ibaInSpectra

Monitor and analyze vibrations in real time

Manual

Issue 1.2

Measurement Systems for Industry and Energy

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The content of this publication has been checked for compliance with the described hardware and software. Nevertheless, discrepancies cannot be ruled out, and we do not provide guarantee for complete conformity. However, the information furnished in this publication is updated regularly. Required corrections are contained in the following regulations or can be downloaded on the Internet.

The current version is available for download on our web site www.iba-ag.com.

Version	Date	Revision - Chapter / Page	Author	Version SW
1.2	02/2020	New modules	st	7.1.0

Content

1 About this manual

This documentation describes the function, setup and application of the *ibaInSpectra* and *ibaAnalyzer-InSpectra* software.

1.1 Target group and previous knowledge

This documentation is aimed at qualified professionals, who are familiar with handling electric and electronic modules as well as communication and measurement technology. A person is regarded as professional if he/she is capable of assessing safety and recognizing possible consequences and risks on the basis of his/her specialist training, knowledge and experience and knowledge of the standard regulations.

In particular, this documentation is aimed at people who deal with the acquisition and analysis of vibration measurement data. Since *ibaInSpectra* is an integral part of *ibaPDA*, the following previous knowledge is required for the configuration of *ibaInSpectra* or *ibaAnalyzer-InSpectra*:

- Windows operating system
- Basic knowledge of *ibaPDA*
- Knowledge of vibration measurement technology
- Knowledge of frequency analysis

1.2 Notations

In this manual, the following notations are used:

Action	Notation
Menu command	Menu *Logic diagram*
Calling the menu command	*Step 1 – Step 2 – Step 3 – Step x* Example: Select the menu *Logic diagram - Add - New function block*.
Keys	<Key name> Example: <Alt>; <F1>
Press the keys simultaneously	<Key name> + <Key name> Example: <Alt> + <Ctrl>
Buttons	<Key name> Example: <OK>; <Cancel>
File names, paths	"Filename", "Path" Example: "Test.doc"

1.3 Used symbols

If safety instructions or other notes are used in this manual, they mean:

Danger!

The non-observance of this safety information may result in an imminent risk of death or severe injury:

- Observe the specified measures.

Warning!

The non-observance of this safety information may result in a potential risk of death or severe injury!

- Observe the specified measures.

Caution!

The non-observance of this safety information may result in a potential risk of injury or material damage!

- Observe the specified measures

Note

A note specifies special requirements or actions to be observed.

Tip

Tip or example as a helpful note or insider tip to make the work a little bit easier.

Other documentation

Reference to additional documentation or further reading.

2 Introduction

ibaInSpectra is used to continuously monitor any vibrations in real time in order to detect possible sources of error at an early stage. As *ibaInSpectra* is integrated in *ibaPDA*, not only mere vibration analyses can be performed, but also possible relations between vibration effects and process behavior can be detected immediately.

Using spectral analyses, vibrations can be monitored online and correlated with other process parameters. If vibrations reach critical states, the plant operator is informed immediately, for example by alarm message or e-mail. In addition, a feedback in the plant control can be implemented to automatically adjust the corresponding parameters.

2.1 ibaInSpectra – the concept

Designed as an integrated technology module of *ibaPDA*, *ibaInSpectra* serves to monitor and analyze vibrations. *ibaInSpectra* provides different modules, which are configured in the I/O manager of *ibaPDA*.

- The expert module offers the most diverse parameterization options for the frequency band analysis and is the preferred tool for vibration experts. The frequency bands to be monitored can be defined as fixed or dependent on process variables and checked for limit value exceedance.
- The auto-adapting module automatically learns spectra for different process conditions and uses this as a reference to detect changes in the spectrum over time.
- The orbit module is used to monitor and analyze the shaft motion, for example of journal bearings.
- The universal module is easy to configure and calculates the most common characteristic values for vibration monitoring in the time domain.
- The fan module is used to monitor fans and calculates special indicators for the state of fans.

ibaAnalyzer-InSpectra makes it possible to configure calculation rules in the form of profiles offline and to test them on already recorded data. These profiles can be transferred to *ibaInSpectra* with the help of export and import functions and used there. Existing calculation profiles from *ibaInSpectra* can also be transferred to *ibaAnalyzer-InSpectra* in order to adjust the calculations or limits.

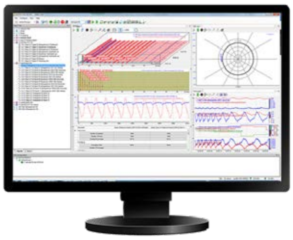
With *ibaAnalyzer-InSpectra* not only raw signals and calculated characteristic values, but also the calculation profiles can be opened in *ibaAnalyzer*. Therefore it is also possible to carry out the calculations of *ibaInSpectra* offline. Characteristic values that have triggered an alarm can be validated and the problem can be analyzed offline. The extensive features of *ibaAnalyzer-InSpectra* offer a useful option here: Changing the analysis rules gives you a better view of the information relevant to the respective problem. Due to the integration in *ibaAnalyzer*, it is very easily possible to use and compare all recorded process parameters for the analysis.

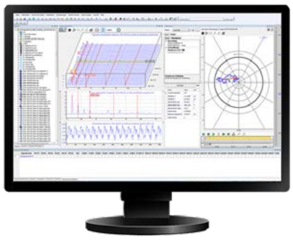
The focus when acquiring mechanical vibrations is usually on acceleration sensors or distance sensors for *ibaInSpectra* orbit. Different input modules from the iba hardware are available for connecting these sensors.

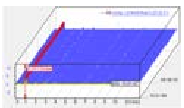
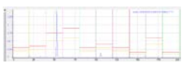
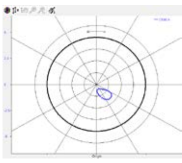
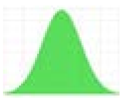
Basically, *ibaInSpectra* can also be used to process all other vibration-related parameters, e.g. shaft speed, speed, torque, force, etc. By analyzing the vibrations (causing damage) interfering these measured parameters, root-cause analysis can be performed. For the acquisition of such parameters, the entire connectivity of *ibaPDA* can be used.

Note

Aliasing is to be observed for signals that were not acquired with iba hardware for IEPE acceleration sensors. If necessary, an appropriate lowpass filter must be applied to the signal.





	Modules	**online**		**offline**
	Expert	Spectral analysis, frequency band monitoring	↔	Configuration, validation and detailed analysis
	Auto adapting	Self-learning and adaptable expert module	↔	Configuration, validation and detailed analysis
	Orbit	Monitoring the shaft position and shaft motion	↔	Configuration, validation and detailed analysis
	Universal	Monitoring statistic characteristic values		--
	Fan	Fan monitoring		--

2.2 ibaInSpectra (ibaPDA)

ibaInSpectra is an integrated technology module of the process data recording system *ibaPDA* and processes vibration signals continuously and in real time. Any vibrations can be monitored continuously in the process and possible error sources can be detected at an early stage. As *ibaInSpectra* is integrated in *ibaPDA*, not only mere vibration analyses can be performed, but also possible relations between vibrational effects and process behavior can be detected.

License information

Order no.	Product name	Description
30.681222	ibaInSpectra bundle	Spectrum Analysis Library ibaPDA license upgrade includes license for ibaAnalyzer-InSpectra
30.681220	ibaInSpectra	Spectrum Analysis Library ibaPDA license upgrade
30.681221	ibaInSpectra-Lite	Spectrum Analysis Library, Condition Monitoring System, max. 8 modules

2.3 ibaAnalyzer-InSpectra

ibaAnalyzer-InSpectra offers the functionality of *ibaInSpectra* for vibration monitoring offline in *ibaAnalyzer*. The configuration of the online system can thus be carried out offline based on acquired data and calculations can be validated and adjusted subsequently. In addition, *ibaAnalyzer-InSpectra* allows a detailed machine diagnosis.

License information

Order no.	Product name	Description
33.010410	ibaAnalyzer-InSpectra	Add-on for ibaAnalyzer, offline vibration analysis

2.4 License model

Purchasing a license *ibaInSpectra* enables the function of the modules in *ibaPDA*. If the license is not enabled in the dongle, the *ibaInSpectra* branch does not appear in the signal tree of the I/O manager. The *ibaInSpectra* license contains all different module types of *ibaInSpectra*.

With a license, up to 1024 *ibaInSpectra Expert* modules can be created in the I/O manager in theory. The actually usable quantity depends on the type and number of signals and configurations of the calculations as well as the computing power of the computer.

The *ibaInSpectra-lite* license provides all functions of *ibaInSpectra*. However, only 8 modules can be created. Purchasing an *ibaAnalyzer-InSpectra* license enables the functions in *ibaAnalyzer*. If the license is not released in the dongle, then the respective module view cannot be opened. The *ibaAnalyzer-InSpectra* license contains all module types of *ibaInSpectra* available offline.

The *ibaInSpectra* bundle contains the *ibaInSpectra* full version and an *ibaAnalyzer-InSpectra* license.

2.5 InSpectra profiles

All InSpectra profiles with configurable calculation rules use profiles for the configuration. These profiles can be used to reuse calculation rules and exchanged between different systems or *ibaPDA* and *ibaAnalyzer*. Profiles without know-how protection can be exported and imported as a file in xml format.

Profile endings

The exported profiles of the individual modules have the following file extensions:

- InSpectra-Expert: .inSpectraProfile
- InSpectra-Auto-Adapting: .inSpectraTeachProfile
- InSpectra-Orbit: .inSpectraOrbitProfile

3 System requirements

3.1 Hardware

- PC, Multicore CPU 2 GHz, 4 GB RAM, 100 GB HDD

3.2 Software

- ibaPDA, version 7.0.0 or higher
- ibaAnalyzer, version 7.0.0 or higher

4 The ibaInSpectra interface in ibaPDA

The *ibaInSpectra* interface in the I/O manager in *ibaPDA* offers several tabs, which provide superordinate features for all InSpectra modules. For this purpose, mark the *ibaInSpectra* interface in the module tree.

Diagnostics tab

The *Diagnostics* tab provides information about the capacity utilization of the system on which *ibaInSpectra* is running and about available and pending jobs as well as jobs done and skipped jobs.

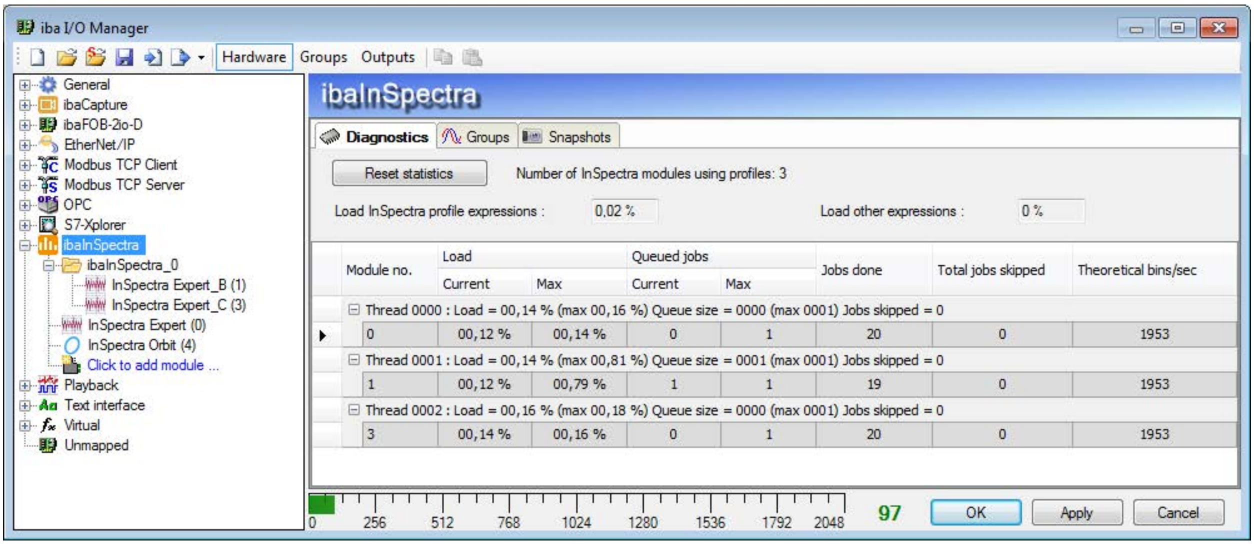


Fig. 1: ibaInSpectra, Diagnostics tab

Groups tab

Based on this hierarchic structure in the module tree, *ibaInSpectra* groups are created in the *Groups* section in the I/O manager. These groups are locked and cannot be modified. You cannot add signals to a locked group or its sub-group(s).

The signal group allocation as well as the group name are stored in the measurement file. In this way, they can also be used in *ibaAnalyzer* and you can have the signals displayed in the signal tree sorted by groups.

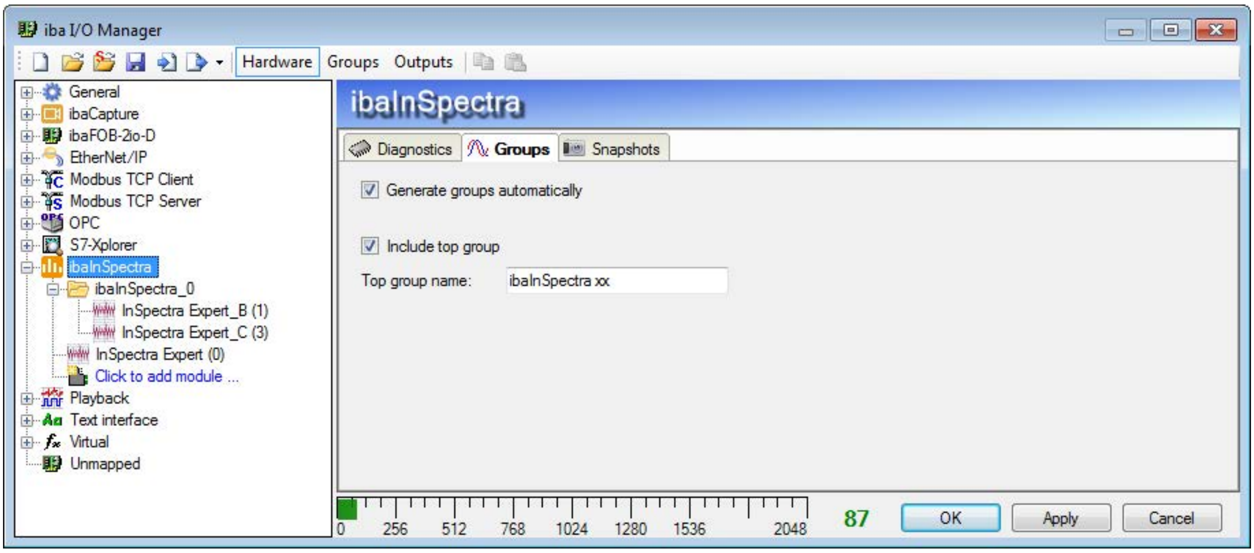


Fig. 2: ibaInSpectra, Groups tab

Groups in the I/O manager:

Fig. 3: Groups in the I/O manager

Snapshots tab

In the *Snapshots* tab, you can enable general snapshots for all InSpectra modules and define a directory for the snapshot files. You can specify a maximum total size for the FFT input buffer.

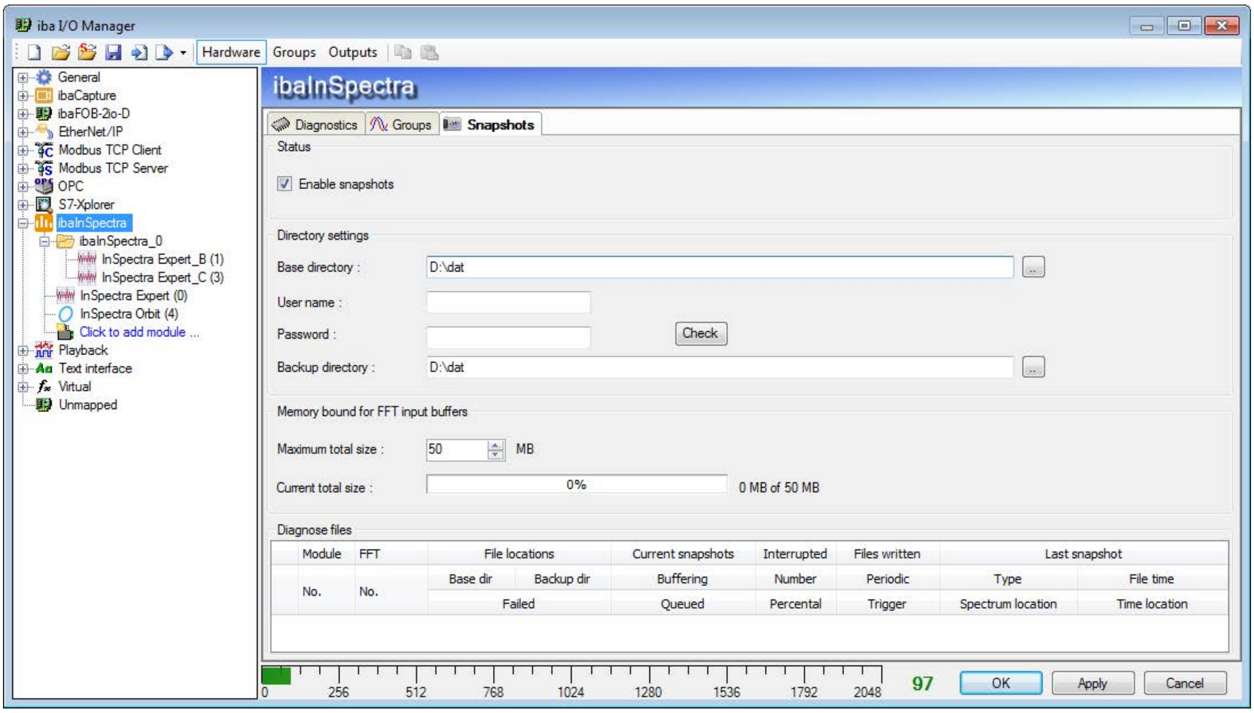


Fig. 4: ibaInSpectra, Snapshots tab

4.1 Arranging and structuring ibaInSpectra modules

Below the *ibaInSpectra* interface in the I/O manager in *ibaPDA*, the user can establish a hierarchic structure, e. g. in accordance with the system installation, using directories. Such folders can be created by right-clicking on the *ibaInSpectra* interface or an existing folder.

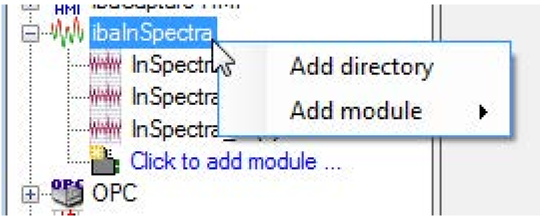


Fig. 5: I/O manager, context menu ibaInSpectra interface

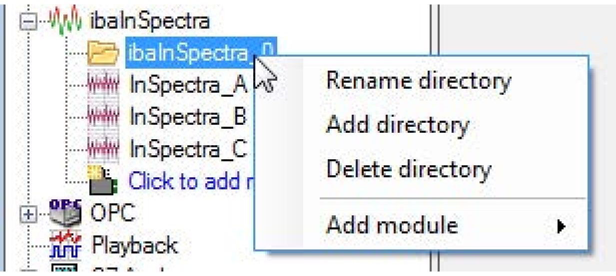


Fig. 6: I/O manager, context menu ibaInSpectra sub-folders

If several folders were created on the same hierarchical level, they can be marked by mouse-click and moved within the level by using the key combination <Ctrl>+<cursor up> or <cursor down> or by drag & drop.

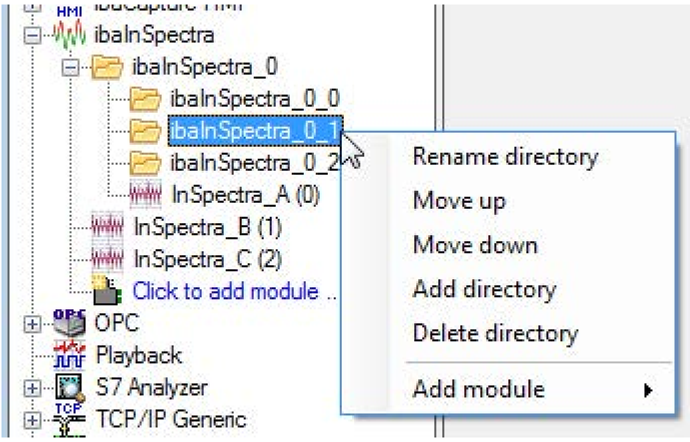


Fig. 7: I/O manager, context menu ibaInSpectra sub-folder (several subdirectories)

InSpectra modules can be moved to directories by drag & drop. New modules can be directly added to a folder via the context menu, too.

The folders can be renamed just as you like.

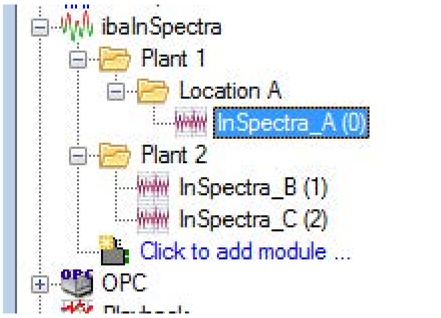


Fig. 8: Example of a hierarchic ibaInSpectra Expert structure

Based on this hierarchic structure, *ibaInSpectra* groups are automatically created in the "Groups" section in the I/O manager. These groups are locked and cannot be modified. You cannot add signals to a locked group or its sub-group(s).

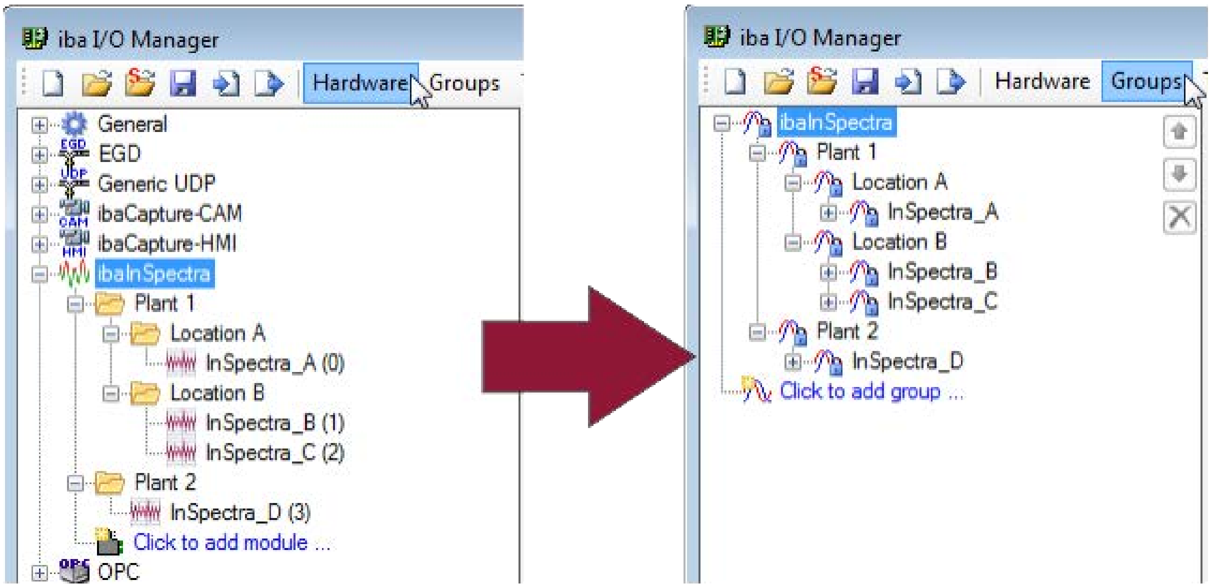


Fig. 9: ibaInSpectra interface structure and resulting group structure

4.2 Know-how protection

4.2.1 Introduction

The know-how protection area offers mechanisms for protecting intellectual property associated with certain calculations and/or settings in *ibaPDA*, which are considered as user know-how worth protecting.

In the first version of this protection function (ibaPDA-V6.37.0), the know-how protection can only be applied to InSpectra profiles.

The following protective functions are realized:

- Protection against change
  The protected elements cannot be changed without entering a password.
- Read protection
  The configuration of the protected elements is not displayed without entering a password.
- Dongle protection
  The protected elements are only executed on systems that run with a previously registered dongle. Several dongle numbers can be registered.

The protection is realized via so-called protection schemes that, once defined, can always be applied again.

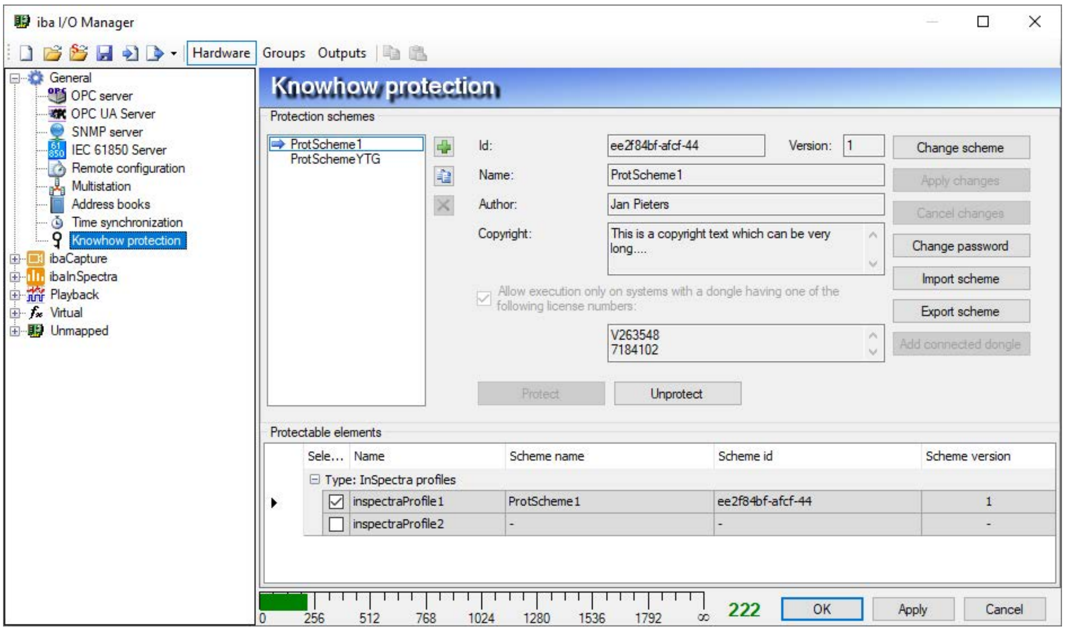


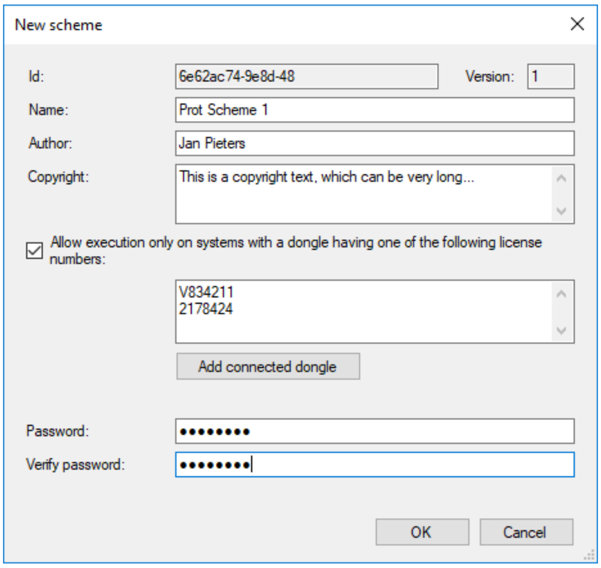
Fig. 10: Configuration of the know-how protection

The basic procedure is as follows:

1. Generating a protection scheme
2. Applying a protection scheme to an element

4.2.2 Creating a protection scheme

1. Open the I/O manager and highlight the branch *Knowhow protection* in the interface tree under the node *General*.
2. Click on the button with the green plus symbol to add a new rule.
   The "New scheme" dialog opens.
   The parameters ID and version are automatically generated.



3. Now enter the other parameters and then click on <OK>.

The settings and entries to be made for a protection scheme are specifically as follows:

Author (optional)
Enter the name of the author here.

Copyright (optional)
You can enter a note text here about the copyright of the elements protected by this scheme.

Allow execution only on systems with a dongle having one of the following license numbers
Enable this option if the elements protected by this scheme are only to be executed on systems with certain license numbers (dongle protection). Then enter all respective dongle or license numbers in the field below. You can easily enter the number of the respective connected dongle using the <Add connected dongle> button. If you do not enable this option, there is no execution restriction of the protected elements with respect to the license number.

Password
Enter a password that consists of at least 8 characters. Spaces are not permitted. You will need the password for the following actions:

- Viewing the configuration of a protected element
- Changing the configuration of a protected element
- Changing or removing the protection scheme

4.2.3 Application of a protection scheme

An element can always only be protected by one protection scheme, but a protection scheme can be applied to several elements.

If you have elements in your *ibaPDA* configuration worth protecting, such as InSpectra profiles, then these elements are shown in the table below in the dialog.

In order to protect one or more elements, first highlight the desired scheme in the list of the protection schemes (top left).

Then highlight the relevant lines at the bottom by setting a check mark in the selection box and click on the button <Protect>.

Then enter the password for the respective protection scheme and click <OK>.

4.2.4 Removing the protection

In order to remove the protection for one or more elements, highlight the corresponding lines in the table below in the dialog by setting a check mark in the selection box. Then click on the button <Unprotect>.

Then enter the password for the respective protection scheme and click <OK>.

If you want to remove the protection for several elements at the same time that are protected with different schemes, then you have to enter the passwords for all respective schemes in the password dialog.

4.2.5 Importing and exporting protected elements

When elements are protected, they can be exported and imported. The configuration of the elements is encrypted in the export files (*.protectionScheme). You therefore have an easy way of spreading protected know-how to different *ibaPDA* systems.

For an export, highlight the desired element and click <Export scheme>. Then select the desired storage path, enter a file name and close the dialog by pressing <Save>.

If you have highlighted several elements for export, then a prompt dialog appears asking whether all highlighted elements should be saved in the export file or whether you want to select more first.

If you want to import a protected element file, click on <Import scheme>, select the desired file (*.protectionScheme) and close the dialog by pressing <Open>.

4.2.6 Unlocking protected items

If you want to access protected items in the application, then you must first unlock the respective item by entering the password for the protective rule.

If, for example, you want to view the configuration of the protected InSpectra profiles, then you must first enter the password in the “Configure profiles” dialog and click on <Unlock>.

The access remains protected until the I/O manager is closed again.

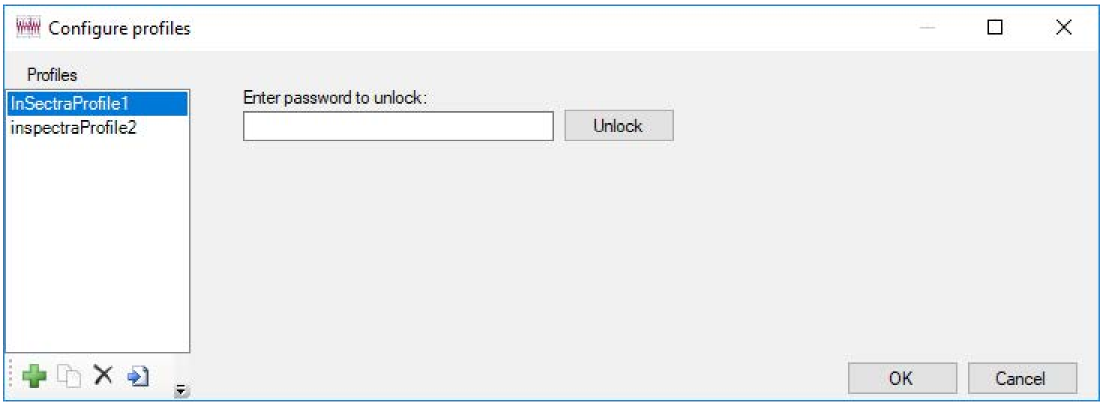


Fig. 11: ibaInSpectra example: The password must be entered in order to view protected profiles.

5 ibaInSpectra in ibaAnalyzer

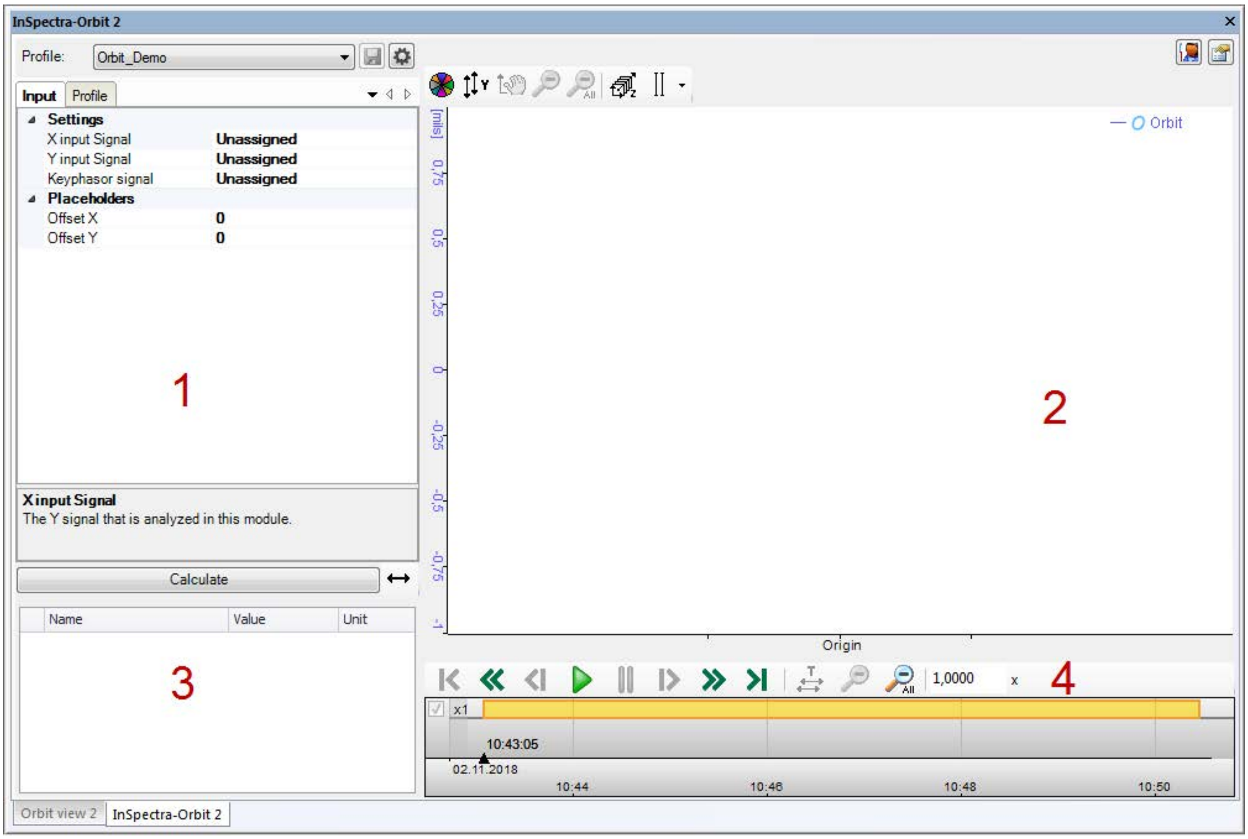
ibaInSpectra is integrated in *ibaAnalyzer* as a product *ibaAnalyzer-InSpectra* and offers the most important modules offline there.

5.1 The InSpectra views in ibaAnalyzer

ibaAnalyzer-InSpectra currently offers two views:

1. InSpectra Expert view (based on the FFT view)
2. InSpectra Orbit view

Each of these views consists of 4 areas, which are explained in the following sections.



1 Configuration area

2 Visualization area

3 Results area

4 Playback area

There are also two buttons in the top right area of the views for the settings of the respective views:

- The button *Properties* takes you to the settings for the current view.
- In *Preferences,* global settings can be made for all InSpectra views

Note

Changes to the preferences are not applied to existing views.

5.1.1 Configuration area

The input signals, placeholders and profiles of the respective InSpectra module are defined in the configuration area. Above the input signals, the path of the dat file currently used in this InSpectra view is displayed. A detailed description can be found under the respective modules.

You can find the configuration description of the InSpectra Expert module in chapter ➚ *The InSpectra Expert module*, page 81

You can find the configuration description of the InSpectra Orbit module in chapter ➚ *The InSpectra Orbit module*, page 137.

5.1.2 Visualization area

The visualization area of the *ibaAnalyzer-InSpectra* views shows the same view that is used in *ibaPDA* for the respective InSpectra module. A detailed description can be found under the respective modules.

The description of the FFT view can be found in chapter ➚ *FFT view overview*, page 32

The description of the Orbit view can be found in chapter ➚ *Orbit view*, page 148.

5.1.3 Results area

The results of the respective module are shown in *ibaAnalyzer-InSpectra* in the results area at the bottom left.

All characteristic values and output signals of the respective modules are available as results. The results always relate to the current cursor position of the playback area. The calculation is shown, which was last calculated before this time.

The description of the results of the InSpectra Expert module can be found in chapter ➚ *Calculation results of the Expert module*, page 105

The description of the results of an Orbit module can be found in chapter ➚ *Calculation results*, page 144

5.1.4 Playback area

In the playback area, you can control the playback of the dat file using the buttons and the slider.

Fig. 12: Playback area

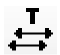
Meaning of buttons:

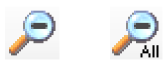
 Start / stop playback

 Jump to start / end

 Reduce/increase replay speed
(The set replay speed is shown on the left (1))

 Jump to the next result in the respective direction

 Display the total time period



Remove one/all zoom level(s)

More features:

1 Input of the replay speed
You can enter the factor of the replay speed here. The new speed is adopted by pressing <Enter>.
The replay speed is relative to the normal speed. For example, 2.00x means that the current replay speed is twice the normal speed.

2 Display of the replay speed

3 Time marker
On the timeline, a black triangle represents the current time stamp. If the time marker is moved, the FFT display jumps to the time stamp of the marker. The time marker can be moved by clicking and dragging it with the mouse. If you click anywhere on the timeline, the marker will jump to this position.

4 Tooltip
If you move the mouse over the timeline, the time stamp of the mouse position will be shown in the tooltip.

The playback area can also be controlled using the keyboard.

Key	Function
< ← >	One result backward
< → >	One result forward
< ↑ >	Increase playback speed
< ↓ >	Decrease playback speed
< Space bar >	Play / Pause

Zooming and shifting the time scale

You can zoom in the time scale by drawing a rectangle with the mouse button pressed down on the timeline.

You can shift the time range by clicking the time axis and then dragging the mouse horizontally. The cursor then appears as a double arrow.

Synchronized markers

By default, the markers in the playback area of *ibaAnalyzer* and the markers of the *ibaInSpectra* view are synchronized. The same also applies to markers in the Orbit view.

Shifting the X1 time marker in the playback area causes all markers in every InSpectra view to move to the same position. Even if the marker is moved by the playback of an audio channel or an *ibaCapture* video, the markers move in the InSpectra view synchronously with it.

The shifting of a marker in an InSpectra view causes the X1 time marker to be moved to the same position in the playback area. If you enlarge an area in *ibaAnalyzer*, the zoom area is moved so that the X1 marker remains in the same position on the screen if possible. If other InSpectra views are available, their markers also move to the same position. If the markers in the InSpectra view are also moved by clicking the Play button in the InSpectra view, the marker synchronously moves in the playback area.

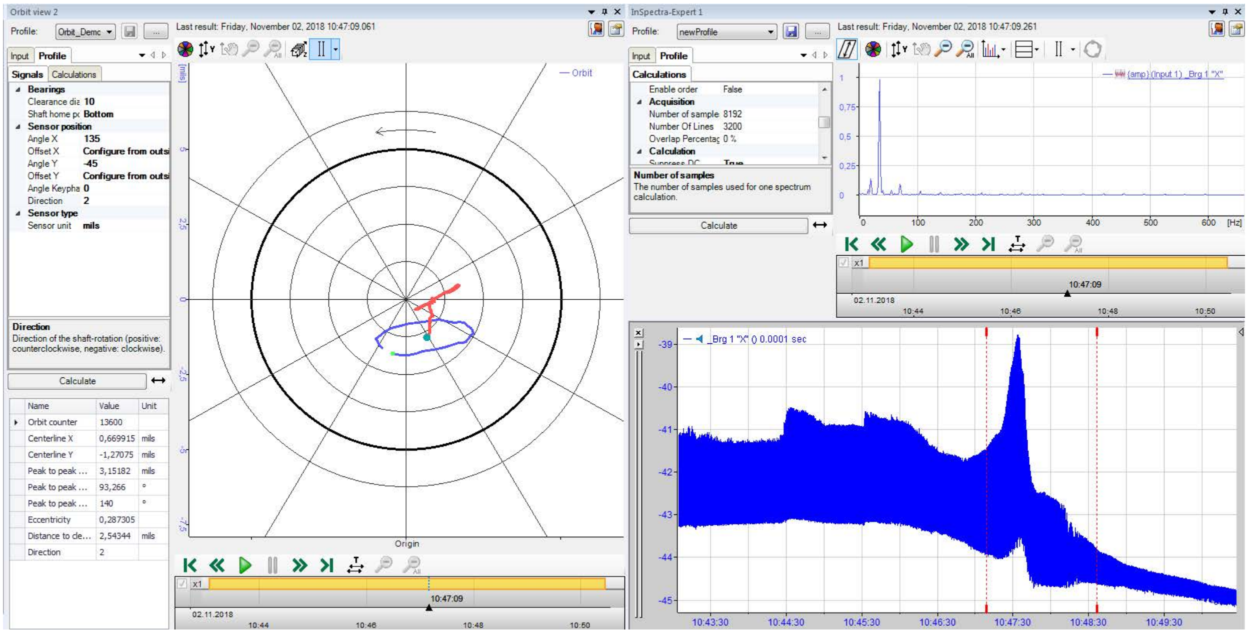


Fig. 13: Example of synchronized markers

If the markers are not to be synchronized, you can configure this in the preferences of *ibaAnalyzer*. Disable the option *Enable marker synchronization* in the tab *InSpectra*.

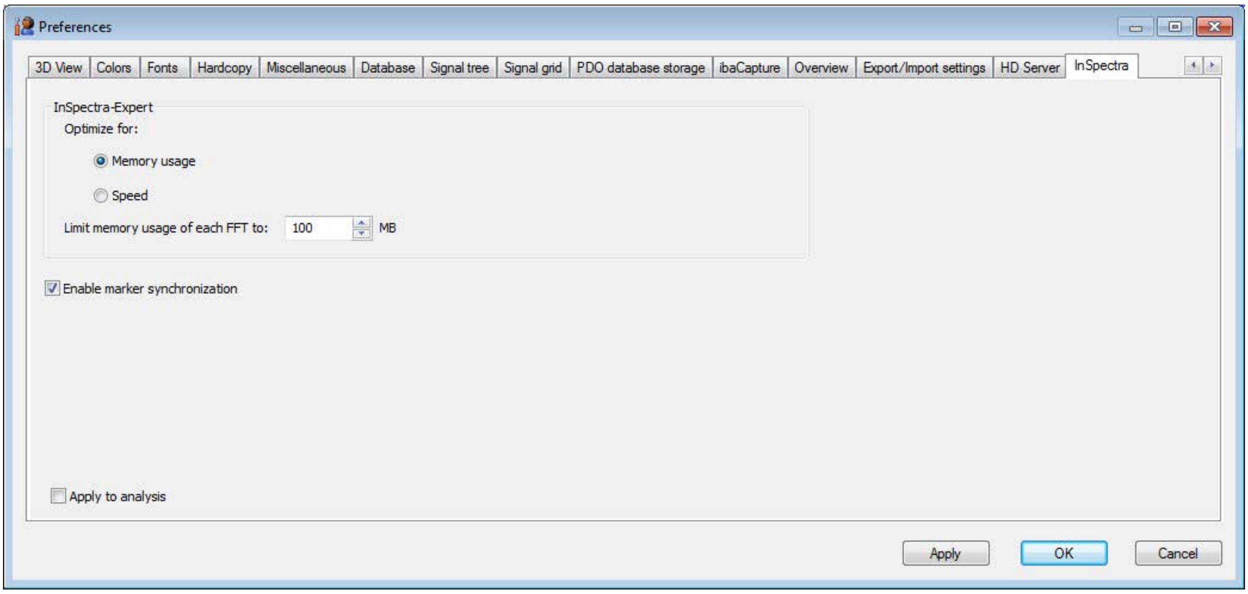


Fig. 14: Preferences for InSpectra

6 FFT view

The FFT view serves to visualize the results of the InSpectra Expert module and the auto-adapting module in *ibaPDA* and *ibaAnalyzer*. In *ibaPDA*, the FFT view can also be used to display frequency spectra of signals without InSpectra calculations. In *ibaAnalyzer*, the view is enabled with the *ibaAnalyzer-InSpectra* license.

With the FFT view, the term “spectrum” is used instead of the term “signal.” A spectrum in the frequency domain is what an input signal is in the time domain. An FFT view can contain one spectrum or several spectra. The spectra can have individual value axes or lie on a common value axis.

6.1 Opening an FFT view in ibaPDA

Use the button to add a new FFT view:

You can move individual or several highlighted signals from the signal tree to the main view of the FFT view using drag & drop. In the case of an InSpectra module, you can drag the entire module into the FFT view. In doing so, relevant parameters for the FFT view are copied from the module settings.

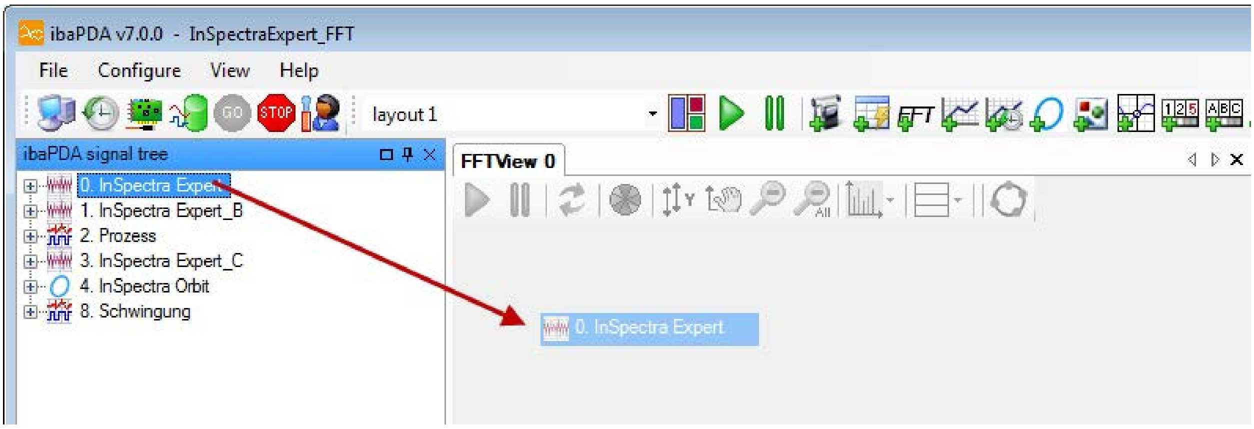


Fig. 15: Dragging an InSpectra module in the FFT view

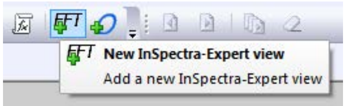
The following hotkeys are available for dragging new signals into a FFT view:

- <Shift>: When you press the <Shift> button while dragging several signals into the FFT view, all signals are placed on a joint Y-axis.
- <Ctrl>: When you press the <Ctrl> key when dragging one or more signals into the FFT view, the existing signals are replaced with new signals. If there are more signals in the view than new signals, the first signals will be replaced. If there are more new signals, the additional signals will be appended.

The description of the FFT view can be found in chapter ↗ *FFT view overview*, page 32

6.2 Opening an FFT view in ibaAnalyzer

Use the button in the toolbar to add a new InSpectra-Expert view:



You can move individual or several highlighted signals from the signal to the main window of the FFT view using drag & drop.

The following hotkeys are available for dragging new signals into a FFT view:

- <Shift>: When you press the <Shift> button while dragging several signals into the FFT view, all signals are placed on a joint Y-axis.
- <Ctrl>: When you press the <Ctrl> key when dragging one or more signals into the FFT view, the existing signals are replaced with new signals. If there are more signals in the view than new signals, the first signals will be replaced. If there are more new signals, the additional signals will be appended.

The InSpectra Expert view in *ibaAnalyzer* contains additional display areas in addition to the actual FFT view.

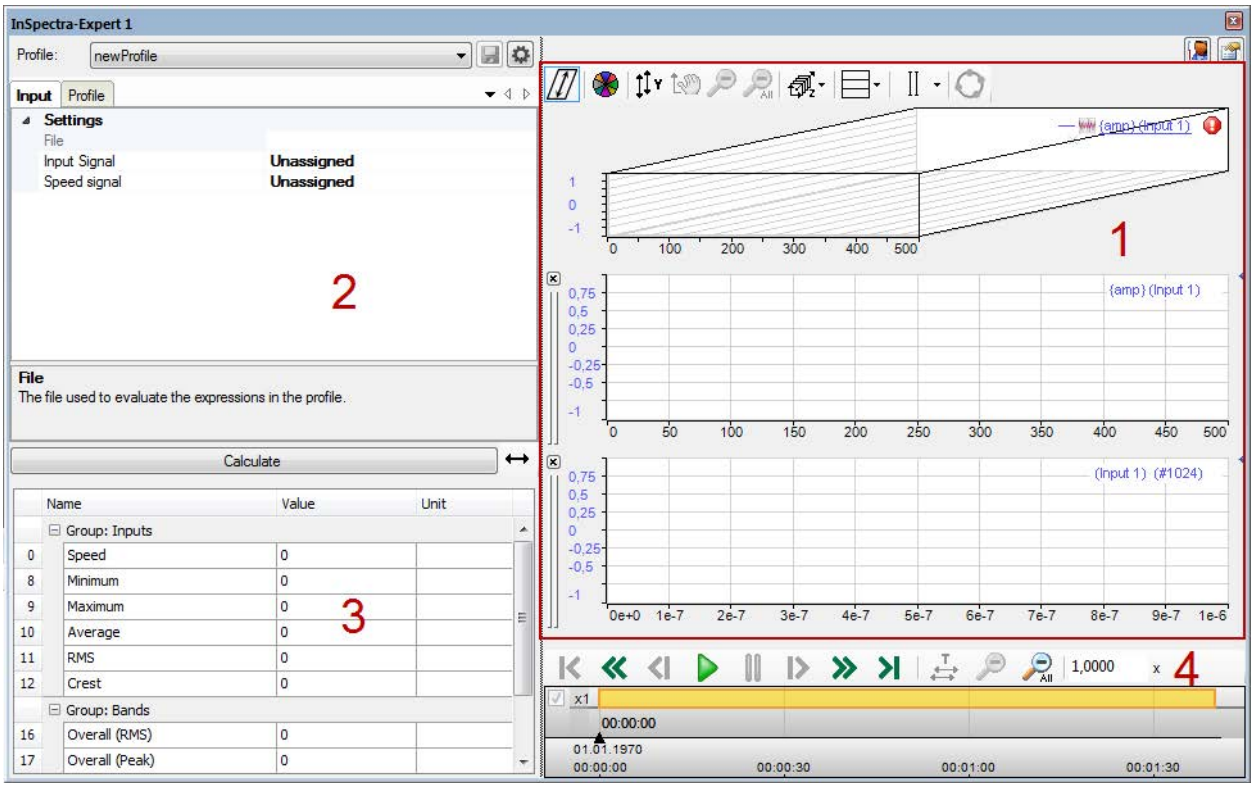


Fig. 16: InSpectra Expert view in ibaAnalyzer

1 FFT view visualization area

2 Configuration area (input signals, profiles) see ➚ *Configuration of a calculation profile in ibaAnalyzer*, page 118

3 Result area, see ➚ *Calculation results of the Expert module*, page 105

4 Playback area (playback settings), see ➚ *Playback area*, page 26

The description of the FFT view can be found in chapter ➚ *FFT view overview*, page 32

6.3 FFT view overview

The FFT view offers a number of special graphs and tables, which can be individually displayed or hidden as needed.

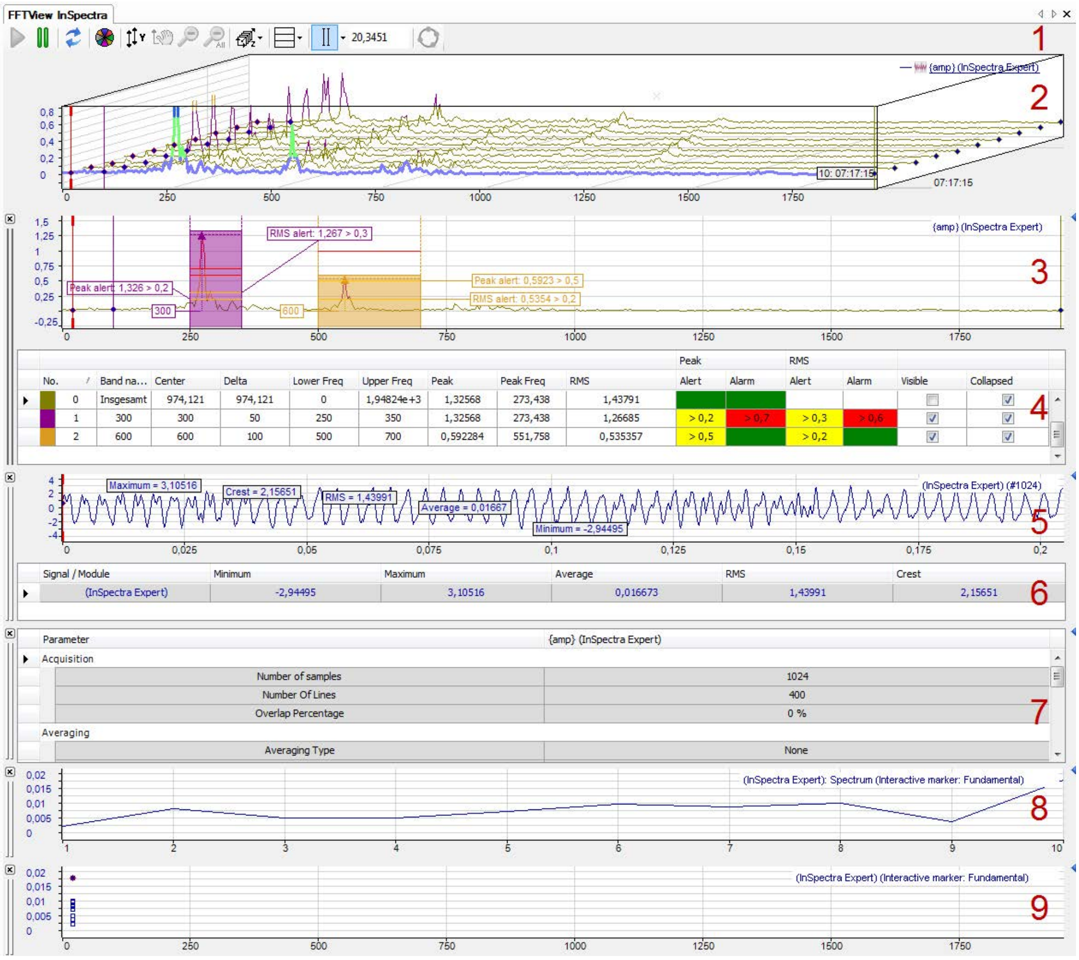


Fig. 17: Example of an FFT view

Legend

1 Toolbar

2 Main window, signal spectrum of the input signal

3 Spectrum slave graph (bands, frequency domain) [1]

4 Spectrum slave table (data, frequency domain) [2]

5 Time slave graph (graph, time domain)

6 Time slave table (table, time domain)

7 Spectrum parameter table

8 Slice slave[3]

9 Marker spectrum slave[3]

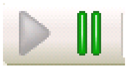
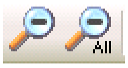
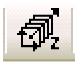
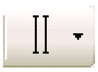
[1] With ibaInSpectra, additional static values, warning and alarm limits

[2] Can only be used with ibaInSpectra

[3] Slice slaves and marker spectrum slaves can exist several times

The main window is always displayed at the top. The additional windows for graphs and data of spectrum and time domain are grouped in pairs. In analogy to normal trend views, their position can be changed at the header bar by using the mouse. You can display or hide the individual graphs and tables within the FFT view by means of the buttons as shown in the above figure.

