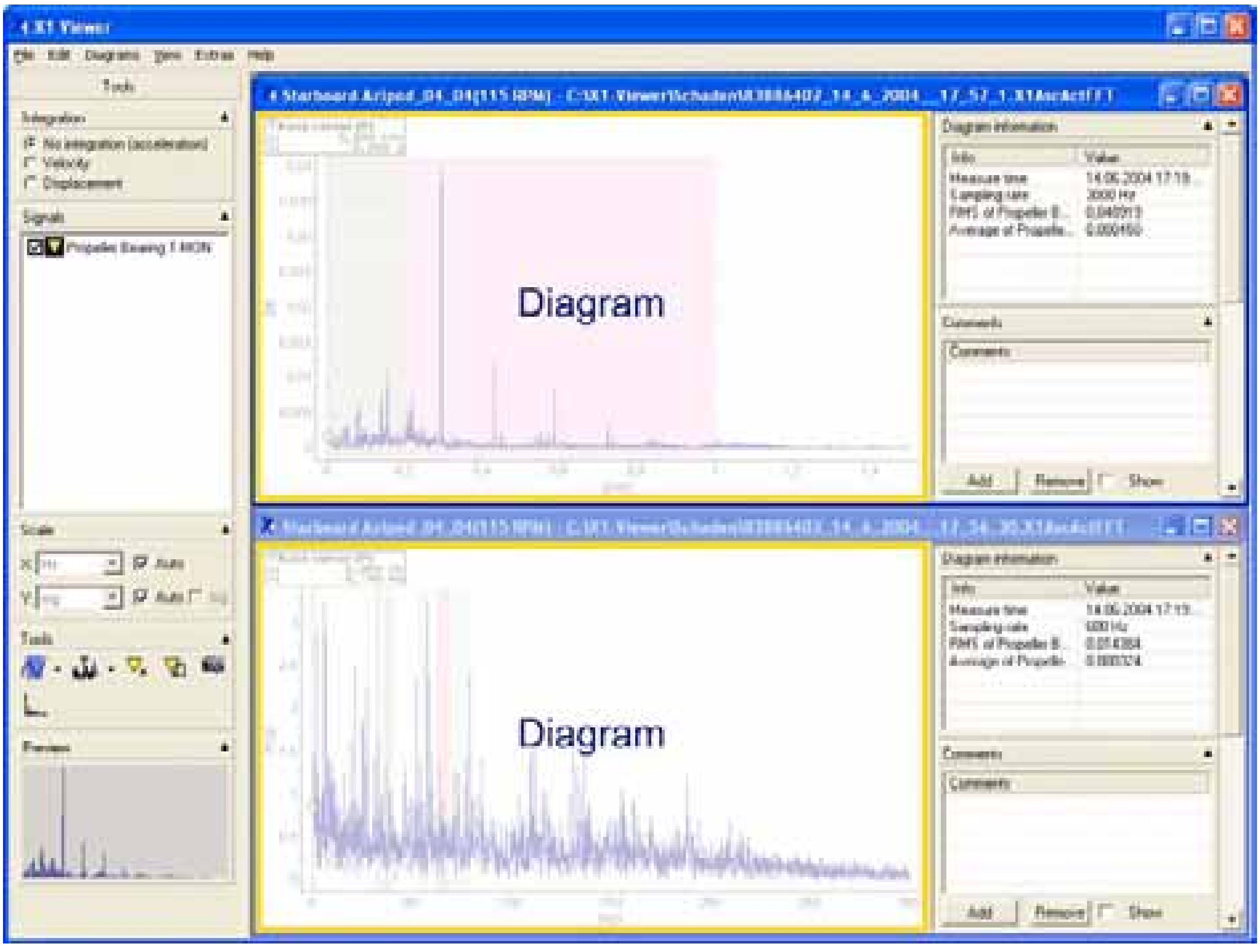
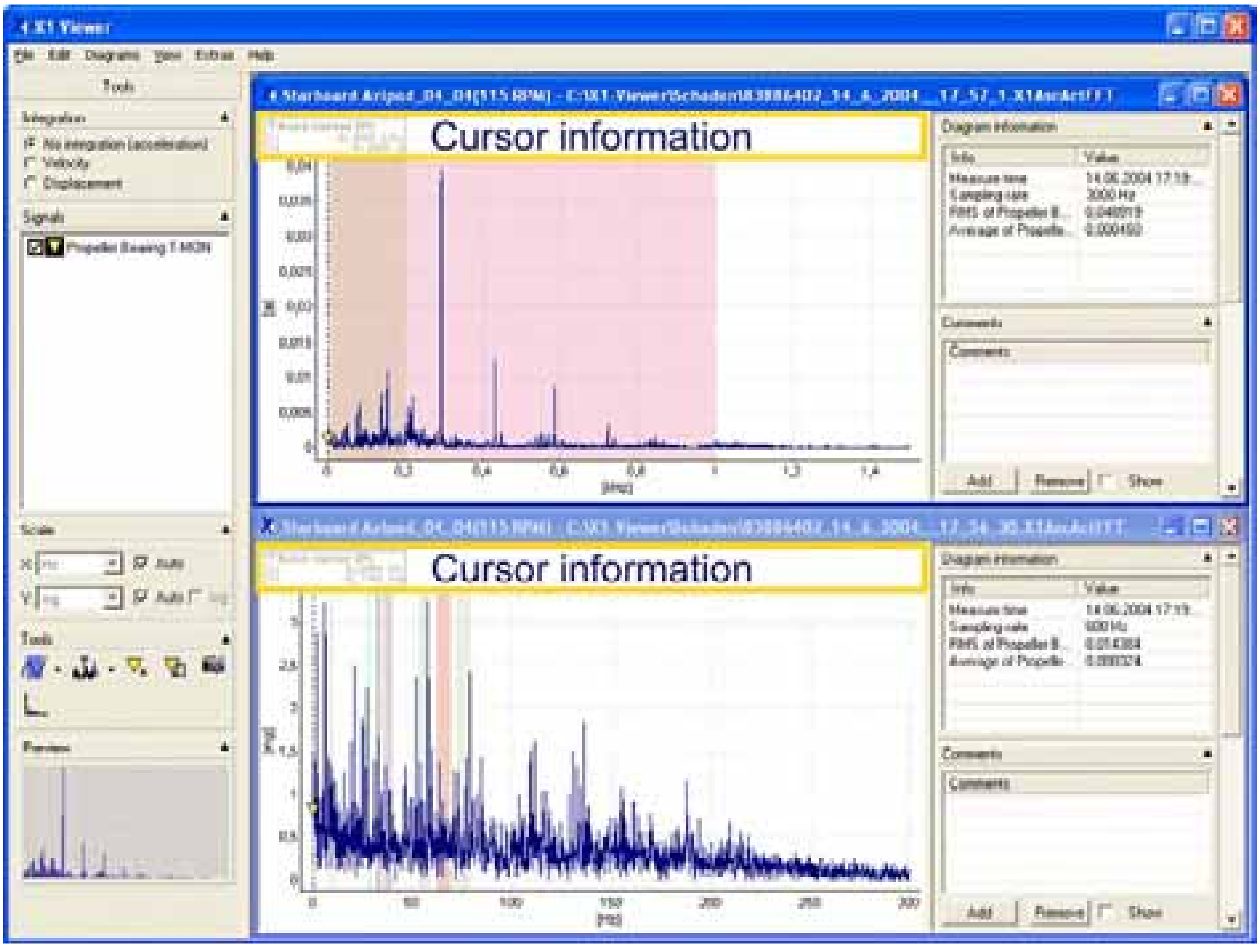


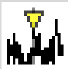
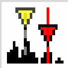
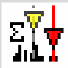
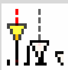
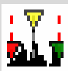
4.1.5 Cursor and measuring information

The **cursor information** for the Viewer shows important values and measurement data that vary depending on the cursor tool used. Each item of cursor information contains either the value pairs for a measured value or calculated characteristic values that are obtained by combining different cursors within the diagram such as the difference cursor or RMS/AMV cursor. The cursor information can be displayed or removed with **Ctrl + U** for each diagram.

The **measuring information** for the Viewer shows important measurement data according to the diagram type. This measuring information is always visible in the diagram and cannot be removed.

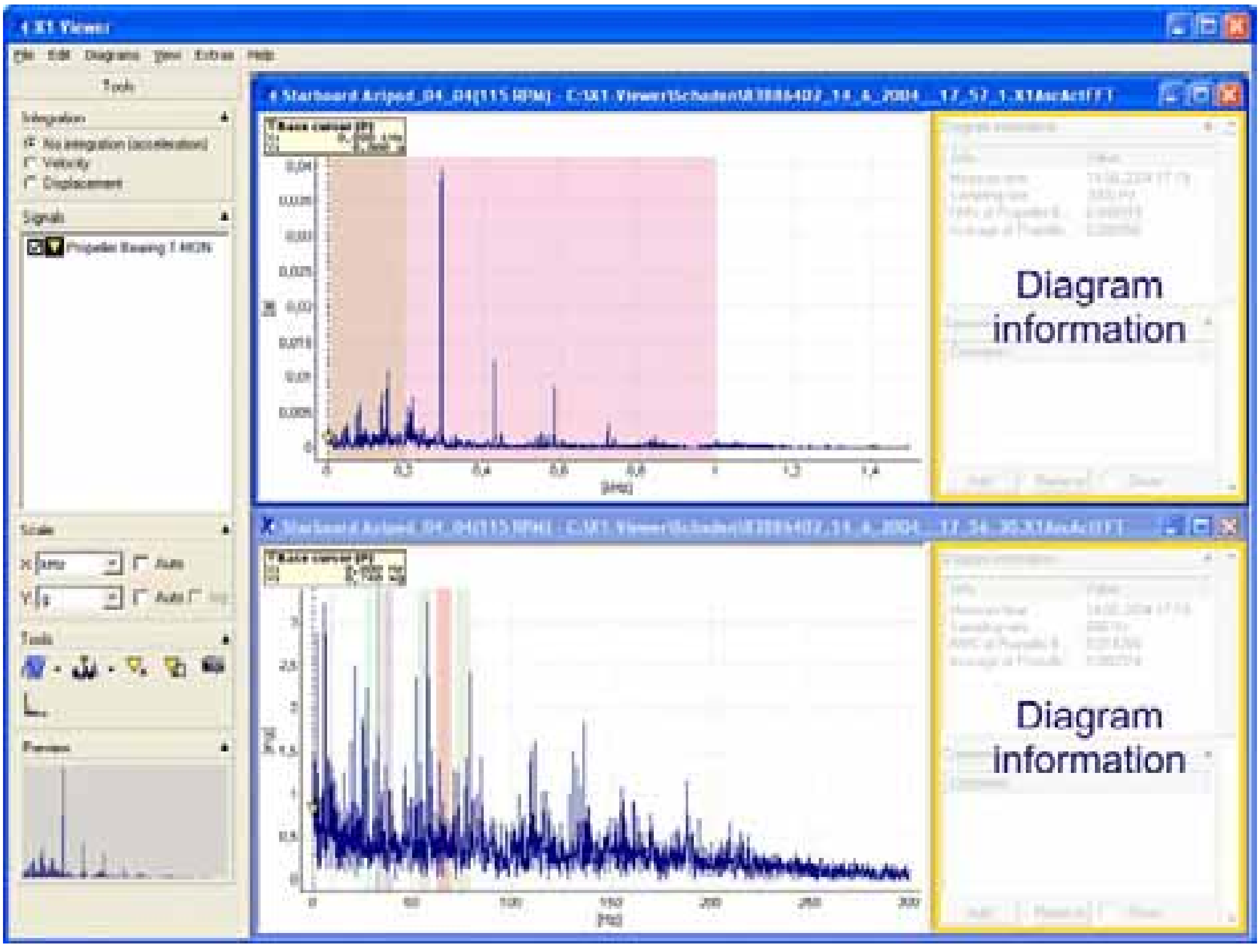


The table below shows the corresponding values displayed in the cursor information for the currently active cursor type:

Cursor type		Cursor information displayed
	Base cursor	Base cursor (P) X: 0,000 kHz Y: 0,000 mg
	Difference cursor	Base cursor (P) X: 0,000 kHz Y: 0,000 mg Difference cursor X: 0,000 kHz Y: 0,000 mg Delta: X: 0,000 kHz Y: 0,000 mg
	RMS/AMV cursor	Base cursor (P) X: 0,000 kHz Y: 0,000 mg RMS/AMV cursor X: 0,000 kHz Y: 0,000 mg RMS/AMV: RMS: 0,000 mg AMV: 0,000 mg
	Harmonic cursor	Base cursor (P) X: 0,057 kHz Y: 29,279 mg Micro step: X: 0,057 kHz Sub index: 0
	Sideband cursor	Base cursor (P) X: 0,000 kHz Y: 0,000 mg Sideband delta: X: 0,000 kHz
	HS cursor	Base cursor (P) X: 0,000 kHz Y: 0,000 mg Sideband delta: X: 0,000 kHz
	Revolutions cursor	Base cursor (P) X: 0,000 kHz Y: 0,000 mg Revolutions cursor Delta x: 0,000 kHz Revolutions: 0,000 Rev./min.

4.1.6 The diagram information bar

You can find the diagram information bar in the right-hand column of the working area. This column contains additional information on the diagram currently selected and can be displayed or removed as required.



The table below provides an overview of the corresponding information displayed with the active cursor type for FTT diagrams in the diagram information bar:

Information displayed in the diagram information bar	Base cursor	Difference cursor	RMS/AMV cursor
Diagram information	✓	✓	✓
Comments	✓	✓	✓
Frequency bands	✓	✓	✓
Highest peaks	✓	✓	✓
Harmonic			
Sidebands			

Information displayed in the diagram information bar	 Harmonic cursor	 Sideband cursor	 HS cursor
Diagram information	✓	✓	✓
Comments	✓	✓	✓
Frequency bands	✓	✓	✓
Highest peaks	✓	✓	✓
Harmonic	✓		✓
Sidebands		✓	

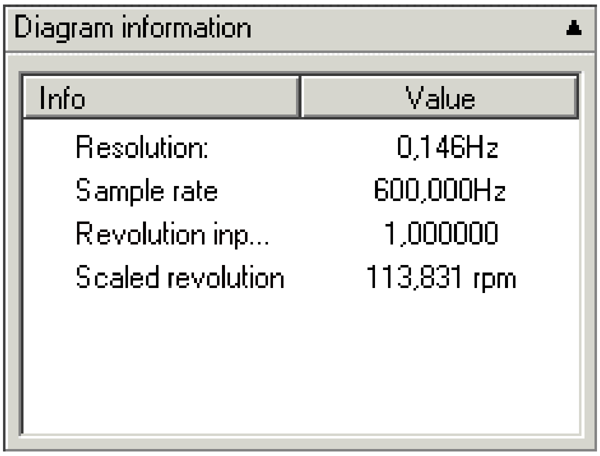
Information displayed in the diagram information bar	 Revolutions cursor
Diagram information	✓
Comments	✓
Frequency bands	✓
Highest peaks	✓
Harmonic	
Sidebands	

Diagram information and comments for time signals and trend diagrams are displayed in the diagram information bar irrespective of the cursor type selected. Further, information on the alarm values of the data set currently open is displayed in the trend diagrams.

Diagram information

This field contains general information on the measurement data including

- Information on the measuring process such as the low pass or sampling frequency settings
- Further information included in the data sets.

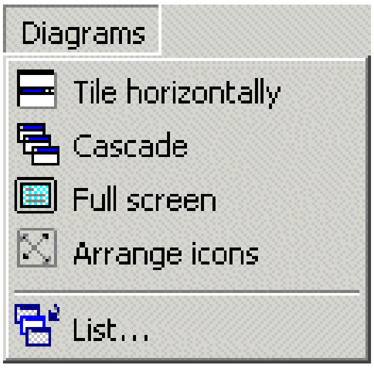


4.2 Working with the Viewer

4.2.1 Displaying several diagrams simultaneously

You can open several diagrams in the Viewer simultaneously and arrange these in the working area according to your requirements.

Select one of the following options from the **Diagrams** menu: **Tile horizontally, Cascade, Full screen, Arrange minimized windows** or **List…**.

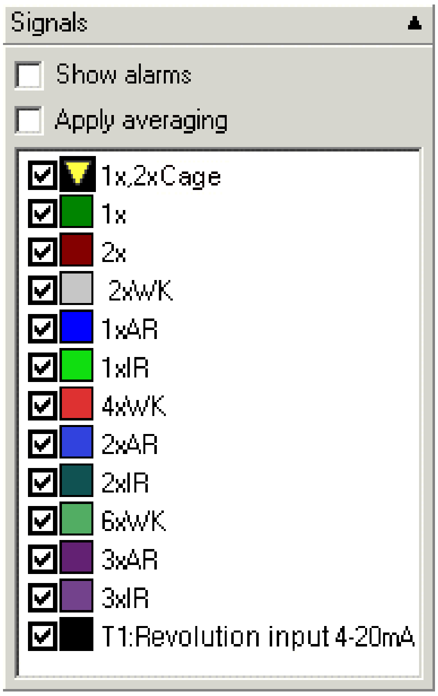


➔The windows are rearranged accordingly.

4.2.2 Modifying the appearance of a diagram

Displaying and removing signals

When a new data set is opened the Viewer simultaneously displays all signals contained in the data. All series of measurements included in the current data set are listed in the **signals** field.



Click on the **checkbox** in front of the signal.

➔This signal will be displayed or removed.

Automatic scaling of axes

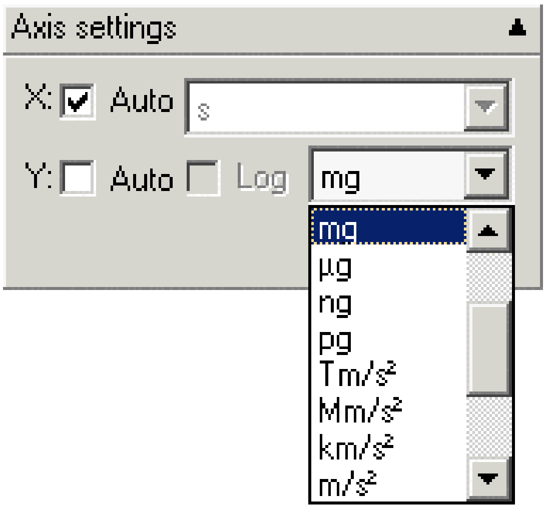
The diagram axes can be set to the nearest thousand scaling (10^3) using the **Automatic scaling** option. Using the basic unit of the diagram as the starting point the nearest smaller unit (g ’ mg or m ’ mm, for example) is selected for measured values < 1, or conversely, the nearest larger unit is selected (ms ’ s or Hz ’ kHz, for example) for values > 1000.

1. Click the **"Auto"** checkbox to activate it.

➔The scaling of the diagram will be adjusted automatically.

Manual scaling of axes

You can select one of the specified, equivalent axes scaling units independently by deactivating the **Automatic scaling** option. The available scaling units depend on the type of diagram (Hz or kHz with FFTs for frequencies, g, mg, m/s² or mm/s² for acceleration values, s or ms for time signals, etc.). The scaling for the axes can be set independently of one another, i.e. you can specify any desired unit for the X and Y axes respectively.



1. Click the **"Auto"** checkbox to deactivate it.
2. Select one of the units provided in the **X unit** field.
3. Select one of the units provided in the **Y unit** field.

➔The scaling of the axes is carried out independently of one another and can be modified in accordance with the setting selected.

Logarithmic scaling of the Y axis

It may be possible under certain conditions to present signals more clearly using a logarithmic scale if they do not contain zero values or negative values. You can therefore switch over to logarithmic scaling in the diagram.

1. Click on the **"log"** checkbox to activate the logarithmic scaling of the Y axis.

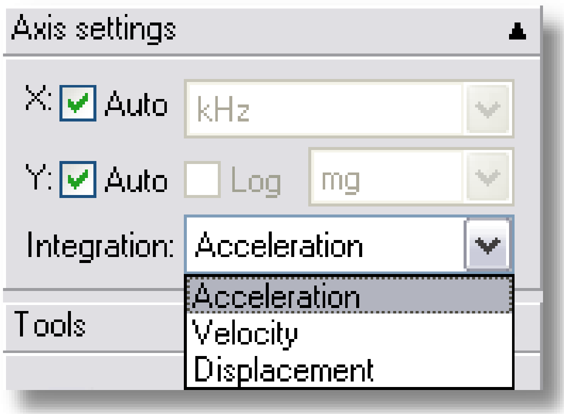
➔The scaling of the diagram will be modified according to the settings selected.

This option is deactivated if the measurement data cannot be presented logarithmically (if the measurement data contain values smaller than or equal to zero, for example).

Displaying Y axis integrations

You have a number of display options for the integration of signals in FFT diagrams that contain an acceleration signal, for example:

- No integration: acceleration
- Velocity
- Displacement



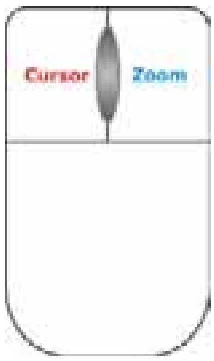
1. Click on the **Velocity** option to display the first signal integration.
2. Click on the **Displacement** option to display the second signal integration.
3. Click on the **None** option to restore to the standard signal display (acceleration).

➔The scaling and display of the diagram will be modified in accordance with the chosen settings.

Once you have selected the integration option for the Y axis you can also modify the scaling of the axes here (automatic, manual or logarithmic) and display any desired part of the diagram using the zoom tools.

4.2.3 Using the mouse to control the cursor or zoom function

1. You can position the various cursors using the left-hand mouse button.
2. You can adjust the zoom selection setting using the right-hand mouse button.

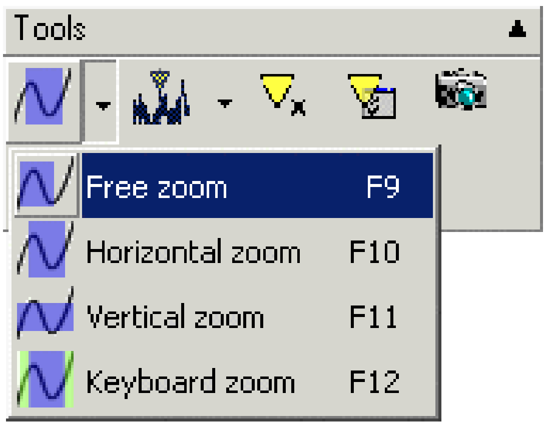


4.2.4 Zoom tools

1. Select one of the zoom tools from the selection list.
2. Mark a zoom area in the diagram using the **right-hand mouse button**.

➔Your selection is marked in the diagram.

3. **Right click** on the diagram if you wish to return to the previous zoom selection.
4. If you wish to return to the full view of the diagram hold the **Shift button** down and **right click** on the diagram



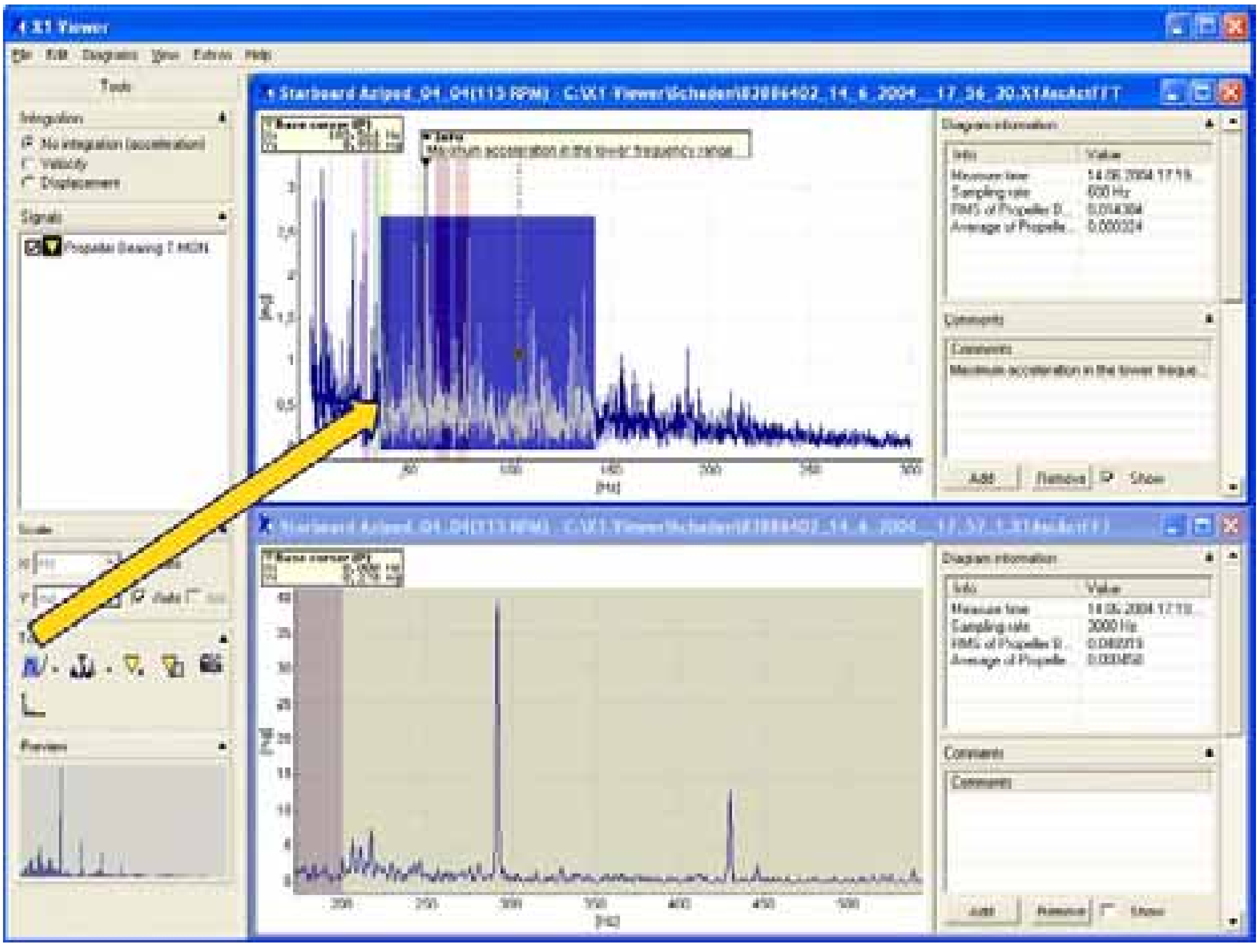
Free zoom

 **Free zoom** symbol:

You can use the Free zoom tool to enlarge any chosen rectangular area within a diagram:

1. Select the Free zoom tool from the zoom tool selection list using the mouse or press the F9 button.
2. Keeping the right-hand mouse button pressed down, drag the mouse across the section of the diagram you wish to enlarge.

➔The zoom selection is now marked dark blue in the diagram.



3. Release the right-hand mouse button.

➔Your selection is marked in the diagram.

4. Right click once again on the diagram if you wish to return to the previous zoom selection.
   or
5. To return to the full view of the diagram hold the Shift button down and right click

on the diagram

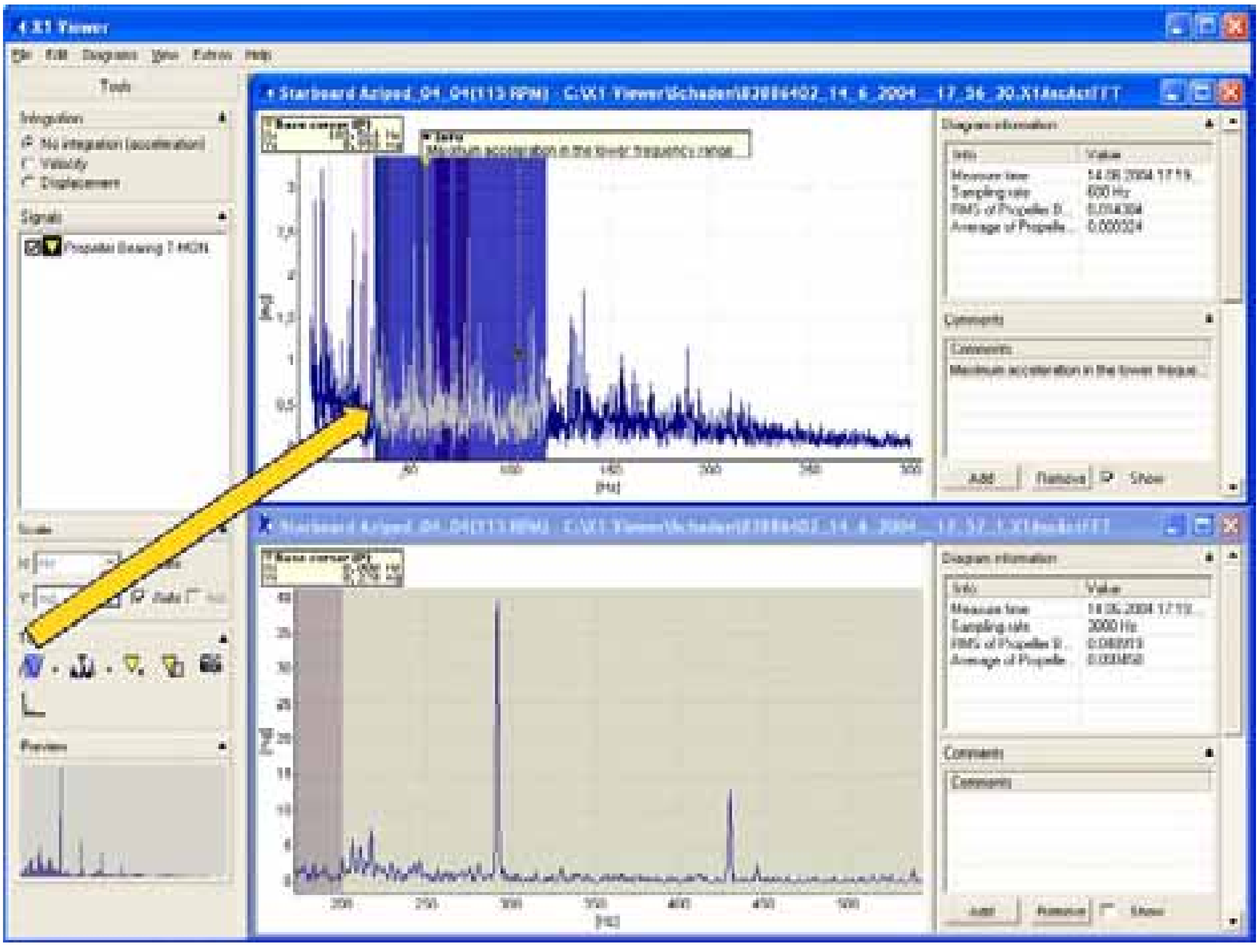
Horizontal zoom

 **Horizontal zoom** symbol:

You can enlarge any part of a diagram in a horizontal direction using the Horizontal zoom tool. The range of values and scaling of the Y axis remain unchanged:

1. Select the Horizontal zoom tool from the zoom tool selection list using the mouse or press the F10 button.
2. Keeping the right-hand mouse button pressed down, drag the mouse across the horizontal section of the diagram you wish to enlarge.

➔The zoom selection is now marked dark blue in the diagram.



3. Release the right-hand mouse button.

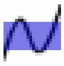
➔Your selection is marked in the diagram.

4. Right click once again on the diagram if you wish to return to the previous zoom selection.

or

5. To return to the full view of the diagram hold the Shift button down and right click on the diagram

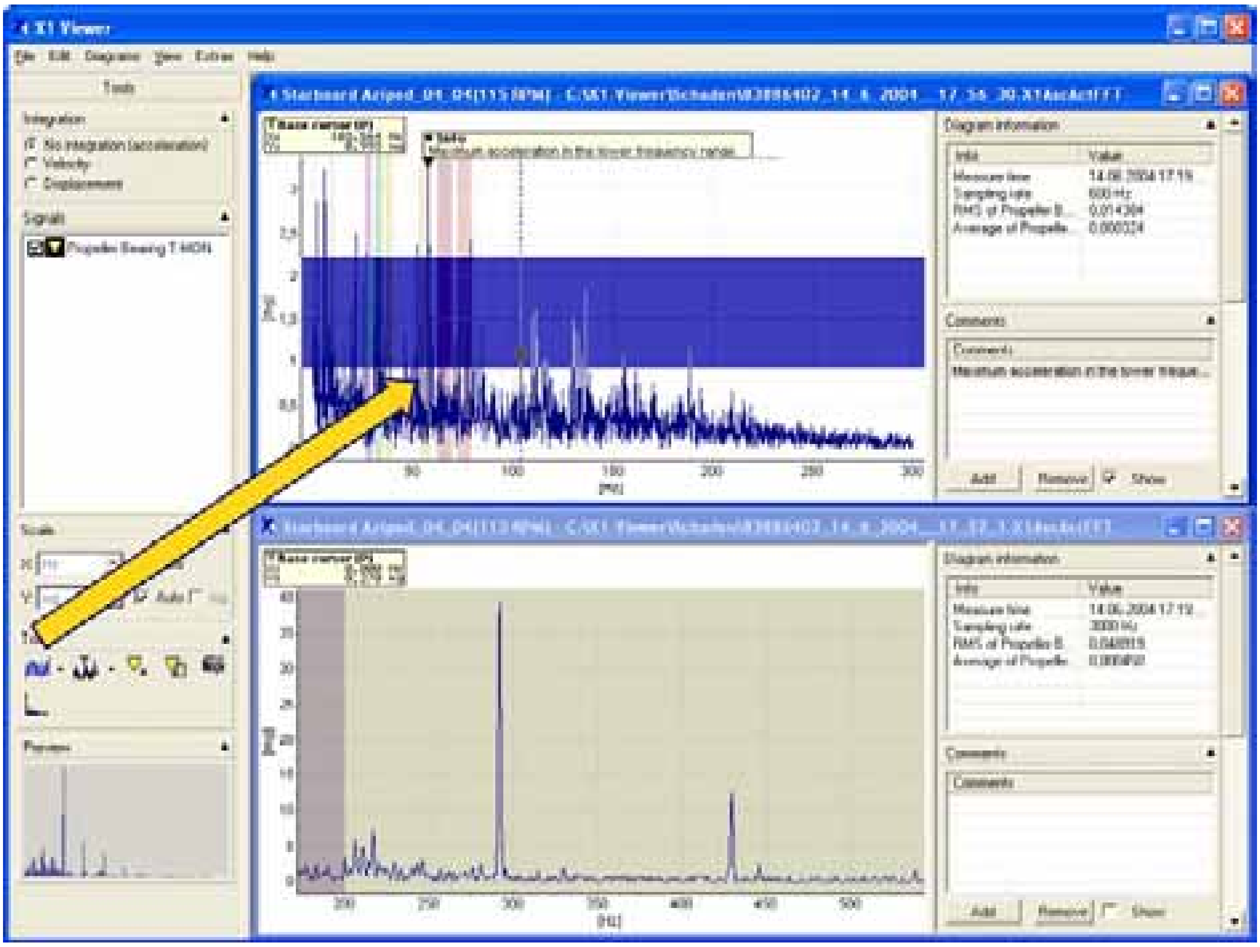
Vertical zoom

 **Vertical zoom** symbol:

You can enlarge an area inside a diagram in a vertical direction using the Vertical zoom tool. The range of values and scaling of the X axis remain unchanged:

1. Select the Vertical zoom tool from the zoom tool selection list using the mouse or press the F11 button.
2. Keeping the right-hand mouse button pressed down, drag the mouse across the vertical section of the diagram you wish to enlarge.

➔The zoom selection is now marked dark blue in the diagram.



3. Release the right-hand mouse button.

➔ Your selection is marked in the diagram.

4. Right click once again on the diagram if you wish to return to the previous zoom selection.
   or
5. To return to the full view of the diagram hold the Shift button down and right click on the diagram

Keyboard zoom

Keyboard zoom symbol:

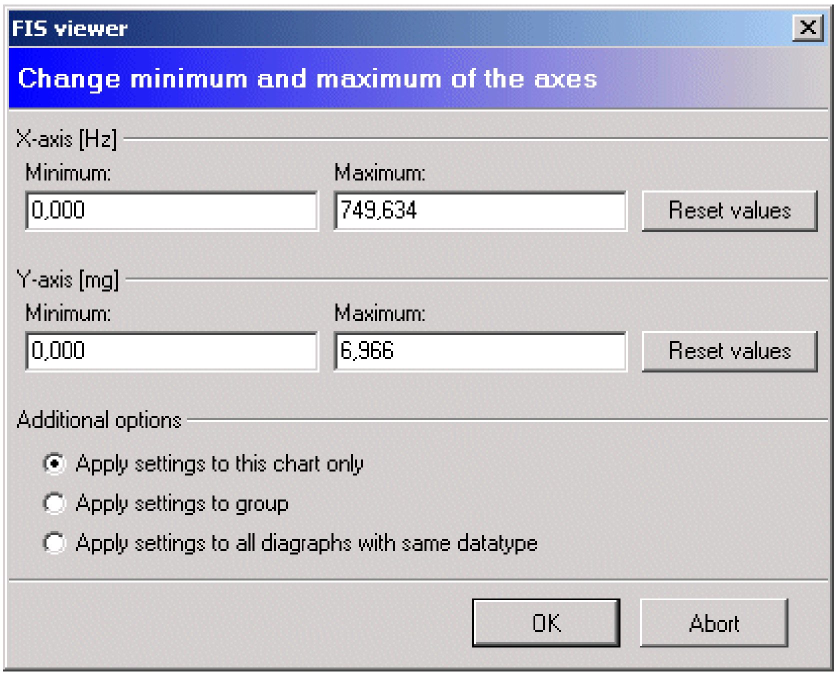
You can use the **keyboard zoom** feature to enlarge an area of the diagram using the keyboard instead of the mouse.

1. Select the **Keyboard zoom** tool from the zoom tool selection list using the mouse or press the **F12** button.
2. Use the **Q** and **W** buttons to shift the start of the zoom selection.
3. Use the **A** and **S** buttons to shift the end of the zoom selection.
4. Use the **Y** and **X** buttons to shift the highlighted zoom selection to the right or the left.
5. You can enlarge a section of the diagram by pressing **Enter** (zoom in).
6. You can reduce a section of the diagram by pressing **Backspace** (zoom out).
7. You can return to the full view of the diagram by pressing the **space bar**.

