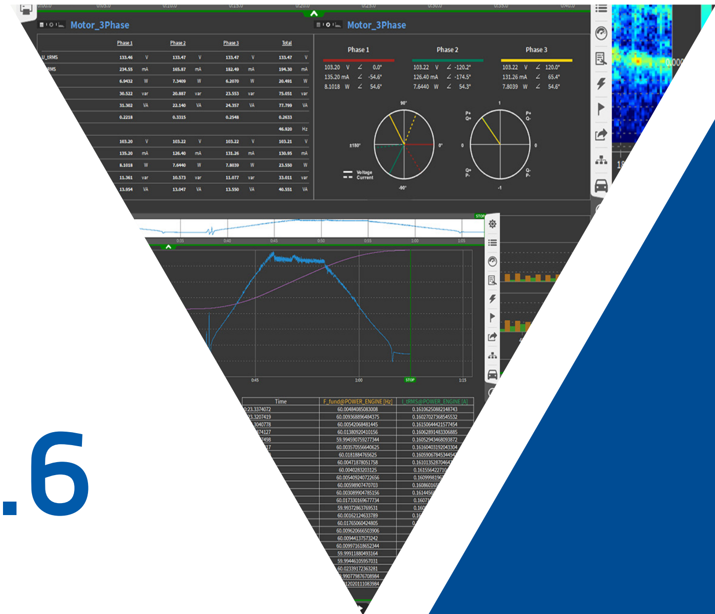
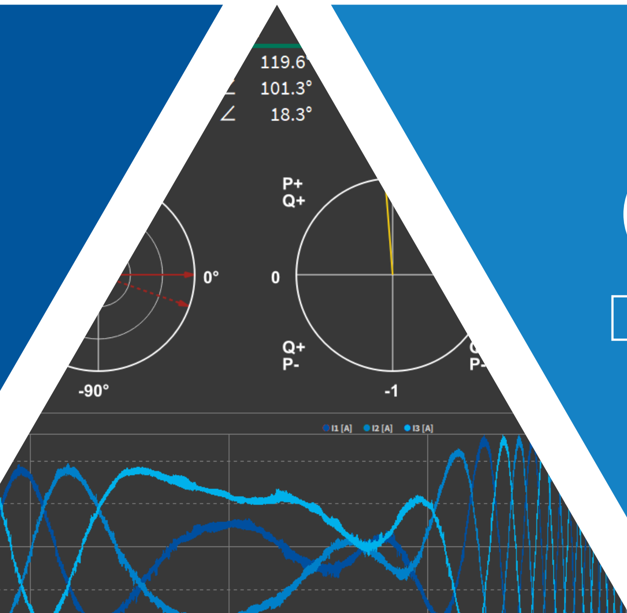
DEWETRON



OXYGEN R7.6

SOFTWARE MANUAL



EN ISO 14001

ISO 9001

CONTENTS

Software Feature Manual

CHAPTER

ONE

PREFACE

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CHAPTER

TWO

INSTALLING OXYGEN

To install OXYGEN on your measurement PC, launch the installer *DEWETRON_OXYGEN_Setup_Rx.x_x64.exe* which can be found in the folder *\files\software\OXYGEN\Software* of the *Install Media* USB stick which is delivered with the measurement system and follow the installation instructions:

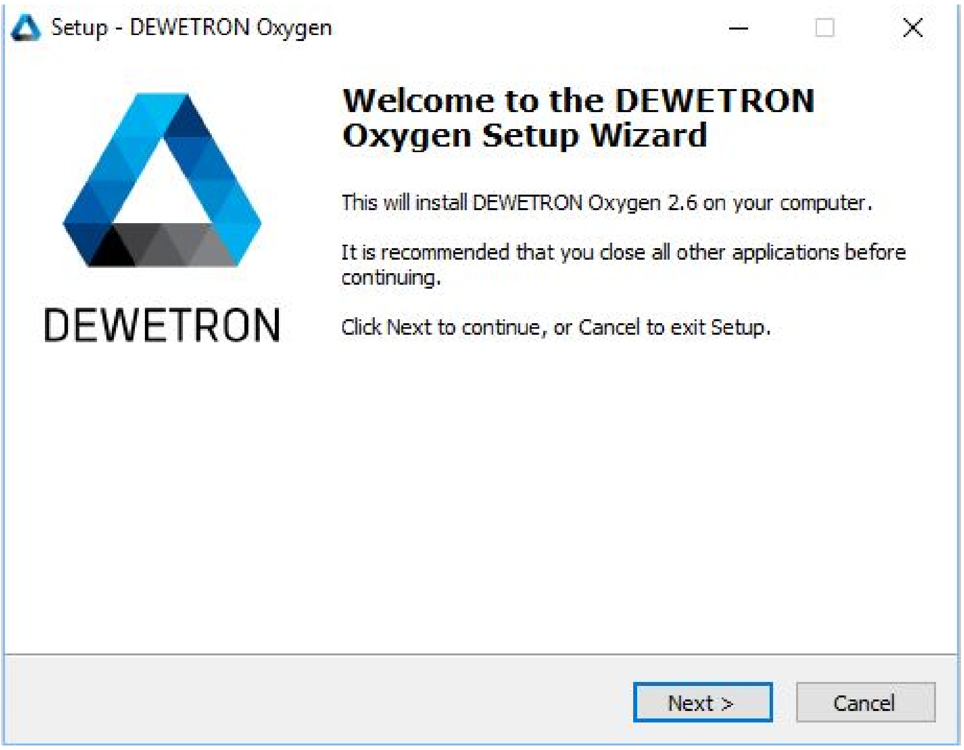

Fig. 2.1: Starting the installation wizard

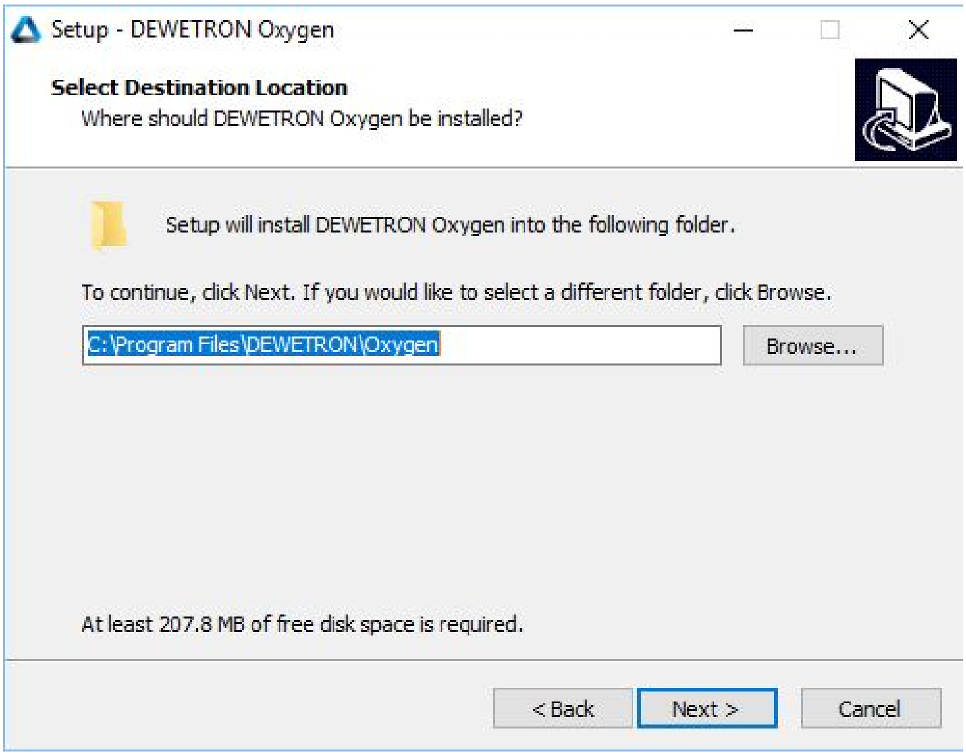

Fig. 2.2: Select destination location

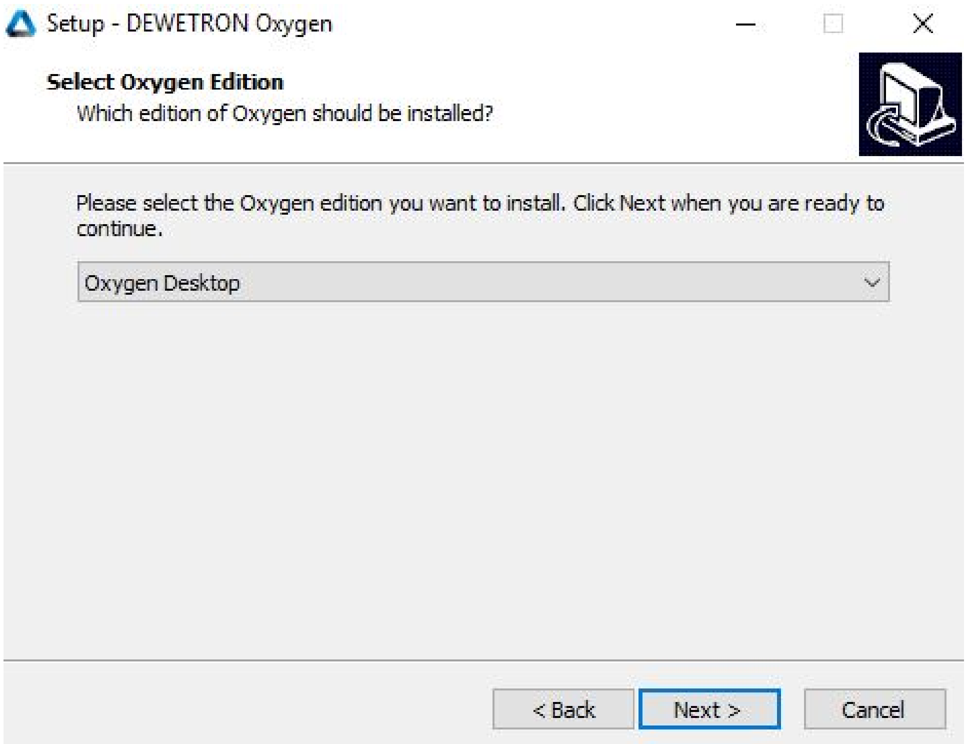

Fig. 2.3: Select OXYGEN edition

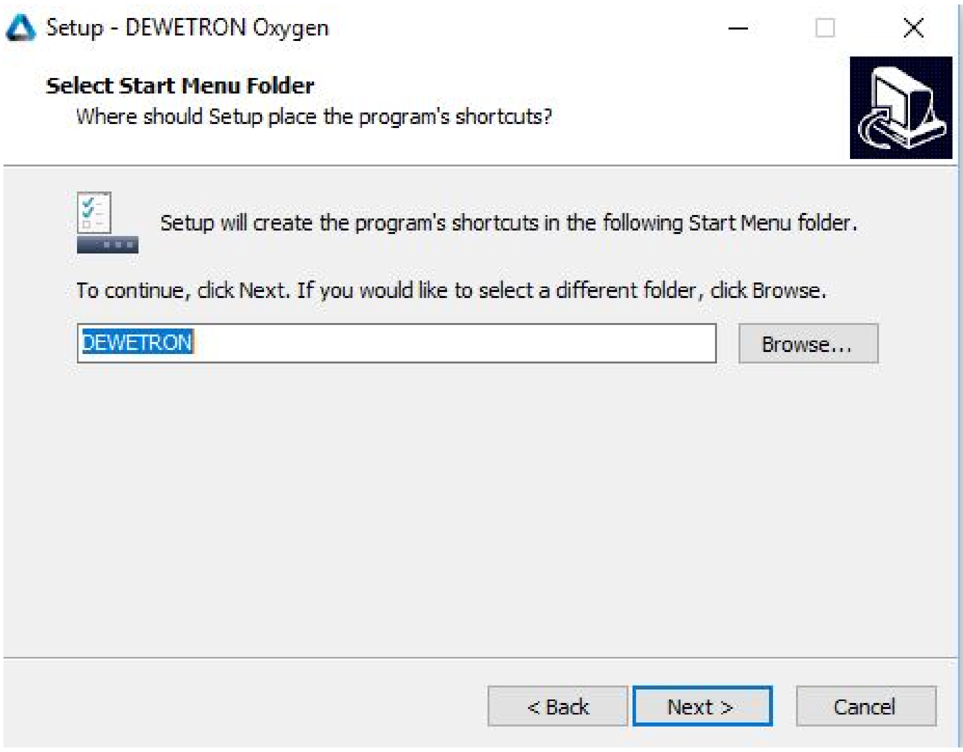

Fig. 2.4: Select start menu folder

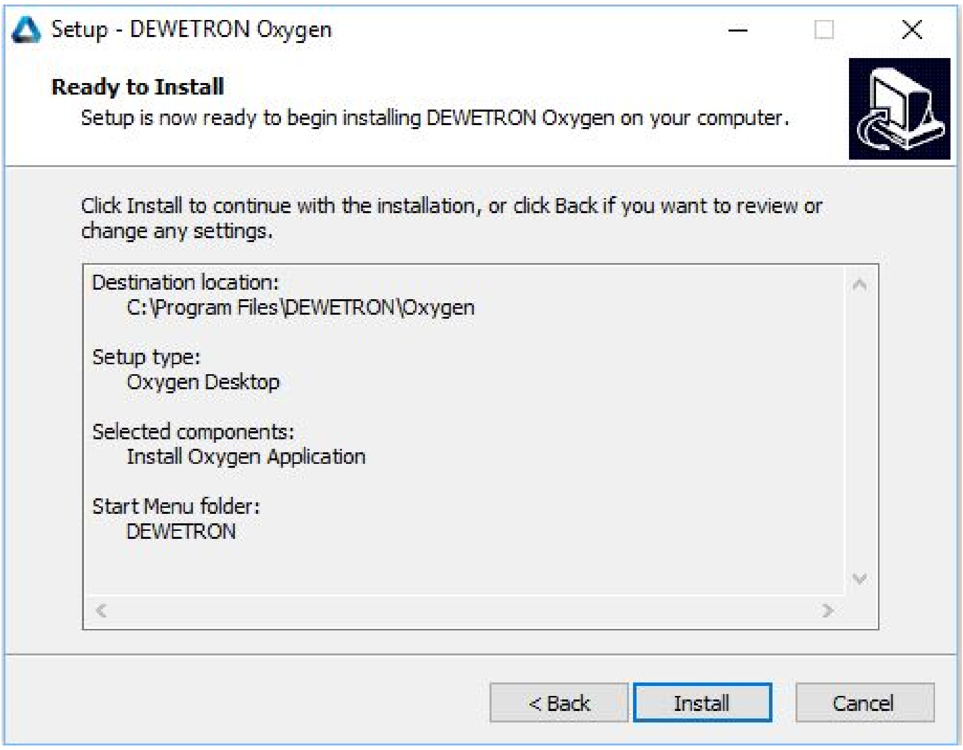

Fig. 2.5: Ready to install

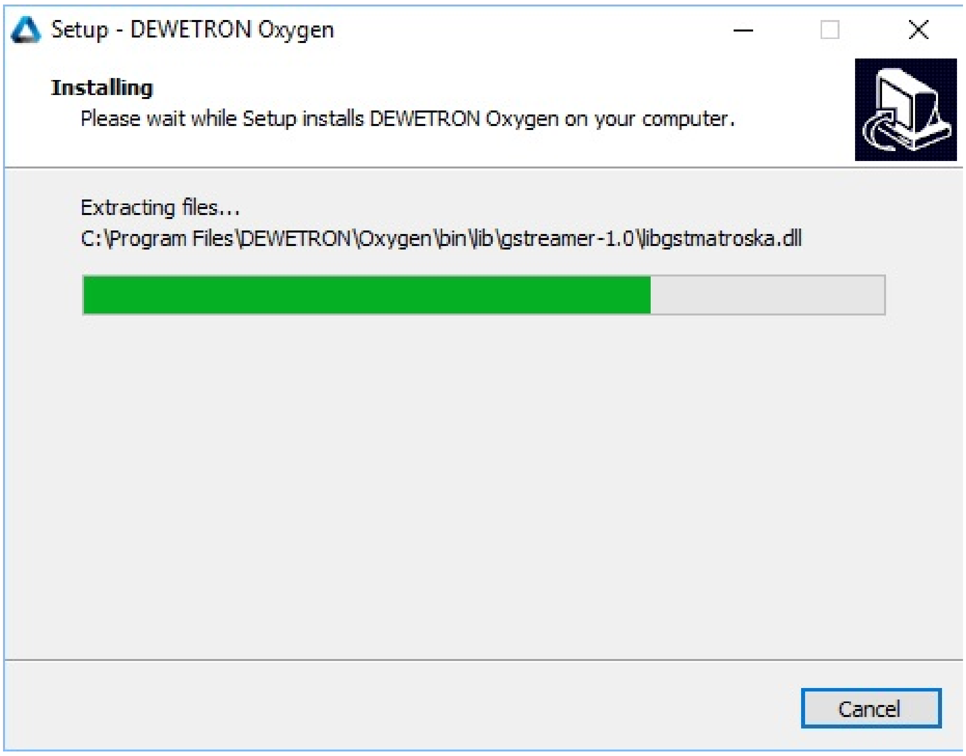

Fig. 2.6: Installing

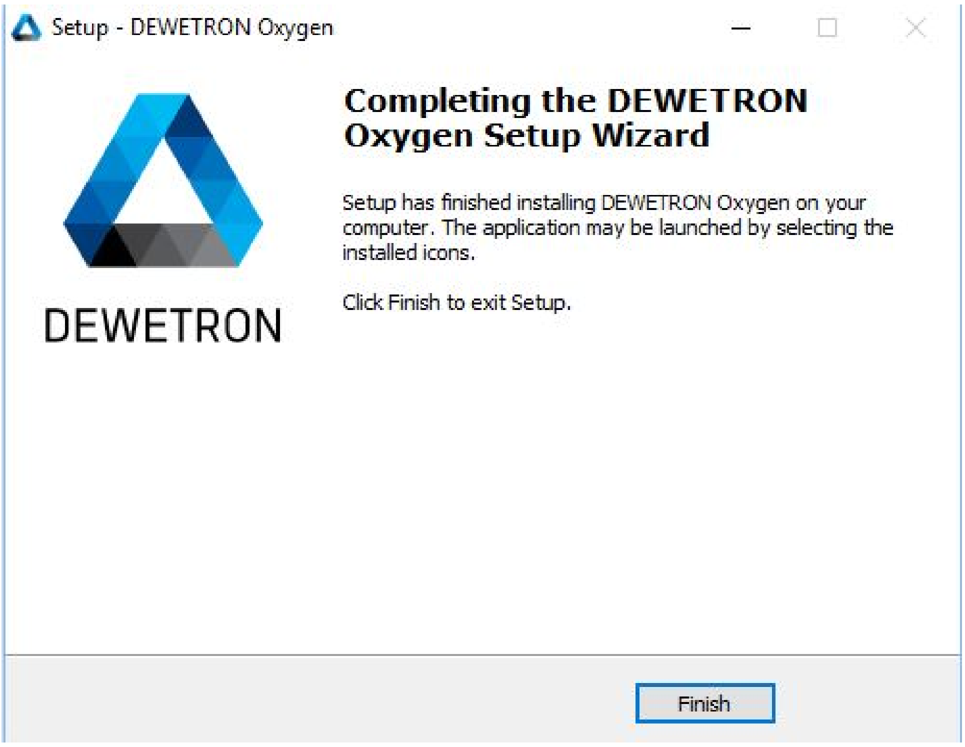

Fig. 2.7: Installation completed

After starting OXYGEN the first time, the software will be started in *Evaluation Mode*.

In *Evaluation Mode*, all features and options are activated to test the capabilities of the software. The recording time is limited to 30 seconds in *Evaluation Mode*. In addition, OXYGEN data files can be loaded if the software is started in *Evaluation Mode*. For data review, analysis and post-processing no software license is required.

A software license is only required for data recording.

The license can be updated under the System Information tab (see Fig. 2.8). This requires a .lic file provided by DEWETRON.

You can find the license on your *Install Media* USB stick in the folder *\\files\software\OXYGEN*.

A license update requires a restart of OXYGEN.

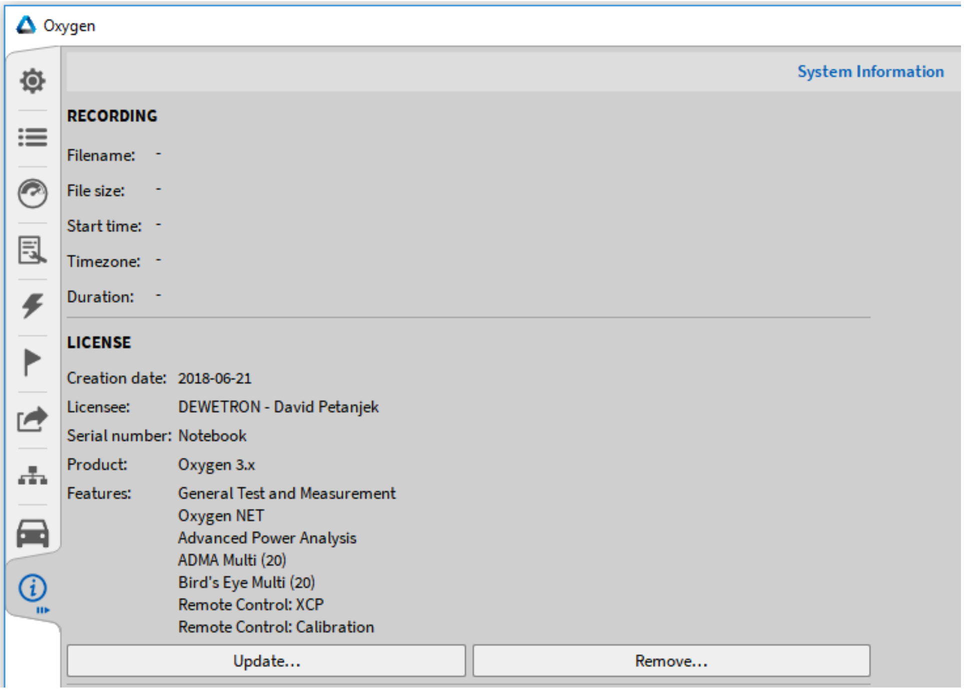

Fig. 2.8: Updating the OXYGEN license

Note: **Information** Note that a license file for OXYGEN 6.x is not valid for OXYGEN 7.x.

After installing a license, the license information can be found in the *System Information* menu (see Fig. 2.9).

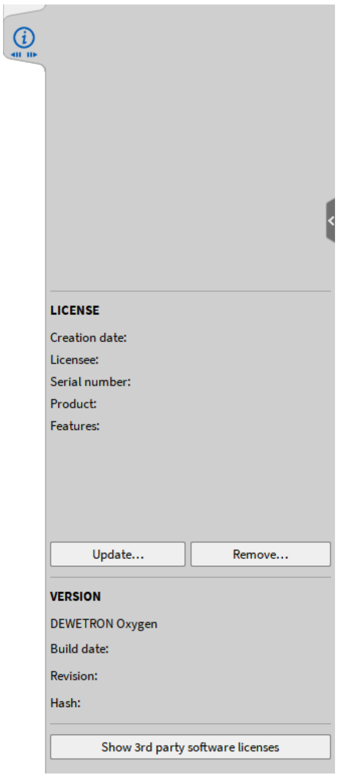

Fig. 2.9: *System information* menu

CHAPTER

THREE

SOFTWARE OVERVIEW

3.1 Welcome tour

After the software has been started, a “Welcome Tour” will automatically begin to guide you through the basic functionalities of OXYGEN. For this purpose, a window appears at the beginning (see 1 in Fig. 3.1).

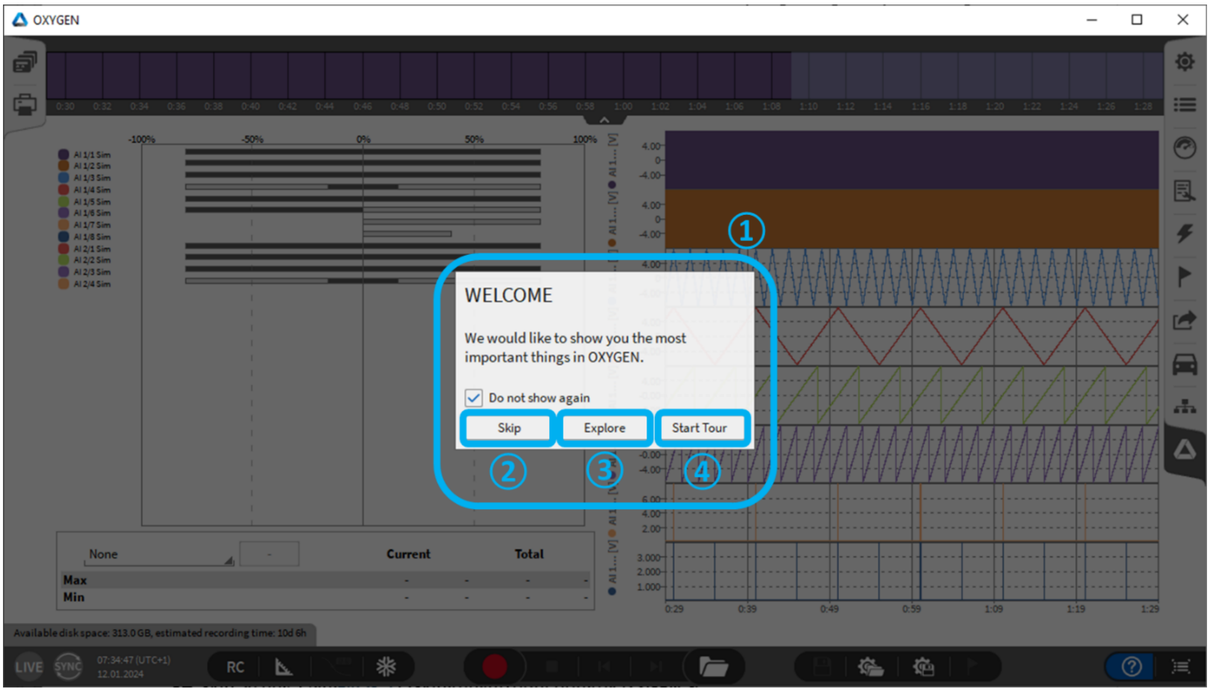

Fig. 3.1: Welcome

You have the following options for the introduction to OXYGEN:

- “Skip” (see 2 in Fig. 3.1): Skip the introduction to OXYGEN.
- “Explore” (see 3 in Fig. 3.1): The introduction is started. Now all available icons and buttons on the measurement screen are outlined in red. If you navigate with the mouse cursor over a bordered area, a short descriptive text about the function is displayed. Click on “x” (see 2 in Fig. 3.2) to quit the introduction.

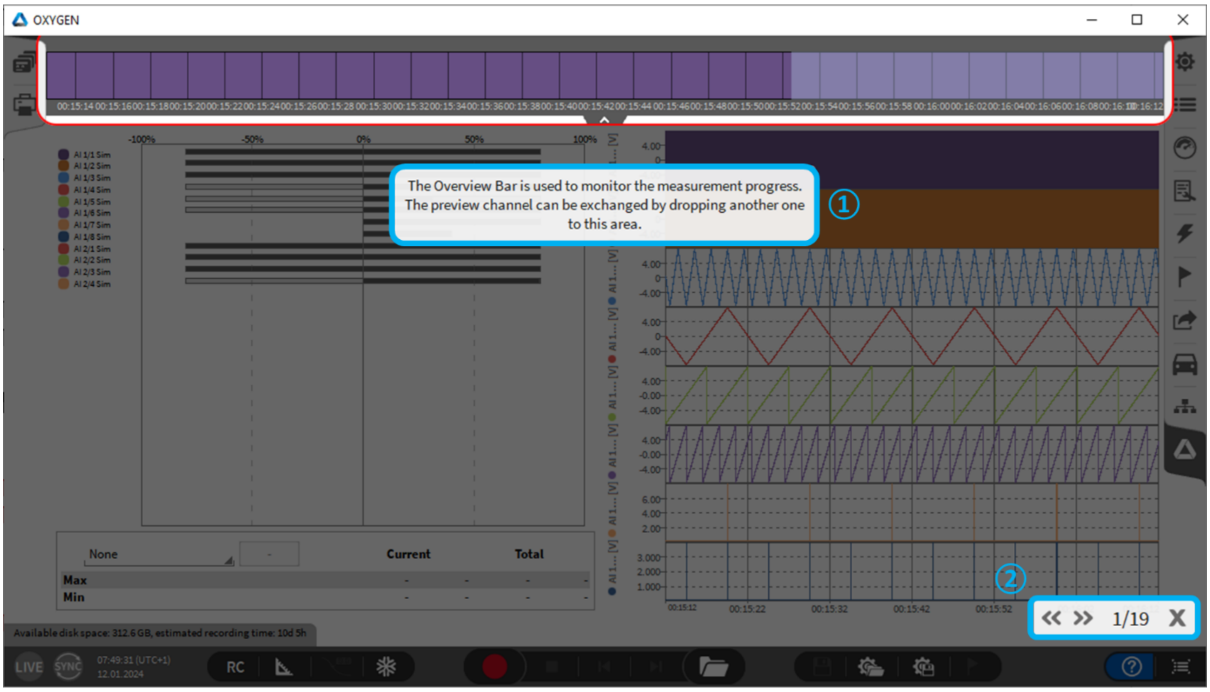

Fig. 3.2: Welcome tour description

"Start tour" (see ④ in Fig. 3.1): Let yourself be guided through the various basic functions of OXYGEN. By clicking on "<<" or ">>" (see ① in Fig. 3.3) it is possible to jump through the individual icons, buttons and displays, the descriptions are automatically displayed for the respective area. By clicking on "x" (see ① in Fig. 3.3) you can quit the introduction.

Fig. 3.3: Welcome tour start

3.2 Measurement screen

After starting the software, the following screen will appear. OXYGEN will instantly start to acquire data but will not store it yet.

To activate the default measurement screen when OXYGEN will be started, the corresponding startup setting must be checked (see Fig. 3.4). This setting is activated per default, when starting OXYGEN the first time.

The saturation meter (*Saturation meter*) as well as a chart recorder instrument (see *Recorder*), displaying the first 8 analogue input channels, is part of the OXYGEN default measurement screen (see Fig. 3.5).

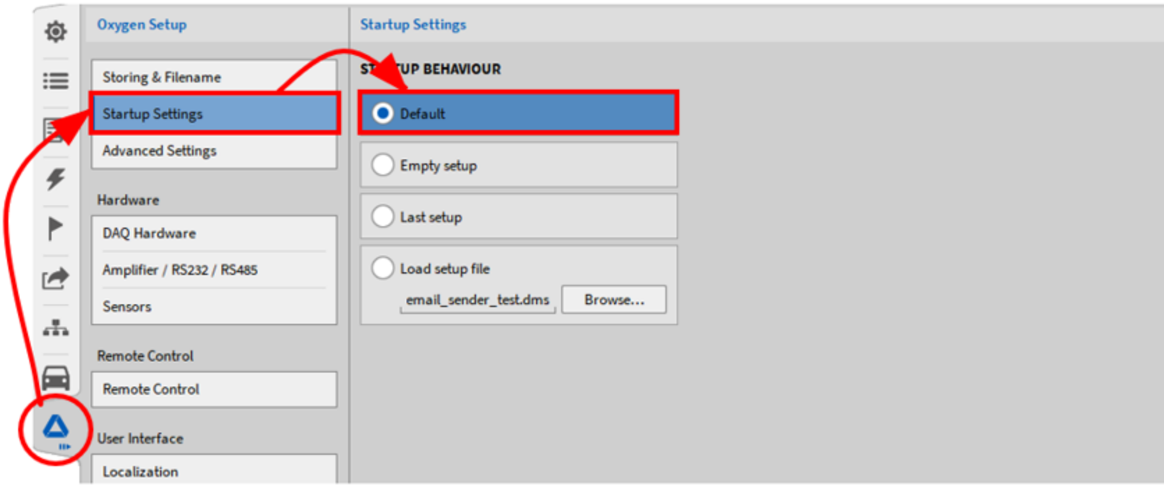

Fig. 3.4: Settings to activate automatic visualization of default measurement screen

Fig. 3.5: Software Overview

Fig. 3.5: Software overview

Table 3.1: Software overview

No.	Name	No.	Name
A - Overview bar		**C - Menu functions**	
-	*Overview bar*	15	*Save setup file button*
B - Measurement display		16	*Add Marker button*
-	*Measurement display area*	17	Welcome tour button
C - Menu functions		18	*Toggle button*
1	*Mode indicator*	**D - Action bar**	
2	*Sync mode indicator*	19	*Screens menu*
3	*Time*	20	*Reporting menu*
4	*Lock Screen button*	21	*Measurement settings menu*
5	*Design mode button*	22	*Data Channels menu*
6	*Data Labels button*	23	*Instruments menu*
7	*Freeze button*	24	*Instrument properties menu*
8	*Record button*	25	*Triggered Events menu*
9	*Stop button*	26	*Event List menu*
10	*Reverse button*	27	*Export Settings menu*
11	*Fast forward button*	28	*OXYGEN-NET menu*
12	*Open data file button*	29	Bird's eye
13	*Store data button*	30	*OXYGEN setup*
14	*Open Setup file button*		

3.2.1 Overview bar

Fig. 3.6: Overview bar

The *Overview bar* gives a rough overview about the measurement data. It displays the time dependent trend of one selected data channel. During the data review and analysis, the orange box shows the position of the currently displayed data in the measurement file (see Fig. 3.19). The user can change the displayed channel. Therefor he must open the *Data Channels* Menu and move the desired channel via drag and drop to the *Overview bar* (see Fig. 3.6).

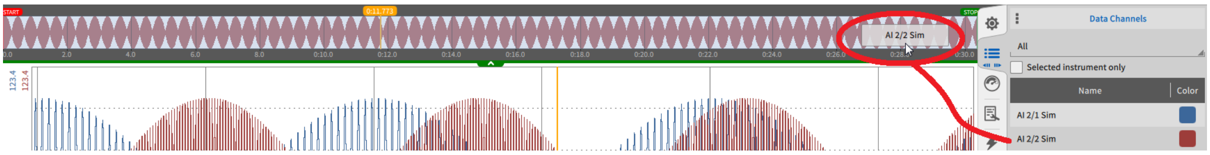

Fig. 3.7: Change displayed channel in the Overview bar

Shows the time dependent trend of one selected input channel.

3.2.2 Measurement display area

Default measurement screen header with several instruments that display the acquired data.

- For adding or changing instruments on a screen, refer to *Adding an instrument to the measurement screen and channel assignment*.
- For managing several screens, refer to *Screens menu*.

3.2.3 Action bar

Contains relevant push buttons.

Record button

Starts or pauses *REC* mode.

Stop button

Terminates an active recording or returns to then *LIVE* mode when the *PLAY* mode is active.

Reverse button

Only active in *PLAY* mode; A click on this button will move the cursor 5 seconds back.

Fast forward button

Only active in *PLAY* mode; A click on this button will move the cursor 5 seconds forward.

Open data file button

Opens a UI to select a data file and switches in the *PLAY* mode.

Store data button

Stores changes to a data file that were made during analysis in the *PLAY* mode, whereas the file will be overwritten. To save the measurement file under a new name with the changes made, open the small *Measurement Settings* menu and click on *Save DMD as…* .

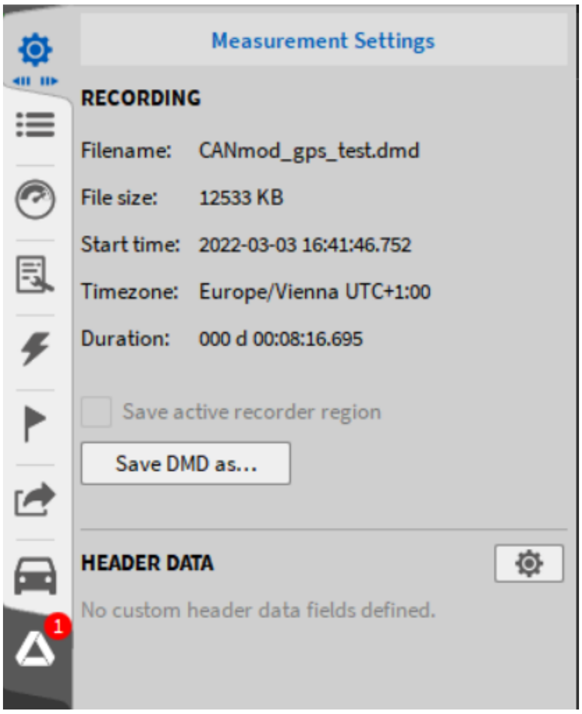

Fig. 3.8: Save DMD as…

Open Setup file button

Opens a UI to select a setup file, for more information refer to *Loading a Measurement Setup File*.

Save setup file button

Saves software settings to a setup file, for more information refer to *Saving a Measurement Setup file*.

Add Marker button

Adds a marker on the actual point of time; Enabled in *REC* and *PLAY* mode.

Lock Screen button

Locks the measurement screen.

Design mode button

Activates the *Design* mode to manipulate the surface of the measurement screens and add, delete or change the Instruments on the screen. For detailed information refer to *Adding an instrument to the measurement screen and channel assignment*. With the middle mouse button, the Design Mode can be toggled.

Data Labels button

Activates measurement labels; for detailed information refer to *Mouse-over information*.

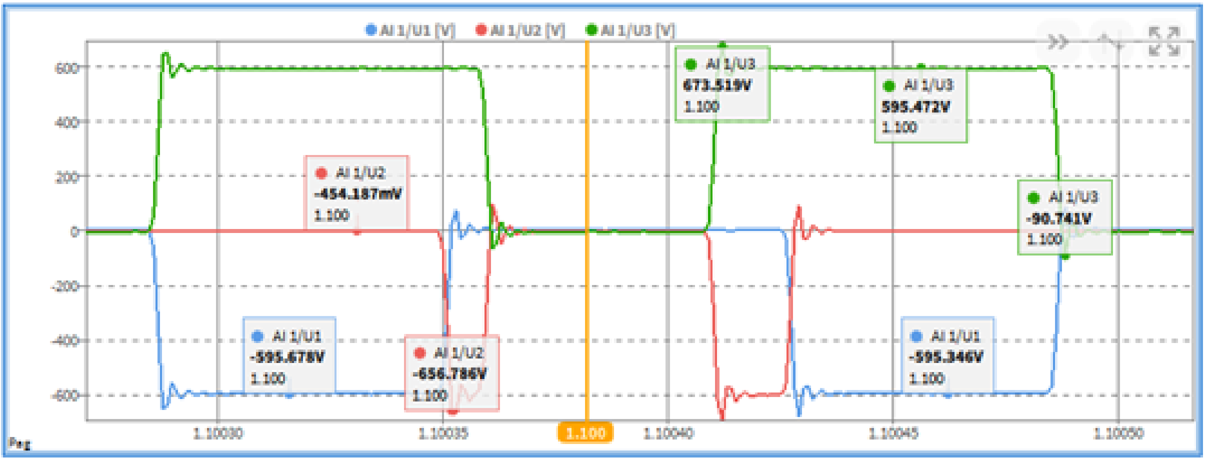

Fig. 3.9: Activate labels

Freeze button

Freezes the actual screen.

Mode indicator

Shows the current software indicator mode. OXYGEN has three different Operating Modes: *LIVE*, *REC* and *PLAY*. The actual software mode is displayed in the Action bar (see 1 in Fig. 3.5). The properties of the different modes are explained in the following section:

- *LIVE* mode: OXYGEN is only acquiring and displaying data but not storing it to a data file yet. This mode is active when OXYGEN is started, a measurement is stopped or when a data file is closed.

- *REC* mode: OXYGEN is acquiring data and storing it to a data file. A red line above the Action bar indicates this mode. OXYGEN stores the data automatically to a data file. An explicit command for storing the acquired data to a file is not necessary. For changing the data storing settings, refer to *General settings*.
- *PLAY* mode: Mode for reviewing, analyzing and exporting data. This mode is activated after a data file was loaded. A green line above the Action bar indicates this mode.

Sync mode indicator

Shows the current Sync status of the software.

Time

Shows the actual time, time zone and date; can be displayed on the measurement screen via drag'n'drop, for more details see *Text instrument*.

Toggle button

Quick access to Data channels menu; toggles between the current screen and the data Channel list

3.2.4 Menu functions

Measurement settings menu

Opens the System Settings menu; for detailed information refer to *Measurement settings*.

Data Channels menu

Opens the *Data Channels* menu; for detailed information refer to *Data channels menu*.

Instruments menu

Opens the *Instruments* menu for detailed information refer to *Instruments and instrument properties*.

Instrument properties menu

Opens the properties of a||| selected Instrument; for detailed information refer to *Instruments and instrument properties*. The Instrument Properties can also be opened with a double click on the desired instrument.

Triggered Events menu

Opens the *Triggered Events* menu; for detailed information refer to *Triggered Events*.

Event List menu

Opens the *Event List* menu; for detailed information refer to *Event List*.

Export Settings menu

Opens the *Export Settings* menu; for detailed information refer to *Export Settings*.

OXYGEN-NET menu

Opens the *OXYGEN-NET* menu; for detailed information refer to *OXYGEN-NET*.

OXYGEN setup

Opens the *System Information* that contains information about the software license and version.

Screens menu

Opens the *Screens* menu; for detailed information refer to *Screens menu*.

Reporting menu

Opens the *Reporting* menu; for detailed information refer to *Reporting tool*.

3.3 Working with OXYGEN software

3.3.1 Online vs. Offline Data Processing

This chapter explains the difference between online and offline data processing. As explained in *Action bar*, there are three different operating modes: LIVE, REC and PLAY mode.

All the data processing, which is done and configured in the LIVE mode is called online data processing. OXYGEN is acquiring data, formula channels etc. can be created and will be saved in the setup, but no data has yet been recorded. These channels cannot be deleted in the post-processing.

All the data processing, which is done after a recording in the post-processing is called offline data processing. When reviewing a measurement file OXYGEN is opened in PLAY mode. That is the mode for reviewing, analyzing, and exporting data. These channels can be deleted until the file is closed the first until upon creating the channels. The channels will not be saved in the setup, unless a new setup file is created from the measurement file (see 5 in Fig. 3.18).

The difference for an online and offline created channel, can also be seen in the different colored Stored indicator in the channel list. This indicator is red for online created channels and green for offline created channels. As seen in Fig. 3.10, both statistics channels were created before the recording was started, therefore in the LIVE mode of OXYGEN. The two formula channels were created after the recording, when the file was opened again in OXYGEN.

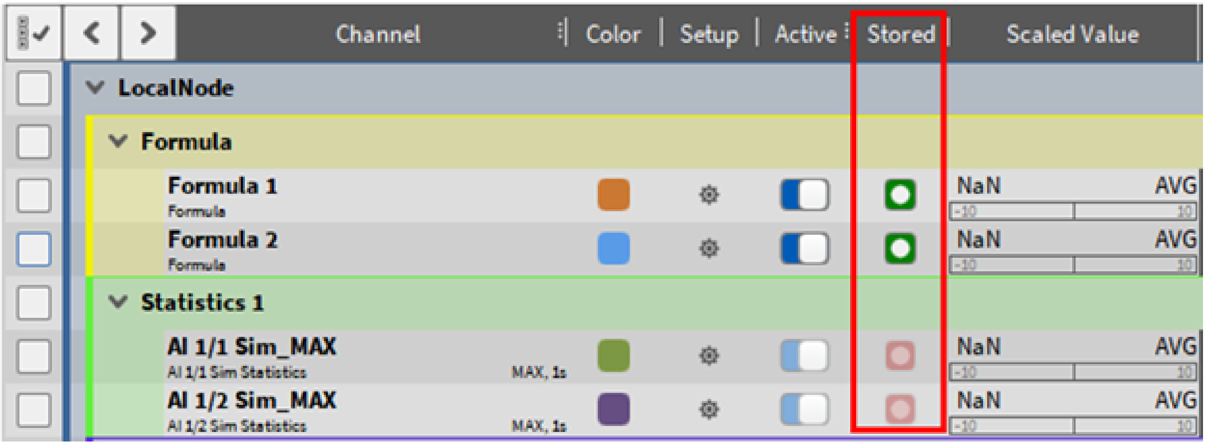

Fig. 3.10: Different colored stored indicator for online and offline created channels

3.3.2 Saving a Measurement Setup file

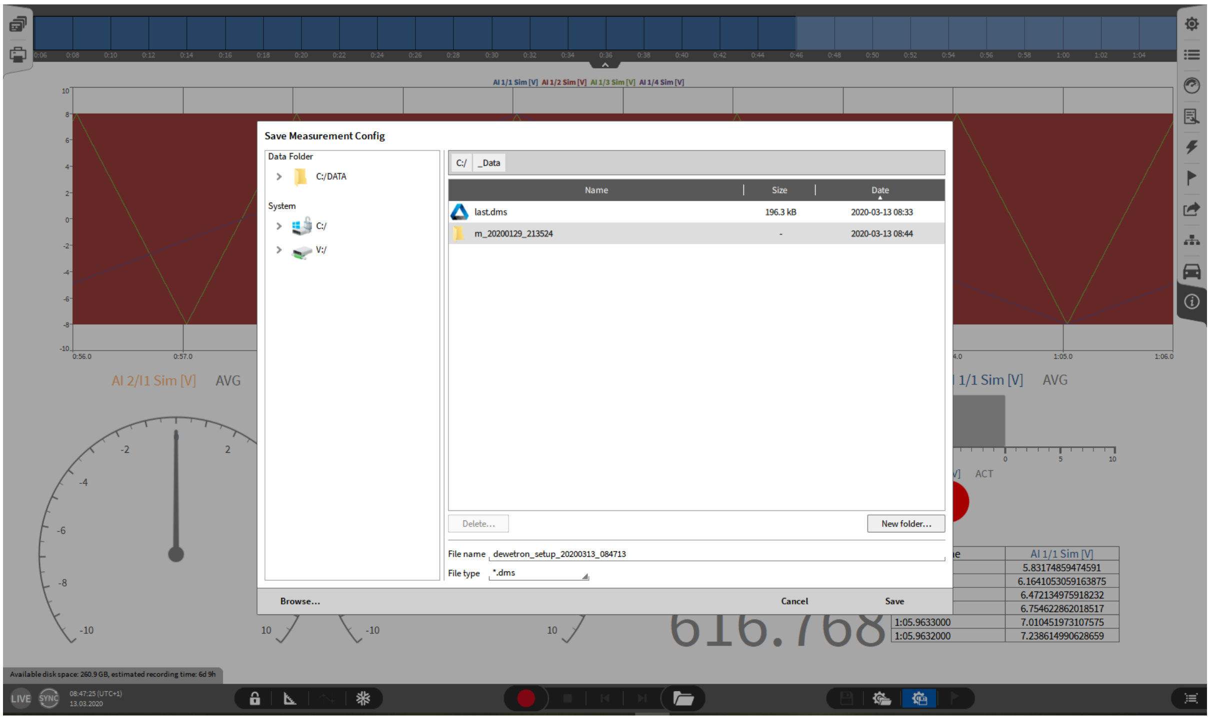

Fig. 3.11: : Different colored stored indicator for online and offline created channels

In order to save a measurement setup file proceed as follows:

1. Touch or left click the gear and diskette icon in the Action Bar (see Fig. 3.11 or ⑮ in Fig. 3.5)
2. Upon selecting this icon, the *Save Measurement Config* dialog will appear
3. Within this dialog select the *Data* folder, create a *New folder* or click on the *Browse* button to open the Windows Explorer dialog and select a location

4. Define a *file Name* and by clicking on the *Save* button the current software settings will be stored to a setup file

3.3.3 Loading a Measurement Setup File

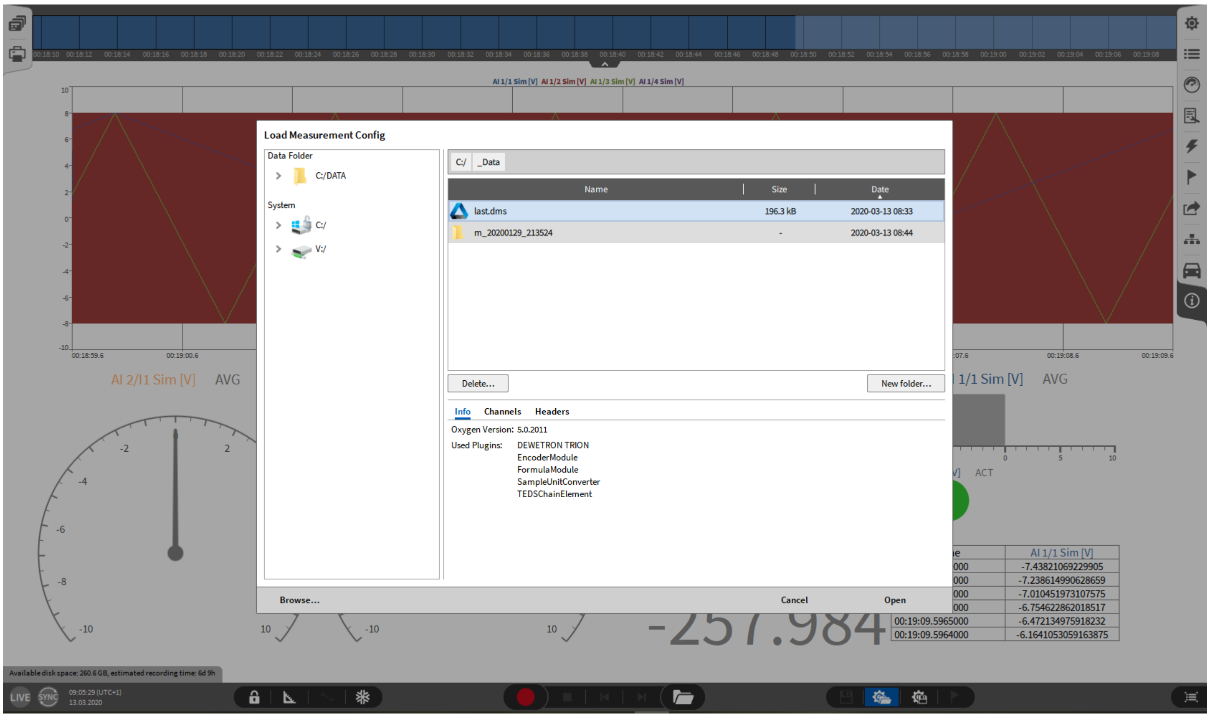

Fig. 3.12: Loading a Setup file

1. Touch or left click the gear and folder icon along the bottom tool bar (see Fig. 3.12 ⑭ in Fig. 3.5)
2. Upon selecting this icon, a *Load Measurement Config* dialog will appear
3. Within this dialog, the user can select the Measurement Setup he would like to open. *Info*, *Channels* and *Headers* contain additional information about the file to ease the search for the correct file.
4. By clicking on the *Browse* button, the Windows Explorer dialog will open to more easily browse another folder location
5. The *Open* button will open the selected Setup file
6. If the measurement hardware does not match with the hardware stored in the setup file, the *Hardware Match* dialog will open (see Fig. 3.13). Within this dialog, the user can rematch his connected hardware to the hardware stored in the setup file before opening it. Identical TRION modules will be matched automatically or use the *Auto* button (see Fig. 3.13). Clicking on *Clear* will delete the complete match that is done so far. After connecting all necessary channels, the user can click on *Apply* and the setup loading will be continued.

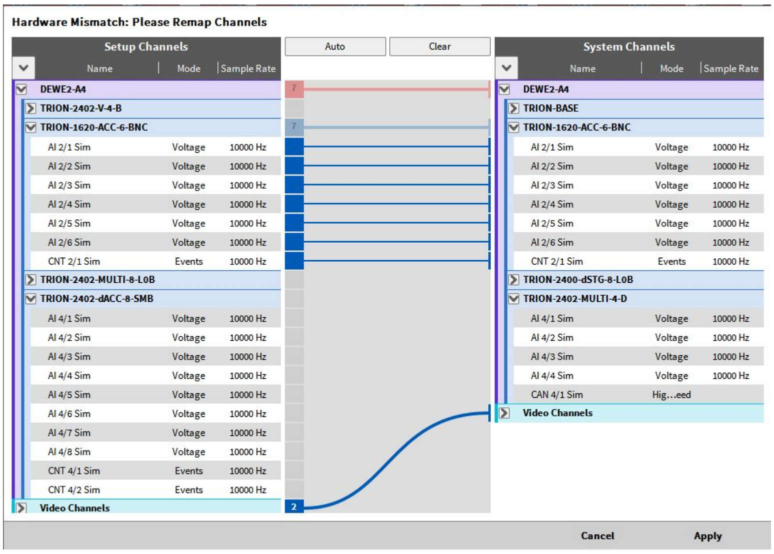

Fig. 3.13: Hardware Mismatch dialog

The hardware *Mismatch dialog* can also be forced to show up, even if the actual hardware matches the hardware in the setup. This is possible by selecting the *Show channel mapping dialog*, when opening an OXYGEN Setup (see Fig. 3.14)

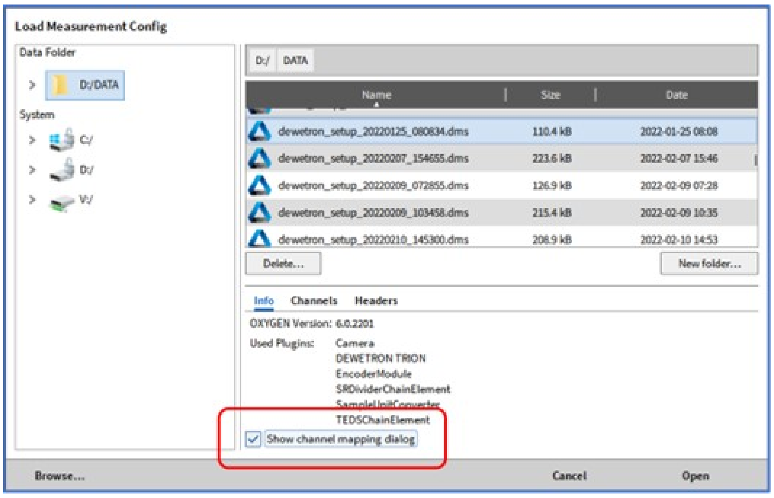

Fig. 3.14: Forced Hardware Mismatch dialog

3.3.4 Reviewing a Data File (PLAY mode)

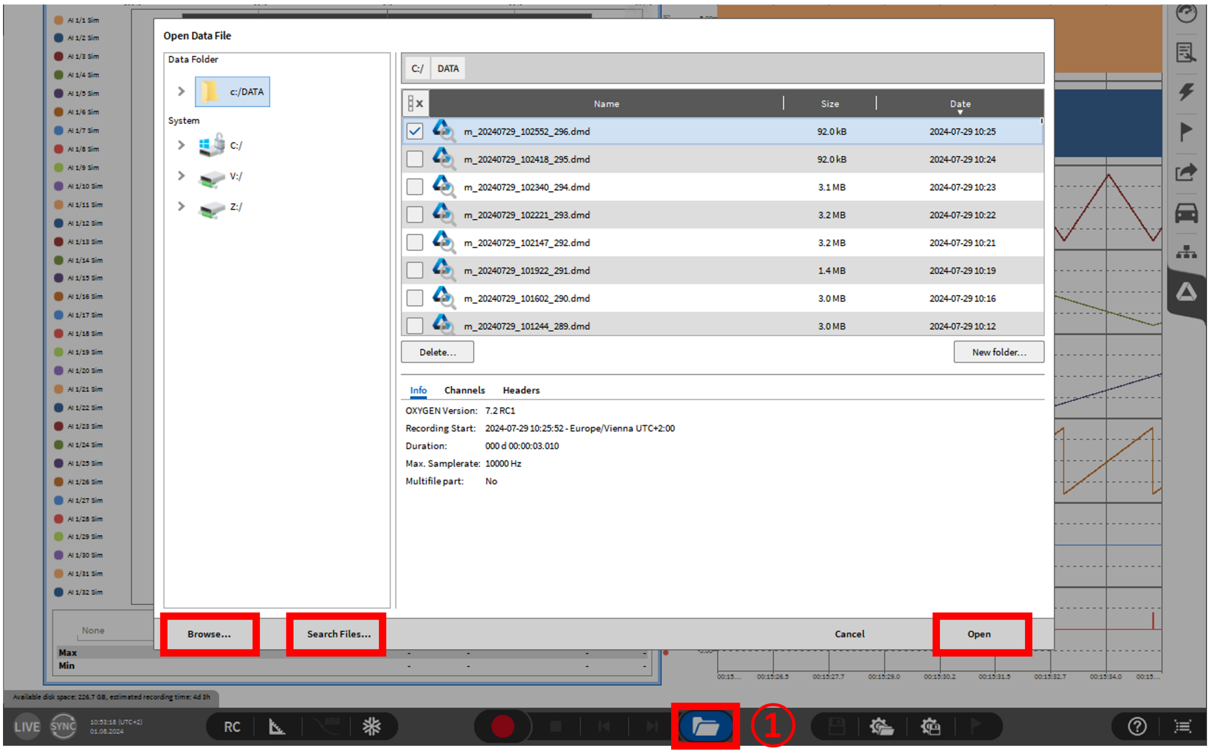

Fig. 3.15: Opening a Data File

1. Touch or left click the folder icon in the Action bar (see ① Fig. 3.15 or ⑫ in Fig. 3.5)
2. Upon selecting this icon, an *Open Data File* dialog will appear.
3. Select the appropriate *Data Folder* on the left side of the menu.
4. Once the *Data Folder* is found, the Data file list will be populated with *.dmd Data files showing their name, size, and date of recording.
5. Within this dialog, the user can select the Data file he would like to open. *Info*, *Channels* and *Headers* contain additional information about the file to ease the search for the correct file.
6. By clicking on the *"Browse…"* button the Windows Explorer dialog will open to browse the right *Data Folder.*
7. The *"Search Files…"* button will open a dialog window enabling to filter the data files by AND, OR conditions. The conditions cannot be used sequentially. To switch from AND to OR, simply click on the AND (see Fig. 3.16).

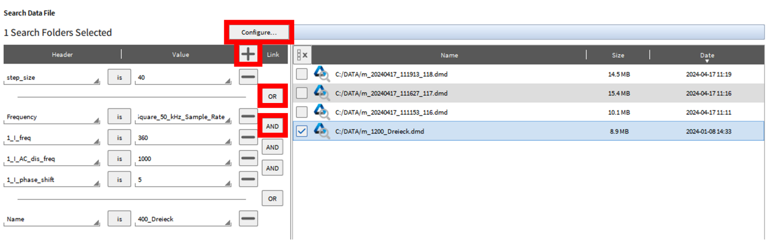

Fig. 3.16: Search files filter options

8. The *"Configure…"* button enables to specify additional folders via to scan and whether subfolders are scanned for data files (see Fig. 3.17).

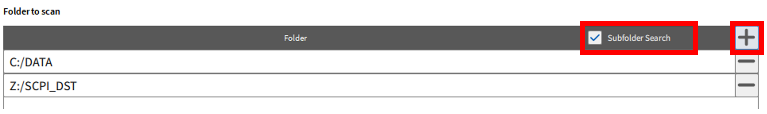

Fig. 3.17: Configure folder and optional subfolder to scan

9. The *Open* button will open the selected Setup file (see Fig. 3.15).
10. Along the top of the newly opened data file lies the *Overview Bar* (see Fig. 3.18 or ⍰ in Fig. 3.5). The *Overview Bar* displays the events that have taken place during this measurement. Such as: start, pause, resume, current playback time position, and termination of recording.
11. Once the user clicks the green *PLAY* button (see 1 Fig. 3.18) at the bottom of the screen the yellow playback position cursor will stream across the screen and the displays currently on the screen will then become active, displaying the data currently seen at that playback position.
12. The playback speed can be changed by clicking on the *Speed* button (see 2 Fig. 3.18 or Fig. 3.19). Select a speed from the shown buttons or enter an individual value in the field between 1000x to 1/1000x. Note: Audio replay only working with a playback speed of 1x (original speed).
13. Once finished reviewing the data file, save the file by clicking on the save button in the action bar or save the file with a new name by opening the small measurement settings menu and click on *Save DMD as*. Select then the *Eject* button (see 3 in Fig. 3.18) which is located to the right of the Speed button. If you do not want to save the data file, only click on the *Eject* button and select *Discard* in the pop-up window. After that OXYGEN will be in *LIVE* mode again and start to acquire data.

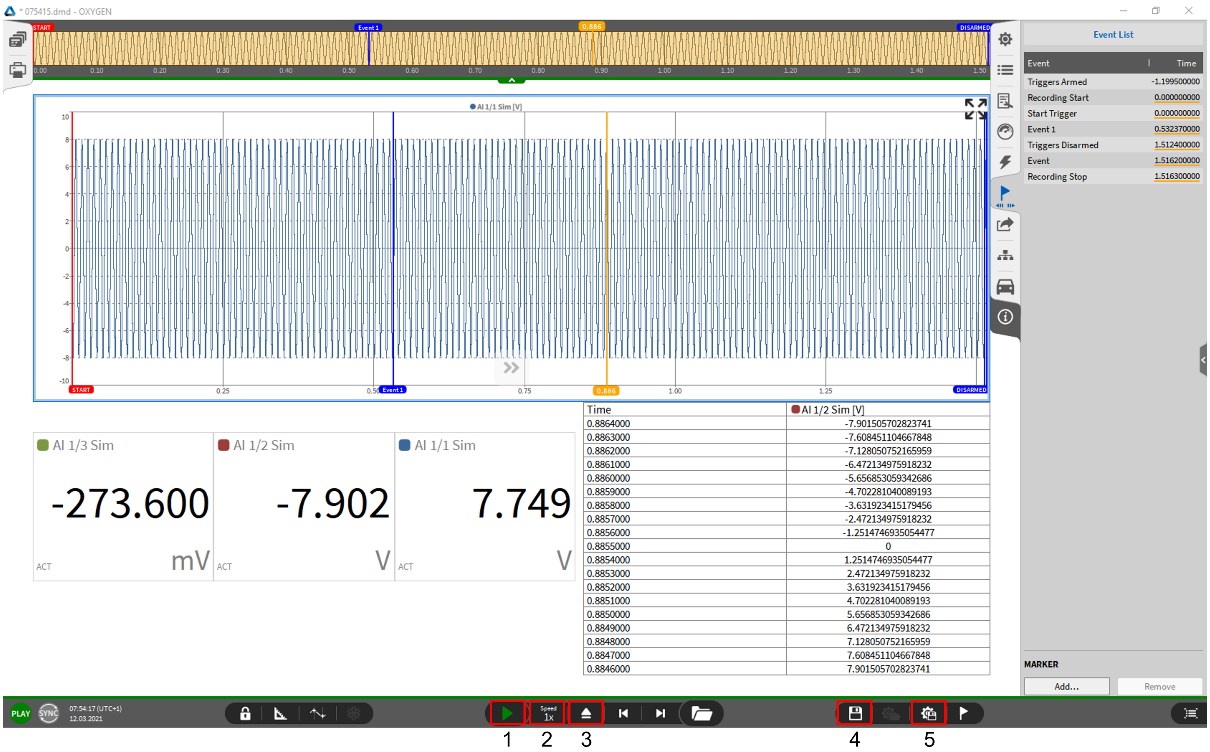

Fig. 3.18: Loaded Data File – Overview

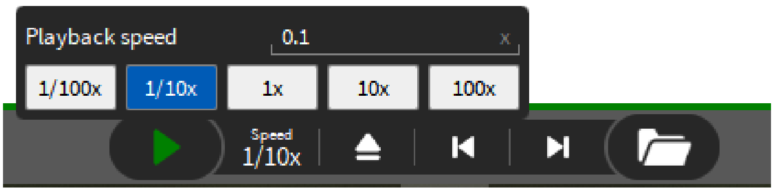

Fig. 3.19: Changing the playback speed of a data file

Note:

- The *Design* mode can be activated to add, move or delete Instruments in the *PLAY* mode as well. For detailed information, refer to *Adding an instrument to the measurement screen and channel assignment*.
- A Recorder instrument is very useful during playback, because it also allows you to see all the different events that may have happened during a measurement
- The *Event List* menu (see Fig. 3.18) will clearly display all events and the points of time the events occurred in a list. For adding a marker to an event, refer to *Event List*.
- Changes that were applied to the data file during the analysis can be saved to the data file by pressing the diskette-button (see 4 in Fig. 3.18).
- A setup file based on the settings of a data file can be created by pressing the gear-diskette-button (see 5 in Fig. 3.18).

3.3.5 Custom ordering of menu locations

OXYGEN allows the user to customize his experience within the software. Users can re-order the menu selection panels on the opposing side bar. This allows the user to have multiple menus open at the same time. To change the order, the user can select the respective menu and must keep the mouse button pressed for one second. Then a blue background on the menu sign will appear. Now the user can move the menu to the desired position while keeping the button pressed. It is also possible to move a menu from the right sidebar to the left sidebar and vice versa.

Note:

- The user may find it difficult to place the menus back in the default order once a change has been made. To reset the position of your menus, head into *System Settings* > *UI Options* and select the *Reset* button found under the *Sidebar position* section (see 1 in Fig. 3.20).
- The user can also swap the right and the left sidebar. To do so, head again into *System Settings* > *UI Options* and select *Left side* under the *Sidebar position* (see 2 in Fig. 3.20).
- The user can also change the width of the menu sidebar.

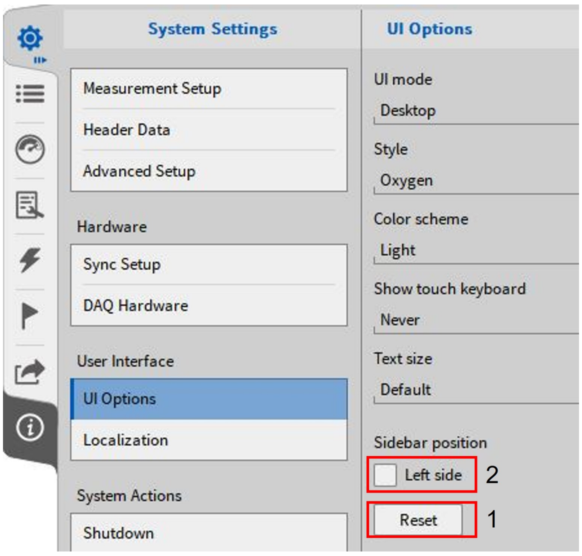

Fig. 3.20: Sidebar position reset

3.3.6 OXYGEN shortcuts

The following shortcuts can be helpful when using OXYGEN.

Table 3.2: OXYGEN shortcuts

Shortcuts	Effect
Ctrl + Q	Close OXYGEN
Ctrl + O	Open recordings (data files)
Ctrl + A	Select all (Screens, Instruments)
Ctrl + S	Save measurement setup (*.dms) in LIVE Mode or store the currently opened datafile (*.dmd) in PLAY Mode
Ctrl + F	Toggle between channel list and last used screen
Ctrl + C	Copy instrument, channel settings…
Ctrl + V	Paste from clipboard
F11	Enable fullscreeen mode

3.3.7 OXYGEN viewer

- It is possible to open OXYGEN multiple times to review and analyze data in the Viewer Mode. Datafiles can be opened directly from a folder, whenever OXYGEN is already running. This Viewer Mode is displayed on the splash screen with the addition "*Viewer*" when OXYGEN is starting, shown in Fig. 3.21.

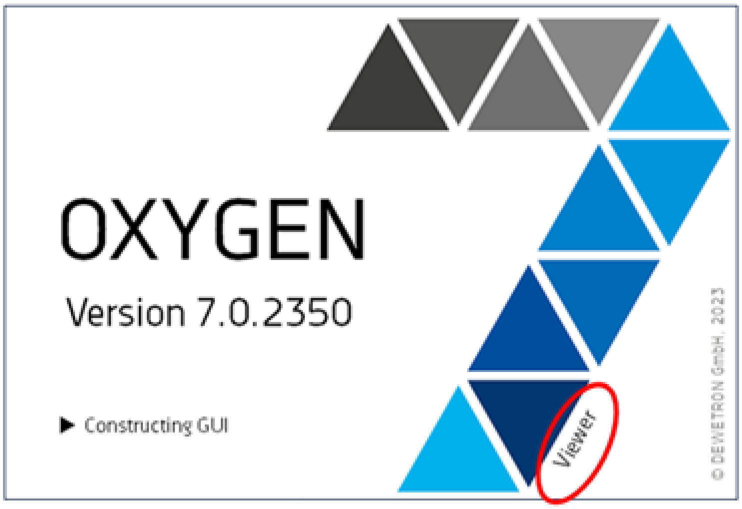

Fig. 3.21: Splash Screen for the OXYGEN Viewer

- The core feature of recording data is only available with the main OXYGEN window, nonetheless, all other features like the post-processing features are also available in the Viewer Mode. Also, during recording this mode can be used to look at an already recorded datafile by opening it in the Viewer Mode.
- If a datafile is opened in Viewer Mode and ejected again (see 2 in Fig. 3.18), a notice appears above the Action Bar shown in Fig. 3.22. Another datafile can be opened to analyze and review.

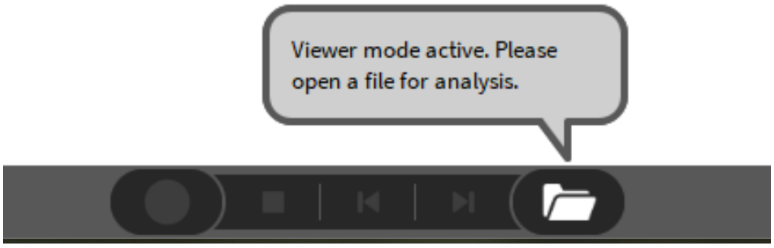

Fig. 3.22: OXYGEN Viewer notice

Note: Multiple OXYGEN Viewer windows can be opened at the same time.

CHAPTER

FOUR

HARDWARE SETUP

The usage of different hardware types can be enabled and disabled in the *DAQ Hardware* setup which can be found in the *System Settings*. To access, the *System Settings* must be expanded to the full screen.

4.1 Using TRION hardware with OXYGEN

- Make sure that the driver for the TRION-hardware is installed. The installer is named *DEWETRON-TRION-Applications-x64.exe* and can be found in the folder *\files\drivers\2_daqboards\dewetron\trion_driver\DEWETRON TRION Rx.x* of the *Install Media* USB stick which is delivered with the measurement system.
- If the driver was installed correctly, the *DEWE2 Explorer* will be available in Windows start menu.
- Go to the *DAQ Hardware* setup in the *System Settings* and make sure that the *TRION Series* is enabled (see Fig. 4.1). Changes take effect on application restart.

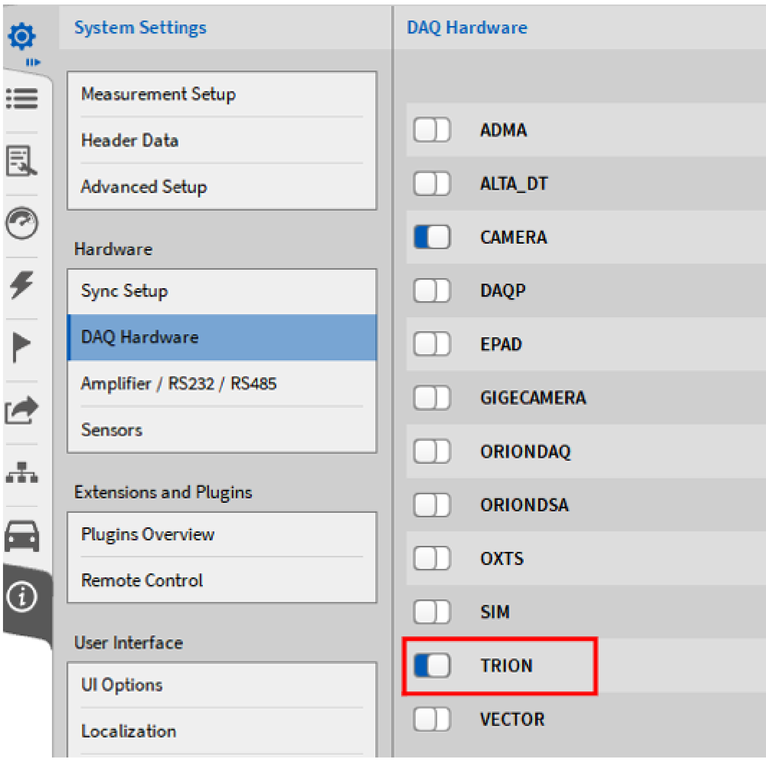

Fig. 4.1: Enabling the TRION Series in the DAQ Hardware setup

- The channels of the connected TRION hardware will now be visible and editable in the Channel List (see Fig. 4.2):

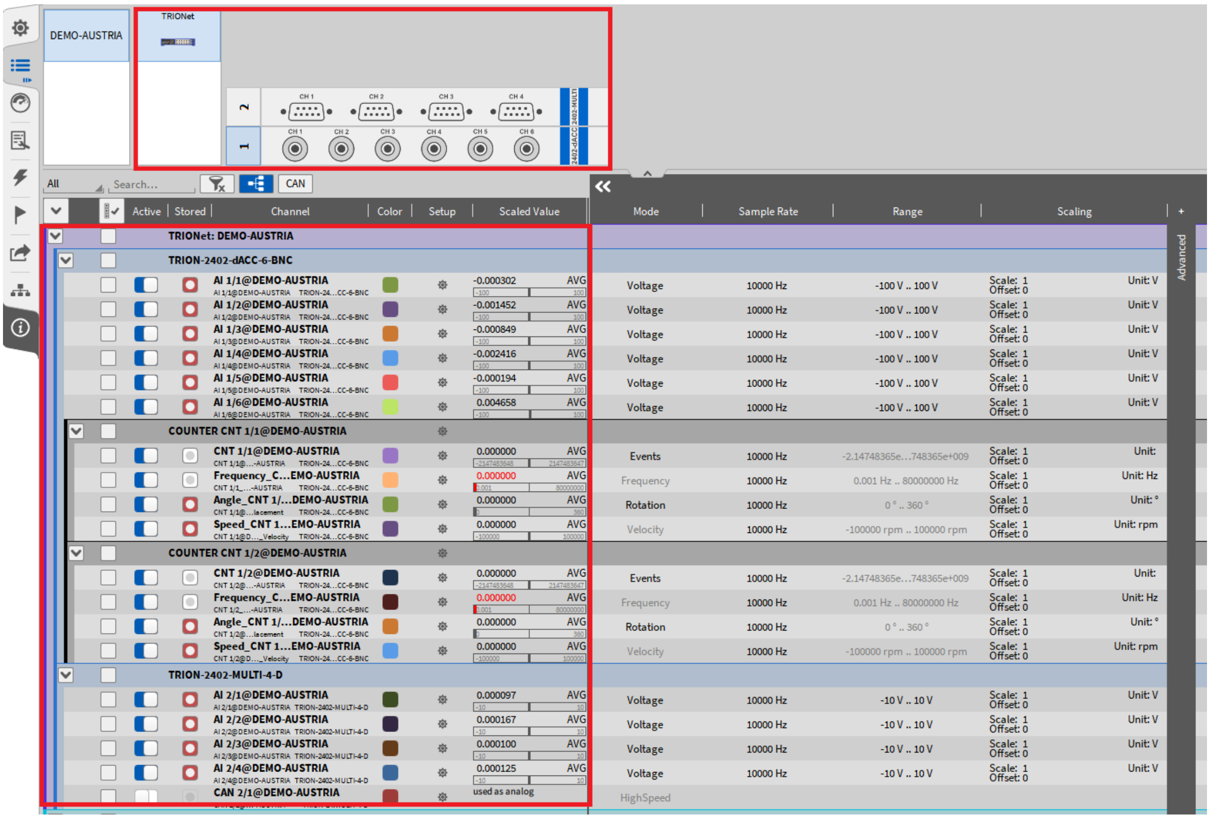

Fig. 4.2: Overview of connected TRION hardware in the Channel List

4.2 Using TRION3-AOUT-8 in OXYGEN

This section will explain the software functions for the TRION3-AOUT module in OXYGEN. In order to use these functionalities, the TRION3-AOUT in combination with a TRION3-18xx-MULTI module and OXYGEN 5.4 version or above are required. The configuration of the two modules can only be done at factory and cannot be changed by the user.

For a detailed explanation of the hardware functionalities refer to the TRION3-AOUT datasheet, which can be found on our website www.DEWETRON.com.

The TRION3-AOUT-8 module has two functions:

- Conditioned signal output
- Calculated channel output

Conditioned signal output

A direct or processed output of each conditioned analog input of the TRION3-18xx-MULTI is available here. This can be a ±5 V, ±10 V or 0-10 V analog signal as direct output or RMS or average value for the same ranges as processed output.

Calculated channel output

Any channel or the TRION3-18xx-MULTI can be used for basic calculations on the FPGA and output the result as a ±5 V, ±10 V or 0-10 V analog signal.

These two functions are available through 4 different modes, which are available in OXYGEN:

- Monitor Output
- Math Output
- Constant Output
- Function Generator

The small gear button, seen in Fig. 4.3 opens the channel setting of each channel.

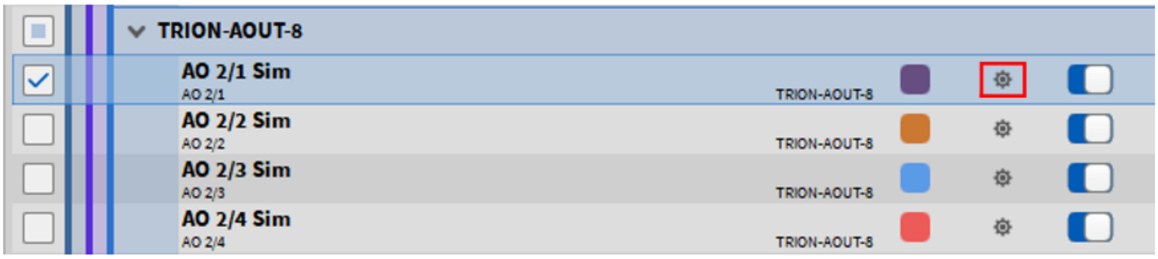

Fig. 4.3: Opening the channel settings of the TRION3-AOUT module

The settings are divided in 3 sections seen in Fig. 4.4 output amplifier options, mode settings and scaling information.

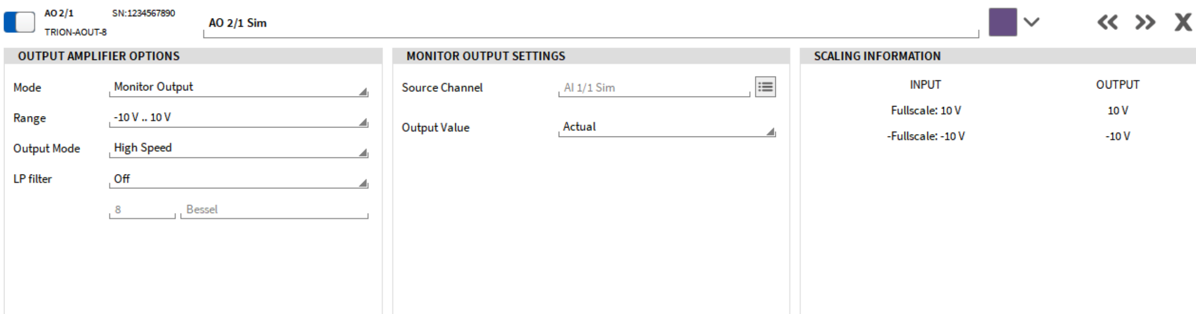

Fig. 4.4: Channel settings of the TRION3-AOUT module

In the output amplifier options the according *Mode* can be selected. Following, each Mode and the according settings will be explained.

Also, the *Range* of the output can be selected here, whereby ±5 V, ±10 V, 0-5 V, 0-10 V, ±30 mA or 0-30 mA are available.

For the *Output Mode* two different options can be selected: High-Speed or High-Resolution. The following table will explain the differences between these two modes.

Table 4.1: Differences between High-speed and High-Resolution mode of TRION3-AOUT module

	High-speed mode	High-resolution mode
Update rate	2.5 MS/s	500 kS/s
Resolution	16-bit	32-bit
Latency	<5 µs	<100 µs

A lowpass filter can also be selected in this section with the cut-off frequency and the filter characteristic.

If the range of the TRION3-18xx-MULTI module exceeds the possible output range of the TRION3-AOUT module, the signal will be scaled accordingly. This scaling information can be seen in the Scaling Information section. An example of an exceeded range can be seen in the following Fig. 4.5.

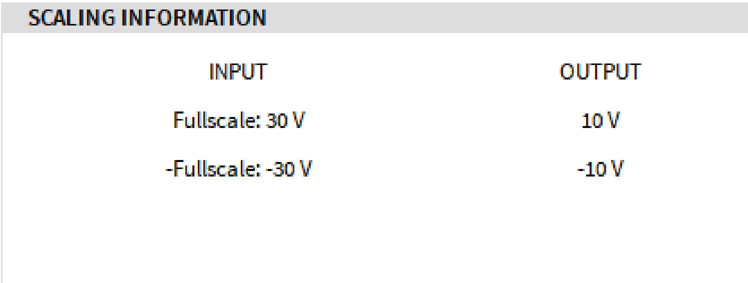

Fig. 4.5: Scaling information for an exceeded range

4.2.1 Monitor Output

Fig. 4.6 shows the available settings for the Monitor Output mode. This mode enables to monitor an input channel of the TRION3-18xx-MULTI module as different output values. The source channel can be selected by clicking on the button marked red in Fig. 4.6. Fig. 4.7 shows the dialog which opens to select the corresponding source channel. Only one channel can be selected.

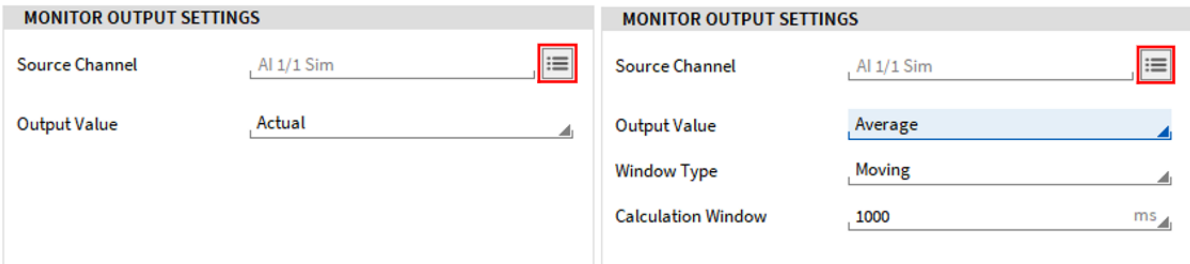

Fig. 4.6: Monitor Output settings

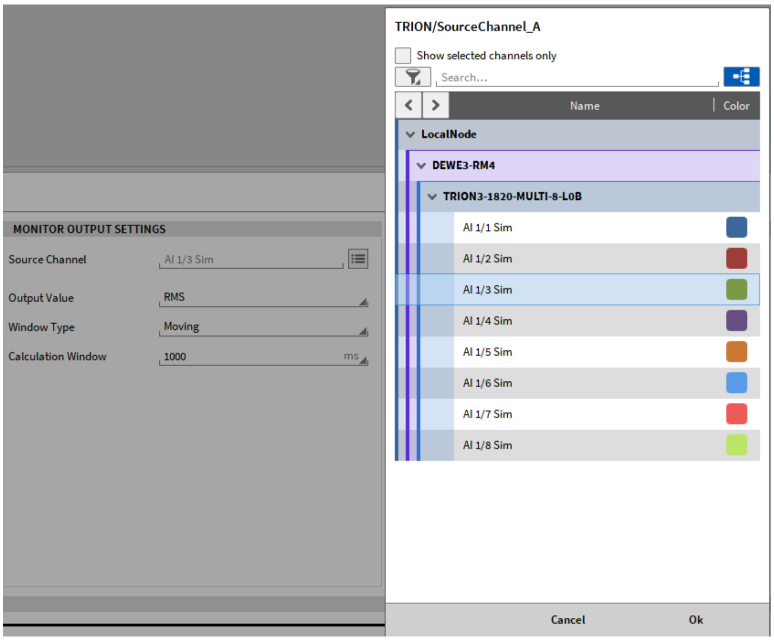

Fig. 4.7: Source channel selection for the Monitor Output Mode

It is possible to output the actual value or the average or RMS value of an input channel of the TRION3-18xx-MULTI module. If the average or RMS is selected, two additional settings are available as seen in Fig. 4.6 on the right side. The *Window Type* can be *Fixed* or *Moving* and for the *Calculation Window* a value can be chosen from the dropdown list or a value can be entered manually.

4.2.2 Math Output

Fig. 4.8 shows the settings for the Math Output mode. Again, two source channels can be selected by clicking on the button marked red in Fig. 4.8. The following three *Math Operations* are available for the two source channels:

- A + B
- A – B
- A * B

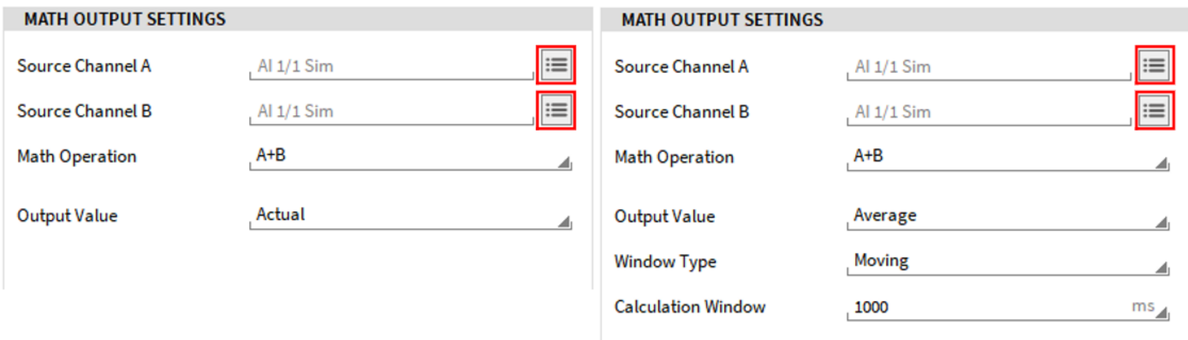

Fig. 4.8: Math Output settings

It is possible to output the actual value of the operation result or the average or RMS value. If the average or RMS is selected, two additional settings are available as seen in Fig. 4.8 on the right side.

The *Window Type* can be *Fixed* or *Moving* and for the *Calculation Window* a value can be chosen from the dropdown list or a value can be entered manually.

4.2.3 Constant Output

Fig. 4.9 shows the setting for the Constant Output mode. The Source Channel cannot be selected, since for the constant output this is not necessary. Depending on the *Range*, which is selected in the *Output Amplifier Options* (see Fig. 4.4 a *Constant Value* can be entered, which lies within the range. The slider can be used to set a value, or it can be entered manually in the provided field.

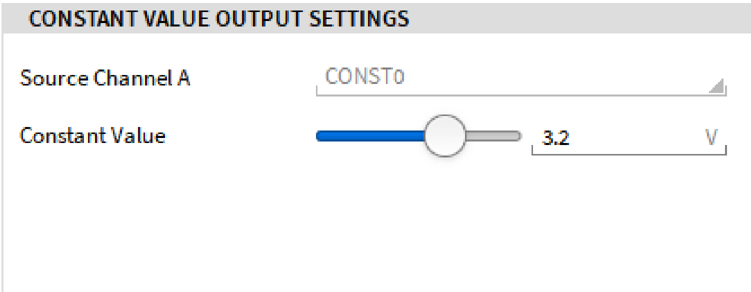

Fig. 4.9: Constant Output settings

4.2.4 Function Generator

As a last mode the Function Generator is available. The different settings can be seen in Fig. 4.10

- Waveform: sine, square or triangle waveform can be selected or an individual pattern, which can be defined in the *Custom Waveform Store* section (see Fig. 4.10). For a more detailed explanation see *Custom Waveform Store*.
- Frequency: the frequency can be selected from the dropdown list or an individual value can be entered between 0.001 Hz and 1 MHz.
- Amplitude: the amplitude can be between 0–10 V or 0–30 mA as peak or RMS value.
- Offset: an offset between ±10 V or ±30 mA can be defined.
- Phase: a phase between ±180° can be defined.
- Symmetry/Dutycycle: this option is only available for a triangle or square waveform and can be defined between 0.001–100 %.

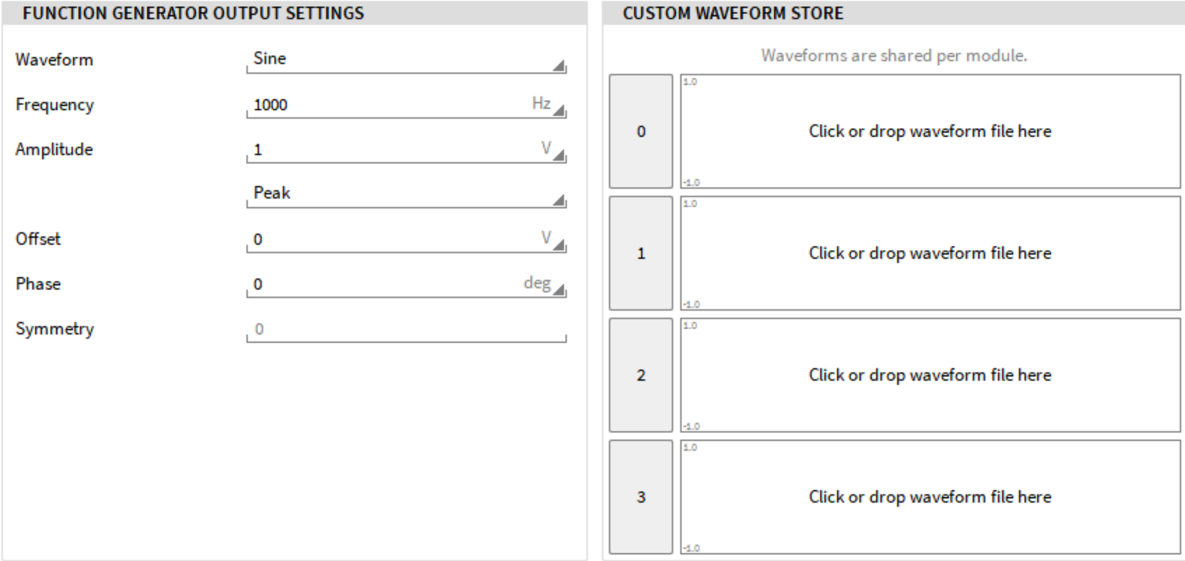

Fig. 4.10: Function Generator settings

4.2.5 Custom Waveform Store

If a custom waveform wants to be used, Pattern 0-3 must be selected as *Waveform* in the *Function Generator Output* settings. In the section *Custom Waveform Store* 4 different waveforms can be defined accordingly. Only one waveform can be selected per channel. A custom waveform file can either be dragged and dropped to one of the provided fields or selected by clicking on the filed directly and a file dialog will open. The waveforms are also shared per module; therefore 4 different waveforms can be dropped and are available on each channel of that module. These waveforms are also saved in the setup file.

There are some rules for the waveform file:

- The file must be a .csv format
- Each row is one value or sample
- Only values between -1 and 1 are allowed
- The separator must be a . (dot)
- A maximum of 16384 rows are allowed

The defined waveform corresponds to one period and will be repeated periodically.

Fig. 4.11 shows 3 different custom waveforms and Pattern2 is currently selected as Waveform in the settings.

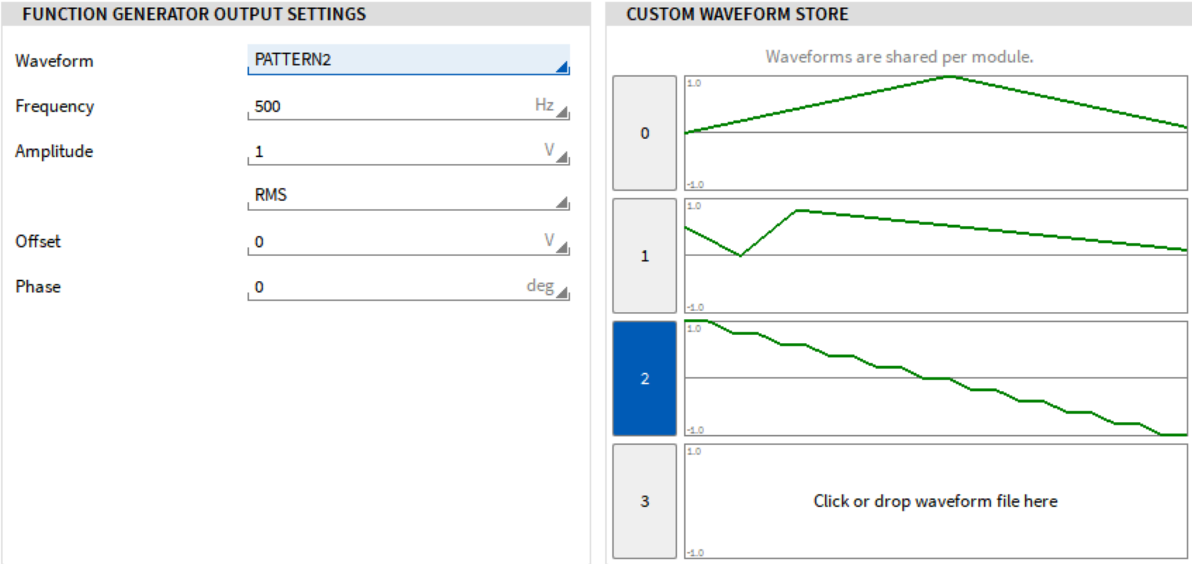

Fig. 4.11: Custom Waveform for the Function Generator mode

4.2.6 Stream Output / File Replay

The Stream Output functionality can be used to output scalar channels via the analog output channels of the TRION3-AOUT board, this is also possible with channels of a previously recorded OXYGEN file. This mode is also supported by the TRION3-AOUT as a standalone module.

To use this mode, the software must be in *LIVE* mode (data acquisition) or *REC* mode and is not supported in *PLAY* mode.

To use this mode, follow these steps:

- Open the channel settings of each channel, that should be used for the stream output (see Fig. 4.12).
- Change the mode to StreamOutput and select the desired range and output signal (voltage or current). For the output of channels of a previously recorded OXYGEN file, select the data source *Replay* in the *Stream Output Settings*, all further settings are done in the Stream Output instrument. For the output of any scalar OXYGEN channel, specify “Live” as data source, as well as the source channel in the *Stream Output Settings* and define the delay time (0.5 .. 10 s), as well as a necessary conversion factor or offset.

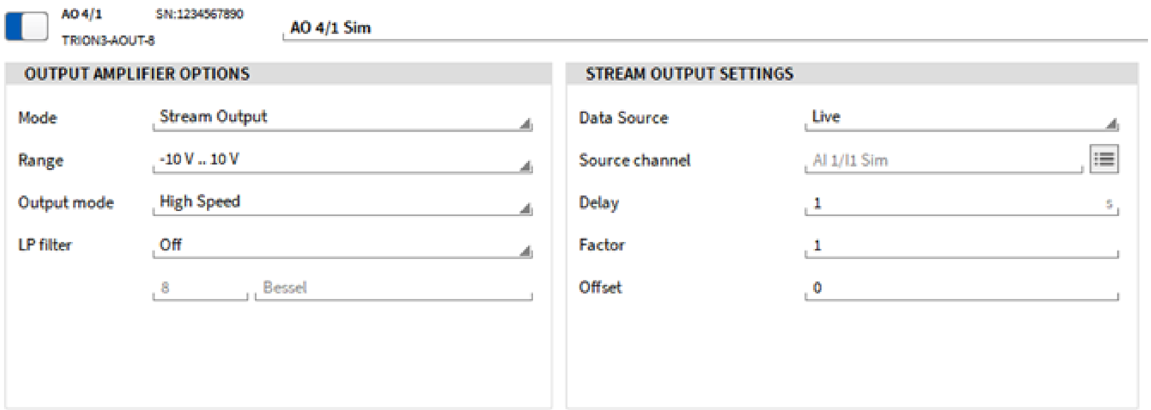

Fig. 4.12: Channel settings for the Stream Output functionality

- To replay channels of a previously recorded OXYGEN file, go to your measurement screen and open the small Instrument menu. A separate instrument exists for loading the data file and choosing the channels to be output/restreamed. As seen in Fig. 4.13, drag and drop the instrument on your measurement screen, adjust the size and place it to a desired location.

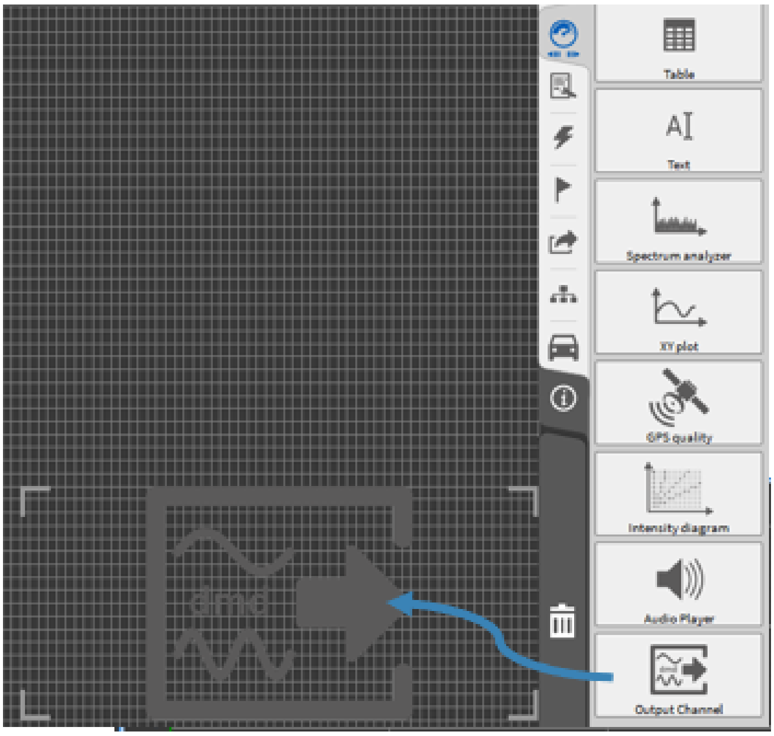

Fig. 4.13: Use Stream Output Instrument on the measurement screen

- Open the small Data Channel list in order to choose the analog output channels, which should be used for the Stream Output functionality. Select the instrument and click on the respective channels or drag and drop the channels into the instrument. Up to 8 channels can be used in one instrument.

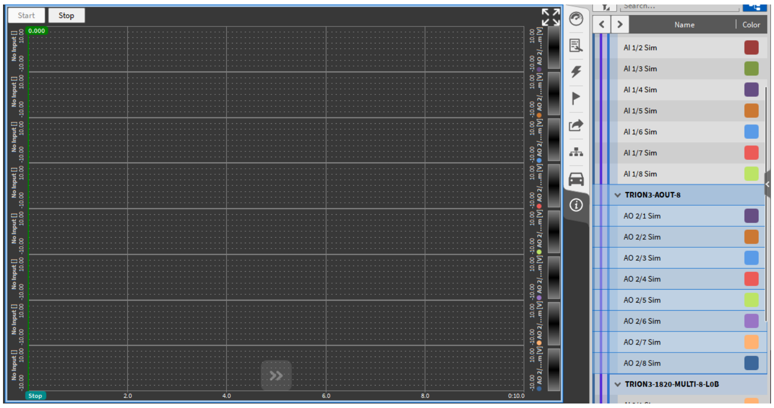

Fig. 4.14: Choosing the analog output channels

Note: Only channels with the mode StreamOutput can be used in the instrument (see above). If analog output channels are used, which have another mode selected in the channel settings, a warning appears in the instrument itself, see Fig. 4.15. In this case, open the channel settings of the used channel and check the selected mode.

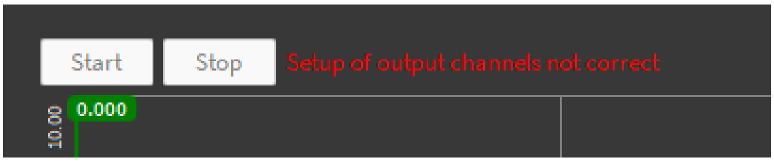

Fig. 4.15: Warning when using analog output channel with wrong mode in Stream Output Instrument

- To load a data file and choose the channels to be output, open the instrument properties by either double-clicking on the instrument itself or selecting the instrument and open the Instrument Properties menu tab (see Fig. 4.16).
- ① Click on Browse to choose the .dmd file to be replayed.
- ② Assign the input channel to the output channel.
- ③ Adjust the output scaling factor.
- ④ Adjust the output offset, if desired.
- ⑤ Loop the playback, otherwise the signal will only be output once.
- ⑥ Use the cursors to replay only a certain part of the data file.
- ⑦ Start/stop/pause the playback.
- ⑧ Playback mode “Replay” is used to play back channels of a previously recorded OXYGEN file. (see Fig. 4.16) Playback mode “Live” is used to play back scalar channels of the current measurement (see Fig. 4.17), no data is displayed in the instrument. In “Live” mode, the instrument is only used to set the channels to be transmitted, which are directly output as AOUT channels with the set delay time.

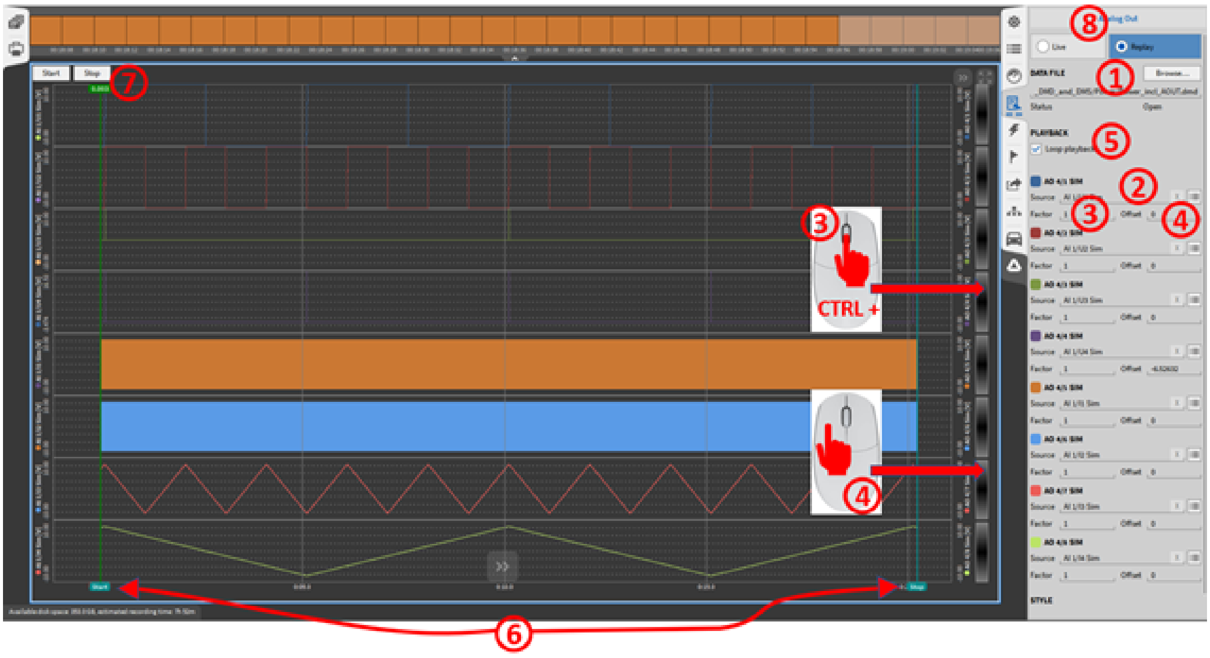

Fig. 4.16: Stream Output Instrument: Instrument properties (Replay)

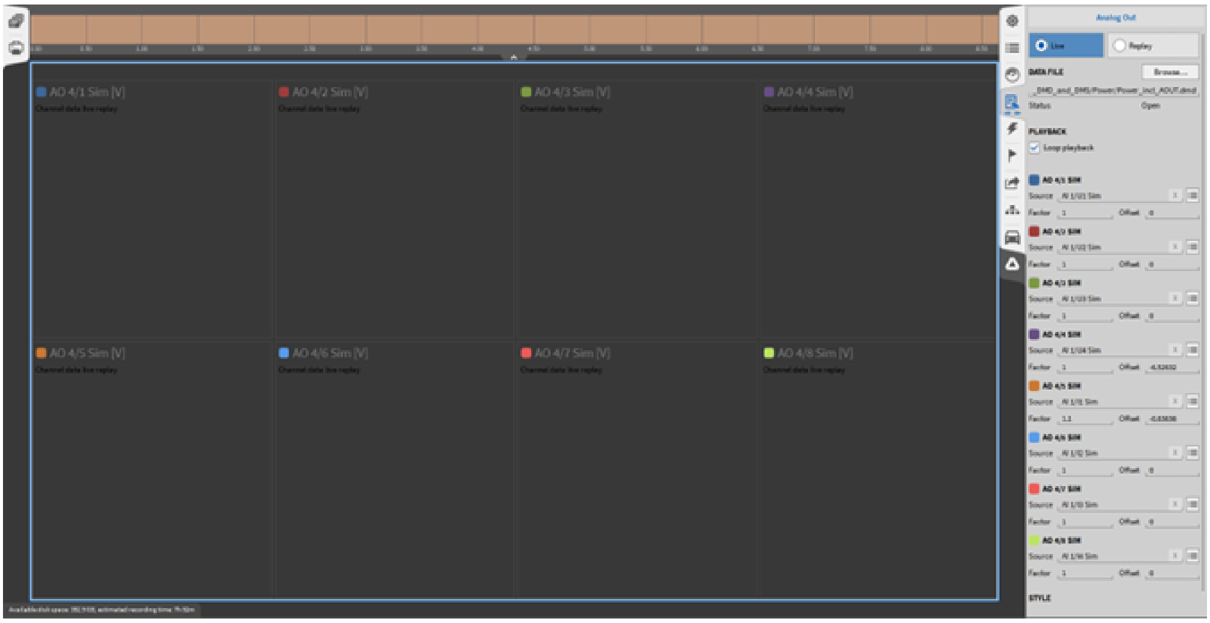

Fig. 4.17: Stream Output Instrument: Instrument properties (Live)

4.2.7 Channel SUM Mode

The channel mode "Channel Sum", enables the creation of a linear equation of up to 8 AIs and can output this via an AO channel. To use this feature, a firmware update must be made. Useful for shaker control.

$$AO_i = (X_1 AI_1 + X_2 AI_2 + X_3 AI_3 + X_4 AI_4 + X_5 AI_5 + X_6 AI_6 + X_7 AI_7 + X_8 AI_8) * Y$$

For the first 8 analog inputs a scaling between -10 and 10 can be chosen ① denoted in the equation before as X_i. To scale the resulting formula the output scale can be set between -100 and 100 ② denoted before as Y. Lastly, the output value type can be selected as actual, average or RMS ③. When choosing Average or RMS, the window type ④ can be defined as moving or fixed.

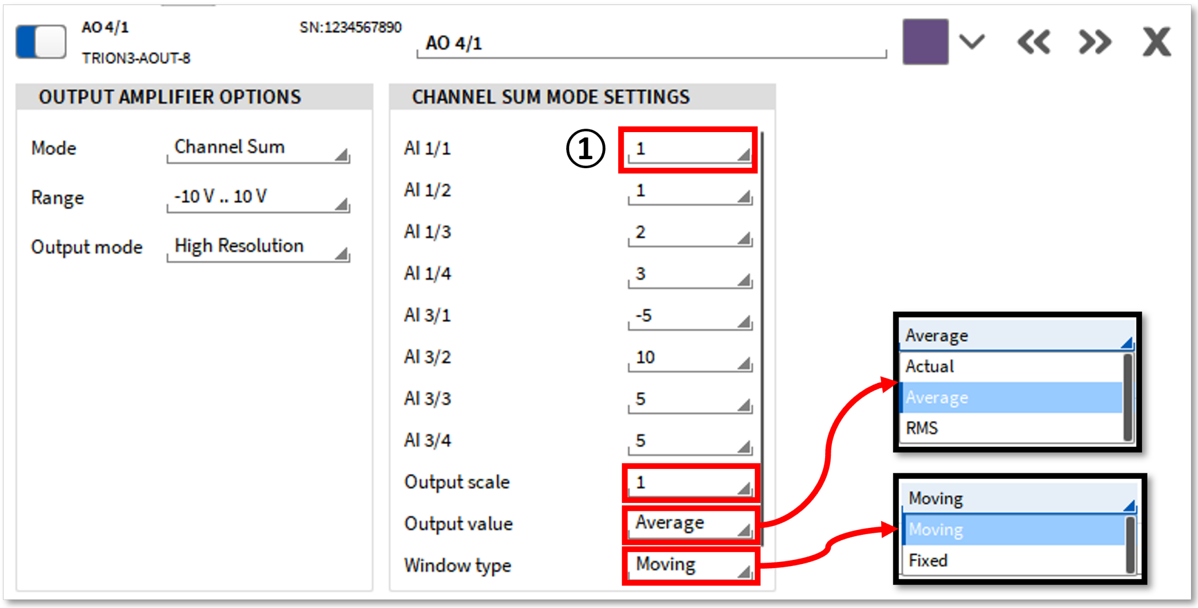

Fig. 4.18: Channel Sum mode settings

4.3 Using TRIONet in OXYGEN

In addition to the steps explained in *Using TRION hardware with OXYGEN*, the following steps must be carried out if TRION hardware is used in combination with a TRIONet.

- Choose 'Auto' from the '*Network Interfaces*' drop-down menu (see *Using TRION hardware with OXYGEN*). This will scan all ethernet ports and automatically detect the TRIONet device.

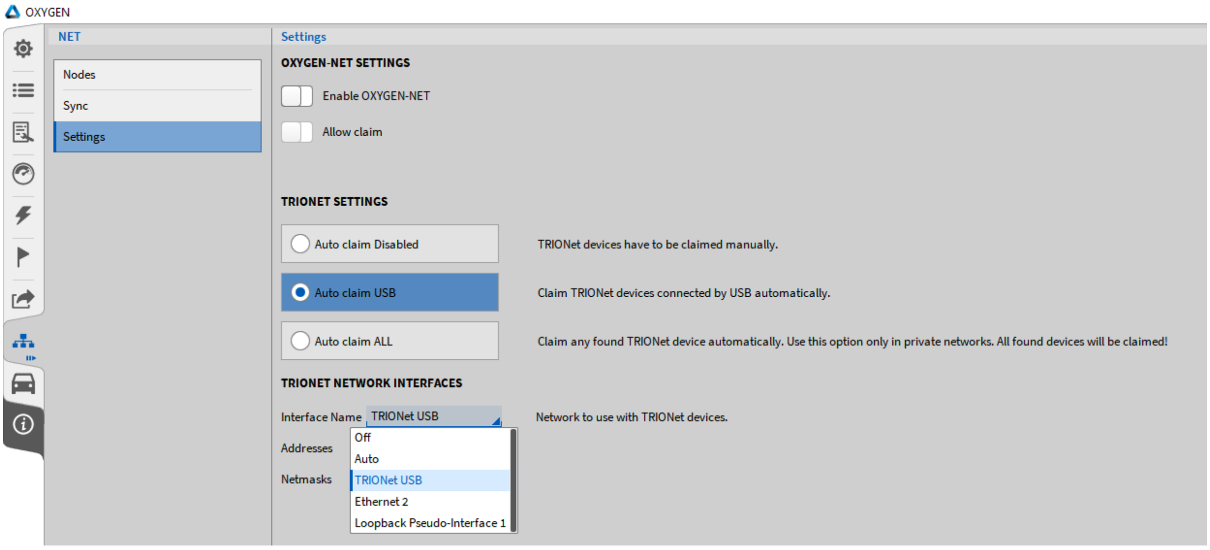

Fig. 4.19: Network Interface settings

- The IP-address of the adapter is shown in the field below (see Fig. 4.20)

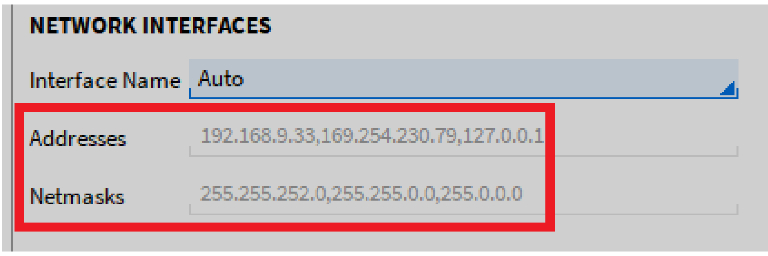

Fig. 4.20: IP addresses of connected TRIONets

- Now switching to *Channel List* will display the TRIONet and installed modules

Note: Besides the TRION hardware driver, there is no additional driver required to use a TRIONet with your measurement system. For additional information about the TRIONet and troubleshooting, please refer to the TRIONet Technical Reference Manual.

4.4 Using EPAD2 with OXYGEN

4.4.1 Using EPAD2 with OXYGEN on a DEWE or DEWE2 system

For connecting an EPAD2 module with your hardware, the DEWE and DEWE2 series products (except TRIONet) have a connector on the housing marked with the word *EPAD* (see Fig. 4.21).

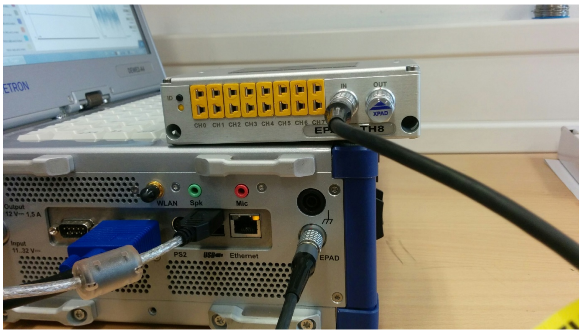

Fig. 4.21: Connection of EPAD modules

- Expand the *System Settings* menu fully across the screen
- Select the *DAQ Hardware* section and ensure the slider button next to the EPAD Series is activated (see Fig. 4.22). Changes take effect on application restart.

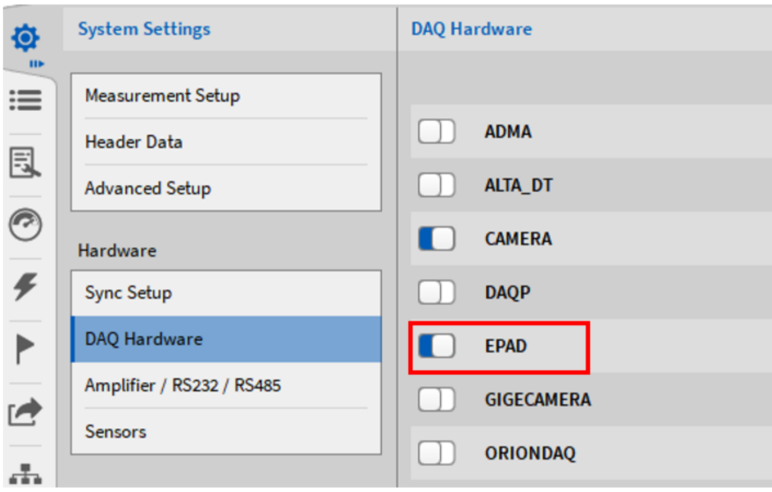

Fig. 4.22: Enabling the EPAD Series in the DAQ Hardware setup

- Select the proper Serial Port for your EPAD2 module by clicking on the *Select ports…* button (see Fig. 4.23). Systems in Europe are typically assigned to COM2 and systems in the USA are typically assigned to COM3).

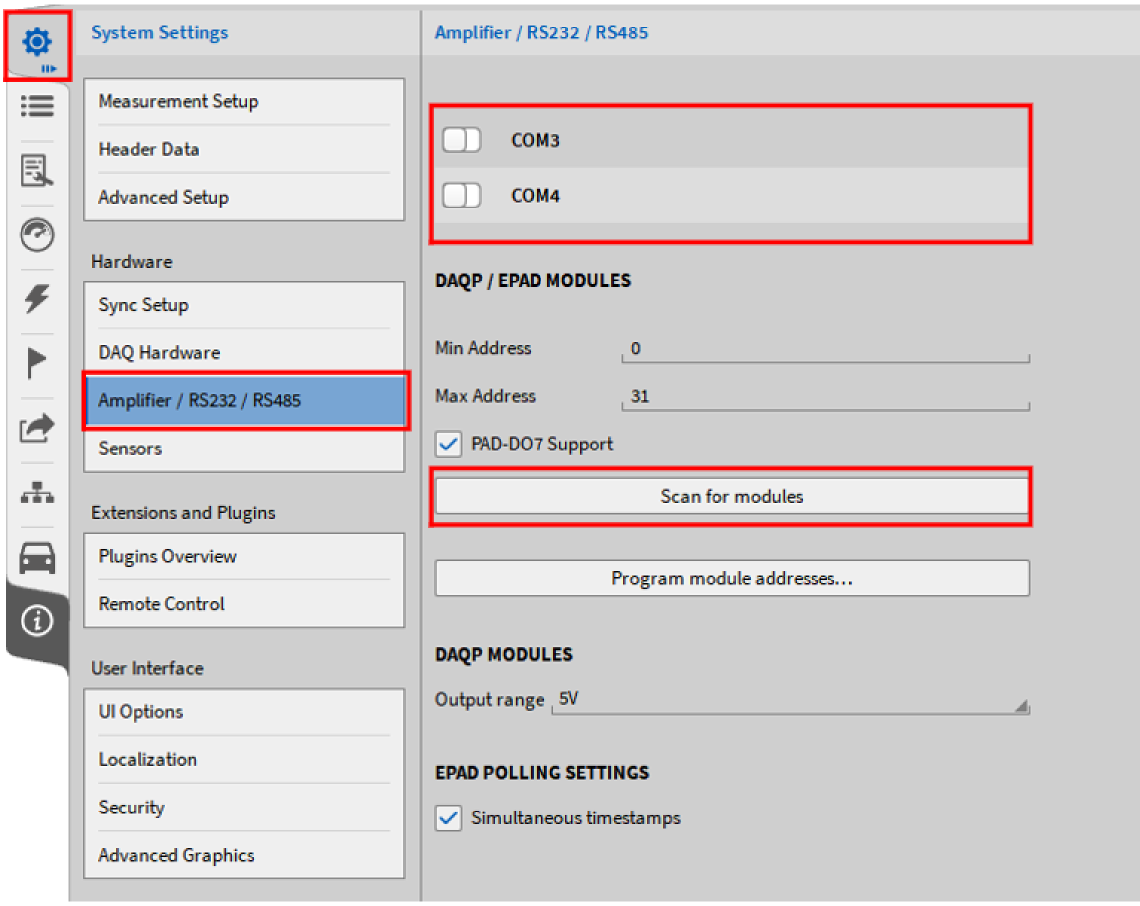

Fig. 4.23: Selection of the proper COM port

- Press the *Scan for modules* button (see Fig. 4.24). The system will scan the selected Serial Port for any present EPAD2 modules. The status can be seen in the lower right corner of the software.

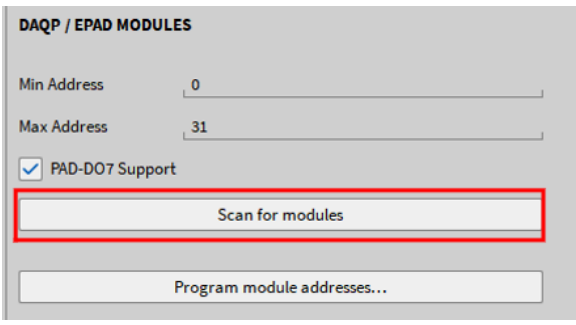

Fig. 4.24: *Scan for modules* button

- If an EPAD2 module is found, the user will be presented with a message in the lower right corner of the software (see Fig. 4.25) stating that the software has found an EPAD2 module.

Fig. 4.25: EPAD found message

- If you have multiple EPAD2 modules daisy chained together, the user can select the *Program module addresses…* button (see Fig. 4.26).

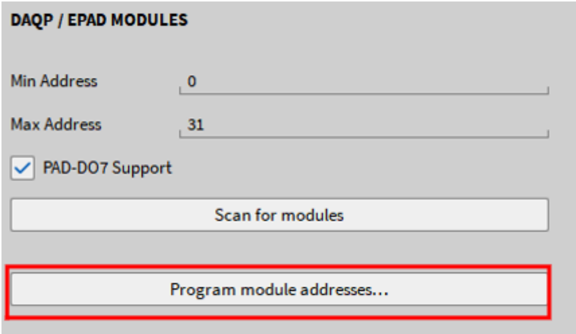

Fig. 4.26: *Program module addresses* button

- Next, select the starting EPAD2 address (cannot be 0) and then select *Start programming* (see Fig. 4.27).
- Once the programming has begun, the software will ask you to press the black *ID* button (see Fig. 4.28) on the first EPAD2 module. Then it will increment the address in the software by one. At this point you will press the second EPAD2s' black *ID* button and so on.
- When finished programming, select the *Stop Programming* button (see Fig. 4.27).

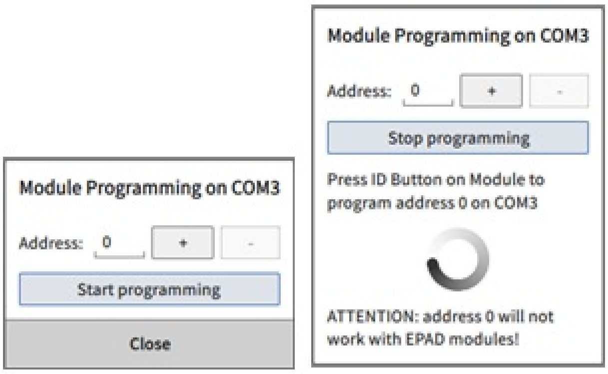

Fig. 4.27: EPAD-programming procedure

Fig. 4.28: Front of an EPAD2 module

4.4.2 Using EPADS with OXYGEN via EPAD2-USB module

EPAD2 modules can also be used as stand-alone measurement solution (CVT-Logger) without DEWE or DEWE2 hardware. Therefore, they can be connected via the EPAD2-USB module to the measurement PC. This is also a solution for using EPAD2 modules in combination with a TRIONet which has no EPAD connector.

Make sure that the driver for the EPAD2-USB module is installed on the measurement PC. The *setup.exe* file can be found in the folder *\files\drivers3_communication\dewetron_usb* of the *Install Media* USB stick which is delivered with the EPAD2-USB module. After finishing the driver installation, the EPAD2 module can be programmed in OXYGEN in the same manner which is explained in *General settings*. The correct COM port can be found in the Device Manager of your PC in this case. The COM port which is called *TUSB3410 DEVICE* is the correct one (see Fig. 4.29).

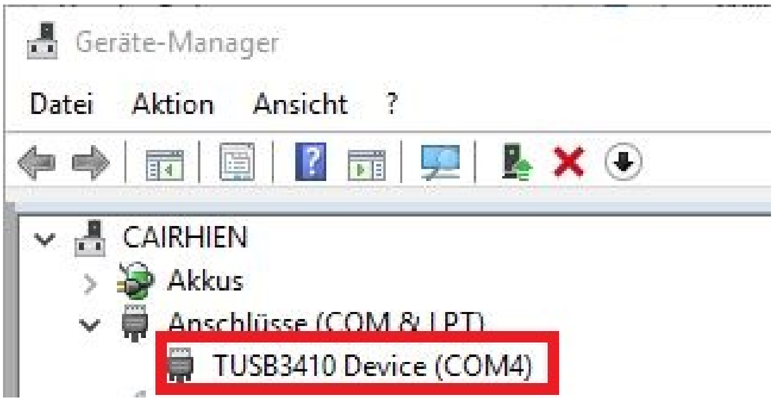

Fig. 4.29: COM port section in the Device Manager

4.4.3 Troubleshooting

If no EPAD module is found during the scan for modules although it is connected, check the following items and then rescan for EPAD2 modules:

- Ensure your EPAD2 is compatible with OXYGEN (in OXYGEN 3.2 and higher all EPAD-modules except EPAD2-USB are supported).
- Check to see if the EPAD2 is properly connected to the system.
- Make sure the LED beneath the ID push button is illuminated when the EPAD2 is connected to the system.
- Choose another COM port, and rescan for the EPAD2 modules.
- If using several EPAD2 modules, ensure that the terminating resistor is in place.

4.4.4 EPAD channel list

- After the programming of the EPAD2 module(s) is finished, close the System Settings menu and fully open the Data Channels menu across the screen
- The EPAD2 module(s) are now visible in the system overview at the top of the Channel List (①) and are available in an own EPAD channel section in the Channel List (②) (see Fig. 4.30)
- The Channel List can also be filtered to EPAD channels
- By clicking the Up and Down arrow next to the picture of the EPAD-module, the user can quickly navigate between several EPAD-modules connected to the system

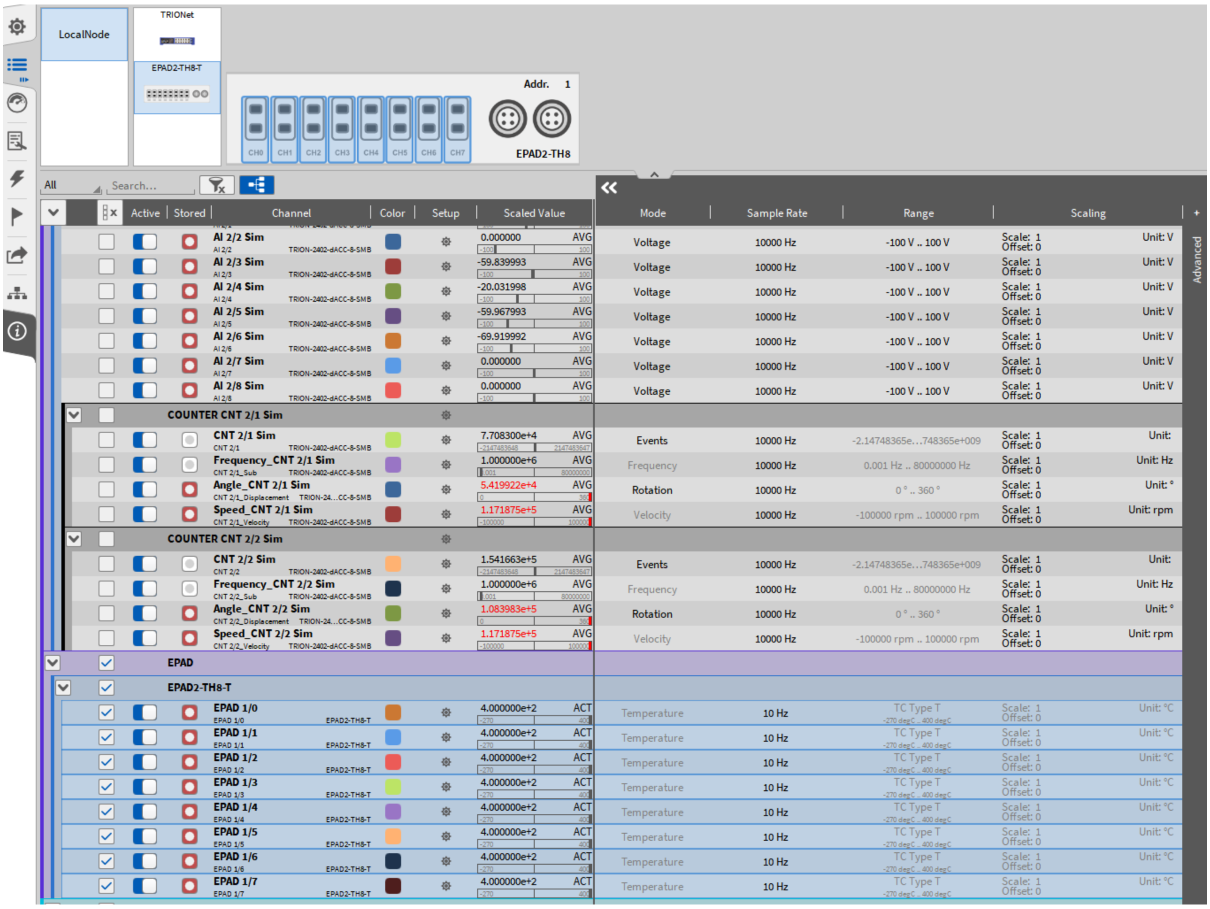

Fig. 4.30: EPAD channel list

Note: If no thermocouple is connected to an EPAD-channel, the value 1372.0 °C (2501.6 °F) is displayed.

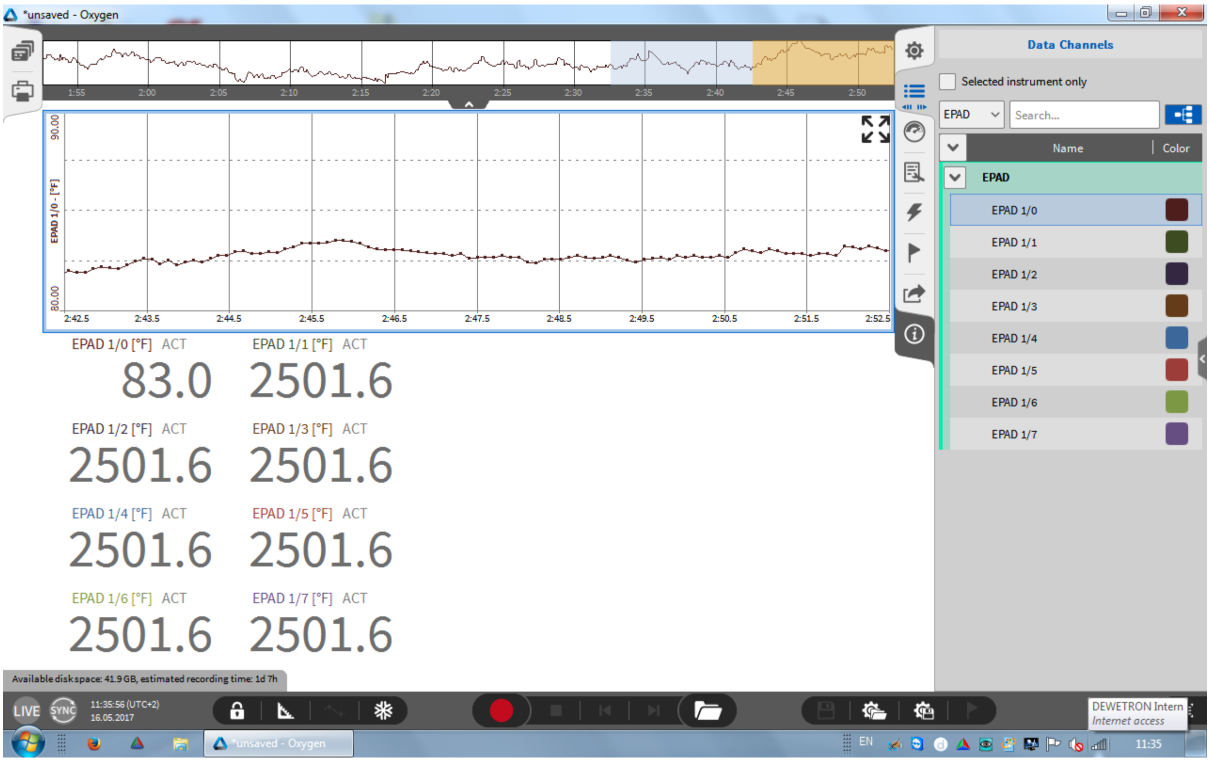

Fig. 4.31: Displaying EPAD2 data

4.5 Using XRs / CPADs with OXYGEN

This section describes the setup process when using CPADs in OXYGEN. The same process is valid for setting up an XR.

For settings up CPADs and decoding their data without the need to load a .dbc file OXYGEN R5.6 (and later) provides a CPAD Decoder plugin. All CPAD types are supported.

This plugin can be used to do the following in OXYGEN: - Change the CPAD module's Baud rate - Read out module properties - Edit CPAD channel settings - Change CPAD sample rate

For sure, the conventional approach of decoding the CPAD's CAN data by loading a .dbc file is still supported.

To decode CPAD data with the CPAD Decoder plugin per form the following steps:

- Connect the CPAD to the desired CAN port and open its Channel settings in the Channel List (see ① in Fig. 4.32).
- Select the Baud rate of the CPAD (see ② in Fig. 4.32)
- If you don't know the CPAD's Baud rate change the Baud rates until the Frame Preview shows alternating Message IDs and frames (see ③ in Fig. 4.32)
- Make sure that the CAN bus is terminated with a 120 Ohm resistor or set the internal module termination to True (see ④ in Fig. 4.32)
- When the Baud rate is set up correctly press Add decoder (see ⑤ in Fig. 4.32)

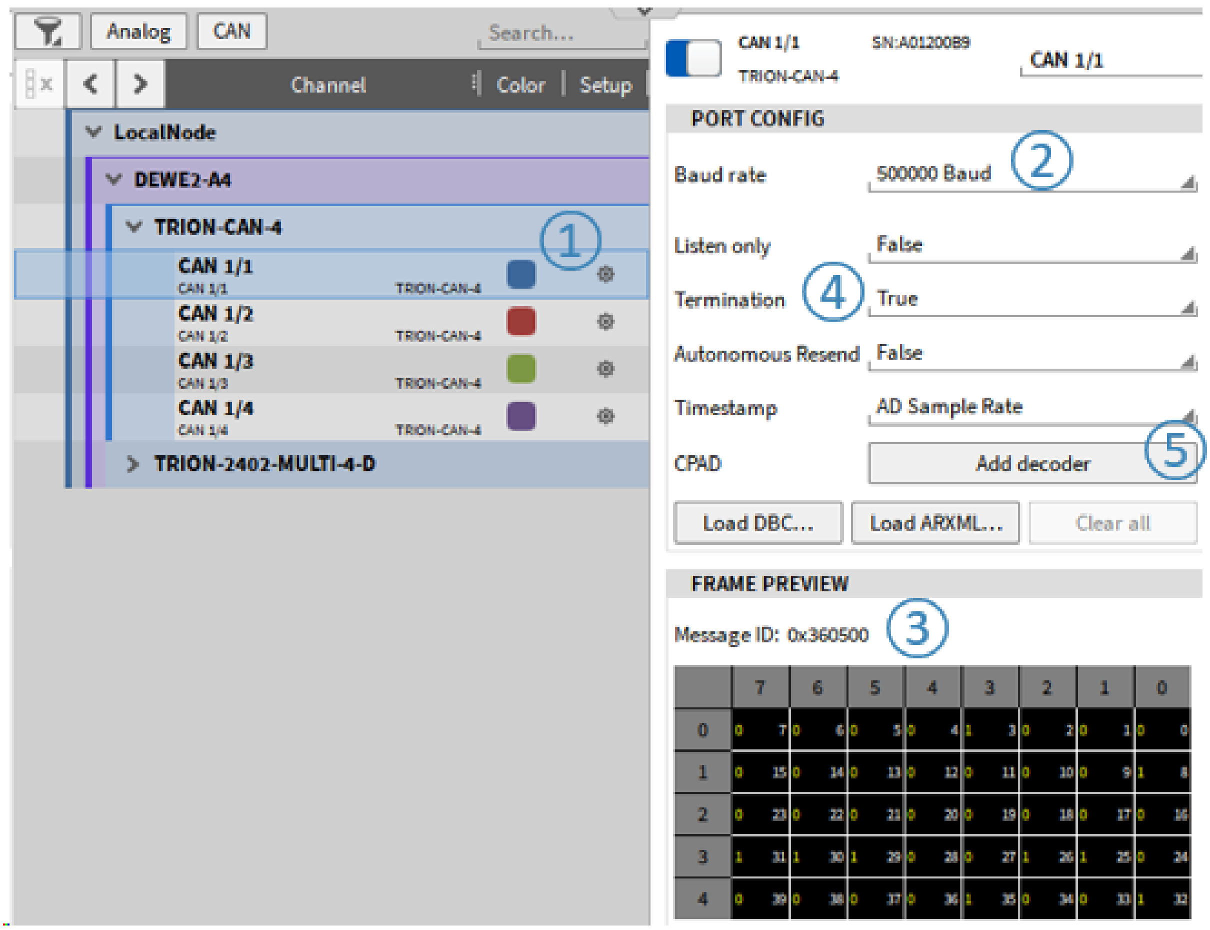

Fig. 4.32: Adding a CPAD decoder

Alternately, the CPAD decoder plugin can be added by the "+"-button as well. To do so, select the correct CAN-bus, press "+", choose *CPAD Decoder* and press *Add* (see Fig. 4.33). With the option "Synchronous output channels" (4), the acquired CAN data is forced to equidistant timestamps.

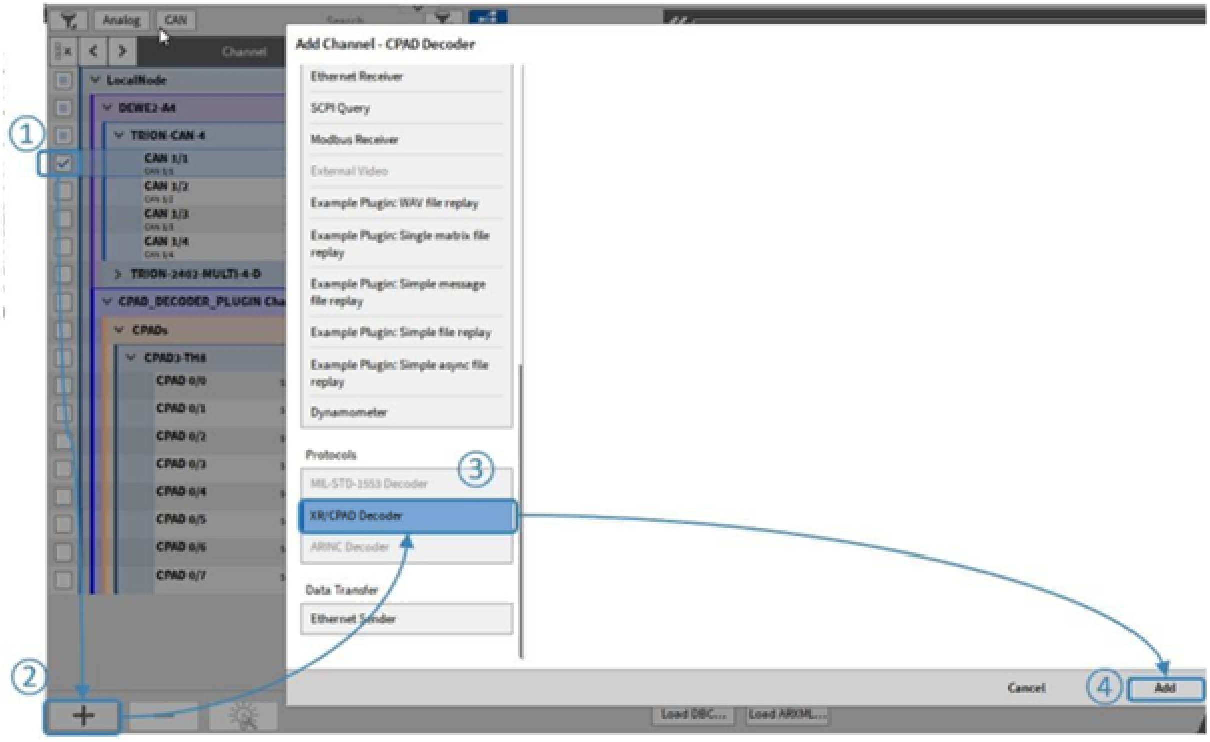

Fig. 4.33: Adding a CPAD decoder Adding a CPAD decoder (alternate approach)

After creating the CPAD decoder, the detected CPADs and their channel can be found in the channel list (see ① in Fig. 4.34). If desired, the referring CAN port can be changed (i.e. when a CPAD is connected to a different port) by selecting a different CAN port in ② in Fig. 4.34. The module baud rate can be changed here as well (see ④ in Fig. 4.34) in addition to the synchronous timestamp forcing equidistant timestamps if "True" ⑤. Make sure to change the CAN bus baud rate as well to properly receive and decode data in ② of Fig. 4.32.

Additionally, the configuration of the CPAD / XR can be saved into a DBC-file here (see ③ in Fig. 4.34).

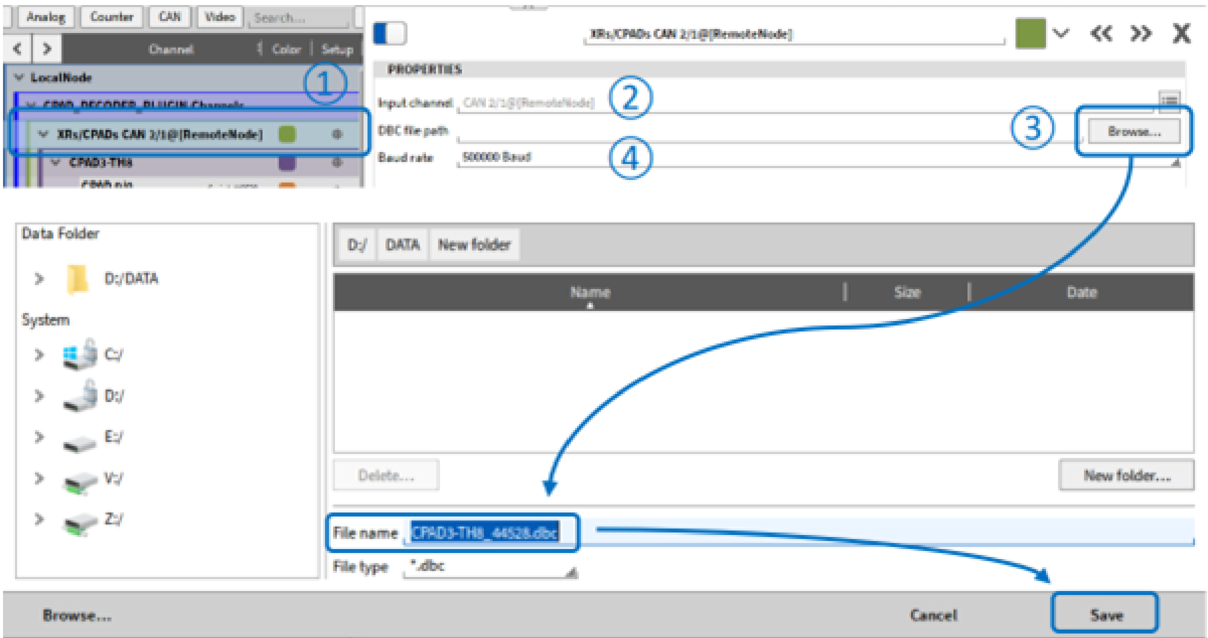

Fig. 4.34: CPAD decoder settings

Note: If one of several connected modules cannot be found in the list it has most likely a different baud rate that the others. Change the CAN bus baud rate until the missing module is detected and change the module baud rate to the desired baud rate. You can disconnect all modules but the missing module for an easier workflow here.

The CPAD's specific properties can be found in the CPAD's individual channel setup (see Fig. 4.35):

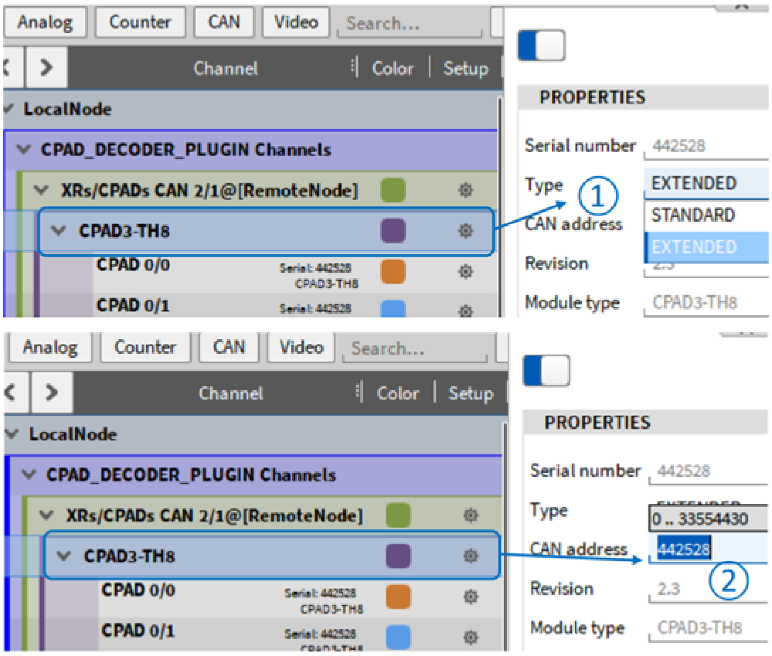

Fig. 4.35: CPAD specific properties

It is possible to edit the CAN address/ID of the CAN Message sent by the CPAD in decimal form (see 1 in Fig. 4.35).ID Type Extended (by default) or Standard can be selected (see 2 in Fig. 4.35).

The channel settings can be edited in the individual CPAD channel setup (see Fig. 4.36):

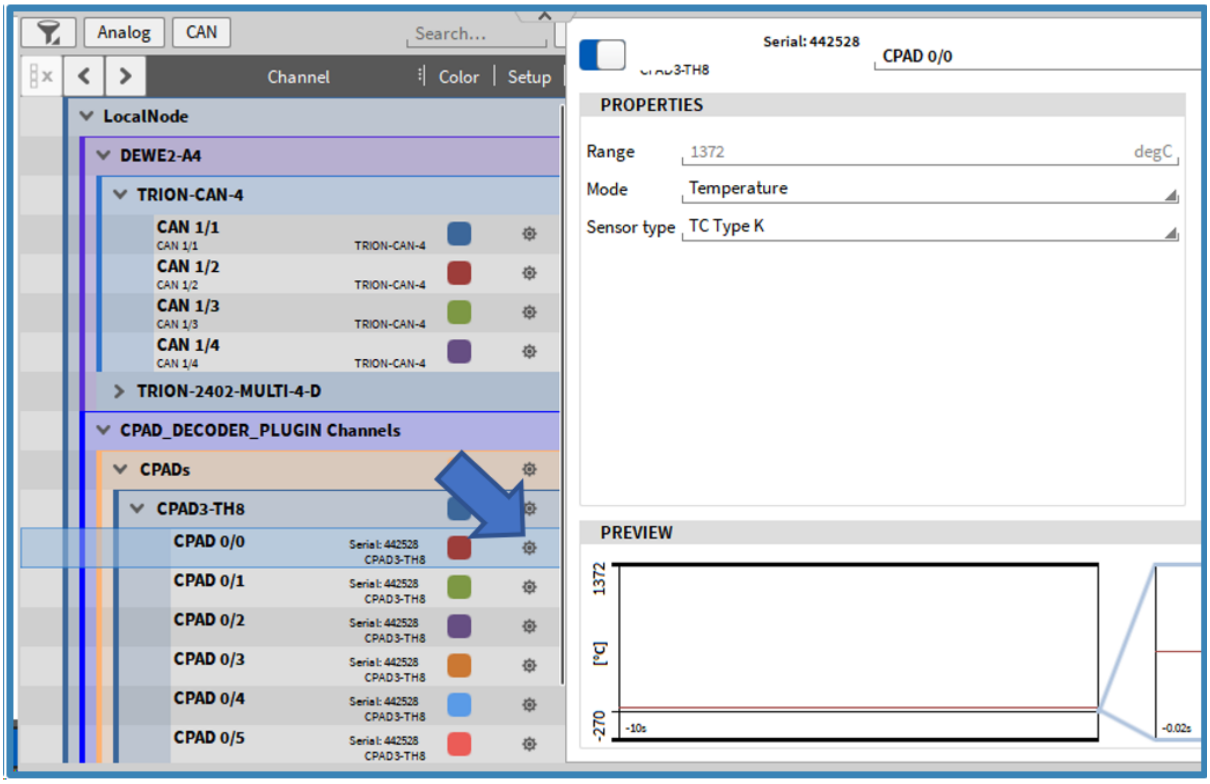

Fig. 4.36: CPAD channel setting

The CPAD's sample rate can be changed in the Sample Rate column of the Chanel List (see Fig. 4.37):

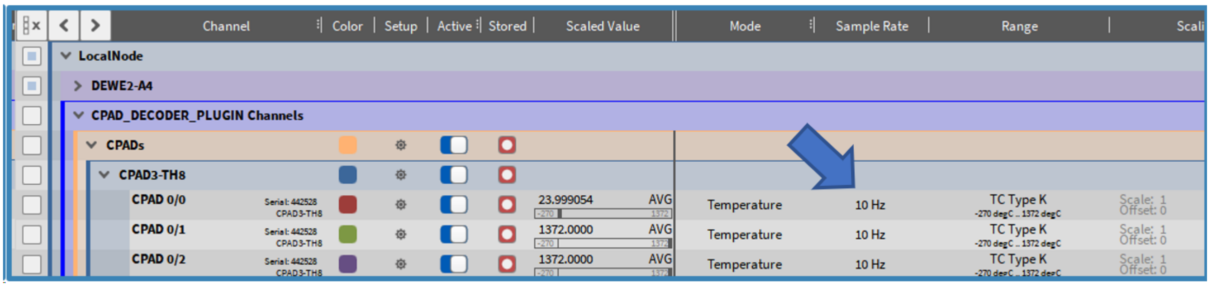

Fig. 4.37: Changing the CPAD sample rate

4.6 Using DAQP/HSI Modules with OXYGEN

4.6.1 Connecting DAQP/HSI Modules via an ORION Card to the Measurement System

- DEWE-ORION-xx16-xxx boards

  If the DAQP/HSI modules are connected via DEWE-ORION-xx16-xxx boards to the measurement system, go to the *DAQ Hardware* setup and make sure that the *ORIONDAQ Series* hardware is enabled as well as the *DAQP Series* (see Fig. 4.38) (Changes take effect on application restart) and that the proper driver is installed.

  The installer is named DeweDevSetup_x64.exe for 64-bit systems and DeweDevSetup_x86.exe for 32-bit systems and can be found in the folder

\files\drivers\2_daqboards\dewetron\orion_driver\DAQ-BOARDS_DRIVER_v2.1.0.0 of the *Install Media* USB stick which is delivered with the measurement system.

- DEWE-ORION-xx22-xxx and DEWE-ORION-xx24-xxx boards

  If the DAQP/HSI modules are connected via DEWE-ORION-xx24-xxx or DEWE-ORION-xx22-xxx boards to the measurement system, go to the *DAQ Hardware* setup and make sure that the *ORIONDSA Series* hardware is enabled as well as the *DAQP Series* (see Fig. 4.38) (changes take effect on application restart) and that the proper driver is installed.

  The installer is named DeweDevSetup_x64.exe for 64-bit systems and DeweDevSetup_x86.exe for 32-bit systems and can be found in the folder *\files\drivers\2_daqboards\dewetron\orion_driver\DSA-BOARDS_DRIVER_v4.1.0.0* of the *Install Media* USB stick which is delivered with the measurement system.

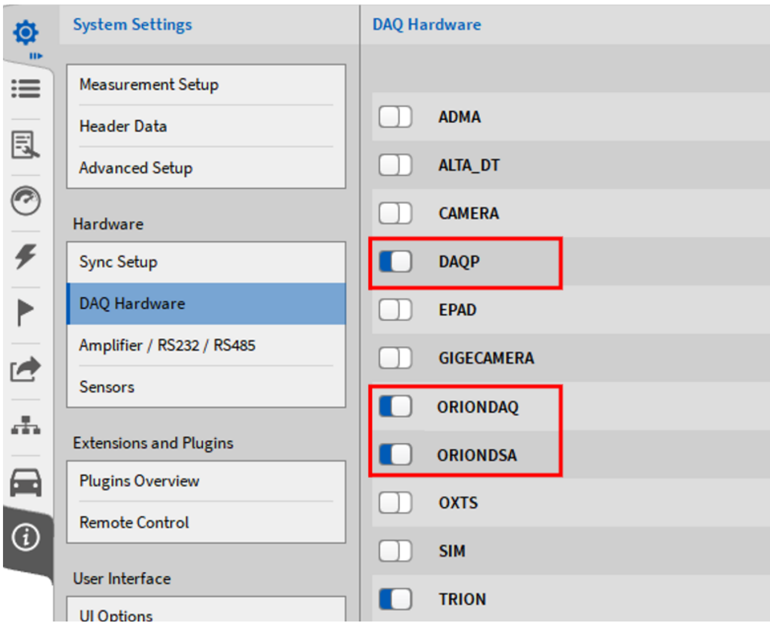

Fig. 4.38: Enabling the ORION DAQ/DSA Series in the DAQ Hardware setup

4.6.2 Connecting DAQP/HSI modules via a TRION-1802/1600-dLV board

- Go to the *DAQ Hardware* setup in the *System Settings* and make sure that the *DAQP Series* and the *TRION Series* are enabled (see Fig. 4.39). Changes take effect on application restart.

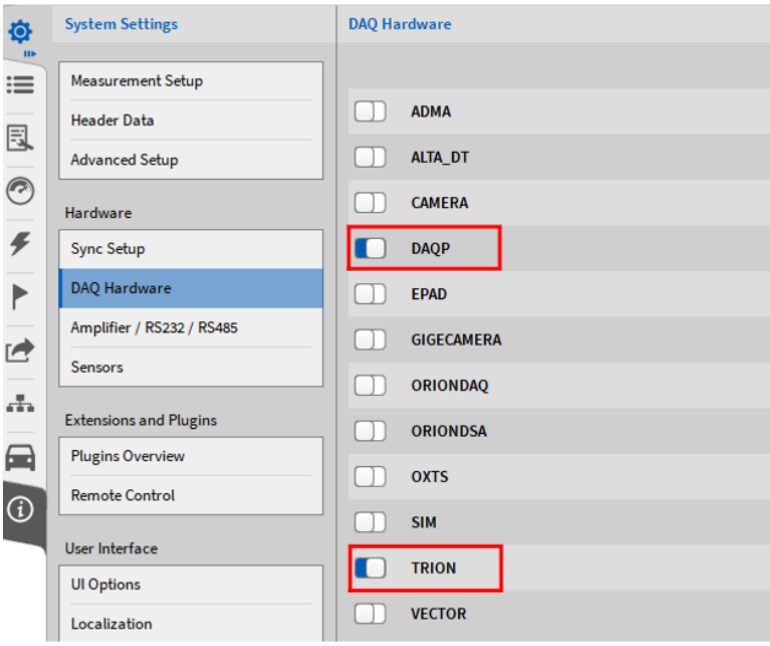

Fig. 4.39: Enabling DAQP and TRION hardware in the DAQ Hardware setup

- Make sure that the driver for the TRION-hardware is installed. The installer is named *DEWETRON-TRION-Applications-x64.exe* and can be found in the folder *\files\drivers\2_daqboards\dewetron\trion_driver\DEWETRON TRION Rx.x* of the *Install Media* USB stick which is delivered with the measurement system.
- If the driver was installed correctly, the *DEWE2 Explorer* will be available in Windows start menu.

4.6.3 Programming the modules addresses

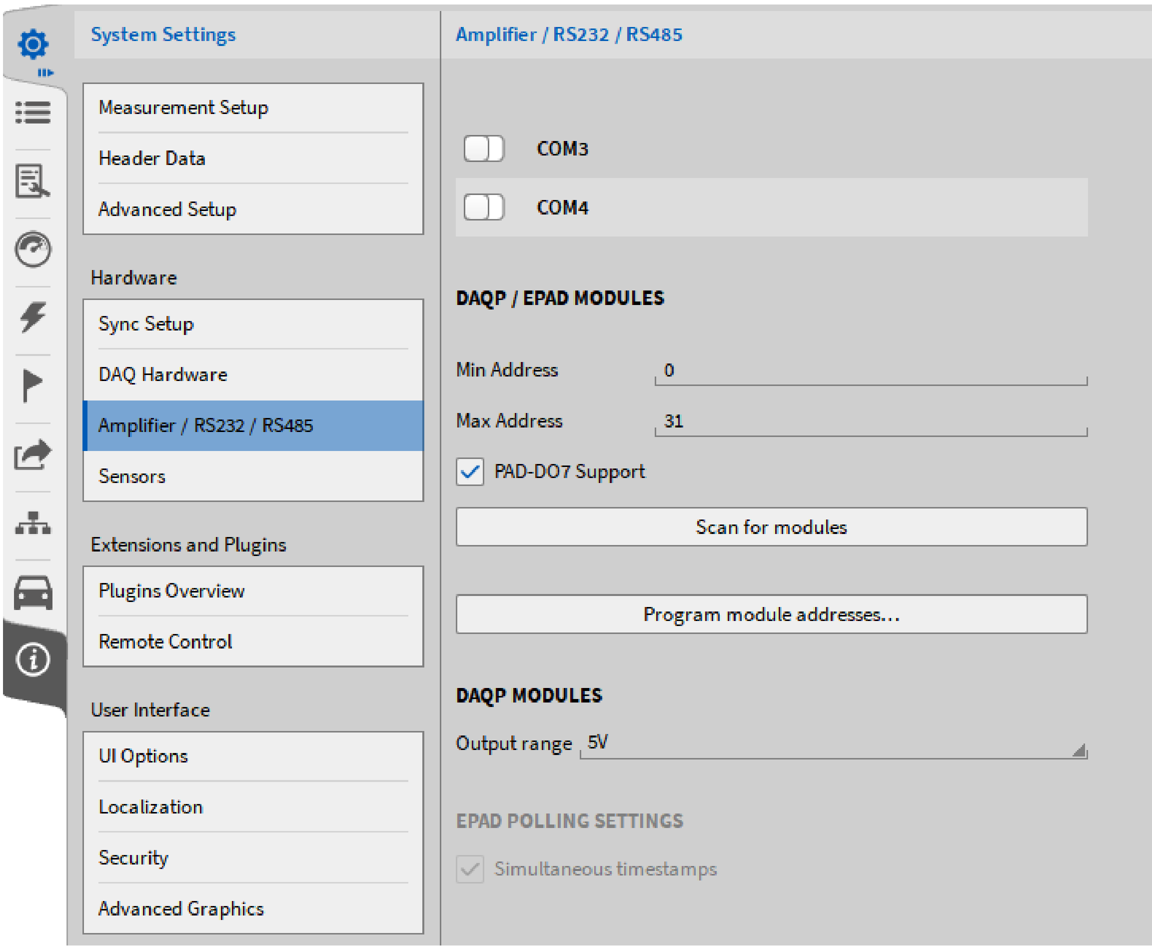

Fig. 4.40: Programming module addresses

- Enable the Serial Port(s) on which the modules are connected (see ① in Fig. 4.40).
- Select the proper output range of the module in the *Advanced Setup* (see *Advanced settings*).
- Click on *Program module addresses* (see ② in Fig. 4.40).

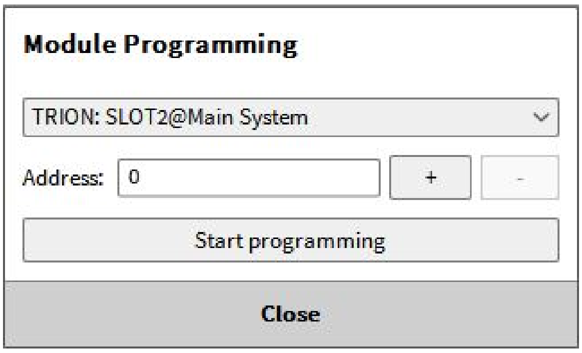

Fig. 4.41: Module programming UI

- Select the proper Serial Port and click on *Start programming* (see Fig. 4.41). If the modules are connected to several serial ports, the Programming must be repeated for each serial port. The following window will appear:

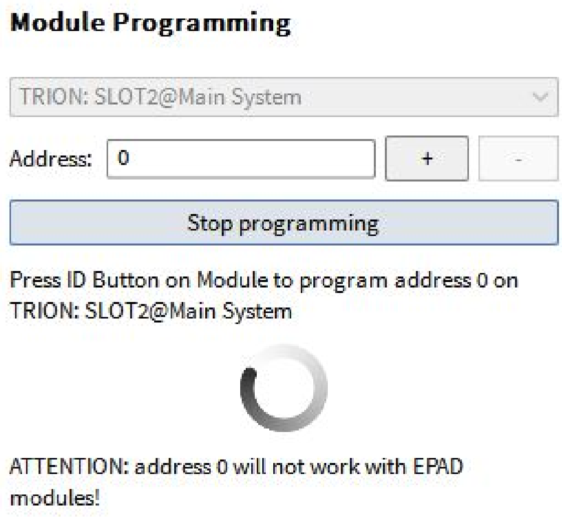

Fig. 4.42: Programming the module addresses

- Keep the ID button of the DAQP/HSI module pressed until the *Address* increases. Repeat that procedure for all DAQP modules. After finished, press on *Stop programming* and close the window by pressing *Close & Scan* (see Fig. 4.43) or start the programming for a further Serial Port

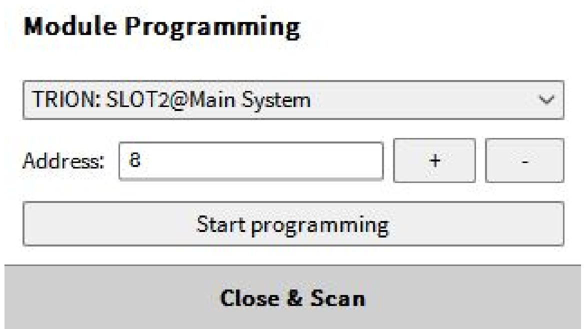

Fig. 4.43: Finish the module programming

- OXYGEN will now read the actual settings from the DAQP modules and write them to the channel settings in the software

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Note: A click on *Scan for modules* will only scan for modules that have already been programmed and store the actual module settings

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- The modules will appear in the Channel List now and the settings can be edited.

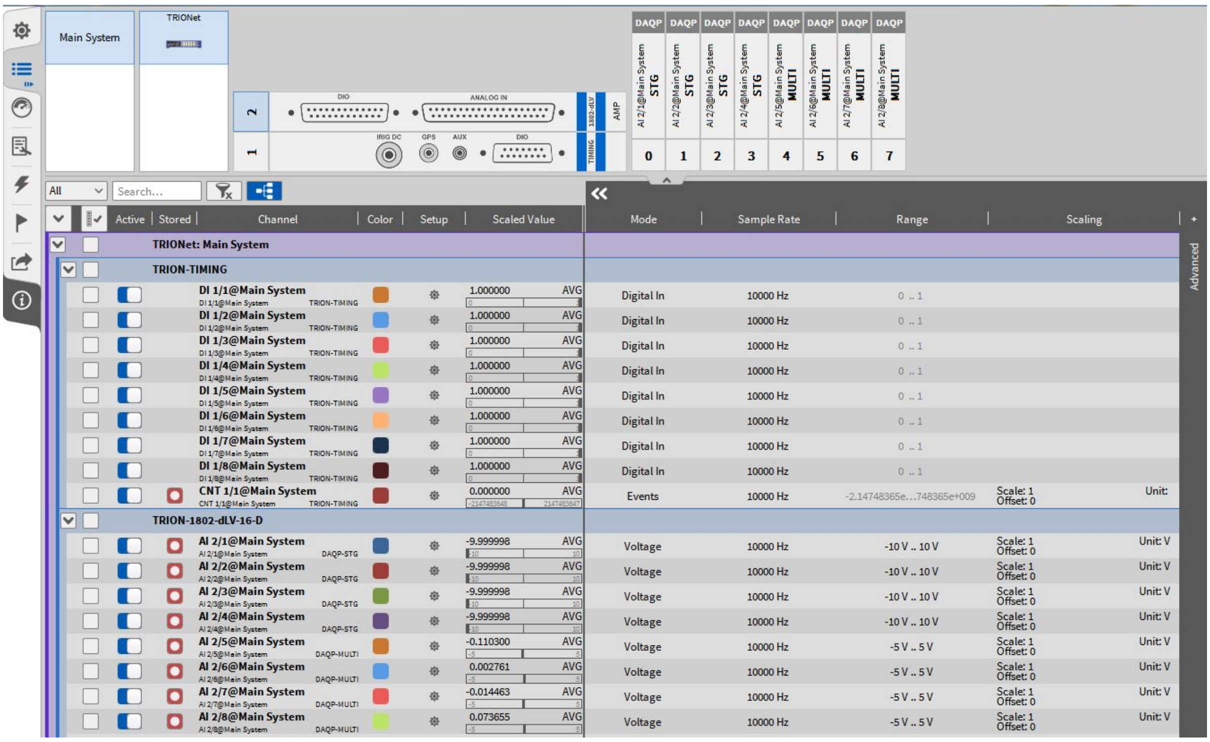

Fig. 4.44: DAQP/HSI modules in the Channel List connected via TRION-1802-dLV

Note:

- Counter and Digital channels of an ORION card are not supported by OXYGEN.
- CAN channels of an ORION card are supported by OXYGEN and can be found at the bottom of the Channel List.

4.7 CAN-FD & FlexRay

Using CAN-FD is possible via NEXDAQ or a software option and using external hardware in the form of a vector box.

4.7.1 CAN-FD via NEXDAQ

Currently the NEXDAQ is the only DEWETRON DAQ which natively supports CAN-FD by default. Just switch to the channel list and enable the CAN-FD channel and set the appropriate baud rate high and baud rate (low). In case of using CAN mode set the same baud rate for both.

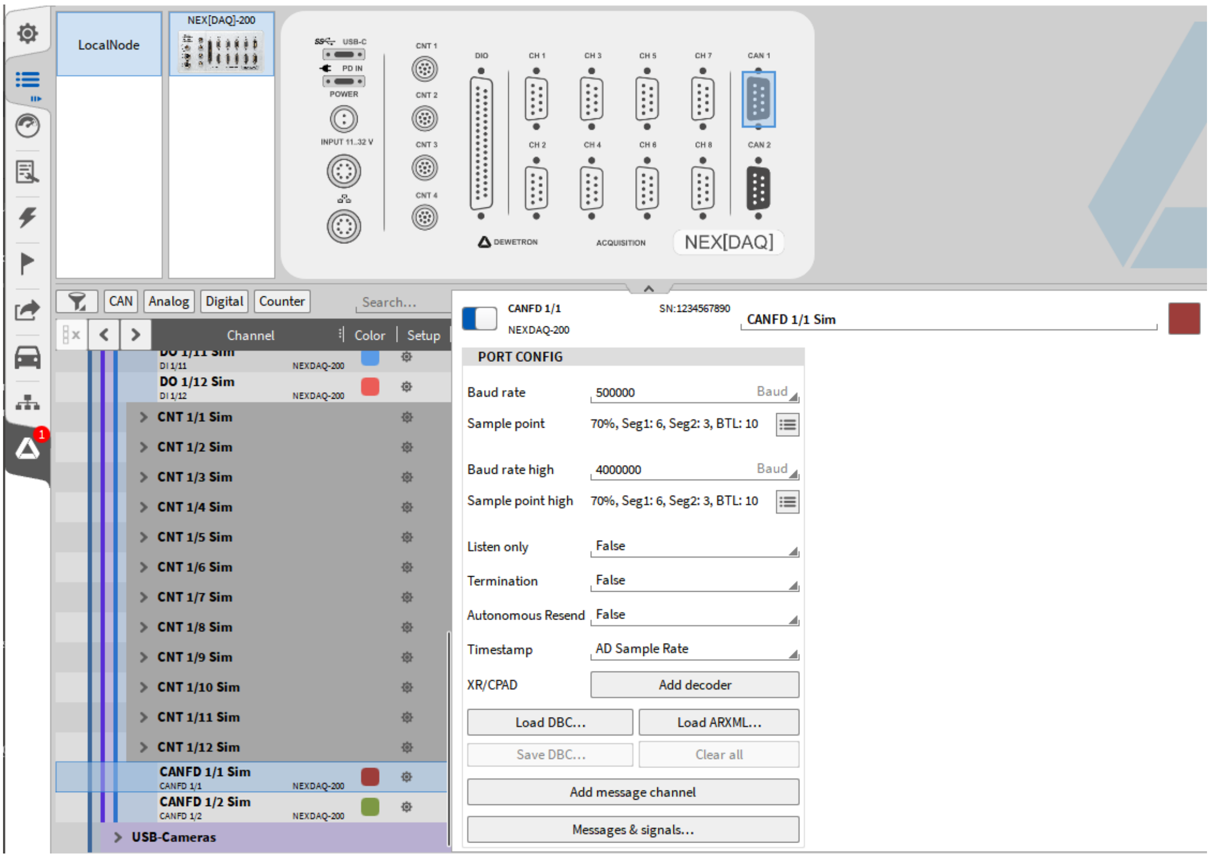

Fig. 4.45: CAN-FD channels with the NEXDAQ

To switch between CAN-FD and CAN, create a message and switch the protocol.

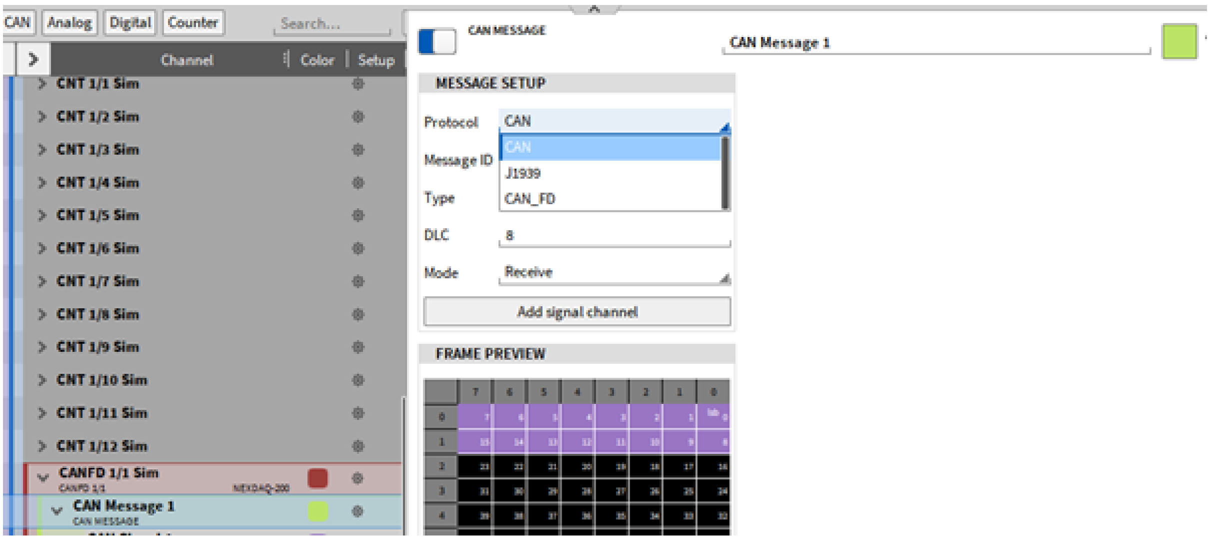

Fig. 4.46: Change protocol between CAN, CAN-FD and J1939

4.7.2 CAN-FD & Flexray in OXYGEN via Vectorbox

Note: CAN-FD data acquisition is an optional feature and requires a separate license for OXYGEN.

CAN-FD data streams can be acquired with OXYGEN if and only if the following hardware is used in combination with OXYGEN:

- Vector VN1610 (2 CAN-FD interfaces)
- Vector VN1630 (2 CAN-FD interfaces)
- Vector VN1640 (4 CAN-FD interfaces)

FlexRay data streams can be acquired with OXYGEN if and only if the following hardware is used in combination with OXYGEN:

- Vector VN7610 (1 FlexRay interfaces)
- The hardware must be connected via USB to the measurement system where OXYGEN is running on.
- Besides CAN-FD data acquisition, the VN16x0 interfaces can also be used to acquired conventional CAN-Data streams (up to 1 MBaud).
- In addition, it can also be used to transmit data over CAN. This is an additional optional feature and requires a separate license. For details, refer to *CAN-OUT - transmitting OXYGEN data via CAN*:.
- To use one the above-mentioned CAN-FD and FlexRay interfaces, proceed the following steps:
- Run the latest *Vector_Driver_Setup* which is available on the Vector homepage and delivered together with the Vector hardware.
- Select the drivers of the hardware device that shall be used and run the installation procedure (see Fig. 4.47).

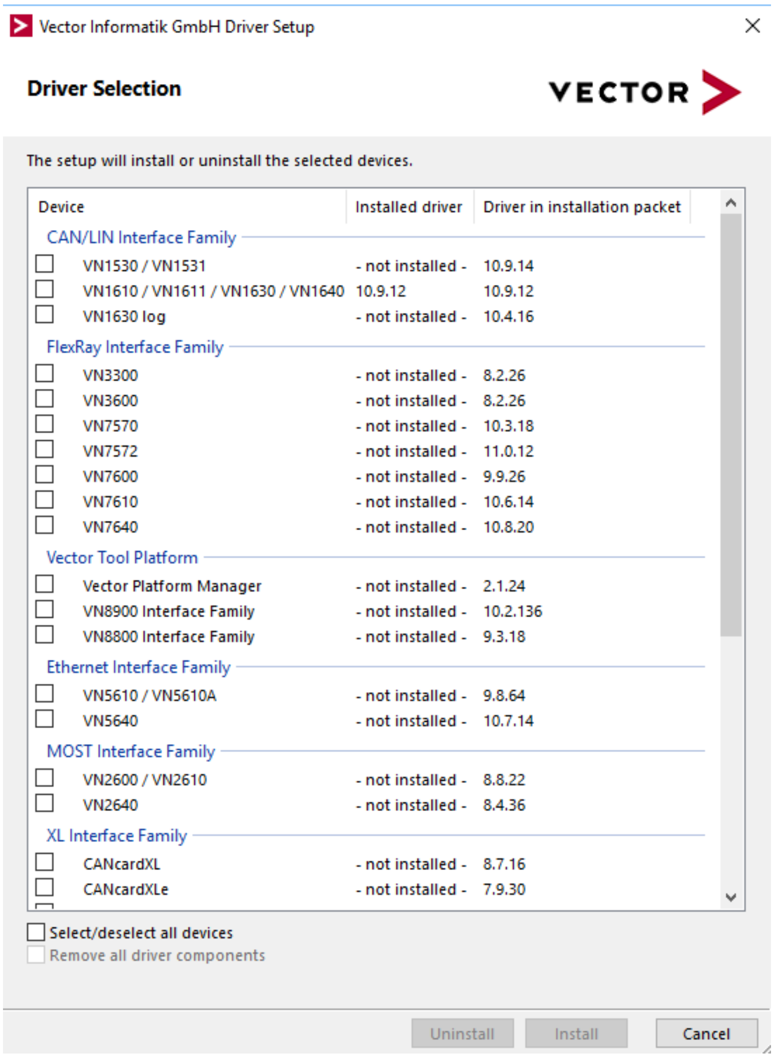

Fig. 4.47: Vector driver selection

- After the installation is finished, connect the Vector device to the measurement system if not already happened.
- Open OXYGEN and go to *System Settings DAQ Hardware* and make sure that *VECTOR* Hardware is enabled (see *DAQ Hardware*)

Note: If *VECTOR* is written in red (see Fig. 4.49), your currently installed OXYGEN license does not support Vector CAN-FD hardware (see Fig. 4.49). Contact our support team for help and also for compatible drivers.

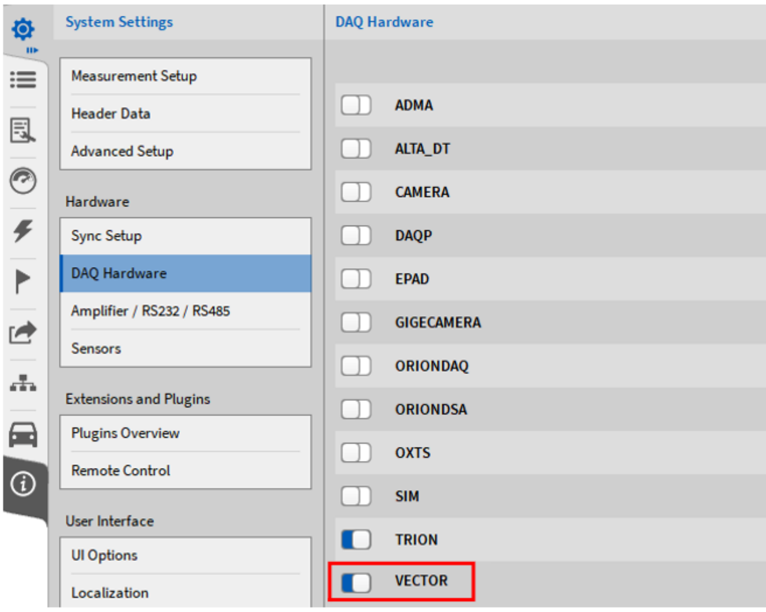

Fig. 4.48: Enabling Vector CAN-FD hardware in OXYGEN

Fig. 4.49: Missing Vector CAN-FD hardware license

- Changing the settings in this menu, requires an OXYGEN restart.

Note: If the connection between the Vector hardware device and the measurement system should fail during the operation (i.e. the USB cable is unplugged), OXYGEN must be restarted after solving the connection problem to enable the CAN-FD data acquisition again.

4.7.3 Channel Setup for CAN-FD channels

- Open the OXYGEN Channel List. The Vector Hardware channels will be visible in the section *VNxxxx* of the Channel List (marked red in Fig. 4.50).

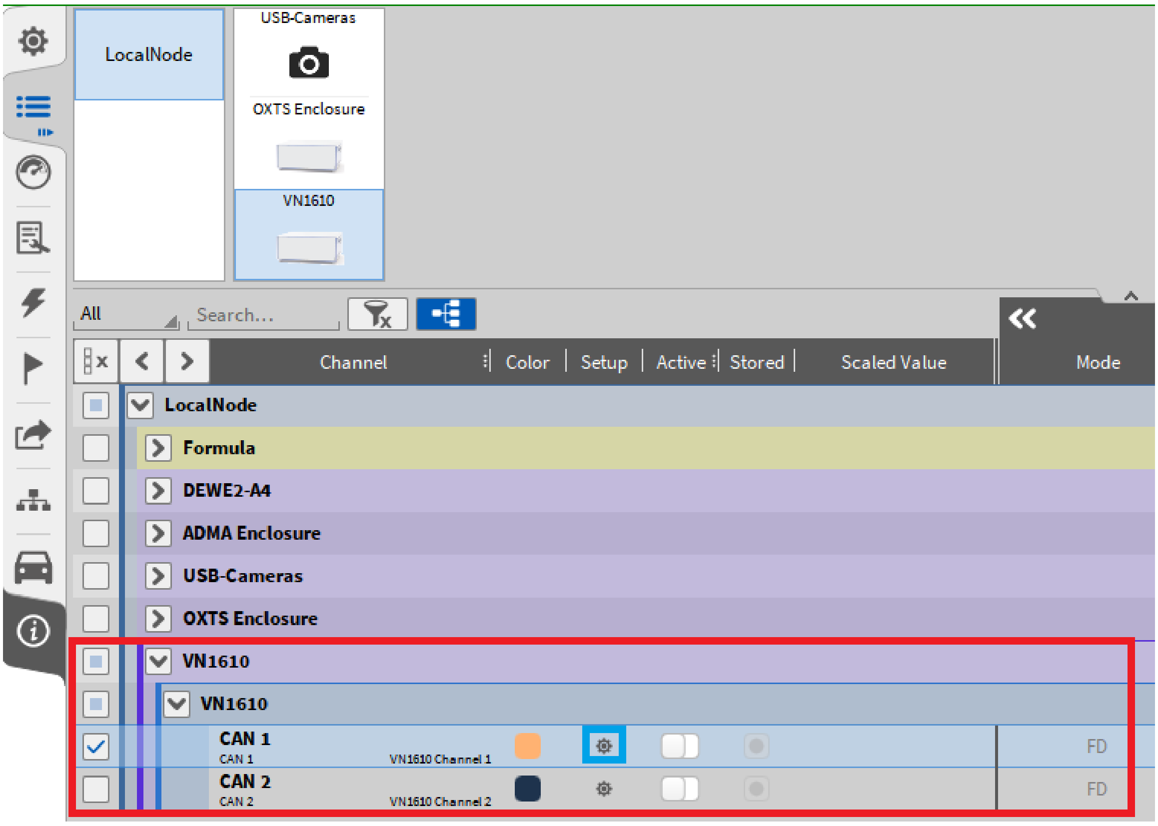

Fig. 4.50: Channel List with Vector VN hardware included

- Click on the Gear button to open the Channel settings (marked blue in Fig. 4.50). The Baud rate and additional settings can be changed here and the dbc-file can be loaded (see Fig. 4.51).

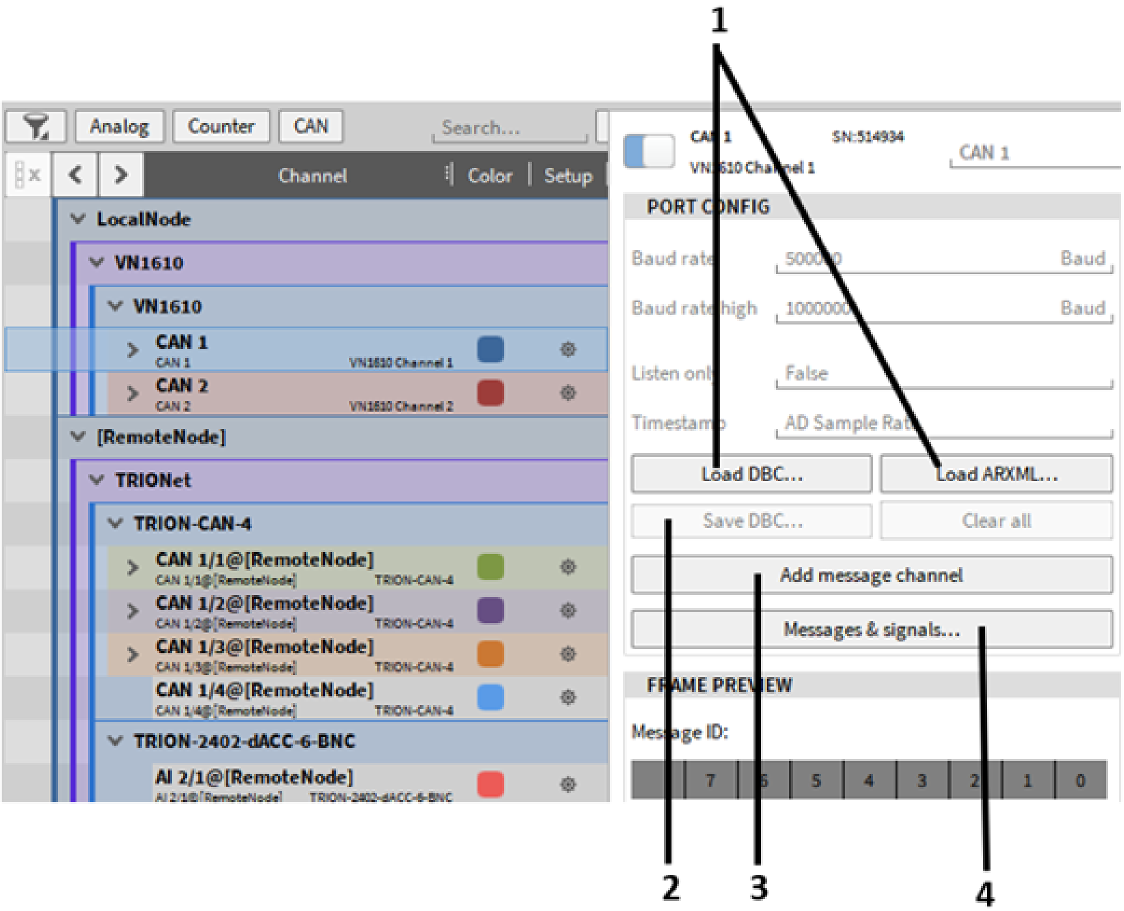

Fig. 4.51: CAN-FD channel settings

Table 4.2: CAN-FD channel settings (1)

Nr.	Feature	Description
1	Load a dbc/arxml file	After the dbc/arxml file has been loaded, a channel selection dialog opens (see Fig. 4.55), in which the CAN FD messages and channels can be selected. It is possible to select single channels, messages or all channels and messages.
2	Save DBC file	If all CAN messages and signals have been configured, a *.dbc file can be created via Oxygen. After pressing "Save DBC" a window opens to define the save path and the file name.
3	Add message channel	After pressing the button, a new message channel is added automatically. Additional CAN signals can be defined for this channel (see numref:*CAN_messages_signal_1*).
4	Messages and signals	After pressing, a new window opens for a clearer display of all CAN messages and signals (see Fig. 4.53).

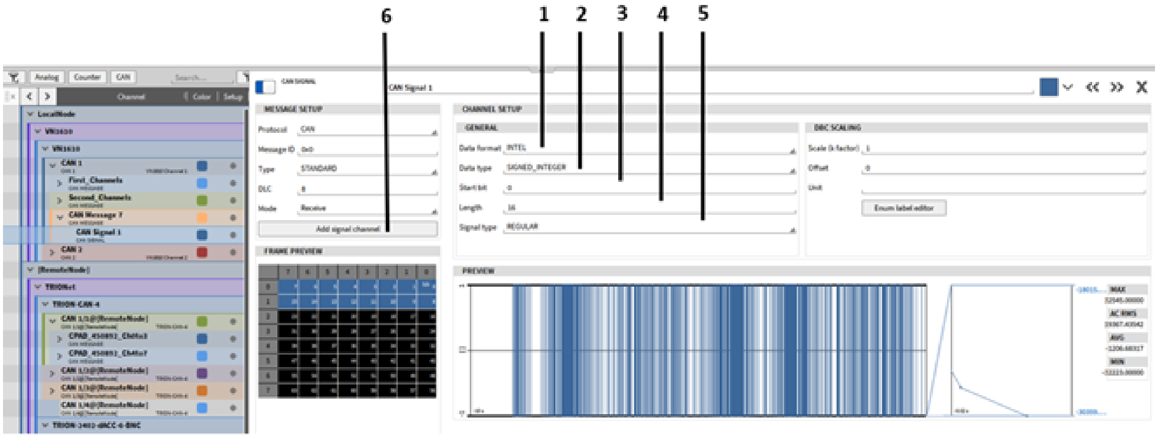

Fig. 4.52: CAN messages and signal settings (1)

Table 4.3: CAN-FD channel settings (2)

Nr.	Feature	Description
1	Dataformat	Selection of the data format. You can choose between INTEL (little-endian) or MOTOROLA (big-endian).
2	Datatype	Here the data type of the signal is defined. DOUBLE, FLOAT, SIGNED_INTEGER and UNSIGNED_INTEGER are available for selection.
3	Start Bit	Here the start bit of the respective signal is defined (first bit = 0).
4	Length of the signal	Here the length of the signal is defined, or the number of bits that represent the signal.
5	Signaltype	The choices are “REGULAR”, “MULTIPLEXED” and “MULTIPLEXOR”. “REGULAR”: The individual signals within a CAN message are defined based on the start bit and length and are always constant for the CAN message. “MULTIPLEXOR”: The signal is used to define the transmitted signals within the CAN message. The first bits represent the transmitted signals. Thus different signals can be transmitted with a CAN message of the same CAN ID, depending on the “MULTIPLEXOR” value. The “MULTIPLEXOR” value is called MUX ID. “MULTIPLEXED”: Indicates that the signal is defined by the “MULTIPLEXOR”. A multiplexed signal needs to specify its MUX ID. The signal or signals matching the MUX ID will be decoded.
6	Add signal channel	Additional signals can be added simply by pressing the “Add Signal Channel” button. A new window opens (see Fig. 4.53) for a better overview of all CAN messages and signals of the selected CAN port.

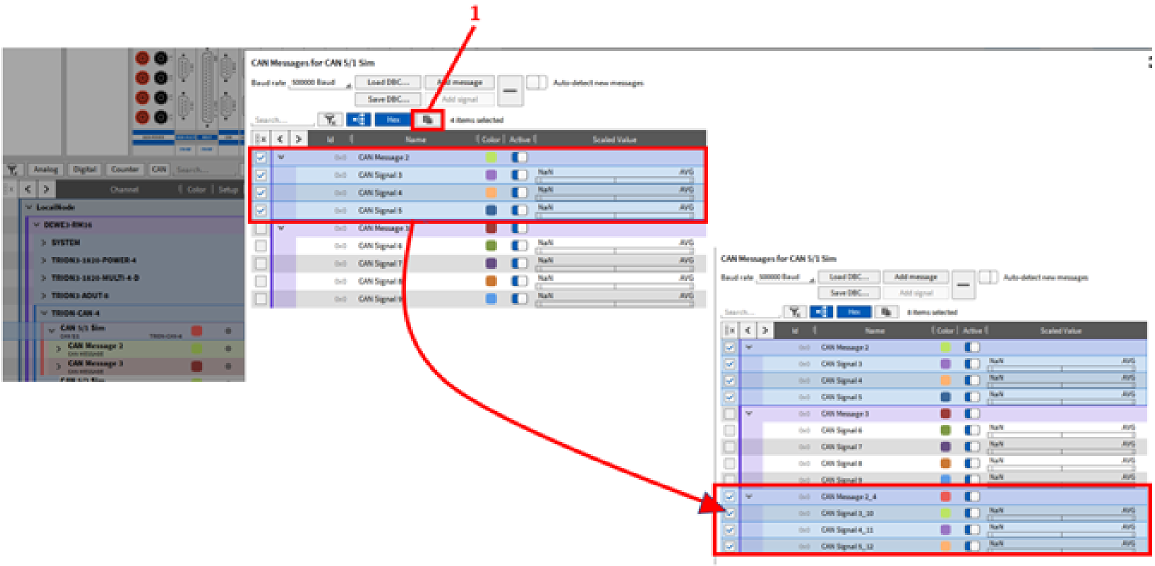

Fig. 4.53: CAN messages and signal settings (2)

- By pressing the button “1” (see Fig. 4.53), the marked CAN messages and signals are copied and added to the list of existing CAN messages and signals including the settings.