Toolbar

	Start FFT view / Pause FFT view (only *ibaPDA*) Stop or continue the FFT display update
	Reset all displayed data (only *ibaPDA*) The display is cleared only once and all values are set to zero until the next FFT calculation is completed.
	Determine planecount automatically (only *ibaAnalyzer*)
	Auto color signals
	Auto scale value axis
	Restore manual scale [1)]
	Zoomout one level / Zoomout all [1)]
	Toggle display type in the FFT main window (single spectrum / waterfall / contour)
	Open the sub menu for showing/hiding the windows Main window with/without waterfall (graph, frequency domain) Sectrum slave graph (graph, frequency domain) Spectrum slave table (table, frequency domain) Time slave graph (graph, time domain) Time slave table (table, time domain) Display spectrum parameter table Add slice slave... Add marker spectrum slave...
	Toggle interactive marker visibility No function for configured markers
	Switch to the order spectrum (if speed signal and parameters of the order calculation are configured)
	[1)] Individually affects the main window, spectrum or time slave graph, depending on the focus

6.4 Main window

In the main window, the result of the FFT of the signal to be examined is shown in the frequency domain. The standard view for the main window is the individual spectrum.

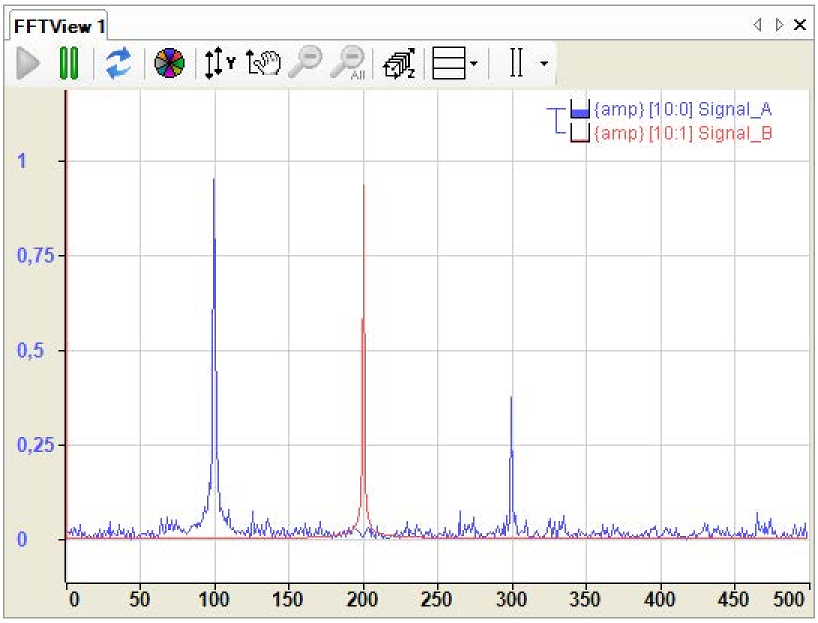


Fig. 18: Main window of the FFT view

You can enable an interactive marker that you want to use to read frequency values and the associated amplitudes along the X-axis.

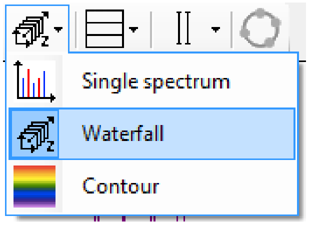
When switching to the waterfall or contour view, the individual results of the frequency analysis are displayed spatially offset. This provides an overview of the history of the frequency response curve.

Detailed information can be found in chapter ↗ *Waterfall*, page 35

6.4.1 Waterfall

The main window of the FFT view can be converted to an isometric perspective. In this mode, the successive FFT events of a spectrum are displayed on a Z-axis, with the newest result closest to the axes origin, in order to create a waterfall effect. The display is restricted in *ibaPDA* to 262144 data points, in *ibaAnalyzer* configurable via memory usage per FFT. However, note that using a waterfall display requires more resources than a single spectrum.

You can switch to the waterfall perspective via the corresponding button in the toolbar of the FFT view.



Alternatively, you can switch perspectives in the properties dialog of the FFT view as well.

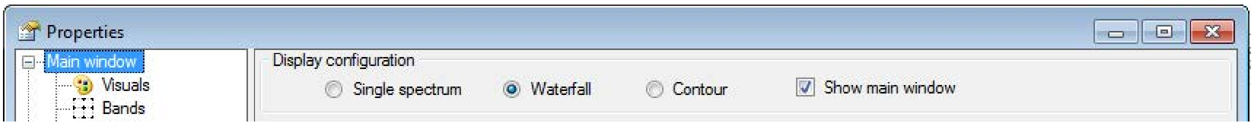


Fig. 19: Display configuration in the properties window

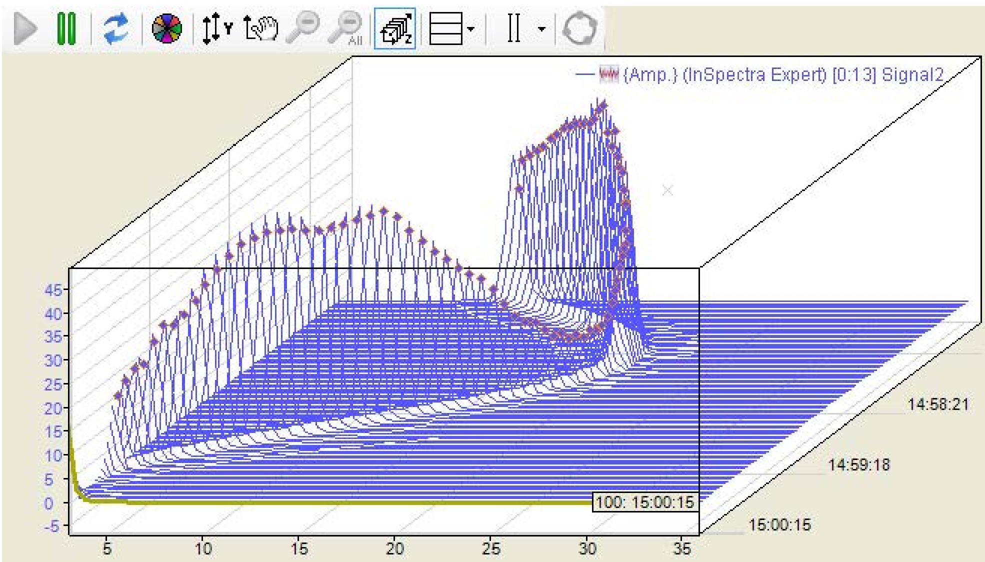


Fig. 20: FFT view with enabled waterfall perspective

In the above figure, you can see the results of the last 100 calculations and it is clearly visible how the spectrum changed in the course of time.

By using the <Up> and <Down> cursor keys or by scrolling with the mouse wheel, you can move through the planes and have displayed the related spectra and parameters.

When moving the mouse with the <Ctrl> key pressed, you can change the angle and perspective of the view. If you press the <Shift> key at the same time, then the display pans to 0 degrees. The axis position settings are overwritten in this mode.

If you have set the desired perspective, you can save this and re-enable it again later at any time. See chapter ➚ *Settings in the FFT view*, page 65

Scales are always displayed at the side of the chart not overlapping with the perspective flow direction. Several spectra can have different sample rates or bin values and thus the clock in which the FFT results are available may vary. That is why it is pre-set that every spectrum moves on the Z-axis at its own pace.

However, there is the option to synchronize the Z-planes across several spectra. With this option enabled, the FFT view will not allow a spectrum to advance over the Z planes until all spectra have generated a new FFT result. While the view is waiting for certain spectra to generate results, the other spectra keep showing their newest results on the front plane.

While the waterfall perspective is enabled, the label, marker and zoom rectangle functionality is limited to the foremost plane.

The appearance options of the waterfall display is determined in the properties window in the node *Time axis*. See chapter ➚ *Time axis*, page 80.

6.4.2 Contour view

The contour view corresponds to a 2D top view of the waterfall, where the amplitude height is represented by colors.

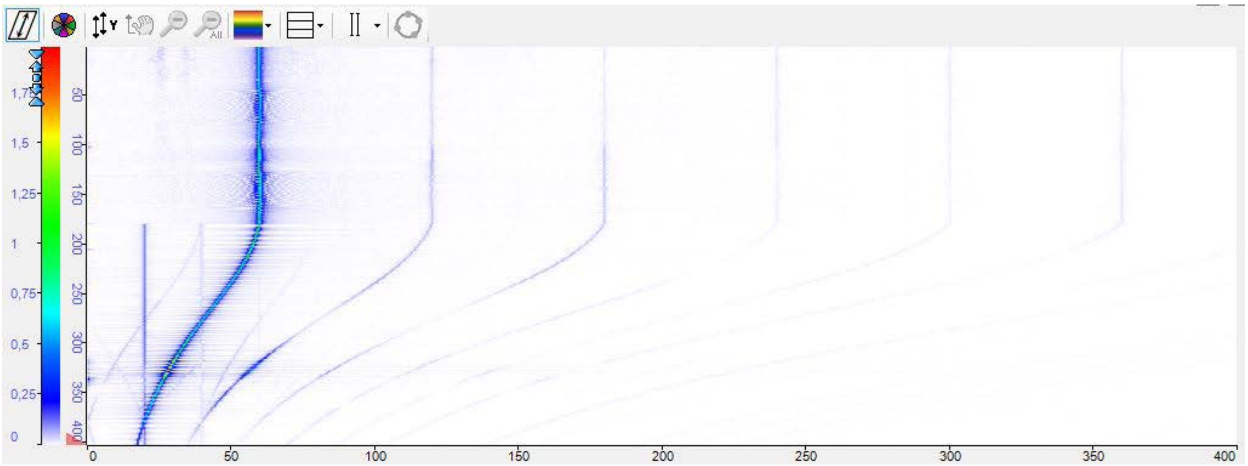


Fig. 21: Example contour view

The color scheme can be configured in the properties of the value axis. Both pre-defined schemes can be selected here and separate color schemes can be created.

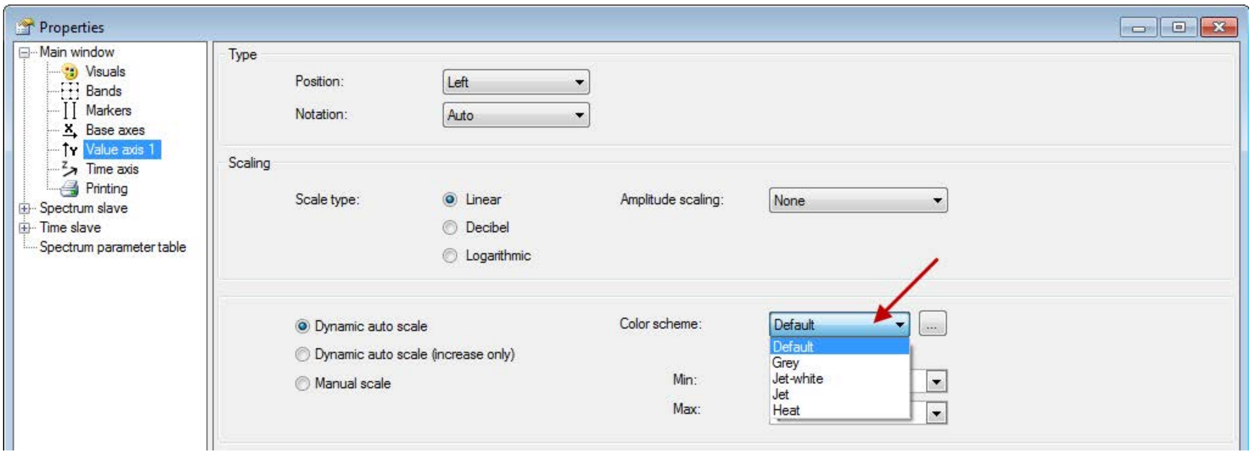


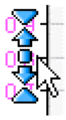
Fig. 22: Setting the color scheme for the contour view

6.4.3 Zoom

The scale of an axis can be manipulated in three ways.

- Autoscale
  You can perform an autoscale via the context menu of the axis or by using the middle mouse button to click on the axis.
- Shift
  You can shift an axis by dragging it with the mouse.
- Zoom
  Using the mouse wheel, you can zoom in and out in the area of the cursor.

You can change the scale via the pop-up buttons on the axis too. These buttons appear when you move the mouse over the right side of a horizontal axis or over the top of a vertical axis.



The outermost symbols halve/double the scale range based on the average. The arrows have a similar function, but with a smaller zoom factor. The button in the middle autoscales the axis.

In addition, you can zoom into a certain area of the diagram using the zoom rectangle (click with mouse and drag). The zoom rectangle enables the zoom buttons in the view toolbar, which allow you to return to previous zoom levels.

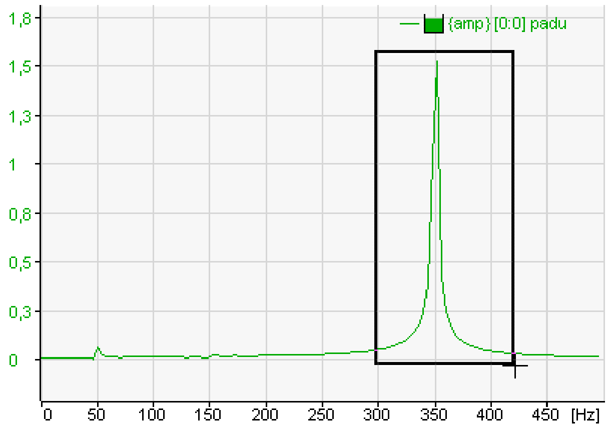


Fig. 23: Zoom rectangle

6.4.4 Legend

The legend indicates which signals are added to the view. The first part of the legend is the tree structure of the value axis. This shows which spectra are shown on which axis. The second part of the legend shows a visual representation of the percentage buffer fill grade for each signal. The last part indicates the signal name, listed by signal ID and calculation mode. If a signal is invalid, this is indicated by an exclamation mark at the end of the signal row.

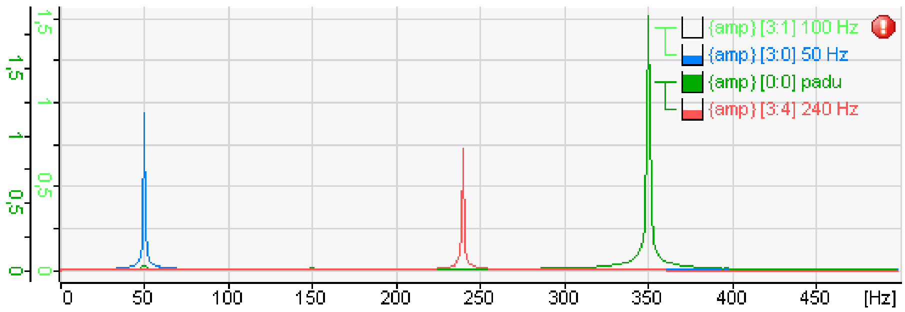


Fig. 24: Legend with 4 signals in 2 groups, 1st signal (100 Hz) invalid

The legend has a drag & drop function. This way, a spectrum can be laid upon different value axes. While dragging the spectrum, an arrow appears in the value axis tree pointing to the tree that will contain the spectrum when it is dropped. If a spectrum is not dropped inside a legend row, the spectrum will be laid upon a new axis.

Right clicking in a legend row makes the context menu of the legend appear.

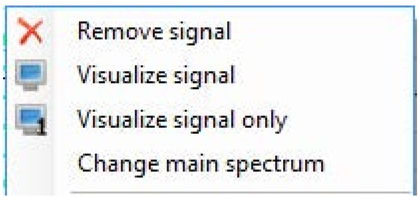


Fig. 25: Context menu of the legend

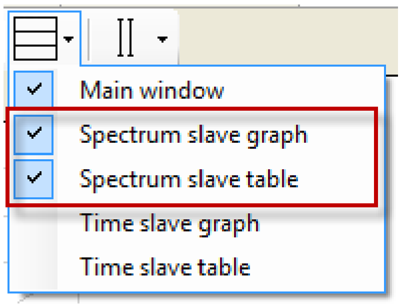
Clicking on “Remove signal” removes the corresponding signal. Clicking on “Hide signal” hides the signal and shows the signal name transparently. The signal is only temporarily hidden and can always be displayed again. By clicking on “Visualize signal only” in the context menu, only the selected spectrum remains in the display and all other spectra are hidden. Clicking on “Change main spectrum” makes the selected spectrum the main spectrum.

In the context menu under “Properties,” you can display the selected settings for the spectra.

In the properties of the FFT view (main window), you can also configure and enable a separate legend that contains additional information, such as name, comments and sampling time of the input signal, marker values or any literal text.

6.5 Spectrum slave graph and spectrum slave table

In addition to the main window, you can open a graphical and/or tabular display of the data of the frequency spectrum. Click on the button for the window menu in the toolbar of the FFT view for this purpose.



Graphical display and data table form one group, as the table always provides the data matching the spectrum in the graph. However, the graph and table can be individually displayed or hidden.

In addition, the graph and data table can be minimized or displayed together. To do this, simply click on the small triangle on the right margin of the display:

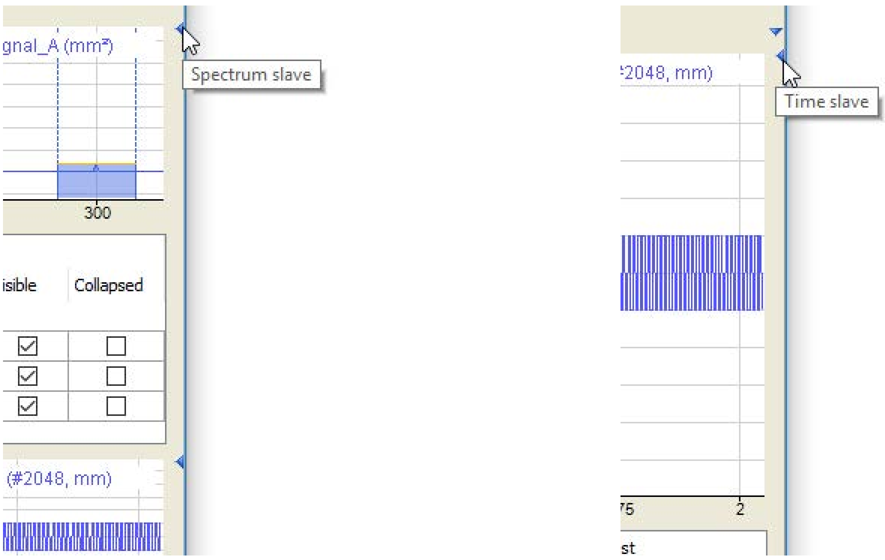


Fig. 26: The graph and table of the spectrum slave are visible (left) and minimized (right)

Note

Without *InSpectra* modules, the spectrum slave shows the same information as the individual spectrum in the main window and the table does not contain any data.

You define general display properties in the properties dialog of the FFT view in node *Spectrum slave*.

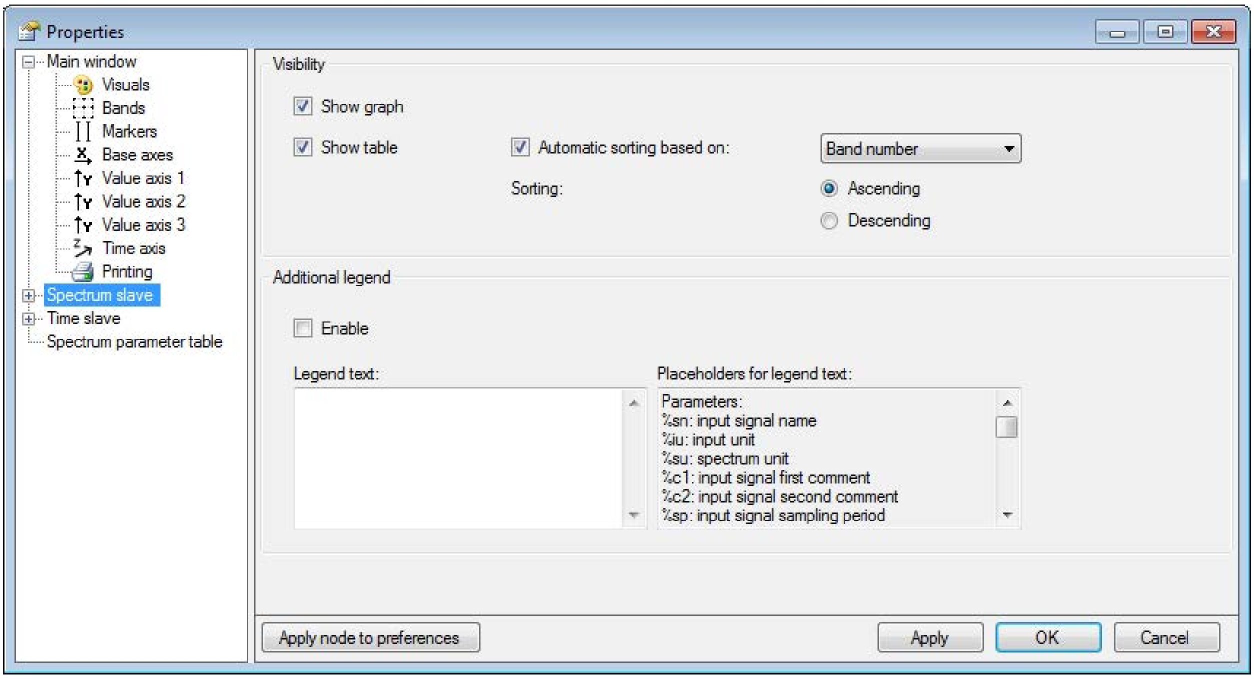


Fig. 27: Properties of the spectrum slave

Visibility
You can define here whether the graph and the data table for the spectrum slave are shown by default. Even if a view is disabled here, it can be re-enabled later in the FFT view toolbar.

The data table can be sorted automatically. Define the parameter (column) here according to which and in which sequence the table is sorted.

Additional legend
When this option is enabled, another legend is displayed in the spectrum slave window in addition to the normal signal legend. You can define the content of this legend yourself. For example, you can enter a detailed multi-line text, in which placeholders for dynamic information can also be used. The following placeholders are available:

- %sn: Input signal name
- %iu: Input unit
- %su: Spectrum unit
- %c1: Input signal first comment
- %c2: Input signal second comment
- %sp: Input signal sampling period
- %x: X-value at interactive marker
- %y: Y-value at interactive marker
- %xmouse: X-value at mouse cursor
- %ymouse: Y-value at mouse cursor
- %tmouse: Z-value at mouse cursor

- %xmv: X-value of the nearby marker position
- %ymv: Y-value of the nearby marker position
- %tmv: Time value of the nearby marker position
- %nmv: Name of the nearby marker position
- %imn: InSpectra Expert module name
- %n: Band name
- %nb: Band number
- %r: RMS value
- %p: Peak value
- %pf: Peak frequency
- %c: Center frequency
- %d: Delta frequency
- %l: Lower frequency

6.5.1 Spectrum slave graph

The graphical display of the frequency spectrum always shows the last result of the FFT in two-dimensional appearance or the spectrum selected in the waterfall or contour plot. (The selected spectrum in the waterfall view is shown with a different color, marked in the contour plot with a triangle):

- Spectrum
- Frequency bands
- Value bands
- InSpectra bands
- Characteristic values of the InSpectra bands
- Limits of the InSpectra bands

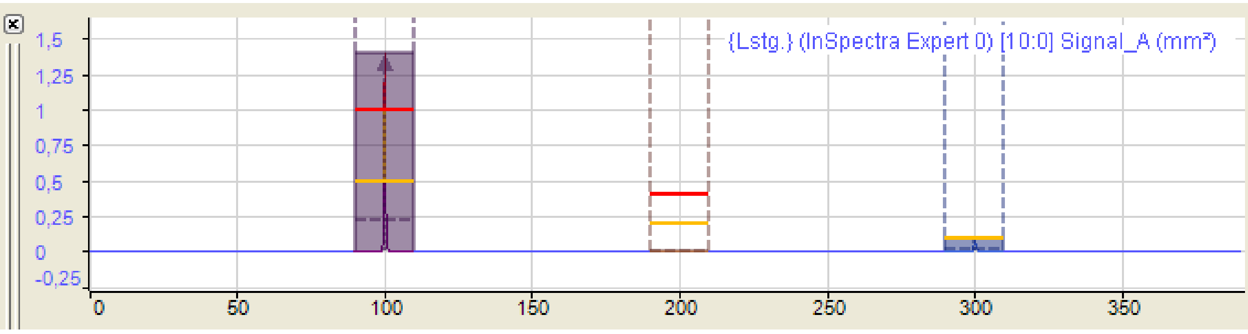


Fig. 28: Display of 3 different frequency bands

The display shows at least a part of the spectral curves from the main window. You can add additional charts by dragging and dropping them from the main window or from the signal tree via drag & drop. The displays are linked so that all graphs in the small spectral display can also be seen in the main window.

When zooming in, more details can be seen.

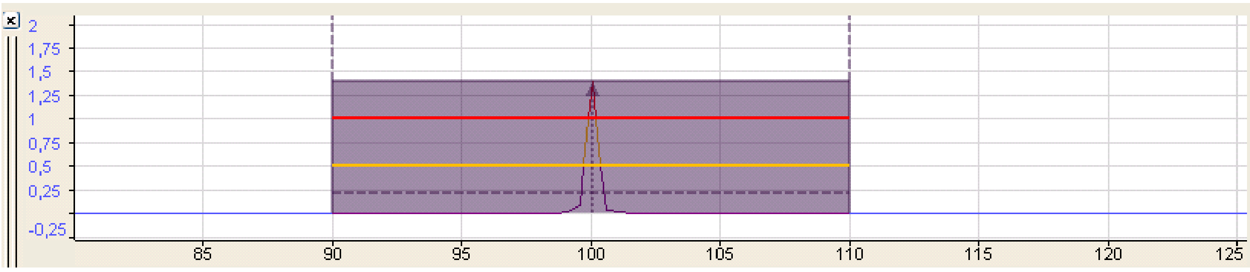


Fig. 29: Frequency band display

The most important parameters of the frequency bands and of the spectrum are shown with dotted and colored lines. You are shown the respective values when you position the cursor on the lines (hovering).

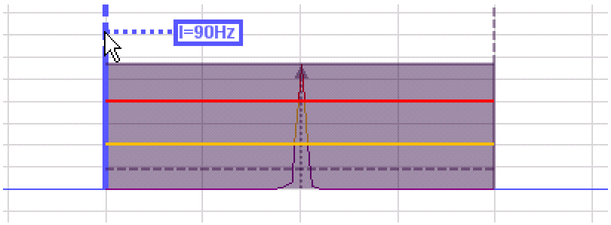
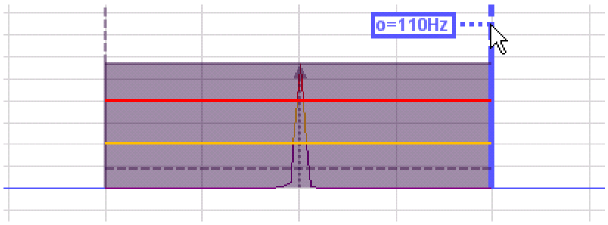
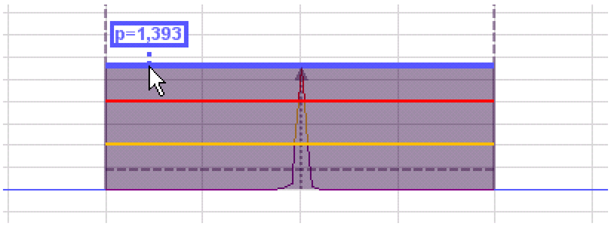
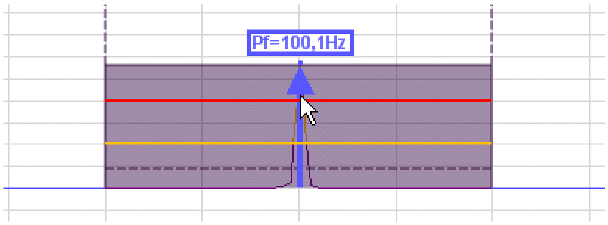
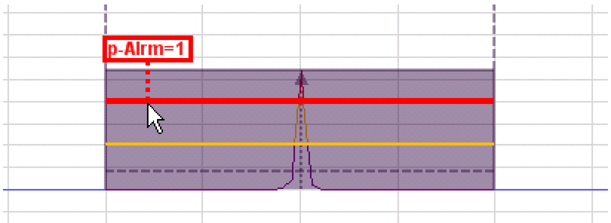
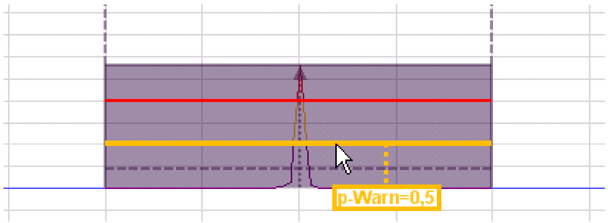
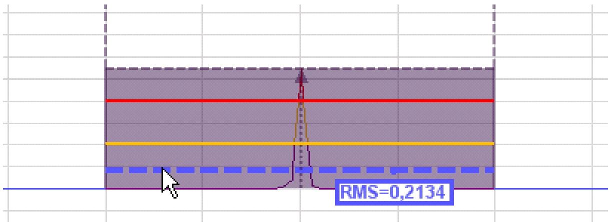
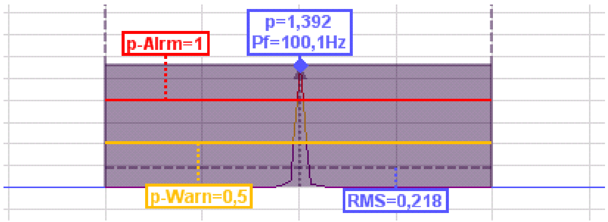
 Lower cutoff frequency	 Upper cutoff frequency
 Peak (peak amplitude)	 Peak frequency
 Alarm limit	 Warning limit
 RMS	 Display of all descriptors by selection in the spectrum properties

Table 1: Information in the spectrum slave graph

The configuration of the bands is described in chapter ➚ *Bands*, page 68.

You can decide in the spectrum properties (by using the context menu of the display) which markings and parameters are to be displayed (permanently) and whether the graph should change the color when exceeding the alarm limits.

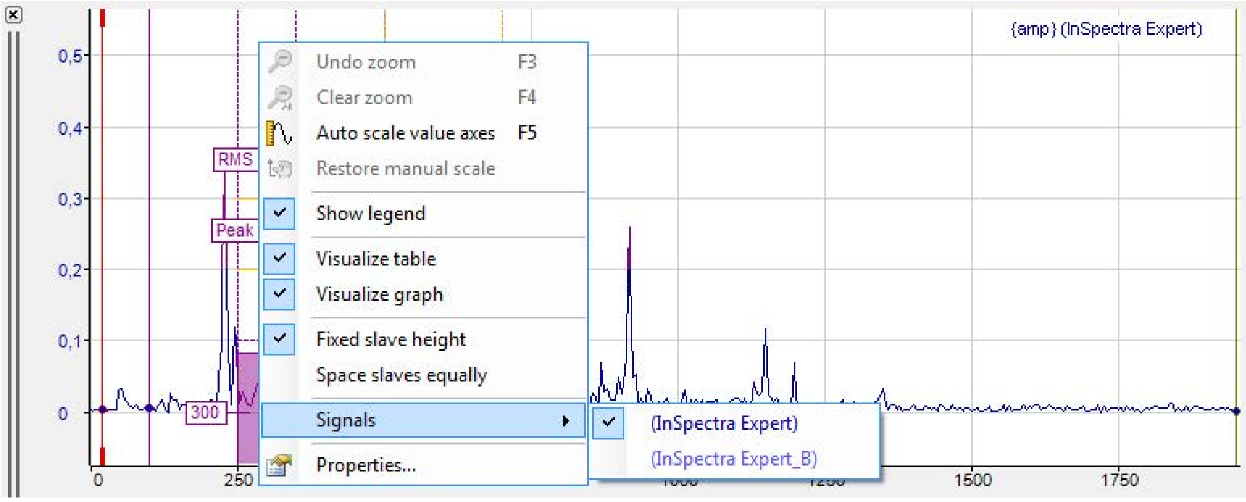


Fig. 30: Frequency spectrum display, context menu for adding further signals

If there are several spectra in the display, individual display properties can be assigned to every spectrum.

If the spectrum slave graph has the focus (after a mouse click on the header bar), the tool buttons for zooming out and restoring the manual scale relate to this graph and not to the main window. The same applies to the assigned function keys <F3>, <F4> and <F5>.

Base axis

The display has a base axis corresponding to that of the main window. You can still modify the settings of the base axis in the display properties, for example, to select a logarithmic division instead of a linear division or to provide manual scaling. In addition, you can display the period instead of the frequency.

If you zoom in the spectrum slave graph or in the main window, this is usually independent from each other. By using the "Synchronize actual scale with main window" option, you can determine that a zoom action in one of the windows also affects the other, but only in horizontal direction.

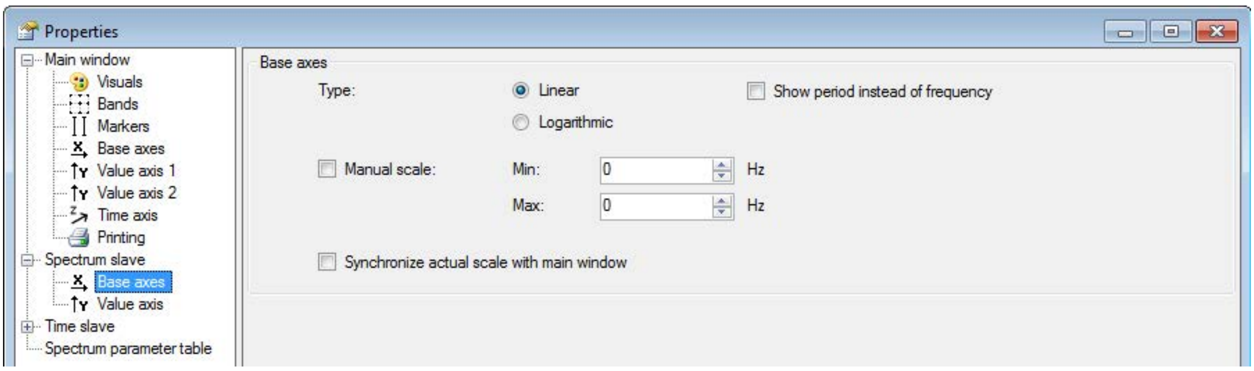


Fig. 31: Properties of the spectrum slave graph, base axes

Value axis

The spectrum slave graph has only one value axis. All charts in the display are displayed on the same scale of values. You can change the settings of the value axis in the properties of the display.

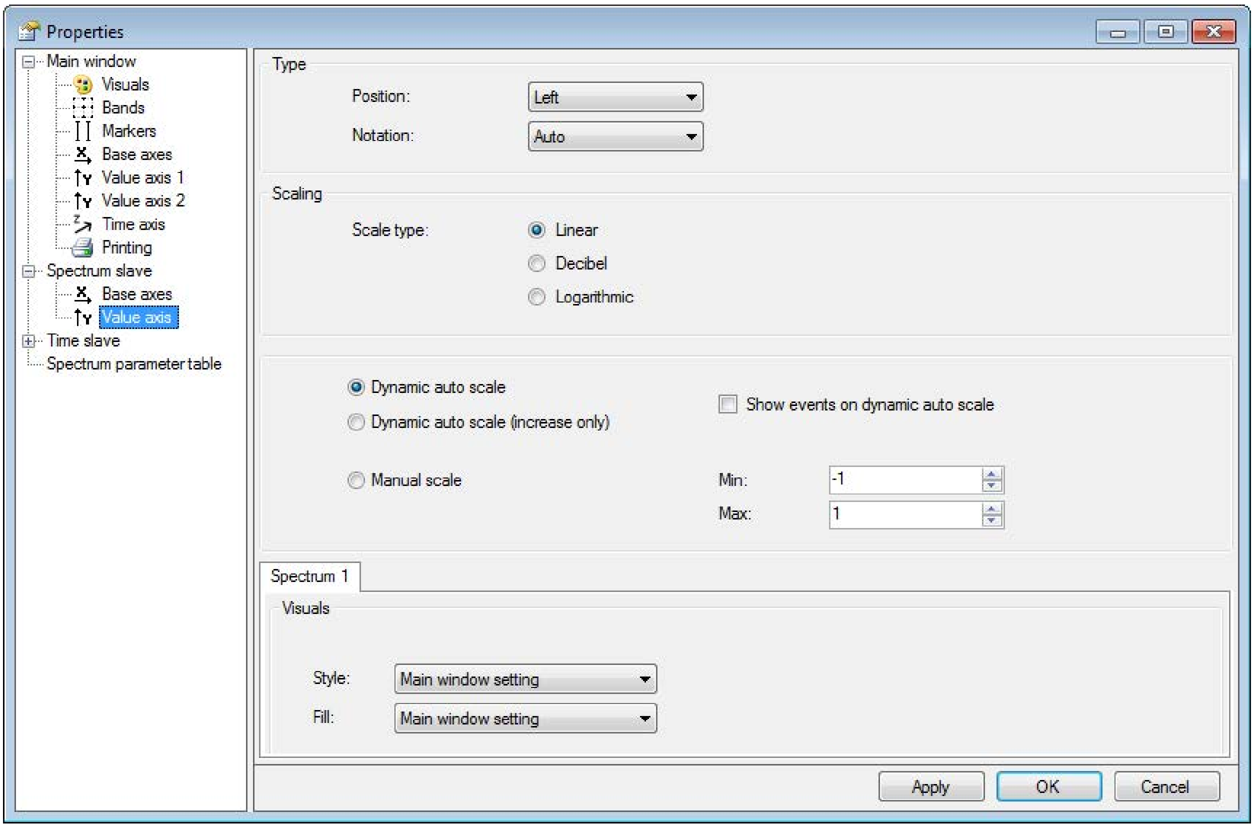


Fig. 32: Properties spectrum slave graph, value axis

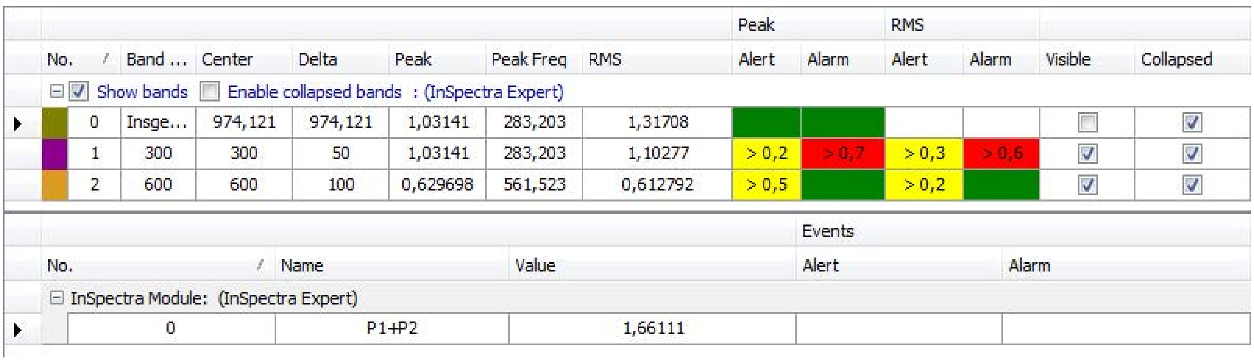
For scaling the value axis, you can choose between linear, decibel and logarithmic.

In the *Spectrum x tab*, you can determine the display properties for style and filling for each spectrum separately. You can adopt the main window setting or select individual settings from the respective dropdown menu.

6.5.2 Spectrum slave table

The data table regarding the frequency spectrum only contains data if it is an InSpectra module. In case of a simple analog signal, the table remains empty.

In the table, a line is automatically created for every defined band of the displayed InSpectra module.



No.	Band ...	Center	Delta	Peak	Peak Freq	RMS	Peak Alert	Peak Alarm	RMS Alert	RMS Alarm	Visible	Collapsed
Show bands	Enable collapsed bands : (InSpectra Expert)											
0	Insge...	974,121	974,121	1,03141	283,203	1,31708					☐	☑
1	300	300	50	1,03141	283,203	1,10277	> 0,2	> 0,7	> 0,3	> 0,6	☑	☑
2	600	600	100	0,629698	561,523	0,612792	> 0,5		> 0,2		☑	☑

No.	Name	Value	Events Alert	Events Alarm
InSpectra Module: (InSpectra Expert)				
0	P1+P2	1,66111		

Fig. 33: Spectrum slave table

The parameters and – if configured – the results are shown for each band. Results and alarms for characteristic values are displayed in the area below. A line is created for each parameter.

If there are several InSpectra modules in the spectrum slave graph, the table also shows the data for the bands of the other spectra.

										Peak		RMS			
		No.	Band...	Center	Delta	Lower F...	Upper F...	Peak	Peak Freq	RMS	Alert	Alarm	Alert	Alarm	Visible	Collapsed
	☑ Show bands ☐ Enable collapsed bands : (InSpectra Expert)															
▶		0	Insge...	974,121	974,121	0	1,94824...	1,48727	458,984	1,68337					☐	☑
		1	300	300	50	250	350	0,074371	297,852	0,130026					☑	☑
		2	600	600	100	500	700	0,100702	517,578	0,217807			> 0,2		☑	☑
	☑ Show bands ☐ Enable collapsed bands : (InSpectra Expert_C)															
		0	Insge...	974,121	974,121	0	1,94824...	0,653055	449,219	0,918155					☑	☐
		1	400	400	100	300	500	0,653055	449,219	0,748773	> 0,5		> 0,2	> 0,4	☑	☐

Fig. 34: Example of a spectrum slave table with 2 InSpectra modules

You can display or hide the parameter columns via the context menu (right mouse click in the heading).

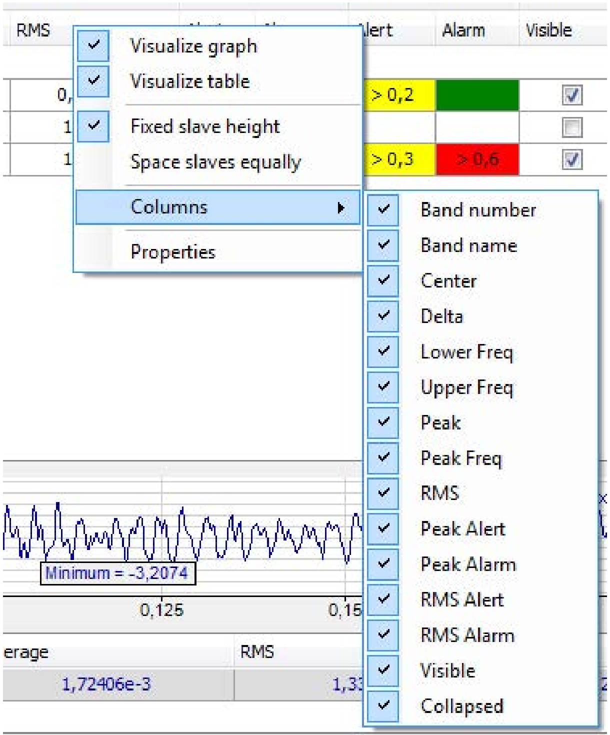
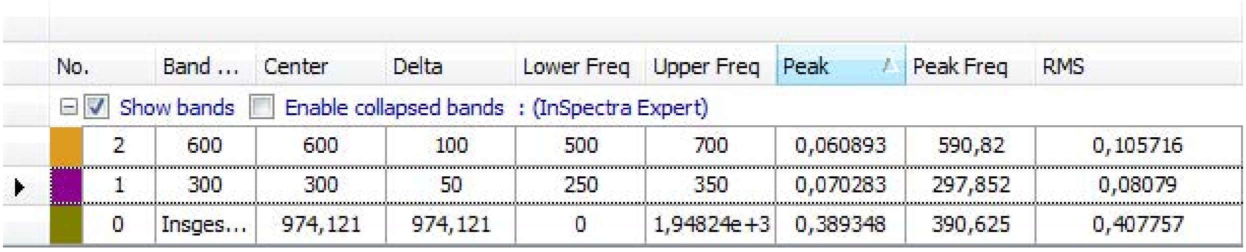


Fig. 35: Parameter columns

In every parameter column, the displayed values can be sorted by clicking on the table header. A triangle in the header indicates whether the sorting direction is ascending or descending. The order is automatically re-sorted if the order changes during acquisition.

You define the preference for sorting in the properties dialog of the FFT view in the node *Spectrum slave table*, see chapter ➚ *Spectrum slave graph and spectrum slave table*, page 40.



No.	Band ...	Center	Delta	Lower Freq	Upper Freq	Peak	Peak Freq	RMS
Show bands	Enable collapsed bands : (InSpectra Expert)							
2	600	600	100	500	700	0,060893	590,82	0,105716
1	300	300	50	250	350	0,070283	297,852	0,08079
0	Insges...	974,121	974,121	0	1,94824e+3	0,389348	390,625	0,407757

Fig. 36: Sorting the data table according to the peak value

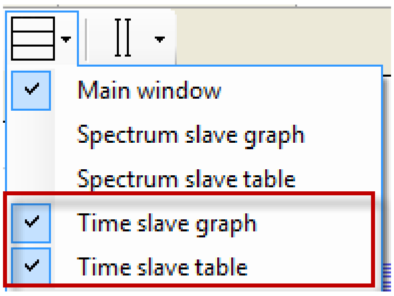
Show bands / enable collapsed bands
Use this option to globally decide for all bands whether these are displayed in the frequency spectrum and whether they can be shown as collapsed bands.

If the option *Show bands* is enabled, the display of individual bands in the *Visible* column can be determined separately.

If the option *Enable collapsed bands* is marked, the display of the individual bands in the *Collapsed* column can be determined separately. Collapsed bands are indicated by a triangle at the center frequency.

6.6 Time slave graph and time slave table

In addition to the main window, you can open a graphical and/or tabular display of the data of the input signal in the time domain. Click on the button for the window menu in the tool bar of the FFT view.



Graphical display and data table form a group, as the table always provides the data suitable for the graph in the display. However, the graph and table can be individually displayed or hidden.

In addition, the graph and data table can be minimized or displayed together. To do this, simply click on the small triangle on the right margin of the display.

6.6.1 Time slave graph

In the time slave graph, the time curve of the input signal is graphically displayed. The displayed section contains exactly the samples of the input signal which were included in the FFT calculation.

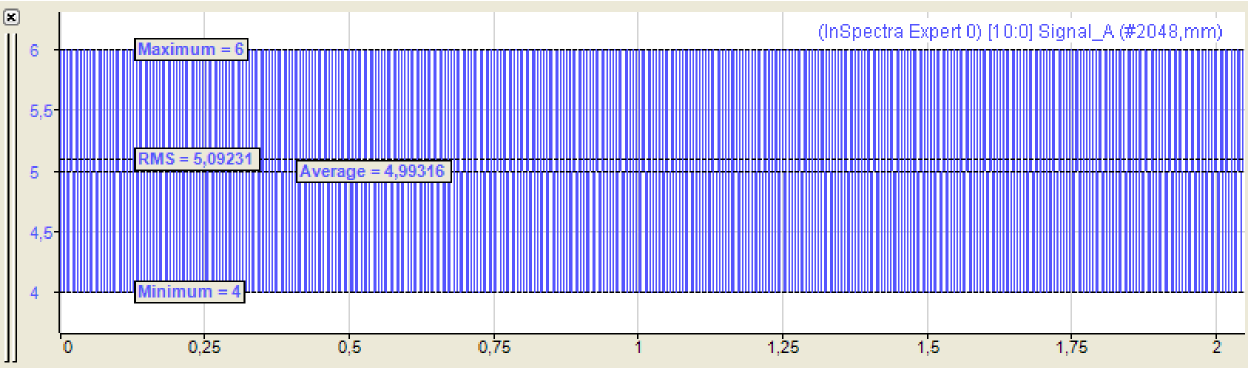


Fig. 37: Time slave graph

If the averaging function was enabled in the calculation settings of the profile, then the display shows the time signal of the last internal FFT calculation. The displays of the FFT results in the main window and frequency range, however, are also based on prior values of the input signal.

Basically the input signal of the InSpectra module is displayed. However, you can also drag further signals from the signal tree into the time slave graph. If there are several signals in the main window already, you can select those in the context menu of the graph.

If the time slave graph has the focus (after a mouse click on the header bar), the tool buttons for zooming out and restoring the manual scale relate to this graph and not to the main window. The same applies to the assigned function keys <F3>, <F4> and <F5>.

Markers

You can also enable a marker via the context menu of the display.

Legend

The legend of the display contains various information:

- Name of the InSpectra module (if present)
- channel number of the input signal
- Name of the input signal
- Number of samples for the FFT, unit of the input signal

Base axis

The time slave graph has a base axis. When autoscaling, the length of the base axis results from the number of samples and the sampling time. You can modify the settings of the base axis in the properties of the graph.

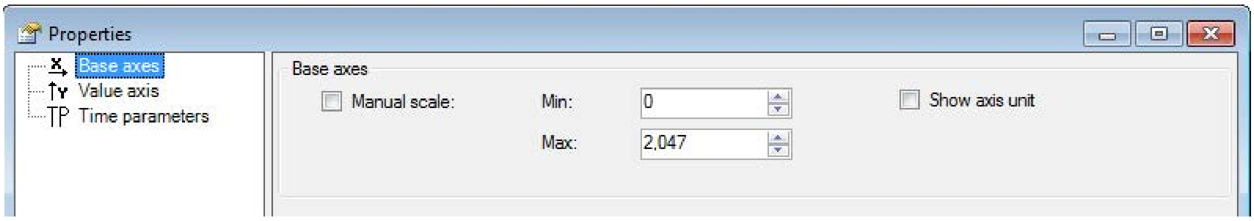


Fig. 38: Properties of the time slave graph, base axes

Value axis

The time slave graph has only one value axis. All curves in the graph are displayed on the same scale of values. You can modify the settings of the value axis in the properties of the graph.

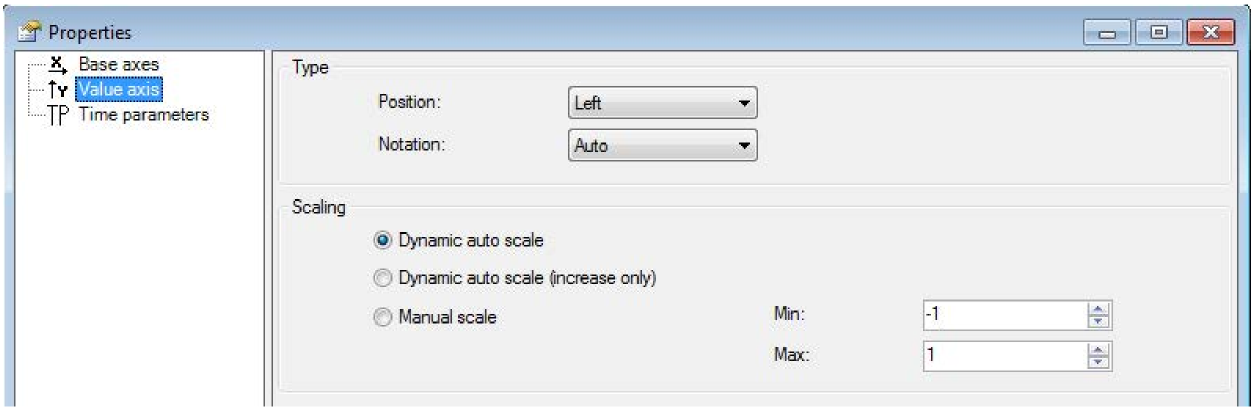


Fig. 39: Properties of the time slave graph, value axis

Time parameters

The statistical values (average, minimum, maximum, RMS, crest) determined for the input signal in the shown time range can be displayed in the graph. For this purpose, select the desired parameters in the properties dialog of the graph.

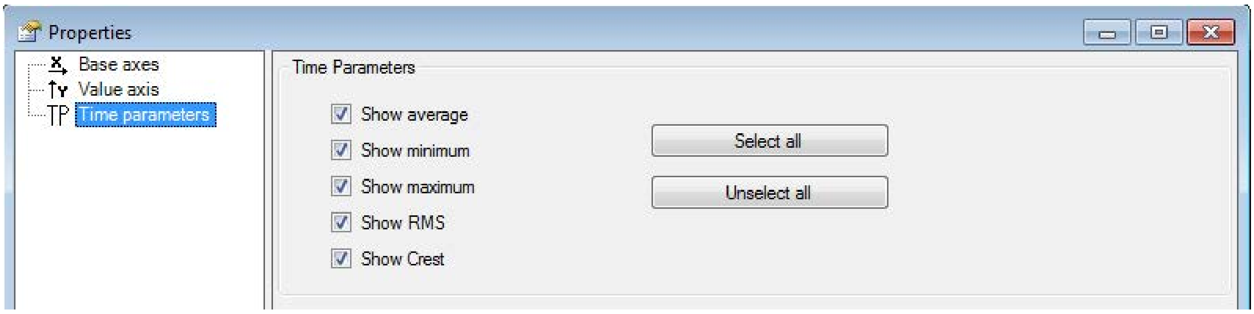


Fig. 40: Properties of the time slave graph, time parameter

Note

Sometimes, the crest factor and RMS value is not immediately visible in the graph, as it can be significantly higher or lower than the values of the signal curve. Change the scale of the value axis to see the crest factor.

6.6.2 Time slave table

The data table of the time domain shows the same statistical values of the input signal which were described as time parameters above.

Signal / Module	Minimum	Maximum	Average	RMS	Crest
(InSpectra Expert)	-2,40479	1,85547	4,17233e-4	0,899231	2,0634

Fig. 41: Example of data table of the time domain

6.7 Spectrum parameter table

The spectrum parameter table is used to display the FFT calculation parameters. This allows you to display the calculation parameters you wish to observe without having to open the properties dialog of the FFT view.

You can add the spectrum parameter table to the display using the drop-down menu.

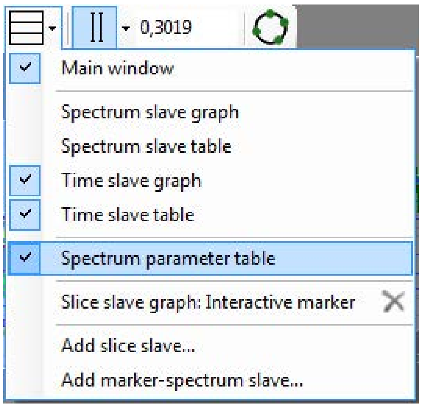


Fig. 42: Adding the spectrum parameter table

Before doing so, you should specify what information will be displayed in the table, as not all parameters are of interest and you can save some space by reducing the number of parameters.

