






F "ZLM Synchron" - Dynamic Measurement Software

The "ZLM Synchron" program module combines the capabilities of the distance and angle measuring modules. It can acquire and analyse distance, velocity, acceleration, angle and angular velocity measurement data. The software can be used in conjunction with distance and/or angle measuring optics of standard or enhanced resolution, as well as with 2m or 10m straightness optics. The program module is primarily intended for multi-axis interferometer arrangements. The quantity to be measured and the optics used can be individually selected for each axis involved.

This section describes the basic procedure, which comprises three steps: **Preparation** (subsection F4), **Measurement** (F5), and **Analysis** (F6).

F 1 Starting the "ZLM Synchron" program module

When the "Esox" management program is started, the "ZLM Synchron" program module is not active yet. To start this program module, proceed as follows (see also the detailed description in section C 3 "Starting measurement programs"):

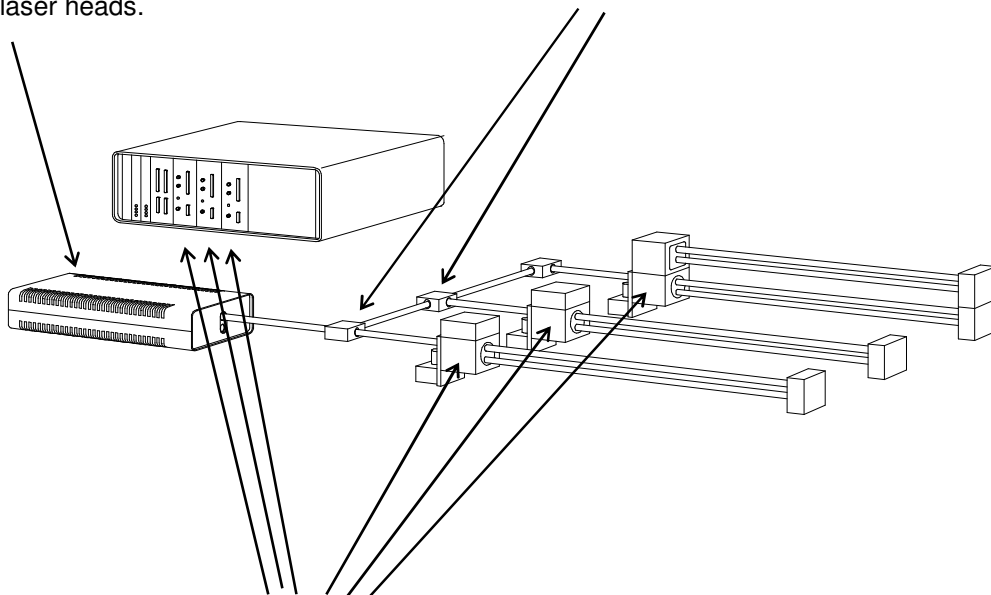
1. Activate the "ZLM" application window and open it to regular or maximized size.
2. Either double-click the "ZLM Synchron" icon with the mouse or use the keys , , , or  to activate this icon, and then press the  key.

F 2 Measuring axes and channels

The "ZLM Synchron" measurement program is generally sold in conjunction with a multi-axis measuring system.

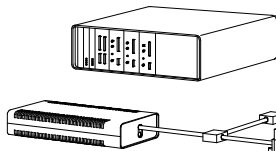
Such a system may include either one or several laser heads.

The laser beam is divided by beam splitters.



You need one interferometer and one counter card for each measuring axis.

Measurement data can be formed from the counter reading of one measurement axis or from a combination of the counter readings of several measurement axes.



An angle measurement, e.g., can be carried out with one optical angle measuring component

or

by computing the angle from the counter readings of two axes equipped with distance measuring components.

The program uses the term "channel" for all measurement data acquired and displayed. This is because the data measured in one channel may be compiled from the counter readings taken along several measuring axes.

F 3 Elements of the "ZLM Synchron" window

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

Within the window the following areas can be distinguished:

The screenshot shows the ZLM Synchron software interface. At the top, there are three display and setting boxes for different channels, each showing a numerical value (0.089, 0.079, and Off) and units (Distance, Microns). Below this is a large numerical display field showing 0.089. The main area is a real-time diagram showing two data series (red and green) plotted against time (0 to 60 seconds). On the right side, there is a vertical column of control buttons. At the bottom, there is a status line showing the number of values (4676) and a button labeled 'Messung abbrechen'.

