

# ECUMASTER

## EMU PRO Software Guide



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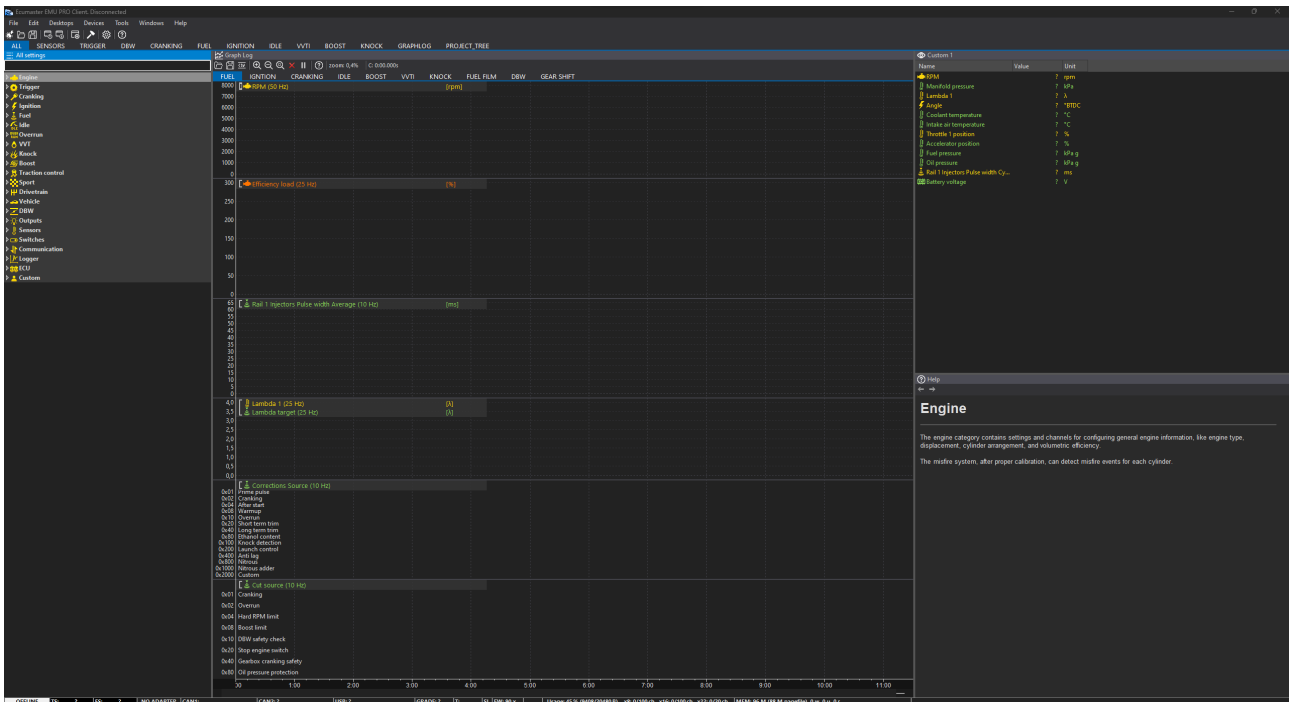
Software version 99.3

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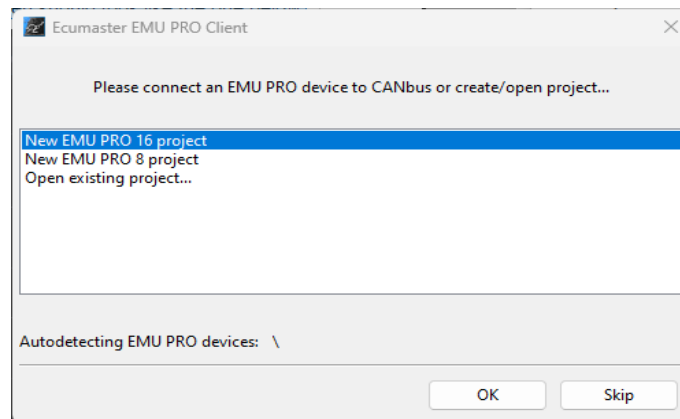
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## Appearance of the application

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
<b>File</b>	
<b>Open project...</b>	Open a project ( <b>Ctrl + O</b> )
<b>Save project</b>	Save a project in the last used location ( <b>Ctrl + S</b> )
<b>Save project as...</b>	Save a project to a new file ( <b>Ctrl + Shift + S</b> )

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

<b>Set device #n</b>	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 ( <b>Ctrl + Shift + 1 – 2</b> ).
<b>Set device name</b>	Assign a name to a connected EMU PRO device
<b>Reboot device</b>	Reset a connected device ( <b>Ctrl + Shift +R</b> )
<b>Reconnect</b>	Re-establish communication with the device ( <b>Ctrl + Shift + B</b> )
<b>Browse PC connected flash drive...</b>	Read logs from a USB storage device connected to the PC ( <b>Shift + F4</b> )
<b>Set Real Time Clock</b>	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.
<b>Restart project in the EMU PRO</b>	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. ( <b>F5</b> )
<b>Tools</b>	
<b>Test outputs</b>	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.
<b>Assigned outputs</b>	Opens window which allows user to display all EMU PRO outputs with information if given output is assigned and what is its function.
<b>Assigned inputs</b>	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.
<b>APS tuner</b>	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 <i>Main signal/ Voltage for 0% position</i> , <i>Main signal/ Voltage for 100% position</i> will be corrected, the table <i>Check signal/ Expected voltage</i> will be filled in.
<b>DBW tuner</b>	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.
<b>VVT tuner</b>	<p>Opens window with the wizard performing auto-calibration of chosen Variable Valve Timing camshaft.</p> <p>To perform an automatic calibration, following parameters must be configured by the user:</p> <p>Activation, <b>Camshafts count</b> for <b>Intake</b> and <b>Exhaust</b>, <b>Position/ Sensor input</b> and among others <b>Sensor type</b> and <b>Pullup/ pulldown</b> for each <b>Intake Camshaft</b> and <b>Exhaust Camshaft</b>, <b>Actuator/ Solenoid/ Output</b> and <b>Frequency</b>, <b>Duty cycle min</b> and <b>Duty cycle max</b> for each <b>Intake Camshaft</b> and <b>Exhaust Camshaft</b>.</p> <p>Position target separately for Exhaust and Intake must be configured separately</p>
<b>Customize keys</b>	Change the shortcut keys assignment
<b>Memory report</b>	Display a window with information on the current usage and the amount of free memory.
<b>Tune Display</b>	Display a floating window showing the selected engine parameters live. Go to the Tune Display Panel description for more details ( <b>F7</b> ).
<b>Logged channels</b>	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) ( <b>F8</b> ).
<b>Project tree</b>	Display the project management panel. Go to the <i>Project tree</i> panel description for more details. ( <b>Shift + F7</b> ).
<b>Variables inspector</b>	Display the user-defined variable monitoring panel. Go to the <i>Variables inspector</i> panel description for more details. ( <b>Shift + F11</b> ).
<b>Smart Grid Window</b>	Display the panel with all ECU settings and strategies. Go to the Smart Grid panel description for more details.
<b>Options</b>	<p>Display a dialogue window with the application options (<b>Ctrl + Shift + O</b>)</p> <p>The description of the <i>General Options window</i> is available below.</p>
<b>Windows</b>	
<b>Next panel</b>	Activate the next panel ( <b>Tab</b> )
<b>Previous panel</b>	Activate the previous panel ( <b>Shift + Tab</b> )
<b>Help</b>	
<b>View help</b>	Display the panel with help for each ECU setting. Go to the Help panel description for more details.
<b>Online ChangeLog</b>	Open an online <i>Change Log</i> document.
<b>About</b>	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
<b>Save project (Ctrl+S) without dialog</b>	With this option active, the user will not be asked to select save file name and destination
<b>3D tables color scheme</b>	Color scheme for 3D maps
<b>Auto save logs</b>	Automatic saving of logs onto the disc
<b>Use mouse wheel to zoom on Graph Log</b>	Log scaling function using the mouse wheel

## Status field

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

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

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

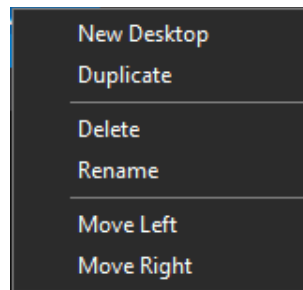
Explanation of CAN statuses of the ECUMASTER USBtoCAN adapter

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:



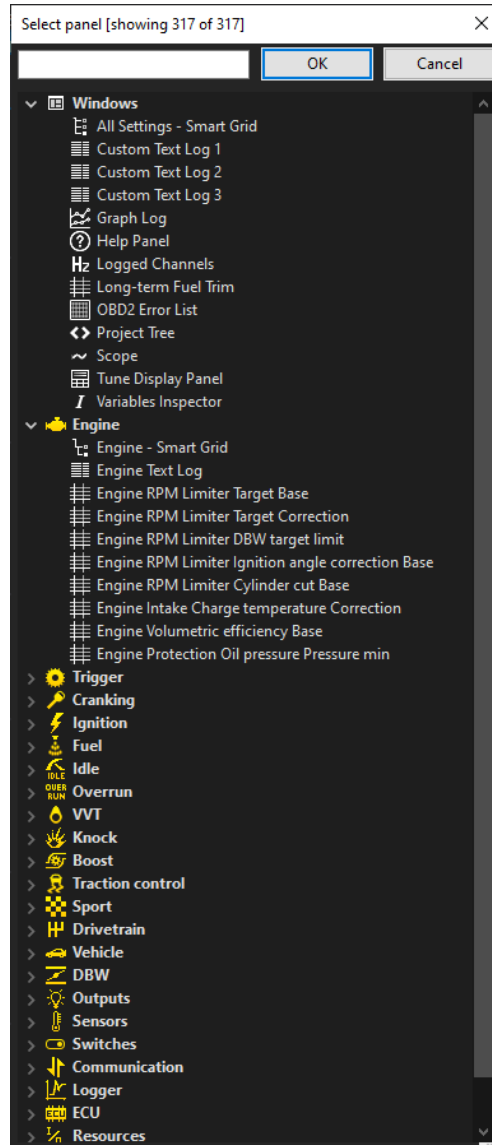
Option	Description
<b><i>New desktop</i></b>	Create a new desktop[.
<b><i>Duplicate</i></b>	Duplicate a desktop. This option creates a new desktop and copies into it the contents of a selected one
<b><i>Delete</i></b>	Delete desktop
<b><i>Rename</i></b>	This function makes it possible to change the name of a desktop
<b><i>Move Left</i></b>	Moves a desktop to the left
<b><i>Move Right</i></b>	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. Some 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
<b>Add panel above</b>	<b>Tab+Shift+Up</b>	Adding a panel above
<b>Add panel below</b>	<b>Tab+Shift+Down</b>	Adding a panel below
<b>Add panel on left</b>	<b>Tab+Shift+Left</b>	Adding a panel on the left
<b>Add panel on right</b>	<b>Tab+Shift+Right</b>	Adding a panel on the right
<b>Replace panel</b>	<b>Shift+F9</b>	Replacing a panel
<b>Close panel</b>	<b>Ctrl+F4</b>	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.

