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USER MANUAL

EMU Black - V3 Software Guide

Document version: 1.1
Software version: 3.059 or later
Published on: 17 November 2025

ECUMASTER

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1. Introduction

Note:

This document provides a detailed guide to the EMU Black V3 software application.

For information about the EMU Black hardware, including device specifications, wiring, installation, and connections, please refer to the separate **EMU Black Hardware Manual** (https://www.ecumaster.com/files/EMU_BLACK/EMU_BLACK_manual.pdf).

For information about the differences between V2 and V3 software, as well as details on project conversion, see the **EMU Black Migration Guide to V3 Software** (https://www.ecumaster.com/files/EMU_BLACK/EMU_BLACK_Migration_Guide_to_V3_Software.pdf).

Descriptions of individual strategies and parameters can be found directly within the EMU Black software, in the built-in Help.

The EMU Black V3 software provides complete access to engine control setup, including fueling, ignition, boost control, I/O configuration, sensor calibration, and advanced functions such as drive-by-wire, VVT, and launch control.

Using the application, you can create or open a project, which is a tune file that contains all calibrations, settings, maps, and user-defined objects.

2. Software and Firmware version

Firmware is the internal EMU Black program that controls all aspects of device behavior. Firmware and Client software are distributed together, and the latest Client must be used with the latest firmware.
The Client software is backward-compatible, meaning it can communicate with older firmware versions, but older Client versions will not work with newer Firmware.

The latest versions of the EMU Black software, including test and development builds, are always available at Ecumaster Test Versions: (https://www.ecumaster.com/testVersions.html). Official stable releases can be downloaded from the EMU Black product page: (https://www.ecumaster.com/products/emu-black/).

Firmware can be updated directly from the EMU Black software by selecting **Upgrade firmware** from the *File* menu and opening the appropriate firmware file. The process must not be interrupted, and all injectors and ignition coils should be disconnected beforehand. To prevent data loss, it is recommended to save the current project before performing the upgrade. If communication issues occur or the computer's power supply is unstable (for example, due to low battery on a laptop), the upgrade should not be attempted. If the upgrade fails, restart the device and repeat the procedure.

3. Connection, Projects, and Files

Note:
The EMU Black Client software can be launched and used without connecting the device. This allows creating and editing projects offline, which can later be uploaded to the ECU when connected.

During the first connection to the EMU Black device, a window will appear displaying the device name. By default, the device's unique serial number is used, but it can be changed to any preferred name. A subdirectory with this name is created in **My Documents / EMU_BLACK_V3**, where device configurations, projects, and logs are stored.

A quicksave subdirectory is created for each device, storing working copies of calibrations when the user presses F2 (to *Make maps permanent*).

The following file types are used by the Client software:

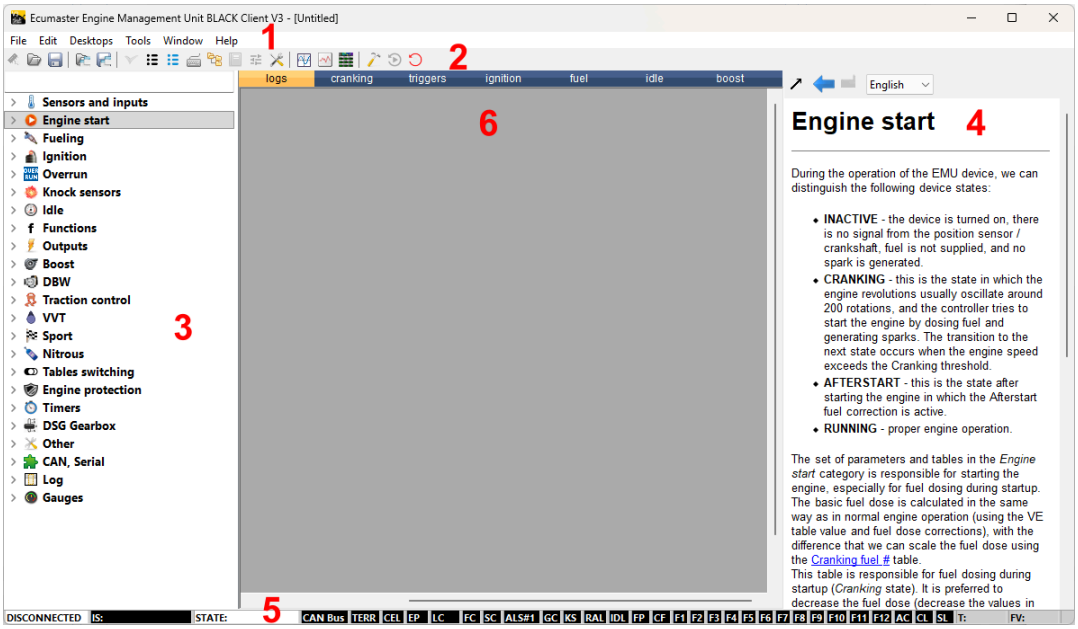
File description	File extension
Project file	*.emub3
Data log file	*.emublog3
Scope file	*.emubscp3
Layout files	*.emublayout

Saving Changes

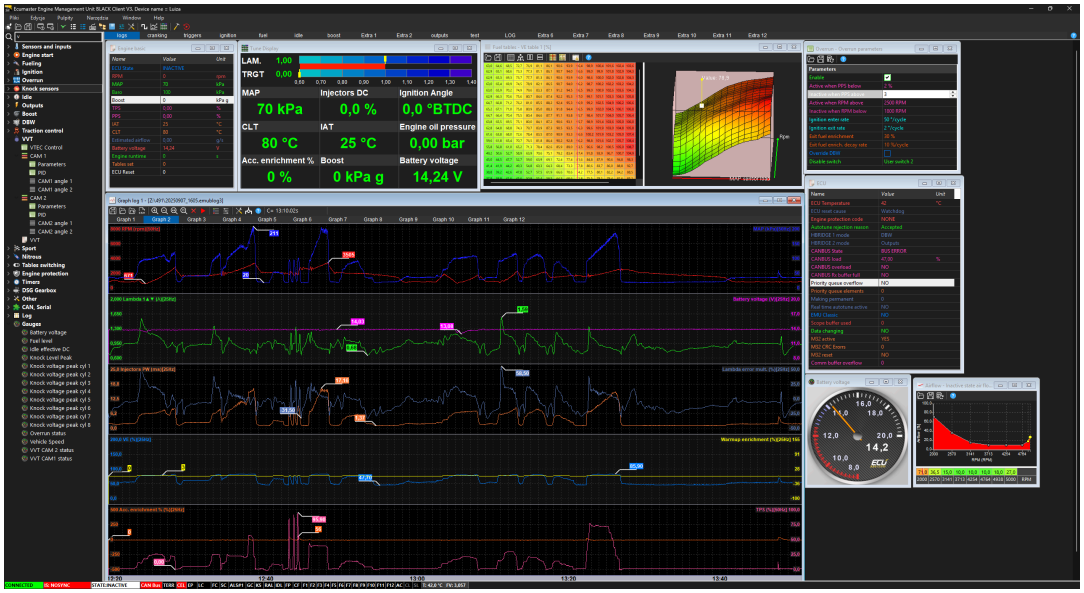
When a parameter or table value is changed, it is immediately sent to the EMU Black device, but only stored in a temporary copy of the project. To keep the changes after disconnecting the PC, the *Make permanent* command must be used.

4. Appearance of the application

The screenshot below shows the Client after the launch in **Standard** appearance (light mode):



The application can also be displayed in **Dark mode** interface.