For example, if you do not want to use an order spectrum, the order parameters can remain hidden.

You can configure the settings in the spectrum parameter table node in the properties of the FFT view. All parameters from the calculation profile are available for selection.

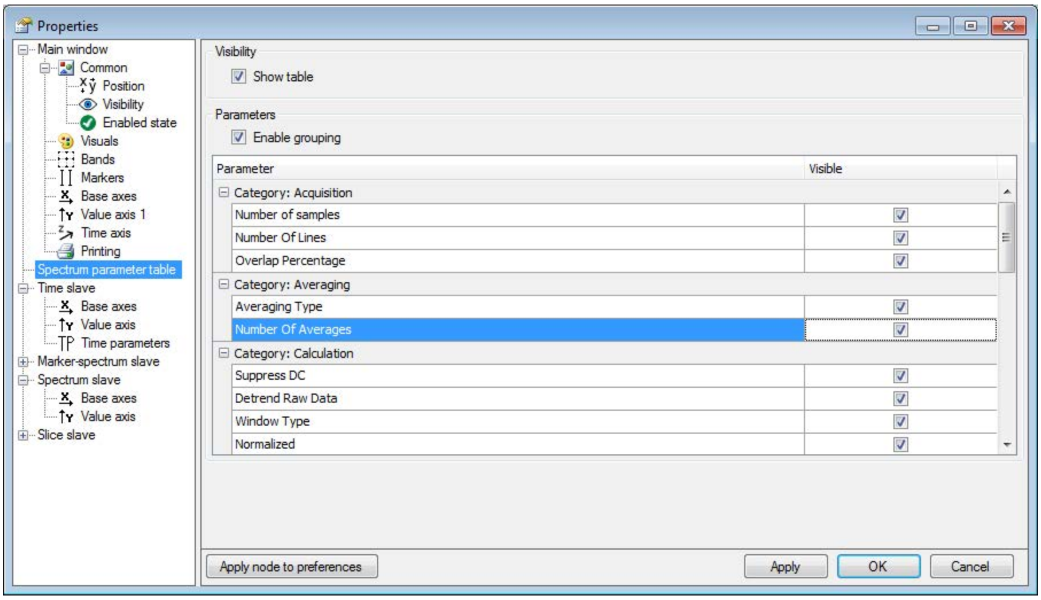
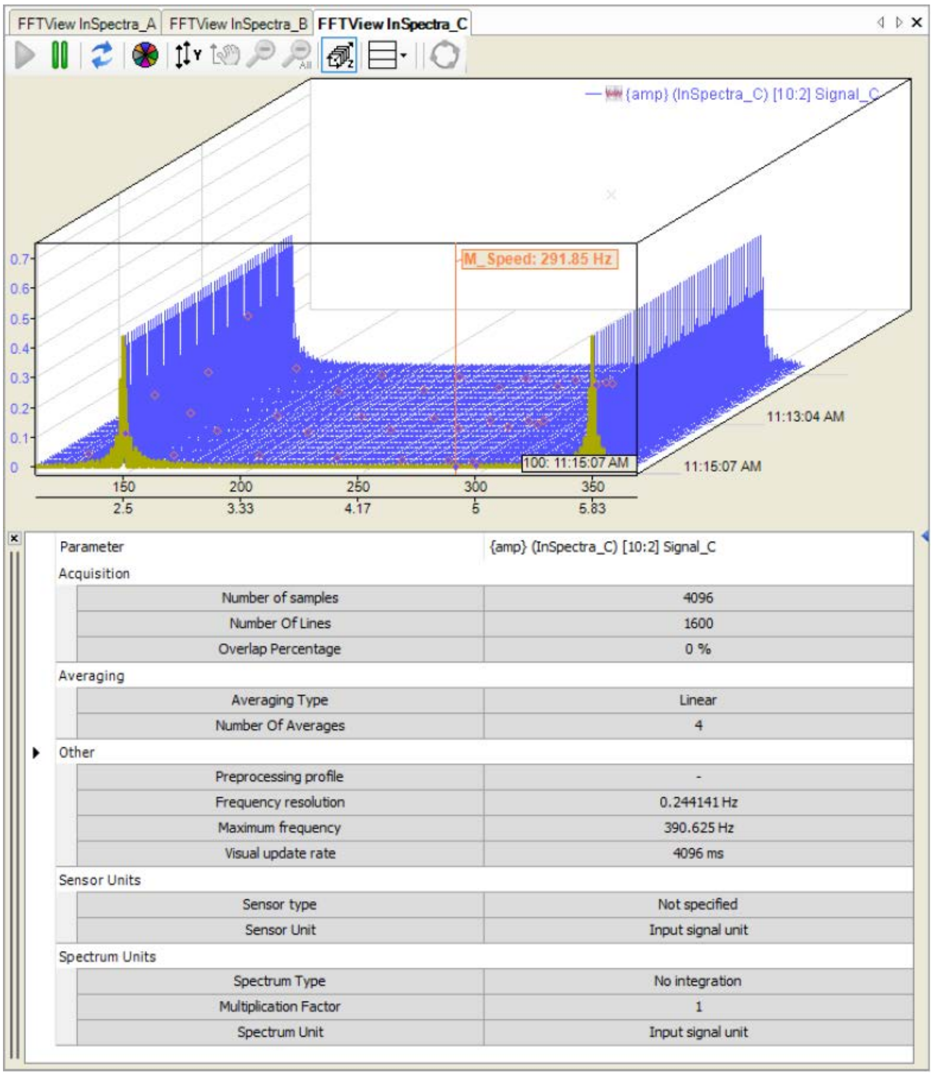


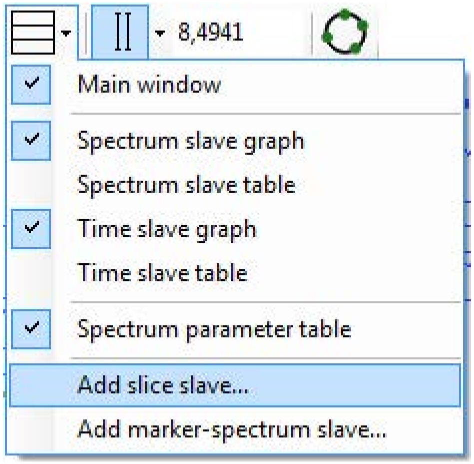
Fig. 43: Configuration of the spectrum parameter table in the FFT properties

The result might look like this:



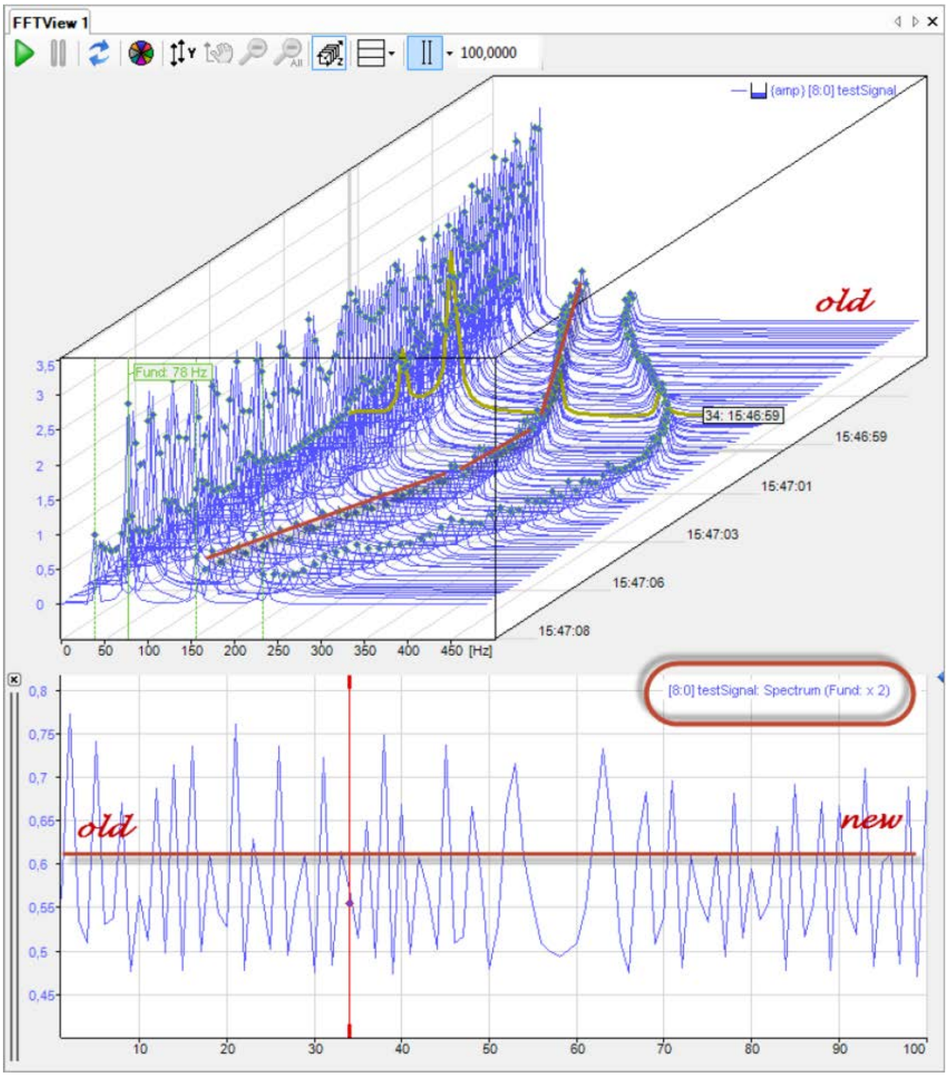
6.8 Slice view

With a slice graph, you can essentially represent the chronological sequence of an FFT for a selected marker position. The amplitude profile of a frequency therefore becomes clear, especially in conjunction with the isometric waterfall view. You add a slice slave using the drop-down menu for the FFT display.

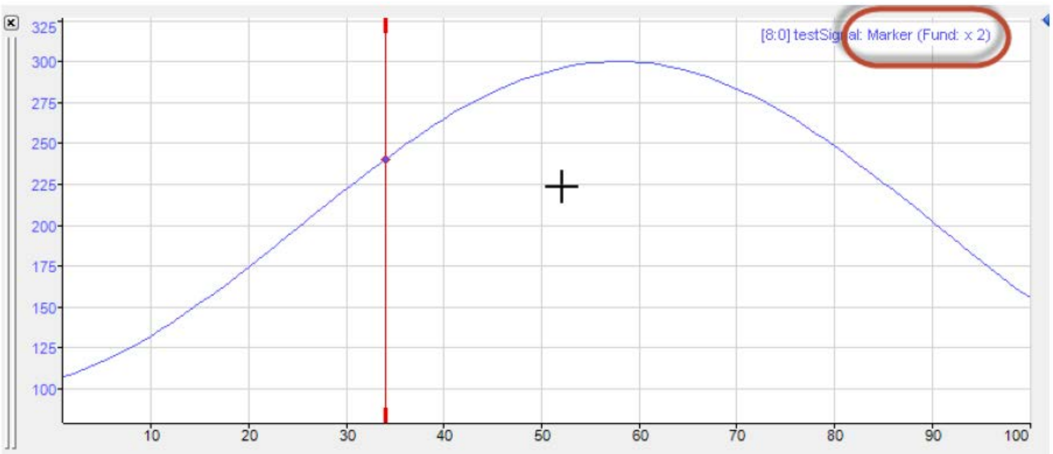


The slice slave can operate in two modes:

- In **Spectrum Mode** you can monitor a spectrum value that changes over time:
  - The temporal dimension corresponds to the number of planes in the waterfall view. The highest-numbered plane contains the most recent data (front plane). The scale of the X-axis shows the plane number.
  - The frequency dimension is specified by an interactive marker or a configured marker, which is connected to a signal, e.g., a speed signal.



- In **Marker Mode** you can monitor a frequency value that changes over time:
  - Here again, the temporal dimension corresponds to the number of planes.
  - Application example: Tracking a speed marker to show the speed history.



The mode of the slice slave is also displayed in the signal legend.

You can add multiple slice slaves for different applications.

Once defined, the slice slaves are listed in the drop-down menu and can also be displayed, hidden and deleted there.

The slice slave is specified by a marker. In the properties of the slice slave, you can select any defined marker, including any available harmonic markers. You can also quickly switch between the different markers in the context menu on the slice slave.

In addition, each slice slave has its own interactive marker. The “Link markers with waterfall” option lets you associate the interactive marker with the currently selected plane in the waterfall view. Note that the position of the interactive markers in the slice slave always corresponds to one plane in the waterfall view.

6.9 Marker spectrum display

The marker spectrum display is used to represent the relationship between a dynamic marker (horizontal axis in Hz) and the associated spectrum value (vertical axis).

For each plane of the waterfall view, a point for the value pair is entered in the graph.

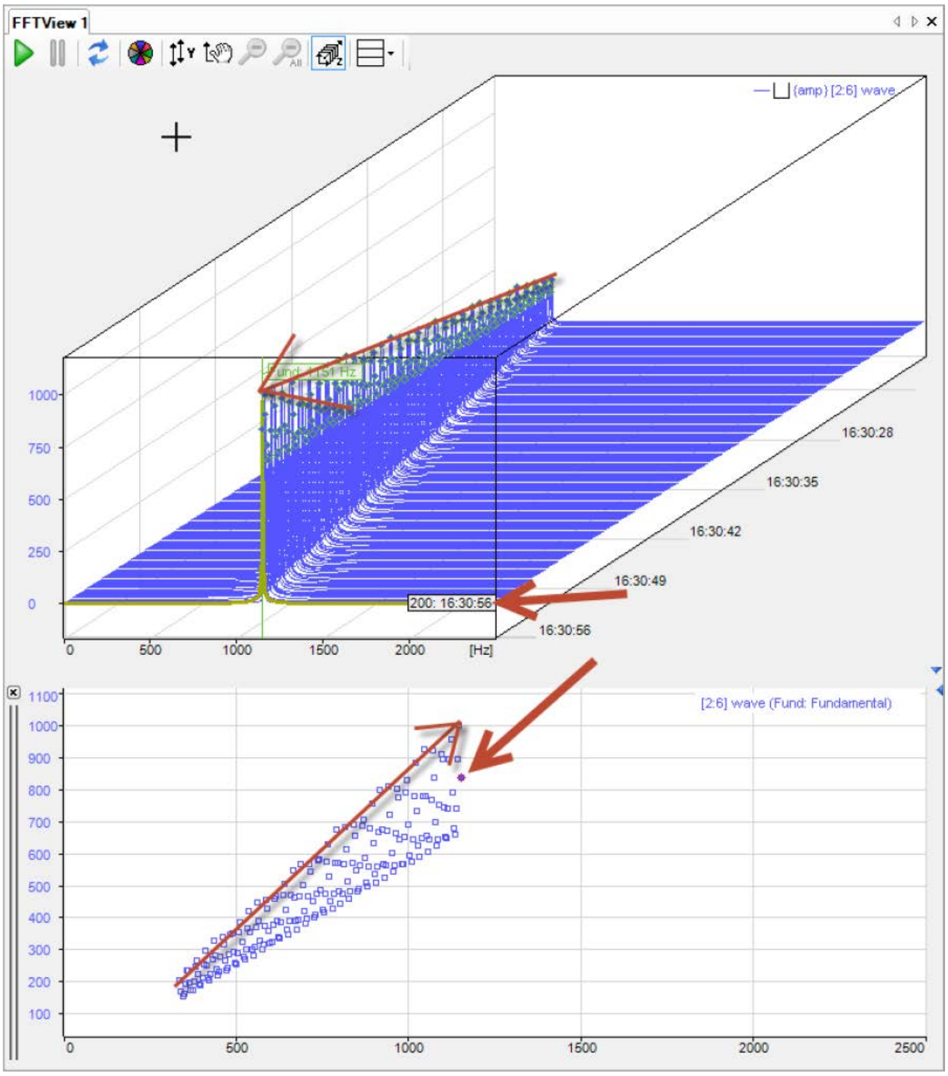


Fig. 44: Marker spectrum display example

This display does not have its own interactive marker. When you hold down the <M> key, the mouse moves over the points and the corresponding values (X, Y, and plane) are displayed in a pop-up.

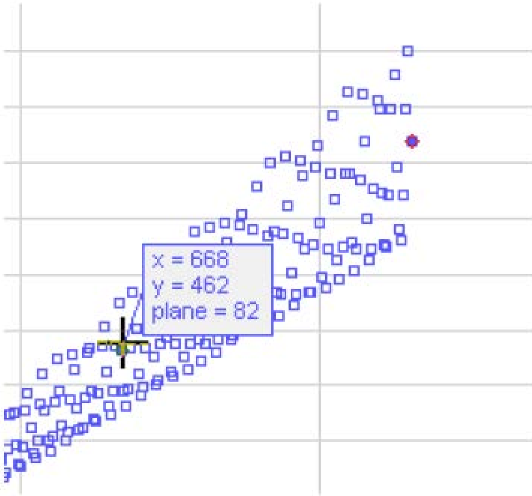


Fig. 45: Value display at mouse over

The point within the currently selected plane is highlighted with a red circle.

You can add multiple marker spectrum displays and configure them differently.

6.10 Markers

For a better evaluation of the frequency analysis, markers can be displayed in the main window and in the spectrum slave graph. The markers mark frequency values along the x-coordinate. Frequencies of interest can be, for example, a constant or variable fundamental frequency, known resonance frequencies or the harmonic components.

There are several types of markers having different functions:

- Interactive marker
  There is one interactive marker. This marker can be switched on or off and manually moved. In the time slave graph, only this type of marker is available.
- Configured marker
  Several markers of this type can be used in a display. This marker cannot be moved manually but its position is not necessarily fixed. The marker position can be set to a constant value or controlled by a signal.
- InSpectra marker
  This marker is configured in the InSpectra Expert module and cannot be moved manually.

For all markers, harmonic markers and sideband markers can be additionally configured.

You can enable or disable the display of the interactive marker by clicking the button in the tool bar of the FFT view. Depending on the focus, the button refers to the main window and the spectrum slave graph or to the time slave graph.

You enable or disable the display of the configured markers and the InSpectra marker solely in the properties dialog of the main window.

The markers are configured in the properties of the FFT view (main window).

Fig. 46: General marker properties

For all markers, you can set that the factors are shown in the label of the harmonic markers.

In the waterfall display, you can connect the marker dots between the planes.

The intersections of the markers with the spectrum are displayed by small diamonds. You can hide these with the option *Hide marker dots*. If *Connect marker dots between planes* is also selected, the markers are shown as a line in the waterfall and in the contour view.

For better differentiation, you can assign your own line patterns or bold type to the different markers (first harmonic, harmonic markers and sideband markers).

6.10.1 Interactive marker

The interactive marker is used for spontaneous reading of X and Y values in a spectrum display. It can be shown or hidden at any time.

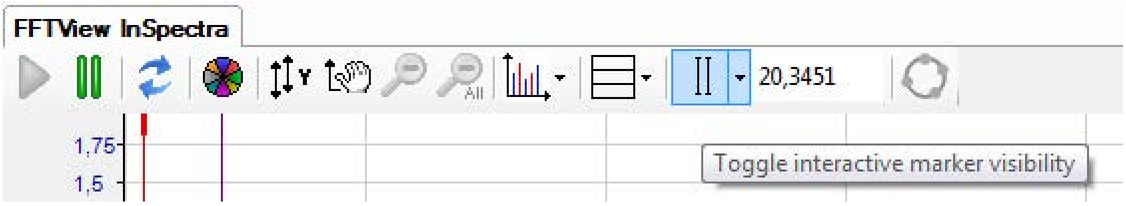


Fig. 47: Interactive marker symbol

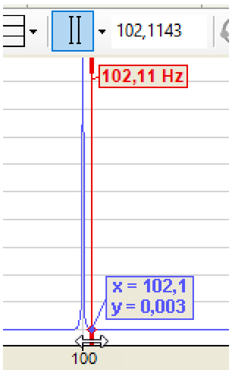
When activating for the first time, the marker is displayed at the position 1 Hz. Every time the marker is switched off and on again, it memorizes the last position.

You can change the marker position either by clicking on the thick ends at the top or at the bottom of the marker or by using the cursor keys:

Keys	Function
<Cursor to the left>/<cursor to the right>	Normal step width
<Shift>+<cursor to the left>/<cursor to the right>	Large steps
<Ctrl>+<cursor to the left>/<cursor to the right>	Small steps

Table 2: Key operation for marker movement

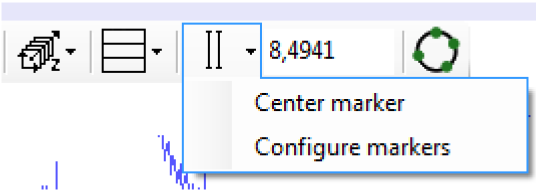
When you move the mouse over the thickened end of the marker, the cursor changes to a double-arrow symbol. You can then move the marker. In the label with the marker color (default: red), the X value is displayed on the base axis. If there are several base axes, you must specify in the settings of the base axes which axis the marker should refer to (Marker Axis). In addition, X and Y values are displayed at the intersection of the marker with the spectrum.



Center markers

Since the marker has a certain position on the frequency axis, it is possible that it is not visible in the image anymore after zooming. Switching the marker off and on to bring it back into the image is useless, as it does not change its position because of that.

This is what the *Center Marker* function is for. With this function, you place the marker in the center of the section currently visible.



Click on the arrow symbol at the marker button in the tool bar and then on "Center marker."

Configure marker

In addition to general properties such as color and label, you can also configure harmonic markers and sideband markers in the settings.

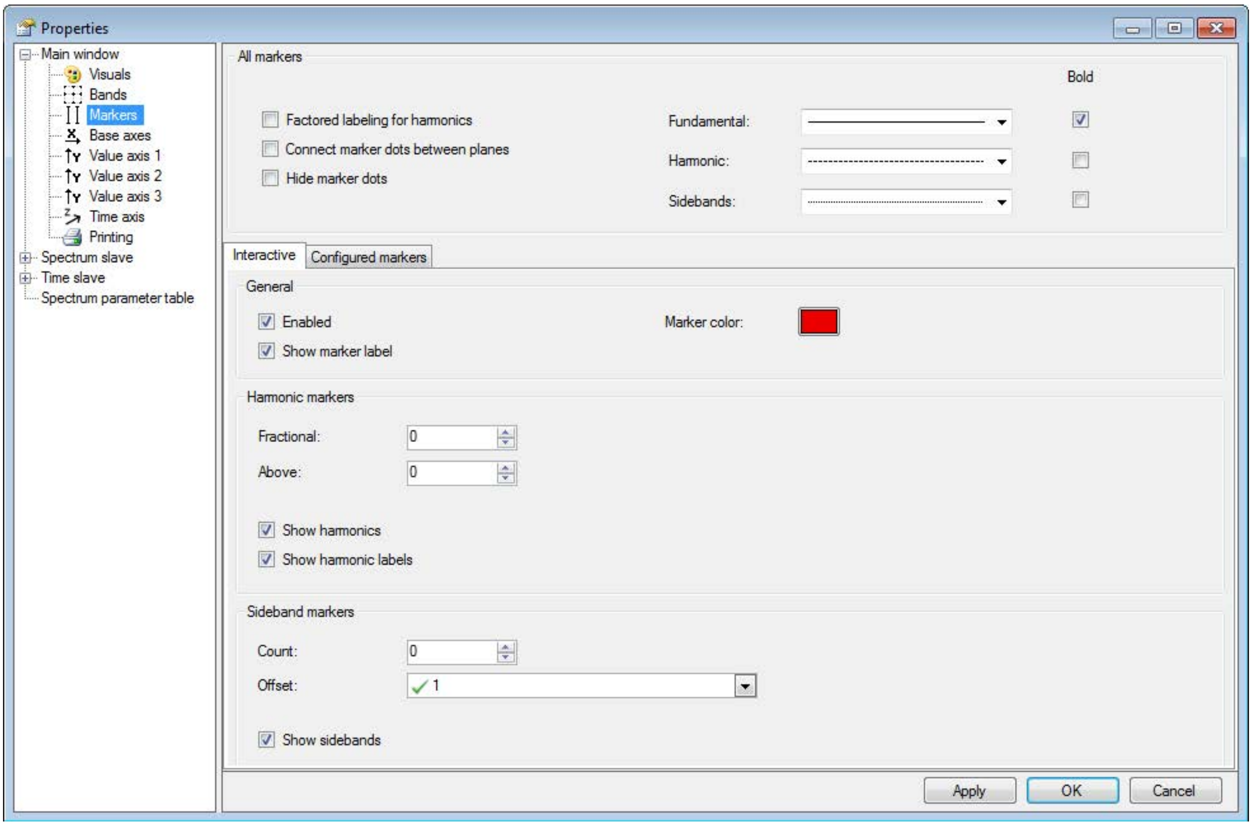


Fig. 48: Interactive marker properties

Harmonic markers always have a frequency that corresponds to an integer multiple of the main marker. For the harmonic markers, determine the requested number of the harmonic components below and above the current marker frequency. For the harmonic frequencies, further lines are displayed. Additionally, in the “Markers” branch, enable the option “Show harmonic labels” to display the frequency values on the markers.

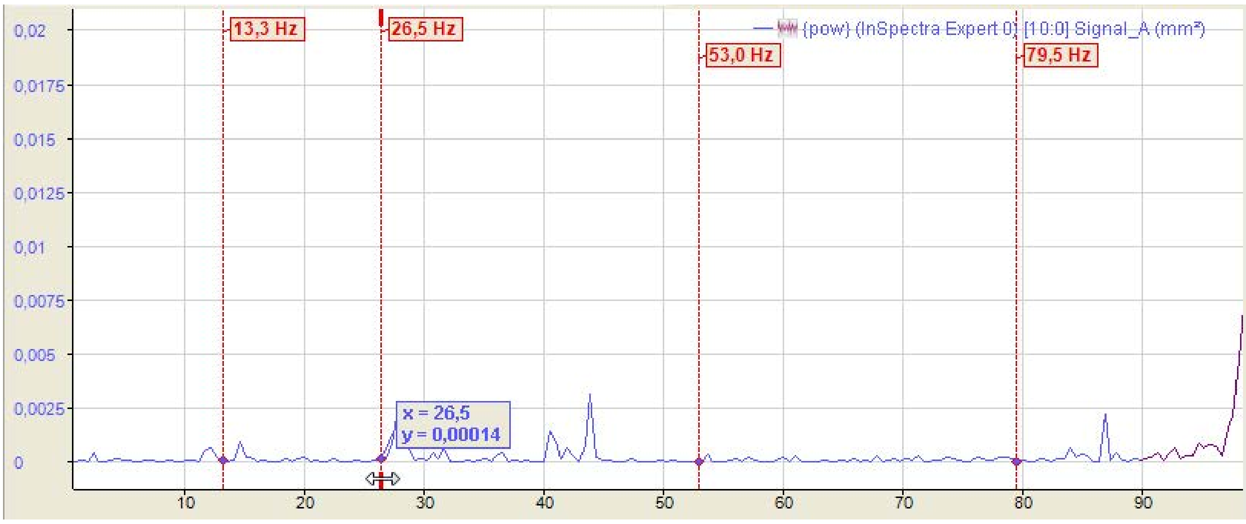


Fig. 49: Example of interactive markers with harmonic components

The above figure shows an interactive marker with 1 harmonic component below and 2 harmonic components above the marker frequency of 26.5 Hz.

The values of the harmonic markers are displayed at the maximum height of the value axis. The unit of these values corresponds to the unit of the base axis (see the chapter Base axes). The view can be configured to show only the frequency of the main marker.

An adjustable number of sideband markers is added symmetrically right and left of the main marker. The distance to the main marker and the neighboring sidebands is the sideband offset, represented in units of the base axis. The sideband offset can be a constant value or an analog signal. The offset can also be changed with the mouse by touching one of the outer markers with the cursor and moving it to the left or right with the mouse button pressed down.

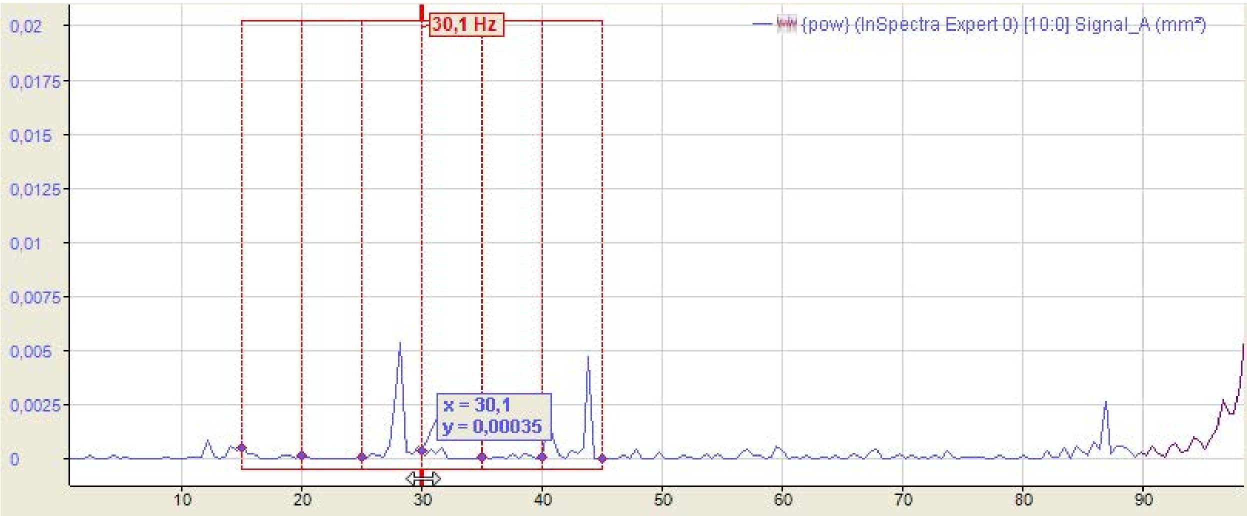
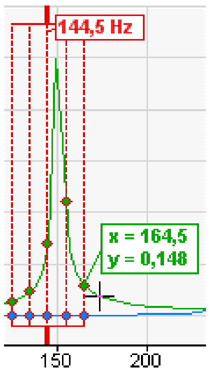


Fig. 50: Example of interactive markers with sidebands

The above figure shows an interactive marker with 3 sidebands and offset of 3 Hz each.

Small diamonds indicate where markers and spectra intersect. If the mouse pointer is moved near a diamond, its coordinates (X and Y values) become visible.



Harmonic component and sideband markers can be displayed in combination, too.

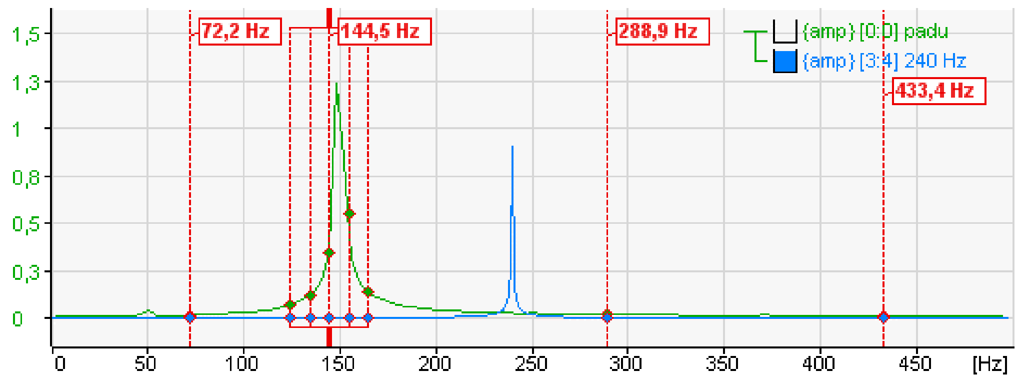


Fig. 51: View with a harmonic marker below and two above the main marker. The sideband offset is set to 10 Hz

Note

If the sideband offset is specified by a signal, the value of this signal always has to be >=0. If the value is negative, the offset = 0 and no sideband markers are displayed.

Note

You can make the general settings of the markers in the preferences. You will find individual settings for the FFT views in the properties of a view.

For further information, see chapter ↗ *FFT view overview*, page 32

6.10.2 Configured marker

The so-called configured markers can either be anchored at certain positions on the base axis with fixed values or moved dynamically along the base axis by means of analog signals.

The markers must first be defined and configured. You can configure the markers in the Properties dialog of the FFT view, in the “Marker” branch.

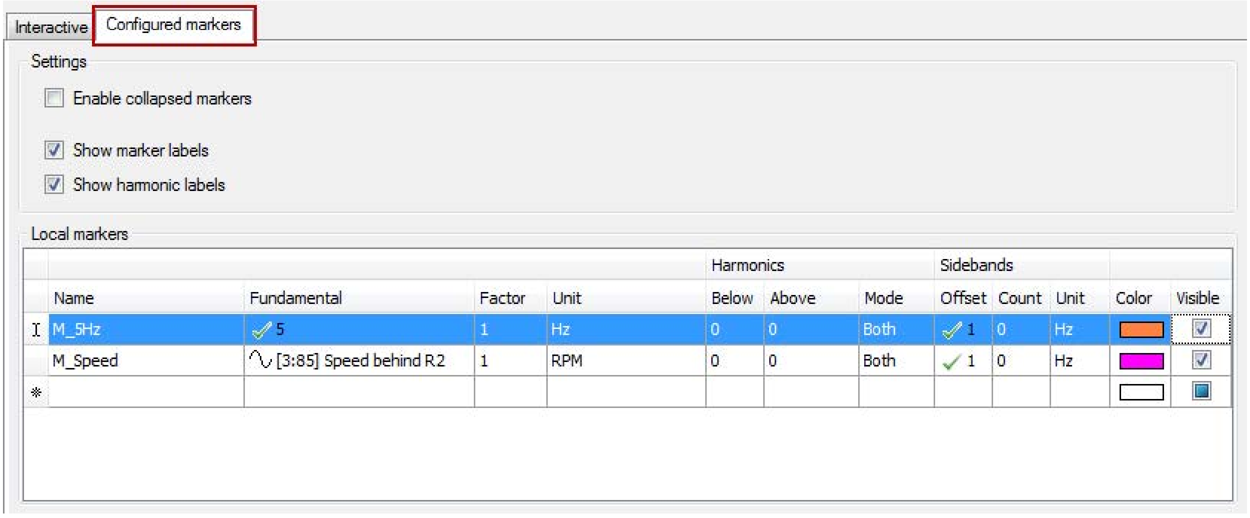


Fig. 52: Configured marker properties

To create a marker, you simply have to enter the required information in the table line. As soon as you click in the empty space below, a new, empty line is added.

Name
Enter a clear name to be able to easily identify the marker. The name is shown in the display later on, too.

The entries for fundamental frequency, factor and unit determine the position of the marker on the base axis. The marker position is calculated by multiplying these three parameters.

Fundamental
You can enter a fixed value or select a signal for the fundamental oscillation or fundamental frequency. To select a signal, click in the table line and then on the arrow symbol. Select the signal from the signal tree.

If you want to use a signal for controlling the marker position, select a signal complying with the frequency you want to monitor.

In the example of the above image, we have selected a velocity, more precisely the speed of a drive in rpm, to control the marker. In doing so, frequencies of interest can be easily tracked, e. g. during the acceleration and braking phase of a machine. This is especially easy to see in the main window’s waterfall and contour view.

Note

If the signal for the fundamental frequency is negative, the marker is not displayed.

Factor
The default value of the factor is 1. You can enter another factor if, for example, the marker is to be positioned at a multiple or a fractional part of the fundamental frequency.

Unit
As to the unit, you can choose between Hertz (Hz) and revolutions per minute (rpm). Depending on the settings, another, internal factor is taken into consideration:

- Hz: Factor = 1
- rpm: Factor = 1/60

Order can also be selected for order spectra.

Harmonics
As with the interactive marker, you can individually determine the number of harmonic markers above or below the marker frequency for every static marker. Additionally, this mode allows you to select whether only the even or odd harmonic components are taken into consideration or both types.

Sidebands
As with the interactive marker, you can individually determine the number of sideband markers and the sideband offset for every static marker. Sidebands can have a different unit than the marker itself. You can select the unit here.

Note

If the sideband offset is specified by a signal, the value of this signal always has to be >=0. If the value is negative, the offset = 0 and no sideband markers are displayed.

Color
Here, you can allocate an individual color to every static marker

Visible
This option decides whether a fixed marker is displayed or not. This is the only possibility of enabling or disabling static markers for the display. The marker button in the toolbar of the FFT view does not control the static markers!

“Enable collapsed markers" option

When you enable this option, an additional column appears in the marker table, in which you can decide for each marker whether it is normal, i.e. it should be displayed as a line and possibly with a label, or only as a triangle based on a spectrum.

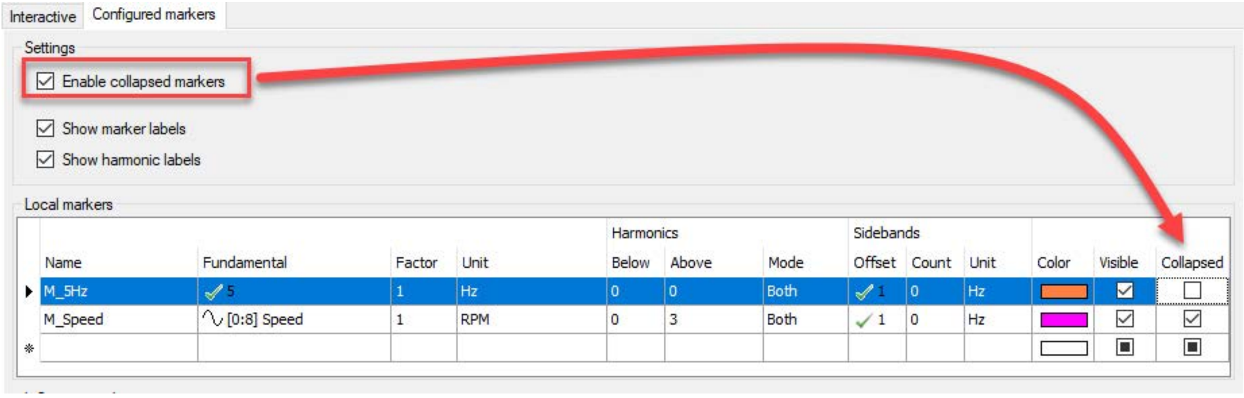


Fig. 53: Marker definition table

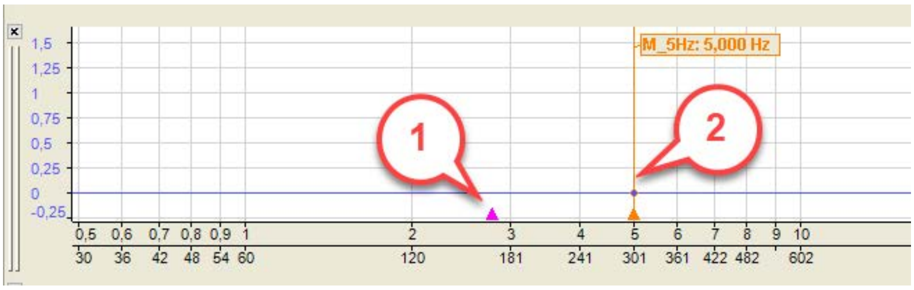


Fig. 54: Example of collapsed marker (1) and normal marker (2)

InSpectra marker

The InSpectra markers are shown in the table below.

InSpectra markers

Number	Name	Fundamental	Color	Visible
Type: Linked				
0	Mark peak	{fmax}		☐
0	Max	{fmax}		☐
Type: Normal				
0	Max	{fmax}		☑
1	300	100		☑

Fig. 55: InSpectra marker table

The settings of the InSpectra markers can only be changed in the InSpectra profile. Only the visibility can be set here.

6.11 Settings in the FFT view

In the FFT view of *ibaInSpectra (ibaPDA)* and *ibaAnalyzer-InSpectra,* all settings can be adopted node by node in the preferences and are thus applied to the newly opened FFT views. Changes can be saved by pressing the button <Apply node to preferences>. The preferences cannot be viewed separately in *ibaAnalyzer*. A new FFT view must be opened in order to view preferences. In *ibaPDA*, you open the preferences via the menu *Configuration - Preferences*.

The node *Main window* offers general settings for the display of the calculated FFTs.

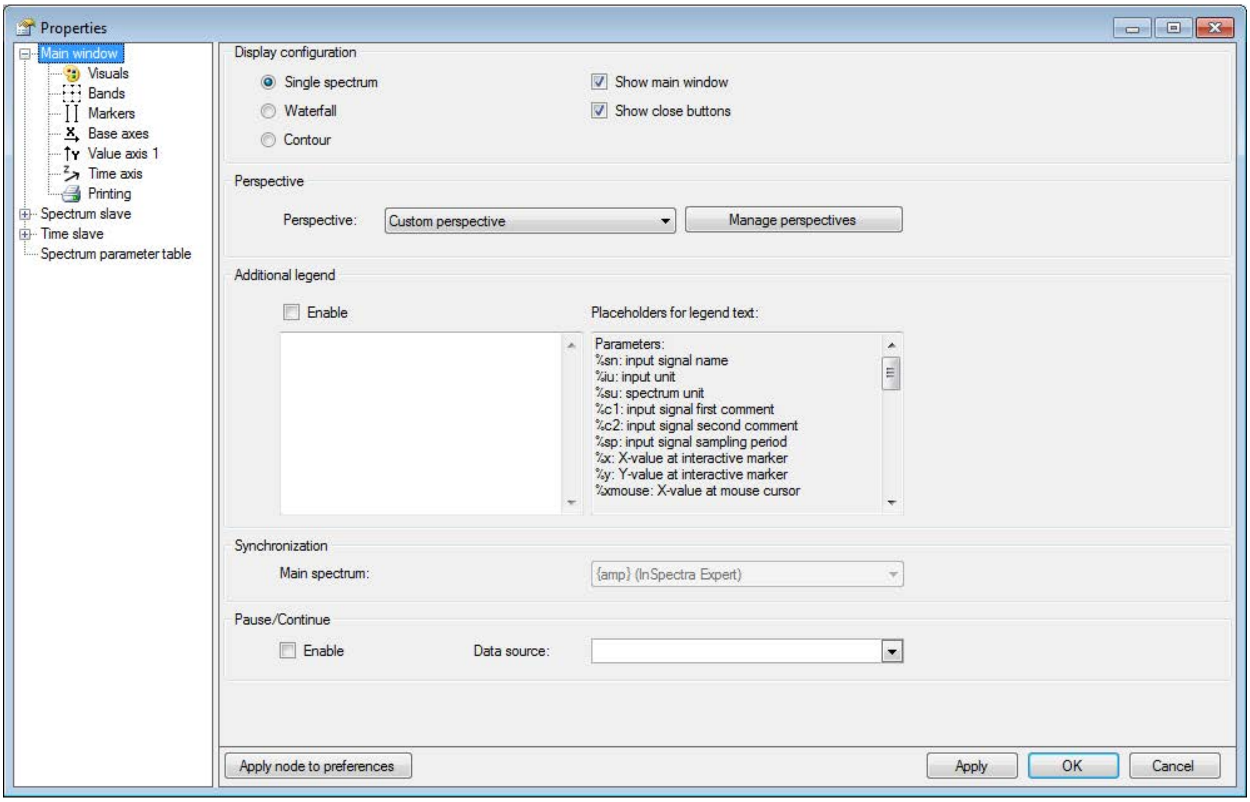
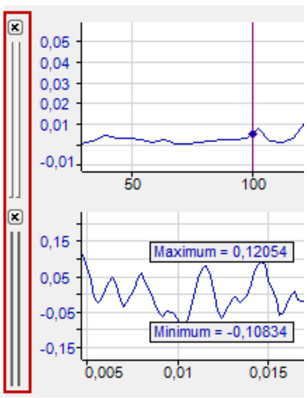


Fig. 56: FFT view properties

Display configuration

Choose between single spectrum, the waterfall view and the contour view of the spectra. The visibility of the main window can also be set here. With the *Show close buttons* option you can control the visibility of the close buttons and the lines to the left of the display.



Perspective: Drop-down list *Custom perspective*
If you have saved different perspectives for the waterfall (3D) view, then you can select one of them.

Click the button <Manage perspectives> to open the dialog for managing perspectives. This lets you delete existing perspectives, copy them to the clipboard or paste them from the clipboard. Since perspectives are always specific to one FFT view, you must copy and paste a perspective that you want to use in exactly the same way in another FFT view into the other FFT view.

The perspective is saved in the display. Once you have configured the desired perspective, select *Save perspectives* in the context menu of the main window. Give the perspective a name and close the dialog with <OK>.

Additional legend
When this option is enabled, another legend is displayed in the main window in addition to the normal signal legend. You can define the content of this legend yourself. For example, you can enter a detailed multi-line text, in which placeholders for dynamic information can also be used. The following placeholders are available:

- %sn: Input signal name
- %iu: Input unit
- %su: Spectrum unit
- %c1: Input signal first comment
- %c2: Input signal second comment
- %sp: Input signal sampling time
- %x: X-value at interactive marker
- %y: Y-value at interactive marker
- %xmouse: X-value at mouse cursor
- %ymouse: Y-value at mouse cursor
- %tmouse: Z-value at mouse cursor
- %xmv: X-value of the nearby marker position
- %ymv: Y-value of the nearby marker position
- %tmv: Time value of nearby next marker position
- %nmv: Name of the nearby marker position
- %imn: InSpectra Expert module name
- %rms: RMS value of the selected plane (based on incoming values)

By default, all signal-related placeholders are determined based on the first spectrum. To identify another spectrum, use a colon followed by the word “spectrum” and the index of the spectrum, e.g. "%sn:spectrum1", in order to refer to the first spectrum.

Use the optional formatting string “w.p” to specify the format of the numeric parameters, where “w” is the width and “p” is the precision. The width is the minimum number of the characters shown. Precision is the number of decimal places. Example: "%5.3y1" indicates the Y-value for marker X1 with a width of 5 characters and a precision of 3.

The display always shows the information for the uppermost signal in the main window.

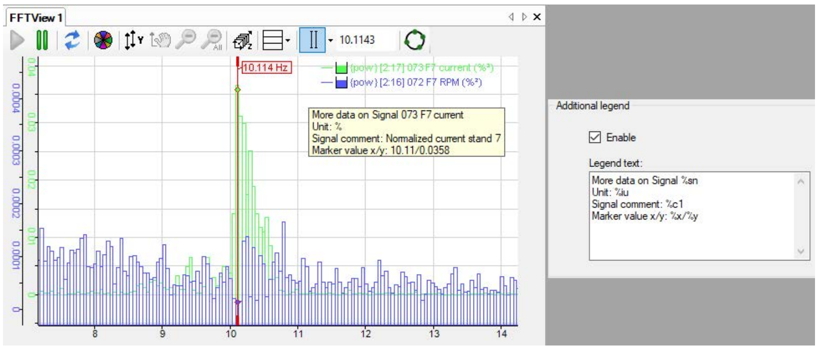


Fig. 57: Definition of additional legend (right) and display (left)

Synchronization
By default, if only one spectrum is displayed in the FFT view, identifiers, markers and zones are synchronized with this spectrum and this setting is not available. If multiple spectra are displayed in the FFT view, you can define the main spectrum here which will be used for synchronization.

Pause/Continue
This function is only available in *ibaPDA*. If this option is enabled, the visualization of the FFT is controlled by a digital signal. The FFT calculation is continued.

If the digital signal is TRUE (1), the visualization is paused and the display shows the frozen image of the last result.

If the digital signal is FALSE (0), the visualization continues and the display is updated regularly.

6.11.1 Visuals

In the dialog of the *Visuals* node, you can set the appearance and colors of the FFT view.

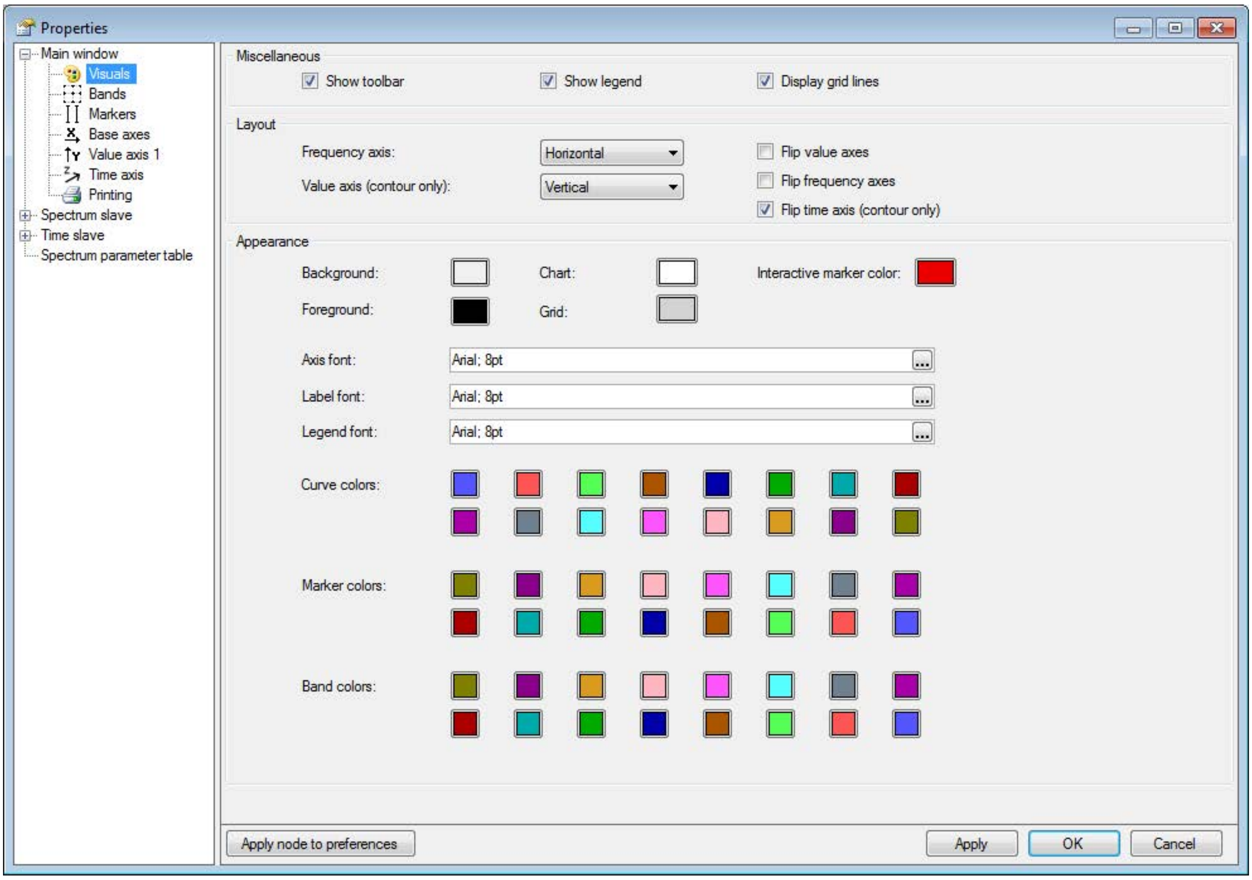


Fig. 58: Preference for the visualization of the FFT view

Layout
You can change the alignment of the FFT axes from horizontal to vertical or vice versa by selecting the relevant option from the picklist *Frequency axis*. You can also flip the individual axes.

For a contour view, the color axis (value axsis) can be displayed horizontally or vertically next to it.

Appearance
Here you make the settings for colors and fonts. For the coloring of curves, markers and bands, 16 colors are available, which are automatically assigned to the corresponding items one after the other when they are added in the view.

6.11.2 Bands

The display supports frequency and value bands. These bands highlight certain parts of the spectra in a different color. Frequency bands (horizontal) have a static or dynamic average (center frequency) and a delta width. Value bands (vertical) start at a dynamic or static value and either reach upward to the next value band or positive infinity.

The frequency bands can optionally be assigned to individual spectra or to all spectra. Value bands apply to all spectra.

Bands are configured in the properties dialog in the node *Bands*. There are two types of bands:

- You can allocate *custom bands* to any spectrum or all spectra
- *InSpectra bands* are bands that were configured in the calculation profile of an InSpectra module

Custom bands

In the *custom bands* tab, you define the frequency bands with a static or dynamic center frequency and a delta frequency. You can allocate a color to the band and a certain spectrum or all spectra.

In the diagram below, you can see the effects of the following settings.

Example:

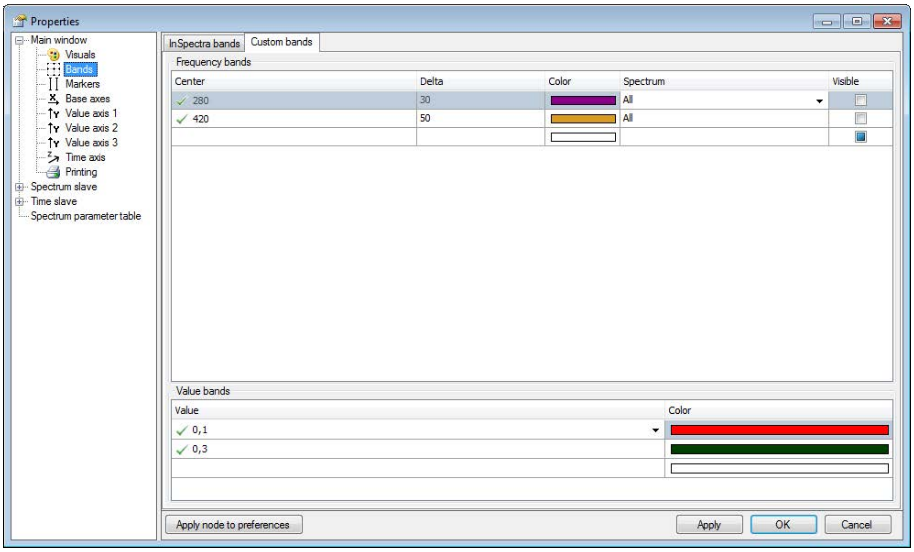


Fig. 59: Band coloring settings

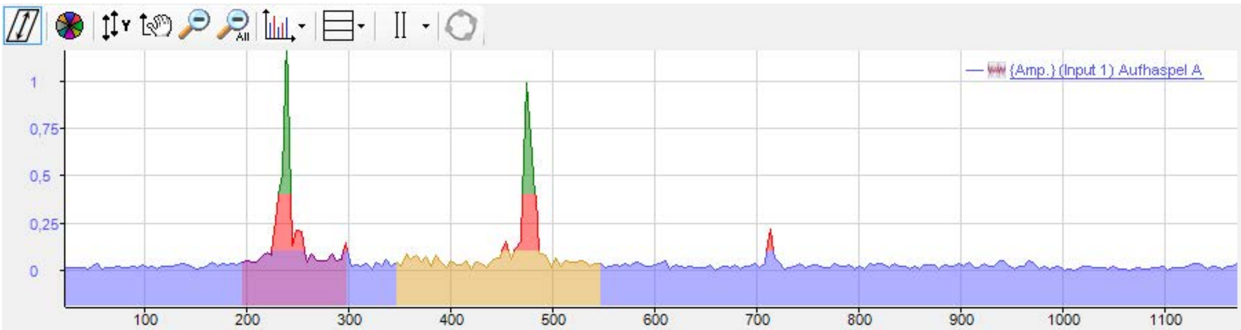


Fig. 60: Example of band coloring

InSpectra bands

If you use the FFT view with InSpectra, an additional *InSpectra Bands* tab will appear in this dialog.