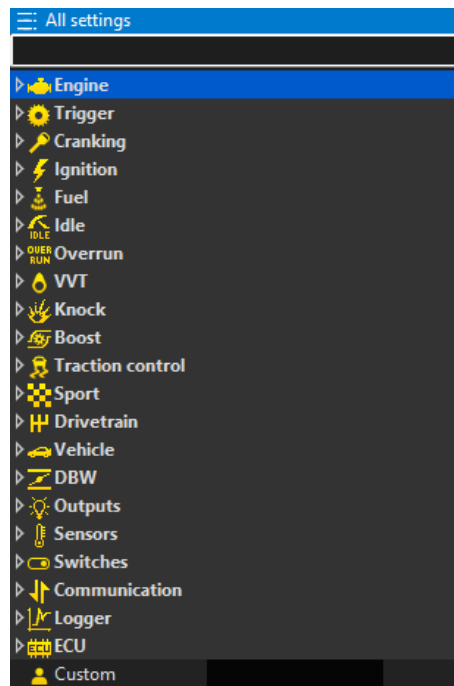
The **Project Tree** panel allows you to create your own elements such as: CAN bus Receive Frame, Table , Number, Logical Function, CAN bus Transmit Frame, Group, Import .CANX/.DBC frame.

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.

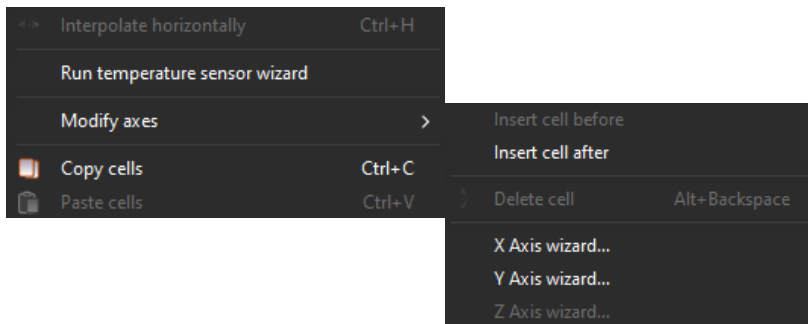
### Scalar

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).

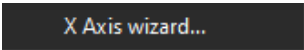


Description of the commands available in the context menu for a 2D table.

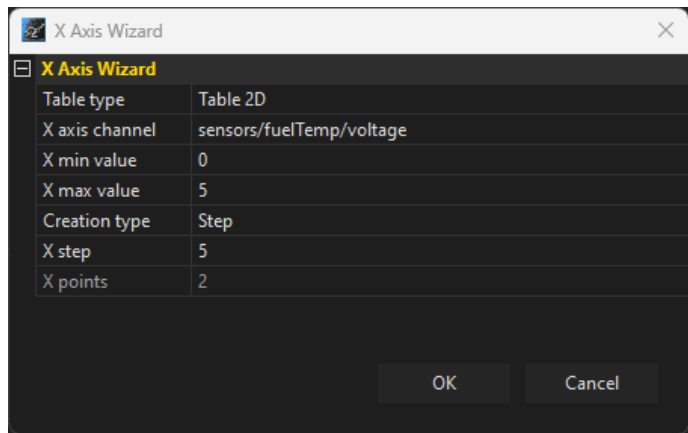
Command	Key shortcut	Description
<b><i>Interpolate horizontally</i></b>	Ctrl+H	Horizontal interpolation: cell values in the selection area are calculated as a linear interpolation of the cells from the left and right edges of the selection.
<b><i>Run temperature sensor wizard</i></b>		Automatic wizard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

<b>Copy cells</b>	Ctrl+C	Copying the value of the selected cell(s)
<b>Paste cells</b>	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.

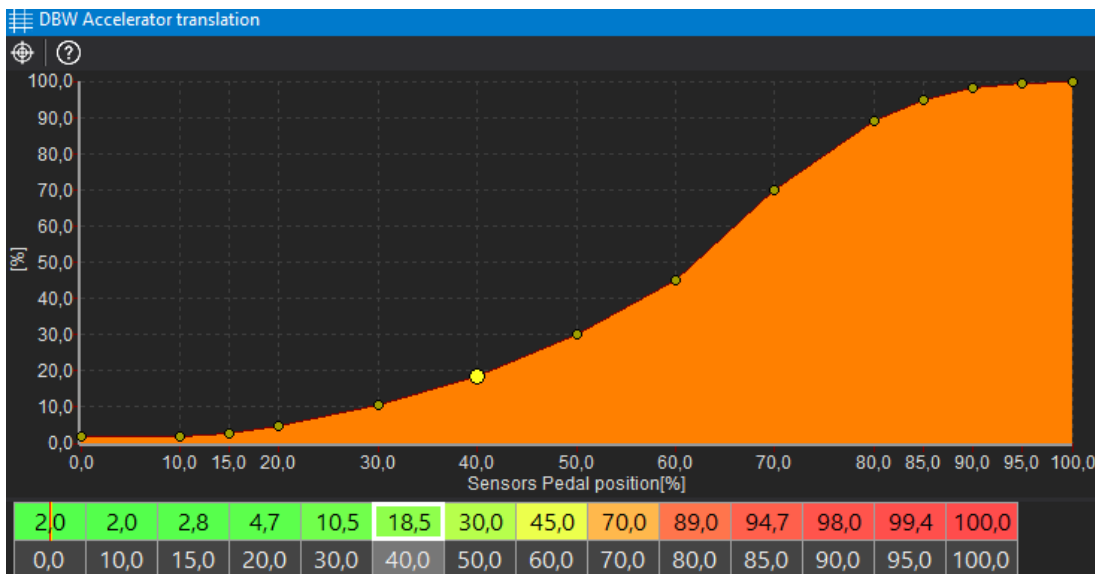


Parameter	Description
<b>Table Type</b>	Select the table type: Scalar or 2D. The x-axis parameters are only available for the 2D table.
<b>X axis channel</b>	Selecting a channel defining the X axis
<b>X min value</b>	The minimum value on the X axis, (for all arguments smaller than <i>X min value</i> , the function value is the same as for <i>X min value</i> )
<b>X max value</b>	The maximum value on the X axis, (for all arguments greater than <i>X max value</i> , the function value is the same as for <i>X max value</i> )
<b>Creation type</b>	Selecting the type of distribution of points on the X axis <b>Step</b> - the distribution of points evenly spaced from each other by a given step: <b>X step</b> <b>Linear interpolation</b> - distribution of a specified number of points ( <b>X points</b> ), evenly distributed over a specified interval (between the minimum and maximum values) <b>Exponential interpolation #1/#2</b> - distribution of a specified number of points ( <b>X points</b> ) 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 <b>#1</b> and 1.6 for <b>#2</b> .
<b>X step</b>	For distribution of points by a given step - a distance between two consecutive points
<b>X points</b>	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 using 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:

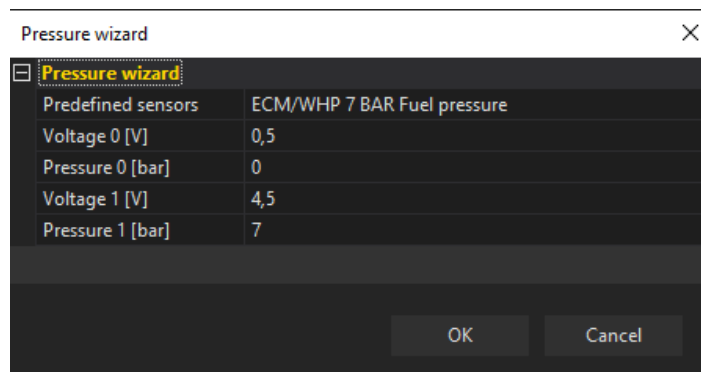
The image shows a 'Temperature sensor wizard' dialog box. It contains the following configuration parameters:

Predefined sensors	Bosch NTC M12-L 0280130039
Rx value (pullup) [Ohm]	2200
Use table best fit for a sensor	<input checked="" type="checkbox"/>
Number of X axis cells	20
Temperature point 0 [°C]	-40
Sensor R 0 [Ohm]	45313
Temperature point 1 [°C]	0
Sensor R 1 [Ohm]	5896
Temperature point 2 [°C]	100
Sensor R 2 [Ohm]	187

At the bottom of the dialog box, there are 'OK' and 'Cancel' buttons.

