DEWETRON

OXYGEN R3.7

SOFTWARE FEATURE MANUAL

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1 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:

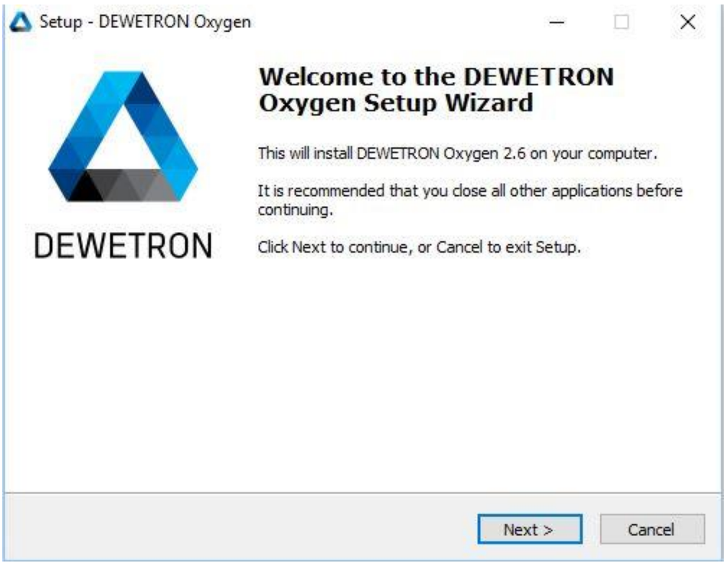


Figure 1-1: Starting the installation wizard

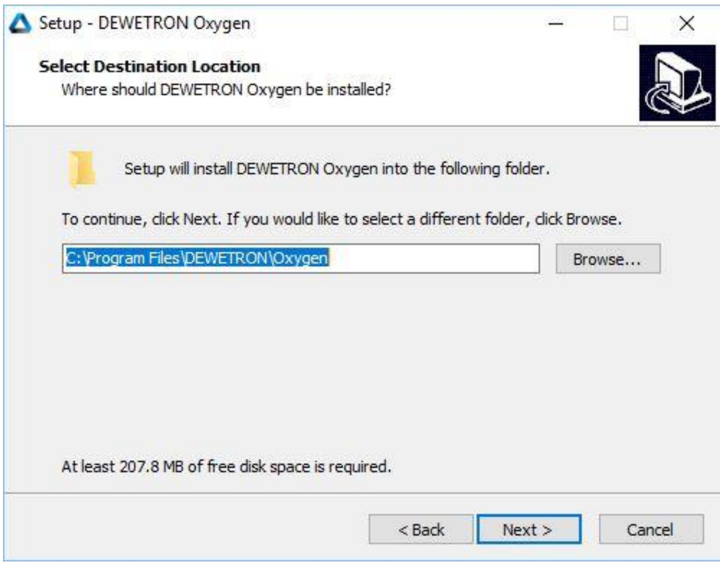


Figure 1-2: Select Destination Location

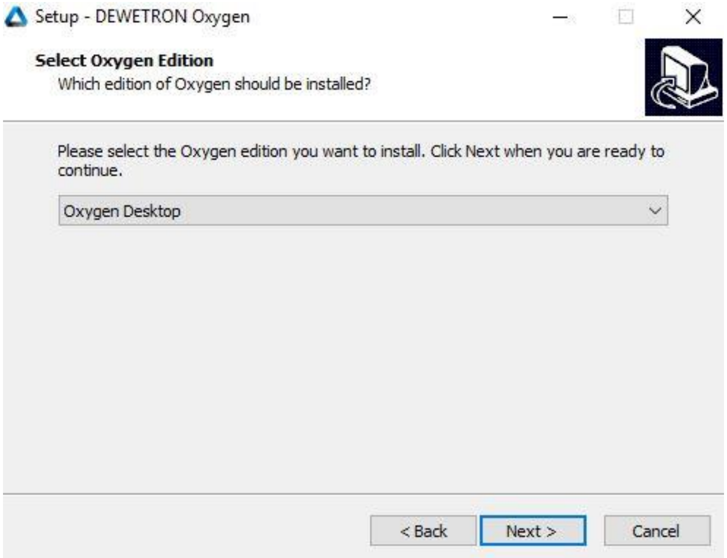


Figure 1-3: Select OXYGEN Edition

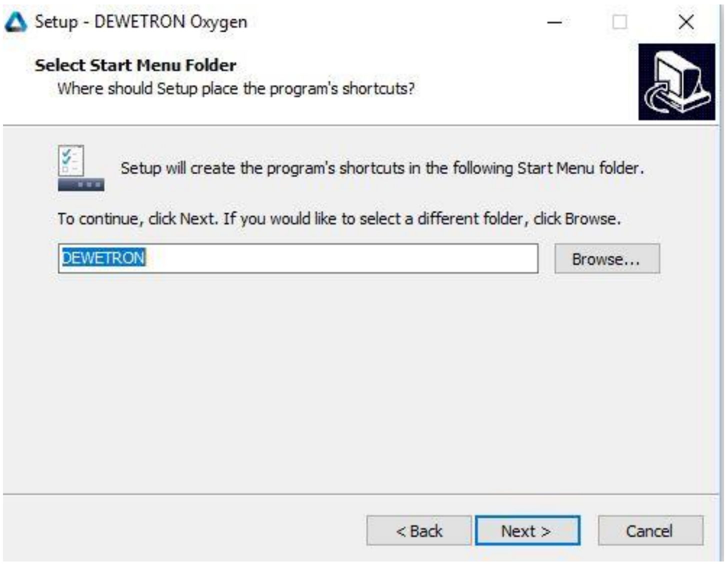


Figure 1-4: Select Start Menu Folder

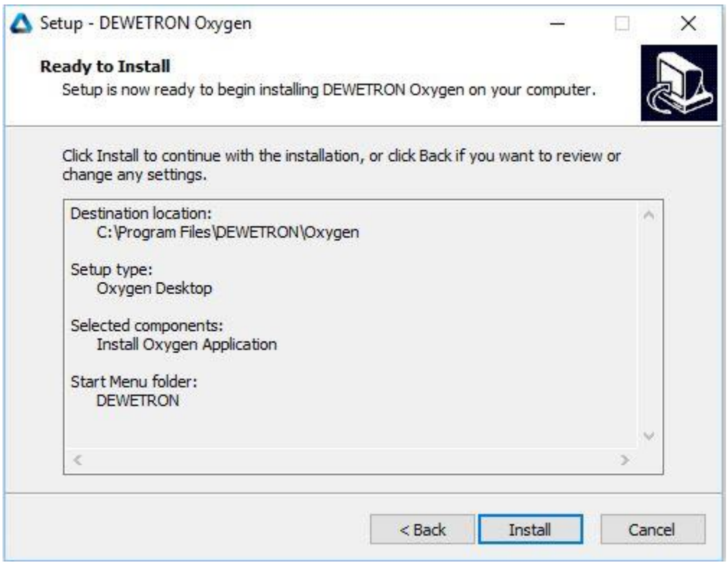


Figure 1-5: Ready to Install

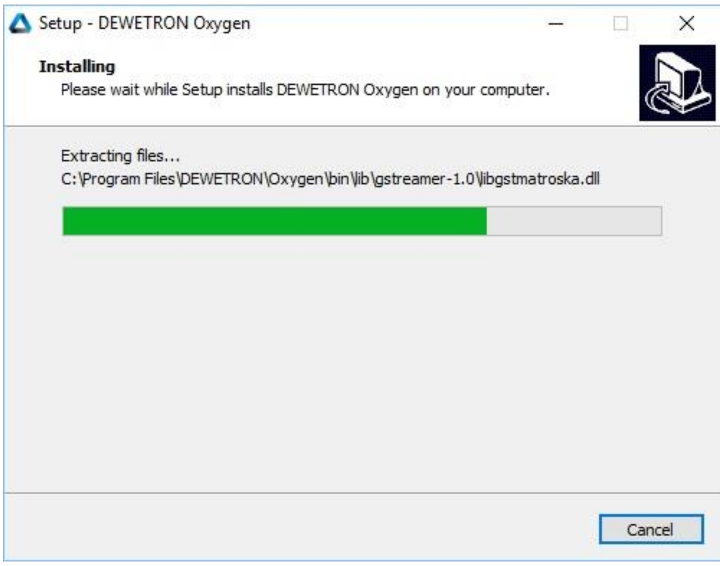


Figure 1-6: Installing

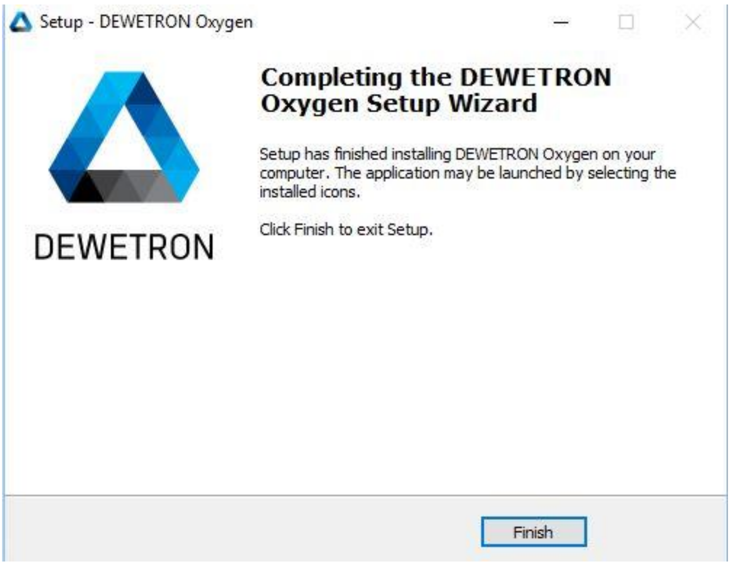


Figure 1-7: Installation completed

- 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 5 minutes 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 Figure 1-8). 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.

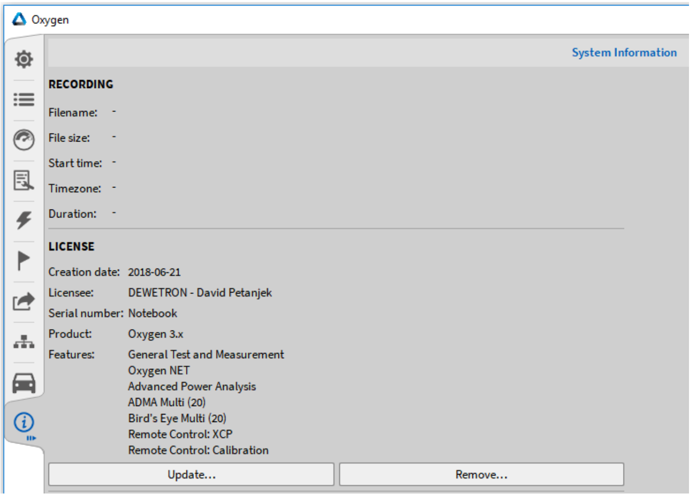


Figure 1-8: Updating the OXYGEN-license

Remark: Please note that a license file for OXYGEN 2.x is not valid for OXYGEN 3.x!

- After installing a license, the license information can be found in the *System Information* menu (see Figure 1-9)

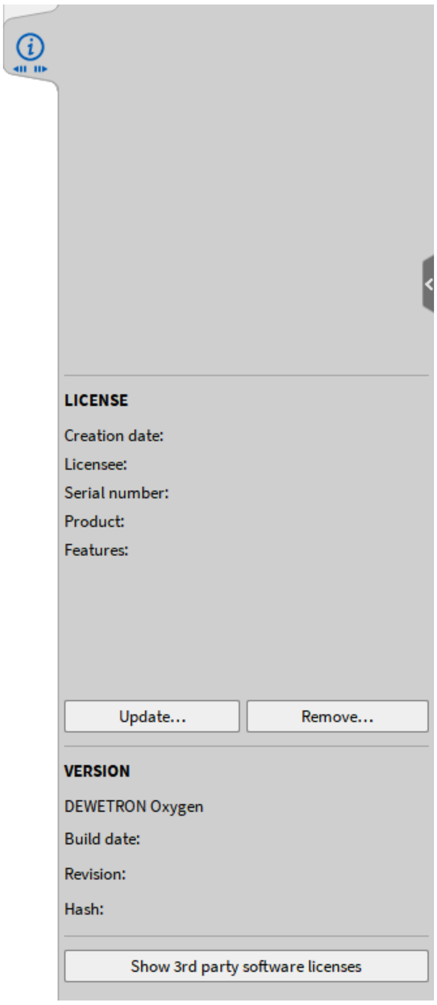


Figure 1-9: *System Information* menu

2 SOFTWARE OVERVIEW

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

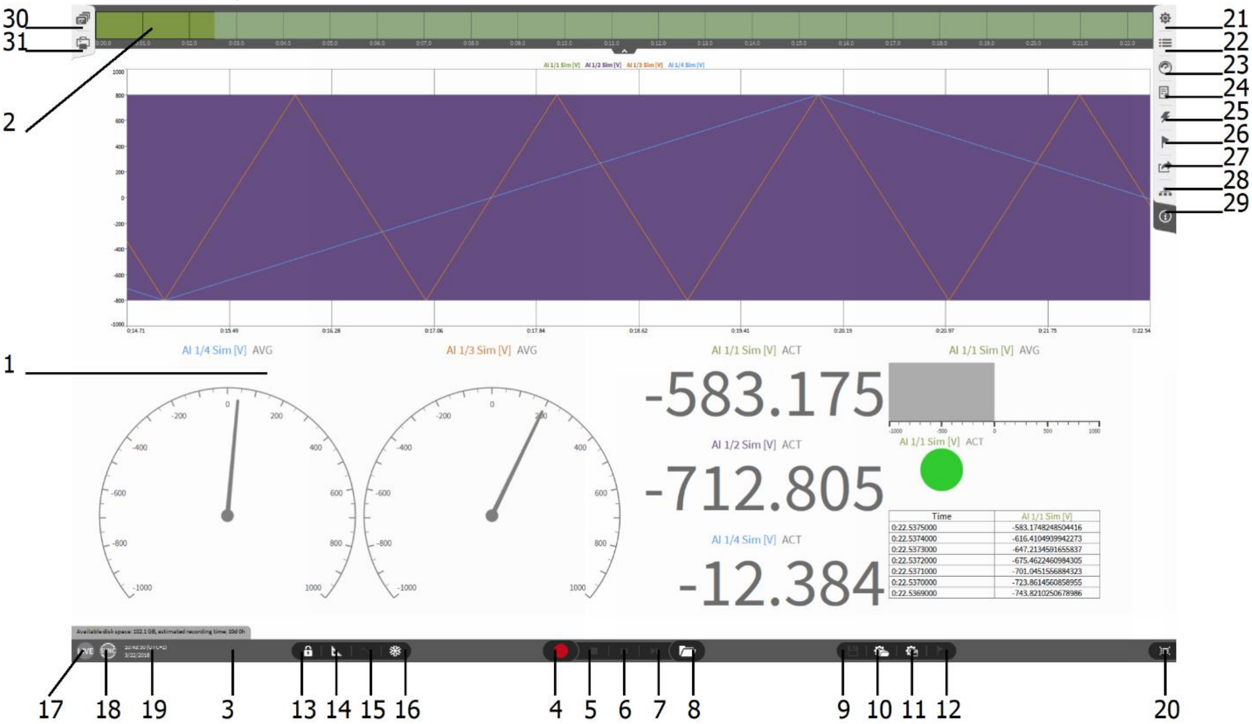


Figure 2-1: Software Overview

1	Measurement Screen	Default measurement screen with several Instruments that display the acquired data. For adding or manipulating instruments on a screen, please refer to section 6.1. For managing several screens, please refer to section 10
2	Overview bar	Shows the time dependent trend of one selected input channel. For changing the channel, please refer to section 2.5
3	Action bar	Contains relevant push buttons
4	*Record* button	Starts or pauses *REC* mode
5	*Stop* button	Terminates an active recording or returns to the *LIVE* mode when the *PLAY* mode is active
6	*Fast Forward* button	Only active in *PLAY* mode; A click on this button will move the cursor 5 seconds forward
7	*Reverse* Button	Only active in *PLAY* mode; A click on this button will move the cursor 5 seconds back
8	*Open Data file* button	Opens an UI to select a data file and switches in the *PLAY* mode
9	*Store data* button	Stores changes to a data file that were made during analysis in the *PLAY* mode
10	*Open Setup file* button	Opens an UI to select a setup file
11	*Save setup file* button	Saves software settings to a setup file
12	*Add Marker* button	Adds a marker on the actual point of time; Enabled in *REC* and *PLAY* mode

13	*Lock Screen* button	Locks the measurement screen
14	*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 please refer to section 6.1
15	*Cursor* button	Activates measurement cursors; for detailed information please refer to section 6.4.2.3
16	*Freeze* button	Freezes the actual screen
17	*Mode* indicator	Shows the current software mode; for detailed information please refer to section 2.1
18	*Sync mode* indicator	Shows the current Sync status of the software
19	Time	Shows the actual time, time zone and date
20	Quick access to Data channels menu	Toggles between the current screen and the Data Channel list
21	*System Settings* Menu	Opens the *System Settings* menu; for detailed information please refer to section 4
22	*Data Channels* Menu	Opens the *Data Channels* menu; for detailed information please refer to section 5
23	*Instruments* Menu	Opens the *Instruments* menu; for detailed information please refer to section 6
24	*Instrument Properties* Menu	Opens the properties of a selected Instrument; for detailed information please refer to section 6 **Remark:** The Instrument Properties can also be opened with a double click on the desired Instrument
25	*Triggered Events* Menu	Opens the *Triggered Events* menu; for detailed information please refer to section 7
26	*Event List* Menu	Opens the *Event List* menu; for detailed information please refer to section 8
27	*Export Settings* Menu	Opens the *Export Settings* menu; for detailed information please refer to section 9
28	*OXYGEN Net* Menu	Opens the *OXYGEN Net* menu; for detailed information please refer to section 12
29	*System Information* Menu	Opens the *System Information* that contains information about the software license and version
30	*Screens* Menu	Opens the *Screens* menu; for detailed information please refer to section 10
31	*Reporting* Menu	Opens the *Reporting* menu; for detailed information please refer to section 11

Table 2-1: Software Overview

2.1 SOFTWARE MODES

OXYGEN has three different Operating Modes: *LIVE*, *REC* and *PLAY*. The actual software mode is displayed in the Action bar (see ⑰ in Figure 2-1). 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, please refer to section 4.1.
- *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.

2.2 SAVING A MEASUREMENT SETUP FILE

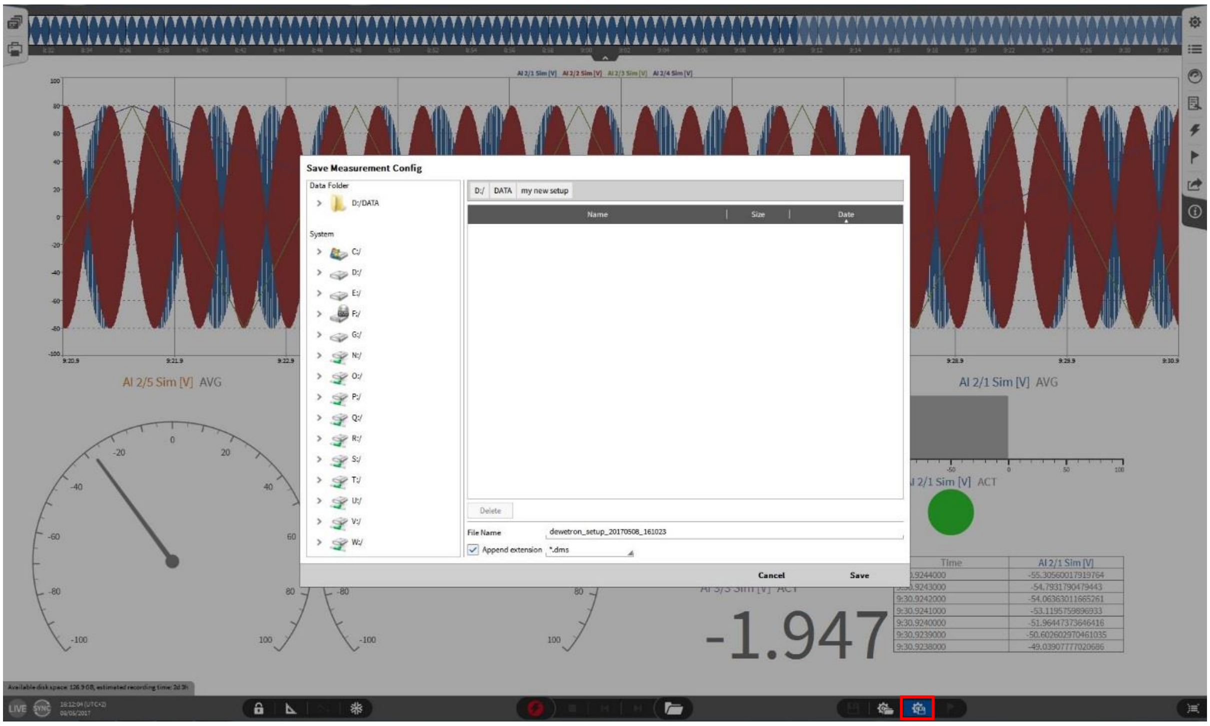


Figure 2-2: Saving a Setup file

- Touch or left click the gear and diskette icon in the Action Bar (see Figure 2-2 or ⑪ in Figure 2-1)
- Upon selecting this icon, the *Save Measurement Config* dialog will appear
- Within this dialog, the user can select the *Data* folder location and a *file Name*
- The *Save* button will store the current software settings to a measurement file

2.3 LOADING A MEASUREMENT SETUP FILE

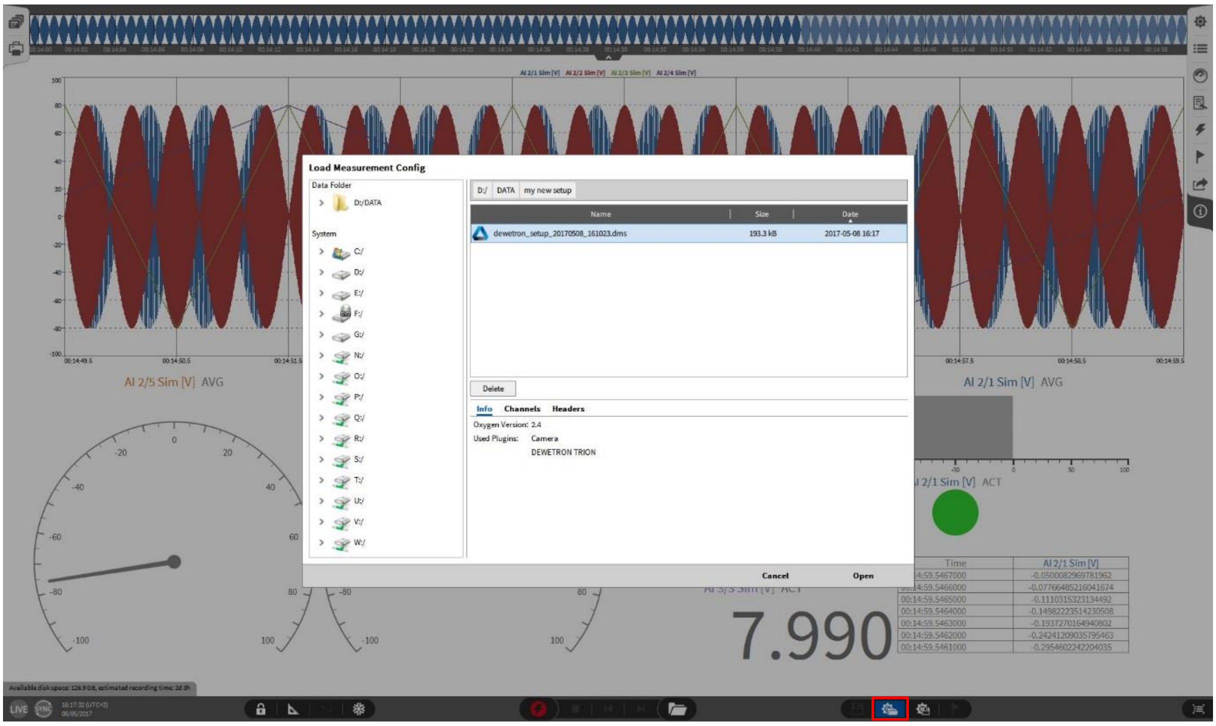


Figure 2-3: Loading a Setup file

- Touch or left click the gear and folder icon along the bottom tool bar (see Figure 2-3 or ⑩ in Figure 2-1)
- Upon selecting this icon, a *Load Measurement Config* dialog will appear
- 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.
- The *Open* button will open the selected Setup file
- If the measurement hardware does not match with the hardware stored in the setup file, the *Hardware Match* dialog will open (see Figure 2-4). 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 Figure 2-4). 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.

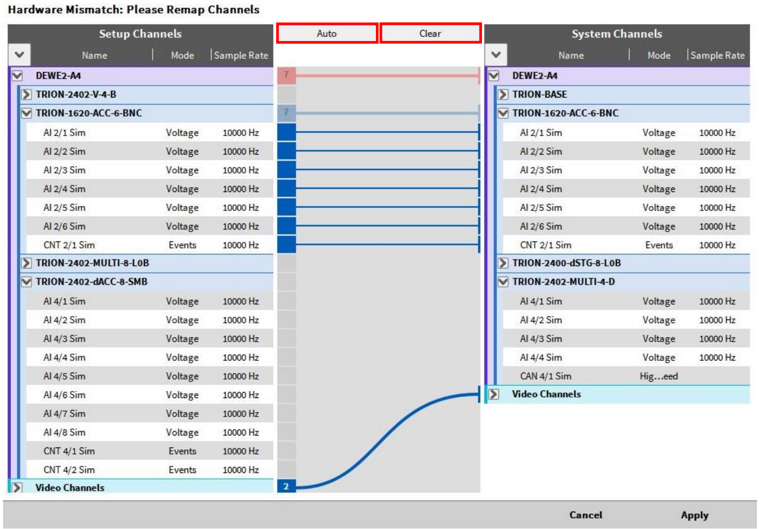


Figure 2-4: Hardware Mismatch dialog

2.4 Reviewing a Data File (*PLAY* mode)

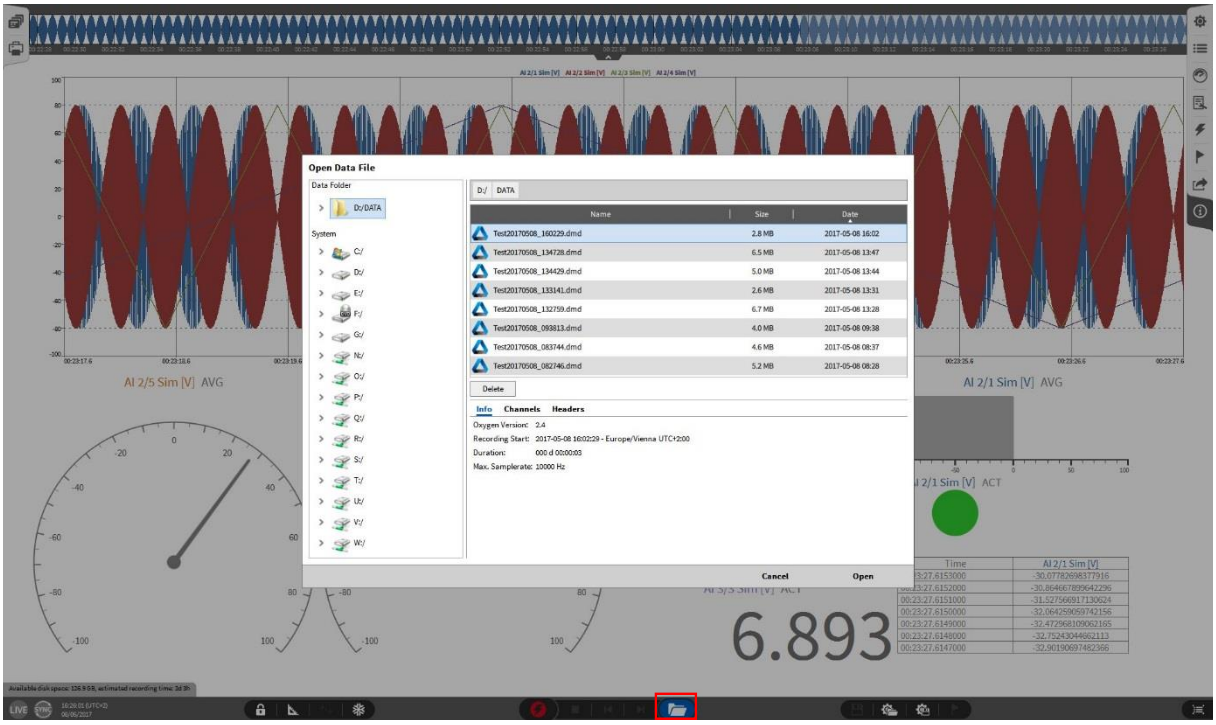


Figure 2-5: Opening a Data file

- Touch or left click the folder icon in the Action bar (see Figure 2-5 or ⑧ in Figure 2-1)
- Upon selecting this icon, an *Open Data File* dialog will appear
- Select the appropriate *Data Folder* on the left side of the menu
- 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
- 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.
- The *Open* button will open the selected Setup file

- Along the top of the newly opened Data file lies the *Overview Bar* (see Figure 2-6 or ② in Figure 2-1). 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.
- Once the user clicks the green *PLAY* button (see ① Figure 2-6) 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
- Once finished reviewing the Data File, select the *Eject* button (see ② Figure 2-6) which is located to the right of the *Play* button. After that OXYGEN will be in *LIVE* mode again and start to acquire data.

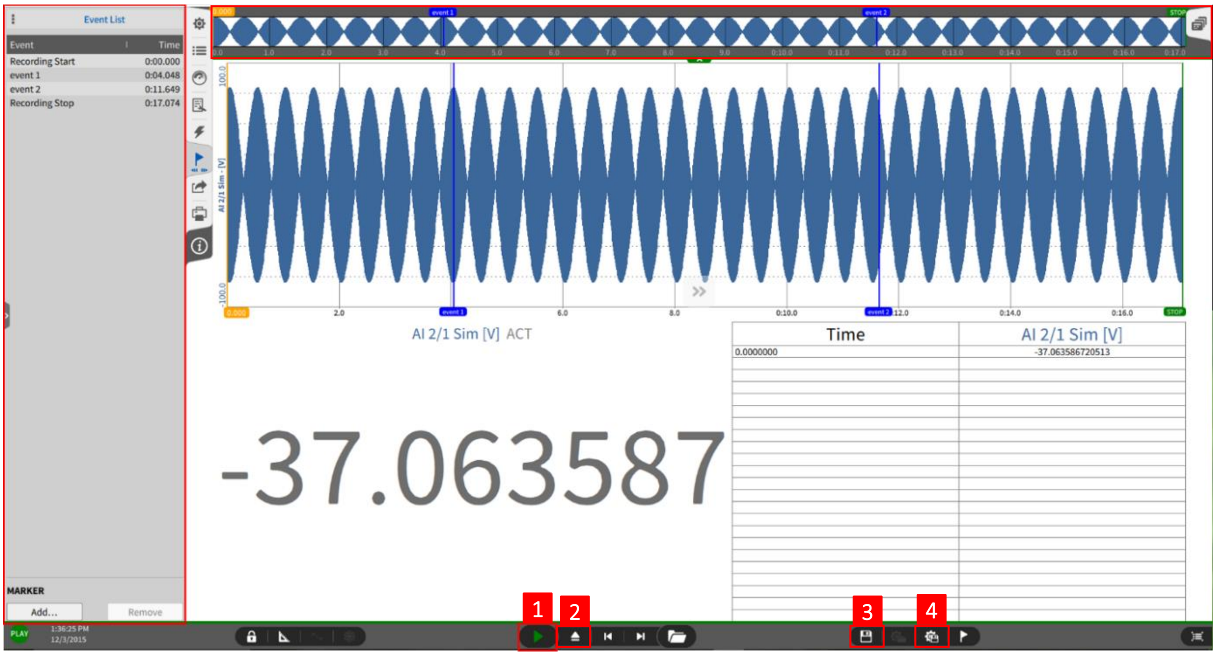


Figure 2-6: Loaded data file - Overview

Remarks:

- The *Design* mode can be activated to add, move or delete Instruments in the *PLAY* mode as well. For detailed information, please refer to section 6.1.
- The implementation of Offline Math software features has begun with OXYGEN 3.0, and the functionalities will be expanded with the proximate software releases. The available features will be explained in section 0
- 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 Figure 2-6) will clearly display all events and the points of time the events occurred in a list. For adding a marker to an event, please refer to section 8.
- Changes that were applied to the data file during the analysis can be saved to the data file by pressing the diskette-button (see ③ in Figure 2-6)
- A setup file based on the settings of a data file can be created by pressing the gear-diskette-button (see ④ in Figure 2-6)

2.5 Overview Bar

Figure 2-7: 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 Figure 2-7). 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 Figure 2-8).

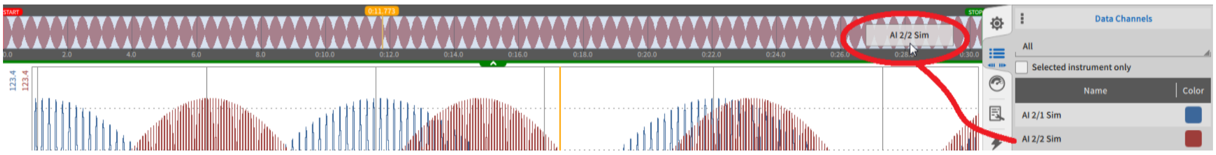


Figure 2-8: Change displayed channel in the Overview bar

2.6 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.

Remarks:

- 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 Figure 2-9).
- 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 Figure 2-9).

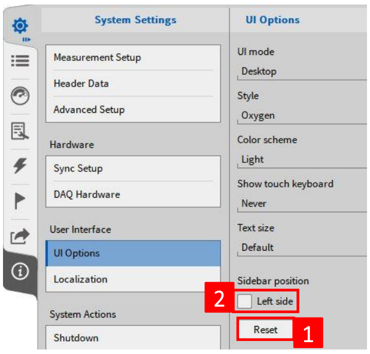


Figure 2-9: Sidebar position reset

3 USING DEWETRON MEASUREMENT HARDWARE WITH OXYGEN

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.

3.1 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 Figure 2-10) (Changes take effect on application restart)

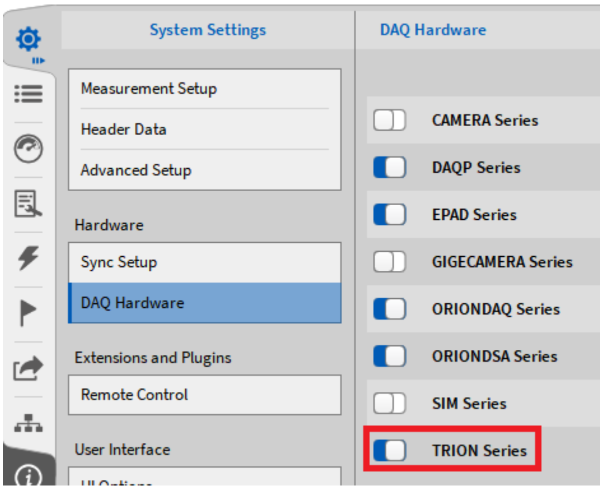


Figure 2-10: Enabling the TRION Series in the DAQ Hardware setup

- The channels of the connected TRION™ hardware will now be visible and editable in the Channel List (see Figure 2-11):

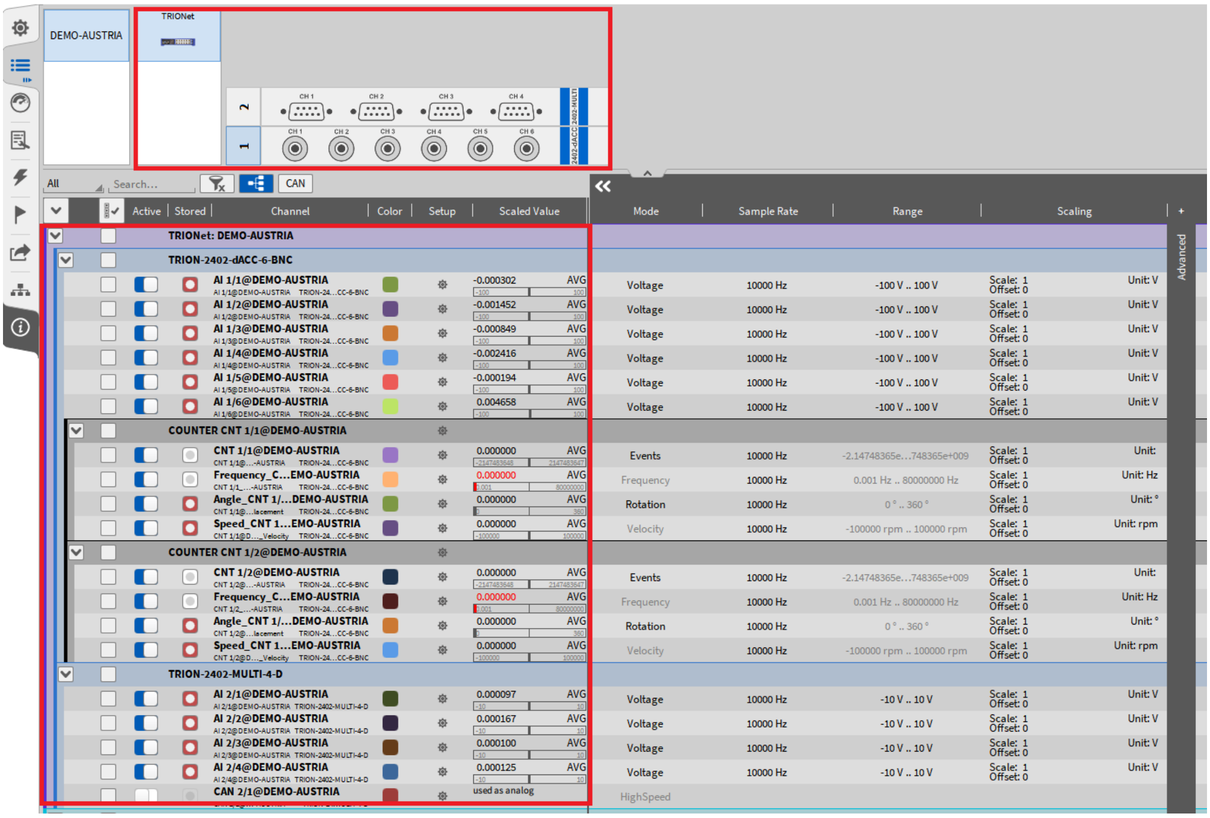


Figure 2-11: Overview of connected TRION™ hardware in the Channel List

3.1.1 USING A TRIONET™ IN OXYGEN

- In addition to the steps explained in section 3.1, the following steps must be respected if TRION™ hardware is used in combination with a TRIONet™
- Choose 'Auto' from the '*Network Interfaces*' drop-down menu (see Figure 2-12). This will scan all ethernet ports and automatically detect the TRIONet device

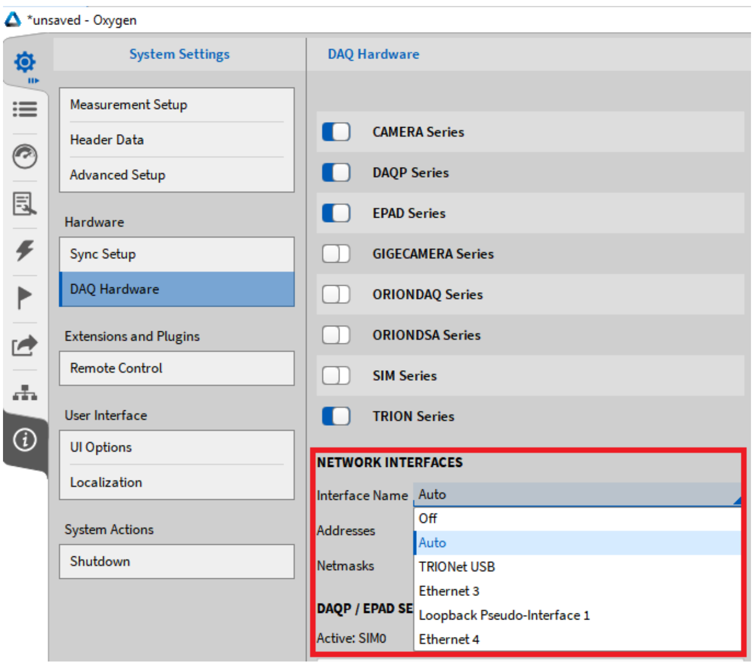


Figure 2-12: Network Interface settings

- The IP-address of the adapter is shown in the field below (see Figure 2-13)

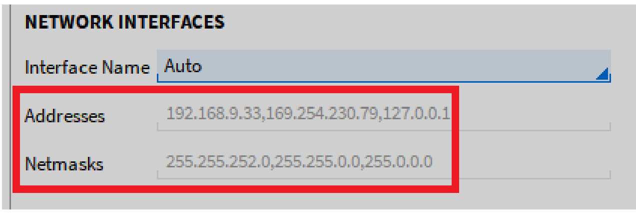


Figure 2-13: IP addresses of connected TRIONet™s

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

Remark: 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.

3.2 Using EPAD2s with OXYGEN

3.2.1 Using EPAD2s 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 Figure 2-14).

Figure 2-14: 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 Figure 2-15) (Changes take effect on application restart)

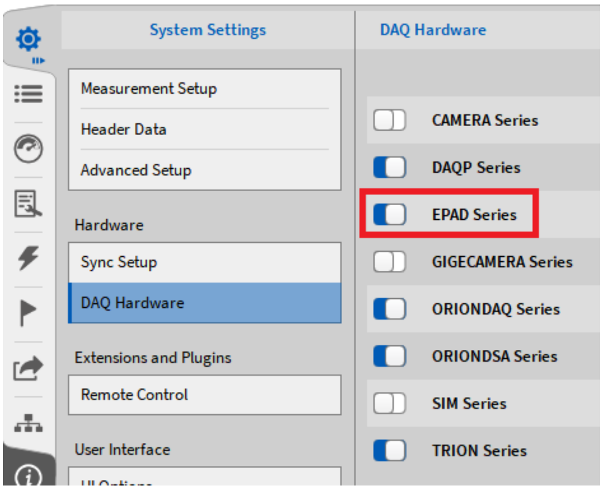


Figure 2-15: Enabling the EPAD Series in the DAQ Hardware setup

- Select the proper Serial Port for your EPAD2-module by clicking on the *Select ports…* button (see Figure 2-16). Systems in Europe are typically assigned to COM2 and systems in the USA are typically assigned to COM3)

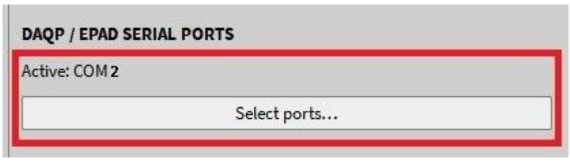


Figure 2-16: Selection of the proper COM port

- Press the *Scan for modules* button (see Figure 2-17). 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

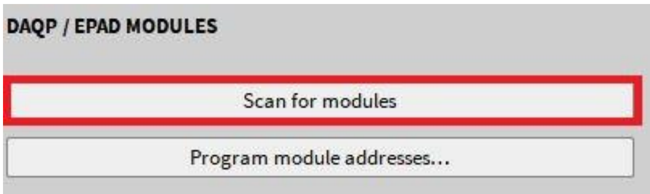


Figure 2-17: *Scan for modules* button

- If an EPAD2-module is found, the user will be presented with a message in the lower right corner of the software (see Figure 2-18) stating that the software has found an EPAD2-module

Figure 2-18: EPAD found message

- If you have multiple EPAD2-modules daisy chained together, the user can select the *Program module addresses…* button (see Figure 2-19)

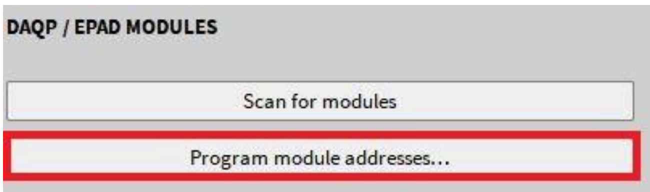


Figure 2-19: *Program module addresses* button

- Next, select the starting EPAD2 address (cannot be 0) and then select S*tart programming* (see Figure 2-20)
- Once the programming has begun, the software will ask you to press the black *ID* button (see Figure 2-21) 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 Figure 2-20).

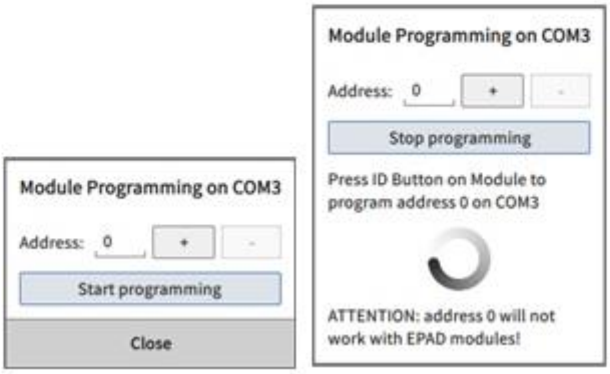


Figure 2-20: EPAD-programming procedure

Figure 2-21: Front of an EPAD2-module

3.2.2 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-BASE module to the measurement PC. This is also a solution for using EPAD2 modules in combination with a TRIONet^{TM} which has no EPAD connector.

Please 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\drivers\3_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 section 4.1.1. 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 Figure 2-22).

Figure 2-22: COM port section in the Device Manager

3.2.3 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 3.1 all EPAD-modules except EPAD-AO4 and EPAD-BASE2 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

3.2.4 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 Figure 2-23)
- 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

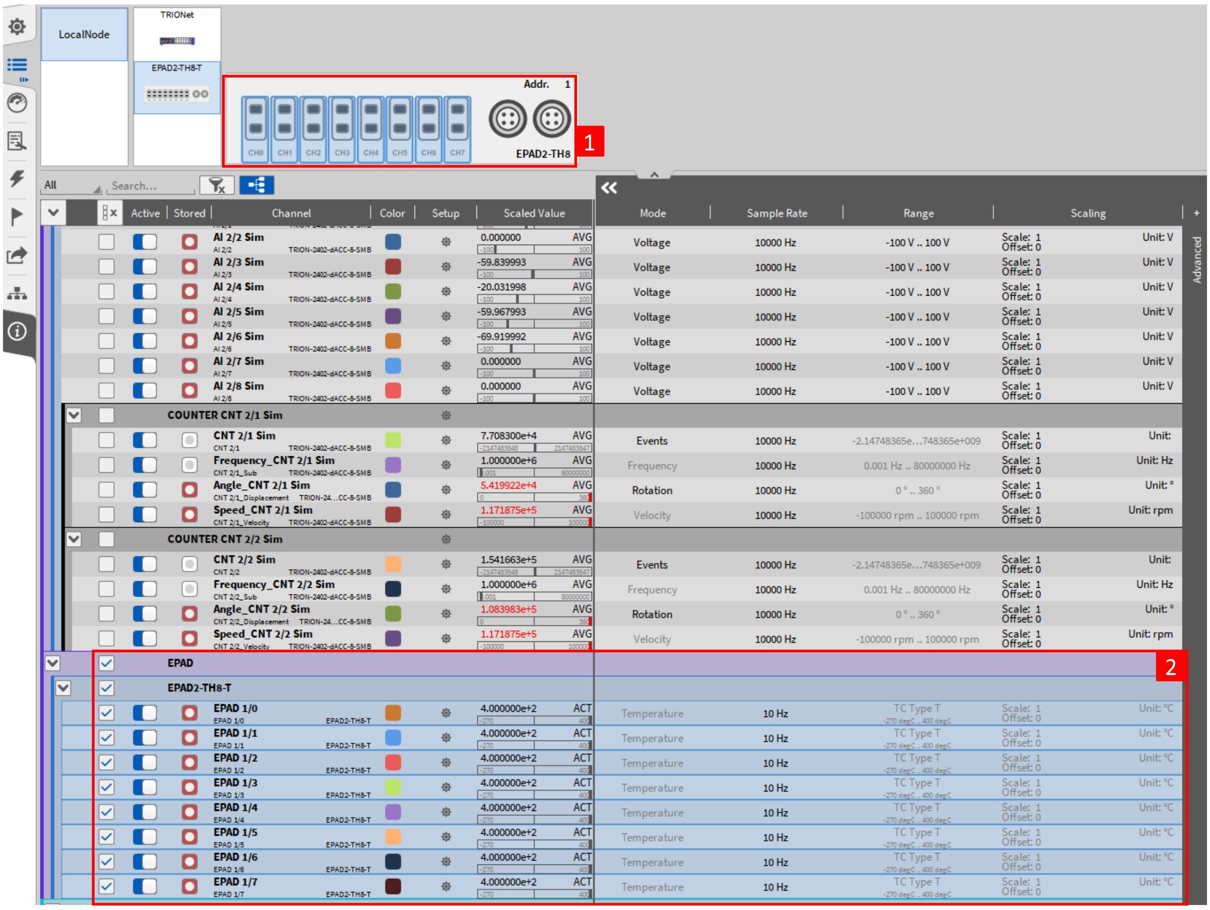


Figure 2-23: EPAD-Channel List

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

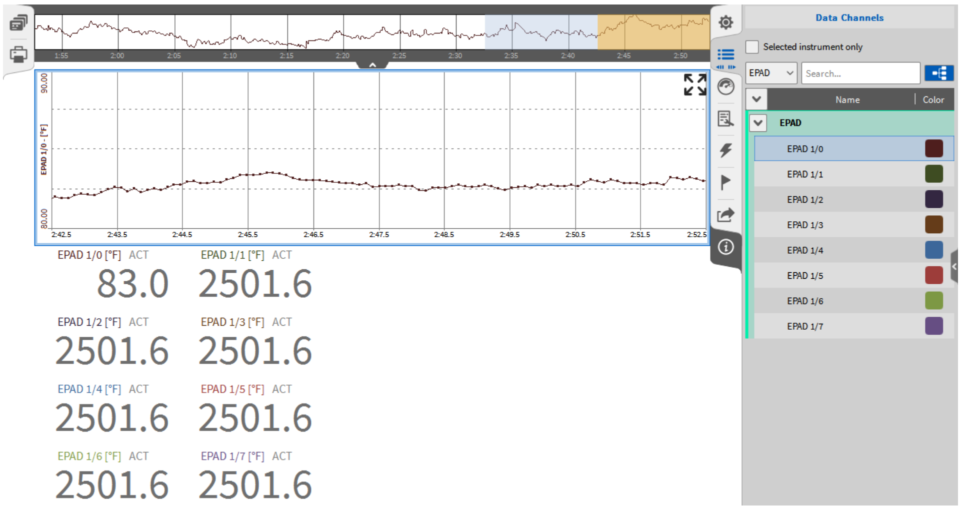


Figure 2-24: Displaying EPAD2-data

3.3 Using DAQP/HSI Modules with OXYGEN

3.3.1 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 Figure 2-25) (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 Figure 2-25) (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.

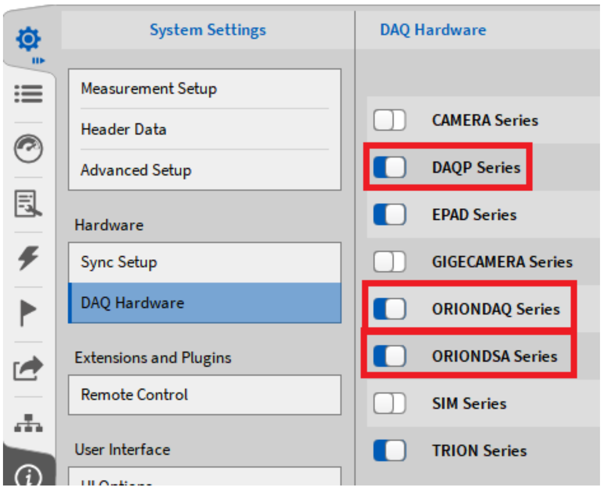


Figure 2-25: Enabling the ORION DAQ/DSA Series in the DAQ Hardware setup

3.3.2 Connecting DAQP/HSI Modules via a TRION™-1802/1600-dLV Card to the Measurement System

- Go to the *DAQ Hardware* setup in the *System Settings* and make sure that the *DAQP Series* and the *TRION Series* are enabled (see Figure 2-26) (Changes take effect on application restart).

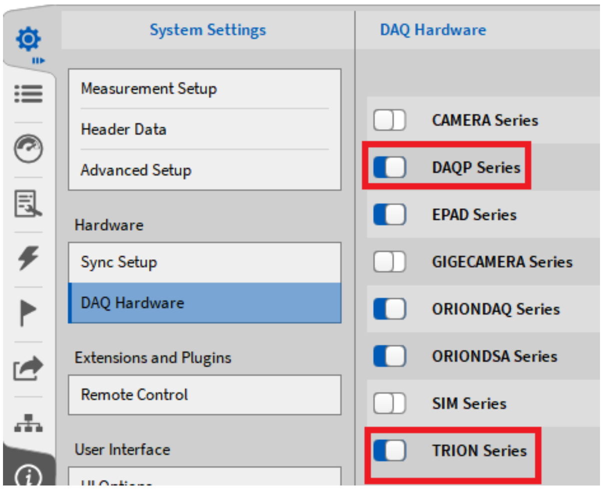


Figure 2-26: Enabling DAQP and TRION™ hardware in the DAQ Hardware setup

- 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

3.3.3 PROGRAMMING THE MODULES ADDRESSES

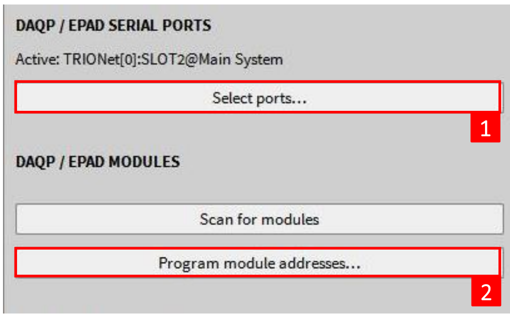


Figure 2-27: Programming module addresses

- Enable the Serial Port(s) on which the modules are connected (see ① in Figure 2-27)
- Select the proper output range of the module in the *Advanced Setup* (see section 4.3)
- Click on *Program module addresses…* (see ② in Figure 2-27).

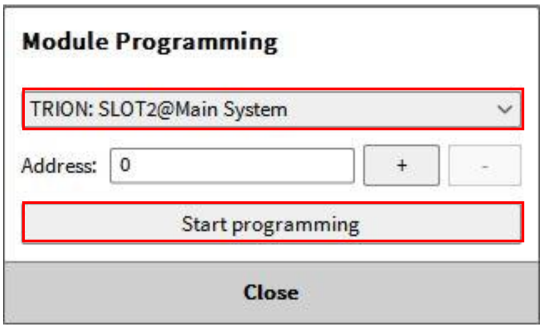


Figure 2-28: Module programming UI

- Select the proper Serial Port and click on *Start programming* (see Figure 2-28Figure 2-28). If the modules are connected to several serial ports, the Programming must be repeated for each serial port
- The following window will appear:

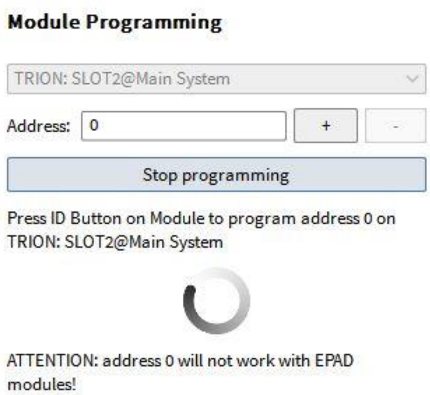


Figure 2-29: Programming the module addresses

- 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 Figure 2-30) or start the programming for a further Serial Port

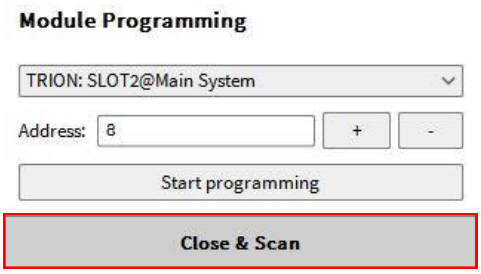


Figure 2-30: Finish the module programming

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

Remark:

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

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

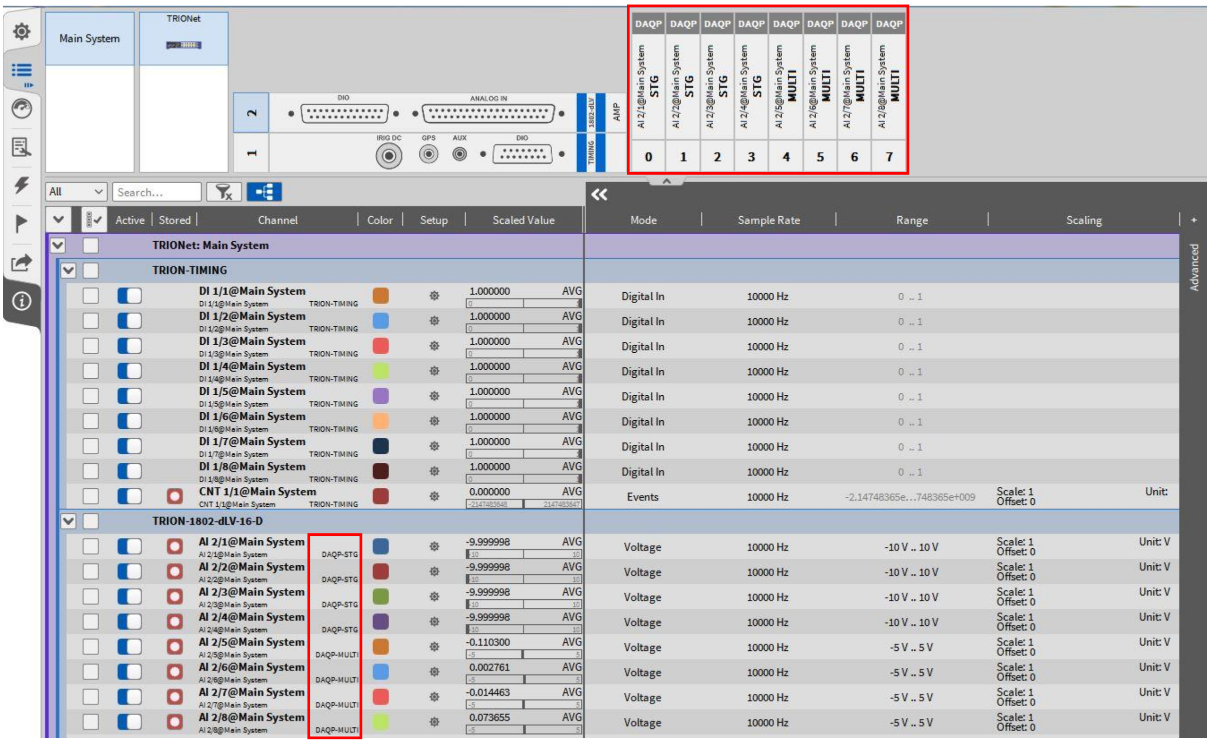


Figure 2-31: DAQP/HSI modules in the Channel List connected via TRION™-1802-dLV

Remarks:

- 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 SYSTEM SETTINGS

The OXYGEN System Settings can be accessed via enlarging the System Settings menu to the full screen.

Remark: 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.

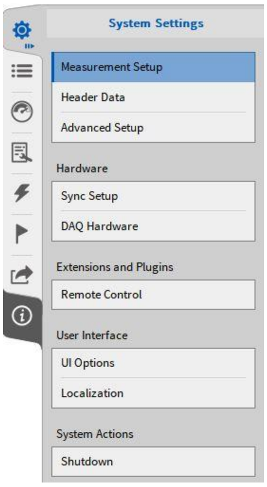


Figure 4-1: System Settings – Overview

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

4.1 Measurement Setup

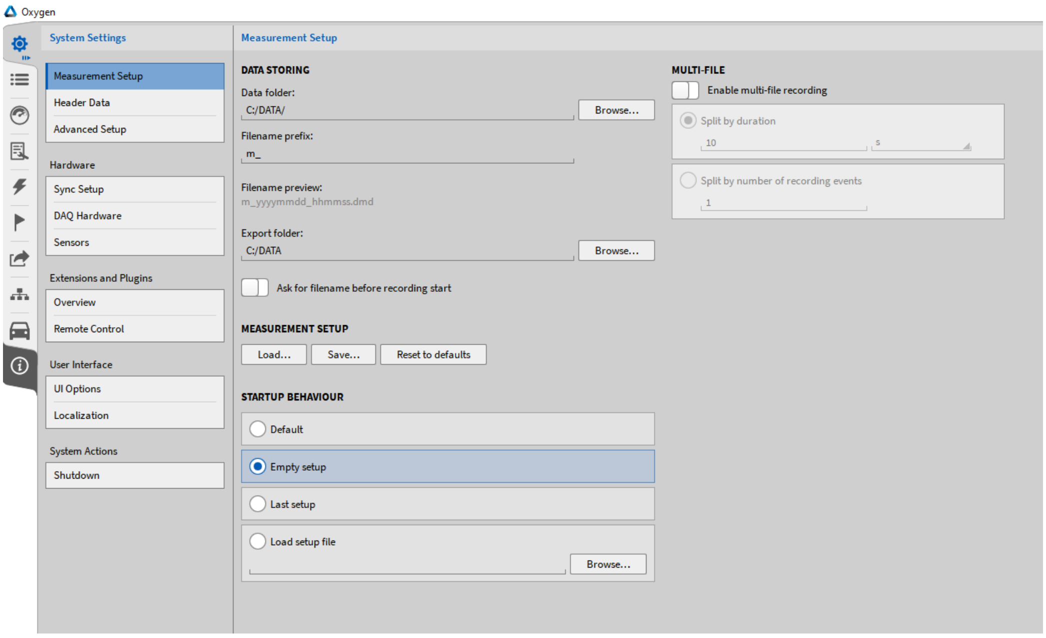


Figure 4-2: System Settings *Measurement Setup* – Overview

4.1.1 General Settings

- *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.
  To specify a filename before recording start enable the button *Ask for filename before recording start*.

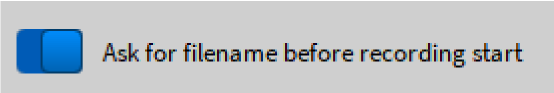


Figure 4-3: Enabled *Ask for filename before recording start* button

If this button is enabled, a popup window (see Figure 4-4) will appear where the filename can be entered.

Remark: the recording only starts by clicking on the *Record* button (marked red in Figure 4-4) in the popup window after entering the filename.

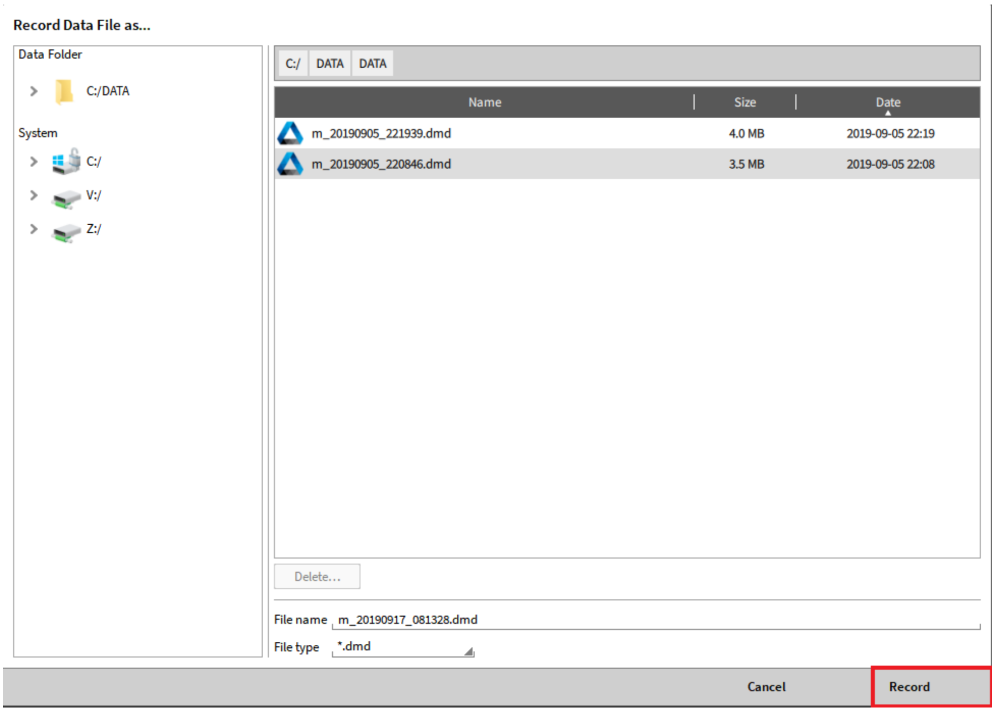


Figure 4-4: Popup window to enter the filename before recording start

- *Measurement Setup*: A measurement setup file can be loaded or stored here. To reset the Measurement settings to the startup defaults, use the *Reset to defaults* button.
- *Startup Behavior*: The user can select if the *Default* setup file (see Figure 2-1), an *Empty setup* file, the *Last setup* file or a user defined setup file shall be opened when OXYGEN is started.

4.1.2 MULTI-FILE RECORDING

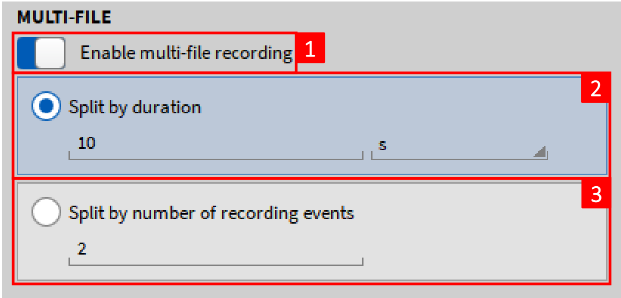


Figure 4-5: Multi-file menu

4.1.2.1 Recording a 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 (see ① in Figure 4-5), OXYGEN supports two different ways to split files: *Split by duration* and *Split by number of recording events*.

4.1.2.1.1 Split by duration

If *split by duration* (see ② in Figure 4-5) is selected, OXYGEN stores data automatically to a new file if the defined time interval is exceeded. I.e. in the example of Figure 4-5, a new data file will be created after 10s, 20s, 30s, … 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 section 7).

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 Figure 4-6 will illustrate this case:

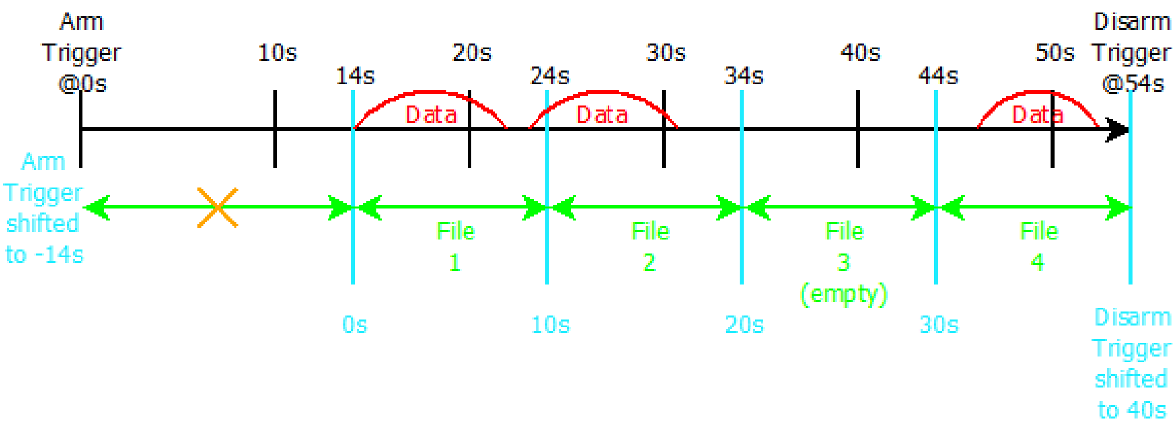


Figure 4-6: Special case 1 for Multi-File Recording; Split duration: 10s

- 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 Figure 4-6)
- 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 Figure 4-7 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.

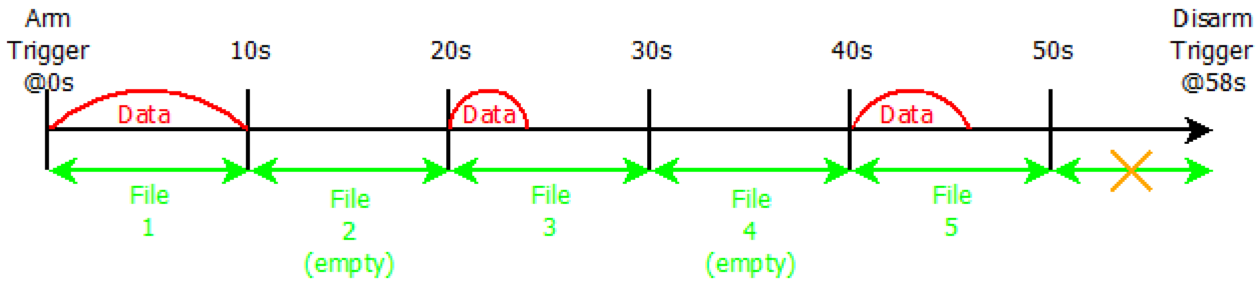


Figure 4-7: Special case 2 for Multi-File Recording; Split duration: 10s

Remark: 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.

4.1.2.1.2 Split by number of recording events

If *split by number of recording events* (see ③ in Figure 4-5) is selected, OXYGEN creates a new data file if the defined number of recording events is reached. I.e. in the example of Figure 4-5, 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:

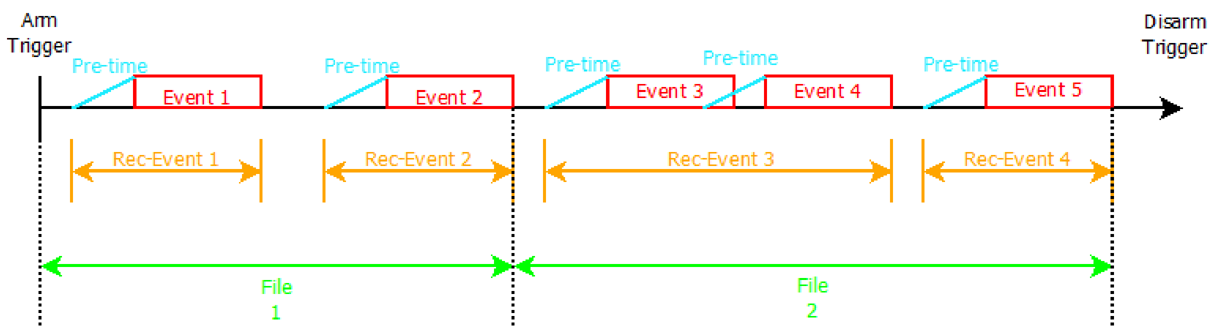


Figure 4-8: Special Case 3 for Multi-File Recording; Split after 2 Recording Events

Remarks:

- The Deja View™ functionality (see section 6.4.3) 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 section 8) as *Split Start* and *Split Stop* marker (see Figure 4-9).

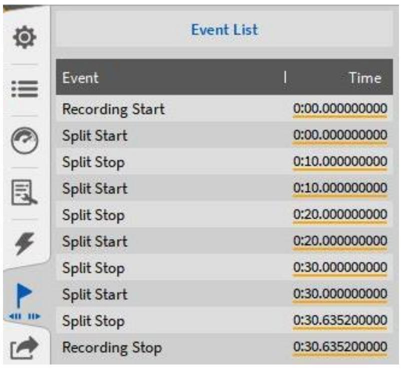


Figure 4-9: *Split Start* and *Split Stop* Marker

4.1.2.2 Loading a Multi-File

Multi-File parts that belong to the same measurement are stored in a separate folder of the selected data storing folder (see section 4.1.1). The individual Multi-Files are enumerated starting with 1. To load Multi-Files, click on the *Open Data File* button (see Figure 4-10) and select the desired Multi-File data folder. The folder is named to the same manner as datafiles are named. Thus, a prefix can be freely defined, and the actual date and time is appended automatically to the folder name (see section 4.1).

Figure 4-10: *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 Figure 4-11). It is possible to open all parts (see Figure 4-12), several parts (see Figure 4-13) or only one single part (see Figure 4-14) 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.

