

## D "ZLM Distance" - Dynamic Measurement Software

With this program module the distance, velocity and acceleration data of a test object can be recorded and analysed.

This section describes the basic measurement procedure, which comprises three steps: **Preparation** (subsection D3), **Measurement** (D4), and **Analysis** (D5).






The **archiving** of measured data and **printing** of results are not part of the "ZLM Distance" measurement program. For these functions, see the "Cardfile" and "Document" program modules described in sections K and L of this manual.

### D 1 Starting the "ZLM Distance" program module

When the "Esox" management program is started, the "ZLM Distance" program module is not active yet. To start this program module,

1. activate the "ZLM" application window (as described in detail in Section "C 3 Starting measurement programs") and open it to regular or maximized size.

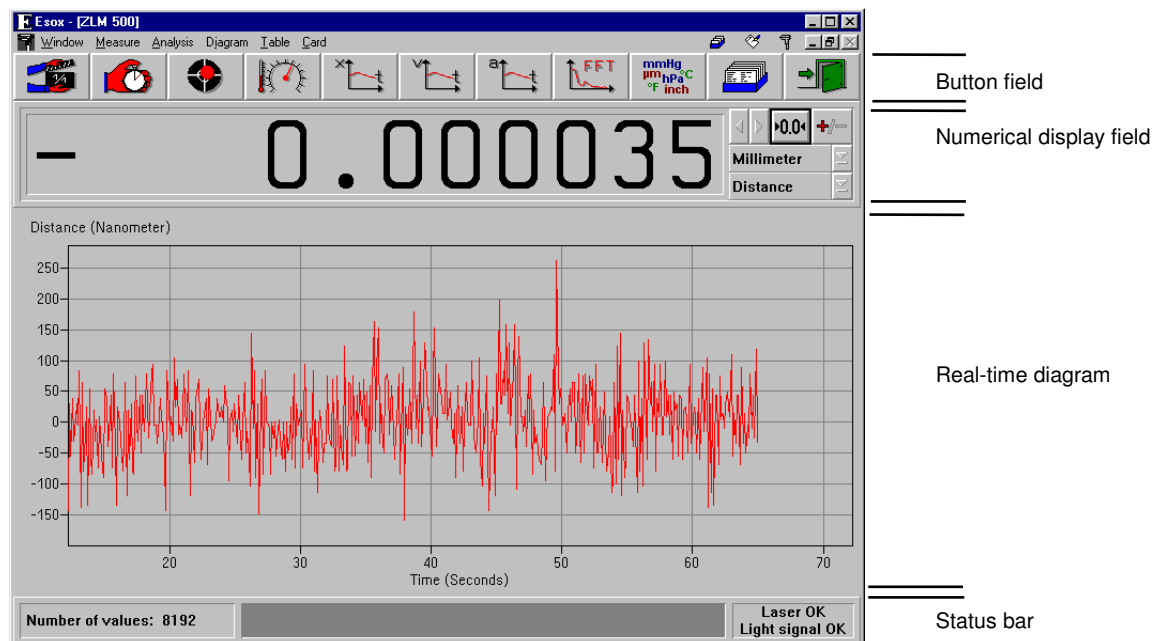
2. Now, either double-click the "ZLM Distance" icon with the mouse or use the keys

, , , or  to activate this icon and then press the  key.

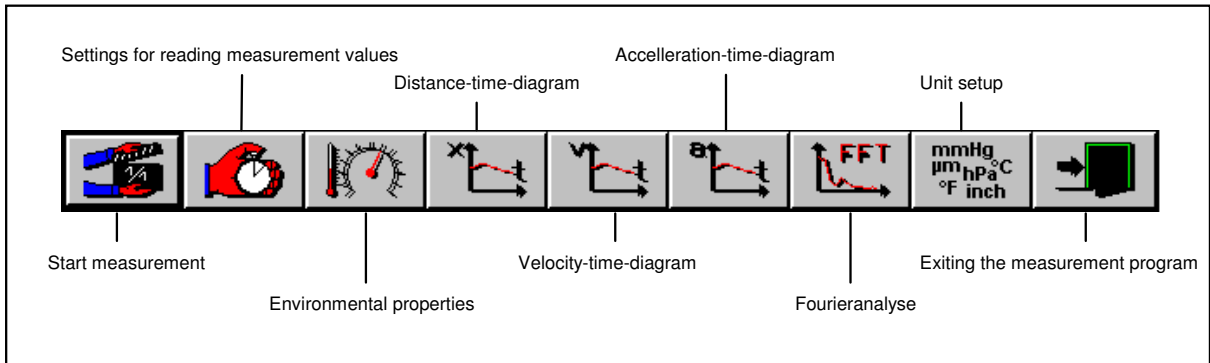
### D 2 Elements of the "ZLM Distance" window

If you want to work with the "ZLM Distance" measurement program for a longer time, we recommend to maximize its window after having started it.