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

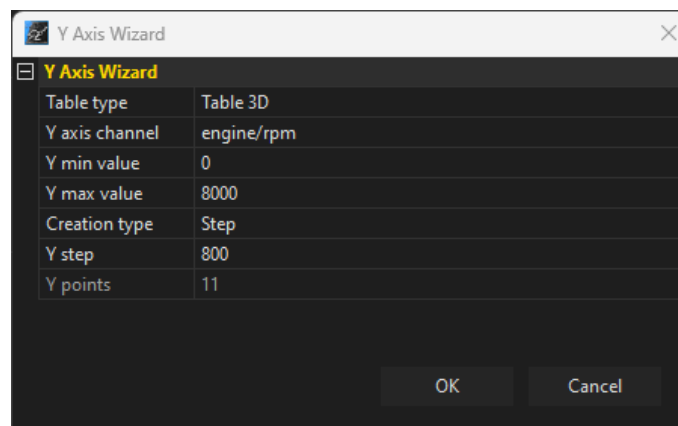
Pressure sensor configuration:



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



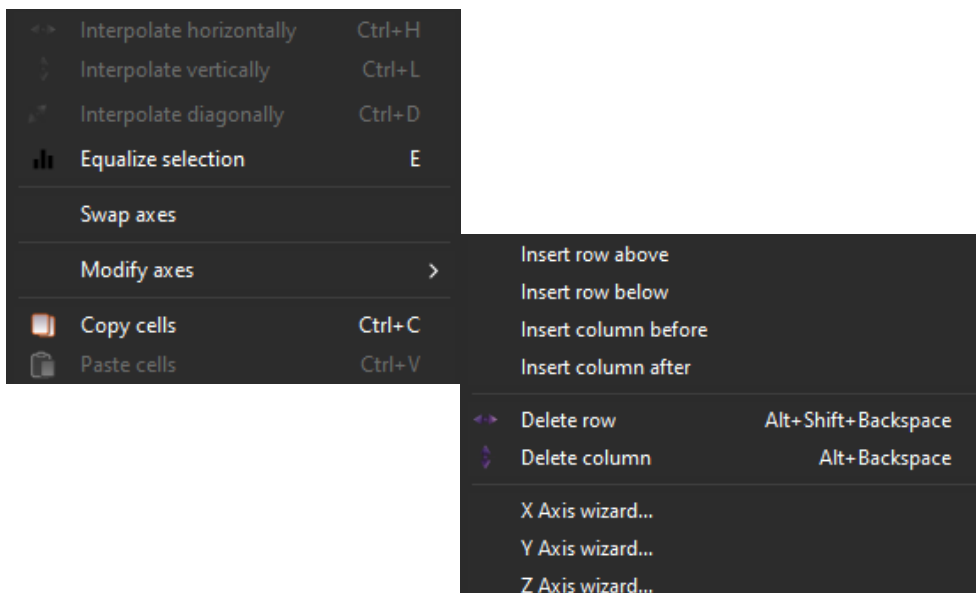


Parameter	Description
<b>Table type</b>	Select the table type: 2D or 3D. The y-axis parameters are only available for the 3D table.
<b>Y axis channel</b>	Selection of the channel defining the Y axis
<b>Y min value</b>	The minimum value on the Y axis
<b>Y max value</b>	The maximum value on the Y axis
<b>Creation type</b>	Selection of the type of distribution of points on the Y axis <b>Step</b> - the distribution of points evenly spaced from each other by a given step: <b>Y step</b> <b>Linear interpolation</b> - the distribution of a specified number of points ( <b>Y points</b> ), evenly distributed over a specified interval (between the minimum and the maximum value) <b>Exponential interpolation #1/#2</b> - distribution of a specified number of points ( <b>Y points</b> ) 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 <b>#1</b> and 1.6 for <b>#2</b> .
<b>Y step</b>	For distribution of points by a given step - a distance between two consecutive points
<b>Y points</b>	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.

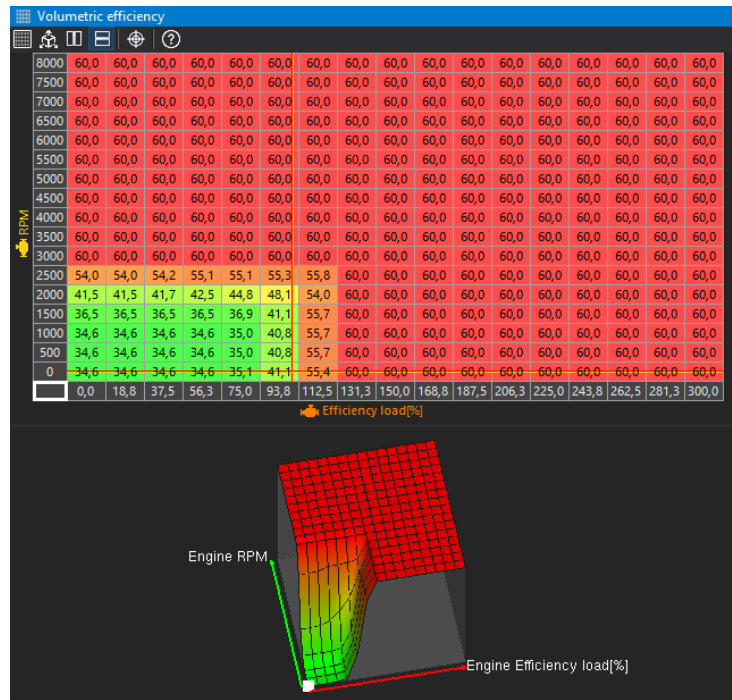


Description of the commands available in the context menu for the 3D table:

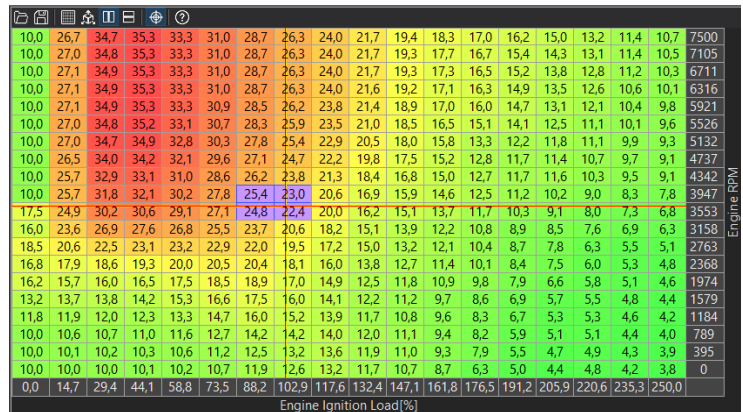
<b>Command</b>	<b>Key shortcut</b>	<b>Description</b>
<b><i>Interpolate horizontally</i></b>	Ctrl+H	Horizontal interpolation: the cell values in the selection area are calculated as a linear interpolation of the cells from the left and right edges of the selection.
<b><i>Interpolate vertically</i></b>	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.
<b><i>Interpolate diagonally</i></b>	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.
<b><i>Equalize selection</i></b>	E	Smoothing of the selected cells
<b><i>Swap axes</i></b>		Replacement of axes
<b><i>Modify axes/ Insert row above</i></b>		Inserting a row above a selected cell
<b><i>Modify axes/ Insert row below</i></b>		Inserting a row below a selected cell
<b><i>Modify axes/ Insert column before</i></b>		Insert a column to the left of the selected cell
<b><i>Modify axes/ Insert column after</i></b>		Insert a column to the right of the selected cell
<b><i>Modify axes/ Delete row</i></b>	Alt+Shift+Backspace	Delete the row containing the selected cell
<b><i>Modify axes/ Delete column</i></b>	Alt+Backspace	Delete the column containing the selected cell
<b><i>Modify axes/ X Axis wizard</i></b>		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
<b><i>Modify axes/ Y Axis wizard</i></b>		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
<b><i>Modify axes/ Z Axis wizard</i></b>		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
<b><i>Copy cells</i></b>	Ctrl+C	Copying the value of the selected cell(s)
<b><i>Paste cells</i></b>	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

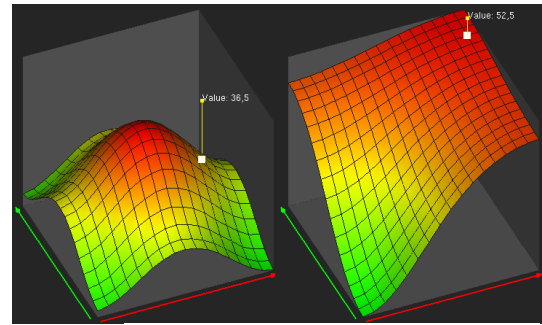
A 4D table is an expansion of a 3D table that introduces an additional dimension - the Z axis. It can be visualized as a series of 3D tables stacked together, with each table representing a distinct slice along the Z axis. The Z axis determines the quantity of these 3D tables that exist in the structure.

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

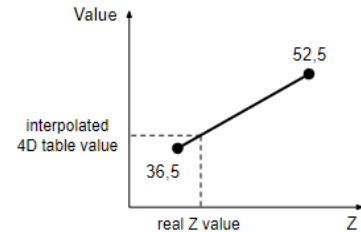
If the Z-axis channel is discrete (not continuous), such as being determined by rotary switch positions, the value is directly retrieved from the specified 3D table. In this case, there is no need for interpolation as the value is readily available in the predefined table.

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.

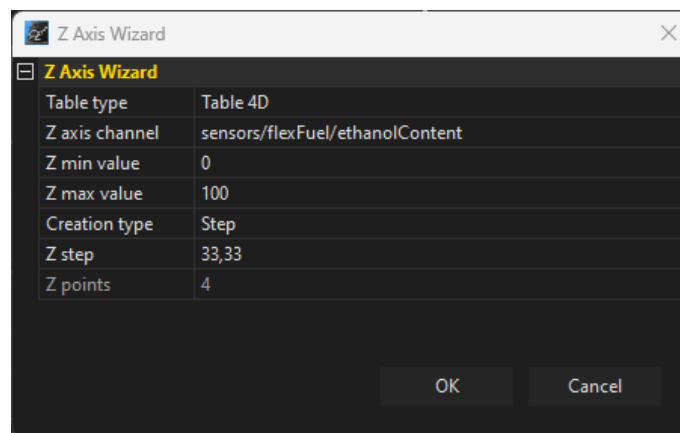
Interpolation in a 4D table involves the process of estimating values along the Z-axis by interpolating between the 3D tables. When performing interpolation in a 4D table, we consider the known values in adjacent 3D tables along the Z-axis. By analyzing the data in these neighboring tables, we can approximate 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
<b>Table type</b>	Select the table type: 3D or 4D. The z-axis parameters are only available for the 4D table.
<b>Z axis channel</b>	Selection of the channel defining the Z axis
<b>Z min value</b>	The minimum value on the Z axis
<b>Z max value</b>	The maximum value on the Z axis
<b>Creation type</b>	Selection of the type of distribution of points on the Z axis <b>Step</b> - the distribution of points evenly spaced from each other by a given step: <b>Z step</b> <b>Linear interpolation</b> - the distribution of a specified number of points ( <b>Z points</b> ), evenly distributed over a specified interval (between the minimum and the maximum value) <b>Exponential interpolation #1/#2</b> - distribution of a specified number of points ( <b>Z points</b> ) 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 <b>#1</b> and 1.6 for <b>#2</b> .
<b>Z step</b>	For distribution of points by a given step - a distance between two consecutive points
<b>Z points</b>	The number of points marked on the Z axis