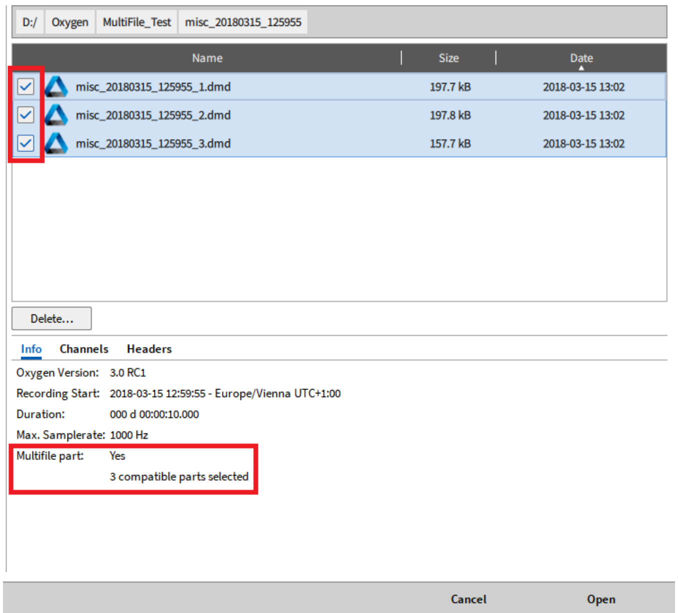


Figure 4-11: Opening a Multi-File

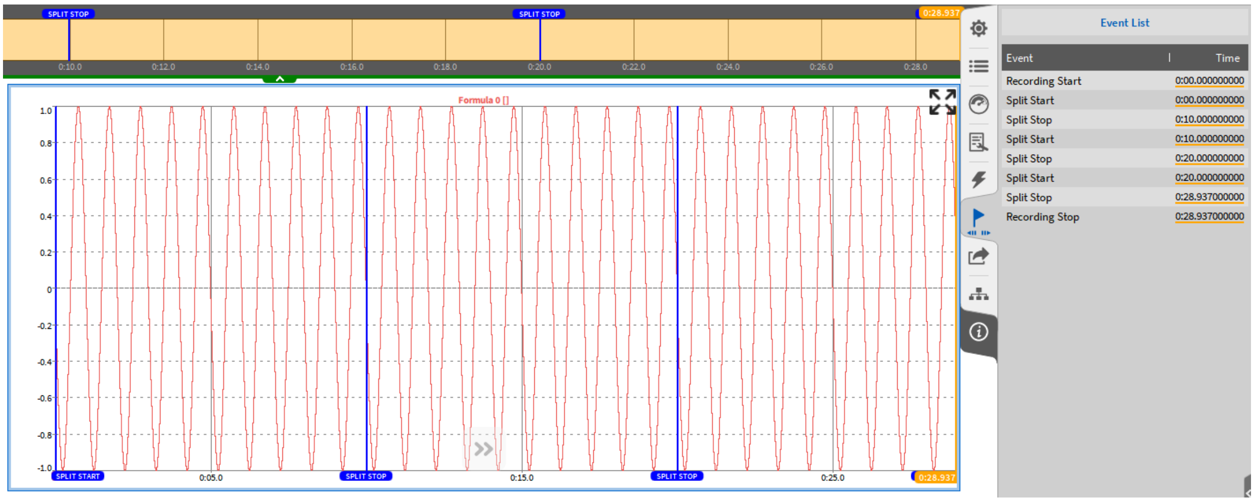


Figure 4-12: Opening all parts of a Multi-File Recording

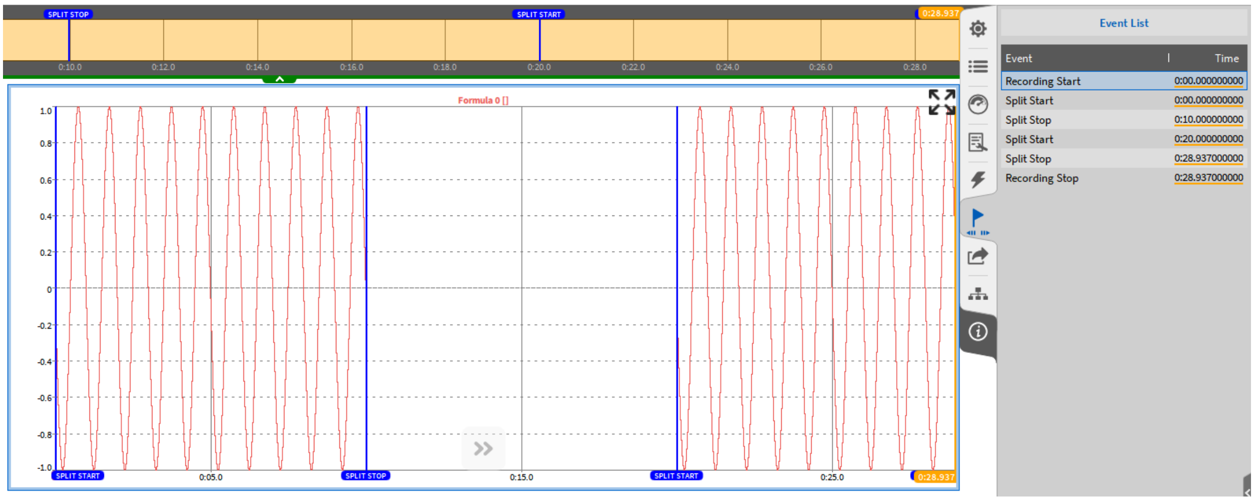


Figure 4-13: Opening several parts of a Multi-File Recording

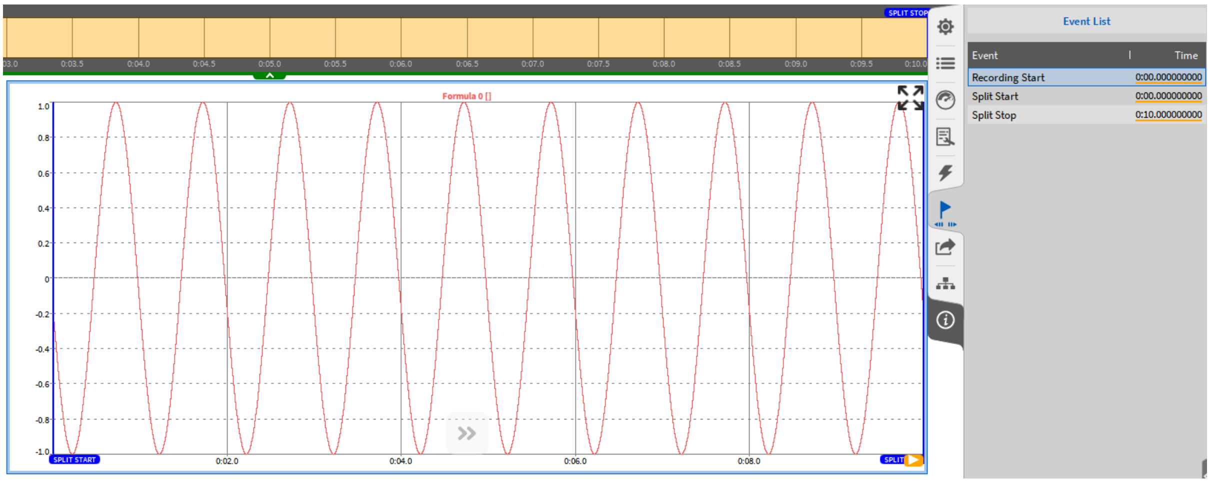


Figure 4-14: Opening one part of a Multi-File Recording

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 Figure 4-15).

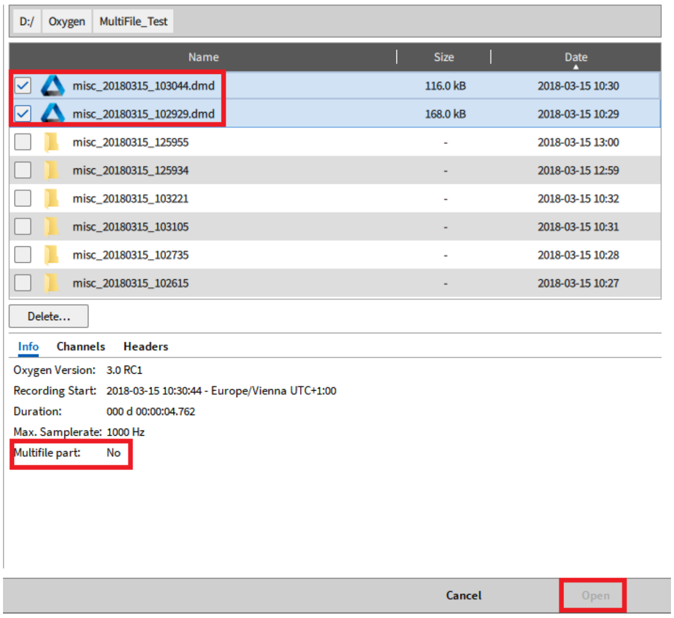


Figure 4-15: Selection of non-compatible Multi-File parts

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.

4.2 Global Header Data

Figure 4-16: System Settings *Header Data* – Overview

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. 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 (see Figure 4-17). 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. Otherwise the UI cannot be closed.

Figure 4-17: Header Data UI at the recording start

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 Figure 4-18).

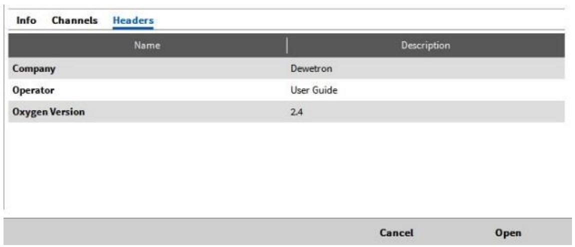


Figure 4-18: Header Data information when loading a data file

It is possible to add the Headers in a Text Box (please refer to section 6.10) 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 System Settings and add it by Drag and Drop to the Measurement Screen (see Figure 4-19)

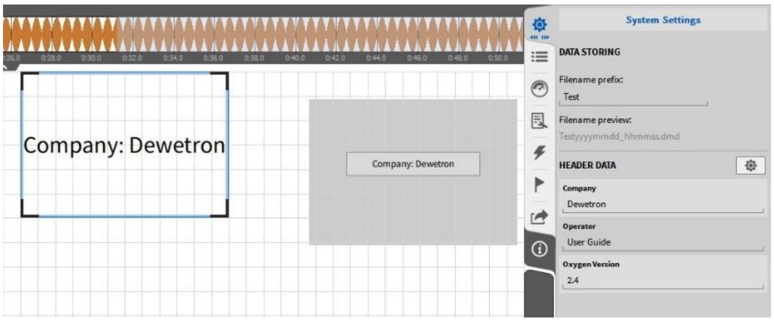


Figure 4-19: Adding Header Data via drag and drop from the System Settings to the measurement screen

Header 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

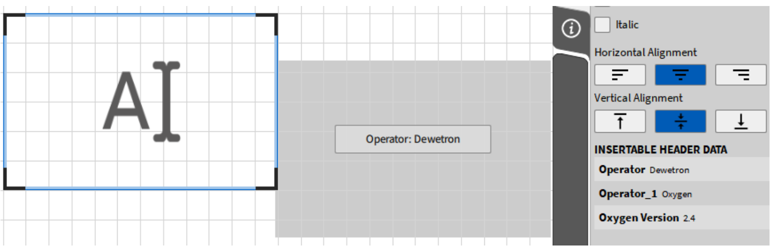


Figure 4-20: Adding Header Data via drag and drop from the Text Box Instrument Properties to the measurement screen

- 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 Figure 4-21).

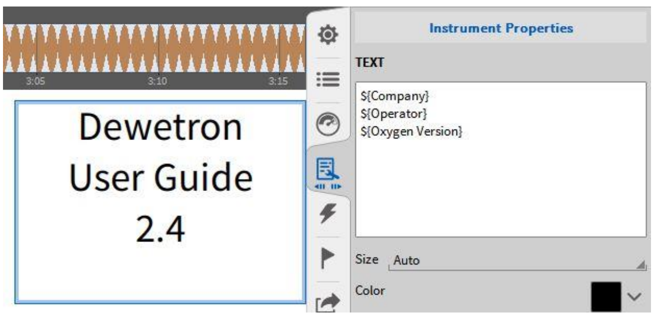


Figure 4-21: Adding the Header Description in a Text Box

4.3 Advanced Setup

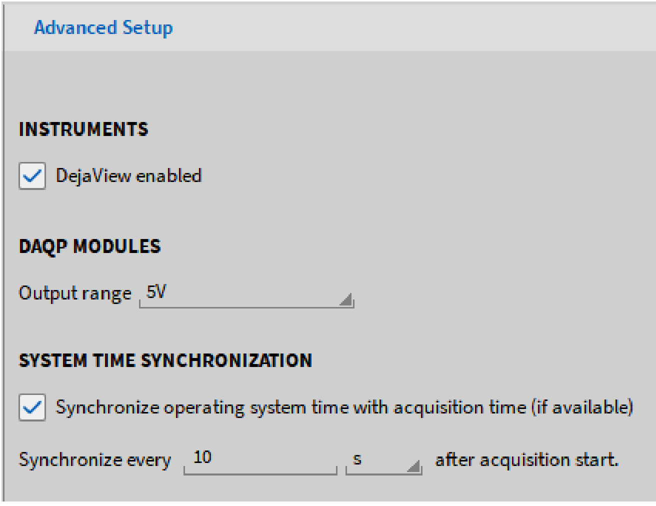


Figure 4-22: System Settings *Advanced Setup* – Overview

- Instruments: In the Instruments section, DejaView™ can be enabled/disabled. By default, DejaView™ is always enabled. For a detailed description of DejaView™ please refer to section 6.4.3.
- DAQP Modules: If DAQP/HSI modules are connected via ORION or a TRION-1802-dLV module, it must be defined if the output signal of the module is conditioned to ±5V or ±10V. The *Output Range* can be defined here.
- 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, please refer to section 4.4.3. The synchronization interval can be selected below and the minimum time interval is 10 seconds.

Remark: OXYGEN must be started with Administrator rights to use this 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 Figure 4-23) will be displayed in the lower right corner of the software. Please note that this setting is not stored to a dms-setup file but only to the registry.

Figure 4-23: Error message *System time synchronization not allowed*

4.4 Sync Setup - Synchronization Options using OXYGEN with TRION™ Hardware

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 are depending on model and configuration of the DEWE2/3 instruments.

- The synchronization input represents 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 represents the output configuration of a device, which defines what kind of signal this instruments routes to the corresponding output, in order to synchronize with the next connected device.

4.4.1 INTERNAL TIMING SOURCE

Each DEWE2/3 chassis has an internal 10 MHz clock which is used as the clock source in this particular DEWE2/3 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 Figure 4-24).

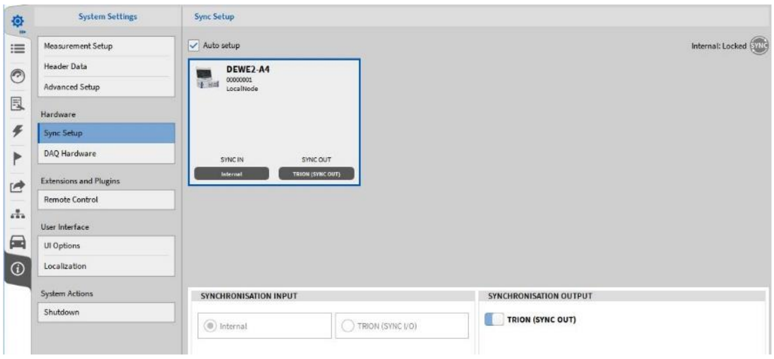


Figure 4-24: Sync Setup - Internal Sync Clock selected

The Sync indicator in the upper right corner of the menu will be grey if the Internal clock is used for Synchronization.

4.4.2 TRION-SYNC-BUS

In addition, each DEWE2/3 system can output the synchronization signal of the 10 MHz of clock and forward it to another DEWE2/3 system. That's what the SYNC I/O connectors on the system are for (see Figure 4-25).

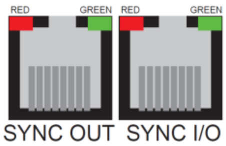


Figure 4-25: SYNC I/O connectors of a DEWE2/3 system

One socket being a synchronization OUT, whilst the other one could either be used as synchronization IN or OUT. The synchronization signal forwarding is activated per default (TRION (SYNC OUT) is activated in the *Synchronization Output* menu; see Figure 4-24) and cannot be deactivated.

To clock another DEWE2/3 system with this forwarded synchronization signal, the following Sync Settings must be applied to the DEWE2/3 system that shall receive the synchronization signal: Uncheck the *Auto Setup* box and set the *Synchronization Input* source to *TRION (SYNC I/O)* (see Figure 4-26).

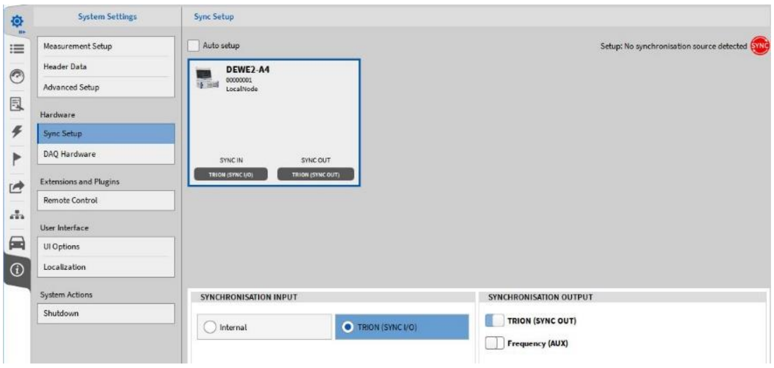


Figure 4-26: Sync Setup – TRION-SYNC-BUS selected

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 ⑱ in Figure 2-1).

The LED indication of the *SYNC OUT* and *SYNC I/O* connector have the following meaning:

	SYNC OUT	SYNC I/O
RED (stable)	Clock detected	Clock detected / Receiving clock
GREEN (stable)	Acquisition running	Acquisition running

Table 4-1: LED indication of the *SYNC OUT* and *SYNC I/O* connector

Depending on the usage of the SYNC I/O (input or output) the LED indicates if the system clock is available or received correctly from another system. The green LED indicates that the acquisition is running. If the acquisition stops the LED will be off.

Depending on the TRIONTM board which is mounted to the First (Star) slot of the system, different synchronization signals can be applied to the system.

4.4.3 Applying an External Synchronization Signal to the DEWE2/3 System

Depending on the TRIONTM board which is mounted to the First (Star) slot of the system, different external synchronization signals can be applied to the system.
The following Table 4-2 provides an overview about the supported external synchronization sources and proper TRIONTM modules:

	IRIG A DC	IRIG B DC	IRIG A/B AC	GPS	PTP / IEE1588	PPS (Rising edge)	PPS (Falling edge)
TRIONTM-BASE	☒	✓	☒	☒	☒	✓	☒
TRIONTM-TIMING	✓	✓	✓	✓	☒	✓	☒
TRIONTM-TIMING-V3	✓	✓	✓	✓	✓	✓	✓
TRIONTM-VGPS-20/-100	✓	✓	✓	✓	☒	✓	☒
TRIONTM-VGPS-20/-100-V3	✓	✓	✓	✓	✓	✓	✓

Table 4-2: Compatibility of TRIONTM modules and synchronization source

4.4.3.1 Synchronization Possibilities with a TRIONTM-BASE Board

If a TRIONTM-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 TRIONTM-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 Figure 4-27).

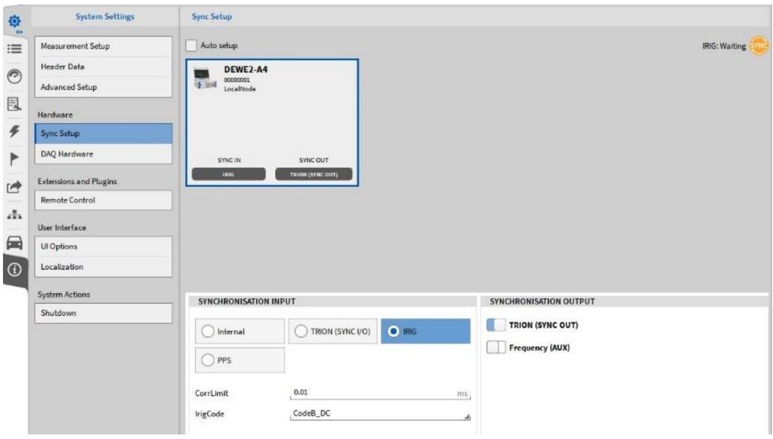


Figure 4-27: Selecting an external synchronization source using a TRIONTM-BASE board

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 ⑱ in Figure 2-1).

If an external synchronization signal is applied to the system, the signal can be forwarded via the TRION-SYNC-BUS (see section 4.4.2) as well to synchronize other DEWE2/3 chassis.

In addition, the TRIONTM-BASE board has an AUX connector which can output a rectangular (LVTTL) signal to synchronize other devices, i.e. a GigE camera, to the TRIONTM hardware clock. To do so, enable the *Frequency (AUX)* switch in the *Synchronization Output* setup (see Figure 4-28). The *Frequency* can be set from 10 Hz to 10 MHz and the *Start Edge* can be the *Rising* or *Falling* signal edge.

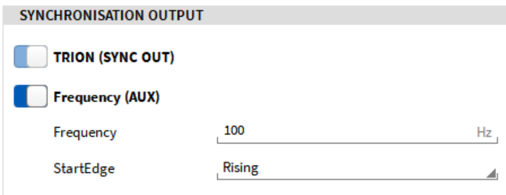


Figure 4-28: Providing a LVTTL signal via the AUX connector of the TRIONTM-BASE board

4.4.3.2 Synchronization Possibilities with a TRIONTM-TIMING/VGPS Board

If a TRIONTM-TIMING or TRIONTM-VGPS board is mounted to the first system slot (Star slot), the system can be synchronized with an external IRIG (A-DC, A-AC, B-DC, B-AC) or a PPS signal (synchronization to the Rising signal edge; synchronization to the Falling signal edge only if it is a TRIONTM-TIMING/VGPS-**V3** board).

- IRIG:

  To use an IRIG signal as synchronization signal, connect the signal to the IRIG input of the TRIONTM board. Uncheck the *Auto setup* box in the *Sync Setup* and select *IRIG* in the *Synchronization Input* menu (see Figure 4-30). Go to the *IrigCode* dropdown menu and select the correct IRIG Code (see Figure 4-29).

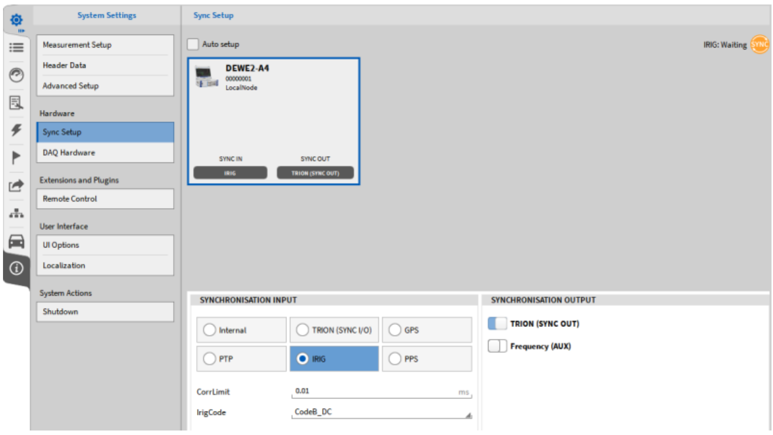


Figure 4-29: Sync Settings for an IRIG synchronization

- PPS:

  To use a PPS signal as synchronization signal, connect the signal to the IRIG input of the TRION^{TM} 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 Figure 4-30). If the system shall be synchronized to the *Rising* signal edge, go to the *InvertedInput* dropdown menu and select *False*. If the system shall be synchronized to the *Falling* signal edge, go to the *InvertedInput* dropdown menu and select *True*.

  Remark: Only TRION^{TM}-TIMING/VGPS-**V3** boards support PPS synchronization to the Falling signal edge!

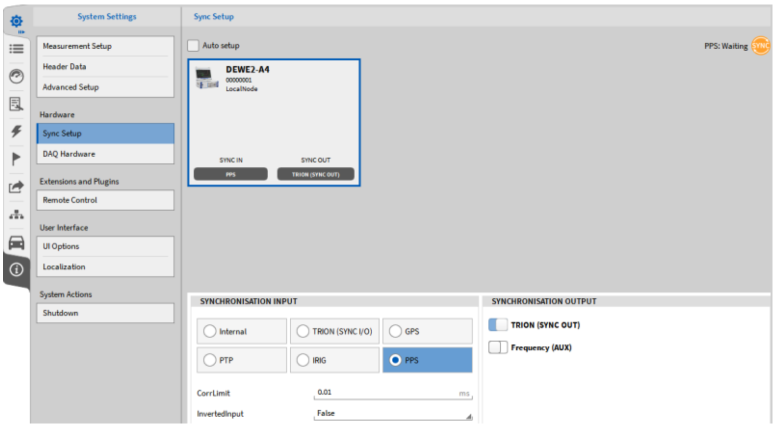


Figure 4-30: Sync Settings for a PPS synchronization

- GPS:

To use a GPS signal as synchronization signal, connect the signal to the GPS input of the TRIONTM board. Uncheck the Auto setup box in the Sync Setup and select GPS in the Synchronization Input menu (see Figure 4-31).

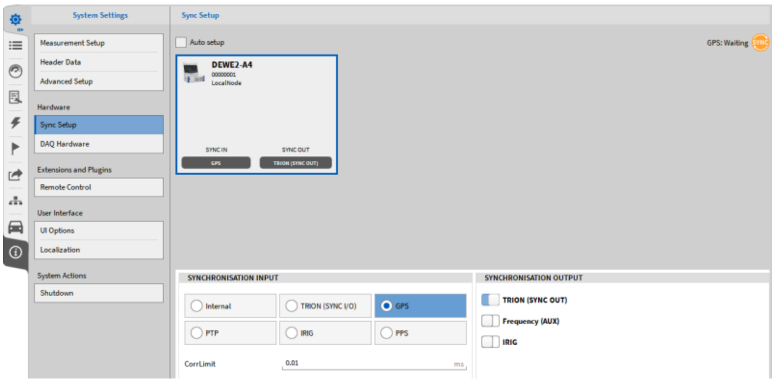


Figure 4-31: Sync Settings for a GPS synchronization

- PTP/IEE 1588 (Only TRIONTM-TIMING/VGPS-**V3** boards support PTP synchronization):
  To use a PTP signal as synchronization signal, connect the signal to the PTP input of the TRIONTM board. Uncheck the *Auto setup* box in the *Sync Setup* and select PTP in the *Synchronization Input* menu (see Figure 4-32).

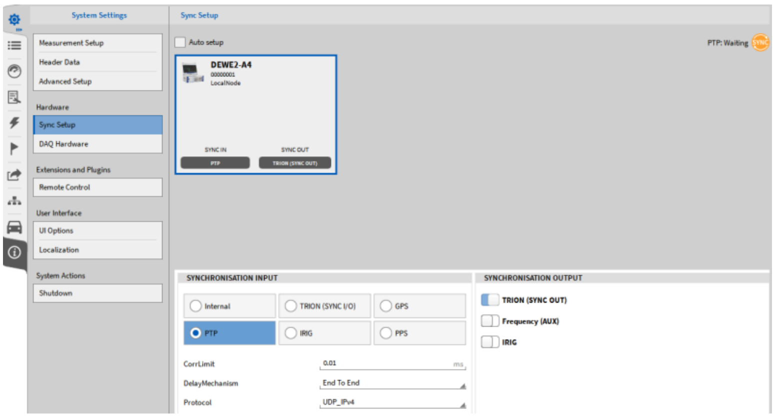


Figure 4-32: Sync Settings for a PTP synchronization

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 ⑱ in Figure 2-1).

If an external synchronization signal is applied to the system, the signal can be forwarded via the TRION-SYNC-BUS (see section 4.4.2) as well to synchronize other DEWE2/3 chassis.

- IRIG-B-DC Output (Only TRIONTM-TIMING/VGPS-**V3** boards support the IRIG-OUT option)
  If the *Synchronization Input* source is set to the *Internal* 10 MHz time base, *GPS* or *PTP*, the TRIONTM board can be used as an IRIG generator and provide an IRIG-B-DC signal on the IRIG connector.
  To generate an IRIG-B-DC signal, go to the *Synchronization Output* menu and enable the *IRIG* switch (see Figure 4-33). **Other signals than IRIG-B-DC cannot be generated!**

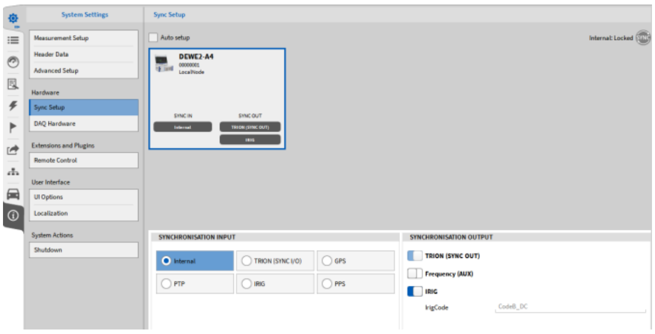


Figure 4-33: IRIG-B-DC OUT settings

In addition, the TRION™-TIMING/VGPS boards have 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 Figure 4-28). The *Frequency* can be set from 10 Hz to 10 MHz and the *Start Edge* can be the *Rising* or *Falling* signal edge.

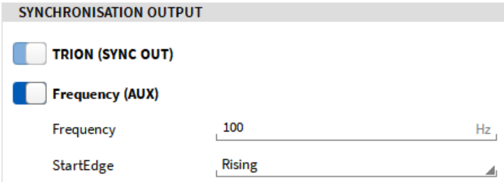


Figure 4-34: Providing a LVTTL signal via the AUX connector of the TRION™- TIMING/VGPS board

4.4.4 General Remarks on PPS and IRIG 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 (see Figure 4-35)

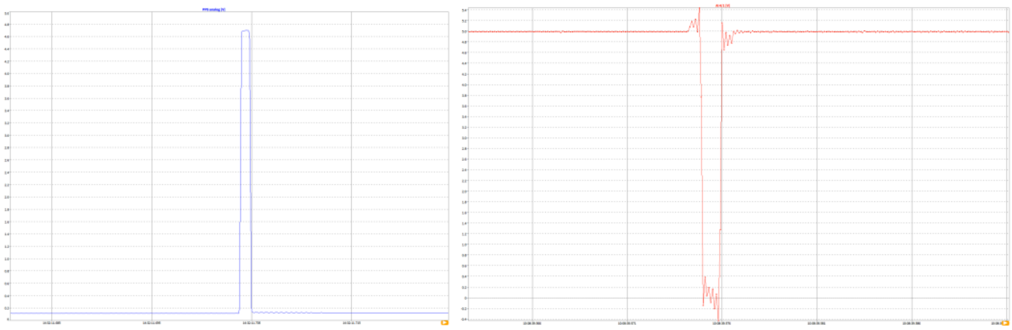


Figure 4-35: PPS signal provided by an ADMA (blue) and an RT (red)

- 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

Figure 4-36: IRIG connector; Detailed view

- The IRIG LED has the following 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

Table 4-3: IRIG-LED indication

4.5 DAQ HARDWARE

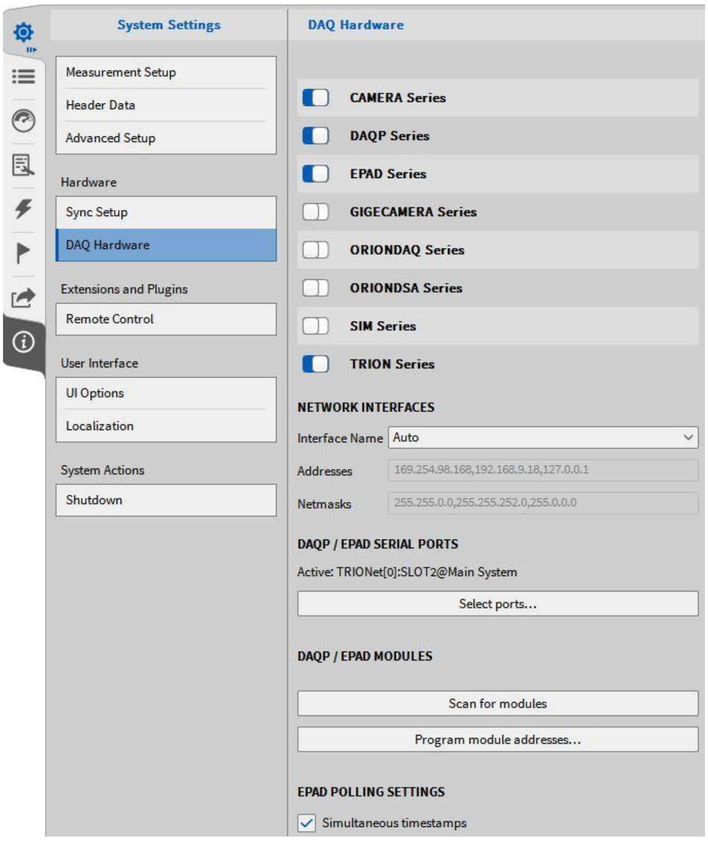


Figure 4-37: System Settings *DAQ Hardware* – Overview

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, please refer to the section 3.

4.6 Sensor Database

Please note that this is an optional feature and requires a license.

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

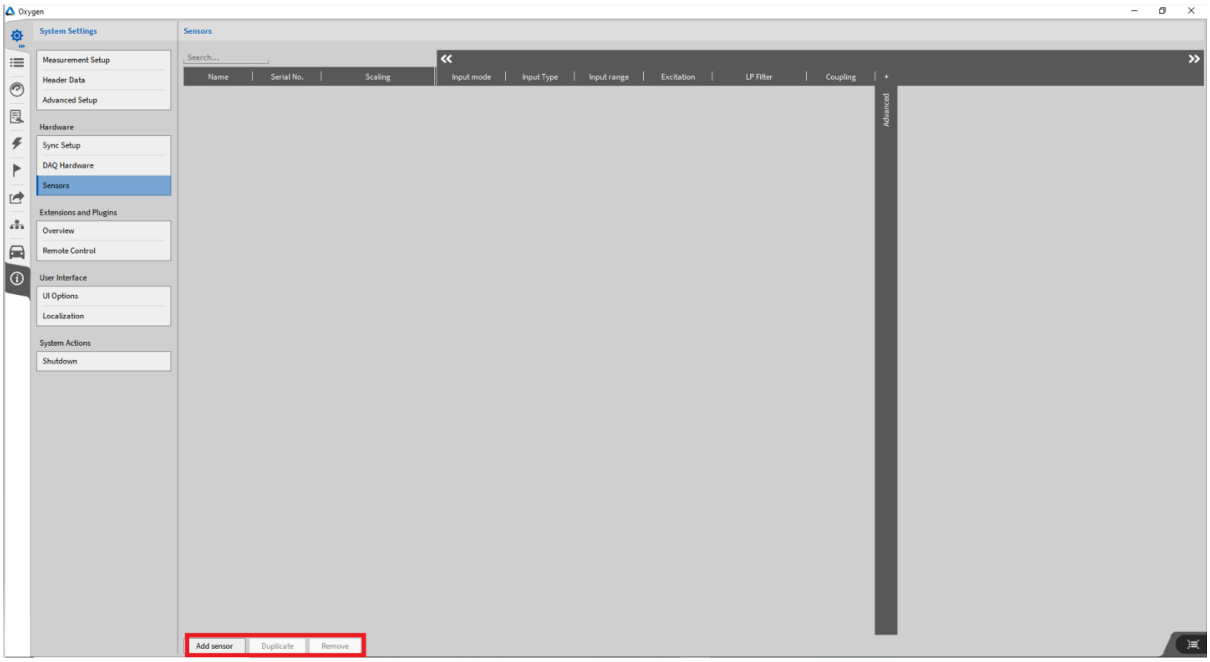


Figure 4-38: System Settings *Sensors* – Overview

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 Figure 4-38). The properties of the sensor are the same which are also available in the channel settings (for detailed explanation see section 5.2). By clicking on the properties, a small popup window will appear as seen in Figure 4-39 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 and table 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 Bride-Input Specific Settings*

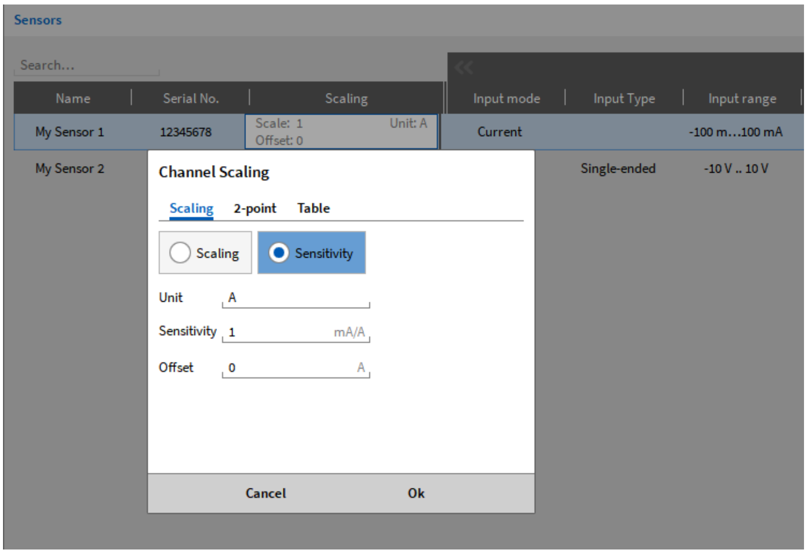


Figure 4-39: Sensor database – popup window to change channel scaling

To duplicate or remove a sensor simply click on the respective sensor and on the *Duplicate* or *Remove* button as marked red in Figure 4-38.

By clicking on *+ Advanced* (see Figure 4-40) 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*

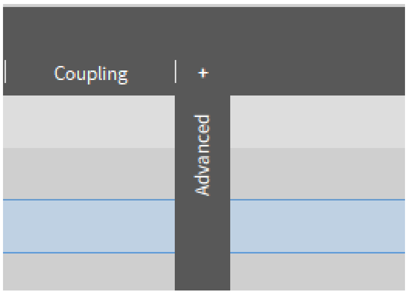


Figure 4-40: Sensor database – open advanced menu

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 Figure 5-2 or Table 5-1, for details see section 5.2.2).
- Click on the *Choose sensor* button in the upper right corner, seen in Figure 4-41.

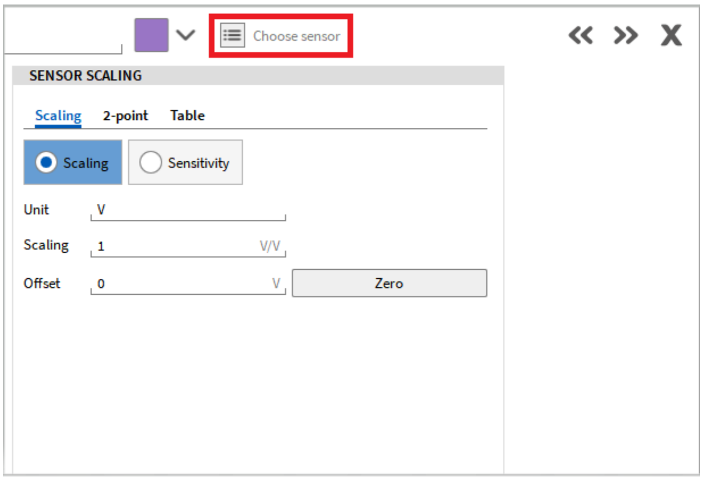


Figure 4-41: Applying a sensor to a channel in the channel settings

- A popup window will appear with a list of all defined sensors seen in Figure 4-42.
- Choose the desired sensor and click *Ok*. The search field might ease the search for a specific sensor in the list.

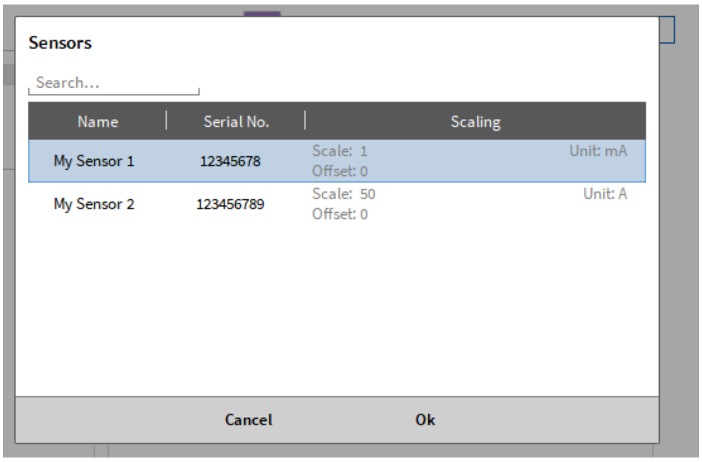


Figure 4-42: Popup window to apply a sensor for a channel in the channel settings

- 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 Figure 4-43.
- To remove an applied sensor from a channel simply click on the *X* button next to the sensor name in the channel settings (see Figure 4-43).

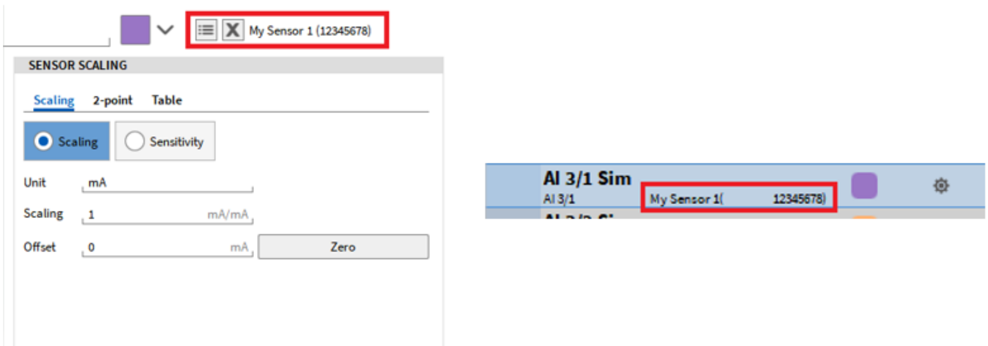


Figure 4-43: Name of chosen sensor for the channel seen in the channel list and channel settings

Remarks:

- Only analog sensors 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.

4.7 Remote Control

4.7.1 SCPI over Ethernet

Figure 4-44: *Remote Control* – SCPI over Ethernet menu

OXYGEN can be controlled by remote via SCPI. To do so, the *Enable remote control* button (see Figure 4-44) must be switched on and *SCPI over Ethernet* must be enabled.
For detailed instructions and programming examples, please 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, please refer to Table 4-4.

4.7.2 XCP over Ethernet

Please note that 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 (see Figure 4-44) must be switched on and *XCP over Ethernet* (see Figure 4-45) must be enabled.

Figure 4-45: Remote Control – XCP over Ethernet menu

Within OXYGEN, the following XCP settings can be edited:

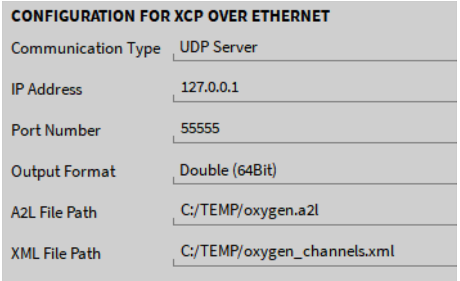


Figure 4-46: Configuration for XCP over Ethernet

- Communication Type: *TCP server* or *UPD 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

Remark: Please be aware that the directory *C:/Temp* the a2l-file and the xml-file is stored to is not created automatically. Please 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, please refer to Table 4-4.

4.7.3 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 section 4.7.1 and the instructions for XCP in section 4.7.2.
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, please 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/).

4.7.4 Remote Control Indicator

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 Figure 4-47).

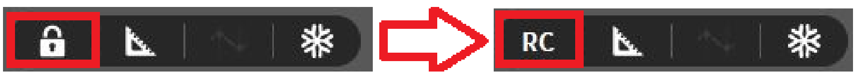


Figure 4-47: *Remote Control* indicator

4.8 Streaming Interfaces

4.8.1 EtherCAT Slave

Please note that 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, please 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, please refer to Table 4-4.

4.8.2 Data Stream Plugin

Please note that 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

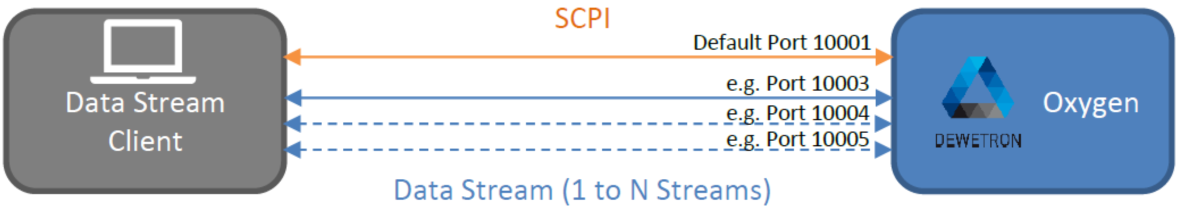


Figure 4-48: Data Stream Plugin – Overview

For detailed instructions and programming examples, please refer to the manual *Oxygen DataStream 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, please refer to Table 4-4.

4.9 Remote Control and Data Transfer Interfaces – Summary

The following Table 4-4 provides an overview and comparison about the licensing, typical performance and other additional information of the different remote control and data transfer interfaces

Interface Option	Included in OXYGEN	Interface	Typ. application	Typ. Performance
SCPI	Yes	Standard Ethernet	Fetching of actual values, loading setup, application control	~ 50 S/s with 50 Channels; Up to 10 kS/s with 10 channels (buffered reading "ELOG")
XCP Slave	Plugin required	Standard Ethernet	Stream of measurement values, basic recoding 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
Typical I/O Delay is 100-200ms within all interface options				

Table 4-4: Remote Control and Data Transfer - Overview

4.10 UI Options

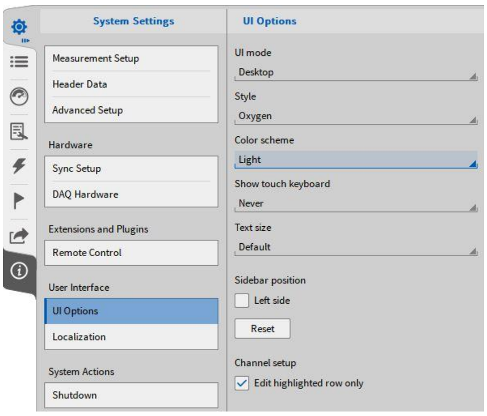


Figure 4-49: System Settings *UI Options* – Overview

In the UI Options, the user can change different settings of the UIs' 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, please refer to section 2.6.
- *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.

4.11 Localization

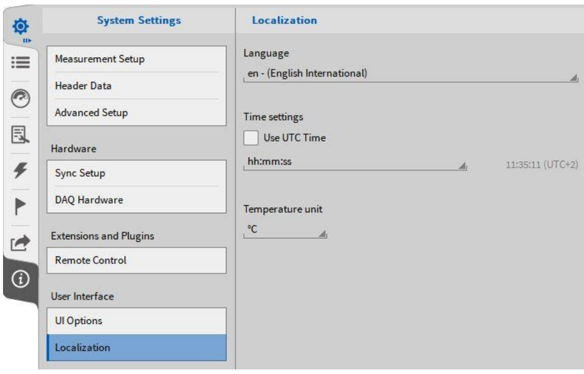


Figure 4-50: System Settings *Localization* – Overview

In the *Localization* menu, the user can change the software language, set the software time to UTC time as well as change the time format and swap between the temperature units Celsius and Fahrenheit.

Remark: In OXYGEN 3.4, the user can opt for German, English, French, Polish and Chinese.

4.12 Shutdown

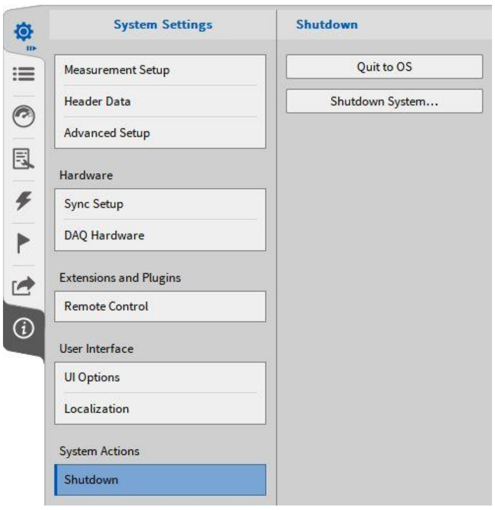


Figure 4-51: System Settings *Shutdown* – Overview

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

5 DATA CHANNELS MENU

5.1 OVERVIEW

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

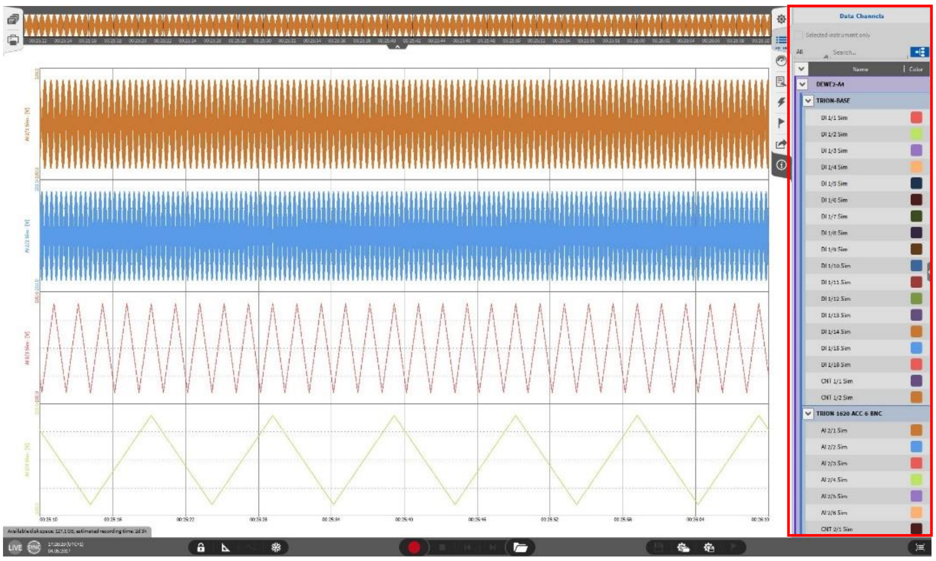


Figure 5-1: *Data Channels* Menu - Quick view

A single click on the *Data Channels* menu button will open the quick view where the user can see the activated hardware channels (see Figure 5-1). 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 Figure 5-2. 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.

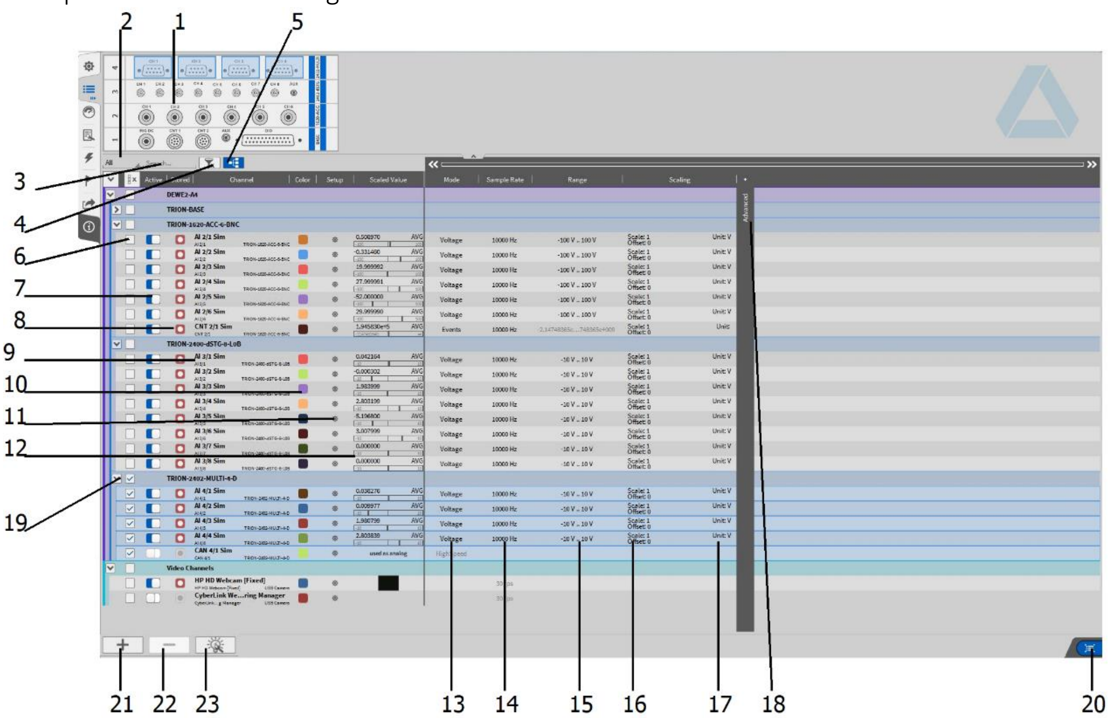


Figure 5-2: Complete *Data Channels* menu

1	Hardware Overview	Quick overview of your connected TRION™-Cards and available channels. Click on a certain channel or whole TRION™-Card and the respective channel(s) will be highlighted in the list
2	Channel Filter	Filters the displayed channels according to their channel type (*All*, *Analog*, *Digital*, *Counter*, *EPAD*, *Math*, *Video*, *Power*, *CAN*)
3	Search Filter	Search a channel according to its name
4	Clear Filters	Clear active Channel and Search Filters
5	Channel Grouping	Sort the Channel list according to the connected TRION™-Cards or in an alphabetical order
6	*Select* button	Select several channels in the list, i.e. for setting them active or inactive simultaneously
7	*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
8	*Stored* button	Select whether channel data shall be stored or not when a measurement is running
9	Channel Name	Individual channel name; Can be changed individually; for additional information please refer to section 4.10
10	Color	Color scheme of the channel can be changed here
11	Setup	Enter the input channel setup (All channel dependent settings can be changed here)
12	Scaled Value	Preview of the input signal
13	Mode	Change the mode of the input channel here
14	Sample Rate	Change the sample rate here; Remark: The sample rate can only be changed for a complete card, not for single channels
15	Range	Change the input range of the channel here
16	Scaling	Change the channel scaling here
17	Physical unit	Physical unit of the channel, can be changed in the channel setup
18	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*
19	*Hide* button	Hide the channels of a complete card
20	*Toggle* button	Toggle between the Channel List and the previously opened menu
21	*Add* button	Add a Formula, Statistics, Filter, FFT, Rosette, Power Group or Ethernet Receiver
22	*Delete* button	Delete the Formula, Statistics, Filter, FFT, Rosette, Power Group or Ethernet Receiver that is currently selected
23	Delete PowerGroup	Delete selected PowerGroup

Table 5-1: Push buttons in the Channel Menu – Overview

5.2 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 pushbutton ⑫ (see Table 5-1).

5.2.1 CHANGING THE CHANNEL SETTINGS IN THE DATA CHANNEL MENU

To change the individual channel settings in the *Data Channels* menu that can be seen in Figure 5-2 just click on the desired parameter with the left mouse button and a popup window will appear. If a parameter can be changed or not depends on the channel type (i.e. it's not possible to change the range of a digital channel) and the selection of the parameters depends on the TRION™-Card (i.e. different Input Modes). For illustration, the following figures will show the different options that are available with a TRION™-1620-ACC card.

- Changing the channel color:

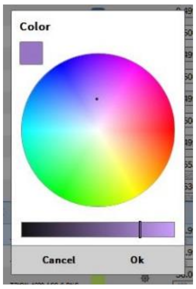


Figure 5-3: Popup window for changing the channel color

- Changing the input mode:

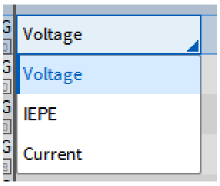


Figure 5-4: Popup window for changing the input mode

- Changing the sample rate (can only be changed for the whole card and not for single channels):

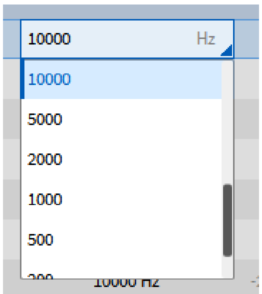


Figure 5-5: Popup window for changing the sample rate

- Changing the input range:

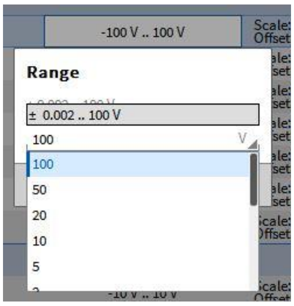


Figure 5-6: Popup window for changing the input range

- Changing the channel scaling and physical unit:

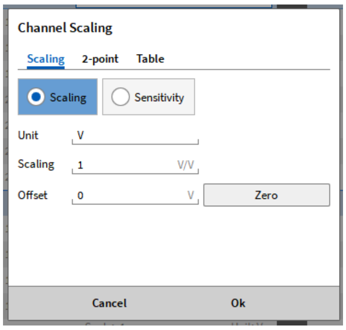


Figure 5-7: Popup window for changing the scaling and physical unit

- Zeroing an input channel: After selecting the desired channel in the list the *Zero* pushbutton will appear at the lower end of the *Data Channels* menu:

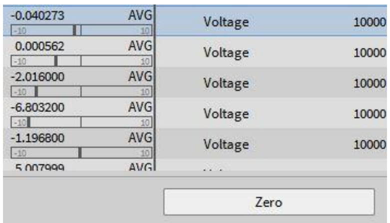


Figure 5-8: Zeroing an input channel

- Changing the sensitivity (also available in the Channel Scaling popup window):

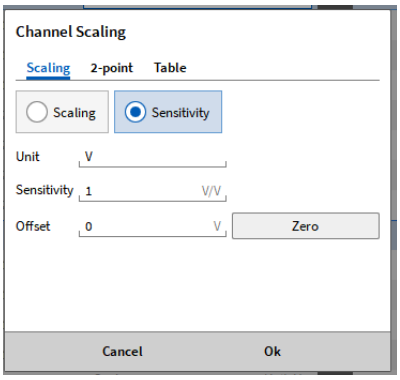


Figure 5-9: Popup window for changing the sensitivity

- Changing the 2-point-scaling (also available in the Channel Scaling popup window):

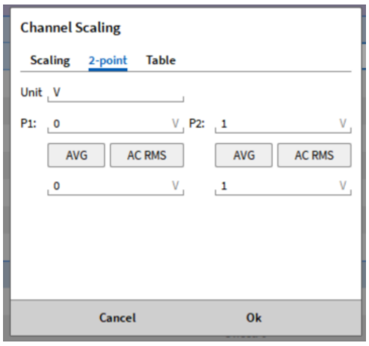


Figure 5-10: Popup window for changing the 2-point-scaling

- Applying table scaling (also available in the Channel Scaling popup window):

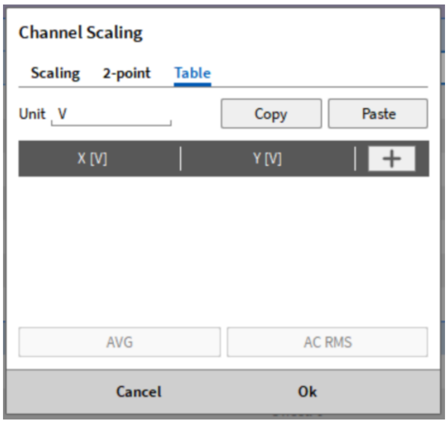


Figure 5-11: Popup window for applying table scaling

- Changing the LP-filter (Expand advanced settings):

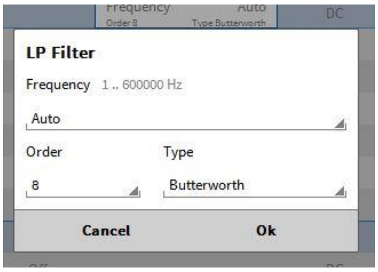


Figure 5-12: Popup window for changing the LP-filter

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

- Changing the coupling mode (Expand advanced settings):

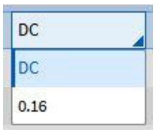


Figure 5-13: Popup window for changing the coupling mode

- Changing the bit rate (Expand advanced settings; can only be changed for the whole card and not for single channels):

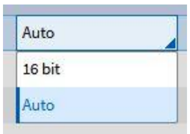


Figure 5-14: Popup window for changing the bit rate

5.2.1.1 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 Figure 5-15)
- A point can be removed by clicking on the – button (see Figure 5-16)

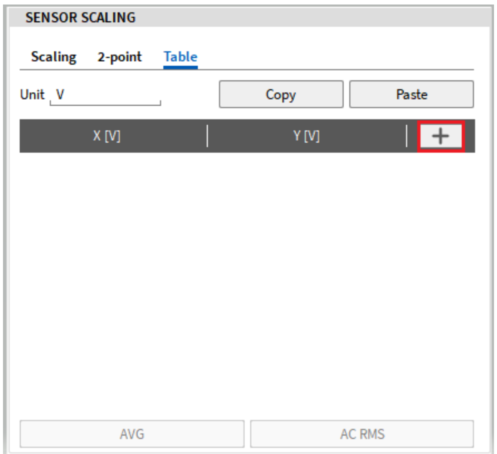


Figure 5-15: Table scaling – add point to specify x- and y-value

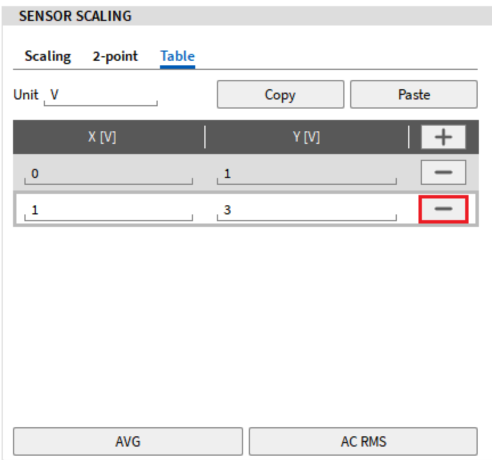


Figure 5-16: Table scaling – delete point

- 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 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 Figure 5-17).

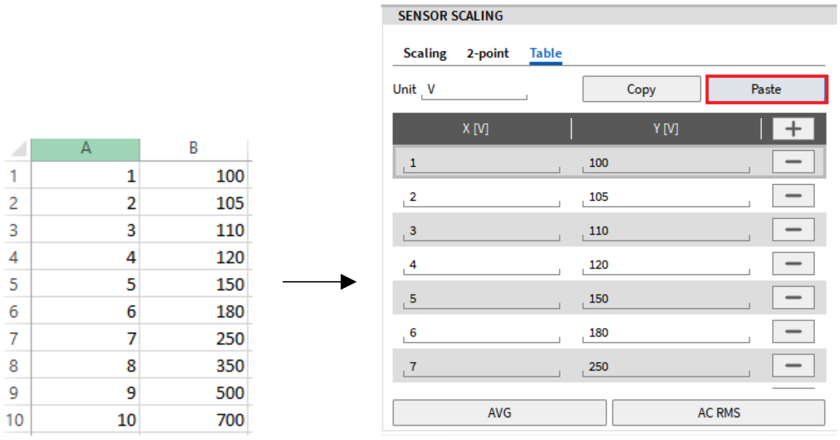


Figure 5-17: Table scaling – copy and paste table from Excel into OXYGEN

- 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.

Remarks:

- 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 channel output will return NaN.
- 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.
- Like it will also be noted in section 5.10, the whole channel settings, including the table scaling, can be copied and pasted between different channels using CTRL+C and CTRL +V.

5.2.2 Changing the Channel Settings in the Channel Setup

All channel settings (except the sample rate and the bit rate) can also be changed in the individual Channel Setup (see Figure 5-18) which can be accessed via pushbutton ⑪ (see Figure 5-2 or Table 5-1).

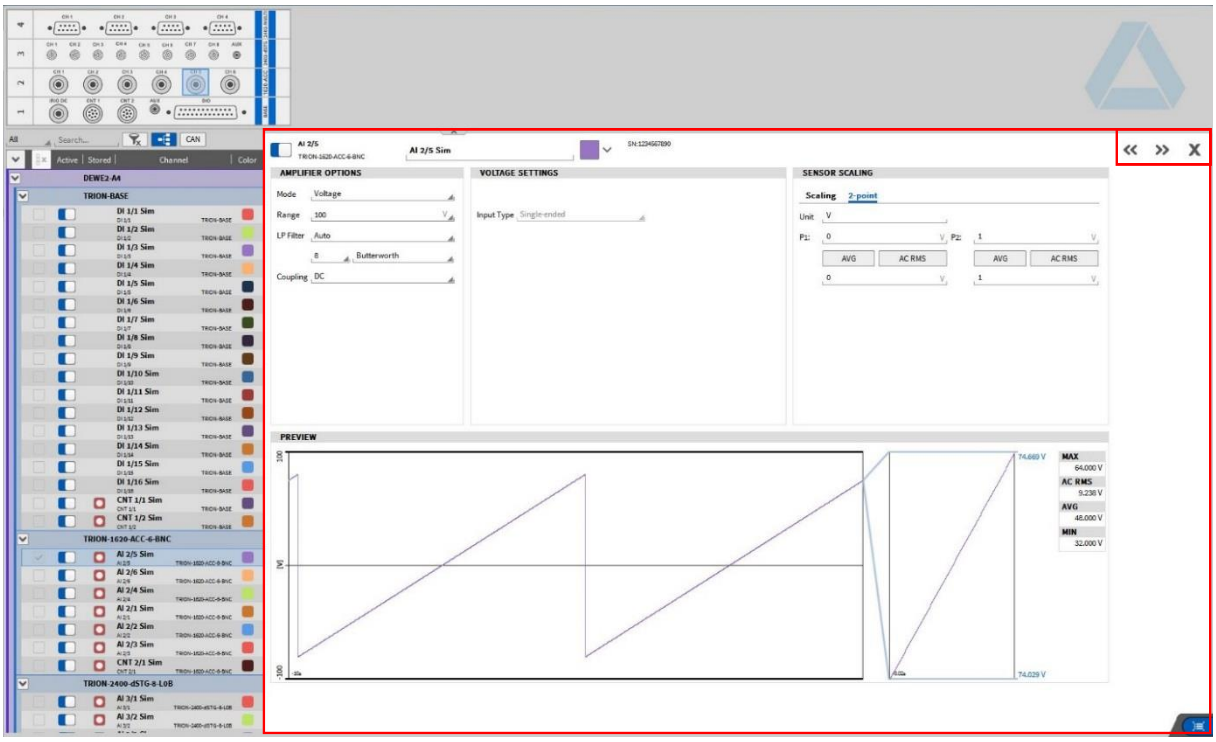


Figure 5-18: Channel Setup of a TRION^{TM}-1620-ACC channel

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.

5.3 Creation of Mathematical Channels

OXYGEN enables the user to easily create Formula (see section 5.3.1), Statistics (see section 5.3.3), Filters (see section 5.3.5), FFT (see section 5.3.6) or (Strain gauge) Rosette channels (see section 5.3.7) which are calculated in real time. For details about the Psophometer calculation, please refer to section 13. The Swept sine Analysis calculation is explained in section 5.3.9.

To create a new channel, the user needs to click on the *Add* button in the lower left corner (marked red in Figure 5-19) and a popup 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.

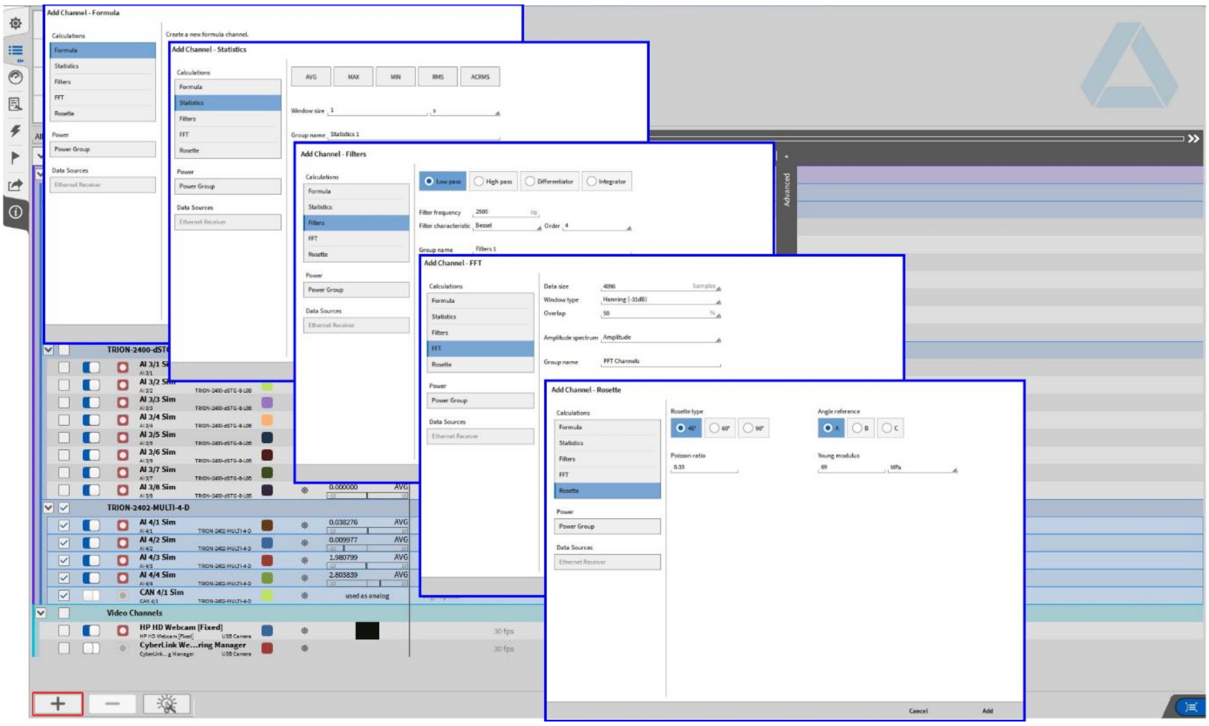


Figure 5-19: Creation of a math channel

Remark: 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

5.3.1 Creation of a Formula Channel

For creating a Formula math channel, the user must click on the *Add* button in the lower left corner (marked red in Figure 5-19) and select *Formula* (see Figure 5-20).

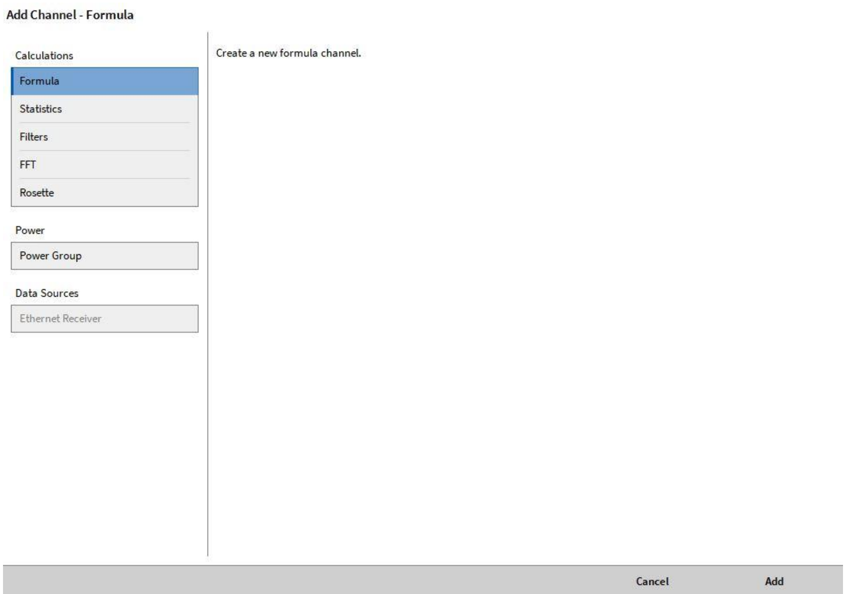


Figure 5-20: Popup window for creating a Formula channel

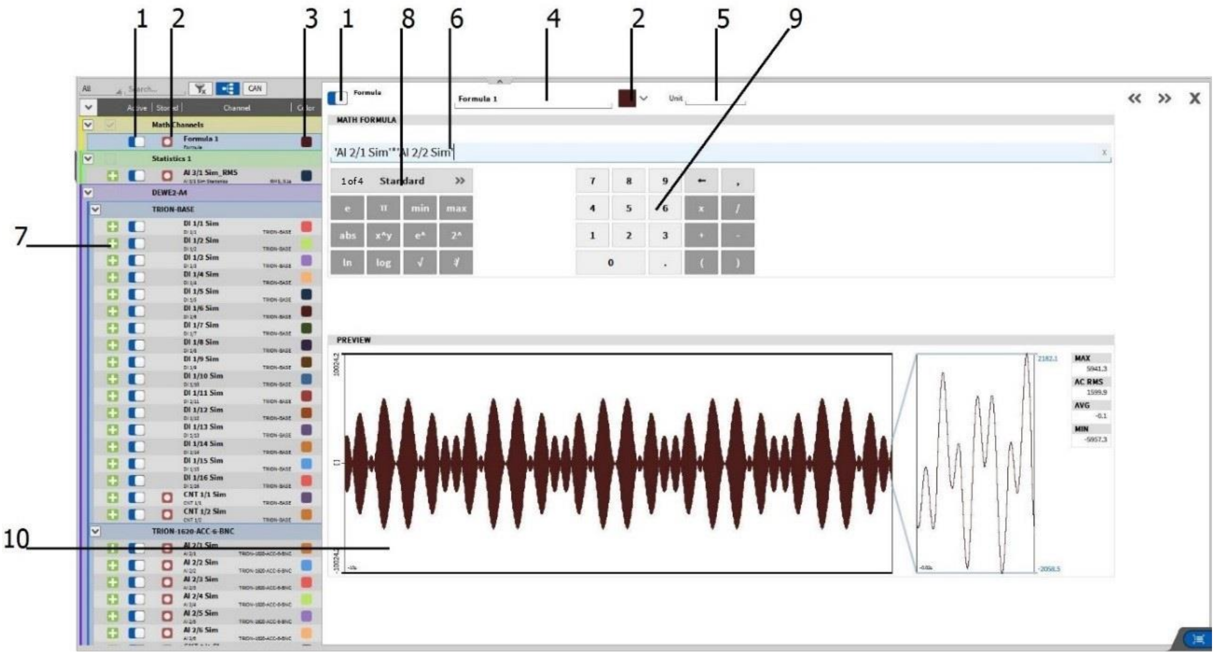


Figure 5-21: Formula Channel Setup – Overview

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 a 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	Physical unit	Physical unit of the channel, can be changed in the channel setup
6	Command line	Type your desired formula here
7	*Add* Button	Adds the individual channel to the command line; Channels can be added to the command line by drag and drop, too
8	Functions	Available mathematical and logical functions can be selected here. By clicking on >>, the user can swap between *Standard*, *Trigonometric*, *Logic* and *Miscellaneous* functions. For a description and the correct syntax of the individual functions, please refer to section 5.3.2.
9	Keys and Operators	Numerical pad and mathematical operators; Can also be entered via the keyboard.
10	Preview window	Real Time preview of the calculation

Table 5-2: Pushbuttons in the Formula Channel Setup – Overview

Remark: 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.

5.3.2 DESCRIPTION OF THE MATHEMATICAL AND LOGICAL FUNCTIONS

Function	Description	Syntax
e	Euler's number	e
π	Constant Pi	pi
min	Minimum of two values	min(x,y)
max	Maximum of two values	max(x,y)
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)
$\sqrt{\ }$	Square root	sqrt(x)
$\sqrt[3]{\ }$	Cube root	cbrt(x)

Table 5-3: Standard mathematical operators - description and syntax

Function	Description	Syntax
sin	Sine	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 5-4: Trigonometrical 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 5-5: Logical operators - 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	Edge(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)
rmin[8]	Measure rolling overall minimum of a channel during a measurement with optional reset condition	rmin(value,reset)
rmax[8]	Measure rolling overall maximum of a channel during a measurement with optional reset condition	rmax(value,reset)
ravg[8]	Measure rolling overall average of a channel during a measurement with optional reset condition	ravg(value,reset)
rrms[8]	Measure rolling overall RMS of a channel during a measurement with optional reset condition	rrms(value,reset)
rsum[8]	Measure rolling overall sum of a channel during a measurement with optional reset condition	rsum(value,reset)
racrms[8]	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[8]	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)

[1] For a detailed description of the ecnt-funtion, please refer to section 5.3.2.1
[2] For a detailed description of the hold-function, please refer to section 5.3.2.2
[3] For a detailed description of the stopwatch-function, please refer to section 5.3.2.3
[4] For a detailed description of the measdiff-function, please refer to section 5.3.2.4
[5] For a detailed description of the period-function, please refer to section 5.3.2.5
[6] For a detailed description of the dutycycle-function, please refer to section 5.3.2.6
[7] For a detailed description of the edge-function, please refer to section 5.3.2.7
[8] For a detailed description of the rolling-overall-functions, please refer to section 0

Table 5-6: Measurement functions – description and syntax

Function	Description	Syntax
time*	Returns the elapsed time since acquisition (re)start	time
scnt*	Counts the number of samples since acquisition (re)start	scnt
sr*	Returns the Sample Rate in Hz	sr
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)
* A channel to which the function refers must be specified, i.e. in the following manner: *'Ref_Ch'*0+time*		

Table 5-7: Miscellaneous operators - description and syntax

5.3.2.1 Description of the 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 Figure 5-22).

  The reason why the ecnt-function increases by more than 1 in Figure 5-22 is that the signal is floating around the *Cond*ition level several times due to noise. This can be seen in the magnification in Figure 5-22. 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 Figure 5-23.