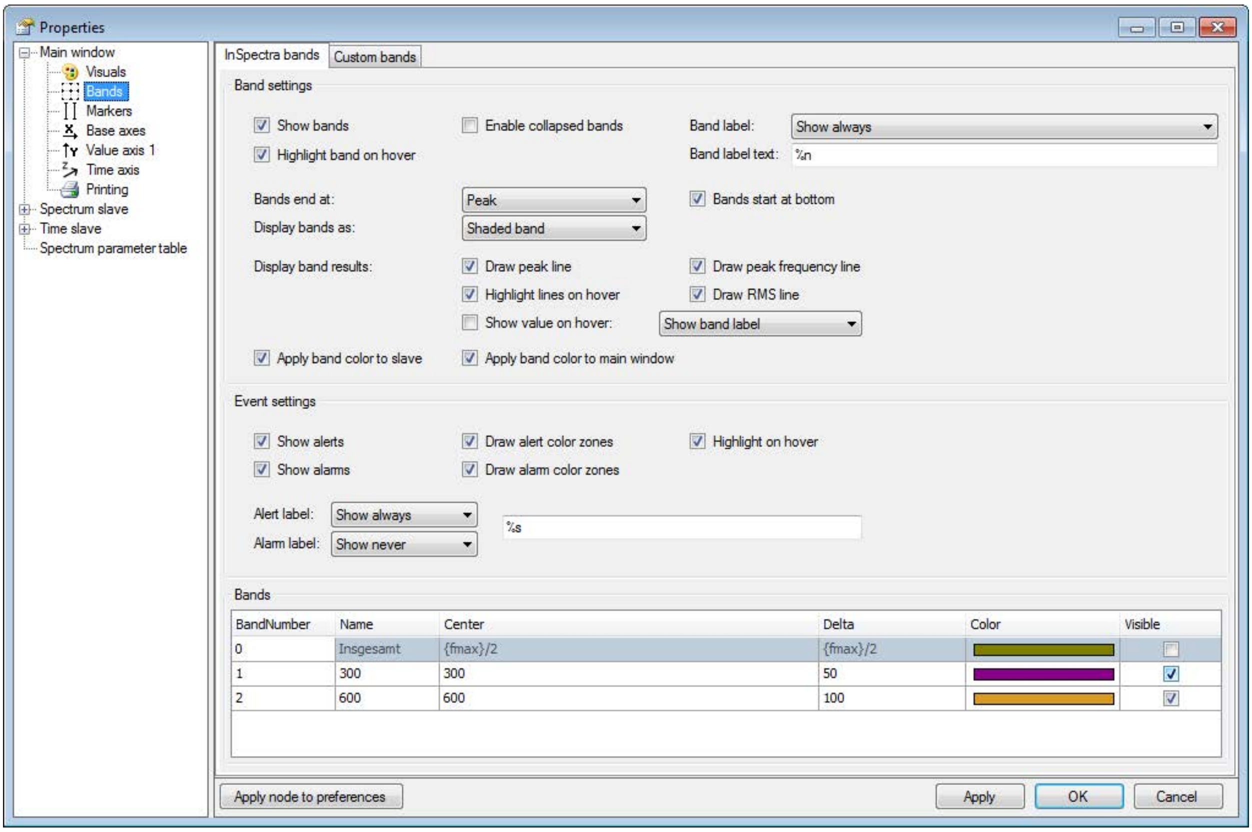


Fig. 61: InSpectra bands settings

Band settings

Display properties of the InSpectra bands can be determined in the *Band settings* area.

You can enable the collapsed appearance of the bands and whether the band is highlighted on hover. If this option is enabled, the band is highlighted in the display of the frequency spectrum and in the data table.

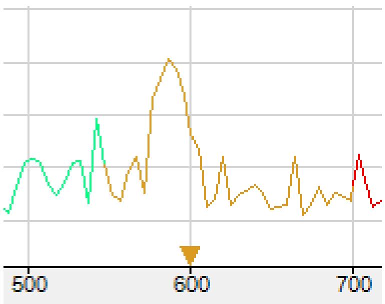


Fig. 62: Collapsed bands are indicated by a triangle at the center frequency

You can determine when the band labels are displayed (never, always or on hover) and what is displayed in the label. If you click the band label text field, a list of parameters appears that you can use for dynamic information in the label text.

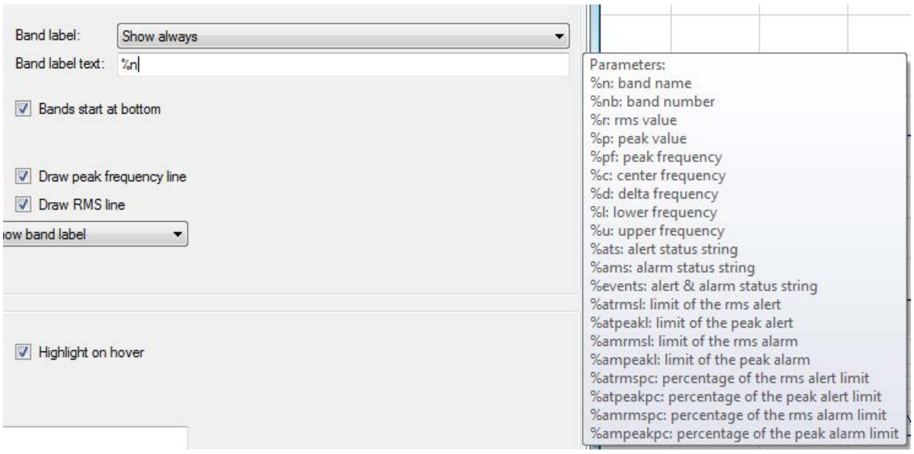


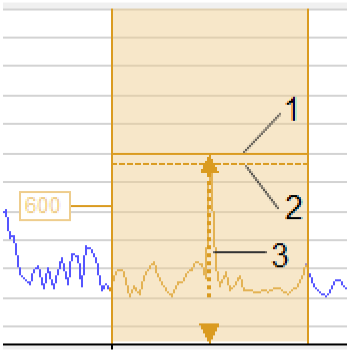
Fig. 63: Parameters for dynamic label text

The following parameters can be used:

- %n: Band name
- %nb: Band number
- %r: RMS value
- %p: Peak value
- %pf: Peak frequency
- %c: Center frequency
- %d: Delta frequency
- %l: Lower frequency
- %u: Upper frequency
- %ats: Alert status string
- %ams: Alarm status string
- %events: Alert and alarm status string
- %atrmsl: Limit of the RMS alert
- %atpeakl: Limit of the peak alert
- %amrmsl: Limit of the RMS alarm
- %ampeakl: Limit of the peak alarm
- %atrmspc: Percentage of the RMS alert limit
- %atpeakpc: Percentage of the peak alert limit
- %amrmspc: Percentage of the RMS alarm limit
- %ampeakpc: Percentage of the peak alarm limit

You can determine whether the bands should begin at the lower margin and where they should end (at the end of graph, at the peak or at the RMS value). The frequency bands can be shown as a shaded band or non-shaded band or only as a line at the center frequency.

The characteristic values of the bands can be displayed as lines, which can be highlighted on hover. Example:



1 line for peak value

2 line for RMS value

3 line for frequency peak value, highlight on hover

In addition, the band color can be adopted as a curve color both in the spectrum as well as in the main window.

Event settings

Display properties for events (alerts, alarms) can be set in the *Event settings* area. Dynamic label texts can also be defined for events. See band settings.

Bands

The bands configured in an InSpectra profile are shown in the table below in the dialog. The name, center frequency and delta frequency are already defined in the InSpectra profile and can no longer be changed here. The color and visibility can still be changed here.

Bands

BandNumber	Name	Center	Delta	Color	Visible
0	Insgesamt	{fmax}/2	{fmax}/2		☐
1	300	300	50		☑
2	600	600	100		☑

Fig. 64: Example of bands table

6.11.3 Markers

You will find the description of the marker settings in chapter ↗ *Markers*, page 56.

6.11.4 Base axes

You can choose between linear and logarithmic display here and whether the axis unit is displayed or not. Typically, the base axis has the unit Hz in the frequency domain and seconds in the time domain.

The base axis can be inverted so that, for example, the vibration period (T) is shown instead of frequency (f). The following applies here: T = 1/f.

Properties

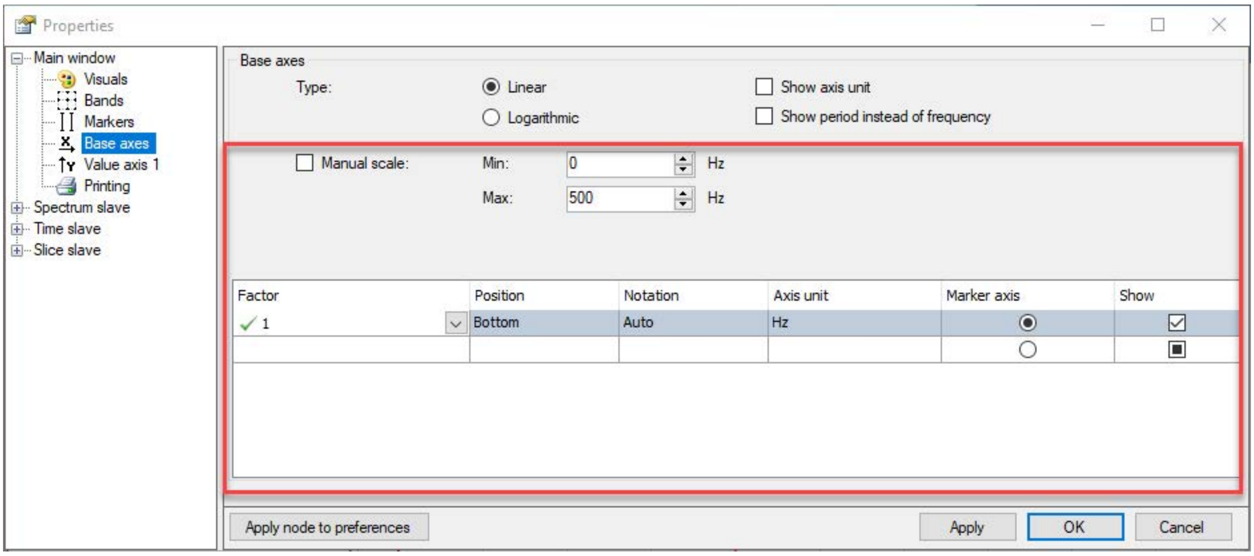


Fig. 65: Properties of the base axis of an FFT view

By default, the scaling values are automatically determined. However, you can also make a manual specification.

By default, the table of axes only shows the default Hz axis or order axis with optional setting options for the position (top/bottom), notation (auto/standard/scientific), and axis unit. To change these settings, click on the corresponding cell and select the setting from the drop-down list.

If you have defined several base axes, select which base axis the markers in the display should refer to in the *Marker Axis* column.

Use the *Show* option to control whether the base axis is displayed or not.

You can add and configure other base axes as needed. These additional base axes can have a different scale, reference value or unit. By default, the basic display settings for the base axes are adopted from the main window and from the spectrum slave graph. You can then either change some display settings for the base axes for the spectrum slave graph or synchronize them again with those from the main window.

Note

The manual “Minimum” and “Maximum” scale settings always apply only to the main axis (Hz). All other base axes enabled in the FFT view are scaled automatically.

Each axis to be shown in the graph is represented by a line in the table below.

In the following example, two base axes were defined. The first shows the frequency in Hz and the second in rpm. The base axes in the main window (1) are linear. The base axes in the spectrum slave graph (2) are logarithmic.

In addition, the main window was zoomed in.

Note

Axis = 1/scaling factor

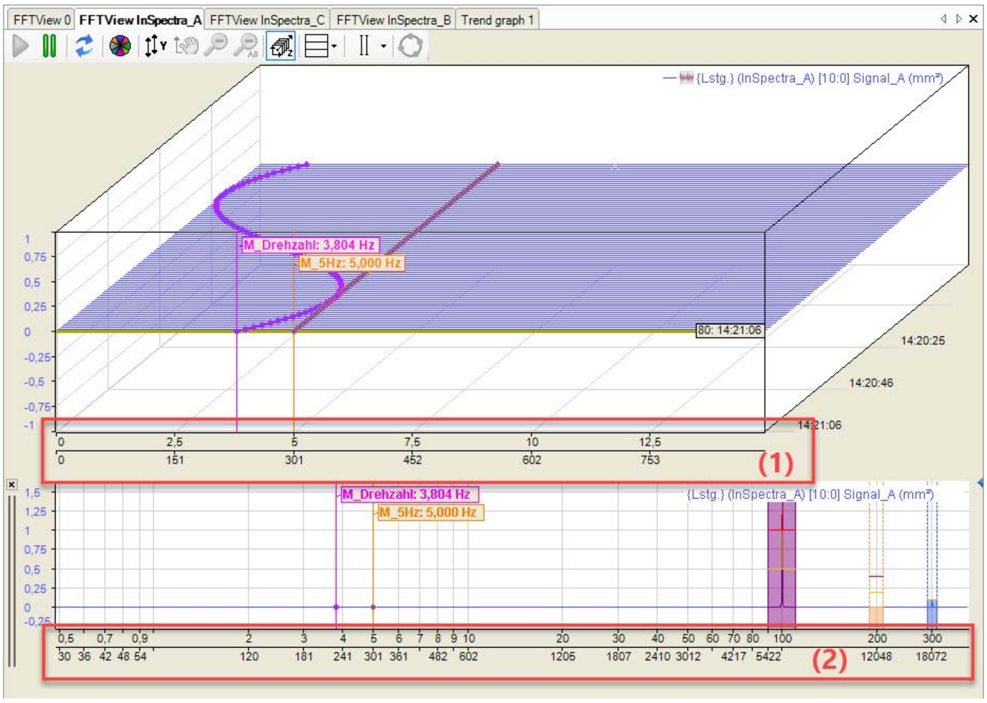


Fig. 66: Several base axes and different scale divisions

6.11.5 Value axes

A value axis can contain several spectra. Using the legend, you can change the value axis used by a spectrum by changing the sequence of the signals. A value axis can be deleted via its context menu. This also deletes all spectra on this axis. You can also display the settings for the value axis via the context menu.

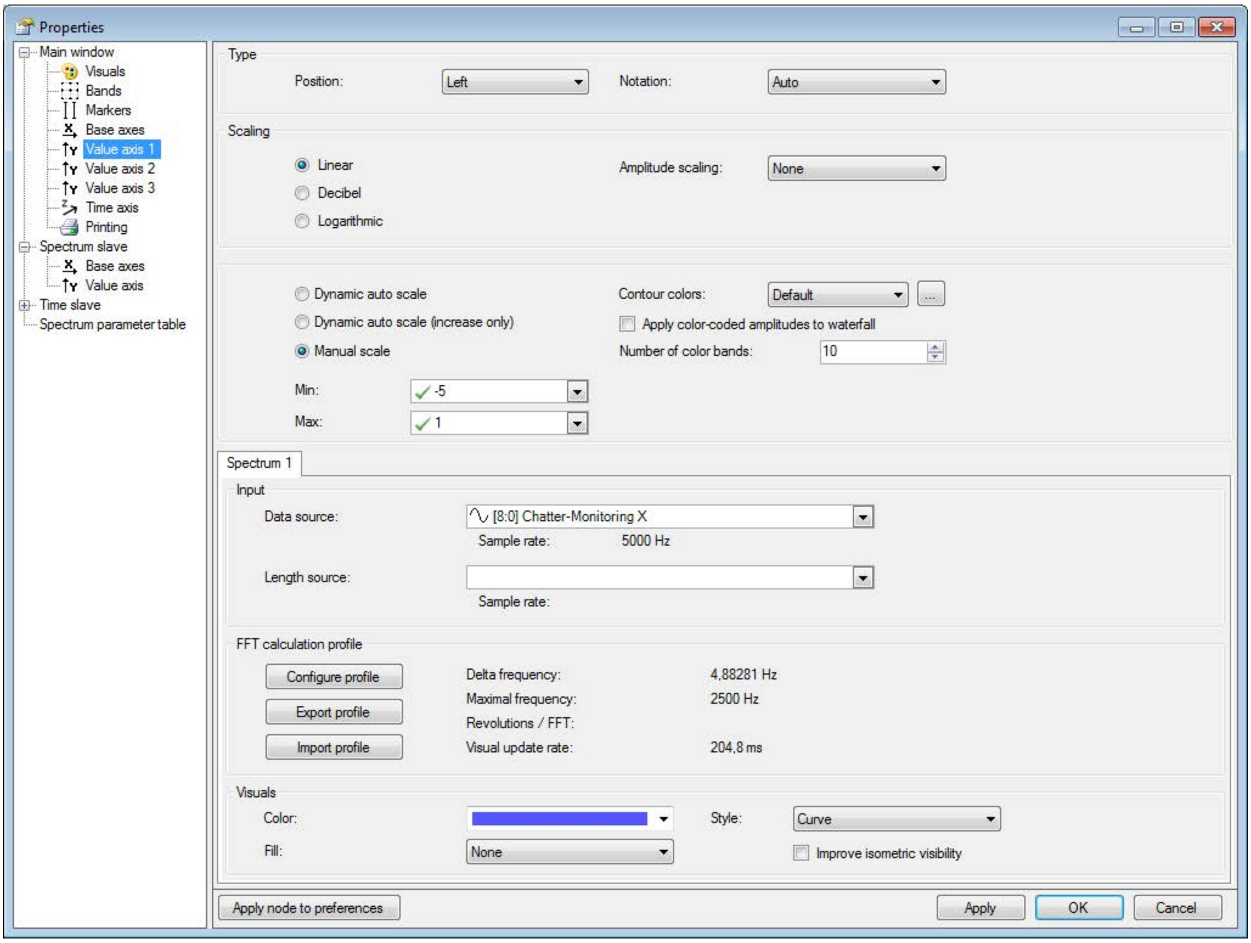


Fig. 67: Properties of the value axis

Settings for type, scaling and view correspond to the usual settings in *ibaPDA* and are self-explanatory.

Scaling

Linear, decibel or *logarithmic* can be set as scale type. This scale type is applied to the appearance of single spectrum, waterfall and contour.

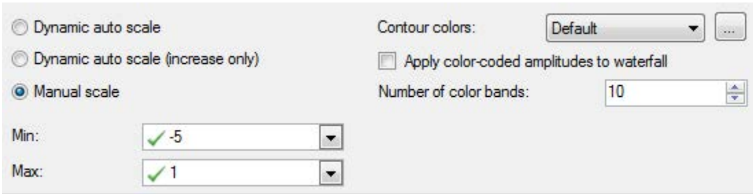
Amplitude scaling

Depending on the requirements for the visualization, it may be useful to either emphasize or suppress the amplitudes for the display. The following methods are available:

- Peak-to-peak
  Amplitude values are practically multiplied by a factor of two
- RMS
  Amplitude values are practically divided by the root 2, thus moving closer to the RMS value.

Note

If *Decibel* is selected, the values of the manual scale nevertheless relate to the linear axis. The resulting decibel values are shown next to them.



In addition, the colours of the contour view can also be applied to the waterfall view. To do this, enable the *Apply color-coded amplitudes to waterfall* option. The number of color bands defines the color resolution. A maximum of 50 color bands is possible.

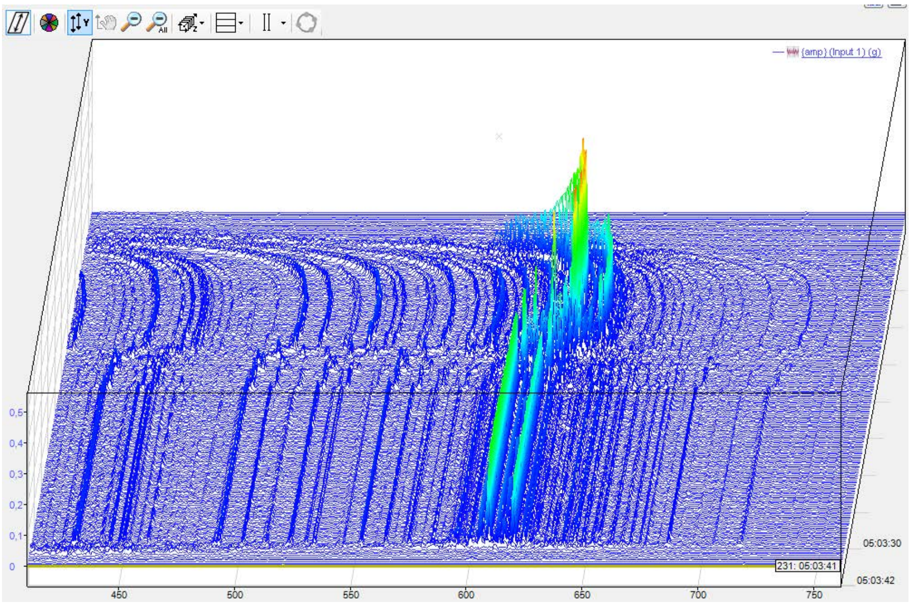


Fig. 68: Example for color-coded amplitudes

Note

If *Apply color-coded amplitudes to waterfall* is enabled, custom value bands are displayed only in the spectrum slave graph.

Spectrum x

By default, a *Spectrum 1* tab is available. These settings are used to process a new signal that is dragged into the FFT view. You can drag multiple signals into an FFT view. If the signals share the same value axis, you will find a separate tab for each signal or spectrum. In the properties, the settings for each spectrum can be changed individually. If each signal or spectrum has its own value axis in the display, each spectrum in the tree structure on the left receives its own node for the value axis.

No calculation profile can be configured in the FFT view of *ibaAnalyzer-InSpectra*. A profile can only be configured for the data acquisition in *ibaPDA* without *ibaInSpectra*. This option is only used for the visualization. The results cannot be acquired. The FFT calculation profile, however, is compatible with InSpectra profiles.

Input

- Select *Data Source* to specify the signal or InSpectra module to be displayed. If you have already dragged the signal into the display via drag & drop, the field is already filled in.
- You only need to enter a *Speed Source* if you want to perform speed-dependent analyses or work with the order spectrum.

FFT calculation profile

The way in which *ibaPDA* calculates an FFT is defined in so-called profiles. A profile is a collection of various parameters that are relevant to an FFT.

Each spectrum can be calculated with a different profile. You can define as many profiles as you wish and save them in the system via the export function. You can also import saved profiles into a spectrum.

In the profiles, parameters are defined, including

- Sensor data (important for vibration measurements)
- Spectrum type (e.g. integrate, differentiate)
- Speed data (important for order analysis)
- Number of samples and lines, overlap
- Basic calculation rules for the FFT (e.g. calculation mode, averaging, window type)

The button <Configure profile> opens the configuration dialog for profiles. The buttons <Export profile> and <Import profile> below can be used to export and import profiles.

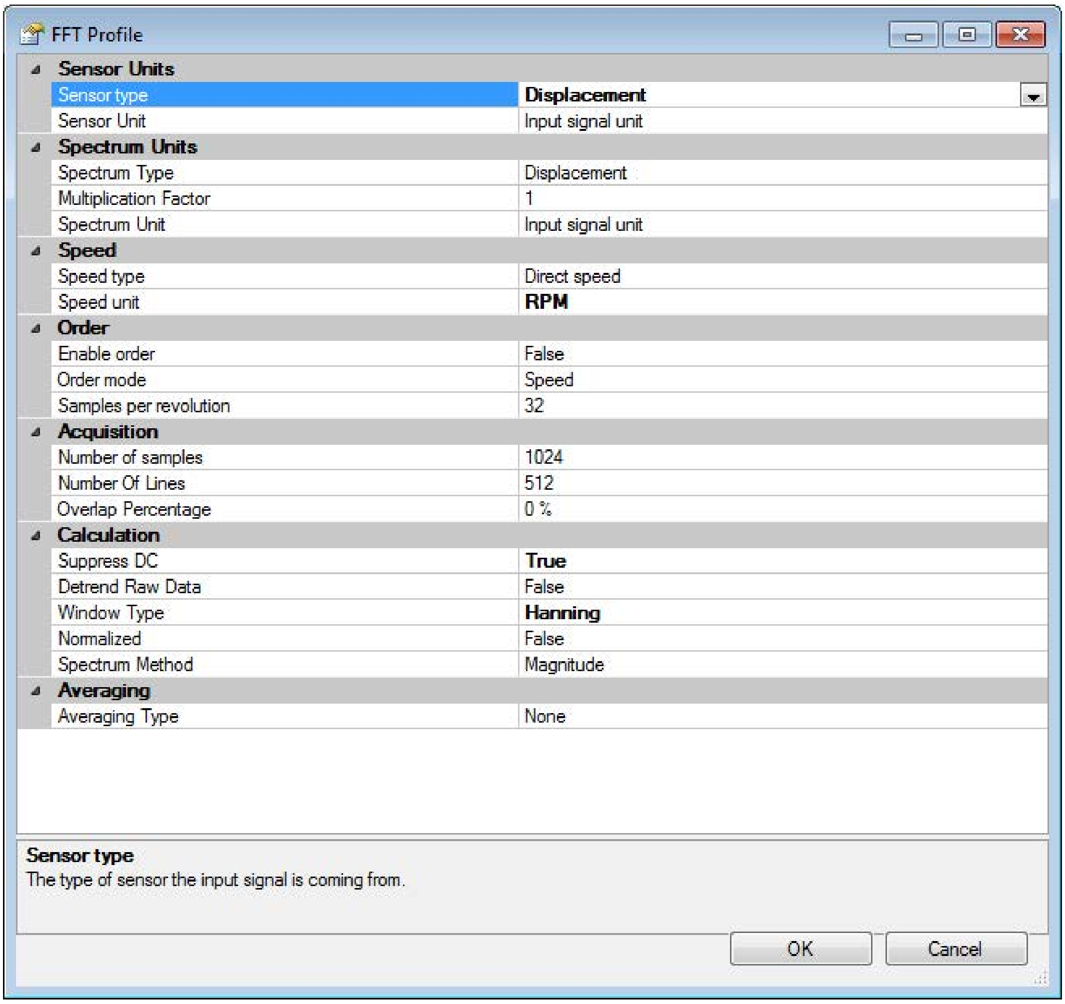


Fig. 69: Configuration dialog for profiles

The calculation parameters and their meaning are explained in chapter ➚ *Setting calculation parameters*, page 87.

The information next to the “Profile...” buttons describes the influence of the acquisition parameters:

- Delta frequency:
  Shows the frequency steps between the results of the division of maximum frequency by bin count.
- Max. update rate:
  Time required for update of the FFT view depending on bin count and overlap factor.

To avoid having to look at the properties to see the profile parameters, the display shows the *Spectrum Parameter Table*. This table is part of the FFT view and can be activated via the drop-down menu in the FFT view. The parameters from the calculation profile shown in the table can be defined in the *Spectrum Parameter Table* node in the FFT view properties. See chapter ➚ *Spectrum parameter table*, page 51

View

A spectrum can be visualized in four different ways:

- Lines,
- Bars,
- Curve or
- Dots

The inner area of a spectrum can be filled with a transparent or opaque color.

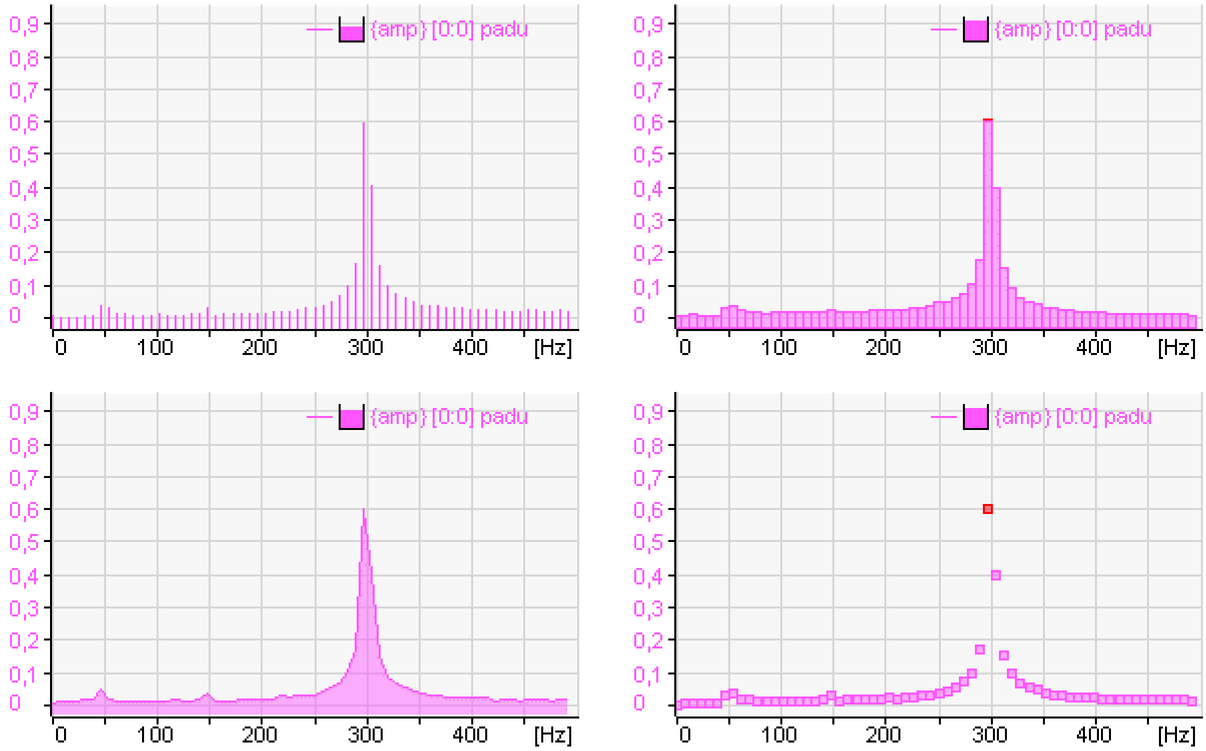
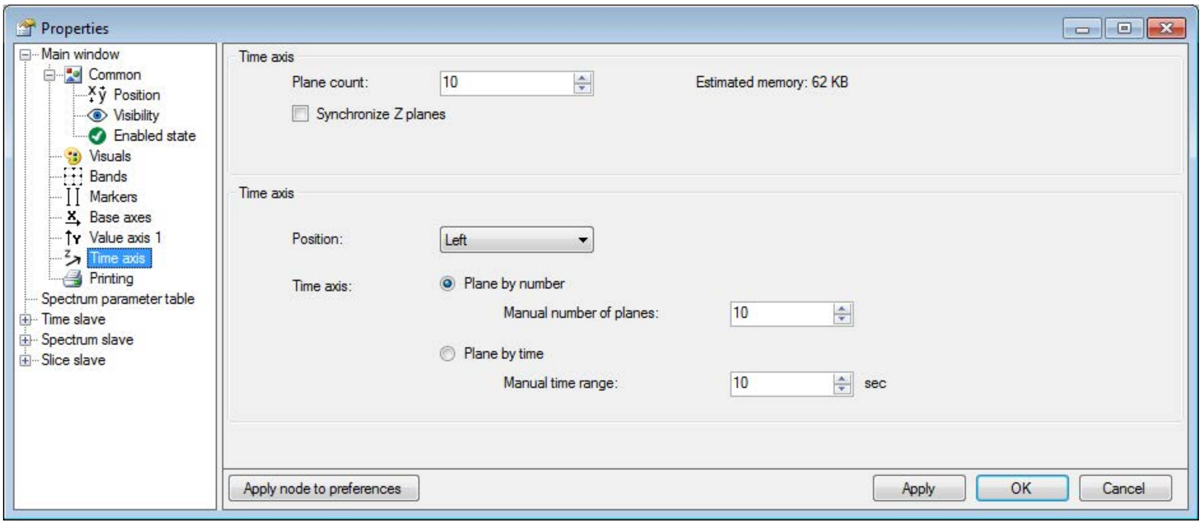


Fig. 70: The four types of spectra visualization, all filled transparently

The option *Improve isometric visibility* is used to make spectra opaque. This makes some effects in the waterfall view more visible.

6.11.6 Time axis

In the *Time axis* node you can define the display options for the waterfall view.



Time axis

- Plane count
  Set the number of planes you wish to be displayed in the Z direction.
- Synchronize Z planes
  If you use multiple spectra in an FFT view, the spectra move forward at their own pace by default, depending on their sample rate or bin count.
  With this option you can synchronize the advance rates of the Z planes across multiple spectra. With this option enabled, the FFT view will not allow a spectrum to advance over the Z planes until all spectra have generated a new FFT result. While the view is waiting for certain spectra to generate results, the other spectra keep showing their newest results on the front plane.
- Determine plane count automatically (option in *ibaAnalyzer* only)
  Number of spectra is detected automatically (max = 500).

Contour time axis

- Manual scale
  You can choose between a manually defined number of planes or whether a new plane will be displayed after a defined time.
- Position
  Specify the position (left or right) of the time axis.

7 The InSpectra Expert module

The InSpectra Expert module monitors and analyzes vibrations in the frequency spectrum, which was generated using an FFT analysis. It can be used for a wide range of applications thanks to the high level of flexibility and versatility of the module.

In the expert module, the frequency bands to be monitored can be freely defined, both statically as well as dynamically depending on other measurands. The following parameters are determined for each frequency band as a result of the analysis:

- Peak
- RMS (Root Mean Square)
- Peak frequency

Freely configurable characteristic values can be calculated based on these parameters. In addition, it is possible to define two limits (alert, alarm) for characteristic values or individual band parameters.

In addition to the values from the frequency domain, additional values are determined in the signal's time domain, such as minimum, maximum, average, RMS or crest.

The calculations for the analysis can be individually adjusted on many planes by the user or saved as profiles. In particular, the sensor type, type of spectrum and FFT calculation parameters, such as the number of samples, window shape or overlapping factor, can be set. Different methods of averaging are also available, such as the option of detrending in order to compensate for a slow drift of the measured value. Defined profiles can be saved and used multiple times.

7.1 The InSpectra Expert profile

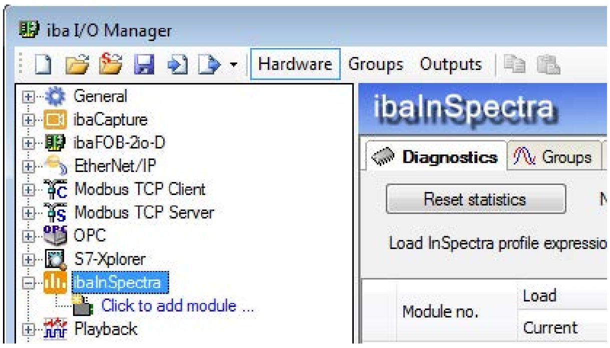
With InSpectra Expert, several frequency bands in the frequency spectrum of a signal can be monitored. The parameters for the frequency band analysis can be freely configured and stored in profiles. This makes it possible to reuse created profiles. Any number of profiles can be configured to adequately analyze different input signals or sensor types. An InSpectra Expert module is to be configured for each signal to be monitored. The modules can be structured through a directory structure to improve the overview.

Since an InSpectra Expert module can only be completely configured if at least one valid calculation profile exists, in the following the configuration of a profile is first explained and then the configuration of the module settings is explained.

7.1.1 Create and manage profiles in ibaPDA

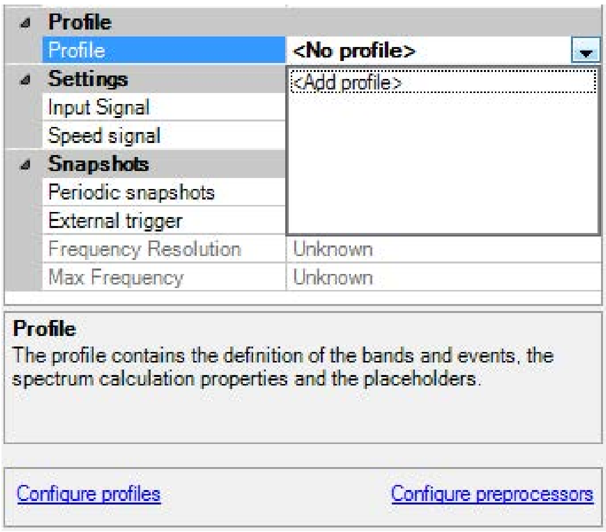
If you create an InSpectra Expert module for the first time, no profiles are yet available. To be able to create and edit profiles, first add an InSpectra Expert module. Then proceed as follows:

1. Open the I/O manager in *ibaPDA*.
2. If necessary, expand the *ibaInSpectra* branch and click on the blue link "Click to add module...".



3. Select the "InSpectra Expert" module type in the following "Add module" dialog and enter a module name in the corresponding field. Then click <OK>.
   The module is now created and you see the *General*, *Analog*, *Digital* and *Linked markers* tabs in the right part of the I/O manager.
   Alternatively, you can use the right mouse key to click on the interface *ibaInSpectra* and select "Add module" in the context menu. The module will then be created immediately. You can then rename it.

4. In the field “Profile” in the *General* tab of the module, open the drop-down list and click on <Add profile>.



   Alternatively, you can also click on the blue link “Configure profile” below in the dialog window.

The dialog for the configuration of the (new) profile opens. Profiles can be created, changed, exported and imported in the profile manager.

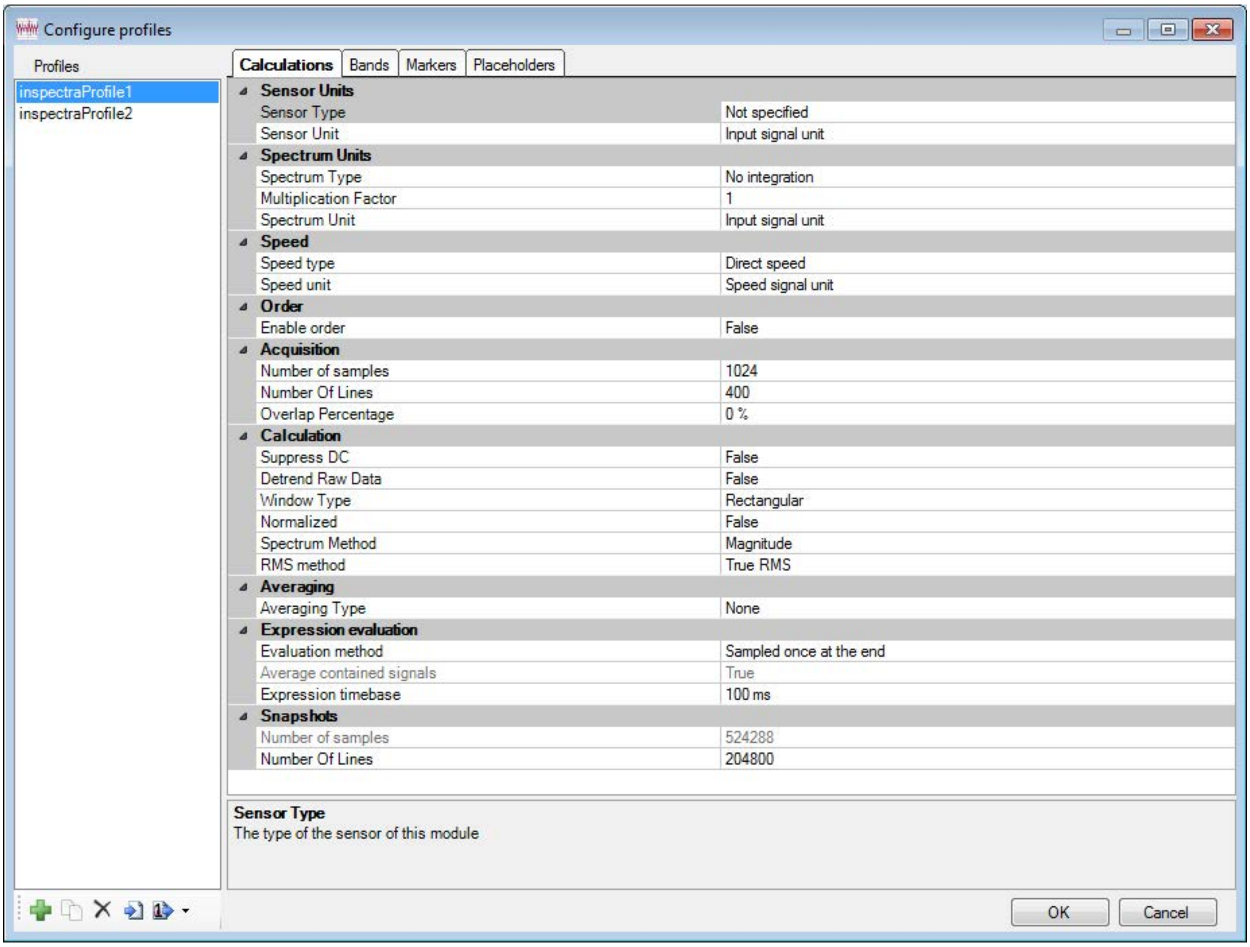


Fig. 71: Profile manager

All available profiles are listed on the left side of the profile manager. Profiles can also be re-named here.

Below this list, there are buttons with the following functions:

- Add new profile
- Clone current profile
- Delete current profile
- Import profiles
- Export selected profile

The settings of the profile selected in the list are made in the main area of the dialog.

7.1.2 Create and manage profiles in ibaAnalyzer

ibaAnalyzer-InSpectra can be used to configure profiles offline and test them on acquired data. First open an InSpectra Expert view with the <FFT> button in the toolbar, see chapter ➚ *Opening an FFT view in ibaAnalyzer*, page 30.

Existing profiles are managed in the profile manager. You can open the profile manager with the button to the right of the profile selection.

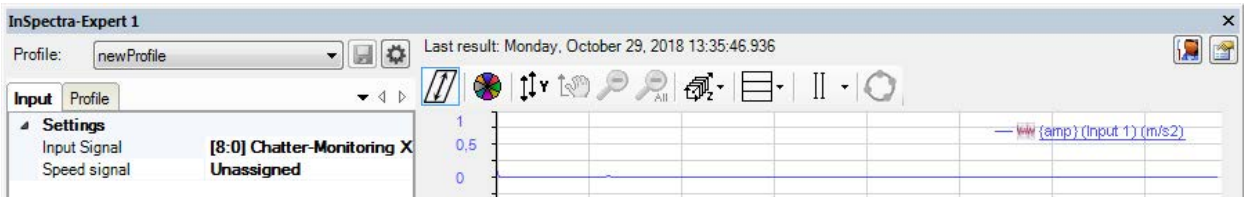


Fig. 72: Open profile manager

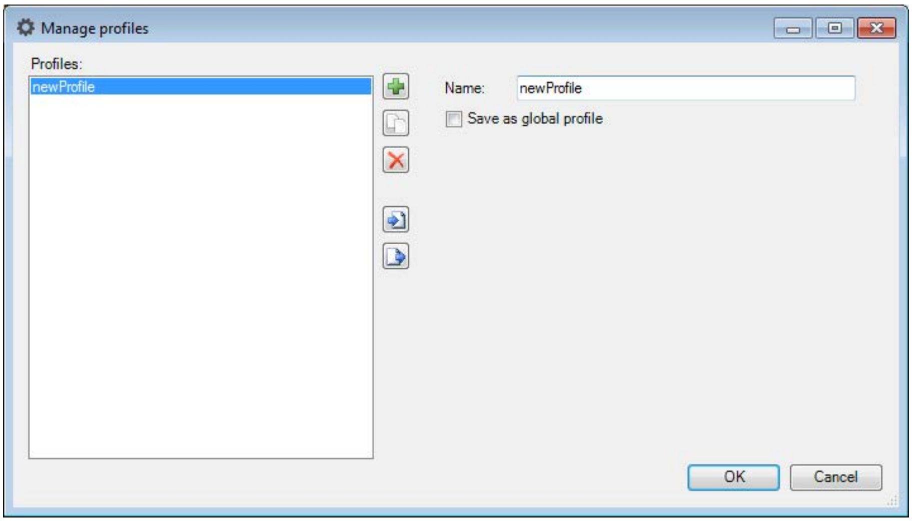


Fig. 73: Profile manager

All available profiles are listed on the left side of the profile manager. Next to the list, there are buttons with the following functions:

 Create new profile

 Clone selected profile

 Delete selected profile

 Import profiles

 Export selected profile

Save profile

On the right side in the field *Name,* the name of the currently selected profile can be changed and it can be determined how the profile should be stored.

InSpectra profiles are stored in *ibaAnalyzer* by default with the respective analysis. However, if the option “Save as global profile” is selected, the profiles are not stored in the analyses, but rather under a global location and are therefore always available on this system.

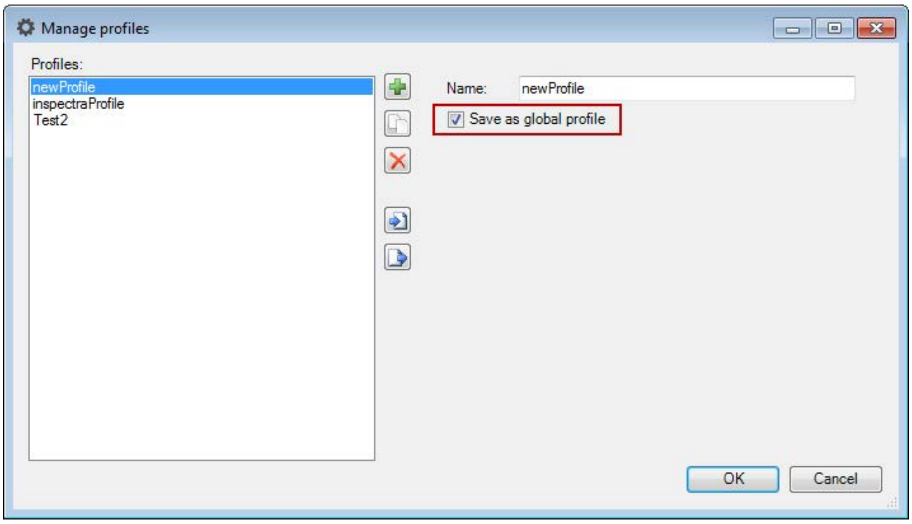


Fig. 74: Save profile globally

The storage location for global InSpectra profiles can be changed in the preferences in the *Miscellaneous* tab.

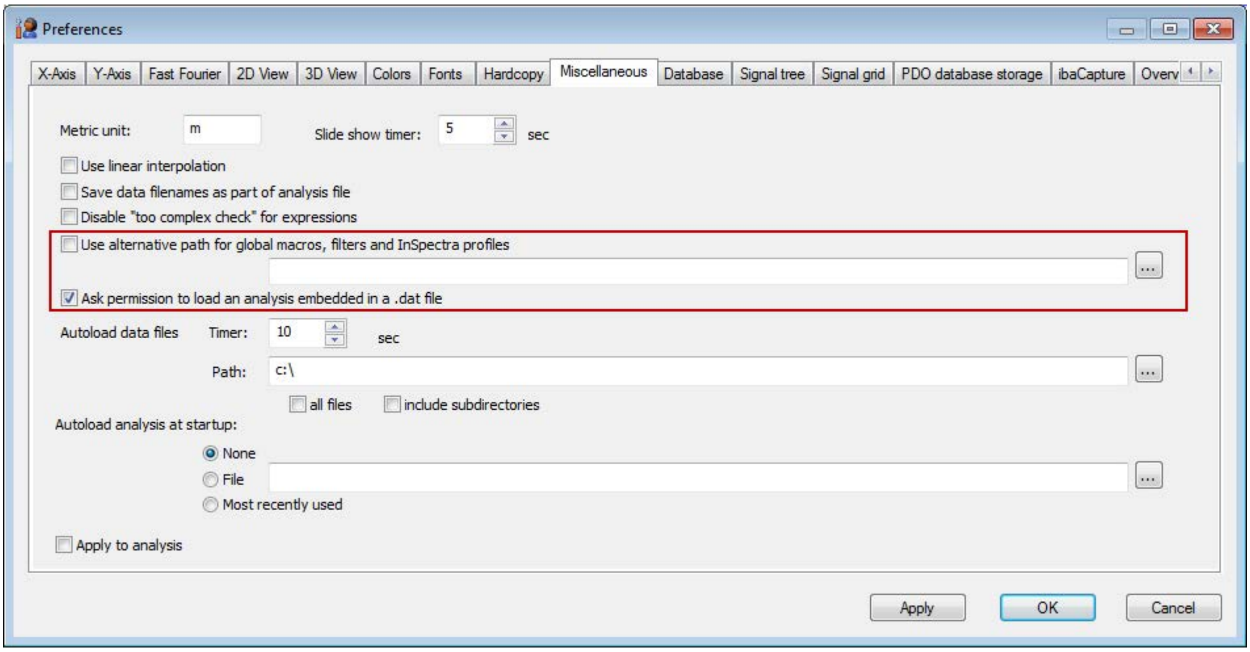


Fig. 75: Storage location for global profiles

Profile settings

You can set or change the settings of the profile selected in the list in the *Profile* tab. Changes in the profile can be saved with the button .

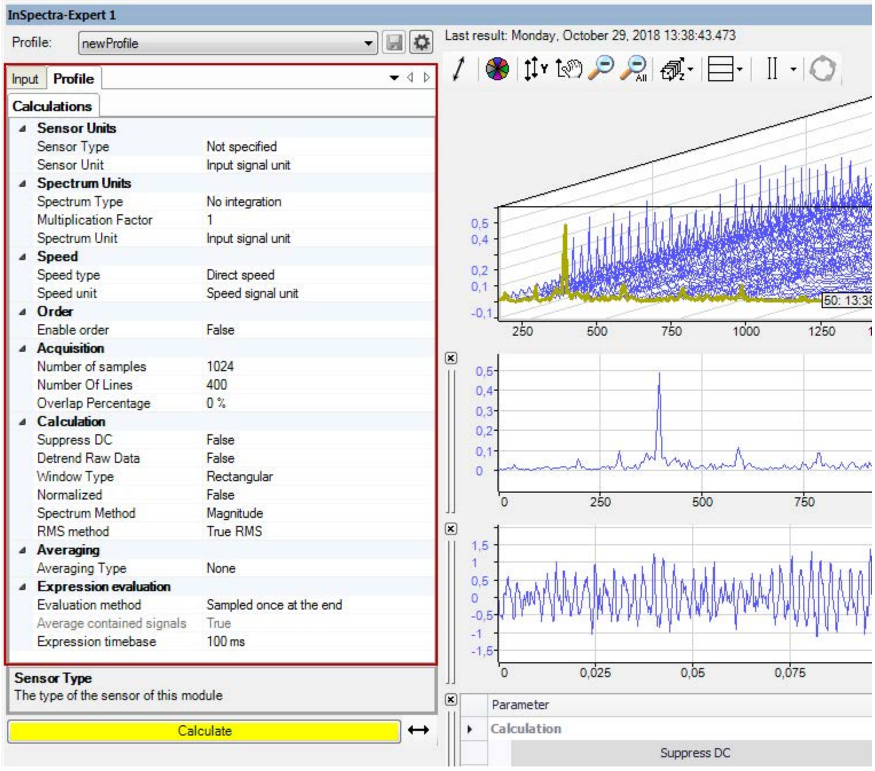


Fig. 76: Changing settings in the “Profile” tab

7.2 Setting calculation parameters

By entering the calculation parameters, you determine how the frequency spectra are to be calculated mathematically.

The settings are made in the configuration dialog for the profiles in the *Calculations* tab.

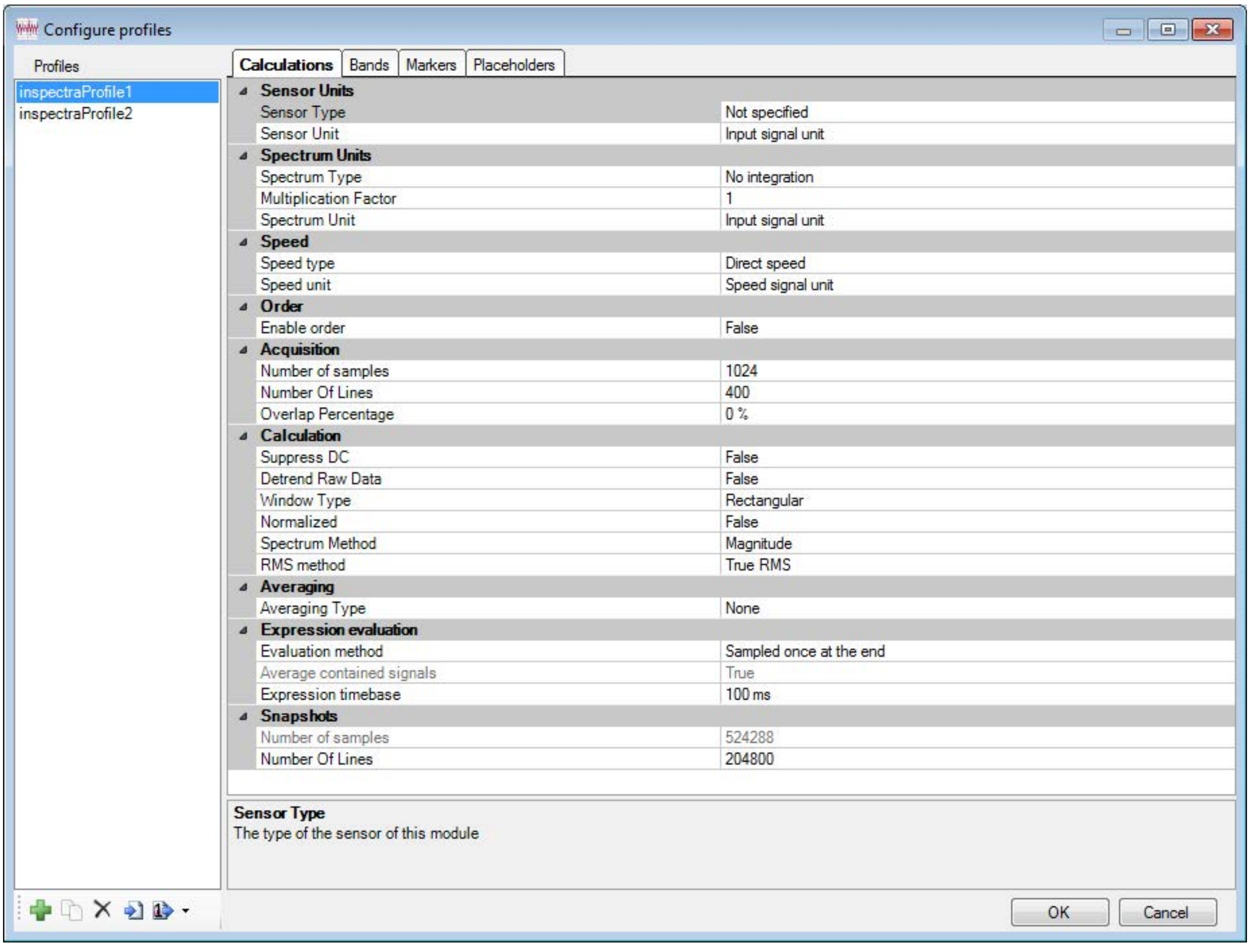


Fig. 77: Configuration dialog for profiles

The following explains the calculation parameters and their meanings.

7.2.1 Sensor

Type

Select the type of the sensor here on which the signal to be examined is based.

Selection	for sensor type...	Examples
Not specified	unknown or other signal	
Displacement	Amplitude sensor	Eddy current sensors
Velocity	Vibration speed sensor	Electrodynamic velocity sensor, Doppler laser
Acceleration	Acceleration sensor	Capacitive, piezoelectric or piezoresistive sensors; this group also contains IEPE sensors

Table 3: Sensor types

Unit

This practically complies with the unit of the input signal.