## 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.



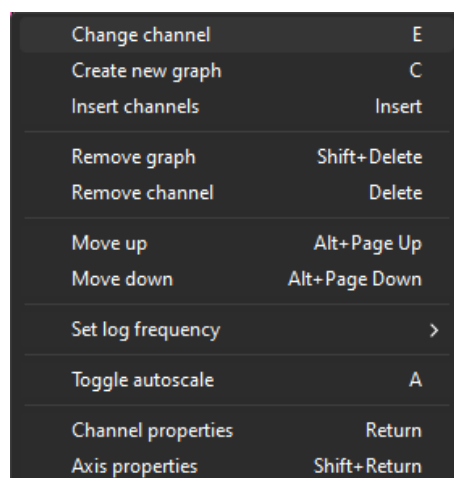
Elements of the *Graph Log* panel:

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:



Change channel	E
Create new graph	C
Insert channels	Insert
Remove graph	Shift+Delete
Remove channel	Delete
Move up	Alt+Page Up
Move down	Alt+Page Down
Set log frequency	>
Toggle autoscale	A
Channel properties	Return
Axis properties	Shift+Return



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

### Channel properties

Option	Description
<i>Log channel</i>	Name of the edited channel
<i>Graph color</i>	Select the display color of the channel
<i>Filter samples [0=off]</i>	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.
<i>Enable alarm</i>	Checking the box will activate the alarm (displayed on the application toolbar) if the condition defined in the <b>Condition</b> and <b>Alarm value</b> fields is met at the cursor position
<i>Condition</i>	Condition specifying alarm activation for values: <b>Greater</b> - greater than <b>Alarm value</b> <b>Lower</b> - smaller than <b>Alarm value</b>
<i>Alarm value</i>	Alarm value

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

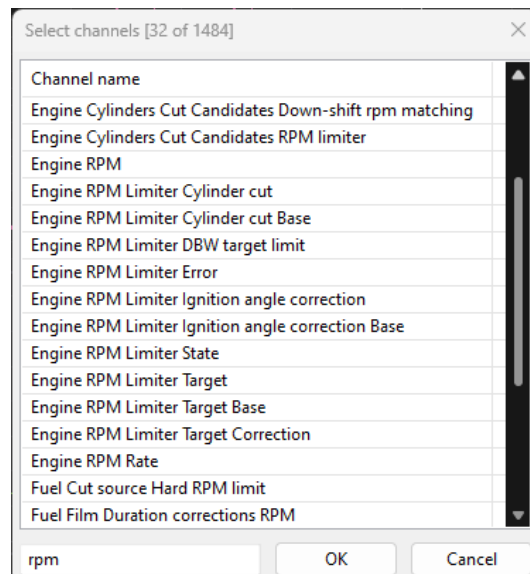
Option	Description
<i>Unit</i>	Displays information in which unit the axis is expressed
<i>Range mode</i>	<b>Autoscale</b> – This option causes the range of values to be calculated automatically based on the logged data <b>Manual</b> – the range of values is fixed
<i>Min value</i>	Minimum value of the axis (in manual mode)
<i>Max value</i>	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	<b>Ctrl +</b> ←/→	Moves the cursor forward/backward by ten units
Screen offset	<b>Shift +</b> ←/→	Moves the screen without changing the cursor position
Marking the area	<b>Ctrl + Shift +</b> ←/→	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	<b>Home</b>	Moves to the start of the log/ lap in lap comparison mode
Positioning the cursor at the end	<b>End</b>	Moves to the end of the log/ lap in lap comparison mode
Changing the active channel	<b>PageUp</b> <b>/PageDown</b>	Changes the active channel to the channel above/below
Add bookmark	<b>Ctrl+T</b>	Adding a new bookmark
Toggle line style	<b>Shift + S</b>	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.

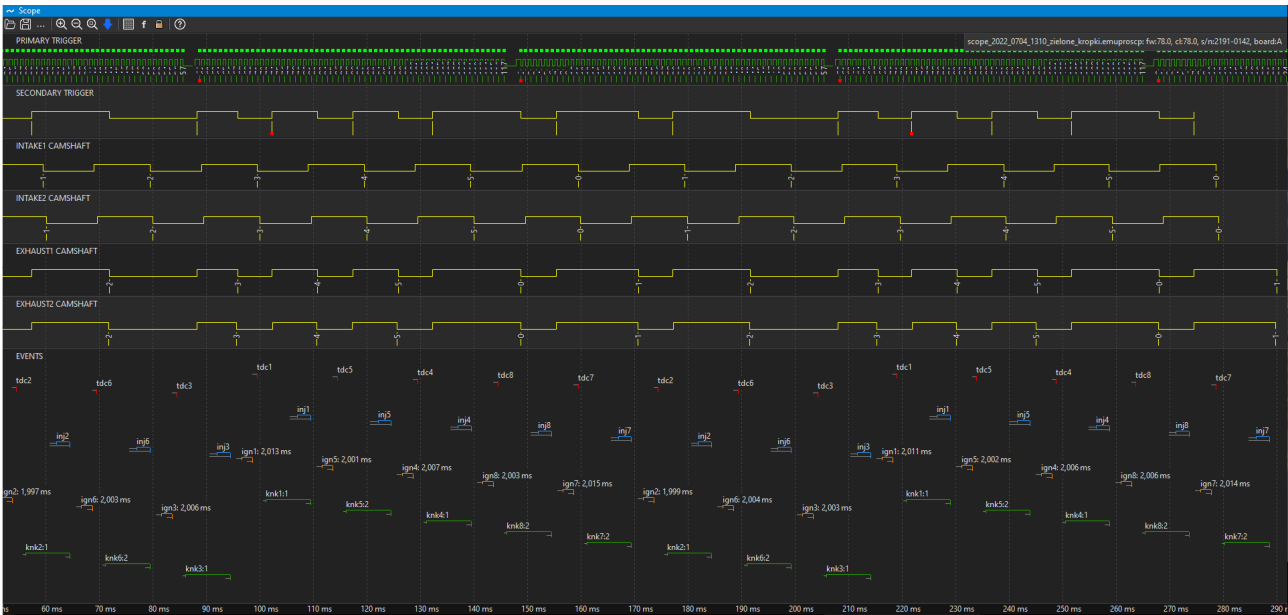


## Scope

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

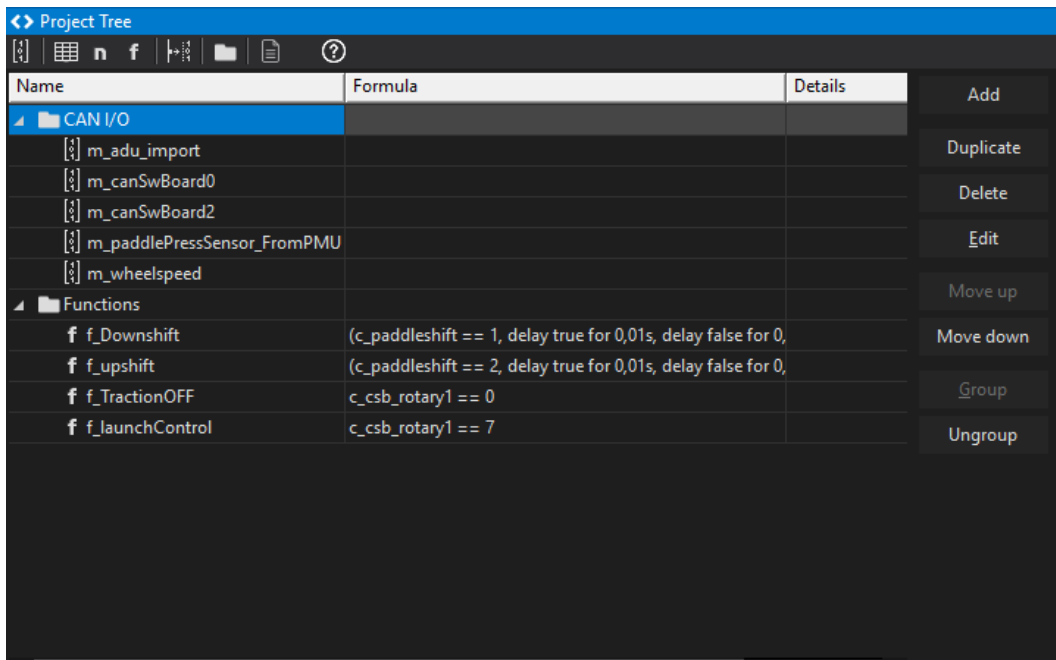
**inj#** - injection time for individual cylinders

**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:

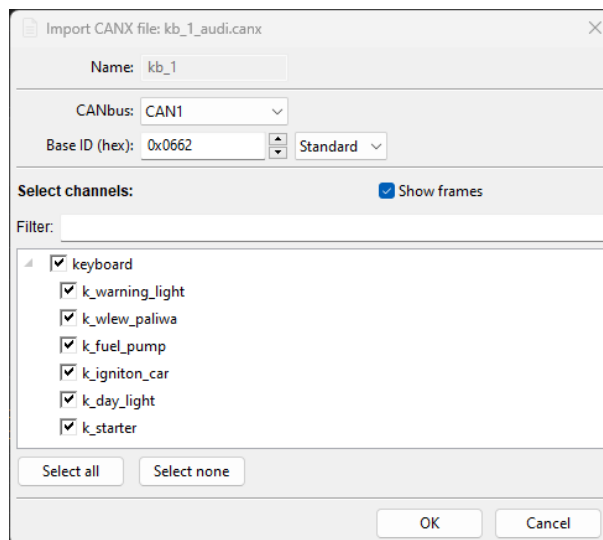
- **CANbus Receive Frame (rx)** – a CAN message frame, where an incoming CAN frame can be defined. Within each frame, data channels are defined.
- **CANbus Keyboard** – an element defining the keyboard
- **Table** – an element defining the table that can be used to transform data (e.g. transform an analog 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)

Dialog: Edit CANbus Receive Frame (rx)

Name:

CANbus:

Frame ID (hex):  Standard

Type:

Timeout [s]:

Channels:

Name	Type	Endian	Bytes (bits)	Start bit	Bit count	Format	Factor	Offset	Unit
T1	unsigned	BIG	0	56	8	X8	1,000000	0,000000	°C
T2	unsigned	BIG	1	48	8	X8	1,000000	0,000000	°C
T3	unsigned	BIG	2	40	8	X8	1,000000	0,000000	°C
T4	unsigned	BIG	3	32	8	X8	1,000000	0,000000	°C
T5	unsigned	BIG	4	24	8	X8	1,000000	0,000000	°C
T6	unsigned	BIG	5	16	8	X8	1,000000	0,000000	°C
T7	unsigned	BIG	6	8	8	X8	1,000000	0,000000	°C
T8	unsigned	BIG	7	0	8	X8	1,000000	0,000000	°C

Test data:

Length: Data: (hex)

Live Capture

Freq. [Hz]:

Buttons: Add channel, Add index, Duplicate, Delete, Edit, Move up, Move down, OK, Cancel

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!

