ECUMASTER

EMU PRO Software Guide

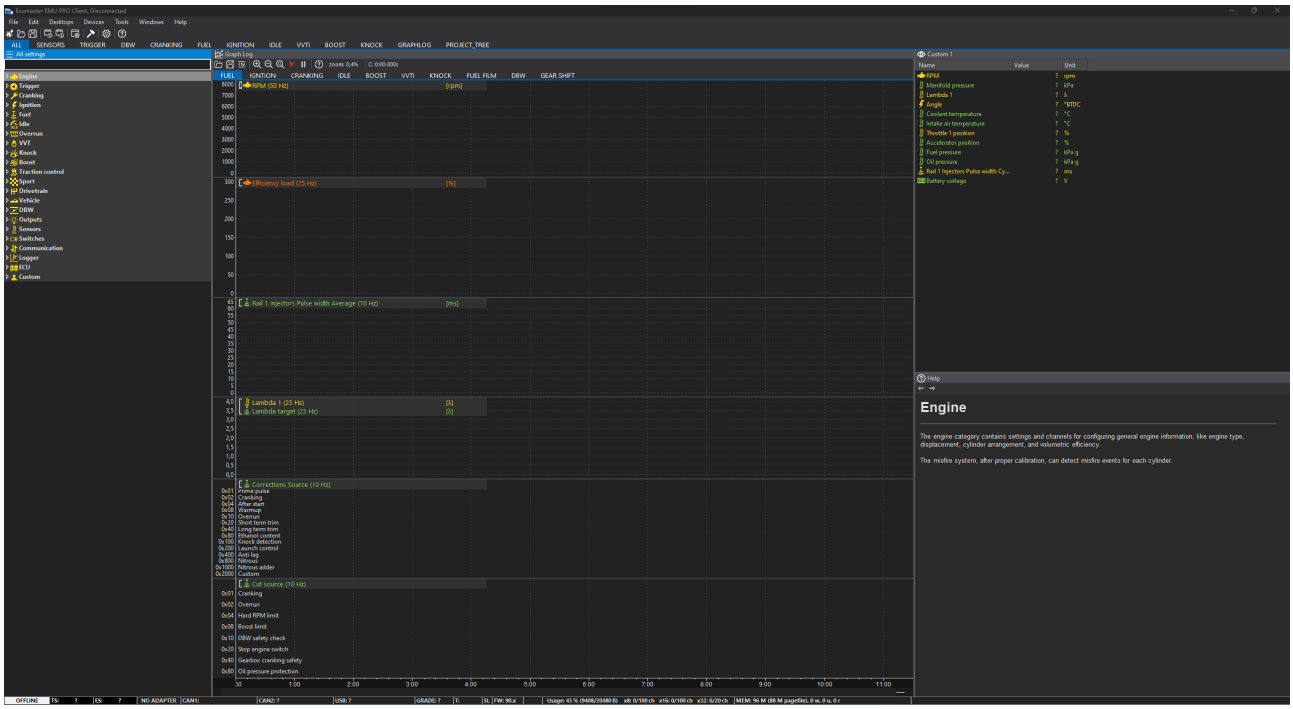
Document version 96.0, 2023.05.15

Software version 96.0

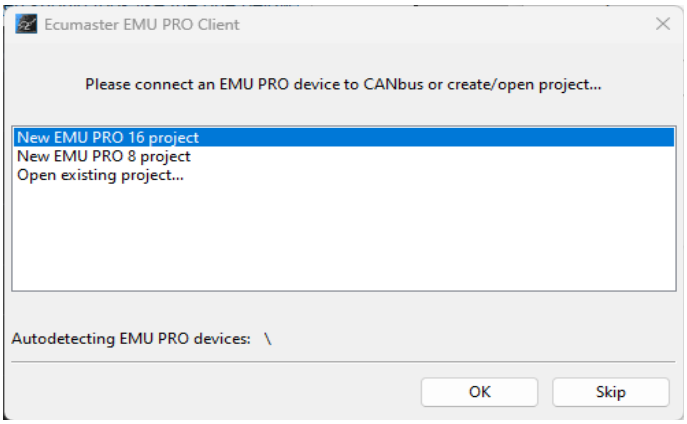
Contents

Appearance of the application

After installing and launching the application, the application screen should look like the one below:



When starting the application without a connected device, first select for which device (EMU PRO 8 or EMU PRO 16) you want to create a new project or open an existing project. If you connect a device at this point, the appropriate selection will be made automatically.



Below is a description of all available menu functions

Option	Description
File	
Open project...	Open a project (***Ctrl + O***)
Save project	Save a project in the last used location (***Ctrl + S***)
Save project as...	Save a project to a new file (***Ctrl + Shift + S***)

Load log > Browse PC connected flash drive...	Import a log from a memory stick connected to the PC (***Shift + F4***)
Show full screen	Full screen mode. This increases the screen space available to the application (***Ctrl + F***).
Change target device...	When working offline, you can choose the target device: EMU PRO 8 or EMU PRO 16
Upgrade firmware...	Change the internal software of a device
Restore to defaults	Restore a device to the default settings Deletes all settings
Make permanent	Save changes to the Flash memory of a device. Additionally, a file containing the current settings is saved to the *MyDocuments / EMU_PRO / DeviceName / QuickSave* directory (***F2***)
Exit	Exit the application. The desktop arrangement is saved upon exiting (***Alt + X***)
Edit	
Undo	Undo the last operation performed (***Ctrl+Z***)
Redo	Redo a previously undone operation (***Ctrl+Y***)
Show undo list	Display a window with all operations performed.
Desktops	
Revert desktops	Reads desktop configurations from the following file: *MyDocuments/EMU_PRO/DEFAULT/desktops.emuprolayout*
Store desktops	Save desktop configurations to the following file: *MyDocuments/EMU_PRO/DEFAULT/desktops.emuprolayout*
Open desktop templates...	Read the desktop configuration from a selected file. This allows to transfer configurations between computers.
Save desktop templates...	Save desktop configurations to a selected file. This allows to transfer configurations between computers.
Restore desktops to default	Load default desktop configuration. Restores all default panels in tabs and channels in the graph log.
Add new panel	Add a new panel to the desktop (***F9***)
Replace panel	Replace an existing panel with another (***Shift + F9***)
Switch desktop to...	Switch to any selected desktop (***Ctrl + 1*** – ***9***)
Next desktop	Move to the next desktop (***Ctrl + Tab***)
Previous desktop	Move to the previous desktop (***Ctrl + Shift + Tab***)
Devices	
Device selector	If one or more EMU PRO devices are connected, a panel enabling toggling between the devices will pop up. After switching to a device, the data between the PC and the device will be automatically synchronized. The names of particular devices can be found on the right-hand side of the application's toolbar. The currently connected device is shown in bold.

Set device #n	Automatic toggling to the connected device no. #n. After switching to a device, the data between the PC and the device will be automatically synchronized. The names of particular devices can be found on the right hand side of the application's toolbar. The currently connected device is shown in bold type (***Ctrl + Shift + 1*** – ***2***).
Set device name	Assign a name to a connected EMU PRO device
Reboot device	Reset a connected device (***Ctrl + Shift +R***)
Reconnect	Re-establish communication with the device (***Ctrl + Shift + B***)
Browse PC connected flash drive...	Read logs from a USB storage device connected to the PC (***Shift + F4***)
Set Real Time Clock	Set the real-time clock of EMU PRO according to the current PC time. This time is used to date the files of a log saved into an external USB storage device. It can also be displayed on the screen of a device.
Restart project in the EMU PRO	Save the whole project to the EMU PRO device. It's equivalent to saving and restoring the project from the project file. All strategies are reinitialized. (***F5***)
Tools	
Test outputs	Opens window which allows user to test all EMU PRO outputs from each category: Auxiliary outputs, H-Bridge output, Injector outputs, and ignition outputs. Output can be tested in modes: switch on/off, set PWM frequency, test sequences for each cylinder for ignition and injectors outputs.
Assigned outputs	Opens window which allows user to display all EMU PRO outputs with information if given output is assigned and what is its function.
Assigned inputs	Opens window which allows user to display all EMU PRO inputs (digital, analog and precision analog) with information if given inputs is assigned and what is its function.
APS tuner	Opens window with the wizard performing auto-calibration of accelerator position sensor. To perform an automatic calibration, select the appropriate analog inputs in the following fields: Main signal/ Input, Check signal/ Input, Main signal/ Voltage reference and Check signal/ Voltage reference. After the calibration the values *Main signal/ Voltage for 0% position* , *Main signal/ Voltage for 100% position* will be corrected, the table *Check signal/ Expected voltage* will be filled in.
DBW tuner	Opens window with the wizard performing auto-calibration of chosen drive-by-wire throttle. Throttle position sensor and controller parameters are automatically set up. To perform an automatic calibration, select the appropriate parameters in the following Throttle position sensor fields: Main signal/ Input, Check signal/ Input, Main signal/ Voltage reference and Check signal/ Voltage reference.

	Setup/Output and *Setup/Output frequency* in *DBW* category for chosen Throttle must be filled by the user.
VVT tuner	Opens window with the wizard performing auto-calibration of chosen Variable Valve Timing camshaft. To perform an automatic calibration, following parameters must be configured by the user: Activation, ***Camshafts count*** for ***Intake*** and ***Exhaust***, ***Position/ Sensor input*** and among others ***Sensor type*** and ***Pullup/ pulldown*** for each ***Intake Camshaft*** and ***Exhaust Camshaft, Actuator/ Solenoid/ Output*** and ***Frequency***, ***Duty cycle min*** and ***Duty cycle max for each Intake Camshaft and Exhaust Camshaft.*** Position target separately for Exhaust and Intake must be configured separately
Customize keys	Change the shortcut keys assignment
Memory report	Display a window with information on the current usage and the amount of free memory.
Tune Display	Display a floating window showing the selected engine parameters live. Go to the Tune Display Panel description for more details (***F7***).
Logged channels	Display a dialogue window with a list of all log channels and their frequency. Current size of the log data is visible at the bottom of the window (number of parts and bytes) (***F8***).
Project tree	Display the project management panel. Go to the *Project tree* panel description for more details. (***Shift + F7***).
Variables inspector	Display the user-defined variable monitoring panel. Go to the *Variables inspector* panel description for more details. (***Shift + F11***).
Smart Grid Window	Display the panel with all ECU settings and strategies. Go to the Smart Grid panel description for more details.
Options	Display a dialogue window with the application options (***Ctrl + Shift + O***) The description of the *General Options window* is available below.
Windows	
Next panel	Activate the next panel (***Tab***)
Previous panel	Activate the previous panel (***Shift + Tab***)
Help	
View help	Display the panel with help for each ECU setting. Go to the Help panel description for more details.
Online ChangeLog	Open an online *Change Log* document.
About	Open a window with information about the software version

There are icons on the taskbar  indicating:

- ***Make permanent*** – Saving changes to the non-volatile memory of a device
- ***Open project*** – opening a project
- ***Save project*** – saving the current project
- ***Restore desktops*** – loading the desktop configurations from the file
- ***Store desktops*** – saving desktop configurations to the file
- ***Add panel*** – adding a panel
- ***Configuration*** – opening the *General Options* configuration window

The *General Options* window contains the following settings:

Option	Description
Save project (Ctrl+S) without dialog	With this option active, the user will not be asked to select save file name and destination
3D tables color scheme	Color scheme for 3D maps
Auto save logs	Automatic saving of logs onto the disc
Use mouse wheel to zoom on Graph Log	Log scaling function by means of the mouse wheel

Status field

The status field contains important information on the status of a connected device.

Connection status	Specifies, whether a device is connected. One of following is available: DISCONNECTED, CONNECTED, MAKE PERMANENT, OFFLINE
Trigger sync status	Displays value of channel *Trigger/Sync state* channel: One of following is available: No sync, Skipping time, Skipping impulses, Searching, Primary synced, Fully synced
Engine state	Displays value of channel *Engine/State* channel. One of following is available: Inactive, Cranking, Running
USB to CAN adapter	Shows the CAN to USB interface type. The following interface types are supported: - **USBtoCAN** - ECUMASTER interface - **PCAN-USB** - Peak System interface - **Kvaser** - Kvaser interface
CAN 1 status (seen from PC)	The status of the CAN 1 bus from the USB to CAN interface
CAN 2 status (seen from device)	The status of the CAN 2 bus read from Can controller of the ADU display
USB logger state	Pendrive save status
USB buffer usage	Information about the quality of the pendrive (from A to F) and the buffer status
Board temperature	Device temperature
Saving log in progress	Log auto-save status
Device firmware version	Firmware version
Device type	Device type
Used resources	The number of user-defined elements used

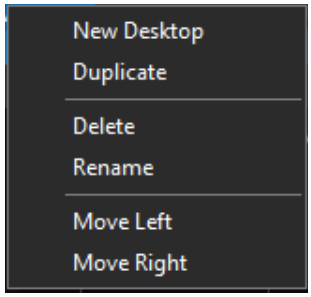
If the CAN bus (1 or 2) status differs from OK, it means errors along the bus.

Explanation of CAN statuses of the ECUMASTER USBtoCAN adapter

Status	Typical cause of the problem
OK	CAN bus fully functional, no faults
stuff	Not all devices on the CAN bus send frames at the same speed (wrong speed of device along the CAN bus).
form	Not all devices on the CAN bus send frames at the same speed.
bitrec	No terminator on the CAN bus.
bitdom	CANL and CANH are short-circuited.
bit	Two devices send frames with the same ID but with different DLC / DATA fields.
ack	Interface is the only device on the CAN bus, no other devices. Or: CANL or CANH is disconnected from other equipment. Or: CAN and CANH are interchanged.
Offline	The program operates in Offline mode - there is no access to the CAN bus.

Desktops

Desktops are an important part of the application. They allow you to arrange your own sets of panels, which makes the software easier and quicker to use. After pressing the right mouse button on the tab the following menu appears:



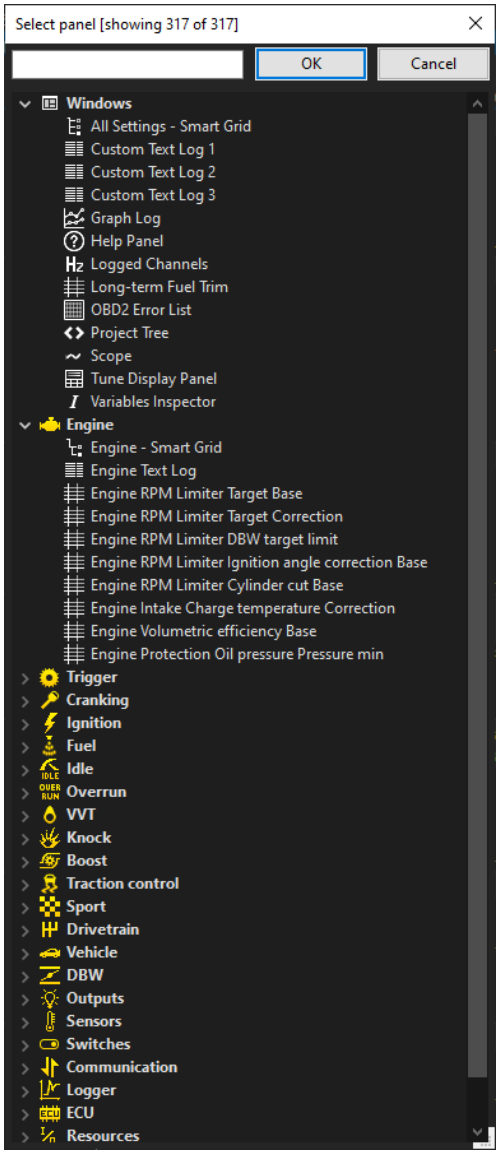
Option	Description
New desktop	Create a new desktop[.
Duplicate	Duplicate a desktop. This option creates a new desktop and copies into it the contents of a selected one
Delete	Delete desktop
Rename	This function makes it possible to change the name of a desktop
Move Left	Moves a desktop to the left
Move Right	Moves a desktop to the right

You can switch between desktops using keyboard shortcuts:

- **Ctrl+1..0** – Switch to any selected desktop (with the appropriate number)
- **Ctrl+Tab** – Switch to the next desktop
- **Ctrl+Shift+Tab** – Switch to the previous desktop

Panels

Another element of the interface are panels. Through them you can configure the device. To add a new panel, press **F9** (or click on the ***Add* panel** icon in the toolbar). A window with all available panels will open. For a quicker search, you can enter the panel you are looking for in the filter field.



Newly opened panel always show up on the right side of the desktop. You can move them by pressing the left mouse button on the *Title bar* and moving the mouse to a new position. To remove a panel from the desktop, press the right mouse button on its bar. A menu will appear from which you can delete it *(Close panel).*

Some panels have a taskbar with dedicated icons. Same options are also available in the context menu displayed by right-clicking in the panel field.

