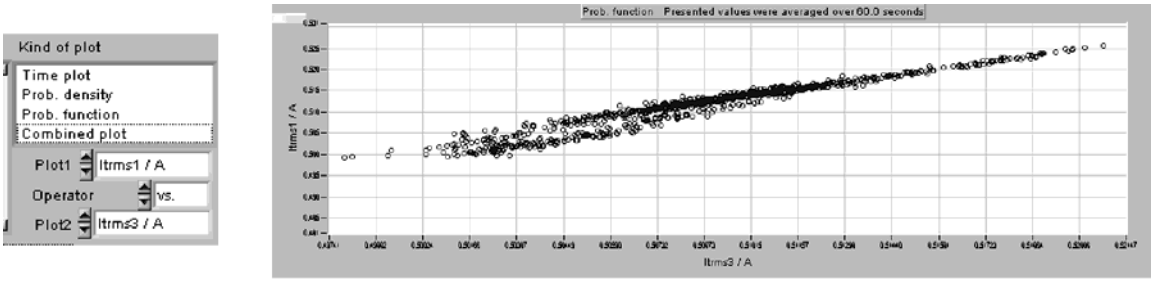


Fig. 14

9 Vector diagram and unbalance

The user can analyse the values which were relevant while calculating the unbalance of a three-phase system. The following values belong to this group:

- R.m.s. values of the phase voltages and currents
- Phase angles of voltages and currents
- Frequency
- Positive, negative and zero components of voltage as well as the unbalance factor as a ratio between negative component and the positive one.

After pre-processing of the original data the following window with a vector diagram appears (Fig. 15).

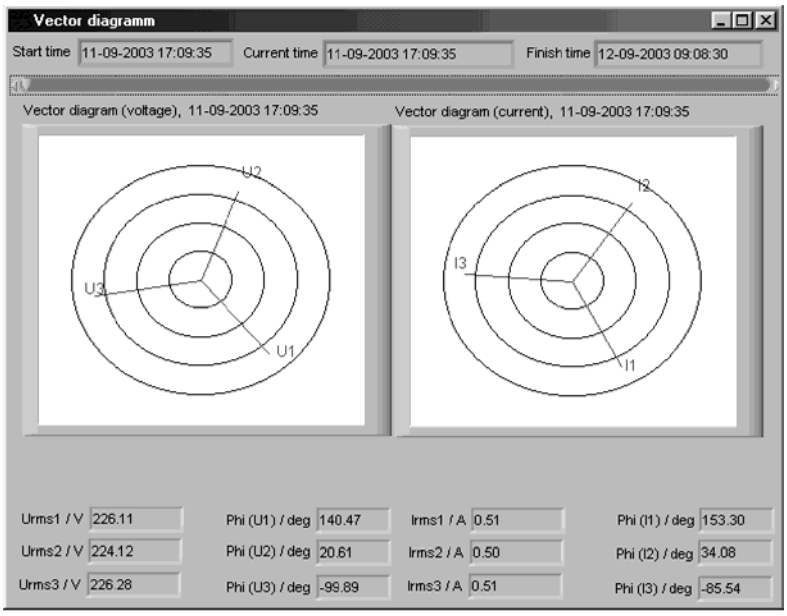


Fig. 15

This window gives you the information about the r.m.s. values and phase angles of voltages and currents. You can change the actual time by means of the slider and analyse the voltages and currents in each point of the observation time. The visualisation tools for this task are the same as for harmonics and were described in details in the previous chapter.

10 Flicker analysis

The values which are important while analysing flicker and flicker emission are collected here. The analysing tools are the same as ones for harmonics and unbalance. The use has an additional possibility to present and analyse the fluctuations of voltages, currents and powers together with flicker in order to find out the reason of flicker. One has to note that the duration of short-term measurement of flicker doesn't correspond with the resolution for another values. That is why you can obtain the following picture (Fig. 16) while analysing the data with resolution of 200 ms. The voltage fluctuation and Pst values are presented here. The Pst values looks step-like because they have the same value over 10 minutes.

Please take care that the first Pst value will be appearing after 10 minutes. This means you will no Pst values in the first 10 minutes.

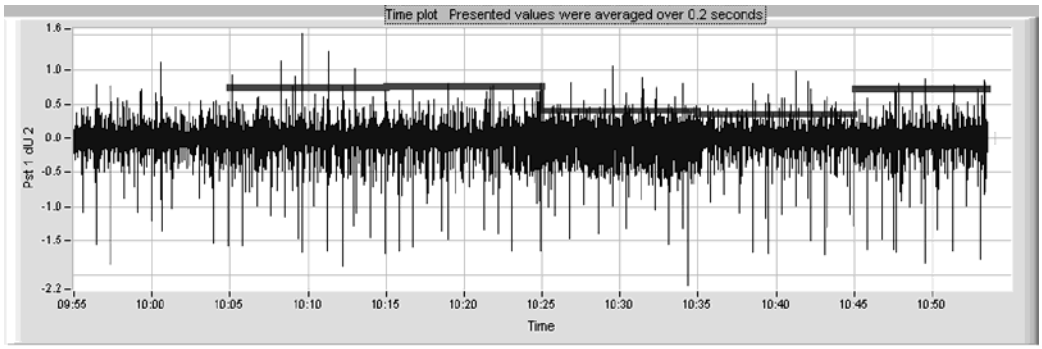


Fig. 16

11 Waveform analysis

You can see the list of recorded waveform in the field „Events registered“ as shown at the Fig. 17. Each line contains the information about the date and the time of an event as well as the triggering condition. If there was no events recorded, than this window is empty.