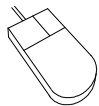
Within the window four fields can be distinguished:



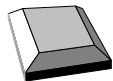
### D 2.1 Button field





With these buttons you can activate specific functions of the program, such as start of data recording, setting options for data recording, and data evaluation by diagrams. All these functions can also be started via menu commands. They are explained in detail in the following subsections.



Clicking a button with the mouse activates the function assigned to this button.



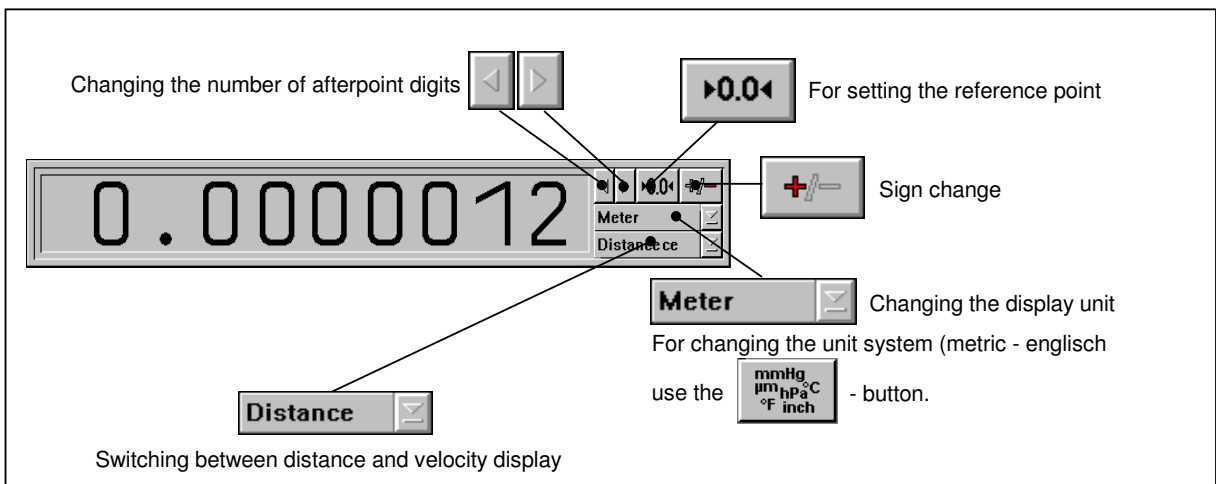
On program start, the first (left) button  is made active as is indicated by the

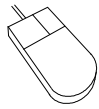
thicker black frame around it. By pressing the  key you can make the next button active. The function assigned to the active button is released by pressing the  key.





### D 2.2 Numerical display field

The numerical display field shows the current distance or velocity. The displayed numerical value is updated 10 times per second unless the computer is overloaded by other tasks.

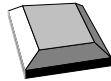
Several operating elements are located at the right margin of the numerical display field.







The button functions ( , ,  or  ) are released by clicking the button with the mouse.




To change the active option in a drop-down list box, click on the underlined arrow right of the list box. This opens the list box and allows you to click the desired option.




Press the  key until the wanted list box or button is marked and thus active. Active