Right-clicking on the panel bar opens a menu with the following options:

Option	Key shortcut	Description
Add panel above	***Tab+Shift+Up***	Adding a panel above
Add panel below	***Tab+Shift+Down***	Adding a panel below
Add panel on left	***Tab+Shift+Left***	Adding a panel on the left
Add panel on right	***Tab+Shift+Right***	Adding a panel on the right
Replace panel	***Shift+F9***	Replacing a panel
Close panel	***Ctrl+F4***	Closing a panel

You can switch between panels using keyboard shortcuts:

- **Tab** – Switch to the next panel
- **Shift+Tab** – Switch to the previous panel

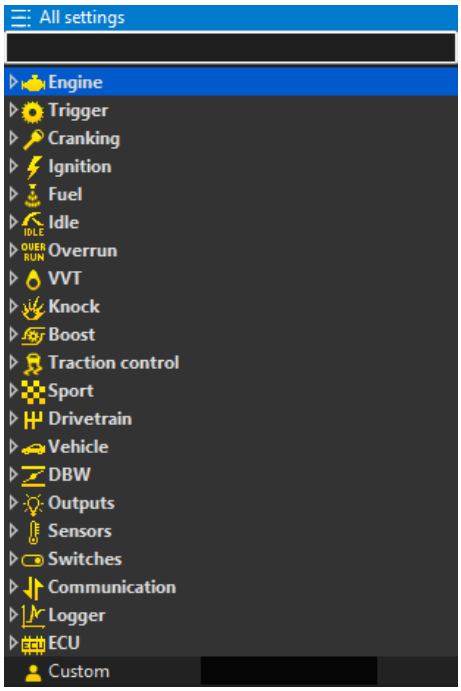
There are different panel types.
The most important of them is ***Smart grid*** containing all settings, tables and channels used in individual strategies. ***Tables*** can also be displayed as separate panels. Closely related to the Smart grid panel is the ***Help*** panel, which shows a description of the currently selected parameter.

The ***Scope*** panel allows measurement of signals present at primary trigger, secondary trigger and all cam inputs. Calculated TDC (top dead center) point, injection time, ignition dwell time and knock window for each cylinder are presented in visual form.
By using this tool it is possible to determine the trigger pattern for crankshaft and camshafts trigger wheels, to check if the polarity of the signal is correct and to save the trace for further analysis or for our technical support for troubleshooting.
For correct reading the signal inputs assignment is required. Pattern setting can be left unset.

The ***Project Tree*** panel allows you to create your own elements such as: CAN bus Receive Frame, Table , Number, Logical Function, CAN bus Transmit Frame, Group, Import .CANX/.DBC frame.
Another type are panels for viewing variables, such as ***Text log***, ***Variables Inspector***, ***Tune Display*** or ***Graph Log*** showing the course of logging channels over time.
The ***Logged Channels*** panel defines the logging frequency (in Hz) for each channel.

Smart grid – All Settings

Smart grid is a panel containing all settings for individual strategies arranged in the form of a tree.



In each category there are dedicated:

- settings of variables (white color)
- tables (light pink color)
- channels (with a color corresponding to the color of the appropriate channel set in the Graph Log panel)
- resources (resources) - for assignment of inputs or outputs of the device to a given function.

There is no separate category for Resources. Settings menu for each resource is displayed when given resource is used.

In the upper part of the panel there is a filtering field that is used to quickly find the desired parameter. It is enough to enter a part of the name to get all the parameters with the searched word in their name.

Navigation in the Smart grid Panel is done with keyboard arrows (up/down for selecting upper/lower entry, left/right for expanding/collapsing node of the tree) or a mouse (double-click is expanding/collapsing node of the tree).

Changed parameter/table value is instantly sent to the EMU PRO device, but stored in the volatile copy of the project. Make permanent command is necessary to keep the project after disconnecting the PC.

Tables

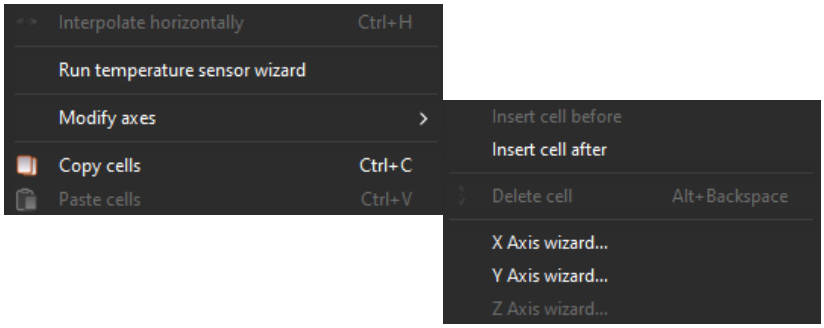
There are four types of tables: scalar, 2D table, 3D table, and 4D table.

Scalar

A scalar is a constant value (independent of any channel or condition). However, if more flexibility is needed it can be transformed into a 2,3, or 4 dimensional table).

2D tables

The configuration of each type of table is available in the context menu. Click the right mouse button on the top row of the table (specifying the function value).

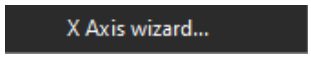


Description of the commands available in the context menu for a 2D table.

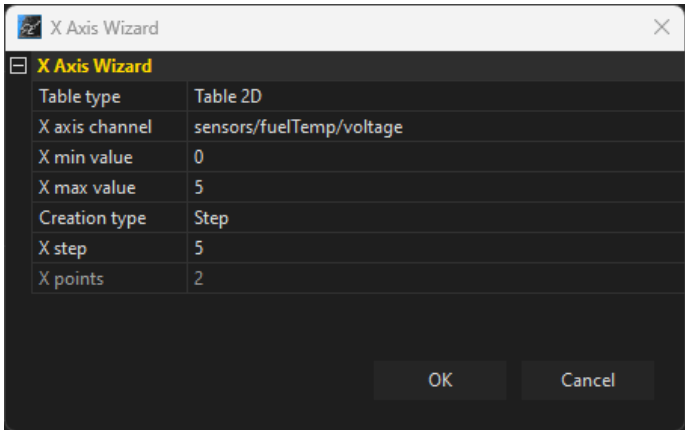
Command	Key shortcut	Description
Interpolate horizontally	Ctrl+H	Horizontal interpolation: cell values in the selection area are calculated as a linear interpolation of the cells from the left and right edges of the selection.
Run temperature sensor wizard		Automatic wizard for temperature or pressure sensor
Equalize selection	E	Smoothing of the selected cells
Modify axes/ Insert cell before		Inserting a point to the left of the selected cell
Modify axes/ Insert cell after		Insert a point to the right of the selected cell
Modify axes/ Delete cell	Alt+Backspace	Delete a selected point (selected cell)
Modify axes/ X Axis wizard		Launching a wizard for the X axis to define a new number of columns and generate X axis cells according to the selected type of interpolation. The X axis define the table type: scalar or 2D
Modify axes/ Y Axis wizard		Launching a wizard for the Y axis to define the table type: 2D or 3D
Modify axes/ Z Axis wizard		Launching a wizard for the Z axis to define the table type: 3D or 4D

Copy cells	Ctrl+C	Copying the value of the selected cell(s)
Paste cells	Ctrl+V	Pasting of the copied value(s) of the cell(s) in the highlighted area

Each scalar table has no axes defined, the 2D table has only an x-axis defined, the 3D table has an x-axis and y-axis, and the 4D table has an x-axis, y-axis and z-axis defined. It is possible to change the channel that represents a particular axis. To define the X axis (the channel assigned to the X axis and the number of feature points), you can right-click on the bottom row of the table (which defines the points on the X axis) and select ***X Axis wizard***.



A window for configuring the X axis will appear.



Parameter	Description
Table Type	Select the table type: Scalar or 2D. The x-axis parameters are only available for the 2D table.
X axis channel	Selecting a channel defining the X axis
X min value	The minimum value on the X axis, (for all arguments smaller than X *min* value, the function value is the same as for *X min value*)
X max value	The maximum value on the X axis, (for all arguments greater than *X max* value, the function value is the same as for *X max value*)
Creation type	Selecting the type of distribution of points on the X axis ***Step*** - the distribution of points evenly spaced from each other by a given step***: X step*** ***Linear interpolation*** - distribution of a specified number of points (***X points***), evenly distributed over a specified interval (between the minimum and maximum values) ***Exponential interpolation #1/#2*** - distribution of a specified number of points (***X points***) over a given range but with a higher density at the beginning of the interval and a lower density at the end. The distribution of points is described by an exponential function with an exponent equal to 1.4 for ***#1*** and 1.6 for ***#2***.
X step	For distribution of points by a given step - a distance between two consecutive points
X points	The number of points marked on the X axis

To change the distribution of points on the X axis and to assign a specific value to each point, double-click the left button on a specific cell in the table and enter the desired value.

The values of the functions in the table can also be changed by means keyboard shortcuts. The currently selected value in the table can be changed using the following keys:

[– reduces a value by a ***fine*** step

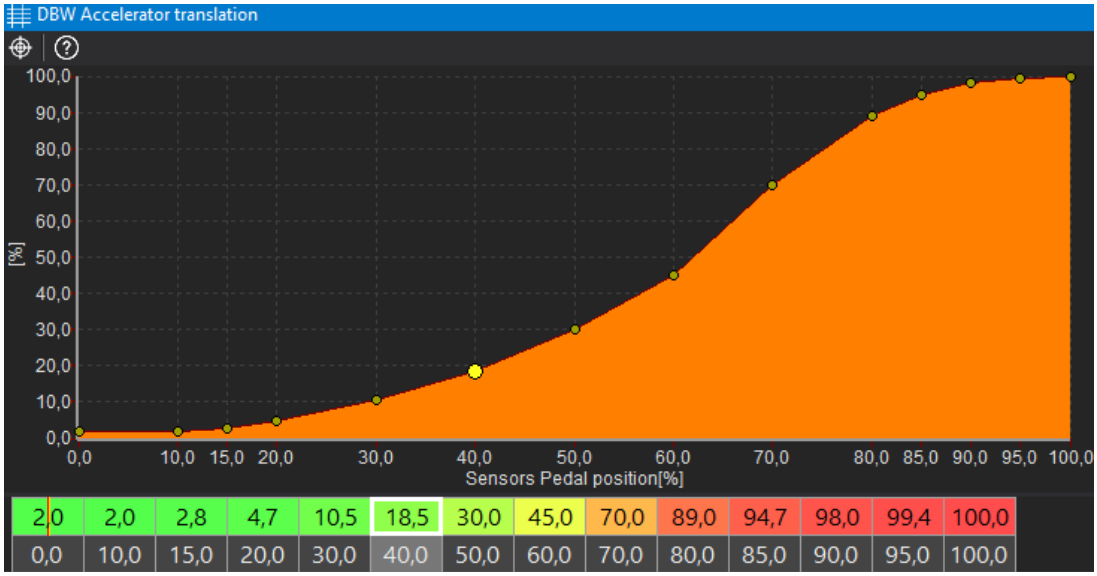
] – increases a value by a ***fine*** step

‘**-**‘ – reduces a value by a ***normal*** step

‘**+** ‘ – increases a value by a ***normal*** step

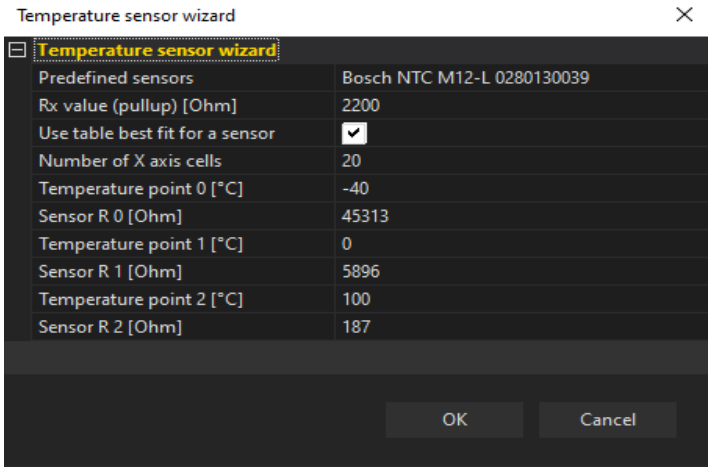
Shift + ‘**-**‘ – reduces a value by a ***coarse*** step

Shift + ‘**+**‘ - increases a value by a *coarse* step



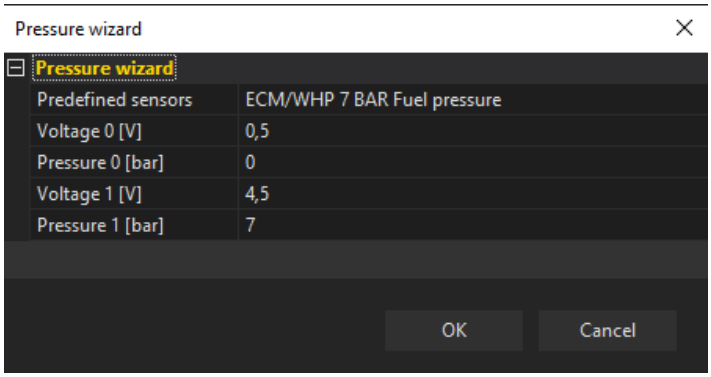
Automatic wizards are available for pressure sensors (linear characteristic sensors) and temperature sensors (NTC type sensors). After selecting a predefined sensor (from the list of those available) and specifying certain parameters, the characteristics are generated automatically.

Temperature sensor configuration:



Parameter	Description
Predefined sensors	Selection of a predefined sensor for which the resistance measurement points for the wizard are completed automatically.
Rx value (pullup) [Ohms]	The value of the pullup resistor used with the sensor
Use table best fit for a sensor	Automatic adjustment of the density of the axle compartments according to the change in the sensor characteristics
Number of X axis cells	The number of cells for a characteristic
Temperature point # [°C]	The sensor temperature value for the # of the measuring point
Sensor R # [Ohms]	Sensor resistance value for the # of the measuring point

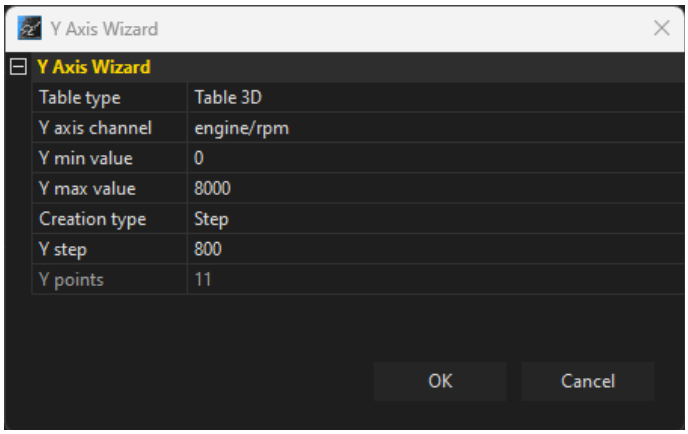
Pressure sensor configuration:



Parameter	Description
Predefined sensors	Selection of a predefined sensor for which the voltage measurement points for the wizard are completed automatically.
Voltage # [V]	Voltage value for the sensor for the # of the measuring point
Pressure # [bar]	Pressure value for the sensor for the # of the measuring point

3D tables

To define the table type 3D, select the ***Y Axis wizard*** from the context menu. The Y axis configuration window will appear.

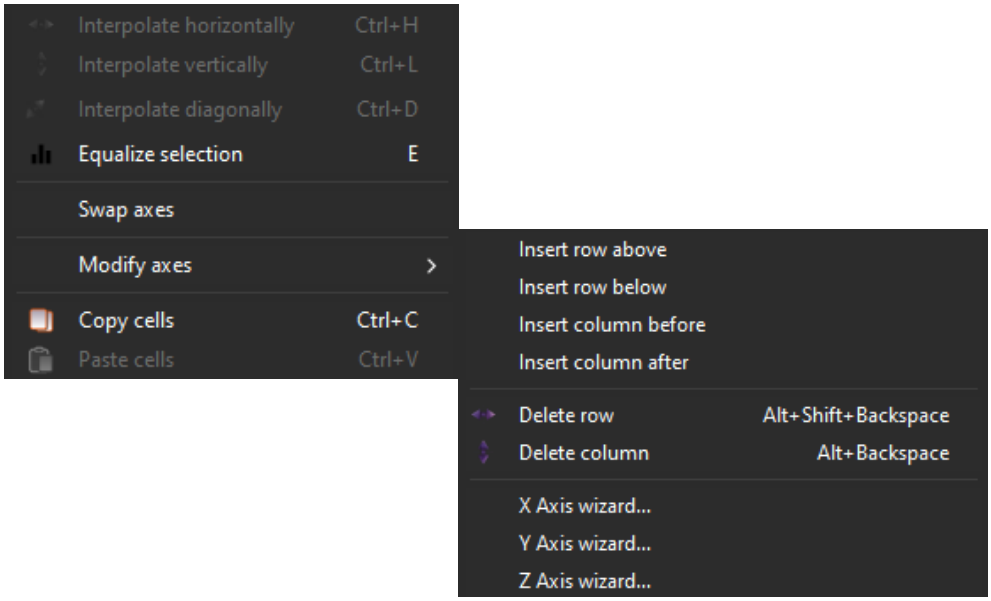


Parameter	Description
Table type	Select the table type: 2D or 3D. The y-axis parameters are only available for the 3D table.
Y axis channel	Selection of the channel defining the Y axis
Y min value	The minimum value on the Y axis
Y max value	The maximum value on the Y axis
Creation type	Selection of the type of distribution of points on the Y axis ***Step*** - the distribution of points evenly spaced from each other by a given step***: Y step*** ***Linear interpolation*** - the distribution of a specified number of points (***Y points***), evenly distributed over a specified interval (between the minimum and the maximum value) ***Exponential interpolation #1/#2*** - distribution of a specified number of points (***Y points***) over a given interval, with a higher density at the beginning of the interval and a lower density at the end. The distribution of points is described by an exponential function with an exponent equal to 1.4 for ***#1*** and 1.6 for ***#2***.
Y step	For distribution of points by a given step - a distance between two consecutive points
Y points	The number of points marked on the Y axis

Next the cells and axes should be filled with values.