User interface is divided into 5 areas:

1. Menu bar
2. Toolbar
3. Tree view panel with project parameters
4. Help panel
5. Status bar
6. Desktop workspace area

5. Menu bar

The menu bar is located at the top of the application. Below is a description of all available menu functions:

File	
Open project..	Open previously saved project *.emub3 (***Ctrl + O***)
Save project as..	Save current project to a new file *.emub3 (***Ctrl + S***)
Save project as XML..	Save current project as XML (***Ctrl + S***)
Import EMU BLACK V2 project..	Import EMU Black V2 project file *.emub
Compare current project..	Opens the *Project comparator* window.
Show full screen	Toggle full screen mode (***Ctrl + F***)
Upgrade firmware...	Change the internal software of a device
Restore to defaults	Restore a device to the default settings. Deletes all settings.
Make permanent / Clear modified cells mark	**Online mode:** saves all changes to device Flash memory and stores a settings file in MyDocuments/EMU_BLACK/ DeviceName/QuickSave (***F2***). **Offline mode:** removes modified cell highlights in parameter tables.
Exit	Exit the application. The desktop arrangement is saved upon exiting (***Alt + X***)

Edit	
Undo	Undo the last operation performed (***Ctrl+Z***).
Redo	Redo a previously undone operation (***Ctrl+Y***).
Show undo list..	Display a window with all operations performed.
Show/hide Tree view panel	Show or hide the Tree view (option) panel (***F9***).
Show/hide Event log	Show or hide application log panel (***Shift + F9***).

Desktops	
Restore desktops	Reads desktop configurations from the following file: *MyDocuments / EMU_BLACK_V3/DEFAULT / desktops.emublayout*

Desktops	
Store desktops	Save desktop configurations to the following file: *MyDocuments / EMU_BLACK_V3/DEFAULT / desktops.emublayout*
Open desktop templates...	Read the desktop configuration from a selected file.
Save desktop templates...	Save desktop configurations to a file.
Next desktop	Switch to the next desktop (***Ctrl + Shift + P***).
Previous desktop	Switch to the previous desktop (***Ctrl + Shift + O***).
Switch desktop to...	Switch to any selected desktop (***Ctrl + 0 – 9***).
Switch Tree view panel / windows	Switch between option panel and workspace windows (***TAB***)
Collapse all items in Tree view panel	Collapse all options in the left parameters Tree view (***Ctrl + ***)

Tools	
Device password	Device password *(on page 42)*
DBW calibration tool	DBW calibration tool *(on page 43)*
Calibrate WBO circuit	Calibrate WBO circuit *(on page 45)*
Test outputs	Opens window which allows to test all EMU Black outputs. Test outputs *(on page 69)*
Diff. oil bleed	Diff. oil bleed *(on page 71)*
Autotune	Log based autotune. Autotune *(on page 30)*
Logbook	The logbook records some data like maximum RPM, maximum CLT, etc. Logbook *(on page 70)*
User defined CAN stream	Allows user to define custom CAN stream. User Defined CAN stream *(on page 38)*
Set EDL-1 datalogger time	In the case of using EDL-1 data logger, this options copy the PC computer time to the logger internal clock. Set EDL-1 datalogger time *(on page 70)*
Show assigned outputs	Opens window which allows user to display all EMU Black outputs with information if given output is assigned and what is its function. Outputs assignment *(on page 68)*

Tools	
Show assigned inputs	Opens window which allows user to display all EMU Black inputs (digital, analog and precision analog) with information if given inputs is assigned and what is its function. Inputs assignment *(on page 68)*
User names...	Assign a name to a connected EMU Black device. User names *(on page 41)*
Scope	Add a *Scope* window to the desktop. Scope *(on page 52)*
Graph log	Add a *Graph Log* window to the desktop (***F6***). Graph Log *(on page 47)*
Tune display	Display a floating window showing the selected engine parameters live. Go to the *Tune display* window description for more details (***F7***). Tune Display *(on page 58)*
Customize keys	Change the shortcut keys assignment. Customize keys *(on page 67)*
General options	Display a dialogue window with the application options. The description of the *General options* window is available below. General Options *(on page 64)*
Available strategies	The list of available strategies. When the strategy is unchecked it will disappear from parameters tree view. Available strategies *(on page 67)*
Decode VW coding...	Decode VW coding *(on page 71)*
Vehicle VIN...	Vehicle VIN *(on page 71)*
Project comment...	Project Comment *(on page 41)*

Windows	
Tile Horizontally	Organizes all open windows in a horizontal layout, reducing empty space between them.
Tile Vertically	Organizes all open windows in a vertical layout, reducing empty space between them.
Next	Activate the next window.
Previous	Activate the previous window.
Close all windows	Close all windows on current desktop (***Ctrl + Shift + C***).

Help	
General help	Display *Help* window. Help *(on page 66)*
Show pinout	Opens the *Help* window at the **Pinout** section.
Show/Hide help panel	Show or hide the panel with help for each ECU setting. Help panel *(on page 15)*
About	Open a window with information about the software version

6. Toolbar

There are icons on the toolbar  indicating:

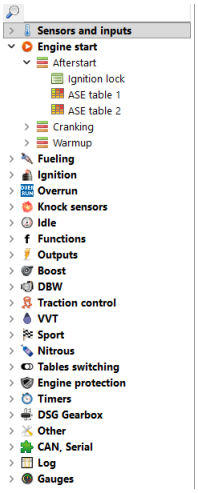
- ***Make tables permanent*** – saving changes to the non-volatile memory of a device.
- ***Open project*** – opening a project.
- ***Save project*** – saving the current project.
- ***Restore desktops*** – loading the desktop configurations from a file.
- ***Store desktops*** – saving the current desktop configurations to a file.
- ***Outputs test*** – opens a window that allows testing of all EMU Black outputs. Test outputs *(on page 69)*
- ***Show assigned outputs*** – opens a window displaying all EMU Black outputs with information about their assignment and function. Outputs assignment *(on page 68)*
- ***Show assigned inputs*** – opens a window displaying all EMU Black inputs (digital, analog, and precision analog) with information about their assignment and function. Inputs assignment *(on page 68)*
- ***Customize keys*** – opens a dialog to change shortcut key assignments. Customize keys *(on page 67)*
- ***Available strategies*** – displays the list of available strategies. When a strategy is unchecked, it will disappear from the parameters tree view. Available strategies *(on page 67)*
- ***Logbook*** – opens the logbook, which records data such as maximum RPM, maximum coolant temperature (CLT), and other key engine values. Logbook *(on page 70)*
- ***Autotune*** – opens the log-based autotune function. Autotune *(on page 30)*
- ***General options*** – opening the *General options* configuration window. General Options *(on page 64)*
- ***Scope*** – opening a *Scope* window. Scope *(on page 52)*

- ***Graph log*** – opening a *Graph log* window. Graph Log *(on page 47)*
- ***Tune display*** – opening a *Tune display* window. Tune Display *(on page 58)*

7. Tree view panel

The **Tree view panel** is located on the left side of the main application window. It can be resized by dragging its border, allowing you to adjust the layout to your needs.

The Tree view provides quick access to all functions of the **EMU Black**, organized into an expandable tree structure. This panel contains all settings for individual strategies, arranged in categories for clear and intuitive navigation. Depending on the firmware version, the available set of categories and functions may vary.



Structure of the panel

The tree consists of main categories and their subcategories. Expanding a category gives the user access to parameters, tables, and configuration tools.