Defining the zoom selection by inputting values

1. Click the **left-hand mouse button** on the current zoom tool.

➔The zoom selection dialogue window opens and shows the current settings for the boundary values.



2. Enter a minimum and a maximum value for the X axis.
3. Then enter a minimum and a maximum value for the Y axis.
4. Click on "OK".

➔ The diagram displays your defined zoom selection.

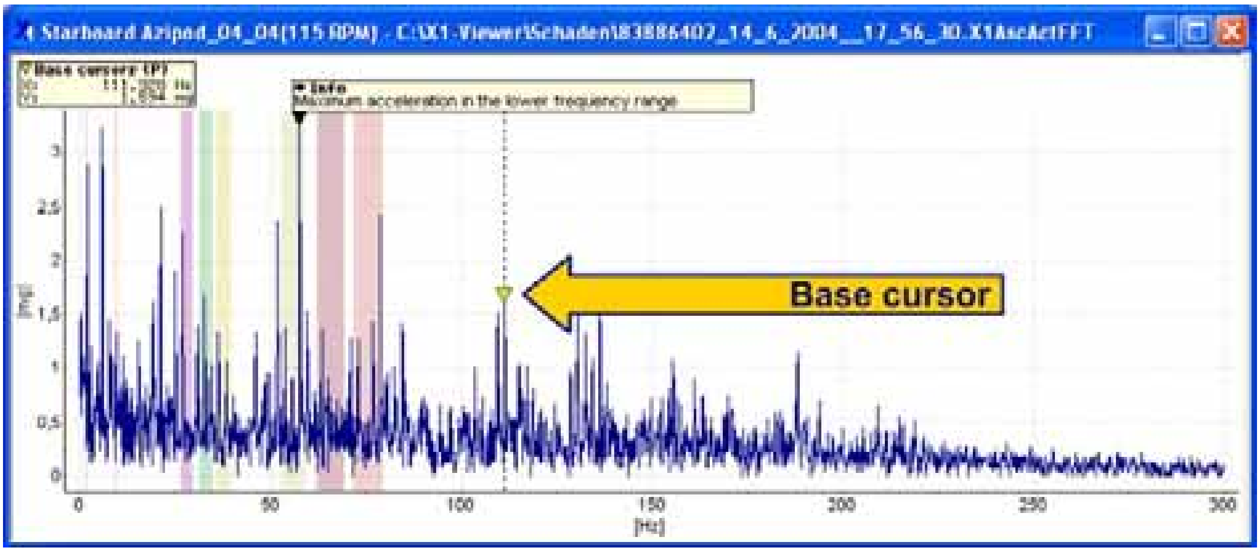
4.2.5 Cursor tools

A cursor can be positioned in the diagram by clicking near a measured value or moved by dragging the dotted vertical line along the diagram axis keeping the mouse button pressed down.
Sliding cursors are always represented by a dotted vertical line whereas fixed cursors or automatically calculated data displays are represented by a continuous vertical line.

Base cursor

You can use the **base cursor** to determine the measured values on the X and Y axis of a measuring point.

To do this, place a base cursor at any desired measuring point in the diagram. The corresponding measured values are displayed in the cursor information.



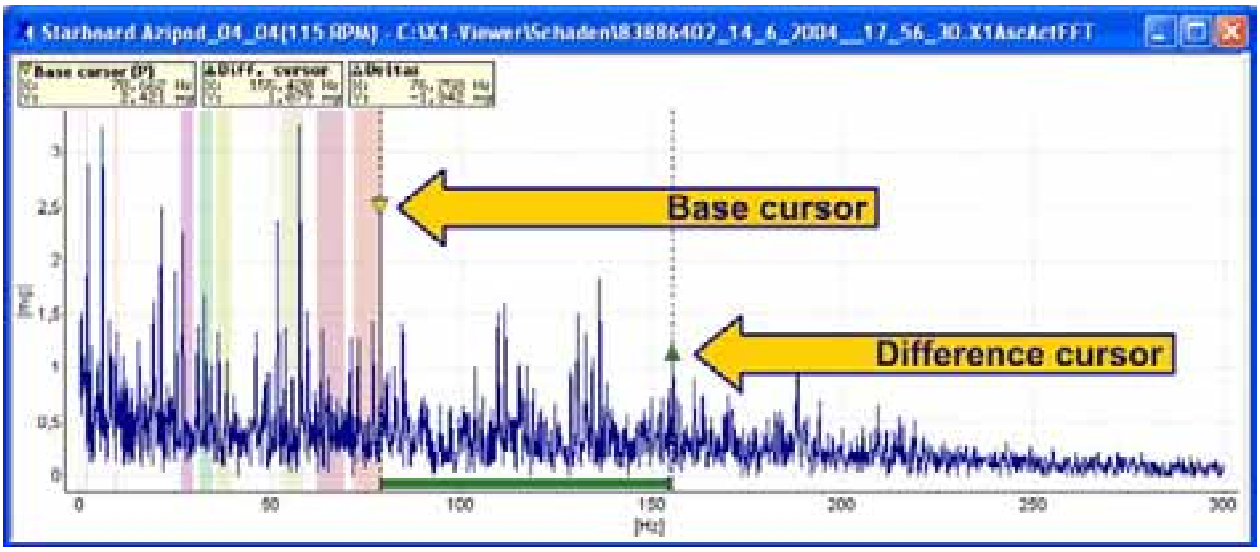
1. Select the **base cursor** option from the cursor selection list or press the **F2** button.
2. Position the base cursor by **left clicking the mouse** near a measuring point in the diagram.

➔The base cursor jumps to the nearest measuring point in the diagram. The current position in the diagram is represented by a vertical dotted line. The measured values for this measuring point are displayed in the cursor information above the diagram.

Difference cursor

You can use the **difference cursor** to calculate the difference between two measured values.

To do this, place the base cursor and a difference cursor at the desired measuring points in the diagram. The distance between the cursors is indicated by a coloured bar directly above the X axis. Both measured values obtained via the cursors and the resulting differential values are displayed in the cursor information.



1. Select the **difference cursor** option from the cursor selection list or press the **F3** button.

➔The base cursor and the difference cursor are displayed in the diagram, these are connected by a coloured bar that runs along and slightly above the X axis.

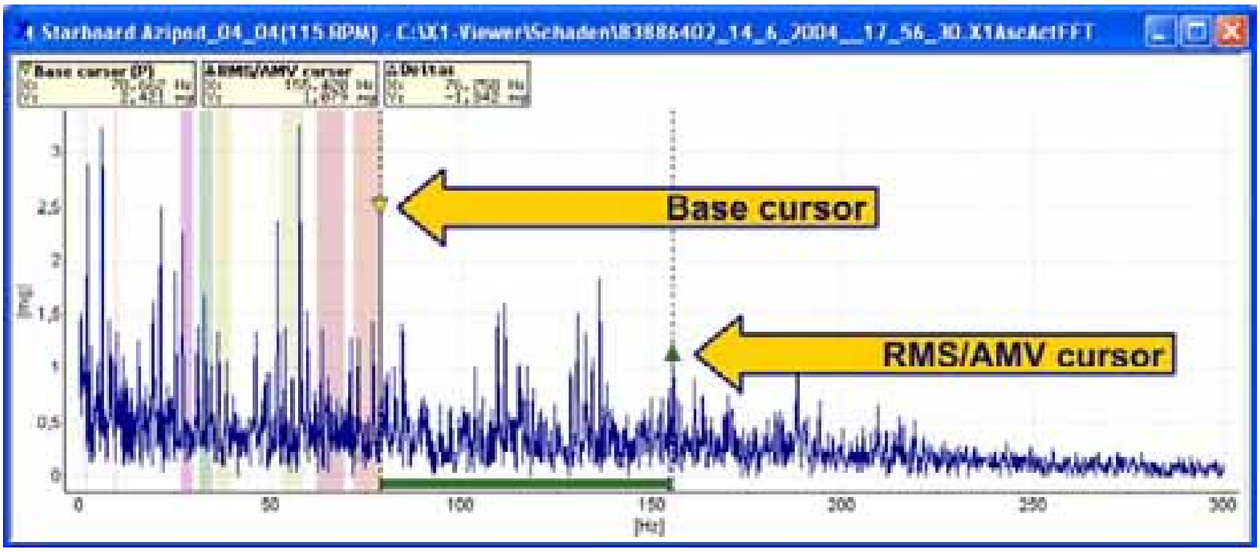
2. You can place the base cursor at any desired measuring point in the diagram by clicking the **left-hand mouse button**.
3. You can position the difference cursor at any desired measuring point in the diagram by clicking the **left-hand mouse button** with the **Shift button** pressed down.

➔The cursor information above the diagram displays the measured values for the base cursor and difference cursor as well as the delta value.

RMS/AMV cursor

You can calculate the RMS (root mean square/effective value) and the AMV (arithmetic mean value) between two measuring points using the **RMS/AMV cursor**.

To do this, place the base cursor and an additional averaging cursor at any desired measuring point in the diagram. The distance between the cursors is indicated by a coloured bar directly above the X axis. Both measured values obtained via the cursors and the resulting mean values are displayed in the cursor information.



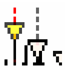
1. Select the **RMS/AMV cursor** option from the cursor selection list or press the **F4** button.

➔The base cursor and the averaging cursor are displayed in the diagram, these are connected by a coloured bar that runs along the X axis and slightly above it.

2. You can place the base cursor at any desired measuring point in the diagram by clicking the **left-hand mouse button**.
3. You can position the RMS/AMV cursor at any desired measuring point in the diagram by clicking the **left-hand mouse button** with the **Shift button** pressed down.

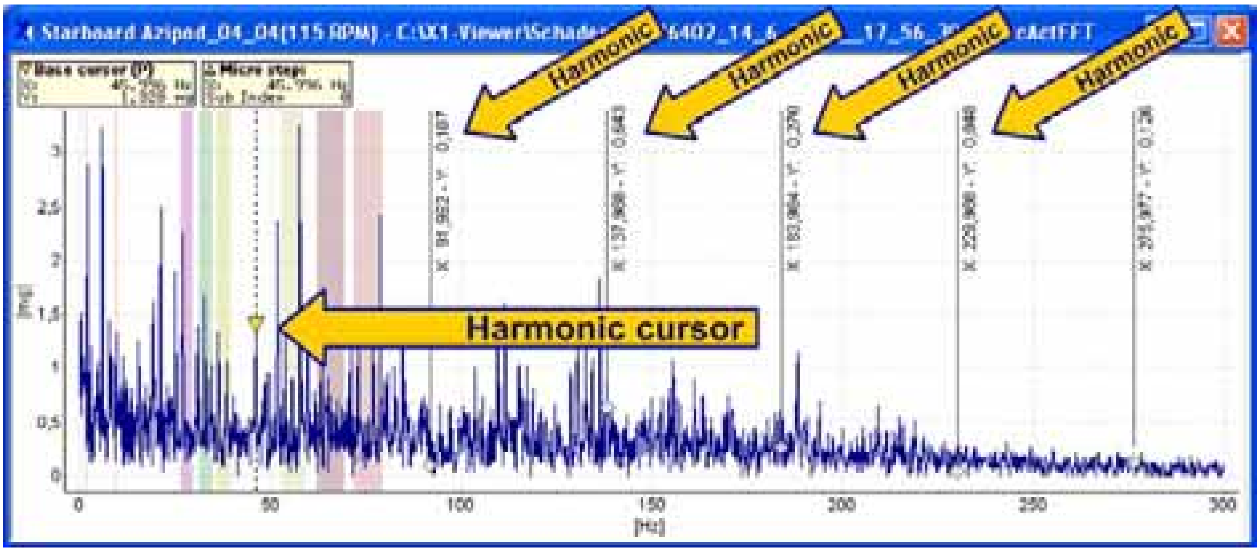
➔The measured values of the base cursor, the averaging cursor as well as the arithmetic and RMS value for the area specified are displayed in the cursor information above the diagram

Harmonic cursor



You can use the **harmonic cursor** to determine whether harmonics are present in the diagram (integer multiple of a vibration).

To do this, place the base cursor at any desired measuring point in the diagram. The harmonics are displayed in each case as continuous vertical lines. The corresponding measured values are displayed at the upper end of the vertical lines and the measured values for the base cursor are displayed in the cursor information.



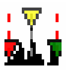
1. Select the **harmonic cursor** option from the cursor selection list or press the **F5** button.

➔The base cursor and vertical lines are displayed at the harmonic of the basic frequency.

2. You can shift the base cursor to any desired measuring point in the diagram using the **left-hand mouse button**.

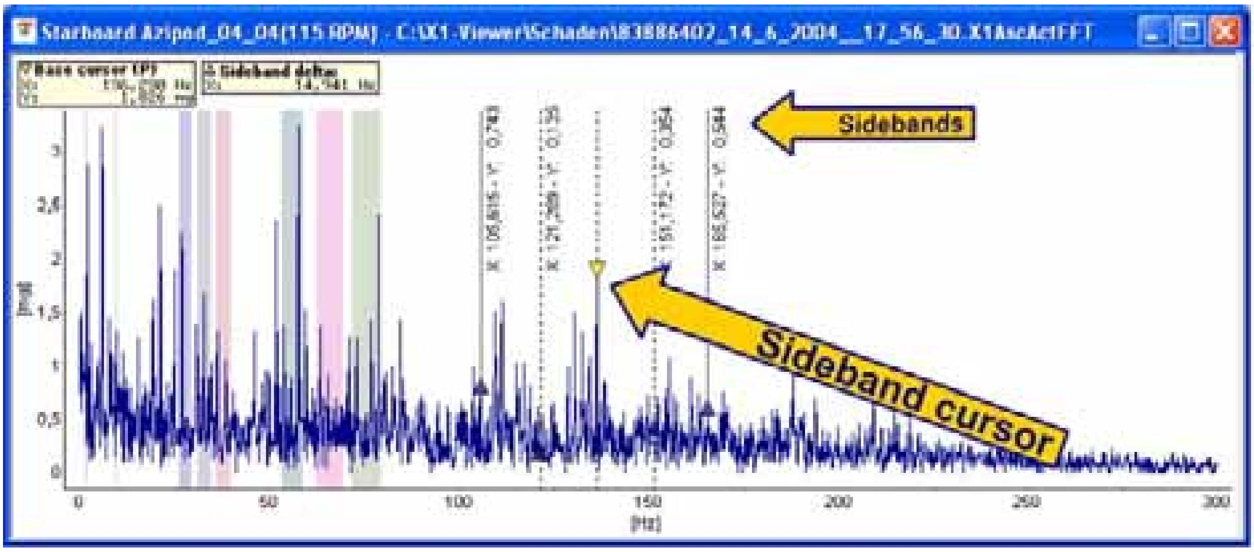
➔When the position of the harmonic cursor is changed the harmonics are automatically shifted. The cursor information above the diagram displays the measured values for the base cursor and the micro-increments set. The measured values of the harmonics are each displayed vertically as text next to the corresponding vertical line.

Sideband cursor



You can use the **sideband cursor** to determine additional measured values in definable sidebands starting from the base cursor.

To do this, the base cursor must first of all be placed at any desired measuring point in the diagram. You can then shift the nearest sideband to another measuring point in the diagram. All other sidebands displayed are simultaneously adjusted.



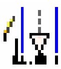
1. Select the **sideband cursor** option from the cursor selection list or press the **F6** button.

➔The base cursor and vertical lines are displayed at the sidebands of the frequency.

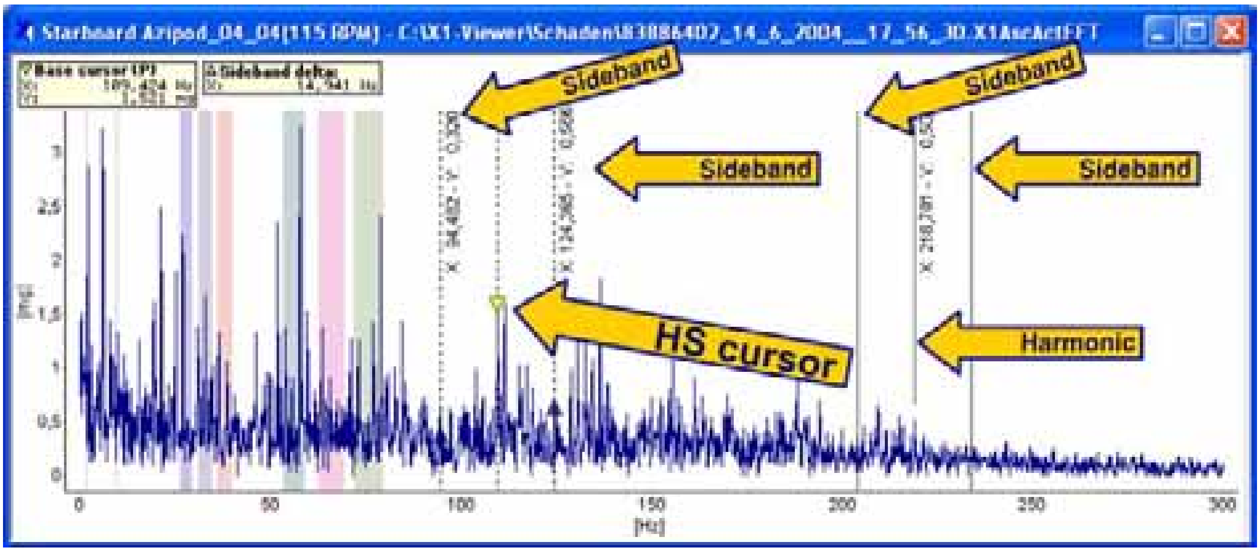
2. You can use the **left-hand mouse button** to shift the base cursor to any desired measuring point in the diagram and also modify the position of the sidebands.

➔The cursor information above the diagram displays the measured values for the base cursor as well as the differential delta of the sideband frequencies. The measured values of the sidebands are each displayed vertically as text next to the corresponding vertical line.

HS cursor



The **HS cursor** (**H**armonic with **S**idebands) combines both cursor types described above which means that the measured values of the harmonics and their sidebands will be displayed.



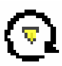
1. Select the **HS cursor** option from the cursor selection list or press the **F7** button.

➔The base cursor and vertical line are displayed at each harmonic of the base cursor frequency as well as its sidebands.

2. You can use the **left-hand mouse button** to shift the base cursor to any desired measuring point in the diagram and also modify the position of the sidebands.

➔The cursor information above the diagram displays the measured values for the base cursor as well as the differential delta of the sideband frequencies. The measured values of the harmonics are each displayed vertically as text next to the corresponding vertical line.

Revolutions cursor



The **revolutions cursor** places a mark at the frequency that is assigned to a specific speed. The value for this speed is calculated as follows:

$$velocity\ n\,[rpm] = 60 \cdot frequency\ f\,[Hz]$$

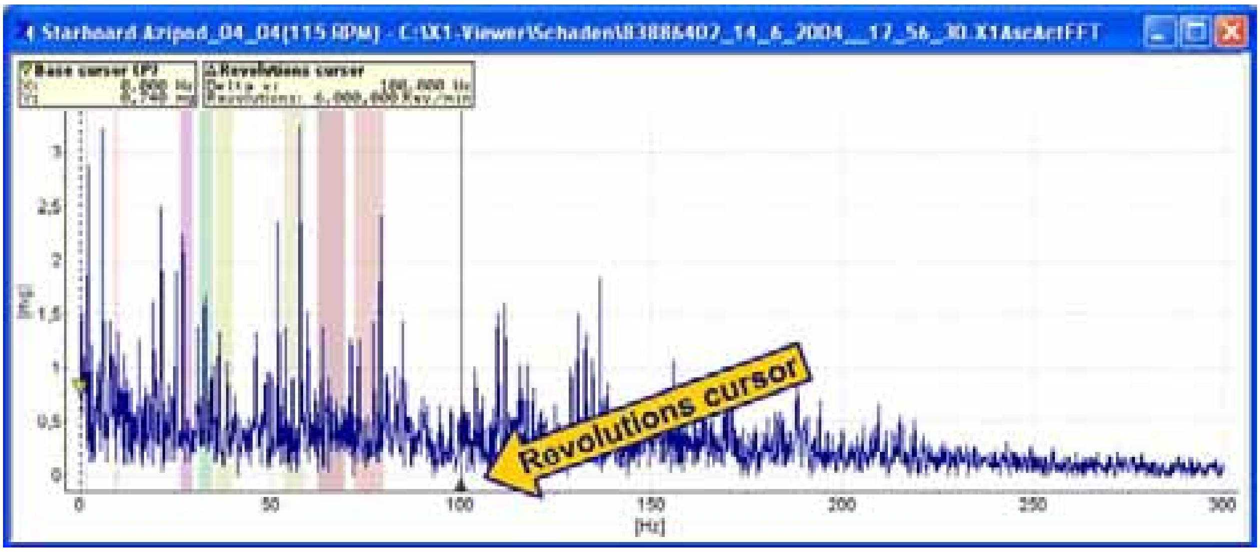
1. Select the **revolutions cursor** option from the cursor selection list or press the **F8** button.

➔The "revolutions cursor" dialogue opens.

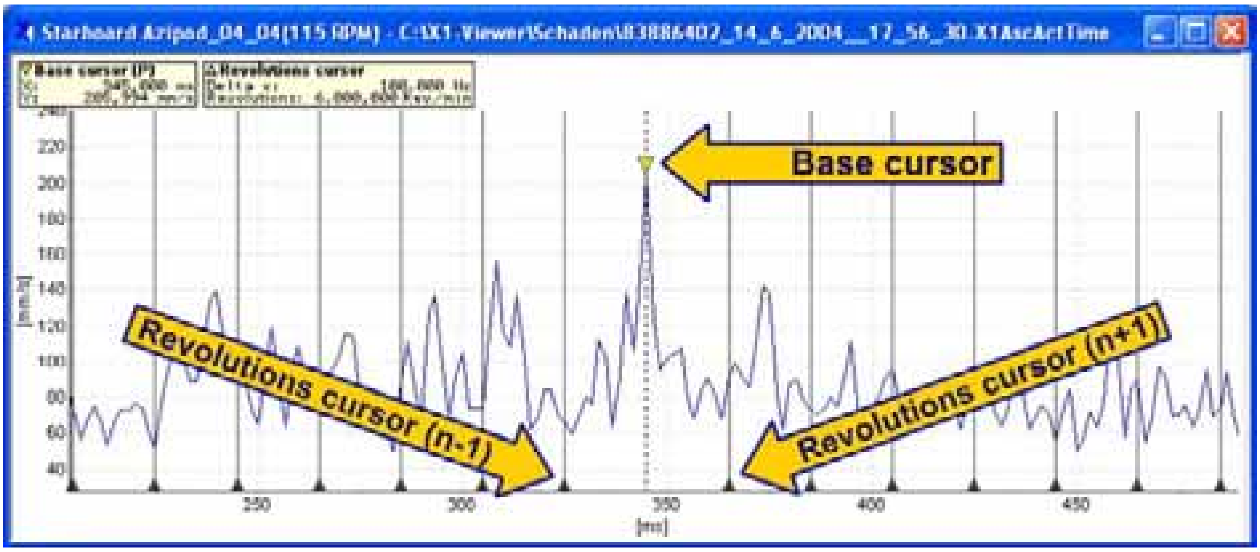
2. Activate or deactivate the options for the cursor settings in the "revolutions cursor" dialogue.

3. Enter any desired speed in the **rpm** field and click **OK**. The revolutions cursor is displayed in different ways depending on the diagram type (FFT or time signal):

➔In a FFT diagram a single revolutions cursor is displayed at the point previously specified for the speed in the dialogue. The cursor information above the diagram shows the base cursor value as well as the speed setting.

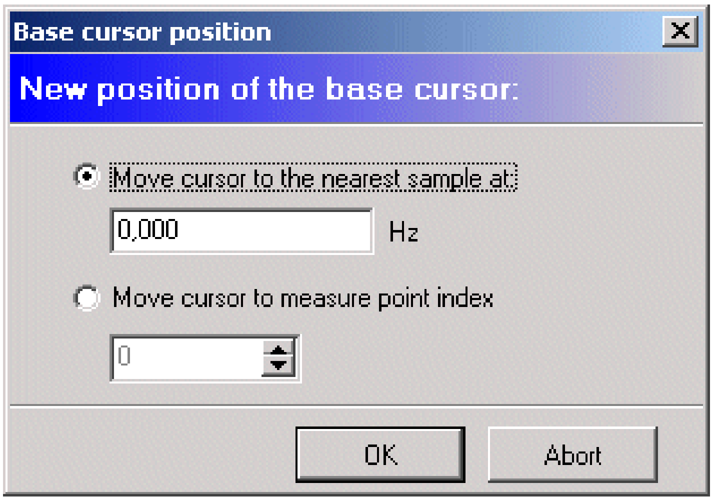


➔For a time signal a speed field with a series of revolutions cursors is displayed. In this case the individual lines correspond to an additional revolution before or after the current position of the base cursor. If you move the base cursor or position it at another measuring point the speed field moves automatically with it.



4.2.6 Positioning of base cursor

You can position the base cursor at a point in the diagram defined via numeric input in the base cursor positioning dialogue box. The base cursor jumps to the nearest measuring point.



1. Click on the **base cursor positioning** symbol.

➔The base cursor positioning dialogue is displayed.

2. Select the **"Position cursor at nearest measuring point:"** option and enter any desired value inside the diagram area in the input field.

or

3. Select the **"Position cursor at measuring point index:"** option and enter an index value for the corresponding measured value in the input field.
4. Click on **"OK"**.

➔The base cursor is now positioned at the point you entered numerically.

4.2.7 Modifying the cursor properties

You can change the properties of the cursor currently selected using the cursor properties dialogue.

1. Click on the **Cursor properties** symbol.

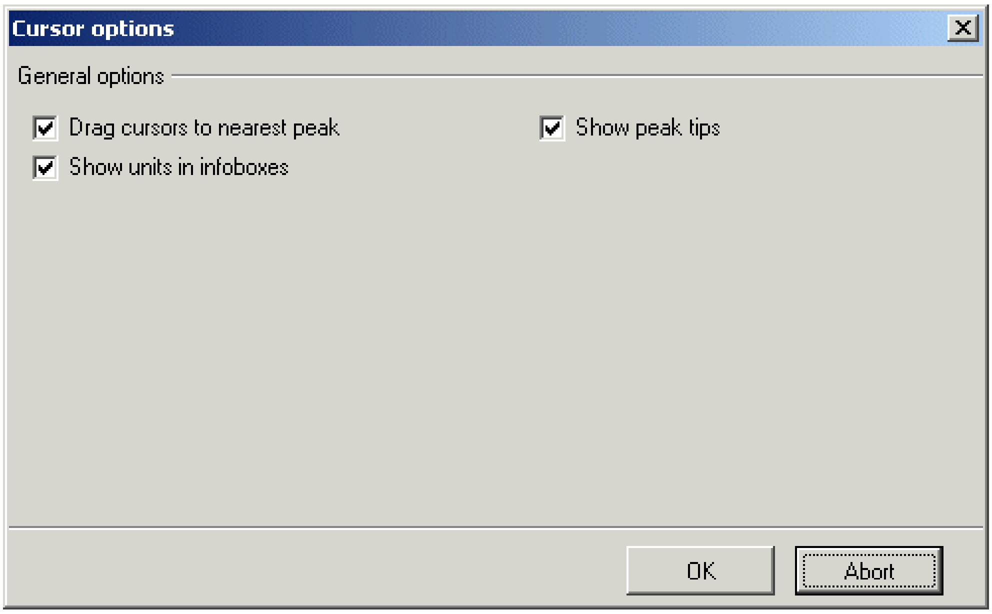
➔A dialogue opens that shows the properties of the cursor tool that is currently selected.

2. Activate or deactivate the relevant fields in the dialogue window and pick one of the values in the selection boxes or enter the required value in the input fields provided.
3. Click on **"OK"**.

➔The cursor properties are adopted and saved.

General cursor properties

You can modify the general cursor options described below. These properties apply for all available cursor types and can be activated or deactivated in the dialogue window shown below.



Next maximum

Switched on: the cursor jumps to the maximum value which is nearest the mouse pointer. If no maximum value can be found in the vicinity of the mouse the cursor remains in its previous position.

Switched off: the cursor jumps precisely to the measuring point in the diagram which is nearest the mouse pointer.

Show peaks

Switched on: in addition to the vertical lines current symbols are used to label measured values at the characteristic points of the various cursors in the diagram.

Switched off: the symbols that identify measured values at characteristic points are removed. However, the vertical lines remain displayed.

Displaying units in information boxes

This option only is only relevant for the cursor information display which must also be switched on.

Switched on: numerical values and units for the current cursor are displayed in the information boxes at cursor information.

Switched off: only the numerical values for the current cursor are displayed in the information boxes at cursor information.

Modifying the properties of the base cursor

When using the base cursor you can only modify the general cursor options described in Modify the cursor properties 145. To do this, activate or deactivate the corresponding checkboxes in the dialogue window.

Modifying the properties of the difference cursor

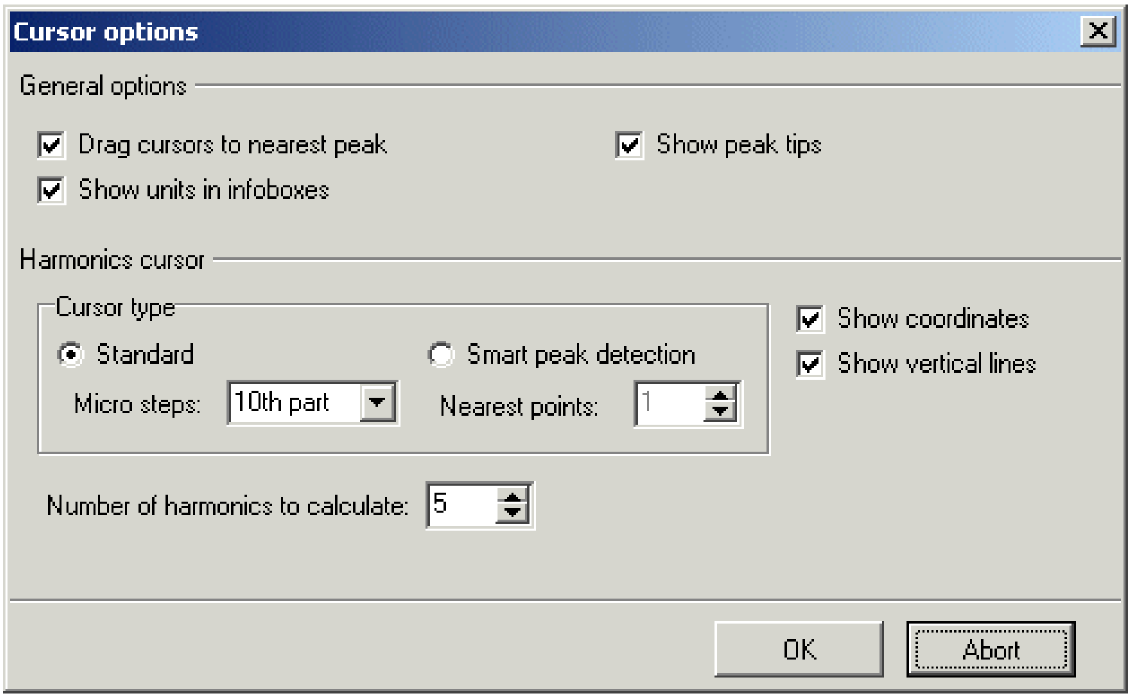
When using the difference cursor you can only modify the general cursor options described in Modify the cursor properties 145. To do this, activate or deactivate the corresponding checkboxes in the dialogue window.

Modifying the properties of the RMS/AMV cursor

Similarly, when using the RMS/AMV cursor you can only modify the general cursor options described in Modify the cursor properties 145. To do this, activate or deactivate the corresponding fields in the dialogue window.

Changing the properties of the harmonic cursor

In addition to the general cursor options described in Modify the cursor properties 145 you can also modify the additional options for the harmonic cursor (described below). To do this, activate or deactivate the appropriate fields in the dialogue window or select the value required from the selection boxes.



Cursor type "Standard"

The harmonics are precisely calculated for the current cursor. The indicators for the harmonics are set so they locate the **nearest measured value** for the harmonics calculated.

Micro-increments

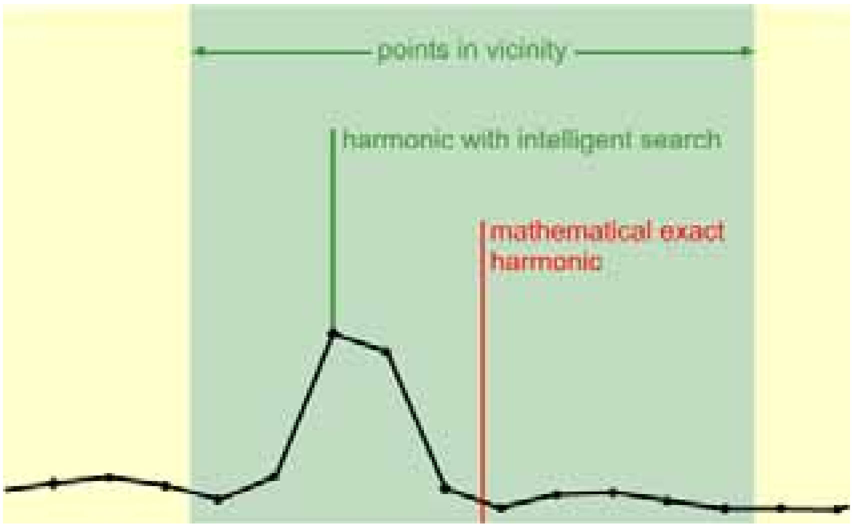
Micro-increments are necessary to allow the basic frequency to be more precisely defined. In this selection box you can enter the increment between two measured points that will be used to specify the basic frequency and also calculate the harmonic.

Cursor type "Fault-tolerant search"

The harmonics are precisely calculated for the current cursor. The indicators for the harmonics are set so they locate the **nearest maximum value** for the harmonics calculated.

Nearest points

The Viewer calculates the precise mathematic values of the harmonic. The intelligent cursor analyses the number of nearest points specified in this field (measuring points in the diagram in both directions) for maximum values and positions the indicator for the harmonic at the nearest maximum value.



Calculated harmonic

You can enter the number of harmonics that must be calculated in each case in this field.

Coordinates

Switched on: the coordinates (value pairs) of the harmonics are displayed in the diagram.

Switched off: the coordinates (value pairs) of the harmonics are removed from the diagram.

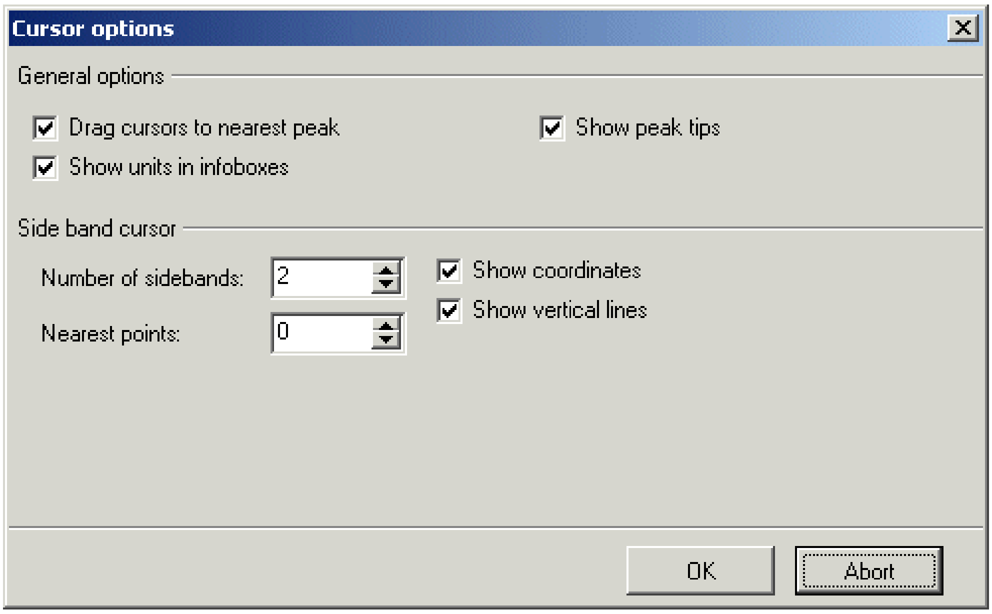
Vertical lines

Switched on: the harmonics are identified in the diagram using the cursor symbol and a vertical line.

Switched off: the harmonics are identified using only the corresponding cursor symbol.

Modifying the properties of the sideband cursor

In addition to the general cursor options described in Modify the cursor properties 145 you can also modify additional options of the sideband cursor (described below). To do this, activate or deactivate the appropriate fields in the dialogue window or select the value required from the selection boxes.



Number of sidebands In this field you can enter the number of sidebands that must be calculated for the current cursor in each case.

Nearest points The Viewer calculates the precise mathematic values of the sidebands. The number of nearest points specified in this field (existing measuring points in the diagram) are then analysed for maximum values and the sideband marker is positioned at the nearest maximum value.

Displaying coordinates **Switched on:** the measured values of the respective sidebands on the X and Y axes are displayed at the vertical lines.