buttons are displayed with a thicker black frame around the button ( , ,  or

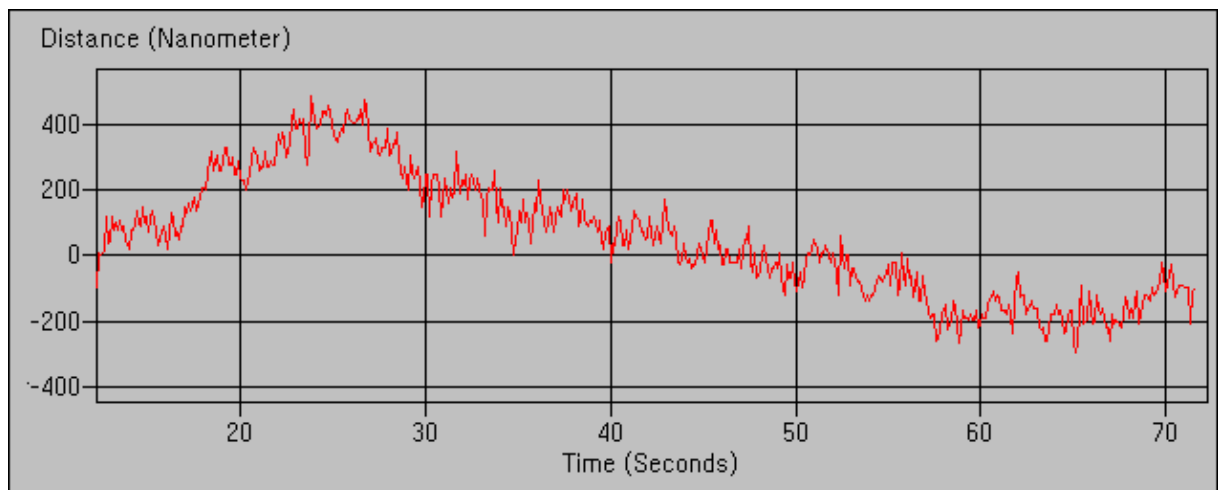
 ). Active list boxes are marked by highlighted entries. To open the pull-down list,

press the key combination **Alt** + . By pressing the  or  keys you can choose


the wanted option. To confirm your choice, press the  key.

To release a button function, press the  key.

### D 2.3 Real-time diagram



The real-time diagram presents the distance as a function of time for the last 60 seconds approximately. The current distance value is added 10 times per second unless the computer is overloaded by other tasks. The scale graduation is automatically determined from the measured data, so you need not preselect it.

Any change of the sign with the  button has an effect also on the measured data recorded before and is reflected by the diagram.


### D 2.4 Status line



At the left end of the status line you will see the number of measured data currently stored in the memory (This figure refers to the number of permanently stored data, not to those of the real-time diagram). In the middle of the status line you can find a bar that indicates how many of the preselected number of readings have currently been taken. At the right end of the status line there is a field telling you whether the laser is stabilized or not. With program functions taking a longer time, such as measurements or fast Fourier transformation, the appearance of the status line changes as will be described in detail in the respective sections of this manual.

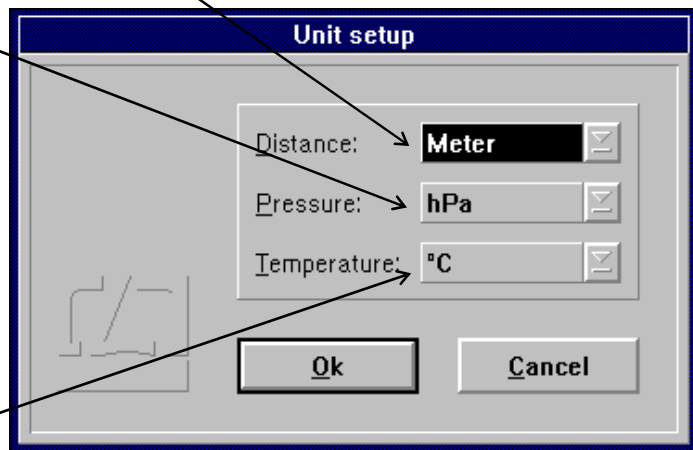
## D 2.5 Unit systems

Units of distance, atmospheric pressure and temperature can be selected in the **"Unit setup"** dialogue box.

Open this box by clicking the  button or selecting the **"Units"** option of the **"Measure"** menu.

The program can show distances and quantities derived from them in either metric (metre) or imperial (Inch) measure. Switch between them in the **"Distance"** list box.

In the "Pressure" list box you can select between "Hectopascal" and "Millimetre mercury".  
(1000 hPa = 100 kPa = 1000 mbar,  
and  
1 mmHg = 1 torr)



In the "Temperature" list box you can select between "Degree Celsius" and "Degree Fahrenheit".

If you selected a metric or imperial unit for the numerical display of the current reading, the same unit will also be used for the diagrams.

## D 3 Preparation for a measurement

The data displayed numerically and in the real-time diagram will not be saved permanently, nor can they be analysed any further. Analysable data will only be read in and stored upon a specific command.

Whenever mention is made below of the acquisition or recording of measurement data (readings), this means the acquisition of data to be permanently saved.