The selection of the sensor units is adjusted according to the selected sensor type. Select the suitable unit which can be found in the data sheet of the sensor.

If no sensor type is set, all units are provided.

If the suitable unit is not available or unknown, select "Input signal unit".

7.2.2 Spectrum

Type
The selection of the spectrum type is automatically preset in accordance with the setting of the sensor type. However, it can be modified.

If you choose different settings for sensor and spectrum, ibaInSpectra Expert automatically converts the frequency spectrum (via corresponding integration or differentiation in the frequency range).

If, for example, an acceleration sensor is used, but the spectrum type velocity is set, *ibaInSpectra* automatically performs a corresponding integration.

If you do not specify the sensor type, different differentiation and integration options are available for the type of spectrum.

Multiplication factor
With this factor, you can change the amplitude of the spectrum. This factor mainly serves to convert the unit of the input signal (sensor unit) to another unit in the spectrum. The multiplication factor is automatically adjusted, if you select another predefined setting for the spectrum unit than for the sensor unit. In other cases, you can also enter the factor manually.

For example, you can select in/s² for the spectrum of an acceleration sensor even if the sensor unit is mm/s².

Example

Sensor unit	Spectrum unit	Multiplication factor
mm/s²	in/s²	0.03937....
g	mm/s²	9806.65...
Input signal unit (mm/s²)	1000 mm/s² (= m/s²)	0.001

Table 4: Connection between sensor unit, spectrum unit and factor

Unit
The spectrum unit is automatically set to the value of the sensor unit. If you choose a different setting anyway, the multiplication factor is automatically adjusted (see above).

7.2.3 Speed

Speed type

Three speed types are supported:

- Direct speed: Actual speed of a rotating machine (Hz or rpm) or other machine (mm/s, m/s, etc.)
- Pulse counter: The speed is calculated based on the pulse counter.
- Pulse train: The speed is calculated based on the rising edges of the digital speed signal. (Warning: The time base of the pulse train signal should be compared with the pulse width.)

Speed unit

Unit of the speed signal. This can be a rotational speed unit or a unit for linear speed.

7.2.4 Order

Enable order

Enables the order sampling. This means that the input signal is resampled based on the speed.

Order mode

Only speed can be selected.

Samples per revolution/order resolution for the order analysis

Depending on the speed unit or order mode, you can either set here how many samples should be recorded per revolution or how big the distance between two sampling points should be based on the speed unit.

Note

The minimum speed for the pulse train and pulse counter is 0.1 Hz. At lower speeds, no data points are sampled for the order spectrum.

7.2.5 Acquisition

Number of lines and number of samples

The number of samples of an FFT calculation can be selected. Based on this, the possible "number of lines" of the spectrum are available for selection.

The following combinations are possible:

Number of samples	Number of lines (*2)	Number of lines (*2.56)
512	256	200
1024	512	400
2048	1024	800
4096	2048	1600
8192	4096	3200
16384	8192	6400
32768	16384	12800
65536	32768	25600
131072	65536	51200
262144	131072	102400
524288	262144	204800

Note

The relationship between lines and samples is as follows:

Number of lines = number of samples / 2

With the recording of 1024 samples, e. g., only 1024/2 = 512 frequencies per measurement can be computed.

However, the factor 2.56 is frequently used because amplitudes at frequencies near half the sampling frequency cannot be reliably acquired due to the sampling. In *ibaInSpectra,* the factor 2 or 2.56 can be selected.

A higher number of lines also increases the period for the calculation of the spectrum, as more values (samples) have to be acquired. This explains the waiting time until the first spectrum appears in the display.

The advantage of a longer recording period is the higher frequency resolution of the spectrum, i.e. the distances between the frequency values are smaller than with a small number of lines.

Note

This setting does not affect the maximum frequency which can be displayed in the spectrum! The maximum frequency of the spectrum solely results from the time base of the input signal.

Overlap Percentage

The overlap can be set between 0 % and 95 %. It indicates how many of the recorded values are used again for each calculation. In case of a 0 % overlap, all recorded values are used only once for a calculation. In case of an overlap of 50 %, only half of the values are overwritten by new values so that every value is used twice in a calculation. An overlap of 75 % results in every measured value being used in 4 successive calculations.

The greater the overlap, the more calculations are carried out in the same time, as with an increasing overlap, fewer (new) values have to be recorded which reduces the waiting time.

Example

An input signal is acquired with a time base of 1 ms. The number of lines is set to 800 (number of samples = 2048). For a 0% overlap, a new spectrum is thus calculated every 2048*0.001 s = 2.048 s. In case of an overlap of 75%, the update time is only 2048*0.001*(1 - 0.75)= 0.512 s. The only exception is the first calculation after starting the measurement. The first calculation always takes about 2 s, irrespective of the overlap set.

Note

The update time is less due to the overlap. Changes in the input signal, however, are only gradually effective in the spectrum.

The following figure illustrates the principle of overlapping at 0%, 50% and 75%:

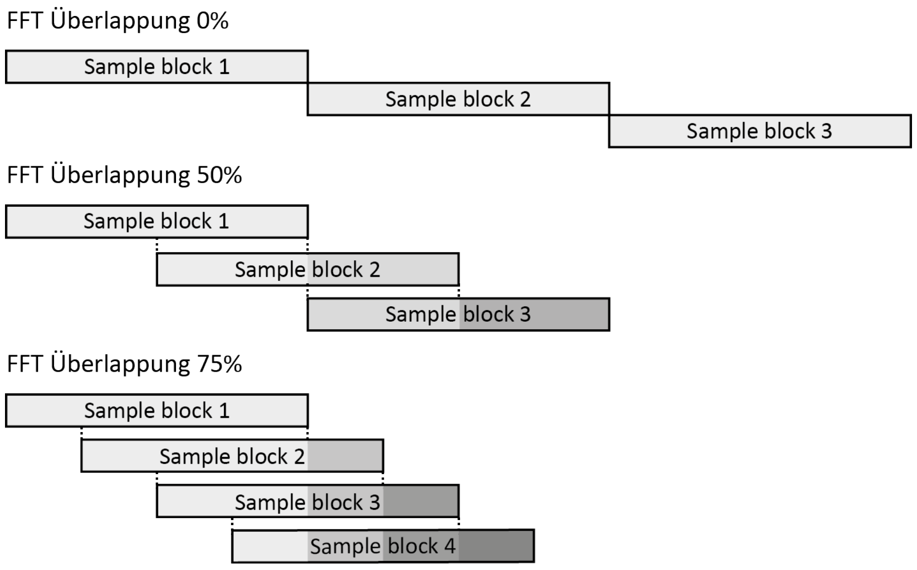


Fig. 78: Overlapping for FFT calculations

7.2.6 Calculation

Suppress DC
If you set this parameter to TRUE, the DC component is removed from input signal by subtraction of the average. This setting suppresses the so-called ski slope at the frequency of 0 Hz.

This results in a better presentation of the AC components which matters in the end.

Detrend Raw Data
If you set this parameter to TRUE, a slow drift of the measured values is suppressed (detrending).

This is achieved by removing the linear component from the input samples for the FFT calculation. With the method of least squares, a linear function (y=a*t+b) is determined matching the input data. This function is subtracted from the input samples before the FFT is computed.

If you want to make sure that the DC component = 0, you have to additionally activate the suppression of the DC component (see above)

Window Type
By selecting one of the window functions, the so-called leakage effect can be reduced when analyzing the frequency. Select the most suitable type of window for your application:

- Hamming
- Hanning
- Bartlett
- Blackman
- Blackman-Harris
- Rectangle
- Flat-top

Normalized
If you set this parameter to TRUE, the values of the FFT are normalized, i. e. the result values are independent of the scaling of the input values.

Spectrum Method
By selecting the spectrum method, you determine whether the amplitude spectrum (magnitude) or the power spectrum (power) is computed. The latter is calculated by squaring the amplitude spectrum. Therefore, the spectrum unit is displayed squared in the "Power" setting.

RMS Method
This setting determines how the RMS of a band is to be computed.

- Mathematical (default setting)
  Root mean square of all values of the spectrum within the band.
  Is seldom used in the machine analysis.
- True RMS
  The RMS value of the output signal of a bandpass filter defined by this band that filters the input signal.

This method is preferably suitable for wide frequency bands, i. e. with a great distance between lower and upper cutoff frequency.

- Dominant RMS
  RMS value of the sine component, corresponding to the peak of the band
  This simple evaluation method is usually applied in the practical machine analysis.

7.2.7 Averaging

Averaging type and number of averages
If the averaging is activated, the results of several frequency analyses are combined to an averaged spectrum. By setting the number of averages, you can determine how many spectra are included in the averaging.

For calculating averages, you may choose between different methods:

Method	Description
None	No averaging is carried out. InSpectra Expert always shows the results of each calculation.
Linear	Averaging *n* spectra at time T is done from the calculations at times T, T-δ, T-2δ,.., T-(*n-1*)δ. *n* = number of averages (spectra) δ = (time base)*(number of samples)*(1-overlap/100) $$X = \frac{1}{N}\left(\sum_{i=1}^{N} x_i\right)$$ *N* = number of the FFTs for the average calculation *i* = Index of the FFT; i = 1 oldest, i = N latest FFT *xi* = amplitudes or power value of a frequency line in the i'th FFT
Exponential	The exponential method of the averaging represents a weighted average calculation in which the most recent FFT results are weighted higher than older ones. $$X = \frac{1}{N}\left(\sum_{i=1}^{N}\left(\frac{N-1}{N}\right)^{N-i} x_i\right)$$ *N* = number of the FFTs for the average calculation *i* = Index of the FFT; i = 1 oldest, i = N latest FFT *xi* = amplitudes or power value of a frequency line in the i'th FFT
Peak hold	The highest available value is used for each frequency.

Table 5: Methods of the average calculation

7.2.8 Expression evaluation

Evaluation method
The evaluation method determines how the center and delta expressions of a band are calculated.

- Average: The expression is averaged over the time stamps of the input (the precision depends on the setting of the time base of the expression)
- Sampled once at the end: The expression is acquired once at the end of the input for the spectra calculation. This option requires the fewest resources.

Average contained signals

- True: all contained signals are individually averaged
- False: The complete expression is averaged

Expression timebase
The timebase that is used for the expressions in the bands and events of a profile.

7.2.9 Snapshots

The setting for *Snapshots* is only available in *ibaPDA*.

Number of samples and number of lines
The "Number of lines" setting defines the number of the frequency values in the snapshot. The number of lines is directly related to the number of samples. With the number of lines, the number of samples is automatically set which cannot be changed manually.

7.3 Configuring frequency bands and characteristic values

In the *Bands* tab in the configuration dialog for the profile, configure the settings for the frequency bands to be monitored.

You determine in the table which bands you want to monitor, at which frequency the band should be and how wide the band is. Moreover, you can also configure the alert and alarm limits.

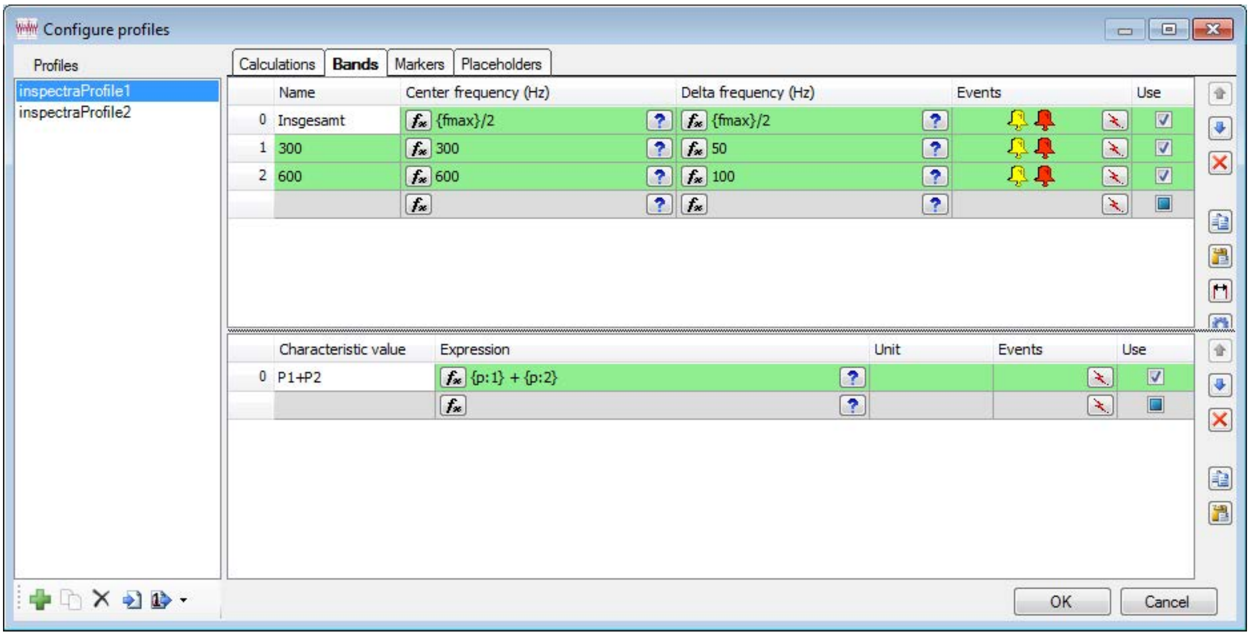


Fig. 79: Configuration dialog for profiles, bands tab

For every band, 3 analog values are created which are visible in the *Analog* tab of the module later on:

- Peak
  The peak value in the spectrum within the band.
- Peak frequency
  The frequency where the peak value occurred
- RMS
  Average according to the set method for averaging
  (see chapter ➚ *Calculation*, page 92, Item “RMS method”)

The settings and their meanings:

Name
Enter a descriptive name in this column to be able to identify the band later on.

Center frequency
The center frequency is the frequency value in the middle of the band. The center frequency can be a constant value or specified by another analog signal.

If you want to use an analog signal for controlling the center frequency, click the <fx> button in the table cell. The expression builder opens and you can select either an existing signal or enter an expression for calculating the center frequency.

Delta frequency
The setting of the delta frequency determines the distance of the lower and upper frequency limit of the band to the center frequency and therefore defines the width of the frequency band (width = 2*delta frequency). This value can also be either a fixed number or an analog signal and expression, respectively.

Events
This column shows whether events of type alert ( ) and/or alarm ( ) were configured for this band.

For every band, up to 2 alerts and 2 alarms can be configured. These events relate to the peak value (peak) and the average of the band calculated according to the set RMS method. See chapter ↗ *Configuration of the events*, page 98

If the events were enabled, there is a digital or analog signal in the module for every event and *ibaInSpectra* monitors the corresponding values during measurement operation.

To the right of the table there are buttons with the following functions:

	Moves the selected rows up or down
	Deletes the selected rows
	Copies the content of the list in the clipboard and can be inserted in e.g. MS Excel
	Inserts a list separated by tabs at the selected row
	Opens the band generation wizard, see chapter ↗ *Band generation wizard*, page 100
	Opens the dialog for determining the maximum number of bands

Maximum bands
The maximum number of bands is limited by the signal numbering of the characteristic values. By default, the maximum number of bands is specified as 77.

If more than 77 bands are needed, the maximum number of bands must be increased in this dialog. The technical upper limit is 512 bands.

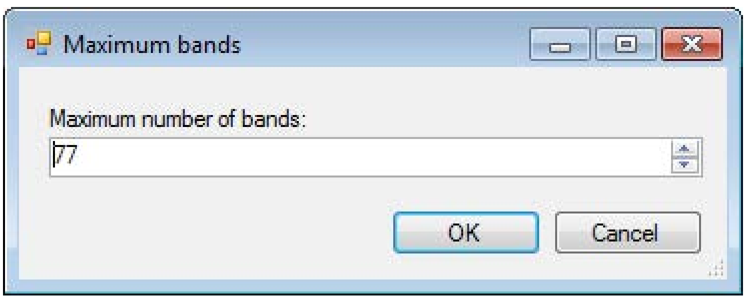


Fig. 80: Set the maximum number of bands

Note

If this value is changed, the signal numbers of the characteristic values change. These are not automatically mapped if they are used in other modules.

Calculation of characteristic values

Characteristic values can be calculated from placeholders and results of the frequency band analysis. For example, results of various bands can be calculated with each other. All defined characteristic values can be recorded as analog signals.

Click on the <fx> button in the table cell and open the expression builder.

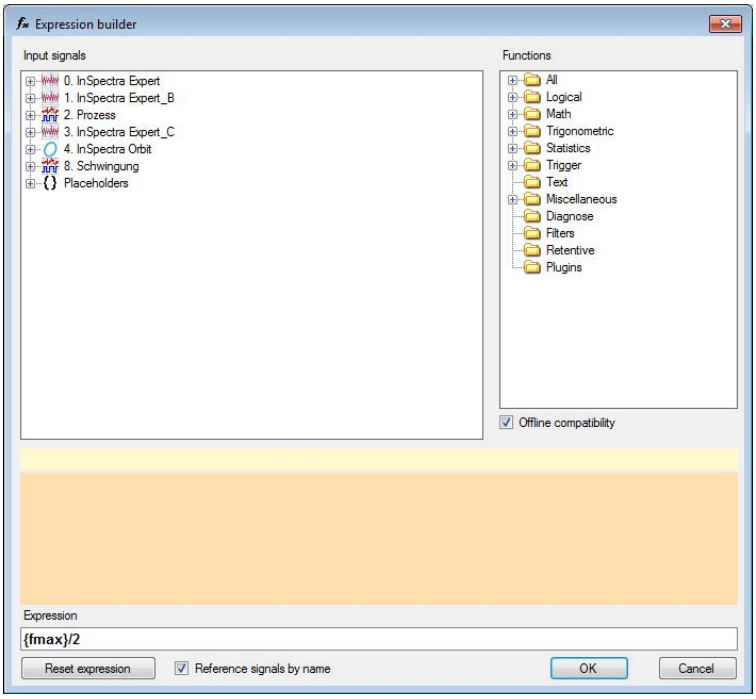


Fig. 81: Expression builder for calculating characteristic values

For each defined band, characteristic values and results are available as placeholders, which can be linked to each other with any features. User-defined placeholders also appear in the list and can be used.

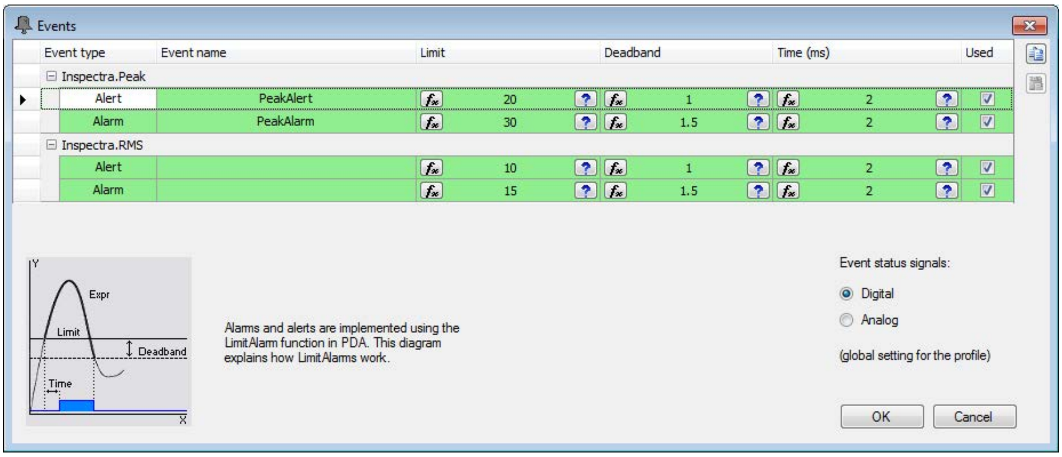
For expressions in profiles in *ibaPDA* it is possible to limit the available functions to the same selection as in ibaAnalyzer-InSpectra with the option *Offline compatibility*. This ensures that these expressions in the profiles can be used offline without any problems. See also chapter ↗ *Online-offline compatibility of expressions*, page 171.

The unit of the characteristic values can be configured manually, it is not determined automatically on the basis of the input values of the calculation.

7.3.1 Configuration of the events

To configure the events for a frequency band, proceed as follows:

1. Click in the "Events" column on the button . The "Events" dialog opens.

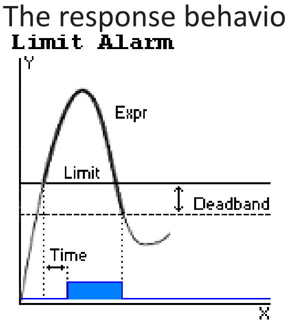


2. Enter a name in the "Event name" column to be able to unambiguously identify the event later on.

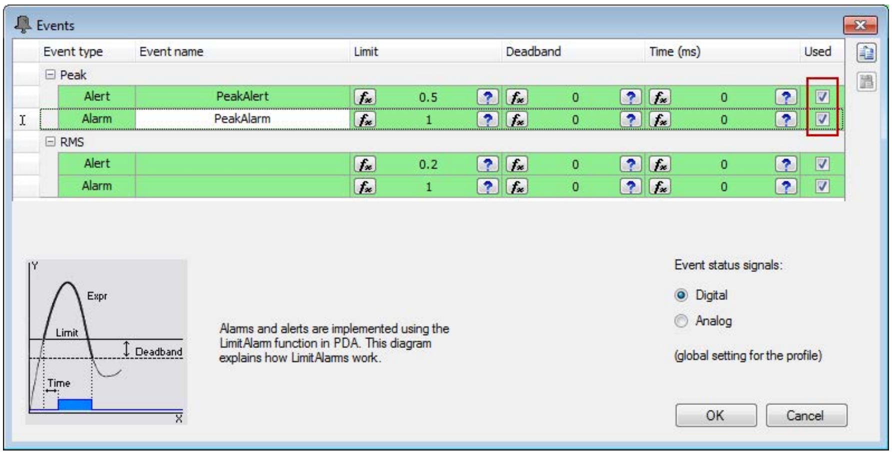
3. Configure the settings for limit value, deadband and delay time. You can enter fixed numerical values, select analog signals or define expressions for these values.
   - The limit value defines the response limit for the event.
   - With the help of the deadband, you prevent an event from being reset too fast. The event is reset only after the measuring value comes below the mark (limit value – deadband).
   - With the delay time, you can delay the triggering of the event. The event is triggered only after the measuring value exceeds the limit value for a longer period than the time set.

Note

The response behavior for the events conforms to the "LimitAlarm" function.



4. Please make sure that the check boxes are enabled in the "Used" column.



5. You can select whether digital or analog event status signals are used.

- *Digital*: When exceeding the entered limit value, the corresponding digital signal is set to TRUE (logical 1) and can be used for signaling.
- *Analog*: The analog signal can have several values and, for example, can be used to control a traffic light display in *ibaQPanel*.

  0 undefined

  1 OK

  2 Warning

  3 Alarm

6. Exit the dialog with <OK>.

After you have configured all settings, close the "Configure profile" dialog by clicking <OK>. As described in the chapter ➚ *“General” tab*, page 108, you can now assign the profile to the module. Then exit the I/O manager for the new configuration to be applied.

With this, the configuration of the profile is completed and you can now make further settings on the InSpectra module or go to the display.

7.3.2 Band generation wizard

Harmonics to a “base band” can automatically be generated with the band generation wizard.

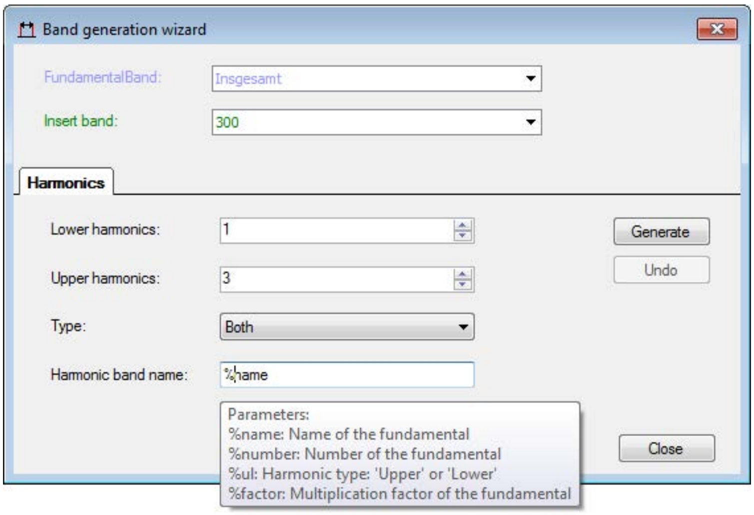


Fig. 82: Band generation wizard

In the *FundamentalBand* drop-down menu, select the band for which harmonics are to be generated. Enter the desired number of harmonics below and above the base band. The bandwidth of the harmonics is the same as that of the base band.

In the *Insert band* field, select the band in the table before which the harmonics are to be inserted.

You can allocate dynamic names to the bands of the harmonics using parameters. Click in the *Harmonic band name* field and the list of available parameters will be displayed. Enter the desired parameters in the field.

Click on <Generate> to insert the harmonic bands in the table and you can check the entries. <Undo> removes the harmonics from the table again. <Exit> closes the band generation wizard.

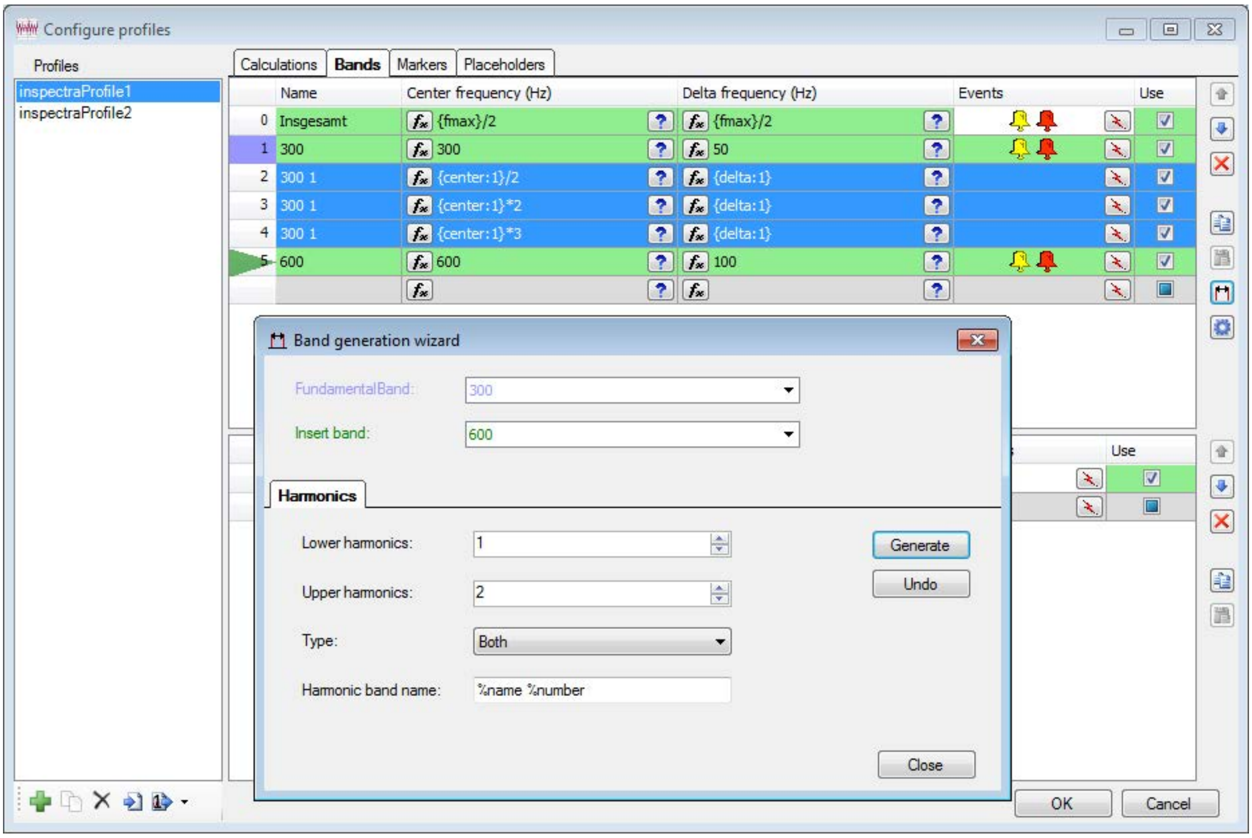


Fig. 83: Example of the generation of harmonic bands

7.4 Markers

You can configure markers for a calculation profile here. The markers configured here appear in the table *InSpectra markers* in the properties of the FFT view in the node *Markers*, in the tab *Configured markers,* see chapter ➚ *Bands*, page 68

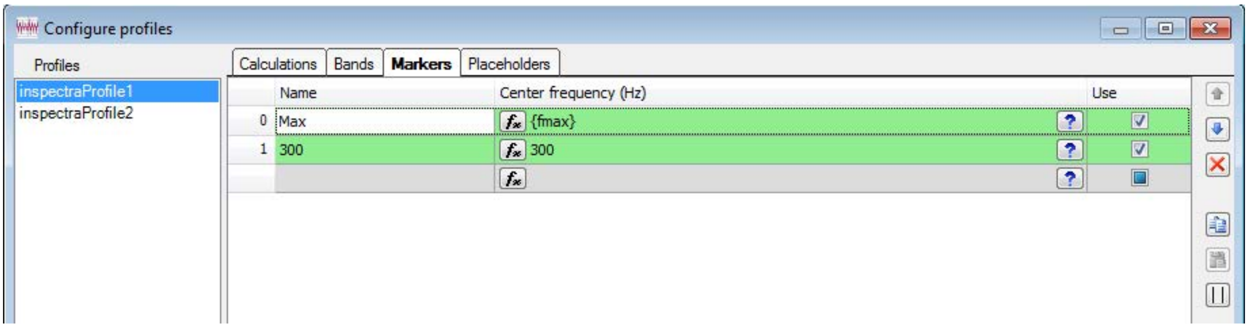


Fig. 84: Configure a marker in the profile

To create a marker, enter a name to be able to identify the marker. The center frequency can be a constant value or be specified by a signal. If you want to use a signal for controlling the center frequency, click the <fx> button in the table cell. The expression builder opens and you can select either an existing signal or enter an expression for calculating the center frequency.

To the right of the table there are buttons with the following functions:

	Moves the selected rows up or down
	Deletes the selected rows
	Copies all rows in the clipboard, can be inserted in e.g. MS Excel
	Pastes a list separated by tabs from the selected column on
	Opens the marker wizard

Marker wizard

You can use the marker generation wizard to determine harmonic markers above and below the center frequency.

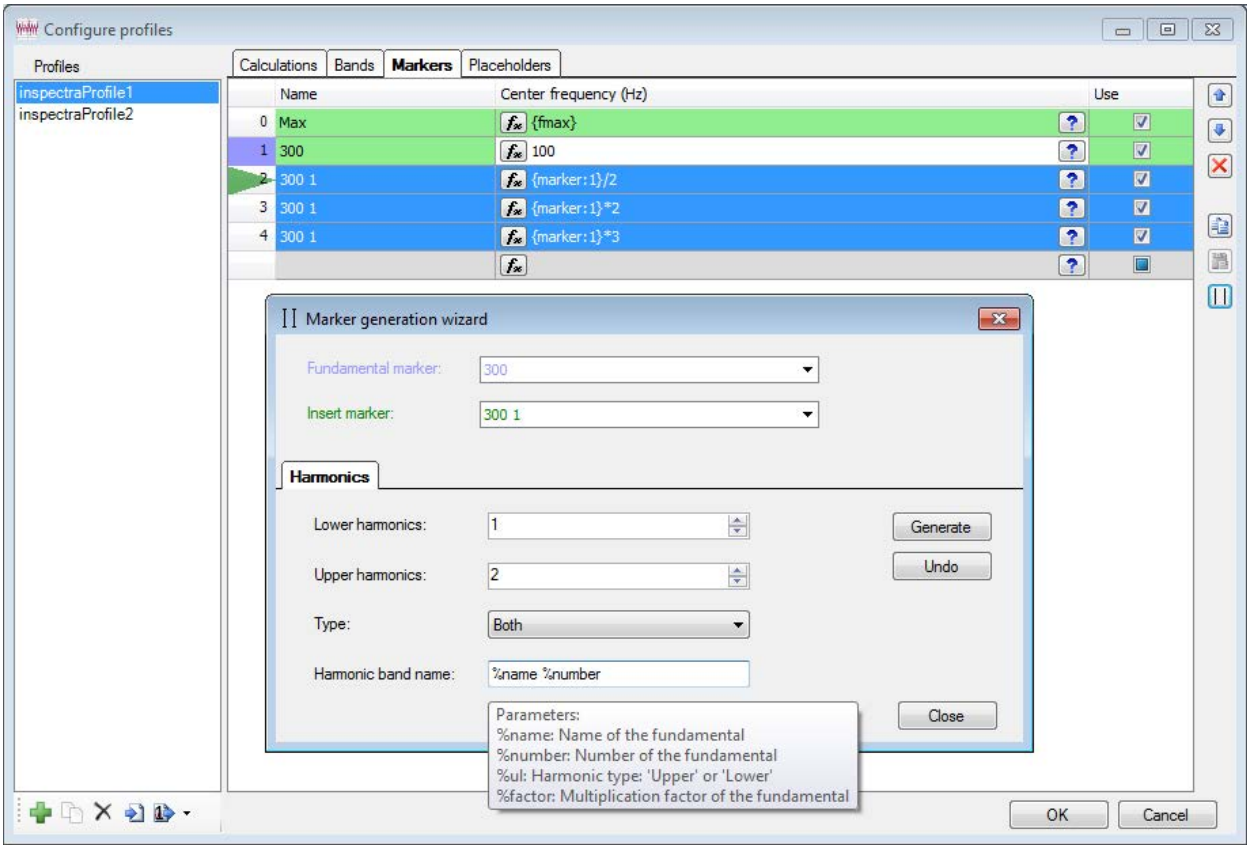


Fig. 85: Example of the generation of harmonic markers

In the *Fundamental marker* drop-down menu, select the markers for which harmonics are to be generated. Enter the desired number of harmonics below and above the fundamental marker.

In the *Insert Marker* field, select the marker in the table before which the harmonics are to be inserted.

You can allocate dynamic names to the markers of the harmonics using parameters. Click in the *Harmonic marker name* field and the list of available parameters will be displayed. Enter the desired parameters in the field.

Click on <Generate> to insert the harmonic marker in the table and you can check the inputs. <Undo> removes the harmonic markers from the table again. <Exit> closes the marker wizard.

7.5 Placeholder

Placeholders can be used to reuse profiles for similar monitoring tasks. For example, a placeholder can be used for the diameter when monitoring different rolls.

Placeholders are defined in the profile, in the *Placeholder* tab. The value is allocated in the InSpectra Expert module, in the *General* tab.

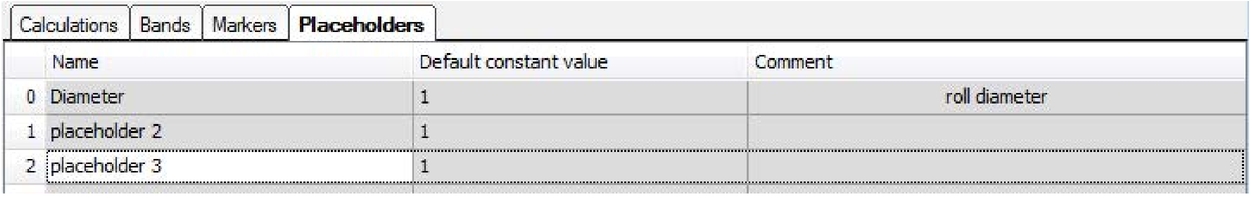


Fig. 86: Definition of placeholders

In the *Name* column, enter a name for the placeholder. In addition, you can enter a default constant value and a comment.

All defined placeholders appear in the InSpectra Expert module in the *General* tab under *Profile*. You can allocate a constant value there or select a signal, which controls the value. Also see chapter ↗ *"General" tab*, page 108

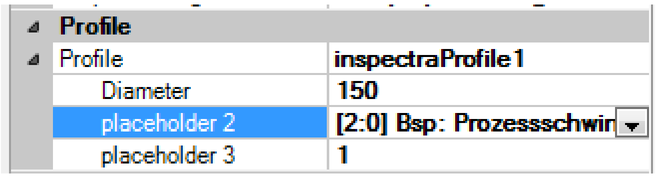


Fig. 87: Placeholder in the InSpectra Expert module

In addition, the defined placeholders can be used in the expression builder for additional calculations.

7.6 Calculation results of the Expert module

The InSpectra Expert module calculates a number of characteristic values based on the configured settings.

7.6.1 Results in ibaPDA

The results of the calculations are available in *ibaPDA* as analog signals of the respective InSpectra Expert module in the *Analog* tab. See chapter ↗ *"Analog" tab*, page 115

7.6.2 Results in ibaAnalyzer

The results of the calculations are shown in *ibaAnalyzer-InSpectra* in the results area at the bottom of the FFT view and are available as signals in the signal tree. The view of the characteristic values in the result table and in the signal tree can be configured individually.

All calculated characteristic values and output signals of the respective modules are available as results. The signals are grouped according to inputs, bands, characteristic values and digital signals. The sequence of the signals corresponds to the sequence in the analog and digital signal tables in the InSpectra Expert module in *ibaPDA*.

The results always relate to the current cursor position of the playback area. The calculation is shown, which was last calculated before this time.

	Name	Value	Unit
	⊟ Group: Inputs		
0	Speed	Invalid	
8	Minimum	-0,873375	
9	Maximum	1,09053	
10	Average	0,065246	
11	RMS	0,301035	
12	Crest	3,6226	
	⊟ Group: Bands		
16	Overall (RMS)	0,297417	
17	Overall (Peak)	0,077435	
18	Overall (Peak frequency)	99,6094	Hz
	⊟ Group: Characteristic values		
401	val1	0	

Fig. 88: Example result area FFT view

The context menu (right mouse click) opens a dialog where you can select which values are to be displayed in the result area and which results are to be available as signals in the signal tree.

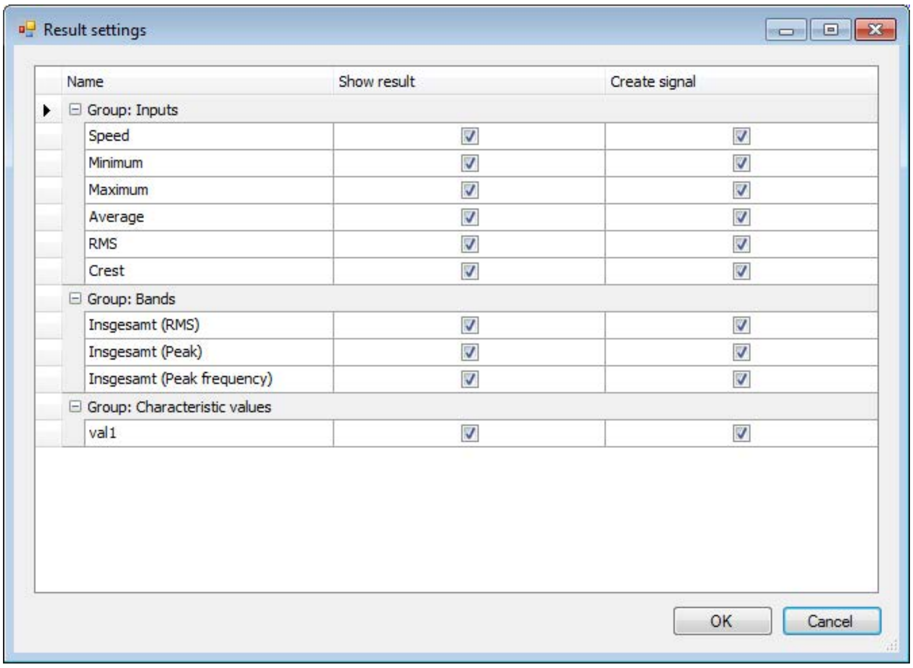


Fig. 89: Result settings dialog

Results as signals

The analog and digital outputs of ibaInSpectra such as results of calculations, band results, chracteristic values and events are available as signals in the signal tree.

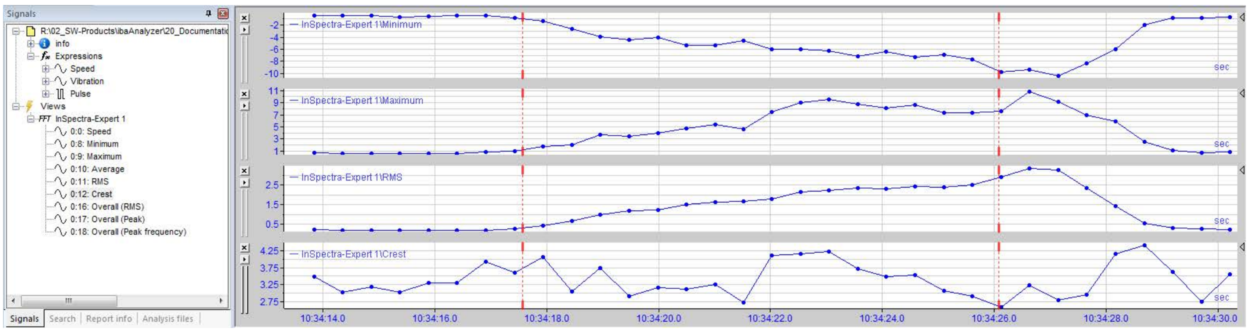


Fig. 90: Results as signals in the signal tree

The time base of these signals is based on the calculations in the InSpectra views. Note that for InSpectra Expert views with order resampling and also Orbit views, the resulting time base is speed dependent.

The results are grouped per view in the signal tree. The name of the view can be changed via right-click on the title bar. The names for bands and characteristic values can be changed in the calculation profiles. The signal names cannot be changed.

When extracting the results of a dat file, the extracted expressions are also grouped per view.

The following signals can appear in the signal tree:

If a speed signal has been defined in *ibaPDA*, the signal *Speed* appears in the signal tree. This is the value of the speed signal, which was used during the FFT calculation.

In addition, 5 further signals are automatically generated:

- Minimum
  Minimum of the input signal
- Maximum
  Maximun of the input signal
- Average
  Arithmetic average of the input signal
- RMS
  Square mean value of the input signal
- Crest
  Crest factor (ratio of maximum to RMS) of the input signal

If the event status signals (alarm and alert) are analog, see chapter ➚ *Configuration of the events*, page 98 there is the signal *Overall module event.*

Furthermore, the calculation results "peak," "peak frequency" and "RMS" are created for every frequency band defined in the selected profile.

After the bands, the defined characteristic values are available in the table for display and recording.

For the respective bands and characteristic values, there are also two analog alarm values *Peak event* and *RMS event* if the event status signals are defined as analog signals.

7.7 Creating an InSpectra Expert module in ibaPDA

1. Open the I/O manager in *ibaPDA*.
2. Proceed as described in chapter ➚ *Create and manage profiles in ibaPDA*, page 81 in steps 2 and 3. If a suitable profile already exists, you do not need to create a new profile.
3. Now configure the general settings for the module in the *General* tab.

7.7.1 “General” tab

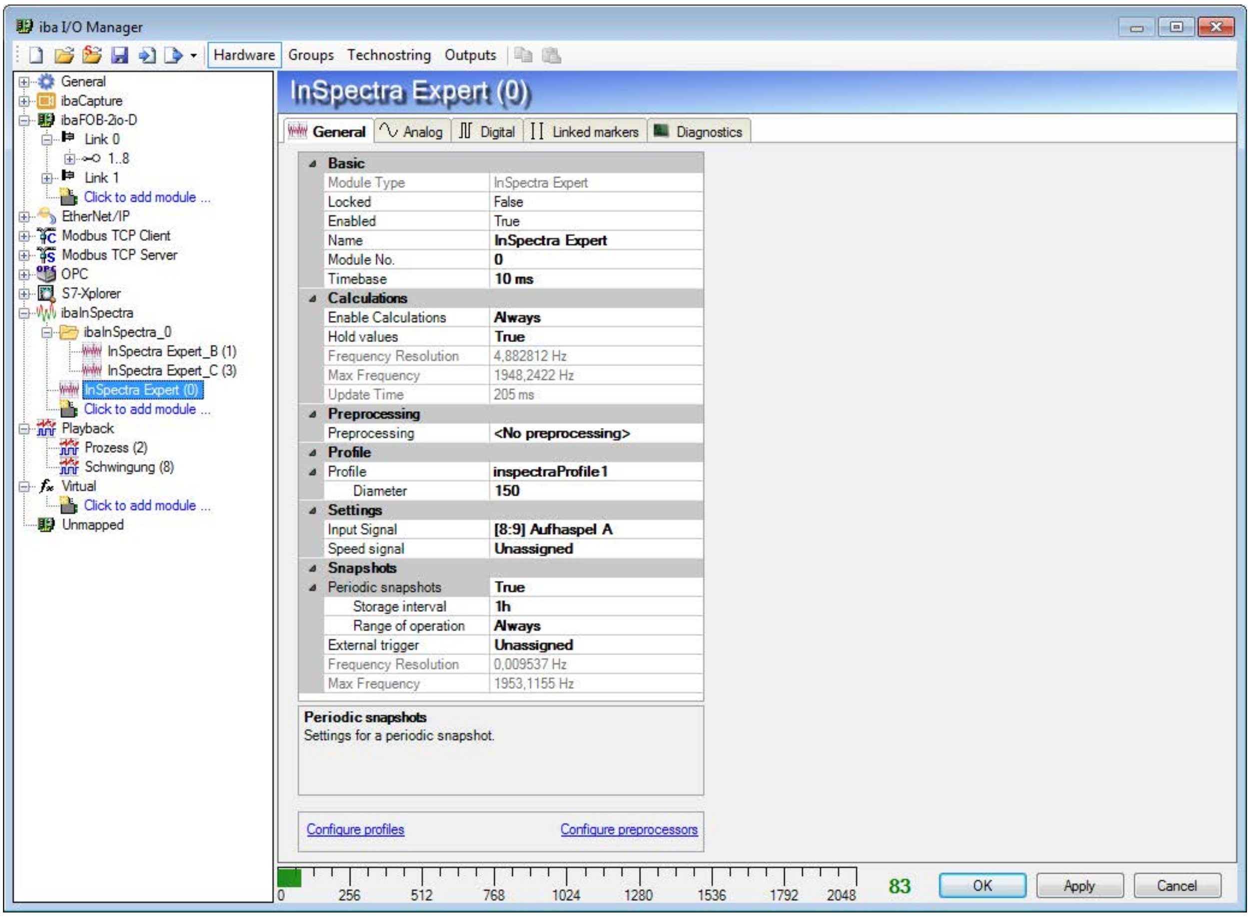


Fig. 91: General settings of an InSpectra expert module

Basic settings

Module Type

Indicates the type of the current module.

Locked

A module can be locked in order to prevent change of module settings by accident or unauthorized users. The lock function is linked to the user management in *ibaPDA*. A module can be locked (true) or unlocked (false) only by users who have the required right, provided the user management is activated.

- FALSE: Any user can change the module settings.
- TRUE: No change of module settings possible. Module must first be unlocked by authorized users in order to change the settings.

Enabled
By selecting the options in the dropdown list in the field on the right side of "*Enabled,*" you determine whether the module is enabled (TRUE) or disabled (FALSE). If a module is disabled, its signals are excluded from acquisition. This means they are neither available for display nor for recording. Furthermore, the number of signals of a disabled module will not be taken into account in the signal statistics (signal-o-meter).

Name
Enter a comprehensive name for the module here.

It is recommended to use an application-specific naming rule for a better clearness and comprehension, particularly with vast numbers of modules. The name may refer to a technological purpose or a special location in the plant where the module is used or installed. The number of characters in the name is unlimited. The name of the module is stored in the dat file and visible in *ibaAnalyzer*.

Module No.
If you add modules to the configuration, the system automatically assigns the numbers in chronological order. However, you can select another order for subsequent analysis in the data file by changing the number. Feel free to change the module number according to your needs. It must be ensured that the number is unambiguous. The order of the modules in the signal tree of *ibaAnalyzer* is determined by their numbers.

Time base
As *time base*, you may enter a value here, given in ms, which is an integer multiple of the general time base as configured in the "*General*" branch of the I/O manager. The time base of the module determines the update time of the output signals of the module. It should be smaller than the interval between two calculations (see update time display below). Usually, 100 ms is enough.

The ratio between maximum and minimum time base is limited to the value 1000. The value of the time base is limited upwards to 1000 ms.

Calculations

Enable calculations
With this setting, you can control whether the calculations are always performed or controlled by a signal. Click on the drop-down arrow in this field and select one of the following options from a reduced signal tree:

- Always
  With this setting, the frequency band calculation is permanently being executed. Please note that the system load can be quite high due to a permanent computation depending on the type and number of signals and the profile settings.
- Signal tree
  As an alternative, all other (digital) signals, incl. the virtual signals, can be selected to activate the calculation (selected signal = TRUE) or to disable it (selected signal = FALSE). This allows you to link the calculation of the *ibaInSpectra* module to particular process states or e. g. to an ibaQPanel input.

Hold values
If you set this option to "TRUE," the values of the most recent computation remain visible in the online display of the InSpectra Expert module, even if the calculation is deactivated by means of a control signal.
If you set this option to "FALSE," the display is cleared and the computed values are set to 0 if the computation is disabled by means of a control signal.

Frequency resolution, max. frequency and update time (only display)
These values result from the calculation parameters set and are only displayed.

Preprocessing

Preprocessing can be used to filter the vibration signal or to carry out mathematical pre-calculations. In the process, an envelope calculation with freely configurable bandpass filter as a signal preprocessing profile is available too.

Here, you can select a calculation profile for preprocessing. You can define a profile if no calculation profile is available. To do this, select <Configure preprocessors> from the dropdown menu or click on the blue link under *Configure preprocessors*.

The explanations for this can be found in chapter ➚ *Preprocessing of signals*, page 111

Profile

Select the requested profile from the drop-down list for analyzing the selected signal. If no profile is available or a suitable profile is missing, you have to define a profile first. Please read the explanations in chapter for this purpose ➚ *Setting calculation parameters*, page 87

If no profile is selected or available, an error message will be output when checking the I/O configuration:

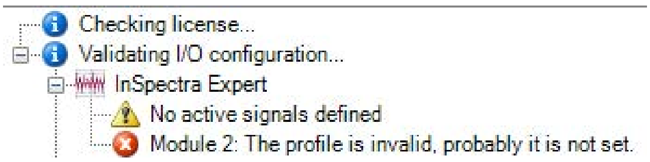


Fig. 92: Error message when profile is missing

The example shown above defines 3 vibration signals in the I/O manager with an InSpectra Expert module being created for each of these signals.

A profile (InSpectra profile 1) was already prepared for the I/O configuration to be accepted.

If a placeholder was defined in the profile, a signal can be selected here for the placeholder or a fixed value can be entered.

Settings

Input signal
Select the input signal whose frequency bands are to be analyzed. All signals configured in *ibaPDA* are available in the signal tree.

If no input signal is selected or available, an error message is output when validating the I/O configuration:

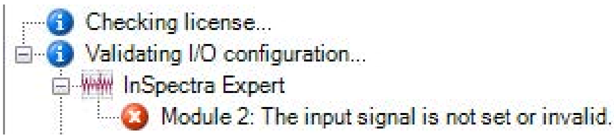


Fig. 93: Error message when input signal is missing

Speed signal
This speed signal is used to calculate an order spectrum. This signal is optional if no order calculation is configured.

The speed signal is saved in snapshot files.

Snapshots

Periodic snapshots
You can determine here whether snapshots are created periodically. The storage interval is used to determine the time interval between the buffer start of two consecutive snapshots. The "range of operation signal" is a digital signal that determines whether the periodic snapshot is taken immediately or whether the snapshot will be delayed. The periodic snapshot is taken as soon as the range of operation signal for the entire buffer time for the snapshot is TRUE.

External trigger
A snapshot can also be triggered with the rising edge of a digital signal.

Frequency resolution, max. frequency
These values result from the snapshot spectrum and are only displayed

7.7.1.1 Preprocessing of signals

Calculation profiles for preprocessing the signals are created, changed and imported in the *Configuring preprocessors* dialog.

All available preprocessors are listed on the left side. Preprocessors can also be renamed here.

Below this list, there are buttons with the following functions:

Add preprocessor

Duplicate preprocessor

Delete preprocessor

Import *ibaAnalyzer* filter (in *ibaAnalyzer* filters can conveniently be created, saved and imported here with the filter editor)

The settings of the preprocessor selected in the list are made in the main area of the dialog. Several preprocessing methods are available:

- Envelope curve: created by linking the high/low peaks of the signal curve

- Low pass: allows lower frequency to pass and eliminates high frequencies
- High pass: eliminates the lower frequency components and allows the high frequency components to pass
- Bandpass: allows frequencies within the frequency range set to pass and eliminates the lower and higher frequencies
- Bandstop: eliminates the frequency components within the specified frequency range and allows lower and higher frequencies to pass

First select the preprocessing method and the configuration mode. Depending on the selection, additional parameters must be specified. The configuration mode is only relevant for filters:

- Simple: Filter frequencies can be configured. All other parameters are automatically set.
- Advanced: Filter type, approximation method, stop and pass frequencies as well as amplifications can be configured.

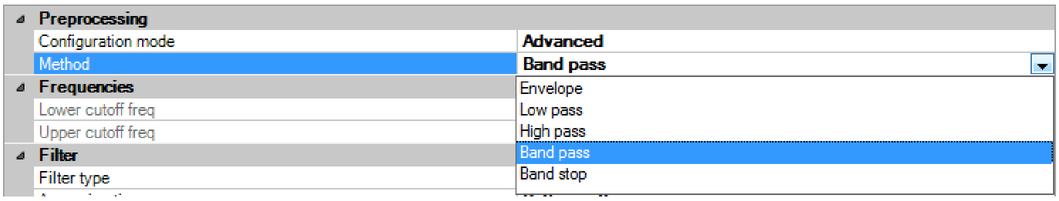


Fig. 94: Selecting the preprocessing method

The following explains the settings using the example of a bandpass and envelope curve. The settings for other filters are similar. You will find a detailed description of the filter settings in the *ibaAnalyzer* manual, chapter 'Filter editor.'