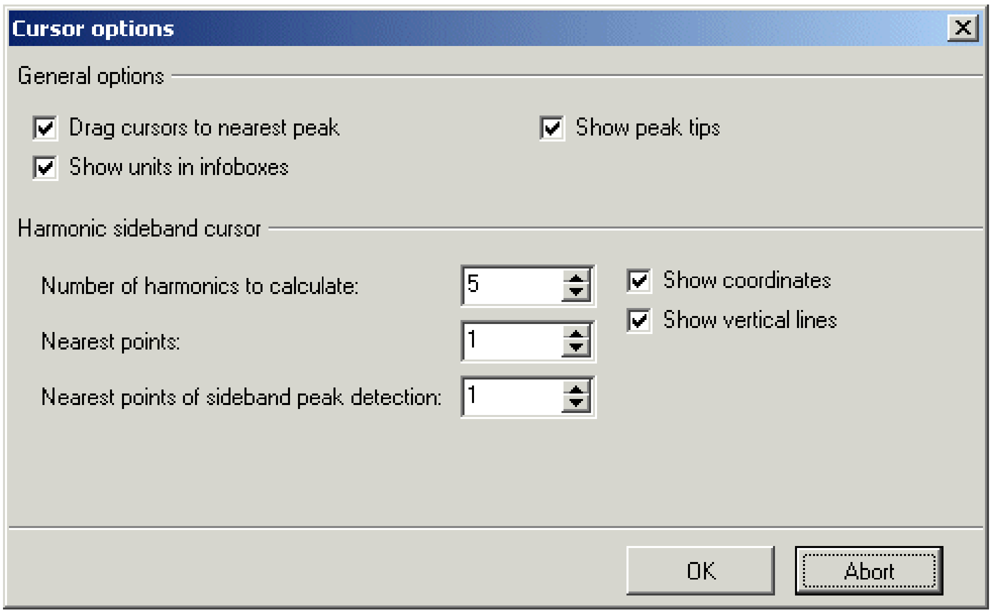
Switched off: the measured values of the sidebands are removed from the display.

Displaying vertical lines **Switched on:** the harmonics are identified in the diagram using the cursor symbol and a vertical line.

Switched off: the harmonics are identified using only the corresponding cursor symbol.

Changing the properties of the HS cursor

In addition to the general cursor options described in Modify the cursor properties 145 you can also modify the additional options for the HS cursor (described below). To do this, activate or deactivate the appropriate fields in the dialogue window or select the value required from the selection boxes.



Calculated harmonic You can enter the number of harmonics that must be calculated in each case in this field.

Nearest points Each harmonic is determined precisely using a mathematical process. You can enter the number of nearest points to the left and right of the harmonic identified to be analysed for maximum values. The highest value in each case is then labelled as a harmonic and displayed.

Number of nearest points Each sideband is also determined precisely using a mathematical process. You can enter the number of nearest points to the left and right of the sideband identified to be analysed for maximum values. The highest value in each case is then labelled as a sideband and displayed.

Displaying coordinates **Switched on:** the measured value for each harmonic and sideband on the X and Y axes is displayed at the vertical line.

Switched off: the measured values of the harmonics and sidebands are removed from the display.

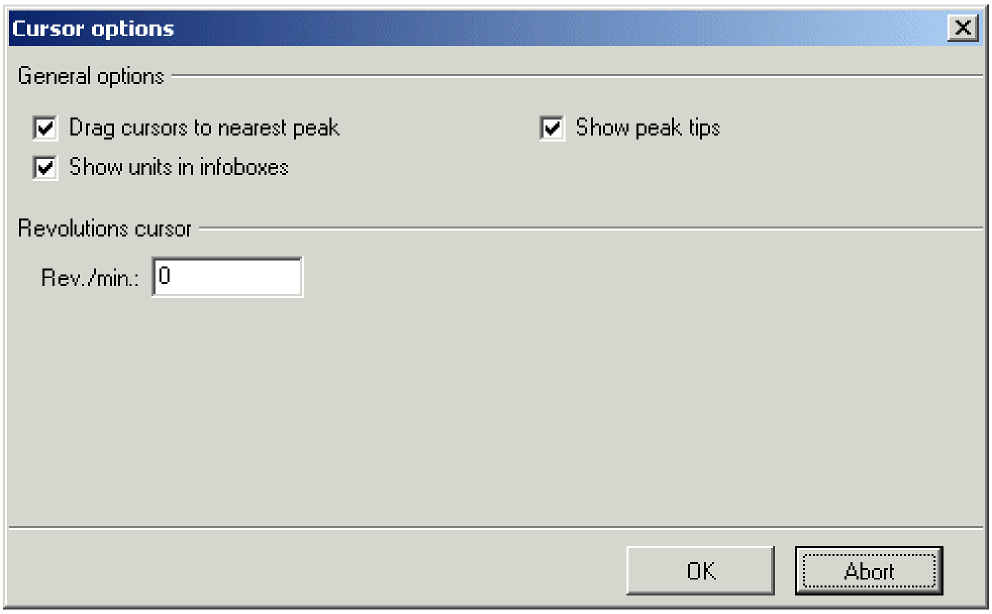
Displaying vertical lines **Switched on:** the harmonics and sidebands are identified in the diagram using the cursor symbol and a vertical line.

Switched off: the harmonics and sidebands are identified using only the corresponding cursor symbol.

Modifying the properties of the revolutions cursor

In addition to the general cursor options described in Modify the cursor properties

145 you can also modify the additional option for the revolutions cursor – this is described below. To do this, activate or deactivate the appropriate fields in the dialogue window or enter the appropriate value in the input field.



Rpm Enter a speed [rpm] in the input field. The Viewer uses this value to calculate the corresponding frequency and positions the revolutions cursor at the appropriate location in the diagram.

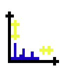
4.2.8 Other tools

Copying a diagram as a graphic to the clipboard

 You can use this tool to copy the current diagram view to the clipboard.

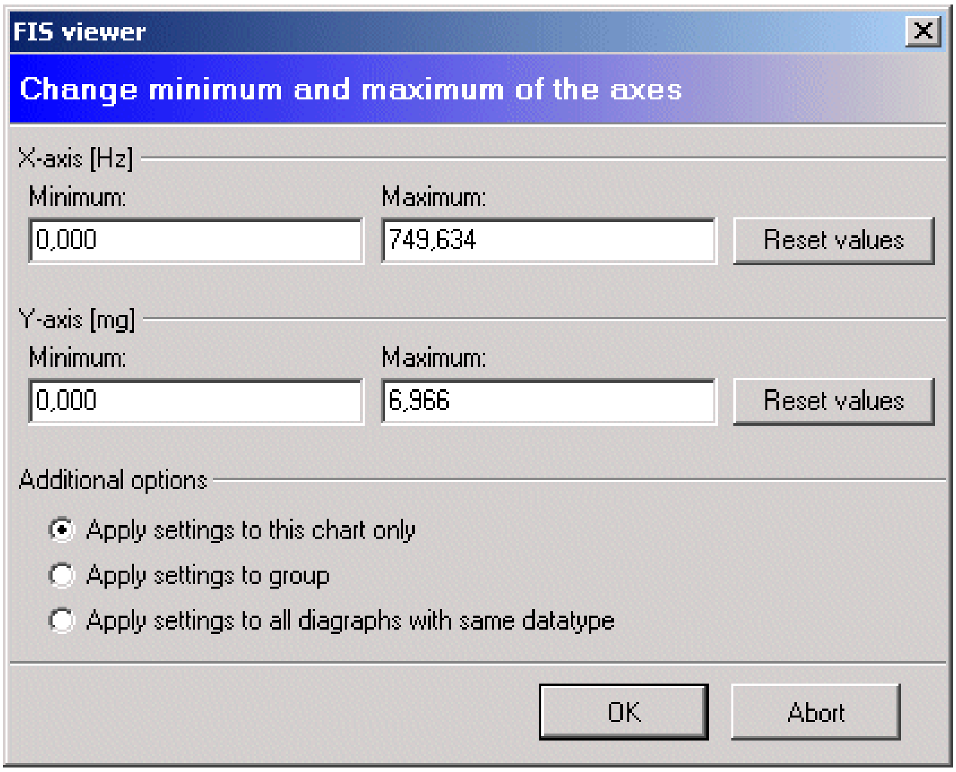
1. Click on the **Copy diagram to clipboard** symbol.
2. Switch to the application in which you wish to insert the image.
3. Select the **Paste** option from the **Edit** menu for the application or use the shortcut **Ctrl+V**

Modifying coordinates of axes

 You can use this tool to change the minimum/maximum values displayed on the X and Y axis.

1. Click on the **Modify diagram limits** symbol.

➔The "Modify maximum values" dialogue is displayed.



2. Enter a new minimum/maximum value for the X and/or Y axis in the corresponding fields.
3. If you click on the **Reset** button the original maximum value of axes is determined from the actual measurement data and reset.
4. If the settings also need to be adopted for other diagrams in the group or for those of the same type then select the required option under **Additional options**.
5. Click on **"OK"**.

➔ The diagram (and other diagrams if relevant) is displayed with the chosen settings applied.

4.2.9 Using the diagram information bar

Displaying the diagram information bar

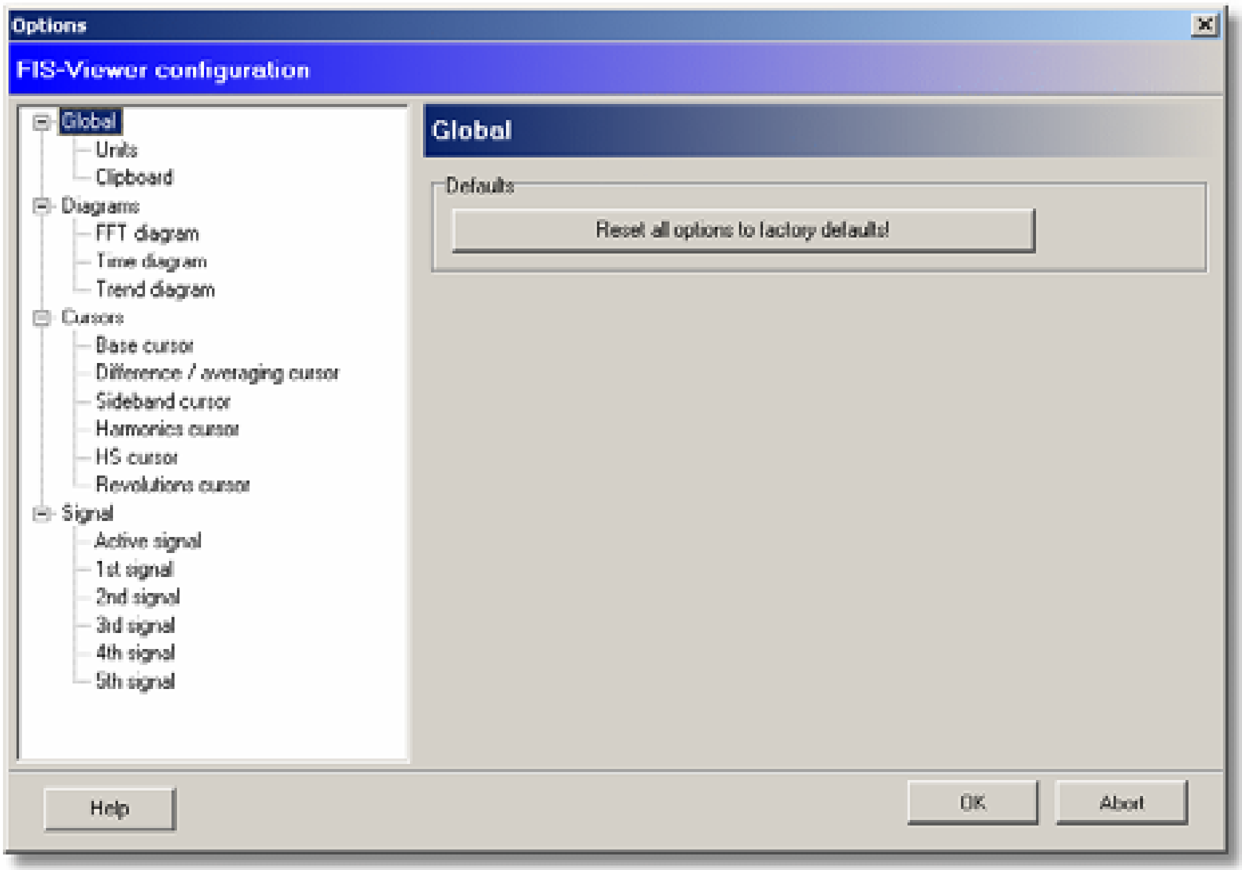
The diagram information bar contains additional information on the diagram displayed and outputs the relevant characteristic measured values in tabular form depending on the cursor selected. There a number of ways in which the diagram information bar can be displayed.

Adjusting the default setting for the diagram information bar display via the options

The default setting for the diagram information bar display can be adjusted via the options. The adjustments can be made for each diagram type individually (FFT, time signal or trend data). This default setting is used when new diagrams are opened.

1. Click the mouse on the **Extras** menu.
2. Select the **Options** menu item.

➔The options dialogue opens.



3. Select the **Diagrams** heading in the left-hand column. Open the navigation menu by clicking the mouse on the "+" symbol.
4. Select the required diagram type (FFT viewer, time signal viewer or trend viewer) to change the setting.

➔The options for the selected diagram type are displayed in the right-hand field.

5. Activate the **Display diagram information bar at start up** checkbox in the **Diagram information bar** field.

➔The changes are applied the next time this diagram type is opened.

Displaying the diagram information bar with the mouse

1. Click the mouse on the slim grey bar to the right of the diagram display.

➔The diagram information bar appears.

2. Once the diagram information bar is displayed click the mouse on the narrow grey bar to the left of the diagram display.

➔The diagram information bar is removed.

Displaying the diagram information bar via the keyboard

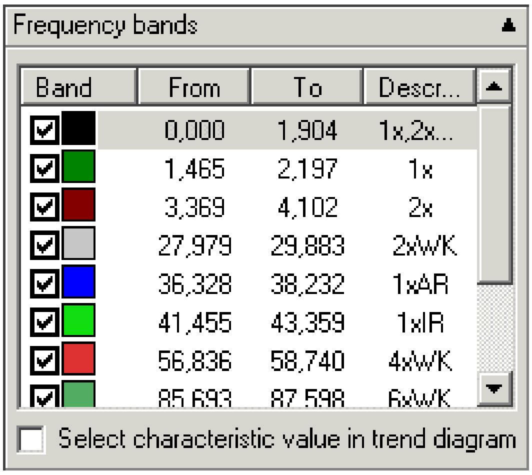
1. Use the keyboard shortcut **Ctrl+I** to display the diagram information bar.

➔The diagram information bar appears.

Displaying frequency bands

The diagram data in an FFT diagram contain important frequency bands from which characteristic values may be determined. The frequency bands which are defined by the higher-level application are highlighted in colour in the diagram. These frequency bands cannot be edited in the Viewer but can be displayed or removed as required. Frequency bands are only displayed in FFTs.

You can zoom to a range by double-clicking the frequency band. If the checkbox **Select characteristic value in trend diagram** is activated, a click in the frequency band will link to the corresponding signal in the trend view.



Frequency bands are only displayed in FFTs.

1. To activate or deactivate a frequency band in an FFT diagram click the checkbox ☑ in front of the required frequency band in the list.

➔The frequency bands selected are displayed in the diagram as coloured fields

You can switch the display of all frequency bands in an FFT diagram on or off via the context menu in the frequency band information window.

1. Right click the mouse at any desired point in the frequency band window in the diagram information bar.
2. Click **Select all** in the context menu to display all available frequency bands.

or

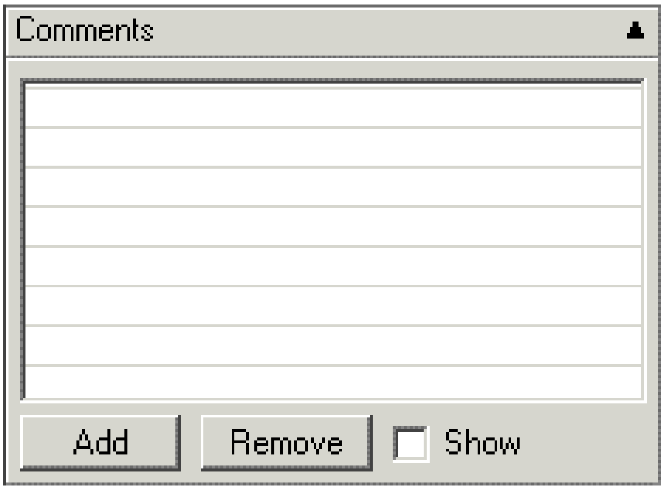
3. Click **Remove all** in the context menu to remove all available frequency bands from the diagram.

➔The frequency bands are displayed or removed depending on the setting.

Inserting comments into the diagram

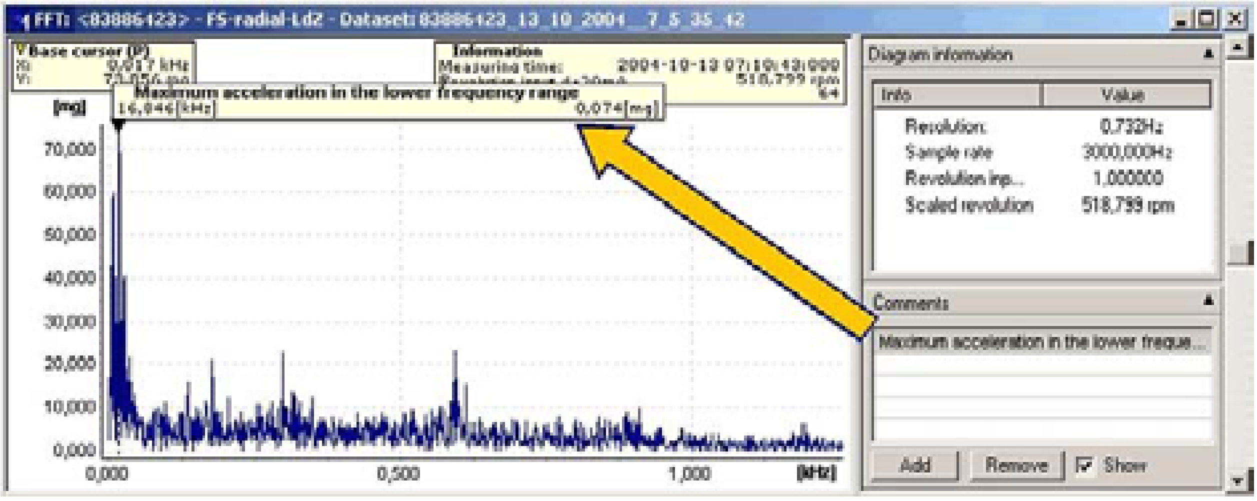
You can assign comments to individual measuring points in the diagram. The comments in the diagram are presented at the corresponding measuring point in an information field if the display field is activated.

1. Select the required measuring point using the **base cursor**.
2. Click the **Add** button in the **Comments** field in the right-hand section of the information area.



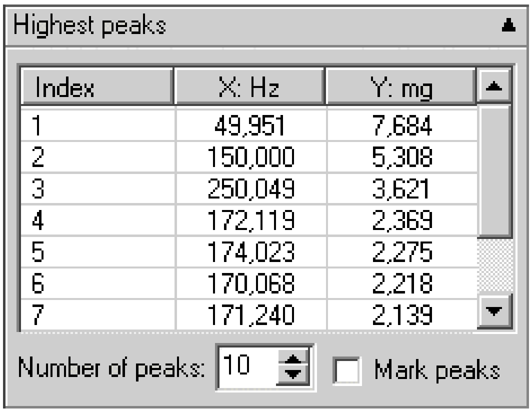
3. Enter a comment for the measuring point selected at the line provided for this in the table.

➔The comment is displayed in an information field at the corresponding measuring point in the diagram. You can remove the comment by left clicking with the mouse.



Displaying maximum values

The **highest peaks** field shows the highest measured values in Y axis of the diagram. You can define the number of maximum values displayed via the selection box. You can use the checkbox provided to display the maximum values in the diagram view.

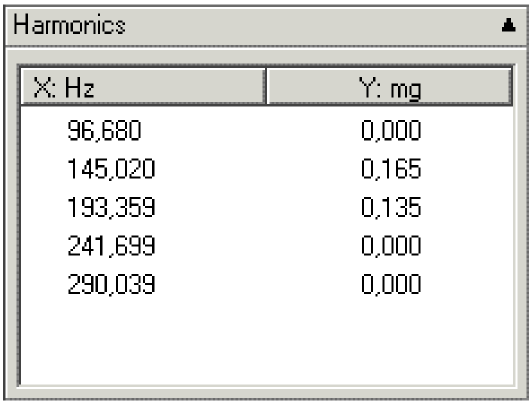


Index	X: Hz	Y: mg
1	49,951	7,684
2	150,000	5,308
3	250,049	3,621
4	172,119	2,369
5	174,023	2,275
6	170,068	2,218
7	171,240	2,139

1. If you wish to modify the number of maximum values displayed click the **Maximum value** field in the "Number of maximum values" option field.
2. Activate the **Display maximum values** checkbox to display the corresponding maximum values in the diagram.

Displaying the measured values of harmonics

If the harmonic cursor is selected this diagram information area is displayed. The table shows the measured values that most closely correspond to the harmonic.



X: Hz	Y: mg
96,680	0,000
145,020	0,165
193,359	0,135
241,699	0,000
290,039	0,000

The **Harmonic** table displays the measured values for harmonics calculated.

Modifying the settings for the harmonic cursor

You can modify the settings used to calculate the harmonics via the harmonic cursor properties.

1. To modify the settings click on the **Cursor properties** symbol  in the "Navigation and Tools" field.
2. Modify the settings in the cursor properties dialogue field.

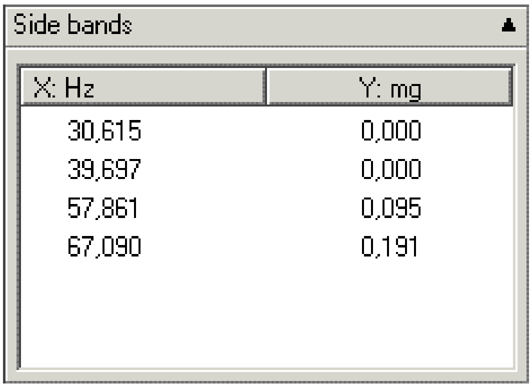
Copying measured values for the harmonics via the clipboard

You can transfer measured values for the harmonics to other applications via the clipboard.

1. Highlight each measured value you wish to transfer to another application in the table or right click on the table and pick the **Select all** menu item from the context menu.
2. To copy the highlighted measured values to the clipboard click the **right-hand mouse button** on the table. Pick the **Copy selected values to the clipboard** menu item from the context menu.
3. Switch to the other application and click the paste symbol or select the **Paste** menu item from the **Edit** menu.

Displaying the measured values of sidebands

If the sideband cursor or HS cursor is selected this field is displayed in the information area and contains the measured values that most closely correspond to the defined sidebands.



Side bands

X: Hz	Y: mg
30,615	0,000
39,697	0,000
57,861	0,095
67,090	0,191

The **Sidebands** table displays the measured values for the relevant sidebands calculated.

Modifying the settings for the sideband cursor

You can modify the settings used to calculate the sidebands via the sideband cursor properties.

1. To modify the settings click on the **Cursor properties** symbol  in the "Navigation and Tools" field.
2. Modify the settings in the cursor properties dialogue field.

Copying measured values for the sidebands via the clipboard

You can transfer measured values for the sidebands to other applications via the clipboard.

1. Highlight each measured value you wish to transfer to another application in the table or right click on the table and pick the **Select all** menu item from the context menu.
2. To copy the highlighted measured values to the clipboard click the **right-hand mouse button** on the table. Pick the **Copy selected values to the clipboard** menu item from the context menu.
3. Switch to the other application and click the paste symbol or select the **Paste** menu item from the **Edit** menu.

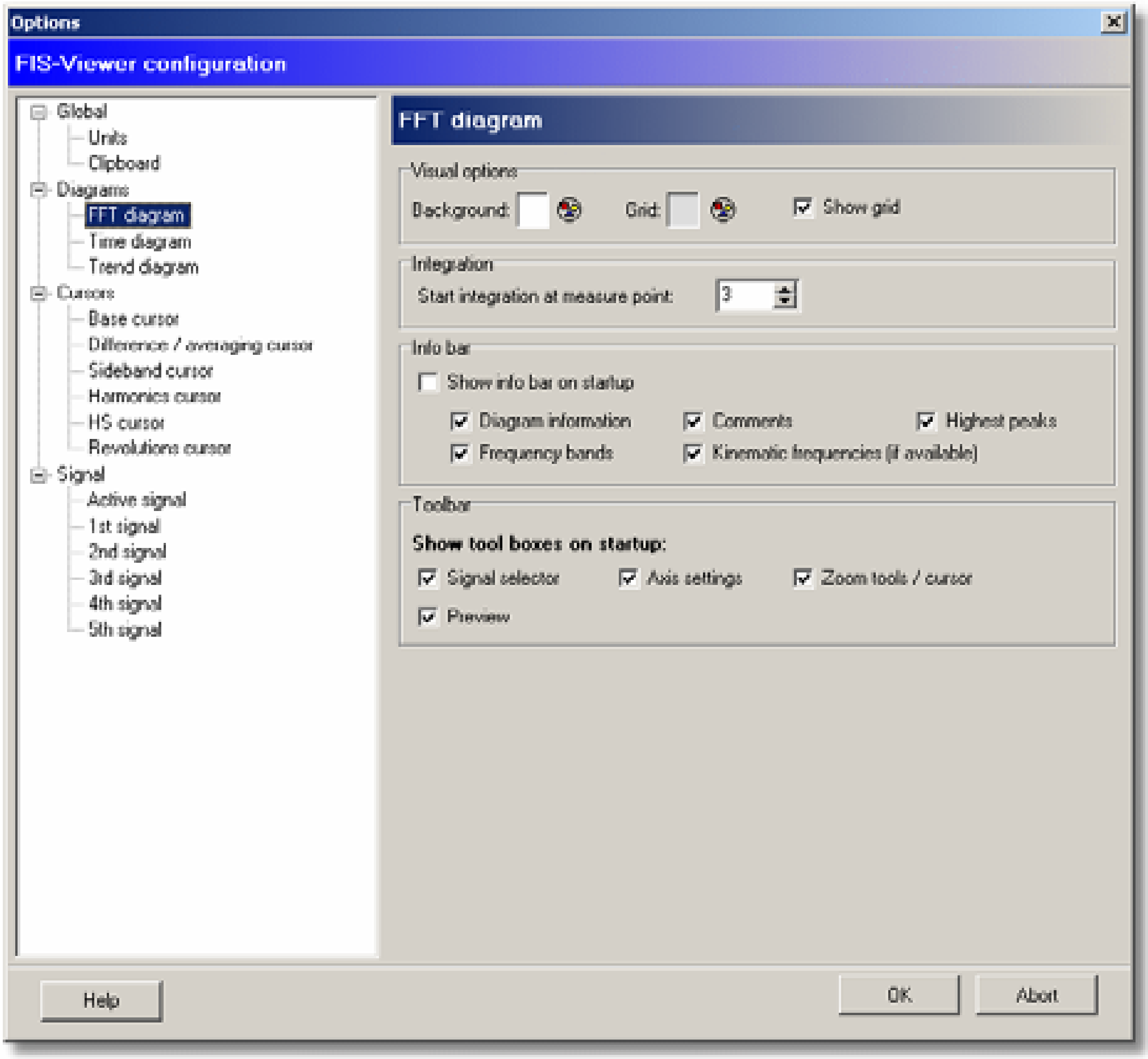
Removing the diagram information bar from the display

Adjusting the default setting for removing the diagram information bar from the display via the options

The default setting for the diagram information bar display can be adjusted via the options. The adjustments can be made for each diagram type individually (FFT, time signal or trend data). This default setting is used when new diagrams are opened.

1. Click the mouse on the **Tools** menu.
2. Select the **Options** menu item.

➔The options dialogue opens.



3. Select the **Diagrams** heading in the left-hand column. Open the navigation menu by clicking the mouse on the **+** symbol.
4. Select the required diagram type (FFT viewer, time signal viewer or trend viewer) to change the setting.

➔The options for the selected diagram type are displayed in the right-hand field.

5. Deactivate the **Show right info bar of viewer at startup** checkbox in the **Info bar** field.

➔The changes are applied the next time this diagram type is opened.

Removing the diagram information bar with the mouse

1. Click the mouse on the slim grey bar to the left of the diagram information bar.

➔The diagram information bar is removed.

Removing the diagram information bar via the keyboard

1. Use the keyboard shortcut **Ctrl+I** to remove the diagram information bar from the display.

➔The diagram information bar is removed.

4.2.10 Exporting data via the clipboard

You can use this button to copy the current diagram view to the clipboard.

1. Click on the **Copy diagram to clipboard** symbol.
2. Switch to the application in which you wish to insert the image.
3. Select the **Paste** option from the **Edit** menu for the application or use the shortcut **Ctrl+V**.

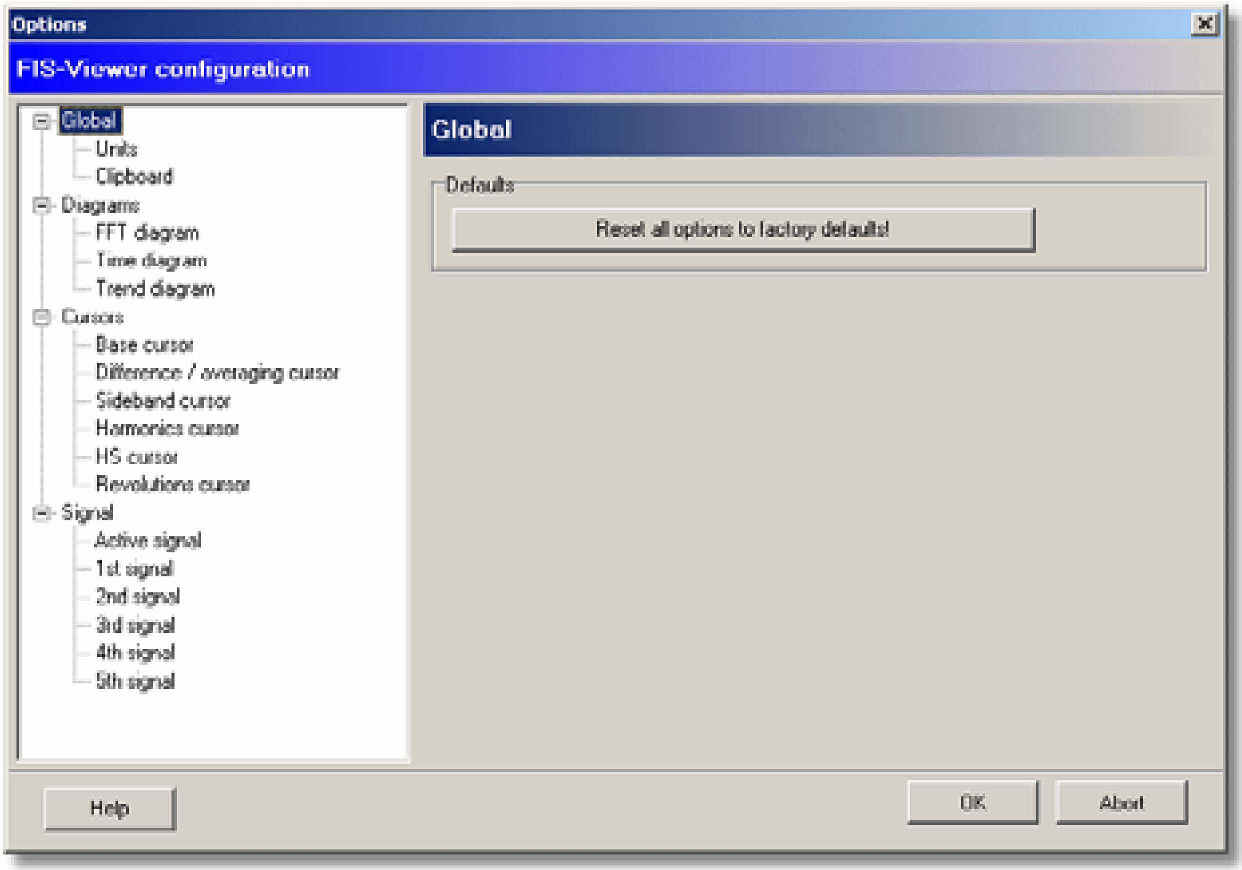
4.2.11 Viewer settings

Modifying the global settings

You can restore the factory settings for the Viewer using the **Global** dialogue window (status following initial installation of the Viewer).

1. Click the **Replace all settings with factory settings!** button

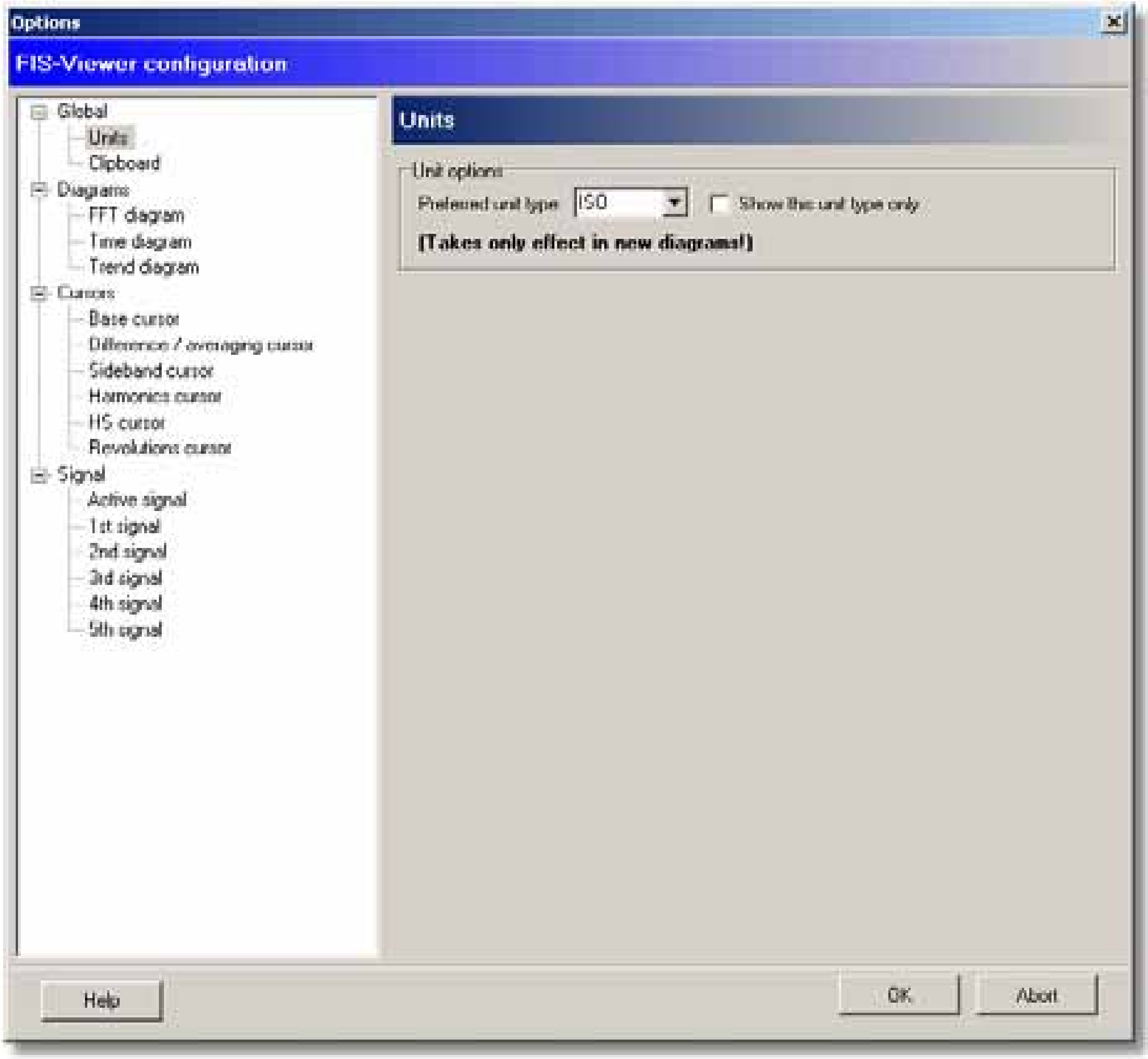
➔The settings are reset.



Measurement units

You can specify the options for scaling units used in the diagrams in the **Measurement units** dialogue window. The available options are ISO units (e.g. metres) and US units (e.g. inches).