In preparation for a measurement you need to specify

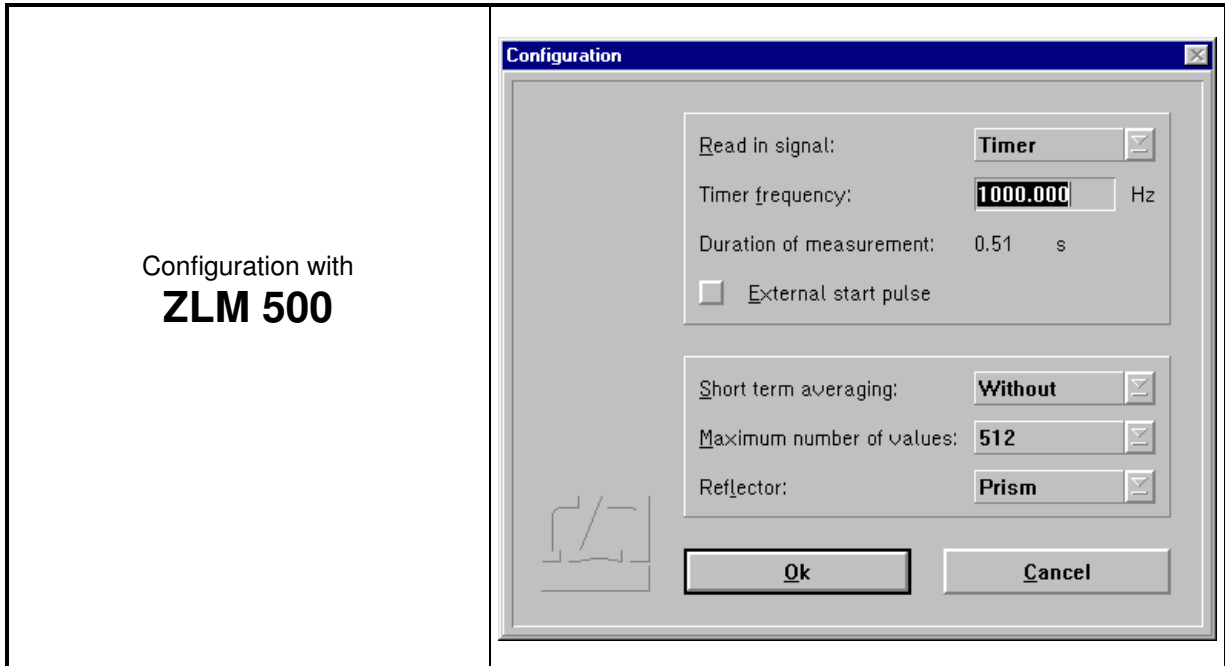
- the time at which the readings are to be taken,
- the type of interferometer used,
- the maximum number of readings to be taken, and
- the required mode of compensation for environmental influences.

For this purpose, use the "Configuration" and "Environment" dialogue boxes.



### D 3.1 Parameter setting for measurement data acquisition

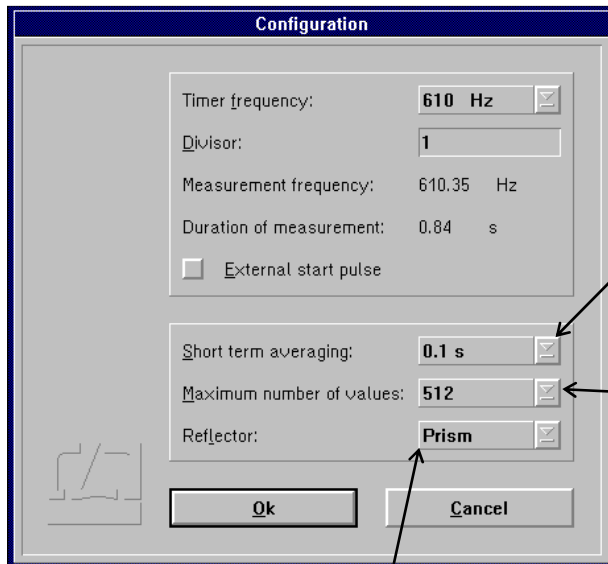
Access the "Configuration" dialogue box by opening the "Measure" menu and choosing the "Configuration" option or by clicking the  button.

Select the times for data reading in the top part of the dialogue box. You need to choose between three possible trigger sources for data reading.