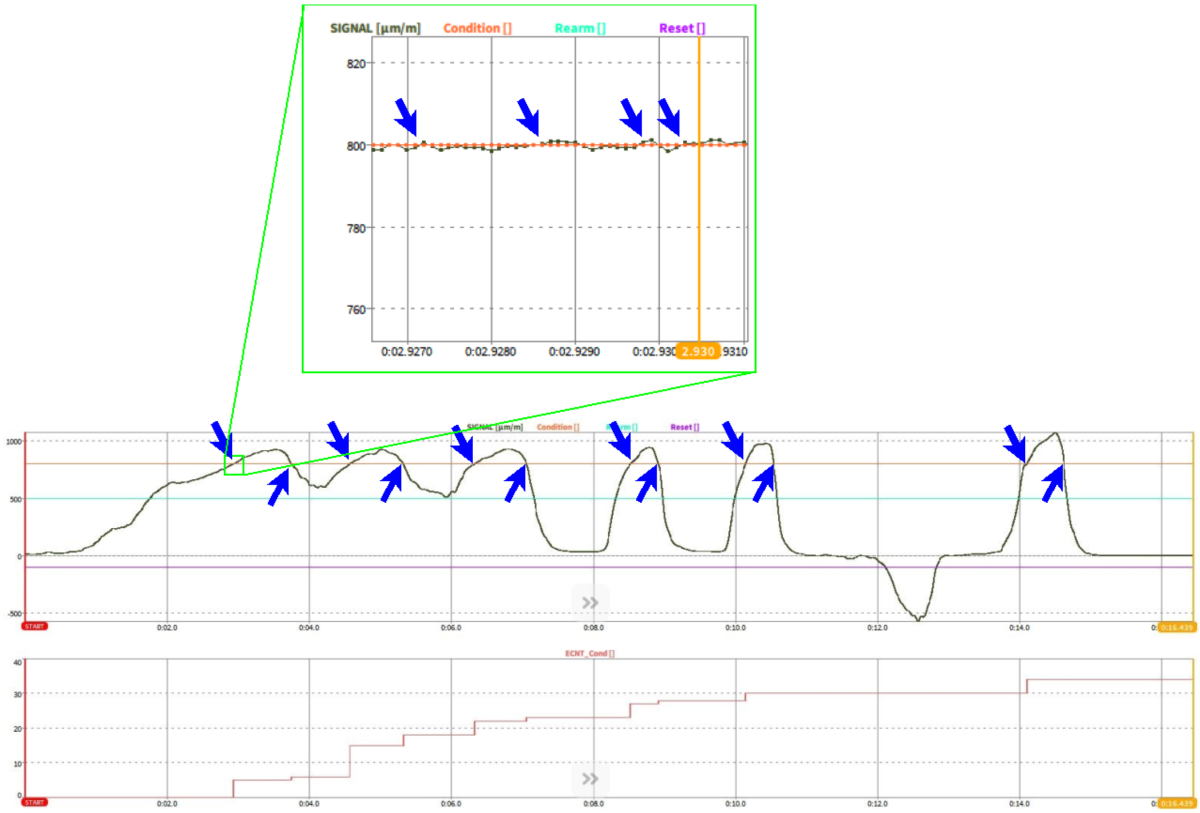


Figure 5-22: ECNT-function with *Condition* only

- 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 Figure 5-23).

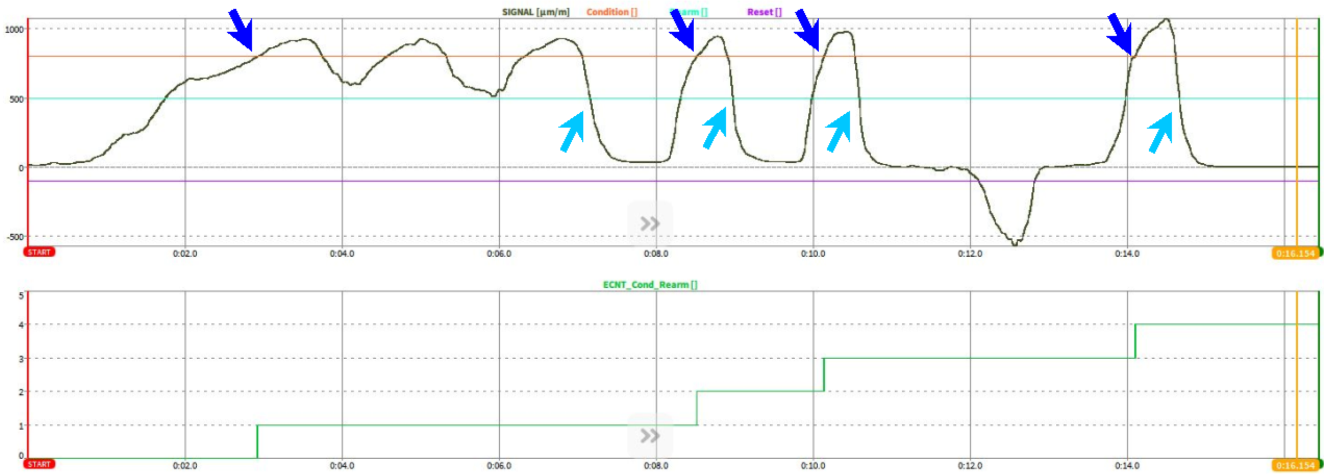


Figure 5-23: ECNT-function with *Condition* and *Rearm*

- 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 Figure 5-24).

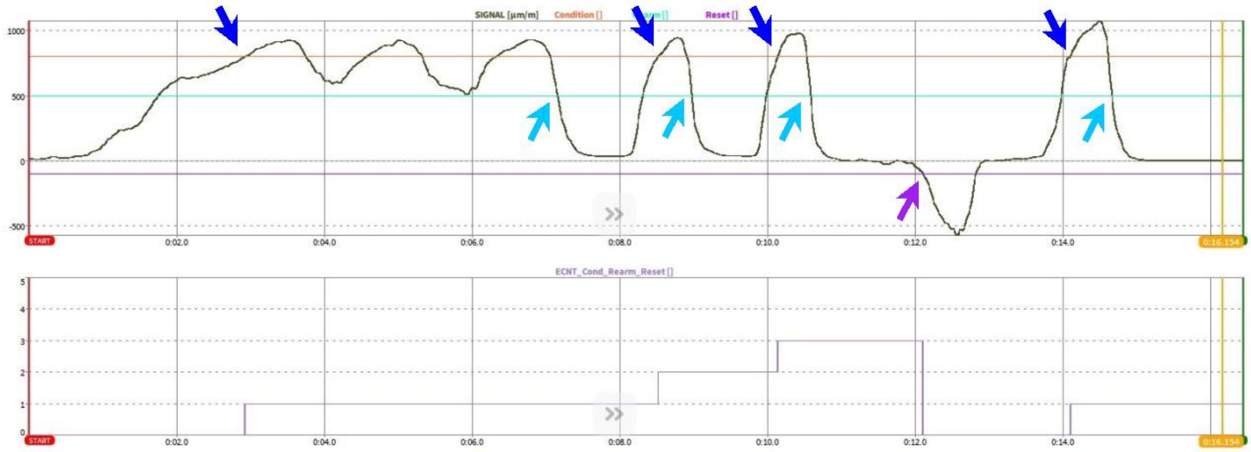


Figure 5-24: ECNT-function with *Cond*ition, *Rearm* and *Reset*

5.3.2.2 Description of the 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 Figure 5-25).

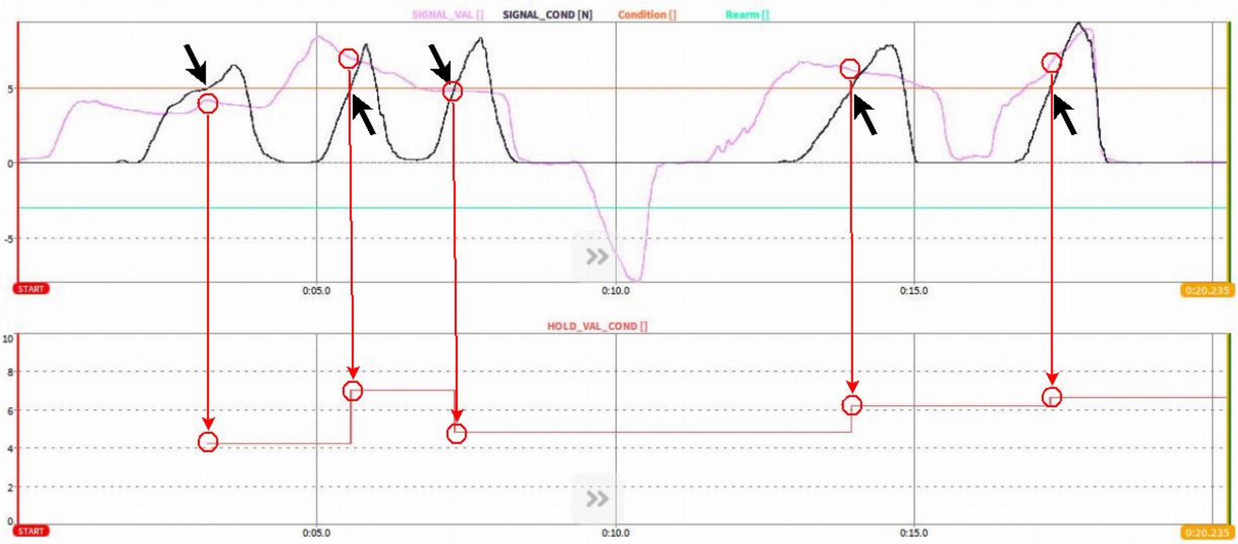


Figure 5-25: HOLD-function with *Cond*ition

- 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 Figure 5-26).

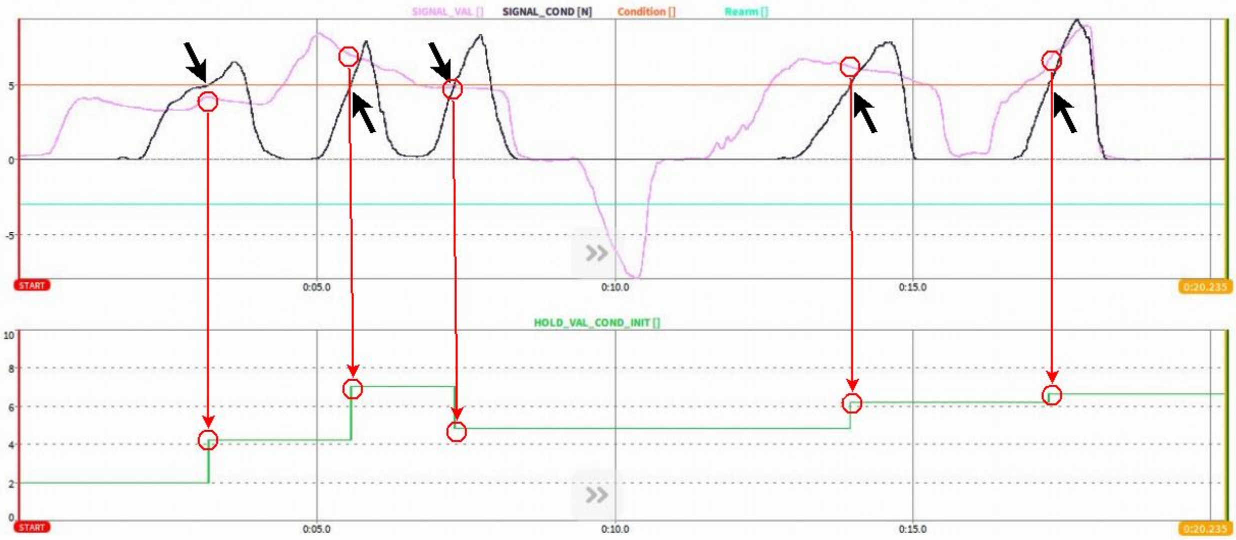


Figure 5-26: HOLD-function with *Cond*ition and *Init*ial value

- 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 Figure 5-27).

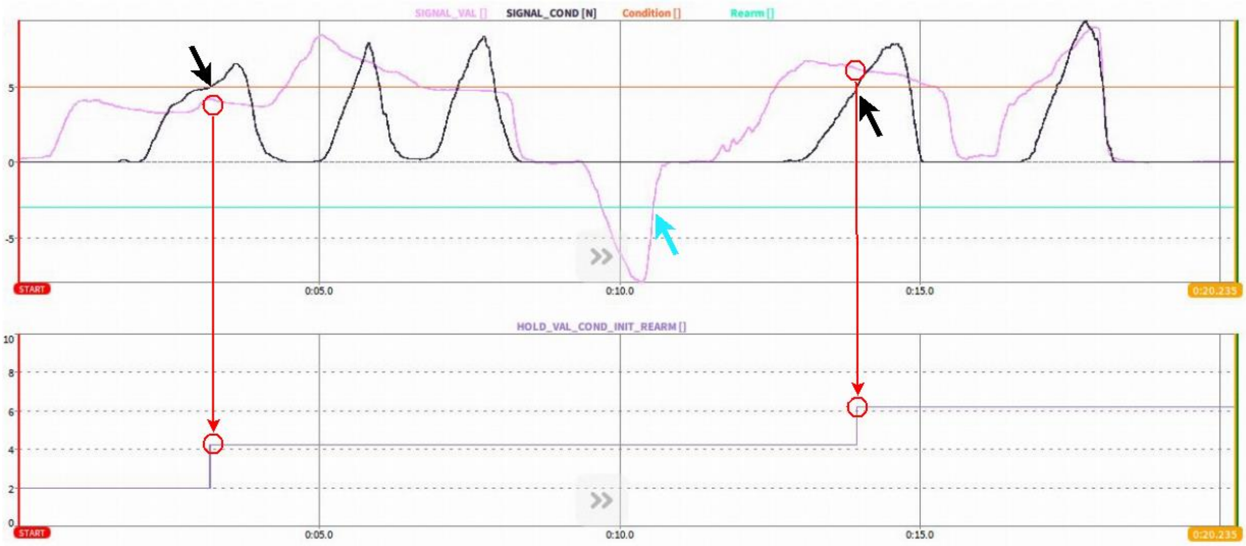


Figure 5-27: HOLD-function with *Cond*ition, *Init*ial value and *Rearm* level

5.3.2.3 Description of the stopwatch-function (stopwatch)

Syntax: stopwatch(start_cond,stop_cond, reset)

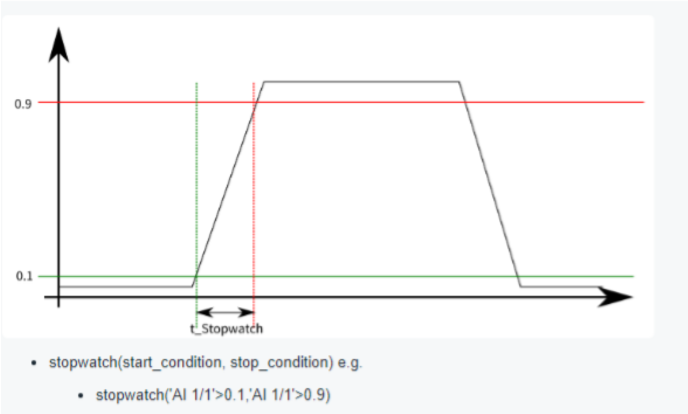


Figure 5-28: Schematic explanation of the stopwatch function

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 if this certain event occurs and continues counting from the last value 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 Figure 5-29) will start to measure the time in seconds if the channel *SIGNAL1* (light blue graph in Figure 5-29) 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.

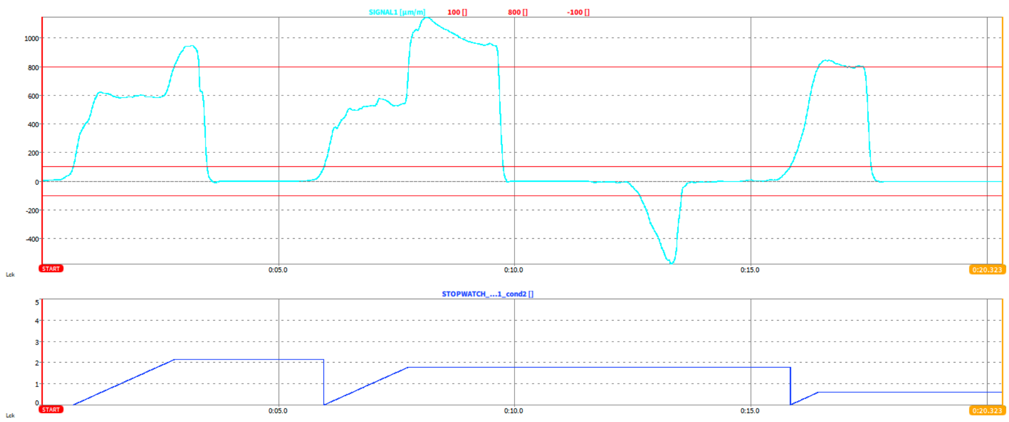


Figure 5-29: Stopwatch with start and stop condition

- STOPWATCH_cond1_cond2_0 = stopwatch('SIGNAL1'>100,'SIGNAL1'>800,0):
  The stopwatch function (pink graph in Figure 5-30) will start to measure the time in seconds if the channel *SIGNAL1* (light blue graph in Figure 5-30) exceeds 100 and stop to measure the time in seconds of the channel *SIGNAL1* exceeds 800. If *SIGNAL1* will exceed 100 again, the stopwatch function restarts to measure from the last value and NOT reset.

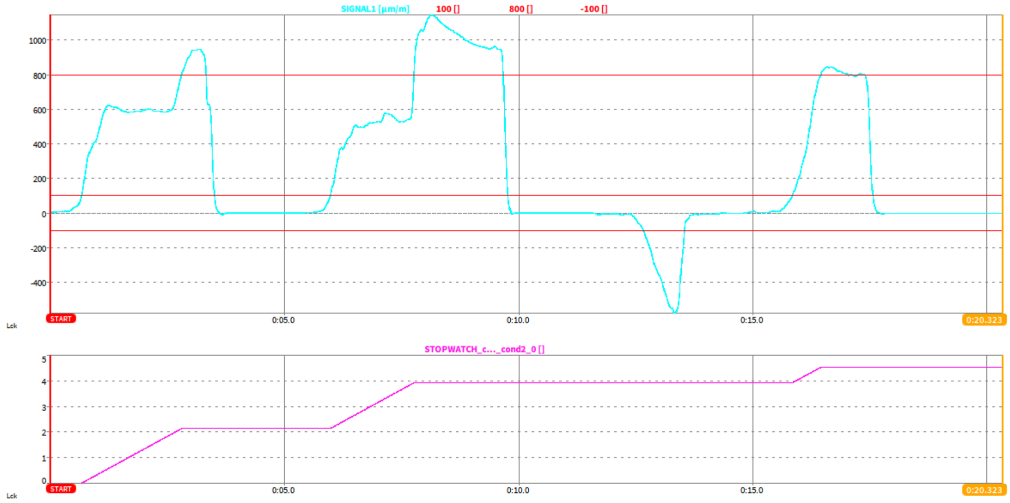


Figure 5-30: Stopwatch with start and stop condition, no reset

- STOPWATCH_cond1_cond2_reset = stopwatch('SIGNAL1'>100,'SIGNAL1'>800,'SIGNAL1'<-100):
  The stopwatch function (green graph in Figure 5-31) will start to measure the time in seconds if the channel *SIGNAL1* (light blue graph in Figure 5-31) exceeds 100 and stop to measure the time in seconds of the channel *SIGNAL1* exceeds 800. If (and only if) *SIGNAL1* will decreases -100, the stopwatch function will reset to *NaN* and restart to measure from 0s if *SIGNAL1* exceeds 100 again.

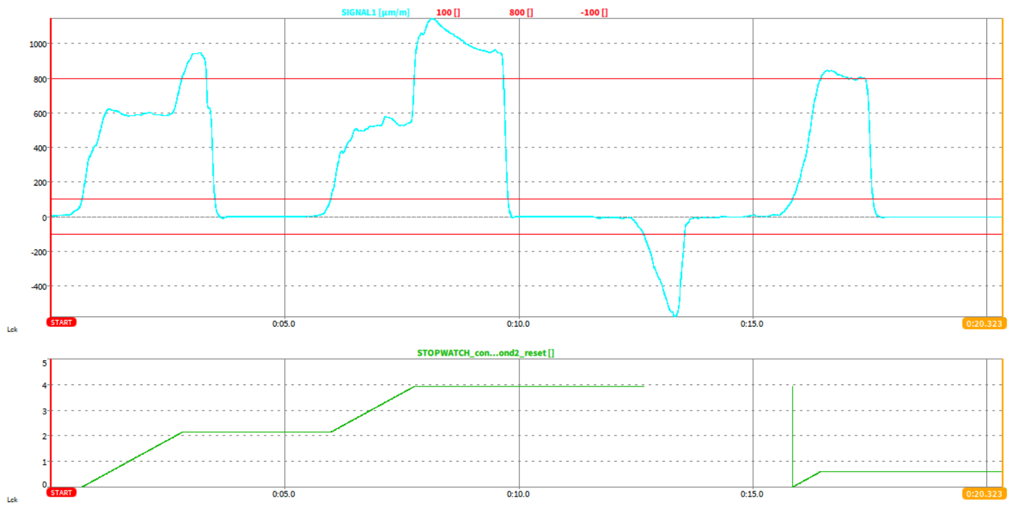


Figure 5-31: Stopwatch with start and stop condition, reset specified

5.3.2.4 Description of the 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 Figure 5-32) will measure and return the value difference of *SIGNAL2* (green graph in Figure 5-32) triggered by the following conditions: The measurement is initialized when *SIGNAL1* (light blue graph in Figure 5-32) exceeds 100 and stopped when *SIGNAL1* exceeds 800.

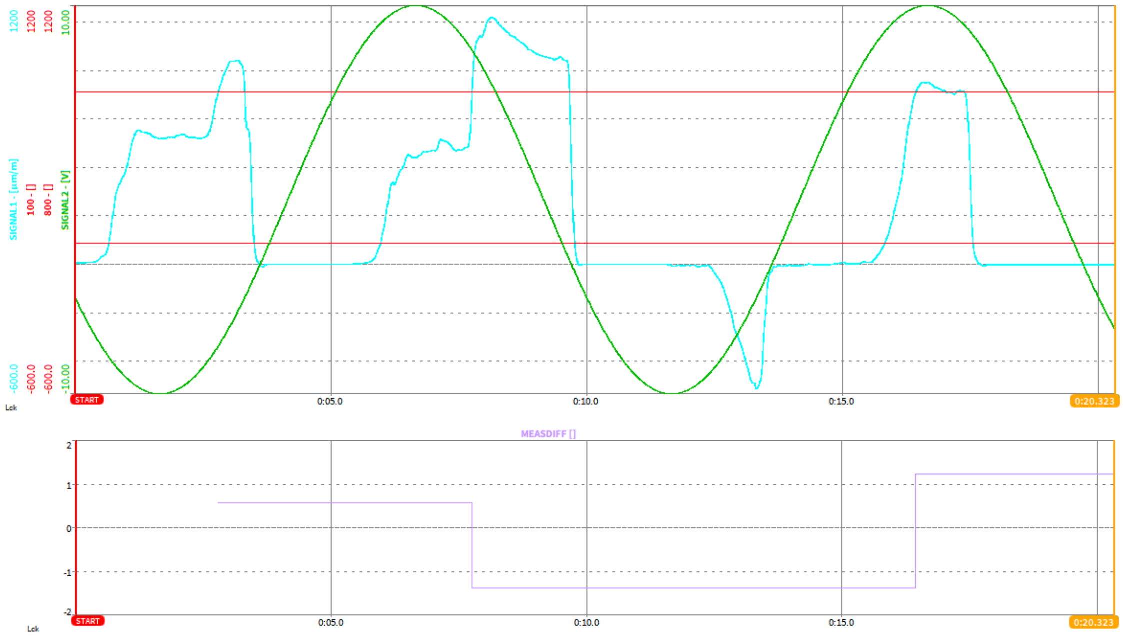


Figure 5-32: Measdiff function

5.3.2.5 Description of the 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 Figure 5-33) will measure and return the period time of *SIGNAL* (brown graph in Figure 5-33) 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 Figure 5-34) 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 Figure 5-33) will measure and return the period time of *SIGNAL* 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 Figure 5-33 is suppressed and the detected period time is always 2s as it can be seen in the blue graph of Figure 5-33.

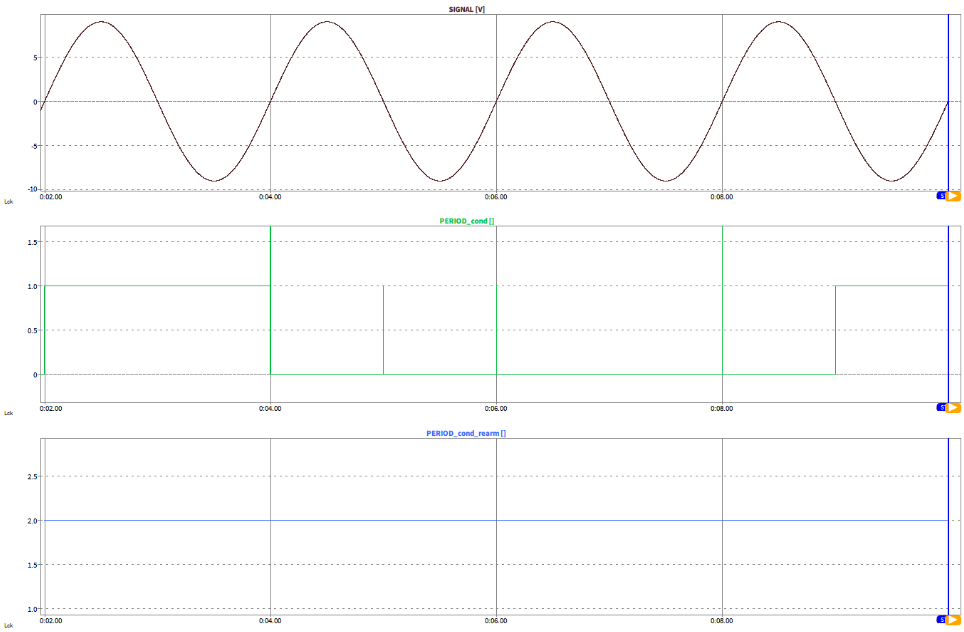


Figure 5-33: Period function

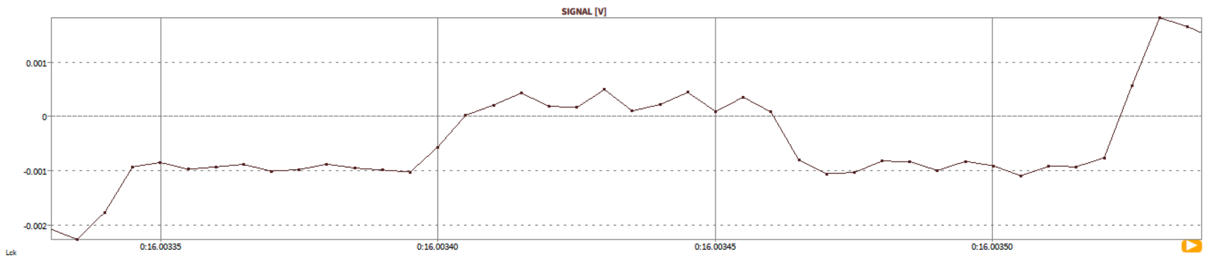


Figure 5-34: Noise disturbing the correct functionality of the period determination

5.3.2.6 Description of the 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 Figure 5-35) will measure and return the dutycycle of *SIGNAL* (brown graph in Figure 5-35) 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 Figure 5-36) 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 Figure 5-35) 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 Figure 5-36 is suppressed and the detected dutycycle is always 0.5 (50%) as it can be seen in the blue graph of Figure 5-36.

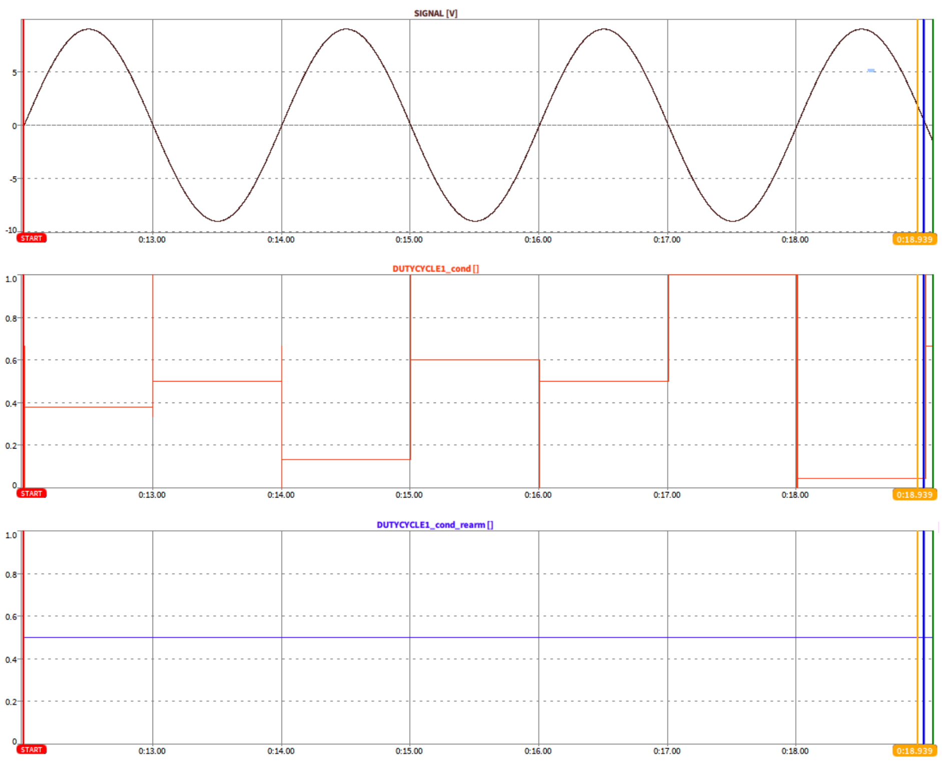


Figure 5-35: Dutycycle function

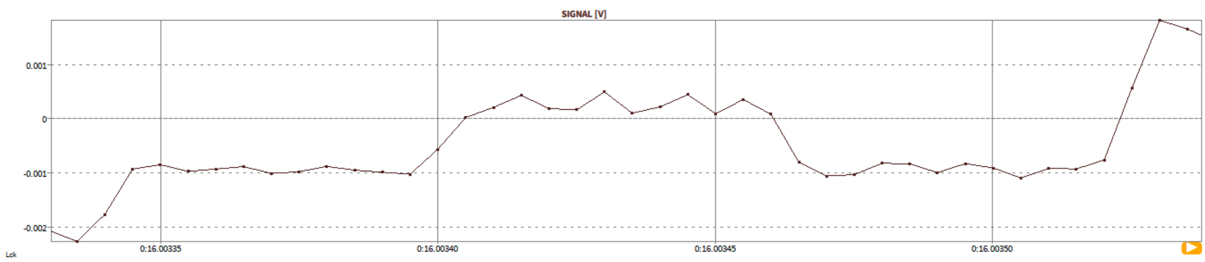


Figure 5-36: Noise disturbing the correct functionality of the dutycycle determination

5.3.2.7 Description of the 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 Figure 5-37) will return a rising edge from 0 to 1for the condition that the *SIGNAL* level exceeds 800 (brown graph in Figure 5-37). In case the *SIGNAL* falls below -100, the edge function will return a falling edge from 1 to 0.

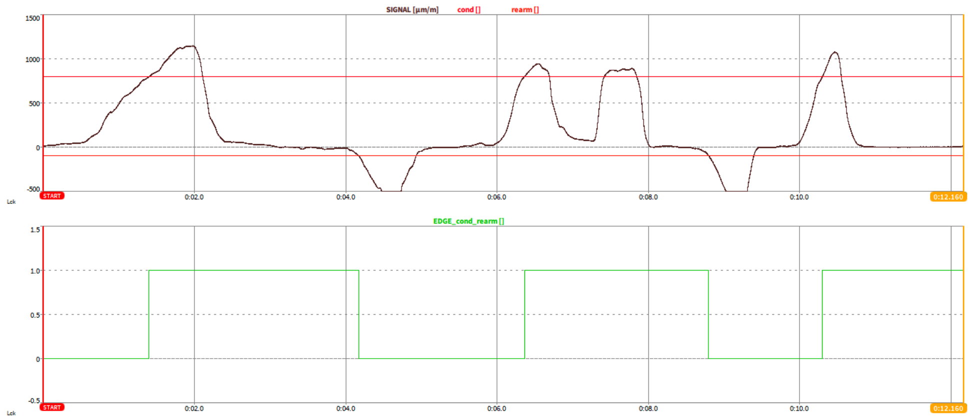


Figure 5-37: Edge function

5.3.2.8 Combination of edge function and other formulas

In case a formula that does not contain a rearm level as optional parameter, like the stopwatch function(see section 5.3.2.3) or the measdiff function (see section 5.3.2.4), the edge function (see section 5.3.2.7) 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 Figure 5-38 will measure the time using the stopwatch between the following two conditions: *cond1* is true if *SIGNAL1* (green signal in Figure 5-38) exceeds 100. *Cond2* is true if *SIGNAL1* (green signal in Figure 5-38) exceeds 800.
The formula syntax of the blue signal in Figure 5-38is 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 Figure 5-38. 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)

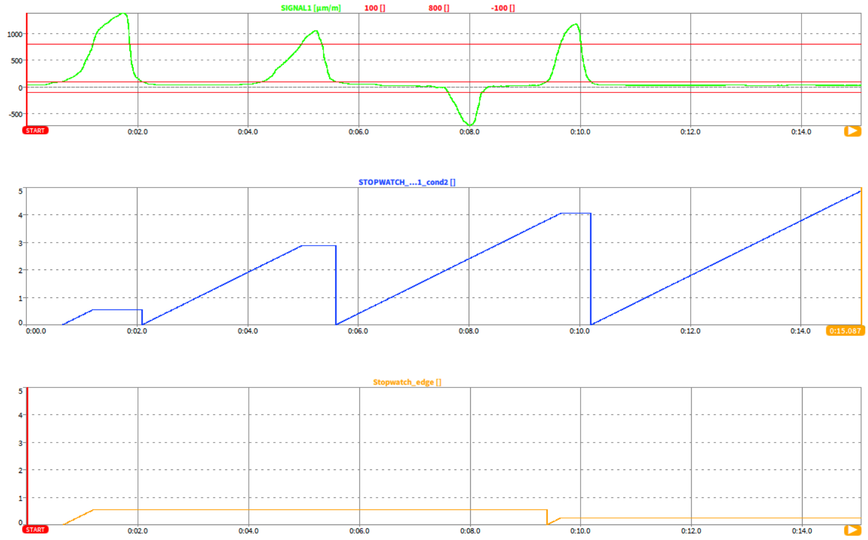


Figure 5-38: Combination of edge and stopwatch function

5.3.2.9 Description of the 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, please refer to section 5.3.4.

- 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

5.3.3 CREATION OF A STATISTICS CHANNEL

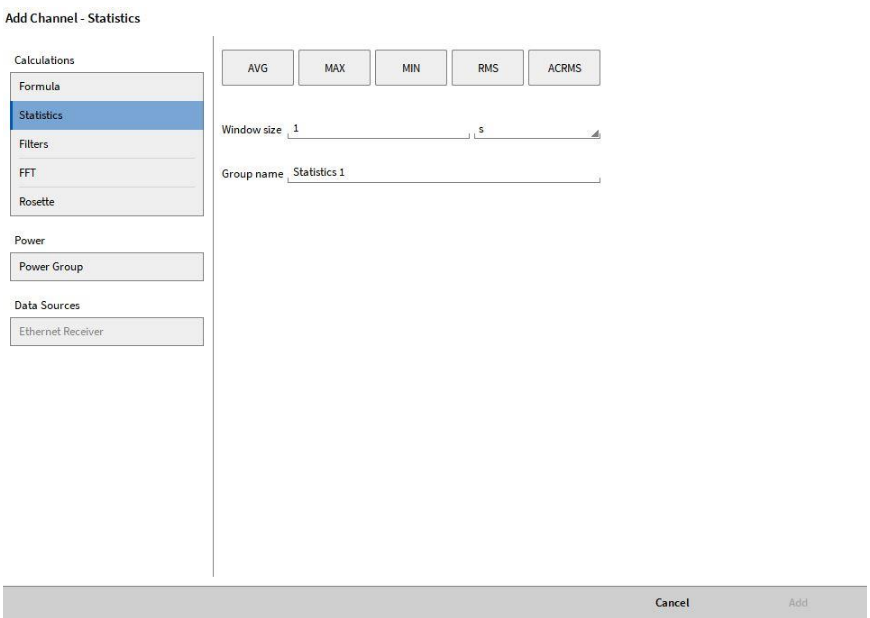


Figure 5-39: Popup window for creating a Statistics channel

After clicking on the *Add* button, the *Calculation Setup* window will appear (see Figure 5-39). 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 if the Statistics channel shall calculate the AVG, MAX, MIN, RMS or ACRMS value of the input channel. The user may select several statistical values. An individual channel for each value will be created afterwards. After that a time interval (*Window Size*) 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 Figure 5-40).

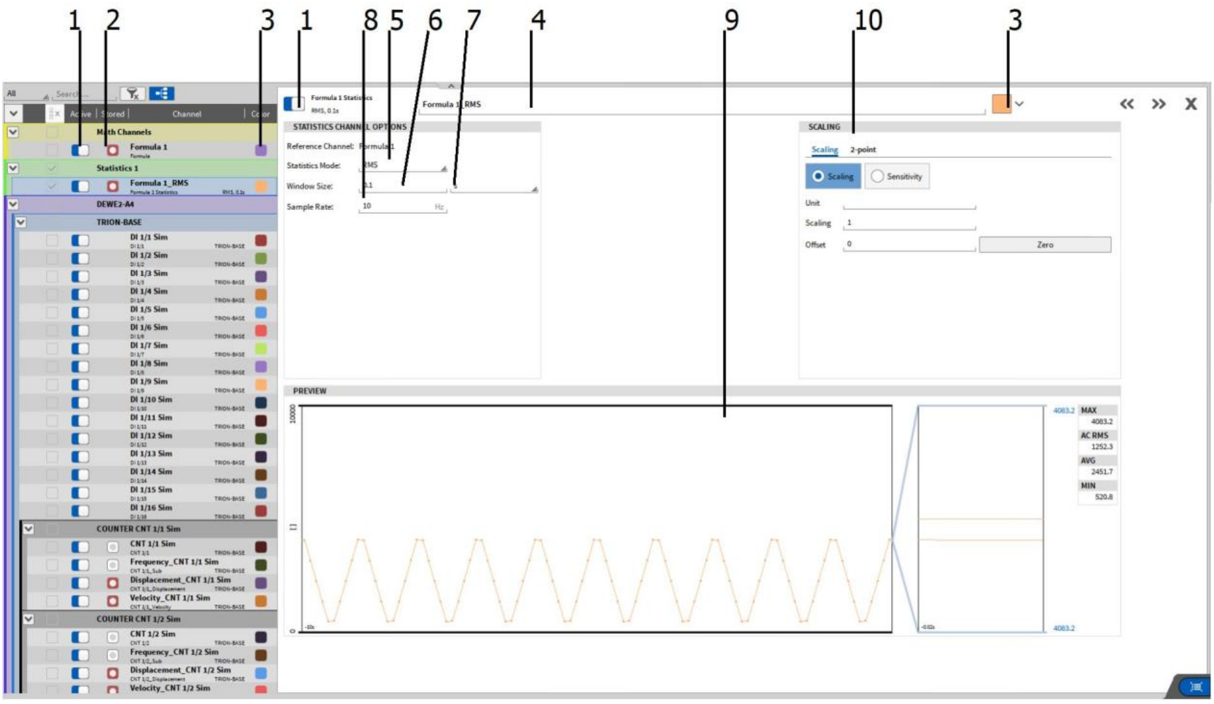


Figure 5-40: Statistics Channel Setup- Overview

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 a 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	*Statistics Mode* Setup	Select the statistical value that shall be calculated. Select between *AVG, MAX, MIN, RMS* and *ACRMS*
6	Window Size	Type in the desired window size (will affect the Sample Rate ⑧)
7	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 ⑧)
8	Sample Rate	Sample rate that is calculated from the Window size in Hz (Window Size can also be changed via Sample Rate changes)
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

Table 5-8: Pushbuttons in the Statistics Channel Setup – Overview

5.3.4 DESCRIPTION OF THE SELECTABLE STATISTICAL PARAMETERS

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

$$AVG = \frac{1}{N}\sum_{i=1}^{N} SignalLevel_i$$

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

$$MAX = MAX\{SignalLevel_i\}$$

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

$$MIN = MIN\{SignalLevel_i\}$$

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

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(SignalLevel_i)^2} = \sqrt{AVG^2 + ACRMS^2}$$

- 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

$$ACRMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(SignalLevel_i - AVG)^2}$$

i = 1…N
*N = Sample Rate of Input Channel * Window Size*

Remark: 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:

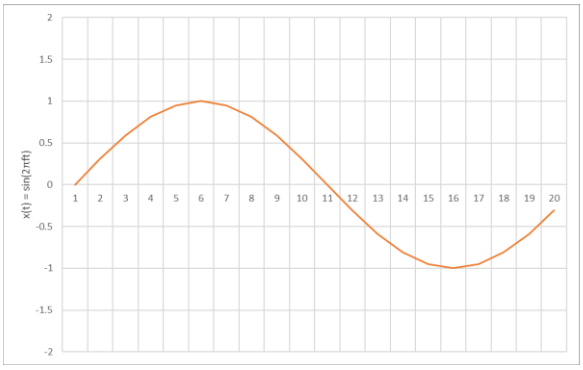


Figure 5-41: Sine wave with amplitude 1, no DC component

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:

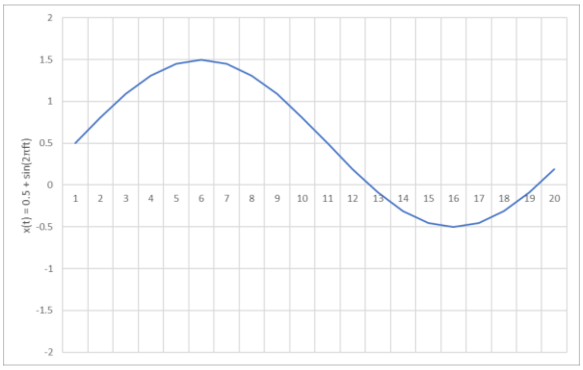


Figure 5-42: Sine wave with amplitude 1, 0.5 DC component

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.

5.3.5 CREATION OF A FILTER CHANNEL

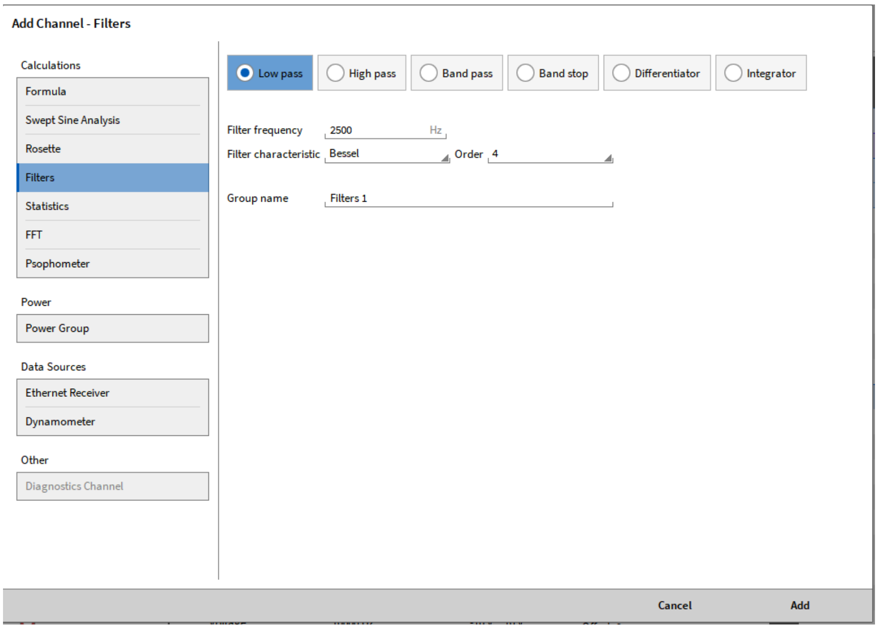


Figure 5-43: Popup window for creating a (Low or High pass) Filter channel

After clicking on the *Add* button, the *Calculation Setup* window will appear (see Figure 5-43). 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 Figure 5-43), the user can select

- *Filter Frequency*: from 0 Hz to $(\frac{Sample\ Rate}{2} - \frac{Sample\ Rate}{200})$ 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 Figure 5-43), the user can select

- *Low Frequency*: from 0 Hz to $< High\ Frequency$ Hz
- *High Frequency*: from $(Low\ Frequency + 1)$ Hz to $(\frac{Sample\ Rate}{2} - \frac{Sample\ Rate}{200})$ 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

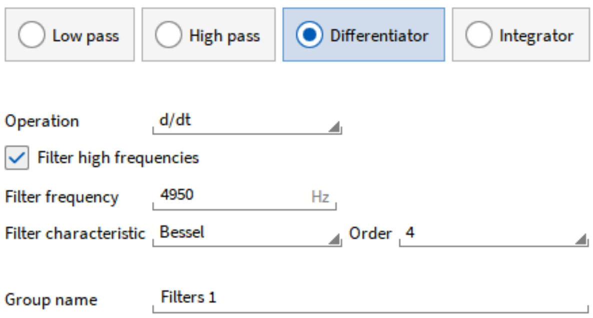


Figure 5-44: Popup window for creating a Differentiator channel

- *Operation*: Single or double differentiation
- If high frequencies shall be filtered
- *Filter Frequency*: from 0 Hz to $(\frac{Sample\ Rate}{2} - \frac{Sample\ Rate}{200})$ 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 *Integrator* is selected, the user can select

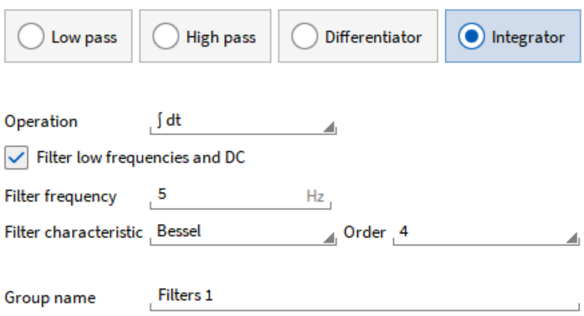


Figure 5-45: Popup window for creating an Integrator channel

- *Operation*: Single or double integration
- If low frequencies shall be filtered
- *Filter Frequency*: from 0 Hz to $(\frac{Sample\ Rate}{2} - \frac{Sample\ Rate}{200})$ 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

Remark: Filters can only be applied to synchronous channels, like analog input channels or counter channels but not to asynchronous channels, like 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 Figure 5-46).

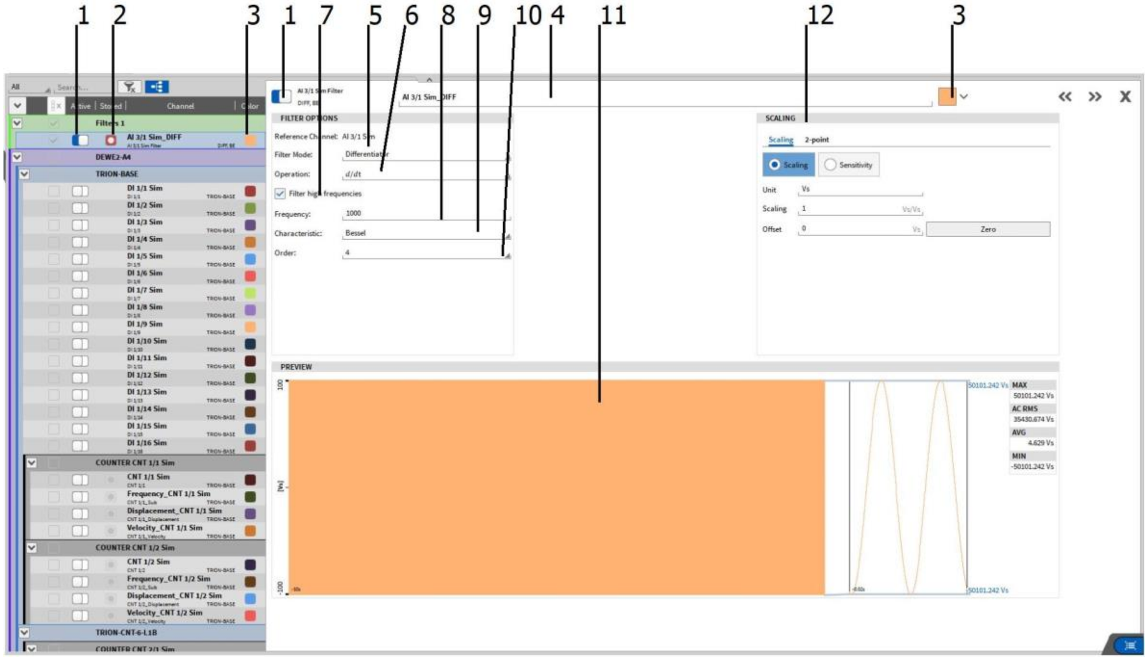


Figure 5-46: Filters Channel Setup- Overview

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 a 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 $\left(\frac{Sample\ Rate}{2} - \frac{Sample\ Rate}{200}\right)$ 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

Table 5-9: Pushbuttons in the Filter Channel Setup – Overview

5.3.6 Creation of FFT Channels

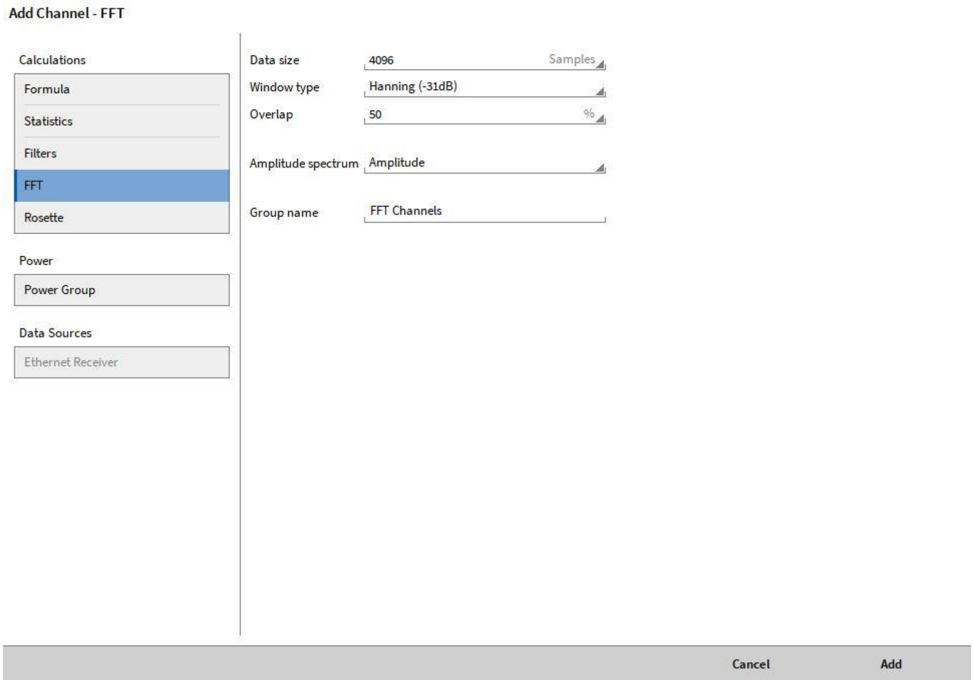


Figure 5-47: Popup window for creating an FFT channel

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 Figure 5-19) and select *FFT* in the appeared window (see Figure 5-47). The user can select several input channels simultaneously to create several FFT channels with the same settings at once.

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

Remark: 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 the 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, please refer to section 9). This is not the case for the calculation using the Spectrum Analyzer.

Three channels may be created for each FFT calculation:

- The channel containing the complex spectrum Y_k (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.
- The channel containing the amplitude spectrum A_k (called *Channel_Name_Amp*) which is calculated according to the following formula:

$$A_k = \frac{1}{N}\sqrt{Re\{Y_k\}^2 + Im\{Y_k\}^2}\ ; \qquad k = 0 \qquad [Signal\ Unit]$$

$$A_k = \frac{2}{N}\sqrt{Re\{Y_k\}^2 + Im\{Y_k\}^2}\ ; \qquad k = 1 \dots N \qquad [Signal\ Unit]$$

This channel can be visualized within OXYGEN using the Spectrum Analyzer (see section 6.12) if the actual spectrum shall be plotted or it may also be assigned to the Spectrogram Instrument (see section 6.17) if the time dependent spectral trend shall be displayed.

- The channel containing the phase information φ_k (called *Channel_Name_Phi*) which is calculated according to the following formula:

$$\varphi_K = arctan\frac{Im\{Y_K\}}{Re\{Y_K\}}; \quad k = 0 \dots N \quad [Signal\ Unit]$$

This channel can be visualized within OXYGEN using the Spectrum Analyzer (see section 6.12) if the actual spectrum shall be plotted or it may also be assigned to the Spectrogram Instrument (see section 6.17) 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 Figure 5-49).

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

- *Data size:* Select the number of samples to be transformed simultaneously in the frequency domain here. The data size may vary between 42 to 1048576 (2^{20}) samples. For calculation details, please refer to section 6.12.3.
- *Overlap:* Select an overlapping factor from 0 to 99.97559% here. For calculation details, please refer to section 6.12.7.
- *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, please refer to section 6.12.3.1.1.
- Amplitude Spectrum: Select the type of amplitude spectrum the Amplitude channel shall contain. The following amplitude spectra are available: Amplitude, Amplitude_RMS, Amplitude², PSD, Decibel (Ref: 1), Decibel_RMS (Ref:1) or Decibel_Max_Peak (Ref: Max). For calculation details, please refer to section 6.12.3.2
  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

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 Figure 5-48).

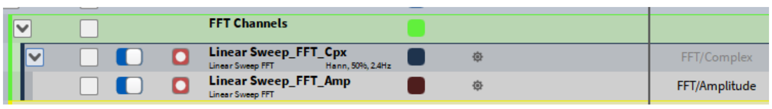


Figure 5-48: FFT channels within the Channel List

5.3.6.1 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*:

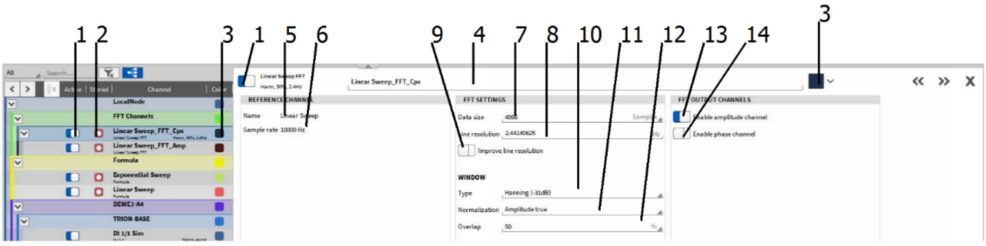


Figure 5-49: Complex FFT channel Setup- Overview

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 a 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	Input channel of the FFT calculation is displayed here	
6	Sample Rate of the input channel is displayed here	
7	*Data size* selection	Select the number of samples to be transformed simultaneously in the frequency domain here. The data size may between 42 to 1048576 (220) samples. For calculation details, please refer to section 6.12.3.
8	*Line resolution* selection	Enter the data size by entering the desired line resolution here. For calculation details, please refer to section 6.12.3.
9	*Improve Line Resolution* selection	Enable Zero-Padding here. For calculation details, please refer to section 6.12.5.
10	*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, please refer to section 6.12.3.1.1.
11	*Normalization Type* selection	Select between *Amplitude True*, *Power True* or *No* normalization. For calculation details, please refer to section 6.12.6.
12	*Overlap* selection	Select an overlapping factor from 0 to 99.97559% here. For calculation details, please refer to section 6.12.7.
13	*Enable Amplitude channel* selection	Enable or disable the calculation of the amplitude channel here; Enabled per default
14	*Enable Phase channel* selection	Enable or disable the calculation of the phase channel here; Disabled per default

Table 5-10: Complex FFT channel Setup – Overview

5.3.6.2 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*:

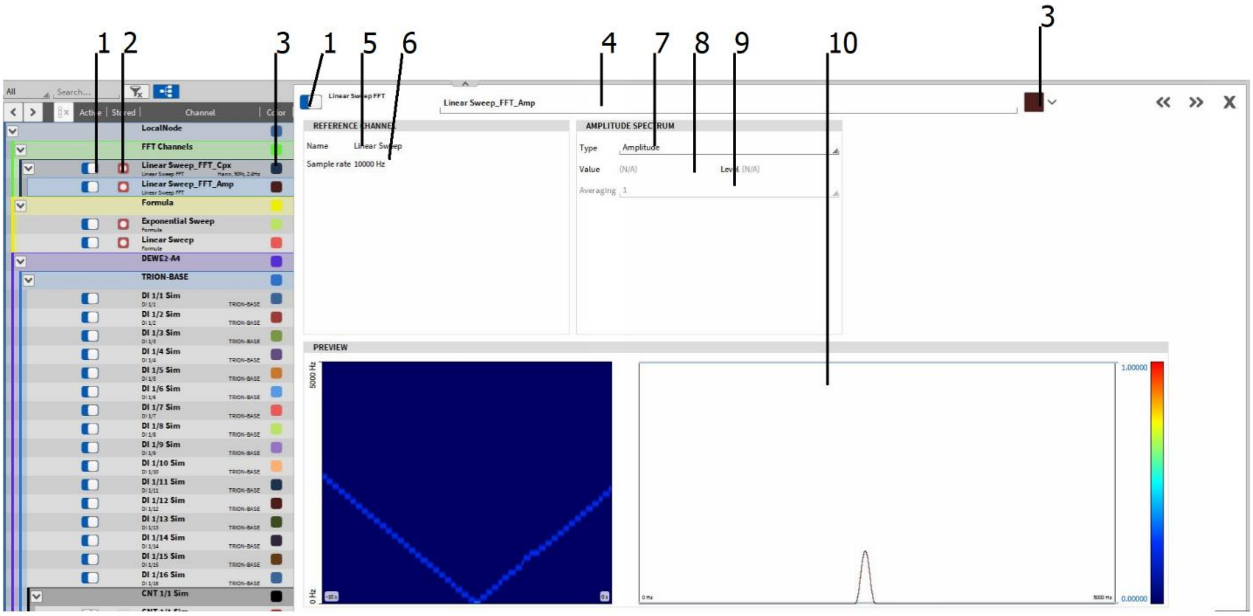


Figure 5-50: Amplitude FFT channel Setup- Overview

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 a 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	Input channel of the FFT calculation is displayed here	
6	Sample Rate of the input channel is displayed here	
7	*Spectrum Type* selection	Change the type of the amplitude spectrum here. For calculation details and spectra to be selected, please refer to section 6.12.3.2
8	*Value* selection	If Decibel or Decibel RMS spectrum type is selected, the reference value can be entered here
9	Averaging *selection*	Not implemented yet
10	Preview window	Real Time preview of the calculation

Table 5-11: Amplitude FFT channel Setup- Overview

5.3.6.3 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*:

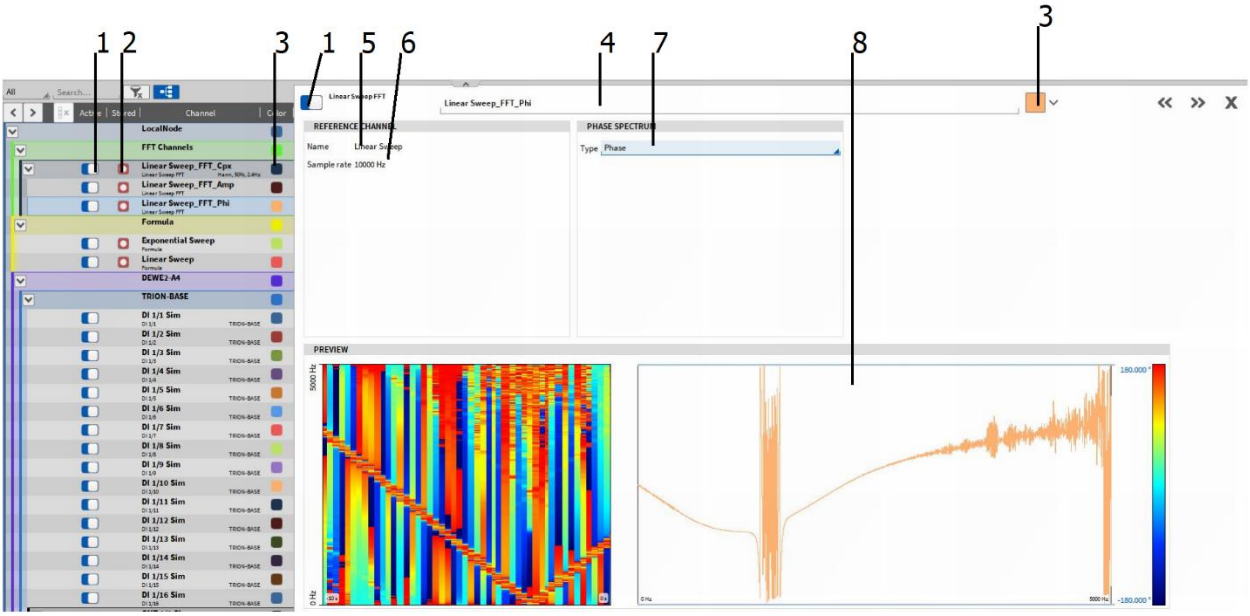


Figure 5-51: Phase FFT channel Setup- Overview

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 a 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	Input channel of the FFT calculation is displayed here	
6	Sample Rate of the input channel is displayed here	
7	*Spectrum Type* selection	Change the type of the phase spectrum here. For calculation details and spectra to be selected, please refer to section 6.12.3.2
8	Preview window	Real Time preview of the calculation

Table 5-12: Phase FFT channel Setup- Overview

5.3.7 Creation of (Strain Gauge) Rosette Channels

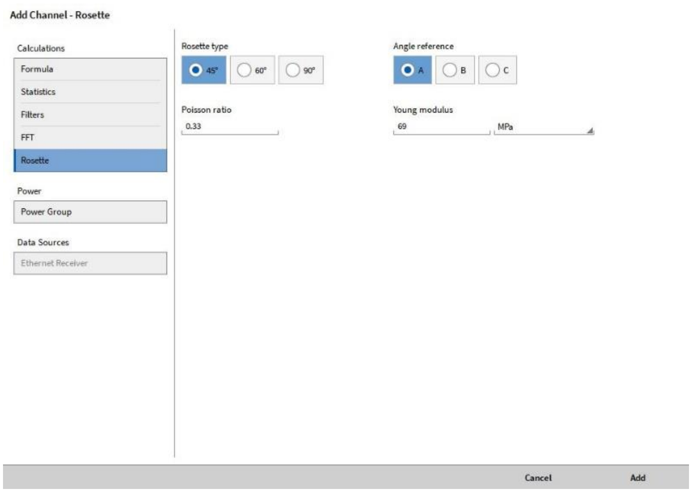


Figure 5-52: Popup window for creating a Rosette calculation

For creating a Rosette channel, the user must click on the *Add* button in the lower left corner (marked red in Figure 5-19) and a window will appear (see Figure 5-52). To create a Rosette channel, select *Rosette.* After clicking on the OK button, a Rosette main channel (*Rosette_1* in Figure 5-53) with its Sub channels (*Max Principal strain* to *VonMises Stress* in Figure 5-53) 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 Figure 5-53).

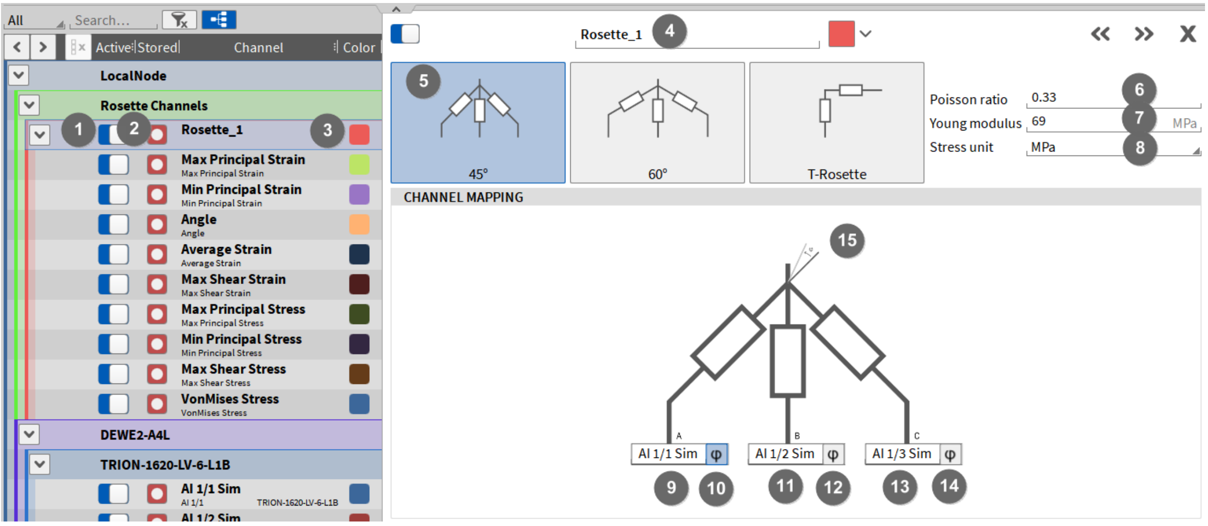


Figure 5-53: Rosette channel setup – Overview

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 a 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	*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	*Epsilon A* channel assignment	Assign the input channel for *Epsilon A* here
10	*Reference Angle* Selection	Select *Epsilon A* as Reference Angle here; If selected, the background will highlight grey-blue
11	*Epsilon B* channel assignment	Assign the input channel for *Epsilon B* here
12	*Reference Angle* Selection	Select *Epsilon B* as Reference Angle here; If selected, the background will highlight grey-blue
13	*Epsilon C* channel assignment	Assign the input channel for *Epsilon C* here
14	*Reference Angle* Selection	Select *Epsilon C* as Reference Angle here; If selected, the background will highlight grey-blue
15	*Reference Angle* hint	Highlights the selected reference angle in the rosette schematics

Table 5-13 Rosette channel setup – Overview

5.3.7.1 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.

Remarks:

- 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 Figure 5-54)

Figure 5-54: 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 Figure 5-53) 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 Figure 5-55)

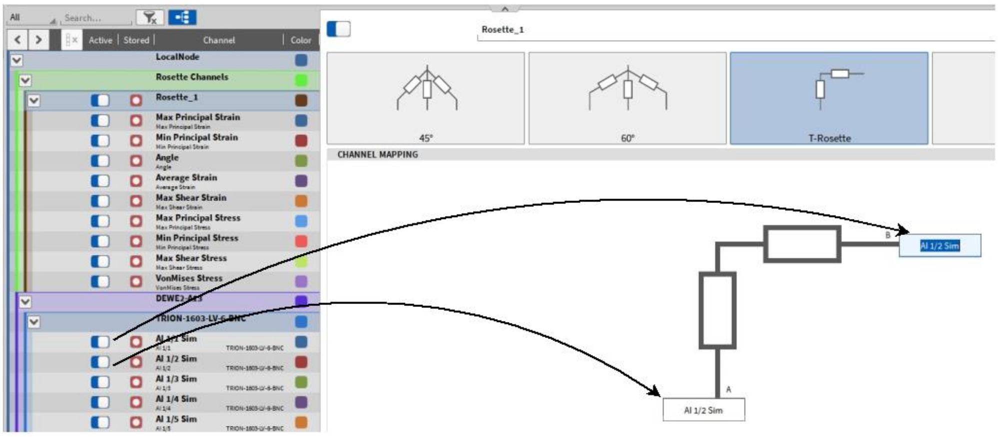


Figure 5-55: Channel assignment in the rosette channel setup

- 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 Figure 5-56)

Input channels not ready

Figure 5-56: 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 Figure 5-57)

Sample rates of input channels differ

Figure 5-57: Error message in case of different channel sample rates

- The sub channels (see ⑰ in Figure 5-53) 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.

5.3.7.2 Resulting Output Channels

The plugin uses the so-called Mohr's circle (see Figure 5-58) for the calculations. For details, please refer to the relevant literature.

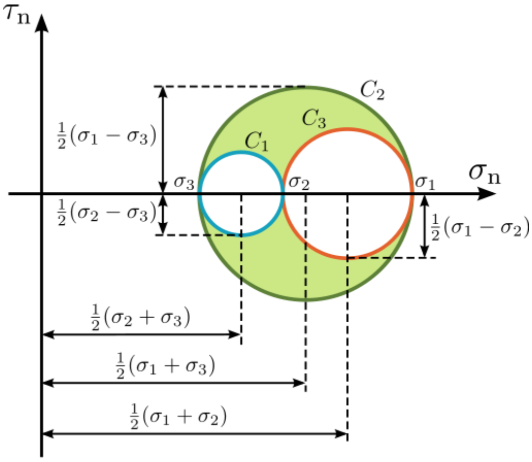


Figure 5-58: Mohr's circle[1]

[1] Source: https://en.wikipedia.org/wiki/Mohr%27s_circle from 2018-09-03

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

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

5.3.7.3 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's possible to use three separate strain gauges (planar construction).
Figure 5-59 shows sketches of different rosette types.

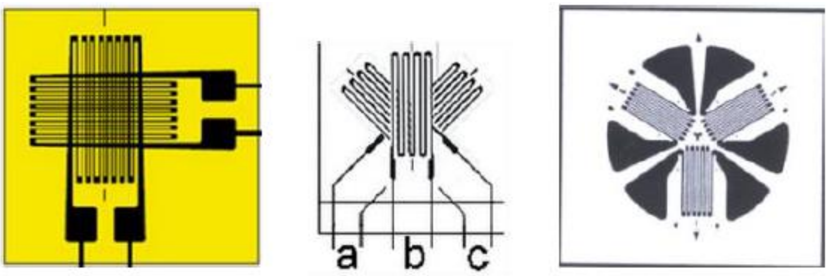


Figure 5-59: Sketch of different rosette types: left: 90° (T), Middle: 45°, Right: 120° rosette

5.3.7.4 Physical Basics

This chapter includes some important term explanations.

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

$$\varepsilon = \frac{dl}{l}\left[\frac{\mu m}{m}\right]$$

  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 σ: Is defined as the average force per unit area, also taking in account the material.

$$\sigma = \frac{F}{A}\left[\frac{\mathrm{N}}{mm^2}\right]$$

- Young's modulus E: The formulas shown above only work in the linear part of the *Strain-Stress-Curve*, which is shown in Figure 5-60. In this area a constant factor between stress and strain exists.

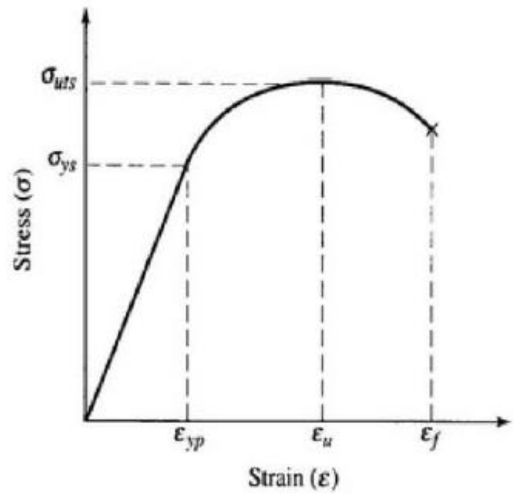


Figure 5-60: Strain-Stress-Curve

$$E = \frac{\sigma}{\varepsilon}\left[M\frac{\mathrm{N}}{mm^2} = GPa\right]$$

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 $\sigma = E * \varepsilon$.

5.3.7.5 Implemented Formulas

The Rosette calculations depend on the selected rosette type and angle reference.

5.3.7.5.1 Constants

ε_P ... $Max. Principle\ Strain$
ε_Q ... $Min. Principle\ Strain$
θ ... $Angle\ in\ max. strain\ direction$

5.3.7.5.2 Angle Reference

$$A: \theta_{P,Q} = (\dots)$$
$$B: \theta_{P,Q} = (\dots) - 45° \ or\ 60°$$
$$C: \theta_{P,Q} = (\dots) - 90° \ or\ 120° \ or\ 240°$$

5.3.7.6 Calculation of 45° and 90° Rosette

Avg Strain
MaxShearStrain

$\varepsilon_P = \varepsilon_1$
$\varepsilon_Q = \varepsilon_2$

$$\varepsilon_{P,Q} = \frac{\varepsilon_1 + \varepsilon_3}{2} \pm \frac{1}{\sqrt{2}}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2}$$

$$\theta_{P,Q} = \frac{1}{2}\tan^{-1}\left(\frac{2\varepsilon_2 - \varepsilon_1 - \varepsilon_3}{\varepsilon_1 - \varepsilon_3}\right)$$

5.3.7.7 Calculation of 60° and 120° Rosette

$$\varepsilon_{P,Q} = \frac{\varepsilon_1 + \varepsilon_2 + \varepsilon_3}{3} \pm \frac{\sqrt{2}}{3}\sqrt{(\varepsilon_1 - \varepsilon_2)^2 + (\varepsilon_2 - \varepsilon_3)^2 + (\varepsilon_3 - \varepsilon_1)^2}$$

$$\theta_{P,Q} = \frac{1}{2}\tan^{-1}\left(\frac{\sqrt{3}(\varepsilon_2 - \varepsilon_3)}{2\varepsilon_1 - \varepsilon_2 - \varepsilon_3}\right)$$

5.3.7.8 Calculations valid for all Rosette Types

- Max/Min Principle Stress

$$\sigma_P = \frac{E}{1-\gamma^2}(\varepsilon_P + \gamma\varepsilon_Q)\left[\frac{\mathrm{N}}{m^2}\right]$$

$$\sigma_Q = \frac{E}{1-\gamma^2}(\varepsilon_Q + \gamma\varepsilon_P)\left[\frac{\mathrm{N}}{m^2}\right]$$

- Von Mises Stress

$$\sigma_{vM} = \sqrt{\frac{(\sigma_P - \sigma_Q)^2 + \sigma_P^2 + \sigma_Q^2}{2}}\left[\frac{\mathrm{N}}{m^2}\right]$$

- Max Shear Stress

$$\sigma_{SP} = \frac{\sigma_P - \sigma_Q}{2}\left[\frac{\mathrm{N}}{m^2}\right]$$

- Addition to Angle Calculation

Quadrant	*Z*	*N*	*Angle φ0*	$\varphi^* = tan^{-1}\left(\frac{num}{denom}\right)$
I	+	+	*0° ≤ φ0 ≤ +45°*	$\varphi_0 = \frac{\varphi^*}{2}$
II	+	-	*+45° ≤ φ0 ≤ +90°*	$\varphi_0 = \frac{180° + \varphi^*}{2}$
III	-	-	*-45° ≤ φ0 ≤ -90°*	$\varphi_0 = \frac{\varphi^* - 180°}{2}$
IV	-	+	*0° ≥ φ0 ≥ -45°*	$\varphi_0 = \frac{\varphi^*}{2}$

Table 5-14: Determining the principal axis angle *φ0 taking the sign of the numerator and the enumerator into account*

5.3.8 PSOPHOMETER

Please refer to section 13.