Annotations on the right side of the screenshot:

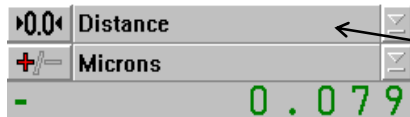
- Display and setting boxes for the various channels
- Numerical display field for a selected channel
- Column of control buttons
- Status line

Annotation on the left side of the screenshot:

- Real-time diagram

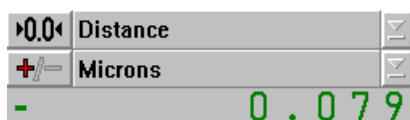
F 3.1 Display and setting boxes

At the upper margin of the window there is an area with boxes for the most frequently used settings. At the far left you find the boxes for channel 1, with the boxes for the next channels following in succession from left to right. The number of channels is preconfigured to match the number of measuring axes. Further settings for the channels can be made in the "Configuration" dialog box. These are described in section F 4.1 "Parameter setting for measurement data acquisition".



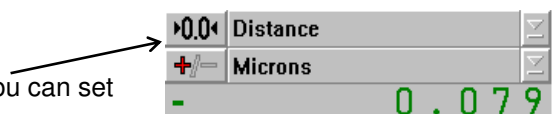
In the upper drop-down list box you can select the unit of measurement to be assigned to the channel.

List box option	Explanation
"Off"	No measured data are displayed for the respective channel. During the acquisition of data for permanent storage, this channel is ignored.
"Distance"	The n-th display from the left indicates the distance computed from the counter reading of the n-th measuring axis.
"Angle"	The n-th display from the left indicates the angle computed from the counter reading of the n-th measuring axis.
"Straightness"	Use this option if you want to measure a transverse displacement with an optical straightness measuring component at the n-th measuring axis, to be indicated in the n-th display box from the left.
"Displacement m-n"	The n-th display box from the left indicates the distance computed from the difference between the counter readings of the m-th and n-th measuring axes.
"Displacement m+n"	The n-th display box from the left indicates the distance computed from the sum of the counter readings of the m-th and n-th measuring axes.
"Angle m-n"	The n-th display box from the left indicates the angle computed from the difference of the counter readings of the m-th and n-th measuring axes via the arc tan function. You need to enter the required reflector spacing in the " Beam spacing " line of the "Configuration" dialog box for the n-th axis.



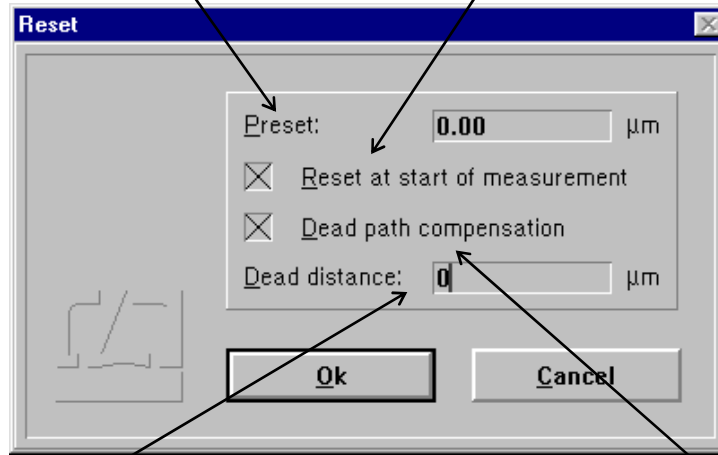
In the lower drop-down list box you can select the unit of measurement for the display. See section F 3.6 "Unit systems" for information on how to change from one system of units to another (metric or imperial measure, or degrees/minutes/seconds/radian).

Use this button to open a dialog box "Reset", in which you can set the reference point and the dead distance.



In the "**Preset**" text box you can preset the distance or angle 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.



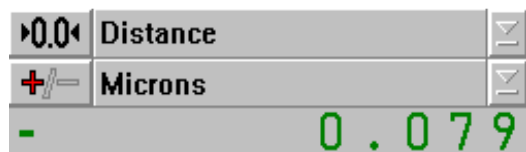
In the "**Dead distance**" box you can enter the distance between the reflectors. See Annex III for a detailed explanation of the term "dead distance".