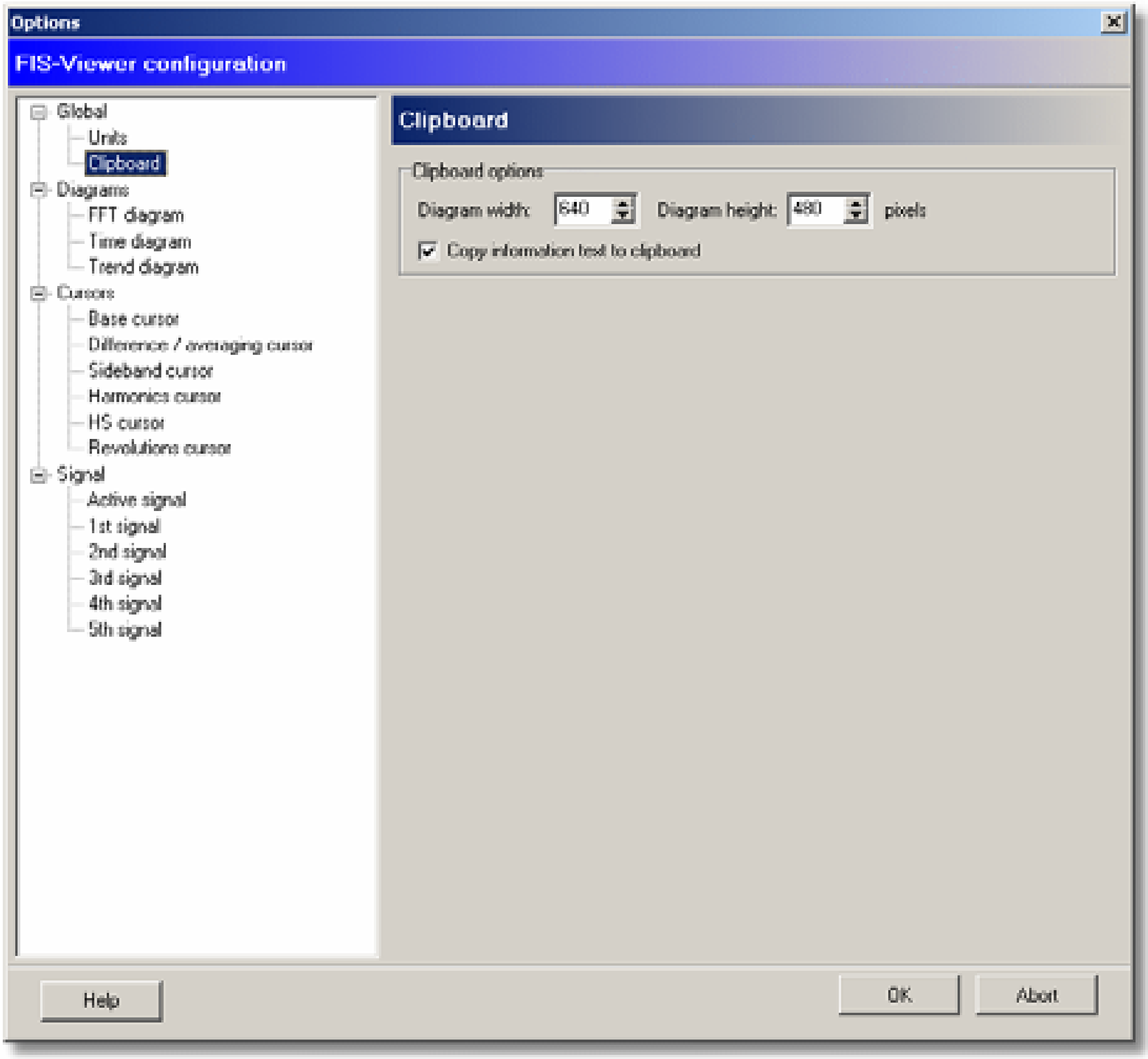
1. Select ISO units or US units from the **Preferred type** dropdown menu. The units you selected are displayed first in the list of available scaling units during scaling.
2. If you wish to use only ISO or US units activate the **Display only this unit type** checkbox. Only the units you selected are displayed in the list of available scaling units during scaling.
3. Click on **OK** to apply these settings.



Clipboard

You can select the options for transferring the diagrams as graphics to the clipboard in the **Clipboard** dialogue window.

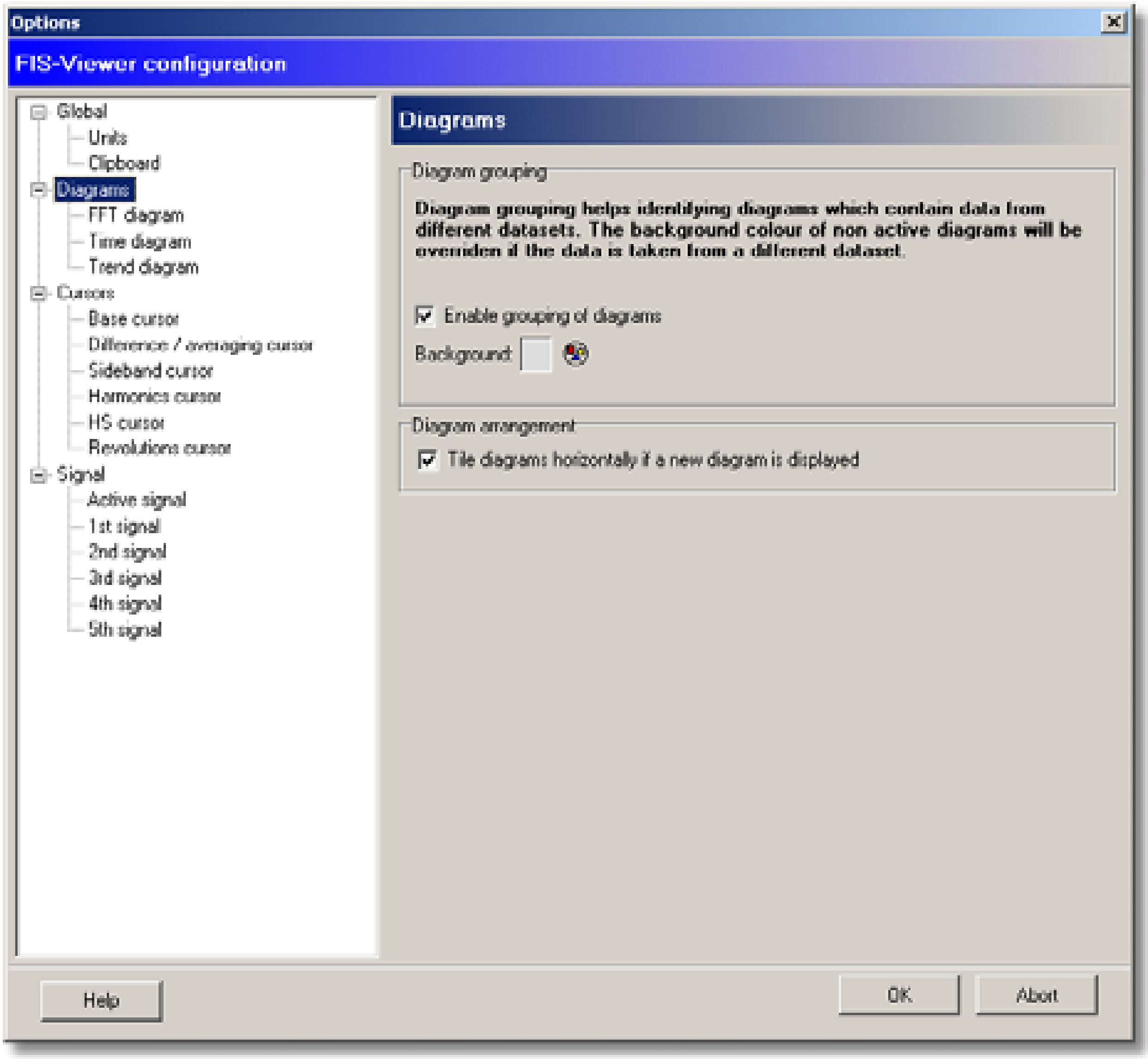
1. Select the required dimensions for the diagram display in the **Diagram width** and **Diagram height** fields.
2. Activate the **Copy information text to clipboard** checkbox if you also wish the diagram title to be copied with the graphic.
3. Click on **OK** to apply these settings.



Modifying the diagram settings

You can specify the general diagram settings in the **Diagrams** dialogue window.

1. You can specify whether diagrams belonging to the same data set should be identified using colour in the **Diagram grouping** field.
2. If required, activate the **Arrange diagrams horizontally if new diagram is displayed** checkbox.
   a) If this option is activated the Viewer arranges the diagram windows horizontally (below one another) and the new diagram is opened at the lowest position in the diagram window.
   b) If this option is deactivated new diagram windows are cascaded.
3. Click on **OK** to apply these settings.

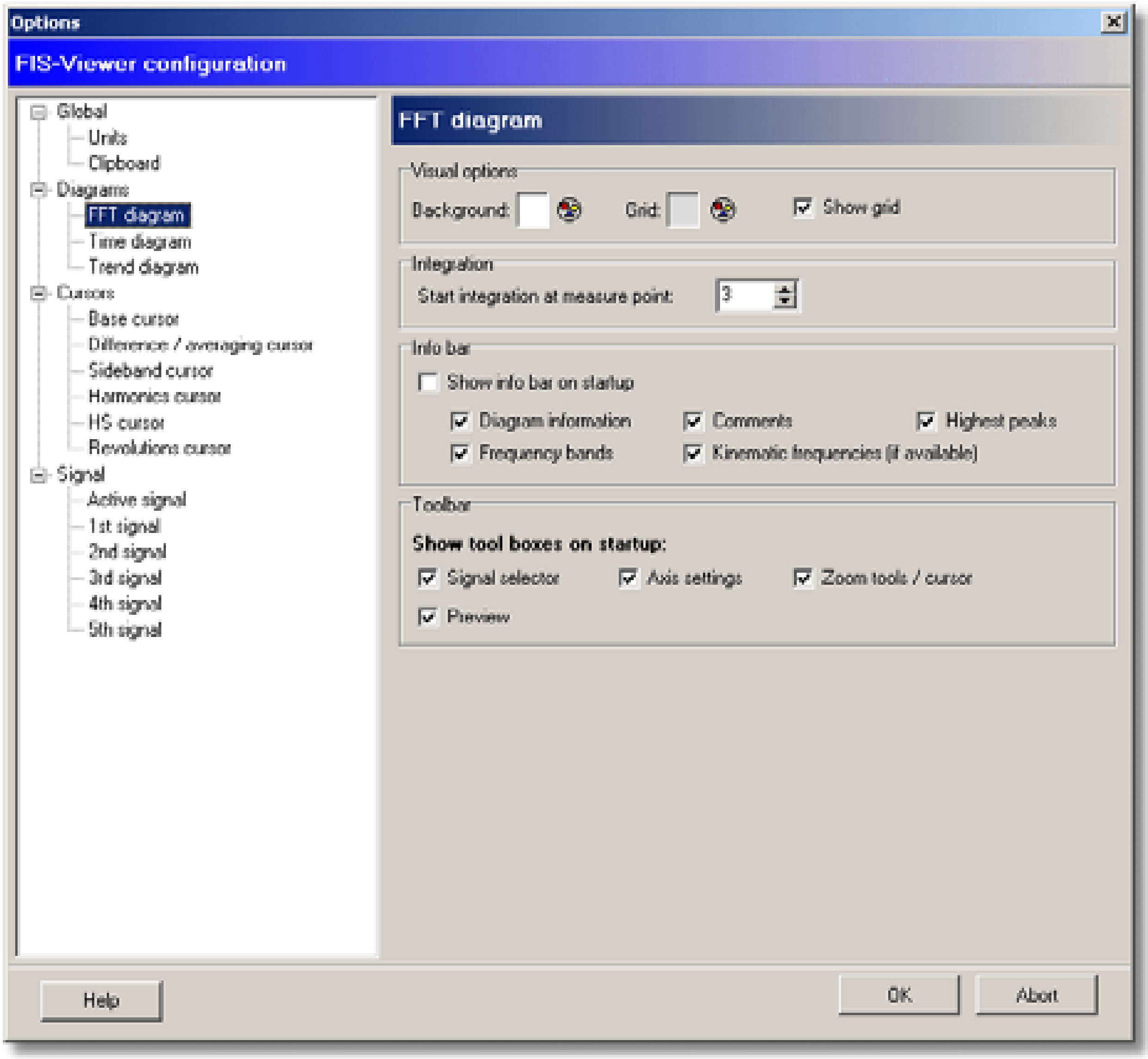


FFT diagrams

You can select the various FTT diagram display options in the **FFT diagram** dialogue window.

1. You can specify the background colour for the FTT diagram in the **Display settings** field. You can also define here whether you wish the grid to be displayed in the background and also its colour
2. You can specify from which point in the diagram an integration should take place in the **Integration** field.
3. In the **infobar** area you can define which diagram information (see "Using the diagram information bar" 152) should be shown after opening a new diagram.
4. In the **toolbar** dialogue you can select, whether the signal selector, axis settings, zoom tools and preview are displayed when opening a new diagram.

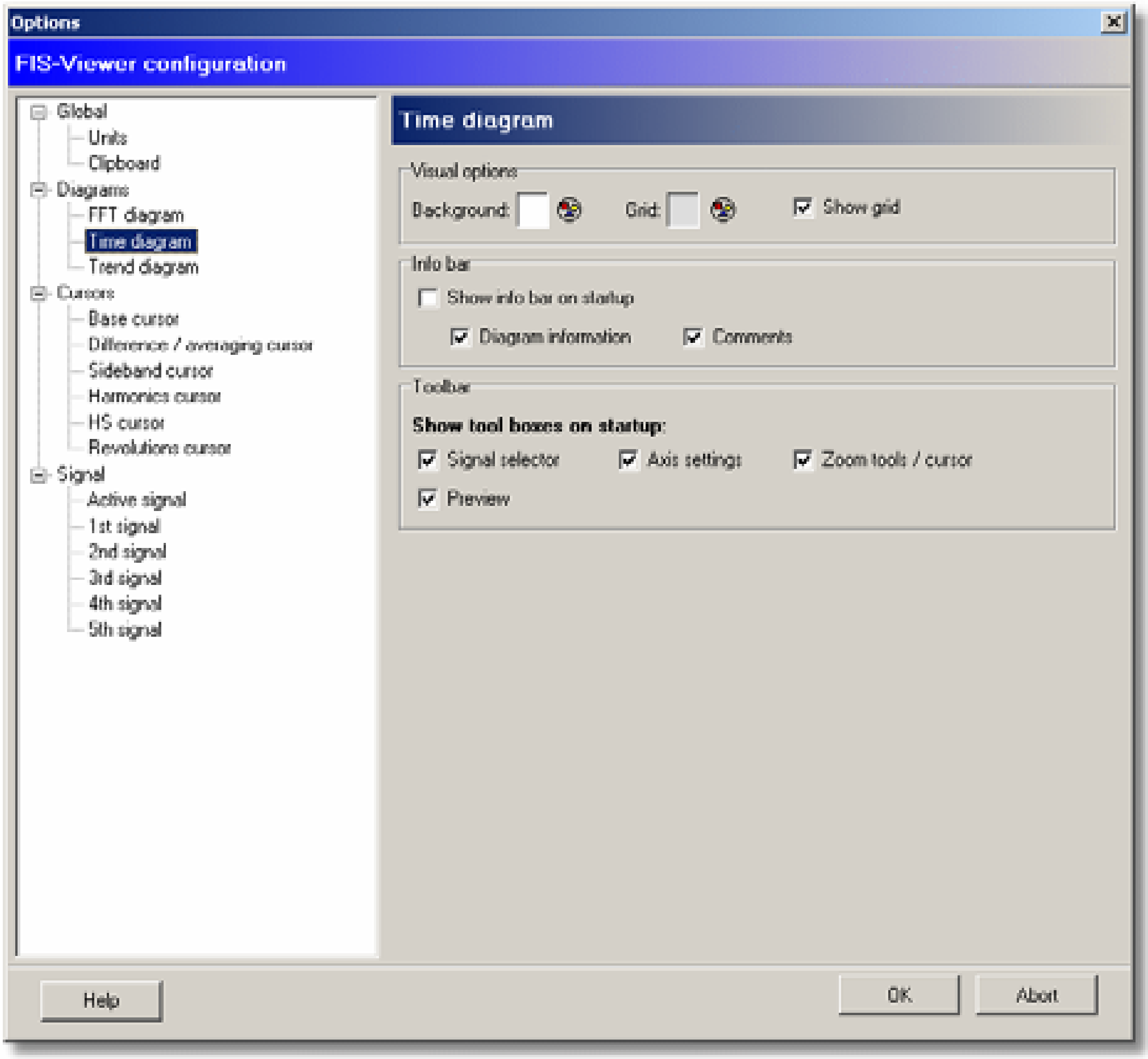
5. Click on **OK** to apply these settings.



Time signal diagram

You can define certain options for displaying a time signal diagram in the dialog window **Timesignal diagram**.

1. The section **Visual options** allows you to adjust the background color of the timesignal diagram. Furthermore you can toggle the display of the background grid and change its color.
2. The section **Info bar** allows you to specify, whether the diagram information will be displayed immediately when opening a new diagram.
3. In the **toolbar** dialogue you can select, whether the signal selector, axis settings, zoom tools and preview are displayed when opening a new diagram.
4. Click on **OK** to apply these settings.



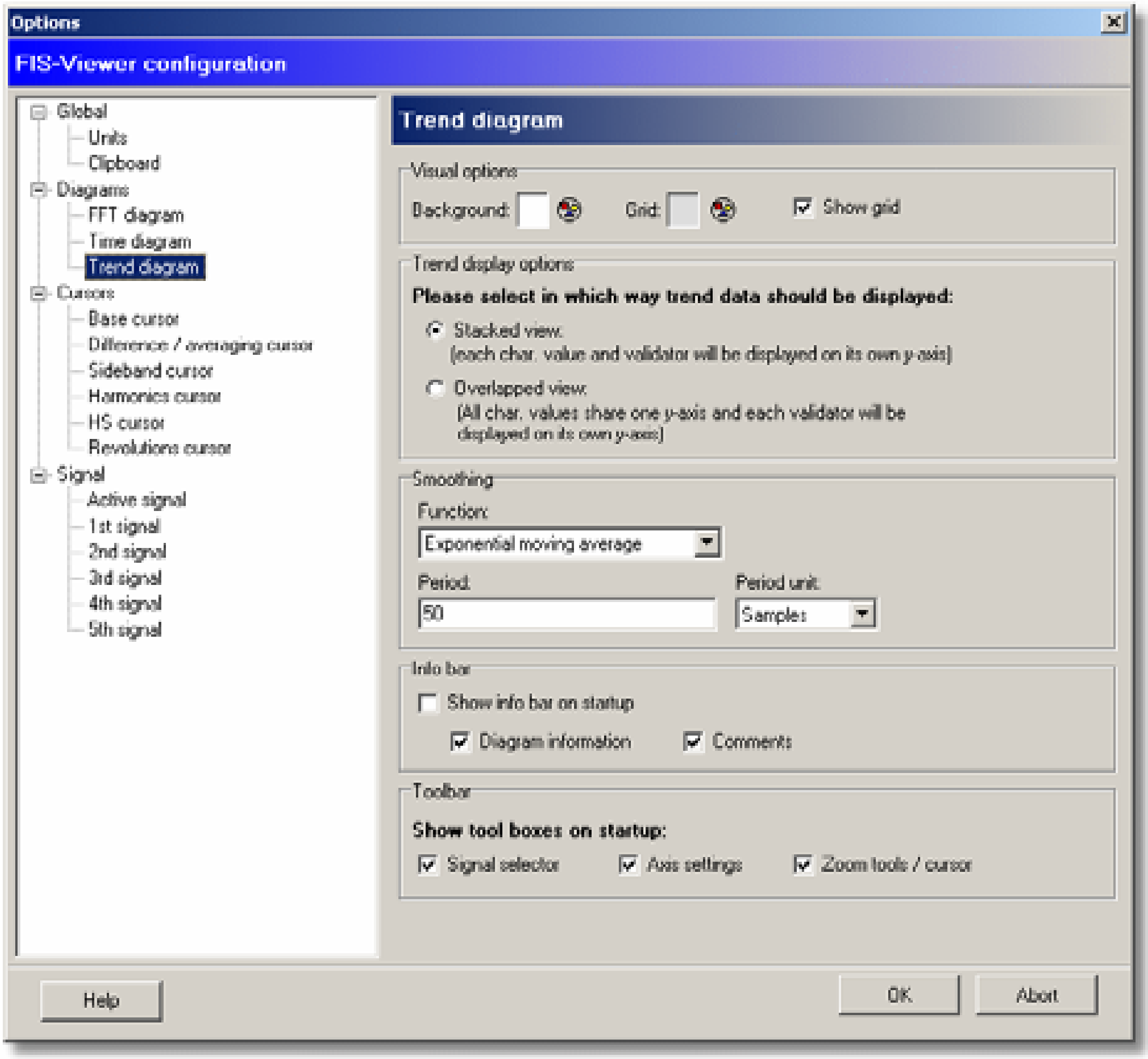
Trend diagram

In addition to the display settings already presented with the FTT diagram 164 and the diagram information bar option the settings for the trend display and smoothing can also be specified in the **Trend diagram** dialogue window.

1. You can specify in the **Trend display settings** field whether each characteristic value should be displayed in a separate diagram or whether all characteristic values should be displayed in one diagram.
2. You can specify which function and which period length should be used to carry out the smoothing calculation in the **Smoothing** field.
3. The section **Info bar** allows you to specify, whether the diagram information will be displayed immediately when opening a new diagram.
5. In the **toolbar** dialogue you can select, whether the signal selector, axis

settings, zoom tools and preview are displayed when opening a new diagram.

6. Click on **OK** to apply these settings.

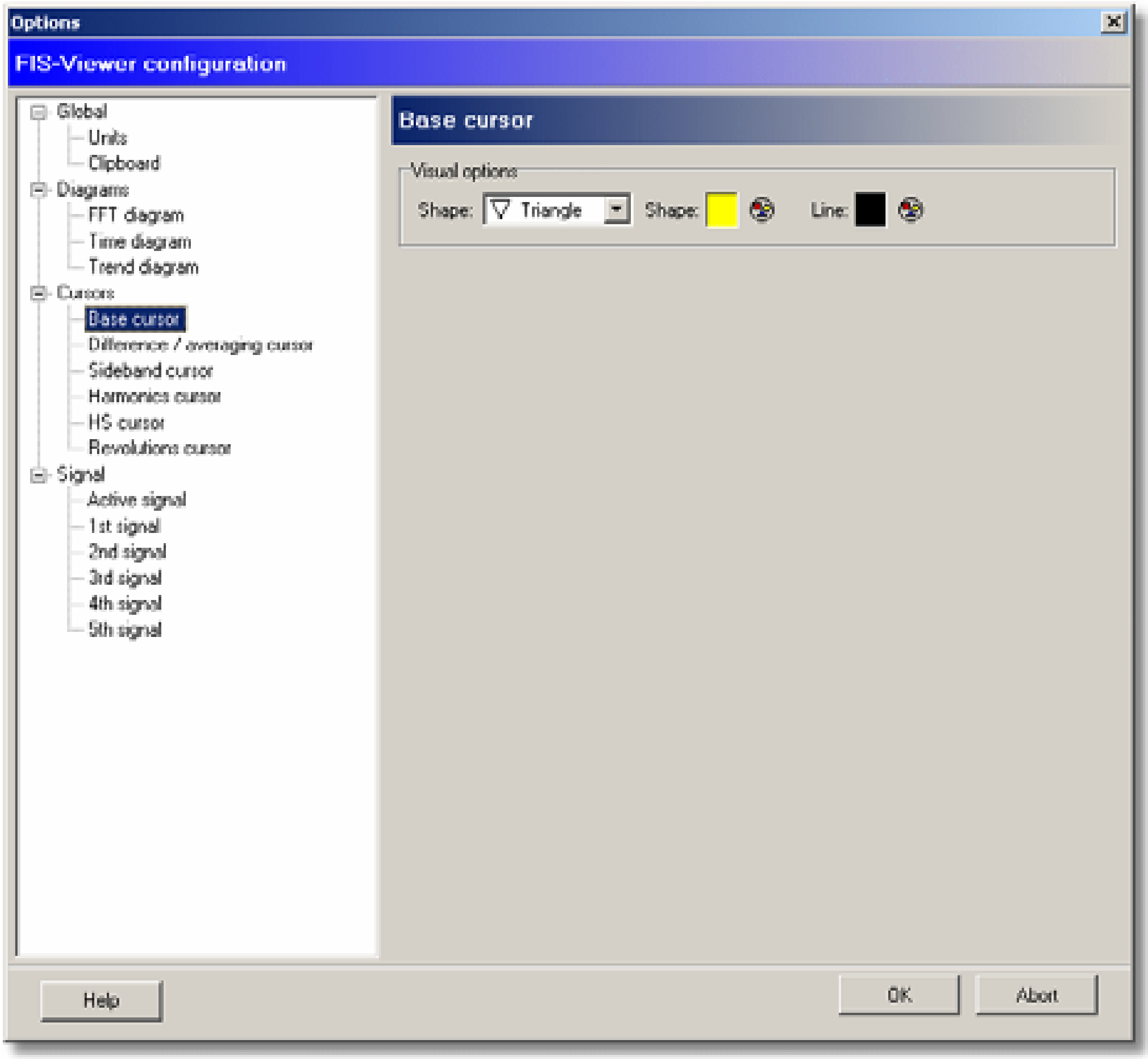


Modifying the cursor settings

You can modify how each individual cursor is displayed in the dialogue windows for the various cursors.

1. Select the cursor you wish to modify from the list of cursors on the left.
2. Select the required cursor shape for the cursor specified above from the **Symbol** dropdown menu.
3. Select the symbol and **colour** to be used for the cursor as well as the colour for vertical cursor **line**.
4. As the differential and averaging cursors work in pairs you can also modify the appearance of the second cursor in this field accordingly.

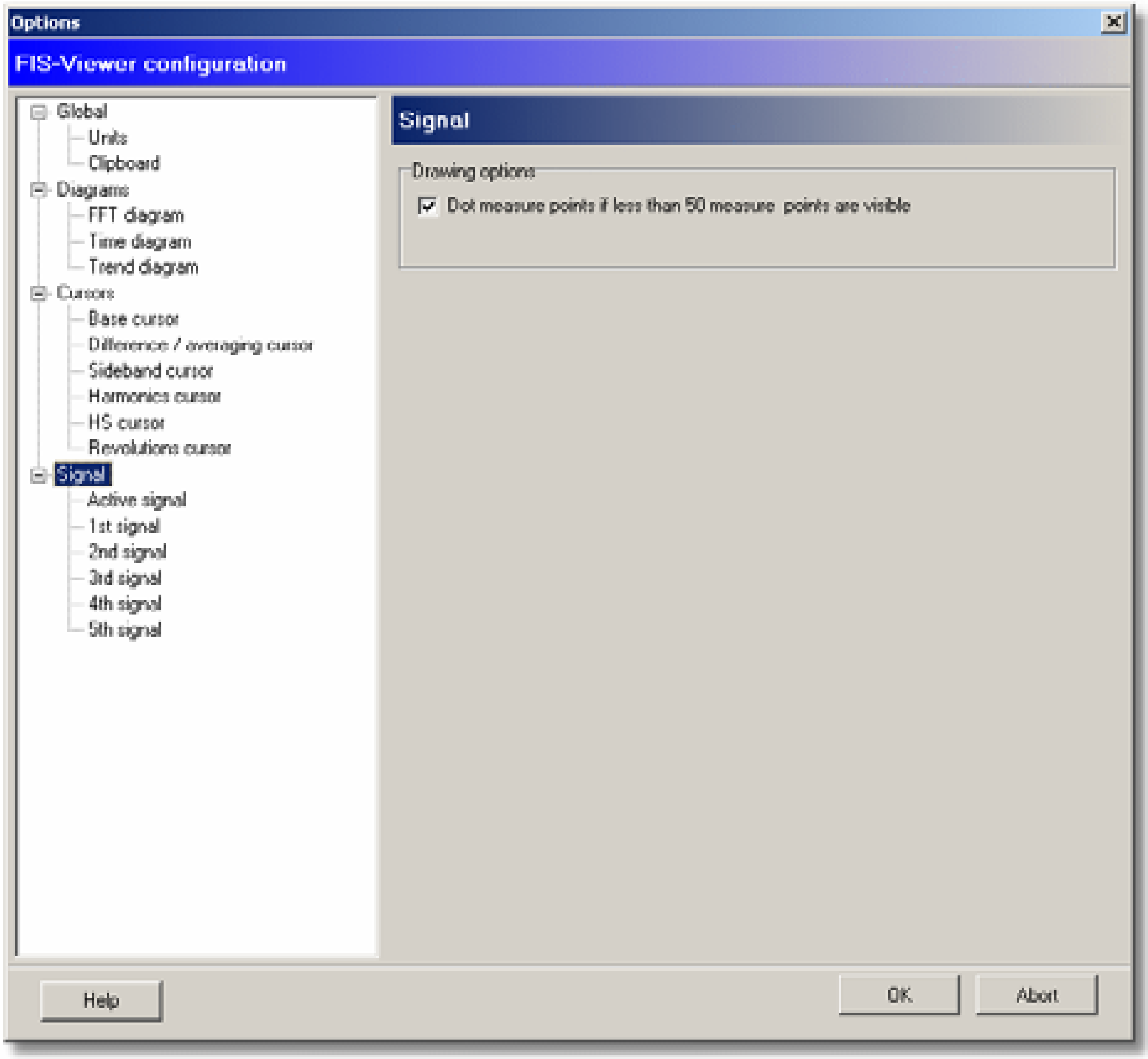
5. Click on **OK** to apply these settings.



Modifying the signal settings

You can select measurement data display options in the signal dialogue windows.

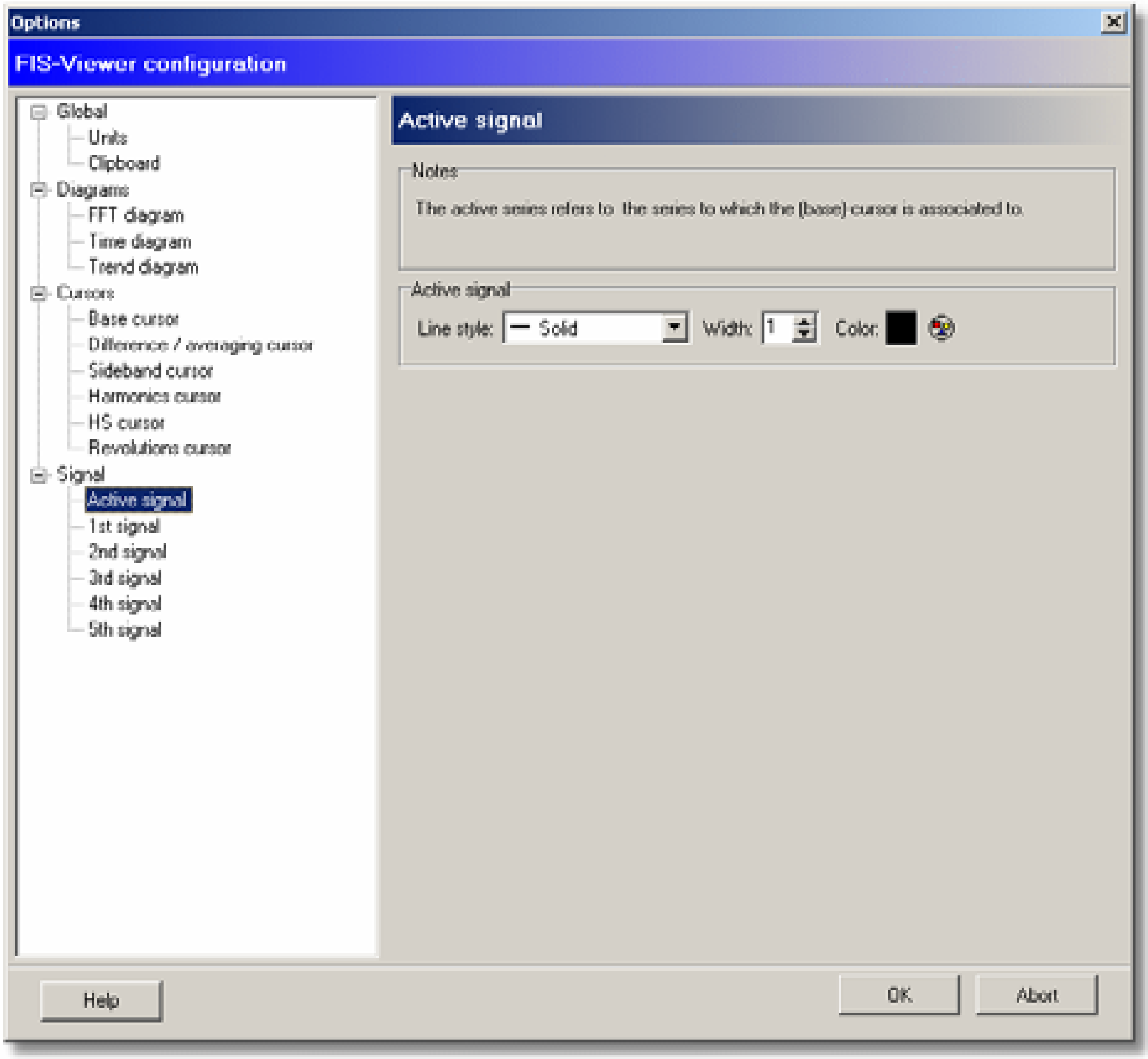
1. If less than 50 measured points are displayed in the diagram window each measuring point can be made clearly visible as a dot. If more than 50 measuring points are displayed in the diagram window the display of individual measuring points is automatically deactivated and only the graph of the function and not the measuring points remains visible.
2. Click on **OK** to apply these settings.



Active signal

You can modify the display of the individual signals in the signal options.

1. Select a **line type** for the signal from the dropdown menu.
2. Select a **line width** for the signal in pixels from the field provided.
3. Click on the palette to select a **colour** for the signal.
4. Click on **OK** to apply these settings.



You can also adopt these settings for additional signals.

4.3 Keyboard shortcuts

Cursor selection

Key	Function
F2	Activation of the base cursor
F3	Activation of the difference-cursor
F4	Activation of the averaging-cursor
F5	Activation of the harmonic-cursor
F6	Activation of the sideband-cursor
F7	Activation of the HS-cursor (harmonics with side bands)
F8	Activation of the speed-cursor

Cursor shift

Key	Function
Arrow left	Moves the base cursor to the next measuring point on the left
Arrow right	Moves the base cursor to the next measuring point on the right.
Arrow up	Moves the additional cursor to the next measuring point on the left
Arrow down	Moves the additional cursor to the next measuring point on the right
Ctrl + arrow left	Sets the base cursor on the first measuring point in the diagram
Ctrl + arrow right	Sets the base cursor on the last measuring point in the diagram
Ctrl + arrow up	Sets the additional cursor on the first measuring point in the diagram
Ctrl + arrow down	Sets the additional cursor on the last measuring point in the diagram
Alt + arrow left	Moves the base cursor 10 points to the left
Alt + arrow right	Moves the base cursor 10 points to the right
Alt + arrow up	Moves the additional cursor 10 points to the left
Alt + arrow down	Moves the additional cursor 10 points to the right
Ctrl + K	Moves the cursor one microstep to the left (only with harmonics cursor when the default detection is activated)
Ctrl + L	Moves the cursor one microstep to the right (only with harmonics cursor when the default detection is activated)
Ctrl + D	Shows or hides the cursor

Key	Function
Ctrl + P	Opens the dialogue window for the numeric positioning of the cursor
Ctrl + O	Opens the dialogue for the cursor option settings

Zoom

Key	Function
F9	Activates the free mouse zoom
F10	Activates the horizontal mouse zoom
F11	Activates the vertical mouse zoom
F12	Activates the keyboard zoom

Keyboard zoom

Key	Function
Ctrl + Q	Moves the start of the zoom area to the left
Ctrl + W	Moves the start of the zoom area to the right
Ctrl + A	Moves the end of the zoom area to the left
Ctrl + S	Moves the end of the zoom area to the right
Ctrl + Y	Moves the defined zoom area to the left
Ctrl + X	Moves the defined zoom area to the right
Ctrl + enter	Shows the defined zoom area
Ctrl + backspace	Shows the last zoom area again
Ctrl + space	Shows the complete diagram
Ctrl + Z	Opens the dialogue window for the numeric input of the zoom area

Diagram scrolling

Key	Function
Ctrl + B	Moves the display view to the left
Ctrl + N	Moves the display view to the right
Ctrl + J	Moves the display view up
Ctrl + M	Moves the display view down

Trend-Diagram

Key	Function
Ctrl + H	Reads an additional data set

Other shortcuts

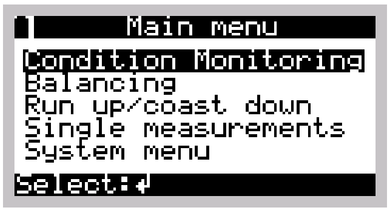
Key	Function
Ctrl + R	Reset comment positions
Ctrl + U	Shows/hides right infobox on the top border of the diagram
Ctrl + T	Shows/hides the toolbar
Ctrl + I	Shows/Hides the diagram infos on the right screen border
Ctrl + C	Copies a screenshot of the diagram into the clipboard

5 Detector III

5.1 Detector display

All information necessary for operating the instrument are shown to the user on a display. This includes

- selection of measuring points,
- user guidance while measuring,
- display of measured values,
- status display of data transfer between computer and Detector
- and system settings.



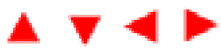
Main Detector menu

The accumulator symbol (top left in the display) informs you about the current accumulator 176 condition.

5.2 Keyboard

Detector III is exclusively operated via the keys on the foil-covered keypad.

The key functions can be found in the following table:

Button	Meaning
	On/off button
	Cursor buttons: Move cursor in direction of arrow
	Switch the display lighting on and off
	Cancel button: Cancel action, back one menu level
	Input key: Confirm selection Both input keys perform the same function and are equally valid.
	HOME button: Press this button to go directly to the main menu from any menu.
	Time signal button: You can use the time signal button to display the time signal and FFT following a measurement.

F	Function key: You can use the function key to call up special functions. You can also use this key to enter a decimal point when entering numbers.

Navigation through menus

Menu items can be marked using the ▲ or ▼ key and selected using the ↵ key. You can go back one level using the esc-key.

Entering numbers

- If you can enter numbers in the Detector (when inputting the rotational speed manually, for example) the default numerical value flashes. Now press a numerical key to delete the old value and enter the new one.
- To overwrite a specific digit position the cursor on the right or left of this digit using the cursor keys and enter the new digit. The previous value is overwritten.

The alpha-numeric keys are currently not used.

5.3 Explanation of the symbols

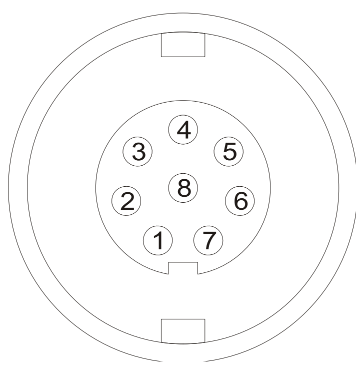
Several icons are used in the Detector to guide the user. In the following table these icons are explained:

Symbol	Meaning
esc	Escape key
↵	Enter key ↵
	▲ key
	▼ key
	▲ or ▼ key
	◄ or ► key
	• sub-tree has been measured partially, or • the balancing job has been started, but isn't finished yet.
	• sub-tree has been measured completely, or • a balancing job has been finished.
	symbol for time signal key 174
>	is displayed in front of a menu entry, when this entry can be selected.

–	is displayed in front of a menu entry, when this entry cannot be selected.