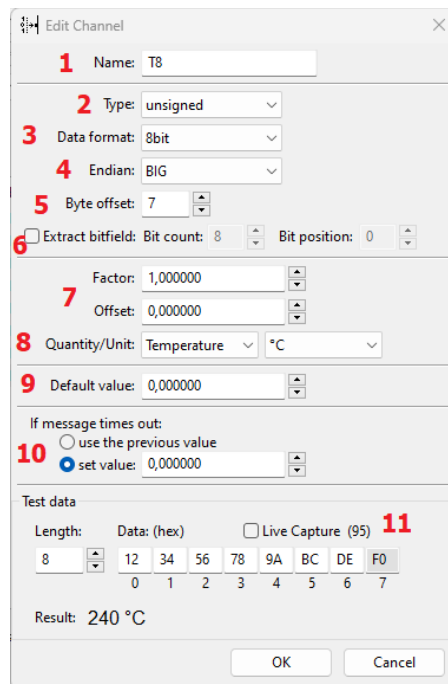


For **Live Capture** preview to work properly, active logging is required - logging cannot remain in pause mode!

### 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):

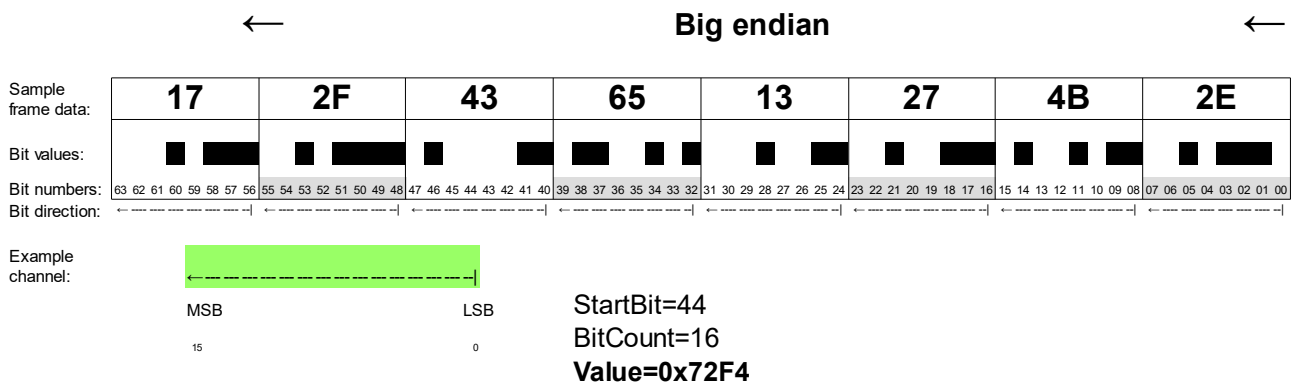
- **BIG / little** – the “sequence” of bytes for 16bit, 32bit, and custom “Data format”. It shows how a number stored in consecutive bytes shall be interpreted. E.g. numbers 0x12, 0x34 can be interpreted as 0x1234 for the **big endian** or 0x3412 for the **little endian**.

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.

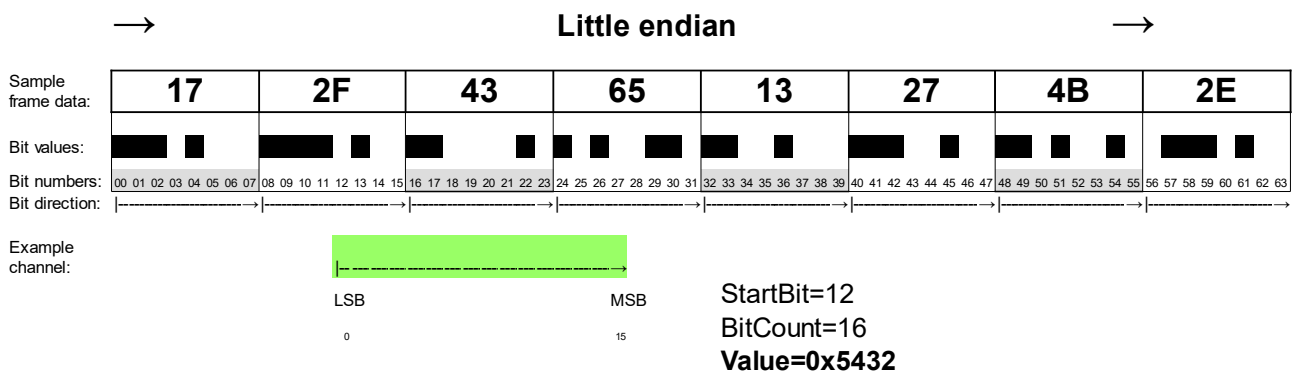
The **Bit count** parameter determines how many consecutive bits (1-32 bits) of information are present.

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)

1 CANbus: CAN1 2 ID (hex): 0x0501 Standard 3 DLC: 8

4 Transmit mode: Cycle Frequency [Hz]: 10

Endian: BIG

Channel	Data Type	Resource	Value	Multiplier
Channel #0:	16-bit unsigned	resources/analogInputs2/v	*	*1
Channel #1:	16-bit unsigned	resources/analogInputs2/v	*	*1000
Channel #2:	16-bit unsigned	resources/analogInputs2/v	raw	
Channel #3:	8-bit unsigned	resources/analogInputs2/v	*	*custom 51
Channel #4:	8-bit unsigned	15	*	*1
Channel #5:	8-bit unsigned		*	*1
Channel #6:	8-bit unsigned		raw	
Channel #7:	8-bit unsigned		raw	

8 Save .CANX File

OK Cancel

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)

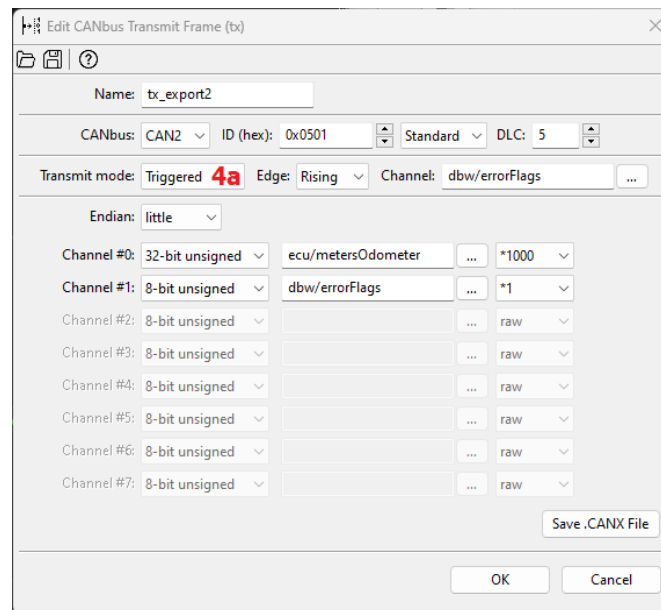
The *DLC* determines the length of a frame: from 0 to 8 bytes.

### 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<sup>16</sup>-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<sup>15</sup>)..(2<sup>15</sup>-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<sup>32</sup>-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<sup>31</sup>)..(2<sup>31</sup>-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  $10^{-3}$ ).

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:

ID	DLC	Bytes	Freq	Count
501h	8	00 05 13 88 0F FF FF 0F	10,0 Hz	1181
		<b>#0 #1 #2 #3 #4</b>		

- **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

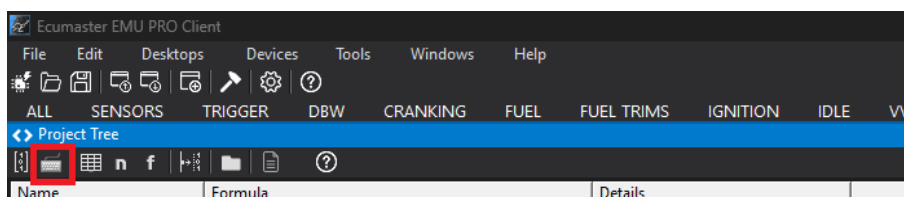
### CAN bus keypad support



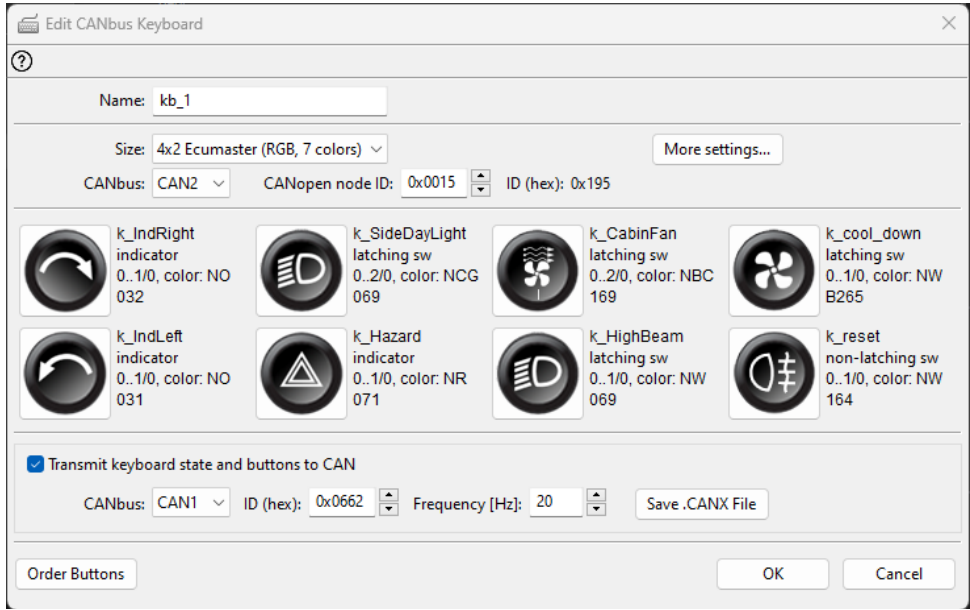
From software version 98.0, the option of connecting and operating a CAN bus keypad is available. Keyboards from Ecumaster and Grayhill are supported.