Available categories include:

- **Sensors and inputs** – setup of engine sensors and fail-safe values.
- **Engine start** – functions and tables related to engine cranking.
- **Fueling** – fuel dose settings.
- **Ignition** – ignition angle configuration.
- **Overrun** – parameters related to fuel cut during engine braking.
- **Knock sensors** – configuration of knock detection system.
- **Idle** – idle speed control.
- **Functions** – auxiliary strategies.
- **Outputs** – AUX outputs setup (fuel pump, coolant fan, PWM outputs, etc.).
- **Boost** – boost pressure control.

- **DBW (Drive By Wire)** – electronic throttle control.
- **Traction control** – traction control system settings.
- **VVT (Variable Valve Timing)** – camshaft phasing configuration.
- **Sport** – motorsport-oriented features.
- **Nitrous** – nitrous oxide system control.
- **Tables switching** – switching between maps and tables.
- **Engine protection** – engine safety strategies.
- **Timers** – time-based functions.
- **DSG Gearbox** – integration with DSG transmission.
- **Other** – strategies that cannot be assigned to other categories.
- **CAN, Serial** – CAN bus communication.
- **Log** – data logging configuration.
- **Gauges** – real-time parameter visualization.

Search bar (filtering)

The search bar is used to quickly locate items or parameters within the tree. Entering a keyword filters the entire tree so that only relevant elements remain visible.

- The search is applied not only to item names, but also to the parameters available within those items. This means that even if the item itself has a different name, it will still appear in the results if one of its parameters matches the search term.
- All unrelated items are hidden while the filter is active.
- Once the search term is cleared, the full tree with all items becomes visible again.

Types of data elements

Inside categories and subcategories, users can find different types of data configuration elements, such as:

- **Wizard** – guided setup wizard. Wizard *(on page 30)*
- **Parameters** – list of settings for specific category. Parameters *(on page 21)*
- **Table 2D** – two-dimensional table. Table 2D *(on page 22)*
- **Table 3D** – three-dimensional table. Table 3D *(on page 25)*
- **Text Log** – a list of channels with their current values. Text Log *(on page 57)*
- **Graph Log** – a graph showing channels values over time. Graph Log *(on page 47)*
- **Gauge** – real-time gauge. Gauge *(on page 61)*
- **Dyno** – on-road power estimation tool. Dyno *(on page 62)*
- **Scope** – oscilloscope for signal analysis. Scope *(on page 52)*

- **Tune Display** – view and analyze relevant engine information in real time. Tune Display *(on page 58)*
- **Autotune** – a tool that processes gathered log data and assists in building the VE table. Autotune *(on page 30)*
- **DBW Autotune** – used for automatic throttle calibration. DBW calibration tool *(on page 43)*
- **Scatter Plot** – diagnostic and visualization tool that displays logged data points on a 2D chart, with an optional third dimension represented by color. Scatter Plot *(on page 59)*
- **Project comment** – allows saving comments within both the ECU memory and the project file, enabling easy comparison between projects. Project Comment *(on page 41)*
- **User defined CAN stream** – in addition to predefined CAN devices, users can send and receive custom CAN frames. User Defined CAN stream *(on page 38)*
- **Functions** – user-defined logical functions. Functions *(on page 33)*

Double-clicking an element opens its configuration window in the Workspace area (default position: top left corner).

Context menu

Right-clicking a category or subcategory opens a context menu with the following options:

Command	Description
Collapse subitems	Collapse all subcategories of the selected item
Collapse all	Collapse the entire tree
Open all windows on desktop	Open all elements from the selected category in the Workspace
Close all windows on desktop	Close all opened windows from the selected category.

Keyboard shortcuts and navigation

The following keyboard and mouse actions are available for faster navigation and operation within the *Tree view* panel and Workspace windows:

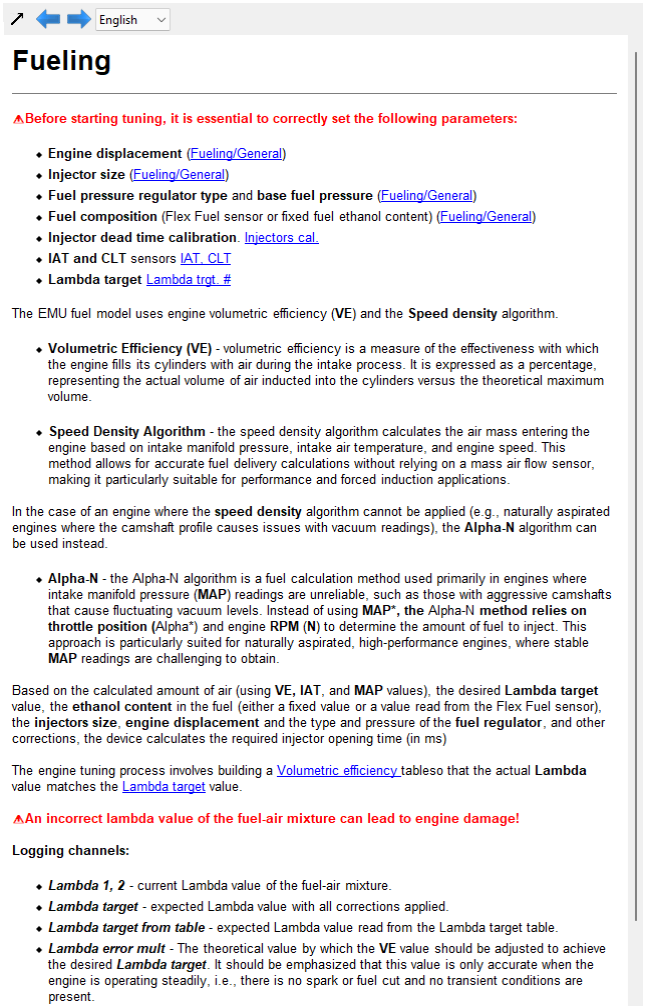
Shortcut	Description
Tab	Switch between the *Tree view* panel and Workspace windows
**Ctrl + **	Collapse all categories in the *Tree view*
F9	Show or hide the *Tree view* panel
Arrow Up/Down	Move between entries

Shortcut	Description
Arrow Left/Right	Collapse or expand nodes of the tree
Enter	Collapse/expand a node (like Arrow Left/Right), or open the configuration window if the selected entry is not expandable
Mouse double-click	Collapse/expand a node of the tree, or open the selected configuration window

8. Help panel

The ***Help*** panel provides descriptions of individual settings and parameters available in the *Tree view* panel.

It is closely linked to the ***Tree view*** panel and dynamically displays information related to the currently selected parameter.

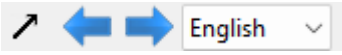


When a setting, table, or channel is selected in the ***Tree view***, the ***Help*** panel automatically updates to show a detailed description, including its purpose, functionality, and available

configuration options. This feature allows users to quickly understand the meaning and usage of each parameter without the need to refer to external manuals.

Above the name of each described parameter, there is a blue, underlined link showing the full path to its location within the tree structure. This makes it easy to trace where the parameter is found within the *Tree view* panel.
Additionally, within the *Help* panel text, other parameters may be referenced as links. These links are also displayed in blue and underlined, allowing quick navigation to those related parameters.

The *Help* panel includes a toolbar with two navigation buttons:



- ***Expand / collapse*** – shows / hides the help panel
- ***Move to previous page*** – returns to the previously viewed parameter.
- ***Move to next page*** – moves forward in the browsing history.
- **Language selection** – the EMU Black V3 help is available in multiple languages. The language can be changed at any time. Please note that the content is translated automatically.

