liftpc®

mobile Diagnosis

Manual

Version 4.00

henning
Made in Germany

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CONTENT

1 Introduction

liftpc® is a powerful and versatile computer system of modular structure that has been specially developed for elevator construction. It has been designed for the particular requirements of elevator and building engineering and meets the highest quality demands.

Being an open system it is forward-pointing with a guaranteed future as new developments can easily be implemented. Therefore, liftpc® represents at any time the state of the art.

This manual deals with the module liftpc® ***mobile Diagnosis***. It has been developed as an independent system for mobile performance and safety examination which can be used with any laptop and a connected 3D diagnosis sensor in a fully flexible way. Performance data and ride quality of the elevator to the new standard ISO / DIS 18738 can be precisely determined.

The core is made up of a newly developed 3D acceleration sensor with associated evaluation software for measuring the performance data and the ride quality. The following data is measured by the sensor:

- Acceleration and deceleration behaviour in all 3 axes,
- Velocity curve and travel at creep speed,
- Time and path curves to locate malfunctions,
- Impact and vibration movements resulting from the car and the guide rails,
- All door movements,
- Quality of the quietness of operation according to ISO 18738.

The complementary sensorics (optional) comprises:

- Noise sensor (microphone),
- Load sensors at each rope for measuring the rope load.

By the extension with microphone and rope load sensors it becomes a universal diagnosis system for the elevator. Further software modules are in preparation for the analysis of escalators and other dynamic systems. Thanks to the almost unlimited recording time (until the capacity of the hard disk is exhausted) entirely new fields of applications are opened up.
The measurement data is filtered, the travel curves regarding the achieved acceleration values, velocity and path, as well as the so-called "jerk" are calculated; furthermore the frequency spectra are determined and compared with stored pattern curves.
By the evaluation of the measurements any irregularity in the sequence of motions is immediately detected; namely with the exact assessment to ISO 18738 and with the information about the location where they are to be found.

A variety of options allows the selection of the representation parameters, so that you can choose a design of the general view as requested.

The entire data of the performance and the ride quality are automatically stored and in this way it forms a basis for statistical evaluations. Objective data documents the quietness of operation and the ride comfort and serves as a basis for the establishment of quality certificates.

Safety and reliability

liftpc® ***mobile Diagnosis*** is used as a transportable system for the flexible performance and safety inspection and is designed to meet the increased demands on safety, reliability and ride comfort. The new standard ISO 18738 is met.

By means of objective measurement and evaluation instead of subjective estimation fault diagnosis is considerably improved. Possible defects are immediately detected and the necessary corrective measures can immediately be carried out and verified.

Cost reduction

Thanks to liftpc® ***Mobile Diagnosis*** it is, for the first time, possible to carry out maintenance and servicing that can be planned and is oriented towards the condition of the elevator. When used regularly, changes can be detected in good time and malfunctions can be avoided. This results in an enormous increase in economy.

Verification in the case of complaints and after repairs can immediately be carried out. Also problems in connection with new installations are recognized in good time and can be improved immediately. This is of great advantage for the planning of commissioning and TÜV acceptance inspections.

Universal application

The mobile system permits the highest possible flexibility in an extensive field of applications. It is applied both in the elevator construction and service field and it is used for the demonstration of performance to experts and inspectors.
liftpc® ***Mobile Diagnosis*** is equally suitable for rope and hydraulic elevators and is applicable for all types of elevators – independent of the make and year of construction.
For the analysis of escalators and other dynamic systems further software modules are being developed. Thanks to the almost unlimited recording capacity entirely new fields of application are opened.

2 System requirements

The preconditions for the operation of the software liftpc® ***mobile diagnose*** are as follows:

1. A mobile computer having the following performance data:
   - processor: 1 GHz or faster
   - random access memory: 64 MB or greater
   - hard disk: min. 100 MB
   - a free USB interface
   - a sound board 44.1 kHz with microphone input (for noise studies)

2. A Microsoft Windows operating system
   The software has been tested without failure using the following Windows variants:
   - Windows 95,98,ME
   - Windows NT 4.0 SP 4
   - Windows 2000
   - Windows XP Home and Prof.
3. the acceleration sensor including the connecting cable
4. the reference plate
5. the software liftpc® ***mobile diagnose***
6. the license file „license.dat“ supplied together with the software

3 Software installation

3.1 First installation

Place the installation CD in your CD-ROM drive. The installation program starts automatically, unless you have deactivated the corresponding option in your operating system. If this is the case, manually start the file „setup.exe“ by a double-click.
The installation procedure is user-prompted.
After the files have been installed, you are prompted to indicate the path to the license file. Now, please, load the diskette and select the diskette drive using the "Search" button or indicate the path to the location where the license file is already stored.
You can also copy the license file manually into the program directory. Simply click on "Continue" and confirm the reference display window with "Yes".

3.2 Deinstallation

You can deinstall liftpc® ***mobile diagnose*** any time, **without** erasing your measuring data and the license file as follows; using either the deinstallation possibility under Control Panel →Software or the Uninstaller under Start→Programs→Henning.

3.3 Software update

If you have already installed an older version of liftpc® ***mobile diagnose,*** please deinstall it before you install the new version (see chapter Deinstallation).

4 First steps

Before you carry out an elevator diagnosis, the program should be configured to your requirements.

4.1 Interface configuration

As the first step, carry out the settings for the serial interface, so that the sensor data can be received.
For this setting it is not yet necessary that you connect the sensor to the computer. In order to configure the interface, please, start the menu items Measurement →Parameter, as can be seen below.

If you use an acceleration sensor of the QS2 series, interface configurations are not necessary!

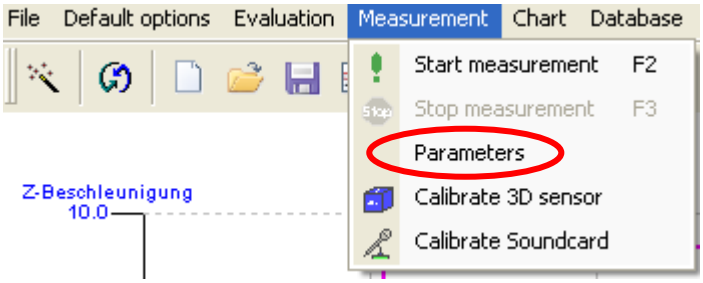


Figure 1: Menu item Interface configuration

Please, carry out the following settings in the **group field "Acceleration sensor"** in the dialog box (see figure 2) that follows:

Data port: Here choose the serial COM interface at which you wish to operate the sensor. As a rule this will be COM1.

Baud rate: For sensors with serial numbers 02 XX XXX the baud rate must be set to the value 38400. For sensors with serial numbers 03 XX XXX the value is 115200.

When you have carried out the settings, the group box "Acceleration sensor" should appear as follows:

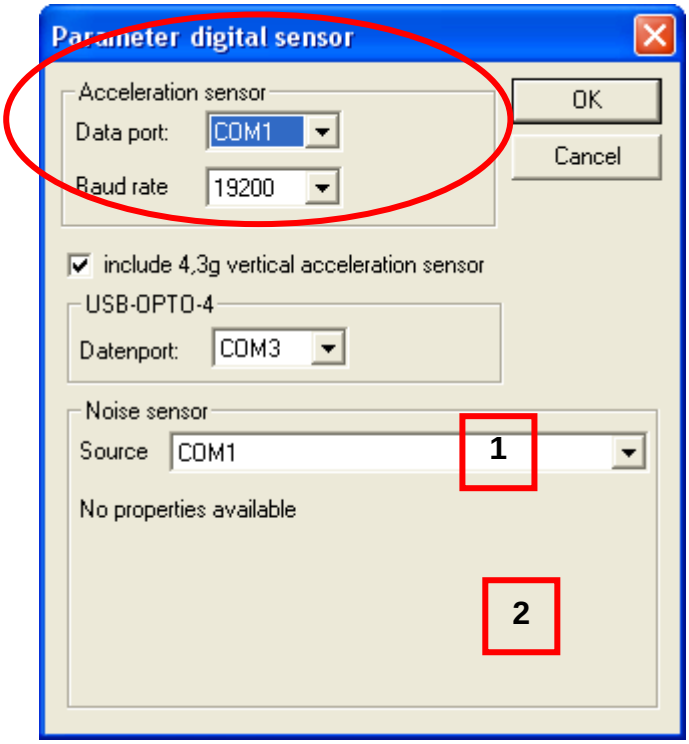


Figure 2: Dialog window Interface parameters

In order to enable the sensor to transfer data, it must now be connected to your computer. Now insert the serial connector of the sensor into the COM interface chosen by you. Afterwards, insert the USB connector of the sensor into a free USB port.
In the lower part of the dialog window you see the **group box "Noise sensor".**

If in addition to the ride quality you also want to use the noise development for the elevator diagnosis, please also connect the measuring microphone to the micro-phone input of your sound board und make the following settings in input field [1]:

[1] Source
Here, please select the sound board to which you have connected the supplied measuring microphone.

[2] Sound board properties
Here are indicated all supported audio formats of the sound board selected under [1]

4.2 Calibration of the sensor

If you use an acceleration sensor of the QS2 series, the calibration need not be carried out; these sensors are supplied with factory-calibration!
Now the sensor must be calibrated. The calibration is user-prompted.
It is important that this stage is carried out accurately as incorrect entries will have a negative effect on all future evaluations.
During the calibration it is important that you have at your disposal a suitable base for the acceleration sensor (reference plate with adjustable levelling screws and spirit level). The base must be horizontal, free of dirt and flat.
The base must be isolated from any vibrations. For this purpose you should look for an appropriate place.
You will be requested by the calibration wizard to place the sensor into different positions in relation to the Earth's attraction force. The following illustration explains these positions.

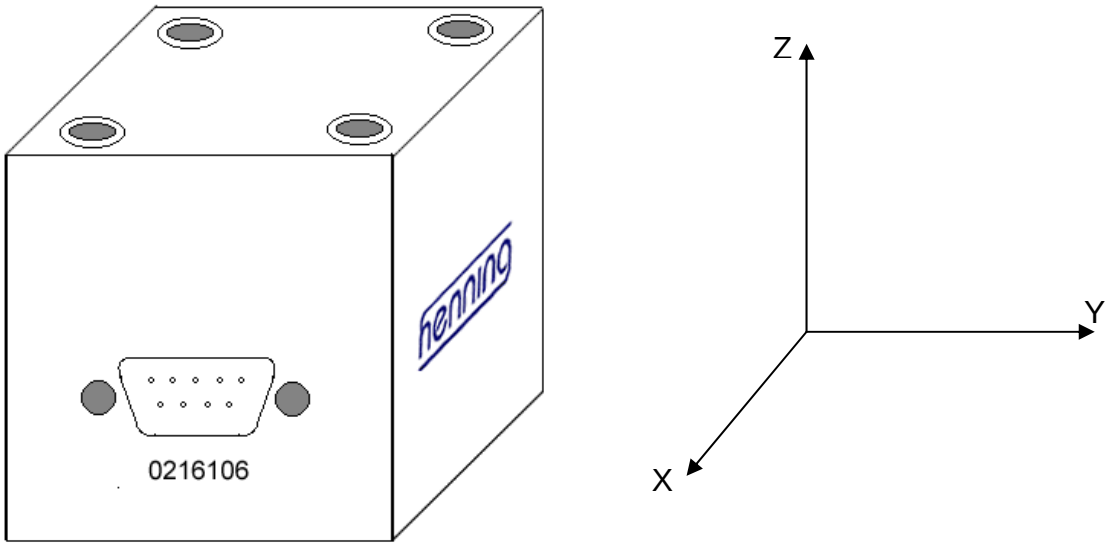


Figure 3: Schematic of the sensor orientation

Start the calibration process by selecting the menu item Measurement→Calibrate 3D-sensor (see figure 1). Simply follow the steps of the wizard. The data collected is stored and automatically retrieved for measurements each time the software is run.

4.3 Sound-card calibration

As the sound level is calculated by means of the analogue signals of the sound level microphone to the sound card, in most cases it is essential to calibrate the sound card, as corrosion of the plugs and sockets etc. affect the quality of the signals.
For this purpose, proceed as follows:

1st Step
From the Measurement menu take the "Calibrate sound card" option. After the following dialog box has opened, you will hear a test tone.

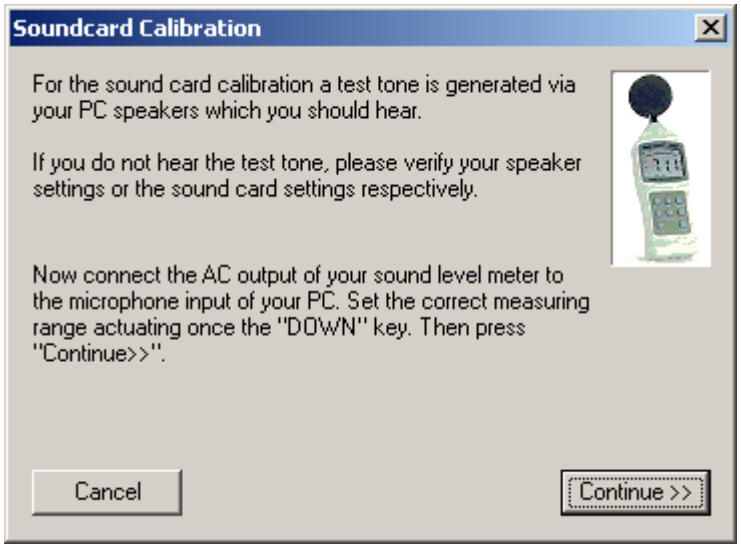


Figure 4: Sound card calibration dialog

If you do not hear the test tone, please verify whether you have chosen the correct sound card under Settings and whether your speakers are set to "mute" or "very quiet".

2nd Step
Now connect the AC output of the sound level meter to the microphone input of your sound card using the included cable.

3rd Step
Switch on the sound level meter, wait for the initializing phase and afterwards actuate the DOWN key of the instrument until the value 30 appears on the left side above the bar display and the display AUTO (left side below the bar display) has changed to MANU.
Now you are in the correct measuring mode.
Terminate this dialog box by clicking on the "CONTINUE>>" button.

4th Step
Now you must ensure that as little background noise as possible occurs while you place the measuring head of your sound level meter as near as possible to your speakers from which the test tone is still to be heard.

5th Step
In the dialog box (see below), that has now opened you see a horizontal slider. By means of this slider you can regulate the volume of the test tone.
Adjust the volume so that the sound level meter displays the value **60** while you continue to maintain a low level of background noise.

As soon as the value 60 on the display remains stable (permissible deviation +/- 0.2 dB(A)), again click on the "Continue>>" button.
Now a 10 seconds countdown starts. At the end of the countdown the calibration is finished. If during the countdown further background noises occur which can be seen on the display of the sound level meter, the entire procedure must be repeated.

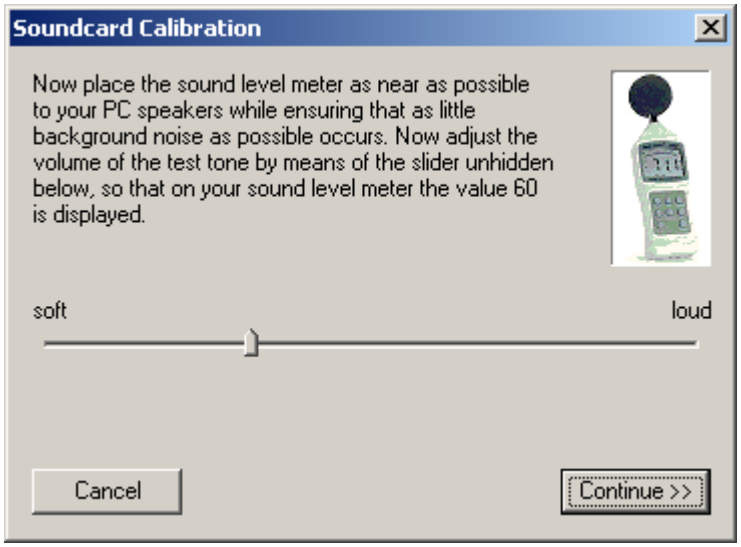


Figure 5: 2nd Sound card calibration dialog

4.4 Default options

Approved default options have already been adopted when the software was installed. These settings refer to the representation of the on-line measurement curves and the result curves.
If you do not want to change these settings, skip this point and go to point 4.4 Test measurement.

4.4.1 Representation of the measurement curves

The default settings concerning the display of the measurement curves for the channels X, Y and Z are found in the menu under the menu item Default settings.

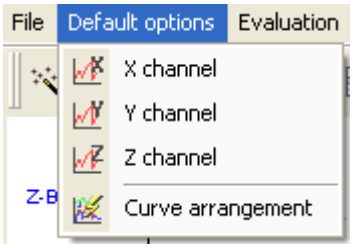


Figure 6: Menu Default settings

Handle one after the other the menu items X-channel, Y-channel and Z-channel.
For each curve the dialog box shown on the left opens up in which you can make the settings shown below.

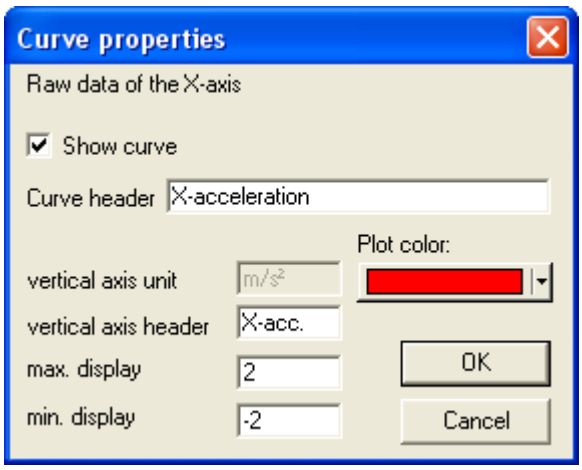


Figure 7: Dialog Default settings x,y,z-curves

Unhide curve:
Only if this option is selected, the curve of the current measurement channel (in the case shown the "X-axis) is visible.
The actual data is recorded in any case.

Curve title:
Here you can insert any title for the measurement curve. The default setting is „x-acceleration“ or „y-acceleration“ and „z-acceleration“

Vertical axis unit:
Here you can indicate the unit to be used for the Y-axis (vertical axis) on print-outs and screen displays of the channel concerned.
As the data is recorded in m/sec^2 renaming wouldn't make much sense.

Vertical axis title:
Indicate here the name of the Y-axis (vertical axis) as it shall be designated on print-outs and screen displays.

Max. display:
The value to be indicated is the biggest value of the Y-axis to be displayed. Together with the parameter "Display start" you can in this way define the window in which the data is displayed.

Min. display:
The value to be indicated is the smallest value of the Y-axis to be displayed. Together with the parameter "Display end" you can in this way define the window in which the data is displayed.

Plot colour:
Here you can select in which colour the curve shape of the corresponding channel shall be displayed.

4.4.2  Arrangement of curves

Under this menu item you may determine the representation in which the results shall be displayed.
With the help of the opening dialog box selected result curves are positioned on the screen or the print-out.

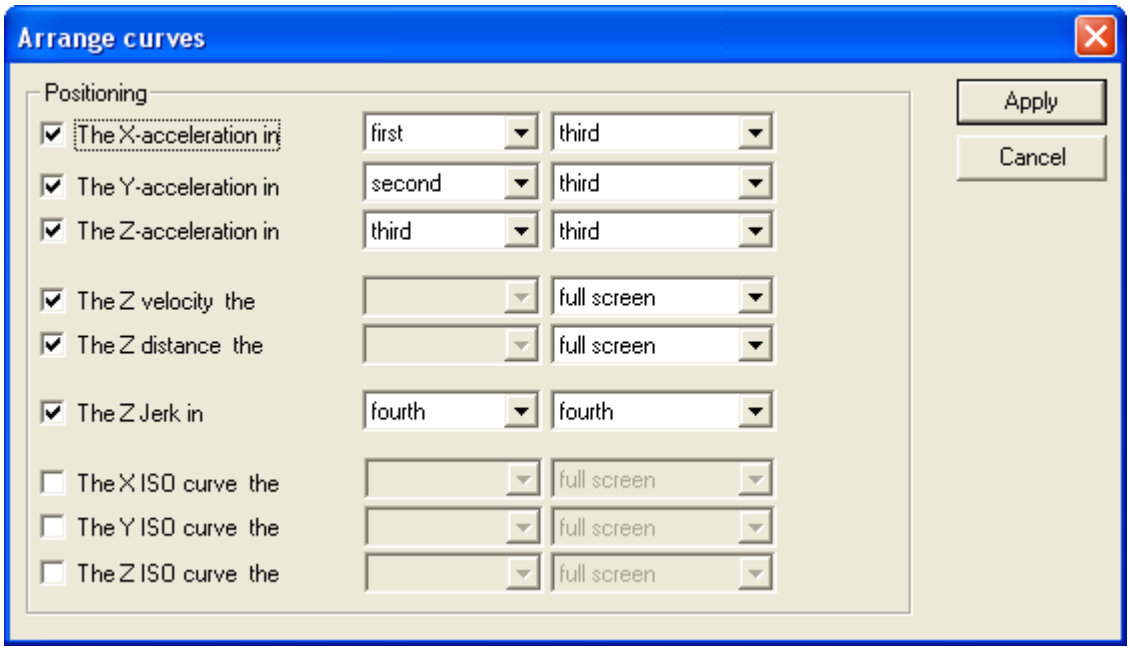


Figure 8: Dialog box Arrangement of curves

If you tick the checkbox in front of the listed curves the corresponding curve will be shown after the evaluation. Using the drop down list boxes you can determine the position and size on the screen.
For example, according to the above settings the curves on the screen will be displayed as follows:

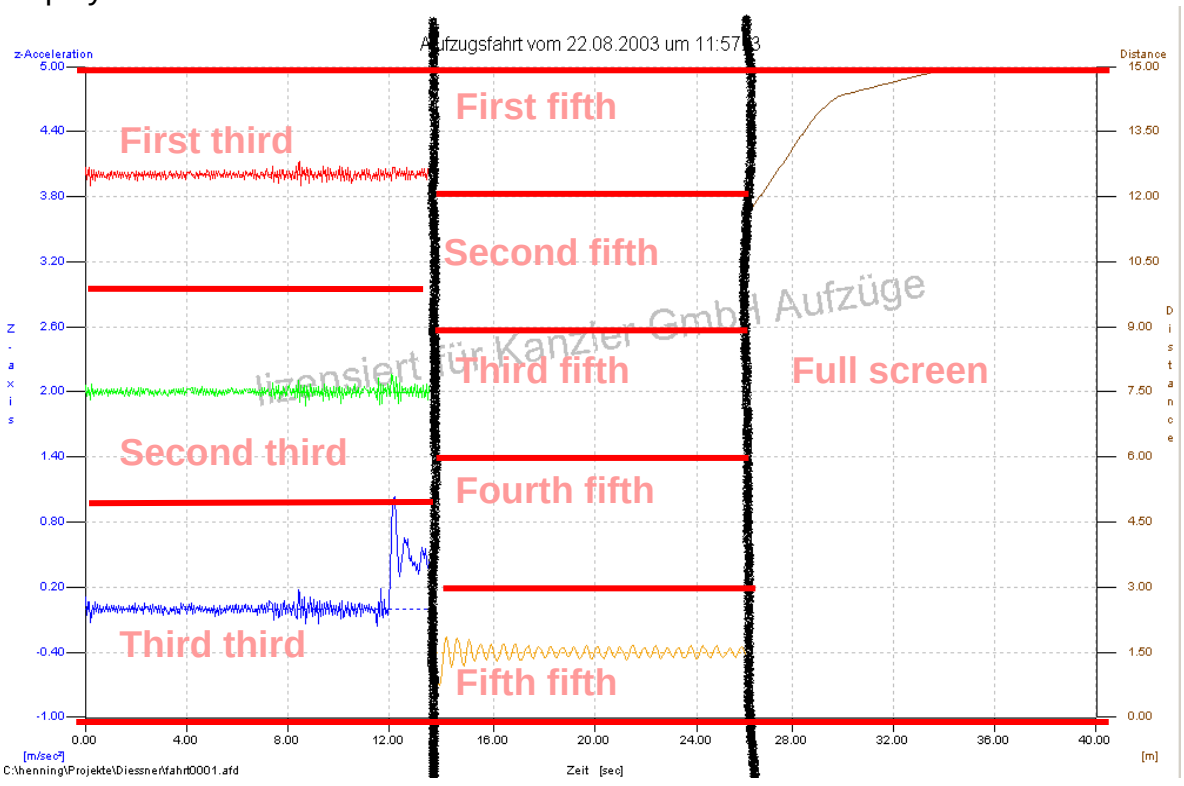


Figure 9: Example for a curve arrangement

4.5 Test measurement

Now you have made all settings which are necessary to carry out elevator diagnoses with liftpc® ***mobile diagnose***.
At this point you should now carry out a test measurement in order to verify your settings.
For this purpose place the sensor on the flat, clean and vertical surface of the reference plate, as shown in figure 3.
Now, create a new project in which the test measurement is saved. For this purpose use the menu item File→New project.
The subsequent dialog has the following appearance.