Up to two keypads can be connected to the EMU PRO device.

To configure a keyboard, click **Add** in the **Project Tree** and then select **CANbus Keyboard** from the list or click the keyboard icon in the toolbar.

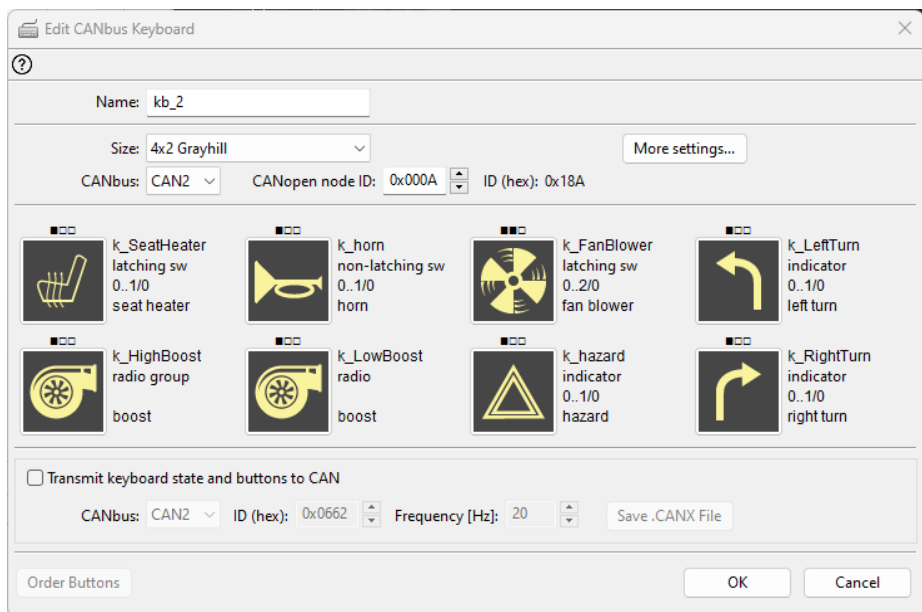


After opening the **CANbus Keyboard** window, individual parameters must be set:



- **Name** - name of the keyboard
- **Size** - size and type of keyboard to be configured.
- **CANbus** - CAN communication bus to which the keypad is connected

The default speed of Ecumaster keyboards is 500 kbps, so it is recommended to select the CAN2 communication bus, which is set to the same speed by default. The CAN1 bus can only be selected for keyboards communicating at 1 Mbps.



– **More settings**

Settings	Description
<b>Show open ceremony</b>	Opening ceremony, i.e. key highlight animation when switching on the device (only for Ecumaster keyboards)
<b>Key LED brightness</b>	Backlighting intensity of the keys (Ecumaster keyboards) or LEDs above the keys (Grayhill keyboards)
<b>Back light brightness</b>	Backlighting intensity of the entire keyboard (night backlighting)
<b>Back light color</b>	Full keyboard backlighting color (only for Ecumaster keyboards)
<b>Alternative brightness channel</b>	Channel defining alternative backlighting
<b>Alternative key LED brightness</b>	Intensity of alternative key backlighting (Ecumaster keyboards) or LED above the keys (Grayhill keyboards)
<b>Alternative back light brightness</b>	Alternative backlighting intensity of the entire keyboard (night backlighting)
<b>Alternative back light color</b>	Alternative backlighting color of the entire keyboard (only for Ecumaster keyboards)

- **CANopen node ID** - the factory setting for Ecumaster keyboards is 0x0015 (this item needs to be changed if there is a **CANopen node ID** conflict with another keyboard connected to the CAN bus).

A detailed description of **CANopen node ID** changes can be found at:

[www.ecumaster.com/files/LightClient/LightClientManual\\_1\\_0.pdf](http://www.ecumaster.com/files/LightClient/LightClientManual_1_0.pdf) in section 11.3.

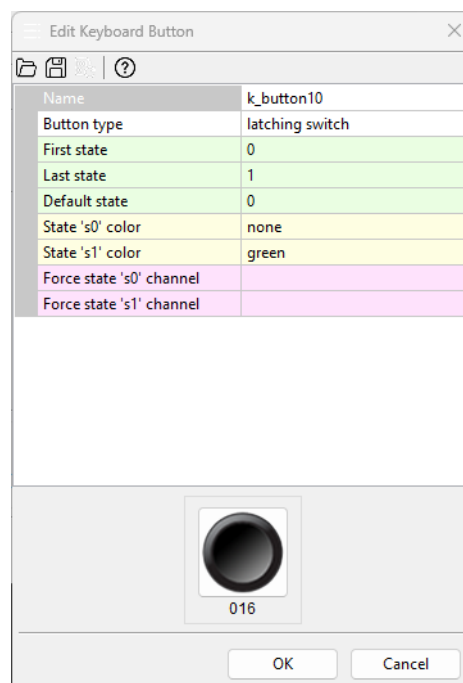
- **Export keyboard state and buttons to CAN** - allows the export of keyboard status from the keyboard to the same or another CAN bus without the need to create and configure the **CANbus export**. With this feature, the keyboard configured in the **EMU PRO** will also work on other devices, e.g. **ADU** or **PMU** modules.

For the **EMU PRO**, simply save the keyboard configuration settings to a **.CANX** file and then load the saved file (Import **.CANX** / **.DBC** file), which automatically configures the **CANbus Receive Frames** in the software.

- **Edit Keyboard Button** - edit individual keys:

Parameter	Description
<b>Name</b>	Button name
<b>Button type:</b>	Button mode of operation: - <b>non-latching switch</b> - a non-latching button in which the user-defined backlight color of the button depends on one of the two possible states of the button.

	<ul style="list-style-type: none"> <li>- <b><i>latching switch</i></b> - a latching button in which two to four stable states can be defined. The color of the key's backlighting depends on the status of the button.</li> <li>- <b><i>radiobutton group</i></b> - button to open a group of radio buttons</li> <li>- <b><i>radiobutton</i></b> - further buttons in the radio button group</li> <li>- <b><i>indicator</i></b> - a momentary pushbutton, with illumination to the specified color done by channel-assigned conditions (as opposed to a non-latching switch). Up to three different conditions can be set to change the state of illumination.</li> <li>- <b><i>indicator 3</i></b> - in Grayhill keyboards, indicator mode 3 is available in addition to indicator mode. The difference between the two is that in indicator 3 mode, the independent illumination of each diode (in each possible configuration) is triggered by the fulfilment of three individual conditions assigned by separate channels. For the <b><i>indicator</i></b> mode on <b><i>Grayhill</i></b> keyboards however, there is only one channel to assign conditions, the fulfilment of which allows the LEDs to be illuminated in up to three different states - one, two or three LEDs lit.</li> </ul>
<b><i>Default state</i></b>	Default setting for the status of the button when the keyboard is activated
<b><i>State 's#' color</i></b>	Setting the color for a button state (only for Ecumaster keyboards)
<b><i>Force state 's#' channel</i></b>	Option available in <b><i>latching switch</i></b> mode. A channel for assigning a condition the fulfilment of which forces a change in the state of the button.
<b><i>Source channel</i></b>	Option available for <b><i>indicator</i></b> mode. Source channel for assigning a condition, the fulfilment of which triggers the illumination assigned to the button state.
<b><i>Choose Button Image</i></b>	Choice of button icons



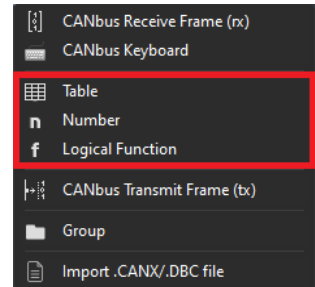
- ***Order buttons*** - prepares copy-ready information on the numbers of plastic key inserts, with selected laser-engraved icons, for order preparation.



## 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).

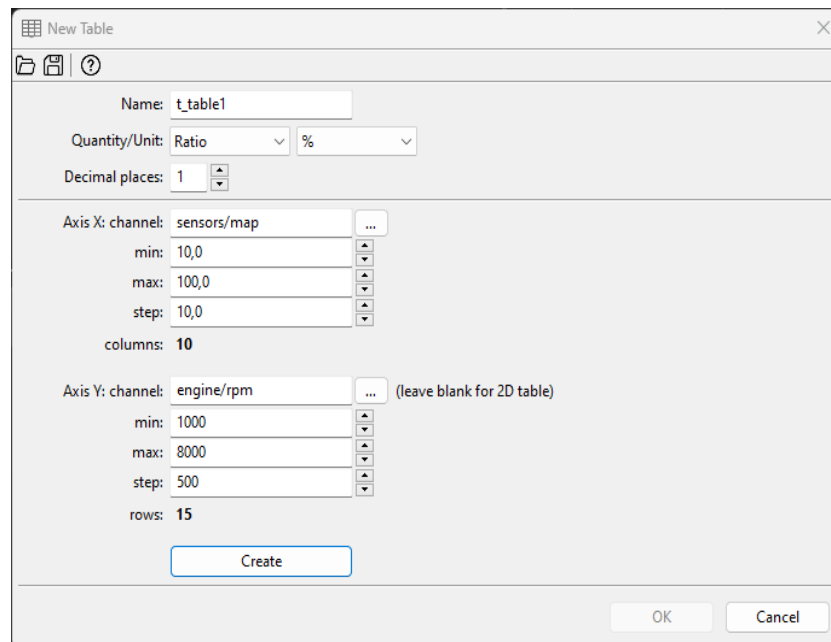
Processing elements can be put in arbitrary order. The order in which the elements are listed in the project tree is in the order in which they are processed. The type of the element does not affect the order of evaluation.