You can select several cells using the **Shift + arrow** key. The **Ctrl + arrow** key copies to adjacent cells. Horizontal and vertical interpolation commands can also be helpful.

The size of the table (number of columns or rows) can be changed at any time using the context menu available under the right mouse button.

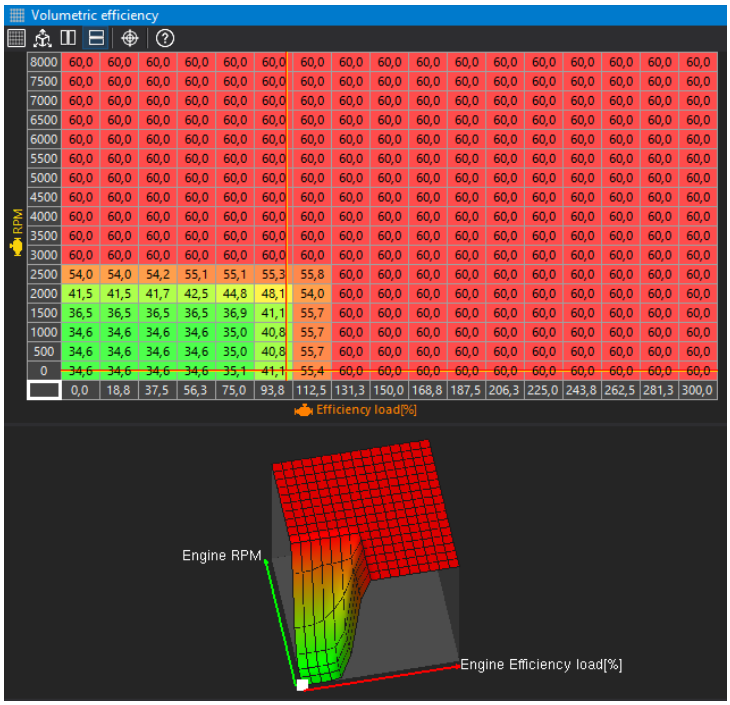


Description of the commands available in the context menu for the 3D table:

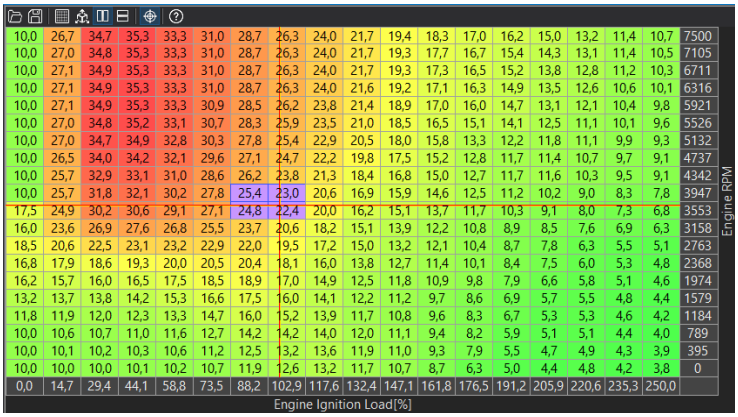
Command	Key shortcut	Description
Interpolate horizontally	Ctrl+H	Horizontal interpolation: the cell values in the selection area are calculated as a linear interpolation of the cells from the left and right edges of the selection.
Interpolate vertically	Ctrl+L	Vertical interpolation: the cell values in the selection area are calculated as a linear interpolation of the cells from the top and bottom edges of the selection.
Interpolate diagonally	Ctrl+D	Interpolation between vertices. Define the 4 corner points of the selection and the rest of the cells will be counted as bilinear interpolation. Combines two commands - first the horizontal interpolation followed by the vertical interpolation.
Equalize selection	E	Smoothing of the selected cells
Swap axes		Replacement of axles
Modify axes/ Insert row above		Inserting a row above a selected cell
Modify axes/ Insert row below		Inserting a row below a selected cell
Modify axes/ Insert column before		Insert a column to the left of the selected cell
Modify axes/ Insert column after		Insert a column to the right of the selected cell
Modify axes/ Delete row	Alt+Shift+Backspace	Delete the row containing the selected cell
Modify axes/ Delete column	Alt+Backspace	Delete the column containing the selected cell
Modify axes/ X Axis wizard		Launching a wizard for the X axis to define a new number of columns and generate X axis cells according to the selected type of interpolation
Modify axes/ Y Axis wizard		Launching the Y-axis wizard to define a new number of rows and to generate Y-axis cells according to the selected type of interpolation
Modify axes/ Z Axis wizard		Launching the Z-axis wizard to define a new number of 3D tables and to generate Z-axis cells according to the selected type of interpolation
Copy cells	Ctrl+C	Copying the value of the selected cell(s)
Paste cells	Ctrl+V	Pasting of the copied value(s) of the cell(s) in the highlighted area

The panel toolbar contains icons allowing:

- displaying only a table: *Only 3D table*
- displaying only a graph: *Only 3D graph*
- displaying a graph next to a table: *Split vertically*
- displaying a graph below a table: *Split horizontally*
- highlighting in violet the cell(s) based on which a value is interpolated: *Follow cursor*



The 3D chart view can be rotated in any way by holding down the left mouse button on the chart and moving the mouse. To return to the default view, double-click the left mouse button on the chart.



4D tables

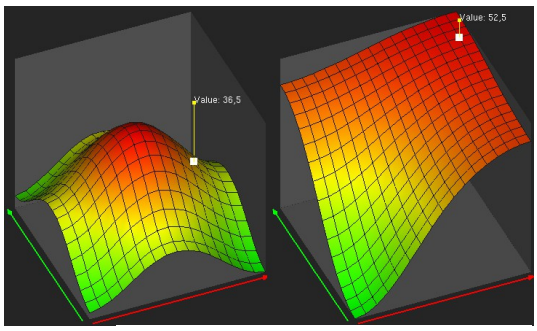
A 4D table is an expansion of a 3D table that introduces an additional dimension - the Z axis. It can be visualized as a series of 3D tables stacked together, with each table representing a distinct slice along the Z axis. The Z axis determines the quantity of these 3D tables that exist in the structure.

To obtain a value from a 4D table, there are two approaches based on the characteristics of the Z-axis.

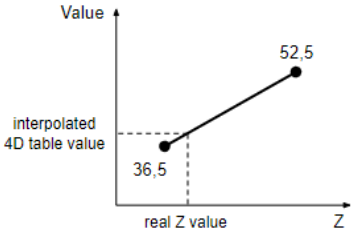
If the Z-axis channel is discrete (not continuous), such as being determined by rotary switch positions, the value is directly retrieved from the specified 3D table. In this case, there is no need for interpolation as the value is readily available in the predefined table.

If the Z-axis channel is continuous (e.g., ranging from 0% to 100%), the returned value is obtained through interpolation. This means the value is estimated by considering the slices nearest to the current Z value, and the interpolation process fills in the gap between those slices. You can refer to the accompanying diagram for a visual representation.

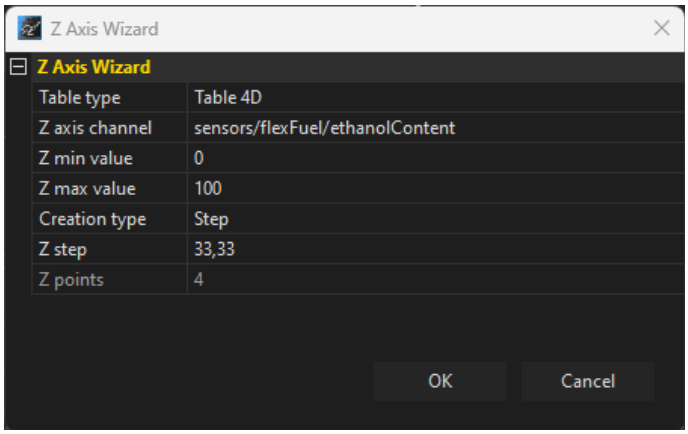
Interpolation in a 4D table involves the process of estimating values along the Z-axis by interpolating between the 3D tables. When performing interpolation in a 4D table, we consider the known values in adjacent 3D tables along the Z-axis. By analyzing the data in these neighboring tables, we can approximate the values for the intermediate slices.



The keyboard shortcut **Z** allows switching between the active Z-axis and the currently selected 3D table. Additionally, the keyboard shortcuts **Page Up** and **Page Down** enable users to move through the cells in the Z-direction.



Select the ***Z Axis wizard*** from the context menu to define the 4D table and configure the Z axis.

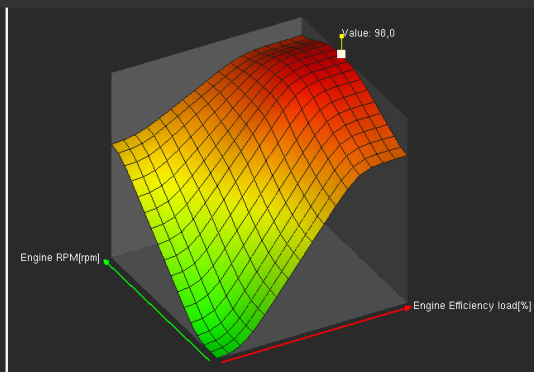


Parameter	Description
Table type	Select the table type: 3D or 4D. The z-axis parameters are only available for the 4D table.
Z axis channel	Selection of the channel defining the Z axis
Z min value	The minimum value on the Z axis
Z max value	The maximum value on the Z axis
Creation type	Selection of the type of distribution of points on the Z axis ***Step*** - the distribution of points evenly spaced from each other by a given step***: Z step*** ***Linear interpolation*** - the distribution of a specified number of points (***Z points***), evenly distributed over a specified interval (between the minimum and the maximum value) ***Exponential interpolation #1/#2*** - distribution of a specified number of points (***Z points***) over a given interval, with a higher density at the beginning of the interval and a lower density at the end. The distribution of points is described by an exponential function with an exponent equal to 1.4 for ***#1*** and 1.6 for ***#2***.
Z step	For distribution of points by a given step - a distance between two consecutive points
Z points	The number of points marked on the Z axis

Engine Volumetric efficiency Base

RPM[rpm] \ Efficiency load[%]	0,0	18,8	37,5	56,3	75,0	93,8	112,5	131,3	150,0	168,8	187,5	206,3	225,0	243,8	262,5	281,3	300,0
8000	75,6	75,8	76,4	77,6	79,3	81,1	83,0	84,8	86,7	88,5	90,2	91,4	92,0	92,2	92,2	92,2	92,3
7500	74,8	74,9	75,6	77,0	78,9	80,9	82,9	84,9	86,9	88,9	90,7	92,1	92,8	93,0	93,0	93,0	93,0
7000	72,8	72,9	73,7	75,4	77,6	79,9	82,3	84,6	87,0	89,3	91,5	93,3	94,2	94,5	94,5	94,5	94,5
6500	70,0	70,2	71,1	73,0	75,6	78,4	81,1	83,9	86,7	89,4	92,1	94,3	95,6	96,0	96,1	96,1	96,1
6000	67,0	67,2	68,3	70,4	73,4	76,6	79,8	82,9	86,1	89,3	92,3	94,9	96,6	97,2	97,3	97,3	97,3
5500	64,0	64,3	65,4	67,9	71,2	74,8	78,4	81,9	85,5	89,1	92,5	95,3	97,1	97,7	97,8	97,8	97,8
5000	61,0	61,3	62,5	65,3	69,0	72,9	76,9	80,9	84,9	88,8	92,6	95,6	97,3	97,9	98,0	98,0	98,0
4500	58,0	58,4	59,7	62,7	66,7	70,9	75,3	79,6	83,9	88,2	92,3	95,5	97,2	97,8	97,8	97,8	97,8
4000	55,1	55,4	56,8	59,9	64,1	68,6	73,1	77,6	82,1	86,6	91,0	94,5	96,5	97,2	97,3	97,4	97,3
3500	52,1	52,4	53,8	57,0	61,2	65,7	70,3	74,8	79,4	83,9	88,4	92,3	94,9	96,0	96,2	96,2	96,2
3000	49,1	49,4	50,8	54,0	58,3	62,8	67,4	72,1	76,7	81,3	85,8	90,0	93,0	94,4	94,7	94,8	94,8
2500	46,1	46,4	47,9	51,1	55,5	60,1	64,9	69,6	74,3	79,0	83,7	88,0	91,3	92,7	93,1	93,1	93,1
2000	43,3	43,6	45,1	48,4	52,9	57,7	62,6	67,4	72,2	77,0	81,8	86,3	89,6	91,1	91,5	91,5	91,5
1500	41,3	41,6	43,1	46,4	51,0	55,8	60,7	65,5	70,4	75,3	80,1	84,6	88,0	89,5	89,9	89,9	89,9
1000	40,3	40,6	42,1	45,4	49,9	54,7	59,5	64,3	69,1	73,9	78,6	83,1	86,4	87,9	88,3	88,3	88,3
500	40,1	40,4	41,9	45,1	49,4	54,1	58,8	63,5	68,1	72,8	77,5	81,8	85,0	86,4	86,8	86,8	86,8
0	40,1	40,4	41,9	45,0	49,3	53,8	58,4	63,0	67,7	72,3	76,9	81,1	84,3	85,7	86,0	86,1	86,2

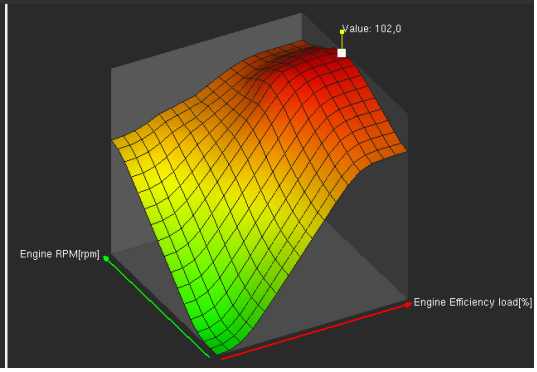
Flex fuel Ethanol content[%]: 0,0 | 33,3 | 66,7 | 100,0



Engine Volumetric efficiency Base

RPM[rpm] \ Efficiency load[%]	0,0	18,8	37,5	56,3	75,0	93,8	112,5	131,3	150,0	168,8	187,5	206,3	225,0	243,8	262,5	281,3	300,0
8000	80,6	80,8	81,4	82,6	84,3	85,1	86,0	86,8	88,7	90,5	92,2	93,4	94,0	94,2	94,2	94,2	94,3
7500	79,8	79,9	80,6	82,0	83,9	84,9	85,9	86,9	88,9	90,9	92,7	94,1	94,8	95,0	95,0	95,0	95,0
7000	77,8	77,9	78,7	80,4	82,6	83,9	85,1	87,5	89,1	91,1	93,1	94,7	95,7	96,3	96,5	96,5	96,5
6500	75,0	75,2	76,1	78,0	80,6	83,4	85,2	87,1	89,2	91,5	94,8	96,6	97,9	98,7	99,0	99,0	98,1
6000	72,0	72,2	73,3	75,4	78,4	81,6	84,1	86,7	89,4	92,1	96,7	98,9	99,4	100,2	100,7	100,9	99,3
5500	69,0	69,3	70,4	72,9	76,2	79,8	83,0	86,3	89,6	92,9	97,9	100,4	101,1	102,0	102,4	102,6	101,8
5000	66,0	66,3	67,5	70,3	74,0	77,9	81,9	85,9	89,9	93,8	98,6	101,6	102,3	102,9	103,0	103,0	102,0
4500	63,0	63,4	64,7	67,7	71,7	75,9	80,3	84,6	88,9	93,2	97,3	100,5	102,2	102,8	102,8	102,8	102,8
4000	60,1	60,4	61,8	64,9	69,1	73,6	78,1	82,6	87,1	91,6	96,0	99,5	101,5	102,2	102,3	102,4	102,3
3500	57,1	57,4	58,8	62,0	66,2	70,7	75,3	79,8	84,4	88,9	93,4	97,3	99,9	101,0	101,2	101,2	101,2
3000	54,1	54,4	55,8	59,0	63,3	67,8	72,4	77,1	81,7	86,3	90,8	95,0	98,0	99,4	99,7	99,8	99,8
2500	51,1	51,4	52,9	56,1	60,5	65,1	69,9	74,6	79,3	84,0	88,7	93,0	96,3	97,7	98,1	98,1	98,1
2000	48,3	48,6	50,1	53,4	57,9	62,7	67,6	72,4	77,2	82,0	86,8	91,3	94,6	96,1	96,5	96,5	96,5
1500	46,3	46,6	48,1	51,4	56,0	60,8	65,7	70,5	75,4	80,3	85,1	89,6	93,0	94,5	94,9	94,9	94,9
1000	45,3	45,6	47,1	50,4	54,9	59,7	64,5	69,3	74,1	78,9	83,6	88,1	91,4	92,9	93,3	93,3	93,3
500	45,1	45,4	46,9	50,1	54,4	59,1	63,8	68,5	73,1	77,8	82,5	86,8	90,0	91,4	91,8	91,8	91,8
0	45,1	45,4	46,9	50,0	54,3	58,8	63,4	68,0	72,7	77,3	81,9	86,1	89,3	90,7	91,0	91,1	91,2