The *Move to previous/next page* buttons are active when there is a browsing history available.

Right-clicking within the *Help* panel opens a context menu with the following options:

Command	Description
Copy	Copies the current description or parameter information to the clipboard (**Ctrl** + **C**). This option is available only when text is selected within the *Help* panel or after using the *Select all* option.
Select all	Selects all text within the *Help* panel, allowing you to quickly copy or review the entire description (**Ctrl** + **A**).

Note that when navigating to a previous description or clicking the path link in the *Help* panel, the *Tree view* panel will not highlight the selected parameter, and the previous selection will remain in place.

For more general information about the software (pinout, main menu, desktops, etc.), a separate *General Help* window can be opened from the main menu or with the **F1** key.

9. Status bar

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

Connection status	DISCONNECTED - there is no communication with EMU device CONNECTED - communication with EMU device established
Ignition status (IS)	Information about synchronization of ignition system NO SYNC – no synchronization SYNCHRONIZING – trying to synchronize SYNCHRONIZED – ignition system synchronized
EMU state (STATE:)	Current state of the EMU device UNKNOWN INACTIVE - there are no calculations connected to fuelling and ignition system CRANKING - in this state, fuel dose is taken directly from Cranking fuel table, and ignition angle is defined by Cranking ignition angle parameter AFTERSTART - the engine is running, Afterstart enrichment is present RUNNING - the engine is running normally DELAYED TURN OFF
CAN BUS state (CAN Bus)	Current state of CAN BUS BUS OK - CAN BUS works correctly BUS ERROR - CAN BUS error (inappropriate speed, wrong connection, termination problems)
Trigger error (TERR)	NO ERROR TOOTH OUT OF RANGE UNEXPECTED MISSING TOOTH CAM SYNC ERROR CAM SYNC ERROR, TOOTH OUT OF RANGE FALSE SEC TRIGGER, FILTERED FALSE PRIM TRIGGER, FILTERED FALSE CAM2 TRIGGER, FILTERED

Check engine error codes (CEL)	Information about check engine light NONE CLT - CLT sensor error IAT - IAT sensor error MAP - MAP sensor error WBO - WBO sensor error EGT1 - EGT 1 sensor error EGT2 - EGT 2 sensor error EGT ALARM - exhaust gas temperature exceeds a defined limit KNOCK - engine knock detected FF SENSOR - Flex Fuel sensor error DBW - DBW error FPR - effective fuel pressure exceeds defined limits DIFF CTRL - differential control error (oil pressure pump issue) EWG - electronic wastegate error (position sensor issue) OILP - low oil pressure (< 0.25 bar)
Engine protection codes (EP)	NONE - none CLT - coolant temperature EGT - exhaust gas temperature FPRD - fuel pressure protection active OILTL - oil temperature low OILTH - oil temperature high OVEB - overboost STT - stuck throttle protection active OILP - oil pressure low
Launch control (LC)	Launch control strategy active
Fuel Cut (FC)	Fuel cut value
Spark Cut (SC)	Spark cut value
Anti lag system state (ALS#1)	ALS strategy active
Gear cut (GC)	Gear cut strategy active
Knocking (KS)	Knock detected
Rolling anti lag state (RAL)	Rolling anti lag strategy active

Idle control state (IDL)	Idle control strategy active
State of Fuel Pump output (FP)	Fuel pump enabled
State of Coolant Fan output (CF)	Coolant fan enabled
State of Fn #1-12 (F1-F12)	Current value of each function (on or off)
State of air condition clutch (AC)	Current state of AC clutch
Conditional logging (CL)	Conditional logging enabled
Saving log in progress (SL)	Auto save log in progress
ECU board temperature (T:)	Temperature of the ECU. The Emu Black is designed to operate within a temperature range of -40°C to +105°C.
Device firmware version (FV:)	Firmware version of connected EMU device

10. Desktop workspace area

Desktops are an important part of the application. They allow you to arrange your own sets of windows, which makes the software easier and quicker to use.
At the top of the workspace area, each desktop is represented as a tab, making it easy to switch between different window layouts.

Right-clicking on the tab allows you to use the ***Rename active desktop*** option to change the name of the active desktop.

Keyboard shortcuts

Shortcut	Description
Ctrl + 1..0	Switch to any selected desktop (with the appropriate number)
Ctrl + Shift + P	Switch to the next desktop
Ctrl + Shift + O	Switch to the previous desktop

Each set of desktops is associated with a specific device connected to the PC. This makes it possible to maintain different window layouts for different devices. Details on how device directories and configuration files are created can be found in the Connection, Projects, and Files *(on page 6)* chapter.
When the EMU Black client software starts, the default set of desktops is opened from:
My Documents/EMU_BLACK_V3/DEFAULT/desktops.emublayout.

If you want to use an existing set of desktops for another project, select ***Save desktop template*** from the Desktops menu and overwrite the `desktops.emublayout` file of the target device.
Alternatively, you can use ***Desktops / Open desktop template*** to load a set of desktops created for another device.

During work on the desktop layout, you can save the current configuration with the ***Store desktops*** option from the ***Desktops*** menu, or by clicking the ***Store desktops*** toolbar icon. The layout is saved to the `desktops.emublayout` file in the device directory, or in the **Default** directory if no device was connected.
To restore a previous layout, select ***Restore desktops*** from the ***Desktops*** menu. This option reloads the `desktops.emublayout` file from the device directory (or from **Default** if no device is connected). You can also restore a layout by clicking the ***Open desktops*** icon on the taskbar.

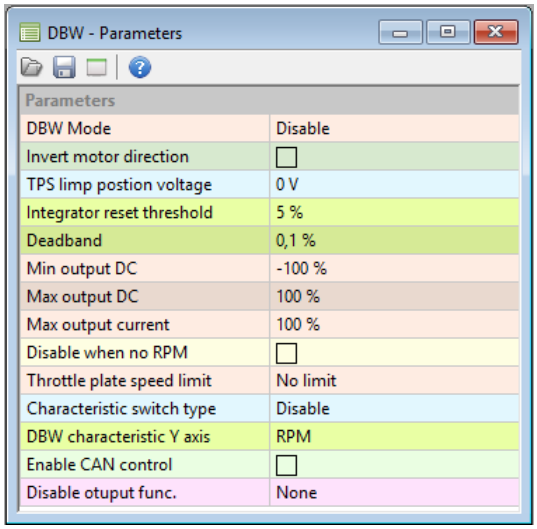
The `desktops.emublayout` file is automatically saved when exiting the program.
When a device is connected, its desktops layout is automatically loaded from the device directory.

11. Project Calibration

Project Calibration windows include all tools used for tuning, editing parameters and tables, configuring functions, and performing calibration tasks. These windows provide intuitive access to project data and support efficient management of the tuning process.

11.1. Parameters

The ***Parameters*** is a window containing specific options. It can be opened from the *Tree View* panel, depending on the selected category.



A *Parameters* always has two columns. The left column contains name of each option, while the right column displays the corresponding values. Clicking on a cell in the right column allows you to modify its content. This can be a selection from a list, an on/off option, or a field to enter a custom value.