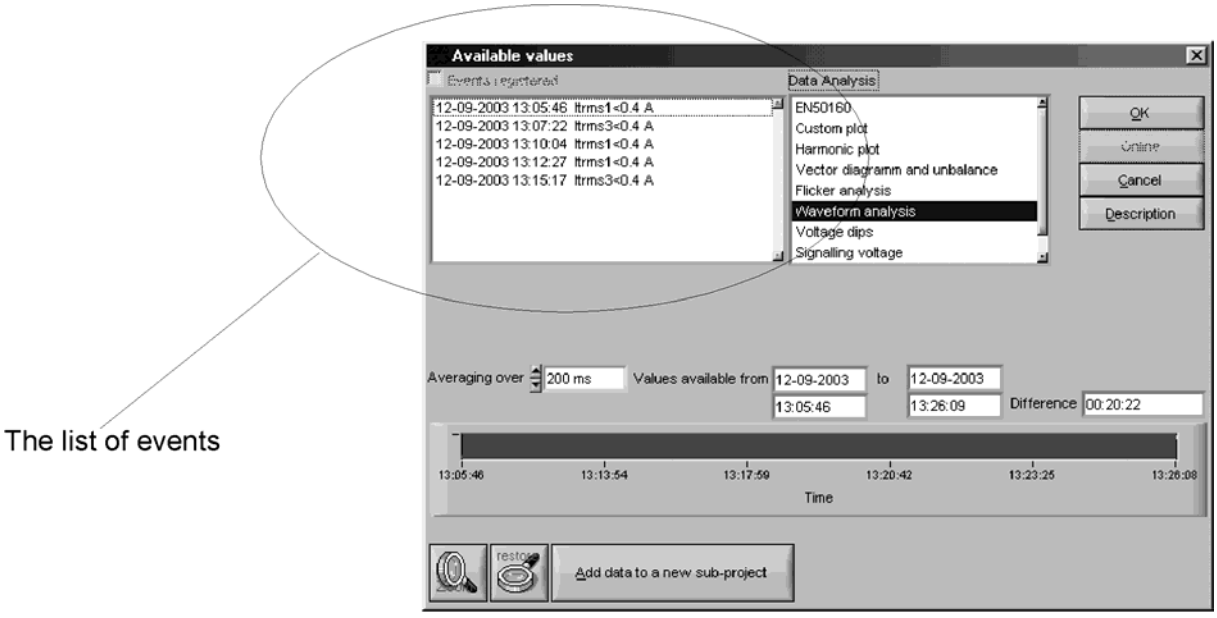


Fig. 17

After choosing an event and double clicking at the appropriate line the program switches in the main window. If you check one of the values in the field “Signals available” an marked waveform will be presented (Fig. 18).

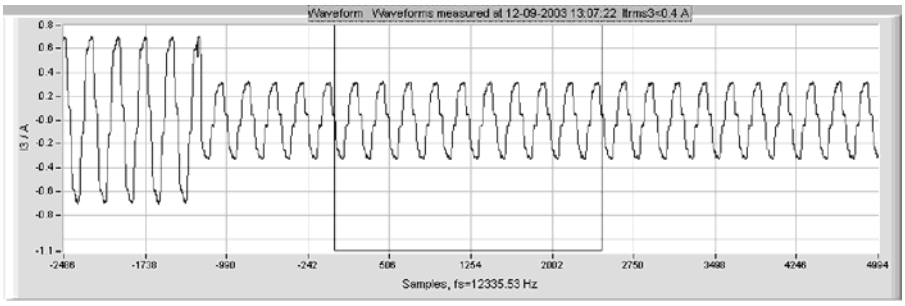


Fig. 18

X-axis contains the numbers of samples. A negative number means the pre-triggering domain. The first value from the measuring cycle of 200ms where the event was detected has the number zero. This cycle is marked with a blue rectangle.

Take care that the recording of sampling values impacts the logging of r.m.s. values. There is a gap during transferring and saving the samples. The time plot of, for example, a harmonics looks like Fig. 19.

Fig. 19

The switching from one event to another can be carried out either by pushing the buttons with the arrows or by choosing an events needed from the list of events. These possibilities are presented at the Fig. 20.

Fig. 20

12 Voltage dips

The basic values for this analysis are the half-wave r.m.s. values of the line voltages which will be compared with a threshold. The reference voltage and the percentage threshold will be taken from the window „Available values“ (Fig. 21). The resolution equals 10 ms independent from the main one.