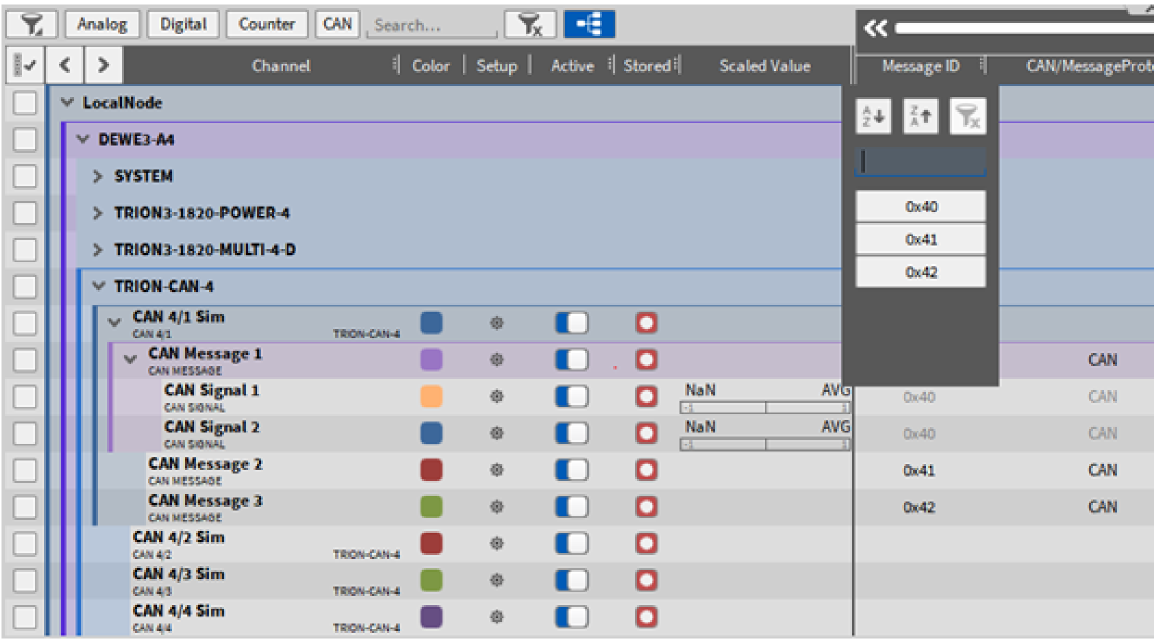

Fig. 4.54: CAN messages ID

- In the channel list it is also possible to filter the available CAN message IDs to get a better overview or to display only the CAN messages that are needed for the current application (see Fig. 4.54)

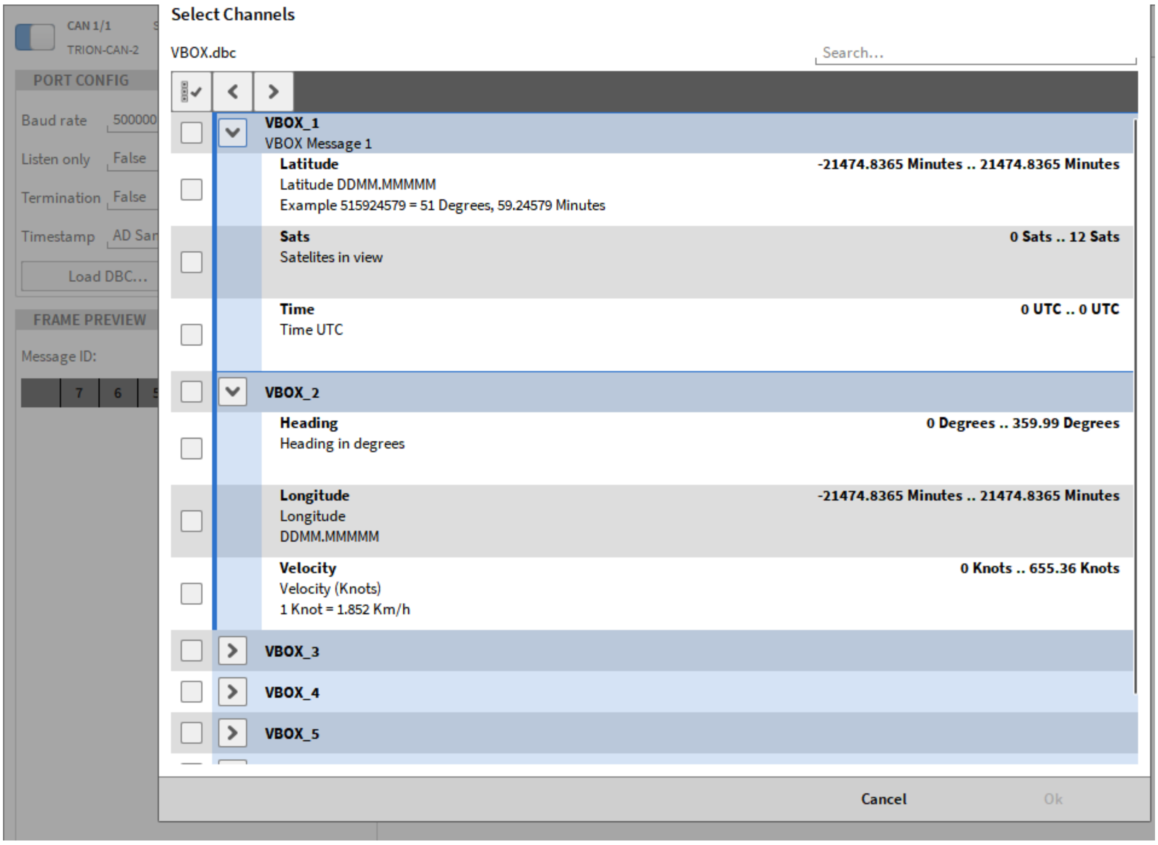

Fig. 4.55: Channel Picker dialog

- To select additional channels later on, just reload the dbc-file and pick more channel In the channel picker dialog. The *Clear all* (Fig. 4.51) buttons deletes the current channel selection.
- After loading the channels from the dbc-file, an arrow positioned left to the Channel name will appear. A click on the Arrow will expand the CAN-FD channel list and show the individual CAN-FD messages including their channels (see Fig. 4.56).

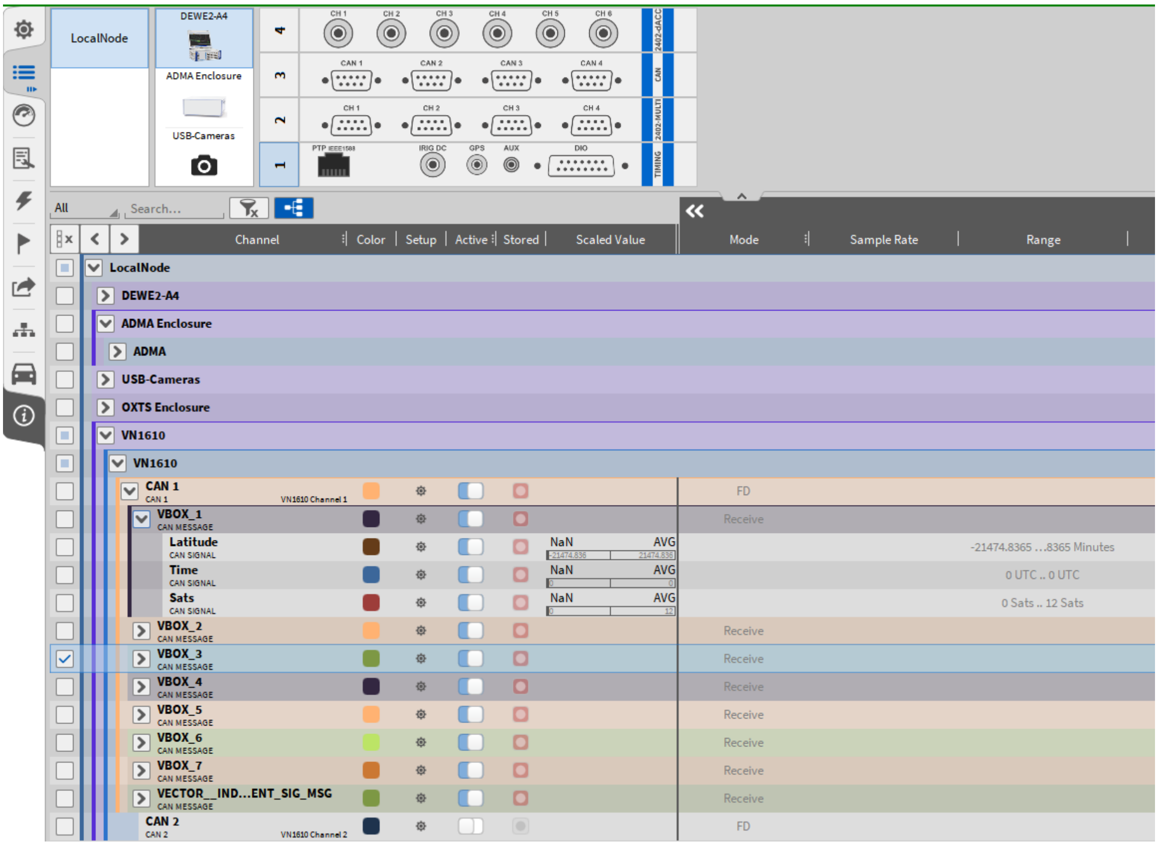

Fig. 4.56: CAN-FD channel list in OXYGEN

Note: For more details about CAN-channels in OXGYEN, refer to *CAN Input Channels*.

Offline decoding of CAN-FD:

- It is possible to add additional channels that shall be decoded during the data analysis. Therefore, open the respective CAN-FD port in the channel list and load the dbc-file again. Additional channels can be selected and decoded now.

  Note: It is not possible to delete previously recorded and decoded channels from a data file.

CAN-FD Bit Timing - Port Configuration

The CAN-FD Bit Timing option is included since OXYGEN R5.1.1

Note: This is an advanced feature and not intended to be changed for the normal CAN-FD data acquisition.

Different Bit Timing per Sample point can be selected from a predefined table for the baud rate and the baud rate high in the CAN-FD port configuration:

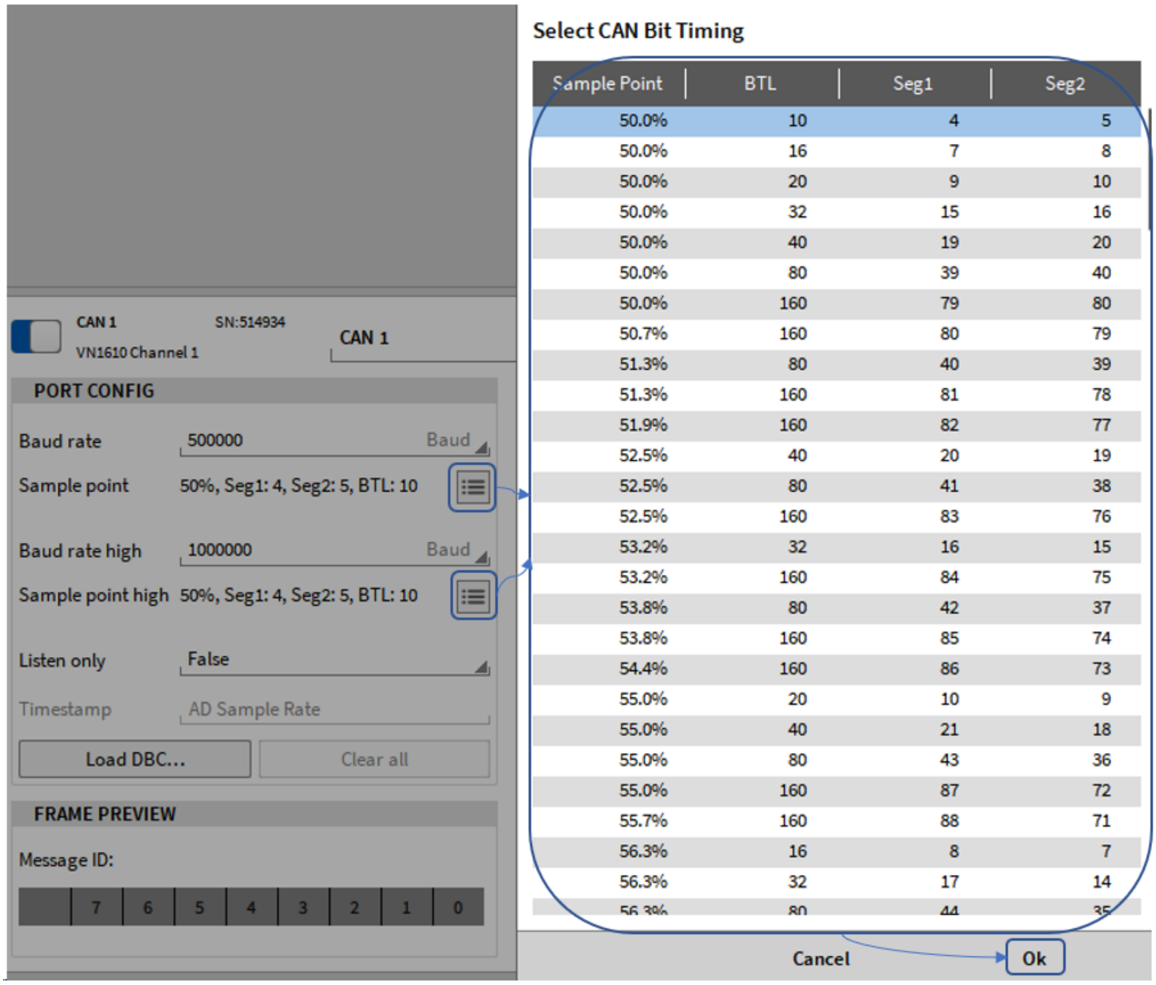

Fig. 4.57: CAN-FD Bit Timing selection

CAN-FD Bit Timing - CAN(-FD) samplepoint

The sample point is the location (percent value), inside each bit period where the CAN controller looks at the bus state to determine if it is a logic 0 or logic 1. OXYGEN allows this point to be configured. It is specified as a percentage from the start of the bit period.

The location of the sample point is a trade-off. An early sample point decreases the sensitivity to oscillator tolerances and allows lower-quality oscillators. A late sample point allows for a longer signal propagation time and therefore a longer bus. A later sample point is useful for non-ideal bus topologies.

Due to the two different baud rates CAN-FD uses, the importance of a correct sample-point-setup along all bus-participants is of increased importance. (http://www.bittiming.can-wiki.info/ and https://kb.vector.com/entry/861/)

OXYGEN choses a default sample-point of 70 %, (please note, that all bus-timings are realized in hardware by integer clock-dividers for the base clock of 80 MHz, not every value can be met exactly)

As mentioned above, the sample point is a trade-off, and thereby different buses may be designed to choose a sample-point-setup different to 70 % to satisfy other constraints or needs.

To allow interaction with a wide range of such busses, OXYGEN allows to configure the sample-point for both baud rates.

Generally, a range of 50 % ≤ sample-point ≤ 97.0 % is considered, in 0.1 % steps.

Due to the clock-generation and segment-timing generation using integer clock-dividers with their own constraints not all values are possible for all baud rates.

Note: For details about the constraints of the parameters see XL_Driver_Library_Manual_EN.pdf

On the other hand, this also means, that various equal sample-point-values can be achieved by several different divider-settings.

Eg. 70.1 % @ 500 kBd can be achieved by 5 different divider settings.

Additional to the sample-point the time-quanta-values for 2 relevant segments are represented in the table. This allows easy matching if the time-quanta-values of the bus-participants is known.

- All lengths in timequanta (the smallest unit for all configuration values)
- BTL denotes the length of the Propagation_Delay_Segment + Phase_Segment_1 + Phase_Segment_2 + 1
- Seg1 denotes the length of Propagation_Delay_Segment + Phase_Segment_1
- Seg2 denotes the length of Phase_Segment_2
- The samplepoint is [(Seg1 + 1) / BTL]

If the baud rate changes, the bit timing parameters (sample point and prescaler) will automatically be adjusted to the best matching values.

4.7.4 Channel Setup for FlexRay channels

- Open the OXYGEN Channel List. The Vector Hardware channels will be visible in the section *VNxxxx* of the Channel List (marked red in Fig. 4.58).

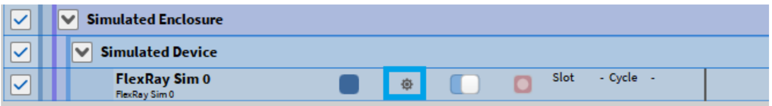

Fig. 4.58: Channel List with Vector VN hardware included

- Click on the Gear button to open the Channel settings (marked blue in Fig. 4.58). Click on the *Load Fibex...* button to select the proper fibex-file (see Fig. 4.59).
- The fibex file must be compatible with Fibex 2.0 to 4.1.2 Standard for description file (ASAM MCD-2 NET)

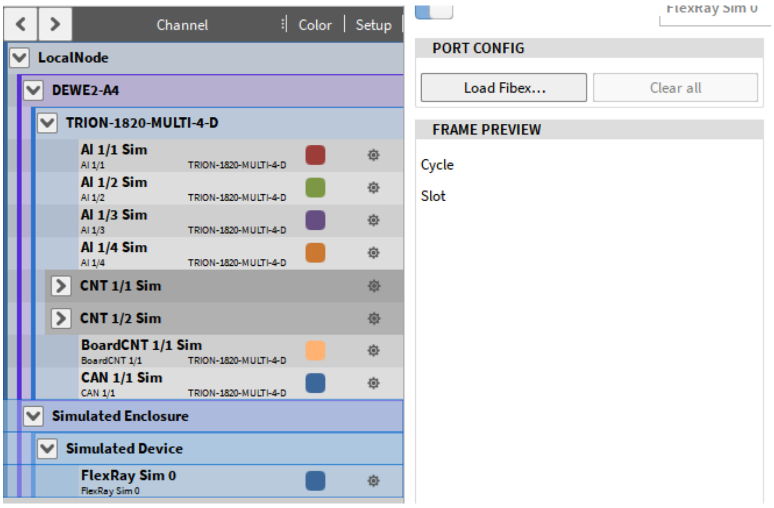

Fig. 4.59: FlexRay channel settings

- After loading the fibex-file, a Channel picker dialog (see Fig. 4.60) will open to select the channels from the fibex file that shall be decoded during data acquisition. It is possible to select only certain channels and messages or all channels.

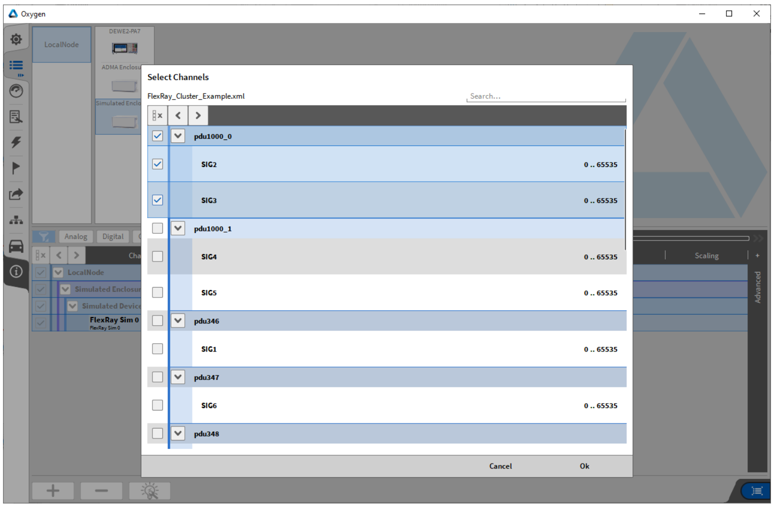

Fig. 4.60: Channel Picker dialog

- To select additional channels later on, just reload the fibex-file and pick more channel In the channel picker dialog. The *Clear all* (Fig. 4.59) buttons deletes the current channel selection.
- After loading the fibex-file, an arrow positioned left to the Channel name will appear. A click on the Arrow will expand the FlexRay channel list and show the individual FlexRay messages including their channels (see Fig. 4.61).

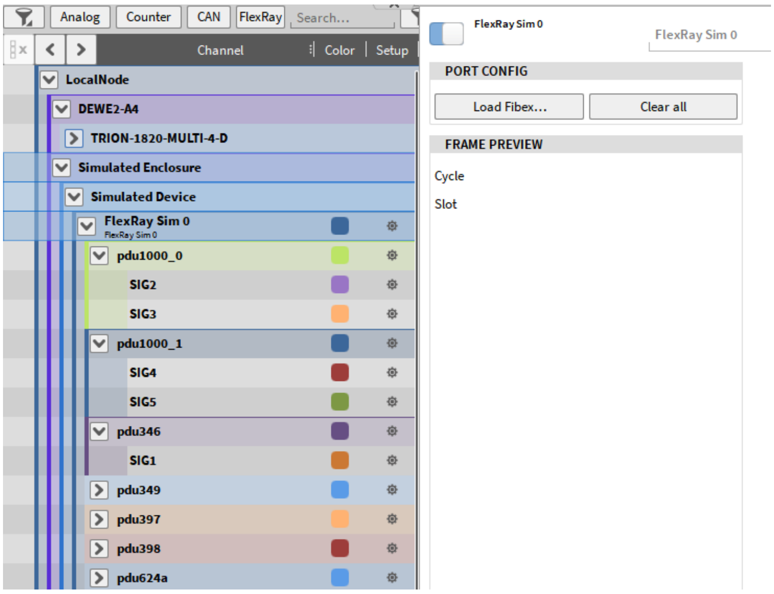

Fig. 4.61: FlexRay channel list in OXYGEN

Offline decoding of FlexRay:

- It is possible add additional channels that shall be decoded during the data analysis. Therefore, open the respective FlexRay port in the channel list and load the fibex-file again. Additional channels can be selected and decoded now.

Note: It is not possible to delete previously recorded and decoded channels from a data file.

Limitations of FlexRay in OXYGEN:

- No support of ARXML (AUTOSAR XML) description files
- No support of Multiplexed Frames
- No bus settings possible – Auto Detection Enabled
- No support of STRING channels
- No support of different scaling types of one signal depending on range

CHAPTER

FIVE

MEASUREMENT SETTINGS

The Measurement Settings menu contains all settings which apply to a measurement itself and must be stored in a setup file. The different sections will be explained in the following chapters. To jump to the system options settings, click on the link *Jump to system options*, seen in Fig. 5.1.

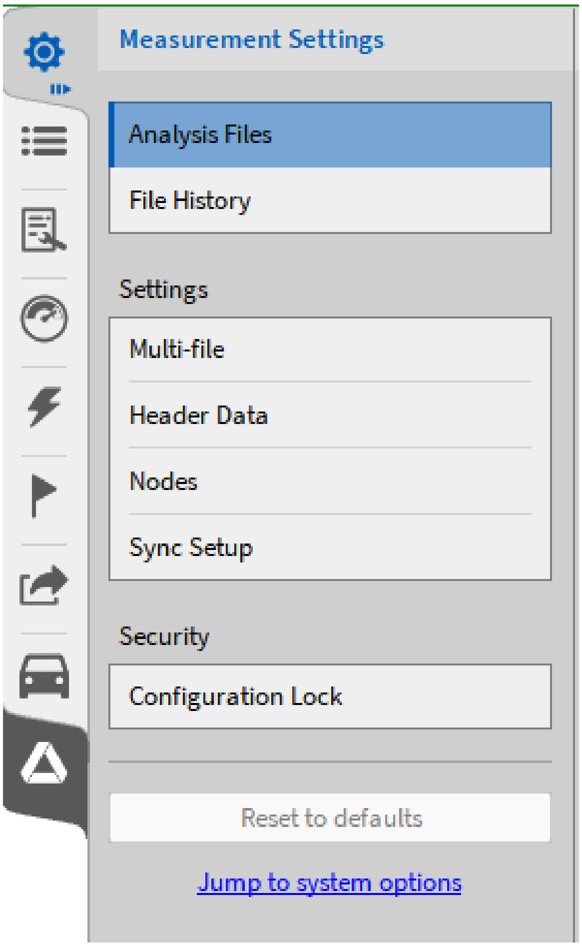

Fig. 5.1: Measurement Settings section

Note: A single click on any menu button will show a small view of the menu that contains the most important functionalities and information. Keeping the left mouse button on the menu button pressed and moving the mouse to the opposite side of the screen will expand the menu to the full screen and show all options.

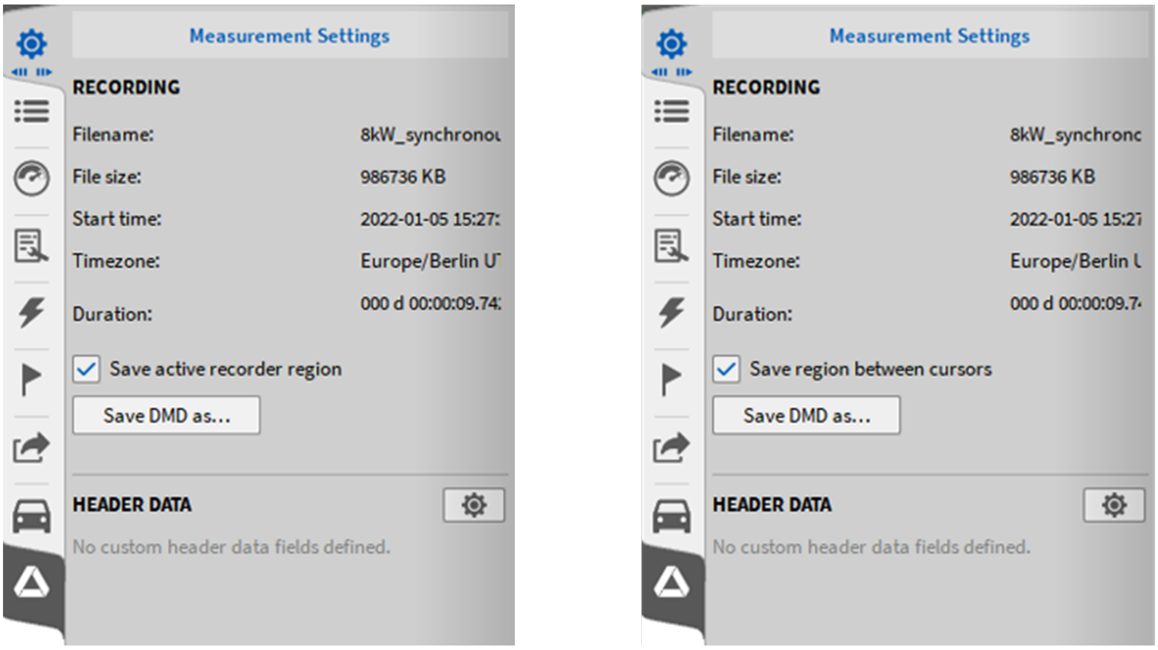

Fig. 5.2: Measurement Settings in OXYGEN viewer

Opening the small sidebar measurement settings menu of a recorded file in OXYGEN viewer enables the *Save DMD as…* button. Here it is possible to save only a time slice of the measured data. For more information see *Export active recorder region or between cursors*.

All settings can be reset by clicking on the button Reset to default, on the left seen in in Fig. 5.3.

The content of the individual submenus will be explained in the following sections in detail.

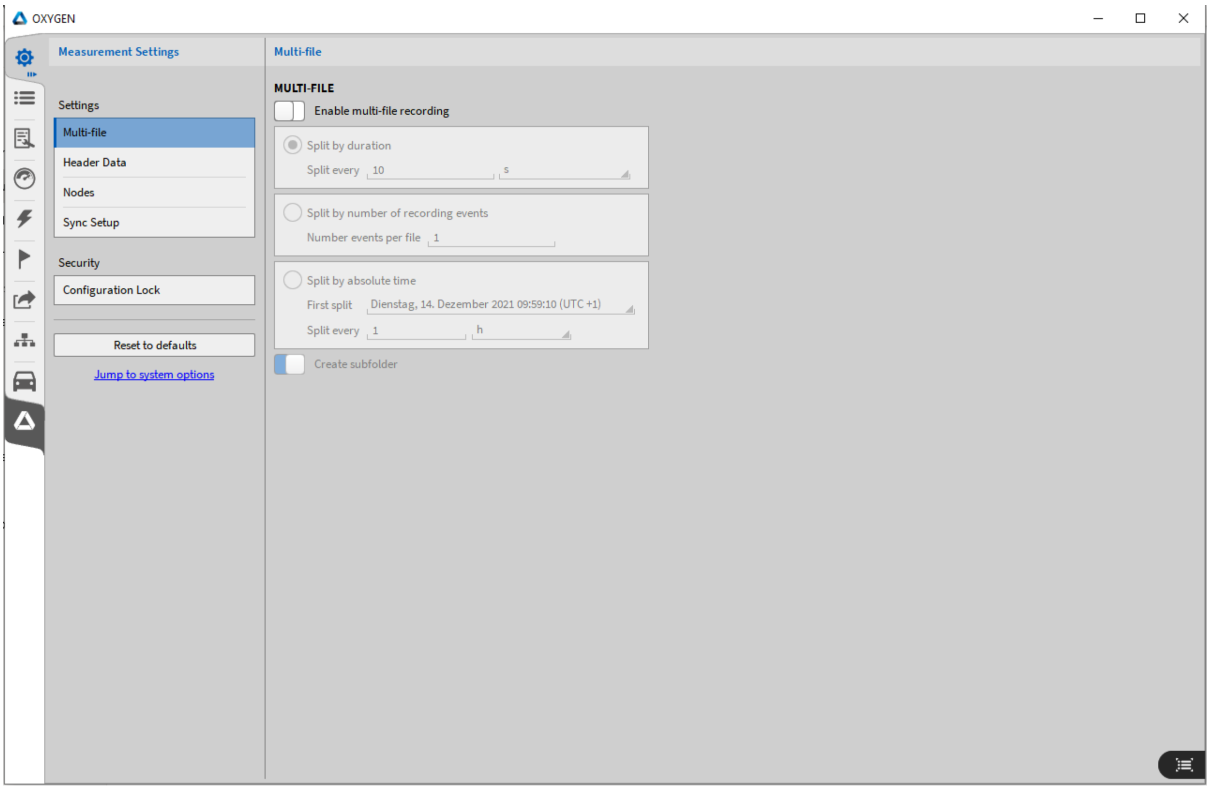

Fig. 5.3: Measurement Settings menu

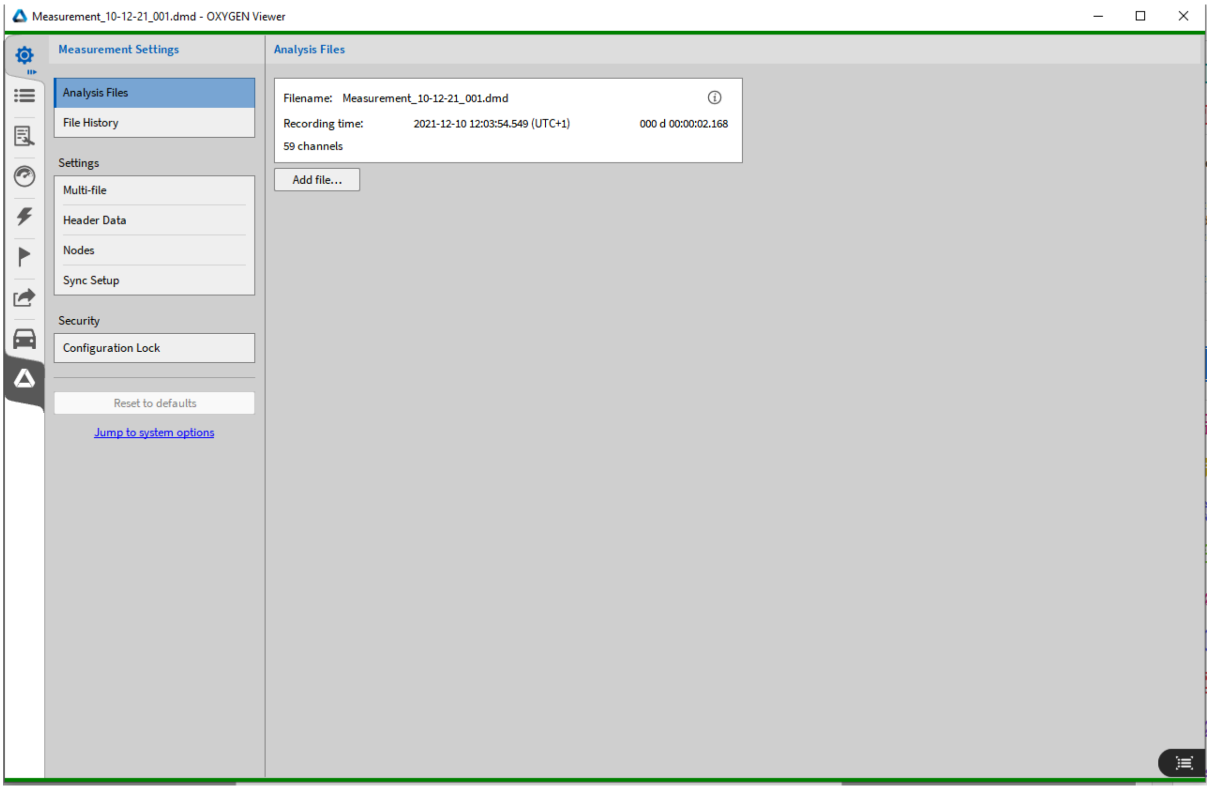

Fig. 5.4: Measurement Settings menu in PLAY Mode

5.1 Functions in PLAY mode

5.1.1 Analysis Files

This section is only available in PLAY mode, i.e. only when a measurement file is opened with OXYGEN, as seen in Fig. 5.4.

It shows some information about the currently opened measurement file. By clicking on the button *Add file…* multiple files can be opened. For more information, refer to *Opening multiple data files*.

5.1.2 File History

This section is only available in PLAY mode, therefore only when a measurement file is opened with OXYGEN, as seen in Fig. 5.4.

In this section it is possible to apply changes made to a measurement file in the post-processing to other files. For more information, refer to *Batch processing*.

5.2 Settings

5.2.1 Multi-File

Especially during long measurement campaigns, it might be useful if data is not stored to one single file but to several individual files. Among others, this mechanism allows the user to analyze and post-process data from the beginning of the measurement while the measurement itself is still running. This mechanism is called multi-file recording.

If multi-file recording is enabled, OXYGEN supports three different ways to split files:

- Split by duration
- Split by number of recording events
- Split by absolute time.

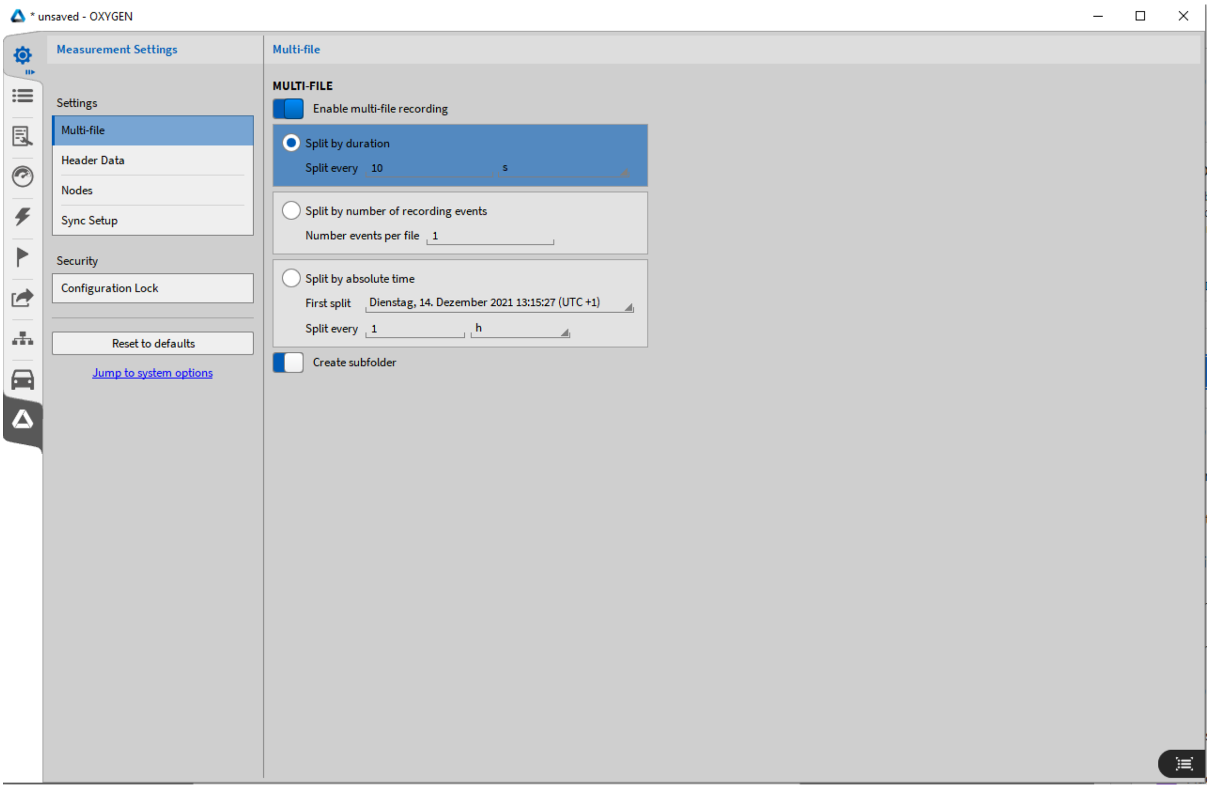

Fig. 5.5: Multi-File recording settings

Multi-file recording

File names

Multi-file recordings are stored in a separate folder per default, which has the same name as the first multi-file. For more details about the file name pattern see *Storing and File name*.

To deactive the creation of a subfolder for multi-files, deactivate the slider in the multi-file settings (see Fig. 5.5). A separate multi-file counter (00x) is used if the individual file names are identical. With the optional text *File Start* in the *Time* placeholder, the timestamp of the recording start of each multi-file recording can be used.

Examples

#{Date, Local}_#{Number, Session}

The session counter is 3. Therefore, the multi-file recordings will have the following names: 20210503_003_001, 20210503_003_002, 20210503_003_003 etc.

#{Time, File Start, "hh-mm-ss"}

The multi-file recordings will have the following names: 09-55-29, 09-55-39, 09-55-49 etc.

Split by duration

If *split by duration* is selected, OXYGEN stores data automatically to a new file if the defined time interval is exceeded: A new data file will be created after 10 s, 2 0s, 30 s etc, overall recording time. The minimum time interval is 10 seconds.

Special case

Split by Duration in combination with enabled *event based waveform recording* and disabled *User Reduced Statistics recording* (see *Triggered Events*). With this combination, it can happen that no data is stored to a multi-file part. The following cases might appear:

- No data recording after arming the Trigger: If it takes a certain time after arming Trigger and the first occurring recording event, the time between arming the Trigger and the first occurring recording event will be rejected and the '0s' position will be shifted to the Arm Trigger position to the first occurring recording event. Thus, the first data file begins not at the position the Trigger is armed but at the position the first recording event occurs. The following Fig. 5.6 will illustrate this case:

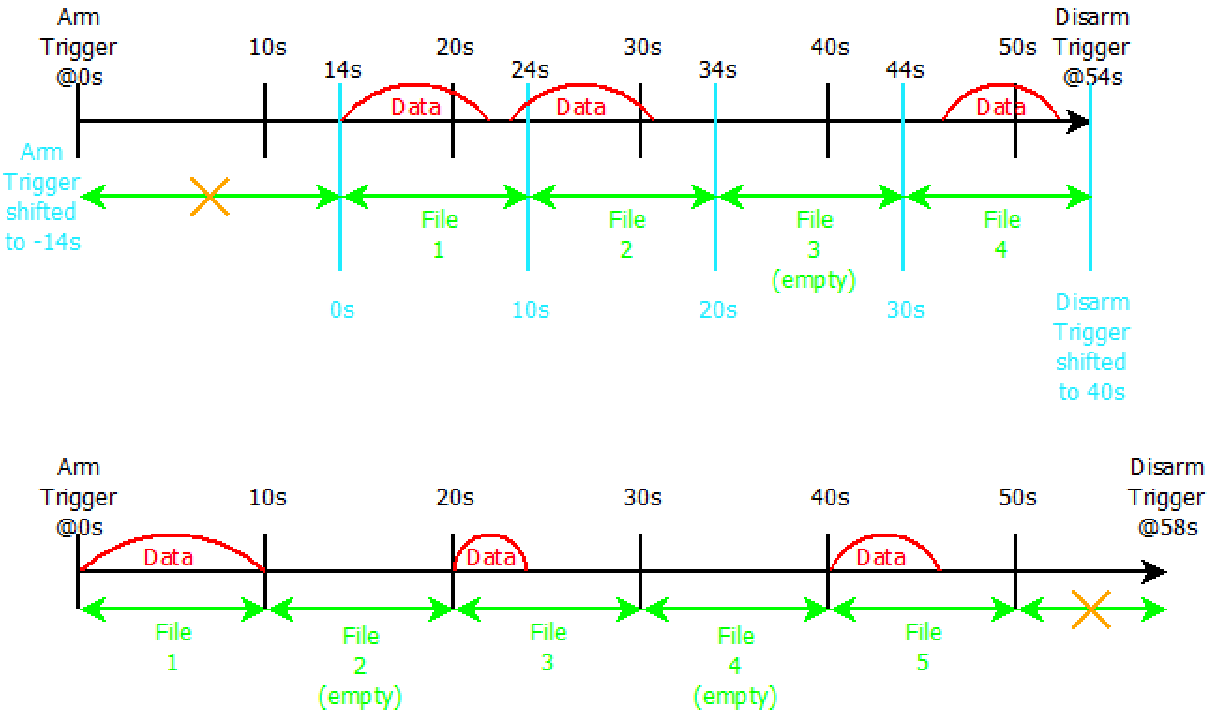

Fig. 5.6: Special case 1 for multi-file recording; split duration: 10s

- No data recording between two recording events: If the time between two occurring recording events is longer than the specified Split time interval, an empty data file created. (see File 3 in Fig. 5.6)
- No data between the last occurring recording event and disarming the Trigger: If it takes a certain time between the last occurring recording event and disarming the Trigger, the time within will be rejected and no new data file will be created. The following Fig. 5.7 will illustrate that case. This is also the reason why the Split Stop/Start Marker is only created retroactively if a new recording event occurs and not at the exact time the split duration is exceeded.

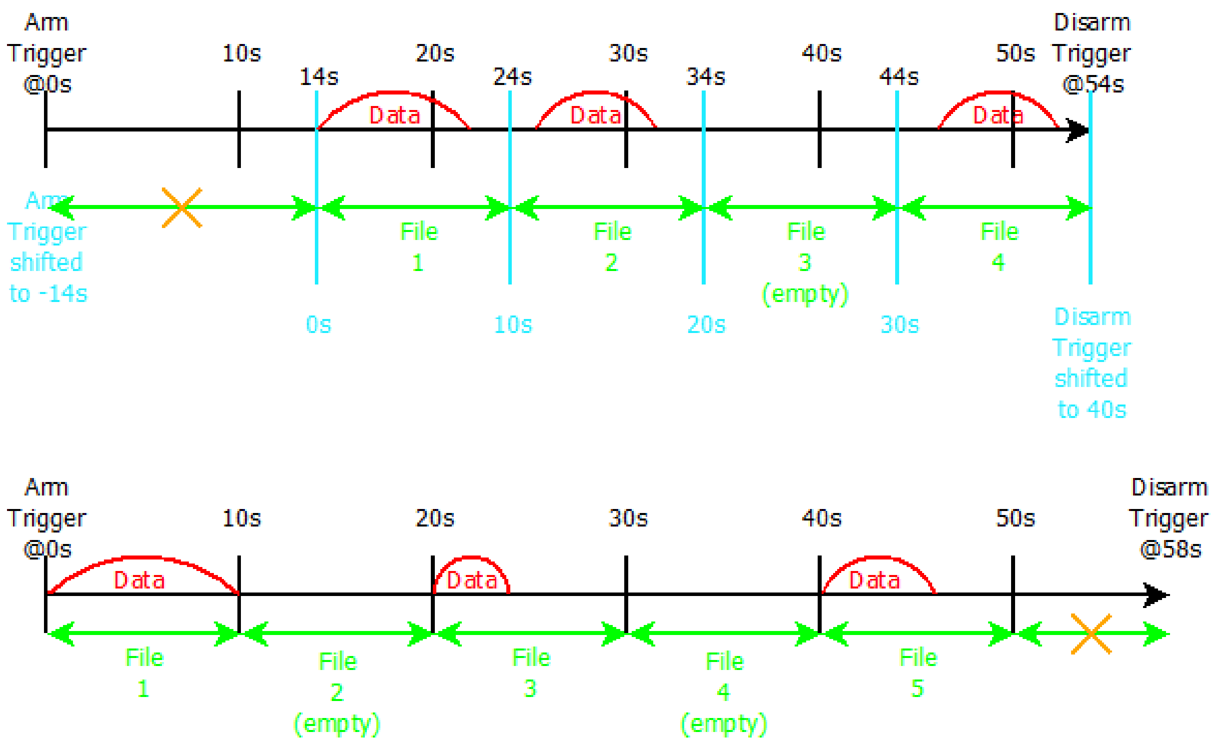

Fig. 5.7: Special case 2 for multi-file recording; split duration: 10s

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Note: If *User Reduced Statistics* recording is enabled for the upper explained special case, this special case will not be applied, because (statistics) data will be recorded continuously.

Split by number of recording events

If split by number of recording events (see ③ in Fig. 5.5) is selected, OXYGEN creates a new data file if the defined number of recording events is reached. I.e. in the example of Fig. 5.5, a new data file will be created after the 2nd, 4th, 6th, … recording event is terminated.

Special Case

If *Split by number of recording events* is used in combination with a pre-recording time which lasts back to the recording event that occurred before, both recording events will be regarded as one entire recording event, because they are connected by the pre-recording time. The following will illustrate this case for a recording split after two events:

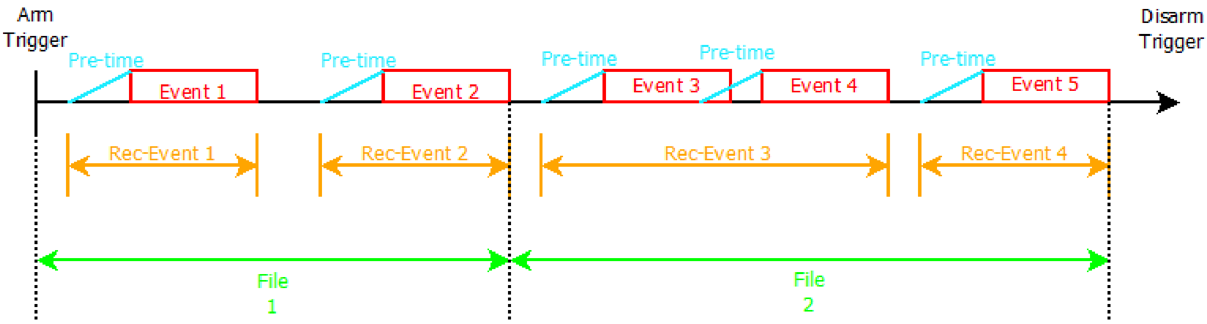


Fig. 5.8: Special Case 3 for multi-file recording; Split after 2 recording events

Note: The DejaView™ functionality (see *DejaView™*) is applicable during multi-file recording as well. The instant of time a new data file is created is visible in the event List (see *Event List*) as Split Start and Split Stop marker (see Fig. 5.9).

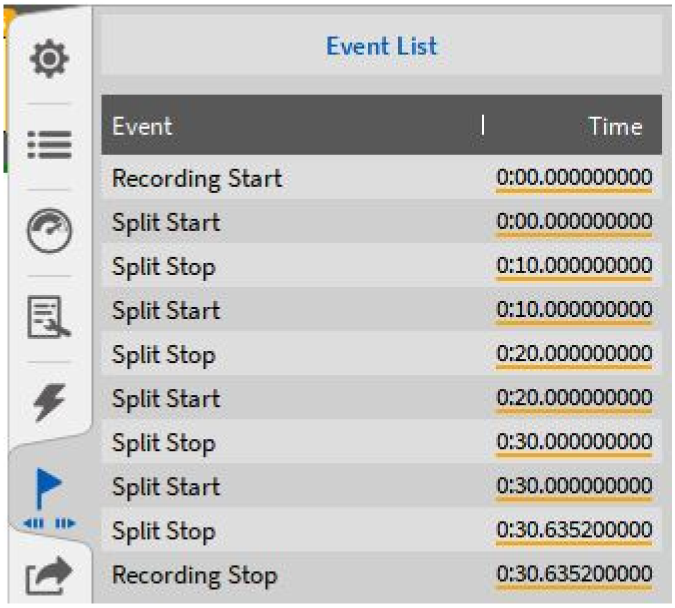


Fig. 5.9: Split Start and Split Stop Marker

Split by absolute time

If split by absolute time (see ④ in Fig. 5.5) is selected, OXYGEN stores data automatically to a new file after every defined time interval. The OXYGEN Acquisition Time is used as the reference time. The first split can be selected using the popup calendar.

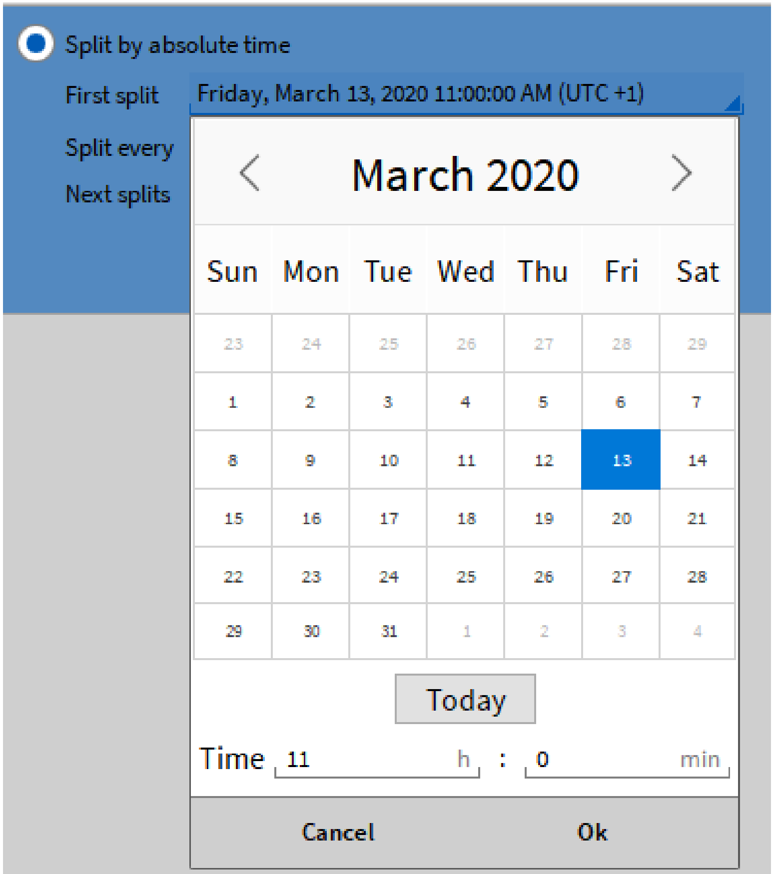


Fig. 5.10: Pop-up to select the first split

The files can be split after minutes, hours or days. The minimum interval for a split is one minute. After selecting the interval, a small preview of the next splits is shown in the settings in the multi-file section, also shown in Fig. 5.11. In that way the user can check if the settings are right.

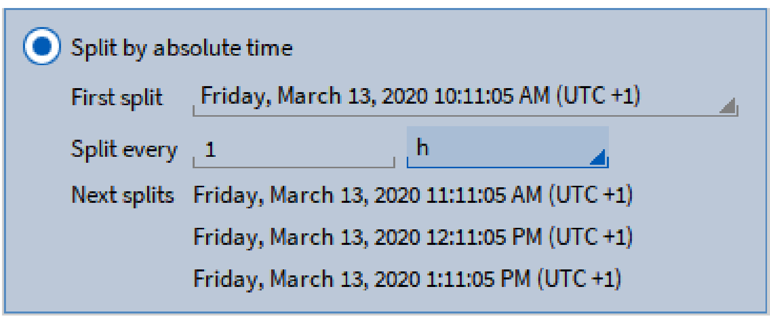


Fig. 5.11: Split options and split preview for split by absolute time

Special case

Split by absolute time in combination with enabled event based waveform recording and disabled User Reduced Statistics recording (see *Triggered Events*).

With this combination, it can happen that no data is stored to a multi-file part. The following cases might appear:

- No data recording after arming the Trigger

  If it takes a certain time after arming Trigger and the first occurring recording event, the first file split will also occur with the first occurring recording event. Thus, the first data file begins not at the position the Trigger is armed but at the position the first recording event occurs. The first file can, therefore, be shorter than the defined interval. The next splits are done correctly according to the defined interval as shown in the split preview. This case is shown in Fig. 5.12.

- No data recording between two recording events

  If the time between two occurring recording events is longer than the specified Split interval, an empty data file will be created. (see File 4 in Fig. 5.12)

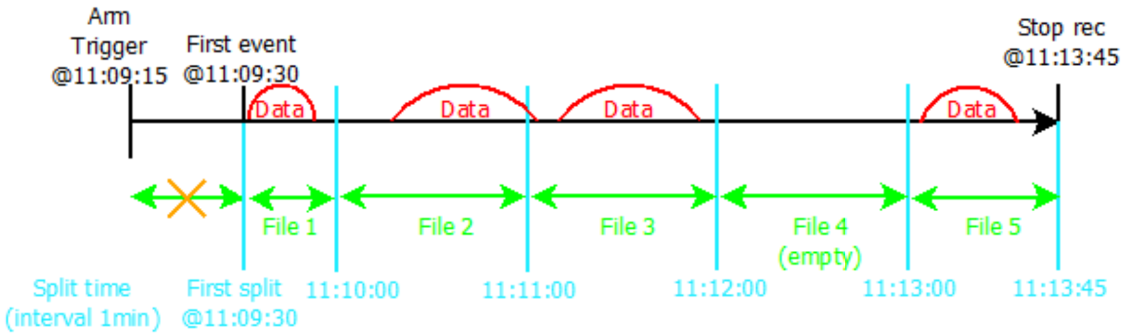


Fig. 5.12: Special case 1 for multi-file recording; Split by absolute time; interval: 1 min

- No data between the last occurring recording event and disarming the Trigger

  If no recording event happens after disarming the Trigger, the files will be split and created, nonetheless, according to the defined interval until the stop button is pressed. This case is shown in Fig. 5.13.

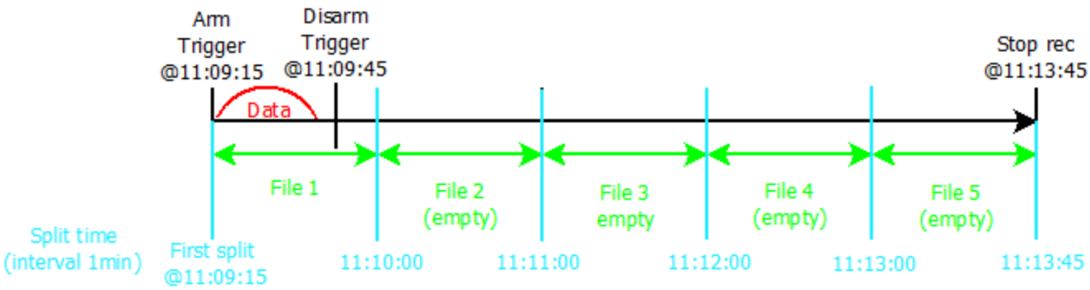


Fig. 5.13: Special case 2 for multi-file recording; Split by absolute time; interval: 1 min

Note:

- If User Reduced Statistics recording is enabled for the upper explained special case, this special case will not be applied, because (statistics) data will be recorded continuously.
- Splits are only possible on rounded times, therefore only integer numbers can be used, e.g. 1, 2, …, 5 etc. min/h/d. It is not possible to split files every 1.5 hours.
- If the first split lies in the past the next splits will be calculated correctly using the actual time.

Loading a multi-file

Multi-file parts that belong to the same measurement are stored in the folder of the selected data storing folder (see *General settings*) or in a separate folder of the selected folder, if the option create subfolder is active. The individual multi-files are enumerated starting with 1.

To load multi-files, click on the Open Data File button (see Fig. 5.14) and select the desired multi-file data folder. The folder is named to the same manner as data files are named. Thus, a prefix can be freely defined, and the actual date and time is appended automatically to the folder name (see *General settings*).

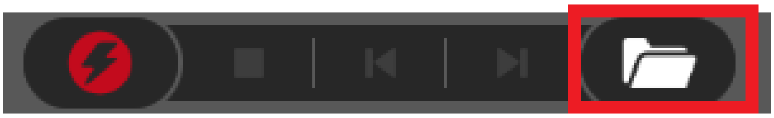


Fig. 5.14: Open data file button

After selecting the correct folder, the single multi-files are shown in a list. The Info tab shows if the selected file(s) is (are) a part(s) of a multi-file-recording and the number of compatible parts selected (see Fig. 5.15). It is possible to open all parts (see Fig. 5.16), several parts (see Fig. 5.17) or only one single part (see Fig. 5.18) of a multi-file recording. The file selection can be done with the check boxes which are placed left to the file name. If several or all parts are opened, they are displayed in the correct chronological order.

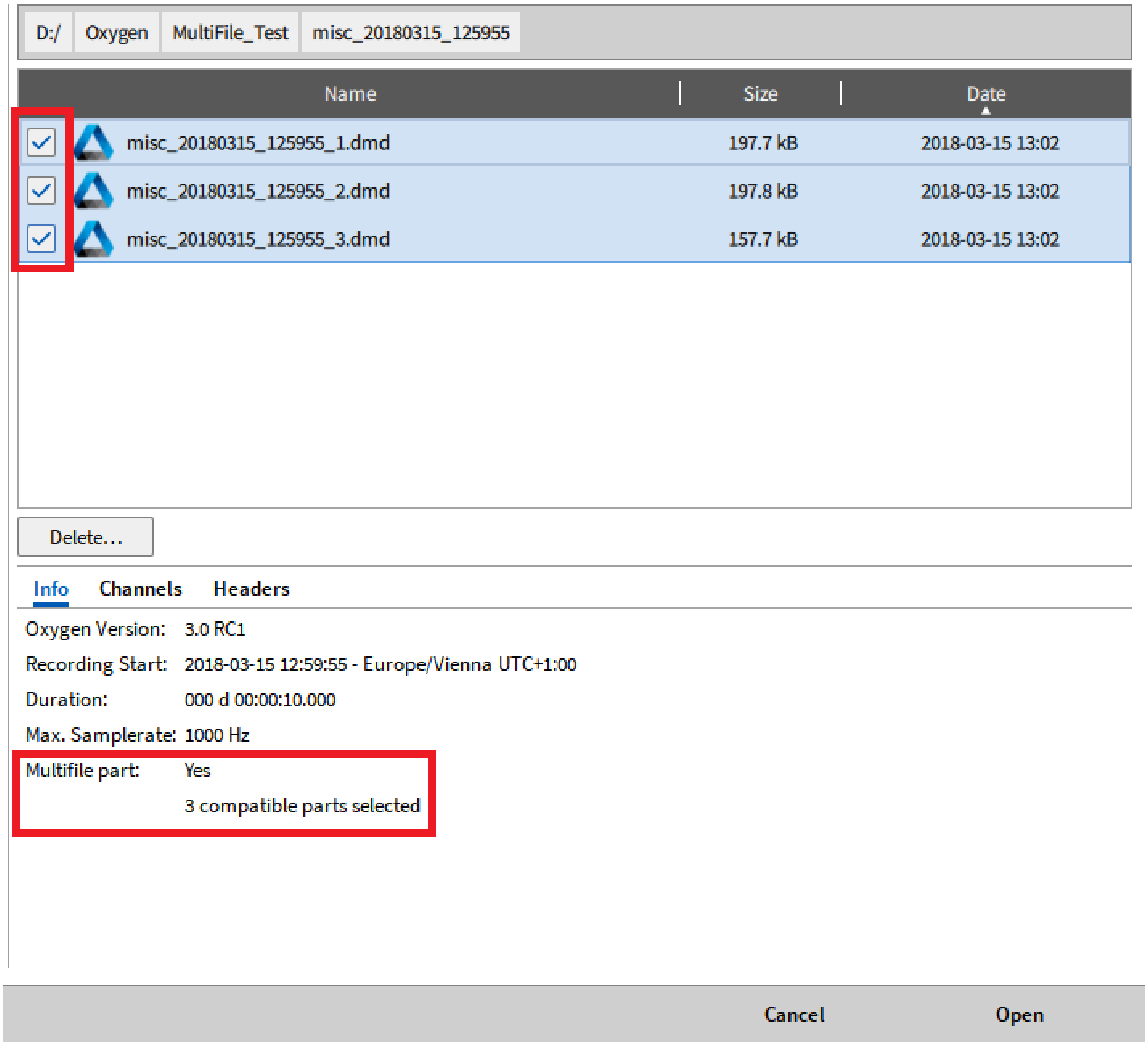


Fig. 5.15: Opening a multi-file

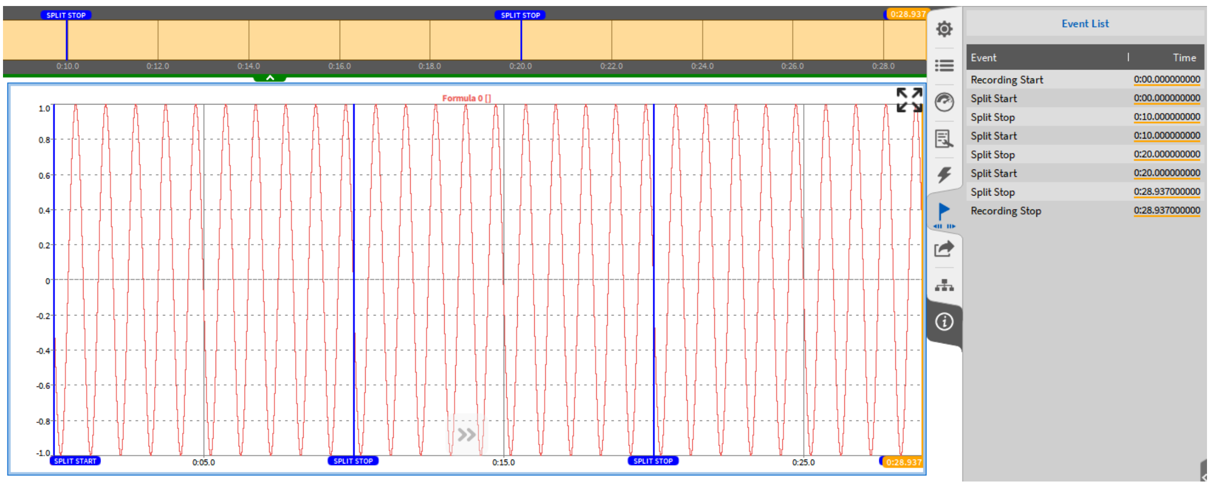


Fig. 5.16: Opening all parts of a multi-file recording

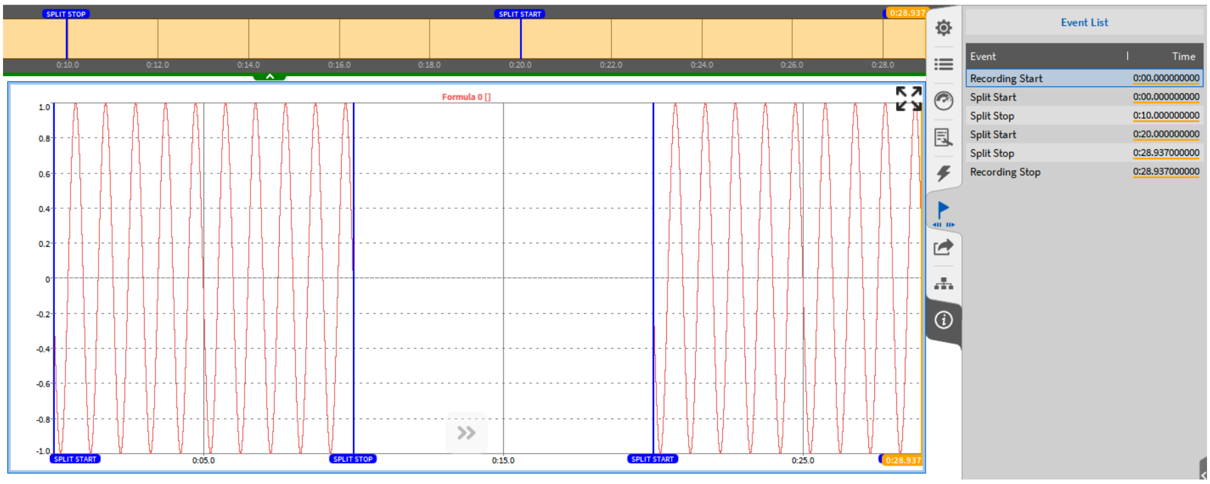


Fig. 5.17: Opening several parts of a multi-file recording

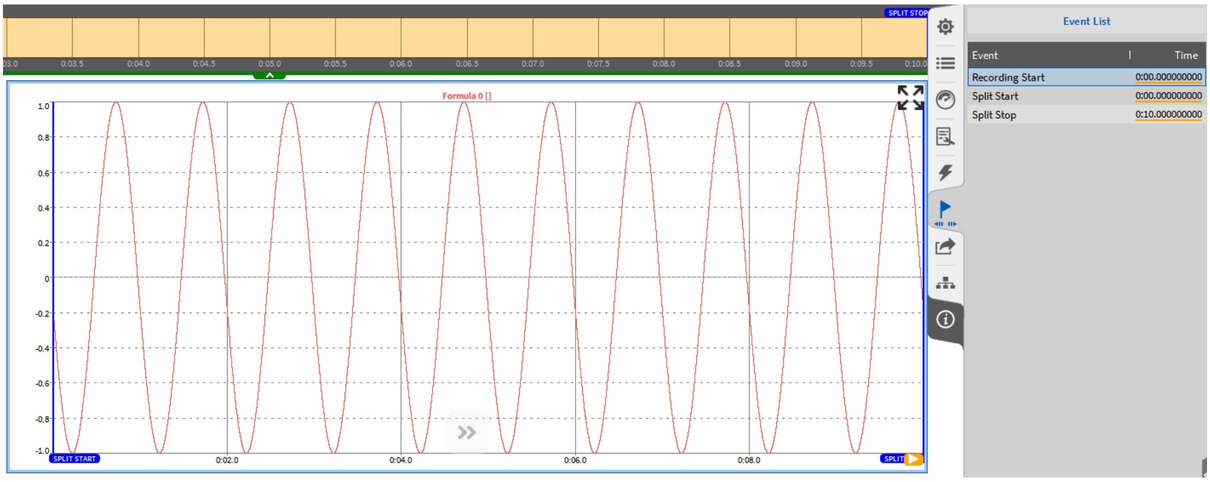


Fig. 5.18: Opening one part of a multi-file recording

If several parts are selected that are not part of a multi-file recording or don't belong to the same multi-file recording, an information will be displayed in the Info tab and the Open button will be disabled (see Fig. 5.19).

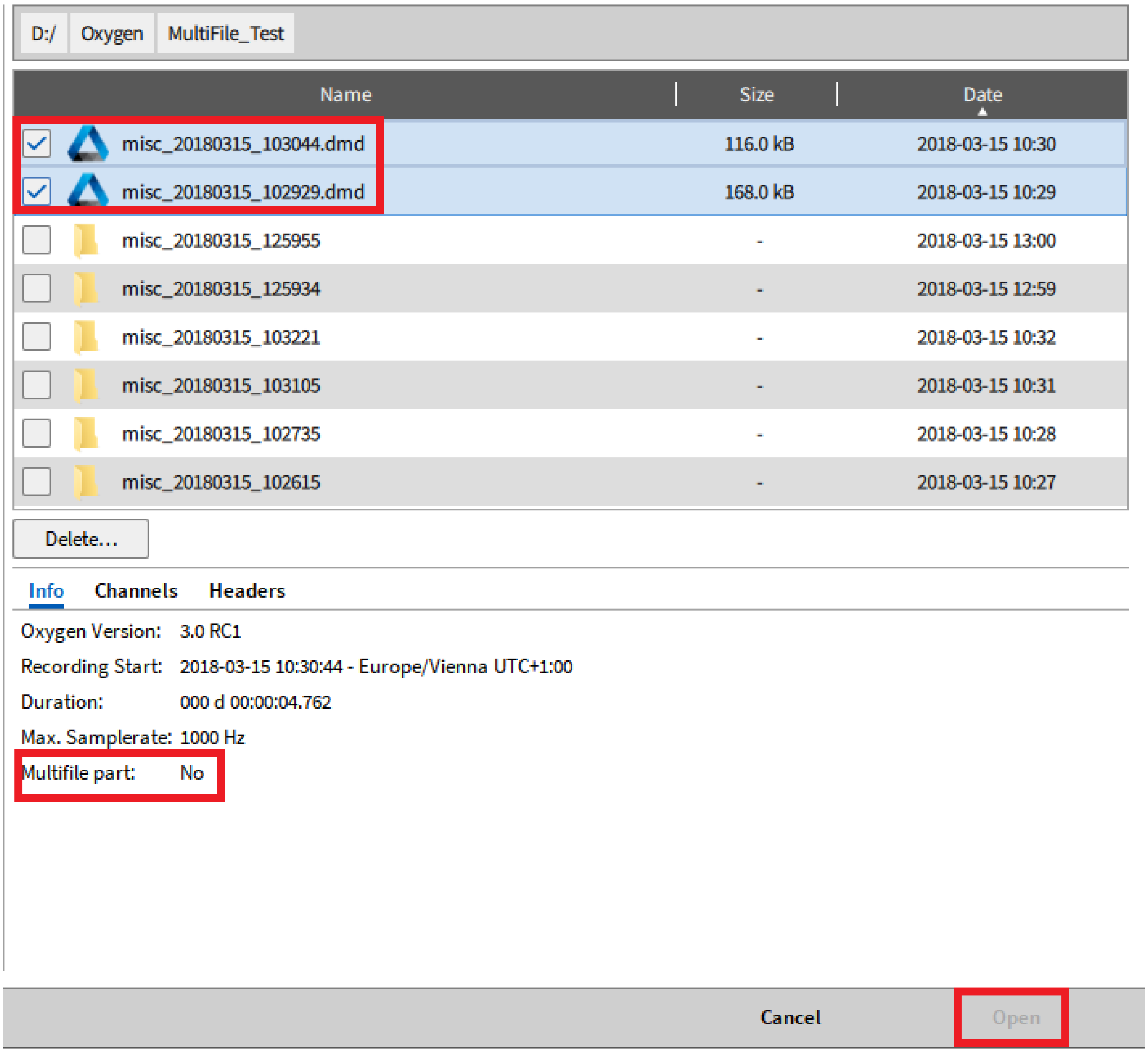


Fig. 5.19: Selection of non-compatible multi-file parts

If several multi-file parts are opened simultaneously and data shall be exported, data is exported to one file. If data of multi-file parts shall be exported to separate files, the multi-file parts must be opened and exported successively.

5.2.2 Header data

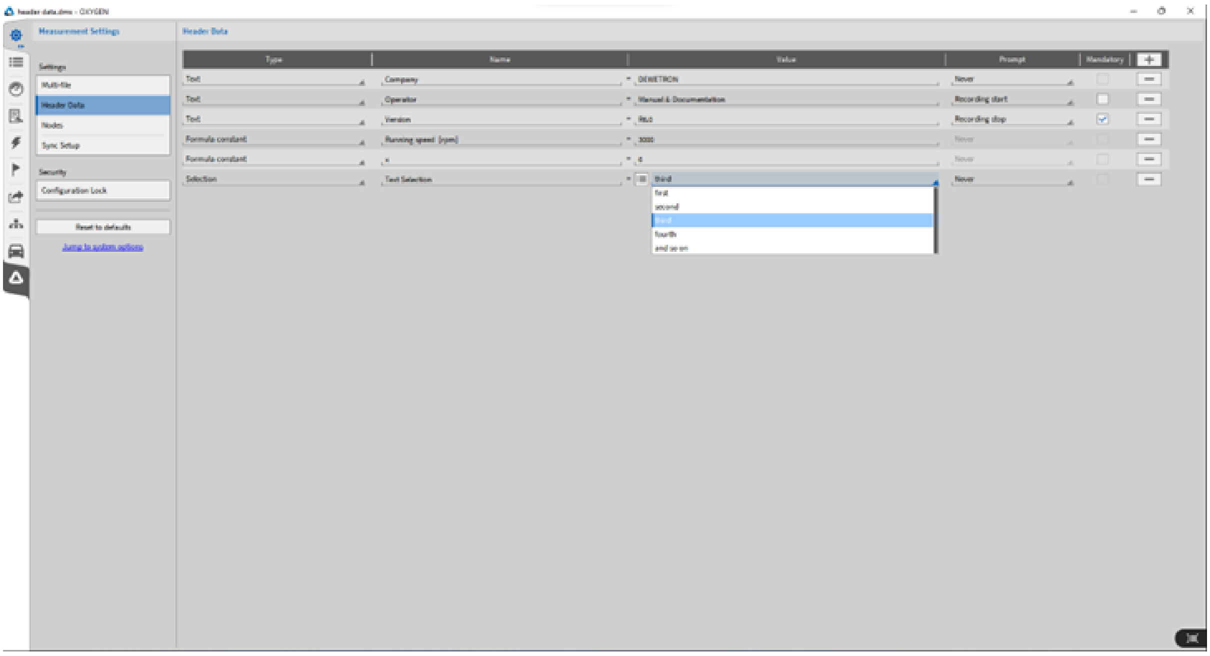


Fig. 5.20: Header Data – settings

The user can define Header Data here by clicking on the + in the upper right corner or remove it again by clicking on the – behind the respective header information. Two types of header can be defined: *Text header* and *Formula constant header*.

Text header

When Header Data is added, a name must be assigned to the certain header information and a description can be added. It can also be selected if the header information shall be prompted at the recording start or at recording stop (see Fig. 5.21). If this option is selected, the description of each Header Information can be changed there by the certain operator. If *Mandatory* is selected, the operator must fill in information in the respective Header Description at the recording start or stop. Otherwise the UI cannot be closed.

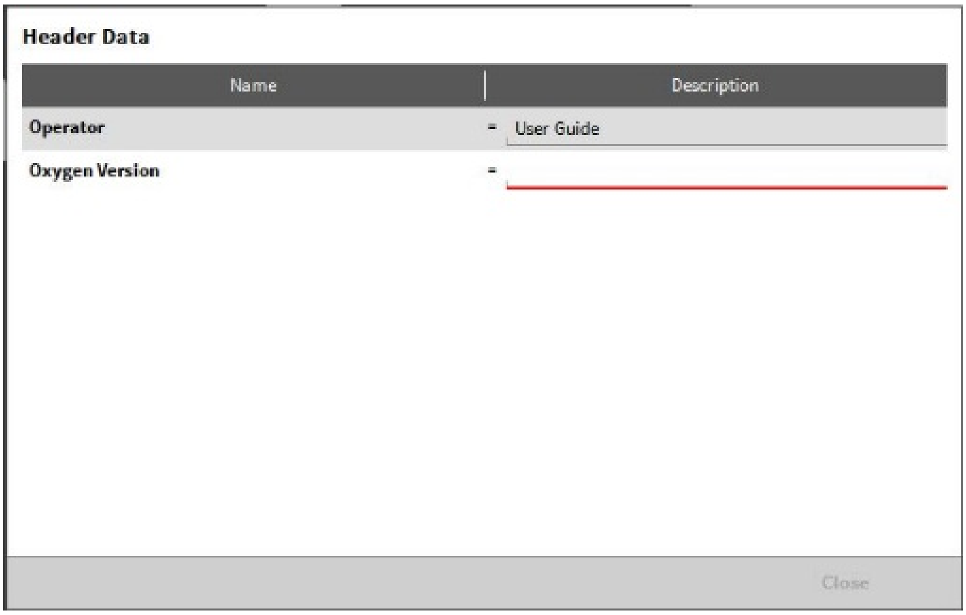


Fig. 5.21: Header Data UI at the recording start or stop

Formula constant header

In addition, the user can define numerical header which can be further used in a formula for mathematical operations. After defining the header name and value, the header can be found in the math formulas for further processing (see Fig. 5.22). For details about formulas, refer to *Formula channel*. The prompt option is not available for numerical headers.

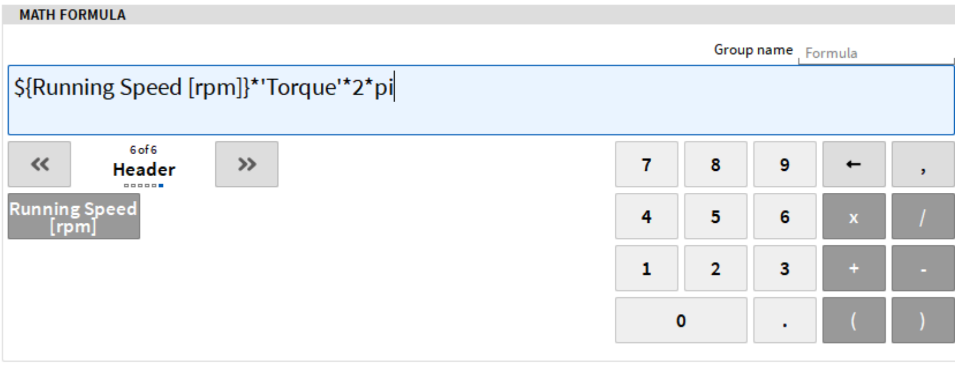


Fig. 5.22: Processing numerical headers in formulas

When a data or setup file is loaded, the user can also look at the Header Data here to facilitate the search for the correct data file (see Fig. 5.22).

Selection header

Furthermore, the user can define a selection header which can be used such as a text header, but with multiple manually defined values. As with a text header, the selection can be prompted at the recording start or at recording stop. If this is chosen, a pop-up window will appear on recording start or stop and one value of the selection can be chosen from a drop-down menu.

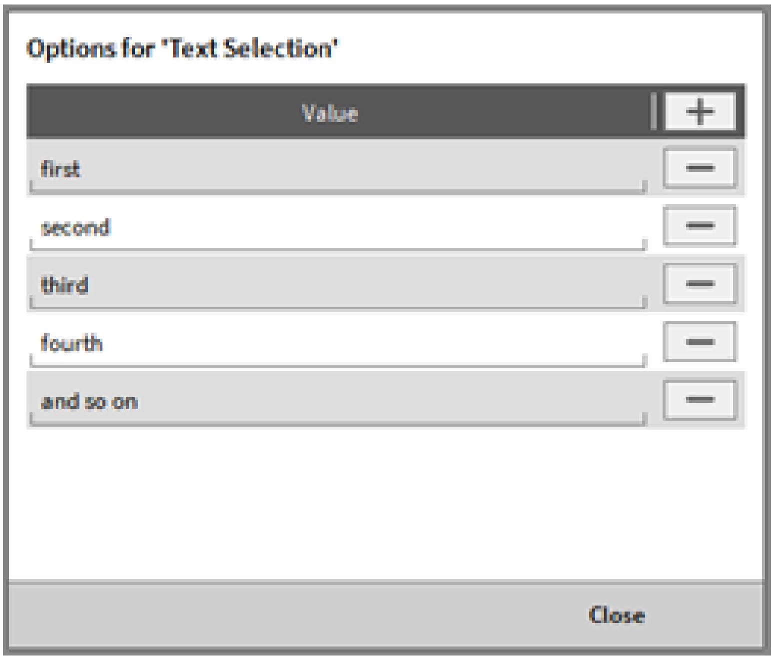


Fig. 5.23: Options for a selection header

In the options for a selection header a set of values can be defined (see Fig. 5.23). These can be text or numerical values.

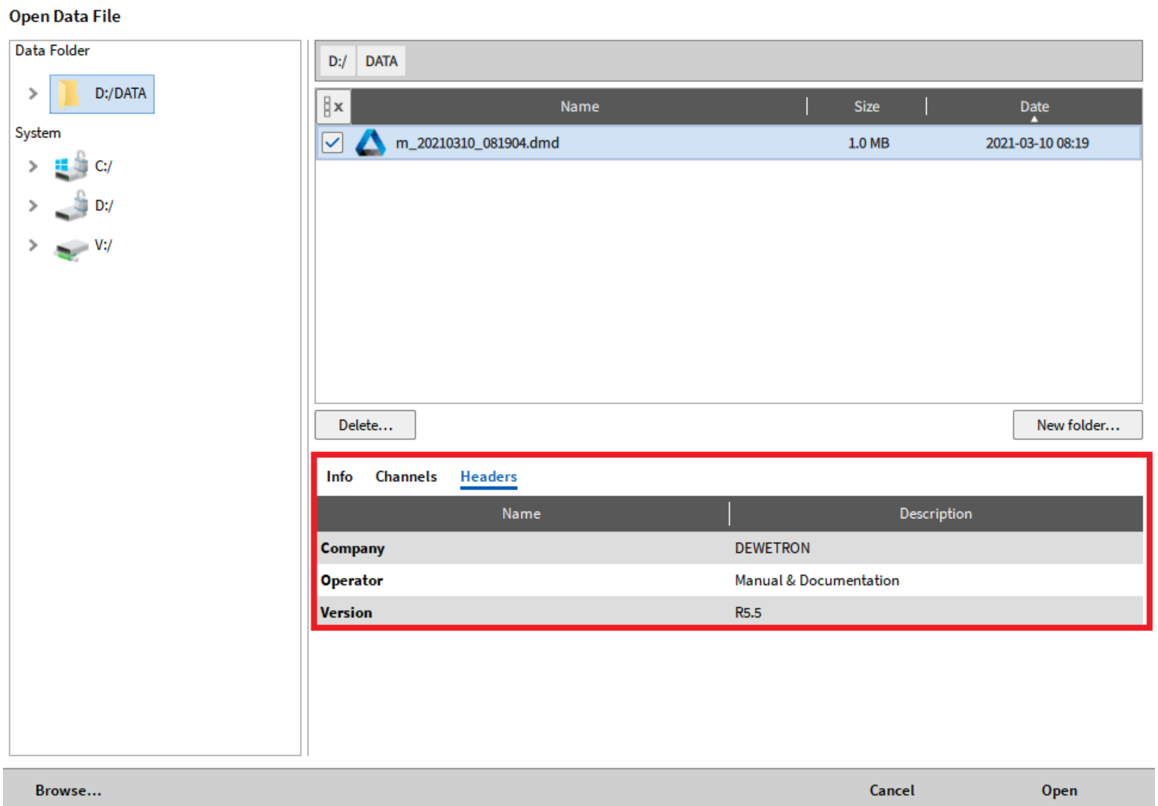


Fig. 5.24: Header Data information when loading a data file

It is possible to add the Headers in a Text Box (refer to *Text instrument*) on the measurement screen.

Three different procedures exist for adding Headers in a Text Box:

- Select the desired Header information at the Header Name in the small view menu of the Measurement settings and add it by Drag and Drop to the Measurement Screen (see Fig. 5.26).

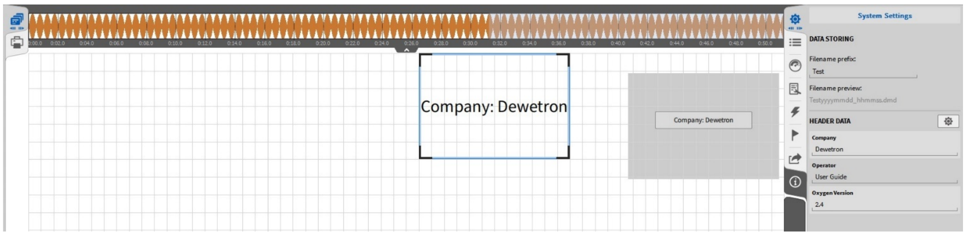


Fig. 5.25: Adding Header Data via drag and drop from the Measurement settings to the measurement screen

- Adding Header Data via drag and drop from the Measurement settings to the measurement screenHeader information can also be added to an existing Text Box by dragging and dropping it into it.
- Create a Text Box and go to its Instrument Properties. Created Header Data is there visible, too and can be added to the Text Box via a double click on the individual Header Data or via drag and drop

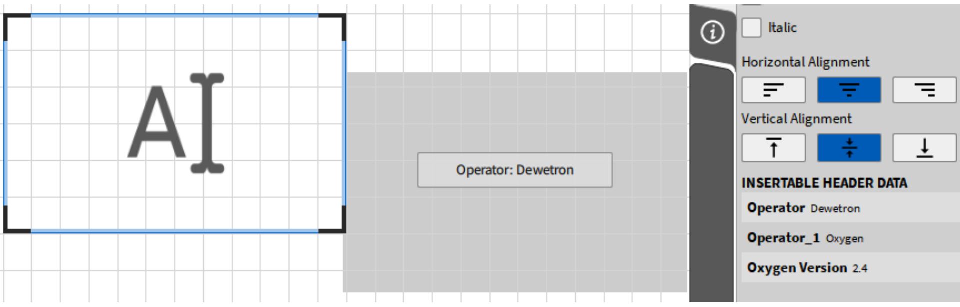


Fig. 5.26: Adding Header Data via drag and drop from the Text Box Instrument Properties to the measurement screen

- Create a Text Box and type in the Header Data Name according to the following syntax: *${Header Data Name}* and the Header Data Description will show up in the Text Box (see Fig. 5.27).

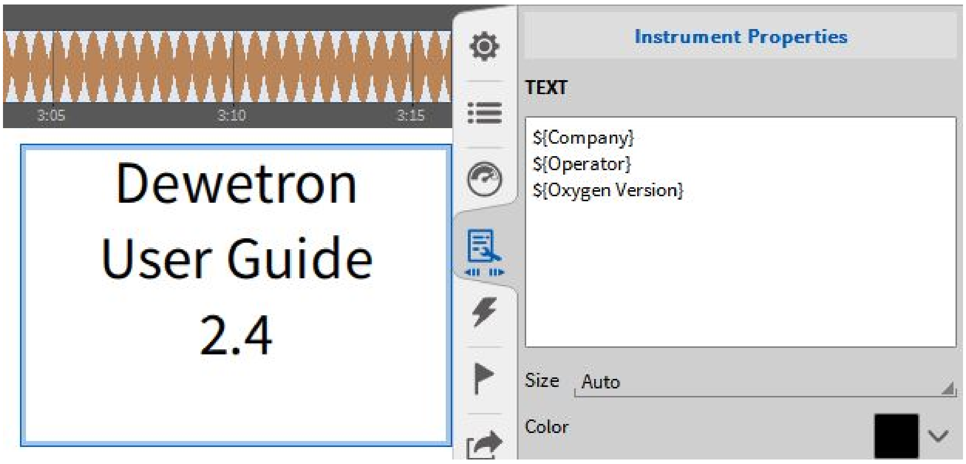


Fig. 5.27: Adding the Header Description in a Text Box

5.2.3 Nodes

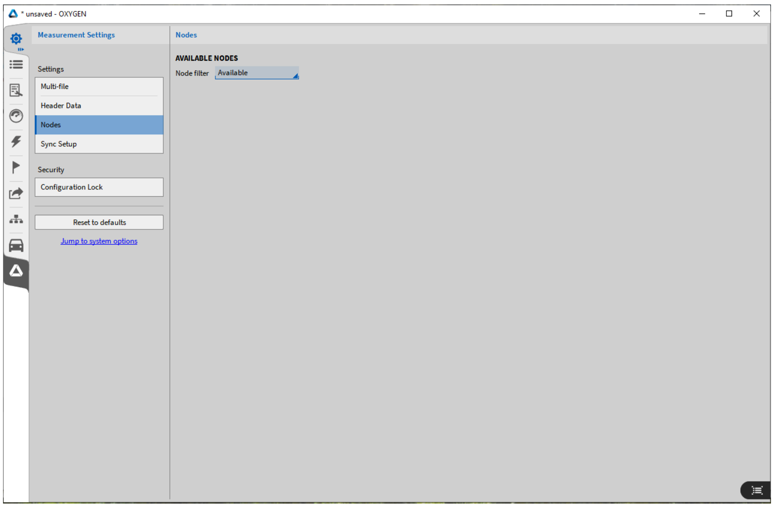


Fig. 5.28: Nodes menu

Refer to *OXYGEN-NET Menu – Nodes* for more information.

5.2.4 Sync Setup

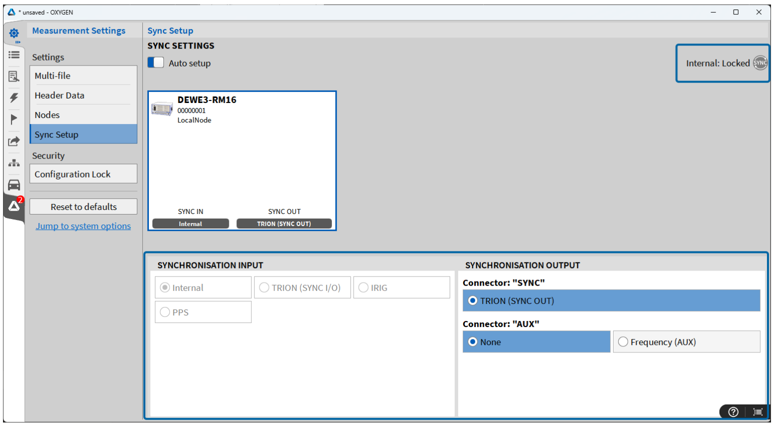


Fig. 5.29: Sync settings

Refer to *OXYGEN-NET menu – Sync* for more information.

The following section provides information about the various synchronization options using OXYGEN with TRION hardware or the chassis controller. With DEWE2/3 instruments there is nearly no limit when synchronizing systems with each other. The synchronization of the devices is either done via an Internal 10 MHz clock, TRION-SYNC-BUS (SYNC I/O, SYNC OUT), IRIG, PPS, PTP/IEE1588, or GPS. The synchronization options depend on model and configuration of the DEWE3, instruments.

Fig. 5.29 displays the *Sync Setup* settings highlighting:

- the SYNCHRONIZATION INPUT section - representing the input configuration of a device on how this instrument "gets" the input signal from any source or "generates" an input signal.
- the SYNCHRONIZATION OUTPUT section - representing the output configuration of a device, which defines what kind of signal this instrument routes to the corresponding output to synchronize with the next connected device.
- the Sync Status Indicator – providing information about the current synchronization status. For details on the different statuses, see *OXYGEN-NET menu – Sync*, subsection Sync Status Indicator.

DEWE3 devices can either be synchronized via internal or external timing sources, which can further be forwarded to synchronize additional systems.

Internal Timing Source

Each DEWE3 chassis has an internal 10 MHz clock which is used as the clock source in this particular DEWE3 system. This internal clock is used per default for synchronization. Therefore, the *Auto Setup* box is checked per default and *Internal* selected as *Synchronization Input* Source (see Fig. 5.30).

Each DEWE3 chassis has an internal 10 MHz clock which serves as the default clock source for that system. Therefore, the Auto Setup box is enabled by default and *Internal* is selected as the *Synchronization Input Source* (see Fig. 5.30). When the internal clock is active, the sync status indicator in the upper-right corner of the synchronization menu appears grey, indicating local synchronization.

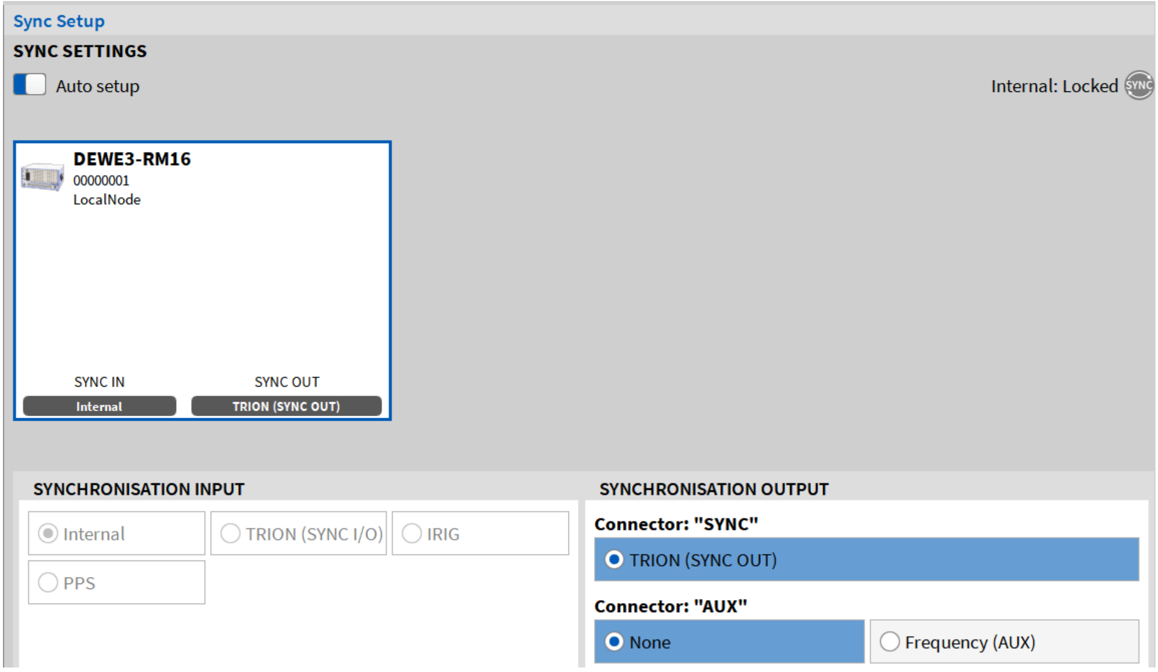


Fig. 5.30: Sync setup - internal sync clock selected

TRION-SYNC-BUS

In addition, each DEWE3 system can output the 10 MHz clock synchronization signal and forward it to another DEWE3 system via the SYNC In/Out connectors on the system (see Fig. 5.31). Note that this feature requires the OXYGEN-NET option.

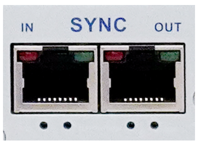


Fig. 5.31: SYNC IN/OUT connectors of a DEWE3-A4

The *SYNC IN* connector receives the synchronization signal, while the *SYNC OUT* connector transmits it. Both connectors are equipped with green and red LEDs that indicate the current acquisition and clock status:

Table 5.1: LED indication of the *SYNC OUT* and *SYNC IN* connector

	SYNC OUT	SYNC IN
RED (stable)	Clock detected	Receiving clock
GREEN (stable)	Acquisition running	Acquisition running

To synchronize another DEWE3 system via the TRION-SYNC-BUS, the following Sync Settings must be applied to the receiving DEWE3: Uncheck the *Auto Setup* box and set the *Synchronization Input* source to TRION (SYNC I/O) (see Fig. 5.32). By default, TRION (SYNC OUT) is enabled and cannot be disabled.

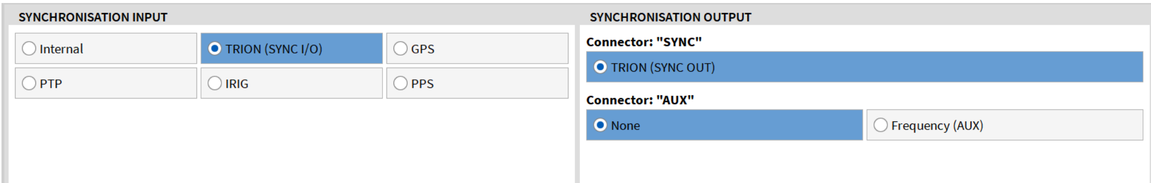


Fig. 5.32: Sync setup – TRION-SYNC-BUS

External Timing Source

Depending on the hardware used, various external synchronization signals can be used. The following hardware options are available:

- Chassis controller of a DEWE3 device
- TRION-BASE module
- TRION-TIMING module
- TRION-VGPS module

Note: The TRION modules must be mounted in the first (Star) slot of the system.

The following Fig. 5.33 provides an overview about the supported external synchronization:

Devices	Input synchronization signal										
	PTP/ IEEE 1588	*GNSS*				*PPS*		*IRIG*			
		GPS	*Galileo*	*Bei Dou*	*GLONASS*	*Rising Edge*	*Falling Edge*	*A DC*	*B DC*	*A AC*	*B AC*
Chassis Controller	✓	✓	x	✓	✓	✓	✓	✓	✓	x	x
TRION-BASE	x	x	x	x	x	✓	x	x	✓	x	x
TRION-TIMING	✓[1]	✓	✓	✓	✓	✓	✓[1]	✓	✓	✓	✓
TRION-VGPS	✓[2]	✓	x	x	✓	✓	✓[2]	✓	✓	✓	✓
	Output synchronization signal										
Chassis Controller	✓	x	x	x	x	✓	x	x	✓	x	x
TRION-BASE	x	x	x	x	x	x	x	x	x	x	x
TRION-TIMING	✓[1]	x	x	x	x	x	x	x	✓[1]	x	x
TRION-VGPS	✓[2]	x	x	x	x	x	x	x	✓[2]	x	x

Fig. 5.33: Compatibility of TRION modules and synchronization source

1) TRION-TIMING-V3 required; 2) TRION-VGPS-V3 required

Synchronization with a TRION-BASE board

If a TRION-BASE board is mounted to the first system slot (Star slot), the system can be synchronized with an external IRIG-B-DC or a PPS signal (synchronization to the Rising signal edge).

To use either IRIG-B-DC or the PPS signal as synchronization signal, connect the signal to the IRIG input of the TRION-BASE board (PPS signal must be input as well via the IRIG connector). Uncheck the *Auto setup* box in the *Sync Setup* and select either *IRIG* or *PPS* in the *Synchronization Input* menu (see Fig. 5.34).

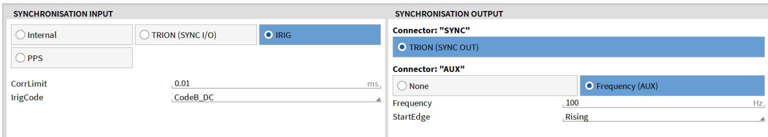


Fig. 5.34: Selecting an external synchronization source using a TRION-BASE board

The Sync indicator in the upper right corner of the menu will be

- Red, if no valid synchronization signal is connected to the SYNC I/O connector
- Orange, if a valid synchronization signal is connected to the SYNC I/O connector but the system is not locked yet (this might take some seconds and will be locked automatically)
- Green, if a valid synchronization signal is connected to the SYNC I/O connector and the system is locked.

The Sync indicator is available in the Action bar as well if the Sync Setup is closed (see ② in Fig. 3.5).

Note: If an external synchronization signal is applied to the system, the signal can be forwarded via the TRION-SYNC-BUS (see *TRION-SYNC-BUS*) as well to synchronize other DEWE3 chassis.

In addition, the TRION-BASE board offers an AUX connector which can output a rectangular (LVTTL) signal to synchronize other devices, i.e. a GigE camera, to the TRION hardware clock. To do so, enable the *Frequency (AUX)* switch in the *Synchronization Output* setup (see Fig. 5.34). The *Frequency* can be set from 10 Hz to 10 MHz and the *Start Edge* can be the *Rising* or *Falling* signal edge.

Synchronization with a TRION-TIMING/VGPS board

When a TRION-TIMING or TRION-VGPS board is mounted to the first system slot (Star slot), in addition to TRION (SYNC I/O), multiple other synchronization options are available:

I. IRIG (A-DC, A-AC, B-DC, B-AC)
II. PPS (rising edge; falling edge requires TRION-TIMING/VGPS-V3)
III. GNSS (VGPS supports GPS & GLONASS; TIMING supports GPS, GLONASS, BeiDou, Galileo)
IV. PTP (requires TRION-TIMING/VGPS-V3)
V. LVTTL

I. IRIG

To use an IRIG signal as synchronization signal, connect the signal to the IRIG input of the TRION board. Uncheck the *Auto setup* box in the *Sync Setup* and select *IRIG* in the *Synchronization Input* menu. Go to the *IrigCode* drop-down menu and select the correct IRIG Code (see Fig. 5.35).

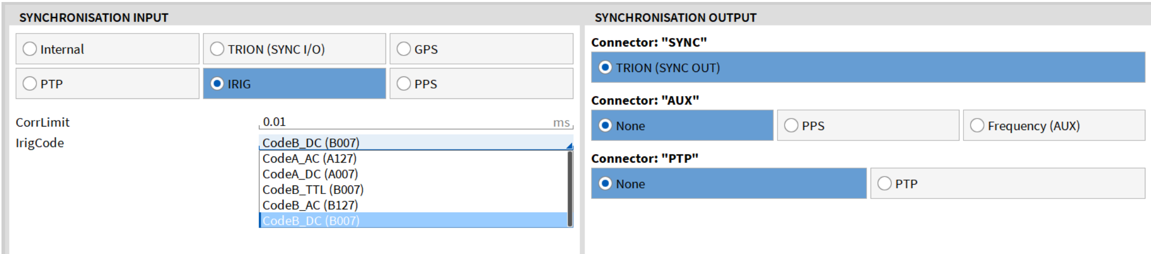


Fig. 5.35: Sync settings for IRIG input synchronization

The TRION-TIMING/VGPS-V3 board also supports the output of an IRIG B-DC signal. This can be configured in section *Synchronisation Output -> Connector: "IRIG/BNC" -> IRIG* (see Fig. 5.36).

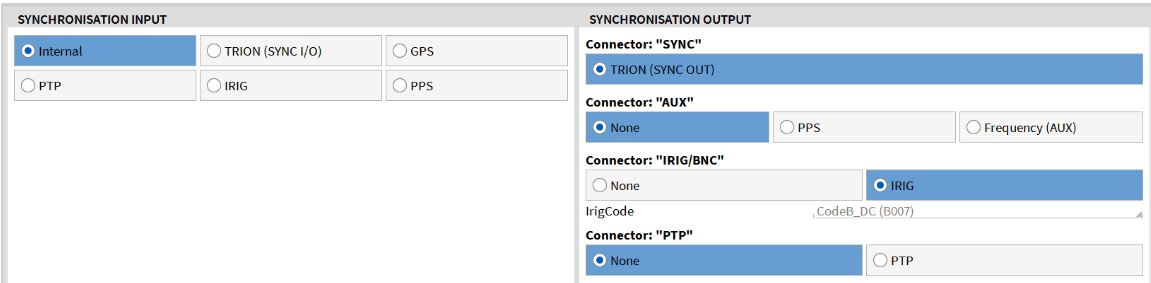


Fig. 5.36: Sync settings for IRIG output synchronization

Note: The IRIG/BNC connector on TRION-TIMING/VGPS-V3 boards can be used for IRIG input or output, but not simultaneously. Hence, dual IRIG input and output is not supported.

II. PPS

To use a PPS signal as synchronization signal, connect the signal to the IRIG connector of the TRION board (PPS signal must be input as well via the IRIG connector). Uncheck the *Auto setup* box in the *Sync Setup* and select *PPS* in the *Synchronization Input* menu (see Fig. 5.37). If the system shall be synchronized to the *Rising* signal edge, go to the *InvertedInput* drop-down menu and select *False*. If the system shall be synchronized to the *Falling* signal edge, go to the *InvertedInput* drop-down menu and select *True*.

Note: Only TRION-TIMING/VGPS-**V3** boards support PPS synchronization to the falling signal edge.

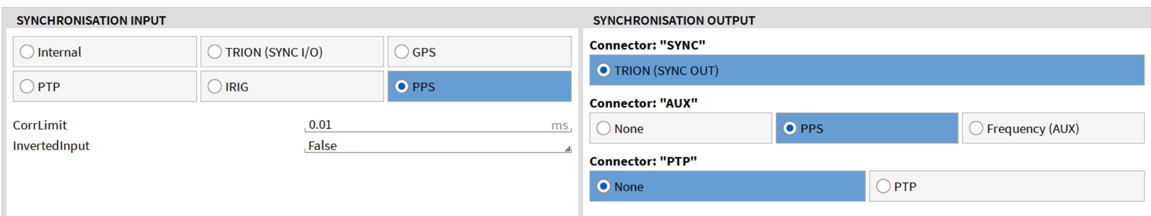


Fig. 5.37: Sync settings for PPS synchronization

III. GPS

To use GPS as synchronization signal, connect the antenna to the GPS input of the TRION board. Uncheck the Auto setup box in the *Sync Setup* and select *GPS* in the *Synchronization Input* menu (see Fig. 5.38).

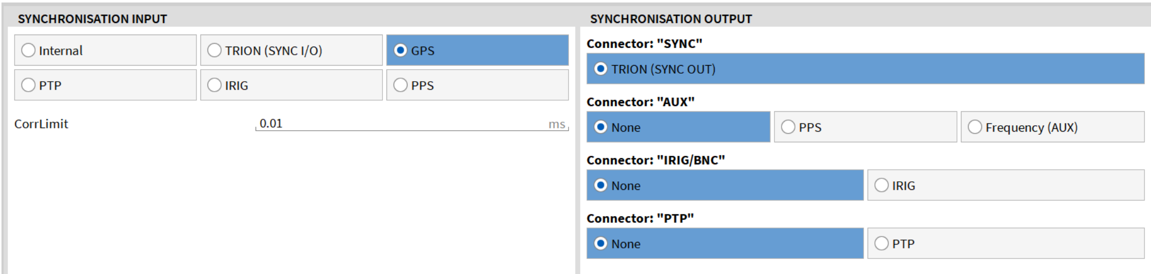


Fig. 5.38: Sync settings for GPS synchronization

Note: In this context, the term GPS refers to all GNSS sources. The source ultimately used depends on the available signal and the antenna.

IV. PTP/IEEE 1588

To use a PTP signal as synchronization signal, connect the signal to the PTP input of the TRION board. Uncheck the *Auto setup* box in the *Sync Setup* and select PTP in the *Synchronization Input* menu (see Fig. 5.39).

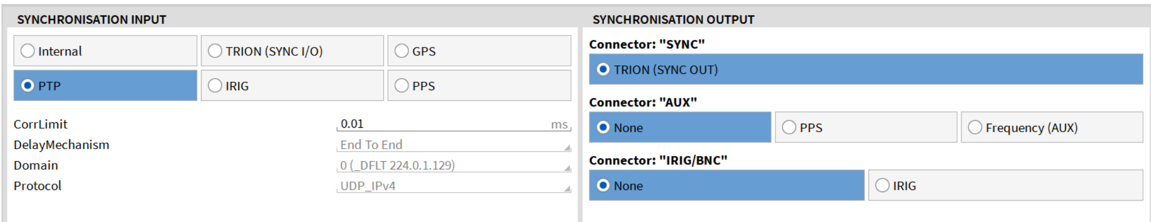


Fig. 5.39: Sync settings for PTP input synchronization

Note: If an external synchronization signal is applied to the system, the signal can be forwarded via the TRION-SYNC-BUS (see *TRION-SYNC-BUS*) as well to synchronize other DEWE3 chassis.

TRION-TIMING/VGPS-V3 additionally supports PTP out. Thus, a DEWETRON measurement device can also be used as a PTP master to synchronize other devices via PTP. To do so, on the PTP Master use the PTP connector as the output source and connect it to an additional input port. Uncheck the Auto setup box in the Sync Setup and select PTP in the Synchronization Output menu (see Fig. 5.40).

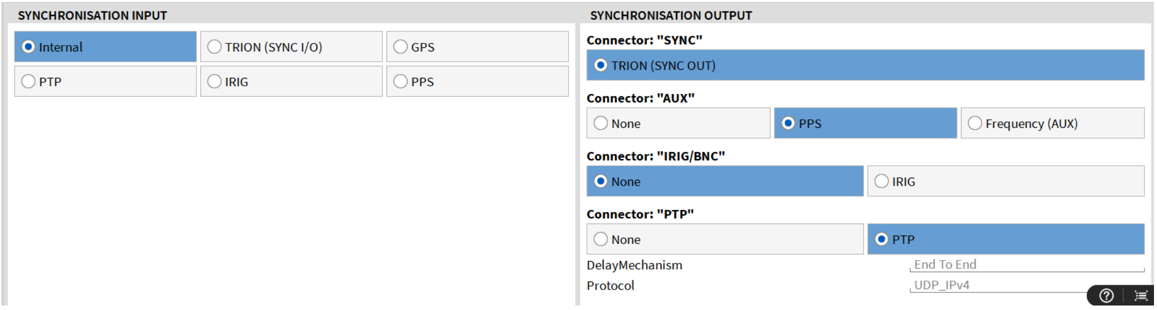


Fig. 5.40: Sync settings for a PTP input synchronization

PTP input and output use the same connector on TRION-TIMING/VGPS-V3 boards. Hence, simultaneous use of PTP input and output is not possible.

V. LVTTL output

In addition, the AUX connector of the TRION-TIMING/VGPS modules can output a rectangular (LVTTL) signal to synchronize other devices, i.e., a GigE camera, to the TRION hardware clock. To do so, enable the Frequency (AUX) in the Synchronization Output setup (see Fig. 5.35). The Frequency can be set from 10 Hz to 10 MHz and the Start Edge can be the Rising or Falling signal edge. For the AUX output to fully work, the “Use Chassis Controller for Sync” option must be set to false.

Synchronization with a Chassis Controller of any DEWE3 system

The chassis controller of any DEWE3 system supports a range of external synchronization options, similar to the TRION-TIMING/VGPS modules. These include IRIG, PPS, LVTTL, PTP, and GPS signals.

For IRIG and PPS synchronization, the connection must be made through the digital I/O connector. Use pin 8 for input signals and pin 24 for output signals (see Fig. 5.41 for the entire connector pinout). Because input and output are assigned to separate pins, the chassis controller is capable of handling simultaneous IRIG input and output. In addition to IRIG/PPS output, pin 24 can also be configured to emit a rectangular LVTTL signal. This is useful for synchronizing external devices such as GigE cameras. The output frequency of the LVTTL signal is configurable and can range from 1 Hz to 10 MHz.

Note: To use IRIG and PPS at the chassis controller, the hardware option DEWE3-OPT-IRIG/PTP is required.

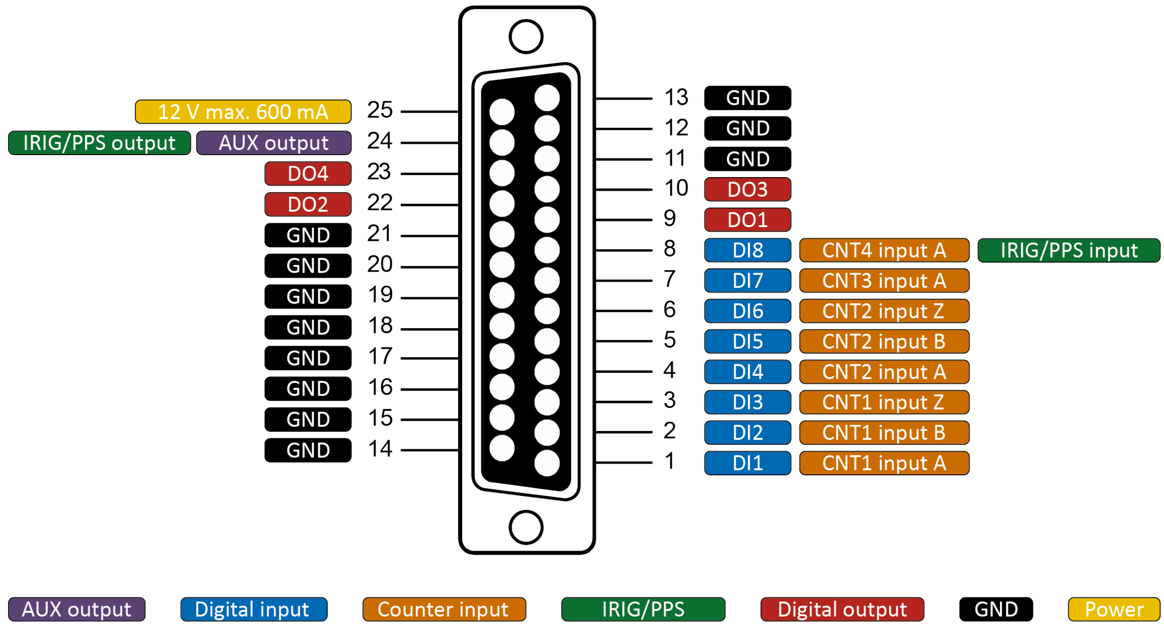


Fig. 5.41: DIO pinout of chassis controller

To synchronize the system using GPS, simply connect the GPS antenna to the corresponding GPS input on the chassis controller. Uncheck the *Auto setup* box in the *Sync Setup* and select *GPS* in the *Synchronization Input* section.

Note: To use the GPS input at the chassis controller, the hardware option DEWE3-OPT-GPS is required.

PTP synchronization is also supported and uses a dedicated connector on the chassis (see Fig. 5.42). Since this connector is used for both input and output, the chassis controller can function as either a **PTP slave** or a **PTP master**.

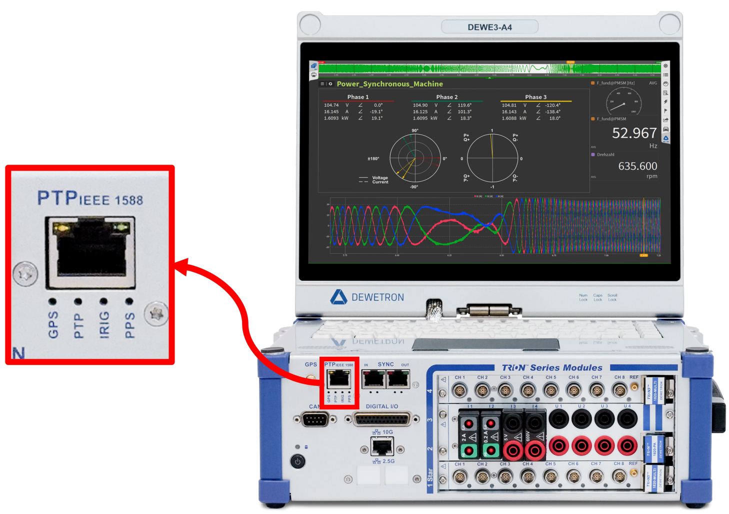


Fig. 5.42: PTP connector on chassis

Note: To use the PTP input at the chassis controller, it requires the hardware option DEWE3-OPT-IRIG/PTP. In addition to use the PTP Master option requires the software license OXY-OPT-PTP-OUT in combination with the firmware version >R6.6.1. Further note that this option is not available in EVALUATION mode.

The process for configuring these synchronization signals follows the same general steps as described for TRION-TIMING/VGPS modules. For detailed setup instructions, refer to the corresponding sections.

General remarks on PPS, IRIG and PTP synchronization

- PPS is the abbreviation for Pulse Per Second. PPS signals provide one pulse per second whose Rising or Falling Edge is used for data synchronization.
- PPS signals are usually provided by GPS receivers or IMUs, i.e. GeneSys ADMA's or OxTS RT's
- PPS signals may look like the following:

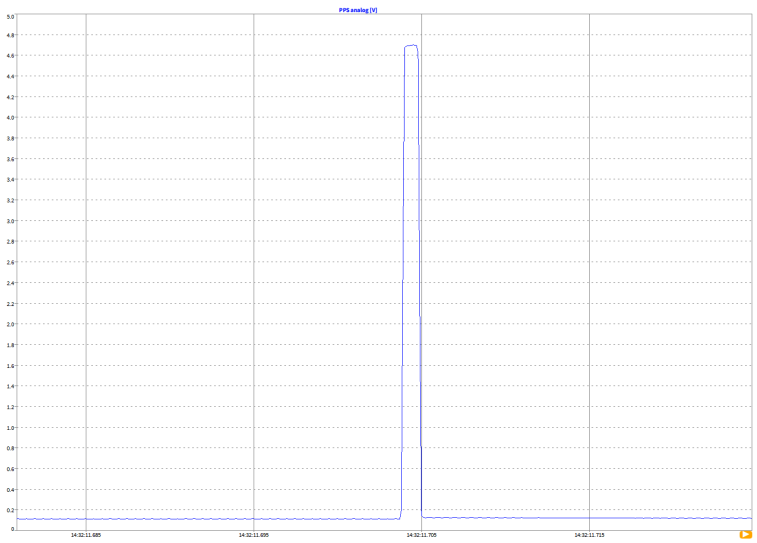


Fig. 5.43: PPS signal - example 1

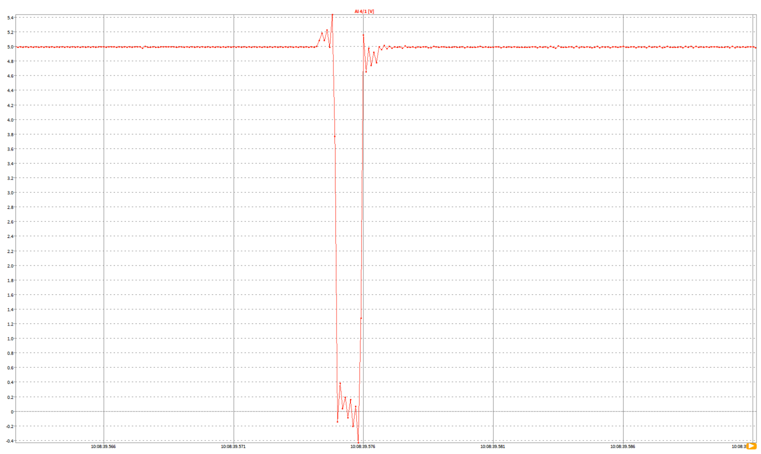


Fig. 5.44: PPS signal - example 2

- The IRIG timecode is used to control a PLL, which is then used as the system time base.
- The IRIG connector also has an indication LED flashing either green or red

Fig. 5.45: IRIG connector; detailed view

- The IRIG LED has the following indication:

Table 5.2: IRIG-LED indication

	OFF	ON	Description
GREEN (flashing)	20 %	80 %	SYNC IN not available
RED (flashing)	80 %	20 %	SYNC detected, not locked
Green (flashing)	80 %	20 %	SYNC detected and locked

- PTP is the abbreviation for Precise Time Protocol and is a protocol for clock synchronization throughout a computer network.
- PTP is defined in the IEEE 1588 standard.

5.3 Security

Configuration lock

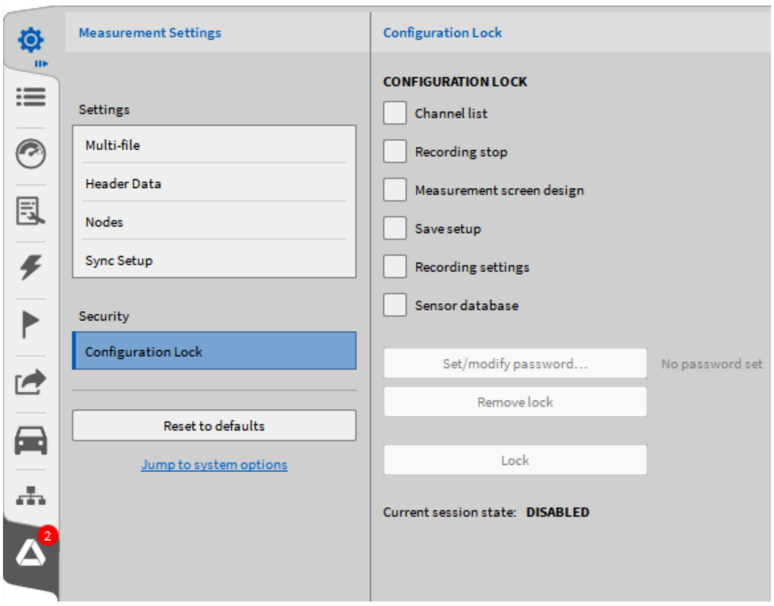


Fig. 5.46: Security settings

In the Security menu, the user can log certain measurement setup and recording options against unauthorized or unwanted changes and protect the measurement setup. These settings are stored to the measurement setup.

If this option is enabled, the settings are automatically locked after loading the setup.

The following functionalities can be locked:

- Channel List: Protects all settings in the Channel List (see *Data channels menu*). If this option is enabled, the Channel List settings can only be viewed. To edit the settings, the setup must be unlocked by entering the correct password. The password must be entered in the *Security* tab of the *Measurement settings*. Additionally, no acquisition restart will be made when switching between measurement screen and channel list.
- Recording Stop: A password has to be entered to stop or pause a recording based on a measurement setup that has this option enabled. A popup will open to enter the password after pressing the stop or pause button.
- Measurement Screen design: If this option is enabled, a password has to be entered to access the Design Mode (see *Adding an instrument to the measurement screen and channel assignment*), to change the instrument's channel assignment, axes scaling or their instrument properties. The password must be entered in the *Security* tab of the *Measurement settings*.
- Save Setup: If this option is enabled, a password has to be entered to save changes on the measurement setup. A popup will open to enter the password after pressing the save setup button.
- Recording Settings: If this option is enabled, a password has to be entered to edit the *Data Storing* and *Multi-File* settings (in *Measurement settings* see *General settings*) and the settings in the *Triggered Events* menu (see *Triggered Events*). The password must be entered in the *Security* tab of the *Measurement settings*. Additionally, no acquisition restart will be made when switching between measurement screen and channel list.
- Sensor database: If this option is activated, a password must be set as before. This means that the sensor database can no longer be edited unless the lock has been removed in the security menu.

To activate the lock of certain setup settings, proceed the following steps:

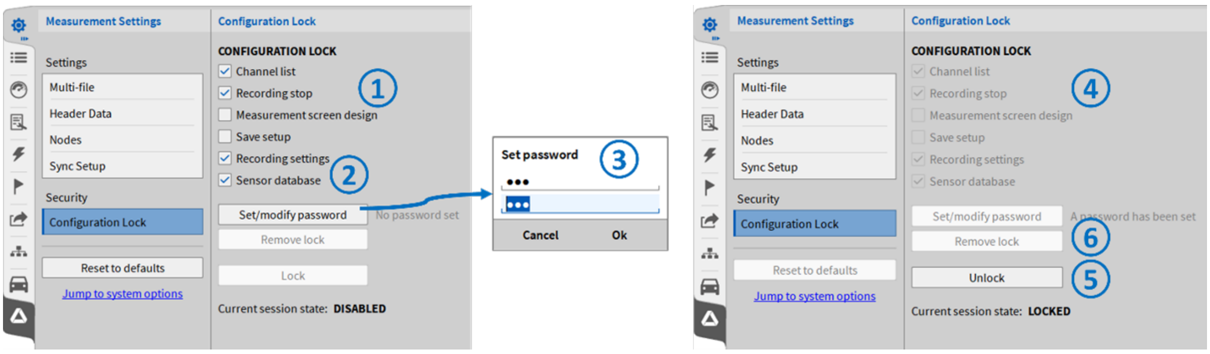


Fig. 5.47: Activation setup lock

- Select the settings that shall be locked (see 1 in Fig. 5.47).
- Press *Set/modify password* (see 2 in Fig. 5.47).
- Enter the password and confirm it (see 3 in Fig. 5.47).
- The selected settings will be locked afterwards (see 4 in Fig. 5.47).
- To unlock the settings again, press the *Unlock* button and enter the password (see 5 in Fig. 5.47).
- To remove the lock from the setup again, press *Remove lock* in the unlocked state (see 6 in Fig. 5.47).

CHAPTER

SIX

OXYGEN SETUP

The OXYGEN Setup menu contains all settings which affect software settings and will be stored in the registry. These settings are saved per default and do not have to be saved in a setup file.

The content of the individual submenus will be explained in the following sections in detail.

6.1 General settings

6.1.1 Storing and File name

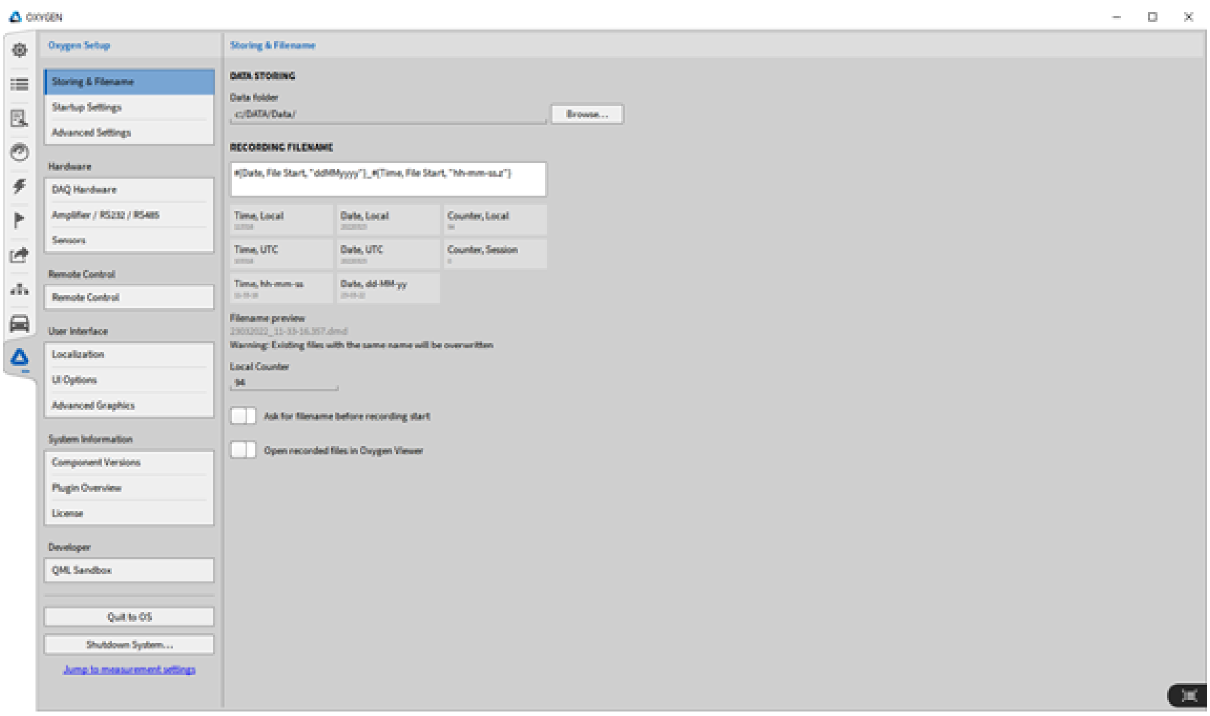


Fig. 6.1: System settings - overview

- Data storing: The folder to which data shall be stored, a prefix for data-filename and a folder to which data shall be exported can be specified here.
- Recording Filename: The user can use the file name pattern to set an individual file name. Different placeholders are available. Additionally, text can be entered to individually set a name for the datafile. The 4 different placeholders are the following:

- Time
- Date
- Number
- Header

Note: The header title must be written manually in the formula, which creates the data name. This file name formula cannot be changed during recording, see Fig. 6.2.

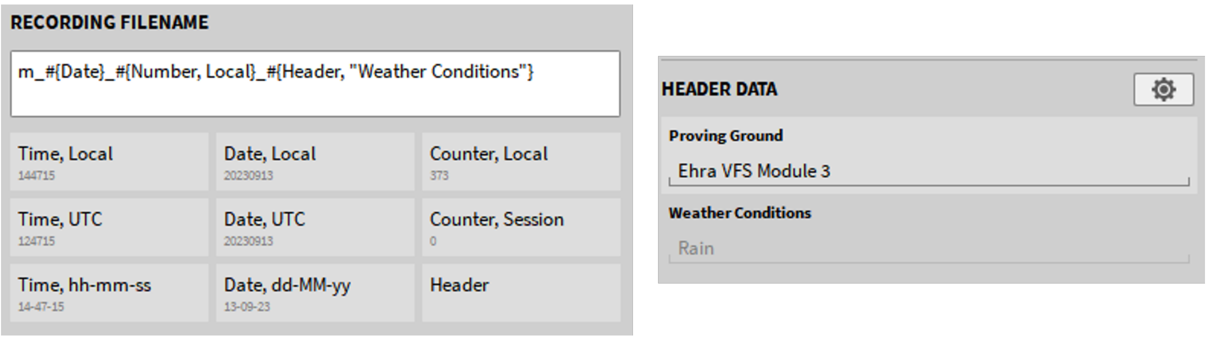


Fig. 6.2: Filename with header in formula

Time

- Time, Local: the local time is used.
- Time, UTC: the UTC time is used.
- Time, hh-mm-ss: the time can be used in different formats.
- Hours [h], minutes [m], seconds [s] and milliseconds [z] can be arranged individually. As separator [- . _] can be used, e.g. ss-mm-hh", "mm_hh", "ssmmhh".

Note: The text File Start can be added, in order to guarantee the individual recording start for multi-file recordings. Example: #{Time, File Start, "hh-mm-ss"}.

Date

- Date, Local: the local date is used.
- Date, UTC: the UTC date is used.
- Date, dd-MM-yy: the date can be used in different formats. Day, month and year can be arranged individually. As separator "-" or none must be used, e.g. "yy-MM-dd", "dd-MM", "ddMMyy".

Note: The placeholder letter for month (M) is written in capitals, to distinguish it from the placeholder for minutes (m).

Note: The text *File Start* can be added, in order to guarantee the individual date of recording start for multi-file recordings. Example: #{Date, File Start, "dd-MM-yy"}.

To specify a file name before recording start enable the button Ask for file name before recording start.

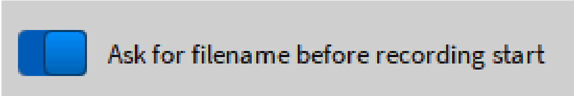


Fig. 6.3: Ask for file name before recording start button

If this button is enabled, a pop-up window (see Fig. 6.4) will appear where the file name can be entered.

Note: The recording only starts by clicking on the *Record* button (marked red in Fig. 6.4) in the pop-up window after entering the file name.

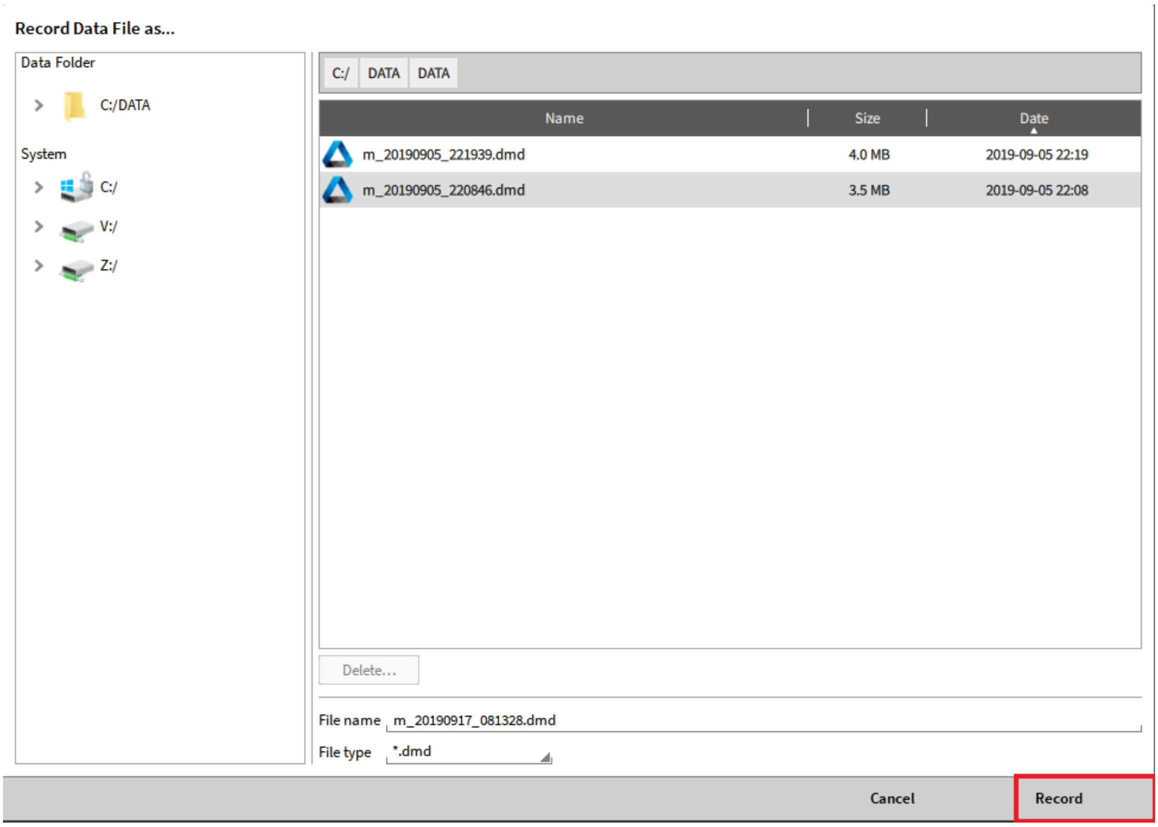


Fig. 6.4: Pop-up window to enter the file name before recording start

To open a file right after recording stop in the OXYGEN Viewer, activate the button Open recorded file in OXYGEN Viewer. Therefore, the last recorded measurement file will automatically be opened right after recording stop in the OXYGEN Viewer. OXYGEN can then be used for the next measurement, while the last recording can be analyzed.

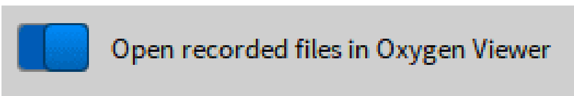


Fig. 6.5: Button, to open the recorded file right after recording stop

Number

- Counter, Local: this counter is persistent, meaning it will continue to increase also after OXYGEN or the whole system will be restarted. This counter can be reset by entering a desired number (e.g. 0) in the field for the Local Session Counter, see Fig. 6.1.
- Counter, Session: this counter is dependent on the OXYGEN session and will increase every time a new measurement is started. It will be reset if OXYGEN is closed and started again.
- Counter, Custom: this counter is a custom counter and must be adjusted manually to increase.

It is also possible to enter individual text in the text field. With these options it is possible to configure an individual name for standard or advanced use.

The filename preview shows the result of the configured file name.

6.1.2 Startup settings

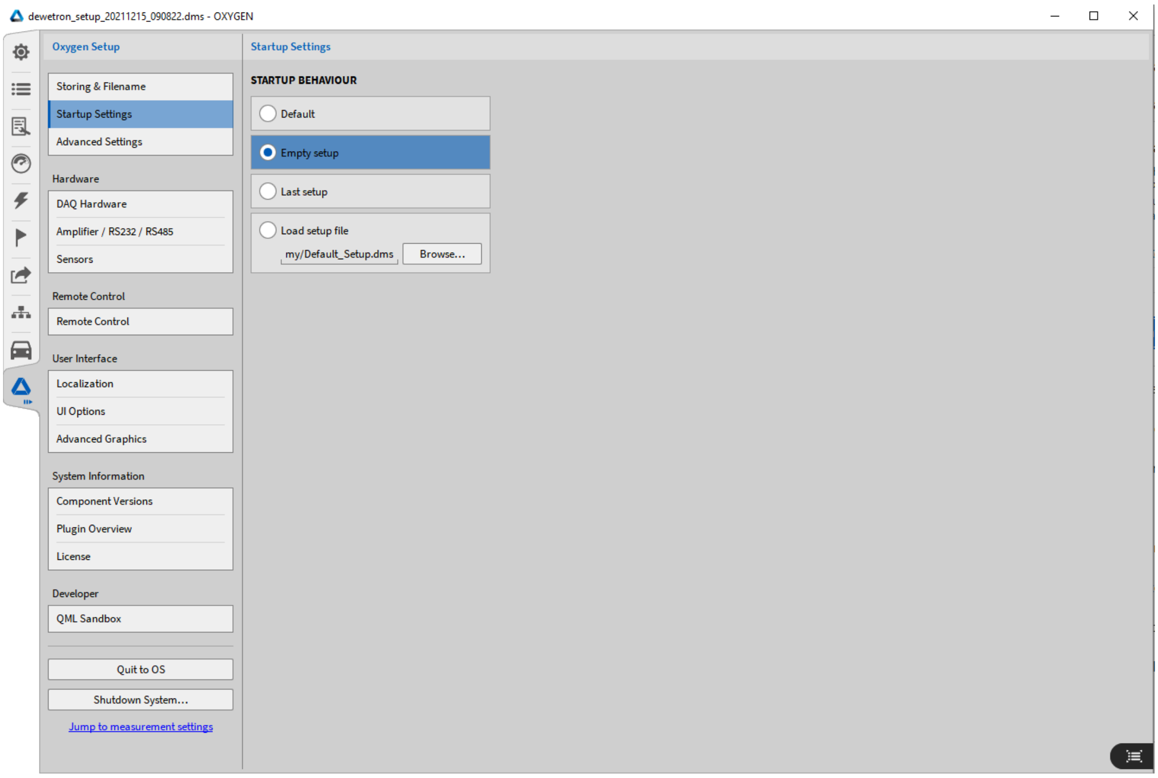


Fig. 6.6: Startup Behaviour settings

The user can select if the default setup file, an empty setup file, the last setup file or a user defined setup file shall be opened when OXYGEN is started (see Fig. 6.6).

6.1.3 Advanced settings

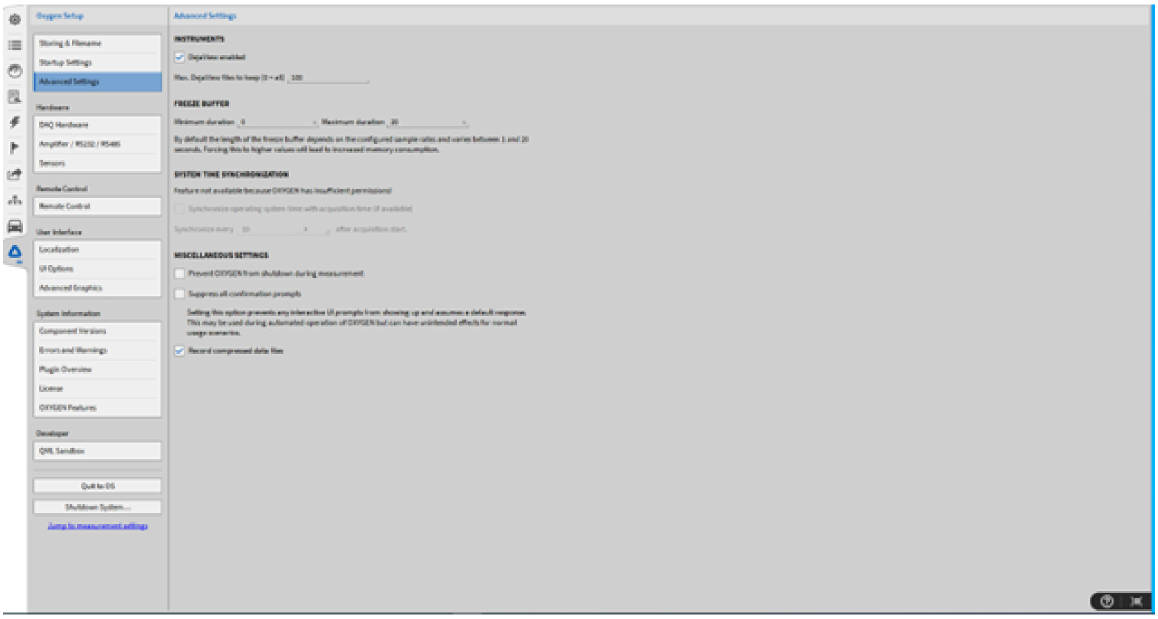


Fig. 6.7: Advanced settings

- **Instruments:** In the Instruments section, DejaView™ can be enabled/disabled. By default, DejaView™ is always enabled. For a detailed description of DejaView™ refer to *DejaView™*.
- **Freeze Buffer:** The minimum and maximum duration of the freeze buffer can be changed manually here by entering a duration of 0-100 s. By default, the length of the buffer depends on the set sample rate and varies between 1-20 s. WARNING: A manual increase of the freeze buffer leads to a higher load of the main memory. Change with caution! If decreasing the memory consumption is necessary, lower the maximum duration of the freeze buffer.
- **System Time Synchronization:** If an IRIG or GPS signal is received via a TRION-BASE (IRIG only), TRION-TIMING or TRION-VGPS module and if this signal is used for synchronization, the system time of the PC OXYGEN is running on can be set to this timing signal. For synchronization with an external timing source, refer to *External Timing Source*. The synchronization interval can be selected below and the minimum time interval is 10 seconds.
- **Miscellaneous settings:** Closing OXYGEN by shutting down the system can be prevented by one setting here. The second setting allows to suppress confirmation messages like saving or discarding changes. This has advantages in automated operation, but can lead to undesired behavior in manual operation. The third setting is activated by default and allows to save recorded measurement files in a compressed data format. The data type for both compressed and uncompressed measurement files is .dmd in both cases. With this setting the size of the measurement file can be reduced up to 30%. However, the use of the compressed measurement files leads to a higher system load, if the system load is too high, the function should be deactivated.

Note: OXYGEN must be started with Administrator rights to use the system time synchronization function as this functionality changes the system settings of the PC. If OXYGEN is started without Administrator rights but this functionality is activated, the error message *System time synchronization not allowed* (see Fig. 6.8) will be displayed in the lower right corner of the software. note that this setting is not stored to a dms-setup file but only to the registry.

Fig. 6.8: Error message *System time synchronization not allowed*

6.2 Hardware

6.2.1 DAQ Hardware

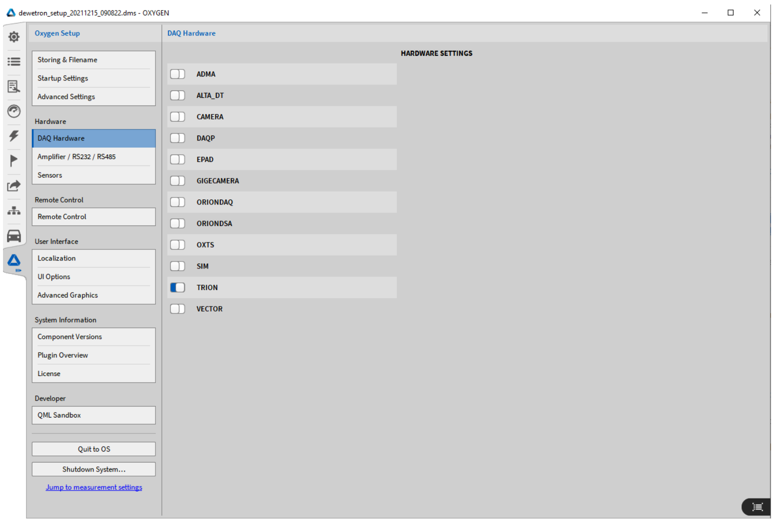


Fig. 6.9: DAQ Hardware settings

In the DAQ Hardware setup, the user can enable and disable the usability of different hardware series. For the detailed installing procedure of measurement hardware, refer to *Hardware setup*.

6.2.2 Amplifier / RS232 / RS485

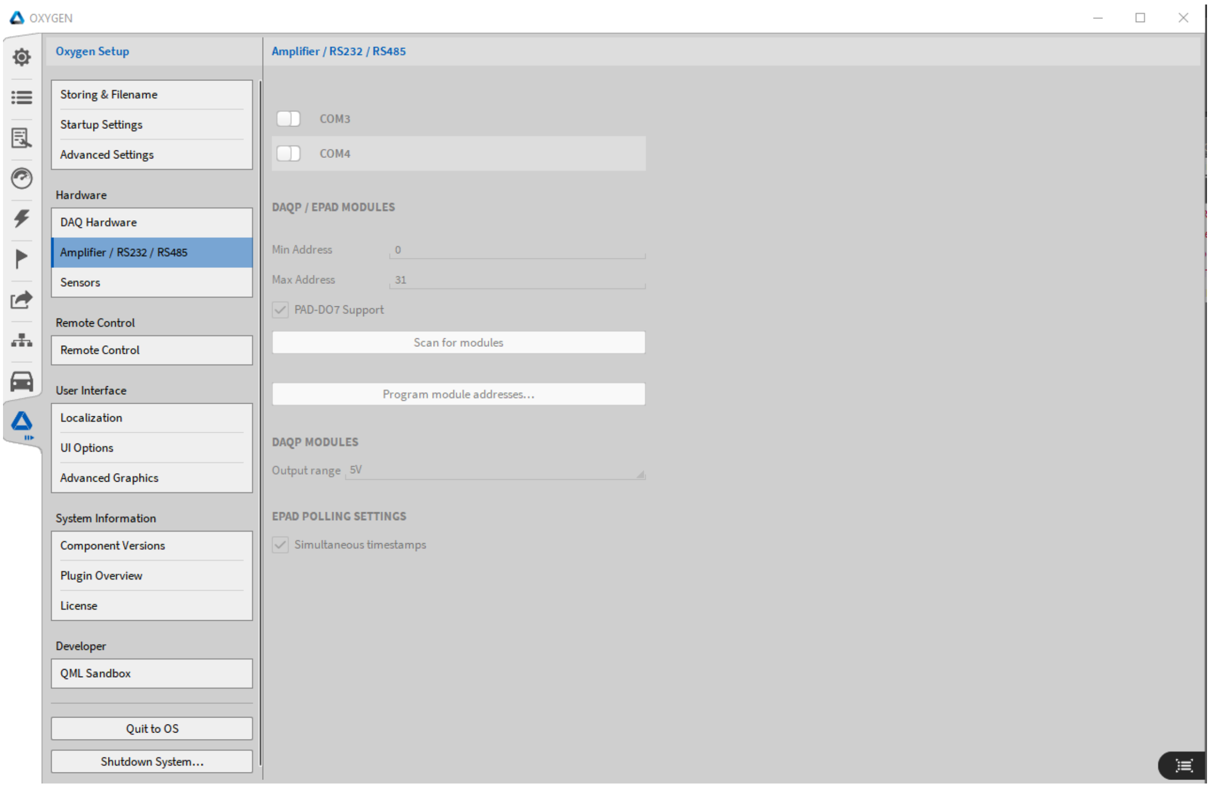


Fig. 6.10: Amplifier / RS232 / RS485

For more information, refer to *Using EPAD2 with OXYGEN* for EPADs and *Using DAQP/HSI Modules with OXYGEN* for DAQP/HSI modules.

6.2.3 Sensors

OXYGEN offers the possibility of a sensor database to hold all relevant information about the user's sensors.

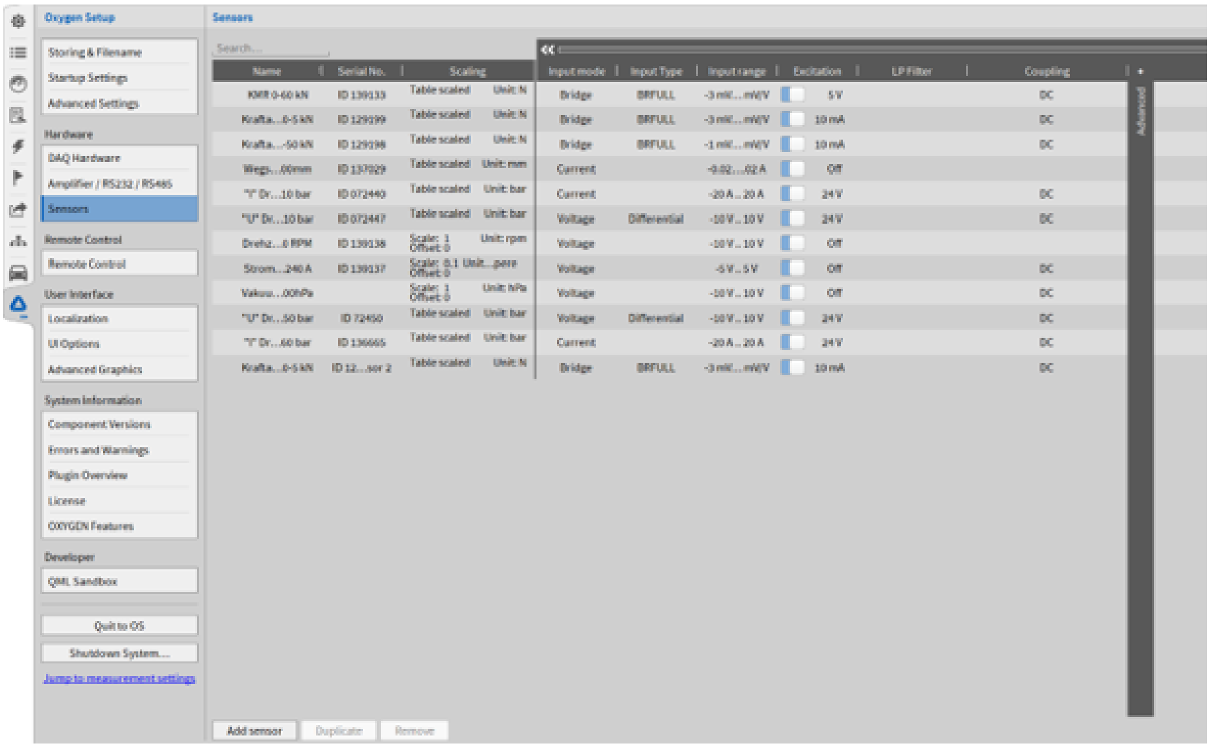


Fig. 6.11: Sensor Database

The sensor database can be found in the System Settings and provides a comfortable user interface with familiar sub-menus.

To add a new sensor, click on the *Add sensor* button in the lower left corner (marked red in Fig. 6.11). The properties of the sensor are the same which are also available in the channel settings (for detailed explanation see *Changing the channel settings*). By clicking on the properties, a small pop-up window will appear as seen in Fig. 6.12 where the following parameters can be edited:

- *Name*: name of the sensor
- *Serial No.*: add the serial number of the sensor
- *Scaling*: add channel scaling or sensitivity; also 2-point, table or polynomial scaling is available
- *Measurement Input Properties (required by the sensor)*
  - *Input mode*: define the input mode which is required by the sensor; choose between Voltage, Current, Bridge, Resistance, Potentiometer, Temperature and IEPE
  - *Input Type*: define the input type (depending on the input mode the input type varies)
  - *Input range*: define the input range (depending on the input mode the input range varies)
  - *Excitation*: choose excitation (off, Voltage, Current) and corresponding value
  - *LP Filter*: add optional lowpass filter, define the frequency, order (2, 4, 6, 8) and type (Bessel or Butterworth)
  - *Coupling*: choose coupling mode
  - *And Bridge-Input Specific Settings*

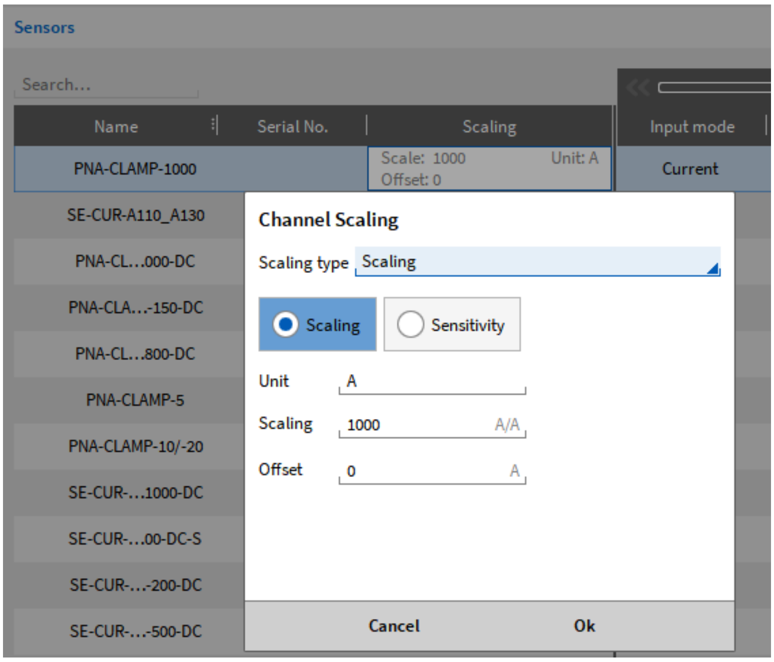


Fig. 6.12: Sensor database – pop-up window to change channel scaling

To duplicate or remove a sensor simply click on the respective sensor and on the *Duplicate* or *Remove* button as marked red in Fig. 6.11.

By clicking on *+ Advanced* (see Fig. 6.13) in the parameter bar the advanced menu will open, and more properties can be added:

- *Bridge resistance*
- *Bridge Sensor Offset*
- *Bridge Shunt Target*
- *Shunt Resistance*
- *RTD Sensor Type*

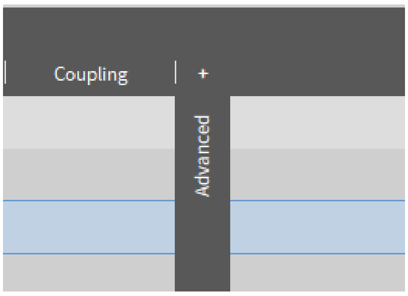


Fig. 6.13: Sensor database – open advanced menu

Bridge shunt target

The purpose of the bridge shunt target is to check Quarter Bridge, Half Bridge or Full Bridge wiring and determining the sensi¬tivity loss due to cable resistance. By applying a known resistor to the internal completion resistor, a known bridge unbalance can be simulated. In case of ideal wiring the measured unbalance will correlate exactly with the simulated unbalance. But in reality, cable resistance will decrease the measured value. By using the ratio between expected and measured unbalance this effect could be compensated.

The TRION(3)-18xx-MULTI measurement board supports a programmable shunt. The user can directly enter the "mV/V" or engineering unit within certain limits. The module calculates the appropriate resistor and applies it on demand. Sensor failures during test could easily be checked with this function. Simply compare the Shunt Cal result before and after the test run.

To apply a sensor to a channel, proceed with the following steps:

- Enter the channel settings by clicking on the little gear of the individual channel in the channel list (pushbutton ⑪ in Fig. 7.2 or Table 7.1, for details see *Changing the channel settings in the channel setup*).
- Click on the *Choose sensor* button in the upper right corner, seen in Fig. 6.14.

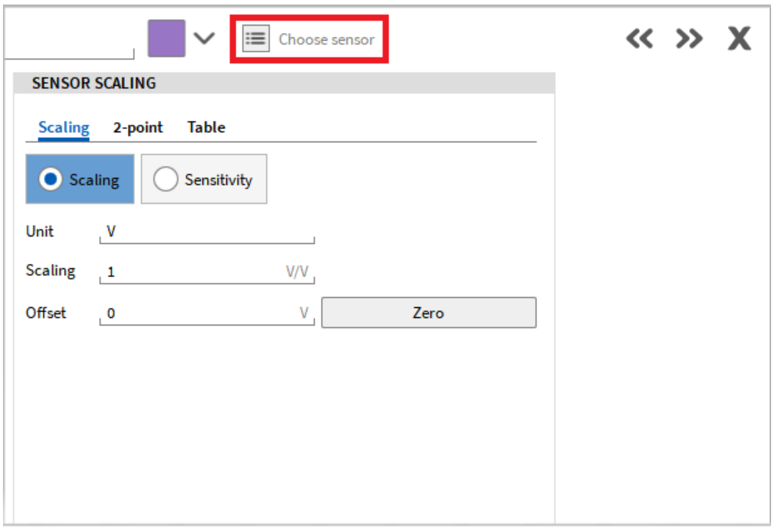


Fig. 6.14: Applying a sensor to a channel in the channel settings

- A pop-up window will appear with a list of all defined sensors seen in Fig. 6.15.
- Choose the desired sensor and click *OK*. The search field might ease the search for a specific sensor in the list.

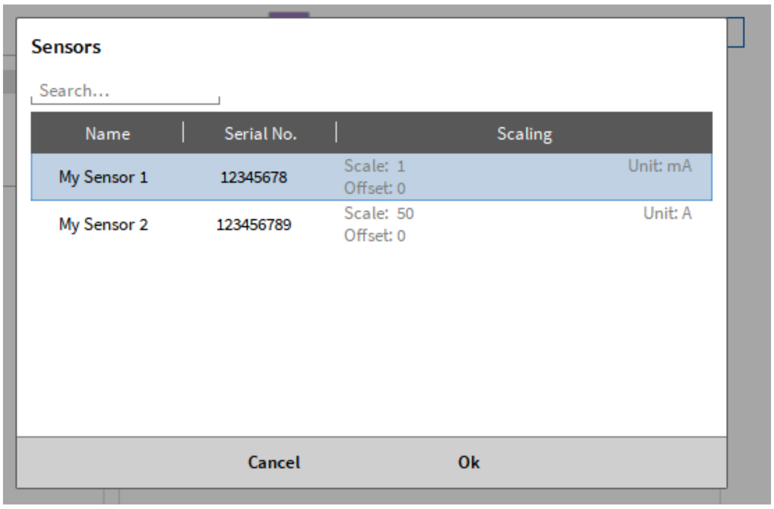


Fig. 6.15: Pop-up window to apply a sensor for a channel in the channel settings

- The parameters of the sensor will be applied on the channel. This can be recognized by the name of the sensor, which will be displayed in the channel settings and in the channel, list seen in Fig. 6.16.
- To remove an applied sensor from a channel simply click on the *X* button next to the sensor name in the channel settings (see Fig. 6.16).

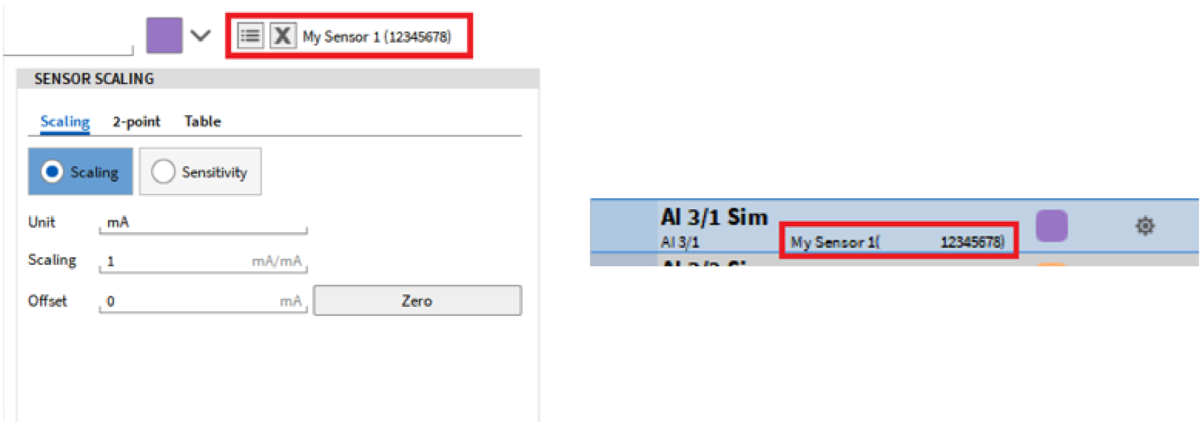


Fig. 6.16: Name of chosen sensor for the channel seen in the channel list and channel settings

Note:

- Only analog sensors, including XR modules, are supported in the database (no encoder).
- Whenever the database is changed, the sensors on the assigned channels do not update automatically and must be assigned again.
- An .xml file will be created with the sensor information, which can also be edited externally in a third-party software.

  The name of the xml-file is *sensor_db.xml* and can be found in the following directory: %PUBLIC%\Documents\Dewetron\OXYGEN.

It is also possible to transfer set sensors directly from the channel list to the sensor database or to overwrite existing sensors from the database (see Fig. 6.17).

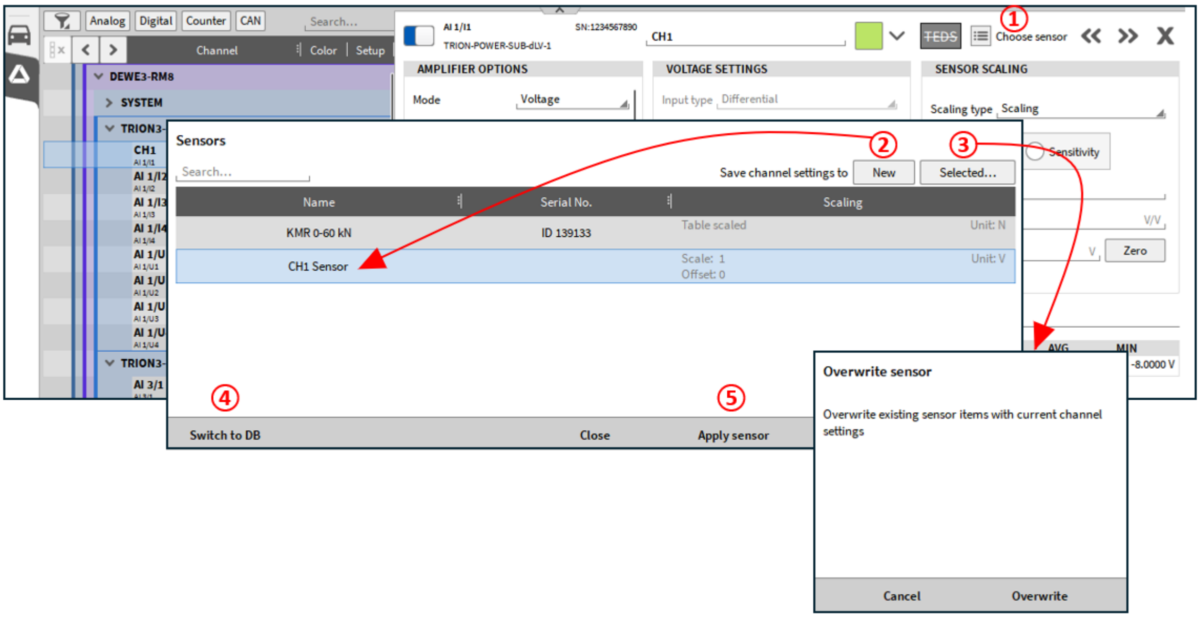


Fig. 6.17: Sensor database via channel list

Table 6.1: Sensor database via channel list

No.	Function	Description
1	Choose sensor	Clicking on the button opens the sensor database. It is possible to select a sensor from the database in order to transfer the settings to the selected channel, or to create a new sensor in the database with the current settings of the selected channel or to overwrite an existing one.
2	New	When you click on the “New” button, a new sensor is created in the sensor database according to the settings of the selected channel. An automatic name is assigned that corresponds to the channel name, this name can be changed later in the sensor database.
3	Selected	Overwrites the selected sensor in the list of the sensor database with the settings of the currently selected channel in the channel list. After clicking on the corresponding button, a window appears indicating that the existing data for the selected sensor will be overwritten after clicking on “Overwrite”.
4	Switch to DB	Switch to the sensor database (see Fig. 6.17).
5	Apply sensor	After clicking on the “Apply Sensor” button, the settings of the selected sensor are applied from the sensor database to the selected channel in the channel list.

6.3 Remote control

If remote control is enabled, the *Lock Screen* button will change to a *Remote Control* indicator and marks if OXYGEN is controlled by remote (see Fig. 6.18).

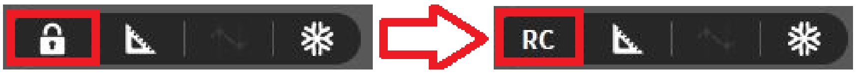


Fig. 6.18: *Remote Control* indicator

6.3.1 SCPI over Ethernet

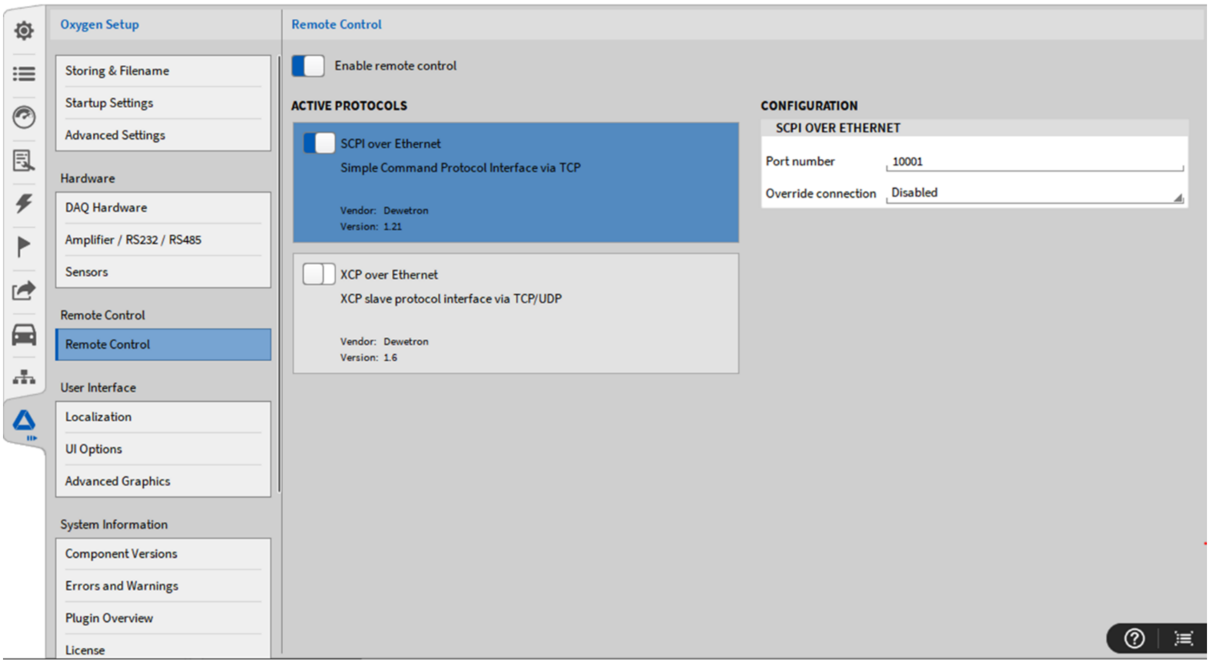


Fig. 6.19: Remote Control – SCPI over Ethernet menu

OXYGEN can be controlled by remote via SCPI. To do so, the *Enable remote control* button (see Fig. 6.19) must be switched on and *SCPI over Ethernet* must be enabled. The “override connection” setting “disabled” ensures that no other device can connect once a connection has been established.

For detailed instructions and programming examples, refer to the manual *OXYGEN Remote Control-SCPI Version Vx.x* which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

For additional information about typical performance and other basic points, refer to Table 6.2.

6.3.2 XCP over Ethernet

Note: This is an optional feature and requires a license.

OXYGEN can be controlled via XCP over Ethernet. To do so, the *Enable remote control* button must be switched on and *XCP over Ethernet* must be enabled (see Fig. 6.20).

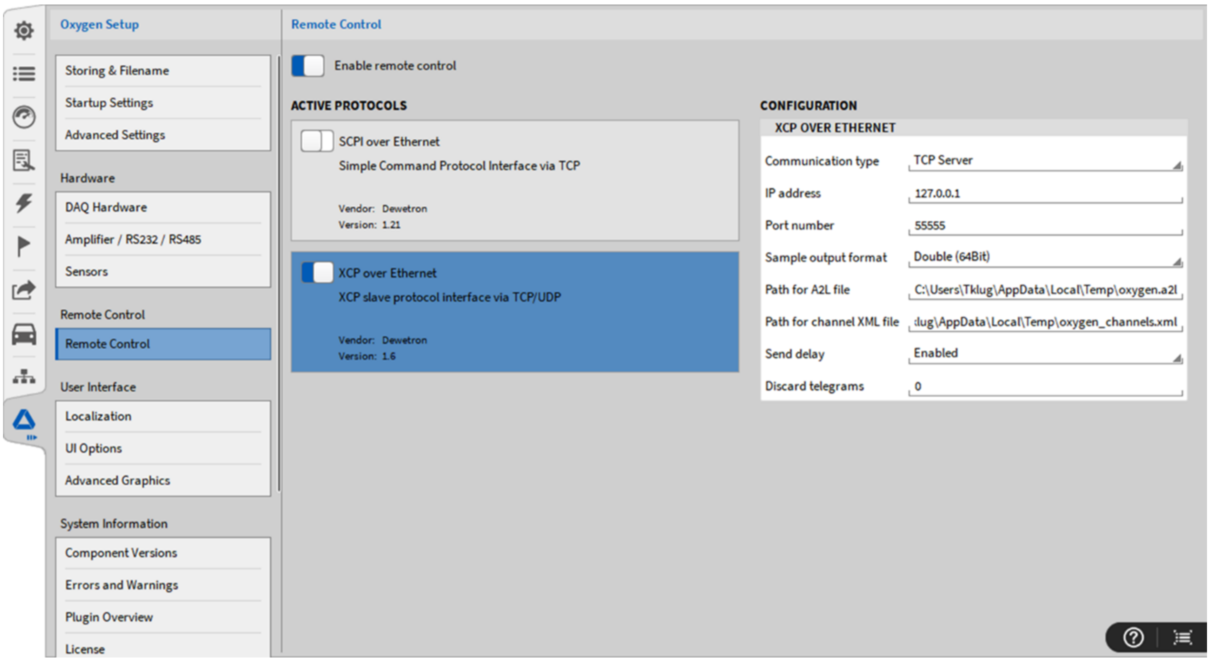


Fig. 6.20: Remote Control – XCP over Ethernet menu

Within OXYGEN, the following XCP settings can be edited:

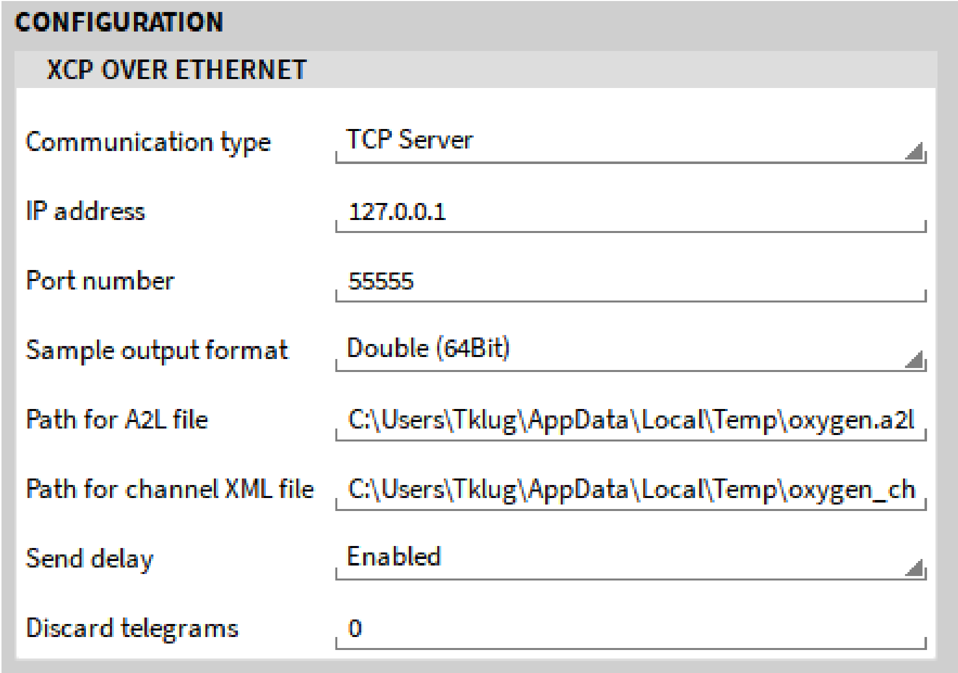


Fig. 6.21: Configuration for XCP over Ethernet

- Communication Type: *TCP server* or *UDP server*
- IP address of the OXYGEN device
- Port Number
- Output format: Double (64bit) or Float (32bit)
- A2L File Path: The path the a2l-file is stored to. An a2l-file is automatically generated when XCP remote control is enabled and when OXYGEN is started
- XML File Path: The path the xml-file is stored to. A xml-file is automatically generated when XCP remote control is enabled and when OXYGEN is started
- Send delay: Can be set to enabled/disabled and refers to the number of telegrams discarded at the start.
- Discard telegrams: Can be set between 0 and 20 and defines the number of telegrams discarded at the start.

Note: Be aware that the directory *C:/Temp* the a2l-file and the xml-file is stored to is not created automatically. Create the directory *C:/Temp* manually or change the path to an existing directory.

A user instruction to setup a remote control via CANape can be found in the document *DEWETRON_OXYGEN_XCP_User_Instructions_Vx.x* which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

For additional information about typical performance and other basic points, refer to Table 6.2.

6.3.3 Usage SCPI and XCP simultaneously

It is possible to use the SCPI and the XCP plugin both simultaneously. Just enable both plugins and follow the instructions for SCPI from *SCPI over Ethernet* and the instructions for XCP in *XCP over Ethernet*.

As stated above, detailed and latest user manuals for both plugins are available on the DEWETRON CCC portal:

For detailed SPCI instructions and programming examples, refer to the manual *OXYGEN Remote Control-SCPI Version Vx.x* which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

A user instruction to setup a remote control via CANape can be found in the document *DEWETRON_OXYGEN_XCP_User_Instructions_Vx.x* which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

6.4 Streaming interfaces

6.4.1 EtherCAT slave

Note: This is an optional feature and requires a license.

Using the EtherCAT slave subsystem, an OXYGEN system is able to provide timestamped periodic measurement values to an EtherCAT master. The most important control features as well as some status information are provided as well.

OXYGEN EtherCAT functionality currently only supports TRION-ETHERCAT boards.

For detailed instructions, refer to the manual *OXYGEN EtherCAT Slave Vx.x.* which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

For additional information about typical performance and other basic points, refer to Table 6.2.

6.4.2 Data stream plugin

Note: This is an optional feature and requires a license.

The OXYGEN Data Stream plugin provides the following features:

- High Speed data access
- Efficient raw data transfer
- Multi data stream support
- Multi network port support
- Configurable via SCPI

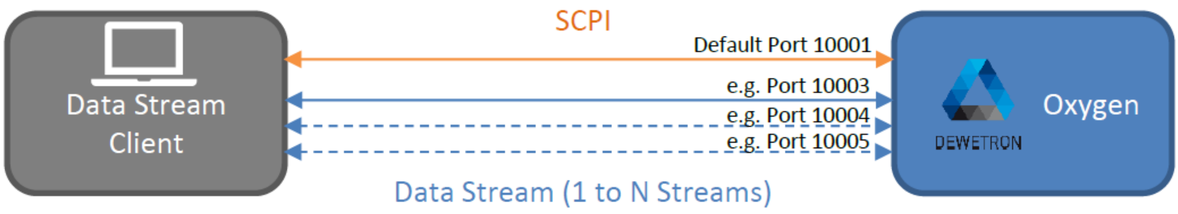


Fig. 6.22: Data stream plugin – overview

For detailed instructions and programming examples, refer to the manual *OXYGEN CSV Plugin Vx.x* which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

For additional information about typical performance and other basic points, refer to Table 6.2.

6.4.3 Ethernet sender plugin

Note: This feature is included in the installer by default.

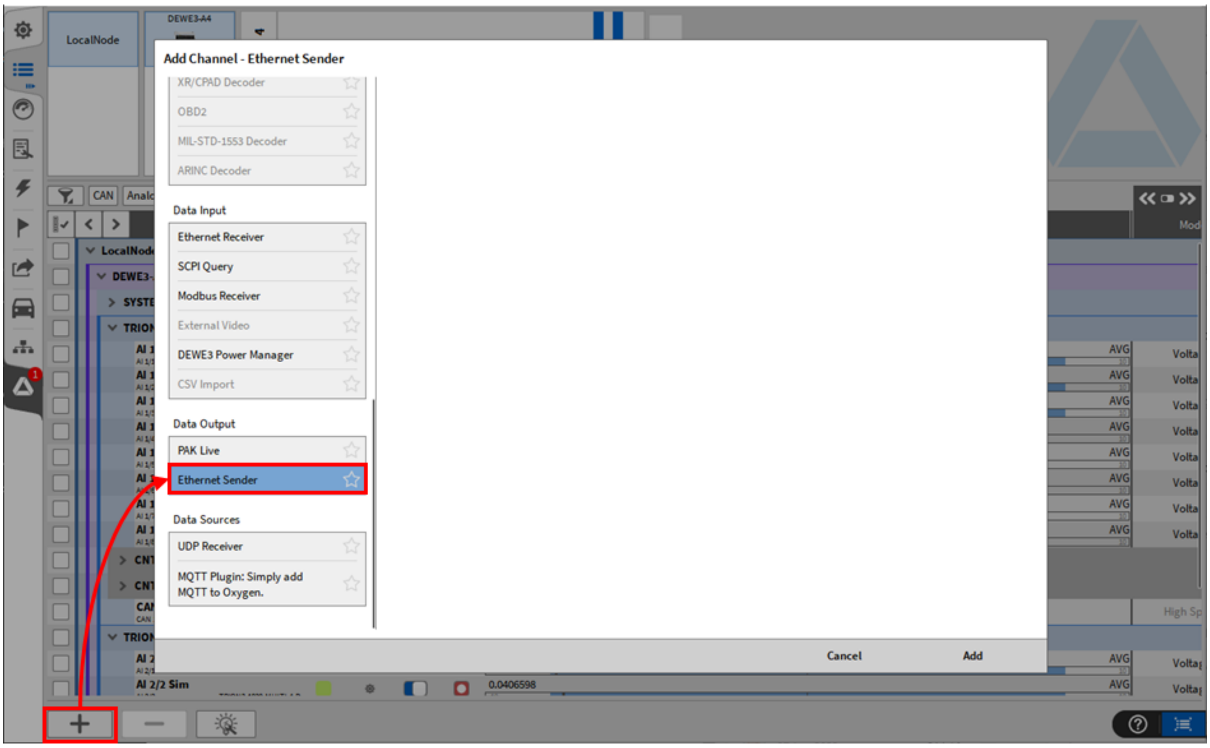


Fig. 6.23: Pop-up window to create an Ethernet sender

An Ethernet sender can be created and configured by pressing the *Add* button in the lower left corner of the Data Channels menu (marked red in Fig. 6.23).

For details about the Ethernet Sender plugin refer to the *DEWETRON_OXYGEN_Ethernet_Sender_Vx.x* Manual which is available on the DEWETRON CCC portal (https://ccc.dewetron.com/).

6.5 Remote control and streaming interfaces

The following Table 6.2 provides an overview and comparison about the licensing, typical performance and other additional information of the different remote control and streaming interfaces.

Table 6.2: Remote control and streaming interfaces - overview

Interface option	Included in OXYGEN	Interface	Typ. application	Typ. performance
SCPI	Yes	Standard Ethernet	Fetching of actual values loading setup, application control, application	~50 S/s with 50 channels; up to 10 kS/s with 10 channels (buffered reading "ELOG")
XCP Slave	License required	Standard Ethernet	Stream of measurement values, basic recording control; only compatible with CANape yet; INCA compatibility is in progress	~10 kS/s with 8 channels
EtherCAT	License required	TRION EtherCAT	EtherCAT testbed environment; Provide measurement values on the EtherCAT bus with PDO mechanism	~400 S/s with 100 channels
Data Stream	License required	Standard Ethernet	Live processing of raw and full speed data in 3rd party application; uses native TCP/IP sockets for data transfer; multiple streams can be created	~100 kS/s with 350 channels or ~2 MS/s with 12 channels
Ethernet Sender	Plugin required	Standard Ethernet	Send actual and synchronized data with timestamps	1-100 Hz
Typical I/O delay is 100-200 ms within all interface options				

6.6 User interface

6.6.1 Localization

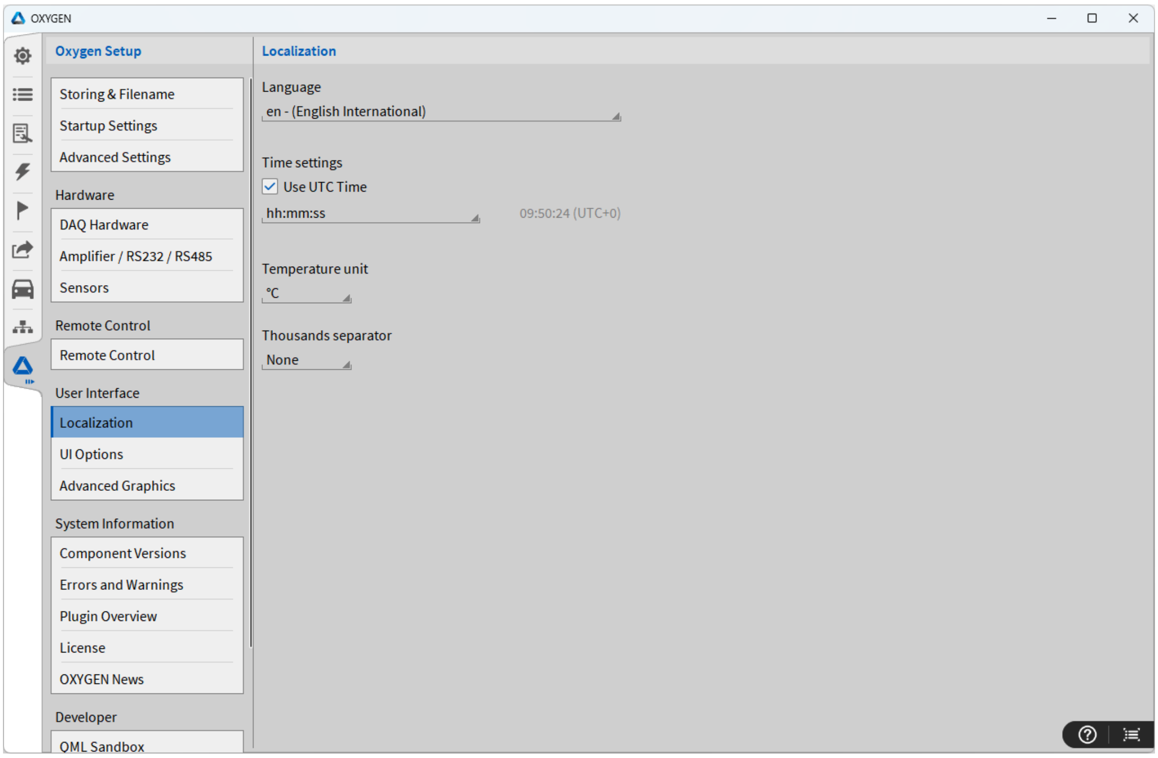


Fig. 6.24: Localization – settings

The Localization menu allows users to adjust the following settings:

- Language: Change the software language.
- Time settings: Set the time to UTC and choose the desired time format.
- Temperature unit: Select between Celsius and Fahrenheit.
- Thousands separator: Define a separator to improve the readability of large numbers. This setting applies to the Analog Meter, Digital Meter, and Table instruments.

6.6.2 UI options

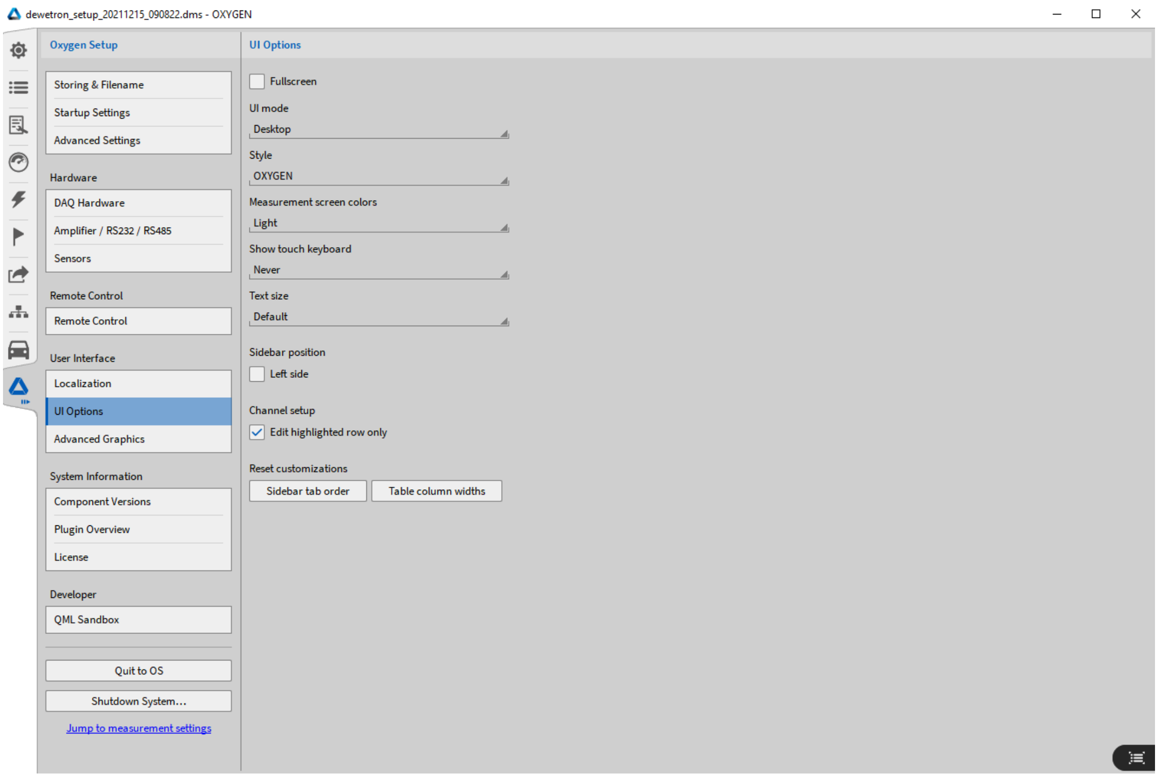


Fig. 6.25: UI Options – settings

In the UI Options, the user can change different settings of the UI appearance:

- *UI mode* will change the size of the icons and adjust it for different PC types
- *Style* will change the menu style
- *Color Scheme* will change the color scheme of the software. A light and a dark mode are available.
- *Show touch keyboa*rd regulates the appearance of a touch keyboard
- *Text size* changes the text size in OXYGEN
- *Sidebar position:* If *Left side* is selected, the sidebars will swap and the *Reset* button will set the menu order to the default order if changes have been made. For customizing the menu order, refer to *Custom ordering of menu locations*.
- *Channel setup: Edit highlighted row only:* When this option is selected and the user selects a channel in the Channel Setup, the selected channel will only be highlighted when the user clicks on the channel name and a second click for changing the channel name is necessary. When this option is NOT selected, the user will be able to change the channel name by a single click on the channel name.

6.6.3 Advanced graphics

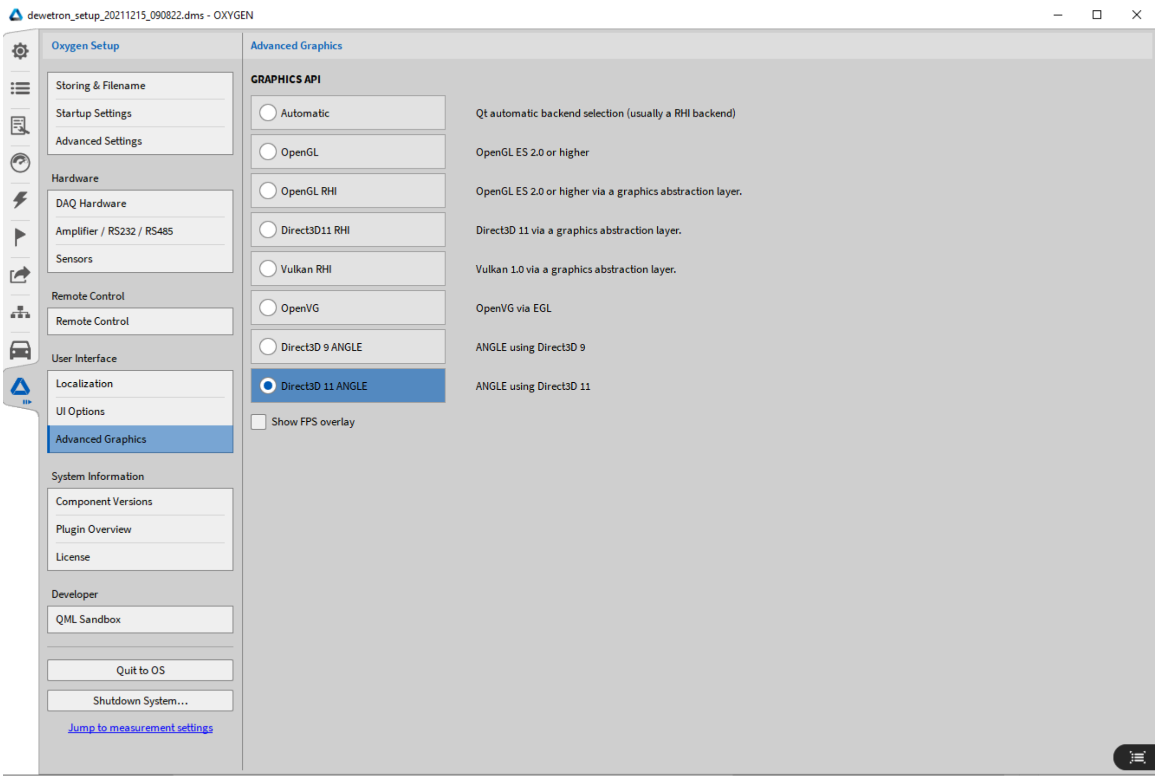


Fig. 6.26: Advanced graphics – settings

In this section the user can change the graphic framework, if there any problems with the graphic occurred. Contact us for more information or any help.

6.7 System information

6.7.1 Component version

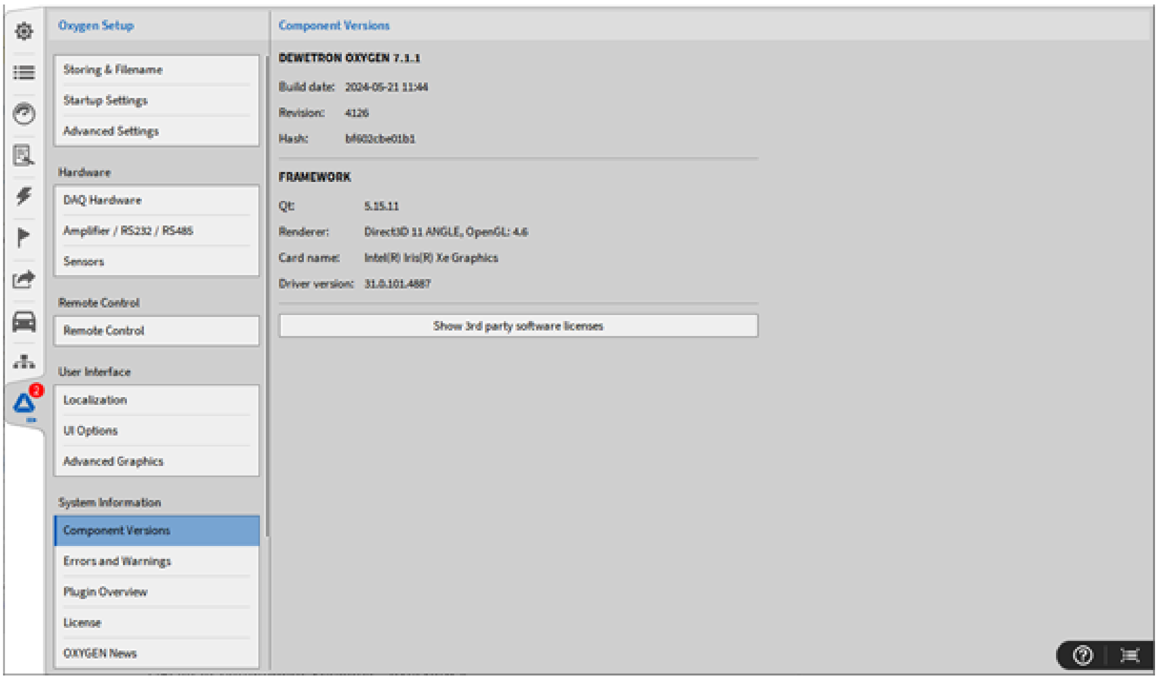


Fig. 6.27: Component Versions – overview

In this section the versions of all components and 3rd party licenses are displayed.

6.7.2 Errors and warnings

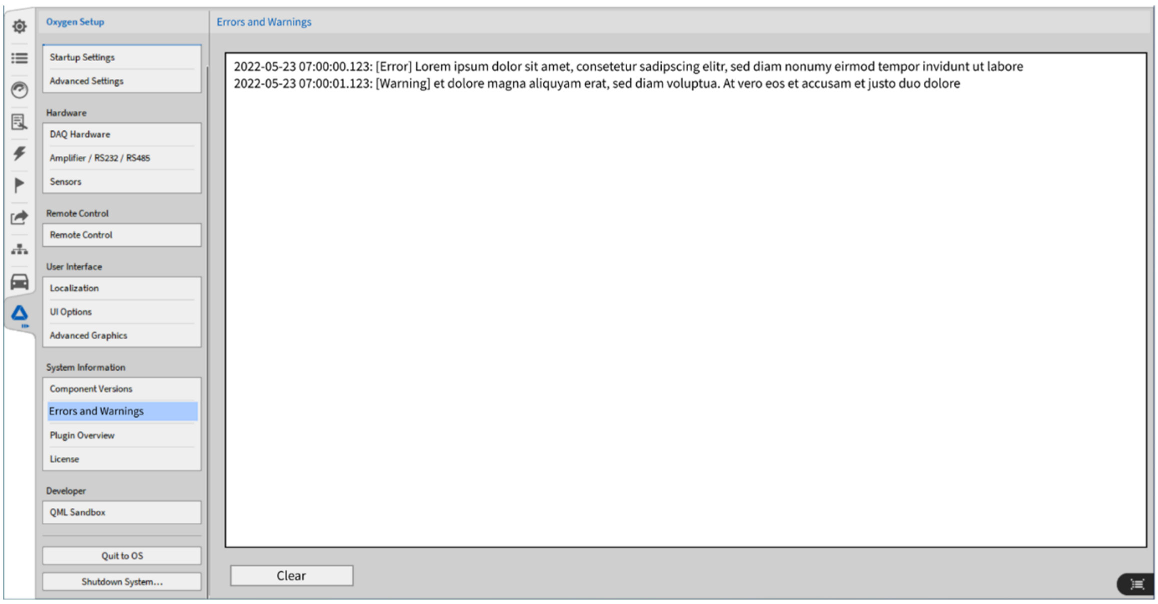


Fig. 6.28: Errors and warnings

This menu displays all raised errors and warnings as a list with time stamps.