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.

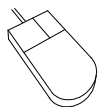
If it can be assumed that the environmental conditions will not change during a measurement, the "**Dead path compensation**" button can be switched off ()

The reference point is only assigned when the button is activated. The actions and settings made in this dialog box only act on the respective measuring axis.

With this button you can change the sign.

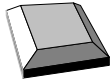










The bottom line indicates the current reading. It is updated 10 times a second, unless the computer is overloaded by other tasks.




To release a function with the or button, click on it.

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 ( or ) are displayed with a thicker black frame around the button. An active drop-down list box is marked by a highlighted (white on black ground) entry. To open the pull-down list and see the options available, press the key combination  + . 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.

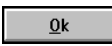
F 3.2 Large numerical display

This display box indicates the instantaneous reading of a channel with large digits. Use the drop-down list box on the right of the display to select the channel.



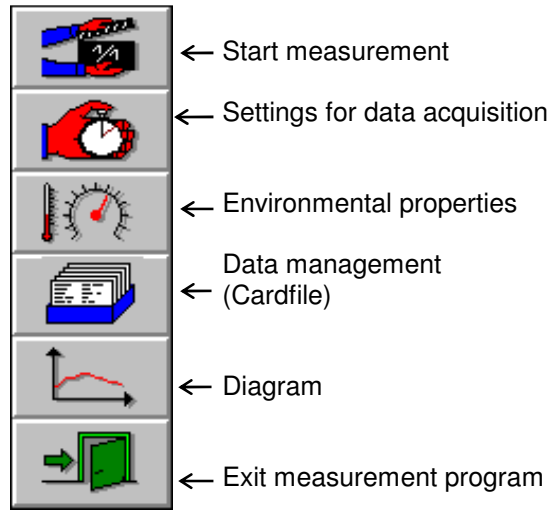
Use the button below the list box to set the reference point simultaneously for all measuring axes. Clicking this button opens the "Reset" dialog box. In this box you can make the same settings as in the Reset boxes of the individual channels, but here they act on all measuring axis simultaneously.



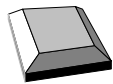
Upon actuating the  button, assignment of the reference points is made simultaneously for all measurement axes.



F 3.3 Column of buttons

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.

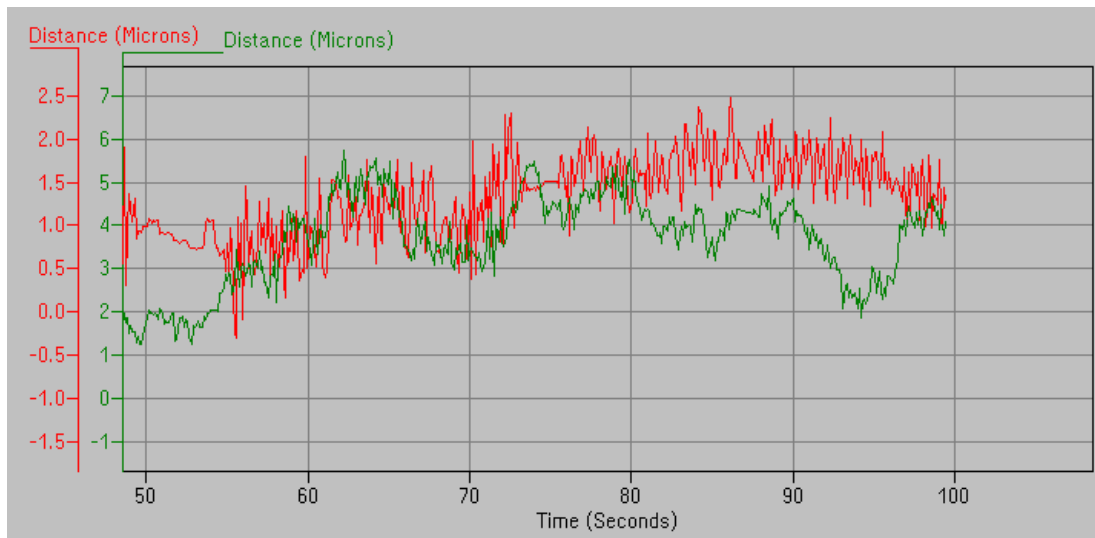


Clicking a button with the mouse activates the function assigned to this button.