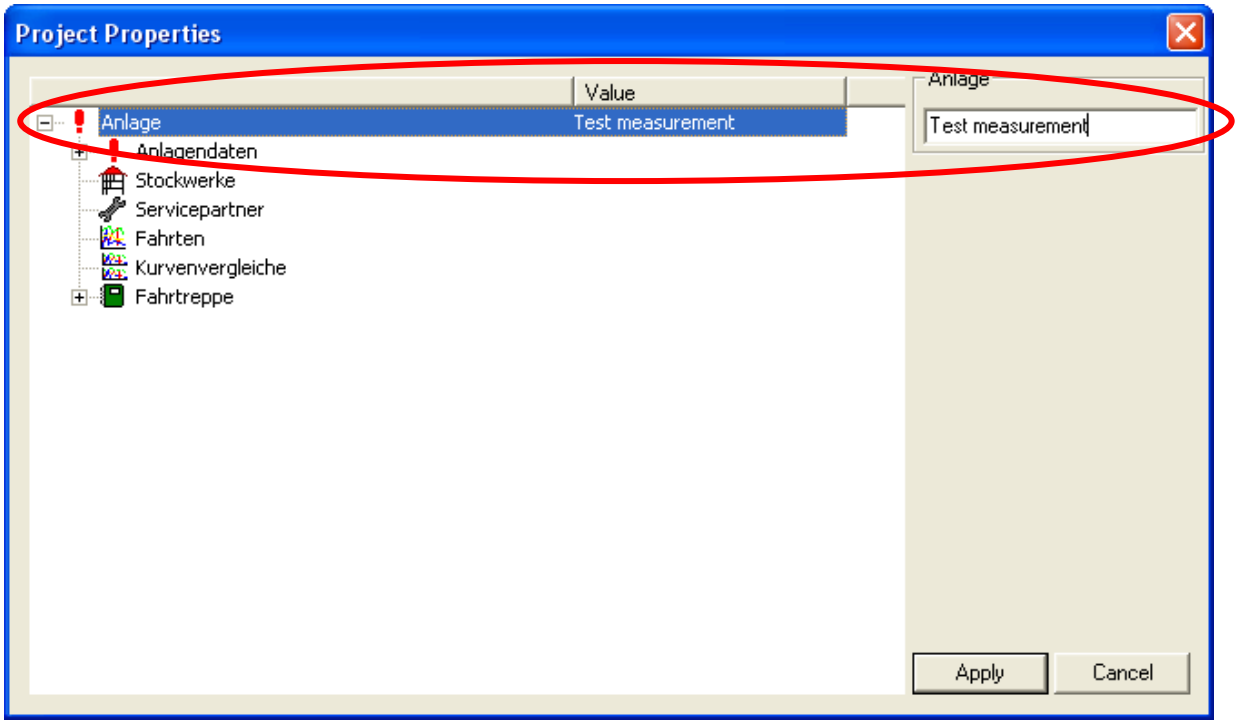
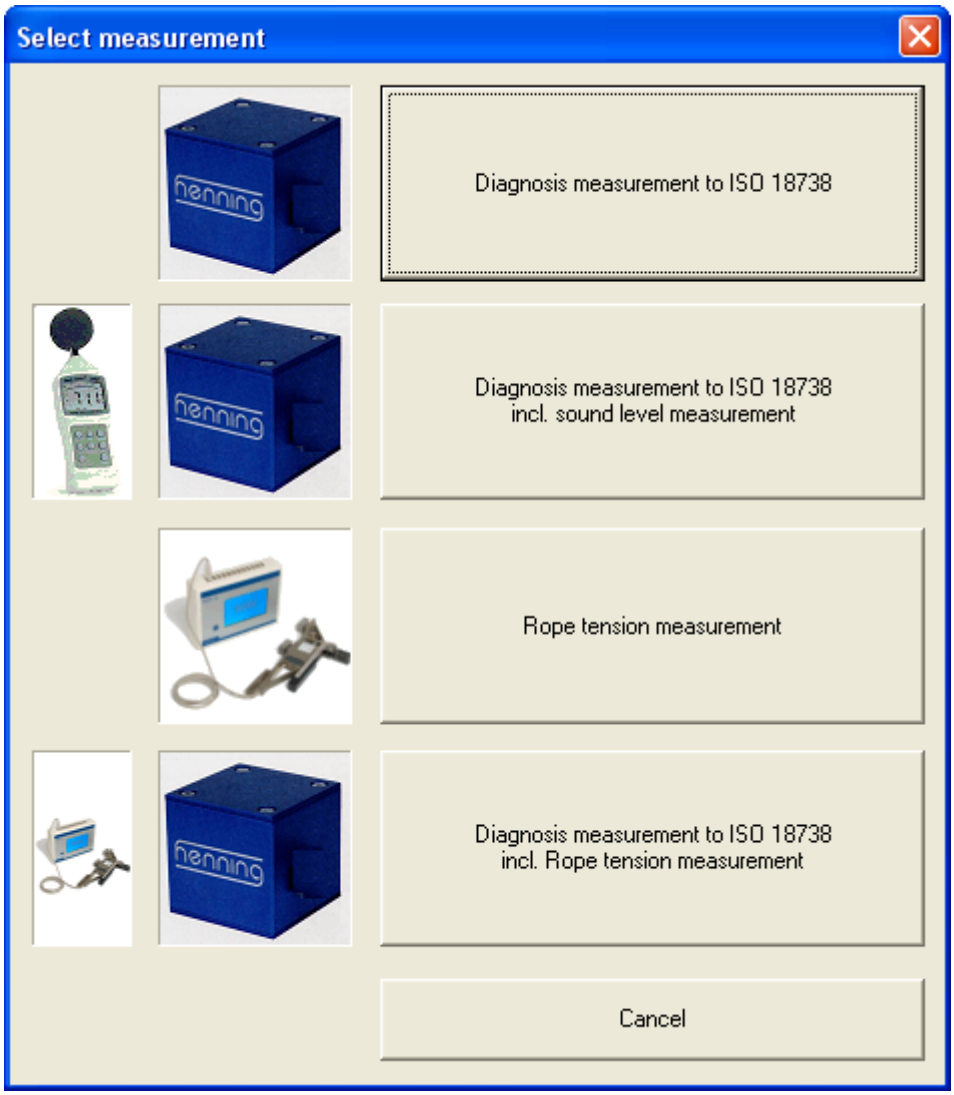


Figure 10: Create a new project

As you only want to carry out a test measurement here it is sufficient to issue a name for this project on the first register card.
For this purpose enter any designation under "Project name", e. g. "Test project" and finish the dialog using the button "OK".

In order to start the measurement choose the menu item Measurement→Start (compare figure 1).
You can determine the type of measurement to be carried out.
Depending on the types of modules of liftpc® ***mobile diagnose*** you have installed, the following dialog box opens up.



As soon as you select one of these measurements by a mouse click and a project is active, data is read by the sensors and displayed as curves on the software interface. During the first seconds no display is made on the chart as at this time calibrations and initializations of the software are carried out. Afterwards you see the online data as it is recorded by the sensor.
Terminate the measurement with the menu item Measurement→Terminate.
The display is based on the settings selected by you (see chapter Default settings). If the display is not to your liking, you can now change the default settings and restart the measurement.

5 Elevator diagnosis

5.1 Limit values

According to the guidelines ISO 18738 the diagnosis determines diagnosis values for the individual elevator travels.
However, the guidelines do not stipulate limit values. For this reason it is left to each user of liftpc® ***mobile diagnose*** to stipulate own limit values which are specially adapted to his requirements or his elevator type.
For this purpose the menu item "Limit values" in the menu "Evaluation" is used (compare chapter 7.2.3.4 "Set limit values").

The dialog *appears as follows*:

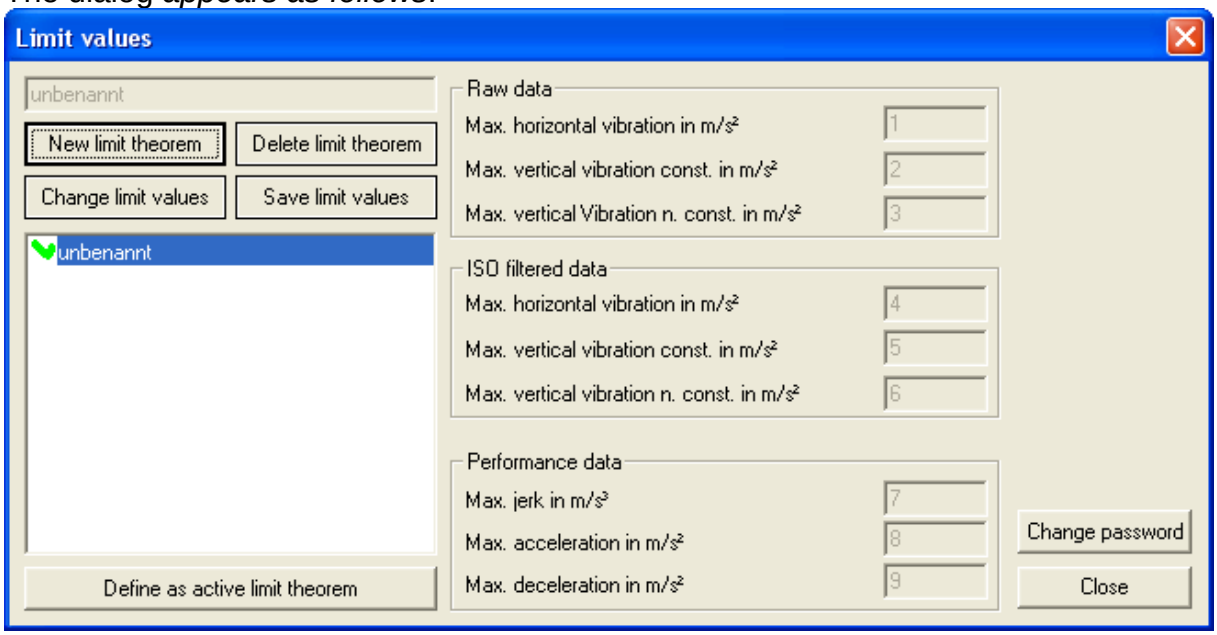


Figure 11: Limit value dialog

The measured values in comparison to the limit values are found in the Report. Please, compare chapter 5.4 "Report".

5.2 Measurement

The measurement must be carried out according to ISO 18738 paragraph 7 „Measurement and reporting“.
The sensor must have sufficient contact with the elevator car. Ensure this by using the mentioned reference plate as a sensor seat.
The seat must be placed horizontally in the centre of the car floor space. Ensure that during the measurement no foreign vibrations (e.g. the movement of people in the car, machine vibrations in the individual stories, etc.) occur.

The axes of the sensor have to be aligned according to the following illustration in relation to the car door and floor (X in direction of the door, Z upwards).
The grey circle marks the area in the centre of the car floor where the sensor should be placed.
Furthermore, you must ensure that the sensor is precisely calibrated, i. e. the curves x, y and z should run to 0 (compare chapter 4.2 "Calibration of the sensor").

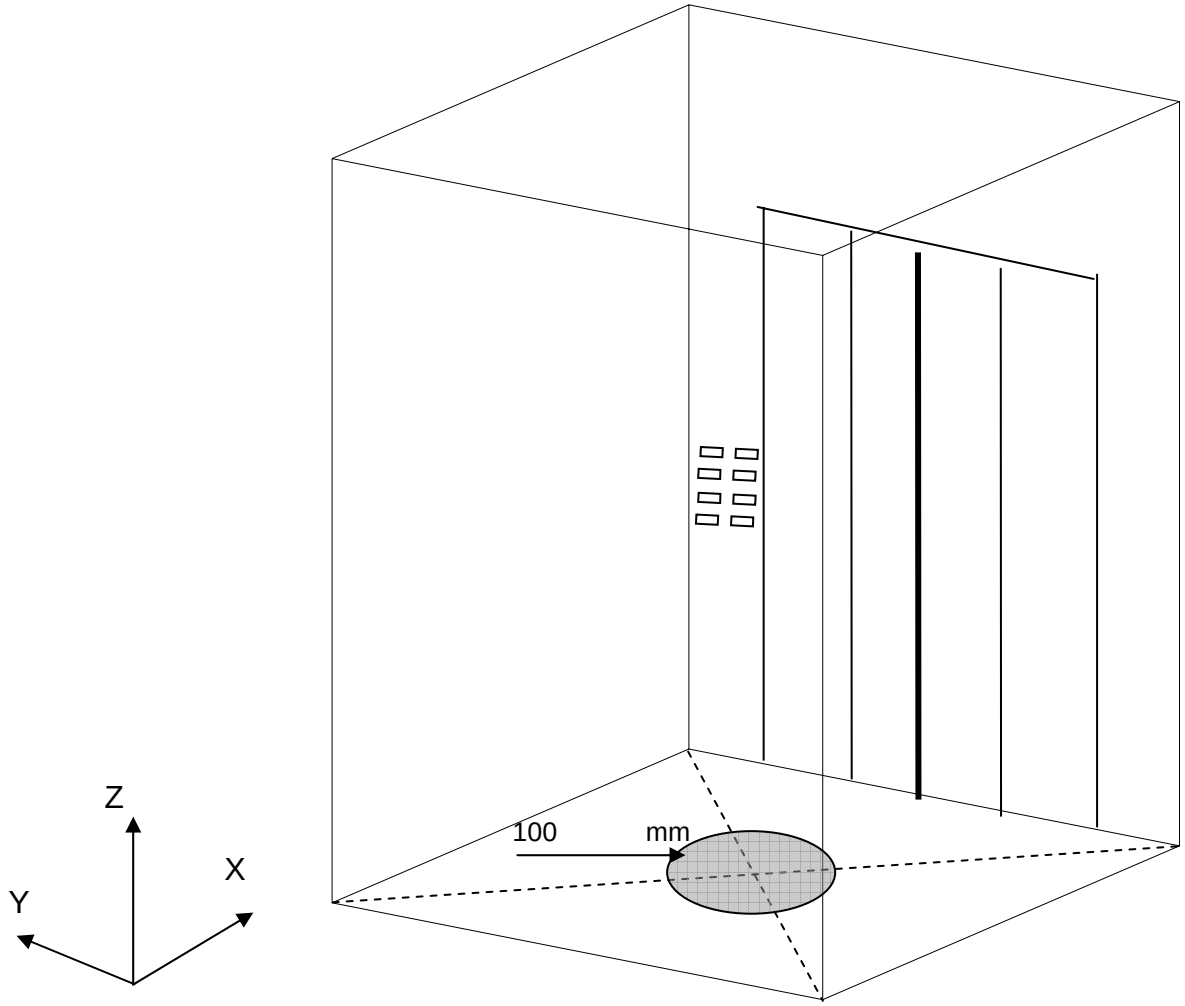


Figure 12: Sketch of sensor placement

As soon as you have placed the sensor according to the instructions you can start the diagnosis wizard by selecting the menu item "Start diagnosis wizard" in the menu Evaluation.

The diagnosis wizard will now assist you in the measurement. At the end of the measurement a report will be established which you can immediately study and print out.

After the start of the wizard you have to carry out the following steps:

5.2.1 Project selection

Each measurement must be allocated to a project (i. e., to an elevator). Therefore, the first step is the selection of the project to which the measurement is allocated.

The dialog box for the project selection appears as follows:

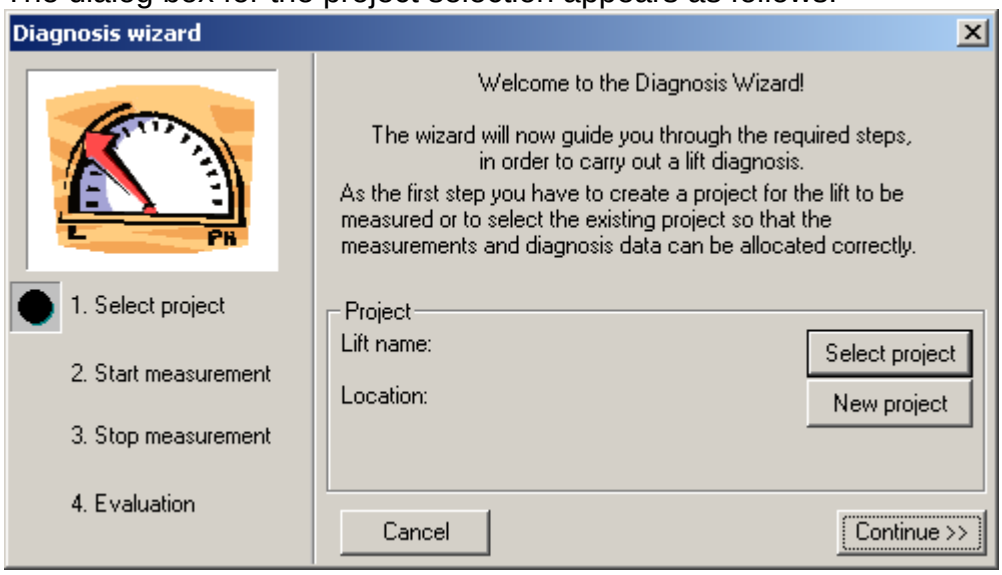


Figure 13: Wizard step 1

Now you can either select an existing project (button "Select project") or create a new project (button "New project").
If you create a new project, some indications regarding the elevator are required; compare chapter 7.2.1.1 "New project".
If you wish to select an existing project, compare chapter 7.2.1.2 "Open project".

As soon as you have created or selected a valid project, the button "Continue" is released and you can proceed to the next step.

5.2.2 Start of measurement

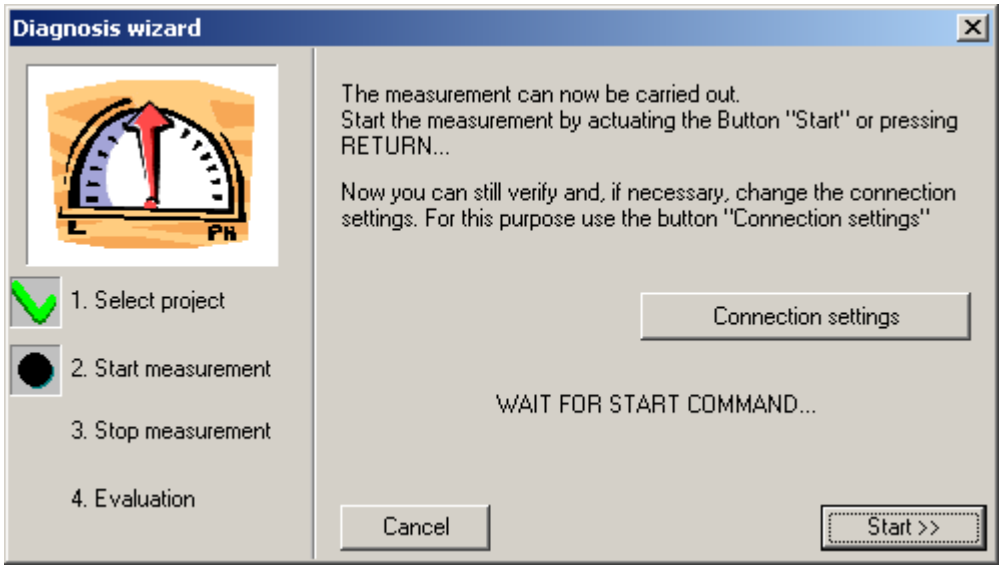


Figure 14: Step 2

In this step you can once more verify the settings of the serial interface using the button "Connection settings" or carry out last changes (compare chapter 7.2.4.3 "Settings")!
After that start the measurement using the "Start" button or the "Return" key. Afterwards a further dialog box will open in which you can select the measurement to be carried out (compare chapter 7.2.4.1 "Start measurement").
If you also want to evaluate the door movements, please take care that you start the measurement before closing the elevator doors.
Then give the elevator the command for the travel movements you want to analyze.
During the measurement you can observe the measuring curves online on the screen.

5.2.3 Stopping the measurement

While you can follow the measurement on the screen, in the upper left corner the following dialog box is unhidden with which you can terminate the measurement.

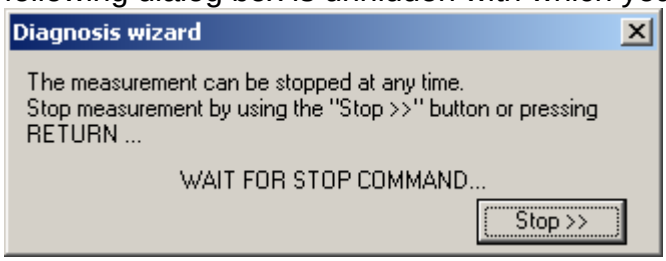


Figure 15: Step 3

You can stop the measurement by either using the "Stop" button or the "Return" key.

Take care that you only terminate the measurement when the car has really come to a standstill and the doors have opened, in order to warrant a correct elevator diagnosis.

5.2.4 Evaluation

The fourth and last step of the diagnosis wizard looks as follows:

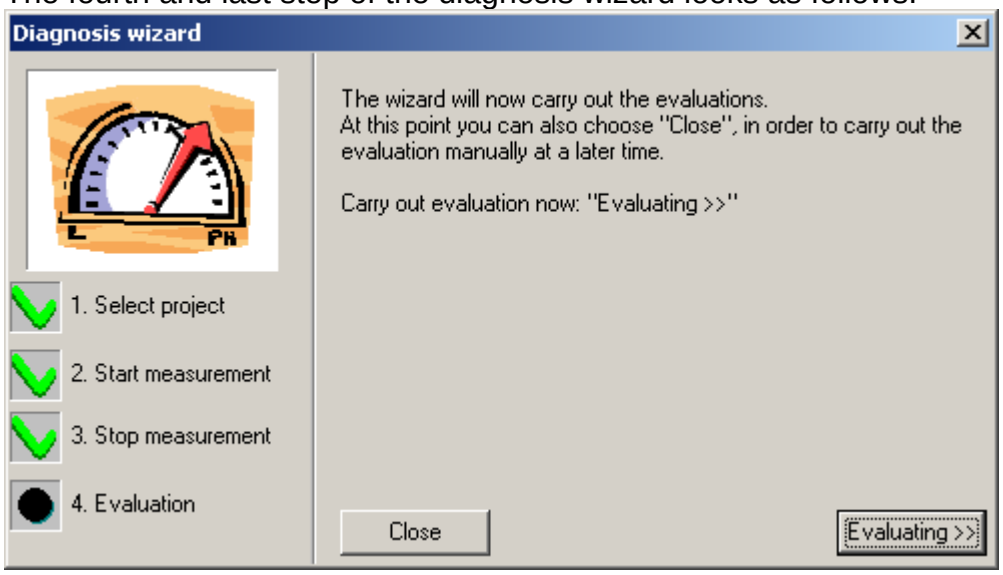


Figure 16: Step 4

If you now want to have carried out the evaluation of the collected data, confirm the dialog box using the button "Evaluate". You can also manually trigger the evaluation at a later time, if you want to save time and carry out further measurements first.
If you now carry out the evaluation, the calculations will be completed and the selected curves will be displayed over the total period of measurement.
In order to adapt this representation to your requirements, compare chapter 6 "Representation options".
As all data is now available you can view the Report now and carry out report print-outs (compare chapter 5.4 "Report").

5.3 Measuring by shortcuts

Besides the diagnosis wizard described in chapter 5.2 Measurement the short commands are recommended for experienced users. These short commands permit a diagnosis measurement with a minimum use of the mouse and in less time.

A measuring sequence comprises essentially 4 steps which are described in detail below:

1st Step
If the elevator installation to be examined has already been created as a project in the program, please read section a) otherwise proceed to section b).
a) In order to select a project (elevator) under which the measurement shall be stored, please use the short command for "Open project", the key "F1" on your keyboard and select the project as usual.
b) In order to create a new project, please use the short command for "New project", the key "+" on your keyboard. Afterwards the usual dialogue opens up, in which the new project can be created. Here, it is sufficient to stipulate a project name and to close the dialogue box using the ENTER (Return) key.

2nd Step
The measurement can now be started by means of the short command "F2" ("Start measurement") and the arrow keys in order to choose the desired measuring type. After that, please use the space bar. If you use ENTER (Return), the standard measurement, the pure acceleration diagnosis according to ISO 18738 is chosen.

The subsequent indication regarding the initialization phase can also be closed with the ENTER (Return) key and the measurement can be started.

3rd Step
In order to terminate the measurement after the elevator travel has been carried out, please use the short command for "Stop measurement", the "F3" key. As a result the measurement is immediately stopped and stored.

4th Step
In order to evaluate this measurement on the spot, please use the short command for "Complete new evaluation", the "F4" key.
The security request can be confirmed with the "j" key. The same refers to the question regarding the storage of the evaluation results.

5th Step (optional)
In order to take a look at the report on the evaluation results, please use the short command for "Report preview", the "F5" key.

5.4 Evaluation

5.4.1 Diagnosis

The evaluation is carried out according to the latest ISO 18738 guidelines. Following the ISO instructions, characteristic limits in the course of the travel of the elevators are determined, selected areas are examined and characteristic numbers regarding the ride quality are determined.
For more detailed information (see enclosure), please consult ISO 18738, in which all evaluations are described in detail.

The automatic evaluation forms a part of the diagnosis wizard (compare chapter 5.2.4 "Evaluation")

For the examination of the diagnosis data obtained the limit values of the active limit value set (compare chapter 7.2.3.4 "Set limit values") are used.
However, at any time you can manually call the evaluation in order to evaluate, for example, imported measurements or to establish a new Report after change of limit values (compare chapter 7.2.3.2 "Complete new evaluation").
Please note that the evaluation results obtained are only stored, if you save the project or the elevator travel respectively (compare chapter 7.2.1.3 "Save project"). If you carry out an operation which would result in data loss you will be warned by a reference display window.

After the execution of the evaluation, by default you reach a view which has been parameterized in the default settings (compare chapter 4.3.2 "Arrangement of curves").

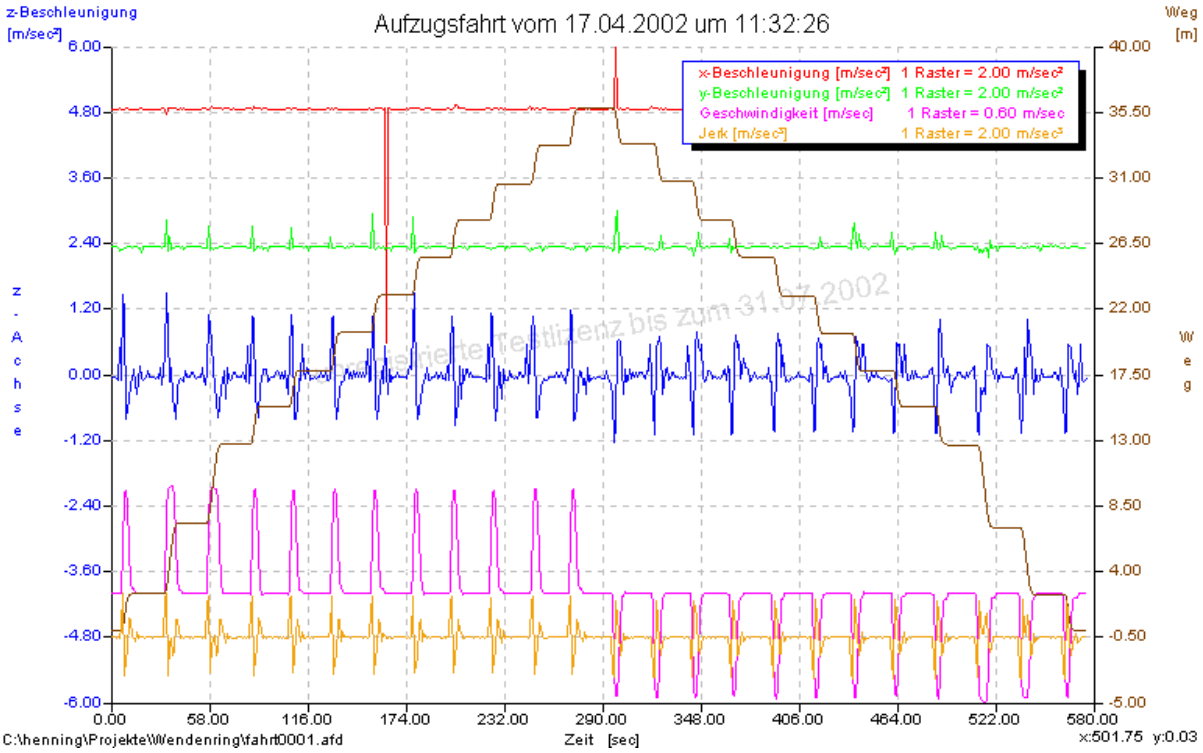


Figure 17: Example for an evaluation view

5.4.2 Diagnosis comparison

With this tool it is possible for you to compare different diagnosis travels of an elevator with each other. For example, you can record the state before and after a service measure and compare the results with each other.