Bandpass

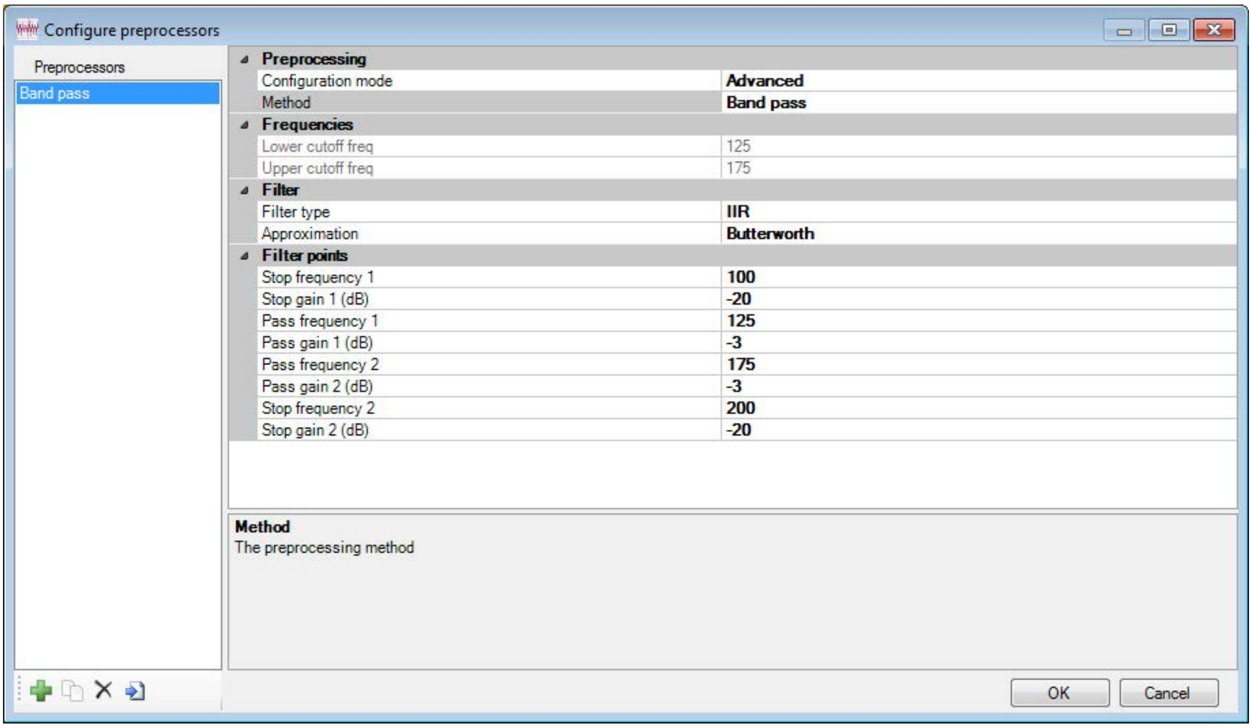


Fig. 95: Settings for the bandpass filter

Frequencies

Indicates the upper and lower cutoff frequency of the bandpass filter. The values displayed comply with the pass frequency 1 and 2 defined under filter points.

Filters

The following filter types are available:

- IIR (Infinite Impulse Response): Filters with an infinite impulse response are often preferred in practical situations, because they calculate faster and require less memory.
- FIR (Finite Impulse Response): Filters with a finite impulse response offer good control of the phase and amplitude form.

If the filter type *IIR* is selected, filter approximations are available, which vary in their evaluation methods.

- Butterworth
- Chebyshev
- Elliptic
- Inv-Chebyshev

The characteristic to be selected depends on the particular application case.

If the filter type FIR is selected, different window types are available:

- Rectangle
- Bartlett

- Blackman
- Hamming
- Hanning
- Kaiser
- Blackman-Harris
- Flat-top

Filter points
Define the frequencies and amplifications characteristic for the filter here.

Envelope curve

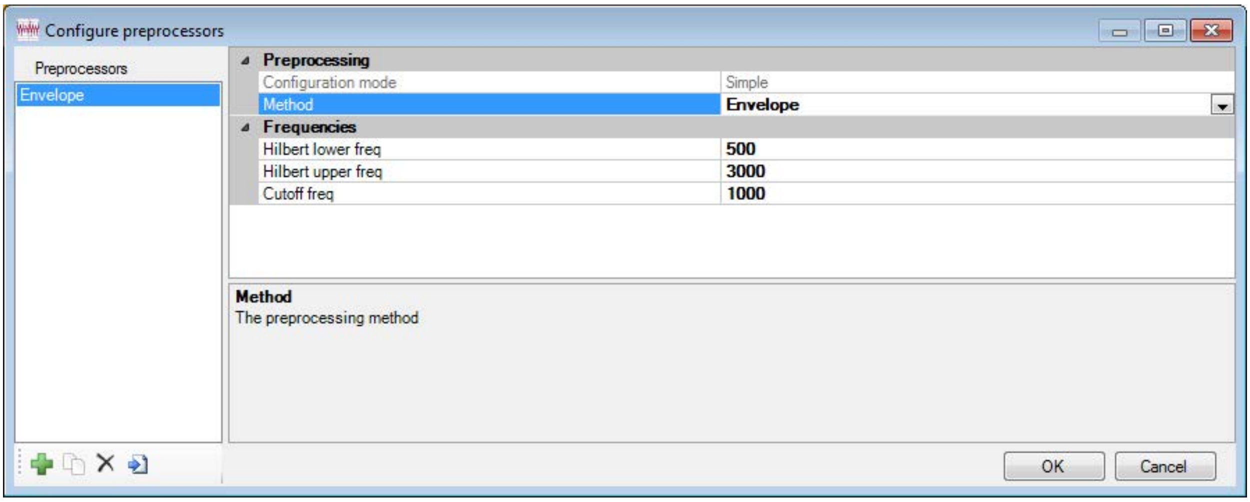


Fig. 96: Settings for envelope curve

Frequencies

- Hilbert lower frequency: The lower frequency of the band. This value cannot be smaller than 10% of the Nyquist frequency. (Nyquist frequency = sampling frequency/2)
- Hilbert upper frequency: The upper frequency of the band. This value cannot be greater than 90% of the Nyquist frequency.
- Cutoff frequency: The cutoff frequency of the lowpass filter, which is applied after the envelope calculation. If the value is 0, then no low pass is applied. This value cannot be greater than 90% of the Nyquist frequency.

7.7.2 "Analog" tab

Example of an *Analog* tab:

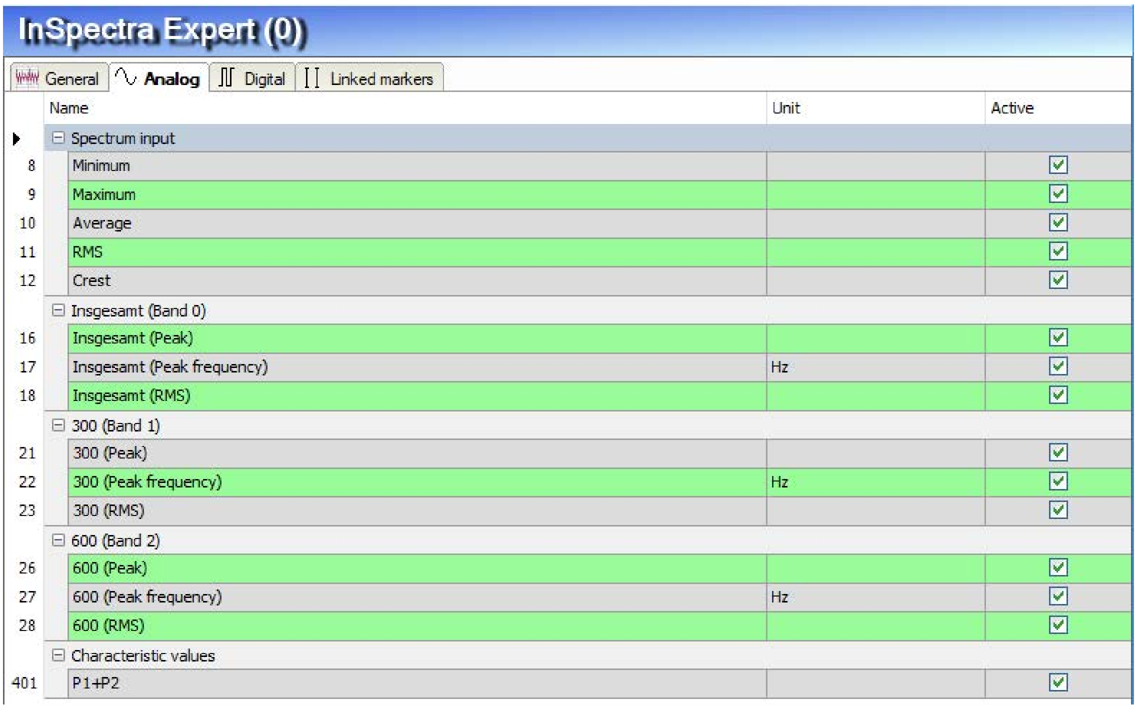


Fig. 97: Example of an InSpectra module with 3 bands and analog event status signals

If a speed signal has been defined in the *General* tab, the signal *Speed* appears in the *Analog* tab. This is the value of the speed signal, which was used during the FFT calculation.

In addition, 5 signals are automatically generated in the group “Spectrum input.”

- Minimum
  Minimum of the input signal
- Maximum
  Maximum of the input signal
- Average
  Arithmetic average of the input signal
- RMS
  Square mean value of the input signal
- Crest
  Crest factor (ratio of maximum to RMS) of the input signal

These 5 signals are available later in the signal tree for the display and recording. For the online display in the *ibaPDA* client, enable the “Time domain” display in the FFT view of the InSpectra module.

If the event status signals (alarm and warning) are analog, see chapter ➚ *Configuration of the events*, page 98, there is the signal *Overall module event.*

Furthermore, in the *Analog* tab, the calculation results "peak", "peak frequency" and "RMS" are created for every frequency band defined in the selected profile.

Also these values will be available later in the signal tree for display and recording. For the online display in the *ibaPDA* client, activate the "Data frequency spectrum" in the FFT view of the InSpectra module.

After the bands, the defined characteristic values are available in the table for display and recording.

For the respective bands and characteristic values, there are also two analog alarm values *Peak event* and *RMS event* if the event status signals are defined as analog signals.

Note

The signals are enabled for the display and recording by default. If required, they can be disabled, too. Other signal properties such as name and unit cannot be modified in the tables. These properties are specified by the profile and the module name. A modification of the module name automatically results in a modification of the signal names.

7.7.3 “Digital" tab

If the event status signals are configured as digital signals, the configured warning and alarm messages are created in the *Digital* tab for each frequency band that is defined in the selected profile. In addition, the signal *Overall module event* appears.

If digital alert and alarm messages are configured for characteristic values, these signals also appear in the *Digital* tab.

For the online display in the *ibaPDA* client, activate the "Spectrum slave graph” in the FFT view of the InSpectra module.

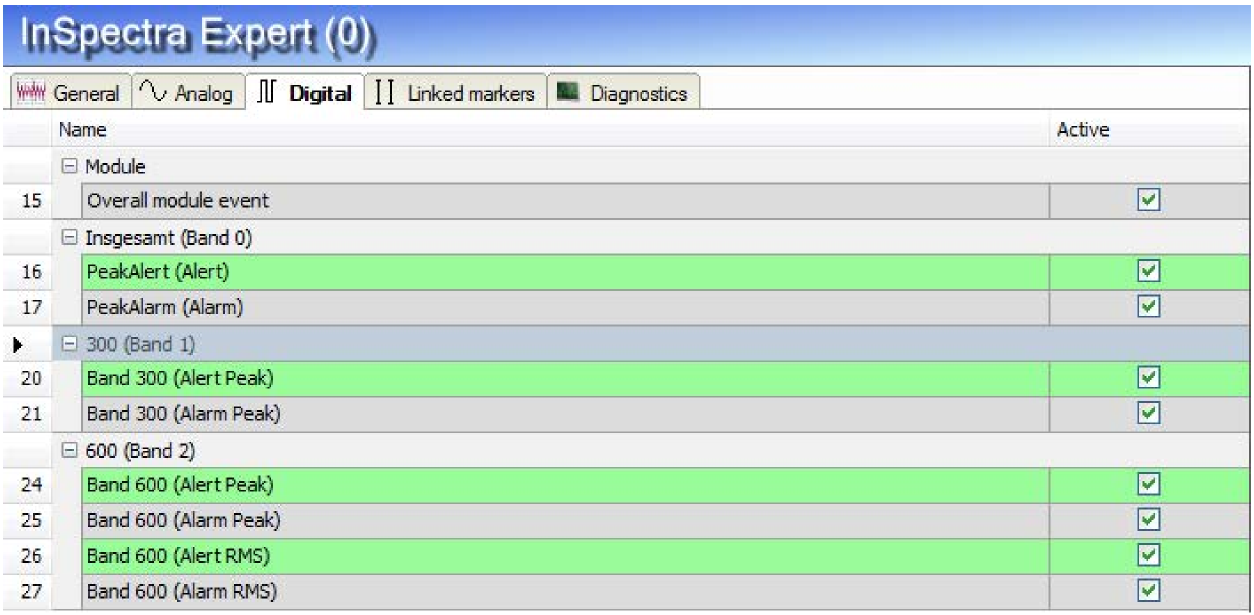


Fig. 98: Example of an InSpectra Expert module with 3 bands

Note

The signals are enabled for the display and recording by default. If required, they can be disabled, too. Other signal properties such as name and unit cannot be modified in the tables. These properties are specified by the profile and the module name. A modification of the module name automatically results in a modification of the signal names.

7.7.4 "Linked markers" tab

Markers from an InSpectra Expert module can be connected to another InSpectra Expert module. For this purpose, select an InSpectra Expert module in the module tree. In the *Linked markers* tab, the markers of the other InSpectra Expert module are shown, provided markers have been defined in the modules.

You can use a check mark to select the markers that should be connected to the highlighted module.

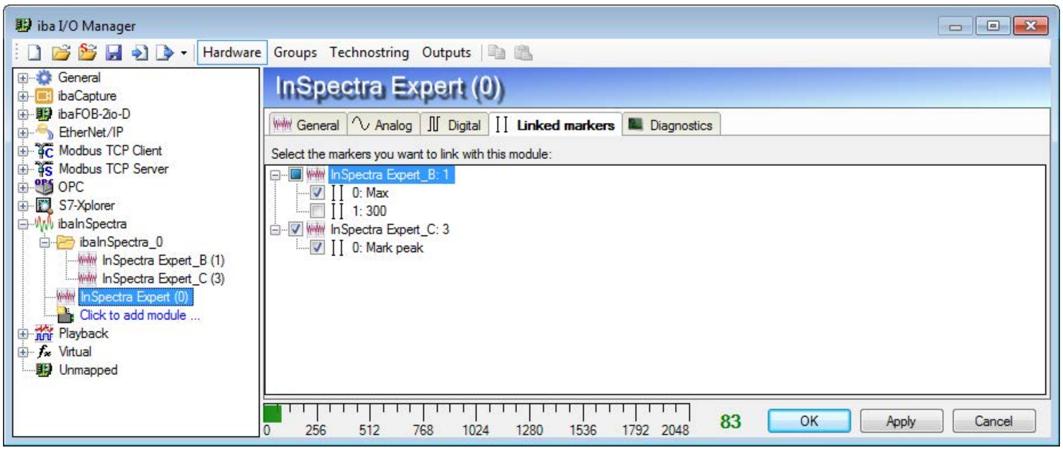


Fig. 99: Selecting linked markers

7.8 Configuration of a calculation profile in ibaAnalyzer

With *ibaAnalyzer-InSpectra* it possible to configure calculation rules in the form of profiles off-line and to test them on recorded data.

First open an InSpectra Expert view with the <FFT> button in the toolbar, see chapter ➚ *Opening an FFT view in ibaAnalyzer*, page .30

Open a data file containing the signals to be examined either

- via the menu *File - Open data file ...*
- or drag a data file via drag & drop from the Windows Explorer into the opened *ibaAnalyzer* program window.

In the signal tree, any analog signals can now be selected and moved into the main window of the InSpectra Expert view using drag & drop. If several signals are moved into the main window, each signal initially receives its own value axis.

The first selected signal forms the main spectrum and is also shown in the displays ‘spectrum slave’ and ‘time slave.’

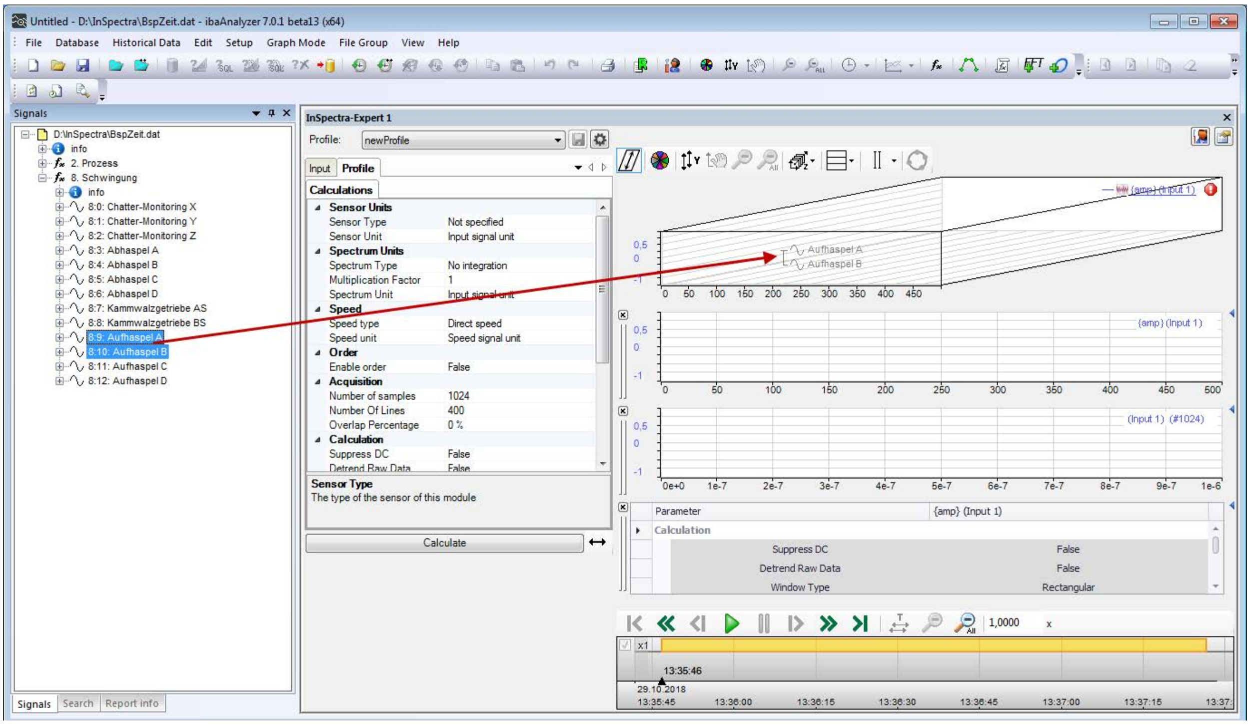


Fig. 100: Move signals into the main view

For each signal, a tab *Input* appears in which the respective signal is entered as *Input Signal*. The speed signal can be selected from the drop-down menu and is used to calculate an order spectrum. This signal is optional if no order calculation is configured.

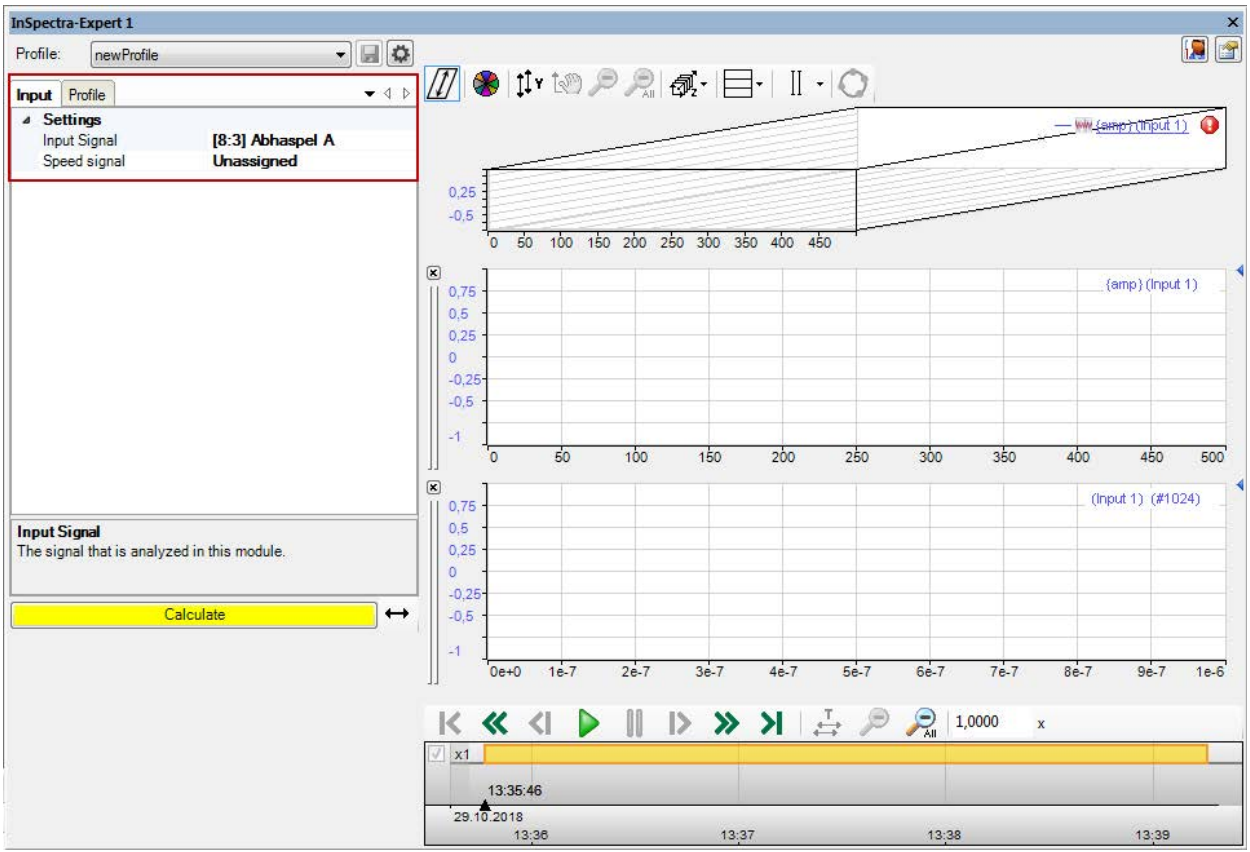


Fig. 101: Input tab in the FFT view

In the *Profile* tab, you can now create a calculation profile or, if profiles have already been imported or created, you can select a profile from the drop-down menu. The parameters for the calculation rules are identical to the parameters in *ibaPDA*. See chapter ➚ *Setting calculation parameters*, page 87

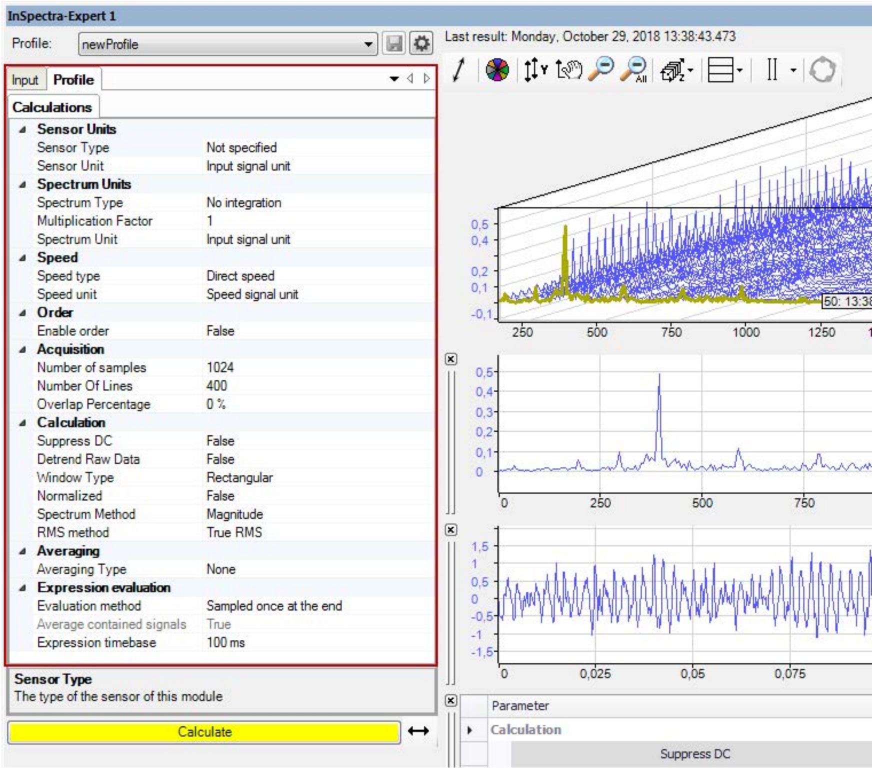


Fig. 102: Configure calculation profile

You can save configured profiles using the disk button. If you change the name, export profiles or would like to import profiles from *ibaPDA*, open the profile manager by using the ⚙ button. See chapter ➚ *Create and manage profiles in ibaAnalyzer*, page 138

The FFT calculation is started by pressing the <Calculate> button. The signal can be analyzed in detail in the FFT view on the right. The properties and settings in FFT view in *ibaAnalyzer-InSpectra* are identical to the FFT view in *ibaPDA*. See chapter ➚ *FFT view overview*, page 32.

Playback area

In the playback area, you can control the playback of the data file using the buttons and the slider. You can find the description in chapter ➚ *Playback area*, page 26

8 The InSpectra auto adapting module

The InSpectra auto adapting module automatically learns spectra for different process conditions and uses this as a reference to detect changes in the spectrum over time.

The module is based on the InSpectra Expert module. It also calculates spectra using the fast fourier transformation, but not only considers individual frequency bands, but the entire spectrum.

The relative and absolute difference of the current spectrum compared to the learned reference spectrum is determined. In addition, it is possible to output the following parameters as a signal for the areas with the greatest differences:

- Center frequency: Frequency of the closest learned dot of the reference spectrum
- Relative difference: The relative difference to the reference spectrum
- Peak: The amplitude of the spectrum

For alerting, digital or analog event signals are generated for these areas. In addition to these values from the frequency domain, additional values are determined in the signal's time domain, such as minimum, maximum, average, RMS or crest.

A characteristic of the InSpectra auto adapting module is that the results and reference spectra take the current process conditions into consideration and therefore, for example, processes with changing speeds or loads can also be reliably monitored.

The calculation rules can be individually adjusted and saved in profiles as with the InSpectra Expert module. In particular, the sensor type, type of spectrum and FFT calculation parameters, such as the number of samples, window shape or overlapping factor, can be set. Different methods of averaging are also available, such as the option of detrending in order to compensate for a slow drift of the measured value. Defined profiles can be saved, imported, exported and used multiple times.

8.1 The auto adapting profile

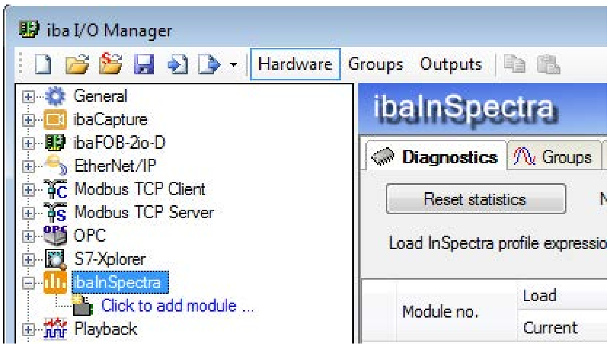
The InSpectra auto adapting module can be used to monitor a frequency spectrum of a signal for changes. The parameters can be freely configured and stored in profiles. This makes it possible to reuse created profiles. Any number of profiles can be configured to adequately analyze different input signals or sensor types. An InSpectra auto adapting module is to be configured for each signal to be monitored. The modules can be structured through a directory structure to improve the overview.

Since an InSpectra auto adapting module can only be completely configured if at least one valid calculation profile exists, in the following the configuration of a profile is first explained and then the configuration of the module settings is explained.

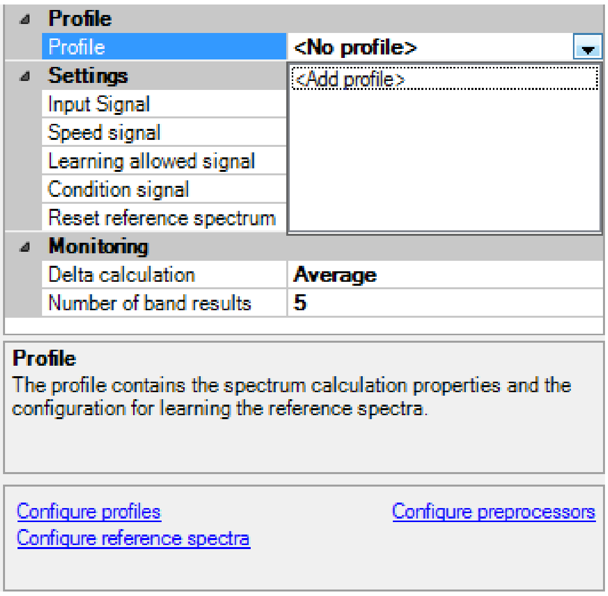
8.2 Create and manage profiles in ibaPDA

If you create an InSpectra auto adapting module for the first time, no profiles are yet available. To be able to create and edit profiles, first add an InSpectra auto adapting module. Proceed as follows:

1. Open the I/O manager in *ibaPDA*.
2. If necessary, expand the *ibaInSpectra* branch and click on the blue link "Click to add module...".



3. Select the "InSpectra auto adapting" module type in the following "Add module" dialog and enter a module name in the corresponding field. Then click <OK>. The module is now created and you see the *General*, *Analog*, *Digital* and *Linked marker* tabs in the right part of the I/O manager. Alternatively, you can use the right mouse key to click on the interface *ibaInSpectra* and select "Add module" in the context menu. The module will then be created immediately. You can then rename it.
4. In the field “Profile” in the *General* tab of the module, open the dropdown list and click on <Add profile>.



Alternatively, you can also click on the blue link “Configure profiles” below in the dialog window.

The dialog for the configuration of the (new) profile opens. Profiles can be created, changed, exported and imported in the profile manager.

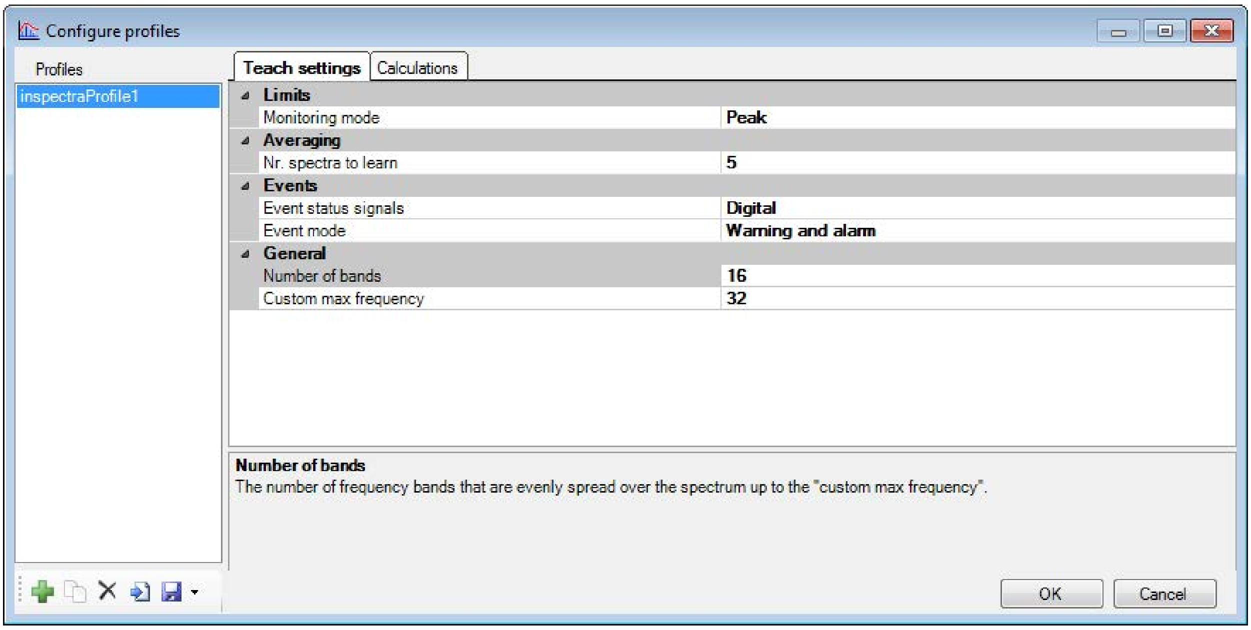


Fig. 103: Profile manager

All available profiles are listed on the left side of the profile manager. Profiles can also be renamed here.

Below this list, there are buttons with the following functions:

- Add new profile
- Clone current profile
- Delete current profile
- Import profiles
- Export selected profile

The settings of the profile selected in the list are made in the main area of the dialog.

8.3 Setting the teach phase

By entering the settings for the teach phase, you determine how the reference spectra should be determined.

The settings are entered in the configuration dialog for the profiles in the *Teach settings* tab.

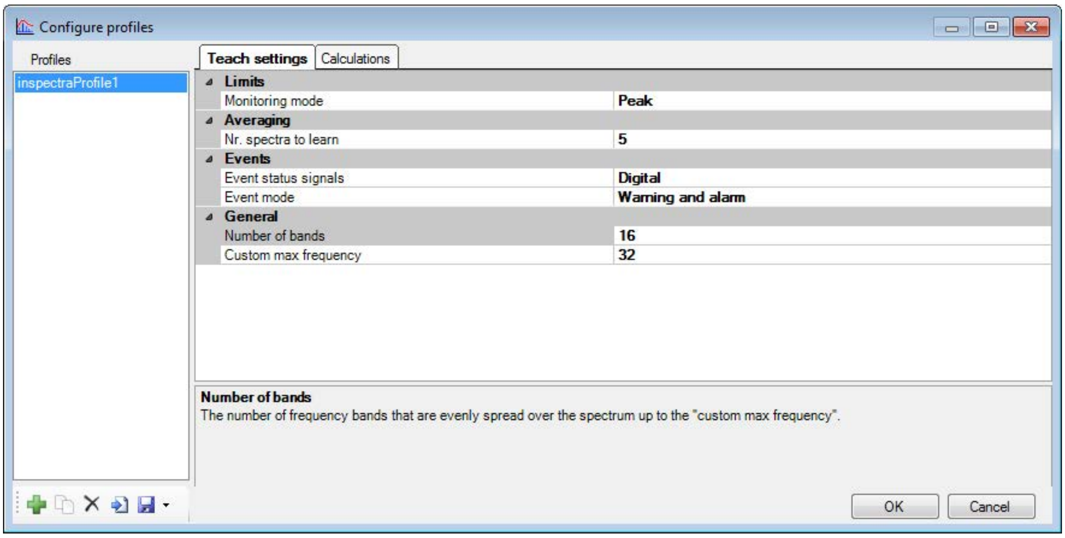


Fig. 104: Configuration dialog for the teach phase

The following explains the settings parameters and their meanings.

8.3.1 Limits

Monitoring mode

The monitoring mode defines which characteristic value is taught for each range of the reference spectrum and is therefore also used later for monitoring.

- Peak: The value of the amplitude of the ranges is calculated.
- RMS (Root-Mean-Square): The effective value of the ranges is calculated.

Note

Monitoring based on the RMS value usually only makes sense if the width of the ranges is much larger than the frequency resolution.

8.3.2 Averaging

Number of spectra to learn

This defines how many spectra the learning phase should include. The duration of the learning phase is therefore indirectly configured here. Different values for certain process conditions can also be defined for this purpose under “Configure reference spectra.”

Only “whole” spectra are used to learn the reference spectrum. This means that if the process conditions change while data points for a spectrum are acquired, then the data acquired from the last calculated spectrum up to the change is not used for the reference spectrum.

8.3.3 Events

Event status signals

You can select here whether digital or analog event status signals are used.

- *Digital*: When exceeding the entered limit value, the corresponding digital signal is set to TRUE (logical 1) and can be used for signaling.
- *Analog*: The analog signal can have several values and, for example, be used to control a traffic light display in *ibaQPanel*.

  0 undefined

  1 OK

  2 Warning

  3 Alarm

Event mode

This property defines how the spectra are monitored:

- Warning and alarm: generates events based on warning and alarm limits.
- Lower and upper: generates events based on lower and upper threshold values for the individual ranges.

8.3.4 General

Number of bands

Defines the number of equally sized zones that are distributed seamlessly and evenly across the spectrum up to the user-defined maximum frequency.

Note

The number of ranges should not be larger than the number of calculated lines in this range. It should also be noted that the required resources increase with the number of bands.

Custom max. frequency

Defines the maximum frequency up to which the reference spectrum should be learned. This must not be higher than the maximum calculated frequency.

8.4 Setting calculation parameters

By entering the calculation parameters, you determine how the frequency spectra are to be calculated mathematically. The possible calculation parameters are identical to those of the expert module. For a description of the parameters, see chapter ↗ *Setting calculation parameters*, page 87.

The settings are defined in the configuration dialog for the profiles in the *Calculations* tab.

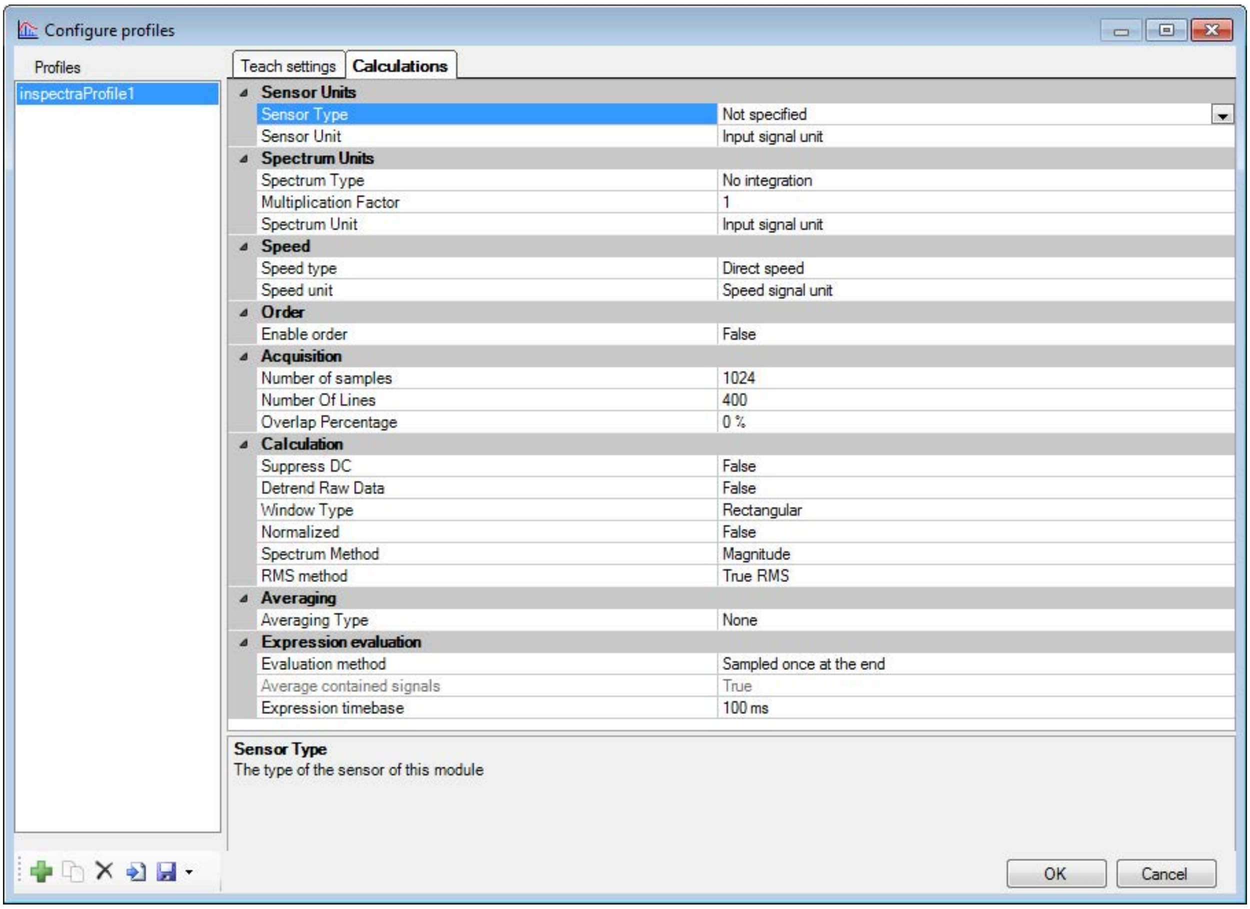


Fig. 105: Configuration dialog for calculation parameters

8.5 Visualization and results of the auto-adapting module

The results of the auto-adapting module are calculated based on the configured profile and the settings for monitoring (see chapter ➚ *Setting the teach phase*, page 124). The following explains which results the module offers and how these can be visualized and used as signals.

8.5.1 Characteristic values

Like the InSpectra Expert module, the auto-adapting module also calculates different characteristic values:

- General
  - Learned spectra
    Number of previously learned spectra for the current state
  - Condition
    Integer value of the current process state
  - Absolute delta
    Absolute difference between the current calculated spectrum and the reference spectrum in the unit configured in the calculation profile for the spectrum
  - Relative delta
    Relative difference between the current calculated spectrum and the reference spectrum in percent
- Spectrum input
  - Minimum
    Minimum of the input signal
  - Maximum
    Maximum of the input signal
  - Average
    Arithmetic average of the input signal
  - RMS
    Root mean square value of the input signal
  - Crest
    Crest factor (ratio of maximum to RMS) of the input signal

These characteristic values are available as signals in the *Analog* tab (see chapter ➚ *"Analog" tab*, page 135).

8.5.2 Band results

In addition to the characteristic values, ranges with the biggest differences to the respective limits are offered as signals for the configured “Number of band results.” These are listed in the range “Bands with exceeded limits” under the name “Exceeded limit.”

- Center frequency:
  Center frequency of the range
- Relative difference:
  Relative difference between the current value and limit
- Peak/RMS:
  Absolute peak or RMS value of the range

Only the results of the range with the biggest differences to the respective limits are available as signals.

8.5.3 Visualization

Spectrum and reference spectrum

If an InSpectra auto adapting module is dragged into an FFT view, the main window shows the current spectra just as the InSpectra Expert module does. The individual visualization of the auto adapting module is located in the “spectrum slave graph”.

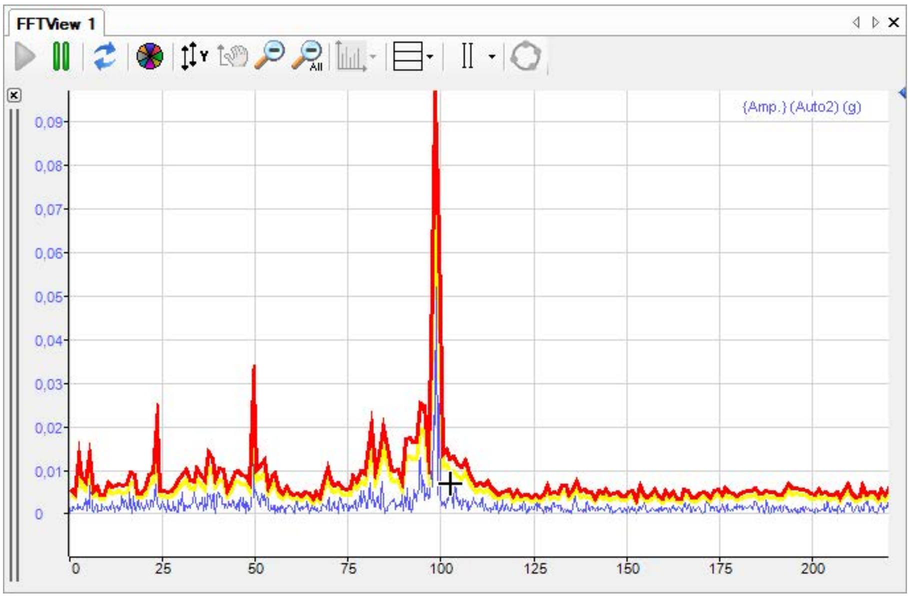


Fig. 106: Example of current spectrum (blue) and warning and alarm reference (yellow and red)

The current spectrum and the limit curves based on the reference spectrum are shown here.

If “Warning and alarm” is used as an event mode, the warning limit is shown in yellow and the alarm limit in red.

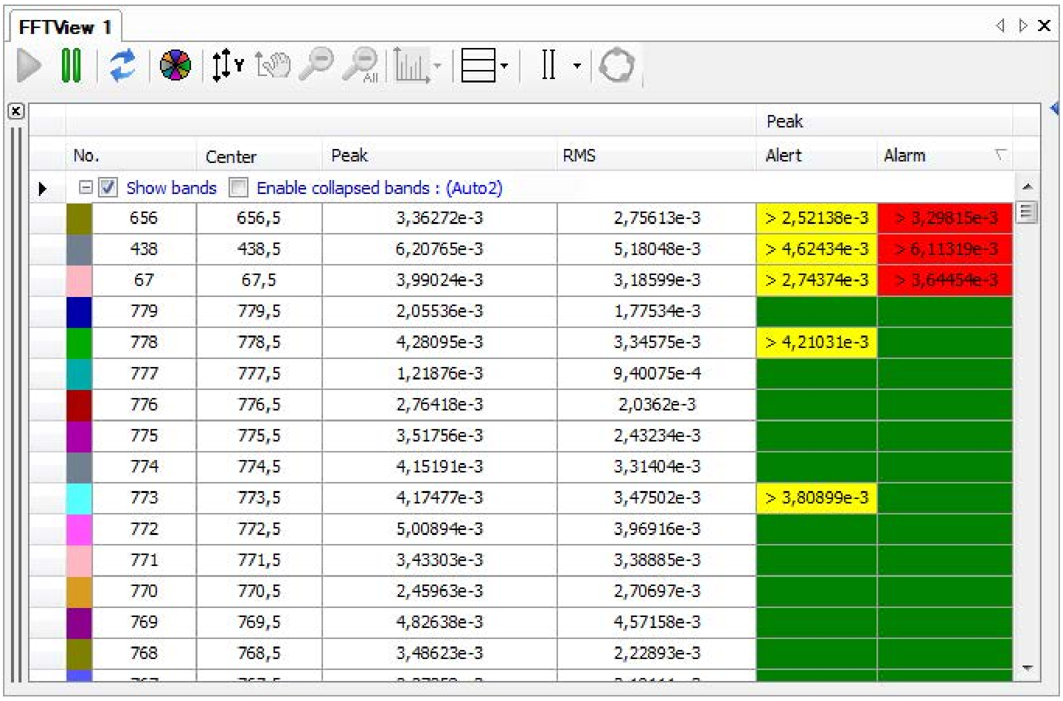
If “Lower and upper” is used as an event mode, the lower limit is shown in blue and the upper limit in green.

Note

For a high zoom level, the current spectrum sometimes exceeds the displayed limit curves. This is due to the fact that the limit curves are only displayed based on the learned dot in the center of the respective range. The dominant frequency, however, may occur at the start or end of the range as well and therefore be, for example, above the limit curve falling from the center.

Band results of the individual ranges

To view the calculated values of all ranges, the frequency domain data can be opened in the FFT view of an auto-adapting module. All results for the individual ranges are shown in a table here and can be sorted according to various parameters.



No.	Center	Peak	RMS	Peak Alert	Peak Alarm
656	656,5	3,36272e-3	2,75613e-3	> 2,52138e-3	> 3,29815e-3
438	438,5	6,20765e-3	5,18048e-3	> 4,62434e-3	> 6,11319e-3
67	67,5	3,99024e-3	3,18599e-3	> 2,74374e-3	> 3,64454e-3
779	779,5	2,05536e-3	1,77534e-3		
778	778,5	4,28095e-3	3,34575e-3	> 4,21031e-3	
777	777,5	1,21876e-3	9,40075e-4		
776	776,5	2,76418e-3	2,0362e-3		
775	775,5	3,51756e-3	2,43234e-3		
774	774,5	4,15191e-3	3,31404e-3		
773	773,5	4,17477e-3	3,47502e-3	> 3,80899e-3	
772	772,5	5,00894e-3	3,96916e-3		
771	771,5	3,43303e-3	3,38885e-3		
770	770,5	2,45963e-3	2,70697e-3		
769	769,5	4,82638e-3	4,57158e-3		
768	768,5	3,48623e-3	2,22893e-3		

Fig. 107: Results of the individual ranges in the spectrum slave table are sorted according to the alarm exceedances of the reference spectrum

8.6 Creating an auto adapting module in ibaPDA

1. Open the I/O manager in *ibaPDA*.
2. Proceed as described in chapter ➚ *Create and manage profiles in ibaPDA*, page 122 in steps 2 and 3. If a suitable profile already exists, you do not need to create a new profile.
3. Now configure the general settings for the module in the *General* tab.

8.6.1 "General" tab

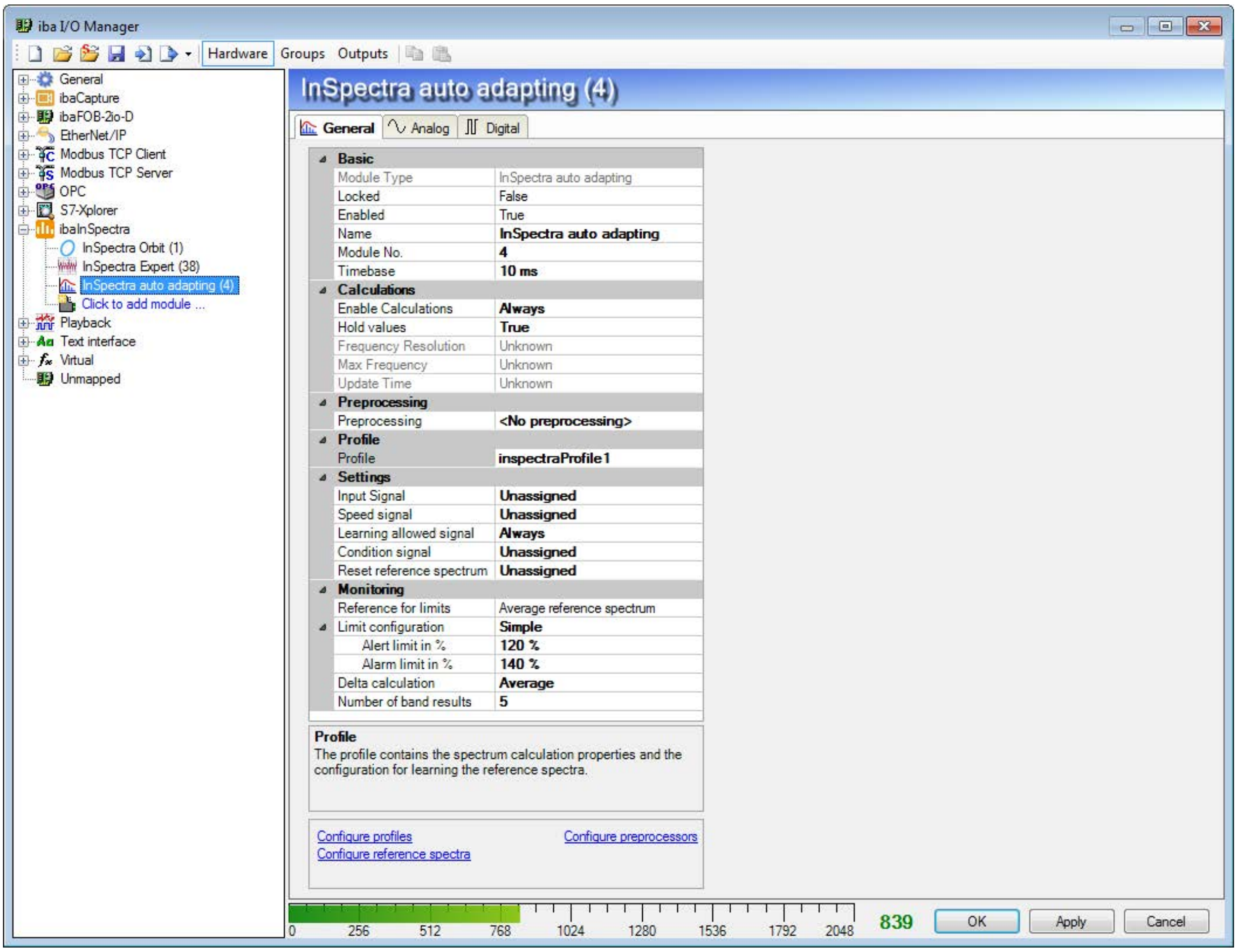


Fig. 108: General settings of an InSpectra auto adapting module

Basic settings

Module Type

Indicates the type of the current module.

Locked

A module can be locked in order to prevent change of module settings by accident or unauthorized users. The lock function is linked to the user management in *ibaPDA*. A module can be locked (true) or unlocked (false) only by users who have the required right, provided the user management is activated.

- FALSE: Any user can change the module settings.
- TRUE: No change of module settings possible. Module must first be unlocked by authorized users in order to change the settings.

Enabled

By selecting the options in the dropdown list in the field on the right side of "Enabled," you determine whether the module is enabled (TRUE) or disabled (FALSE). If a module is disabled, its signals are excluded from acquisition. This means they are neither available for display nor for recording. Furthermore, the number of signals of a disabled module will not be taken into account in the signal statistics (signal-o-meter).

Name
Enter a comprehensive name for the module here.

It is recommended to use an application-specific naming rule for a better clearness and comprehension, particularly with vast numbers of modules. The name may refer to a technological purpose or a special location in the plant where the module is used or installed. The number of characters in the name is unlimited. The name of the module is stored in the dat file and visible in *ibaAnalyzer*.

Module No.
If you add modules to the configuration, the system automatically assigns the numbers in chronological order. However, you can select another order for subsequent analysis in the data file by changing the number. Feel free to change the module number according to your needs. It must be ensured that the number is unambiguous. The order of the modules in the signal tree of *ibaAnalyzer* is determined by their numbers.

Time base
As time base, you may enter a value here, given in ms, which is an integer multiple of the general time base as configured in the "*General"* branch of the I/O manager. The time base of the module determines the update time of the output signals of the module. It should be smaller than the interval between two calculations (see update time display below). Usually, 100 ms is enough.

The ratio between maximum and minimum time base is limited to the value 1000. The value of the time base is limited to 1000 ms.

Calculations

Enable calculations
With this setting, you can control whether the calculations are always performed or controlled by a signal. Click on the drop-down arrow in this field and select one of the following options from a reduced signal tree:

- *Always*: With this setting, the frequency band calculation is permanently being executed. Please note that the system load can be quite high due to a permanent computation depending on the type and number of signals and the profile settings.
- *Signal tree*: As an alternative, all other (digital) signals, including the virtual signals, are available to activate the calculation (selected signal = TRUE) or to disable it (selected signal = FALSE). This allows you to link the calculation of the InSpectra module to particular process states or e.g. to an ibaQPanel input.

Hold values
If you set this option to "TRUE," the values of the most recent computation remain visible in the online display of the InSpectra module, even if the calculation is disabled by means of a control signal.

If you set this option to "FALSE," the display is cleared and the computed values are set to 0 if the computation is disabled by means of a control signal.

Frequency resolution, max. frequency and update time (only display)
These values result from the calculation parameters set and are only displayed.

Preprocessing
Preprocessing can be used to filter the vibration signal or to carry out mathematical pre-calculations. In the process, an envelope calculation with freely configurable bandpass filter as a signal preprocessing profile is available too.

Here, you can select a calculation profile for preprocessing. You can define a profile if no calculation profile is available. To do this, select <Configure preprocessors> from the drop-down menu or click on the blue link under *Configure preprocessors*.

The settings for the preprocessing of the signals are identical to the InSpectra Expert module. The explanations for this can be found in chapter ↗ *Preprocessing of signals*, page 111.

Settings

Input signal
Select the input signal whose frequency bands are to be analyzed. All signals configured in *ibaPDA* are available in the signal tree.