The toolbar of the *Parameters* window includes the following icons:

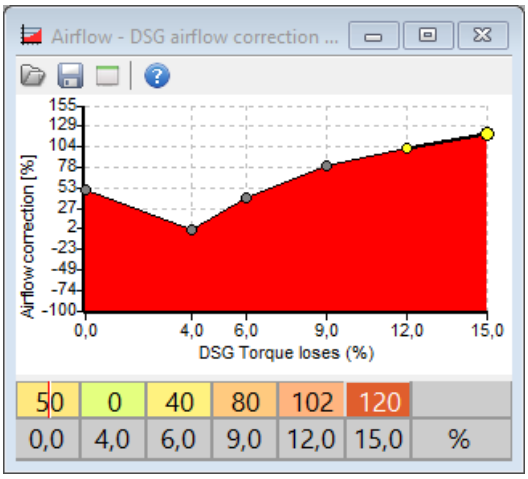
- ***Open parameters*** – open a file containing the configuration of the current parameters block.
- ***Save parameters*** – save the configuration of the current parameters block.
- ***Restore to defaults*** – restore default values for the current parameters block.
- ***Help***– open the *Help* panel related to this *Parameters*.

Saving individual *Parameters* is useful for sharing configurations with other users or creating a base set of settings, for example, configurations for different ignition systems.

11.2. Table 2D

2D tables are used to show the relationship between two variables in a simple graphical form. The *2D Table* window can be opened from the *Tree View* panel, depending on the selected category. The values corresponding to the graph are located in the table below it, and each cell can be modified.

The upper row of the table corresponds to the vertical axis of the graph, while the lower row defines the horizontal axis (bins).



Toolbar icons

The toolbar provides quick access to basic operations on 2D tables:

- ***Open 2D table*** – load the current 2D table from disk.
- ***Save 2D table*** – save the current 2D table to disk.

- ***Restore to defaults*** – restore the table to default values.
- ***Help*** – open the *Help* panel with a description of the currently selected 2D table.

Editing cell values

To change a cell value, highlight the desired cell and enter a new value. You can also adjust the value using the **+** and **–** keys. For finer adjustments, hold the **ALT** key; for larger adjustments, hold the **SHIFT** key.

Arithmetic operators can be applied to selected cells by entering a value followed by an operator. For example:

- Enter `5+` to add 5 to the selected cells.
- Enter `0.5*` to scale down the selected cells by 50%.
  Available operators: +, –, *, /, %.

Context menu

The context menu provides additional editing and configuration options. Its content depends on whether you right-click the top or bottom row of the table.
To interpolate between table cells, right-click on the top row of the table.

The context menu for the top row:

Command	Description
Interpolate horizontally	Horizontal interpolation: fills selected cells using linear interpolation between the left and right edges of the selection (key shortcut: **Ctrl** + **H**).
Equalize selection	Smooths values within the selection (key shortcut: **E**).
Copy cells	Copying the value of the selected cell(s) (key shortcut: **Ctrl** + **C**).
Paste cells	Pasting of the copied value(s) of the cell(s) in the highlighted area (key shortcut: **Ctrl** + **V**).

The context menu for the bottom row:

Command	Description
X Axis bins wizard	Opens a configuration window for defining the X axis
Axes usage info	Opens *Axis usage in Tables* window showing which other tables share the same axis. Changes to the axis affect all linked tables.

X Axis bins wizard

Note:
Some axis definitions are common for several tables (e.g., load, RPM). When an axis definition is modified in one table, the same definition will also change in other tables that use it.

Parameter	Description
X min value	The minimum value on the X axis, (for all arguments smaller than X *min* value, the function value is the same as for *X min value*)
X max value	The maximum value on the X axis, (for all arguments greater than *X max* value, the function value is the same as for *X max value*)
Interpolation type	Selecting the type of distribution of points on the X axis ***Linear interpolation*** - distribution of a specified number of points (***X points***), evenly distributed over a specified interval (between the minimum and maximum values) ***Exponential interpolation #1/#2*** - distribution of a specified number of points (***X points***) over a given range but with a higher density at the beginning of the interval and a lower density at the end. The distribution of points is described by an exponential function with an exponent equal to 1.4 for ***#1*** and 1.6 for ***#2***.

Keyboard Shortcuts

Shortcut	Description
=	Increase cell value
Shift + =	Coarse increase of cell value
Alt + =	Fine increase of cell value
-	Decrease cell value
Shift + -	Coarse decrease of cell value
Alt + -	Fine decrease of cell value
Ctrl + C	Copy selected cells
Ctrl + V	Paste copied cells
Ctrl + H	Interpolate between selected cells

Shortcut	Description
Ctrl + Arrows	Copy cell value to the cell indicated by the arrow key
Ctrl + Z	Undo last operation
Ctrl + Y	Redo last operation
Ctrl + A	Select all table cells

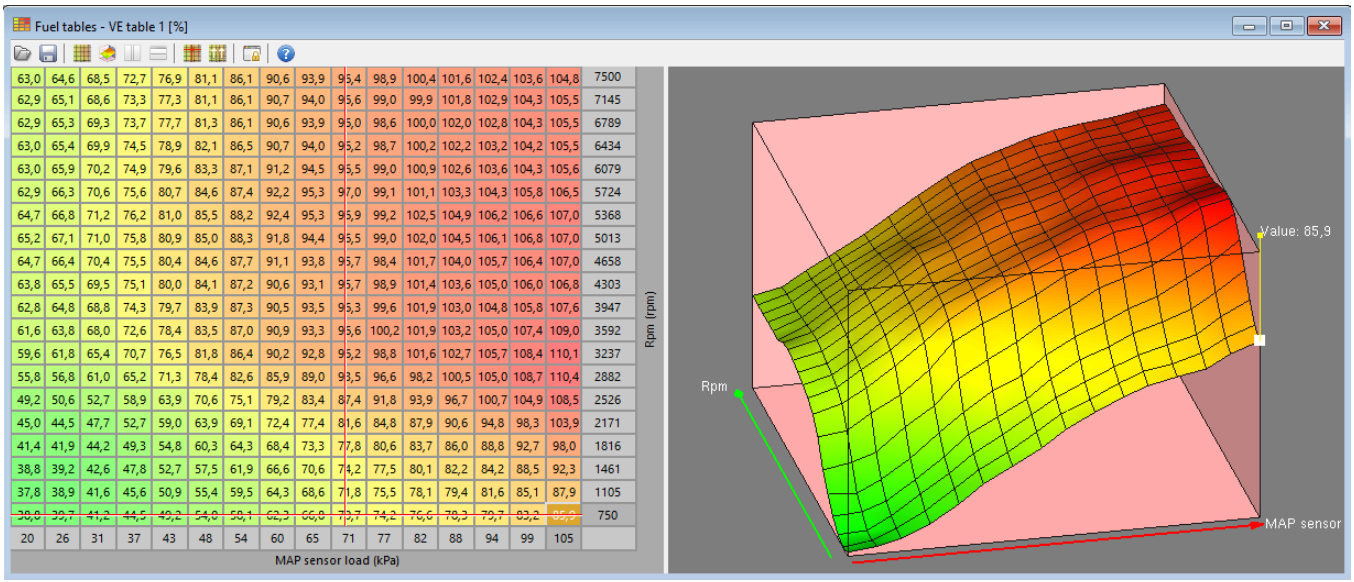
General Options – 2D tables configuration

In the General Options window (available from the main menu or the application toolbar), you can configure global settings for 2D tables:

Parameter	Description
New 2D table size	Defines the default size of a newly created 2D table: Small, Medium, Big.
Tables colour	Defines the color scheme of the 2D table graph. Available options: Standard, Blue-Violet, Blue-Green-Red.