5.3.9 Swept Sine Analysis

5.3.9.1 Introduction

Please note that 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 Figure 5-61):

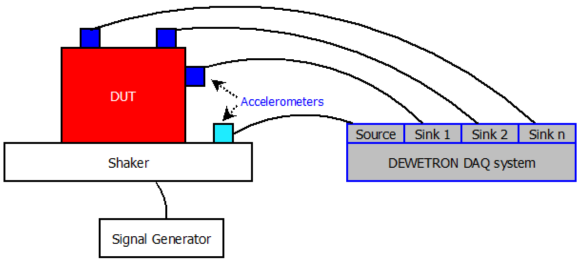


Figure 5-61: Exemplary testbed to use the Swept Sine Analysis plugin

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.

5.3.9.2 Setting up a Swept Sine Analysis

To set up the Swept Sine Analysis plugin, perform the following steps:

- At first, mark the checkbox of the channel which provides the reference signal for the Swept Sine Analysis (see ① in Figure 5-62)
- Next, mark the channel that provides the signal measured on the signal sink (see ② in Figure 5-62). Several sink signals could be applied to one Swept Sine Analysis group.
- Click on the *PLUS* (see ③ in Figure 5-62) 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.

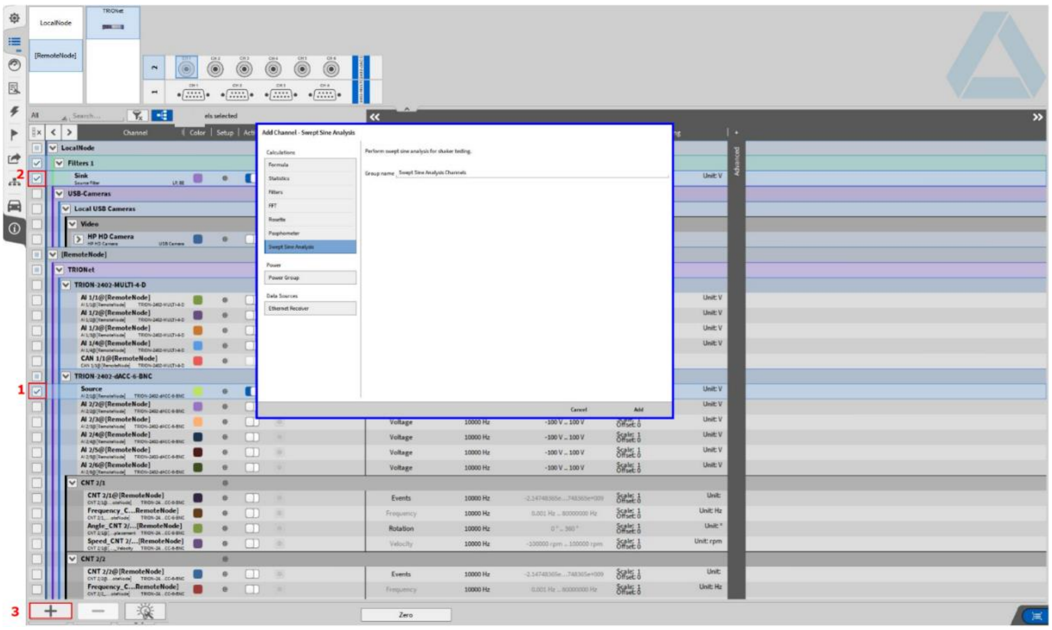


Figure 5-62: Steps to configure a Swept Sine Analysis

5.3.9.3 Setup Overview

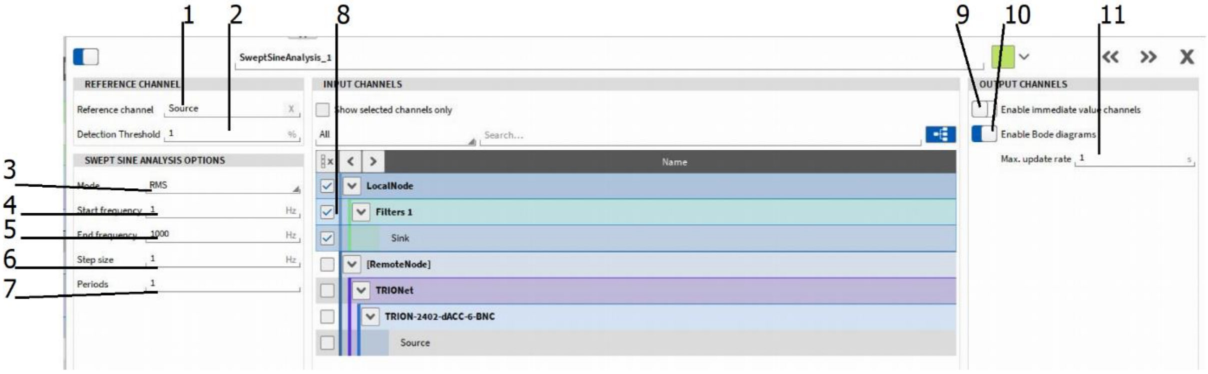


Figure 5-63: Swept Sine Analysis setup – Overview

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 section 5.3.9.4)
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 section 5.3.9.4) 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 (from 1 to 1000 Hz)
5	*Stop frequency* selection	Enter the upper frequency limit for the Swept Sine Analysis (from 1 to 1000 Hz)
6	*Step size* selection	Enter the frequency resolution of the Swept Sine Analysis (from 1 to 100 Hz)
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 section 5.3.9.4) are enabled with this switch; Per default disabled
10	*Enable Bode diagram* switch	The channels that contain the frequency domain signals (see section 5.3.9.4) are enabled with this switch; Per default enabled
11	*Max update rate* selection	Select the calculation update rate (from 1 to 10s)

Table 5-15: Swept Sine Analysis setup – Overview

5.3.9.4 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 Figure 5-63) 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 section 6.4), Digital Meter (see section 6.3) 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 section 6.4), Digital Meter (see section 6.3) 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 Figure 5-63) of the signal at the actual frequency; The amplitude is referring to the entire signal components; Can be assigned to a Recorder (see section 6.4), Digital Meter (see section 6.3) 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 Figure 5-63); The amplitude is referring to the fundamental frequency signal components; Can be assigned to a Spectrum Analyzer (see section 6.12) instrument for displaying the data.
- *ChannelName*_Phi: Frequency domain channel; Contains the phase diagram; Can be assigned to a Spectrum Analyzer (see section 6.12) 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 Figure 5-63); The amplitude is referring to the entire signal components; Can be assigned to a Spectrum Analyzer (see section 6.12) instrument for displaying the data.

5.3.9.5 Calculation Remarks

- The maximum frequency span is from 1 to 1000 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, this 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 section 4.1.2), this data array will only be included in the last data file, the other files won’t contain this data.
- If the sweep is passing the same frequency several times, there won’t 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 ⑯ in Figure 2-1) 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 won’t be reduced Statistics data available (see section 7).

5.3.10 OFFLINE MATH

The topology *Offline Math* deems calculations that shall be performed after the measurement is finished within a data file. OXYGEN 3.1 supports the following Offline Math features. The features will be extended within the proximate OXYGEN releases.

- Channels can only be edited within one open session. This denotes that channels can be created and edited as long as a data file is opened. After re-opening a data file, the previously created channels cannot be edited any more.
- Channels can be added in the same manner as explained in section 5.3 by clicking on the *+* button (see Figure 5-19) at the lower left side of the Channel List.

- Channels created within one open session can be deleted by clicking on the *Delete Math Channel* button (see Table 5-1). After re-opening a data file, the previously created channels cannot be deleted any more.
- Formulas, Filters, Statistics and FFT channels can be created and edited within one session. The Psophometer plugin and the Swept Sine Analysis plugin can be used offline as well. Offline Math is not applicable yet for Power Groups, Rosette calculations or the scaling of an analog input channel.
- 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 Figure 5-64):

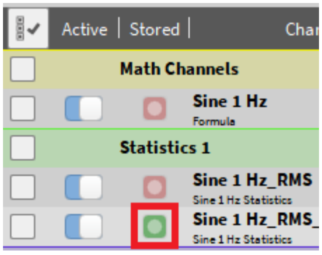


Figure 5-64: Recognition of offline created channels

- Created channels and any changes can be stored to the data file by pressing the *Store data* button (see Figure 5-65 or ⑨ in Figure 2-1):


Figure 5-65: *Store data* button

- Created channels and any changes can be exported to a setup file by pressing the *Save setup file* button (see Figure 5-66 or ⑪ in Figure 2-1):


Figure 5-66: *Save setup file* button

- A *Progress indicator* will inform about the actual calculation progress (see Figure 5-67) and contains information about the number of calculated channels, the calculation progress in percent and the remaining calculation time:

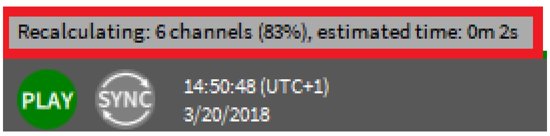


Figure 5-67: Progress indicator for Offline Math calculations

- 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.

- Please 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 section 7). In the example displayed in Figure 5-68, 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.

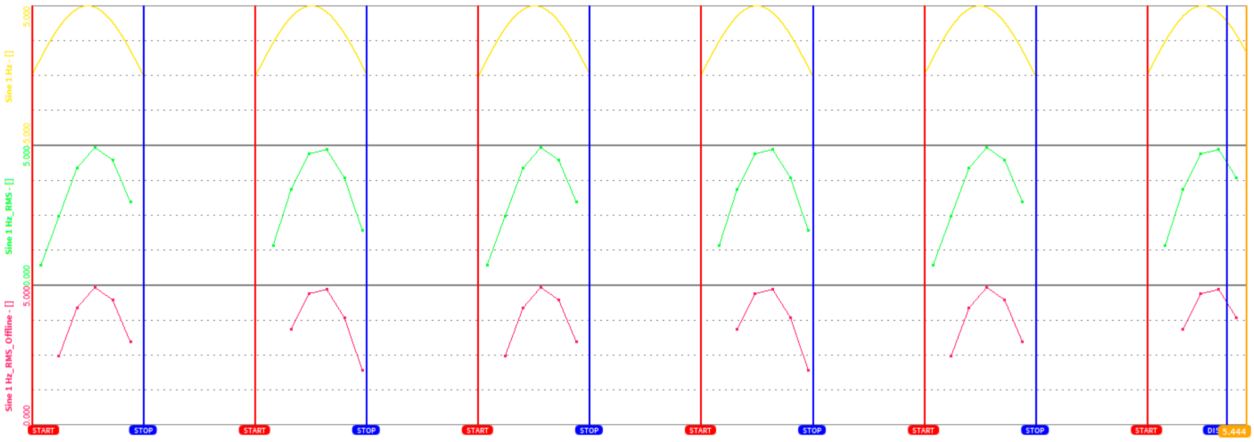


Figure 5-68: Deviation of Offline and Online statistics channels in case of Event based waveform recording

- Please 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 section 7). In the example displayed in Figure 5-69, 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.

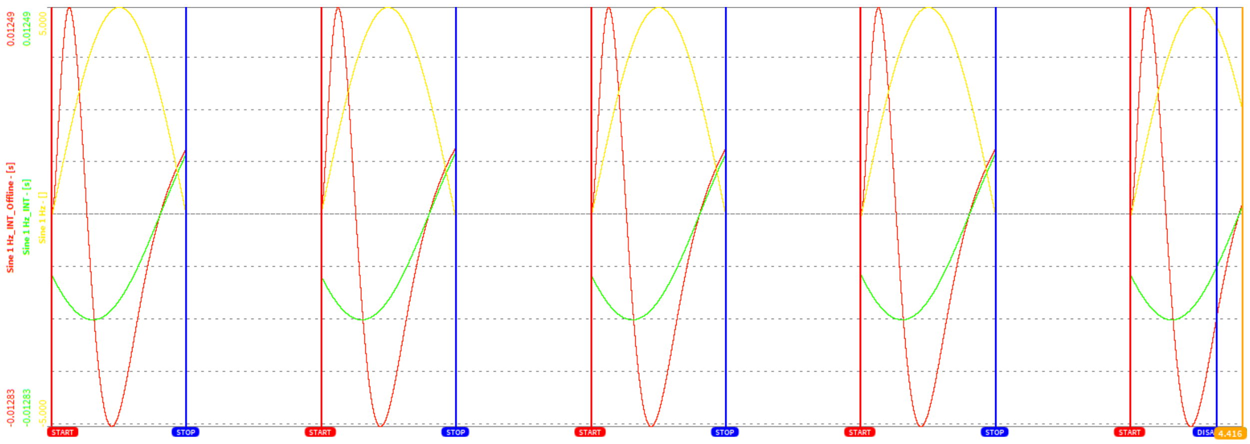


Figure 5-69: Deviation of Offline and Online Filter channels in case of Event based waveform recording

5.4 CREATING POWER GROUPS IN OXYGEN

Please note that this is an optional feature and requires a license.

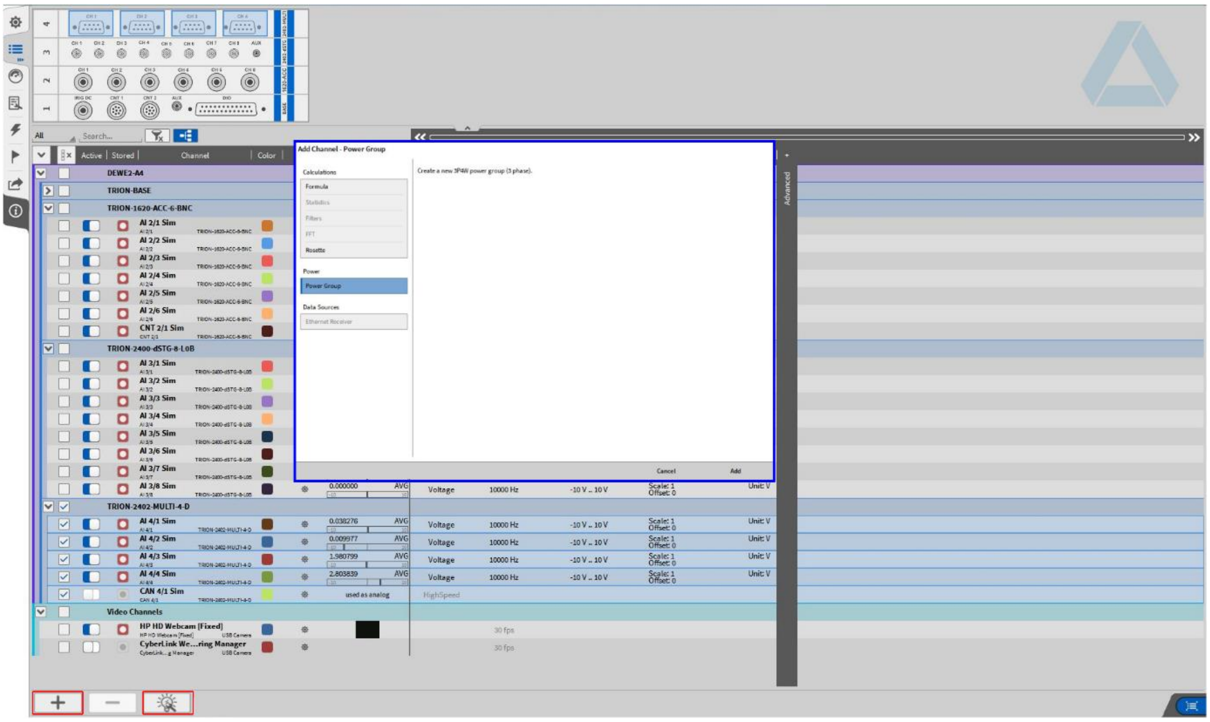


Figure 5-70: Popup window for creating a Power Group

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 Figure 5-70).
For details about the OXYGEN Power module please refer to the *Power Technical Reference Rx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

5.5 OXYGEN ETHERNET RECEIVER PLUGIN

Please note that this is an optional feature and requires a license.

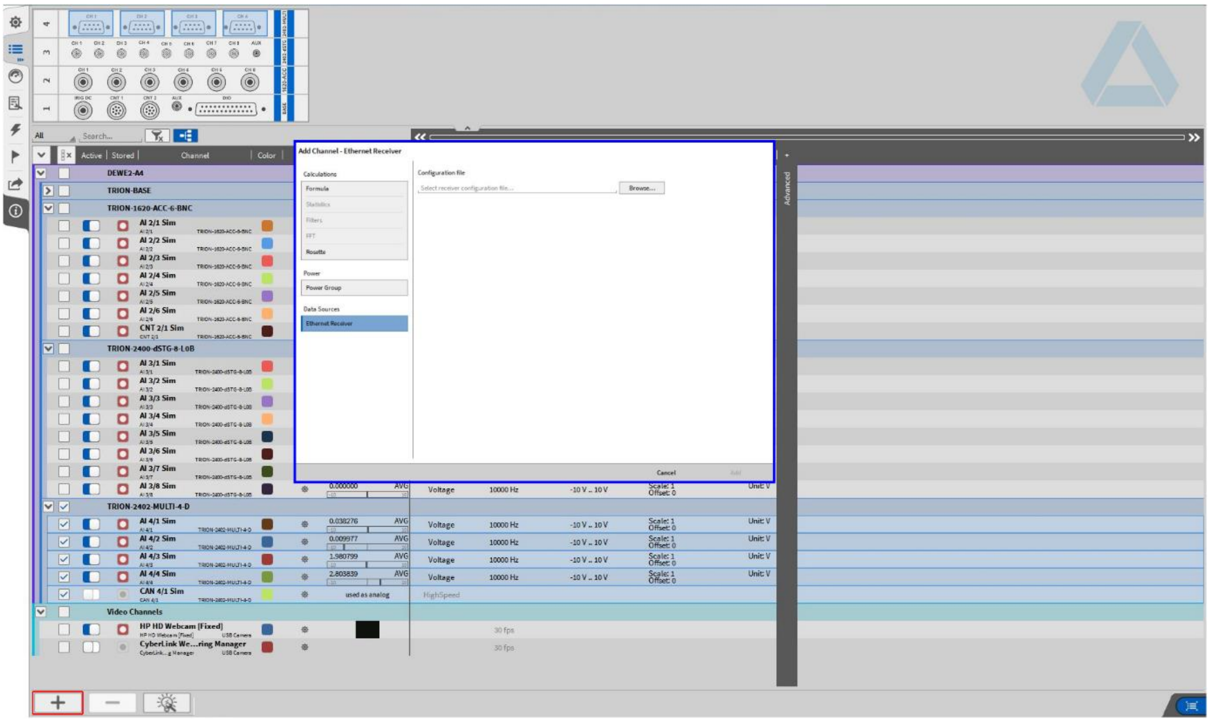


Figure 5-71: Popup window for acquiring an Ethernet Receiver Data stream

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 Figure 5-71).

For details about the Ethernet Receiver plugin please refer to the *Oxygen Ethernet Receiver XML Configuration Vx.x* Manual which is available on the DEWETRON CCC-portal (https://ccc.dewetron.com/).

5.6 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, please refer to the TRION™ module Technical Reference Manual.

5.6.1 EXPLANATION OF THE DIFFERENT COUNTER MODES (EXTRACT FROM THE TRION™ MODULE TECHNICAL REFERENCE MANUAL)

5.6.1.1 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.
Figure 5-72 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).

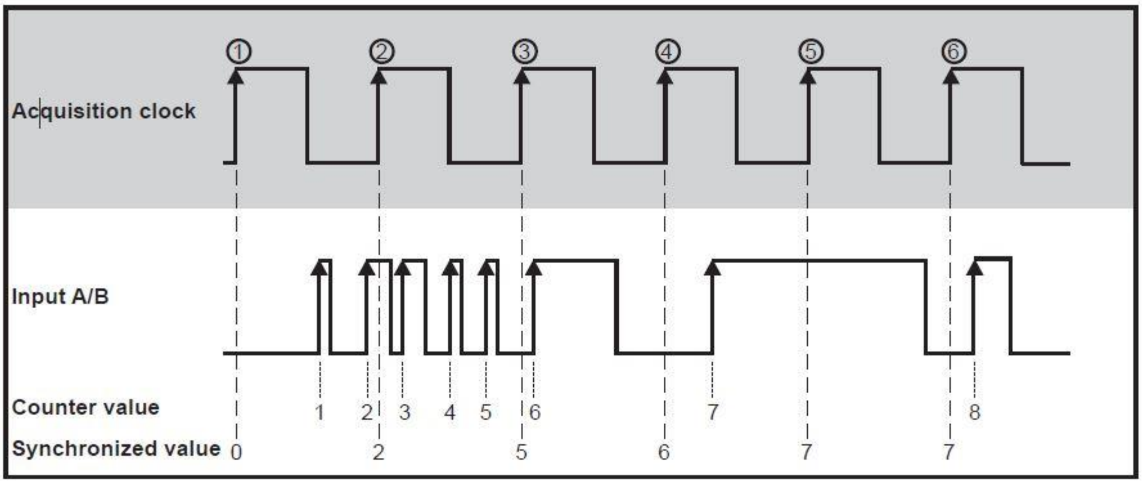


Figure 5-72: Event Counting

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.

5.6.1.2 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

Figure 5-73 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.

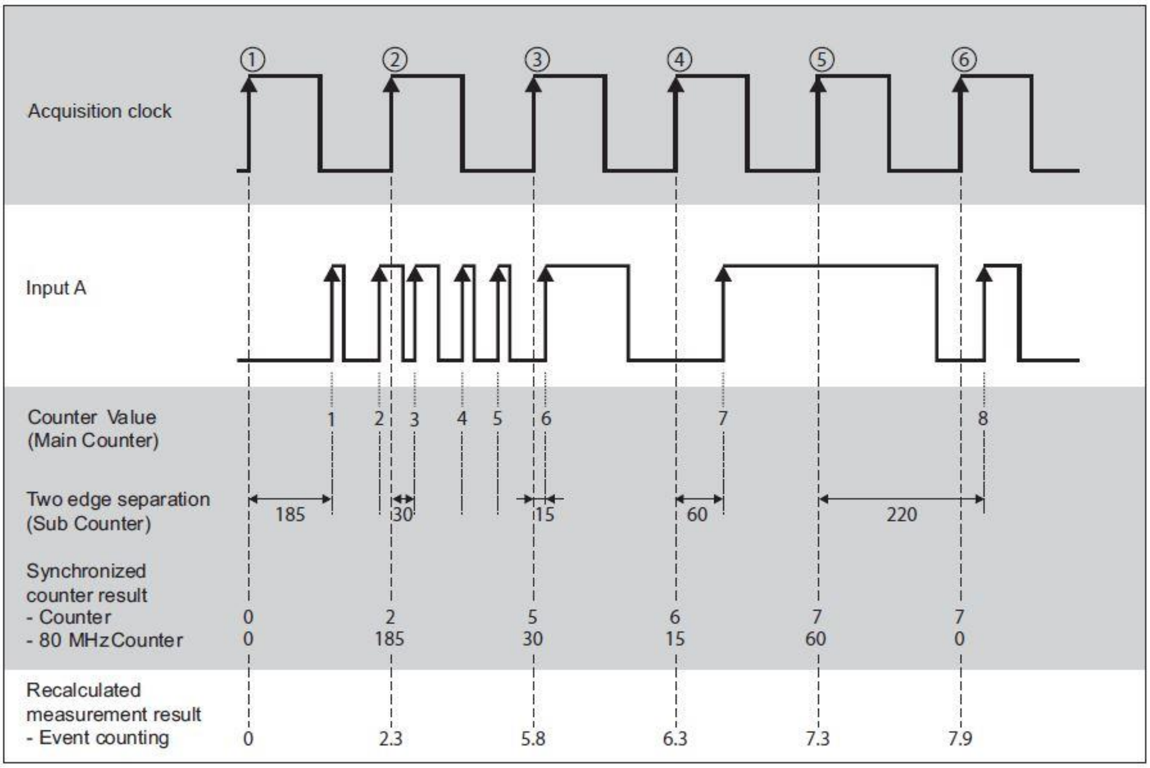


Figure 5-74 Frequency Measurement

5.6.1.3 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.

Figure 5-75 shows the resulting increments and decrements for X1 encoding.

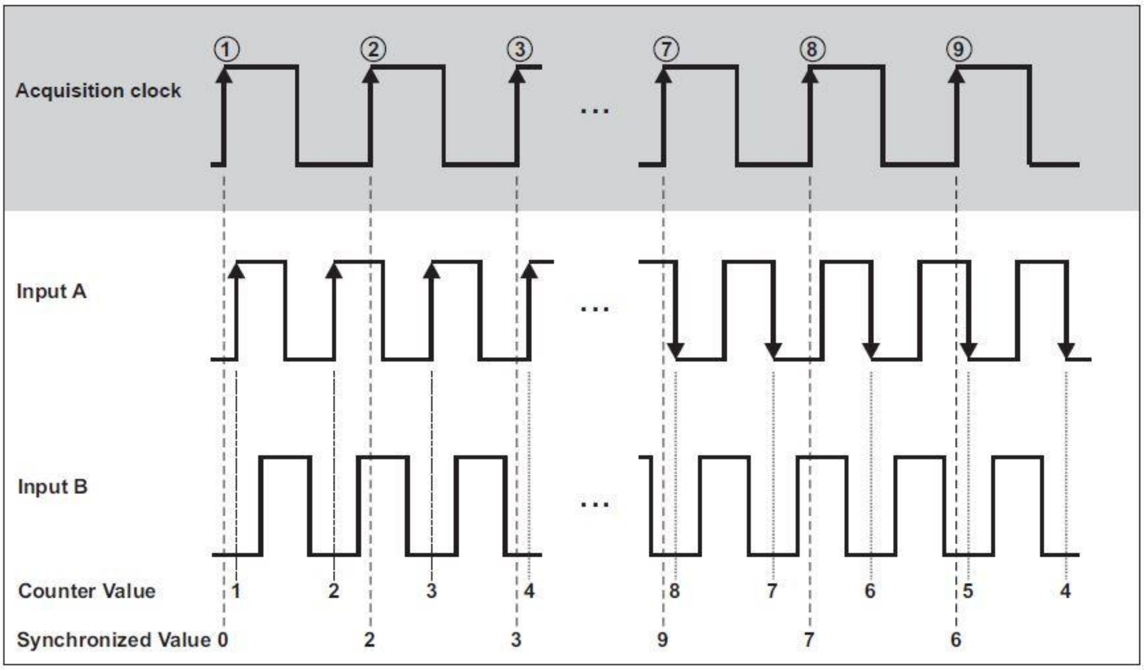


Figure 5-75: Quadrature Encoder X1 Mode

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 Figure 5-76.

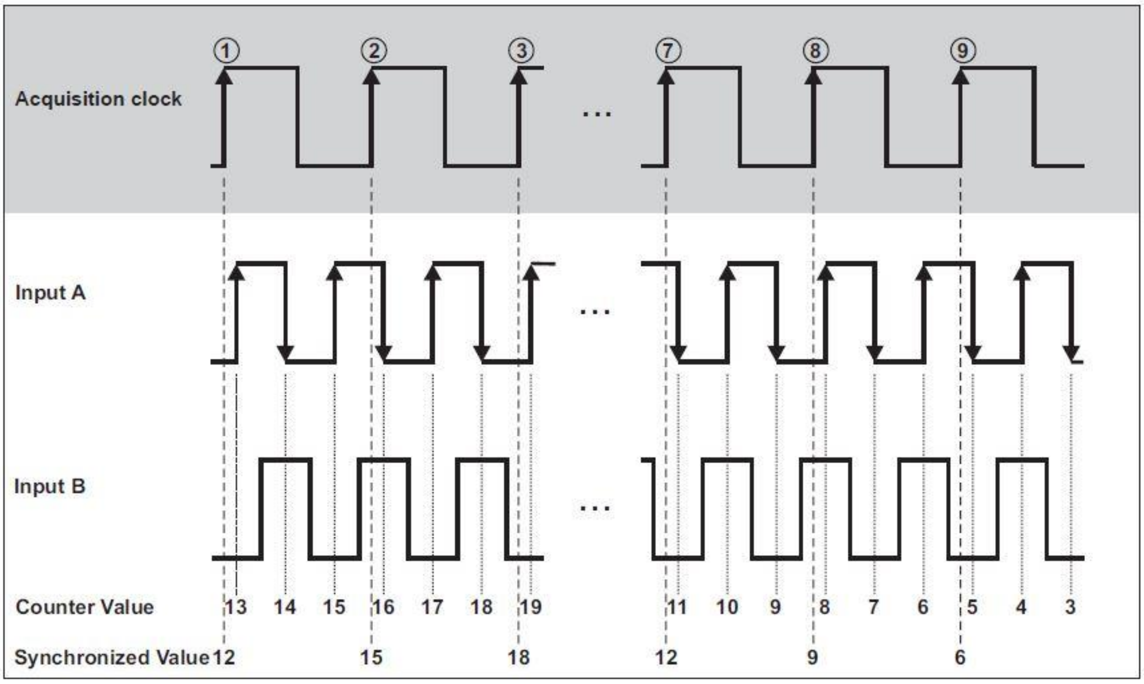


Figure 5-76: Quadrature Encoder X2 Mode

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.

Figure 5-77 shows the results for X4 encoding.

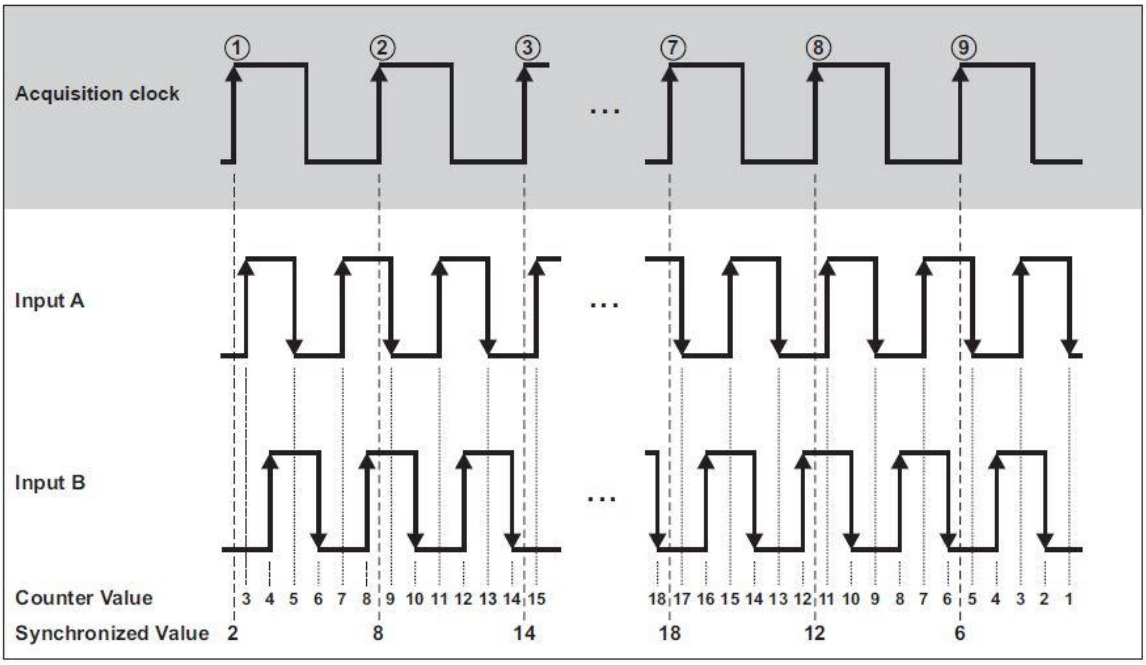


Figure 5-77: Quadrature Encoder X4 Mode

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.

Figure 5-78 shows the results for X1 encoding with input Z.

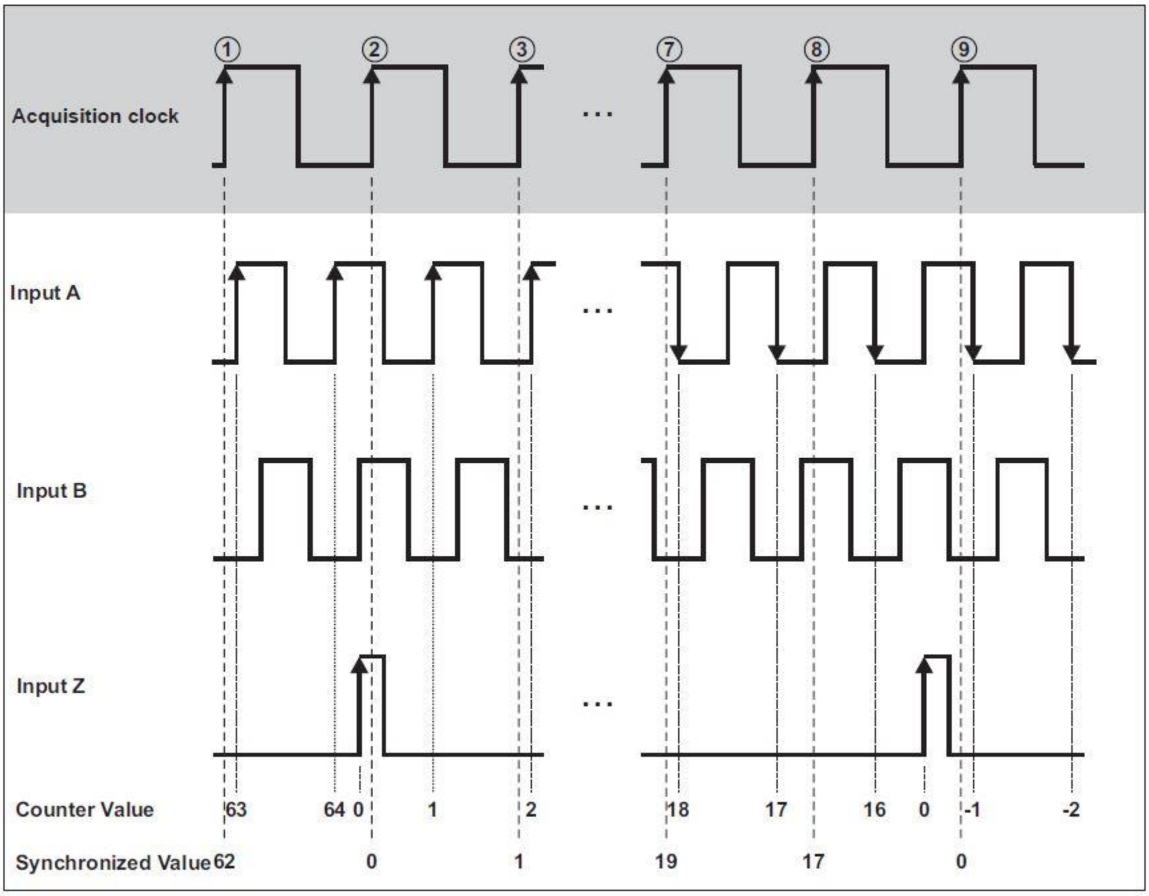


Figure 5-78: Quadrature Encoder with channel Z

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 Figure 5-79.

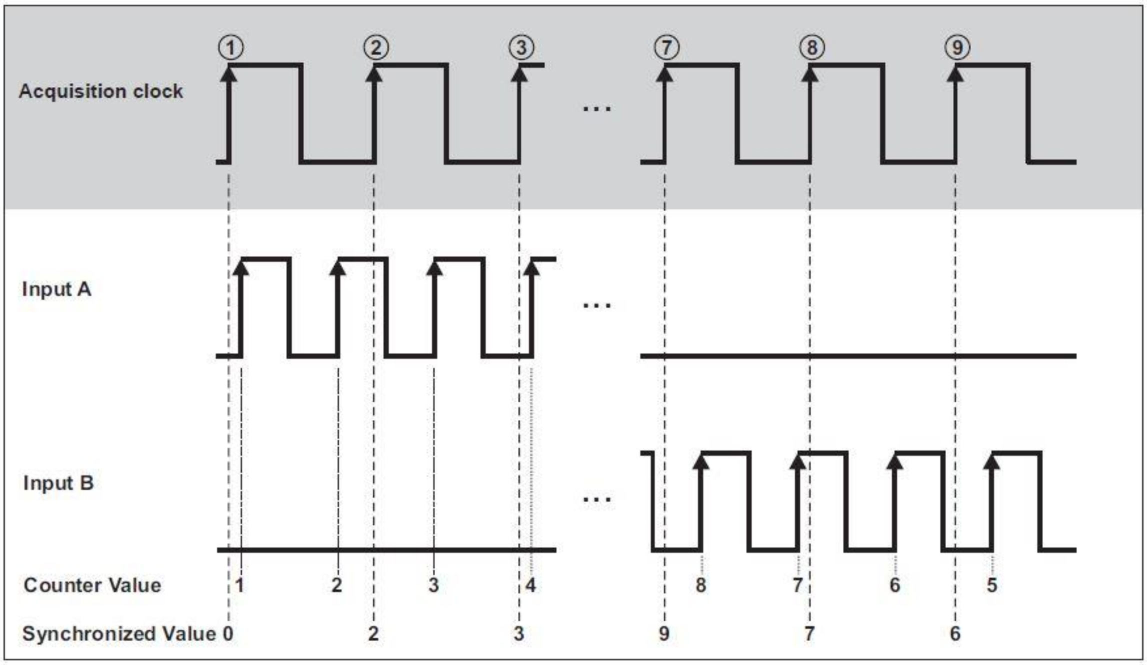


Figure 5-79: A-Up/B-Down Encoder

5.6.2 TRIONTM COUNTER OVERVIEW

Hardware						
	CNT	ACC	dACC	BASE	TIMING	VGPS
#Counter #DI/ Counter	6 18	1 -	2 -	2 6	1 3	1 3
Isolation	✓	✓	☒	☒	☒	☒
Trigger Level	0 to 50V 12mV steps	70% of input range	Progr. within input range	CMOS/TTL	CMOS/TTL	CMOS/TTL
Sensor Supply	5V and 12V	☒	☒	5V and 12V	5V and 12V	5V and 12V
Software						
Encoder CDM+Trigger	✓	☒	☒	✓	✓	✓
Frequency Measurement	✓	✓	✓	✓	✓	✓
Event Counting	✓	✓	✓	✓	✓	✓
Trigger Level	0 to 50V 12mV steps	70% of input range	CMOS/TTL	CMOS/TTL	CMOS/TTL	CMOS/TTL

Table 5-16: TRIONTM Counter Overview

As shown in Table 5-16, *Frequency* measurement and *Event* counting can be done with every TRIONTM module with counter input. Encoders and CDM+Trigger sensors cannot be connected to a the TRIONTM-1620-ACC or the TRIONTM-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 TRIONTM-1620-ACC or TRIONTM-2402-dACC module, but no turning direction can be determined.

Please note that the Trigger Level supported by the TRION^{TM}-2402-dACC module differs from the software possibilities.

5.6.3 CHANNEL LIST OF COUNTER CHANNELS

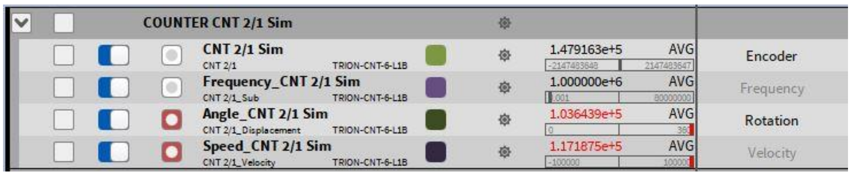


Figure 5-80: Channel List of a Counter channel

4 single sub-channels are created for each available Counter channel (*COUNTER CNT 2/1 Sim* in Figure 5-80)in the Channel List. The counter hardware of one Counter channel (except TRION^{TM}-dACC and TRION^{TM}-ACC hardware) consists of two different counter logics, the *Main counter* and the *Sub counter* (see Figure 5-81).
The first sub-channel (*CNT 2/1 Sim* in Figure 5-80) 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 Figure 5-80).
The second sub-channel (*Frequency_CNT 2/1 Sim* in Figure 5-80) 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 Figure 5-80), sub-channel two (*Frequency_CNT 2/1 Sim* in Figure 5-80) is deactivated and does not display data.
The third sub-channel (Angle_*CNT 2/1 Sim* in Figure 5-80) 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 Figure 5-80) calculates the speed by using the data acquired from the *Main counter* and *Sub counter* logic.

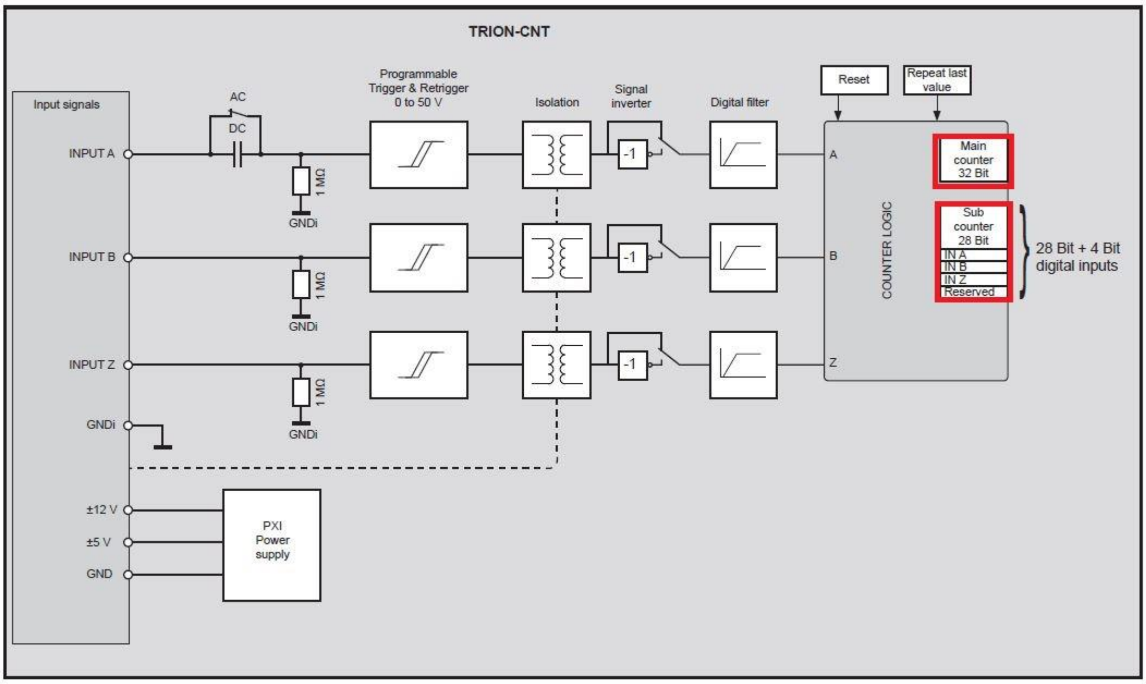


Figure 5-81: Block diagram of one Counter channel on a TRION^{TM}-CNT module

Remark: Please note that 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!

5.6.4 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* Figure 5-82) and can be entered by clicking on the gear button (see Figure 5-82). The scaling of a sub-channel can be changed in the Channel Setup of the individual sub-channel.

Figure 5-82: Channel List 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.

5.6.4.1 Channel Setup for a TRION™-CNT Channel in *Event* mode

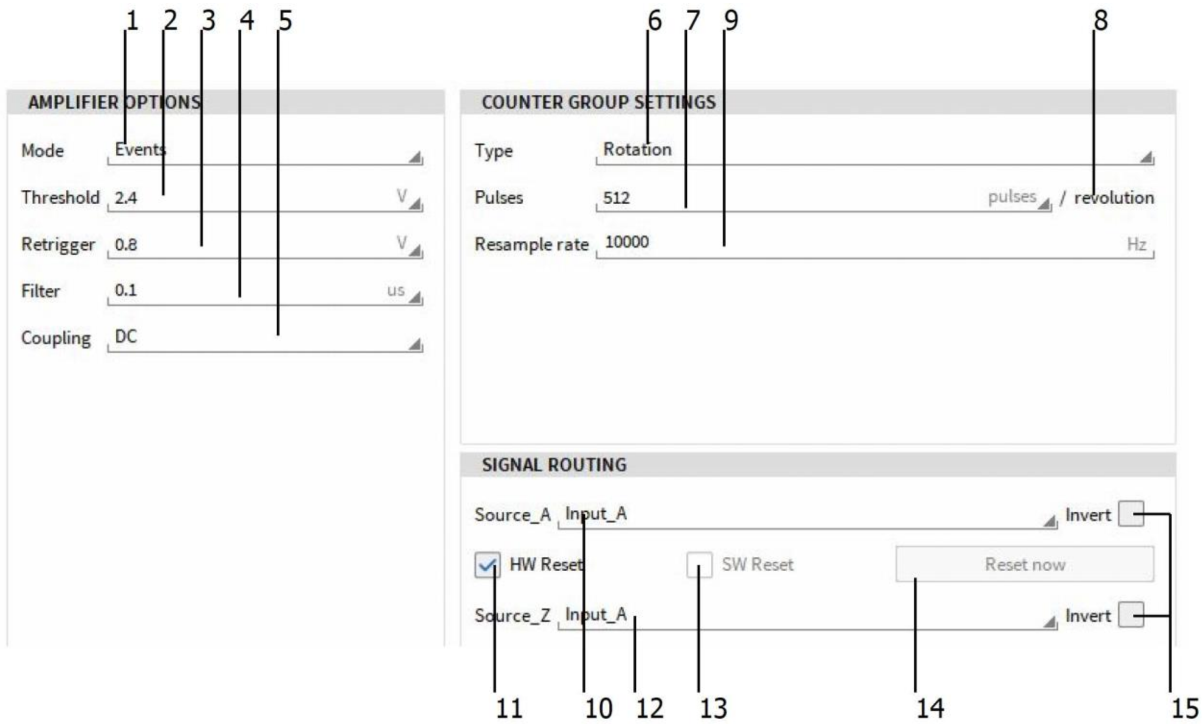


Figure 5-83: Channel Setup for a TRION™-CNT channel in *Event* mode

	Amplifier Options	
1	*Mode* menu	Counter mode selection: *Events*, *Frequency* or *Encoder*
2	*Threshold* level	Threshold (Trigger) Level selection (depends on the TRIONTM hardware, see Table 5-16)
3	*Retrigger* level	Retrigger Level selection (depends on the TRIONTM hardware, see Table 5-16)
4	*Filter* menu	Selection of a digital filter; for additional information please refer to section 5.6.5
5	*Coupling* menu	Coupling (HP filter) selection (availability depends on TRIONTM 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	*Unit* selection	Unit selection; for rotational sensors fixed to *revolution*, set to *meters* per default for linear sensors
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
	Signal Routing	
10	*Source_A* selection	Select the input signal that shall be routed to *Source_A*
11	*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
12	*Source_Z* selection	Select the input signal that shall be routed to *Source_Z* (only applicable if *HW Reset* is selected)
13	*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
14	*Reset now* button	If this button is pressed, a manual hardware reset is forced
15	*Invert channel* button	Inverts the respective input channel

Table 5-17: Menu of a Counter channel in the *Event* mode

Remark: An automatic Counter Reset at Recording Start is not supported

5.6.4.2 Channel Setup for a TRIONTM-CNT Channel in *Encoder* mode

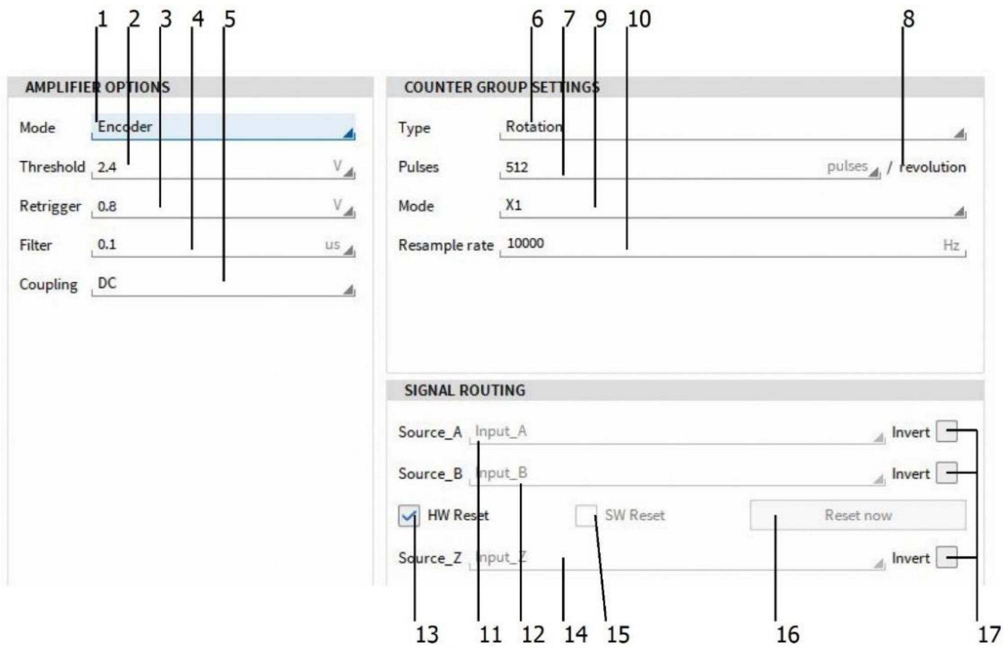


Figure 5-84: Channel Setup for a TRIONTM-CNT channel in *Encoder* mode

	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 5-16)
3	*Retrigger* level	Retrigger Level selection (depends on the TRION™ hardware, see Table 5-16)
4	*Filter* menu	Selection of a digital filter; for additional information please refer to section 5.6.5
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	*Unit* selection	Unit selection; for rotational sensors fixed to *revolution*, set to *meters* per default for linear sensors
9	*Encoder Mode* selection	Select the Encoder mode: *X1*, *X2*, *X4*, *A-Up/B-Down*
10	*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
	Signal Routing	
11	*Source_A* selection	Displays the signal that is routed to *Source_A* (routing can't be edited in the *Encoder* mode)
12	*Source_B* selection	Displays the signal that is routed to *Source_B* (routing can't be edited in the *Encoder* mode)
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
14	*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)
15	*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
16	*Reset now* button	If this button is pressed a manual hardware reset is forced
17	*Invert channel* button	Inverts the respective input channel

Table 5-18: Menu of a Counter channel in the *Encoder* mode

Remark: An automatic Counter Reset at Recording Start is not supported

5.6.5 Digital Filter of a Counter Channel (extract from the TRION™ module Technical Reference Manual)

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.

Figure 5-85 demonstrates the function of the filter.

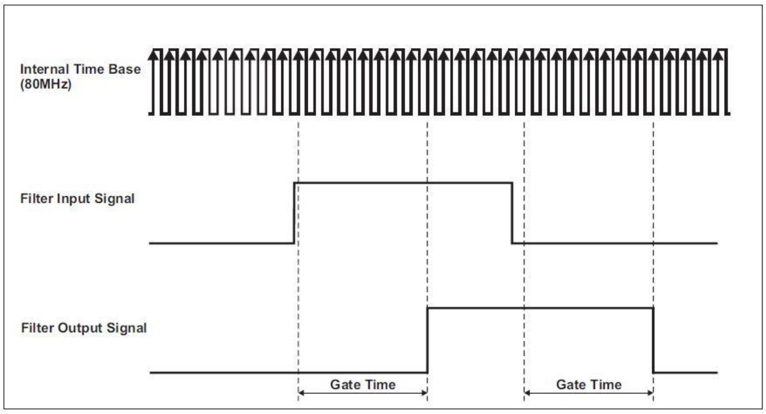


Figure 5-85: Digital filter

The intent of the filter is to eliminate unstable states, e.g. glitches, jitter… which may appear on the input signal, as shown in Figure 5-86.

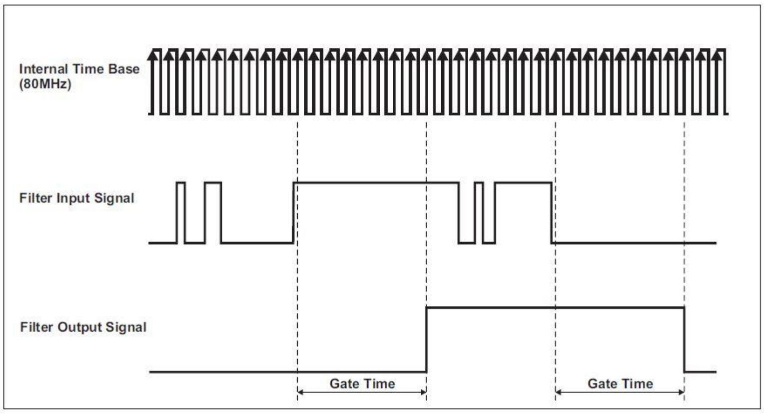


Figure 5-86: Input signal with chatter

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	-	-

Figure 5-87: Filter Gate Times

5.6.6 SUPPORTED COUNTER SENSORS

Due to the software and TRION^{TM}-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:

	Mounting	Connect	Pulses	Frequency	Required Digital counter inputs	Measurement		
						RPM	Angle	Direction
Tacho	Easy	Analog or adj. CNT	1	0.1 kHz	1	✓	☒	☒
CDM+Trigger	Hard	CNT	360/720/xxx	125 kHz	2	✓	✓	☒
Encoder	Hard	CNT	Up to 36000 and more	~100 kHz	3	✓	✓	✓

Table 5-19: Characteristics of Tacho, CDM+Trigger and Encoder sensors

5.6.6.1 Mandatory channel settings for Tacho sensors

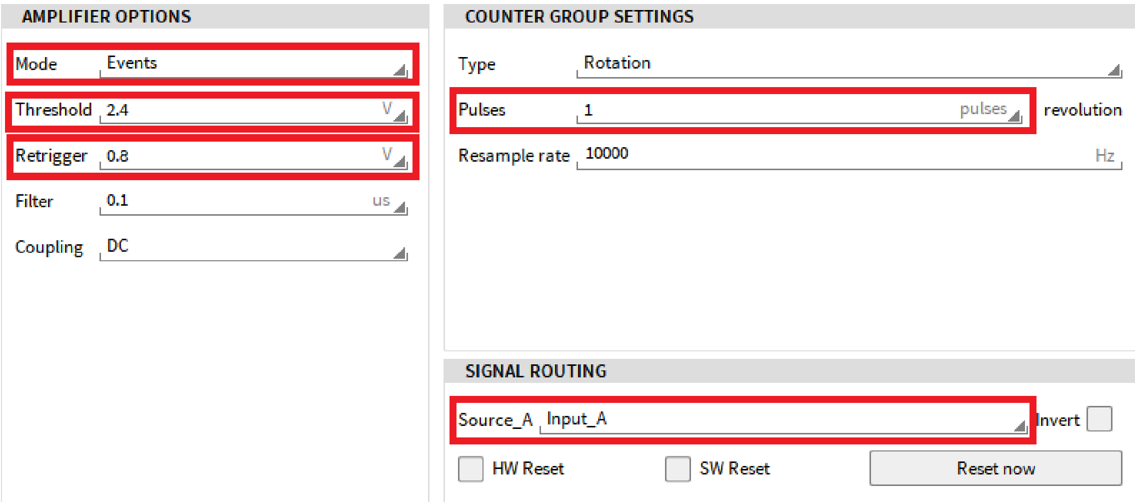


Figure 5-88: Channel settings for a Tacho sensor

- 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*

5.6.6.2 Mandatory channel settings for CDM+Trigger sensors

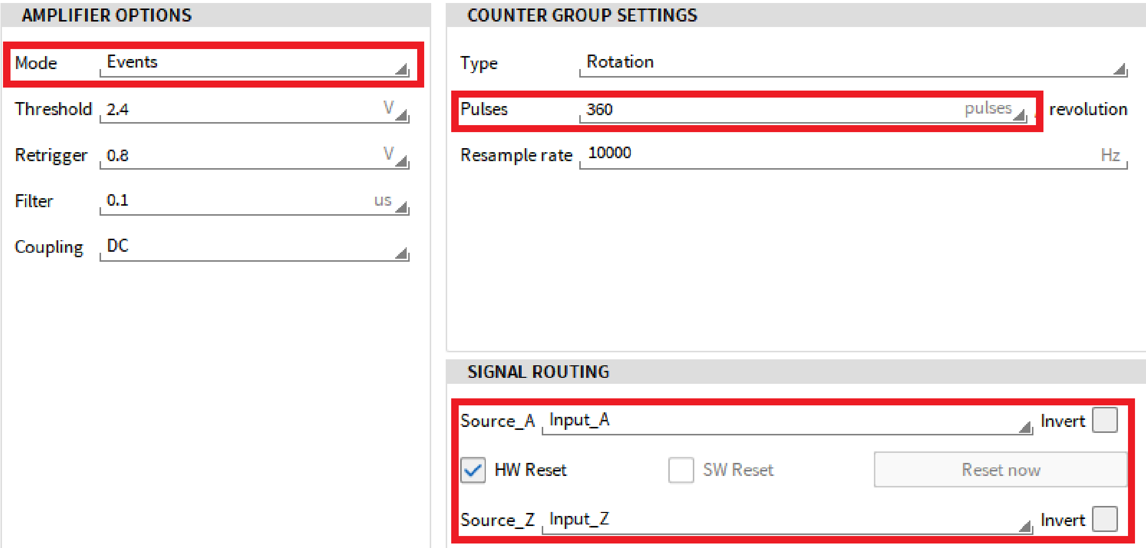


Figure 5-89: Channel settings for a CDM +Trigger sensor

- 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)
- **Remark:** The Amplifier *Mode* can also be set to *Encoder*. In this case, the same settings as in Figure 5-90 are mandatory. Please note that the routing of the *Source_A* and *Source_B* input cannot be changed!

5.6.6.3 Mandatory channel settings for Encoder sensors

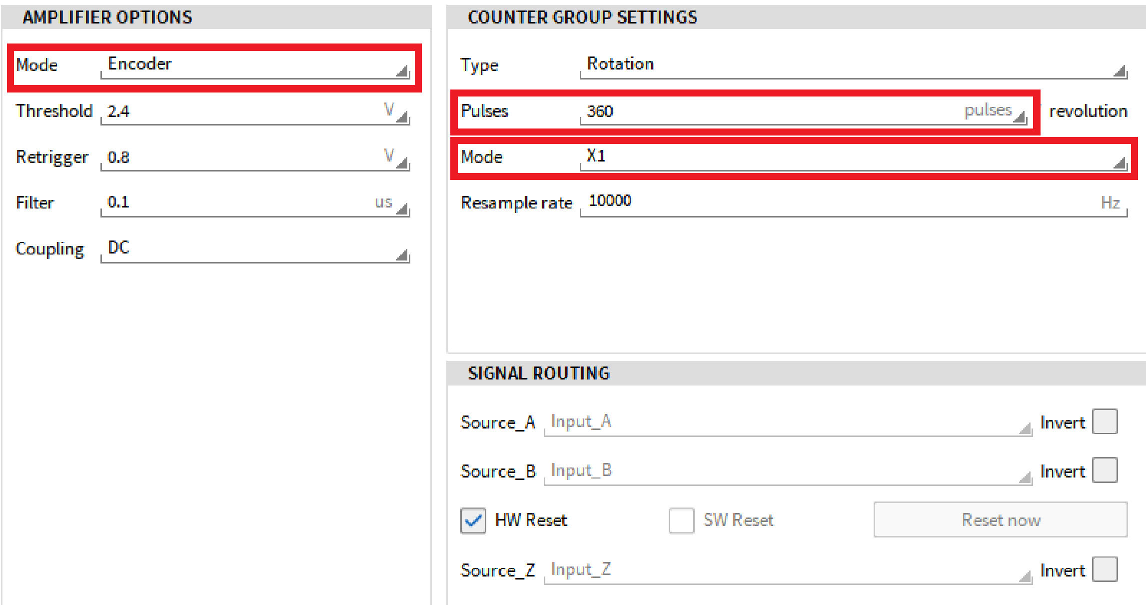


Figure 5-90: Channel settings for an Encoder sensor

- 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

5.7 CAN Input Channels

5.7.1 Loading the DBC-file

To use an input channel as a CAN channel, make sure that the Channel Mode of the Analog Input is set to *CAN* (see Figure 5-91). When this is done, the Analog channel is automatically deactivated and the CAN channel (which can be found below the Analog channels as a separate CAN channel like in Figure 5-91) can be activated.

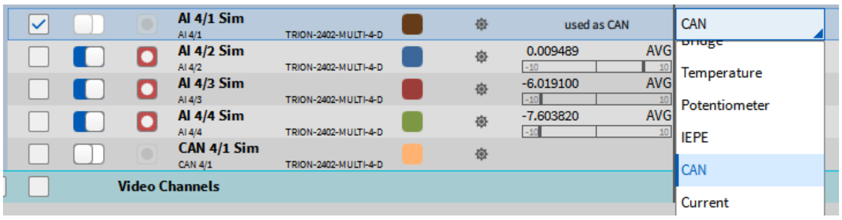


Figure 5-91: Enable CAN-channels

After that, a dbc-file can be loaded via the button *Load DBC* in the Channel Setup of the respective CAN channel (see Figure 5-92). The button *Clear all* deletes the loaded dbc-file again.

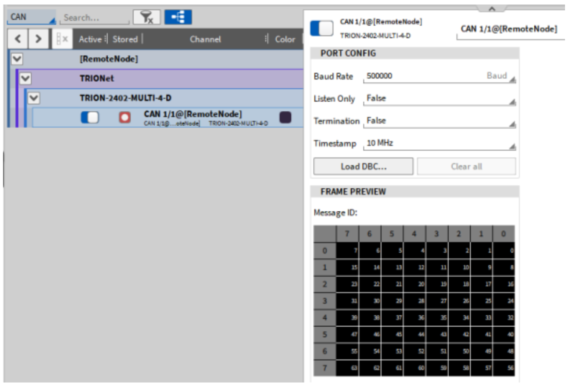


Figure 5-92: CAN-Channel Setup – Overview

After loading the dbc-file, the CAN channels will appear in the Channel List (see Figure 5-93) and can be activated.

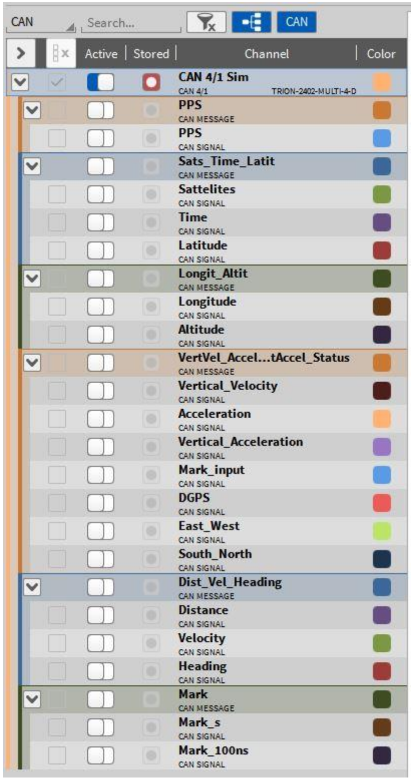


Figure 5-93: CAN channel list

Remark: To view the loaded messages and signals, you have to open the tree of the CAN Port.

5.7.2 SELECTING THE CAN-CHANNEL TIMEBASE

There are different possibilities, how timestamps are generated for the CAN Messages.

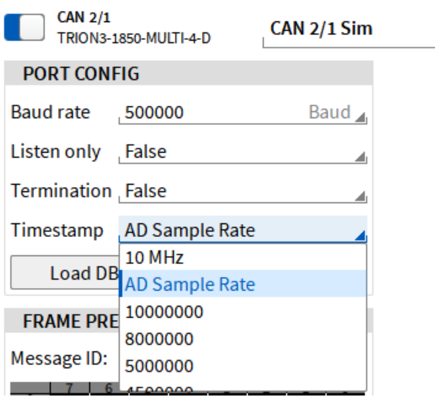


Figure 5-94: Timestamp Selection in the CAN channel menu

- Each CAN input channel on a TRION^{TM} module has a 10 MHz timing clock integrated. If *10 MHz* is selected in the Timestamp dropdown menu in the CAN Channel Setup (see Figure 5-94), the data received by the CAN channel is clocked by using this timing source. The accuracy will be 100ns.
- If *AD Sample Rate* is selected in the Timestamp dropdown menu in the CAN Channel Setup (see Figure 5-94), the data received by the CAN channel is clocked by using this timing source as well. Within OXYGEN the timestamp which is assigned by the 10 MHz timing clock is rounded to the closest timestamp of the sample rate of the Analog input channel. (i.e. CAN-time stamp: 0.0038743s is rounded to 0.0039s of the analog channel with 10 kHz sample rate). If several TRION^{TM}-modules with different sample rates are used, the highest sample rate is used.

- Select any other Timestamp sample rate, to bind the timestamps to an explicit rate.

All options other than *10 MHz* are mainly required for data export when analog and CAN data channels are exported simultaneously. If the *10 MHz* timing source was used for recording data, each CAN data sample is written to a separate line due to the higher timing accuracy. Figure 5-95 will clarify that. If the *AD Sample Rate* timing source was used for recording data, each timestamp of the CAN data is rounded, and the CAN data sample is exported to the line of the analog data which is has the closest timestamp. Figure 5-96 will clarify that.

1	Time [s]	Analog_Channel [V]	CAN_10_MHz_Sample_Rate [deg C]
38	0.0036	0.002324581	
39	0.0037	0.002586842	
40	0.0038	0.001895428	
41	0.0038743		23.5435791

Figure 5-95: CAN data export with 10 MHz timebase. Each CAN data sample is written to a separate line

1	Time [s]	Analog_Channel [V]	CAN_channel_AD_Sample_Rate [deg C]
29	0.0027	0.002026558	
30	0.0028	0.001096725	
31	0.0029	0.002622604	
32	0.003	0.002110004	
33	0.0031	0.001978874	23.86929321

Figure 5-96: CAN data export with AD Sample Rate timebase. Each CAN datapoint is written to the line of the analog data sample which has the closest timestamp

For detailed information about the data export, please refer to section 9.

5.7.3 TRANSMITTING MEASUREMENT DATA VIA CAN

Please note that this is an optional feature and requires a license.

It is not only possible to receive and decode CAN-Messages, it is also possible to transmit selected Oxygen measurement channels cyclically over the CAN-Bus. Each CAN-Message can be individually set to be received or transmitted.

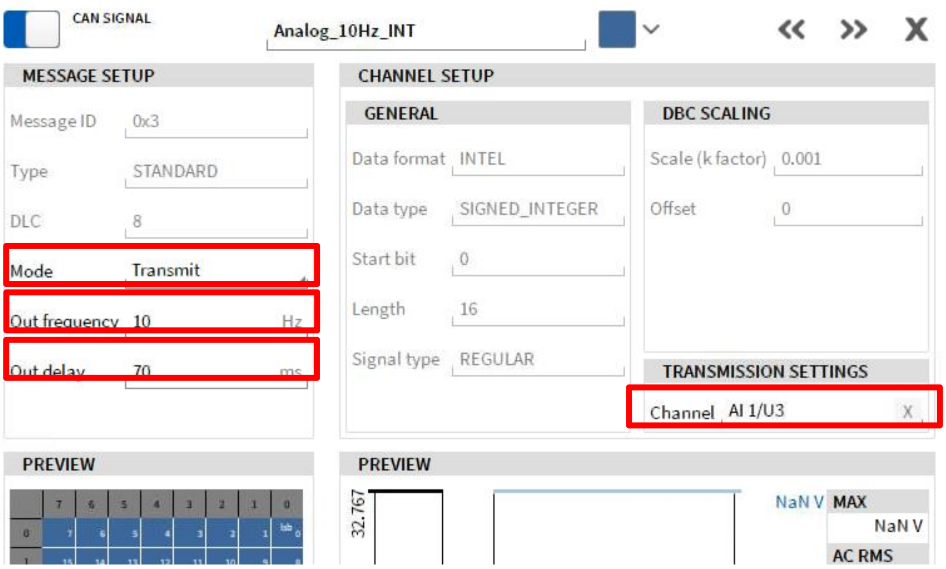


Figure 5-97: Timestamp Selection in the CAN channel menu

- *Message dependent Settings*
- *MODE: Select Transmit-Mode, if you want to transmit measurement data within this message*
- *Out frequency: Set the cyclic output frequency, allowed range is 0.1 to 100 Hz*
- *Out delay: Set an additional delay, to get smoother output due to block-wise operation*
- *Signal dependent Settings*
- *Channel: Drop the channel here, which should be transmitted*

Additional Information

- Message and Signal Encoding
  The signals are encoded with the data type and length defined in the DBC-file. If the channel has a value higher (or lower) than the possible range, the max (or min) value will be transferred. Please 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
- Delay settings
  To tune the responsiveness and the signal quality of the transmitted data, we introduced the *Out delay*. This is the time, which the data is delayed before sent. The following graphs show the difference between two individual settings:

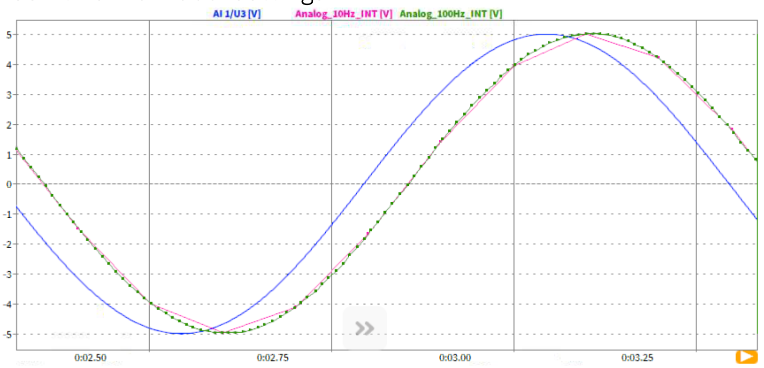


Figure 5-98: Blue: Analog Input; Green: CAN-Output with a delay of 70ms (default value)

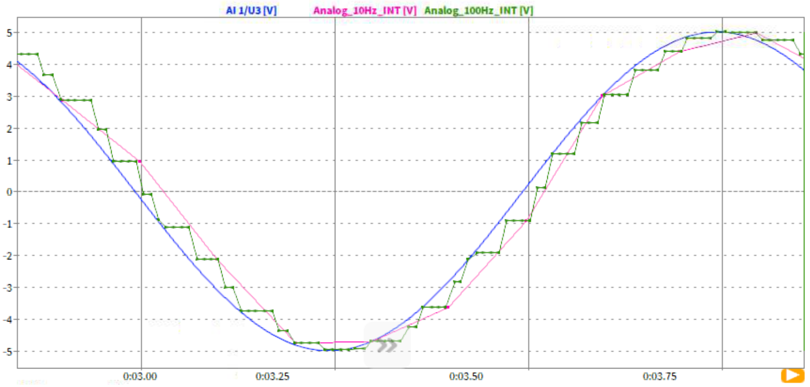


Figure 5-99: Blue: Analog Input; Green: CAN-Output with a delay of 10ms

Remark: This function requires a compatible hardware, at time of publishing of this manual, all TRION-Based CAN interfaces were supporting this feature.

5.8 GPS-CHANNELS

The following GPS data channels can be acquired by a TRION™-TIMING or TRION™-VGPS-20/-100 module:

Default Channel Name	Channel Mode	Channel description	Range	Unit	Data Type	Scaling available
GPS	NMEA	GPS NMEA channel	-	-	String	☒
Latitude_GPS	Latitude	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	-100m … 1000m	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	Satellites	Number of satellites in view	0 … 24	-	Double	☒
Fix Quality_GPS	Quality	GPS Fix Quality	-	-	String	☒
H. Dilution_GPS	HDOP	2D deviation of longitude and latitude	0m … 100m	m	Double	✓
SoD_GPS	Second	Current second of the day	0s … 86400s	m	Double	☒
Date_GPS	Date	Current date in the format yyy-mm-dd hh:mm:ss:ms	-	-	String	☒
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	0m … 1000000m	m	Double	✓

Table 5-20: Available GPS channels

Default Channel Name	Acquired from TRION™ hardware	Calculated channel	Calculation
GPS	✓	☒	-
Latitude_GPS	✓	☒	-
Longitude_GPS	✓	☒	-
Altitude_GPS	✓	☒	-
Velocity_GPS	✓	☒	-
Heading_GPS	✓	☒	-
Satellites_GPS	✓	☒	-
Fix Quality_GPS	✓	☒	-
H. Dilution_GPS	✓	☒	-
SoD_GPS	✓	☒	-
Date_GPS	✓	☒	-
Acceleration_GPS	☒	✓	Differentiation of channel Velocity_GPS
Distance_GPS	☒	✓	Integration of channel Velocity_GPS

Table 5-21: GPS - channel type

Remarks:

- 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 Figure 5-2). 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 section 5.3.1) or statistics calculations (see section 5.3.3).
- GPS channels cannot be filtered (see section 5.3.5) 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:

Default Channel Name	GPS plot	Analog Meter Digital Meter Bar Meter Indicator	Recorder Chart Recorder	Table	Scope	XY plot
GPS*	☒	☒	☒	✓	☒	☒
Latitude_GPS	✓	✓	✓	✓	✓	✓
Longitude_GPS	✓	✓	✓	✓	✓	✓
Altitude_GPS	☒	✓	✓	✓	✓	✓
Velocity_GPS	☒	✓	✓	✓	✓	✓
Heading_GPS	✓	✓	✓	✓	✓	✓
Satellites_GPS	☒	✓	✓	✓	✓	✓
Fix Quality_GPS	☒	☒	☒	✓	☒	☒
H. Dilution_GPS	☒	✓	✓	✓	✓	✓
SoD_GPS	☒	✓	✓	✓	✓	✓
Date_GPS	☒	☒	☒	✓	☒	☒
Acceleration_GPS	☒	✓	✓	✓	✓	✓
Distance_GPS	☒	✓	✓	✓	✓	✓

Table 5-22: GPS channels – compatible instruments

*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 Figure 5-100).

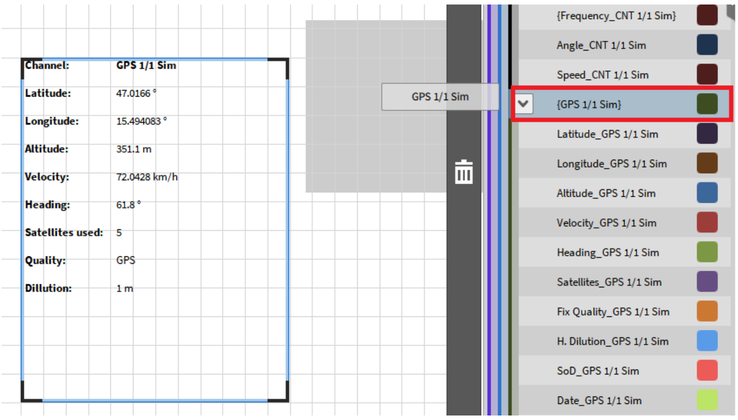


Figure 5-100: Drag and drop the GPS channel to the measurement screen

Remark: During GPS-channel analysis in *PLAY* mode, the GPS channels can also be exported to *.txt, *.csv, *.mdf4 or *.mat format (see section 9). 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.

5.9 Current Measurement Using TRION^{TM} Modules

Different TRION^{TM} 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 Figure 5-101) if *Current Amplifier Mode* is selected.