6.7.3 Plugin overview

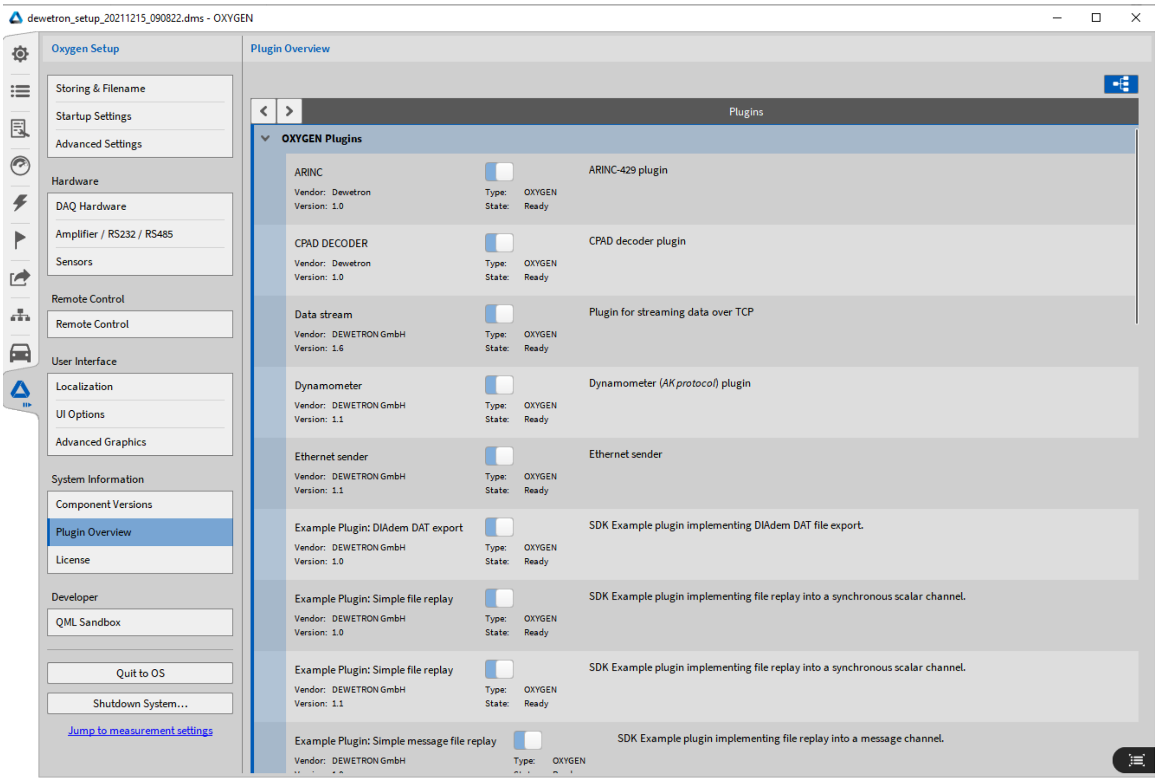


Fig. 6.29: Plugin overview

This menu displays an overview of all active plugins. These cannot be deactived.

6.7.4 License

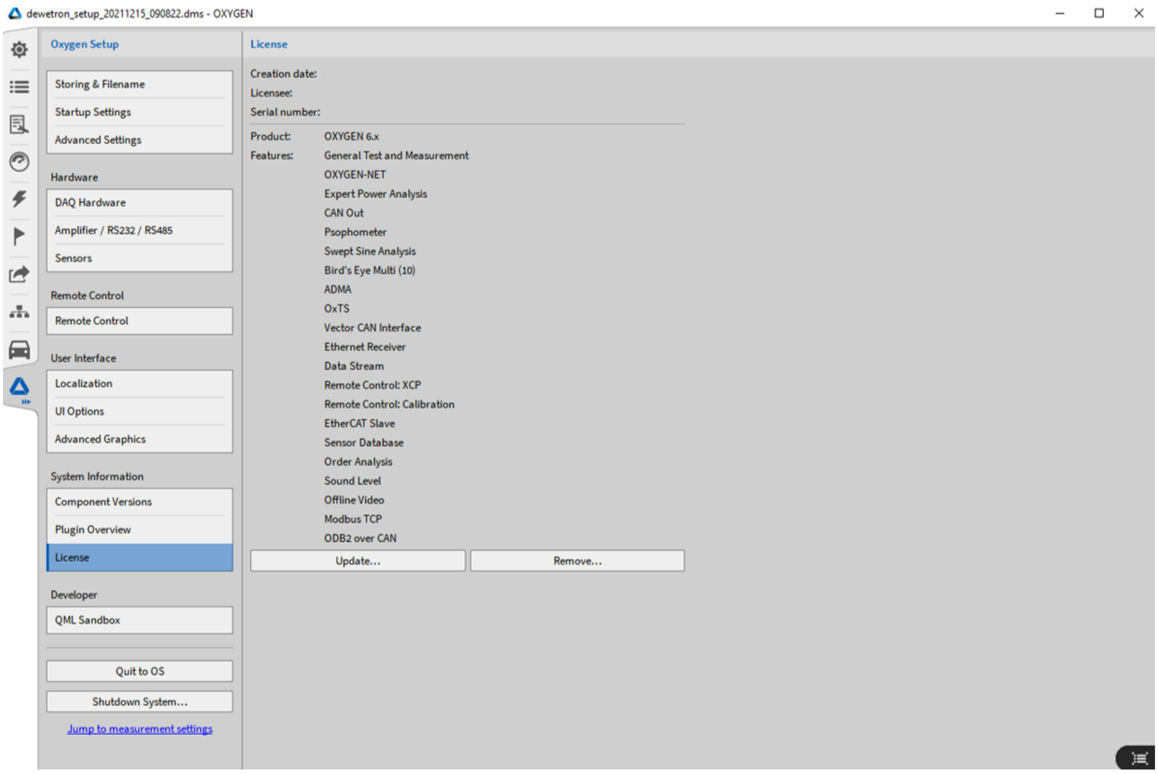


Fig. 6.30: License overview

Here you can find some information about the license and the active features. Additionally, the license can be updated by clicking on the *Update…* button and selecting the new license file. OXYGEN must be restarted. To remove the current license, click on *Remove…*, OXYGEN will switch into the Evaluation mode.

Note: A license file for OXYGEN 5.x is not valid for OXYGEN 6.x

6.7.5 OXYGEN News

In the OXYGEN News tab you can view information on known problems and activate automatic updates for these as well as a list of available features.

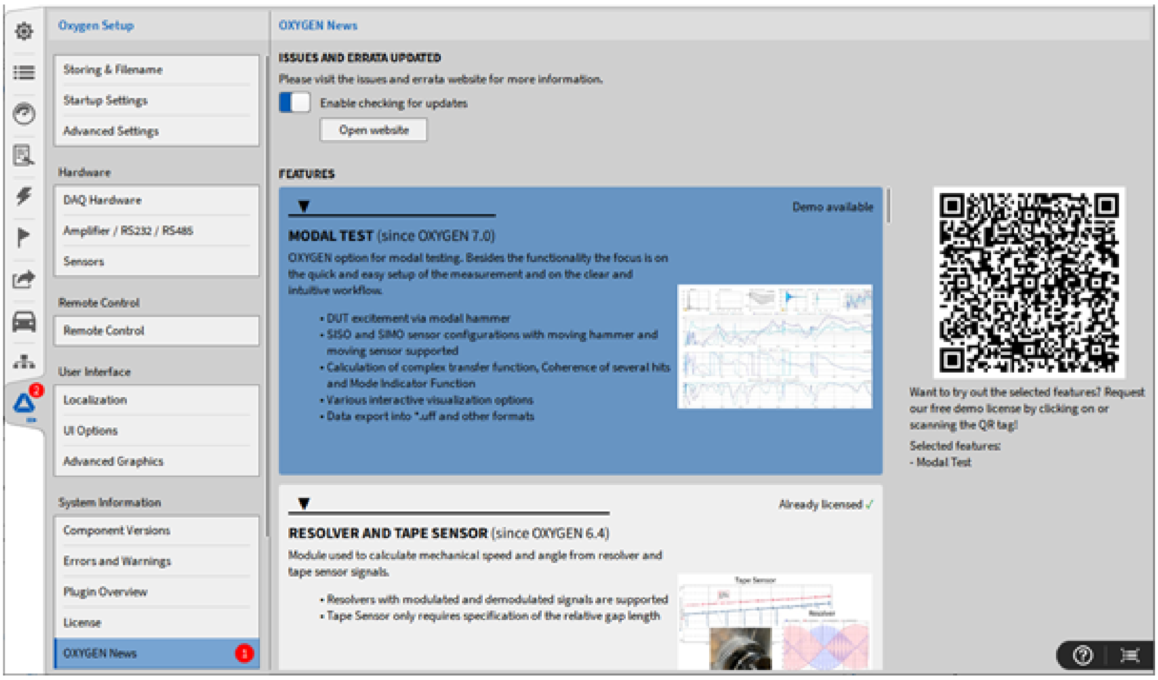


Fig. 6.31: License overview

6.8 Shutdown

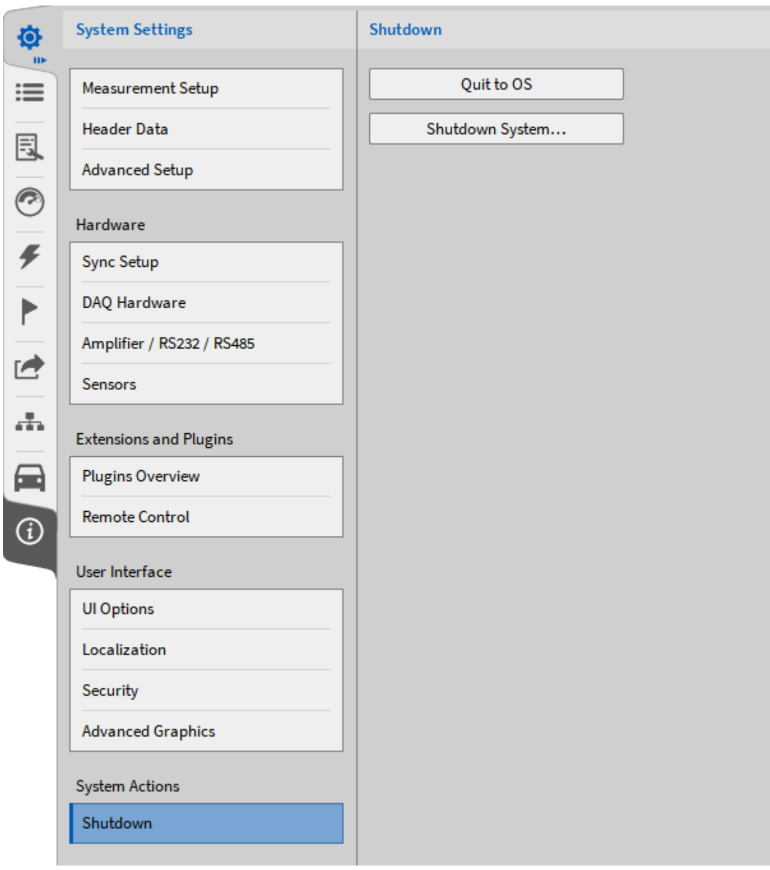


Fig. 6.32: System settings *Shutdown* – overview

In the *Shutdown* menu, the user can terminate OXYGEN and return to the operating system or shut down the whole system.

CHAPTER

SEVEN

DATA CHANNELS MENU

7.1 Overview

In the *Data Channels* menu, the user can manage its input channels and manipulate the hardware settings of the hardware modules.

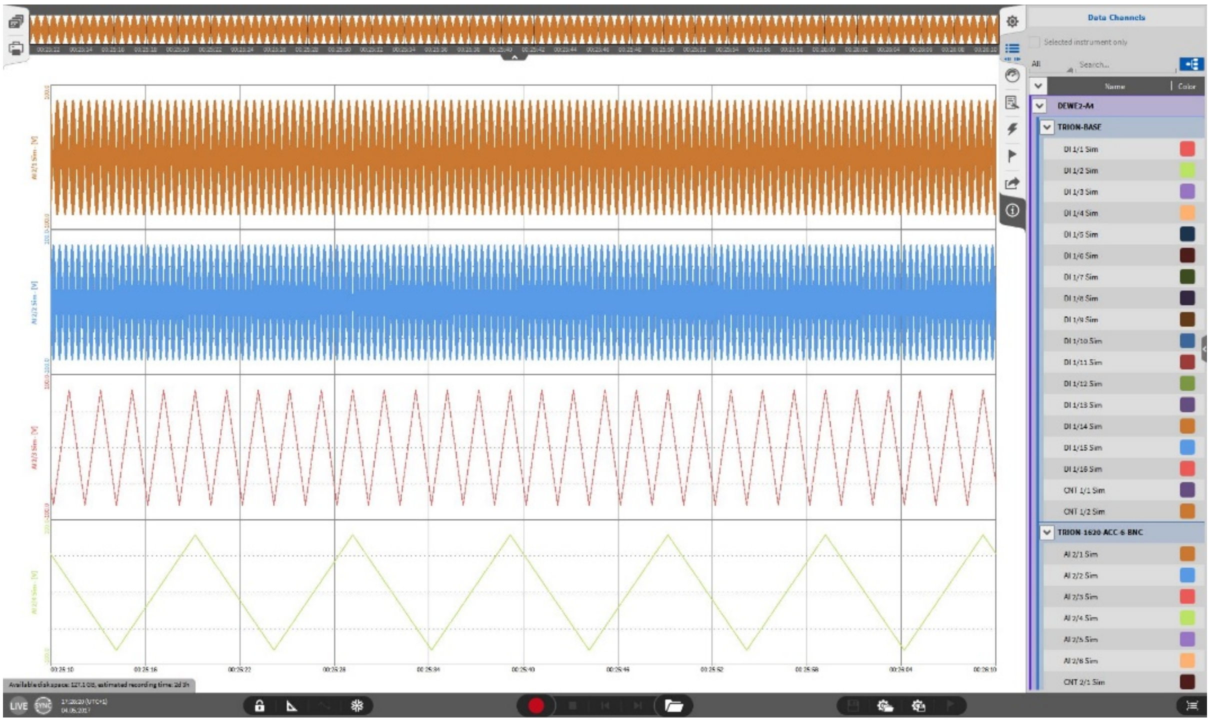


Fig. 7.1: *Data Channels* menu - quick view

A single click on the *Data Channels* menu button will open the quick view where the user can see the activated hardware channels (see Fig. 7.1). Expanding the menu to the full screen by keeping the button pressed and moving the mouse to the opposite side of the screen will open the full data channel menu that can be seen in Fig. 7.2. The full channel list and the connected hardware with the individual settings can be checked and manipulated here. The functionality of the individual buttons will be explained in the following section.

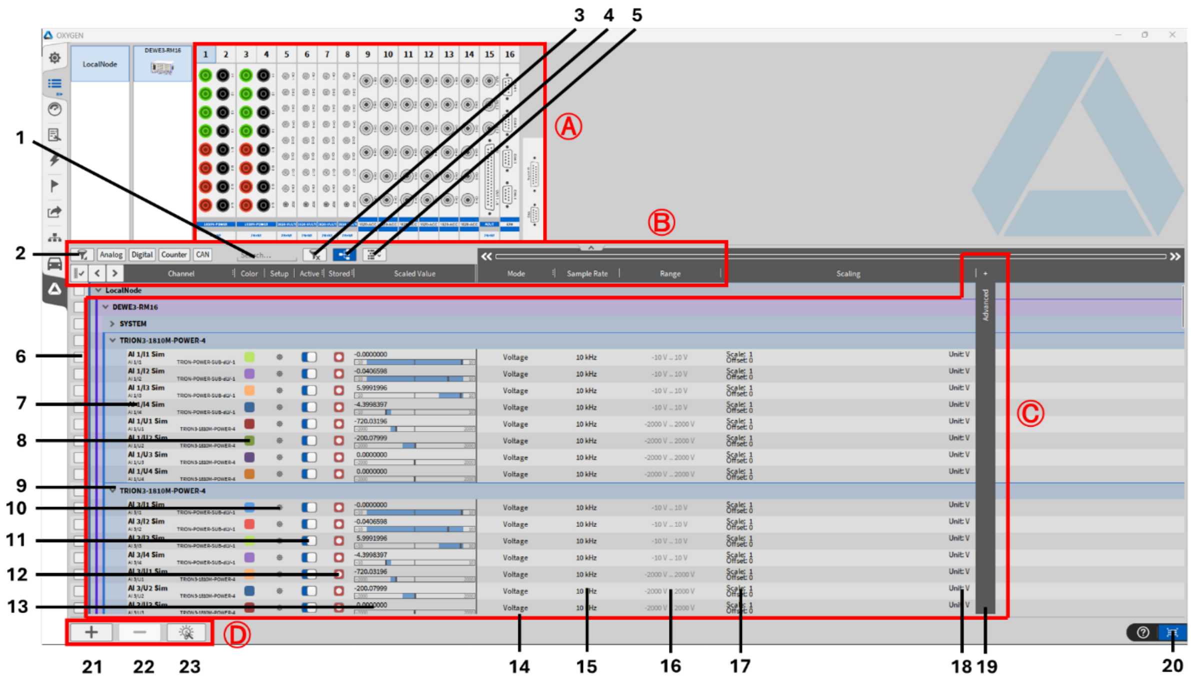


Fig. 7.2: Complete *Data Channels* menu

Table 7.1: Push buttons in the Channel Menu – Overview

No.	Name	Description
A - Hardware overview		
Quick overview of your connected TRION boards and available channels. Click on a certain channel or whole TRION board and the respective channel(s) will be highlighted in the list.		
B - Filter and grouping		
1	Search Filter	Search a channel according to its name
2	Channel Filter	Filters the displayed channels according to their channel type (*All, Analog, Digital, Counter, EPAD, Math, Video, Power, CAN*). These channel types can also be set as favorite.
3	Clear Filters	Clear active Channel and Search Filters
4	Channel Grouping	Sort the Channel list according to the connected TRION board or in an alphabetical order
C - Channel options		
5	Change channel sorting (non-analog channels)	When selected, non analog channels like math or statistic channels can be rearranged (see Fig. 7.3).

continues on next page

Table 7.1 – continued from previous page

No.	Name	Description
6	*Select* button	Select several channels in the list, i.e. for setting them active or inactive simultaneously.
7	Channel Name	Individual channel name; Can be changed individually; for additional information refer to *User interface*. Deleting the channel name and pressing *ENTER* restores the default channel name. In case a name is given twice, a warning is displayed.
8	Color	Color scheme of the channel can be changed here
9	*Hide* button	Hide the channels of a complete card
10	Setup	Enter the input channel setup (All channel dependent settings can be changed here).
11	*Active* button	Set a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel and can be recorded, an inactive channel not
12	*Stored* button	Select whether channel data shall be stored or not when a measurement is running
13	Scaled Value	Preview of the input signal
14	Mode	Change the mode of the input channel here
15	Sample Rate	Change the sample rate here; Remark: to change the sample rate for individual channels refer to *Channel-wise Sample Rate Selector*.
16	Range	Change the input range of the channel here
17	Scaling	Change the channel scaling here
18	Physical unit	Physical unit of the channel, can be changed in the channel setup
19	Advanced Options	Expand the channel dependent advanced Options: *Excitation, LP Filter, Coupling, Input Type, Sample Format, Sensor Offset, Baud rate, Counter_Filter, Inverted_A, ListenOnly, Source_A, Termination, Threshold*
20	*Toggle* button	Quick access to Data channels menu; toggles between the Channel List and the previously opened menu
D - Math options		
21	*Add* button	Add a Formula, Statistics, Filter, FFT, Rosette, Power Group, Ethernet Receiver or Ethernet Sender

continues on next page

Table 7.1 – continued from previous page

No.	Name	Description
22	*Delete* button	Delete the Formula, Statistics, Filter, FFT, Rosette, Power Group, Ethernet Receiver or Ethernet Sender that is currently selected
23	Create Power Group	Create Power Group with selected channels or empty Power Group

The following screenshot belongs to No. 5 in Table 7.1.

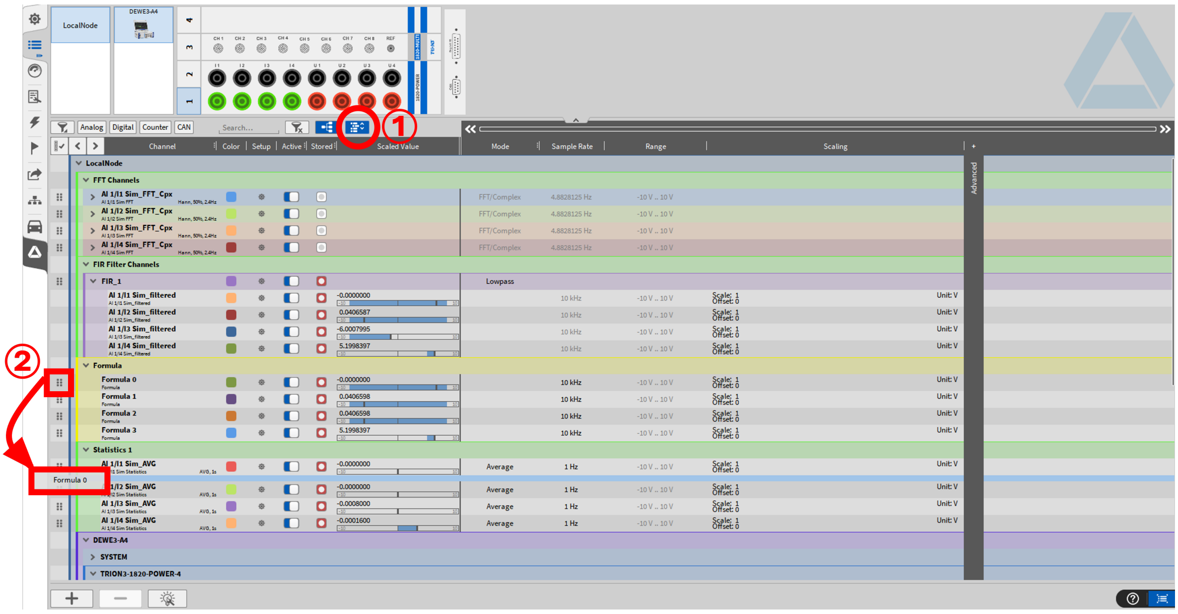


Fig. 7.3: Channel sorting

If a measuring card is completely folded in, as shown in Fig. 7.4, the slot number in which the respective measuring card is located is displayed.

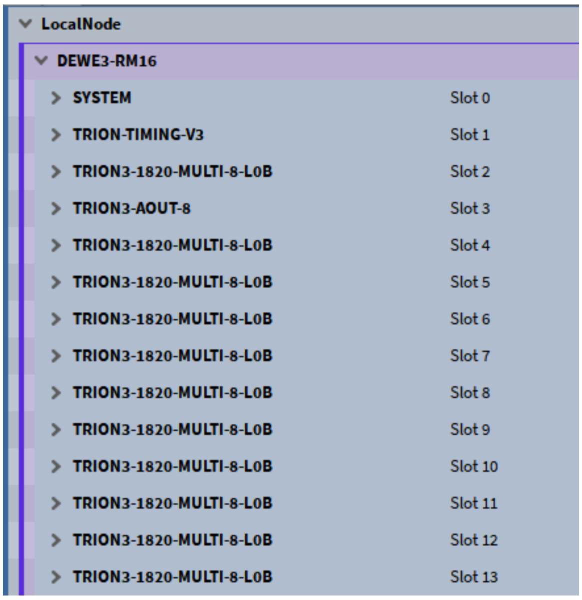


Fig. 7.4: Slot numbering with folded modules

7.2 Filter- and grouping options

7.2.1 Selecting multiple channels

Inside the *Data Channels* menu, the user can select multiple Input channels through various methods. With multiple channels selected, the user can address changes in Channel Settings to multiple channels at one time.

To select multiple channels:

- Select a channel using the system graphic in the upper left-hand corner of the *Data Channels* menu
- Select a check box on the left edge of the individual *Data Channels* menu adjacent to each individual channel
- The user can also just simply click onto the channel row itself and select several channels by keeping the **CTRL** key pressed

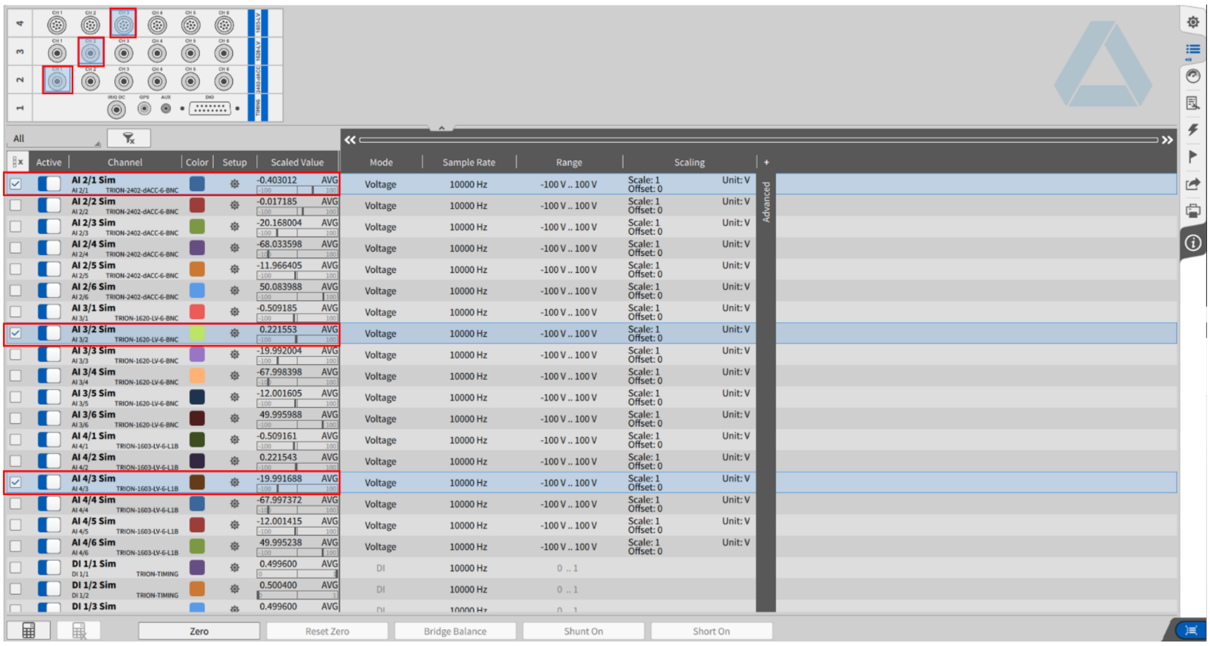


Fig. 7.5: Selection of several channels

7.2.2 Channel List filtering options

As explained in Table 7.1, the user can filter the channels according to their channel type or their channel name, e.g. to only show relevant channels. There are additional filtering options available which are explained in the following sections.

To get to the different filter options in the channel list, fully open the *Data Channel* menu.

Filtering by the Channel Type

To filter the channels by their type different buttons are shown on the upper border of the channel list, shown in Fig. 7.6. These buttons vary depending on the available channels, meaning only those buttons are shown, for which the according channels are really available in the channel list.

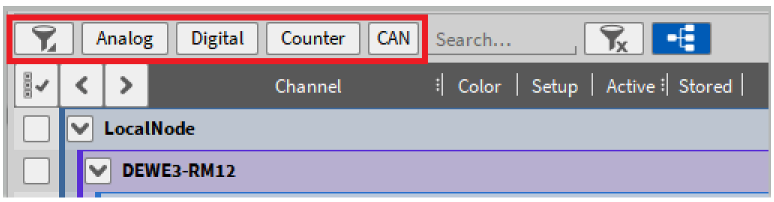


Fig. 7.6: Filtering by the *channel type*

After choosing a type the button turns blue and only the according channels are shown.

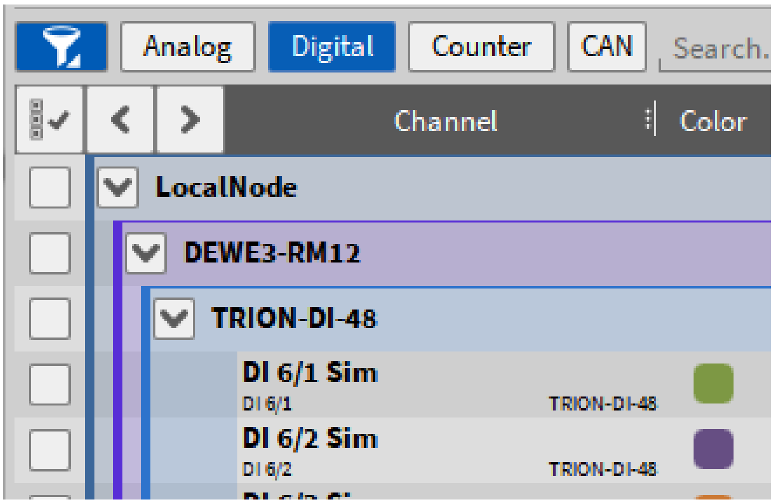


Fig. 7.7: Filtering by the *channel type*: Digital

Note: Only one channel type can be selected, therefore, it is not possible to select more buttons at the same time.

Filtering Channels by *Name/Active/Mode*

Another option is to filter the channels by their names or mode or just to show active channels. Those filter options are shown by 3 dots in the column header (see Fig. 7.8).

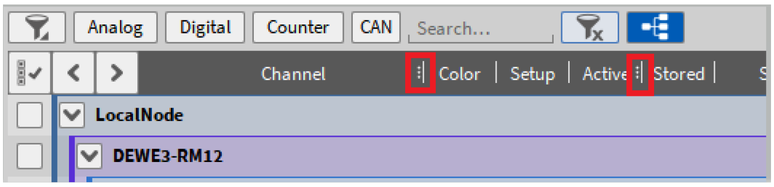


Fig. 7.8: Filter option available in Data Channel Menu

- Fully open the *Data Channels* menu
- Left click onto the column header opens a filter menu for: *channel, active, mode*
- A sorting menu will appear for each filter menu, which allows the user to sort from A to Z, Z to A, by name/prefix such as AI or DI, or by true or false. Sorting by *true* or *false* will sort your channels by whether your channels or active (true) or inactive (false). The user can simply type a channel name within the menus text field. This may seem like a difficult task, but the software will automatically update the channel list as you type. Selecting a specific Mode name such as *Temperature* will only present the user with those specified channels.
- Delete an active filter with the *Clear filter* button again (see 3 in Table 7.1)

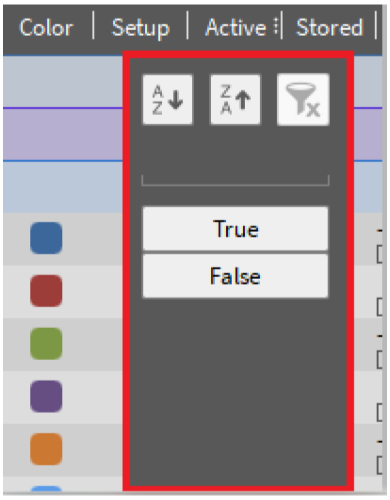


Fig. 7.9: Filtering by the *Active* Column

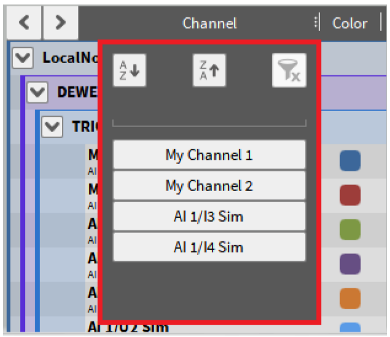


Fig. 7.10: Filtering by the *Channel* Column

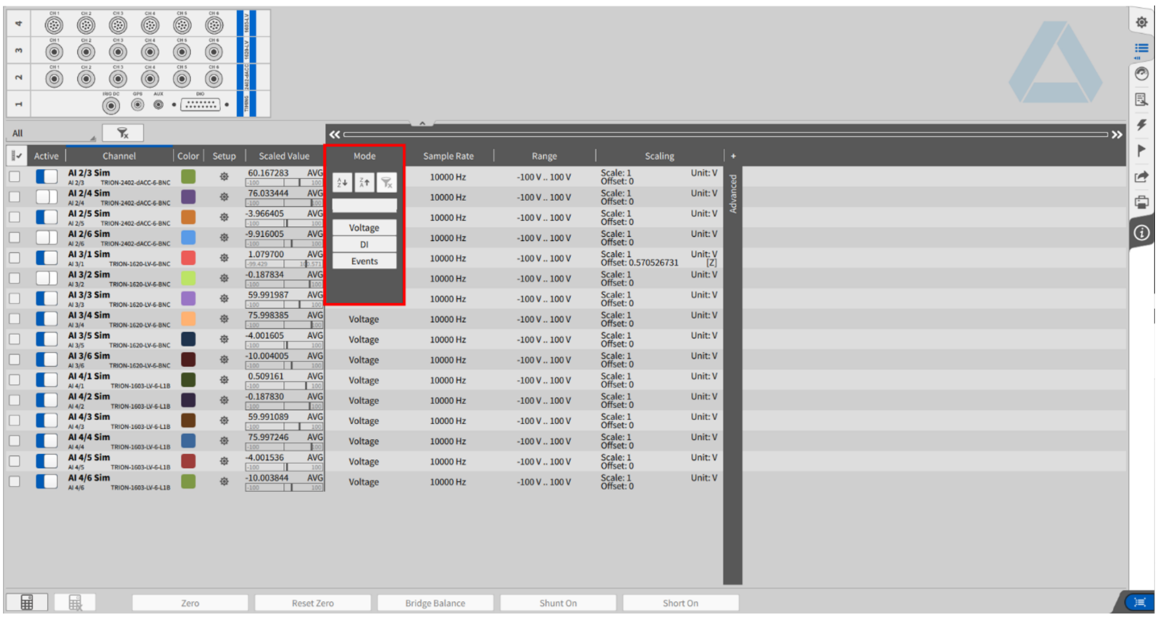


Fig. 7.11: Filtering by the *Mode* Column

7.3 Changing the channel settings

It is either possible to change the channel settings in the *Data Channels* menu or in the individual channel setup that can be accessed via push button ⑨ (see Table 7.1). Additionally, settings can be copied (CTRL+C) and pasted (CTRL+V) between channels of the same type (e.g., from one CNT channel to another, or from one Analog In channel to another, etc.).

For documentation purposes, you can copy the entire channel configuration into third-party software such as Notepad, Excel, or similar tools. To do this, simply select the desired channels, press CTRL+C, and paste the configuration into the target application.

7.3.1 Changing the channel settings in the Data Channel menu

To change the individual channel settings in the *Data Channels* menu just click on the desired parameter with the left mouse button and a pop-up window will appear. If a parameter can be changed or not depends on the channel type (i.e. it is not possible to change the range of a digital channel) and the selection of the parameters depends on the TRION board (i.e. different Input Modes). For illustration, the following figures will show the different options that are available with a TRION-1620-ACC board.

Changing the channel color

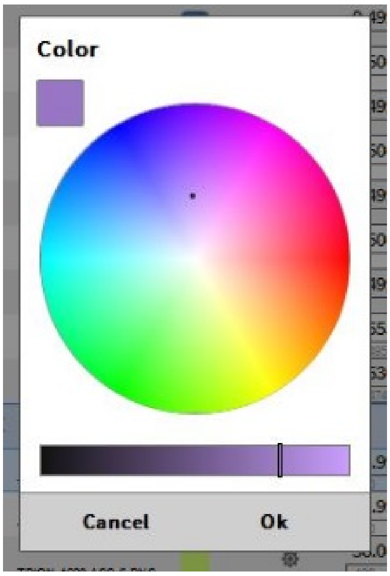


Fig. 7.12: Pop-up window for changing the channel color

Changing the input mode

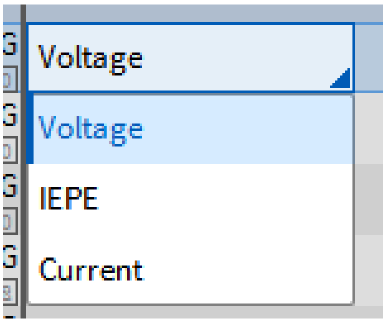


Fig. 7.13: Pop-up window for changing the input mode

Changing the sample rate

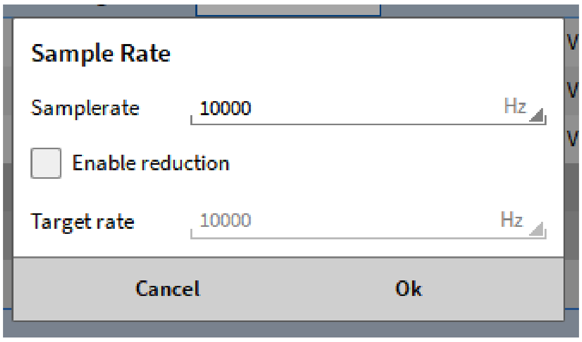


Fig. 7.14: Pop-up window for changing the sample rate

It is possible to change the sample rate for the whole board but also to change the sample rate channel-wise. For a detailed explanation see *Sensor scaling – bridge*.

Changing the input range

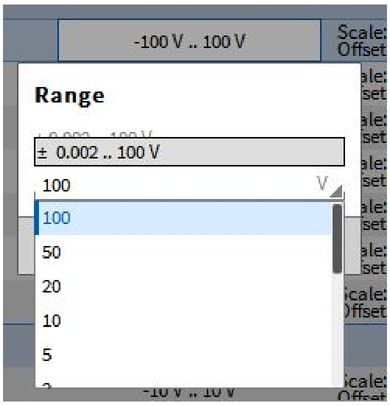


Fig. 7.15: Pop-up window for changing the input range

Changing the channel scaling and physical unit

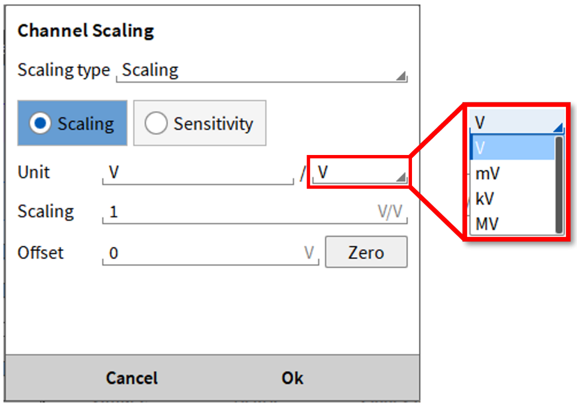


Fig. 7.16: Pop-up window for changing the scaling and physical unit

Zeroing an input channel

After selecting the desired channel in the list the *Zero* push button will appear at the lower end of the *Data Channels* menu:

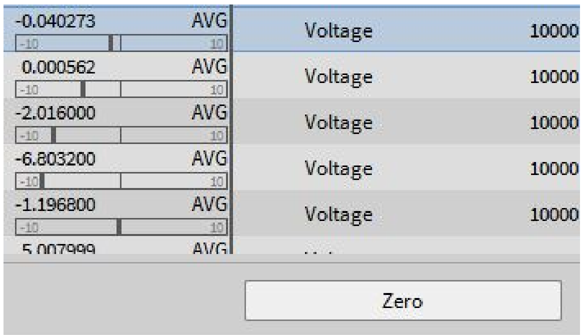


Fig. 7.17: Zeroing an input channel

Changing the sensitivity

Also available in the Channel Scaling pop-up window:

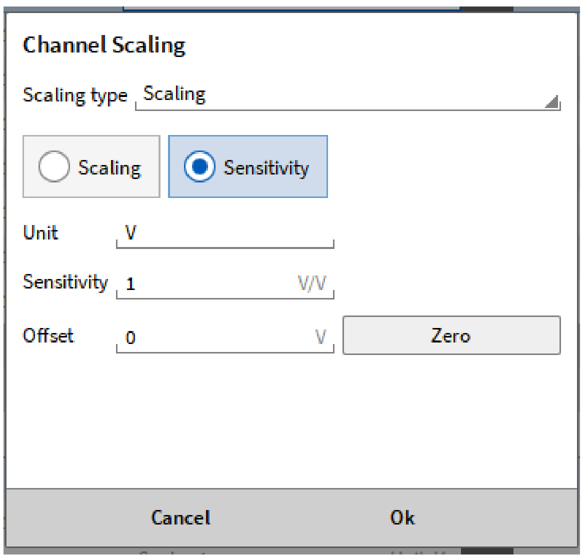


Fig. 7.18: Pop-up window for changing the sensitivity

Changing the 2-point-scaling

Also available in the Channel Scaling pop-up window:

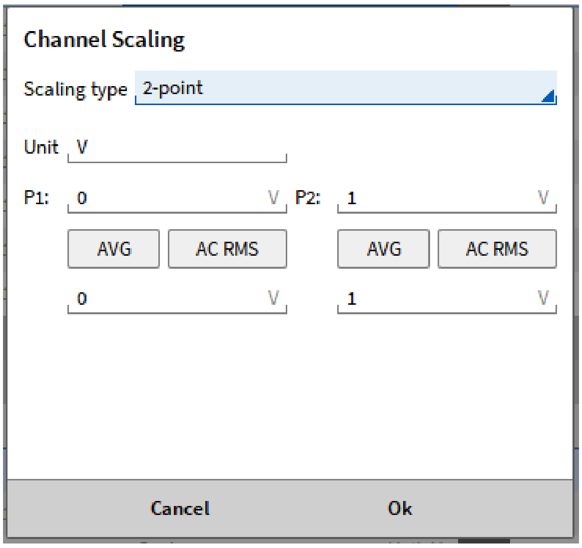


Fig. 7.19: Pop-up window for changing the 2-point-scaling

By clicking the *AVG* or the *ACRMS* button, a direct measurement point at the current instant of time can be used. A time window of 1 s into the past is used.

It is also possible to perform AVG & ACRMS calibration for multiple channels at the same time by selecting multiple channels in the channel list. By clicking on the scaling option in the channel list, the 2-point scaling window opens. By clicking on the AVG or ACRMS button, the respective value is automatically used for each selected channel individually (see Fig. 7.20).

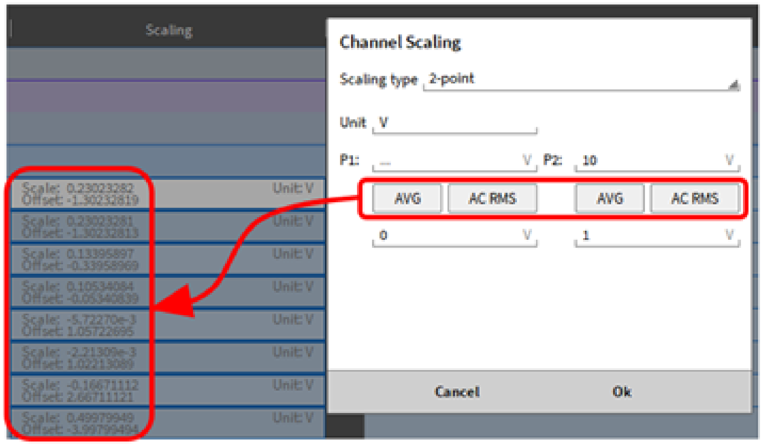


Fig. 7.20: AVG & ACRMS calibration for multiple channels

Applying table scaling

Also available in the Channel Scaling pop-up window:

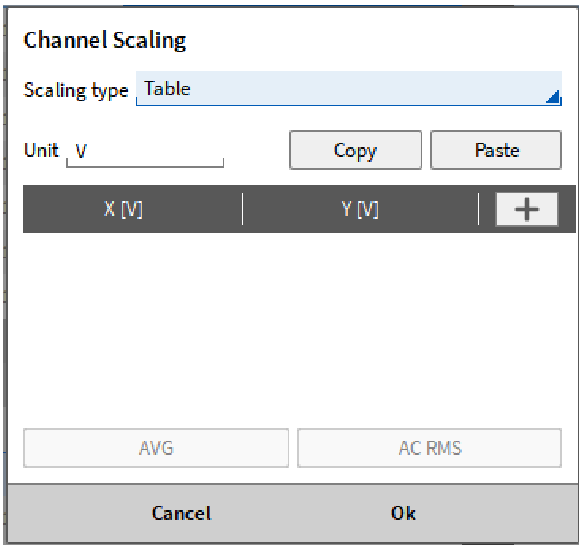


Fig. 7.21: Pop-up window for applying table scaling

Applying polynomial scaling

Also available in the Channel Scaling pop-up window:

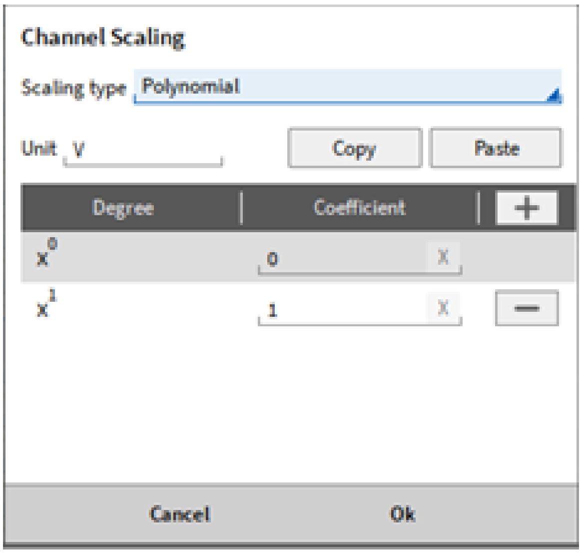


Fig. 7.22: Pop-up window for applying polynomial scaling

Changing the bridge scaling settings

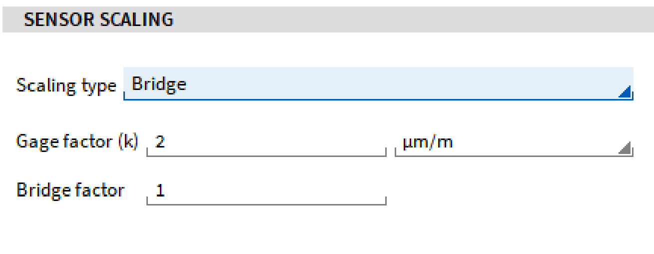


Fig. 7.23: Scaling setting for bridge mode

For more details about the sensor scaling for the bridge mode see *Sensor scaling – bridge*.

Changing the LP filter (Expand advanced settings)

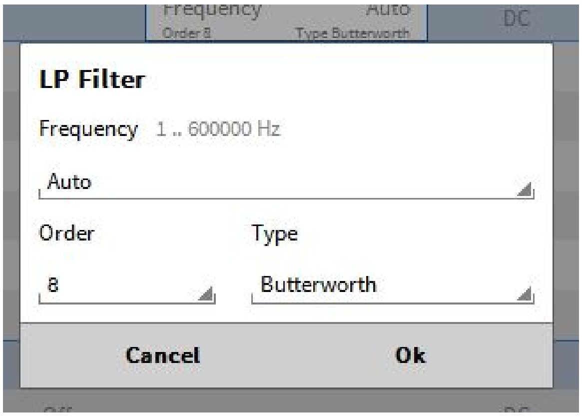


Fig. 7.24: Pop-up window for changing the LP filter

Note: When the sample rate is changed an appropriate filter will be selected automatically (Auto-mode).

Changing the coupling mode (Expand advanced settings)

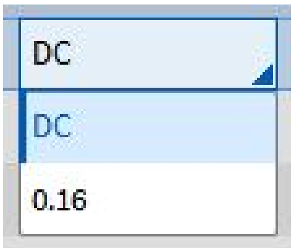


Fig. 7.25: Pop-up window for changing the coupling mode

Changing the bit resolution (Expand advanced settings)

Can only be changed for the whole board and not for single channels:

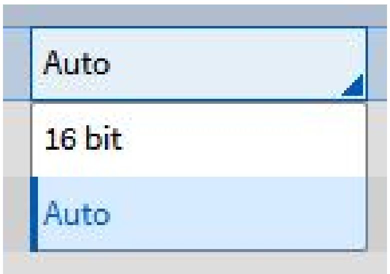


Fig. 7.26: Pop-up window for changing the bit resolution

Setting a sensor specific delay

For analog inputs it is possible to define a sensor specific delay in the range of 0-500ms

Fig. 7.27: Pop-up window for compensating the sensor delay

The delay (of the sensor) on this incoming signal is then compensated by the specified time (see Fig. 7.28).

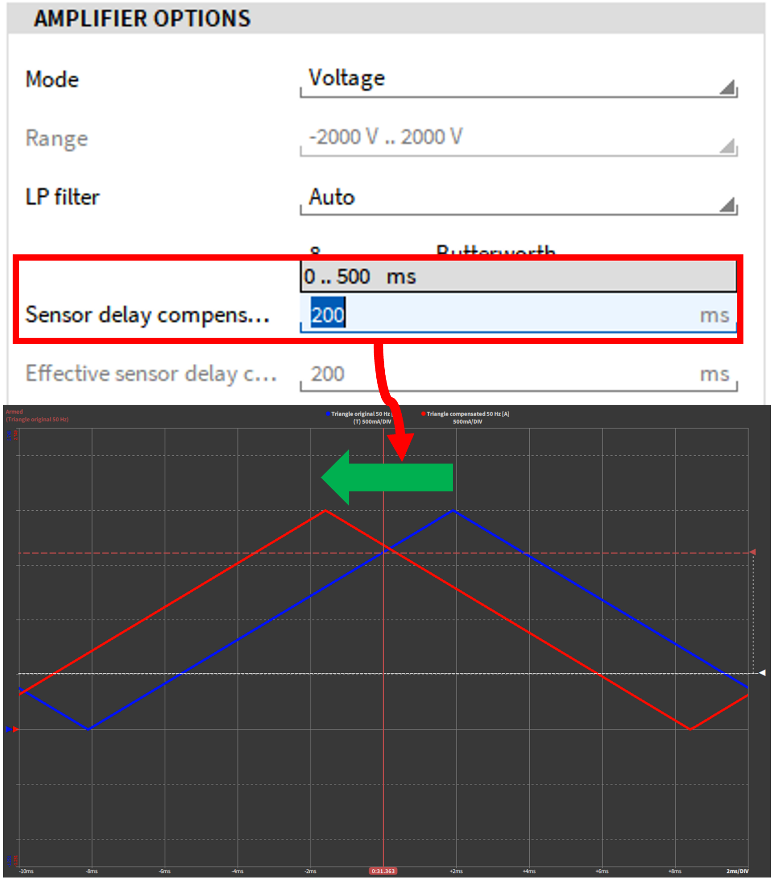


Fig. 7.28: Compensating the sensor delay

The effective sensor delay is calculated based on the sample rate and always rounded off. For example, at a sample rate of 100 Hz and a sensor delay of 99 ms the effective sensor delay is set to 90 ms.

Fig. 7.29: Effective sensor delay which can be applied

Channel-wise Sample Rate Selector

To change the sample rate of whole module simply click on one of the sample rates of a channel of that module and select the desired sample rate from the *Sample rate* drop-down list (see Fig. 7.30).

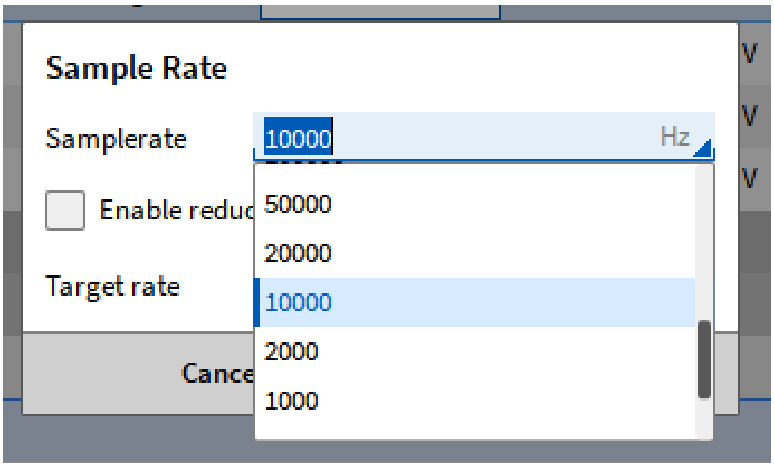


Fig. 7.30: Selection of the sample rate of a TRION module with the drop-down list

To change the sample rate just for an individual channel, click on the *Enable reduction* button in the Sample Rate window (see Fig. 7.31). The target rate can then be selected from the drop-down list. There is a selection of different sample rates available for an individual channel as integer divisors down to 1/10000th of the sample rate of the module. It is not possible to enter a sample rate, only to select one from the drop-down list.

For example, if the sample rate of the module is selected as 200 kHz, the smallest available sample rate for a channel on that module is 20 Hz.

Note: The smallest available reduction is 1 Hz. If the sample rate of the module is 100 Hz, the smallest reduction for a channel is 1 Hz.

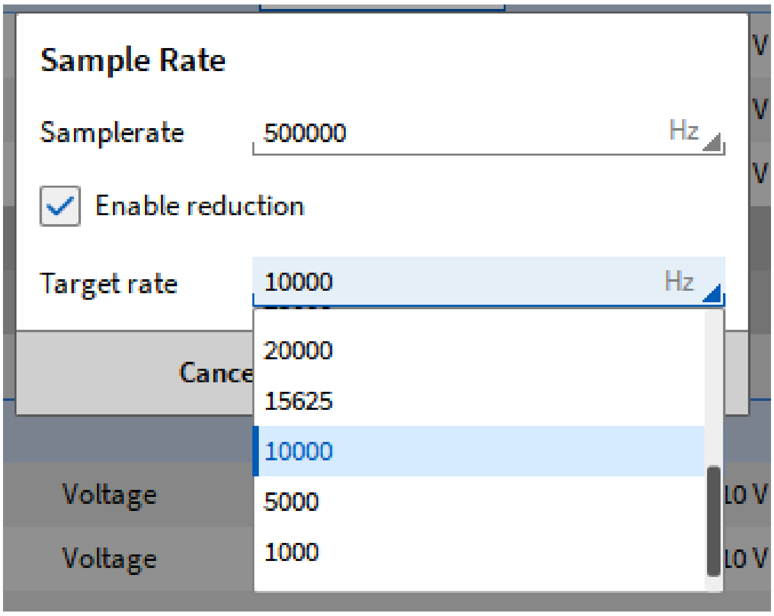


Fig. 7.31: Selection of a sample rate for an individual channel

In case the sample rate of the module will be changed, whenever a reduction is active, the target rate stays the same if it is still an integer divisor of the new sample rate of the module. This also means that only a reduction of the module sample rate is possible.

Example The sample rate of the module is set to 500 kHz and Channel 2 is set to a reduced sample rate of 20 kHz. The sample rate of the module is now changed to 100 kHz, and the target rate of Channel 2 stays at 20 kHz, since this is also an integer divisor of 100 kHz.

In case the target rate does not fulfill this requirement when the sample rate of the module is changed, if i.e. the sample rate is smaller than the reduced rate of a channel, the effective rate is shown in red below the target rate seen in Fig. 7.32. The effective rate is chosen to be as close as possible to the original selected target rate, which is still possible with the new sample rate of the module. With the *Accept* button this effective rate will be used as the new target rate of the channel.

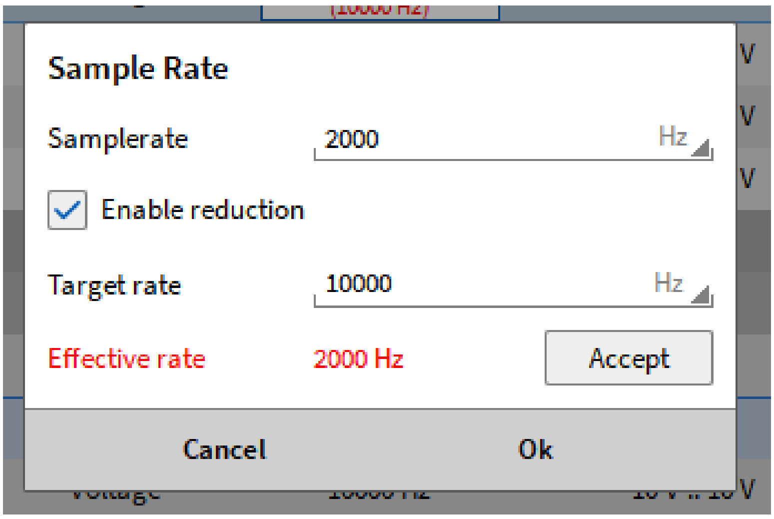


Fig. 7.32: Effective sample rate when changing the sample rate of the module

In case this suggested effective rate is not accepted by clicking the button, the effective rate is shown in red in the channel list (see Fig. 7.33). The originally selected target rate is shown in brackets below. Even though the effective rate was not accepted, it will still be used as new target rate for this channel. The red marking solely serves as an indication for this.

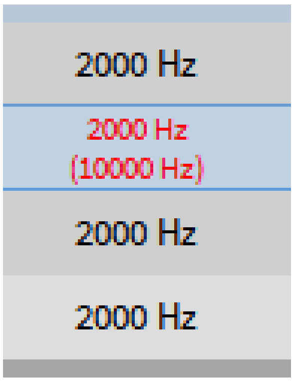


Fig. 7.33: Not accepted effective rate as reduced sample rate in the channel list

Information

- The channel-wise sample rate selector is also applicable with formula channels
- The frequency of the AUTO-Filter will be adjusted automatically with the new sample rate

Working principle

This chapter shortly explains the working principle behind the channel-wise sample rate selector. The samples are physically sampled with the set sample rate, which is defined in the channel list (red box in Fig. 7.34). If the reduction is enabled the user can set a reduced sample rate (blue box in Fig. 7.34) which is converted to an integer divider in the background and unnecessary samples are skipped

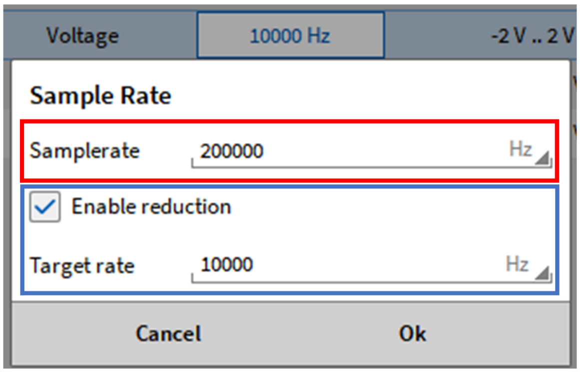


Fig. 7.34: Channel-wise sample rate settings

If the filter settings are set on AUTO, the filter is adjusted according to the target sample rate, therefore, the user must not worry about aliasing. In the exemplary settings above, the filter would be set automatically to 3333.3 Hz for this channel. However, the user can override the filter settings if needed.

Fig. 7.35: Working principle for the channel-wise sample rate reduction

Example

In Fig. 7.36 exemplary signals with and without sample rate reduction and with different filter settings can be seen. The different signals have the following settings:

- Blue signal - Sample rate: 200 kS/s - Filter setting: AUTO
- Red signal - Reduced sample rate: 10 kS/s - Filter setting: AUTO
- Green signal - Reduced sample rate: 10 kS/s - Filter setting: 66666.6 Hz

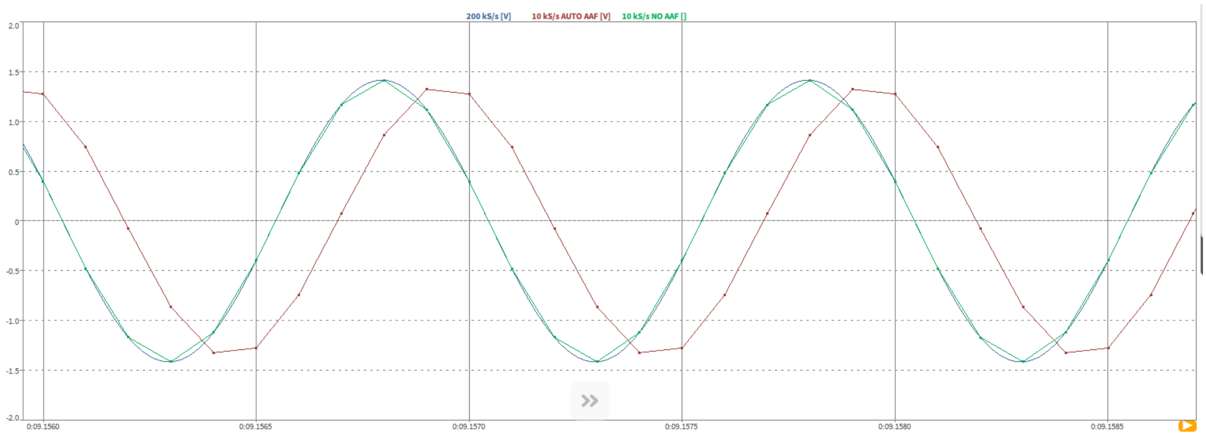


Fig. 7.36: Channel-wise sample rate reduction with example signals

The red signal is phase-shifted due to the anti-aliasing filter, which is automatically set to 3333.3 Hz. The green signal also has a reduced sample rate and a manual set filter, according to the auto filter setting of the blue signal. Therefore, those two signals are not phase-shifted. In this case, the user must be aware of aliasing.

Table scaling

OXYGEN offers the possibility to apply non-linear scaling in form of a table for non-linear sensors. This can be done in the data channel menu but also in the channel settings of an individual channel.

Following options are available:

- The unit can be specified
- Individual points to specify x- and y-values can be added by clicking on the + button (see Fig. 7.34)
- A point can be removed by clicking on the – button (see Fig. 7.35)

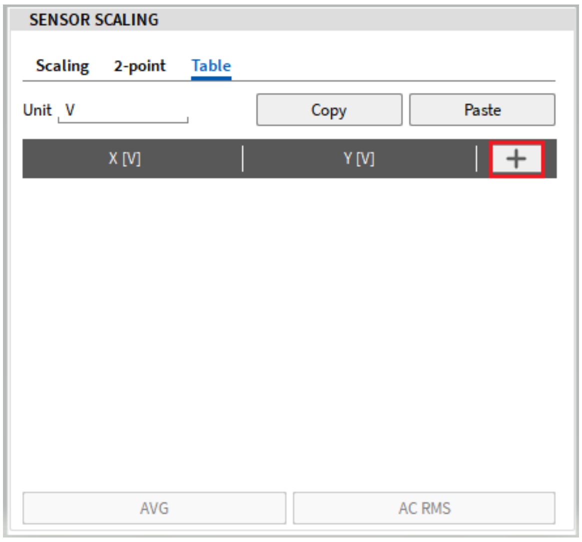


Fig. 7.37: Table scaling – add point to specify x- and y-value

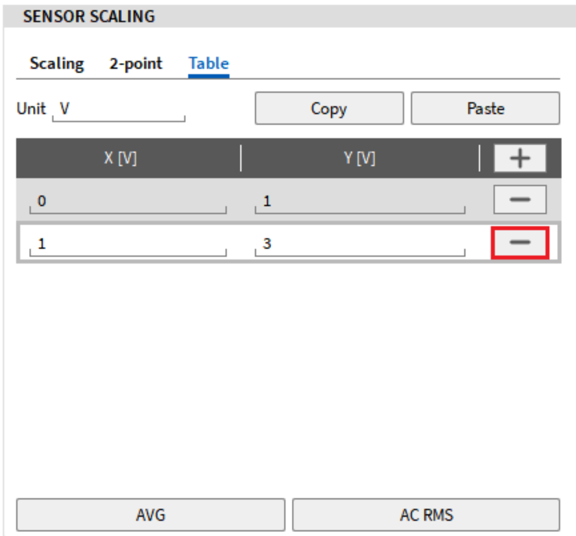
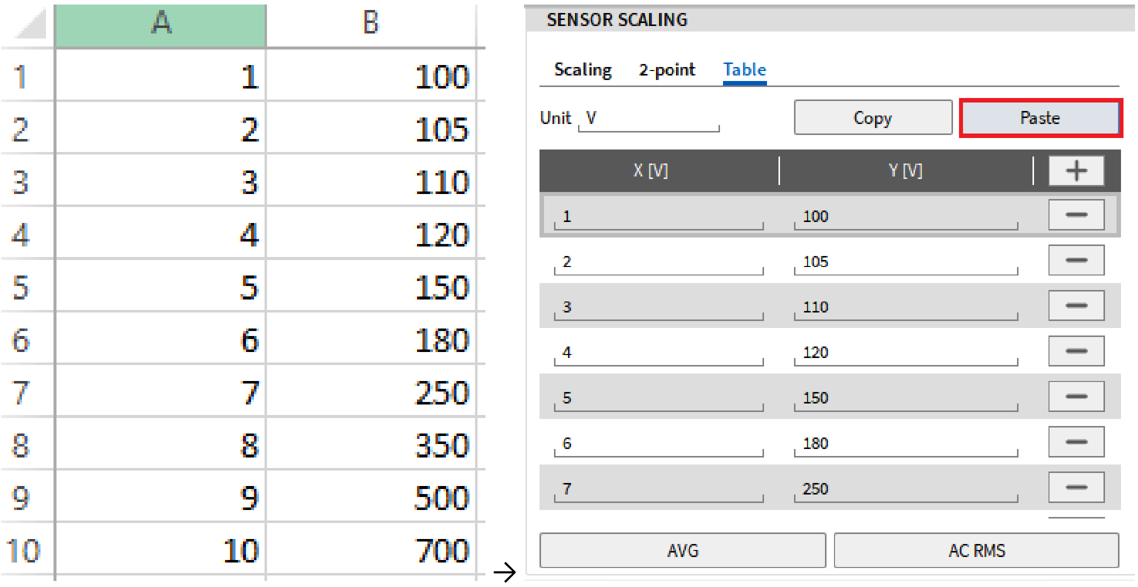


Fig. 7.38: Table scaling – delete point

- By clicking the *AVG* or the *AC RMS* button, a direct measurement point at the current instant of time can be added to the table. A time window of 1s into the past is used.
- A table can also be copied from another source, e.g. Excel and pasted with **CTRL+V** or the *Paste* button into the table scaling menu. Likewise, the table can be copied using **CTRL+C** or the *Copy* button and pasted into e.g. Excel (see Fig. 7.36).



- To copy and paste a whole table from one channel to another the *Copy* button in channel 1 can be used. After entering the channel settings of channel 2, the *Paste* button can simply be clicked on, and the table will also be applied here.

Note:

- For a valid scaling, at least two points have to be added, otherwise an error message will appear.
- If duplicate x-values exist in the table, an error message will appear.
- If a value is out of the defined table range the scaling will be extrapolated.
- Linear interpolation is applied between the table points.
- The x-values do not necessarily have to be entered from lowest to highest value, since the table will be sorted when leaving and entering the menu again.
- As it is also noted in *Selecting multiple channels*, the whole channel settings, including the table scaling, can be copied and pasted between different channels using **CTRL+C** and **CTRL+V**.

Polynomial scaling

OXYGEN offers the possibility to apply non-linear scaling in form of a polynomial for non-linear sensors. This can be done in the data channel menu but also in the channel settings of an individual channel. The following options are available (see Fig. 7.39):

- The unit can be specified.
- A polynomial coefficient can be added by clicking on the + button.
- A polynomial coefficient can be deleted by clicking on the – button.
- By clicking on the Copy button the table can be copied and pasted in e.g. Excel or a third party program.
- The polynomial scaling can also be pasted from another source, e.g. Excel by clicking on the *Paste* button or with the shortcut **CTRL+V**

Each coefficient must be defined. In Fig. 7.39 and Fig. 7.40 the following polynomial is represented:

$$1 + 2x + 6x^2 + 5x^4$$

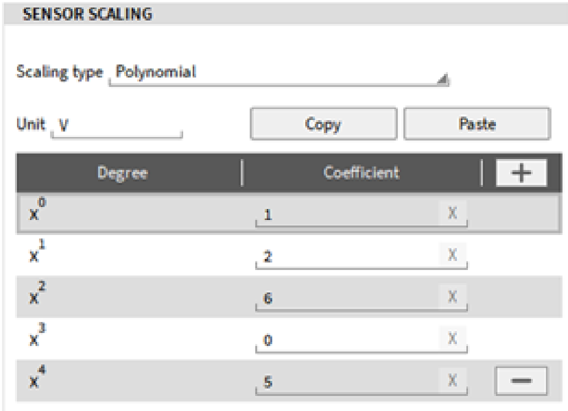


Fig. 7.39: Polynomial scaling

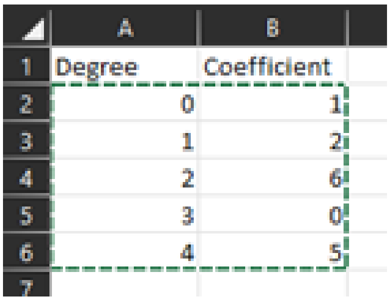


Fig. 7.40: Copying of a table for the polynomial scaling in OXYGEN

Enum scaling

The so-called enum scaling or enum label editor is available in the scaling section of the channel settings for some defined channels. With the enum scaling a text label can be defined for a specific, unique signal value. The text label is then shown in the digital instrument and as labels in the recorder (if activated, see *Instrument properties*), whenever the signal value takes on the specified value, see Fig. 7.43. The following channels support enum scaling:

- CAN channels: If the DBC file already includes an enumeration it can be parsed. The enumeration can be edited in the enum scaling editor.
- Flexray and ARXML channels: Parsing of enum data is not supported
- Ethernet receiver channels
- IMU (ADMA & OxTS) channels: Enum data is not stored in the channel definition

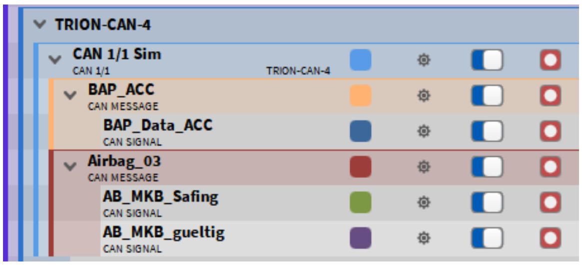


Fig. 7.41: Enum Scaling of a CAN channel

In the enum scaling editor new labels can be created by clicking on the + button, and deleted by clicking on the – button. The table can be copied (Copy button) and pasted into another program. An existing table can also be pasted from another source into OXYGEN (Paste button).

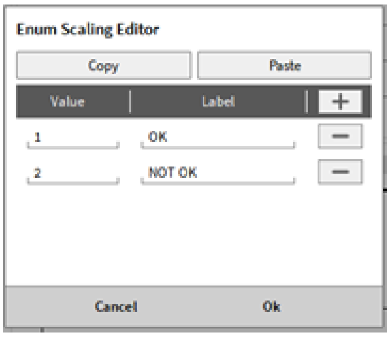


Fig. 7.42: Enum Scaling Editor

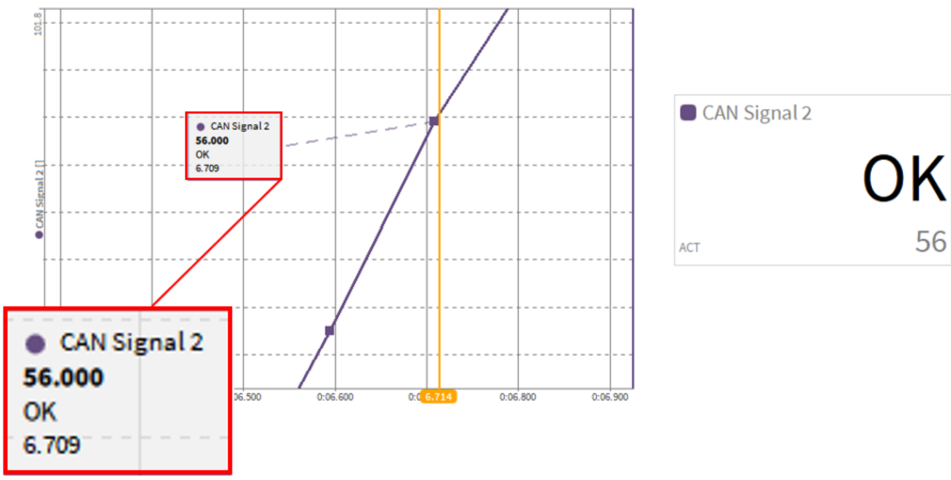


Fig. 7.43: Enum Scaling - display in the digital instrument and as label in the recorder

Sensor scaling – bridge

The following section gives a small overview about the scaling setting for different bridge configurations. For a detailed explanation about this topic refer to further literature.

The following definitions are used for the equations:

R_i … Strain gage resistor of the bridge

U_D … Bridge output voltage

U_{IN} … Bridge supply voltage

ε … Elongation

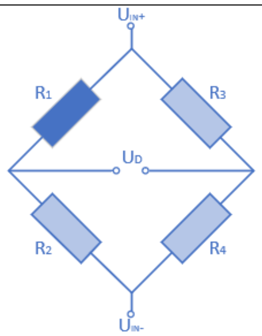
k … Bridge factor

v … Poisson's ratio

Quarter bridge

Used to measure tension and compression

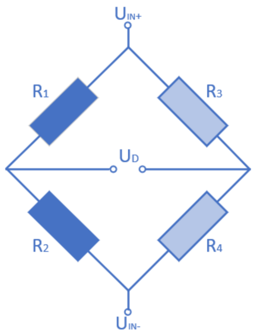
Table 7.2: Quarter bridge

Schematic	U_D / U_{IN} equation	Bridge factor	Linearity	Active strain gauges
	$\frac{U_D}{U_{IN}} = \frac{1}{4} * \frac{\Delta R_1}{R_1}$ $\frac{U_D}{U_{IN}} = \frac{1}{4} * k * \varepsilon$	1	No	One active strain gauge (R_1)

Half bridge

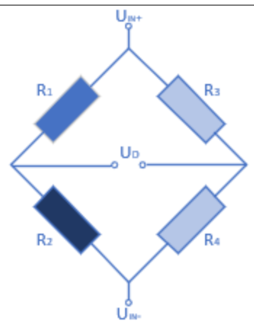
Used to measure bending

Table 7.3: Half bridge - bending

Schematic	U_D / U_{IN} equation	Bridge factor	Lin-earity	Active strain gauges
	$$\frac{U_D}{U_{IN}} = \frac{1}{4} * \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2}\right)$$ $$\frac{U_D}{U_{IN}} = \frac{1}{4} * k * (\varepsilon_1 - \varepsilon_2)$$	2	Yes	Two active strain gauges (R_1 and R_2). The elongation of R_1`and R:sub:`2 must be the same but opposite in sign, i.e. one strain gage can be put on top of a beam and the other on the bottom.

Used to measure tension and compression

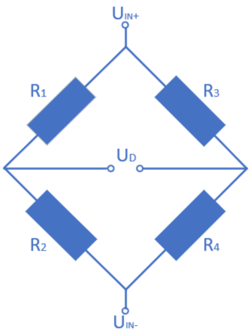
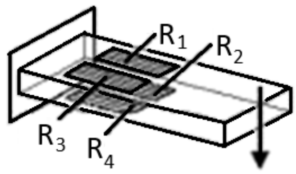
Table 7.4: Half bridge - tension and compression

Schematic	U_D / U_{IN} equation	Bridge factor	Lin-earity	Active strain gauges
	$$\frac{U_D}{U_{IN}} = \frac{1}{4} * \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2}\right)$$ $$\frac{U_D}{U_{IN}} = \frac{1}{4} * k * (\varepsilon_1 - v\,\varepsilon_2)$$	(1 + v)	No	Two active strain gauges (R_1 and R·$_2$). 1x longitudinal elongation / 1x transverse elongation. One strain gauge lies in principal and the other in transverse direction.

Full bridge

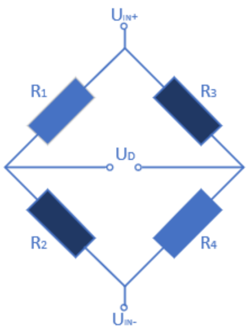
Used to measure bending

Table 7.5: Full bridge - bending

Schematic	U_D / U_{IN} equation	Bridge factor	Linearity	Active strain gauges
	$\frac{U_D}{U_{IN}} = \frac{1}{4} * \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} + \frac{\Delta R_3}{R_3} - \frac{\Delta R_4}{R_4} \right)$ $\frac{U_D}{U_{IN}} = \frac{1}{4} * k * (\varepsilon_1 - \varepsilon_2 + \varepsilon_3 - \varepsilon_4)$	2 x (1 + 1)	Yes	 Four (4) active strain gauges (R_1...R_4). Elongation (and compression) is in the same magnitude; the compression of R_2 and R_4 gives an opposite signal as from elongation of R_1 and R_3.

Used to measure tension and compression

Table 7.6: Full bridge - tension and compression

Schematic	U_D / U_{IN} equation	Bridge factor	Linearity	Active strain gauges
	$\frac{U_D}{U_{IN}} = \frac{1}{4} * \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} + \frac{\Delta R_3}{R_3} - \frac{\Delta R_4}{R_4} \right)$ $\frac{U_D}{U_{IN}} = \frac{1}{4} * k * (\varepsilon_1 - \varepsilon_2 + \varepsilon_3 - v\varepsilon_4)$	2 x (1 + v)	No	Four active strain gauges (R_1, R_2, R_3 and R_4); 1x longitudinal elongation, 2x transverse elongation. One pair of strain gauges lies in principal and the other pair in transverse direction.

7.3.2 Changing the channel settings in the channel setup

All channel settings (except the sample rate and the bit resolution) can also be changed in the individual Channel Setup (see Fig. 7.44) which can be accessed via push button ⑪ (see Fig. 7.2 or Table 7.1).

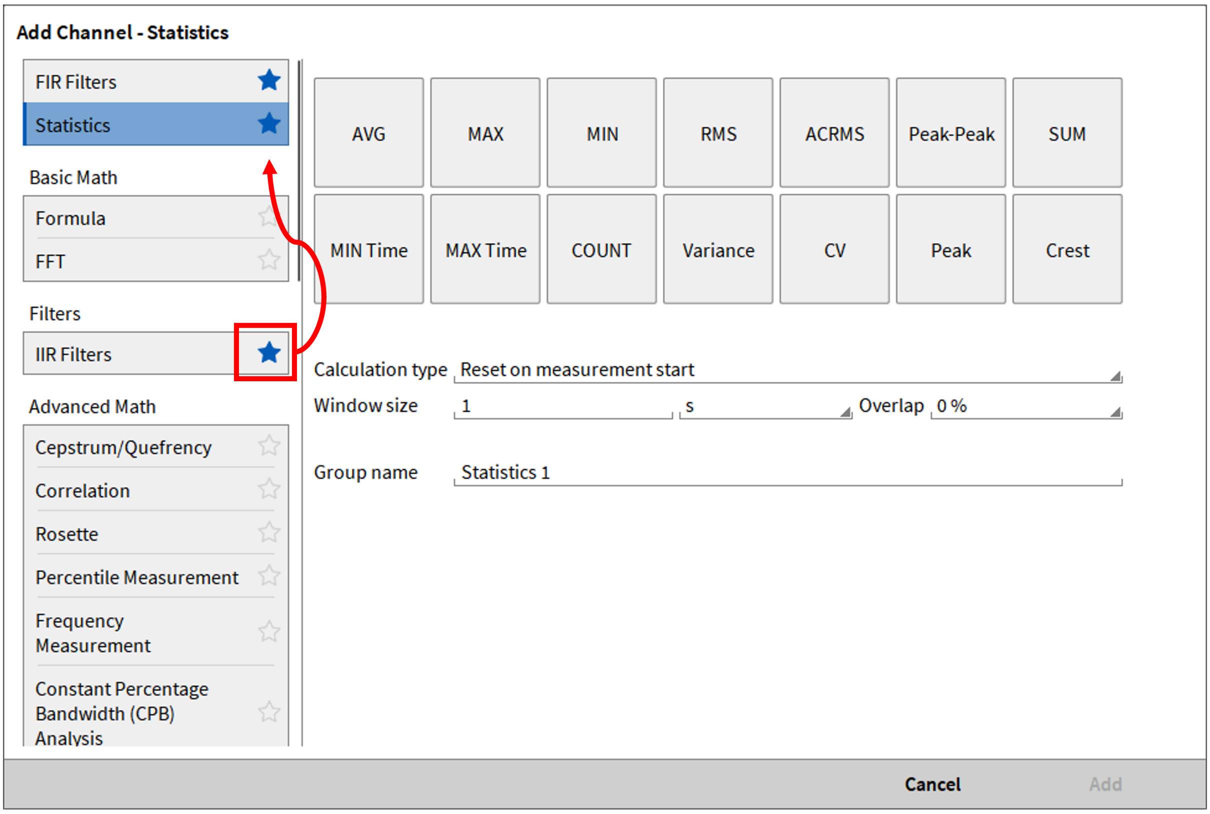


Fig. 7.44: Channel setup of a TRION3-1820-MULTI channel

The main advantage compared to the parameter manipulation in the *Data channels* menu is that a wide preview window is available. With that, the user can see the affection of different parameter changes (i.e. range and scaling) on the input signal in real time. To swap between the channel setups of different channels use the arrows (<< >>) in the upper right corner and to close the channel setup use the *X* next to the arrows. In addition, depending on the mode, a connector pinout is available.

7.3.3 Current measurement using TRION modules

Different TRION modules can be used for current measurement. Current signals can be connected directly to TRION-1603-LV-6-L1B, TRION-1620-LV-6-L1B and TRION-1620-ACC-6-L1B modules and measure the current via an integrated 10 Ω shunt resistor.

Other modules can also be used for current measurements but need an external shunt resistor to support this functionality. These modules are the following: TRION-1603-LV-6-BNC, TRION-1620-LV-6-BNC, TRION-1620-ACC-6-BNC, TRION-1820-dLV, TRION-1600-dLV and TRION-2402-x. The TRION-1820-PA module is excluded from this consideration.

Modules that require an external shunt resistor for the current measurement contain a predefined shunt resistor selection in the Channel List (see Fig. 7.45) if *Current Amplifier Mode* is selected.

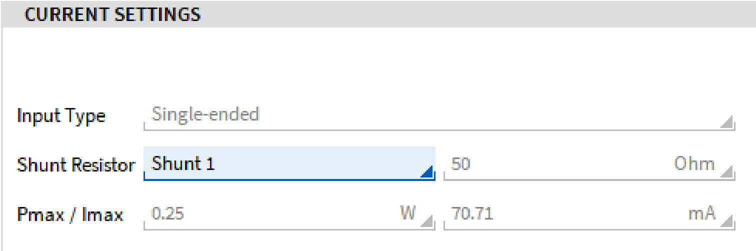


Fig. 7.45: External Shunt resistor selection in the Channel Setup

From the technical point of view, the current measurement via an (external) shunt resistor is the measurement of the potential difference that is caused by the current on the shunt resistor.

$$I = \frac{U}{R}$$

The voltage *U* is measured, the resistance *R* is known and therefore the Current *I* can be determined. Thus, if the current is measured via an external shunt, a voltage signal representing the potential difference caused by the current on the external shunt is provided to the TRION-module. This voltage is rescaled to the current again by using the formula above. This rescaling is done by OXYGEN. Therefore, the resistance must be known and can be selected in the drop-down list from Fig. 7.45.

For sure, any shunt resistor can be used and not the ones contained in the drop-down list. If a shunt is used whose resistance is not contained in the list, the rescaling of the voltage signal representing the current can be done manually in *Voltage* Amplifier mode proceeding the following steps:

- Set the Amplifier Mode to Voltage (see Fig. 7.46):

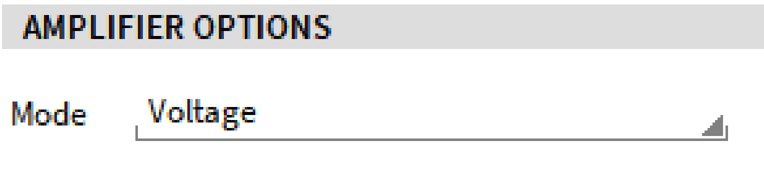


Fig. 7.46: Voltage measurement mode

- Change the Unit to A (Ampere) and enter the resistance of the shunt resistor as Scaling factor, i.e. 50 Ω (see Fig. 7.47).

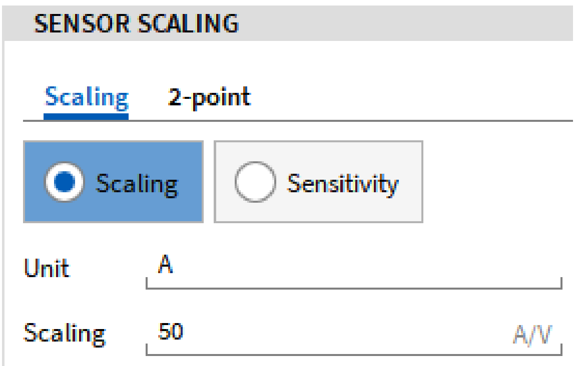


Fig. 7.47: Entering the shunt resistance as scaling factor

- With these settings, the rescaling of the voltage signal to the represented current is done in the same manner as in Current mode with the corresponding shunt resistor selected in the drop-down list. Thereby, the voltage signal is multiplied with the entered *Scaling* factor and the result of this equation is the corresponding current:

$$\text{corresponding current I} = scaling\ factor\ R * measured\ voltage\ U$$

- Considering the physical units of this equation will clarify that:

$$[A] = \left[\frac{A}{V} * V\right]$$

If a TRION module with integrated 10 Ω shunt is used for the current measurement, this consideration can be neglected! This applies only for current measurements via external shunt resistors.

7.4 Mathematical channels

OXYGEN enables the user to easily create Formula (see *Formula channel*), Statistics (see *Statistics channel*), Filters (see *IIR Filter channel*), FFT (see *FFT channels*) or (Strain gauge) Rosette channels (see *Rosette (strain gauge) channels*) which are calculated in real time. For details about the Psophometer calculation, refer to *Psophometer*. The Swept sine Analysis calculation is explained in *Swept Sine Analysis*.

To create a new channel, the user needs to click on the *Add* button in the lower left corner (marked red in Fig. 7.48) and a pop-up window will appear where the user can select if he wants to create a Formula, Statistics, Filter channel, a FFT or Rosette calculation. If a Statistics or Filtering channel or a FFT or Rosette calculation shall be created, the user must select the desired input channel(s) in the *Channel List* before clicking on the *Add* button. The created channels will show up in the *Math* channel section in the *Data Channels* menu.

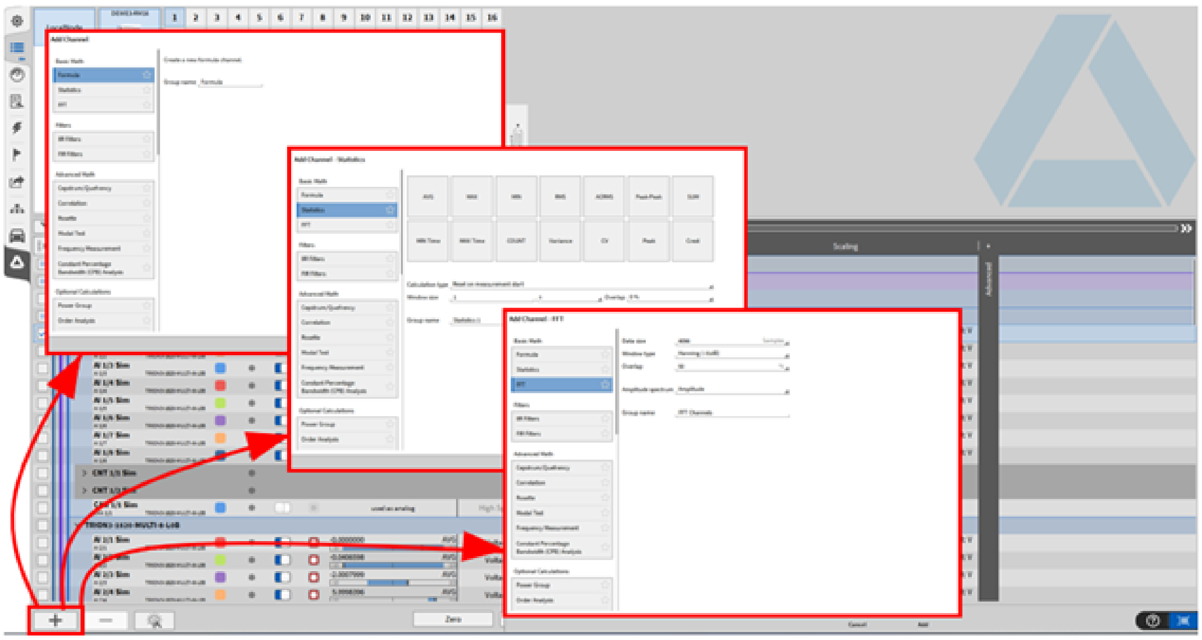


Fig. 7.48: Creation of a math channel

To delete previously added channels, first select the desired channels (1 in Fig. 7.49), then click the "Delete button" (2 in Fig. 7.49). A confirmation window (3 in Fig. 7.49) will appear, requiring you to confirm the deletion. This step helps prevent accidental removal of channels that may have been selected unintentionally.

Abb. 7.5

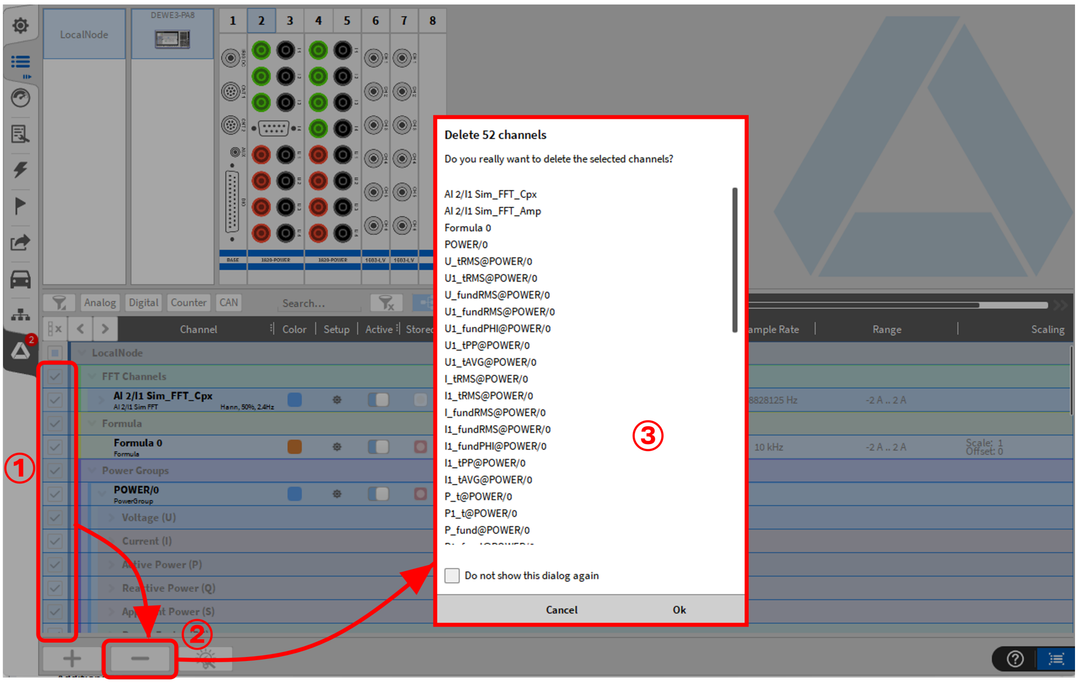


Fig. 7.49: Deleting math channels

Note: The *Calculation Setup* stores the information if a Formula, a Statistics or a Filtering channel was created lastly and selects the respective one automatically when the window is opened the next time.

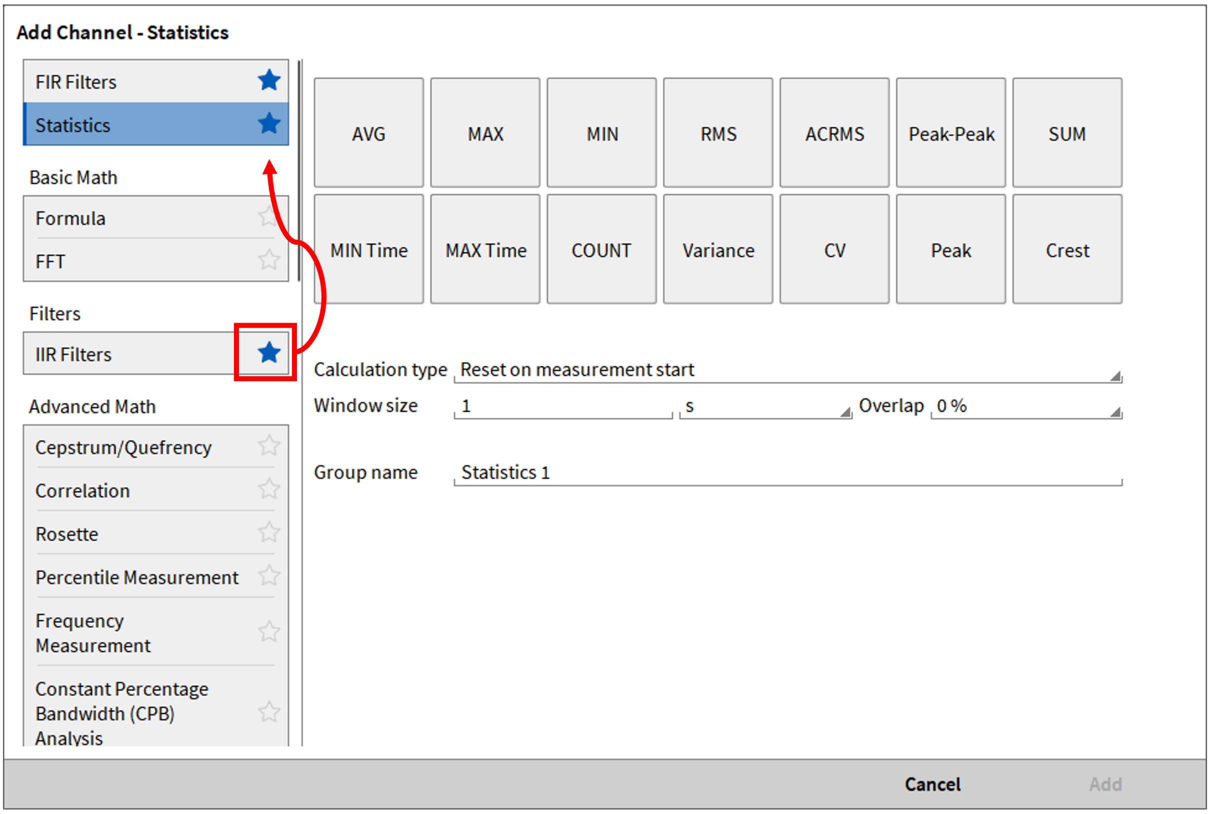


Fig. 7.50: Add favorites

For quick access to certain calculations there is a possibility to mark them as favorite (see Fig. 7.50). When a calculation is marked as a favorite, it is moved to the beginning of the list of available channels, so calculations that need to be used regularly can be selected quickly without searching for them in the list. When a calculation marked as a favorite is deactivated, it is automatically placed back in the list of all available calculations.

7.4.1 Basic math

Formula channel

For creating a Formula math channel, the user must click on the *Add* button in the lower left corner (marked red in Fig. 7.48) and select *Formula* (see Fig. 7.51).

It is possible to assign a group name to summarize several formulas in groups in the channel list for a better overview. Under “Channels”, it is possible to enter the number of formulas to be added to the channel list and to add up to 100 formula channels at once (see Fig. 7.51).

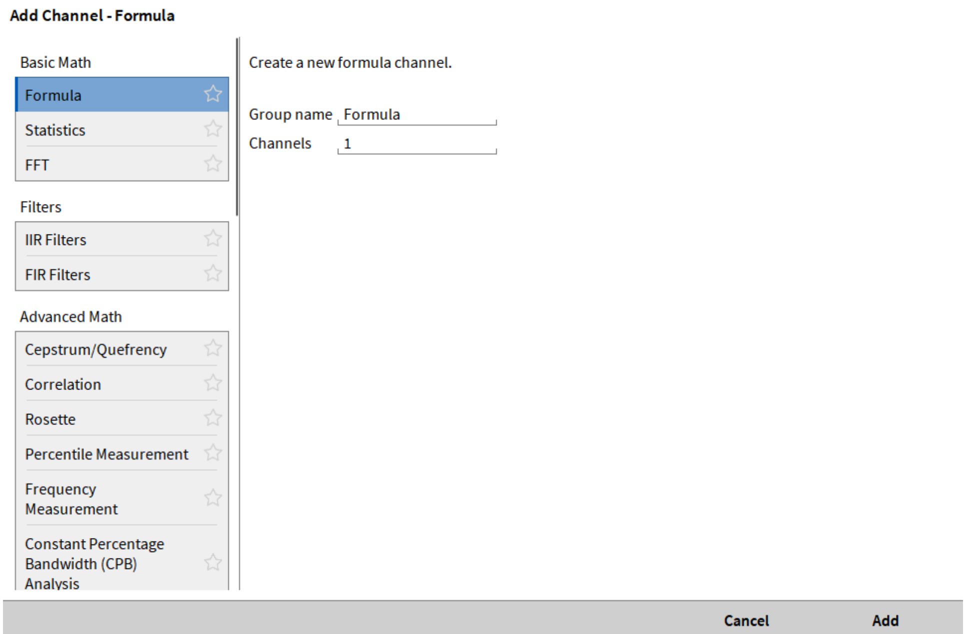


Fig. 7.51: Pop-up window for creating a Formula channel

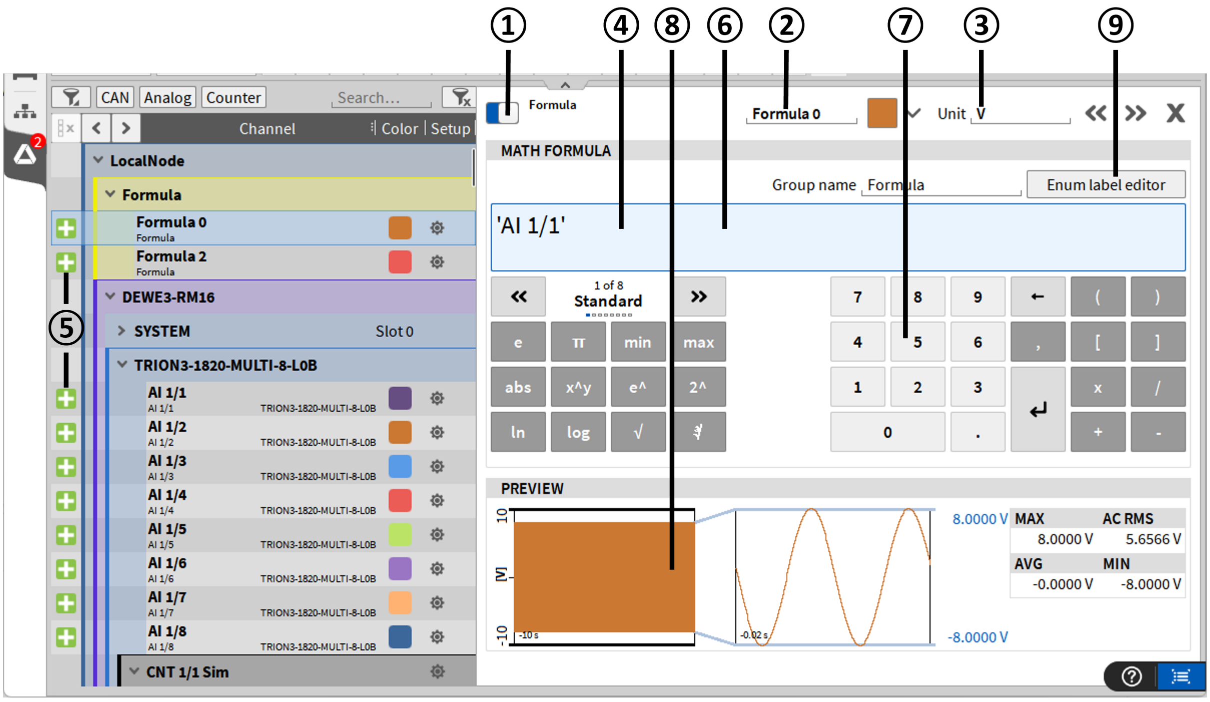


Fig. 7.52: Formula channel setup - overview

Table 7.7: Push buttons in the formula channel setup – overview

No.	Name	Description
1	Active button	Setting a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel, and can be recorded, an inactive channel not
2	Channel name	Individual channel name; Can be changed individually
3	Physical unit	Physical unit of the channel, can be changed in the channel setup
4	Command line	Type your desired formula here
5	Add button	Adds the individual channel to the command line; Channels can be added to the command line by drag and drop, too
6	Functions	Available mathematical and logical functions can be selected here. Using the back (a) and forward (b) buttons the user can swap between Standard, Trigonometric, Logic and Miscellaneous functions. For a description and the correct syntax of the individual functions, refer to *Mathematical and logical functions*.
7	Keys and Operators	Numerical pad and mathematical operators; Can also be entered via the keyboard.
8	Preview window	Real Time preview of the calculation
9	Enum label editor	Enables displayed text labels for set values of this formula. Logic operations are recommended for non-digital channels.

Note: It is possible to assign channels with different sample rates to one formula channel. The sample rate of the formula channel will be set to the highest input channel sample rate. The samples of channels with lower sample rates will not be interpolated, but the last value will be repeated according to the fastest sample rate until the channel is updated.

Table 7.8: Standard mathematical operators - description and syntax

Function	Description	Syntax
e	Euler's number	e
π	Constant Pi	pi
min	Minimum of up to 128 values	min(x,y...n)
max	Maximum of up to 128 values	max(x,y...n)
abs	Absolute value	abs(value)
x^y	Exponential function with arbitrary basis	pow(x,y)
e^	Exponential function with basis e	exp(x)
2^	Exponential function with basis 2	exp2(x)
ln	Natural logarithm to basis e	ln(x)
log	Common logarithm to basis 10	log(x)
√	Square root	sqrt(x)
⍰	Cube root	cbrt(x)

Table 7.9: Trigonometrical operators - description and syntax

Function	Description	Syntax
sin	Sinus based on sin(w*t+phi), e.g. "2*pi*time+pi/180*5"	sin(x)
asin	Arc sine	asin(x)
sinh	Hyperbolic sine	sinh(x)
asinh	Arc hyperbolic sine	asinh(x)
cos	Cosine	cos(x)
acos	Arc cosine	acos(x)
cosh	Hyperbolic cosine	cosh(x)
acosh	Arc hyperbolic cosine	acosh(x)
tan	Tangent	tan(x)
atan	Arc tangent	atan(x)
tanh	Hyperbolic tangent	tanh(x)
atanh	Arc hyperbolic tangent	atanh(x)

Table 7.10: Logical operators - description and syntax

Function	Description	Syntax
<	If 'value1' is less than 'value2', the result is 1.0 else 0.0	value1 < value2
≤	If 'value1' is less than or equals 'value2', the result is 1.0 else 0.0	value1 <= value2
>	If 'value1' is greater than 'value2', the result is 1.0 else 0.0	value1 > value2
≥	If 'value 1' is greater than or equals 'value 2', the result is 1.0 else 0.0	value1 >= value2
=	If 'value 1' equals 'value 2', the result is 1.0 else 0.0 (Two NaNs do not compare equal	value1 == value2
≠	If 'value 1' is different than 'value 2', the result is 1.0 else 0.0	value1 != value2
and	Logic and: value1 != 0.0 and value2 != 0.0 → 1.0 value1 = 0.0 and value2 != 0.0 → 0.0 value1 != 0.0 and value2 = 0.0 → 0.0 value1 = 0.0 and value2 = 0.0 → 0.0	value1 and value2
or	Logic or: value1 != 0.0 or value2 != 0.0 → 1.0 value1 = 0.0 or value2 != 0.0 → 1.0 value1 != 0.0 or value2 = 0.0 → 1.0 value1 = 0.0 or value2 = 0.0 → 0.0	value1 or value2
not	Logic negation: If value = 0.0, the result is 1.0, else 0.0	not value
if	If condition is true, the result is 'true_val', otherwise 'false_val'	if(condition,true_val,false_val)
isnan	If value is NaN, result is 1.0, 0.0 otherwise	isnan(value)

Table 7.11: Measurement functions – description and syntax

Function	Description	Syntax
ecnt[1]	Count number of edges on condition; condition is mandatory, rearm and reset parameter optional	ecnt(cond,rearm,reset)
hold[2]	Hold value at trigger condition; value and condition parameters are mandatory, init and rearm optional	hold(value,cond,init,rearm)
stopwatch[3]	Measure the timespan between two conditions in seconds; start and stop condition is both mandatory, reset is optional	stopwatch(start_cond,stop_cond, reset)
measdiff[4]	Measure the value difference of one channel between two conditions	measdiff(val,cond1,cond2)
period[5]	Measure the period duration in seconds between consecutive conditions with optional rearm condition	period(cond,rearm)
dutycycle[6]	Measure the dutycycle (from 0 to 1) between consecutive conditions with optional rearm condition	dutycycle(cond,rearm)
edge[7]	Generate positive edge on cond with rearm condition	edge(cond,rearm)

Legend to Table 7.11

- [1] For a detailed description of the ecnt-funtion, refer to *Edge-count function (ecnt)*.
- [2] For a detailed description of the hold-function, refer to *Hold function (hold)*.
- [3] For a detailed description of the stopwatch-function, refer to *Stopwatch function (stopwatch)*.
- [4] For a detailed description of the measdiff-function, refer to *Measdiff function (measdiff)*.
- [5] For a detailed description of the period-function, refer to *Period function (period)*.
- [6] For a detailed description of the dutycycle-function, refer to *Dutycycle function (dutycylce)*.
- [7] For a detailed description of the edge-function, refer to *Edge function (edge)*

Table 7.12: Rolling functions – description and syntax

Function	Description	Syntax
rmin[1]	Measure rolling overall minimum of a channel during a measurement with optional reset condition	rmin(value,reset)
rmax[1]	Measure rolling overall maximum of a channel during a measurement with optional reset condition	rmax(value,reset)
ravg[1]	Measure rolling overall average of a channel during a measurement with optional reset condition	ravg(value,reset)
rrms[1]	Measure rolling overall RMS of a channel during a measurement with optional reset condition	rrms(value,reset)
rsum[1]	Measure rolling overall sum of a channel during a measurement with optional reset condition	rsum(value,reset)
racrms[1]	Measure rolling overall ACRMS of a channel during a measurement with optional reset condition; Not included in the selection and must be typed manually	racrms(value,reset)
rp2p[1]	Measure rolling overall Peak-to-Peak of a channel during a measurement with optional reset condition; Not included in the selection and must be typed manually	Rp2p(value,reset)

Legend to Table 7.12

- [1] For a detailed description of the rolling-overall-functions, refer to *Rolling-overall-functions*

Table 7.13: Generator operators - description and syntax

Function	Description	Syntax
time[1]	Returns the elapsed time since acquisition (re)start in seconds	time
mtime[1]	Returns the elapsed time since measurement star in seconds	mtime
scnt[1]	Counts the number of samples since acquisition (re)start	scnt
sr[1]	Returns the Sample Rate in Hz	sr
dim	When multiplied to an array channel x * dim, the output shows the current index of the bin. [1,2…n]. For scalar the index is 0.	dim
noise	Noise(x), random number [-x … x]	noise(x)
chirp	Creates a chirp signal with frequency from f0 to f1 within d seconds.	chirp(f0, f1, d)
sin wave	Creates a sinus wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	sinwave(f,phi)
cos wave	Creates a cosines wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	coswave(f,phi)
saw wave	Creates a saw wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	sawwave(f,phi)
tri wave	Creates a triangle wave with frequency f and optional phase phi. By default, a phase shift of 0 rad is applied.	triwave(f,phi)
pulse wave	Creates a rectangle wave with frequency f , duty cycle d and optional phase phi. By default a phase shift of 0 rad is applied.	pulsewave(f, d, phi)

[1]A channel to which the function refers must be specified, i.e. in the following manner: 'Ref_Ch' * 0 + time

Table 7.14: Miscellaneous operators - description and syntax

mod	Remainder of division x/y, sign of x	mod(x,y)
noise	Creates Noise signal in the range [-x…+x]	noise(x)
atan2	Arc tangent of y/x using signs of arguments to determine the correct quadrant	atan2(y,x)
floor	Rounds x towards minus infinity	floor(x)
ceil	Rounds x towards plus infinity	ceil(x)
round	Round to nearest integer	round(x)
trunc	Round x towards zero	trunc(x)
delay	Delay a signal x for N samples with an optional initial value y0 by default 0	delay(x,N,y0)
lerp	Continue a series of values with lerp(a,b,t)=(1-t)*a+t*b. This allows you to interpolate or continue the straight line for any t values. An example is the starting value a=10, the second value is 15. lerp equals a for t=0, lerp equals b for t=1. For t values between 0 and 1, interpolation takes place between a and b.	lerp(a,b,t)

Edge-count function (ecnt)

Syntax: ecnt(cond,rearm,reset)

The Edge-count function counts the number of fulfilled *cond*itions. If desired, a R*earm* event which must be passed before a *cond*ition can be fulfilled again, can be defined. A *Reset* event can be defined optionally, too. *Cond*ition, *Rearm* and *Reset* can be applied to *Rising* and *Falling* signal edges. *Rising Edges* can be defined by using the logical operators > and ≥. *Falling Edges* can be defined by using the logical operators < and ≤.

The following examples will explain the functionality (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

ECNT_Cond = ecnt('SIGNAL'>800)

Every time the channel *SIGNAL* passes *800* with a *Rising Edge (>)*, the channel *ECNT_Cond* increases by 1 (see Fig. 7.53).

The reason why the ecnt-function increases by more than 1 in Fig. 7.53 is that the signal is floating around the *Cond*ition level several times due to noise. This can be seen in the magnification in Fig. 7.53. This is also the reason why the ecnt-function counts on *Falling Edges* as well. To avoid disturbed results caused by signal noise, a *Rearm* Level can be defined. A suitable example can be found in the following section and in Fig. 7.54.

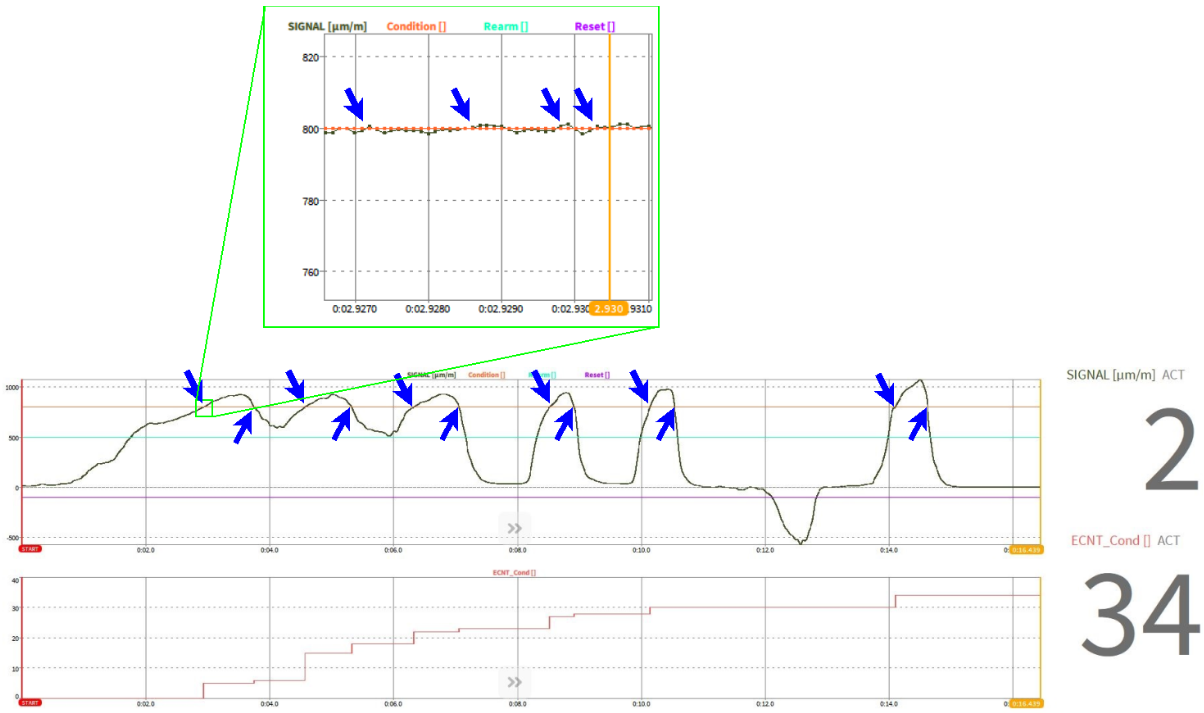


Fig. 7.53: ECNT-function with Condition only

ECNT_Cond_Rearm = ecnt('SIGNAL'>800,'SIGNAL'<500)

If the channel *SIGNAL* passes *800* with a *Rising Edge (>)*, the channel *ECNT_Cond_Rearm* increases by 1. To avoid unwanted increments caused by noise on the signal, the channel *SIGNAL* must pass *500* with a *Falling Edge (<)* before the channel *ECNT_Cond_Rearm* counts again when the channel *SIGNAL* passes *800* with a *Rising Edge (>)* (see Fig. 7.54).

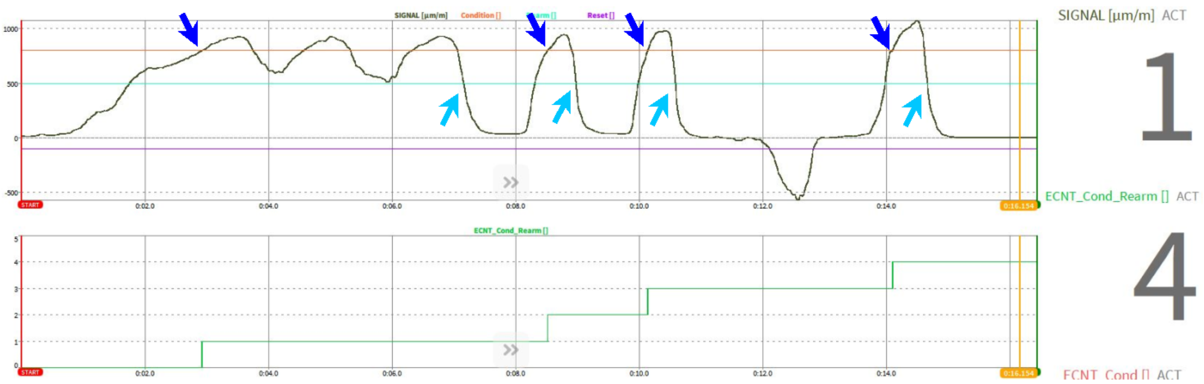


Fig. 7.54: ECNT-function with Condition and Rearm

ECNT_Cond_Rearm_Reset = ecnt('SIGNAL'>800,'SIGNAL'<500,'SIGNAL'<-100)

If the channel *SIGNAL* passes *800* with a *Rising Edge (>)*, the channel *ECNT_Cond_Rearm_Reset* increases by 1. To avoid unwanted increments caused by noise on the signal, the channel *SIGNAL* must pass *500* with a *Falling Edge (<)* before the channel *ECNT_Cond_Rearm_Reset* counts again when the channel *SIGNAL* passes *800* with a *Rising Edge (>)*. If the Channel *SIGNAL* passes *-100* with a *Falling Edge (<)*, the channel *ECNT_Cond_Rearm_Reset* is set to *0* (see Fig. 7.55).

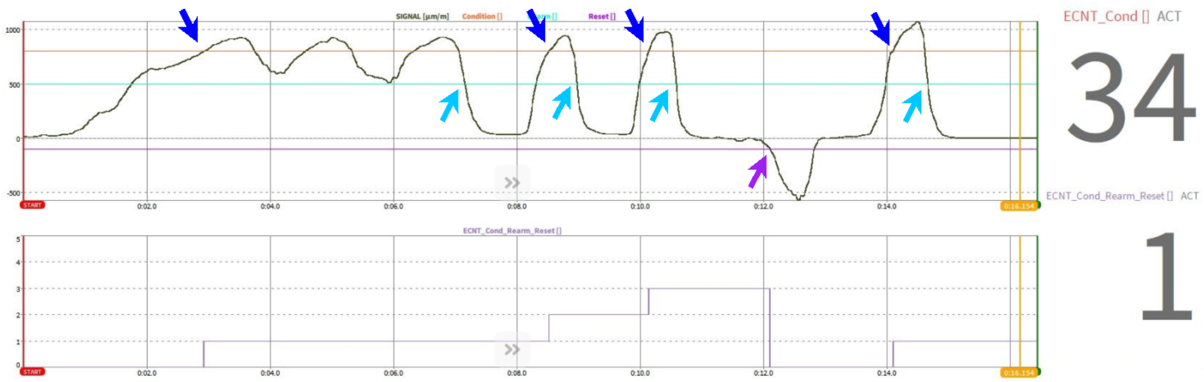


Fig. 7.55: ECNT-function with *Cond*ition, *Rearm* and *Reset*

Hold function (hold)

Syntax: hold(value,cond,init,rearm)

The hold-function requires two input channels. One channel is the *Signal* channel and one channel the *Condition* channel. If the *Condition* channel fulfills a certain *Cond*ition, the actual value of the *Signal* channel is stored to the hold-function channel. If desired, an *Init*ial value and a *Rearm* event which must be passed before a *Cond*ition can be fulfilled again, can be defined. *Cond*ition and *Rearm* can be applied to *Rising* and *Falling* signal edges. *Rising Edges* can be defined by using the logical operators > and ≥. *Falling Edges* can be defined by using the logical operators < and *≤.*

The following examples will explain the functionality (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

HOLD_VAL_COND = hold('SIGNAL_VAL','SIGNAL_COND'>5)

If the channel *SIGNAL_COND* passes *5* with a *Rising Edge (>)*, the actual value of the channel *SIGNAL_VAL* is stored to the channel *HOLD_VAL_COND*. The value of the channel *HOLD_VAL_COND* is *NaN* before reaching the *Cond*ition the first time (see Fig. 7.56).

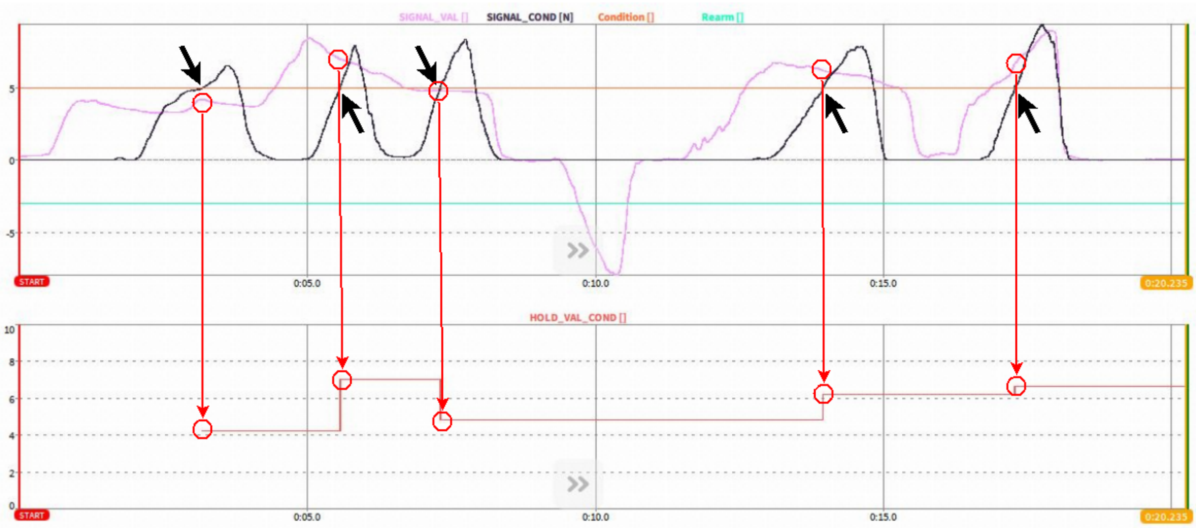


Fig. 7.56: HOLD function with *Cond*ition

HOLD_VAL_COND_INIT = hold('SIGNAL_VAL','SIGNAL_COND'>5,2)

If the channel *SIGNAL_COND* passes *5* with a *Rising Edge (>)*, the actual value of the channel *SIGNAL_VAL* is stored to the channel *HOLD_VAL_COND_INIT*. The *Init*ial value of the channel *HOLD_VAL_COND_INIT* is *2* before reaching the *Cond*ition the first time (see Fig. 7.57).

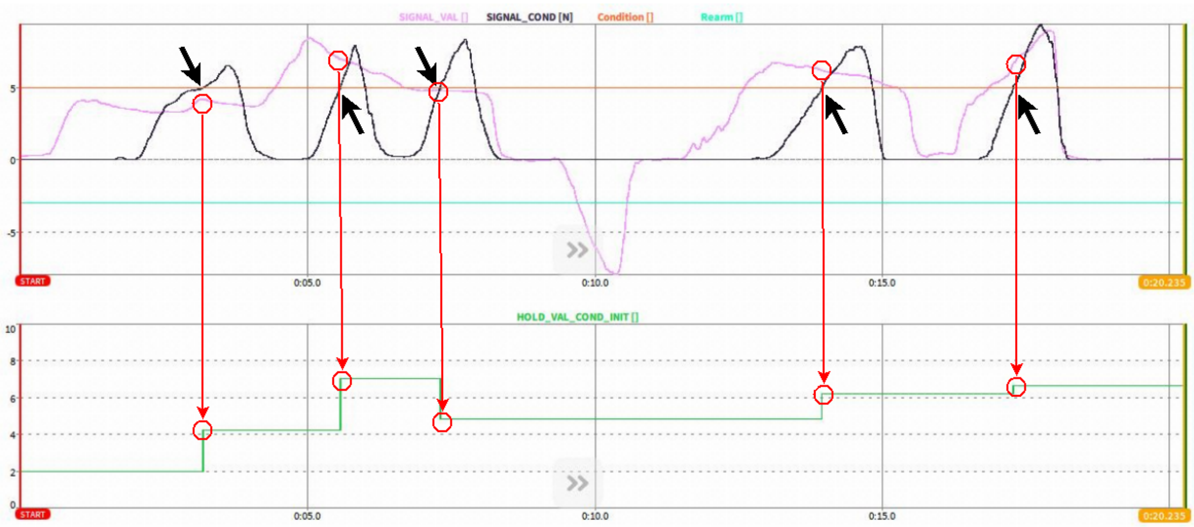


Fig. 7.57: HOLD function with *Cond*ition and *Init*ial value

HOLD_VAL_COND_INIT_REARM = hold('SIGNAL_VAL','SIGNAL_COND'>5,2,'SIGNAL_VAL'>-3)

If the channel *SIGNAL_COND* passes *5* with a *Rising Edge (>)*, the actual value of the channel *SIGNAL_VAL* is stored to the channel *HOLD_VAL_COND_INIT_REARM*. The *Init*ial value of the channel *HOLD_VAL_COND_INIT_REARM* is *2* before reaching the *Cond*ition the first time. In addition, the channel *SIGNAL_VAL* must pass *-3* with a *Rising Edge (>)* before the channel *HOLD_VAL_COND_INIT_REARM* updates again when the channel *SIGNAL_COND* passes 5 with a *Rising Edge (>)* (see Fig. 7.58).

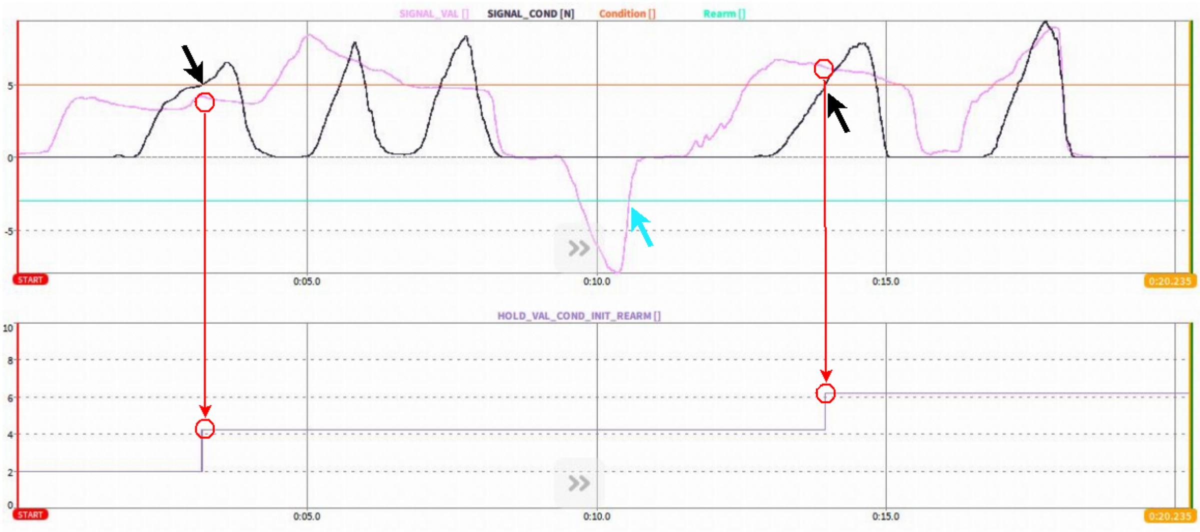


Fig. 7.58: HOLD function with *Cond*ition, *Init*ial value and *Rearm* level

Stopwatch function (stopwatch)

Syntax: stopwatch(start_cond,stop_cond, reset)

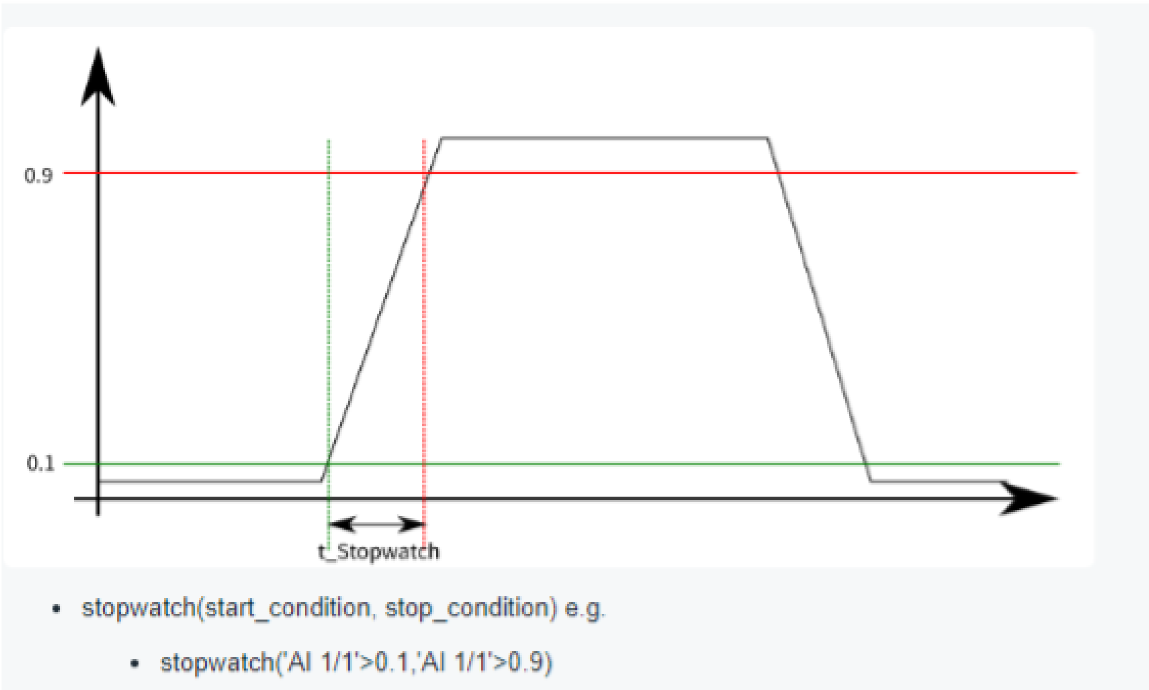


Fig. 7.59: Schematic explanation of the stopwatch function

The stopwatch function returns the timespan in seconds between two conditions (*start_cond* and *stop_cond*). Both conditions may refer to the same channel or to different channels. An optional *reset* condition resets the stopwatch function to *NaN* until the next *start_cond* occurs.

- If the *reset* is not specified, the stopwatch-function restarts to count at 0s automatically at every new *start_cond*.

- If the *reset* is specified as *0* (i.e. *stopwatch (start_cond,stop_cond,0)*), the stopwatch function does not restart to count at 0s when a new *start_cond* occurs but continues counting from the last value.
- If the reset is specified differently, i.e. as *signal<0*, the stopwatch function is reset to *NaN* if this certain event occurs and starts counting from 0s if a new *start_cond* occurs.
- If the *start_cond* appears again before a *stop_cond* is reached, the *start_cond* will be ignored.
- If *start_cond* is equal to the *stop_cond*, the stopwatch returns 0s.

The following examples will clarify the functionality of the stopwatch function (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

STOPWATCH_cond1_cond2 = stopwatch('SIGNAL1'>100,'SIGNAL1'>800)

The stopwatch function (dark blue graph in Fig. 7.60) will start to measure the time in seconds if the channel *SIGNAL1* (light blue graph in Fig. 7.60) exceeds 100 and stop to measure the time in seconds if the channel *SIGNAL1* exceeds 800. If *SIGNAL1* will exceed 100 again, the stopwatch function restarts to measure at 0s.

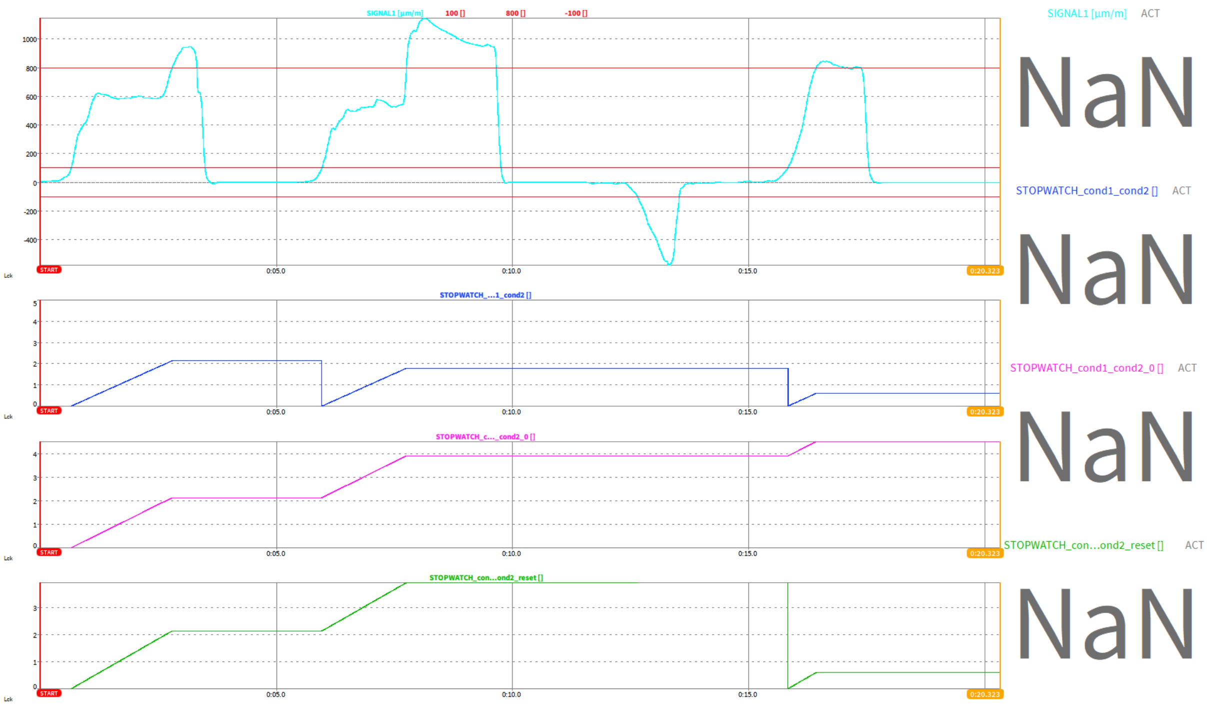


Fig. 7.60: Stopwatch with start and stop condition

STOPWATCH_cond1_cond2_0 = stopwatch('SIGNAL1'>100,'SIGNAL1'>800,0)

The stopwatch function (pink graph in Fig. 7.61) will start to measure the time in seconds if the channel *SIGNAL1* (light blue graph in Fig. 7.61) exceeds 100 and stop to measure the time in seconds when the channel *SIGNAL1* exceeds 800. If *SIGNAL1* will exceed 100 again, the stopwatch function restarts to measure from the last value and NOT reset.

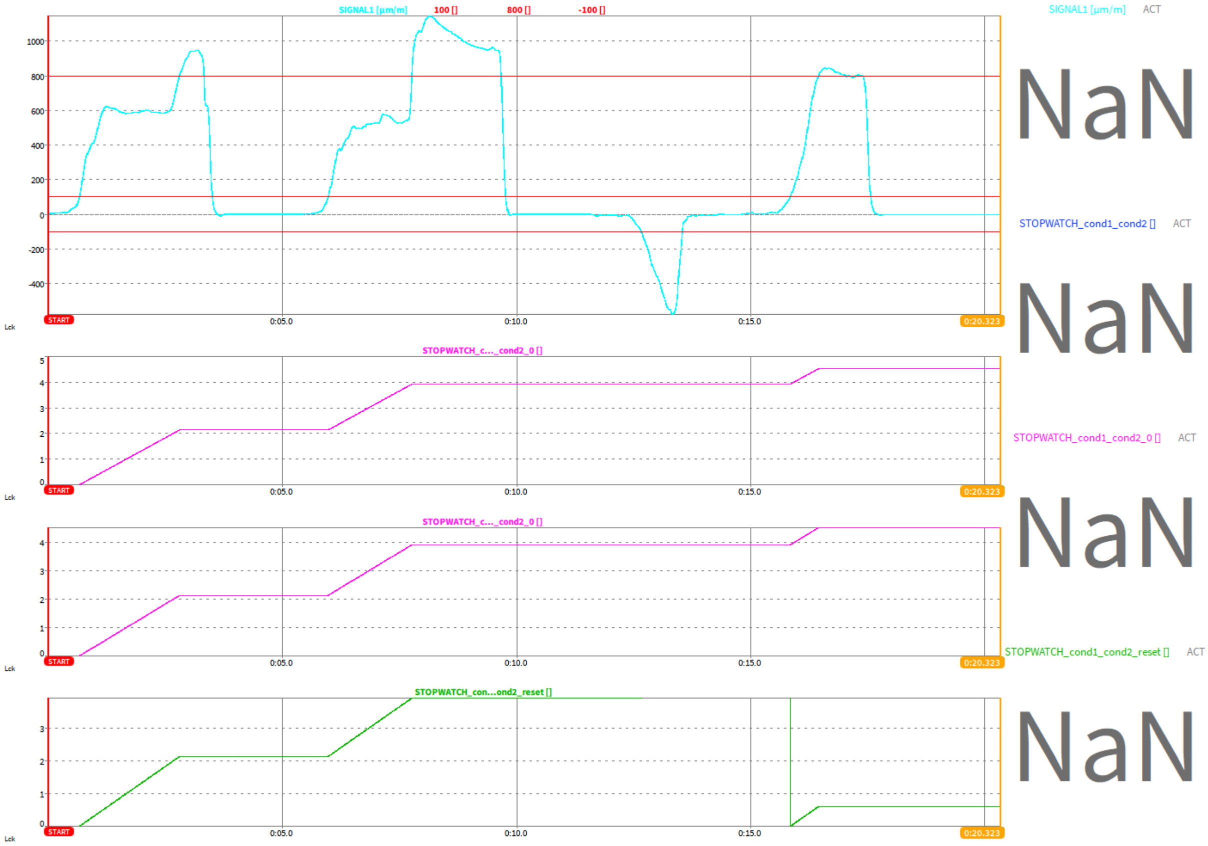


Fig. 7.61: Stopwatch with start and stop condition, no reset

STOPWATCH_cond1_cond2_reset = stopwatch('SIGNAL1'>100,'SIGNAL1'>800,'SIGNAL1'<-100)

The stopwatch function (green graph in Fig. 7.62) will start to measure the time in seconds if the channel *SIGNAL1* (light blue graph in Fig. 7.62) exceeds 100 and stop to measure the time in seconds when the channel *SIGNAL1* exceeds 800. If (and only if) *SIGNAL1* decreases below -100, the stopwatch function will reset to *NaN* and restart to measure from 0s if *SIGNAL1* exceeds 100 again.

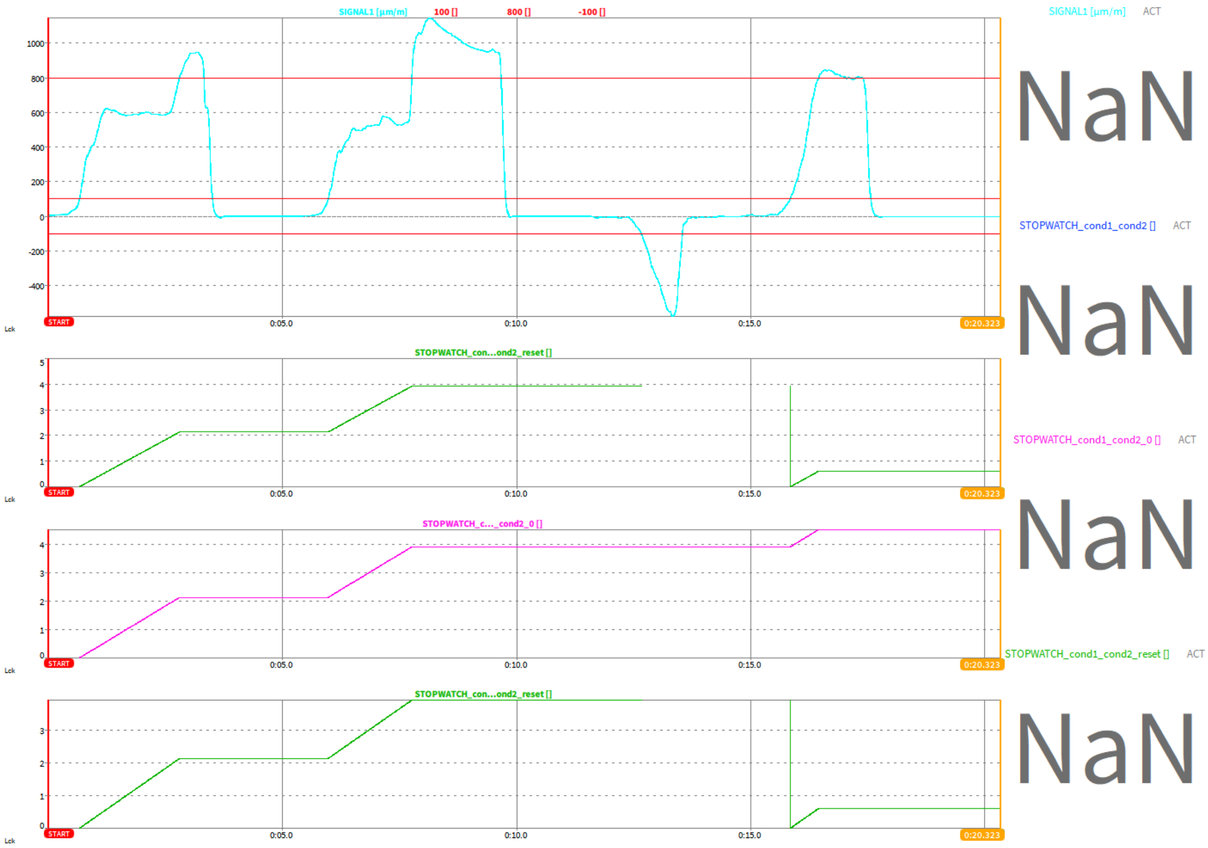


Fig. 7.62: Stopwatch with start and stop condition, reset specified

Measdiff function (measdiff)

Syntax: measdiff(val,cond1,cond2)

The measdiff function returns the value difference between *cond1* and *cond2* of the signal *val*. The three parameters may refer to same channel or each to a different channel.

The measdiff function will return *NaN* before *cond2* is reached for the first time.

- If *cond1* and *cond2* are triggered several times during one measurement, the measdiff function will be updated after *cond2* is reached again.
- If *cond1* is reached several times before *cond2* is reached, the measurement will start when *cond1* is reached for the first time and will not be reset if *cond1* is reached again.

The following examples will clarify the functionality of the measdiff function (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

MEASDIFF_val_cond1_cond2 = measdiff('SIGNAL2','SIGNAL1'>100,'SIGNAL1'>800)

The measdiff function (purple graph in Fig. 7.63) will measure and return the value difference of *SIGNAL2* (green graph in Fig. 7.63) triggered by the following conditions: The measurement is initialized when *SIGNAL1* (light blue graph in Fig. 7.63) exceeds 100 and stopped when *SIGNAL1* exceeds 800.

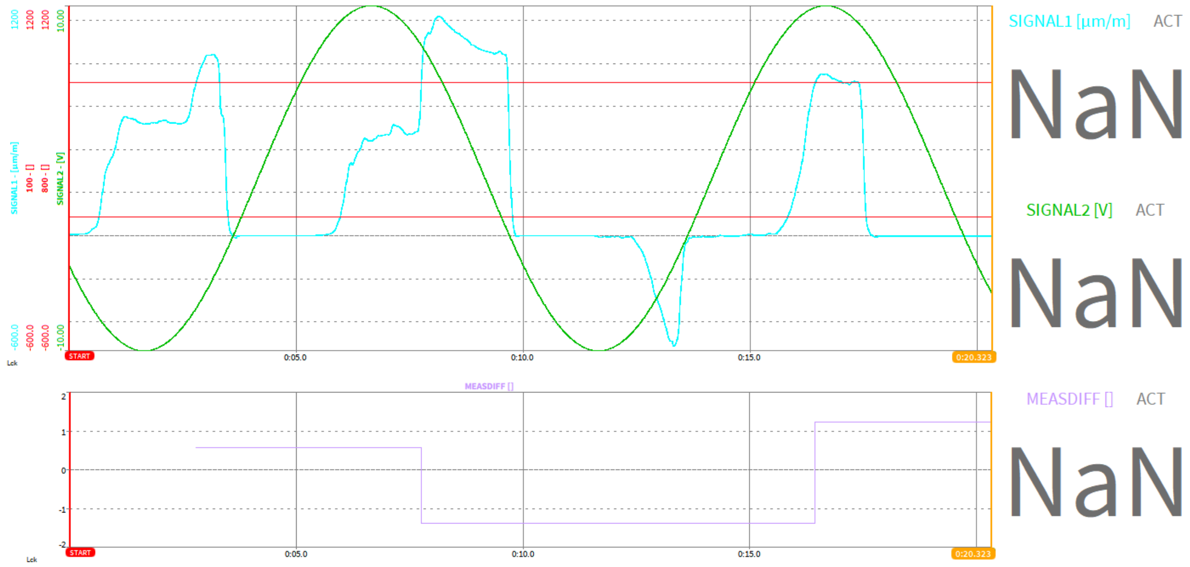


Fig. 7.63: Measdiff function

Period function (period)

Syntax: period(cond,[rearm])

The period function returns the period time of a signal in seconds. The signal to which the function shall be applied to must be specified in the *cond* in combination with the period threshold which is normally zero.

An optional *rearm* level will suppress distortion caused by signal noise. The *rearm* can be applied to the same or to a different signal.

The following examples will clarify the functionality of the period function (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

PERIOD_cond = period('SIGNAL'>0)

The period function (green graph in Fig. 7.64) will measure and return the period time of *SIGNAL* (brown graph in Fig. 7.64) for the condition that the *SIGNAL* level is higher than 0. As the *SIGNAL* is a pure sine wave with frequency 0.5 Hz, its period time should be 2 seconds. But due to noise on the signal, the zero-level is crossed several times (see Fig. 7.65) and causes a wrong measurement result when determining the period time. To suppress the influence of noise on the period time determination, a rearm level can be optionally added. This is explained in the next section.

PERIOD_cond_rearm = period('SIGNAL'>0,'SIGNAL'>-5)

The period function (green graph in Fig. 7.64) will measure and return the period time of *SIGNAL* (brown graph in Fig. 7.64) for the condition that the *SIGNAL* level is higher than 0. As period time measurements can be disturbed by noise, a rearm level is added in this example to avoid the influence of noise to the signal. The rearm level is set to the following condition: The level of the *SIGNAL* must exceed *-5*. This means that the *SIGNAL* must exceed *-5* before the condition *SIGNAL>0* is detected again. With this optional rearm level the influence of noise on the period time measurement that can be seen in the green graph of Fig. 7.64 is suppressed and the detected period time is always 2s as it can be seen in the blue graph of Fig. 7.64.

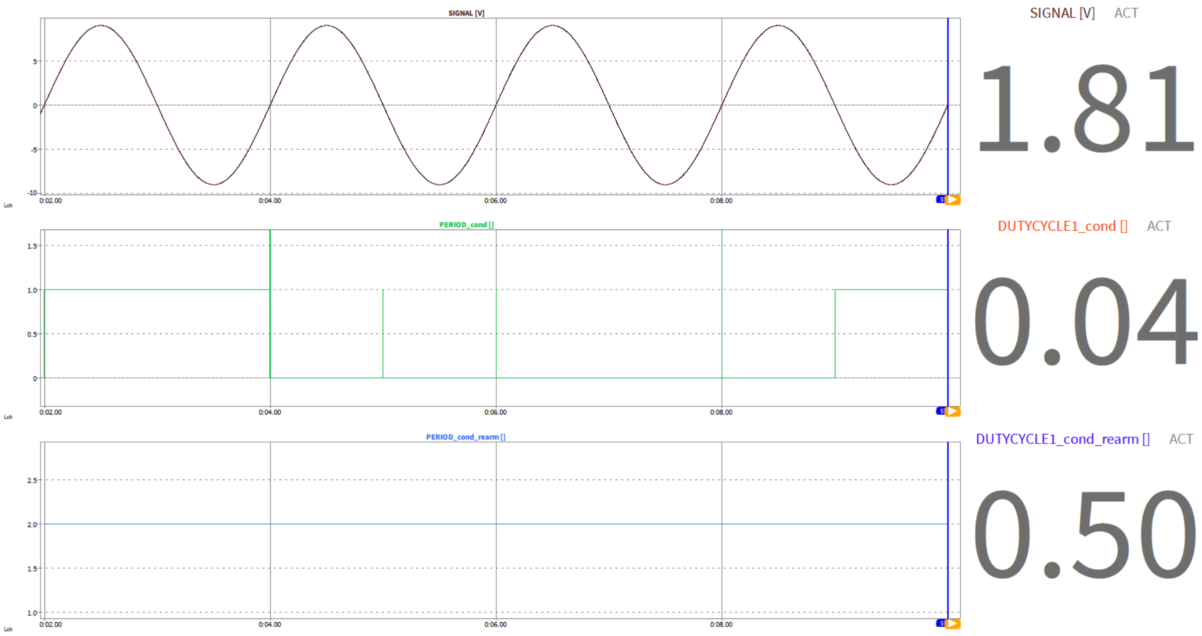


Fig. 7.64: Period function

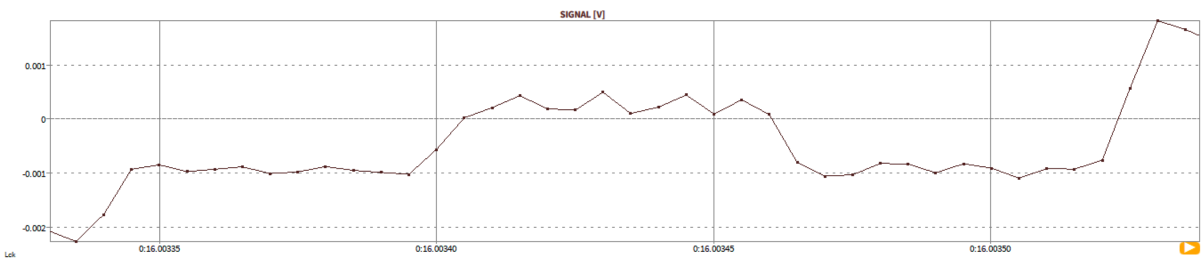


Fig. 7.65: Noise disturbing the correct functionality of the period determination

Dutycycle function (dutycylce)

Syntax: dutycylce(cond,[rearm])

The dutycycle function returns the dutycycle of a signal. The signal to which the function shall be applied to must be specified in the *cond* in combination with the dutycylce threshold.

An optional *rearm* level will suppress distortion caused by signal noise. The *rearm* can be applied to the same or to a different signal.

The following examples will clarify the functionality of the dutycycle function (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

DUTYCYCLE_cond = dutycycle('SIGNAL'>0)

The dutycylce function (orange graph in Fig. 7.66) will measure and return the dutycycle of *SIGNAL* (brown graph in Fig. 7.66) for the condition that the *SIGNAL* level is higher than 0. As the *SIGNAL* is a pure sine wave, its duty cycle should be 0.5 (or 50%). But due to noise on the signal, the zero-level is crossed several times (see Fig. 7.67) and causes a wrong measurement result when determining the dutycycle. To suppress the influence of noise on the dutycycle determination, a rearm level can be optionally added. This is explained in the next section.

DUTYCYCLE_cond_rearm = dutycycle('SIGNAL'>0,'SIGNAL'>-5)

The dutycylce function (orange graph in Fig. 7.66) will measure and return the dutycycle of *SIGNAL* for the condition that the *SIGNAL* level is higher than 0. As dutycycle measurements can be disturbed by noise, a rearm level is added in this example to avoid the influence of noise to the signal. The rearm level is set to the following condition: The level of the *SIGNAL* must exceed *-5*. This means that the *SIGNAL* must exceed *-5* before the condition *SIGNAL >0* is detected again. With this optional rearm level the influence of noise on the dutycylce measurement that can be seen in the orange graph of Fig. 7.67 is suppressed and the detected dutycycle is always 0.5 (50%) as it can be seen in the blue graph of Fig. 7.67.

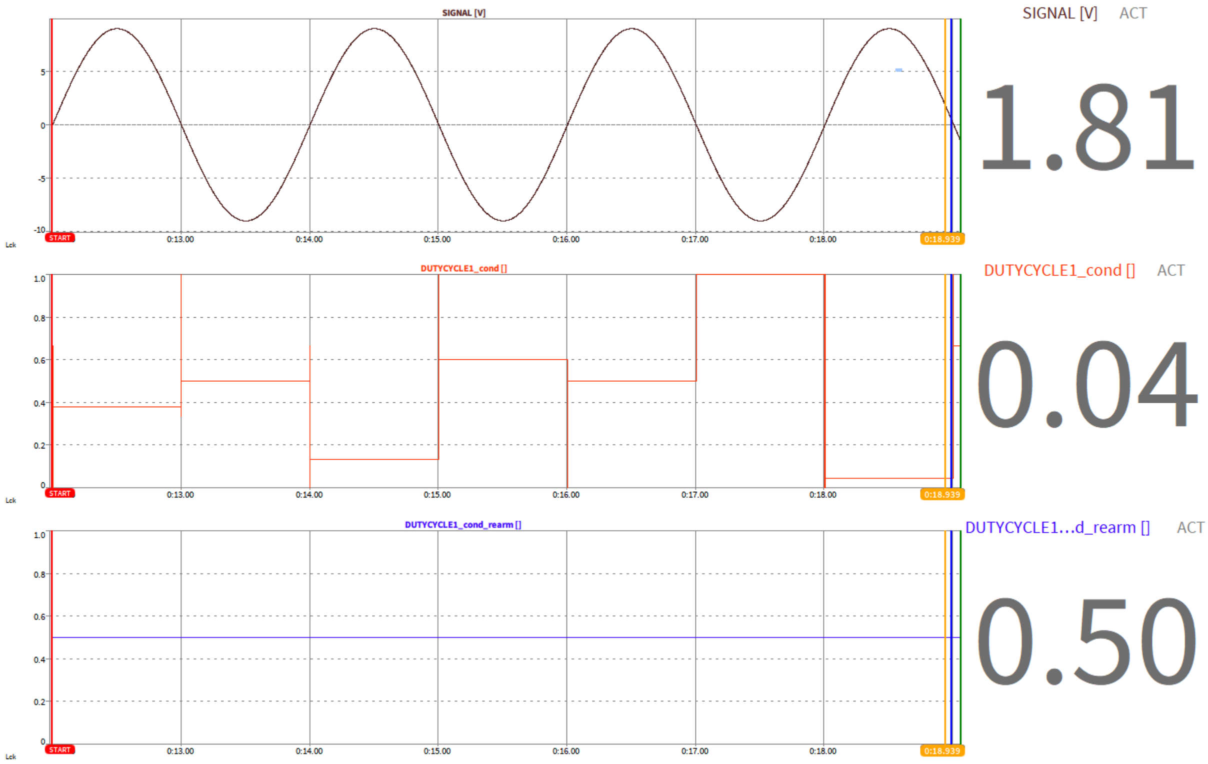


Fig. 7.66: Dutycycle function

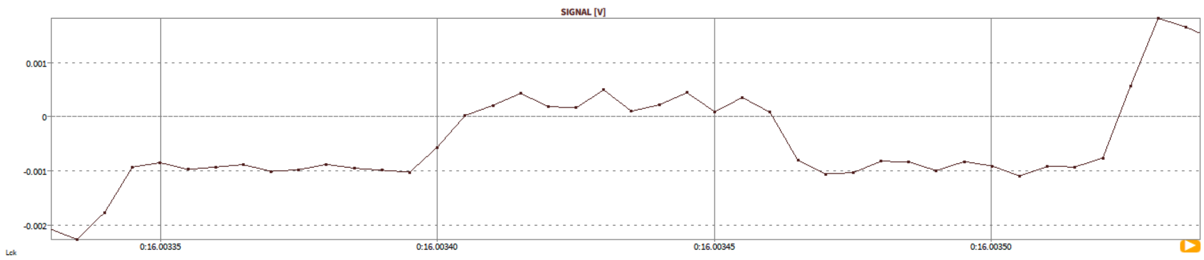


Fig. 7.67: Noise disturbing the correct functionality of the dutycycle determination

Edge function (edge)

Syntax: edge(cond,rearm)

The edge function returns a rising egde from 0 to 1 in case the *cond*ition is passed and a falling edge from 1 to 0 if the *rearm* is passed.

The following examples will clarify the functionality of the edge function (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

EDGE_cond_ream = edge('SIGNAL'>800, 'SIGNAL'<-100)

The edge function (green graph in Fig. 7.68) will return a rising edge from 0 to 1for the condition that the *SIGNAL* level exceeds 800 (brown graph in Fig. 7.68). In case the *SIGNAL* falls below -100, the edge function will return a falling edge from 1 to 0.

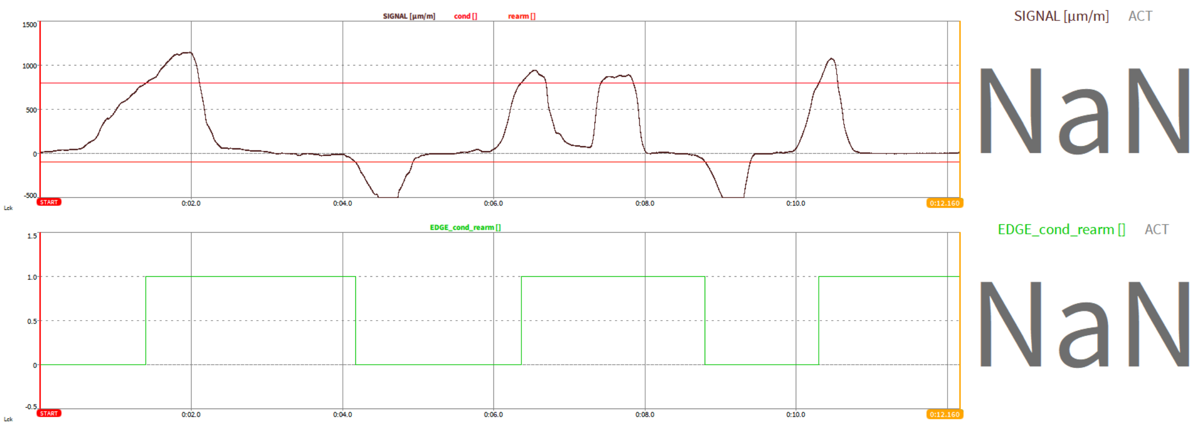


Fig. 7.68: Edge function

Combination of edge function and other formulas

In case a formula that does not contain a rearm level as optional parameter, such as the stopwatch function (see *Stopwatch function (stopwatch)*) or the measdiff function (see *Measdiff function (measdiff)*), the edge function (see *Edge function (edge)*) can be used to generate this rearm level.

The following example will clarify the functionality by demonstration the combination of the edge and stopwatch function (corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN):

The blue signal in Fig. 7.69 will measure the time using the stopwatch between the following two conditions: *cond1* is true if *SIGNAL1* (green signal in Fig. 7.69) exceeds 100. *Cond2* is true if *SIGNAL1* (green signal in Fig. 7.69) exceeds 800.

The formula syntax of the blue signal in Fig. 7.66 is the following:

stopwatch('SIGNAL1'>100,'SIGNAL1'>800)

Due to noise, *cond1* is passed several times which might be undesired. To suppress this influence of noise a rearm level of -100 can be added for cond1 by using the edge function. The result can be seen in the orange graph of Fig. 7.69. In this example, the stopwatch function is only restarted if *SIGNAL1* falls below -100.

The syntax is the following:

stopwatch(edge('SIGNAL1'>100,'SIGNAL1'<-100)>0.5,'SIGNAL1'>800)

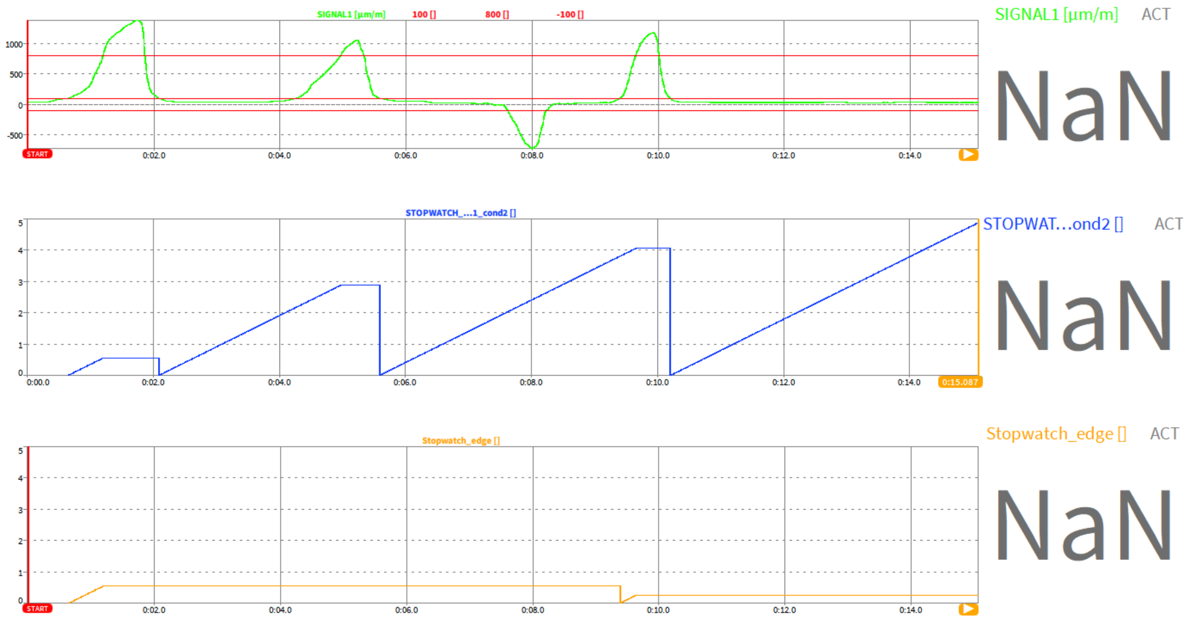


Fig. 7.69: Combination of edge and stopwatch function

Rolling-overall-functions

rmin(value[,reset])

Returns the global minimum of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

rmax(value[,reset])

Returns the global maximum of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

ravg(value[,reset])

Returns the global arithmetic average of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

rrms(value[,reset])

Returns the global RMS of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

rsum(value[,reset])

Returns the global sum of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

racrms(value[,reset])

Returns the global ACRMS of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

For details about the ACRMS, refer to *Statistics channel*.

rp2p(value[,reset])

Returns the global peak-to-peak level of the signal specified as *value* from acquisition start until the current instant of time; Is reset at measurement start; Can be optionally *reset* by specifying a *reset* condition; The update rate is equal to the sample rate of the channel with the highest sample rate that is assigned to this formula.

A corresponding dmd-file can be found here: https://ccc.dewetron.com/pl/OXYGEN

Array channels in formulas

Array channels in OXYGEN are data channels (or vectors) that include several data elements for one instance of time, such as harmonics from a powergroup, amplitude spectra of a FFT calculation or a CPB spectrum. Using OXYGEN, Array channels are typically either visualized by using an Array Chart or a Spectrum Analyzer.

Besides time based synchronous and asynchronous channels it is also possible work with array channels in the Formula editor.

Mathematical operations with array channels

The following mathematical operations are supported when using array channels in formulas:

- Basic math operations for arrays with same dimensions supported (see ① in Fig. 7.70): + - * /
- Operations (+ - * /) with arrays and constants (see ② in Fig. 7.70)

In both cases, the output of the formula will be a new array channel.

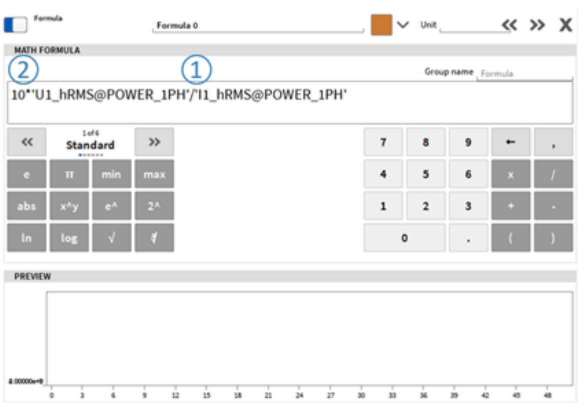


Fig. 7.70: Basic math operations for arrays

In addition to that, it is possible to use the following operators in combination with array channels:

- Standard operators (see Fig. 7.71)

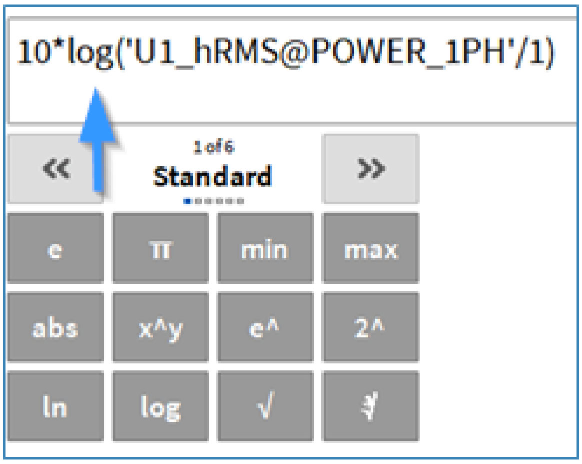


Fig. 7.71: Standard operators in combination with array channels

- Trigonometric operators (see Fig. 7.72)

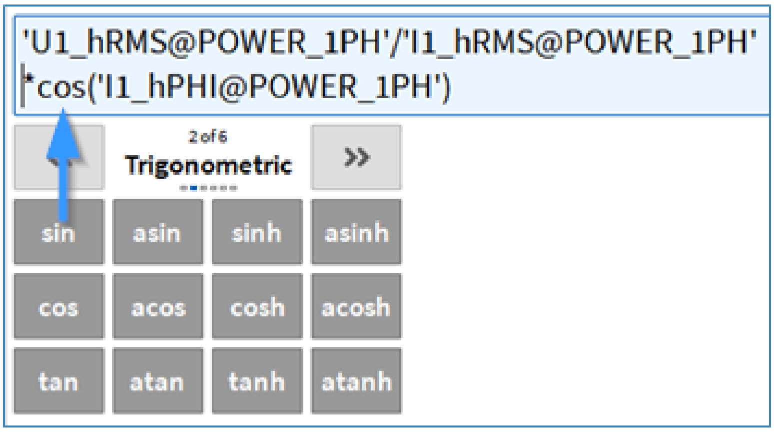


Fig. 7.72: Trigonometric operators in combination with array channels

- Logic operators (see Fig. 7.73)

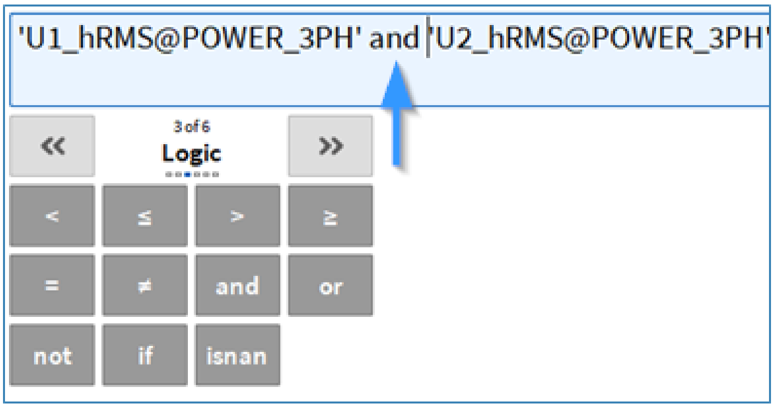


Fig. 7.73: Logic operators in combination with array channels

The formula output will be a new array channel here as well.

Extraction of array elements

It is possible to extract one or several elements from an array channel into a new array channel. The syntax for that is following the Python programming language:

- The first element of an array has always the index 0.
- When extracting several adjacent elements, the first specified index is always inclusive and the last one is always exclusive (see Fig. 7.75)

The following options for extracting array elements exist:

- Extraction of one dedicated element (see Fig. 7.74). The output will be an asynchronous time domain channel

Fig. 7.74: Extraction of one dedicated element

- Extraction of several adjacent elements (see Fig. 7.75). The output will be an array channel with the number of extracted element as new dimension.

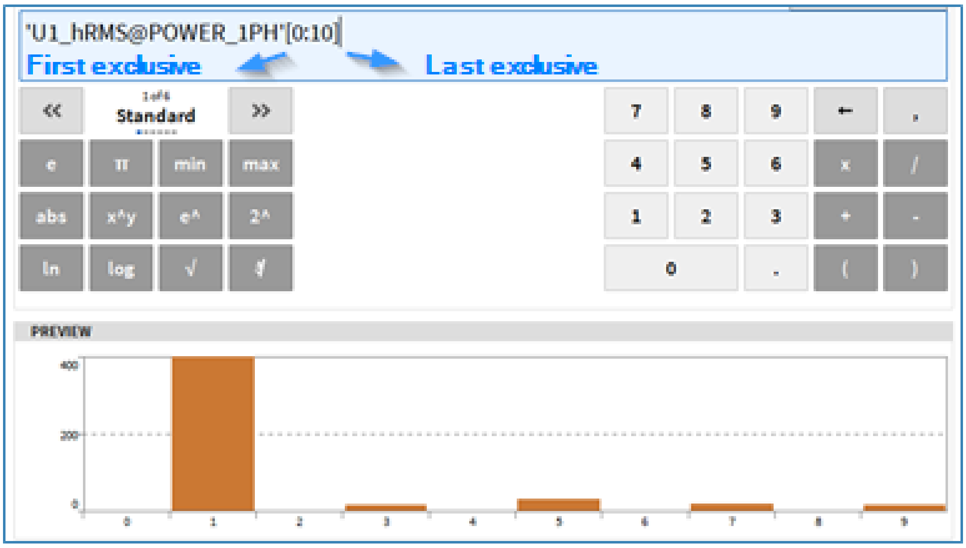


Fig. 7.75: Extraction of several adjacent elements

- Extraction of several adjacent elements with a step size between the elements to be extracted (see Fig. 7.76). The output will be an array channel with the number of extracted element as new dimension.

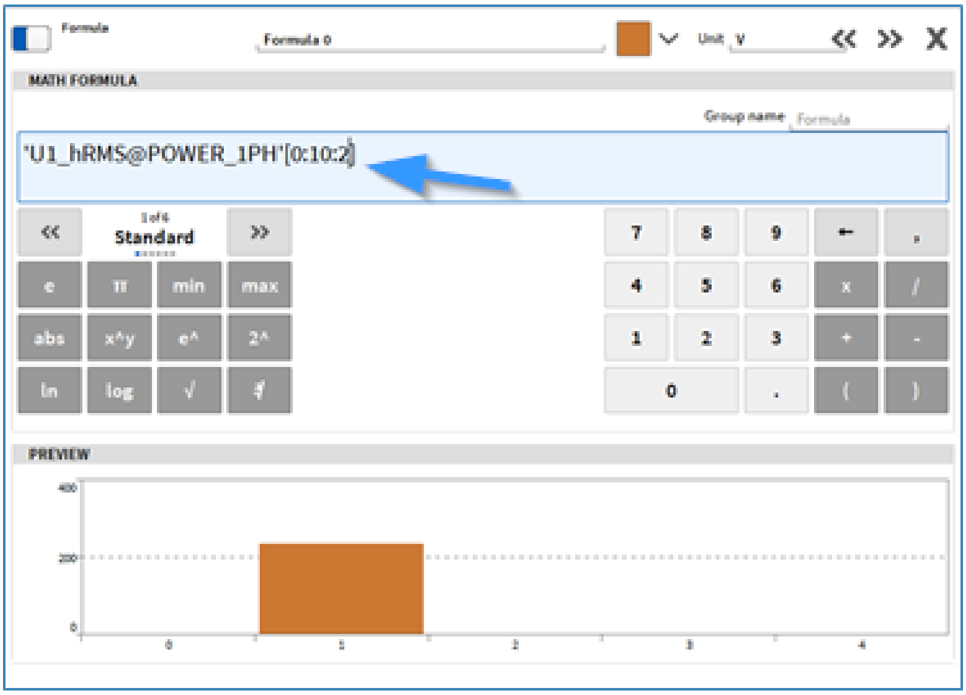


Fig. 7.76: Extraction of several adjacent elements with step size between the elements to be extracted

Creation of arrays with constants

Last but not least it is possible to create array channels with constant elements (see Fig. 7.77). The update rate can be defined by adding a time domain channel and multiplying it with zero. The array will then have the same update rate as the time domain channel.

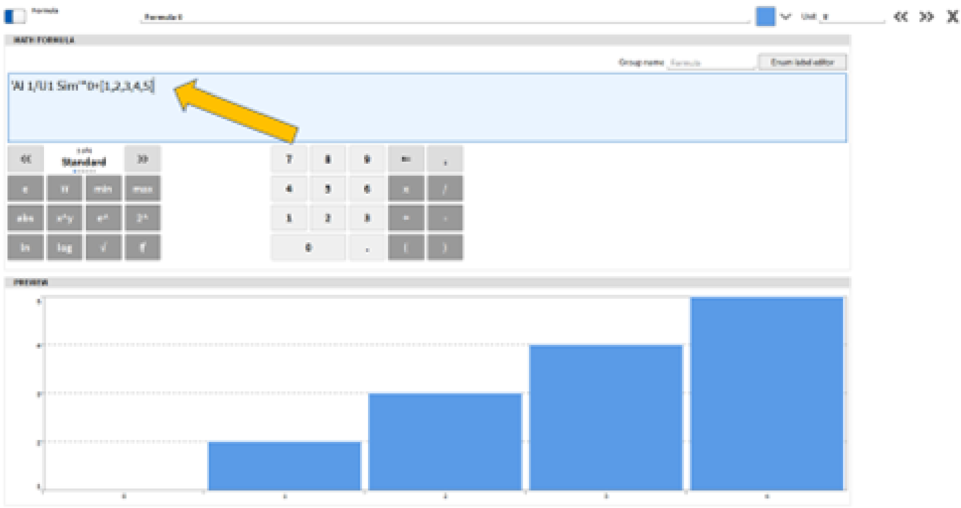


Fig. 7.77: Creation of arrays with constant elements

Statistics channel

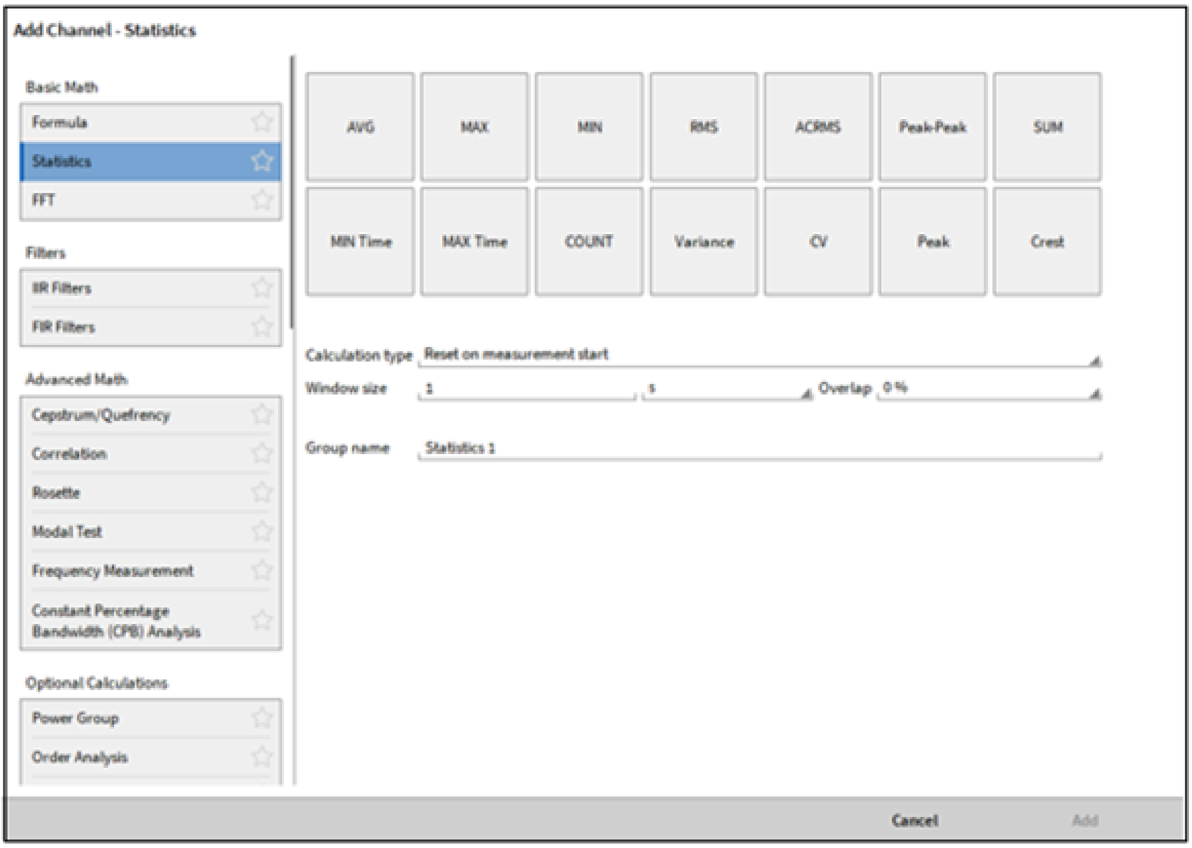


Fig. 7.78: Pop-up window for creating a statistics channel

After clicking on the *Add* button, the *Calculation Setup* window will appear (see Fig. 7.78). For the creation of a Statistics channel, the user must select the desired input channel before clicking on the *Add* button. The user can select several input channels simultaneously to create several statistic channels with the same settings at once. In the *Calculation Setup*, the user can define which statistics shall be calculated for the input channel(s). The user may select several statistical values. An individual channel for each value will be created afterwards. Select if the calculation should be carried on continuously (since acquisition start), if the calculation should be reset on recording start or if an overall value (single value) over the recording duration should be calculated. After that a time interval (Window Size) and optional overlap for the calculation of the desired value must be defined. Furthermore, the user can define a *Group name* in which several channels can be summarized in the *Data Channels* menu. After pressing enter, the channel will appear in the *Data Channels* menu. The defined channel parameters can be changed afterwards in the Channel Setup (see Fig. 7.79:).

Table 7.15: Statistic calculation types

Calculation type	Description	Parameters
Reset on measurement start	Resets calculation of statistics at measurement start.	Window size Overlap
Continuous	Will not be reset at measurement start	Window size Overlap
Overall	Calculates only one value over all acquired data points. Is visible as a horizontal line in a recorder.	None
Triggered	Starts the calculation of a statistic on a trigger event. Trigger channels, rising edge, falling edge, trigger levels and the stop mode can be defined. The stop mode can be retrigger, stop trigger or duration.	Start trigger channel Start trigger level Stop mode Stop trigger channel Stop trigger level
Running	Inherits the sample rate of the channel the statistic is for. Looks back the manually set window time at every new incoming sample and calculates the statistic for this window. Usually has many samples in one window size.	Window size

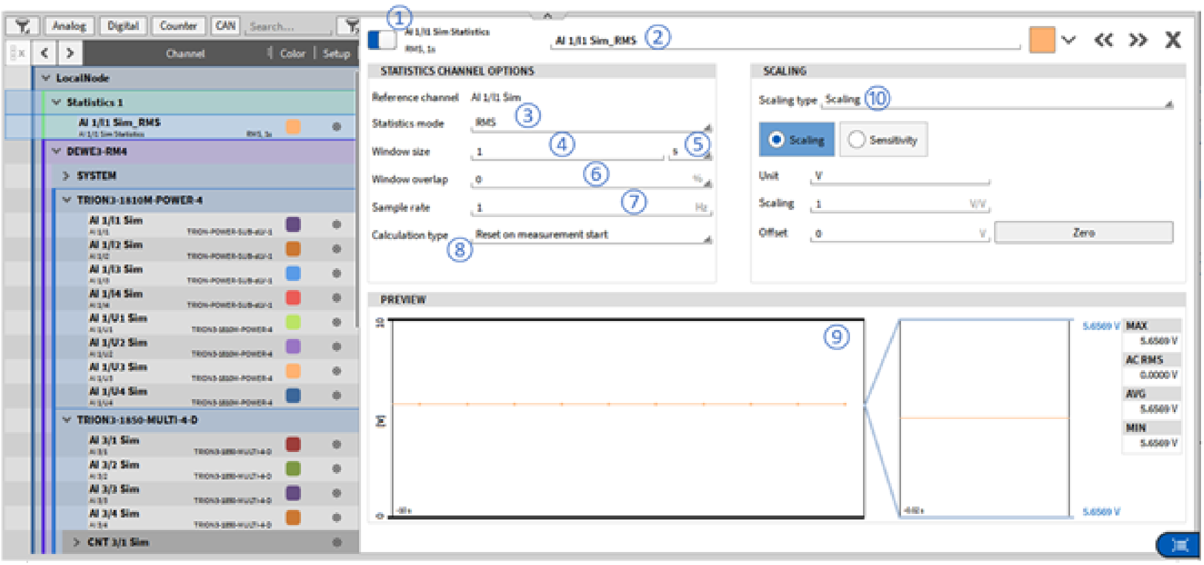


Fig. 7.79: Statistics Channel Setup Overview

Table 7.16: Push buttons in the Statistics Channel Setup – Overview

No.	Function	Description
1	*Active* button	Setting a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel and can be recorded, an inactive channel not.
2	Channel Name	Individual channel name; Can be changed individually.
3	*Statistics Mode* Setup	Select the statistical value that shall be calculated.
4	Window Size	Type in the desired window size (will affect the Sample Rate ⑥).
5	Window Size Unit	Select the unit of the window size. Select between seconds (*s*), minutes (m), hours (*h*) and days (*d*) (will affect the Sample Rate ⑥).
6	Window overlap	Choose a window overlap between 0 and 99 %.
7	Sample Rate	Sample rate that is calculated from the Window size in Hz (Window Size can also be changed via Sample Rate changes).
8	Calculation type	Select if the calculation should be carried on continuously, if the calculation should be reset on measurement start or if an overall value (single value) over the recording duration should be calculated.
9	Preview window	Real Time preview of the calculation.
10	*Scaling* menu	Change the channels' scaling by entering a Scaling factor or changing the sensitivity (and/or entering an offset) or by a 2-point scaling.

The following figure shows the mechanism for the statistics calculations and how the calculation window is moved.

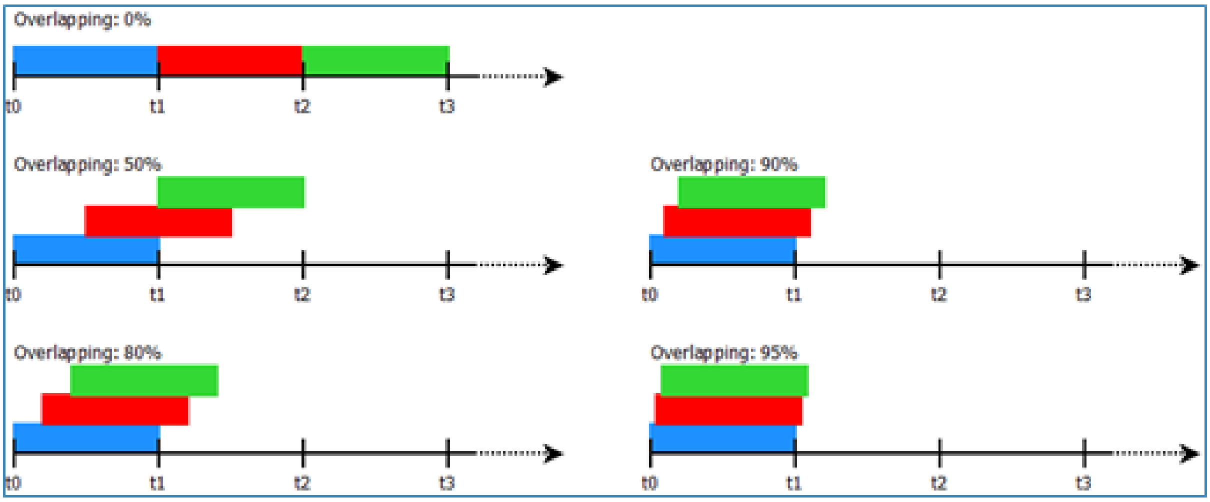


Fig. 7.80: Overlapping mechanism for the statistic calculations

Selectable statistical parameters

i = 1...N

N = Sample Rate of Input Channel * Window Size

- AVG: Calculates the linear mean value for the selected Window size according to the following formula:

$$\text{AVG} = \frac{1}{N}\sum_{i=1}^{N}\text{Signal level}_i$$

- MAX: Calculates the maximum signal level appearing in the individual time window

$$\text{MAX} = \text{MAX}\left\{\text{Signal level}_i\right\}$$

- MIN: Calculates the minimum signal level appearing in the individual time window

$$\text{MIN} = \text{MIN}\left\{\text{Signal level}_i\right\}$$

- RMS: Calculates the quadratic mean value (RMS) for the selected window size according to the following formula

$$\text{RMS} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\text{Signal level}_i)^2} = \sqrt{\text{AVG}^2 + \text{ACRM}S^2}$$

- ACRMS: Calculates the quadratic mean value which is revised from DC components. This value is identical to the standard deviation calculated according to the following formula

$$\text{ACRMS} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\text{Signal level}_i - \text{AVG})^2}$$

- Peak-Peak: Calculates the peak-peak value for the selected window size by following formula:

$$\text{Peak - Peak = 2 * RMS *}\sqrt{2}$$

- SUM: calculates the sum of the signal level within the window size by following formula

$$\text{SUM} = \sum_{i=1}^{N} \text{Signal level}_i$$

- MIN Time: Determines the time, where the minimum of the signal was reached.
- MAX Time: Determines the time, where the maximum of the signal was reached.
- COUNT: Counts the number of samples within a calculation window.
- Variance: Calculates the variance, which is calculated by the squared ACRMS value by following formula:

$$\text{Variance} = \frac{1}{N} \sum_{i=1}^{N} (\text{Signal level}_i - AVG)^2$$

- CV: Calculates the coefficient of variation by following formula

$$\text{CV} = \frac{ACRMS}{AVG}$$

- Peak: Calculates the peak value by following formula

$$\text{Peak} = \text{MAX} - \text{AVG}$$

- Crest: Calculates the crest factor by following formula

$$\text{Crest factor} = \frac{MAX}{RMS}$$

Note: Difference between the RMS and the ACRMS value: The RMS and the ACRMS value of a signal without DC component is the same. Let's assume a sine wave with an amplitude of 1 and no DC offset:

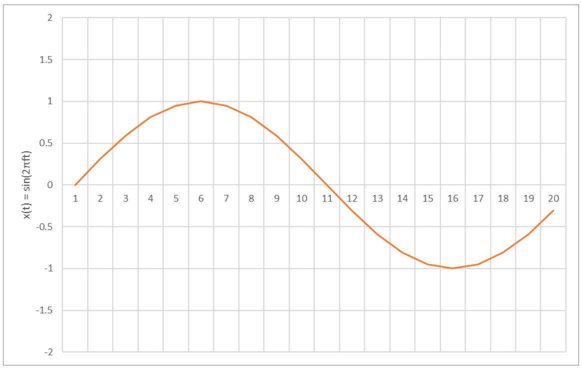


Fig. 7.81: Sine wave with amplitude 1, no DC component

In this case the RMS value is ~0.707 and the ACRMS value is ~0.707 as well.

If the signal has a DC component, the RMS value respects this DC component, but the ACRMS value does not respect the DC component:

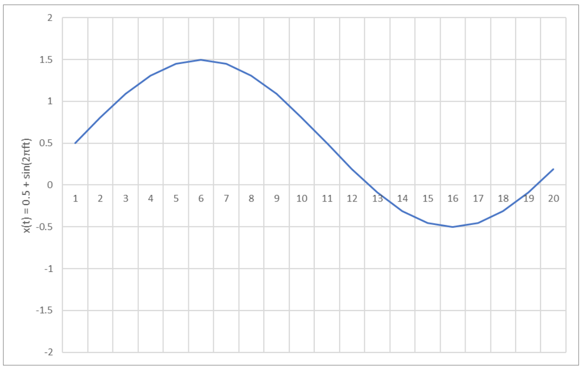


Fig. 7.82: Sine wave with amplitude 1, 0.5 DC component

For this signal, the RMS value is ~0.866, because the DC component is respected, but the ACRMS value is again ~0.707, because the DC component is not respected.

Using Array channels in Statistics

Besides time based synchronous and asynchronous channels it is also possible to assign array channels to Statistics calculations.

The calculation is created in the same manner as for time domain channels (see Fig. 7.83).

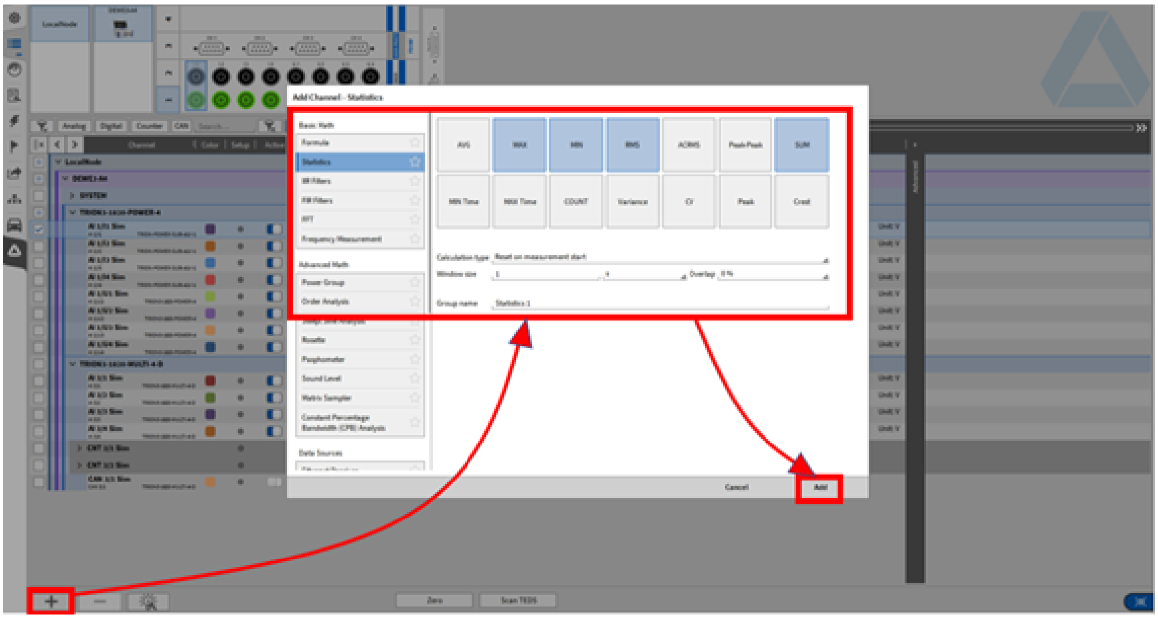


Fig. 7.83: Creation of statistics calculations with array channels

The resulting Statistics channel will be another array with same dimensions as the source channel. The update rate will be equal to the statistics window size (see Fig. 7.84).

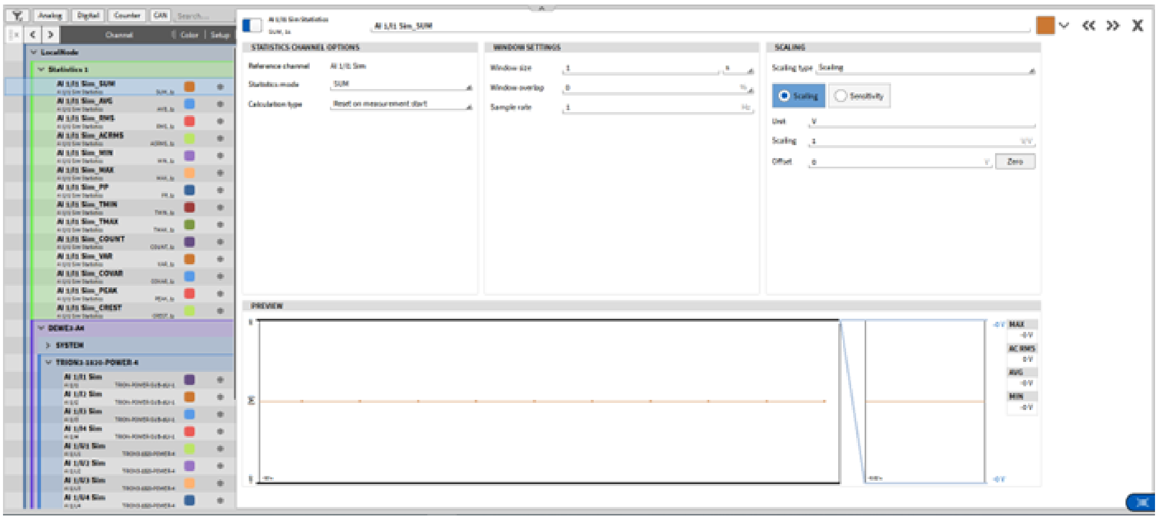


Fig. 7.84: Resulting statistics channels

FFT channels

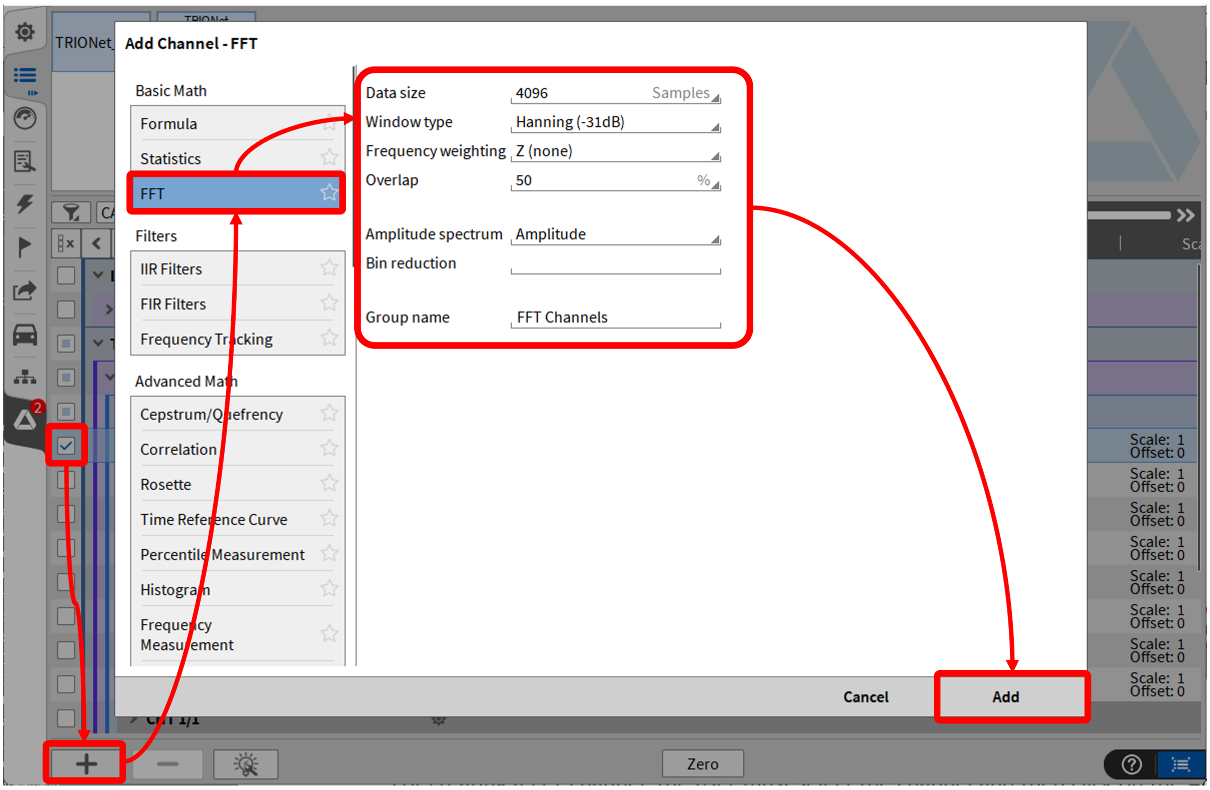


Fig. 7.85: Pop-up window for creating an FFT channel

For creating a FFT channel, the user must select the channel and then click on the *Add* button in the lower left corner (marked red in Fig. 7.48) and select *FFT* in the appearing window (see Fig. 7.93). The user can select several input channels simultaneously to create several FFT channels with the same settings at once.