If no input signal is selected or available, an error message is output when validating the I/O configuration:

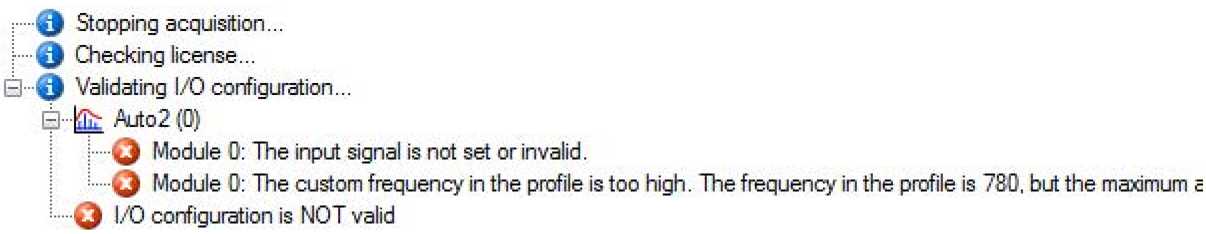


Fig. 109: Error message when input signal is missing

Speed signal
This speed signal is used to calculate an order spectrum. This signal is optional if no order calculation is configured.

'Learning allowed' signal
This signal defines whether new spectra may be learned or not. Click on the drop-down arrow in this field and select one of the following options from a reduced signal tree:

- *Always*: This setting can be used to constantly learn new spectra until the number of spectra to be learned that is defined in the profile is met.
- *Signal tree:* As an alternative, all digital signals, including the virtual signals, are available to activate the learning phase (selected signal = TRUE) or to disable it (selected signal = FALSE). This allows you to link the learning phase of the InSpectra module to particular process states or e.g. to an ibaQPanel input. New spectra are also learned here until the number of spectra to be learned that is defined in the profile is met.

Condition signal
This signal specifies the actual operation condition. The signal is interpreted as an integer number and a separate reference spectrum is learned for each occurring value.

Reset reference spectrum
This optional digital signal is used to reset the previously learned reference spectrum in the case of a rising edge of the signal. However, only the reference spectrum for the state defined via the "state signal" is deleted.

If learning is allowed, a new reference spectrum can then be learned afterwards for this condition.

Profile
Select the requested profile from the drop-down list for analyzing the selected signal. If no profile is available or a suitable profile is missing, you have to define a profile first. Please read the explanations in chapter ↗ *Setting calculation parameters*, page 126 for this purpose.

If no profile is selected or available, an error message will be output when validating the I/O configuration:

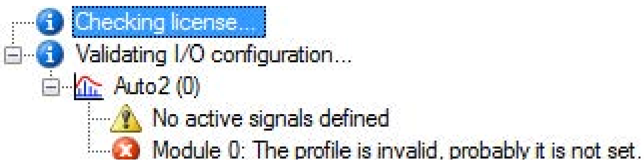


Fig. 110: Error message when profile is missing

Monitoring
The "Monitoring" section defines how the spectra are to be compared with the learned reference spectra and evaluated after the learning phase. The settings made here only affect the results of the module, but not the learning phase or the learned reference spectra.

Reference for limits
This setting is used to define the reference for the limits based on the reference spectrum. A distinction is made here about which event mode is used in the profile.

If "Warning and alarm" is used as the event mode, these options are available:

- Average reference spectrum: The averages of the individual ranges of the reference spectrum that are learned across all spectra are used as the reference here.
- Maximum reference spectrum: The maximum values of the individual ranges of the reference spectrum occurring during the learning phase are used as the reference here

If "Lower and upper" is used as the event mode, these options are available:

- Average reference spectrum: The averages of the individual ranges of the reference spectrum that are learned across all spectra are used as the reference here.
- Min./Max. reference spectrum: The maximum and minimum values of the individual ranges of the reference spectrum occurring during the learning phase are used as the reference here.

Limit configuration
This defines how the limits should be calculated based on the reference for limits. Two possible types are available for selection:

- *Simple*: A factor or percentage can be used here to specify at how many percentage the respective limits exceed or fall below the reference.

- *Advanced*: In addition to a percentage share of the reference, the standard deviation for the limit learned for each range can be used for the advanced limits.

Clicking in the field *Limit configuration* opens the corresponding dialog.

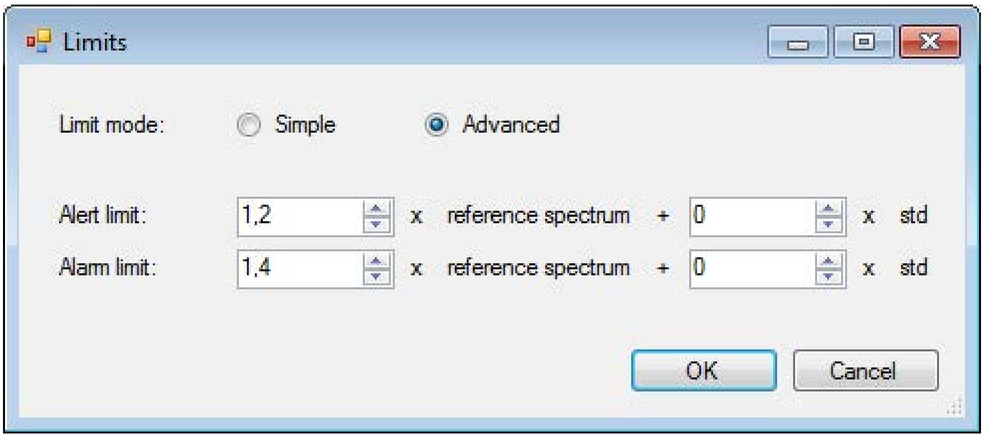


Fig. 111: Dialog about the configuration of limits (event mode = “Warning and alarm;” Limit mode = “Advanced”)

The limits can be configured here depending on the selected limit mode and the event mode defined in the profile.

If “Warning and alarm” is used as the event mode, these limits can be configured:

- Alert limit: Limit for warnings
- Alarm limit: Limit for alarms

If “Lower and upper” is used as the event mode, these limits can be configured:

- Lower limit: Lower limit value
- Upper limit: Upper limit value

Note

The alarm value or the upper and lower limit are used as the reference for the calculation of the delta characteristic values.

Delta calculation

This setting determines how the characteristic values *absolute* and *relative delta* are calculated.

- Sum: The differences between the current calculated spectrum and the reference spectrum are summed up across all ranges.
- Average: The average of differences between the current calculated spectrum and the reference spectrum are formed across all ranges.

Number of band results

Number of ranges with the largest differences to the reference spectrum, for which results are available as signals. The signals are called “Exceeded limit 1 - X” in the *Analog* tab. The results for “Exceeded limit 1” come from the range in which the difference between the current calculated spectrum and the reference spectrum is the biggest.

8.6.2 "Analog" tab

Example of an *Analog* tab:

General | **Analog** | Digital

	Name	Unit	Active
	General		
1	Learned spectra		☑
2	Condition		☑
3	Absolute delta		☑
4	Relative delta	%	☑
	Spectrum input		
8	Minimum		☑
9	Maximum		☑
10	Average		☑
11	RMS		☑
12	Crest		☑
	Bands with exceeded limits		
16	Exceeded limit 1 (Center frequency)	Hz	☑
17	Exceeded limit 1 (Relative difference)	%	☑
18	Exceeded limit 1 (Peak)		☑
21	Exceeded limit 2 (Center frequency)	Hz	☑
22	Exceeded limit 2 (Relative difference)	%	☑
23	Exceeded limit 2 (Peak)		☑
26	Exceeded limit 3 (Center frequency)	Hz	☑
27	Exceeded limit 3 (Relative difference)	%	☑
28	Exceeded limit 3 (Peak)		☑
31	Exceeded limit 4 (Center frequency)	Hz	☑
32	Exceeded limit 4 (Relative difference)	%	☑
33	Exceeded limit 4 (Peak)		☑
36	Exceeded limit 5 (Center frequency)	Hz	☑
37	Exceeded limit 5 (Relative difference)	%	☑
38	Exceeded limit 5 (Peak)		☑

Fig. 112: Example of an InSpectra auto adapting module with 5 bands and digital event status signals

The signal *Speed* is the value of the speed signal, which was used during the FFT calculation.

In addition, 4 other signals in the “General” group, 5 signals in the “Spectrum input” group and several signals in the “Bands with exceeded limits” group are generated automatically. These are explained in chapter ➚ *Visualization and results of the auto-adapting module*, page 127.

These signals are available later in the signal tree for the display and recording. For the online display in the *ibaPDA* client, enable the “Time slave graph" in the FFT view of the *InSpectra* module.

If the event status signals are analog, they are also listed here. For the online display in the *ibaPDA* client, enable the "Spectrum slave table" in the FFT view of the InSpectra module.

Note

The signals are enabled for the display and recording by default. If required, they can be disabled, too. Other signal properties such as name and unit cannot be modified in the tables. These properties are specified by the profile and the module name. A modification of the module name automatically results in a modification of the signal names.

8.6.3 “Digital" tab

If the event status signals are configured as digital signals, the automatically configured alert and alarm messages are created in the *Digital* tab for each band. In addition, the signal *Overall module event* appears.

For the online display in the *ibaPDA* client, activate the "Spectrum slave table” in the FFT view of the *InSpectra* module.

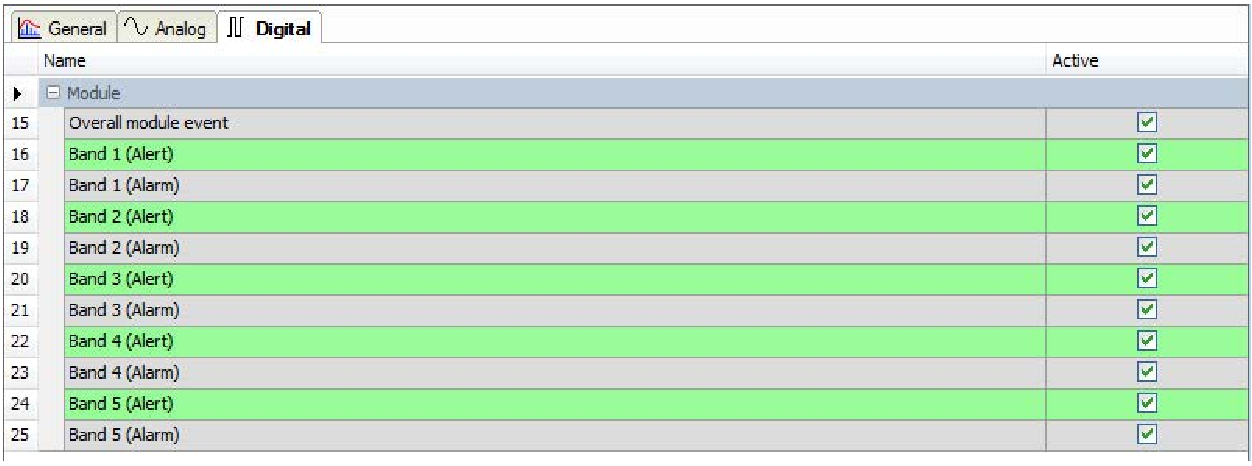


Fig. 113: Auto adapting module, Digital tab

Note

The signals are enabled for the display and recording by default. If required, they can be disabled, too. Other signal properties such as name and unit cannot be modified in the tables. These properties are specified by the profile and the module name. A modification of the module name automatically results in a modification of the signal names.

9 The InSpectra Orbit module

Note

The characteristic values calculated from this module are determined from the position of the shaft in the bearing. Some known characteristic values for the orbit monitoring (oil whirl, etc.), however, are based on frequency spectra. These are not calculated in the InSpectra Orbit module, but can be determined with the InSpectra Expert module at any time. Calculation profiles and configuration instructions for this can be found in our FAQs (support area at www.iba-ag.com)

9.1 Orbit Profile

All settings for interpreting the signals and calculating the orbit are configured in the profile. Configured profiles can be used for several modules and analyses. Changes to the settings of a profile then affect all modules using this profile. Profiles can be exported and imported and can therefore be exchanged between different *ibaPDA* systems or between *ibaAnalyzer* and *ibaPDA*.

9.1.1 Create and manage profiles in ibaPDA

Profiles are managed in the profile manager. To create a new profile, open the drop-down list in the *Profile* field in the *General* tab of the module and select <Add profile>.

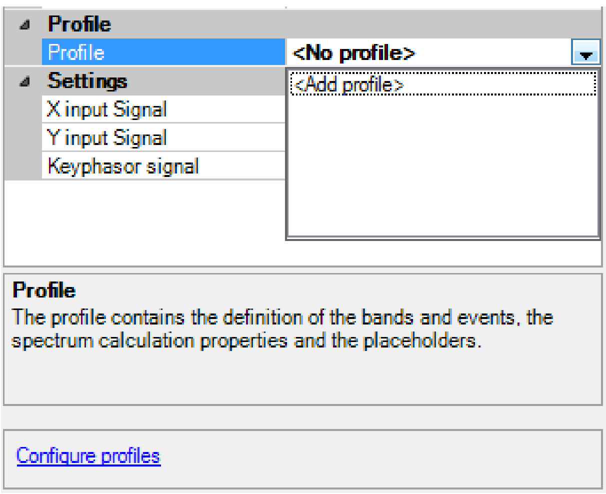


Fig. 114: Adding profile

The profile manager will open. Profiles can be created, changed, exported and imported in the profile manager. Alternatively, the profile manager can also be opened with the blue link “Configure profiles” below in the dialog window.

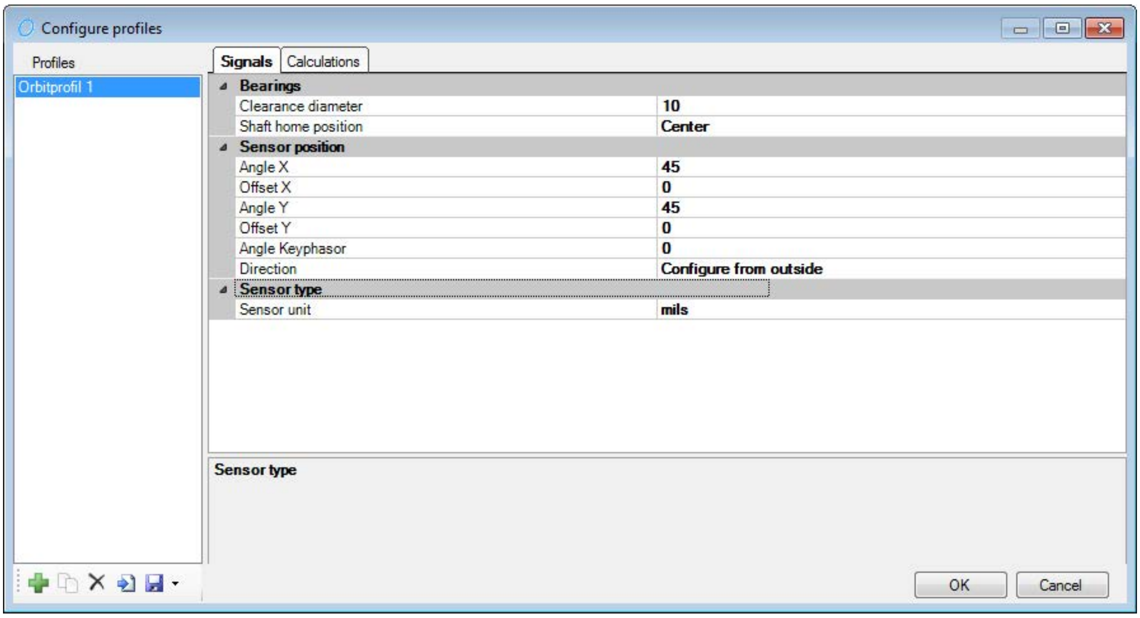


Fig. 115: Profile manager

All available profiles are listed on the left side of the profile manager. Profiles can also be renamed here.

Below this list, there are buttons with the following functions:

 Add new profile

 Clone current profile

 Delete current profile

 Import profiles

 Export selected profile

The settings of the profile selected in the list are made in the main area of the dialog.

9.1.2 Create and manage profiles in ibaAnalyzer

ibaAnalyzer-InSpectra can be used to configure profiles offline and test them on acquired data. First open an InSpectra Orbit view with the <Orbit> button in the toolbar, see chapter ➚ *Opening an FFT view in ibaAnalyzer*, page 30.

Existing profiles are managed in the profile manager. You can open the profile manager with the button to the right of the profile selection.

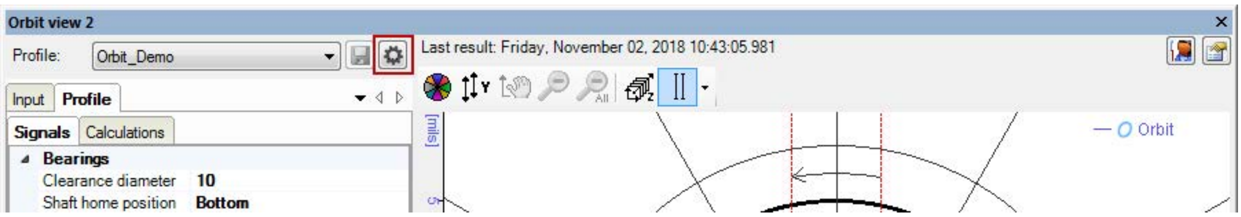


Fig. 116: Open profile manager

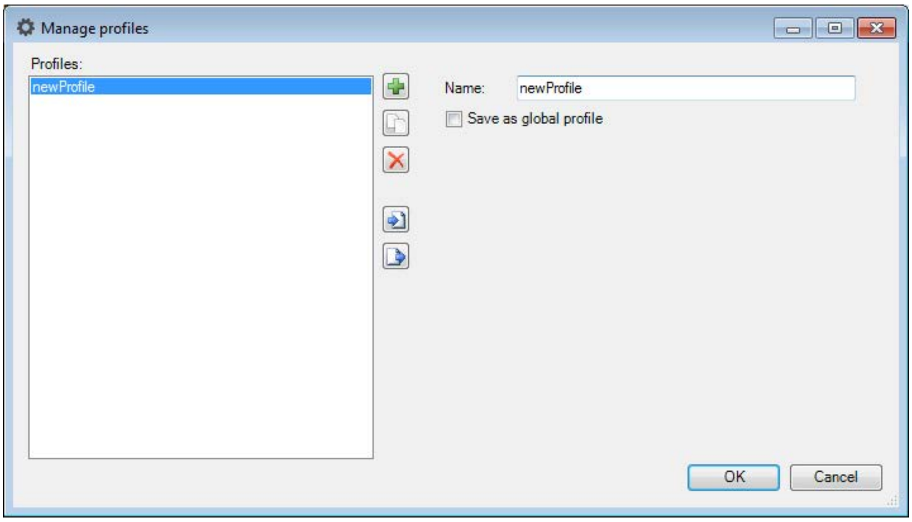


Fig. 117: Profile manager

All available profiles are listed on the left side of the profile manager. Next to the list, there are buttons with the following functions:

 Add new profile

 Clone selected profile

 Delete selected profile

 Import profiles

 Export selected profile

On the right side in the field *Name,* the name of the currently selected profile can be changed and it can be determined how the profile should be stored.

If “Save as global profile” is selected, the profile is saved on the computer and is always available in *ibaAnalyzer*. If “Save as global profile” is not selected, the profile is saved in the analysis.

You can set or change the settings of the profile selected in the list in the *Profile* tab. Changes in the profile can be saved.

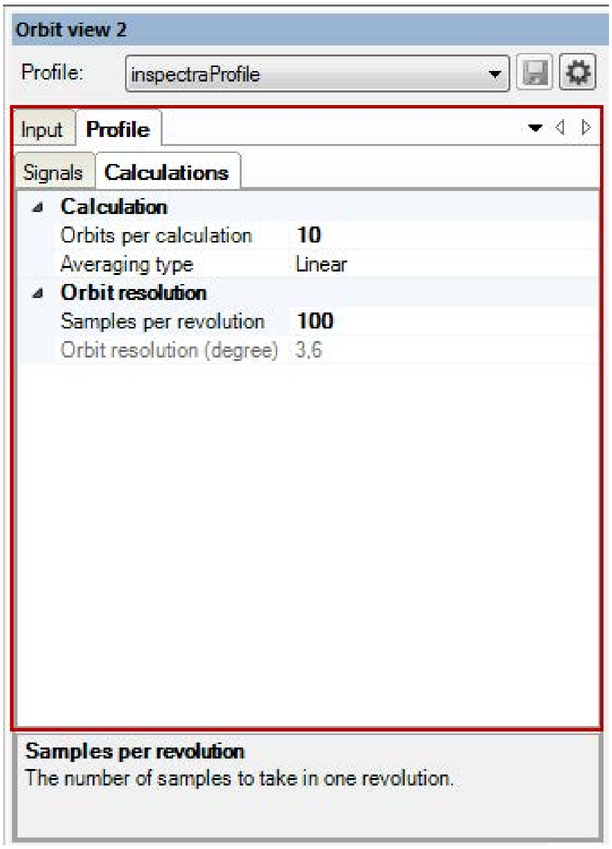


Fig. 118: Changing settings in the "Profile" tab

9.1.3 Configure profile

The different settings of the orbit profile are explained below. The settings for the orbit profile are divided into two categories. The tab *Signals* defines the ambient conditions of the measurement and visualization. The tab *Calculations* specifies the settings for the calculation of the visualized charts and characteristic values.

9.1.3.1 Signals

With almost all settings in the *Signals* tab, the option "Configure from the outside" can be selected. In this case, the inputs can be made similar to placeholders (ibaInSpectra Expert) outside the profile for the allocation of signals and are therefore not permanently defined in the profile.

"Bearings" section

Clearance diameter

The clearance diameter is the difference between the inner diameter of the bearing and the shaft diameter. The "sensor unit" specified under "sensor type" is used here as a unit.

This setting is used for the visualization for scaling the coordinate system and as a diameter for the drawn clearance diameter. This setting is also needed to calculate the parameters *Eccentricity* and *Distance to clearance*.

Shaft home position
Position of the shaft to which the zero position was determined. In most cases for horizontally set up machines, the home position or zero position is determined when the machine is not in operating mode and the shaft has set down. In this case, the shaft is at the bottom of the bearing and the home position “bottom” can be selected. Other setting options for the home position of the shaft are “Center” and "Top".

This setting is used in the visualization to set the zero point of the coordinate system. In addition, the home position is required to calculate the characteristic values *Eccentricity* and *Distance to clearance*.

"Sensor position” section

The sensor positions for *ibaInSpectra* are defined as follows:

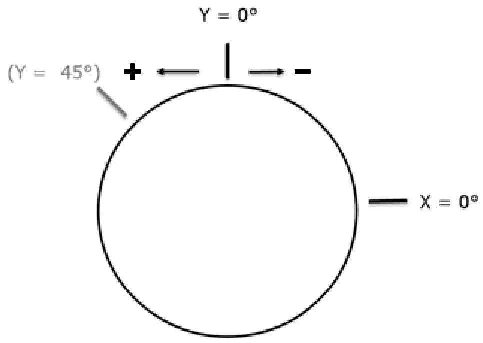


Fig. 119: Sensor positions

- Sensor Y is defined with 0° if it is placed on top of the clearance circle.
- Sensor X is defined with 0° if it is placed on the right side of the clearance circle.
- Phase reference is defined with 0° if it is placed on top of the clearance circle, like sensor Y.
- Angle deviations are defined negative in the clockwise direction and positive in the counter-clockwise direction.

Angle X
Angle deviation of the X-input signal (see definition)

Offset X
Offset of the input signal in the X-direction at the shaft home position. No offset is required if the X-input signal is 0 at the defined home position. (Offset X = 0). The offset is to be specified with 2 if the X-input signal is 2 at the defined home position. (Offset X = 2)

Angle Y
Angle deviation of the Y-input signal (see definition)

Offset Y
Offset of the input signal in the Y-direction at the shaft homeposition. No offset is required if the Y-input signal is 0 at the defined home position. (Offset Y = 0). The offset is to be specified with 2 if the Y-input signal is 2 at the defined home position. (Offset Y = 2)

Angle Keyphasor
Angle deviation phase reference (see definition). Required for the visualization and calculation of the characteristic value *Peak to peak max shaft angle*.

Direction of rotation
Shaft direction of rotation (positive: counter-clockwise; negative: clockwise). This value is only used for the visualization. If the direction of rotation changes, the setting *Configure from outside* can be selected and a signal that changes depending on the direction of rotation can be assigned to this setting.

"Sensor type” section

Sensor unit
The sensor unit defines which unit the X and Y-input signals have. In the ideal case, the input signals already have the correct unit and *Input signal unit* can be selected. Otherwise, the suitable unit can be selected from the drop-down list.

Note

A conversion from one unit to another is not performed here.

9.1.3.2 Calculations

"Calculations” section

Orbits per calculation
This setting is used to define how many revolutions of the shaft should be used for a calculation. This concerns both the calculation of the parameters as well as the visualization.

Averaging type
This setting specifies how the characteristic values and visualized curves should be determined for several orbits per calculation. Depending on the application and effects that are to be detected, the individual methods have advantages and disadvantages.

- *Linear*: For linear averaging, the average is determined across all revolutions for each data point. This method emphasizes the wave motion at 1X and suppresses other effects. That is why this setting is only recommended for orbit motions with dominant 1X.
- *Peak hold*: With this method, the coordinate system is divided into angle sectors based on the center of all orbits considered and the dot that is furthest away from the center of all orbits is saved for each angle sector. This results in the largest deflection of the shaft in each direction. This method is suitable for all orbit movements. It is the best way to illustrate the maximum orbit motion across several shaft revolutions. Other effects, such as rubbing of the shaft on the bearing (occurrence of an “inner loop") are, however, no longer detected using this method. This setting cannot be used to visualize the phase reference during the orbit motion.

Peak hold also determines the maximum distance from the center in all sectors for one revolution.

"Orbit resolution" section

The input signals are resampled depending on the speed in order to be able to compare the shaft motions with each other at different and changing shaft speeds. This so-called "order resampling" ensures that the same data points are always taken into consideration per revolution and the data points are always taken at the same angle of the shaft rotation.

Samples per revolution
This setting indicates how many data points are taken per revolution. If possible, make sure here that the sample rate at the expected maximum shaft speed is not significantly above the sample rate of the input signal. The value should only be selected as large as necessary.

Orbit resolution (degrees)
The resolution of the orbit resulting form the number of samples per revolution is shown here. The resolution is given in degrees of rotation angle of the shaft. This value can only be changed indirectly via the number of samples per revolution.

Example:

Samples per revolution = 36; orbit resolution = 360°/36 = 10°; The data points that are sampled during a revolution have a distance of 10°.

9.1.4 Calculation results

The *ibaInSpectra* orbit module automatically calculates a number of characteristic values based on the configured settings. Depending on the configuration (e.g. averaging), the characteristic values may have different informational value. That is why the module configuration is always to be taken into consideration when interpreting the results.

9.1.4.1 Results in ibaPDA

The results of the orbit calculations are available in *ibaPDA* as analog signals of the respective InSpectra orbit module in the *Analog* tab.

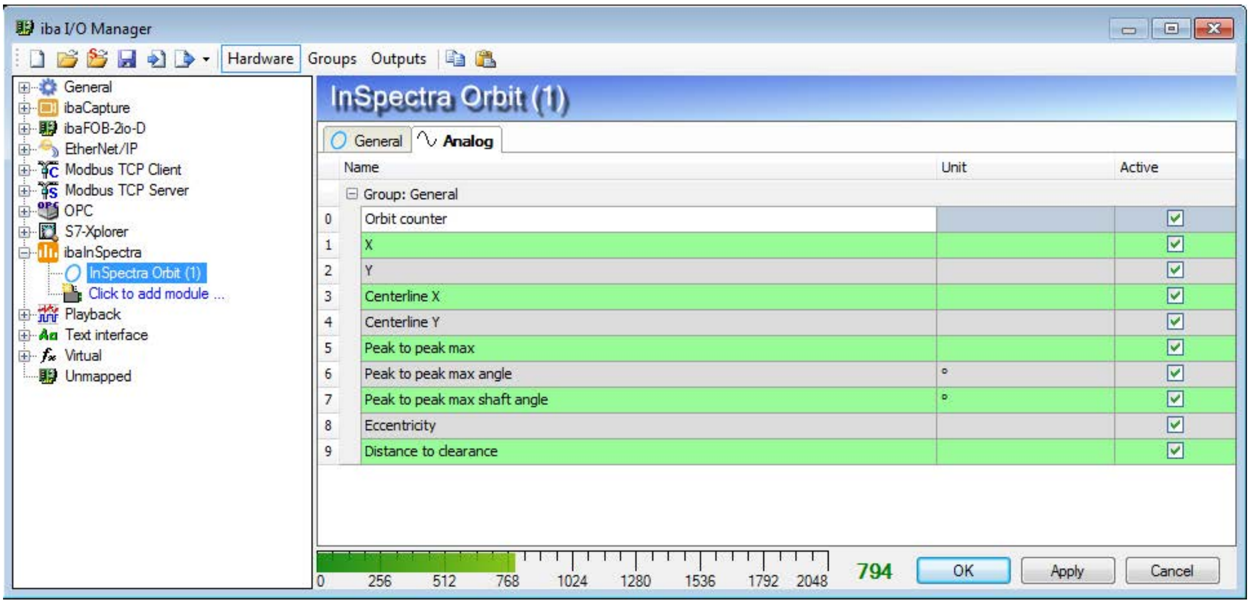


Fig. 120: Module InSpectra Orbit, Analog tab

Signals that are not required can be disabled in the right column.

9.1.4.2 Results in ibaAnalyzer

The results of the orbit analysis are shown for *ibaAnalyzer-InSpectra* in the results area at the bottom left in the Orbit view.

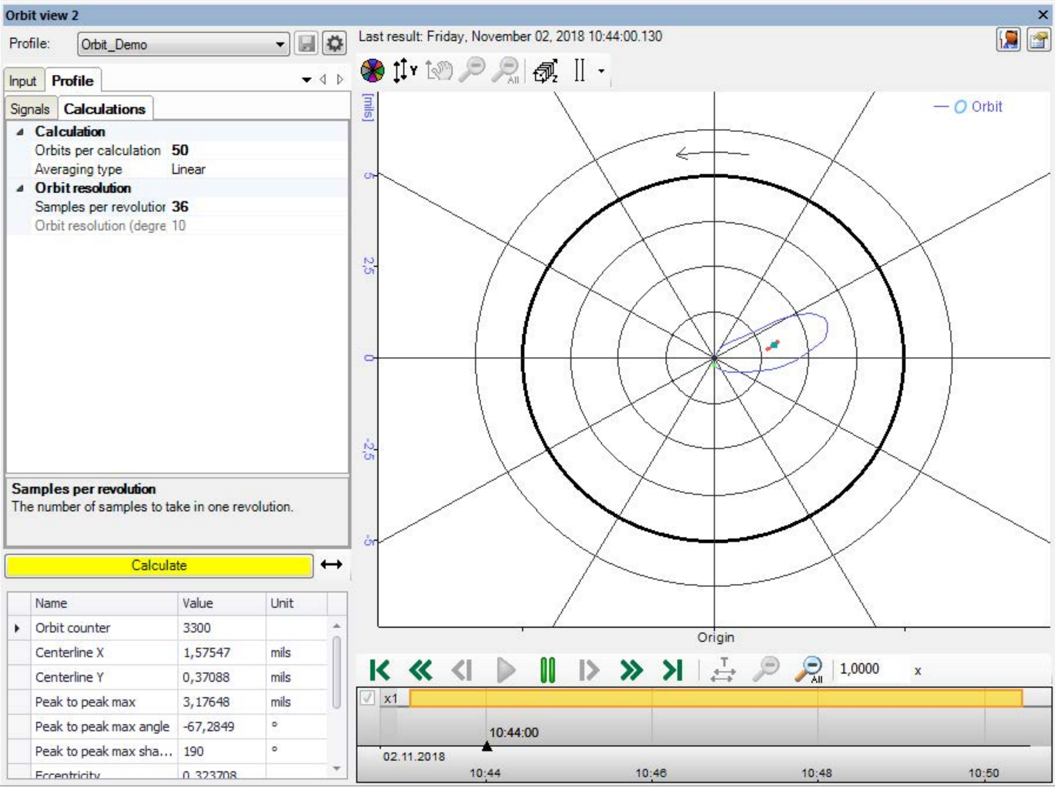


Fig. 121: Orbit view in ibaAnalyzer

The results always relate to the current cursor position of the playback area. The calculation is shown, which was calculated last before this time.

The context menu (right mouse click) opens a dialog where you can select which values should be displayed in the result area and which results should be available as signals in the signal tree.

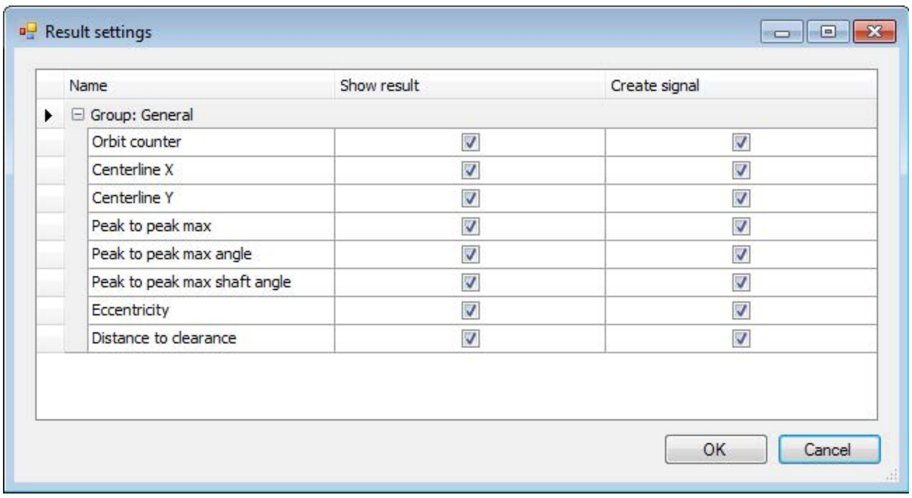


Fig. 122: Configuration dialog result settings

In the playback area at the bottom right, you can control the playback of the data file using the buttons and the slider. For a description, see chapter ➚ *Configuration of a calculation profile in ibaAnalyzer*, page 118

9.1.4.3 The calculated characteristic values and their output signals

Orbit counter
The *Orbit counter* specifies the number of orbits used so far for complete calculations.

X
The calculated current X-coordinate of the orbit while considering the sensor angle and the offsets. The result is shown in the configured sensor unit.

Y
The calculated current Y-coordinate of the orbit while considering the sensor angle and the offsets. The result is shown in the configured sensor unit.

“X” and “Y” also define the visualization of the orbit in the Orbit view.

Centerline X
X-coordinate of the center of all orbits used for the calculation. The result is shown in the configured sensor unit.

Centerline Y
Y-coordinate of the center of all orbits used for the calculation. The result is shown in the configured sensor unit.

“Centerline X” and “Centerline Y” also define the visualization of centerline in the Orbit view.

Peak to peak max
“Peak to peak max” is the “peak to peak vibration displacement” according to DIN ISO 7919. The distance of the two dots of the orbit, which are furthest away from each other, are determined here. In this way, a statement can be made about the maximum shaft motion. The value is determined based on the result of the averaging if several orbits are averaged for one calculation. The result is shown in the configured sensor unit.

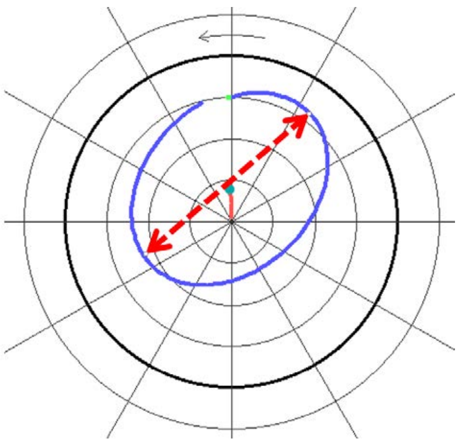


Fig. 123: Peak to peak max

Peak to peak max angle

This characteristic value specifies the angle to the bearing at which the “peak to peak max” value occurs. 0° is defined vertically in the upper part here. Angle deviations are defined negative in the clockwise direction and positive in the counter-clockwise direction. The decision which of the two possible angles of the “peak to peak max” line with the vertical line through the center point is selected depends on which of the two peak points is closer to the clearance diameter. The result is expressed in degrees.

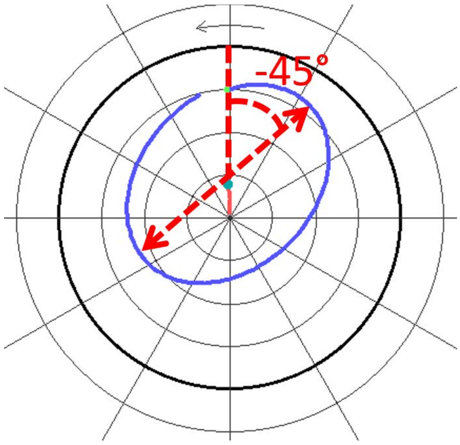


Fig. 124: Peak to peak max angle

Peak to peak max shaft angle

This characteristic value specifies the angle of rotation at which the shaft is located at the time the “peak to peak max” value occurs. The angle is positively specified in the direction of rotation and the angle is selected for this characteristic value whose peak point is closer to the clearance diameter. Averaging across several orbits, especially with the “peak hold” methods, has a negative impact on the significance of this characteristic value. The result is expressed in degrees.

Eccentricity

Eccentricity is the deviation of the center point of the orbit from the center point of the bearing relative to the clearance circle diameter. The characteristic value is 0 if both center points overlap exactly and 1 if the center point of the orbit is on the clearance diameter.

Distance to clearance

This characteristic value specifies the distance between the characteristic value and the point of the orbit with the smallest distance to the clearance diameter. The result is shown in the configured sensor unit.

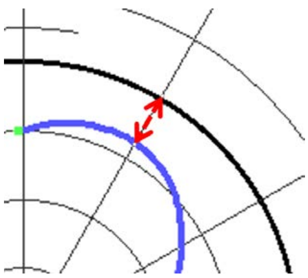


Fig. 125: Distance to clearance

9.2 Orbit view

A new Orbit view can be opened using the "Add Orbit view" button. This button is in the toolbar or can be added to the toolbar as a button both in *ibaPDA* and in *ibaAnalyzer*. The Orbit view in *ibaPDA* and *ibaAnalyzer* is identical.

9.2.1 Elements of the Orbit view

The toolbar is located to the left above the Orbit view. The control elements are largely identical to those of the other views.

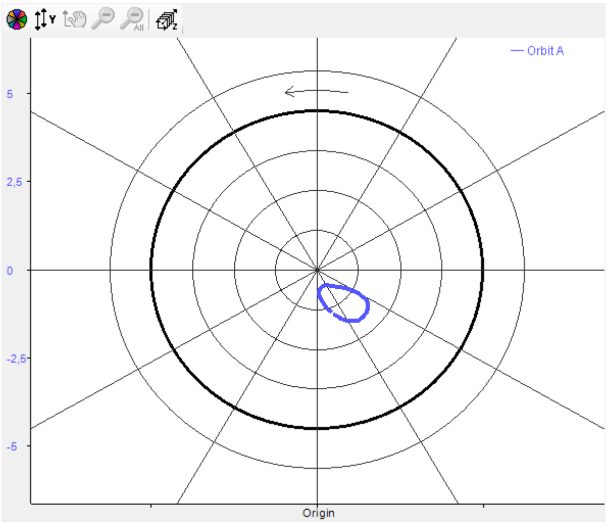


Fig. 126: Elements of the Orbit view

The exception is the button *Toggle isometric perspective* .That can be used to switch between 2D and isometric 3D view.

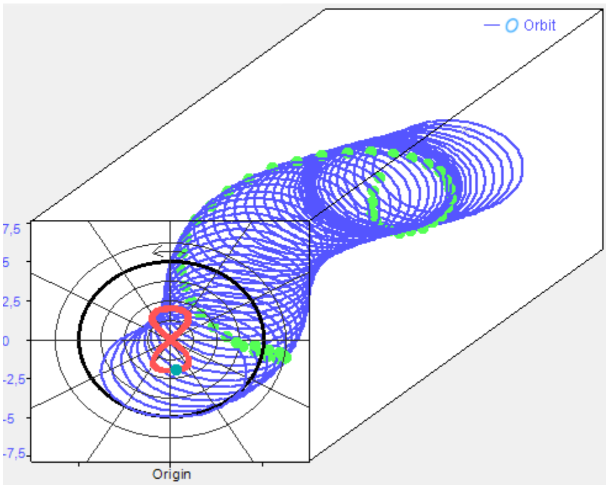


Fig. 127: Isometric 3D view

Note

In the isometric view, the perspective "Front" can be set via the context menu. In this way, several planes (temporally consecutive orbit results) are displayed in a 2D front view. This is particularly helpful if a recurring orbit movement is over several wave revolutions or if 1X is not dominant.

9.2.1.1 Orbit circle

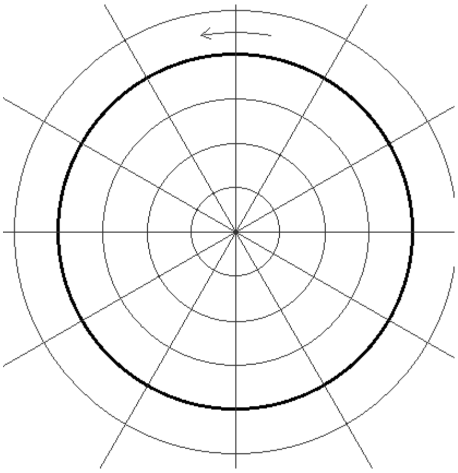


Fig. 128: Orbit circle

The background of the Orbit view is a so-called orbit circle, similar to a polar coordinate system. The circular grid lines show the distance to the center of the system while the straight lines divide the circle into angular sectors. The thicker circle symbolizes the clearance circle. Simplified, it can be regarded as the inner surface of the bearing. The arrow above the clearance circle shows the direction of rotation of the shaft.

9.2.1.2 Orbit

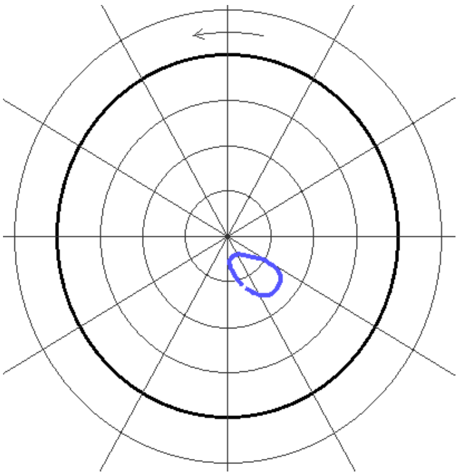


Fig. 129: Orbit view

The orbit itself is the appearance of the X/Y data pair during a (or several) revolution(s) of the shaft. Neglecting effects such as the surface condition of the shaft, the orbit represents the motion of the center of the shaft during the rotation of the shaft.

9.2.1.3 Phase reference

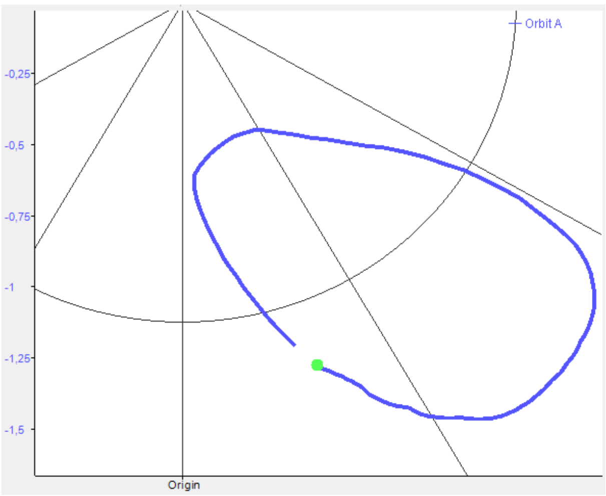
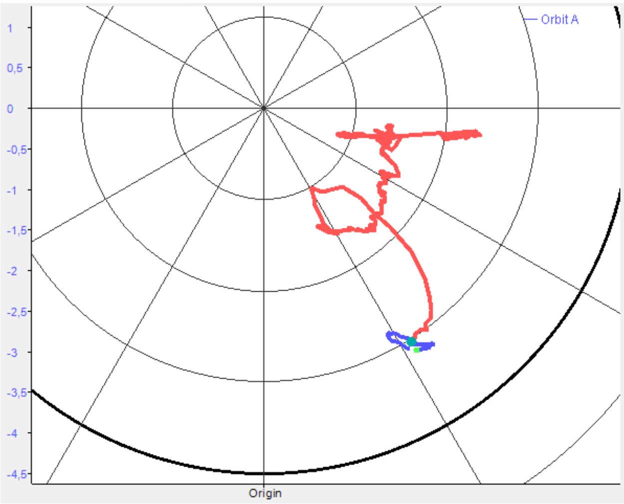


Fig. 130: Phase reference

The phase reference indicates at which dot on the orbit motion the zero point of the phase reference occurred during the shaft rotation. The “Blank-bright convention” is used here. This means that in the course of the movement the phase reference is represented by a gap with a following dot.

9.2.1.4 Centerline



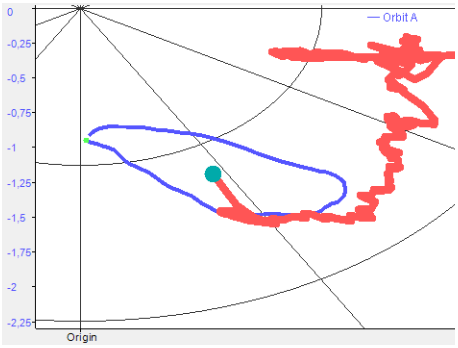


Fig. 131: Centerline

The centerline is the visualization of the orbit center points across a defined number of calculations. The center point of the current orbit is highlighted in color. The centerline shows the position of the shaft over a longer period of time, such as during a startup.

9.2.1.5 Speed steps

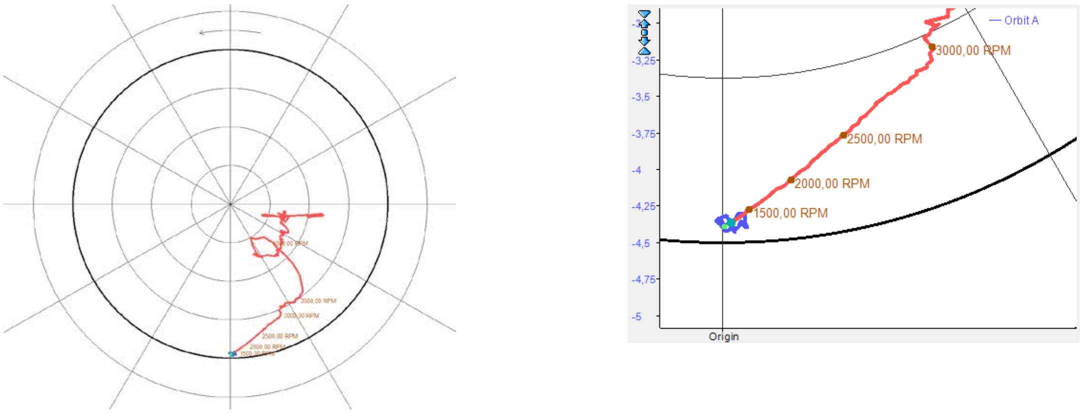


Fig. 132: Speed steps

In order to analyze the behavior during start-up or shutdown, there is an option to display the speed steps on the centerline. These generated dots indicate at which position on the centerline a certain speed was exceeded or undershot for the first time.

9.2.1.6 Sensor positions

You can enable the display of the sensor positions in the properties dialog of the Orbit view. See chapter ➚ *Configuration*, page 153.

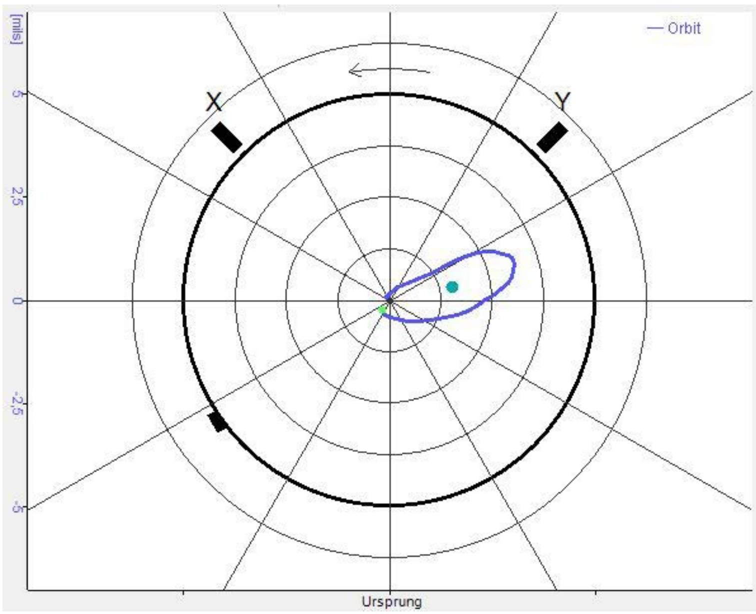


Fig. 133: Sensor positions

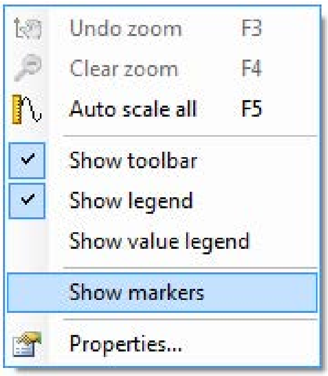
The position of sensor X and Y are configured as shown under ‘Sensor position’ in the *Signals* tab. The position of the phase reference is visualized by the two dots.

9.2.1.7 Markers

Markers can be shown for a better analysis. You can enable or disable the display of the marker either:

- with the marker button in the toolbar of the Orbit view

- select *Show markers* in the context menu of the Orbit view



2 markers are displayed, which can be moved in 2 planes with the mouse button pressed. If you click on the black cross, you can shift the markers in the X and Y direction at the same time. On red lines, you can shift a marker in the X or Y direction.

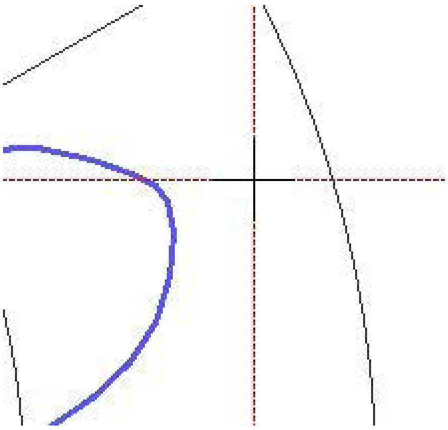


Fig. 134: Marker display

If you cannot see the markers any more after a zoom operation, you can use the *Center marker* function to bring it back into the middle of the visible area.

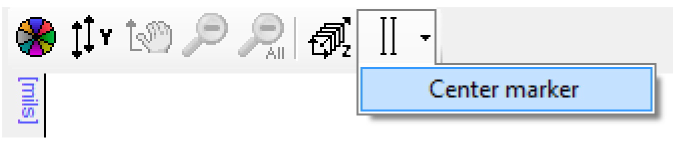


Fig. 135: Center marker

Click on the arrow symbol at the marker button in the toolbar and then on *Center marker.*

Values in the legend
The value legend can be displayed in order to see the marker positions. Select *Show value legend* in the context menu of the Orbit view.

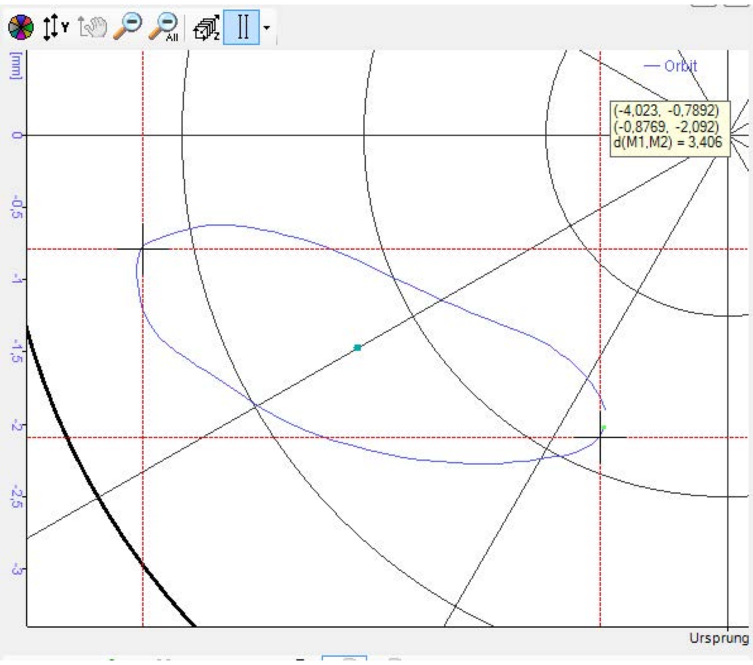


Fig. 136: Markers with value legend

In the value legend, the positions of both markers are given in the X-Y coordinates and the distance of both markers to each other is displayed.

9.2.2 Configuration

Right click in the view to open the context menu and select “Properties.” All settings for the Orbit view can be made in the properties dialog.

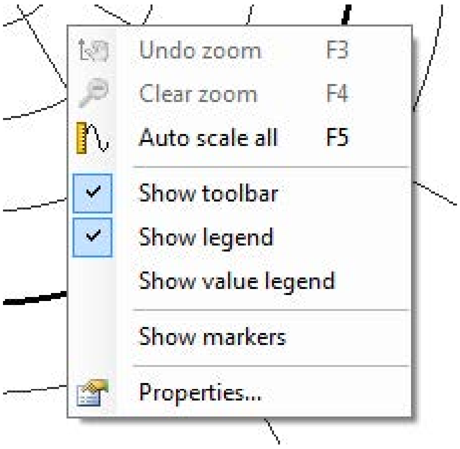


Fig. 137: Context menu of the Orbit view

The settings of the individual appearance options of the orbit are made under the point “Items” in the respective item.