11.3. Table 3D

3D tables are used to represent three-dimensional non-linear relations in an easy-to-use graphical form. The *3D Table* window can be opened from the *Tree View* panel, depending on the selected category. Each 3D table consists of numerical values defining a variable (e.g., ignition timing) in relation to two axes (e.g., load and RPM).



Toolbar icons

The toolbar provides quick access to common 3D table functions:

- ***Open 3D table*** – load the current 3D table from disk.
- ***Save 3D table*** – save the current 3D table to disk.
- ***Only 3D table*** – switch to table-only view.
- ***Only 3D graph*** – switch to graph-only view.
- ***Split vertically*** – table and graph arranged vertically.
- ***Split horizontally*** – table and graph side by side.
- ***Follow cursor*** – track current table position with crossbar.
- ***Automodify above*** – automatically increase values in cells above the modified cell if they are lower (cells marked with a white checker); useful when shaping VE tables.
- ***Help***– open the *Help* panel with a description of the currently selected 3D table.

To load a table from an existing project, change the file extension mask to **.emu** in the open dialog window.

Editing cell values

To change a cell value, highlight the desired cell and enter a new value. You can also adjust the value using the = and − keys. For finer adjustments, hold the Alt key; for larger adjustments, hold the Shift key.

Arithmetic operators can be applied to selected cells by entering a value followed by an operator. For example:

- Enter `5+` to add 5 to selected cells.
- Enter `0.5*` to reduce all selected cells by 50%.

Available operators: **+, −, *, /, %**.

Context menu

The context menu provides editing and configuration options. Right-clicking on the table area opens the table context menu (interpolation and edit commands). Right-clicking on an axis description opens the axis context menu (axis wizards and info).

The context menu for the table area:

Command	Description
Interpolate horizontally	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 (key shortcut: **Ctrl** + **H**).
Interpolate vertically	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 (key shortcut: **Ctrl** + **L**).
Interpolate diagonally	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 (key shortcut: **Ctrl** + **D**).
Equalize selection	Smoothing of the selected cells (key shortcut: **E**).
Copy cells	Copying the value of the selected cell(s) (key shortcut: **Ctrl** + **C**).
Paste cells	Pasting of the copied value(s) of the cell(s) in the highlighted area (key shortcut: **Ctrl** + **V**).

The context menu for the axis:

Command	Description
X Axis wizard	Launching a wizard for the X axis to define a new number of columns and generate X axis cells according to the selected type of interpolation
Y Axis wizard	Launching the Y-axis wizard to define a new number of rows and to generate Y-axis cells according to the selected type of interpolation
Axes usage info	Opens *Axis usage in Tables* window showing which other tables share the same axis. Changes to the axis affect all linked tables.

X / Y axis configuration

> **Note:**
> Some axis definitions are common for several tables (e.g., load, RPM). When an axis definition is modified in one table, the same definition will also change in other tables that use it.

Parameters available in the axis wizard:

Parameter	Description
X/Y min value	The minimum value on the Y axis
X/Y max value	The maximum value on the Y axis
Interpolation type	Selection of the type of distribution of points on the Y axis ***Linear interpolation*** - the distribution of a specified number of points (***Y points***), evenly distributed over a specified interval (between the minimum and the maximum value) ***Exponential interpolation #1/#2*** - distribution of a specified number of points (***Y points***) over a given interval, with a higher density at the beginning of the interval and a lower density at the end. The distribution of points is described by an exponential function with an exponent equal to 1.4 for ***#1*** and 1.6 for ***#2***.

Navigation

The 3D chart view can be rotated 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.
Cells and axes should be filled with appropriate values. Multiple cells can be selected with **Shift + arrow** keys, and **Ctrl + arrow** keys copy values to adjacent cells. Horizontal and vertical interpolation commands can also be helpful.

Keyboard shortcuts

Shortcut	Description
=	Increase cell value
Shift + **=**	Coarse increase of cell value
Alt + **=**	Fine increase of cell value
-	Decrease cell value

Shortcut	Description
Shift + -	Coarse decrease of cell value
Alt + -	Fine decrease of cell value
Ctrl + C	Copy selected cells
Ctrl + V	Paste copied cells
Ctrl + H	Interpolate between selected cells
Ctrl + Arrows	Copy cell value to the cell indicated by the arrow key
Ctrl + Z	Undo last operation
Ctrl + Y	Redo last operation
Shift + Arrows	Select area
Ctrl + A	Select all table cells
F	Toggle cursor tracking
D	Toggle auto-modification of cells above RPM

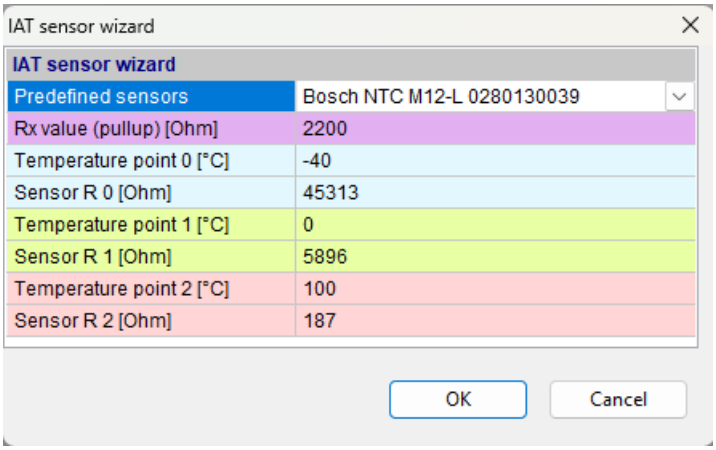
General Options – 3D tables configuration

In the *General Options* window (available from the main menu or the application toolbar), you can configure global settings for 3D tables:

Parameter	Description
Color scheme	Defines the color scheme of the 3D tables. Available options: Standard, Blue-Violet, Blue-Green-Red.
Load on Y axis	Sets the load axis direction in VE, AFR, and IGN tables
Display square tables	Makes rectangular tables appear more square by increasing cell height
New 3D table appearance	Defines how newly created 3D tables are displayed: **Table and Graph** shows both views; **Only Table** displays numerical data only.
New 3D table size	Defines the default size of a newly created 3D table: Small, Medium, Big.
Cubic 3D graph	3D table visualization is displayed with constant aspect ration instead of filling all available space.

11.4. Wizard

The **Wizard** tool allows quick selection of a pre-saved, predefined configuration for a given sensor. For example, a wizard for an intake air temperature sensor provides an intuitive interface to set sensor characteristics.



The first cell in the right column is always a drop-down list, allowing you to select the appropriate characteristics from sensors or devices defined by the manufacturer, such as thermistors, NTC sensors, or injectors. Each predefined configuration can be further modified to adjust individual parameters according to specific requirements.

11.5. Autotune

The *Autotune* function is a tool used for analyzing gathered log data and help to build VE table. The *Autotune* window can be opened from the *Tree view* panel.

The process consists from the 3 main steps:

1. Gathering data (making log)
2. Processing data
3. Analyzing data and apply VE changes

Gathering data

Gathering data is the most important part of the whole process. It is important to keep the engine in steady state in as many load / rpm setpoints. Any data gathered during transient condition (eg. cceleration) will be ignored.

It is very important to build Lambda/AFR target table before you start the autotune. For data collecting, the engine coolant should be at normal operating temperature. It is allowed to use

EGO correction. Collect data using different gears and different throttle position. The goal is to cover as big VE table area as possible.