Note: FFT math can only be applied to synchronous channels, such as analog input channels or counter channels but not to asynchronous channels, CAN channels, EPAD cannels, or power group channels.

Note: The difference between the FFT calculation using this math module or the Instrument Spectrum Analyzer is that the calculation using the math module is deterministic and the calculation using the Spectrum Analyzer is stochastic, i.e. the deterministic calculation can always be reproduced, because the exact instant of time each FFT spectrum is calculated is contained. This is not the case for stochastic calculation.

In addition, as the FFT calculation using the math module results in own FFT channels, the data can be exported to third party formats using the Export menu in the *PLAY* mode (for details, refer to *Export Settings*). This is not the case for the calculation using the Spectrum Analyzer.

Five channels may be created for each FFT calculation:

1. The channel containing the **complex spectrum** *Yk* (called *Channel_Name_Cpx*). This channel cannot be visualized with an OXYGEN Instrument but is only useful for exporting it and using it for post-processing in a 3rd party software.
2. The channel containing the **amplitude spectrum** *Ak* (called *Channel_Name_Amp*) which is calculated according to the following formula:

$$A_k = \frac{1}{N}\sqrt{\text{Re}\left\{Y_k\right\}^2 + \text{Im}\left\{Y_k\right\}^2}\,; \qquad k = 0 \qquad [\text{Signal unit}]$$

$$A_k = \frac{2}{N}\sqrt{\text{Re}\left\{Y_k\right\}^2 + \text{Im}\left\{Y_k\right\}^2}\,; \qquad k = 1\ldots N \qquad [\text{Signal unit}]$$

   - This channel can be visualized within OXYGEN using the Spectrum Analyzer (see *Spectrum analyzer*) if the actual spectrum shall be plotted or it may also be assigned to the Spectrogram Instrument (see *Spectrogram*) if the time dependent spectral trend shall be displayed.

3. The channel containing the **phase spectrum** *φk* (called *Channel_Name_Phi*) which is calculated according to the following formula:

$$\varphi_k = \text{arctan}\,\frac{Im\{Y_K\}}{Re\{Y_K\}}; \qquad k = 0\ldots N \qquad [\text{Signal unit}]$$

   - This channel can be visualized within OXYGEN using the Spectrum Analyzer (see *Spectrum analyzer*) if the actual spectrum shall be plotted or it may also be assigned to the Spectrogram Instrument (see *Spectrogram*) if the time dependent spectral trend shall be displayed.
   - This channel is not calculated automatically but must be selected manually in the Channel Setup of the complex spectrum Channel *Channel_Name_Cpx* after creating the FFT channel (see ⑭ in Fig. 7.87).

4. The channel containing the **overall peaks** of the amplitude spectrum
   - This channel is deactivated by default and holds the maximum of the amplitude values for each bin over the acquisition time.
5. The channel containing the **overall average** of the amplitude spectrum
   - This channel is deactivated by default and holds the average of the amplitude values for each bin over the acquisition time.

After selecting the FFT section, the user can define the following FFT characteristics:

- Data size: Select the number of samples to be transformed simultaneously into the frequency domain here. The data size may vary between 42 to 1048576 (2^{20}) samples. For calculation details, refer to *FFT properties for Time Domain Channels*.
- Window Type: Select an appropriate Window function here. The following windows are available: Hanning, Hamming, Rectangular, Blackman, Blackman-Harris, Flat Top or Bartlett. For calculation details, refer to *Window type*.
- Frequency weighting: If no frequency weighting is required, Z (none) is set as default. Additionally, A, B, C and D weighting are available.
- Overlap: Select an overlapping factor from 0 to 99.97559 % here. For calculation details, refer to *Additional information: calculation of a Periodogram*.
- Amplitude Spectrum: Select the type of amplitude spectrum the Amplitude channel shall contain. The following amplitude spectra are available: Amplitude, Amplitude_RMS, Amplitude², PSD, PSD TISA, PSD MSA, PSD SSA, Decibel (Ref:1), Decibel_RMS (Ref:1), Decibel_Max_Peak (Ref: Max), Decibel V-RMS, Decibel U-RMS, Sound Pressure Level or Sound Pressure Level (Water). For calculation details, refer to *Section Spectrum*.
  - If None is selected, no amplitude spectrum channel Channel_Name_Amp but only the complex spectrum channel is created.
- *Group Name:* Define a group in the Channel List to which the channel shall be added
- *Bin reduction:* Reduces the calculated FFT array for all FFT channels to a certain number of spectral lines in relation to the line resolution.
- After pressing the Add button, the FFT for the selected input channel(s) will be calculated and the Output channels will be visible within the *FFT Channels* topology in the Channel List (see Fig. 7.86).

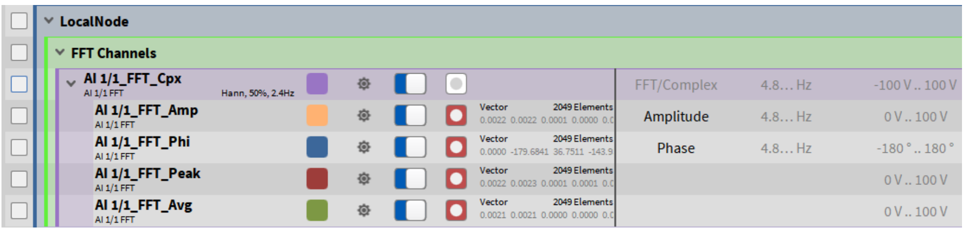


Fig. 7.86: FFT channels within the channel list

Channel Setup of the Complex spectrum channel

After creating the FFT channel, the following options can be added afterwards within the Channels Setup of the complex Spectrum channel *Channel_Name_Cpx*:

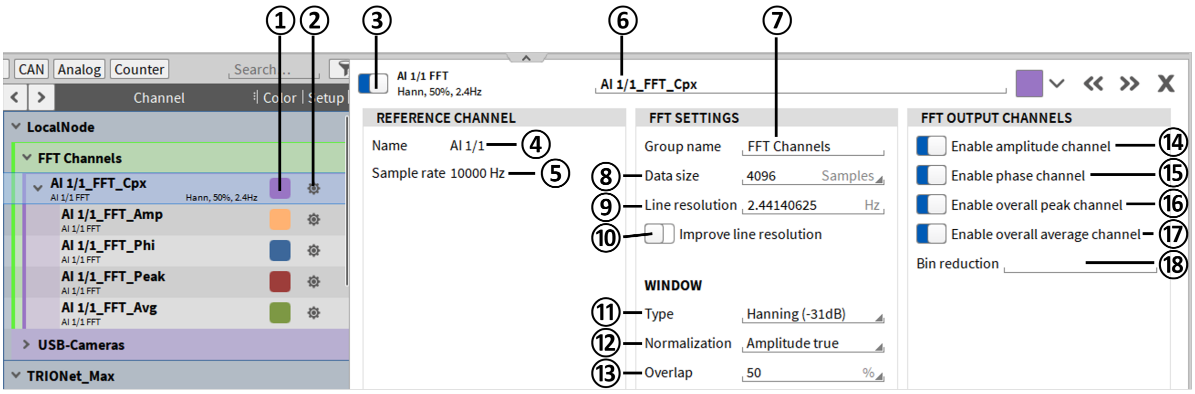


Fig. 7.87: Complex FFT channel setup - overview

Table 7.17: Complex FFT Channel Setup – Overview

No.	Function	Description
1	Channel color	Color scheme of the channel can be changed here.
2	Channel setup	Open channel settings window
3	*Active* toggle	Setting a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel and can be recorded, an inactive channel not
4	Name (of input channel)	The name of the input channel for the FFT calculation.
5	Sample rate (of input channel)	The sample rate of the input channel is displayed here.
6	Channel name	Individual channel name; can be changed individually.
7	Group name	FFT channels can be grouped. By default, all FFT channels are put into the FFT Channels group. This can be changed at any time.
8	*Data size*	Select the number of samples to be transformed to the frequency domain here. The data size can be between 42 to 1048576 (2^20) samples. This automatically results in a certain line resolution. For calculation details, refer to *FFT properties for Time Domain Channels*.
9	*Line resolution* selection	Instead of selecting the number of samples, the line resolution in Hz can be entered, for which the data size is calculated. For calculation details, refer to *FFT properties for Time Domain Channels* .

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Table 7.17 – continued from previous page

No.	Function	Description
10	*Improve Line Resolution* selection	Enable Zero-Padding here. For calculation details, refer to *Additional information: improve line resolution (Enable zero-padding)*.
11	*Window Type* selection	Select an appropriate Window function here. The following windows are available: Hanning, Hamming, Rectangular, Blackman, Blackman-Harris, Flat Top or Bartlett. For calculation details, refer to *Window type*.
12	*Normalization Type* selection	Select between *Amplitude True*, *Power True* or *No* normalization. For calculation details, refer to *Additional information: normalization of FFT Spectra*.
13	*Overlap* selection	Select an overlapping factor from 0 to 99.97559% here. For calculation details, refer to *Markers*.
14	*Enable Amplitude channel* selection	Enable or disable the calculation of the amplitude channel here; enabled per default
15	*Enable Phase channel* selection	Enable or disable the calculation of the phase channel here; disabled per default
16	*Enable Peak channel* selection	Enable or disable the calculation of the total peak channel (see Fig. 7.87); disabled per default.
17	*Enable overall average* selection	Enable or disable the calculation of the total overall average channel (see Fig. 7.87); disabled per default.
18	*Bin reduction*	Reduces the FFT bins to the defined spectral lines, e.g. 1st, 2nd and 5th order in relation to the line resolution.

Channel Setup of the Amplitude spectrum channel

After creating the FFT channel the following options can be added afterwards within the Channels Setup of the Amplitude Spectrum channel *Channel_Name_Amp*:

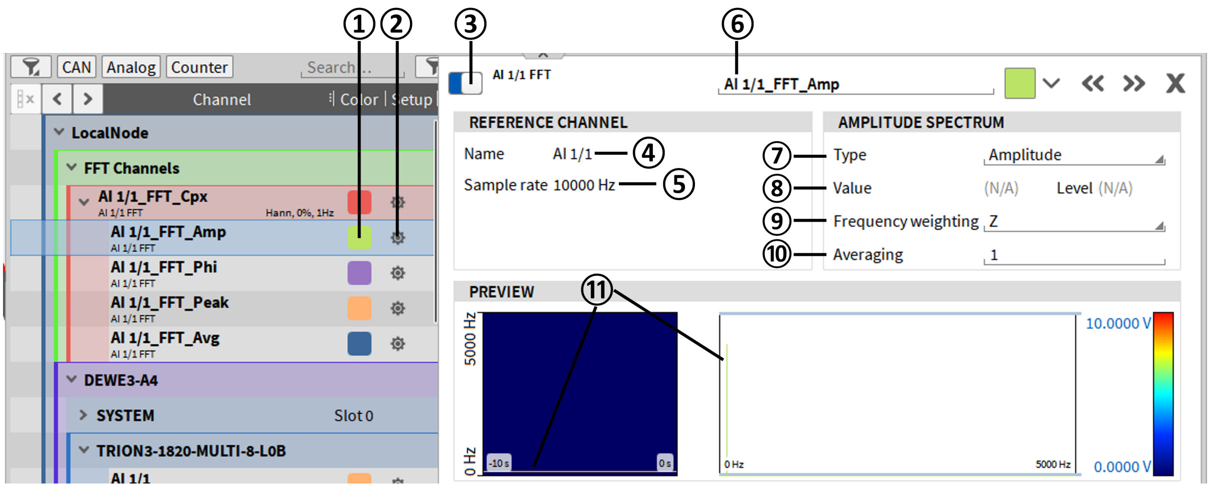

Fig. 7.88: Amplitude FFT channel setup - overview

Table 7.18: Amplitude FFT Channel Setup - Overview

No.	Function	Description
1	Color	The color scheme of the channel can be changed here.
2	Channel setup	Open channel settings window
3	Active button	Setting a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel and can be recorded, an inactive channel not.
4	Name (of input channel)	The name of the input channel for the FFT calculation.
5	Sample rate (of input channel)	Sample rate of the input channel is displayed here.
6	Channel name	Individual channel name; Can be changed individually.
7	Spectrum type selection	Change the type of the amplitude spectrum here. For calculation details and spectra to be selected, refer to *Section Spectrum*.
8	Value selection	If Decibel or Decibel RMS spectrum type is selected, the reference value can be entered here.
9	Frequency weighting	Select if a frequency weighting should be applied to the amplitude spectrum A, B, C, D or Z (none) are available.
10	Averaging selection	Average over 1 to 16 spectra.
11	Preview window	Preview of the calculation in time (left) and frequency domain (right).

Channel Setup of the Phase spectrum channel

After creating the FFT channel, the following options can be added afterwards within the Channels Setup of the Phase Spectrum channel *Channel_Name_Phi*:

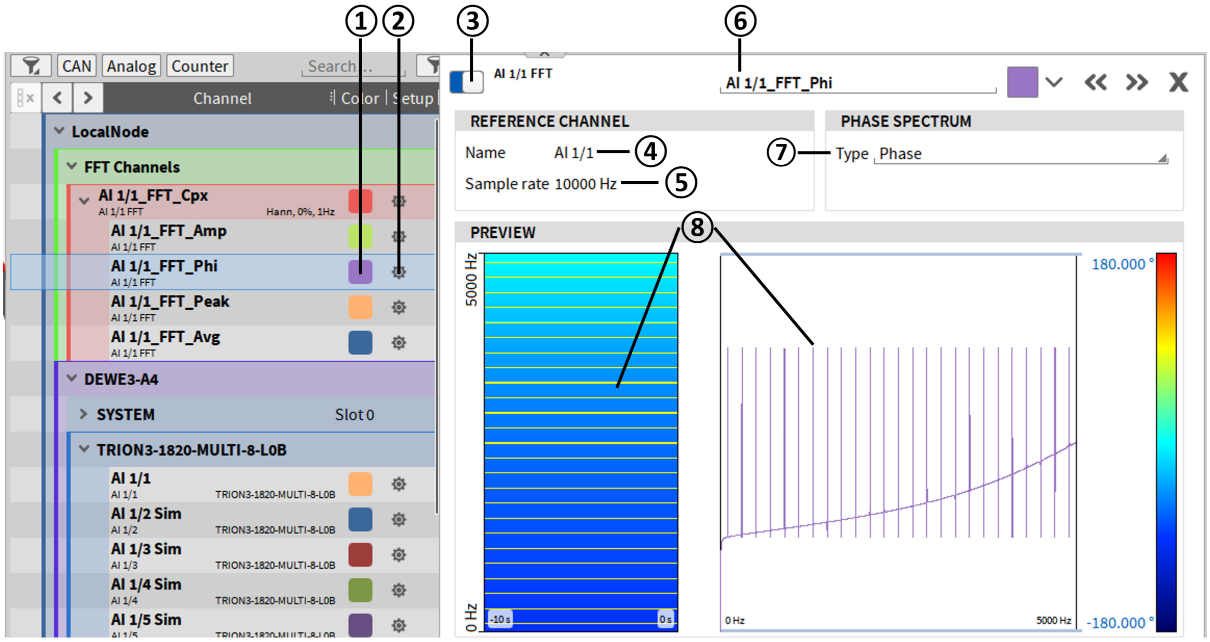

Fig. 7.89: Phase FFT channel setup - overview

Table 7.19: Phase FFT Channel Setup - Overview

No.	Function	Description
1	Color	The color scheme of the channel can be changed here.
2	Channel setup	Open channel settings window.
3	Active button	Setting a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel and can be recorded, an inactive channel not.
4	Name (of input channel)	The name of the input channel for the FFT calculation.
5	Sample rate (of input channel)	Sample Rate of the input channel is displayed here.
6	Channel name	Individual channel name; can be changed individually
7	Spectrum type selection	Change the type of the phase spectrum here. Available types are Phase, Phase unwrapped, Phase (radiant) and Phase unwrapped (radiant). For calculation details and spectra to be selected, refer to *Section Spectrum*.
8	Preview window	Preview of the calculation in time (left) and frequency domain (right).

Channel Setup of the overall Peak channel

After the FFT channels have been created, the following channel settings can be made for the Peak Channel:

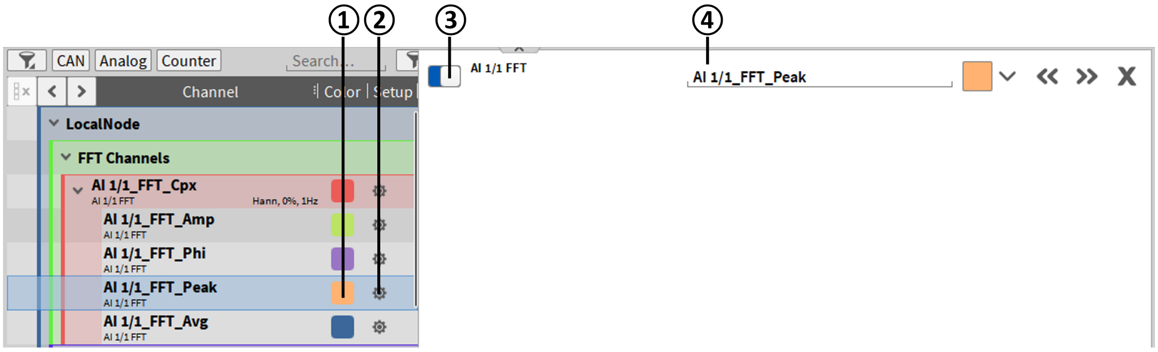

Fig. 7.90: Overall Peak channel settings

Table 7.20: Overall Peak channel settings

No.	Feature	Description
1	Color	Color scheme for a channel can be changed here.
2	Channel setup	Open channel settings window.
3	Active	Activate or deactivate a channel; an active channel can be displayed in a measuring instrument, used for a math channel and recorded, an inactive channel not.
4	Channel name	Individual channel name; can be customized.

Channel Setup of the overall average channel

After the FFT channels have been created, the following channel settings can be made for the overall average channel:

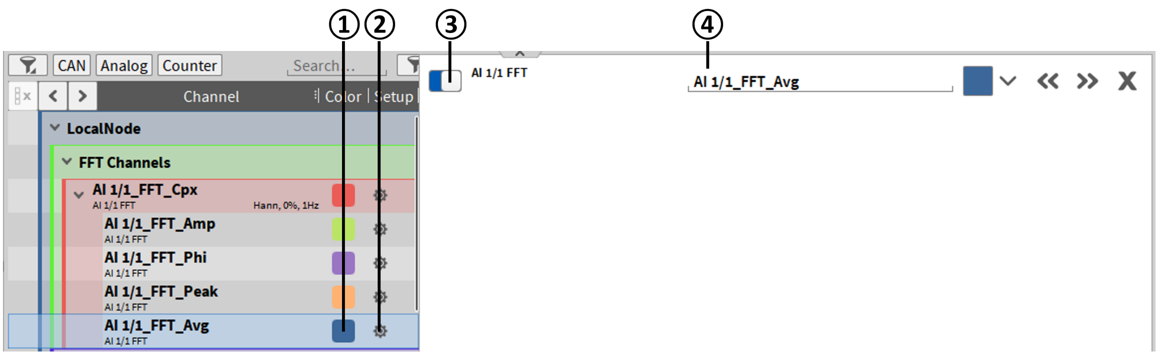

Fig. 7.91: Overall Average channel settings

The channel has the same amplitude scaling as the FFT_AMP channel and will be reset at measurement start. The data will be continuously updated during recording, but only the last valid spectrum will be stored to *.dmd file, this means the data is stored as single value channel.

Table 7.21: Overall Average channel settings

No.	Feature	Description
1	Color	Color scheme for a channel can be changed here.
2	Channel setup	Open channel settings window.
3	Active	Activate or deactivate a channel; an active channel can be displayed in a measuring instrument, used for a math channel and recorded, an inactive channel not.
4	Channel name	Individual channel name; can be customized.

The following figure shows all three amplitude channel types: the amplitude channel, the total peak value, and the total average value of the amplitudes.

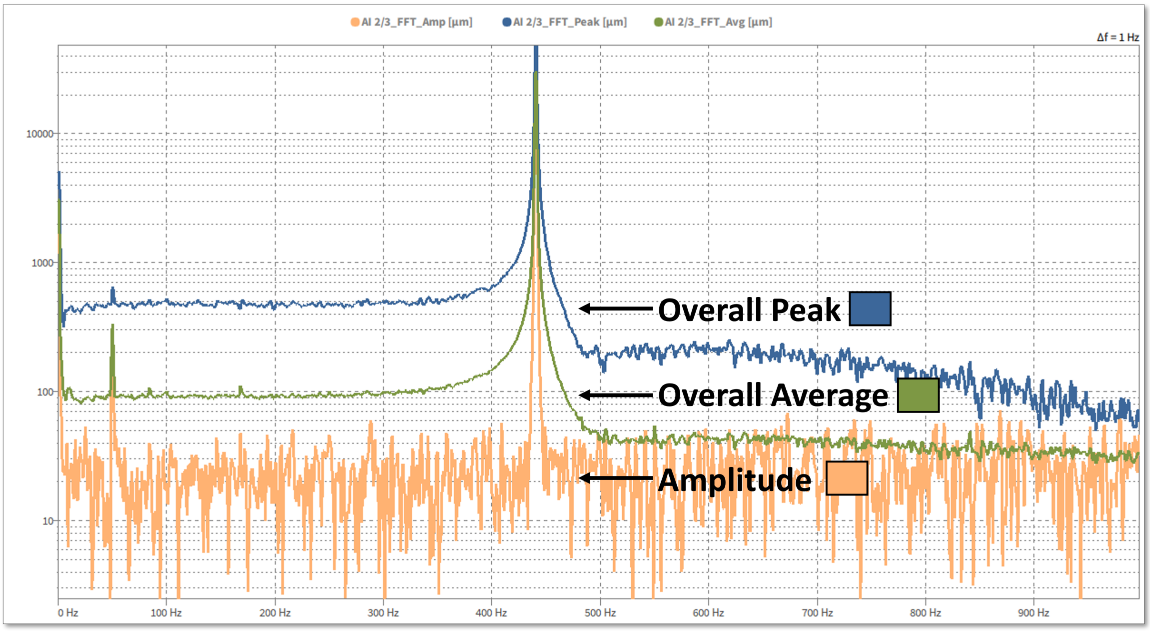

Fig. 7.92: Example of amplitudes, overall peak, and overall average in the spectral view

7.4.2 Filters

IIR Filter channel

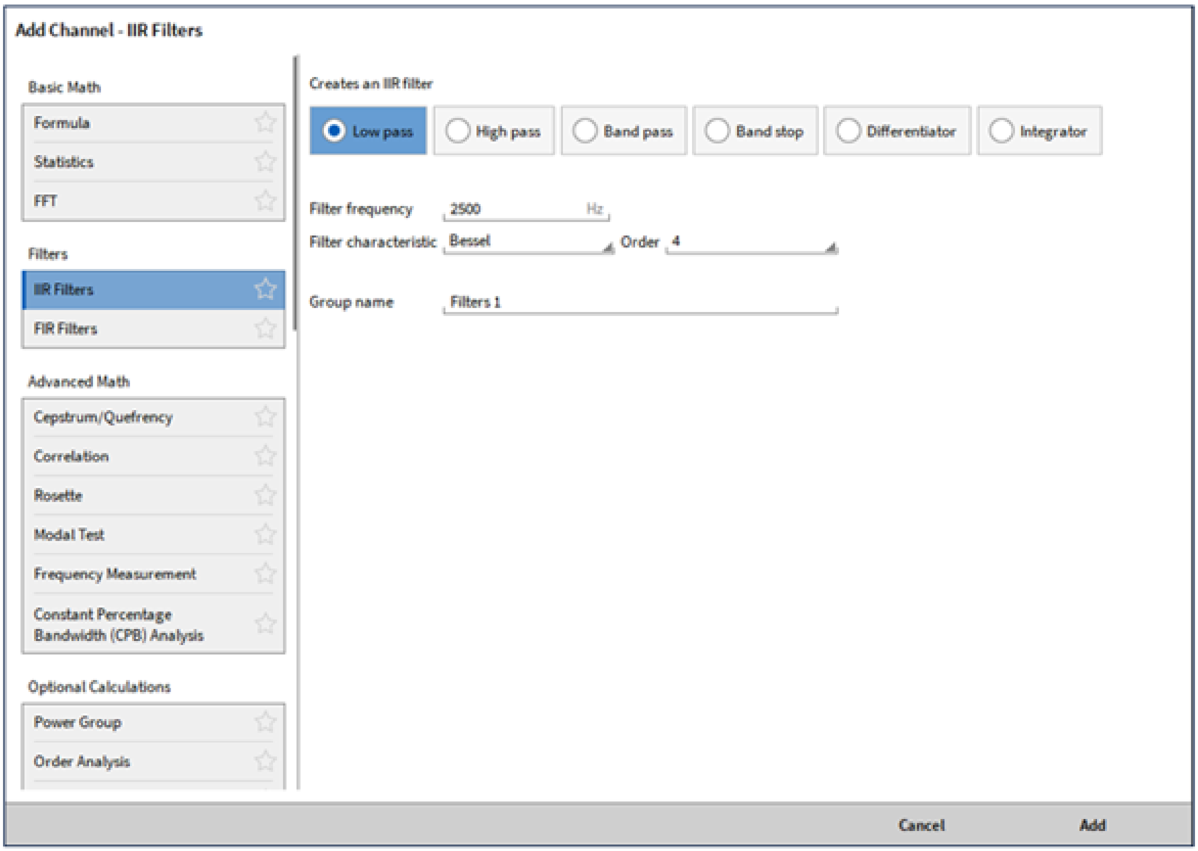

Fig. 7.93: Pop-up window for creating a (low or high pass) IIR filter channel

After clicking on the *Add* button, the *Calculation Setup* window will appear (see Fig. 7.93). For the creation of a Filter channel, the user must select the desired input channel before clicking on the *Add* button. The user can select several input channels simultaneously to create several filter channels with the same settings at once. After selecting the *Filters* section, the user can define the following filter characteristics:

- *Filter Type*: Low pass, High pass, Bandpass, Band-stop, Differentiator, Integrator

If *Low pass* or *High pass* filter is selected (see Fig. 7.93), the user can select

- Filter Frequency: from 0 Hz to $(\frac{\text{Sample}rate}{2} - \frac{\text{Sample}rate}{200})$ Hz
- *Filter Characteristic*: Bessel or Butterworth
- *Filter Order*: 2, 4, 6, 8, 10
- *Group name*: Define a group in the Channel List to which the filter shall be added

If *Bandpass* or *Bandstop* filter is selected (see Fig. 7.93), the user can select

- Low Frequency: from 0 Hz to $<$ Upper frequency Hz
- High Frequency: from $($Lower frequency $+ 1)$ Hz to $(\frac{\text{Sample}rate}{2} - \frac{\text{Sample}rate}{200})$ Hz
- *Filter Characteristic*: Bessel or Butterworth

- *Filter Order*: 2, 4, 6, 8, 10
- *Group name*: Define a group in the Channel List to which the filter shall be added

If *Differentiator* is selected, the user can select

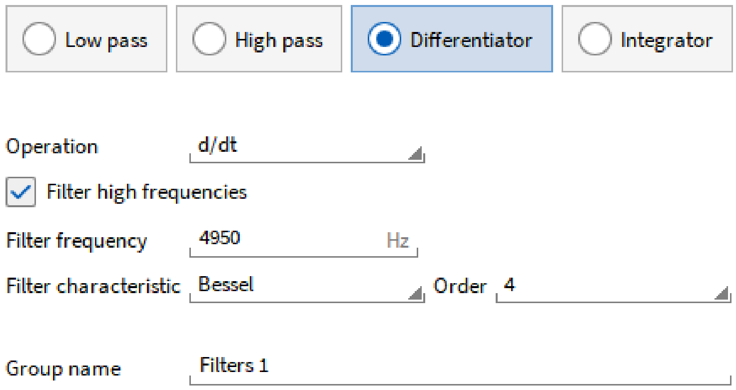

Fig. 7.94: Pop-up window for creating a Differentiator channel

- *Operation*: Single or double differentiation

If high frequencies shall be filtered

- Filter Frequency: from 0 Hz to $\left(\frac{\text{Samplerate}}{2} - \frac{\text{Samplerate}}{200}\right)$ Hz
- *Filter Characteristic*: Bessel or Butterworth
- *Filter Order*: 2, 4, 6, 8, 10
- *Group name*: Define a group in the Channel List to which the filter shall be added

If *Integrator* is selected, the user can select

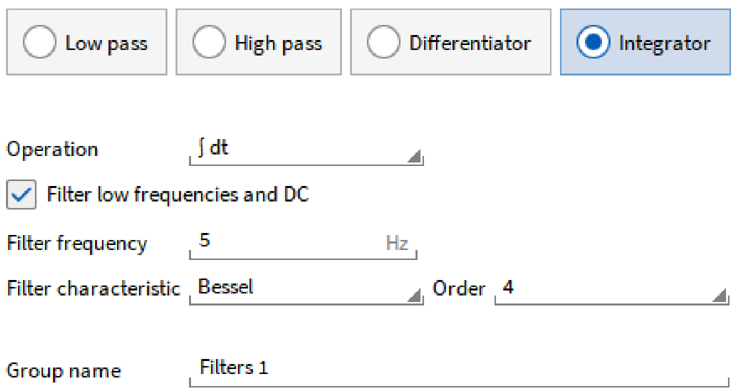

Fig. 7.95: Pop-up window for creating an Integrator channel

- *Operation*: Single or double integration

If low frequencies shall be filtered

- Filter Frequency: from 0 Hz to $\left(\frac{\text{Samplerate}}{2} - \frac{\text{Samplerate}}{200}\right)$ Hz
- *Filter Characteristic*: Bessel or Butterworth
- *Filter Order*: 2, 4, 6, 8, 10

- *Group name*: Define a group in the Channel List to which the filter shall be added

---

Note: Filters can only be applied to synchronous channels, such as analog input channels or counter channels but not to asynchronous channels, such as CAN channels, EPAD cannels, or power group channels.

- After pressing enter, the channel will appear in the *Data Channels* menu. The defined channel parameters can be changed afterwards in the Channel Setup (see Fig. 7.96).

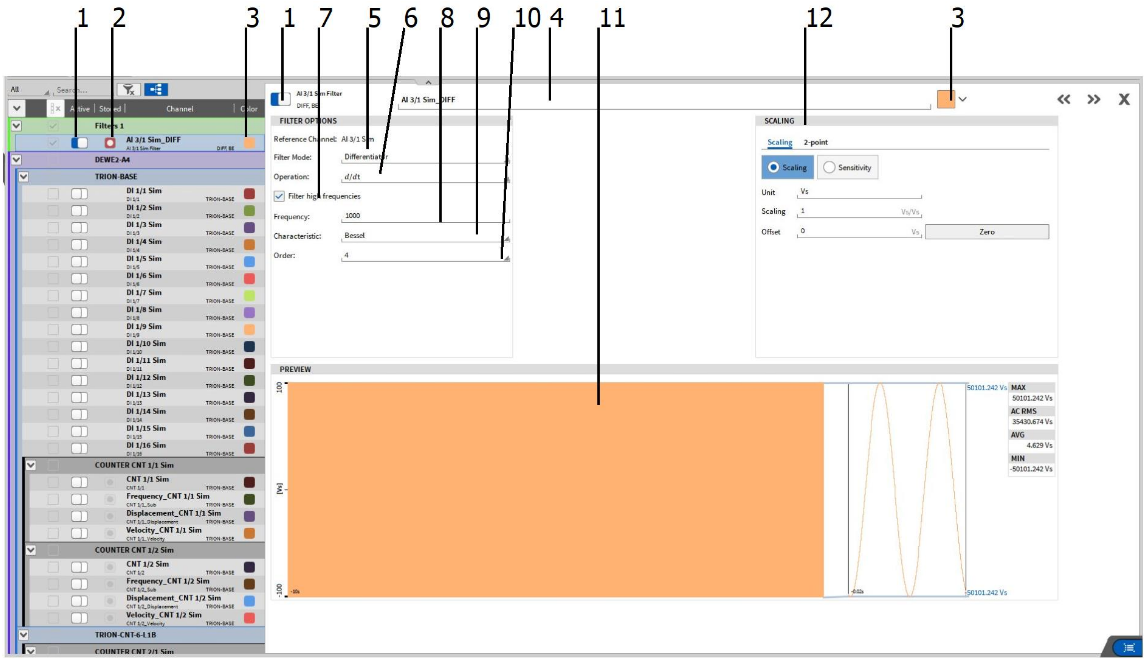

Fig. 7.96: Filter channel setup - overview

Table 7.22: Push buttons in the Filter Channel Setup – Overview

No.	Function	Description
1	*Active* button	Setting a channel active or inactive; An active channel can be displayed in an instrument, used in a math channel and can be recorded, an inactive channel not
2	*Stored* button	Select whether channel data shall be stored or not when measurement is running
3	Color	Color scheme of the channel can be changed here
4	Channel Name	Individual channel name; Can be changed individually
5	*Filter Mode* Setup	Select the filter type: Lowpass, High pass, Differentiator, Integrator
6	*Operation* Setup	Select the Operation type *Single* or *Double* Integration/ Differentiation (only applicable for Differentiators and Integrators)
7	• Integrator: Select if low frequencies and DC components shall be filtered. • Differentiator: Select if high frequencies shall be filtered • Lowpass/Highpass: not applicable.	
8	*Frequency* Selection	Specify the cut-off frequency from 0 to Hz
9	*Filter Characteristic* Selection	Select between Bessel and Butterworth filter characteristic
10	*Filter Order* selection	Select a 2^{nd}, 4^{th}, 6^{th}, 8^{th} or 10^{th} filter order
11	Preview window	Real Time preview of the calculation
12	*Scaling* menu	Change the channels' scaling by entering a Scaling factor or changing the sensitivity (and/or entering an offset) or by a 2-point scaling

FIR Filter channel

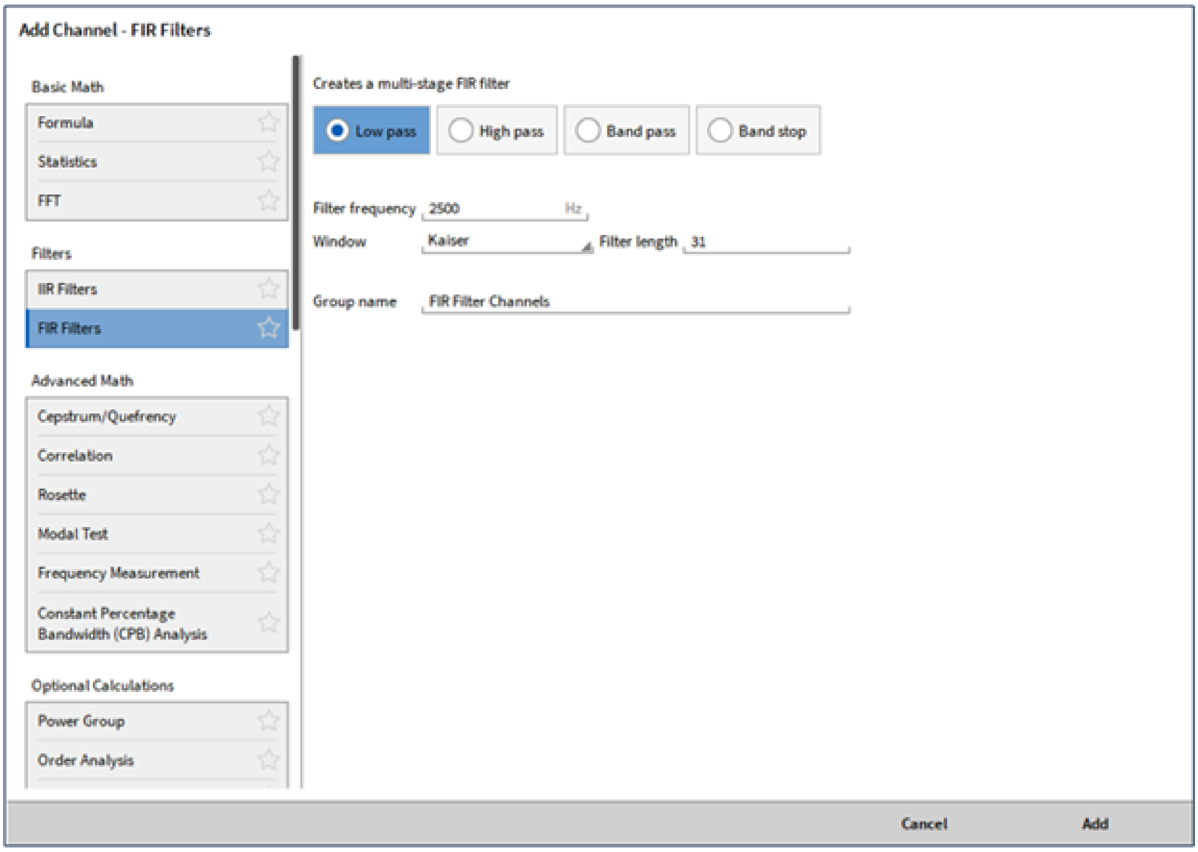

Fig. 7.97: Pop-up window for creating an FIR (high or low pass) filter channel

To create a filter channel, select a channel, click the *Add button* in the lower left corner (marked red in Fig. 7.93) and select FIR Filter. Multiple channels can be selected at the same time to create multiple filter channels with the same settings.

After *FIR Filter* is pressed, the following filter characteristics can be selected:

- Filter type: low pass, high pass, band pass, band stop.

If low-pass or high-pass filter is selected, the following can also be set:

- Filter frequency: from 0 Hz to $\left(\frac{\text{Sample rate}}{2} - \frac{\text{Sample rate}}{200}\right)$ Hz, Default $(0.25 * \text{Sample rate})$
- Window mode: Kaiser, Rectangular, Hann, Hamming, Blackman, Blackmann/Harris, Flat Top, Bartlett, Cosine
- Filter length: between 8 and 32768
- Group name: define a group name in the channel list to which the filter should be added

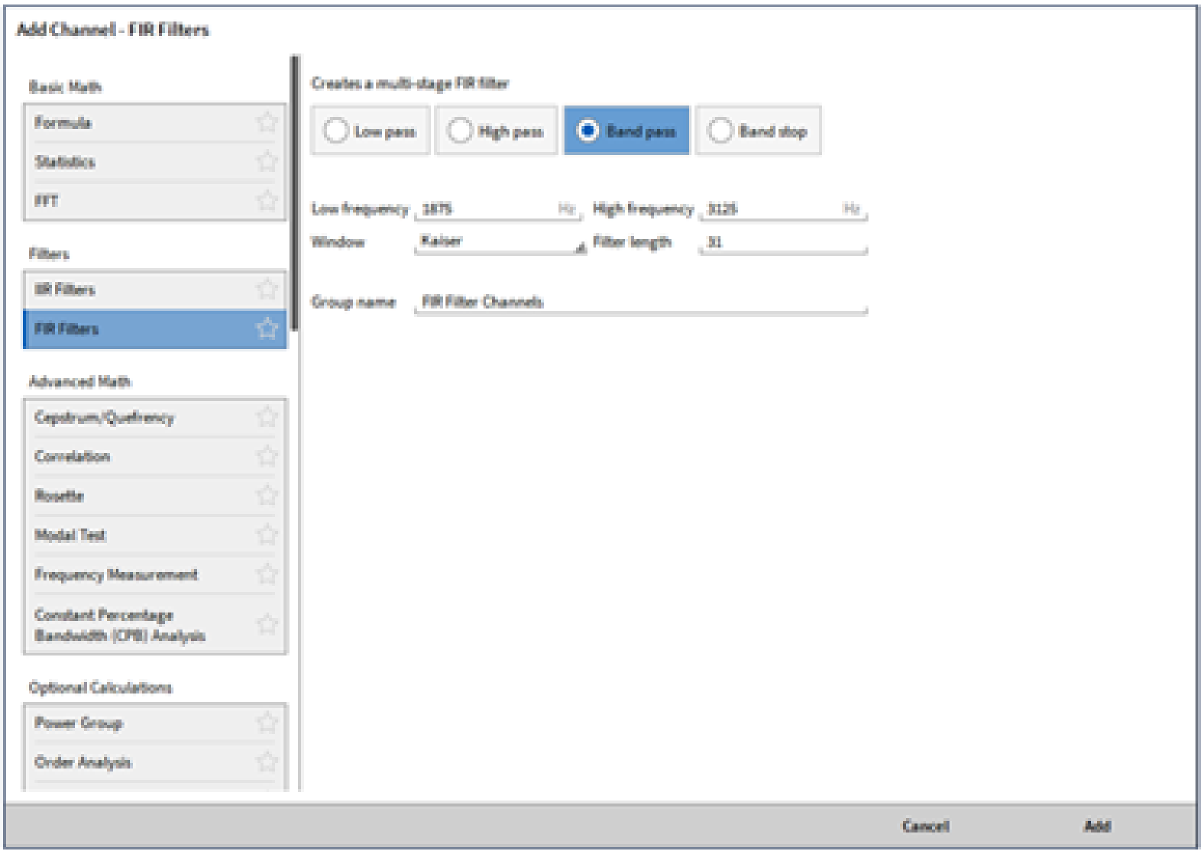

Fig. 7.98: Bandpass and Bandstop

When Bandpass or Bandstop is selected:

- Lower frequency: from 0 Hz to < Upper frequency Hz
- Upper frequency: from (Lower Frequency + 1) Hz bis $\left(\frac{\text{Sample rate}}{2} - \frac{\text{Sample rate}}{200}\right)$ Hz
- Window mode: Kaiser, Rectangular, Hann, Hamming, Blackman, Blackmann/Harris, Flat Top, Bartlett, Cosine
- Filter length: between 8 and 32768 (default = 31)
- Group name: define a group name in the channel list to which the filter should be added

Note: Filters can be applied only to synchronous channels, like analog input channels or counter channels, but not to asynchronous channels, like CAN channels, EPAD channels or power group channels.

Pressing Enter creates the filter channels in the channel list. The defined channel parameters can also be changed afterwards in the channel settings.

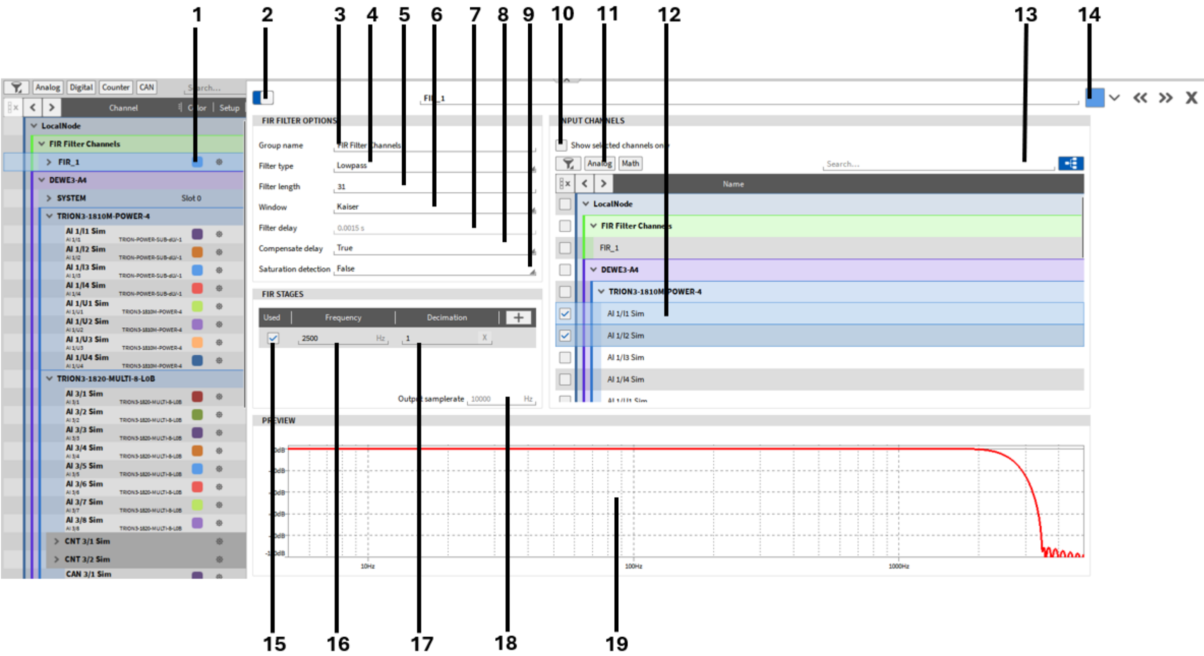

Fig. 7.99: FIR settings

Table 7.23: FIR settings

Nr.	Feature	Description
1	Color	Color scheme for a channel can be changed here.
2	Activate	Activating or deactivating a channel; an active channel can be displayed in a measuring instrument, be used for a math channel and be recorded, an inactive channel cannot.
3	Group name	Define the name of the channel group within the OXYGEN channel list
4	Filter type	Select the filter type: Lowpass, Highpass, Bandpass, Bandstop
5	Filter length	Between 8 and 32768
6	Window	Kaiser, Rectangular, Hann, Hamming, Blackman, Blackman/Harris, Flat Top, Bartlett, Cosine
7	Filter delay	Delay depending on filter length (see point 4)
8	Compensate delay	Automatically compensate filter delay Yes = TRUE, No = FALSE

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Table 7.23 – continued from previous page

Nr.	Feature	Description
9	Saturation detection	Activate or deactivate saturation detection. If the detection is activated and the input channel is in saturation or exceeds the measuring range, the calculated FIR channel returns “NAN” as value as long as the input channel is in saturation. For illustration see Fig. 7.100.
10	Selected channels	When activated, only analog channels that have already been selected as FIR filter channel are displayed.
11	Analog channels	When activated, only analog channels are displayed in the list
12	Channel list	List of available input channels according to the selection in 9 / 10 / 12
13	Search filter	Only channels that match the search input are listed.
14	Color	Color scheme for a channel can be changed here.
15	FIR stages	Selection which FIR stages should be used, it is possible to specify several stages and to activate or deactivate them afterwards.
16	Frequency selection	Define the cutoff frequency from 0 to (sample rate/2 - sample rate/200)
17	Decimation factor	Reduces the sampling frequency by the specified factor (only for low-pass filter). If a signal is recorded with e.g. 10 kHz and you specify a decimation factor of 5, you get a filtered signal with a sampling frequency of 2 kHz. Thus, the sample points between the sample points of the filtered signal are skipped.
18	Output sample rate	Shows the actual outputsamplerate of the FIR channels, according to the selected decimation steps.
19	Preview	Filter behavior in the preview area

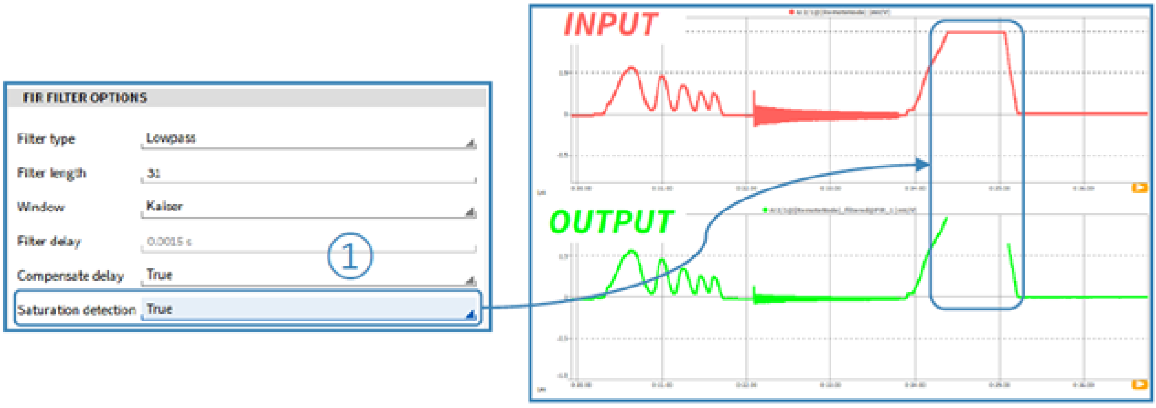

Fig. 7.100: FIR – Saturation detection

Choice of filter length:

A shorter filter length has fast execution times and therefore shorter delay times; however, choosing very short filter lengths results in a flat attenuation drop. The attenuation drop is displayed in the preview window when the filter lengths are changed.

The filter length can be defined with the following formula.

$$Filterlength = 2 * \frac{\text{Sample rate}}{\text{Cutoff frequency}}$$

High attenuations in the stopband or low ripples in the passband may require a higher filter length. In the case of a low pass filter it makes sense to define several filter stages if the calculated filter length is too high. This happens, for example, if for a signal with a sampling frequency of 200 kHz, you are only interested in frequencies below 100 Hz. As a result, the individual filter stages are performed with lower filter lengths, which results in a reduction of the computational load.

Frequency tracking

In the filter options, you can create a bandpass filter with variable center frequency.

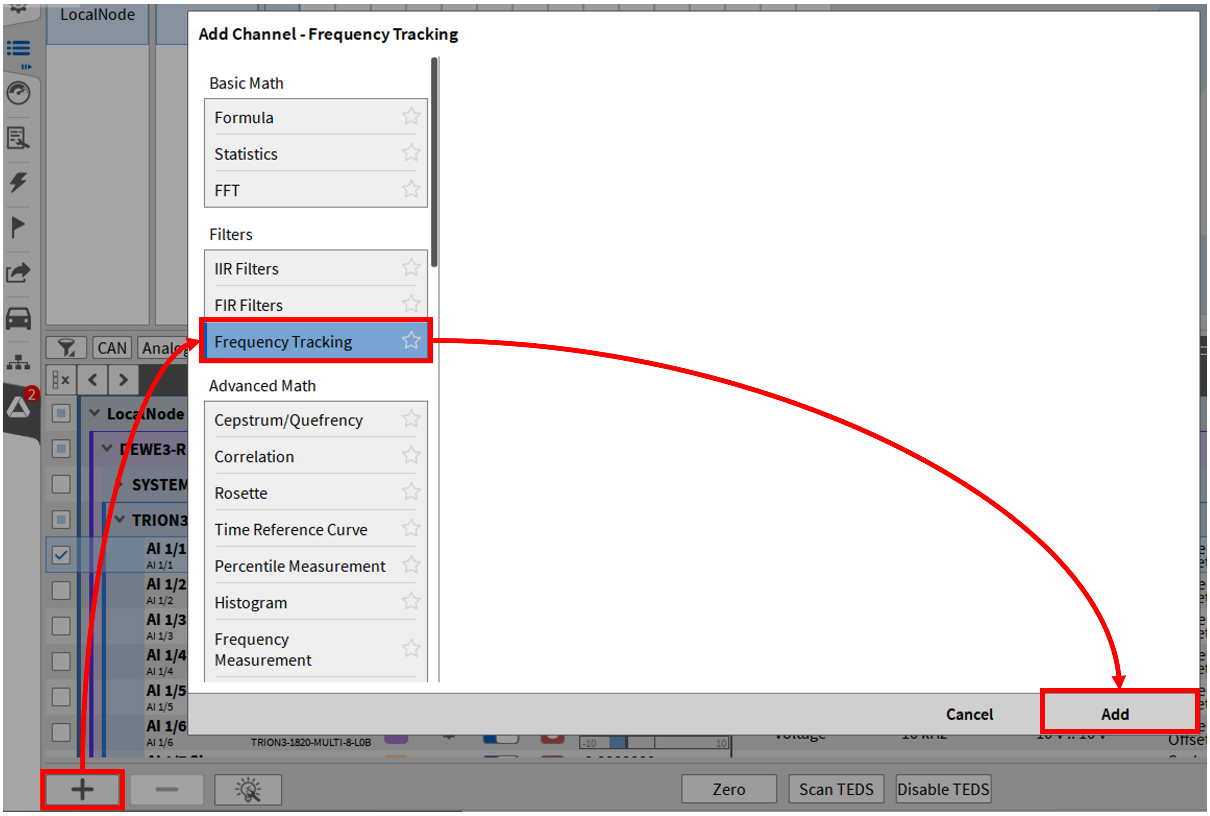

Fig. 7.101: Creating a frequency tracking filter

If channels were selected before creating the filter, the first selected channel is assigned as the reference channel, and all subsequent channels are assigned as input channels.

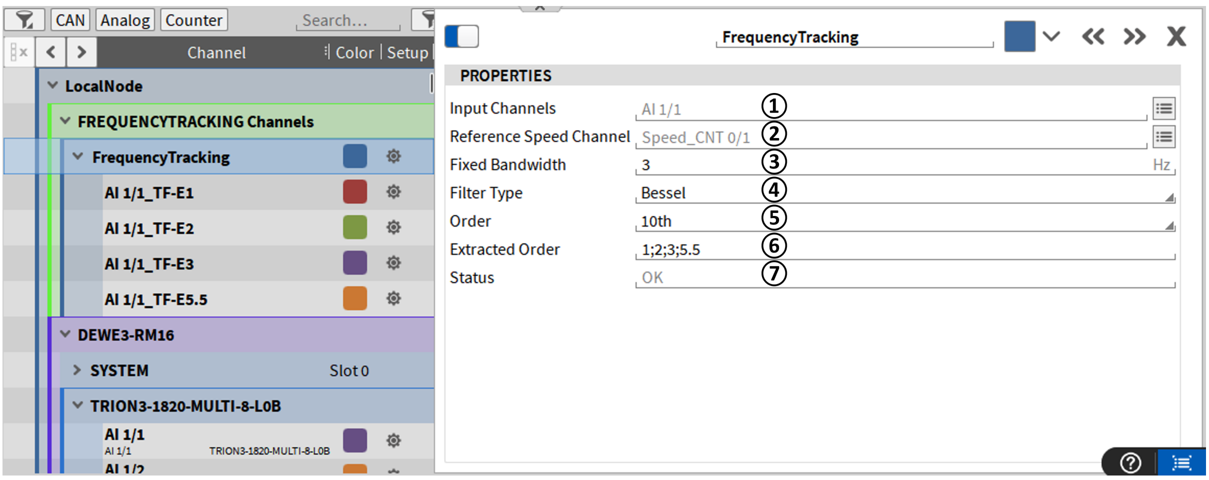

Fig. 7.102: Channel settings of the frequency tracking

Table 7.24: Tracking filter channel settings

Nr.	Function	Description
1	Input channels	One output channel per extracted order is created for the assigned input channels
2	Reference speed channel	The reference channel determines the center frequency of the bandpass filter. This can be specified in rpm or Hz. If there is a unit error, this is displayed in the status line 7.
3	Fixed bandwidth	The fixed bandwidth determines the frequency above and below the reference frequency at which the input signals are attenuated by 3 dB. Meaning for a fixed bandwidth of 3 Hz, the damping of frequencies which are 3 Hz above the reference frequency is -3 dB.
4	Filter type	Select the filter function, either Bessel or Butterworth.
5	Order	Determines the power of the filter function from 2nd to 10th order.
6	Extracted order	Determines the ratio to the reference frequency for which the bandpass filter is to be applied. Non-integer values are also possible.
7	Status	Potential errors in the channel units or sampling rates are displayed here.

7.4.3 Advanced math

Cepstrum/Quefrency

Cepstrum is a signal processing algorithm introduced in the 1960s for audio and acoustic analysis. Originally, Cepstrum was used to separate excitation parameters from sound-affecting parameters.

Examples:

- Speech: Excitation of the vocal cord and impairment of the oral cavity.
- Stringed instruments: string excitation and body resonance

Cepstral analysis is nowadays also used for vibration analysis and can be used, for example, to characterize seismic echoes, such as those from earthquakes and bomb blasts. It is a non-linear Fourier method which is used to “deconvolve” two signals.

In general, Cepstrum analysis is performed in the following way (see Fig. 7.103):

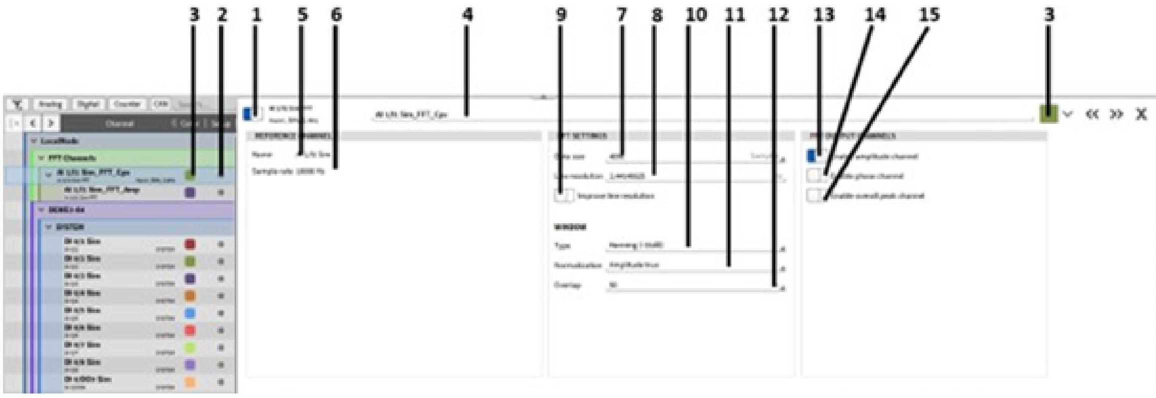

Fig. 7.103: Cepstrum analysis

The term "Cepstrum" is an artificial word, which is created from the word "Spectrum" by swapping the first four letters. In the same way "Frequency" becomes "Quefrency" and "Filtering" becomes "Liftering". (see Fig. 7.103):

The algorithm is defined as follows. When measuring an acoustic signal, the signal is transformed into the frequency domain by means of FFT, then the natural logarithm of the spectrum is formed and finally transformed back into the time domain by means of an inverse FFT. The result of this algorithm is the cepstrum.

Use in OXYGEN

Clicking on "+" in the channel list opens the window for selecting the various math functions. Under the basic math functions there is the option to add a cepstrum/quefrency analysis. (see Fig. 7.104) It is possible to choose among 3 different cepstral analyses. You can choose between "Amplitude", "Power" and "Complex". Furthermore it is possible to activate a filtering (liftering) and to define a group name in which the new channels will be added to the channel list. (for more information on the functions, see Fig. 7.103) By clicking on the "Add" button in the lower right corner of the window, the created channels are automatically created to the defined group name.

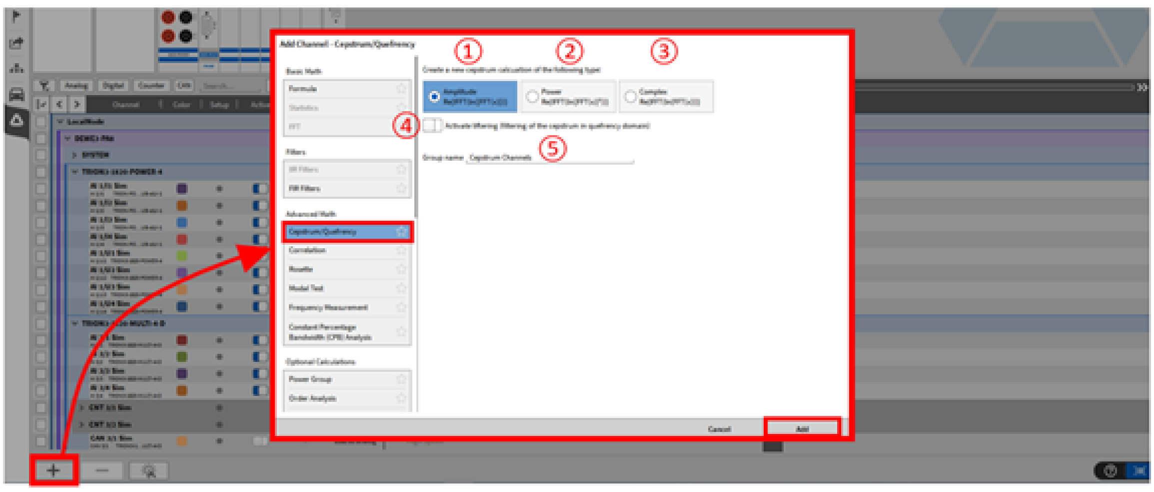

Fig. 7.104: Adding Cepstrum/Quefrency

Table 7.25: Setting for creating a cepstral analysis

Nr.	Function	Description
1	Amplitude	The amplitude cepstrum or real cepstrum is defined as follows: $Re\left\{IFFT\left(ln\left(\left\|FFT\left(x\right)\right\|\right)\right)\right\}$ It takes a time signal and proceed block by block as follows: - FFT calculation - Formation of the absolute value - Non-linearization with the logarithm naturalis (ln) - Inverse Fourier Transformation - Extraction of the real part
2	Power	In Power Cepstrum, the absolute value is squared before it is logarithmized. The calculation is: $Re\left\{IFFT\left(ln\left(\left\|FFT\left(x\right)\right\|^{2}\right)\right)\right\}$
3	Complex	With the complex spectrum, not the magnitude of the FFT, but the complex spectrum is logarithmized. Thus, the phase info is preserved during the reverse transformation. The calculation is: $Re\left\{IFFT\left(ln\left(FFT\left(x\right)\right)\right)\right\}$
4	Liftering	When activated, the filtering is activated and can then be adjusted in the settings of the created channel.
5	Groupname	Defines the group name in which the generated channels of the cepstral analysis are listed.

After clicking on “Add”, a new Cepstrum group is added under the specified group name. By opening the properties of the newly created group, further settings for the cepstral analysis can be made (see Fig. 7.105). In addition to the “Liftering channels”, 3 further channels are automatically created and are thus available to you.

- Cepstrum: This is the continuous Cepstrum
- Overall: The total Ceptrsum averaged from the start of measurement to the end of measurement.
- Spectrum: The logarithmized signal in the frequency domain

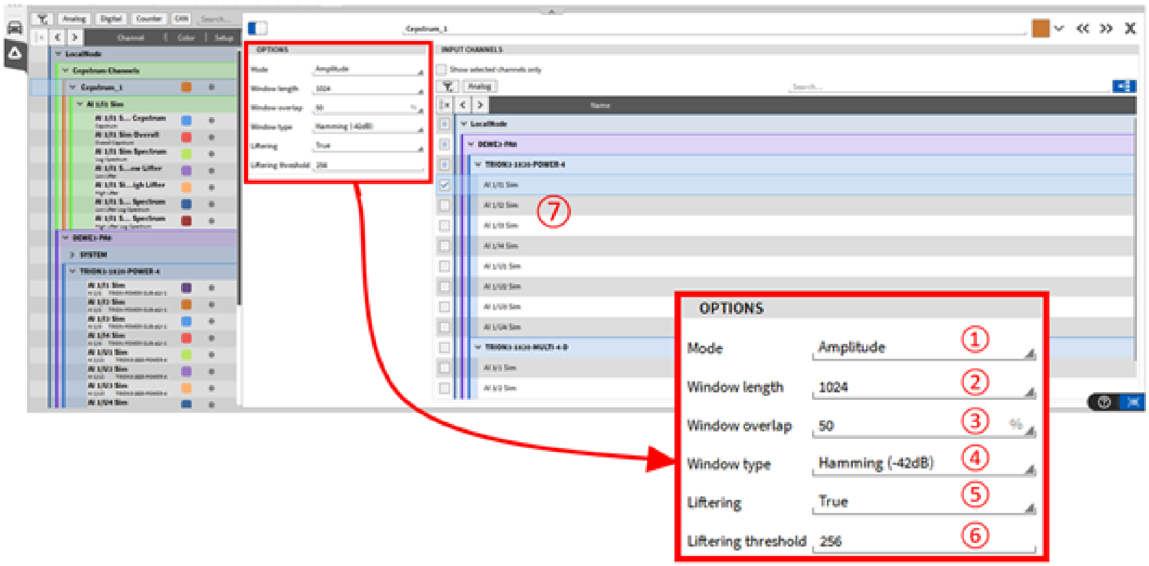

Fig. 7.105: Cepstrum settings

Table 7.26: Cepstrum settings

Nr.	Function	Description
1	Mode	The choices are: Amplitude, Power and Complex.
2	Window length	Select the number of samples to be simultaneously transformed into the frequency domain. The window width can vary between 32 and 262144 (2^{18}) samples. For more details on the calculation, see *Instruments and instrument properties*.
3	Window overlap	Select an overlap factor between 0 to 90 %. For more details, see *Additional information: calculation of a Periodogram*.
4	Window type	Choose a suitable window. The choices are: Hanning, Hamming, Rectangle, Blackman, Blackman-Harris, Flat Top or Bartlett. For more details of the calculation, see *Window type*.
5	Liftering	Here the liftering (filtering) can be activated or deactivated.
6	Liftering threshold	Here you can enter a limit value in samples. The cepstrum is thus divided into an upper (H) and lower (L) cepstrum. All cepstrum samples below the limit value (incl. limit value) are written into a new channel "Low-Lifter". - Output channel Low-Lifter-Spectrum: Re{ FFT(L * Cepstrum) } - Output channel Low-Lifter: Re{ IFFT(exp(FFT(L * Cepstrum))) } All cepstrum samples above the threshold (excl threshold) are written to a new channel "High-Lifter". - Output channel High-Lifter-Spectrum: Re{ FFT(H * Cepstrum) } - Output channel High-Lifter: Re{ IFFT(exp(FFT(H * Cepstrum))) } This applies to amplitudes and power cepstrum. For the complex cepstrum, the absolute value of the complex signal is always output instead of the real part.
7	Channel selection	Here you can select the channels for which a cepstral analysis has to be performed.

Auto/Cross-correlation

Clicking on "+" in the channel list opens the window for selecting the different math functions. Under the basic math functions there is the option to add a correlation (see Fig. 7.106). It is possible to choose between an Auto or a Cross-correlation. Then press the "Add" button in the bottom right corner of the window and a new correlation channel will automatically be added to the channel list under the specified group name (see ③ in Fig. 7.106).

The Auto-correlation

The Auto-correlation (see ① in Fig. 7.106) mathematically describes the convolution of a signal with itself and is used to detect periodicity in signals, e.g. in modulated and noisy signals.

Formula Auto-correlation:

$$\varphi_{xx}(\tau) = \int_{-\infty}^{+\infty} x(t) * x(t+\tau) d\tau = IFFT\{FFT\{x\} * FFT\{x\}\}$$

The calculation is performed as follows:

Take a time signal and proceed block by block as follows:

- FFT calculation
- Multiplication of the spectrum with itself
- Inverse FFT
- Normalization to amplitude +/-1

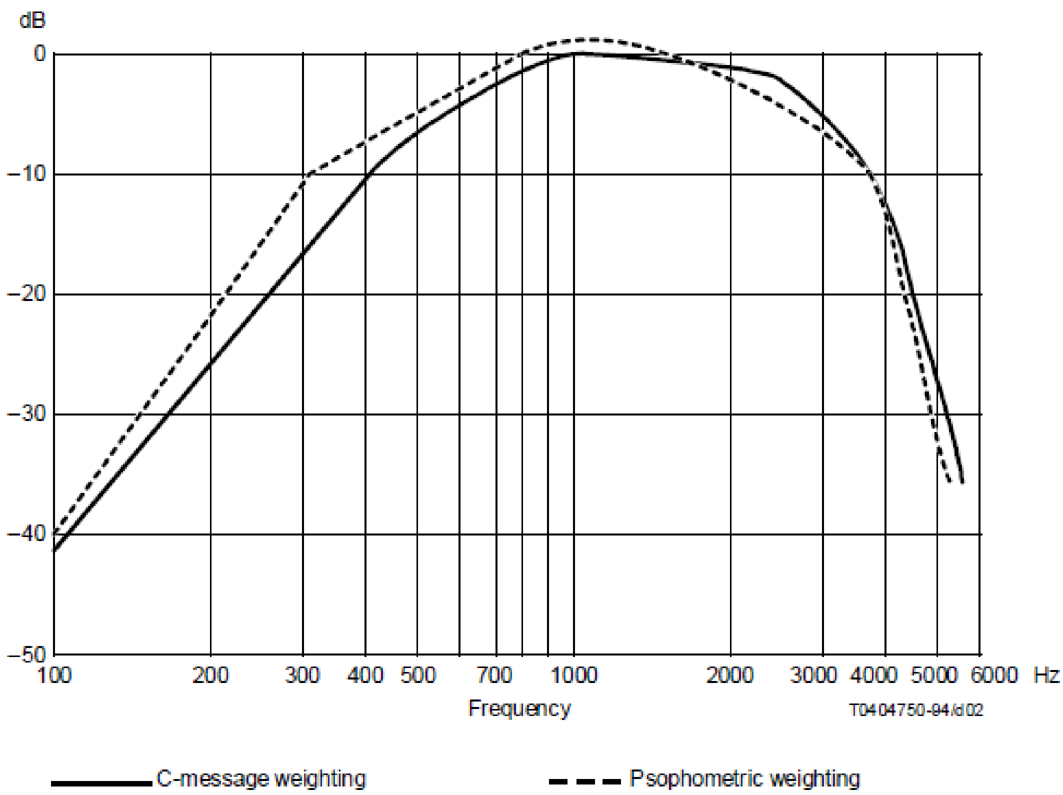

Fig. 7.106: Adding Auto and Cross-correlation

Settings of the Auto-correlation

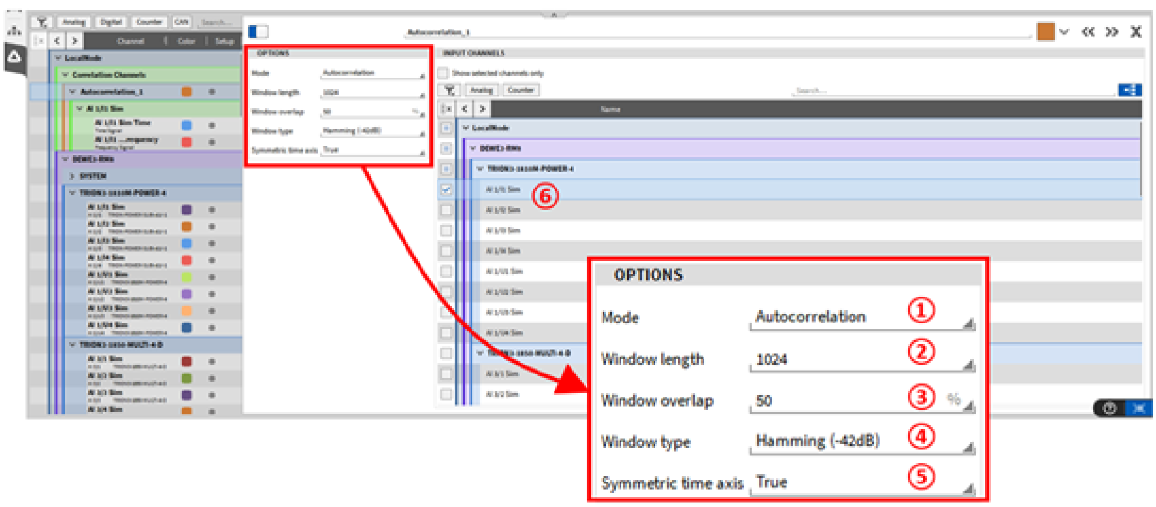

Fig. 7.107: Auto-correlation – settings

Table 7.27: Auto-correlation – settings

Nr.	Function	Description
1	Mode	The choices are: Auto-correlation and Cross-correlation. Here you can also switch between both calculations afterwards.
2	Window length	Select the number of samples to be simultaneously transformed into the frequency domain. The window width can vary between 32 and 262144 (2^{18}) samples. For more details of the calculation, see *Instruments and instrument properties*.
3	Window overlap	Select an overlap factor between 0 to 90 %. For more details, see *Additional information: calculation of a Periodogram*.
4	Window type	Choose a suitable window. The choices are: Hanning, Hamming, Rectangle, Blackman, Blackman-Harris, Flat Top or Bartlett. For more details of the calculation, see *Window type*.
5	Symmetric time axis	Visualization of the autocorrelation either from -t/2 … +t/2 (True) or 0 … t (False).
6	Channel selection	Here you can select the channels for which an Auto-correlation is to be performed.

Generated channels of the Auto-correlation

When you perform an autocorrelation, OXYGEN will automatically create 2 channels for you:

- Time - The result of the autocorrelation in the time domain.

$$IFFT\{FFT\{x\} * FFT\{x\}\}$$

- Frequency - The result of multiplying signal x by itself in the frequency domain

$$FFT\{x\} * FFT\{x\}$$

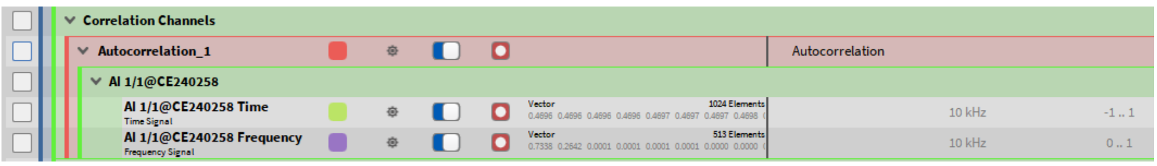

Fig. 7.108: Auto-correlation generated channels

The Cross-correlation

The Cross-correlation (see (2) in Fig. 7.106) mathematically describes the convolution of a signal x with another signal y. The Cross-correlation is used e.g. to detect identical components in 2 different signals or to analyze the delay time between 2 signals.

Formula Cross-correlation:

$$\varphi_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t) * y(t+\tau)d\tau = IFFT\{FFT\{x\} * FFT\{y\}\}$$

The calculation is performed as follows:

Take a time signal and proceed block by block as follows:

- FFT calculation
- Multiplication of the spectrum of signal x with the spectrum of signal y
- Inverse FFT
- Normalization to amplitude +/-1

Settings of the Cross-correlation

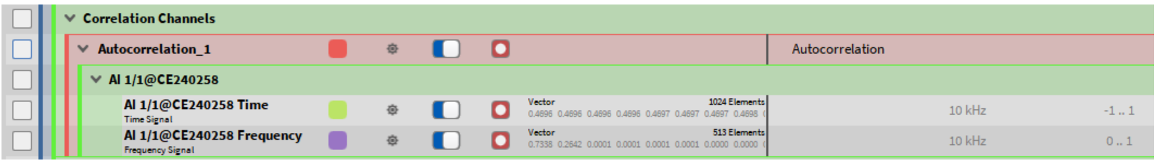

Fig. 7.109: Cross-correlation - settings

Table 7.28: Cross-correlation – settings

Nr.	Function	Description
1	Mode	The choices are: Auto-correlation and Cross-correlation. Here you can also switch between both calculations afterwards.
2	Reference channel	Select a reference channel for the calculation of the Cross-correlation. To do this, drag and drop the desired reference channel from the channel list (7) into the field for the reference channel (2).
3	Window length	Select the number of samples to be simultaneously transformed into the frequency domain. The window width can vary between 32 and 262144 (2^{18}) samples. For more details, see *Instruments and instrument properties*.
4	Window overlap	Select an overlap factor between 0 to 90%. For more details, see *Additional information: calculation of a Periodogram*.
5	Window type	Choose a suitable window. The choices are: Hanning, Hamming, Rectangle, Blackman, Blackman-Harris, Flat Top or Bartlett. For more details of the calculation, see *Window type*.
6	Symmetric time axis	Visualization of the autocorrelation either from -t/2 … +t/2 (True) or 0 … t (False).
7	Channel selection	Here you can select the channels for which a Cross-correlation is to be performed, referring to the selected reference channel (2).

Generated channels of the Cross-correlation

When you perform a cross-correlation, OXYGEN will automatically create 3 channels for you:

- Time - The result of the cross-correlation in the time domain.

$$IFFT\left\{FFT\left\{x\right\} * FFT\left\{y\right\}\right\}$$

- Frequency - The result of the multiplication of signal x and signal y in the frequency domain

$$FFT\left\{x\right\} * FFT\left\{y\right\}$$

- Coherence

$$y^2 = \frac{|Powerspectrum_{xy}|^2}{Powerspectrum_x * Powerspectrum_y}$$

The coherence is an indicator to see if the reference signal x and the signal y match. The more identical the two signals are, the closer the value is to 1. If the signals are exactly identical, the coherence would return "1" as a result.

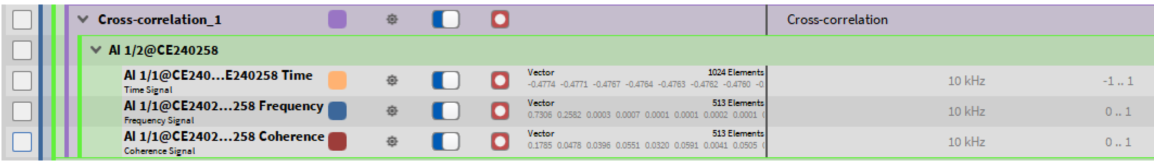

Fig. 7.110: Cross-correlation generated channels

Rosette (strain gauge) channels

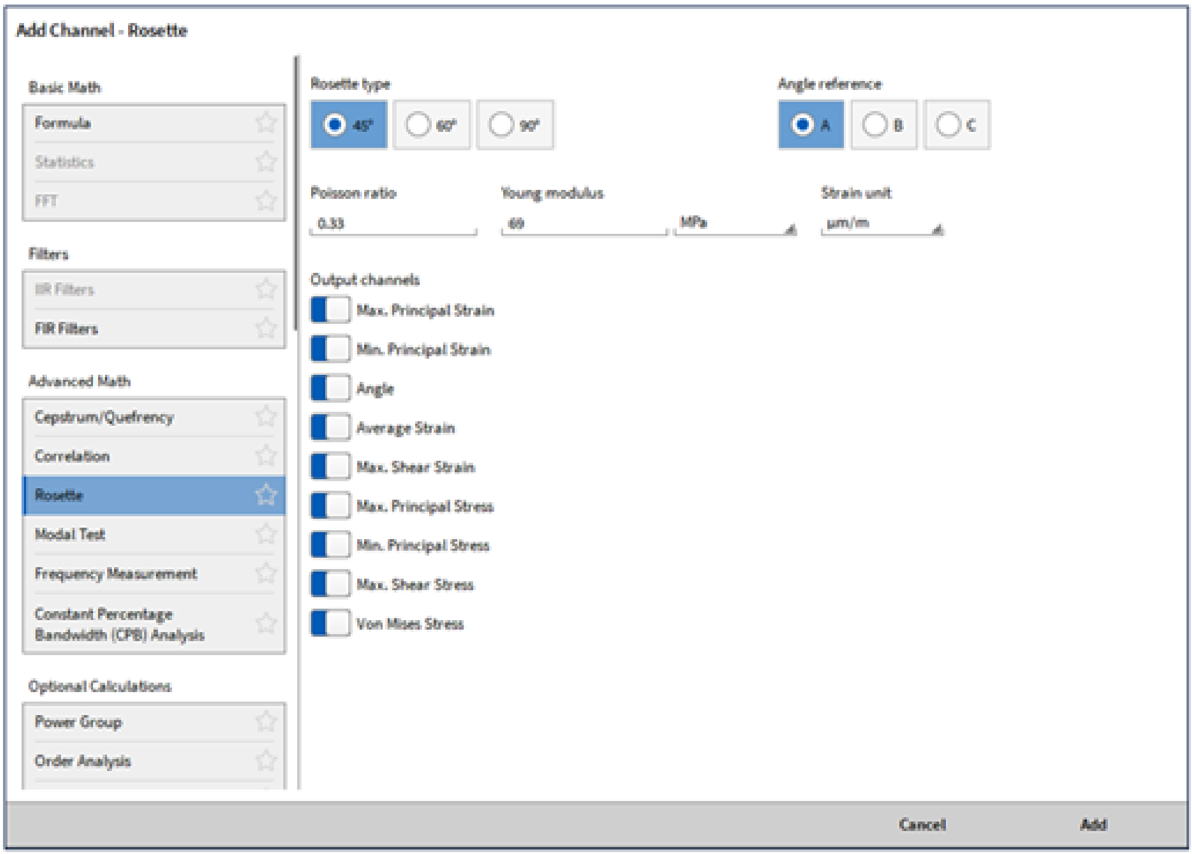

Fig. 7.111: Pop-up window for creating a Rosette calculation

For creating a Rosette channel, the user must click on the *Add* button in the lower left corner (marked red in Fig. 7.48) and a window will appear (see Fig. 7.111). To create a Rosette channel, select *Rosette*. After clicking on the OK button, a Rosette main channel (*Rosette_1* in Fig. 7.112) with its Sub channels (*Max Principal strain* to *VonMises Stress* in Fig. 7.112) is added to the channel List. A click on the gear button of the main rosette channel will open the Rosette settings to perform changes afterwards (see Fig. 7.112).

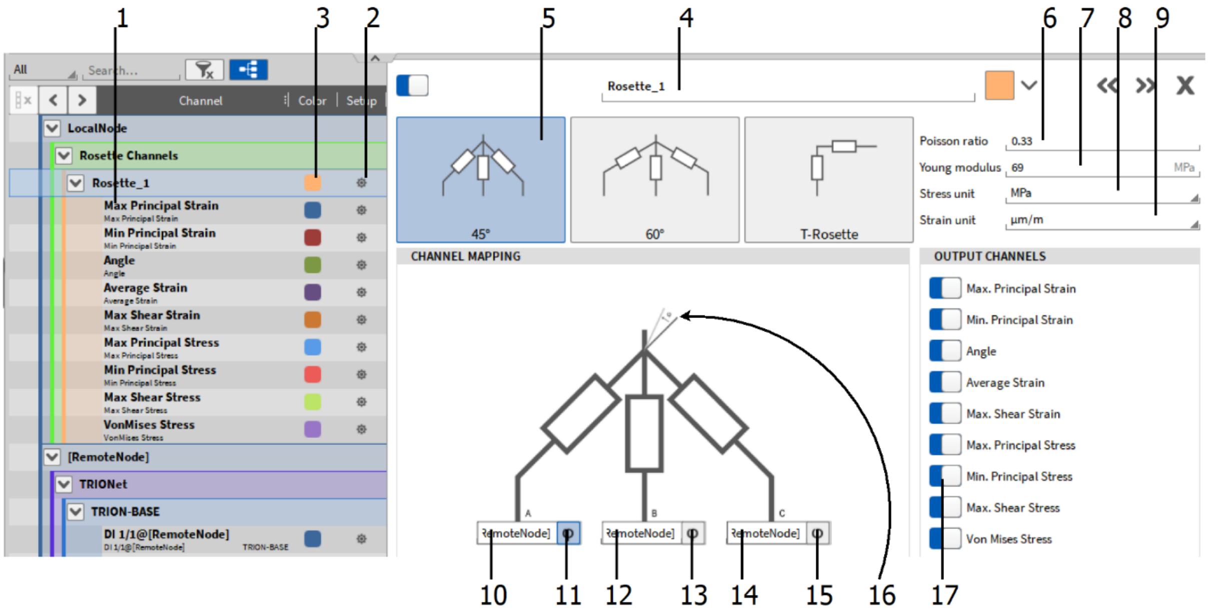

Fig. 7.112: Rosette channel setup – overview

Table 7.29: Rosette channel setup – overview

No.	Function	Description
1	*Channel List*	Channel List including the output channels of the Rosette calculation.
2	*Channel setup* button	Opens the channel setup of the individual channel.
3	Color	Color scheme of the channel can be changed here.
4	Channel Name	Individual channel name; Can be changed individually.
5	*Rosette Type* selection	Select the rosette calculation type here: 45°, 60°, 90° (T).
6	*Poisson ratio* selection	Enter the poisson ration here.
7	*Young modulus* selection	Enter the Young modulus of the used material here.
8	*Stress unit* selection	Select the unit of the Young modulus here: [MPa], [GPa] or [kgf/mm²].
9	*Strain unit* selection	Select the strain unit here: [µm/m] or [microstrain].
10	*Epsilon A* channel assignment	Assign the input channel for *Epsilon A* here.
11	*Reference Angle* Selection	Select *Epsilon A* as Reference Angle here; If selected, the background will highlight grey-blue.
12	*Epsilon B* channel assignment	Assign the input channel for *Epsilon B* here.
13	*Reference Angle* Selection	Select *Epsilon B* as Reference Angle here; If selected, the background will highlight grey-blue.
14	*Epsilon C* channel assignment	Assign the input channel for *Epsilon C* here.

continues on next page

Table 7.29 – continued from previous page

No.	Function	Description
15	*Reference Angle* Selection	Select *Epsilon C* as Reference Angle here; If selected, the background will highlight grey-blue.
16	*Reference Angle* hint	Highlights the selected reference angle in the rosette schematics.
17	*Output channel activation*	Activate or deactivate the single channels that shall be calculated and output by the calculation.

Required input channels

The Plugin requires three strain gauge input channels (*Epsilon A, B, C*), the angular rosette alignment (*45°, 60°, 90° (T)*) and the angle reference (*A, B, C*). Available input channels for *Epsilon A, B, C* are analog input channels. The 90° or Tee type rosette requires only 2 input channels (*Epsilon A, B*).

The advantage of using three-channel rosettes is to minimize the effect of error due to misalignment to the elements from the physical axis. Furthermore, the bigger the angle between the gauges, the better the result concerning noise influence.

Note: Channels that are assigned to the Rosette plugin require the engineering unit *µm/m* or *um/m.* Other engineering units are not accepted and will lead to the error message *Unit of input channels not µm/m or um/m* in the Channel Setup of the main rosette channel (see Fig. 7.113).

Fig. 7.113: Error message in case of wrong engineering unit

The channel to be used for the rosette calculation can be selected before clicking on the Calculator button. If channels 1/1, 1/2 and 1/3 are selected one after the other and a three channel is selected, the channels will be assigned automatically in the following manner after clicking the *OK* button in the *Rosette Calculation Setup*: 1/1 to Epsilon A, 1/2 to Epsilon B and 1/3 to Epsilon C.

If channels 1/3, 1/1 and 1/2 are selected one after the other and a three channel is selected, the channels will be assigned automatically in the following manner after clicking the *OK* button in the *Rosette Calculation Setup*: 1/3 to Epsilon A, 1/1 to Epsilon B and 1/2 to Epsilon C

If six channels 1/1, 1/2, 1/3, 1/4, 1/5 and 1/6 are selected one after the other, two three-channel rosettes or three two-channel rosettes can be created with one click on the Calculator button. The input channels will be assigned in the following manner (example for two three-channel rosettes):

- Rosette 1: 1/1 to Epsilon A, 1/2 to Epsilon B and 1/3 to Epsilon C
- Rosette 2: 1/4 to Epsilon A, 1/5 to Epsilon B and 1/6 to Epsilon C

If four channels1/1, 1/2, 1/3, 1/4 are selected one after the other and two three-channel rosettes shall be created, the input channels will be assigned in the following manner:

- Rosette 1: 1/1 to Epsilon A, 1/2 to Epsilon B and 1/3 to Epsilon C
- Rosette 2: 1/4 to Epsilon A, Epsilon B and Epsilon C will remain unassigned

The channel assignment can be edited after creating the Rosette calculation in the Channel setup of the main channel (see ⑯ in Fig. 7.112) by dragging and dropping the desired channel from the Channel List on the left-hand side to the individual input channel of the rosette calculation (see Fig. 7.114).

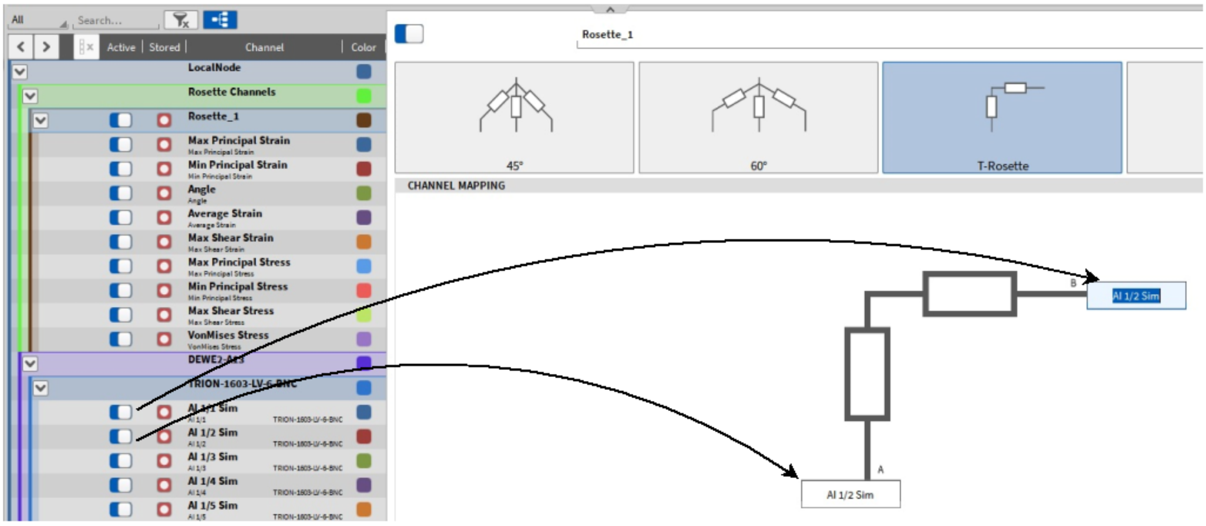

Fig. 7.114: Channel assignment in the rosette channel setup

If the assignment of a rosette input channel is missing, the error message *Input channels not ready* will be displayed at the bottom of the Channel Setup (see Fig. 7.115).

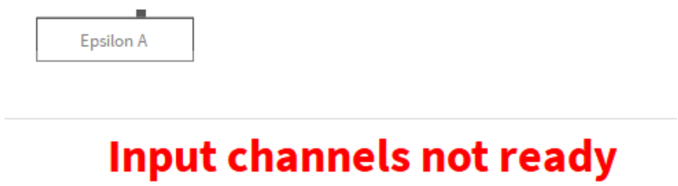

Fig. 7.115: Error message in case of missing channel assignment

The sample rate of the channels assigned to one rosette calculation must all be same . If they differ, the error message *Sample rates of input channels differ* will be displayed at the bottom of the Channel Setup (see Fig. 7.116).

Fig. 7.116: Error message in case of different channel sample rates

The sub channels (see ⑰ in Fig. 7.112) resulting from the rosette calculation have a Channel Setup that can be accessed via the Gear Button in the Channel List as well. But only the Channel scaling can be edited there.

Resulting output channels

The plugin uses the so-called Mohr's circle (see Mohr's circle) for the calculations. For details, refer to the relevant literature.

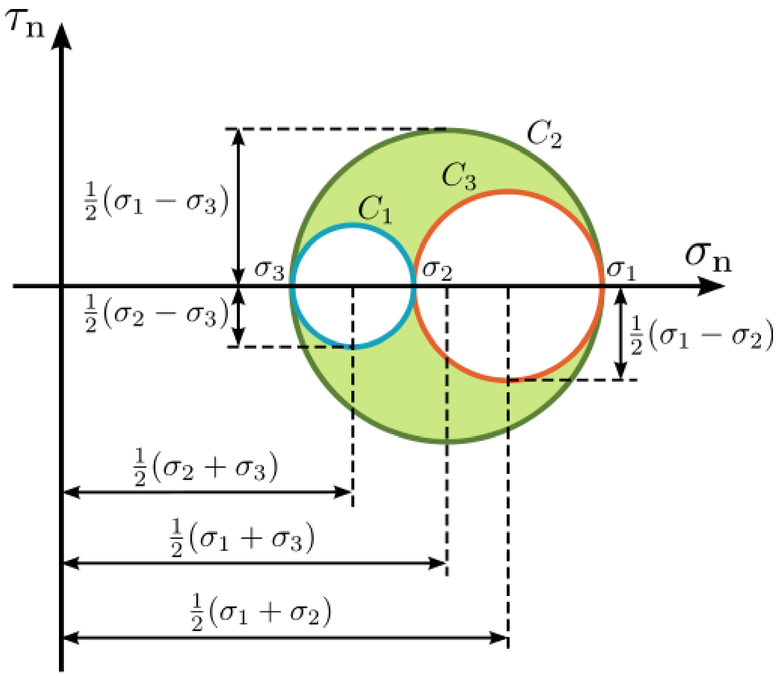

Fig. 7.117: Mohr's circle

The calculated values are represented in channels, which are shown below.

- Max Principle Strain → Max. Strain in angle direction [µm/m] or [microstrain]
- Min Principle Strain → Min. Strain in angle +90° direction [µm/m] or [microstrain]
- Angle → Angle of max. strain [°]
- Average Strain → Center of Mohr's circle [µm/m] or [microstrain]
- Max Shear Strain → Radius of Mohr's circle [µm/m] or [microstrain]
- Max Principle Stress → Max. stress in angle direction [MPa]
- Min Principle Stress → Min. stress in angle +90° direction [MPa]
- Max Shear Stress → Max. shear stress in angle direction [MPa]
- Von Mises Stress → Virtual uniaxial stress [MPa]

Usage of the plugin

The Rosette Math plugin is used to determine the angle and max/min amplitude of strain and stress on a surface. This is used when it is not known which direction of strain/stress has to be expected.

Rosette strain gauges are available combined in one foil (stacked construction), alternatively it is possible to use three separate strain gauges (planar construction).

Fig. 7.118 shows sketches of different rosette types: left: 90° (T), middle: 45°, right: 120° rosette.

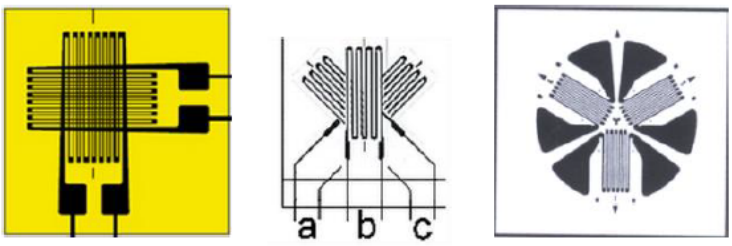

Fig. 7.118: Sketch of different rosette types

Physical basics

This chapter includes some important term explanations.

- Strain : Is the mechanical deformation measured as a relation between length change relative to the initial length:

$$\varepsilon = \frac{\mathrm{dl}}{l} \left[\frac{m}{m}\right]$$

- The strain is usually presented in µm/m, so the ratio of elongation is micrometers comparing to the length of a specimen in meters. So, what does that mean if we measure a value of 2000? First of all, we can also express this in percent. Strain in µm/m divided by a factor of 10000 results in elongation in percent. In the case of 2000, the elongation will be 0.2 %.
- Stress : Is defined as the average force per unit area, also taking in account the material.

$$\sigma = \frac{F}{A} \left[\frac{N}{mm^2}\right]$$

- Young's modulus: The formulas shown above only work in the linear part of the *Strain-Stress-Curve*, which is shown in Fig. 7.119. In this area a constant factor between stress and strain exists.

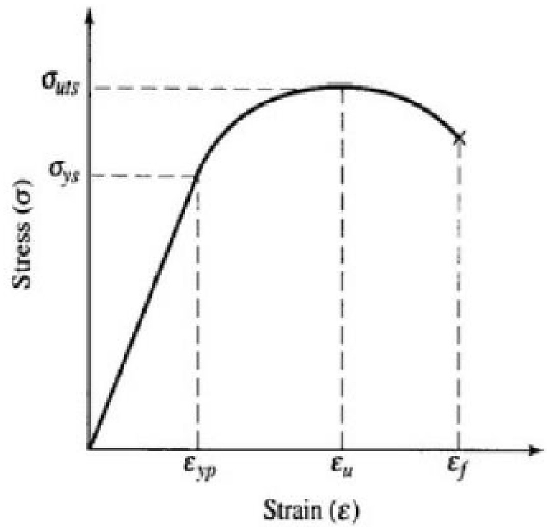

Fig. 7.119: Strain-Stress-Curve

$$E = \frac{\sigma}{\varepsilon} \left[M\frac{N}{mm^2} = GPa \right]$$

Where E is the Young's modulus or Elastic modulus. This constant is depending on the used material (e.g. steel = 210 kN/mm²). The measured value from the strain gauge is therefore the strain and you get the stress by calculating .

Implemented formulas

The Rosette calculations depend on the selected rosette type and angle reference.

Constants

$$\varepsilon_P \ldots Max.\, main\, strain$$

$$\varepsilon_Q \ldots Min.\, main\, strain$$

$$\theta \ldots Angle\, in\, direction\, of\, the\, max.\, main\, strain$$

Angle Reference

- $A:\ \theta_{P,Q} = (\ldots)$
- $B:\ \theta_{P,Q} = (\ldots) - 45°$ or $60°$
- $C:\ \theta_{P,Q} = (\ldots) - 90°$ or $120°$ or $240°$

Calculation of 45° and 90° Rosette

Avg Strain

MaxShearStrain

$$\varepsilon_P = \varepsilon_1$$

$$\varepsilon_Q = \varepsilon_2$$

$$\varepsilon_{P,Q} = \frac{\varepsilon_1 + \varepsilon_3}{2} \pm \frac{1}{\sqrt{2}}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2}$$
$$\theta_{P,Q} = \frac{1}{2}\tan^{-1}(\frac{2\varepsilon_2 - \varepsilon_1 - \varepsilon_3}{\varepsilon_1 - \varepsilon_3})$$

Calculation of 60° and 120° Rosette

$$\varepsilon_{P,Q} = \frac{\varepsilon_1 + \varepsilon_2 + \varepsilon_3}{3} \pm \frac{\sqrt{2}}{3}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2 + (\varepsilon_3 - \varepsilon_1)^2}$$
$$\theta_{P,Q} = \frac{1}{2}\tan^{-1}(\frac{\sqrt{3}(\varepsilon_2 - \varepsilon_3)}{2\varepsilon_1 - \varepsilon_2 - \varepsilon_3})$$

Calculations valid for all Rosette types

- Max/Min Principle Stress

$$\sigma_P = \frac{E}{1-\gamma^2}(\varepsilon_P + \gamma\varepsilon_Q)\left[\frac{N}{m^2}\right]$$
$$\sigma_Q = \frac{E}{1-\gamma^2}(\varepsilon_Q + \gamma\varepsilon_P)\left[\frac{N}{m^2}\right]$$

- Von Mises Stress

$$\sigma_{\text{vM}} = \sqrt{\frac{(\sigma_P - \sigma_Q)^2 + \sigma_P^2 + \sigma_Q^2}{2}}\left[\frac{N}{m^2}\right]$$

- Max Shear Stress

$$\sigma_{\text{SP}} = \frac{\sigma_P - \sigma_Q}{2}\left[\frac{N}{m^2}\right]$$

- Addition to Angle Calculation

The following table shows how to determine the principal axis angle *φ0 taking the sign of the numerator and the enumerator into account*

Quadrant	Z	N	Angle φ_0
I	+	+	*0° ≤ φ0 ≤ +45°*
II	+	-	*+45° ≤ φ0 ≤ +90°*
III	-	-	*-45° ≤ φ0 ≤ -90°*
IV	-	+	*0° ≥ φ0 ≥ -45°*

Time reference curve

In OXYGEN, a time reference curve can be created in the Advanced Math options. This serves as a purely visual reference and can be used like other channels in the recorder, etc.

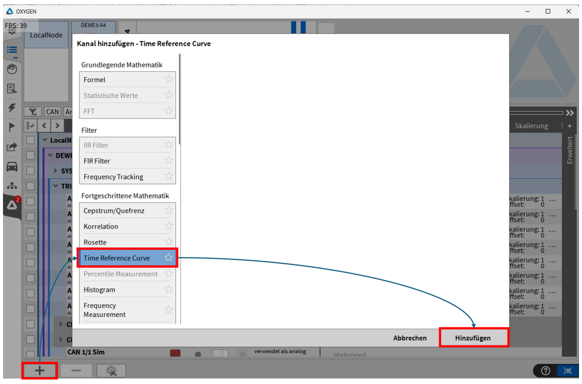

Fig. 7.120: Creating a time reference curve

After creating the reference curve, settings can be defined for, among other things, the type, i.e., whether one or two curves should be created, and the data source, i.e., whether a table or another measurement file should determine the curves. The other options are explained in more detail in Table 7.30. In the following figure, Fig. 7.121, two reference curves, Upper/Lower, was selected as type, the data source is a Table and the start on condition is On Channel.

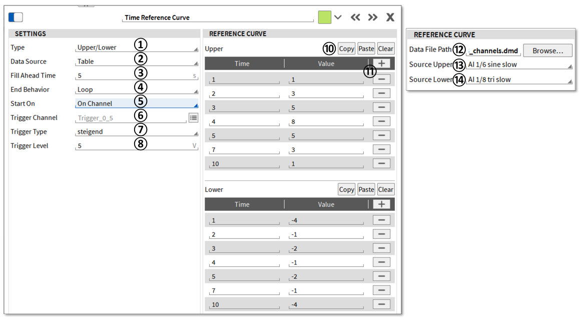

Fig. 7.121: Properties of the time reference curve

Table 7.30: Reference curve channel properties

Nr.	Name	Description
1	Type	Select whether to create one (*Single*) or two (*Upper/Lower*) reference curves.
2	Data Source	Select what should be the basis for the reference curve. Either a *Table* with time and value or based on channel from *Data file*.
3	Fill Ahead Time	A time offset for the reference curve can be set here. This means that the reference curve begins 0…500 s before the current time, see Fig. 7.122.

continues on next page

Table 7.30 – continued from previous page

Nr.	Name	Description
4	End Behavior	Select whether the reference curve should be completely repeated after the data points have been processed: Loop, hold the last data point – *Repeat Last Value* or do not continue – *NaN*.
5	Start On	There are three options for starting the reference curve. Start *On Channel* means that the start of the curve is triggered by a channel. Start *On Acquisition* means that the reference curve starts when data acquisition begins (without measurement). Start *On Measurement* means that the reference curve starts when the measurement is armed. If the start condition is not met, the first value of thereference curve is repeated.
6	Trigger Channel	Only available for start condition *On Channel* selection. Select the trigger channel for starting the reference curve. This can be either math channels or analog channels.
7	Trigger Type	Only available for start condition *On Channel* selection. Select whether the reference curve should start when the trigger level ⑧ is exceeded or not reached.
8	Trigger Level	Only available for start condition *On Channel* selection. Selection of the level at which the start condition is met.
9	Rearm Level	Only available for start condition *On Channel* selection. Selection to define the level required to start the reference curve again on trigger.
10	Reference curve Copy/Paste/Clear	If a data file has been selected as the data source, the data points can be defined either in OXYGEN or in a third-party text editor. To export the table from OXYGEN, use *Copy*. To import the table from a text editor, use *Paste*. The structure is “Time in s” ‘Tab’ “Value.” The table can be deleted with *Clear*.
11	Reference curve Plus/Minus	Here, lines can be added (+) or deleted (-) for the reference curve.
12	Datafile path	If Table has been selected as the data source, an OXYGEN measurement file *.dmd can be selected to define the reference curves.
13	Source Upper	Select the channel for the upper reference curve from the measurement file selected in ⑫.
14	Source Lower	Select the channel for the lower reference curve from the measurement file selected in ⑫.

The next figure Fig. 7.122 shows an example for an Upper- and Lower-time reference curve with a 5s pre time and the loop end behavior.

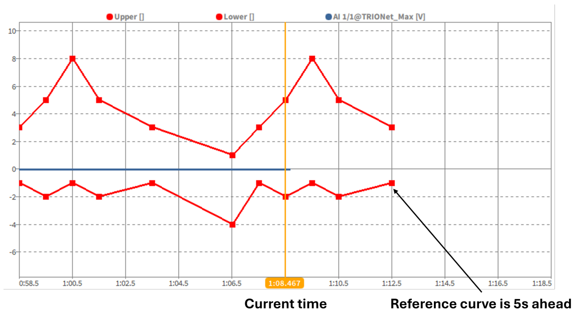

Fig. 7.122: Example for Upper and Lower Time Reference Curve with 5 s pre time (Fill ahead time)

Percentile

This module can be used to add a percentile measurement based on a synchronous or asynchronous time-dependent channel or array. With this calculation it is possible to calculate the threshold value that is exceeded in x% of the measurement time.

To create one or more channels for a percentile measurement, click on the + button in the bottom left corner of the channel list. A pop-up window appears in which the percentile measurement must be selected in the list (see Fig. 7.123). One or more channels must be selected in the channel list before clicking on the + button (see ① in Fig. 7.123). It is also possible to add channels for the measurement afterwards (see ① Fig. 7.124). You can specify 1 or more threshold values in %. When selecting multiple threshold values, the individual values must be separated by ";" (see ② in Fig. 7.123).

After clicking the Add button, a new section appears in the channel list called PERCENTILE MEASUREMENT Channels. To change the settings afterwards or to add channels or thresholds, click on the small cogwheel (see Fig. 7.124).

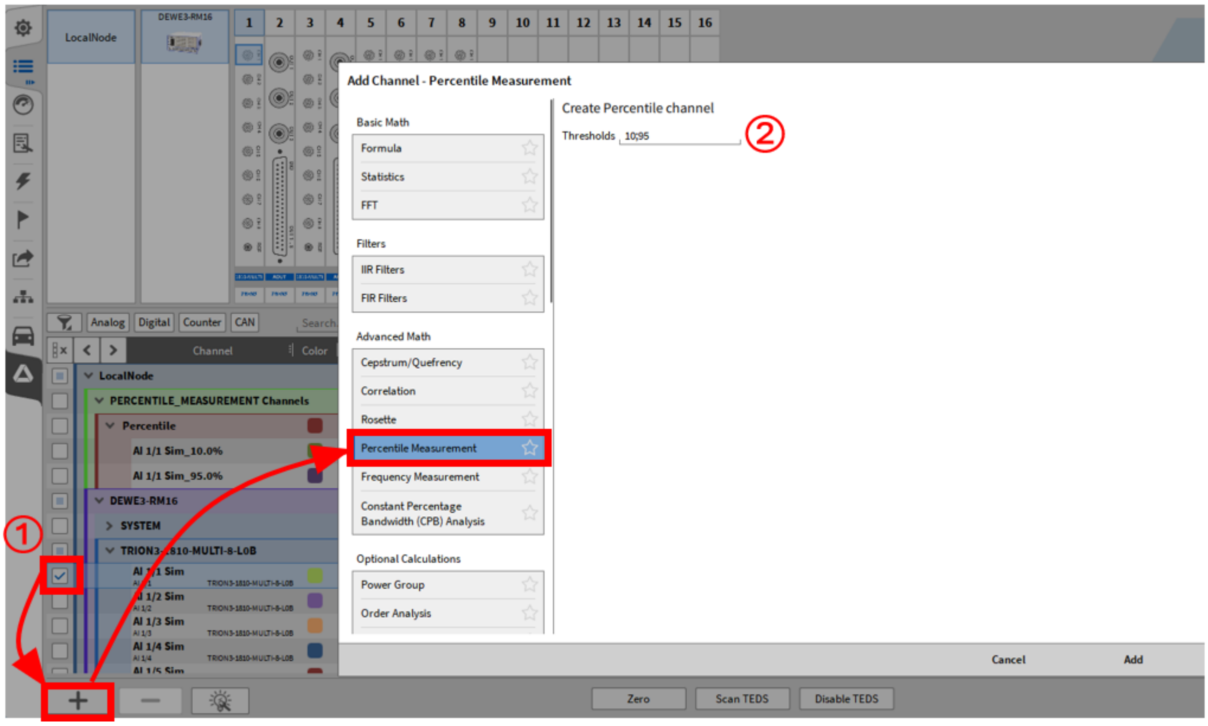

Fig. 7.123: Add a percentile measurement

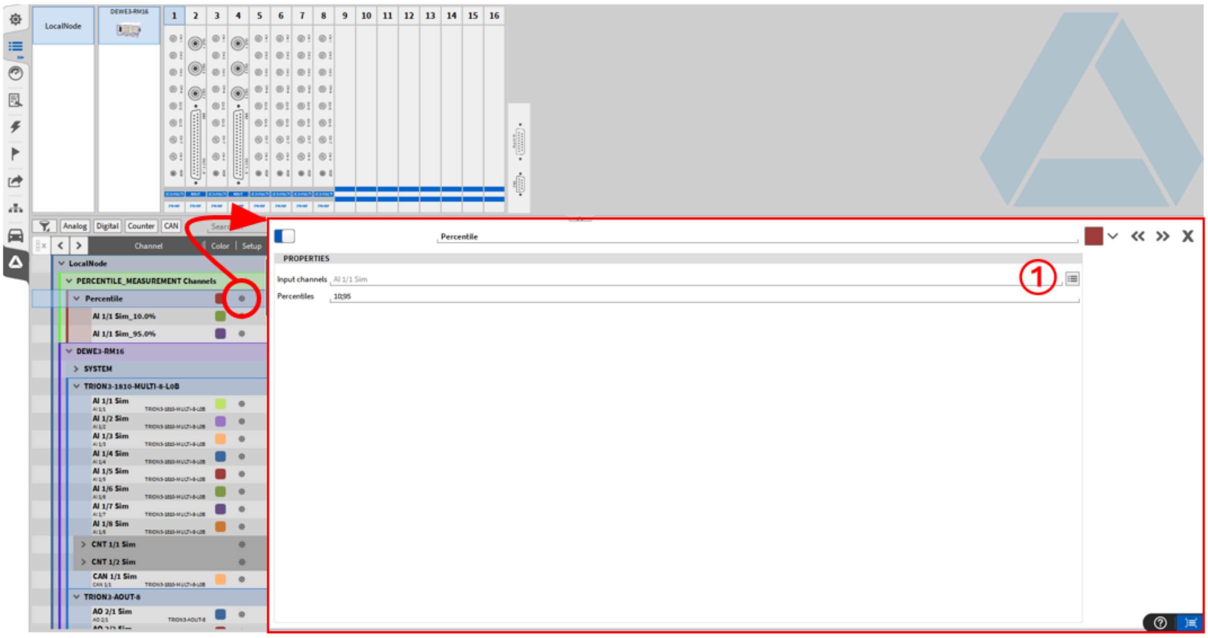

Fig. 7.124: Subsequent changes to the percentile measurement

During the measurement, the values for the percentile measurement are continuously recalculated, but only the last calculated value is saved in the measurement file (*.dmd) and is then available as a single value.

Histogram

The histogram is a math function for the statistical evaluation of a single channel. It can be found in the *Advanced Math* options (see Fig. 7.125).

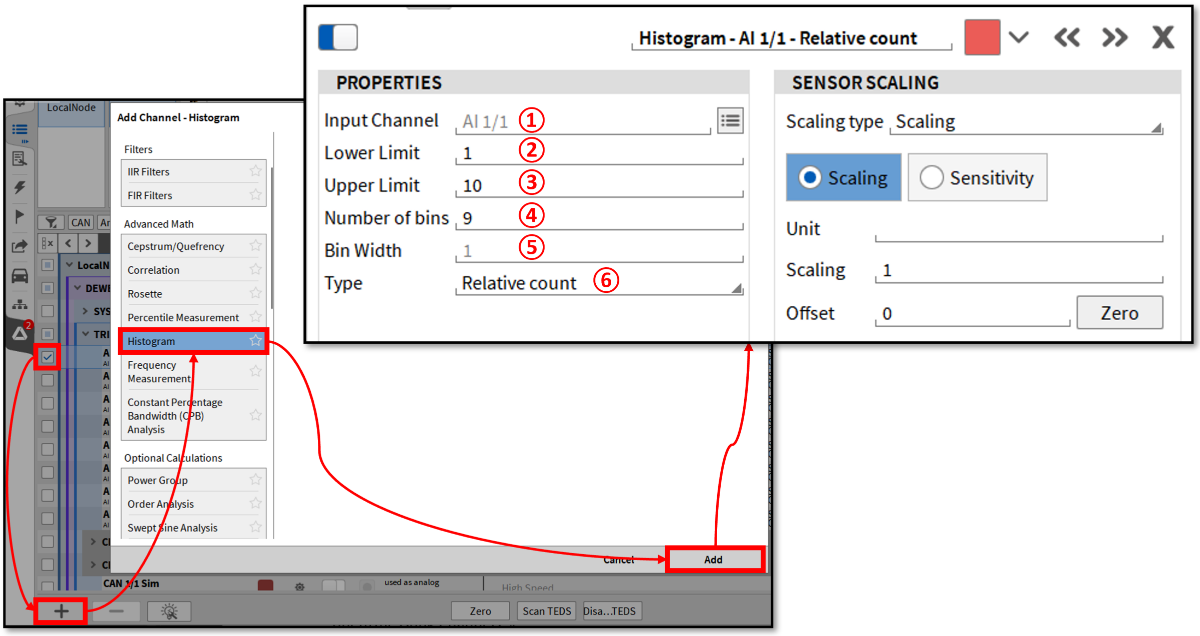

Fig. 7.125: Creation and configuration of a Histogram

Table 7.31: Settings of a Histogram

No.	Function	Description
1	Input channel	Selection of channel for which a histogram calculation is to be performed.
2	Lower limit	Minimum value for creating the histogram; values below the limit are ignored.
3	Upper limit	Maximum value for creating the histogram; values above the limit are ignored.
4	Number of bins	The number of bins (intervals) displayed on the X-axis.
5	Bin width	The resulting width of the bins is from the limits and number of bins. (upper limit - lower limit) / number of bins
6	Histogram type	The histogram type defines the output (amplitude) of the calculation and the information stored in the output channels. The following types are available for selection: Absolute number, Relative number and Relative number in [%], Density and Density in [%], Distribution and Distribution in [%]

Histogram type descriptions:

- Absolute count: Each bin contains the number of measured values within the bin (the value is always counted upwards)
- Relative count: Each bin value is the number of samples within the bin, normalized to the total number of samples counted (the sum of all bins is always 1)
- Relative count [%]: Same as relative count, but expressed as a percentage (the sum of all bins is always 100)
- Density: With empirical probability density, each relative count is divided by the bin width. In this case, the value is not dependent on the number of bins within a range
- Density [%]: Same as density but expressed as a percentage (multiplied by 100).
- Distribution: In an empirical probability distribution, the relative count is cumulated for each bin. This means that each bin is the sum of all lower bins and the current bin. The highest bin has the value 1.
- Distribution [%]: Corresponds to the distribution but is expressed as a percentage. The highest bin has a value of 100.

An example is the following histogram with 13 bins, a lower limit of 1, and an upper limit of 10 is shown in Fig. 7.126. The signal has a maximum value of 8 V, meaning all bins above 8 show no relative count and density, but still a distribution of 1.

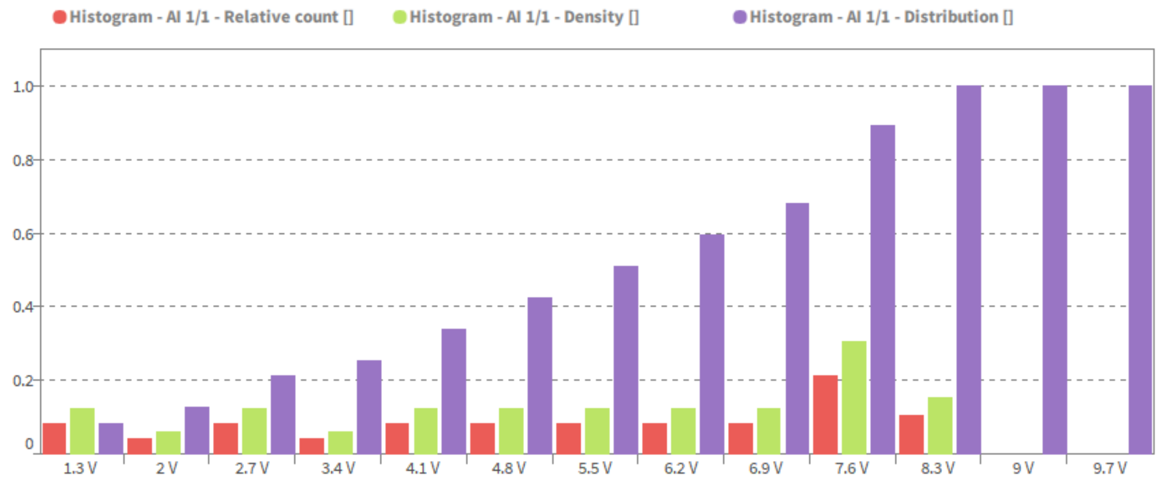

Fig. 7.126: Example of a Histogram with relative count, density and distribution

Frequency measurement

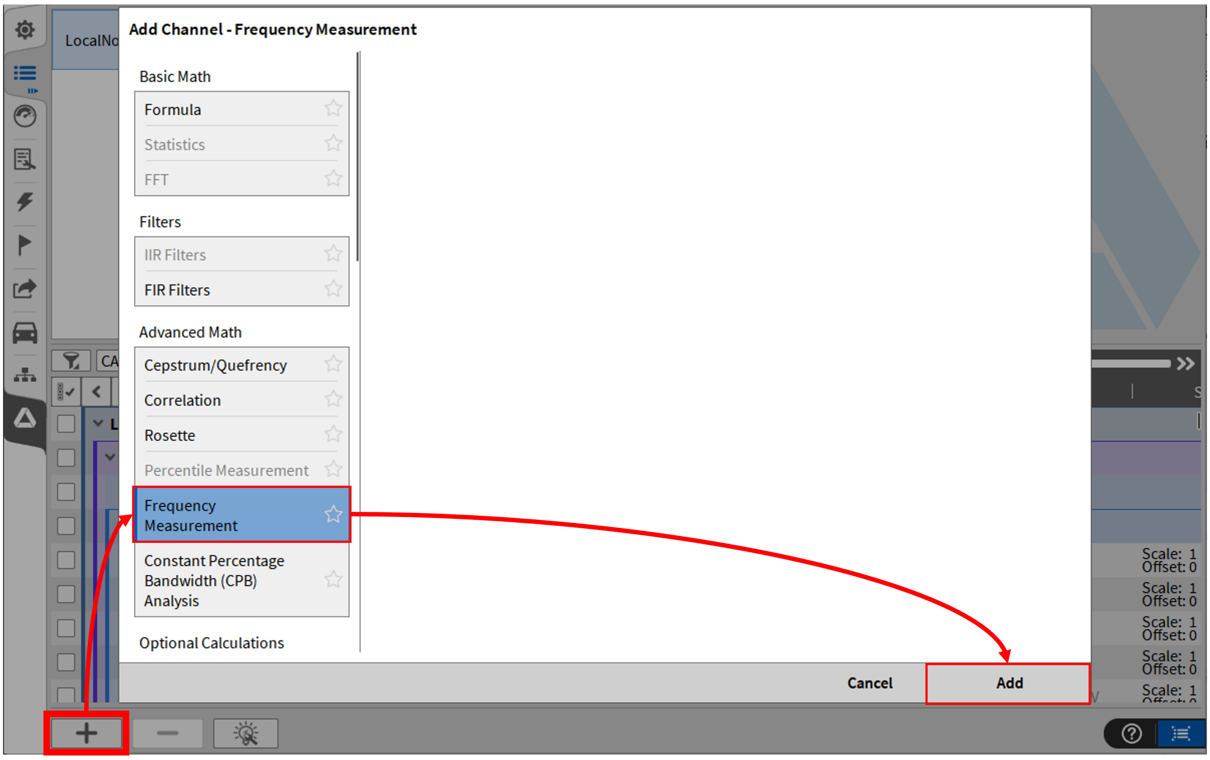

Fig. 7.127: Pop-up window for creating a frequency measurement channel

With this module it is possible to calculate the frequency of a periodical signal. The calculation is based on a block-wise calculation. To create one or several Frequency Measurement Channels click on the + button in the lower left corner of the channel list menu. A pop-up window will appear (see Fig. 7.127) where *Frequency Measurement* must be selected. The user can select several input channels simultaneously to create several frequency calculations before clicking on the + button or choose the channels after creating the Frequency Measurement channel.

After clicking on the *Add button* a new section in the channel list appears named Frequency Measurement Channels.

When clicking on the little gear button the settings of the frequency channel will open.

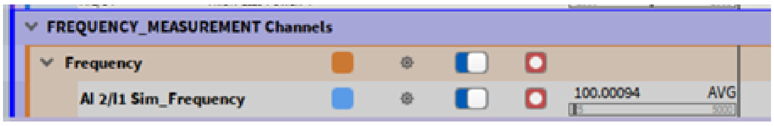

Fig. 7.128: Frequency Measurement Channels in Channel List

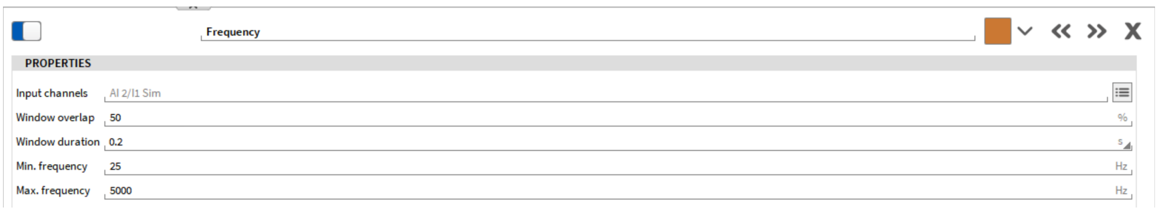

Fig. 7.129: Frequency Measurement Channel settings

The following settings are available:

- Input channels: the input channels for the calculation can be selected when clicking on the button; a small pop-up window will appear where the desired channels can be changed or selected.
- Window overlap: the window overlap can be entered here from 0 to 90 %.
- Window duration: the window duration can be entered in this field, or a value can be chosen from the dropdown list; the minimum window duration is 10 ms up to 1 s.
- Min. frequency: the minimum frequency which should be calculated must be entered here; the minimum frequency is 0 Hz.
- Max. frequency: the maximum frequency is half the sample rate to account (Nyquist frequency).

CPB analysis

This is a standard feature and requires no additional license.

The CPB analysis computes a constant percentage bandwidth spectrum according to EN 61260 in Octave, Third octave or Twelfth octave resolution.

Creating a CPB Analysis

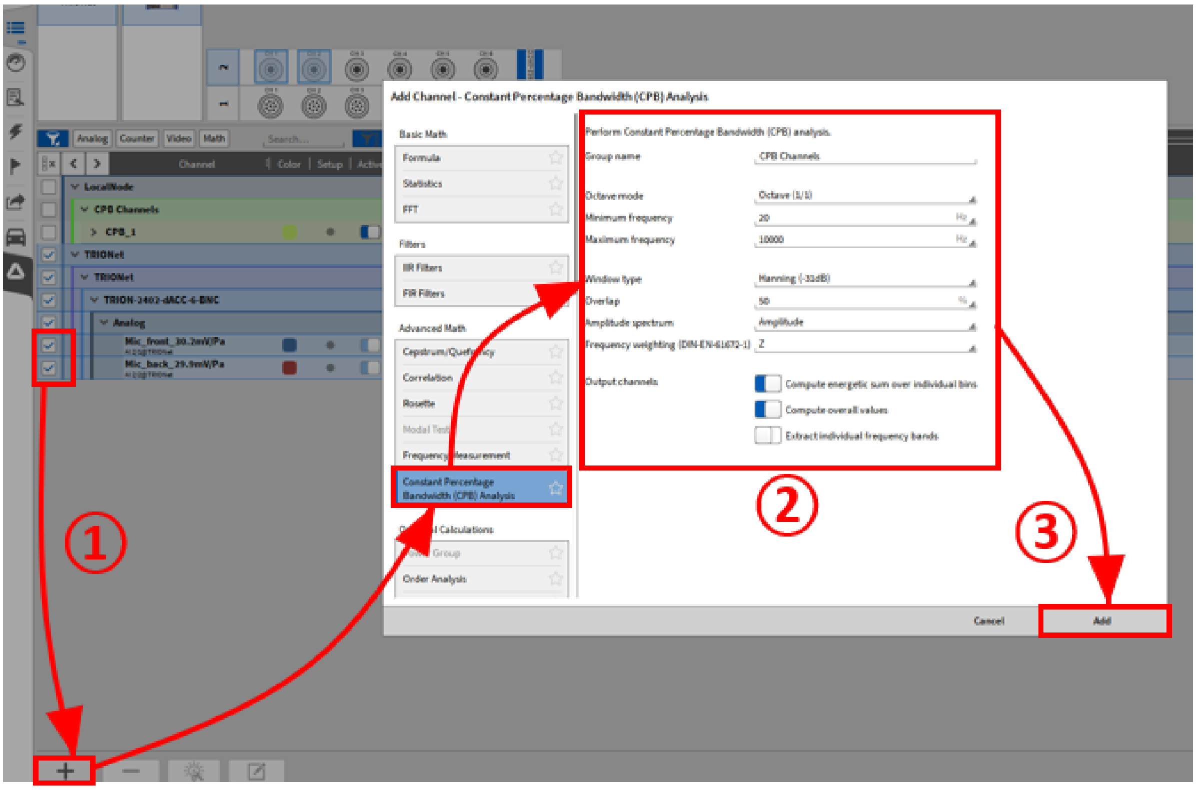

Fig. 7.130: Creating a CPB Analysis

1. Go to the Channel List and select one or several channels by checking their check boxes and press the + button
2. Select *CPB Analysis*, choose the proper calculation options and enable the required output channels (Details can be found in *CPB analysis options*)
3. Press *Add* afterwards to create the calculation. The channels will be added to the Channel List (see ④ in Fig. 7.131)
4. The settings can be accessed afterwards by clicking on the Gear button of the channel (see ⑤ in Fig. 7.131)

An *Array Chart* instrument can be used for visualizing the CPB spectrum. Further details can be found in *Array Chart with Total column included*.

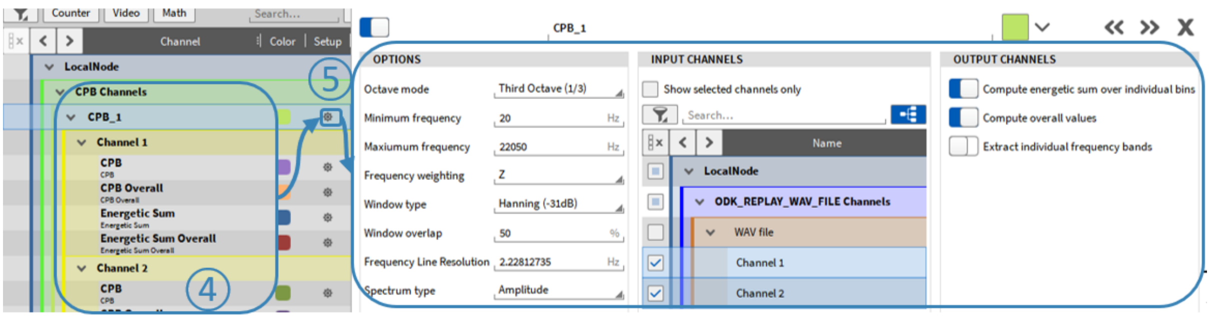

Fig. 7.131: CPB Analysis with extracted 100 Hz and 250 Hz bin

CPB analysis options

The following options can be selected for a CPB Analysis (see ② in Fig. 7.130):

- Group Name: Set a group name for the actual calculation which appears in the Channel List
- Octave mode: Select Octave, Third octave or Twelfth octave resolution (grouping according to EN 61260)
- Minimum Frequency: Set a minimum frequency for computation. If the selected frequency is not the center frequency of a CPB bin, the bin including this frequency will be used as minimum bin.
- Maximum Frequency: Set a maximum frequency for computation. If the selected frequency is not the center frequency of a CPB bin, the bin including this frequency will be used as maximum bin. The maximum frequency which can be set is 500 kHz.
- Window type: Select between Hamming, Hanning, Rectangular, Blackman, Blackman-Harris, Flattop, Flattop-Bartlett Window for the spectral analysis
- Overlap: Select an overlapping factor from 0 … 90 % for the spectral analysis
- Amplitude Spectrum: Select between Amplitude spectrum or Decibel spectrum with freely definable reference value and corresponding reference level
- Frequency Weighting: Select between frequency weighting according to DIN-EN 61672: A-, B-, C-, D- or Z- (linear) weighting
- Output Channels: Activate output channels:

  The actual CPB spectrum (changing in time) is calculated per default. The channel name is *CPB* (see ④ in Fig. 7.131).

  If *Compute energetic sum over individual bins is* enabled, the energetic sum for the spectrum is calculated. The channel name is *Energetic Sum* (see ④ in Fig. 7.131).

In case it is an *Amplitude* spectrum, the calculation is the following:

$$\text{Energetic Sum} = \sqrt{\sum_{i=1}^{n} x_i^2}$$

- n … Number of CPB bins
- x_i … CPB bin with index i

In case it is a *Decibel* spectrum, the calculation is the following:

$$\text{Energetic Sum} = 10 * log \sqrt{\sum_{i=1}^{n} (10^{\frac{x_i}{10}})^2}$$

- *n … Number of CPB bins*
- *xi … CPB bin with index i*

If *Compute overall Values* is enabled, one CPB spectrum averaged for the whole measurement time and an energetic sum (if enabled) averaged for the whole measurement time will be calculated.

The calculation will be reset at recording start. The channel name will be *CPB Overall* and *Energetic Sum Overall* (see ④ in Fig. 7.131).

If *Extract individual frequency bands* is enabled, frequency bands can be output as time domain channels. I.e. If 100 Hz is entered, the 100 Hz band will be extracted as time domain channel to analyze the time dependent trend.

It is possible to extract several bands (see Fig. 7.132).

If the entered frequency is not the center frequency of a CPB bin, the bin including this frequency will be extracted.

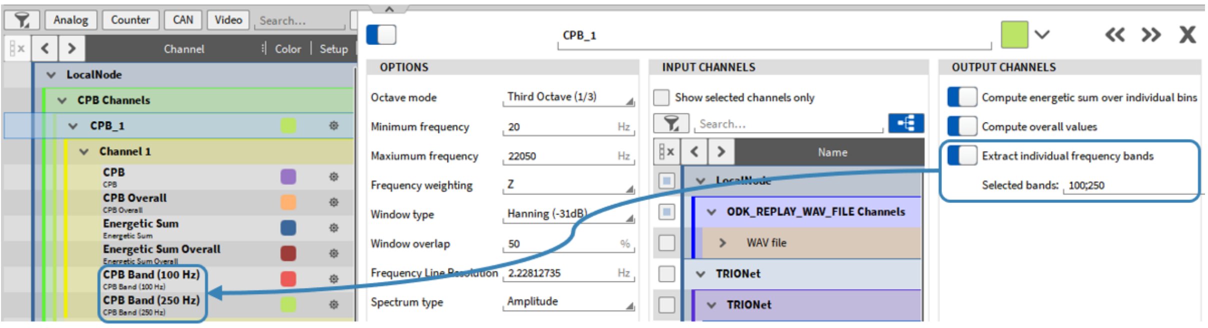

Fig. 7.132: CPB Analysis with extracted 100 Hz and 250 Hz bin

7.4.4 Optional calculations

Power Group

This is an optional feature and requires a license.

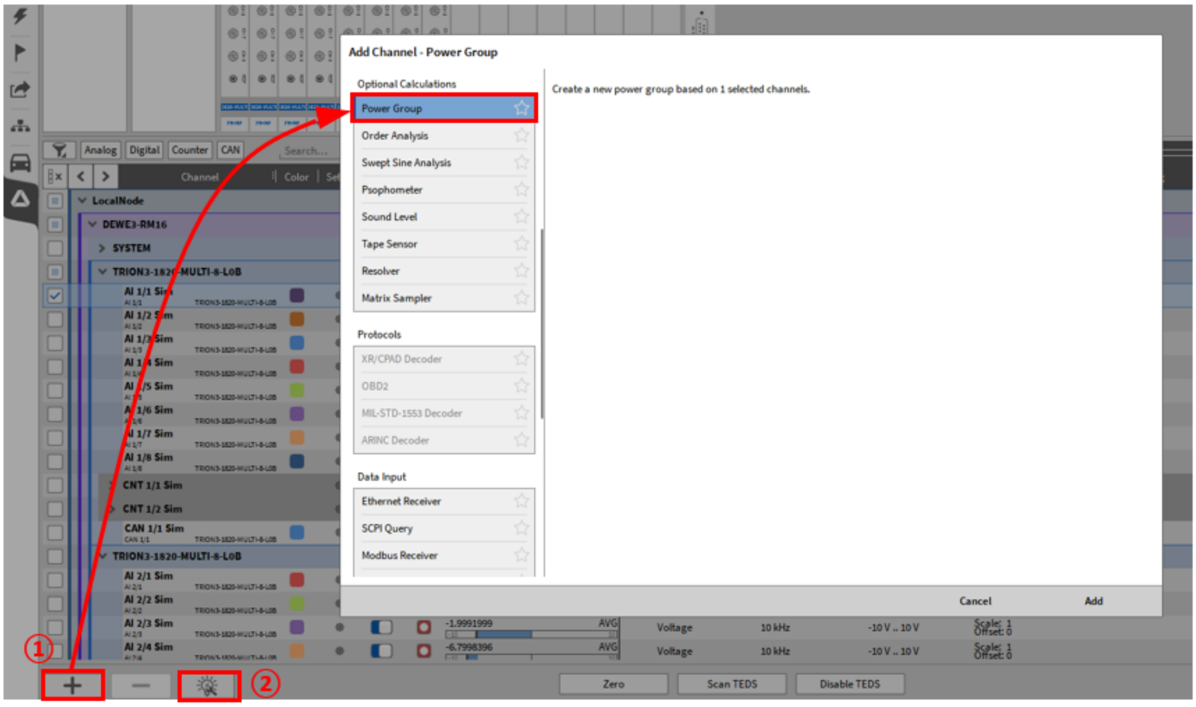

Fig. 7.133: Pop-up window for creating a Power Group

A Power Group can be created by pressing either the *Add* button or the *Calculator* button in the lower left corner of the Data Channels menu (both buttons marked red in Fig. 7.133).

For details about the OXYGEN Power module refer to the *Power Technical Reference Rx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

OXYGEN Order Analysis plugin

This is an optional feature and requires a license.

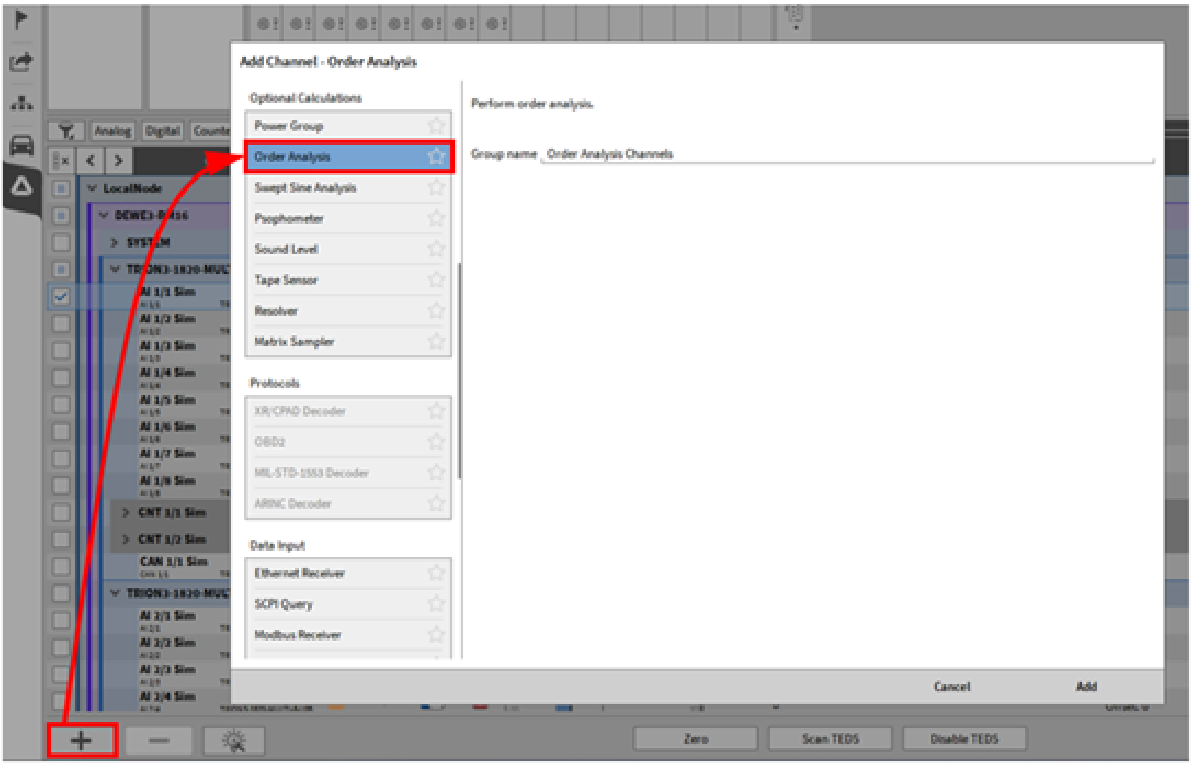

Fig. 7.134: Pop-up window generating an order analysis

An order analysis can be created and configured by pressing the *Add* button in the lower left corner of the Data Channels menu (marked red in Fig. 7.134).

For details about the Order Analysis plugin refer to the *DEWETRON_Oxygen_Order_Analysis_vx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

Swept Sine Analysis

This is an optional feature and requires a license.

The Swept Sine Analysis can be used to determine the transfer function and the bode diagram of a DUT that is stimulated by a shaker which is driven by a wave-generator replaying a sine sweep. An exemplary testbed could look like the following (see Fig. 7.135):

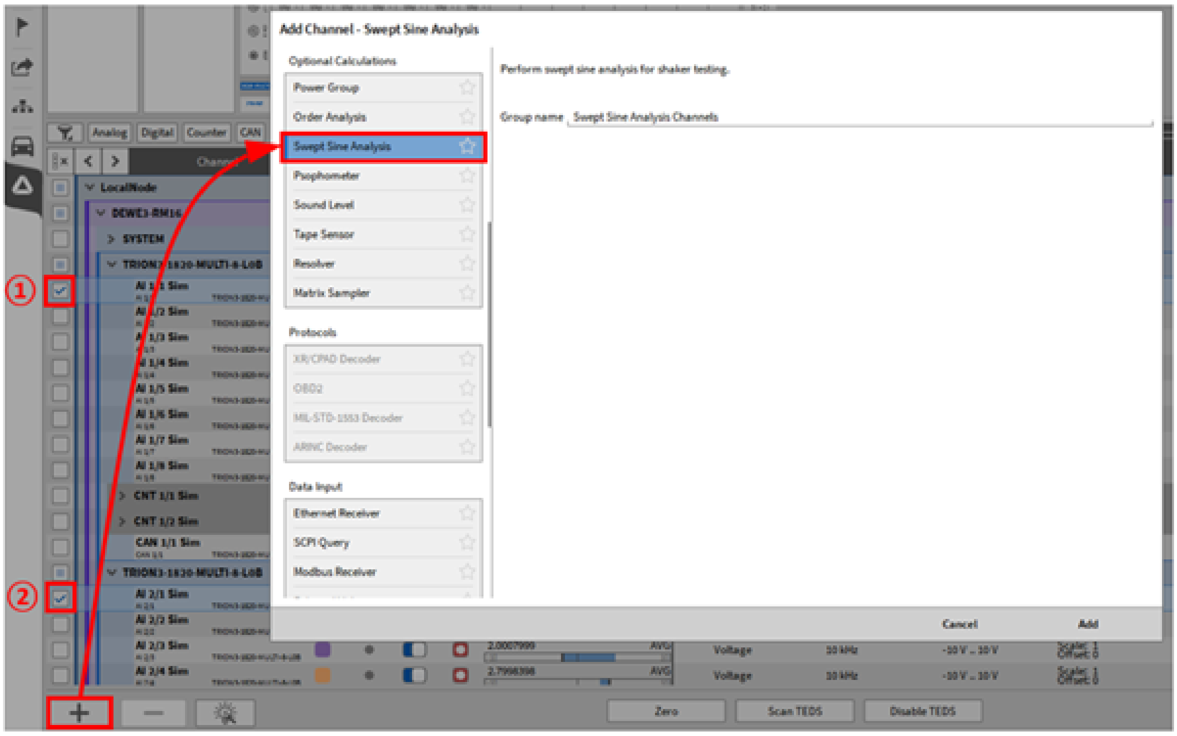

Fig. 7.135: Exemplary testbed to use the Swept Sine Analysis plugin

A DUT is standing on a shaker. The shaker is driven by a Signal Generator which replays a sine sweep. One accelerometer is applied directly on the shaker and provides the reference (source) signal that is used to stimulate the DUT. One or several additional accelerometers are applied directly on the DUT that measure the acceleration on the DUT surface on different positions (sink).

These signals can be applied to the Swept Sine Analysis plugin to determine the transfer function and the phase shift from source to sink.

Setting up a Swept Sine Analysis

To set up the Swept Sine Analysis plugin, perform the following steps:

1. At first, mark the checkbox of the channel which provides the reference signal for the Swept Sine Analysis (see ① in Fig. 7.136)
2. Next, mark the channel that provides the signal measured on the signal sink (see ② in Fig. 7.136). Several sink signals could be applied to one Swept Sine Analysis group.
3. Click on the *PLUS* (see ③ in Fig. 7.136) sign to open the math setup and select *Swept Sine Analysis*. Edit the channel group name if desired and click on the *OK* button afterwards.

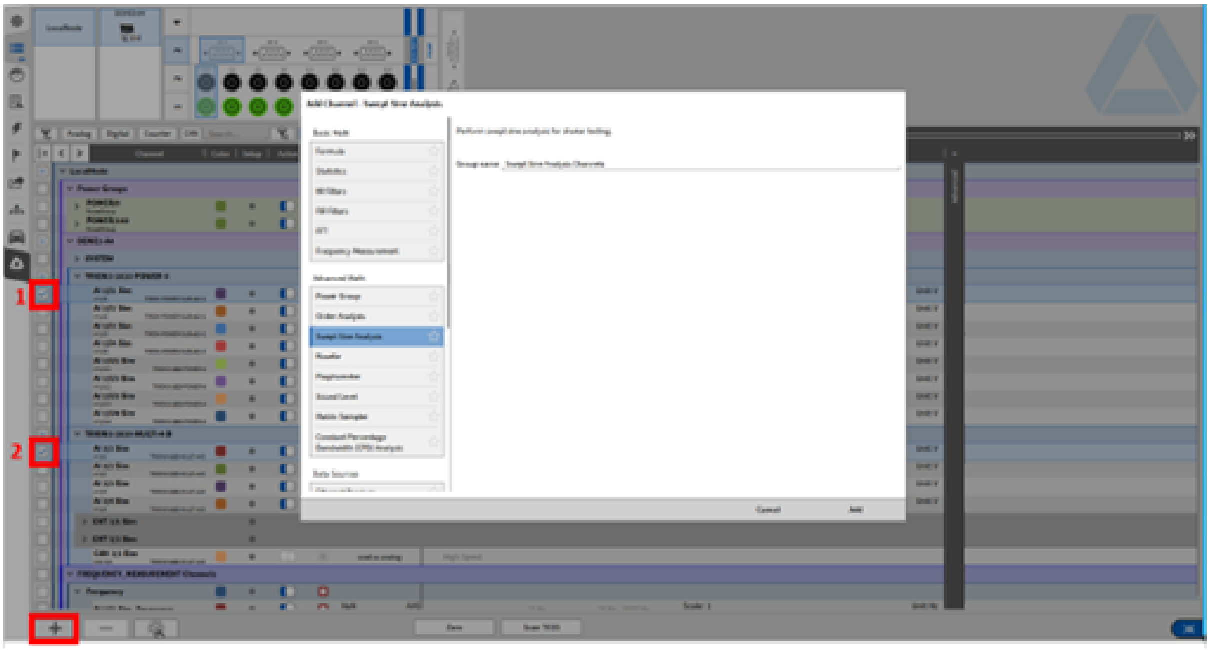

Fig. 7.136: Swept Sine Analysis

Setup overview

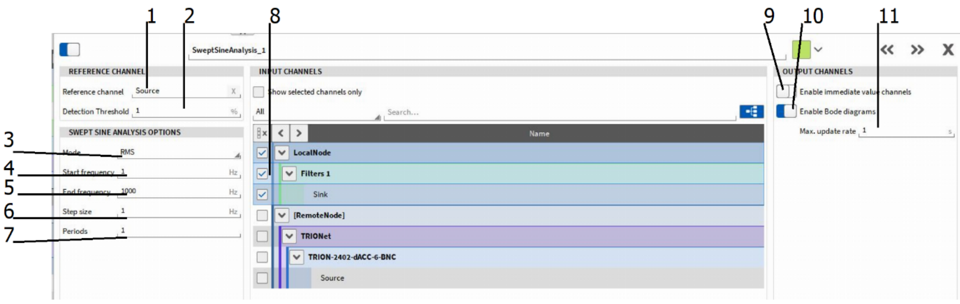

Fig. 7.137: Swept Sine Analysis setup – overview

Table 7.32: Swept Sine Analysis setup – overview

No.	Function	Description
1	*Reference channel* selection	The channel that provides the reference signal can be edited here; This channel is used to determine the fundamental frequency which is available in the channel *F_fund* (see *Swept Sine analysis output channels*)

continues on next page

Table 7.32 – continued from previous page

No.	Function	Description
2	*Detection Threshold* selection	Amplitude threshold for determining the fundamental frequency; If the amplitude of the reference channel is below the specified threshold (percentage of the channel input range), the fundamental frequency will not be determined; I.e. Channel Input Range = 100 V and Detection Threshold = 1%; The signal amplitude must be 1V or higher to determine the fundamental frequency
3	Calculation *mode* selection	*RMS* or *Zero-Peak* selectable; The output channels (see *Swept Sine analysis output channels*) may contain either the RMS or Zero-to-Peak level as result
4	*Start frequency* selection	Enter the lower frequency limit for the Swept Sine Analysis
5	*Stop frequency* selection	Enter the upper frequency limit for the Swept Sine Analysis
6	*Step size* selection	Enter the frequency resolution of the Swept Sine Analysis
7	*Periods* selection	Number of signal periods of the reference signal that shall be used for updating one value
8	*Input channels* selection	Select the input channels that contain the sink signals (sensors that applied on the DUT); One or several sensors can be selected
9	*Enable immediate value channels* switch	The channels that contain the time domain signals (see *Swept Sine analysis output channels*) are enabled with this switch; Per default disabled
10	*Enable Bode diagram* switch	The channels that contain the frequency domain signals (see *Swept Sine analysis output channels*) are enabled with this switch; Per default enabled
11	*Max update rate* selection	Select the calculation update rate (from 1 to 10s)

Swept Sine analysis output channels

- F_fund: Contains the fundamental frequency of the Swept Sine Analysis; Calculation based on the signal provided by the reference (source) channel
- *ChannelName*_iRMS or *ChannelName*_iPeak: Time domain channel; Contains the amplitude (RMS or Zero-to-Peak level depending on the selection in ③ in Fig. 7.137) of the signal at the actual frequency; The amplitude is only referring to the fundamental frequency signal components; Can be assigned to a Recorder (see *Recorder*), Digital Meter (see *Digital meter*) or similar.
- *ChannelName*_iPhi: Time domain channel; Contains the phase shift of the signal at the actual frequency; Can be assigned to a Recorder (see *Recorder*), Digital Meter (see *Digital meter*) or similar.
- *ChannelName*_iUFRMS or *ChannelName*_iUFPeak: Time domain channel; Contains the amplitude (RMS or Zero-to-Peak level depending on the selection in ③ in Fig. 7.137) of the signal at

the actual frequency; The amplitude is referring to the entire signal components; Can be assigned to a Recorder (see *Recorder*), Digital Meter (see *Digital meter*) or similar

- *ChannelName*_RMS or *ChannelName*_Peak: Frequency domain channel; Contains the transfer function (RMS or Zero-to-Peak level depending on the selection in ③ in Fig. 7.137); The amplitude is referring to the fundamental frequency signal components; Can be assigned to a Spectrum Analyzer (see *Spectrum analyzer*) instrument for displaying the data.
- *ChannelName*_Phi: Frequency domain channel; Contains the phase diagram; Can be assigned to a Spectrum Analyzer (see *Spectrum analyzer*) instrument for displaying the data.
- *ChannelName*_UFRMS or *ChannelName*_UFPeak: Frequency domain channel; Contains the transfer function (RMS or Zero-to-Peak level depending on the selection in ③ in Fig. 7.137); The amplitude is referring to the entire signal components; Can be assigned to a Spectrum Analyzer (see *Spectrum analyzer*) instrument for displaying the data.

Calculation remarks

- The maximum frequency span is from 1 to 20000 Hz. To achieve a suitable accuracy, it is recommended to set the sample rate of the input channels to at least 20 times the maximum frequency, i.e. to 20 kHz in case of 1 kHz maximum frequency span.
- The highest resolution of the frequency domain channels is 1 Hz. Data of non-integer frequency bins is rounded to the next integer frequency bin.
- If the sweep does not exactly hit exactly one frequency bin which is contained in the data array, data for the certain frequency bin is filled up by linear interpolation of the two narrowed frequency bins
- The channels containing frequency domain data contain only one single value data array at the end of the measurement. In case of multi-file recording (see *Multi-file recording*), this data array will only be included in the last data file, the other files will not contain this data.
- If the sweep is passing the same frequency several times, there will not be several values for the same frequency stored, but the maximum value only is stored to the data file.
- If the screen is frozen (see ⑦ in Fig. 3.5) and the orange cursor is moved either in the Overview Bar or in a Recorder, the data of the single value array will change approximately every second as the array is continuously filled with data. In the end, there will only be the final value.
- As the channels containing frequency domain data contain only one single value data array at the end of the measurement, there will not be reduced Statistics data available (see *Triggered Events*).

Psophometer

In telecommunications, a psophometer is an instrument that measures the perceptible noise of a telephone circuit.

The core of the meter is based on a true RMS voltmeter, which measures the level of the noise signal. This was used for the first psophometers, in the 1930s. As the human-perceived level of noise is more important for telephony than their raw voltage, a modern psophometer incorporates a weighting network to represent this perception. The characteristics of the weighting network depend on the type of circuit under investigation, such as whether the circuit is used to normal speech standards (300 Hz – 3.3 kHz), or for high-fidelity broadcast-quality sound (50 Hz – 15 kHz).

Setup

The Psophometer plugin is installed with every OXYGEN installation, starting from R3.5.1

A dedicated plugin license is required for the calculation option to be visible.

Usage

1. Select one or multiple channels as inputs for the Psophometer calculation.

   Note: Input channels must have a sampling rate of 20 kHz or higher.

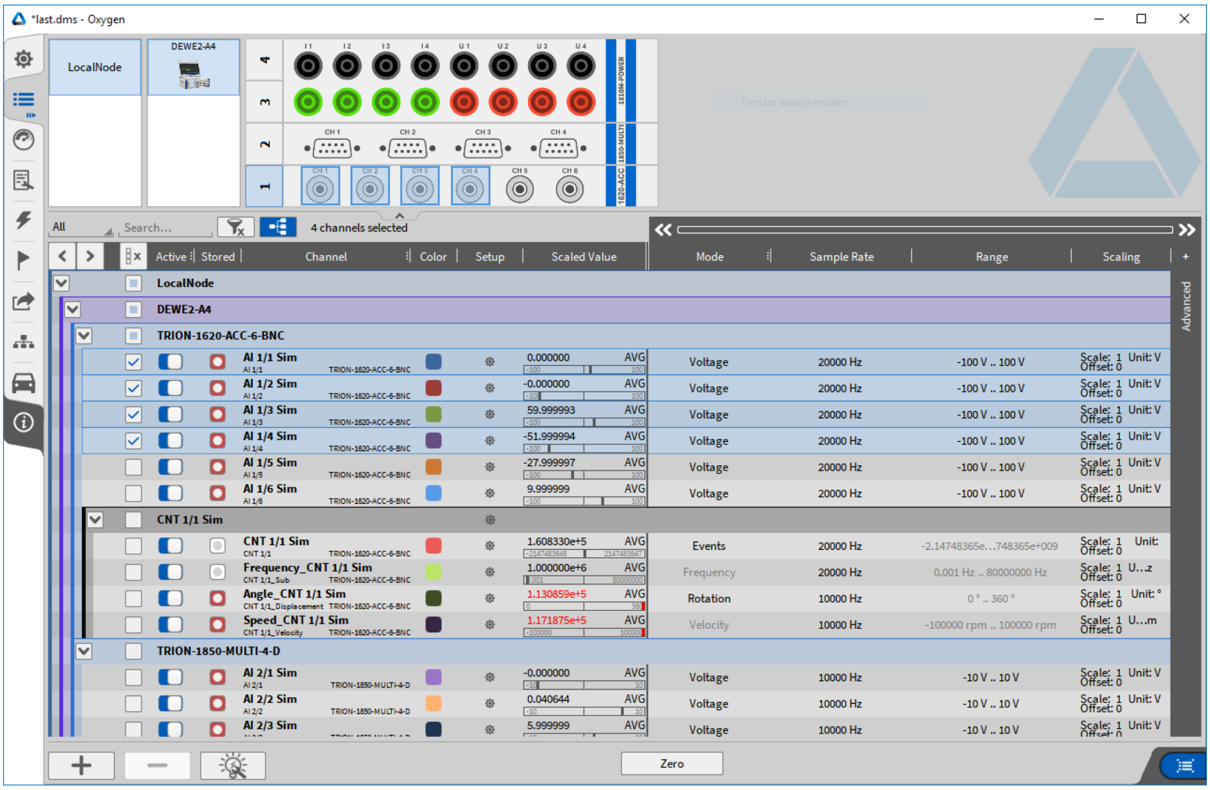

Fig. 7.138: Channel list with multiple selected channels

2. Then open the "Add Channel" dialog by pressing the plus button.
3. Select Psophometer. The dialog now shows the Psophometer frequency weighting settings (see *Weighting*) which can be made.
4. The newly created Psophometer calculation group can be named individually.

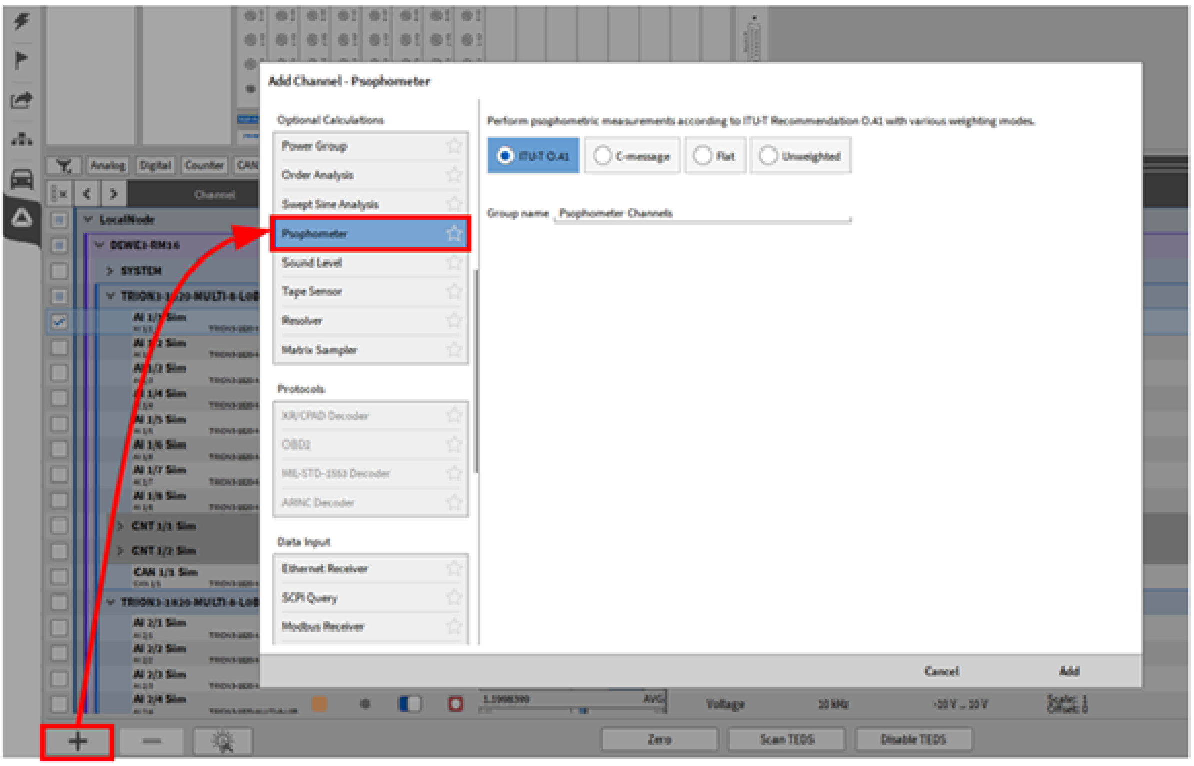

Fig. 7.139: Add Channel dialog showing Psophometer options

5. Finally, press Add to create the new calculation group.

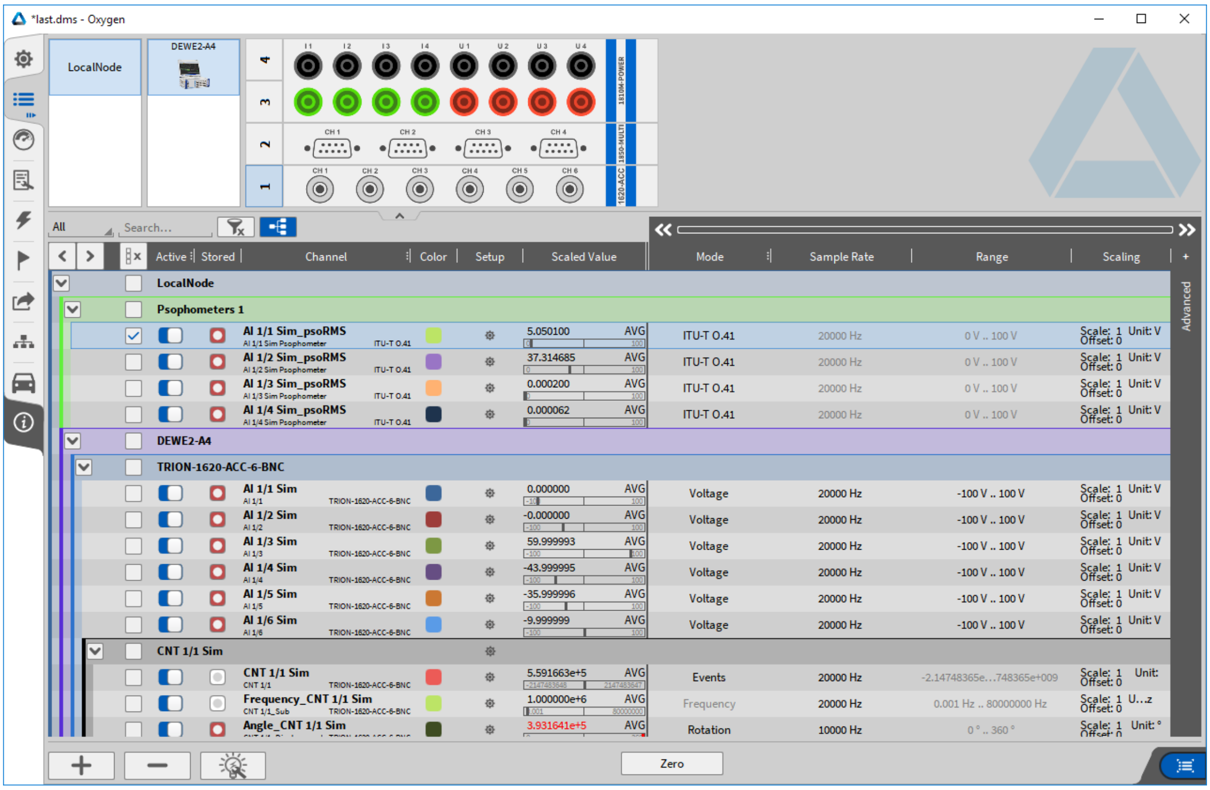

Fig. 7.140: Channel list showing new Psophometer calculation group

The channel setup is used to modify each channel's settings and a top review of signals. Additionally, depending on the selected mode, connector pinout is displayed.

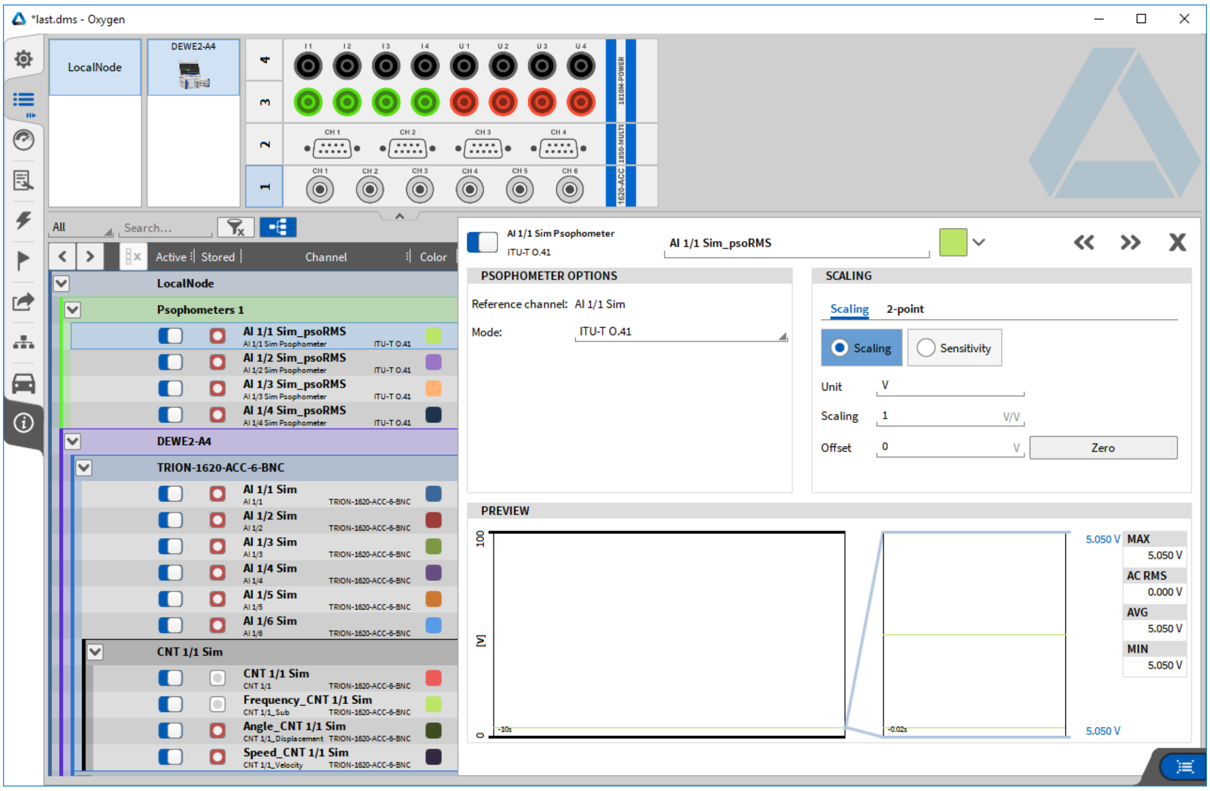

Fig. 7.141: Channel setup, preview, and pin out and connection

Psophometer calculations are then available as math channels.

Fig. 7.142: Sidebar channel list showing the calculated Psophometer channels

Calculation

The calculation is based on FFT.

Depending on the input sampling rate, the FFT block size is chosen to be 2^N samples while the time window stays between 75 and 125 ms, to ensure passing the detector circuitry tests (see *ITU-T Recommendation O.41 (10/94)*).

Sampling rate	FFT block size
20 kHz	2048
50 kHz	4096
100 kHz	8192
200 kHz	16384

Weighting

Different weighting options are available:

ITU-T O.41

Frequency (Hz)	Relative weight (dB)	Tolerance (± dB)
16.66	–85.0	–
50	–63.0	2
100	–41.0	2
200	–21.0	2
300	–10.6	1
400	–6.3	1
500	–3.6	1
600	–2.0	1
700	–0.9	1
800	0.0	0,0 (reference)
900	+0.6	1
1000	+1.0	1
1200	0.0	1
1400	–0.9	1
1600	–1.7	1
1800	–2.4	1
2000	–3.0	1
2500	–4.2	1
3000	–5.6	1
3500	–8.5	2
4000	–15.0	3
4500	–25.0	3
5000	–36.0	3
6000	–43.0	–

Fig. 7.143: Telephone circuit Psophometer weighting coefficients and limits

C-message

Frequency (Hz)	Relative weight (dB)	Tolerance (± dB)
60	–55.7	2
100	–42.5	2
200	–25.1	2
300	–16.3	2
400	–11.2	1
500	– 7.7	1
600	– 5.0	1
700	– 2.8	1
800	– 1.3	1
900	– 0.3	1
1000	0.0	0.0 (reference)
1200	– 0.4	1
1300	– 0.7	1
1500	– 1.2	1
1800	– 1.3	1
2000	– 1.1	1
2500	– 1.1	1
2800	– 2.0	1
3000	– 3.0	1
3300	– 5.1	2
3500	– 7.1	2
4000	–14.6	3
4500	–22.3	3
5000	–28.7	3

NOTE – The attenuation shall continue to increase above 5000 Hz at a rate of not less than 12 dB per octave until it reaches a value of –60 dB.

Fig. 7.144: C-message weighting coefficients and accuracy limits

Flat

Frequency (Hz)	Attenuation
< 300	Increasing 24 dB/octave (Note 1)
300	Approximately 3 dB (Note 2)
400-1020	≤ ± 0.25 dB
1020	0 dB
1020-2600	≤ ± 0.25 dB
3400	Approximately 3 dB (Note 2)
> 3400	Increasing 24 dB/octave (Note 1)

NOTES

1 Below 300 Hz and above 3400 Hz the attenuation shall increase at a slope not less than 24 dB/octave up to an attenuation of at least 50 dB.

2 The exact cut-off frequency shall be chosen to achieve an equivalent noise bandwidth of 3.1 kHz ± 155 Hz.

Fig. 7.145: Characteristics of the optional flat filter with an equivalent noise bandwidth of 3.1 kHz (bandwidth of a telephone channel)

Unweighted

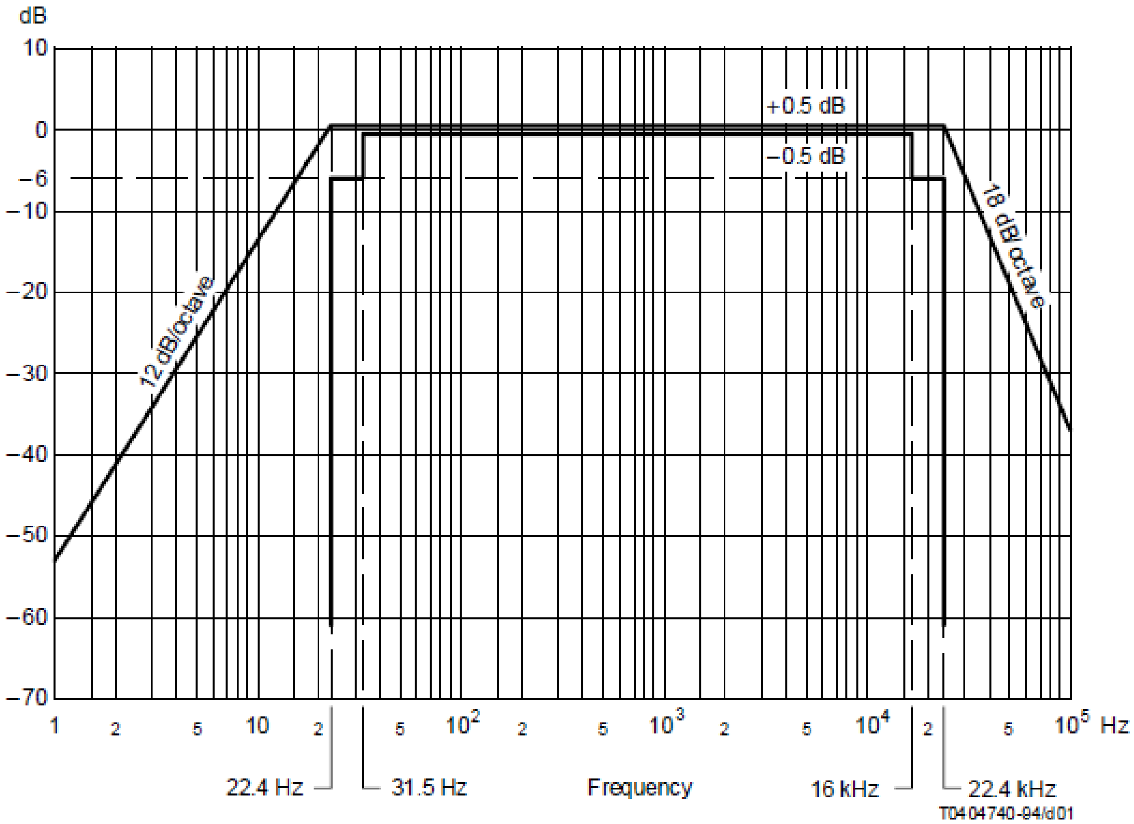

Fig. 7.146: Frequency response characteristics for unweighted measurements

Comparison between Psophometric and C-message weighting

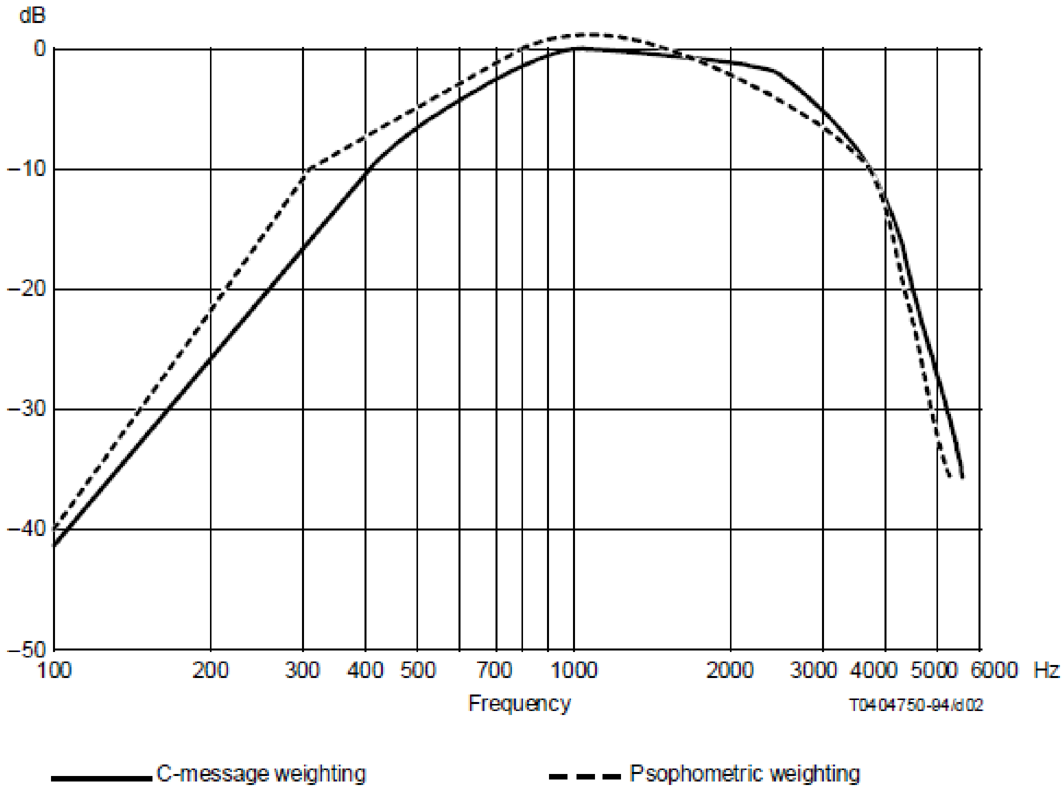

Fig. 7.147: Comparison between psophometric and C-message weighting

ITU-T Recommendation O.41 (10/94)

https://www.itu.int/rec/T-REC-O.41-199410-I/en

OXYGEN Sound Level plugin

This is an optional feature and requires a license.

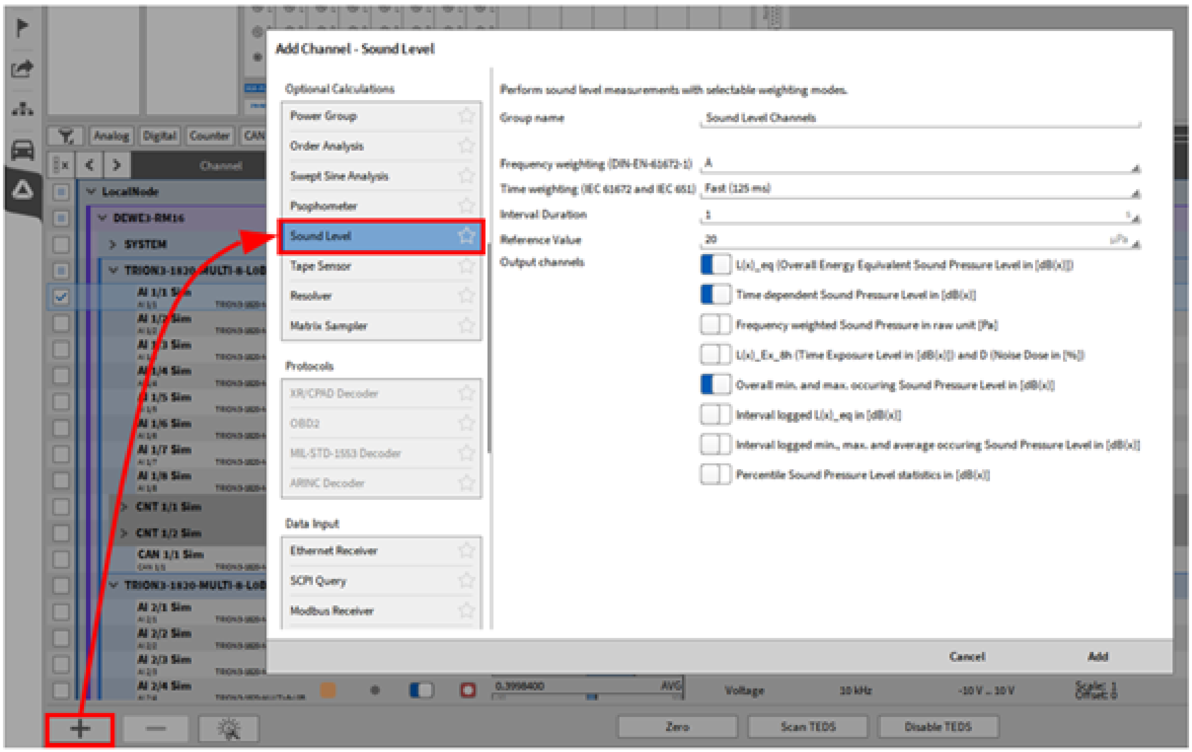

Fig. 7.148: Pop-up window for generating a sound level plugin

A Sound Level can be created and configured by pressing the *Add* button in the lower left corner of the Data Channels menu (marked red in Fig. 7.148).

For details about the Sound Level plugin refer to the *DEWETRON_Sound_Level_determination_vx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

Modal test

This is an optional feature and requires a license (OXY-OPT-MODAL).

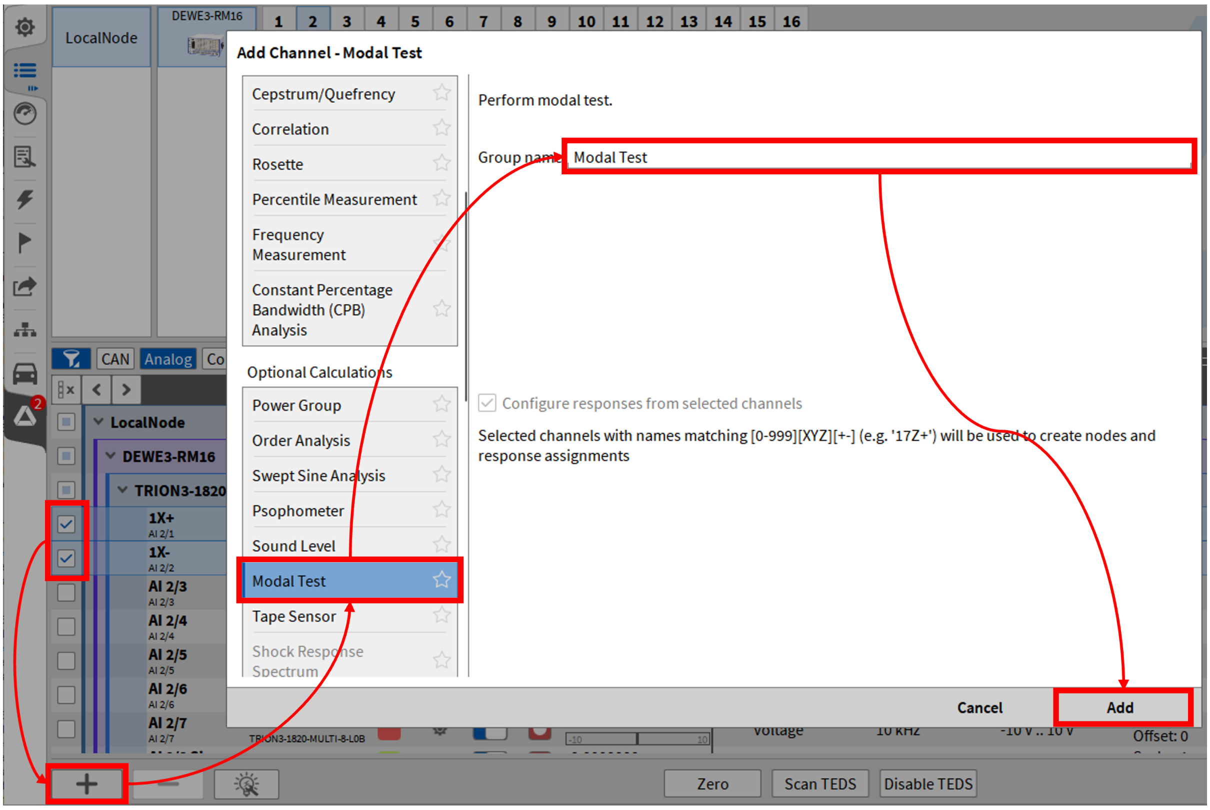

Fig. 7.149: Pop-up window for generating a Modal Test plugin

A Modal Test can be created in LIVE mode and configured by pressing the Add button in the lower left corner of the channel list (marked red in Fig. 7.149).

For details about the Modal Test plugin refer to the DEWETRON_Oxygen_Modal_Technical_Reference_vx.x Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

Tape Sensor

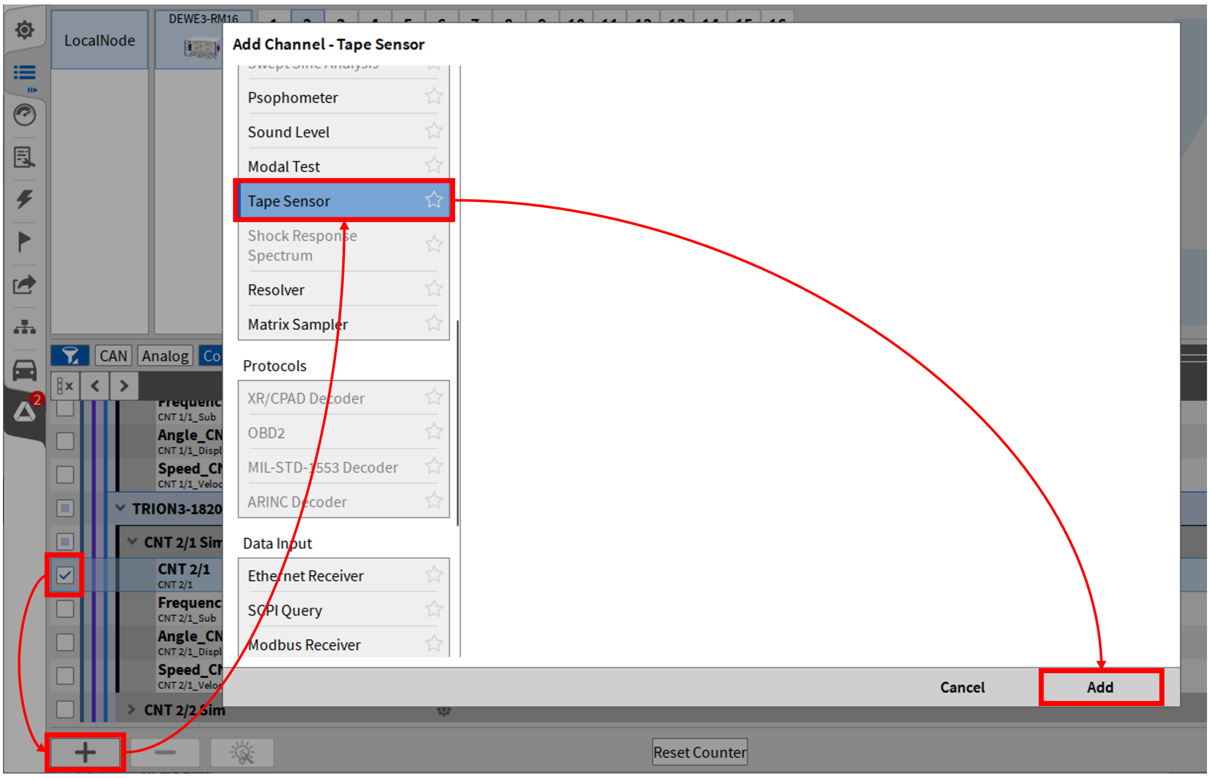

Fig. 7.150: Pop-up window for generating a Tape Sensor plugin

A Tape Sensor can be configured by selecting the input counter channel and pressing the Add button in the lower left corner of the channel list (marked red in Fig. 7.150).

For details about the Tape Sensor plugin refer to the DEWETRON_OXYGEN_Tape_Sensor_and_Resolver_vx.x Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

Shock Response Spectrum

This is an optional feature and requires a license (OXY-OPT-SRS).

The Shock Response Spectrum helps to understand how different systems react to sudden movements or impacts. It is used to calculate the maximum movement of structures and to create requirements for the design of buildings or machines that must withstand sudden loads, such as earthquakes or explosions.

An acceleration signal is applied to a series of mass-damping systems for defined frequency sections, the deflection is determined in maximum, minimum or absolute maximum and entered in a diagram for the respective frequency.

The following figure Fig. 7.151 shows the calculation process. The acceleration input can be seen at the bottom right as a half-sine, which is broken down into its spectral components and applied to single-degree-of-freedom (SDOF) oscillating elements. The response, i.e. the SDOF acceleration response, is then analyzed for the maximum in the example and plotted in the shock response spectrum above. The oscillating elements are defined solely by their damping factor, hence Single-Degree-Of-Freedom.

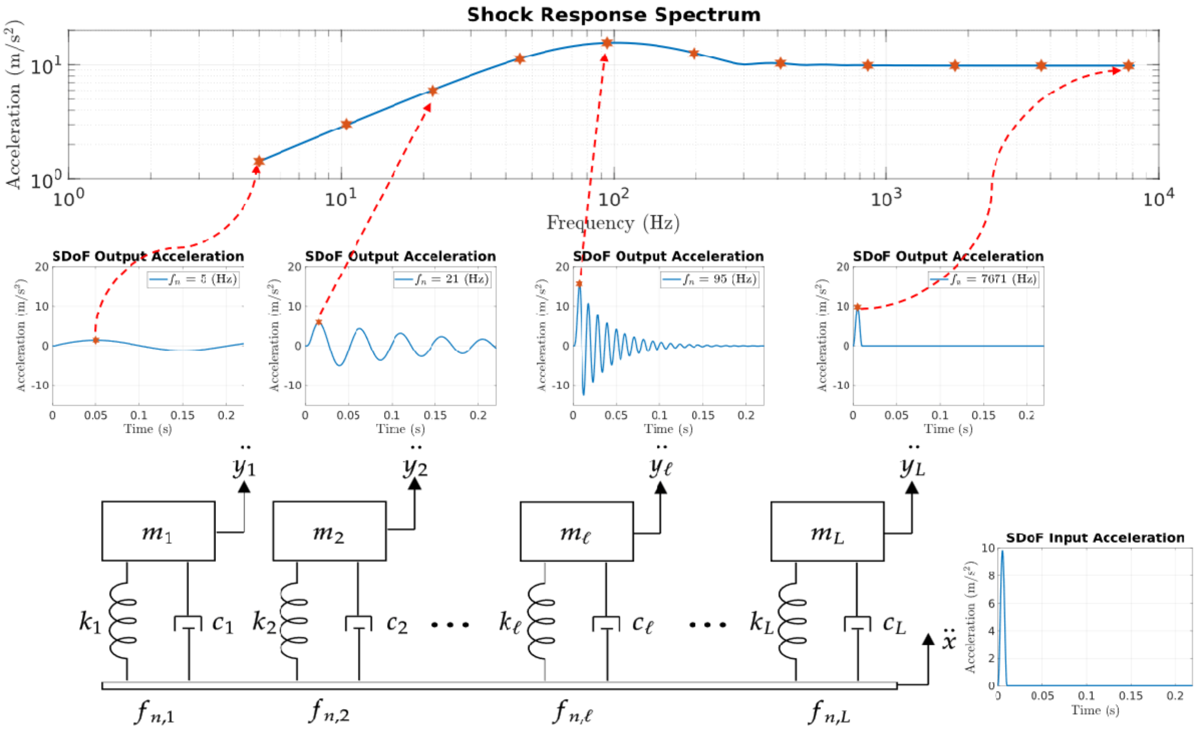

Fig. 7.151: Schematic procedure for calculating a shock response spectrum

[06.05.2025 https://de.mathworks.com/help/signal/ug/practical-introduction-to-shock-waveform-and-shock-response-

A Shock Response Spectrum (SRS) can be configured in PLAY mode (*.dmd) by selecting at least one input channel and pressing the Add button in the lower left corner of the channel list (marked red in Fig. 7.152). If the Group name is left empty, the group is named “SRS_n” by default (n=1,2,3).

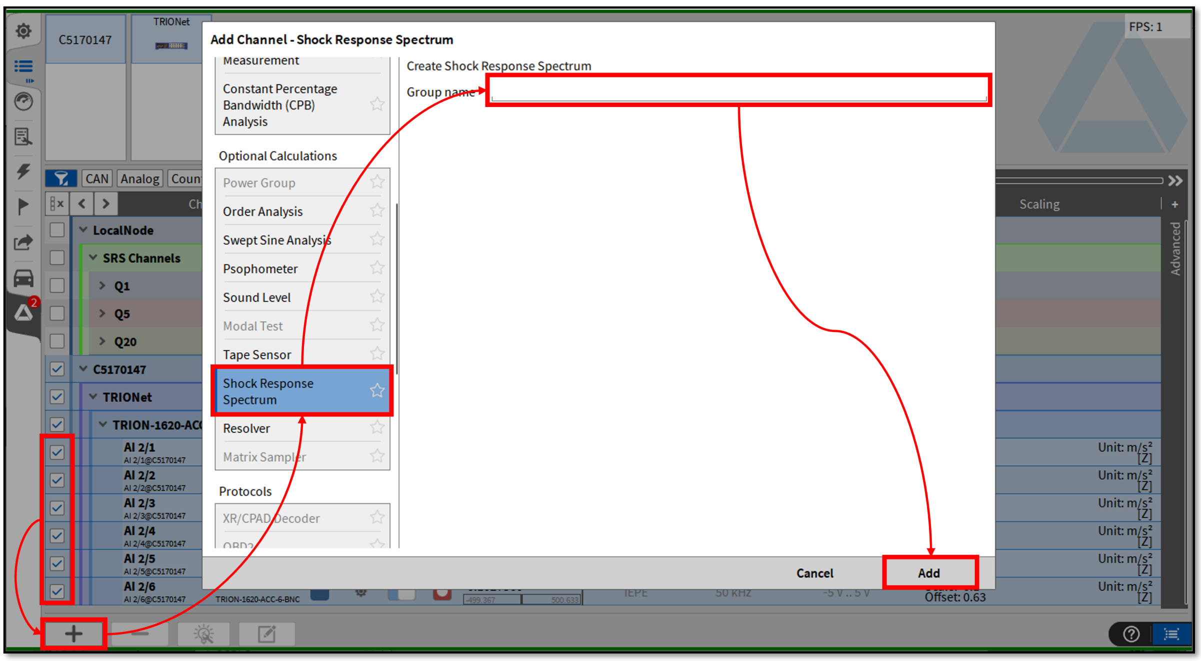

Fig. 7.152: Pop-up window for generating Shock Response Spectrum plugin

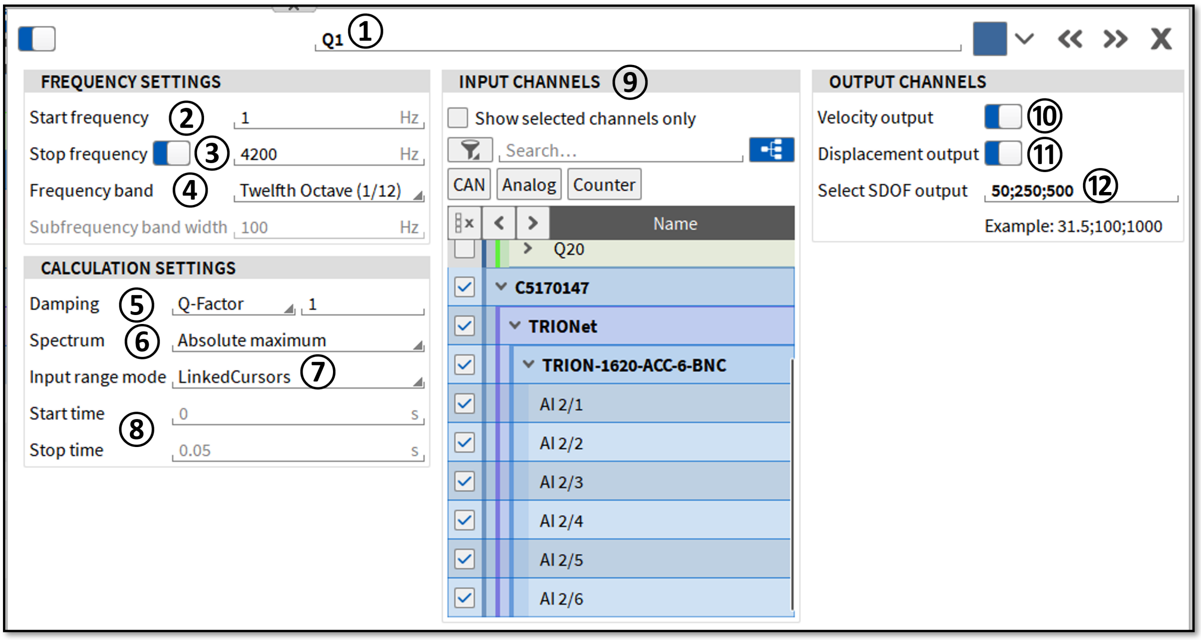

Fig. 7.153: Setup of Shock Response Spectrum plugin with calculation setting

Table 7.33: SRS channel setup parameters

Index	Name	Description
1	SRS channel group name, by default SRS_n (n=1,2,3)	Set the name of the shock response spectrum channel group, which always includes the acceleration shock response.
2	Start frequency	Define the starting frequency for the shock response spectrum calculation. Valid values are (0.01 Hz up to the stop frequency)
3	Stop frequency	Define the end frequency of the shock response calculation. With the toggle automatically half the sample rate as stop frequency is set. Valid values are (Start frequency up to half the sample rate)
4	Frequency band	Select the frequency band in which the SRS is calculated. If "Linear" is selected, the subfrequency band width text field below is enabled. For octave bands the octave, 1/3 octave and 1/12 octave band are available.
5	Damping	Define the damping via Q-factor or damping ratio by choosing the respective dropdown option and value.
6	Spectrum	Select either one spectrum of the single degree of freedom (SDOF) elements, Absolute maximum, Maximum or Minimum.
7	Input range mode	Define the time frame selection method. In case "Manual" is selected, the Start time and Stop time in point ⑧ are used for calculation.
8	Start/Stop time	In case the input range mode is set to "Manual" the time frame for SRS calculation is done for the samples between start and stop time.
9	Input channels	List view of channels for whom the SRS is calculated. These channels can be changed anytime, but their sample rate must be equal. Expected input channels are acceleration channels in m/s2.
10	Velocity output	Additional to the SRS of acceleration, the time integral of the acceleration, the velocity can be enabled.
11	Displacement output	Additional to the SRS of acceleration, the second time integral of the acceleration, the displacement can be enabled.
12	Select SDOF output	Define for which frequencies the SDOF acceleration elements should be added to the SRS group. If the input frequency is not the center frequency of the SDOF element, the closest element is chosen.