## 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.

A screenshot of the 'New Table' dialog box in the EMU PRO software. The dialog has a title bar 'New Table' and a close button. It contains the following fields and controls:

- Name: t\_table1
- Quantity/Unit: Ratio (dropdown), % (dropdown)
- Decimal places: 1 (spin box)
- Axis X: channel: sensors/map (dropdown), min: 10,0 (spin box), max: 100,0 (spin box), step: 10,0 (spin box), columns: 10
- Axis Y: channel: engine/rpm (dropdown), min: 1000 (spin box), max: 8000 (spin box), step: 500 (spin box), rows: 15
- A note next to the Axis Y channel: '(leave blank for 2D table)'
- Buttons: Create, OK, Cancel

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

The screenshot shows the 'Edit Table' window with the following data:

RPM [rpm]	10,0	20,0	30,0	40,0	50,0	60,0	70,0	80,0	90,0	100,0
8000	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
7500	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
7000	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
6500	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
6000	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
5500	89,4	89,9	90,3	93,0	96,2	99,2	99,9	100,0	100,0	100,0
5000	65,4	65,5	66,3	71,9	87,0	95,4	99,2	99,9	100,0	100,0
4500	34,6	34,5	35,4	43,5	63,7	86,1	95,4	99,2	99,9	100,0
4000	10,6	10,1	10,9	17,0	37,5	62,9	86,1	95,4	99,2	99,8
3500	1,3	1,2	1,6	4,9	14,0	37,1	62,9	86,0	95,0	98,1
3000	0,0	0,0	0,1	0,8	4,6	13,9	37,1	62,5	82,9	88,1
2500	0,0	0,0	0,0	0,1	0,8	4,6	13,9	36,3	56,5	63,9
2000	0,0	0,0	0,0	0,0	0,1	0,8	4,6	13,0	28,1	33,4
1500	0,0	0,0	0,0	0,0	0,0	0,1	0,8	3,8	7,1	10,0
1000	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

You can select several cells using 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 screenshot shows the 'Edit Table' window with a context menu open over the table. The menu options are:

- Interpolate horizontally (Ctrl+H)
- Interpolate vertically (Ctrl+L)
- Interpolate diagonally (Ctrl+D)
- Equalize selection (E)
- Swap axes
- Modify axes
- Copy cells (Ctrl+C)
- Paste cells (Ctrl+V)
- Insert row above
- Insert row below
- Insert column before
- Insert column after
- Delete row (Alt+Shift+Backspace)
- Delete column (Alt+Backspace)
- X Axis wizard...
- Y Axis wizard...

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:

<b>Command</b>	<b>Key shortcut</b>	<b>Description</b>
<b><i>Interpolate horizontally</i></b>	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.
<b><i>Interpolate vertically</i></b>	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.
<b><i>Interpolate diagonally</i></b>	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.
<b><i>Equalize selection</i></b>	E	Smooths out selected cells values
<b><i>Swap axes</i></b>		Swaps channels on axis x and axis y and makes transpose of the table values.
<b><i>Insert row above</i></b>		Inserts a row above the selected cell
<b><i>Insert row below</i></b>		Inserts a row below the selected cell
<b><i>Insert column before</i></b>		Inserting a column to the left of the selected cell
<b><i>Insert column after</i></b>		Inserts a column to the right of the selected cell
<b><i>Delete row</i></b>	Alt+Shift+Backspace	Deletes a row containing the selected cell
<b><i>Delete column</i></b>	Alt+Backspace	Deletes a column containing the selected cell
<b><i>X Axis bins wizard</i></b>		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
<b><i>Y Axis bins wizard</i></b>		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 =**

$$\begin{aligned} & \mathbf{C1} \\ & * \mathbf{C2} \\ & * \mathbf{C3} \\ & * \dots \\ + & \\ & \mathbf{C4} \\ & * \mathbf{C5} \\ & * \dots \\ + & \\ & \dots \end{aligned}$$

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

<b>Clamp</b>	Input	if $Input < Min$ then FACTOR = $Min$
	Min	else if $Input > Max$ then FACTOR = $Max$
	Max	else FACTOR = $Input$

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

<sup>2</sup> – The constant value may be in the range  $[-2147483.000, +2147483.000]$  range.

<sup>3</sup> – 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  $10^{[Decimal\ places]}$ )

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.  $\pm 2 \cdot 10^9$ ). For example, calculations can be performed for the following values  $1000 \cdot 1000 / 123$ . 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.

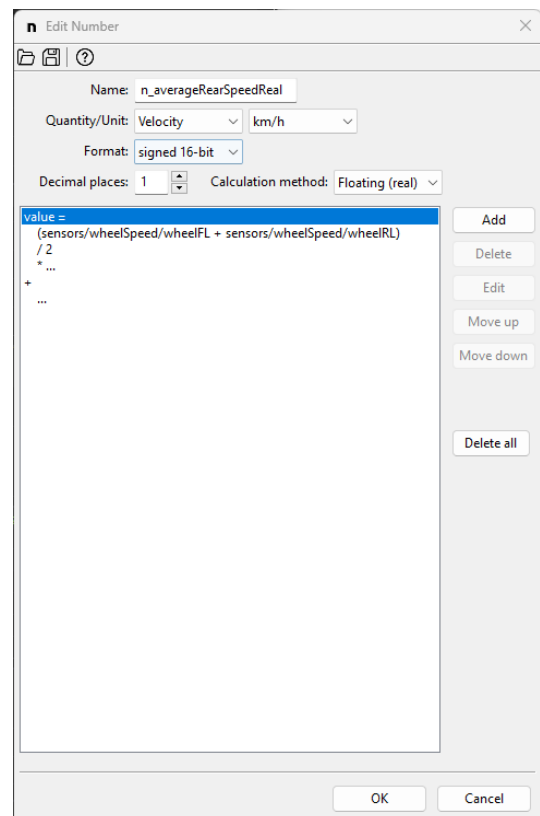
Let's assume that we want to obtain a result accuracy of 0.1 km/h.

### 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.

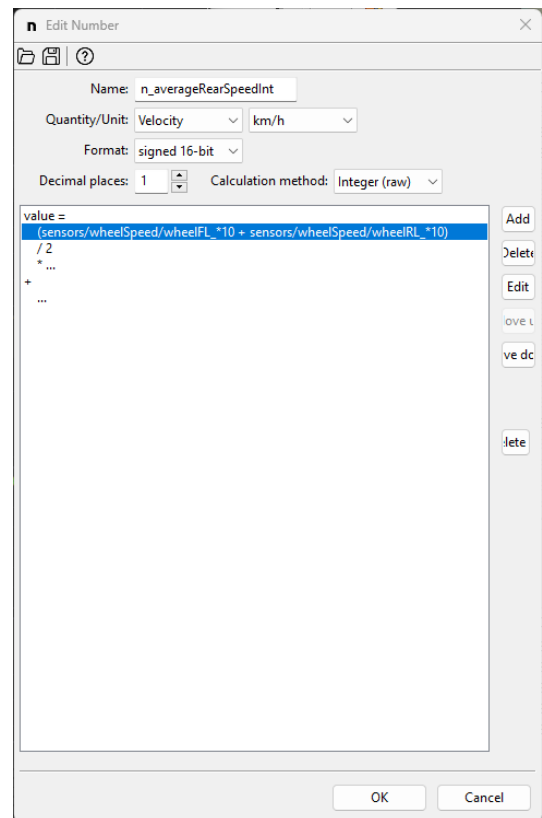


### For Calculation method: Integer (raw)

The following formula should be input:

$$\mathbf{n\_averageRearSpeedInt = (c\_sensors/wheelSpeed/wheelFL*10 + c\_sensors/wheelSpeed/wheelRL*10)/2}$$

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*), ( $=, \neq, <, \leq, >, \geq$ ) comparisons, and logic operations (*And, Or, Xor*).



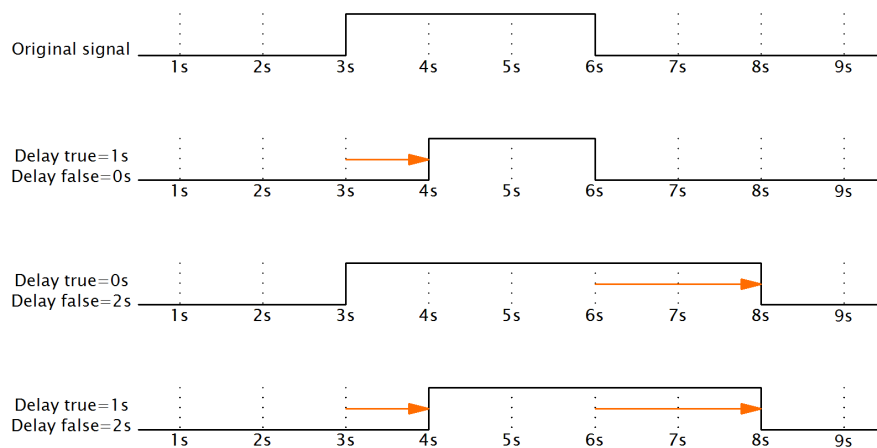
## IMPORTANT!



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	
<b>Is True</b>	Returns <b>1</b> when the Channel value is <b>true</b> (non-zero); <b>0</b> otherwise.
<b>Is False</b>	Returns <b>1</b> when the Channel value is <b>false</b> (zero); <b>0</b> otherwise. (In electronics a NOT gate is analogous to this operation.)
Comparing operations	
<b>Equal</b>	Returns <b>1</b> when the Channel value = Constant; returns <b>0</b> otherwise.
<b>Not Equal</b>	Returns <b>1</b> when the Channel value $\neq$ Constant; returns <b>0</b> otherwise.
<b>Less</b>	Returns <b>1</b> when the Channel value $<$ Constant; returns <b>0</b> otherwise.
<b>Less or Equal</b>	Returns <b>1</b> when the Channel value $\leq$ Constant; returns <b>0</b> otherwise.
<b>Greater</b>	Returns <b>1</b> when the Channel value $>$ Constant; returns <b>0</b> otherwise.
<b>Greater or Equal</b>	Returns <b>1</b> when the Channel value $\geq$ Constant; returns <b>0</b> otherwise.
Logic operations	
<b>And</b>	Returns <b>1</b> when the values of both Channel #1 and Channel #2 are <b>true</b> (non-zero); returns <b>0</b> otherwise.
<b>Or</b>	Returns <b>1</b> when at least one of the channels, i.e. Channel #1 or Channel #2 is <b>true</b> (non-zero), returns <b>0</b> otherwise.
<b>Xor</b>	(Exclusive Or) Returns <b>1</b> only when exactly one of the channels Channel #1 or Channel #2, has a value of <b>true</b> (non-zero), returns <b>0</b> 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 using the *Is True* operation with the parameter Delay false = 120 s.