Processing data

To process data it is important that calibration used for data logging is loaded (or EMU with calibration is connected), and proper datalog is present. The next step is to open *Autotune* tool (*Menu / Tools / Autotune*).

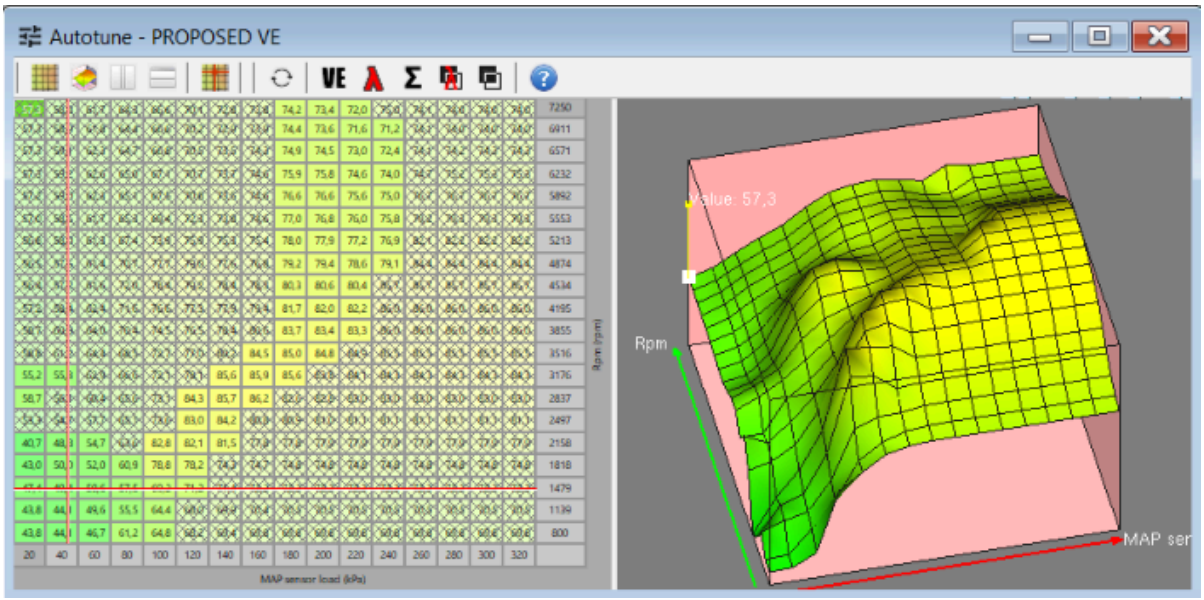
Parameter	Description
Min./ Max. RPM	The RPM range for valid data samples
Min./ Max. TPS	The TPS range for valid data samples
Min./ Max. MAP	The MAP range for valid data samples
Transients delay	The time after transient condition (fuel resume, acc/decc enrich) during all collected data will be ignored
VE table	The table that will be modified. It is important that this table must be the same as a table used during data collecting

After pressing OK button, the data is processed and autotune window will appear. This window is also accessible from the left tree view (*Log / Autotune*).

The toolbar provides quick access to common functions:

- ***Only 3D table*** – switch to table-only view.
- ***Only 3D graph*** – switch to graph-only view.
- ***Split vertically*** – change view to both table and 3D graph horizontally divided.
- ***Split horizontally*** – table and graph side by side.
- ***Follow cursor*** – track current table position with crossbar.
- ***Refresh autotune***
- ***Show VE table*** – show the proposed VE table.
- ***Show lambda/AFR*** – show the current measured Lambda values.
- ***Show num samples*** – show the number of collected samples in give set point.
- ***Show lambda/AFR difference*** – show the difference between Lambda target and measured Lambda.
- ***Show VE table difference*** – show the difference between current VE table and proposed VE table.
- ***Help***– show context help.

Analyzing data and apply VE changes



The last step is data analyzing and applying VE changes. The base view is proposed VE table. All cells that are calculated from log are clear, cells that are not calculated are masked (hatched). If you select any cells on Autotune table the corresponding cells on VE and Lambda tables will be also selected.

The Proposed VE table shows the VE values calculated based on the log, the VE table, and the Lambda/AFR target table.

The Proposed VE table shows the VE values calculated from the log, the current VE table, and the Lambda/AFR target table.

To apply the changes from the selected cells to the VE table, open the context menu (right mouse button) and choose an option. You can also use keyboard shortcuts.

- **Apply 100%** (right-click → *Apply selection 100%* or press **S**):
  Copies the proposed VE values directly into the VE table.
- **Apply 50%** (right-click → *Apply selection 50%* or press **ALT+S**):
  Uses the average between the current VE table value and the proposed value.

The view Actual Lambda shows us the measured Lambda/AFR during the data collecting.

The view Number of collected samples shows us how many data samples was used for calculating proposed VE table. The more samples the better proposed VE values.

The view Actual VE difference shows us the difference between proposed VE values and current VE table.

Step by step autotune procedure

1. Prepare VE table that allows the engine running and assure that in high engine load the mixture is rich
2. Prepare Lambda target table
3. Drive the car under different load / RPM conditions
4. Run *Autotune* tool
5. Apply changes in desired VE cells
6. Correct unmodified (not visited during test drive) VE table cells manually to fit them to autotune ones. You can use Equalize function (E button on selected cells)
7. Clear the log
8. Repeat the procedure from point 3

11.6. Functions

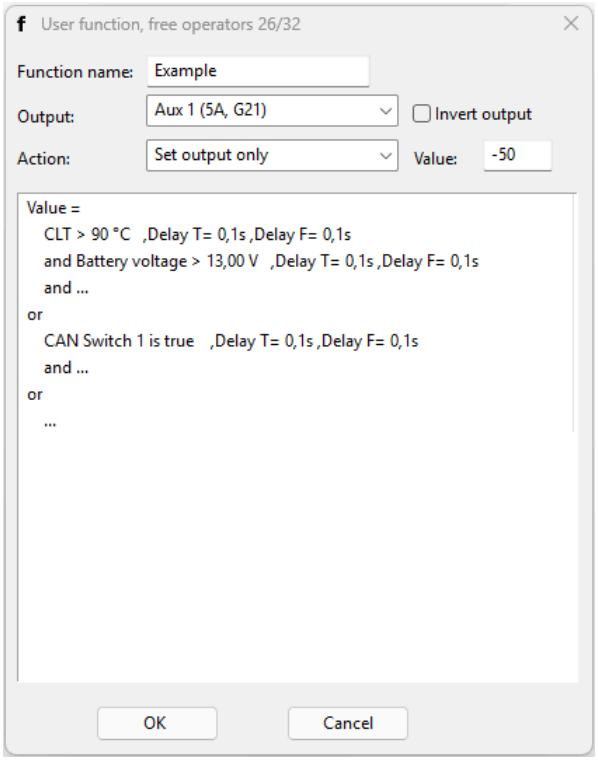
Functions allow the user to define up to 12 custom logical functions that can be used to build complex strategies.
Functions are based on operators (32 available types) that can be combined using logical connectors **AND** and **OR**.

Functions may serve as virtual logic blocks or be assigned to control specific ECU outputs.
The *Functions* window can be opened from the Tree View panel.
They can be used to:

- activate ECU strategies,
- control outputs,
- set the rev limiter,
- adjust ignition timing,
- activate the check engine light.

Defining a function

To create or edit a function, double-click the desired item in the main tree view.
A configuration window will appear where operators can be added by double-clicking the **...** symbol.



Function parameters

Function name – user-defined name (max. 8 characters). Displayed everywhere the function can be assigned.