To link AB-cursor as the timeframe for the SRS calculation of any SRS group, enable AB-cursor and click on the button to the right to the AB-cursor checkbox, select the SRS groups that should be linked to the cursor and click Ok. Moving the cursor now changes the timeframe for which the SRS is calculated.

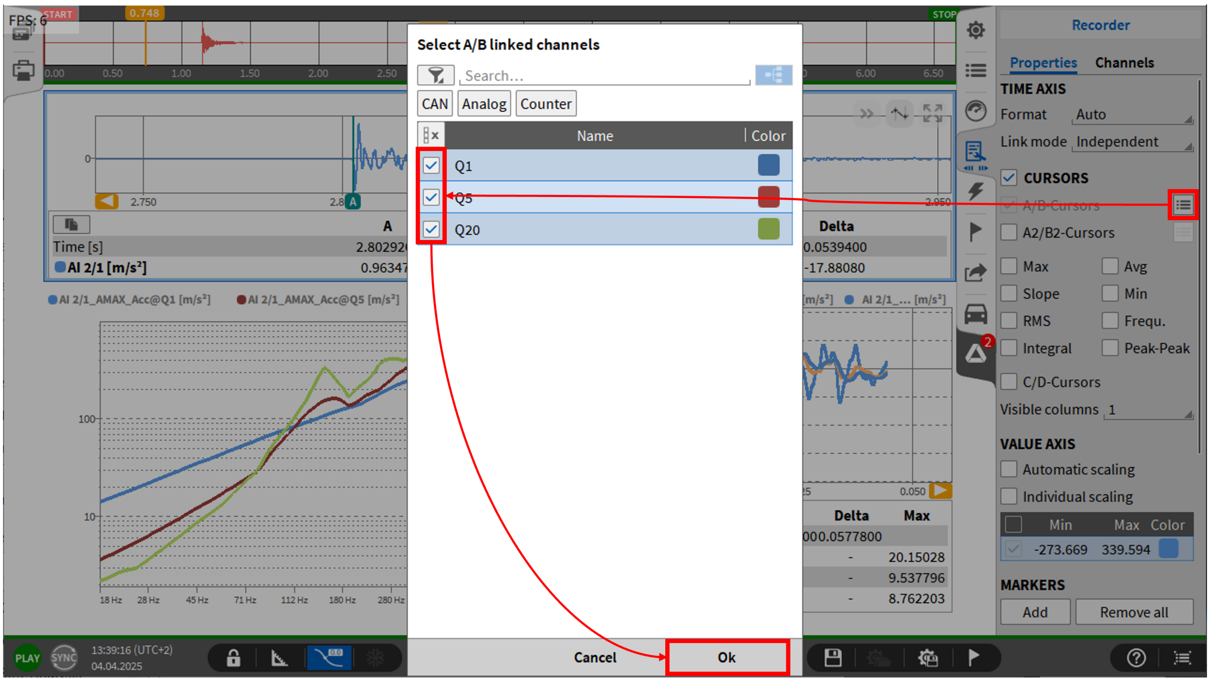

Fig. 7.154: Link AB-cursor as timeframe for SRS calculation

The SRS channels (acceleration, velocity, and displacement) are 1D arrays. For example, e.g. "AI 2/1_AMAX_Acc" has one acceleration per bin/frequency and can be displayed in an Array chart. The array chart can be copied and pasted for further analysis. The extracted SDOF channels are the acceleration-time response of the damping elements for the selected frequencies and can be displayed in a recorder.

Fig. 7.155: Show SRS data in instruments

Note: Note that to update the time interval in the calculation the *Edit Mode* must be active. This is done in the channel list with the *Edit already stored channels* button.

Matrix Sampler

This is an optional feature and requires a license (OPT-POWER-ADV).

The matrix sampler is a feature, which is included in the advanced Power calculation. This feature displays the relation between two channels and an input channel in form of a color-coded matrix which is displayed in the Intensity Diagram instrument.

Creation of a Matrix Sampler Channel

There are two ways to create a matrix sampler channel:

1. Select at least one channel which should be used as reference channel (X, Y and input channel Z) in this order (channels can also be changed afterwards). Click on the + button in the lower left corner, select *Matrix Sampler* in the list and click on the *Add* button (see Fig. 7.156).

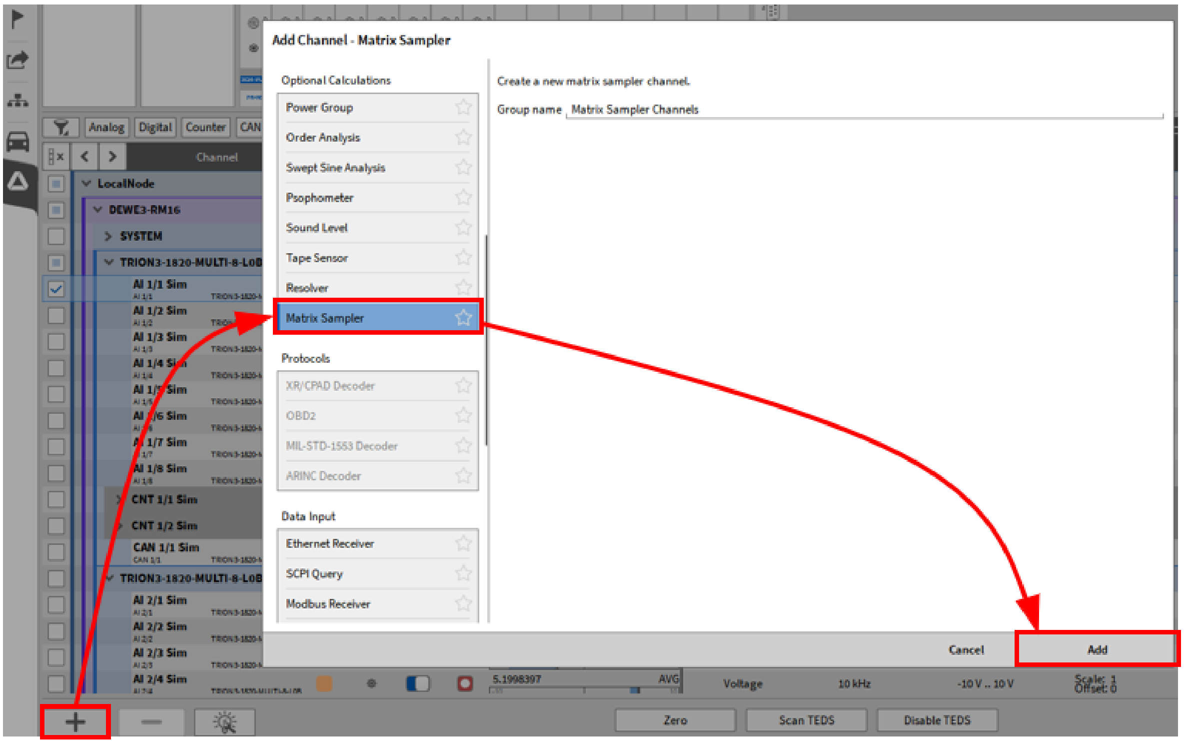

Fig. 7.156: Creation of a Matrix Sampler channel from channels in the channel list

2. The other possibility to create a matrix sampler channel in form of an efficiency map is in the Power Group settings. For a detailed explanation on how to create a Power Group see *Power Group* or refer to the *Power Technical Reference Rx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

Open the Power Group settings and go to *Efficiency* in the advanced settings. By simply clicking on the *Add efficiency map* button (see Fig. 7.157), a matrix sampler channel will be created with the according channels (speed, torque, and efficiency) to display the respective efficiency map of the Power Group.

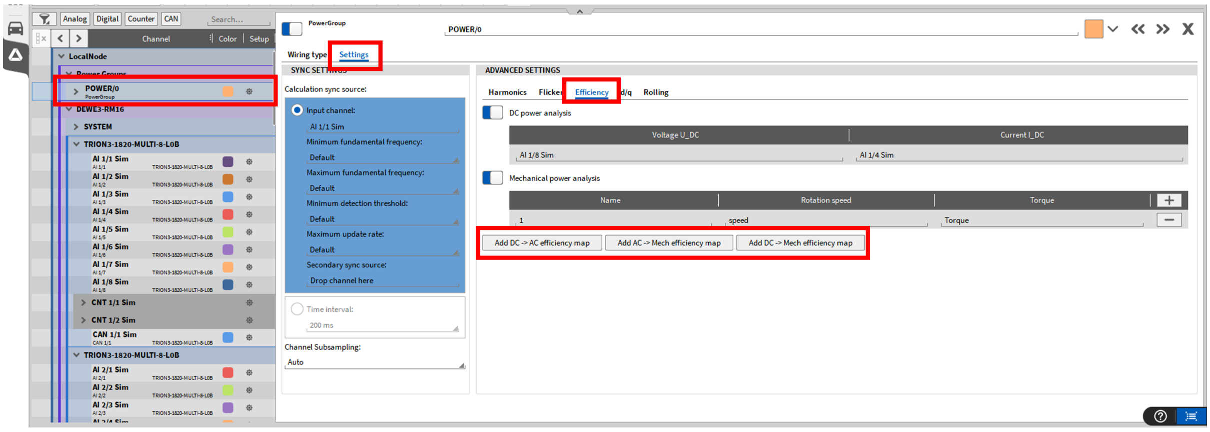

Fig. 7.157: Creation of a Matrix Sampler channel as an efficiency map of an according Power Group

After creating a matrix sampler channel by either one of these ways, a new section appears in the channel list seen in Fig. 7.158. For each matrix sampler one new channel will be created.

Fig. 7.158: New section for Matrix Sampler channels in the channel list

Matrix Sampler Channel Settings

Some of the channel settings of the matrix sampler channel in this section will be explained by the example of an efficiency map. However, the settings or channels are not bound to a unit of a channel and can be used with any measured channel. An overview of the channel settings can be seen in Fig. 7.159. To enter the channel settings, click on the gear icon of the channel in the channel list (see Fig. 7.158).

The following section will explain all the settings, respectively.

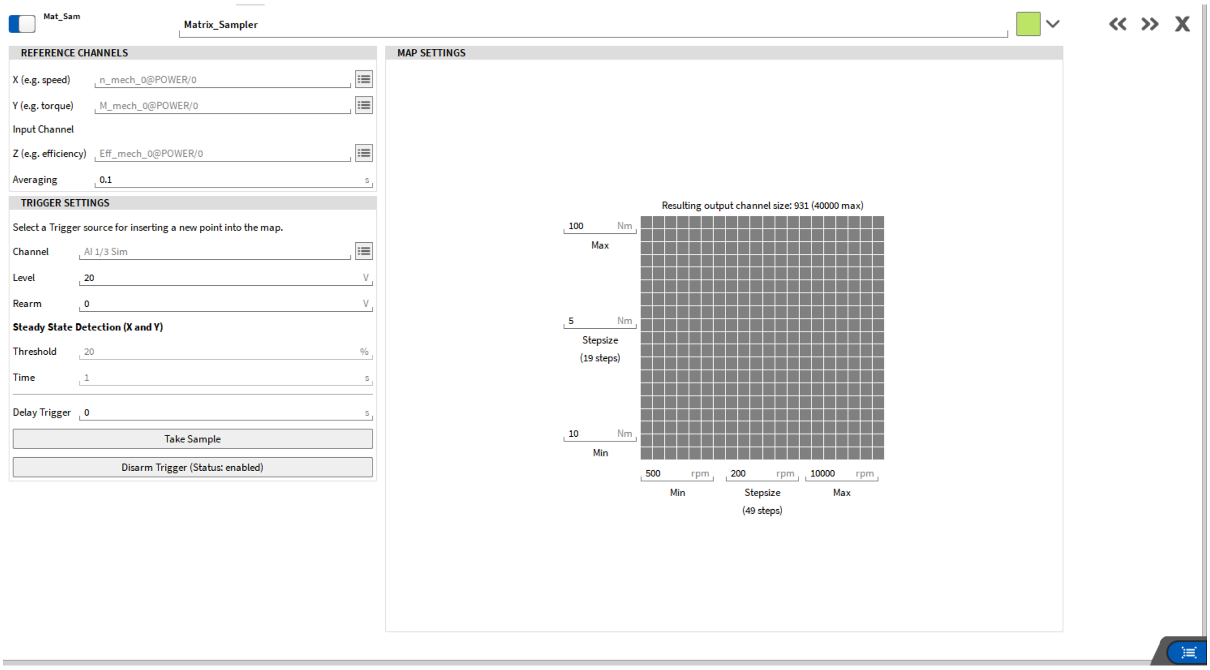

Fig. 7.159: Channel settings of a Matrix Sampler channel

Fig. 7.160 shows a detailed overview of the available channel settings of a matrix sampler channel.

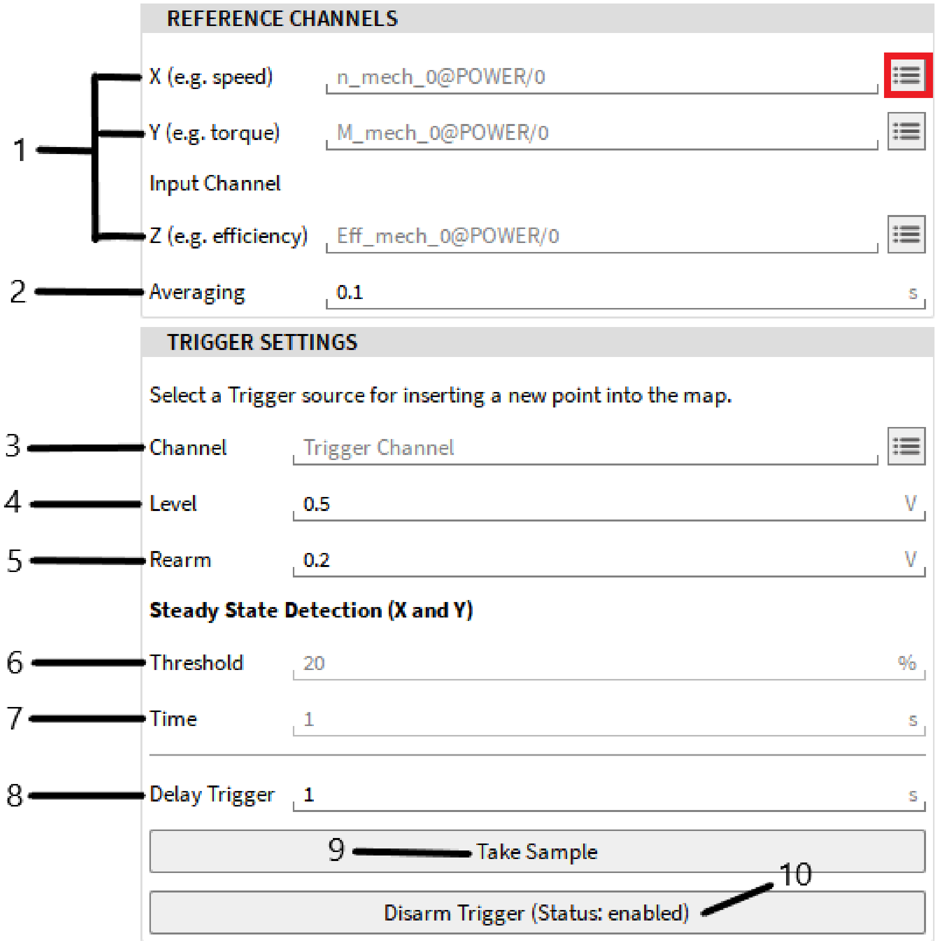

Fig. 7.160: Detailed view of the setting of a Matrix Sampler channel

Table 7.34: Detailed view of the setting of a Matrix Sampler channel

No.	Function	Description
1	*X, Y, Z reference channels* selection	The reference channels for X, Y and Z can be selected here. Z acts as the input channel, which will be displayed. Channels can also be assigned via drag'n'drop or by clicking on the channel list button marked in red in Fig. 7.160
2	*Averaging*	The time window to calculate the average of input channel Z
3	Trigger *Channel*	Selection of a trigger channel; this channel is used as a trigger to take a sample for the matrix
4	Trigger *Level*	Defines the level upon which the trigger is initiated
5	*Rearm*	Defines the rearm level, upon which the trigger will be reactivated
6	*Threshold*	Defines the range within the X and Y signal must stay in order to arm the trigger
7	*Time*	Defines the time of the X and Y signal to stay within the defined threshold range to arm the trigger
8	*Delay Trigger*	Defines the time delay, after which a sample will be put into the matrix after the trigger is activated
9	*Take Sample*	Button to manually take a sample to put in the matrix
10	*Disarm/Arm Trigger*	Trigger settings will be disarmed/armed; if disarmed matrix will not be updated anymore

Note: To quickly navigate through long channel lists, use the shortcut CTRL + PAGE UP / PAGE DOWN. This function works both in full-screen view and in the compact side panel view of the channel list.

As explained in the section before, the channels can either be chosen in the right order before creating the matrix sampler channel, but they can also be changed or assigned via drag'n'drop or the channel list button afterwards.

The channels for an efficiency map are assigned properly when creating an efficiency map out of the Power Group settings. For an efficiency map the speed is used as the reference channel for the X-axis, torque for the Y-axis and the mechanical efficiency for the Z-axis as input channel.

For the trigger channel a signal can be used from a testbed environment to define, when a sample should be put into the matrix. In the example shown in Fig. 7.160 it can be seen, that a sample will be taken whenever the channel *Trigger Channel* rises above a defined level of 0.5 V. The trigger will be activated again, once the Trigger Channel drops below 0.2 V, which is defined as the rearm level.

Note: For the trigger settings, either a channel can be selected as trigger or the Steady State Detection (X and Y) can be used. If a channel is selected as trigger channel, the Steady State Detection is disabled. To use the Steady State Detection no channel can be selected as trigger channel or must be deleted. The conditions threshold and time for the Steady State Detection have to be fulfilled by the X and the Y channel in order to arm the trigger.

The *Disarm/Arm Trigger* button is very useful if a specific measurement point needs to be repeated. In order not to overwrite the whole matrix, the trigger can be disarmed. Therefore, the matrix will not be updated for each trigger, and samples are not saved. Whenever the measurement point is reached, a sample can manually be put in the matrix by clicking the *Take Sample* button.

Fig. 7.161 shows the exemplary resulting output matrix in the channel settings. For each the Y- and the X-axis the minimum, maximum and step size can be defined in the corresponding channel unit. When entering the step size, the resulting steps are displayed below.

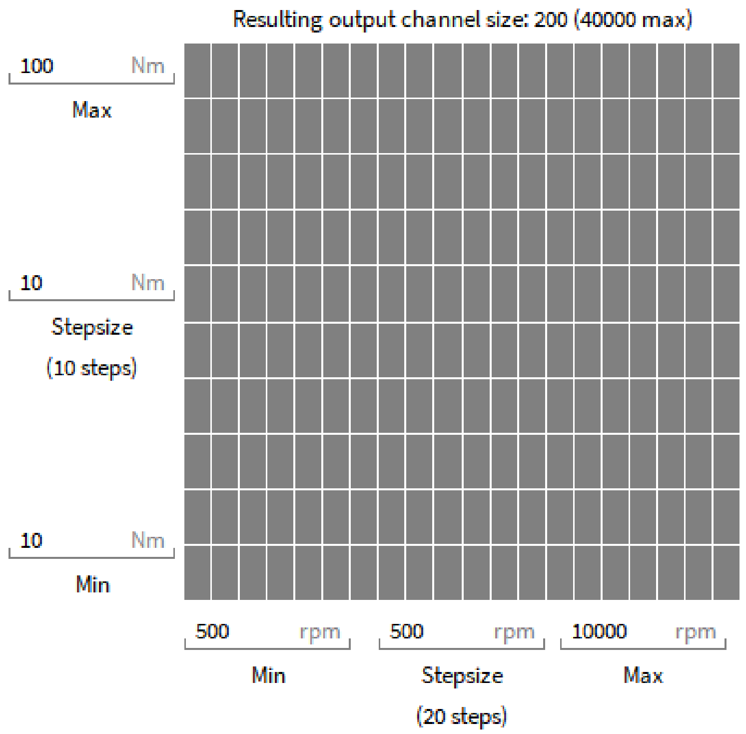

Fig. 7.161: Detailed view of the map setting of a Matrix Sampler channel

To display this efficiency map on the measurement screen simply drag and drop the matrix sampler channel onto the measurement screen. Otherwise use the intensity diagram instrument and select the channel accordingly.

For more information about the instrument refer to *Intensity Diagram*.

7.4.5 Protocols

MIL-STD-1553 Decoder

For details about the MIL-STD-1553 Decoder plugin refer to the MIL-STD-1553 Decoder manual which is available on the DEWETRON CCC portal.

ARINC Decoder

For details about the ARINC Decoder plugin refer to the ARINC Decoder manual which is available on the DEWETRON CCC portal.

7.4.6 Data input

OXYGEN Ethernet Receiver

This is an optional feature and requires a license.

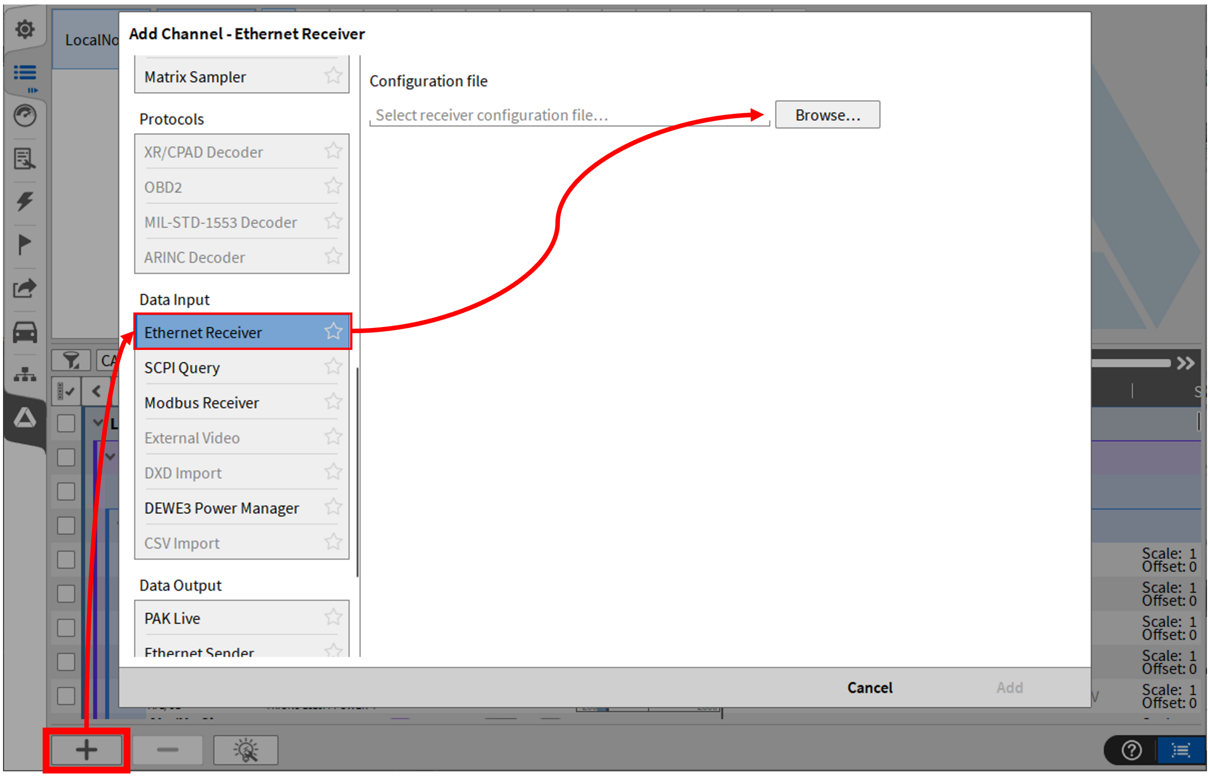

Fig. 7.162: Pop-up window for acquiring an Ethernet Receiver Data stream

An Ethernet Receiver data stream can be acquired and configured by pressing the *Add* button in the lower left corner of the Data Channels menu (marked red in Fig. 7.162).

For details about the Ethernet Receiver plugin refer to the *OXYGEN Ethernet Receiver XML Configuration Vx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

Modbus Receiver

For details about the Modbus receiver plugin refer to the OXYGEN Modbus TCP manual which is available on the DEWETRON CCC portal.

Loading external video data

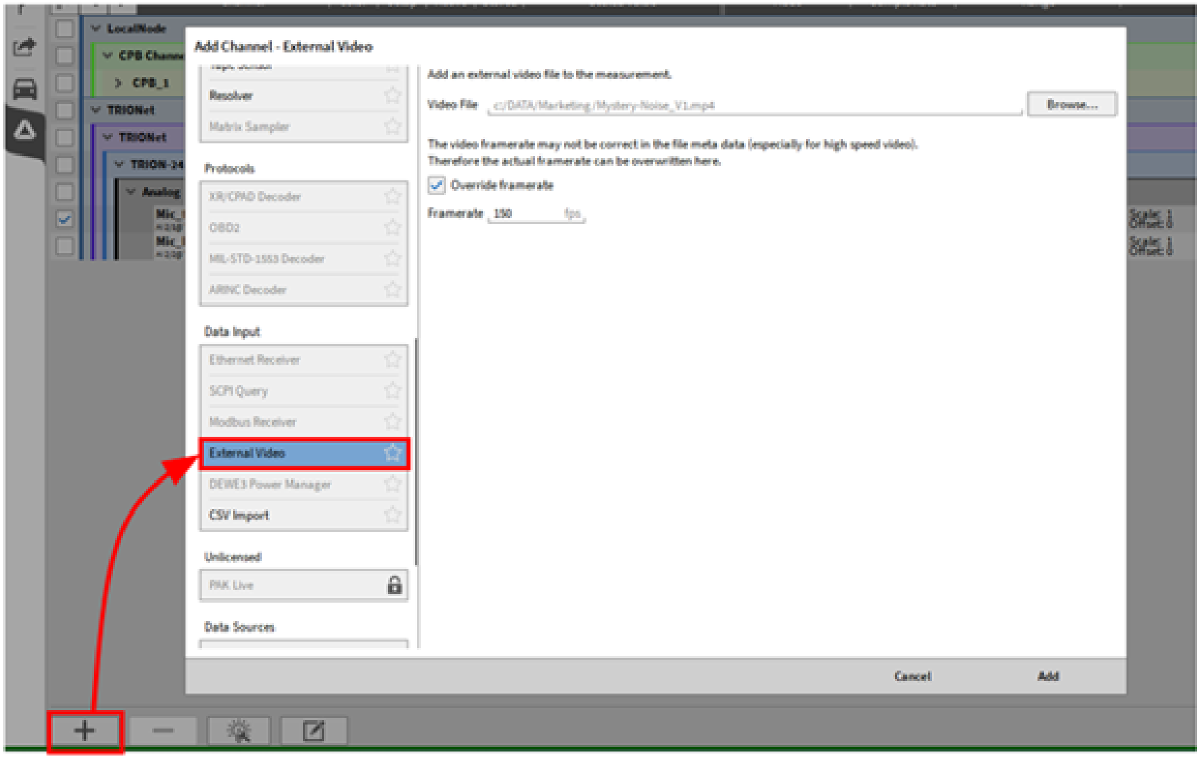

Fig. 7.163: Pop-up window for loading an external video

OXYGEN's External video () option provides the possibility to:

- Load an video file that was recorded with a 3rd party software in PLAY mode during analysis
- Manually synchronize the video to the measurement data
- Analyze both video and sensor data synchronized in OXYGEN

This feature was mainly developed to synchronize video data recorded with highspeed cameras to the sensor data but it can be used to load a video file from any camera into OXYGEN. The focus of the following section is on high speed video data.

Benefits:

- Load videos from any camera into OXYGEN for analysis
- Supported formats:
  - AVI (uncompressed)
  - MKV (VP8 and h264)
  - MP4 (h264)

- No file size increment as only path to video file is stored to the .dmd-file
- Support of various recording and trigger scenarios (see *Possible Recording scenarios*)
- Adjustable playback speed (see *Reviewing a Data File (PLAY mode)*)
- Quick and easy reporting by exporting measurement screen to video (see *Saving the screen as video*)

Possible Recording scenarios

The section describes different scenarios to initiate the recording start of the DAQ system and the camera and lists certain advantages or disadvantages of the different methods.

Recording start of DAQ system and camera triggered by external signal

Fig. 7.164: Recording start of DAQ system and camera triggered by external signal

An external signal / device is used to trigger the recording start of DAQ system and camera. The signal is normally a TTL signal with a rising edge to initiate the recording start.

Modern highspeed cameras provide trigger signal input. The DAQ system requires a digital signal input to acquire the signal and trigger the recording state. Analog inputs could be used as well.

Advantages:

- Parallel recording start of camera and DAQ system without any latencies
- Easy synchronization of sensor data and video data
- No manual recording start on any device required

Disadvantage:

- Separate hardware required for generating the trigger signal

Recording start of DAQ system triggered by camera

Fig. 7.165: Recording start of DAQ system triggered by camera

The camera generates a TTL signal with rising edge at recording start which is forwarded to the DAQ system via the Trigger output of the camera. Modern highspeed cameras provide a trigger signal for triggering the recording state of 3rd party hardware. The DAQ system requires a digital signal input for acquiring the signal and triggering the recording state. Analog inputs could be used as well.

Advantages:

- Parallel recording start of camera and DAQ system without any latencies
- Easy synchronization of sensor data and video data
- No separate hardware required for generating the trigger signal

Disadvantage:

- Recording must be started manually for the camera

Recording start of camera triggered by DAQ system

Fig. 7.166: Recording start of camera triggered by DAQ system

The DAQ system generates a TTL signal with Rising edge at recording start which is forwarded to the camera via an digital output of the DAQ system. Modern highspeed cameras provide a trigger signal input.

The operating system of the DAQ system will cause a delay between the DAQ system's recording start and the instant of time the digital output is physically set to high which results in the recording start of the camera. This delay can be measured by recording the Digital Out channel. In real-life, a delay in the msec-range between DAQ system recording start and camera recording start will occur which can be compensated while loading the video into OXYGEN for post processing.

Advantages:

- No separate hardware required for generating the trigger signal
- Recording start of the DAQ system could be triggered

Disadvantages:

- Deterministic latency between recording start of camera and DAQ system caused by the operating system
- Latency needs to be compensated while loading and post processing the video

Manual Recording start of DAQ system and camera

Fig. 7.167: Manual Recording start of DAQ system and camera

Recording is started manually both on the DAQ system and the camera.

Advantages

- No separate hardware required for generating the trigger signal
- No wiring between camera and DAQ system required

Disadvantages

- Stochastic latency between recording start of camera and DAQ system caused by the operating system
- Latency needs to be determined empirically and compensated while loading and post processing the video

Loading the external video into OXYGEN

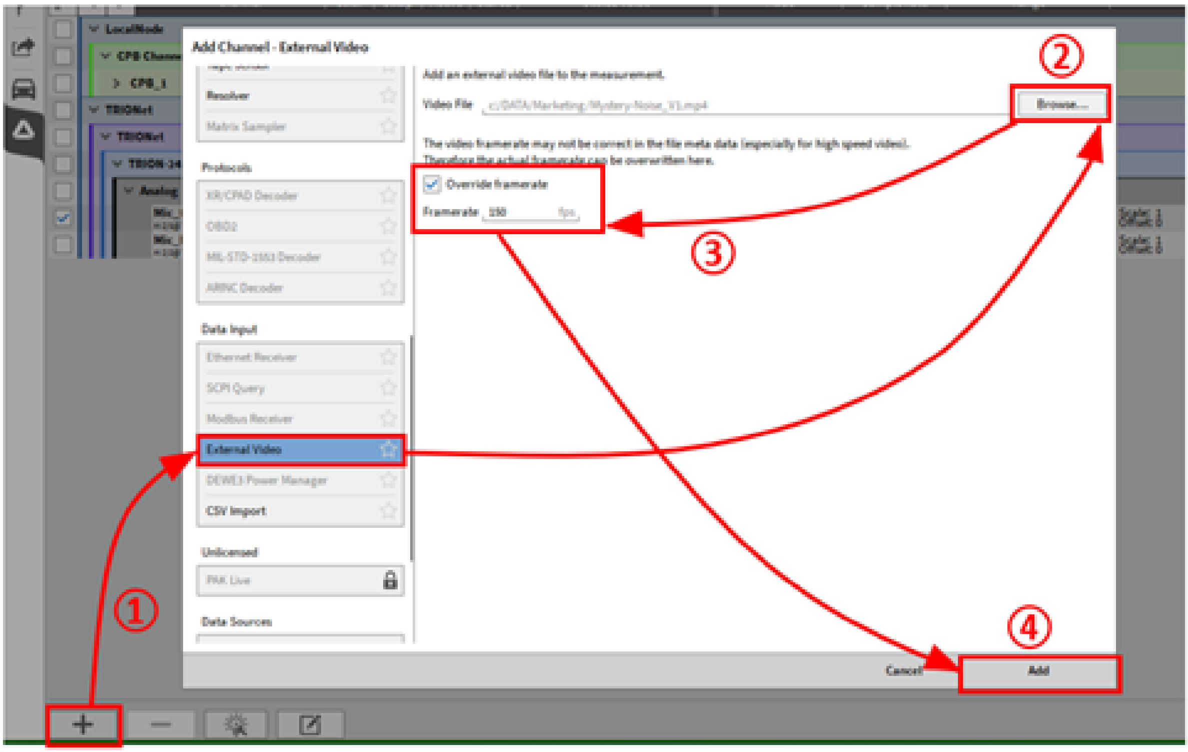

Fig. 7.168: Procedure to load an external video

To load an external video proceed the following steps:

- Go to the Channel List, press the *+* Button and select *External Video* (see ① in Fig. 7.168)
- Click on *Browse…* to select the video file (see ② in Fig. 7.168)
- Enter the native recording frame rate of the video (see ③ in Fig. 7.168)
- Press *Add* to create a new video channel (see ④ in Fig. 7.168)

Synchronization of external videos

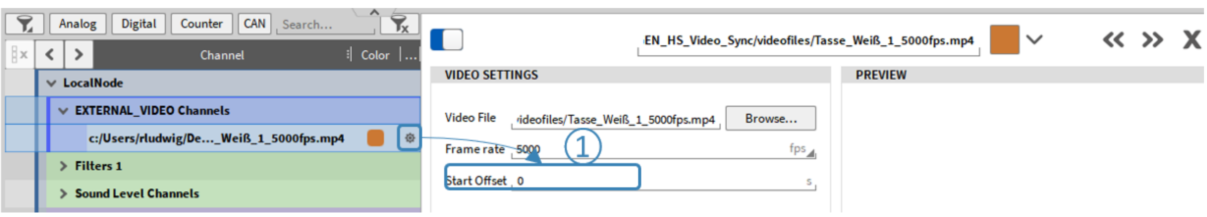

Fig. 7.169: Compensating a deterministic delay between video and sensor data

If the latency between video and sensor data is known it can be compensated by entering the delay in *Start Offset* in the video's channel setup (see ① in Fig. 7.169).

Positive offset denotes that OXYGEN data recording was started first and video data recording second.

Negative offset denotes that video data recording was started first and OXYGEN data recording second.

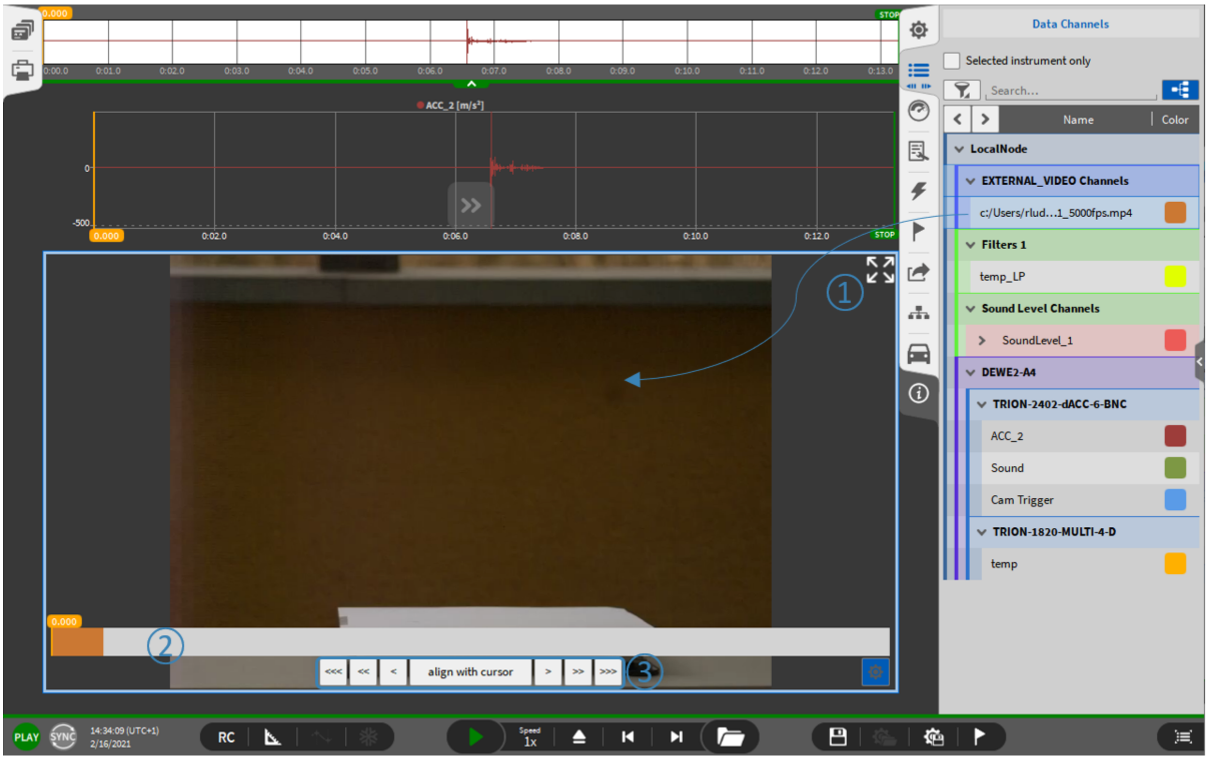

Fig. 7.170: Manual delay compensation between video and sensor data

If the latency between video and sensor data in unknown, the video timeline can be aligned to sensor data's timeline by using the video instrument (see *Video instrument* for details).

1. Go to the measurement screen and drop the external video channel to the measurement screen (see ① in Fig. 7.170). This will create a video instrument including the video.

   The timebar shows the actual position of the video within the OXYGEN data file (see ② in Fig. 7.170)

2. The buttons (see ③ in Fig. 7.170) can be used to change the position of the video within the data file

   <<< << < align with cursor >>> >> >

   - <<< Move the video +1 frame
   - << Move the video +10 frames
   - < Move the video +100 frames
   - *Align with cursor*: Move video start to actual cursor position
   - > Move the video -1 frame
   - >> Move the video -10 frames
   - >>> Move the video -100 frames

In general, the following workflow to manually align sensor and video data is recommended:

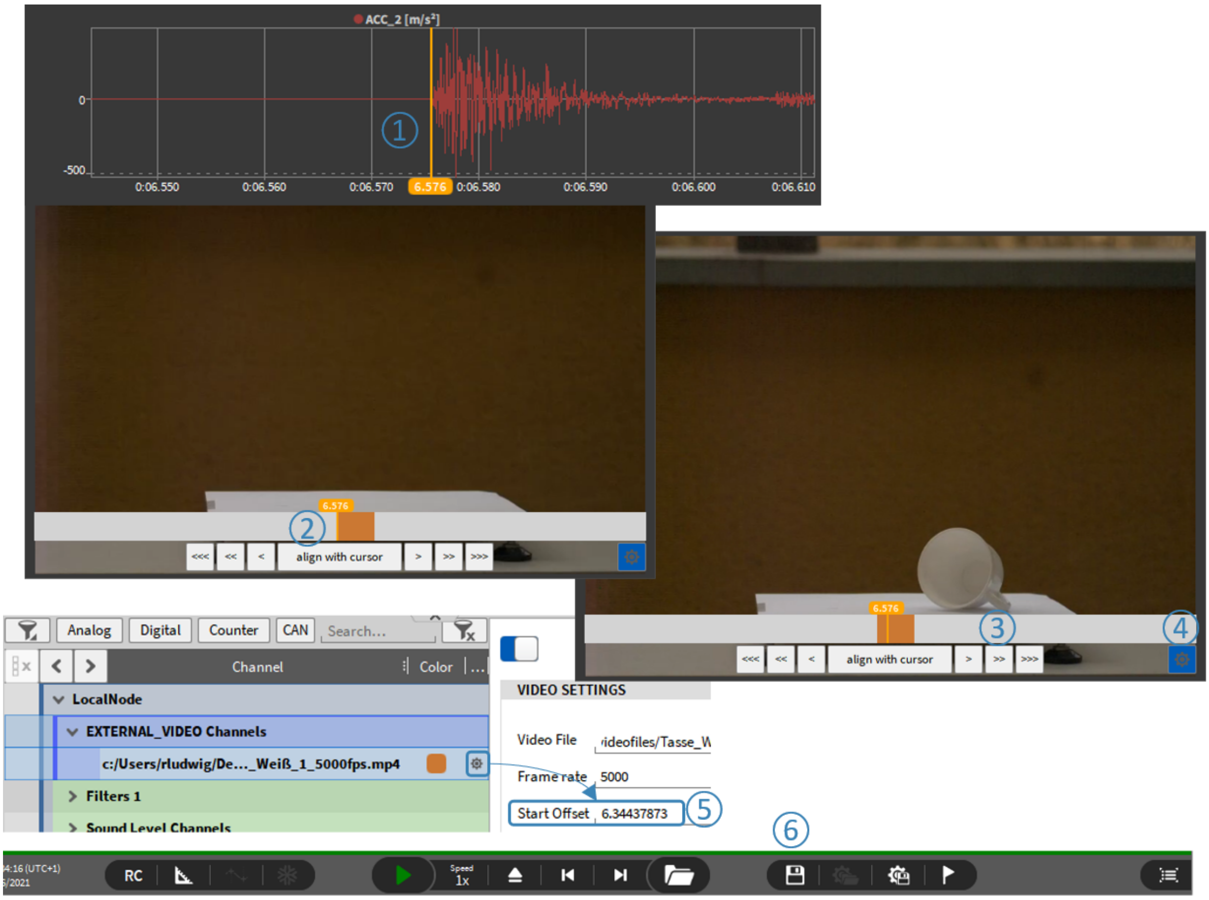

Fig. 7.171: Alignment of sensor and video data

1. Use the Recorder to move the orange cursor to the reference event for data synchronization (see ① in Fig. 7.171)
2. Press *align with cursor* to move the video start to the orange cursor position for a rough time adjustment (see ② in Fig. 7.171)
3. For fine time adjustments, use the <<<, <<, < & >, >>, >>> buttons to align the timeline (see ③ in Fig. 7.171)
4. When finished, the timebar can be hidden (see ④ in Fig. 7.171)
5. The absolute time offset can also be seen in the video‘s channel setup (see ⑤ in Fig. 7.171)
6. The settings can be saved to the data file (see ⑥ in Fig. 7.171)

Note: Only the file path to the video is stored to the OXYGEN data file but not the video itself.

Replaying the data file

Details can be found in *Reviewing a Data File (PLAY mode)*.

Saving the measurement screen to video

Details can be found in *Saving the screen as video*.

UDP Receiver

This is an optional feature and requires a license.

An UDP Receiver data stream can be acquired and configured by pressing the Add button in the lower left corner of the Data Channels menu (marked red in Fig. 7.172).

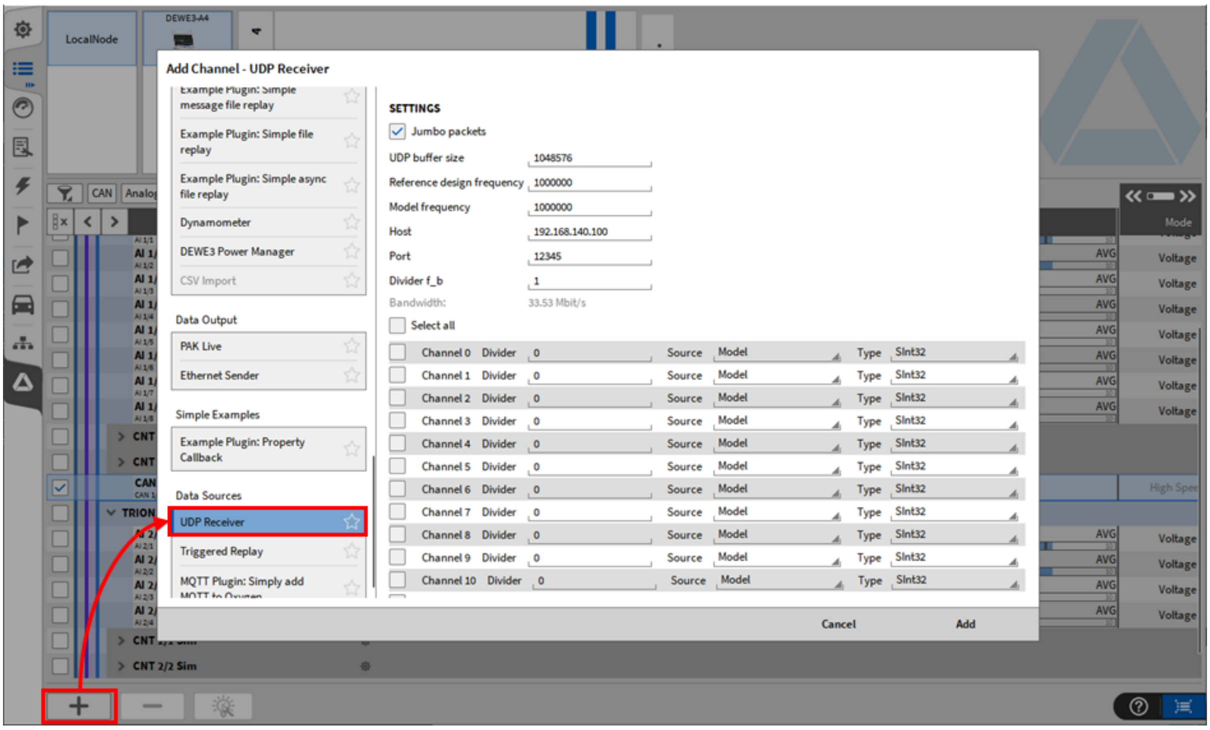

Fig. 7.172: UDP Receiver – data source

DXD import

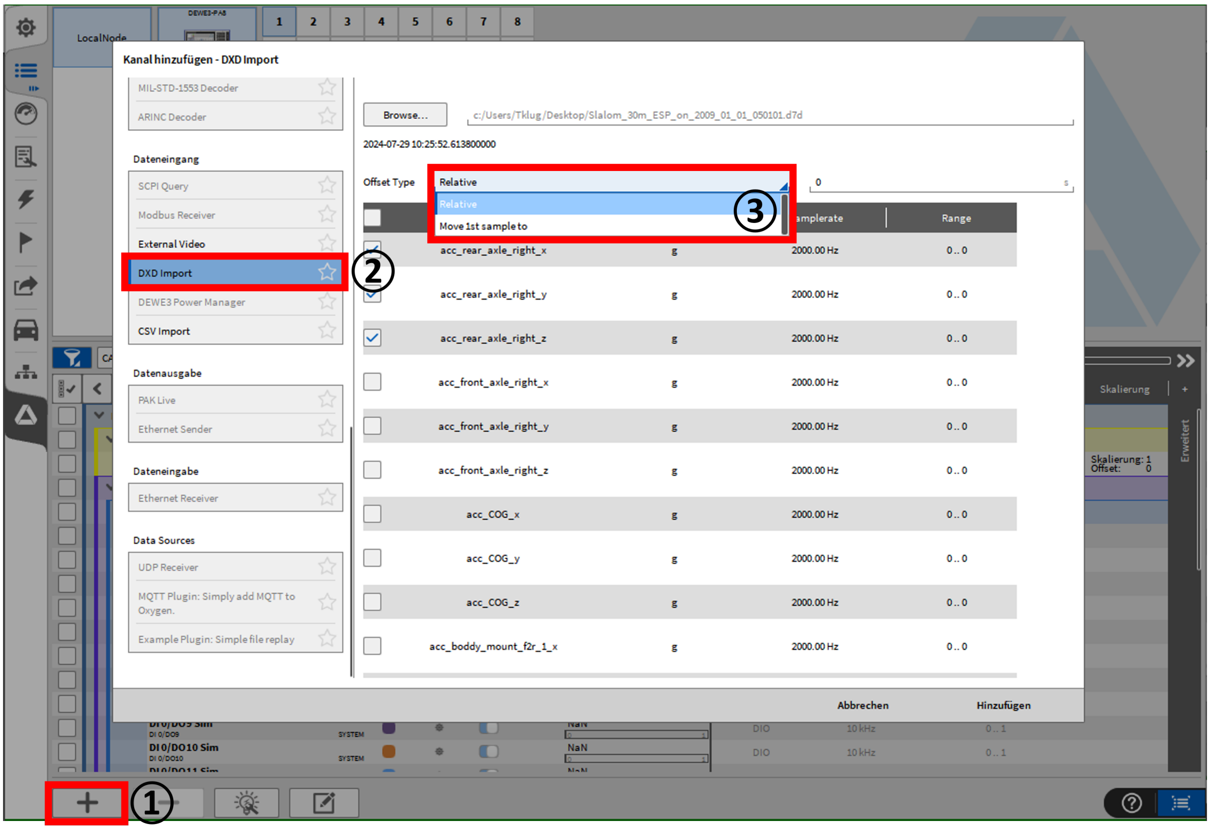

Fig. 7.173: DXD import

In OXYGEN Viewer (PLAY mode) it is possible to import *.dxd or *.d7d (2) data as a channel. Data can be sifted by relative time and absolute time (3). Both synchronous and asynchonous time domain channels are supported.

CSV import

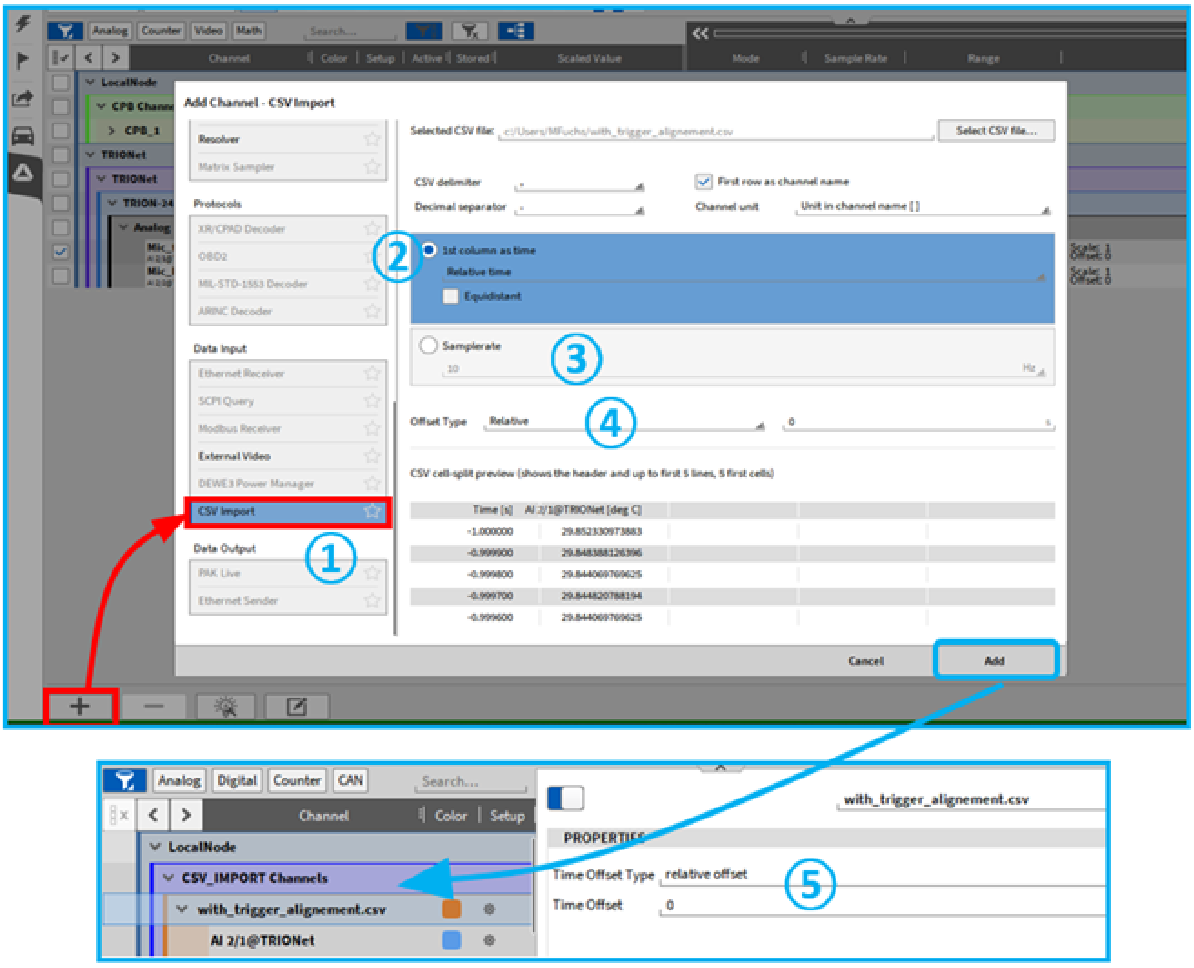

Fig. 7.174: CSV import

In OXYGEN Viewer it is possible to import CSV data as a channel. This is only available in PLAY mode (see ① in Fig. 7.174). The first column can be interpreted as relative or absolute time (see ② in Fig. 7.174). In case no time is included a synchronous sample rate can be defined (see ③ in Fig. 7.174). An optional time offset can be defined before adding the channel (see ④ in Fig. 7.174) or subsequently in the properties (see ⑤ in Fig. 7.174). The imported channel can be found in the group CSV_IMPORT Channels in the channel list.

7.5 Offline math

The topology *Offline Math* deems calculations that shall be performed after the measurement is finished within a data file (.dmd). The following Offline Math features are supported. The features will be extended within the proximate OXYGEN releases.

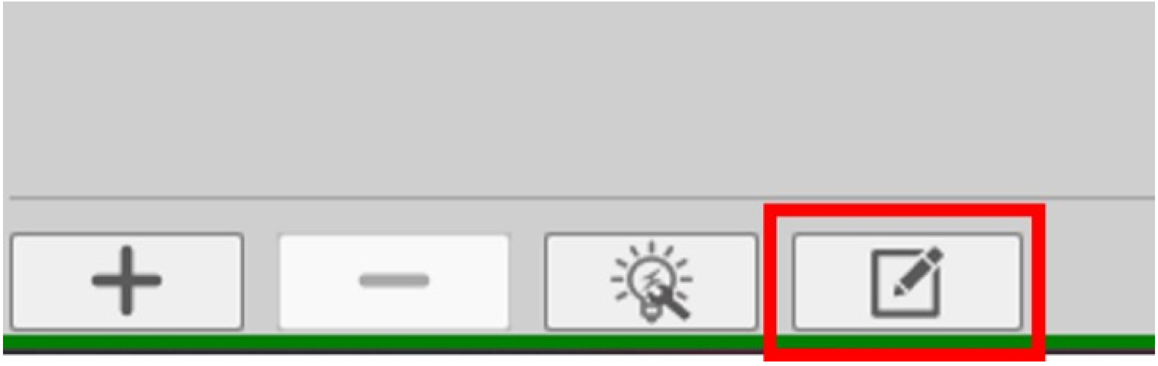

Fig. 7.175: Editing of already stored channels

- The "Edit already stored channels" button (see Fig. 7.175) software channels, such as formulas, statistics or power groups, which were calculated during recording, can also be modified offline. Dependencies of these channels are updated automatically. Additionally, it is also possible to change the name as well as the unit of hardware channels offline.
- Offline Math is not applicable for the scaling of an analog input channel.
- Channels can be added afterwards in the same manner as explained in *Mathematical channels* by clicking on the + button (see Fig. 7.48) at the lower left side of the Channel List.
- Channels created or edited within one open session can be deleted by clicking on the *Delete Math Channel* button (see Table 7.1). After re-opening a data file, the previously created channels cannot be deleted any more.
- Formulas, Filters, Statistics, FFT channels, the Psophometer plugin, the Swept Sine Analysis plugin, the Rosette determination, the sound level option and the CPB analysis can be used offline as well.
- Channel dependencies are respected during Offline Math calculations. This denotes that it is possible to create a Filter channel and a Statistics Channel that is applied on this certain Filter channel within one session. If the Filter channel is edited again, the Statistics channel will automatically be recalculated, too.
- Channels that have been created offline can be recognized on the Green Record button in the Channel List (see Fig. 7.176):

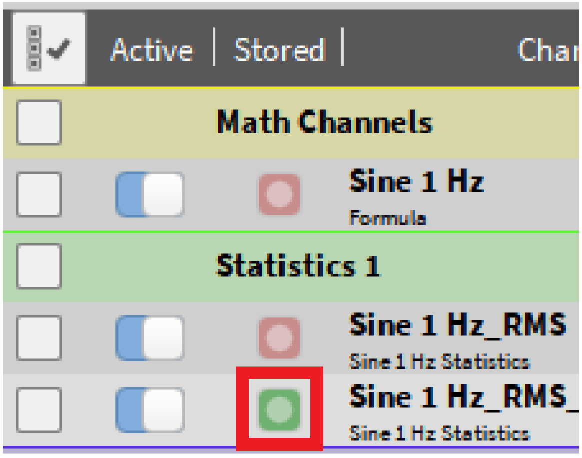

Fig. 7.176: Recognition of offline created channels

- Created channels and any changes can be stored to the data file by pressing the *Store data* button (see Fig. 7.177 or ⑬ in Fig. 3.5):

Fig. 7.177: *Store data* button

- Created channels and any changes can be exported to a setup file by pressing the *Save setup file* button (see Fig. 7.178 or ⑮ in Fig. 3.5):

Fig. 7.178: *Save setup file* button

- A *Progress indicator* will inform about the actual calculation progress (see Fig. 7.179) and contains information about the number of calculated channels, the calculation progress in percent and the remaining calculation time:

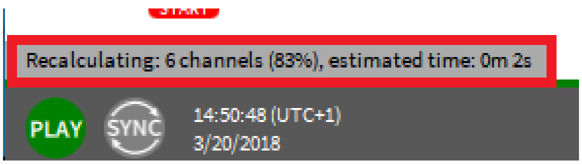

Fig. 7.179: Progress indicator for Offline Math calculations

- A data file recorded with OXYGEN 2.x can be opened with OXYGEN 3.x to apply Offline Math. After storing changes to the data file, it cannot be opened with OXYGEN 2.x again but only with OXYGEN 3.x.

- Be aware that an Offline Statistics channel will differ from an Online Statistics channel, i.e. at the beginning of the file or in case of Event based waveform recording (see *Triggered Events*). In the example displayed in Fig. 7.180, the green channel is an online calculated Statistics channel applied on the yellow analog channel and the red channel is an offline calculated Statistics channel applied on the yellow analog channel with identical channel settings. The deviation of the green and the red channel is due to the availability of the full analog data during online calculation. During the offline calculation, only the event based recorded analog data is available.

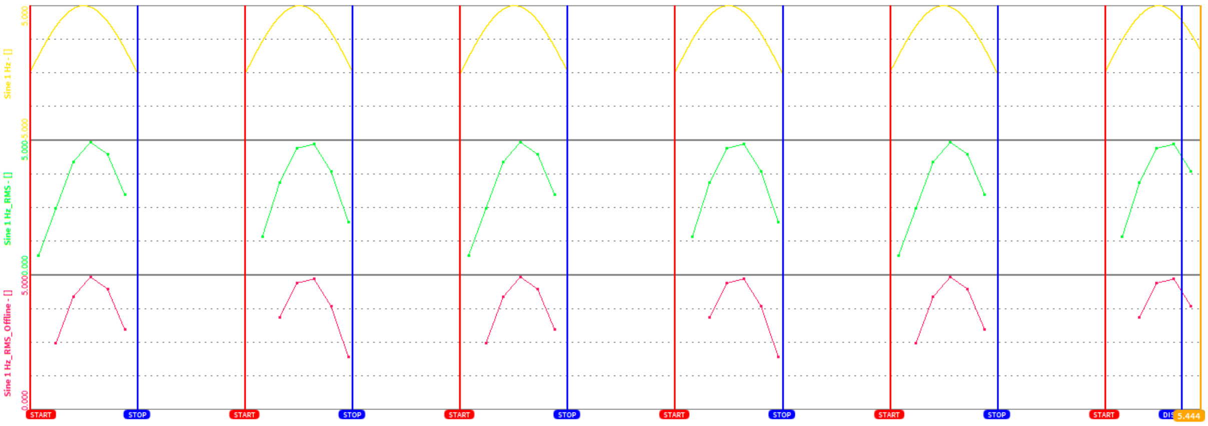

Fig. 7.180: Deviation of Offline and Online Statistics channels in case of Event based Waveform recording

- Be aware that an Offline Filter channel will differ from an Online Filter channel, i.e. at the beginning of the file or in case of Event based waveform recording (see *Triggered Events*). In the example displayed in Fig. 7.181, the green channel is an online calculated Integrator applied on the yellow analog channel and the red channel is an offline calculated integrator applied on the yellow analog channel with identical channel settings. The deviation of the green and the red channel happens, because the offline calculated integrator will oscillate at the beginning of each new event, but the online calculated integrator not, because the analog data is always available during online calculation.

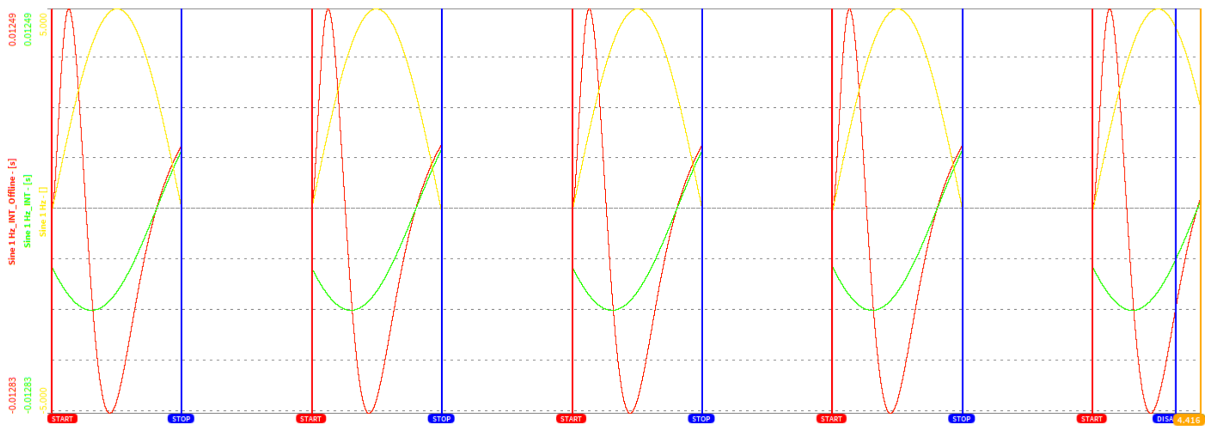

Fig. 7.181: Deviation of Offline and Online Filter channels in case of Event based Waveform recording

7.6 Counter Channels in OXYGEN

OXYGEN supports three different Counter modes: Event Counting, Frequency determination and Encoder Mode (incl. X1, X2, X4 and A-up / B-down) counting.

The following extract from TRION module Technical Reference Manual provides an explanation of the different counting modes. For detailed information, refer to the TRION module Technical Reference Manual.

7.6.1 Counter Modes

Event counting

In Event Counting, the counter counts the number of pulses that occur on input A/B. At every acquisition clock, the counter value is read without disturbing the counting process.

Fig. 7.182 shows an example of event counting where the counter counts eight events on Input A or B. Synchronized Value is the value read by the TRION-CNT module at Acquisition Clock (encircled numbers in the figure, e.g. 1, 2).

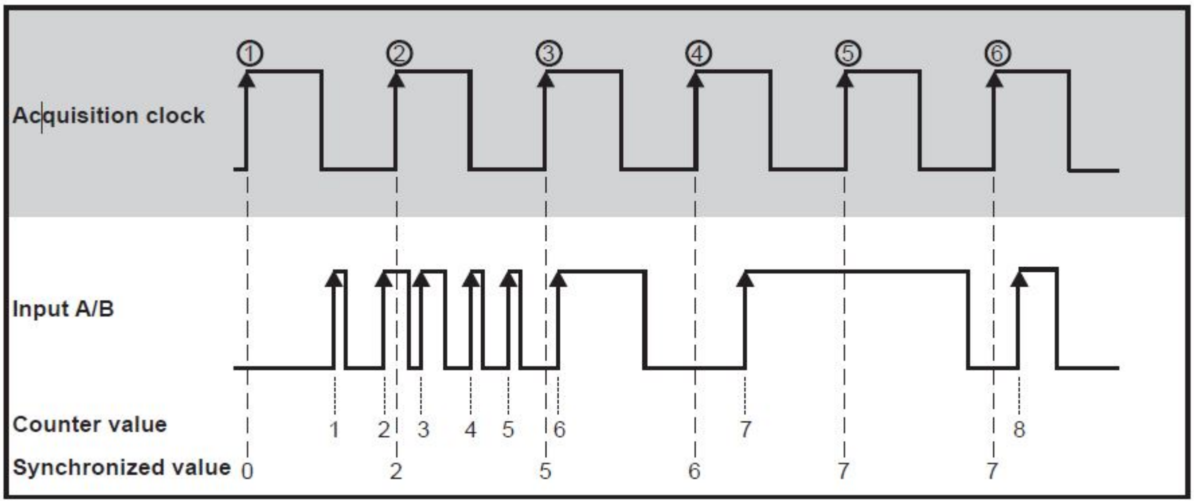

Fig. 7.182: Event Counting

If counting at falling edges is necessary, the input signal must be inverted. This can be done directly in the software by selecting inverted input.

Frequency measurement

In general, it is possible to take the inverse of a period measurement to get the frequency of the input signal. If the period time measurement is done, an inaccuracy of counted internal time base cycles of ±1 cycle appears, because the counted cycles of the internal time base depend on the phase of the input signal with respect to the internal time base. For long period times, and therewith low frequencies, the measurement error is negligible. At high frequencies, and therewith short period times, few cycles are counted. In this case the error of ±1 cycle becomes significant.

Input Frequency	Number of internal time base cycles	Measurement error of -1 cycle	Measurement error of +1 cycle	Calculated frequency with error of -1 cycle	Calculated frequency with error of +1 cycle
40 kHz	2000	1999	2001	39,98 kHz	40,02 kHz
10 MHz	8	7	9	8,75 MHz	11,25 MHz

Fig. 7.183: Accuracy at period time measurement

For higher precision result, a combination of main and sub counter is used internally for getting higher precision at the frequency measurement. The main counter is running on event counting (or encoder mode). The sub counter measures the time between. The sub counter measures exactly the time of the input event with a resolution of 12.5 ns relative to the acquisition clock. At every rising edge on Input A the counter value of the sub counter is stored in a register. At every Acquisition Clock (1, 2, ...,6) the values of both counters are read out.

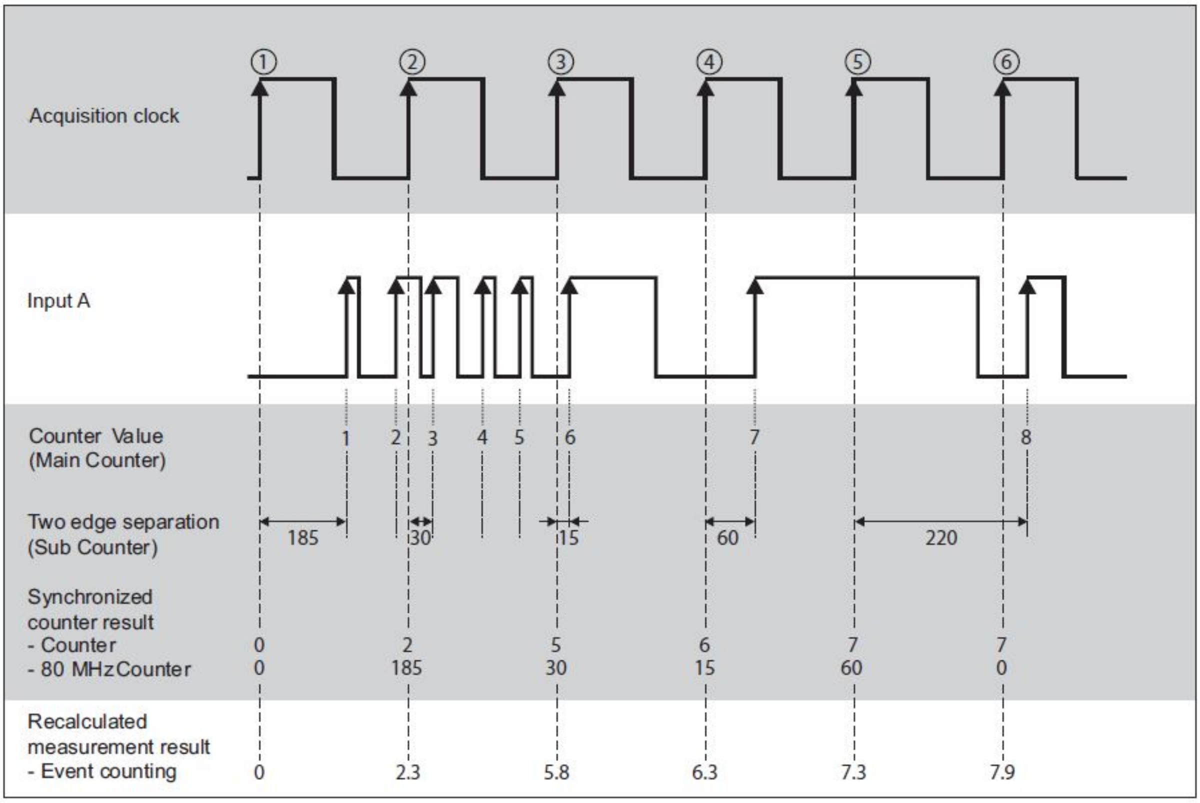

Fig. 7.184: Frequency measurement

Pulse width measurement

In Pulse Width Measurement the counter uses the internal time base to measure the pulse width of the signal present on Input A. The counter counts the rising edges of the internal time base after a rising edge occurs on Input A. At the falling edge on Input A the counter value is stored in a register and the counter is set to zero. With the next rising edge on Input A the counter starts counting again. At every Acquisition Clock (1 , 2 , ..., 6) the register value is read out.

Fig. 7.185 shows a pulse width measurement.

Note: For measuring the low time of the signal, the input signal has to be inverted on the TRION-CNT module.

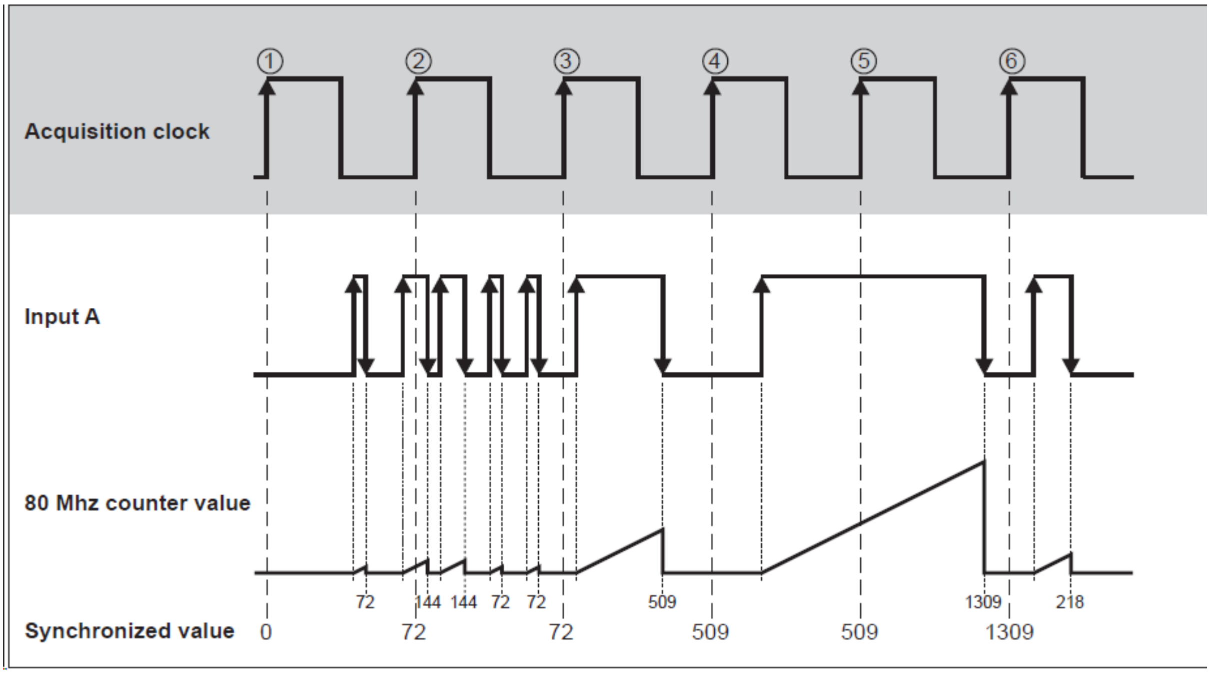

Fig. 7.185: Pulse width measurement

Encoder

Motion encoders have usually three channels: channel A, B and Z. Channel A and channel B are providing the square signals for the counter and have a phase shift of 90°. With this phase shift, the decoder can recognize the rotation direction of the motion encoder. The third channel types out one pulse at a certain position at each revolution. This pulse is used to set the counter to zero. The amount of counts per cycle at a given motion encoder depends on the type of decoding: X1, X2, X4. All three types are provided by the TRION-CNT module. Some motion encoders have two outputs, which are working in a different way. Either channel A or channel B providing the square signal, depending on the direction of the rotation. Also, this type is supplied by the TRION-CNT module.

In the first case X1 decoding is explained. When Input A leads Input B in a quadrature cycle, the counter increments on rising edges of Input A. When Input B leads Input A in a quadrature cycle, the counter decrements on the falling edges of Input A. At every Acquisition Clock (1, 2, …, 9), the counter value is read out.

Fig. 7.186 shows the resulting increments and decrements for X1 encoding.

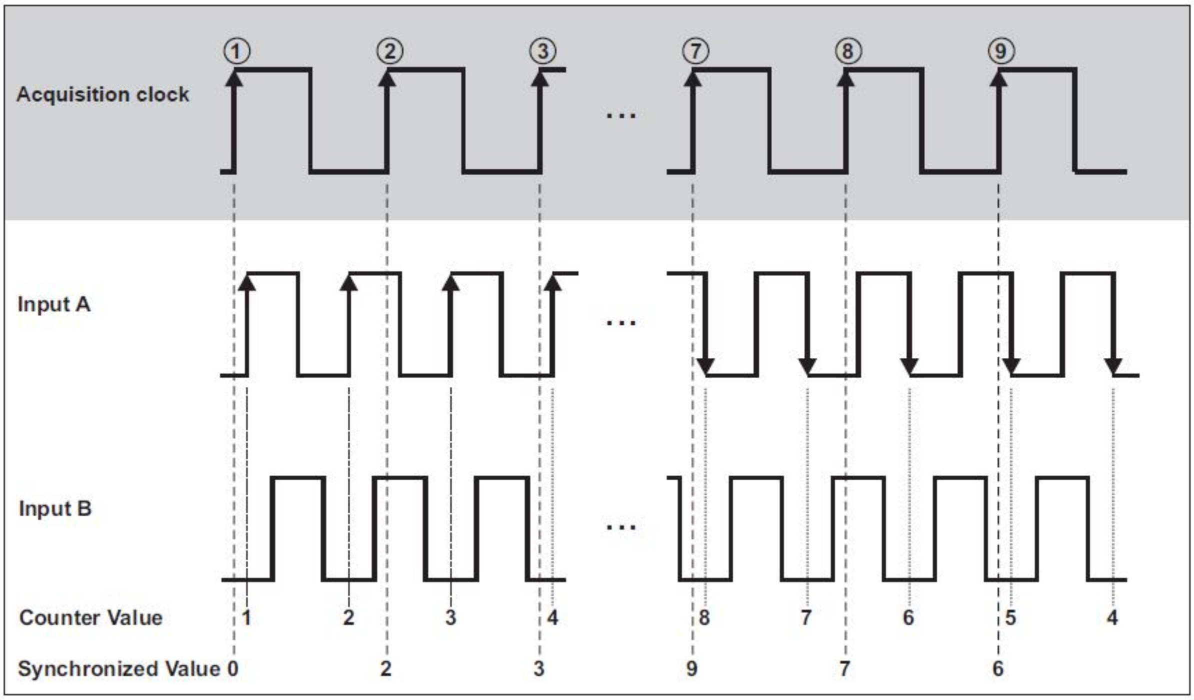

Fig. 7.186: Quadrature Encoder X1 Mode

For X2 encoding, the rising edges and the falling edges of Input A are used to increment or decrement. The counter increments if Input A leads Input B and decrements if Input B leads Input A. This is shown in Fig. 7.187.

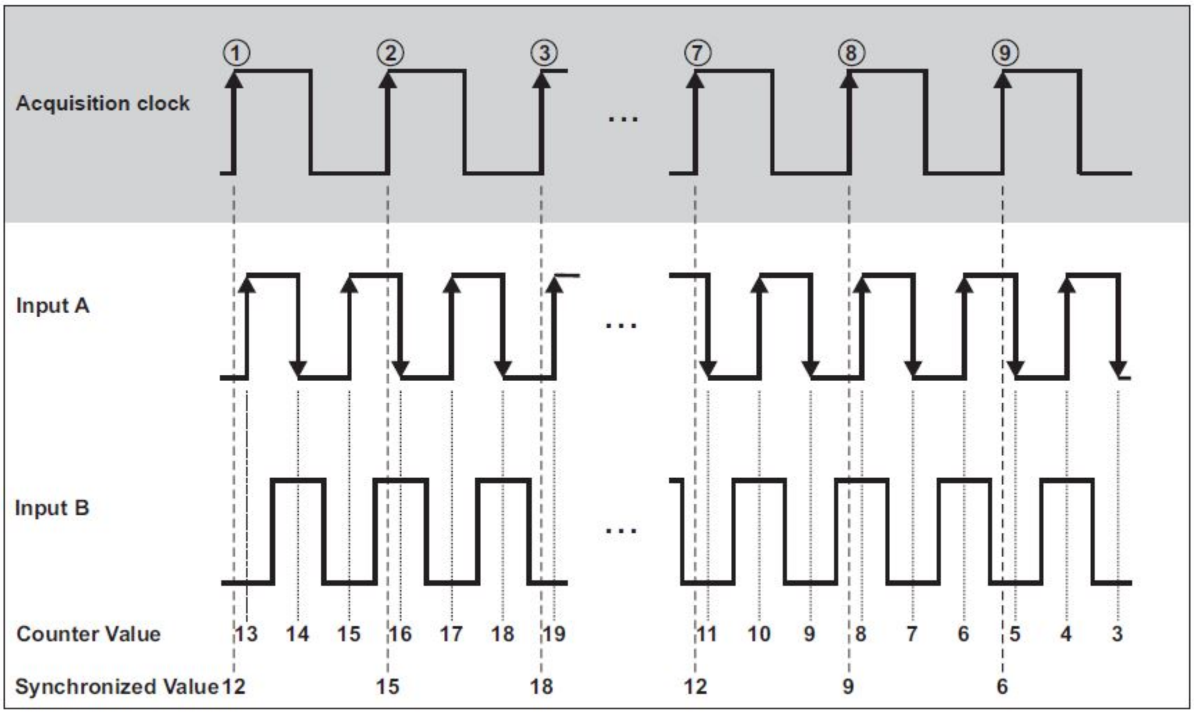

Fig. 7.187: Quadrature Encoder X2 Mode

Similarly, the counter increments or decrements on each edge of Input A and Input B for X4 decoding.

The condition for increment and decrement is the same as for X1 and X2.

Fig. 7.188 shows the results for X4 encoding.

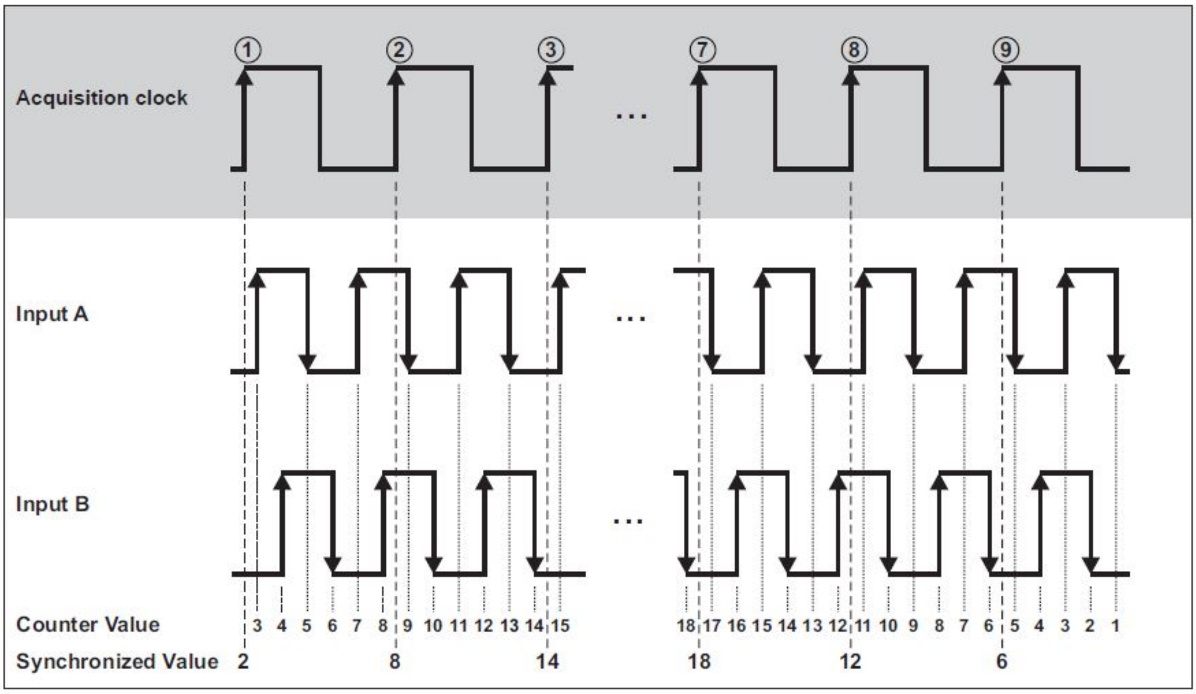

Fig. 7.188: Quadrature Encoder X4 Mode

The third channel Input Z, which is also referred as the index channel, causes the counter to be reloaded with zero in a specific phase of the quadrature cycle.

Fig. 7.189 shows the results for X1 encoding with input Z.

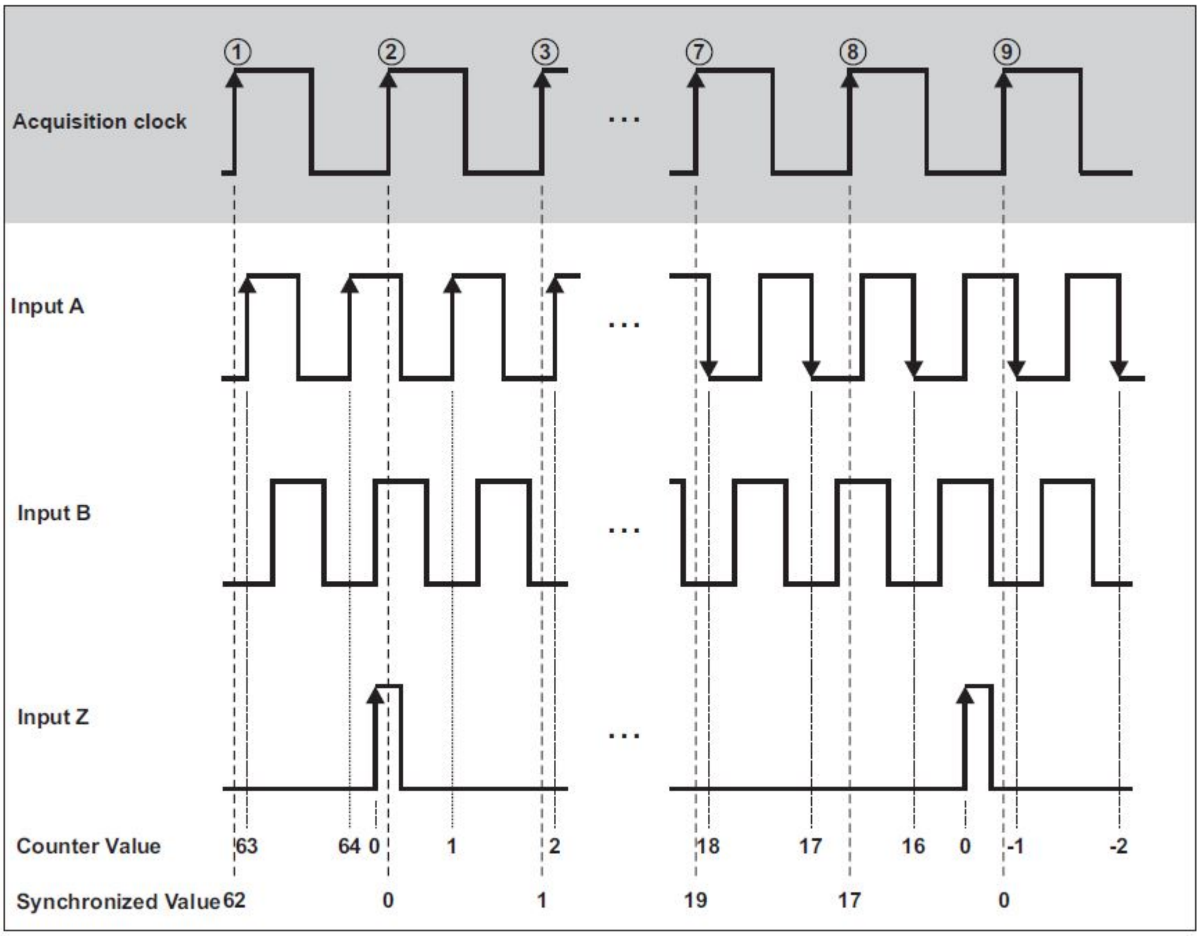

Fig. 7.189: Quadrature Encoder with channel Z

The A-Up/B-Down Encoder supports two inputs, A and B. A pulse on Input A increments the counter on its rising edges. A pulse on Input B decrements the counter on its rising edges. At every Acquisition Clock (1, 2, …, 9), the counter value is read out.

This situation is shown in Fig. 7.190.

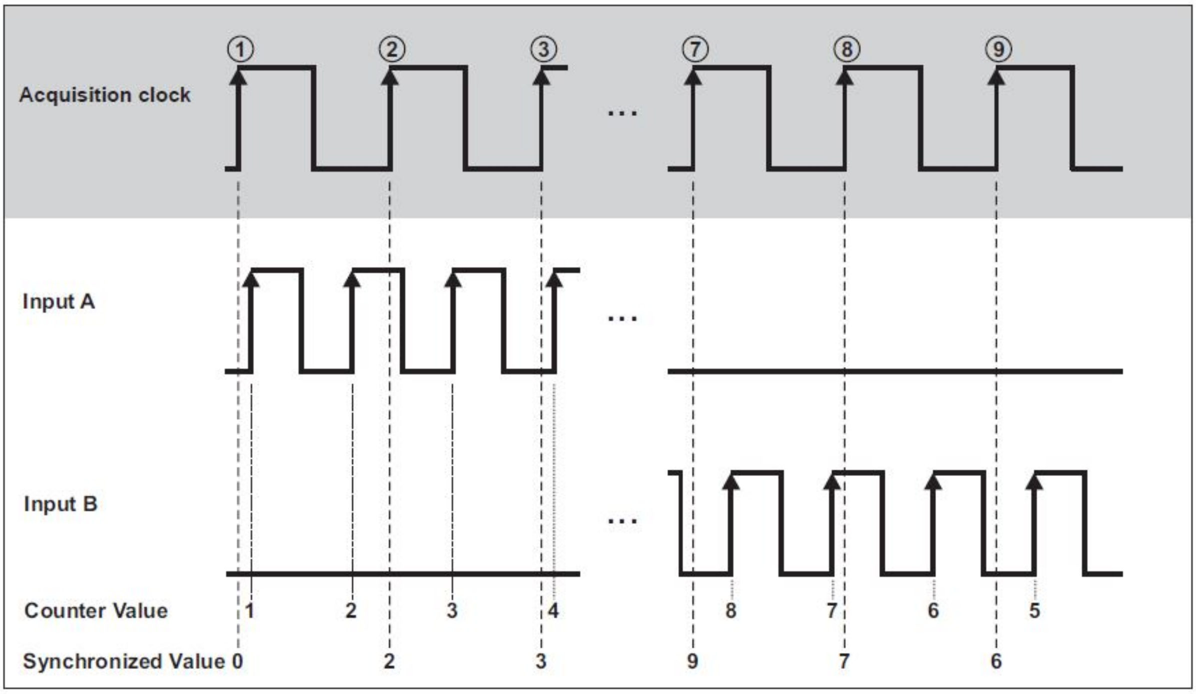

Fig. 7.190: A-Up/B-Down Encoder

7.6.2 TRION Counter Overview

Table 7.35: TRION Counter overview

TRION	-CNT	-BASE	-TIMING	-VGPS	-1620-ACC	-2402-dACC	(3)-18x0-MULTI	-1802/1600-dLV
#Counter #Inputs/counter	6 3	2 3	1 3	1 3	1 1	2 1	2 1	1 3
Isolation	✓	x	x	x	✓	x	✓	x
Trigger level	0 to 50 V / 12 mV steps	CMOS/TTL	CMOS/TTL	CMOS/TTL	70 % of input range	Progr. within input range	75 % of input range	CMOS/TTL
Event counting	✓	✓	✓	✓	✓	✓	✓	✓
Frequency/pulse width measurement	✓	✓	✓	✓	✓	✓	✓	✓
Encoder support	✓	✓	✓	✓	x	x	x	✓
Angle determination (SW)	✓	✓	✓	✓	✓	✓	✓	✓
Speed determination (SW)	✓	✓	✓	✓	✓	✓	✓	✓
Sensor supply	5 and 12 V	5 and 12 V	5 and 12 V	5 and 12 V	x	x	x	5 and 12 V

As shown in Table 7.35, *Frequency* measurement and *Event* counting can be done with every TRION module with counter input. Encoders and CDM+Trigger sensors cannot be connected to a the TRION-1620-ACC or the TRION-2402-dACC module as they don't have several digital input channels per counter channel. Hence, angle and rpm measurements are possible with a counter channel of a TRION-1620-ACC or TRION-2402-dACC module, but no turning direction can be determined.

Note: The Trigger Level supported by the TRION-2402-dACC module differs from the software possibilities.

7.6.3 Channel List of Counter Channels

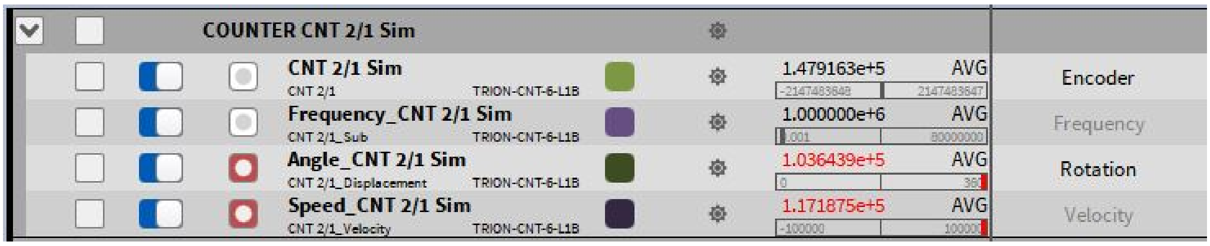

Fig. 7.191: Channel List of a Counter channel

4 single sub-channels are created for each available Counter channel (*COUNTER CNT 2/1 Sim* in Fig. 7.191)in the Channel List. The counter hardware of one Counter channel (except TRION-dACC and TRION-ACC hardware) consists of two different counter logics, the *Main counter* and the *Sub counter* (see Fig. 7.192).

The first sub-channel (*CNT 2/1 Sim* in Fig. 7.191) is linked to the Main counter. If the Counter channel shall be used in the *Event Counting* or *Encoder mode* (X1, X2, X4, A-up/B-down), it must be defined in the Channel Setup of this sub-channel. The *Frequency mode* can be selected in this sub-channel as well, but this is only due to guarantee the compatibility with old setup files. The sub-channels 3 and 4 will disappear if the *Frequency mode* is selected (*Angle_CNT2/1 Sim* and *Speed_CNT 2/1 Sim* in Fig. 7.191).

The second sub-channel (*Frequency_CNT 2/1 Sim* in Fig. 7.191:) is linked to the Sub counter. This channel is used for the frequency measurement. If *Frequency mode* is selected in sub-channel one (*CNT 2/1 Sim* in Fig. 7.191), sub-channel two (*Frequency_CNT 2/1 Sim* in Fig. 7.191) is deactivated and does not display data.

The third sub-channel (Angle_*CNT 2/1 Sim* in Fig. 7.191) calculates the angle by using the data acquired from the *Main counter* and *Sub counter* logic and the fourth sub-channel (*Speed_CNT 2/1 Sim* in Fig. 7.191) calculates the speed by using the data acquired from the *Main counter* and *Sub counter* logic.

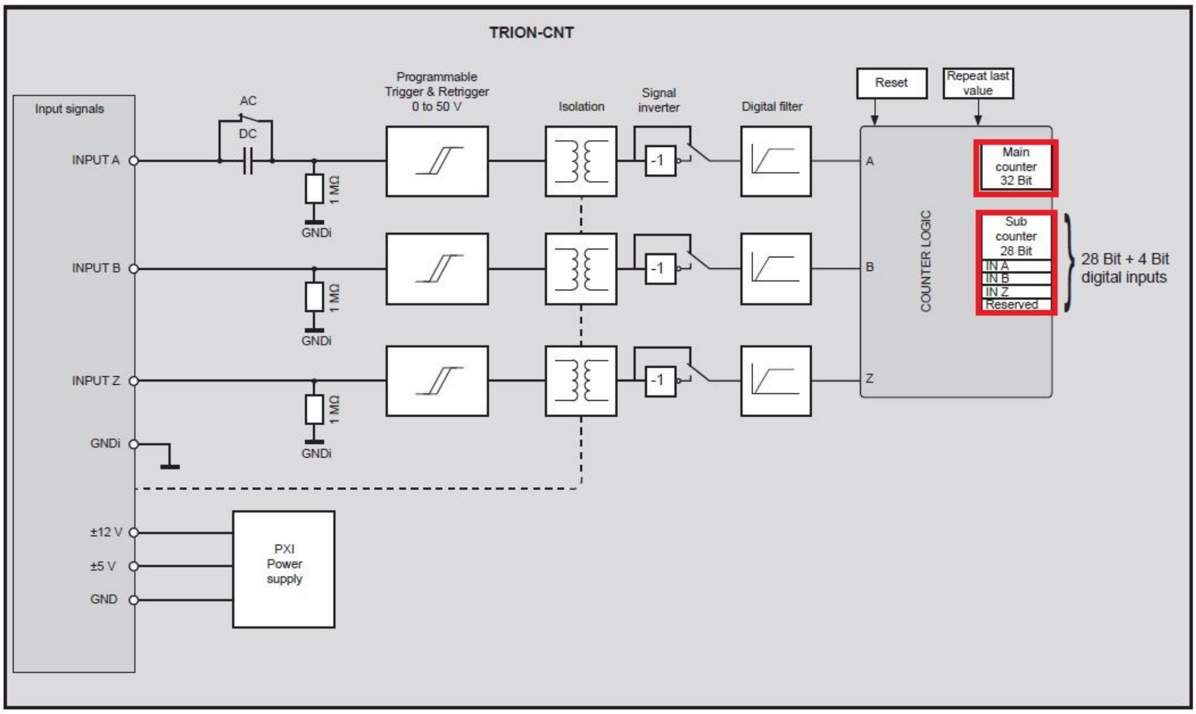

Fig. 7.192: Block diagram of one Counter channel on a TRION-CNT module

Note: The maximum bus data rate of 90 MB/s is reached if 6 channels of a TRION-CNT module are stored with 2 MHz Sample Rate.

7.6.4 Channel Setup of a Counter Channel

Each of the four sub-channels has an own Channel Setup. The Channel Setups of all 4 sub-channels is summarized in the Channel Setup of the main counter channel (*COUNTER CNT 2/1 Sim in* Fig. 7.193) and can be entered by clicking on the gear button (see Fig. 7.193). The scaling of a sub-channel can be changed in the Channel Setup of the individual sub-channel.

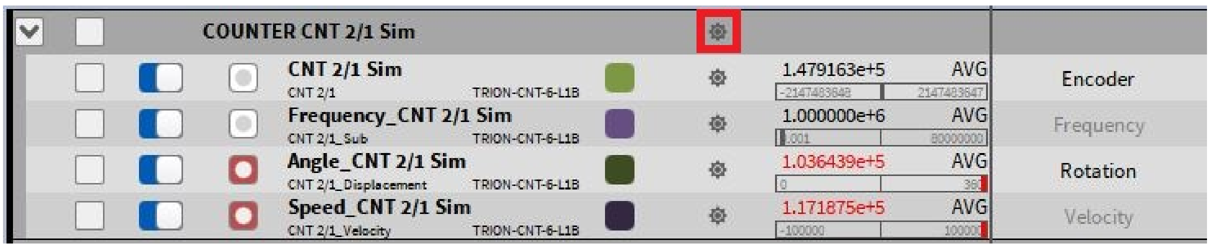

Fig. 7.193: Channel setup of a Counter channel

In the following, the Channel Setup of a Main Counter channel for and its options for an *Event* mode and an *Encoder* mode are explained on the example of a TRION-CNT module. Due to limited hardware possibilities, the channel setup of a TRION-ACC or TRION-dACC module counter channel provides less options.

Channel Setup for a TRION-CNT Channel in *Event* mode

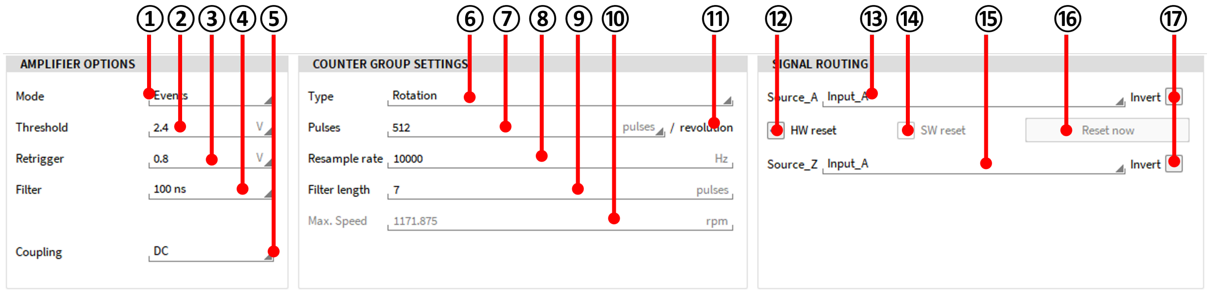

Fig. 7.194: Channel Setup for a TRION-CNT channel in *Event* mode

Table 7.36: Menu of a Counter channel in the *Event* mode

No.	Function	Description
Amplifier Options		
1	*Mode* menu	Counter mode selection: *Events*, *Frequency* or *Encoder*
2	*Threshold* level	Threshold (Trigger) Level selection (depends on the TRION hardware, see Table 7.35)
3	*Retrigger* level	Retrigger Level selection (depends on the TRION hardware, see Table 7.35)
4	*Filter* menu	Selection of a digital filter; for additional information refer to *Digital Filter of a Counter Channel*
5	*Coupling* menu	Coupling (HP filter) selection (availability depends on TRION hardware)
Counter Group Settings		
6	*Type* menu	Decoding type: *Rotation* or *Linear* decoding type
7	*Pulses* selection	Number of pulses transmitted by the counter per revolution, meter, …
8	*Resample rate* selection	Select the Resample rate here; needed if time synchronous counter and analog data is required. Enter the sample rate of the analog channel here and counter data will be time synchronous to the analog data
9	Filter length	Apply a moving average filter on speed by number of pulses. For speed signal smoothing without delay. Applicable in Event and Encoder mode.

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Table 7.36 – continued from previous page

No.	Function	Description
10	Maximum speed	Maximum recommended speed calculated by sample rate (per minute) divided by pulses per revolution. *Max. speed [rpm] = Sample rate [Hz] x 60 / pulses per revolution*
11	*Unit* selection	Unit selection; for rotational sensors fixed to *revolution*, set to *meters* per default for linear sensors
Signal Routing		
12	*HW Reset* button	HW reset selection; If this option is selected, a second input *Source_Z* must be selected. *Source_A* channel is reset if the edge of *Source_Z* raises from 0 to 1
13	*Source_A* selection	Select the input signal that shall be routed to *Source_A*
14	*SW Reset* button	SW Reset selection; If this option is selected, *Source_A* is reset after the number of pulses entered in 7 is reached
15	*Source_Z* selection	Select the input signal that shall be routed to *Source_Z* (only applicable if *HW Reset* is selected)
16	*Reset now* button	If this button is pressed, a manual hardware reset is forced
17	*Invert channel* button	Inverts the respective input channel

Note: An automatic Counter Reset at Recording Start is not supported

Channel Setup for a TRION-CNT Channel in *Encoder* mode

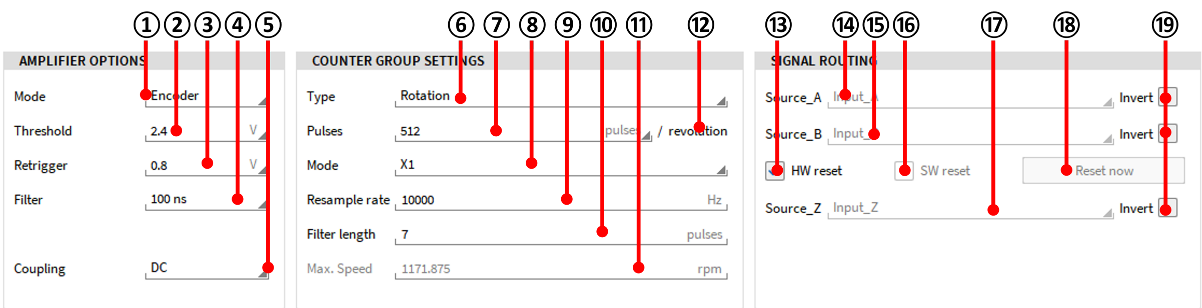

Fig. 7.195: Channel Setup for a TRION-CNT channel in *Encoder* mode

Table 7.37: Menu of a Counter channel in the *Encoder* mode

No.	Function	Description
Amplifier Options		
1	*Mode* menu	Counter mode selection: *Events*, *Frequency* or *Encoder*
2	*Threshold* level	Threshold (Trigger) Level selection (depends on the TRION hardware, see Table 7.35)
3	*Retrigger* level	Retrigger Level selection (depends on the TRION hardware, see Table 7.35)
4	*Filter* menu	Selection of a digital filter; for additional information refer to *Digital Filter of a Counter Channel*
5	*Coupling* menu	Coupling (HP filter) selection (availability depends on TRION hardware)
Counter Group Settings		
6	*Type* menu	Decoding type: *Rotation* or *Linear* decoding type
7	*Pulses* selection	Number of pulses transmitted by the counter per revolution, meter, …
8	*Encoder Mode* selection	Select the Encoder mode: *X1*, *X2*, *X4*, *A-Up/B-Down*
9	*Resample rate* selection	Select the Resample rate here; needed if time synchronous counter and analog data is required. Enter the sample rate of the analog channel here and counter data will be time synchronous to the analog data
10	Filter length	Apply a moving average filter on speed by number of pulses. For speed signal smoothing without delay. Applicable in Event and Encoder mode.
11	Maximum speed	Maximum recommended speed calculated by sample rate (per minute) divided by pulses per revolution. *Max. speed [rpm] = Sample rate [Hz] x 60 / pulses per revolution*
12	*Unit* selection	Unit selection; for rotational sensors fixed to *revolution*, set to *meters* per default for linear sensors
Signal Routing		
13	*HW Reset* button	HW reset selection; If this option is selected, a second input *Source_Z* must be selected. *Source_A* channel is reset if the edge of *Source_Z* raises from 0 to 1

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Table 7.37 – continued from previous page

No.	Function	Description
14	*Source_A* selection	Displays the signal that is routed to *Source_A* (routing can't be edited in the *Encoder* mode)
15	*Source_B* selection	Displays the signal that is routed to *Source_B* (routing can't be edited in the *Encoder* mode)
16	*SW Reset* button	SW Reset selection; If this option is selected, Source_A is reset after the number of pulses entered in 7 is reached
17	*Source_Z* selection	Displays the signal that is routed to *Source_Z* (only applicable if *HW Reset* is selected, routing can't be edited in the *Encoder* mode)
18	*Reset now* button	If this button is pressed a manual hardware reset is forced
19	*Invert channel* button	Inverts the respective input channel

Note: An automatic Counter Reset at Recording Start is not supported

7.6.5 Digital Filter of a Counter Channel

Each counter and digital input has a digital filter, which can be set to various gate times. If the gate time is set to "Off", no filter is on the input signal. The filter circuit samples the input signal on each rising edge of the internal time base. If the input signal maintains his state for at least the gate time, the new state is propagated. As an effect the signal transition is shifted by the gate time.

Fig. 7.196 demonstrates the function of the filter.

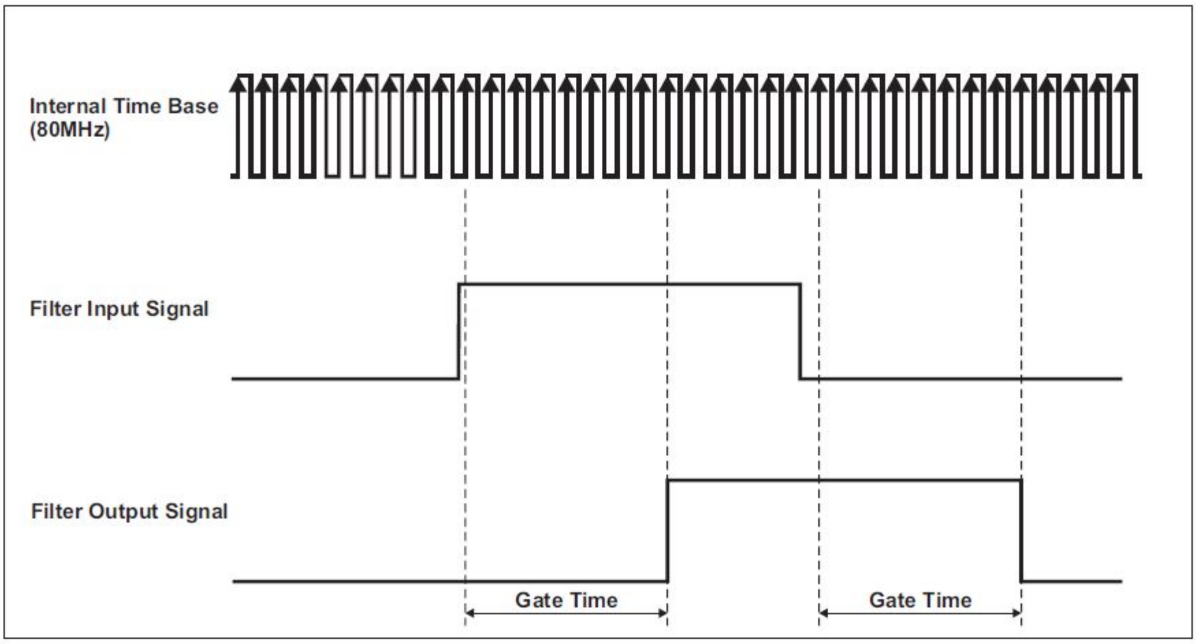


Fig. 7.196: Digital filter

The intent of the filter is to eliminate unstable states, e.g. glitches, jitter… which may appear on the input signal, as shown in Fig. 7.197.

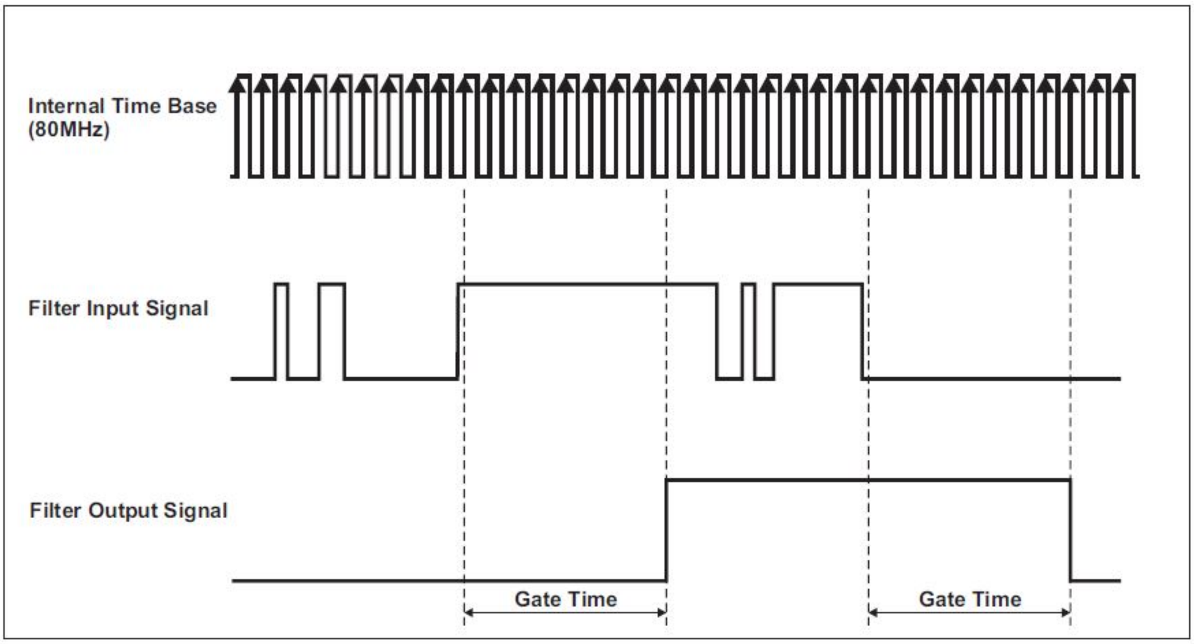


Fig. 7.197: Input signal with chatter

It can be chosen between eight filter settings: Off, 100 ns, 200 ns, 500 ns, 1 µs, 2 µs, 4 µs and 5 µs. Two examples of filter settings are described. The 100 ns filter will pass all pulse widths (high and low) that are 100 ns or longer. It will block all pulse widths that are 75 ns or shorter. The 5 µs filter will pass all pulse widths (high and low) that are 5 µs or longer and will block all pulse widths that are 4.975 µs or shorter. The internal sampling clock (time base) is 80 MHz, so the period time amounts 12.5 ns. Pulse widths between gate time minus two internal time base period times may or may not pass, depending on the phase of the input signal with respect to the internal time base.

Properties of all filter settings:

Filter settings	Pulse width to pass	Pulse width to be blocked
100 ns	100 ns	75 ns
200 ns	200 ns	175 ns
500 ns	500 ns	475 ns
1 µs	1 µs	975 ns
2 µs	2µs	1.975 µs
4 µs	4 µs	3.975 µs
5 µs	5 µs	4.975 µs
Off	-	-

Fig. 7.198: Filter Gate Times

7.6.6 Supported Counter Sensors

Due to the software and TRION-hardware possibilities, OXYGEN supports three different types of counter sensors: Tacho sensors, CDM+Trigger sensors and Encoder sensors. The following table provides an overview about the possibilities and differences of the different types of sensors:

Table 7.38: Characteristics of Tacho, CDM+Trigger and Encoder sensors

	Mounting	Connect	Pulses	Frequency	Required digital counter inputs	Measurement		
						RPM	Angle	Direction
Tacho	Easy	Analog or adj. CNT	1 kHz	0.1	1	✓	x	x
CDM+ Trigger	Hard	CNT	360/720/xxx	125 kHz	2	✓	✓	x
Encoder coder	Hard	CNT	Up to 36000 and more	~100 kHz	3	✓	✓	✓

Mandatory channel settings for Tacho sensors

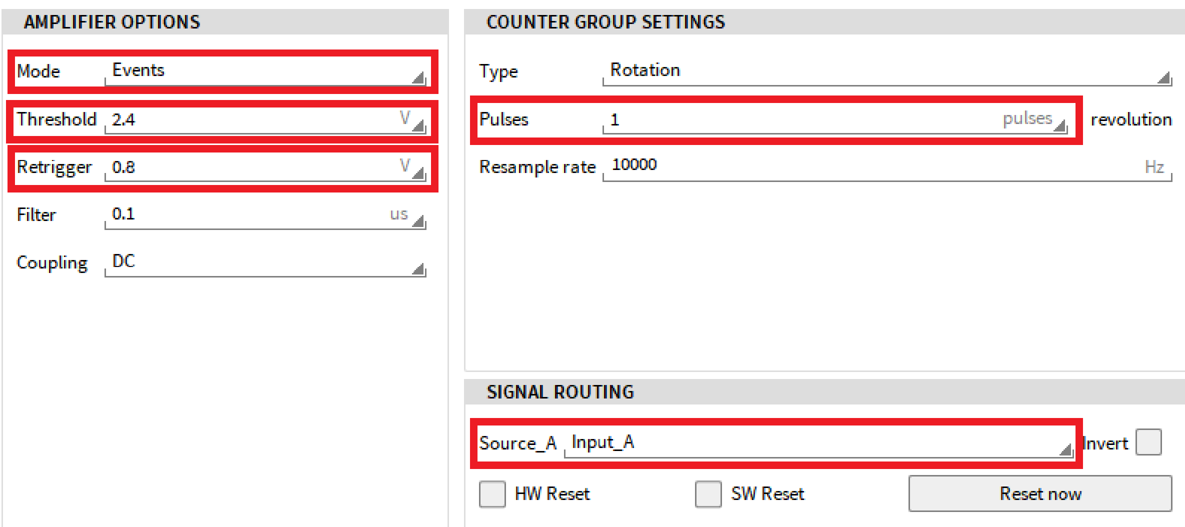


Fig. 7.199: Channel settings for a Tacho sensor

- Amplifier *Mode* must be set to *Events*
- *Threshold* and *Retrigger* Level must be adjusted depending on the sensor signal
- Number of *Pulses* must be set to 1 pulse /revolution
- Sensor signal must be routed to *Source_A*

Mandatory channel settings for CDM+Trigger sensors

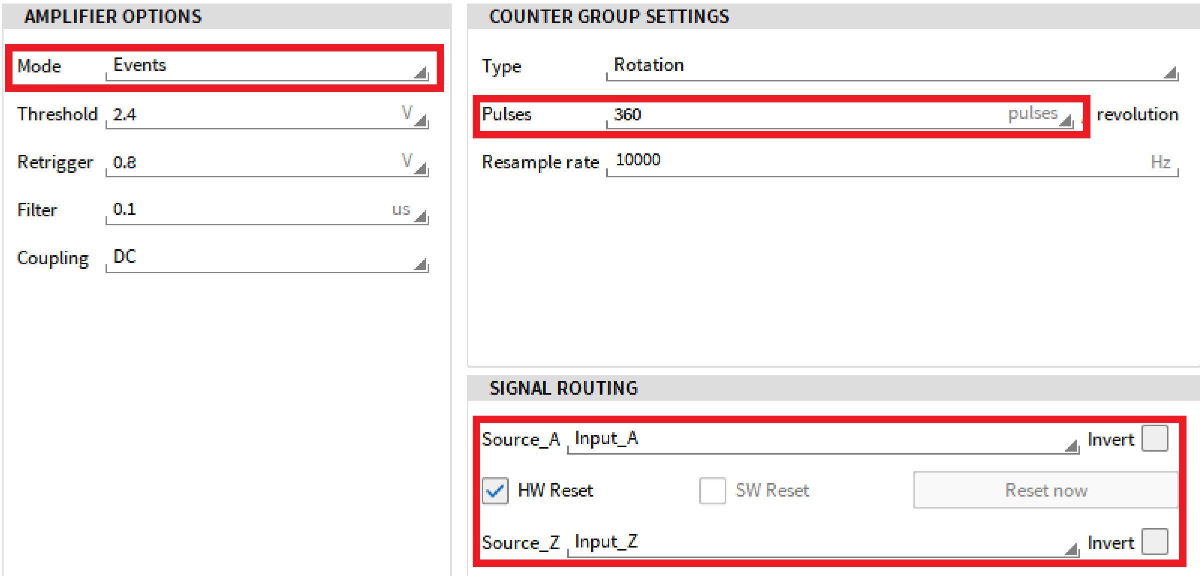


Fig. 7.200: Channel settings for a CDM +Trigger sensor

- Amplifier *Mode* must be set to *Events*
- Number of *Pulses* per revolution provided by the CDM signal must be entered
- Route the CDM signal to *Source_A* and the Trigger signal to *Source_Z* (*HW reset* must be enabled)

Note: The Amplifier *Mode* can also be set to *Encoder*. In this case, the same settings as in Fig. 7.201 are mandatory. Note that the routing of the *Source_A* and *Source_B* input cannot be changed.

Mandatory channel settings for Encoder sensors

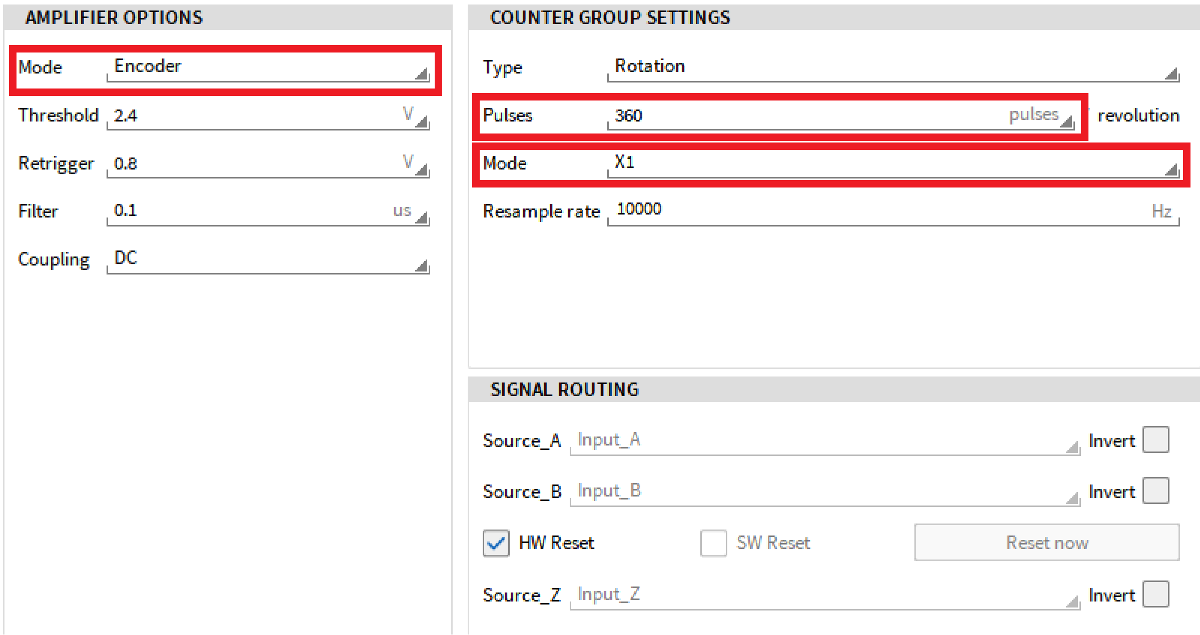


Fig. 7.201: Channel settings for an Encoder sensor

- Amplifier *Mode* must be set to *Encoder*
- Number of *Pulses* per revolution provided by the *Input_A* and *Input_B* must be entered
- The counting mode *X1*, *X2*, *X4* or *A-Up/B-Down* must be selected

7.7 CAN Input Channels

The following TRION-boards provide one or several CAN ports

- TRION-CAN: 2 or 4 ports
- TRION(3)-18x0-MULTI: 1 CAN port
- TRION-2402-MULTI: 1 CAN port
- TRION-1600-1802-dLV-CAN: 1 CAN port

In addition, Vector devices from the VNxxxx series (i.e. VN1610 or VN7610) can be used for the CAN data acquisition as well. These devices are the dedicated hardware to also acquire CAN-FD data streams and can therefore be used for CAN data acquisition.

Note: The usage of Vector VNxxxx devices requires a separate software license.

7.7.1 CAN port configuration

To configure the CAN port properly, go to the Channel List and open the CAN port configuration of the dedicated CAN port by pressing the Gear button (see (1) in Fig. 7.202).

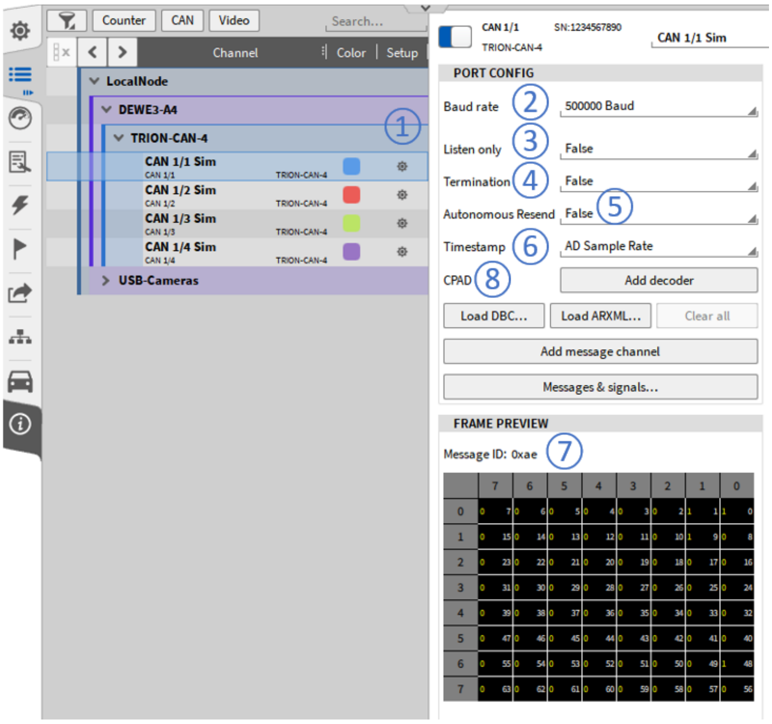


Fig. 7.202: CAN port configuration

Note: When using the CAN port of a TRION(3)-18x0-MULTI or a TRION-2402—MULTI board, the CAN port is available on AI 1 of these boards. For accessing and using these CAN ports, you have to set the Input mode of AI 1 to CAN first and activate the dedicated CAN port second (see Fig. 7.203)

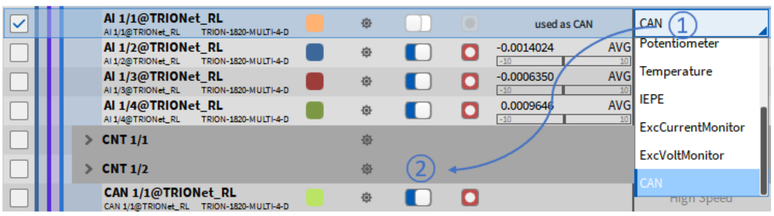


Fig. 7.203: Using the CAN port of a TRION-MULTI board

The following settings are available:

- Baud rate (see (2) in Fig. 7.202):

  Select the proper Baud rate of the CAN bus here

- Listen only (see (3) in Fig. 7.202):

  With the listen-only mode activated, normal bus activity can be monitored by the device. However, if an error frame is generated by the local CAN controller, it is not transmitted to the bus.

Since in listen-only mode the module has no transmit function this feature must not be used in a point-to-point connection.

For more information, refer to the to the *TRION series technical reference* manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

- Termination (see ④ in Fig. 7.202):

  TRION-CAN ports offer a programmable termination resistance, either high impedance (False) or 120 Ω (True).

  For more information, refer to the to the *TRION series technical reference* manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

- Autonomous Resend (see ⑤ in Fig. 7.202):

  Only affects CAN data output. For details, refer to *CAN data recording*.

- Timestamp (see ⑥ in Fig. 7.202): Sets the time base on which the CAN signals are aligned.
  - 10 MHz:

    Assigns a timestamp with 100 ns resolution to the CAN messages and signals. This is the internal time base of the CAN port
  - AD sample rate:

    Assigns the timestamp of the highest analog sample rate to the CAN messages and sig-nals, i.e. 10 kHz analog sample rate results in a timestamp with 100 µs.
  - 100 Hz … 10 MHz:

    A user defined CAN timestamp resolution can be defined as well.

The frame preview (see ⑦ in Fig. 7.202) will show a preview of the received messages if all settings (especially Baud rate and Termination) are set correctly ad data is available on the CAN port.

Additional settings:

CPAD (see ⑧ in Fig. 7.202): If a module of the CPAD series is connected to the CAN bus, a CPAD decoder can be added for decoding their messages and signals without the need for a proper dbc-file. For more information, refer to *Using XRs / CPADs with OXYGEN*.

7.7.2 CAN data recording

After configuring the CAN port properly, the CAN stream must be decoded.

Decoding CAN data by using .dbc or .arxml files

The conventional way to decode the CAN data stream is to load either a dbc-file or an arxml-file which includes the information which CAN messages are included in the CAN data stream and how to decode them into CAN signals.

Thus, press *Load DBC…* (see ① in Fig. 7.204) or *Load ARXML…* (see ② in Fig. 7.204).

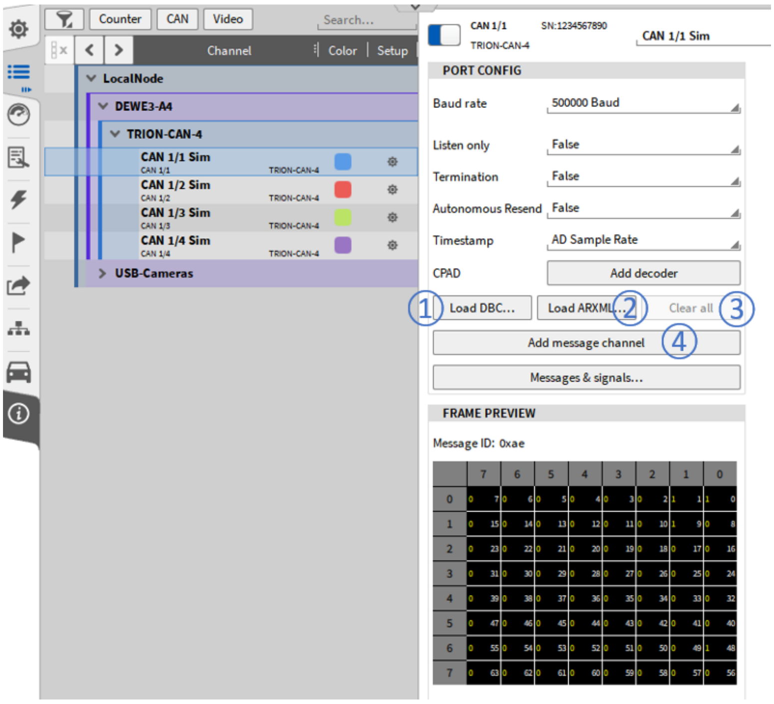


Fig. 7.204: Decoding CAN data

A file dialog will open to browse and select the proper file.

Note:

- ARXML file decoding is supported in OXYGEN R5.6 or higher
- ARXML file version 4.1 or high is required

After loading the dbc/arxml-file, a channel picker dialog will appear. It is possible to select only dedicat-ed CAN messages and signals for decoding or all channels contained in the file and press Ok afterwards.

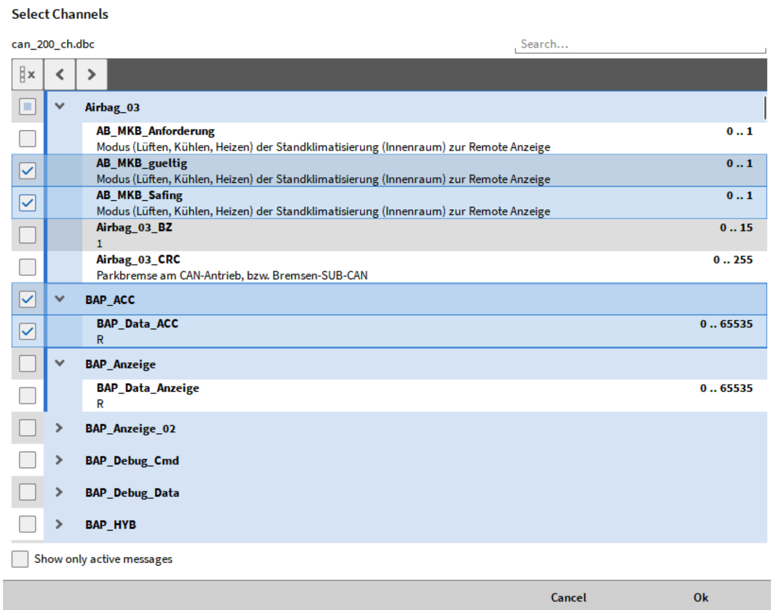


Fig. 7.205: CAN channel picker dialog

Note: The option *Show only active messages* performs a scan on the CAN bus to check which CAN messages are available on the CAN bus. You will only see the CAN messages and signals included in the dbc- or arxml-file that are currently available on the CAN bus when this option is activated.

After pressing Ok you will find the selected messages and signals in the channel list (see Fig. 7.206)

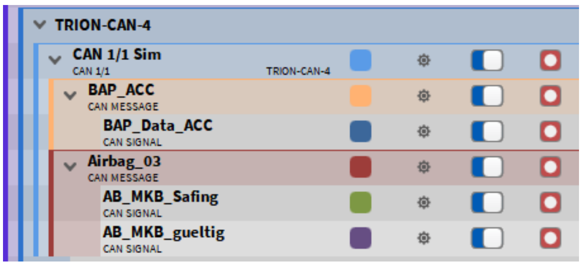


Fig. 7.206: CAN messages and signals in the Channel List

You can delete all decoded messages and channels by pressing the Clear All button the CAN port config-uration (see ③ in Fig. 7.204).

If one or several messages available on the CAN bus should not be defined in the selected dbc- or arxml-file you can manually add them by pressing *Add message channel* (see ④ in Fig. 7.204) and defining the correct settings in the CAN message setup. More details can be found in *CAN message setup*.

Note: It is also possible to add and decode other CAN channels from a dbc- or arxml file during the data analy-sis (CAN offline decoding). To do so, the steps above have to be repeated within the loaded data file. The only condition is that the raw CAN data stream was stored during data recording.

CAN message setup

The CAN message setup can be accessed by pressing the gear button of the respective CAN message in the Channel List (see ① in Fig. 7.207).

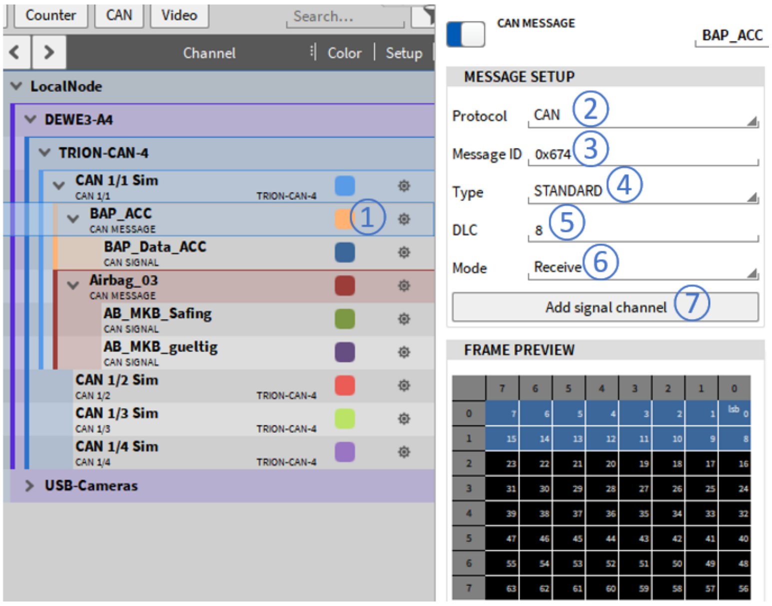


Fig. 7.207: CAN message channel setup

The following CAN message settings can be edited here if certain settings in the loaded dbc-file were defective:

- Protocol type (see ② in Fig. 7.207): CAN or J1939 or CAN-FD (if applicable)

  For additional information about SAE J1939 data decoding, refer to section 4.

- Message ID (see ③ in Fig. 7.207): The message's ID can be set from 0x00 to 0x7ff
- Message Type (see ④ in Fig. 7.207): Standard or Extended
- DLC (see ⑤ in Fig. 7.207): The DLC can be set from 0 … 8 (…64 for CAN-FD)
- Mode (see ⑥ in Fig. 7.207): The Mode can be set from Receive (Receiving CAN data) to Transmit (Outputting OXYGEN data over CAN).

  For additional information, please refer to section 5.

- Add signal channel (see ⑦ in Fig. 7.207):

  If the CAN message includes one additional signal which is not loaded from the dbc-or arxml-file or available within the dbc-file, a new signal can be added. The signal's setting are described in *CAN signal setup*.

CAN signal setup

The CAN signal setup can be accessed by pressing the gear button of the respective CAN signal in the Channel List (see ① in Fig. 7.208).

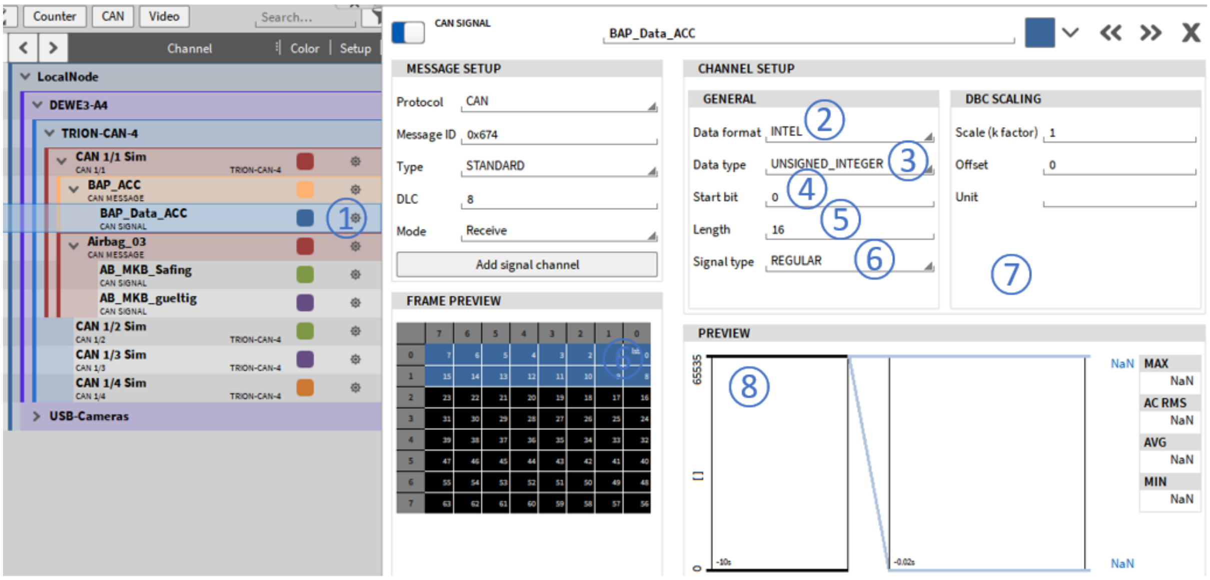


Fig. 7.208: CAN signal setup

The following CAN signal settings can be edited here if certain settings in the loaded dbc-file were defective:

- Data format (see ② in Fig. 7.208): Intel or Motorola
- Data type (see ③ in Fig. 7.208): Double, Float, Signed Integer or Unsigned Integer
- Start bit (see ④ in Fig. 7.208): Define the start bit of the signal within its message
- Length (see ⑤ in Fig. 7.208): Define the length of the signal within its message
- Signal Type (see ⑥ in Fig. 7.208): Regular, Multiplexed or Multiplexor
- DBC Scaling (see ⑦ in Fig. 7.208): Change the scaling of the signal
- Preview: (see ⑧ in Fig. 7.208): The preview shows the past 10 seconds of the signal to check if proper settings have been applied to the signal.

Signal type

Three different signal types are available in OXYGEN. Signals are the smallest unit of information in a CAN message. The start bit is used to indicate the signal's position within the message.

- Regular: The same signal is transmitted having the same position within the message.
- Multiplexed: Different signals are transmitted within the message. The position of the signals is defined using a multiplex value. This value is transmitted in another signal.
- Multiplexor: This signal contains the information of the different signal's positions within the message, which are transmitted as multiplexed signals.

CAN data decoding using the CAN editor

Instead of using .dbc or .arxml files for data decoding it is also possible to add CAN messages and signals manually. OXYGEN provides a CAN editor for this purpose which can be opened by pressing the *Messages & signal* button the CAN port configuration (see ① in Fig. 7.209):

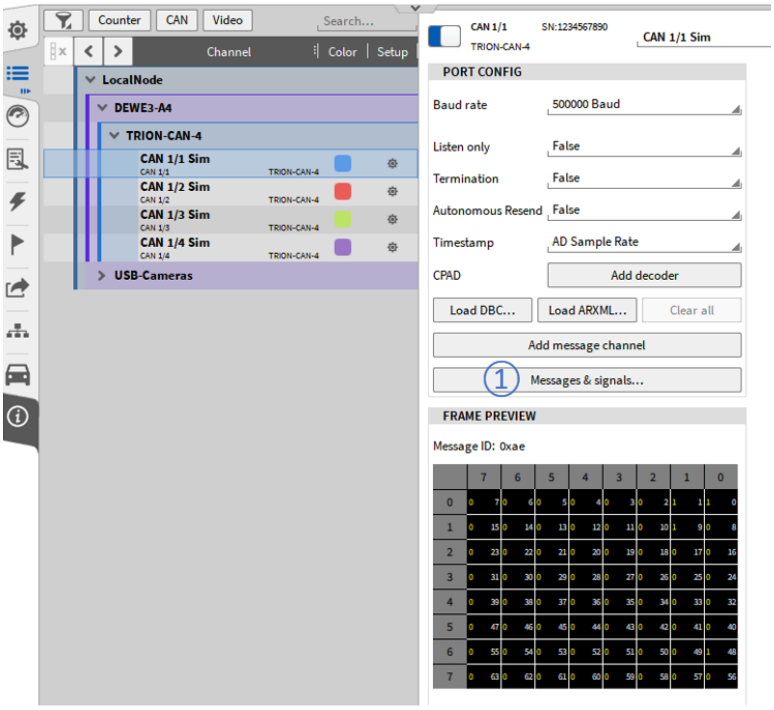


Fig. 7.209: CAN port configuration

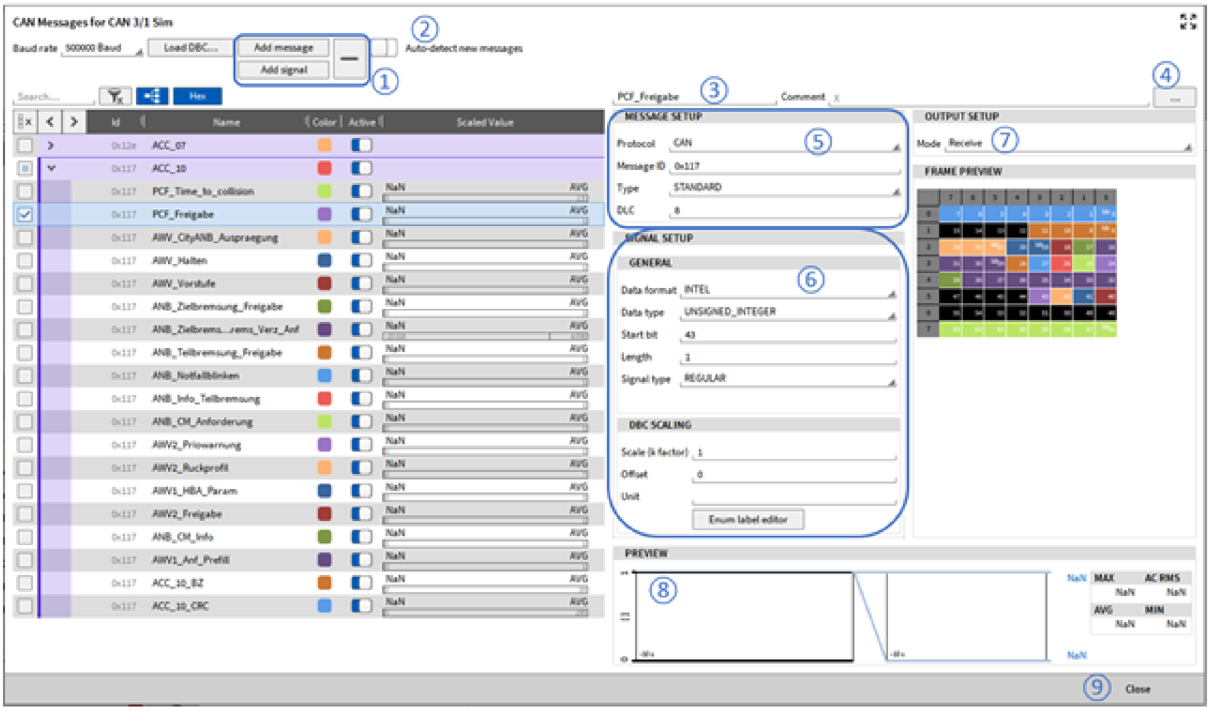


Fig. 7.210: CAN editor overview

The CAN editor can be used to

- Manually add or delete CAN messages and signals (see 1 in Fig. 7.210).
- Scan for CAN messages, which will automatically be created with their ID and DLC. After the scan, a name can be given and signals can be created (see 2 in Fig. 7.210).
- Rename the currently selected CAN message and signal (see 3 in Fig. 7.210).
- Add comments to messages and signals (see 4 in Fig. 7.210).
- Edit CAN messages and access the same settings as described in section *CAN message setup* (see 5 in Fig. 7.210). With the enum label editor a text label can be defined for a specific, unique signal value which is then shown in the digital instrument (see also *Enum scaling*).
- Edit CAN signals and access the same settings as described in *CAN signal setup* (see 6 in Fig. 7.210).
- Set the CAN Message mode to Receive for acquiring data or transmit for outputting OXYGEN data over CAN (see 7 in Fig. 7.210).
- Providing a preview of the past 10 seconds of the signal to check if proper settings have been applied to the signal (see 8 in Fig. 7.210).

When finished you can exit the CAN editor again by pressing the Close button (see 9 in Fig. 7.210).

Note: The CAN editor and the related CAN message / signal setup is also available for CAN-FD streams.

7.7.3 SAE J1939 DATA DECODING

SAE J1939 is an overlay of standard CAN for primary use in heavy duty vehicles. It uses a standardized messaging system with parameter group numbers encoded in the extended message frame ID.

Main properties

- Message ID consists of
  - PGN-Number
  - Priority and
  - Source address
- Messages can be longer than standard CAN Frame size due to Multi Frame Messaging system

Decoding of J1939 messages

A simple CAN decoder could receive and decode messages with standard length when the decoder is parametrized with the exact message id. When it comes to practical use, and the user wants to decode and read data with different priority and/or source address, it gets difficult. Also the reading of multi frame messages is not possible with standard tools. OXYGEN supports the Multi Frame Messages as well as decoding messages with varying priority and source address.

Example: DBC-File defines the following Message ID: 0x0CF004FE

- PRIORITY (Encoded) = 0x0C >> bit shift 2 = 0x03 (=3)
- PGN-Number = 0xF004 (=61444)

- Source Address = 0xFE (=254, broadcast)

If a message on the CAN has the following Message ID: 0x18F00400

Standard CAN-Decoder would recognize a different message and does not decode it (because the message ID is not identical to the defined one)

To decode it anyway, OXYGEN ignores the priority and the source address (if it is originally defined as 0xFE)

Table 7.39: Decoding of J1939 messages in OXYGEN

Frame Description (DBC)	Decoded in OXYGEN
PRIO/PGN/SA=0xFE	0x*PGN** (only PGN matters, source address and priority is ignored)
PRIO/PGN/SA≠0xFE	0x*PGN*SA (PGN and Source Address matters, priority is ignored)

Supported DBC-Formats for Description of J1939 Messages (Requirements):

Correct Specification of the VFrameFormat [J1939 PG (ext. ID)]

```
BA_DEF\_ BO\_ "VFrameFormat" ENUM "StandardCAN","ExtendedCAN", "reserved","J1939PG"; BA_DEF_DEF\_ "VFrameFormat" "J1939PG"; BA\_ "ProtocolType" "J1939";
```

Each Message must have the VFrameFormat Property 3 (according to ENUM)

```
BA\_ "VFrameFormat" BO\_ 2633805054 3;
```

The "Old" format (J1939 PG) is not supported, ask our support, how to convert it to the newer format (J1939 PG (ext. ID)).

Replace Source Address:

If a dbc- or arxml file is loaded that contains J1939 messages, the source Address will be displayed when Show only active messages is activated (see ① in Fig. 7.211). By Selecting Replace Address it is possible to replace the current source address of the dedicated mes-sage by a user defined one (see ② in Fig. 7.211).

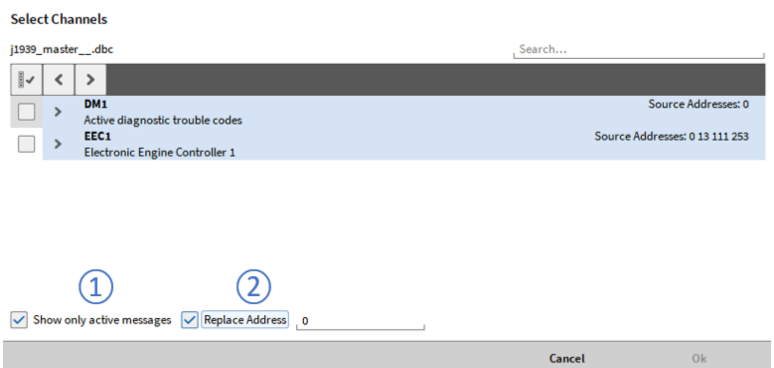


Fig. 7.211: Channel picker for SAE J1939 messages and signals

7.7.4 CAN-OUT - transmitting OXYGEN data via CAN

Note: This is an optional feature and requires a license.

It is possible to transmit OXYGEN channels cyclically over the CAN bus. This functionality is supported by all CAN ports available on the different TRION boards and also by the Vector VN series CAN ports. For transmitting CAN data, it is either possible to load a dedicated dbc file or to define the CAN messages and signals individually by using the CAN editor. To transmit OXYGEN data over CAN, the CAN message Mode must be set to Transmit (see 1 in Fig. 7.212) for that.

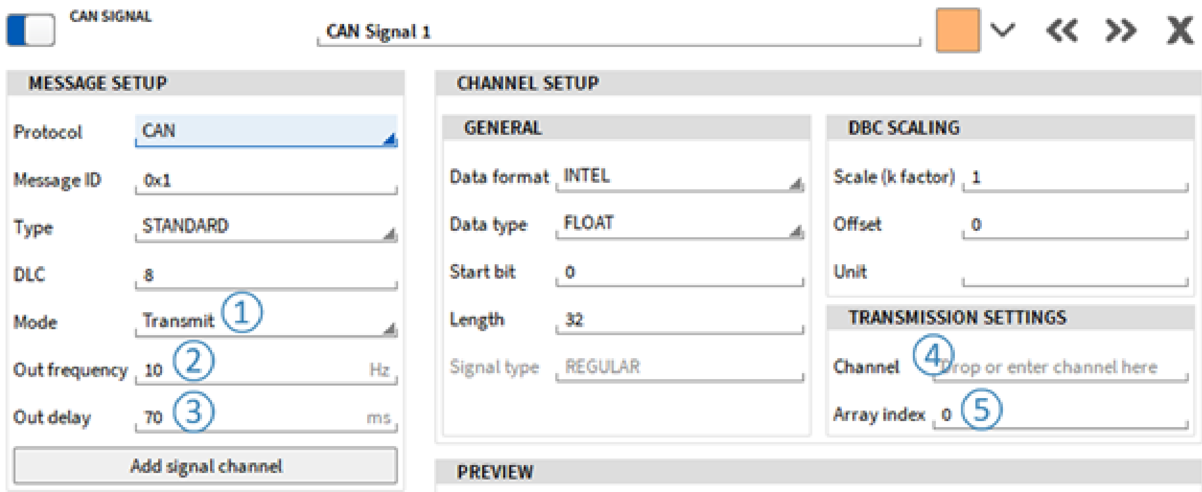


Fig. 7.212: CAN output settings

The output rate can be defined from 0.1 … 100 Hz (see 2 in Fig. 7.212) individually for each message. The output delay can be set from 1 … 500 ms (see 3 in Fig. 7.212). One dedicated OXYGEN scalar time domain channel (i.e. Analog or Digital input, power value such as Active power or another CAN channel) can be assigned to one CAN signal by dropping the channel or typing its name into the Channel section of Transmission settings (see 4 in Fig. 7.212).

It is also possible to output dedicated elements of an array channels (such as harmonics from a power group) over CAN. To do so drop the array channel in to the Channel section (see 4 in Fig. 7.212) of the Transmission Settings and enter the index of the array elements that shall be output in Array index (see 5 in Fig. 7.212). As an example: If the second harmonics of a voltage channel shall be output over CAN, type in the harmonics channel name in the Channel section, i.e. *U1_hRMS@POWER/0* and enter the index 1 in the Array index section (see Fig. 7.213).

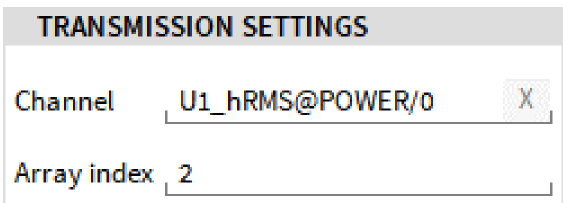


Fig. 7.213: Outputting arrays elements over CAN

Note that the preview will not show the currently transmitted data but has no functionality when the message mode is Transmit.

The Autonomous Resend option (see ① in Fig. 7.214) provides the following functionality for CAN buses which transmit data:

- False (Default): The transceiver only sends the data once no matter if the receiver send an acknowledgement or not and sends the next message right afterwards. This makes the CAN da-ta transmission more deterministic on a correctly terminated CAN bus. But there is a remaining risk that a messages gets lost.
- True: The risk of losing messages during transmission is low as message is resend in case no acknowledgement is sent by the receiver. But the risk of colliding messages of several transceivers is higher.

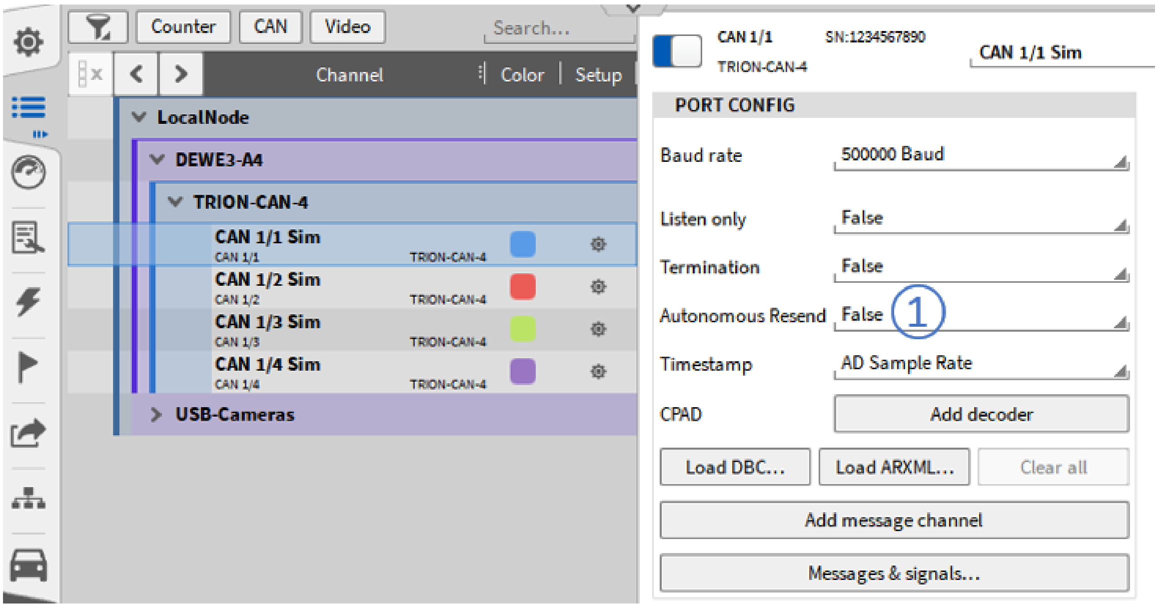


Fig. 7.214: Autonomous resend option

To tune the responsiveness and the signal quality of the transmitted data, we introduced the Out delay (see ③ in Fig. 7.212). This is the time, which the data is delayed before sent. The following graphs show the difference between two individual settings:

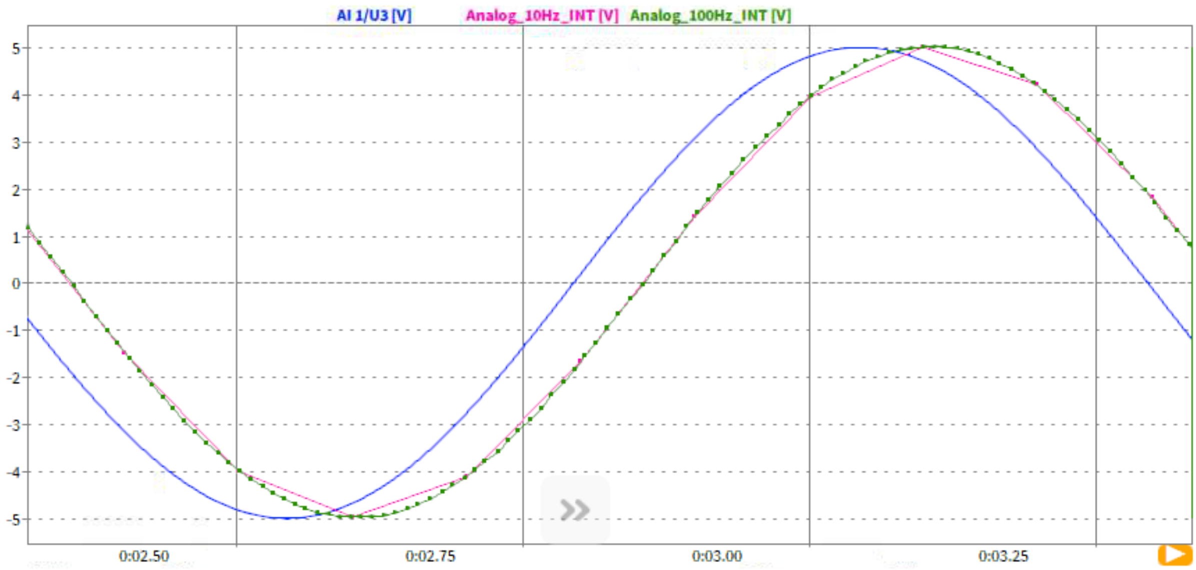


Fig. 7.215: Blue: Analog Input; Green: CAN-Output with a delay of 70 ms (default value)

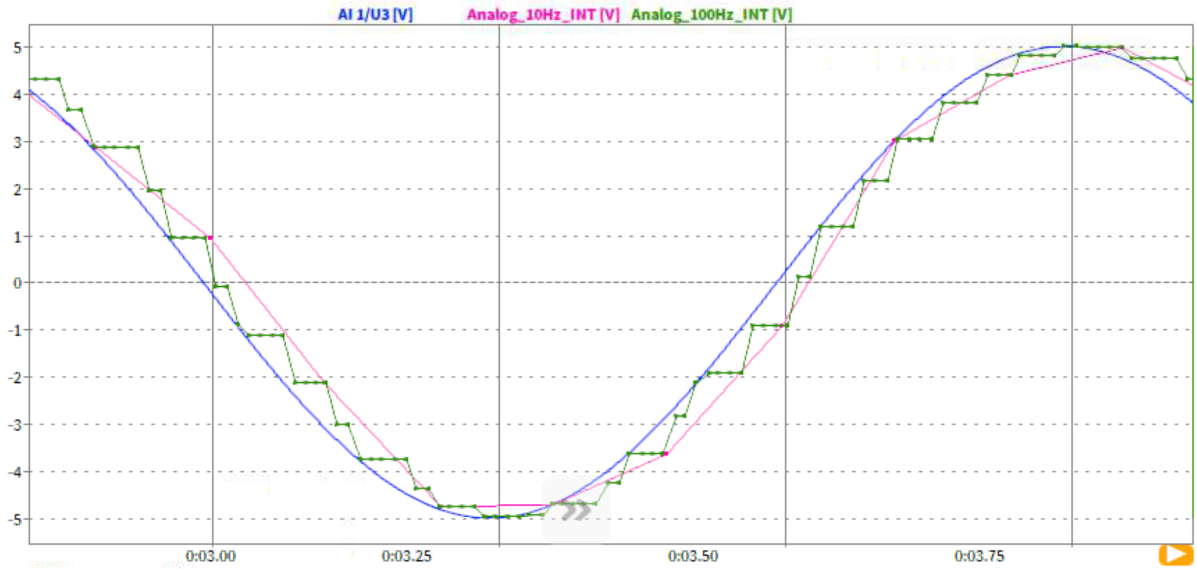


Fig. 7.216: Blue: Analog Input; Green: CAN-Output with a delay of 10ms

It is visible that a sample is repeated in case the delay is too low and no updated data is available yet.

Note:

- Message and Signal Encoding

  The signals are encoded with the data type and length defined in the dbc-file or in the CAN sig-nal setup. If the channel has a value higher (or lower) than the possible range, the max (or min) value will be transferred. Make sure, you selected the right range and resolution for the specific channel not to lose information.

- No channel assigned to a signal: the value 0 (Zero) is transmitted

- Channel data is NaN: NaN is transmitted in case of float or double, 0 is transmitted in all other cases

7.8 GPS channels

The following GPS data channels can be acquired by a TRION-TIMING or TRION-VGPS-20/-100 module:

Table 7.40: Available GPS channels

Default channel name	Channel mode	Channel description	Range	Unit	Data type	Scaling available
GPS	NMEA	GPS NMEA channel	•	•	String	x
Latitude_GPS	Latidtude	Current latitude of the object	-90° … 90°	°	Double	✓
Longitude_GPS	Longitude	Current longitude of the object	-180° … 180°	°	Double	✓
Altitude_GPS	Altitude	Current altitude of the object	-100 m … 1000 m	m	Double	✓
Velocity_GPS	Velocity	Current velocity of the object	0 km/h … 300 km/h	km/h	Double	✓
Heading_GPS	Direction	Current heading of the object	0° … 360°	°	Double	✓
Satellites_GPS	Sat	Number of satellites in view	0 … 24	•	Double	x
Fix Quality_GPS	Quality	GPS Fix	•	•	String	x
H.Dilution_GPS	HDOP	2D deviation of longitude and latitude	0 m … 100 m	m	Double	✓

continues on next page

Table 7.40 – continued from previous page

Default channel name	Channel mode	Channel description	Range	Unit	Data type	Scaling available
SoD_GPS	Second	Current second of the day	0 s … 86400 s	m	Double	x
Date_GPS	Date	Current date in the format yyy-mm-dd hh:mm:ss:ms	•	•	String	x
Acceleration_GPS	Acceleration	Current acceleration of the object	-1000 m/s²… 1000 m/s² …	m/s²	Double	✓
Distance_GPS	Distance	Distance covered from start of measurement	0 m … 1000000 m	m	Double	✓

Table 7.41: GPS channel type

Default channel name	Acquired from TRION hardware	Calculated channel	Calculation
GPS	✓	x	•
Latitude_GPS	✓	x	•
Longitude_GPS	✓	x	•
Altitude_GPS	✓	x	•
Velocity_GPS	✓	x	•
Heading_GPS	✓	x	•
Satellites_GPS	✓	x	•
Fix Quality_GPS	✓	x	•
H. Dilution_GPS	✓	x	•
SoD_GPS	✓	x	•
Date_GPS	✓	x	•
Acceleration_GPS	x	✓	Differentiation of channel Velocity_GPS
Distance_GPS	x	✓	Integration of channel Velocity_GPS

Note:

- The ranges of the channels are defined per default and have the purpose to define a min/max value if the channels are displayed in an Instrument. The ranges are neither minimum nor maximum limits. Thus, the defined ranges can be overrun and underrun without "clipping".
- Channels of data type *double* with physical unit can optionally be scaled (see ⑰ in Fig. 7.2). This option might be used for changing the physical channel unit from (kilo)meters to miles or km/h to mph.
- Channels of data type *double* can be assigned to mathematical formulas (see *Formula channel*) or statistics calculations (see *Statistics channel*).

- GPS channels cannot be filtered (see *IIR Filter channel*) as these channels are asynchronous channels.
- During the measurement it might happen that the *GPS Fix Quality* is not *fix* all the time (i.e. GPS connection is lost during a ride through a tunnel). If this happens, the last value of the GPS channels will be hold until the *GPS Fix Quality* will be *fix* again and a new value is received.
- If the *GPS Fix Quality* is not *fix* for more than 60 seconds, the calculated channels *Acceleration_GPS* and *Distance_GPS* will change to *NaN* until the *GPS Fix Quality* is *fix* again.
- The *GPS Fix Quality* is *fix* if the channel receives 1 (GPS fix), 2 (Differential GPS fix), 3 (PPS fix), 4 (Real Time Kinematic) or 5 (Float RTK). The *GPS Fix Quality* is not *fix* if the channel receives 0 (Fix not available), 6 (Estimated (dead reckoning)), 7 (Manual input more) or 8 (Simulation mode)

The individual channels can be assigned to the following Instruments:

Table 7.42: GPS channels - compatible instruments

Default Channel Name	GPS plot	Analog Meter Digital Meter Bar Meter Indicator	Recorder Chart Recorder	Table	Scope	XY plot
GPS*	x	x	x	✓	x	x
Latitude_GPS	✓	✓	✓	✓	✓	✓
Longitude_GPS	✓	✓	✓	✓	✓	✓
Altitude_GPS	x	✓	✓	✓	✓	✓
Velocity_GPS	x	✓	✓	✓	✓	✓
Heading_GPS	✓	✓	✓	✓	✓	✓
Satellites_GPS	x	✓	✓	✓	✓	✓
Fix Quality_GPS	x	x	x	x	x	x
H.Dilution_GPS	x	✓	✓	✓	✓	✓
SoD_GPS	x	✓	✓	✓	✓	✓
Date_GPS	x	x	x	x	x	x
Acceleration_GPS	x	✓	✓	✓	✓	✓
Distance_GPS	x	✓	✓	✓	✓	✓

*The channel *GPS* can be dragged and dropped directly from the Channel List to the measurement screen. If this is performed, the current value of the channels *Latitude*, *Longitude*, *Altitude*, *Velocity*, *Heading*, *Satellites used*, *Quality* and *Dilution* will be displayed (see Fig. 7.217).

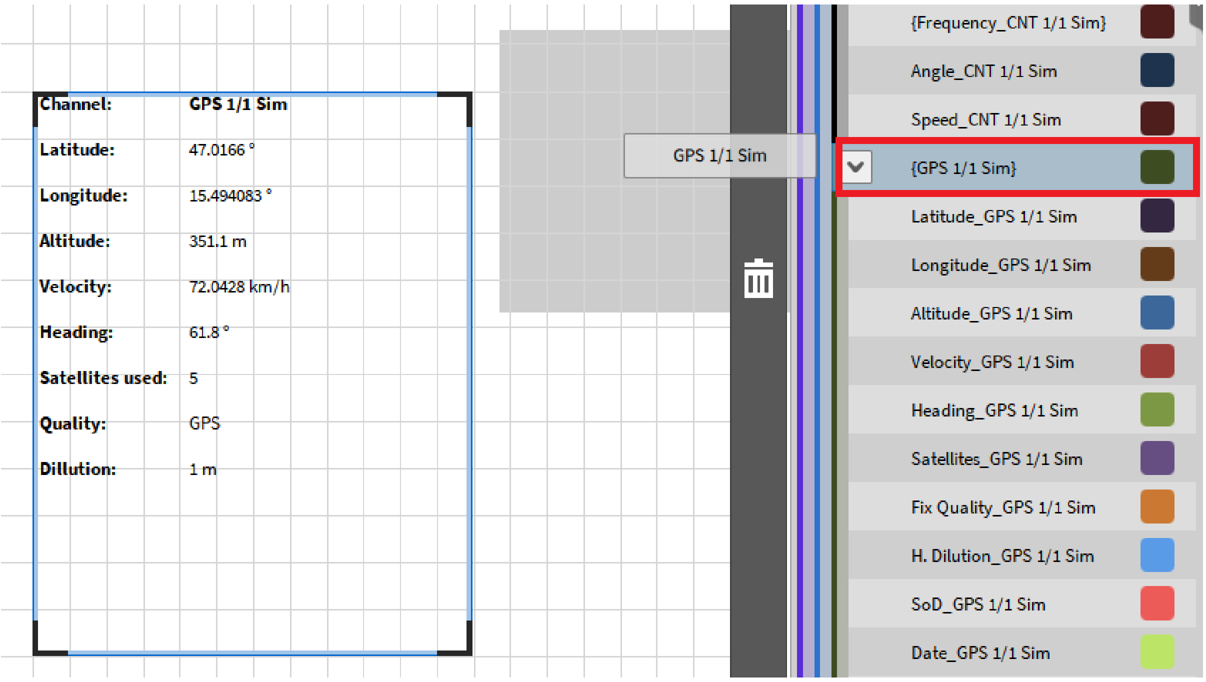


Fig. 7.217: Drag and drop the GPS channel to the measurement screen

Note: During GPS-channel analysis in *PLAY* mode, the GPS channels can also be exported to *.txt, *.csv, *.mdf4 or *.mat format (see *Export Settings*). Please note that GPS-Channels of data type *String* can only be exported to *.txt or *.csv format as the data type is not supported for *.mdf4 and *.mat format.

7.9 TEDS support

TEDS stands for Transducer Electronic Datasheet and is used to identify and apply settings from a sensor directly without manually entering them. The following TRION(3) modules support TEDS:

- TRION(3)-18xx-MULTI
- TRION-2402-MULTI
- TRION-2402-dACC[1]

[1]TEDS functionality only supported in IEPE® mode.

7.9.1 Use in OXYGEN

If a sensor with TEDS interface is connected to an according TRION(3) module, the TEDS interface is automatically detected and the settings are applied to the channel.

To scan for a TEDS interface, also on multiple channels, there is a button Scan TEDS on the lower edge of the channel list menu, seen in Fig. 7.218. Whenever the full channel list menu is open, the scan for TEDS is done continuously and a manual scan is not necessary when the sensor is changed. This is not the case for the TRION-2402-dACC, where the scan must be done with the button in order to scan for TEDS.

It is also possible to disable the TEDS detection by choosing one or multiple channels in the channel list and clicking on the button Disable TEDS, also seen in Fig. 7.218. After disabling the TEDS detection, all set settings from the TEDS are deleted and can be entered manually.

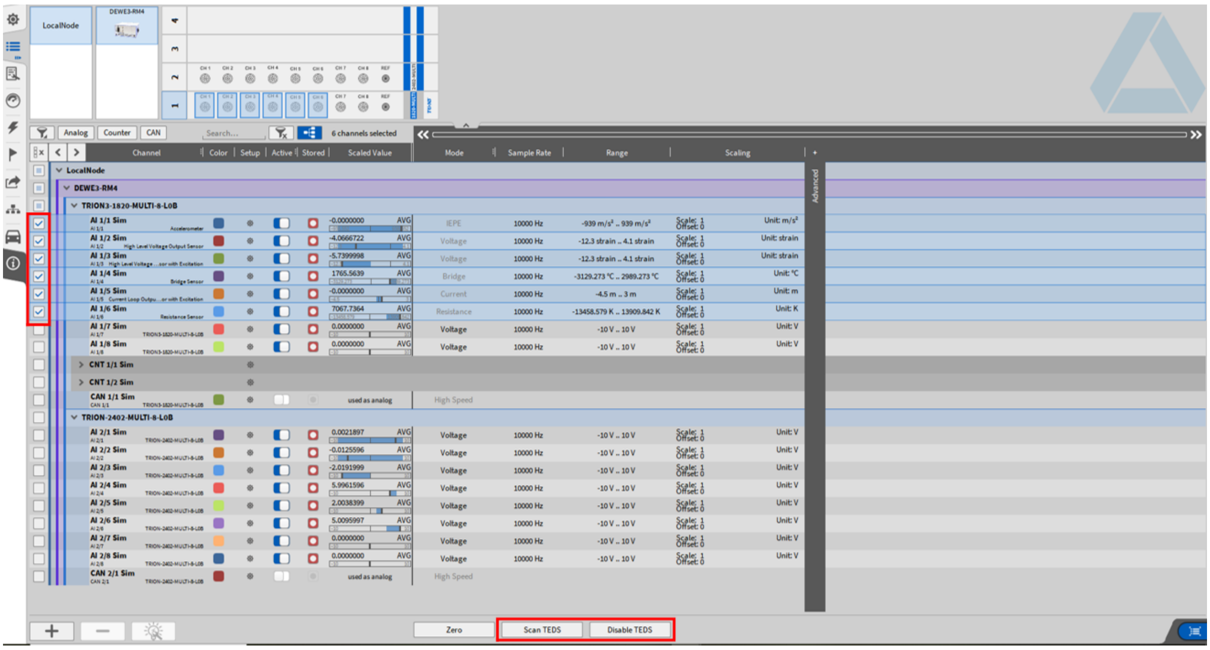


Fig. 7.218: Channel List Menu and TEDS scanning

A detailed channel setting can be seen in Fig. 7.219. Depending on the type of sensor some settings might vary. The settings from the TEDS can be seen here and some settings can be adjusted manually, like the range. By clicking on the shown TEDS serial number, marked red in Fig. 7.219, all the TEDS information and settings can be seen (see blue frame in Fig. 7.219).

By clicking on “Editor” (see green circle in Fig. 7.219) the TEDS editor can be opened (see green frame) which offers the possibility to edit the stored data on the TEDS chip. It is possible to choose between a set of templates (see ① in Fig. 7.219) or to change the information stored on the TEDS chip manually (see ② in Fig. 7.219). When all changes are finished the information can be written to the TEDS chip, by clicking on “Write to TEDS” (see purple circle in Fig. 7.219). A window will pop up which asks for confirmation that the data should be written to the TEDS chip.

Note: If the changes will be stored on the TEDS chip, the existing data on the TEDS chip gets lost.

The following TEDS chips are supported: - DS2406 - DS2430A - DS2431 - DS2432 - DS2433

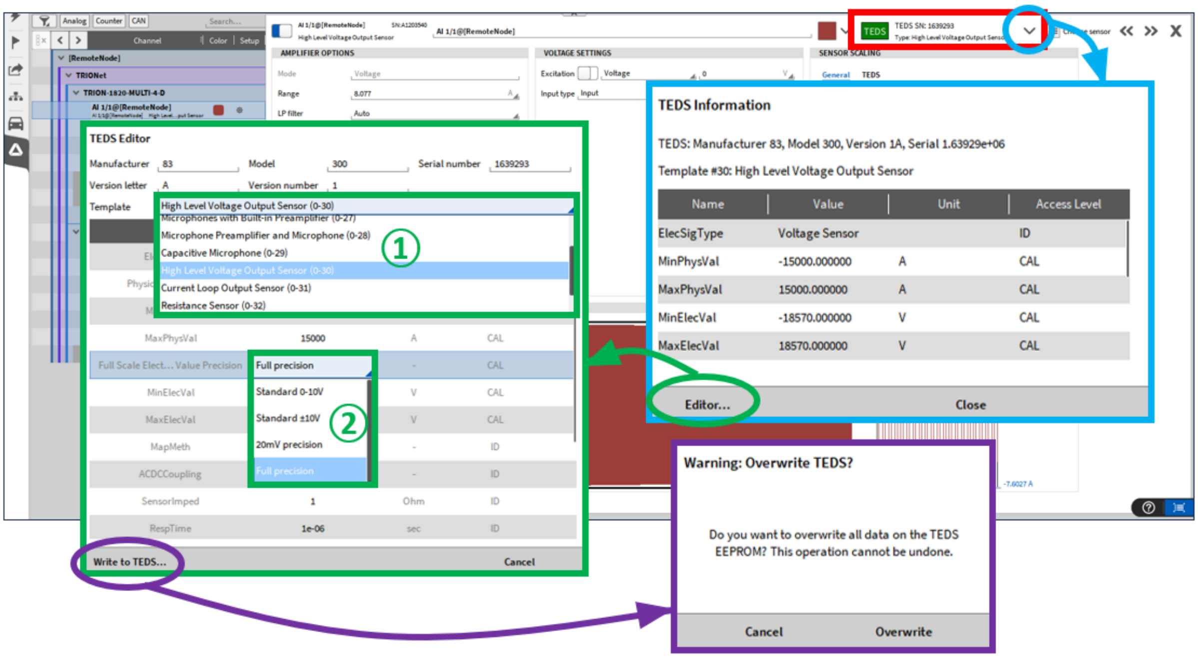


Fig. 7.219: Detailed Channel Settings with TEDS interface and TEDS editor

To prevent the TEDS data from being overwritten by mistake, the function for writing TEDS chips is deactivated by default. To activate the function, go to the Advanced settings in the *OXYGEN Setup* and activate the corresponding checkbox "Enable TEDS editor" (see Fig. 7.220).

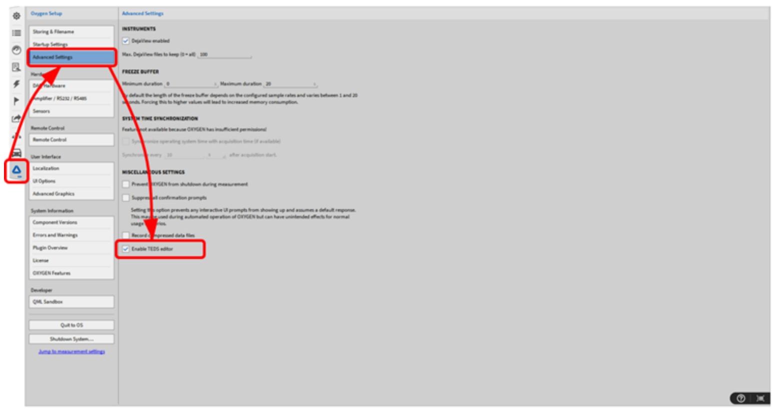


Fig. 7.220: Activation for writing data to TEDS

More information about the set scaling can be found in the *Sensor Scaling* section by switching to the TEDS tab. This cannot be changed and is only for information for the user. However, it is possible to add an additional scaling in the General tab, which will be used additionally to the already set scaling from the TEDS.

More information about the set scaling can be found in the *Sensor Scaling* section by switching to the TEDS tab. The current scaling will be written in grey and cannot be changed directly and is only for information for the user. To change the scaling information it is possible to perform a 2-point scaling (for detailed information see "Changing the 2-point-scaling" in *Changing the channel settings*) and write it to the TEDS chip by clicking "Write to TEDS in the scaling section of the channel settings (see Fig. 7.221).

Note: If the changes are stored on the TEDS chip, the existing data on the TEDS chip gets lost. However, it is possible to add an additional scaling in the *General* tab, which will be used additionally to the already set scaling from the TEDS.

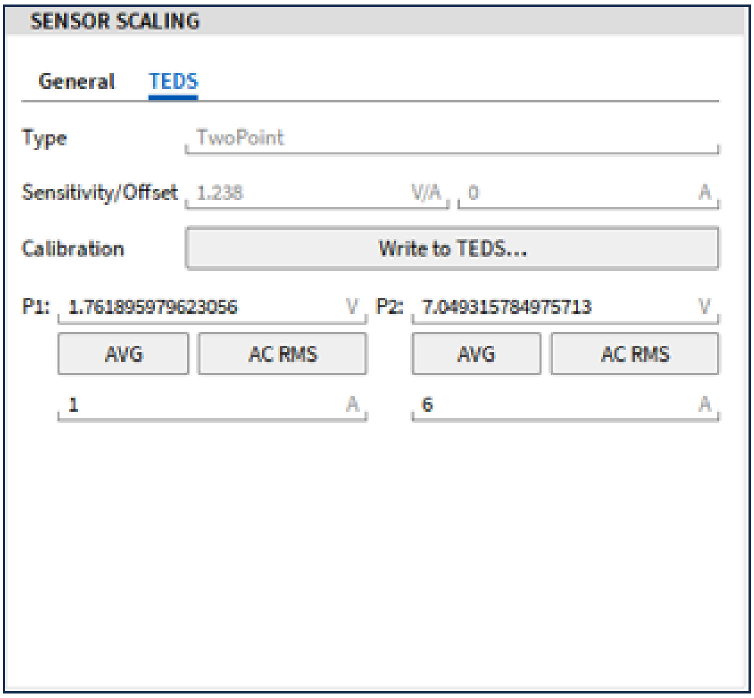


Fig. 7.221: Sensor Scaling Information: TEDS

TEDS detection can also be disabled in the detailed settings by clicking on the green TEDS button (marked green in Fig. 7.219). This button has different colors depending on the state, which will be explained here:

-  TEDS active; sensor was detected and is in use.
-  TEDS active; no sensor was detected.
-  TEDS active; sensor was detected but is not compatible, remove the sensor or disable TEDS.

  This case is also shown in the channel list:

-  TEDS active, sensor lost and not detected anymore
-  TEDS disabled

7.9.2 Loading a setup

When loading a setup, OXYGEN automatically checks the if the same TEDS can be detected on the current system. If there is a mismatch in the TEDS detection, this specific channel or rather TEDS type is marked red. If a new sensor is detected, the new detected TEDS will be marked red, seen in Fig. 7.222 and the new settings of the sensor can be applied by clicking on Apply of the pop-up window. Otherwise, the remapping must be cleared and the channels, on which the settings should be applied, must be remapped manually, seen in Fig. 7.223. If a sensor from the setup file is missing and is not detected when loading the file, the TEDS type will show the message missing, seen in Fig. 7.224.

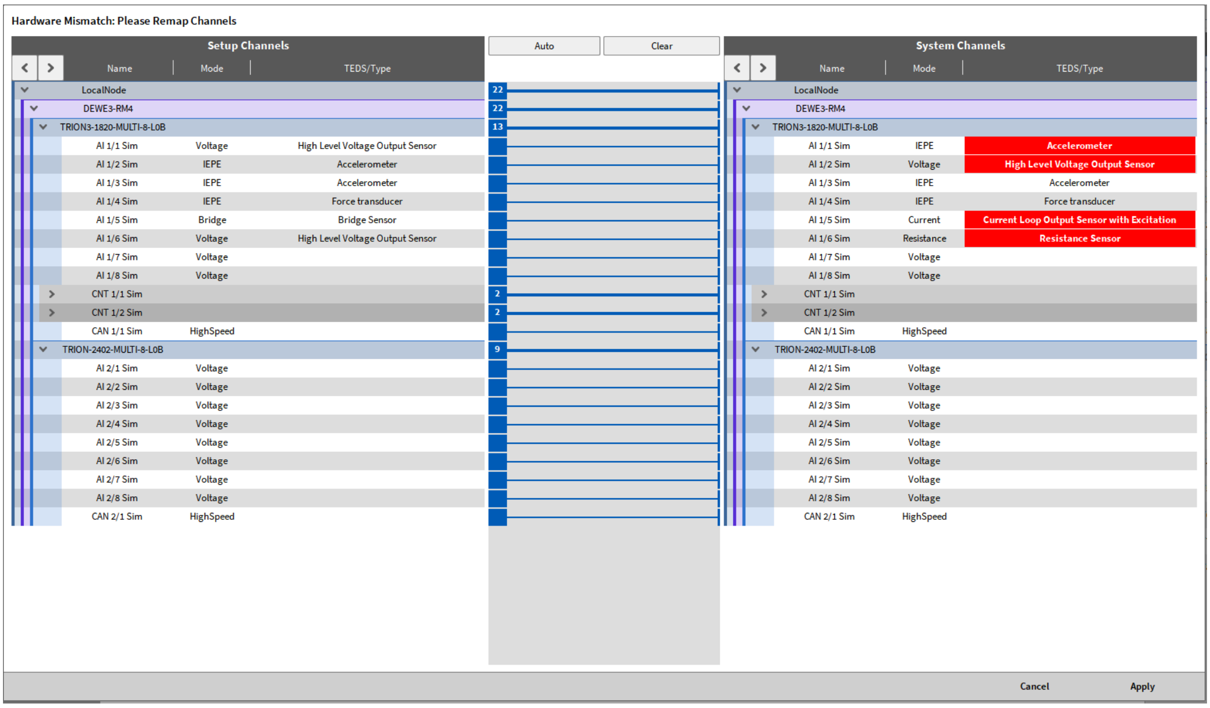


Fig. 7.222: Hardware mismatch: different TEDS were detected

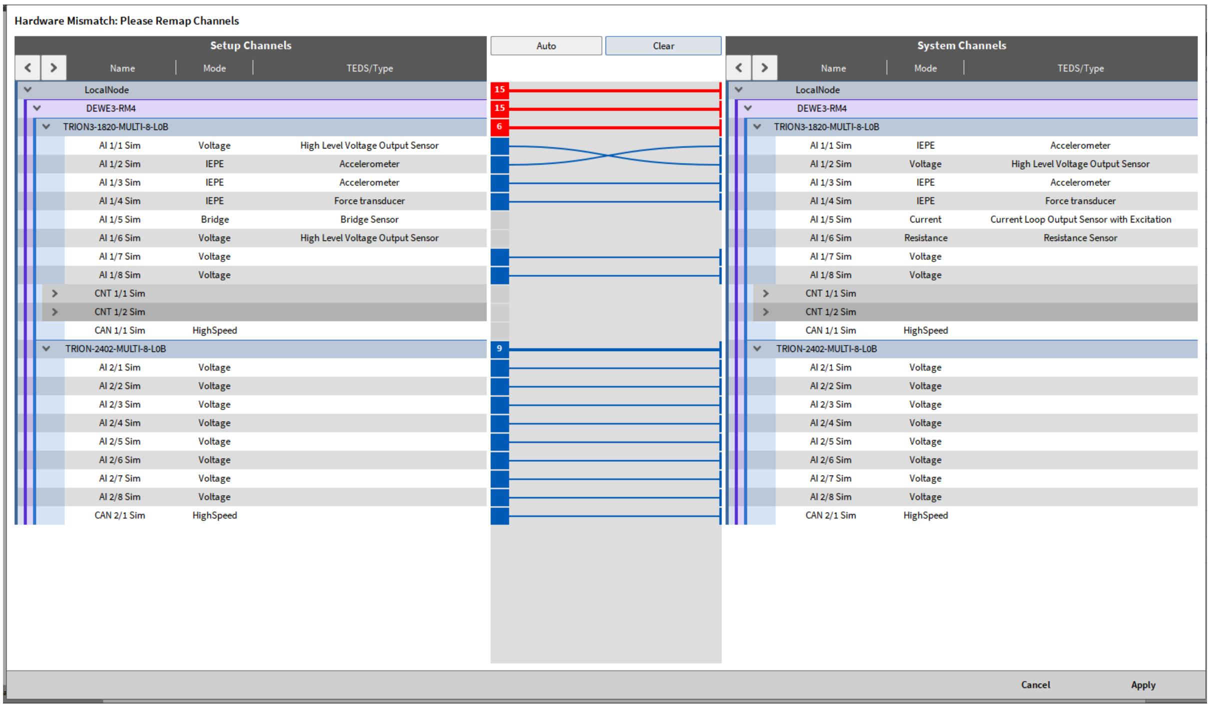


Fig. 7.223: Hardware mismatch: manual remapping of TEDS

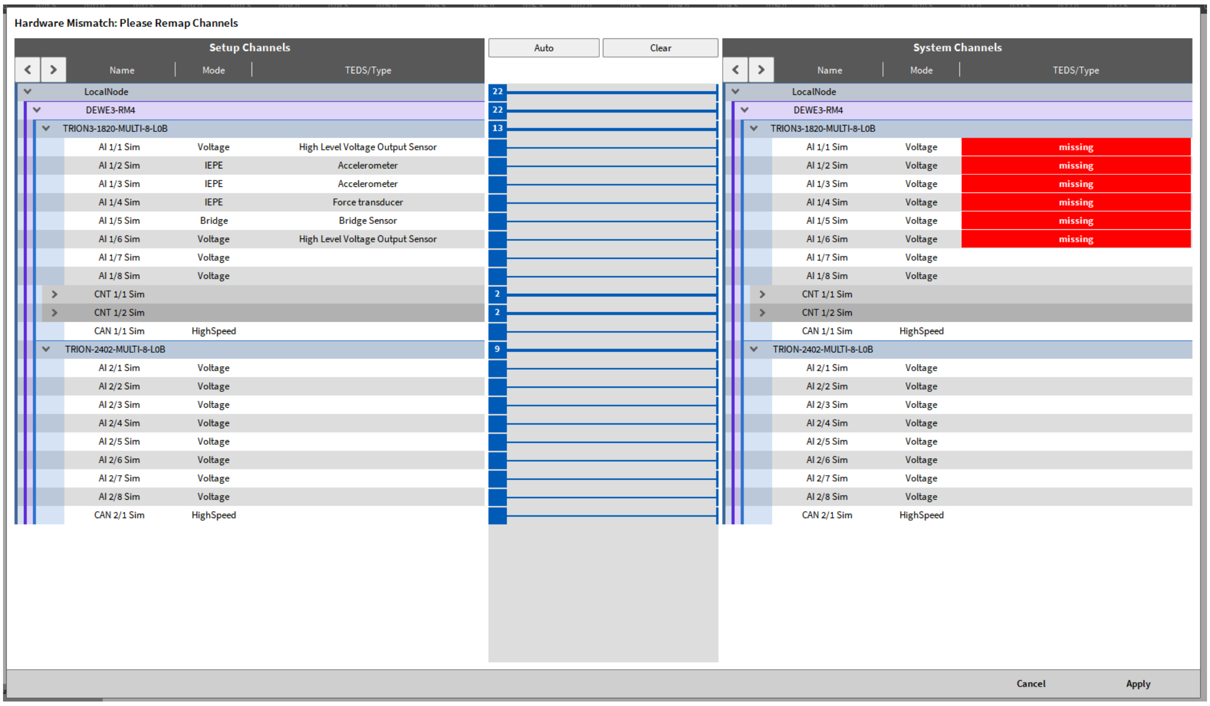


Fig. 7.224: Hardware mismatch: missing TEDS in loaded setup file

CHAPTER

EIGHT

INSTRUMENTS AND INSTRUMENT PROPERTIES

8.1 Adding an instrument to the measurement screen and channel assignment

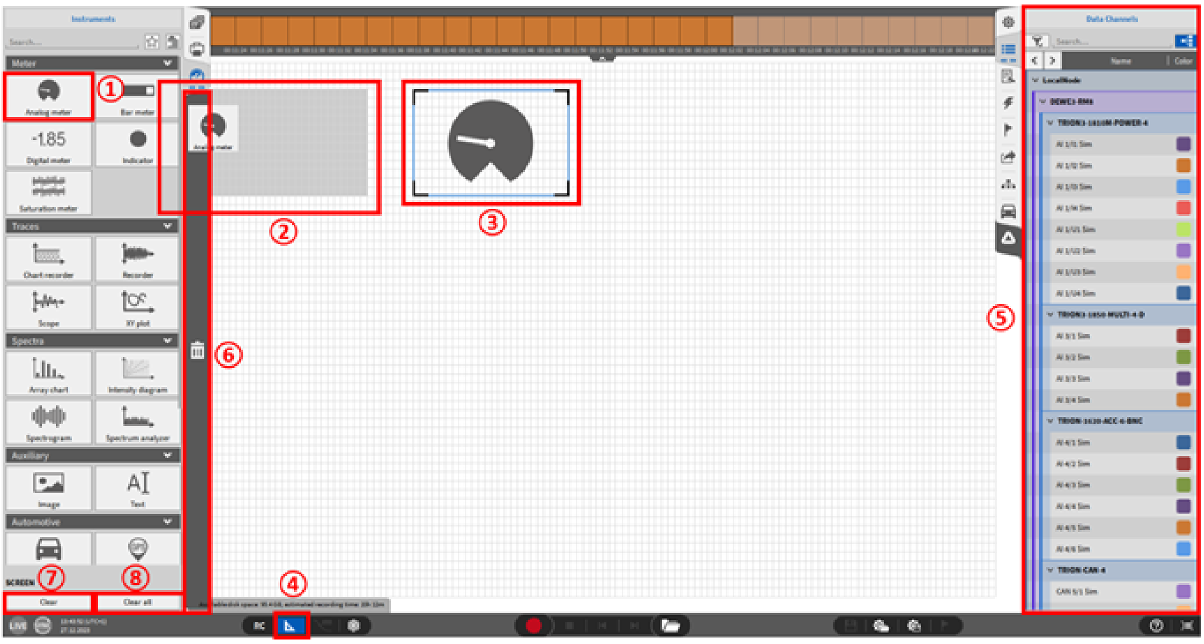


Fig. 8.1: Adding Instruments to the measurement screen

To add an Instrument to the measurement screen, the user must click on the *Instruments* menu and open it while a measurement screen is open. Select the desired Instrument by clicking on it (①), move it to the measurement screen by keeping the mouse button pressed (②) and place it wherever you like by releasing the mouse button (③). In the example of Fig. 8.1, an Analog meter is added to the measurement screen. The Instruments are aligned to the grey grid in the screen background. The *Design* mode is automatically activated when an Instrument is added to the measurement screen. The user can see that the *Design* mode is activated because of the blue background of the *Design* mode button (④) and because of the grey grid in the background of the measurement screen.

In the *Design* mode, the user can now change the size of the Instrument by moving the black corners of the Instrument or change the position of the Instrument by grabbing it at the blue frame.

Instrument properties – Channels tab

In the "Channel" tab, the selected data channels can be rearranged by drag and dropped. This changes the order in the label.

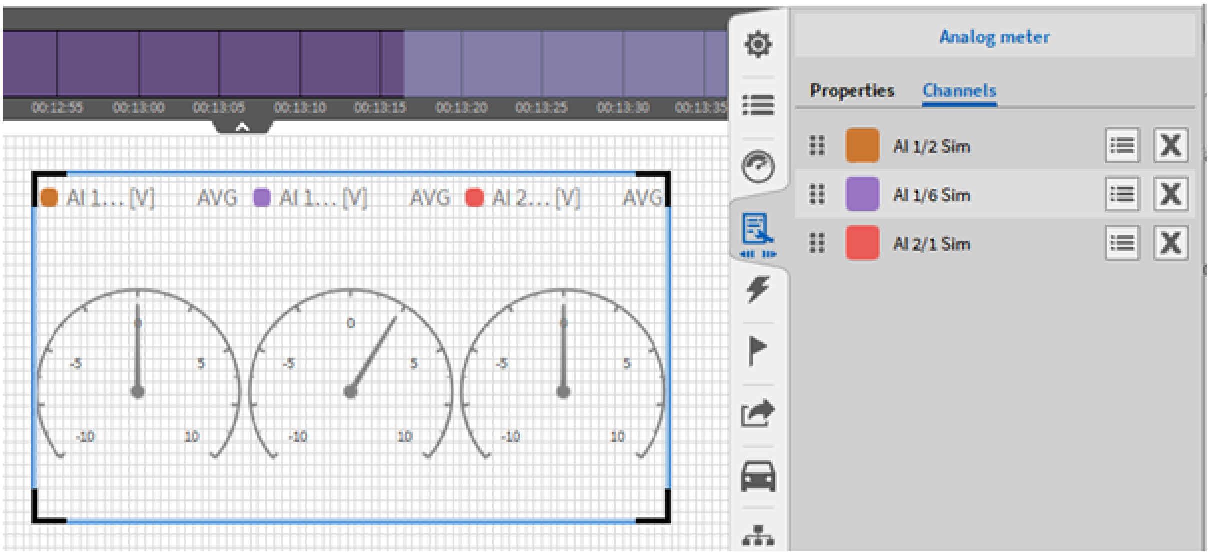


Fig. 8.2: Instrument properties - Channels tab

Deactivated channels are displayed in {} brackets and remain assigned to the instrument.