Thanks to this function it is for the first time possible to completely document the state of an elevator and to log changes in the ride comfort.
All functions regarding the diagnosis comparison can be reached over the menu item "Project Properties" (compare chapter 7.2.1.4 "Project Properties").
A diagnosis comparison always consists of two diagnosis travels already carried out, which are compared with each other. You have the possibility to make a visual comparison of the curve shapes. Furthermore, a diagnosis comparison report (compare chapter 5.4.2. "Diagnosis comparison report") which records the changes in the elevator behaviour, can be established and printed-out.
The a/m user dialog appears as follows:

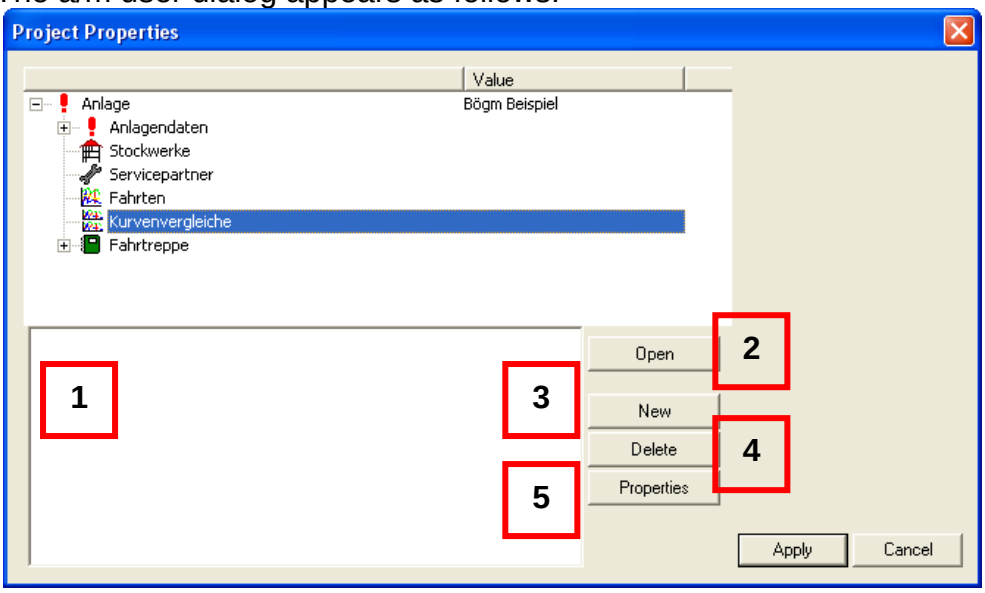


Figure 18: Diagnosis comparisons

[1] Diagnosis comparison list
In this window all diagnosis comparisons carried out are shown. You can select the relevant curve comparison from the list by a mouse click in order to apply one of the functions "Open", "Cancel" and "Properties" to it.
By a double click on a diagnosis comparison the function "Open" is called.

[2] Open
With this function you open diagnosis comparisons already carried out. A diagnosis comparison is presented on the screen and the print-outs as a split window. In the upper half the first travel to be compared and in the lower half the second one is shown.
The functions of the tool bar, the mouse etc. can be applied in the usual way to the two diagnosis travels.
The active diagnosis travel is highlighted by a red frame. A single mouse click in the relevant diagnosis travel selects the active diagnosis travel. In the following example this is the lower diagnosis travel.

[3] New
With this function you can select two **already evaluated** diagnosis travels of the current project for comparison.

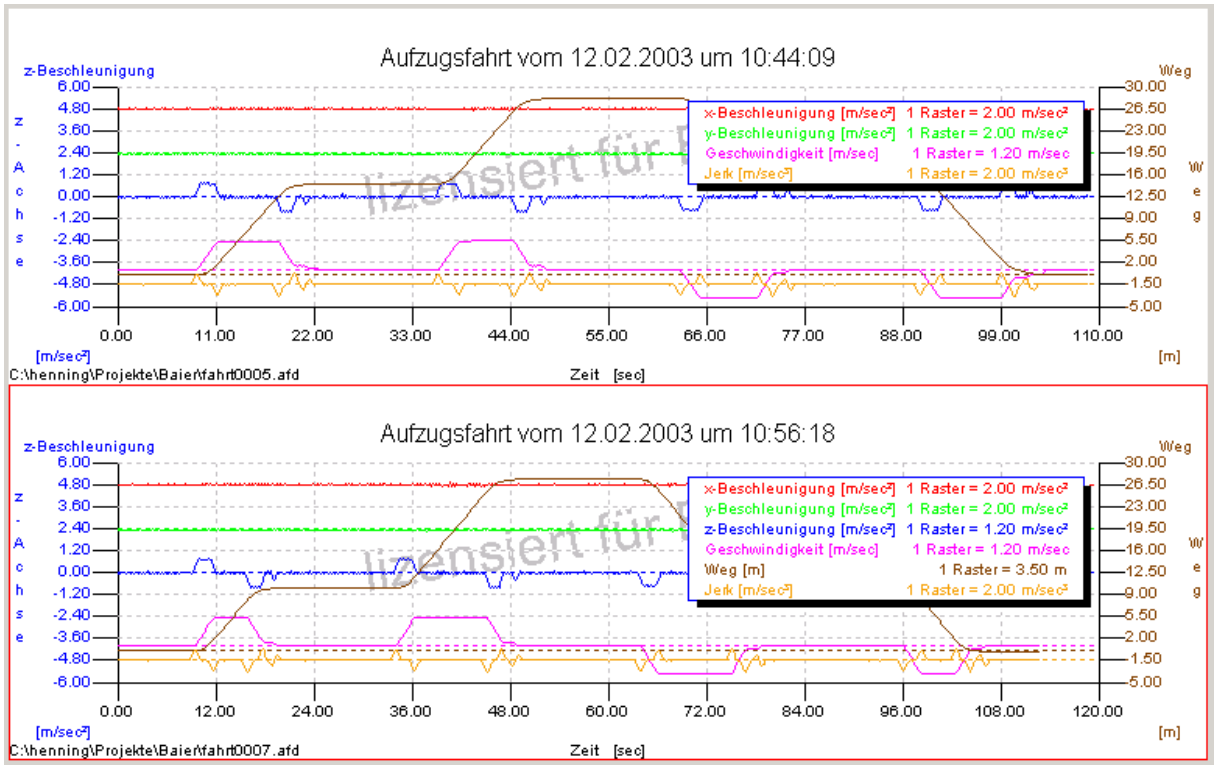
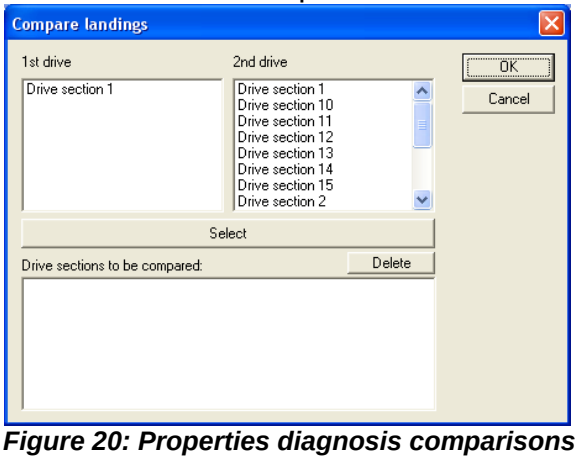


Figure 19: View of a diagnosis comparison

[4] Cancel
The diagnosis comparison selected in [1] is cancelled by this function.

[5] Properties
With this function the relations between the two diagnosis travels to be compared can be defined. In this dialog box you can select which sections of the first diagnosis travel should be compared with sections of the second diagnosis travel.



For this purpose, first select the section of the first diagnosis travel, then the section of the second. When you then use the button "Select" the travel section comparison is added to the comparison list (lower third).

Figure 20: Properties diagnosis comparisons

5.5 Report

5.5.1 Diagnosis report

The report functions are an integral part of liftpc® ***mobile diagnose***. You have the possibility to view the reports on the screen or to print them to create a permanent document.
You reach the report view over the menu File→Report preview (compare chapter 7.2.1.7 "Report preview").
A report always consists of a total evaluation and one sheet per story travel and the pertinent results.
The preview appears as follows:

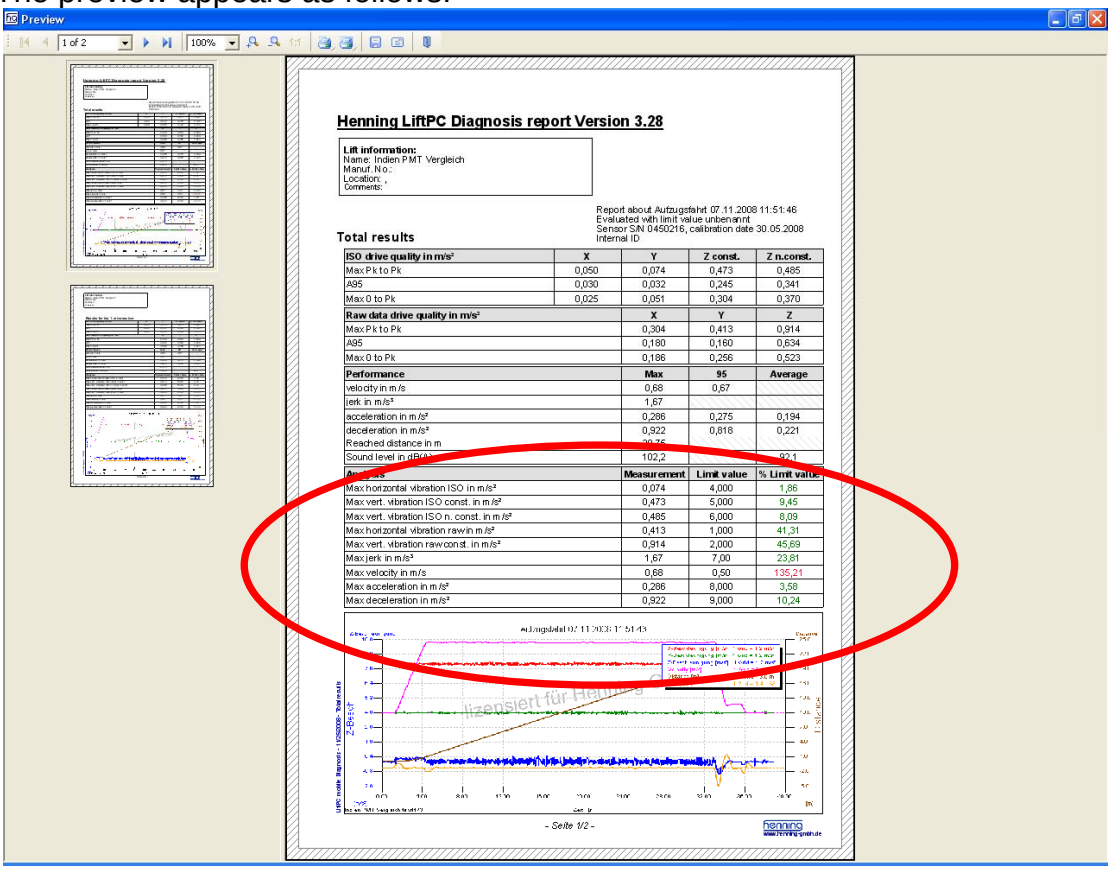


Figure 21: Report preview

In the marked area you find on each side a comparison of the measured values with the limit values (compare chapter 5.1 "Limit values").

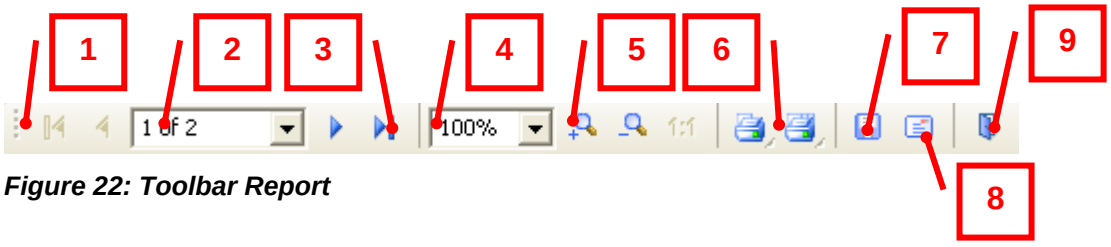


Figure 22: Toolbar Report

[1] Prev Page
Use this button to browse backward in the preview. The button is blocked, if you are on the first page of the report.

[2] Page number
This indication shows the number of the page you are just viewing.

[3] Next Page
Use this button to browse forward in the preview. The button is blocked, if you are already on the last page of the report.

[4] Zoom
Here you can directly enter the zoom percentage.

[5] Zoom in and Zoom out
If you find the representation of the report too large or too small, you can zoom in the view of the displayed page in steps. As soon as you have reached the maximum display size, the button will be represented as blocked.

[6] Print
With this function you can immediately print out the diagnosis report. The print-out always comprises the total report and bears the current date.
The print can also be started outside the report preview; compare chapter 7.2.1.6 "Print report".

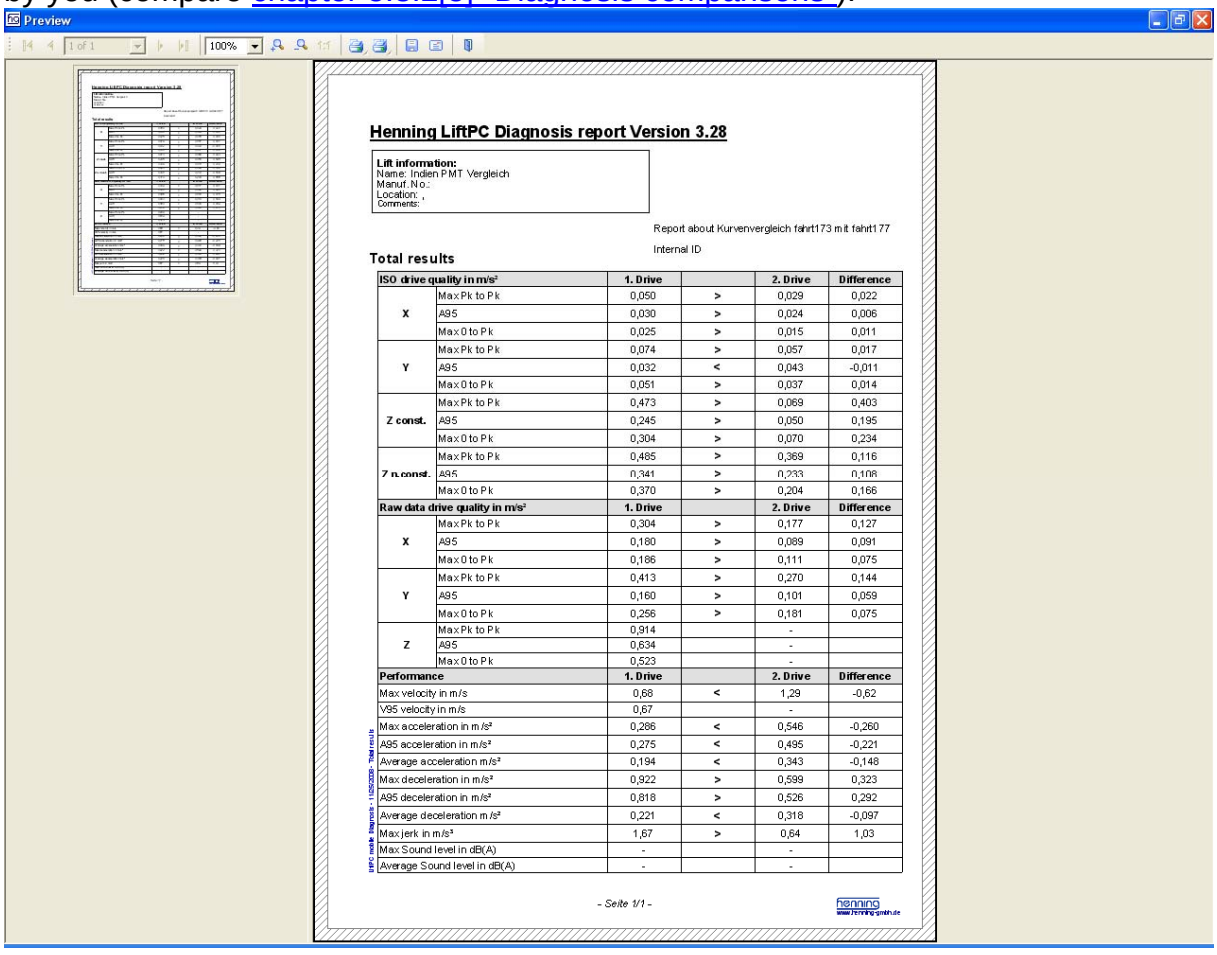
[7] To store as a PDF document
Using this function, you can store the report as a PDF document.

[8] To send by e-mail
With this function you automatically create a PDF document from the report and send it by e-mail.

[9] Close
Please, use this button in order to terminate the report preview and return to the normal software interface.

5.5.2 Diagnosis comparison report

The diagnosis comparison report is controlled by the same buttons and menu options as the diagnosis travel report.
Which report is displayed or printed is only dependent on whether you have currently opened a diagnosis travel or a diagnosis comparison.
Also as regards the content the diagnosis comparison report is similar. It contains all values of the two diagnosis reports and in addition the deviation from each other.
The first page of the report comprises the comparison of the maximum values of the two diagnosis travels.
The pages that follow show the comparison of the travel section comparisons chosen by you (compare chapter 5.3.2[5] "Diagnosis comparisons").



ISO drive quality in m/s²		1. Drive		2. Drive	Difference
X	Max Pk to Pk	0,050	>	0,029	0,022
	A95	0,030	>	0,024	0,006
	Max 0 to Pk	0,025	>	0,015	0,011
Y	Max Pk to Pk	0,074	>	0,057	0,017
	A95	0,032	<	0,043	-0,011
	Max 0 to Pk	0,051	>	0,037	0,014
Z const.	Max Pk to Pk	0,473	>	0,069	0,403
	A95	0,245	>	0,050	0,195
	Max 0 to Pk	0,304	>	0,070	0,234
Z n.const.	Max Pk to Pk	0,485	>	0,369	0,116
	A95	0,341	>	0,233	0,108
	Max 0 to Pk	0,370	>	0,204	0,166
Raw data drive quality in m/s²		**1. Drive**		**2. Drive**	**Difference**
X	Max Pk to Pk	0,304	>	0,177	0,127
	A95	0,180	>	0,089	0,091
	Max 0 to Pk	0,186	>	0,111	0,075
Y	Max Pk to Pk	0,413	>	0,270	0,144
	A95	0,160	>	0,101	0,059
	Max 0 to Pk	0,256	>	0,181	0,075
Z	Max Pk to Pk	0,914		-	
	A95	0,634		-	
	Max 0 to Pk	0,523		-	
Performance		**1. Drive**		**2. Drive**	**Difference**
Max velocity in m/s		0,68	<	1,29	-0,62
V95 velocity in m/s		0,67		-	
Max acceleration in m/s²		0,286	<	0,546	-0,260
A95 acceleration in m/s²		0,275	<	0,495	-0,221
Average acceleration m/s²		0,194	<	0,343	-0,148
Max deceleration in m/s²		0,922	>	0,599	0,323
A95 deceleration in m/s²		0,818	>	0,526	0,292
Average deceleration m/s²		0,221	<	0,318	-0,097
Max jerk in m/s³		1,67	>	0,64	1,03
Max Sound level in dB(A)		-		-	
Average Sound level in dB(A)		-		-	

Figure 23: Report view for diagnosis comparisons

6 Representation options

You have many possibilities to adapt the representation of the curves on the screen or the printer output, respectively, to your requirements.

6.1 Arrange curves

Similarly as already described in chapter 4.3.2 "Arrangement of curves", afterwards you can have the curves arranged by the software.
For this purpose, please use the menu item "Arrange curves" in the menu "View".
By means of the opened dialog box selected result curves are positioned on the screen or the print-out.

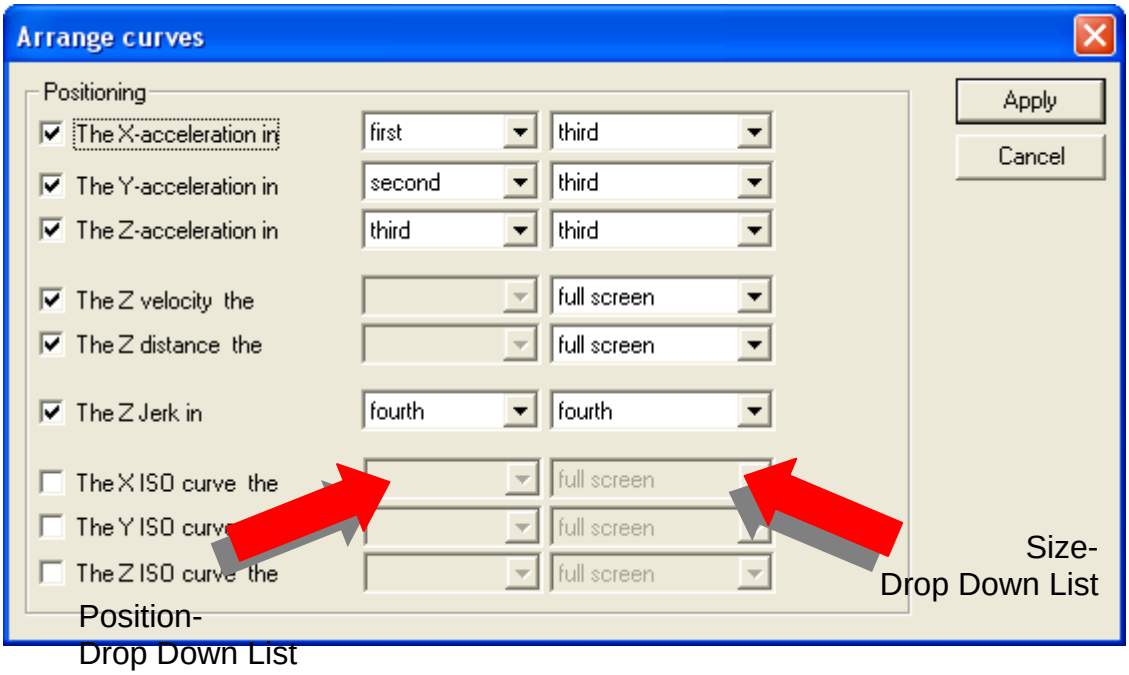


Figure 24: Arrangement of curves

If you tick the check box in front of the listed curves the corresponding curve will be unhidden. All curves which are not ticked or are not listed will automatically be hidden. These curves can be unhidden/hidden and their position can be determined with their min/max values over the menu item Chart→Properties (compare chapter 6.6.2 "Curve properties").
Using the following drop down lists you can determine the position and the size on the screen.
The size can be determined as follows: full-screen display, half, third, quarter and fifth. Dependent on the chosen size the position-defining drop down list changes to integral divisions of the size.
(Example: see chapter 4.3.2 "Arrangement of curves").

6.2 Unhide/hide curves

You have several possibilities to unhide and hide certain curve shapes. The curve arrangement that carries out this task for the selected curves has already been discussed in the previous chapter.
A further possibility will be presented in chapter 6.6.2 "Curve properties".
Here it is shown how you can unhide/hide certain curve types using the toolbar.
The toolbar is found directly under the menu bar. The functions for the representation of the curves are positioned in the centre and at the right side of the toolbar.

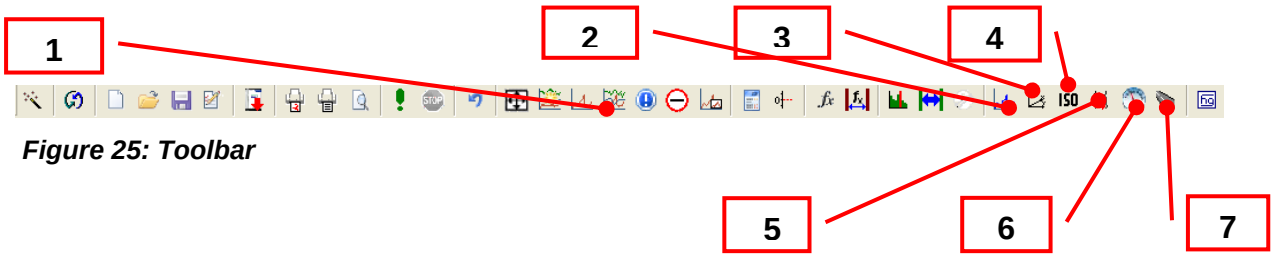


Figure 25: Toolbar

6.2.1 Unhide/hide individual curves

In order to unhide or hide individual curves, please use the button **[1]** in figure 25. After actuation of the button a window opens up in which you find all curves recorded and created in the current chart, with their designation and represented in their plot colour.