Configuration with  
**ZLM 500**

<p><b>Triggering by the timer</b></p>	<p>In the drop-down list box "<b>Read-in signal</b>" select the "<b>Timer</b>" entry. In the "<b>Timer frequency</b>" dialogue box enter the desired frequency of readings. The button "<b>External start pulse</b>" determines which event is to trigger the measurement.</p> <p>When this <input type="checkbox"/> button is not checked:</p> <p>The measurement is started by activating the "<b>Measure</b>" menu and choosing the menu option "<b>Start measurement</b>" or by clicking the  button.</p> <p><input checked="" type="checkbox"/> button is checked:</p> <p>The measurement is started by an external trigger pulse connected to the respective input. Annex I shows where the respective external signal lead must be connected to.</p>
<p><b>Triggering by an external read-in signal</b></p>	<p>In the drop-down list box "<b>Read-in signal</b>" select the "<b>External</b>" entry. Annex I shows where the external signal lead must be connected to.</p> <p>The "<b>External start pulse</b>" button has no function in this mode.</p>
<p><b>Triggering by pressing the  of the keyboard</b></p>	<p>For this mode open the drop-down list box "<b>Timer frequency</b>" and choose the option "<b>Space bar</b>".</p> <p>The "<b>Divisor</b>" and "<b>External start pulse</b>" settings will be ignored by the program in the measurement.</p>



In static measurements, the program can filter out vibrations by time averaging. The time over which an average is to be obtained can be set in the "**Short term averaging**" list box. In dynamic measurements, however, use the entry "**without**".

The pull-down list box "**Maximum number of values**" displays the number of measured values to be read before the software stops a measurement automatically. Of course, you can stop a measurement by command at any time before this number of values has been reached. Section "D 4.3 Cancelling the measurement" contains detailed information on this topic. The options, i.e. the numbers of readings listed in the pull-down list box "Maximum number of values", allow Fourier analysis to be carried out as efficiently as possible.

In the pull-down list box "**Reflector**" choose the interferometer type used. With cube corner reflector interferometers, choose the option "**Prism**", and with plane mirror interferometers choose the option "**Mirror**". The **Manual on the basic equipment** describes the design of these interferometers and their properties.

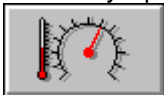
### D 3.2 Compensation of environmental influences

The accuracy of a distance measurement made with a laser interferometer depends on whether the refractive index of the ambient air is known and allowed for. The ZLM Distance program can compute the refractive index from properties of the atmospheric environment and correct the measurements accordingly.

The ZLM Distance software can further allow for the thermal expansion of the test object as a function of its temperature, and correct the measured data so that they represent the readings that would have been obtained with the test object having a temperature of 20 °C.

The necessary settings can be made in the "**Environment**" dialogue box.

This is accessible by opening the "**Measure**" menu and choosing the "**Environment**" option, or by

clicking the  button.

All the settings made in this box have an effect both on the taking of readings as well as on the numerical display and the real-time diagram.

### D 3.2.1 Atmospheric properties

In the top part of the "Environment" dialogue box you can choose how to compensate for the effects of atmospheric properties on the refractive index and thus on the measured result.

**Manual Correction** Choose the "**Manual**" option of the pull-down list box "**Correction type**". You will have to enter the atmospheric properties in the respective text boxes.



Keys that facilitate inputs:

Coarse setting - and

Fine setting - and



1. Move the mouse pointer to the field where you want to make an entry.
2. Press the left mouse button and keep it depressed.
3. Drag the mouse until the thermometer column or the pointer indicates the desired value.
4. Release the mouse button.

Consult Annex III for information about the accuracy required for the measurement and entry of atmospheric properties.

**Automatic Correction** When you use the AUK 500 Automatic Environment Detector to measure the atmospheric properties, choose the option "**Automatic**" of the pull-down list box "**Correction type**".

The screenshot shows the "Environment" dialog box with the following details:

- Properties of air:**
  - Correction type: **Automatic**
  - Temperature: 22.1 °C
  - Pressure: 985 hPa
  - Humidity: 49%
- Expansion:**
  - Correction type: **Automatic**
  - Coefficient of expansion: 11.0  $\times 10^{-6} \text{K}^{-1}$
  - Expansion 1: 22.7 °C
  - Expansion 2: 22.3 °C
  - Expansion 3: 22.7 °C
  - Expansion 4: --- °C
  - Expansion 5: --- °C

### D 3.2.2 Material temperature

In the bottom part of the "Environment" dialogue box you can choose whether and how the measured values are to be corrected for thermal expansion (material temperature). With correction activated, the readings are converted into readings that would be obtained at a material temperature of 20 °C.