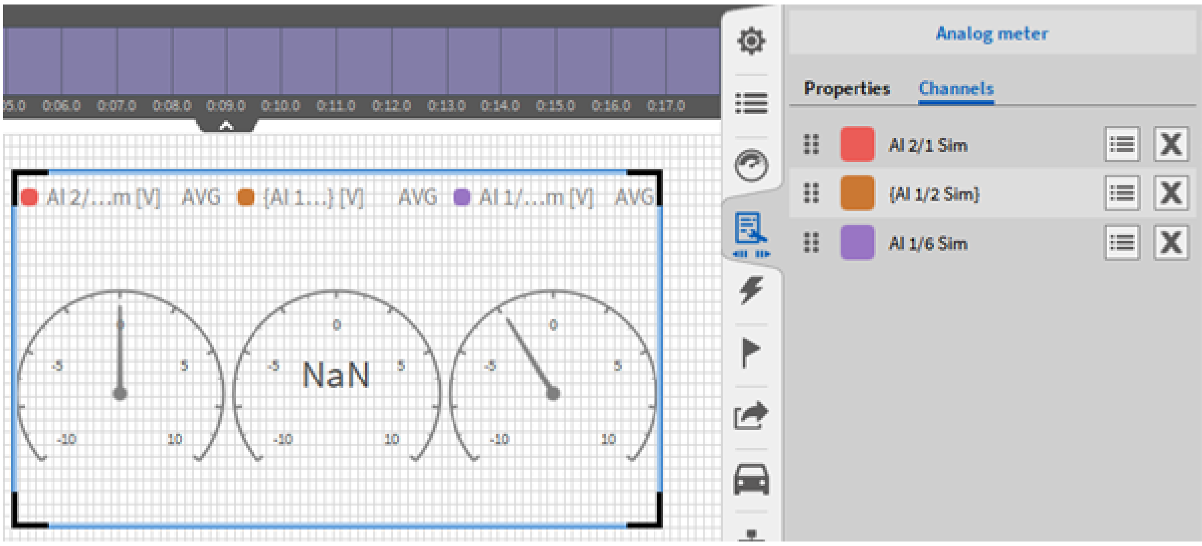


Fig. 8.3: Instrument properties - Channels tab, deactivated channels

Note:

- Several Instruments on the screen can be selected by drawing a selection rectangular with the left mouse button like it is known from Windows Explorer or similar (see Fig. 8.4) or by keeping **CTRL+SHIFT** pressed while selecting the Instruments. All Instruments on a measurement screen can be selected by pressing **CTRL+A**.

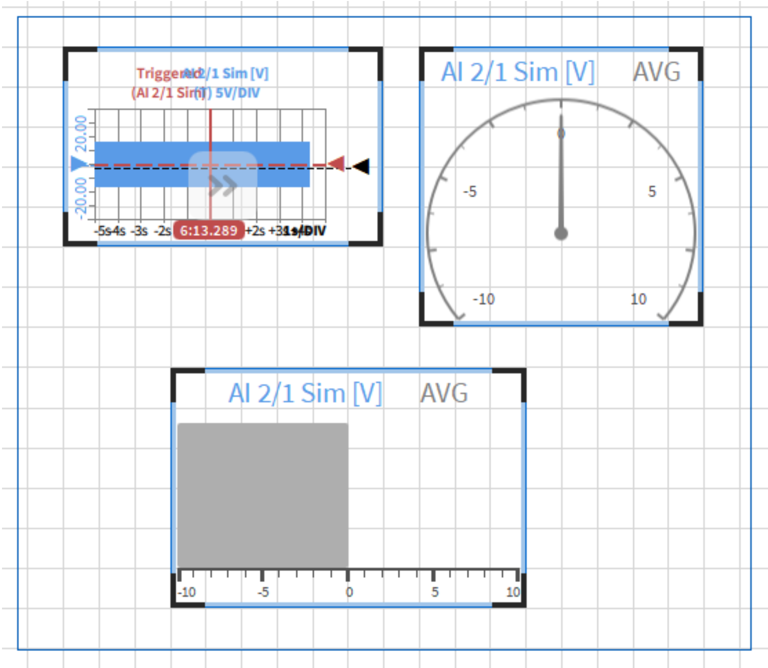


Fig. 8.4: Selection of several Instruments in the Design Mode

- It is possible to activate the *Design* mode in the *LIVE* mode as well as in the *REC* mode and in the *PLAY* mode.

To assign a data channel to an Instrument, the user can select the desired channel in the *Data Channel* menu (⑤) by just clicking on it when the respective Instrument is selected in the measurement screen.

The functionality and properties of the individual Instruments will be explained in the following sections in detail.

As explained above, the user can add and modify the instruments on the measurement screen when the *Design* mode is activated. The user can also delete Instruments from the screen by selecting them and clicking on the rubbish bin (⑥) next to the Instruments menu or by grabbing the respective Instrument and move it to the rubbish bin or by selecting the Instrument and pressing the **DEL**-key. To exit the *Design* mode again, the user must click on the *Design mode* button and the grey grid on the background of the measurement screen will disappear. The *Clear* button (⑦) will erase all Instruments from the currently displayed measurement screen. The *Clear All* button (⑧) will erase all Instruments from all measurement screens.

Note: Pressing the Clear and the Clear all button can NOT be reverted.

Adding a whole board to an instrument via drag'n'drop instead of single channels

To add an entire measurement map to an instrument, the instrument must be placed on the measurement screen and then the map outline must be dragged into the instrument.

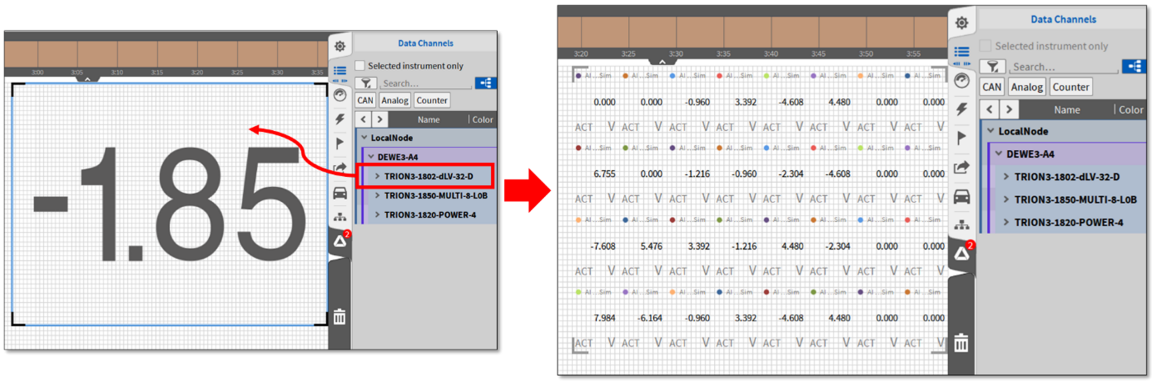


Fig. 8.5: Drag and drop of whole measurement board into Instrument

8.2 Analog meter

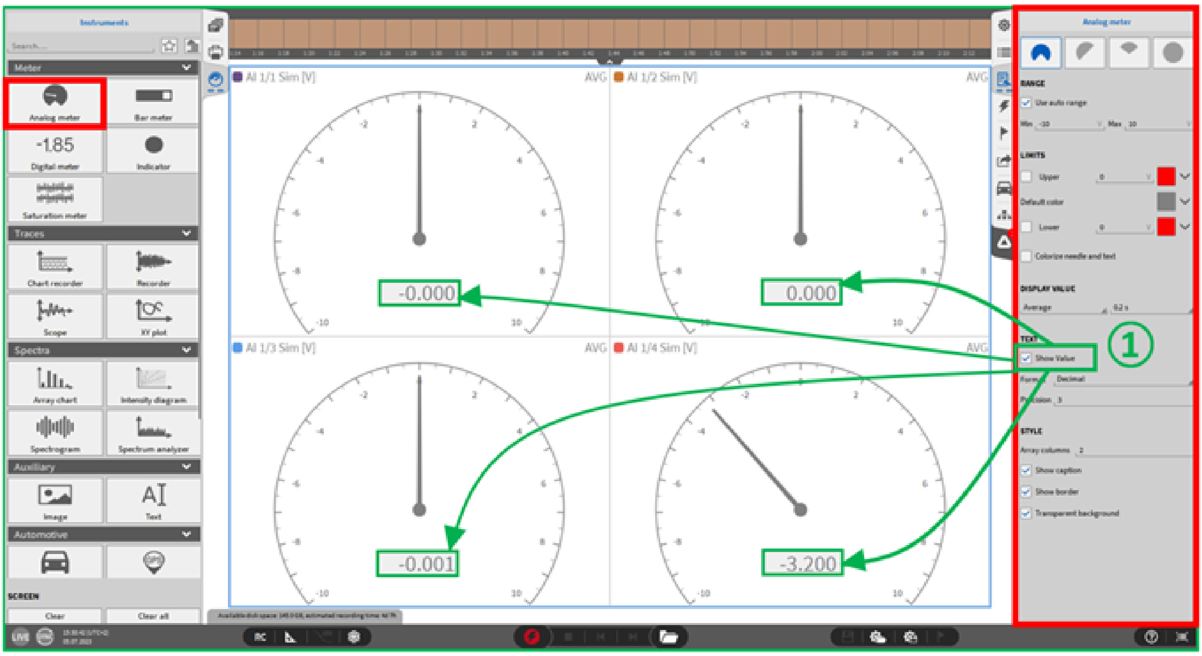


Fig. 8.6: Analog meter - Overview

The Analog meter can be set up in quite a few different ways. The screen capture to the right shows the various customizable Instrument Properties for this display and they are as follows:

- Four different visualization options for the indicator:

Fig. 8.7: Analog meter - visualization options

- Range settings: The user has the options of using auto range or a user defined range.
- Limits: Allows users to color the dial based on different limit values. The user also has the option to colorize the indicators needle which helps in identifying signals which have hit a limit. This is illustrated in the screen capture.
- Display value: The Instruments displays either the actual channel value or the Average, RMS, ACRMS, Min, Max or Peak2Peak value at a user defined time interval of 0.1 s, 0.25 s, 0.5 s, 1.0 s, Delay, Sat (saturation).
- Show value: If the checkbox for “Show value” is activated (see ① in Fig. 8.6), the value is additionally shown in digital form in the analog display.
- Style: The user can specify the number of columns for an Analog meter cluster if several channels are selected. Selection of a transparent or untransparent background.
- Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*).

Note: Up to 96 channels can be assigned to one single Analog Meter.

8.3 Digital meter

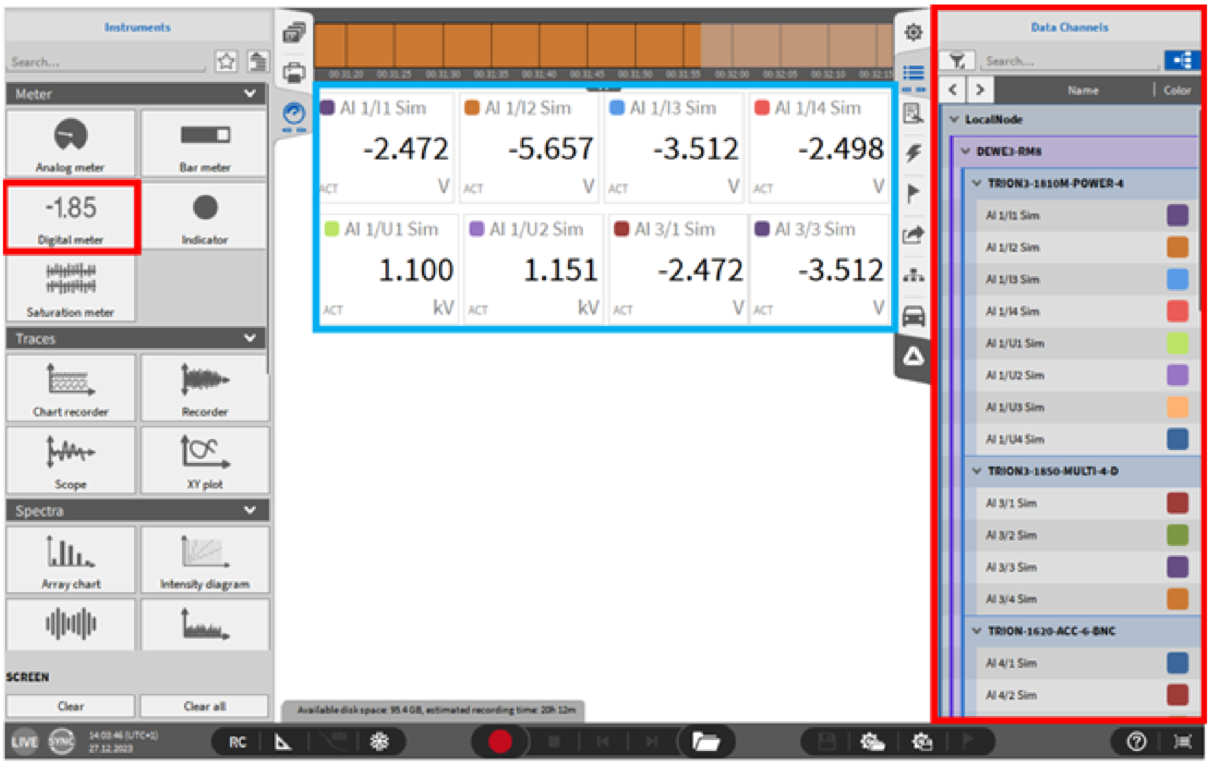


Fig. 8.8: Digital meter – overview

The Digital meter provides the user with the ability to definitively and quickly see what is going on with a measurement channel. This capability is further enhanced with the following list of features:

- Limits: Allows users to color the Digital meters' text based on different limit values. This really helps in identifying signals which have hit a limit when the display is very "busy". This is illustrated in Fig. 8.9. It is possible to define colors for upper and lower limit as well as a default color between the upper and lower limit. First, it is necessary to define a value for the limits (except of the default setting). Afterwards it is possible to define a color for the text and the background by pressing the button ① shown in Fig. 8.9. When pressing one of the buttons in ① for the respective limit a new window appears (② in Fig. 8.9). Here it is possible to define the color for the text itself as well as the color for the background. With the buttons "Default text color" and "Default background color" it is possible to go back to the default settings, with the button "Swap" it is possible to switch the setting of the text and the background. By pressing the "Ok" button the settings will be stored for the selected digital meter.

  For the background it is necessary to deactivate the "Transparent Background" option (③ in Fig. 8.9).

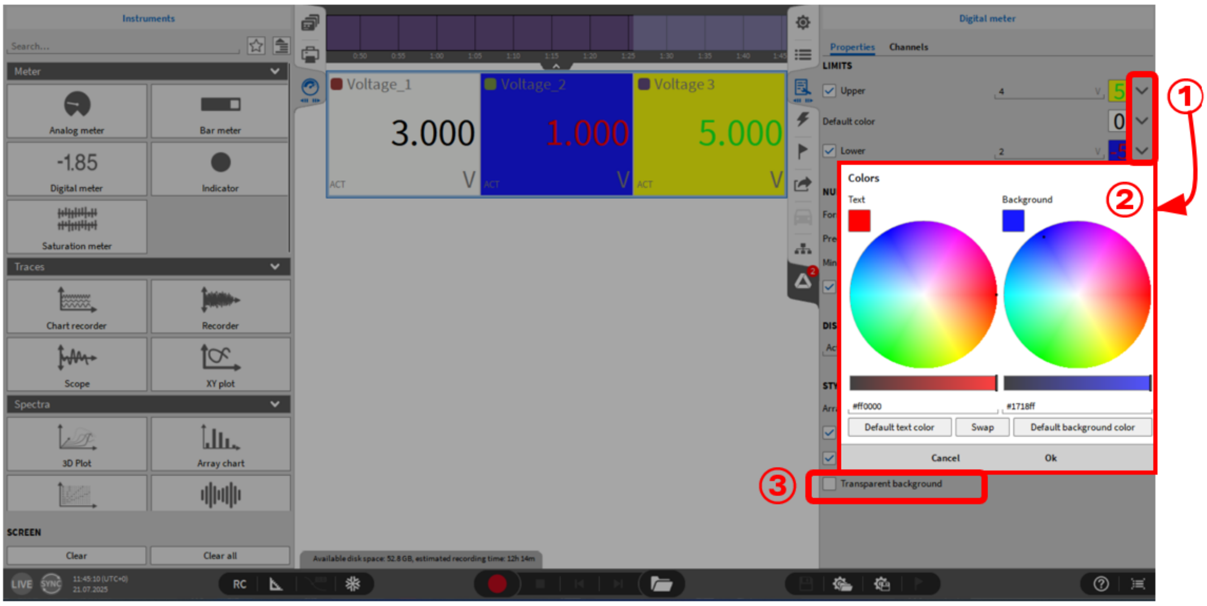


Fig. 8.9: Digital meter – Limits

- Number Format: This option gives the ability to either display the shown values in *Scientific* or *Decimal* format.
- Precision: Number of decimals right to the right of the comma can be entered here
- Minimum digits: Minimum number of digits can be entered here; If the measurement value exceeds the number of digits, it will be displayed anyway but the font size will be decreased
- Select suitable unit: a suitable unit prefix (i.e. milli or kilo) will be automatically selected if it makes sense in case this option is selected
- Display Value: The Instrument displays either the actual channel value or the Average, RMS, ACRMS, Min, Max or Peak2Peak value at a user defined time interval of 0.1 s, 0.25 s, 0.5 s, 1.0 s, Delay, Sat (saturation).
- Style: The user can specify the number of columns for a Digital meter cluster if several channels are selected. Selection of a transparent or untransparent background.
- Show border: A grey line is drawn between the single measurement channels in case this option is selected.

- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*).

Note: Up to 96 channels can be assigned to one single Digital Meter.

8.4 Recorder

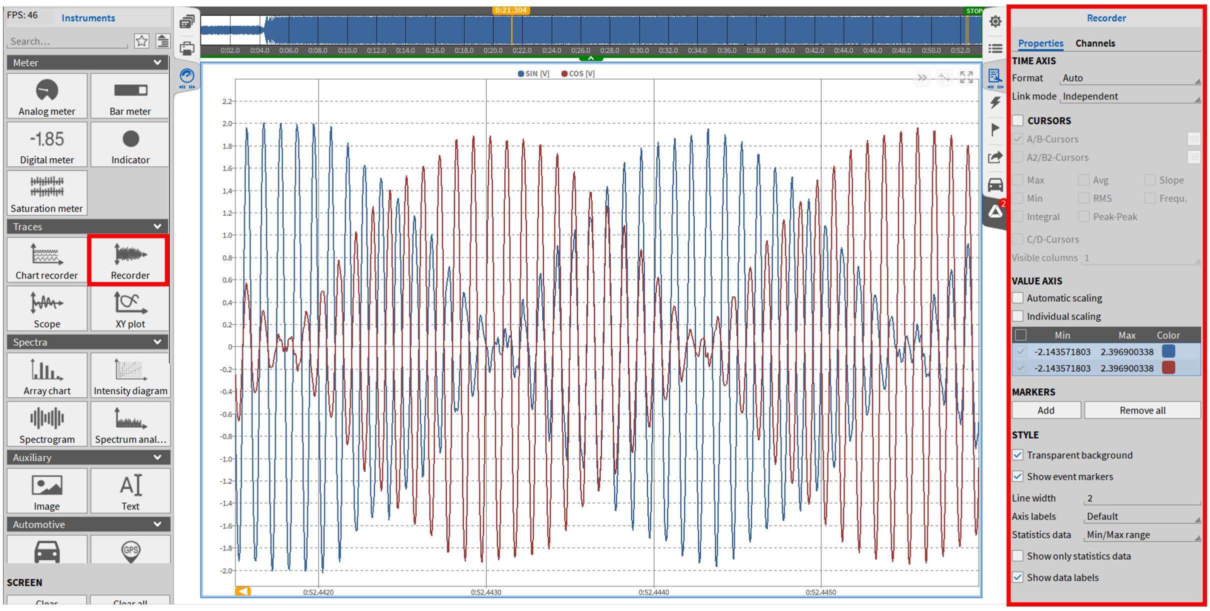


Fig. 8.10: Recorder - Overview

This Instrument replicates the functionality of a strip chart recorder in combination with many additional features.

Note: Up to 40 channels can be assigned to one single Recorder.

8.4.1 Instrument properties

The following properties can be manipulated via the Instrument Properties menu:

- Time Axis: This property changes the format of the X-axis. The user can select between *Auto*, *Absolute time* and *Relative time*.
  - *Auto*: In Sync Mode, the Auto time format is the Absolute time, otherwise the Auto time format is the Relative time
  - *Absolute time*: The unit of the X-axis is the actual time of day set in the OS settings
  - *Relative time*: The unit of the X-axis is the relative time starting with 0:00 for every new measurement

- Cursors: Select the individual parameters that are calculated when the cursors are used. For the detailed cursor description refer to section *Activate cursors*.
- Value Axis: This property allows the user to specify the range on the Y-axis.
  - When the option *Individual Scaling* is selected, the scaling can be changed individually per channel and each channel will have an own Y-axis. If it is deselected, all channels will have one common Y-axis. For further scaling details, please refer to *Quick selection Y-axis scaling*.
  - If *Automatic Scaling* is selected, the Y-axis will always be adjusted to the actual displayed data.
- Markers: Add up to 10 markers or remove all set markers at once. This option is only available in PLAY or Freeze mode. The markers behave similarly to the *Markers*.
- Style: The following properties can be adjusted:
  - Enable/disable transparent background
  - Show/hide event markers
  - Adjust the line width
  - Change the granularity of the time axis scaling via Axis labels
  - Show only statistics data will solely display statistical data. The type of statistical data to be visualized can be selected via Statistics data. To display statistical data, enable statistics within the menu *Triggered Events* – tab *Recording Mode* – section *Statistics*.
  - Show data labels hides/displays permanent data labels in PLAY mode
  - Layer (only applicable in Design Mode): Moves the Instrument in front of or behind another object

8.4.2 Labels

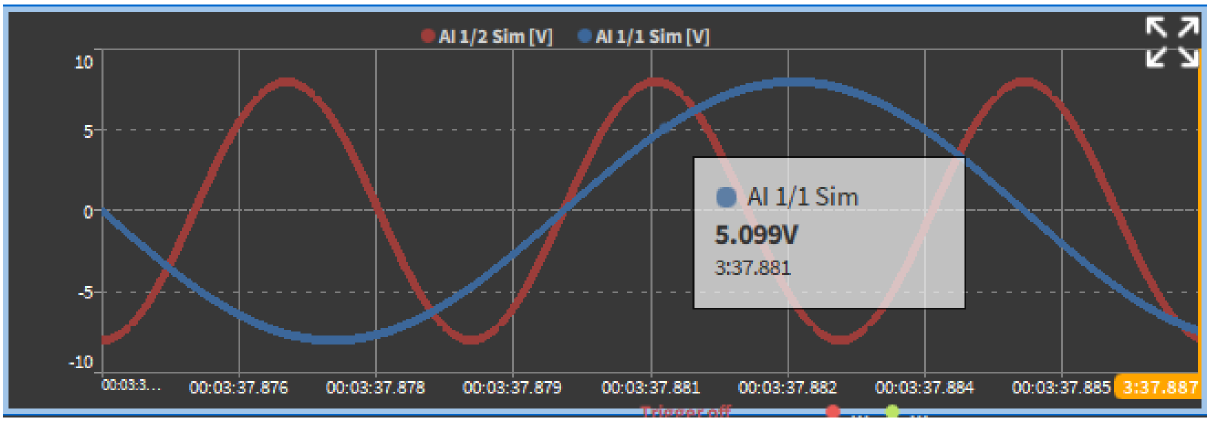


Fig. 8.11: Mouse-over information

To show data labels the Data Labels (see Measurement screen) button must be active.

- In LIVE mode, labels appear only when the Freeze function is active and the user hovers over a data point.

- In PLAY mode, clicking a data point will permanently display its label. Each permanent label can be individually positioned and removed. By unticking the Show data labels option in the instrument properties, permanent labels can be hidden. Disabling this option prevents labels from being displayed in the recorder but does not delete them.

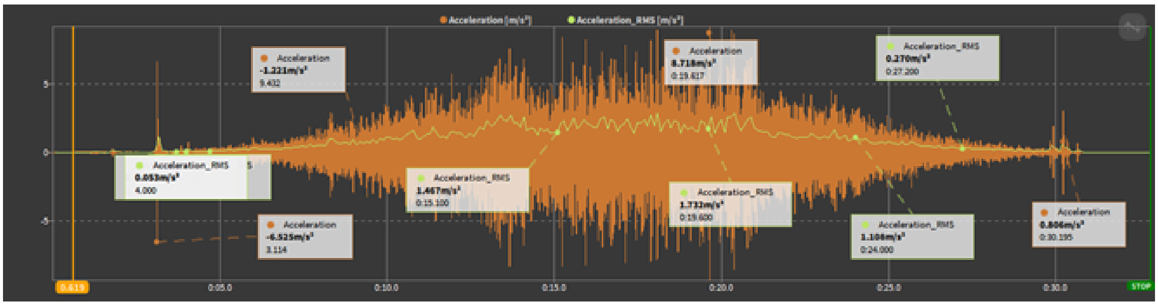


Fig. 8.12: Permanent labels in PLAY mode

8.4.3 Linking the time axis of several recorders

It is possible to link the time axis of several adjacent Recorders, the time axis of all Recorders on one page or it is possible to define Recorder groups which can also be linked over several measurement screens. This simplifies time zooming operations with several Recorders tremendously. This can be selected in the Link mode dropdown menu available in the Instrument properties (see Fig. 8.13) and must be selected for each Recorder separately.

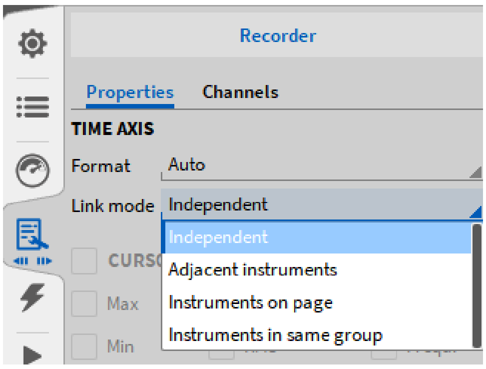


Fig. 8.13: Recorder link mode

When "Instruments in same group" is selected as Link Mode, there will be added an additional property to define a link group. It is possible to define any number of groups, see Fig. 8.14.

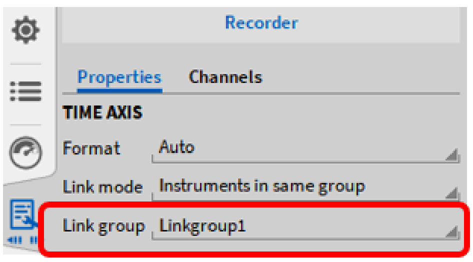


Fig. 8.14: Recorder link groups

The selected link mode is denoted in the lower left side of each Recorder: "Pag" for *Instruments on Page* and "Lnk" of *Adjacent Recorders*. If the link mode is set to Instruments on page "Pag", the AB cursors are also linked for all instruments on the page.

8.4.4 Additional properties

To use further functionality of this instrument, the *Design* mode must be left. The following additional features are available:

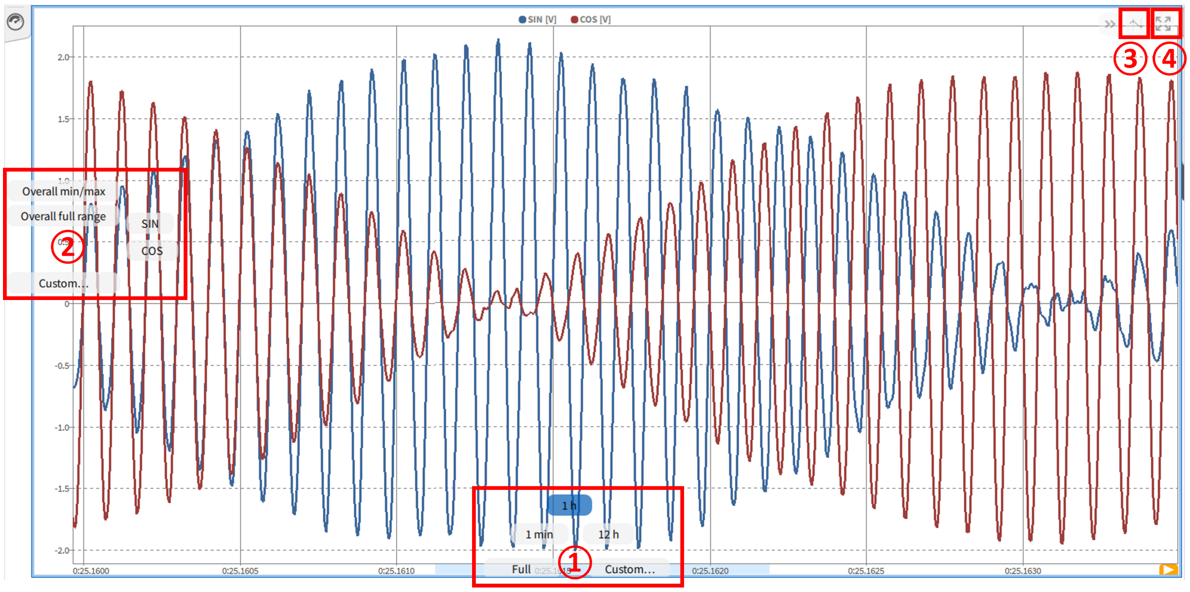


Fig. 8.15: Additional features of the Recorder

1. *Quick selection X-axis scaling*
2. *Quick selection Y-axis scaling*
3. *Activate cursors*
4. *Quick expansion button*
5. *Pinch/Scroll zoom feature* (mousewheel or right mouse button)

Quick selection X-axis scaling

This property menu appears via left click or touch and hold the X-axis of the recorder. By dragging your clicked mouse cursor or your finger into one of these menu fields and releasing you will select a new range setup. The user can select the following options:

- Full: Sets the time axis of the recorder to the total elapsed recording time

Note: By one right click on the X-axis, the total elapsed recording time will be displayed as well.

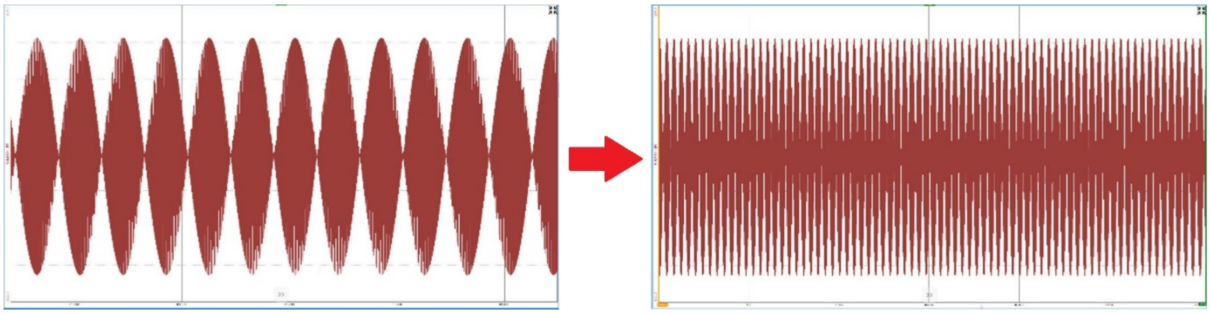


Fig. 8.16: Changing the X-axis scaling to the full time with one right click

- 1 min: Sets the time axis of the recorder to a one-minute window of the current recording time
- 1 h: Sets the time axis of the recorder to a one-hour window of the current recording time
- 12 h: Sets the time axis of the recorder to a twelve-hour window of the current recording time. If your current recording duration is below twelve hours, you will see negative time within your recorder if *Relative time* is selected in the *Time Axis* properties.
- Custom: Possibility to select an individual time window:

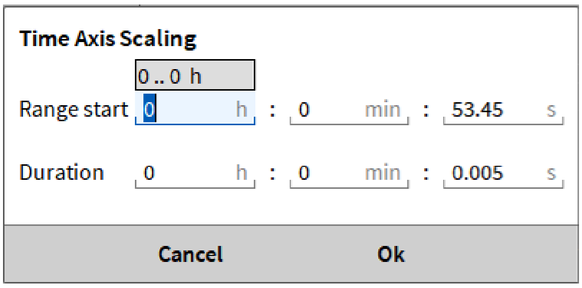


Fig. 8.17: Window to define a customized X-axis scaling

Useful shortcuts

- Scrolling with the mouse wheel will zoom into the X-axis
- Pressing the **Shift** key while scroll zooming will accelerate your zooming speed
- Right clicking and dragging across the Recorder will allow the user to zoom into a specific region of the recorder (only available during recording or in *freeze* mode)
- Performing a single right click will un-zoom the users Recorder instrument one step at a time

Quick selection Y-axis scaling

This property menu appears via left click or touch and hold the Y-axis of the recorder. By dragging your clicked mouse cursor or your finger into one of these menu fields and releasing, you will select a new range setup. The user can select the following options:

- Overall min/max: Will set the range of all channels in the recorder to min/max value range of the highest signal amplitude displayed in the recorder
- Overall full range: Sets the range of all channels in the recorder to the specified range of the channel with the highest range settings.

Note: This Scaling option is also accessible by pressing the **CTRL** key and clicking on a channel name.

- Individual full range (Only available when *Individual scaling* is selected in the Instrument Properties): Sets the range of all channels assigned to the recorder to their individual full range values.
- Individual min/max (Only available when *Individual scaling* is selected in the Instrument Properties): Sets the range of all the channels assigned to the recorder to their own individual min/max values.
- A click on the individual channel name will only set the selected channel to its individual min/max value. This scaling option is also possible by clicking on the channel name on the Y-axis
- Custom: (Only available when *Individual scaling* is not selected in the Instrument Properties): Possibility to define a customized range for the Y-axis that will affect all plotted signals:

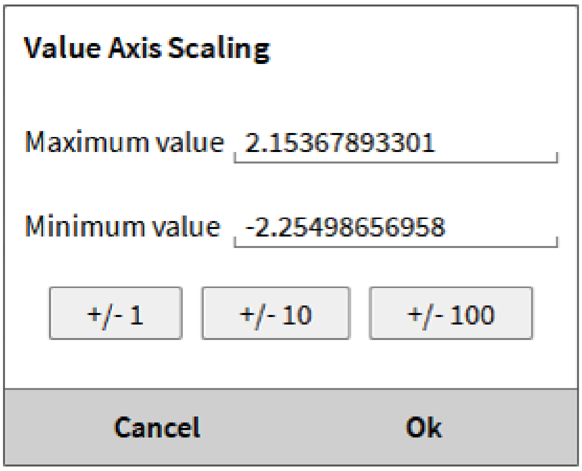


Fig. 8.18: Window to define a customized Y-axis scaling (Individual Scaling selected)

Example: Two channels are displayed in one Recorder. Channel 1 has a Signal Input Range of ±10 V and the range of the currently displayed data is ±8 V. Channel 2 has a Signal Input Range of ±3 V and the range of the currently displayed data is ±2 V.

- Clicking on *Overall min/max*: The scaling of both channels is set to ±8 V
- Clicking on *Overall full range*: The scaling of both channels is set to ±10 V.
- Clicking on *Individual full range*: The scaling of channel 1 is set to ±10 V and the scaling of channel 2 to is set to ±3 V
- Clicking on *Individual min/max*: The scaling of channel 1 is set to
- Clicking on the name of Channel 1
  - will set the scaling of Channel 1 to ±8 V and not affect the scaling of Channel 2 if *Individual scaling* is selected
  - will set the scaling of the Y-axis to ±8 V if *Individual scaling* is de-selected
- Clicking on the name of Channel 2
  - will set the scaling of Channel 2 to ±2 V and not affect the scaling of Channel 1 if *Individual scaling* is selected

– will set the scaling of the Y-axis to ±2 V if *Individual scaling* is de-selected

Note: When *Individual scaling* is selected, the *Custom* option will not be available by clicking on the Y-axis and keeping the mouse button pressed. To enter this pop-up window when *Individual scaling* is selected, click on the min/max value of the Y-axis scaling:

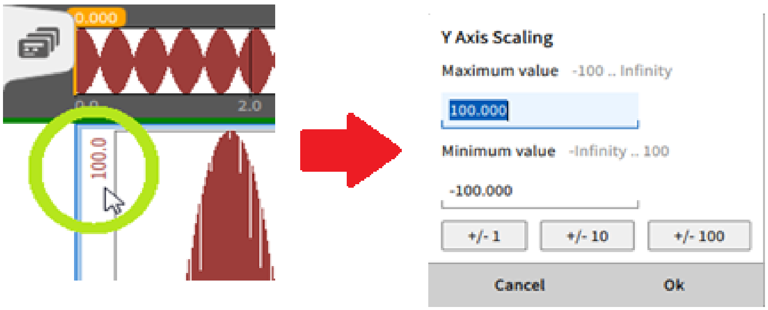


Fig. 8.19: Define a customized Y-axis scaling for one channel (Individual Scaling not selected)

If several channels are displayed and the scaling of all channels shall be set to the same range, click on the min/max scaling of one channel while keeping the **CTRL** key pressed and the scaling menu will appear as well. In this case the settings will be assigned to all displayed channels:

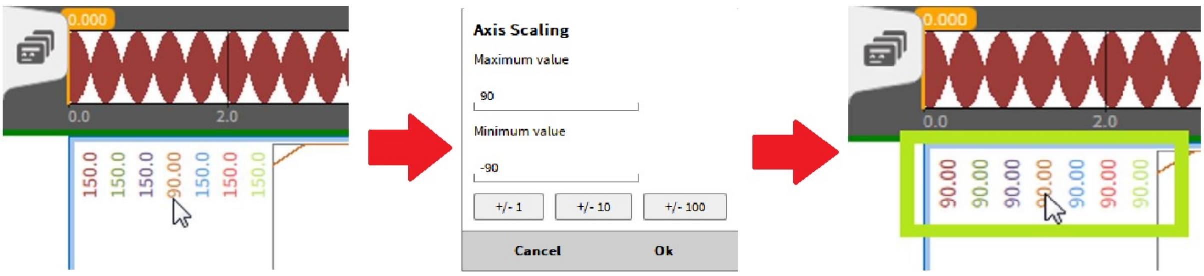


Fig. 8.20: Define a customized Y-axis scaling for all channels (individual scaling not selected)

Useful shortcuts

- Pressing the **CTRL** key while scrolling with the mouse wheel will zoom into the Y-axis.
- Pressing the **Shift** key while scroll zooming will accelerate your zooming speed
- Right clicking and dragging across the Recorder will allow the user to zoom into a specific region of the recorder (only available during recording or in *freeze* mode and if *Automatic Scaling* is *not* selected)
- Performing a single right click will un-zoom the users Recorder instrument one step at a time
- Right clicking on a channel along the Y-axis will set the channels' maximum and minimum value to the channels full range which is dictated in that channel's setup page

Activate cursors

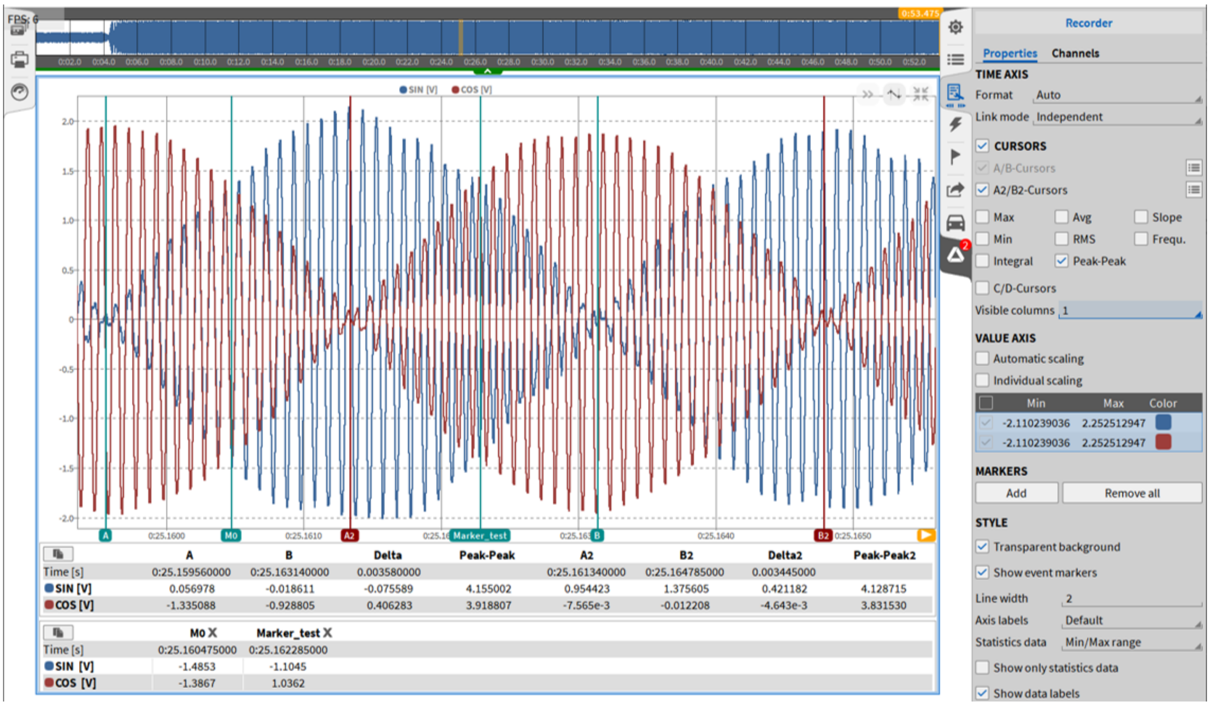


Fig. 8.21: Activated cursors - overview

The cursors can be activated in the upper right corner of the recorder. This option is only available in *PLAY* or *Freeze* mode. After the cursors are activated, 2 cursors *A* and *B* appear in the recorder window. It is also possible to add another AB-cursor pair (A2/B2). In addition, a table appears with the current position of the cursors, the corresponding signal value and the difference *Delta* between the cursor positions (see Fig. 8.21).

$$Delta = \text{Time}_{\text{CursorB}} - \text{Time}_{\text{CursorA}}\ [s]$$

The position of the cursors can be changed by moving them to the left and right. By holding SHIFT both A and B cursor can be moved simultaneously. By default, the cursor snaps to the sample points. When holding CTRL the cursor can be moved freely between samples.

Renaming the cursors

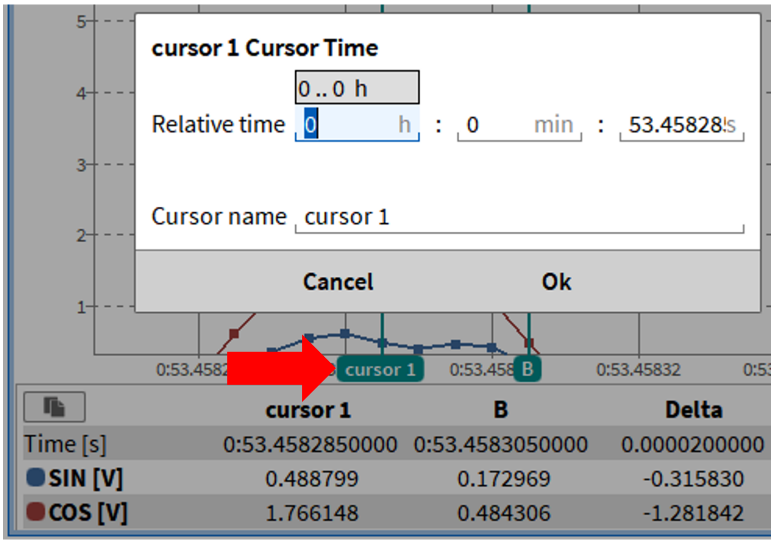


Fig. 8.22: Renaming the cursors

A click on the cursor name (see red arrow in Fig. 8.22) opens a popup with the possibility to enter a specific instant of time where the cursor shall be placed at and to change the *Cursor Name*. This applicable for cursor *A* and *B*. If several Recorders are used, the cursors of each Recorder can be renamed individually. If the cursors are deactivated and activated again, the individual names will be stored.

Measurement capabilities by using cursors

Additional information can be displayed in the table by selecting it in the *CURSORS* section in the Instrument Properties (see Fig. 8.21). The additional values are the following:

- Max: Displays the maximum signal level between cursor A and cursor B

$$\text{Max} = \text{Max}\left\{\text{Signal level}_i\right\}\ [\text{Unit}]$$

- Avg: Calculates the arithmetic mean value respecting the signal level from cursor A to cursor B according to the following formula:

$$\text{Mean} = \frac{1}{N}\sum_{i=1}^{N}\text{Signallevel}_i\ [\text{Unit}]$$

- Slope: Calculates the slope of the signal between cursor A and cursor B according to the following formula:

$$\text{Slope} = \frac{\text{Signal level}_{\text{CursorB}} - \text{Signal level}_{\text{CursorA}}}{\text{Delta}}\left[\frac{\text{Unit}}{s}\right]$$

- Min: Displays the minimum signal level between cursor A and cursor B

$$\text{Min} = \text{Min}\left\{\text{Signal level}_i\right\}\ [\text{Unit}]$$

- RMS: Calculates the quadratic mean value respecting the signal levels from cursor A to cursor B:

$$\text{RMS} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\text{Signal level}l_i)^2}\ [\text{Unit}]$$

- Peak-Peak: Calculates the difference between maximum and minimum signal level in range of cursor A to cursor B:

$$\text{Peak-Peak} = \text{Max}\{\text{Signal level}_i\} - \text{Min}\{\text{Signal level}_d\}$$

- Frequ.: This value is the reciprocal value of *Delta*.

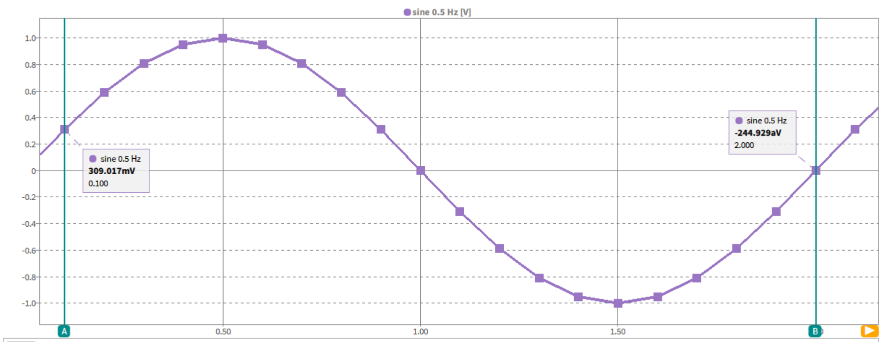
$$\text{Frequ.} = \frac{1}{\text{Delta}} \quad \left[\frac{1}{s} = \text{Hz}\right]$$

- Integral: Calculates the area within the Y-axis and the signal from cursor A to cursor B according to the following formula:

$$\text{Integral} = \ \text{Mean} * \text{Delta}\ [\text{Unit} * s]$$

- C/D-cursors: Adds two additional cursors that can be moved vertically (not available for a Chart Recorder). Holding shift will move both cursors simultaneously.
  - *TimeCursorA… Instant of time at position of cursor A*
  - *TimeCursorB… Instant of time at position of cursor B*
  - *Signal LevelCursorA…. Level of the signal at position of cursor A*
  - *Signal LevelCursorB…. Level of the signal at position of cursor B*
  - *Signal Leveli…. Signal level at position i between cursor A and B*
  - *i = 1…N*
  - *i = 1 =: Cursor A*
  - *i = N =: Cursor B*

The following example of a 0.5 Hz sine wave that was sampled with 10 Hz will demonstrate the calculations:



	A	B	Delta	Frequency	Slope [/s]	Min	Max	Avg	RMS	Integral [*s]	Peak-Peak
Time [s]	0.100000	2.000000	1.900000	526.3mHz							
sine 0.5 Hz	0.309017	-2.449e-16	-0.309017		-0.162641	-1.000000	1.000000	4.049e-17	0.707107	7.693e-17	2.000000

Fig. 8.23: 0.5 Hz sine wave in a Recorder; Cursor A @ 0.1s and cursor B @ 2.0 s

In table format, the signal looks as follows:

Table 8.1: 0.5 Hz sine wave sampled with 10 Hz in table format

i = 1…20; N = 20		Time [s]	Sine 0.5 Hz [V]
Cursor A	1	0.1	0.309017
	2	0.2	0.587785
	3	0.3	0.809017
	4	0.4	0.951057
	5	0.5	1.000000
	6	0.6	0.951057
	7	0.7	0.809017
	8	0.8	0.587785
	9	0.9	0.309017
	10	1.0	0.000000
	11	1.1	-0.309017
	12	1.2	-0.587785
	13	1.3	-0.809017
	14	1.4	-0.951057
	15	1.5	-1.000000
	16	1.6	-0.951057
	17	1.7	-0.809017
	18	1.8	-0.587785
	19	1.9	-0.309017
Cursor B	20	2.0	0.000000

In the following section, the values displayed with the cursors are calculated for this signal and can be compared with the OXYGEN results in Fig. 8.23.

- Delta:

$$\text{Delta} = \text{Time}_{\text{CursorB}} - \text{Time}_{\text{CursorA}} = 2.0s - 0.1s = 1.9s$$

- Max:

  The maximum value between cursor A and B is 1.0 V @0.5s

- Avg:

$$\text{AVG} = \frac{1}{N}\sum_{i=1}^{N} \text{Signallevel}_i =$$

$$\frac{1}{20} * (\text{ 0.309017 V + 0.587785 V + 0.809017 V + 0.951057 V + 1.000000 V + 0.951057 V + 0.809017 V + 0.587785}$$

- Slope:

$$\text{Slope} = \frac{\text{Signal level}_{\text{CursorB}} - \text{Signal level}_{\text{CursorA}}}{\text{Delta}} = \frac{0.000000\ V - 0.309017\ V}{1.9\ s} = -0.162640\ \frac{V}{s}$$

- Min:

  The minimum value between cursor A and B is 0.0 V @1.0s and 2.0s

- RMS:

$$\sqrt{\{\frac{1}{20}\sum_{1}^{20}}$$

$$[(0.309017\;V)^2 + (0.587785\;V)^2 + (0.809017\;V)^2 + (0.951057\;V)^2 + (1.000000\;V)^2 + (0.951057\;V)^2 + (0.8$$

- Frequ.:

$$\text{Frequ.} = \frac{1}{\text{Delta}} = \frac{1}{1.9} = 526.3\text{ mHz}$$

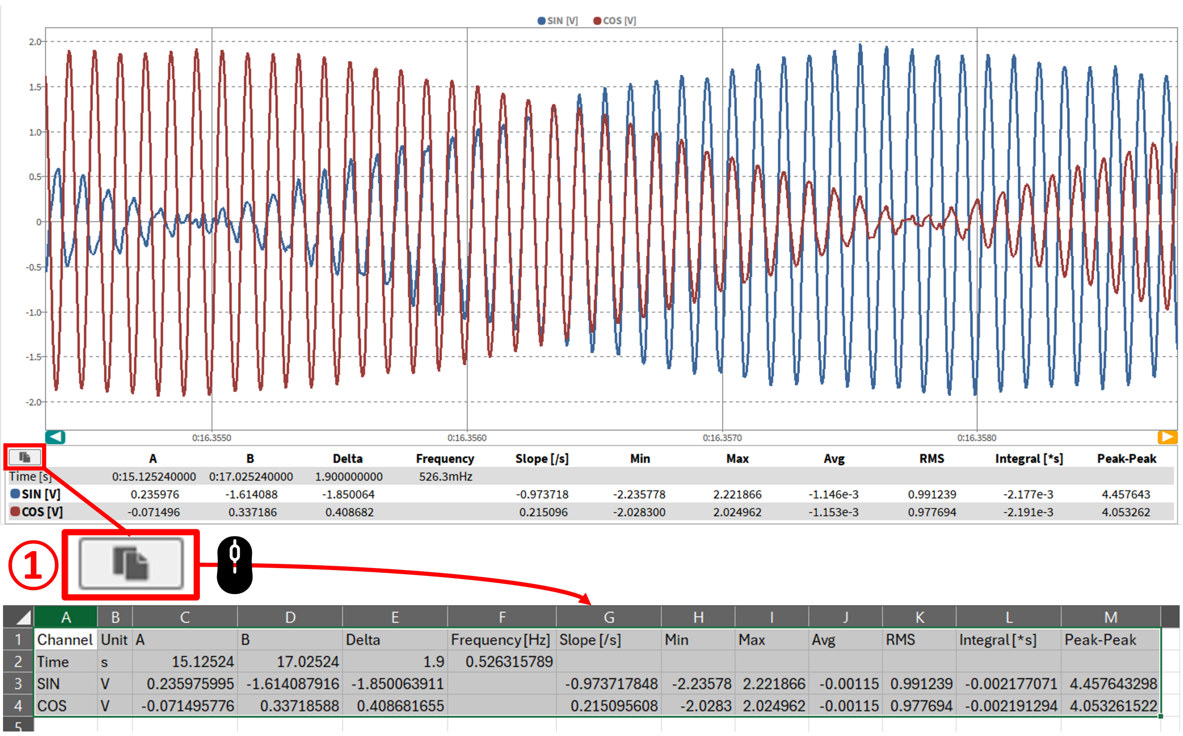
- Integral:

$$\text{Integral} = \text{ Mean} * \text{Delta} = 0.000000\;V * 1.9\;s = 0\text{ Vs}$$

Note: Besides the Recorder Instrument, the cursor option is also available for the Chart Recorder and the Scope.

Copy cursor values to clipboard

It is also possible to copy the displayed cursor values directly from the instrument in use to the clipboard and paste them into an Excel file or a simple text file, for example. To do this, simply click on the copy button displayed on the left above the table of cursor values (see 1 in Fig. 8.24) or you can simply click in the instrument with the left mouse button and copy the values with the key combination “CTRL + C”.



	A	B	Delta	Frequency	Slope [/s]	Min	Max	Avg	RMS	Integral [*s]	Peak-Peak
Time [s]	0:15.125240000	0:17.025240000	1.900000000	526.3mHz							
SIN [V]	0.235976	-1.614088	-1.850064		-0.973718	-2.235778	2.221866	-1.146e-3	0.991239	-2.177e-3	4.457643
COS [V]	-0.071496	0.337186	0.408682		0.215096	-2.028300	2.024962	-1.153e-3	0.977694	-2.191e-3	4.053262

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Channel	Unit	A	B	Delta	Frequency [Hz]	Slope [/s]	Min	Max	Avg	RMS	Integral [*s]	Peak-Peak
2	Time	s	15.12524	17.02524	1.9	0.526315789							
3	SIN	V	0.235975995	-1.614087916	-1.850063911		-0.973717848	-2.23578	2.221866	-0.00115	0.991239	-0.002177071	4.457643298
4	COS	V	-0.071495776	0.33718588	0.408681655		0.215095608	-2.0283	2.024962	-0.00115	0.977694	-0.002191294	4.053261522
5													

Fig. 8.24: Copy cursor values to clipboard

Quick expansion button

This button enlarges the Recorder to the full size of the measurement screen and reduces it to its original size. When the Recorder is set to the full size, all other instruments will move to the background.

Remark: Besides the Recorder, the Quick expansion button is also available for the Chart Recorder, the Scope, the FFT, the Video and the XY Plot.

Pinch/Scroll zoom feature

The zoom feature is a fundamental tool for the usage of the Recorder. It offers the user the possibility to scrutinize the data easily in **real time**.

- Operating on a touch screen:

  To perform this action with a touch screen, just do what you do with an everyday picture on your smart phone, pinch and zoom. Since the screen on a Trendcorder is so large, it is sometimes easier to use both hands to perform this action until you drill down into the finer data points.

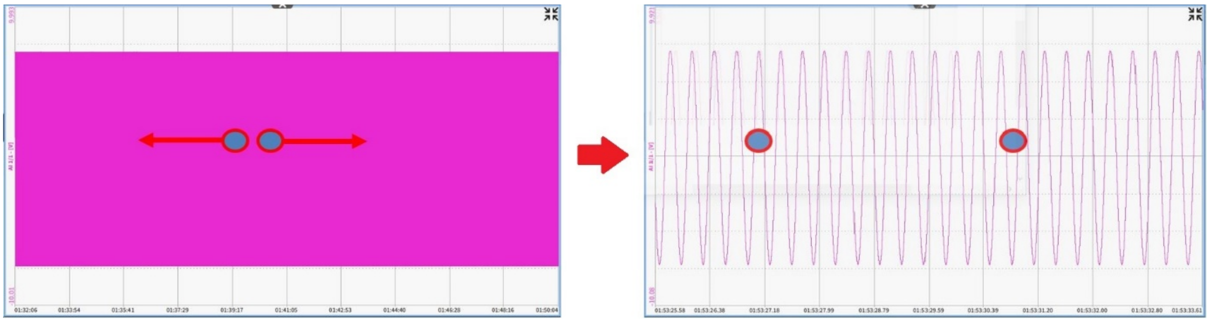


Fig. 8.25: Zooming on a touch screen

- Operating with a mouse:

  To zoom into the data with a mouse simply scroll upwards with the mouse's scroll wheel or use the **right** mouse button in the following way:

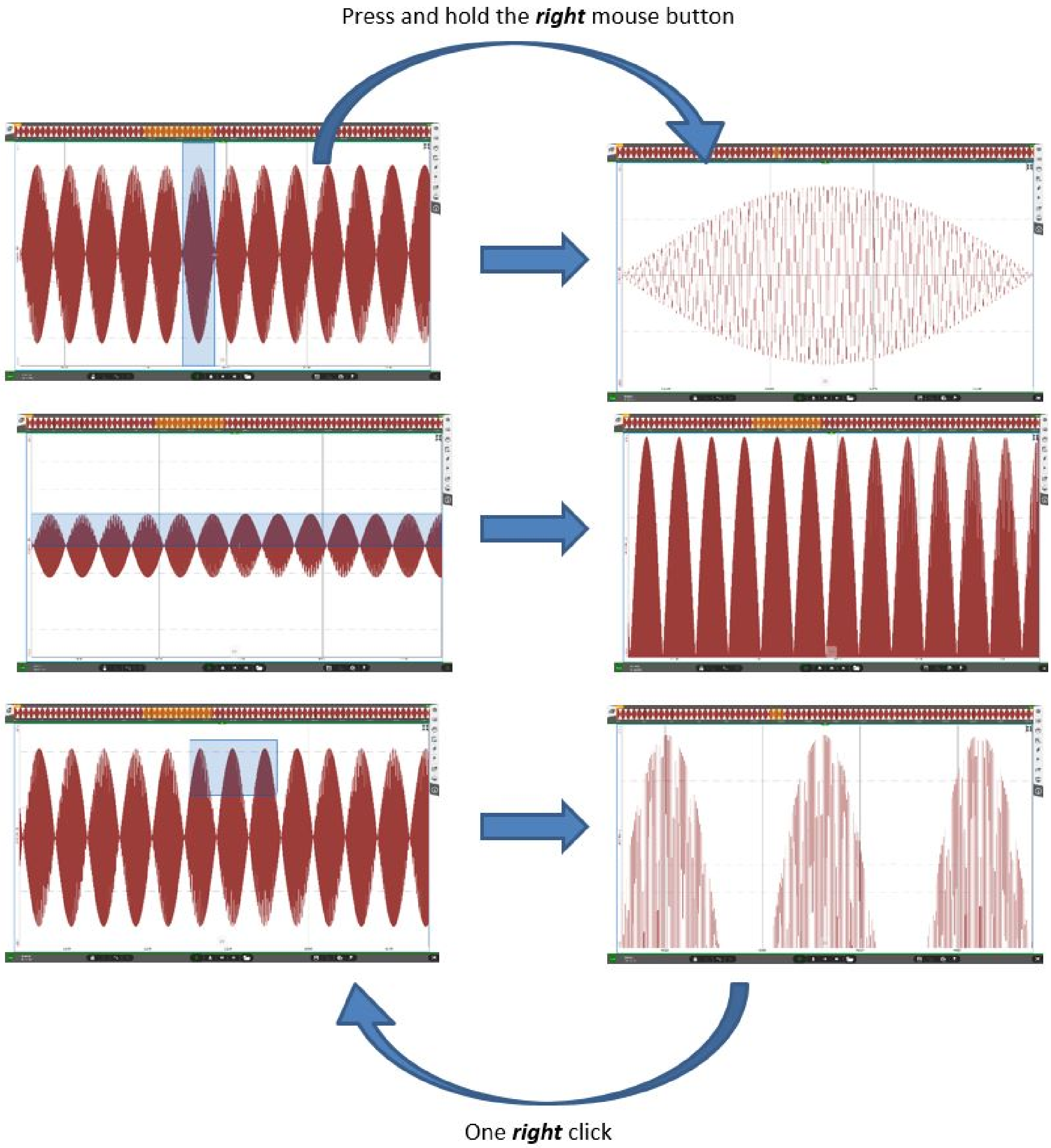


Fig. 8.26: Zooming with a mouse

8.4.5 DejaView™

While recording data, the user is free to use the Recorder to view data from the past, even during long duration recording. This feature is called DejaView™. For activating this function, the user must click with the left mouse button in the recorder or touch the recorder with his finger and drag or swipe to the right. From this point the user is also free to pinch or scroll zoom into the data. To quickly get back to looking at the current data the user can simply press the grey >> symbol (see ② in Fig. 8.27) and they will be snapped back into time with the current incoming data. This is one of the most **powerful** features of the OXYGEN software.

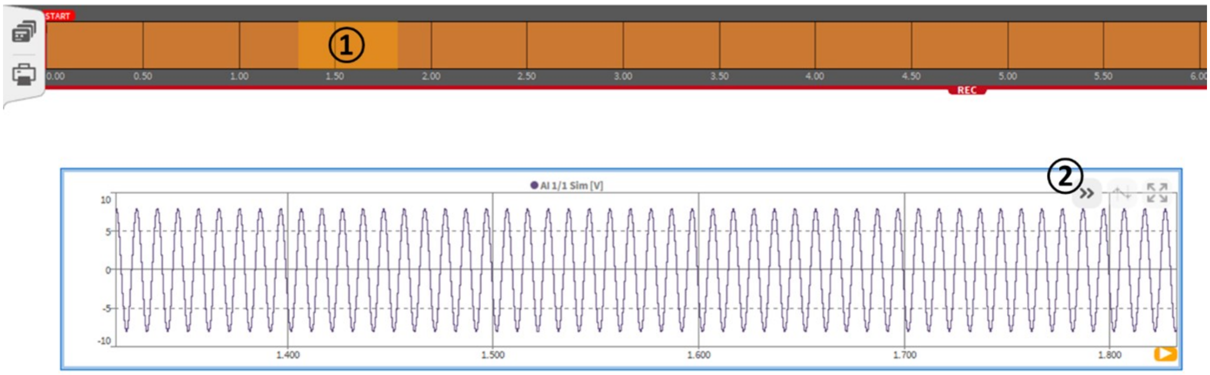


Fig. 8.27: Operational Features of DejaView™

- Operational features of DejaView™ (see Fig. 8.27)
- ① Shows the part of the measurement file that is displayed in the recorder
- ② After pressing this button, the recorder will jump to the actual position of the measurement file and show the latest recorded data. A right click on this button makes the recorder show the recorded data from the recording start to the actual time position on the right end of the recorder

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Note: The DejaView™ feature can be enabled and disabled in the *System Settings* menu point *Advanced Setup* (see *Advanced settings*).

8.5 Chart Recorder

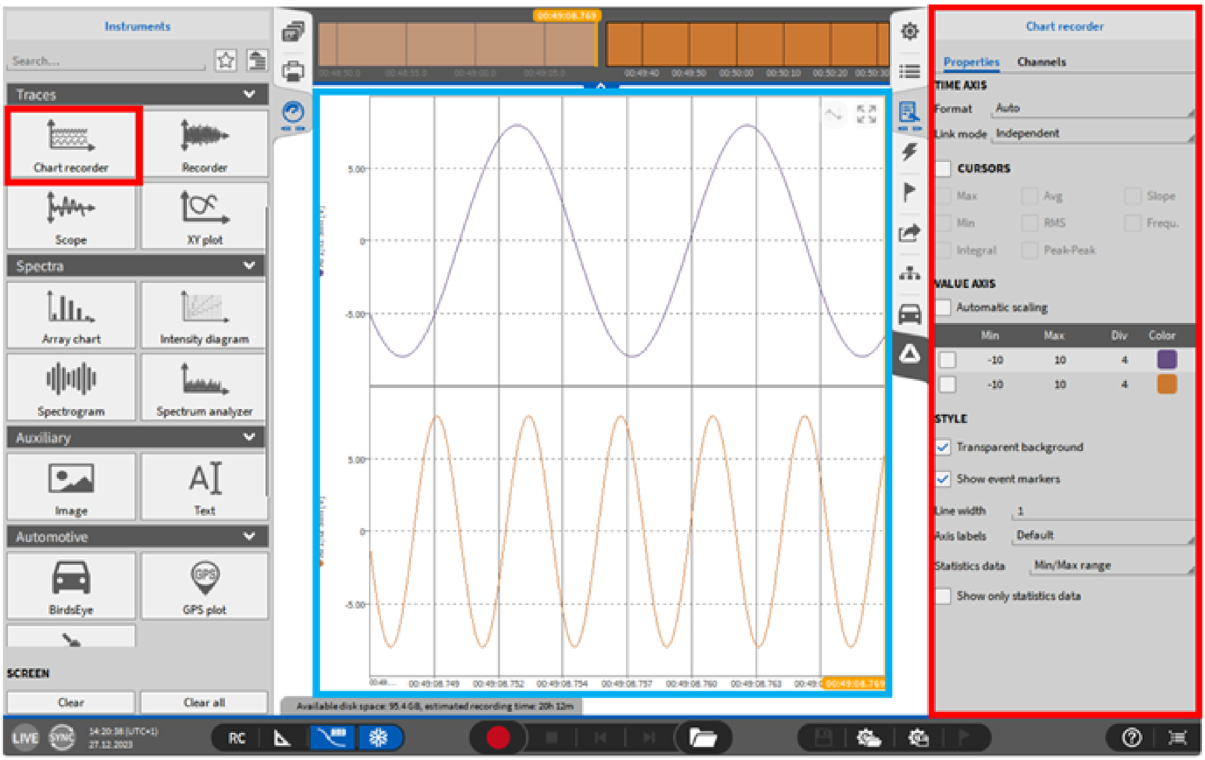


Fig. 8.28: Chart Recorder - overview

The Chart Recorder provides the user with the ability to view data together in one instrument as separate strip charts that are arranged one below the other. The Chart Recorder offers the same properties and analysis possibilities as the Recorder. For a detailed description refer to *Recorder*.

Note: Up to 16 channels can be assigned to one single Chart Recorder.

8.6 Bar Meter

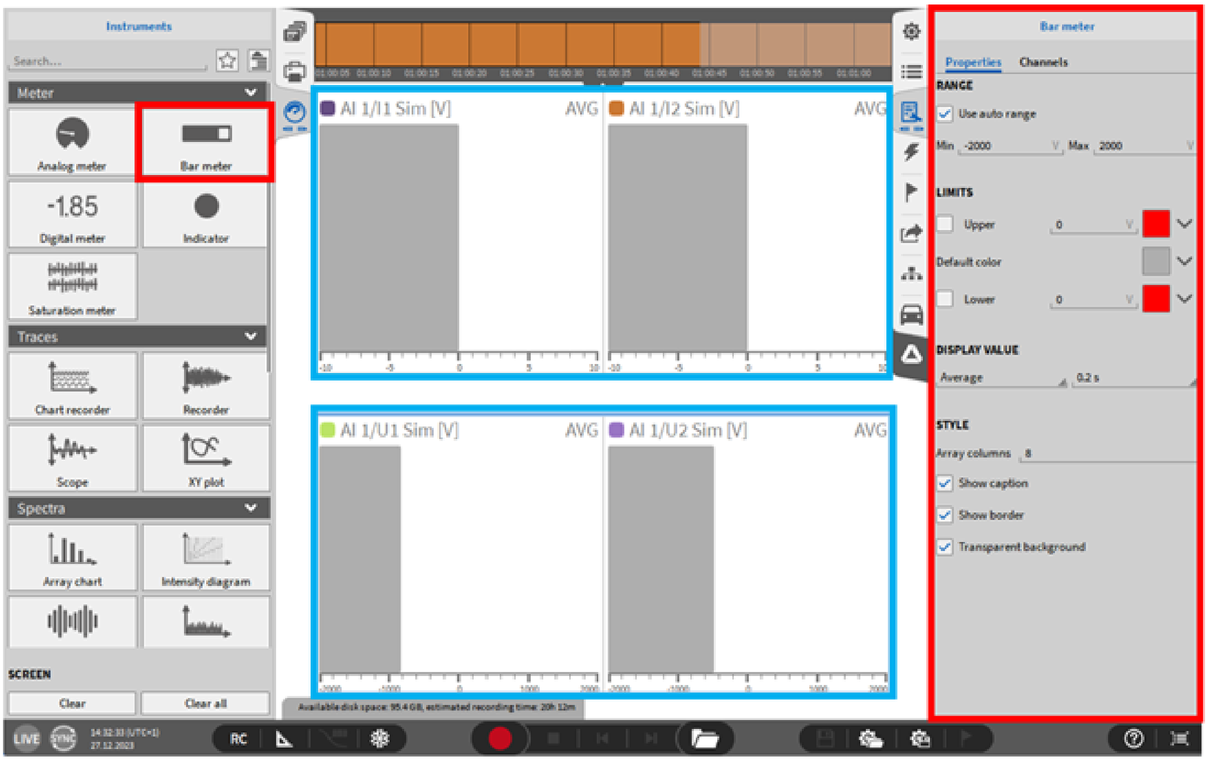


Fig. 8.29: Bar Meter - overview

The Bar meter is an additional tool to show the user the measurement value of a channel. The following properties are available:

- Range: Allows the user to define the range of the Bar meter. There is also the option to auto range the meter based upon the input channels range setting.
- Limits: Allows users to color the Bar meter fill color based on different limit values. This helps in identifying signals which have hit a limit when the display is very "busy".
- Display Value: The meter shows either the actual channel value or the Average, RMS, ACRMS, Min, Max, Peak2Peak value at a user defined time interval of 0.1 s, 0.25 s, 0.5 s, 1.0 s, Delay, Sat (saturation).
- Style: The user can specify the number of columns for a Bar meter cluster if several channels are selected.

  Selection of a transparent or untransparent background.
- Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*).

Note: Up to 96 channels can be assigned to one single Bar Meter.

8.7 Indicator

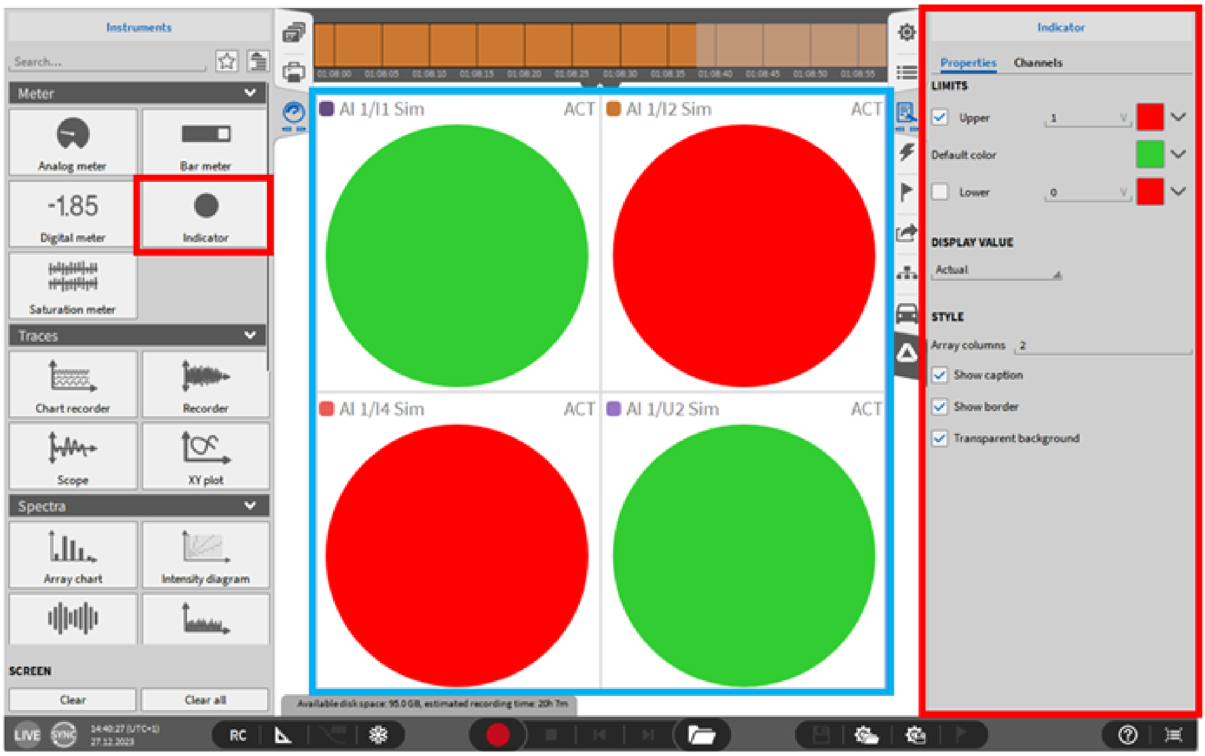


Fig. 8.30: Indicator – overview

The Indicator can be used for a quick status overview feedback. Depending on the current channels' value, the Indicator changes its color. The following Indicator properties can be configured:

- Limits: The user can define a default color for the indicator as well as upper and lower limit values and colors
- Display Value: Assigns the Indicators' color to the actual channel value or to the Average, RMS, ACRMS, Min, Max, Peak2Peak channel value at a user defined rate in seconds, Delay, Sat (saturation).
- Style: The user can specify the number of columns for an Indicator cluster if several channels are selected

  Selection of a transparent or untransparent background.
- Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*)

Note: Up to 96 channels can be assigned to one single Indicator.

8.8 Table instrument

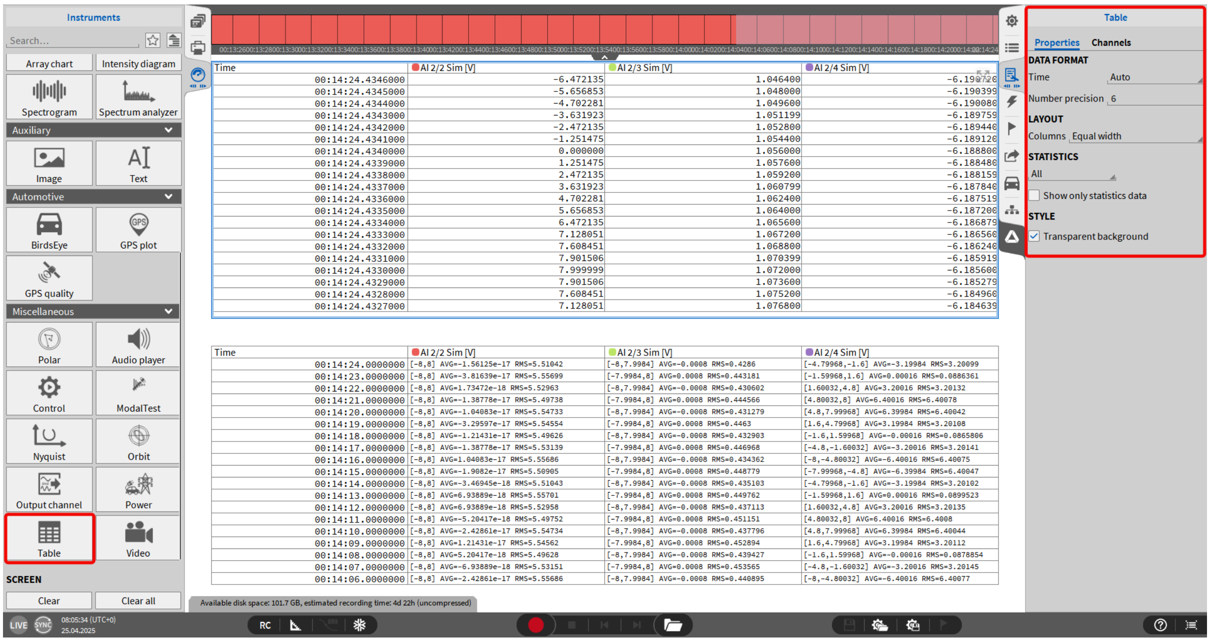


Fig. 8.31: Table instrument - overview

The Table instrument displays measurement data in tabular format, with individual columns for each signal and one for the time axis. The following configuration options are available:

- Time Format: Choose between Auto, Absolute time, or Relative time.
- Number Precision: Set the number of decimal places displayed.
- Column Layout: Select from Equal width, Dynamic distribution, or Stable distribution.
- Statistics Display: Enable Show only statistics data to display statistical values instead of raw data. Use the dropdown menu to select specific statistics. Note: Statistics Recording (*Triggered Events*) must be enabled during acquisition for this feature to work.
- Style: Choose between a transparent or non-transparent background.

Note: Up to 8 channels can be assigned to one single Table instrument.

8.9 Image instrument

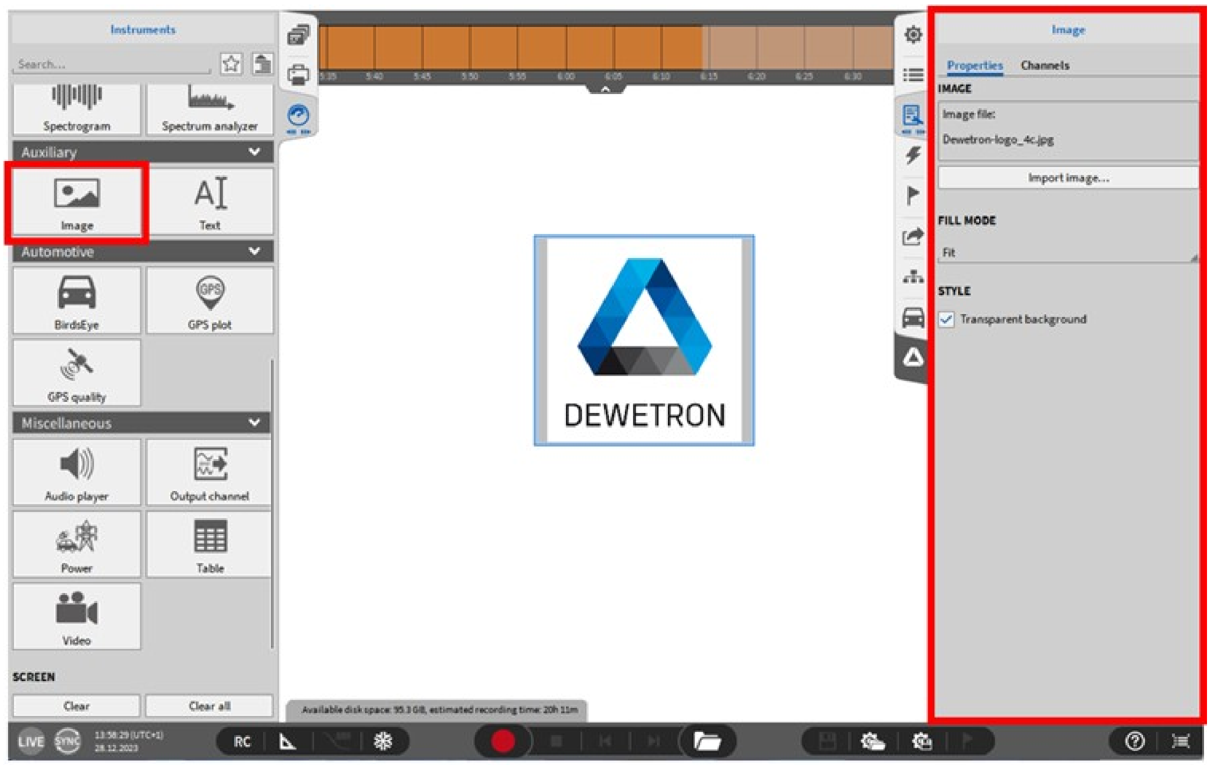


Fig. 8.32: Image Instrument – overview

This feature allows the user to add an image to the measurement screen, i.e. a picture of the device under test or the company logo. The data path can be selected via the Instrument Properties:

- Source: Browse for the desired image file
- Fill Mode: Select different modes to adjust the image file to the Instrument size
- Style: Selection of a transparent or untransparent background.
- Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*).

Note: An image file (.jpeg or .png) can also be copied and pasted directly from the Windows Explorer into the OXYGEN measurement screen (see Fig. 8.33).

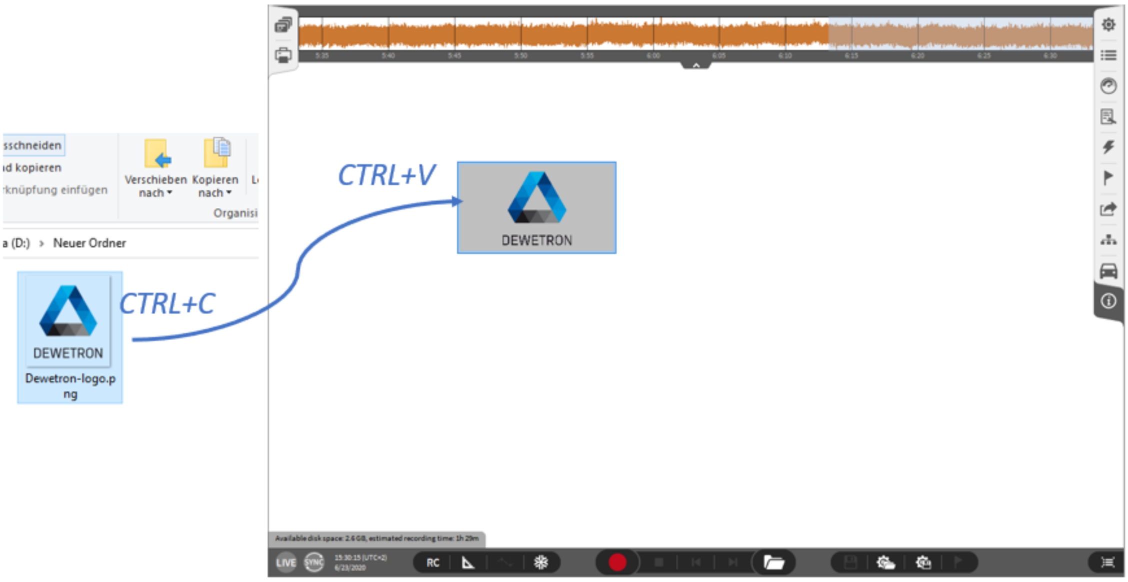


Fig. 8.33: Pasting an image file to the measurement screen

8.10 Text instrument

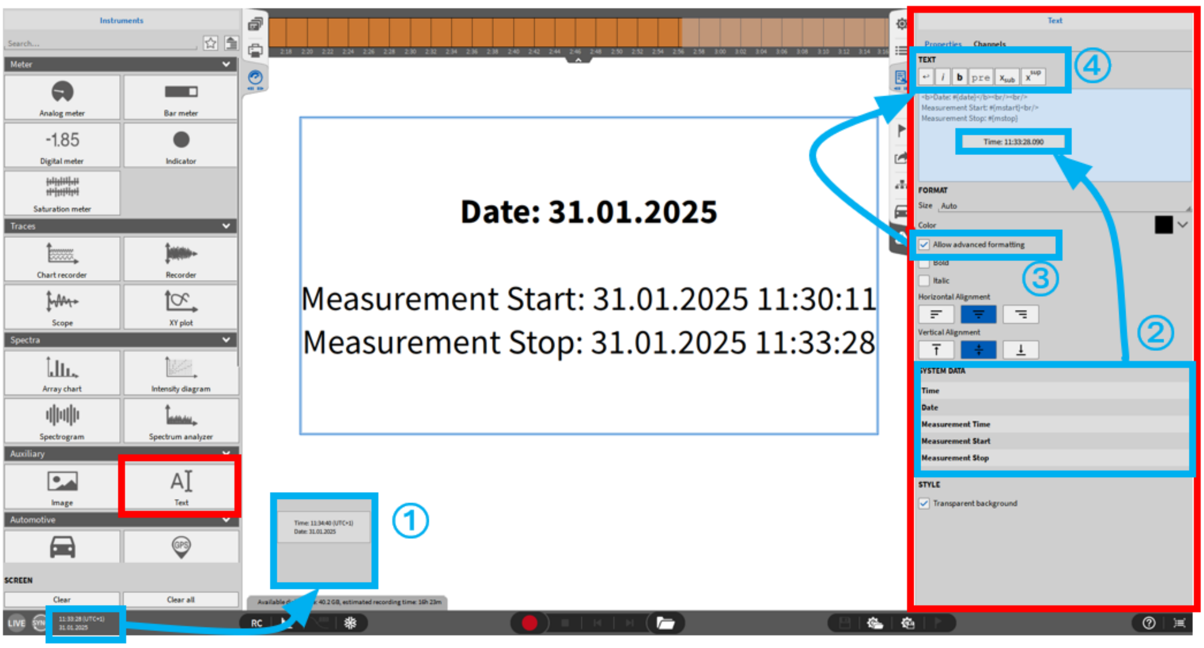


Fig. 8.34: Text instrument – overview

This feature allows the user to create customized text items on the measurement screen. Header data, time, data and the measurement time can also be displayed in the Text Box. For a detailed description how to display header data in the text box refer to *Header data*, for the other features see the next section. The following Instrument Properties are available:

- Text: the desired text must be entered there. The entered text is automatically resized to fit within the boundaries of the text box. To change the color of the text, left click onto or touch the *Color* square to bring up the color selection palette. The style can be adjusted to **Bold** and *Italic*. Furthermore, the horizontal and vertical alignment can be changed. The advanced text formatting options (see ④ in Fig. 8.34) for formatting only certain words or characters instead of the entire text must be activated via the checkbox (see ③ in Fig. 8.34).

- Style: Selection of a transparent or untransparent background.
- Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*).

Note: A text can also be copied and pasted directly to the OXYGEN measurement screen (see Fig. 8.35).

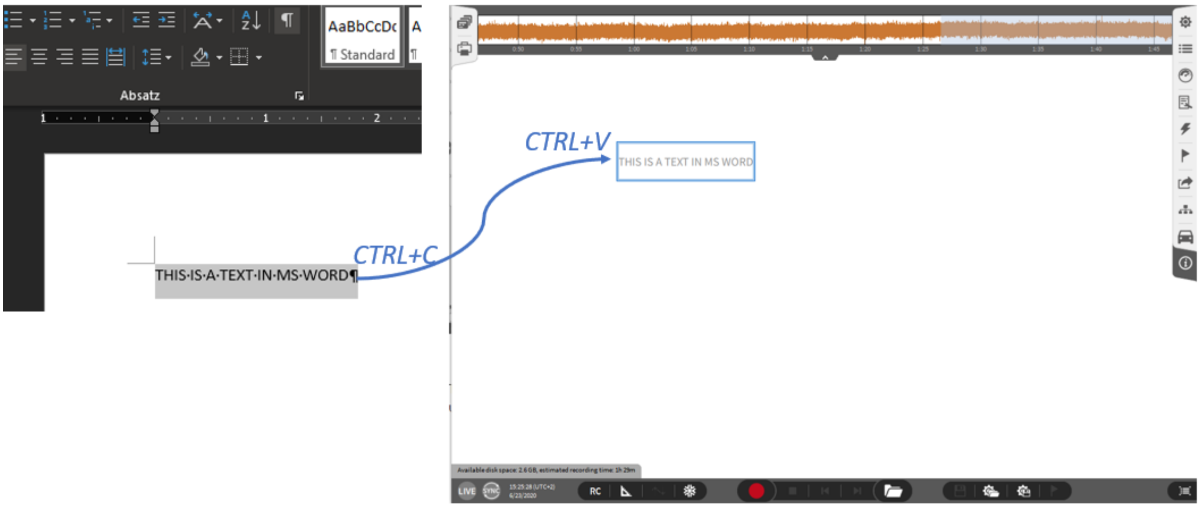


Fig. 8.35: Pasting a text to the measurement screen

Show Time, Date, Measurement Time

The Text instrument can also be used to show time, date or the elapsed time since measurement start (recording start) on the measurement screen. It is also possible to select the start and end time of the measurement. There are two possibilities available:

1. The time and date display in the lower left corner can directly be dragged and dropped on the measurement screen (see ① in Fig. 8.34). A Textbox will be created automatically with the according time and date.
2. In the instrument properties the time, date and measurement time can again dragged and dropped into the text field (see ② in Fig. 8.34) or be added with a double click on the respective element.

Note: The text in front of the #-sign can be changed individually.

8.11 Scope

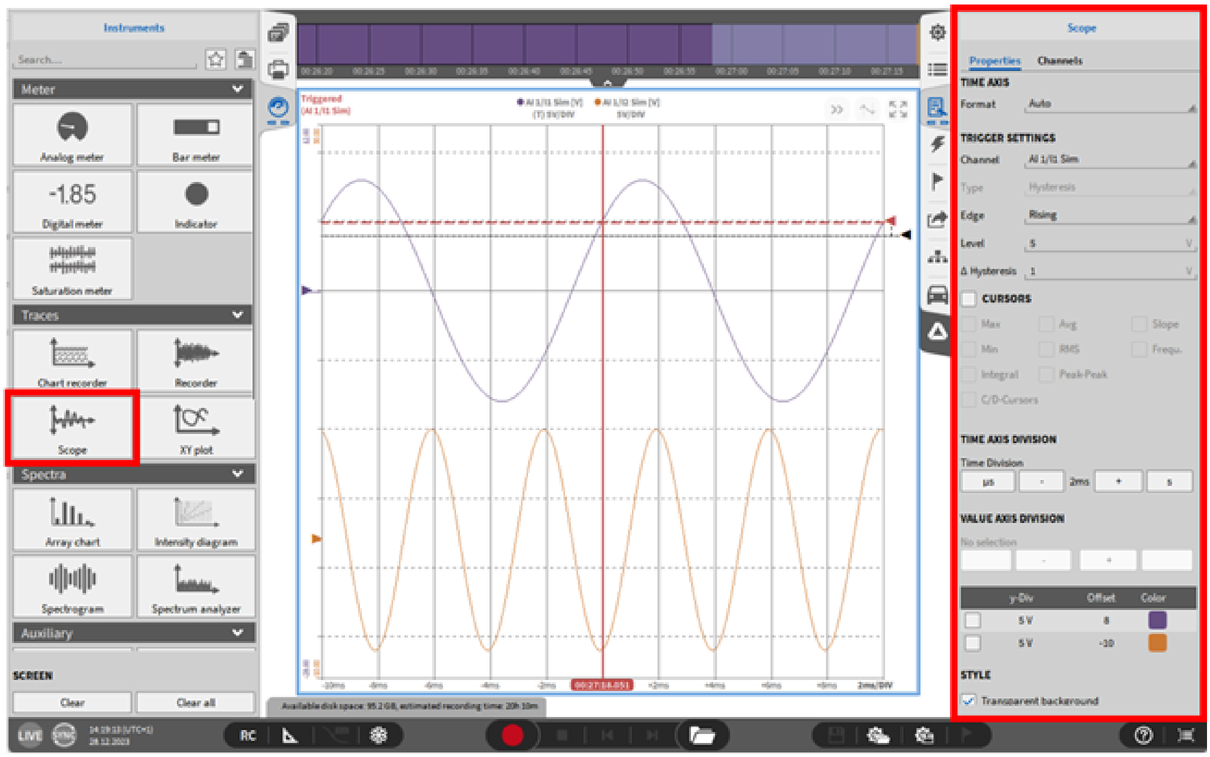


Fig. 8.36: Scope instrument – overview

This instrument affords the user the analysis options of a scope.

Note: Up to 8 channels can be assigned to one single scope.

Instrument properties

- Trigger settings:
- In the *Channel* selection, the user can select the trigger channel. Any channel that is displayed on the scope can be selected.
- In the *Edge* selection, the user can select if the selected signal shall be triggered on a *Rising* or on a *Falling* edge. The difference between the two modes is shown in Fig. 8.37 for a 1 Hz sine wave that has an amplitude of 1.

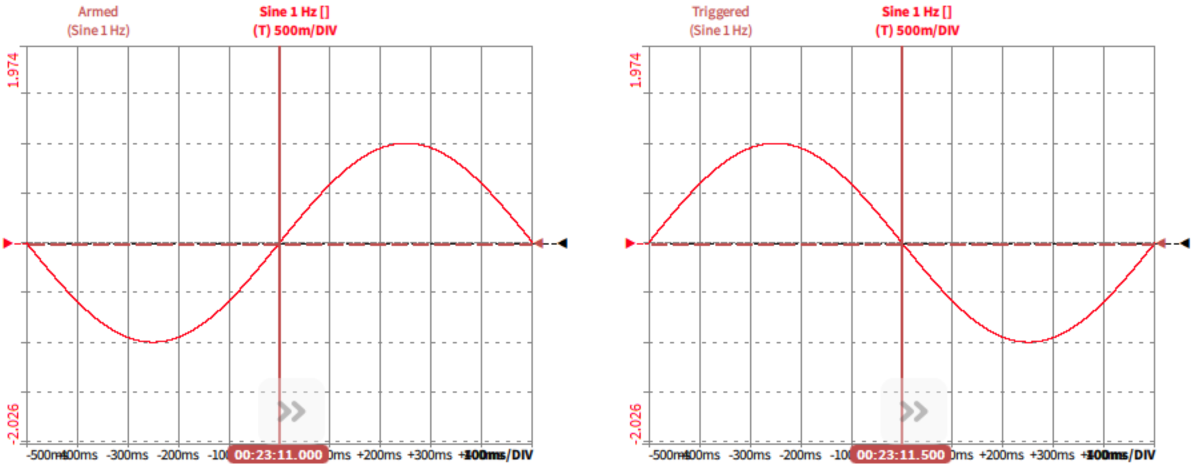


Fig. 8.37: Trigger on a *Rising* (left) and on a *Falling* (right) edge

- In the *Level* selection, the user can define the level of the trigger. The level can also be set with the *Level* cursor (see Fig. 8.36) and must be within the signal range. Fig. 8.38 shows a 1 Hz sine wave with an amplitude of ±1 which is triggered with a rising edge on level 0 and level +0.5.

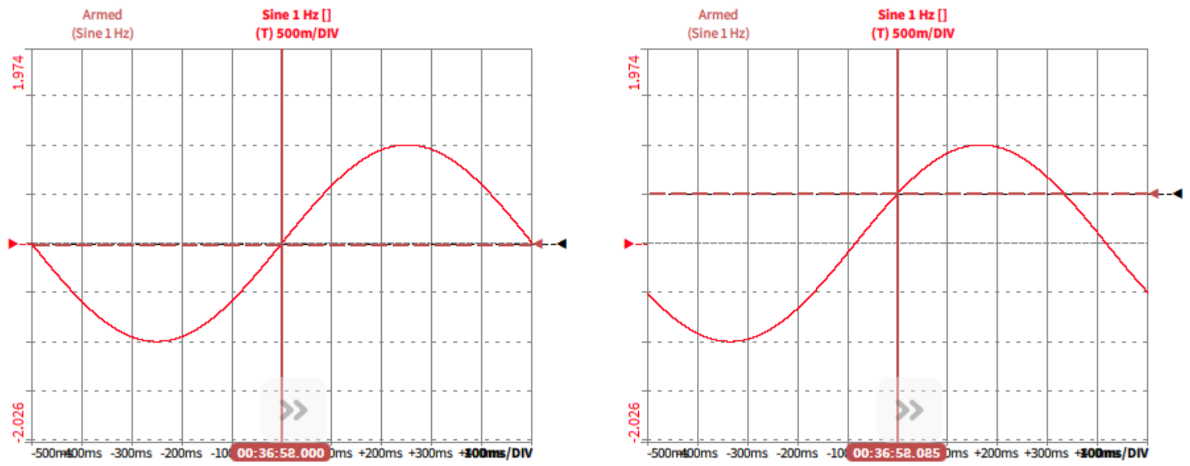


Fig. 8.38: Rising trigger edge with level 0 (left) and level +0.5 (right)

In the *Δ Hysteresis* selection, the user can define a level the signal must pass before a new trigger event occurs. Setting a hysteresis level avoids unwanted trigger events that may occur caused by noise around the trigger level. The *Δ Hysteresis* level can also be set with the *Hysteresis* cursor (see Fig. 8.36).

- If the signal is triggered on a *Rising* edge, the range of the *Δ Hysteresis* level can be set from [0 … (max_A + TL)].
- If the signal is triggered on a *Falling* edge, the range of the *Δ Hysteresis* level can be set from [0 … (max_A – TL]].

Note: *max_A: maximum signal Amplitude*

TL: selected Trigger Level

- Cursors: Select the desired values that shall show up when the cursors are activated. For a detailed description of the cursors refer to *Activate cursors*.
- Time Axis Division: Change the scaling of the X-axis per division
- Value Axis Division: Change the scaling of the displayed signals individually per division
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)
- Style:
  - Selection of a transparent or untransparent background.
  - Line Width selection from 1…10
- The Offset Cursors (see Fig. 8.36) can be used to displace the displayed signals vertically. Using this function will not affect the phase accuracy.

8.12 Spectrum analyzer

The FFT-Instrument provides the user with the ability to analyze data in real time within the frequency domain.

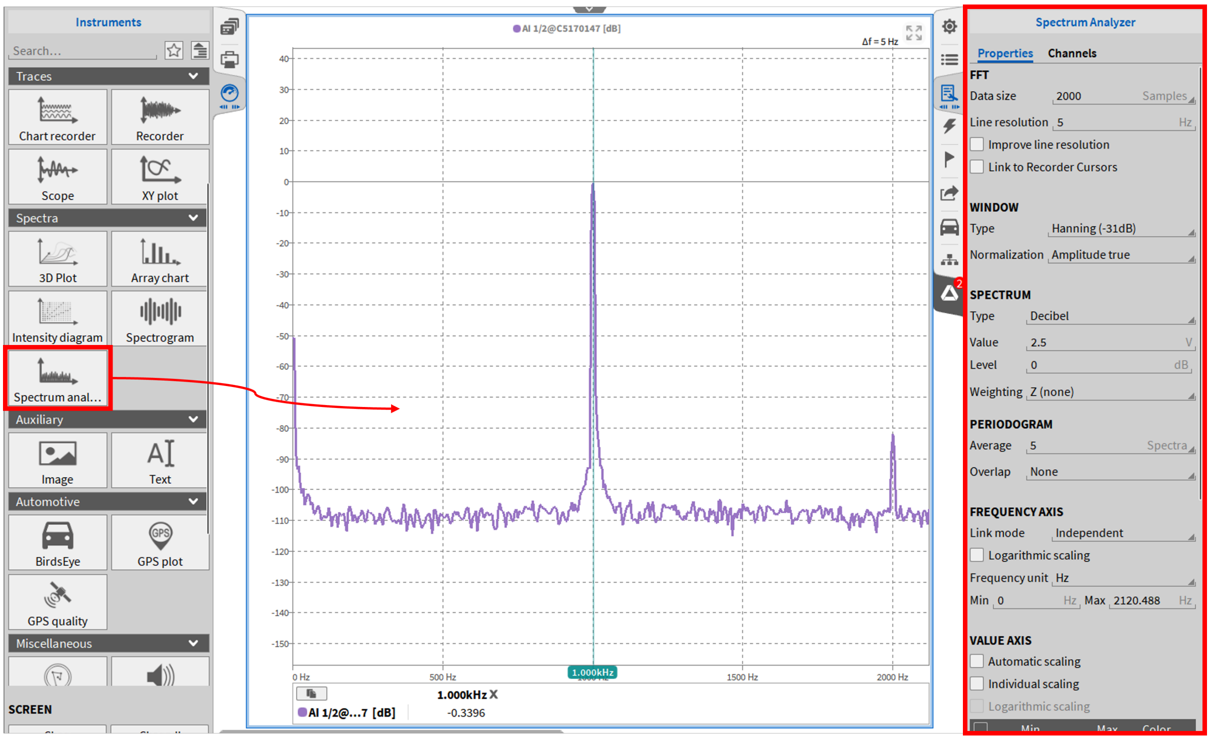


Fig. 8.39: Spectrum Analyzer - overview

The main properties of the instrument are FFT, Window, Spectrum, Periodogram, Frequency Axis, Value Axis, Markers, Reference curve, Style and Cross Hairs.

Both time domain and frequency domain channels can be added to the spectrum analyzer. Frequency domain channels are for example the amplitude channel created by a FFT channel from the basic math options.

8.12.1 Assignment of Frequency Domain Channels

Mathematical frequency channels that are calculated using the FFT math (see FFT channels) can be assigned and displayed to the Spectrum Analyzer as well. The Amplitude channel (called Channel_Name_Amp per default) and the Phase channel (called Channel_Name_Phi per default) can be assigned to the Spectrum Analyzer but no complex FFT channels (called Channel_Name_Cpx per default).

Note:

- Time domain channels and frequency domain channels cannot be assigned to the same Spectrum Analyzer but only to separate ones.
- If frequency domain channels are assigned to the Spectrum Analyzer, the Instrument Properties are reduced to the Frequency axis and Value Axis settings (see Fig. 8.40). For details, refer to Additional instrument properties.

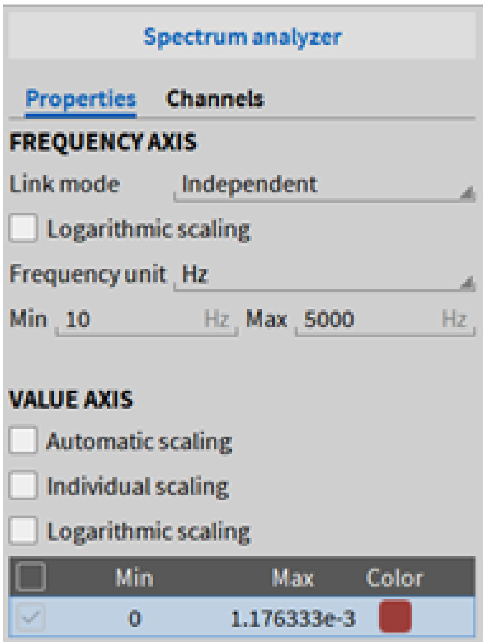


Fig. 8.40: Instrument Properties of the Spectrum Analyzer if Frequency Domain channels are assigned

8.12.2 Frequency Axis Settings

The unit of the X-axis is Hertz [Hz] per default (see ① in Fig. 8.41). The unit can be changed to Cycles Per Minute [CPM] which is defined as [Hz] * 60 (see ② in Fig. 8.41). The axis' minimum can be freely defined (see ③ and ④ in Fig. 8.41). The scaling can optionally bet set from linear to logarithmic scaling (see ⑤ in Fig. 8.41).

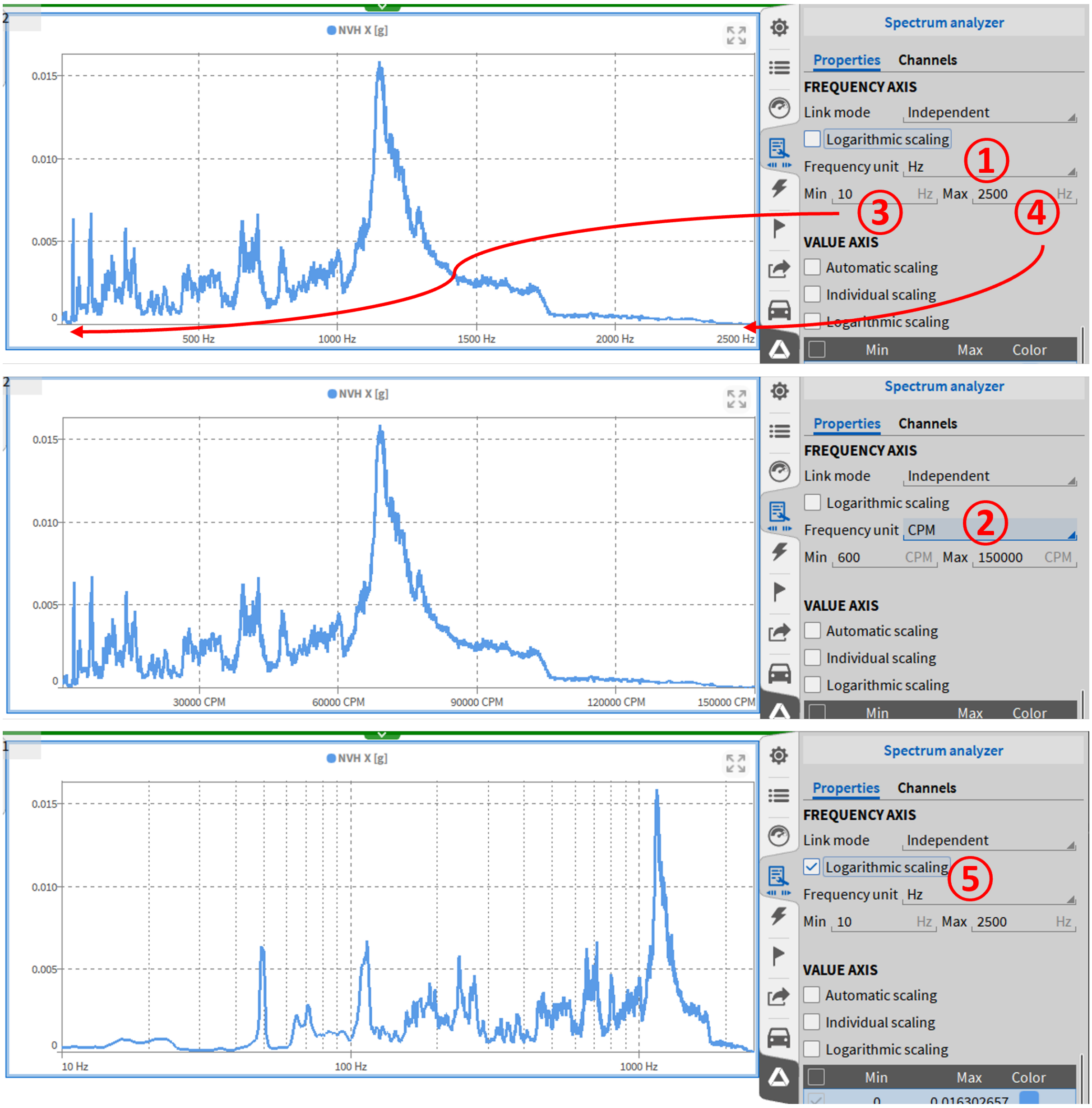


Fig. 8.41: Frequency axis settings

8.12.3 Assignment of Time Domain Channels

If analog channels that represent a time domain signal are assigned to the Instrument, the FFT is calculated according to the following formula:

$$Y_k = \sum_{n=0}^{N-1} X_n e^{\frac{-i2\pi kn}{N}}; \qquad k = 0 \ldots N-1$$

Xk… (complex) input signal

Yk… complex Fourier Transform of Xk

N… number of samples

Depending on the spectrum to be plotted, the complex Fourier Transform Y_k is used for further calculations. For continuative information, refer to *Section Spectrum*.

Note:

- Up to 8 channels can be assigned to one single Spectrum analyzer.
- The Spectrum analyzer provides the zooming option as well. For the detailed description of the zooming function, refer to *Pinch/Scroll zoom feature*.
- The user can easily export the currently displayed FFT-spectrum via pressing **CTRL+C** and paste it into an Excel file or Notepad window
- Peak Hold function: To facilitate the read off from local maxima, the user can press the **SHIFT** key. This makes the cursor remain at local maxima.

8.12.4 Assignment of Frequency Domain Channels

Mathematical frequency channels that are calculated using the FFT math (see *FFT channels*) can be assigned and displayed to the Spectrum Analyzer as well. The Amplitude channel (called *Channel_Name_Amp* per default) and the Phase channel (called *Channel_Name_Phi* per default) can be assigned to the Spectrum Analyzer but no complex FFT channels (called *Channel_Name_Cpx* per default).

Note:

- Time domain channels and frequency domain channels cannot be assigned to the same Spectrum Analyzer but only to separate ones.
- If frequency domain channels are assigned to the Spectrum Analyzer, the Instrument Properties are reduced to the Frequency axis and Value Axis settings (see Fig. 8.42). For details, refer to *Additional instrument properties*.

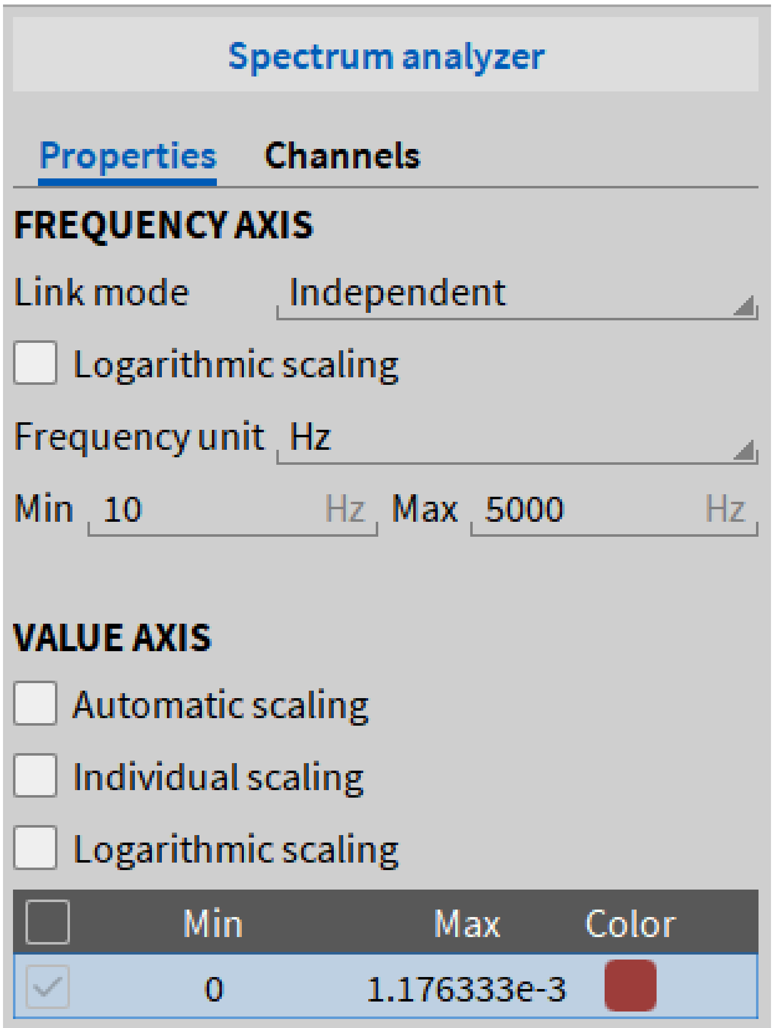


Fig. 8.42: Instrument Properties of the Spectrum Analyzer if Frequency Domain channels are assigned

8.12.5 FFT properties for Time Domain Channels

The desired *Data size* (i.e. the number of samples in time domain used for the calculation of one spectrum which is denoted with *N* in the upper formula) can be edited here. The data size is freely definable within a range from 42 to 1048576 (2^{20}) samples. The default settings are

1024 (2^{10}), 2048 (2^{11}), 4096 (2^{12}), 8192 (2^{13}), 16384 (2^{14}), 32768 (2^{15}), 65536 (2^{16}) 131072 (2^{17}) and 262144 (2^{18}) samples.

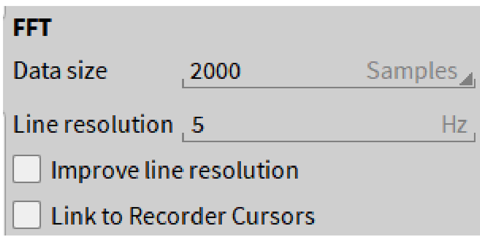


Fig. 8.43: FFT property of the spectrum analyzer instrument

The Line resolution relates to the sample rate and the Data size:

$$Line\ Resolution = \frac{\text{Samplerate}}{\text{Window size}}\ [Hz]$$

The radio button *Improve line resolution* will enable zero-padding. For detailed information, refer to *Additional information: improve line resolution (Enable zero-padding)*.

Note:

- If channels with different sample rates are displayed in one Spectrum analyzer:
- The *Line resolution* is calculated for each sample rate individually and cannot be edited in the Instrument Properties. Thereby, the number of plotted FFT bins is the same for each signal but the FFT resolution is different.
- Zero-padding (*Improve line resolution*) cannot be activated.
- Note that changing the *Data size* will affect the *Line resolution*. Therefore, the line resolution is within a range from $\frac{\text{Samplerate}}{2^{20}}$ to $\frac{\text{Samplerate}}{42}$ samples.
- If *Improve line resolution* is de-selected, the number of calculated FFT bins is equal to the *Data size*. If *Improve line resolution* is selected, the number of calculated FFT bins is always higher than the number of data samples.
- The number of plotted FFT bins is always $trunc(\frac{\text{Number of calculated frequency bins}}{2}) + 1$. The first line is plotted @ 0 Hz and the last line is plotted @ $\frac{\text{Samplerate}}{2}$ Hz. If logarithmic frequency axis scaling is selected, the 0 Hz line will not be plotted, because the common logarithm is not defined for 0.

Section *Window*

The *Type* and *Normalization* of the window function can be edited here.

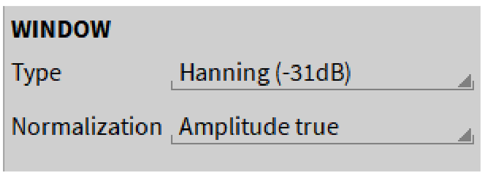


Fig. 8.44: Window settings for the spectrum analyzer

Window type

The Spectrum analyzer offers the usage of 7 different window functions (N denotes the Window size in samples and corresponds to the *Data size*):

- Hanning window

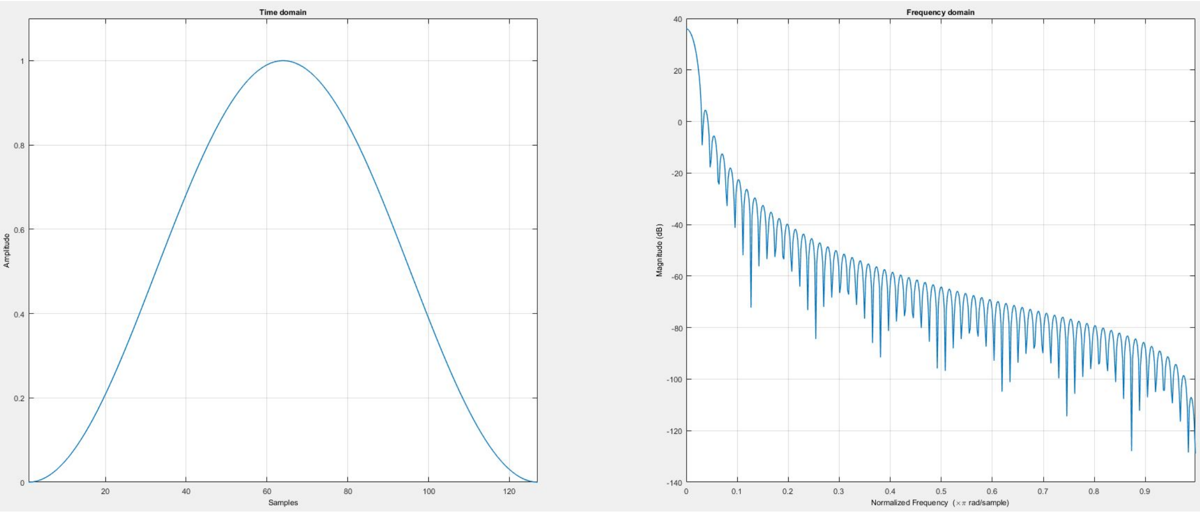


Fig. 8.45: Hanning window in time and frequency domain (N = 128)

$$w(n) = \frac{1}{2}\left[1 - \cos\left(\frac{2\pi n}{N-1}\right)\right]; \qquad n = 0 \ldots N-1$$

- Hamming window

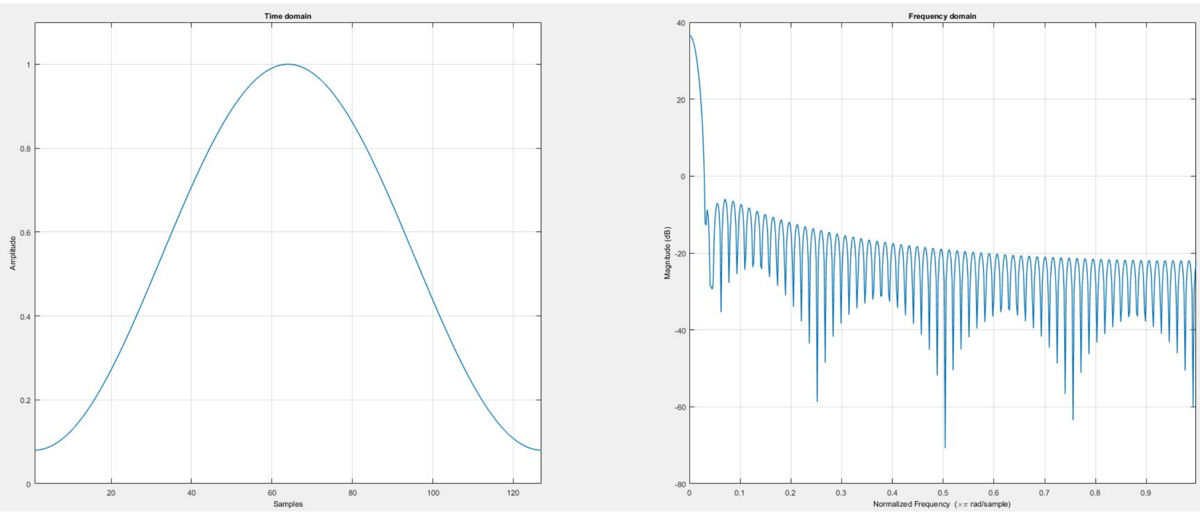


Fig. 8.46: Hamming window in time and frequency domain (N = 128)

$$w(n) = \alpha - \beta \cos\left(\frac{2\pi n}{N-1}\right); \qquad n = 0 \ldots N-1$$

α = 0.54

β... *1 – α*

- Rectangular window

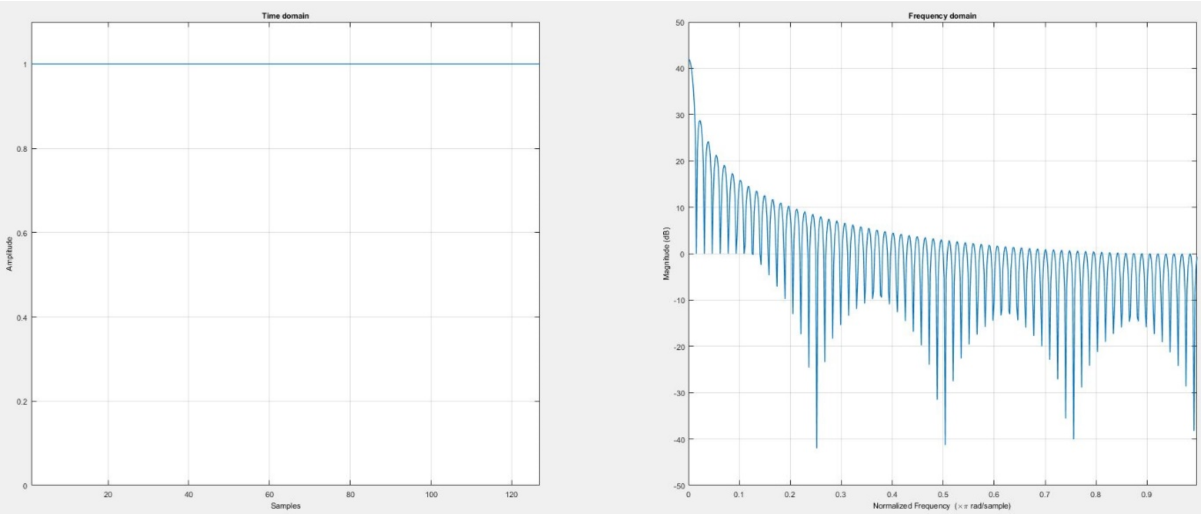


Fig. 8.47: Rectangular window in time and frequency domain (N = 128)

$$`w(n) = \ 1\,; \qquad n = 0 \ldots N` - 1$$

- Blackman window

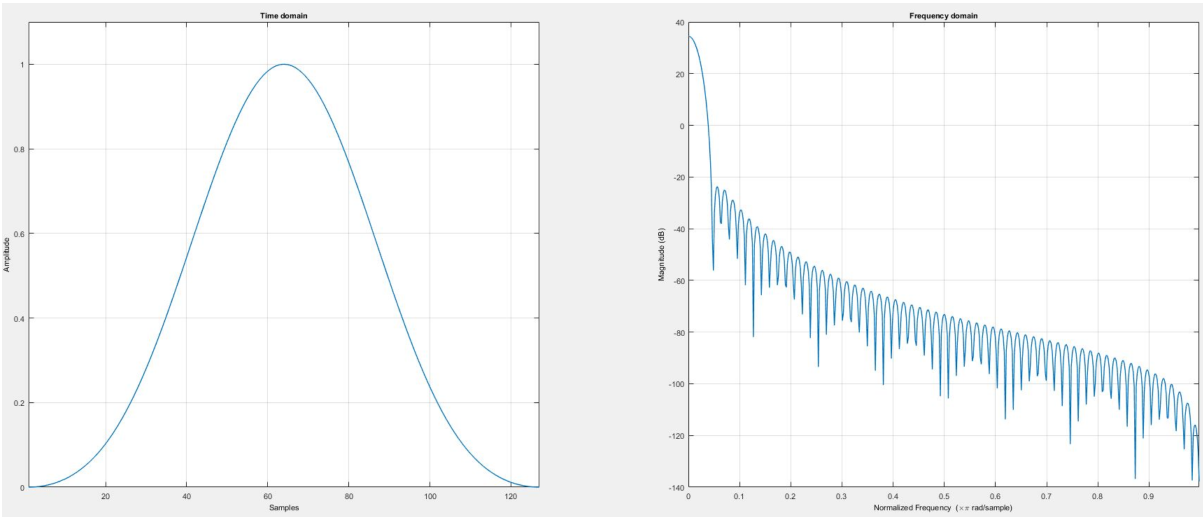


Fig. 8.48: Blackman window in time and frequency domain (N = 128)

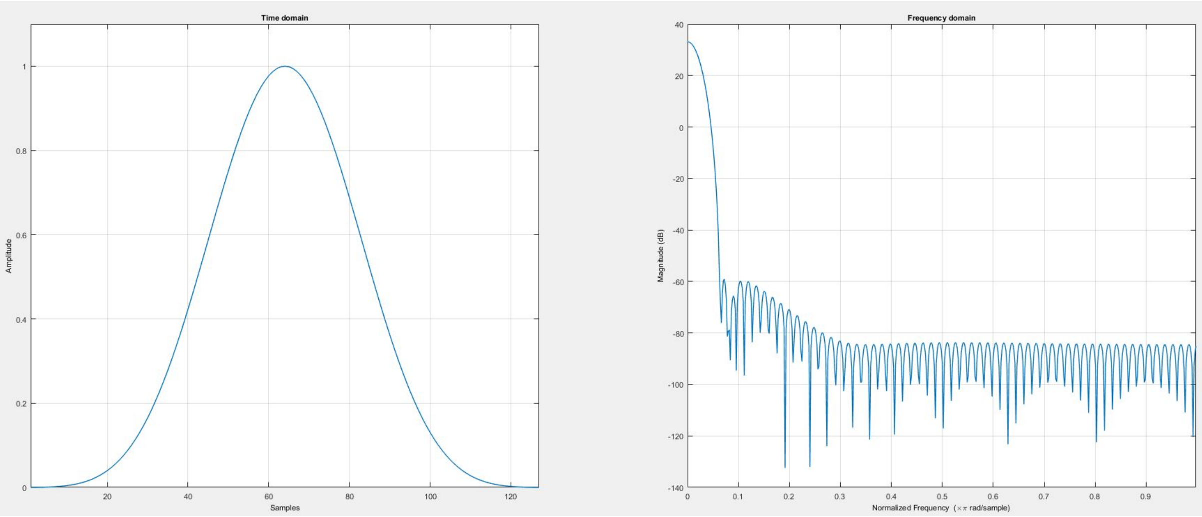
$$w(n) = \ a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right); \qquad n = 0 \ldots N - 1$$

a0 = 0.42

a1 = 0.5

a3 = 0.08

- Blackman-Harris window



Blackman-Harris window in time and frequency domain (N = 128)

$$w(n) = a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right) - a_3 \cos\left(\frac{6\pi n}{N-1}\right); \quad n = 0 \ldots N-1$$

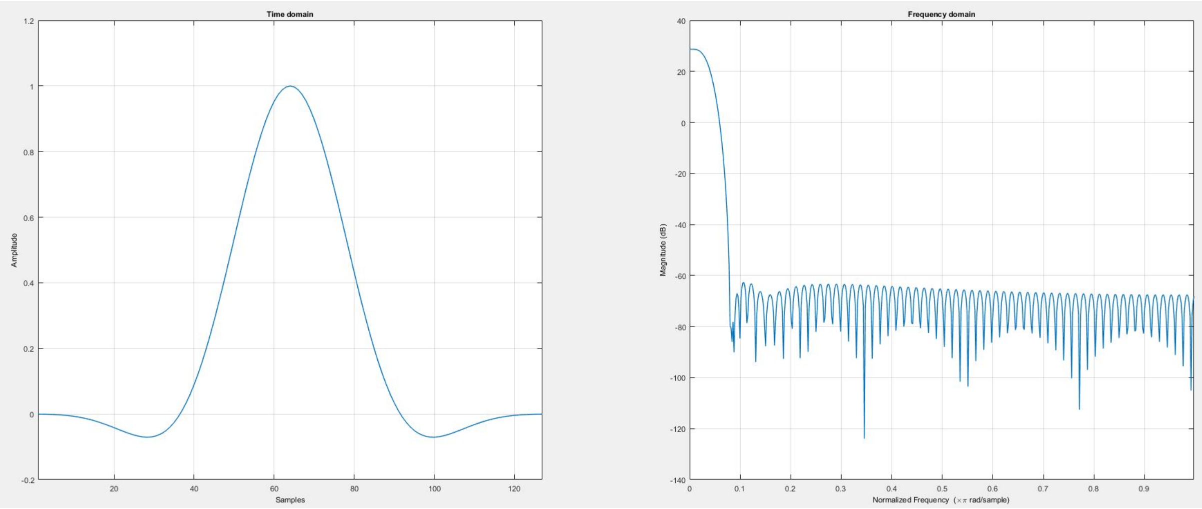
a0 = 0.35875

a1 = 0.48829

a2 = 0.14128

a3 = 0.01168

- Flat-Top window



Flat-Top window in time and frequency domain (N = 128)

$$w(n) = a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right) - a_3 \cos\left(\frac{6\pi n}{N-1}\right) + a_4 \cos\left(\frac{8\pi n}{N-1}\right); n = 0 \ldots N-1$$

a0 = 0.21557895

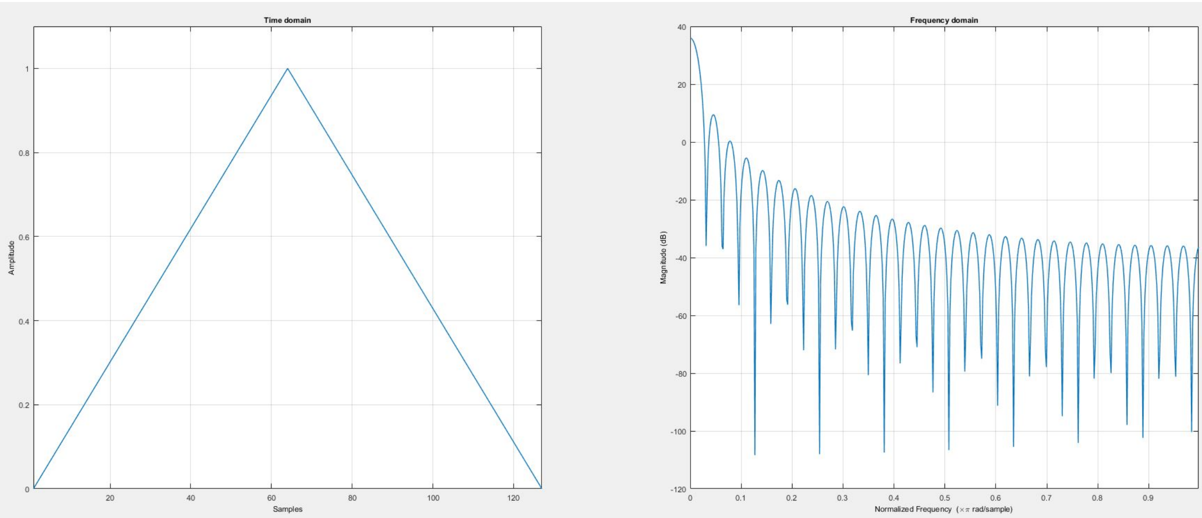
a1 = 0.41663158

a2 = 0.277263158

a3 = 0.083578947

a4 = 0.006947368

- Bartlett window



Bartlett window in time and frequency domain (N = 128)

$$w(n) = 1 - \left| \frac{n - \frac{N-1}{2}}{\frac{N-1}{2}} \right|$$

The following table will give an overview and recommendations about the usage of the different window functions.

Note: This table is only a matter of recommendation and makes no claim to be complete or correct.

Table 8.2: Recommendation about the usage of different window functions (Source)

Signal Content	Window
Sine wave or combination of sine waves	Hanning
Sine wave (amplitude accuracy is important)	Flat Top
Narrow-band random signal (vibration data)	Hanning
Broadband random (white noise)	Rectangular
Closely spaced sine waves	Rectangular, Hamming
Unknown Content	Hanning
Accurate single tone amplitude measurements	Flat Top

The following figure compares the different window functions in time domain:

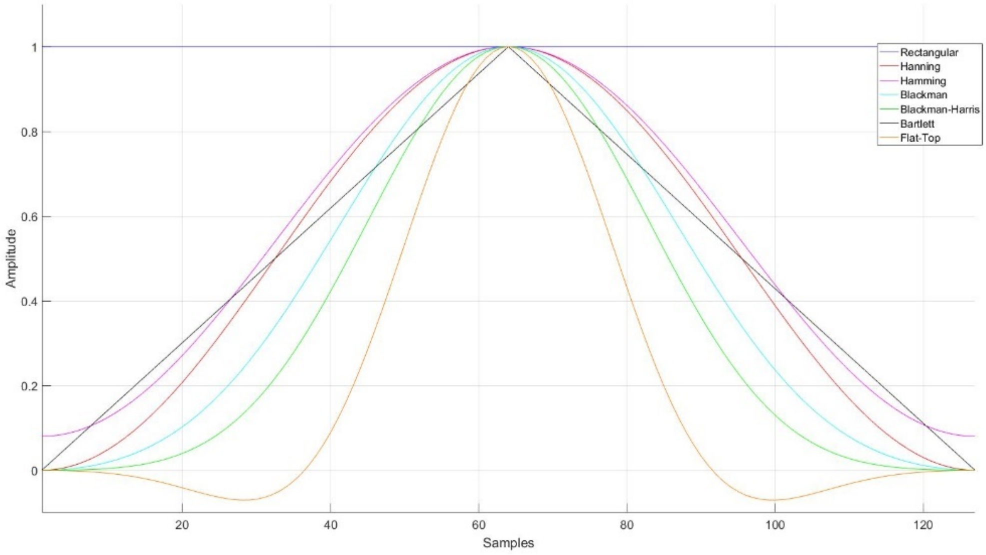


Fig. 8.49: Comparison of the window functions in time domain (N = 128)

The following table summarizes the two most important characteristics of the different window functions. The *Main Maximum Width* describes the single-sided width of the main maximum as number of FFT bins. The *Main Maximum Width* in Hz is the product of *Main Maximum Width* and *Line resolution*. The *Max. Side Lobe Level* denotes the damping of the first side lobe compared to the main maximum in decibel.

Table 8.3: Properties of the window functions

Window function	Main Maximum Width	Max. Side Lobe Level [dB]
Hanning	2	-31
Hamming	2	-43
Rectangular	1	-13
Blackman	3	-58
Blackman-Harris	4	-92
Flat-Top	5	-68
Bartlett	2	-27

Normalization

As the usage of a window function causes a decrement of the signals' amplitude and power, the user can select between *None*, *Amplitude True* and *Power True* Normalization.

- *None:* The spectrum will not be normalized, and the amplitude and the power error will remain
- *Amplitude True:* The damping of the signal amplitude caused by the window function will be compensated. The power loss will remain. The correction happens according to the following

formula:

$$S_{\text{AmpCorr }k} = S_k * \left[\frac{N}{\sum_{k=1}^{N} W_k}\right]$$

- *Power True:* The Power loss caused by the multiplication with the window function will be compensated and the amplitude error will remain. The correction happens according to the following formula:

$$S_{\text{PowCorr }k} = S_k * \sqrt{\frac{N}{\sum_{k=1}^{N} W_k^2}}$$

Sk... Un-normalized signal at position k

N... Length of the Window function

Wk...Value of the window function at position k

- A detailed example for the necessity to normalize FFT spectra can be found in *Additional information: normalization of FFT Spectra*.

Note: The normalization is applied to the signal in time domain.

Section *Spectrum*

In the *Spectrum* section, the user can select the type of spectrum plotted in the Spectrum analyzer. In the following section, the available spectra and their formula are listed.

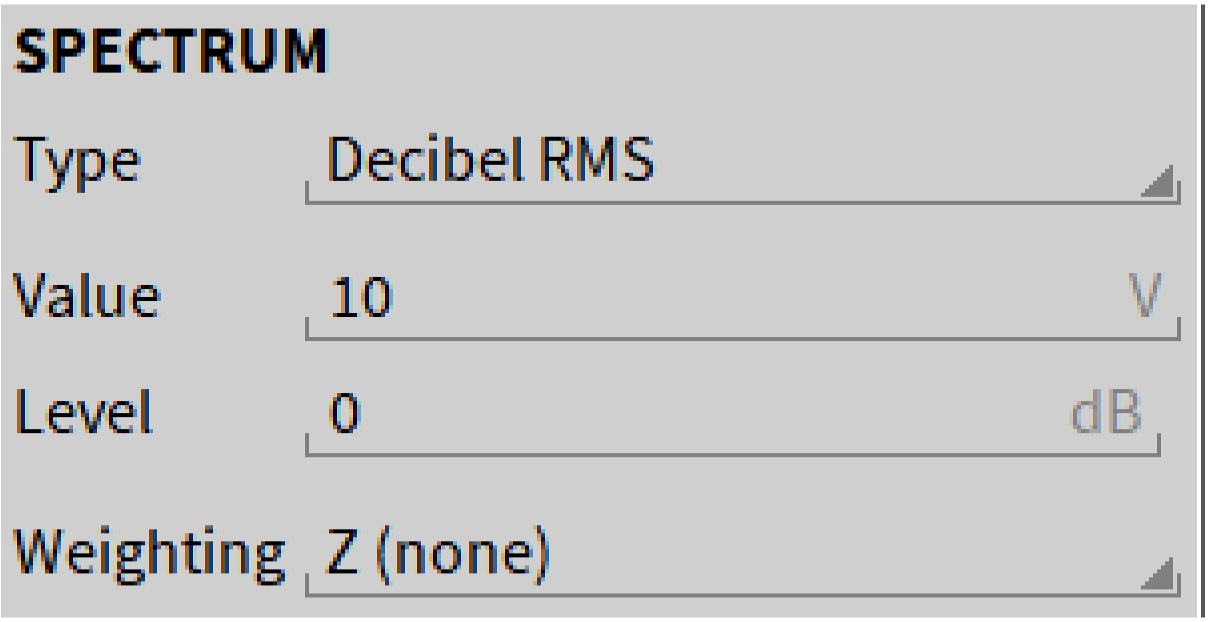


Fig. 8.50: Spectrum settings for the Spectrum Analyzer

- Amplitude: Plots the default amplitude spectrum normalized to the number of FFT lines according to the following formula:

$$A_k = \frac{1}{N}\sqrt{\text{Re}\left\{Y_k\right\}^2 + \text{Im}\left\{Y_k\right\}^2}\,; \qquad k = 0 \quad [\text{Unit}]$$

$$A_k = \frac{2}{N}\sqrt{\text{Re}\left\{Y_k\right\}^2 + \text{Im}\left\{Y_k\right\}^2}\,; \qquad k = 1\ldots N \quad [\text{Unit}]$$

- Amplitude RMS: Plots the RMS amplitude spectrum by dividing the Amplitude spectrum by .

$$A_{\text{RMS}\;k} = \frac{A_k}{\sqrt{2}}; \qquad k = 1\ldots N \quad [\text{Unit}]$$

- Amplitude²: Plots the squared amplitude spectrum by squaring the Amplitude spectrum

$$A_{\text{sq}\;k} = A_k^2; \qquad k = 1\ldots N \quad [(\text{Unit})^2]$$

- Decibel: Plots the logarithmic Amplitude spectrum referred to a freely definable reference level A_{Ref}. The reference value A_{ref} can be edited in the Value section and its corresponding level can be defined in the Level section.

$$L_{A\;k} = 20 * \log_{10}\left(\frac{A_k}{A_{\text{Ref}}}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- Decibel RMS: Plots the logarithmic Amplitude RMS spectrum referred to a freely definable reference level A_{Ref}. The reference value A_{ref} can be edited in the Value section and its corresponding level can be defined in the Level section.

$$L_{A\;\text{RMS}\;k} = 20 * \log_{10}\left(\frac{A_{\text{RMS}\;k}}{A_{\text{Ref}}}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- Decibel Max Peak: Plots the logarithmic Amplitude spectrum referred to the highest occurring value in the Amplitude spectrum. Thus, the highest occurring value corresponds to 0 dB.

$$L_{A\;\text{Max}\;k} = 20 * \log_{10}\left(\frac{A_k}{\max\{A_k\}}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- Decibel V-RMS: Plots the logarithmic Amplitude spectrum referred to 1 [Signal Unit] (1 V (RMS) is a common reference level for voltage and corresponds to 0 dBV)

$$L_{A\;\text{Max}\;k} = 20 * \log_{10}\left(\frac{A_{\text{RMS}}}{1}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- Decibel u-RMS: Plots the logarithmic Amplitude spectrum referred to $\sqrt{0.6}$ [Signal Unit] ($\sqrt{0.6} = 0.775$V (RMS) is a common reference level for voltage and corresponds to 0 dBu. 0.775V is the voltage that converts 1 mW electrical power on a 600 Ω resistance)

$$L_{A\;\text{Max}\;k} = 20 * \log_{10}\left(\frac{A_{\text{RMS}}}{\sqrt{0.6}}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- Sound Pressure Level: Plots the logarithmic Amplitude spectrum referred to 20µ [Signal Unit] (20 µPa is the common reference level for sound pressure in air and corresponds to 0 dB)

$$L_{A\;\text{Max}\;k} = 20 * \log_{10}\left(\frac{A_{\;\text{RMS}}}{20}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- Sound Pressure Level (Water): Plots the logarithmic Amplitude spectrum referred to 1µ [Signal Unit] (1 µPa is the common reference level for sound pressure in water and corresponds to 0 dB)

$$L_{A\;\text{Max}\;k} = 20 * \log_{10}\left(\frac{A_{\;\text{RMS}}}{1}\right); \qquad k = 1\ldots N \quad [\text{dB}]$$

- PSD: The Power Spectral Density (PSD) is based on the magnitude squared spectrum (M_{sq}) which differs from the amplitude squared spectrum (A_{sq}) insofar that the magnitude squared spectrum is only a one-sided spectrum.

$$M_{\mathrm{sq}\ k} = \mathrm{Re}\left\{Y_k\right\}^2 + \mathrm{Im}\left\{Y_k\right\}^2; \qquad k = 1 \dots N \quad [(\mathrm{Unit})^2]$$

$$\mathrm{PSD}_k = \frac{1}{N^2} * \frac{1}{\mathrm{df}} * M_{\mathrm{sq}\ k}; \qquad \text{with df} = \frac{\text{Samplerate}}{N} \quad \left[(\mathrm{Unit})^2/\mathrm{Hz}\right]$$

- PSD-TISA: plots the Time Integrated Squared Amplitude (TISA) PSD

$$PSD - TISA_k = \frac{1}{N} * \mathrm{dt} * M_{\mathrm{sq}\ k}; \qquad k = 1 \dots N, \quad \mathrm{dt} = \frac{1}{\text{Samplerate}} \quad \left[(\mathrm{Unit})^2\, s\right]$$

- PSD-MSA: plots the Mean Squared Amplitude (MSA) PSD

$$PSD - MSA_k = \frac{1}{N^2} * M_{\mathrm{sq}\ k}; \qquad k = 1 \dots N \quad \left[(\mathrm{Unit})^2\right]$$

- PSD-SSA: plots the Sum Squared Amplitude (SSA) PSD

$$PSD - SSA_k = \frac{1}{N} * M_{\mathrm{sq}\ k}; \qquad k = 1 \dots N \quad \left[(\mathrm{Unit})^2\right]$$

Note: PSD, PSD-TISA, PSD-MSA and PSD-SSA are different scalings of the same spectral content and differ in the physical unit.

- Phase: Plots the phase spectrum from -180° … +180°.

$$\varphi_{\ k} = \tan^{-1} \frac{Im\{Y_k\}}{Re\{Y_k\}}; \qquad k = 1 \dots N \quad [°]$$

- Phase unwrapped: Plots the unwrapped phase spectrum to avoid discontinuities from -900° … +900°.

$$\varphi_{\ k,unwrapped} = \tan^{-1} \frac{Im\{Y_k\}}{Re\{Y_k\}}; \qquad k = 1 \dots N \quad [°]$$

- Phase radiant: Plots the phase spectrum from - … +.

$$\varphi_k = \frac{\varphi_k}{360°} 2\pi; \qquad k = 1 \dots N \quad [rad]$$

- Phase unwrapped (radiant): Plots the unwrapped phase spectrum to avoid discontinuities from – … +..

$$\varphi_{\ k,\ unwrapped} = \frac{\varphi_{\ k,unwrapped}}{360°} 2\pi; \qquad k = 1 \dots N \quad [rad]$$

- Weighting: allows you to apply frequency-dependent weighting to the amplitudes. The default setting is Z (none). There are also sound level weightings according to A, B, C, and D.

Section *Periodogram*

The usage of a window function damps the signal information at the window edges and emphasizes the signal information in the middle of the window function. If the signal is stationary, the variance of its spectrum rises. This problem can be avoided with a periodogram. If the option *Periodogram* is selected, the spectrum is calculated for overlapping signal parts and averaged afterwards. This procedure reduces the variance, but the spectral resolution is degraded as well.

- In the *Average* selection, the user can select the number of spectra that shall be used for the mean value calculation. 2, 3, 4, 5, 8 or 10 spectra can be used for the mean value calculation.
- In the *Overlap* selection, the user can select how much the single spectra used for the mean value calculation shall overlap in the time domain. The user can select an overlapping factor of 0 %, 50 %, 75 % 80 % or 90 %.
- The Periodogram calculation is exemplified in *Additional information: calculation of a Periodogram*.

Additional instrument properties

- Frequency Axis: Change the scaling of the X-axis
- Value Axis: Change the scaling of the Y-axis. For quick Y-axis scaling features, refer to *Quick selection Y-axis scaling*.
- Style:
  - Selection of a transparent or untransparent background.
  - Line Width selection from 1…10
- Layer: Moves the Instrument in front of or behind another object

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Note: The properties of the FFT can be changed and updated in the *PLAY* mode as well as in the *LIVE* and *REC* mode.

8.12.6 Markers

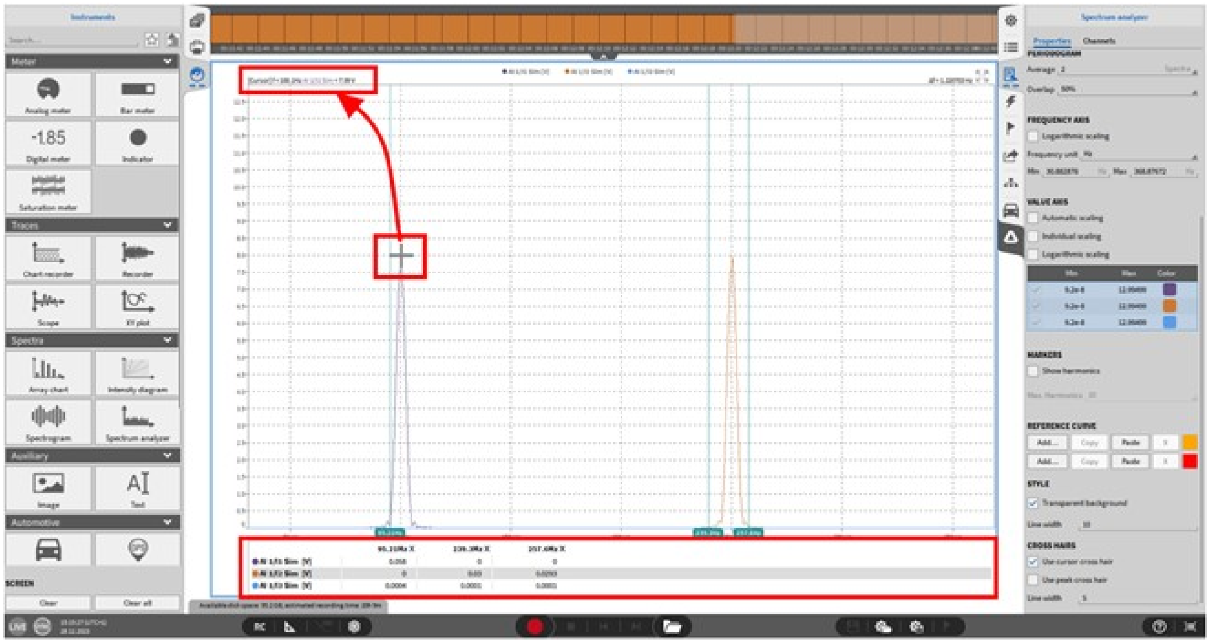

Fig. 8.51: FFT Marker - Overview

To analyze the behavior of a certain frequency line, the user can display the actual value in a table below the FFT plot. Therefore, the user must select the desired frequency line with a mouse click. Then, the selected point will show up in the table. The user can change the frequency position by moving the respective cursor across the frequency axis or with a double click on the frequency in the table. Up to five frequency lines can be displayed in the table simultaneously. While moving the mouse in the frequency plot, the actual frequency and the actual signal value of the signal next to the cursor are displayed in the upper left corner.

8.12.7 Usage Of Harmonics Cursors

Harmonics Cursors can be displayed by checking *Show Harmonics* (see 1 in Fig. 8.52). The number of harmonics can be set from 1 to 10 (see 2 in Fig. 8.52). Harmonics are marked with cursors (see 3 in Fig. 8.52) and the harmonics amplitude is displayed at the instrument‘s bottom (see 4 in Fig. 8.52).

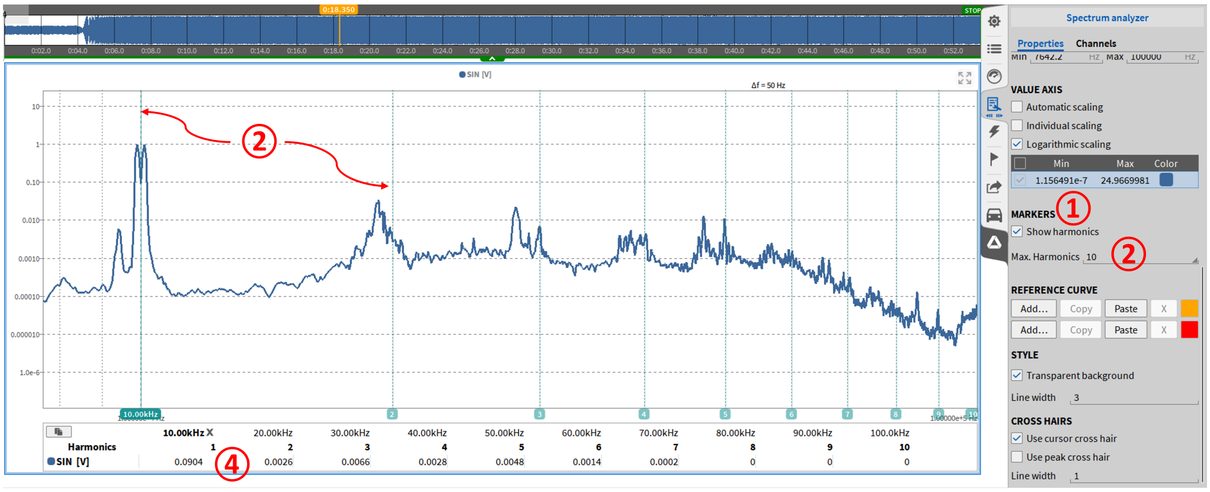

Fig. 8.52: Usage of Harmonics Cursors

The cursor position can be changed by entering a new frequency for the first harmonic (see ⑤ in Fig. 8.53). It is also possible to move the first harmonic cursor with the left mouse button (see ⑥ in Fig. 8.53). The position of the higher harmonics is automatically adjusted.

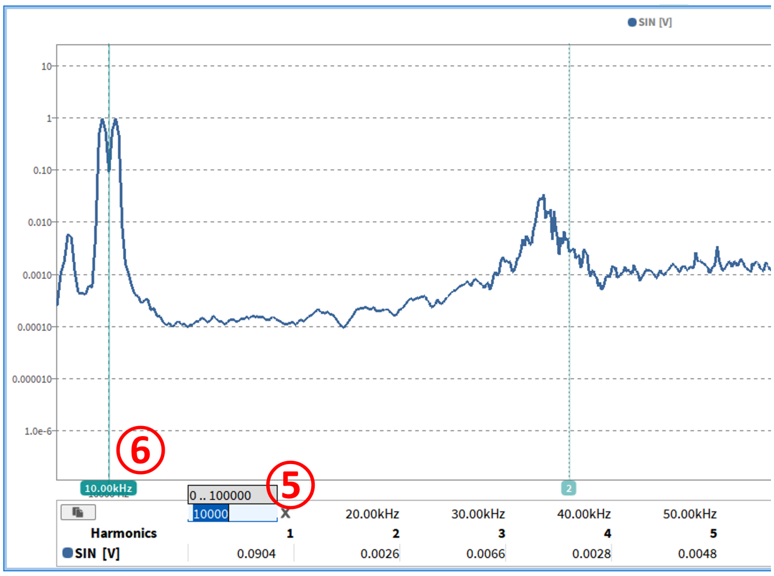

Fig. 8.53: Changing the 1st Harmonics cursor position

8.12.8 Reference Curves for the Spectrum Analyzer

The Spectrum Analyzer provides the possibility to create reference curves for threshold monitoring in the frequency domain.

An orange and a red colored reference curves can be created which will colorize the instruments' background orange or re if the signal exceeds the reference curve.

The red reference curve has a higher priority than the orange one. This means that the instruments' background will be colored red if the threshold of both reference curves will be exceeded. The colored background will be reset automatically when the threshold is decreased again.

To create a Reference curve, press the *Edit..* button in the Reference Curve section of the Spectrum Analyzers' Instrument Properties (see Fig. 8.54).

Fig. 8.54: Instrument properties for Reference curves

A popup menu will open and the reference curve can be set up in table form (see Fig. 8.55). The *+* button can be used to add a value.

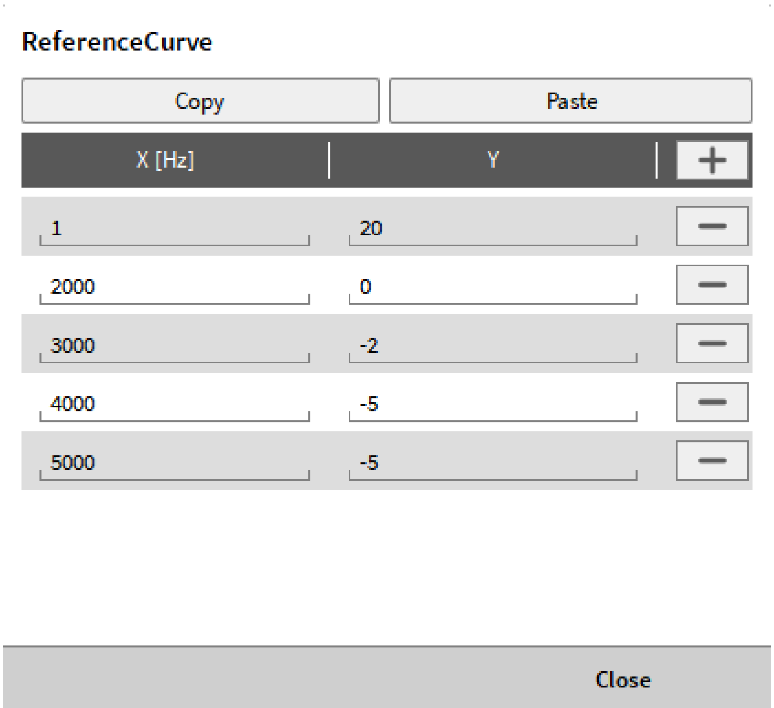

Fig. 8.55: Table for reference curves definition

The following Fig. 8.56 and Fig. 8.57 demonstrate the steps to create an orange and a red reference curve:

1. Click on the *Edit...* button
2. Press *+* to add one or more lines to the table
3. Enter the frequency and the corresponding reference value to the table
4. Press *Close* when finished and the curve will instantly be displayed

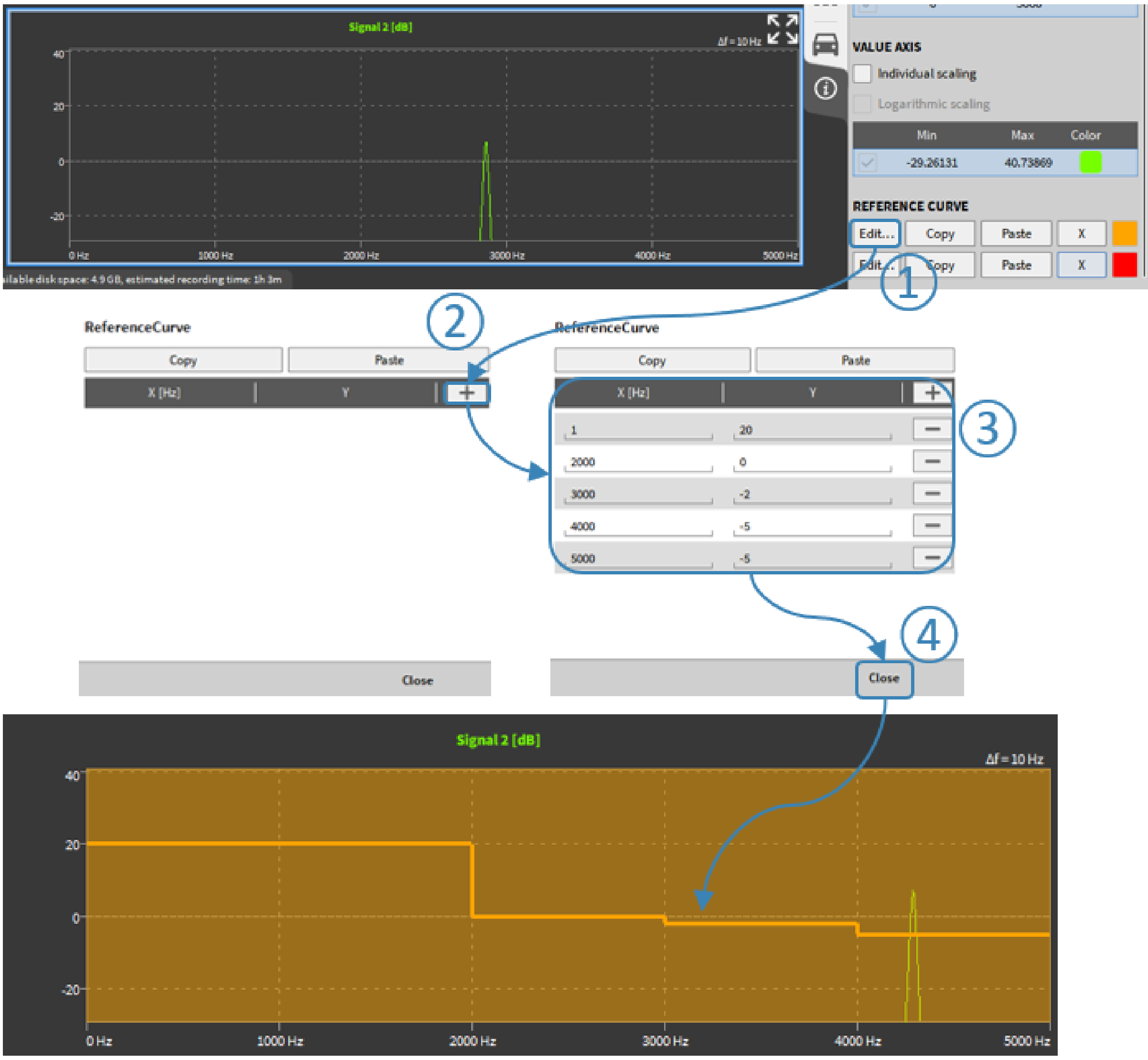

Fig. 8.56: How to create an orange reference curve

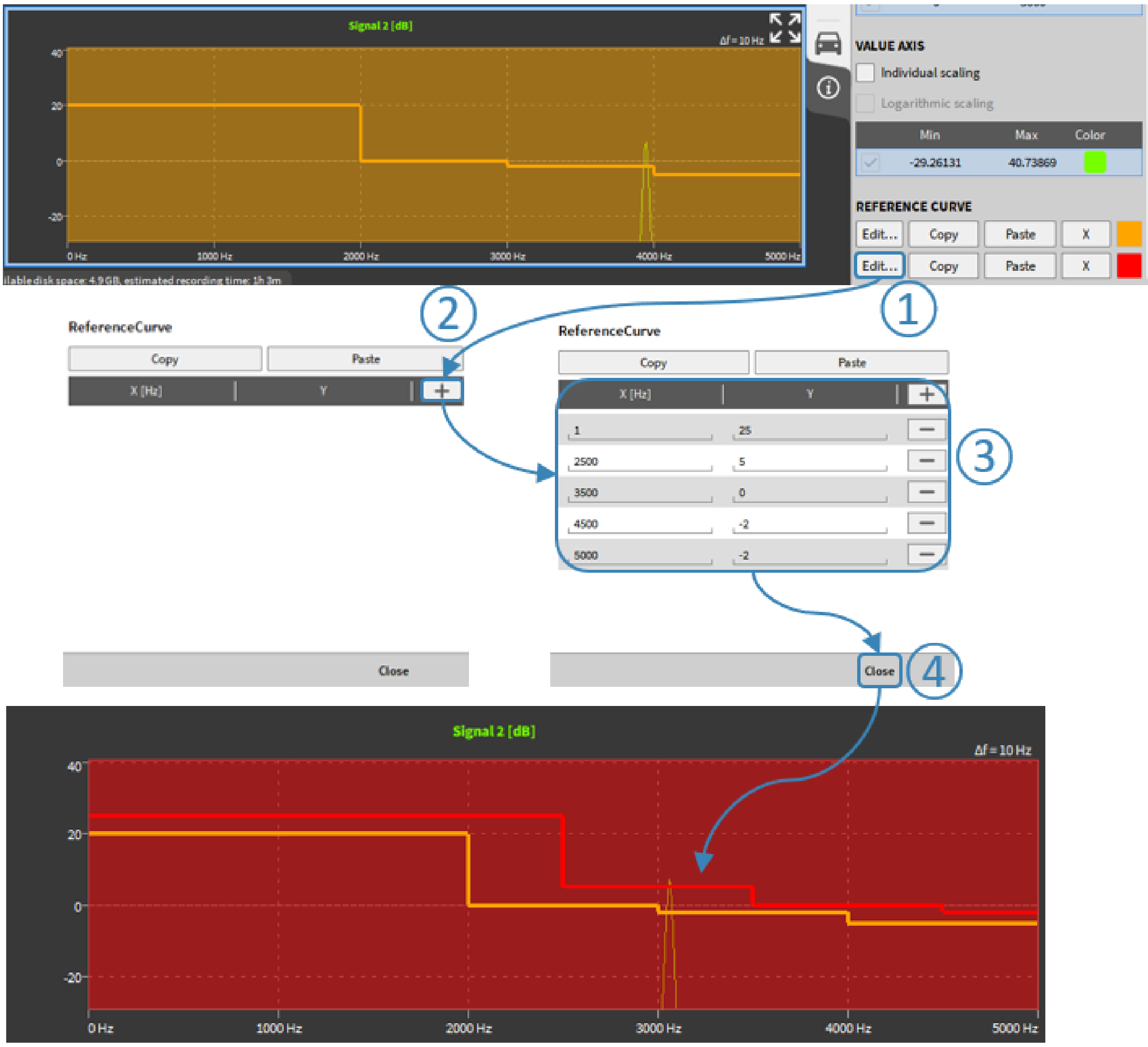

Fig. 8.57: How to create a red reference curve

The *Copy* and *Paste* buttons can be used to copy and paste the table from the orange to the red curve and vice versa (see Fig. 8.58) or to export and import a value table into / to clipboard for interacting with Excel or other 3rd party software (see Fig. 8.59).

The *X* button (see Fig. 8.54) can be used to delete a reference curve again.

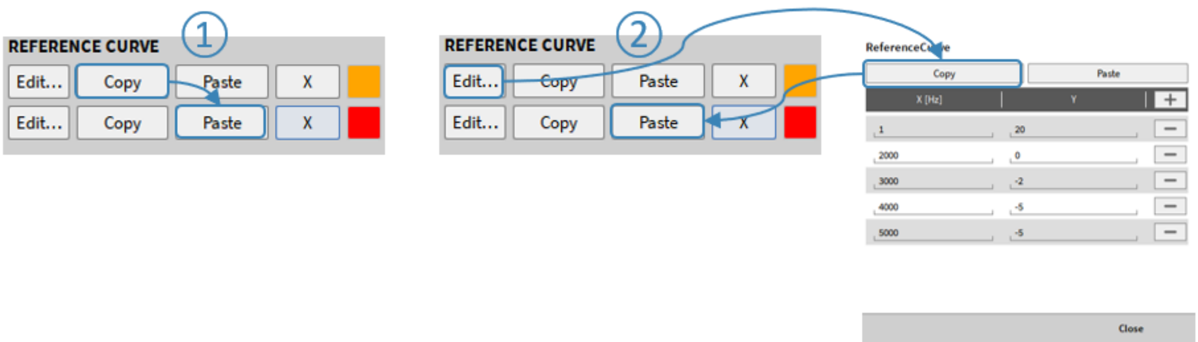

Fig. 8.58: Copy and paste settings from one reference curve to another

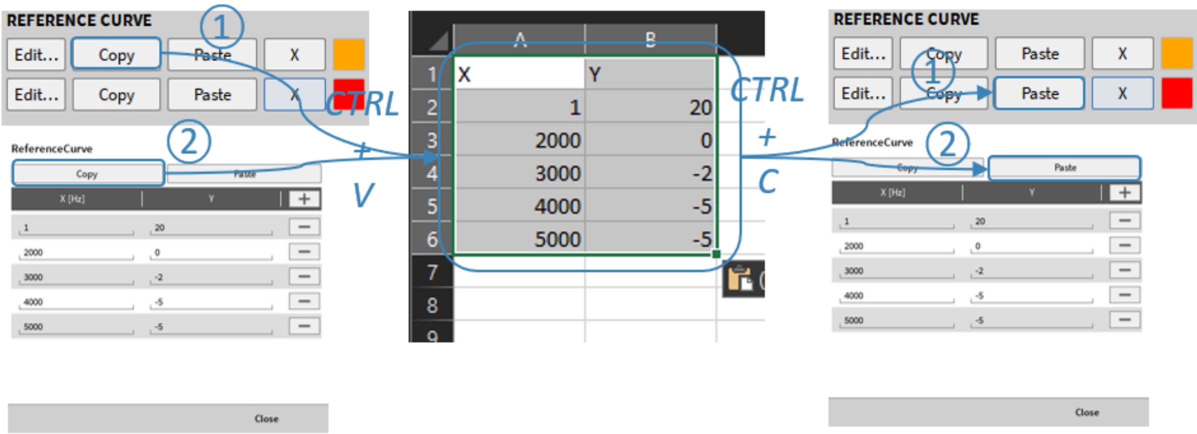

Fig. 8.59: Copy and paste values from/into Excel

As soon as the table has been set up, the reference curve will be displayed in the Spectrum Analyzer (see Fig. 8.60, Fig. 8.61 and Fig. 8.62).

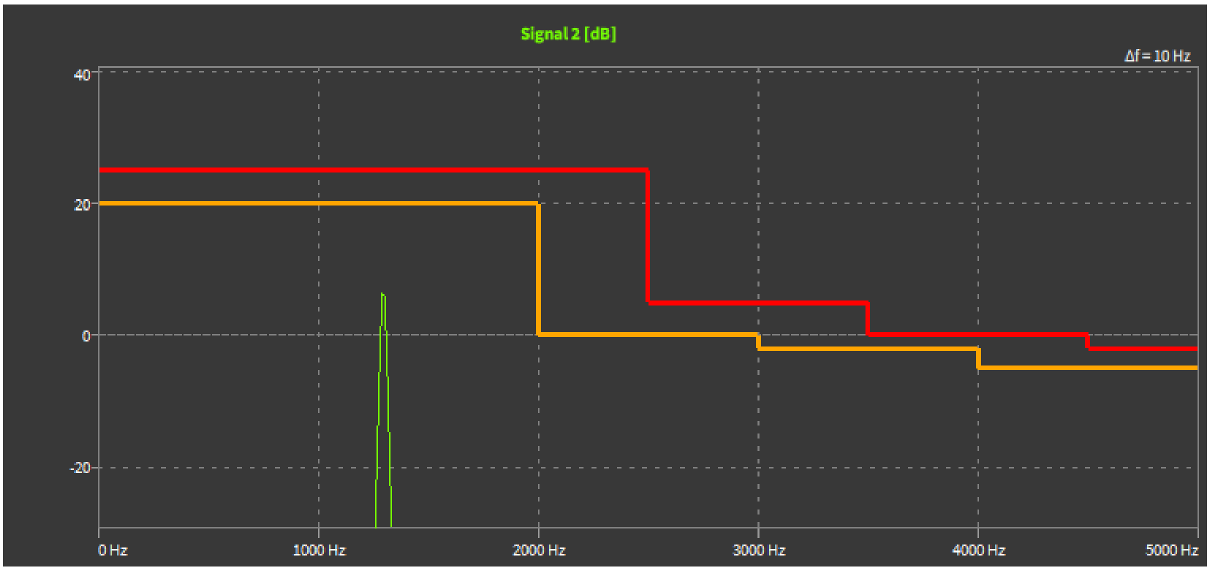

Fig. 8.60: Reference curves without limit exceeded

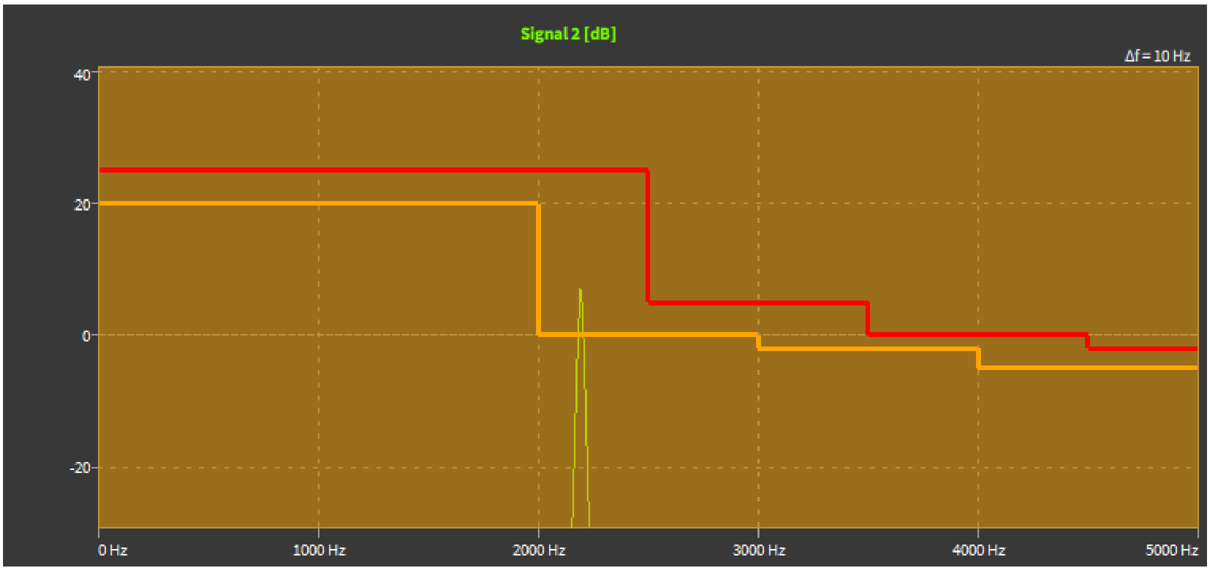

Fig. 8.61: Reference curves with orange limit exceeded

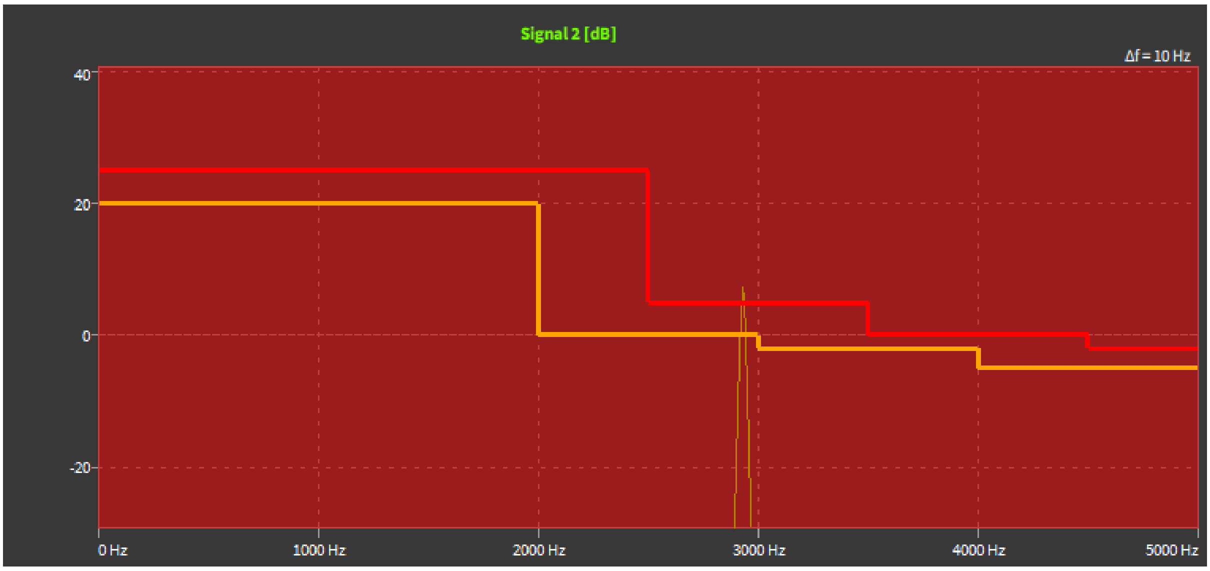

Fig. 8.62: Reference curves with orange and red limit exceeded

8.12.9 Cross hairs

There are 2 options for crosshairs: *Use crosshair cursor* and *Use peak cross hair*. Additionally the Line width of the cross hair can be defined.

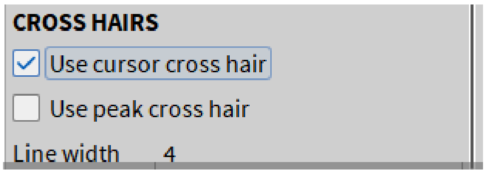

Fig. 8.63: Cross hairs option of the spectrum analyzer

With the "Follow Peak" function at the Crosshairs option, the peak value in the visible area of the FFT instrument is visually marked with the help of a crosshair (see Fig. 8.64). The cross hairs jumps automatically to the highest peak, which makes it easy to recognize.

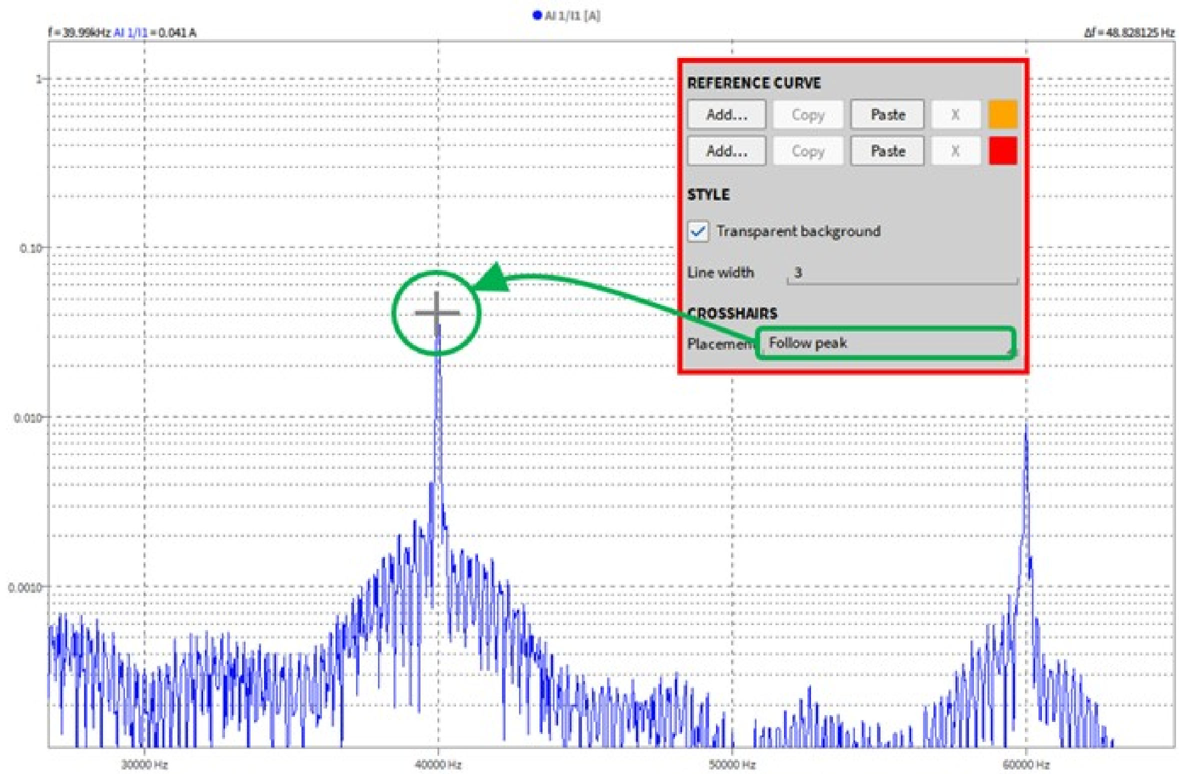

Fig. 8.64: Follow Peak

8.12.10 Additional information for the spectrum analyzer properties

Further explanations on line resolution, normalization, and averaging are provided below.

Additional information: improve line resolution (Enable zero-padding)

If *Improve Line Resolution* is selected, zero-padding is enabled. The following paragraph explains the idea of zero-padding and its properties.

Theory of zero-padding

If zero-padding is not applied, the line resolution and thus the accuracy of a FFT depends on the length of the transformed signal and on the sample rate:

$$Line\ Resolution = \frac{\text{Samplerate}}{\text{Window size}}\,[Hz]$$

The data size is equal to the number of FFT bins here. Thus, a higher line resolution can be achieved by reducing the sample rate or increasing the data size. Normally, a sample rate reduction cannot be accepted due to bandwidth reasons. Increasing the data size may cause problems in Realtime applications, because the delay until an FFT is displayed increases with increasing data size. Moreover, if short signals are transformed, a data size increment is simply not possible.

Zero-padding adds zeros at the end of the signal part to be transformed and thus increases the data size artificially. Please note that the *Data size* is not any more equal to the number of FFT bins. The following example will clarify that: A 64-sample signal in time domain shall be matched to an FFT with 256 FFT bins. Therefore, 192 zeros must be added at the end of the 64-sample signal in time domain. Thus, the Line resolution can be determined according to the following formula:

$$Line\ Resolution = \frac{\text{Samplerate}}{Window\ size + Number\ of\ zeros} = \frac{\text{Samplerate}}{\text{Number of frequency lines}}\ [Hz]$$

In OXYGEN, the number of attached zeros can be manipulated indirectly by varying the *Data size* or the *Line resolution* in the Instrument Properties of the Spectrum analyzer (see *FFT properties for Time Domain Channels*).

In OXYGEN, the Line resolution can be selected from $\frac{\text{Samplerate}}{2^{20}}$ to $\frac{\text{Samplerate}}{\text{Window size}}$ if zero-padding is selected. If a lower line density is desired, zero-padding is not required and can be de-selected.

In the signal theory, the two most common application areas of zero-padding are the already explained increased sample density in the frequency domain and the signal enlargement to a length of 2^n samples, because time signals with a length of 2^n samples permit a faster FFT-computation.

Even though zero-padding increases the sample density in the frequency domain, the FFT is not more accurate if zero-padding is used. Zero-padding is only a kind of an interpolation and does not increase the resolution. This characteristic is shown in *Zero-padding – A practical example*. To increase the resolution, a longer signal in time domain is required.

Note: Zero-padding is applied after multiplying the signal with the window function.

Zero-padding – A practical example

In this section, zero-padding is explained with an easy practical example. For this purpose, the following signal is used:

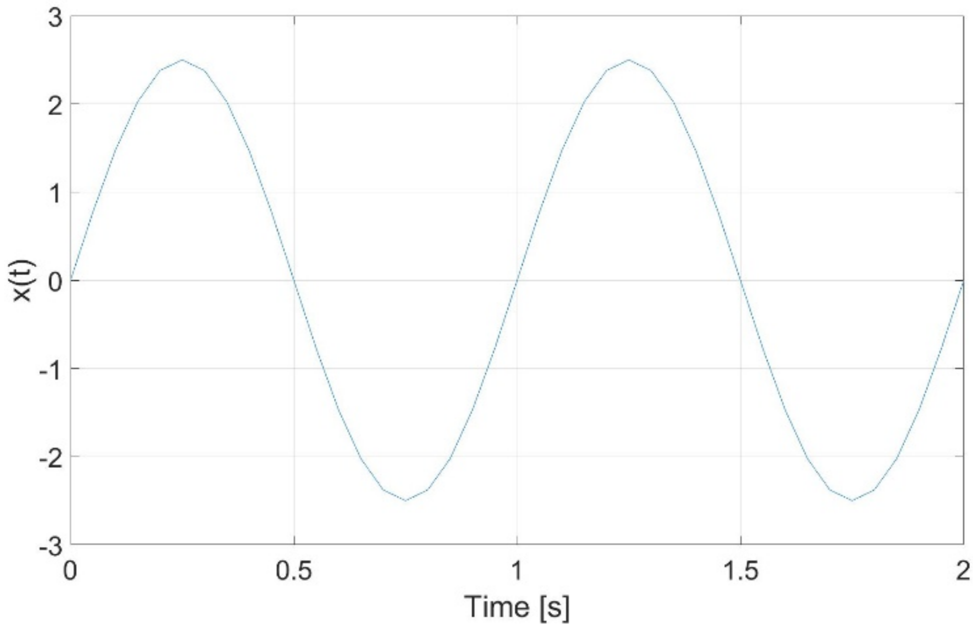

Fig. 8.65: Signal 1 in time domain, 2s (41 samples)

$$x(t) = 2.5 * sin(2 * \pi * 1 * t)$$

The signal has a length of 2 seconds and is sampled with 20 Hz. Thus, the signal consists of 41 samples. Transforming the signal into the frequency domain leads to the following spectrum:

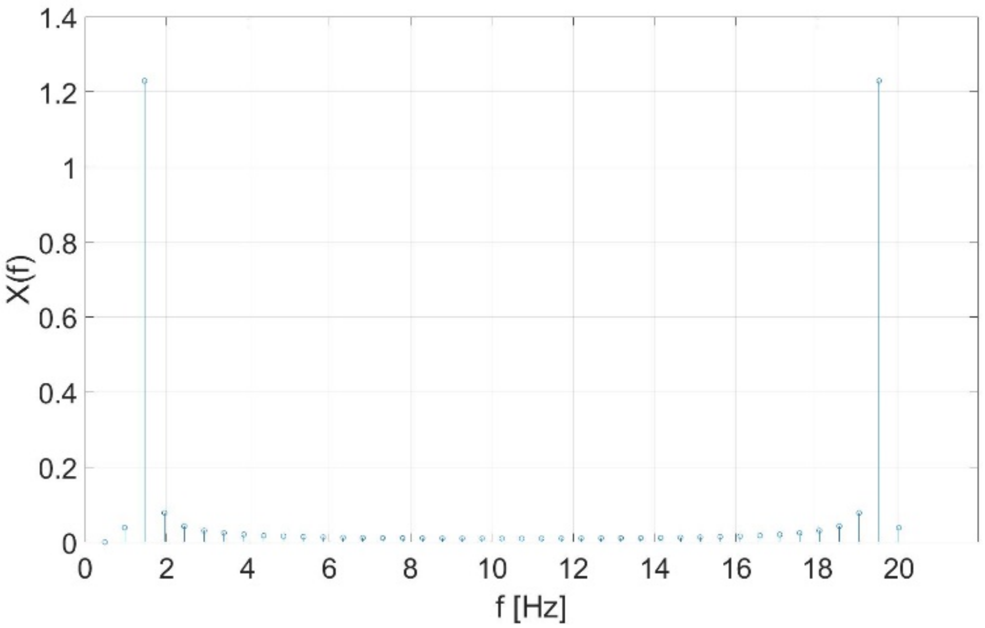

Fig. 8.66: Signal 1 in frequency domain, no zero-padding

The spectrum consists of 41 bins and the peaks @1 Hz and 19 Hz are clearly visible.

Now, the signal length is enhanced from 41 samples to 64 samples by adding 23 samples at the end of the signal:

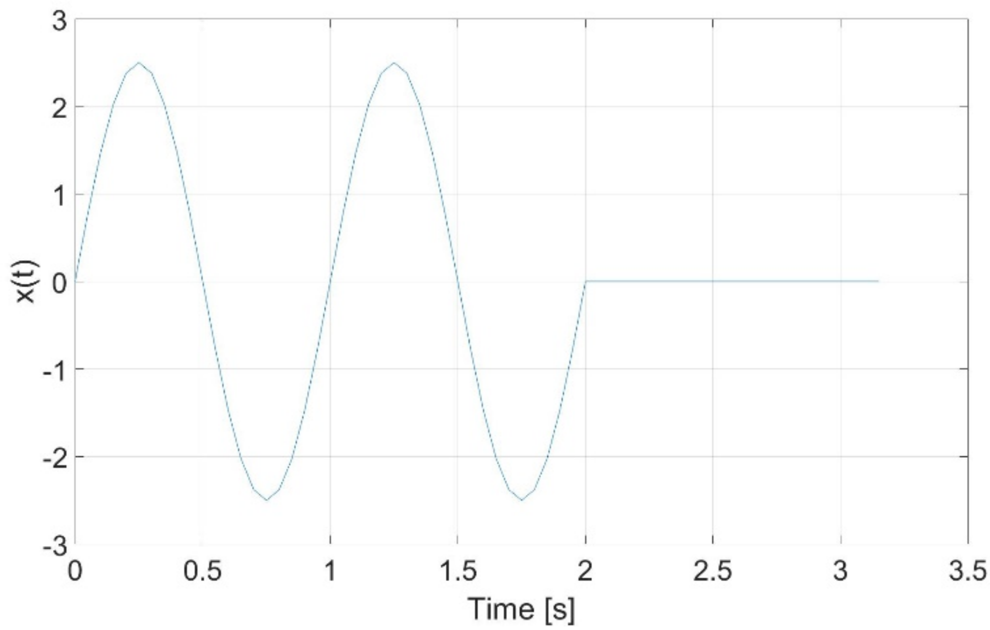

Fig. 8.67: Signal 1 in time domain, zero-padding to 64 samples

Transforming the signal to the frequency domain leads to the following spectrum:

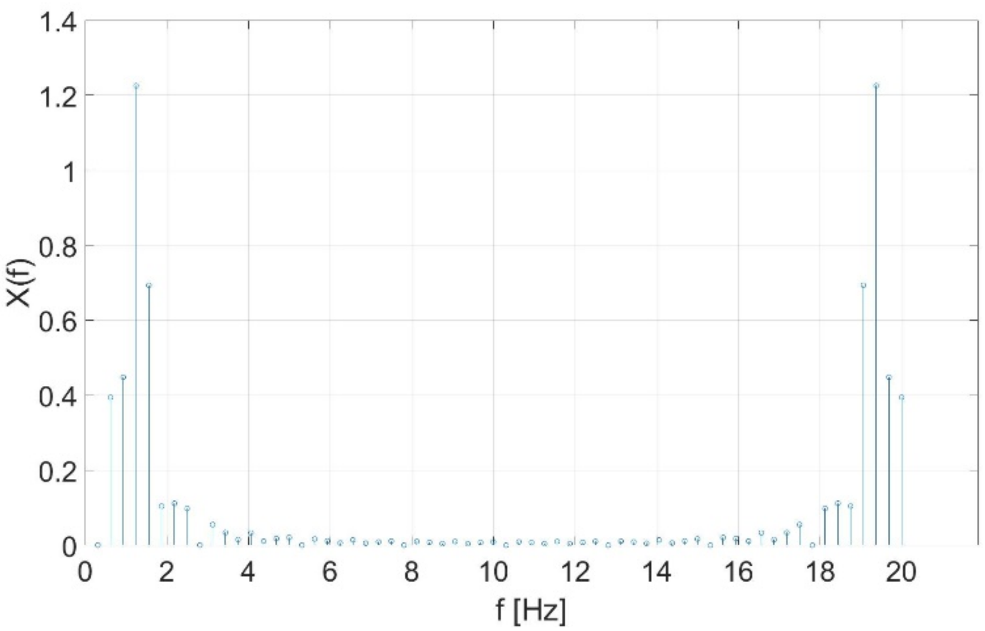

Fig. 8.68: Signal 1 in frequency domain, zero-padding to 64 samples

Now the spectrum consists of 64 samples and not 41 samples and the additional frequency bins are kind of an interpolation but do not lead to a sharper spectrum.

The same trend is visible if the original signal is enhanced from 41 samples to 128 samples by adding

87 zeros at the end of the signal:

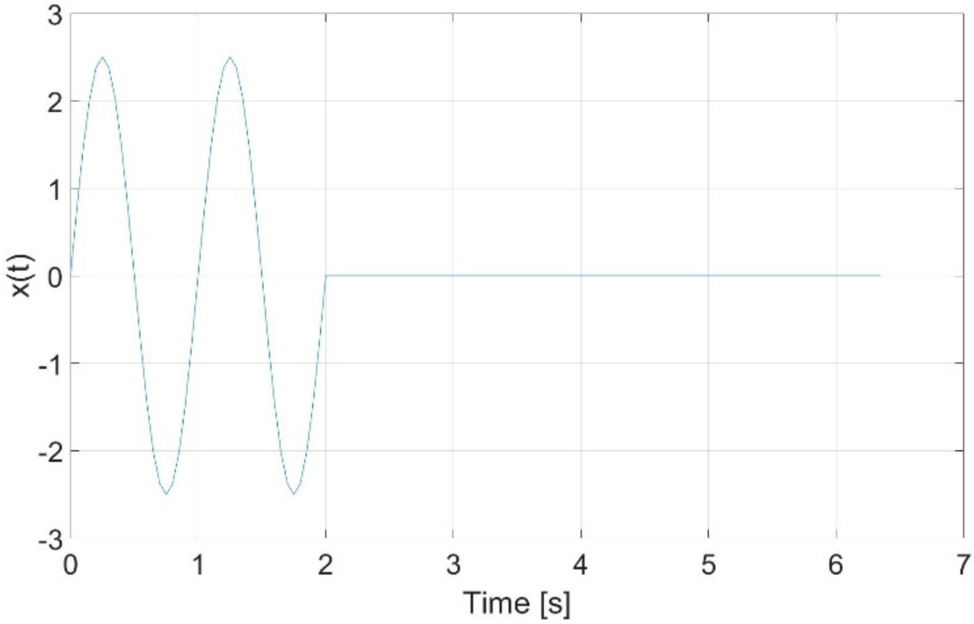

Fig. 8.69: Signal 1 in time domain, zero-padding to 128 samples

This signal leads to the following spectrum with 128 frequency bins:

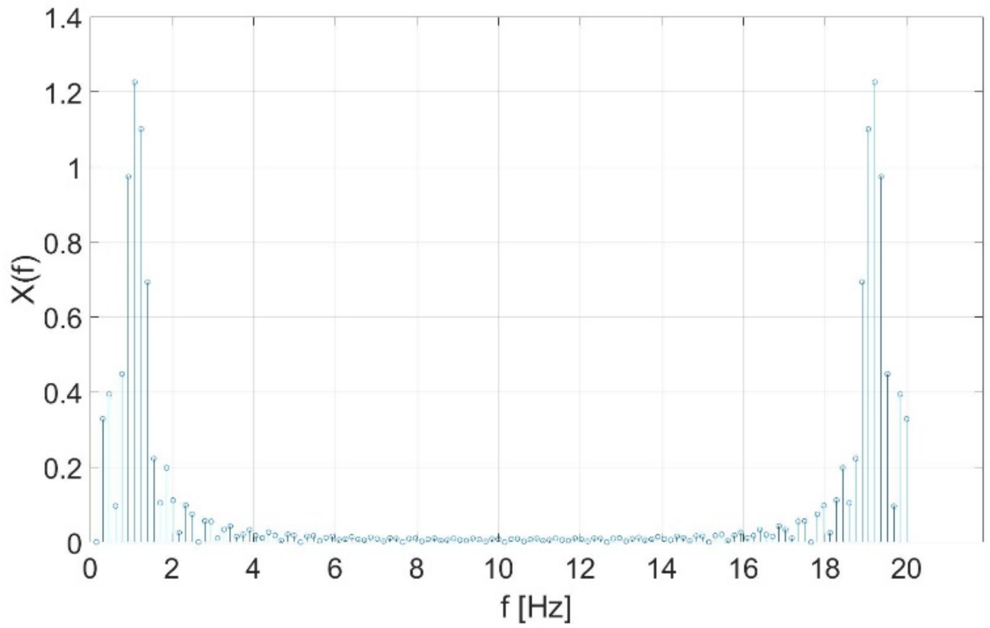

Fig. 8.70: Signal 1 in frequency domain, zero-padding to 128 samples

Again, the additional bins are only kind of an interpolation, but do not lead to a sharper spectrum.