Figure 26: Unhide/hide curves

Selected curves have a black check mark. These curves are already represented.
By a single click on a curve it is represented or hidden. The selection dialog box remains open until you click the left mouse button outside the window to close it.
If you want to represent an individual curve without disturbing accompanying curves as single view you should choose the **button [2]**. Then the same window as before will open (compare figure 26), however with the difference that here you can select only one curve. As soon as you have selected the curve the window will close and the selected curve is represented as the only one on the chart surface.

6.2.2 Unhide/hide curves

Furthermore, you have the possibility to unhide complete curve sets at the same time, e. g. all raw data curve shapes, all ISO curve shapes, the jerk curves etc. For this purpose use the numbered buttons in figure 25.

The meaning of the individual buttons:

Button 3:
With this button you can hide all curve shapes. Only the raw data of the channels X, Y and Z remain unhidden or will be shown in addition.

Button 4:
Using button [4] only the ISO weighted curve shapes will be displayed.

Button 5:
This button will solely unhide the jerk curve.

Button 6:
With button [6] you unhide the obtained velocity curve.

Button 7:
Button [7] unhides the calculated path shape.

6.3 Zoom

At any time you have the possibility to take a close look at individual areas of the curve shapes by zooming in the area.
To this end proceed as follows:

1. Mark one corner of the area to be examined by a left mouse click. Do not release the mouse button!

2. Drag the mouse pointer with the left mouse button held down to the opposite corner of the area to be examined. During the mouse action the area marked and to be zoomed will show inverted colours.

3. Release the left mouse button as soon as you see the desired marked area: The representation now shows the marked area.

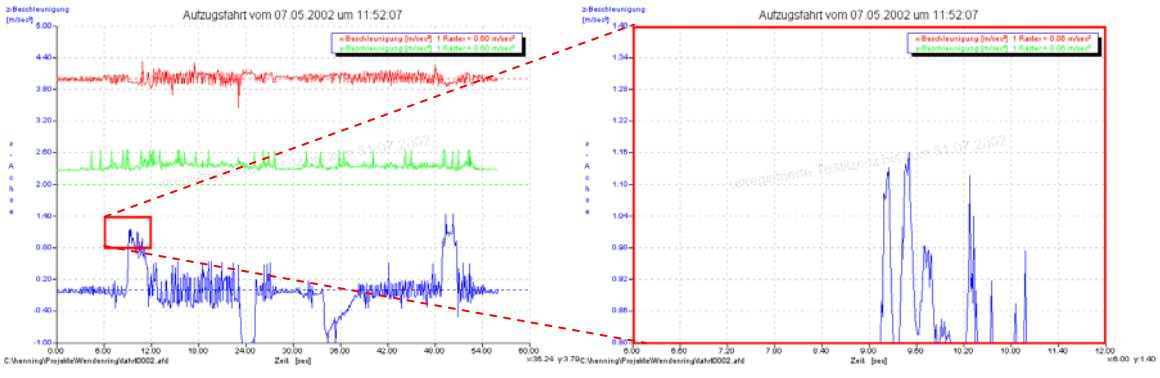


Figure 27: Zoom

This procedure can be repeated at will, so that it is possible to examine the curve shape down to the last detail. At any time you can return to the full-screen display by selecting the menu item "Total view" in the menu "View" (compare chapter 7.2.6.1 "Total view")
Within the curve shape you can scroll the time axis, on condition that you possess a mouse with scroll wheel. If you actuate the scroll wheel the time axis scrolls in the positive or negative direction by one raster unit without changing the scale. If you want to scroll in a finer scale, during the scroll wheel action you have to press and hold down the SHIFT key on your keyboard

6.4 Unhide curve information

6.4.1 Unhide zero lines

In order to better assess and estimate the shape of a curve it is possible to unhide zero lines. To this end use the menu item "Unhide/hide zero lines" in the menu "View". Now the zero lines will either be hidden or unhidden. The zero lines are unhidden as broken lines in the colour of the corresponding curve shape.

6.4.2 Unhide the legend

By the menu item "Unhide/hide legend" in the menu "View" you can unhide a legend placed in the upper left corner of the chart area. In this legend you find the titles of the current unhidden curve shapes in the relevant plot colour, with the relevant unit per raster.

Figure 28: Legend

6.4.3 Unhide limits

According to ISO 18738 several limits are required for the evaluation of the acceleration shapes. Within these limits the elevator quality is determined (compare ISO 18738 § 6.1 see enclosure). These limits are calculated by the evaluation routine. They can afterwards be unhidden in the curve shapes by using the button "Unhide travel information" in the toolbar (compare chapter 7.3 "Toolbar"). As regards the determination of the limits, compare chapter 9 "Enclosure elevator analysis".
Furthermore, the limit values (compare chapter 7.2.3.4 "Limit values") determined by you are represented as dotted line.

6.4.4 Unhide peak markings

ISO 18738 specifies how the measurement data after malfunctions has to be examined. The evaluation routine determines and displays „Peak to Peak“ maximum values and „0 to Peak“ distinctive features within the weighted acceleration curves (raw data evaluated according to ISO 18738).
These points will be marked in the weighted acceleration curves, if you use the button "Show peaks and evaluation results" in the toolbar (compare chapter 7.3 "Toolbar").
The maximum values "Peak to Peak“ are displayed by two successive crosses (+) and "0 to Peak“ by a square (□). The markings are also printed out, if the a/m button has been actuated.

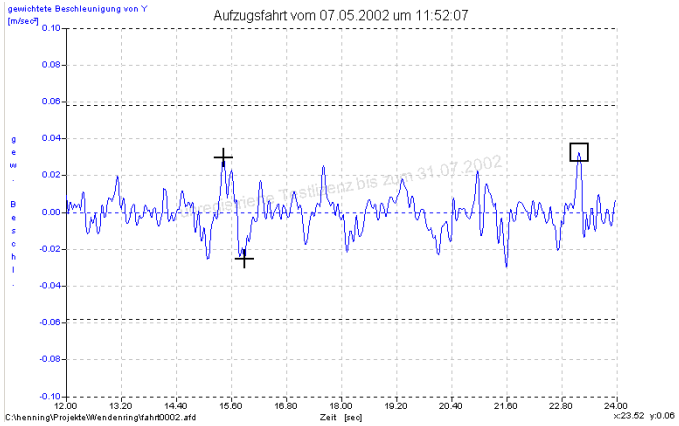


Figure 29: Example of marking

6.5 Power spectrum

An essential part of the evaluation is the so-called power spectrum. With the help of this tool the energy content of a curve shape, averaged over the single frequencies, is calculated. By means of the power spectrum individual travel sections can be examined more in detail and conclusions can be drawn as regards possible sources of error, as you can determine in which frequency range the disturbing signal occurs (e.g. typical frequencies for door rolls, rope pulleys, transmission, rope vibrations etc.).

You reach the power spectrum over the menu "Evaluation", menu item "Power spectrum" . In order to reach an optimum display of the power spectrum, please compare chapter 7.2.3.7 "Power spectrum settings".
Even during the running measurement data recording you can unhide the power spectrum, so that even at this time you are in a position to detect defects.
After unhiding the power spectrum, this will be displayed in the lower third (the same applies to the print-outs).

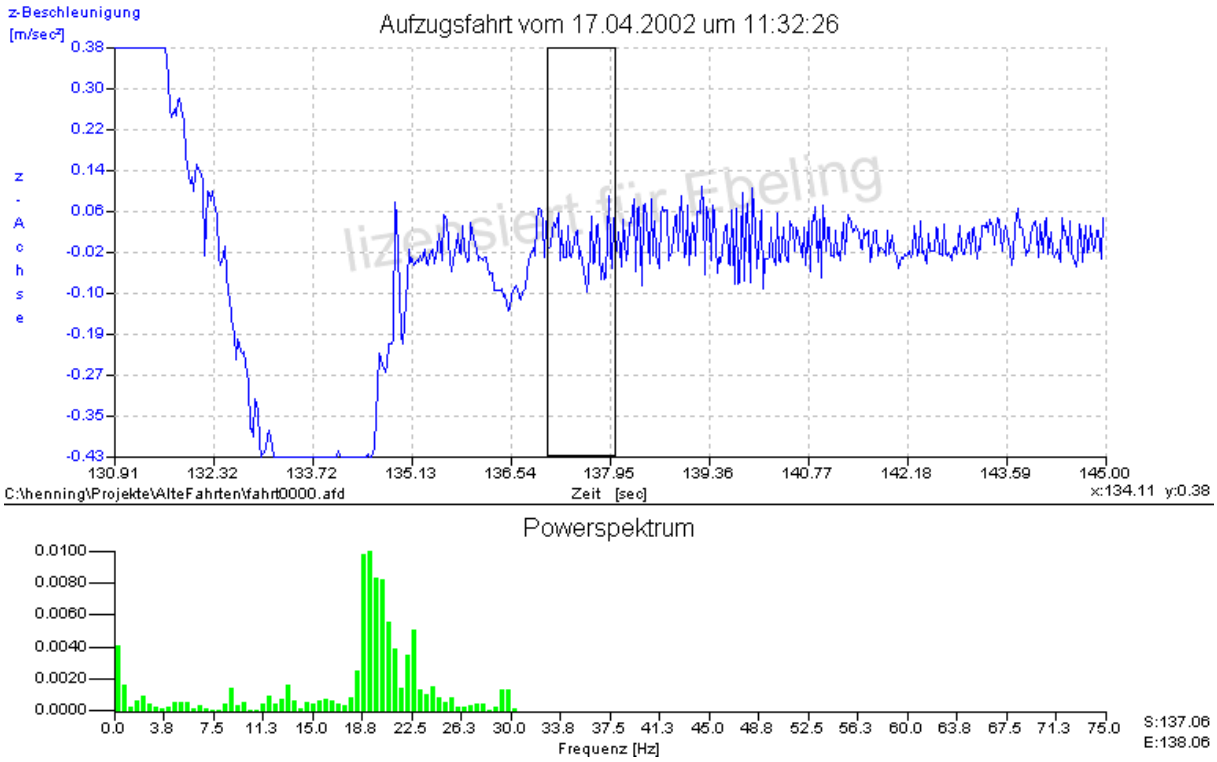


Figure 30: Power spectrum

Furthermore, in the curve shape you see a black rectangle. This rectangle defines the area which is currently evaluated and displayed. Thus, you can select the area which you want to examine with the help of the power spectrum. To this end move the mouse pointer to the rectangle, then click and hold down the left mouse key in order to move the rectangle over the desired area. The power spectrum is immediately updated and always the area which you have currently selected is examined and displayed.

If you have selected a too small power spectrum area the selection rectangle becomes so narrow that you cannot possibly see it any longer or cannot grab it with the mouse. Then you must zoom the curve shape larger or enlarge the evaluation area, in order to re-utilize the selection rectangle.

The power spectrum is always established for the active curve. The active curve is that one the designation and scale of which are represented on the left side of the chart (for the selection of the active curve compare chapter 7.3 "The toolbar" [13].

As soon as you display the power spectrum a further window will appear, the "Frequency Tool Box", which will calculate the most important frequencies of your elevator as a function of the mean travel speed, and display it in the power spectrum.

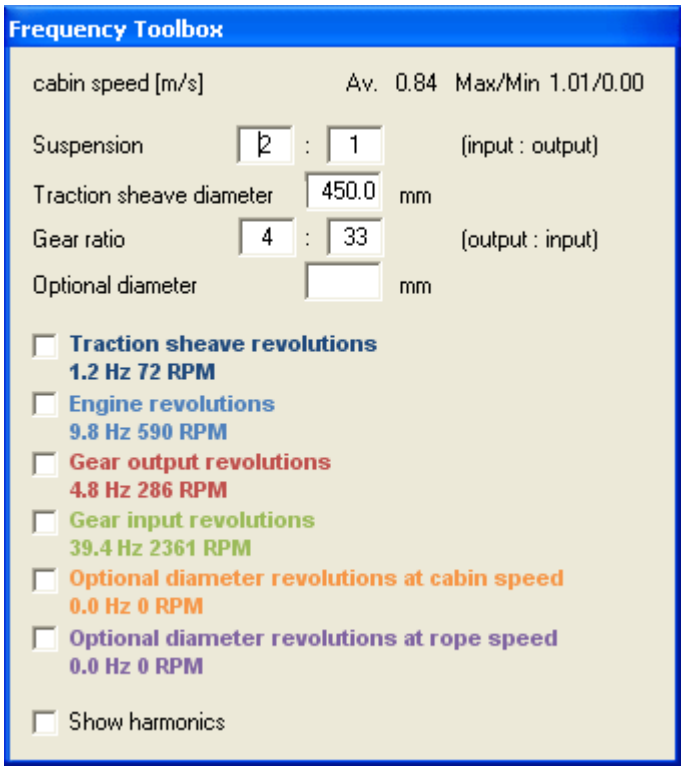


Figure 1: Frequency Toolbox

6.6 Chart properties

6.6.1 General

In the menu "Chart", submenu item "Properties" you will find all settings regarding the representation of the curve shapes on the screen and print-outs. However, the basic settings will not be changed.
The opening dialog box looks as follows:

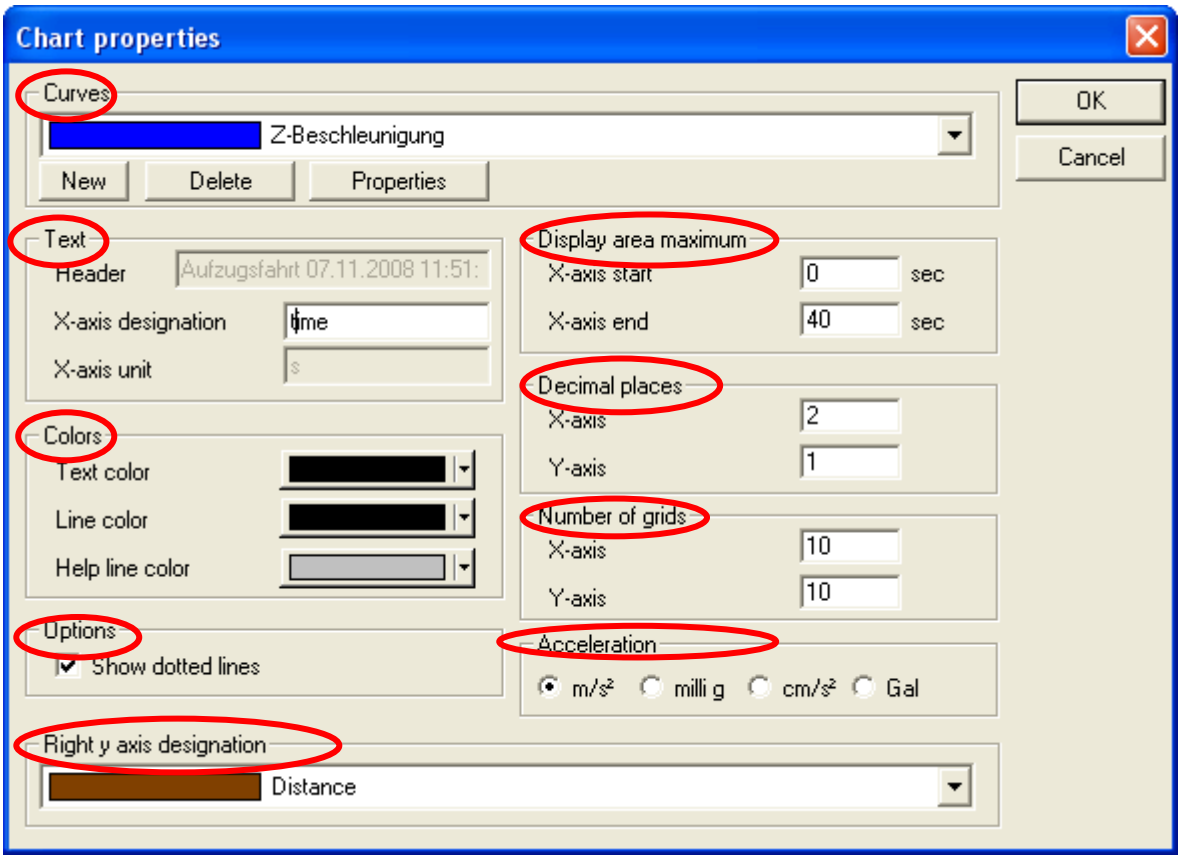


Figure 31: Chart properties

It will be dealt with the first **block "curves"** in the following chapter 6.6.2 "Curve properties".

Text

The **block "Texts"** contains the static texts which are displayed on the chart. The first text is the total headline of the chart as it is also indicated on the print-outs and in the report as distinguishing feature of the different elevator travels. The ***headline*** is automatically generated from time and date and cannot be changed by the user.

The ***X-axis designation*** is the title of the X-axis. As the time is always plotted on the X-axis, this text should not be modified. The ***x-axis unit*** is indicated in seconds.

Colours

In the **block "Colours"** you can determine in which colours the lines and texts shall be plotted.
To this end click on the triangle besides the current colour and select the desired colour in the opened list.

Options
The **block „Options“** consists of the item "Unhide reference lines". If you tick here, the rasters will be unhidden as broken lines.

Right-hand y-axis description
In the **block "Right-hand y-axis description"** you can select a curve shape from the chart and have unhidden its scale and description at the right-hand side of the chart. If you choose the entry "No", this scale will be unhidden.

Display area maximum
In the **block „Maximum display area“** you define start and end of the X-axis (time axis), which shall be used for the total view (compare chapter 7.2.6.1 "Total view") of the chart.

Decimal places
With the entry in the **block "Decimal places"** you change the number of decimal places of the scales. Take care that the representation might become illegible if you choose a too high number of decimal places.

Number of grids
In the **block "Number of rasters"** you determine how many horizontal reference raster lines (number of rasters for the Y-axis) and how many vertical reference raster lines (number of rasters for the X-axis) you want to unhide.

Acceleration unit
Herewith you can determine the unit in which the measured data and results shall be displayed and printed.

Changes in the blocks are only adopted, if afterwards you leave the dialog box using the "OK" button!!!

6.6.2 Curve properties

The **block "Curves"** in figure 32 is intended for the setting up of each individual curve shape. Furthermore, at this point you may add new curve shapes or cancel existing ones.
In this block you see three buttons which always refer to the curve shape currently shown (in figure 32 is the Dialog Box for the z-acceleration). Using [New] you can generate not yet calculated or displayed curves; using [Cancel] you can reject existing curves.
When using the button [Properties] you get to the following dialog box:

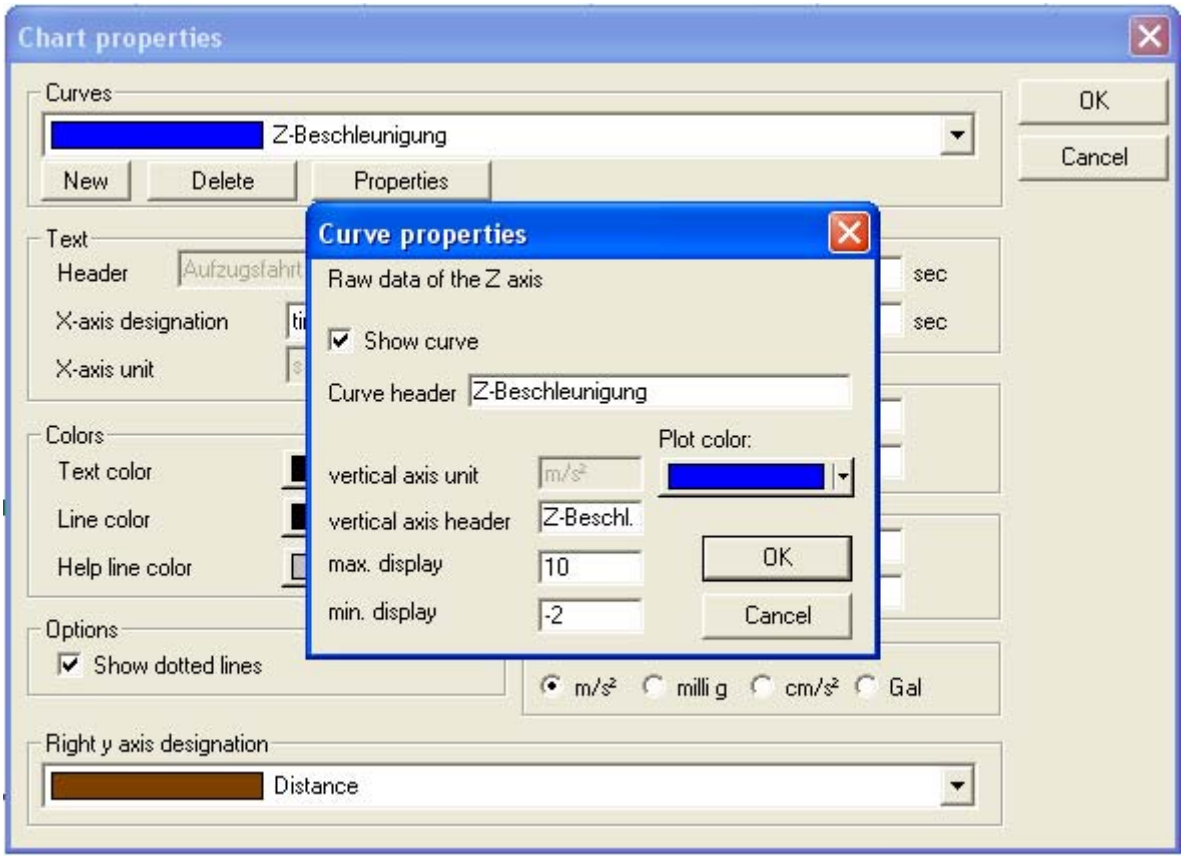


Figure 32: Curve shape properties

The top line of the "Curve properties" window shows the curve type that cannot be changed, in this case "Raw data of the Z-axis".
Underneath you see a checkbox in which you can decide by a click whether the curve shape shall be displayed or not.
The next field contains the designation ("Curve title") of the curve shape. This is automatically generated by the software, but can also be at will adapted by you.
Then follows the unit in which the curve shape ("Y-axis unit") has been generated and the title ("Y-axis title") which shall be used as designation of the Y-axis (compare chapter 7.1.1 "Active curve").

The fields “max. display” (display start) and “min. display” (display end) are identical with the scale start and end of the Y-axis in the current chart view. You may change these values in order to better adapt the current curve.
On the right-hand side of the dialog box you can define the colour in which the curve shape shall be issued on printer and screen (to this end compare the preceding chapter in the block "Colours").

Changes are only adopted, if afterwards you leave the dialog box using the "OK" button!!!

7 The software interface

The software interface is divided into three blocks (chart view, menu and toolbar). These will be described in the following subchapters.