(Repeatedly) press the  key until the desired button is marked as active by the thicker black frame around it. The function assigned to the active button can then be released by pressing the  key.

F 3.4 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.

F 3.5 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.

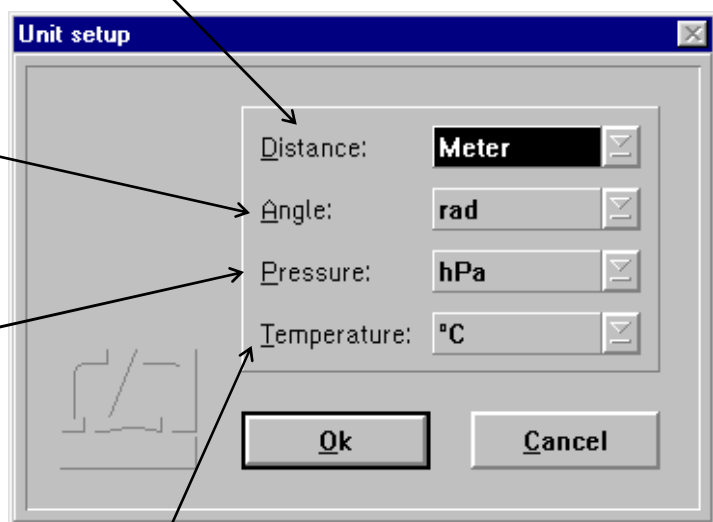
F 3.6 Unit systems

Units of distance, atmospheric pressure and temperature can be selected in the **"Unit setup"** dialog box. Open this box by 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 „Angle“ module you only need to select the angle unit (rad, degrees, minutes or seconds of arc)

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".

F 4 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 permanently saved data.

In preparation for a measurement you need to specify

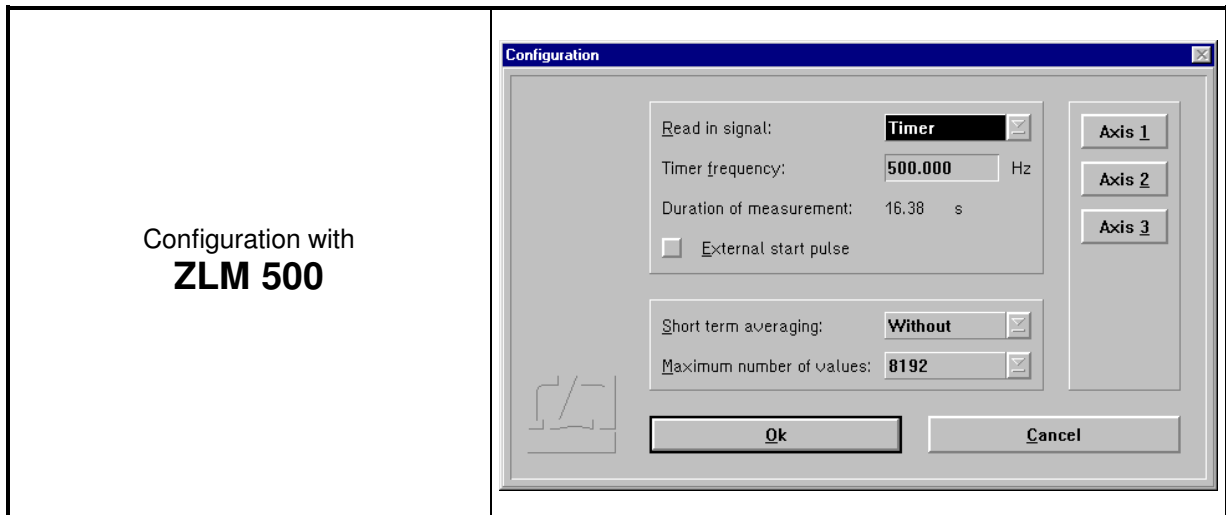
- the time at which the readings are to be taken,
- the type of interferometer used,
- the maximum number of readings to be taken, and
- the required mode of compensation for environmental influences.