To enlarge the accuracy of the FFT, a longer signal in time domain is required. Therefore, the original sine signal is enlarged to 6.4 seconds (128 samples):

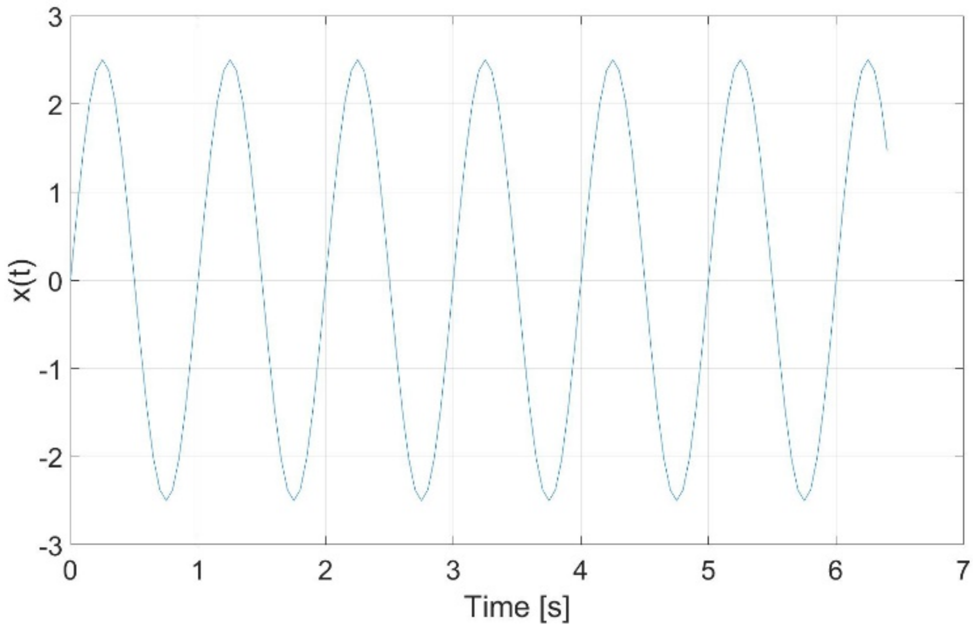

Fig. 8.71: Signal 2 in time domain, 6.4s (128 samples)

The resulting spectrum consists also of 128 bins but now, the additional bins really lead to a sharper spectrum and are no longer only an interpolation of the original 41 frequency bins:

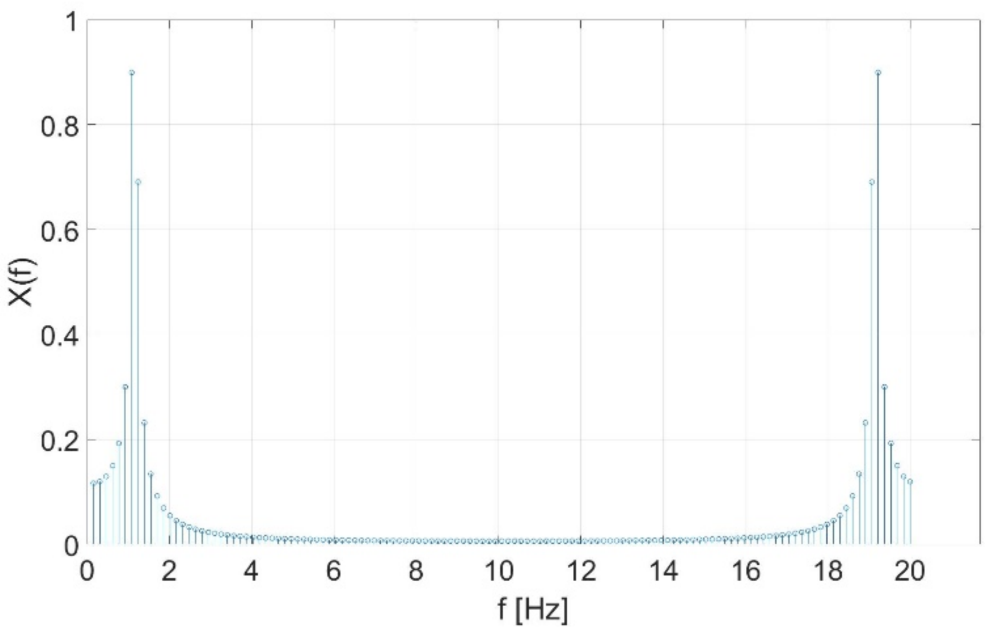

Fig. 8.72: Signal 2 in frequency domain, no zero-padding

Additional information: normalization of FFT Spectra

In this section, the necessity of the normalization during the FFT calculations is explained. Therefore a 50 Hz sine wave with 2.5 amplitude shall be transformed to the frequency domain. The sample rate is 1000 Hz and the signal length 10s. The signal looks as follows in time domain:

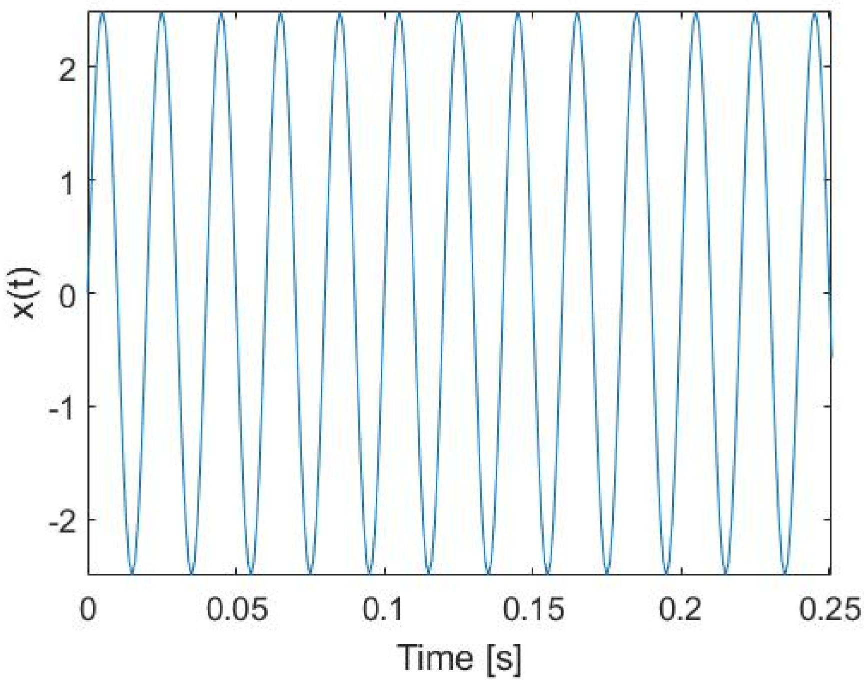

Fig. 8.73: Signal in time domain (first 250 ms)

$$x(t) = 2.5 * sin(2 * \pi * 50 * t)$$

After transforming the signal into the frequency domain according to the formula

$$Y_k = \sum_{n=0}^{N-1} X_k e^{\frac{-i2\pi kn}{N}}; \quad k = 0 \dots N-1 \qquad (N = 10001)$$

and determining the absolute value, the spectrum is the following:

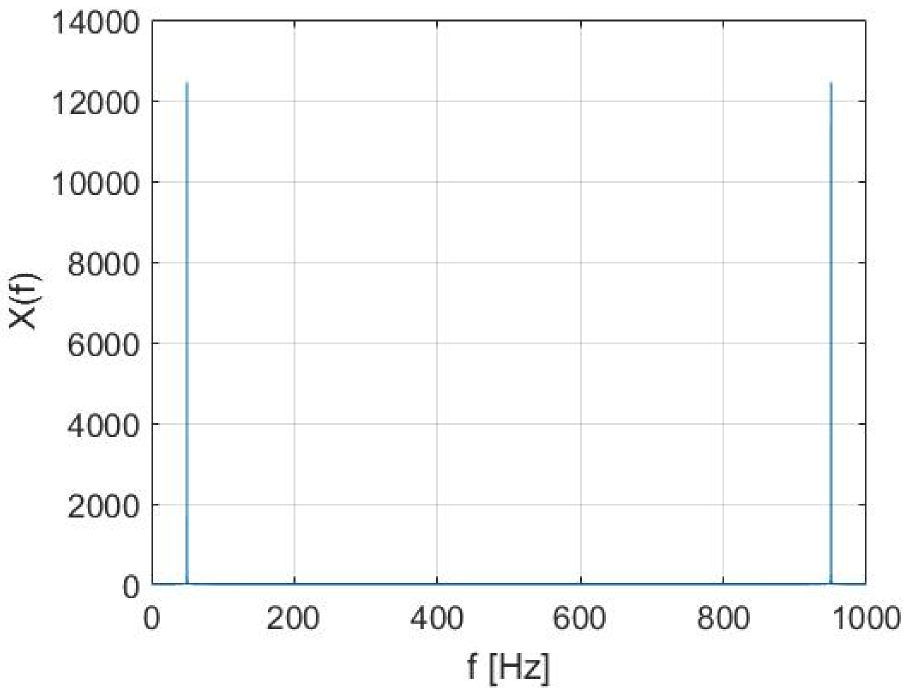

Fig. 8.74: x(t) in frequency domain

Two things are peculiar:

- As the FFT produces a two-sided spectrum, there is a bin @ 50 Hz and @ 950 Hz.
- As the signal level of the two peaks is ~12500, the unit seems to be arbitrary.
- To create a comprehensible signal unit, the Fourier Transform of the signal must be divided by the length of the FFT which is 10001 in this example.

$$Y_{\mathrm{nor}m_k} = \frac{Y_k}{N}; \quad k = 0 \ldots N-1 \quad (N = 10001)$$

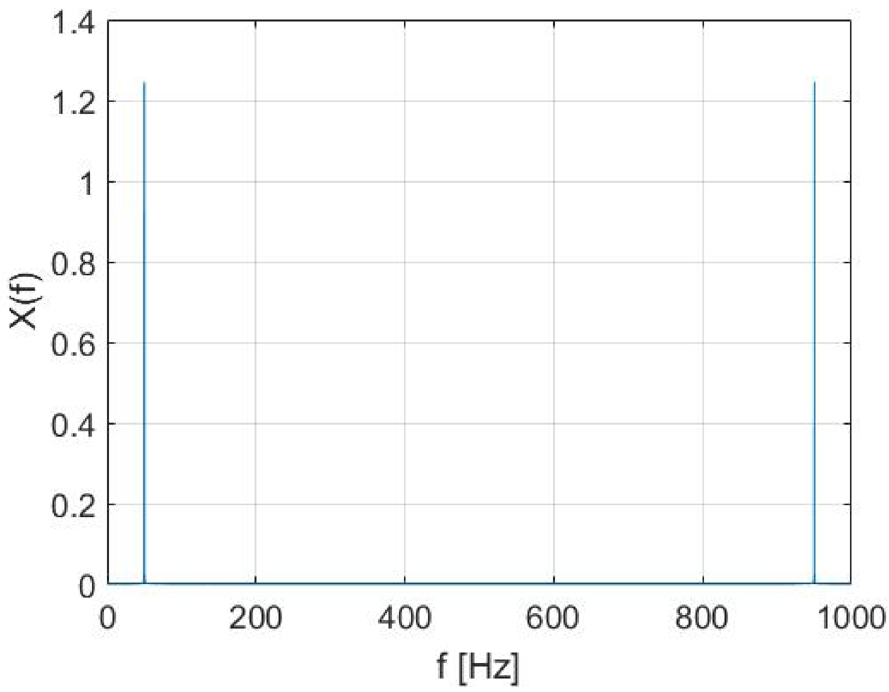

Fig. 8.75: x(t) in frequency domain divided by the FFT-length

Now, the amplitude of both peaks is ~1.25. As we still have two peaks whose sum is ~2.5, the signal unit issue is solved by dividing the spectrum by the length of the FFT.

In a next step, we truncate the spectrum at the Nyquist frequency ($\left(\frac{f_s}{2}\right)$) which is 500 Hz in our case and multiply the remaining spectrum from 0 to 500 Hz with the factor 2 to ensure that the power of the signal in the frequency domain is still the same as in the time domain. After that, the following spectrum results:

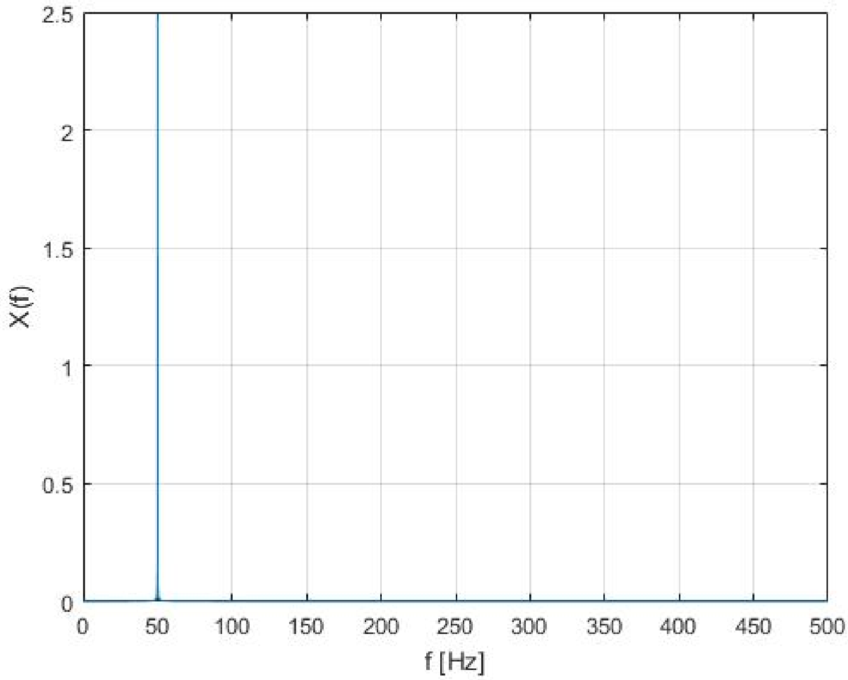

Fig. 8.76: One-sided spectrum X(f) multiplied by factor 2

In this first example, there is no normalization needed, because we didn't use a window function. In this case, there was no window function needed, because we transformed a finite and periodical signal. In practice, this is normally not the case and a continuing signal is transformed block by block. As these block lengths are finite, the Leakage effect occurs if the block length does not coincidentally match with an integer multiple of the signal period. In this case, the frequency spectrum becomes too wide. This is a natural effect resulting from the Fourier Transform property which says that a multiplication in time domain leads to a convolution in the frequency domain. The fact that the frequency spectrum becomes too wide can be optimized but not completely rejected by the usage of a window function. This leads to the fact that the signal is faded in at the beginning of the window and faded out at the end of the window. Thus, an artificial periodical signal results and an error in the signal amplitude results. This amplitude error is corrected by the normalization of the signal.

Let's assume again the 50 Hz sine wave with 2.5 amplitude shown in Fig. 8.73 and multiply it with a Hanning window. The formula for the creation of a Hanning window can be found in section *Window type*. After the multiplication, the signal looks as follows:

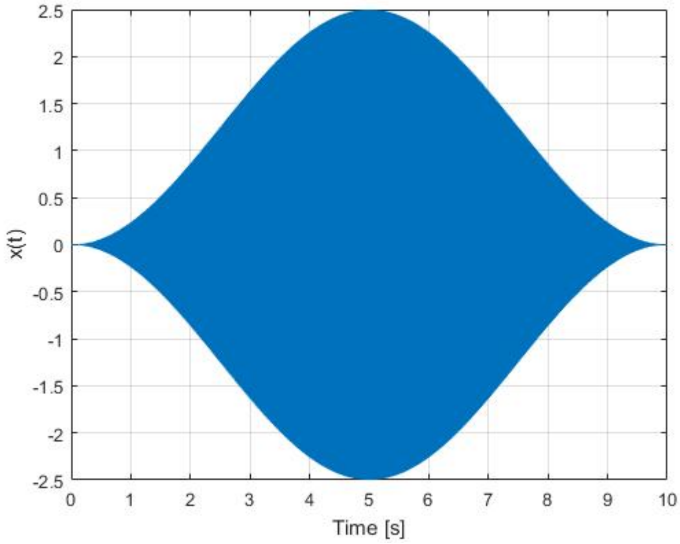

Fig. 8.77: x(t)$_{\text{win}}$ in time domain; multiplied with a Hanning window

$$x(t)_{\text{win}} = [2.5 * sin(2 * \pi * 50 * t)] * \left[0.5 * \left(1 - \cos\left(\frac{2 * \pi * n}{N-1}\right)\right)\right]; \quad n = 0 \ldots N-1$$

The spectrum of the signal looks as follows:

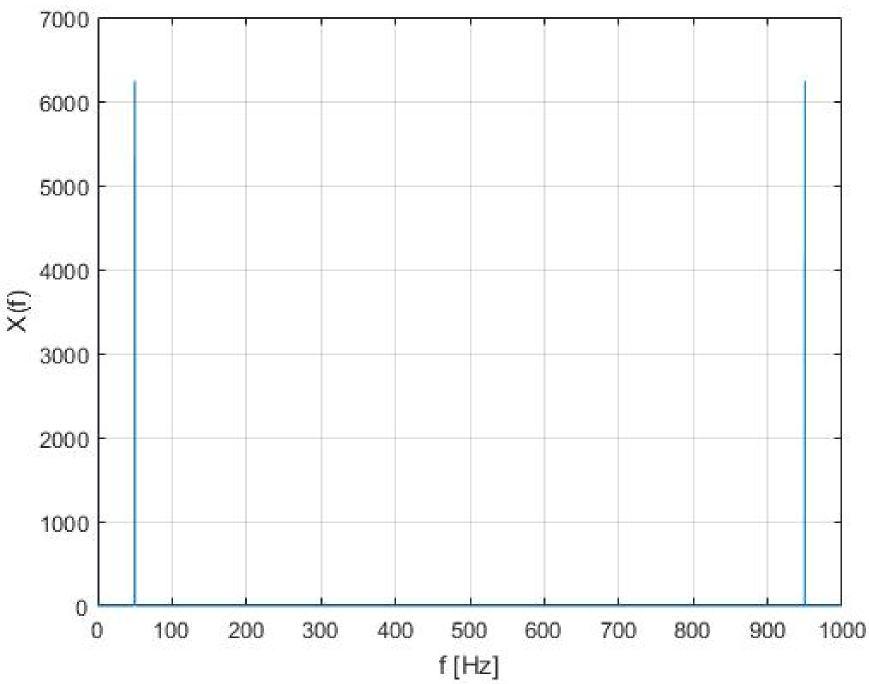

Fig. 8.78: x(t)$_{\text{win}}$ in frequency domain

Again, the signal unit looks arbitrary. Thus, we divide the spectrum by the length of the FFT (N=10001) again.

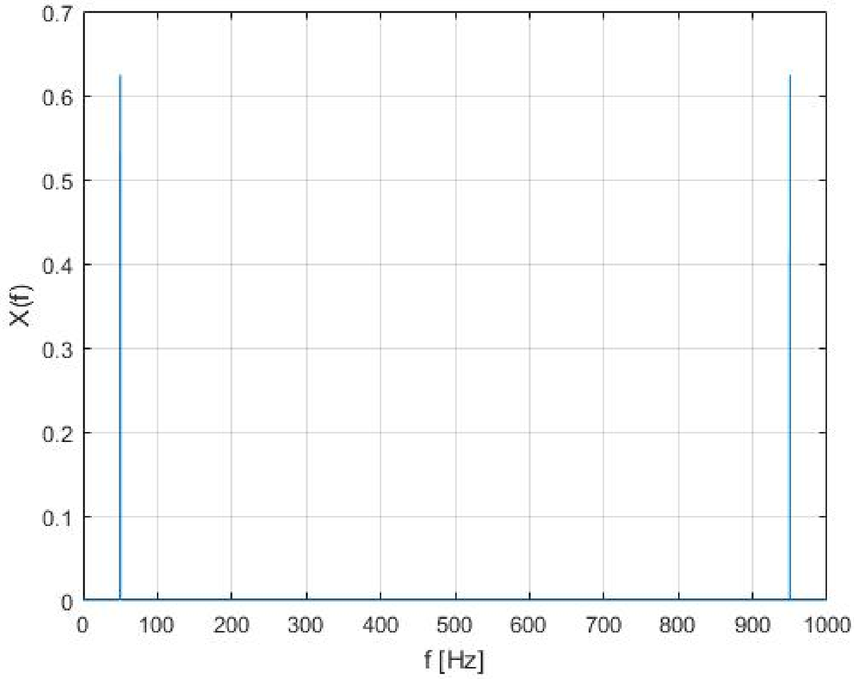

Fig. 8.79: $x(t)_{win}$ in frequency domain divided by the FFT-length

After that we truncate the signal again at the Nyquist frequency and multiply the remaining spectrum with the factor 2 to secure that the signal power in time and frequency domain is equal.

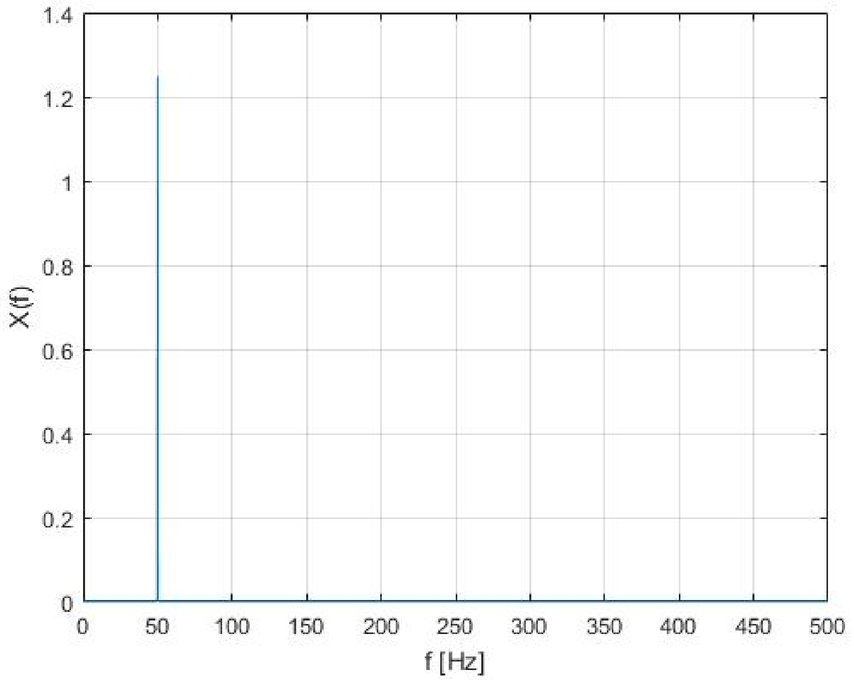

Fig. 8.80: One-sided spectrum $X(f)_{win}$ multiplied by factor 2

Now we clearly see that the peak @50 Hz is not 2.5 as before but only ~1.25. This is because of the windowing. This can be corrected with the normalization. There are two possibilities: We can either normalize the spectrum to the original signal amplitude or to the original signal power.

To refit the spectrum according to the original signal amplitude, we must select the *Amplitude True* normalization:

$$X(f)_{\text{win}_{\text{AmpCorr}}} = X(f)_{\text{win}} * [\frac{N}{\sum_{k=1}^{N} W_k}]$$

where N denotes again the window (and signal) length and W_k the value of the window function at position k.

There we can see that the peak @50 Hz is again 2.5. But in this case, the signal power in frequency domain is not the same as in time domain. If this is required, we must select the *Power True* normalization:

$$X(f)_{\text{win}_{\text{PowCorr}}} = X(f)_{\text{win}} * \sqrt{\frac{N}{\sum_{k=1}^{N} W_k^2}}$$

where N denotes again the window (and signal) length and W_k the value of the window function at position k.

Now, the power in frequency domain is the same as in time domain, but the amplitude does not match correctly anymore.

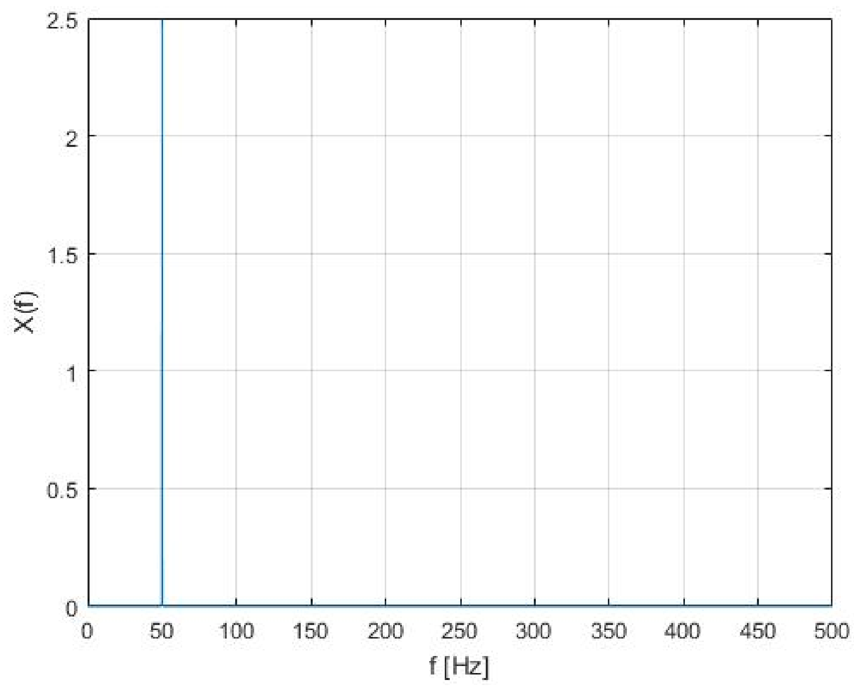

Fig. 8.81: Amplitude-True-normalized spectrum X(f)

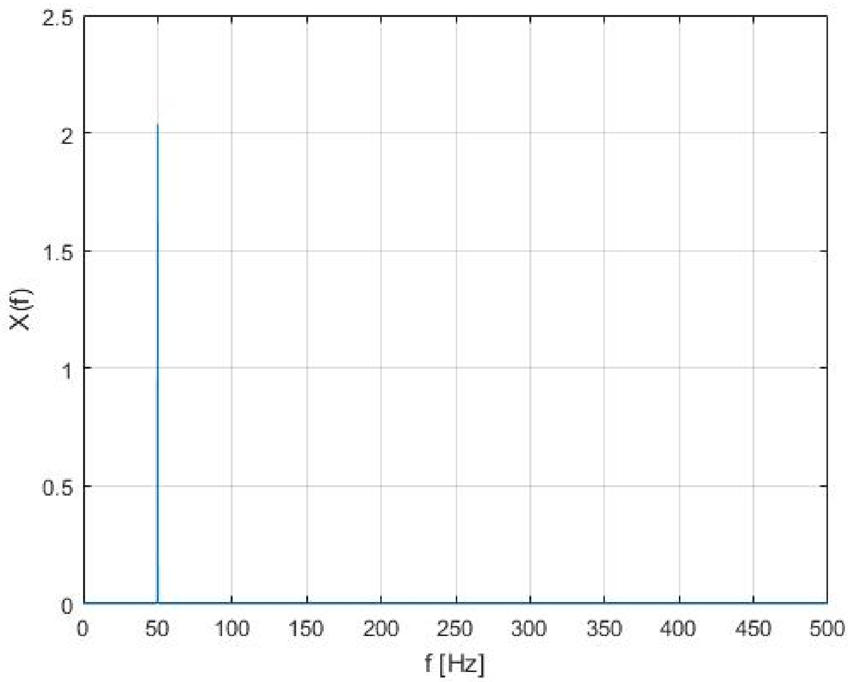

Fig. 8.82: Power-True-normalized spectrum X(f)

Additional information: calculation of a Periodogram

This section will demonstrate the calculation of a periodogram on a practical example. The exemplary window size is 1000 samples. The following figures illustrate the decomposition of a time signal for the calculation of a periodogram:

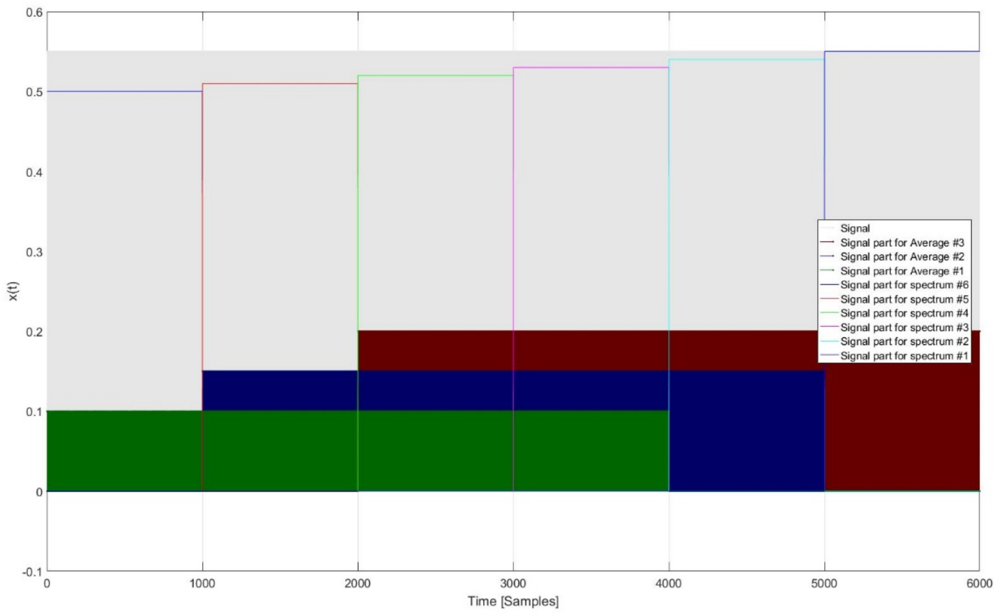

Fig. 8.83: Decomposition of the time signal for a Periodogram with an average of 4 spectra and 0 % overlapping

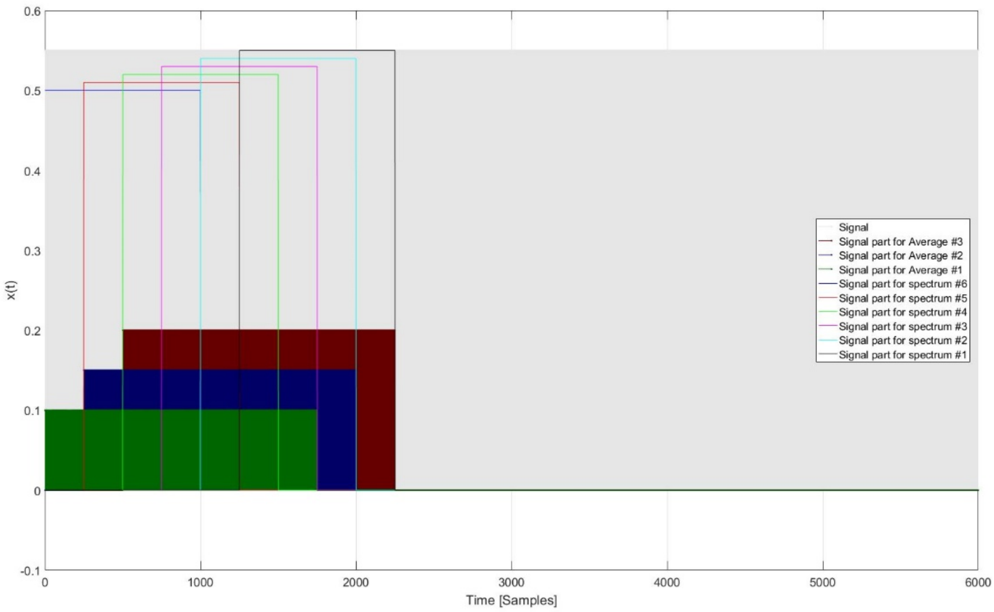

Fig. 8.84: Decomposition of the time signal for a Periodogram with an average of 4 spectra and 75 % overlapping

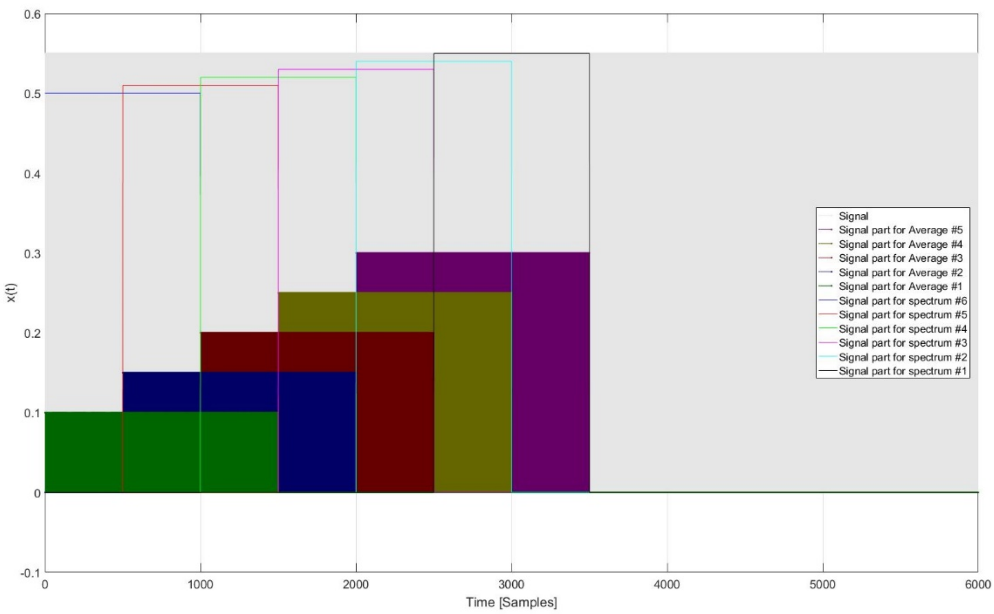

Fig. 8.85: Decomposition of the time signal for a Periodogram with an average of 2 spectra and 50 % overlapping

8.12.11 FFT for recorder region

It is also possible to calculate the FFT for the assigned time domain channel based on a selection from A/B cursor in a recorder. For this to work, the recorder needs to be on the same page and has its settings to “Link mode: Instruments on page” (①). The channel of the recorder must be also assigned to the spectrum analyzer and the FFT option “Link to Recorder Cursor” must be enabled (②).

Fig. 8.86: Spectrum analyzer with data based on recorder region

This function is available in LIVE (freeze), Recording (Deja-View) and PLAY mode.

8.13 Video instrument

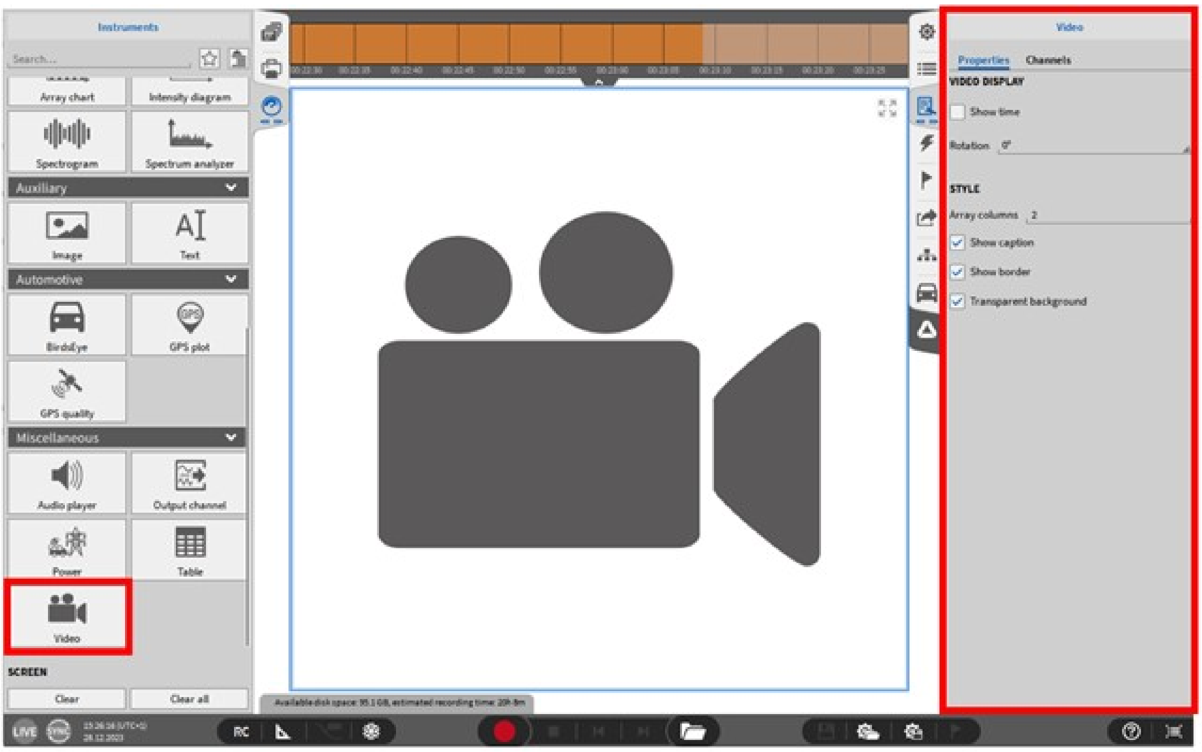

Fig. 8.87: Video instrument – overview

OXYGEN provides the possibility to record a video during the measurement. The following cameras types are supported:

- USB webcams
- DEWE-CAM-GIGE-120 and DEWE-CAM-GIGE-50-HD
- ALVIUM 1800 U-240 and ALVIUM 1800 U-040
- ALVIUM G1 and G5

For example, this is a very useful tool for automotive applications when a test run is performed, and the test track shall be recorded. Please note that the camera channels are not activated by default in a new setup. This can be changed in the *Data Channels* menu in the *Video Channels* section by clicking on the *Activate* switch. This will activate your plugged camera. For enabling the record mode as well, make sure that the *Stored* button has the red colored background (see Fig. 8.88).

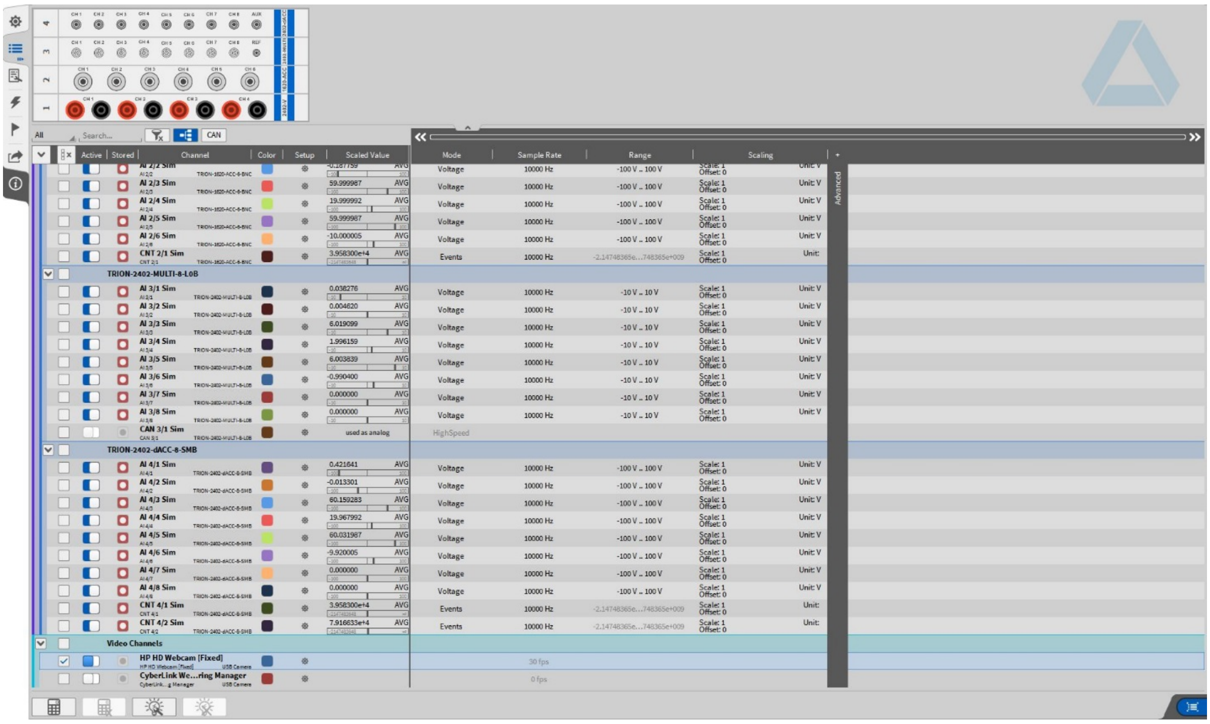

Fig. 8.88: Activate cameras and enable recording

After that the user can find the cameras in the *Data Channel* List of the Video Instrument and assign a video channel.

Note: The video recording with a webcam or a DEWE-CAM-GigE-120/-50-HD in fixed frame rate mode are not synchronized to the other measurement channels. When synchronized recording is required, OXYGEN supports time synchronous recording with a DEWE-CAM-GigE-120/-50-HD.

For the driver installation and the required software settings refer to the Installation Guide of the DEWE-CAM-GigE in OXYGEN.

Note: If the camera channel does not appear in the Channel List although a camera is connected to the measurement system, make sure that *CAMERA Series* for webcams or the *GIGECAMERA Series* for GigE cameras are enabled in the *DAQ Hardware* setup (see Fig. 8.89) in the *System Settings*.

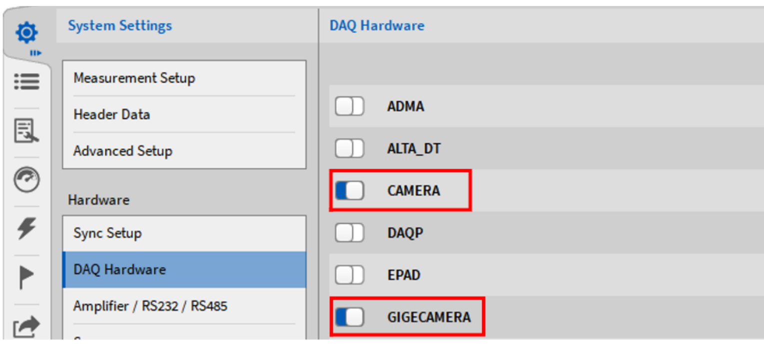

Fig. 8.89: Enabling the Camera Series and the GigE Camera series in the DAQ Hardware setup

The Video Instrument has the following Instrument Properties (see Fig. 8.87):

- Video display
  - If *Show time* is selected, the current measurement time is displayed in the Video Instrument
  - Rotation of video picture by 90°, 180° or 270°
- Style: The user can specify the number of columns if several channels are selected. Selection of a transparent or untransparent background.
- Layer: Moves the instrument in front of or behind another object (only applicable in *Design Mode*).

Note: For each connected camera, there exists a counter channel that counts the number of received frames since acquisition start. The channel has the same name as the respective camera with RcvdCNT appended. To activate the counter, you need to activate the channel (The channel is not activated automatically). The channel can be found in the *Video Channels* section of the Channel List (see Fig. 8.90).

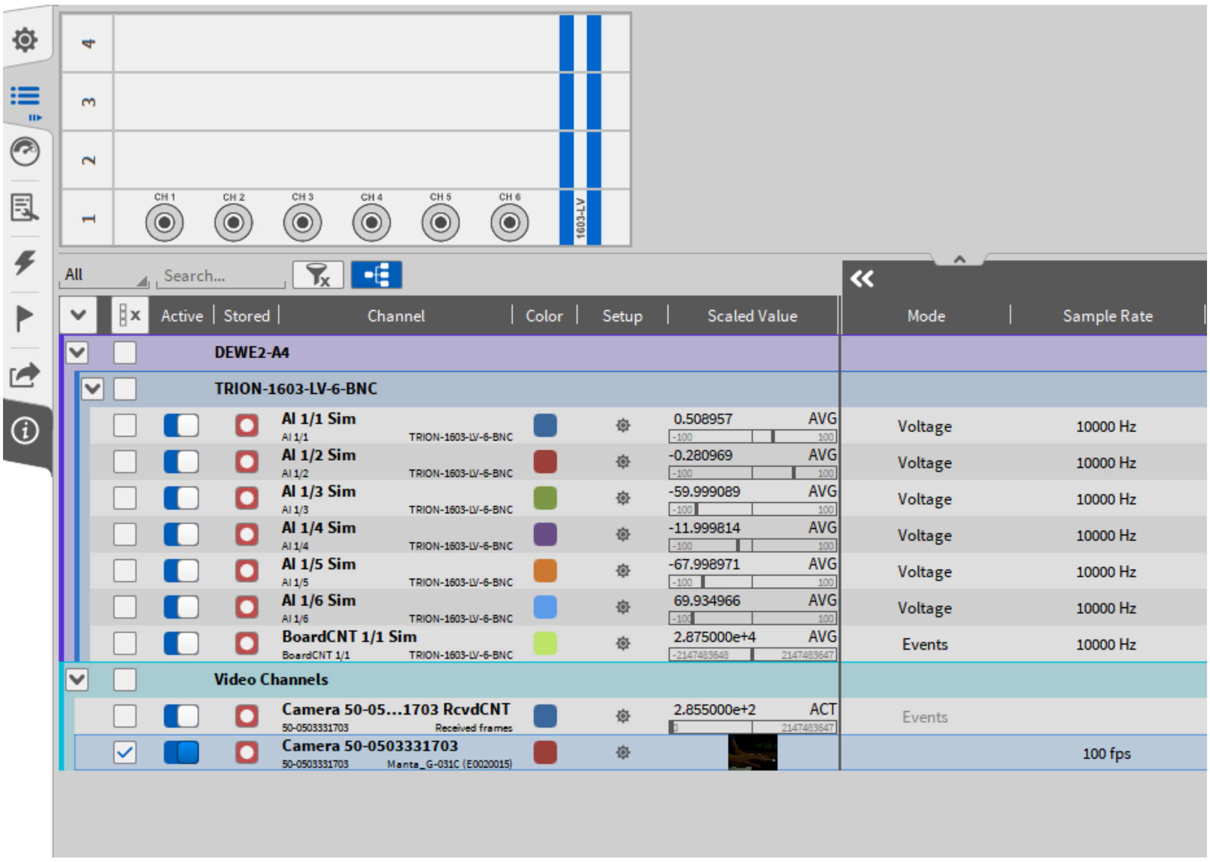

Fig. 8.90: Frame Counter Channel

Note: When using more than one USB camera, problems may occur under Windows 10® if they are connected on the same USB hub. The second camera (and others) may not work/show a picture. If more cameras shall be used, only one camera per USB hub should be connected to the system.

8.14 XY plot

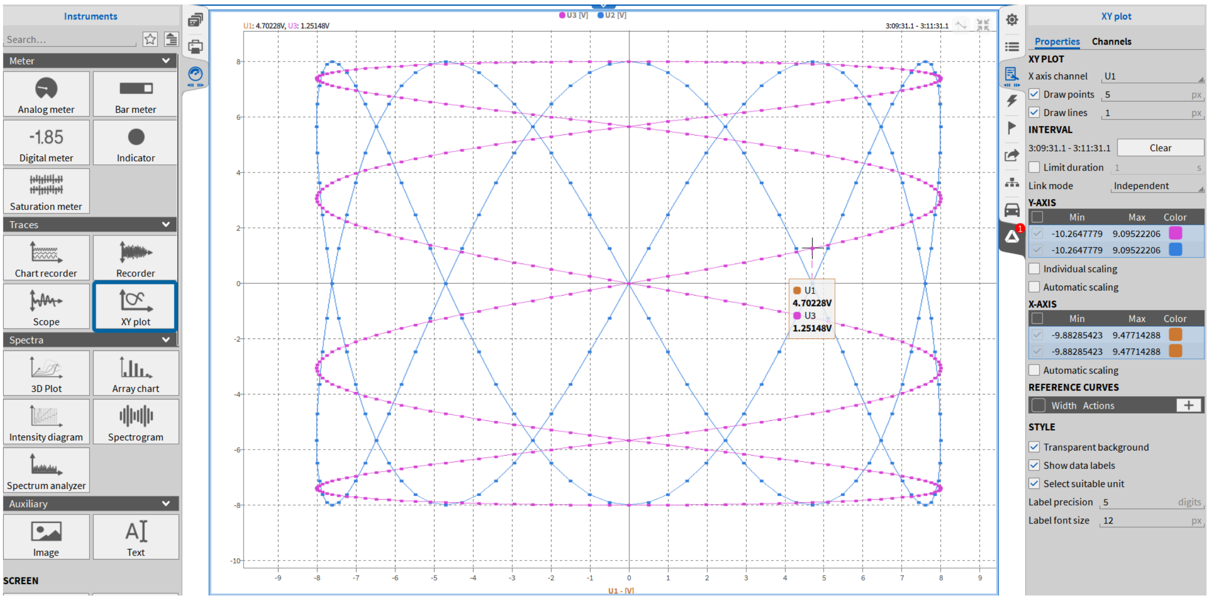

Fig. 8.91: XY plot instrument – overview

With the XY plot, it is possible to analyze the dependency of a measurement channel on the Y-axis to another one on the X-axis. A common application in the automotive sector is the analysis of the engine's sound pressure level (Y-axis) in the dependency of the motor speed (X-axis). The user can adjust the following instrument properties:

- XY plot
  - Use the X Axis Channel drop-down menu to select the channel that shall be plotted on the X-axis. Any further added channels (either via Drag-and-Drop or by clicking on them in the small data channels menu) will be plotted on the Y-axis.
  - Use Draw points and/or Draw lines to change the graphical characteristics of the plotted signal.
- Interval
  - The time interval of the plotted data is displayed here and in the upper right corner of the instrument. To start the drawing of a new plot and delete the currently displayed time interval, press the *Clear* button.
  - If the check box *Limit duration* is selected the user can define a time interval to limit the plotted information, i.e. when 1 second is selected, all information older than 1 second will be deleted automatically.
  - *Link mode* allows users to link the time axis of instruments. See *Linking the time axis of several recorders* for details.
- Y-axis:
  - Assign a user-defined min/max value to the Y-axis scaling
  - *Individual scaling* creates a separate Y-axis for each signal
  - *Automatic scaling* zooms the Y-axis to the actual displayed min and max value

- X-axis:
  - Assign a user-defined min/max value to the X-axis scaling
  - *Automatic scaling* zooms the X-axis to the actual displayed min and max value
- Reference curves:
  - Use the + button to create multiple reference curves as a visual boundary. These serve as guides only; no automatic action is triggered when data crosses a curve.
  - Click Edit to define the reference curve by entering X and Y coordinates. OXYGEN will draw linear segments between the defined points (see Fig. 8.92).

Note: The above-described reference curve applies solely for the XY-Plot. For the advanced math plugin Time Reference Curve, see chapter *Time reference curve*.

- Style:
  - Selection of a transparent or opaque background.
  - *Show data labels* hides/displays permanent data labels in PLAY mode
  - Edit precision and font size of data label via *Label precision* and *Label font size*
  - Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*)

The Channels tab lists all pairs of channels on the X-axis and Y-axis. New pairs can be added. The X-channel and Y-channel for each plotted pair can be manually defined.

The XY Plot instrument supports A/B cursors. Unlike in recorder instruments, no statistical calculations are provided here. The cursor table displays only the current values of cursors A and B, along with their difference. Regardless of whether A/B cursors or data labels are enabled, the crosshair cursor values are always displayed in the upper-left corner of the instrument.

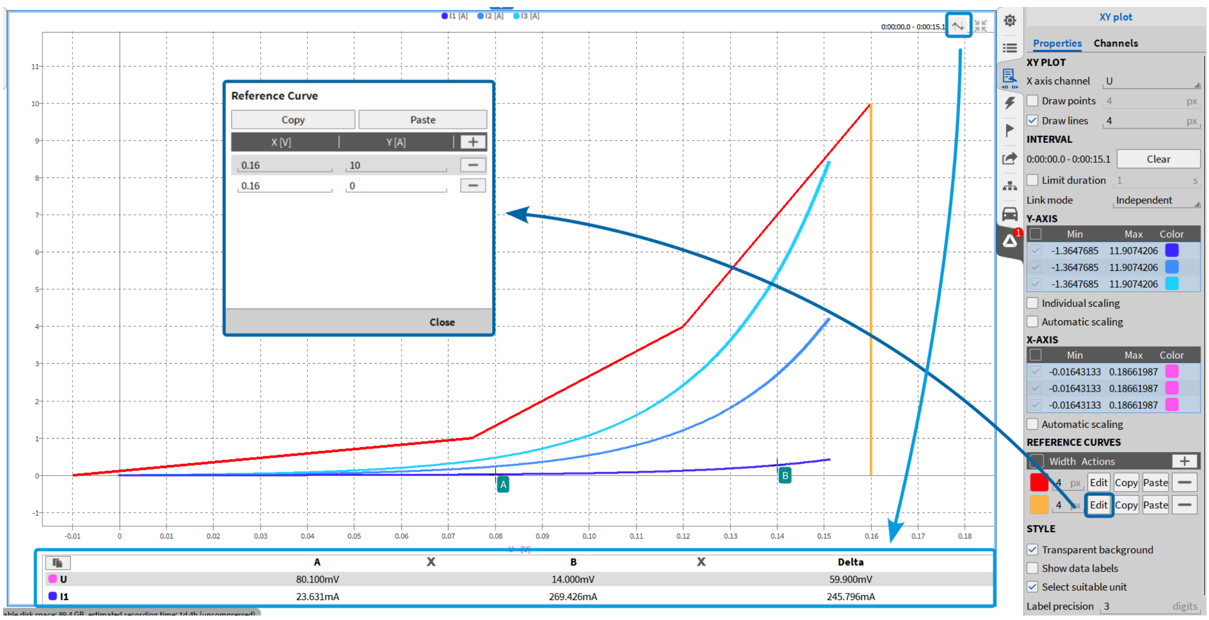

Fig. 8.92: XY plot – highlighted reference curve settings and A/B cursors

Note:

- Additional features for Y-axis scaling (see *Quick selection Y-axis scaling*) and zooming (see *Pinch/Scroll zoom feature*) are also supported in the XY-Plot Instrument
- In the *PLAY* mode and *LIVE* mode (with frozen screen) the user can scroll through the measurement data by moving the orange time marker in the Overview bar or in a Recorder if one is displayed. The Interval settings in the Instrument Properties are respected during this operation.
- Up to 10 channel pairs (X-channel and Y-channel) channels can be assigned to a single Table Instrument.

8.15 GPS plot

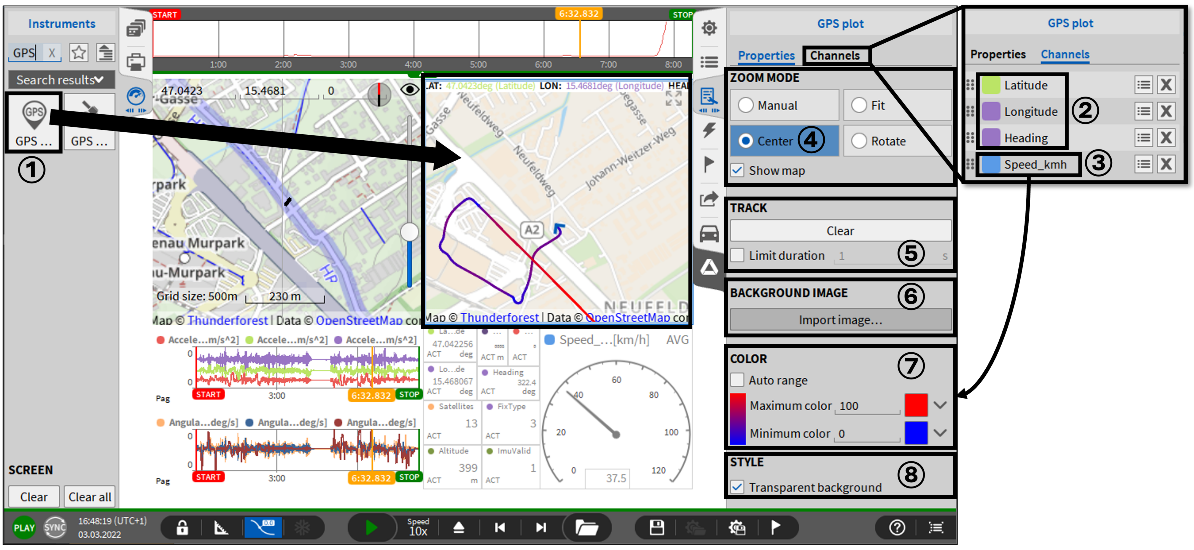

Fig. 8.93: GPS plot instrument – overview

The GPS plot instrument ① displays Latitude, Longitude, and Heading channels acquired by TRION-TIMING or TRION-VGPS modules (see *GPS channels*). These channels are automatically assigned the LAT, LON, and HEAD based on their channel mode ②.

Alternatively, mathematical channels (e.g., Statistics channels) can be assigned to the GPS plot, but they must be assigned in a specific order (Latitude, Longitude, Heading) and cannot be automatically matched. A fourth channel, such as speed, can be added to create a color trail based on a defined minimum and maximum value and color ③.

The displayed map is an online OpenStreetMap, which can be stored in the cache for offline viewing.

The user can manipulate the following Instrument Properties:

④ ZOOM MODE

- *Manual*: The user can zoom with the scroll wheel and move the map with the left mouse button. The actual position will not be centered when the position is updated.
- *Fit*: The complete track of the object is visible in the Instrument. Zooming or moving is not applicable.

- *Center*: The actual position of the tracked object is always displayed in the center of the Instrument. Zooming with the scroll wheel and moving with the left mouse button is possible but the actual position will be centered again when the position is updated.
- *Rotate*: The actual position of the tracked object is always displayed in the center of the instrument and the heading shows always to the top. Zooming with the scroll wheel and moving with the left mouse button is possible but the actual position will be centered again when the position is updated.
- Show Map: Toogle if the Open Street map is shown or not.

⑤ **TRACK**

- The elapsed track will be deleted by clicking on the *Clear* button. The drawing of the elapsed track can be limited by entering a time in seconds in at *Limit duration*
- By default the whole track is displayed as no limit is active.

⑥ **BACKGROUND IMAGE**

- For offline usage, an image can be loaded to replace the map. An image can be selected by clicking on the *Import Image* button and browsing for the desired file. After selecting the desired file, the *Positioning* dialog will open:

Fig. 8.94: Image positioning dialog

Two GPS coordinates within the loaded image must be known to position the image correctly. In Fig. 8.94, the two points and their corresponding coordinates are marked with red and blue. The procedure to position the image is the following:

- Two red cursors are generated by the Positioning dialog. In Fig. 8.94, they can be found at the top of the image. These cursors must be put on the known coordinates.
- The coordinates of both known points must be entered.
- *Latitude* and *Longitude* of *MAP POINT 1* must be entered for the known coordinates the first red cursor is placed on. In Fig. 8.94, this is the GPS coordinate marked with blue
- *Latitude* and *Longitude* of *MAP POINT 2* must be entered for the known coordinates the second red cursor is placed on. In Fig. 8.94, this is the GPS coordinate marked with red
- Alternatively, the image pixel corresponding to *MAP POINT 1* and *MAP POINT 2* can be entered in the X and Y columns
- After the positioning is finished and clicking on *Apply*, the image is placed correctly on the map (see Fig. 8.95):

Fig. 8.95: Positioned image

⑦ COLOR

- Auto range accounts for the channel range as maximum and minimum of the color trail.
- The color of maximum and minimum as well as the values can be freely chosen

⑧ STYLE

- Transparent background: Toggles background opacity.

8.16 GPS quality

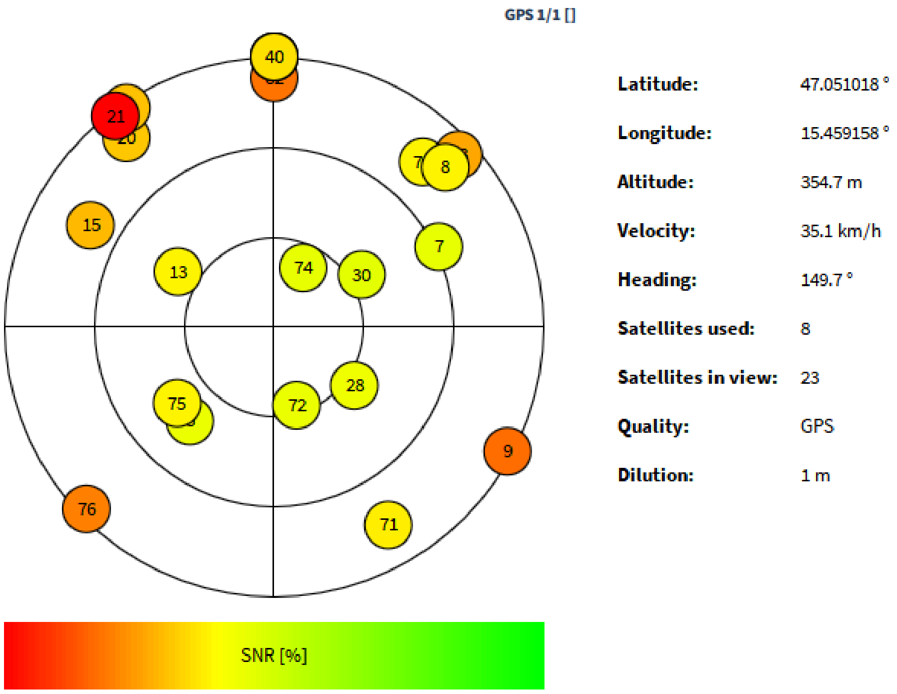

Fig. 8.96: GPS Quality instrument - overview

The GPS quality instrument displays the number of visible and used satellites of GPS data which is acquired by a TRION-TIMING or TRION-VGPS-20/-100 module (see *GPS channels*) and further meta data. The used satellites are thereby the satellites with the best SNR. The NMEA data channel can be assigned to the GPS quality instrument. Normally, the NMEA data channel is called *GPS 1/1* per default and can be found on the top of the GPS data channels list:

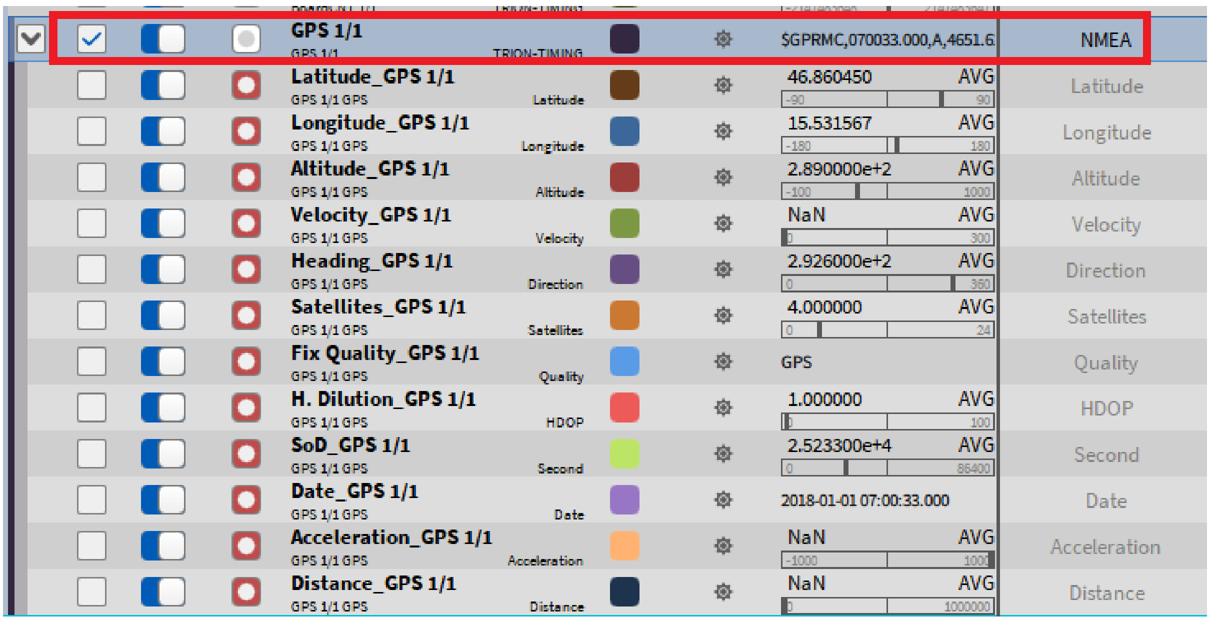

Fig. 8.97: GPS NMEA data channel

Besides the satellites plot, the following meta data which is contained in the NMEA string can be displayed in the GPS quality instrument:

- Latitude
- Longitude
- Altitude
- Velocity
- Heading
- Satellite used
- Satellites in view
- Quality
- Dilution

The following Fig. 8.98 explains the meaning of the three black circles with the same center point in the satellites plot:

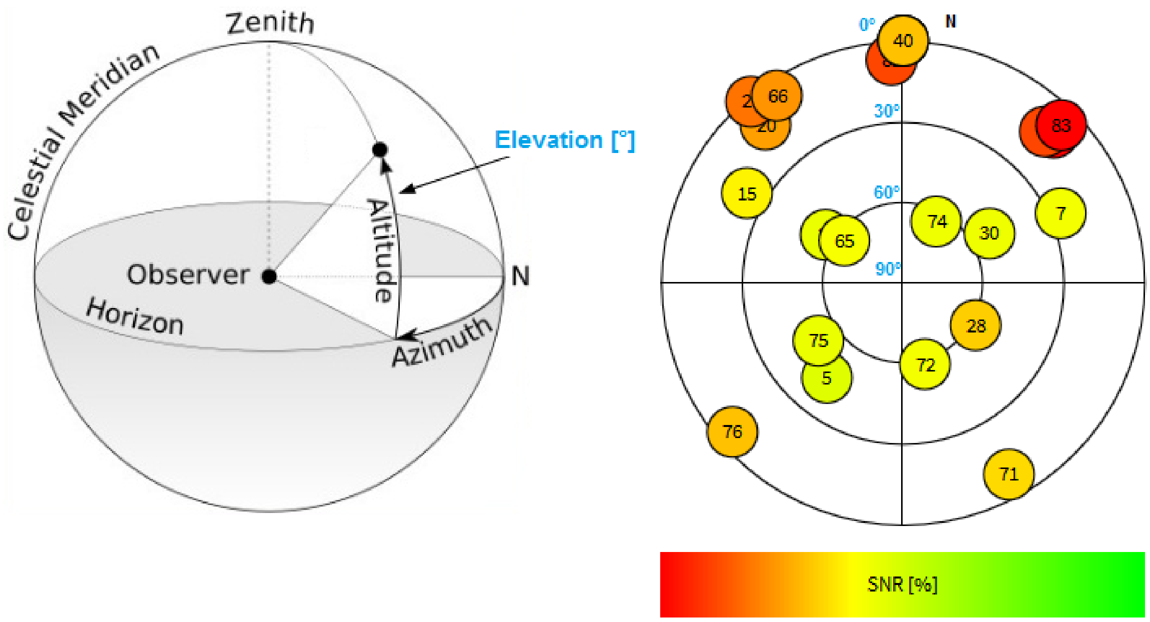

Fig. 8.98: Explanation of the satellites plot

The deselection of the instrument property *Extended View* reduces the content of the GPS plot Instrument to the satellites plot:

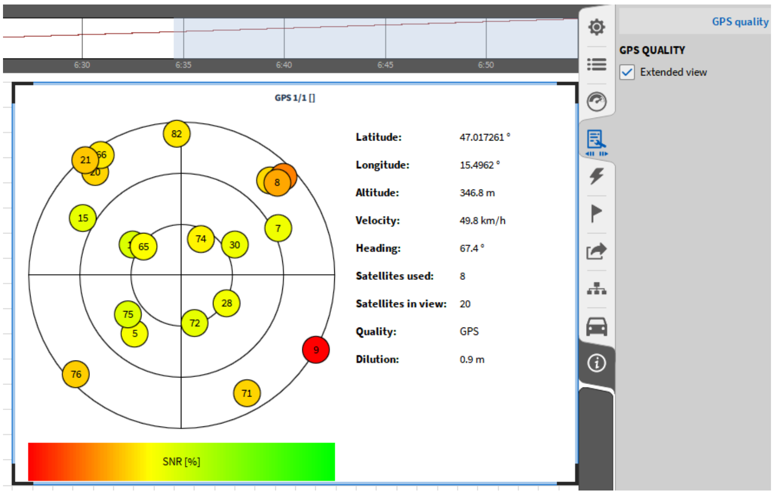

Fig. 8.99: GPS quality instrument - *Extended View* selected

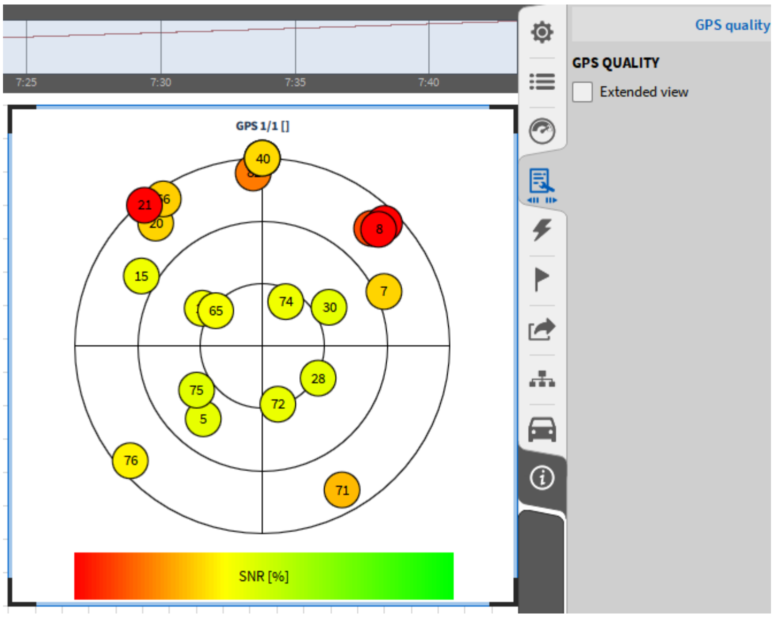

Fig. 8.100: GPS quality instrument - *Extended View* deselected

8.17 Spectrogram

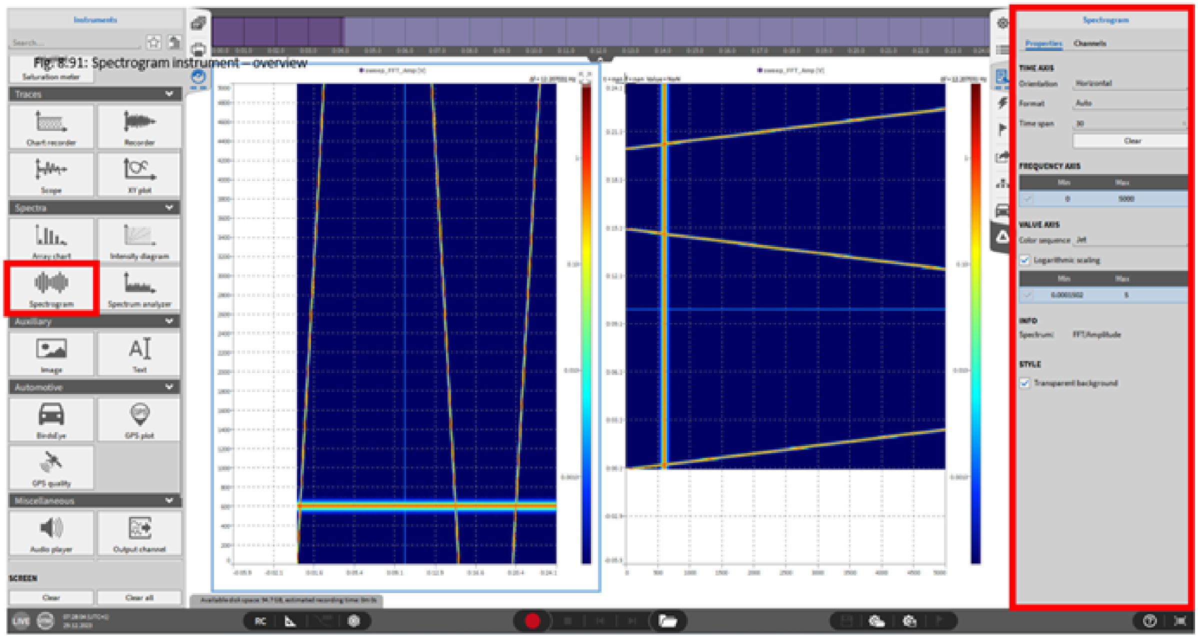

Fig. 8.101: Spectrogram instrument – overview

The Spectrogram may be used to display the time dependent signal trend of a FFT amplitude or phase channel that was created with the FFT math (for details, refer to *FFT channels*).

The elapsed time is displayed on the X-axis, the frequency on the Y-axis and the amplitude of the signal is Color-Coded to the Z-Axis (Left instrument in Fig. 8.101).

Note: Only 1 FFT amplitude or phase channel can be assigned to one single Spectrogram.

The Spectrogram has the following Instrument Properties:

- Time Axis – Orientation: *Horizontal* orientation assigns the time axis to the X-axis of the instrument (see left instrument in Fig. 8.101) and *Vertical* orientation assigns the time axis to the Y-axis of the instrument (see right instrument in Fig. 8.101).
- Time Axis - Format: This property changes the format of the X-axis. The user can select between *Auto*, *Absolute time* and *Relative time*.
  - *Auto*: In Sync Mode, the Auto time format is the Absolute time, otherwise the Auto time format is the Relative time.
  - *Absolute time*: The unit of the X-axis is the actual time of day set in the OS settings.
  - *Relative time*: The unit of the X-axis is the relative time starting with 0:00 for every new measurement.
- Time Axis – Duration: Select the Time interval that shall be plotted on the Time Axis here. The *Clear* button deletes the actual displayed data from the instrument.
- Frequency Axis: Select the upper and lower frequency the of the plotted data here.

- Gradient: Select a color scheme here. The color intensity can either be changed by entering the value in this menu or by moving the color bar within the instrument up or down while keeping the left mouse button pressed.
- Style: Selection of a transparent or untransparent background.
- Layer: Moves the Instrument in front of or behind another object (only applicable in *Design Mode*)

8.18 Power Group

Fig. 8.102: Power Group instrument – overview

OXYGEN Power is the up to date Power Analyzer software add-on for DEWETRON OXYGEN Measurement Software. For a detailed explanation of the functionality and usage of the Power module, refer to the manual DEWETRON_OXYGEN_Power_Technical_Reference_Rx.x.

8.19 Intensity Diagram

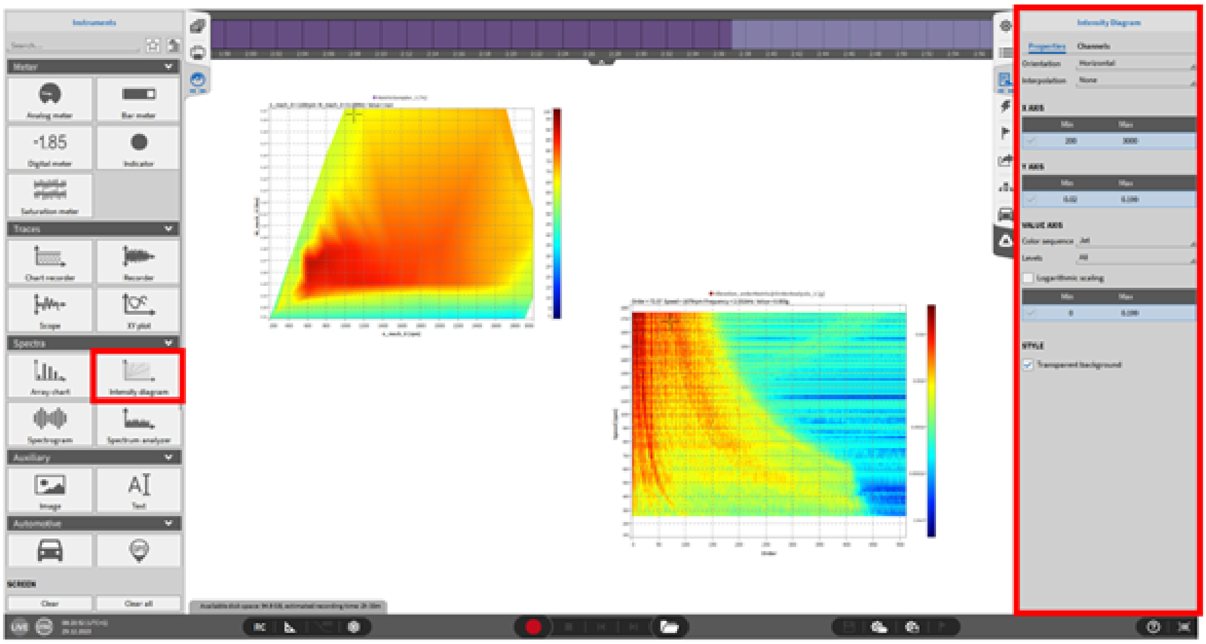

Fig. 8.103: Intensity Diagram instrument - overview

The Intensity Diagram can be used to display the frequency and order matrix of an order analysis channel or the resulting matrix of a matrix sampler channel, i.e. an efficiency map.

The Intensity Diagram has the following Instrument Properties:

- Orientation: *Horizontal* orientation assigns the defined X channel to the X-axis of the instrument and *Vertical* orientation assigns the defined X channel to the Y-axis of the instrument.
- Min/Max: the minimum and maximum value can be entered to be displayed in the instrument.
- Gradient: Select a color scheme here. The color intensity can either be changed by entering the value in this menu or by moving the color bar within the instrument up or down while keeping the left mouse button pressed.
- Select levels to have a more defined grading in the matrix. Select the number of levels which should be defined with a black border. The matrix on the left in Fig. 8.103 shows no grading and the matrix on the right has a 10-level grading.
- Enter the minimum and maximum level of the color-coding
- Enable logarithmic scaling by checking the checkbox.
- Style: Selection of a transparent or untransparent background.

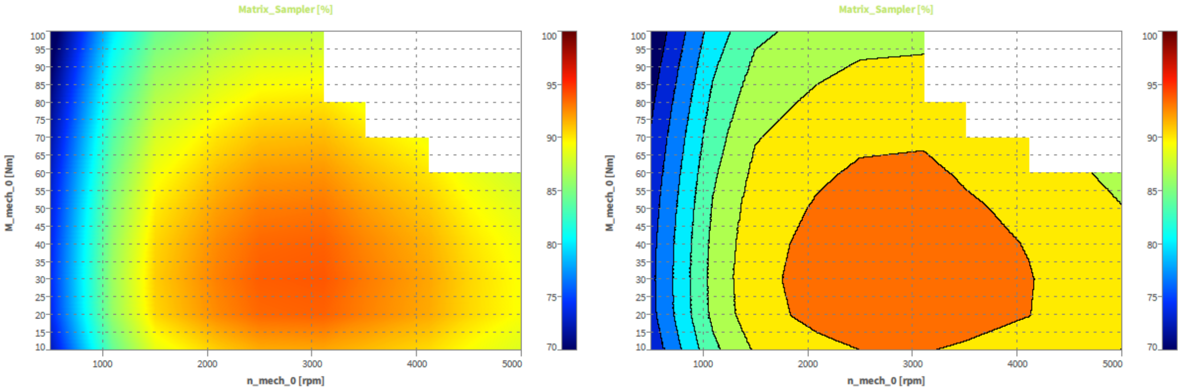

Fig. 8.104: Intensity Diagram of a Matrix Sampler channel without (left) and with level grading (right, 10 levels)

8.20 3D plot

To visualize array data (3-dimensional) the 3D plot can be used. In case 2-dimensional arrays like the amplitude and phase array of the FFT are used, the 3rd dimension is the time. This plot type is useful to analyze data from the order analysis. Also, data from CPB, harmonics or the matrix sample is supported.

The instrument can be found in the spectra tab.

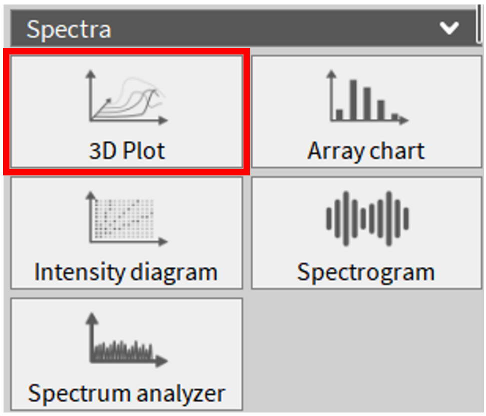

Fig. 8.105: 3D plot instrument in Spectra tab

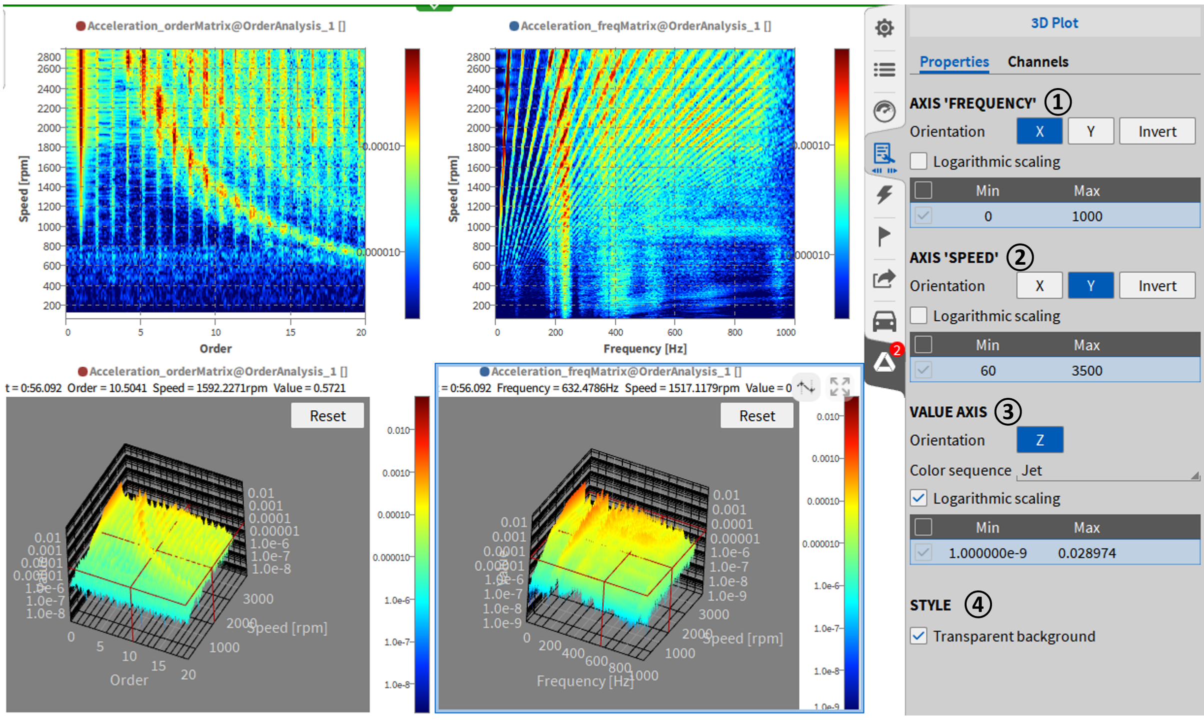

Fig. 8.106: 3D plot example and instrument properties

Table 8.4: 3D plot instrument properties

No.	Function	Description
1	Axis 1	Depending on the assigned channel, the first axis can be frequency, order or time. By default, the orientation of the first axis is the X-axis. This can be changed to Y or inverted. The range can be toggled as logarithmic, and the axis range can be edited manually. If the axis is a time axis, there are 2 additional properties: format and time span. Format sets the time as relative (acquisition time), absolute time. The time span determines the length of the dataset displayed in the 3d plot.
2	Axis 2	Depending on the assigned channel, the second axis can be speed, amplitude or frequency. By default, the orientation of the second axis is the Y-axis. This can be changed to X or inverted. The range can be toggled as logarithmic, and the axis range can be edited manually.
3	Value axis	The orientation of the value axis is fixed as Z-axis. The color sequence can be chosen: RGB, Jet, Hue, Grayscale, Hot or Polar. The range can be toggled as logarithmic, and the axis range can be edited manually.
4	Style	In style the background opacity can be set to transparent.

Example for first axis as time axis.

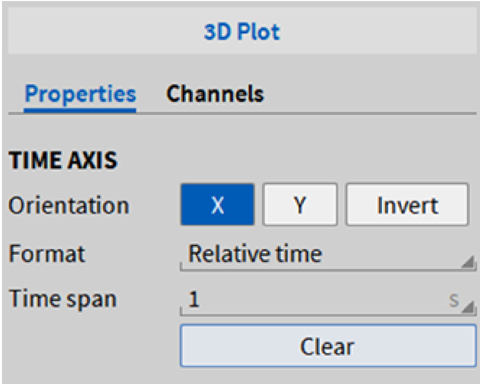

Fig. 8.107: 3D plot with time axis

8.21 Array Chart

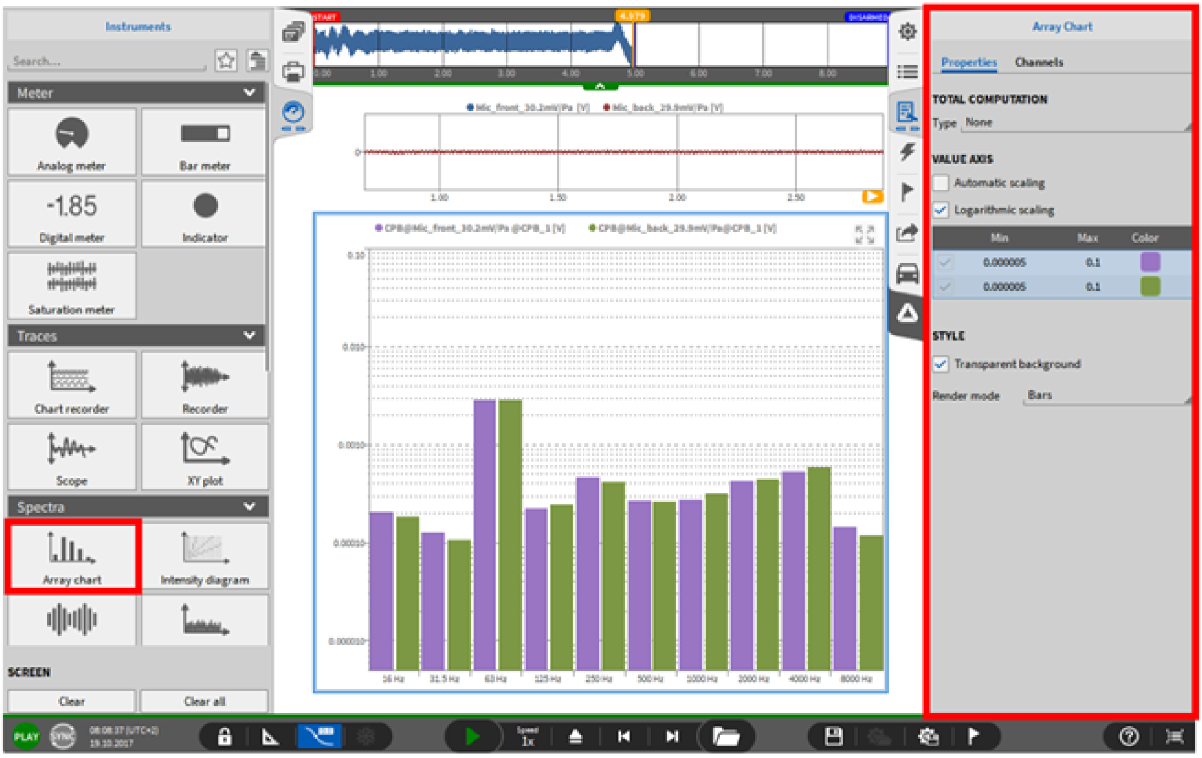

Fig. 8.108: Array Chart instrument – overview

The Array Chart can be used to visualize the CPB channels of a CPB (Constant Percentage Bandwidth) Analysis (refer to *CPB analysis*).

Note: The maximum number of channels that can be assigned to one Array Chart is two.

The Array Chart has the following Instrument Properties:

- Total Computation: It is possible to include a *Total* column (see Fig. 8.109) on the right hand side that display the following value:

- None: No value will be displayed
- Minimum: The minimum CPB value will be displayed
- Maximum: The maximum CPB value will be displayed
- Energetic Sum: The energetic sum across the CPB spectrum will be displayed.
- In case it is an *Amplitude* spectrum, the calculation is the following:

$$\text{Energetic Sum} = \sqrt{\sum_{i=1}^{n} x_i^2}$$

  n … Number of CPB bins

  x_i … CPB bin with index i

- In case it is a *Decibel* spectrum, the calculation is the following:

$$\text{Energetic Sum} = 10 * log\sqrt{\sum_{i=1}^{n} (10^{\frac{x_i}{10}})^2}$$

  n … Number of CPB bins

  xi … CPB bin with index i

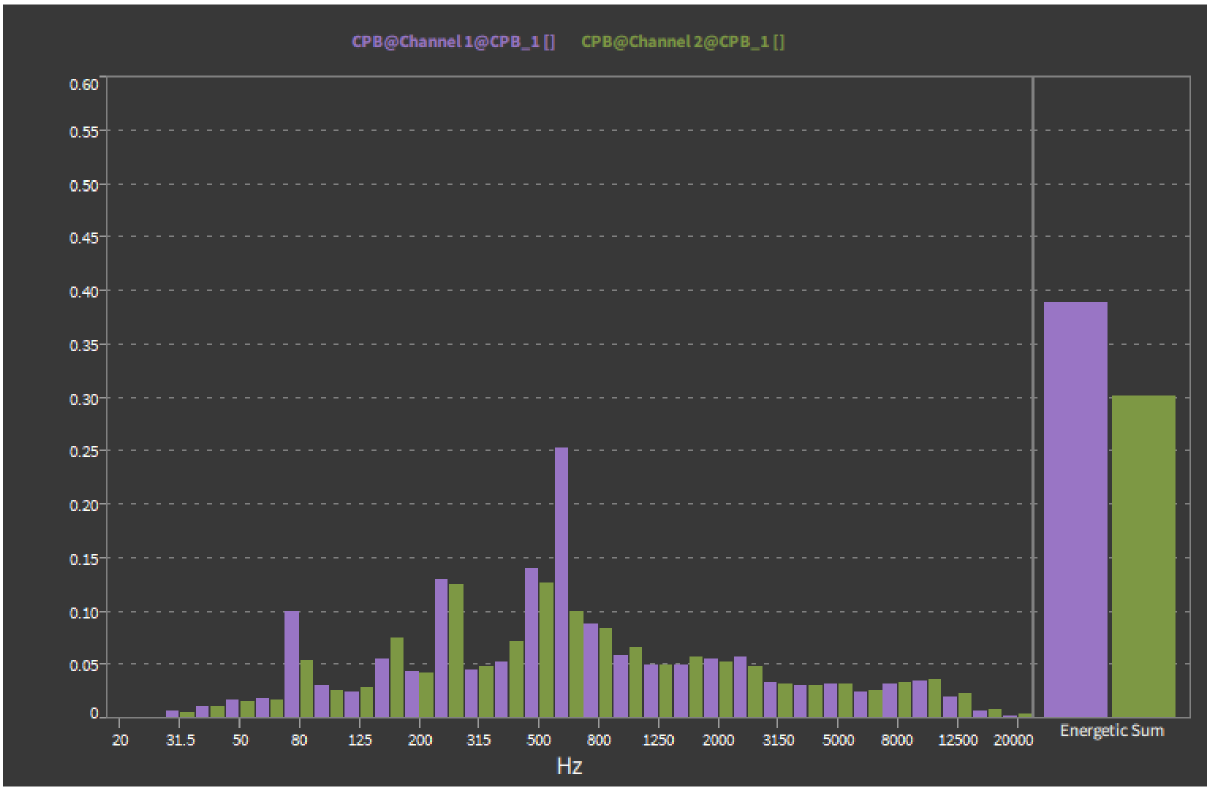

Fig. 8.109: Array Chart with *Total* column included

- Value Axis: Change the upper and lower limit of the Y-axis. It is possible to choose a logarithmic scaling for the Y-axis
- Style: Selection of a transparent or untransparent background.

  The display mode can be selected between bars or lines (see Fig. 8.110).

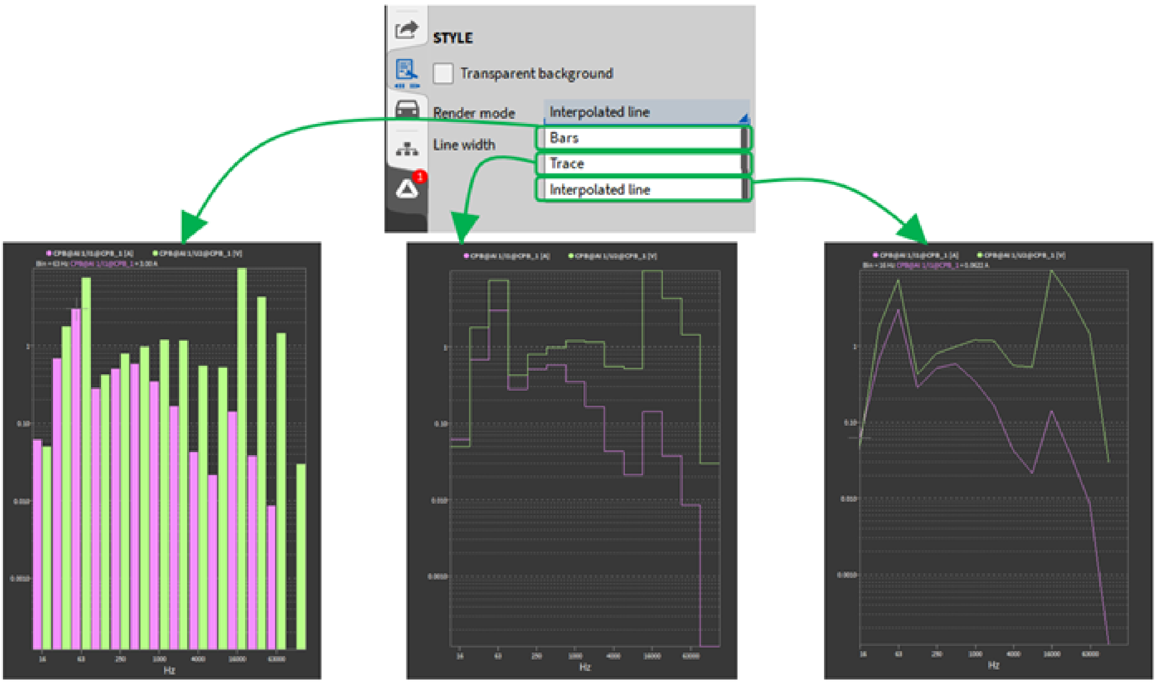

Fig. 8.110: Array chart instrument - bars, lines and interpolated line

8.22 Output Channel

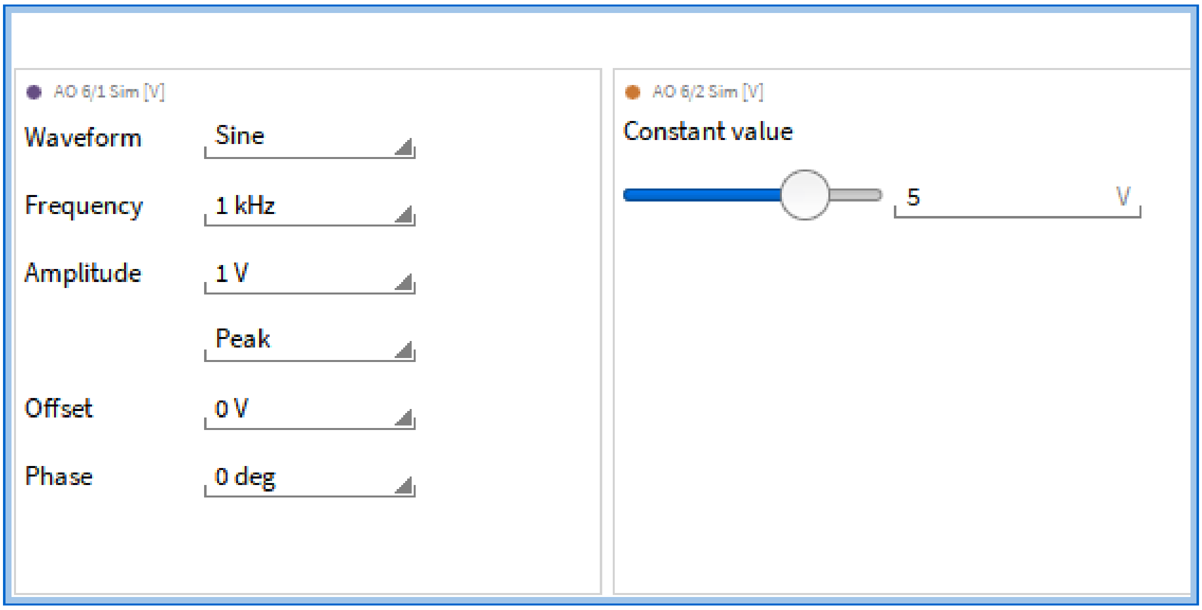

Fig. 8.111: Output Channel instrument

The Output Channel Instrument can be used to set the AOUT channels (Analog Output Channels) in the measurement screen. Channels that are set as constant value output or function generator can be displayed and changed here.

Up to 8 channels can be assigned to an Output Channel Instrument. The functions of the Output Channel

Instrument are available in *LIVE* and *REC* mode.

8.23 Audio Player

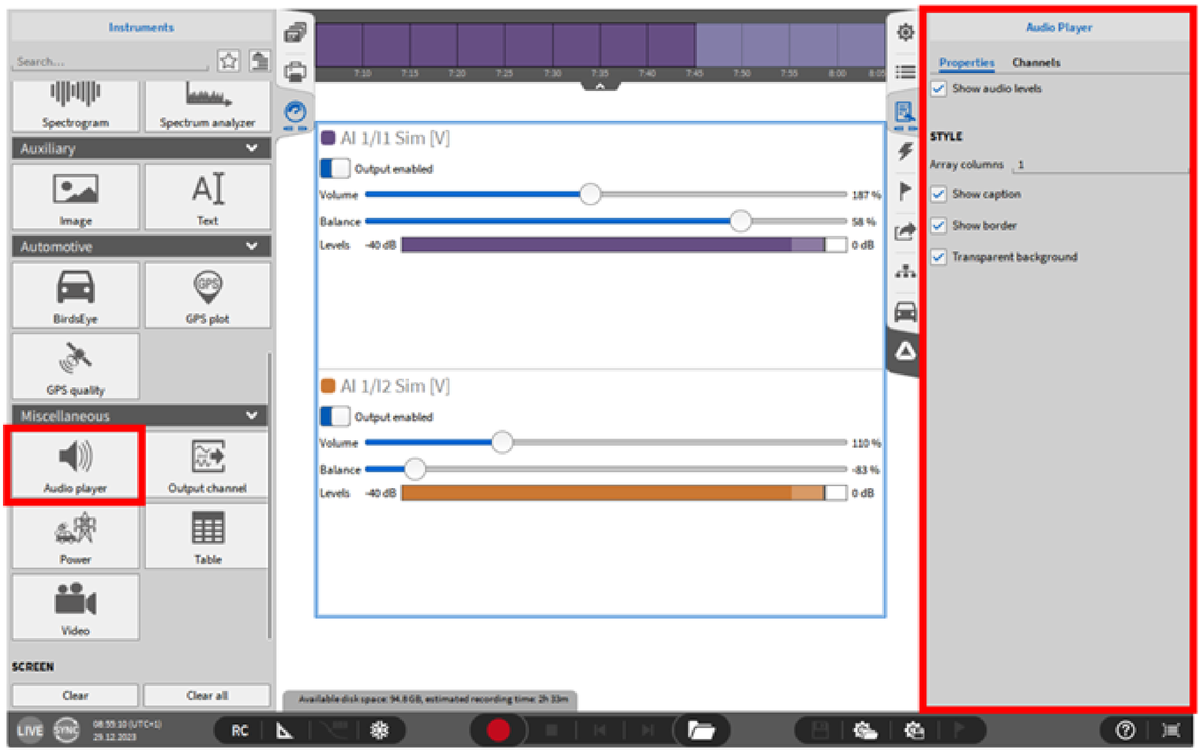

Fig. 8.112: Audio Player instrument – overview

The Audio player Instrument can be used to replay OXYGEN channels via the systems' default sound card.

The instrument provides the possibility to mute the channel(s) (*Output enabled*), to set the output *Volume* and to change to left-right *Balance* (see Fig. 8.112).

The maximum number of channels to be assigned to one Audio Player is 2. It is possible to replay synchronous data channels (i.e. analog inputs and formulas).

The recommended channel sample rate is from 1 kHz to 200 kHz.

Style: Selection of a transparent or untransparent background.

The audio replay functionality is available in *LIVE*, *REC* and *PLAY* mode. In *LIVE* and *REC* mode, the actual data is replayed. In *PLAY* mode the replay is snapped to the position of the Orange cursor (see Fig. 8.113).

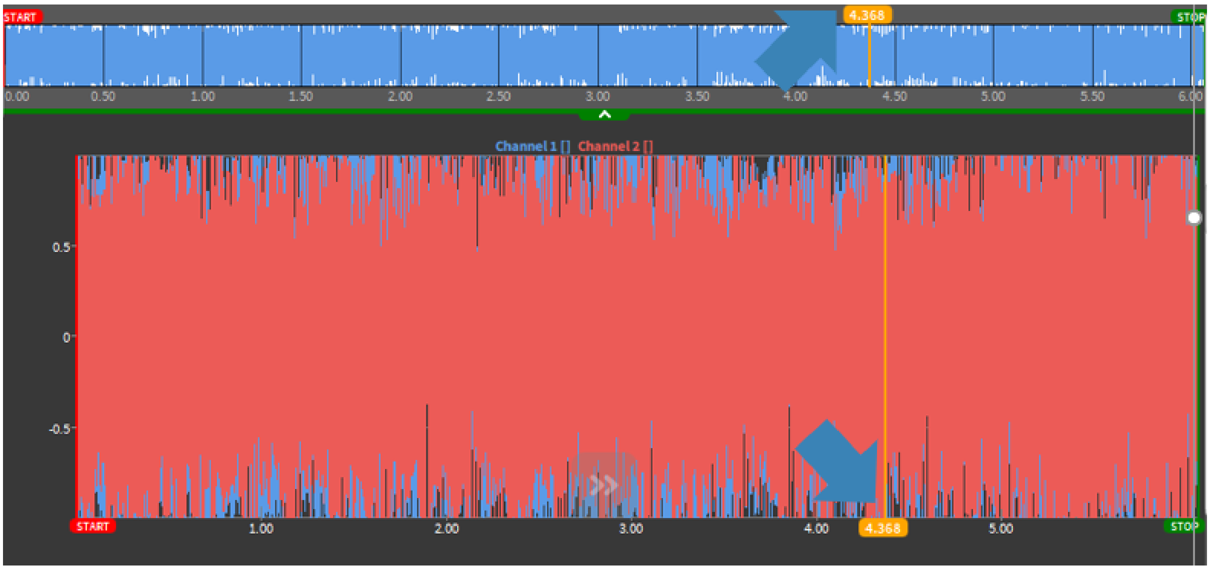

Fig. 8.113: Orange cursor in Overview bar and Recorder

8.24 Change settings of multiple instruments

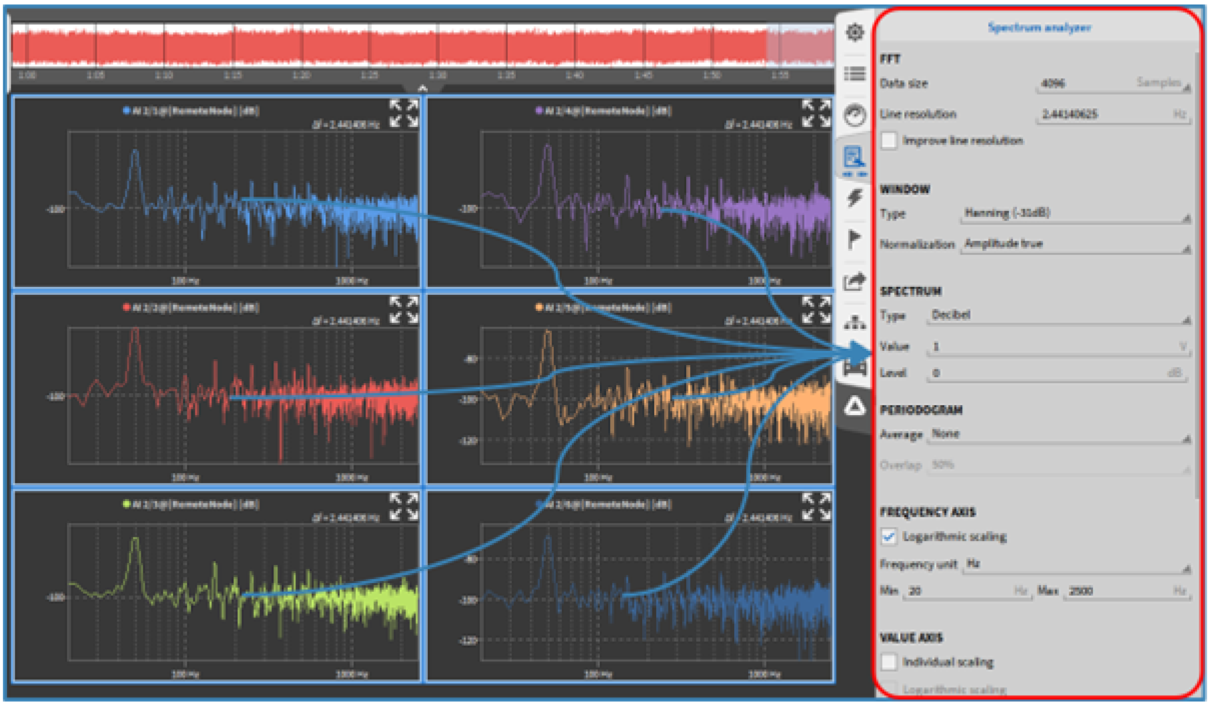

Fig. 8.114: Apply changes to multiple Spectrum Analyzer instruments

It is possible to change the instrument properties of multiple instruments of the same type at once. This is shown in Fig. 8.114 for six spectrum analyzers. Selecting multiple instruments is possible by holding the CTRL-key and clicking on different instruments successively. The combination CTRL+A will select all instruments of this measurement screen.

8.25 Saturation visualization

It is possible to display the saturation visualization for selected channels. This shows the utilization (saturation) of the set measuring range for the channels displayed in the instrument in color based on the MIN/MAX value since the start of data acquisition. The saturation visualization is possible for the following instruments:

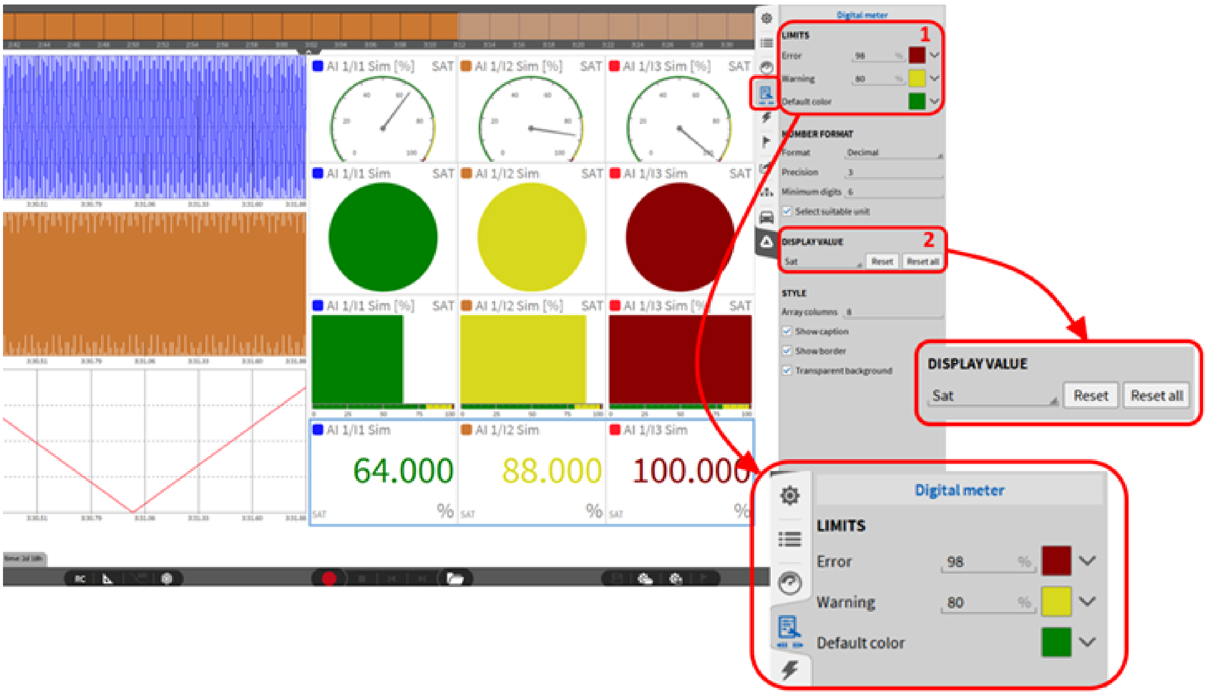

Fig. 8.115: Saturation visualization of channels

- Analog display (see *Analog meter*)
- Digital display (see *Digital meter*)
- Bar graph displaymeter (see *Bar Meter*)
- Indicator (see *Indicator*)

By default, the limits are set as follows:

- 0 … 79 %: Green
- 80 … 98 %: Orange
- 99 … 100 %: Red

After adding one of the previously listed instruments to the measurement screen, the “Sat” (saturation) mode must be selected as the display value in the settings of the respective instrument. (see ② in Fig. 8.115). By pressing the “Reset” button, the selected instrument will be reset, by pressing “Reset all”, all saturation displays will be automatically reset (instruments other than the selected instrument too). After selecting the display value “Sat”, the colors as well as the limit values for the display can be changed if required (see ① in Fig. 8.115).

8.26 Saturation meter

Fig. 8.116: Saturation Meter - Overview

It is possible to visualize the saturation of all available analogue input signals within only one instrument, the so-called saturation meter. With this instrument it is easy to see if any analogue input channel is not activated or in overload.

Fig. 8.117 shows how the saturation will be visualized within the instrument. The minimum and maximum saturation of the channel will be displayed in light grey, the current measured value of the channel will be displayed in dark grey. It is possible to set different colors for the visualization of the channels with the same unit (see 8 in Fig. 8.118).

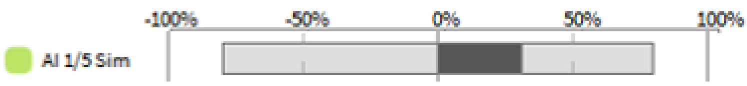

Fig. 8.117: Display of saturation within saturation meter

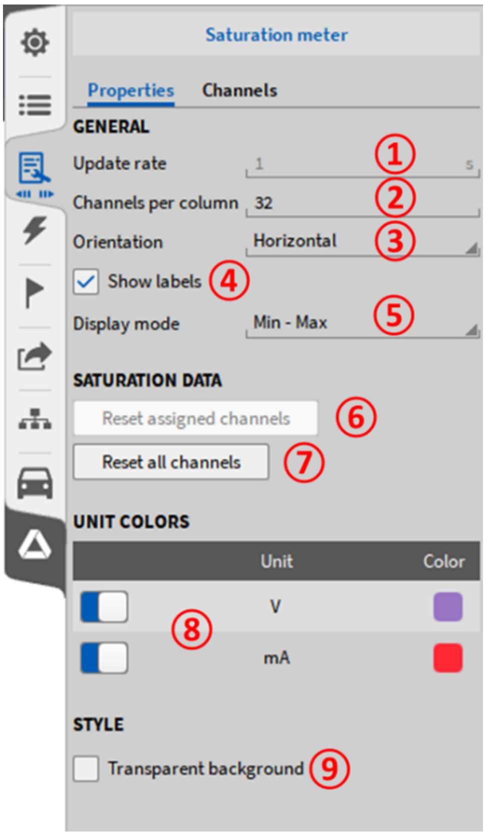

Fig. 8.118: Saturation meter instrument settings

Table 8.5: Saturation meter instrument settings

No.	Function	Description
1	Update rate	Update rate of saturation meter. Default at 1 second and defined by statistics window in the triggered events.
2	Channels per column	Number of channels which will be displayed within one column. If the measurement systems consist, out of 128 analogue input channels and 32 will be selected, as an example, this would lead to 4 displayed columns with 32 channels each.
3	Orientation	Switch between horizontal and vertical alignment of displayed channels.
4	Show labels	Activate or deactivate the display of channel names within the saturation meter. (This is only available in the horizontal orientation.)
5	Display mode	Min – Max: Saturation will be displayed between -100 % and +100 % Zero – Max: Saturation will be displayed between 0 % and 100 %
6	Reset assigned channels	Resets the selected channels within the saturation meter.
7	Reset all channels	Resets all channels in the selected instruments.
8	Format	It is possible to assign a color to a specific unit. With the settings in Fig. 8.118, all channels with the unit [V] will be displayed in purple and all channels with the unit [mA] will be displayed in red.
9	Precision	It is possible to choose between “Decimal” or “Scientific” representation of the numerical display in the saturation meter.
10	Unit colors	Number of decimal places in the numerical display. It is possible to select between 0 and 20 decimal places.
11	Style	Enable or disable a transparent background with the checkbox.

8.27 Control instrument

The Control instrument is available under the Miscellaneous category in the Instrument tab. Its functionality depends on the selected control type. The available control types are:

- Shunt: Turn all shunts on or off for all analog channels in bridge mode.

Note: This action can also be used during recording.

- Bridge balance: Perform bridge balancing for all active analog channels in bridge mode.
- Saturation data: Reset saturation data for all channels.

8.27.1 Control type: Shunt

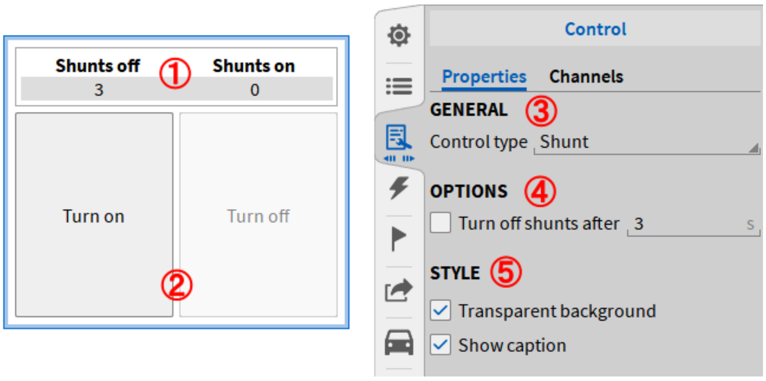

Fig. 8.119: Control instrument properties for control type: shunt

Table 8.6: Control instrument settings shunt

No.	Function	Description
1	Caption	Control type title; shows the number of deactivated and activated shunts for all channels in bridge mode.
2	Control action	Action button to turn on/off all shunts for all channels in bridge mode; can be used during recording.
3	General properties	Select the desired control type
4	Control type-specific options	Checkbox to automatically turn off shunts after a specified duration (1 to 60 seconds).
5	Instrument style properties	Tick box to: - Enable/disable a transparent background. - Show/hide caption.

8.27.2 Control type: Bridge balance

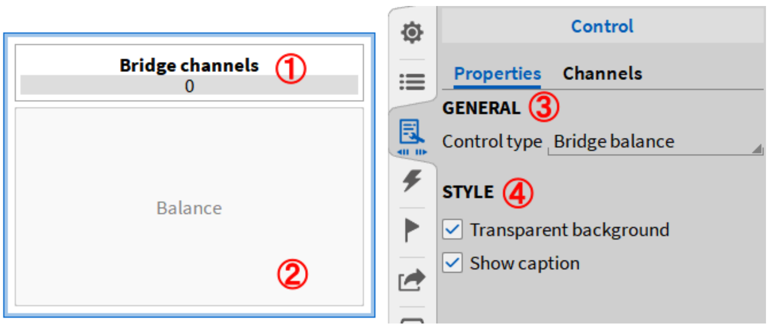

Fig. 8.120: Control instrument properties for control type: Bridge balance

Table 8.7: Control instrument properties Bridge balance

No.	Function	Description
1	Caption	Control type title; shows the number of channels in bridge mode.
2	Control action	Action button to perform a bridge balance for all channels in bridge mode.
3	General properties	Select the desired control type.
4	Instrument style properties	Tick box to: - Enable/disable a transparent background. - Show/hide caption.

8.27.3 Control type: Saturation data

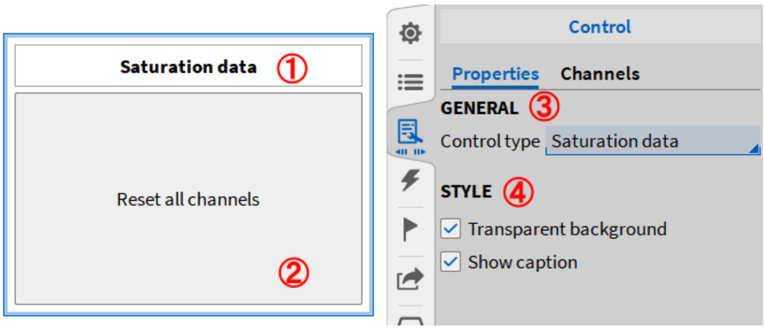

Fig. 8.121: Control instrument properties for control type: Saturation data

Table 8.8: Control instrument properties Saturation data

No.	Function	Description
1	Caption	Control type title
2	Control action	Action button to reset saturation information for all channels.
3	General properties	Select the desired control type.
4	Instrument style properties	Tick box to: - Enable/disable a transparent background. - Show/hide caption.

8.28 Orbit plot

The orbit plot is an instrument for displaying the rotational axis movement for e.g. turbine shafts. A minimum of 2 signals for the deflection of the shaft are always required. The angle between the X and Y signals on the test object is always assumed to be 90°.

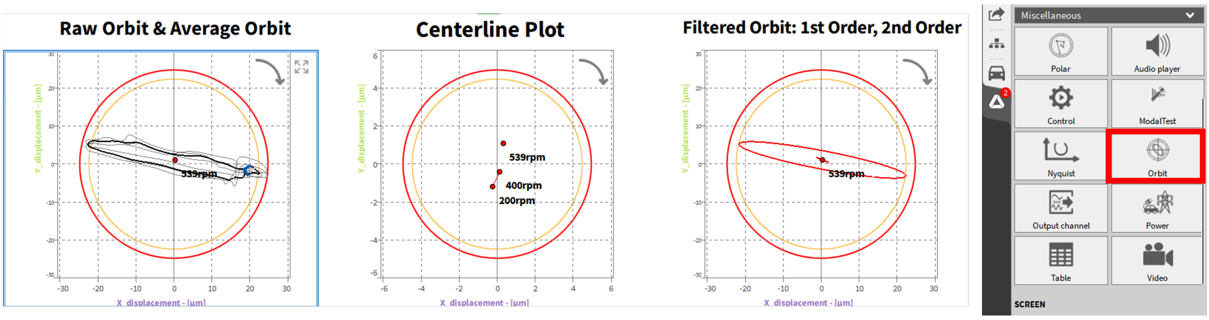

Fig. 8.122: Orbit plot Instrument

The Orbit plot has three display options, which can be activated individually or in combination in the instrument settings, but some of them require different input signals. The scaling of the input channels must be carried out in advance in the channel list. The Orbit plot is a pure display instrument, i.e. there are no separate Orbit plot channels.

For the display options the following Input channels are required:

- Raw orbit & average orbit: X&Y deflection + optional angle and speed
- Centerline plot: X&Y deflection + angle + speed
- Filtered orbit: X&Y deflection + amplitude and phase in X and Y direction per order + angle + speed

  For this view the order analysis license option (OXY-OPT-OA) is required.

The next figure shows an example for X- and Y-Probe arrangement. Additionally, the context of the orbit in a bearing is illustrated. The start and orbit direction are also displayed in OXYGEN.

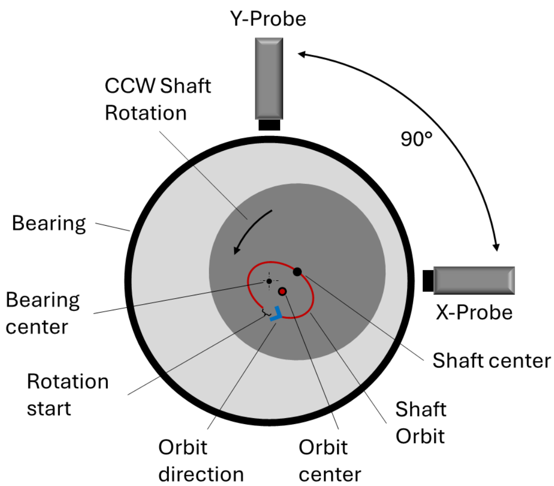

Fig. 8.123: X&Y Probe arrangement and Orbit overview

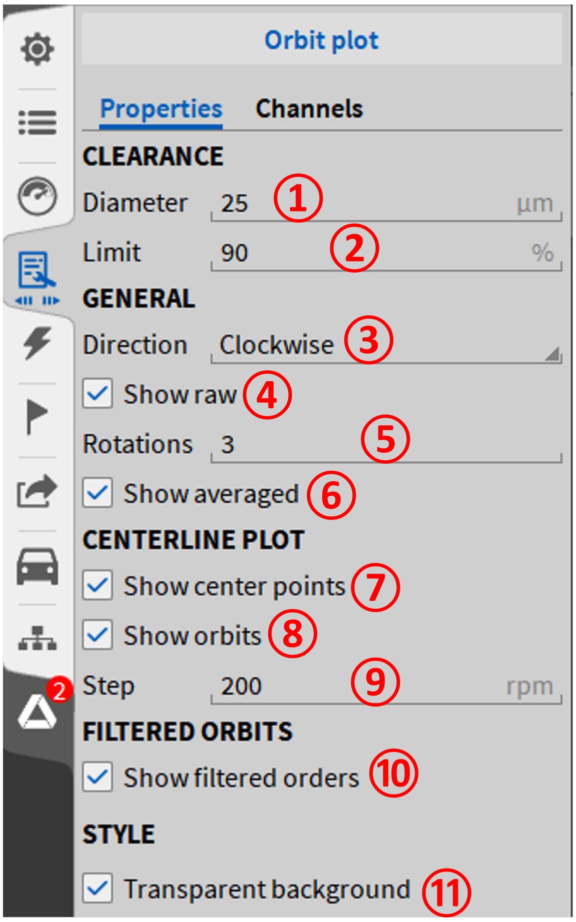

Fig. 8.124: Orbit plot Instrument properties

The settings ①, ② and ③ are relevant for all orbit plot types, as the diameter ① is used to set the rotation in relation to a circular clearance/bearing. In this view, the limit ② helps to easily recognize when a movement radius is exceeded. The direction of rotation of the test can simply be marked via ③ but has no further effect on the display or calculation in the background. The other settings are explained in the following examples.

Table 8.9: Orbit plot properties

No.	Property	Description
①	Diameter	Determines the display scale in the form of a red circle, representative of a clearance/bearing play.
②	Limit	Limit display in % in relation to the clearance/bearing play diameter.
③	Direction	For reporting purposes, the direction of rotation of the shaft is displayed in the instrument (clockwise/counter-clockwise)
④	Show raw	Shows the unaveraged orbit of the rotation axis over x revolutions
⑤	Rotations	Defines the number of orbits displayed in ④ and ⑥.
⑥	Show averaged	Displays the average orbit over x revolutions. The revolutions for the center position are defined in ⑤.
⑦	Show center points	Shows the calculated center of the orbits in x speed steps, which is defined in ⑨.
⑧	Show orbits	Also shows the center of the orbits between the defined speed steps.
⑨	Step	Defines the speed increment for the center points ⑦.
⑩	Show filtered orders	Displays the filtered orbit
⑪	Transparent background	Sets the instrument background to transparent

Example of Raw orbit and Average orbit

X and Y deflection in length dimension are required for the raw and average orbit. If no angle and speed signal is assigned, OXYGEN plots one sample per degree and can therefore still estimate an average over x revolutions. In Fig. 8.125 three orbits are displayed in grey and their average is shown with a black and bold line.

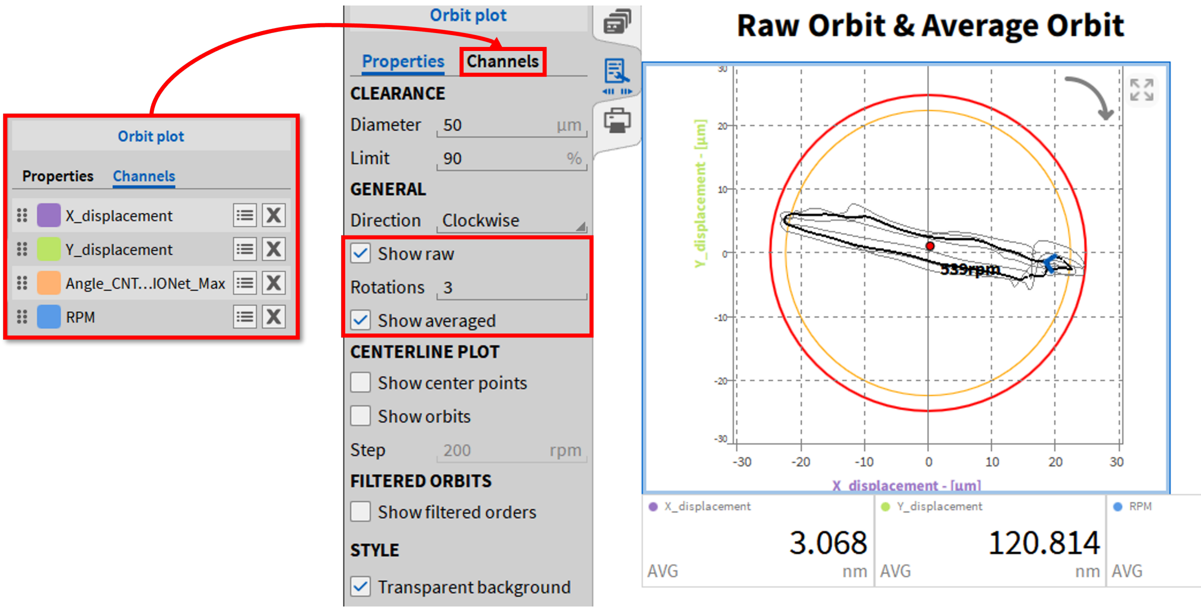

Fig. 8.125: Raw Orbit and Average Orbit

Example of Centerline Plot

In addition to X and Y deflection, angle and speed are always required for the centerline plot. The center points are saved as a snapshot after a short dwell time close to the step size. The calculated center points can be displayed before the snapshot using Show orbits.

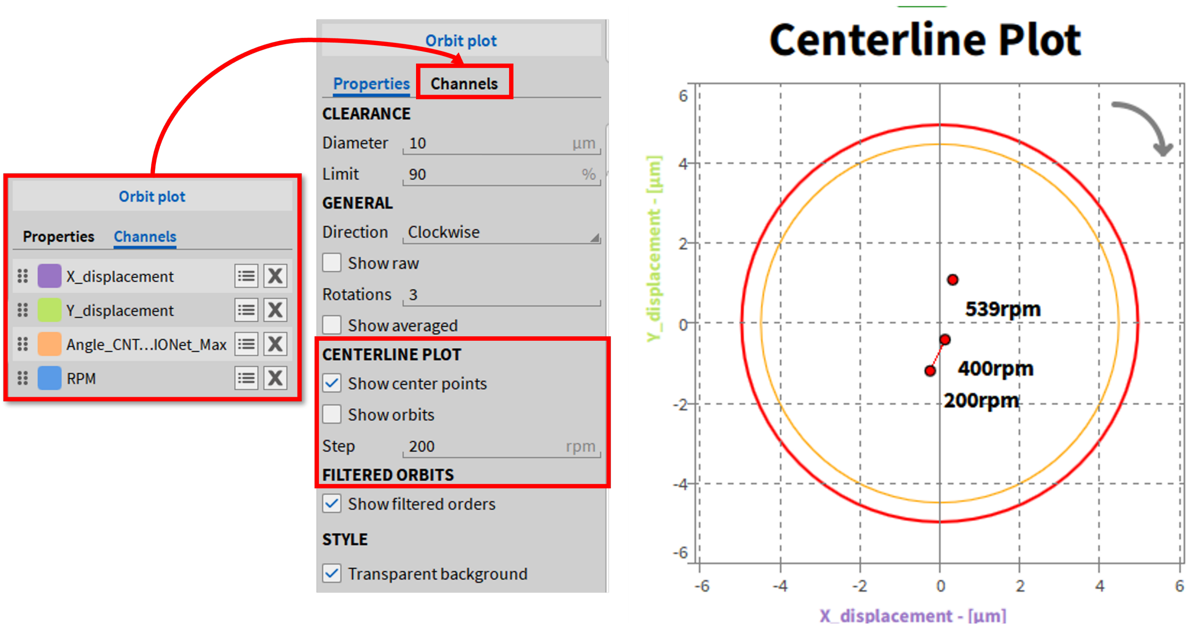

Fig. 8.126: Centerline Plot Example

Example of Filtered Orbit

Based on the amplitude and phase channels of the order analysis (from order analysis), filtered orbits can be used to display the orbit with the same or multiple fundamental frequency in relation to the speed. Speed and angle as well as X and Y deflection channels are required. Amplitude and phase must be assigned for X and Y for each order.

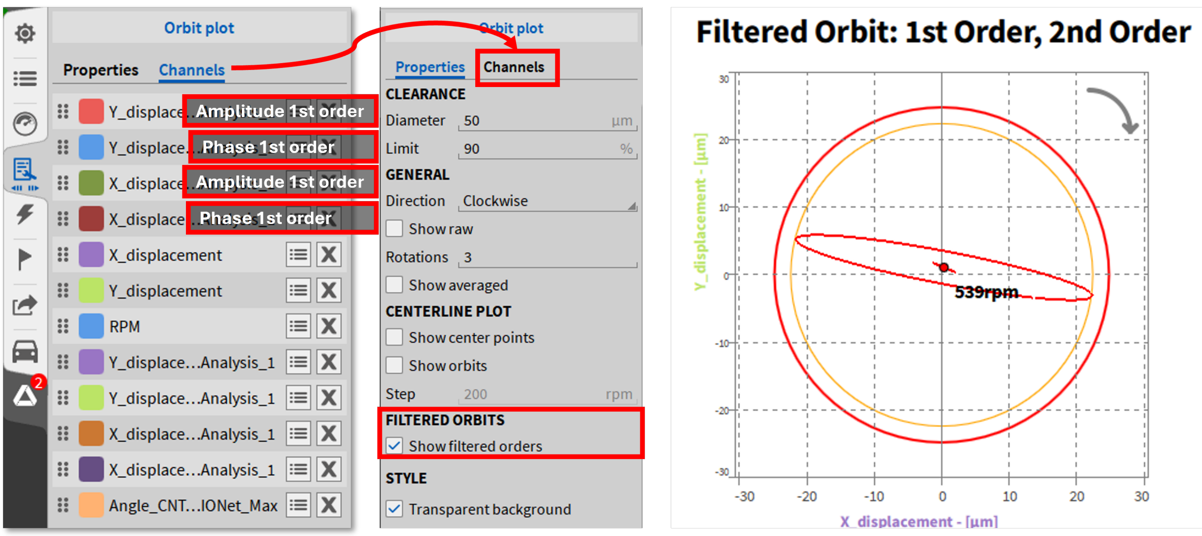

Fig. 8.127: Filtered Orbit Example for 1st and 2nd Ordnung based on Order analysis

8.29 Polar plot

The polar plot complements the orbit analysis and is also a pure display instrument without its own channel. The Polar Plot can be used to display a vector signal in polar coordinates, for example the amplitude and phase of the X deflection for the 1st order in relation to the speed of a shaft. In the polar plot, the amplitude is displayed as a radius and the phase as an angle. The amplitude and phase are calculated using order analysis.

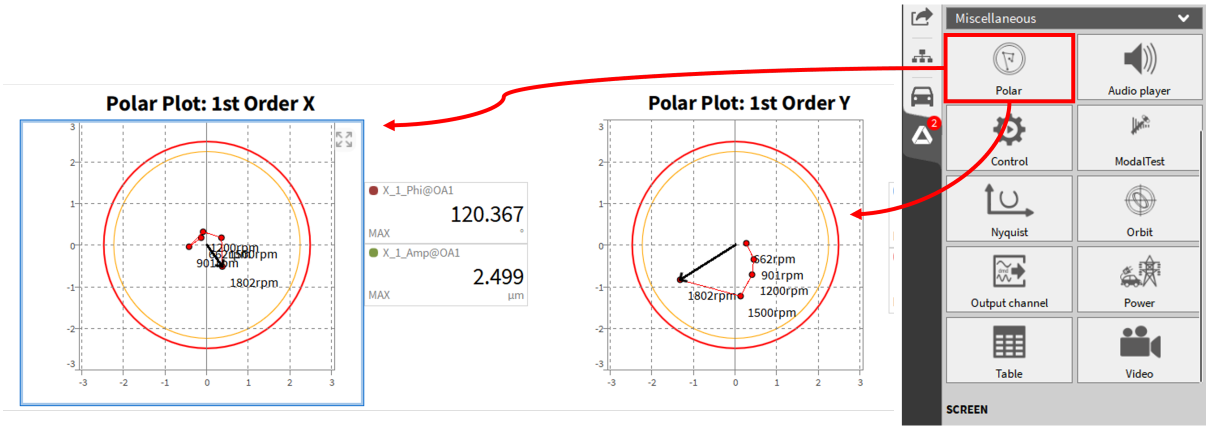

Fig. 8.128: Polar Plot Instrument Overview

Example of Polar Plot settings

Only rotational speed, amplitude and phase from order analysis (requires OXY-OPT-OA) are required for the polar plot. As in the orbit plot, the display is scaled via the free space/bearing clearance diameter ① with a red circle and a limit ② based on this. The steps in which the movement vector is marked by a point can be defined by speed or time ③ in the input field ④. The length of the polar vector represents the amplitude, and the angle represents the phase offset to the starting point of the encoder revolution. This means that for the following example at 2700 rpm, the maximum X-deflection is ~13 µm and is ~145° offset from the speed signal.

Note: The Order analysis calculates the amplitude based on the RMS values, and for Peak or Peak-Peak scaling, the scaling must be done in the channel list.

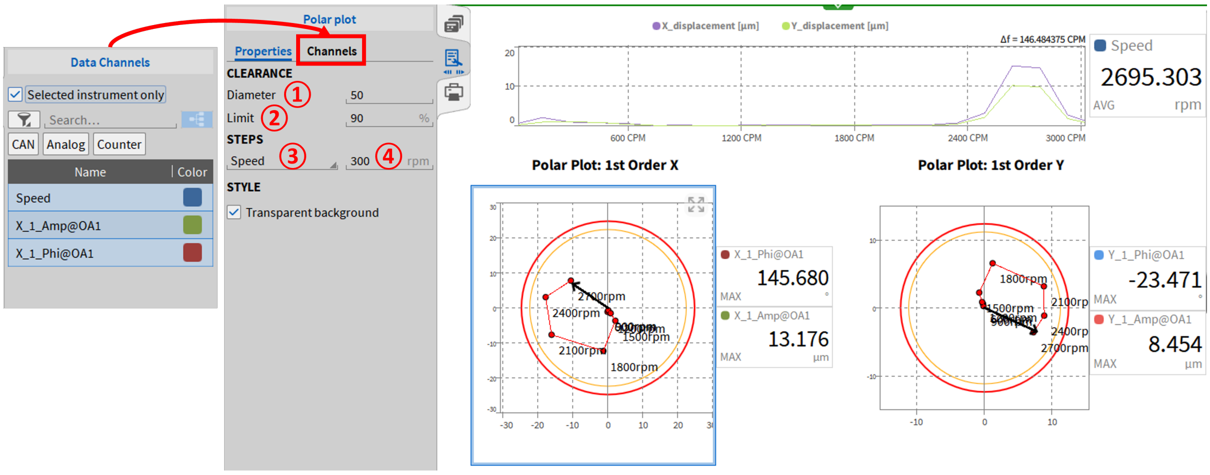

Fig. 8.129: Polar Plot properties and assigned channels

8.30 Nyquist Plot (SDOF circle fit)

The Nyquist plot is an instrument that can numerically determine the natural frequency, and the loss factor based on the frequency response function (FRF) channels from the Modal Test. The data is plotted in a circle and interpolated. There is also a corresponding screen template for this instrument.

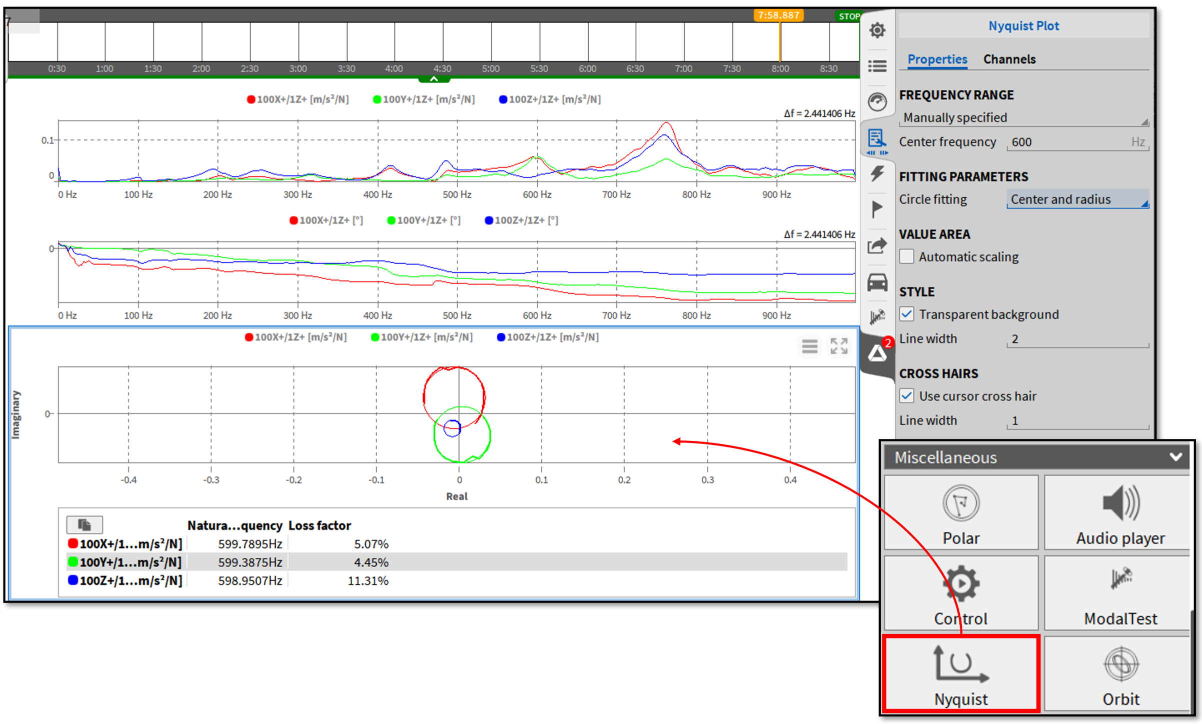

Fig. 8.130: Nyquist Plot properties

Further information on the modal test and the Nyquist plot can be found in the Modal Test manual: DEWETRON_Oxygen_Modal_Technical_Reference_vx.x (https://ccc.dewetron.com/).

CHAPTER

NINE

TRIGGERED EVENTS

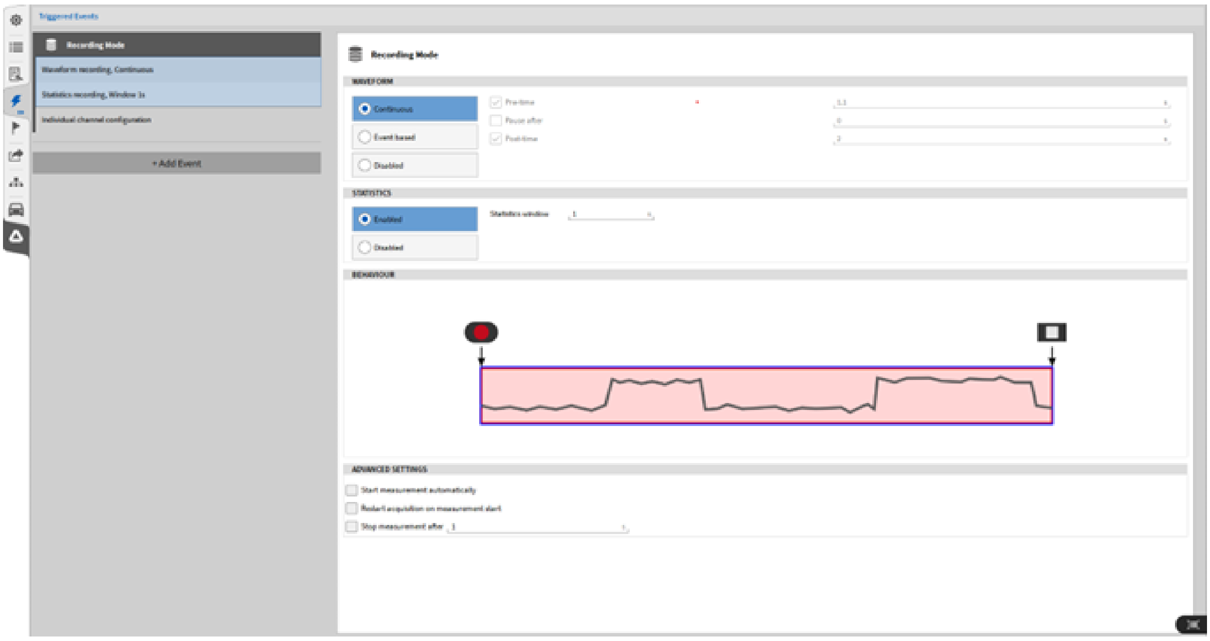

Fig. 9.1: *Trigger Events* Menu – Overview

OXYGEN provides two different recording modes: The *Waveform* Recording and the *Statistics* Recording.

The *Waveform* Recording stores all channels that are enabled for recording @full sample rate into the data file.

The *Statistics* Recording stores only the statistical values MIN, MAX, AVG and RMS of an adjustable time window between 0.1 and 10 seconds into the data file. The Statistics Recording is also only done for the input channels that are enabled for recording.

Both recording modes can be enabled independently. The default software setting enables both *Continuous Waveform* Recording and *Statistics* Recording (Statistics window: 1 second).

If the user does not want OXYGEN to enable *Waveform* Recording for the complete recording time but only when certain input signal levels are reached, he can control that with the *Event Based Waveform* Recording (=Triggering) which is explained in the following sections.

Event Based Waveform Recording and Statistics Recording

A very useful combination is the *Event Based Waveform* Recording in combination with the *Statistics* Recording. Especially over long measurement periods with rare trigger events, the *Statistics* Recording gives the user the guarantee that data was recorded without consuming much hard disk space. In the data file, the waveform data is plotted when the trigger event was active and otherwise the *MIN* and *MAX* value of the *Statistics* Recording data (see Fig. 9.2).

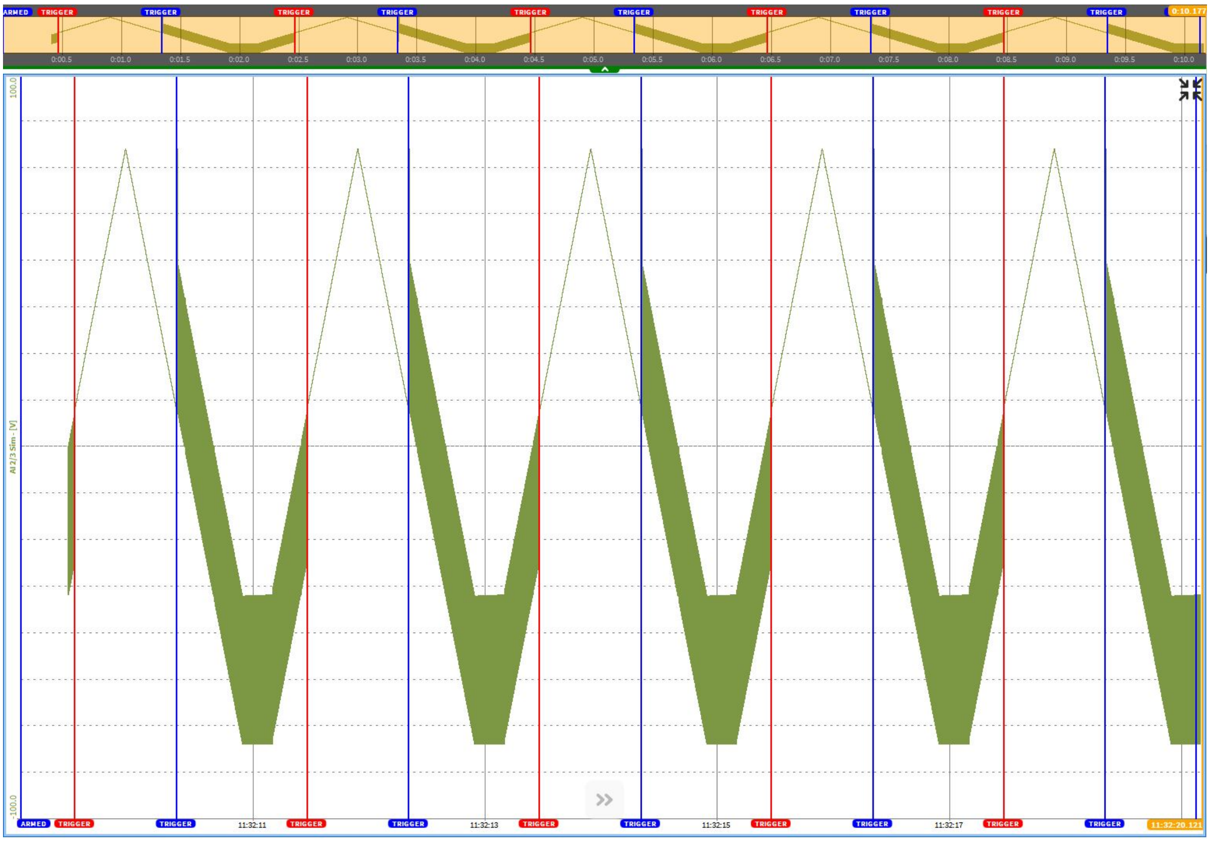

Fig. 9.2: *Event Based Waveform* Recording (marked in red) and enabled *Statistics* Recording

Automatic Measurement Start

OXYGEN offers the possibility to start the measurement automatically after the software has started. To activate the Automatic measurement start, enlarge the Triggered Events menu to the full screen and check *Start measurement automatically* in the *Advanced Settings* (see Fig. 9.3).

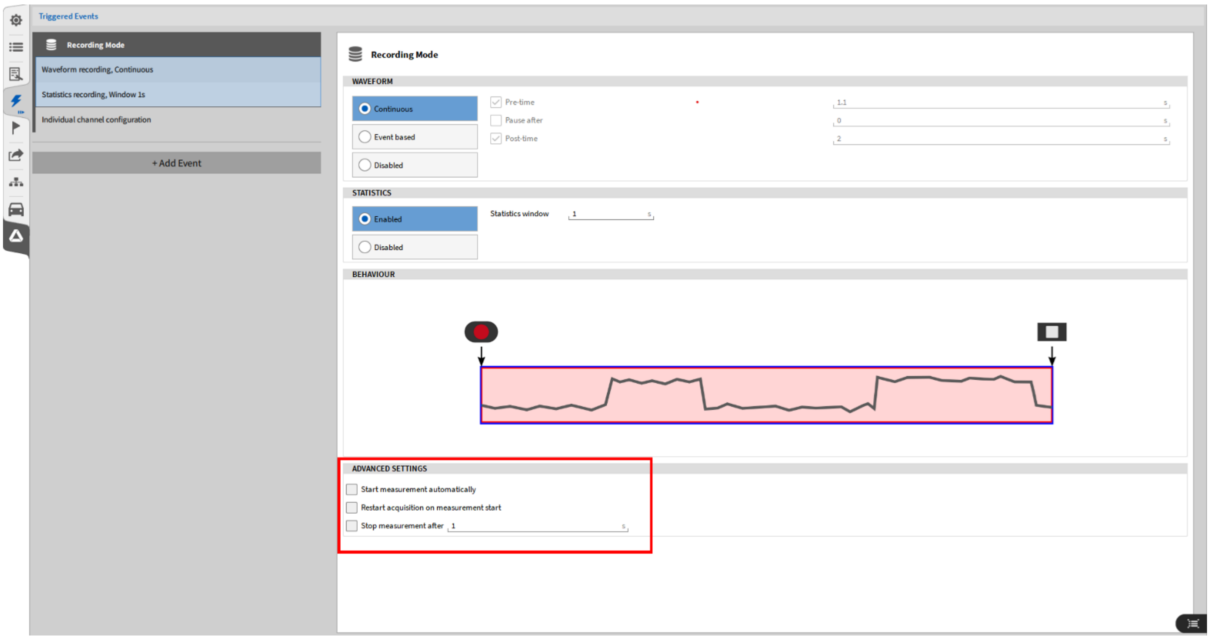

Fig. 9.3: Triggered Events menu, Automatic measurement start

In case of *Continuous Waveform Recording* (refer to *Triggered Events*), the measurement will start automatically after OXYGEN has started and makes the manual press of the Recording button obsolete (see ⑧ in Fig. 3.5).

As DEWETRON measurement systems start automatically after they are connected to a power supply, the measurement can start automatically after the measurement system is powered without any interaction of the user. To start OXYGEN automatically, the startup setting "Automatically start OXYGEN at log on" can be enabled.

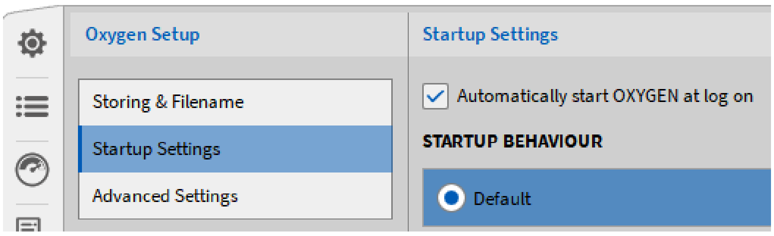

Fig. 9.4: AutoStart option at startup settings

The *Restart acquisition on measurment start* checkbox enables calculated channels and CNT channels to be reset when recording is started.

In case of *Event based Waveform Recording* (refer to *Triggered Events* and *Record action*), the measurement will start automatically when the Start Recording condition (see *Record action*) is active. Therefore, it is not necessary to arm the trigger manually anymore (see *Arming the Trigger*).

9.1 Adding a Trigger Event

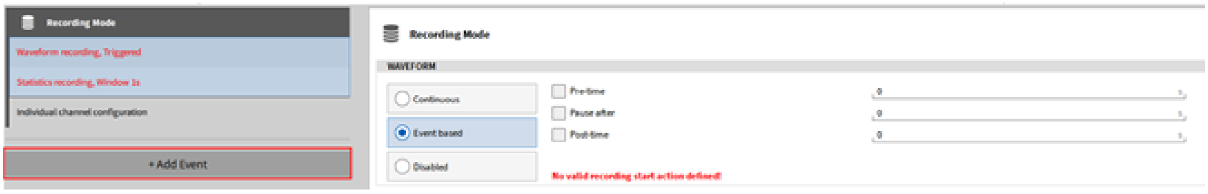

Fig. 9.5: Enable Trigger Mode

If the Event Based Recording is activated, the user must add one or several Trigger Events that regulate the recording start. This can be done via the *+Add Event* button (see Fig. 9.5). Optionally the user can also store the data before the trigger event was reached by adding a *Pre-time* between 0 and 500 seconds and he can also define a time after which the record is paused automatically (*Pause after*). To increase the pre-time, increase the capacity of the freeze buffer, see *Advanced settings*.

9.2 Adding an Event Condition

After an event was added, the user must define an event condition and assign a data channel that is surveilled by the event condition:

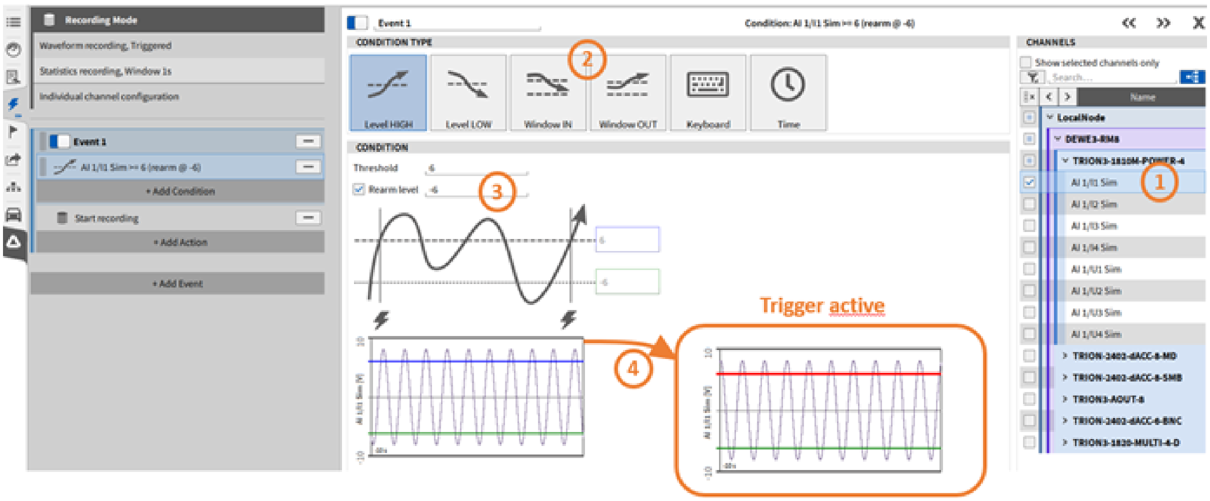

Fig. 9.6: Define an Event Condition and Trigger on *Level HIGH*

The channel to be triggered on can be selected from the channel list on the right screen side (see 1 in Fig. 9.6). After selecting the channel, a preview window is displayed (see 4 in Fig. 9.6). The measuring range displayed in the preview window is the set measuring range of the channel to be triggered. The preview window also contains the set threshold and rearm level. As soon as the threshold value is exceeded and the trigger is active, the line for the threshold value in the preview window changes color from blue to red. The user can select between six different event conditions (see 2 in Fig. 9.6):

- Level HIGH: Activate Event if selected signal exceeds defined Threshold. A *Rearm* Level that must be passed before the trigger is activated again can optionally be defined (see 3 in Fig. 9.6).
- Level LOW: Activate Event if selected signal falls below defined Threshold. A *Rearm* Level that must be passed before the trigger is activated again can optionally be defined (see Fig. 9.7).

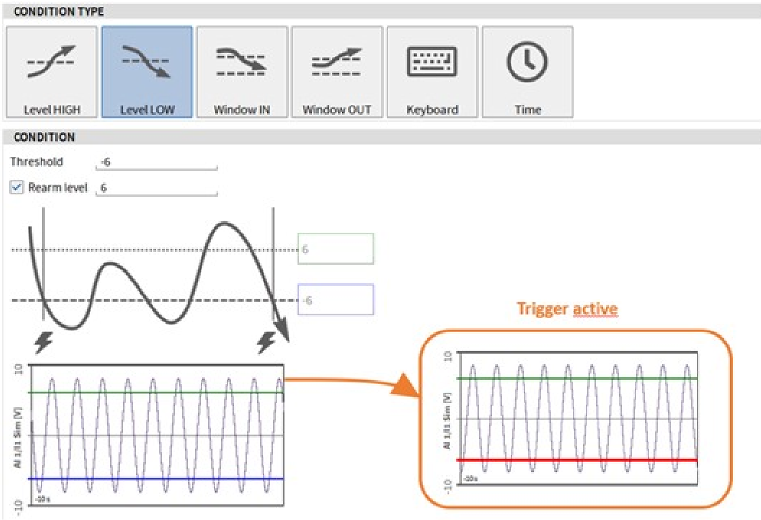

Fig. 9.7: Trigger on *Level LOW*

- Window IN: Activate Event if selected signal is within a certain range. The user can define an upper and a lower limit (see Fig. 9.8). A *Rearm* Level that must be passed before the trigger is activated again can optionally be defined for the lower and upper limit (see 1 in Fig. 9.8).

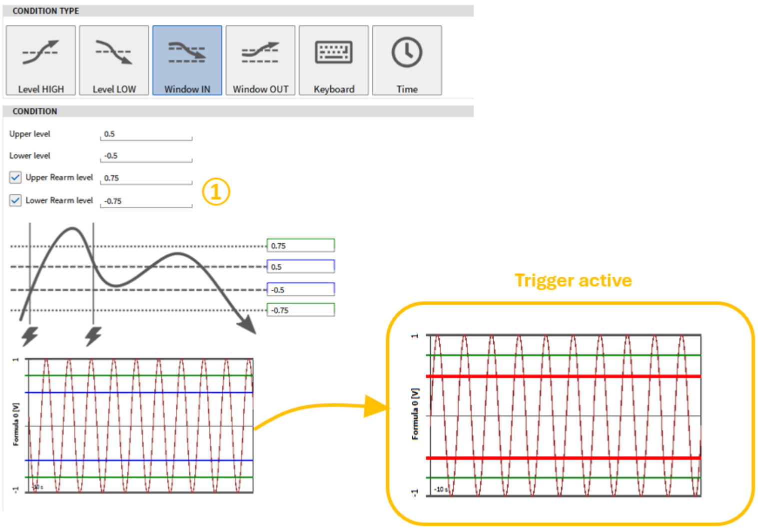

Fig. 9.8: Trigger on *Window IN*

- Window OUT: Activate Event if selected signal is out of a certain range. The user can define an upper and a lower limit (see Fig. 9.9). A Rearm Level that must be passed before the trigger is activated again can optionally be defined for the lower and upper limit (see 1 in Fig. 9.9).

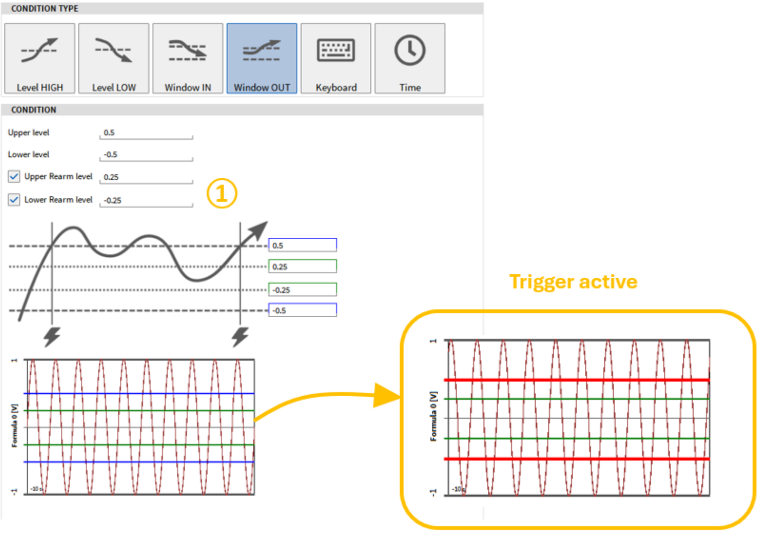

Fig. 9.9: Trigger on *Window OUT*

- Keyboard Event: Control Trigger via the keyboard. The user can select two different states: *True while hold* activates the Event if the selected key is pressed and *Toggle when pressed* toggles between activating and deactivating the Event every time the button is pressed. The key can be selected with a click on the field right to *Shortcut*. In this example, the Space key was selected.

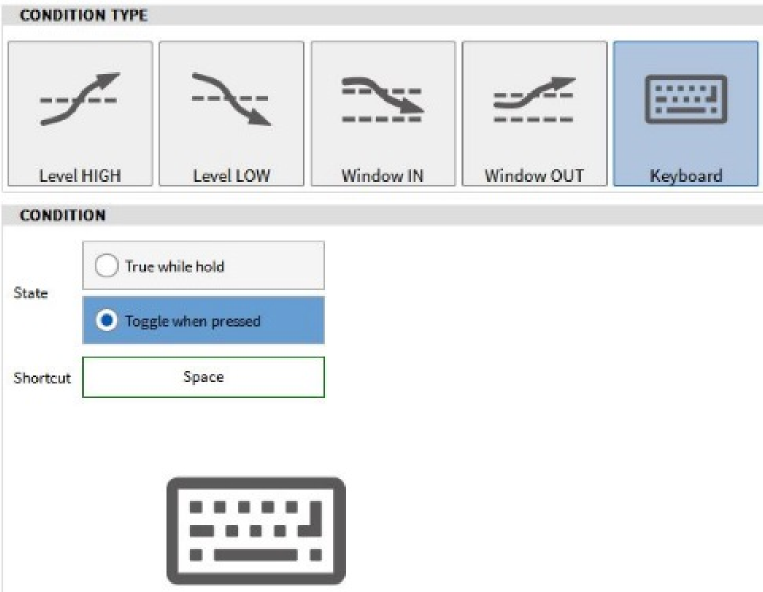

Fig. 9.10: Trigger on *Keyboard* Event

- Time Event: The event is activated in the dependency of a time condition. In the example in Fig. 9.11, the event is activated every 30 minutes for a duration of 1 minute, starting at 15:48:47 on Wednesday 14th of December 2022. If the *Active for* option is not enabled, the Event will be active for one Sample interval, i.e. for 1 ms if the sample Rate is 1 kHz. The red indicator (see 1 in Fig. 9.12) won't highlight if the *Active for* option is not enabled.

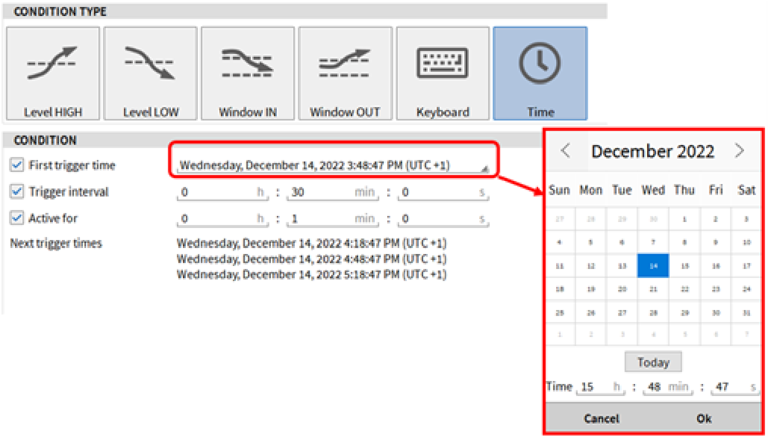

Fig. 9.11: Trigger on *Time* Event

Note:

- The red indicator shows if the respective event is active or not (see ① in Fig. 9.12)
- The blue switch deactivates the event permanently (see ② in Fig. 9.12)
- The – deletes the event (see ③ in Fig. 9.12)
- It is possible to add several Event Conditions to the same event

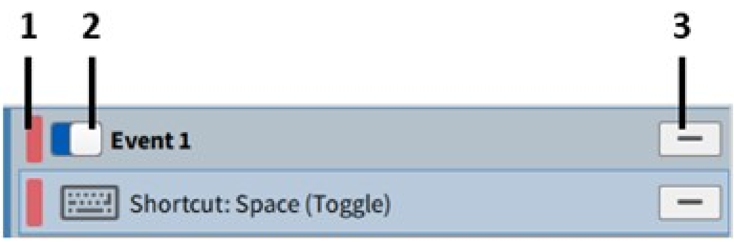

Fig. 9.12: Trigger Menu - Additional information

9.3 Adding an Event action

After the Event Condition is configured the user must define an action that shall be performed when the event is activated, the *Event Action*. Four different actions are available: A *Record* action, an *Alarm* action, a *Marker* action and a *Snapshot* action. Each action has a submenu with different possibilities that are explained in the following sections.

Note: It is possible to add several Event Actions to the same Event

9.3.1 Record action

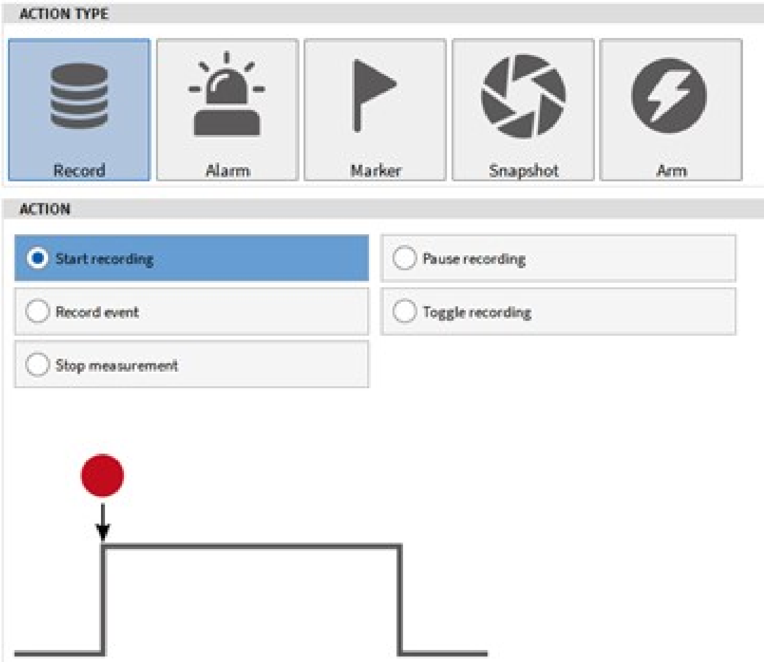

Fig. 9.13: Trigger - Recording Actions

- *Start Recording*: Starts the recording mode when the event is activated
- *Pause Recording*: Pauses the recording mode when the event is activated
- *Record Event*: Recording is enabled if the event is active
- *Toggle Recording*: Toggles recording status if the event is activated
- *Stop measurement*: Stops the recording mode when the event is activated

  Post-time: a post-time can be defined in the trigger menu overview (see Fig. 9.1 or Fig. 9.5). If activated, the recording stops after the defined time when the stop measurement event is activated. For example, if a post-time of 5 seconds is defined, the recording stops 5 seconds after the actual condition with the stop measurement action was defined (see Fig. 9.14).

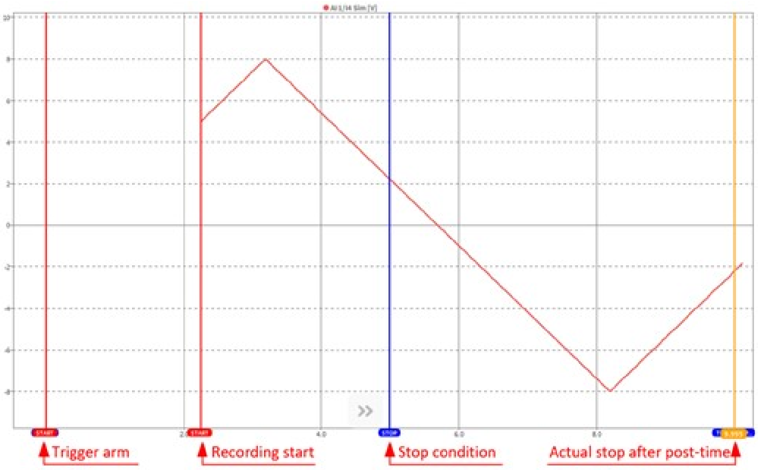

Fig. 9.14: Trigger – example of stop measurement action with post time

9.3.2 Digital Out action

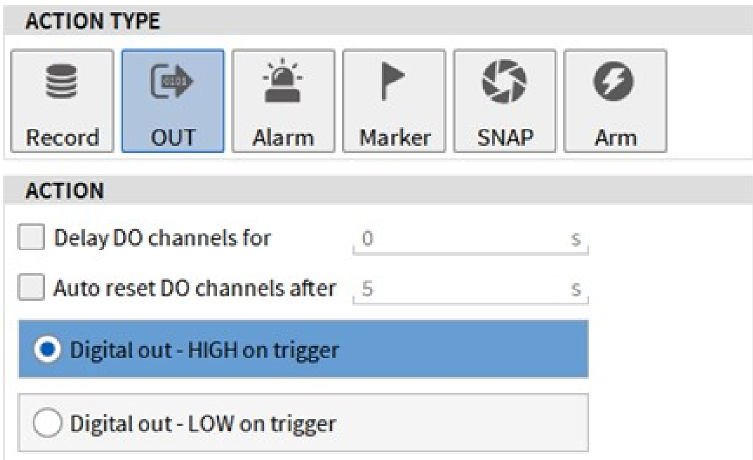

Fig. 9.15: Trigger – Digital Out Action

This can be used to create a heartbeat signal and works like the alarm trigger, however without counting the alarm in the overview bar.

- Delay DO channels for: Duration until the digital channel is triggered.
- Auto reset DO channels after: Duration after which the digital channel is set to the default state and can be triggered again.
- Digital out – HIGH on trigger: Digital channel is set to HIGH on trigger.
- Digital out – LOW on trigger: Digital channel is set to LOW on trigger.

9.3.3 Alarm action

Fig. 9.16: Trigger - Alarm Actions

- *Add marker on Alarm*: A marker will be set when the event is activated
- *Define delay for digital output*: The digital output is only set to LOW or HIGH after the defined delay.
- *Define delay for automatic reset of digital output*: The digital output is only reset after the defined delay.
- *Digital out – HIGH on alarm*: The status of a digital out channel will be set to High when the Event is activated. The channel(s) can be selected from the channel list on the right-hand side. An automatic reset of the channel after 0 - 3600 seconds can optionally be selected.
- *Digital out – LOW on alarm*: The status of a digital out channel will be set to Low when the Event is activated. The channel(s) can be selected from the channel list on the right-hand side. An automatic reset of the channel after 0 - 3600 seconds can optionally be selected.

Note:

- To use connected digital channels as *Digital Out* channels the Channel Mode must be set to *Digital Out* in the *Data Channels* menu (see Fig. 9.17).

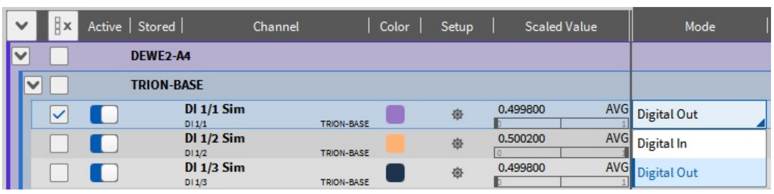

Fig. 9.17: Changing the channel mode of a digital channel

- The number of alarms is counted and displayed in the Action bar. To quit the alarms, click on the bell symbol in the action bar and click on the green check mark (see Fig. 9.18).

Fig. 9.18: Alarm Counter

- An Alarm Action can also be selected if Continuous Waveform Recording is enabled and does not have to be event based.

9.3.4 Marker Action

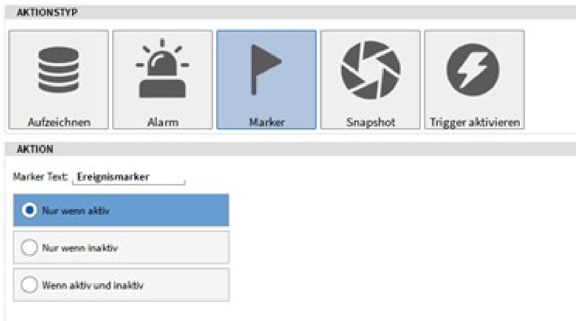

Fig. 9.19: Trigger - Marker Action

This action adds a marker with a user defined marker text.

- *On active only*: Marker is only set if the event is activated
- *On inactive only*: Marker is only set if the event is deactivated
- *On active and inactive*: Marker is set if the event is activated and if the event is deactivated

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Note: A Marker Action can also be selected if Continuous Waveform Recording is enabled and does not have to be event based.

9.3.5 Snapshot Action

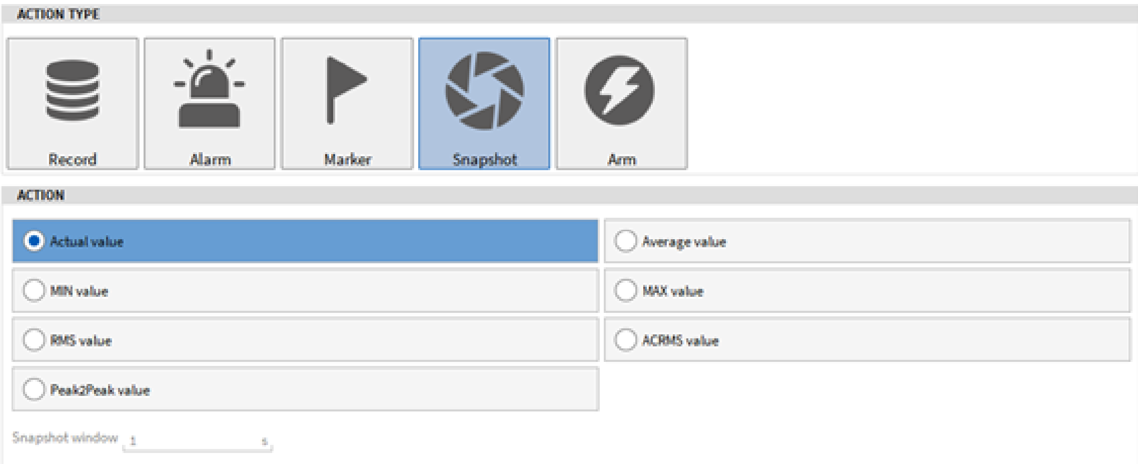

Fig. 9.20: Trigger - Snapshot Action

The Snapshot action can be used to query the Actual Value, Average, MIN, MAX, RMS, ACRMS or Peak2Peak value of one or several channels that may be selected on the right-hand side of the menu (see ① in Fig. 9.6) and copy this value to a new channel. This channel is added to the Channel List and can be found in the *Snapshot: Event x* section (see Fig. 9.21). If a statistical value is selected, the calculation time interval can be defined in the *Snapshot window* input field (see Fig. 9.20). The time interval is applied prior to the activation of the event.

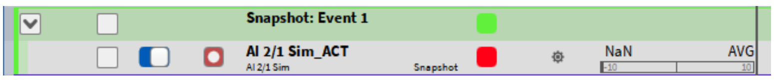

Fig. 9.21: Snapshot channel in the Channel List

Note: The same snapshot action can be applied to several channels by selecting them in the Channel list on the right-hand side (see Fig. 9.22). An own snapshot channel for each selected channel is created in the Channel List (see Fig. 9.23). Selecting several channels in the Snapshot Action menu will result in an own snapshot channel in the Channel List for each selected channel

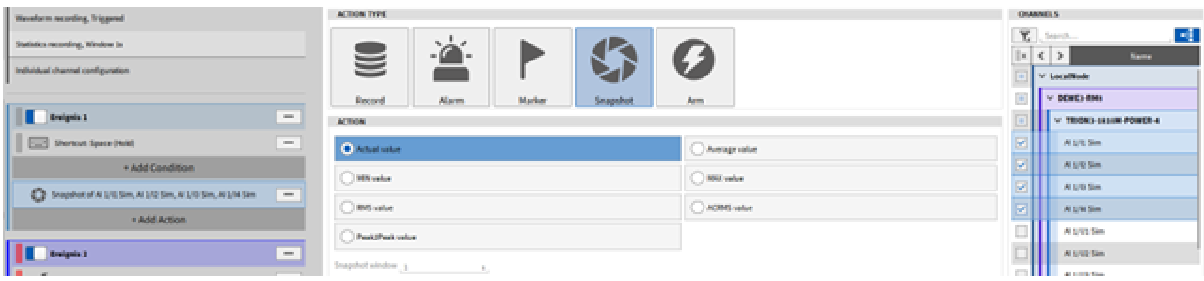

Fig. 9.22: Selecting several channels in the Snapshot Action menu

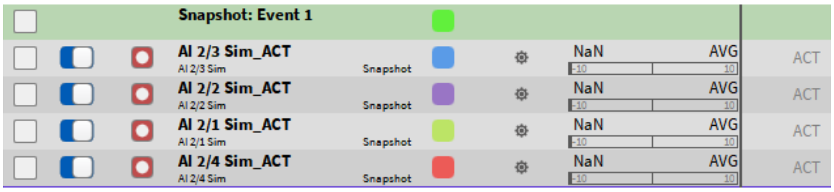

Fig. 9.23: Snapshot channel in the Channel List for each selected channel

9.3.6 Activate Trigger action

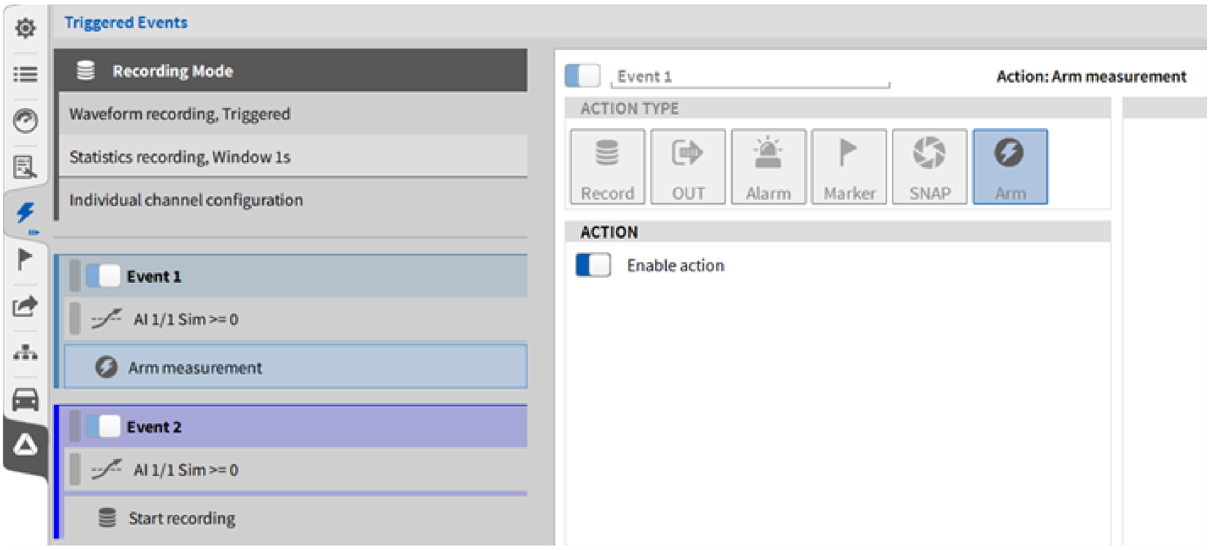

Fig. 9.24: Trigger - Actviate Trigger action

The *Activate trigger* action can be used to automatically arm and thus activate other set trigger actions. After the trigger condition has been met, eventbased recording is enabled and recording starts and pauses according to the defined trigger events. Measurement data is stored in ONE file. This action can also be performed manually (see Fig. 9.24).

9.4 Arming the Trigger

If Event Based Waveform Recording is selected, a flash will appear within the sign of the record button (see Fig. 9.25).

Fig. 9.25: Action bar with enabled *Event Based Waveform* Recording

After pressing the record button, the *Event Based Waveform* Recording is armed and the recording will be started and paused according to the defined trigger events. Measurement data will be written to ONE data file.

Note: If the trigger condition is active while arming the trigger, the trigger will not be detected as the trigger condition is not passed.

9.5 Application Examples

9.5.1 Event Based Waveform Recording triggered by an input channel

Example 1

Challenge: Start Recording when the value of a certain analog input channel exceeds 1 and Pause Recording again when the value exceeds 2.

- Select *Event based Waveform Recording* as Recording Mode (see Fig. 9.26):

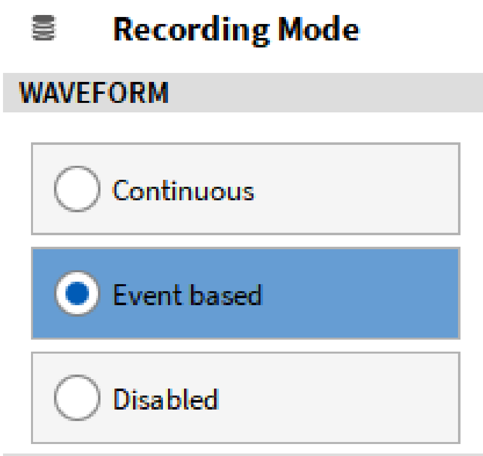

Fig. 9.26: Event based Waveform Recording selection

- Add an Event. Select *Level High* as *Condition Type* and set the *Threshold* to *1*. Select the analog input channel to be triggered on in the Channel List on the right-hand side (see Fig. 9.27):

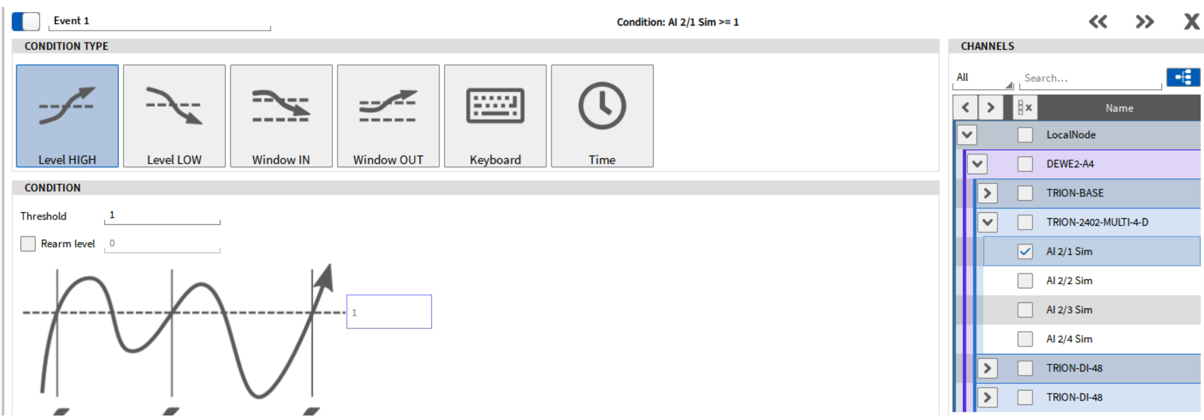

Fig. 9.27: Level High Condition Type; Threshold: 1

- Select *Start recording* as *Action Type* (see Fig. 9.28):

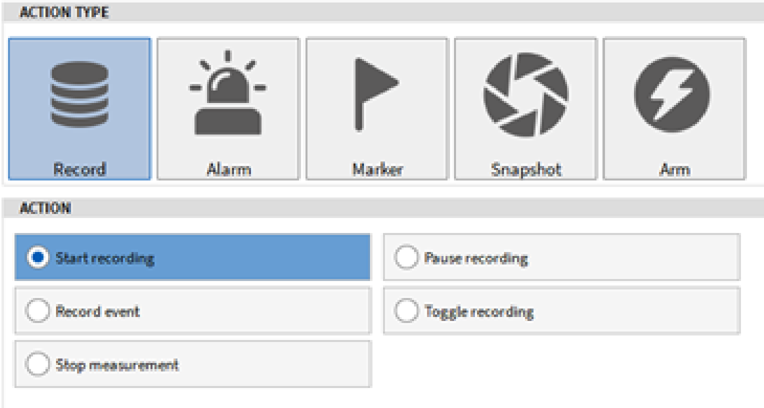

Fig. 9.28: Start Recording Action Type

- Add another event. Select *Level High* as *Condition Type* and set the *Threshold* to 2. Select the analog input channel to be triggered on in the Channel List on the right-hand side (see Fig. 9.29):

Fig. 9.29: Level High Condition Type; Threshold: 2

- Select *Pause recording* as *Action Type* (see Fig. 9.30):

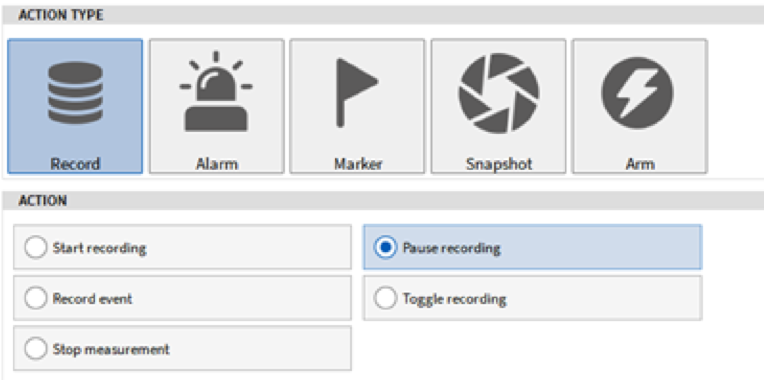

Fig. 9.30: Pause Recording Action Type

Example 2

Challenge: Record data every time the value of an analog input channel is within 1 and 2. The difference to the example above in *Example 1* is that in Example 1 data recording is not started when the value decreases below 2 and does not pause the recording when the value decreases below 1. In this Example 2, it is the case as well.

- Select *Event based Waveform Recording* as Recording Mode (see Fig. 9.31):

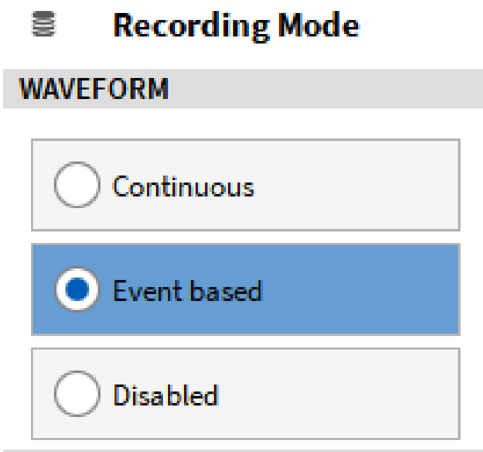

Fig. 9.31: Event based Waveform Recording selection

- Select *Window IN* as *Condition Type* and set the *Lower level* to *1* and the *Upper level* to *2*. Select the analog input channel to be triggered on in the Channel List on the right-hand side (see Fig. 9.32):

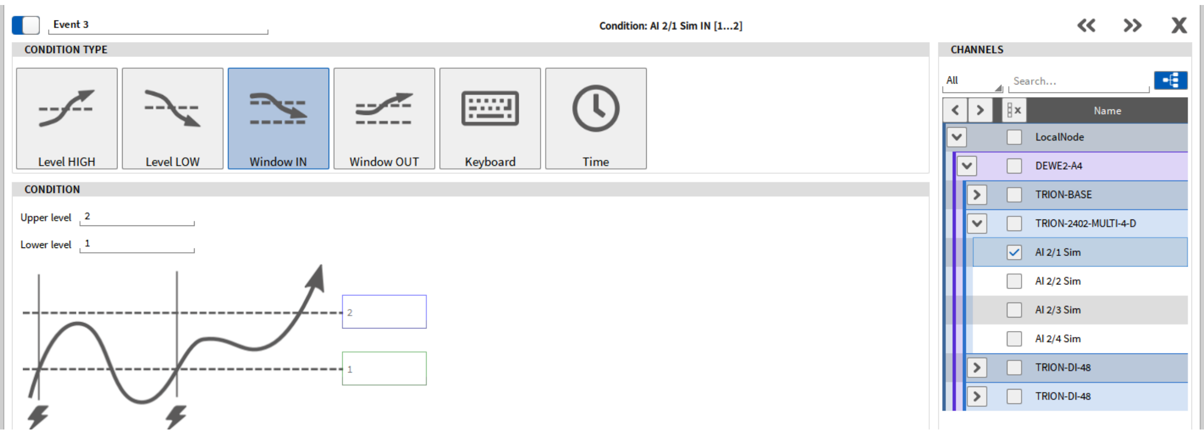

Fig. 9.32: Window In Condition Type; 1...2

- Select *Record Event* as *Action Type* (see Fig. 9.33):

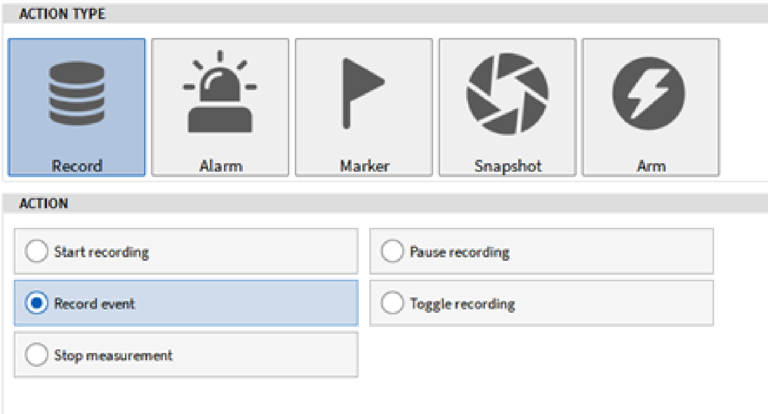

Fig. 9.33: Record Event Action Type

9.5.2 Time Triggered Data Recording

Challenge: Record data every 60 minutes for 2 minutes.

- Select *Event based Waveform Recording* as Recording Mode (see Fig. 9.34):

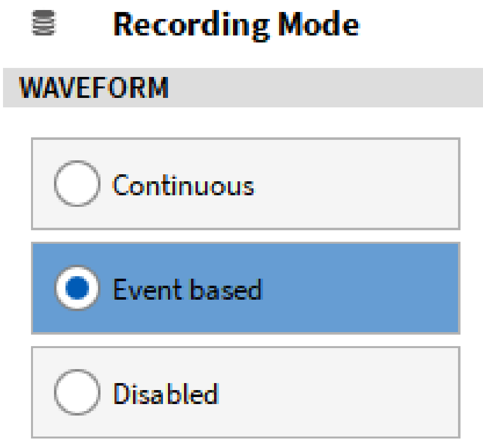

Fig. 9.34: Event based Waveform Recording selection

- Select the *Time* Condition and enter *1h* as *Time interval* and enable *Active for 2 minutes* (see Fig. 9.35):

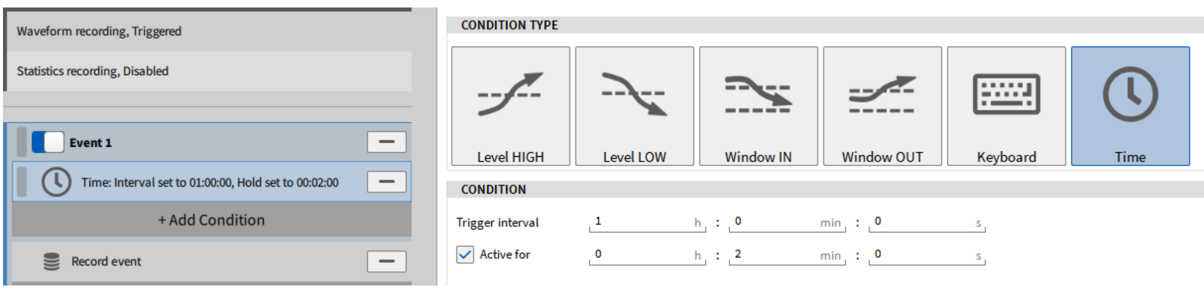

Fig. 9.35: Recording every 60 minutes for 2 minutes

- Select *Record Event* as *Recording Action Type* (see Fig. 9.36):

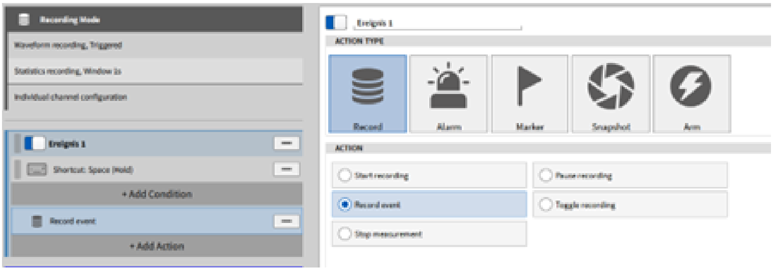

Fig. 9.36: Record Event Action Type

9.5.3 Data Query using the Snapshot Action

Challenge: When the space key is pressed, the RMS value 0.5s prior to the event of 4 analog input channels shall be queried using the snapshot action. When the space button is pressed, a marker shall be added to the time position and a Digital Out channel shall be set to High state.