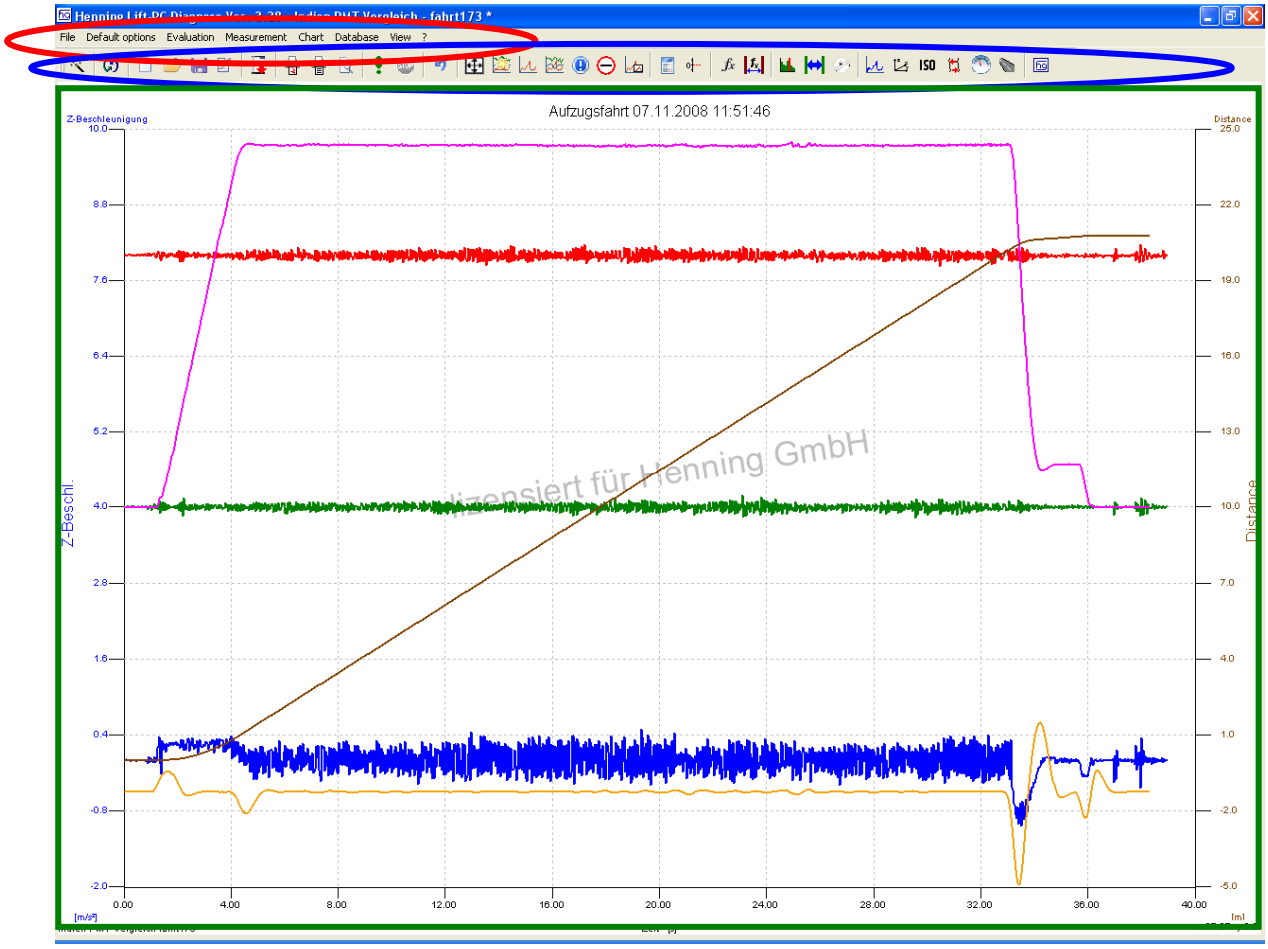


Figure 33: Software interface

7.1 The Chart view

The chart view is divided into several segments

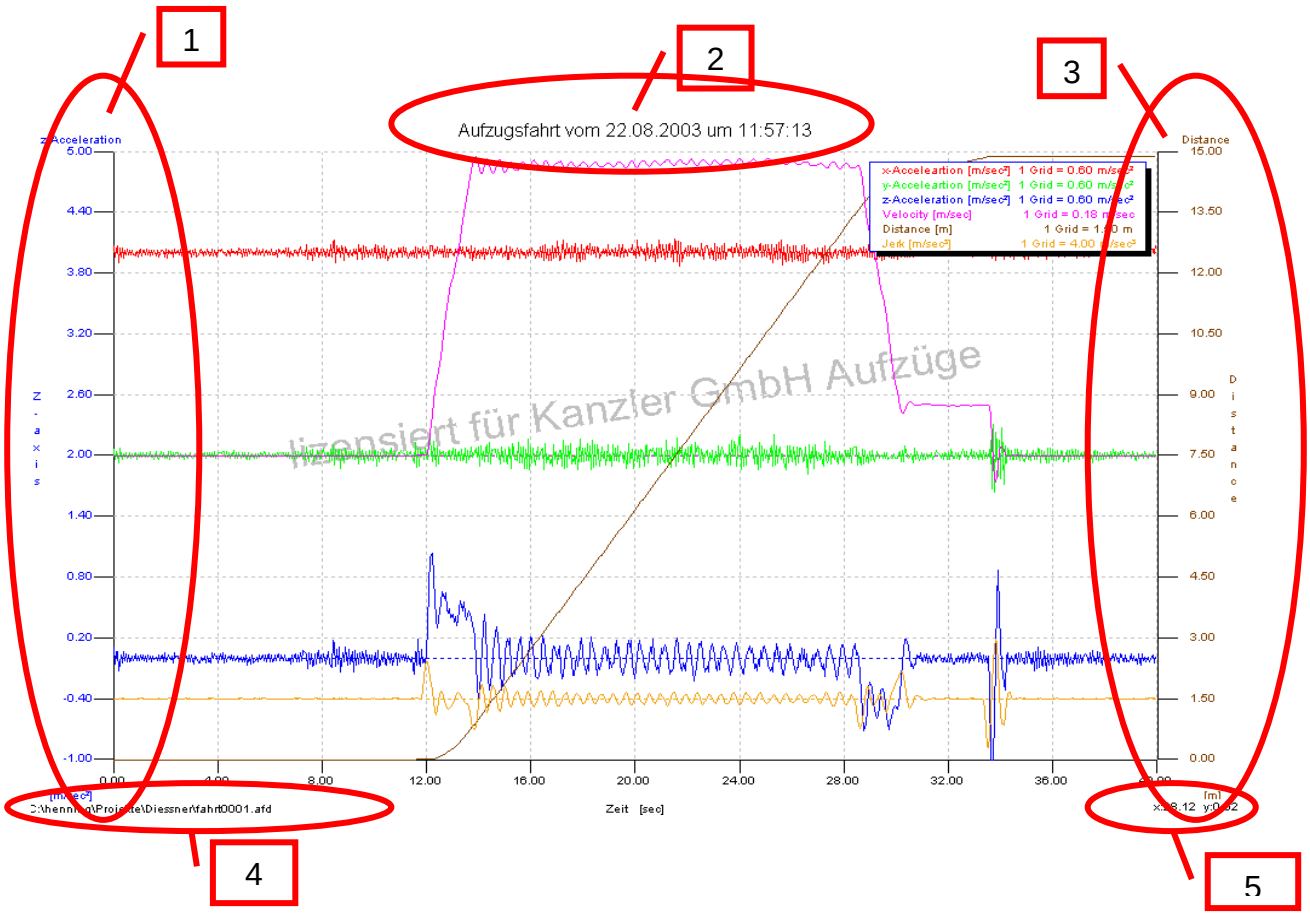


Figure 34: Chart view

7.1.1 Active curve

On the left-hand side, in figure 34 marked with [1], in the chart view the active curve is always plotted. On top of the scale the unit and the curve title are unhidden (compare chapter 6.6.2). The Y-axis title (here z-axis) is vertically unhidden.
You can determine the active curve with the help of the toolbar (button [13]) (compare chapter 7.3).

7.1.2 Chart headline

By means of date and time the chart headline (in figure 34 marked with [2]) is the significant distinguishing feature for all measurements.

7.1.3 Second Y-scale

The second Y-scale (in figure 34 marked with [3] has the same structure as the scale of the active curve. It contributes to an increase of the information content of a chart. After the successful evaluation the software automatically unhides the path curve as the second Y-scale.
In the chart properties (compare chapter 6.6.1) you can determine which curve shape should be used as the second, Y-scale.

7.1.4 Storage location

In the lower left-hand corner you find the storage location and file name of the chart currently displayed on the screen (in figure 34 marked with [4]). This information is also given on the print-outs.

7.1.5 Mouse position

You determine the exact values of a position in the curve shape of the active curve by simply pointing with the mouse pointer to the relevant position. In the lower right-hand corner of the chart view the X- and Y-value of this position will be unhidden (in figure 34 marked with [5]). This insertion is only made in the screen view and will not be printed.

7.2 The menu

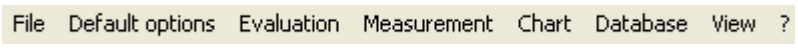


Figure 35: The menu bar

7.2.1 Menu File

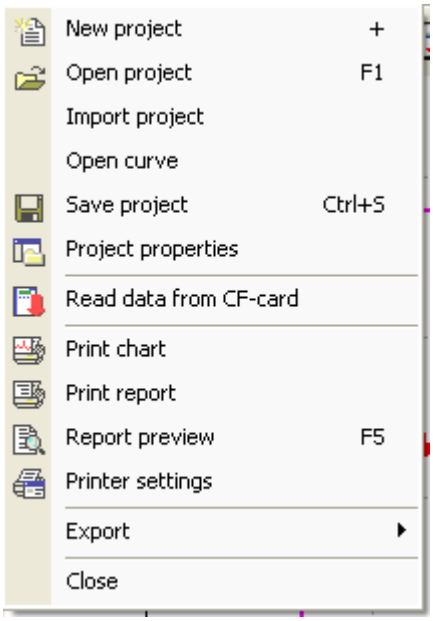


Figure 36: Submenu file

7.2.1.1 New Project

Under this menu point you can create a new project. A project is a certain elevator. Under this project all measured elevator travels, evaluation parameters, evaluated curves as well as technical, organisational and geographical data such as serial number, operator address, elevator type, etc. are stored.
After you have selected the menu item "New project" the "Properties" window of the project appears. Here, in any case you have to enter a project name (compare chapter 7.2.1.4 „Project Properties“

7.2.1.2 Open Project

Project files already saved have the suffix "afp". Such a file can be selected with the dialog "Open". Afterwards all relevant parameters of the project will be loaded.
If you want to record a new elevator travel, after opening the project file you can start the recording process. Compare chapter 7.2.4.1 "Start measurement".

7.2.1.3 Import Project

Under this menu item you may import complete projects which you have before exported using the Project Export Function (compare 7.2.1.11 Export).

7.2.1.4 Save Project

Under this menu item all project-relevant data of the active project, such as evaluation parameters, organisational data etc., is stored. Furthermore, a possibly opened, project-allocated and changed or newly created elevator travel file is saved.

7.2.1.5 Project properties

In the dialog box "Project properties" all specific data referring to this elevator is stored. The dialog box is presented in the form of a list to which you may add own entries. Any changes may be made in the input field on the right.
The list contains the 5 main items „Elevator Data“, „Landings“, „Service Partner“, „Travels“ and „Curve Comparisons“, which are described in the following.

7.2.1.5.1 Elevator data

The Elevator Data contains site and name of the elevator, but above all the technical details.
It is not necessary to complete this list. However, it is advisable at least to give a name to the elevator. The entries can be used in the database evaluation, for example in order to determine mean values of parameters which only come from elevators fulfilling certain mechanical properties.

7.2.1.5.2 Landings

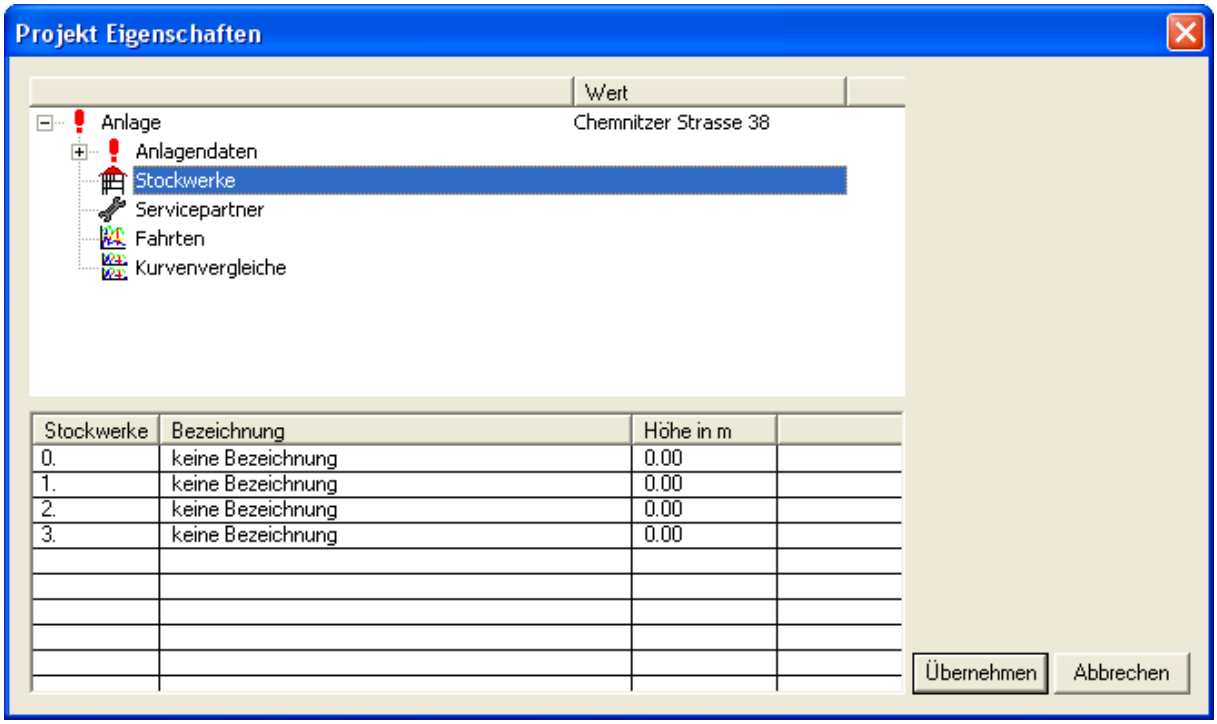


Figure 2: Landings

Dependent on the number of landings which you have indicated under "Elevator Data", here you see the list of the individual landings which are consecutively numbered beginning with zero.
You have the possibility, as shown in the above example, to allocate designations and heights to the landings. Only if you reliably indicate these values, the evaluations of the individual landings are designated in the total report with the correct landing names; otherwise the landings are automatically numbered consecutively.
In order to change the designation or the height slowly click twice the field with the left mouse button and enter your text. The height must be indicated in meters. The maximum resolution is in centimetres which have to be separated from the meter number by a point or comma.

7.2.1.5.3 Service Partner

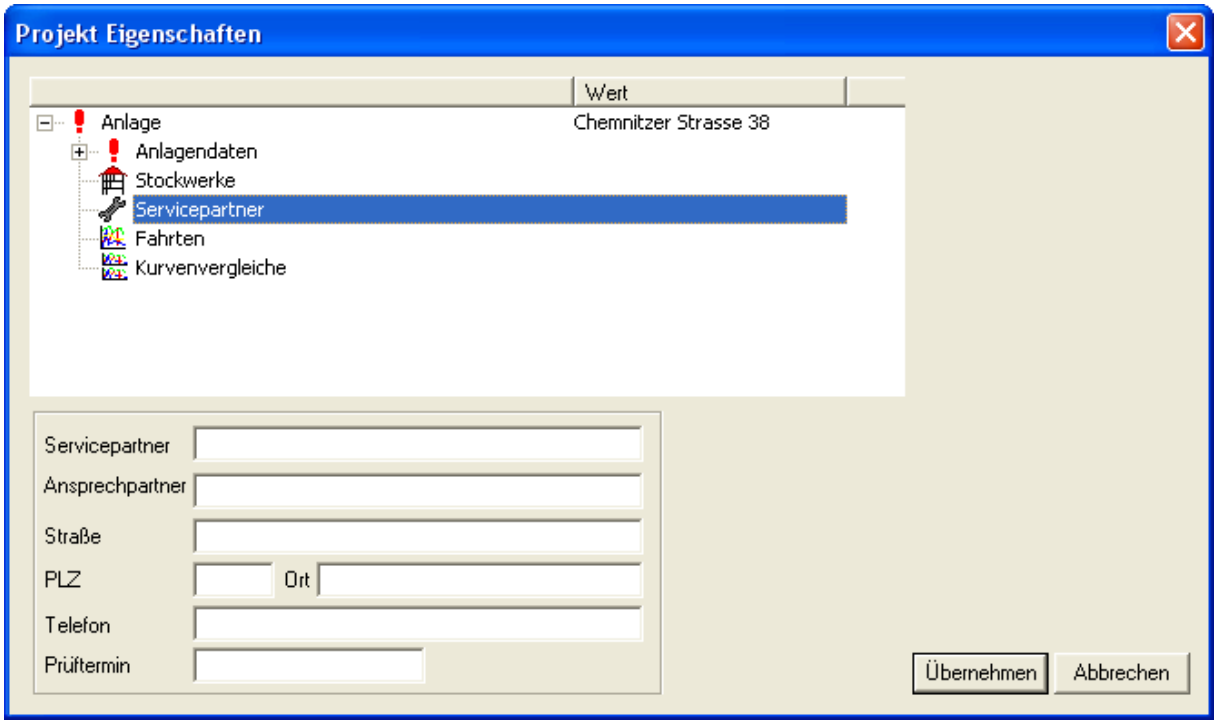


Figure 3: Service Partner

In this section you may enter the relevant information regarding the service company for the elevator. The input is optional and compatible with all other Henning software products.

7.2.1.5.4 Travels

The section **„Travels“** has the following appearance:

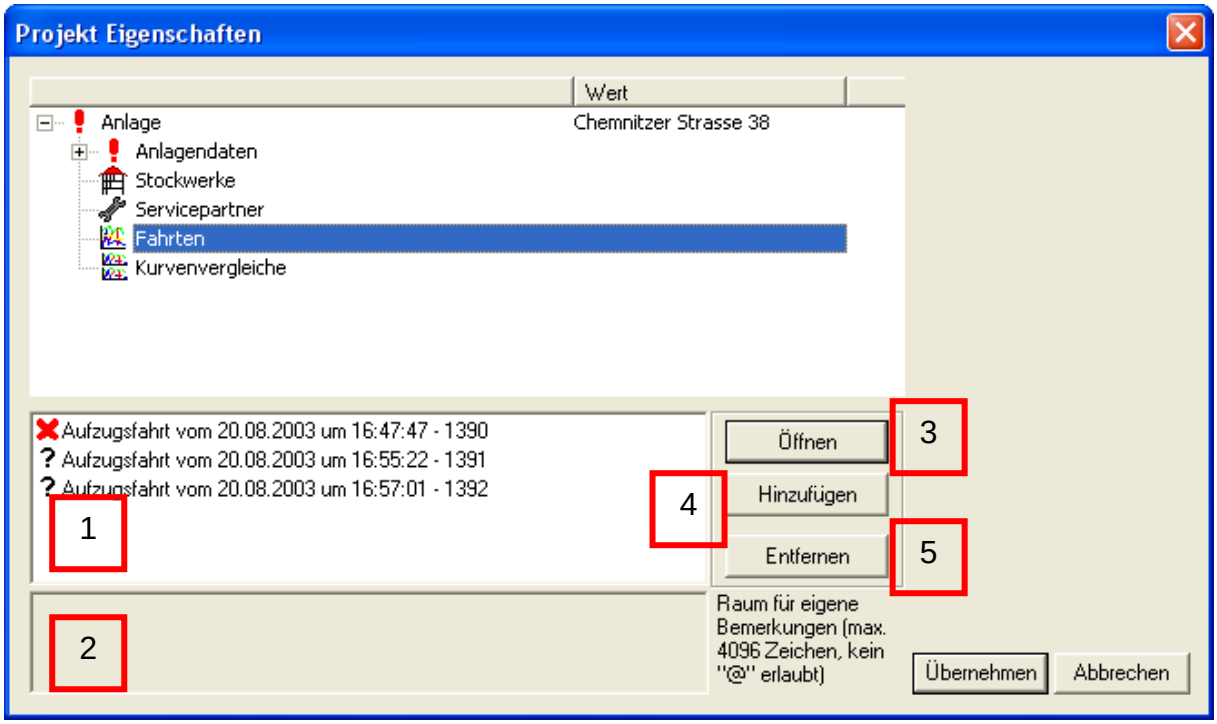


Figure 4: Index card "Travels"

[1] List of measurements
In the field marked with [1] all measurement travels are listed that have been carried out in the active project. The travels are provided with an unambiguous date and time in order to ensure the allocation. Furthermore, the title also comprises the file name under which they have been saved by the system.
The individual travels are marked with an icon which indicates the current evaluation state of the travel:

- ✖ Evaluation carried out, results exceed the limits
- ✔ Evaluation carried out, results within the limits
- ? Evaluation not yet carried out

[2] Notes field
For each individual travel you can file own notes. For this purpose in the area marked with [2] there is space available. The comments may comprise a maximum of 4,096 characters and must not contain an „@“. First highlight the corresponding travel with the mouse and then enter the text.
If you import travels, the remarks are automatically provided with the original time stamp of the original travel.

[3] Open
With a mouse click on the button "Open" [3] you open the highlighted elevator travel. In order to completely view the opened curve shapes you must then close the dialog box "Project properties".

[4] Add
With the "Add" button you can import elevator travels which you have carried out on other computers; the file must have the suffix „*.afd“ or "*.ve2". In the opening dialog box select the file to be imported and confirm with "Open", so that the elevator travel is added to the list [1].

[5] Delete
With the "Delete" button you can delete those curve shapes which you have recorded for test reasons or which should no longer be included in the project for other reasons. This process is made safe by an additional reference display window which you have to confirm with "Yes".

7.2.1.5.5 Curve comparisons

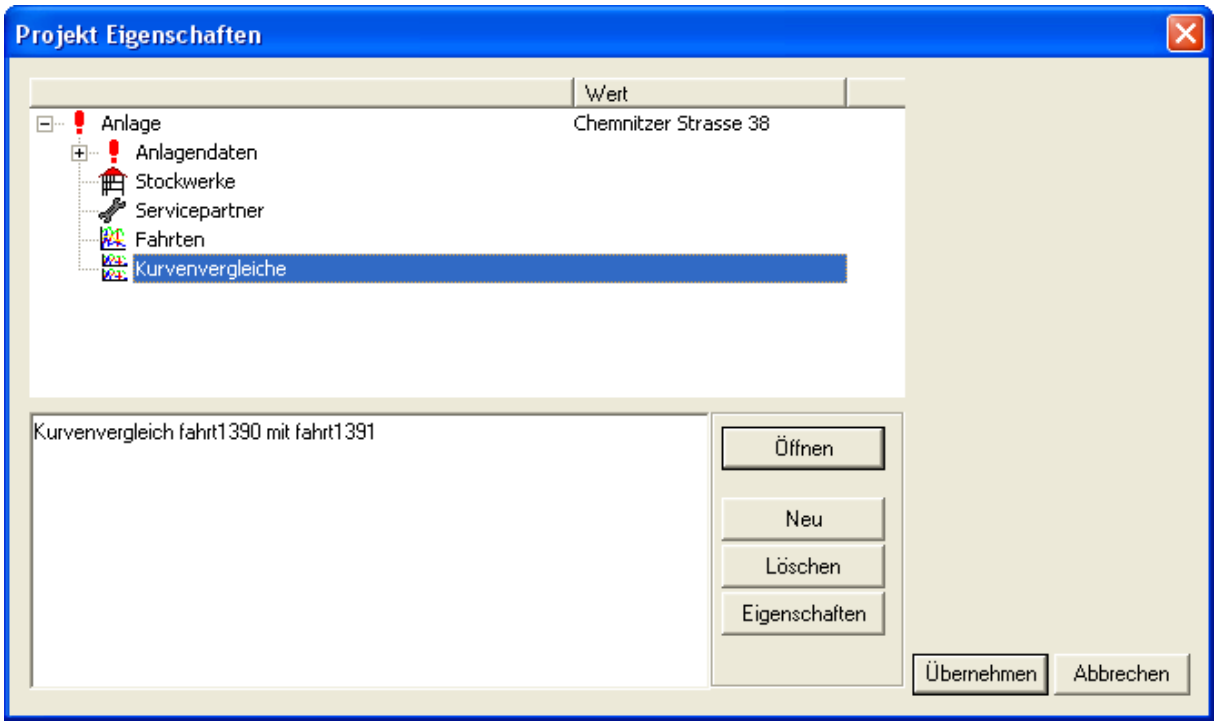


Figure 5: Curve comparisons

In this index card all curve comparisons which you have carried out are indicated. At this point you also have the possibility to change the settings of an existing diagnosis comparison, to cancel the diagnosis comparison or to create a new one. Please compare chapter 5.3.2 "Diagnosis comparison".

7.2.1.6 Read data from CF card

By means of this function you may read in measurements recorded by the hand-held terminal HT 1.
As soon as you select this menu item a dialog box appears in which you choose the file on the Compact Flash that you want to import. Afterwards you have still to select the project to which this measurement shall be allocated.

7.2.1.7 Print chart

If you select this menu entry, the currently displayed screen contents including possibly connected power spectrum are printed by the default printer or the printer that has been first selected with the function "Setup printer". The print-out is by default in the landscape format.

7.2.1.8 Print report

If this menu entry is selected, the diagnosis report for the current chart will be printed. The print-out has the same structure and contents as seen in the preview.
You have the possibility to choose between the short or the complete report. In the short report only the total results are printed. The complete report contains, apart from the total results, also all results of the individual travel sections of the total measurement.
The print-out is by default in the portrait format.

7.2.1.9 Report preview

With this function you reach the online view of a diagnosis report. As regards the various functions please compare chapter 5.4 "Report".

7.2.1.10 Printer setup

Here you can select another printer than the default printer and carry out numerous configurations (dependent on the printer model).
After having configured the printer you use the menu entry "Print" in order to start the actual print.

7.2.1.11 Export

Figure 6: Submenu "Export"

In this submenu you have the possibility to transfer the acceleration curves or the evaluated results into various other data formats.

Acceleration raw data
By means of this function you export the curve data of the currently opened diagnosis measurement into a text file. In this way the data can then be used in programmes such as MatLab, Excel etc. for further evaluations.

Current curve view (BMP)
This function exports the current curve view into the Windows Bitmap format. This file can be further processed in any other graphics program or, for example, attached to documents.

Report in MS Excel
This function exports the evaluation results to ISO 18738 of an *evaluated* diagnostic travel into the Microsoft Excel format. This file can for example be used for own reports, database connections etc.

Current project
By means of this function you export the currently opened project including all data and measurements into a dispatch file which can be read in again using the function "Import project" (compare **Fehler! Verweisquelle konnte nicht gefunden werden.** Import project).

7.2.1.12 Terminate

With this option you terminate the diagnosis programme. If changes carried out have not been saved, a reference display window appears with a warning message, so that the changes can still be saved.

7.2.2 Menu Default options

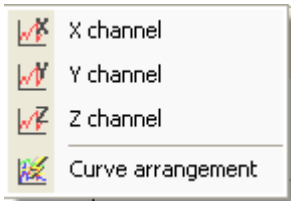


Figure 42: Submenu default options

7.2.2.1 X-channel

Compare chapter 4.3.1 "Representation of the measuring curves"

7.2.2.2 Y-channel

Compare chapter 4.3.1 "Representation of the measuring curves"

7.2.2.3 Z-channel

Compare chapter 4.3.1 "Representation of the measuring curves"

7.2.2.4 Arrangement of curves

Compare chapter 4.3.2 "Arrangement of curves"

7.2.3 Menu Evaluation

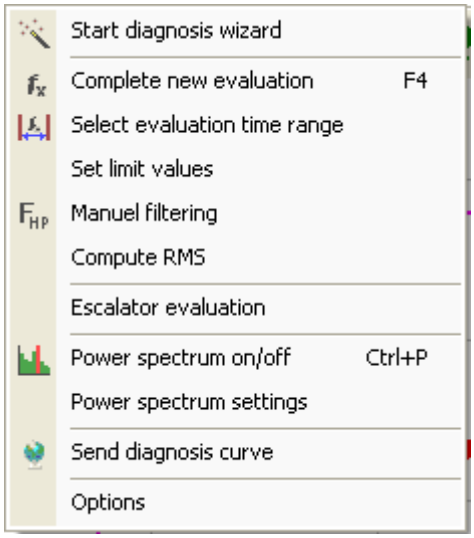


Figure 43: Submenu evaluation

7.2.3.1 Start diagnosis assistant

Compare Chapter 5.2 "Measuring execution"

7.2.3.2 Complete new evaluation

If you select this menu item, the currently opened elevator travel is once more evaluated according to the same criteria as is done by the diagnosis assistant. This function is for example required, if you want to evaluate imported curves or if you want to create a new report after a change of the limit values.
For the evaluation of the determined diagnosis data the limit values of the active limit value set are used (compare chapter 7.2.3.4 "Set limit values".

7.2.3.3 Determine the evaluation area

If you want to evaluate only a certain travel section within a measurement, you may use this function. As soon as this function is activated, two vertical lines appear in the curve view, which you can move using the mouse.
The present measurement is then evaluated only in this area by a new "Complete revaluation"

7.2.3.4 Set limit values

According to the guidelines ISO 18738 the diagnosis determines diagnosis values for the individual elevator travels.