**Without correction** If you want to work without this correction, choose the option "**None**" of the pull-down list box "**Correction type**".

**Manual correction** If you want to enter the material temperature manually, choose the option "**Manual**" of the pull-down list box "**Correction type**".

In the text box "**Coefficient of expansion**" type in the linear expansion coefficient of the test object.

The material temperature can be entered in the same way as the manual entry of atmospheric temperature (see Section "D 3.2.1 Atmospheric properties").

**Automatic correction** If you want to use the AUK 500 Automatic Environment Detector for compensating the errors due to material expansion, choose the option "**Automatic**" of the pull-down list box "**Correction type**".

In the temperature display boxes, temperature sensors that are not connected are indicated by "---". In the figure, material temperature sensors 4 and 5 are not connected.

You have the possibility to select from the available sensors those you want to use for the correction. For this purpose, every temperature display field has a button at the top left.

Button is not checked:

The respective material temperature sensor is excluded from correction and - on colour screens - the temperature value is displayed in grey instead of in black colour. In the figure, material temperature sensors 2 and 5 are not included in the correction of material expansion.

Button is checked:

The sensor reading enters the correction if the sensor is connected.


With automatic correction activated, the program reads the data of the material temperature sensors once per second. The program computes the mean value of all the measured values of the sensors that are connected and activated via the respective button of the display field. This value is used by the program to correct the data for material expansion.

If none of the sensors is connected and activated, the measured values are not corrected. In the example shown in the figure, the mean value of the temperatures detected by sensors 1 and 3 is used for the correction. Sensors 4 and 5 are not connected. Sensor 2 is deactivated.

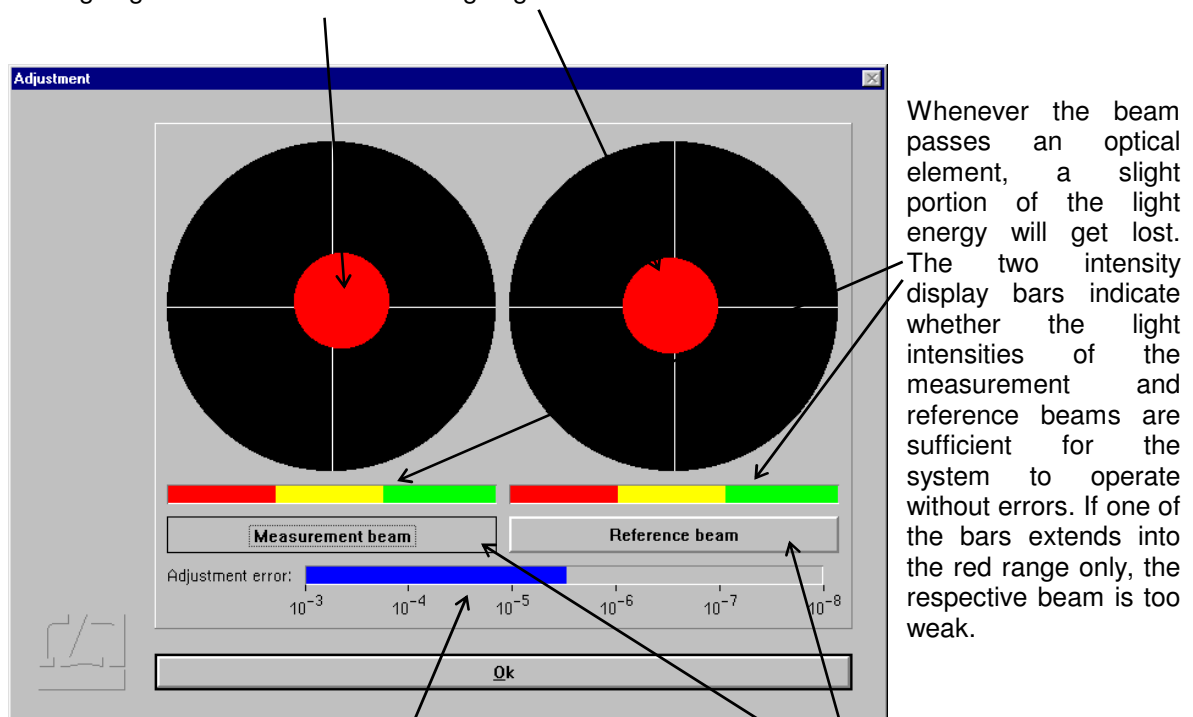


### D 3.3 Laser aligning aid

The laser head of the ZLM 500 contains two quadrant detectors. This feature allows alignments to be made and aligning errors to be estimated even over great distances.