5.4 Connectors

The Detector has altogether over 5 circuit points at the top end:

<table>
<tr><th>Connector</th><th>Meaning</th></tr>
<tr><td>BNC-connectors 1/2</td><td>Each connection accommodates one active sensor with excitation current (4.7 mA). Port 1 is always used for CM measurements. Port 2 can be used for two-plane balancing measurements.
As the Detector is a single-channel device it cannot perform measurements at both ports simultaneously!</td></tr>
<tr><td>3.5 mm jack</td><td>Connection for headphones or analog recording device. The headphones connection can only be activated via the individual measurements menu.</td></tr>
<tr><td>9-pin sub-D socket</td><td>Connection for a serial data line to facilitate exchange of data with the computer (RS 232 interface).</td></tr>
<tr><td>AUX socket
(8p socket)</td><td>A temperature sensor or trigger sensor may be connected to the AUX socket. It is assigned as follows:
<table>
<tr><td>1</td><td>Output</td><td>12V supply for trigger sensors (12V against DGND)</td><td rowspan="8"></td></tr>
<tr><td>2</td><td>Input</td><td>GND Temperature sensor</td></tr>
<tr><td>3</td><td>Input</td><td>+ Temperature sensor</td></tr>
<tr><td>4</td><td>Output</td><td>DGND</td></tr>
<tr><td>5</td><td>Input</td><td>+ Trigger sensor signal</td></tr>
<tr><td>6</td><td>Input</td><td>GND Trigger sensor signal</td></tr>
<tr><td>7</td><td>Output</td><td>5V supply for trigger sensors (5V against DGND)</td></tr>
<tr><td>8</td><td>-</td><td>Not used</td></tr>
</table></td></tr>
<tr><td>Charging port
(4p socket next to serial port)</td><td>For connection of battery charger.</td></tr>
</table>

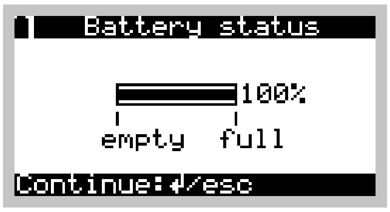
5.5 Accumulator

The power supply of the Detector is provided by a removable accumulator. The Detector constantly checks the accumulator charge level. If the accumulator is not sufficiently charged, the device issues a warning message and then shuts down automatically.

After Charging 177 the accumulator, the Detector is ready for use again. The accumulator stays connected to the device during charging.

Checking accumulator charge level

Click **Accumulator Charge Level** in the System menu to check the accumulator charge level. The accumulator charge level is displayed graphically and in % of maximum capacity.



Accumulator charge level

During normal operation, the accumulator symbol (top left of display) indicates the charge level.

Charging the accumulator

Only use the included charger for charging the battery!

In order to charge the accumulator

- connect the included battery charger to a 230V outlet and
- connect the Detector to the battery charger via the charge connector.

The charging process starts automatically as soon as the Detector is connected to the battery charger and depending on the current accumulator charge level.

The temperature of the accumulator must be between 2 °C and 44 °C. Outside of this range, the charging process is delayed until the accumulator has reached the appropriate temperature.

The LEDs on the battery charger indicate the charge level. Please refer to the battery charger manual for further information.

Note that the Detector cannot be switched on during the charging process.

> *Recharge the accumulator regularly even when it is not in use so that the Detector is always ready for use.*

5.6 Switching on and off

Switching on

Keep the button pressed for one second to switch on the Detector. Right after switching on, the system checks the accumulator charge level. If it is not sufficient for a measuring process, i.e. of battery charge is less than 5% of maximum capacity, you are prompted to recharge the accumulator. The Detector shuts down after this error message.

If no new action is performed within two minutes after the Detector's last action, the device automatically shuts down. You must switch it back on to perform a new action.

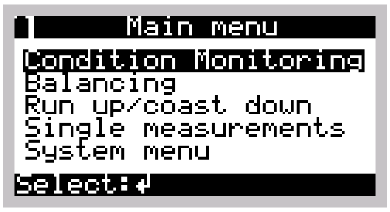
> *If the accumulator is completely empty, you will not be able to switch on the Detector at all (without an error message). This prevents the accumulator from deep discharging. Recharge the accumulator to work with the Detector again.*

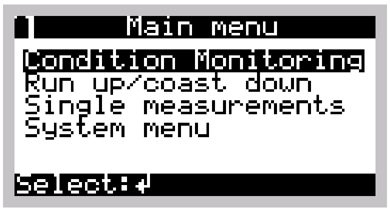
Switching off

Press the button again to switch off the Detector.

5.7 Main menu

The main menu containing the Condition monitoring 179, Balancing 179, Run up/coast down 179, Single measurements 179 and System menu 180 options is displayed when the Detector is switched on.





The Balancing menu item is only available if the balancing function is enabled 38 *on the Detector.*

Condition monitoring

Via the menu **Condition Monitoring** and its submenus the measuring is done. Here, you decide, whether you want to carry out pre-configured or free measurement and, at which measuring points you want to record data. After selecting the measuring point desired, you start measuring and decide subsequently, if you want to store or reject the data. Measured data and system messages are displayed, while you take the measurements. A more detailed description you can find in CM-measurement 182.

Balancing

You can use this option to select the measuring point for the balancing measurement 189.

Run up/coast down

Use this menu item to select the run up/coast down for determining resonant ranges 199.

Single measurements

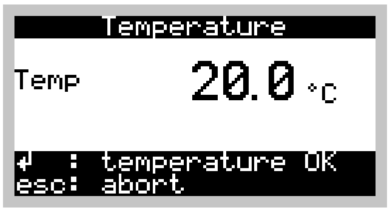
Headphone

With the Detector the headphones cannot be used when a measurement is in progress. The headphones function can be activated via **Single measurements** > **Headphone** in order to "listen to" a measuring point and the amplification factor for this option can be adjusted.

In addition to headphones an analog recorder may also be connected to the 3.5mm jack. Measurement with headphones is described in more detail in using a headphone 189.

Temperature

The temperature can be measured directly via **Individual measurements** > **Temperature** without requiring prior configuration. The same procedure for carrying out a normal Temperature measurement 188 is also used here. The only difference in this case is that the temperature cannot be saved.



Rotational speed

The rotational speed can be measured directly by selecting **Single measurements** > **Rotational speed**.

The Detector shows the current rotational speed and the rotational speed determined.

ICP sensor test

The ICP sensor test checks the following cases based on the bias voltage of the sensor connected to the BNC1 connector:

- The voltage is within the specified range: The sensor is functional.
- The voltage is greater than maximum sensor voltage: The sensor cable is defective or no sensor is connected.
- The voltage is between 0 and minimum sensor voltage: The sensor is defective.

System menu

You can specify global settings for the Detector in the system menu.

Change language

Select display language. The following languages are currently available: German, English, French, Italian, Dutch, Spanish, Portuguese, Swedish, Finnish, Slovenian and Turkish.

Adjust LCD lighting

In order to save battery running time the display lighting switches off automatically once the time preset here has elapsed. The following settings are available: 30s, 60s, 90s and no automatic deactivation.

Adjusting contrast

Press "cursor right" to increase and "cursor left" to decrease display contrast.

Memory manager

Shows the space occupied by configuration and measuring data in the memory. See Dynamic memory management 213.

Accumulator charge level

Displays the charge remaining in the battery 176.

Detector information

Displays the date and time as well as the serial number and software version of the Detector. The date of the last calibration is also displayed here.

RFID settings

This menu item is only visible if the Detector has an RFID reader.

Select whether the Detector should confirm successful import of an RFID tag. The following settings are available: optical, acoustic, both.

5.8 Data transfer

Data are exchanged in both directions between Detector and the computer Trendline software is installed on. With the help of the Trendline software measuring configurations and routes are created and administrated on the computer, and measuring data are stored and evaluated.

On the one hand, measuring configurations and routes created and administrated on the computer are transferred to Detector. On the other hand, recorded measuring data are downloaded from Detector to evaluate and store them using the Trendline software.

The data transfer between Detector and PC is controlled by the Trendline software.

- Connect the serial interface of Detector (9-pin sub-D-connector at the instrument shaft) with a free serial interface of the computer Trendline software is installed on.
- Follow the sequence as described in the Trendline software help menu.
- You can interrupt the data transfer between Detector and computer at any time by pressing the  -key.

The transfer of a new route or configuration to Detector deletes all data stored on the instrument.

5.9 Measuring procedure

During a measuring round the sensor signals are recorded at all measuring points and the characteristic values calculated. The measuring points can be measured in random order.

Before you go out on a measuring round with your Detector III, you should

- You should mark the measuring position, where the sensor should be mounted for the measurement, in a suitable way. (only then will you get comparable results usable for trend analysis), and
- label the measuring points (only then can a measuring point be clearly identified)
- If you are using the RFID addon for the Detector (see also "Automatic assignment of RFID tags to measuring points 43"), make sure that all measuring points have been assigned RFID tags.

Please ensure before every measuring round

- that the measuring data stored in the previous measuring round are transferred to the computer as these will be overwritten by new data (only after due warning),
- that the proper configuration for the system to be measured has been transferred to Detector III.
- that the accumulator is charged.

5.10 CM-measurement

CM measurement procedure

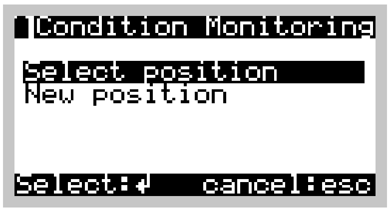
1. First select the measuring point on the Detector at which you wish to perform the measurement. You can use the optional RFID reader for this purpose (see also "Automatic assignment of RFID tags to measuring points 43").
2. The rotational speed is determined at the start of a CM measurement if so

specified in the Measuring point configuration 45. If the rotational speed is outside the defined band, the Detector displays an error message. If no signal is measured for the rotational speed you can enter the speed manually.

3. If active sensors are used, the Detector initializes the sensor and measures the bias voltage. This must reach the defined range 34 within 10s otherwise the Detector cancels the measurement.
4. The Detector then uses the values last transferred by the Trendline software to initialize the PGAs in the following order: main PGA -> demodulation PGA (also see Analog branches in the Detector 214. If these values are not suitable the Detector defines new settings for the PGAs.
5. Measurement and determination of characteristic values:
   a) The Detector measures the specified channels.
   b) The time signals are used to calculate the FFT.
   c) The detector uses the FFT to calculate the characteristic values.
6. If you selected the averaging function 45 for this measuring point in Trendline the measurements are repeated according to the number selected:
   a) The average value of all FFT values calculated is used for FTT averaging. This is then used as the basis for calculating the characteristic values.
   b) When averaging the characteristic values the characteristic values for each measurement are firstly evaluated. The average value for all characteristic values calculated is then determined (steps 5a-5c are repeated).
7. Finally, the temperature is measured providing this has been specified in the configuration.

5.10.1 Selection of measuring point

Using the menu **Condition monitoring** you decide first of all if you want to record data at a measuring point of a pre-configured measuring route or at a new measuring point.



Select measuring point

Measuring at a pre-configured measuring point

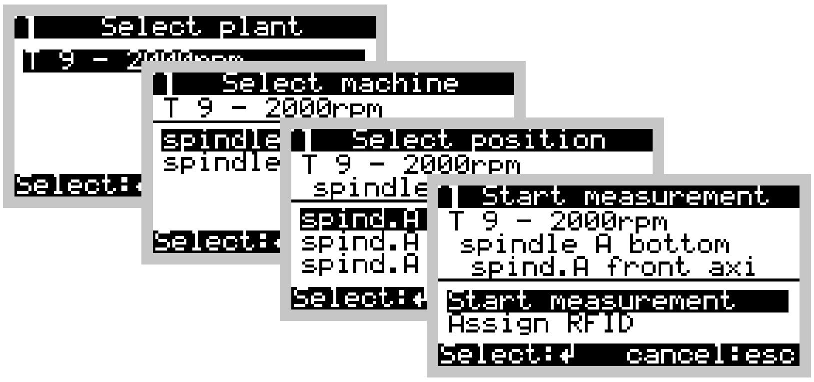
Fix the sensor to the pre-determined point.

- Start with the menu item **Condition Monitoring** > **Select measuring point**.
- If you have marked your measuring points with RFID tags (see Automatic assignment of RFID tags to measuring points 43), the Detector automatically

recognizes the measuring point as soon as you move the area under the display near to the RFID tags.

If the detector recognizes more than one RFID tag, it displays a list of all tags found for selection. If the configuration does not contain one or more of the tags, the Detector displays an error message to indicate this.

- If no RFID tag is available, select then the name of the measuring point you have fixed the sensor to using the subsequent menus.
- Then mark **Start measuring** and
- confirm your selection using the ↵ key.



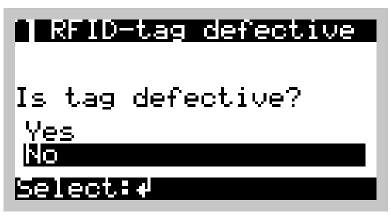
Starting the measurement after selecting a measuring point

A measuring point that has already been measured is indicated in the menu with the ■ symbol.

When all measuring points in a sub-tree of a configuration (e.g. a machine) have been measured, this is also marked like this. Is the subtree only partially measured, then the Detector shows a symbol.

If a line in the menus is crossed out, a data error has occurred at this point. It cannot be selected. For this, see System messages and their meaning 205 as well.

Are at the selected measuring point still data from the last measurement stored in Detector II, you can view the measuring results again before starting the new measurement.



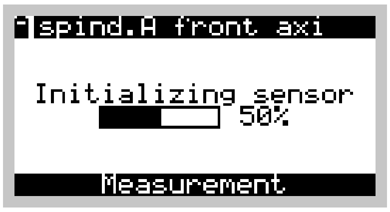
In addition, you can mark an RFID tag as defective with **RFID defective** if the

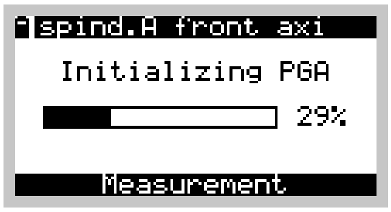
Detector could not recognize it and you manually selected the measuring point.

5.10.2 Measuring procedure

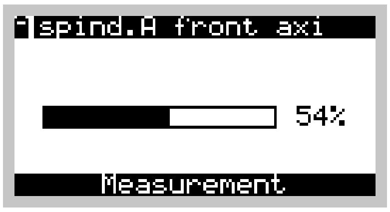
The measuring procedure consists of several steps and runs off automatically as described in CM-measurement 182.

- Initialize the sensor and set the amplification factor





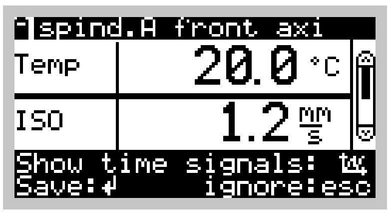
- Record the time signals, calculate the FFTs and the characteristic values.



After the measurement, the calculated results are shown 185.

5.10.3 Display of values measured

You can view time signals measured directly once the measurement has been carried out or by selecting an old measurement in the display. All time signals used to calculate the characteristic values (depending on the configuration) are available directly after the measurement has been carried out, also if the option "Do not save time signals" is selected in the configuration. Depending on the configuration, it is possible when viewing an old measurement to view certain time signals.



A scrollbar is displayed on the right of the display if more than two characteristic values exist. Temperature and rotational speed are also displayed as a characteristic value.

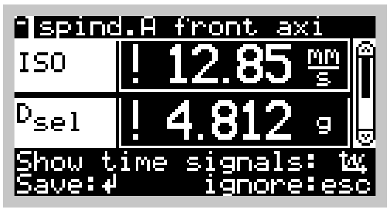
- Press the time signal button to switch to the Time signals display 186.
- If the time signal button is pressed once again in the time signal view the FFT display 187 for the selected time signal appears.
- Press , to switch to comment selection.
- You can now allocate a comment defined in the Trendline software (see " Managing comments for measurements 52") or press the button to abort comment slection.
- The measurement is saved.

If you have already carried out a measurement at this point the Detector asks whether the last measurement should be overwritten (also following a multiple measurement 188!) or whether the latest measurement should be saved in addition to the last measurement.

Once the characteristic values have been saved the Detector jumps to the **Select measuring point** menu item to enable you to record data at an additional measuring point on the same machine (see "Selection of measuring point 183").

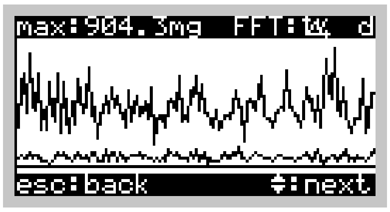
If no further measurements need to be carried out at the machine you can switch the device off and move on to the next machine.

Where a characteristic value is displayed inverted with an exclamation mark the alarm threshold for this characteristic value has been exceeded. A main alarm has occurred.



5.10.4 Viewing time signals on the Detector display

You can go to the time signal view by pressing the button 174 in the measured value view.



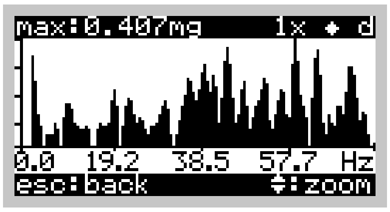
When viewing the time signal, press the or the key to switch between the several time signals. At the top right side a character is displayed (a for acceleration, v for velocity and d for demodulation) to indicate the type of time signal. At the top on the left side the amplitude of the highest peak of all measured values is displayed.

Time signals are only displayed on the Detector to give a first quality assessment of measured data. The detailed analysis is performed with the Trendline software.

Pressing the [****] 174 button opens the FFT display 187.

5.10.5 Display of the FFT on the Detector display

A typical FFT-display:



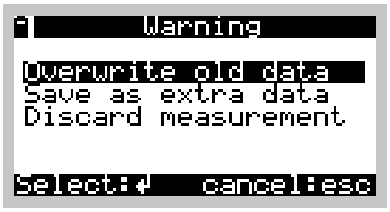
The following data is shown:

Symbol position	Description
Top left	Amplitude of the highest peak in the current window.
Top center	This shows the zoom factor, which can be changed by pressing (zoom in) and (zoom out). The zoom factor can be set to 0.1x – 0.4x – 1x – 2x – 4x – 8x. With zoom factor 8x it is possible to read the frequency value for each peak. When pressing the key in the FFT overview window (zoom factor 0.1x), the Detector leaves the FFT display and returns to the time signal display.
Top right **From the middle**	When the symbol is displayed, the auto-scaling mode is enabled. If so, the peaks in a window are scaled in a way to fit the largest peak in the display. When auto-scaling is disabled, all windows are scaled the same. Press the button to enable/disable auto-scaling. When switching off auto-scaling, the zoom factor is set back to 0.1x.
Top right	This character shows which FFT is displayed: a: acceleration v: velocity d: demodulation
Below the FFT	These numbers are the frequency range of the window, which is displayed. Press the -and the -key to scroll left or right resp. This doesn't work when the zoom factor is 0.1x, because the whole frequency range is already shown.

FFTs are only displayed on the Detector to give a first quality assessment of measured data. The detailed analysis is performed with the Trendline software.

5.10.6 Repeated measurements

You can measure the same measuring point multiple times. For this select a measurement which you have already measured and measure again like described before. After the measurement, press the key to save the data. Then the following menu is shown:



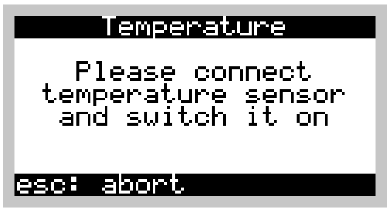
From the menu you can select three items:

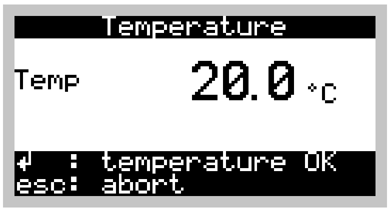
Overwrite old data	The last saved measurement of this measuring point will be overwritten. The time signals, which belong to the last measurement, will also be overwritten.
Add measurement	When you select this item and confirm with the key, this measurement is saved as repeated measurement. In the Trendline software it appears as an additional measurement of the same measuring point. The time signals are also saved, when this is required.
Discard measurement	The measurement is not saved. This corresponds to pressing the key immediately after the measurement.

Bear in mind that multiple measurements can be saved only if sufficient memory is available. If insufficient space is available in the memory for additional time signals these will not be saved, even if the option "Always save time signals" is activated in the configuration. If the memory no longer has the capacity to store characteristic values it will not be possible to save the values obtained during multiple measurement.

5.10.7 Measuring with temperature sensor

If for a give measurement point next to vibration characteristic values temperature should be measured also, the characteristic value Temperature has to set up for this measuring point using the Trendline software. The Detector will record characteristic vibration values first of all. Prior to measuring the temperature you will be prompted to connect, or switch on respectively, the temperature sensor. The Detector takes about 5 seconds between connecting or switching on for initializing the temperature sensor. While measuring the current temperature value is displayed. You can accept this value by pressing the ↵ key.





- The temperature sensor Raynger IP-M switches itself off automatically after a couple of minutes, even if the switch remains ON. If the display prompts you to turn on the temperature sensor, even though the switch is ON, turn it off and on again. If that does not help either, the battery of the temperature sensor is probably no good anymore. Please replace it.
- You can see from the display that the Tecpel temperature sensor has switched itself off. You can switch this sensor back on immediately if required.

5.10.8 Using the headset

When using the headset first of all the sensor is initialized and the amplifier set, same as with any measuring procedure. Then, you will be prompted to connect the headset. The amplification factor of the signal is set automatically, shown in the display and can be adjusted manually by the keys ▲ or ▼ . If this value is shown with an exclamation mark and inverted, the amplifier is over range.

5.11 Balancing measurement

The purpose of balancing is to compensate for imbalances in rotating parts through the selective attachment of balance weights in order to extend their service life. You can use the Detector III to quickly and reliably determine the best location of up to two counterweights.

WARNING ***Damage due to balancing in the resonance range***

If you are balancing a machine in the resonance range, even the smallest changes of weight may lead to severe fluctuations of the vibration amplitude. This may cause serious damage to the machine and operator injuries.

- *Therefore, do not perform balancing in the machine resonance range.*

If you do not know the resonance ranges,

- *ask the manufacturer or consult the enclosed documents about the resonance range of the device being monitored*
- *or determine the resonance range by means of a run up/coast down (see "Determining the resonance range of a machine* 199*").*

Sequence of a balancing measurement

1. Measurement of rotational speed 194: The Detector initially establishes the rotational speed of the component: the trigger sensor counts the revolutions using a reflex mark which is attached to the component as a reference.
2. Reference run 194: During the referencing measurement the amplitude and phase of the existing imbalance is determined at the sensor positions. This serves as the basis for calculation of the positions of the weights.
3. Trial run 195: plane 1 (additional test measurement at plane 2 where two-plane balancing is carried out): During the test measurement the response of the rotor to defined weights is analyzed. The imbalance in the machine is modified by attaching the test weights. The Detector now determines the change with reference to the last measurement (in the case of the first trial run this is the reference measurement) and calculates the coefficients used to determine the optimum position of the balance weights.
4. Display of coefficients and attachment of balance weights 197: The Detector displays the influence coefficients. To carry out the check measurement attach the weights at the positions calculated by the Detector.
5. Trim run 198: The Detector now performs a measurement to check whether or not the vibration caused by the imbalance exceeds the limit defined by Trendline 53. If the balancing procedure was successful the Detector displays a table of results and exits the balancing menu. If not, you can attach weights using the existing coefficients then repeat the check or establish new coefficients by carrying out a new test measurement.

The Detector guides you through the individual steps of the balancing measurement and marks the menu items that are currently selectable. If the > symbol is displayed in front of the menu item it can be selected, otherwise the detector shows a -.

Important information

- If a balancing measurement has been already carried out for a component the Trendline software sends the coefficients of the last trim run to the Detector. Once the reference measurement has been carried out you can decide whether you wish to proceed with the trial run in order to determine new coefficients. Alternatively, you can view the "old" coefficients directly and attach the weights accordingly. However, this is only possible if the current rotational speed corresponds to the speed determined during the previous balancing measurement.

- As a general rule the amplitude units you specified in the Trendline program settings 110 will be displayed during balancing. However, if the value for the amplitude exceeds 1000 the Detector automatically rounds this up to the nearest unit (from 1050 µm to 1,05 mm, for example).
- During balancing the internal amplifier is adapted to the input signal before the start of each measuring process to optimize performance. However, if the signal overmodulates during the measurement the Detector displays a corresponding message and reduces the amplification factor. This message remains displayed if the input continues to overmodulate once the amplification has been reduced. You will not be able to save the measurement and must cancel it using the key.

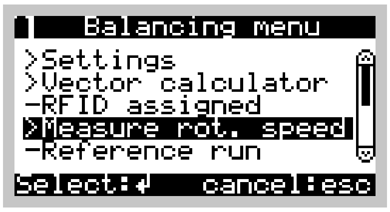
Start of balancing measurement

- Select the measuring point: to do this, press **Balance** in the main menu, then select **measuring point**
- If you have marked your measuring points with RFID tags (see Automatic assignment of RFID tags to measuring points 43), the Detector automatically recognizes the measuring point as soon as you move the area under the display near to the RFID tags.

If the detector recognizes more than one RFID tag, it displays a list of all tags found for selection. If the configuration does not contain one or more of the tags, the Detector displays an error message to indicate this.

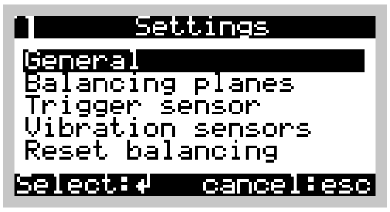
- If no RFID tag is available, select then the name of the measuring point you have fixed the sensor to using the subsequent menus.

- The **Balancing** menu is shown. Depending on the status of the balancing process, you can only select certain menu items. The Detector therefore guides you through the entire balancing process. You can only select lines preceded by a > symbol in this menu. Lines with a - can only be selected later during the balancing process.



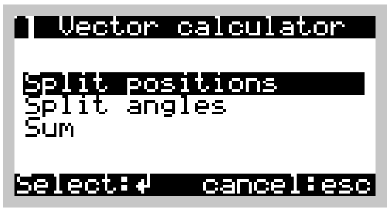
Settings

You can use this menu item to display the settings you specified for the measuring point in the Trendline balancing configuration 53.

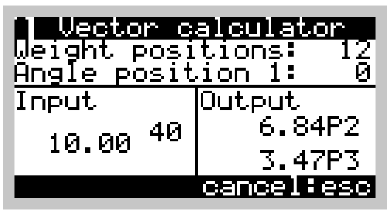


You can also restart the balancing measurement (menu item **Restart balancing**). This resets all balancing measurement data.

Vector calculator



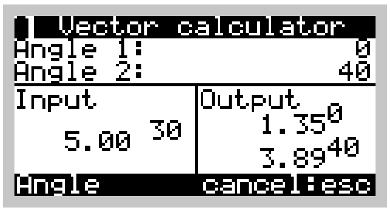
You can carry out calculations with vectors quickly and easily in the Detector using the vector calculator to distribute a weight across different positions or combine several distributed weights, for example.



Split position

Divides the vector of a weight between two positions. In relation to a full circle, enter the number of possible positions (at least 4), the angle of the first position and the weight to split. The Detector displays where the two resulting weights must be attached.

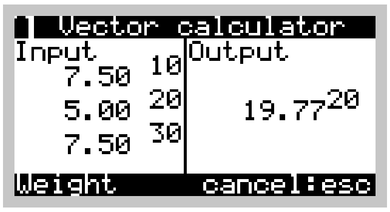
Example Weights can be attached with a spacing of 30° between weights which means that 12 positions are available. A weight of 10g and an angle of 40° was determined for the weight to be attached. The following is determined by the Detector: a weight of 6.8g must be attached at position 2 (at 30°) and a second weight of 3.5 g must be attached at position 3 (at 60°).



Split angle

Divides one weight into two with predefined angles. To do this enter both new angles as well as the weight and angle of the original vector. The Detector calculates both resulting weights. If the angle of the original vector is not between the two new angles, the Detector automatically jumps to the smaller of the two angles so that you can correct your input.

Example You have a fan with 18 blades, the first blade at 0°, the second at 20°, etc. You want to attach a weight of 5 gr at 30°, but you don't have any room left at the 20° blade. Enter 0° at angle 1, 40° at angle 2 and 5g at 30° in the **Divide angle** function. The resulting weights at 0° and 40° are 1.4g and 3.9g respectively.



Sum

You can use this function to determine the sum of up to three weights.

Example You are balancing a shaft on which balance weights can be screwed at 36 positions. You have already attached several weights during the balancing process. The Detector suggests that an additional balance weight should be attached at a position that is already occupied. You can now combine three existing weights to produce one new weight, for example: you have 7,5 gr at 10°, 5 gr at 20° and 7,5 gr at 30°. The sum function then produces a total weight of 19.8g at 20°. You can then remove the three weights at 10°, 20° and 30° and replace them with a new weight of 19.8g at 20°.

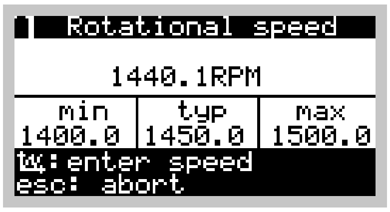
Assign RFID

Select this menu item to assign an RFID tag placed at the measuring point (see " Automatic assignment of RFID tags to measuring points 43").

In the next step you measure the rotational speed 194.

5.11.1 Measuring rotational speed

The Detector determines the rotational speed at the start of the balancing measurement via the trigger sensor. To do this, select **Measure rot. speed** from the balancing menu.



If the rotational speed measured is outside the band defined in the Trendline software, the Detector outputs an error message (Speed out of range, see also " System messages and their meaning 205"). You can then cancel the measurement or apply the current rotational speed as new speed.

Press the button to apply the rotational speed displayed.

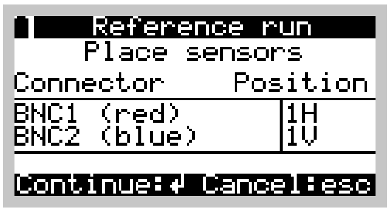
The rotational speed measurement is followed by the reference run 194.

5.11.2 Reference run

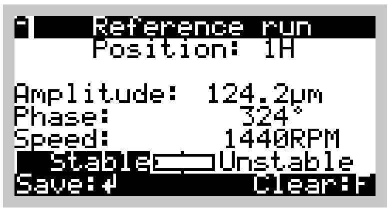
To carry out the reference measurement select **Reference run** from the balancing menu.

The rotational speed is monitored during the reference measurement. If this falls outside the defined band, the Detector outputs an error message.

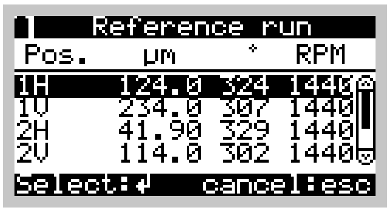
- Attach the sensors to the component and connect these to the BNC connectors of the Detector according to the Balancing configuration 53.



- The Detector guides you through the measurement and determines the amplitude and phase of the vibration at the sensor positions. A bar showing mean variance displays the stability of the values. You can reset the mean by pressing the F function key to restart mean calculation.



- Press the key once amplitude and phase have stabilized after a time.
- Once you have measured all sensor positions, the results are displayed in a table. If the measured values are OK, select the **Values are OK** menu item and press the key to save the measured values. If you are not satisfied with a measured value, you can use the and keys to select this value and the key to repeat this individual measurement.



- At this point, you can add a comment specified in the Trendline software to the measurement (see "Managing comments for measurements 52").

*The measured values obtained during the reference run are only saved after you confirm by clicking **Values are OK** by pressing the key. In the table of results, click the key to discard the measured values and the Detector returns the Balancing menu. Repeat the reference run if necessary.*

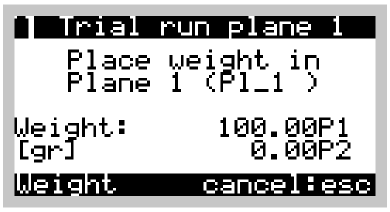
Please now move on to the trial run 195.

5.11.3 Trial run

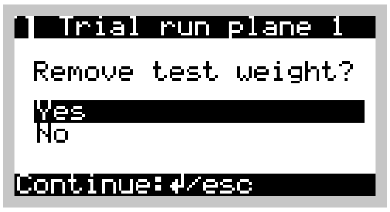
To carry out the trial run select **Trial run** from the balancing menu. With two-plane balancing the Detector initially guides you through the test measurement at plane 1 then continues with plane 2. In the trial runs, apply a known weight to a known position. With this information, the Detector determines the change between reference run and trial run and can thus determine the influence coefficients. These indicate how machine imbalance changes with a certain weight and are used calculate the balancing weights.

- Attach the sensors to the component and connect these to the BNC connectors of the Detector according to the Balancing configuration 53.
- The Detector requests the data for the test weights. Enter them, attach the weights, and confirm this in the Detector. The position of the test weight is counted from the rising or falling edge of the trigger mark (depending on which one you selected in the configuration 57). You can check it up in the Balancing

menu **Settings** -> **Trigger sensor** -> **Trigger pos.** The angle of the weight is always counted AGAINST the direction of shaft rotation. You can specify it in degrees or, if you have set discrete positions, as a position number. Here, P1 is the first position from the trigger mark AGAINST the direction of rotation, P2 the second, etc. When using discrete positions, you can apply one or two test weights.

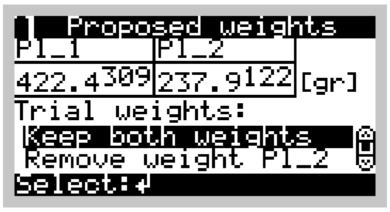


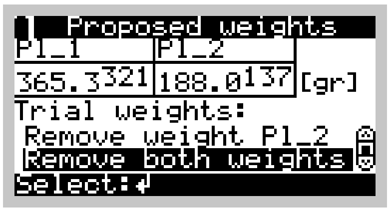
- The Detector guides you through the measurement and determines the amplitude and phase of the vibration at the sensor positions and displays the values.
- You can adopt the values measured or repeat individual measurements.
- Then the Detector asks whether you want to remove the test weight. If you have screwed the test weight on, it is an advantage to unscrew it so as to keep the number of weights on the shaft as small as possible. If you welded it on, it is easier to leave the test weight on the shaft.

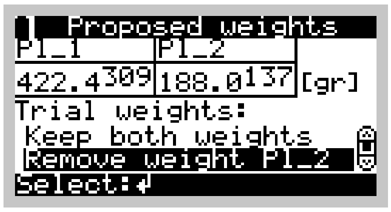


- In two-plane balancing, you can specify what weights you want to remove after the second trial run. You can
  - o keep both weights,
  - o remove the weight last used, or
  - o remove both test weights,

  if you have not removed the test weight in plane 1. Otherwise, you can only choose whether to remove the weight in plane 2 or not.







*The measured values obtained during the trial run as well as the attached test weight are only saved once you have provided the **Values are OK** confirmation with the ↵ key. Once this confirmation has been given this step of the balancing measurement can be read out in Trendline.*

- After the last trial run, the program displays suggestions for weights to apply.
- Next step: display coefficients and attach balance weights 197.

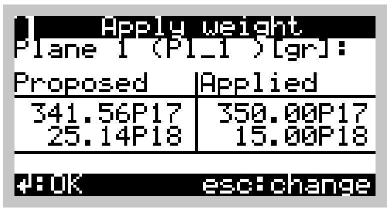
5.11.4 Display coefficients and apply balance weights

Display coefficients

The Detector displays the influence coefficients determined during the test measurements in this overview. These are used to calculate the balance weights. They describe the change in vibration in relation to a weight and have vibration unit / weight unit as their unit of measurement, for example µm/gr. For 1-plane balancing, there is only one coefficient, while two coefficients are determined per sensor position for two planes.

Applying balance weights

In the **Apply weight** menu the Detector shows which balancing weights are calculated for the respective plane. Now the weights have to be placed. When you place different weights (e.g. because you don't have the needed weights), you have to enter the real weights with their positions. On a 2-plane-balancing job, this step is done separately for every plane. If you are using discrete positions, the program always displays two weights. Together they equal the required balancing weight.



You can abort input of weights at any time by pressing in order to use to the vector calculator, for example. When you click **Apply weight** again, the previous inputs are still there, so you can continue at the same point.

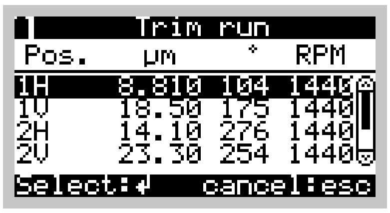
Here again, weight positions are counted AGAINST the direction of rotation starting from the set edge of the trigger mark.

The coefficients calculated and balance weights entered are saved together as part of the subsequent Trim run 198*. This data can only be read out using Trendline once the trim run has been carried out and the **Values are OK** confirmation has been provided with the key.*

5.11.5 Trim run

To carry out the check measurement select **Trim run**.

- Attach the sensors to the component and connect these to the BNC connectors of the Detector according to the Balancing configuration 53.
- The Detector guides you through the measurement and determines the amplitude and phase of the vibration at the sensor positions as well as the rotational speed then displays the values measured.
- You can now either accept the values measured or discard these and repeat the measurement.

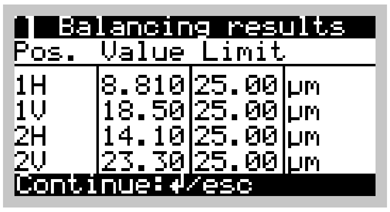


For balancing you will usually need more than one run. If the result is not sufficient after the trim run, the Detector returns to the Balancing menu. You can now reduce imbalance in two ways:

- Use the existing influence coefficients and apply balancing weights calculated with these coefficients again.
- Perform another trial run to determine new influence coefficients. The coefficients always apply to one particular machine condition only: The more it changes, e.g. due to applying additional weight or reducing imbalance, the more inaccurate the existing coefficients become. By means of a new trial run, you can determine new influence coefficients that more accurately fit the current condition ands thus achieve better results.