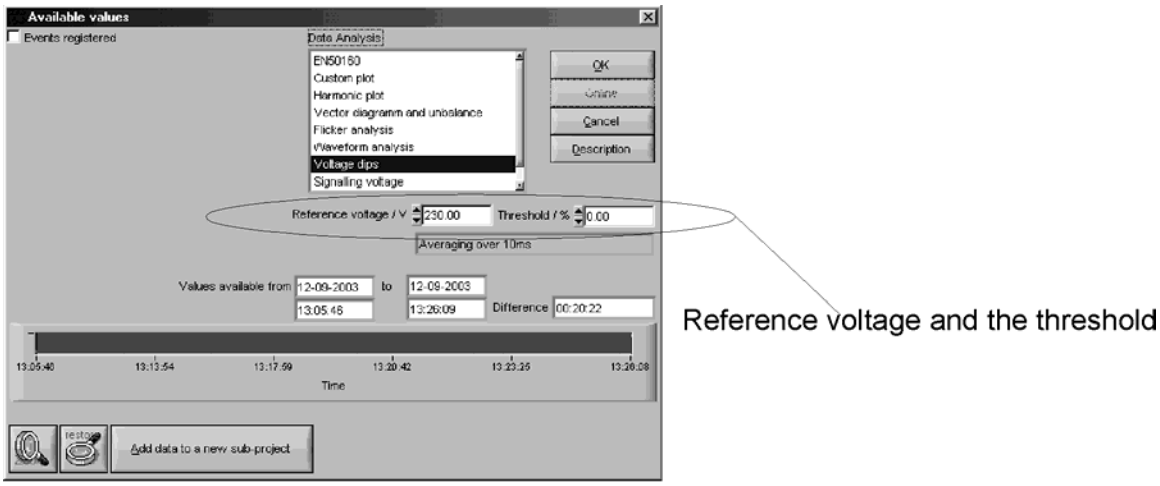


Fig. 21

The software evaluates all dips and swells over the chosen observation time. The Fig. 22 describes the meaning of a voltage dip and a voltage swell.

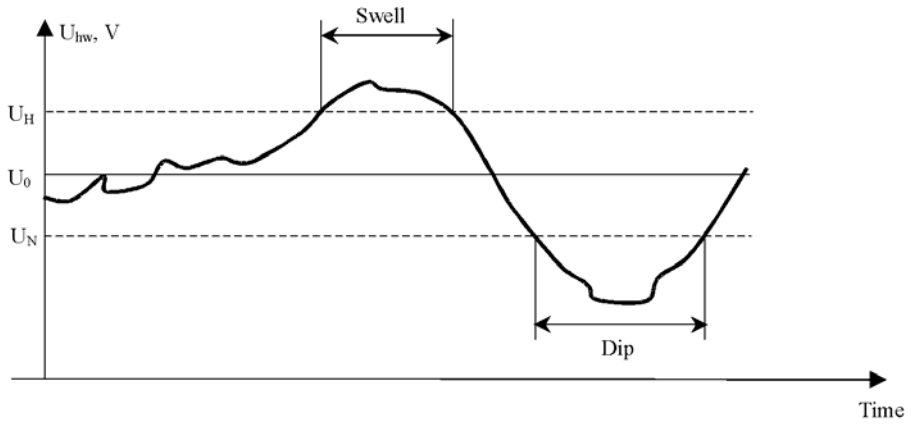


Fig. 22

The limits U_H and U_N follow from the reference voltage U_0 and the threshold S according the expression below:

$$U_N = \frac{S}{100} \cdot U_0, \quad U_H = \frac{(200 - S)}{100} \cdot U_0.$$

The results of an evaluation can be taken from the table which appears in the window „Voltage dips“ as shown at the Fig. 23.

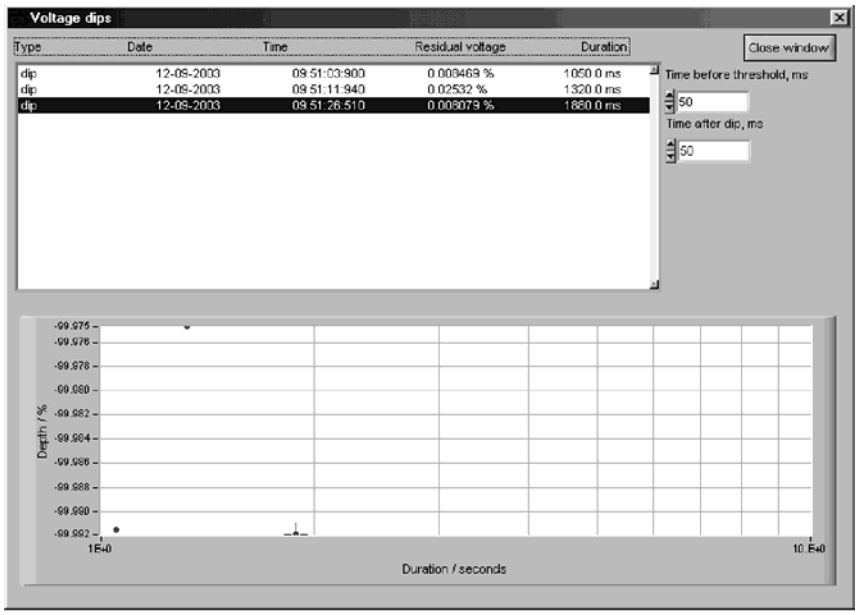


Fig. 23

Each line contains information about the date and time of a dip/swell as well as the residual voltage and the duration of an event.