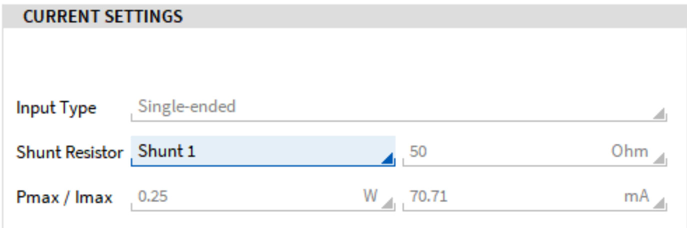


Figure 5-101: External Shunt resistor selection in the Channel Setup

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 dropdown list from Figure 5-101.
For sure, any shunt resistor can be used and not the ones contained in the dropdown 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 Figure 5-102):

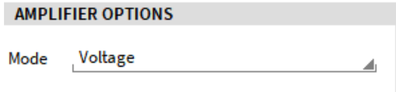


Figure 5-102: Voltage measurement mode

- Change the Unit to A(mpere) and enter the resistance of the shunt resistor as Scaling factor, i.e. 50 Ω (see Figure 5-103).

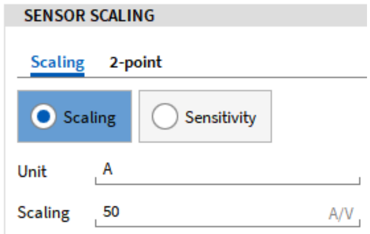


Figure 5-103: Entering the shunt resistance as scaling factor

- 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 dropdown list. Thereby, the voltage signal is multiplied with the entered *Scaling* factor and the result of this equation is the corresponding current:

$$Corresponding\ Current\ I = Scaling\ Factor\ R * Measured\ Voltage\ U$$

  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!

5.10 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

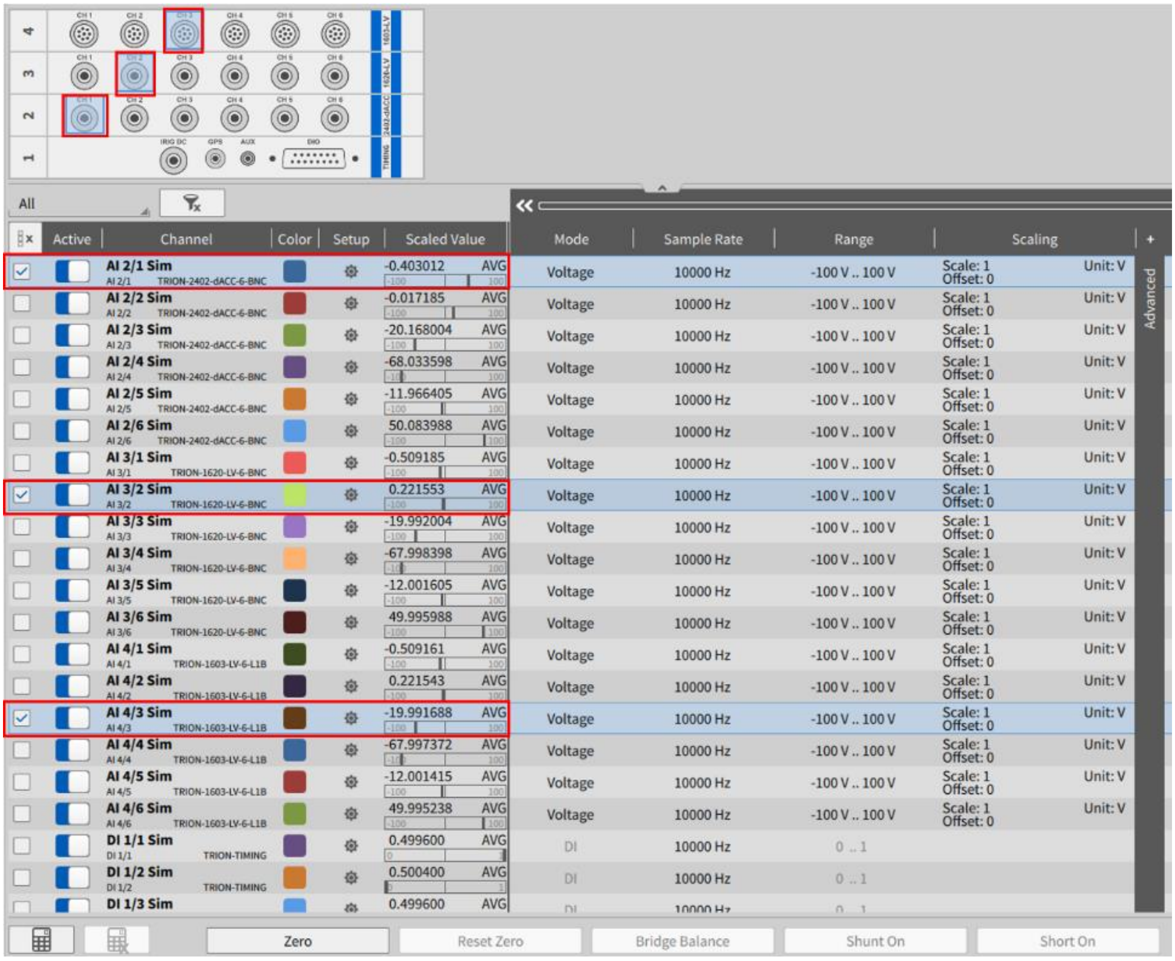


Figure 5-104: Selection of several channels

Remark: It is also possible to Copy (CTRL+C) and Paste (CTRL+V) the settings between identical input channels

5.11 Channel List Filtering Options

As explained in Table 5-1, the user can filter the channels according to their channel type and to their channel name. There are additional filtering options available which are explained in the following sections.

5.11.1 Filtering by the *Active* Column

- Fully open the *Data Channels* menu
- Left click onto the *Active* column header
- A sorting menu will appear which allows the user to sort from A to Z, Z to A, 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 either left click onto the *true* or *false* buttons themselves, or the user can simply type *true* or *false* within the menus text field
- Selecting *true* will present the user only the activated channels. Likewise, if the user selects *false* only the inactive channels will be presented.
- Delete an active filter with the *Clear filter* button again (see ④ in Table 5-1)

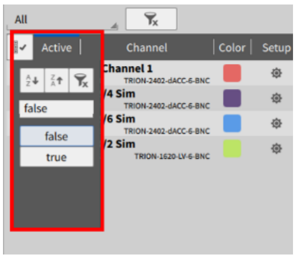


Figure 5-105: Filtering by the *Active* Column

5.11.2 FILTERING BY THE *CHANNEL* COLUMN

- Fully open the *Data Channels* menu
- Left click onto the *Channel* column header
- A sorting menu will appear which allows the user to sort by channel name from A to Z, Z to A. The user can also isolate a specific channel by name or name prefix such as AI or DI.
- The user can either left click onto a channel name button, or 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 channel name such as “My Channel 1”, will only present the user with that specified channel. This makes searching for channels efficient, easy, and effective.
- Delete an active filter with the *Clear filter* button again (see ④ in Table 5-1)

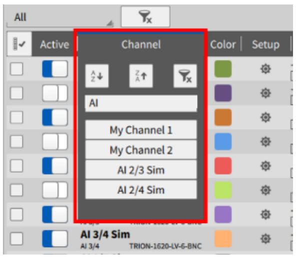


Figure 5-106: Filtering by the *Channel* Column

5.11.3 FILTERING BY THE *MODE* COLUMN

- Fully open the *Data Channels* Menu
- Left click onto the *Mode* column header
- A sorting menu will appear which allows the user to sort by Mode name from A to Z, Z to A, or by clicking on a Mode name
- The user can either left click onto a Mode name button, or the user can simply type a Mode name within the menus text field. The software will automatically update the Mode list as you type.
- Selecting a specific Mode name such as *Temperature* will only present the user with those specified channels. This makes searching for channels efficient, easy, and effective.
- Delete an active filter with the *Clear filter* button again (see ④ in Table 5-1)

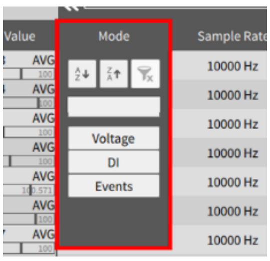


Figure 5-107: Filtering by the *Mode* Column

6 INSTRUMENTS AND INSTRUMENT PROPERTIES

6.1 ADDING AN INSTRUMENT TO THE MEASUREMENT SCREEN AND CHANNEL ASSIGNMENT

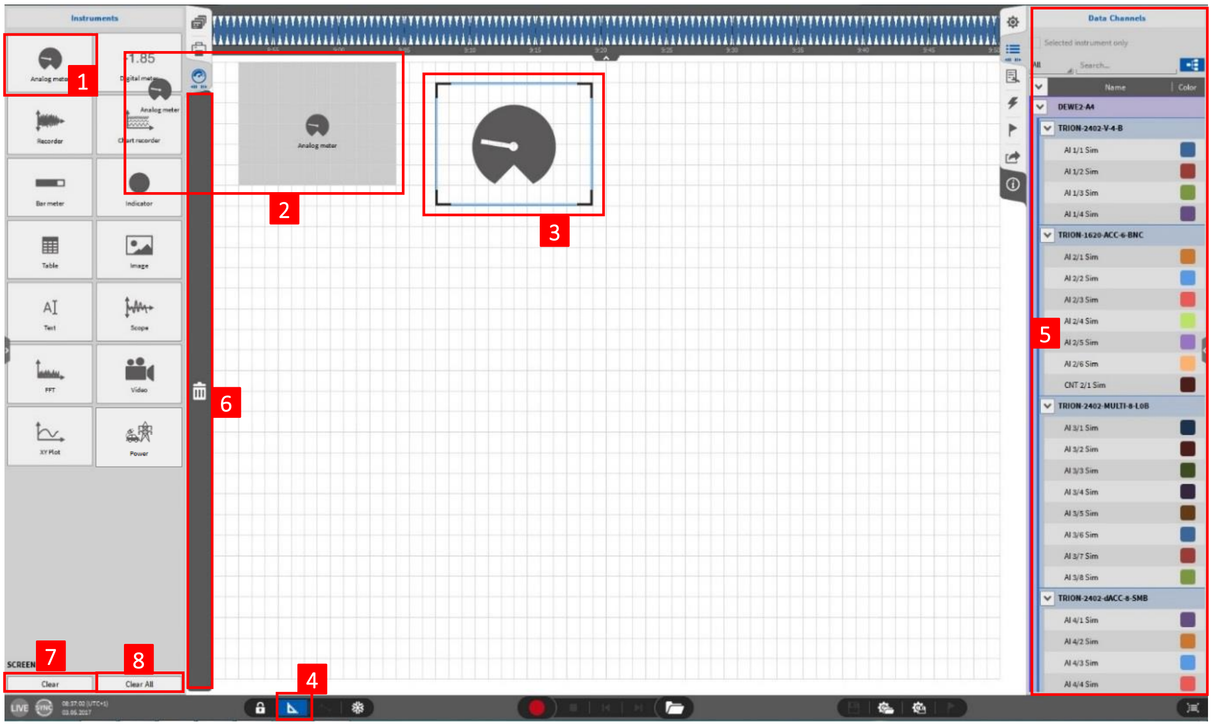


Figure 6-1: Adding Instruments to the measurement screen

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 Figure 6-1, 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.

Remarks:

- 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 Figure 6-2) or by keeping CTRL+SHIFT pressed while selecting the Instruments. All Instruments on a measurement screen can be selected by pressing CTRL+A.

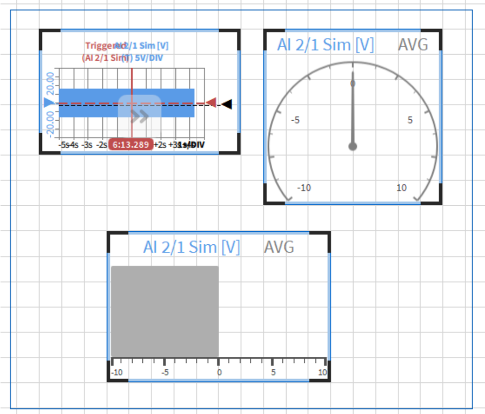


Figure 6-2: Selection of several Instruments in the Design Mode

- 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.

!!! Warning: Pressing the *Clear* and the *Clear all* button can NOT be reverted!!!

6.2 ANALOG METER

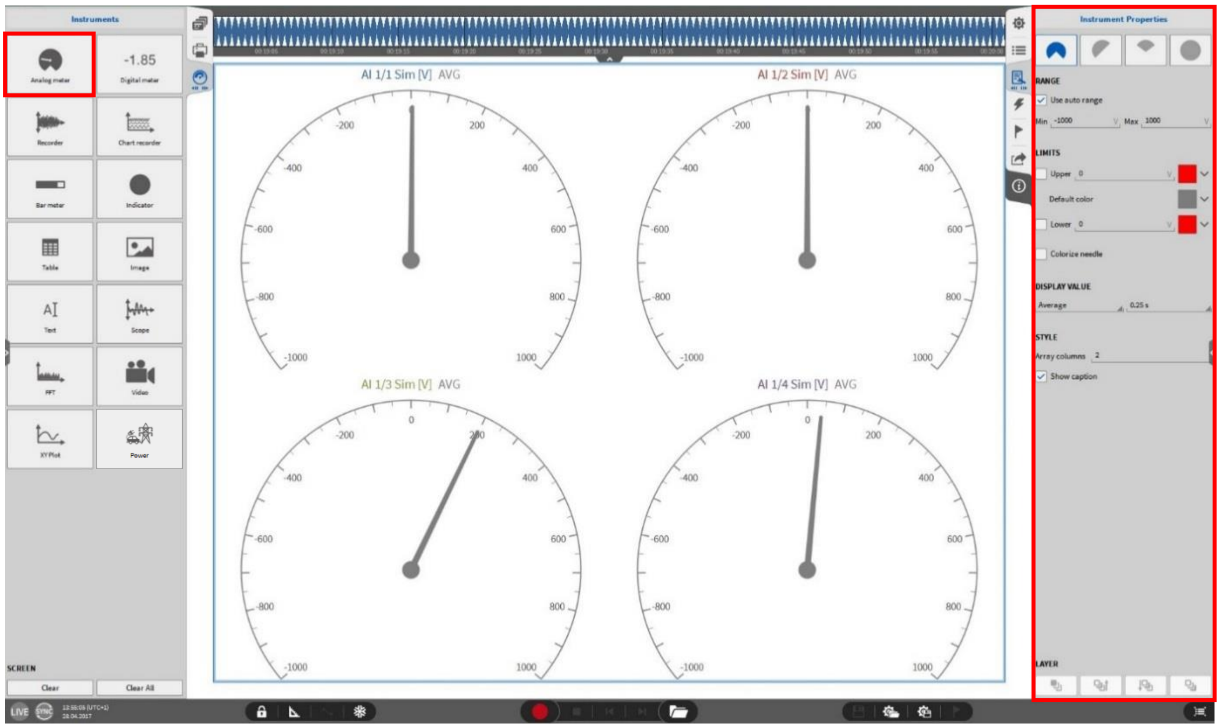


Figure 6-3: Analog Meter - Overview

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:

Figure 6-4: 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 0.1s, 0.25s, 0.5s, 1.0s.
- Style: The user can specify the number of columns for an Analog meter cluster if several channels are selected.
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*).

Remark: Up to 96 channels can be assigned to one single Analog Meter.

6.3 DIGITAL METER

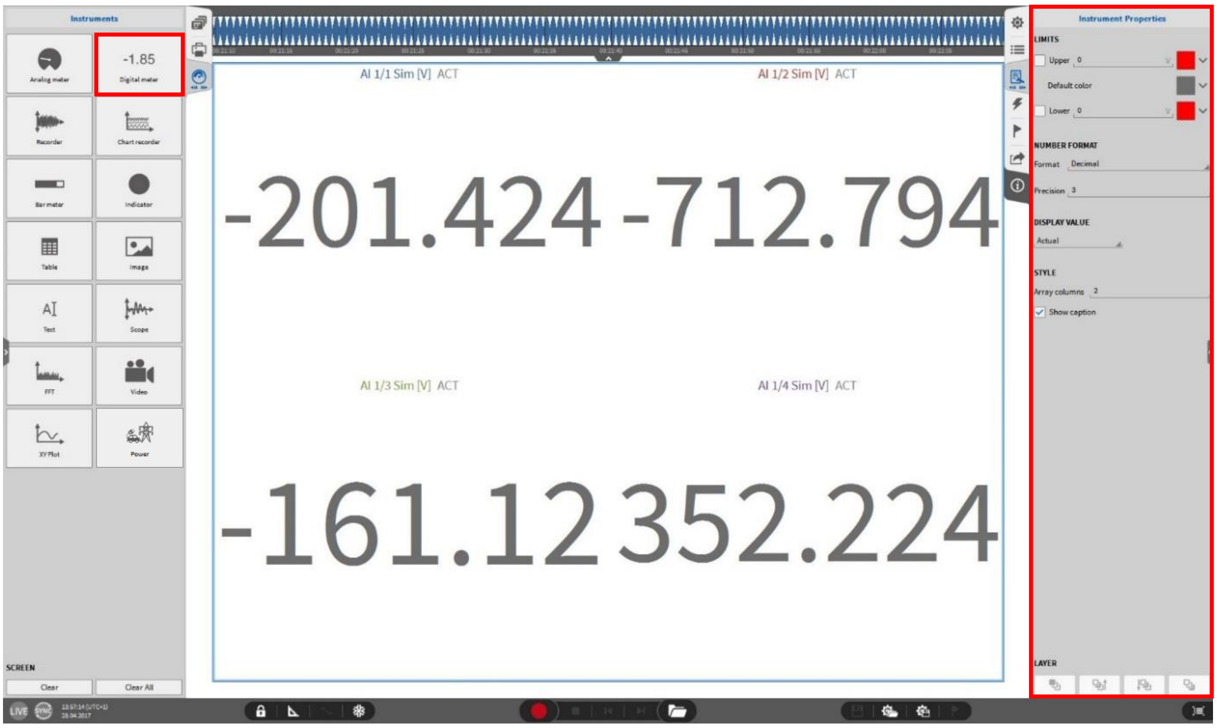


Figure 6-5: Digital Meter – Overview

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 the screen capture.
- Number Format: This option gives the ability to either display the shown values in Scientific or Decimal format.
- 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 0.1s, 0.25s, 0.5s, 1.0s.
- Style: The user can specify the number of columns for a Digital meter cluster if several channels are selected.
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*).

Remark: Up to 96 channels can be assigned to one single Digital Meter.

6.4 RECORDER

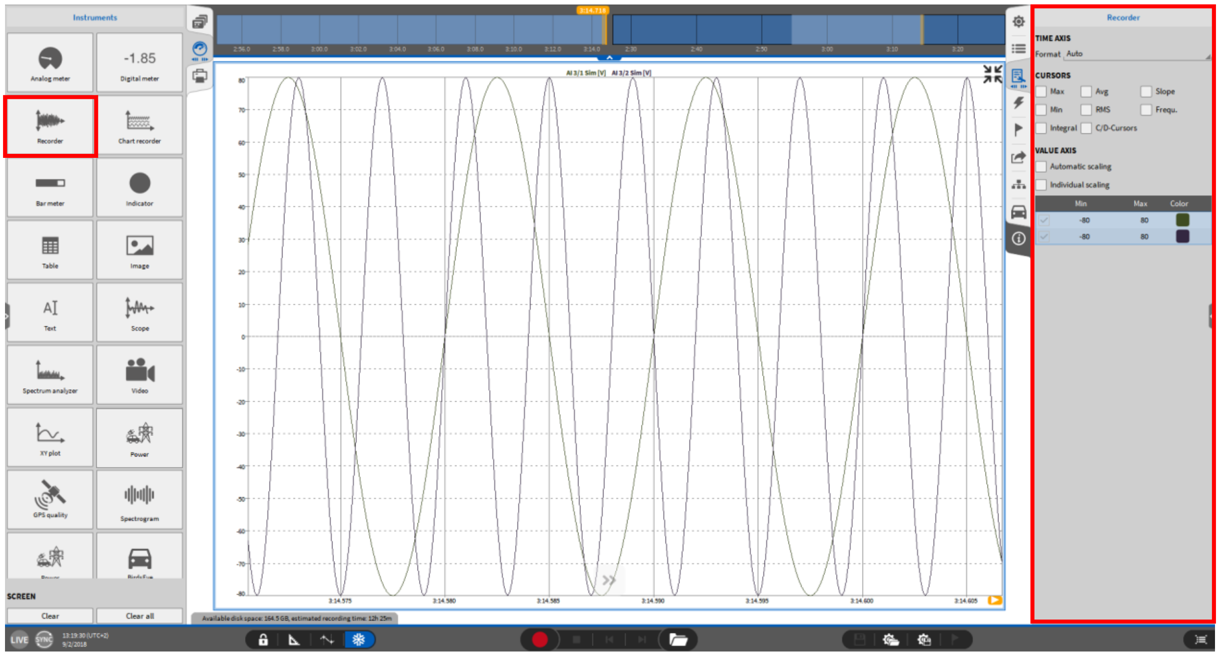


Figure 6-6: Recorder - Overview

This Instrument replicates the functionality of a strip chart recorder in combination with many additional features.

Remarks:

- Up to 8 channels can be assigned to one single Recorder.
- If two or more Recorders are placed below each other and their boundaries are touching each other on more than 2/3 of the Recorder length, the Recorders are *locked*. This means that zooming actions applied to one Recorder apply to the other *locked* Recorders as well.

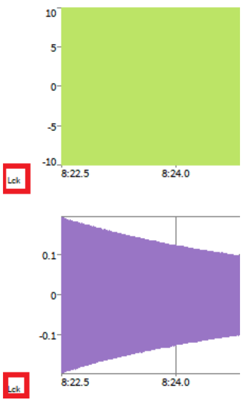


Figure 6-7: Two Recorders *Locked*

6.4.1 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 R*elative 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 please refer to section 6.4.2.3.
- 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 section 6.4.2.2.
  If *Automatic Scaling* is selected, the Y-Axis will always be adjusted to the actual displayed data minimum and maximum.
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

6.4.2 Additional Properties

To use further functionality of this instrument, the *Design* mode must be left. The following additional features are available:

1. Quick selection X-Axis scaling
2. Quick selection Y-Axis scaling
3. Activate Cursors
4. Quick expansion button

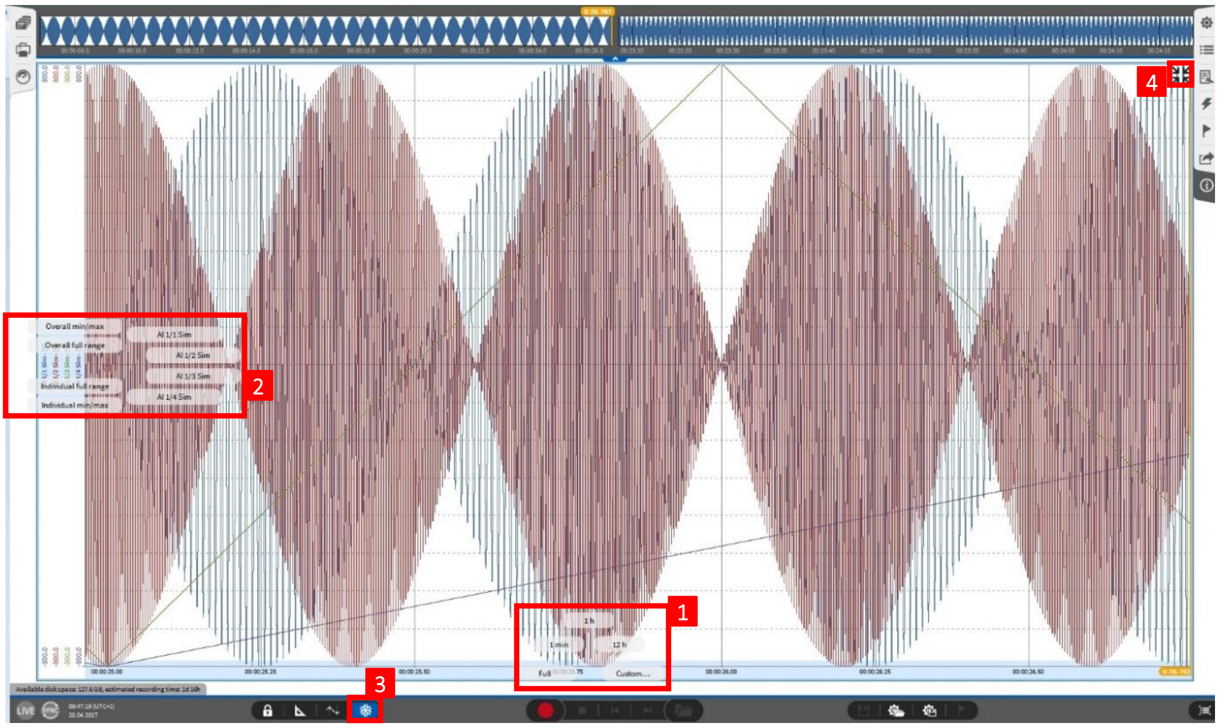


Figure 6-8: Additional features of the Recorder

6.4.2.1 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

Remark: By one right click on the X-Axis, the total elapsed recording time will be displayed as well:

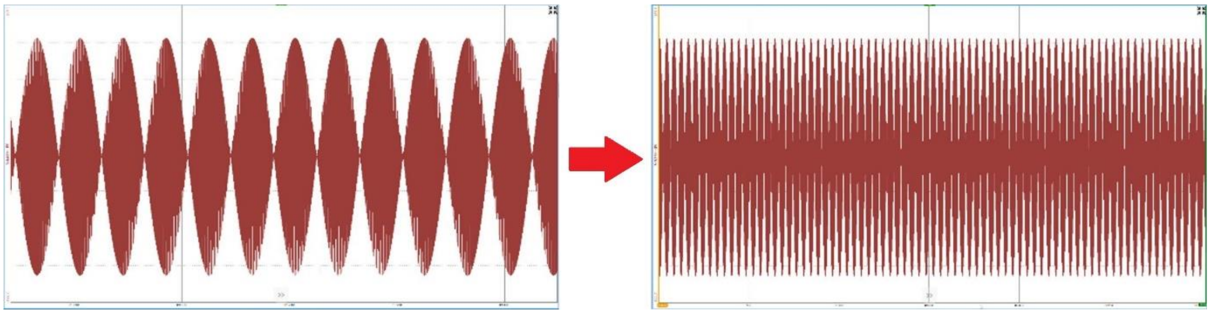


Figure 6-9: Changing the X-Axis scaling to the full time with one right click

- 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:

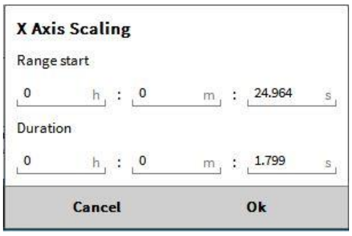


Figure 6-10: Window to define a customized X-Axis scaling

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

6.4.2.2 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.

Remark: 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:

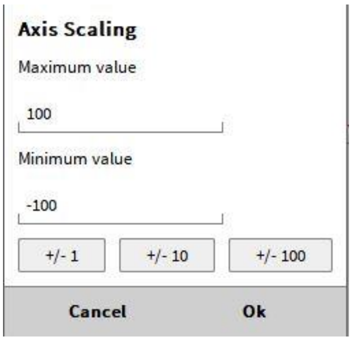


Figure 6-11: Window to define a customized Y-Axis scaling (Individual Scaling selected)

Example: Two channels are displayed in one Recorder. Channel 1 has a Signal Input Range of ±10V and the range of the currently displayed data is ±8V. Channel 2 has a Signal Input Range of ±3V and the range of the currently displayed data is ±2V.

- Clicking on *Overall min/max*: The scaling of both channels is set to ±8V
- Clicking on *Overall full range*: The scaling of both channels is set to ±10V.
- Clicking on *Individual full range*: The scaling of channel 1 is set to ±10V and the scaling of channel 2 to is set to ±3V
- Clicking on *Individual min/max*: The scaling of channel 1 is set to ±8V and the scaling of channel to is set to ±2V
- Clicking on the name of Channel 1
  - will set the scaling of Channel 1 to ±8V and not affect the scaling of Channel 2 if *Individual scaling* is selected
  - will set the scaling of the Y-Axis to ±8V if *Individual scaling* is de-selected
- Clicking on the name of Channel 2
  - will set the scaling of Channel 2 to ±2V and not affect the scaling of Channel 1 if *Individual scaling* is selected
  - will set the scaling of the Y-Axis to ±2V if *Individual scaling* is de-selected

Remark: 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 popup window when *Individual scaling* is selected, click on the min/max value of the Y-Axis scaling:

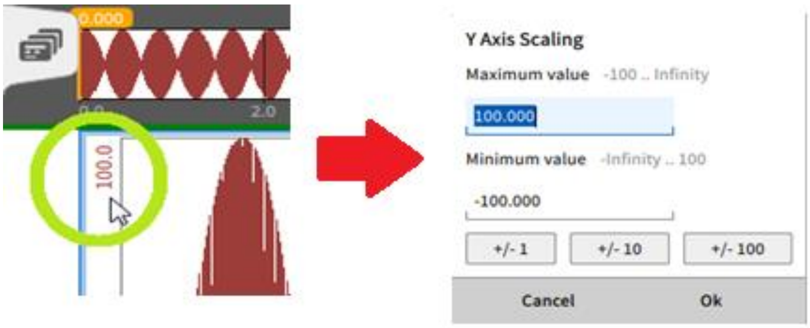


Figure 6-12: Define a customized Y-Axis scaling for one channel (Individual Scaling not selected)

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:

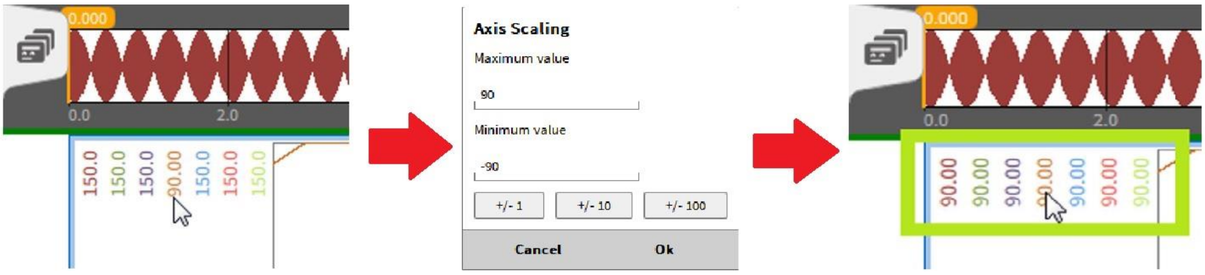


Figure 6-13: Define a customized Y-Axis scaling for all channels (Individual Scaling not selected)

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 <u>not</u> 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

6.4.2.3 Activate Cursors

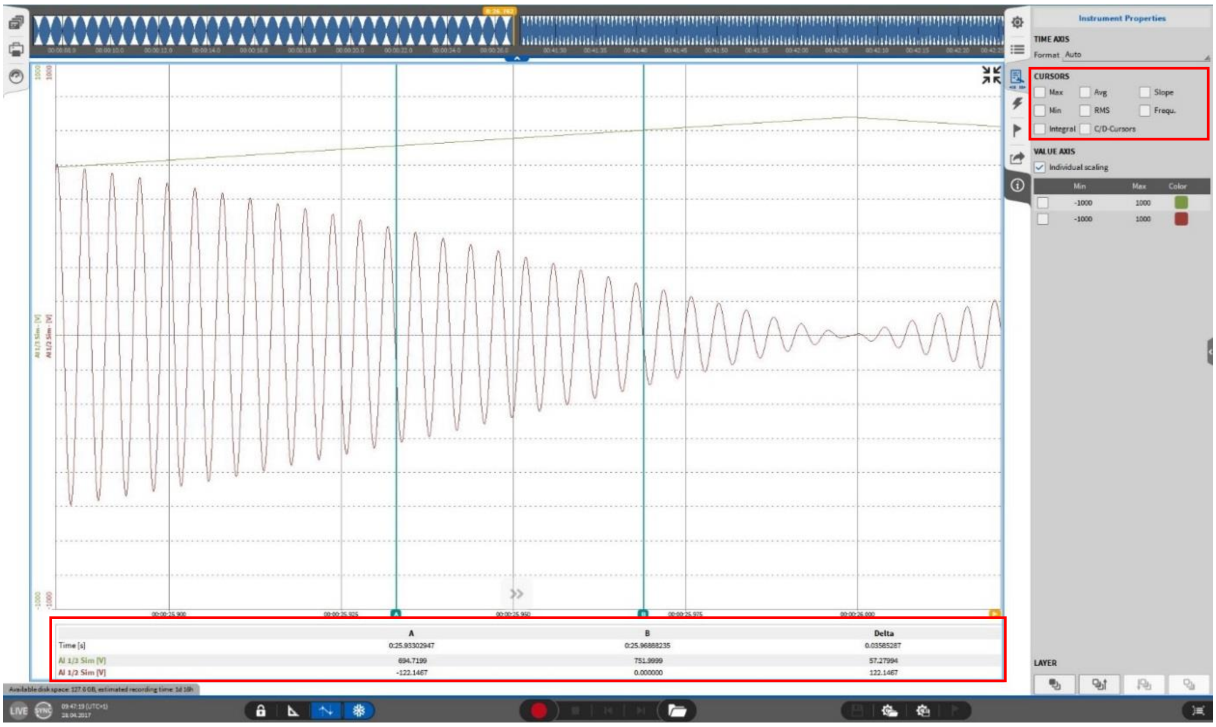


Figure 6-14: Activated Cursors - Overview

This option is only available in the *PLAY* mode or if the measurement screen is frozen. After activating the cursors, cursor *A* and *B* will appear in the recorder window and a table that contains the actual position of both cursors, the respective signal value on the cursor positions and the difference *Delta* between the cursor positions will appear below the Recorder (see Figure 6-14).

$$Delta = Time_{CursorB} - Time_{CursorA}\ [s]$$

The position of the cursors can be changed by moving them to the left and right. Additional information can be displayed in the table by selecting it in the *CURSORS* section in the Instrument Properties. The additional values are the following:

- Max: Displays the maximum signal level between cursor A and cursor B

$$Max = Max\{SignalLevel_i\}\ [Signal\ Unit]$$

- Avg: Calculates the arithmetic mean value respecting the signal level from cursor A to cursor B according to the following formula:

$$Avg = \frac{1}{N}\sum_{i=1}^{N} SignalLevel_i\ \ [Signal\ Unit]$$

- Slope: Calculates the slope of the signal between cursor A and cursor B according to the following formula:

$$Slope = \frac{SignalLevel_{CursorB} - SignalLevel_{CursorA}}{Delta}\ [\frac{Signal\ Unit}{s}]$$

- Min: Displays the minimum signal level between cursor A and cursor B

$$Min = Min\{SignalLevel_i\}\ [Signal\ Unit]$$

- RMS: Calculates the quadratic mean value respecting the signal levels from cursor A to cursor B

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(SignalLevel_i)^2}\ [Signal\ Unit]$$

- Frequ.: This value is the reciprocal value of *Delta*.

$$Frequ. := \frac{1}{Delta}\ [\frac{1}{s} = Hz]$$

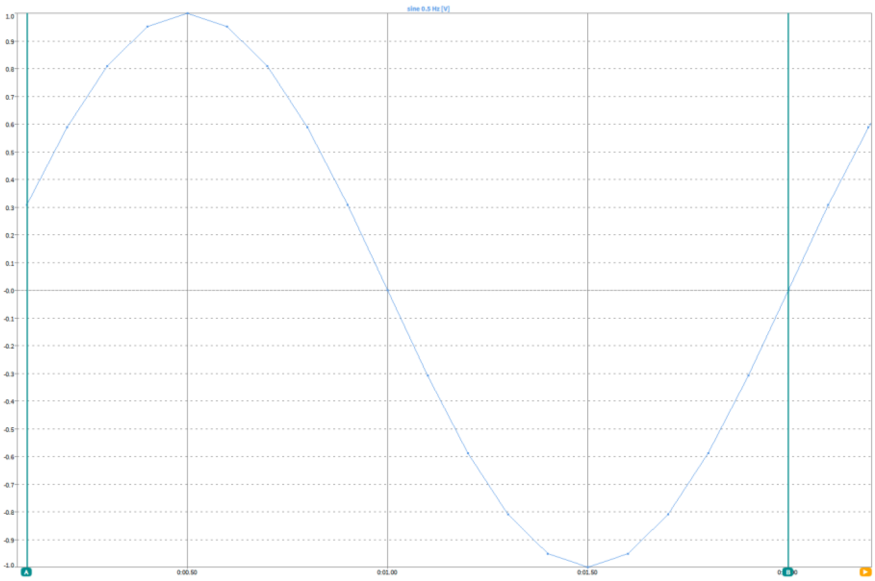
- Integral: Calculates the area within the Y-Axis and the signal from cursor A to cursor B according to the following formula:

$$Integral = Avg * Delta\ [Signal\ Unit * s]$$

- C/D-cursors: Adds two additional cursors that can be moved vertically (not available for a Chart Recorder)

$Time_{CursorA}$... Instant of time at position of cursor A
$Time_{CursorB}$... Instant of time at position of cursor B
$SignalLevel_{CursorA}$.... Level of the signal at position of cursor A
$SignalLevel_{CursorB}$.... Level of the signal at position of cursor B
$SignalLevel_i$.... 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]
Time [s]	0.100000	2.000000	1.900000	526.3mHz						
sine 0.5 Hz [V]	0.309017	-2.449e-16	-0.309017		-0.162641	-1.000000	1.000000	2.071e-17	0.707107	3.936e-17

Figure 6-15: 0.5 Hz sine wave in a Recorder; Cursor A @ 0.1s and cursor B @ 2.0s

In table format, the signal looks as follows:

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

Table 6-1: 0.5 Hz sine wave sampled with 10 Hz in table format

In the following section, the values displayed with the cursors are calculated for this signal and can be compared with the OXYGEN results in Figure 6-15.

- Delta:

$$Delta = Time_{CursorB} - Time_{CursorA} = 2.0s - 0.1s = 1.9s$$

- Max:

The maximum value between cursor A and B is 1.0 V @0.5s

- Avg:

$$Avg = \frac{1}{N}\sum_{i=1}^{N} SignalLevel_i =$$

$$= \frac{1}{20} * (0.309017\text{ V} + 0.587785\text{ V} + 0.809017\text{ V} + 0.951057\text{ V} + 1.000000\text{ V} + 0.951057\text{ V} + 0.809017\text{ V} + 0.587785\text{ V} + 0.307017\text{ V} + 0.000000\text{ V} + (-0.309017\text{ V}) + (-0.587785\text{ V}) + (-0.809017\text{ V}) + (-0.951057\text{ V}) + (-1.000000\text{ V}) + (-0.951057\text{ V}) + (-0.809017\text{ V}) + (-0.587785\text{ V}) + (-0.309017\text{ V}) + (-0.000000\text{ V})) = 0.000000\text{ V}$$

- Slope:

$$Slope = \frac{SignalLevel_{CursorB} - SignalLevel_{CursorA}}{Delta} = \frac{0.000000\,V - 0.309017\,V}{1.9\,s}$$

$$= -0.162640\,\frac{V}{s}$$

- Min:

The minimum value between cursor A and B is 0.0 V @1.0s and 2.0s

- RMS:

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(SignalLevel_i)^2} =$$

$$\sqrt{\{\frac{1}{20}\sum_{1}^{20}[(0.309017\text{ V})^2 + (0.587785\text{ V})^2 + (0.809017\text{ V})^2 + (0.951057\text{ V})^2 + (1.000000\text{ V})^2}$$
$$+ (0.951057\text{ V})^2 + (0.809017\text{ V})^2 + (0.587785\text{ V})^2 + (0.307017\text{ V})^2$$
$$+ (0.000000\text{ V})^2 + (-0.309017\text{ V})^2 + (-0.587785\text{ V})^2 + (-0.809017\text{ V})^2$$
$$+ (-0.951057\text{ V})^2\text{dewe} + (-1.000000\text{ V})^2 + (-0.951057\text{ V})^2$$
$$+ (-0.809017\text{ V})^2 + (-0.5877852\text{ V})^2 + (-0.309017\text{ V})^2 + (-0.000000\text{ V})^2]\ \}$$
$$= 0.707107\ V$$

- Frequ.:

$$Frequ. \coloneqq \frac{1}{Delta} = \frac{1}{1.9} = 526.3\,mHz$$

- Integral:

$$Integral = Avg * Delta = 0.000000\,V * 1.9\,s = 0\,Vs$$

Remark: Besides the Recorder Instrument, the cursor option is also available for the Chart Recorder and the Scope.

6.4.2.4 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.

6.4.2.5 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.

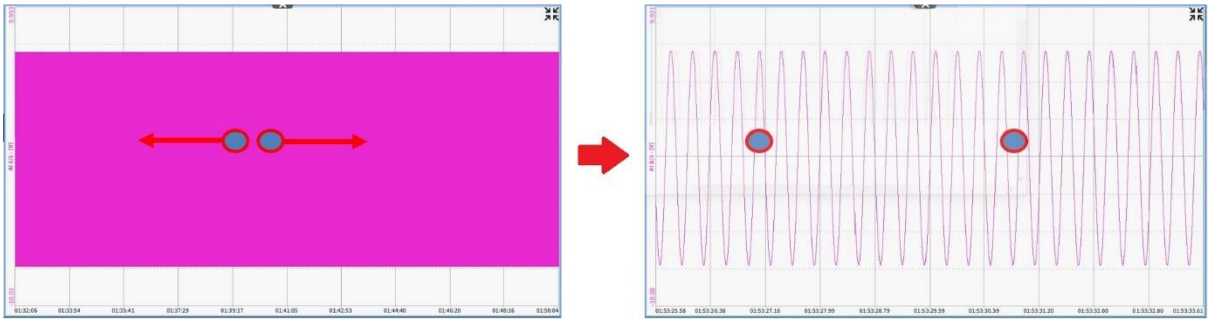


Figure 6-16: Zooming on a touch screen

- 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:

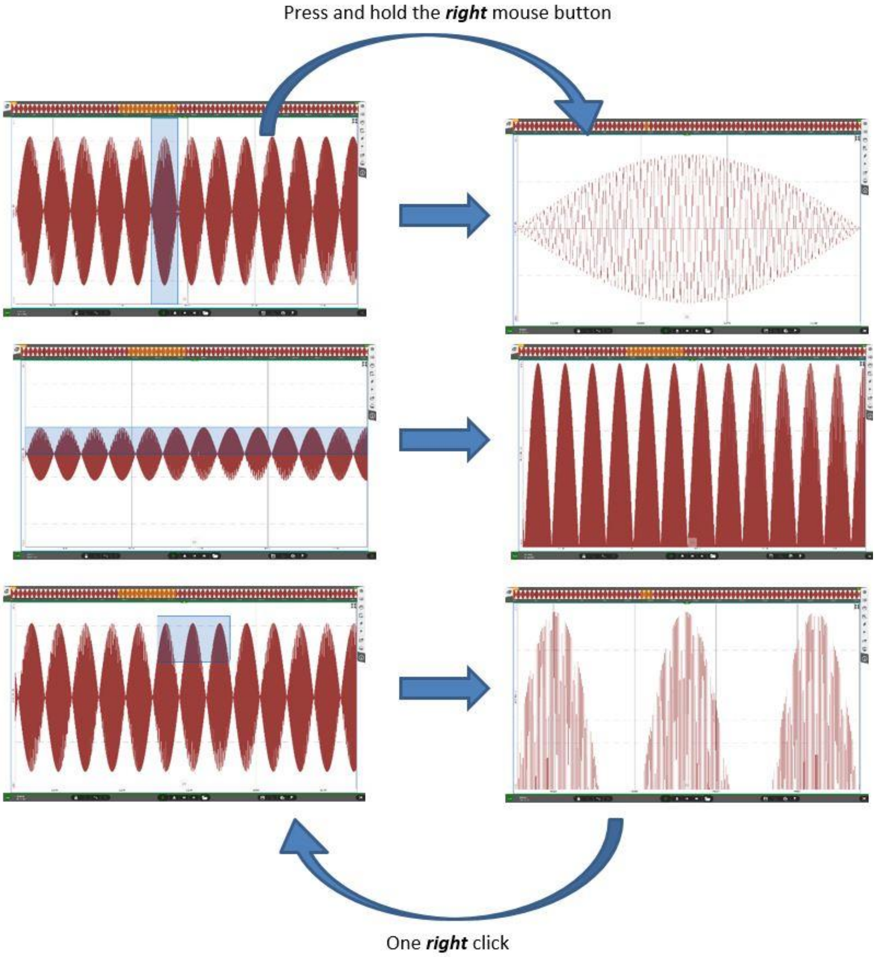


Figure 6-17: Zooming with a mouse

6.4.3 Deja View™

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 Deja View™. 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 (see② in Figure 6-18) 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.

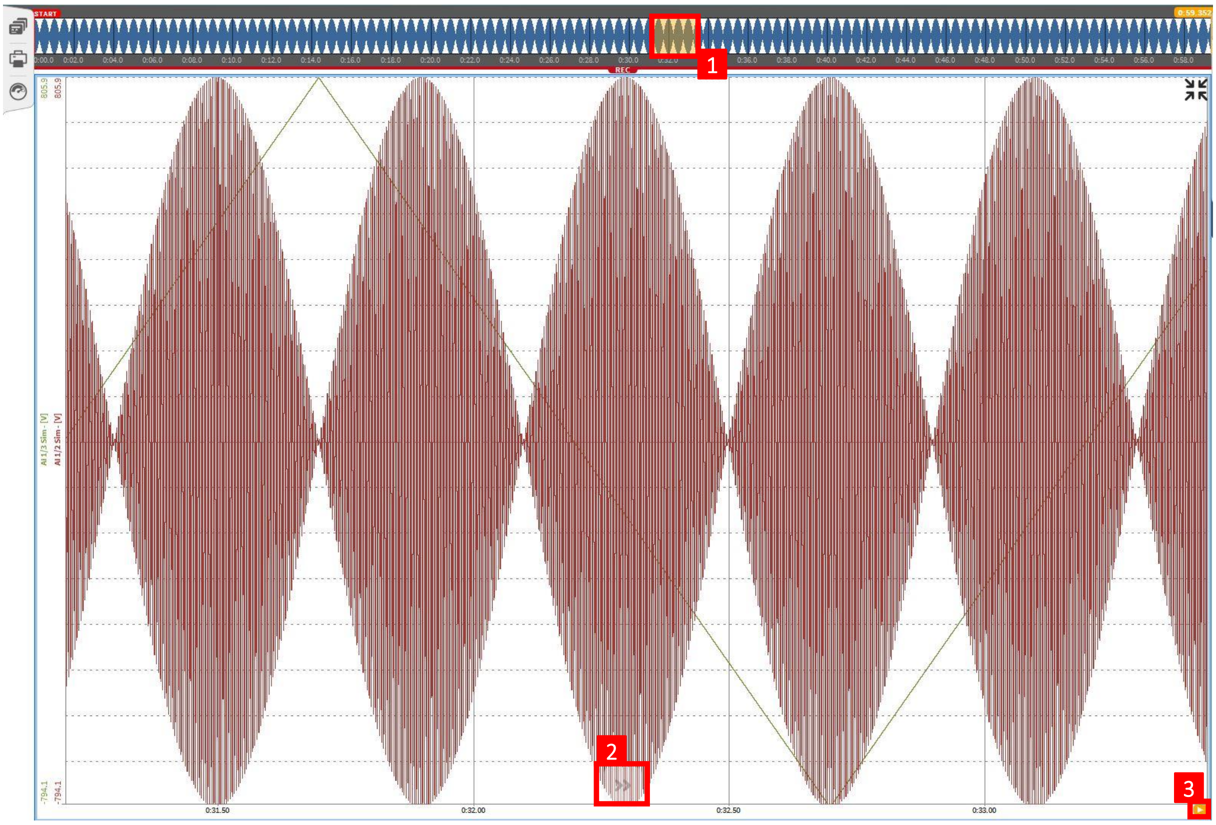


Figure 6-18: Operational Features of Deja View™

Operational features of Deja View™ (see Figure 6-18)

- 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
- ③ 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

Remark: The Deja View™ feature can be enabled and disabled in the *System Settings* menu point *Advanced Setup* (see section 4.3).

6.5 CHART RECORDER

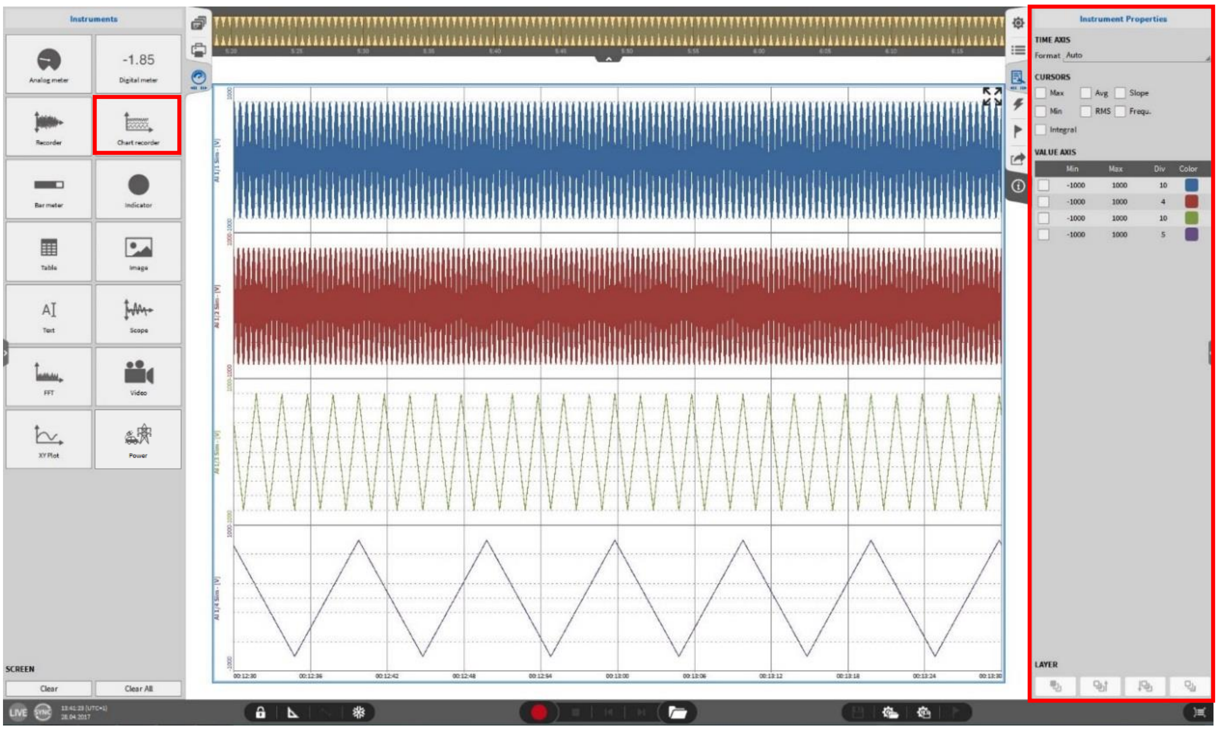


Figure 6-19: Chart Recorder - Overview

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 please refer to section 6.4.

Remark: Up to 16 channels can be assigned to one single Chart Recorder.

6.6 BAR METER

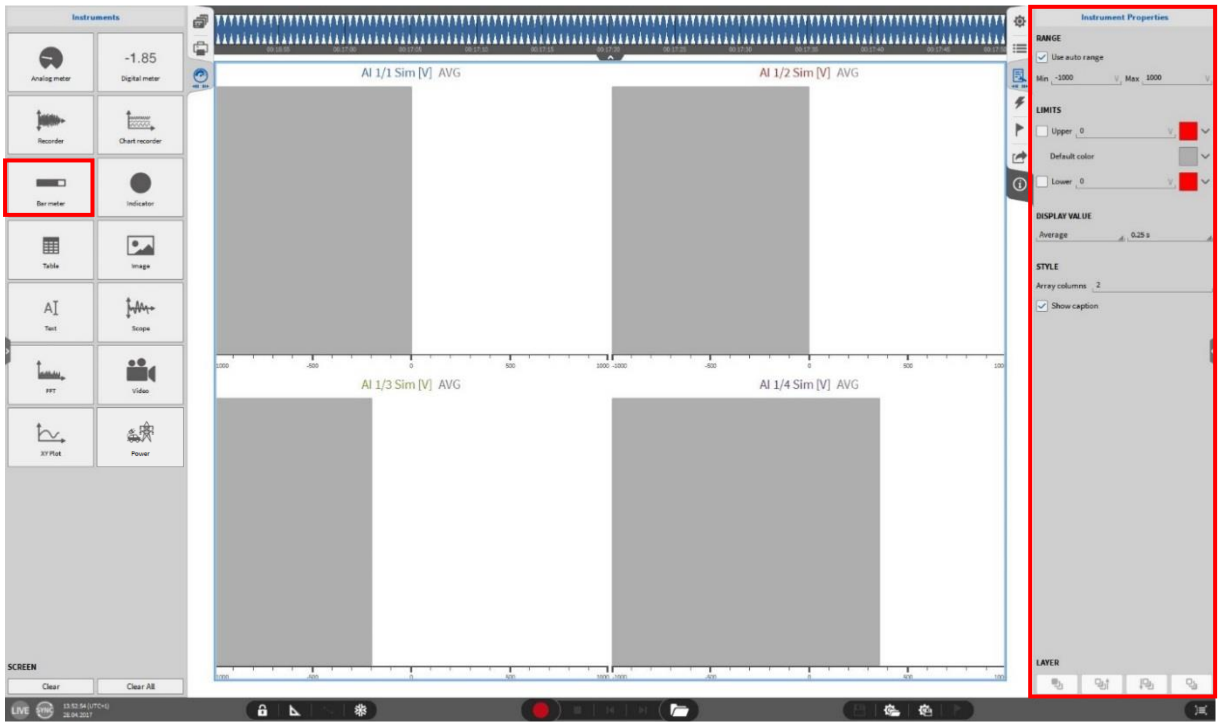


Figure 6-20: Bar Meter - Overview

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 0.1s, 0.25s, 0.5s, 1.0s.
- Style: The user can specify the number of columns for a Bar meter cluster if several channels are selected.
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*).

Remark: Up to 96 channels can be assigned to one single Bar Meter.

6.7 INDICATOR

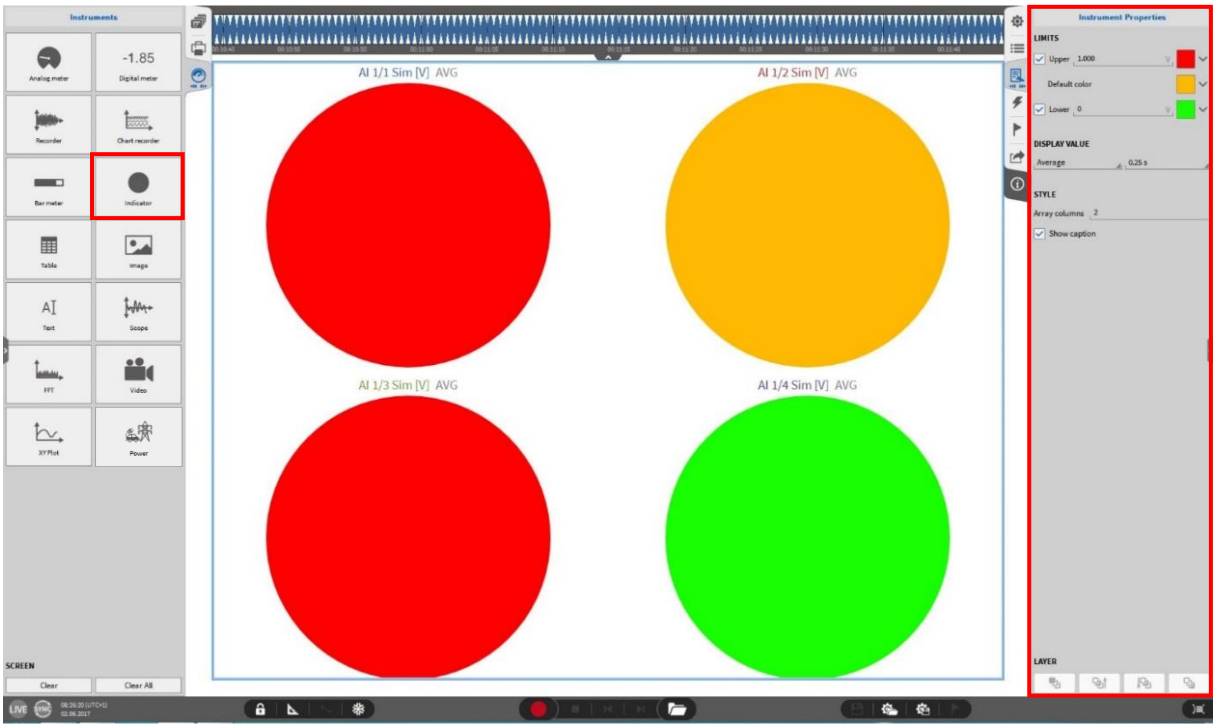


Figure 6-21: Indicator – Overview

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
- Style: The user can specify the number of columns for an Indicator cluster if several channels are selected
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

Remark: Up to 96 channels can be assigned to one single Indicator.

6.8 Table Instrument

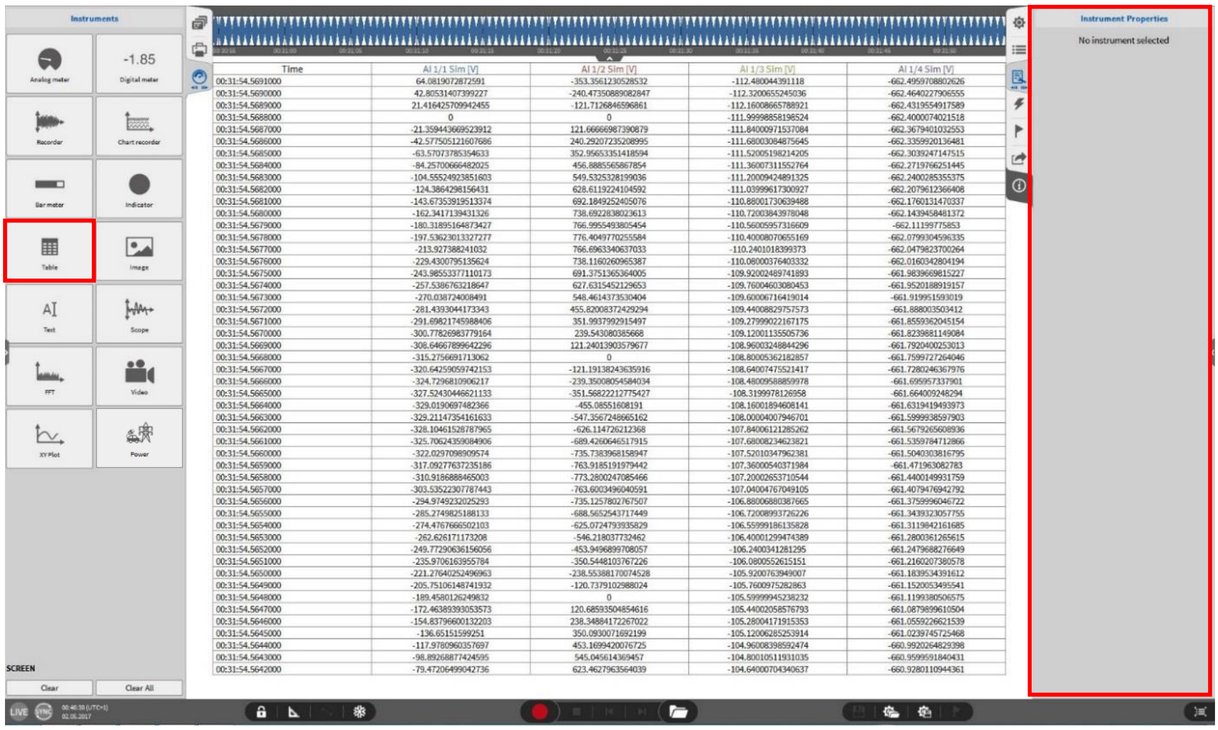


Figure 6-22: The Table - Overview

The Table provides the user the measurement data in table form with an individual column for each signal and a column for the Time Axis. There are no Instrument Properties that can be manipulated by the user.

Remark: Up to 8 channels can be assigned to one single Table Instrument.

6.9 IMAGE INSTRUMENT

Figure 6-23: The 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
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

6.10 Text Instrument

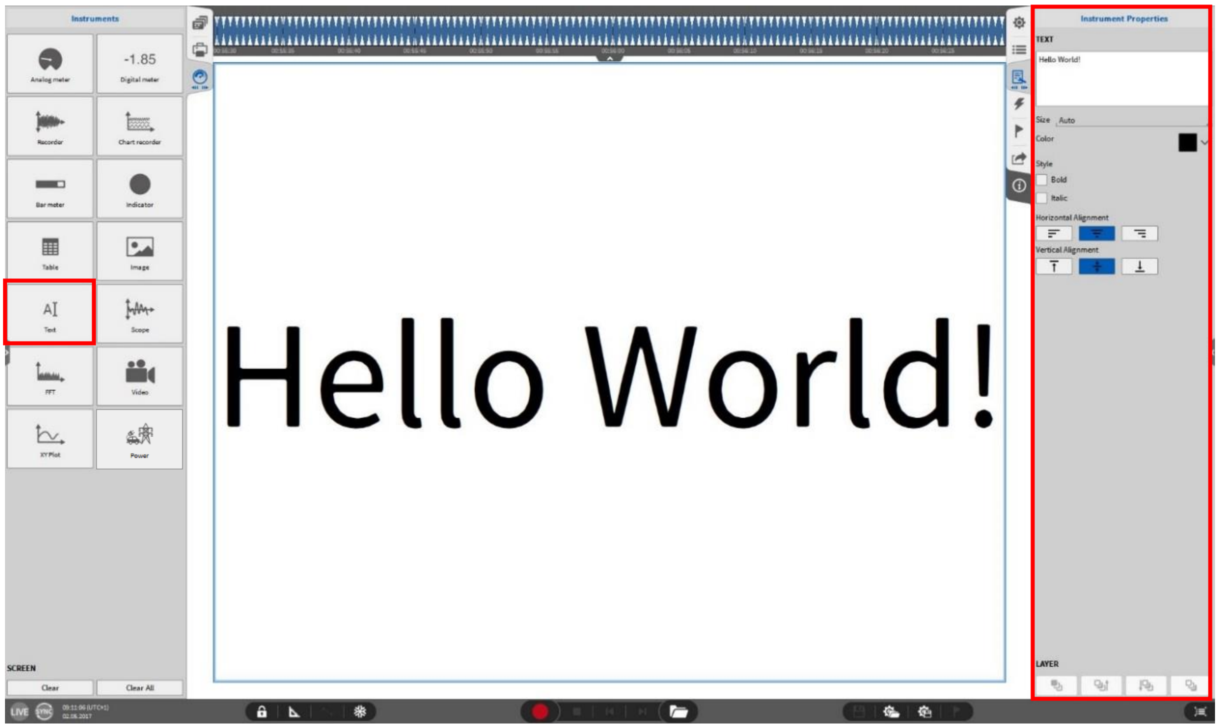


Figure 6-24: The Text Instrument – Overview

This feature allows the user to create customized text items on the measurement screen. Header Data can be displayed as well in the Text Box. For a detailed description of this feature please refer to section 4.2. 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.
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

6.11 Scope

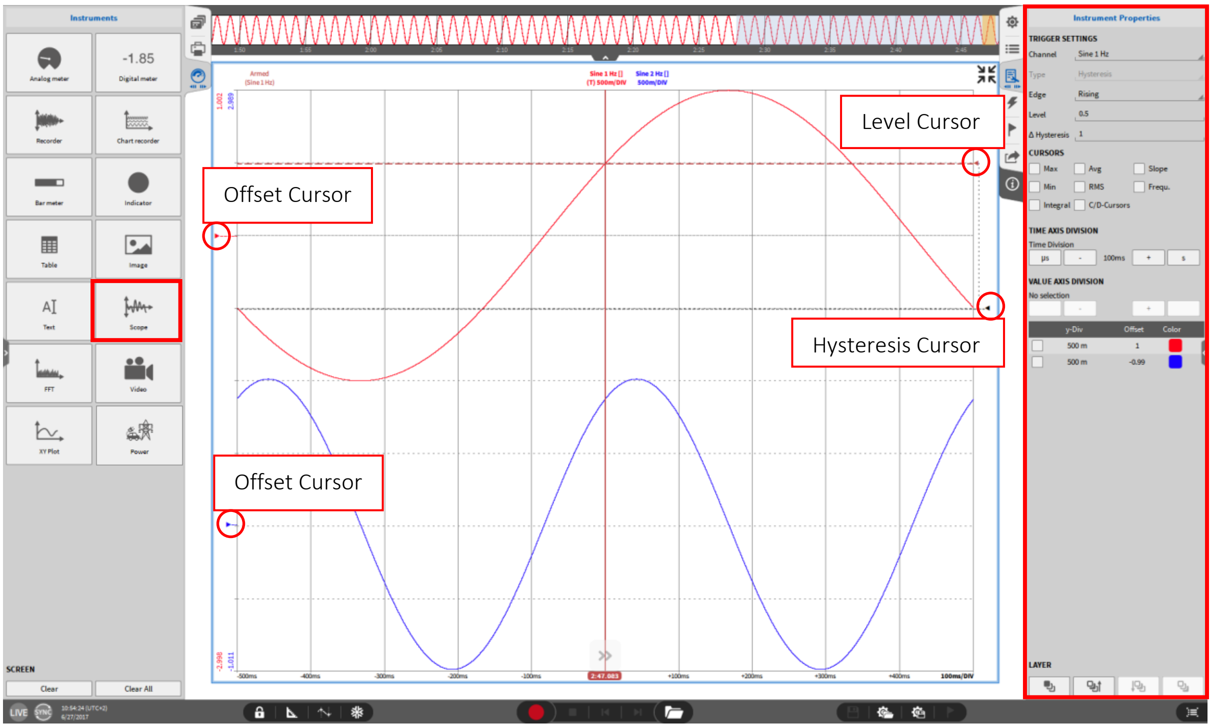


Figure 6-25: The Scope – Overview

This instrument affords the user the analysis options of a scope.

Remark: Up to 8 channels can be assigned to one single Scope.

6.11.1 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 Figure 6-26 for a 1 Hz sine wave that has an amplitude of 1.

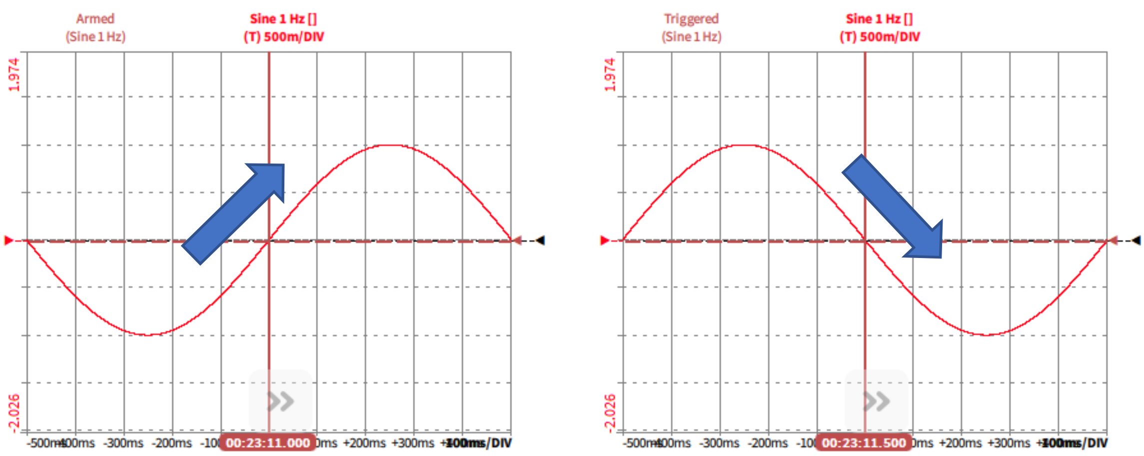


Figure 6-26: Trigger on a *Rising* (left) and on a *Falling* (right) edge

- In the *Level* selection, the user can define the level of the trigger. The level can also be set with the *Level* cursor (see Figure 6-25) and must be within the signal range. Figure 6-27 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.

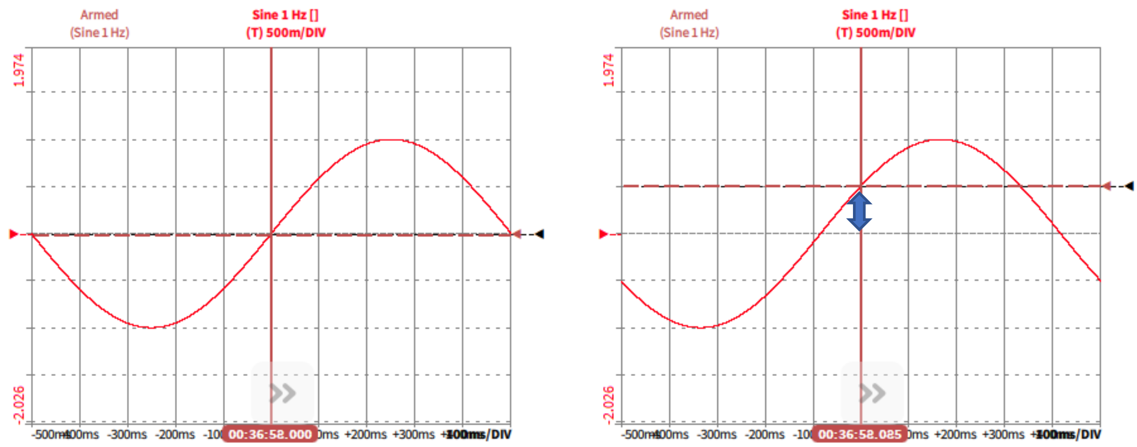


Figure 6-27: Rising trigger edge with level 0 (left) and level +0.5 (right)

- 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 Figure 6-25).
  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]].

  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 please refer to section 6.4.2.3.
- 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*)
- The Offset Cursors (see Figure 6-25) can be used to displace the displayed signals vertically. Using this function will not affect the phase accuracy.

6.12 SPECTRUM ANALYZER

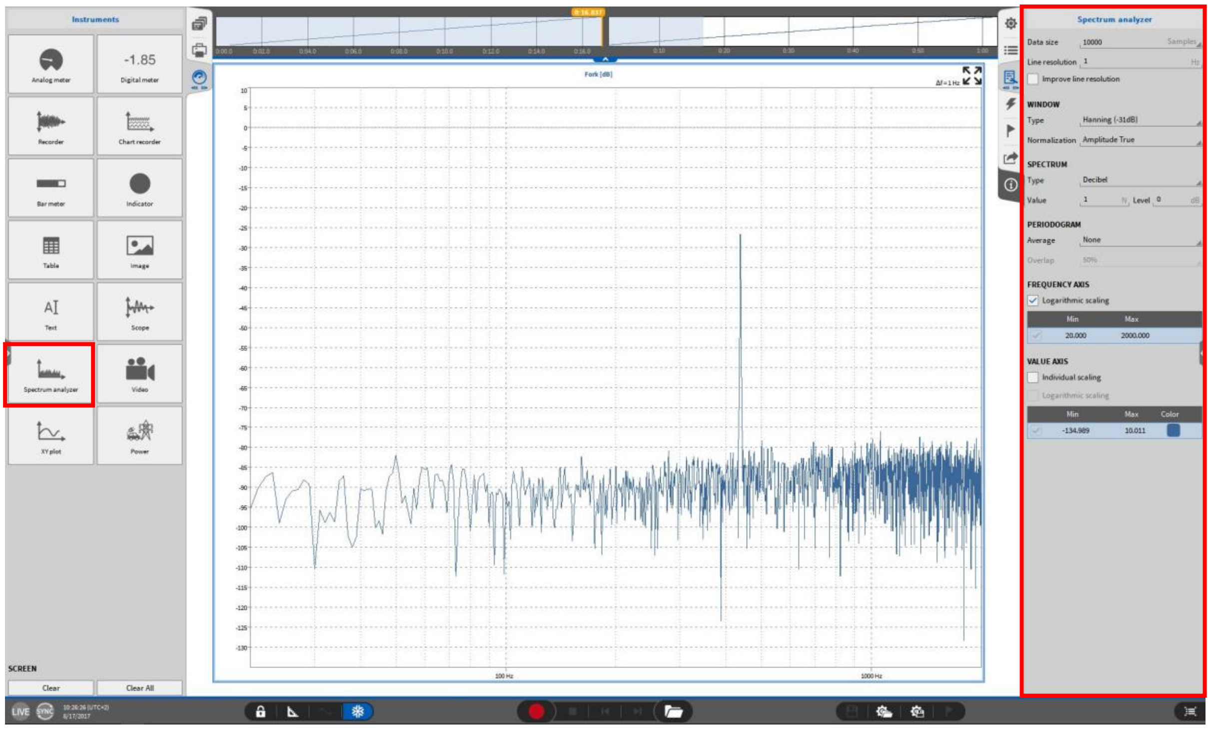


Figure 6-28: The Spectrum analyzer - Overview

The FFT-Instrument provides the user with the ability to analyze data in real time within the frequency domain.

6.12.1 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:

$$Y_k = \sum_{n=0}^{N-1} X_n e^{\frac{-i2\pi kn}{N}}; \qquad k = 0 \dots N-1$$

X_k... (complex) input signal
Y_k... complex Fourier Transform of X_k
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, please refer to section 6.12.3.2.

Remarks:

- 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, please refer to section 6.4.2.5.
- 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.

6.12.2 Assignment of Frequency Domain Channels

Mathematical frequency channels that are calculated using the FFT math (see section 5.3.6) 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).

Remarks:

- 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 Figure 6-29). For details, please refer to section 6.12.3.4.

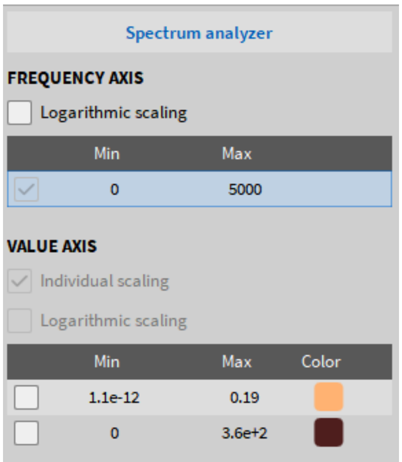


Figure 6-29: Instrument Properties of the Spectrum Analyzer if Frequency Domain channels are assigned

6.12.3 Instrument 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.

The Line resolution relates to the sample rate and the Data size:

$$Line\ resolution = \frac{Sample\ Rate}{Data\ size}\ [Hz]$$

The radio button *Improve line resolution* will enable zero-padding. For detailed information, please refer to section 6.12.5.

Remarks:

- 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.
- Please note that changing the *Data size* will affect the *Line resolution*. Therefore, the line resolution is within a range from $\frac{Sample\ Rate}{2^{20}}$ to $\frac{Sample\ Rate}{42}$ 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 $trunc(\frac{number\ of\ calculated\ FFT\ bins}{2}) + 1$. The first line is plotted @ 0 Hz and the last line is plotted @ $\frac{Sample\ Rate}{2}$ 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.