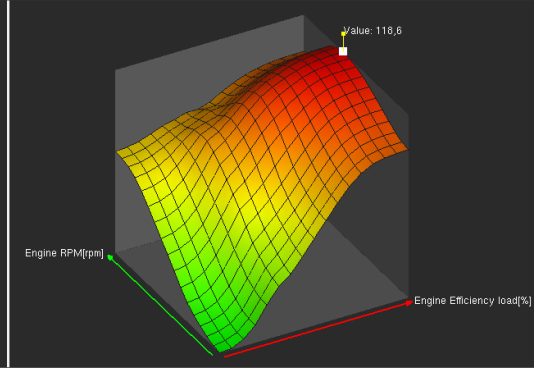
Flex fuel Ethanol content[%]: 0,0 | 33,3 | 66,7 | 100,0



Engine Volumetric efficiency Base

RPM[rpm] \ Efficiency load[%]	0,0	18,8	37,5	56,3	75,0	93,8	112,5	131,3	150,0	168,8	187,5	206,3	225,0	243,8	262,5	281,3	300,0
8000	93,8	94,1	94,8	96,0	97,4	98,2	99,3	99,3	100,4	102,4	104,1	105,5	106,4	107,0	107,3	107,4	107,4
7500	93,6	93,9	94,7	96,0	97,7	98,8	99,8	101,2	101,3	103,4	105,1	106,6	107,6	108,2	108,6	108,7	108,7
7000	93,0	93,3	94,3	95,9	97,8	99,6	101,0	102,6	102,9	105,1	106,9	108,5	109,7	110,4	110,8	111,0	111,1
6500	91,6	92,0	93,1	95,2	98,2	100,9	102,0	102,9	105,4	107,7	109,7	111,4	112,6	113,4	113,9	114,2	114,2
6000	89,4	89,9	91,2	93,8	97,5	101,3	102,7	105,0	107,8	110,3	112,2	113,8	115,0	115,9	116,4	116,6	116,7
5500	86,6	87,2	88,7	91,7	96,2	101,2	103,1	106,0	109,3	111,9	113,9	115,2	116,5	117,4	117,8	118,0	118,0
5000	83,7	84,3	85,9	89,2	94,3	99,8	102,3	105,5	109,2	112,3	114,3	115,8	117,1	118,0	118,4	118,6	118,6
4500	80,7	81,3	83,1	86,6	92,0	97,8	100,5	104,1	108,1	111,3	113,7	115,4	116,9	117,9	118,4	118,5	118,5
4000	77,7	78,4	80,2	83,8	89,4	95,3	98,3	102,1	106,2	109,5	112,0	114,2	116,1	117,3	117,8	117,9	117,9
3500	74,7	75,3	77,3	81,0	86,7	92,7	95,6	99,3	103,5	107,0	109,7	112,5	114,7	116,1	116,7	116,9	116,9
3000	71,5	72,2	74,2	78,1	83,8	89,8	92,4	95,8	99,9	103,8	107,4	110,4	113,0	114,6	115,3	115,6	115,6
2500	68,8	69,3	71,3	75,2	80,7	86,6	89,5	92,8	96,5	100,6	104,8	108,5	111,3	112,9	113,7	114,0	114,1
2000	66,9	67,4	69,0	72,6	78,3	83,5	86,7	90,2	94,1	98,3	102,7	106,6	109,6	111,3	112,1	112,4	112,5
1500	65,5	66,1	67,4	70,6	75,8	81,6	84,8	88,5	92,2	96,5	100,9	104,9	107,9	109,7	110,5	110,9	110,9
1000	64,3	64,8	66,1	69,1	74,4	79,8	83,0	86,8	90,8	95,1	99,6	103,5	106,5	108,3	109,1	109,4	109,4
500	63,3	63,9	65,2	68,5	73,4	78,7	81,5	85,5	89,7	94,2	98,5	102,4	105,4	107,2	108,0	108,3	108,3
0	63,1	63,4	65,1	68,3	73,5	78,0	80,6	84,8	89,3	93,7	98,1	102,0	104,9	106,7	107,5	107,8	107,9

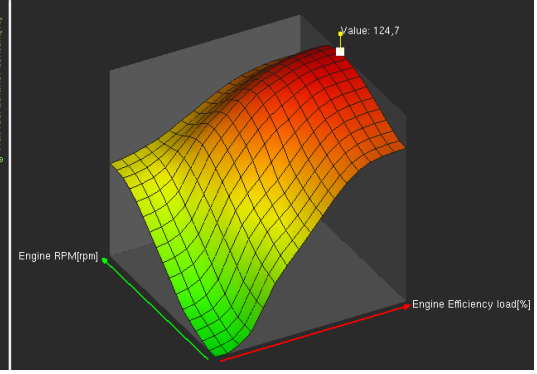
Flex fuel Ethanol content[%]: 0,0 | 33,3 | 66,7 | 100,0



Engine Volumetric efficiency Base

RPM[rpm] \ Efficiency load[%]	0,0	18,8	37,5	56,3	75,0	93,8	112,5	131,3	150,0	168,8	187,5	206,3	225,0	243,8	262,5	281,3	300,0
8000	93,7	94,0	94,8	95,9	97,1	98,9	101,0	103,0	105,1	107,1	108,8	110,1	111,0	111,6	111,9	111,9	111,7
7500	93,6	93,9	94,7	96,0	97,7	99,8	101,9	104,2	106,3	108,4	110,1	111,6	112,6	113,2	113,5	113,6	113,7
7000	93,1	93,4	94,3	96,0	98,5	101,3	103,8	106,3	108,6	110,8	112,7	114,3	115,5	116,2	116,6	116,8	116,9
6500	91,6	92,1	93,1	95,2	99,4	103,2	106,3	109,0	111,5	113,9	115,9	117,6	118,8	119,7	120,2	120,4	120,4
6000	89,4	89,8	91,0	93,7	99,2	104,4	108,3	111,2	114,1	116,5	118,4	120,1	121,3	122,2	122,7	122,9	122,9
5500	86,5	87,1	88,4	91,5	98,0	104,7	108,8	112,4	115,8	118,3	120,3	121,3	122,7	123,6	124,0	124,2	124,2
5000	83,5	84,1	85,5	88,9	96,0	103,1	107,8	111,7	115,5	118,8	120,6	121,9	123,3	124,2	124,6	124,7	124,7
4500	80,5	81,1	82,7	86,3	93,6	101,0	106,0	110,3	114,3	117,6	120,1	121,6	123,2	124,2	124,5	124,6	124,6
4000	77,5	78,2	79,8	83,5	91,1	98,6	103,8	108,3	112,5	115,8	118,2	120,4	122,4	123,5	123,9	124,0	124,0
3500	74,5	75,2	76,9	80,7	88,3	95,9	101,1	105,5	109,9	113,4	115,6	118,6	121,0	122,4	122,9	123,0	123,0
3000	71,3	72,0	73,8	77,8	85,6	93,2	97,8	101,6	105,9	110,0	113,5	116,5	119,2	120,8	121,4	121,6	121,7
2500	68,3	68,9	70,7	74,8	83,2	90,6	95,1	98,8	102,1	106,4	110,8	114,6	117,5	119,1	119,8	120,1	120,1
2000	66,7	67,1	68,5	72,1	80,2	88,1	92,9	97,0	99,8	104,1	108,7	112,7	115,8	117,5	118,2	118,5	118,5
1500	65,3	66,0	67,0	70,0	77,2	85,6	91,4	94,7	98,0	102,4	107,0	111,1	114,1	115,9	116,6	116,9	116,9
1000	64,1	64,7	65,7	68,6	76,1	83,7	89,4	92,8	96,6	101,0	105,6	109,6	112,7	114,4	115,2	115,3	115,4
500	63,0	63,6	64,6	68,0	74,9	82,6	87,7	91,6	95,5	100,1	104,5	108,5	111,5	113,2	113,9	114,2	114,2
0	63,0	63,0	64,8	67,8	74,6	81,7	86,4	90,7	95,1	99,6	104,1	108,0	111,0	112,7	113,4	113,7	113,8

Flex fuel Ethanol content[%]: 0,0 | 33,3 | 66,7 | 100,0



Graph Log

Graph log is the panel plotting channels data as a function of time

The panel toolbar allows to:

- ***Open log*** - reading the log file from the disk - adding a new log (***Append data***) or replace the currently open logs with other (***Replace data***)
- ***Save log*** - saving the log file to disk along with user-created bookmarks
- ***Export to CSV*** - exporting to CSV file
- ***Zoom In***, ***Zoom Out***, ***Zoom extents*** - change of scale
- ***Clear log*** – remove logged data
- ***Pause/ Resume log*** – when connected to the device, the log has to be paused to view past data. Otherwise the cursor will be always showing the current data point.
- ***zoom:*** - the current zoom rate is displayed on the taskbar
- ***C:*** - information about the current position of the cursor is displayed on the taskbar.

The **Graph Log** panel, just like the main application dashboard, has tabs that can be used to organise the displayed channels (e.g. Fuel, Ignition, etc.). The handling of the tabs is no different to that of the main application desktop.

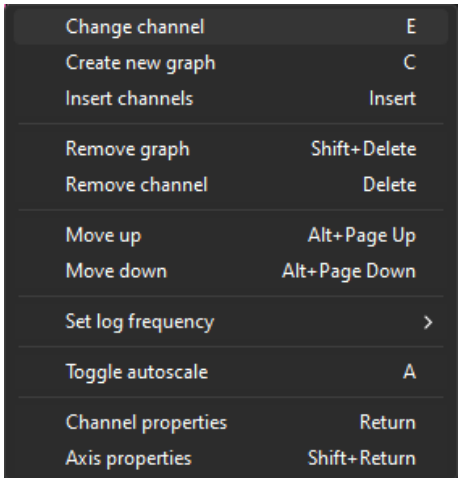
Elements of the *Graph Log* panel:

1. **Channel panel** – displays the channels presented on a given chart along with the values of these channels indicated by the cursor. In case of a selection, it displays the channel value for the start cursor. The active channel is indicated by a vertical white line next to the name. The active channel can be changed with the Page Up/Down keys or by right clicking on the channel name. It is also possible to select a channel by right-clicking on the chart.
2. **Cursor**
3. **Value axis** – if two or more channels are displayed on one chart, the channels with the same unit have a common axis, the next added channel with a different unit has a separate axis (displayed on the right hand side), and each next added channel with a different unit has the displayed axis on the left when this channel is selected (the axis for the underlined channel is visible on the left hand side).
   In the autoscale mode, the maximum and minimum values of all channels within the graph are searched. Green dashes next to the channel name mean that autoscaling is enabled. When autoscaling is off, the lines are white. Autoscaling is enabled/disabled by using the '**A**' hotkey or calling the ***Axis properties*** window.
4. **Time axis** - time elapsed from the beginning of the log

Navigation in the *Graph Log* panel

Clicking the left mouse button on the chart causes the cursor to move. Double-clicking with the left mouse button starts edition of the selection. The selection can be confirmed by clicking the left mouse button again, in which case the selected fragment will be zoomed in. If you hold down the Shift key when confirming a selection, the selected area remains selected without zooming in.

By pressing the right mouse button in the log area, the context menu is called up:



Option	Key shortcut	Description
Change channel	***E***	Replace the selected channel
Create new graph	***C***	Add a channel on a new graph
Insert channels	***Insert***	Add a channel on the currently active graph
Remove graph	***Shift+Delete***	Delete a graph
Remove channel	***Delete***	Remove a selected channel from the graph
Move up	***Alt + PageUp***	Move a graph up
Move down	***Alt + PageDown***	Move a graph down
Set log frequency	***Alt + 1..8, Alt + `***	Change the logging frequency
Toggle autoscale	***A***	Enable/disable auto-scaling of the selected axis
Channel properties	***Return***	Display the properties window for the channel
Axis properties	***Shift + Return***	Display the axis properties window

Channel properties

Option	Description
Log channel	Name of the edited channel
Graph color	Select the display color of the channel
Filter samples [0=off]	Filter of the waveform, i.e. how many samples the value at a given point is to be determined from. A value of 0 means no filtering.
Enable alarm	Checking the box will activate the alarm (displayed on the application toolbar) if the condition defined in the ***Condition*** and ***Alarm value*** fields is met at the cursor position
Condition	Condition specifying alarm activation for values: ***Greater*** - greater than ***Alarm value*** ***Lower*** - smaller than ***Alarm value***
Alarm value	Alarm value

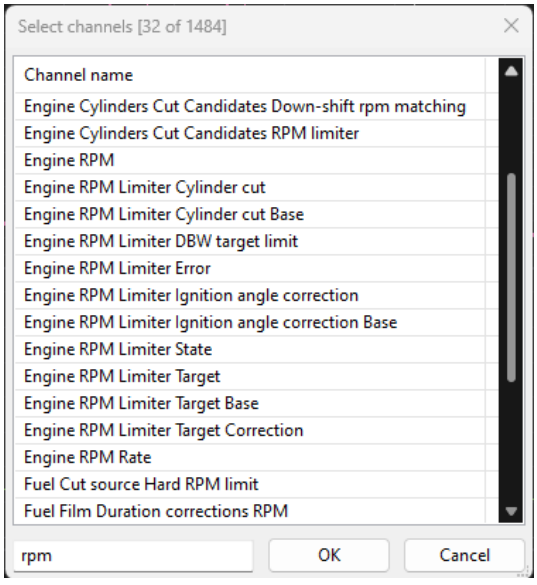
The axis settings are available by selecting the following option from the menu ***Axis properties***.

Option	Description
Unit	Displays information in which unit the axis is expressed
Range mode	***Autoscale*** – This option causes the range of values to be calculated automatically based on the logged data ***Manual*** – the range of values is fixed
Min value	Minimum value of the axis (in manual mode)
Max value	Maximum value of the axis (in manual mode)

Additional operations on the *Graph Log* panel are possible using the following keyboard shortcuts:

Option	Key shortcut	Description
Cursor movement	←/→	Moves the cursor forward/backward by one unit
Move the cursor by a bigger distance	***Ctrl*** **+** ←/→	Moves the cursor forward/backward by ten units
Screen offset	***Shift*** **+** ←/→	Moves the screen without changing the cursor position
Marking the area	***Ctrl + Shift*** **+** ←/→	Marks the area between the start and end positions of the cursor
Zoom in/out	↑/↓	Zoom in/out view
Positioning the cursor at the beginning	***Home***	Moves to the start of the log/ lap in lap comparison mode
Positioning the cursor at the end	***End***	Moves to the end of the log/ lap in lap comparison mode
Changing the active channel	***PageUp /PageDown***	Changes the active channel to the channel above/below
Add bookmark	***Ctrl+T***	Adding a new bookmark
Toggle line style	***Shift + S***	Changing the display mode: line / dots / connected dots

If you change or add a new channel to the chart, the channel selection window appears. For easier searching, the channel name can be entered in the lower field of the window, which will filter the available channels. For example, if you enter the word **rpm** , only channels containing the word **rpm** will be displayed. Using the Shift or Ctrl keys, it is possible to select multiple channels to be added to one chart.