However, the guidelines do not stipulate limit values. For this reason it is left to each user of liftpc® ***mobile diagnose*** to stipulate own limit values which are specially adapted to his requirements or his elevator type.
As liftpc® ***mobile diagnose*** is in a position to examine all types of elevators and as this is a large spectrum, you have the possibility to determine different limit value sets. This means that you could, for example, determine another limit value set for hydraulic elevators than for rope elevators, etc.
The limit value sets are password-protected so that only the authorized group of people can change the tolerances.

If you have not yet issued a password, the initial setup is an "empty" password; therefore, simply confirm the password query with "OK".
If you change the limit values after you have established a report, this will not have an effect on the saved report.
New elevator diagnoses are always evaluated with the "active limit value set" of the project. In the list (compare figure 47 [6]) the active limit value set has a green check mark.

The limit value dialog appears as follows:

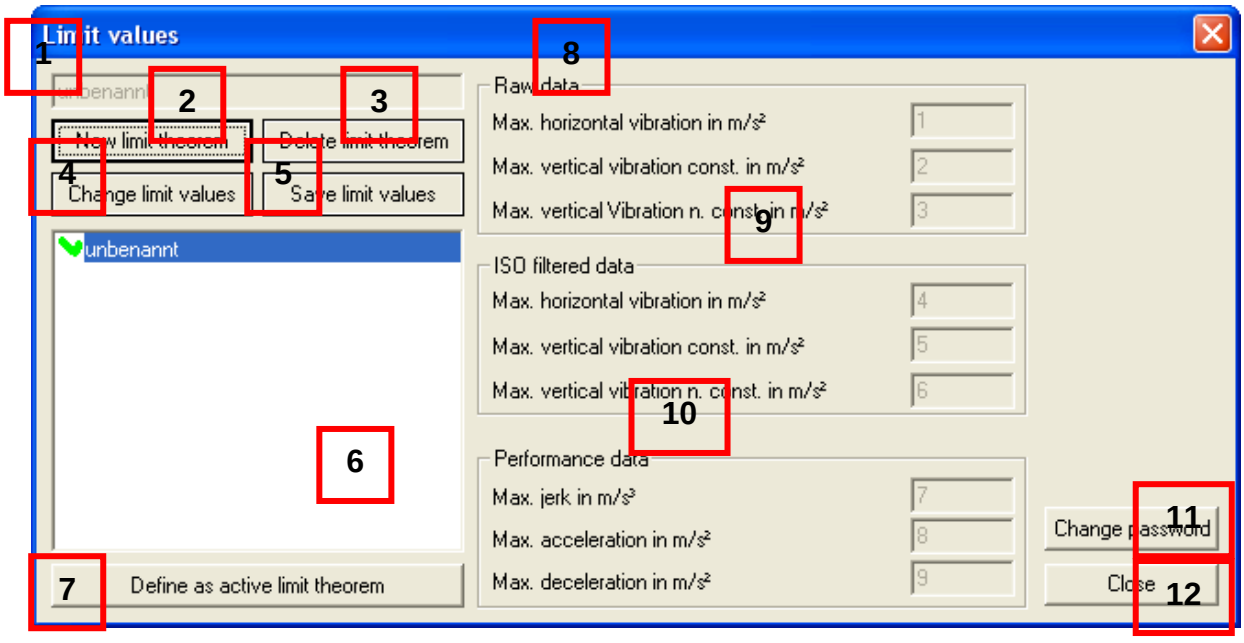


Figure 47: Process limit value sets

[1] Limit value set name
As a distinguishing feature a name should be allocated to each limit value set. As long as you do not change the limit value set the input field is blocked. The name which you have selected from list [6] is displayed. Please use button [4] to change the name, enter the new name and save the change with button [5].

[2] New limit value set
In order to create a new limit value set please actuate button [2]. Then you will be prompted to enter a password for the new set and to repeat it in order to ensure that the intended password is adopted. Afterwards you can enter the limit values in the group boxes [8], [9] and [10], input a name for the limit value set in entry field [1] and save the new limit value set with button [5].

[3] Delete limit value set
In order to delete a limit value set that is no longer required, please use button [3]. After the input of the password for this limit value set it is deleted and also disappears from the list [6].

[4] Change limit values
Existing limit value sets can be edited using button [4]. After the input of the valid password all entry fields which are represented as locked in figure 44 are activated. The changes will be saved as soon as you use button [5].

[5] Save limit values
After changes or the creation of new limit value sets you can save them using button [5]. Prior to the saving process you are prompted to issue a new password. If you want to keep the existing password, you simply confirm the password query with "OK" without changing the password input field.

[6] Limit value set list
In list [6] you see all existing limit value sets. Those limit values currently shown in the group boxes [8], [9] and [10] and the name [1] belong to the limit value set which is currently selected in this list. The currently selected limit value set is highlighted with a blue bar (in figure 44 this is for example the limit value set “Set1”).
If you choose another limit value set with the mouse or the arrow keys, its data appears in the blocked input fields.
The limit value set having a green check mark in the list is the "active limit value set". In the case of a new elevator diagnosis this set will be used for the evaluation of the diagnosis data in the report.

[7] Select active limit value set
With button [7] you can select the limit value set which is used in the case of a new elevator diagnosis for the evaluation of the diagnosis data in the report. For the selection of the active limit value set you require a valid password.
The limit value set which has a green check mark in the list represents the "active limit value set".

[8] Raw data limit values
Here the limit values are specified which are used for the examination of the raw, unfiltered measuring data

[9] Limit values for ISO-filtered data
In the group box [9] the limit values are indicated which are used for the ISO-filtered and assessed measuring data.

[10] Performance data limit values
At this point the maximum values are specified which may be reached by the individual performance data of the examined elevator.

[11] Change password
Please use this button if you wish to change the password for the access to the limit value sets. The new password is only adopted if you have input the password and the password repetition in identical fashion. In order to deactivate the password query, please enter an "empty" password.
The password is case sensitive!

[12] Terminate
With button [12] you leave the dialog box.

7.2.3.5 F_{HP} Manual filtering

In order to carry out manual filtering over a certain curve shape, you have to select the curve to be filtered as the "active curve" (compare chapter 7.1.1. "Active curve").
Afterwards you start the menu item "Manual filtering".
After that this dialog box will open:

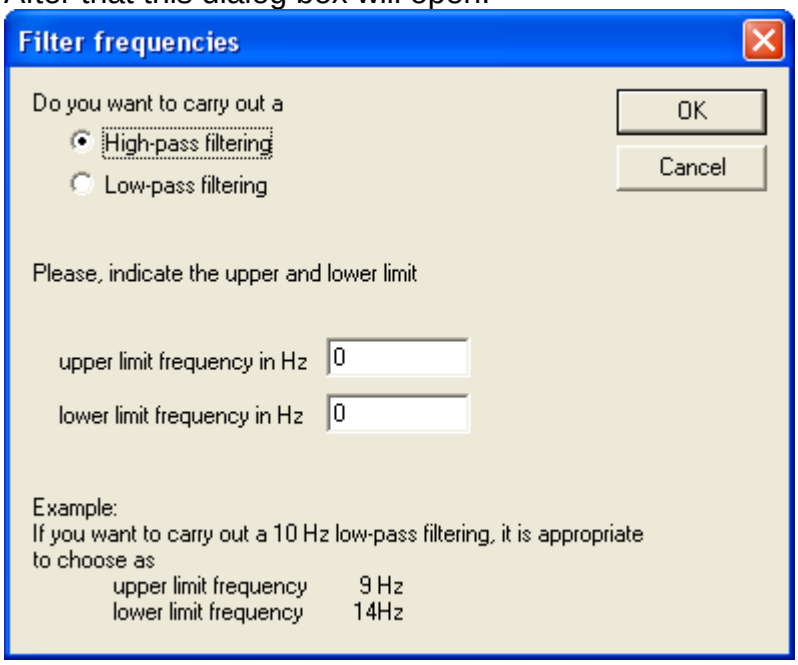


Figure 48: Filter frequencies dialog box

Here the frequencies have to be indicated from which the filter to be chosen (high-pass or low-pass) shall start. Required are the upper and lower frequency in Hertz.
For this purpose compare the example in the dialog box
When the frequencies have been selected, start the filtering with the "OK" button. A new curve, plotted in black, will be unhidden. This curve is the filtered original curve which has been defined as the "active curve". The name of the curve is automatically generated, however it can be changed by you at any time in the "Chart properties" (compare chapter 7.2.5.1 "Chart properties").

7.2.3.6 Calculate RMS

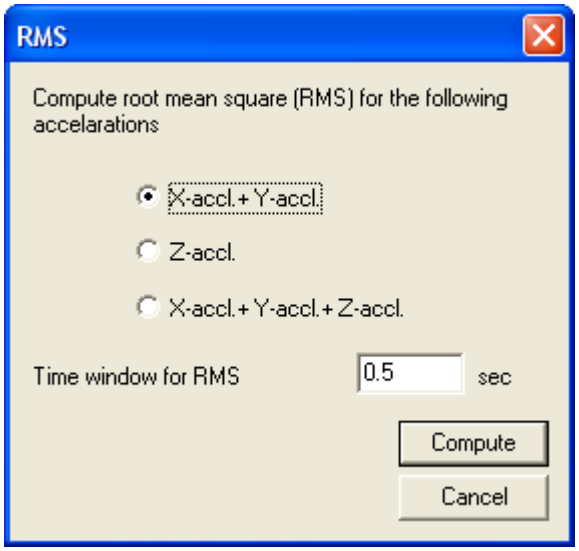


Figure 7: Calculate RMS

By means of this dialog box you may carry out any RMS (Root Mean Square) evaluations. The RMS shapes are added to the current diagnostic travel in the form of a new curve. Here, the time slot of the RMS calculation can also be adjusted.

7.2.3.7 Escalator evaluation

This module must explicitly be released. For this purpose, please, contact Henning GmbH.

7.2.3.8 Unhide/hide power spectrum

Compare chapter 6.5 "Power spectrum"

7.2.3.9 Power spectrum settings

The dialog box for the power spectrum parameters appears as follows:

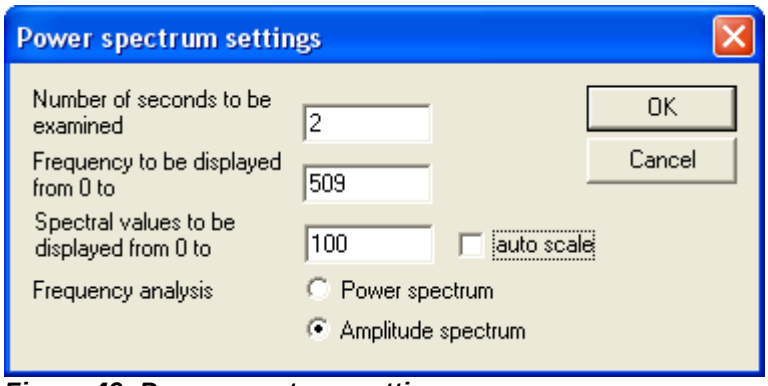
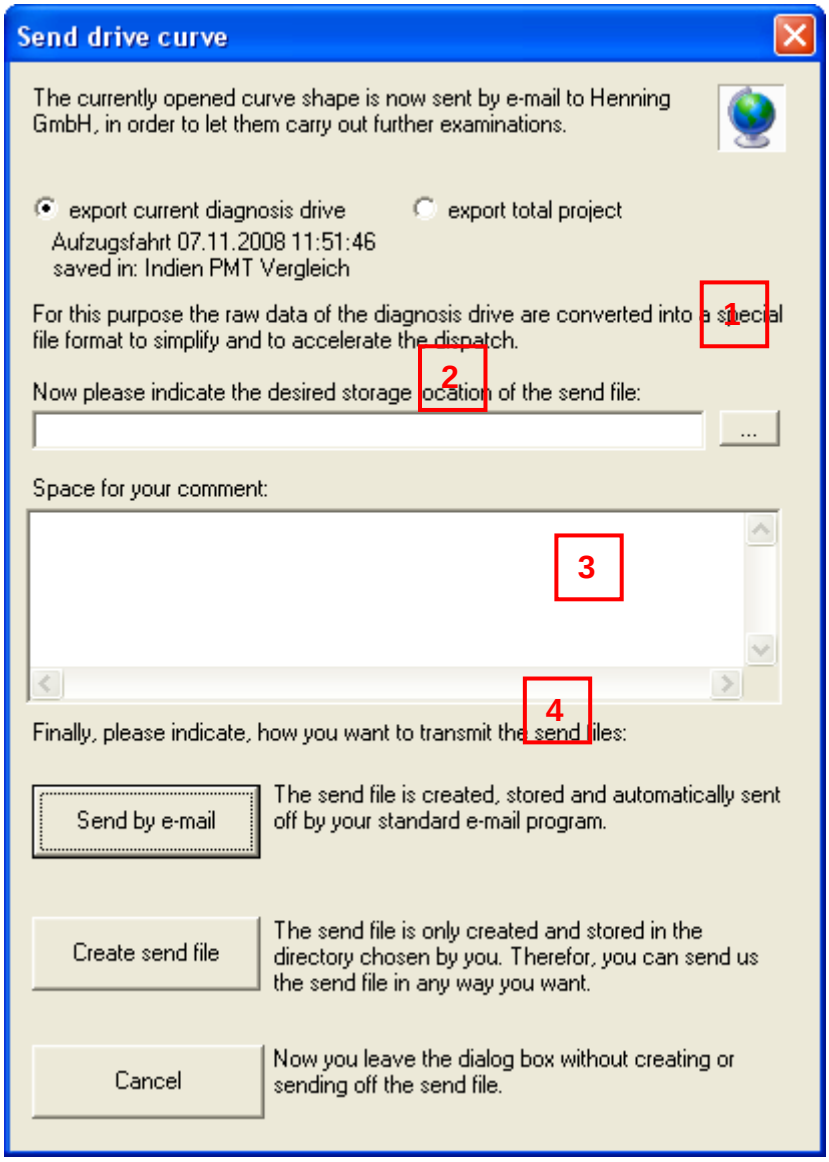


Figure 49: Power spectrum settings

In the first input field you indicate over how many seconds of the active curve shape the power spectrum shall be generated. If, for example, you want to examine door zones, you input about 3 seconds, and if you want to examine the travels between landings you enter the number of seconds it takes the elevator to pass one story.
The field "Spectral values to be displayed from 0 to" determines the range of values of the y-axis of the power spectrum and should not be chosen larger than for producing the usual swings for a "good" measurement. If the limit indicated by you is exceeded, in the bar chart the relevant "interfering" frequency is represented in red, or green if the limit is not exceeded.
The field "Frequency to be displayed from 0 to" determines the range of values of the x-axis of the power spectrum. Here, please indicate the maximum interesting frequency in Hertz.
If you use the field "Automatic scaling" the "spectral value to be displayed" will be ignored and instead the power spectrum is automatically scaled, so that you always obtain an optimum viewing result. This setting is above all recommended for newcomers.
Two different analysis methods can be used for the spectrum.
The power density spectrum creates a frequency spectrum of the power contained in the acceleration shapes.
The amplitude spectrum informs about the real amplitudes of the different frequencies. The amplitude spectrum increases in particular small power shares and, therefore, it is sometimes preferred.

7.2.3.10 Dispatch diagnosis travel

With this function you have the possibility to send us your measured diagnosis travels by e-mail or in others ways.
We have provided this function for the case that the evaluation of a travel does not work or that there are other problems with the results. We will then examine in detail the file sent to us in order to offer you a solution for the problems occurred. In order to dispatch a diagnosis travel, first open the travel so that you can see it on the screen; afterwards please select the menu item "Dispatch diagnosis travel", whereupon the following dialog box opens up.



Under **[1]** you can choose whether you wish to export only the currently opened diagnostic travel or the total project with all data and measurements. In the upper third in **field [2]** you see the file name and the curve designation of the travel to be mailed. In **field [3]** please indicate a file name under which the dispatch file shall be stored (where it will still be found after the dispatch).
In **field [4]** you have the option to send us a comment regarding possible problems with the travel. If you then use **"Send by e-mail"**, the file will be sent to us by e-mail.

Figure 50: Dispatch diagnostic travel

With **"Create dispatch file"** you can also merely create the file, if, for example, you have any problem with the dispatch etc., and send it to us in another way.

7.2.3.11 Options

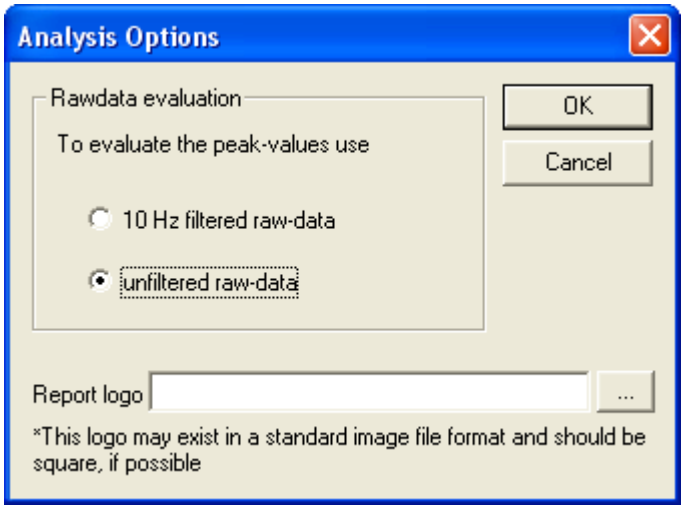


Figure 8: Analysis Options

In the analysis options you can determine whether the measured acceleration data shall be used as a basis for the calculation according to ISO18738 or with 10 Hz low-pass filtering. This option is offered in order to enable the comparability with systems using acceleration sensors of lower resolution.
Furthermore, you can define the logo which is printed in the upper right corner of the reports. This logo may exist in a standard image file format and should be square, if possible. If necessary, the logo will be rescaled by the program, however the proportions will be maintained.

7.2.4 Menu Measurement

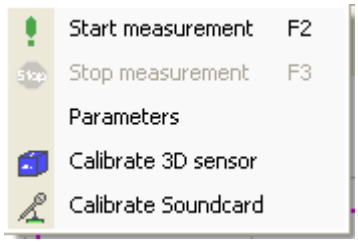
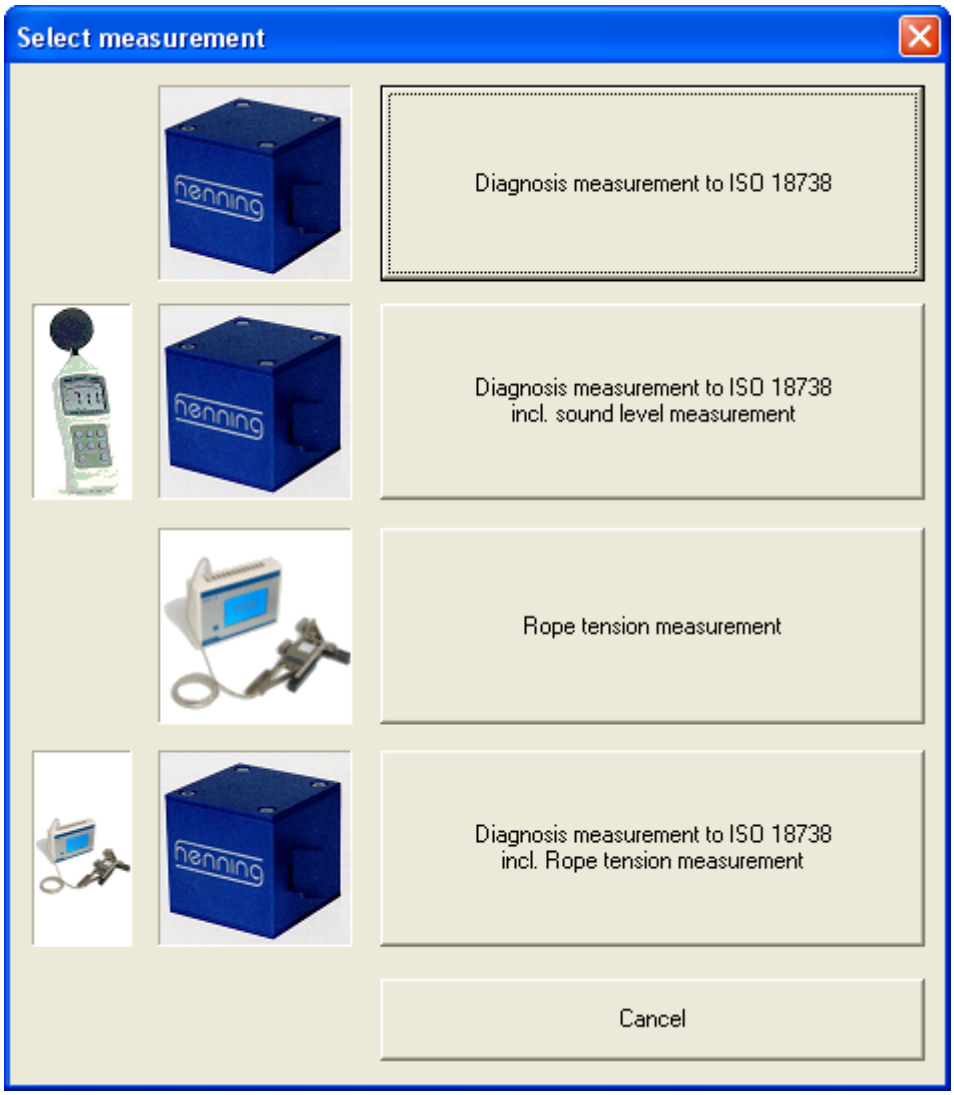


Figure 51: Submenu measurement

7.2.4.1 Start

With this function you start the data recording. You can determine which type of measurement shall be executed. Dependent on the modules of liftpc® ***mobile diagnose*** you have installed, the following dialog box opens:



As soon as you select one of these measurements with a mouse click and a project is active, data is read out by the sensors and displayed on the software interface as curve shapes.

During the first seconds no display appears on the chart, as during this time calibrations and initialisations of the software take place.
Afterwards you see the online data as they are recorded by the sensor. If you wish to change this representation, please complete these changes prior to the measurement (compare chapter 4.3.1 "Representation of the measuring curves").

7.2.4.2 Stop

With this function you stop a previously started measurement.

7.2.4.3 Parameters

Compare chapter 4.1 "Interface configuration"

7.2.4.4 Calibrate 3D-sensor

Compare chapter 4.2 "Calibration of the sensor"

7.2.4.5 Calibrate sound-card

Compare chapter 4. 3 "Calibration of the sound card"

7.2.5 Menu chart

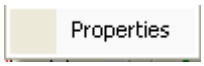


Figure 52: Submenu chart

7.2.5.1 Properties

Compare chapter 6.6 "Chart properties"

7.2.6 Menu Database

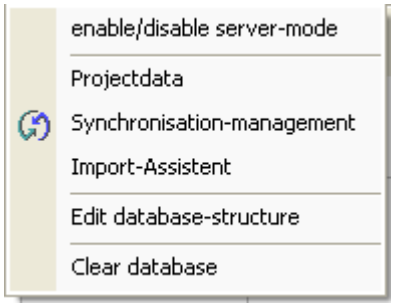


Figure 9: Menu "Data management"

7.2.6.1 Switch on and off the Server Mode

The server mode enables the access to the data stock of the server. As soon as the server mode is activated it is exclusively possible to access projects and measurements of the server. As explained in the following subchapters some operations can only be carried out in the server mode.
The server mode can be password-protected, compare chapter 7.2.6.3
The activated server mode is visually displayed by the word "SERVER MODE“ in the title bar of the software and a bold red frame around the chart view.

7.2.6.2 Project management

In this submenu projects can be deleted. Select the projects to be deleted by ticking the check box. Then confirm the deletion by the "Delete" button. As a result the projects will be marked in the database as "deleted" and will no longer appear in the project list.

7.2.6.3 Synchronisation management

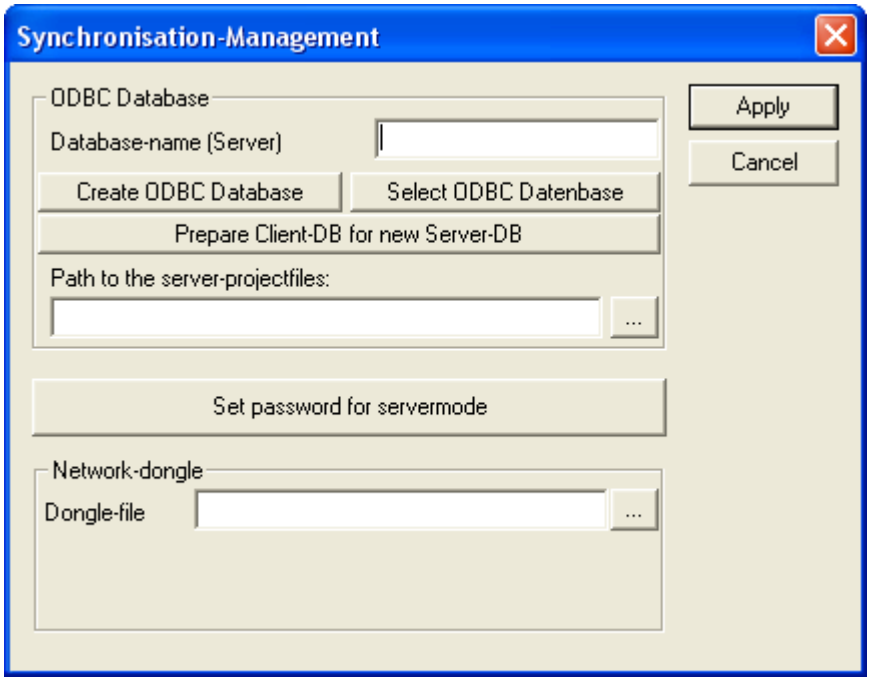


Figure 10: Synchronisation management

Under this menu item the necessary parameters for the synchronisation between the data server, the client and the server mode are entered.
The data source name is the data source with ODBC function, which takes care of the central management of all measurements and projects. It should be installed on a computer which is permanently accessible in the company's network.
The "Path" to the server project files is a path to a physical drive of the server. The database (data source) stores the project data and diverse settings, but not the actual measurements which soon may occupy several Mega Byte. This data is instead written into individual files on the server. In order to be adapted to synchronisation with the clients, the clients must know the relative path to the data (from the view of the clients).
The "password for the server mode" can be issued by option, so that before each change to the server mode a password query takes place. In this way, at the same time the menu item treated here is password-protected, too. In order to deactivate the password query an empty password must simply be set.