Below the table you can find the „depth-duration“ plot where each dip/swell is shown as a point in a„depth-duration“ domain. If you click double onto a line, the corresponding dip will be presented as a voltage profile. The Fig. 24 shows such a profile.

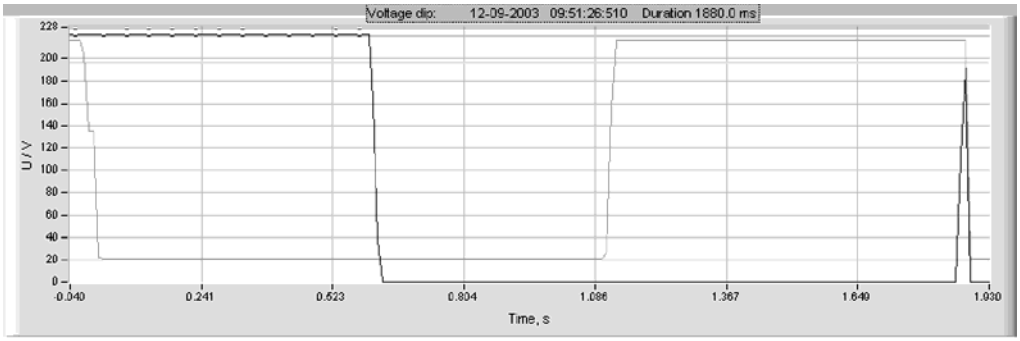


Fig. 24

The X-axis contains the relative time. The negative time means pre-history. The pre- and post-history can be changed from the window „Voltage dips“. The switching back to this window can be carried out from the menu point „View->Result table“.

When analysing voltage dips and swells take care that a dip will be detected if **one of the line voltages** becomes lower than threshold. A dip is over when **all line voltages** are back.

Therefore:

If you evaluate a single-phase dips / swells, connect the channels 2 and 3 parallel to the channel 1. Otherwise you will not be able to evaluate voltage dips and swells properly.

13 Signalling voltages

The supply utility controls the energy counter, lighting equipment etc. by means of transmitting the code sequences via supply network. They are a modulating signals with a frequency from 167 up to 200 Hz. The way to detect such signals is to filter the whole signal with a band-pass and to estimate the r.m.s. of filtered one.

If this r.m.s. value exceeds the threshold than the recording begins. After the code sequence is recorded, the PQA450 will be waiting about 10 minutes. The filtered r.m.s. values will be still saved. If there is no signals exceeded the threshold during the 10 minutes, than the recording is over. Otherwise the recording will be continuing.

The list of events registered can be found in the window “Available values” at the left (Fig. 25).

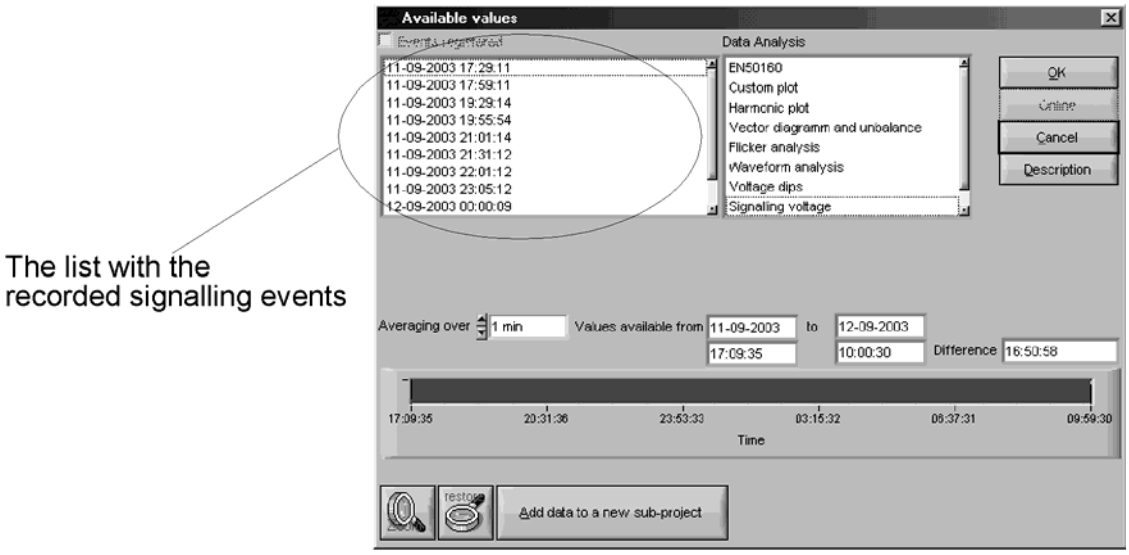


Fig. 25

After switching to the main window the code sequences will be presented as shown at the Fig. 26. The resolution is 200 ms. The switching from one signalling to another can be carried out as described earlier.