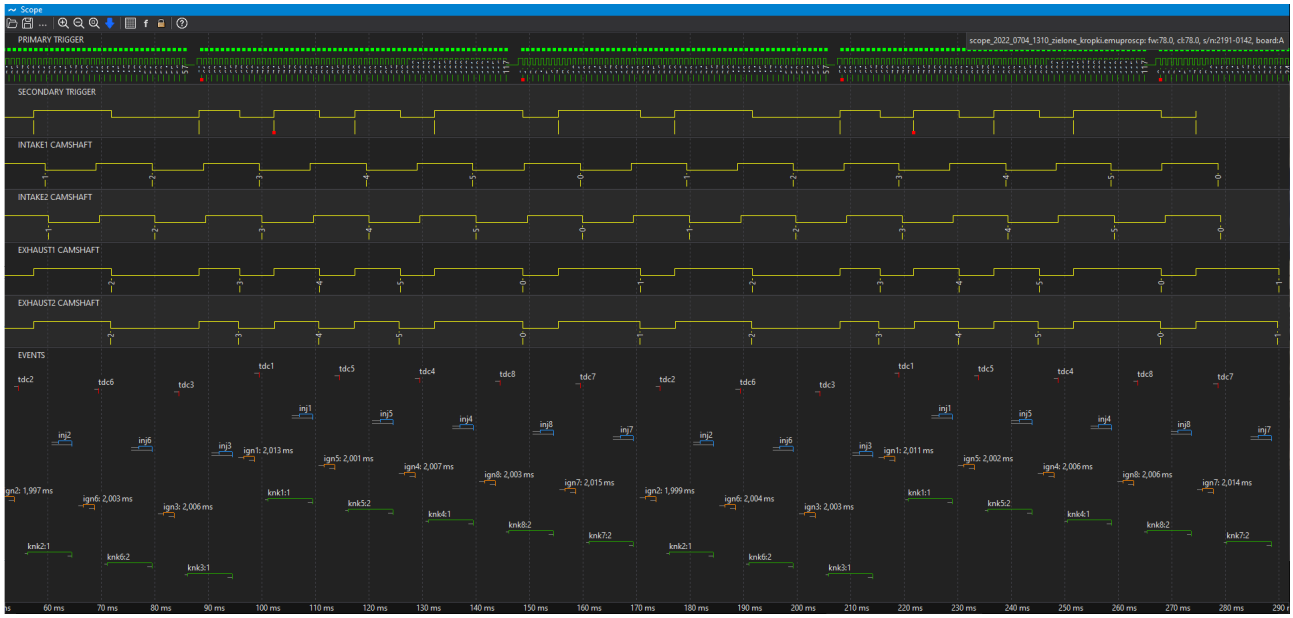


Scope

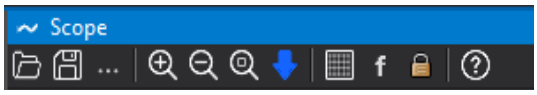
The ***Scope*** panel allows measurement of signals present at primary trigger, secondary trigger and all cam inputs. Calculated TDC (top dead center) point, injection time, ignition dwell time and knock window for each cylinder are presented in visual form.

By using this tool it is possible to determine the trigger pattern for crankshaft and camshafts trigger wheels, to check if the polarity of the signal is correct and to save the trace for further analysis or for our technical support for troubleshooting.

For correct reading the signal inputs assignment is required. Pattern setting can be left unset.



The panel toolbar allows to:



- ***Open scope*** – opening a previously saved chart Scope
- ***Save scope*** – saving the chart Scope
- ***More commands*** → ***Configure VVT angles*** – automatically fills in Position/Initial teeth angles table for all used camshafts for position based on the downloaded scope.
- ***Zoom In/ Out*** – zooming the chart in/ out
- ***Zoom extents*** – zooming in on the selected area of the chart
- ***Get scope data*** – sampling the signal from sensors (samples), recording the signal (rising and falling edges) from crankshaft and shaft position sensors.
- ***Toggle vertical lines*** – displaying a bar graph where the height of the bar is the time between the occurrence of the successive *Primary Trigger* teeth
- ***Toggle factors*** – a factor determining the distance between the current and the previous

edges relative to the distance between the two preceding edges (used for a *Longer than factor* toothed wheel)

– ***Toggle lock cycle*** – locks displayed cycle on following downloaded scopes data on the previously set cycle.

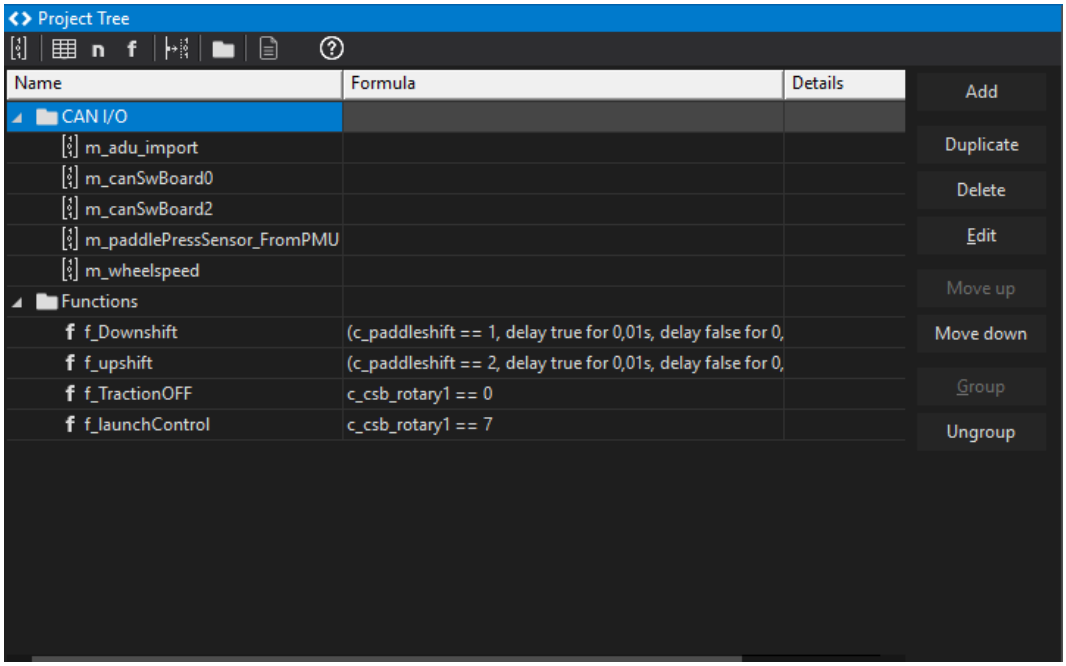
To start downloading the data click *Get scope data*, turn on the starter and turn it off after the graph appears.

PRIMARY TRIGGER graph (green) is a record of the crankshaft signal.
SECONDARY TRIGGER graph - from the camshaft (used as the *Secondary Trigger*).
INTAKE# CAMSHAFT and ***EXHAUST# CAMSHAFT*** shown the signal from individual camshafts (intake and exhaust).

Once all settings have been properly corrected and a new signal recording has been downloaded, a visualization of the following events in relation to time will appear on the graph under **EVENTS***:*
tdc# - upper dead center position of individual pistons
inj# - injection time for individual cylinders
ign# - ignition coil charging time *(Dwell time*) and ignition time for individual cylinders
knk# - knocking monitoring window for individual cylinders for *the Knock* strategy (knock window)

Project Tree

The ***Project Tree*** panel is used to define all user custom elements in the project.



To add a new element, select the icon from the toolbar or click the **Add** button on the right side of the panel. The following selection options will appear:

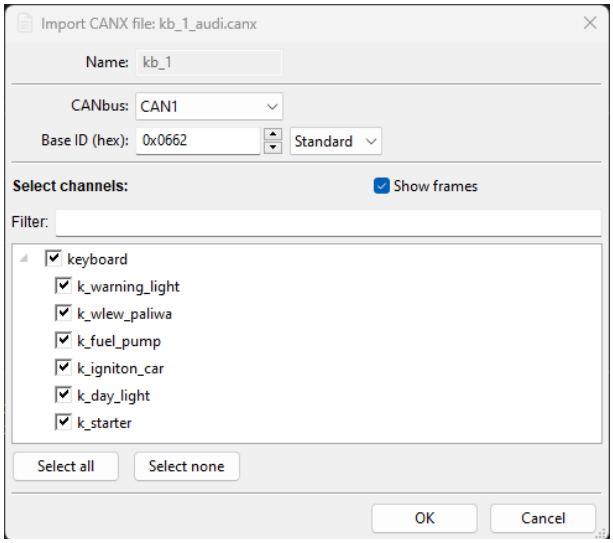
- ***CANbus Receive Frame (rx)*** – a CAN message frame, where an incoming CAN frame can be defined. Within each frame, data channels are defined.
- ***Table*** – an element defining the table that can be used to transform data (e.g. transform an analog input voltage into temperature)
- ***Number*** – an element defining complex mathematical operations combining other channels values
- ***Logical Function*** – an element for creating complex logical functions combining other channels values
- ***CANbus Transmit Frame (tx)*** – an element for sending CAN frames with chosen channel values or constant values.
- ***Group*** – a function for grouping elements; it allows a hierarchy to be introduced into a project in an easy way.
- ***Import .CANX / .DBC*** file – this function is intended for downloading predefined CAN streams for different devices (e.g. CAN Switchboard, PMU-16, etc.)

When adding different elements to the project, it is recommended to use the ***Group*** element, which allows elements to be grouped into logical sets. You should also make sure to assign correct names to elements and variables. This will facilitate project management in the future.

You can also duplicate project elements using the **Duplicate** button.

Using predefined streams from .CANX and .DBC files

The simplest way to work with the CAN bus is to use predefined streams from ***.CANX*** and ***.DBC*** files. Having selected an icon from the taskbar or choosing the ***Project tree*** > ***Add*** > ***Import .CANX / .DBC file*** option and pointing to the *.CANX* or *.DBC* file, a window with the import settings will open.

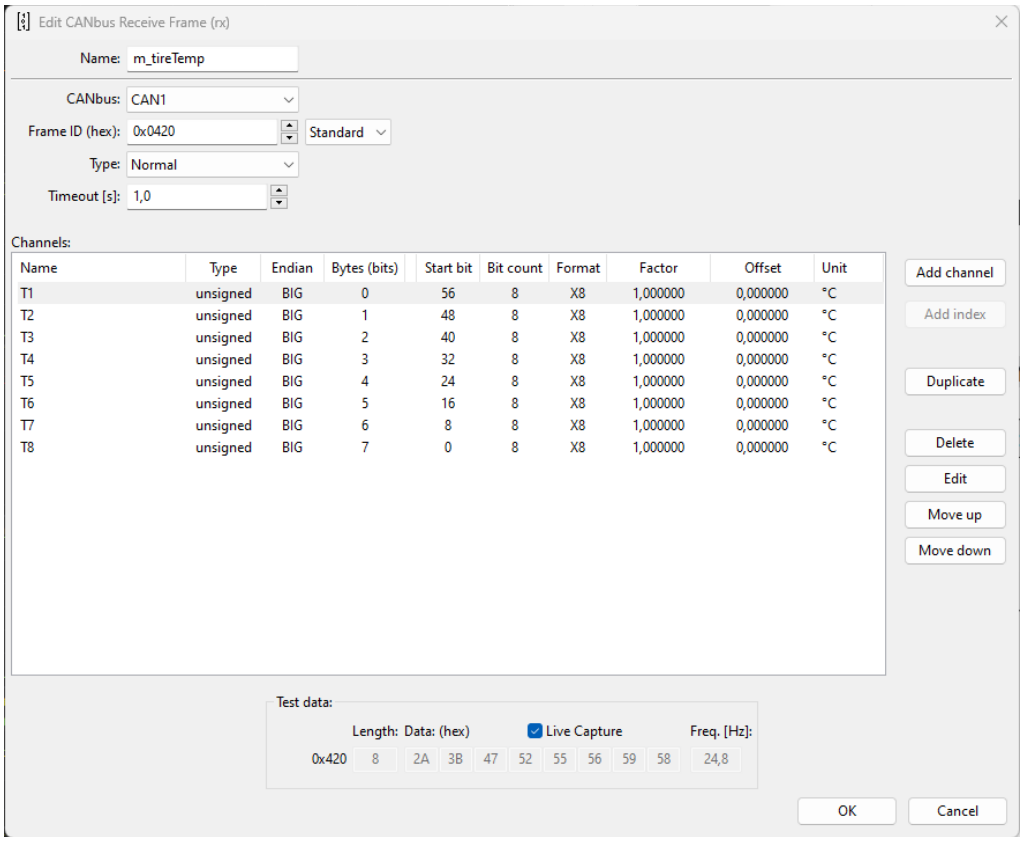


First, choose the CAN bus from which data will be received. The EMU PRO device has two CAN buses: CAN1 and CAN2. Next, select the channels to be imported. You can use the filter to select individual channels or select all using the '***Select all***' button.
The following warnings may appear when importing a *.DBC* file:

- about units not defined in the EMU PRO;
- about channels already existing under a particular name.

After confirming with the OK button, the selected channels will be added to the ***Project Tree***. In addition, one or more ***CANbus Receive Frame*** responsible for receiving frame groups will be created.

CANbus Receive Frame (rx)



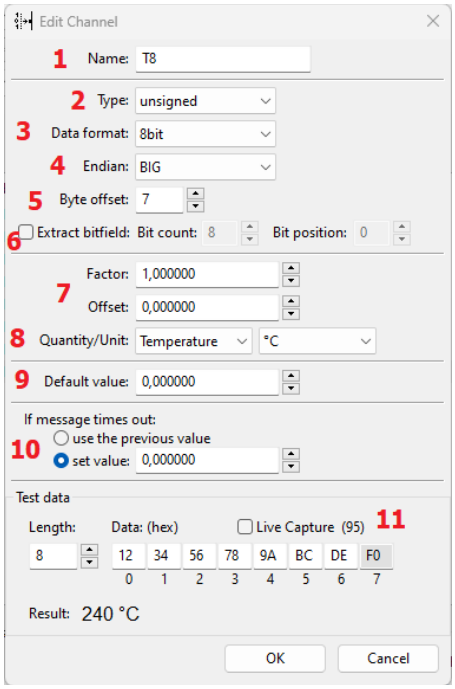
In the EMU PRO device, you can create your own CAN streams. The configuration begins with the creation of a ***CANbus Receive Frame (rx)*** element in the ***Project tree***. After choosing a CAN bus you should select a ***Frame ID*** and the ***Type*** *(Normal or Compound)* of received frames. If the device is connected, a preview of the stream in real-time (***Live Capture***) will be displayed. It facilitates diagnostics and speeds up work.

IMPORTANT!

For ***Live Capture*** preview to work properly, active logging is required - logging cannot remain in pause mode!

IMPORTANT!

Frame CAN IDs in the EMU PRO Client are always presented in hexadecimal notation (they usually begin with the *0x* prefix, which is a symbol of the hexadecimal notation).



In the next step, you can start adding and defining channels

To create a new channel, choose a unique name (1) so that it can be identified.

The next step is setting the ***Byte offset*** parameter (5). It marks the location of the values in the CAN frame (0– 7).

You should select:

the ***Type*** of the number (2):

- ***Signed*** – a number with a sign (it can receive positive and negative values, as well as zero). An example of such a value is the value from the coolant temperature sensor.
- ***Unsigned*** – positive numbers or zero. For example engine speed (RPM).
- ***Float*** – a number using IEE 754 notation (32-bit floating point number)

the ***Data format*** (3):

- **8 bit** / **16 bit** / **32 bits**– number width in bits; 1 byte, 2 bytes, or 4 bytes, respectively
  - signed 8 bit – range of numbers -128–127
  - unsigned 8 bit- – range of numbers 0–255
  - signed 16 bit – range of numbers -32768–32767
  - unsigned 16 bit – range of numbers 0– 65535
  - signed 32 bit - range of numbers $(-2^{31}) – (2^{31}-1)$
  - unsigned 32 bit - range of numbers $0 – (2^{32}-1)$
- The ***Custom*** data format allows the exact width and position (expressed in bits count) of the information stored in the CAN frame to be determined. The information can occupy a maximum of 32 bits, but these can be taken from up to 5 bytes. The bit numbering is compatible with Kvaser Database Editor 2.

the ***Endian*** (4):

- ***BIG / little*** – the “sequence” of bytes for 16bit, 32bit, and custom “Data format”. It shows how a number stored in consecutive bytes shall be interpreted. E.g. numbers 0x12, 0x34 can be interpreted as 0x1234 for the ***big endian*** or 0x3412 for the ***little endian*.**

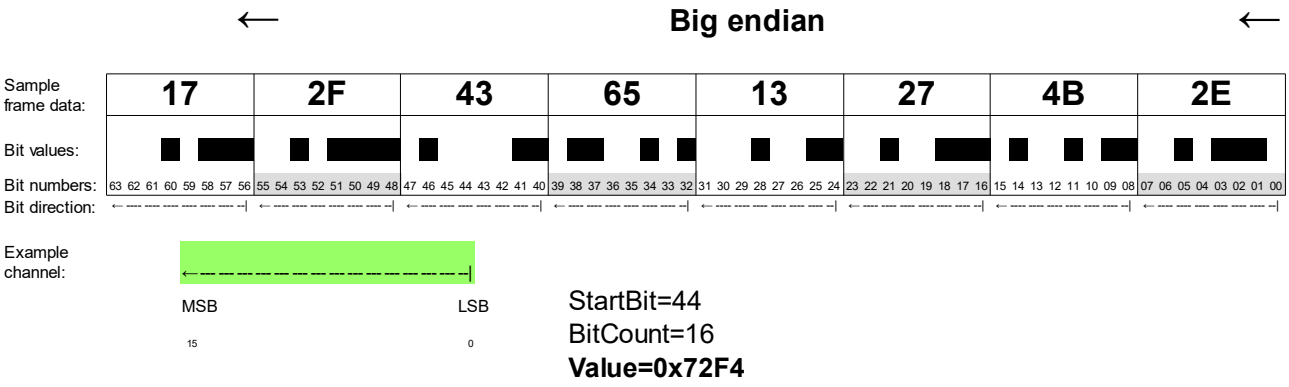
You can also define “***Extract bitfield***” (6) (for Data format 8bit, 16bit, and 32bit) to take only a part of an 8- or 16- or 32-bit number.