Click the  button to open the "Alignment" window.

The upper two fields in this window indicate the positions of the re-entering measurement and reference beams. In a standard setup, the left-hand figure represents the measurement beam, and the right-hand one the reference beam. When aligning the laser, try to keep the two red spots at the centres of the crosshairs throughout the distance travelled. See the Basic Equipment manual for the aligning elements to be used for aligning the laser head.



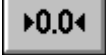
When the measuring reflector is moved, the program can compute the alignment error from the change in position of the returning beam portions and the distance travelled. An alignment error of  $1 \cdot 10^{-6}$  means that misalignment between the laser beam and the travelling path causes a measurement error of  $1 \mu\text{m}$  per 1 m of distance. This alignment error is allowed for and displayed at every reversal of the travelling direction. In order to obtain highly reliable information on alignment, move the measuring reflector back and forth several times without keeping it at prolonged standstills between the strokes.

The ZLM 500 Laser Interferometer operates at two different wavelengths. In precise measurements ( $< 1.4 \mu\text{m/m}$ ), you need to tell the program which beam is used as the measurement beam. To do so, simply intercept the measurement beam with your hand, so that one of the two red spots disappears from the screen. Click on the button on the respective side so that it reads "Measurement beam". With a standard optical arrangement, the measurement beam is invariably shown on the left side.

## D 4 Measurement procedure

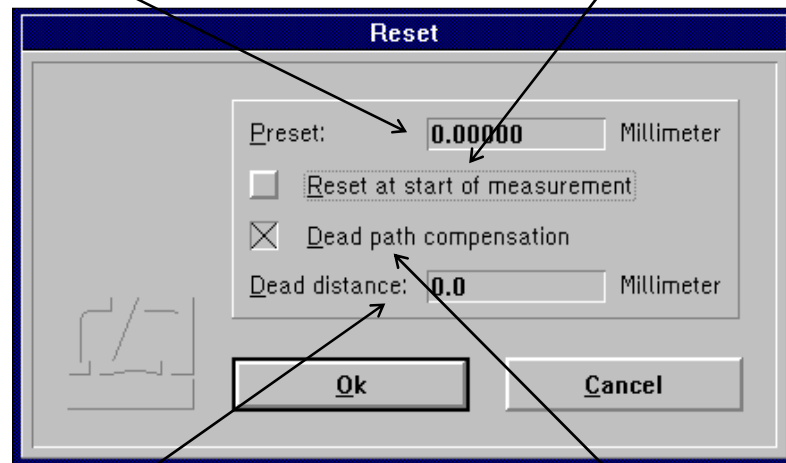
The ZLM 500 Laser Distance Measuring System is a "relative" measuring system. A defined position of the test object is assigned a certain distance value. The measured values are read and indicated relative to this position. Therefore, this reference point must be set before any measurement is taken.

### D 4.1 Setting the reference point and specifying the dead distance

For setting the reference point, move the test object to the reference position. Then either activate the  button or choose the "Reset" option of the "Measure" menu. The screen displays the "Reset" dialogue box.

In the "**Preset**" text box you can preset the distance value to be assigned to the present position.


If the button "**Reset at start of measurement**" is on , the preset value will be assigned to the instantaneous position at the time you start a measurement.






In the "**Dead distance**" box you can enter the distance between the reflectors. See Annex III for a detailed explanation of the term "dead distance".

The dead distance is of significance only in high-accuracy measurements with the environmental properties changing during the measurement. If you specify a dead distance, mind the correct sign. Specify the dead distance so that, after resetting, the sum of measurement readout and dead distance has always the same amount as the distance between the two reflectors.

If it can be assumed that the environmental conditions will not change during a measurement, the "**Dead path compensation**" button can be switched off ().

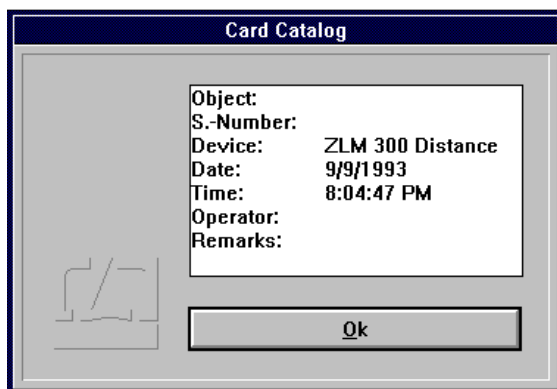
The reference point is only assigned when the  button is activated.