As the setup of databases, depending on the software used, can be very different, only the most simple case is treated here as an example. For this purpose a permanently accessible Windows computer in the company's network is necessary. This computer requires minimum one folder released for the clients and a Windows version later than Windows ME on each client.

Starting out from the fact that the Windows network within the company already exists, the following steps have to be taken:

SERVER

1. Install the software „LiftPC Mobile Diagnosis“ on the server in the usual way. A release is not required!
2. Release the "Projects" directory of the just installed software in the network for all Clients which shall have access to the server database. The easiest way is, you start the Windows Explorer, navigate to the Projects" directory and press the right mouse button. Then select the point "Release and Safety" from the context menu and release the "Projects" folder in the network.

   It is required that the Clients dispose of a read and write permission on this folder.

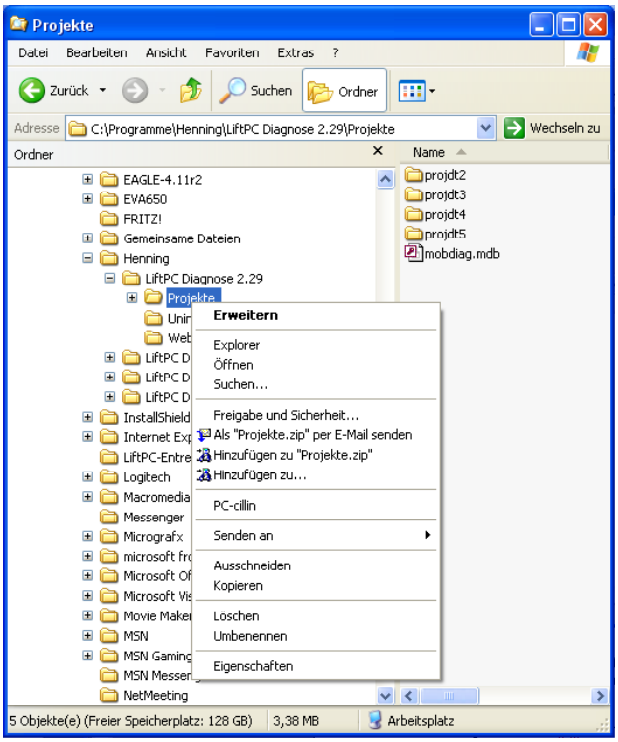


Figure 11: Release of the "Projects" folder

CLIENT

1. On the Client in the software „LiftPC Mobile Diagnosis“ navigate to the menu "Data Management" and press the button „Create ODBC Data Source". Afterwards you will be requested to indicate the path to the file „servdiag.mdb“ just installed on the Server (see above). Select the correct path.
2. Now, the correct "Path to the server project files" must be selected. This is the path to a physical drive of the Server which you have selected when installing the software on the Server (see above). As a rule, this path is identical with the path of step 1 of the Client installation.
3. If you use a network dongle, please indicate under "Dongle File" the path to the file „lpdbm.mx“ on the dongle server.
4. Leave the dialog box "Synchronisation Management" with "Apply".
5. **Start the menu item "Data Management -> Switch on / off Server Mode" to ensure that the server database has the current version.**
6. Afterwards you should once more call the menu item "Switch on / off Server Mode" in order to work again with the local data stock.

You may test the synchronisation procedure on the Client by selecting from the tool bar the item "Synchronisation of the data stock" (figure 59, point 2).

7.2.6.4 Import wizard

By means of the present version all data is kept in one database. In order to integrate also projects from former versions into the database, you may use the import wizard. This wizard looks as follows:

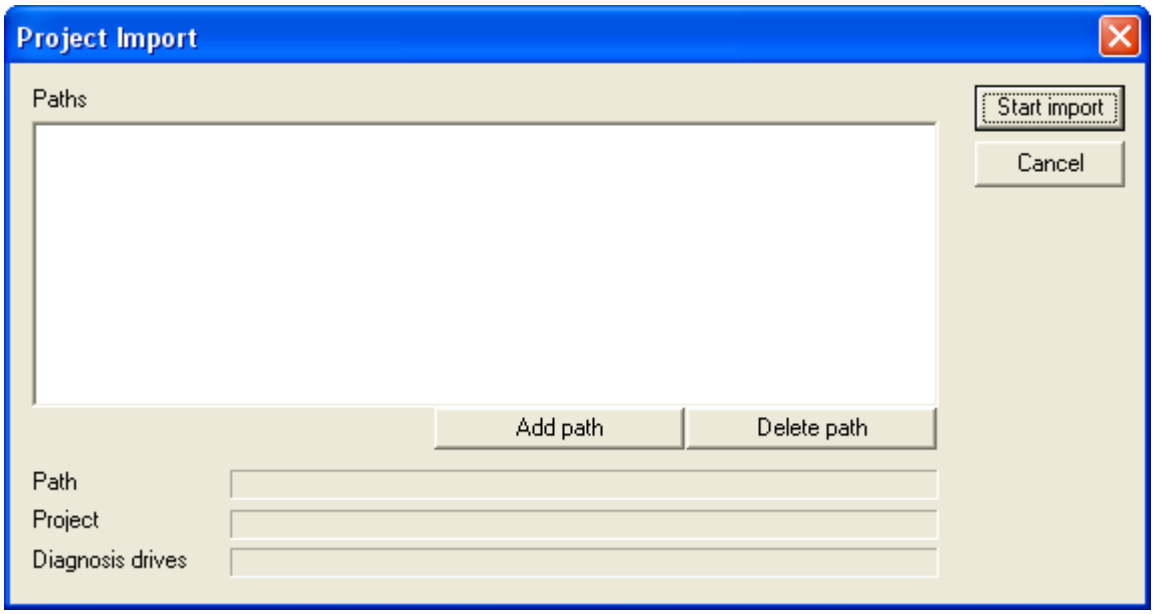


Figure 12: Import wizard

Using the "Add" button you may add any directory from your hard disk or your network to the import list. As a rule, all your projects are contained in the subdirectory „LiftPC Diagnosis/Projects“.
After you have added the directories, you start the import process using the button "Import". According to the number of projects and diagnostic travels the process may take a long time. By the three progress bars you are informed about the current state of the import.
Your projects to be imported are not deleted, however only renamed from „*.afp“ into „*.ifp“ (Project files) and from „*.afd“ and „*.afm“ into „*.ifd“ (Diagnostic travels and comparisons).
Files with these suffixes may be deleted after the import process without danger to your program function.

7.2.6.5 Process data structure

The entries regarding the lift installations which are already provided under "Project properties" in the software can still be adapted by the user by adding new entries or deleting existing ones.
By the process of synchronisation with the Server any changes of the data structure on the Clients are ignored and set into the state of the Server! If you want to change the data structure for all Clients, you must carry out this in the Server Mode on the Server. In the next synchronisation all clients will then be of the same state again.
If you start the menu item "Process data structure" you will reach a dialog box which is similar to the dialog box of the Project properties.

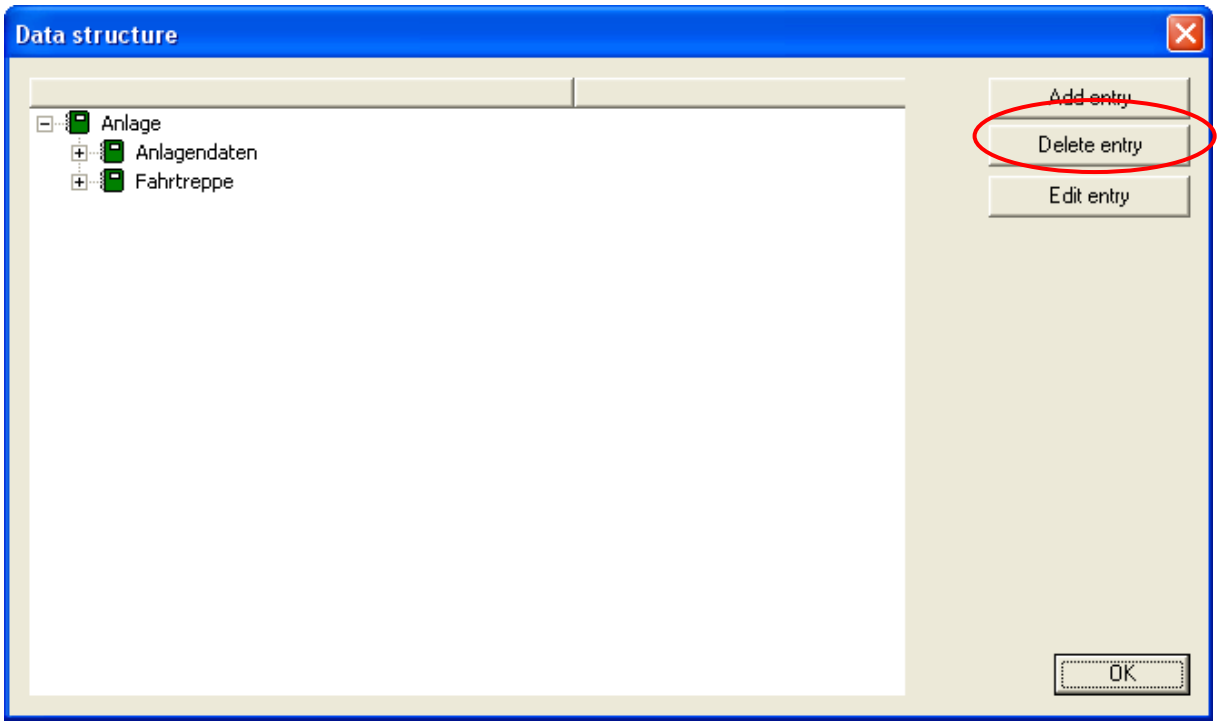


Figure 13: Dialog box "Data structure"

In order to add a new entry, please, mark with a left mouse click a node in the list which shall serve as the "Parent node" for the new entry. If, for example, you want to add a new subentry for "Suspension and Ropes", first mark the entry "Suspension and Ropes" and then use the "Add entry" button.
As a result, the following dialog box is opened:

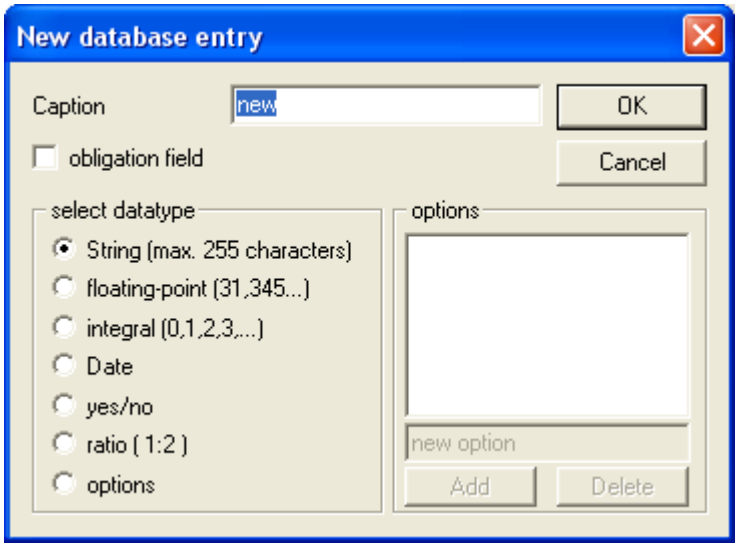


Figure 14: Dialog box New database entry

There, you can issue a name for the new database entry and select the data format for the new database entry. You may choose from 7 different formats. The format once determined can no longer be changed!

Formats for database fields:

1. Text box
   This is a database field which may contain any text, however with a maximum of 255 characters
2. Floating point number
   This database field stores floating point numbers with a resolution of 32 Bit
3. Integral number
   Only integral numbers (also negative ones)
4. Date
   This field can store any type of data in the format preset by you (operating system level)
5. Yes/No field
   Stores logical „Yes“ or logical „No“
6. Ratio field
   This database field stores a ratio in the form of XX:YY
7. Check box "Options"
   In the Project Properties this field offers the user a list of possible values. In the „Options“ list you may „Add“ or „Delete“ these values.

7.2.6.6 Revise database

This function finally deletes those measurements and projects (already no longer displayed on the interface) from the hard disk of your computer which are marked as deleted.

7.2.7 Menu View

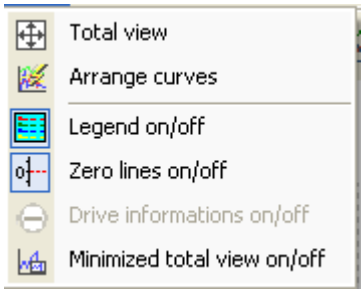


Figure 53 Submenu view

7.2.7.1 Overall view

After any zoomed representations with this function at any time you may return to the overall view. Automatically the maximum range of values is displayed.

7.2.7.2 Arrange curves

Compare chapter 6.1 "Arrange curves"

7.2.7.3 Unhide/hide legends

Compare chapter 6.4.2 "Unhide legends"

7.2.7.4 Unhide/hide zero lines

Compare chapter 6.4.1 "Unhide zero lines"

7.2.7.5 Unhide/hide travel information

Compare chapter 6.4.3 "Unhide limits" and chapter 6.4.4 "Unhide peak markings"

7.2.7.6 Minimized overall view on/off

With this command you unhide or hide a minimized overall view of the total diagnosis travel in order to facilitate the navigation within the travel.

7.3 The toolbar

Figure 54: Toolbar

[1] Start diagnosis wizard
Compare chapter 5.2

[2] Synchronisation of the data stock with the data server
Compare chapter 7.2.6

[3] New project
Compare chapter 7.2.1.1

[4] Open project
Compare chapter 7.2.1.2

[5] Save Project
Compare chapter 7.2.1.3

[6] Project properties
Compare chapter 7.2.1.4

[7] Read data from CF card
Compare chapter 7.2.1.5

[8] Print chart
Compare chapter 7.2.1.5

[9] Print report
Compare chapter 7.2.1.6

[10] Report preview
Compare chapter 7.2.1.7

[11] Start measurement
Compare chapter 7.2.4.1

[12] Stop measurement
Compare chapter 7.2.4.2

[13] Undo
With this button the last 100 view changes can be undone

[14] Overall view
Compare chapter 7.2.6.1

[15] Arrange curves
Compare chapter 6.1 Arrange curves

[16] Determine active curve
When you use this button, the list of the curves contained in the chart opens up in a window. The active curve is marked with a check mark. In order to determine a curve to be an active curve, click the right mouse key on the corresponding curve shape in the selection box.

[17] Unhide/hide curves
Compare chapter 6.2.1

[18] Unhide peak markings
Compare chapter 6.4.4 Unhide peak markings

[19] Unhide limits
Compare chapter 6.4.3 Unhide limits

[20] Minimized overall view
Compare chapter 7.2.6.6

[21] Legend
Compare chapter 6.4.2

[22] Zero lines
Compare chapter 6.4.1

[23] Complete new evaluation
Compare chapter 7.2.3.2

[24] Determine the evaluation area
Compare chapter 7.2.3.3

[25] Power spectrum
Compare chapter 6.5

[26] Display arithmetic mean values
As soon as you activate this function two vertical lines are displayed in the curve shape. These lines can be moved with the mouse. Between these lines the arithmetic mean value is calculated for all currently shown curves and issued instead of the legend.

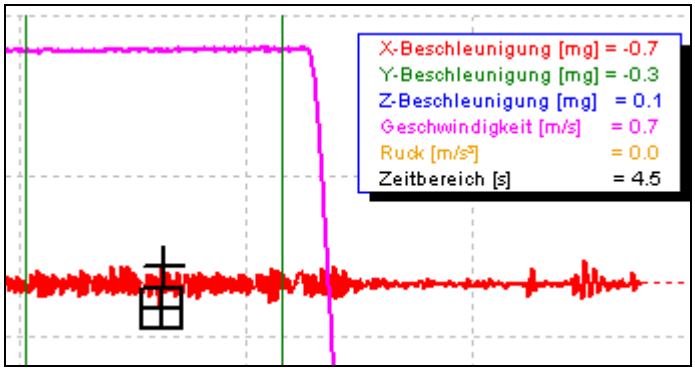


Figure 60: Display of the arithmetic mean values

[27] Escalator evaluation
This module must explicitly be released. For this purpose, please contact Henning GmbH.

[28] Single view
Compare chapter 6.2.1

[29] Display raw data
Compare chapter 6.2.2

[30] Display ISO curves
Compare chapter 6.2.2

[31] Display jerk curve
Compare chapter 6.2.2

[32] Display velocity curve
Compare chapter 6.2.2

[33] Display path curve
Compare chapter 6.2.2

[34] Display information
Displays information window about liftpc® *Mobile diagnosis*

8 Annex elevator analysis

The analysis of the travel quality of an elevator is based on the data of the acceleration sensors in horizontal x, y and vertical z direction (a_X, a_Y, a_Z).

8.1 Low-pass filtering

The generally noisy raw data (sampling frequency 143 Hz) of the sensors are filtered according to standard ISO 18738 with a low-pass filter of 10 Hz limit frequency as noises of higher frequency are merely found irritating to the human ear. The filtered data (a_{X10}, a_{Y10}, a_{Z10}) is used for the calculation of characteristic values. For the robust determination of the times of a travel operation the vertical acceleration a_{Z10} is smoothed to a_{Z1} using a linear compensation filter. A threshold of 0.1 m/sec² used in this function will result in the time limits for one travel operation described in the following.

8.2 Drive analysis

Travels between two consecutive landings are characterized by an acceleration curve in direction z, as shown in figure A1.

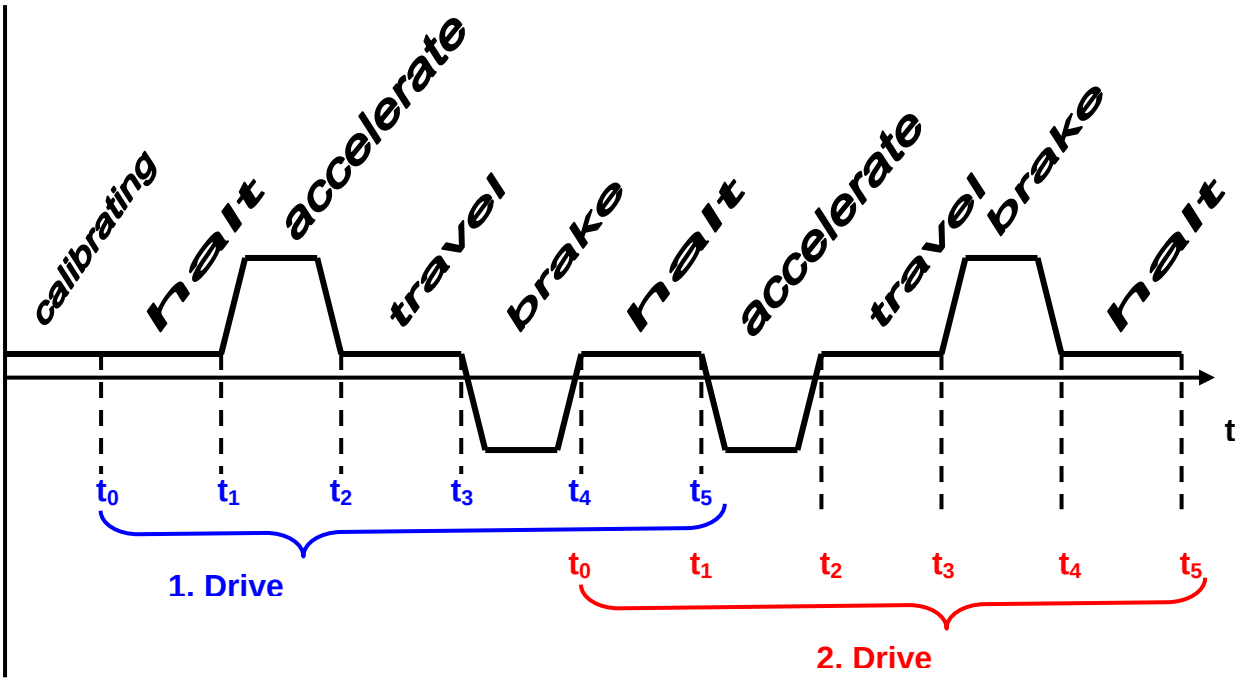


Figure A1: Time limits for travel sections

The times t_0 to t_5 divide a travel into the sections halt, accelerate, travel, brake, and halt.

These time segments are used for the analysis of all travels of one measurement as well as for the determination of the time segments required in the standard 18738. Prior to the first travel an elevator halt of 4 sec is measured. This serves for the calibration of the acceleration sensors and any possible existing offset is corrected.
The measurements must always start and terminate with a standstill.

8.3 Velocity

The velocity v_Z in z direction is obtained by integration of the acceleration a_{Z10}.
It is integrated from t_1 - t_{off} to t_4 + t_{off} with a set offset t_{off} = 3 sec. First the accelerations in the idle times prior to and after the travel are verified; if they are non-zero, the acceleration is correspondingly linearly increased or decreased.

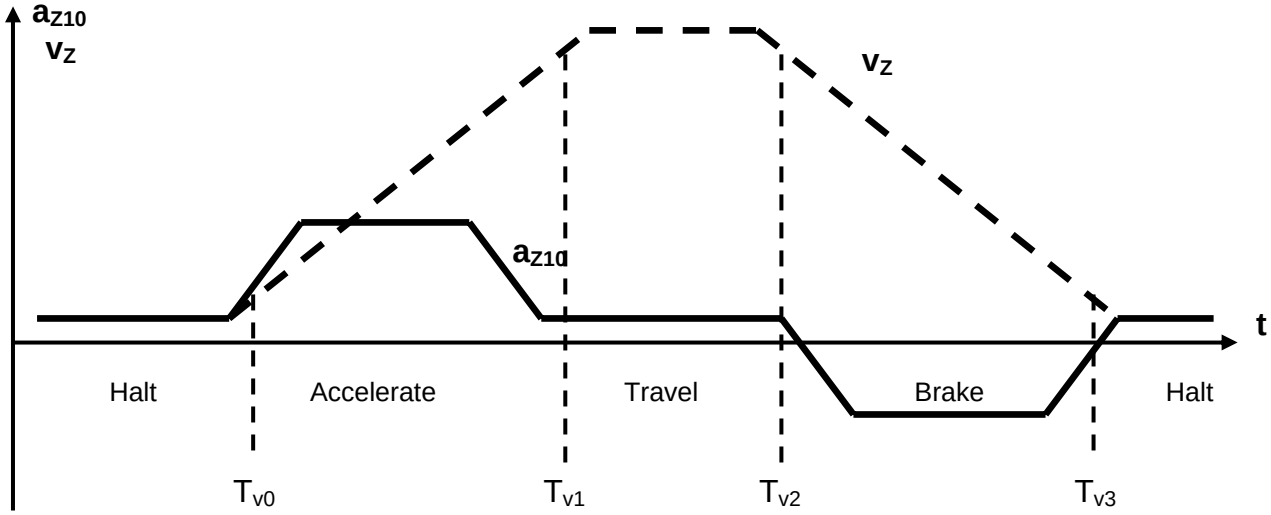


Figure A2: Acceleration a_{Z10}, velocity v_Z and limit times T_{vi}

With the velocity, limit times T_{vi} for the calculation of a 95 % value for the acceleration or deceleration, respectively, are determined.
A 95 % value determines a limit value within which 95 % of all measurement values fall in a predetermined time period.
The times T_{v0} to T_{v3} are obtained by the intersection of the velocity curve with a value of 5 % of the maximum velocity v_{zmax} and T_{v1}, T_{v2} correspondingly at 95 % v_{zmax}.

Characteristic values

a95 (Acceleration):	between T_{v0} and T_{v1}
a95 (Braking):	between T_{v2} and T_{v3}

8.4 Distance

The integration of the velocity v_Z results in the path s_Z, the velocity v_Z in the stoppage times being explicitly set to zero.
The path is also used in ISO 18738 in order to determine the following points of time T_i for the calculation of further characteristic values of the ride quality.

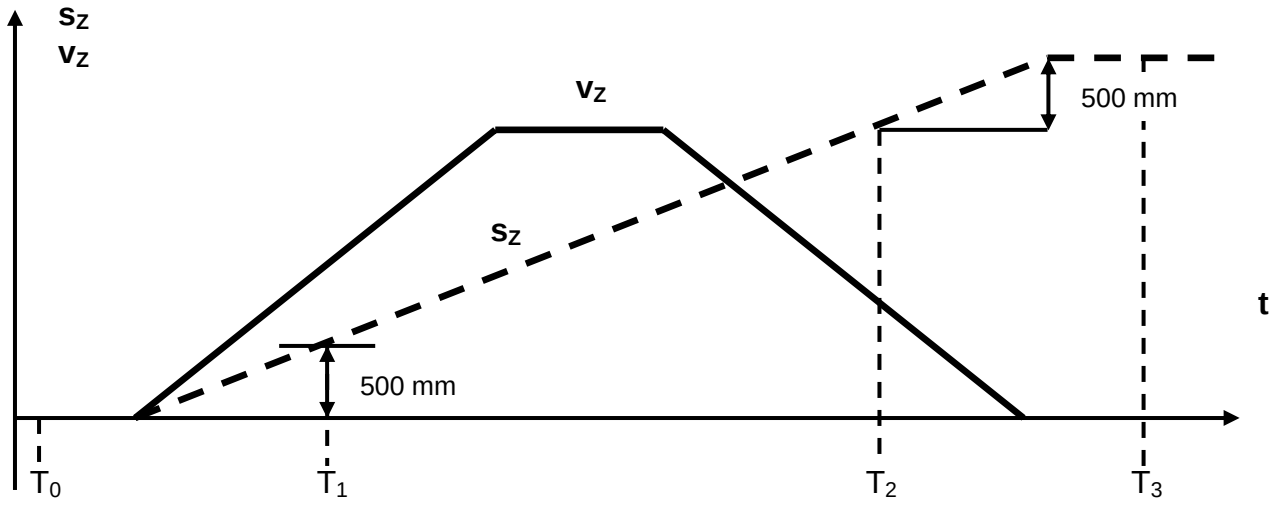


Figure A3: Time limits for the door quality

T_0 : 0.5 sec prior to door closing
T_1 : 500 mm after travel start
T_2 : 500 mm prior to travel end
T_3 : 0.5 sec after door opening

Characteristic values

a_{zmax}: maximum acceleration between T_0 and T_3
a_{zmin}: maximum deceleration between T_0 and T_3

8.5 Jerk

The jerk as a derivation of the acceleration according to the time describes the change of acceleration and in the case of high values becomes apparent as a jerk. In order to obtain a course of jerk as smooth as possible the standard specifies a linear compensation filtering of 0.5 sec.