6.12.3.1 Section *Window*

The *Type* and *Normalization* of the window function can be edited here.

6.12.3.1.1 *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:

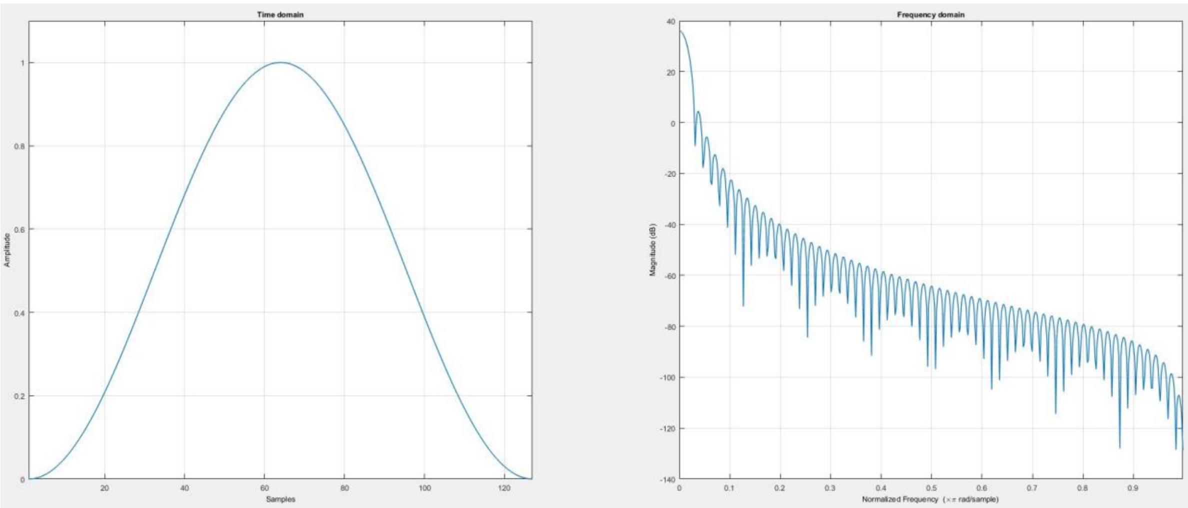


Figure 6-30: Hanning window in time and frequency domain (N = 128)

$$w(n) = \frac{1}{2}\left[1 - \cos\left(\frac{2\pi n}{N-1}\right)\right]; \quad n = 0 \ldots N-1$$

- Hamming window:

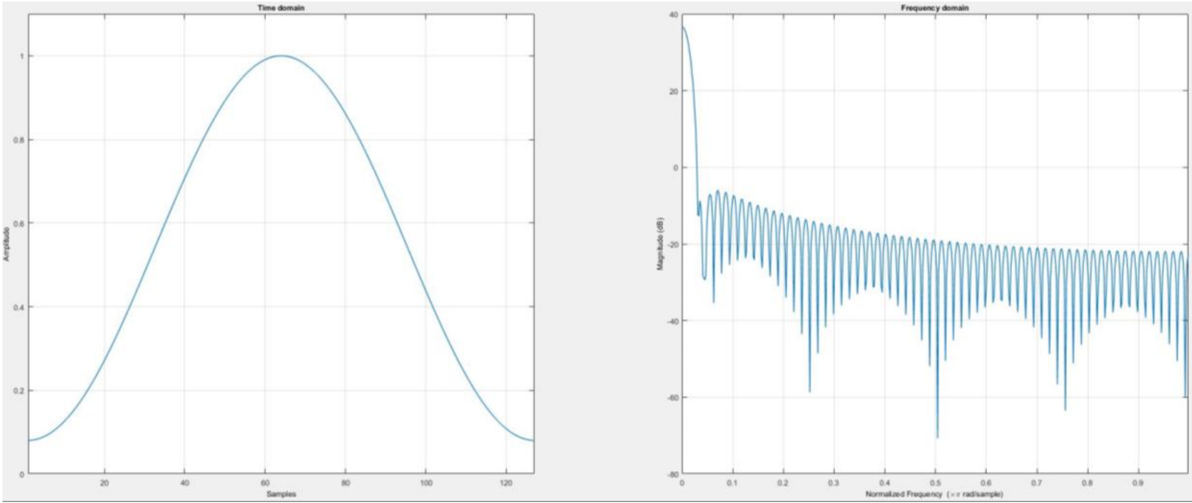


Figure 6-31: Hamming window in time and frequency domain (N = 128)

$$w(n) = \alpha - \beta \cos\left(\frac{2\pi n}{N-1}\right); \quad n = 0 \dots N-1$$

α = 0.54
β… *1 - α*

- Rectangular window:

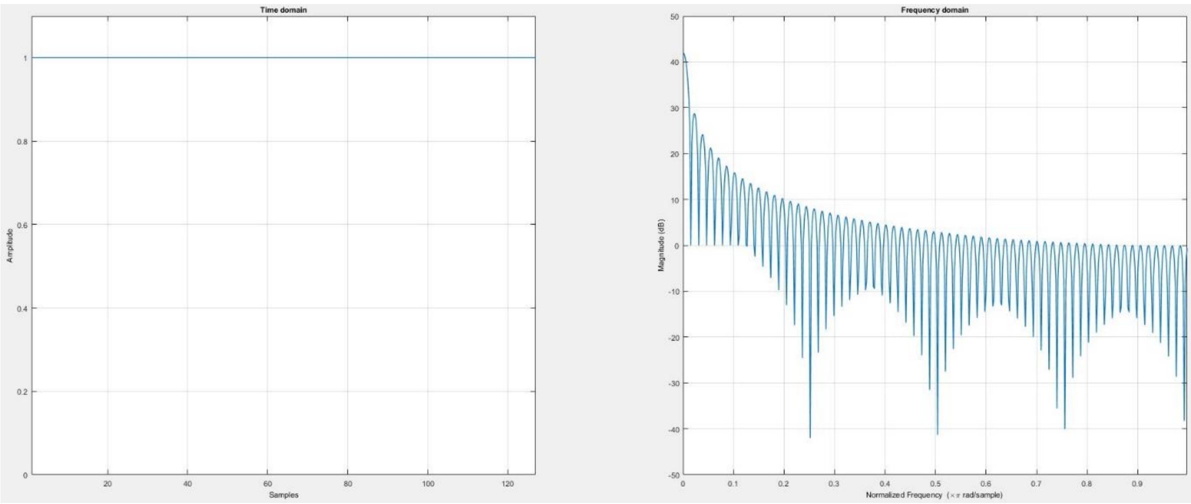


Figure 6-32: Rectangular window in time and frequency domain (N = 128)

$$w(n) = 1\,; \quad n = 0 \dots N\text{-}1$$

- Blackman window:

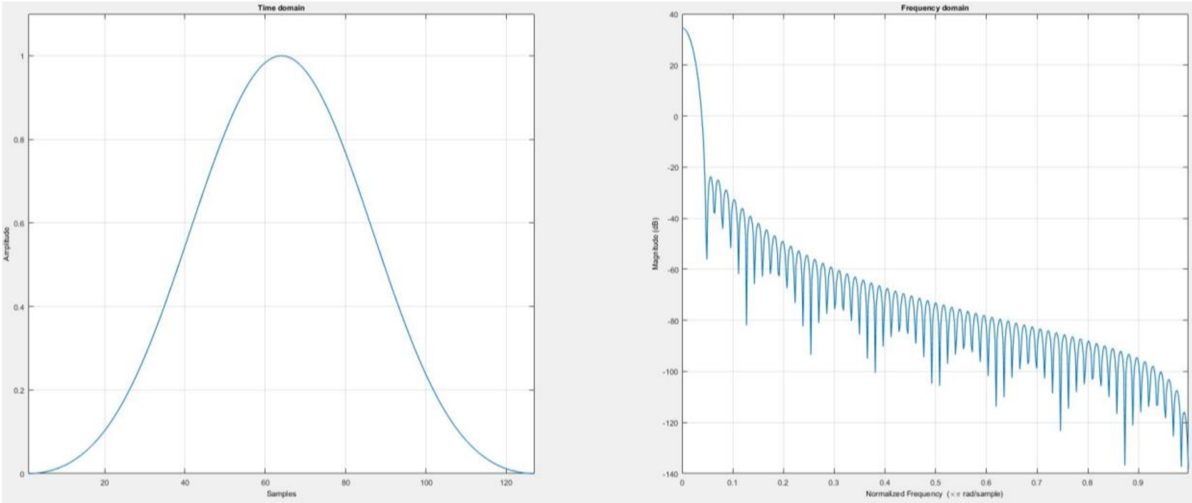


Figure 6-33: Blackman window in time and frequency domain (N = 128)

$$w(n) = a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right); \quad n = 0 \dots N-1$$

a_0 = 0.42
a_1 = 0.5
a3 = 0.08

- Blackman-Harris window:

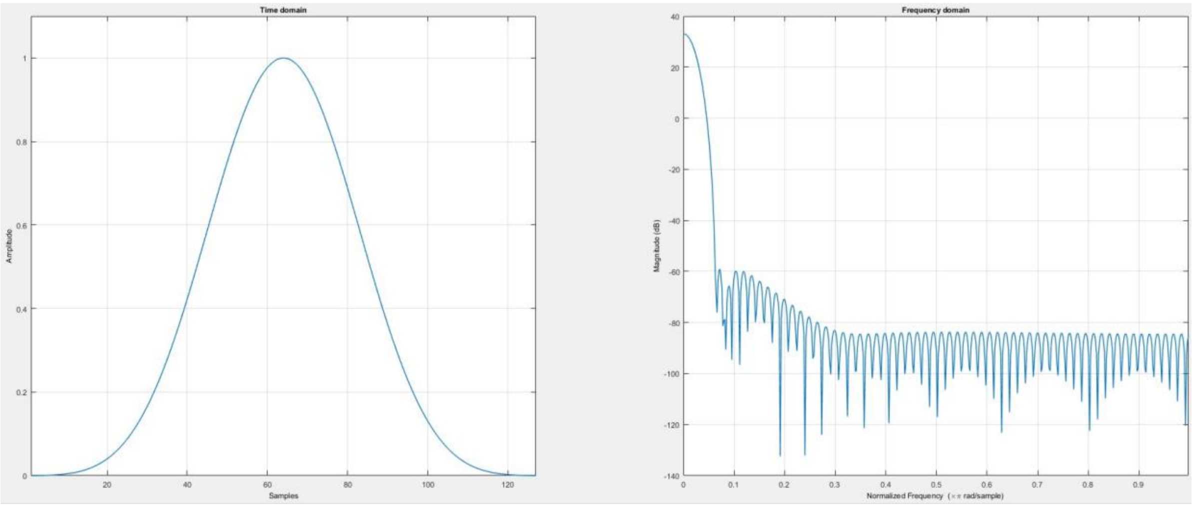


Figure 6-34: Blackman-Harris window in time and frequency domain (N = 128)

$$w(n) = a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right) - a_3 \cos\left(\frac{6\pi n}{N-1}\right); \quad n = 0 \dots N-1$$

a_0 = 0.35875
a_1 = 0.48829
a_2 = 0.14128
a_3 = 0.01168

- Flat-Top window:

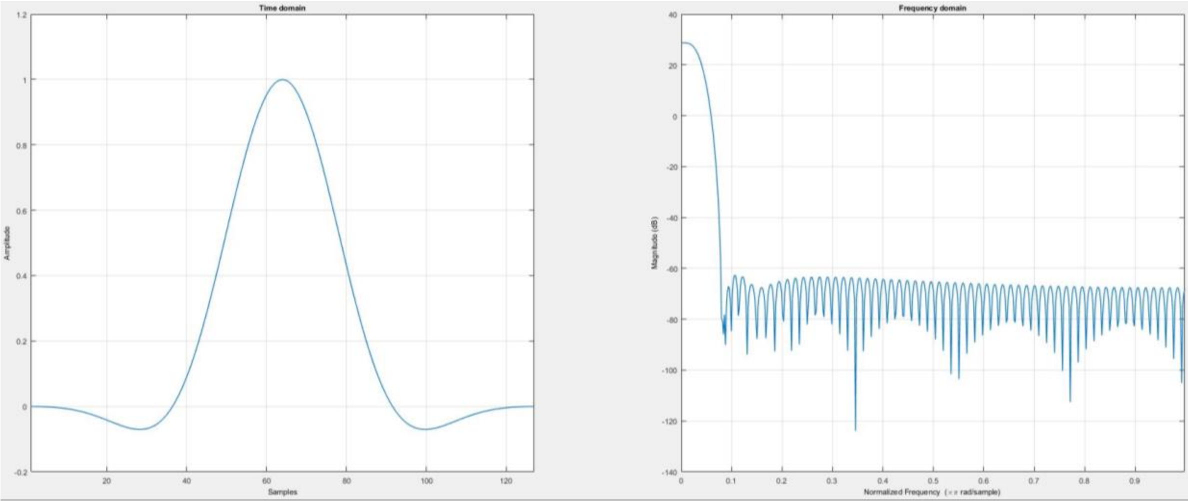


Figure 6-35: Flat-Top window in time and frequency domain (N = 128)

$$w(n) = a_0 - a_1 \cos\left(\frac{2\pi n}{N-1}\right) + a_2 \cos\left(\frac{4\pi n}{N-1}\right) - a_3 \cos\left(\frac{6\pi n}{N-1}\right) + a_4 \cos\left(\frac{8\pi n}{N-1}\right); n = 0 \dots N-1$$

$a_0 = 0.21557895$

$a_1 = 0.41663158$

$a_2 = 0.277263158$

$a_3 = 0.083578947$

$a_4 = 0.006947368$

- Bartlett window:

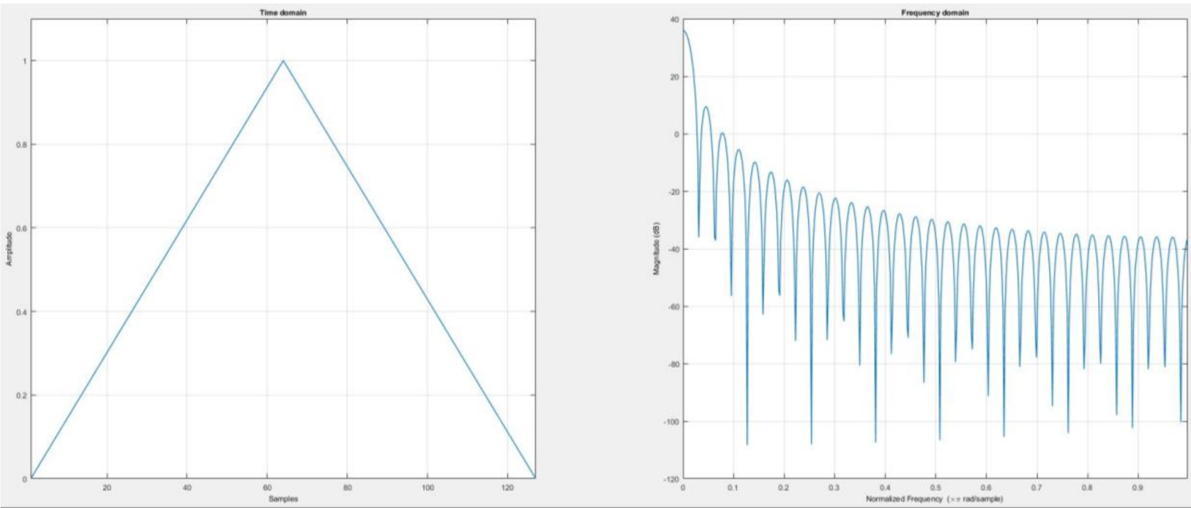


Figure 6-36: Bartlett window in time and frequency domain (N = 128)

$$w(n) = 1 - \left| \frac{n - \frac{N-1}{2}}{\frac{N-1}{2}} \right|$$

The following table will give an overview and recommendations about the usage of the different window functions. **Please note that this table is only a matter of recommendation and makes no claim to be complete or correct.**

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

Figure 6-37: Recommendation about the usage of different window funtions[2]

The following figure compares the different window functions in time domain:

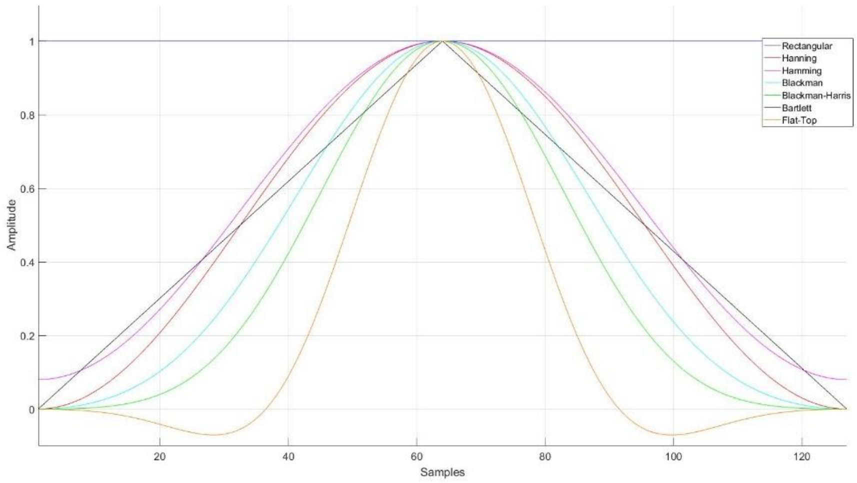


Figure 6-38: Comparison of the window functions in time domain (N=128)

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.

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

Table 6-2: Properties of the window functions

[2] Source: http://www.ni.com/white-paper/4844/de/#toc3

6.12.3.1.2 *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:

$$S_{AmpCorr\ k} = S_k * \left[\frac{N}{\sum_{k=1}^{N} W_k}\right]$$

- *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:

$$S_{PowCorr\ k} = S_k * \sqrt{\frac{N}{\sum_{k=1}^{N} W_k^2}}$$

S_k... Un-normalized signal at position k
N... Length of the Window function
W_k...Value of the window function at position k

A detailed example for the necessity to normalize FFT spectra can be found in section 6.12.6.

Remark: The normalization is applied to the signal in time domain.

6.12.3.2 Section *Spectrum*

In the *Spectrum* section, the user can select the type of the spectrum plotted in the Spectrum analyzer. In the following section, the available spectra and their formula are listed.

- *Amplitude: Plots the default amplitude spectrum normalized to the number of FFT lines according to the following formula:*

$$A_k = \frac{1}{N}\sqrt{Re\{Y_k\}^2 + Im\{Y_k\}^2}\,; \quad k = 0 \quad [Signal\ Unit]$$

$$A_k = \frac{2}{N}\sqrt{Re\{Y_k\}^2 + Im\{Y_k\}^2}\,; \quad k = 1 \dots N \quad [Signal\ Unit]$$

- *Amplitude RMS: Plots the RMS amplitude spectrum by dividing the Amplitude spectrum by $\sqrt{2}$.*

$$A_{RMS\ k} = \frac{A_k}{\sqrt{2}}; \quad k = 1 \dots N \quad [Signal\ Unit]$$

- *Amplitude²: Plots the squared amplitude spectrum by squaring the Amplitude spectrum*

$$A_{sq\ k} = A_k^2; \quad k = 1 \dots N \quad [(\text{Signal Unit})^2]$$

- *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.*

$$L_{A\,k} = 20 * log_{10}\left(\frac{A_k}{A_{Ref}}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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.*

$$L_{A\,RMS\,k} = 20 * log_{10}\left(\frac{A_{RMS\,k}}{A_{Ref}}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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.*

$$L_{A\,Max\,k} = 20 * log_{10}\left(\frac{A_k}{max\,\{A_k\}}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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)*

$$L_{A\,Max\,k} = 20 * log_{10}\left(\frac{A_{RMS}}{1}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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)*

$$L_{A\,Max\,k} = 20 * log_{10}\left(\frac{A_{RMS}}{\sqrt{0.6}}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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)*

$$L_{A\,Max\,k} = 20 * log_{10}\left(\frac{A_{RMS}}{20\mu}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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)*

$$L_{A\,Max\,k} = 20 * log_{10}\left(\frac{A_{RMS}}{1\mu}\right); \qquad k = 1 \dots N \qquad [dB]$$

- *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.*

$$M_{sq\,k} = Re\{Y_k\}^2 + Im\{Y_k\}^2; \qquad k = 1 \dots N \qquad [(Signal\ Unit)^2]$$

$$PSD_k = \frac{1}{N^2} * \frac{1}{df} * M_{sq\,k}; \qquad with\ df = \frac{SampleRate}{N} \qquad [(Signal\ Unit)^2/Hz]$$

- *PSD-TISA: plots the Time Integrated Squared Amplitude (TISA) PSD*

$$PSD_{TISA_k} = \frac{1}{N} * dt * M_{sq\,k}; \qquad k = 1 \dots N, \quad dt = \frac{1}{SampleRate} \qquad [(Signal\ Unit)^2 \mathrm{s}]$$

- *PSD-MSA: plots the Mean Squared Amplitude (MSA) PSD*

$$PSD_{MSA_k} = \frac{1}{N^2} * M_{sq\,k}; \qquad k = 1 \dots N \qquad [(Signal\ Unit)^2]$$

- *PSD-SSA: plots the Sum Squared Amplitude (SSA) PSD*

$$PSD_{SSA_k} = \frac{1}{N} * M_{sq\,k}; \qquad k = 1 \dots N \qquad [(Signal\ Unit)^2]$$

Remarks 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°.*

$$\varphi_k = \tan^{-1}\frac{Im\{Y_k\}}{Re\{Y_k\}}; \qquad k = 1 \dots N \qquad [°]$$

- *Phase unwrapped: Plots the unwrapped phase spectrum to avoid discontinuities from -900° … +900°.*

$$\varphi_{k,unwrapped} = \tan^{-1}\frac{Im\{Y_k\}}{Re\{Y_k\}}; \qquad k = 1 \dots N \qquad [°]$$

- *Phase radiant: Plots the phase spectrum from - π … + π.*

$$\Phi_k = \frac{\varphi_k}{360°} 2\pi; \qquad k = 1 \dots N \qquad [\mathrm{rad}]$$

- *Phase unwrapped (radiant): Plots the unwrapped phase spectrum to avoid discontinuities from --* 5π … + 5π.°.

$$\Phi_{k,unwrapped} = \frac{\varphi_{k,unwrapped}}{360°} 2\pi; \qquad k = 1 \dots N \qquad [\mathrm{rad}]$$

6.12.3.3 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 section 6.12.7.

6.12.3.4 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, please refer to section 6.4.2.2.
- Layer: Moves the Instrument in front of or behind another object

Remark: The properties of the FFT can be changed and updated in the *PLAY* mode as well as in the *LIVE* and *REC* mode.

6.12.4 MARKERS

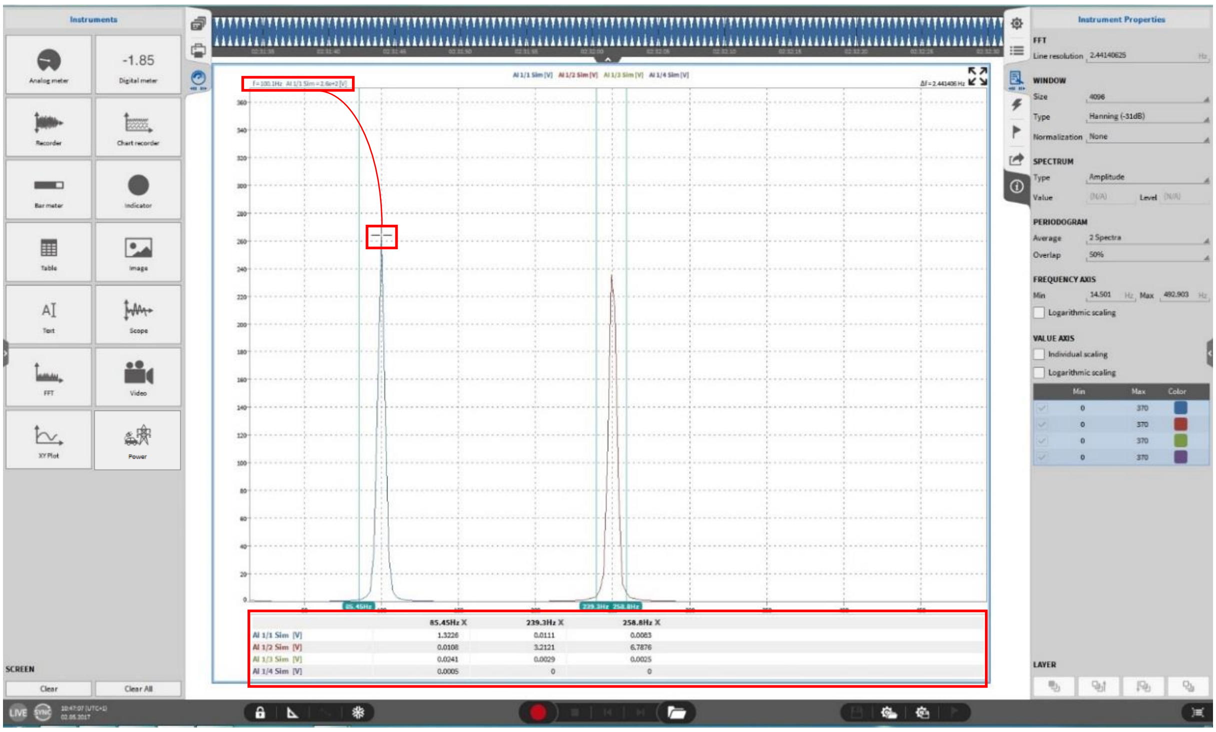


Figure 6-39: FFT Marker - Overview

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.

6.12.5 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.

6.12.5.1 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:

$$Line\ resolution = \frac{Sample\ Rate}{Data\ size}\ [Hz]$$

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:

$$Line\ resolution = \frac{Sample\ Rate}{Data\ size + Number\ of\ zeros} = \frac{Sample\ Rate}{Number\ of\ FFT\ bins}\ [Hz]$$

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 section 6.12.3).
In OXYGEN, the Line resolution can be selected from $\frac{Sample\ Rate}{2^{20}}$ to $\frac{Sample\ Rate}{Data\ size}$ 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 section 6.12.5.2. To increase the resolution, a longer signal in time domain is required.

Remark: Zero-padding is applied after multiplying the signal with the window function.

6.12.5.2 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:

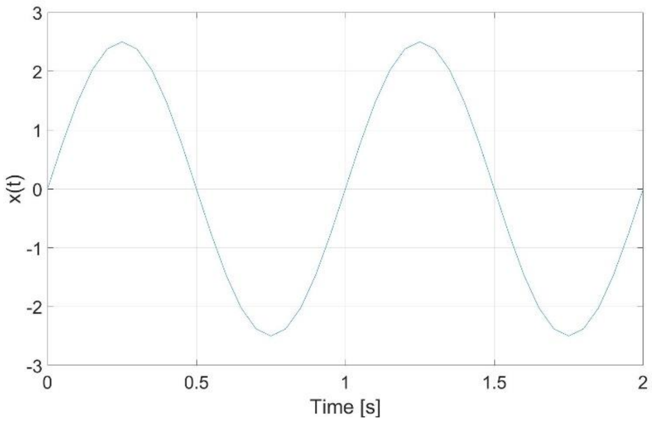


Figure 6-40: Signal 1 in time domain, 2s (41samples)

$$x(t) = 2.5 * sin(2 * \pi * 1 * t)$$

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:

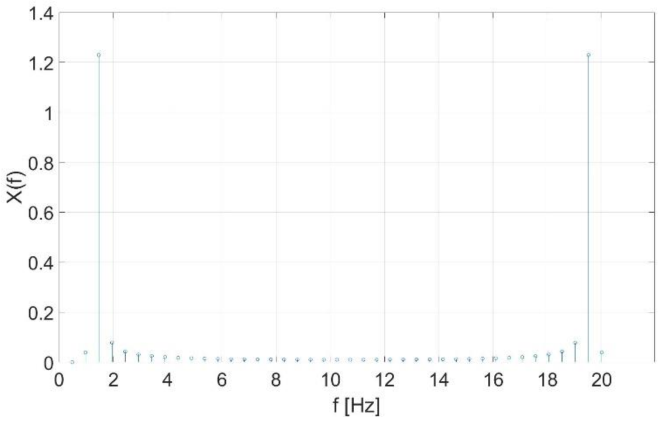


Figure 6-41: Signal 1 in frequency domain, no zero-padding

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:

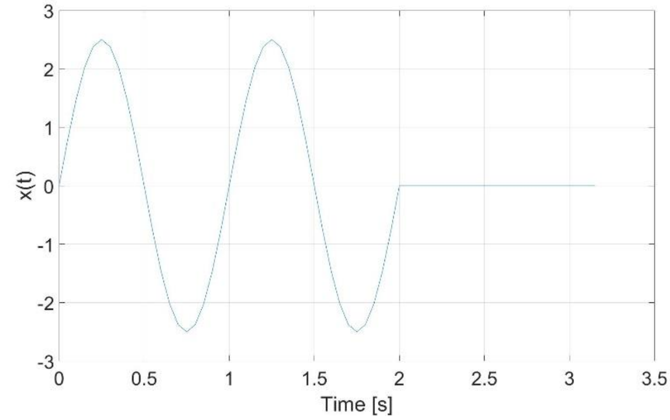


Figure 6-42: Signal 1 in time domain, zero-padding to 64 samples

Transforming the signal to the frequency domain leads to the following spectrum:

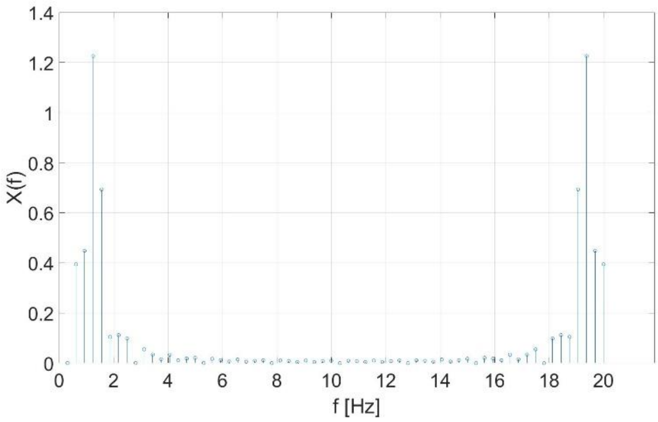


Figure 6-43: Signal 1 in frequency domain, zero-padding to 64 samples

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:

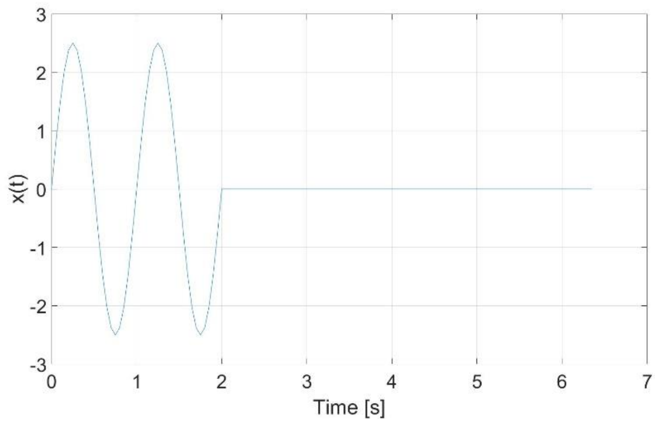


Figure 6-44: Signal 1 in time domain, zero-padding to 128 samples

This signal leads to the following spectrum with 128 frequency bins:

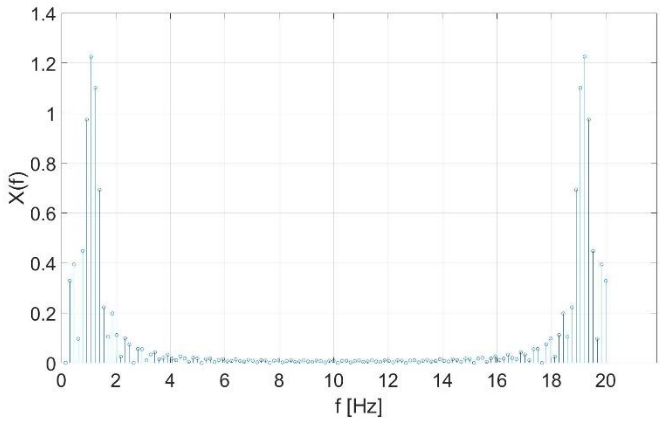


Figure 6-45: Signal 1 in frequency domain, zero-padding to 128 samples

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):

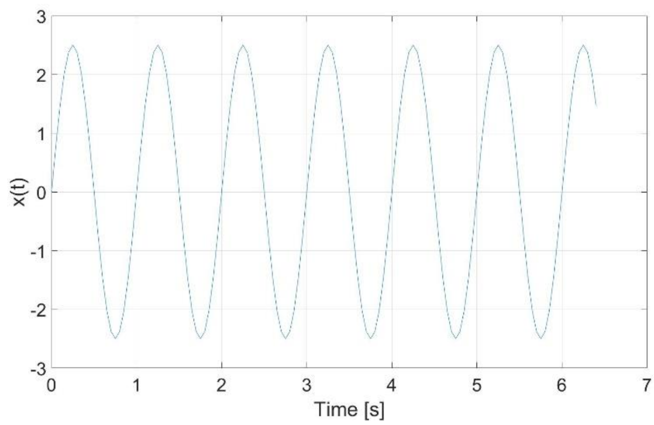


Figure 6-46: Signal 2 in time domain, 6.4s (128 samples)

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:

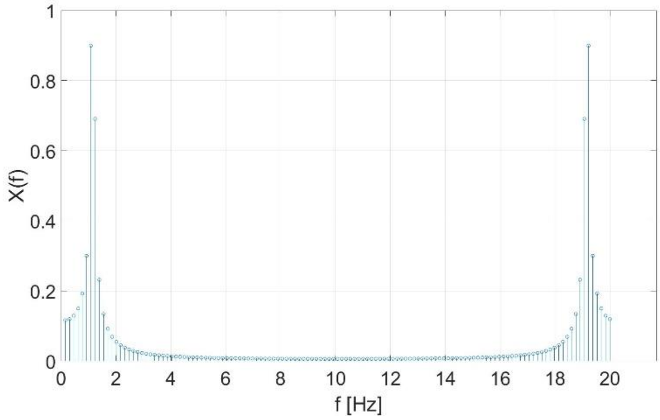


Figure 6-47: Signal 2 in frequency domain, no zero-padding

6.12.6 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:

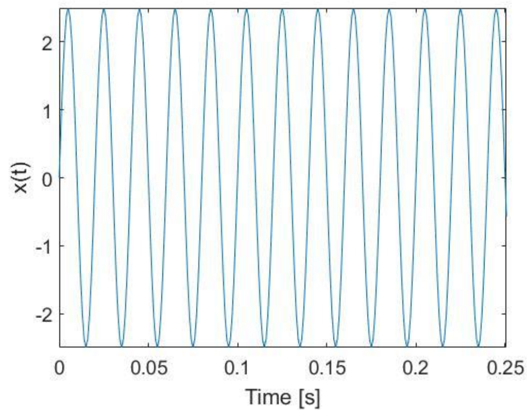


Figure 6-48: Signal in time domain (first 250ms)

$$x(t) = 2.5 * sin(2 * \pi * 50 * t)$$

After transforming the signal into the frequency domain according to the formula

$$Y_k = \sum_{n=0}^{N-1} X_k e^{\frac{-i2\pi kn}{N}}; \quad k = 0 \dots N-1 \quad (N = 10001)$$

and determining the absolute value, the spectrum is the following:

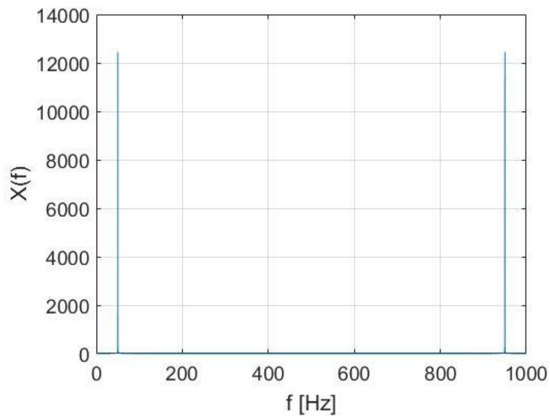


Figure 6-49: x(t) in frequency domain

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.

$$Y_{norm_k} = \frac{Y_k}{N}; \quad k = 0 \dots N-1 \quad (N = 10001)$$

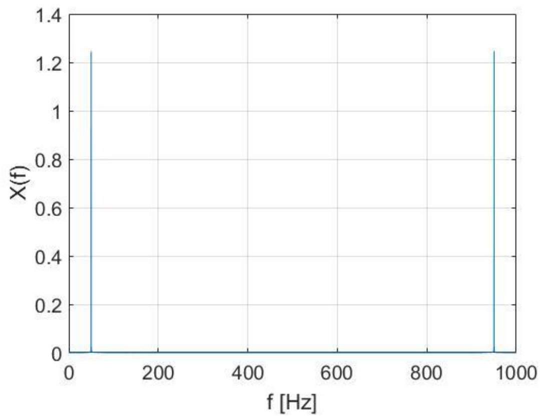


Figure 6-50: x(t) in frequency domain divided by the FFT-length

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 ($\frac{f_s}{2}$) 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:

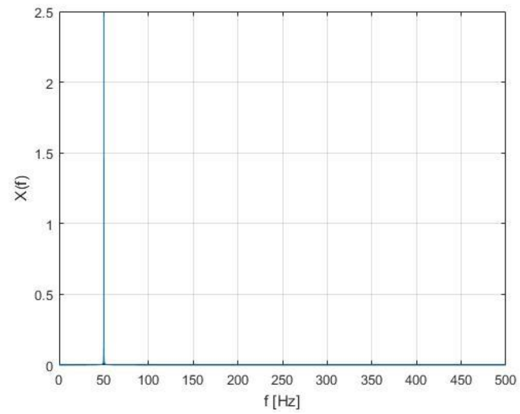


Figure 6-51: One-sided spectrum X(f) multiplied by factor 2

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 Figure 6-48 and multiply it with a Hanning window. The formula for the creation of a Hanning window can be found in section 6.12.3.1.1. After the multiplication, the signal looks as follows:

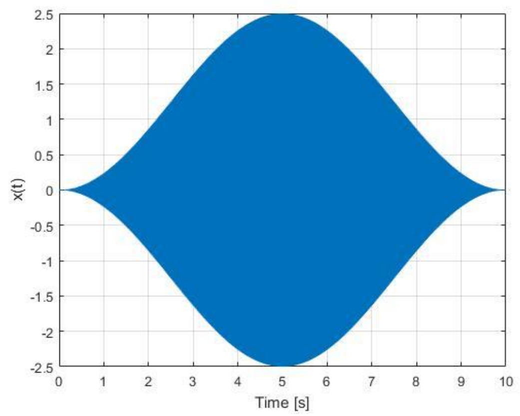


Figure 6-52: $x(t)_{win}$ in time domain; multiplied with a Hanning window

$$x(t)_{win} = [2.5 * \sin(2 * \pi * 50 * t)] * \left[0.5 * \left(1 - \cos\left(\frac{2 * \pi * n}{N - 1}\right)\right)\right]; \quad n = 0 \ldots N - 1$$

The spectrum of the signal looks as follows:

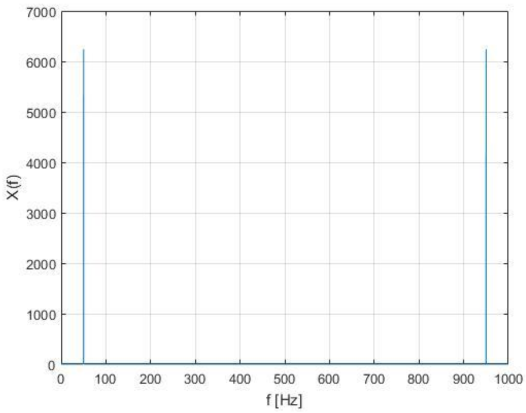


Figure 6-53: $x(t)_{win}$ in frequency domain

Again, the signal unit looks arbitrary. Thus, we divide the spectrum by the length of the FFT (N=10001) again.

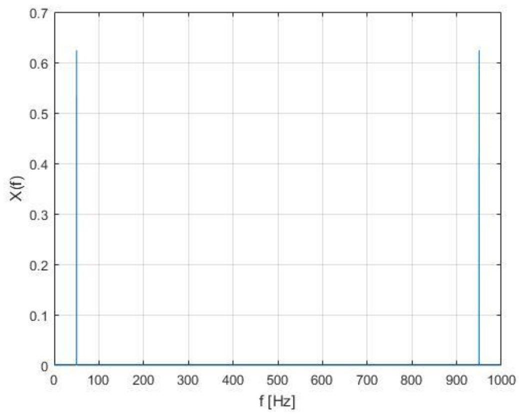


Figure 6-54: $x(t)_{win}$ in frequency domain divided by the FFT-length

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.

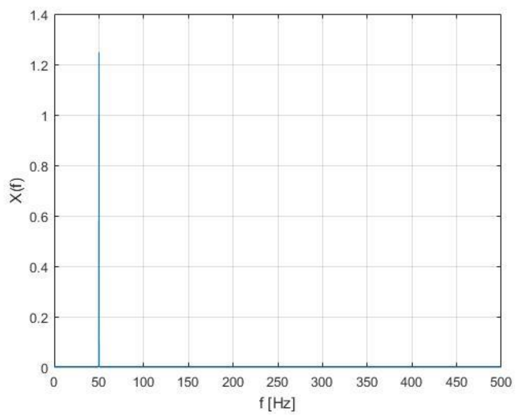


Figure 6-55: One-sided spectrum $X(f)_{win}$ multiplied by factor 2

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:

$$X(f)_{win_{AmpCorr}} = X(f)_{win} * [\frac{N}{\sum_{k=1}^{N} W_k}]$$

where N denotes again the window (and signal) length and W_k the value of the window function at position k.

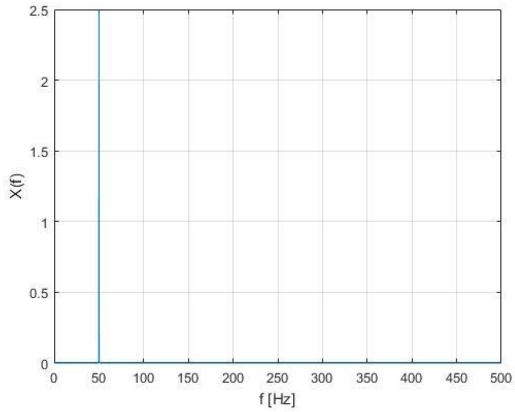


Figure 6-56: Amplitude-True-normalized spectrum X(f)

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:

$$X(f)_{win_{PowCorr}} = X(f)_{win} * \sqrt{\frac{N}{\sum_{k=1}^{N} W_k^2}}$$

where N denotes again the window (and signal) length and W_k the value of the window function at position k.

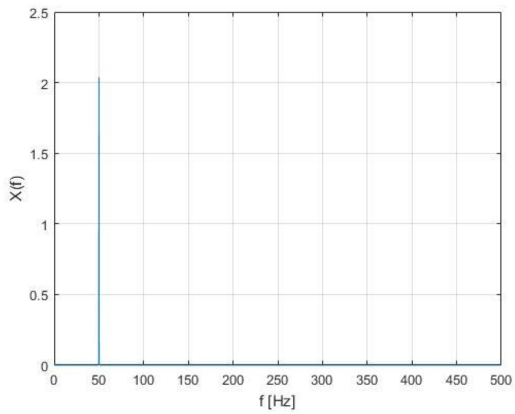


Figure 6-57: Power-True-normalized spectrum X(f)

Now, the power in frequency domain is the same as in time domain, but the amplitude does not match correctly anymore.

6.12.7 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:

- Figure 6-58: periodogram with an average of 4 spectra and 0% overlapping
- Figure 6-59: periodogram with an average of 4 spectra and 75% overlapping (750 Samples)
- Figure 6-60: periodogram with an average of 2 spectra and 50% overlapping (50 Samples)

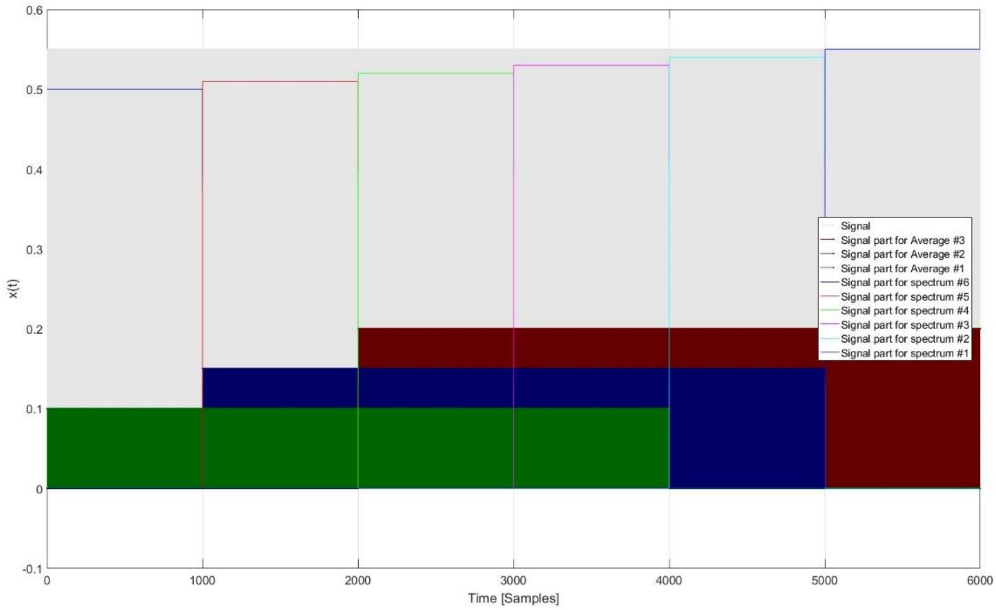


Figure 6-58: Decomposition of the time signal for a Periodogram with an average of 4 spectra and 0% overlapping

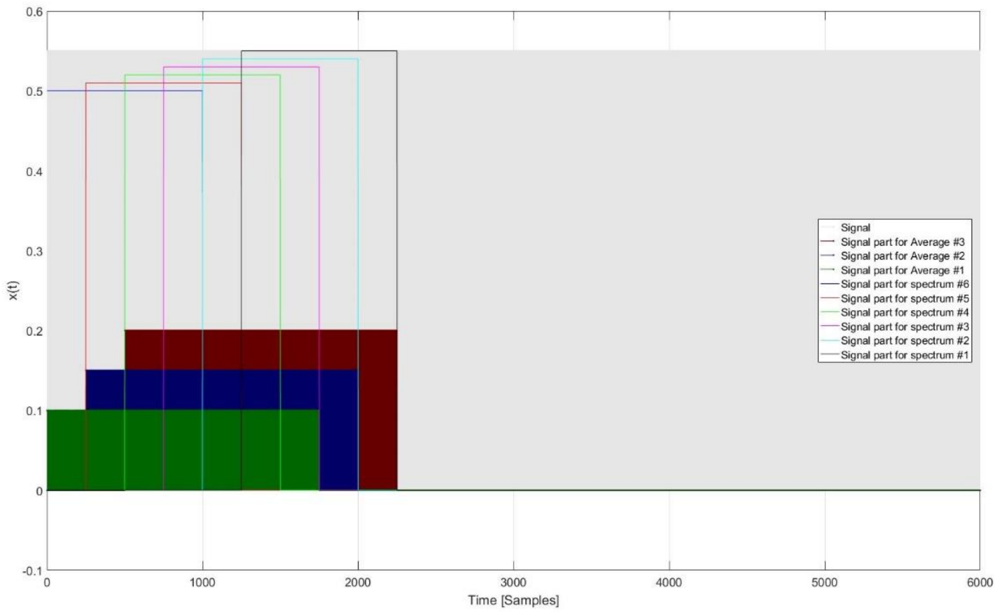


Figure 6-59: Decomposition of the time signal for a Periodogram with an average of 4 spectra and 75% overlapping

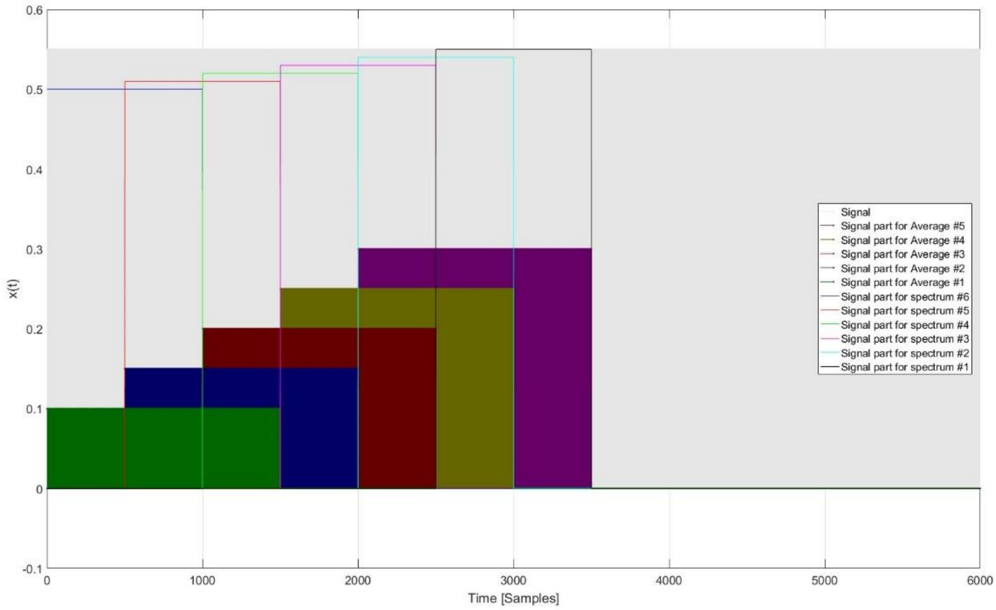


Figure 6-60: Decomposition of the time signal for a Periodogram with an average of 2 spectra and 50% overlapping

6.13 VIDEO INSTRUMENT

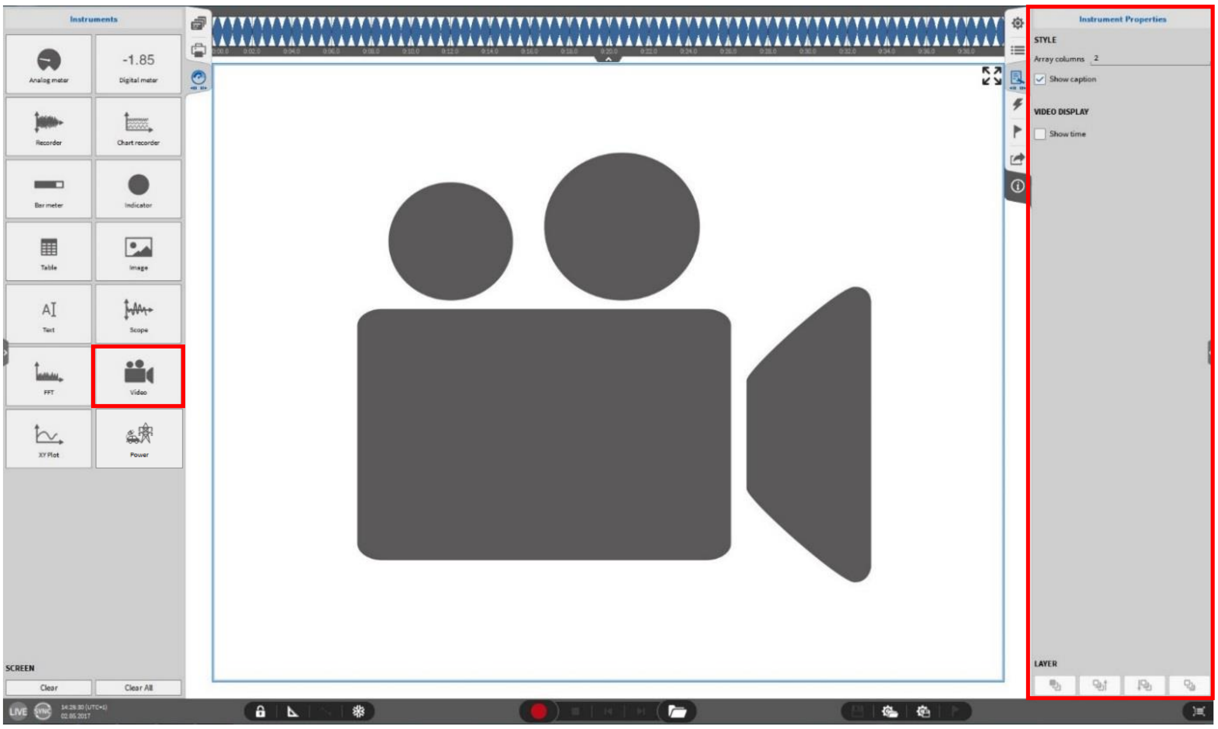


Figure 6-61: Video Instrument – Overview

OXYGEN provides the possibility to record a video during the measurement with a webcam or with a DEWE-CAM-GIGE-120. 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 Figure 6-62).

Figure 6-62: 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. **Please note that the video recording with a webcam or a DEWE-CAM-GigE-120 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**. For the driver installation and the required software settings please refer to the Installation Guide of the DEWE-CAM-GigE-120 in OXYGEN.

Remark: 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 Figure 6-63) in the *System Settings*.

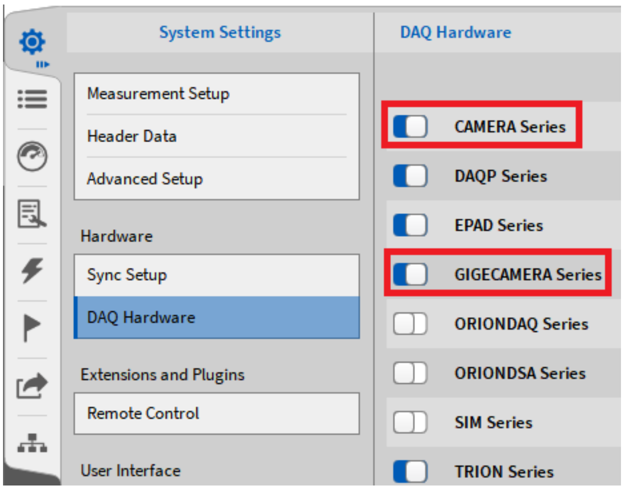


Figure 6-63: Enabling the Camera Series and the GigE Camera series in the DAQ Hardware setup

The Video Instrument has the following Instrument Properties (see Figure 6-61):

- Style: The user can specify the number of columns if several channels are selected
- Video Display: If *Show time* is selected, the current measurement time is displayed in the Video Instrument
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

Remark: 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 Figure 6-64).

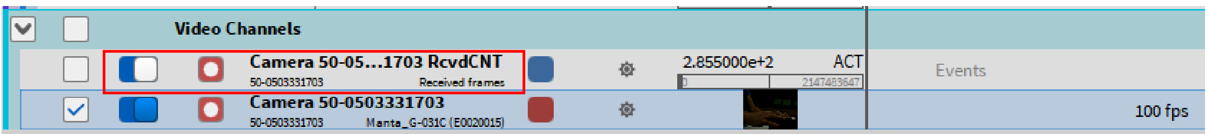


Figure 6-64: Frame Counter Channel

6.14 XY-PLOT

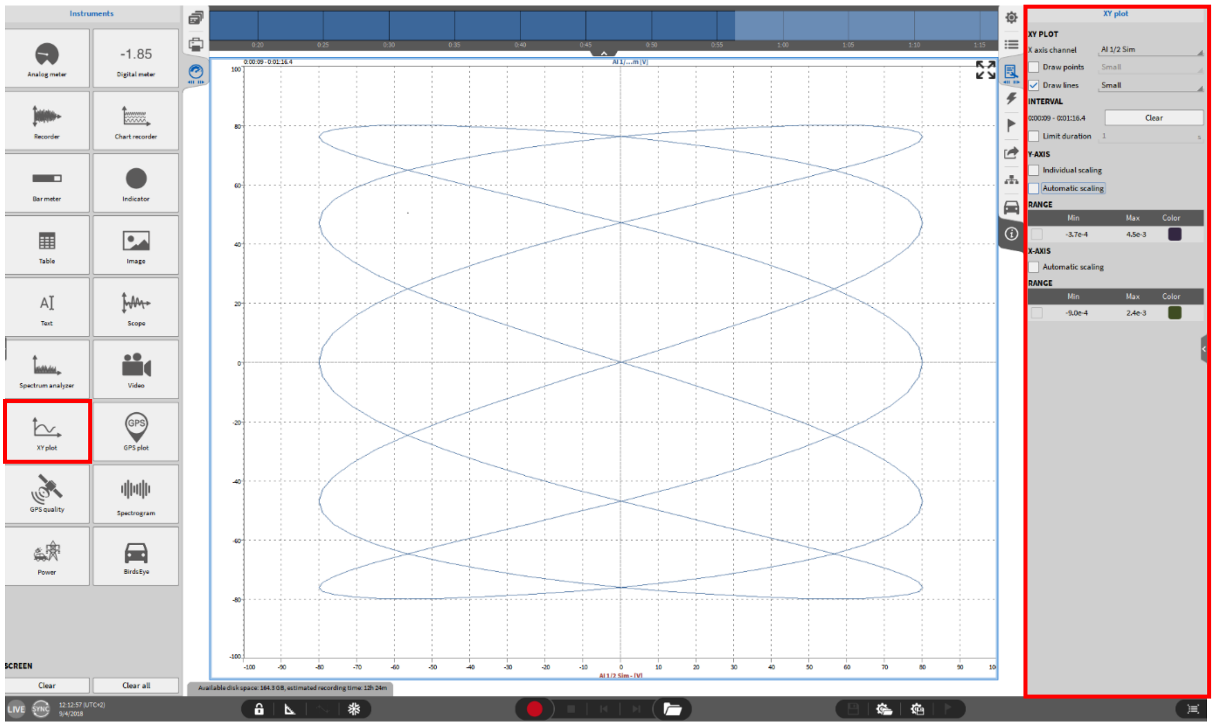


Figure 6-65: The XY-Plot – Overview

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 sound in the frequency domain (Y-Axis) in the dependency of the motor speed (X-Axis). The user can manipulate the following Instrument Properties:

- XYPLOT: The user can select the channel that shall be plotted on the X-Axis in the *X Axis Channel* dropdown menu. The other selected channels will be plotted on the Y-Axis. With the menus *Draw points*, *Draw lines* and their size selection the user can change the graphical characteristics of the plotted signal.
- Interval: The time interval of the plotted data is displayed here and in the upper left corner of the Instrument. To start the drawing of a new plot and delete the currently displayed time interval the user can 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.
- Y-Axis:
  Individual scaling creates a separate Y-Axis for each signal
  Automatic scaling zooms the Y-axis to the actual displayed min and max value
  Range: Assign a user-defined min/max value to the Y-Axis scaling
- X-Axis:
  Automatic scaling zooms the X-axis to the actual displayed min and max value
  Range: Assign a user-defined min/max value to the X-Axis scaling

Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

Remarks:

- Additional features for Y-Axis scaling (see section 6.4.2.2) and zooming (see section 6.4.2.5) 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 (see Figure 6-66) or in a Recorder if one is displayed. The Interval settings in the Instrument Properties are respected during this operation.
- Up to 9 channels can be assigned to one single Table Instrument (1 channel to the X-Axis, 8 channels to the Y-Axis).

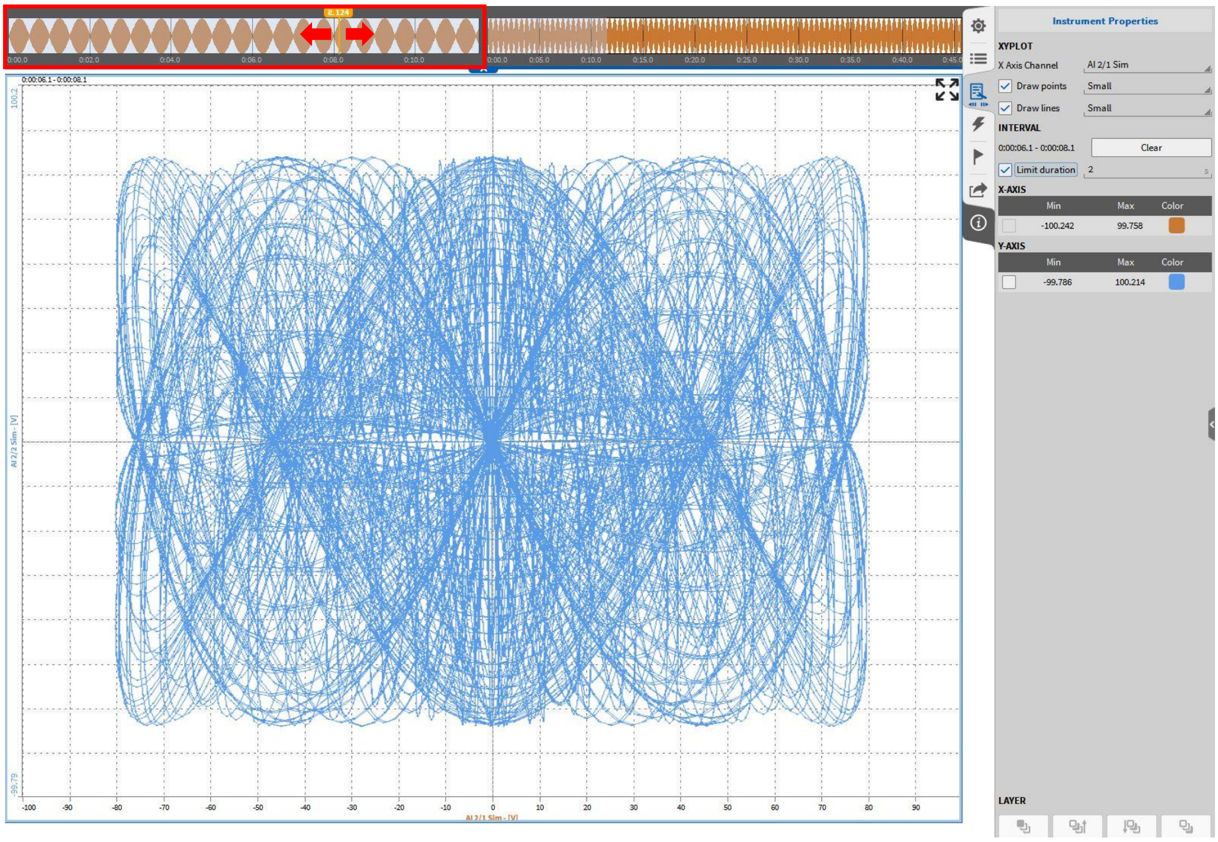


Figure 6-66: XY-Plot - Data scrolling

6.15 GPS PLOT

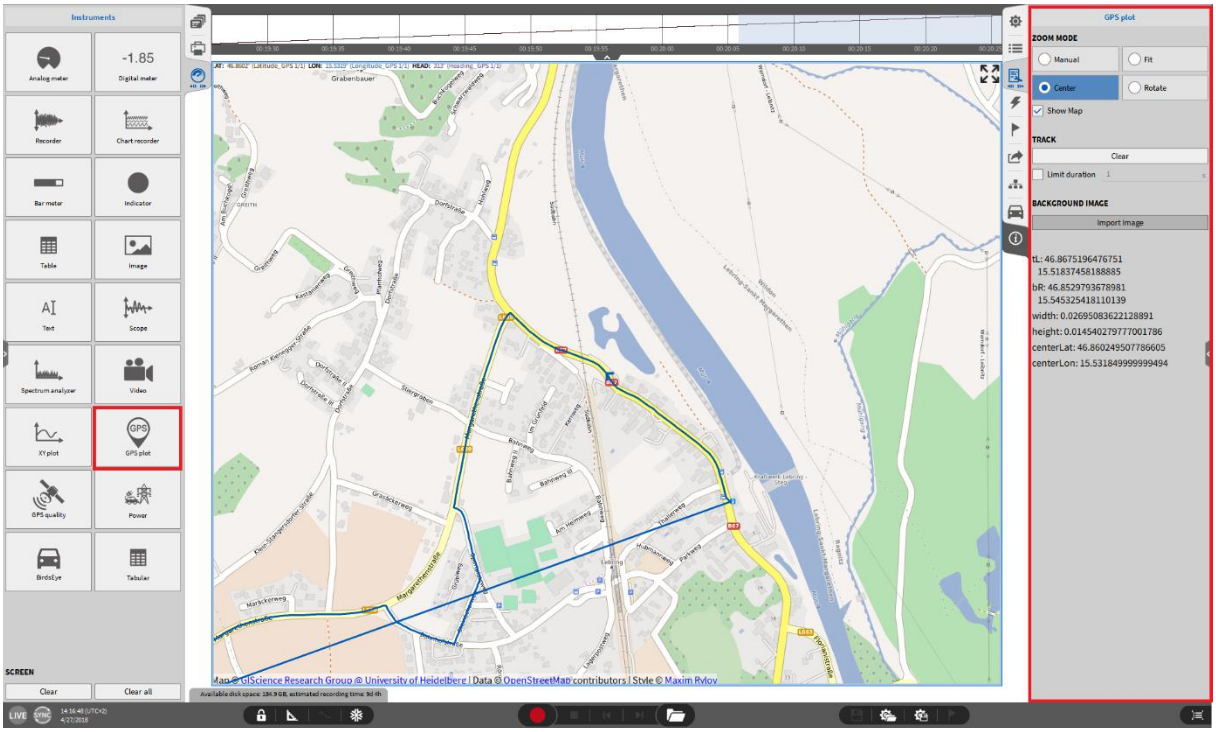


Figure 6-67: The GPS plot – Overview

With the *GPS plot*, the user can display the GPS-channels *Latitude*, *Longitude* and *Heading* which are acquired by a TRION^{TM}-TIMING or TRION^{TM}-VGPS-20/-100 module (see section 5.8). The individual channels *Latitude*, *Longitude* and *Heading* are matched automatically to the *LAT*, *LON* and *HEAD* input parameter of the Instrument according to the *Channel Mode*. Thus, the channels can be renamed arbitrarily.

Instead of the raw hardware channels *Latitude*, *Longitude* and *Heading*, mathematical channels can be assigned to the *GPS plot* as well (i.e. Statistics channels of *Longitude*, *Latitude* or *Heading*). If mathematical channels shall be assigned to the *GPS plot*, the corresponding *Latitude* channel must be assigned first, the *Longitude* channel second and the *Heading* channel third. In this case, an automatic channel match is not possible, because the *Channel Mode* information is missing.

The assignment of the individual channel to the *LAT*, *LON* and *HEAD* input parameter of the Instrument can be seen in the upper left corner of the Instrument.

The displayed map is an online map from OpenStreetMap©. If the PC has no internet connection, the map is displayed if it is stored in the cache. If the cache is empty, no map is displayed without internet connection.

The user can manipulate the following Instrument Properties:

- 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: The user can select if the map shall be displayed or not
- 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*
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)
- 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:

Figure 6-68: Image positioning dialog

Two GPS coordinates within the loaded image must be known to position the image correctly. In Figure 6-68, 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 Figure 6-68, 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 Figure 6-68, 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 Figure 6-68, 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 Figure 6-69):

Figure 6-69: Positioned image

- The positioning can be edited by clicking on *Position image* and removed by clicking on the *X* button (see Figure 6-70):

Figure 6-70: Editing the loaded image

6.16 GPS QUALITY

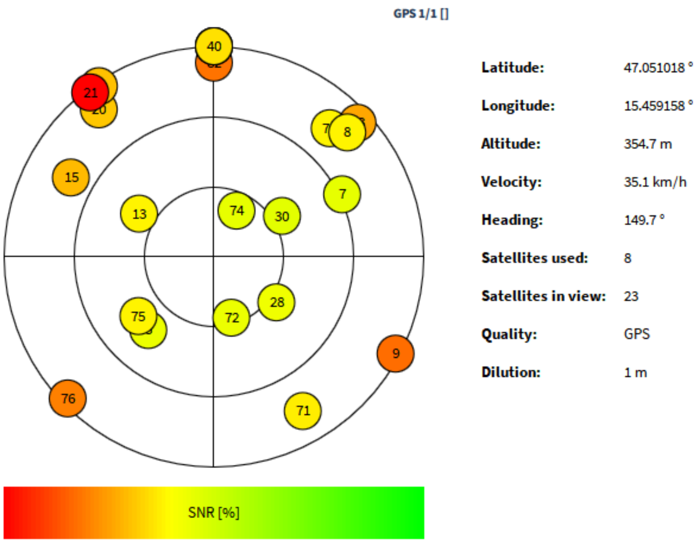


Figure 6-71: GPS quality Instrument - Overview

The GPS quality instrument displays the number of visible and used satellites of GPS data which is acquired by a TRION^{TM}-TIMING or TRION^{TM}-VGPS-20/-100 module (see section 5.8) 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:

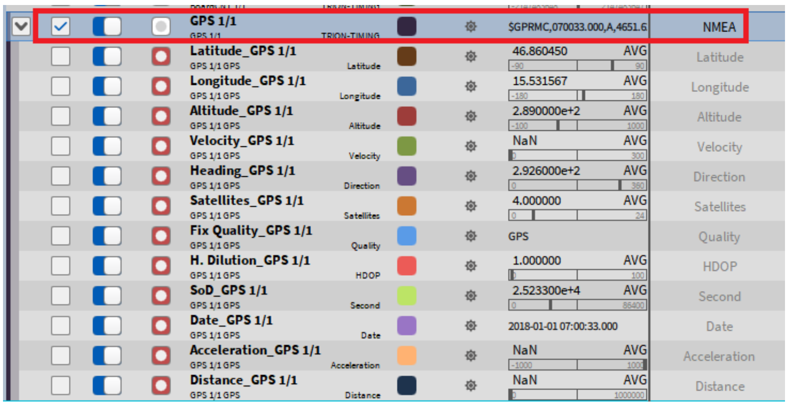


Figure 6-72: GPS NMEA data channel

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 Figure 6-73 explains the meaning of the three black circles with the same center point in the satellites plot:

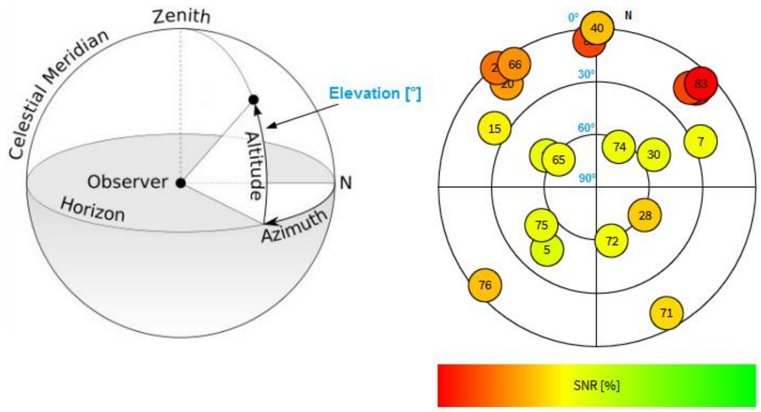


Figure 6-73: GPS quality instrument - Explanation of the satellites plot

The deselection of the instrument property *Extended View* reduces the content of the GPS plot Instrument to the satellites plot:

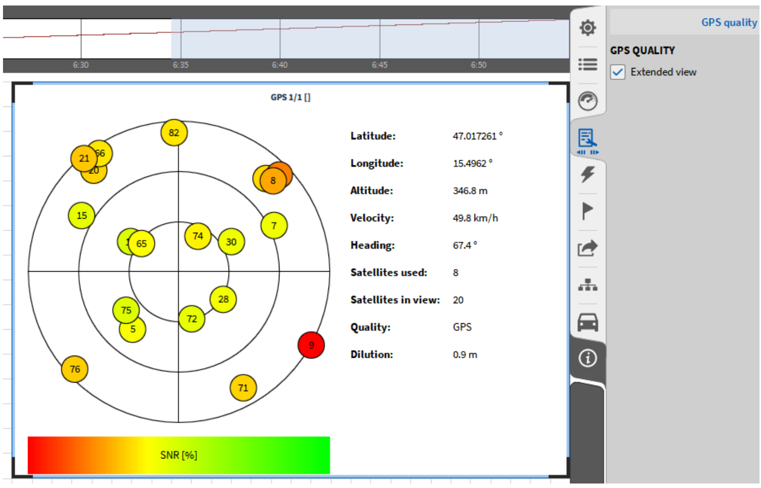


Figure 6-74: GPS quality instrument - *Extended View* selected

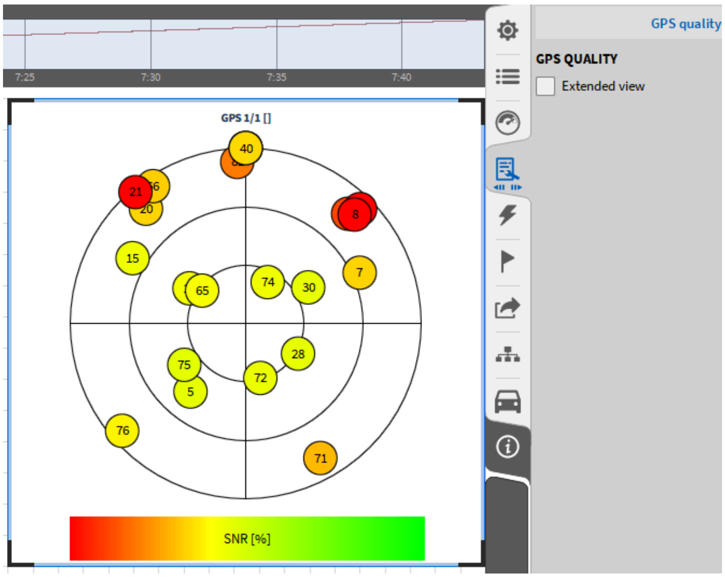


Figure 6-75: GPS quality instrument - Extended View de-selected

6.17 SPECTROGRAM

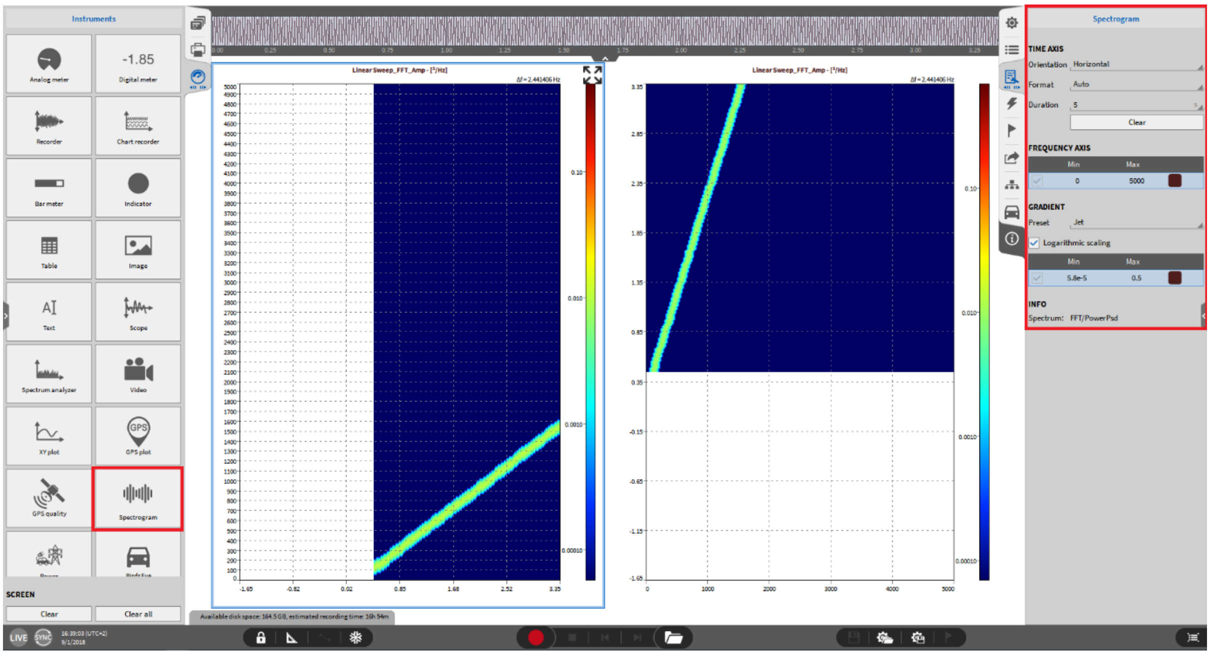


Figure 6-76: Spectrogram – Overview

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, please refer to section 5.3.6).
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 Figure 6-76).