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


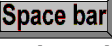
F 4.1 Parameter setting for measurement data acquisition

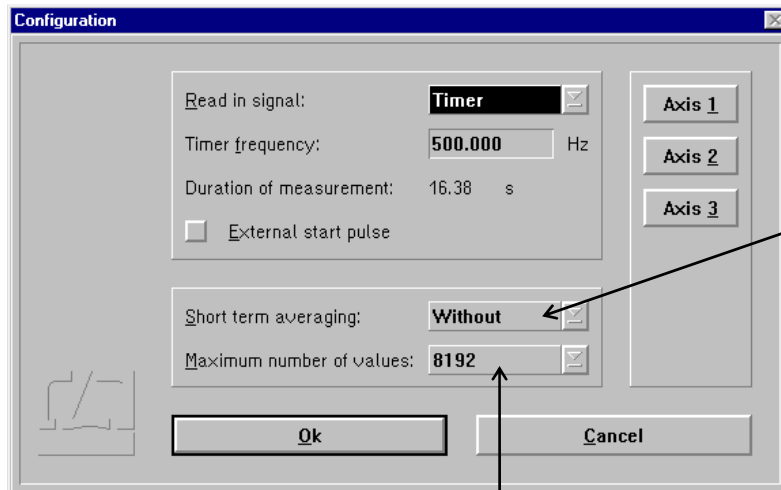
Access the "Configuration" dialog box by opening the **"Measure"** menu and choosing the **"Configuration"** option or by clicking the  button.

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



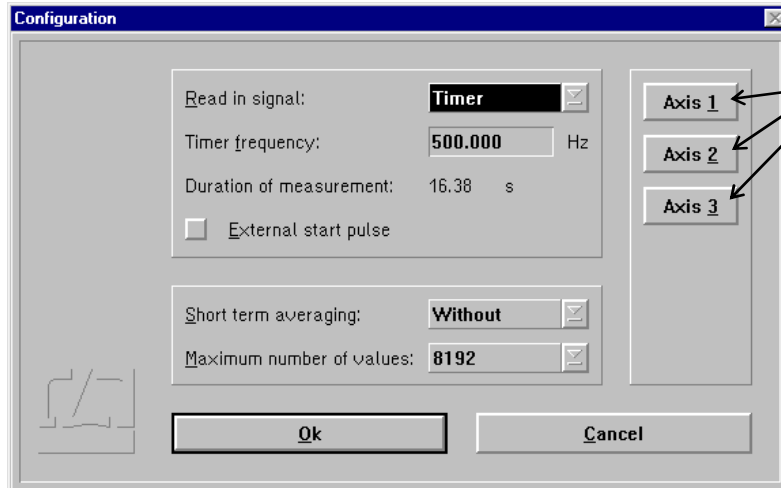
Configuration with
ZLM 500

<p>Triggering by the timer</p>	<p>In the drop-down list box "Read-in signal" select the "Timer" entry. In the "Timer frequency" dialog box enter the desired frequency of readings.</p> <p>The button "External start pulse" 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 "Measure" menu and choosing the menu option "Start measurement" 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>Triggering by an external read-in signal</p>	<p>In the drop-down list box "Read-in signal" select the "External" entry. Annex I shows where the external signal lead must be connected to.</p> <p>The "External start pulse" button has no function in this mode.</p>
<p>Triggering by pressing the  of the keyboard</p>	<p>For this mode open the drop-down list box "Timer frequency" and choose the option "Space bar".</p> <p>The "Divisor" and "External start pulse" 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"**.

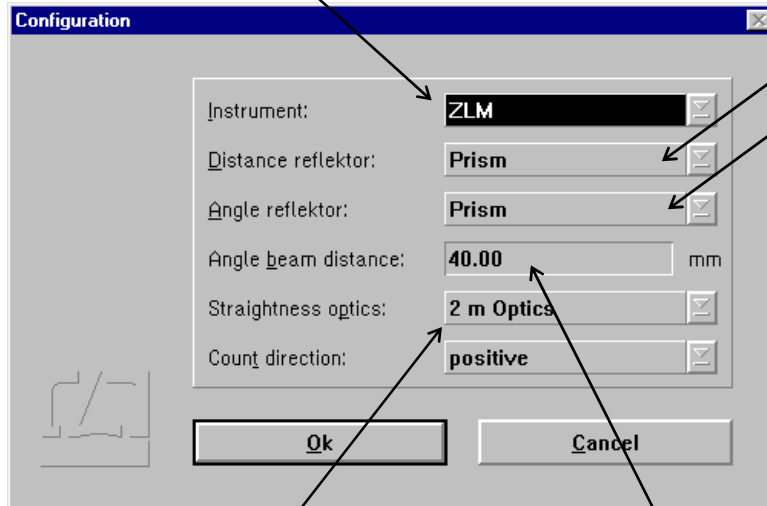
The pull-down list box **"Maximum number of values"** displays the number of measured values to be read before the software stops a measurement automatically. Of course, you can stop a measurement by command at any time before this number of values has been reached. Section "F 5.2 Cancelling the measurement" 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.