If you repeat the steps of applying weights and trim run with existing influence coefficients and you notice that the imbalance does not improve, this is a sign that the influence coefficients are no longer good and that you need to re-determine them with a new trial run.

If the amplitudes measured at all sensor positions in the trial run are smaller than the balancing threshold defined in Trendline (**balancing OK at**), the balancing process is finished. The Detector displays the table of results displaying the last measured values and the balancing threshold. Then, the Detector returns to the menu, where you can select a new measuring point.



*The measured values obtained during the trim run, the coefficients calculated and attached weights are only saved once the **Values are OK** confirmation has been provided using the key. Once this confirmation has been given this step of the balancing measurement can be read out in Trendline.*

5.12 Determining the resonance range of a machine

Background

Balancing a machine with the aid of the Detector must not be performed in the resonance range as the vibration amplitude increases severely and the phase changes considerably when the machine is operated at or near resonant frequencies. Even the smallest weight changes may lead to severe amplitude changes so that, if the worst comes to the worst, a balancing attempt may even destroy the machine.

In order to avoid such damage, you can determine the resonant ranges of a machine using the Detector and the Trendline software. To do so, the machine is started up and shut down in a controlled manner (run up/coast down test) while the Detector continuously measures the amplitude and phase of the vibration and rotational speed at the measuring point. The data measured in this test are displayed in an amplitude/phase diagram.

For the measurement, you can specify a rotational speed range to automatically start and stop the measurement. Alternatively, you can start and stop measuring manually.

WARNING ***Damage due to operation outside manufacturer's specifications***

The machine must be operated within rotational speed limits permitted by the manufacturer for normal operation while determining resonant ranges. Therefore, always observe these rotational speed limits when performing the run up/coast down test. Determination of resonant range is always performed at the system operator's own risk!

Conditions

- Run up/coast down must be set up in the configuration 45 .

Other notes

- The Detector performs the measurement with only one vibration sensor. If you want to determine the resonant ranges at multiple sensor positions, you must repeat the entire run up/coast down procedure there.

Determining resonant range

Proceed as follows to carry out the measurement with a defined rotational speed range:

1. Select the **Run up/coast down** menu item in the Detector.
2. Select the measuring point with the RFID Reader or manually (see "Selection of measuring point 183").
3. Press **Start measurement**.
4. Perform the run up/coast down test on the machine.
   a) If you pre-set the rotational speed range, the Detector automatically measures in the defined rotational speed range.
   b) Otherwise, press **Start** once the desired start speed has been reached and **Stop** once the desired end speed has been reached.
5. You can now allocate a comment defined in the Trendline software (see " Managing comments for measurements 52") or press the button to abort comment slection.
6. The Detector saves the measured values. Transfer the data from the Detector to the Trendline software.

Proceed as follows to perform the measurement manually:

1. Select the **Run up/coast down** menu item in the Detector.
2. Select the measuring point (see "Selection of measuring point 183").
3. Perform the run up/coast down test on the machine.
4. Once the desired start speed has been reached, press **Start measurement**.

The Detector starts measuring.

5. Once the desired end speed has been reached, press **Stop**.
6. You can now allocate a comment defined in the Trendline software (see " Managing comments for measurements 52") or press the button to abort comment slection.
7. The Detector saves the measured values. Transfer the data from the Detector to the Trendline software.

*You can display the run up/coast down settings made in the Trendline software in the Detector by pressing **Settings** after selecting the measuring point.*

See also

- Transferring the data to the Trendline software 181.
- Creating an amplitude/phase diagram in the Trendline software 88.

5.13 Free measurement

In addition to the planned route 82 measurements you can also use the Detector to carry out what are known as free measurements. For CM/balancing measurements and run up/coast down measurements, select the **New measuring point** menu item.

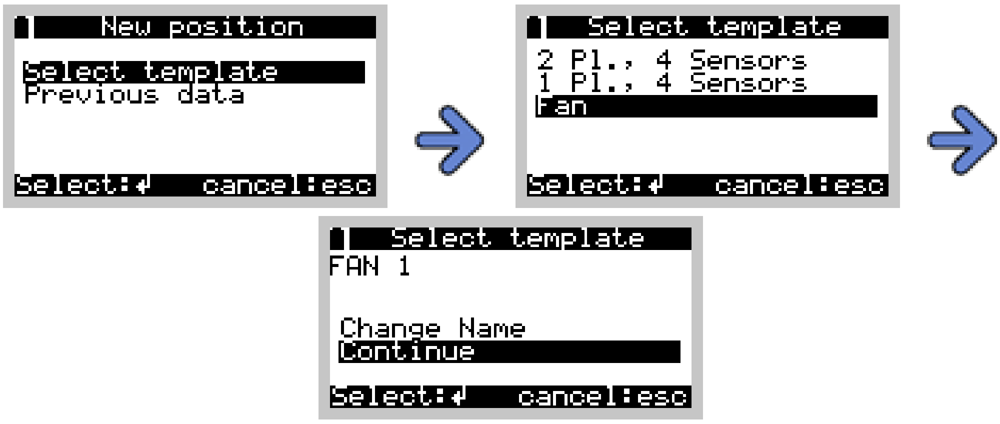
> **Example** You are on your measuring round. You notice an unusual noise or unusually high temperature on a machine that is not included in this round of measurements. You can use the **New position** option to carry out an additional on-the-spot measurement.

In these situations measurement templates must be defined using the Trendline - Software. The templates you create depend on your particular circumstances. The procedure for creating and transferring measurement templates is described in detail under Create template 83.

Free CM measurement

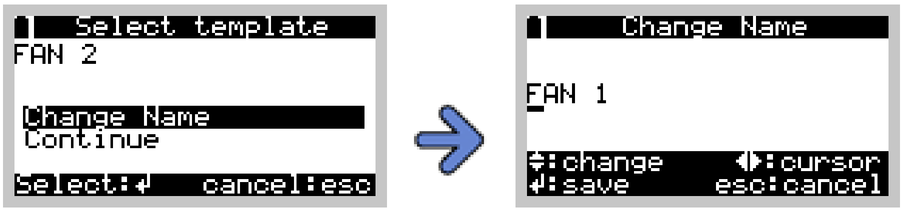
Position the sensor at the required measuring point.

- Select **Condition monitoring** > **New position**.
- Then go to **Select template** to choose a suitable template.



In the next menu you can change the template name so that the free measurement can later be assigned to the measuring point at which it was recorded. If you accept the name without changing it the free measurement is assigned the template name and also a reference number that increases by one each time a new measurement is made using this template (<Name> 1, <Name> 2, ...).

To change the name select **Change name** and confirm your choice with the ↵ key. In the next screen the name of the template selected and the current order number are displayed and a cursor is positioned under the first letter.



You can move the cursor into the required position using the ◄ and ► keys. You can step through the available letters and numbers using the ▲ and ▼ keys. Carry out the same procedure for all additional characters. Press ↵ to save your new name for the free measurement (valid characters are A,B,C... Z,<space>,0,1 ... 9.)

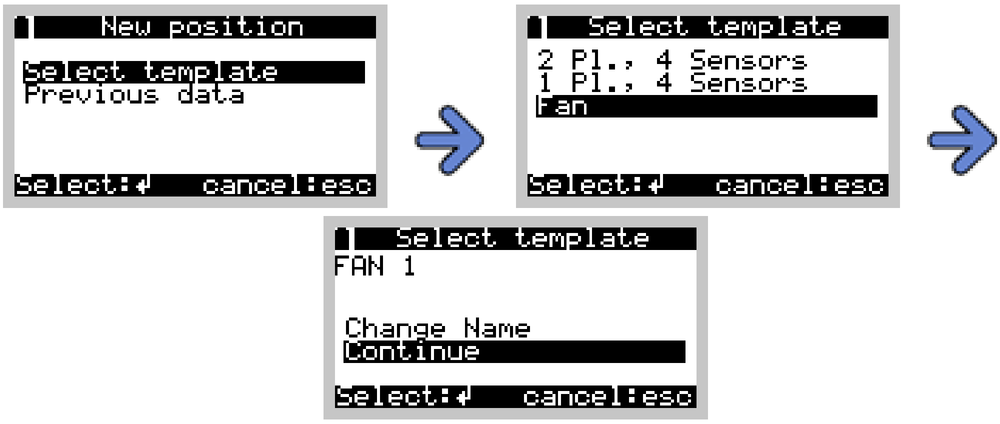
Once the name has been changed select **Continue** to start the measuring process. From this point onwards the sequence of the measuring process is identical to the Standard measurement 182 process (initialization of hardware, recording of characteristic values, display of measuring results, storage of measured data).

Call up previous measurements

In order to view the results for free measurements previously carried out select **Condition monitoring** > **New position** > **Previous data**.

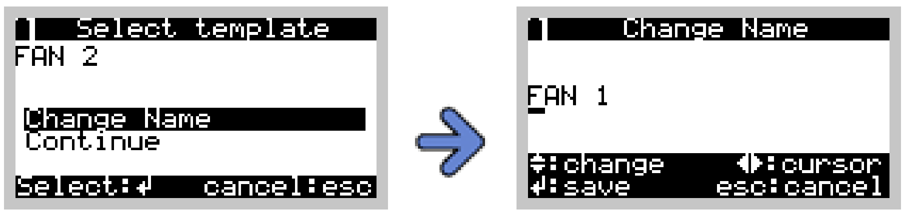
Free balancing measurement

- Select **Balancing** > **New** measuring **point**.
- Then go to **Select template** to choose a suitable template.



In the next menu you can change the template name so that the free measurement can later be assigned to the measuring point at which it was recorded. If you accept the name without changing it the free measurement is assigned the template name and also a reference number that increases by one each time a new measurement is made using this template (<Name> 1, <Name> 2, ...).

To change the name select **Change name** and confirm your choice with the ↵ key. In the next screen the name of the template selected and the current order number are displayed and a cursor is positioned under the first letter.



You can move the cursor into the required position using the ◄ and ► keys. You can step through the available letters and numbers using the ▲ and ▼ keys. Carry out the same procedure for all additional characters. You can then position the cursor under the ↵symbol on the far right and save the new name you have chosen for the free measurement by pressing ↵ (valid characters are A,B,C... Z, <space>,0,1 ... 9).

Once the name has been changed select **Continue** to start the measuring process. From this point onwards the sequence for the measuring process is identical to the Balancing measurement 189 process.

When carrying out a free balancing measurement all other values can be changed in addition to the template name. To do this, select the **Settings** item in the balancing menu. You can now select the relevant values using the ↵ key. Depending on the type of setting you can now type in a new value directly, make a selection from a dropdown menu or modify a text as described above.

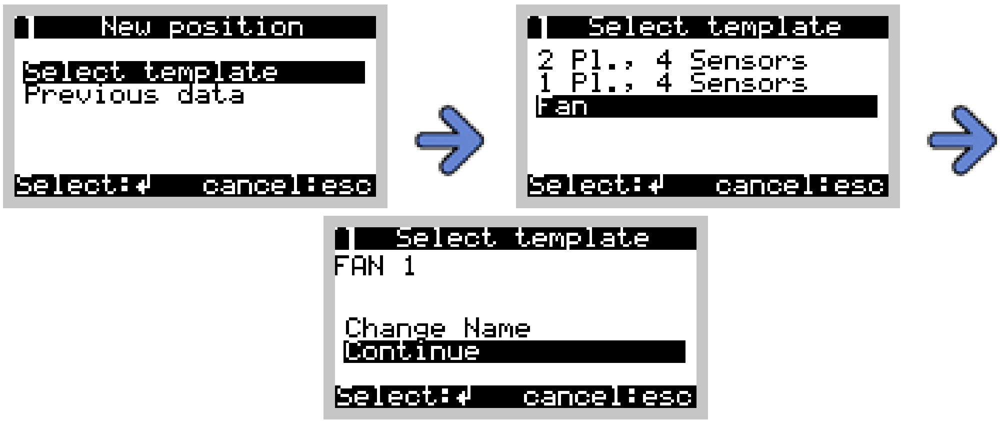
You can change the settings for the free balancing measurement until the first reference run 194 *has been completed and saved. After this your settings are frozen and can no longer be changed.*

Continue with a free balancing measurement

Once the Detector has been switched on you can continue with an free measurement that was started previously. To do this, select **Balance** > **New position** > **Previous data** and then the required measurement. You can now continue with the usual balancing process.

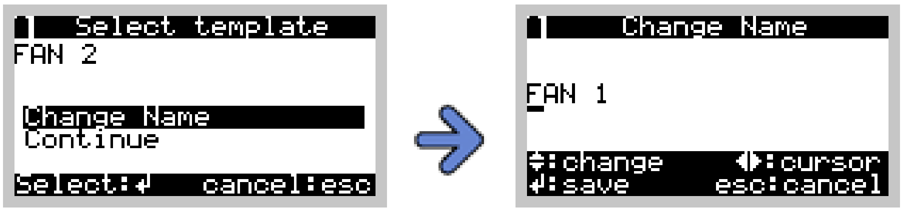
Free run up / coast down measurement

- Select **Run up / coast down** > **New measuring point**.
- Then go to **Select template** to choose a suitable template.



In the next menu you can change the template name so that the free measurement can later be assigned to the measuring point at which it was recorded. If you accept the name without changing it the free measurement is assigned the template name and also a reference number that increases by one each time a new measurement is made using this template (<Name> 1, <Name> 2, ...).

To change the name select **Change name** and confirm your choice with the ↵ key. In the next screen the name of the template selected and the current order number are displayed and a cursor is positioned under the first letter.



You can move the cursor into the required position using the ◄ and ► keys. You can step through the available letters and numbers using the ▲ and ▼ keys. Carry out the same procedure for all additional characters. You can then position the cursor under the ↵symbol on the far right and save the new name you have chosen for the free measurement by pressing ↵ (valid characters are A,B,C... Z, <space>,0,1 ... 9).

Once the name has been changed select **Continue** to start the measuring process. As of here, the procedure corresponds to the run up / coast down test (see "Determining the resonant range of a machine 199").

When carrying out a free measurement all other values can be changed in addition to the template name. To do this, select the **Settings** item in the run up / coast down menu. You can now select the relevant values using the ↵ key. Depending on the type of setting you can now type in a new value directly, make a selection from a dropdown menu or modify a text as described above.

Continue free run up / coast down measurement

Once the Detector has been switched on you can continue with an free measurement that was started previously. To do this, select **Run up / coast down** > **New position** > **Previous data** and then the required measurement. You can now continue with the usual balancing process.

5.14 System messages and their meaning

Error message	Description	Cause of the fault / solution
Sensor error	An error occurred during the initialization phase of the measuring process. With active sensors: the measured bias voltage is not within the specified range.	The sensor (or sensor cable) is defective or not correctly connected. Where active sensors are used and the voltage is not within the valid range this may be for the following reasons: • Sensor not connected • Sensor has short circuited • Sensor has a defective cable • The set bias voltages 34 are wrong for the sensor being used. For more detailed troubleshooting, perform a ICP sensor test 180.
Measuring point is crossed out	A data error exists at the current measuring point.	If there are still measured data saved in the Detector, use Trendline to collect them. Only those measurements are

Error message	Description	Cause of the fault / solution
	You cannot start this measurement. If you try to start the measurement the error message "CRC error" will be displayed.	transferred that do not have an data error. Measurements with data errors are lost. The send a new configuration to the Detector.
Input overrange! Please measure again.	The measurement amplifier settings are optimized before the measurement is carried out. If the strength of the measured signal increases once these settings have been made the input may become overmodulated.	If this error occurs you must repeat the measurement. If this error occurs frequently you are probably carrying out measurements at a machine that is turning quite slowly (< 120 revolutions per minute). The Detector is not designed to carry out these kinds of measurements.
Connect temperature sensor and switch on	The temperature measured is outside the technical limits of the temperature sensor.	If you are using a Raytek sensor whose switch is ON, switch it off and on again.
Temperature too high	The measured temperature is beyond the technical limit of the temperature sensor.	Temperature measurement range: -15°C to +550°C
No memory left for saving data	Cannot create any more measurement, balancing step or new data block for run up/coast down because memory is full.	Transfer the data to Trendline and transfer the last balancing configuration or route back to the Detector.
Warning: battery low	The battery is nearly empty.	Please recharge 177 the accumulator before continuing to work with the Detector. Otherwise, the Detector could shut down without any warning so as to protect the accumulator.
The battery is empty Please charge	The battery is empty, the Detector cannot be switched on.	The battery must be recharged 177.
No memory allocated	No memory has been allocated for configurations that have been sent to the Detector.	The Trendline database may contain an error. Please contact support@fis-services.de.
No template loaded	No balancing, CM or run up/coast down template has been saved.	You wish to carry out an free measurement although a template is not stored in the Detector. Templates are only attached if you click in Trendline on **Detector** > **Send route**.
No configuration loaded!	No balancing, CM or run up/coast down configuration has been saved.	You wish to carry out balancing, a CM measurement or a run up/coast down procedure but have not yet transferred a configuration to the Detector. In Trendline click on **Detector** > **Send configuration** or **detector** > **Send route**.
No free measurements are	No free measurements have been carried out yet.	You are attempting to view free balancing, CM measurements or run up/coast down measurements on the Detector although

Error message	Description	Cause of the fault / solution
stored		neither of these types of measurement has been carried out.
No balancing configuration stored.	The Detector is attempting to save time signals but cannot do so as insufficient memory is available.	Send a balancing configuration to the Detector (click in **Trendline on Detector** > **Send configuration** or **Detector** > **Send route**) before you select a configuration from the balancing menu of the Detector.
No memory left for time signals	The Detector is attempting to save time signals but cannot do so as insufficient memory is available.	This may occur if you only wish to save time signals in the event of an alarm and an alarm has occurred. It is also possible that you have carried out multiple measurements at this measuring point. The characteristic values will be saved in each case but none or only some of the time signals will be saved.
Input over range!	The vibration signal too large to be measured by the Detector.	There are two possible causes for this: • The input signal is very large (>50g). Use another sensor (with a sensitivity of 10mV/g, for example). • The strength of the signal increased after the amplifier was adjusted due to an impact on the machine, for example. The vibrations must remain more or less constant throughout the entire measurement.
No RPM signal!	The rotational speed signal is missing.	Possible causes: • The trigger sensor is not correctly aligned with the reflex mark. • The reflex mark was not glued on. • The trigger sensor is too close to the reflex mark (<10cm). Increase the distance. • The trigger sensor has been incorrectly configured 34 in Trendline (incorrect supply voltage, for example). • You have not connected the trigger sensor to the AUX port 176 of the Detector.
Speed unstable!	The rotational speed signal is fluctuating.	Possible causes: • The trigger sensor is not correctly aligned with the reflex mark. • The trigger sensor is too close to the reflex mark (should be at least 10cm). • Machine rotational speed fluctuates.
The rotational speed of the machine is fluctuating.	The measured rotational speed is outside the rotational speed band defined in .	Reduce the speed of the machine or adopt the current rotational speed as the new nominal rotational speed.
No conf. for RFID	No configuration found for the RFID entry.	This error occurs when Trendline sends the RFID status for a measuring point before a balancing, CM or run up/coast down configuration was sent. Make sure that there is a configuration for the measuring point on the Detector. The Trendline database may contain an error. Please contact support@fis-services.de.
Could not find at least one	Detected RFID tags and configured measuring	The Detector found at least one RFID tag without a measuring point configuration. The missing measuring point is therefore

Error message	Description	Cause of the fault / solution
configuration	points do not match.	not offered for selection for the measurement.
Multiple IDs read. Please repeat	Two or more tags were found while trying to assign an RFID tag.	The assignment is not possible as the Detector found at least two tags in the RFID Reader read area. Remove the unnecessary RFID tags from the read area.
ID already in use. Please repeat	An RFID tag was read that is already assigned to another measuring point.	Assign a new RFID tag to the current measuring point.
Change sensor to: …	The next measurement must be performed with a different sensor.	If you have configured sensors with different sensitivities for measuring points, you may need to change the sensor between two measurements. In this case, the Detector tells you which sensor you need to connect for the next measurement.
Maximum number of data reached!	Maximum number of data points reached (in run up/ coast down).	The system aborts after 65535 values in a run up/coast down. The values measured so far are saved.
Resonant frequency!	Machine in resonant range for balancing measurement.	If you have defined one or more resonant ranges for a machine in the Trendline software (see "setting up run up/coast down 61" and "determining the resonant range of a machine 199"), the Detector displays this message during balancing if the current rotational speed is within such a resonant range. You can continue the balancing measurement. However, observe the information given in balancing measurement 189.
Rotational speed to high (low) for Autostart / Autostop	Rotational speed already exceeds the selected autostart and/or autostop speed at run up. Or: Rotational speed is already lower than the selected autostart and/or autostop speed at coast down.	Run up: If rotational speed is too high for an automatic start and/or automatic stop, the system stops the automatic measurement start and/or stop. You can start and/or stop manually by pressing Enter. Coast down: If rotational speed is too low for an automatic start and/or automatic stop, the system stops the automatic measurement start and/or stop. You can start and/or stop manually by pressing Enter.
HW0 to HW2 (backup battery)	Self-test error	At start-up, the Detector performs a self-test to check internal voltages. If one of these three messages is displayed, you must replace the backup battery. Please contact support@fis-services.de and tell us the error number. We will then give you further details on how to replace the battery. You can bypass the error message by pressing **Enter**.
HW3 to HW7 (Internal error)	Self-test error	This is a critical error. Please contact support@fis-services.de and tell us the error number. We will then give you further information.

5.15 Update firmware

The internal software of the Detector is saved in what is known as the firmware. FAG Industrial Services is constantly expanding and improving the Detector firmware. You should therefore update this in the Detector as soon as a new release becomes available. The current version is available for download from our website at (www.fis-services.de).

Before you start...

1. When the firmware is updated all data on the Detector is deleted. You should therefore transfer your data from the Detector to the Trendline software, as described at Read measuring data from Detector 85 .
2. Download the current firmware file from our website: www.fis-services.de.
3. Start the Detector FlashUpdater (in the start menu under **Programs** > **FIS** > **Detector FlashUpdater3**). If it is not installed, install it from the Trendline CD or download it from our website.
4. Have a thin object to hand - an unbent paper clip for example.
5. Connect the Detector to your Windows computer using the enclosed serial cable. Alternatively, you can use the USB serial adapter 36, although communication is more reliable via a serial interface.
6. Ensure that the battery 176 is charged to at least 25% of its capacity.

Update the Detector firmware

Click on **Start** > **Programs** > **FIS** > **DetectorFlashUpdater3** > **Detector Flash Updater 3** and follow the instructions given by the program. The update comprises the following steps:

1. Initialization of Detector
   a) Remove the battery for at least three seconds.
   b) Put the battery back in and connect the Detector to the PC.
2. Select the interface used to connect the Detector.

The "Installing USB serial adapter 37" section explains how to determine the interface number of the USB serial adapter.

3. Select the downloaded firmware file ("Detector_3_x_x.dup"). If you downloaded the firmware from the Internet page you must also unpack the zip archive. The FlashUpdater displays information on the changes made since the previous release.
4. Prepare the Detector
   a) Switch the Detector off.
   b) Insert a thin object (a bent open paper clip, for example) into the small opening on the left-hand side of the Detector and hold it in this position until it encounters resistance.
   c) Switch the Detector on and keep the power-on button pressed down. Wait for three seconds before removing the thin object. Now release the power-on button.
5. The new firmware is now transferred to the Detector. This may take several minutes depending on the speed of the interface.

*You can abort the update as long as the firmware upload has not begun. Click **Cancel** to abort.*

6 Special information

6.1 Time signals

You can select in Trendline software, which time signals should be stored. The Detector can save up to 300 time signals and up to 1600 measuring points. Give careful consideration to what signals you need. You can select, when configuring the measuring point (see "Create a measuring point 45"), if a certain time signal should be stored all the time, or only, if the characteristic value shows a main alarm.

If a configuration or route is sent to the Detector, the detector checks, how many time signals have to be stored all the time. For these time signals the right amount of memory is allocated right after the transfer to ensure that these time signals are guaranteed to be stored. But that automatically means that no more time signals must be marked with Save always in a configuration or route as the amount of memory of the Detector allows. Trendline software checks prior to sending a configuration or route to the Detector, if the available memory of the Detector is sufficient for the data. If this is not the case, an error message is displayed and the data is not sent to the detector.

For time signals, which are to be stored in case of an alarm only, Trendline software cannot check, whether or not they would fit into memory, as one does not know, how many measuring points will show an alarm. This means that eventually one could mark all time signals as Save by main-alarm in the configuration. Even if one of the characteristic values has an alarm and a time signal therefore has to be saved, this is stored only when sufficient memory is available. If the memory is not available, the user will get a message telling him that there is insufficient memory and the time signal was not stored. You can find more information on this in " Dynamic memory management 213".

Bear in mind that a time signal may NOT have been recorded when an alarm was output for a characteristic value even if the field "Save in the event of main alarm" was activated. Time signals that should be saved in the event of an alarm can only be saved if sufficient memory is available.

The recorded time signals are always acceleration signals, which are each differently filtered and sampled. The Detector can measure three different time signals. For this three measuring branches 214 are available.

For the calculation of the characteristic velocity values ISO10816 and V_{sel} the transformation from the acceleration signal into the velocity signal is done in the frequency domain. Because of this the saved and shown time signals for these characteristic values are still acceleration signals. The time signal sampling rates are set for each channel by the lowpass settings.

6.2 Frequency selective characteristic values

With the characteristic value with a "sel"-token you can define within a given range a frequency band, which is used for the value calculation.

In Trendline the low pass cutoff frequency up to which measurements are to be taken is defined for each channel. The sampling rate is always 2.56 times the value of this cutoff frequency. A frequency spectrum is calculated from the time signal thus recorded by means of an FFT calculation. This spectrum is then used to calculate the characteristic values according to the limits set. An a_{eff} value of between 2kHz and 5kHz is therefore calculated for a low pass filter setting of 5kHz, for example.

Characteristic value	Analog channel	Frequency range
a_{eff}	Acceleration	2 kHz - lowpass a
a_{sel}	Acceleration	f_{min_a} - lowpass a (both frequencies adjustable, see table below)
ISO 10816	Speed	10 Hz - 1 kHz
v_{sel}	Speed	f_{min_v} - lowpass v (both frequencies adjustable, see table below)
d_{eff}	Demodulation	f_{min} - lowpass d
d_{sel}	Demodulation	f_{min} - lowpass d (both frequencies adjustable, see table below)

The low pass and FFT length can be adjusted for each channel. Both of these factors affect the sampling rate, the minimum possible frequency and frequency resolution.

Lowpass	Sampling rate	FFT-length	f_{min}	f_{min_v}(* 213)	Frequency resolution
200 Hz	512 SPS	1600 lines	0.125 Hz	0.375 Hz	0.125 Hz
200 Hz	512 SPS	3200 lines	0.1 Hz	0.19 Hz	0.0625 Hz
500 Hz	1.28 kSPS	1600 lines	0.3125 Hz	0.94 Hz	0.3125 Hz
500 Hz	1.28 kSPS	3200 lines	0.156 Hz	0.47 Hz	0.156 Hz
1 kHz	2.56 kSPS	1600 lines	0.625 Hz	1.875 Hz	0.625 Hz
1 kHz	2.56 kSPS	3200 lines	0.3125Hz	0.94 Hz	0.3125 Hz
2 kHz	5.12 kSPS	1600 lines	1.25 Hz	3.75 Hz	1.25 Hz
2 kHz	5.12 kSPS	3200 lines	0.625 Hz	1.875 Hz	0.625 Hz
5 kHz	12.8 kSPS	1600 lines	3.125 Hz	9.375 Hz	3.125 Hz
5 kHz	12.8 kSPS	3200 lines	1.56 Hz	4.7 Hz	1.56 Hz

10 kHz	25.6 kSPS	1600 lines	6.25 Hz	18.75 Hz	6.25 Hz
10 kHz	25.6 kSPS	3200 lines	3.125 Hz	9.375 Hz	3.125 Hz
20 kHz	51.2 kSPS	1600 lines	12.5 Hz	37.5 Hz	12.5 Hz
20 kHz	51.2 kSPS	3200 lines	6.25 Hz	18.75 Hz	6.25 Hz

(SPS = Samples per second)

(*) In the case of characteristic values for speed the minimum frequency is the third line in the spectrum as the first lines may become overly large as a result of the integration.

6.3 Dynamic memory management

The Detector has a dynamic memory management. Because of this the partitioning of the memory is not fixed in the firmware. For measuring points, time signals, etc. there is a memory block of 2.7MB. You can set in the Trendline software whether many configurations or many time signals are needed when taking the next measurements. The required memory can be calculated as follows:

Memory element	Memory usage
Configuration	CM configuration: 314 bytes Balancing configuration: 278 bytes Run up/coast down: 164 bytes
Free measurement	CM measurement: 328 bytes Balancing measurement: 292 bytes
Time signal	8244 bytes (1600 lines), 16436 bytes (3200 lines)
Balancing step	190 bytes
Run up/coast down measurement	48 bytes + 12 bytes per amplitude/phase value

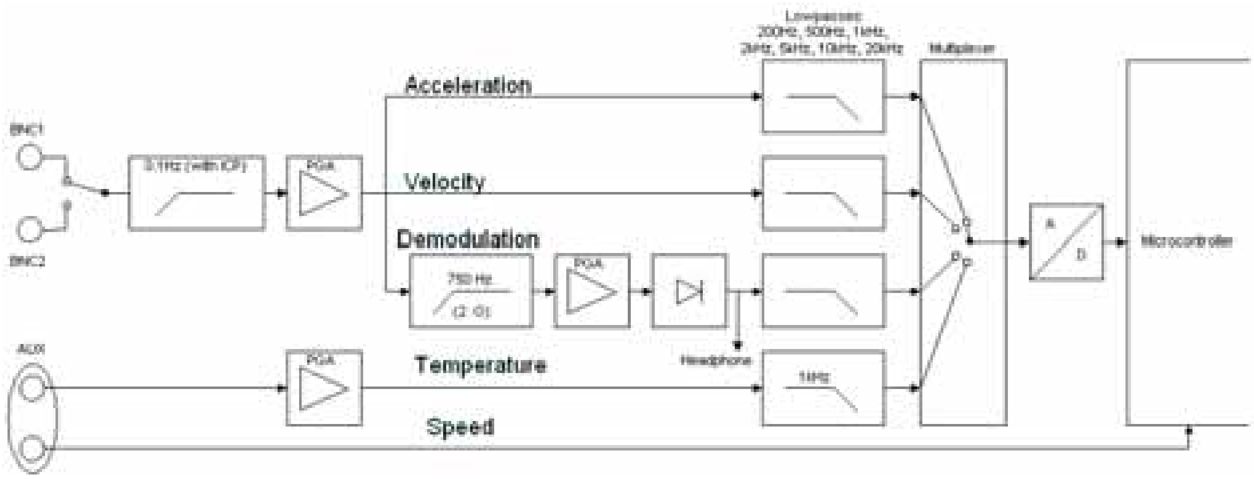
Additionally, the following memory is required depending on the Detector configurations:

- 64 kilobytes if at least one balancing or run up/coast down configuration exists on the Detector.
- 30 bytes for each unit used. As a rule 5-10 units are stored on the Detector.

Example: 500 CM configurations are sent to the Detector (500 * 314 bytes = approx. 155 kB), leaving 2.7 MB - 0.155 MB = 2,545 MB for time signals and free measurements. This means, that 2,545 MB / 16,436 bytes (@ 3,200 lines) = 154 time signals can still be stored. The remaining memory of about 13kB can then be used for about 40 free CM measurements.

6.4 Analog branches in the Detector III

Depending on the selected characteristic value the sensor signals are preconditioned by different signal paths in the Detector.



The measuring signal reaches the Detector via the sensor module (BNC1 or BNC2, see Connectors) 176, where it passes a highpass filter (0.1 Hz) when the sensors are active. The signal is then amplified in a PGA (

programmable gain amplifier

). After the amplifier the signal is subdivided into three branches, each of which can have a different filter.

- The acceleration and velocity branch both have their own lowpass filter with a selectable corner frequency, so only the part of the signal below this frequency can pass. In spite of its name, actually the acceleration signal is measured in the velocity branch. This signal is integrated into the spectrum to calculate the characteristic velocity values.
- The demodulation signal passes through a high-pass filter first (only frequencies higher than the cut-off frequency of 750Hz can pass). Subsequently, it is rectified and finally low-pass filtered. The frequency of this lowpass filter can also be set in the Trendline software 45. The signal to the headset connector is branched off before that low-pass filter.

The Detector can measure temperature and rotational speed via the AUX connector (see "Connectors 176"). The signal from the temperature sensor is amplified in a PGA and filtered with a cutoff frequency of 1kHz in a lowpass.

6.5 Establishing a data connection

When connecting to the Trendline software will try to connect to the serial port used the last time with the baud rate used the last time.

If not successful it searches for the communication parameters by itself and connects to the Detector.

If connection is not possible, it is due to the following causes:

- The Detector is not switched on. Switch on the detector.
- The data cable between Detector and PC is not connected. Connect the Detector with the 9-pin data cable supplied to a serial interface at your PC.
- The Detector is switched on and properly connected. If you still cannot make a connection, it may be because you are not in a menu in the Detector. For example, if you are in the memory manager, if you are currently displaying measured values or if you are in the Detector information window, it is not possible to make a connection. Press **ESC** to change over to the next menu.
- If a connection can be established, but it brakes down before all data are transferred, the accumulator may be empty. For sizeable data transfers the remaining charge in the battery should be at least 10 %.

7 Appendix

7.1 General information on vibration monitoring

7.1.1 Introduction

Condition-based maintenance has proven itself to be particularly advantageous for production plants where an unforeseeable failure leads to enormous costs. Consequential damages, system downtimes and the costs of maintenance can thus be reduced to a minimum. However, a prompt detection of machine damages is a pre-requisite in this case, in other words at a time when the machine is still operative and will remain so for some time to come. This then allows repair work to be planned and performed in the scheduled downtimes. This goal can only be achieved through a reliable determination of the machine status. The monitoring and investigation of machine vibrations is an excellent method.

The operation of machines always entails mechanical vibrations, caused for example by component imperfections or the production process. These machine vibrations spread from their origin via neighboring machine parts. Apart from these solid propagation media, the vibrations are also transferred to the ambient air at the interface machine-air. A differentiation is thus made between structure-borne and air-borne noise depending on the vibrating medium. An investigation of structure-borne noise is more suitable than that of air-borne noise for machine monitoring since the influence of external interfering variables such as ambient noise is lower. Displacement, velocity or acceleration are used as measuring parameters.

Structure-borne noise is recorded with a vibration sensor, generally an acceleration sensor, on the surface of the machine. The sensor converts the mechanical vibrations into an electrical signal which is then amplified, filtered and forwarded to an evaluation unit, e.g. a vibration monitor, where either the broad band vibration level is monitored (e.g. RMS of the vibration velocity according to VDI2056) or where selected frequencies of the vibration signal are monitored for characteristic features of machine damage.

Reliable monitoring and diagnosis is only possible through suitable signal processing. According to **VDI 3841**, machine vibrations should be judged according to their absolute size and appearance.

What are required here are

- dimension figures and
- patterns of known vibration events.

The dimension figures are determinations of the vibration path, velocity or acceleration. These enable a statement on the running quality of a machine and serve as limits for alarming or shutdown.

An evaluation of the vibrations according to their appearance is largely independent of the absolute vibration level. In other words: irregularities are still taken into account even if the vibration level is low and the limits for an alarm or shutdown have not yet been reached.

The various evaluation methods can be split into two groups:

- analysis methods
- methods to determine characteristic parameters.

A number of characteristic values and parameters can be used for vibration monitoring. Some of these characteristic values will be presented in more detail in section 0. However, we shall first of all turn our attention to the analytical methods of frequency analysis and demodulation analysis.

7.1.2 Frequency analysis

Monitoring of the overall vibration levels is often inadequate for an early detection of damage. Rather, the overlying vibration components have to be separated and individually investigated or monitored. The vibration signal is hereby split into its frequency components by a Fourier transformation. In certain cases machine errors can be reliably identified through a classification of characteristic frequency shares. For example, a residual unbalance always causes a higher amplitude at the rotary frequency. The higher the amplitude, the greater the residual unbalance. Fig. 1 shows the frequency spectrum of an intact machine with a small residual unbalance.

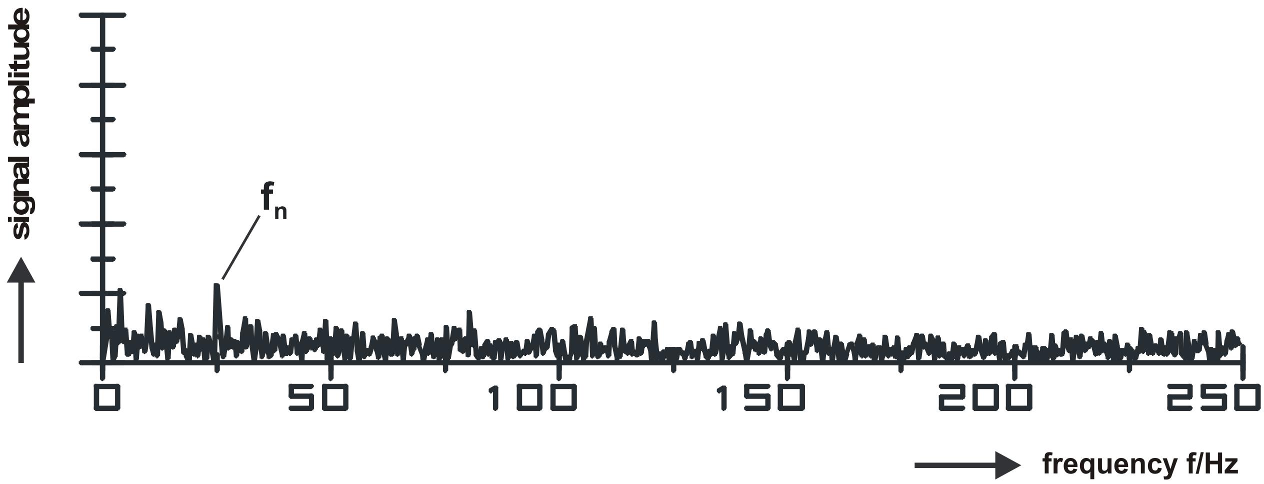


Fig. 1 Frequency spectrum of a machine with a low residual unbalance (rotary frequency f_n =25 Hz)

The amplitude of the rotary frequency at 25 Hz is small. Fig. 2 shows the frequency spectrum of a machine with a greater unbalance. The higher amplitude at the rotary frequency can be clearly seen (25 Hz).