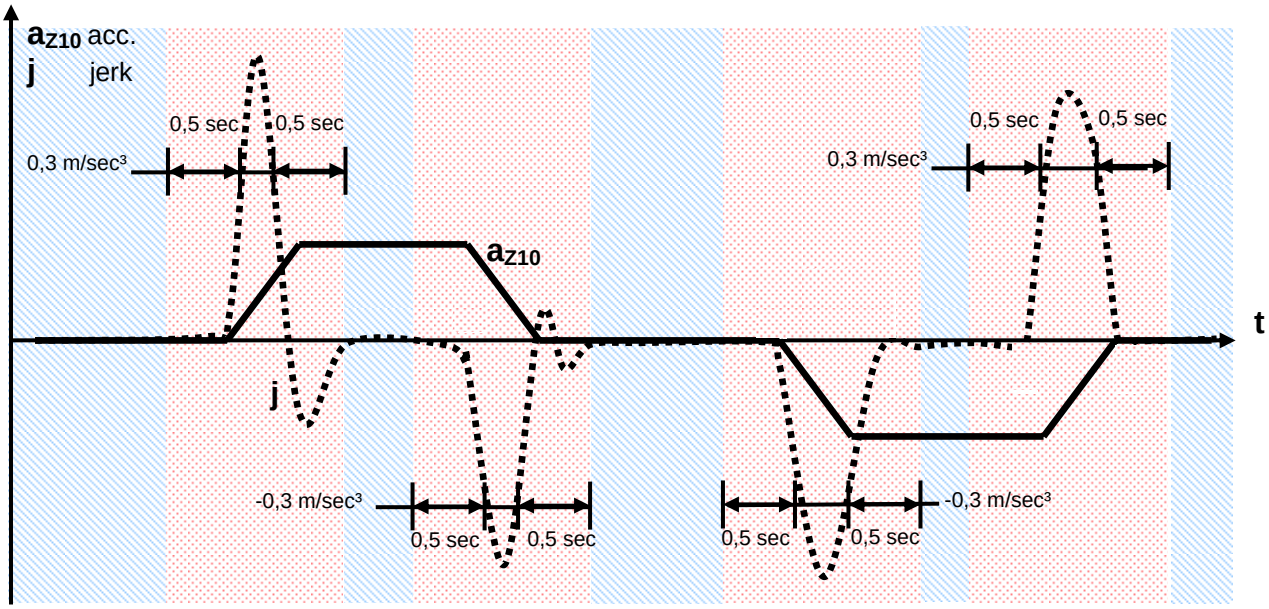


Figure A4: Fundamental shape of jerk

In the following vibration analysis the jerk is used to determine areas of "constant acceleration" and "non-constant acceleration". All time periods in which the jerk is absolutely higher than 0.3 m/sec³ are defined as "non-constant" and are widened at the limits by - 0.5 sec or + 0.5 sec. The area then remaining is considered to be "constant" (in figure A4 the "constant" area is hatched in light blue and the "non-constant" area is dotted in light red).

Characteristic value

j_{max}: between the limits T_0 und T_3 (see figure A3)
absolutely highest jerk value

8.6 Vibration analysis (Evaluation to ISO 8041)

Humans regard acceleration amplitudes in different frequency areas more or less as a nuisance. By means of trials evaluation curves have been determined in which the amplitudes dependent on the frequency are given weightings of 1.0 to 0.0.
These weightings are standardized in ISO 8041 and offer at least a uniform standard for the analysis of the ride quality of an elevator (subjective feeling can be different from person to person)
For horizontal accelerations a_X, a_Y the weighting curve is represented in figure A5 (Fig. C2 of ISO 8041, frequency weighting for whole body, x, y axis). The highest sensitivity (weighting approx. 1.0) is in the area of 1 Hz to 2 Hz and it then decreases to the boundaries. For 0.25 Hz or 10 Hz the amplitude is already weighted with 0.1.

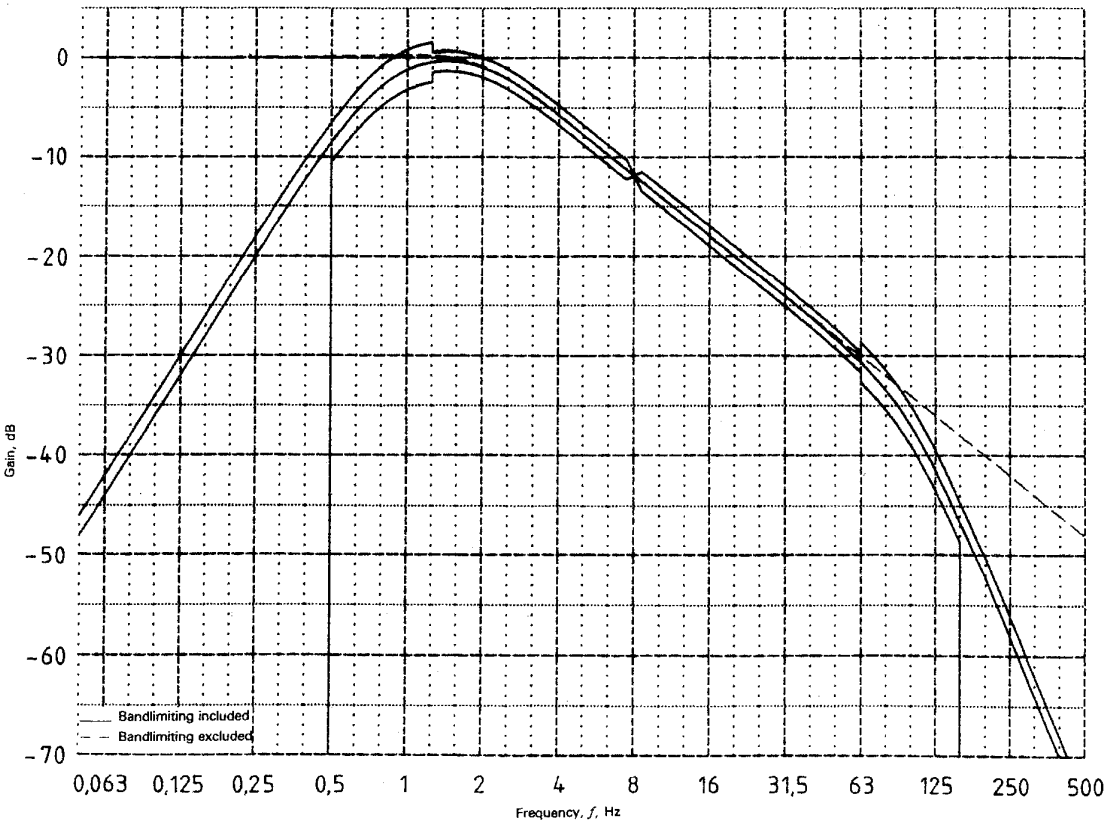


Figure A5: Fig. C2 of ISO 8041

For the vertical acceleration a_Z refer to fig. C3 of the standard (frequency weighting for whole body, z-axis).

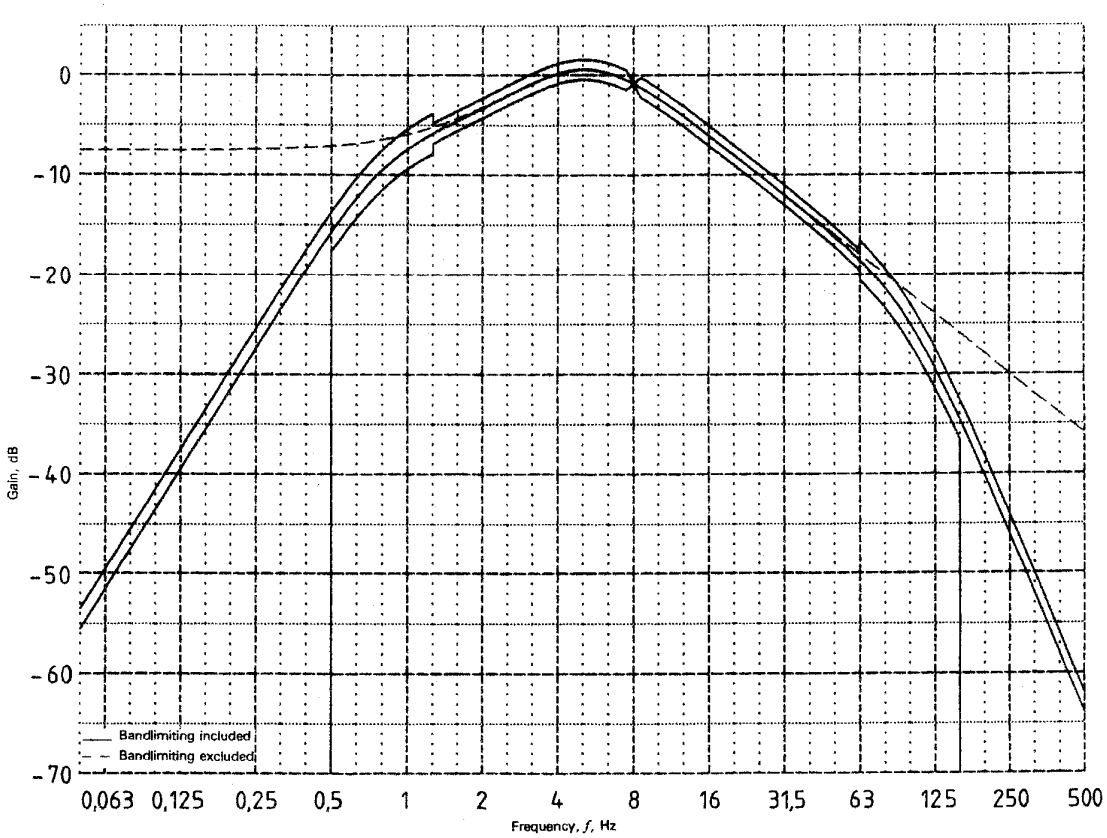


Figure A6: Fig. C3 of ISO 8041

The filtering of the three accelerations a_{X10}, a_{Y10} und a_{Z10} is carried out in the frequency range with the band-limited weighting curves and results in the weighted accelerations a_{xgew}, a_{ygew} und a_{zgew}.

8.7 „peak-to-peak“ evaluation

The subjective feeling of the ride quality can, among other things, be detected by „peak to peak“-characteristic values which are calculated from the accelerations weighted to ISO 8041 as follows.

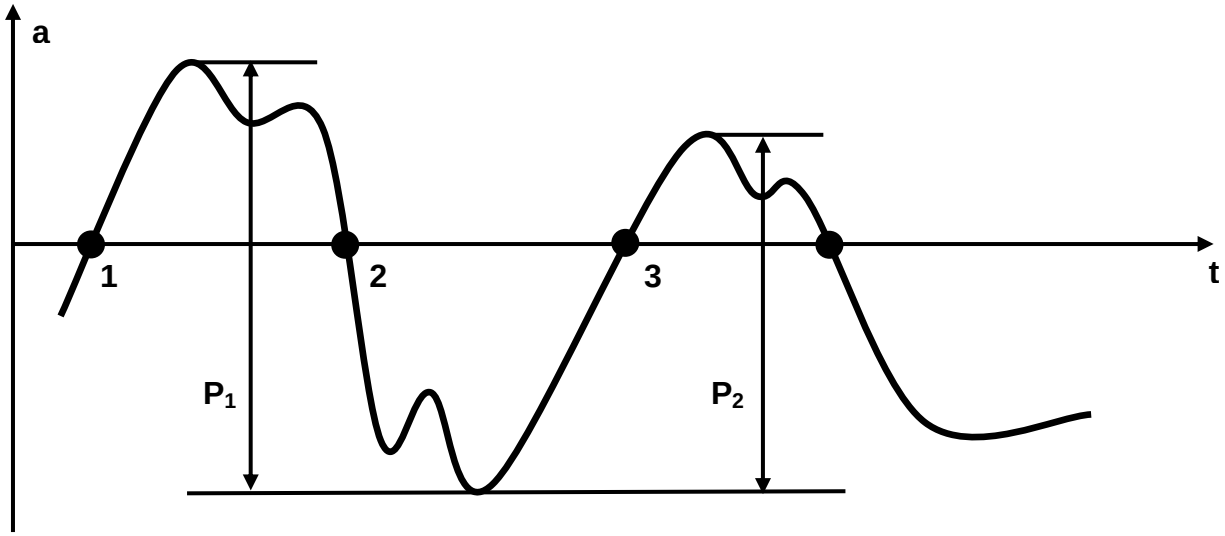


Figure A7: "Peak to peak" acceleration values

In the function course three consecutive zero crossings 1, 2 and 3 are determined and the extreme values are established between (1-2) and (2-3) respectively. Their positive difference then results in the „peak to peak“ value.

Characteristic values x, y axis

a_{xpmax}: maximum peak to peak value between T_1 and T_2 of a_{xgew}
a_{ypmax}: maximum peak to peak value between T_1 and T_2 of a_{ygew}
$a95_{xp}$: 95% value of the peak to peak values
$a95_{yp}$: 95% value of the values

Characteristic values z axis

In vertical direction the acceleration values are calculated separately for the areas of constant and non-constant acceleration. These areas are determined by the analysis of the jerk.

Constant acceleration area

a_{zpmax}: maximum peak to peak acceleration
$a95_{zp}$: 95% value of the peak to peak data

Non-constant acceleration area

$\hat{a}_{zpmax}$: maximum peak to peak acceleration

8.8 Safety braking analysis

For a safety braking test the downward travelling elevator is braked with the help of a suitable safety brake for a short duration to a standstill and then moved by manual control to the next landing.
In figure A8 are represented the downward travel, the safety braking process and the manually controlled travel to the next landing. The safety braking process shows a high short-term acceleration amplitude and the further travel mostly a non-typical vibration shape which cannot be analysed with the normal elevator analysis.

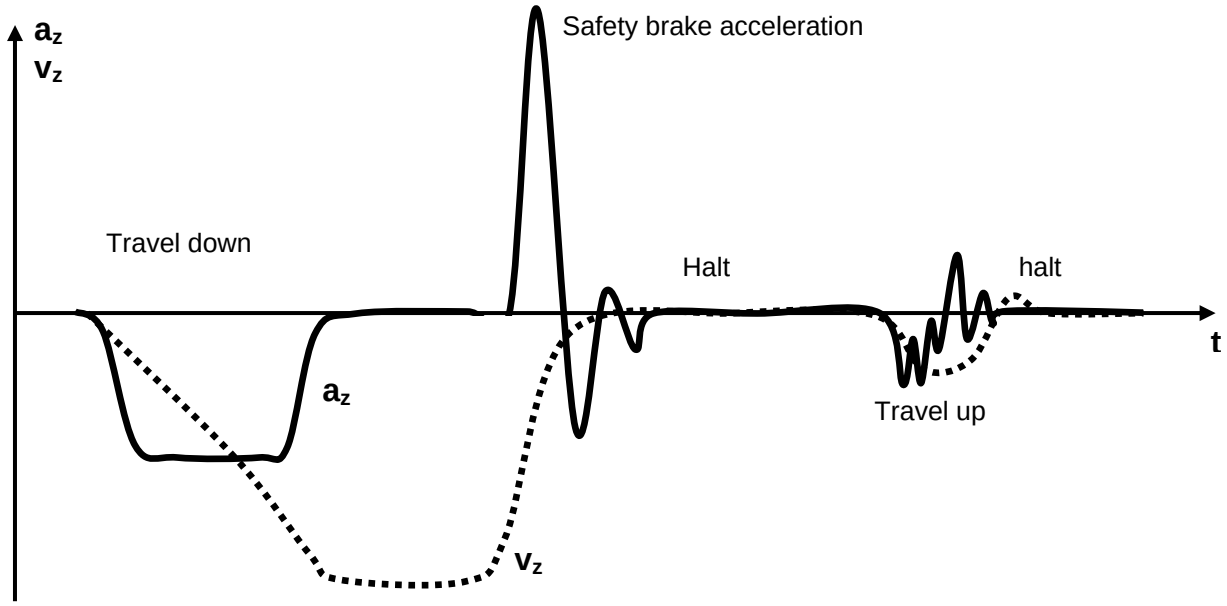


Figure A8: Downward travel, safety braking process and further travel to the stop

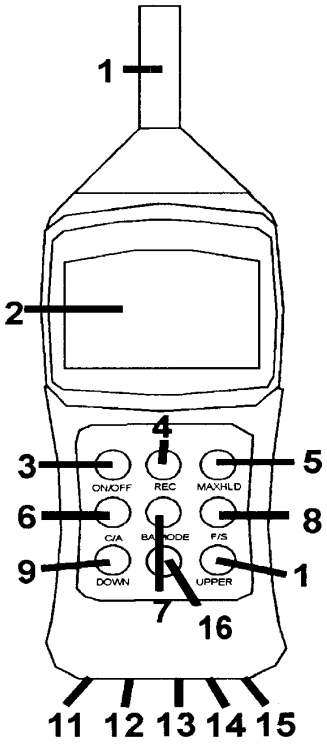
The safety braking process always gives a positive impulse with an acceleration value which is clearly > 2 m/sec². Furthermore the integral furnishes over the impulse a velocity value which corresponds approximately to the velocity reached up to that moment and, therefore, can easily be distinguished from interference impulses.

9 Digital Sound Level Meter Model 8921/8922

The digital sound level meter has an automatic and a manual measuring range selection with six measuring ranges from 30 dB to 130 dB with a resolution of 0.1 dB. The device meets the standards ANSI S1.4 and IEC 651 Type 2.
A special feature is the possibility to compensate the background level by key depression and to assess deliberately noise sources in the foreground. By means of two assessment filters (A or C) the sound level can be weighted according to IEC standard. Furthermore, it is possible to determine the maximum and minimum value for one measuring period.
The sound level meter is fitted with female connectors for the supply of external components, an audio outlet, an envelope curve outlet as well as a digital RS232 interface for the data transfer to a computer.

9.1 Description front view

1. **Microphone**
2. **LCD Display**
3. **ON/OFF - On/off key**
4. **REC - Measurement value recording**
5. **MAXHLD - Maximum value storage**
6. **C/A - IEC assessment filter**
7. **BA MODE - Background clipping**
8. **F/S - Measuring interval setting**
9. **DOWN - Measuring range selection**
10. **UPPER - Measuring range selection**
11. **DC 9V - External power supply**
12. **CAL - Calibration**
13. **AC OUT - Audio outlet**
14. **DC OUT - Envelope curve outlet**
15. **RS232 - RS 232 interface**
16. **BACKLIT - Display light (only Type 8922)**



9.2 Sound level measurement

Press ON/OFF to switch on the meter. When switched on the unit briefly goes into a self diagnosis mode and all segments on the display are switched on. An initialization phase follows in which the meter counts down on the display.
Now, actuate the DOWN key until the value 30 appears on the left side besides the bar display and the measuring mode (on the left side below the bar display) has changed from AUTO to MANU. Only then will the meter start to measure the current level values. Direct the microphone towards the noise source to be measured.
The sound level is represented both numerically in a seven segment display and graphically in a bar display. The numerical value is updated every 160 ms. Every 40 ms the bar display shows the current level values.

9.3 Selection of A or C weighting

After switching-on, the meter is in the measuring mode with the assessment filter type A. In this operating mode the signal spectrum is assessed according to the feeling of the human ear.
The assessment filter type A should be used in the case of environmental measurements or for measurements at the workplace. In particular, this filter should be used if sound level measurements in the scope of the legal noise control regulations are carried out.
The assessment filter, type C, is above all advantageous for the lower measuring ranges. The signal spectrum is linearly assessed. The assessment filter C is for example suitable for the sound analysis of motors and machines.
To change over between these two assessment filters the C/A key is used. The current assessment filter is displayed by an A or C on the right side of the display.

9.4 Selection of the rise time

Using the **F/S** key the response time of the display can be changed over from fast to slow behaviour. The selected operating mode is displayed on the right side of the display.
After switching-on the meter is in the fast mode.

9.5 Storage of the maximum sound level

Actuate the key **MAXHLD** during the measurement in order to save the measured maximum value on the display. In the lower area of the display the operating mode **MAX HOLD** is displayed. This brings up the maximum measured sound level value on the numerical display. The bar display continues representing the current values of the sound level.
In order to exit this mode, once again actuate the key **MAXHLD.**

9.6 Determination of minimum and maximum sound level

Switch on the meter.
Afterwards actuate the **REC** key. In the lower area of the display the indication **REC** appears. The meter now starts to determine the maximum and the minimum sound level value.
Afterwards once again actuate **REC**. On the display the indication **MIN** appears and on the numerical display the minimum measured value is displayed. The evaluation is interrupted. The bar display continues representing the current measurement value.
Now press **REC** a second time, then the maximum sound level is displayed on the numerical display, as well as the indication **MAX**. On the seven-segment display the meter now shows the maximum measured value. However, the bar display continues to show the current data in an analogue form.
If you actuate the **REC** key for about 5 seconds, the recording is interrupted and the meter is again in the normal measuring mode. If you press **REC** again, you can start a new evaluation.

9.7 Suppression of the background sound level

With the help of this special function it is possible to determine the sound level of individual machines, even while in the background a latent noise level exists.
Press **ON/OFF** in order to switch your meter on.
Actuate the **MAXHLD** key. This will be confirmed on the display.
Afterwards actuate the key **BA MODE**. On the display appears **F** besides the indication **SPL** and the display **MAX HOLD** goes out. Now, on the display the sound level of the background noises is displayed.
Now, actuate the key **MAXHLD** again. On the display appears again **MAX HOLD** for confirmation and the meter is ready to assess the sound source in the foreground.

Now switch on the machine the sound level of which you want to measure. The value shown in the display corresponds to the sound level generated by the machine alone, i. e., without the background noises. If the display does not change, the ambient noises are louder than the those of the sound source to be assessed. In order to exit the measuring mode "Background suppression" actuate the key **MAXHLD** and then **BA MODE**. Afterwards the meter is in the normal measuring mode.

9.8 Display light (only for type 8922)

With key **Backlit** the display can be illuminated for about 5 seconds in order to facilitate the reading in the case of poor lighting conditions.

9.9 Automatic or manual measuring range selection

The instrument has six measuring ranges of 10 dB steps: 30~80 dB, 40~90 dB, 50~100 dB, 60~110 dB, 70~120 dB, 80~130 dB.
After switching-on the measuring instrument is in the mode "Automatic range selection". This is shown on the left side of the display (**AUTO**).
The current measuring range can be recognized by means of the two digits at the left side above the bar display. It is also possible to determine the measuring range manually. This can be helpful in order to prevent a change-over of the display during measurement.
For the manual setting the keys **DOWN** and **UPPER** are used. In the "manual mode" **MANU** appears on the display. The current range is represented by the figures below the bar display.
If the **DOWN** or **UPPER** key is pressed for 2 seconds the instrument switches back to "Automatic range selection".
In the mode "Manual range selection" the indication **UNDER** appears on the display, if the measured sound levels are too low for the selected measuring range. When exceeding the measuring range the indication **UPPER** appears on the display. In both cases you have to select the measuring range once more in order to obtain valid values.

9.10 Auto-Off function

After 20 minutes operating time the measuring instrument automatically switches off because of the energy saver function. This can be changed when switching-on the instrument: First switch off the instrument. Press the **MAXHLD** key and keep it pressed while switching-on the instrument. As soon as an **n** appears on the display you may release the **MAXHLD** key. Hereby the auto-off function is deactivated and the instrument can only be switched-off using the **ON/OFF** key.
For measurements taking more time we recommend the use of an external power supply unit. When the instrument is next switched-on the auto-off function is reactivated.

9.11 Replacement of battery

When the display blinks and the message **BAT** appears, the 9 Volt battery is run-down and should be exchanged as soon as possible. Unscrew the cover of the battery chamber on the rear side of the instrument using a screw driver. Insert a new battery and replace the cover.

9.12 Serial interface

The output of the measurement values is made as a continuous ASCII string in the unit of measurement chosen on the instrument. Line closing is made with CR and LF.

Interface parameter: 2400BD8N1

Output: N:044.5dB <0D, 0A>
Interface parameter : 2400BD8N1
Output: N:044.5dB <0D, 0A>

9.13 Technical data

Standards	IEC 651 Type 2 ANSI S1.4 Type 2
Evaluated frequency spectrum	31.5 Hz ~ 8 kHz
Accuracy	± 1.5 dB
Evaluation filter A measuring range	30 dB ~ 130 dB
Evaluation filter C measuring range	35 dB ~ 130 dB
Measuring ranges	6 ranges in 10 dB steps: 30~80 dB, 40~90 dB, 50~100 dB, 60~110 dB, 70~120 dB, 80~130 dB
Automatic measuring range selection	30~130 dB
Weighting	fast or slow
Measuring span	50 dB per measuring range
Digital display	3 ½ digit LCD 0.1 dB resolution updated every 160 ms

Quasi-analogue bar display	1 dB display step 50 dB display range updated every 40 ms
Microphone	6 mm Electret condenser microphone
Analogue output	AC: 0.707 V_{rms}; DC: 10 mV DC/dB
Serial interface	2400BD8N1 N:044.5dB <0D, 0A>
Dimensions	80 mm x 256 mm x 38 mm
Weight	240 g
Operating conditions	4 ~ 50° C, 10 ~ 90% RH
Storage temperature	-20° ~ 60° C
Power supply	9 V Battery Alkali
Operating time using 9 V alkali battery	approx. 20 hours
Scope of delivery	User instructions, battery and carrying case
Extras	Software PCLOG with Interface cable, power supply unit 9 V stabilized