These buttons on the right allow you to make further settings for the individual measuring axes. Each button opens a new dialog field.

Apart from the ZLM 500 Laser interferometers, the measurement software can also process readings taken with incremental shaft encoders having digital 0° and 90° outputs. See the "Manual on multi-axis laser interferometers" for information on how to connect these encoders to the ZLM electronic system.

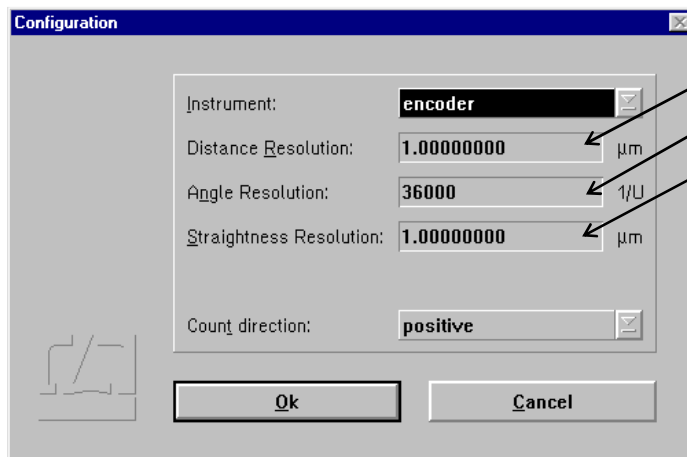
In the **"Instrument"** list box you can tell the program which kind of measuring system is connected.



In the **"Distance reflector"** or **"Angle reflector"** list box you need to specify which kind of interferometer is used for a distance or angle measurement. Select **"Prism"** in case of a corner cube interferometer, **"Mirror"** in case of a plane mirror interferometer. See the "Manual of multi-axis laser interferometers" for suitable interferometer arrangements.

In the **"Straightness optics"** list box you need to select which set of optical straightness measuring components is used, if you want to measure transverse displacements with straightness optics.

In angle measurements, you need to specify in the **"Angle beam distance"** text input box the reflector distance as a basis for angle computation. If you use channel "n" for an angle measurement by way of forming the difference between two measuring axes, the reflector distance must be entered in the n-th field of the axis setting dialog.



In case you use an incremental shaft encoder, you need to tell the program the resolution (least count) of the encoder. For an incremental shaft encoder divided into 1000 increments without interpolator, e.g., enter $4 \times 1000 \text{ r.p.m.} = 4000 \text{ r.p.m.}$, as the software evaluates both flanks each of the 0° and 90° signals.

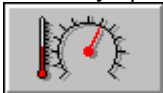
F 4.2 Compensation of environmental influences

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"** dialog 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.

No compensation is required for angle measurements and for measurements with straightness optics, where the influence of the environment is below the measurement resolution.

F 4.2.1 Atmospheric properties

In the top part of the "Environment" dialog 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 settings:

- Properties of air:**
 - Correction type: **Automatic**
 - Temperature: 22.1 °C
 - Pressure: 985 hPa
 - Humidity: 49 %
- Expansion:**
 - Correction type: **Automatic**
 - Coefficient of expansion: 11.0 $\times 10^{-6} \text{K}^{-1}$
 - Five expansion channels are shown with temperatures: 22.7 °C, 22.3 °C, 22.7 °C, --- °C, and --- °C.

Buttons: **Ok** and **Cancel**

F 4.2.2 Material temperature

In the bottom part of the "Environment" dialog 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 **"Without"** 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 "F 4.2.1 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.