The ***Bit count*** parameter determines how many consecutive bits (1-32 bits) of information are present.

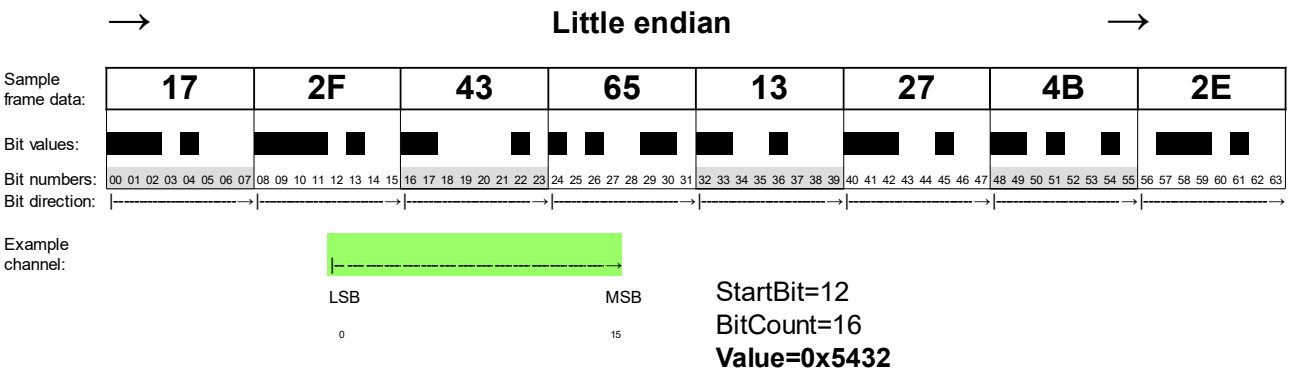
The ***Start bit*** parameter specifies the bit number at which the information in the CAN frame starts.

For example, to check the setting of a bit of a 0x80 mask the following settings should be used: Bit count: 1, Bit position: 7.

Example for Endian *BIG*, for Data format *custom*:



Example for Endian *little*, for Data format *custom*:



The next step is to scale / offset the raw value to the physical value (7).
The “raw” value interpreted using the Format (3) fields can be scaled.
For example, Lambda in the Lambda To CAN stream is saved as the 16-bit value in range 0..65535, where:
- raw value 0 means Lambda = 0.0,
- raw value 1000 means Lambda = 1.0,
- raw value 2000 means Lambda = 2.0,

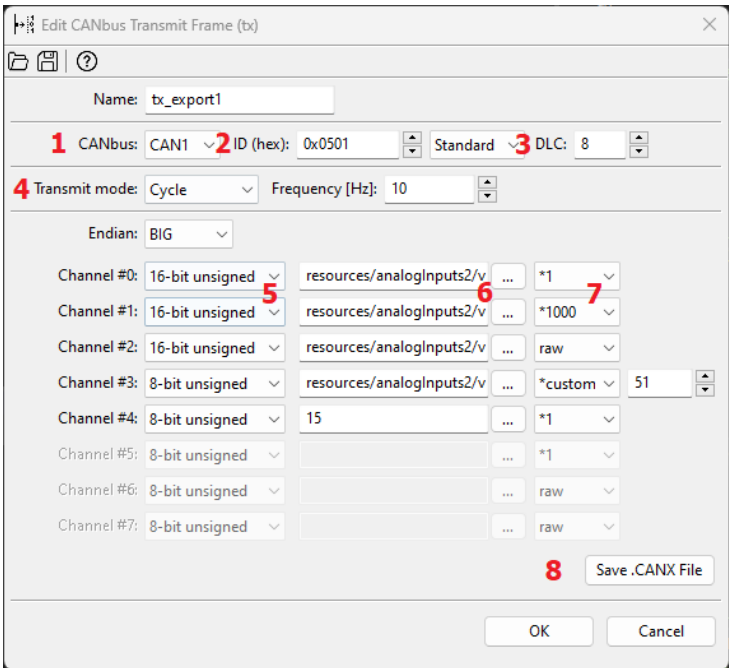
This value should be scaled. The following settings can be used: **Factor**=0,001, ***Offset***=0. This way, you will add the end value of 0.850 for the raw value of 850.
Selection of a physical value and the unit (8). Typical SI units as well as units commonly used in the automotive industry are available. If a requested unit is not on the list, you can also use the ***User*** unit.

Once a unit has been selected, set the selection to the default value (9).
A default value is used from starting the device until receiving the first frame containing the channel. The default value is expressed as a physical (no raw) value.

Defining the behaviour in case of a loss of CAN bus frames is done in the ***If message time out*** (10) field. If a particular frame cannot be received for longer than the timeout defined in the ***CANbus Receive Frame*** configuration (***Timeout*** parameter in seconds), there are two options available:
(a) the last value (possibly the default value if a frame was never received) may remain (***Use previous value***);
(b) a specific value can be set (***Set value***).

The last element of the ***Add channel*** defining window is the ***Test data*** field. They are used only during editing. You can observe a received frame in real time (***Live capture*** on) (11) or enter test data (***Live capture*** off). In both cases, the calculated final value is displayed, which accelerates configuration.

CANbus Transmit Frame (tx)



Access to the CAN bus in the EMU PRO device is open, which allows sending any available channel of the device. Frames with any CAN ID can be transmitted on one of two CAN buses.

*The **CANbus Transmit Frame*** configuration window consists of the following sections:

CAN bus selection (1)

Select on which CAN bus the frame should be transmitted (CAN1 or CAN2)

Selecting the CAN frame ID (2)

When selecting the CAN ID frame identifier, it is important to ensure that it does not come into conflict with other communications on the network. Recommended range of identifiers for the user: 0x500–0x50F, and 0x520–57F. In this respect, ECUMASTER devices will never have their default CAN ID in the future.

IMPORTANT!
In a CAN network, it is not permitted for two devices to transmit frames with the same CAN ID.

Determination of frame length *DLC* (3)

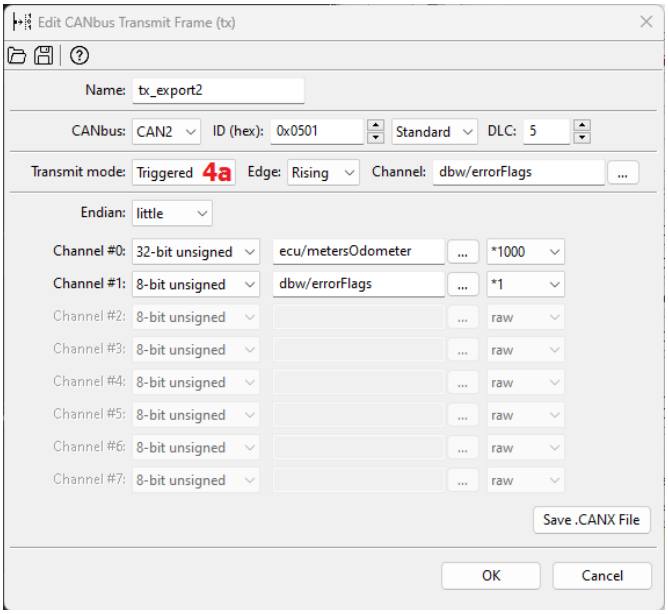
The *DLC* determines the length of a frame: from 0 to 8 bytes.

Selecting transmission type

Continuous transmission *Cycle* (4)

For continuous transmission, select a sending frequency (***Frequency***) in the range from 1 to 100 Hz (from 1 to 100 frames sent per second).

The constraint for the whole system limits the maximum of 500 frames per second possible to be sent on the CAN1 bus and 500 frames per second on the CAN2 bus.



Triggered transmission *Triggered* (4a)

With ***Triggered*** transmission, a frame is sent when the appropriate ***Edge*** appears on the selected ***Channel***: (***Rising*** or ***Falling***).

Endian selection (5)

BIG / *little* – the "sequence" of bytes for 16– or 32– bit or custom numbers. It shows how a number stored in consecutive bytes shall be interpreted. E.g. numbers 0x12, 0x34 can be interpreted as 0x234 for the ***big endian*** or 0x3412 for the ***little endian*.**

Selection of the type of data sent (6)

There are 7 options available:

- ***8bit unsigned***– the value of the channel is limited to the range of 0..255 and sent as a single byte in a frame.
- ***8bit signed*** – the value of the channel is limited to the range of -128..127 and sent as a single byte in a frame.
- ***16bit unsigned*** – the value of the channel is limited to the range of 0..(2^{16}-1) and sent as two bytes in a frame with endianness set in Endian(5) field.
- ***16bit signed*** – the value of the channel is limited to the range of (-2^{15})..(2^{15}-1) and sent as two bytes in a frame with endianness set in Endian(5) field.
- ***32bit big endian*** - the value of the channel is limited to the range of 0..(2^{32}-1) and sent as four bytes in a frame with endianness set in Endian(5) field.
- ***32bit little endian*** - the value of the channel is limited to the range of (-2^{31})..(2^{31}-1) and sent as four bytes in a frame with endianness set in Endian(5) field.

- **Custom –** the value of the channel is limited to the range defined by bits number and signness. Signness and bit count (from 1 to 32) is defined by the user.

4-byte values (***32bit***) are used, for example, to transmit the *ECU/Meters/Odometer* channel value. In order to maintain adequate accuracy of the transmitted data, the ***raw*** value may be used, which, for this example is expressed in 0.001 km (km multiplied by $\boldsymbol{10^{-3}}$).

For signals being transmitted on part of the byte or spread for 2 or more bytes

- LSB bits are occupied first (in the order that channels appear) for *little* Endian selection
- MSB bits are occupied first (in the order that channels appear) for BIG Endian selection

Selected channels or constants (7)

You should select a channel from the list or enter a constant. In addition to the decimal notation, a constant can also be saved in a hexadecimal notation - 0x prefix must be used (e.g. 0xE3 or 0xe3).

Selection of a multiplier or a raw value (8)

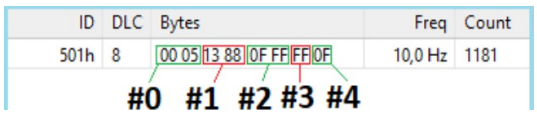
It is possible to multiply the actual value by a constant in the 1-1000 range (the fractional part is discarded) or alternatively to send the ***raw*** value.

Example:

From the drawing of the window tx_ export1:

- ***Channel #0*** – voltage value at input *Analog 2* will be sent as a number from the range: 0, 1, 2, 3, 4, 5 (in volts, but without the fractional part).
- ***Channel #1*** – voltage value at input *Analog 2* will be sent as a number from the range 0 – 5000 (in millivolts).
- ***Channel #2*** – voltage value at input *Analog 2* will be sent as a raw value from the ADC converter as a number from the range– 4095.
- ***Channel #3*** – voltage value at input *Analog 2* will be sent as a number from the range 0 – 255.
- ***Channel #4*** – a constant value will be sent– 15 in the decimal system

Below is a frame preview as seen in the ECUMASTER Light Client. At the input *Analog 2*, the voltage is exactly 5 V. Accordingly, the channels ***Channel #0*** - ***Channel #5*** present themselves as in the example below:



- ***Channel #0*** – 0x0005, i.e. 5 [V]
- ***Channel #1*** – 0x1388, i.e. 5000 [mV]
- ***Channel #2*** – 0x0FFF, i.e. 4095 [adc]
- ***Channel #3*** – value 0xFF, i.e. 255
- ***Channel #4*** – value 0x0F, i.e. 15

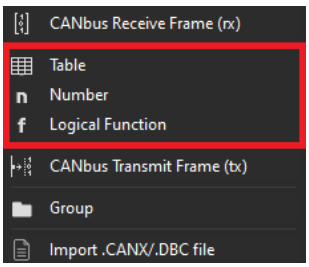
Saving to a .CANX file (9)

A configured ***Transmit Frame*** can be saved into a .CANX file using a toolbar button.

Reserved CAN IDs

ID range	Default CAN bus	CAN bus configuration possible	Configurable ID	Description
0x012-0x017	CAN1	No, only CAN1	No, ID is fixed	Communication with EMU PRO Client
0x032-0x035	CAN1	No, only CAN1	No, ID is determined	Communication with Light Client

Processing information in the project tree in the EMU PRO



The EMU PRO has 3 information processing elements:

1. ***Tables*** – lookup tables
2. ***Numbers*** – complex mathematical operations with result channel
3. ***Functions*** – complex logical operations with result channel

The above elements are processed at 500 Hz (every 2 ms).

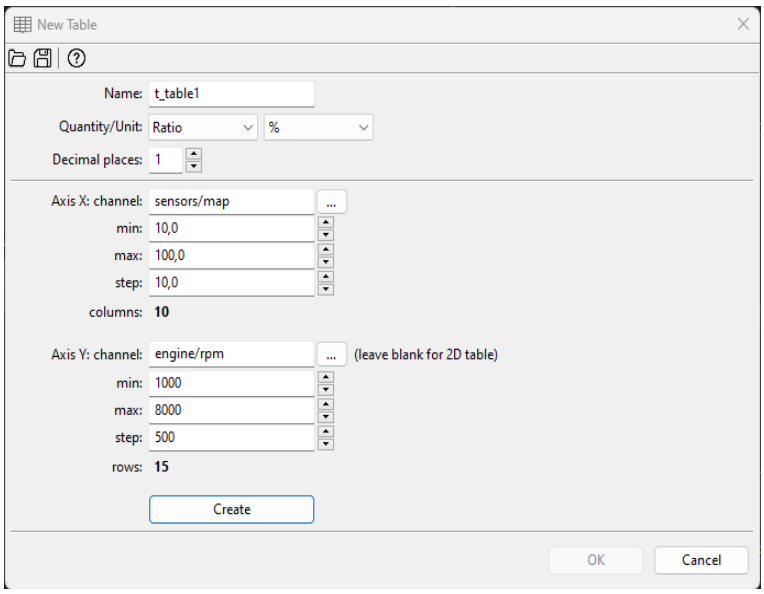
Processing elements can be put in arbitrary order. The order in which the elements are listed in the project tree is in the order in which they are processed. The type of the element does not affect the order of evaluation.

Tables

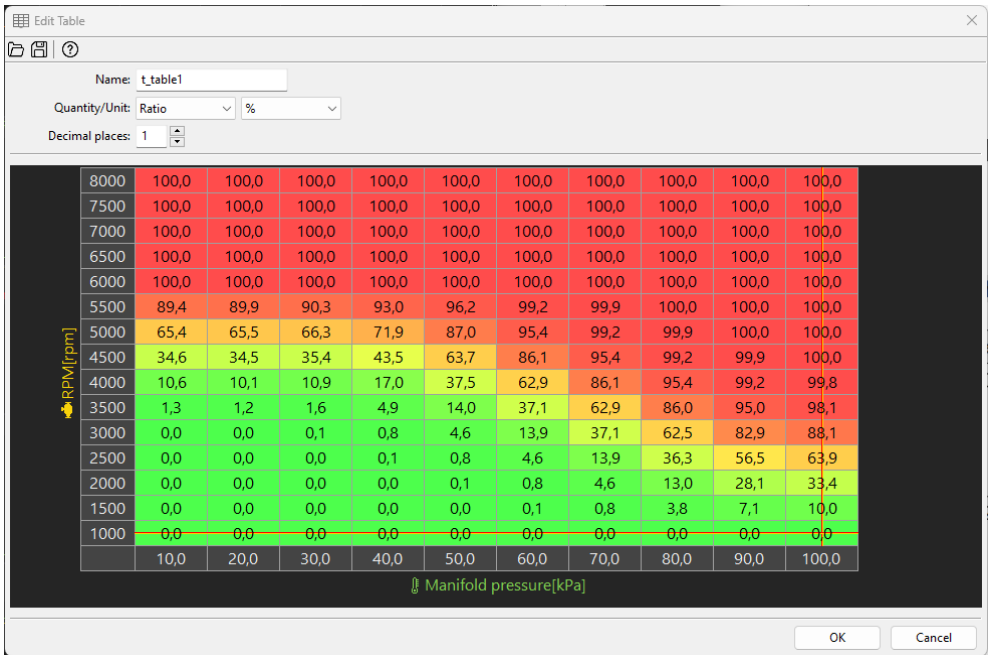
Configuration of a table starts with defining channels representing axe or axes. If a table is to be two-dimensional, leave the ***Axis Y: channel*** field empty.