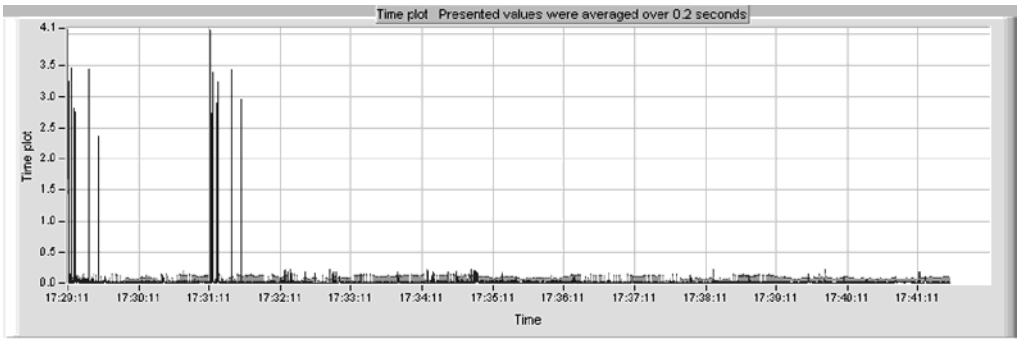


Fig. 26

14 Service signals

If a LMG450 is equipped with an I/O card, than you can record and evaluate the signals additional analogue and digital inputs with a resolution of 200ms.

15 Working with graphic cursors

You can use two graphical cursors while analysing the plots. The following controls make this possible (Fig. 27).

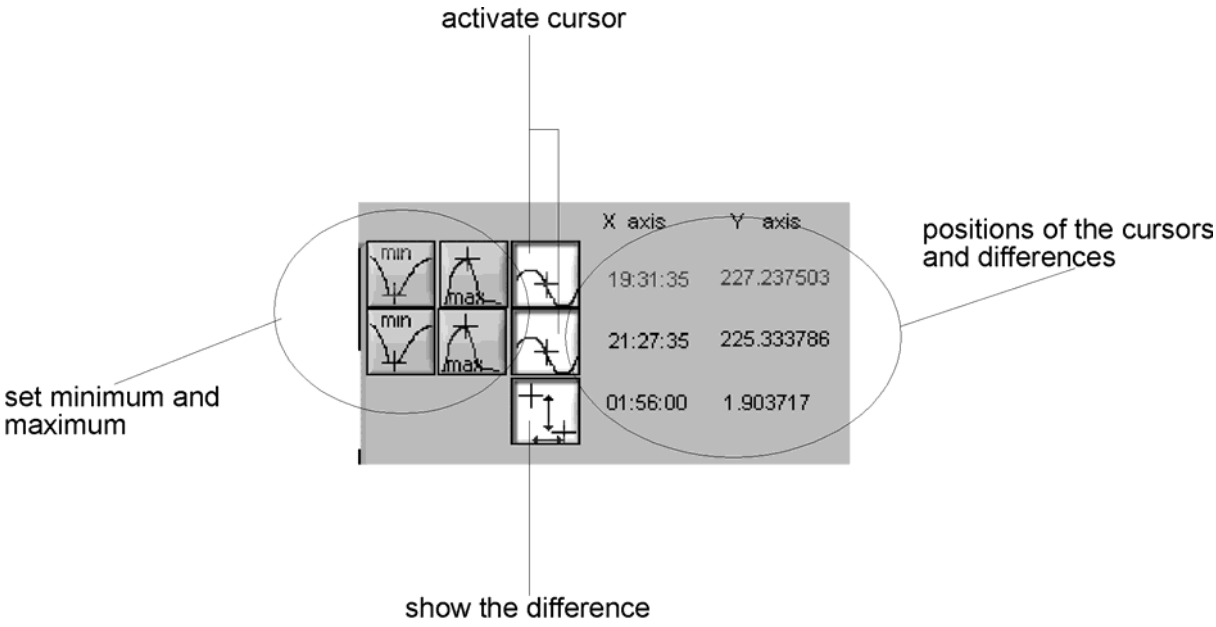


Fig. 27

If a cursor is active, as at the Fig. 28, you can see the position and can move it or set it on the maximum or minimum automatically. If you have activated both cursors, than you can see also the differences between them.