Remark: 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 Figure 6-76)and *Vertical* orientation assigns the time axis to the Y-axis of the instrument (see right instrument in Figure 6-76).
- Time Axis - Format: This property changes the format of the X-Axis. The user can select between *Auto*, *Absolute time* and R*elative 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.
- Layer: Moves the Instrument in front of or behind another object (Only applicable in *Design Mode*)

6.18 POWER GROUP

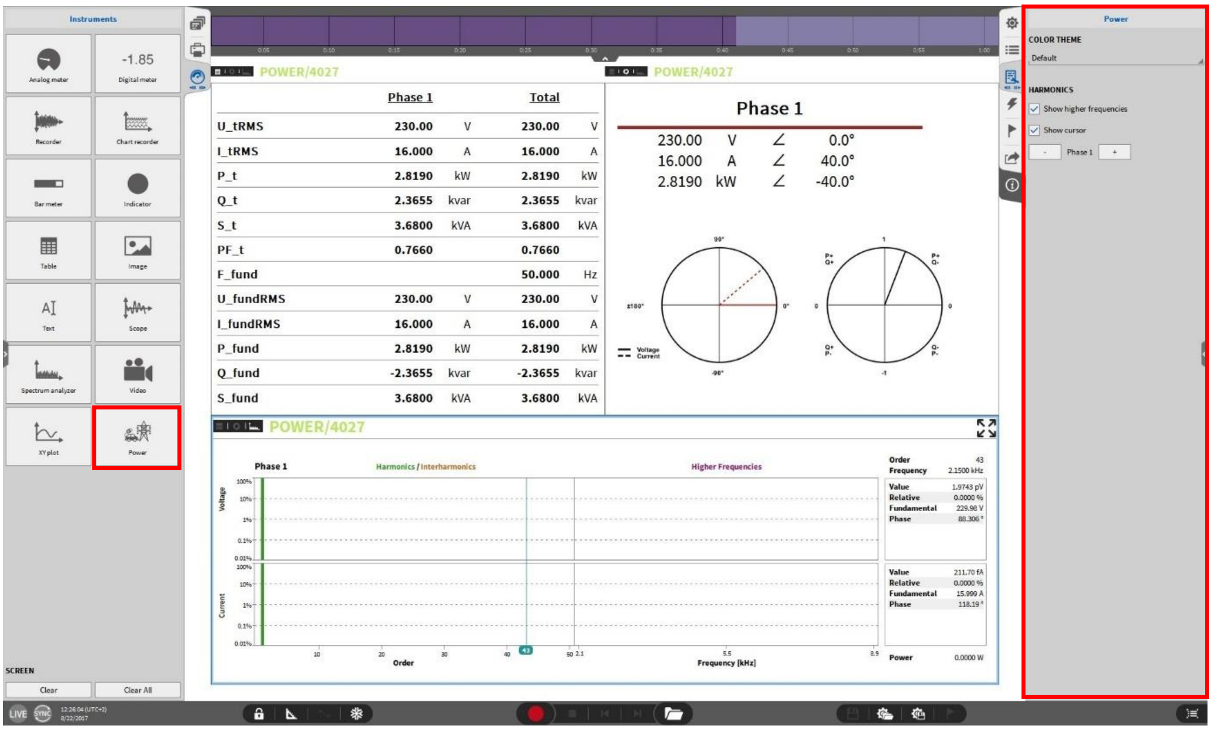


Figure 6-77: Power Group – Overview

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, please refer to the manual DEWETRON_Oxygen_Power_Technical_Reference_Rx.x.

7 TRIGGERED EVENTS

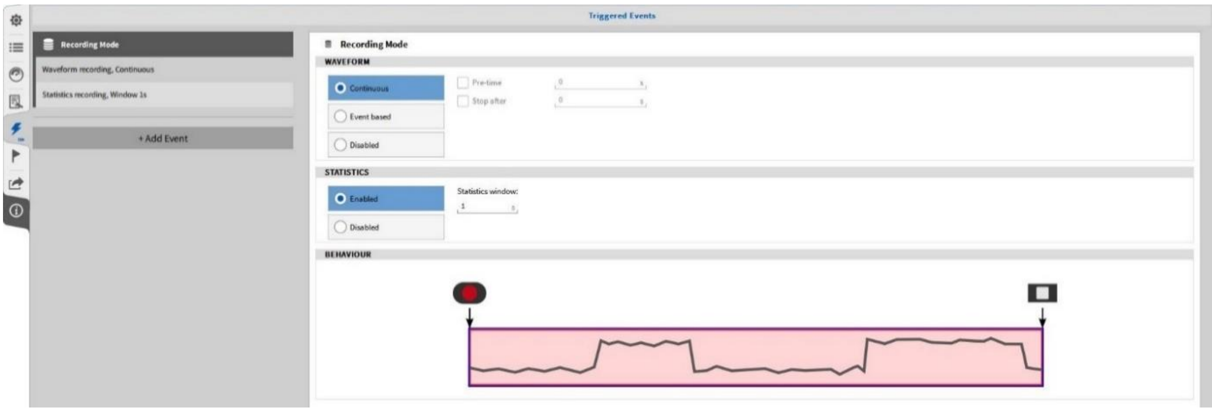


Figure 7-1: *Trigger Events* Menu – Overview

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.

7.1 ADDING A TRIGGER EVENT

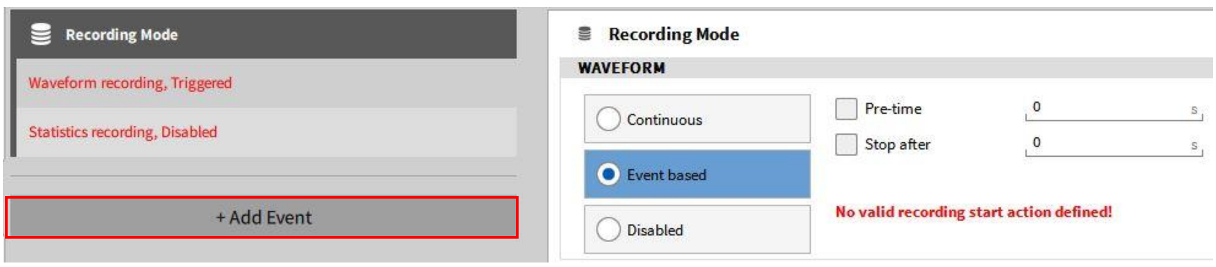


Figure 7-2: Enable Trigger Mode

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 Figure 7-2). Optionally the user can also store the data before the trigger event was reached by adding a *Pre-time* between 0 and 10 seconds and he can also define a time after which the record is stopped automatically again (*Stop after*).

7.2 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:

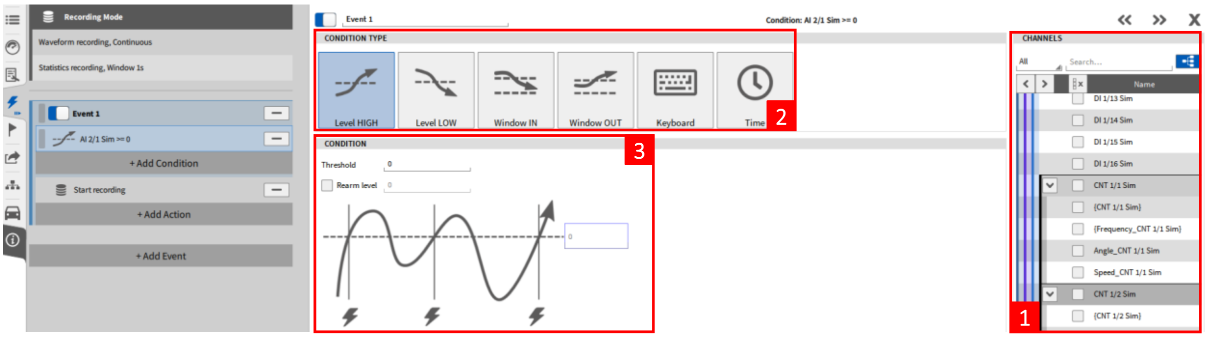


Figure 7-3: Define an Event Condition and Trigger on *Level HIGH*

The channel to be triggered on can be selected from the channel list on the right screen side (see ① in Figure 7-3). The user can select between five different event conditions (see ② in Figure 7-3):

- 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 Figure 7-3).
- 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 Figure 7-4).

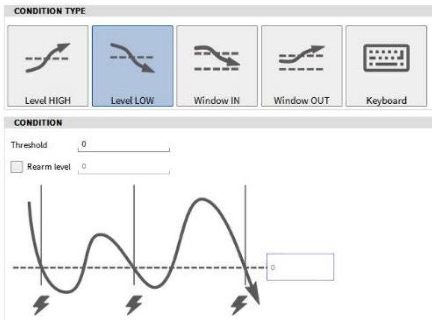


Figure 7-4: Trigger on *Level LOW*

- Window IN: Activate Event if selected signal is within a certain range. The user can define an upper and a lower limit (see Figure 7-5).

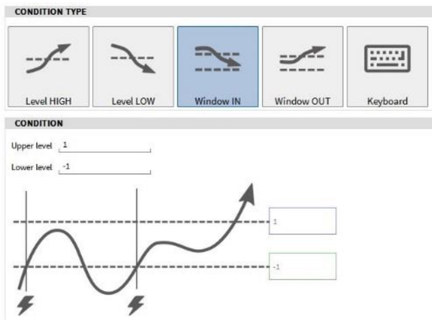


Figure 7-5: Trigger on *Window IN*

- Window OUT: Activate Event if selected signal is out of a certain range. The user can define an upper and a lower limit (see Figure 7-6).

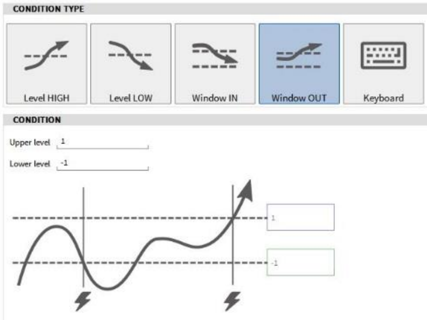


Figure 7-6: Trigger on *Window OUT*

- 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.

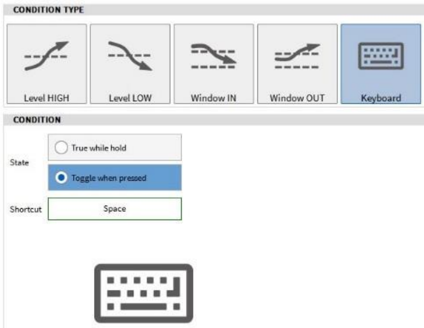


Figure 7-7: Trigger on *Keyboard* Event

- Time Event: The event is activated in the dependency of a time condition. In the example in Figure 7-8, the event is activated every 30 minutes for a duration of 1 minute. 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 Figure 7-9) won't highlight if the *Active for* option is not enabled.

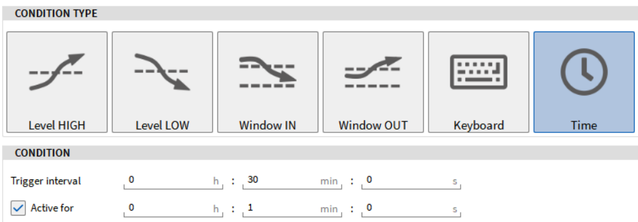


Figure 7-8: Trigger on *Time* Event

Remarks:

- The red indicator shows if the respective event is active or not (see ① in Figure 7-9)
- The blue switch deactivates the event permanently (see ② in Figure 7-9)
- The – deletes the event (see ③ in Figure 7-9)
- It is possible to add several Event Conditions to the same event

Figure 7-9: Trigger Menu - Additional information

7.3 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.

Remark: It is possible to add several Event Actions to the same Event

7.3.1 RECORD ACTION

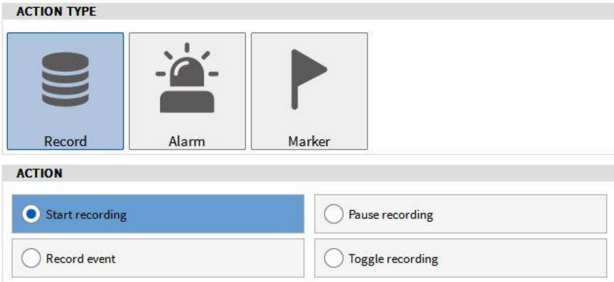


Figure 7-10: Trigger - Recording Actions

- *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

7.3.2 ALARM ACTION

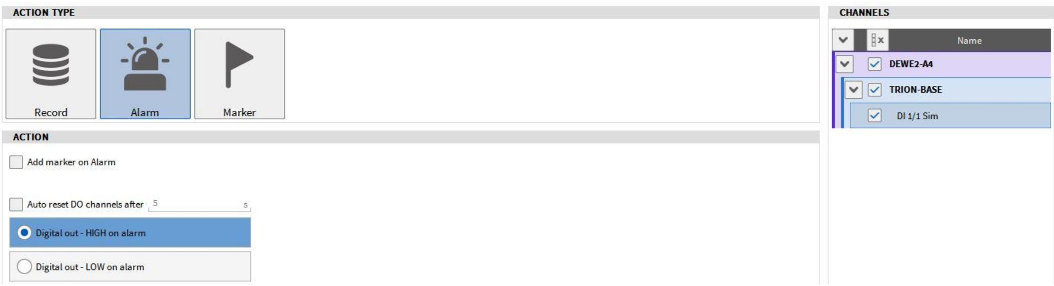


Figure 7-11: Trigger - Alarm Actions

- *Add marker on Alarm*: A marker will be set when the event is activated
- *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.

Remarks:

- To use connected digital channels as *Digital Out* channels the Channel Mode must be set to *Digital Out* in the *Data Channels* menu (see Figure 7-12).

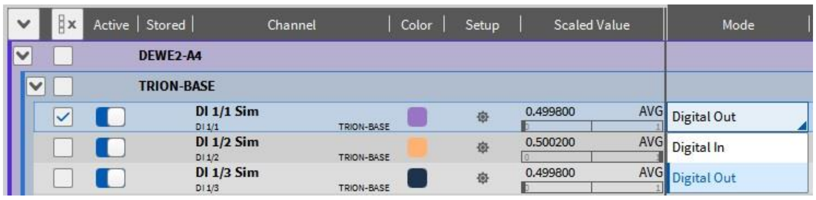


Figure 7-12: Changing the channel mode of a digital channel

- 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 Figure 7-13).

Figure 7-13: Alarm Counter

- An Alarm Action can also be selected if Continuous Waveform Recording is enabled and does not have to be event based.

7.3.3 Marker Action

Figure 7-14: 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

Remark: A Marker Action can also be selected if Continuous Waveform Recording is enabled and does not have to be event based.

7.3.4 Snapshot Action

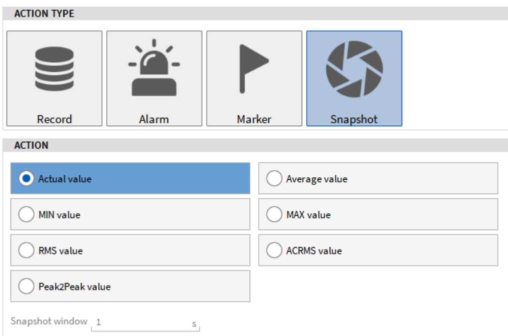


Figure 7-15: Trigger - Snapshot Action

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 Figure 7-3) 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 Figure 7-16). If a statistical value is selected, the calculation time interval can be defined in the *Snapshot window* input field (see Figure 7-15). The time interval is applied prior to the activation of the event.

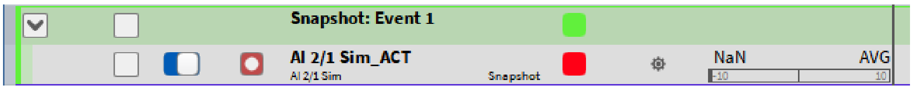


Figure 7-16: Snapshot channel in the Channel List

Remark: The same snapshot action can be applied to several channels by selecting them in the Channel list on the right-hand side (see Figure 7-17). An own snapshot channel for each selected channel is created in the Channel List (see Figure 7-18).

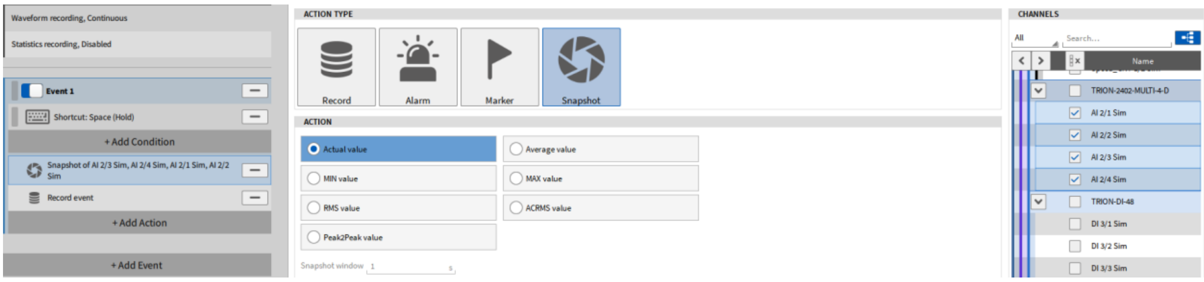


Figure 7-17: Selecting several channels in the Snapshot Action menu...

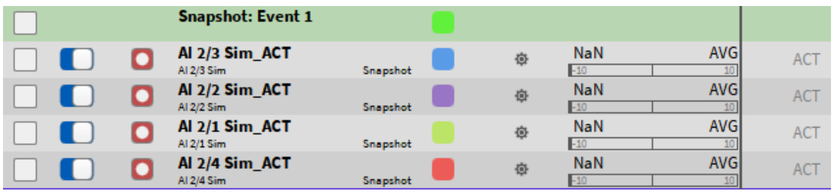


Figure 7-18: ...will result in an own snapshot channel in the Channel List for each selected channel

7.4 Arming the Trigger

If Event Based Waveform Recording is selected, a flash will appear within the sign of the record button (see Figure 7-19).

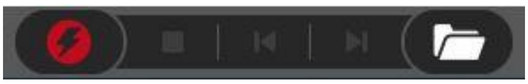


Figure 7-19: Action bar with enabled *Event Based Waveform* Recording

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.

Remark: If the trigger condition is active while arming the trigger, the trigger will not be detected as the trigger condition is not passed.

7.5 Application Examples

7.5.1 Event Based Waveform Recording triggered by an input channel

7.5.1.1 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 Figure 7-20):

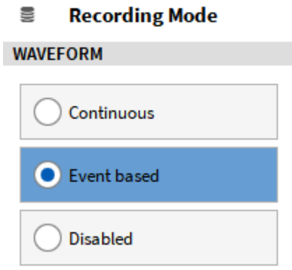


Figure 7-20: Event based waveform Recording selection

- 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 Figure 7-21):

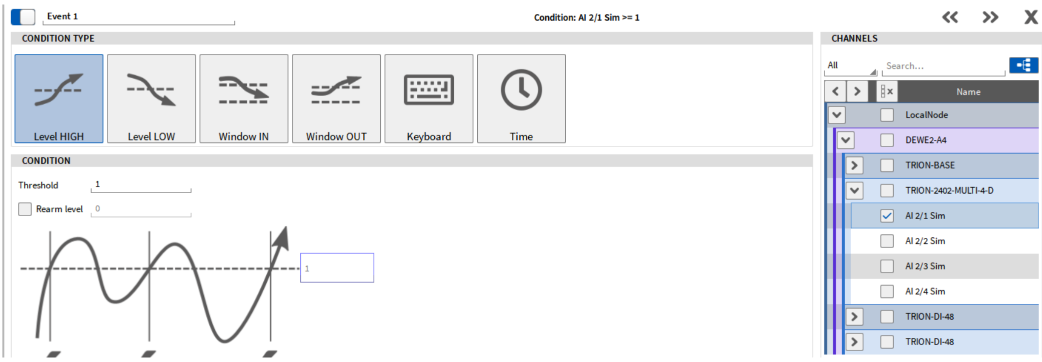


Figure 7-21: Level High Condition Type; Threshold: 1

- Select *Start recording* as *Action Type* (see Figure 7-22):

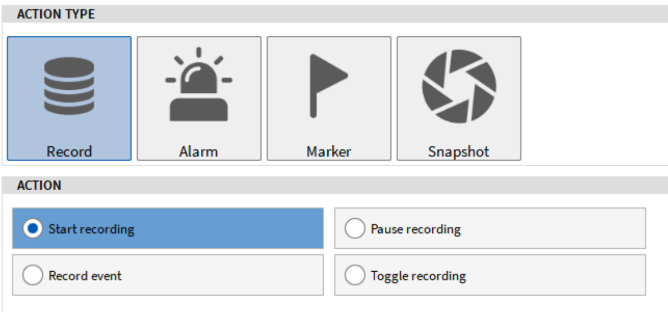


Figure 7-22: Start Recording Action Type

- 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 Figure 7-23):

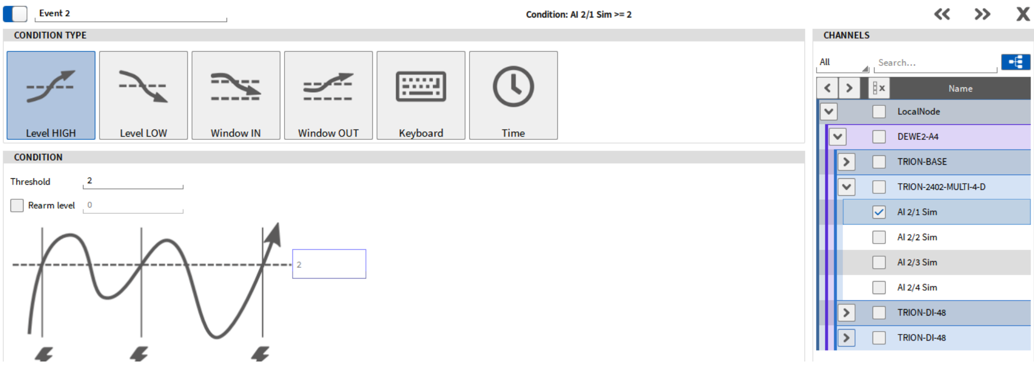


Figure 7-23: Level High Condition Type; Threshold: 2

- Select *Pause recording* as *Action Type* (see Figure 7-24):

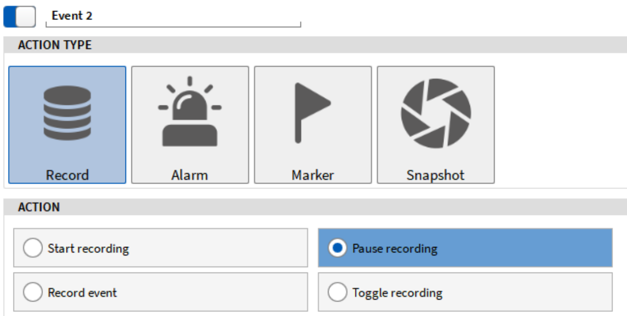


Figure 7-24: Pause Recording Action Type

7.5.1.2 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 section 7.5.1.1 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 Figure 7-25):

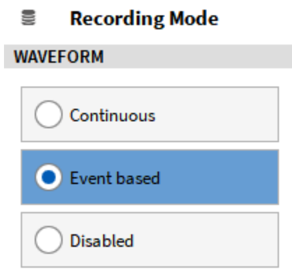


Figure 7-25: Event based waveform Recording selection

- 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 Figure 7-26):

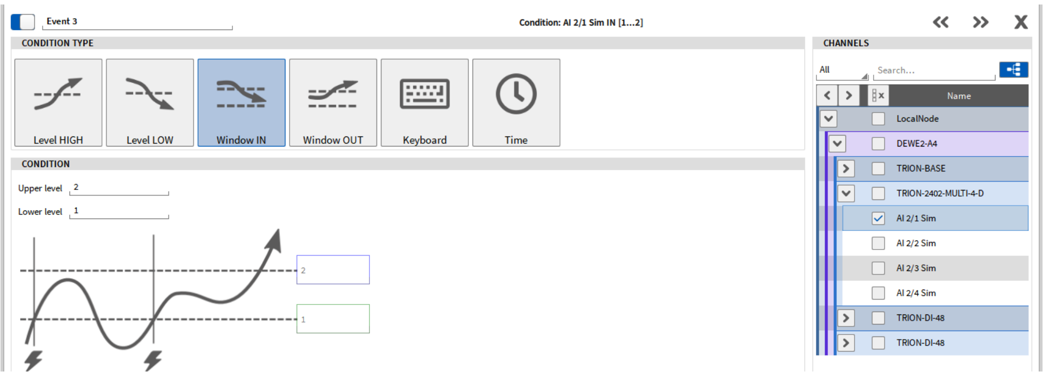


Figure 7-26: Window In Condition Type; 1...2

- Select *Record Event* as *Action Type* (see Figure 7-27):

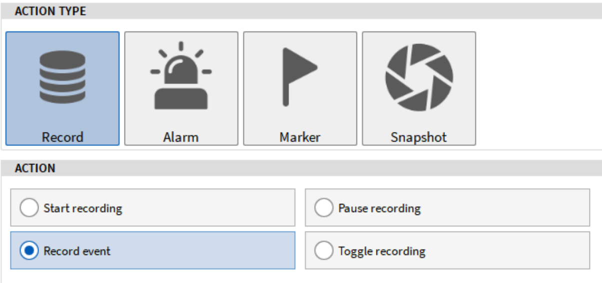


Figure 7-27: Record Event Action Type

7.5.2 Time Triggered Data Recording

Challenge: Record data every 60 minutes for 2 minutes.

- Select *Event based Waveform Recording* as Recording Mode (see Figure 7-28):

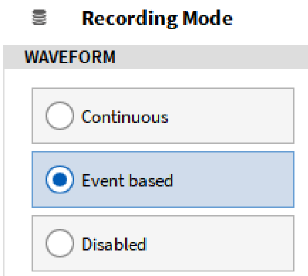


Figure 7-28: Event based waveform Recording selection

- Select the *Time* Condition and enter *1h* as *Time interval* and enable *Active for 2 minutes* (see Figure 7-29):

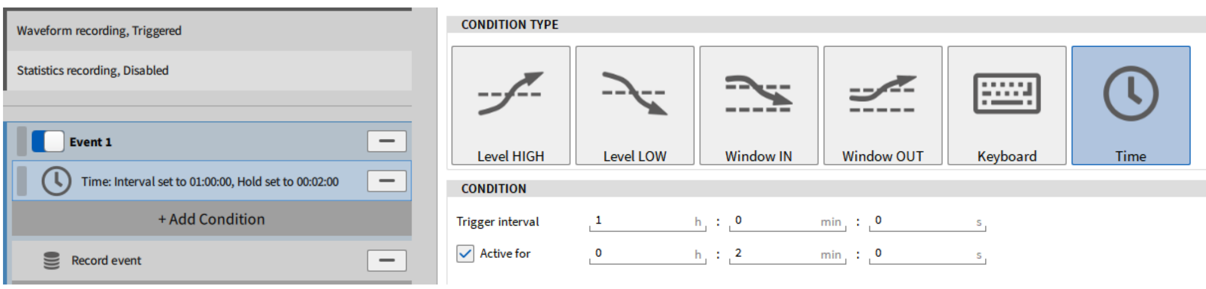


Figure 7-29: Recording every 60 minutes for 2 minutes

- Select *Record Event* as *Recording Action Type* (see Figure 7-30):

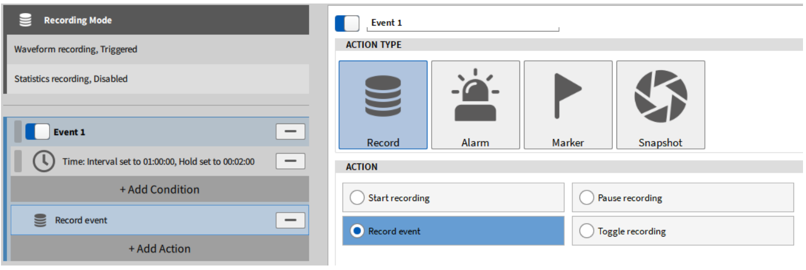


Figure 7-30: Record Event Action Type

7.5.3 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 maker 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 Figure 7-19):

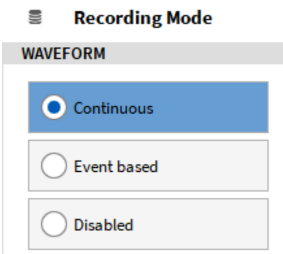


Figure 7-31: Continuous waveform Recording selection

- Select *Keyboard Condition Type* and *True while hold* as *Condition State* with the *Space key* as *Shortcut* (see Figure 7-32):

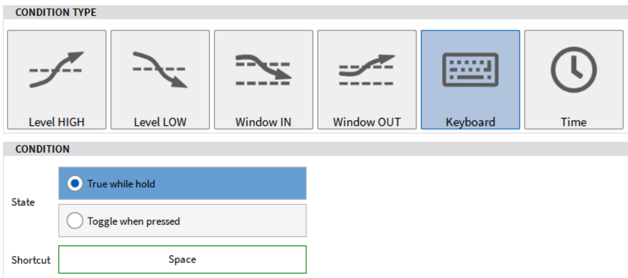


Figure 7-32: Space key Condition type

- 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 Figure 7-33). Data will be queried in the moment the Event configured above is activated.

Figure 7-33: 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 Figure 7-34). The channel mode of the desired Digital channel must be set to *Digital out* in the Channel List (see Figure 7-12)

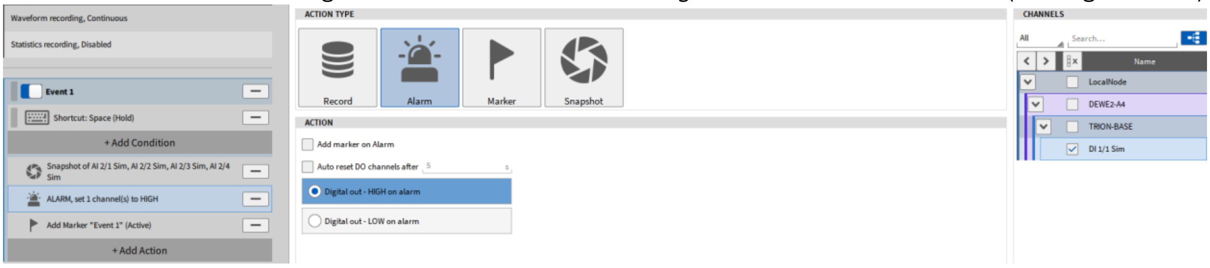


Figure 7-34: Alarm Action Type

- 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.

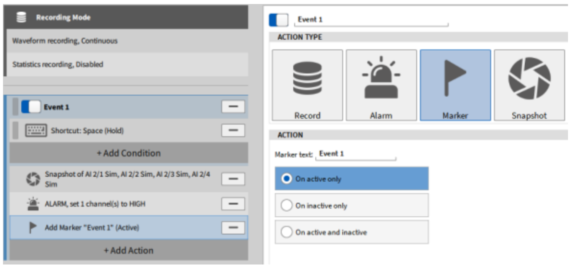


Figure 7-35: Marker Action Type

7.6 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 Figure 7-36).

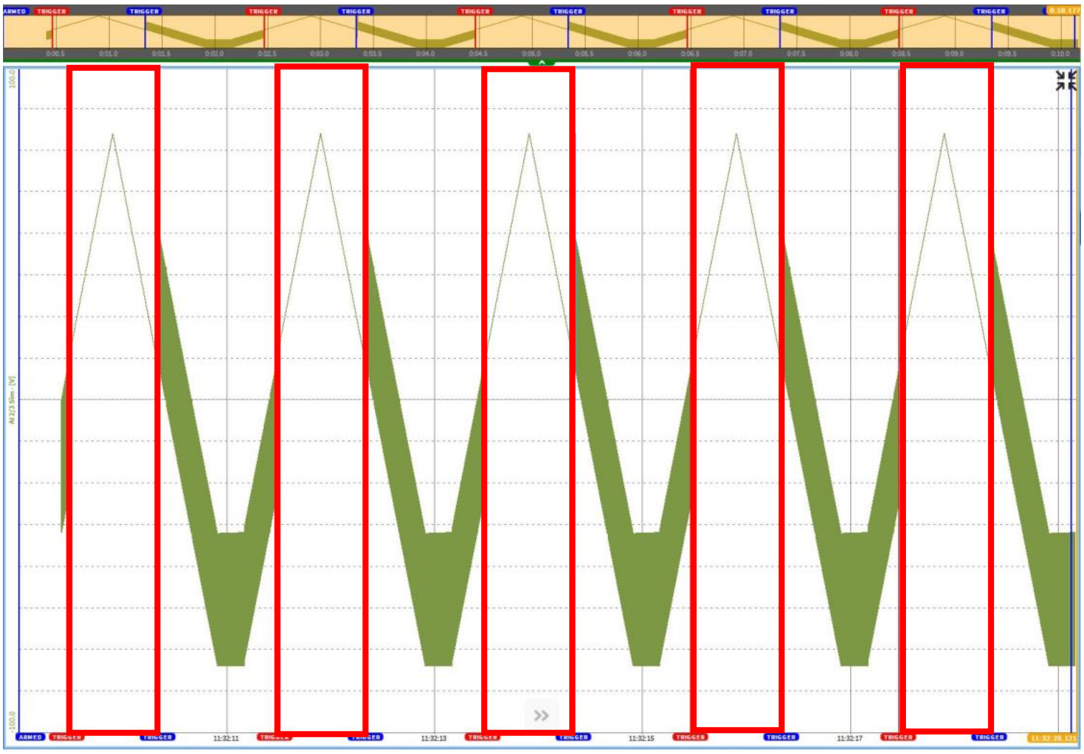


Figure 7-36: *Event Based Waveform* Recording (marked in red) and enabled *Statistics* Recording

7.7 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 Figure 7-37).

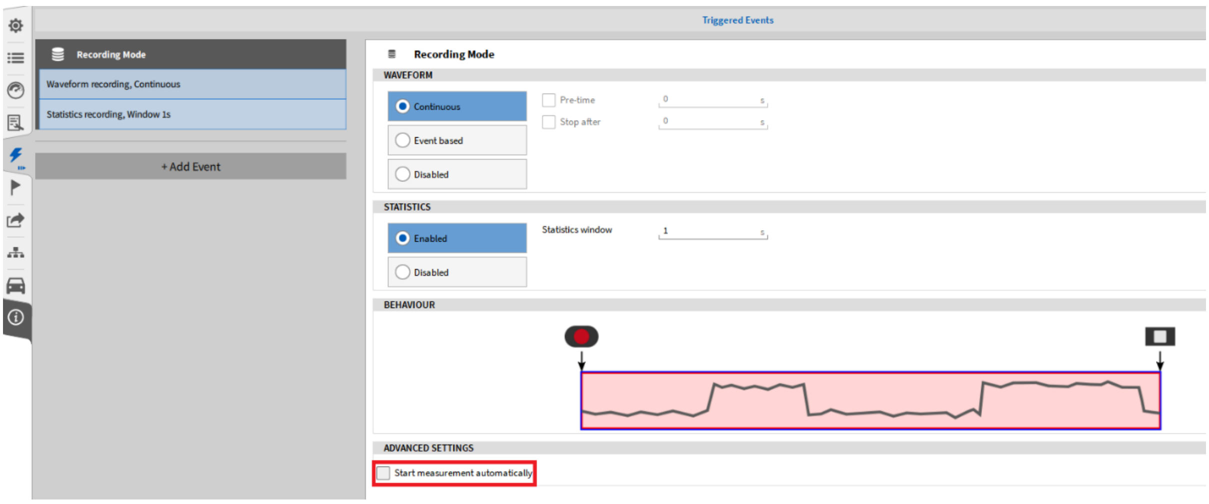


Figure 7-37: Triggered Events menu, Automatic measurement start

In case of *Continuous Waveform Recording* (please refer to section 7), the measurement will start automatically after OXYGEN has started and makes the manual press of the Recording button obsolete (see ④ in Figure 2-1).
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. OXYGEN must be added to the Windows *Autostart* applications for this procedure.

In case of *Event based Waveform Recording* (please refer to section 7 and section 7.3.1), the measurement will start automatically when the Start Recording condition (see section 7.3.1) is active. Therefore, it is not necessary to arm the trigger manually any more (see section 7.4).

8 EVENT LIST

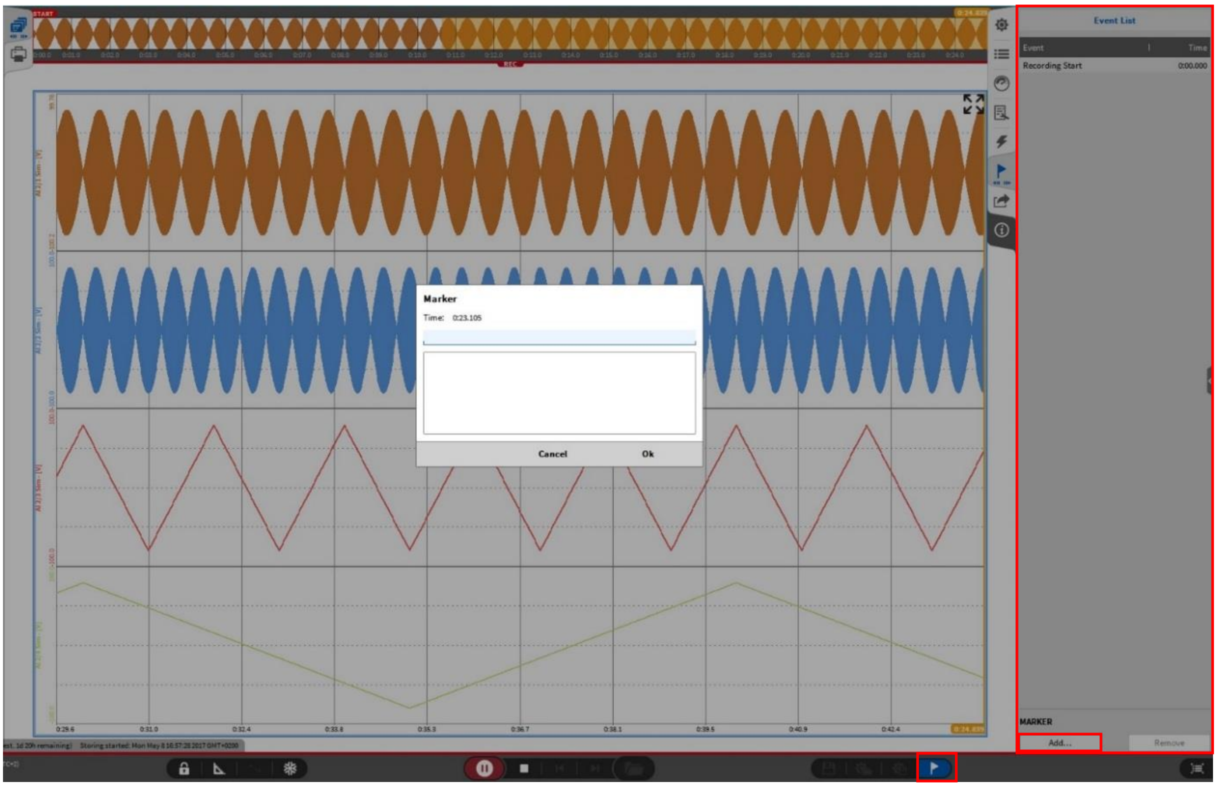


Figure 8-1: Adding a Marker

During an active recording, the user can add markers in its measurement to add additional information at a certain point of time. Therefor the user must click on one of the both buttons marked in Figure 8-1 and a popup 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. 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 Figure 8-2). Further markers can be added in the *PLAY* mode as well.

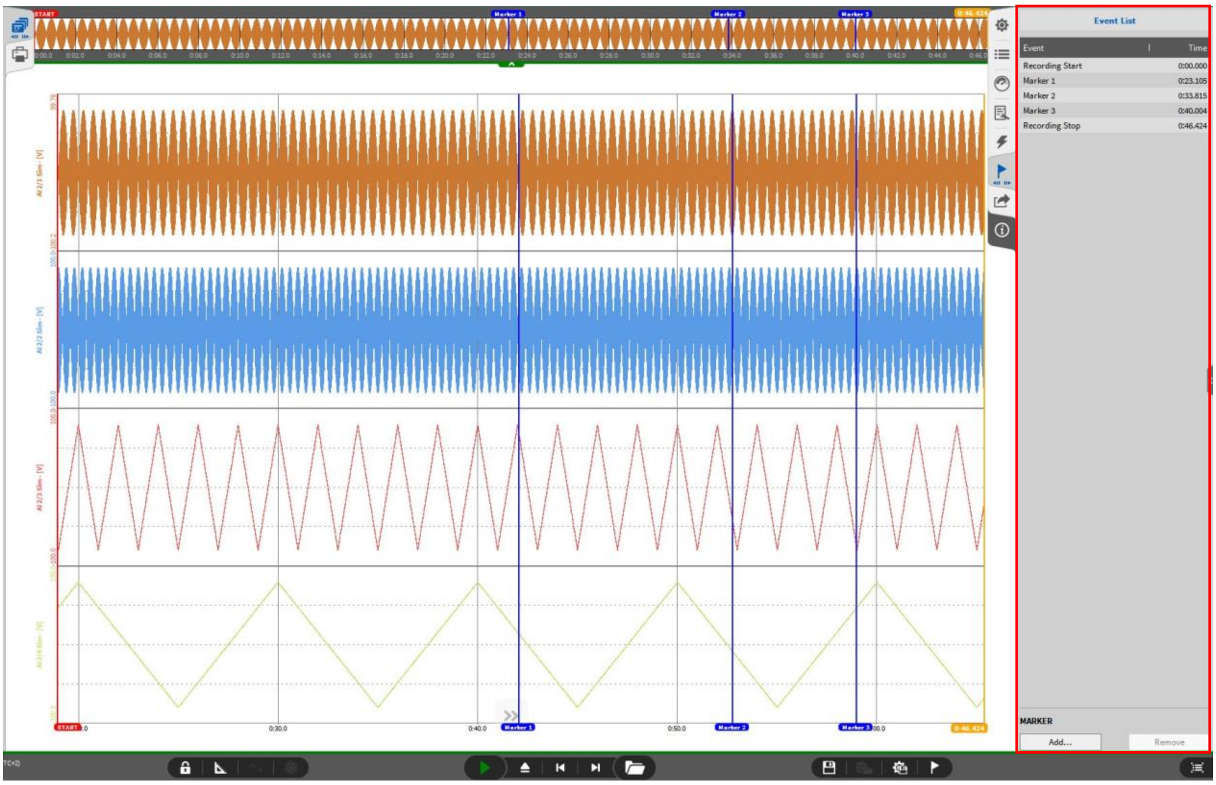


Figure 8-2: Marker review in the *PLAY* mode

Remarks:

- 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 section 7.3.3), 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* in the *Event List*

9 EXPORT SETTINGS

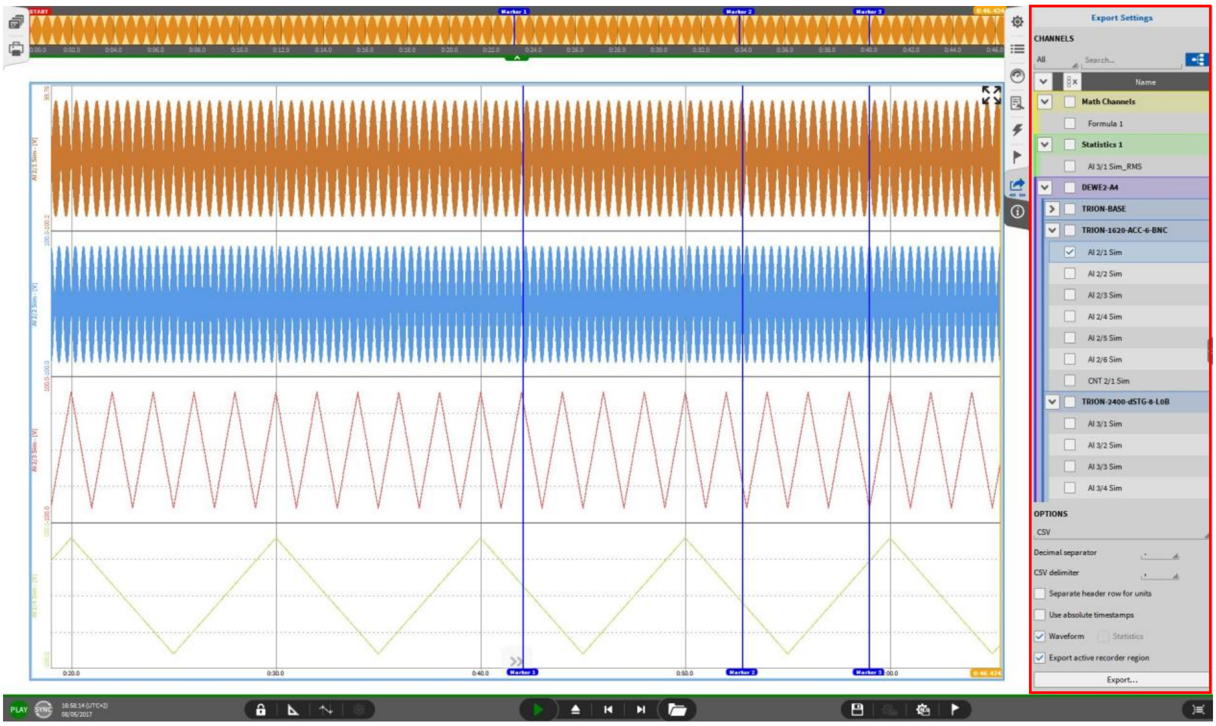


Figure 9-1: Export Settings – Overview and export options for a *.csv-file

In *PLAY* mode, the user can export the recorded data to a *.csv-file, a *.txt-file, a *.dmd-file, a *.mdf4-file or a *.mat-file. The user can select the channels to be exported in the channel list displayed in the Export Settings (Figure 9-1).

9.1 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 Figure 9-2) can be seen. This option is available for all file formats.

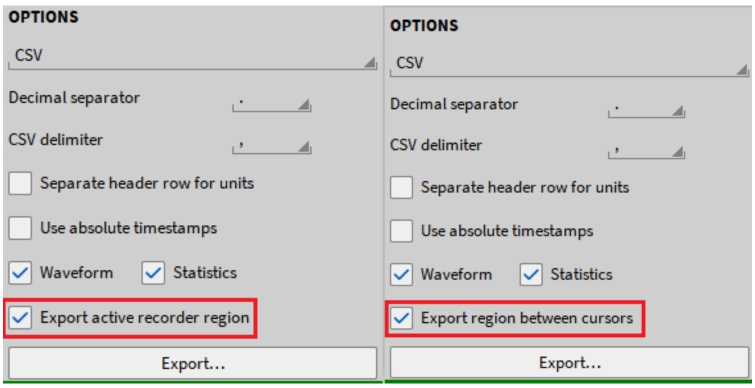


Figure 9-2: Export active recorder region or between cursors

Remark: these options are only available if the export menu is <u>not</u> 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.

9.2 EXPORT OPTIONS FOR A *.CSV-FILE

If *.csv is selected as format, the user has the following additional options (see Figure 9-1):

- Choose between Decimal separator '.' and ','
- Choose between CSV delimiter ',' and ';'
- 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
- Select if *Waveform* data and/or *Statistics* data shall be exported

9.3 EXPORT OPTIONS FOR A *.TXT-FILE

If *.txt is selected as format, the user has the following additional options (see Figure 9-3):

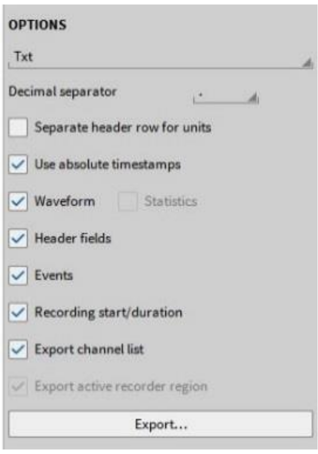


Figure 9-3: Export Options for a *.txt-file

- Choose between Decimal separator '.' and ','
- 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
- Select if *Waveform* data and/ or *Statistics* data 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

9.4 EXPORT OPTIONS FOR A *.DMD-FILE

If *.dmd is selected as format there are no additional options and all channels will be exported. This is a useful export tool for data reduction to export only the active recorder region or between the markers. For details see section 9.1.

9.5 EXPORT OPTIONS FOR A *.MDF4-FILE

If *.mdf4 is selected as format, the user has the following additional options (see Figure 9-4):

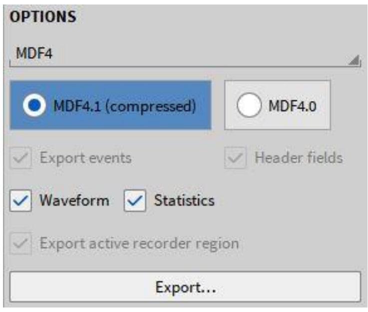


Figure 9-4: Export options for a *.mdf4-file

- Select if the data shall be exported to the compressed *mdf4.1* or the uncompressed *mdf4.0* format
- Select if the *Event List* shall be exported to the file
- Select if the *Header fields* shall be exported to the file
- Select if *Waveform* data and/ or *Statistics* data shall be exported

9.6 EXPORT OPTIONS FOR A *.MAT-FILE

If *.mat is selected as format, the user has the following additional options (see Figure 9-5):

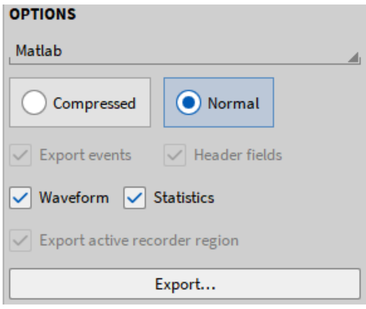


Figure 9-5: Export options for a *.mat-file

- 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
- 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

9.7 EXPORT OPTIONS FOR A *.EXCEL (XLSX)-FILE

If Excel is selected as format, the user has the following additional options (see Figure 9-5):

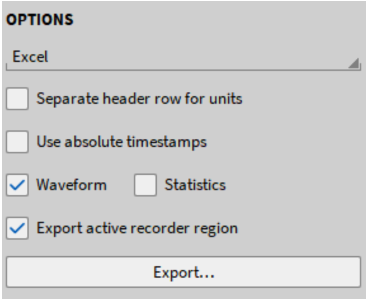


Figure 9-6: Export options for an Excel-file

- 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
- Select if *Waveform* data and/ or *Statistics* data shall be exported

Remark: 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.

9.8 AUTOMATIC DATA EXPORT AFTER MEASUREMENT END

OXGYEN 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 Figure 9-7):

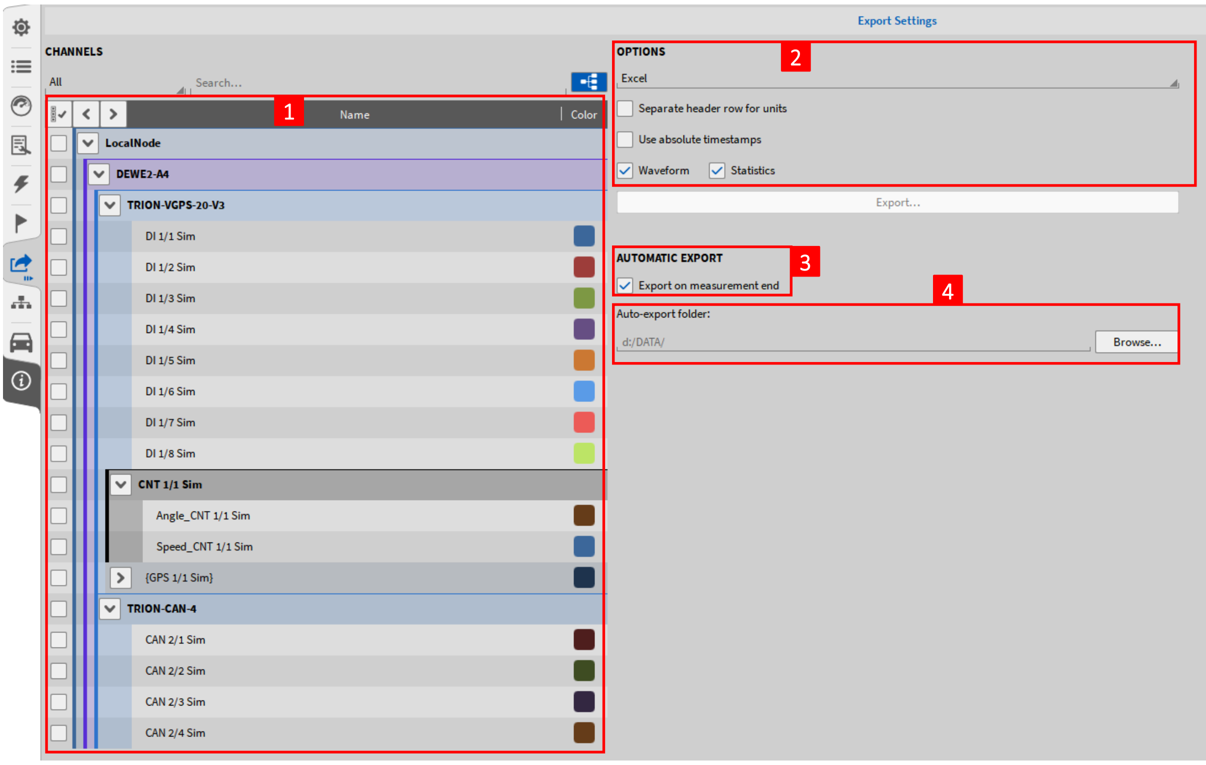


Figure 9-7: Export menu, Auto-export settings

- Select either all or individual channels that shall be exported automatically after the measurement is finished (see ① in Figure 9-7) by checking the certain checkboxes on the left-hand side
- Select the desired file format and its individual export options (see ② in Figure 9-7). For details about the export options, please refer to section 9.2 for *.csv-files, section 9.3 for *.txt-files, section 9.4 for *.dmd-files, section 9.5 for *.mdf4-files, section 9.6 for *.mat-files and section 9.7 for *.xlsx-files.
- Check the checkbox *Export on measurement end* (see ③ in Figure 9-7)
- Specify the desired directory the export files shall be stored to (see ④ in Figure 9-7)

10 THE *SCREENS* MENU

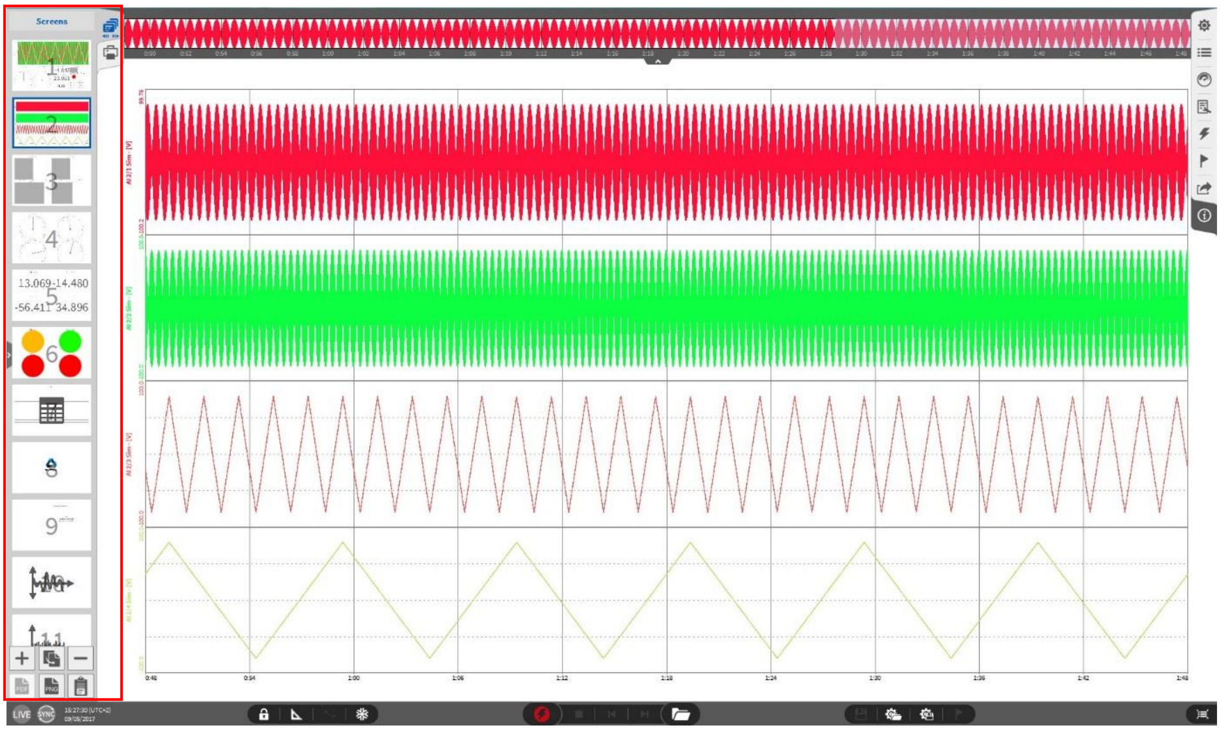


Figure 10-1: The *Screens* Menu - Overview

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 Figure 10-1. 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.
The user can enlarge the *Screens* menu to the whole screen to see several measurement screens simultaneously (see Figure 10-2). Therefore, just click on the *Screens* menu bar and move it to the right side while keeping the mouse button pressed.
If several monitors are used, it is possible to undock a screen and move it on another monitor. Therefor 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.

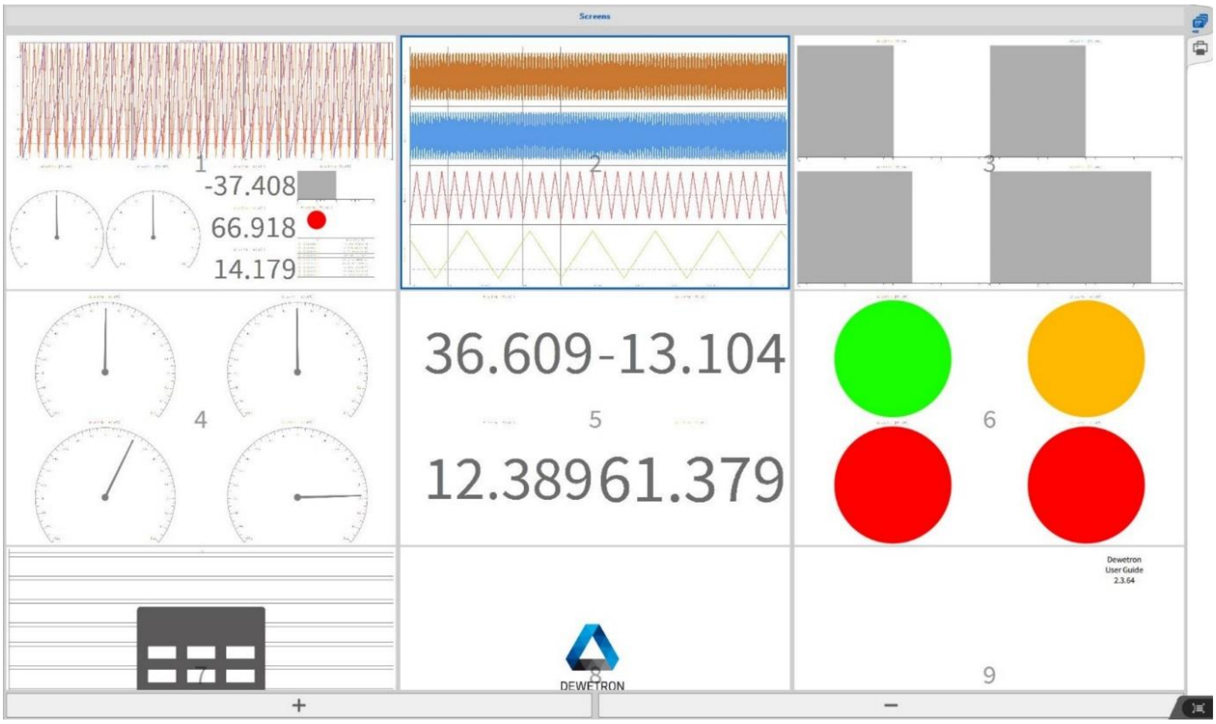


Figure 10-2: Measurement screens enlarged to the whole screen

Remark: The system performance may slow down while the *Screens* menu is partially open

The buttons on the lower end of the *Screens* Menu (see Figure 10-3) have the following functionalities:

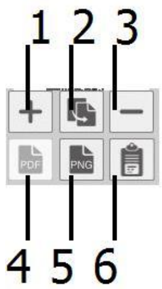


Figure 10-3: Pushbuttons in the *Screens* Menu

1	Add Screen	Add an empty measurement screen beyond the last screen
2	Copy Screen	Copy selected screen beyond the last screen
3	Delete Screen	Delete selected Screen
4	No functionality in OXYGEN 3.x	
5	Export selected screen	Export selected screen as *.png or *.jpg-file
6	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

Table 10-1: Functionality of the pushbuttons in the *Screens* menu

11 THE *REPORTING* TOOL

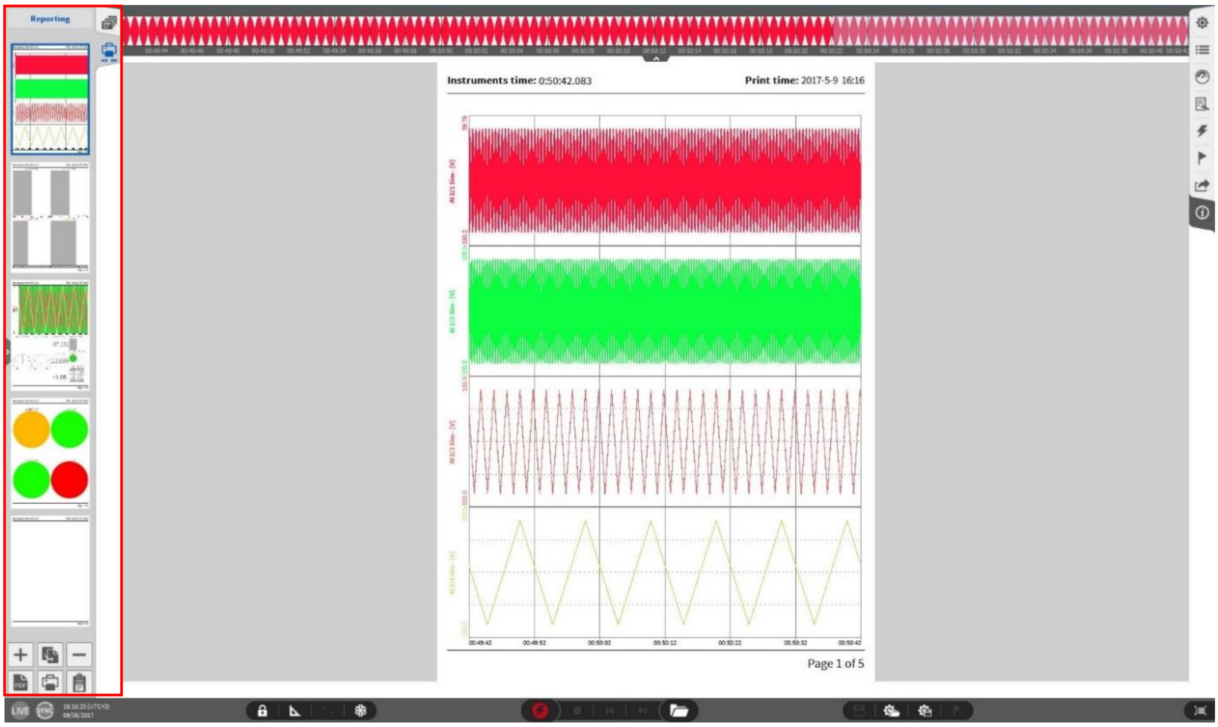


Figure 11-1: The Reporting Tool – Overview

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.

11.1 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 Figure 11-2)
    -

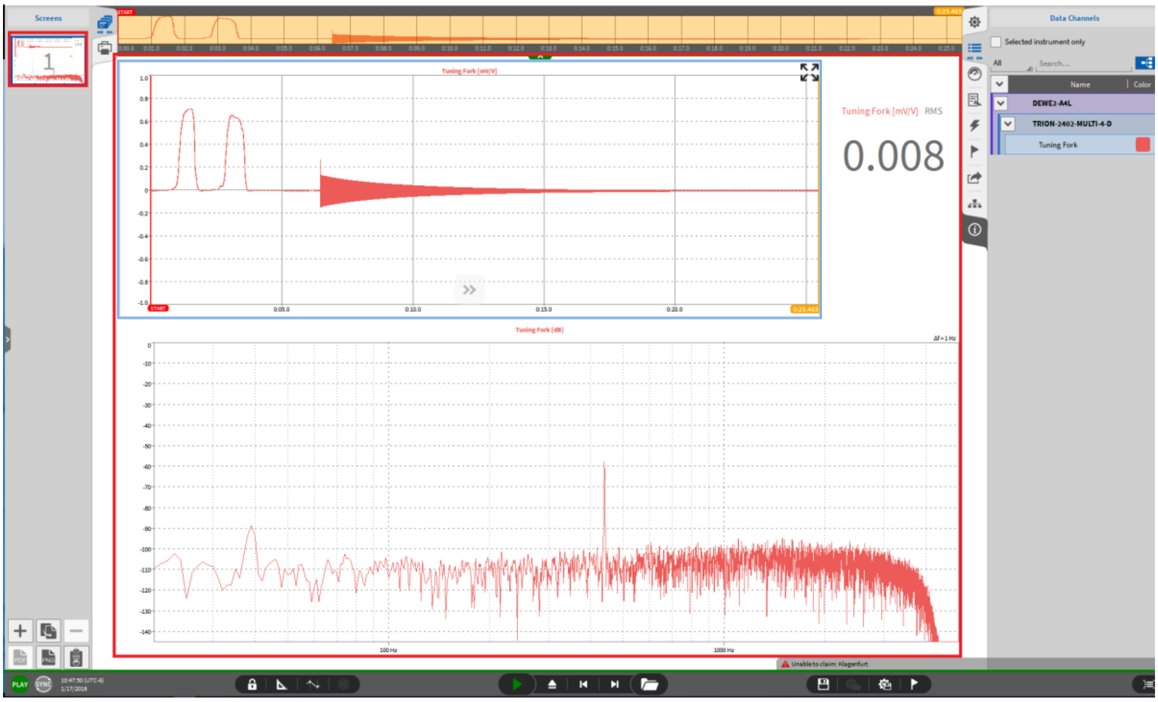


Figure 11-2: Display the measurement screen that shall be copied to the report

- Open the small-view of the Report menu (see Figure 11-3):

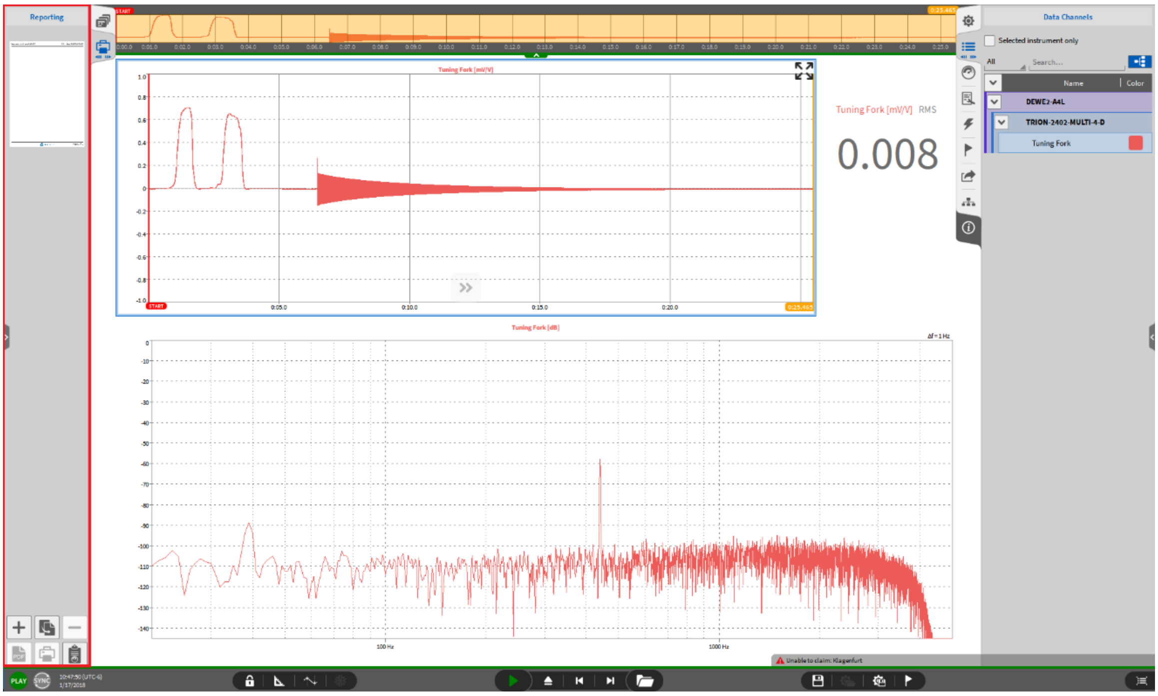


Figure 11-3: Open the small-view of the Reporting menu

- Click the copy button at the lower end of the Reporting menu (see Figure 11-4 or ② in Figure 11-10)

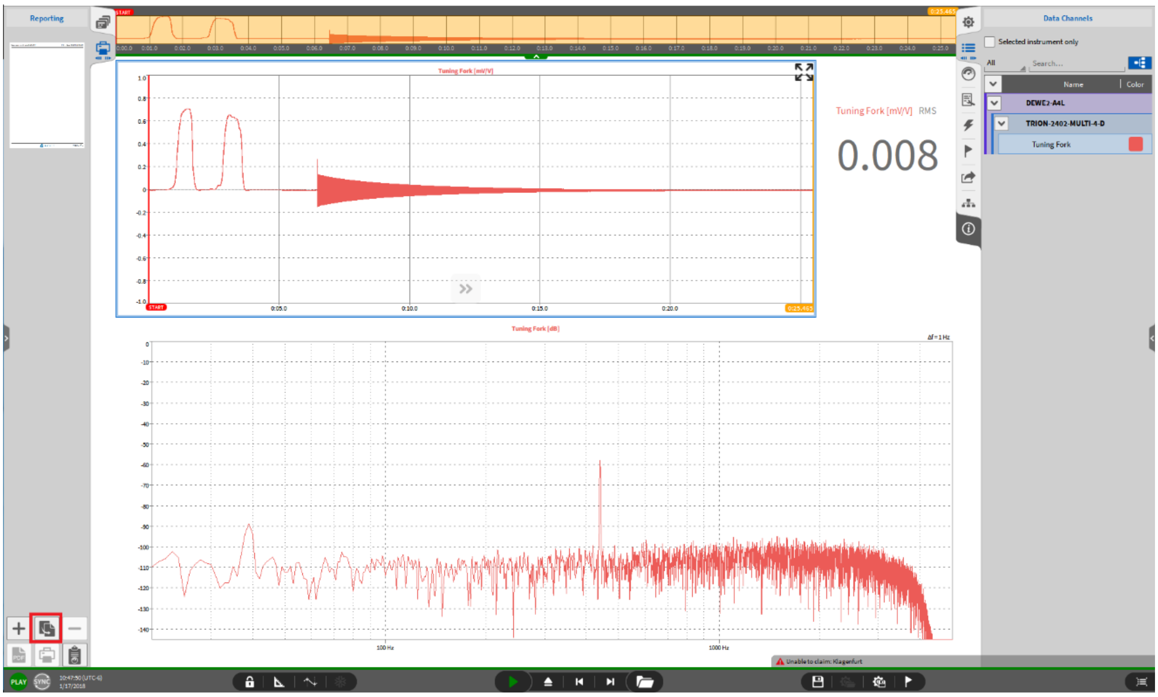


Figure 11-4: Click the *Copy* button

- The entire measurement screen is now copied to the report as a new report page (see Figure 11-5):

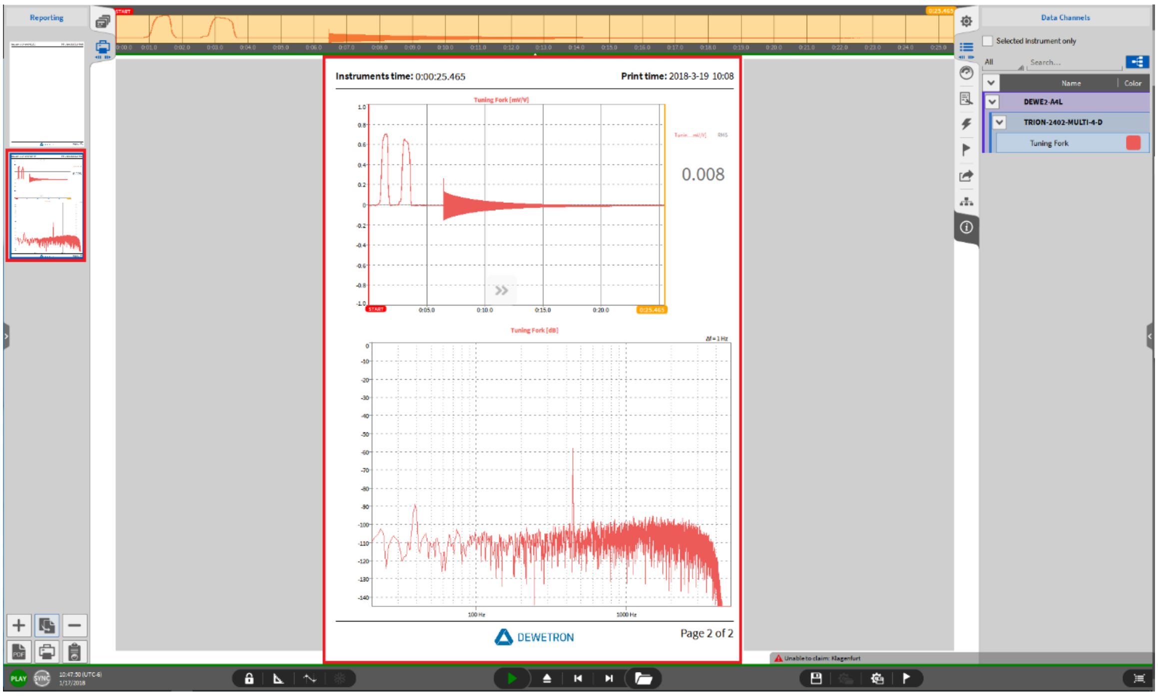


Figure 11-5: Measurement screen added to the report

- Select and copy single instruments from the measurement screen via **CTRL+C** (see Figure 11-6) and paste it to the repot page via **CTRL+V** (see Figure 11-7)

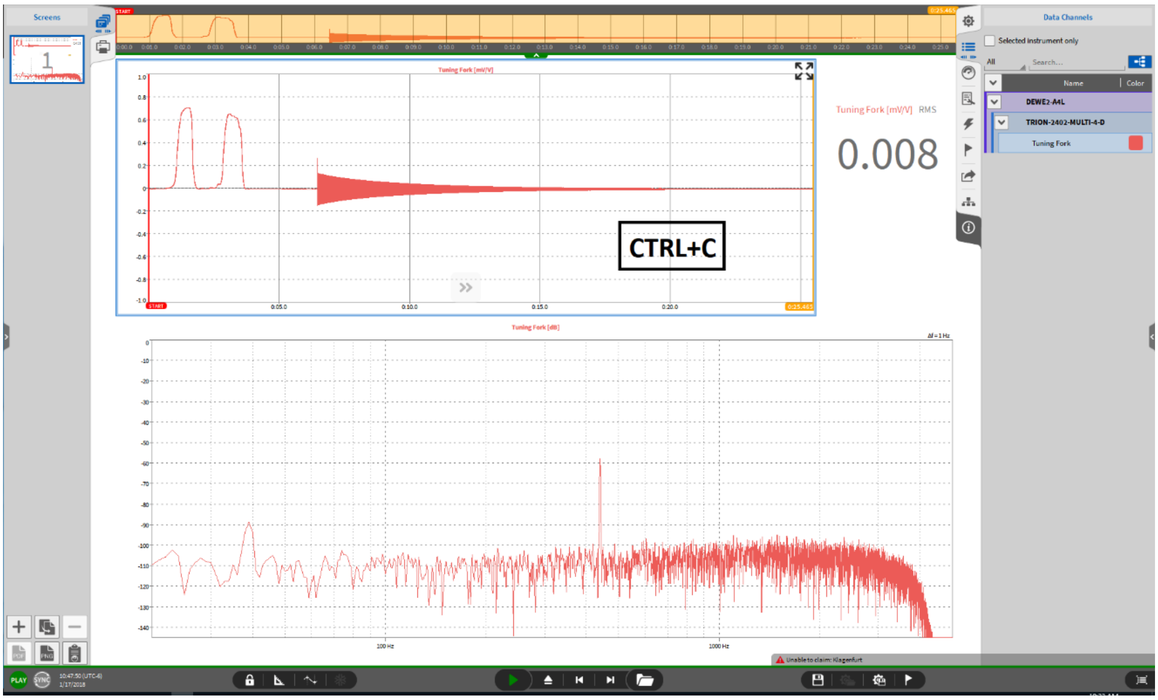


Figure 11-6: Copying single instruments from the measurement screen...