### Special operations

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

<b>Toggle channel</b>	<b>Set channel</b> value	<b>Reset channel</b> value	Operation value
Rising	false (0)	false (0)	state change
Falling	false (0)	false (0)	previous state
x	true (non-zero)	false (0)	1
x	x	true (non-zero)	0

x - regardless of the condition  
The table uses the **Toggle** channel with an **Edge: Rising**.

### Detecting changes

<b>Changed</b>	When the value of the <b>Channel</b> changes by a predefined <b>Threshold</b> , the operation will initiate an active state (it will return the value 1) for the number of seconds defined using the parameter <b>Time on</b> . 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 <b>Time on</b> . After the end of the active state, the operation will begin returning the value 0.
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### Hysteresis

<b>Hysteresis</b>	<p>a) For the <b>Polarity=Above</b> parameter If the value of the <b>Source channel</b> is greater than the predefined <b>Upper value threshold</b>, the value of the operation will be 1. If it is lower than the <b>Lower value threshold</b>, the value of the operation will be 0. If it is within [<b>Lower value, Upper value</b>] range, the value of the operation will be the previous value.</p> <p>b) For the <b>Polarity=Below</b> parameter If the value of the <b>Source</b> channel is lower than the predefined <b>Lower value threshold</b>, the value of the operation will be 1. If it is greater than the <b>Upper value threshold</b>, the value of the operation will be 0. If it is within the [<b>Lower value, Upper value</b>] range, the previous value will be the value of the operation.</p>
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## 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 Elements Limitations

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

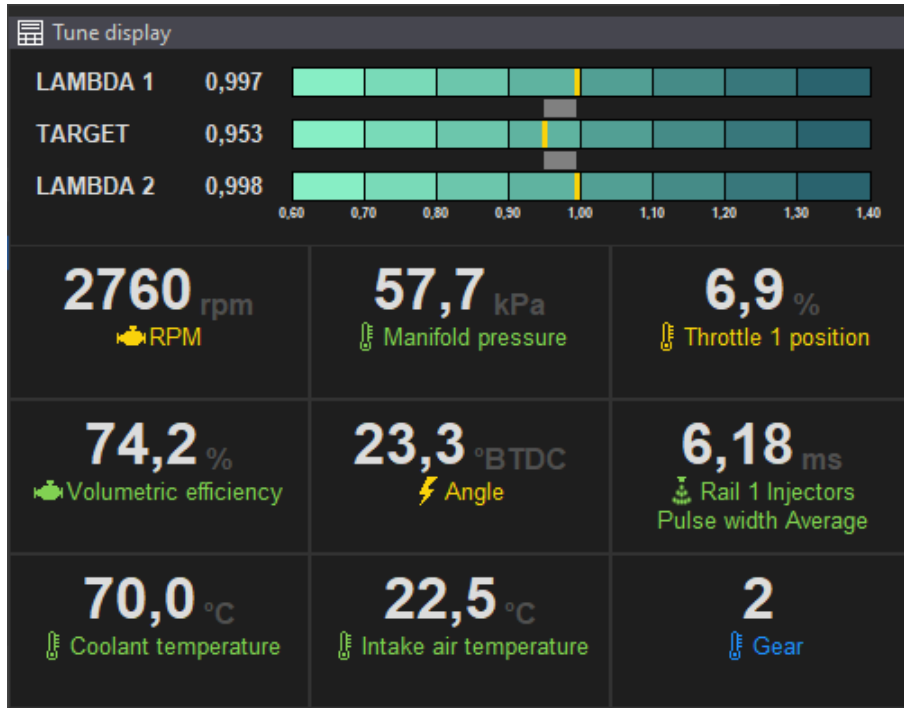
Usage: 47 % (9808/20480 B) x8: 2/100 ch x16: 0/100 ch x32: 1/20 ch

- 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

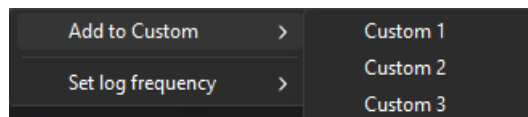
Floating window or docked panel displaying live data values received from the EMU PRO device. Data grid size and displayed channels may be configured by the user. Lambda target with companion of 1- or 2- lambda sensor readouts in graphical form is displayed on the of the window.



## 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:



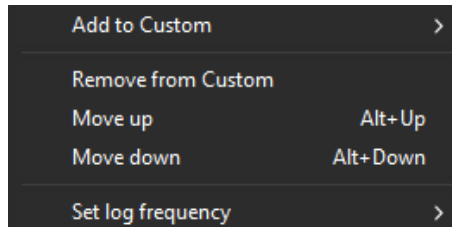
Option	Description
<b>Add to Custom</b>	Adding a channel to <i>Custom</i> panel
<b>Set log frequency</b>	Change the logging frequency

## Custom Text Log

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:

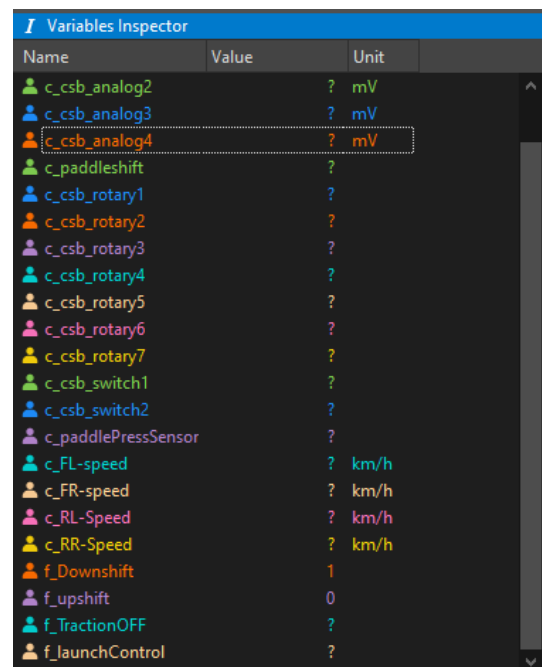


Option	Key shortcut	Description
<b>Add to Custom</b>		Adding a channel to another <i>Custom</i> panel
<b>Remove from Custom</b>		Removing a channel from the Custom panel
<b>Move up</b>	<b>Alt + Up</b>	Moving the selected row up
<b>Move down</b>	<b>Alt + Down</b>	Moving the selected row down
<b>Set log frequency</b>		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).

Name	4 Base profile	Custom profile
▶ Engine		
▶ Trigger		
▶ Cranking 1		
State	5	5
Idle air flow 2	5	5
Fuel Volume correct	5	5
Fuel Lambda target 3	5	5
Volumetric efficienc	5	5
Ignition angle	5	5
Fuel Prime pulse cor	5	5
Fuel Injection angle	5	5
▶ Ignition		
▶ Fuel		
▶ Idle		
▶ Overrun		
▶ VVT		
▶ Knock		
▶ Boost		
▶ Traction control		
▶ Sport		
▶ Drivetrain		
▶ Vehicle		
▶ DBW		
▶ Outputs		
▶ Sensors		
▶ Switches		
▶ Communication		
▶ Logger		
▶ ECU		
▶ Resources		
Custom		
Usage 5	83%	83%
212 logged part(s), 838 B. 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

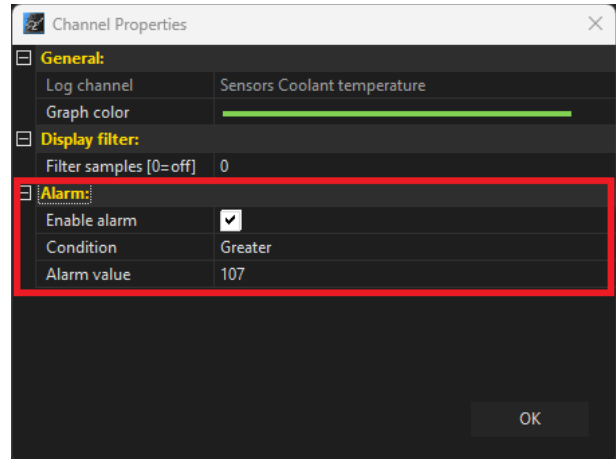
## Alarms

The role of alarms is to display information about emergency states detected by the device.

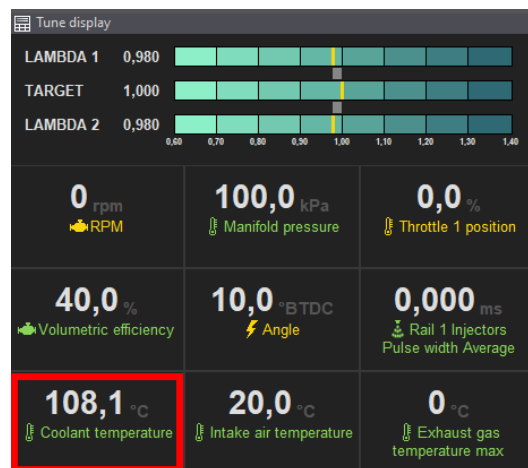
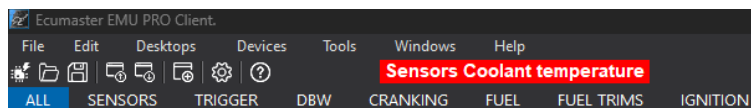
### Alarm configuration

To set an alarm for a channel, right-click on the channel in the Graph Log or Tune Display panel and open the Channel Properties window.

In the Alarm tab, check the Enable alarm box, and specify the condition and value that will activate the alarm.



The alert will be displayed in the main toolbar of the Client software and in the Tune Display panel.



### IMPORTANT!



The alarm will not be activated if a log file is uploaded while the ECU is powered.

There may be a situation where critical parameters, set in the channel options, are exceeded during engine operation while the user is reviewing the data uploaded from a file. In this case, the actual engine data will not be updated.



## 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
<b>Desktops</b>	
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	
<b>Devices</b>	
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	
<b>Edit</b>	
Redo	Ctrl+Y
Show undo list	
Undo	Ctrl+Z
<b>File</b>	
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	
<b>Help</b>	
About	
View help	
<b>Tools</b>	
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
<b>Windows</b>	
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
98.0	2023.05.25	Description of the CAN bus Keyboard added
99.3	2023.09.05	Updated version for official release. No changes in content.