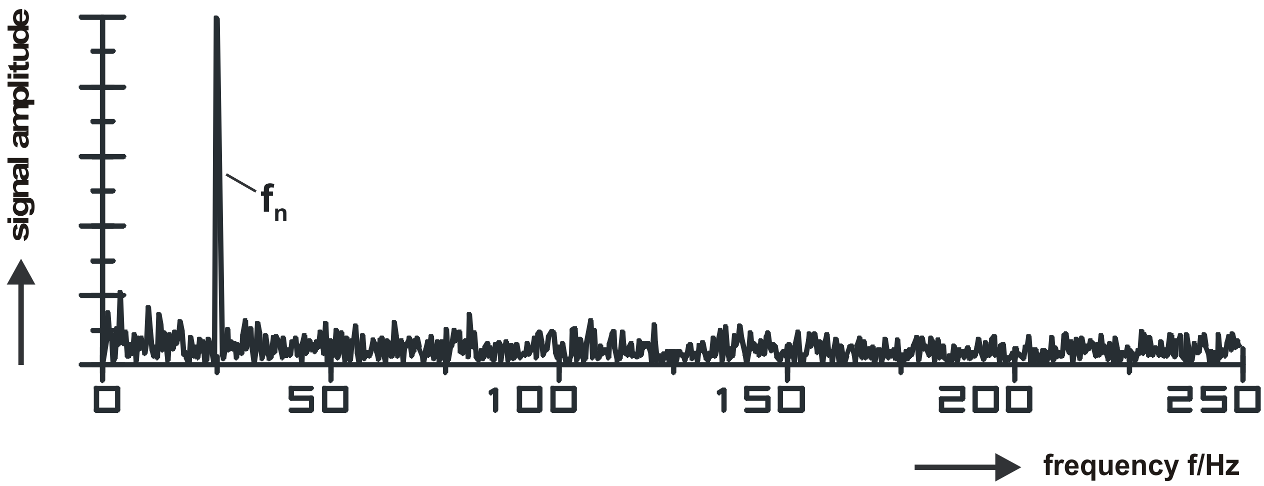


Fig. 2 Frequency spectrum of a machine with a great residual unbalance (rotary frequency f_n =25 Hz)

7.1.3 Demodulation analysis

However, the majority of damages or faults cannot be detected as easily as unbalances since a damage is normally not indicated by simply one frequency. It usually leads to a frequency pattern consisting of various frequency shares whose intensities can fluctuate. A reliable detection and classification is then difficult. In the following we will pay particular attention to faults or damage which are accompanied by impact pulses during operation.

A number of machine damage leads to impacts which cause the machine structure or other neighboring machine parts to vibrate. These impact-like excitations can be caused, for example, through cavitation or a rotor which knocks against a machine housing. These impacts also occur in roller bearing damage where either the roller rolls over a damage on the inner or outer race or where the roller itself is damaged. Impact-like excitations can also occur in intact machines, e.g. teeth meshing in gears.

These impacts excite a number of machine resonances, the natural vibrations. This can be compared to a tuning fork when struck, which then vibrates at its own natural frequency.

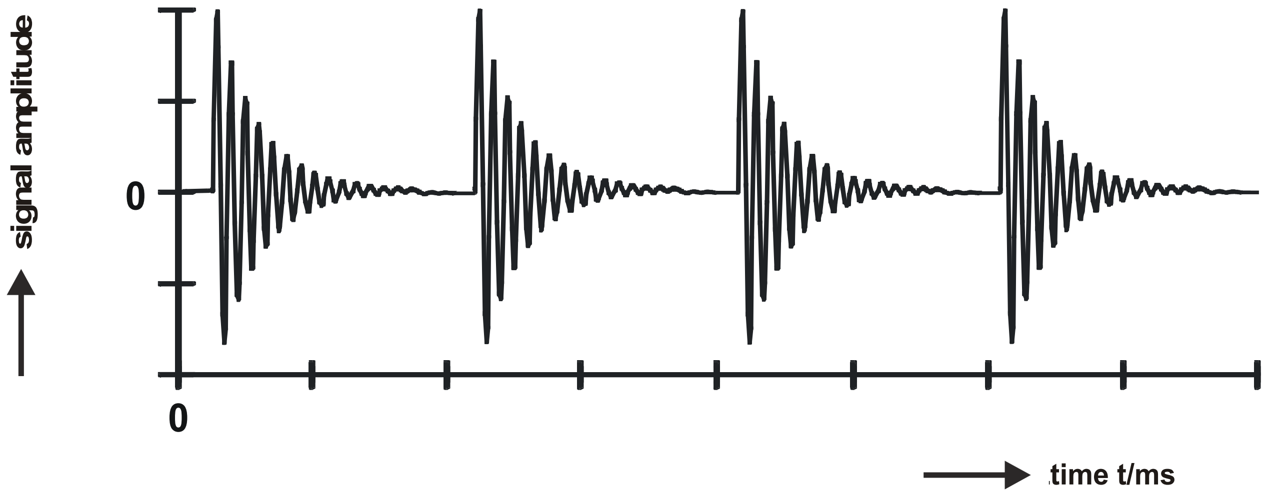


Fig. 3 Excitation of a machine resonance through a periodic sequence of impacts

The machine resonances diminish exponentially. With a periodic excitation there is a basic temporal course as shown in Fig. 3, whereby the excitation of only one resonant frequency is simulated for simplicity sake.

In a number of cases the impact-like excitations are also of a periodic nature in reality, i.e. the impacts are repeated at equal intervals in time, e.g. in roller bearing damage or in gears (assuming a constant speed). The resulting impact sequence frequency is characteristic for the corresponding machine part and/or machine damage. For example, if the outer race of a roller bearing is damaged, the impact sequence frequency is identical to that of the ball pass frequency of outer race.

The frequency spectrum of this type of vibration signal consists of a number of frequencies, where all frequencies are multiples of the impact sequence frequency. The highest amplitudes appear in the range of the resonant frequency or resonant frequencies. Fig. 4 shows the corresponding frequency spectrum.

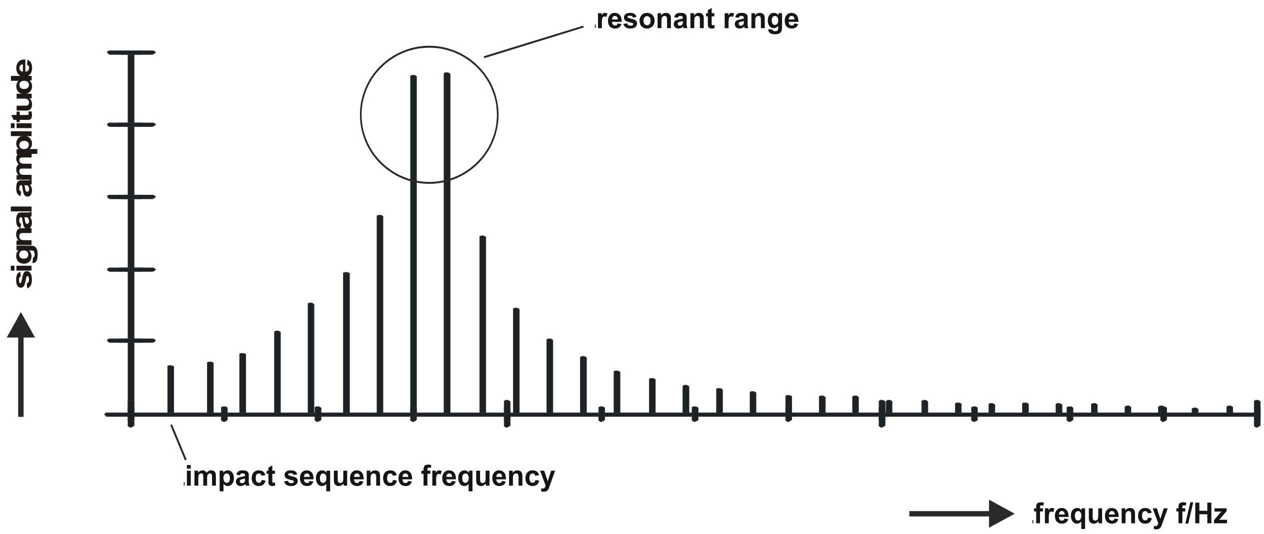


Fig. 4 Frequency spectrum with excitation through a periodic impact sequence

Periodic impact pulses can in principle be identified by monitoring the amplitude of the impact pulse sequence frequency for limit transgressions. However, the amplitude of the impact pulse sequence frequency is usually very low since it is not within the range of the resonance step-ups. Moreover, the lower frequency range (up to 1 kHz), in which the impact pulse sequence frequencies usually lie, is disturbed by various machine noises. This makes it difficult, if not impossible to reliably detect impact pulse sequences. Low-intensity impact pulses such as frequently occur at the start of a damage are almost impossible to detect by this method. Fig. 5 shows the problem. The amplitude of the impact pulse sequence frequency is lost completely in the noise level.

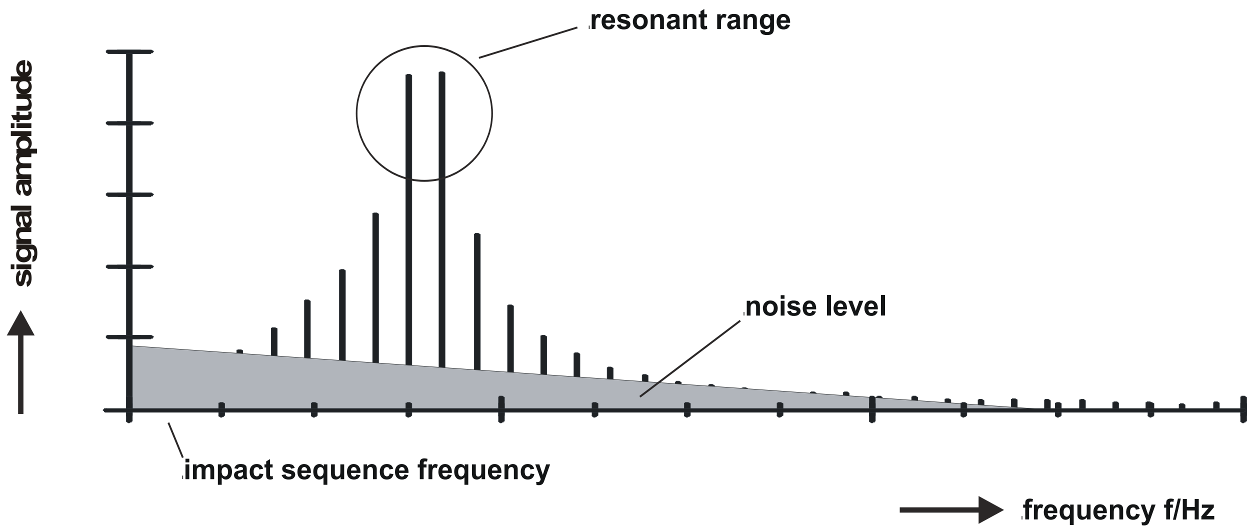


Fig. 5 Frequency spectrum with excitation through a periodic impact sequence taking into account the real noise level

Fig. 6 and 7 show real frequency spectra for two identical roller bearings where one has serious and the other only minor damage to the outer race. In both cases the impact pulse sequence frequency, i.e. the ball pass frequency of the outer race f_A, is around 105 Hz. It can be seen as base frequency in the seriously damaged bearing, but not in the slightly damaged bearing (note the different scales for the signal amplitudes of both spectra!).

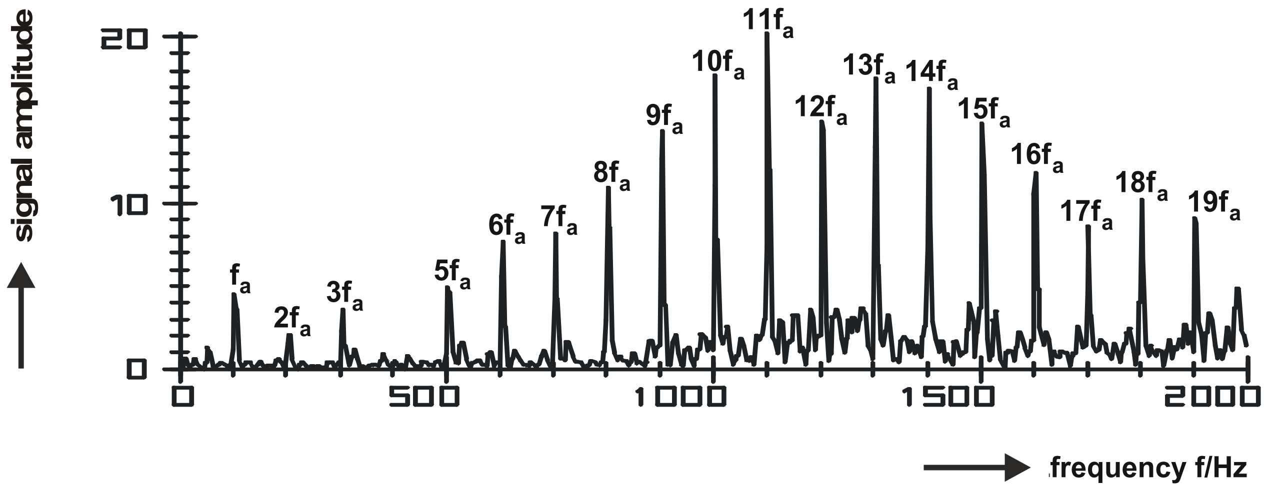


Fig. 6 Frequency spectrum of a bearing with serious outer race damage

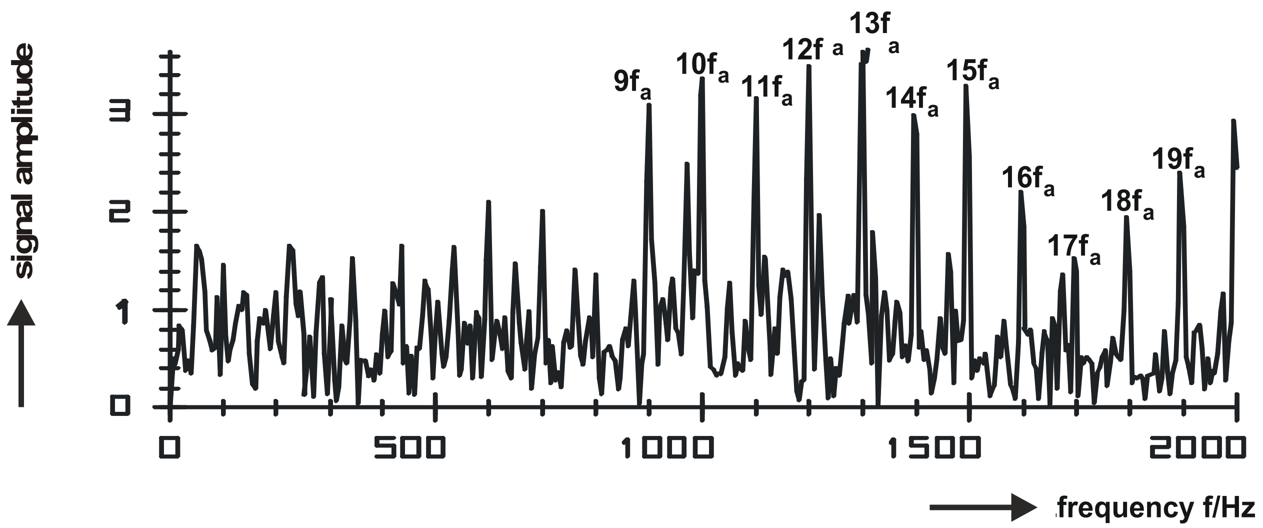


Fig. 7 Frequency spectrum of a bearing with minor outer race damage

The impact pulse sequence is thus mainly identified by the higher multiples of the impact pulse sequence frequency which lie in the machine resonance range, in this case between 1 kHz and 1.5 kHz. The demodulation analysis makes use of this fact.

Impact pulse sequences in a vibration signal can be detected and investigated very precisely by means of an demodulation analysis. The formation of an signal demodulation has been derived from radio technology where it is used to demodulate amplitude-modulated signals (Note). Since the periodic impact excitation of machine resonances is very similar to an amplitude modulation, there follows a brief description of the principle of amplitude modulation:

An amplitude-modulated signal consists of a high-frequency carrier signal and a low-frequency wanted signal, whereby the amplitude of the carrier signal varies as a function of the wanted signal. The wanted signal can thus be transferred together with the high-frequency carrier signal. The wanted signal is then separated from the carrier signal by the receiver by means of enveloping. This procedure is called demodulation.

In the case of machine resonances excited by periodic impact sequences, the machine resonances can be seen as the carrier signal and the low-pass filtered impact pulse sequences as the low-frequency modulation signal. Thus, demodulation separates the impact pulse from the resonant frequencies.

Enveloping can be carried out by various methods, e.g. the use of the Hilbert transformation or through various types of rectification. The most common method of enveloping is shown in Fig. 8.

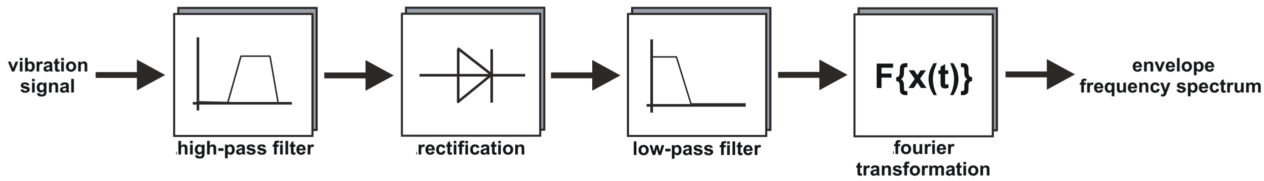


Fig. 8 Principle of demodulation analysis

The high-pass filter before rectification, sometimes also designed as a band pass filter, hereby ensures that only the interesting carrier frequencies are demodulation. Lower-frequency shares of the original signal which would otherwise also be rectified and would pass through the subsequent low-pass filter unhindered can thus be effectively suppressed. Rectification separates the modulation signal from the carrier signal. The subsequent low-pass filter suppresses the signal share of the high-frequency carrier signal. The remaining signal then only consists of the modulation signal with a synchronous share. Fig. 9, 10 and 11 demonstrate this process on the basis of the demodulation of a high-frequency sinusoidal vibration which has been amplitude modulated with a low-frequency sinusoidal vibration.

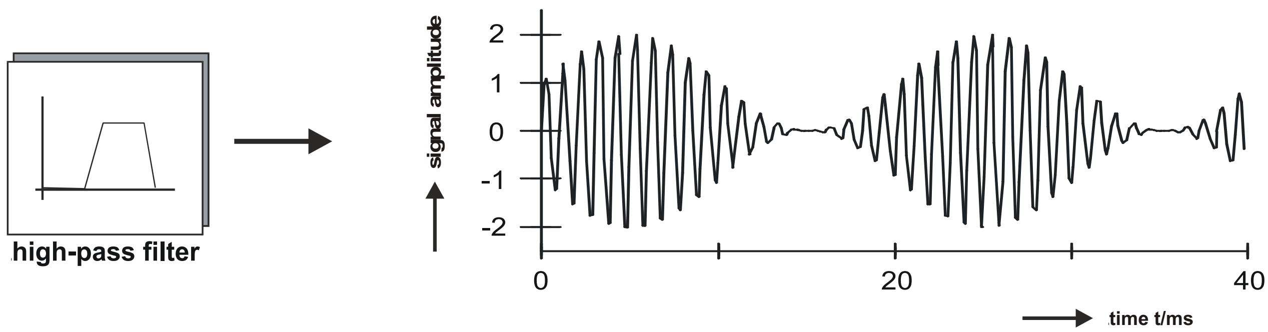


Fig. 9 Amplitude-modulated sinusoidal vibration

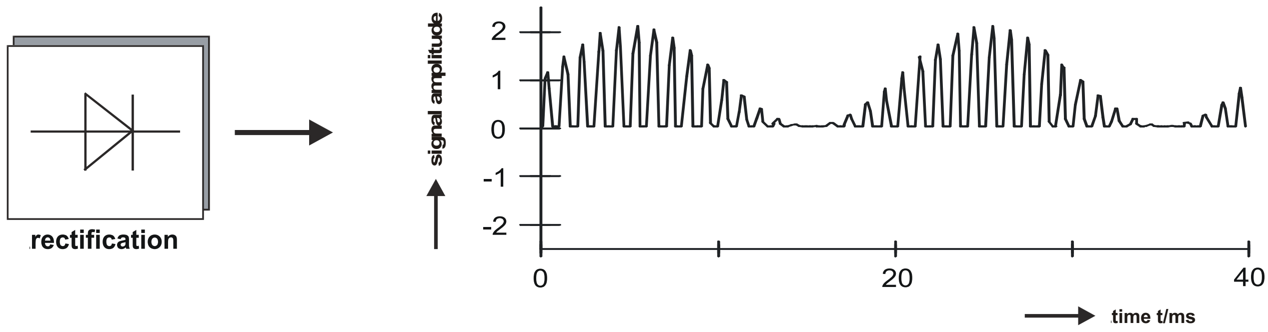


Fig. 10 Rectified, amplitude-modulated sinusoidal vibration

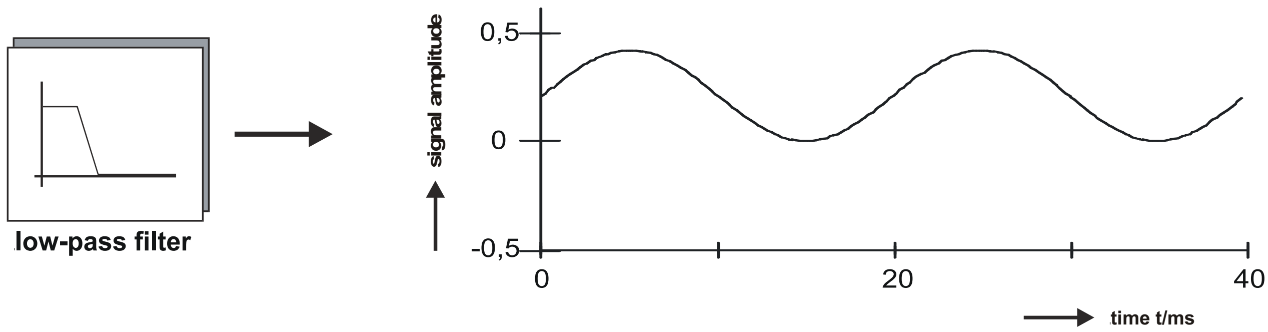


Fig. 11 Low-pass filtered, rectified amplitude-modulated sinusoidal vibration

After low-pass filtering only the modulation signal is present, namely the low-frequency sinusoidal vibration which is displaced by a synchronous share because of rectification. An impact-like excited machine resonance can also be demodulated in a similar manner. This is shown in the Fig. 12, 13 and 14.

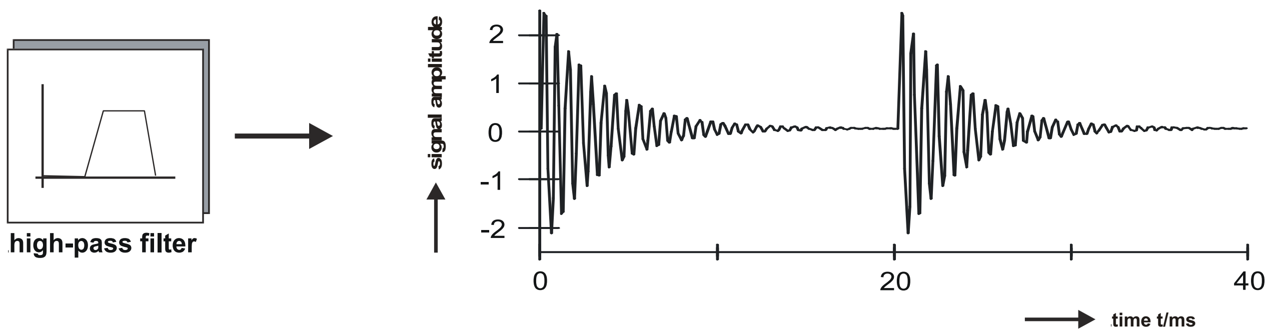


Fig. 12 Impact-like excited machine resonance

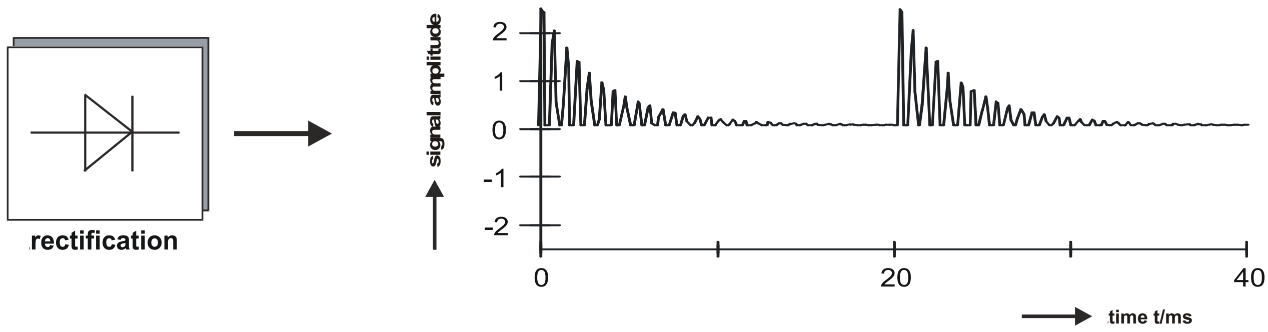


Fig. 13 Rectified, impact-like excited machine resonance

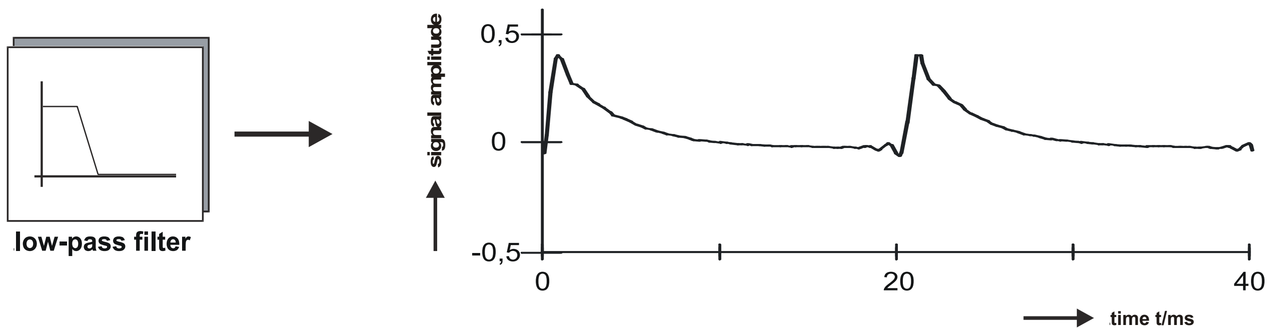


Fig. 14 Low-pass filtered, rectified impact-like excited machine resonance

The frequency spectrum of the demodulation signal is generally investigated using demodulation analysis. The frequency spectrum of the low-pass filtered, rectified amplitude-modulated sinusoidal vibration in Fig. 11 is trivial since this is only a sinusoidal vibration. If the synchronous share is suppressed this leaves a frequency spectrum which shows only one higher amplitude at the frequency of the low-frequency sinusoidal vibration, see Fig. 15.

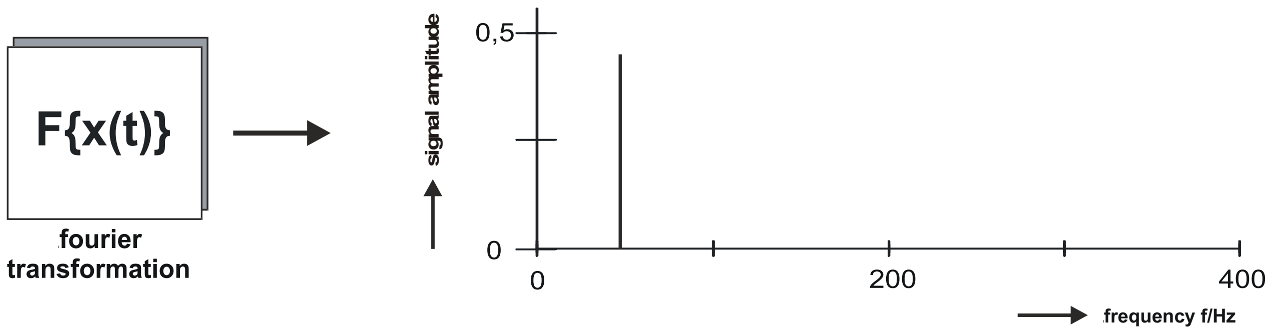


Fig. 15 Frequency spectrum of demodulation signal from Fig. 11 (synchronous share suppressed)

The demodulation signal of the periodic, impact-like excited machine resonance in Fig. 14 on the other hand shows higher amplitudes at the impact pulse sequence frequency and its multiples, see Fig. 16. The intensity of the amplitudes hereby diminishes with increasing multiples.

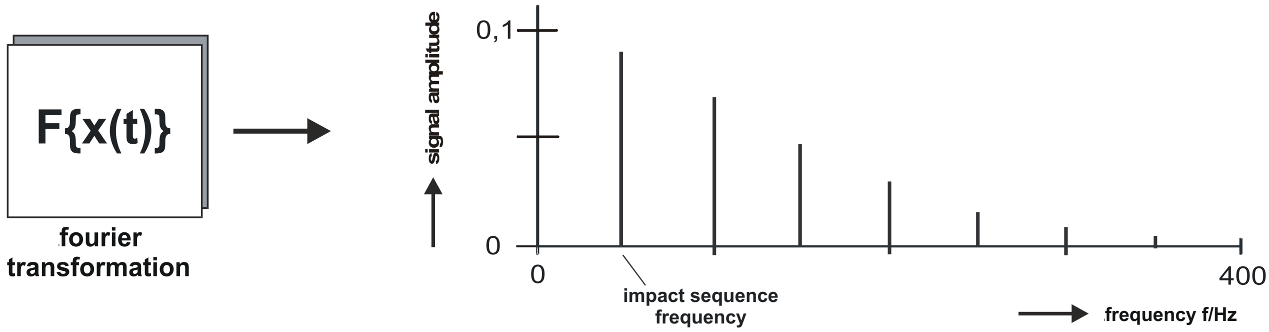


Fig. 16 Frequency spectrum of the demodulation signal from Fig. 14 (synchronous share suppressed)

The appearance of multiples is typical for impact pulses. The intensity can fluctuate - nor must the impact pulse sequence frequency always have the same amplitude - but there are always a number of multiples. If the intensity of the impact pulses fluctuates periodically, further frequencies occur within the demodulation spectrum, namely the base frequency of the intensity fluctuation and side bands around the impact pulse sequence frequency and its multiples. A knowledge of the frequency, intensity and characteristics of an impact pulse sequence enable the detection, localisation and estimation of the extent of machine damage. Enveloping is predestined to extract this information from the vibration signal.

Enveloping has proven itself for the early detection of roller bearing damage in various applications. If a damage is rolled over on the running surface or body of a roller bearing at a constant speed, this leads to a periodic sequence of impact pulses which excite resonances of the bearing or neighboring machine parts. Fig. 17 shows the typical vibration signal for a bearing with a seriously damaged outer race (strong local pitting on the running surface). The corresponding frequency spectrum can be seen in Fig. 6, Fig. 18 and Fig. 19 show the demodulation curves derived from this and the demodulation spectrum. The impact pulse sequence frequency at 105 Hz and its multiples can be clearly seen.

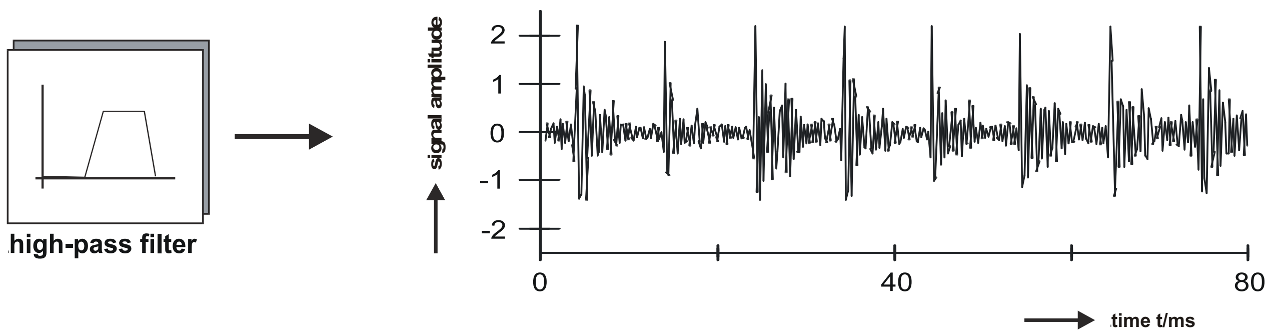


Fig. 17 Vibration signal for a roller bearing with strong pitting on the outer race surface

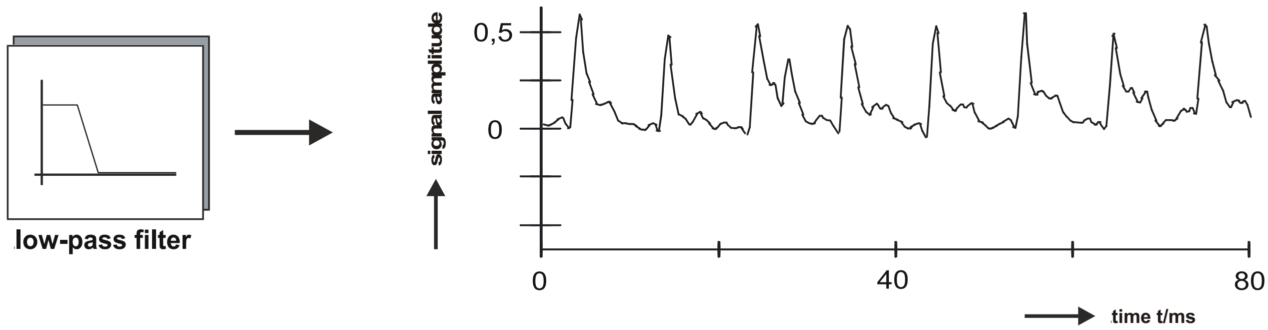


Fig. 18 Demodulation of the vibration signal from Fig. 17 Roller bearing with serious pitting damage on the outer race surface

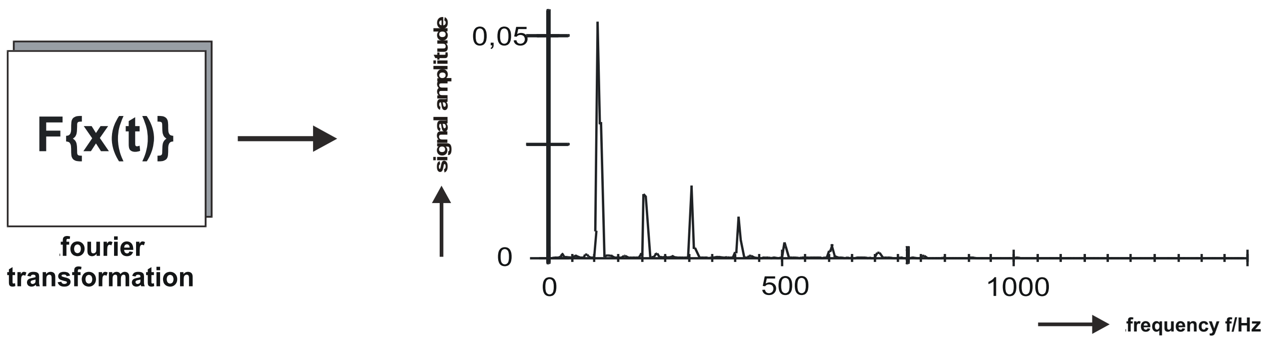


Fig. 19 Frequency spectrum of the demodulation signal from Fig. 18 Roller bearing with serious pitting damage on the outer race surface

The superiority of enveloping compared to investigations in the conventional frequency spectrum is also demonstrated in Fig. 20, Fig. 21 and Fig. 22. Fig. 20 shows the vibration signal of the bearing with a slightly damaged outer race (minor pitting on the outer race surface). The impact pulse sequence frequency cannot be detected in the corresponding frequency spectrum, Fig. 7, so that damage detection proves difficult on the basis of a frequency analysis. On the other hand, the impact pulse sequence frequency and its multiples can be clearly seen in the demodulation spectrum, whereby the amplitude is much lower than with a seriously damaged bearing (note the different scales). The signal-to-noise ratio is also lower.