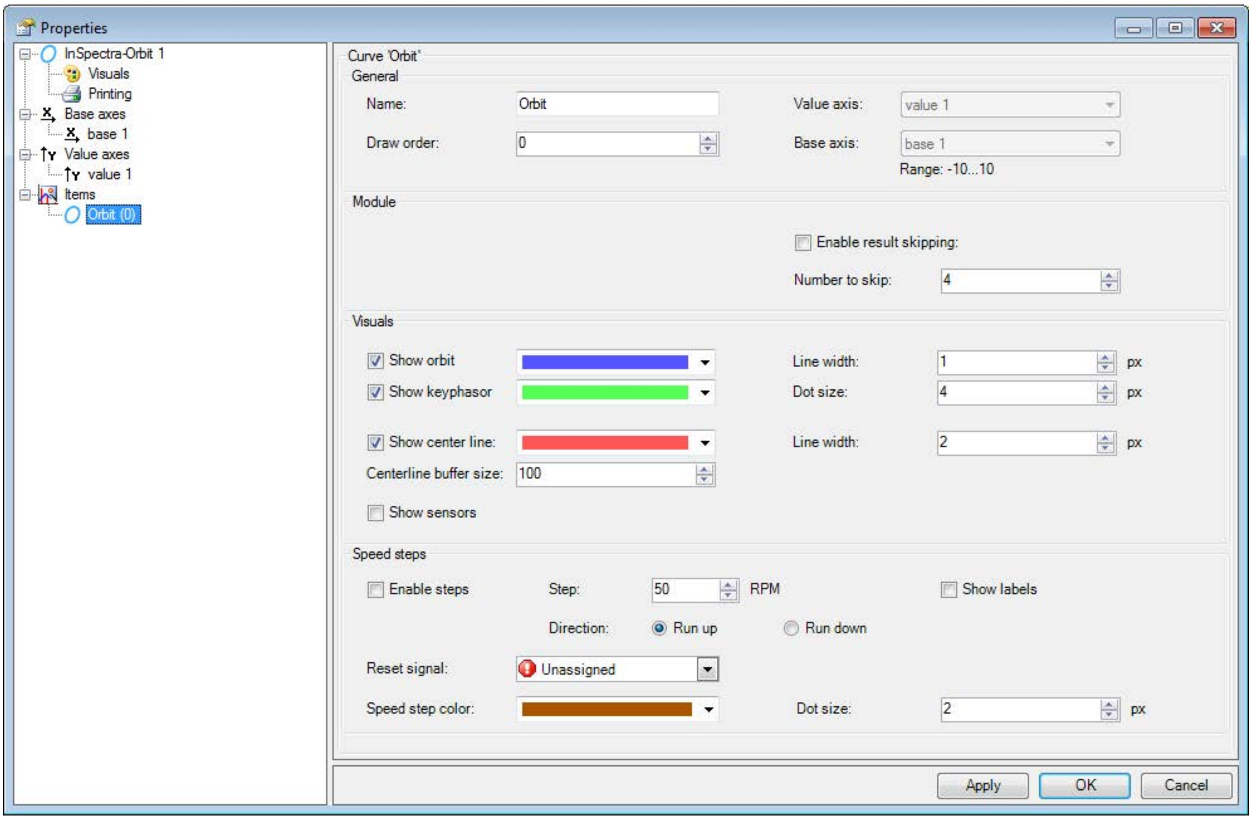


Fig. 138: Properties dialog

Name: The name of the item can be changed here. This name is also shown as a legend in the Orbit view.

Orbit module (only *ibaPDA*): The Orbit module can be selected here.

Enable result skipping: If all calculated orbits cannot be visualized, orbits can be skipped for the visualization. The calculation of the parameters is not affected by this.

Number to skip: Number of orbits that are ignored for the visualization.

Show centerline: Defines whether the centerline should be displayed.

Color of the centerline: The color of the centerline can be selected here. The color highlighting of the current dot cannot be influenced and depends on the color of the centerline.

Line width: Defines the thickness of the centerline.

Show orbit: Defines whether the orbit of the shaft motion should be displayed.

Color of orbit: The color of the orbit of the shaft motion can be selected here.

Line width: Defines the thickness of the line used to draw the shaft motion.

Show keyphasor: Defines whether the keyphasor should be displayed.

Color of the keyphasor: The color of the keyphasor can be selected here.

Dot size: Defines the size of the dot representing the keyphasor.

Enable steps: Enables the speed steps in the Orbit view.

Step: The amount of the speed steps is defined here.

Show labels: If this option is selected, the speed value of the respective step is shown in addition to the dots on the centerline.

Direction: This defines whether a run-up or run down should be observed.

Reset signal: Speed steps are only shown at the point where they are reached for the first time. This signal can be used to clear the previous dots and start a new monitoring.

Speed step color: The color of the speed steps and labels can be selected here.

Dot size: Defines the size of the dot representing the speed steps and labels.

9.2.3 Using the Orbit view

The most important tips and tricks:

- To change the perspective of the isometric 3D view, you can pull the small gray cross on the back of the coordinate system to the desired position using the mouse.
- As with other views in *ibaPDA*, you can zoom into and out of the view by scrolling on the axes. Both axes are always changed in the same aspect ratio here.
- Within the view, depress the left mouse button to select an area to zoom into. If the <Shift> key is pressed at the same time, the aspect ratio of the area of the view is adjusted.
- Speed steps can be reset in the context menu with *Reset speed steps*.

9.3 Creating an orbit module in ibaPDA

1. Open the I/O manager in *ibaPDA*.
2. Proceed as described in chapter ↗ *Create and manage profiles in ibaPDA*, page 137 in steps 2 and 3. If a suitable profile already exists, you do not need to create a new profile.
3. Now configure the general settings for the module in the *General* tab.

The results of the orbit calculation are available as analog signals in the *Analog* tab. See chapter ↗ *Results in ibaPDA*, page 144

9.3.1 "General" tab

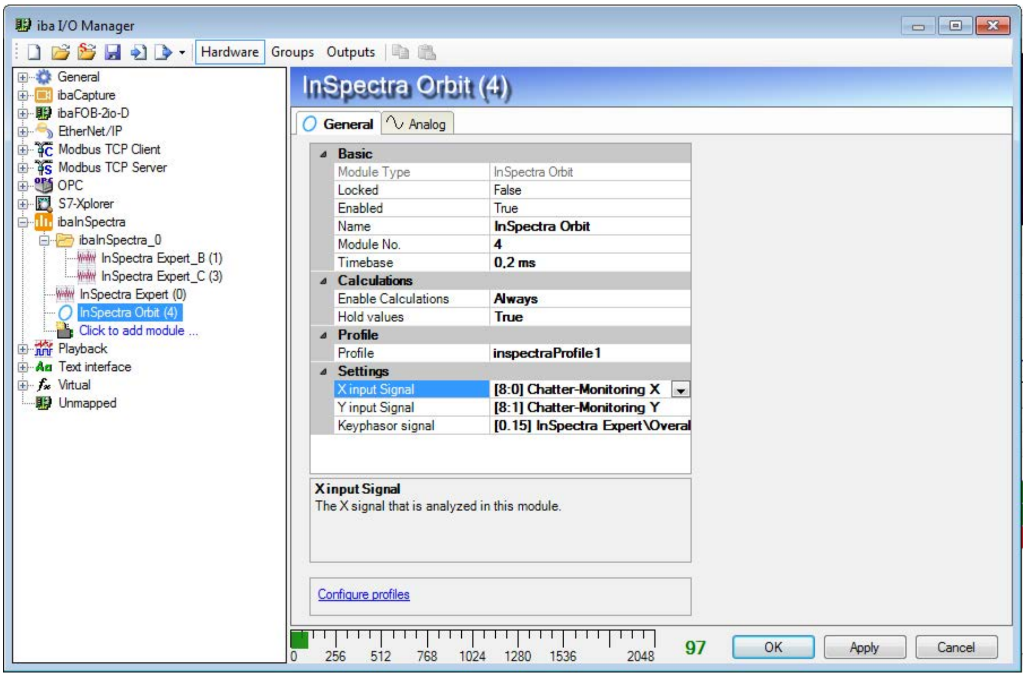


Fig. 139: Orbit module, General tab

Basic settings and **Calculations** see chapter ↗ *"General" tab*, page 108

Profile
Select the requested profile from the drop-down list for analyzing the selected signal. If no profile is available or a suitable profile is missing, you have to define a profile first. Please read the explanations in chapter for this purpose ↗ *Configure profile*, page 140

Settings

X input signal
The X-signal, which is analyzed with this module

Y input signal
The Y-signal, which is analyzed with this module

Keyphasor signal
Digital signal that describes the phase position of the shaft.

9.4 Configuration of a calculation profile in ibaAnalyzer

ibaAnalyzer-InSpectra makes it possible to configure calculation rules in the form of profiles off-line and to test them on recorded data.

Open a data file containing the signals to be examined either

- via the menu *File - Open data file ...*
- or drag a data file via drag & drop from the Windows Explorer into the opened *ibaAnalyzer* program window

Open an Orbit view with the Orbit button in the toolbar, see chapter ↗ *Orbit view*, page 148

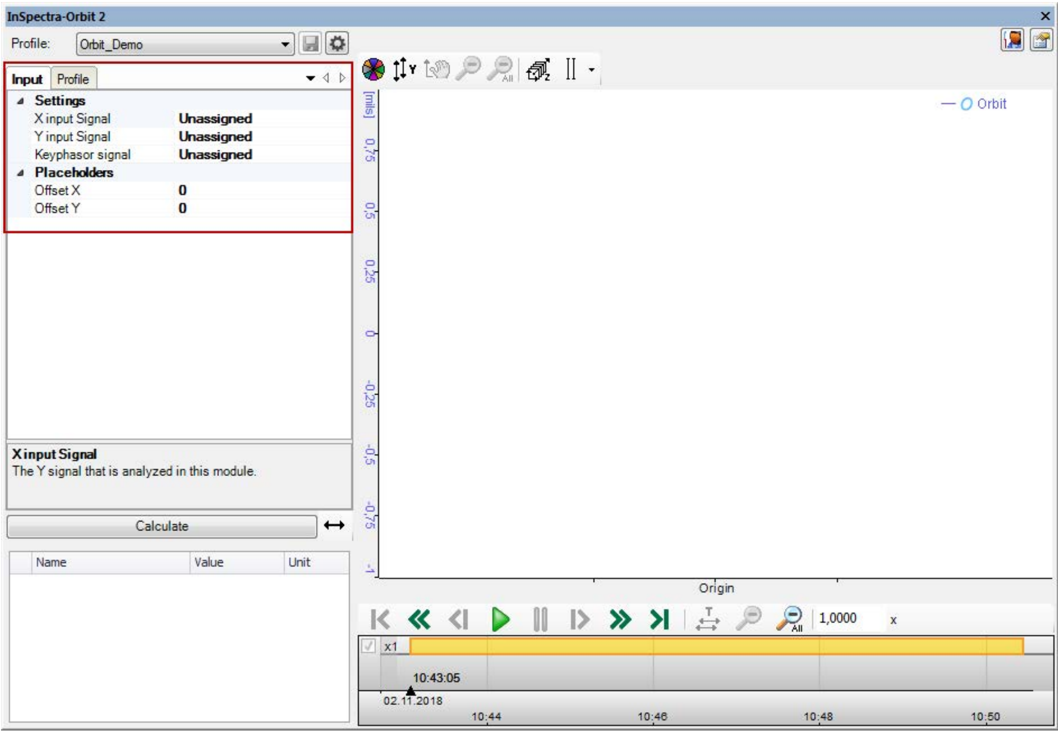


Fig. 140: Orbit view

In the Orbit view in the *Input* tab, select the X input signal, the Y input signal and the keyphasor signal each from the drop-down list or drag the signal from the signal tree to the respective field using drag & drop. Specify the offset of the input signal in the X and Y-direction, if necessary. See chapter ↗ *Signals*, page 140

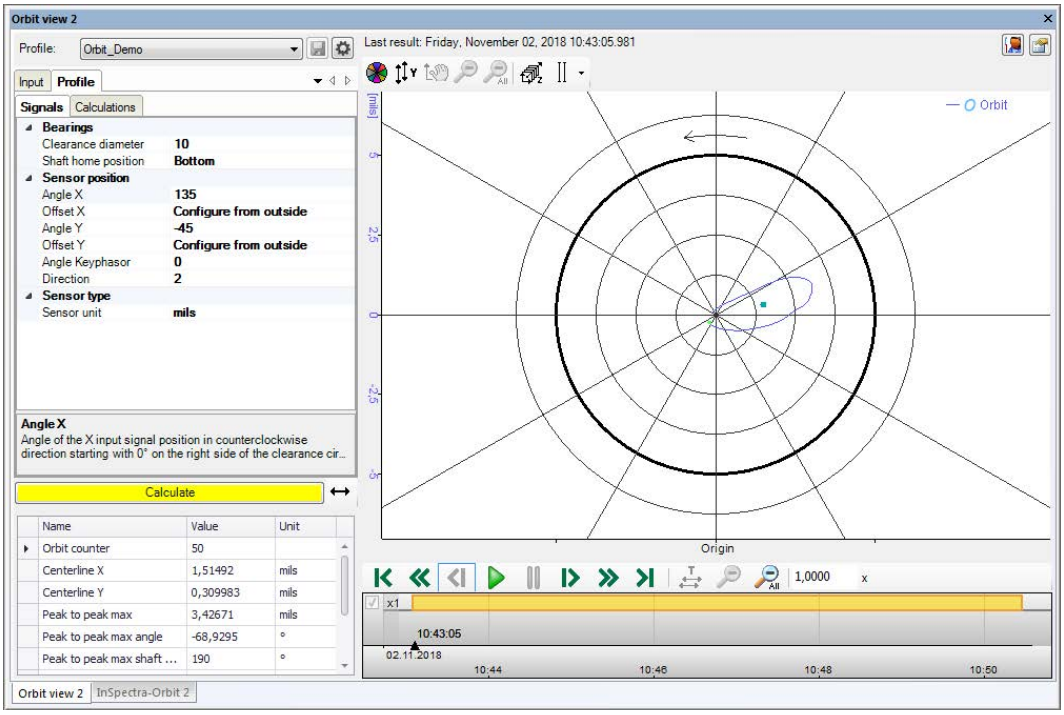


Fig. 141: Orbit view, profile settings

In the *Profile* tab, you can now create a calculation profile or, if profiles have already been imported or created, you can select a profile from the drop-down menu. The parameters for the calculation rules are identical to the parameters in *ibaPDA*. See chapter ➚ *Configure profile*, page 140

You can save configured profiles using the diskette button. If you change the name, export profiles or would like to import profiles from *ibaPDA*, open the profile manager by using the button. See chapter ➚ *Create and manage profiles in ibaPDA*, page 137.

The calculation is started by pressing the <Calculate> button. The result can be analyzed in detail in the Orbit view on the right. The properties and settings in the Orbit view in *ibaAnalyzer-InSpectra* are identical to the Orbit view in *ibaPDA*. See chapter ➚ *Configuration*, page 153

Playback area

In the playback area, you can control the playback of the data file using the buttons and the slider. See chapter ➚ *Playback area*, page 26.

10 The Fan module

The fan module is only available in *ibaPDA*. It is used to monitor fans and calculates special indicators for the state of fans:

- Imbalance
- Blade (indicator of structural problem of a blade)
- Blade rubbing
- Flow turbulence

Adding a fan module

Add a fan module by clicking in the I/O manager in the interface tree on the link under ibaInSpectra (*Click to add module*) and select *InSpectra Fan*.

Alternatively, you can highlight ibaInSpectra in the interface tree, open the context menu using the right mouse button and select *Add module – InSpectra Fan*.

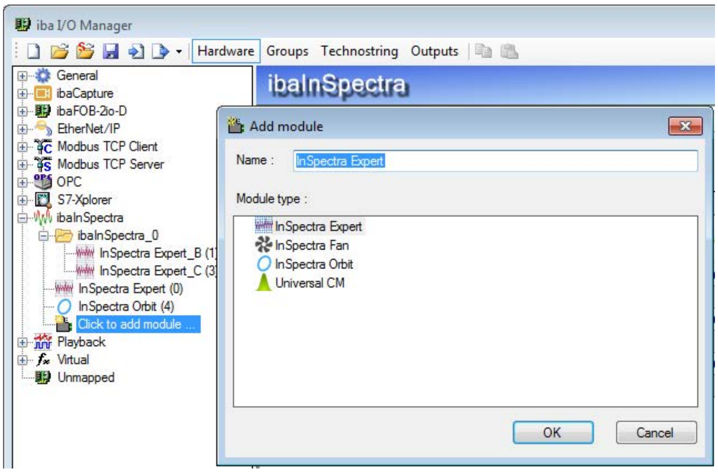


Fig. 142: Add fan module

10.1 Settings and signals

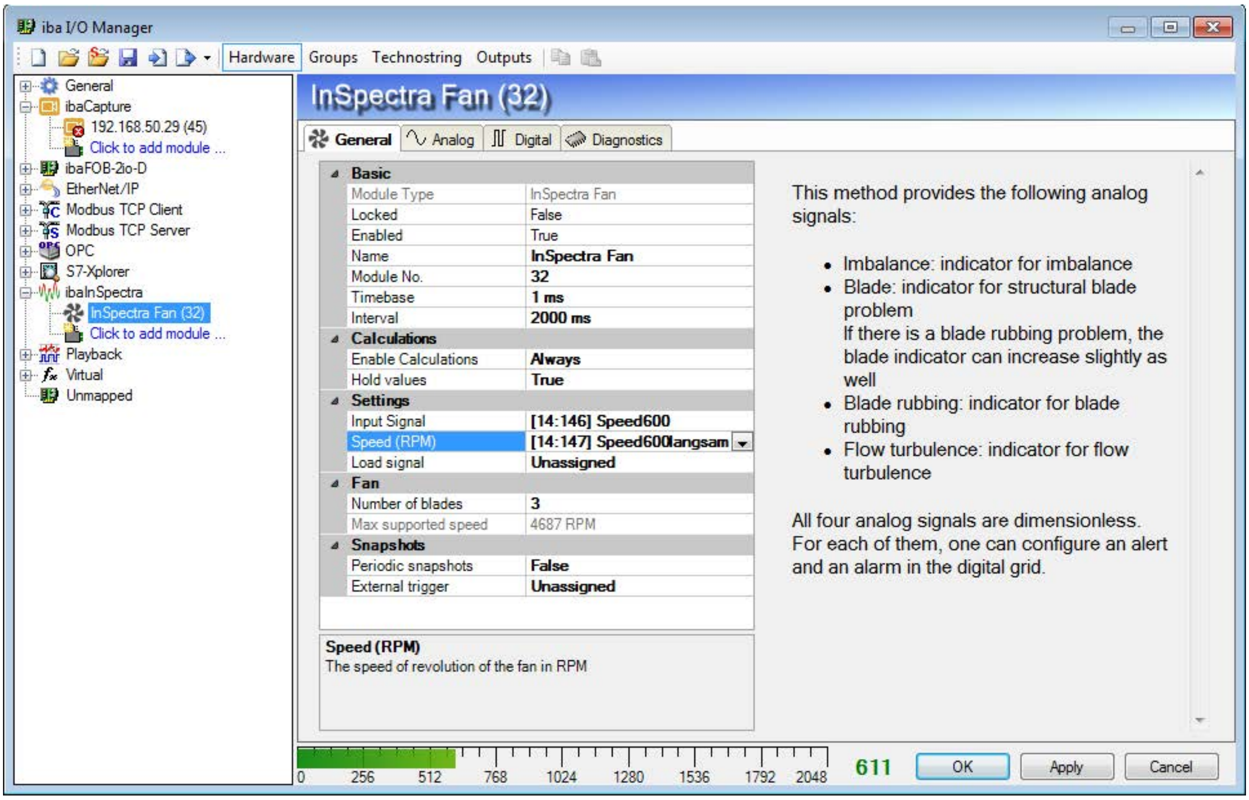


Fig. 143: Module InSpectra Fan, General tab

Basic settings

See General Settings, chapter ➚ *“General” tab*, page 108

Calculations

Enable calculations

With this setting, you can control whether the calculations should always be performed or controlled by a signal. There are two options available:

- Always
  With this setting, the calculation is permanently executed.
- Select signal
  As an alternative, all digital signals, including the virtual signals, are available to choose from to enable the calculation (selected signal = TRUE) or to disable it (selected signal = FALSE).

Hold values

If you set this option to TRUE, the values of the most recent calculation remain visible in the online display of the fan module, even if the calculation is disabled by a control signal.

If you set this option to "FALSE," the display is cleared and the computed values are set to 0 if the computation is disabled by a control signal.

Settings

Input signal
Select the input signal here for which the characteristic values are to be determined. All analog signals configured in *ibaPDA* are available in the signal tree.

Speed (rpm)
Select the signal for the fan speed in rpm here.
Note: If you use a speed signal, this can be converted to rpm using virtual modules.

Load signal
The load signal is optional. It is saved in the snapshot file.

Fan

Number of blades
Enter the number of the fan blades here.

Max. supported speed
This fan module only works correctly if the current speed is lower than the supported maximum speed. You can increase this value by increasing the sample rate of the input signal.

Snapshots

See chapter ➚ *Snapshots*, page 169.

10.2 "Analog" tab

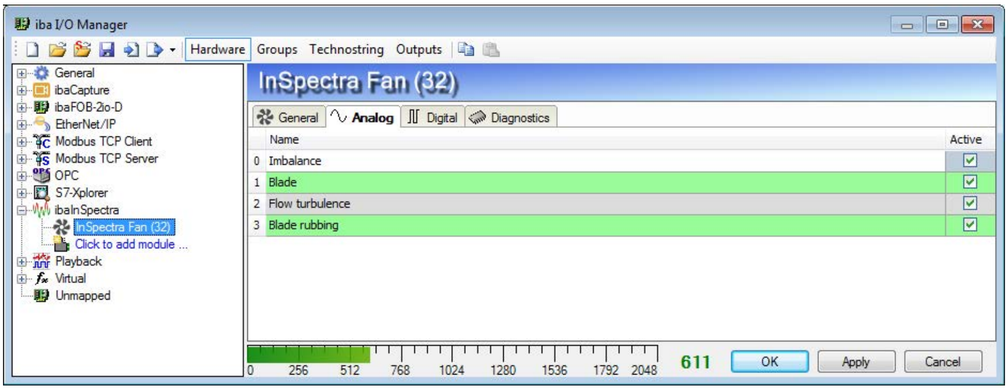


Fig. 144: Module InSpectra Fan, Analog tab

The *Analog* tab contains the 4 determined indicators of ‘imbalance,’ ‘blade,’ ‘flow turbulence’ and ‘blade rubbing’ as an analog signal. The analog signals are dimensionless and have no unit.

The purpose is to monitor the trend of these signals. An increasing long-term trend indicates a fan problem.

The InSpectra fan module can also be used to monitor in real time with short-term warnings or alarms. See the *Digital* tab.

10.3 "Digital" tab

In the *Digital* tab, you can set alerts or alarms for the analog signals. To do this, click on the button in the “Event parameters” column and define the events in the event editor. Also see Universal CM module.

Alternatively, you can display 3 additional columns with the names “Limit,” “Deadband” and “Time (ms)” via the context menu in order to enter the corresponding expressions in the respective column immediately.

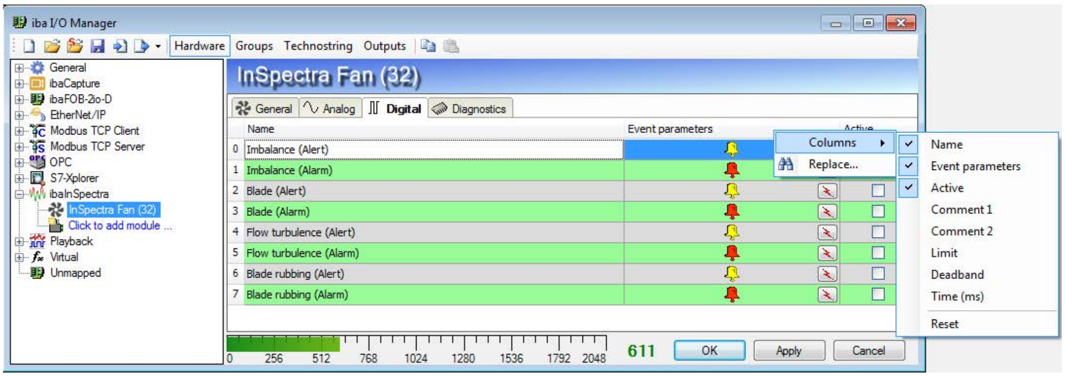


Fig. 145: Digital tab with button for opening the event editor

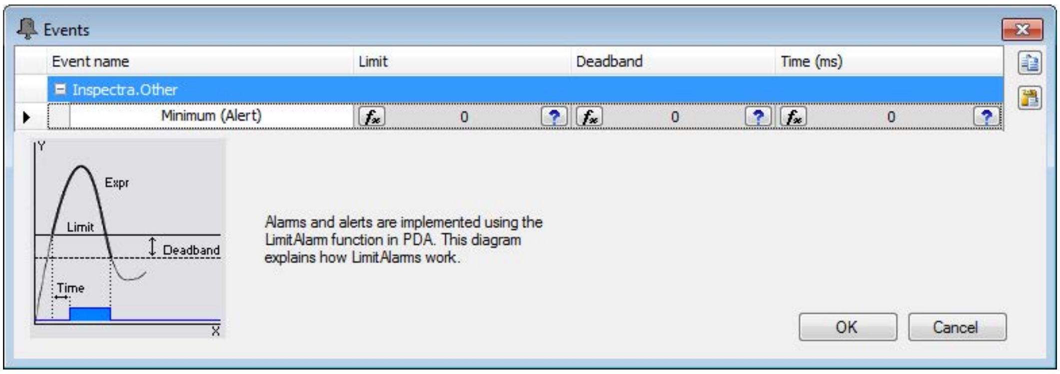


Fig. 146: Event editor

10.4 Snapshots

The fan module always creates snapshot files in pairs: one time snapshot file and one spectrum snapshot file.

The time snapshot file contains the following signals / info fields:

- Input signal (time-based)
- Speed / load signal
- Envelope curve (time-based)
- Averaged characteristic values (imbalance, blade, flow turbulence, blade rubbing)

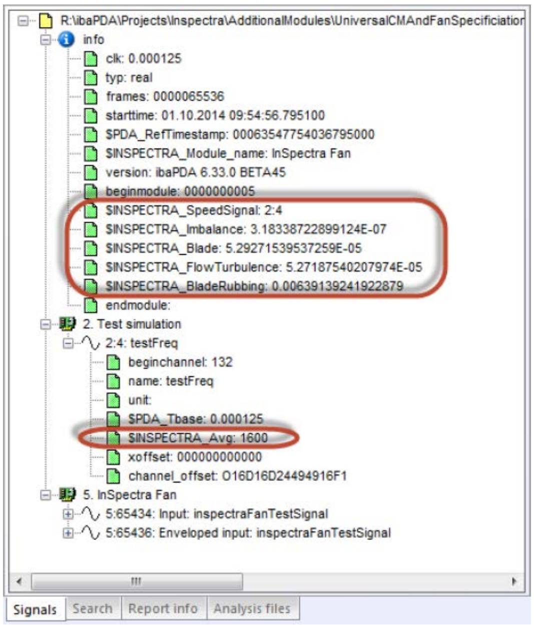


Fig. 147: Time snapshot file

The spectrum snapshot file contains the following signals:

- Input spectrum
- Envelope spectrum

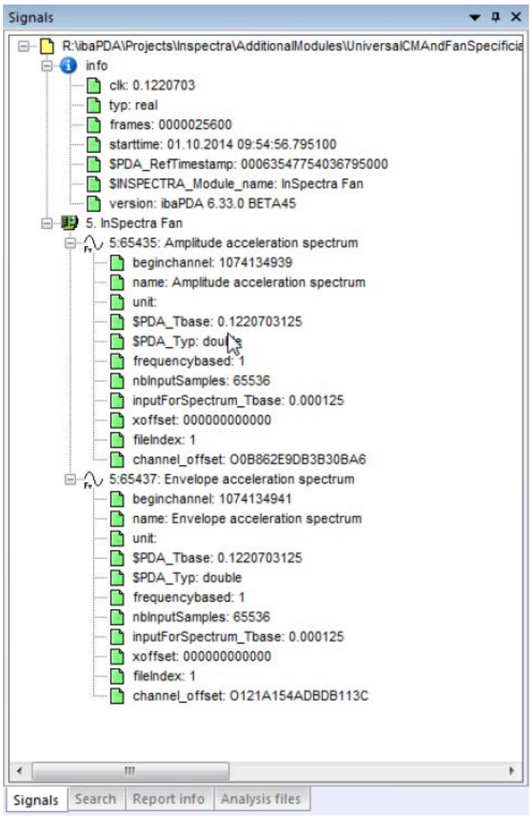


Fig. 148: Spectrum snapshot file

11 The Universal CM module

The Universal CM module is only available in *ibaPDA*. It determines the most common characteristic values for vibration monitoring in the time domain:

- Minimum
- Maximum
- Average
- Peak to Peak (Maximum-Maximum)
- RMS (square average)
- Crest
- Skewness
- Kurtosis

Adding a Universal CM module

Add a Universal CM module by clicking in the I/O manager in the interface tree on the link under ibaInSpectra (*Click to add module*) and select *Universal CM*. Alternatively, you can highlight ibaInSpectra in the interface tree, open the context menu using the right mouse button and select *Add module - Universal CM*.

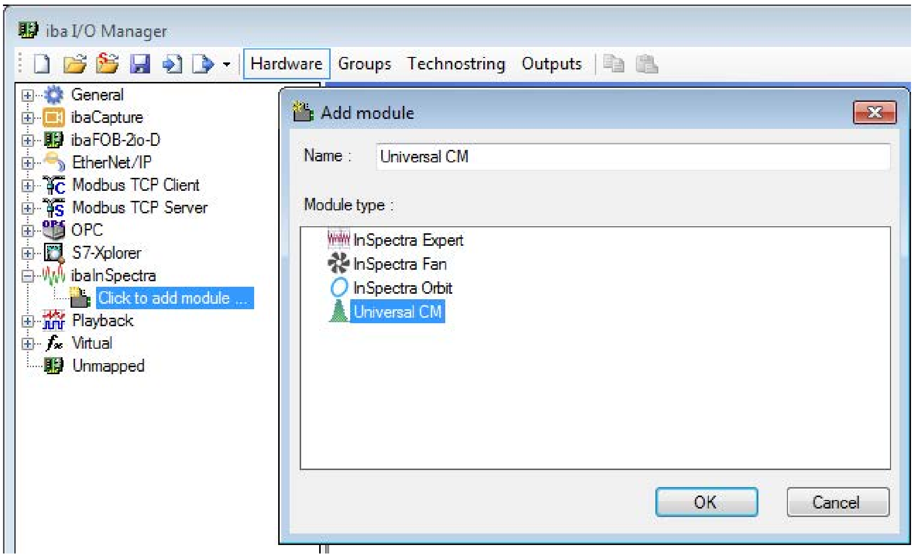


Fig. 149: Add Universal CM module

11.1 Settings and signals

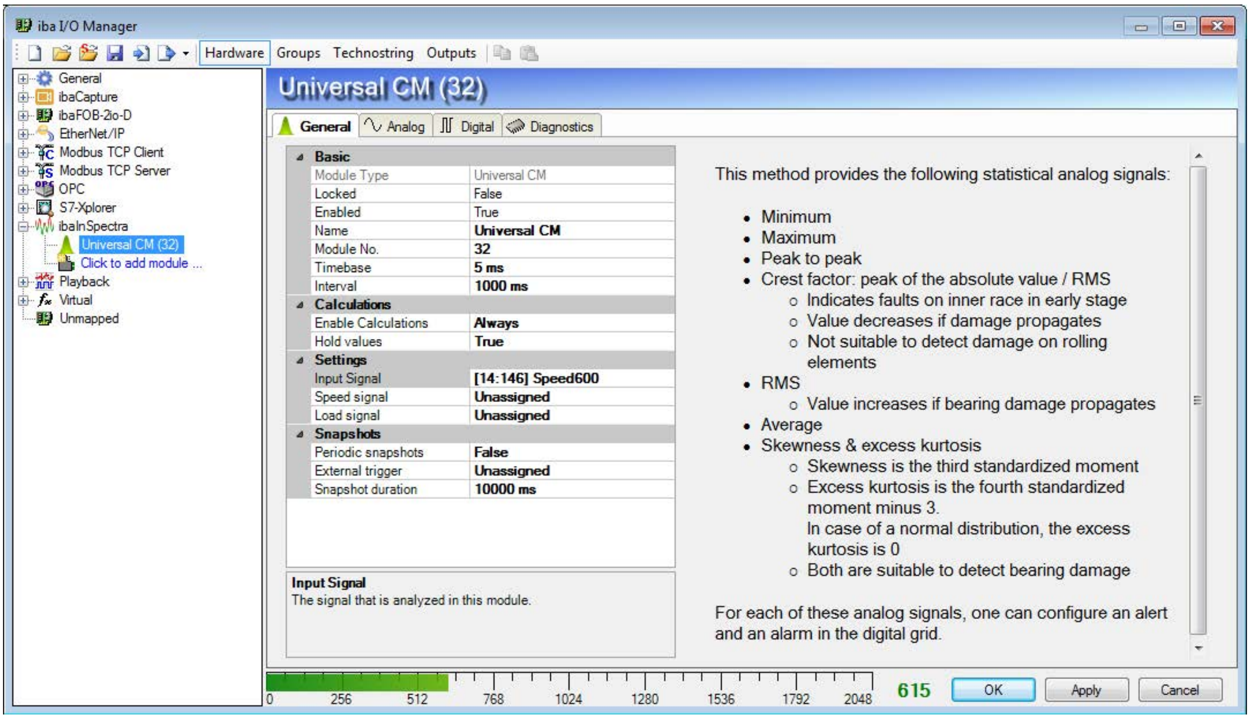


Fig. 150: Universal CM module, General tab

Basic settings

See general module settings, chapter ➚ *"General" tab*, page 108.

Timebase

The module re-calculates the characteristic values every time per set time base with a moving window, which corresponds to the length of the interval.

Interval

The interval must be a multiple of the timebase, but may not be higher than 10,000-times the timebase.

Calculations

Enable calculations

With this setting, you can control whether the calculations should always be performed or controlled by a signal. There are two options available:

- Always
  With this setting, the calculation is permanently executed.
- Select signal
  As an alternative, all digital signals, including the virtual signals, are available to enable the calculation (selected signal = TRUE) or to disable it (selected signal = FALSE).

Hold values
If you set this option to TRUE, the values of the most recent calculation remain visible in the online display of the module, even if the calculation is disabled by a control signal.

If you set this option to "FALSE," the display is cleared and the computed values are set to 0 if the computation is disabled by a control signal.

Settings

Input signal
Select the input signal here for which the characteristic values are to be determined. All analog signals configured in *ibaPDA* are available in the signal tree.

Load signal /speed signal
The speed and load signal are optional settings. They are only saved in the snapshot files.

Snapshots

Periodic snapshots
If snapshots are to be created periodically, you have to specify a storage interval and a range of operation. The range of operation signal is a digital signal that determines whether the period snapshot is taken immediately or whether the snapshot is delayed. The periodic snapshot is taken as soon as the “range of operation signal” for the entire buffer time for the snapshot is TRUE.

External trigger
You can select a digital signal here that triggers a snapshot with a rising edge.

Snapshot duration
Length of the time frame used for snapshot calculations.

11.2 Analog tab

The *Analog* tab contains the determined statistic analog signals. The signal name and units are assigned automatically. The unit corresponds to the unit of the input signal.

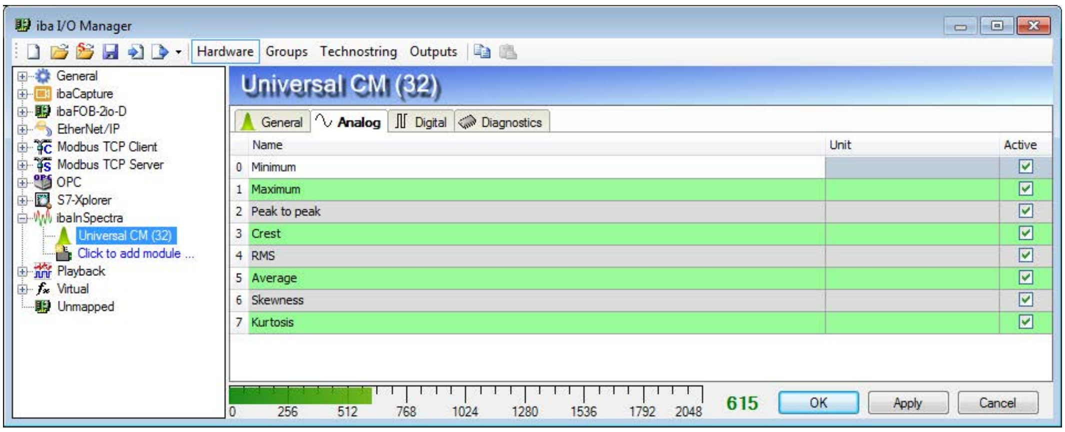


Fig. 151: Universal CM module, analog tab

11.3 "Digital" tab

In the *Digital* tab, you can set alerts or alarms for the analog signals. To do this, click on the button in the “Event parameters” column and define the events in the event editor.

Alternatively, you can display 3 additional columns with the names “Limit,” “Deadband” and “Time (ms)” via the context menu in order to enter the corresponding expressions in the respective column immediately.

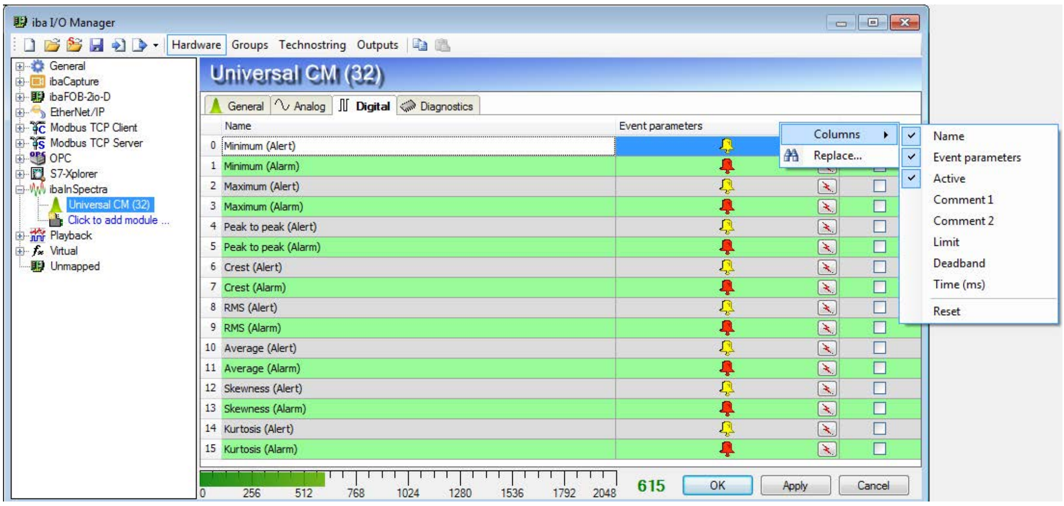


Fig. 152: Digital tab with button for opening the event editor

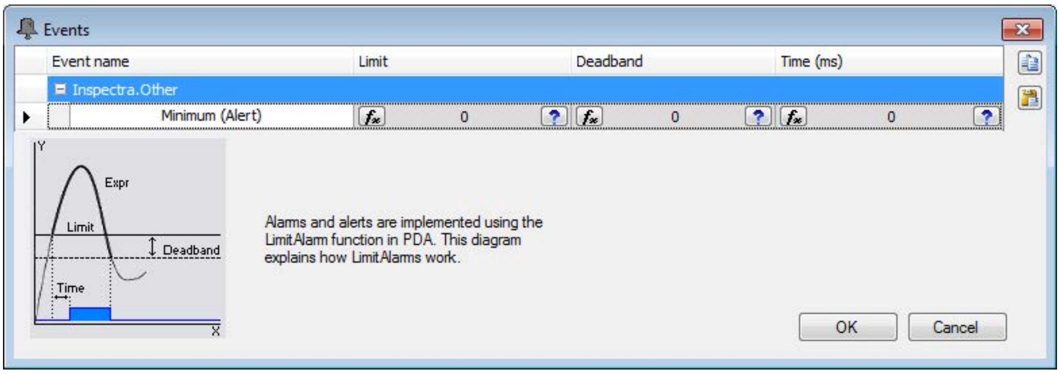


Fig. 153: Event editor

11.4 Snapshots

A Universal CM snapshot contains all analog signals for the duration of the snapshot. There is an offset between the start of these signals and the start of the data file. This offset is equal to the interval length.

Additionally, it contains the data of the speed and load signal during the snapshot duration. The average of these signals is saved as an info field.

To be able to distinguish between the speed and the load signal, two info fields are available, specifying the ID of the speed and the load signal.

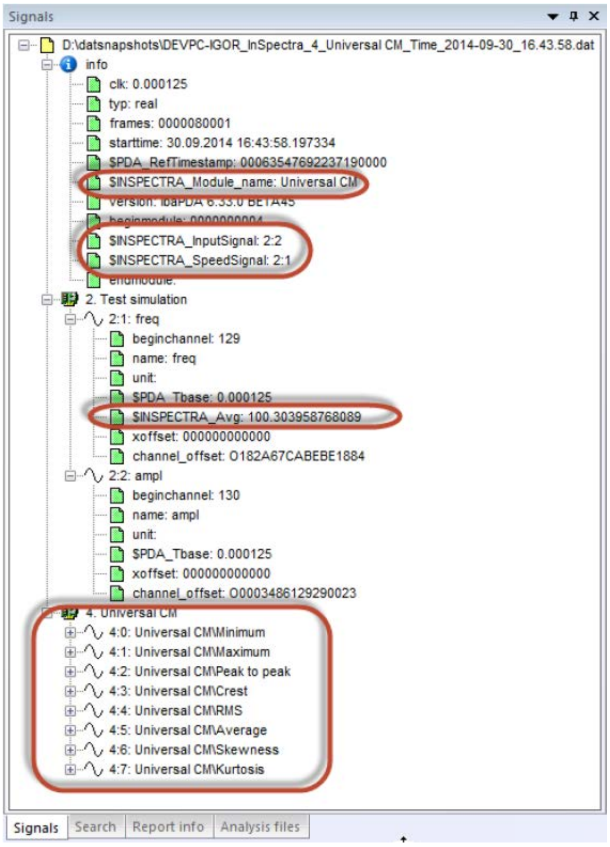


Fig. 154: Snapshot file Universal CM

12 Tips and tricks

This chapter contains tips and functions that do not directly belong to *ibaInSpectra*, but are helpful for analyses.

12.1 Function SampleOnce()

The function is not part of *ibaInSpectra*, but is available in *ibaPDA* and *ibaAnalyzer* and can be used for orbit analysis and phase visualization of vibration signals.

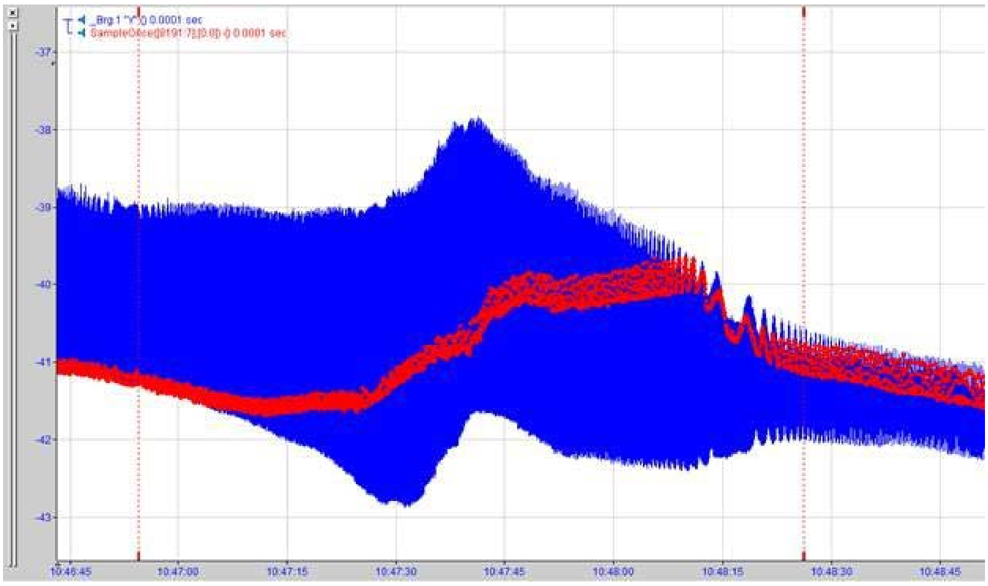
```
SampleOnce('Expression','Sample')
```

Arguments

'Expression'	Input signal
'Sample'	Digital signal whose rising edges determine the sampling points

Description
This function resamples an 'Expression' input signal at individual points determined by the rising edges of the 'Sample' digital signal. The result has one measuring point per rising edge and is invalid in the ranges in between.

Example
This function can be used to display a phase sensor (keyphasor) signal in the time domain. Whenever the phase sensor jumps to 'TRUE', the original signal is sampled. By overlaying both representations, the times of the phase sensor are suitably represented. In the example below, a 180° phase shift can be detected when passing a resonance.



12.2 Online-offline compatibility of expressions

All expressions configured in *ibaAnalyzer-InSpectra* are automatically limited to functions that are also available in *ibaPDA* and provide the same results as in *ibaAnalyzer*. This ensures that all profiles from *ibaAnalyzer-InSpectra* can also be used without problems in *ibaInSpectra* in *ibaPDA*.

For expressions in profiles in *ibaPDA* it is possible to limit the available functions to the same selection as in *ibaAnalyzer-InSpectra* with the checkbox *Offline Compatibility* and hence ensure that these expressions in the profiles can be used offline without any problems.

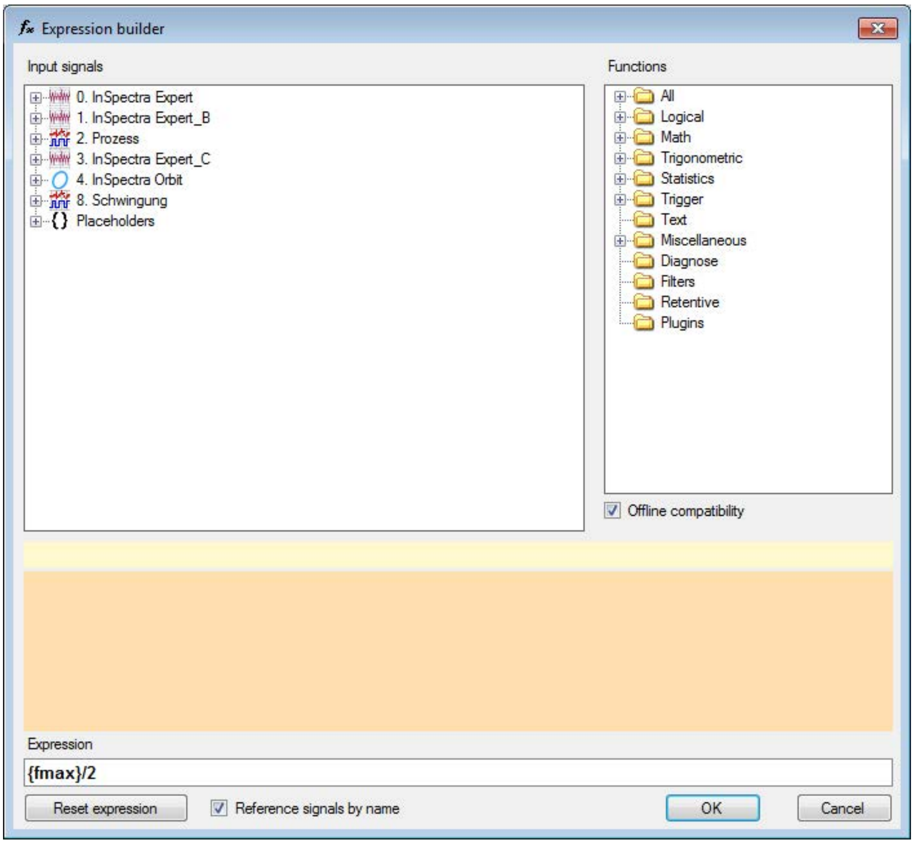


Fig. 155: Expression builder

12.2.1 Functions in InSpectra

In this chapter you will find a list of the functions that are identical in *ibaPDA* and *ibaAnalyzer-InSpectra* and can therefore be used online and offline without any problems.

Other documentation

A detailed description of all functions can be found in the *ibaPDA* manual, part 4 *Expression builder*.

Logical functions

Comparison functions

`>, >=, <, <=, <>, =`

The comparative operations > (greater than), >= (greater than / equal to), < (smaller than), <= (smaller than / equal to), <> (unequal) and = (equal) enable comparisons of the values of two expressions (operands).

Boolean functions

`AND, OR, XOR, NOT`

The Boolean functions AND (logical AND), OR (logical OR), NOT (logical NOT, negation) and XOR (logical exclusive OR) can be used to connect binary expressions, such as digital signals.

False

`False()`

Returns the logical expression, FALSE or zero (0).

If

`If('Condition','Expression1','Expression2')`

The If function can be used for a conditioned execution of further calculations. Depending on the Boolean result of a 'Condition', which can itself be an operation, the operation 'Expression1' will be executed if the result is TRUE and the operation 'Expression2' if the result is FALSE.

Switch

```
Switch('Selector_Expression', 'Case_1_Expression','Value_1_Expression',

'Case_2_Expression','Value_2_Expression',

...

'Case_n_Expression','Value_n_Expression',

'Default_Value_Expr')
```

These instructions compare an incoming 'Selector_Expression' with any number of 'Case_n_Expressions' resembling the SQL statement CASE. At least 3 arguments are needed. With an even number of arguments, the last argument is automatically interpreted as 'Default_Value_Expr,' which is used if none of the 'Case_n_Expressions' matches with the 'Selector_Expression'.

True

`True()`

Returns the logical expression, TRUE or 1.

Mathematical functions

Fundamental arithmetic operations

`+, -, *, /`

All signals and expressions can be processed by fundamental arithmetic operations (addition, subtraction, multiplication and division). If digital signals or expressions are used as operands in fundamental arithmetic operations, the software translates the TRUE value as 1.0 and FALSE as 0.0. The result of a fundamental arithmetic operation is always an analog expression.

Abs
`Abs('Expression')`

The absolute function returns the absolute value (= |value|) of 'Expression'.

Ceiling / Floor / Round
`Ceiling('Expression')`

This function returns the smallest integer value that is greater than or equal to 'Expression'.

`Floor('Expression')`

This function returns the largest integer value that is less than or equal to 'Expression'.

`Round('Expression')`

This function rounds 'Expression' up or down to the nearest whole number (integer).

Eff
`Eff('Expression','Frequency')`

This function calculates the so called "root mean square" value (or the effective value) of 'Expression' with a fundamental frequency of 'Frequency'.

Exp
`Exp('Expression')`

This function calculates the result of (e) 'Expression'.

Log
`Log('Expression')`

This function returns the natural logarithm (ln x) of 'Expression'.

Log10
`Log10('Expression')`

This function returns the common logarithm (lg x) of 'Expression'.

Mod
`Mod('Expression1','Expression2')`

This function returns the modulo of 'Expression1' and 'Expression2' as its result. Internally, the function uses the fmod C-function, which permits the use of floating-point values for 'Expression1' and 'Expression2'.

Pow
`Pow('Expression1','Expression2')`

This function increases 'Expression1' (basis) to the power of 'Expression2' (exponent): $(\text{'Expression1'})^{\text{'Expression2'}}$

Sqrt
`Sqrt('Expression')`

This function returns the square root of 'Expression'.

Truncate

`Truncate('Expression')`

The truncate function truncates the decimal places of a floating point value. Negative numbers are thus rounded up to the nearest integer value, positive numbers rounded down.

Trigonometric funktions

Acos, Asin, Atan, Cos, Sin, Tan

`Sin('Expression')`

This function returns as result the sine of 'Expression' in rad.

`Cos('Expression')`

This function returns as result the cosine of 'Expression' in rad.

`Tan('Expression')`

This function returns as result the tangent of 'Expression' in rad.

`Asin('Expression')`

This function returns as result the arcsine of 'Expression' in rad.

`Acos('Expression')`

This function returns as result the arccosine of 'Expression' in rad.

`Atan('Expression')`

This function returns as result the arctangent of 'Expression' in rad.

Pi

`Pi()`

The number pi is stored as a constant (pi = 3.1415927....) for various calculations in the system. Use this function to insert the number pi into your calculation.

Statistical functions

AvgInTime

`AvgInTime('Expression','Interval','Reset=0')`

This function returns the average value per time segment of the 'interval' length of 'Expression' as result. The signal is written to the RAM of the computer. After an interval has passed, the arithmetic average value over this interval is evaluated.

Max2

`Max2('Expression1','Expression2')`

This function returns the maximum of two signals, 'Expression1' and 'Expression2'. The two signals are compared sample by sample, with the larger value in each case being presented as the result.

MaxInTime
`MaxInTime('Expression','Interval','`*`Reset=0`*`')`

This function returns the maximum value of 'Expression' within each interval of the 'interval' length (in seconds).

Min2
Min2('Expression1','Expression2')

This function returns the minimum of two signals, 'Expression1' and 'Expression2'. The two signals are compared sample by sample, with the smaller value in each case being presented as the result.

MinInTime
`MinInTime('Expression','Interval','`*`Reset=0`*`')`

This function returns the minimum value of 'Expression' within each interval of the 'Interval' length (in seconds).

Trigger functions

TriggerChangeRate
`TriggerChangeRate('Expression','DeltaY*','DeltaT*','DeadTime*')`

The function returns TRUE as long as the change of the measured value 'Expression' (dy) within the interval 'DeltaT' is greater than 'DeltaY'.

TriggerConstant
`TriggerConstant('Expression','Level*','Epsilon*','DeadTime*')`

The function returns TRUE as long as 'Expression' remains within the area ['Level' - 'Epsilon', 'Level' + 'Epsilon'] for at least the duration of the 'DeadTime'.

TriggerEdge
`TriggerEdge('Expression','Level*','EdgeType*','DeadTime*')`

Triggers if 'Expression' exceeds or falls below 'Level' and stays on the same 'Level' side for at least ‘DeadTime' seconds. If 'Expression' is a digital signal, 'Level' is fixed at 0.5. 'EdgeType' determines which edges or crossing are counted.

TriggerLevel
`TriggerLevel('Expression','Level*','LevelType*','DeadTime*')`

Triggers when 'Expression' remains above or below 'Level' for at least 'DeadTime' seconds. 'LevelType' determines which 'level' side is monitored.

Miscellaneous functions

Delay
`Delay('Expression','NumberSamples*')`

This function returns a delayed copy of the 'Expression' signal. The delay is specified in number of measurements ('NumberSamples'). The result is a signal curve with the values of the original signal for 'NumberSamples' before the current time.

GetFloatBit

`GetFloatBit('Expression','BitNo')`

This function returns as result the Boolean value of the 'BitNumber' bit of 'Expression'. Valid bit number sequence: 0 (LSB) to 31 (MSB).

GetIntBit

`GetIntBit('Expression','BitNo')`

This function returns the Boolean value of the 'BitNo' bit of 'Expression' as result after rounding the 'Expression' to the nearest integer value. The rounding limit is in each case the next 0.5 increment (2,49 → 2; 2,50 → 3).
Valid bit number sequence: 0 (LSB) to 31 (MSB).

LimitAlarm

`LimitAlarm('Expression','Limit','DeadBand','Time','Reset=0')`

This function monitors the measured value ('Expression') and sets the result to TRUE if the measured value is longer than the specified time ('Time') above the ('Limit') limit value. The result of the function becomes FALSE again if the measured value falls below the limit value by the value specified under the ('DeadBand') deadzone.

Sign

`Sign('Expression')`

This function returns the sign of 'Expression' as result.

'Expression' > 0 --> +1
'Expression' = 0 --> 0
'Expression' < 0 --> -1

VarDelay

`VarDelay('Expression','Delay', 'MaxDelay=30*')`

This function delays the 'Expression' signal by the 'Delay' time. In contrast to the *Delay* function, the delay time may change over time. *'MaxDelay'* specifies the maximum delay permitted and is preset to 30 s by default.

WindowAlarm

`WindowAlarm('Expression','Limit1','DeadBand1','Limit2','DeadBand2','Time','Reset=0')`

This function monitors the measured value ('Expression') and sets the result to TRUE if the measured value is longer than the specified time ('Time') outside the range between the upper limit value ('Limit1') and the lower limit value ('Limit2'). The result of the function becomes FALSE again if the measured value falls below the upper limit by the value specified under 'DeadBand1', or exceeds the lower limit by the value specified under 'DeadBand2'.

13 Support and contact

Support

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Note

If you require support, indicate the serial number (iba-S/N) of the product and the license number.

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