## D 4.2 Starting the measurement

You can start a measurement by opening the "Measure" menu and choosing the "Start measure" option or by clicking the  button. While the measurement is running, the status bar indicates the number of readings currently taken. The display of laser stability at the right end of the status bar is replaced by the  button. This button is active, as indicated by its black frame, so that the measurement can be stopped immediately by clicking this button with the mouse, or by pressing the -key.




In the case of measurements over longer periods, you can switch to other program modules or run other MS-Windows programs.


After a successful measurement, the measured values are saved on a card of the card file. For this purpose, a dialogue box "Card Catalog" is displayed, containing already entries for the measuring instrument used and the date and time of the start of the measurement. You can type in the remaining items via the keyboard.



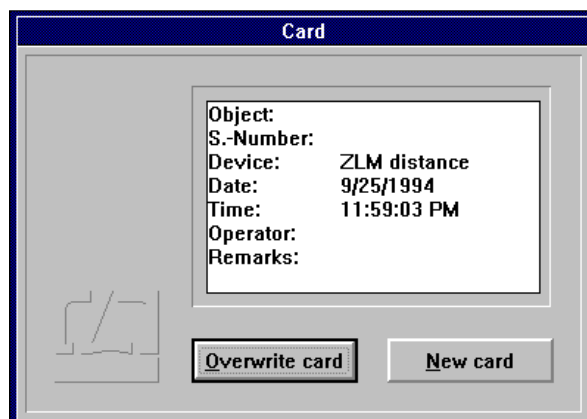
Annex II contains the list of special function keys and key combinations for typing in text boxes.

Additionally, the following keys can be used:

-  -moves the text cursor to the next entry of the file card in the same line.
-  -moves the text cursor down to the next entry of the file card.
-  -moves the text cursor up to the previous entry of the file card.


On clicking the  button, the file card is created. Filing of file cards is handled by the "Cardfile" program module (see Section K).

If a card already exists in the main memory, the program provides the possibility to overwrite this card with new measured values.



### D 4.3 Cancelling a measurement

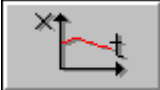
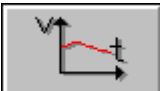
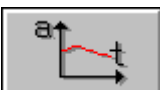

In the following cases the program cancels the measurement before all readings have been taken:


- The laser is unstable or becomes unstable while the measurement is running.
- The light power at the receiver is too low or becomes too low while the measurement is running.
- You have cancelled the measurement by clicking the  button.

You have the option of saving the readings taken until the moment of cancelling the measurement.

### D 5 Analysis of a measurement

The measurement is analysed in the form of diagrams. Four different types of diagrams can be created. For every diagram type a button is available in the button field at the top margin of the window. In addition, corresponding menu options are accessible via the "Analysis" menu.

Type of diagram	Activation
Distance-vs.-time diagram	 button or "x-t diagram" option of "Analysis" menu
Velocity-vs.-time diagram	 button or "v-t diagram" option of "Analysis" menu
Acceleration-vs.-time diagram	 button or "a-t diagram" option of "Analysis" menu
Fourier analysis (amplitude-vs.-frequency diagram)	 button or "Fourier analysis" option of "Analysis" menu

If measurement data acquisition is triggered by external read-in signals or by pressing the keyboard's , the program cannot assign a time to the individual readings. Therefore, on the abscissa of the diagrams the point number is plotted in place of the time and - with Fourier analysis - the unit "per point number" in place of frequency.

### D 5.1 Controls for diagram handling

After calling a diagram the measurement program window is completely changed. Abscissa and ordinate are scaled automatically by the program.

The options include zooming of defined sections of the diagram, marking of points on the diagram to display the individual measured values numerically, and plotting of new diagrams from sections of the "mother" diagram. With the option buttons at the top left you can choose the action to be taken next

The buttons allow


the indication of statistical data,

the opening of a table of measured data,

the transfer of diagram and table into a record, and

quitting the diagram presentation.

With the scroll bars the visible diagram section can be moved.

To move from one button to the next, press the  key.

In addition to these controls, you can also use some submenu items of the "Diagram" and "Table" main menus.

### D 5.2 Zooming of diagram sections

The option button "**Zoom**" or the "**Zoom mode**" option of the "**Diagram**" menu permits a section of the diagram to be magnified for viewing more details.