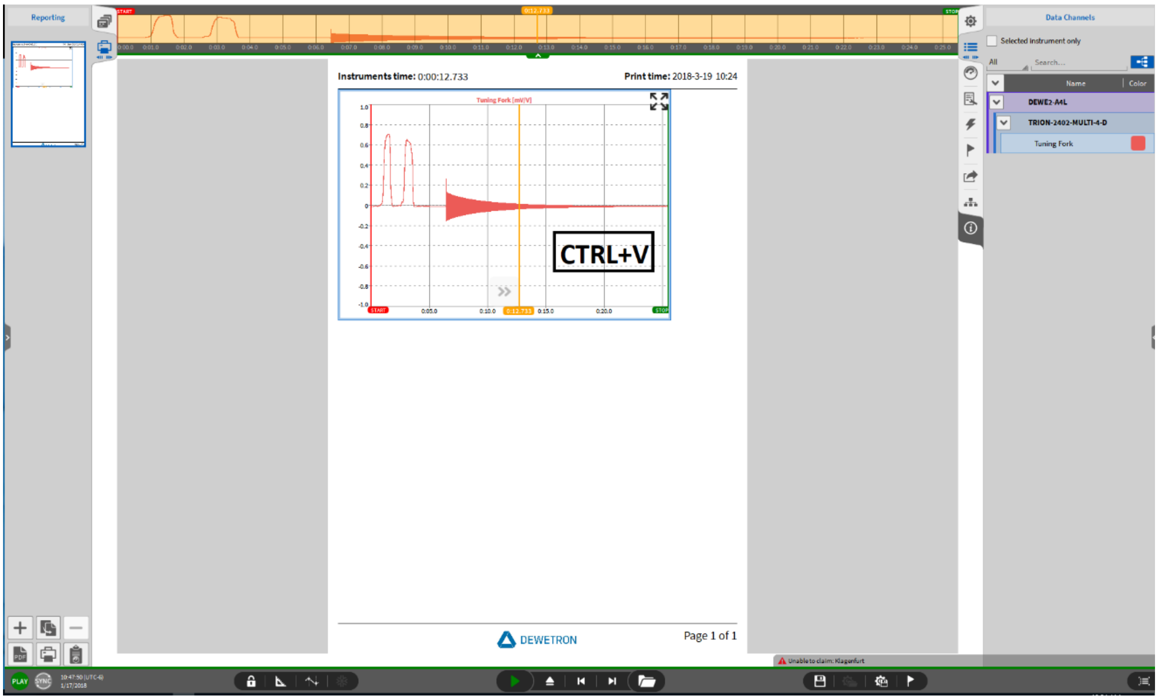


Figure 11-7: ... to the report page

- Activate the *Design Mode* and edit the report page like a measurement screen (see section 6.1)

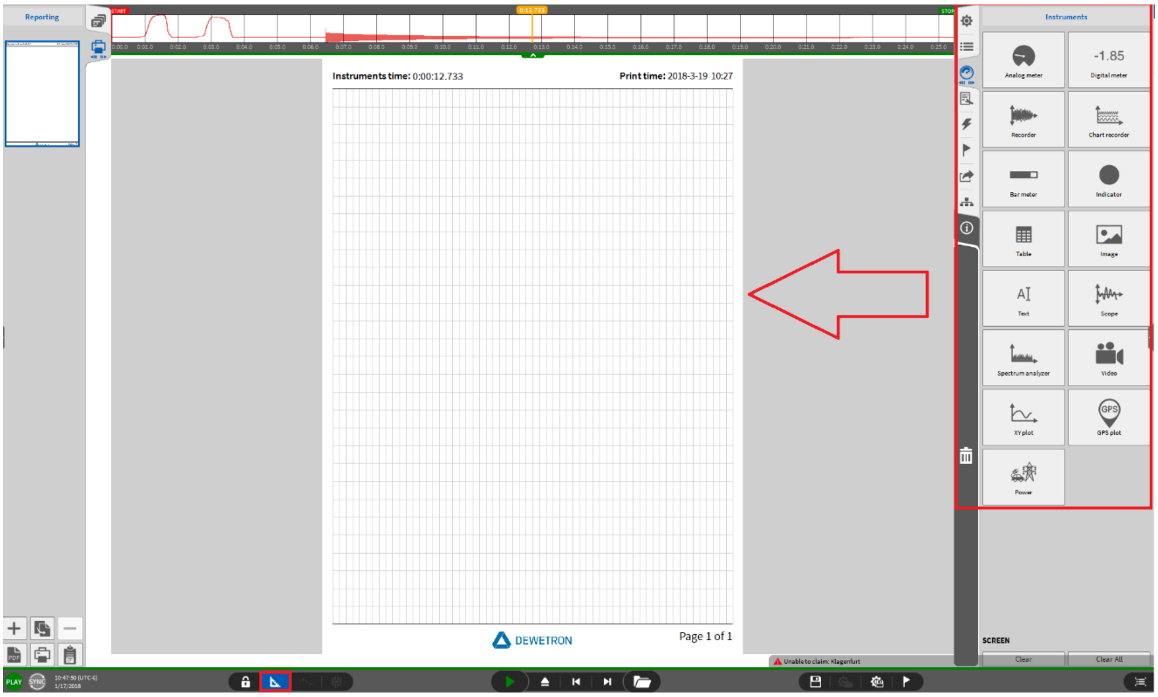


Figure 11-8: Activating the *Design Mode* on report page

11.2 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:

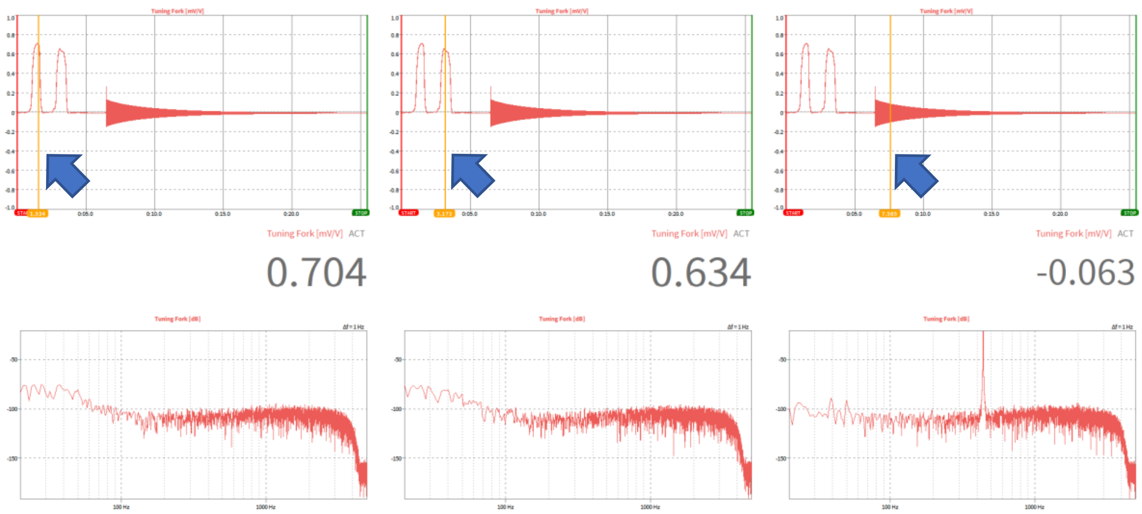


Figure 11-9: Several yellow cursor positions within one report

11.3 MENU DESCRIPTION

The buttons on the lower end of the *Reporting* Menu (see Figure 11-10) have the following functionalities:

Figure 11-10: Pushbuttons in the *Reporting* Menu

1	Add Page	Add an empty page beyond the last page
2	Copy	If a measurement screen is open (like in Figure 11-3), the screen will be copied to the report as a new page. If a report page is open (like in Figure 11-5), 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

Table 11-1: Functionality of the pushbuttons in the *Reporting* menu

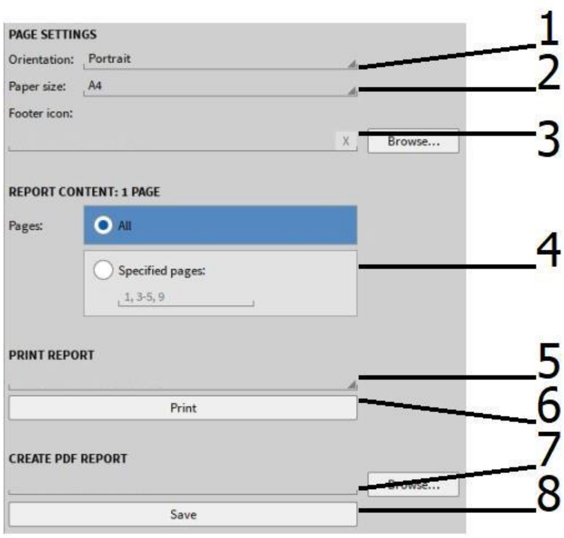


Figure 11-11: Expanded *Reporting* Menu

1	Paper Orientation	Selection of Paper Orientation *Portrait* or *Landscape*
2	Paper size	Selection of Paper size *A4* or *Letter*
3	Footer icon	Browse for an icon that will be added to the footer
4	*Report Content* menu	Specify if the whole report or only certain pages shall be printed
5	Selected Printer	Browse for a Printer
6	*Print* button	Sends the report to a printer
7	PDF-file	Browse for a folder and specify the filename
8	*Save* button	Saves the Report as *.pdf-file

Table 11-2: Expanded *Reporting* Menu - Functionality

Remark: 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 two 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.

12 OXYGEN NET

Remarks:

- Please note that OXYGEN Net is an optional feature and only usable if a proper license which supports OXYGEN Net is installed on the PC.
- OXYGEN Net can be used to combine several DEWE2/3 systems connected to the same ethernet network to one entire high channel count measurement system. DEWE2/3 systems combined to an OXYGEN Net system can be synchronized and controlled with one *Master* unit.
- Glossary:
- Master unit: A measurement unit which queries data from another measurement unit and controls it is denoted as Master unit. Only one measurement unit can be configured as Master unit in an OXYGEN Net system.
- Slave unit: A measurement unit which transfers data to a Master unit and is controlled by it is denoted as Slave unit. Several measurement units can be configured as Slave unit in an OXYGEN Net system.
- ORION DAQ/DSA hardware is not supported with OXYGEN Net.

12.1 Supported Hardware Topologies

The following topologies of synchronization and Data Transfer paths are supported within Oxygen. The main difference between these topologies is, if the single nodes are synchronized via TRION-SYNC-BUS or TIMING Modules, i.e. TRION™-BASE, -TIMING or -VGPS boards.

12.1.1 TRION-SYNC-BUS without TIMING

This topology is free-running without any external synchronization source and all nodes are connected together with TRION-SYNC-BUS. This is the default setting and should be used, if no absolute timestamping is required. All the data acquired within the system is synchronous, but there is no reference to a 3rd party system.

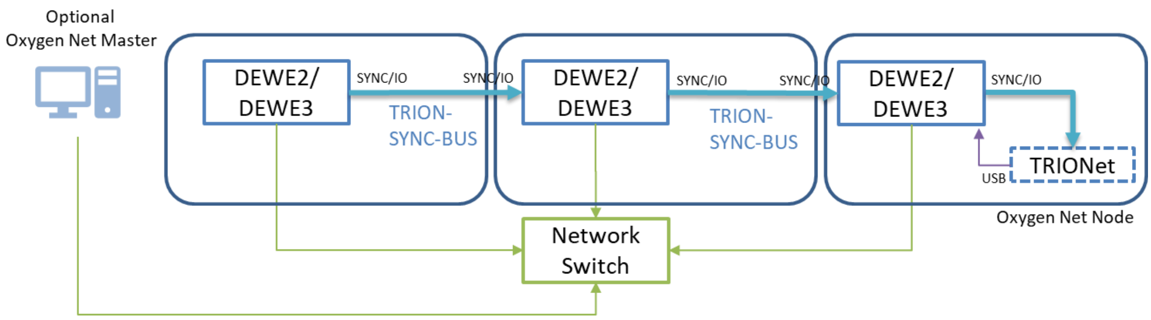


Figure 12-1: Topology for TRION-SYNC-BUS without TIMING

An optional TRIONet must be connected to a measurement node via USB and TRION-SYNC-BUS.

12.1.2 TRION-SYNC-BUS WITH TIMING

In addition to the former topology, this one uses a TIMING-Module in the first measurement node. Use this topology, if you need to be synchronous to an absolute timestamp.

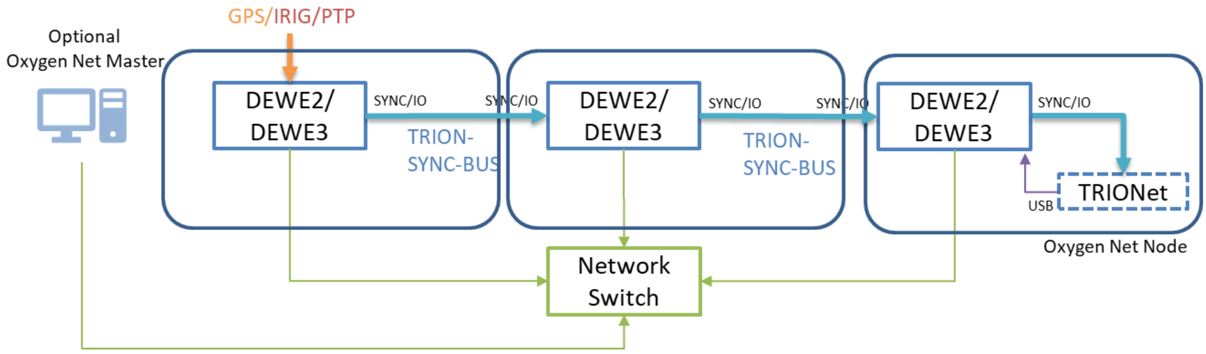


Figure 12-2: Topology for TRION-SYNC-BUS with TIMING

The Enclosure, which has installed the TIMING-Module, is automatically the master for TRION-SYNC-BUS for all other nodes.

12.1.3 TIMING WITHOUT TRION-SYNC-BUS

The third option is, to install a TIMING-Module in every node. Use this topology, if the distance between each node exceeds the limit of TRION-SYNC-BUS, or the use of a cable is not capable (e.g. mobile measurements)

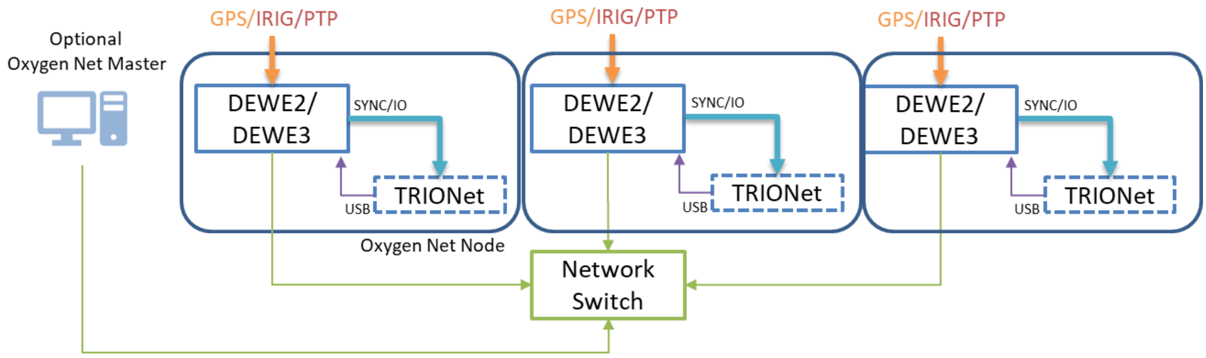


Figure 12-3: Topology for TIMING without TRION-SYNC-BUS

An optional TRIONet must be connected to a measurement node via USB and TRION-SYNC-BUS!

12.1.4 TIMING WITH IRIG OUT

The fourth option is to install a TIMING-Module in every node. Use this topology, if you need to be synchronous to an absolute timestamp and if other 3rd party hardware shall be synchronized to an IRIG signal in parallel. A TRION™-TIMING/VGPS-**V3** board is required to output IRIG with a DEWE2/s system. Only IRIG-B-DC signals can be output, others cannot be generated!

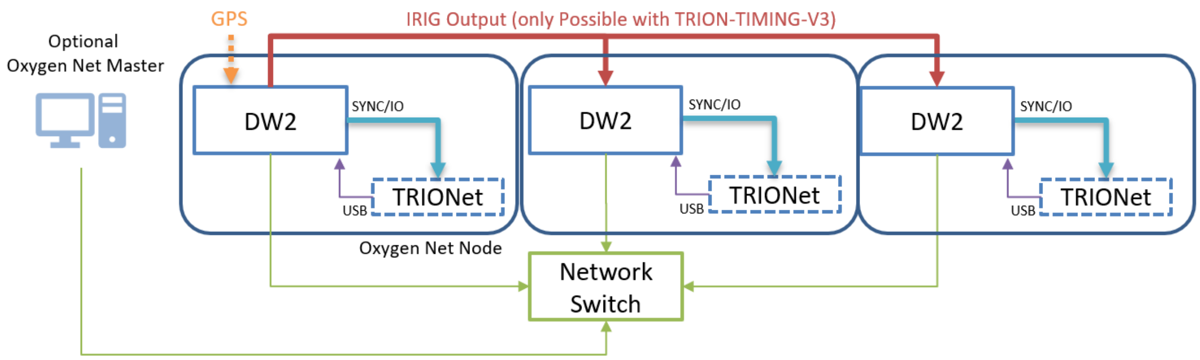


Figure 12-4: Topology of TIMING with IRIG OUT

An optional TRIONet must be connected to a measurement node via USB and TRION-SYNC-BUS!

Remark: A mixed usage of these topologies is not allowed and supported!

12.2 OXYGEN NET - MENU OVERVIEW

The OXYGEN Net menu is split up in three different sections: *Nodes*, *Sync* and *Settings*.

12.2.1 OXYGEN NET MENU – *NODES*

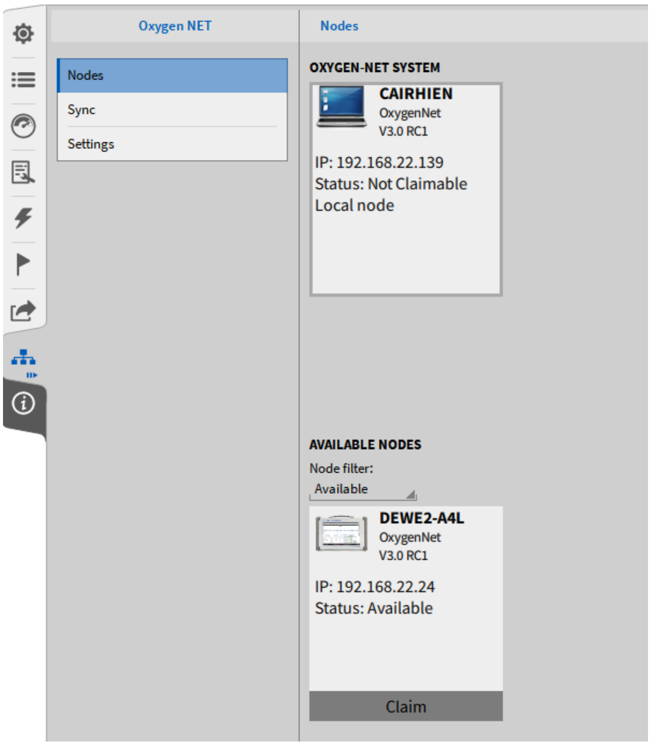


Figure 12-5: OXYGEN Net menu – *Nodes*

In the *Nodes* menu, the user gets an overview about all measurement devices that are connected to the same ethernet network and have the OXYGEN Net option enabled. To enable and disable OXYGEN Net, please refer to section 12.2.3.
Devices with OXYGEN Net enabled and which allow to be claimed can be claimed and connected to the OXYGEN Net system. After claiming a device, it can be used in the OXYGEN Net system. Claimed devices are regarded as *Slaves*. Thus, claiming must always be done by the master device and must not be done by slave devices. For allowing and preventing measurement devices to be claimed, please refer to section 12.2.3. To claim a device, just click on the *Claim* button below the respective measurement device (see Figure 12-6).

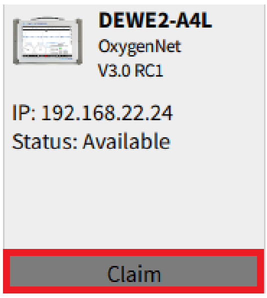


Figure 12-6: Claim a measurement device

Claimed devices can be released from the OXYGEN Net system by clicking on the respective *Release* button (see Figure 12-7). After releasing the measurement device, it can be used as a standalone device again or connected to another OXYGEN Net system.

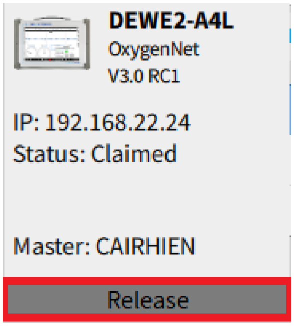


Figure 12-7: Release a measurement device

The Node filter (see Figure 12-8) filters the listed measurement devices according to *All*, *Available* or *Claimed* devices.

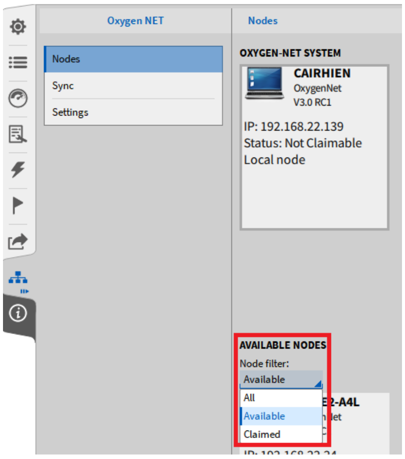


Figure 12-8: Nodes filter

12.2.2 OXYGEN NET MENU – *SYNC*

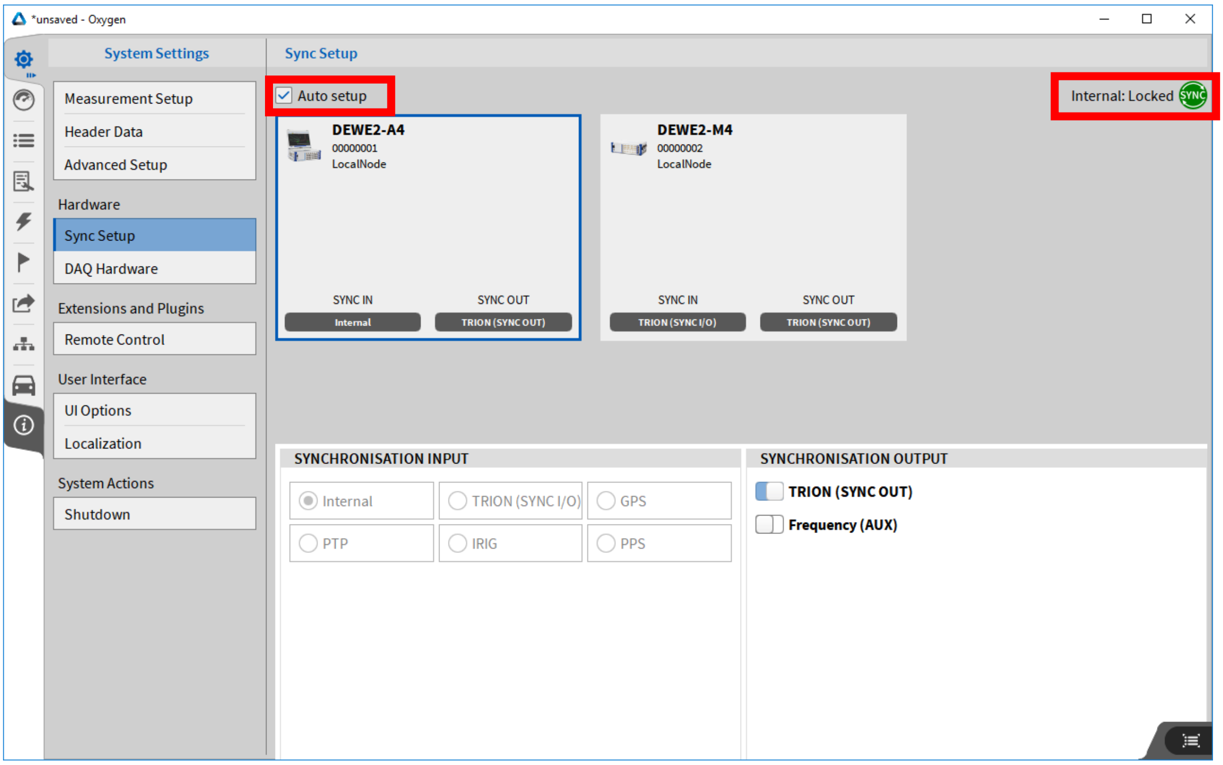


Figure 12-9: OXYGEN Net menu – *Sync*

- *Auto setup: Enable/Disable Automatic Setup of Sync.*
- *Enabled: The synchronization is done automatically by the DEWE2 enclosure. If the Master device does not have a measurement hardware (Notebook, PC), the first claimed Slave is automatically configured as Sync Master. Synchronisation is set to TRION-SYNC-BUS. No setting can be changed, as long as Auto setup is activated.*
- *Disabled: User can change all synchronization settings. Use this, if a TIMING-Module is installed*
- *Sync Status Indicator: See here the actual state of the overall system sync. Please refer to 12.7 for more information.*

  The Sync indicator 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 ⑱ in Figure 2-1).

For details about the different synchronization settings and possibilities with different TIMING modules, please refer to section 4.4.

12.2.3 OXYGEN NET MENU – *SETTINGS*

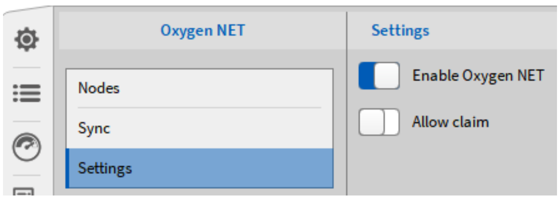


Figure 12-10: OXYGEN Net menu – *Settings*

In the *Settings* menu, the user can enable or disable the OXYGEN Net functionality and select if the measurement device shall be claimable or not.
If OXYGEN Net is disabled, the measurement device can neither be used as Master nor Slave unit in an OXYGEN Net system. Thus, the device is not visible for other users in the *Nodes* menu of other DEWE2/3 systems (see section 12.2.1). If OXYGEN Net is enabled, the device can either be used as Master or Slave unit and is listed in the Nodes menu of other DEWE2/3 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 (see Figure 12-11). 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 (see Figure 12-12).

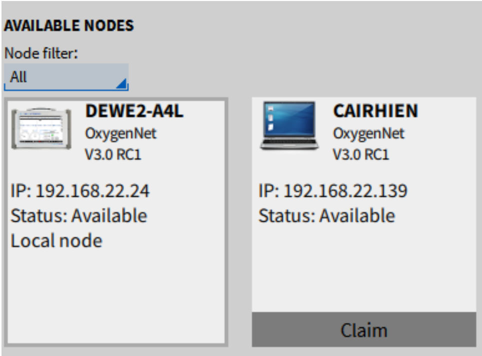


Figure 12-11: Visibility for other users if OXYGEN Net is enabled and *Allow Claim* is enabled

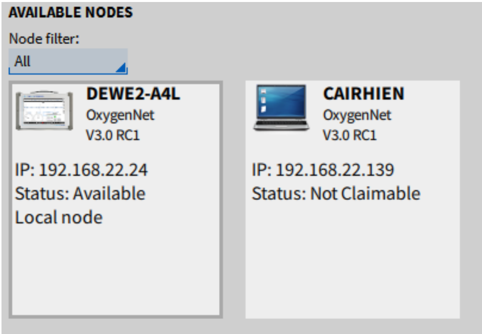


Figure 12-12: Visibility for other users if OXYGEN Net is enabled and *Allow Claim* is disabled

12.3 SETTING UP AN OXYGEN NET SYSTEM

The following steps describe the procedure to configure several devices to an OXYGEN Net system. Possible hardware connection schemes can be found in section 12.1.

12.3.1 GENERIC SETUP

- Connect all measurement devices that shall be used with in the OXYGEN Net system to the same ethernet network and make sure that the IP addresses of all measurement devices are within the combined to one OXYGEN Net system. If the Devices are configured with DHCP and there is no DHCP-Server, the operating system fallback is used (IP-Adress Range 169.x.x.x)

  Remark: The connection to the ethernet network must be finished before OXYGEN is started on the measurement devices!
- Start OXYGEN on all measurement devices and *Enable OXYGEN Net* in the OXYGEN Net menu *Settings* (see Figure 12-13) on all devices

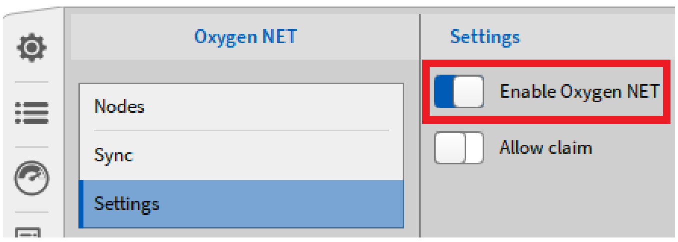


Figure 12-13: Enable OXYGEN Net

- Select *Allow claim* on the devices that shall be configured as slaves (see Figure 12-14). Without enabling *Allow claim*, the Slave units cannot be claimed by the Master unit.

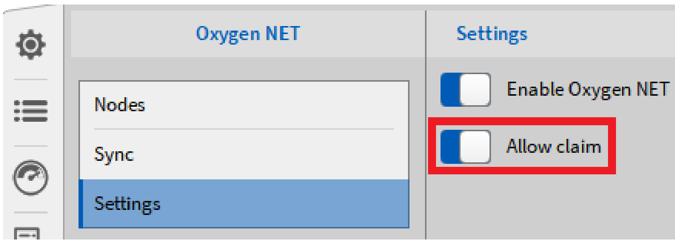


Figure 12-14: Allow claiming of slave devices

- Go to the OXYGEN Net menu *Nodes* on the Master unit. In the *Available Nodes* section, all measurement devices with OXYGEN Net enabled are listed. By clicking on the *Claim* button (see Figure 12-15), the individual device is added to the OXYGEN Net system as a Slave unit and can be controlled by the Master unit.

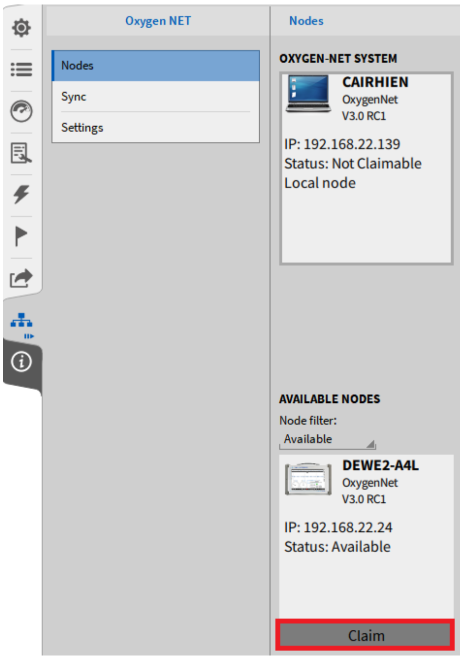


Figure 12-15: Claiming of measurement devices

Remark: If a device should not be listed in the *Available Nodes* section though expected, please refer to section 12.7.

- After claiming a device by the Master unit, it is listed in the *OXYGEN Net System* section (see Figure 12-16) of the OXYGEN Net menu *Nodes* and may be released from the OXYGEN Net system again by clicking on the *Release* button

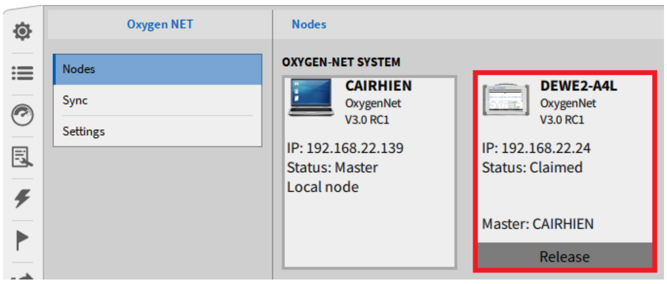


Figure 12-16: List of claimed devices

- After claiming a device, the screen of the device will be locked, and the information *Claimed by…* will be displayed in the lower right corner of the software

Figure 12-17: *Claimed* information on the Slave device

12.3.2 Use with TRION-SYNC-BUS

- Connect the SYNC cables to the measurement devices.
  The Master measurement unit must be the Sync master within the OXYGEN Net system. Therefore, connect one end of the Sync cable to a *SYNC OUT* or *SYNC I/O* connector of the Master unit and connect the other end to a *SYNC IN* or *SYNC I/O* connector of the Slave unit. The Sync signal can be daisy chained to several Slave units (see Figure 12-18).

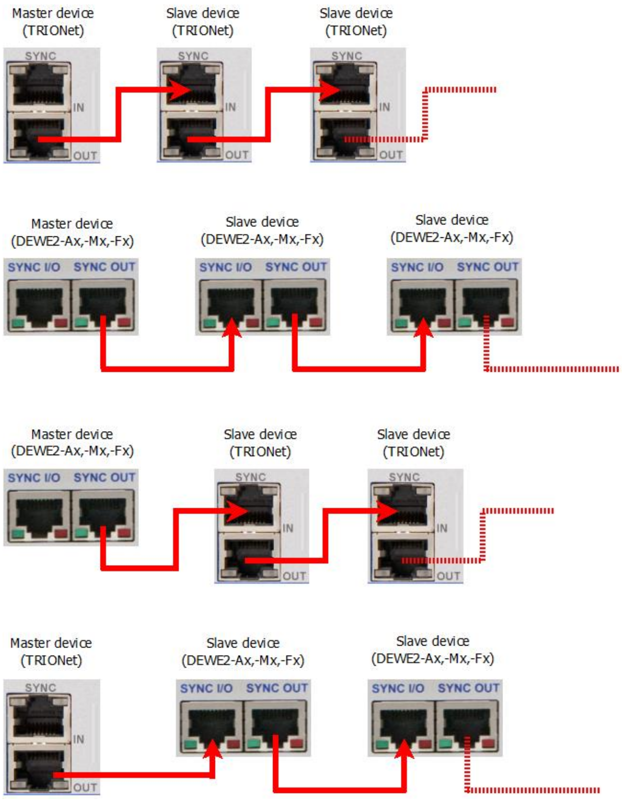


Figure 12-18: Sync wiring of different OXYGEN Net system variants

The cable for the synchronization signal must be connected from measurement device to measurement device and cannot be transmitted via an ethernet router.

- A green background color of the *SYNC indicator* on all devices will display that the sync wiring is correct

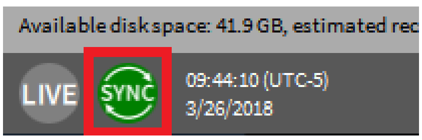


Figure 12-19: Correct sync wiring

Remark: If the background color of the *SYNC indicator* is orange, the sync wiring is incorrect. For further information, please refer to section 12.7.

- 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
- Use a TIMING-Module in case, you need an absolute time base in the first (Master) system

12.3.3 USE WITH TIMING-MODULES ONLY

- Make sure, every DEWE2/3 has installed exact one TIMING-Module in the first slot (Star slot) (except TRIONet, there is no TIMING-Module supported in the case of Oxygen Net)
- Connect the Timing Source Signal (e.g. GPS Antenna, IRIG or PTP Grandmaster Clock)
- It is not necessary to use the same Source within every node, you can use GPS at the first node and PTP at the second node, see Figure 12-20.
- Go to Oxygen Net -> Sync and disable the *Auto setup* option
- Select the right TIMING Source for each Enclosure

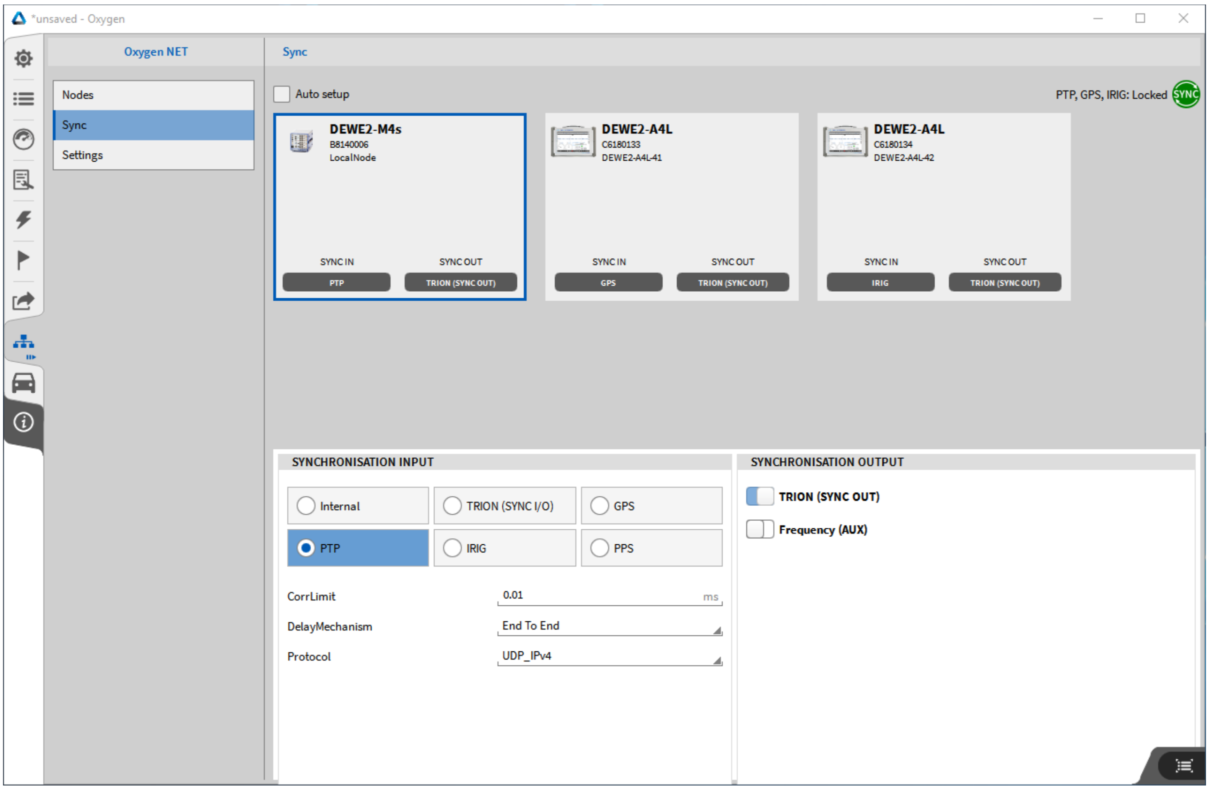


Figure 12-20: Sync View with TIMING-Modules. Select node to change settings

- Inspect the Synchronization Indicator If an error occurs, please check the connection of the selected synchronization source (or the LED Indicator of the TIMING Module)

Error Messages:

- If the system is configured in a way, that is not allowed topology, there is an Error Message:

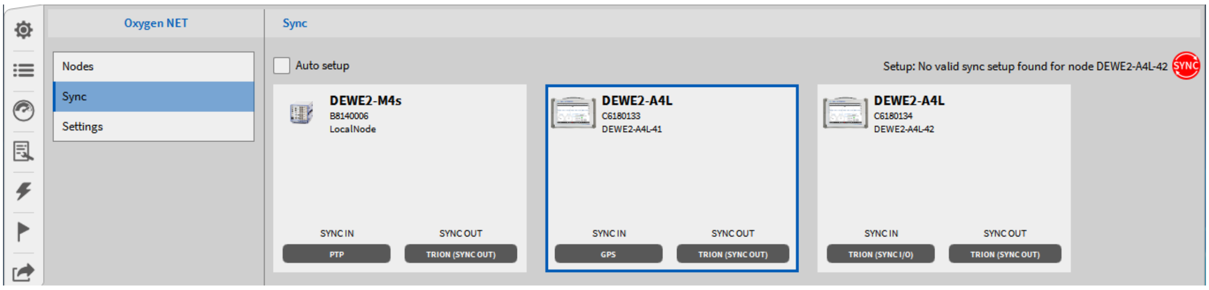


Figure 12-21: No valid sync setup, with a hint, which node is not configured correctly

- If there is a problem, that at least one Node can't be synchronized, there is the *Error (Out of Sync)* message. Please check each node individually!

12.4 Setup Generation on an OXYGEN Net System

- The measurement screens on the Master unit can be configured like on a standalone measurement unit. For details, please refer to section 6.1.
- Measurement screen configuration on Slave units can be configured like on a standalone measurement unit as well. For Setting up the measurement screen and the creation of software channels (like Power, Math Formulas,…), please use the Remote Desktop Connection or a VNC-Tool (we recommend UltraVNC).
- Data acquisition sample rate can differ from each Node. But the user has to take care that only integer multiple sample rates are set.
- Data Channels of a Slave unit can be configured via the Master unit. After claiming the Slave unit by the Master unit, the channels of the Slave unit will be visible and accessible in the Channel List of the Master unit. The example in Figure 12-22 shows a DEWE2-A4L-Slave unit (equipped with one TRION-2402-MULTI-4-D) connected to a Laptop-Master unit without TRION^{TM} hardware connected. When settings of a Slave unit channel are edited via the Channel List of the Master unit, the changes will be transferred to the Slave unit.

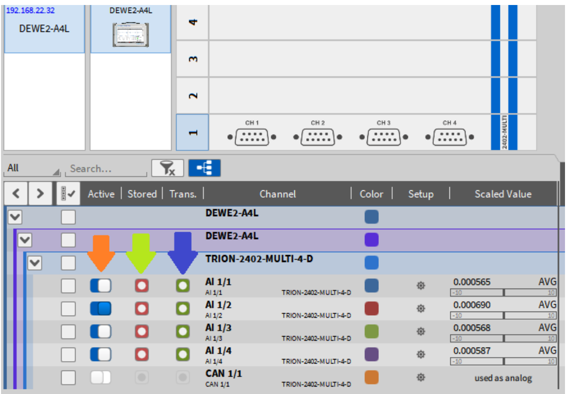


Figure 12-22: Slave unit channels visible in the Master units' Channel List

- The blue slider marked with an orange arrow in Figure 12-22 will activate or deactivate the data acquisition from the channel
- The red button marked with a green arrow in Figure 12-22 will enable the storing of the data
- The green button marked with a blue arrow in Figure 12-22 will enable the data transfer from the Slave unit to the Master unit.
- Figure 12-23 will show 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.

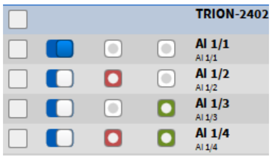


Figure 12-23: Channel transfer and recording combinations

Remark: It is not possible to store a channel only on the Main unit and not on the Slave unit.

- When the setup is saved on a Master unit, the settings of the Slave unit are stored to the setup file on the Master unit, too. There is no separate setup file stored on the Slave unit. The file stored on the Main unit includes channel settings, screen configurations,… on the Slave unit.
- Math channels and Power groups must be created on the Slave units before claiming them by the Master unit. After claiming the Slave unit, these channels can be transferred and stored on the Master unit as well or used for other calculations on the Master unit.
- Math channels and Power groups that are created on the Master unit and include channels from the Slave unit are calculated on the Master unit. I.e. all calculations that are created on the Master unit are rendered on the Master unit. If they shall be rendered on the Slave unit, they must be created before claiming the Slave unit by the Master unit like it is explained in the paragraph above.
- It is not possible to transfer data from the Master unit to a Slave unit or between Slave units but only from the Slave units to the Master unit.
- If a setup file is loaded on the Master unit which contains an OXYGEN Net configuration, OXYGEN tries to claim the required Slave units automatically while the setup is loaded. OXYGEN must already be running on the Slave units and is not started automatically during the setup load. If the Slave unit can't be claimed, the hardware mismatch dialog will open (see Figure 2-4).

12.5 Recording Data with an OXYGEN Net System

- After pressing the Record button on the Master unit, all transferred data channels and the data channels connected directly connected to the Master unit will be stored to one data file on the Master unit.
- After pressing the Record button on the Master unit, a local data file is created on each Slave unit containing all data channels (with the red Record button on the Channel List enabled) that are connected to the Slave unit.
- Triggered Recording is supported. Trigger Events can be defined on the Master. Individual trigger settings on a Slave unit will be ignored.
- Multi-File Recording is supported. If Multi-File Recording is enabled on the Master unit it will also be applied to the data file stored locally on the Slave units. Multi-File settings done on a Slave unit will be ignored.
- User reduced statistics recording is supported (see section 7). The user reduced statistics data are not transferred from the Slave units to the Master unit to avoid an increase of the data to be transferred. They are calculated on the Master unit for the Slave unit channels that are transferred to the Master unit.

- Prompting Header Data at recording start is only applicable to the Master unit, not to Slave units

12.6 Additional Information

- Typical data transfer rates (80 MB/s):
- 16bit: up to 350 channels @ 100 kHz
- 24bit: up to 350 channels @ 50 kHz
- The Master unit can either be a measurement unit with TRION™ hardware connected or a laptop without TRION™ hardware connected to. 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 measurement devices must be connected to the same ethernet subnet before OXYGEN is started
- 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.
- The Node names are the operating systems host names. These can be edited in e.g. Windows under System -> Info -> Change PC Name

12.7 Troubleshooting

- 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
- 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 Figure 12-24). If this appears, make sure that the sync wiring is correct. For further information, please refer to section 12.2.2 and Figure 12-18.

Figure 12-24: 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.

Figure 12-25: Software feedback if sync signal is lost during the measurement

The recording will be continued until the *Stop* button is pressed. Please be aware that the recording won't be time synchronous any more without valid sync connection!
A reconnection of the sync wire won't 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.

Figure 12-26: Software feedback if sync signal is reconnected during the measurement

- 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 Figure 12-27)

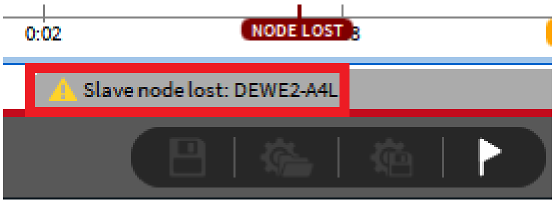


Figure 12-27: Software feedback on master device if slave node loses network connection

  - The affected slave device adds a *Node Lost* marker to the Event List and opens a *Master Lost* popup menu (see Figure 12-28)

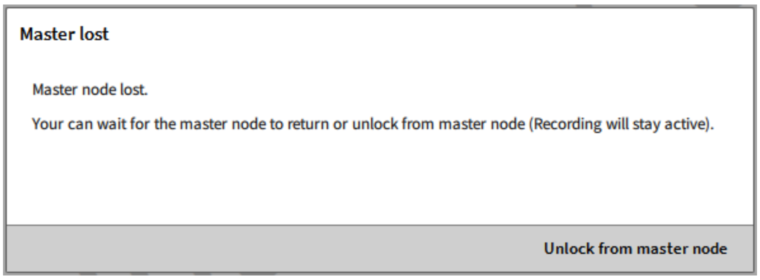


Figure 12-28: Software feedback on slave device if slave node loses network connection

  - 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 popup 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
- 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 Figure 12-27)

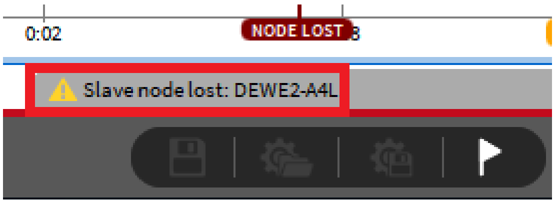


Figure 12-29: Software feedback on master device if slave node loses network connection

- All slave devices add a *Node Lost* marker to the Event List and open a *Master Lost* popup menu (see Figure 12-28)

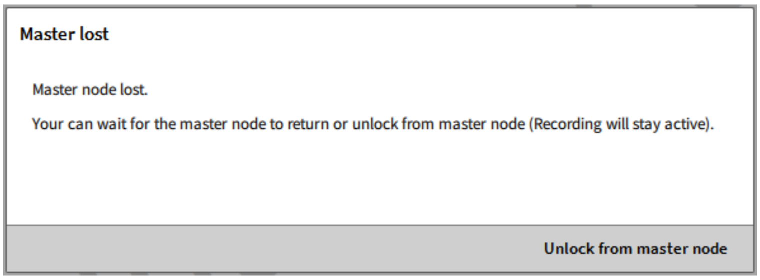


Figure 12-30: Software feedback on slave device if slave node loses network connection

- If the user selects *Unlock from master node*, the recording will be continued until the *Stop* button is pressed and the slave devices can be used as standalone units
- If the network connection is fixed in the meantime, the popup 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

12.8 Limitations of OXYGEN Net within OXYGEN 3.7

- 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.
- Disabling of redundant storing on the Slave unit is not possible. If a channel is transferred to the Master unit, and storing is activated, the data will always be stored on the Slave unit and the Master unit.

13 PSOPHOMETER

13.1 INTRODUCTION

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).

[https://en.wikipedia.org/wiki/Psophometer, 2019-04-15]

13.2 SETUP

The Psophometer Plugin is installed with every Oxygen installation, starting from R3.5.1

Please note that a dedicated plugin license is required for the calculation option to be visible.

13.3 USAGE

Select one or multiple channels as inputs for the Psophometer calculation.

Please note that input channels must have a sampling rate of 20 kHz or higher.

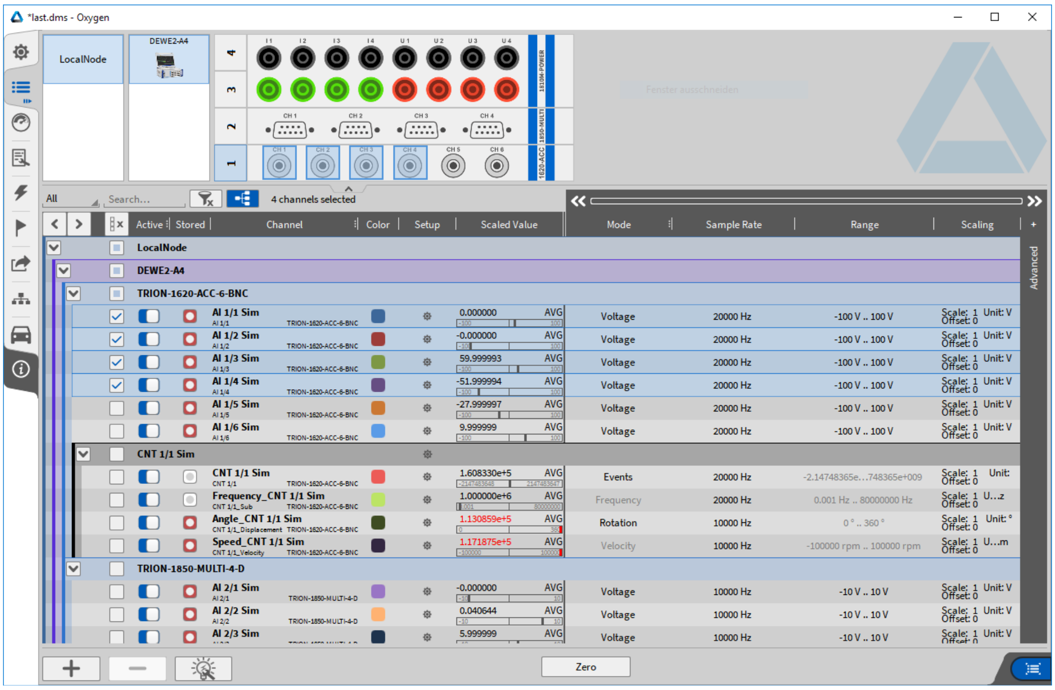


Figure 13-1: Channel list with multiple selected channels

Then open the “Add Channel” dialog by pressing the plus button.

A dialog is shown and Psophometer frequency weighting settings (see 13.4) are made. The newly created Psophometer calculation group can be named individually.

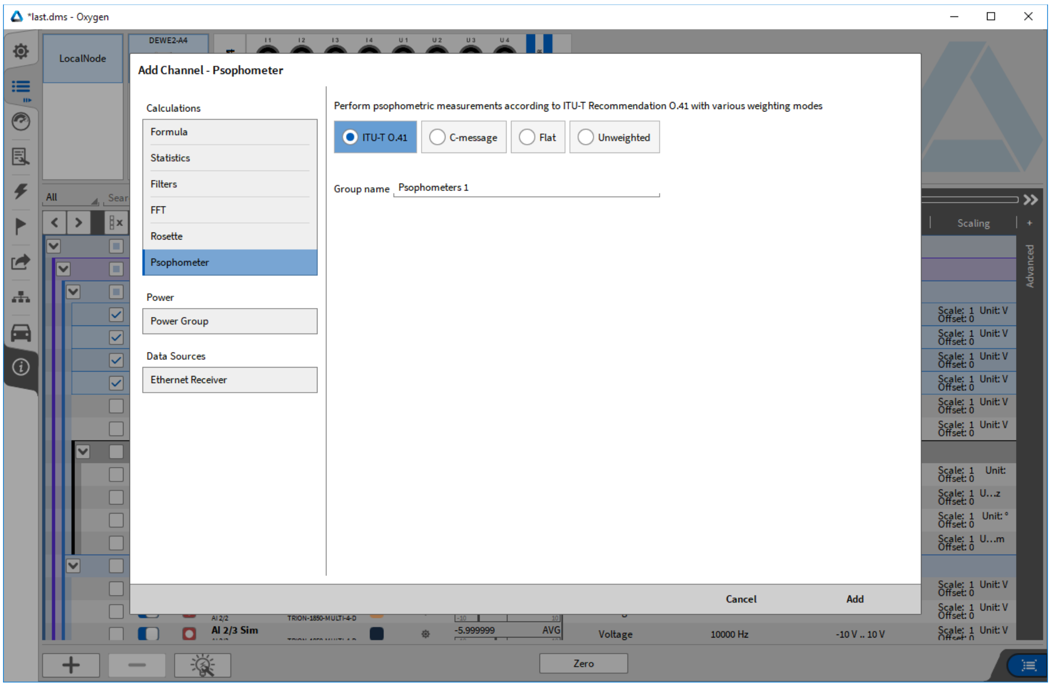


Figure 13-2: Add Channel dialog showing Psophometer options

Finally, press Add to create the new calculation group.

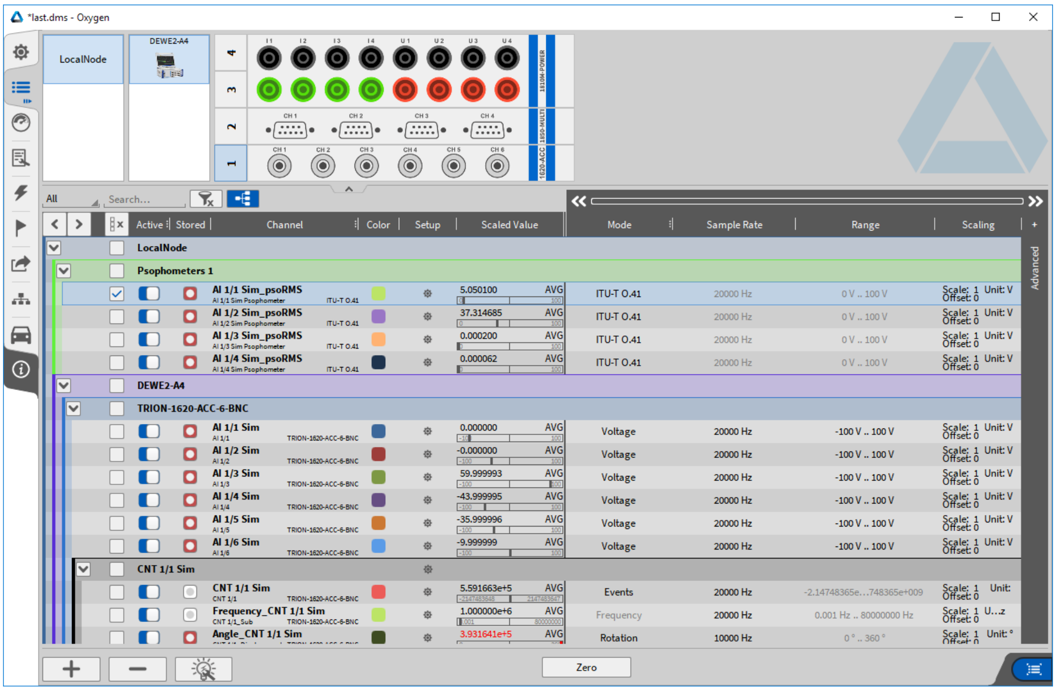


Figure 13-3: Channel list showing new Psophometer calculation group

The channel details view is used to modify each channel's settings individually and for detailed preview.

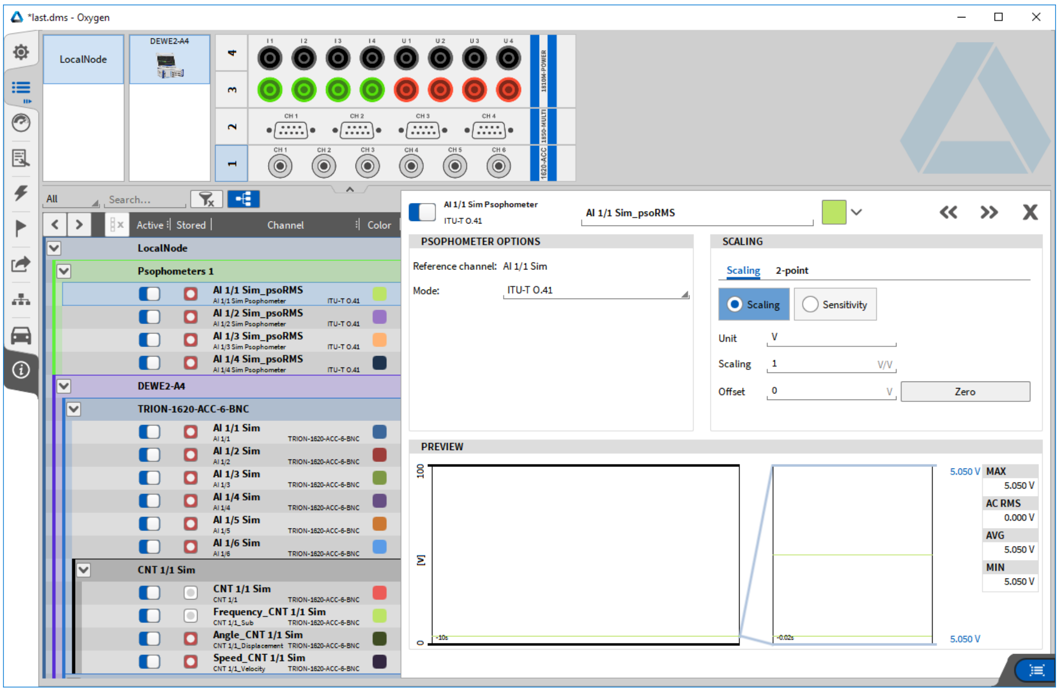


Figure 13-4: Channel details setup of calculation channel

Psophometer calculations are then available as math channels.

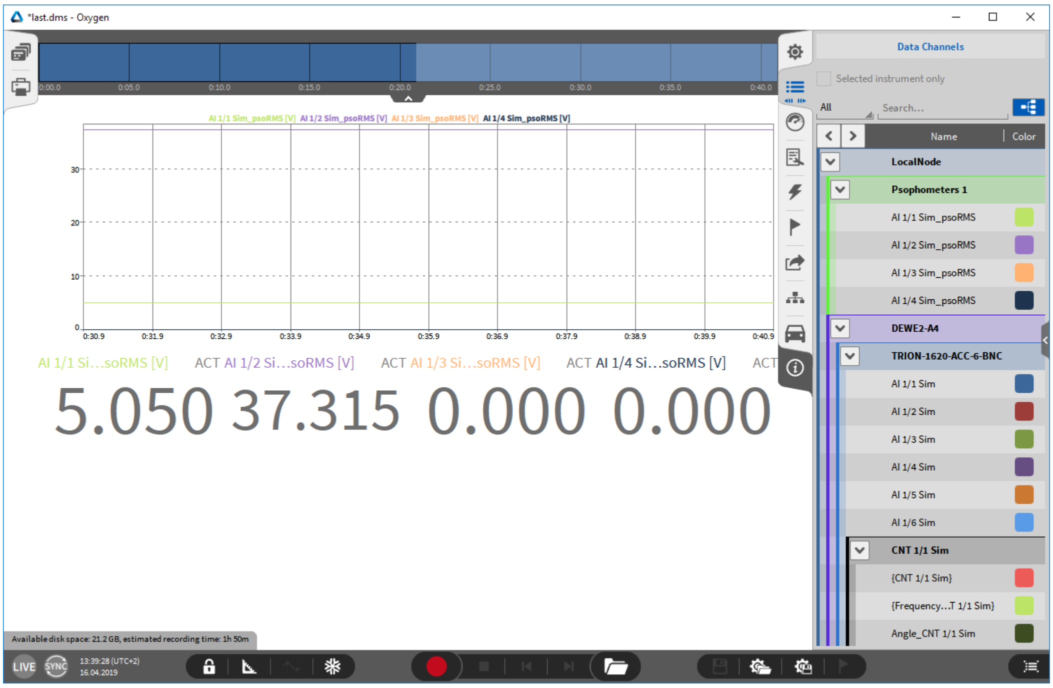


Figure 13-5: Sidebar channel list showing the calculated Psophometer channels

13.4 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 13.6.1 p.5)

Sampling rate	FFT block size
20 kHz	2048
50 kHz	4096
100 kHz	8192
200 kHz	16384

Table 13-1: Sampling rate and FFT block size

13.5 WEIGHTING OPTIONS

Different weighting options are available:

13.5.1 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	–

Table 13-2: Telephone circuit Psophometer weighting coefficients and limits

13.5.2 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.		

Table 13-3: C-message weighting coefficients and accuracy limits

13.5.3 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.	

Table 13-4: Characteristics of the optional flat filter with an equivalent noise bandwidth of 3.1 kHz (bandwidth of a telephone channel)

13.5.4 Unweighted

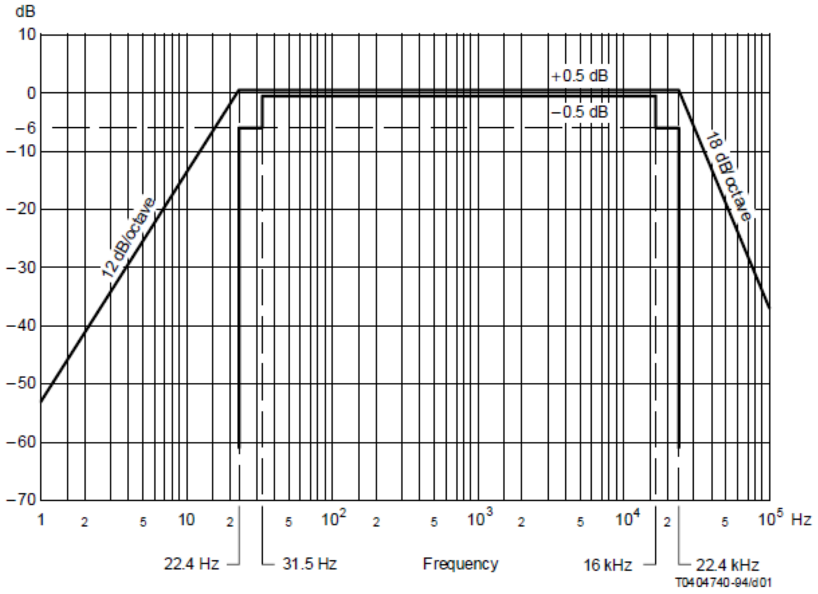


Figure 13-6: Frequency response characteristics for unweighted measurements

13.5.5 Comparison between Psophometric and C-message Weighting

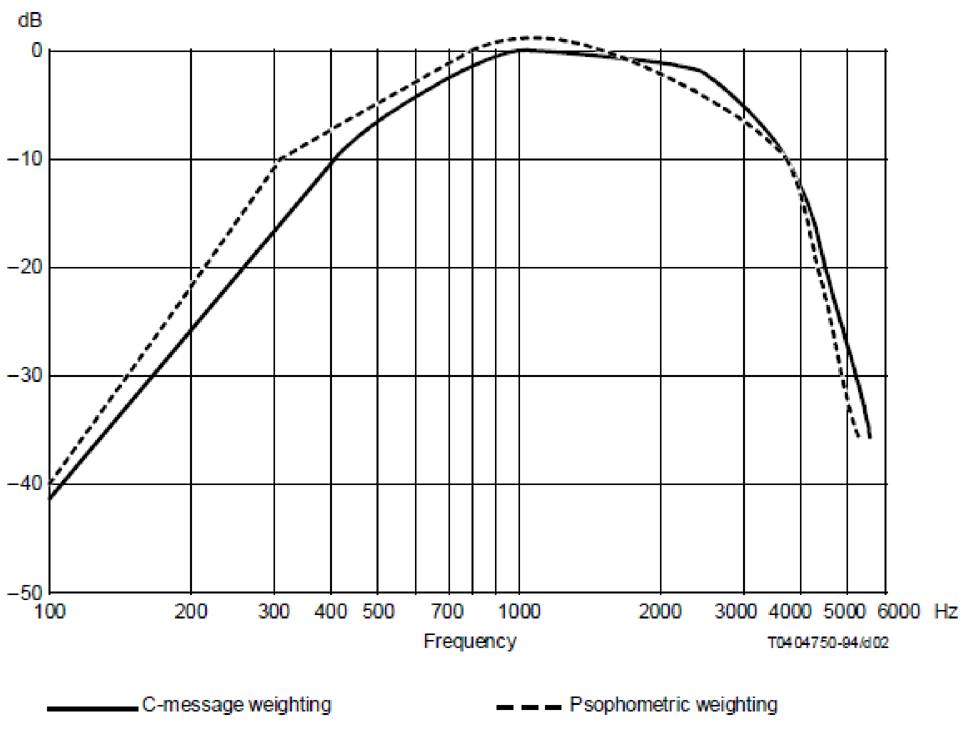


Figure 13-7: Comparison between psophometric and C-message weighting

13.6 Links

13.6.1 ITU-T Recommendation O.41 (10/94)

https://www.itu.int/rec/T-REC-O.41-199410-I/en

14 CAN-FD DAQ SUPPORT IN OXYGEN

Please note that 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 VN1640 (4 CAN-FD interfaces)
- Vector VN5610 (2 CAN-FD interfaces)

The CAN-FD hardware must be connected via USB to the measurement system where OXYGEN is running on.

Besides CAN-FD data acquisition, the above mentioned hardware 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. Please note that this is an additional optional feature and requires a separate license. For details, please refer to section 5.7.3.

To use one the above mentioned CAN-FD interfaces, proceed the following steps:

- Rune the latest *Vector_Diver_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 Figure 14-1)

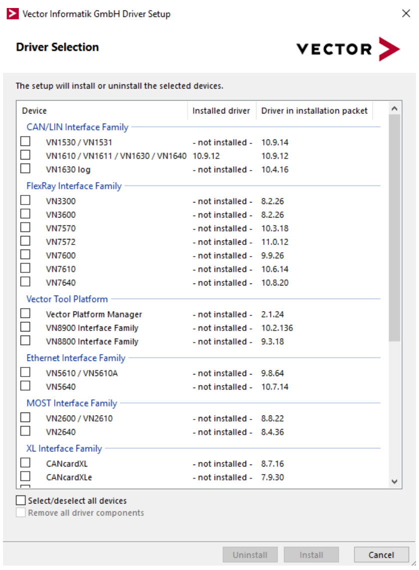


Figure 14-1: Vector driver selection

- 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) Note: If *VECTOR* is written in red (see Figure 14-3), your currently installed OXYGEN license does support Vector CAN-FD hardware. Please contact support@dewetron.com for help.

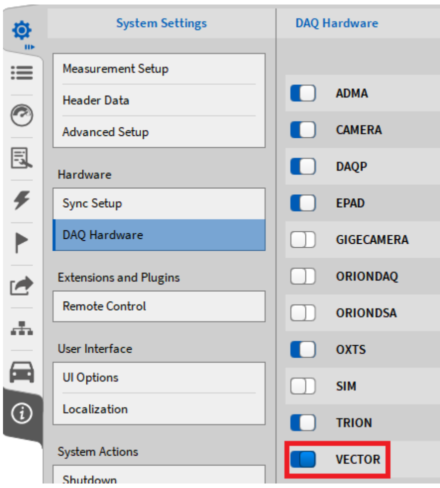


Figure 14-2: Enabling Vector CAN-FD hardware in OXYGEN

Figure 14-3: Missing Vector CAN-FD hardware license

- Changing the settings in this menu, requires an OXYGEN restart
- Open the OXYGEN Channel List. The Vector Hardware channels will be visible in the section *VNxxxx* of the Channel List (marked red in Figure 14-4).

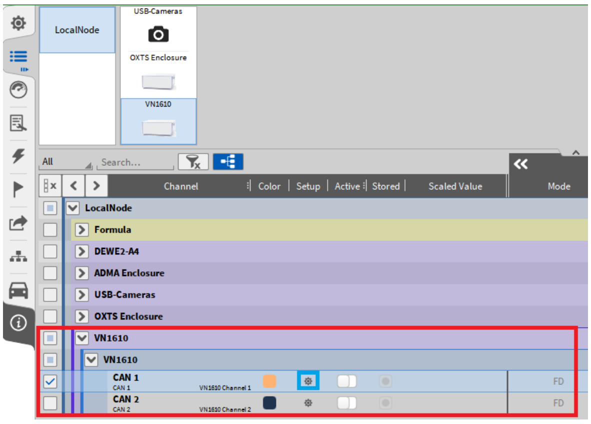


Figure 14-4: Channel List with Vector VN hardware included

- Click on the Gear button to open the Channel settings (marked blue in Figure 14-4). The Baud rate and additional settings can be changed here and the dbc file can be loaded (see Figure 14-5).

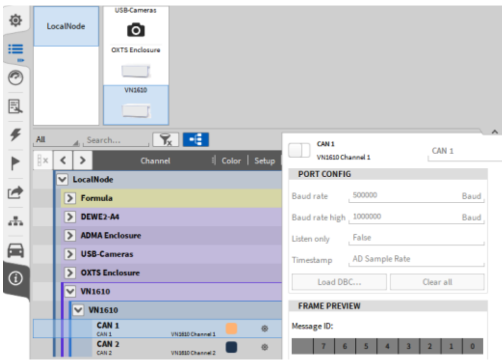


Figure 14-5: CAN-FD channel settings

- After loading 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 included their CAN channels (see Figure 14-6).

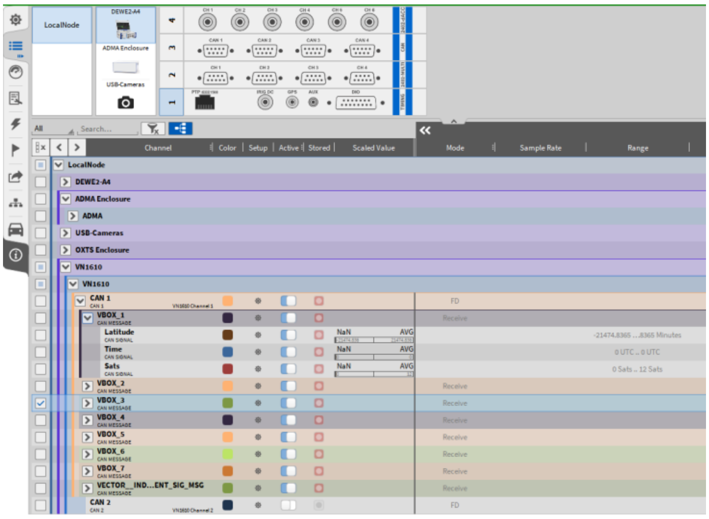


Figure 14-6: CAN-FD channel list in OXYGEN

- For more details about CAN-channels in OXGYEN, please refer to section 5.7.

Remark: 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!

15 LIST OF FIGURES

16 LIST OF TABLES