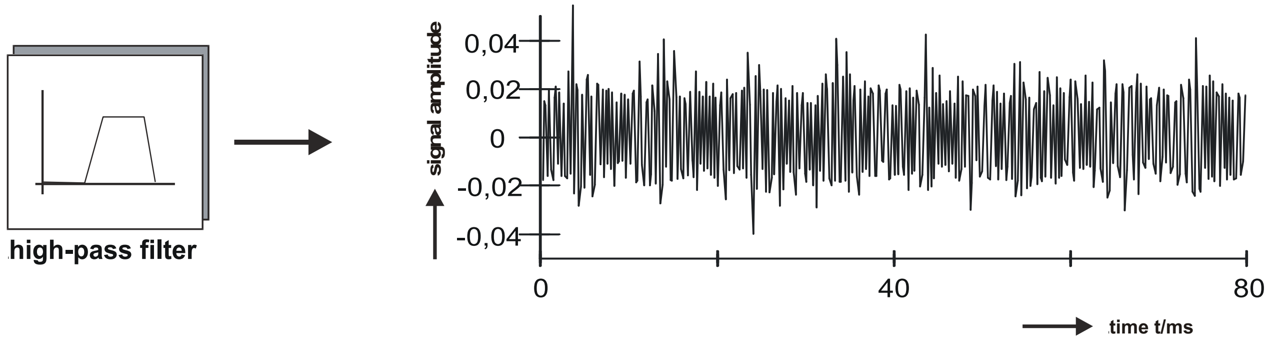


Fig. 20 Vibration signal for a roller bearing with minor pitting damage on the outer race surface

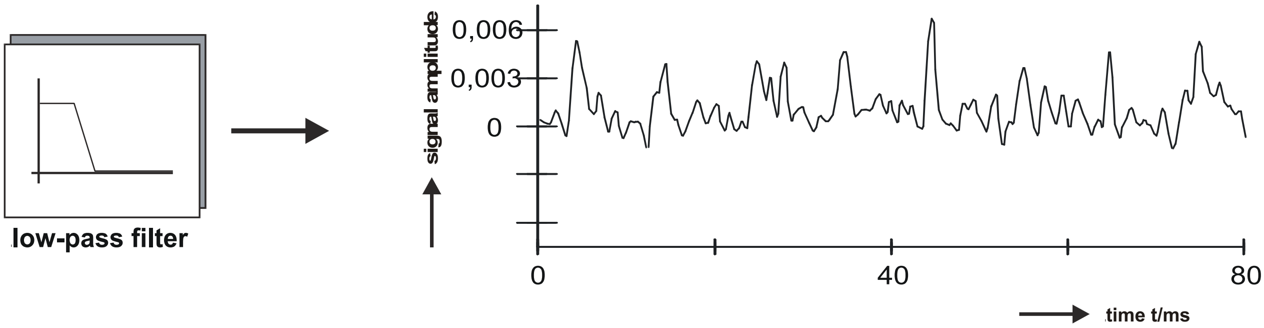


Fig. 21 Demodulation of the vibration signal in Fig. 20 Roller bearing with minor pitting damage on the outer race surface

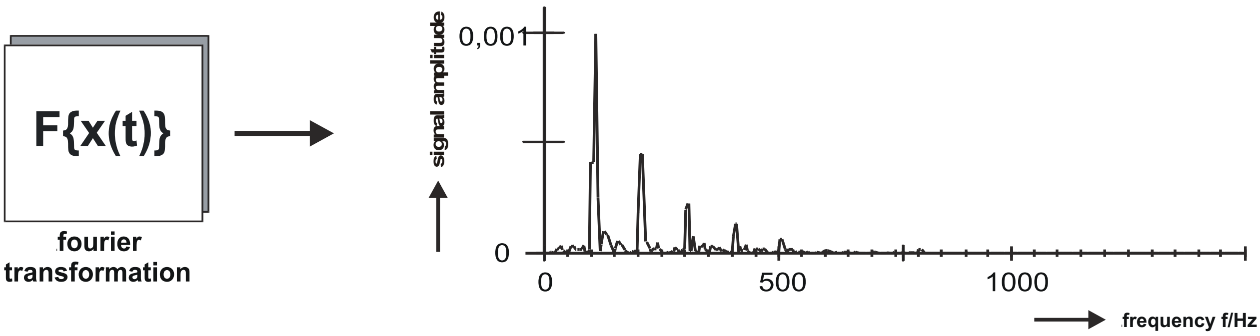


Fig. 22 Frequency spectrum of the demodulation signal from Fig. 20 Roller bearing with minor pitting damage on the outer race surface

Enveloping can be used to diagnose even very slowly rotating roller bearings, provided impact-like excitation occurs when the bearing rolls over the damage. This is the case, for example, in large roller bearings. Damage here can even be detected at speed of 1 rpm /2/.

7.1.4 Vibration characteristic values

A number of characteristic values are used in vibration monitoring. Simple characteristic values such as the arithmetical mean value, the peak-to-peak value though also the peak value of a signal are shown in Fig. 23.

Characteristic values

arithmetical mean value	$\bar{v} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} v(t)\, dt$
peak-to-peak value	v_{pp}
peak value	v_p
RMS value (root mean square)	$v_{RMS} = \sqrt{\frac{1}{T} \int_0^T v^2(t)\, dt}$

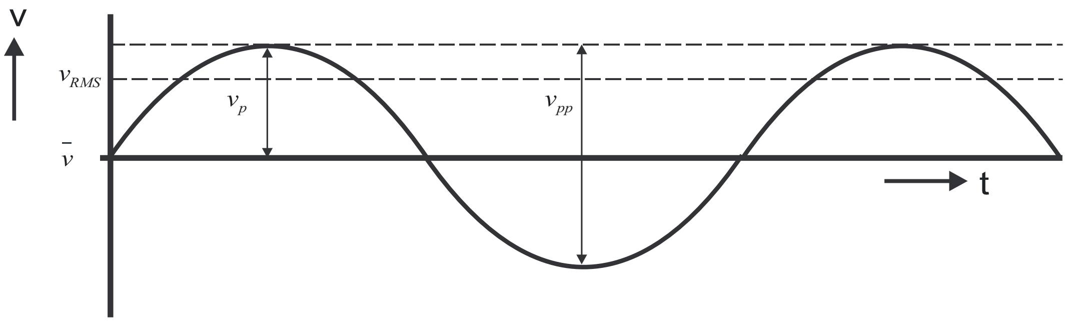


Fig. 23 Simple characteristic values for a vibration signal

7.1.4.1 Arithmetic mean value

The arithmetical mean value is not normally used to monitor the speed or acceleration signal since it results in 0 on account of the symmetry to the time axis.

7.1.4.2 Peak values (peak, peak to peak)

The peak to peak or peak values are monitored as characteristic values if a fast reaction is needed on a machine following a change in vibration, e.g. emergency shutdown if a break is detected.

7.1.4.3 Root mean square (RMS)

The RMS (root mean square) is also called the effective value. It is often used to assess the vibration intensity. The RMS-value can be determined in both the time and frequency range. It is determined from the time signal as follows:

$$RMS=\sqrt{\frac{1}{N}\sum_{t=0}^{t=N}\left(x(t)\right)^2}=\sqrt{\frac{1}{N}\left(\left(x(0)\right)^2+\left(x(1)\right)^2+\left(x(2)\right)^2+\ldots+\left(x(N)\right)^2\right)},$$

where x(t) are the amplitudes of the A/D converted time signal. N is the number of values used to determine the mean. The RMS-value can be calculated from the one-sided frequency spectrum (also called autocorrelation spectrum), e.g.

$$RMS=\sqrt{\left(X(0)\right)^2+\frac{1}{2}\left(\sum_{f=\frac{1}{T}}^{f=\frac{f_{sample}}{2}-\frac{1}{T}}\left(X(f)\right)^2\right)}$$

where X(0) is the synchronous share, X(f) the amplitudes in the frequency spectrum, T the FFT-window size and f_{sample} the sample frequency. If the same vibration signal is taken as a basis the results are almost identical for both types of calculation. The RMS-value of the vibration velocity is generally expressed in the unit [mm/s], the RMS-value of the vibration acceleration in [g].

7.1.4.4 Broad band RMS value

A number of standards and guidelines quote limits for the broad band RMS-value of the vibration velocity in the frequency range between 10 Hz and 1000 Hz, e.g. VDI 2056 or DIN ISO 10816. This effective value of the vibration velocity is a measure of the energy content of the vibration.

In a broad band RMS-value all vibration shares are added together, for example the high vibration amplitudes of an unbalance just as well as the low vibration level of a pending roller bearing damage. This means that only strong deviations to the vibration shares can be detected by monitoring a broad band RMS-value. Changes to individual vibration shares may be overlooked by broad band monitoring. An early and reliable detection of damages, e.g. roller bearing faults, is then impossible.

7.1.4.5 Selective RMS value

The monitoring of individual frequency bands is thus sensible for an early detection of damage. The selective RMS-value can be used as a characteristic value for these frequency bands. This can be formed by selecting the desired frequency band with a suitable band pass filter before RMS calculation. However, a better and more exact calculation is possible by forming the selected RMS in the frequency range, whereby only the amplitudes within the narrow band frequency range are taken into account during summation:

$$RMS=\frac{1}{\sqrt{2}}\sqrt{\sum_{f=f_u}^{f=f_o}\left(X(f)\right)^2}$$

where f_u and f_o are the lower and upper limit for the narrow band frequency range used for RMS formation. This means that selective RMS-values can be calculated which take into account the amplitudes from a number of narrow band frequency ranges.

7.1.5 Bibliography

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7.2 Principles of non-contact temperature measurement

(Dr.-Ing Gruner, Raytek)

7.2.1 Introduction

This manual was written for people who are unfamiliar with noncontact infrared temperature measurement. A conscious attempt has been made to present the subject matter as briefly and simply as possible. Readers who wish to gain more in-depth knowledge can follow the suggestions for further reading in the bibliography. This manual focuses on the practical operations of noncontact temperature measurement devices and IR thermometry, and answers important questions that may arise. If you plan to use a noncontact temperature measurement device and require further advice, send us the completed questionnaire (in the appendix) prior to use.

7.2.2 Advantages of using IR thermometers

Temperature is the most frequently measured physical quantity, second only to time. Temperature plays an important role as an indicator of the condition of a product or piece of machinery, both in manufacturing and in quality control. Accurate temperature monitoring improves product quality and increases productivity. Downtimes are decreased, since the manufacturing processes can proceed without interruption and under optimal conditions.

Infrared technology is not a new phenomenon - it has been utilized successfully in industrial and research settings for decades - but new innovations have reduced costs, increased reliability, and resulted in noncontact infrared sensors offering smaller units of measurement. All of these factors have led infrared technology to become an area of interest for new kinds of applications and users.

What are the advantages offered by noncontact temperature measurement?

- It is fast (in the ms range) - time is saved, allowing for more measurements and accumulation of data (determination of temperature field).
- It facilitates measurement of moving targets (conveyor processes).
- Measurements can be taken of hazardous or physically inaccessible objects (high-voltage parts, great measurement distance).
- Measurements of high temperatures (greater than 1300°C) present no problems. In similar cases, contact thermometers cannot be used, or have a limited life. There is no interference - no energy is lost from the target. For example, in the case of a poor heat conductor such as plastic or wood, measurements are extremely accurate with no distortion of measured values, as compared to measurements with contact thermometers.
- There is no risk of contamination and no mechanical effect on the surface of the object; thus wear-free. Lacquered surfaces, for example, are not scratched and soft surfaces can also be measured.

Having enumerated the advantages, there remains the question of what to keep in mind when using an IR thermometer:

The target must be optically (infrared-optically) visible to the IR thermometer. High levels of dust or smoke make measurement less accurate. Concrete obstacles, such as a closed metallic reaction vessel, allow for only topical measurement - the inside of the container cannot be measured.

- The optics of the sensor must be protected from dust and condensing liquids. (Manufacturers supply the necessary equipment for this.)
- Normally, only surface temperatures can be measured, with the differing emissivities of different material surfaces taken into account.

Summary: The main advantages of noncontact IR thermometry are speed, lack of interference, and the ability to measure in high temperature ranges to 3000°C. Keep in mind that only the surface temperature can be measured.

7.2.3 Infrared measuring system

An IR thermometer can be compared to the human eye. The lens of the eye represents the optics through which the radiation (flow of photons) from the object reaches the photosensitive layer (retina) via the atmosphere. This is converted into a signal that is sent to the brain. Fig. 1 shows an infrared measuring system process flow.

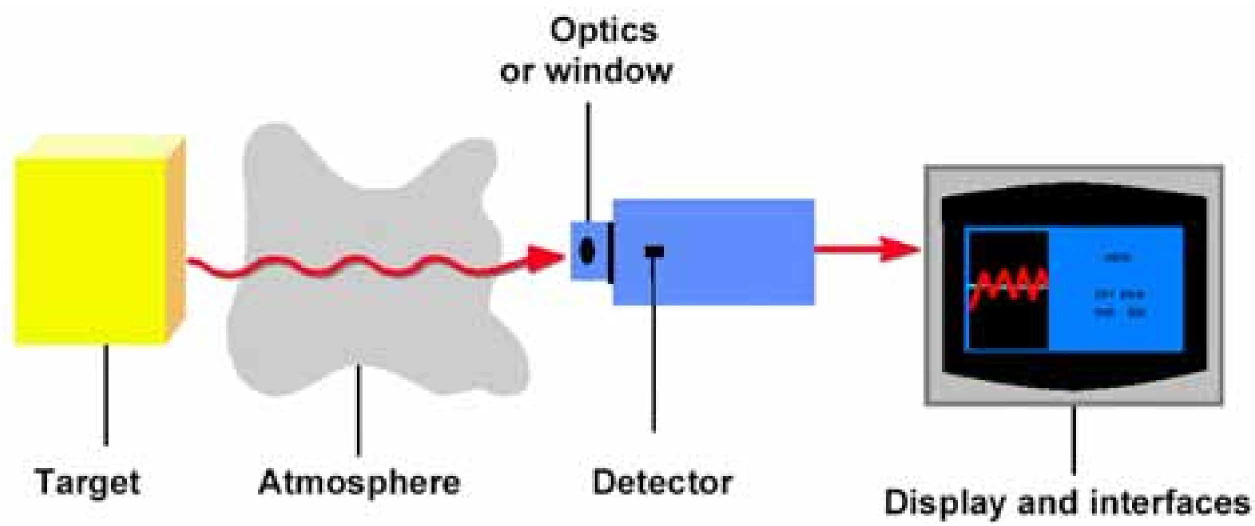

Fig. 1 Infrared measuring system

7.2.4 Target

Every form of matter with a temperature (T) above absolute zero emits infrared radiation according to its temperature. This is called characteristic radiation. The cause of this is the internal mechanical movement of molecules. The intensity of this movement depends on the temperature of the object. Since the molecule movement represents charge displacement, electromagnetic radiation (photon particles) is emitted. These photons move at the speed of light and behave according to the known optical principles. They can be deflected, focused with a lens, or reflected from reflective surfaces. The spectrum of this radiation ranges from 0.7 to 1000 µm wavelength. For this reason, this radiation cannot normally be seen with the naked eye. This area lies within the red area of visible light and has therefore been called "infra"-red after the Latin. (See Fig. 2).

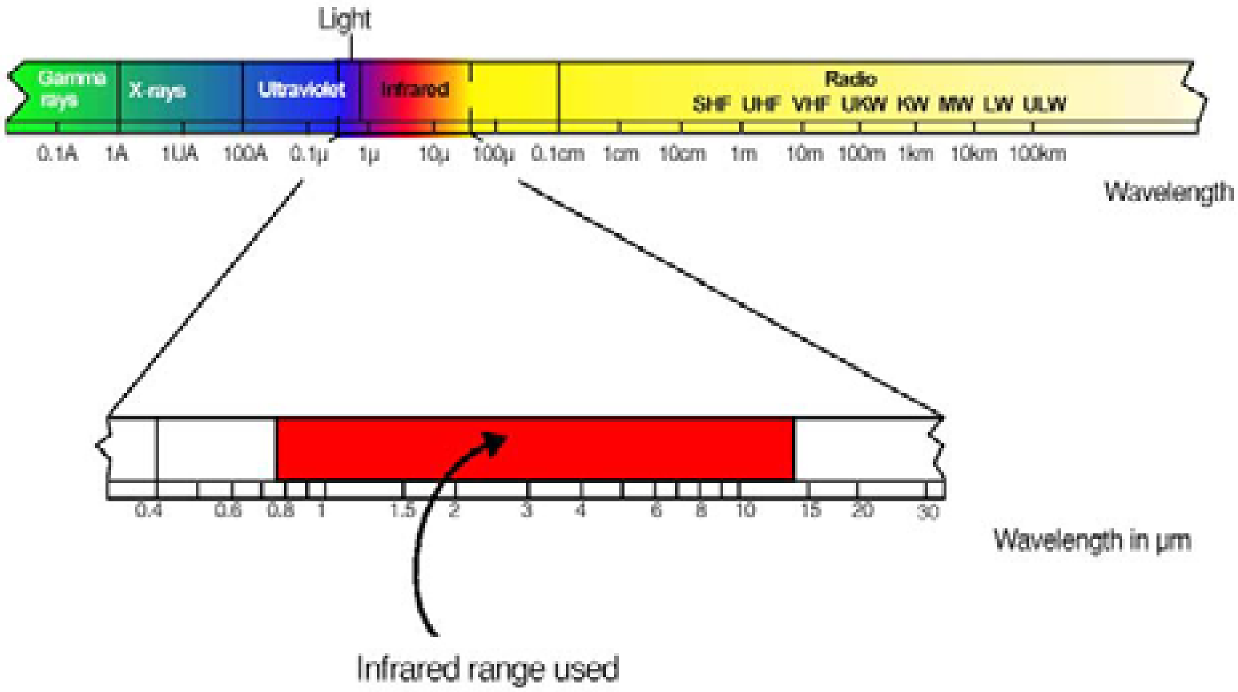

Fig. 2 The electromagnetic spectrum, with range from around 0.7 to 14 µm useful for measuring purposes

Fig. 3 shows the typical radiation of a body at different temperatures. As indicated, bodies at high temperatures still emit a small amount of visible radiation. This is why everyone can see objects at very high temperatures (above 600°C) glowing somewhere from red to white. Experienced steelworkers can even estimate temperature quite accurately from the color. The classic disappearing filament pyrometer was used in the steel and iron industries from 1930 on. The invisible part of the spectrum, however, contains up to 100,000 times more energy. Infrared measuring technology builds on this. It can likewise be seen in Fig. 3 that the radiation maximum move toward ever-shorter wavelengths as the target temperature rises, and that the curves of a body do not overlap at different temperatures. The radiant energy in the entire wavelength range (area beneath each curve) increases to the power of 4 of the temperature. These relationships were recognized by Stefan and Boltzmann in 1879 and illustrate that an unambiguous temperature can be measured from the radiation signal. /1/, /3/, /4/ and /5/.

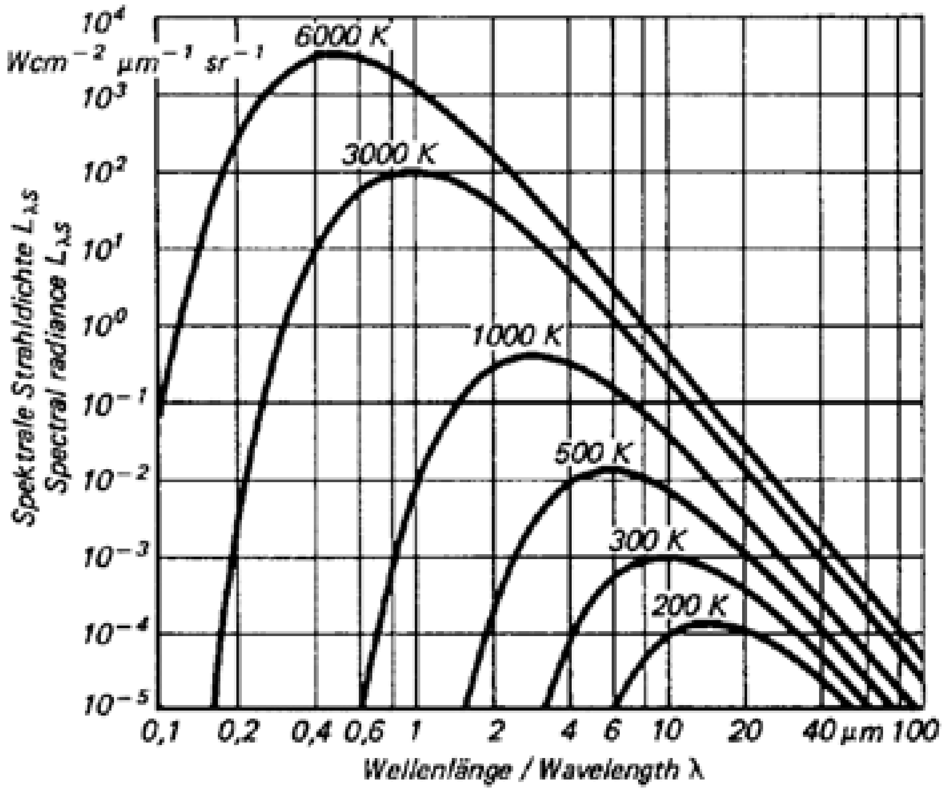

Fig. 3 Radiation characteristics of a blackbody in relation to its temperature. /3/.

Looking at Fig. 3, then, the goal should be to set up the IR thermometer for the widest range possible in order to gain the most energy (corresponding to the area below a curve) or signal from the target. There are, however, some instances in which this is not always advantageous. For instance, in Fig. 3, the intensity of radiation increases at 2 µm - much more when the temperature increases than at 10 µm. The greater the radiance difference per temperature difference, the more accurately the IR thermometer works. In accordance with the displacement of the radiation maximum to smaller wavelengths with increasing temperature (Wien's Displacement Law), the wavelength range behaves in accordance with the measuring temperature range of the pyrometer. At low temperatures, an IR thermometer working at 2 µm would stop at temperatures below 600°C, seeing little to nothing since there is too little radiation energy. A further reason for having devices for different wavelength ranges is the emissivity pattern of some materials known as non-gray bodies (glass, metals, and plastic films). Fig. 3 shows the ideal - the so-called "blackbody". Many bodies, however, emit less radiation at the same temperature. The relation between the real emissive power and that of a blackbody is known as emissivity å (epsilon) and can be a maximum of 1 (body corresponds to the ideal blackbody) and a minimum of 0. Bodies with emissivity less than 1 are called gray bodies. Bodies where emissivity is also dependent on temperature and wavelength are called non-gray bodies. Furthermore, the sum of emission is composed of absorption (A), reflection (R) and transmission (T) and is equal to one. (See Equation 1 and Fig. 4).

A + R + T = 1 (1)

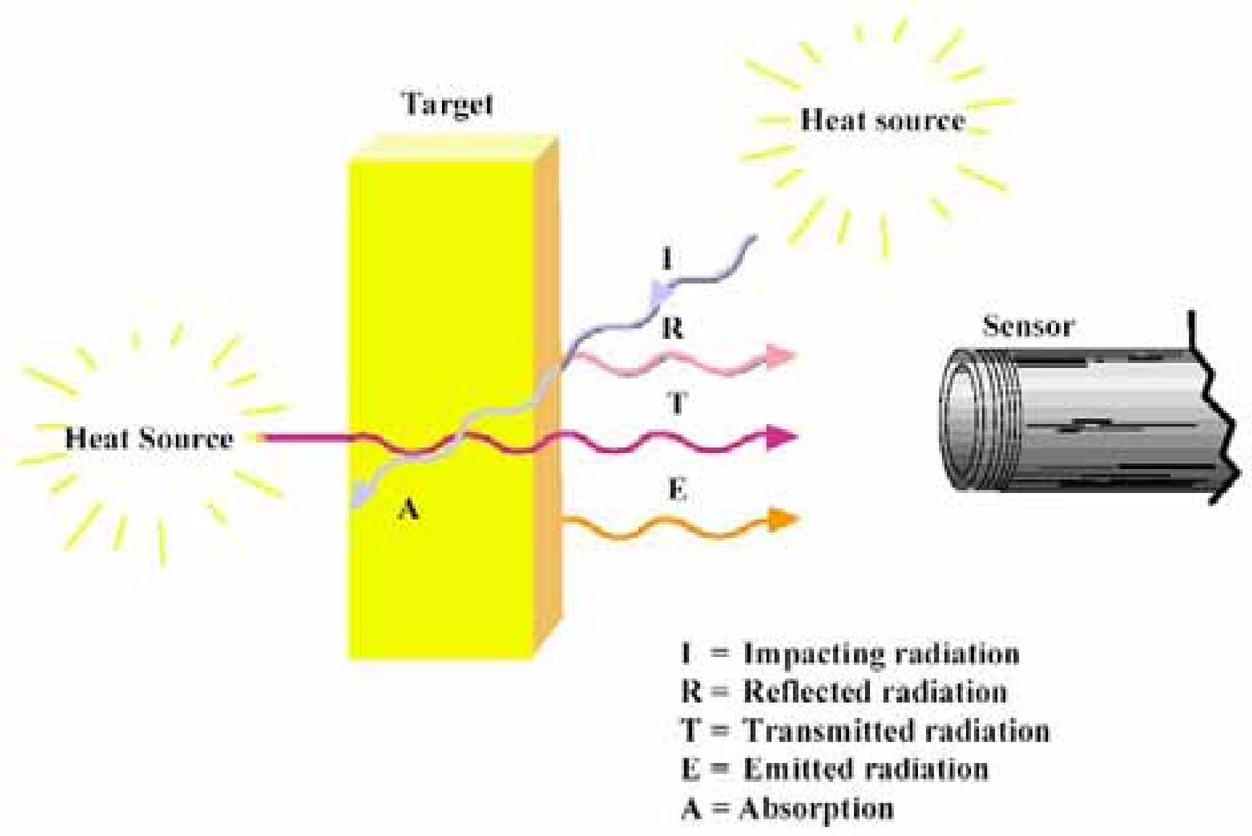

Fig. 4 In addition to the radiation emitted from the target, the sensor also receives reflected radiation and can also let radiation through.

Solid bodies have no transmission in the infrared range (T = 0). In accordance with Kirchhof's Law, it is assumed that all the radiation absorbed by a body, and which has led to an increase in temperature, is then also emitted by this body. The result, then, for absorption and emission is:

A <=> E = 1 - R (2)

The ideal blackbody also has no reflectance (R = 0), so that E = 1.

Many non-metallic materials such as wood, plastic, rubber, organic materials, rock, or concrete have surfaces that reflect very little, and therefore have high emissivities between 0.8 and 0.95. By contrast, metals - especially those with polished or shiny surfaces - have emissivities at around 0.1. IR thermometers compensate for this by offering variable options for setting the emissivity factor. (See also Fig. 5).

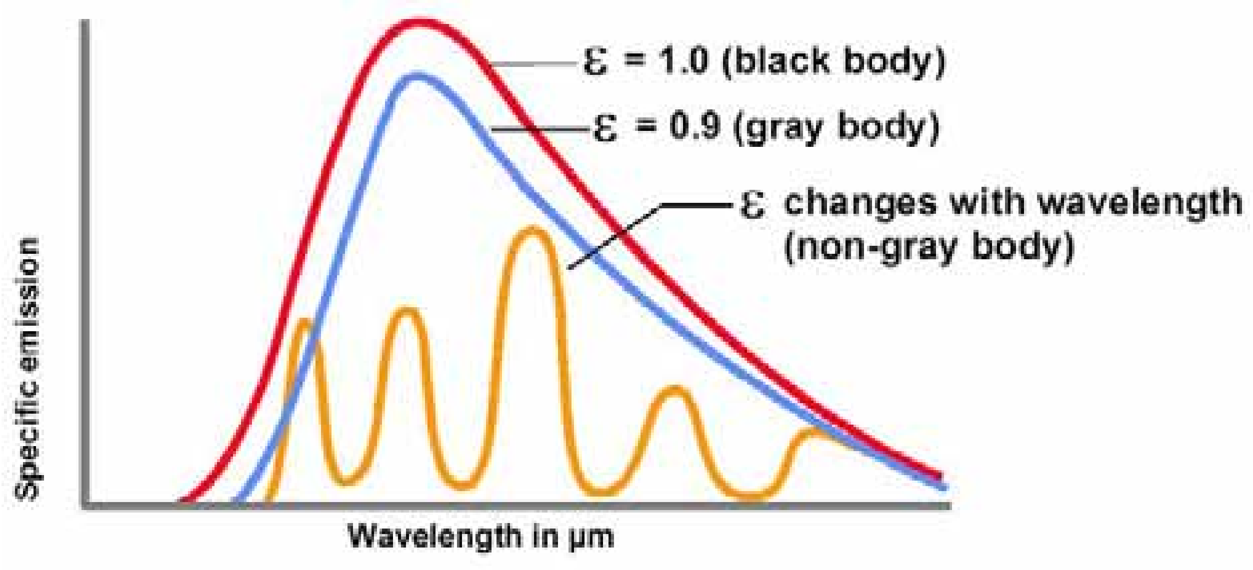

Fig. 5 Specific radiation at various emississivity

7.2.5 Handling the pyrometer

7.2.5.1 Distance to spot size ratio

Distance to spot ratio (or field of view) refers to the diameter of the spot that the probe is sensing at a given distance. The closer you are to the object (or target), the smaller the area (or spot) the probe is sensing. For example when the probe is held at a 200 mm (8 in.) distance from the target, the spot size is approximately 50 mm (2 in.); at 100 mm (4 in.) the spot size is approximately 25 mm (1 in.), and with the probe held at 50 mm (2 in.) distance from the target, the spot size is approximately 13 mm (½ in.).

Hot spots can be missed if too large an area is included in the field of view, so get as close as possible! (See Fig. 6 and Fig. 7).

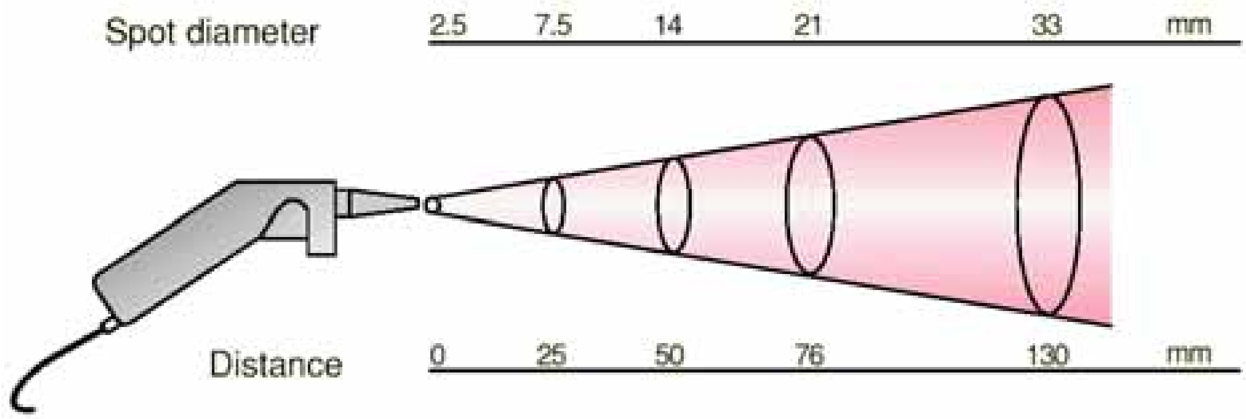

Fig. 6 Spot size

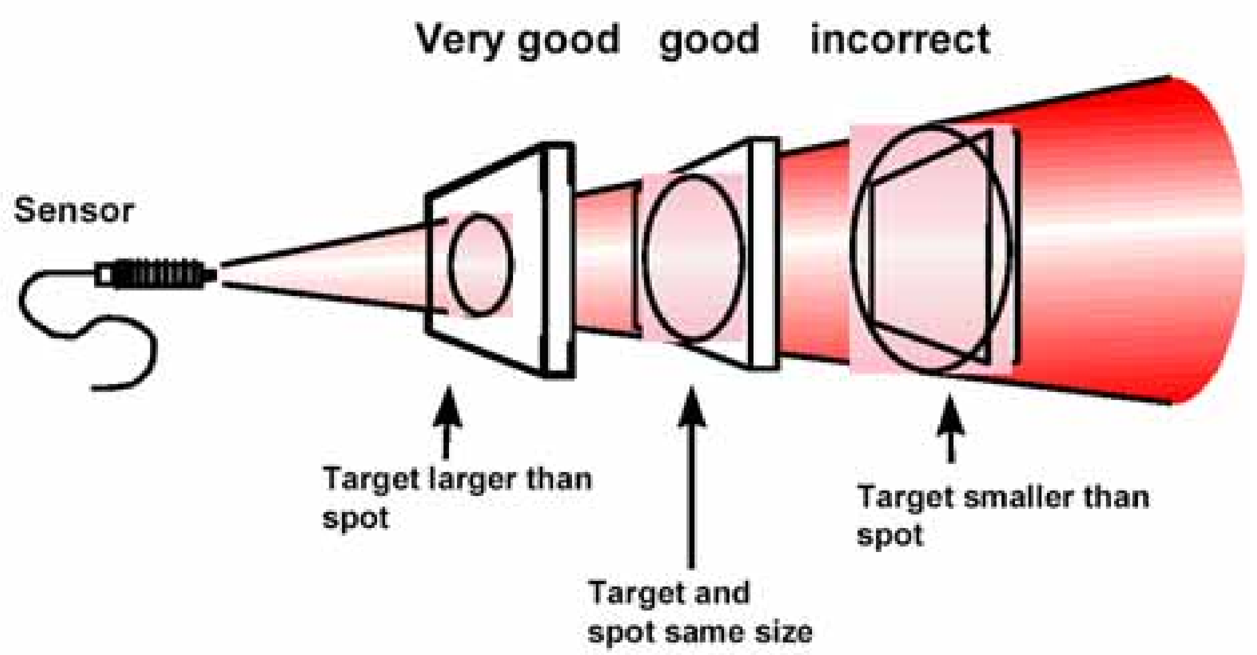

Fig. 7 Size of the measuring object

7.2.5.2 Emissivity

All objects emit invisible infrared energy. The amount of energy emitted is proportional to the object's temperature and its ability to emit IR energy. This ability, called emissivity, is base upon the material that the object is made of and its surface finish. Emissivity values range from 0.10 for a very refective object to 1.00 for a black body. The probe senses this energy and calculates the temperature base on the amount of IR energy it receives and the factory set emissivity value of 0.95, which will cover 90% of typical applications.

7.2.5.3 Measurement considerations

- If the surface to measured is small [13 mm (½ in.) or less], hold the probe as close as possible to the surface [no more than 50 mm (2 in.) away].
- If the surface to be measured is covered by frost or other material, clean it to expose the surface.
- If the surface to be measured is highly refective, apply masking tape or a matte finish black paint to the surface.
- If the probe seems to be giving incorrect readings check the front of the probe. There may be condensation or debris obstructing the sensor; clean according to maintenance instructions.

7.2.6 Bibliography

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8 Technical data

Device name	FAG DETECTOR III, DETECT3-KIT
Inputs	2 * BNC connectors (multiplexer) ICP (4,7 mA), arbitrary configurable sensitivity AC/DC ±5V, impedance >100 kOhm 1 * AUX Tachometer input 5 up to 24V, 30-9999 RPM (rising or falling edge selectable) IR-temperature sensor ±5V, impedance >100 kOhm (freely configurable) Battery charger
Vibration measurements	
Outputs	Headphone (demodulation signal) RS 232 for data transfer (38.4 kbps; 57.6 kbps) AUX: supply trigger sensor (5 V max. 200 mA, 12 V max. 50 mA)
Measuring ranges	Acceleration / velocity 0.1 Hz to lowpass 0.1 Hz to 200 Hz; 0.1 Hz to 500 Hz; … Demodulation 0 Hz until lowpass Lowpasses 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 20 kHz Highpass (demodulation branch) 750 Hz Temperature –20 °C to +550 °C (temperature range depends on the used sensor, freely configurable input)
Characteristic values	A_{eff} (2 kHz to lowpass), RMS value of the vibration acceleration A_{sel} RMS value of the vibration acceleration in a freely configurable frequency range ISO 10816 (10 Hz to 1000 Hz), RMS value of the vibration velocity V_{sel} RMS value of the vibration velocity in a freely configurable frequency range D_{eff} (frequency range depends on lowpass frequency), RMS value of the demodulation signal D_{sel} Effective demodulation signal in a freely configurable frequency range Crest factor, rotational speed, temperature
Window type	Hanning
Averaging in frequency domain	1–9 (FFT, characteristic value per channel)
Sampling rate	Linear max. 51.2 kHz, depending on the configured lowpass frequency (configured lowpass * 2.56)
A/D-converter	16 bit (autoranging) Dynamic range >90 db
Frequency resolution	1600, 3200 lines (0.0625 Hz up to 12.5 Hz depending on the configured lowpass frequency)

Balancing	
	1 or 2 plane balancing Weight positions: continuous (0 to 359°) or discrete (4 to 99 positions) Remove trial weights: yes/no
Balancing type	Acceleration, velocity, displacement
Measurement	Peak, Peak – Peak, RMS
Balancing units	g, mm/s, inch/s, µm, mil
Weights units	gr., oz. (up to 99 999.99 gr. / oz.)
General	
Additional measurements	Temperature, rotational speed, headphone (demodulation)
Keyboard	Foil keyboard with 21 keys
Display	Backlit graphic display (LCD) 128x 64 pixels, dimension 55 x 33 mm
Memory	1600 measuring points plus 270 time signals (maximal 300 time signals)
Power supply	NiMh 2 000 mAh Voltage 6V Operation time approx. 6 to 8 hours (charging time for empty battery approx. 4 h)
Size and weight	230 x 70 (53) x 45 (53) mm (L x W x H) approx. 500g (including battery)
Temperature range	0 to 50 °C (operating temperature) 0 to 40°C (to load the charger) –20 to +70 °C (storage and transport temperature)
Operation time	approx. 6 to 8 hours continuous operation
Housing	ABS IP 40
Protective bag	Two compartments, black nylon material 2 windows with foil cover, openings with Velcro strip fastener Velcro strip ties for cables and sensor, carrying strap
EMC standards	– EN61000-4-2 – EN61000-4-3 – EN61000-4-6
Firmware	Free firmware updates on the Internet Available languages: German, English, Finnish, French, Italian,Dutch, Portuguese, Swedish, Slovenian, Spanish and Turkish
Software	FAG-Trendline (updates on the Internet) Runs on Windows 2000 and XP Available in: German, English, French, Portuguese and Spanish

	– Configuration of the FAG Detector III via RS 232-interface – Bearing database with ca. 20 000 bearings – Graphical display of the measured values and trends – Trend analysis – View of time signals and FFTs – Tabular and graphic view of the balancing data – Configurable report tool

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