- Select *Continuous Waveform Recording* as Recording Mode (see Fig. 9.25):

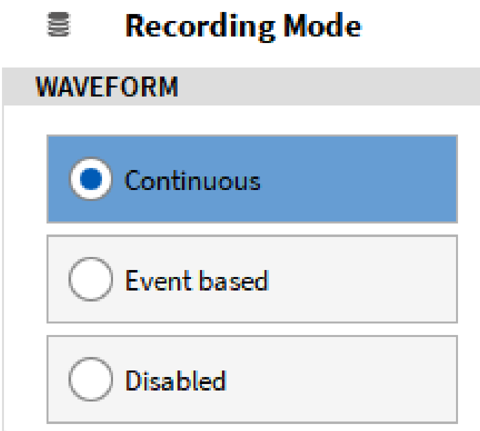

Fig. 9.37: Continuous Waveform Recording selection

- Select *Keyboard Condition Type* and *True while hold* as *Condition State* with the *Space key* as *Shortcut* (see Fig. 9.38):

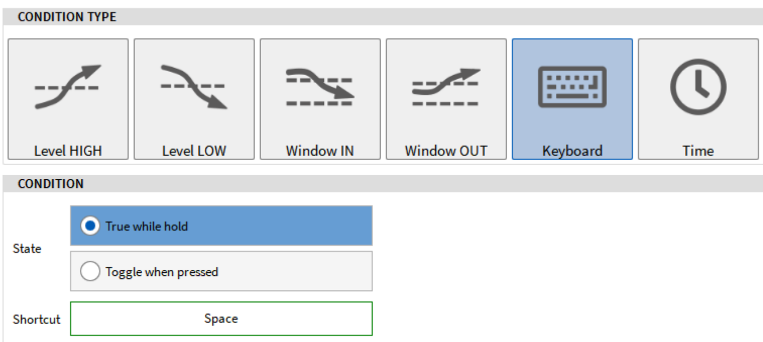

Fig. 9.38: Space Key Condition type

- Select *Snapshot* as *Action Type* and select *RMS value* as *Action* with a *Snapshot window* of *0.5s*. The analog input channels used for the data query can be selected in the channel list on the right-hand side (see Fig. 9.40). Data will be queried in the moment the Event configured above is activated.

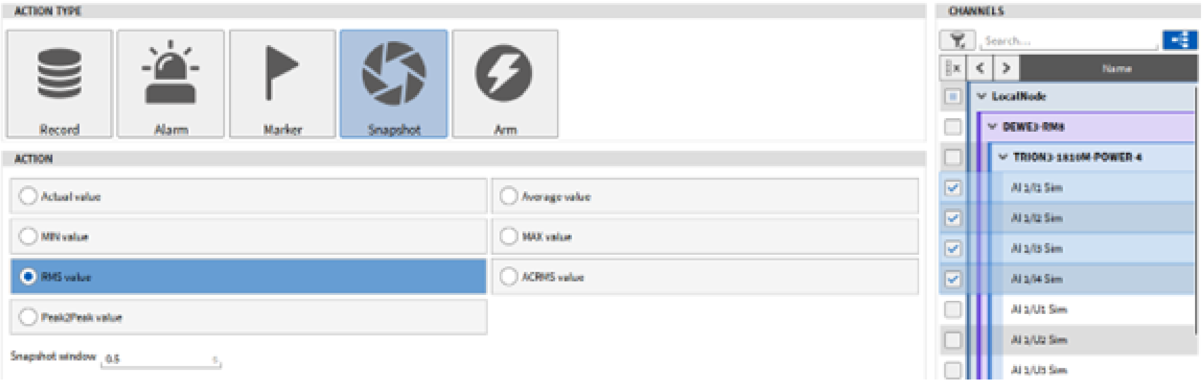

Fig. 9.39: Snapshot Action Type

- To set the Digital Channel to High state, add another Action by pressing the *+Add Action* button, select *Alarm Action Type* and select *Digital out – High on alarm* as *Action*. The Digital out channel to be set can be selected in the channel list on the right-hand side (see Fig. 9.39). The channel mode of the desired Digital channel must be set to *Digital out* in the Channel List (see Fig. 9.17).

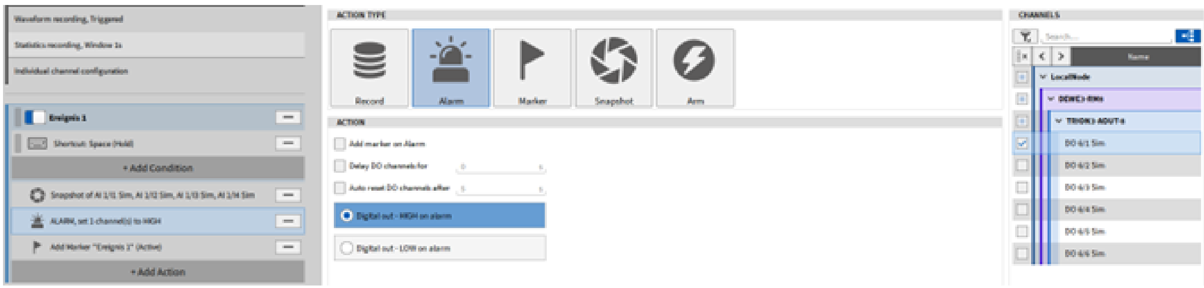

Fig. 9.40: Alarm Action Type

- To add a Marker in the data file at the instant of time the Event is activated and data is queried, add another Action by pressing the *+Add Action* button, select *Marker Action Type* and select *On active only* as *Action*. A marker is now added when the Event is activated.

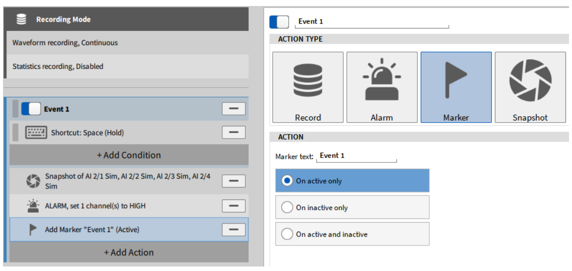

Fig. 9.41: Marker Action Type

9.6 Advanced Storing Modes

The advanced storing modes are available in the Trigger Menu, in the individual channel configuration section (see ① in Fig. 9.42). The individual channel configuration includes the following options:

- Store channels at different sample rates on triggered events
- Choose between different options for the statistics data
- Set different time windows for the statistics data for individual channels

In order to activate the individual channel configuration click on the checkbox button Customize settings per channel (see ② in Fig. 9.42).

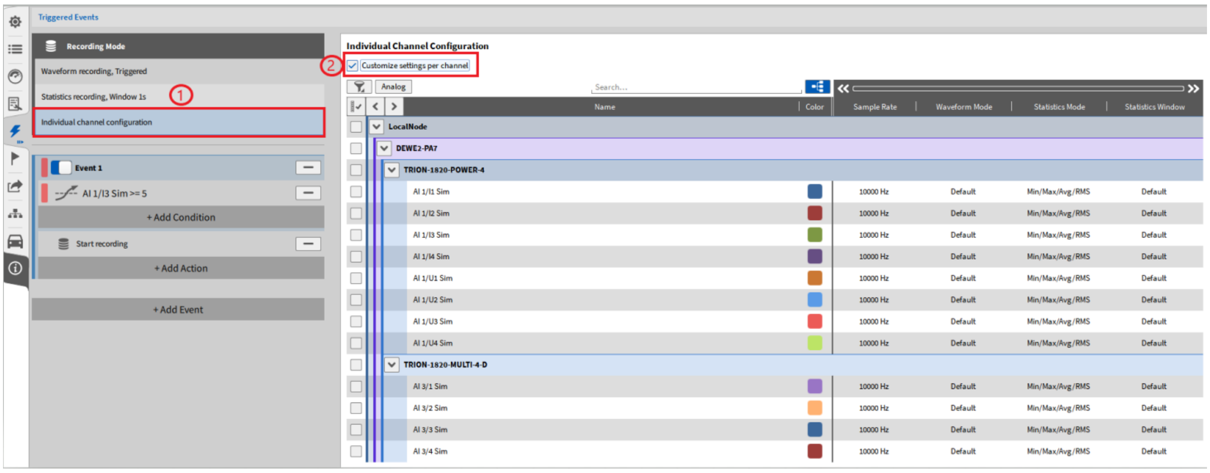

Fig. 9.42: Individual channel configuration in Trigger Menu

In this channel configuration some known settings from the Data Channel List can be found, like the channel filter or color bar. These settings are described in *Data channels menu*. To keep the overview the three relevant columns for the individual channel configuration will be explained here:

- Waveform Mode
- Statistics Mode
- Statistics Window

Note: The sample rate is shown here, just like in the data channel list, but it *cannot* be changed in this configuration menu. In order to change the sample rate for individual channels, go to the Data Channel list and refer to *Channel-wise Sample Rate Selector*, where it is described in detail how to change sample rates channel-wise.

9.6.1 Waveform Mode

The Waveform Mode offers two different options seen in Fig. 9.43.

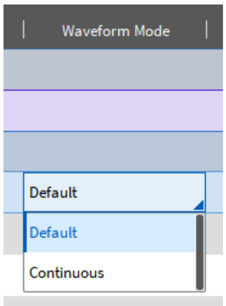

Fig. 9.43: Options for Waveform Mode in Advanced Storing Modes

Default refers to the settings, which were made in the trigger menu. For details about the settings in the trigger menu, refer to *Triggered Events*. *Continuous* means, that the channel will always be stored, from the moment the trigger will be armed, and the trigger settings will be ignored. In this case this button in the action bar  acts as the normal *Recording start* button.

Only after the event happens, the other channels with the default setting will also be stored with the defined sample rate. An exemplary representation on when and what channels are stored is shown in Fig. 9.44. Whenever the trigger is armed on the measurement screen in the action bar, the channels with the Waveform Mode *Continuous* are stored from that moment on. At the time the set events happen, also the channels with the Waveform Mode *Default* are stored at the defined sample rate.

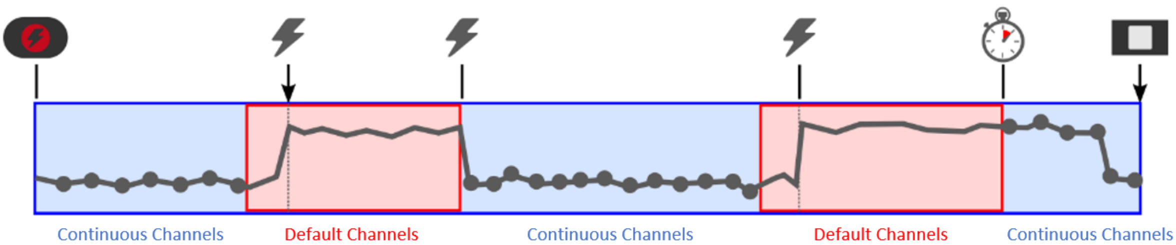

Fig. 9.44: Representation of Continuous and Default Storing Mode

The selected sample rate at which the channel will be stored can be seen in the Sample Rate column. To change the sample rate, go to the Data Channel list.

Note: In case the Waveform Mode of a whole Power Group (all parameters within the Power Group) wants to be changed, the checkbox of the Power Group has to be specifically selected before changing the Waveform Mode (see Fig. 9.45). If only the row of the channel is clicked on, the Mode does not change for the individual Power channels. Of course, all the parameters of the Power Group can also set to an individual Waveform Mode.

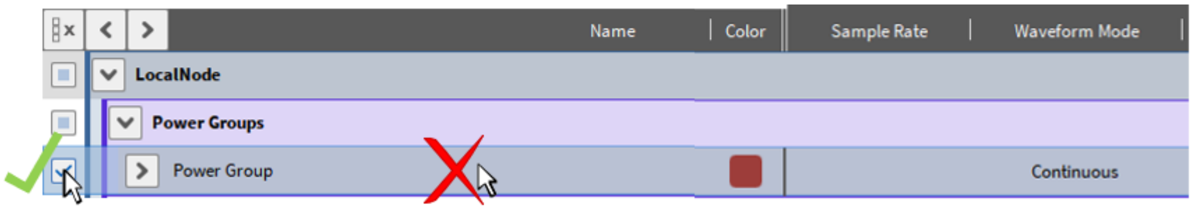

Fig. 9.45: Changing Waveform Mode for a whole Power Group

9.6.2 Statistics Mode

The statistics mode offers different possibilities seen in Fig. 9.46.

- Off: No statistics data will be calculated or stored for this channel
- Min/Max/Avg/RMS: these four values are calculated as statistical values for the channel
- Skip: Only the first sample of the set statistics window is stored

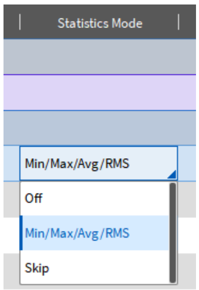

Fig. 9.46: Options for Statistics Mode in Advanced Storing Modes

9.6.3 Statistics Window

The time window to calculate the statistics data can be set individually per channel, seen in Fig. 9.47.

Default refers to the settings for the statistics data in the trigger menu, see Fig. 9.48.

For the time window a value from the drop-down list can be chosen or a value from $\frac{1}{\text{sample rate}}$ up to 10 s can be entered.

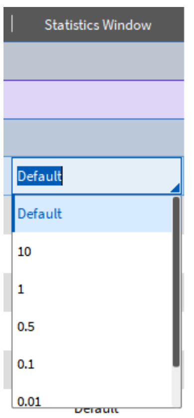

Fig. 9.47: Options for Statistics Window in Advanced Storing Modes

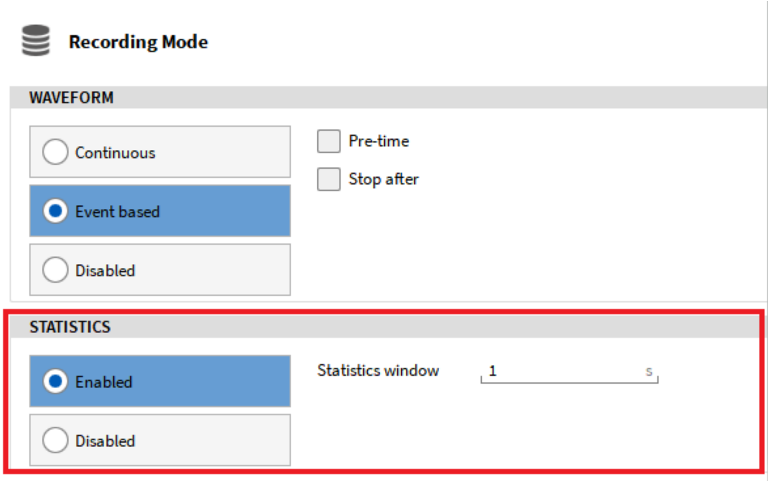

Fig. 9.48: Settings for Statistical Data in Trigger Menu

Note: If the Statistics Data is disabled in the trigger settings (see Fig. 9.48), the columns Statistics Mode and Statistics Window disappear and are not shown in the Individual Channel Configuration anymore.

9.6.4 Example

This section describes an example, to give a better understanding of the Advanced Storing Modes.

Fig. 9.49 and Fig. 9.50 both show the settings, which were made. This example shows how to continuously store the power parameters but only store the raw data in case of an event. For the raw data also different sample rates are set (refer to *Channel-wise Sample Rate Selector*) and different settings for the statistics data.

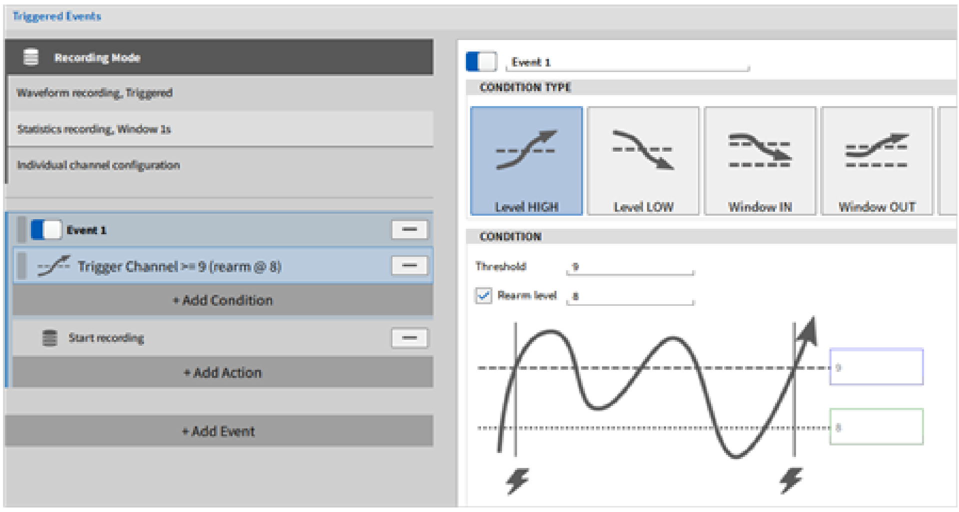

Fig. 9.49: Example: Trigger Event Settings

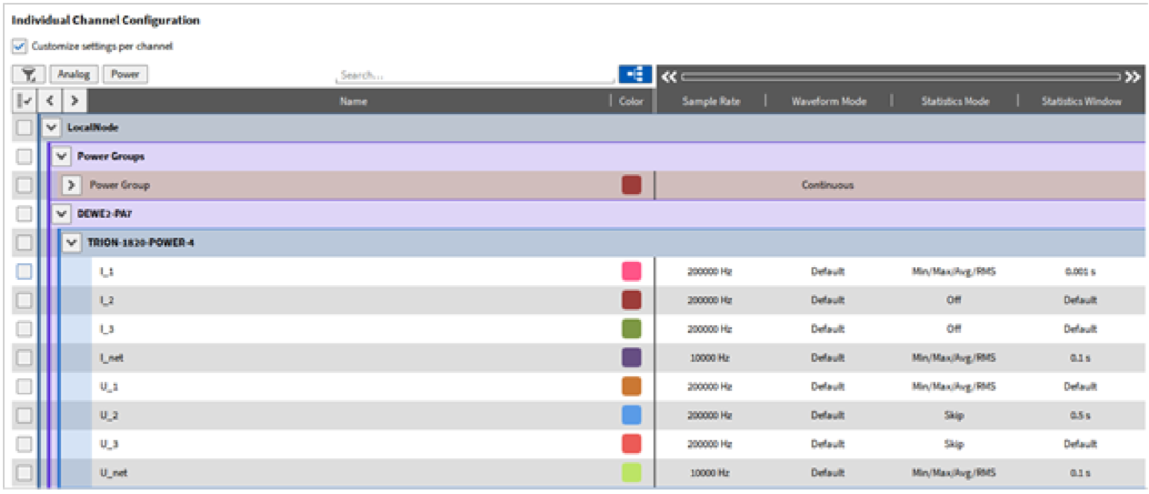

Fig. 9.50: Example: Individual Channel Configuration Settings

1. To continuously store the power parameters the *Waveform Mode* is set to *Continuous* (consider the note in *Waveform Mode*).

   Whenever the trigger will be armed, all those parameters are recorded and stored.

2. The other channels of the TRION-1820-POWER-4 card are set to the *Waveform Mode Default*. This means, that the trigger event settings are considered here. By looking at Fig. 9.49 it can be seen, that the recording will be started whenever the *Trigger Channel* rises above the defined threshold of 9 V. At this point the raw data channels are also recorded and stored with a sample rate of 200 kHz, or 10 kHz for channel *I_net* and *U_net*.

3. Additionally, those channels have different settings for the Statistics Data.

   a. Channel *I_1*: The Min/Max/Avg/RMS value will be stored for a time window of 0.001 s.

   b. Channel *I_2* and *I_3*: Statistics Data is turned off and will not be calculated nor stored.

   c. Channel *I_net*: The Min/Max/Avg/RMS value will be stored for a time window of 0.1 s.

   d. Channel *U_1*: The Min/Max/Avg/RMS value will be stored for the default time window, which is set in the trigger settings and is per default of 1 s.

   e. Channel *U_2*: only the first sample of the defined time window of 0.1 s is stored.

   f. Channel *U_3*: only the first sample of the default time window of 1 s, which is set in the trigger settings, is stored.

   g. Channel *U_net*: The Min/Max/Avg/RMS value will be stored for a time window of 0.1 s.

The individual channel configuration should be done carefully to make the right settings, since complex setups can be created like this.

CHAPTER

TEN

EVENT LIST

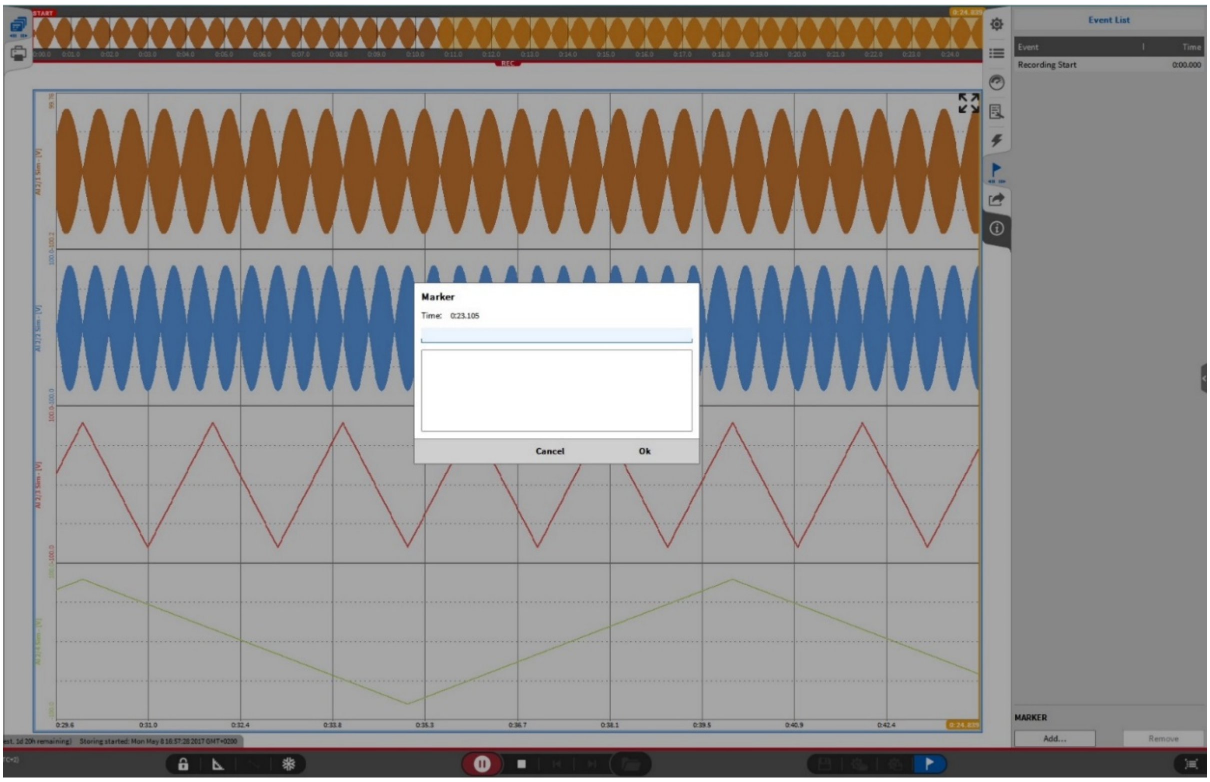

Fig. 10.1: Adding a Marker

During an active recording, the user can add markers in its measurement to add additional information at a certain point of time. Therefore, the user must click on one of the both buttons marked in Fig. 10.1 and a pop-up window will appear. In this window, the user can add the additional information to the marker. After clicking on *OK*, the marker will show up in the Event List. The Marker will be added to the instant of time with the respective timestamp after clicking on one of the both buttons and not only after clicking *OK*.

This list will also be saved to the data file. When a data file is reviewed in the *PLAY* mode, the Markers are displayed in the Overview bar as well as in a Recorder Instrument and will show up in the Event List (see Fig. 10.2). Further markers can be added in the *PLAY* mode as well.

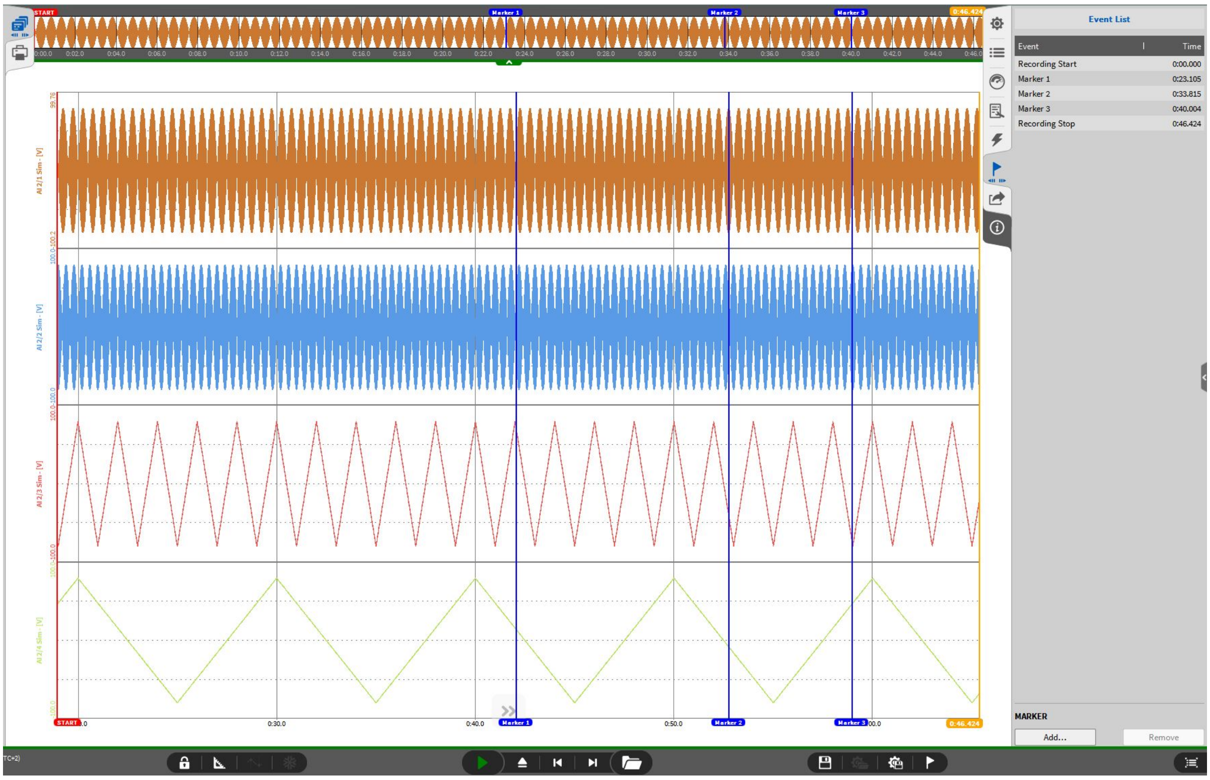

Fig. 10.2: Marker review in the *PLAY* mode

Note:

- The Marker option is only available in the *REC* mode and in the *PLAY* mode, not in the *LIVE* mode.
- If Markers are generated with the *Marker* Action during Event triggering (see *Marker Action*), they will show up in The Event List as well.
- To remove a marker again just select the respective one in the Event List and click on the *Remove* button which is located next to the *Add* button.
- In the *PLAY* mode, the orange cursor jumps to the individual *Event* by clicking on the *Time* of the *Event* or *Marker* in the *Event List*.

When opening the Event List menu to the full screen it is possible to select the time format and timestamp precision [ms], which should be displayed in the Event List.

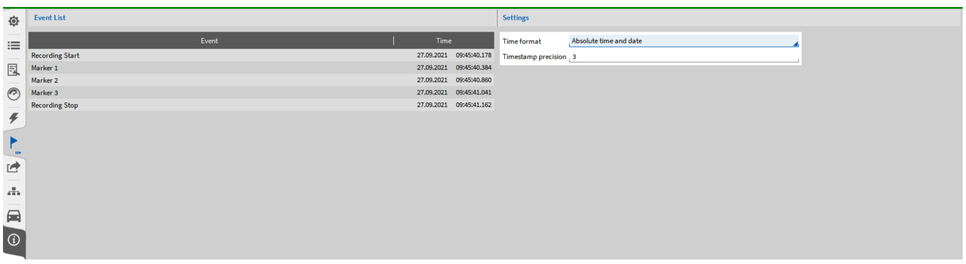

Fig. 10.3: Event List menu - full screen

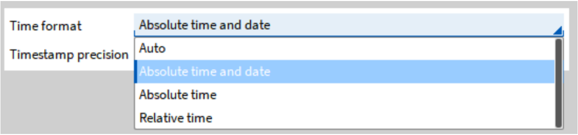

Fig. 10.4: Event List menu - timestamp selection

The following options are available:

- Auto
- Absolute time and date: this can be useful when recording over several days, in order to see the date for each event
- Absolute time
- Relative time

Addidtionally, the timestamp precision can be chosen between 0 and 9 digits [ms].

CHAPTER

ELEVEN

EXPORT SETTINGS

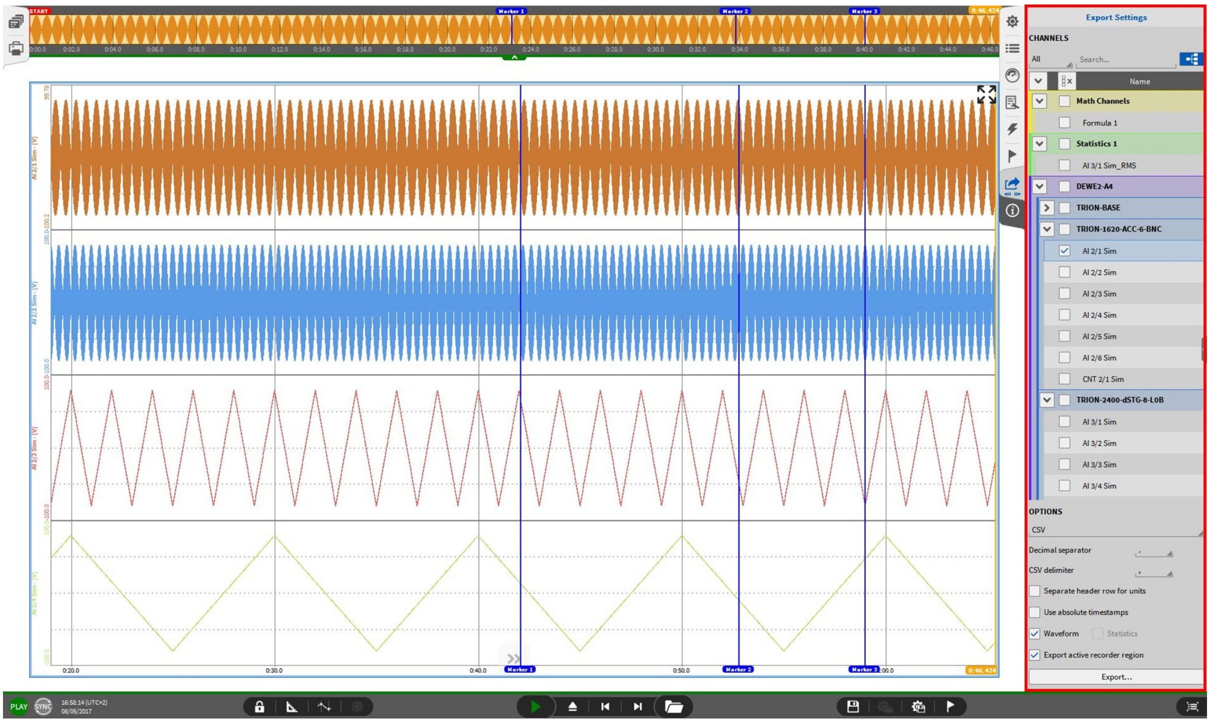

Fig. 11.1: Export Settings – Overview and export options for a *.csv-file

In *PLAY* mode, the user can export the recorded data into the following formats:

Table 11.1: Export formats

Export formats	
*.csv-file	*.txt-file
*.mdf4-file	*.mat-file
*.xlsx-file	*.rsp (rpc III)-file
*.wav-file	*.dat-file (DIADEM)
*.nt-file (DynaWorks)	*.h5-file
*.uff-file (Universal File Format 58; Binary and ASCII)	*.imc-file (FAMOS)
*.tdms-file (LabVIEW)	*.nc-file (NetCDF)
*.datx-file (DSPcon)	

The user can select the channels to be exported in the channel list displayed in the Export Settings (Fig. 11.1).

To change the order of exported channels, use the order tab in the export menu. Select channels to be exported ① and click on the Order tab ②. Next switch the order of channels to your requirements ③. To use this changed order, tick the "Export in configured order" checkbox before exporting the channels. This results in an individual channel order in the exported file ⑤.

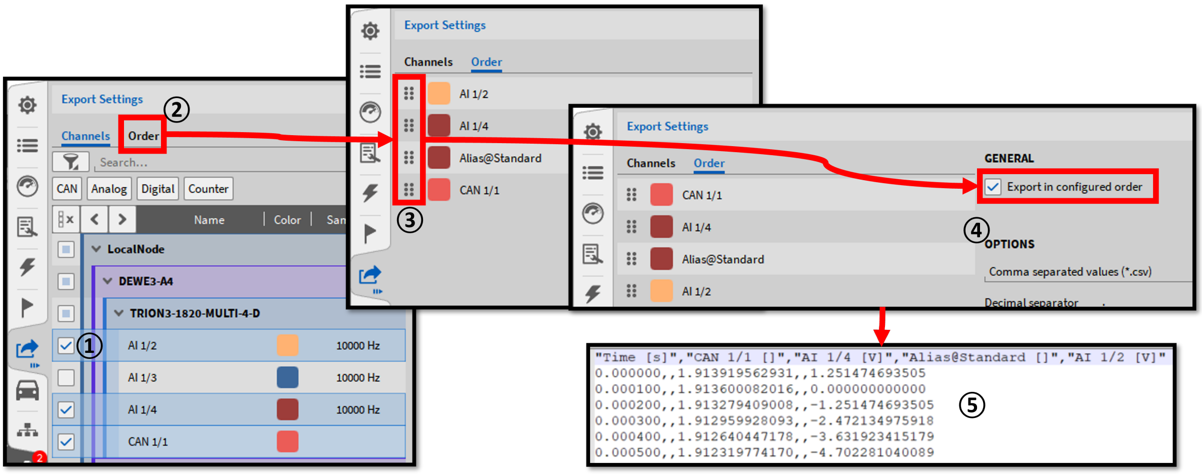

Fig. 11.2: Edit channel export order

11.1 Export active recorder region or between cursors

The user has the possibility to only export the active recorder region of the selected recorder or the region between the cursors. Depending on whether the cursors are activated, one of the following options to export (see Fig. 11.3) can be seen. This option is available for all file formats.

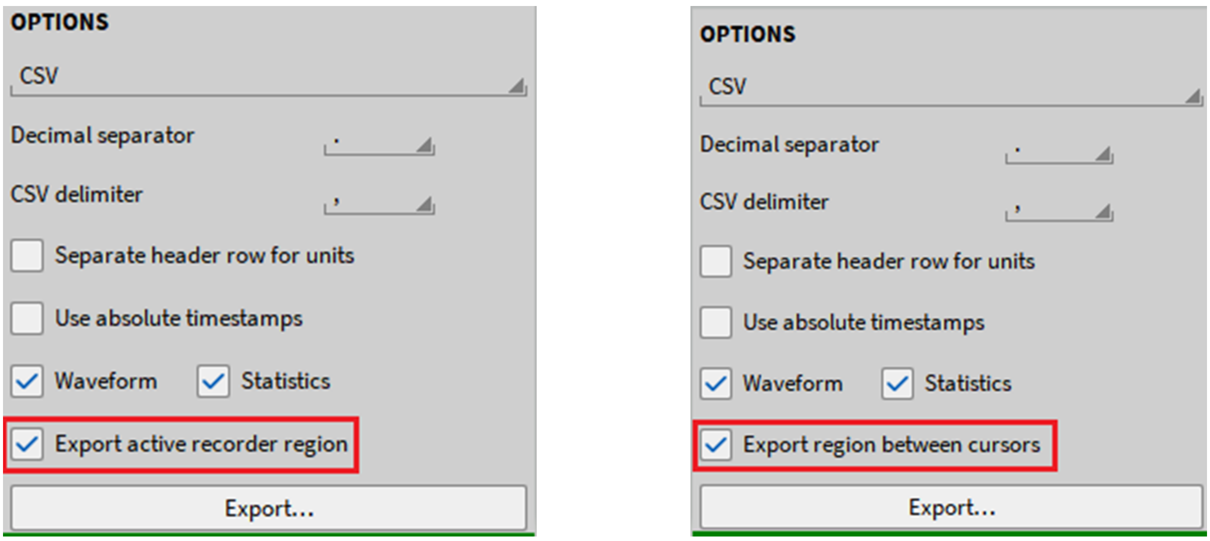

Fig. 11.3: Export active recorder region or between cursors

Note: These options are only available if the export menu is *not* enlarged and opened to full size. If the menu is enlarged to full size or these options are deactivated the whole recorded data will be exported.

11.2 Export triggered data file with trigger aligned to zero

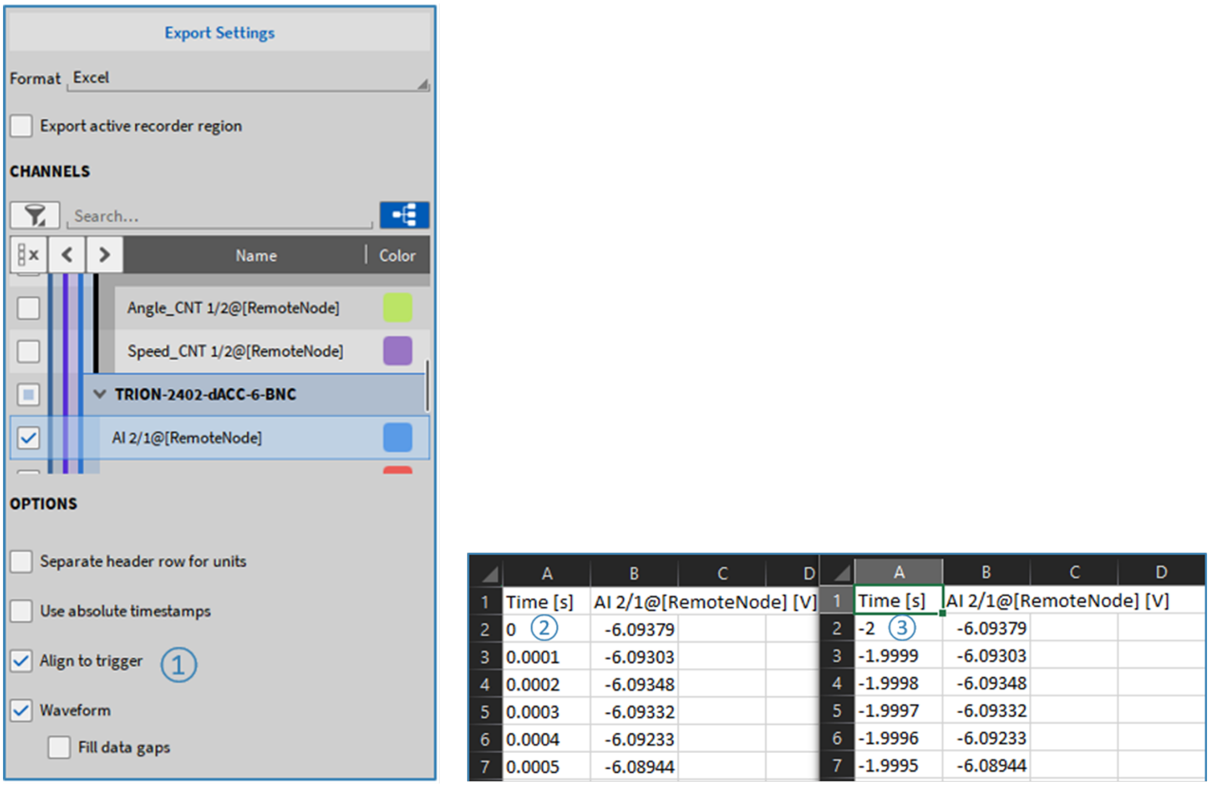

Fig. 11.4: Align timestamps in exported file to zero

Timestamps in an exported data file with a triggered event can be aligned to the trigger (see ① in Fig. 11.4). If align to trigger is not selected, then the 0s timestamp will be at recording start, not at the trigger (see ② in Fig. 11.4). If align to trigger is selected, the timestamp at the trigger will then be set to zero. Thus, the time leading up to the trigger event (e.g. the pre-time) will be negative (see ③ in Fig. 11.4).

If more than one trigger event is in a recording, then the first trigger event will be set to zero, when the align to trigger option is selected.

This option is possible for *.txt, *.csv and *.xlsx-export.

11.3 Export with reduced sample rate

When exporting data, it is possible to reduce the sample rate of selected channels. To do this, enable the Reduced samplerate option in the export settings and choose a desired rate from the dropdown menu. Available rates range from 1 Hz to 10 kHz. This option is supported for the following export formats: .xlsx, .csv, and .txt.

Note: Reducing the sample rate will skip data points—it does not perform averaging or interpolation..

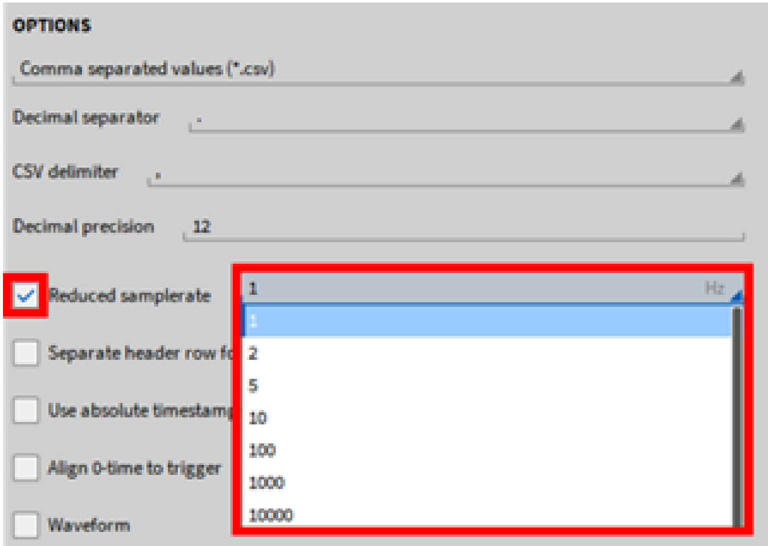

Fig. 11.5: Export channels with reduced sample rate

11.4 Export Options for a *.csv-file

If *.csv is selected as format, the user has the following additional options (see Fig. 11.6):

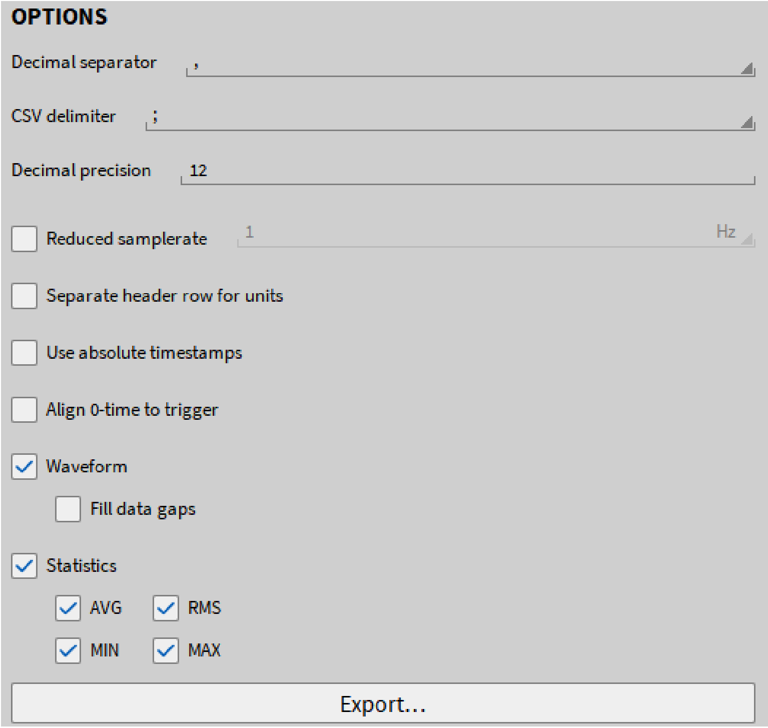

Fig. 11.6: Export Options for a *.csv-file

- Choose between Decimal separator '.' and ','
- Choose between CSV delimiter ',' and ';'
- Select the decimal precision from 1 to 20 digits; the decimals will be rounded to the selected precision
- For reduced sample rate see *Export with reduced sample rate*.
- Selection of *Separate header row for units* will write the units in a separate row below the channel names
- Select *Use absolute timestamps* or export relative timestamps
- For Align 0-time to trigger see *Export triggered data file with trigger aligned to zero*.
- *Waveform*: select if the waveform data shall be exported.
- Fill data gaps: select if data gaps shall be filled up when exporting channels with different sample rates. For channels with a lower sample rate, the samples will be repeated until the next sample is available.
- Statistics: select which of the statistics parameters shall be exported

11.5 Export Options for a *.txt-file

If *.txt is selected as format, the user has the following additional options (see Fig. 11.7):

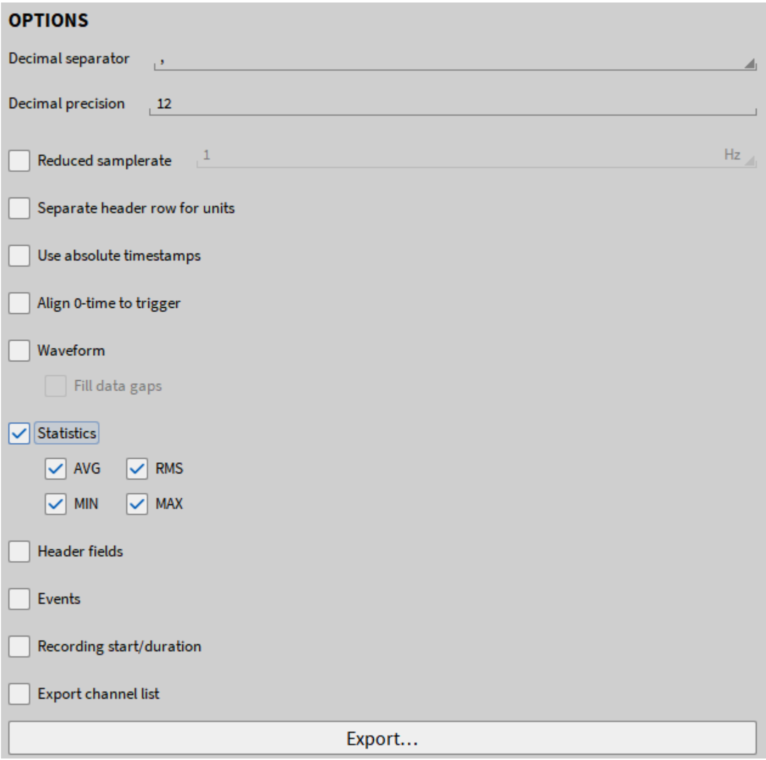

Fig. 11.7: Export Options for a *.txt-file

- Choose between Decimal separator ‘.’ and ‘,’
- Select the decimal precision from 1 to 20 digits; the decimals will be rounded to the selected precision.
- For reduced sample rate see *Export with reduced sample rate*.
- Selection of *Separate header row for units* will write the units in a separate row below the channel names
- Select *Use absolute timestamps* or export relative timestamps
- For Align 0-time to trigger see *Export triggered data file with trigger aligned to zero*.
- *Waveform*: select if the waveform data shall be exported.

  Fill data gaps: select if data gaps shall be filled up when exporting channels with different sample rates. For channels with a lower sample rate, the samples will be repeated until the next sample is available.
- Statistics: select which of the statistics parameters shall be exported
- Select if the *Header fields* shall be exported to the file
- Select if the *Event List* shall be exported to the file
- Select if the *Recording start* and the *Recording duration* shall be exported to the file
- Select if the *Channel List* shall be exported to the file

11.6 Export options for a *.mdf4-file

If *.mdf4 is selected as format, the user has the following additional options (see Fig. 11.8):

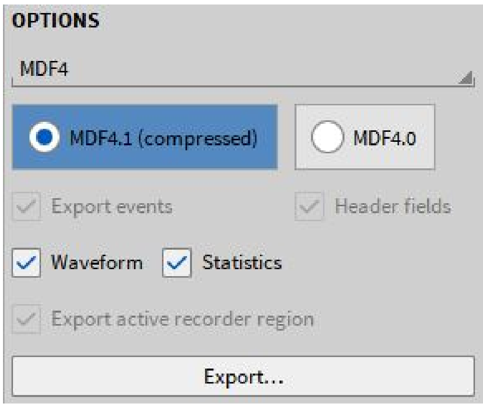

Fig. 11.8: Export options for a *.mdf4-file

- Select if the data shall be exported to the compressed *mdf4.1* or the uncompressed *mdf4.0* format
- *Events* and *Header data* will be exported per default. The check boxes are only displayed for information purpose
- Select if *Waveform* data and/ or *Statistics* data shall be exported

11.7 Export options for a *.mat-file

If *.mat is selected as format, the user has the following additional options (see Fig. 11.9):

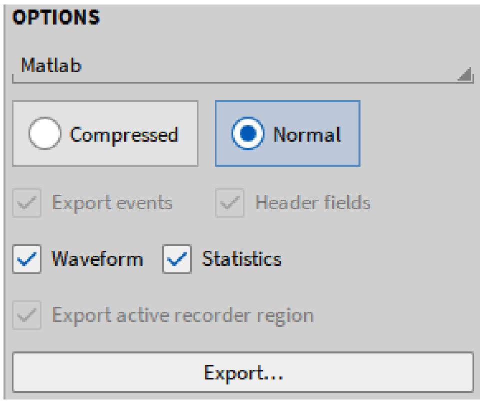

Fig. 11.9: Export options for a *.mat-file

- Choose between *Compressed* and *Normal* export
  - *Compressed*: The *.mat-file will be compressed during export. Thus, the *Compressed* export will take more time than the *Normal* export
  - *Normal*: The *.mat-file will not be compressed during export. Thus, the *Normal* export will be quicker than the *Compressed* export, but the resulting *.mat-file is larger
- The exported file format is a 7.3 MAT-file

- Events and Header data will be exported per default. The check boxes are only displayed for information purpose
- Select if *Waveform* data and/ or *Statistics* data shall be exported

11.8 Export options for an *.xlsx-file (Excel)

If Excel is selected as format, the user has the following additional options (see Fig. 11.10):

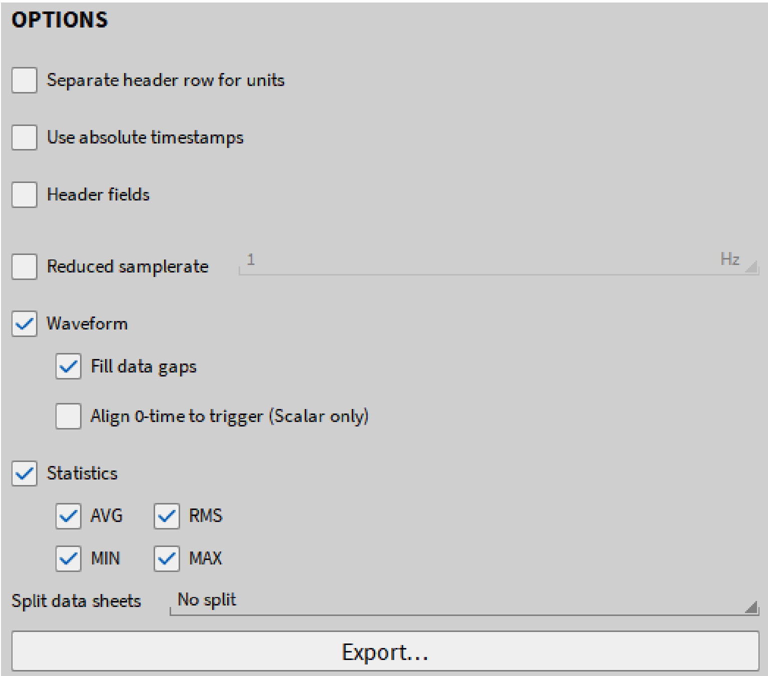

Fig. 11.10: Export options for an Excel-file

- Selection of *Separate header row for units* will write the units a separate row below the channel names
- Select *Use absolute timestamps* or export relative
- Select *Header fields* to export header data in a separate Excel spreadsheet.
- For reduced sample rate see *Export with reduced sample rate*.
- *Waveform*: select if the waveform data shall be exported.
  - Fill data gaps: select if data gaps shall be filled up when exporting channels with different sample rates. For channels with a lower sample rate, the samples will be repeated until the next sample is available.
  - Align 0-time to trigger: see *Export triggered data file with trigger aligned to zero*.
- With *Split data sheets*, select if a new spreadsheet should be created per file (for multi-file recordings) or per event (for triggered recordings). Otherwise, select no split.

Note: As the number of lines on one Excel spreadsheet is limited to 1048576 (2^{20}) the data will be written to a new spreadsheet if this limit is reached.

11.9 Export Options for a *.rsp (rpc III)-file

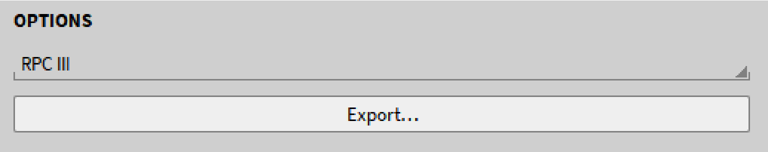

Fig. 11.11: Export options for a *.rsp-file

There are currently no options to select.

11.10 Export Options for a *.wav-file

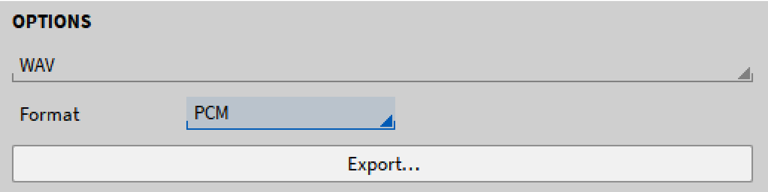

Fig. 11.12: Export options for a *.wav-file

Selection of *PCM* or *Float* Format

- PCM: 16-bit integer format
- Float: 32-bit floating point format

The PCM format results in an export file, which is half the size of the float format file but is also less accurate.

11.11 Export Options for a *.dat-file (DIADEM)

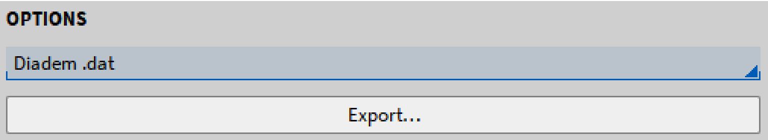

Fig. 11.13: Export options for a *.dat-file

DIADEM-Export only supports the export of Waveform data but no support of Statistics (Reduced) data. The format only supports the export of scalar channels such as analog channels and formulas.

When exporting data, three separate fiels will be created:

- *.dat-file containing header information
- *.R32-file containing the data
- *.R64-file containing the timestamps

11.12 Export Options for a *.nt-file (DynaWorks)

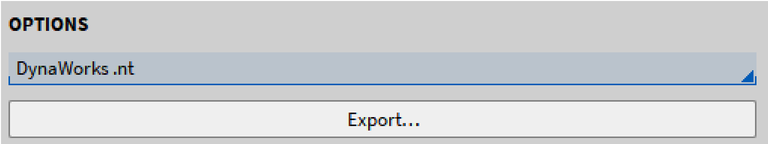

Fig. 11.14: Export options for a *.nt-file

This export generates the DynaWorks Neutral File Format. This export only supports the export of Waveform data but no support of Statistics (Reduced) data.

Each channel is exported into a separate export file. Additional header are required for some databases.

Detailed information about this export format can be found in the DynaWorks export manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

11.13 Export Options for a *.h5-file

This export generates a file in HDF5 file format.

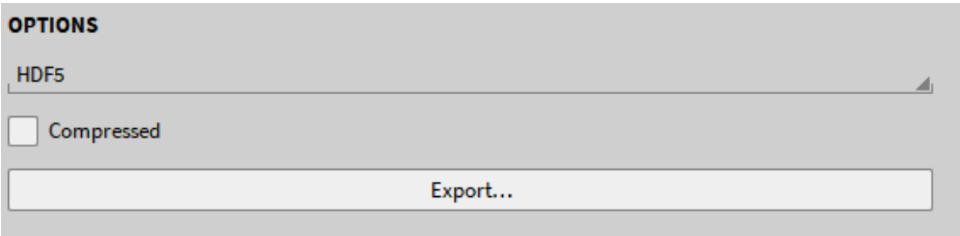

Fig. 11.15: Export options for a *.h5-file

Choose if the file should be exported in a compressed format. This export supports the export of Waveform data and includes metadata but does not support the export of Statistics (Reduced) data.

11.14 Export Options for a *.uff-file

This export generates a file in binary or ASCII universal file data set format 58.

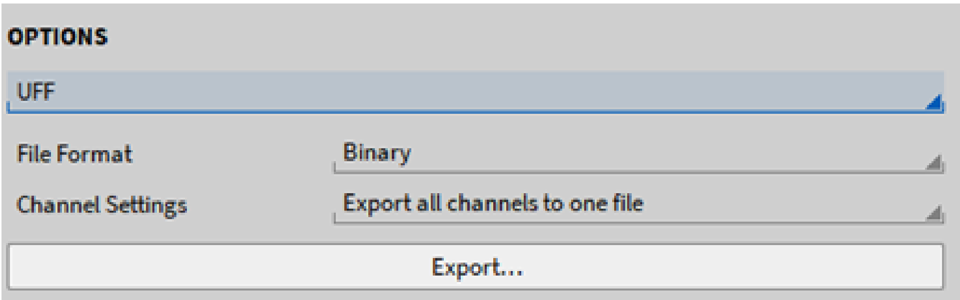

Fig. 11.16: Export options for a *.uff-file

This export only supports the export of Waveform data but no support of Statistics (Reduced) data and has the following export options:

- File Format: Choose between Binary and ASCII
- Channel Settings: Choose if all channels shall be exported into one common file or if each channel shall be exported into a separate file.

11.15 Export Options for a *.imc2-file

This export generates a file in *.imc2 file format.

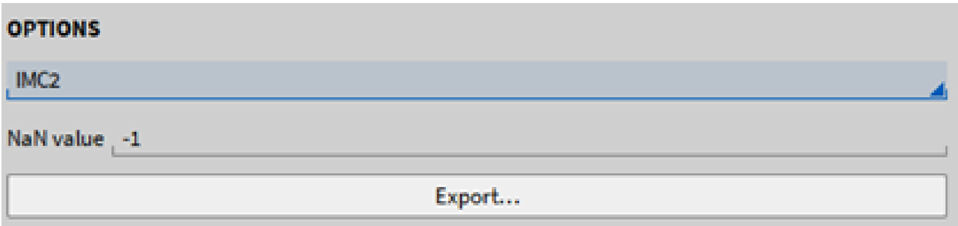

Fig. 11.17: Export options for a *.imc2-file

The options allow the definition of the NaN value in the exported file. This export only supports the export of Waveform data but no support of Statistics (Reduced) data.

11.16 Export Options for a *.tdms-file

This export generates a file in *.tdms file format for further use in NI LabVIEW.

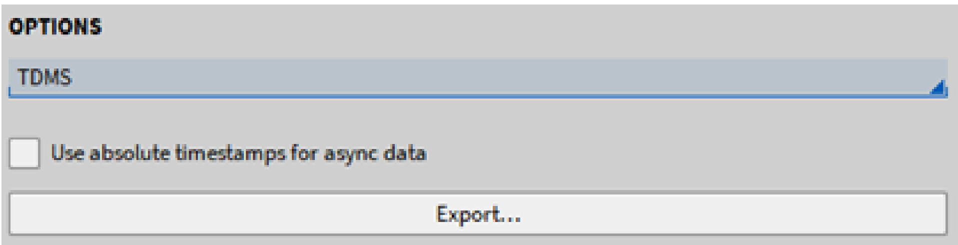

Fig. 11.18: Export options for a *.tdms-file

Choose if absolute timestamps should be used for asynchronous data by checking the box. This export only supports the export of Waveform data but no support of Statistics (Reduced) data.

11.17 Export Options for a *.nc-file (NetCDF)

This export generates the Network Common Data Format (NetCDF).

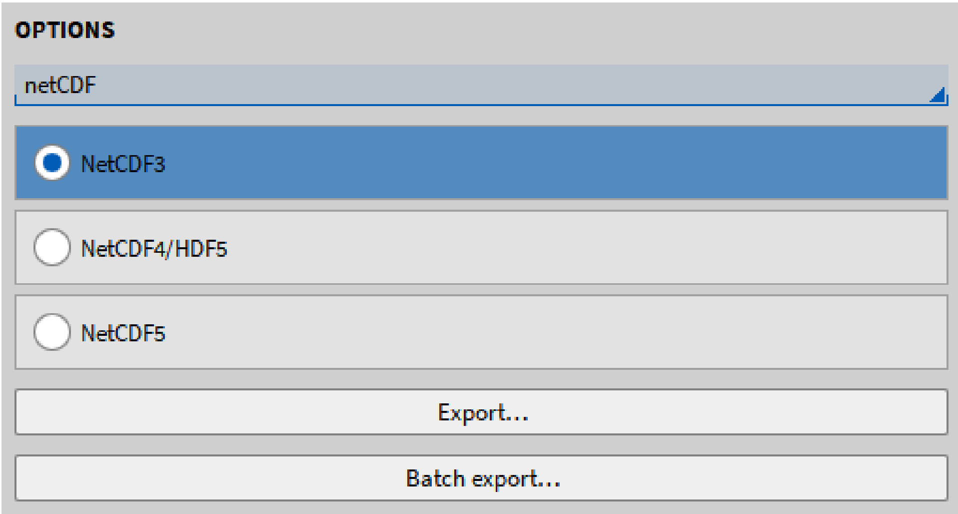

Fig. 11.19: Export options for a *.nc-file

This export only supports the export of Waveform data but no support of Statistics (Reduced) data. The following versions of this format are available:

- NetCDF3
- NetCDF4
- NetCDF5

11.18 Export Options for a *.datx-file (DSPCon)

This export generates a file in *.datx format for use in software from DSPCon

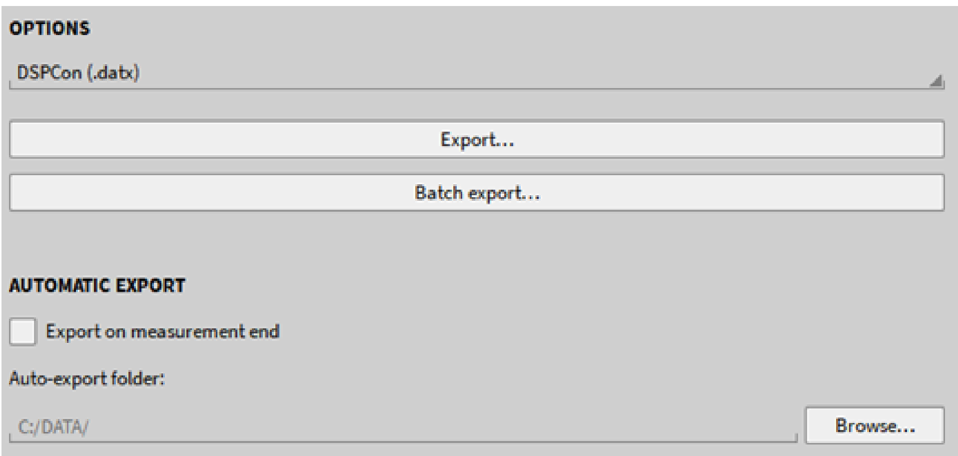

Fig. 11.20: Export options for a *.datx-file

This export supports synchronous channels only. Asynchronous channels, like those of a power group, cannot be exported.

11.19 Batch export

OXYGEN's Batch export option provides the possibility to automatically export several *.dmd-files successively with the same export settings. To do so, open the first *.dmd-file that shall be exported and go to the Export menu.

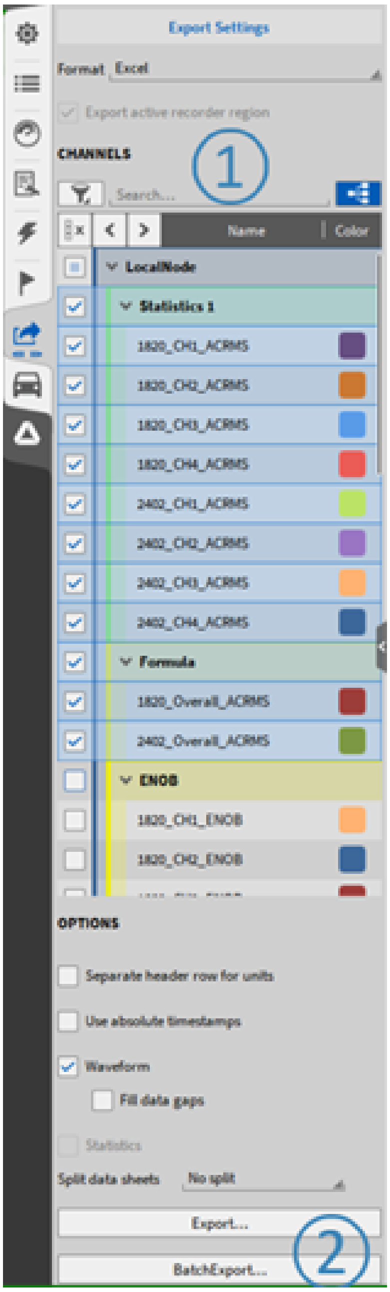

Fig. 11.21: Export menu

Select the desired export format (including the individual options) and the channels to be exported (see ① in Fig. 11.21). Press the Batch Export button next (see ② in Fig. 11.21).

A popup window will open that allows the user to select other *.dmd-files whose data shall be exported with the same export settings that are selected for the first file (see Fig. 11.22). After selecting all desired files, press *Open*.

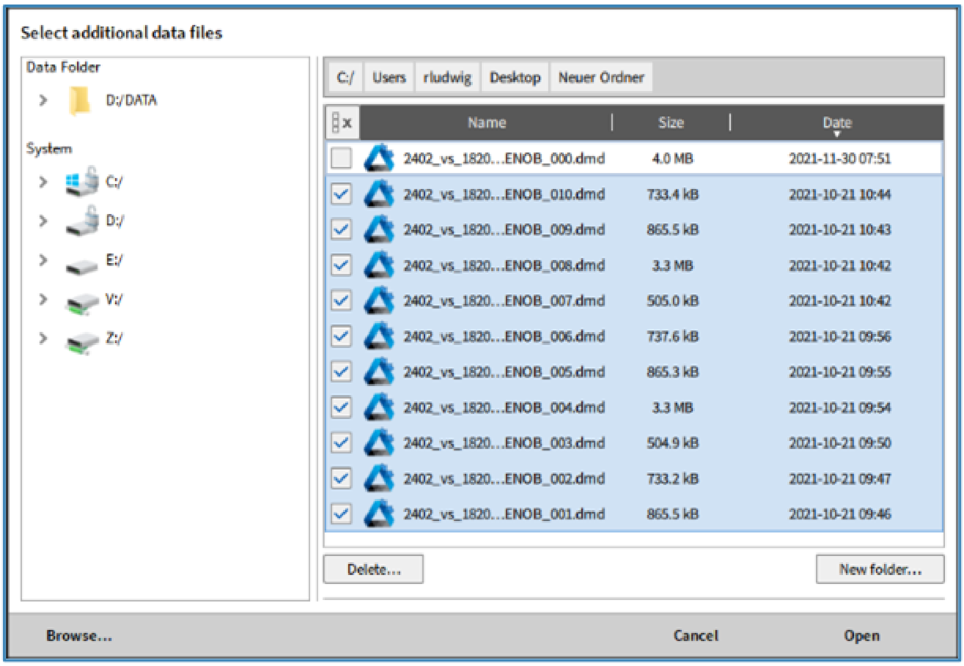

Fig. 11.22: Popup window to select additional *.dmd-files for export

The batch Export menu will open listing all selected *.dmd-files (see Fig. 11.23). The destination folder for the exported files can be specified.

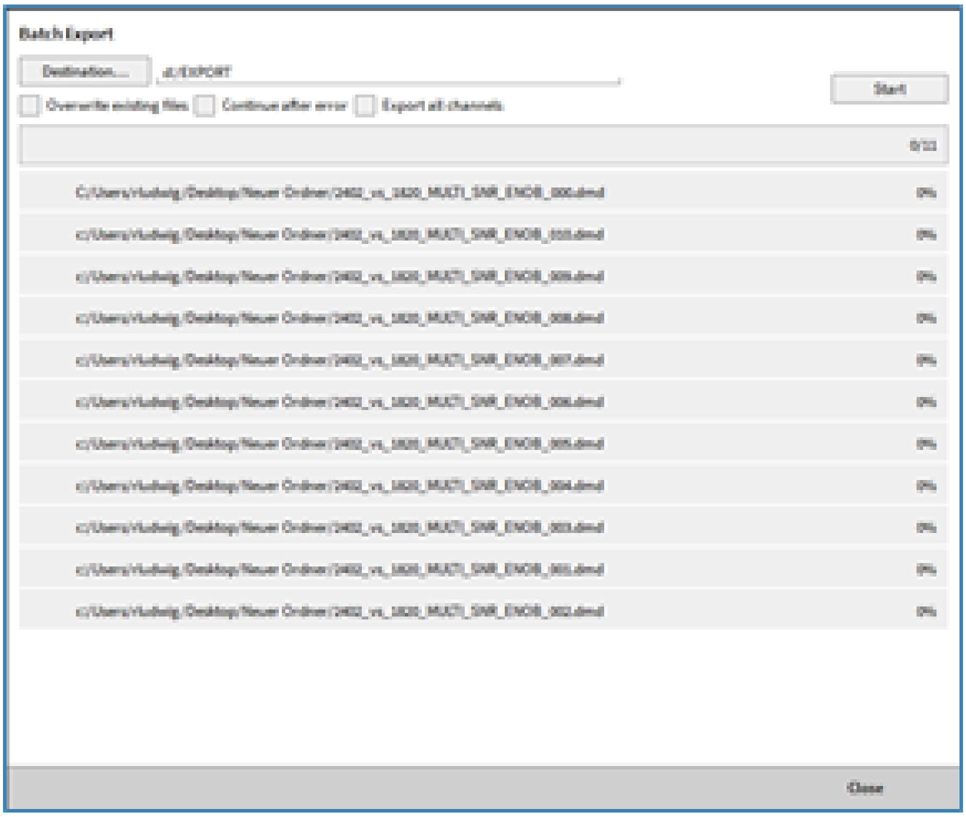

Fig. 11.23: Batch Export menu

Three additional options can be selected :

- Overwrite existing files
- Continue after error
- Export all channels

Press *Start* to initiate the batch export. The progress will be displayed while the export is running. The export file name will be equal to the *.dmd-filename.

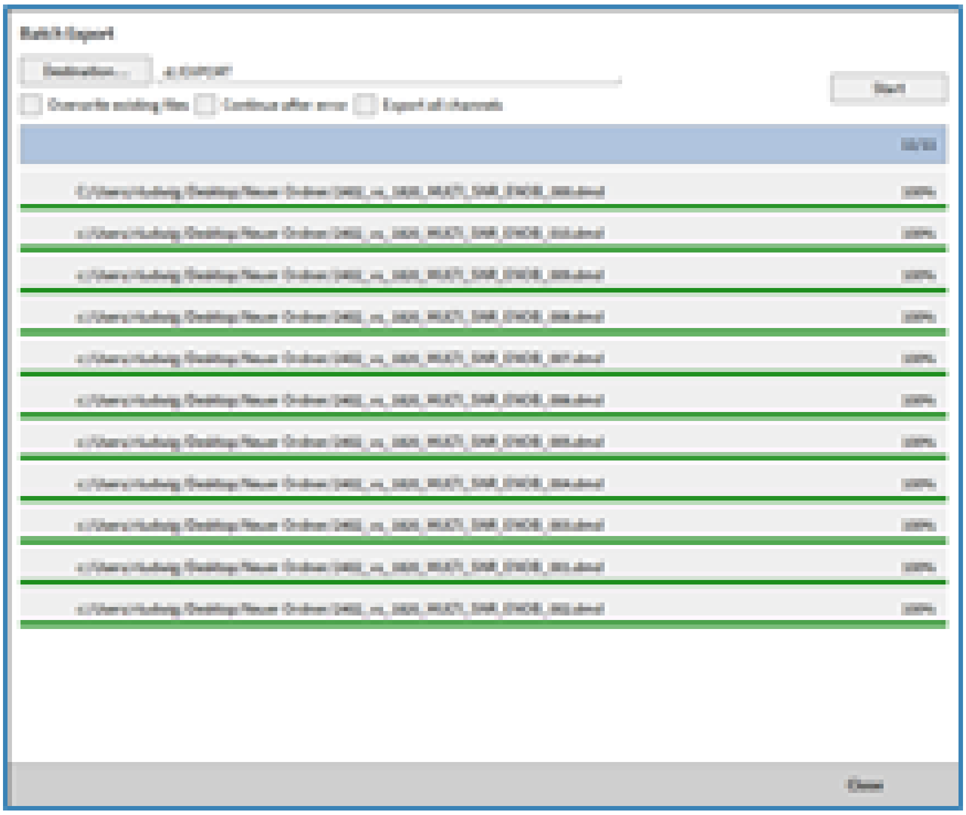

Fig. 11.24: Batch export window after export is finished

After the export is finished (see Fig. 11.24), the Batch Export window can be closed.

Note:

- In case only certain channels shall be exported the selected channel's names must be the same in all *.dmd-files. Alternatively. It is possible to export all channels from the selected files.
- All *.dmd-files that are selected for the batch export must be in the same folder.
- Each *.dmd-file is exported into one separate file.
- Data is always exported from measurement start to measurement end. Active recorder/cursor regions will be ignored.
- Errors occurring during the export could be the following:
  - Channel not found: A channel that is selected for export is not included in one of the *.dmd-files
  - File not accessible: A *.dmd-file is open in another OXYGEN Viewer
  - Export file already exists
- The batch export will stop in case an error occurs but it is possible to continue with the export in case the option *Continue* after error is selected.
- The file for which an error occurs will be skipped during the batch export.

11.20 Automatic Data Export After Measurement End

OXYGEN offers the possibility to export the data automatically after the measurement is finished in one of the above specified file formats including their above specified export options.

To activate the automatic export function, proceed the following steps:

- Open the Export menu and enlarge it to the full screen (see Fig. 11.25):

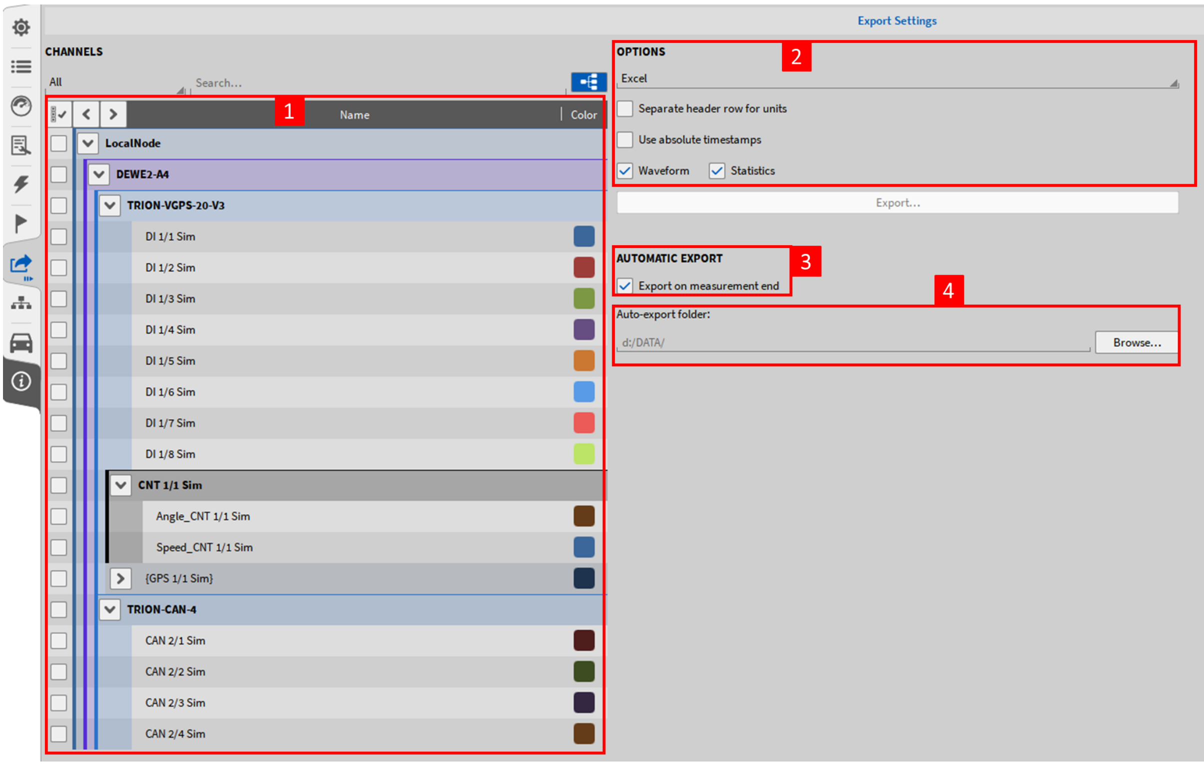

Fig. 11.25: Export menu, Auto-export settings

- Select either all or individual channels that shall be exported automatically after the measurement is finished (see ① in Fig. 11.25) by checking the certain checkboxes on the left-hand side
- Select the desired file format and its individual export options (see ② in Fig. 11.25).
- Check the checkbox *Export on measurement end* (see ③ in Fig. 11.25)
- Specify the desired directory the export files shall be stored to (see ④ in Fig. 11.25)

For details about the other export options, refer to

- *Export Options for a *.csv-file*
- *Export Options for a *.txt-file*
- *Export options for a *.mdf4-file*
- *Export options for a *.mat-file*
- *Export options for an *.xlsx-file (Excel)*
- *Export Options for a *.rsp (rpc III)-file*
- *Export Options for a *.wav-file*

- *Export Options for a *.dat-file (DIADEM)*
- *Export Options for a *.nt-file (DynaWorks)*
- *Export Options for a *.h5-file*
- *Export Options for a *.uff-file*
- *Export Options for a *.imc2-file*
- *Export Options for a *.tdms-file*
- *Export Options for a *.nc-file (NetCDF)*

CHAPTER

TWELVE

DATA NAVIGATION

12.1 Opening multiple data files

It is possible to open multiple *.dmd data files and to review them.

In order to open several files, there are two options. Click on the folder icon in the Action bar (see Fig. 12.2) and select the files to be opened or open the full menu of the *Measurement Settings > Analysis Files* and click on *Add file...* (see Fig. 12.1) and select all files to be opened and reviewed.

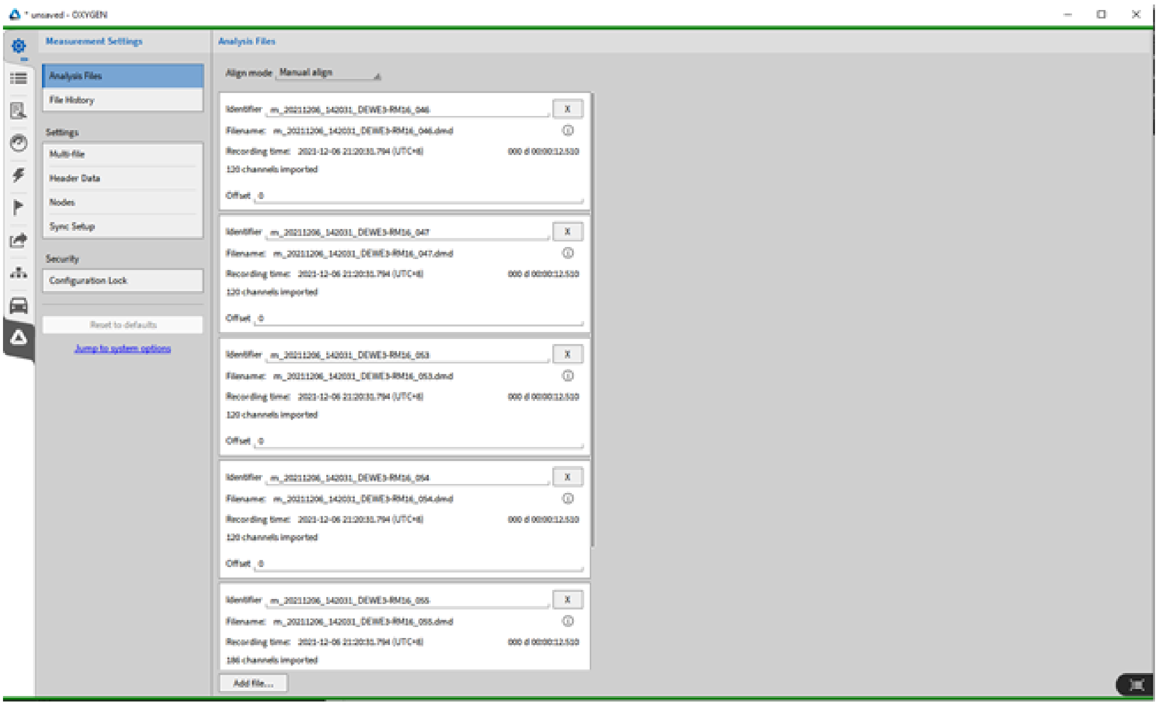

Fig. 12.1: Opening multiple data files in the Measurement Settings menu

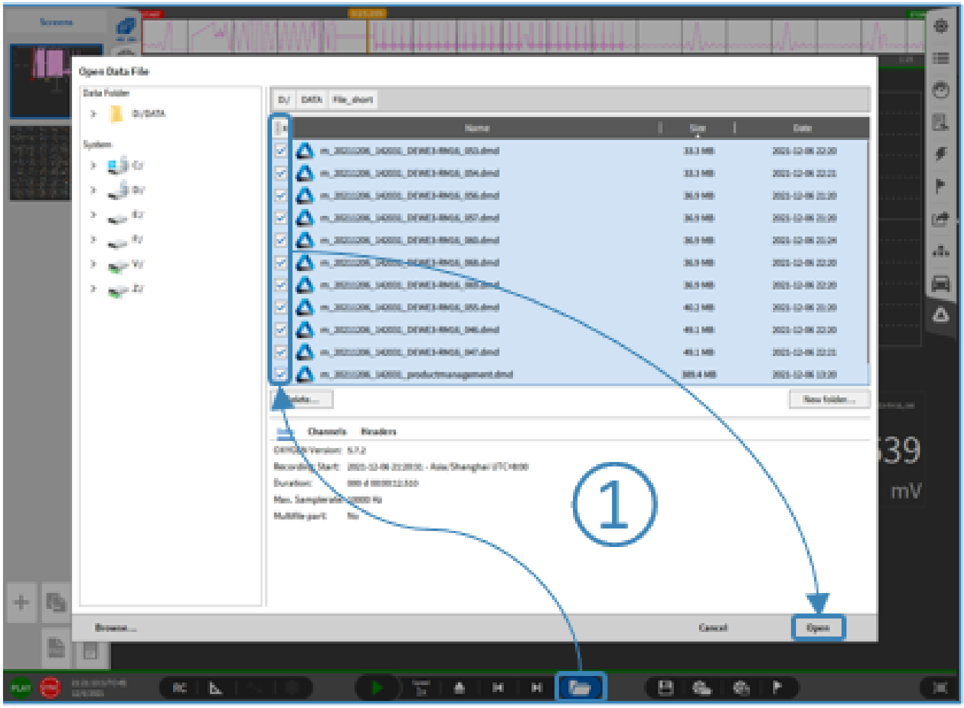

Fig. 12.2: Opening multiple data files

An identifier can be given to the single files, in order to better differentiate between them when analyzing and reviewing them. The original file name will not be changed.

Single files can be removed again, by clicking on the X. By clicking on the circled i, more information can be displayed for each file.

It is possible to align the files on their time axis, to align them to the recording start or to specific events.

- Manual align: enter an offset in seconds for the files in order to align them to a specific event.
- Align to recording start: in case the files were recorded during different periods of time, it is possible to align all files to their recording start.
- Align to absolute time: in case absolute time was used for the recordings, the files can be aligned to the absolute time.

All these options are also available in the small measurement settings menu.

The single files with all the channels are available in the Channel List and shown as individual sections.

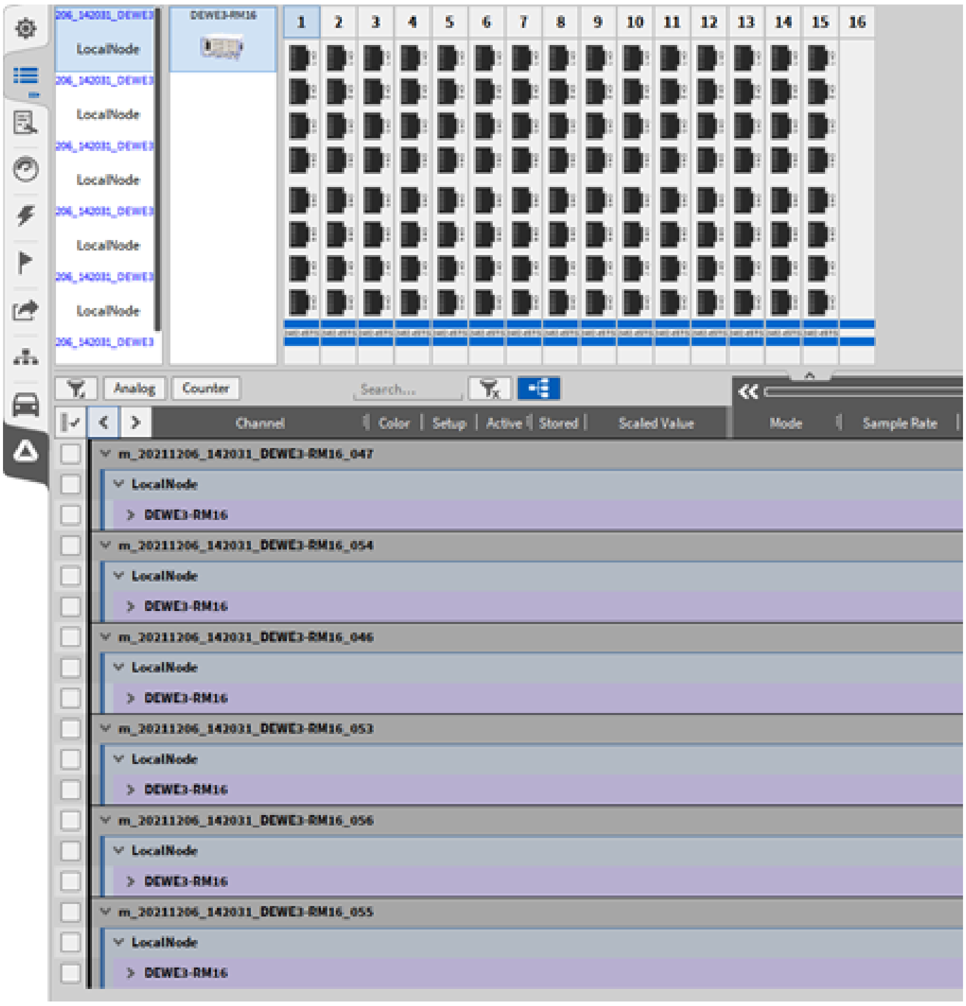

Fig. 12.3: Multiple data files shown as individual sections in the Channel List

All channels from each file can be used for offline math and visualized on the measurement screen. A new data file can be stored, including all channels from each file (see ⑬ in Fig. 3.5).

12.2 Batch processing

Changes, which were done in a measurement file during analysis and post-processing can also be applied to other measurement files. This can be very useful when having measurement series or campaigns, where changes can then be applied to all files. The same setup must have been used for all files and all files must include the same recorded channels, to apply the changes. Following changes will be applied:

- Offline math (formulas, power groups, etc.)
- Offline changes in the channel list (CAN channels, etc.)
- Changes to the measurement screen (instruments)

To do so, simply open one measurement file. After doing the analysis and post-processing save the file, open the full menu of the Measurement Settings and go to File History (see Fig. 12.4). By clicking on the Button Apply changes to other measurement files… the files can be selected from the dialogue which will open (see Fig. 12.5). Files within the same folder can be selected.

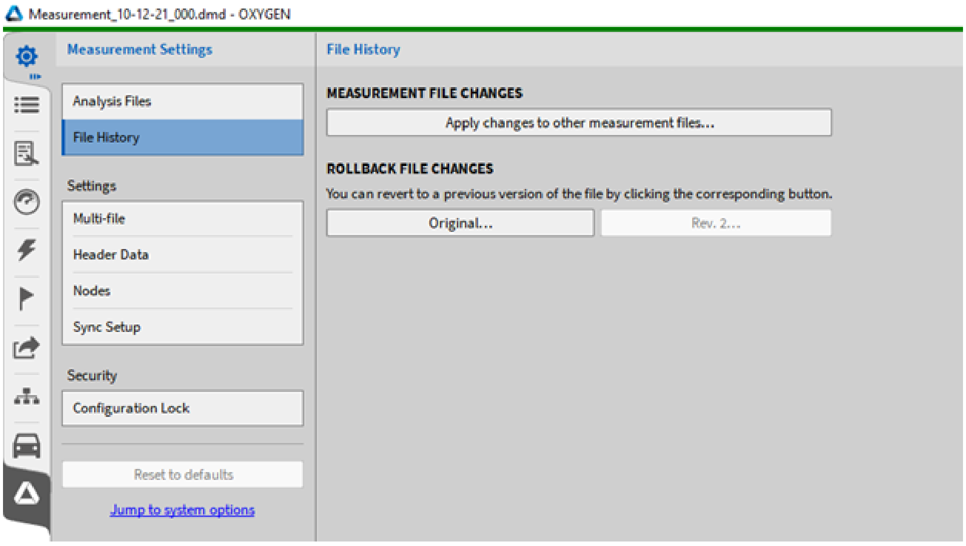

Fig. 12.4: Applying offline changes from one measurement file to others

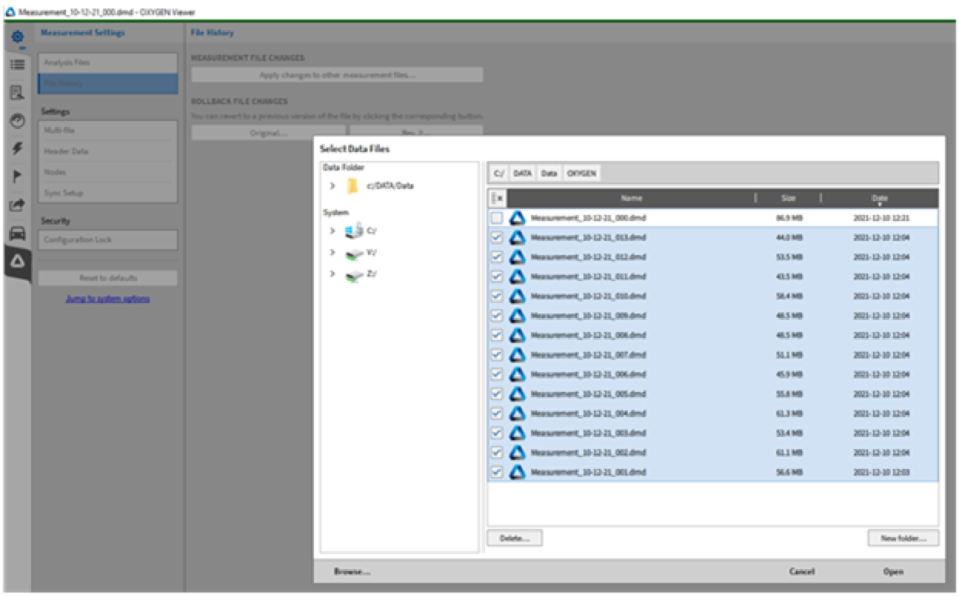

Fig. 12.5: Selecting the files for the batch processing

After selecting the files, click Open and a new dialogue will open (see Fig. 12.6). To apply all changes press Start. Fig. 12.6 shows the dialogue after the processing is done to all files successfully.

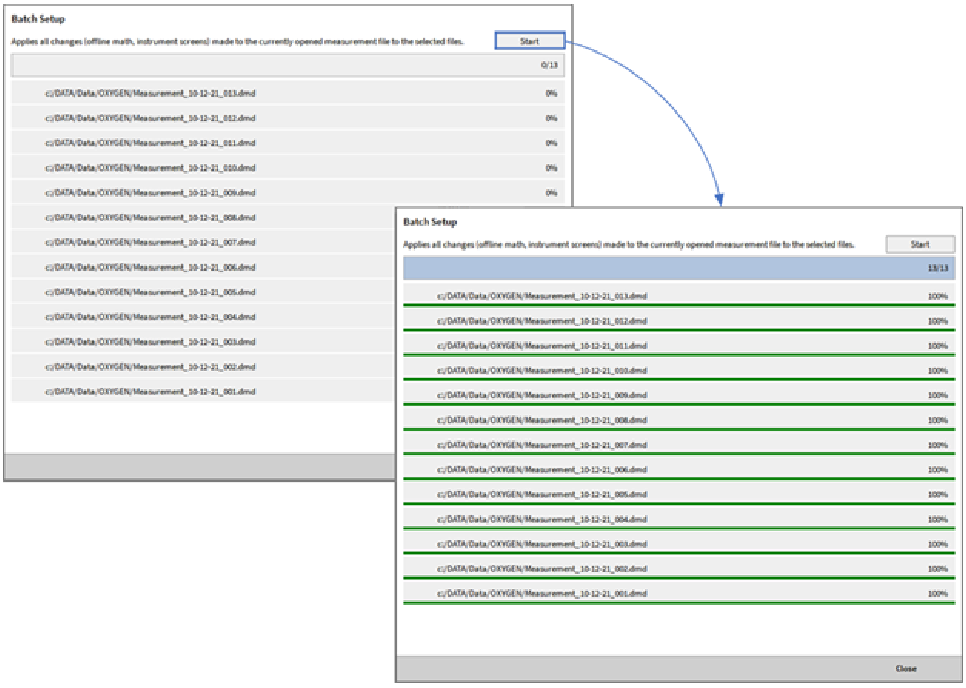

Fig. 12.6: Batch processing before start and after it finished successfully

The dialogue will also show any errors, in case the processing cannot be fulfilled. These files will be ignored, in case the processing is started anyway.

Possible reasons for this could be:

- File not accessible and cannot be opened, because it might be already open.
- Channels are not the same for each file. This file might not be recorded with the same *.dms setup such as the other files.
- Duplicate channel names in the setup.

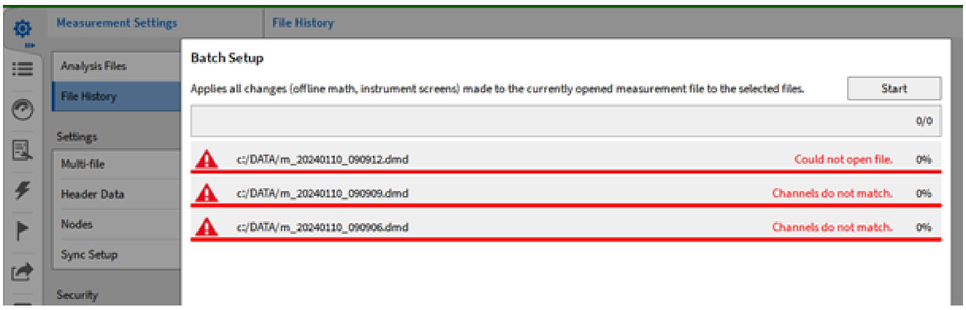

Fig. 12.7: Error message shown for the batch processing

To return to your original file or later revision, click on the corresponding button under Rollback file change seen in Fig. 12.4. The changes made to the file will be deleted.

12.3 Deleting channels in recorded files

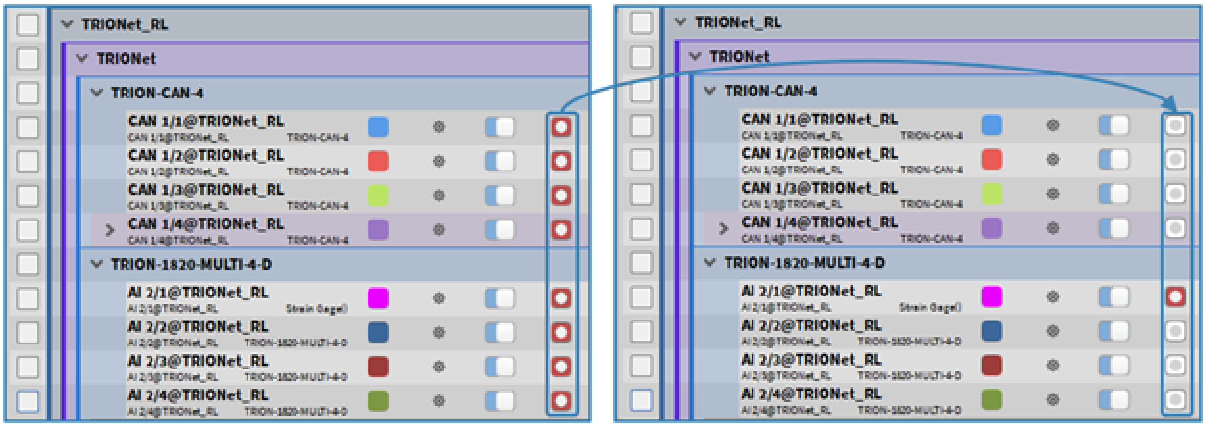

Fig. 12.8: Disabling the stored flag

Removing channels from recorded *.dmd files can be desirable to reduce file size and for a concise channel list overview. To do this, disable the stored flag in the channel list (see Fig. 12.8). Subsequently, saving the *.dmd file as a new file (see *Measurement settings* and Fig. 5.2 for more information) will delete the channel from the channel list in the new file and the stored data of the channel will be removed from the file, thus reducing the file size.

CHAPTER

THIRTEEN

SCREENS MENU

13.1 *Screens* overview

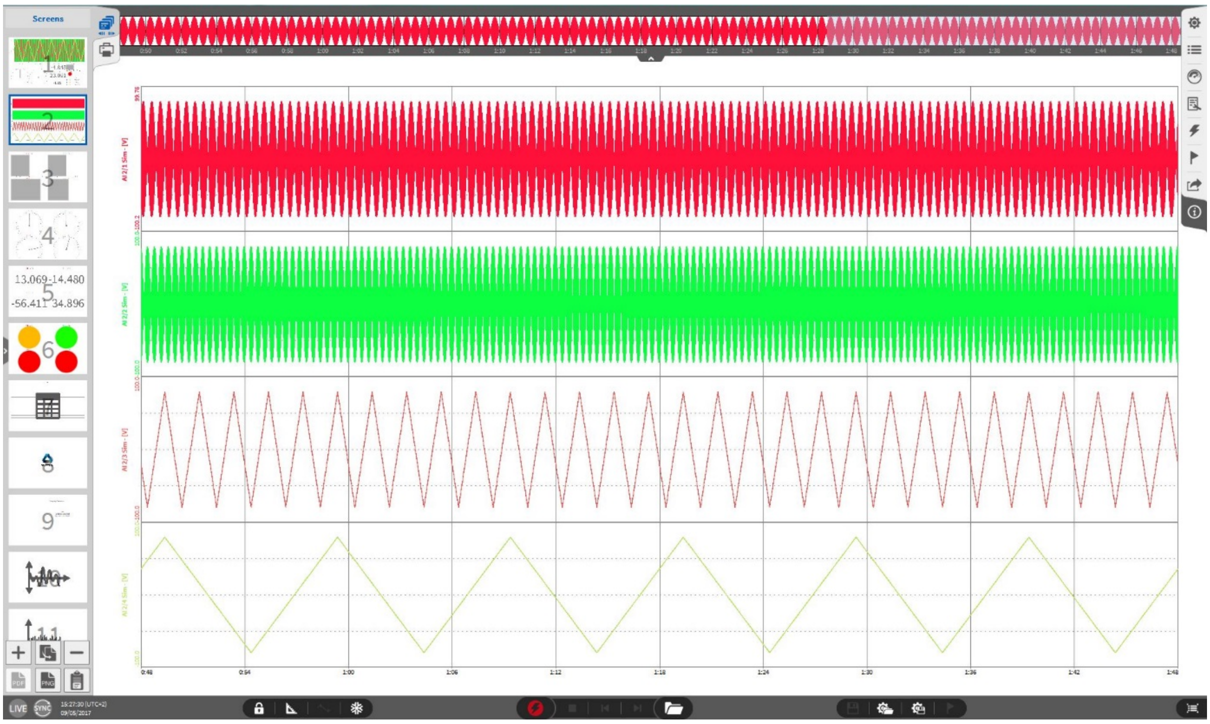

Fig. 13.1: *Screens* Menu - Overview

In the *Screens* menu, the user can organize its measurement screens. By a single click on the icon, a small overview about all created measurement screens will appear like it is shown in Fig. 13.1. The user can add and delete measurement screens by clicking on the + and – signs on the lower end of the *Screens* menu.

To change the currently displayed measurement screen, just click on the desired one in the overview. It is possible to change the order of several measurement screens by selecting the respective screen and keeping the mouse button pressed for 2 seconds. After two seconds, the blue frame will become bold. Now it is possible to change the order of the selected screens to any desired position by keeping the mouse button pressed and moving the screen.

If several monitors are used, it is possible to undock a screen and move it on another monitor. Therefore, the user must select the desired screen and keep the mouse button pressed for 2 seconds again. When the blue bold frame appears, the user can move the screen to another monitor and release it there.

The *yellow cursor* which is displayed in the Overview bar and the Recorders is linked to all instruments on any screen. I.e. If the yellow cursor is moved in a Recorder on screen 1, the value displayed in a Digital Meter on screen 3 will update according to the actual position of the yellow cursor position.

Additionally, measurement screens can be saved as a template to be reloaded later or transferred to other devices. This can be done via the "TPL" button left below the "+" button. The templates are saving the arrangement and configuration of the active screen at C:\Users\Public\Documents\Dewetron\Oxygen\Templates, from where they can be copied and transferred to other devices. To load a template, the magic wand button right to the "+" button must be used. In case an order analysis or power group was created in the channel menu, by default, a template for an order analysis/power group screen can be found also where other saved templates are located. More information can be found in the order analysis and power group manual.

Note: The system performance may slow down while the *Screens* menu is partially open.

The buttons on the lower end of the Screens Menu (see Fig. 13.2) have the following functionalities:

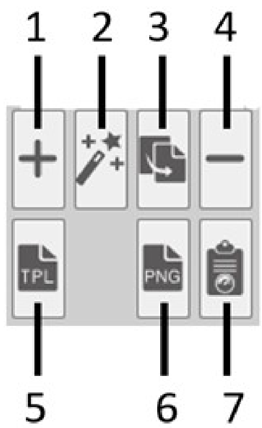

Fig. 13.2: Pushbuttons in the *Screens* Menu

Table 13.1: Functionality of the pushbuttons in the *Screens* menu

No.	Function	Description
1	Add Screen	Add an empty measurement screen beyond the last screen
2	Load Screen	Previously saved configurations of measuring instruments can be loaded.
3	Copy Screen	Copy selected screen beyond the last screen
4	Delete Screen	Delete selected screen
5	Save measurement screen setup	The current arrangement and configuration of the measurement setup is saved as a template.
6	Export selected screen	Export selected screen as *.png or *.jpg-file
7	Copy to Clipboard	If no Instrument is selected, the actual screen will be copied to clipboard. If an Instrument is selected, only the selected Instrument will be copied to clipboard

13.2 Saving the screen as video

When enlarging the *Screens* menu to the whole screen, the functionality *Save Screen as Video* is available in *PLAY* mode (see Fig. 13.3). When being in LIVE or REC mode, this functionality is grayed out.

To do so, click on the *Screens* menu bar and move it to the right side while keeping the mouse button pressed or double click on the *Screens* menu.

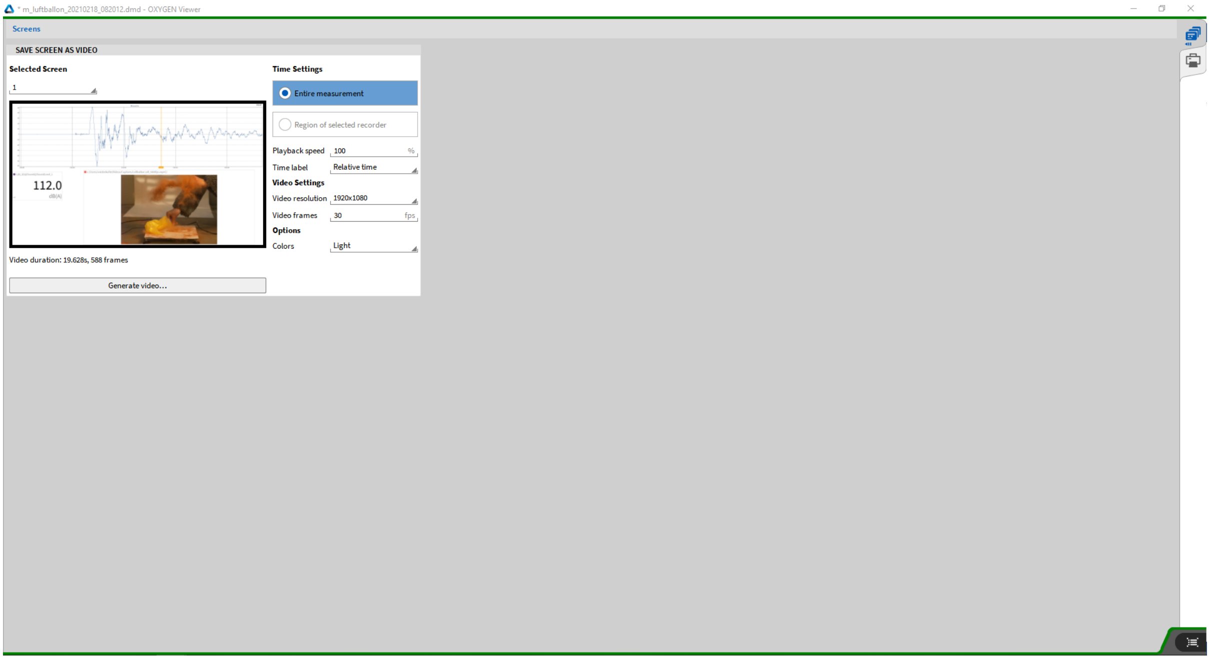

Fig. 13.3: Measurement screens enlarged to the whole screen

Fig. 13.4 shows a close-up of the available settings:

- Selected Screen: Select a screen, which you want to use to make a video of.
- Time Settings:
  - Choose if you want to make a video of the entire measurement or only the region of the selected recorder of this screen.

    Note: A recorder must be selected for this option to be available.

  - The playback speed can be adjusted within a range of 0.1-100%, whereas 100% is the normal speed of the recording.
  - Select a time label: none, relative or absolute time.
- Video Settings:
  - Select a video resolution (640x480, 1280x720, 1920x1080).
  - Select the video frames in fps (frames per second) within a range of 10-100.
- Options:

  The measurement background can be selected to have a light or dark color scheme.

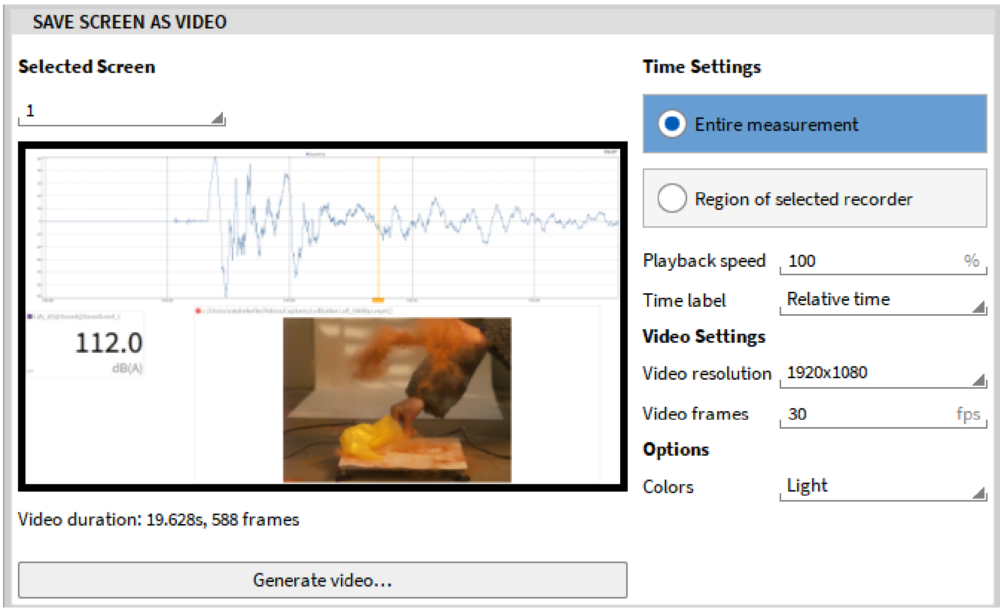

Fig. 13.4: Menu for the *Save Screen as Video* functionality

By clicking on *Generate video*, a name and location folder for the video can be defined. The video will be saved as *.mkv format.

CHAPTER

FOURTEEN

REPORTING TOOL

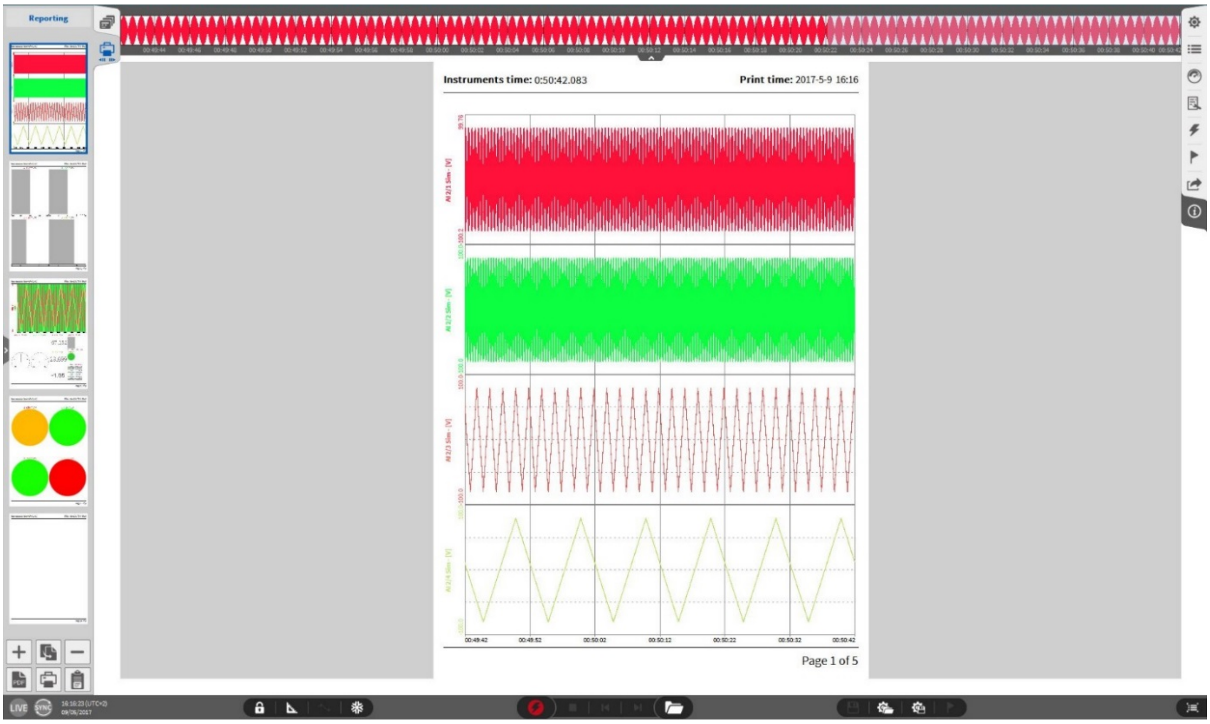

Fig. 14.1: Reporting Tool – Overview

A powerful feature of OXYGEN is the *Reporting* tool. This tool offers the user the possibilities to create reporting pages directly from the measurement screen. This feature can be used in the *REC* mode as well as in the *PLAY* mode and in the *LIVE* mode.

This tool and its functionalities will be explained in the following sections.

14.1 Creating a Report

To create a report, the user can either

- Copy a complete measurement screen to the report with the following steps
- Select the desired measurement screen within the screens menu and display it (see Fig. 14.2)

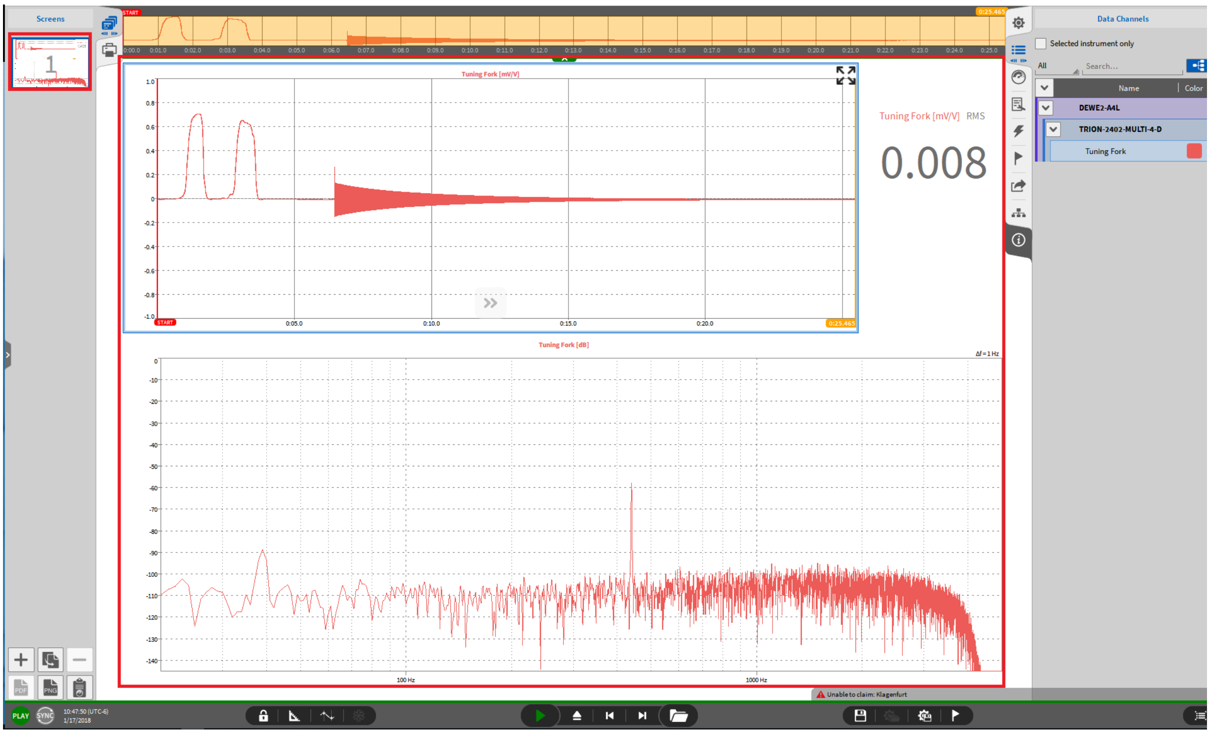

Fig. 14.2: Display the measurement screen that shall be copied to the report

- Open the small-view of the Report menu (see Fig. 14.3):

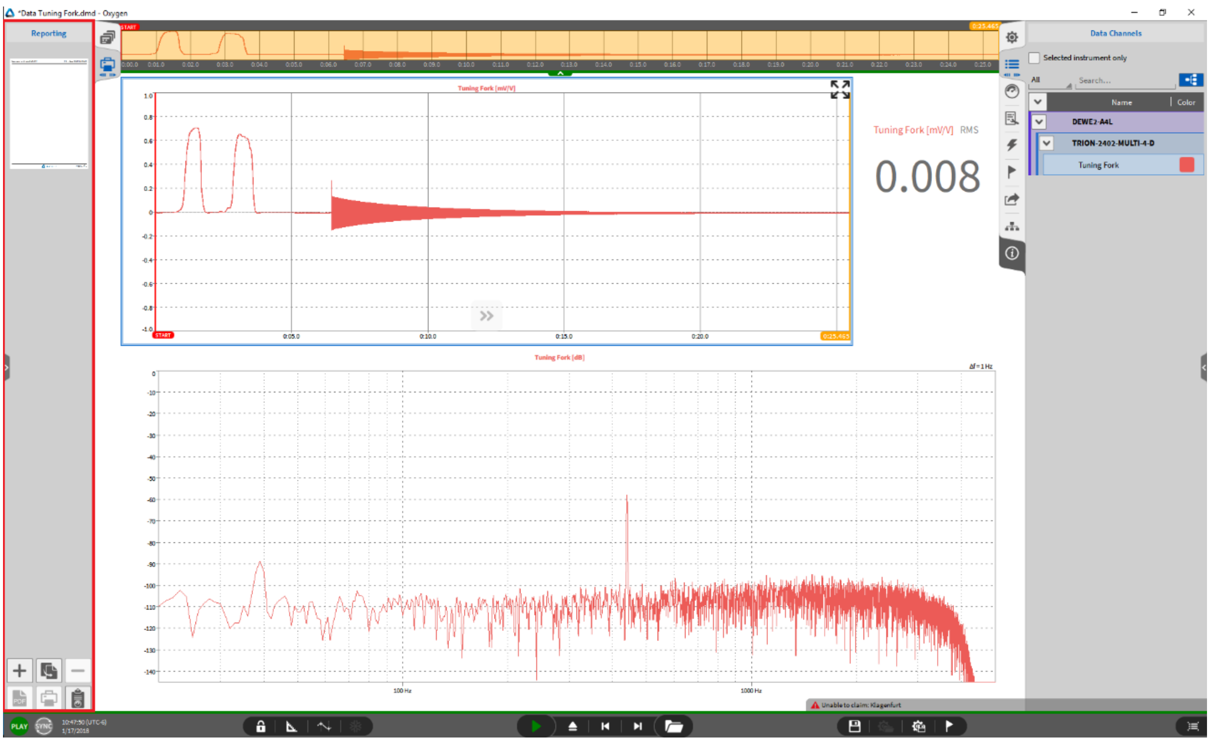

Fig. 14.3: Open the small-view of the Reporting menu

- Click the copy button at the lower end of the Reporting menu (see Fig. 14.4 or ② in Fig. 14.10)

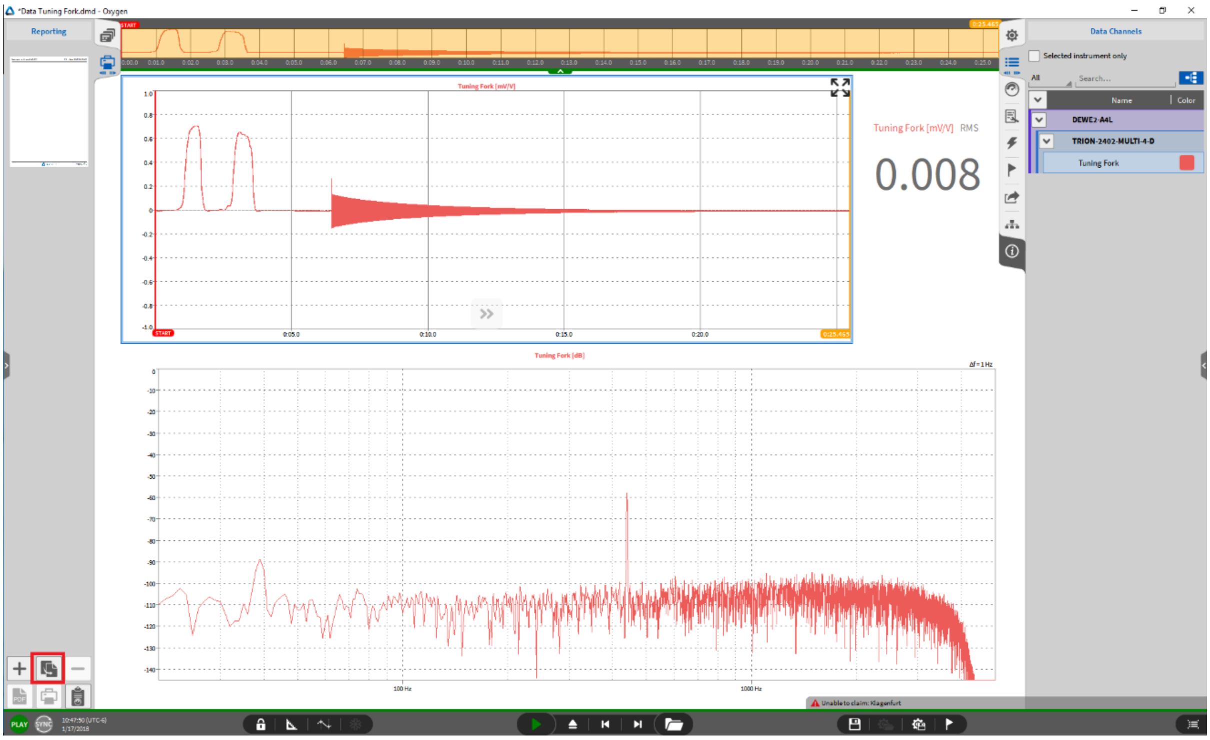

Fig. 14.4: Click the *Copy* button

- The entire measurement screen is now copied to the report as a new report page (see Fig. 14.5):

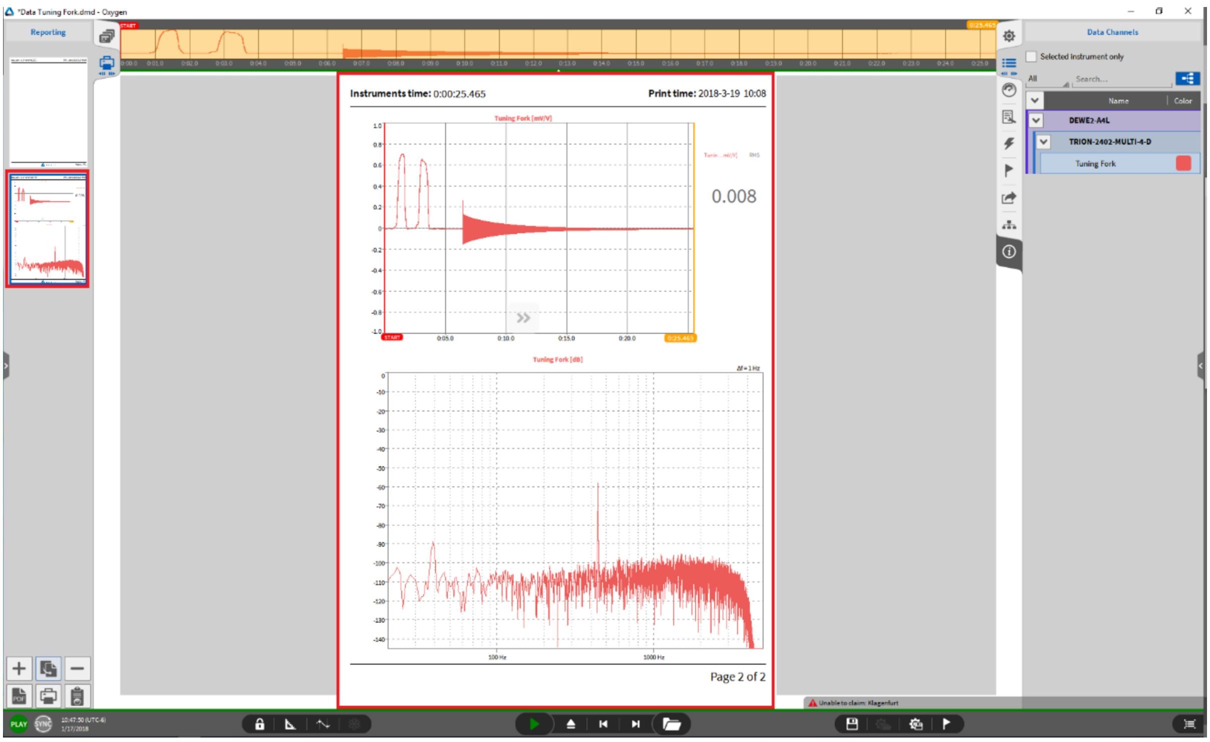

Fig. 14.5: Measurement screen added to the report

- Select and copy single instruments from the measurement screen via **CTRL+C** (see Fig. 14.6) and paste it to the report page via **CTRL+V** (see Fig. 14.7).

Fig. 14.6: Copying single instruments from the measurement screen…

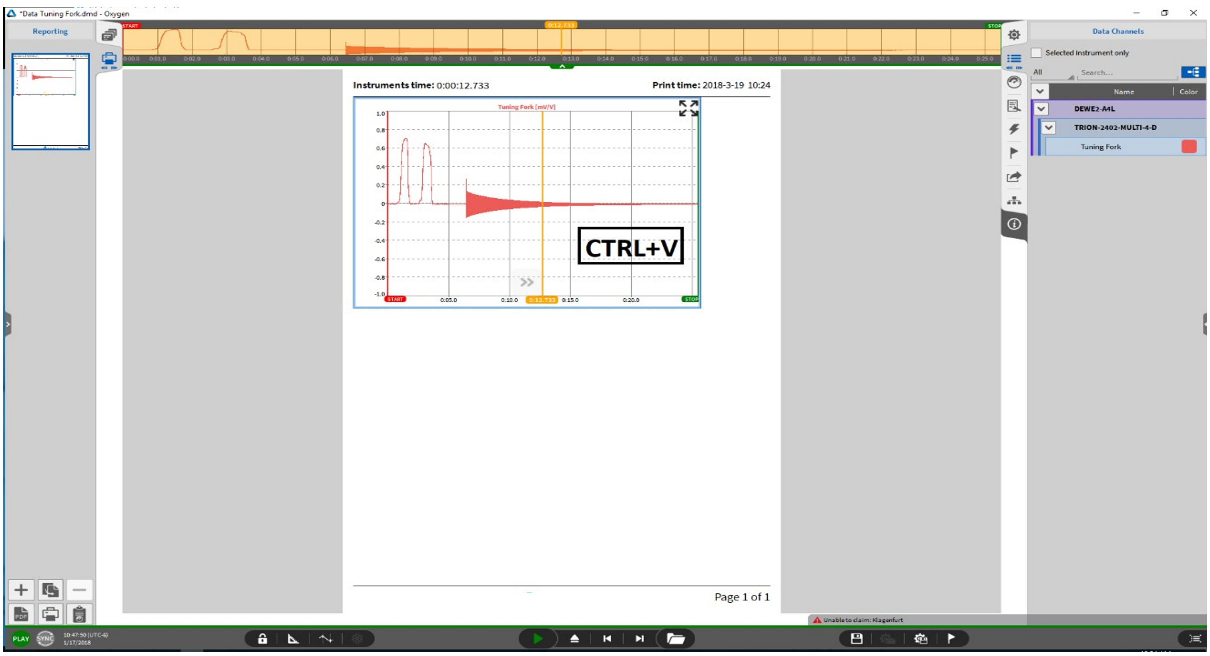

Fig. 14.7: … to the report page

- Activate the *Design Mode* and edit the report page like a measurement screen (see *Adding Instruments to the measurement screen*)

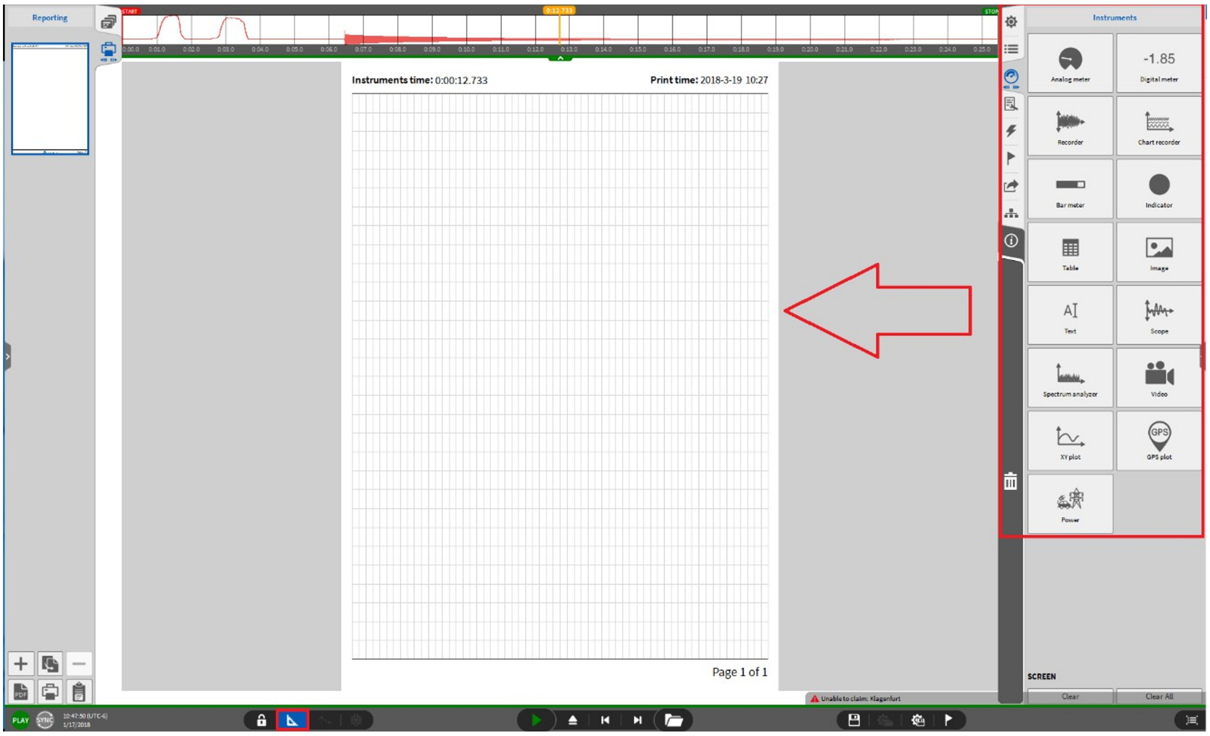

Fig. 14.8: Activating the *Design Mode* on report page

14.2 Reporting cursor

The *yellow cursor* is available on the reporting pages as well. On the measurement screens, the yellow cursor is linked to the instruments on all screens. This is different on report pages. Here, the yellow cursor is only linked to the instruments on the same report page and can therefore be placed on several positions of the data file on different pages:

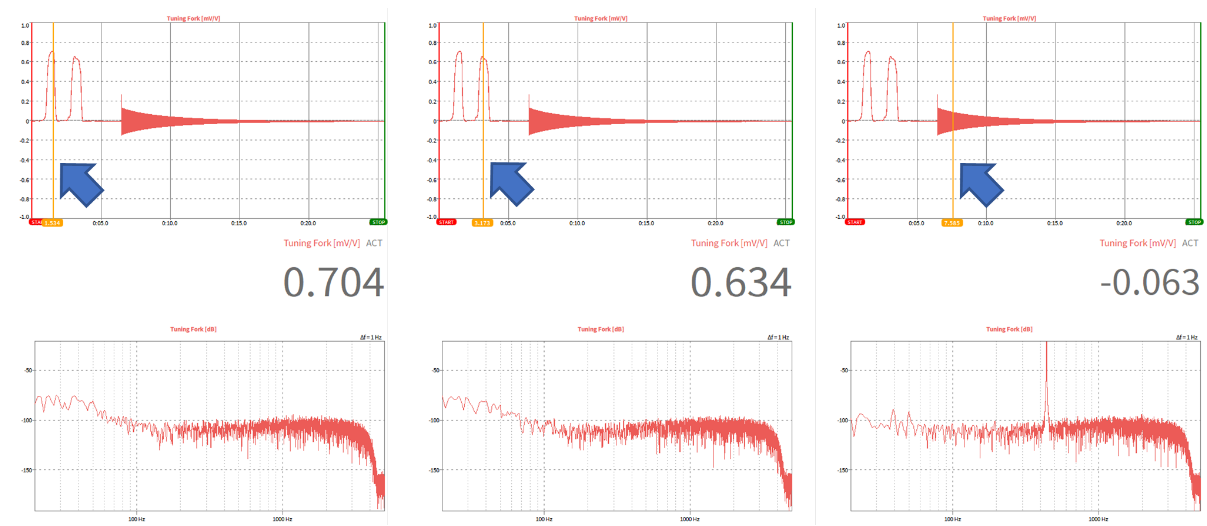

Fig. 14.9: Several yellow cursor positions within one report

14.3 Menu description

- The buttons on the lower end of the *Reporting* Menu (see Fig. 14.10) have the following functionalities:

Fig. 14.10: Push buttons in the *Reporting* Menu

Table 14.1: Functionality of the push buttons in the *Reporting* menu

No.	Function	Description
1	Add Page	Add an empty page beyond the last page
2	Copy	If a measurement screen is open (see Fig. 14.3), the screen will be copied to the report as a new page. If a report page is open (see Fig. 14.5), the selected page will be copied beyond the last page
3	Delete Page	Delete selected page
4	Save as *.pdf	Saves the report as *.pdf-file; for export options, enlarge the *Reporting* menu to the full screen
5	Send to printer	Send the report to a printer; to select a printer, enlarge the *Reporting* menu to the full screen
6	Copy to Clipboard	If no Instrument is selected, the actual page will be copied to clipboard. If an Instrument is selected, only the selected Instrument will be copied to clipboard

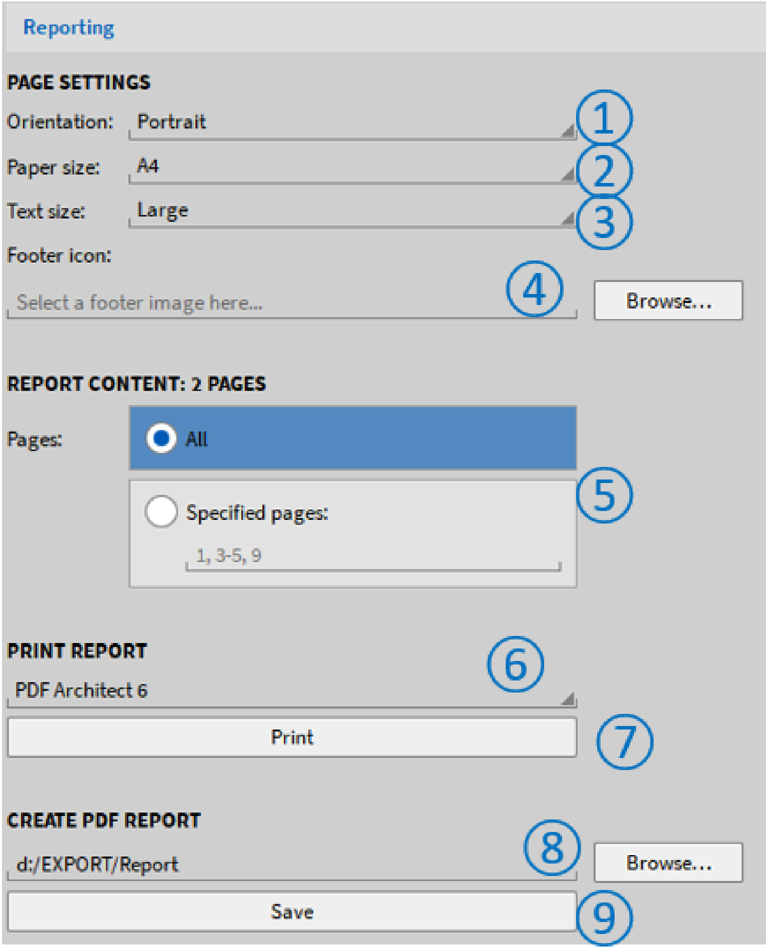

Fig. 14.11: Expanded *Reporting* Menu

Table 14.2: Expanded *Reporting* Menu - Functionality

No.	Function	Description
1	Paper Orientation	Selection of Paper Orientation *Portrait* or *Landscape*
2	Paper size	Selection of Paper size *A4*, *A5*, *A6* or *Letter*
3	Text size	Selection of reporting text size *small*, *medium* or *large*
4	Footer icon	Browse for an icon that will be added to the footer
5	*Report Content* menu	Specify if the whole report or only certain pages shall be printed
6	Selected Printer	Browse for a Printer
7	*Print* button	Sends the report to a printer
8	PDF-file	Browse for a folder and specify the filename
9	*Save* button	Saves the Report as *.pdf-file

Note: It is possible to change the order of the pages by the same procedure as it was explained for the measurement screens: Select the respective page and keep the mouse button pressed for 2 seconds. After 2 seconds, the blue frame will become bold. Now it is possible to change the order of the selected page to any desired position by keeping the mouse button pressed and move the screen.

CHAPTER

FIFTEEN

OXYGEN-NET

Note: This is an optional feature and requires a license.

OXYGEN-NET enables the combination of multiple DEWE3 systems within the same Ethernet network into a single high-channel-count measurement system. These systems can be synchronized and controlled using one or more *Master* units.

Each system in an OXYGEN-NET setup must have a unique hostname. For example, if you are using multiple DEWE3-A4 systems, name them DEWE3-A4-1, DEWE3-A4-2, and so on. The hostnames can be changed in the Windows settings (see Fig. 15.1) under *Control panel → All Control Panel Items → System → Computer name*.

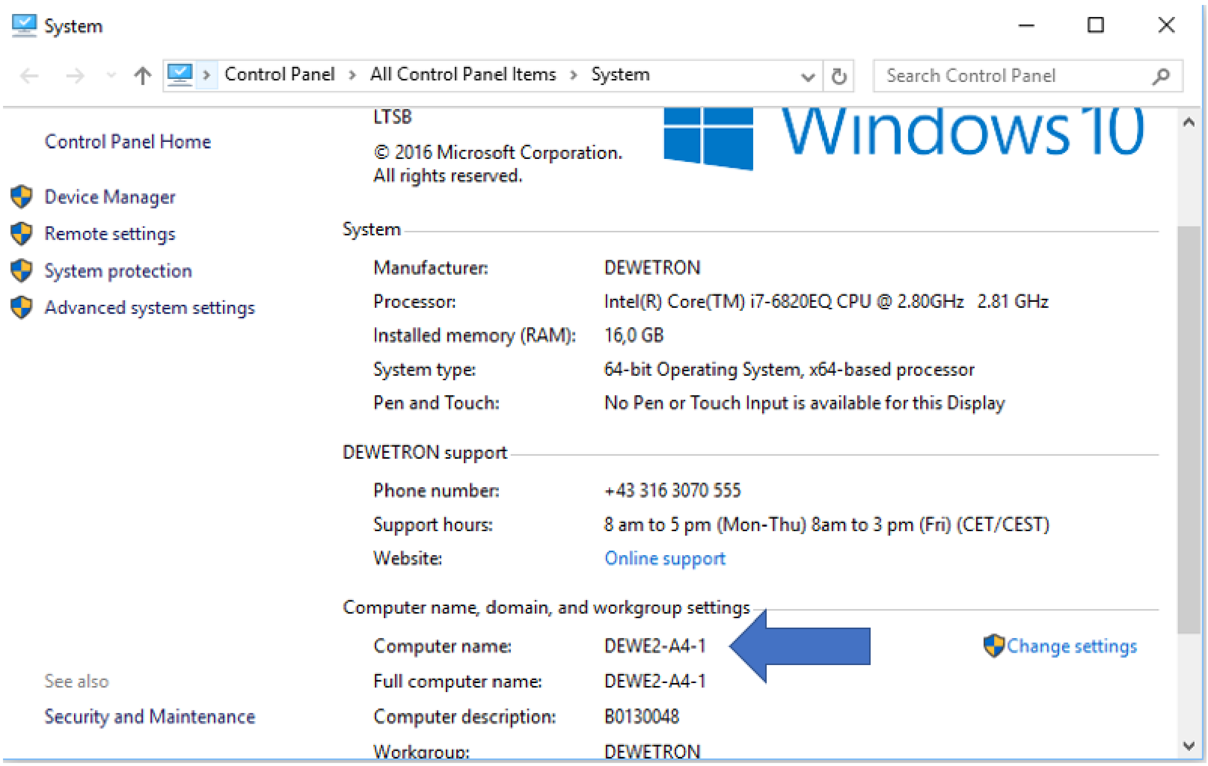

Fig. 15.1: Changing the hostname

Terminology

This glossary defines key terms used in this chapter:

- Acquisition master: The superordinate master responsible for coordinating the synchronized acquisition start across all nodes.
- Master unit: A device that claims and controls slave units. It queries data from Slave units. Multiple devices can act as Master units in an OXYGEN-NET system, but a Master unit cannot simultaneously function as a slave unit.
- Master group: A group of Master units that share the same recording ID.
- Measurement unit: A DEWETRON device that can perform measurements and be integrated into an OXYGEN-NET system.
- Multi-Master system: An OXYGEN-NET system where one or more Slave units are claimed by multiple (>1) Master units.
- Recording group: A group of devices that share the same recording group ID and follow the same recording commands.
- Single-master system: An OXYGEN-NET system where one or more Slave units are claimed by a single Master unit.
- Slave unit: A DEWETRON measurement device claimed and controlled by a Master unit. It sends data to the Master unit. Several devices can be configured as Slave units in an OXYGEN-NET system.
- Synchronization master: A device that serves as the source clock for the synchronization signal in an OXYGEN-NET system.

15.1 OXYGEN-NET topologies

Every OXYGEN-NET system consists of at least one Slave unit and one Master unit, but can also include multiple Slave units and multiple Master units. Both a Slave and a Master can either be a measurement device (e.g. any DEWE3 device) or a standalone PC. This flexibility allows for various system topologies. In general, an OXYGEN-NET system topology consists of two main components: a network topology for data transfer and system control and a synchronization topology for signal synchronization. In case only a single measurement device is used no synchronization network is required, and only a network topology exists. However, when multiple measurement devices are involved, both a network and synchronization topology are required.

This chapter provides examples of various OXYGEN-NET topologies, separating **network** and **synchronization** topologies for better clarity and understanding.

15.1.1 Network topologies

The following examples show different possibilities for network topologies supported by OYXGEN-NET, including both Single-Master and Multi-Master systems. Although Master units are depicted as external PCs in the following illustrations, keep in mind that DEWETRON devices may also be used as Master units.

Single-master system

Fig. 15.2 illustrates a topology where one external PC serves as the Master unit, and three Measurement Nodes function as Slave units.

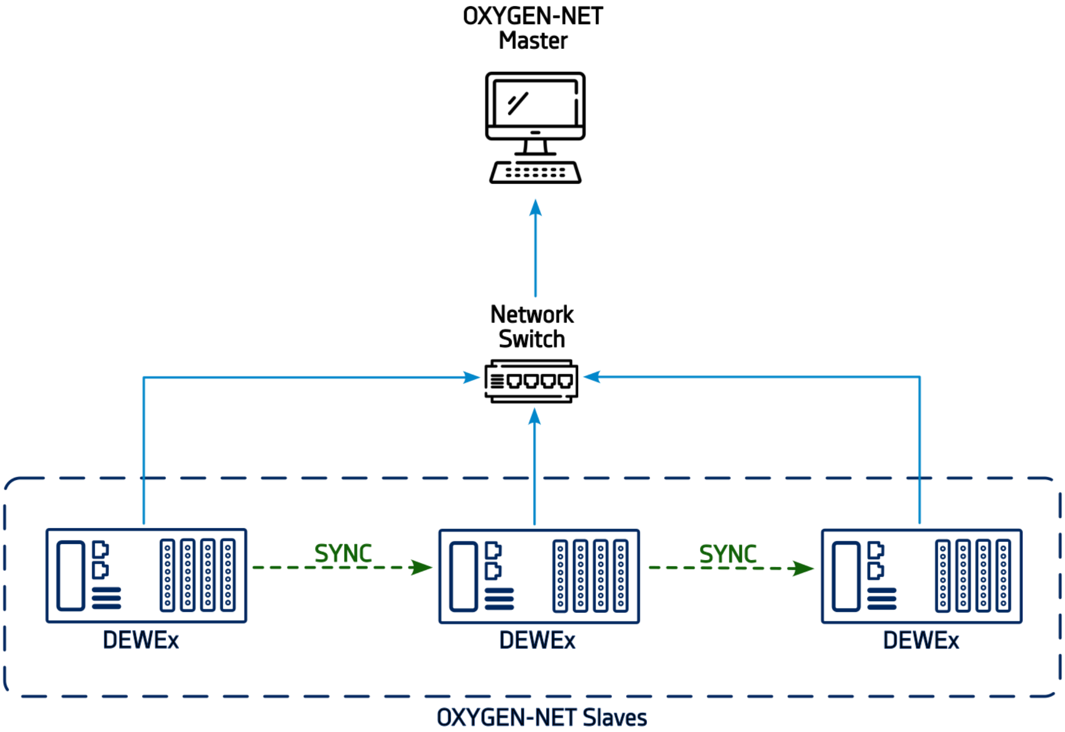

Fig. 15.2: Network topology with a single Master unit and three Slave units

Multi-Master System

Fig. 15.3 displays a topology where multiple external PCs serve as Master units and three Measurement Nodes acting as Slave units. All Units share the same ethernet network.

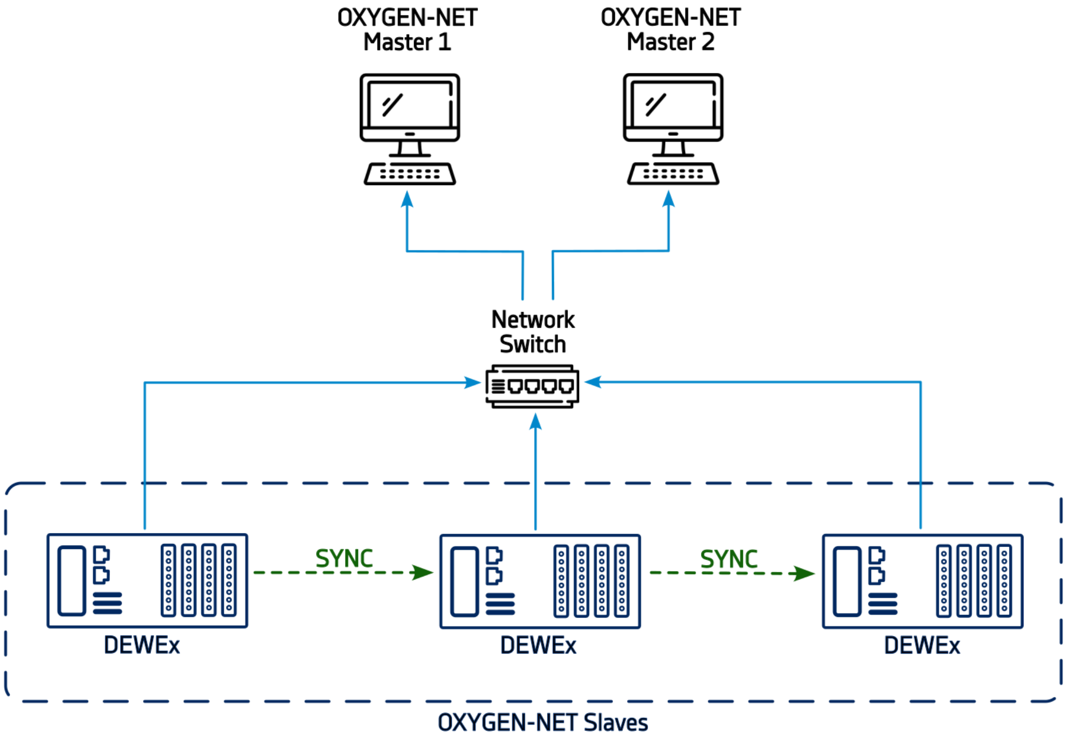

Fig. 15.3: Network topology with multiple Master and multiple Slave units.

Since DEWE3 devices are equipped with at least two Ethernet ports, a dual-LAN network can be implemented. Fig. 15.4 demonstrates an example setup with two Master units and three Slave units, where each Master has its own independent network.

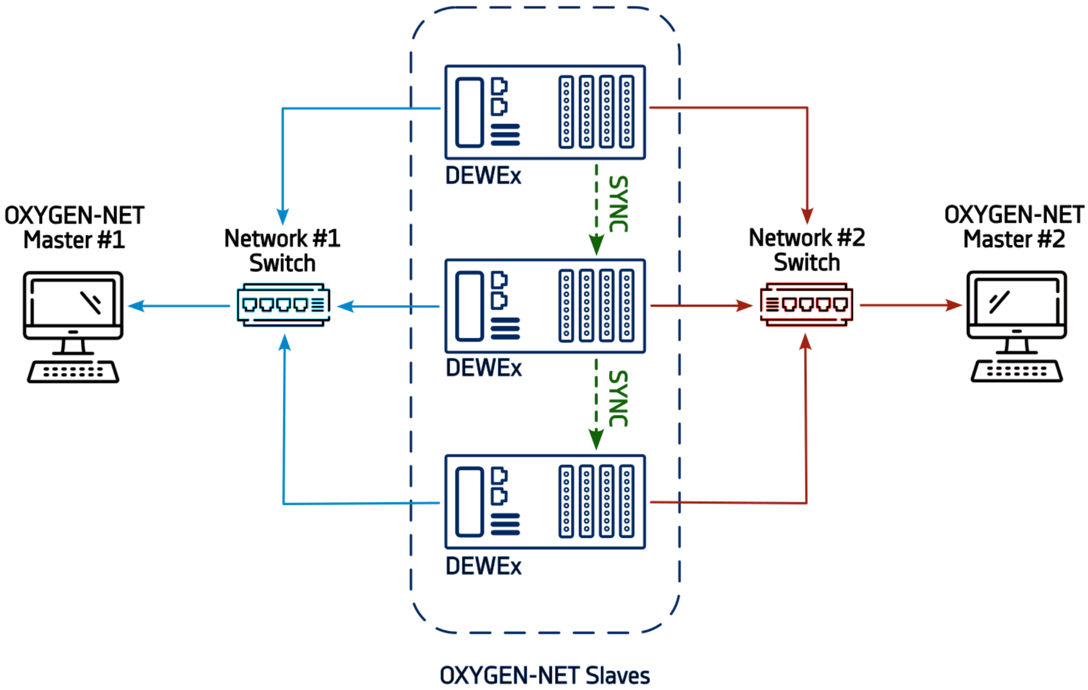

Fig. 15.4: Multi-Master system based on two different networks

Note: The illustrated network switches are optional. In case the Master unit supports enough ports for all Slave units no switch is required.

15.1.2 Synchronization topologies

All DEWETRON devices feature an internal Enclosure Sync, which can be transmitted via the TRION-SYNC-BUS. Additional DEWETRON provides multiple hardware options for signal synchronization across multiple systems, including the DEWE3 Chassis Controller, TRION-BASE module, TRION-TIMING module, and TRION-VGPS module. These hardware options enable the usage of further time codes such as IRIG, GPS, and others.

The following figures illustrate supported synchronization topologies. The primary difference between these topologies is how measurement nodes are synchronized and whether they are connected to an external synchronization source.

Internal TRION-SYNC

Fig. 15.5 shows a synchronization topology using the TRION-SYNC-BUS, based on the internal Enclosure Sync signal of any DEWE3 device. This is the default synchronization method for all DEWE3 devices within an OXYGEN-NET. The system operates in a free-running mode without an external synchronization source, with all nodes connected via TRION-SYNC-BUS. This option is recommended when absolute timestamping is not required and no synchronization with third-party systems is needed.

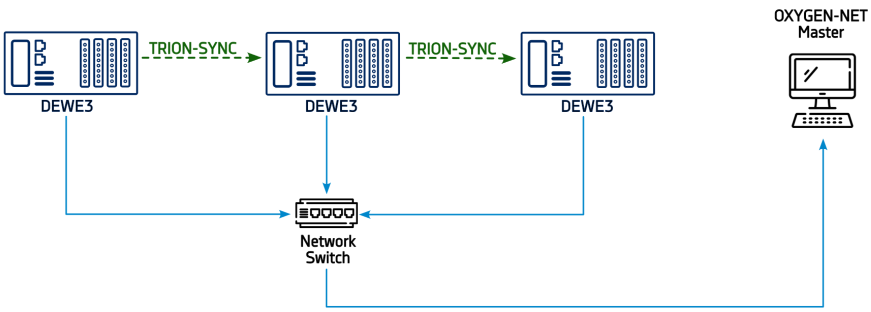

Fig. 15.5: Synchronization topology using the left DEWE3 device as the synchronization source, with the signal distributed via TRION-SYNC-BUS

External SYNC signal

This synchronization topology relies on an external third-party system as a reference clock, distributing the synchronization signal to each measurement node individually. It is recommended for widely distributed systems, where distances exceed the limits of the TRION-SYNC-BUS, or when a wired connection is impractical.

Since the TRION-SYNC-BUS is not used in this setup, each measurement node must be equipped with the appropriate hardware to receive the external synchronization signal. Fig. 15.6 illustrates a potential application of this topology.

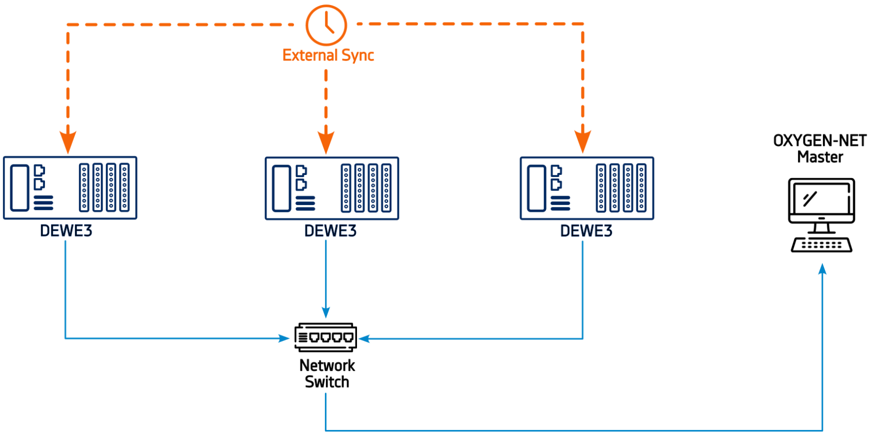

Fig. 15.6: Synchronization topology where each measurement node receives an external synchronization signal individually

Mixed external SYNC signal distributed via TRION-SYNC

This synchronization topology combines both internal TRION-SYNC and external SYNC signal methods. In this setup, an external synchronization signal is received by one DEWE3 device. Based on the received signals timebase a synchronization signal is distributed to all other DEWE3 devices via the TRION-SYNC-BUS.

The enclosure that receives the external sync signal automatically becomes the Synchronization Master and must be equipped with the appropriate hardware. This topology is ideal when synchronization to an absolute timestamp is required.

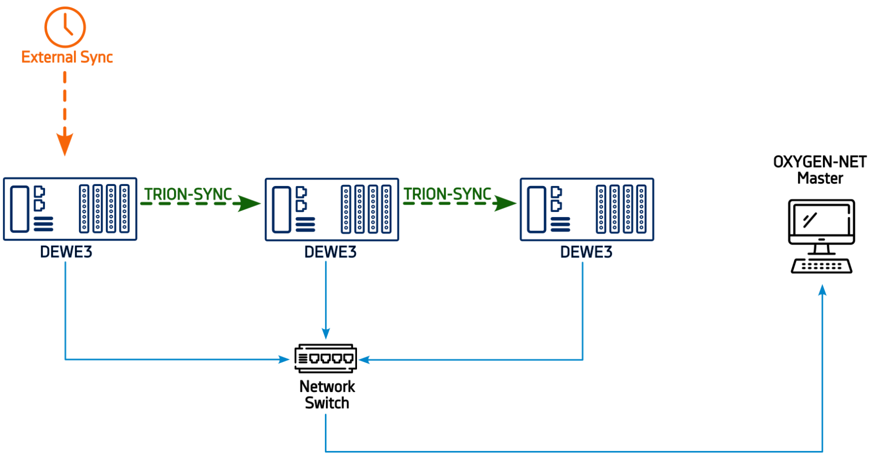

Fig. 15.7: Mixed synchronization topology, where an external sync signal is received by one DEWE3 device and distributed to other devices via TRION-SYNC-BUS

15.1.3 OXYGEN-NET topology including TRIONet3

The TRIONet3 is a front-end device, therefore it does not create an OXYGEN-NET network when connected to another device. Integrating it into an existing OXYGEN-NET system does not alter the network topology. Instead, the TRIONet3 functions as an extension of the connected device, with both acting as a unified measurement node. However, the TRIONet3 still requires both a network and a synchronization connection. Fig. 15.8 illustrates two example topologies incorporating TRIONet3 devices.

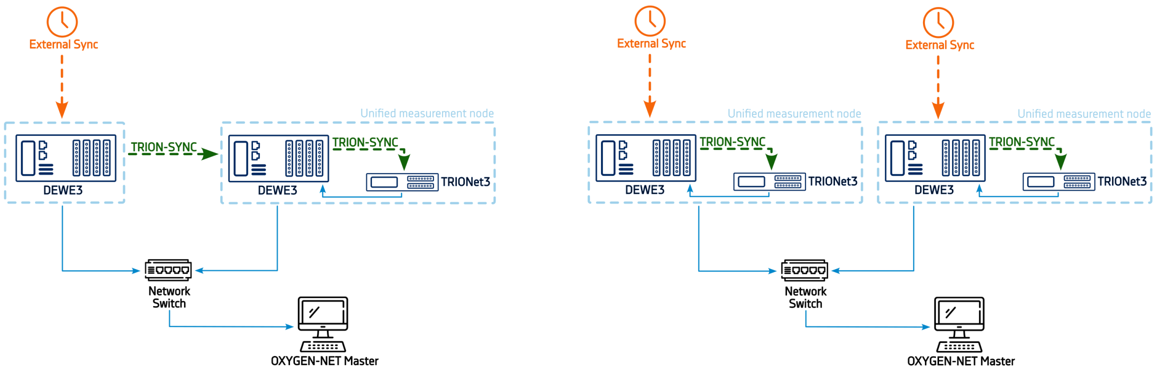

Fig. 15.8: OXYGEN-NET topology examples including TRIONet3s

15.2 OXYGEN-NET - Menu overview

The OXYGEN-NET menu is split up in three different sections: *Nodes*, *Sync* and *Settings*.

15.2.1 OXYGEN-NET Menu – *Nodes*

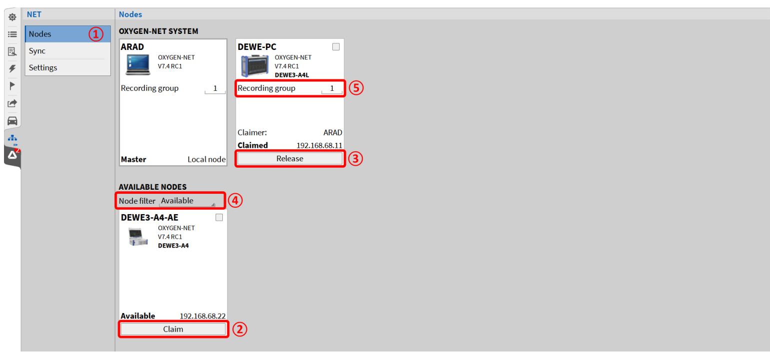

Fig. 15.9: OXYGEN-NET menu – *Nodes*

The *Nodes* menu (see ① Fig. 15.9) provides an overview of all measurement devices connected to the same Ethernet network. The section *AVAILABLE NODES* displays all available devices, while the section *OXYGEN-NET SYSTEM* shows all Slave Units connected to this Master Unit.

To create or extend an OXYGEN-NET network, the *Enable OXYGEN-NET* option must be active on every device involved. Additionally, to allow a device to be claimed, the **Allow claim** option must be enabled. To enable and disable these options, refer to *OXYGEN-NET Menu – Settings*. Devices with *Enable OXYGEN-NET* and **Allow claim** active can be claimed by a Master Unit and connected to the OXYGEN-NET system. To claim a device, click the *Claim button* below the respective measurement device or select multiple devices via the tick box and click any *Claim button* (see ② in Fig. 15.9). Once claimed these devices are regarded as Slave Units.

Claimed devices can be released from the OXYGEN-NET system by clicking on the respective *Release button* (see ③ in Fig. 15.9). After releasing the measurement device, it can be used as a standalone device again or connected to another OXYGEN-NET system.

Node Filters

The Node filter (see ④ in Fig. 15.9) allows users to sort available measurement devices based on their status:

- *Available*: Displays devices on the network that are unclaimed and ready to be claimed.
- *Claimed*: Displays devices that have already been claimed by any Master Unit.
- *All*: Displays all devices connected to the Ethernet network, regardless of their claim status.

Recording Groups

The Recording Group input field (see ⑤ in Fig. 15.9) allows users to set a Recording Group ID. All devices with the same ID form a Recording Group, which shares all recording commands (start, pause, stop). This enables actions such as starting a recording on one Master Unit and stopping it on another.

All Master devices in a Recording Group receive identical data from a slave unit. By default, the recorded data is stored locally on each device within the group. Devices assigned to different Recording Groups operate independently. Recording IDs can be assigned to both master and slave devices, with numbers ranging from 0 to 999. Below are different examples based on an OXYGEN-NET Multi-Master system involving two Master Units and one Slave Unit:

1. Case: Identical ID on All Devices
    - Master 1: Recording ID 1
    - Master 2: Recording ID 1
    - Slave: Recording ID 1

In this setup, a recording command affects all three devices, and identical data is stored locally on each by default.

2. Case: Different ID on All Devices
    - Master 1: Recording ID 1
    - Master 2: Recording ID 2
    - Slave: Recording ID 3

Here, recording commands only affect the device with the matching ID. For example: A recording started on Master 1 must also be stopped on Master 1, and data is stored only on that device. A recording started on Master 2 functions independently. The Slave Unit with its own unique ID, cannot initiate or control recordings.

3. Case: Mixed IDs
    - Master 1: Recording ID 1
    - Master 2: Recording ID 2
    - Slave: Recording ID 1

In this scenario, a recording command issued on Master 1 will also affect the Slave Unit, resulting in identical data being stored on both devices. Master 2, with a different ID, operates independently.

15.2.2 OXYGEN-NET Menu – *Sync*

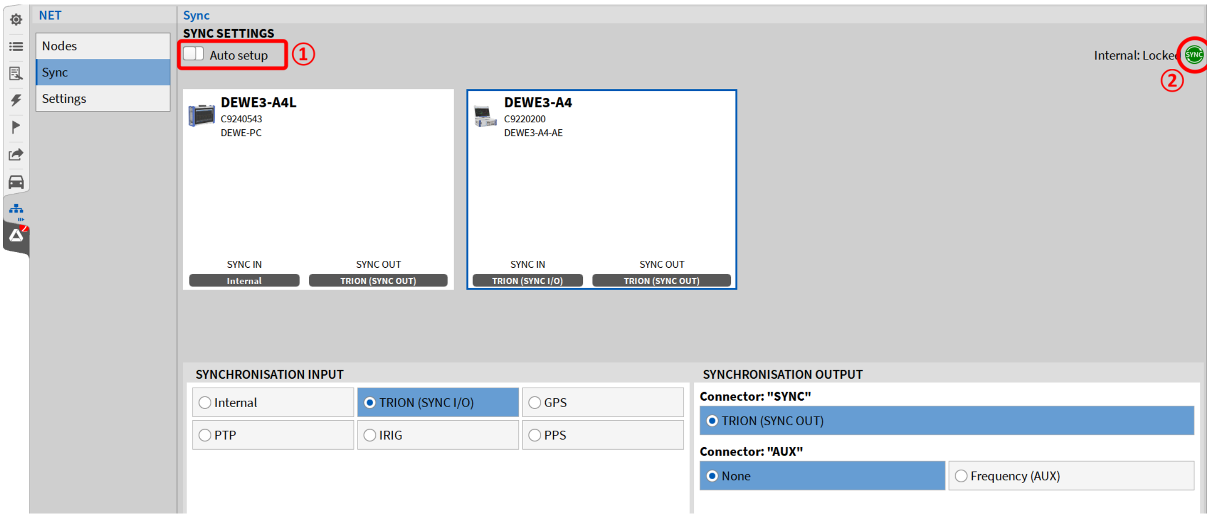

Fig. 15.10: OXYGEN-NET menu – *Sync*

Auto Setup Slider

The Auto Setup slider (see ① in Fig. 15.10) allows users to enable or disable automatic synchronization setup:

- *Enabled*: Synchronization is automatically configured by the DEWE3 enclosure. The synchronization is set to TRION-SYNC-BUS, and no manual settings can be changed while Auto Setup is active. If the Master device lacks measurement hardware (e.g., Notebook or PC), the first claimed Slave is automatically set as the Sync Master. By default, the Sync Master uses its internal time base as SYNCHRONIZATION INPUT.
- *Disabled*: Users can manually configure synchronization input and output settings. For more details, refer to *Sync settings*.

Sync Status Indicator

The Sync Status Indicator (see ② in Fig. 15.10) displays the current synchronization status of the system:

- *Red*: No valid synchronization signal is connected.
- *Orange*: A valid synchronization signal is connected, but the system is not yet locked (this may take a few seconds and will lock automatically).
- *Green*: A valid synchronization signal is connected, and the system is locked.
- *Grey*: The synchronization signal is based on the system's internal clock.

The Sync Status Indicator is also available in the Action Bar when the Sync Setup window is closed (see ② in Fig. 3.5). For additional details, refer to the *Troubleshooting* section.

15.2.3 OXYGEN-NET Menu – *Settings*

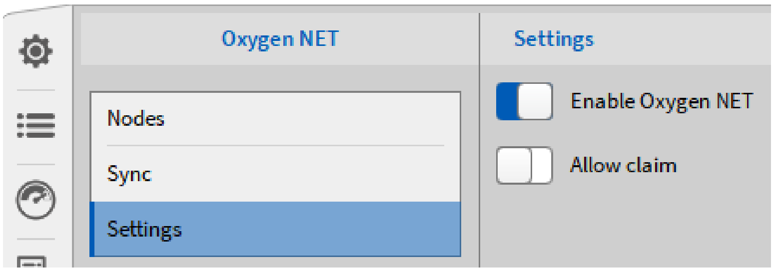

Fig. 15.11: OXYGEN-NET menu – *Settings*

In the *Settings* menu, the user can enable or disable the OXYGEN-NET functionality and select whether the measurement device is claimable or not.

If OXYGEN-NET is disabled, the measurement device can neither be used as a Master nor Slave Unit in an OXYGEN-NET system. Thus, the device is not visible to other users in the Nodes menu of other DEWE3 systems (see *OXYGEN-NET Menu – Nodes*). If OXYGEN-NET is enabled, the device can be used within OXYGEN-NET systems and is listed in the Nodes menu of other DEWE3 systems.

If *Allow claim* is enabled, the measurement device can either be used as a Master unit or be claimed by another device and used as a Slave unit. If *Allow claim* is disabled, the measurement device can only be used as a Master unit (and claim other devices) but not as a Slave unit. Fig. 15.12 illustrates this in OXYGEN, where *Allow claim* is disabled for the device DEWE-PC and enabled for DEWE3-A4-AE.

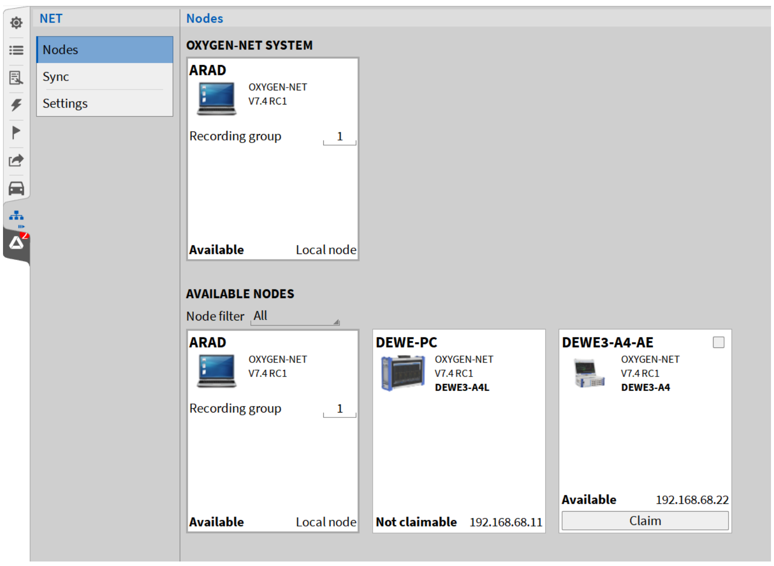

Fig. 15.12: Visibility varieties

The device DEWE3-A4-AE illustrates visibility for other users if OXYGEN-NET is enabled and *Allow Claim* is enabled. The device DEWE-PC illustrates visibility for other users if OXYGEN-NET is enabled and *Allow Claim* is disabled.

15.3 Setting up an OXYGEN-NET System

The following steps describe the procedure for configuring several devices to an OXYGEN-NET system. A detailed description of the following settings and properties is provided in *OXYGEN-NET - Menu overview*. Possible hardware connection schemes can be found in *OXYGEN-NET topologies*.

15.3.1 Generic setup

1. Connect all measurement devices that shall be used within the OXYGEN-NET system to the same ethernet network. Make sure that the IP addresses of all measurement devices are within the same subnet mask. If DHCP is enabled and no DHCP server is available, devices will default to the operating system fallback range (169.x.x.x).
2. Start OXYGEN on all measurement devices and Enable OXYGEN-NET in the OXYGEN-NET menu *Settings* on all devices.
3. Select *Allow claim* on the devices that shall be configured as slaves. Without enabling *Allow claim*, Slave Units cannot be claimed by Master Units.
4. Go to the OXYGEN-NET menu *Nodes* on the Master Unit. Based on the selected node filter, measurement device(s) will appear in the *Available Nodes* section. To claim a device, click the *Claim button* below the respective measurement device or select multiple devices via the tick box and click any *Claim button*.

   Note: If a device should not be listed in the *Available Nodes* section though expected, refer *Troubleshooting*.

5. After claiming a device by the Master unit, it is listed in the *OXYGEN-NET System* section of the OXYGEN-NET menu *Nodes*. A claimed device functions as a Slave Unit and is controlled by its claiming Master Units. The first Master Unit to claim a measurement node is designated as the *Claimer* and performs the role of the *Acquisition Master*, responsible for coordinating the synchronized acquisition start across all nodes. A Slave Unit may be released from the OXYGEN-NET system again by clicking on the *Release button*.
6. After claiming a device, the screen of the Slave Unit will be locked, and the information* Claimed by X* will be displayed in the lower right corner of the software

Fig. 15.13: Claimed information on the Slave device. In this case, the Master device is named CAIRHIEN

15.3.2 Synchronization setup

SYNC-Setup using the internal TRION-SYNC

To synchronize measurement devices using only the TRION-SYNC-BUS, first, connect all devices using SYNC cables. Plug one end into the *SYNC OUT* connector of the Synchronization Master and the other into the *SYNC IN* connector of the next measurement unit. This daisy-chain setup allows the sync signal to be distributed across multiple devices (see Fig. 15.14). Note that synchronization cannot be transmitted via an Ethernet router—it must be directly wired between devices.

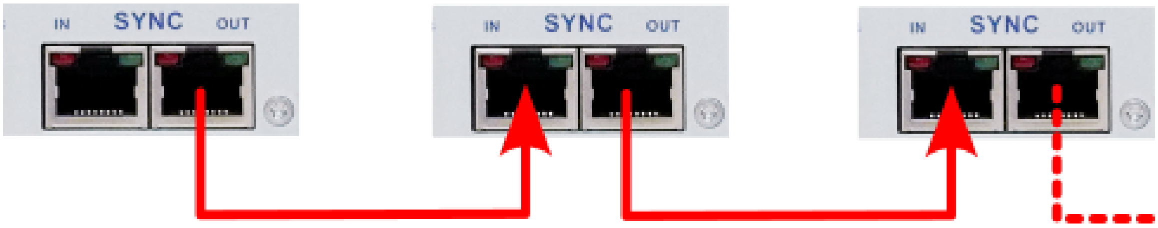

Fig. 15.14: Sync wiring of multiple measurement units using the TRION-SYNC-BUS

Next, configure the OXYGEN-NET Sync settings. The simplest approach is to enable Auto Setup, which automatically applies the correct synchronization settings. If manual configuration is required, follow these steps:

1. Go to the OXYGEN-NET menu Sync and disable *Auto setup*.
2. Select the measurement unit serving as Synchronization Master. In the *SYNCHRONIZATION INPUT* section select Internal. In the *SYNCHRONIZATION OUTPUT* section select TRION (*SYNC OUT*) for connector: “SYNC”, and None for all other connectors.
3. For all other measurement Units select TRION (*SYNC I/O*) as input and TRION (*SYNC OUT*) as output. Set *None* for all other output connectors.

A green background color of the SYNC indicator on all devices will display that the sync wiring is correct and synchronization is completed. All Slave units are now synchronized to the relative time base of the Master unit and a measurement may be started by clicking the Record button on the Master unit.

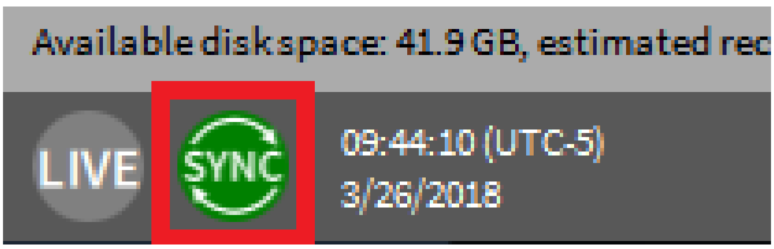

Fig. 15.15: Correct sync wiring

Note: If the background color of the SYNC indicator is orange, the sync wiring is incorrect. For further information, refer to *Troubleshooting*.

SYNC-Setup using an external synchronization signal

When using an external signal for system synchronization, the setup differs slightly.

First, ensure that each DEWE3 device has the appropriate hardware installed to receive the external signal. Then, connect the external synchronization source (e.g., GPS antenna, IRIG grandmaster clock, or PTP signal). It is not required to use the same synchronization source for every node—for example, one node may use GPS while another uses PTP.

Next, open the OXYGEN-NET Sync menu and disable Auto setup. Manually configure the SYNCHRONIZATION INPUT and SYNCHRONIZATION OUTPUT settings based on the external signal source and supported hardware. Once properly configured, the SYNC indicator on all devices will turn green, confirming successful synchronization. Fig. 15.16 illustrates an example where one device receives an IRIG signal from an external source, and another device synchronizes via TRION-SYNC.

For troubleshooting synchronization issues, refer to *Troubleshooting*.

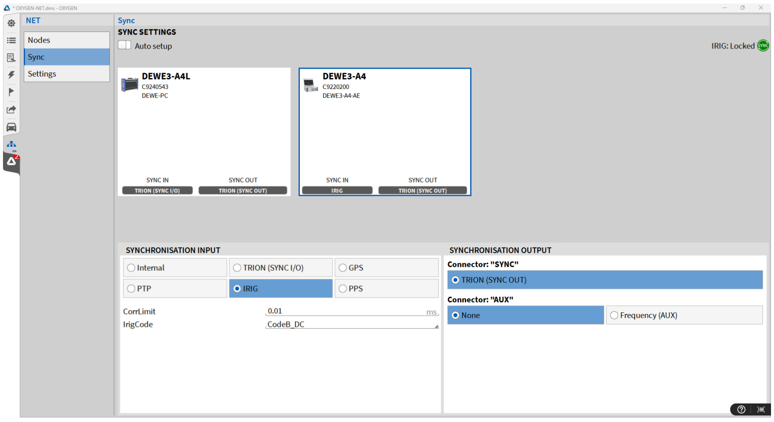

Fig. 15.16: Example SYNC configuration using an external IRIG source

15.4 Setup generation on an OXYGEN-NET system

15.4.1 Setup configuration and shared settings

When configuring an OXYGEN setup for an OXYGEN-NET system, the user has to be aware of which settings are configured for the entire OXYGEN-NET network and which are only locally configured for individual devices. This subchapter provides a brief overview of how different settings and system configurations behave.

Measurement Screens & Reports

Configuring measurement screens and reports is a device-specific process. Any modifications, such as adding, editing, or removing screens or report pages, must be performed individually on each device. This also includes adding, editing, and removing instruments and the respective instrument properties.

Software Channels and software features (incl. channel properties)

Software channels can only be added or removed locally. For Slave Units, this must be done before establishing an OXYGEN-NET system. Once a Slave Unit is part of the network, existing software channels (e.g., modifying formulas) can be edited from any Master Unit. However, in Multi-Master systems, a Master Unit cannot modify software channels on another Master Unit.

Hardware Channels (incl. channel properties)

Hardware channels from any Slave Unit can be configured from any Master Unit. This includes all simple and advanced channel settings except the *Stored* column (green arrow in Fig. 15.17) in the data channels overview. For Multi-Master systems this means, property changes of hardware channels on one Master Unit will automatically be implemented on every other Master Unit. To prevent communication conflicts, we strongly recommend configuring these settings on only one Master Unit at a time.

Note: The sample rate of a channel can differ between each node, as long as only integer multiple sample rates are used.

OXYGEN Setup configurations

Besides the RECORDING FILENAME, all other OXYGEN Setup settings (described in *OXYGEN setup*) are only applied on the local device. As long as the RECORDING FILENAME does not include any header information, the recording filename will be the same across all devices.

Triggered Events

Triggered events are created locally. While trigger conditions can be based on received slave channels, trigger actions only affect the local device, except for recording actions. For more details on recording behavior, refer to *Recording data with an OXYGEN-NET system* with an OXYGEN-NET System. Additional information on working with triggered events can be found in *Triggered Events*.

Header Data

Defined headers in the Header Data section of the Measurement Settings are only generated locally and not shared amongst OXYGEN-NET systems. If header data prompts are enabled at recording start, they will only appear on the Master Unit, not on Slave Units. For more information on header data see *Header data*.

Recording configuration

For details on the recording behavior of devices within an OXYGEN-NET and possible configurations refer to *Recording data with an OXYGEN-NET system* with an OXYGEN-NET System.

System Configuration Tipps

Copy/Paste setups

If multiple devices require an identical or similar setup, including measurement screens and software channels, it is recommended to create a template setup file, copy it to all other devices, and adjust settings as needed.

Use remote control:

For configuring distributed Units before creating an OXYGEN-NET system we recommend using remote control tools like Remote Desktop Connection or a VNC-Tool. This facilitates configuring local settings like setting up measurement screens, software channels, and similar.

Distribute calculations:

Keep in mind that all calculations (from simple math formulas to more complex features like power analysis) are rendered on the device where they are generated. Distributing these calculations across multiple devices in an OXYGEN-NET system can reduce system load for devices near capacity. Examples:

- If a Slave Unit is near full capacity, do not perform demanding calculations on the Slave, but transfer the data to the Master and perform calculations there.

- If a Master Unit is near capacity perform the calculation on the Slave and only transfer the calculation results and not the full raw data.

See *Data transfer and storage* for details on how to transfer and store specific channels only.

15.4.2 Data transfer and storage

In the channel list, the user can decide on various data transfer and storage settings for every single channel via the columns

- *Active*: the slider marked with an orange arrow in Fig. 15.17 will activate or deactivate the data acquisition from a channel
- *Stored*: the red button marked with a green arrow in Fig. 15.17 will enable the storing of the data
- *Trans.*: the green button marked with a blue arrow in Fig. 15.17 will enable the data transfer from the Slave unit to the Master unit.

Note: It is not possible to transfer data from the Master Unit to a Slave Unit nor between Slave Units but only from the Slave Units to the Master Unit.

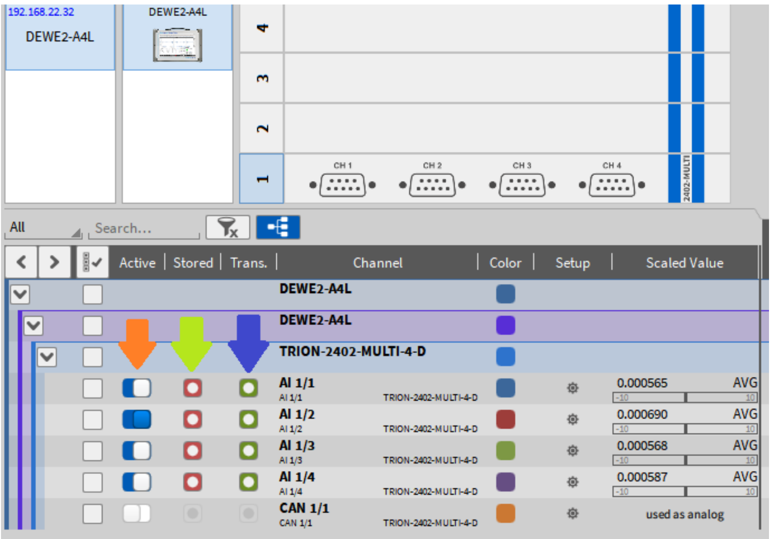

Fig. 15.17: Slave unit channels visible in the Master units' Channel List

Fig. 15.18 shows the following possible combinations:

- Channel A1/1 will only be acquired but not stored or transferred. Data may only be used for math calculations on the Slave unit.
- Channel A1/2 will be stored on the Slave unit but not on the Master unit
- Channel A1/3 will be transferred to the Master unit but neither stored on the Slave unit nor on the Master unit. The channel may only be used for math calculations on the Slave unit or the Master unit.
- Channel A1/4 will be transferred to the Master unit and stored both on the Slave unit and the Master unit.

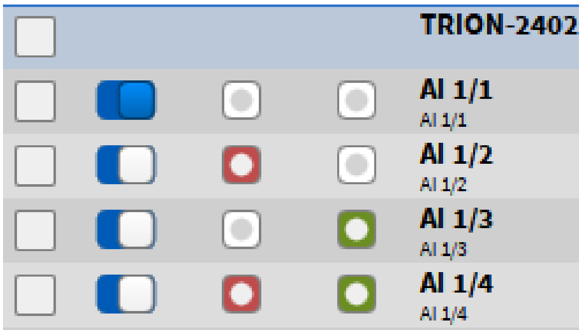

Fig. 15.18: Channel transfer and recording combinations

How to store data on a Master Unit without storing it on a Slave Unit

To prevent data from being stored on a Slave Unit, assign the Slave Unit a different **Recording Group ID** than the Master Unit. This results in no recording taking place on the Slave Unit and consequently, no data being saved on it.

15.4.3 Save & load setup

When a setup is saved on a Master Unit, the configuration of any connected Slave Units (including channel settings, measurement screen configurations, etc.) is included in the setup file stored on the Master Unit. No separate setup file is saved on the Slave Units automatically.

When loading a setup file on a Master Unit that includes an OXYGEN-NET configuration, OXYGEN attempts to automatically claim the required Slave Units during the setup load process. If the Slave unit cannot be claimed, the hardware mismatch dialog will appear (see Fig. 3.13).

Note: OXYGEN must already be running on the Slave Units when loading a setup on a Master Unit, as it does not start automatically when the setup is loaded.

Save & load setup for a Multi-Master System

In a Multi-Master system, successfully loading a setup on one Master Unit will overwrite the current setup on any connected Slave Units and update shared settings across all connected Master Units. To simplify working with multiple Master Units and minimize the risk of errors we suggest the following workflow:

1. Create a general setup file for an OXYGEN-NET system on one Master Unit.
2. Copy this file to all other Master Units.
3. Load the copied file on each Master Unit.
4. After successfully loading the setup files, perform any further adjustments.

15.5 Recording data with an OXYGEN-NET system

OXYGEN-NET systems support the same recording options as an individual system does. However, due to the possibilities of Multi-Master systems and multiple Recording Groups various recording behaviors arise. In the following, we will discuss potential recording behaviors within an OXYGEN-NET system.

Recording Groups

All devices with the same Recording Group ID form a Recording Group. All devices within the same recording group share their recording commands: start recording, pause recording, and stop recording. Meaning if any of these actions are performed on any device within a Recording Group, every device within the Recording Group will follow this command. For examples cases see paragraph Recording Groups in section *OXYGEN-NET Menu – Nodes*.

Manual recording

After pressing the Record button on any Master Unit within the same Recording Group, a recording is started on every device within the Recording Group of the Master Unit. The same applies to pausing and stopping recordings. All devices with the identical Recording ID will follow the command. For details about Recording Groups as well as example cases see section *OXYGEN-NET Menu – Nodes*.

Note: In Multi-Master systems, recording is blocked as soon as a master device has opened the Data Channels menu. Further, as soon as one Master Unit exits the Data Channel menu, every other Master Unit also exits the Data Channel menu.

After stopping a recording, the measurement will be stored the following way in general:

- Any Master Unit stores all transferred data plus data acquired by the Master Unit itself (if available) locally.
- Any Slave Unit stores its respective data locally. One Slave Unit does not store any data from different slave units.

Note: Data transfer and storage settings (see *Data transfer and storage*) significantly influence the finally stored measurement files.

Triggered recording

Triggered recording is supported for OXYGEN-NET systems. The OXYGEN-NET system takes into account all trigger events defined on any Master Unit. This enables flexible trigger setups, but also a high susceptibility to errors for ill-considered trigger events. Individual trigger settings on a slave device are ignored.

User-reduced statistics recording is supported (see *Triggered Events*). The user-reduced statistics data are not transferred from the Slave units to the Master unit to avoid an increase in the data to be transferred. They are calculated on the Master unit for the Slave unit channels that are transferred to the Master unit.

Multi-File recording

OXYGEN-NET systems support Multi-File Recording. When enabled on a Master Unit, the setting also applies to data files stored locally on Slave Units. For seamless recording, it is recommended to use identical Multi-File configurations across all Master Units with the same Recording ID. Any Multi-File settings configured on a Slave Unit will be ignored.

15.6 Additional Information

- Typical data transfer rates (80 MB/s):
  - 16 bit: up to 350 channels @ 100 kHz
  - 24 bit: up to 350 channels @ 50 kHz
- The Master unit can either be a measurement unit with TRION hardware or a laptop without TRION hardware. If a laptop without TRION hardware is used as Master Unit, the first Slave unit claimed by the Master unit is defined as Sync master.
- The sync wiring can be done before OXYGEN is started or when OXYGEN is already running.
- The setup on the Slave units must be roughly prepared before claiming them, only existing channels can be configured from the master.
- If the hard disk of the Master unit is full, the recording will stop automatically on the Master unit and on all Slave units.
- If the hard disk of a Slave unit is full, the recording will only stop on the affected Slave unit but not on the other devices.
- If the software mode of the Master unit is switched to PLAY mode, because a data file is opened, the Slave units are released from the Master unit. To avoid such scenario, use OXYGEN Viewer.
- The Node names are the operating systems host names. These can be edited in e.g. Windows under *System → Info → Change PC Name*.
- ORION DAQ/DSA hardware is not supported with OXYGEN-NET.

15.7 Troubleshooting

15.7.1 General troubleshooting

Device(s) not listed in the Available nodes

If a device is not listed in the *Available Nodes* section as expected, make sure that

- The Node filter is set to *All* or *Available*
- OXYGEN-NET is enabled on the missing measurement device
- The network connection is working
- The IP address of the missing measurement device is within the same subnet range

Sync issues

- If the sync wiring is incorrect, the background color of the SYNC indicator will be orange and the message Waiting for sync will be displayed in the lower right corner of the software (see Fig. 15.19). If this appears, make sure that the sync wiring is correct. For further information, refer to *OXYGEN-NET menu – Sync* and Fig. 15.14.

Fig. 15.19: Incorrect sync wiring

- If the sync wire is disconnected during the measurement, a *Sync Lost* marker is added to the *Event List* and the message *Waiting for sync* will be displayed in the lower right corner of the software. The background color of the *SYNC indicator* will become orange.

Fig. 15.20: Software feedback if sync signal is lost during the measurement

  - The recording will be continued until the *Stop* button is pressed. Be aware that the recording will not be time synchronous any more without valid sync connection.
  - A reconnection of the sync wire will not help to resync data during recording. The measurement must be stopped before data is time synchronous again.

- If the sync wire is reconnected during the measurement, the SYNC indicator will become red and the message *Invalid synchronization signal* will be displayed in the lower right corner of the software.

Fig. 15.21: Software feedback if sync signal is reconnected during the measurement

- If the system is configured in a way, that is a not allowed topology, there is the following error message next to the SYNC indicator within the Sync settings: *No valid sync setup found for node XY.*

Fig. 15.22: Error message displaying a measurement node with an invalid sync setup

- If there is a problem, that at least one node cannot be synchronized, there is an error message saying: *Out of Sync.* In this case check each measurement node individually.

Slave loses network connection

If a slave device loses the network connection during the measurement, the master device adds a *Node Lost* marker to the Event List and displays the message *Slave Node Lost:…* in the lower right corner of the software (see Fig. 15.23).

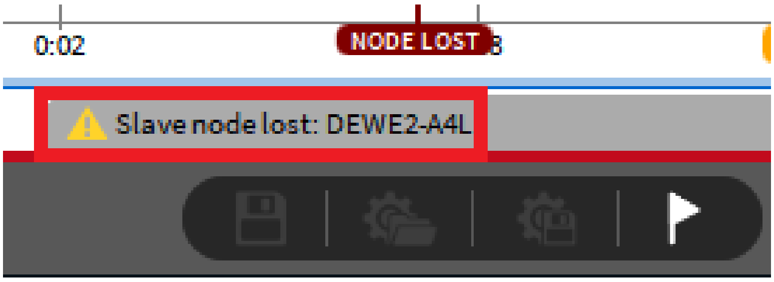

Fig. 15.23: Software feedback on master device if slave node loses network connection

The affected slave device adds a *Node Lost* marker to the Event List and opens a *Master Lost* pop-up menu (see Fig. 15.24).

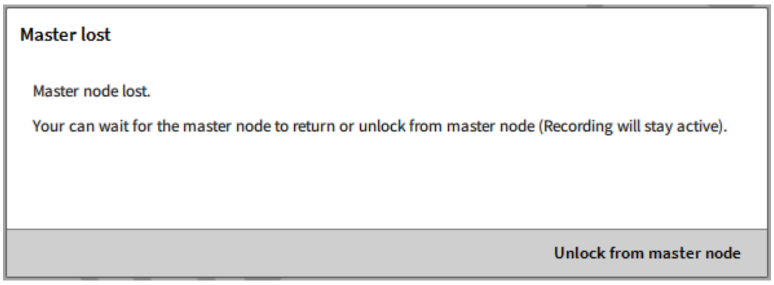

Fig. 15.24: Software feedback on slave device if slave node loses network connection

- If the user selects *Unlock from master node*, the recording will be continued until the *Stop* button is pressed and the slave device can be used as standalone unit.
- If the network connection is fixed in the meantime, the pop-up window on the slave device will close again and the slave device can be controlled by the master device again. Data recording is still synchronous, because the sync connection was still active. A *Node found* marker will be added to the Event List.

  The measurement on potential other slave devices is not affected and they do not realize that a slave node was lost.

Master Unit loses network connection

If the master device loses the network connection during the measurement, the master device adds a *Node Lost* marker to the Event List and displays the message *Slave Node Lost:…* in the lower right corner of the software (see Fig. 15.23).

All slave devices add a *Node Lost* marker to the Event List and open a *Master Lost* pop-up menu (see Fig. 15.24).

- If the user selects *Unlock from master node*, the recording will be continued until the *Stop* button is pressed and the slave devices can be used as standalone units.
- If the network connection is fixed in the meantime, the pop-up window on the slave device will close again and the slave devices can be controlled by the master device again. Data recording is still synchronous, because the sync connection was still active. A *Node found* marker will be added to the Event List.

15.7.2 Multi-Master-specific troubleshooting

Loading setups simultaneously

It is NOT recommended to load setups simultaneously within an OXYGEN-NET system. Loading setups on multiple master clients at the same time may cause extended waiting times and potential issues when determining an acquisition master. To avoid errors, load setups sequentially, one master client at a time.

Losing system devices

This section addresses scenarios involving the unintentional disconnection of any device from an OXYGEN-NET system, which could result from a network disconnection, device crash, power loss, or similar issues.

Losing system devices during recording

If a system device is lost during an active recording, a full system software restart is recommended once the recording has stopped. A full restart involves:

- Releasing all nodes on every master client
- Closing and reopening OXYGEN on each master and slave device,
- Reloading the existing OXYGEN setups on every device.

Losing system devices during non-recording

If a device is lost while the system is not recording or armed, the response depends on the type of device lost:

- If the acquisition master is lost: All master devices will release their measurement nodes. A full system software restart, as described above, is recommended.
- If any master client (other than the acquisition master) is lost: The affected master will release its claimed slaves, but the overall system will remain unaffected. Restarting OXYGEN on the affected device should resolve the issue. If issues persist, perform a full system software restart.
- If any measurement node is lost: Each master device that had the node claimed will release it and display a notification: "Slave node lost: Slave_X." A full system software restart is recommended in this case.

15.8 Limitations of OXYGEN-NET

No data transfer between different Slave units or from Master unit to Slave unit. Data can only be transferred from Slave units to Master units.