You should also define the axis bins scope: ***min*** and ***max***. To change the number of elements in a table, change the ***step*** parameter which defines a step between bins on each axis.

Table size can range from 2x1 to 32x1 for 2D, or 2x2 to 32x32 for 3D.

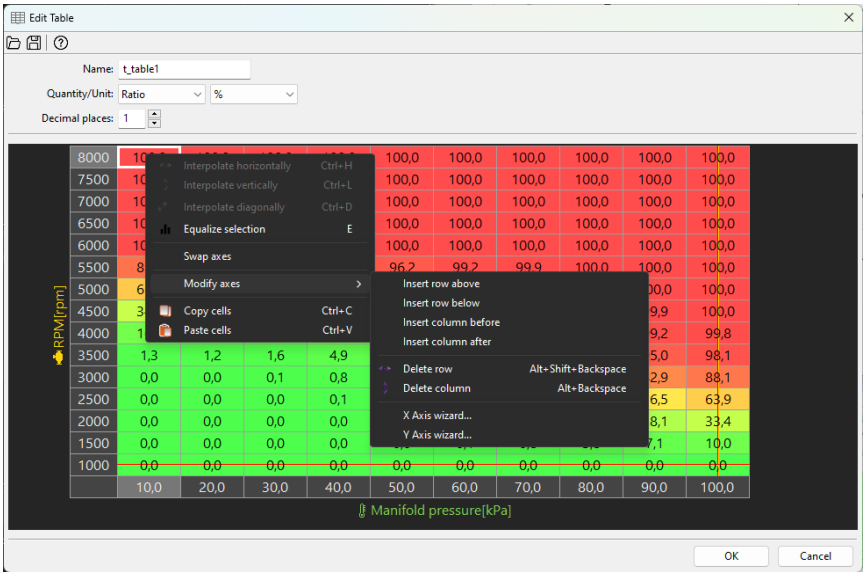


Next, fill the cells and axes with values. The bins values defined on axes are independent for each table.



You can select several cells by means of the Shift key. The Ctrl + arrow key copies to adjacent cells. You can also find the horizontal (Ctrl+H), vertical (Ctrl+L), and diagonal (Ctrl+D) interpolation commands helpful.

The size of the table (number of columns or rows) can be changed at any time using the context menu available under the right mouse button.



Description of the commands in the context menu:

Command	Key shortcut	Description
Interpolate horizontally	Ctrl+H	Horizontal interpolation: the cell values in the selection area are calculated as a linear interpolation of the cells from the left and right edges of the selection.
Interpolate vertically	Ctrl+L	Vertical interpolation: the cell values in the selection area are calculated as a linear interpolation of the cells from the top and bottom edges of the selection.
Interpolate diagonally	Ctrl+D	Interpolation between apexes. Define the 4 corner points of the selection and the rest of the cells will be counted as bilinear interpolation. The command combines two commands: first the horizontal and then vertical interpolation.
Equalize selection	E	Smooths out selected cells values
Swap axes		Swaps channels on axis x and axis y and makes transpose of the table values.
Insert row above		Inserts a row above the selected cell
Insert row below		Inserts a row below the selected cell
Insert column before		Inserting a column to the left of the selected cell
Insert column after		Inserts a column to the right of the selected cell
Delete row	Alt+Shift+Backspace	Deletes a row containing the selected cell
Delete column	Alt+Backspace	Deletes a column containing the selected cell
X Axis bins wizard		Starts the creator for the X axis bins values allowing to define of a new number of columns and generating the X axis bins according to the selected creation type
Y Axis bins wizard		Starts the creator for the Y axis bins values allowing to define of a new number of rows and generating the Y axis bins according to the selected creation type

Numbers

The *Number* allows you to create complex mathematical operations on selected values or channels with a new channel resulting from these operations. When you create a new channel, give it a relevant name (*Name*) and define the physical quantity and unit (*Quantity/Unit*) defining the created channel.

In the simplest form, the *Number* calculates the sum of the products of the selected values or channels.

value =

C1
*** C2**
*** C3**
*** …**

+

C4
*** C5**
*** ...**

+

...

where C1, C2, C3... - is the selected channel or constant value (*Channel or Constant*)

To use the selected channel or constant value for calculations, click on the formula editor and select the field with the ellipsis '***…***'. Then click the ***Add*** button (located on the right).

The Add operation window will appear, in which you select the relevant operation. When selecting the operation (***Operation:***) *Channel or constant*, enter a constant value in the ***Result:*** field or by clicking the button marked '***…***' select the relevant channel from the list.

For a faster search, you can enter the name of the channel you are looking for in the filtering field at the bottom of the ***Select Channel*** window.

After confirming with the ***OK*** button, the selected value or channel will appear in the formula field. Remember to select the relevant field (***…***) when assigning another channel, depending on whether it is multiplied (**** ...***) or added to the previously selected channel.
After marking channels in the formula editor, you can delete (*Delete*), edit (*Edit*), or move one place up (*Move up*) or down (*Move down*) in the formula.

You can also use other mathematical operations, including integer division - the *Divide* operation (*"/"*) or the remainder of the division - *Modulo* operation (***mod***).

e.g. value =
C1
* C2
/ C3

or value =
C1
mod C2
+
C3
* C4
* C5

List of operations available for mathematical channels.

FACTOR is a single multiplier (a constant or a channel) in the C1*C2*C3 notation.
RESULT is the calculated result of previous multiplications or divisions / residues.

Operation	Parameter	Pseudocode
Int constant	Result[1]	*FACTOR* = *Result*
Float constant	Result[2]	*FACTOR* = *Result*
Channel or constant	Result[3]	FACTOR = *Result*
Choose	Condition channel Result if true Result if false	if *Condition_channel* ≠ 0 then FACTOR = *Result_if_true* else FACTOR = *Result_if_false*
Divide	Value	RESULT := RESULT DIV *Value* (DIV - integer division; eg.: 9 DIV 2 = 4)
Modulo	Value	RESULT := RESULT MOD *Value* (MOD - division reminder; eg.: 9 MOD 5 = 4)
Addition	Value 1 Value 2	FACTOR = *Value_1* + *Value_2*
Subtraction	Value 1 Value 2	FACTOR = *Value_1* - *Value_2*
Min	Value 1 Value 2	if *Value_1* < *Value_2* then FACTOR = *Value_1* else FACTOR = *Value_2*
Max	Value 1 Value 2	if *Value_1* > *Value_2* then FACTOR = *Value_1* else FACTOR = *Value_2*

Clamp	Input Min Max	if *Input* < *Min* then FACTOR = *Min* else if *Input* > *Max* then FACTOR = *Max* else FACTOR = *Input*

[1] – The constant value may be in the range $[-2^{31}, +2^{31}-1]$ range

[2] – The constant value may be in the range [-2147483.000, +2147483.000] range.

[3] – The constant value for ***Chanel or constant*** operation may be in the [-16383, +16383] range

Channel value modifiers.

The value of each channel available for mathematical operations can be modified. You may multiply by 1, 10, 100 or 1000.

For the *Integer (raw) Calculation method* the fractional part is discarded after multiplication, so for this calculation method, this value modifier is necessary to not lose the fractional part of the channel value.

You may also choose to use the ***raw*** value with no modification – raw memory representation is used. For example, when it is a voltage value from an ADC converter – the value is in the range of 0-4095.

Calculation method

The result of each mathematical operation within one number is calculated as a floating point (real number representation) or integer number (decimal places of the operation are ignored).

Calculation method: Floating (real)

Calculations are done using real values. Each indirect operation within one number is done using floating point (IEEE 754) but the result is stored as the integer with decimal places (raw value is equal to real value multiplied by $10^{[\text{Decimal places}]}$)

Examples:

- 3.140 with 3 decimal places is stored as 3140
- 3.140 with 2 decimal places is stored as 314

Calculation method: Integer (raw)

Calculations are done using integers. The fractional part of each indirect operation is discarded. In order to obtain the needed accuracy of the created Channel Number, each constant value or channel used in mathematical operations of the created channel should be multiplied by the appropriate value modifier (multiplier) and then take into account the decimal places by "moving" the decimal point by the accuracy by which the individual channels/ values were multiplied. Check

Decimal places

Each mathematical channel can store raw values within the range defined in.

You can additionally define decimal places. For example, when ***Decimal places*** are set to 1, a such 16-bit channel can store real values in the [-3276.8; +3276.7] range.

For Calculation method: Floating (real):

Values of each indirect operation are calculated using the real value saved as a floating point (IEEE 754), so after obtaining any channel/previous operation value fractional part is kept.

For Calculation method: Integer (raw):

Values are calculated based on integers and then the point is “moved” by a defined number of decimal places which divides the operation's final result by $10^{[\text{Decimal places}]}$.

Indirect calculations are performed using a 32-bit range of numbers (ca. $\pm 2*10^9$). For example, calculations can be performed for the following values 1000*1000 / 123. In the end, the result is restricted (*clamp*) to the specified format range.

Example:

Calculating the average speed of left wheels

Two channels are given: *Sensors/Wheel Speed/Front left* and *Sensors/Wheel Speed/Rear left* with speed in km/h with accuracy 0.01km/h.

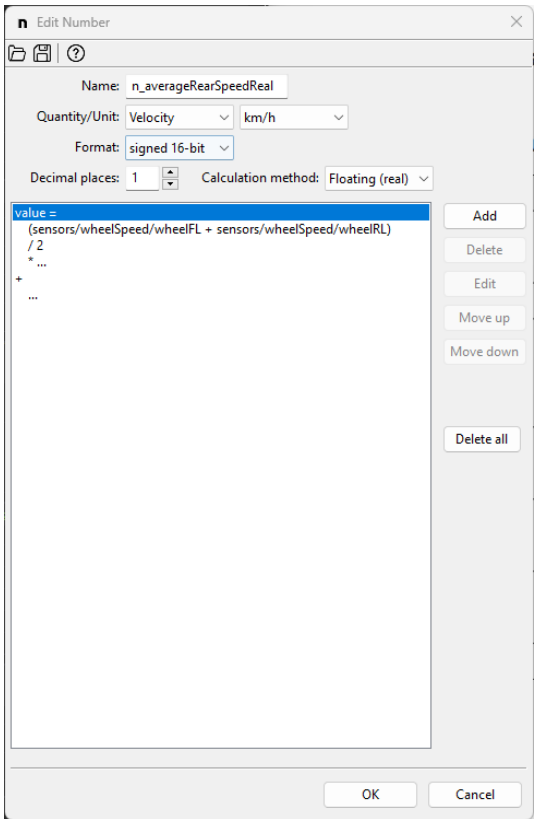
Let’s assume that we want to obtain a result accuracy of 0.1 km/h.

For Calculation method: Floating (real):

The following formula should be input:

n_averageRearSpeedReal =
(sensors/wheelSpeed/wheelFL
+c_sensors/wheelSpeed/wheelRL)/2

The Decimal places should be set to 1.

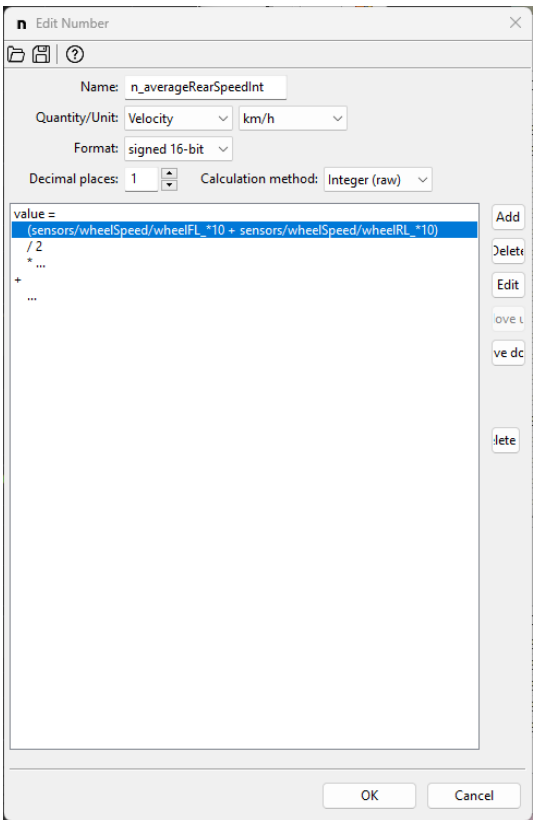


For Calculation method: Integer (raw)

The following formula should be input:

n_averageRearSpeedInt=
(c_sensors/wheelSpeed/wheelFL*10
+c_sensors/wheelSpeed/wheelRL*10)/2

The decimal point should be moved by 1 place to the left. The "*/*" operation means integer division.



If you need to apply more complex mathematical operations (and it is difficult or impossible to keep the order of operations in one *Number* channel), you should break the operation into several stages by using multiple *Number* channels.

e.g. n_1 = C1+C2+C3
n_2 = C4+C5+C6
n_3 = n_1*n_2

If the final result of such operations should have the appropriate accuracy, remember that this accuracy must be taken into account at each stage of the calculation (in each intermediate channel created).

Logical functions

Logical functions are used to create a set of rules and conditions depending on the channel input values. As a result of these operations, a value of 1 - true or 0 - false can be obtained.

List of operations available for logical functions.

Operations for logical functions can be divided into two groups: simple and special.

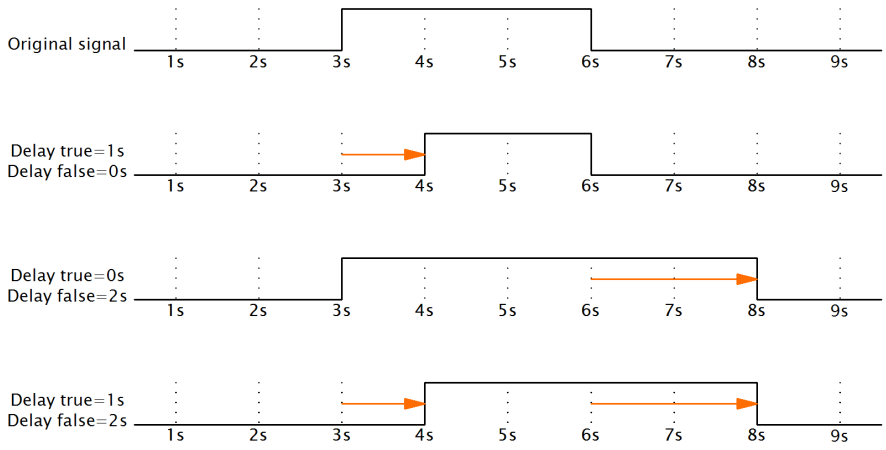
Simple operations are those whose result depends on the input state (alternatively a delay can be used for this result). Simple operations include: testing (*Is False*, *Is True*), (=, ≠, <, ≤, >, ≥) comparisons, and logic operations (*And*, *Or*, *Xor*).

IMPORTANT!

The following description contains **false** and **true** notions. **False** means a value of '**0**' (zero), and **true** means any value **other** than zero (e.g. '**1**').

Testing operations	
Is True	Returns **1** when the Channel value is **true** (non-zero); **0** otherwise.
Is False	Returns **1** when the Channel value is **false** (zero); **0** otherwise. (In electronics a NOT gate is analogous to this operation.)
Comparing operations	
Equal	Returns **1** when the Channel value **=** Constant; returns **0** otherwise.
Not Equal	Returns **1** when the Channel value **≠** Constant; returns **0** otherwise.
Less	Returns **1** when the Channel value **<**Constant; returns **0** otherwise.
Less or Equal	Returns **1** when the Channel value **≤** Constant; returns **0** otherwise.
Greater	Returns **1** when the Channel value **>** Constant; returns **0** otherwise.
Greater or Equal	Returns **1** when the Channel value **≥** Constant; returns **0** otherwise.
Logic operations	
And	Returns **1** when the values of both Channel #1 and Channel #2 are **true** (non-zero); returns **0** otherwise.
Or	Returns **1** when at least one of the channels, i.e. Channel #1 or Channel #2 is **true** (non-zero), returns **0** otherwise.
Xor	(Exclusive Or) Returns **1** only when exactly one of the channels Channel #1 or Channel #2, has a value of **true** (non-zero), returns **0** otherwise.

All simple operations allow to delay of the switching on (***Delay true***) and the switching off (***Delay false***). The figure below shows the original signal and the following figures show how the ***Delay true*** and ***Delay false*** parameters modify with this signal.



The bulb goes on following pressing the button and remains on for another 120 s after releasing it.

This functionality can be achieved by means of the *Is True* operation with the parameter Delay false = 120 s.