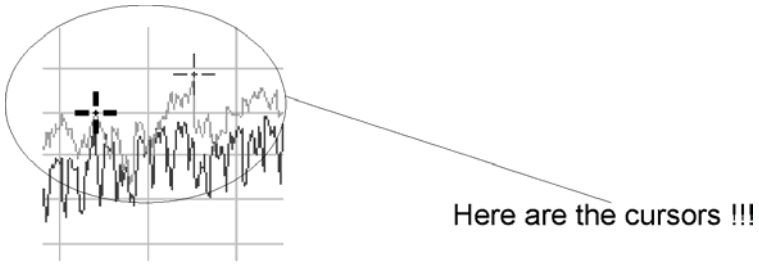


Fig. 28

16 Processing the graphics

There are following tools available to make the presentation more comfortable (Fig. 29)

- Zoom picture
- Restore the whole picture
- Rate the curves
- Change the plot attributes

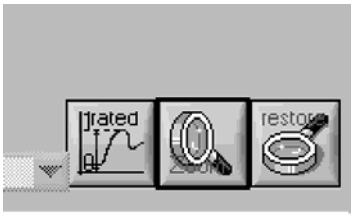


Fig. 29

The zooming can be carried out next way:

1. You have to push the button „Zoom“. The mouse cursor is changing an looks like index finger.
2. You have to place the cursor onto the corner of the rectangle to be zoomed.
3. You press the left mouse button and move the mouse without releasing the button. You can see the rectangle as at the Fig. 30.
4. You release the mouse button and the picture will be zoomed.

The button „Restore“ allows the restoring of the whole picture.

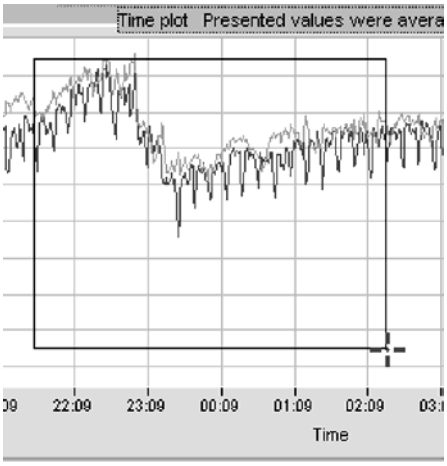


Fig. 30

It is sometimes important to present two curves with different quantities or from different ranges. The Fig 31 shows us the presentation of the first and seventh harmonics at the one plot.

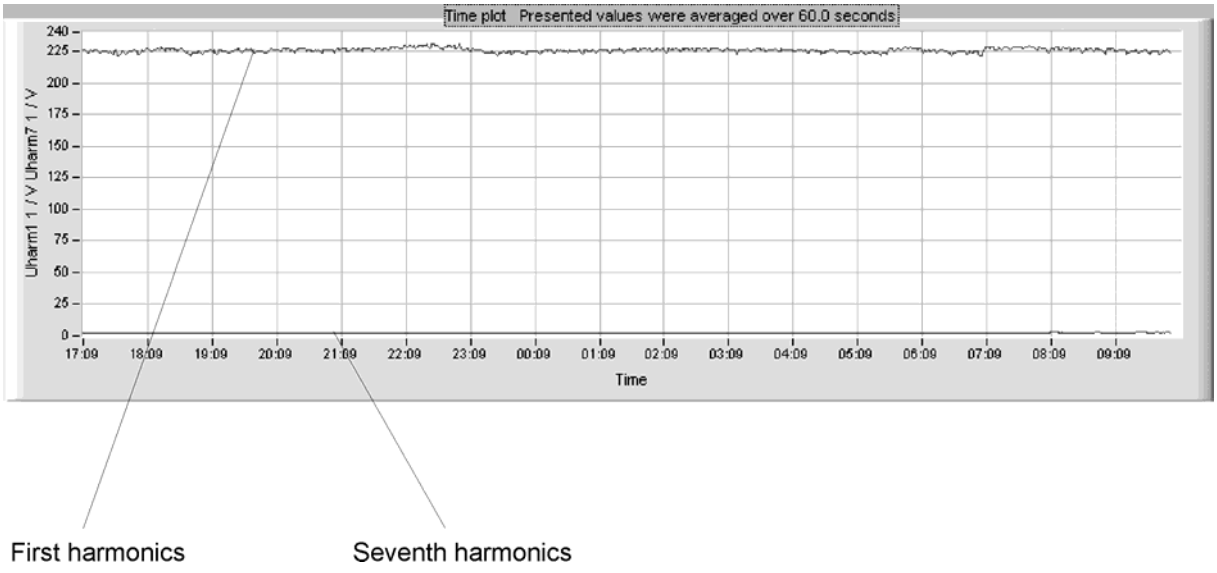


Fig. 31

Such kind of presentation gives us any possibility to analyse these signals together. However if you press the „rated“ button the plot becomes different (Fig. 32). All curves will be scaled to an interval zero till one. After this action all curves will be presented more comfortable. The real maximum and minimum can be taken from a table near the plot. After pulling the “Rated” button the original picture will be restored.