Special operations

<table>
<tr><th colspan="2">Signal generating</th></tr>
<tr><td>Flash</td><td>This operation generates impulses so long as the Channel is true (non-zero).
When the Channel value assumes false (zero), the operation returns the value 0.
When a high state appears on the Channel channel (non-zero value), the Flash operation starts cycling between the value of 1 (duration defined by Time on) and the value 0 (duration defined by Time off). When the Channel value is false (zero), the operation will immediately start returning 0, thus interrupting the cycle.</td></tr>
<tr><td>Pulse</td><td>This operation generates N impulses following the appearance of a trigger edge.
When the selected edge appears (Rising or Falling) on the Channel impulse generation will start. Each impulse has an active phase (then the operation returns 1) and a non-active phase (the operation returns 0).
The number of impulses is determined by the Count parameter.
The length of each pulse high state is determined by the Time on parameter.
The length of the low state between the following pulses is determined by the Time off parameter.
The Retrigger parameter determines if the appearance of a trigger edge during impulse generation will cause the process to restart or if it will be ignored.</td></tr>
<tr><th colspan="2">State-storing operations</th></tr>
<tr><td>Set-Reset Latch</td><td>The operation sets a new or returns the previous one according to the settings of the two input channels: Set Channel and Reset Channel.
<table>
<tr><th>Set channel value</th><th>Reset channel value</th><th>Operation value</th></tr>
<tr><td>true (non-zero)</td><td>false (0)</td><td>1</td></tr>
<tr><td>false (0)</td><td>true (non-zero)</td><td>0</td></tr>
<tr><td>true (non-zero)</td><td>true (non-zero)</td><td>0</td></tr>
<tr><td>false (0)</td><td>false (0)</td><td>previous value</td></tr>
</table>
An analogous operation is performed in the electronic SR latch. SR latch):
https://en.wikipedia.org/wiki/Flip-flop_(electronics)
The initial value of this operation following starting of the device can be defined using the Default State parameter.</td></tr>
<tr><td>Toggle</td><td>Toggle changes the state between 0 and 1 each time the selected Edge (Rising or Falling) appears on the Channel.
The Set channel allows setting the value to 1, and Reset channel resets the value to 0. The initial value of this operation following starting of the device can be defined using the Default State.</td></tr>
</table>

	<table><tr><th>***Toggle channel***</th><th>***Set channel*** value</th><th>***Reset channel*** value</th><th>Operation value</th></tr><tr><td>Rising</td><td>false (0)</td><td>false (0)</td><td>state change</td></tr><tr><td>Falling</td><td>false (0)</td><td>false (0)</td><td>previous state</td></tr><tr><td>x</td><td>true (non-zero)</td><td>false (0)</td><td>1</td></tr><tr><td>x</td><td>x</td><td>true (non-zero)</td><td>0</td></tr></table> x - regardless of the condition The table uses the ***Toggle*** channel with an ***Edge: Rising***.
Detecting changes	
Changed	When the value of the ***Channel*** changes by a predefined ***Threshold*****,** the operation will initiate an active state (it will return the value 1) for the number of seconds defined using the parameter ***Time on***. If, during this time, the channel value changes by the set threshold once again, the active state will be extended again by the number of seconds specified by the parameter ***Time on***. After the end of the active state, the operation will begin returning the value **0**.
Hysteresis	
Hysteresis	a) For the ***Polarity=Above*** parameter If the value of the ***Source channel*** is greater than the predefined ***Upper value threshold*****,** the value of the operation will be **1**. If it is lower than the ***Lower value threshold*****,** the value of the operation will be **0.** If it is within **[*Lower value, Upper value*]** range, the value of the operation will be the previous value. b) For the ***Polarity=Below*** parameter If the value of the ***Source*** channel is lower than the predefined ***Lower value threshold*****,** the value of the operation will be **1**. If it is greater than the ***Upper value threshold*****,** the value of the operation will be **0.** If it is within the **[*Lower value, Upper value*]** range, the previous value will be the value of the operation.

IMPORTANT!

For ***Pulse***, ***Flash***, and ***Changed*** operations setting the ***Time on*** parameter to 0 s will result in the generation of a 2 ms impulse.

Custom Limitations

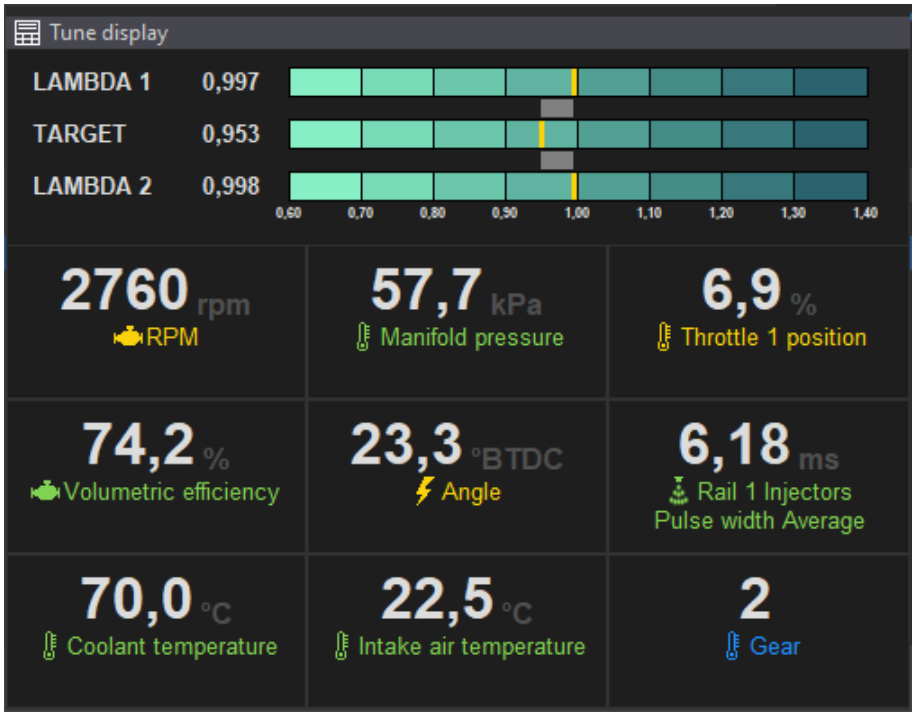
The limits are shown at the bottom right of the status bar:

- 100% of memory - memory is shared for: standard tables, user tables, logical functions, Numbers, CAN channels, and names of every custom project element (project tree elements)
- 100 of 8-bit channels
- 100 of 16-bit channels
- 20 of 32-bit channels
- 20 of CAN ID for reception

Logical functions are always 8-bit. The data type for Numbers and CANbus Receive Channels depends on selected settings. For example "Unsigned 12-bit CANbus Receive Channel" will use one 16-bit channel.

Tune Display

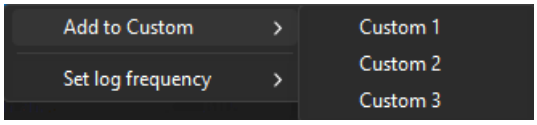
Floating window or docked panel displaying live data values received from the EMU PRO device. Data grid size and displayed channels may be configured by the user. Lambda target with companion of 1- or 2- lambda sensor readouts in graphical form is displayed on the of the window.



Text Log

The Text Log panel presents the values from the channels for a given category in the form of a table for time marked by the cursor on the graph log (when log is paused) or live data if the EMU PRO device is connected. Displays the channel name, value and unit.

Pressing the right mouse button in the panel area displays the context menu:

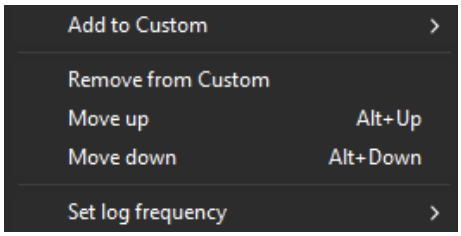


Option	Description
Add to Custom	Adding a channel to *Custom* panel
Set log frequency	Change the logging frequency

Custom

EMU PRO Client allows the user to create three separate custom logging groups. Any channel can be added to each of them (***Custom 1***, ***Custom 2***, ***Custom 3***).
To add a selected channel (from any text log panel) to the Custom group, right-click on it, then select ***Add to Custom*** and select the appropriate group (***Custom 1***, ***Custom 2*** or ***Custom 3***).

Pressing the right mouse button in the **Custom** panel area displays the context menu:



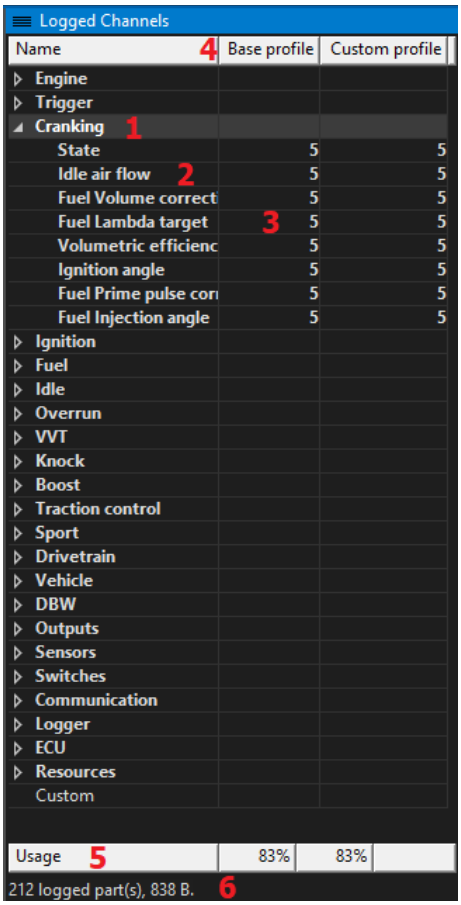
Option	Key shortcut	Description
Add to Custom		Adding a channel to another *Custom* panel
Remove from Custom		Removing a channel from the Custom panel
Move up	***Alt + Up***	Moving the selected row up
Move down	***Alt + Down***	Moving the selected row down
Set log frequency		Change the logging frequency

Variables Inspector

The ***Variable inspector*** panel is used to view values of elements channels values defined in the project tree including ***CANbus Receive Frame channels*** (variables from CAN bus), ***Tables*** (values from the tables), ***Numbers*** (mathematical function values) or ***Logical Functions*** (logical function values).

If a value is not a number but the ***?*** symbol, then the logging function for this channel is deactivated. To activate logging (or change the log frequency for a given channel) click the right mouse button on a given variable and select ***Set log frequency*** and then the desired frequency from the pop up menu. If logging is suspended on the Graph Log (*Pause*), logging should be resumed (*Resume log*).

Logged Channels



The ***Logged Channels*** panel defines the logging frequencies for particular channels. These values are expressed in Hz.

It is worth noting that the same frequencies are used for both logging to the USB storage device and for logging directly to the EMU PRO Client program (via USBtoCAN) on the PC.

In the configuration panel, we can distinguish the following elements:

- Groups (1) containing channels associated with a particular scope
- Channels (2) containing data corresponding to their names
- Channel logging frequencies (3) for Base or Custom profile (4). Custom profile is used when channel associated in Logger/Custom profile enable channel has non-zero value. This channel value change is evaluated 25 times per second.
- The bandwidth usage (5), expressed in [%] for particular Log profiles
- The bandwidth usage expressed in bytes (6).

Configuration can be carried out in the context menu or by using the shortcut keys listed below. If a given command or key is used on an entire group, the frequency will change for all channels within it. However, if they are used in a single channel, they will change the frequency of that channel only. ***Log condition values*** may be changed individually or all at once depending on the column selected.

Key:	Logging frequency:
Alt+`	Deactivation of channel / group logging
Alt+1	1 Hz
Alt+2	5 Hz
Alt+3	10 Hz
Alt+4	25 Hz
Alt+5	50 Hz
Alt+6	100 Hz
Alt+7	250 Hz
Alt+8	500 Hz

Keyboard shortcuts

Smart grid

Ctrl + Space - change parameter value to next, enable/disable passive function

Ctrl + Shift + Space - change parameter value to previous one

Enter - shows the list of possible values / edit parameter value

Custom 1, Custom 2, Custom 3

Alt + Up - move up

Alt + Down - move down

Alt + 1...8 - set logging frequency of selected channel to 1Hz...500Hz

Panels

Tab - activate next panel

Tab + Up – activate panel above

Tab + Down - add panel below

Tab + Left - activate panel on the left

Tab + Right - activate panel on the right

Tab + Shift + Up - add panel above

Tab + Shift + Down - add panel below

Tab + Shift + Left - add panel to the left

Tab + Shift + Right - add panel to the right

Shift + Tab - activate previous panel

Menu

Name	Shortcut
Desktops	
Add new panel	F9
Close panel	Ctrl+F4
Next desktop	Ctrl+Tab
Next desktop #2	Ctrl+Page Down
Open desktops template	
Previous desktop	Ctrl+Shift+Tab
Previous desktop #2	Ctrl+Page Up
Replace panel	Shift+F9
Restore desktops to default	
Revert desktops	
Save desktops template	
Select desktop 1	Ctrl+1

Select desktop 2	Ctrl+2
Select desktop 3	Ctrl+3
Select desktop 4	Ctrl+4
Select desktop 5	Ctrl+5
Select desktop 6	Ctrl+6
Select desktop 7	Ctrl+7
Select desktop 8	Ctrl+8
Select desktop 9	Ctrl+9
Store desktops	
Devices	
Device selector	
Reboot device	Ctrl+Shift+R
Browse PC connected flash drive...	
Reconnect	Ctrl+Shift+B
Restart project	F5
Set Real Time Clock	
Set device #1	Ctrl+Shift+1
Set device #2	Ctrl+Shift+2
Set device name	
Edit	
Redo	Ctrl+Y
Show undo list	
Undo	Ctrl+Z
File	
Exit	Alt+X
Make permanent	F2
Open project	Ctrl+O
Restore to defaults	
Save project	Ctrl+S
Save project as	Ctrl+Shift+S
Show full screen	Ctrl+F
Upgrade firmware	
Help	
About	
View help	
Tools	
APS tuner	
Assigned inputs	
Assigned outputs	
Customize keys	
DBW tuner	

Logged Channels	F8
Memory report	
Options	Ctrl+Shift+O
Project Tree	Shift+F7
Set meters	
Smart Grid Window	
Test outputs	
Tune Display	F7
VVT tuner	
Variables Inspector	Shift+F11
Windows	
Next window (panel)	Tab
Previous window (panel)	Shift+Tab

Table

Name	Shortcut
3D Rotate view anticlockwise	D
3D Rotate view clockwise	A
3D Rotate view downwards	S
3D Rotate view upwards	W
Copy cells	Ctrl+C
Decrease value	-0
Decrease value coarse	Shift+-
Decrease value fine	[
Delete column	Alt+Backspace
Delete row	Alt+Shift+Backspace
Equalize selection	E
Increase value	=
Increase value coarse	Shift+=
Increase value fine	]
Interpolate diagonally	Ctrl+D
Interpolate horizontally	Ctrl+H
Interpolate vertically	Ctrl+L
Move down	Down
Move left	Left
Move right	Right
Move up	Up
Paint cell down	Ctrl+Down
Paint cell left	Ctrl+Left
Paint cell right	Ctrl+Right

Paint cell up	Ctrl+Up
Paste cells	Ctrl+V
Select all cells	Ctrl+A
Select bottom-right cell	End
Select top-left cell	Home
Set default value	Delete
Toggle axis mode	X
Toggle follow cursor	F

Graph log

Name	Shortcut
Add bookmark	Ctrl+T
Axis properties	Shift+Return
Change channel	E
Change selection down	Page Down
Change selection up	Page Up
Channel properties	Return
Clear log	Ctrl+X
Create graph	C
Delete channel	Delete
Delete graph	Shift+Delete
Group selection	Ctrl+G
Insert channels	Insert
Move left	Left
Move left large step	Ctrl+Left
Move left large step with selection	Ctrl+Shift+Left
Move right	Right
Move right large step	Ctrl+Right
Move right large step with selection	Ctrl+Shift+Right
Move screen left	Shift+Left
Move screen right	Shift+Right
Move selected graph down	Alt+Page Down
Move selected graph up	Alt+Page Up
Open log append	Alt+O
Open log replace	O
Save log	S
Set cursor at end	End
Set cursor at start	Home
Set log frequency 1 Hz	Alt+1
Set log frequency 5 Hz	Alt+2

Set log frequency 10 Hz	Alt+3
Set log frequency 25 Hz	Alt+4
Set log frequency 50 Hz	Alt+5
Set log frequency 100 Hz	Alt+6
Set log frequency 250 Hz	Alt+7
Set log frequency 500 Hz	Alt+8
Set zoom 100%	Ctrl+0
Toggle autoscale	A
Toggle dots	Shift+S
Toggle log	Space
Turn logging off	Alt+`
Ungroup selection	Ctrl+U
Zoom extents	Z
Zoom in	Up
Zoom out	Down

Scope

Name	Shortcut
Fit all	X
Get data	Space
Move left	Left
Move left large step	Ctrl+Left
Move right	Right
Move right large step	Ctrl+Right
Set cursor at end	End
Set cursor at start	Home
Zoom extents	Z
Zoom in	Up
Zoom out	Down

Document history

Version:	Date:	Changes:
90.3	2023.02.24	First version
91.2	2023.03.28	Description of the EMU PRO 8/16 device selection window added Project Tree description added
96.0	2023.05.15	Description of the scalar and 4D table added