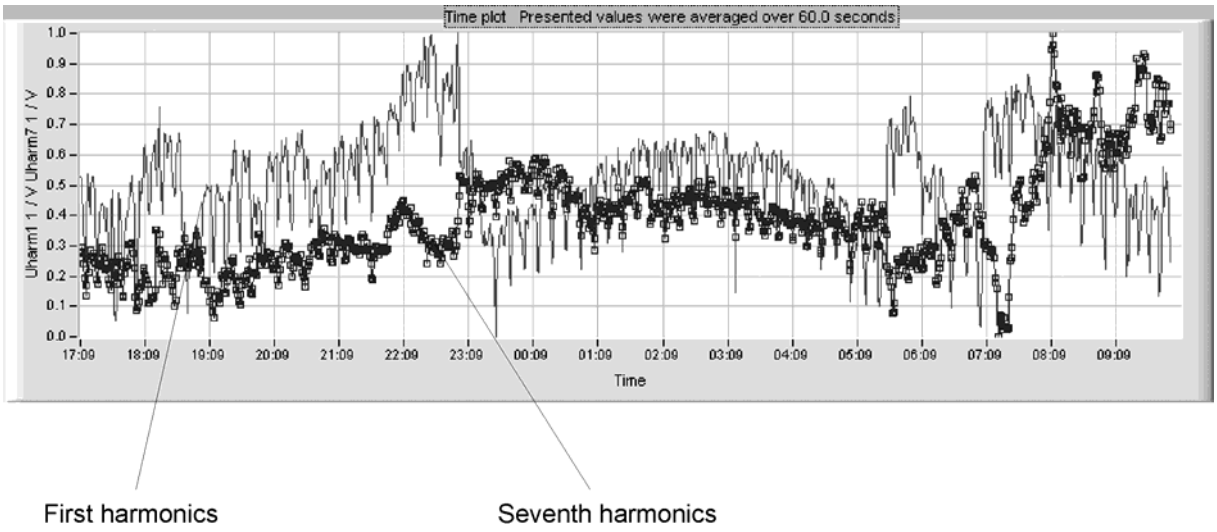


Fig. 32

The plot attributes for each curve can be changed next way:

1. You place the mouse cursor onto the item corresponding the needed curve in the list „Signal plotted“ at the left side of the main window.

2. You push the right mouse button. After it the window with plot attributes becomes visible (Fig. 33)

3. You select the new plot attribute and push „OK“-button.

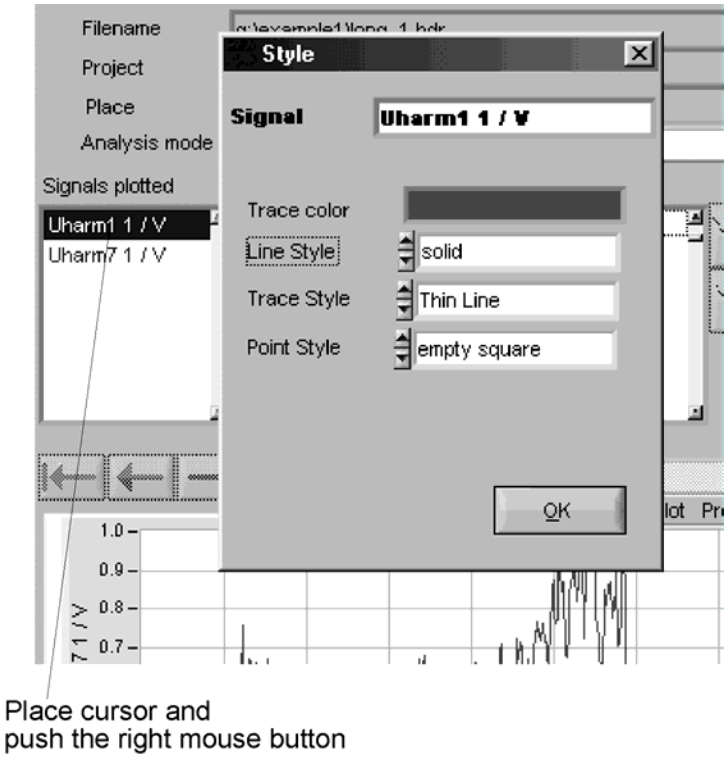


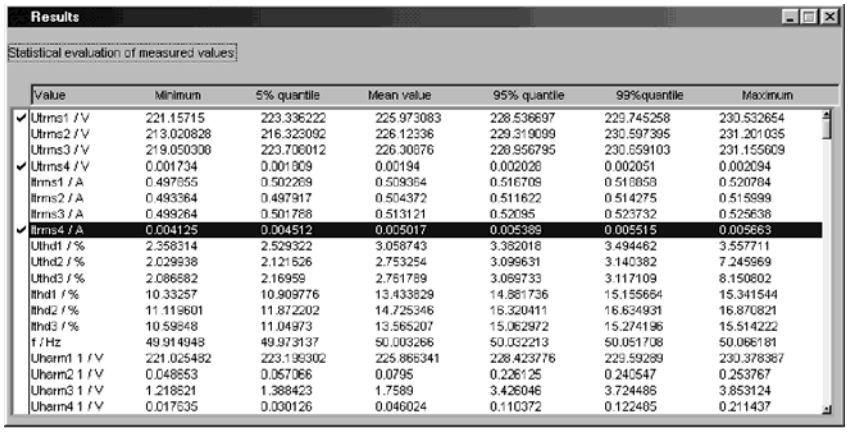
Fig. 33

17 Exporting the measured values

All measured values can be exported in an ASCII file to be processed with a special software, for instance MS Excel, Origin, Matlab and so on. It can be done from the menu point “Export into ASCII”. There are three sub-menu points available. If you choose “Export all” than all signals from the list “Signals available” will be transformed into ASCII. The data will be saved as tab-separated columns, the first one contains the date and time. If you choose the option “Export checked items”, than only items were checked in the list “Signals available” will be converted. The menu point “Coma as decimal divider” defines the number format while saving. Coma is useful if you proceed the data in a German-tuned application of MS-Office. Otherwise it is recommended to use point. Take care that the first line of a ASCII-file contains the title of each column. Therefore if you are going to export such file into, for example, Matlab, you have to remove this line manually, before you load this file.

18 Table with results of measurement

The information about the statistical values of signals were measured can be taken from the table “Results” which is shown at the Fig 34 and is available from the menu point “View->Results table”. Note that this option is unavailable while analysing EN50160, voltage dips and waveforms.



	Value	Minimum	5% quantile	Mean value	95% quantile	99%quantile	Maximum
✔	Utrms1 / V	221.15715	223.336222	225.973083	228.536697	229.745258	230.532654
	Utrms2 / V	213.020828	216.323092	226.12336	229.319099	230.597395	231.201035
	Utrms3 / V	219.050308	223.706012	226.30876	228.956795	230.659103	231.155609
✔	Utrms4 / V	0.001734	0.001809	0.00194	0.002026	0.002051	0.002094
	Itrms1 / A	0.497655	0.502269	0.509364	0.516709	0.518858	0.520784
	Itrms2 / A	0.493364	0.497917	0.504372	0.511622	0.514275	0.515999
	Itrms3 / A	0.499264	0.501788	0.513121	0.52095	0.523732	0.525638
✔	Itrms4 / A	0.004125	0.004512	0.005017	0.005389	0.005515	0.005663
	Uthd1 / %	2.358314	2.529322	3.058743	3.382018	3.494462	3.557711
	Uthd2 / %	2.029938	2.121626	2.753254	3.099631	3.140382	7.245969
	Uthd3 / %	2.086582	2.16959	2.761789	3.059733	3.117109	8.150802
	Ithd1 / %	10.33257	10.909776	13.433829	14.881736	15.155664	15.341544
	Ithd2 / %	11.119601	11.872202	14.725346	16.320411	16.634931	16.870821
	Ithd3 / %	10.59848	11.04973	13.565207	15.062972	15.274196	15.514222
	f / Hz	49.914948	49.973137	50.003266	50.032213	50.051708	50.066181
	Uharm1 1 / V	221.025482	223.199302	225.866341	228.423776	229.59289	230.378387
	Uharm2 1 / V	0.048653	0.057066	0.0795	0.226125	0.240547	0.253767
	Uharm3 1 / V	1.218621	1.388423	1.7589	3.426046	3.724488	3.853124
	Uharm4 1 / V	0.017635	0.030126	0.046024	0.110372	0.122485	0.211437

Fig. 34

You can export these results in an ASCII file. For this purpose you have to mark the items you wish to export and press the right mouse button.

19 Processing the pictures and text descriptions

All pictures and text descriptions can be converted, copied or printed. After you place the mouse cursor onto an appropriate object (picture o text) and press the right mouse button a pop-up menu will appear. From this menu you can choose the processing operation. There are generally the following kinds of picture processing possible:

Save as bitmap. The picture will be saved as a bitmap. You will be able to process it with, for instance, Corel-Draw.

Copy into clipboard. You place the picture into clipboard an can paste it into another program by means of <Ctrl-V>.

Print. The picture can be printed. Take care, the print attribute “Use bitmap printing” must be marked in the window with printing option. Otherwise the printed picture will have a pure quality.

There are following actions with the text descriptions available (also with a pop-up menu). It can be either printed or transformed in a ASCII file. Note that the system printer only will be used for printing. That is why it is strongly recommended to use the following way to print the text:

1. Convert the text into ASCII file. The text will be prepared for an easy formatting. All tables will be saved tab-separated.

2. Load this file with MS-Word.

3. Print it from the MS-Word.

There is another way to copy the text into the clipboard and paste it into MS-Word which seemed to be very clue. You can mark whole text by means of triple clicking and copy it with <Ctrl-C>. However the text will stay unformatted. That is why it is difficult to process it later. We don’t recommend this way.