Output – assigns the function result to an ECU output. If the function is only for logic or strategies (e.g., rev limiter), select Virtual.

Invert output – the output is turned on when the function result is false, and turned off when it is true.

Action – defines what the function does. Regardless of the action, the function value in the log is always 0 or 1.

The following actions are available:

- **Set output only** – sets the assigned output. If *Virtual*, only the function value changes.
- **Set rev limiter** – defines rev limiter value when the function = 1. The lowest value from all active sources is always chosen.
- **Set ignition correction** – applies ignition timing correction (negative = retard, positive = advance).
- **Set check engine** – activates the check engine light when the function = 1.

Note:

If the Output field is not *Virtual*, the assigned ECU output will always be set in addition to the selected action.

Combining operators

- Operators can be grouped using **AND**.
- Groups can then be combined using **OR**, enabling complex logic structures.
- Functions are evaluated sequentially from **F1 to F12** – this order matters if one function depends on another.

Monitoring functions

- In logs: channels **Fn 1 … Fn 12**.
- In the status bar: fields **F1 … F12** (green = active, value = 1).

Operator context menu

Right-click on an operator to open options:

- **Remove operator** – deletes the selected operator.
- **Move down** – shifts operator to the group below.
- **Move up** – shifts operator to the group above.
- **Remove all operators** – deletes all operators in the function.

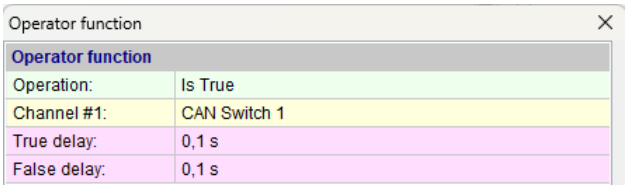
Operator types

The following categories of operators are available.

Values are considered true when non-zero, and false when zero.

Delays (True delay, False delay) define how long the condition must remain valid before changing state.

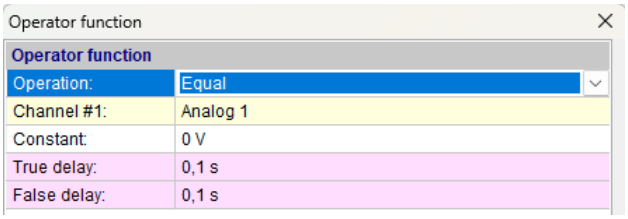
1. **Testing operators**



Is True – returns 1 if the channel is non-zero.

Is False – returns 1 if the channel = 0.

2. **Comparing operators**



Equal – returns 1 if Channel = Constant.

Not Equal – returns 1 if Channel ≠ Constant.

Less – returns 1 if Channel < Constant.

Less or Equal – returns 1 if Channel ≤ Constant.

Greater – returns 1 if Channel > Constant.

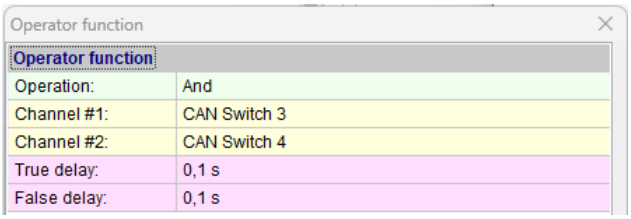
Greater or Equal – returns 1 if Channel ≥ Constant.

Parameters:

Channel #1 – logging channel used for comparison.

Constant – reference value.

3. **Logic operators**



AND – returns 1 if both channels are true.

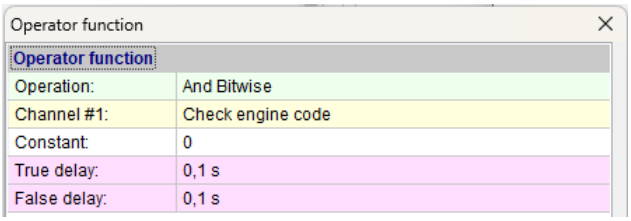
OR – returns 1 if at least one channel is true.

XOR – returns 1 only if exactly one channel is true.

Parameters:

Channel #1 / Channel #2 – input channels.

4. **Bitwise operators**



Used for testing bits in values (e.g., status flags).

AND bitwise – performs bitwise AND between Channel and Constant.

XOR bitwise – performs bitwise XOR between Channel and Constant.

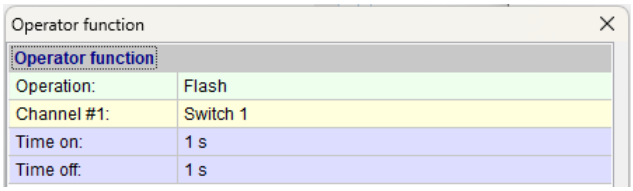
Parameters:

Channel #1 – channel used for bitwise operation.

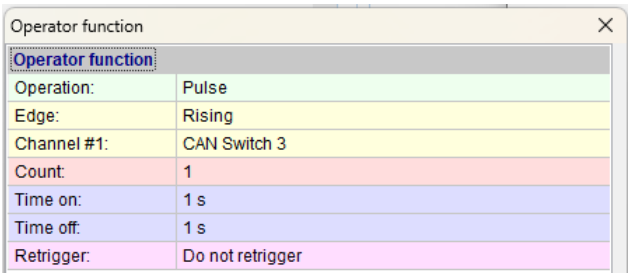
Constant – 16-bit constant mask.

5. **Signal generating operators**

Flash – generates a repeating on/off pulse while the channel is true.

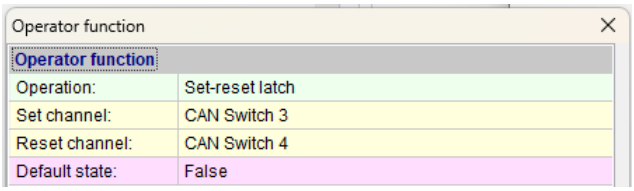


Pulse – generates a defined number of pulses when a trigger edge appears. Parameters: Count, Time on, Time off, Retrigger.

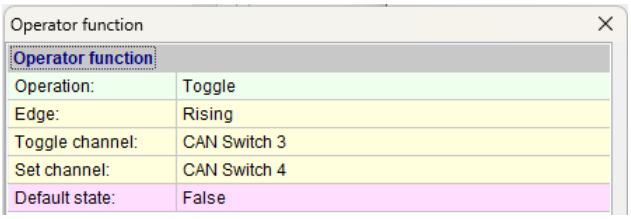


6. **State-storing operators**

   Set-Reset Latch – output state depends on Set and Reset channels. Keeps the previous value if both are inactive. Initial state can be defined with Default State.

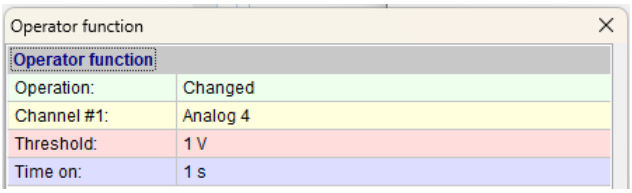


   Toggle – changes state (0/1) on each rising/falling edge. Includes optional Set/Reset channels. Initial state defined with Default State.



7. **Change and hysteresis**

   Change – generates a pulse if channel value changes more than a defined Threshold.



   Hysteresis – returns 1 when channel exceeds Upper Value (with polarity = Above) and keeps it until it falls below Lower Value. Works inversely when polarity = Below.

Note:
Information about log channels bitfields and enumerations is available in built-in help.

11.7. User Defined CAN stream

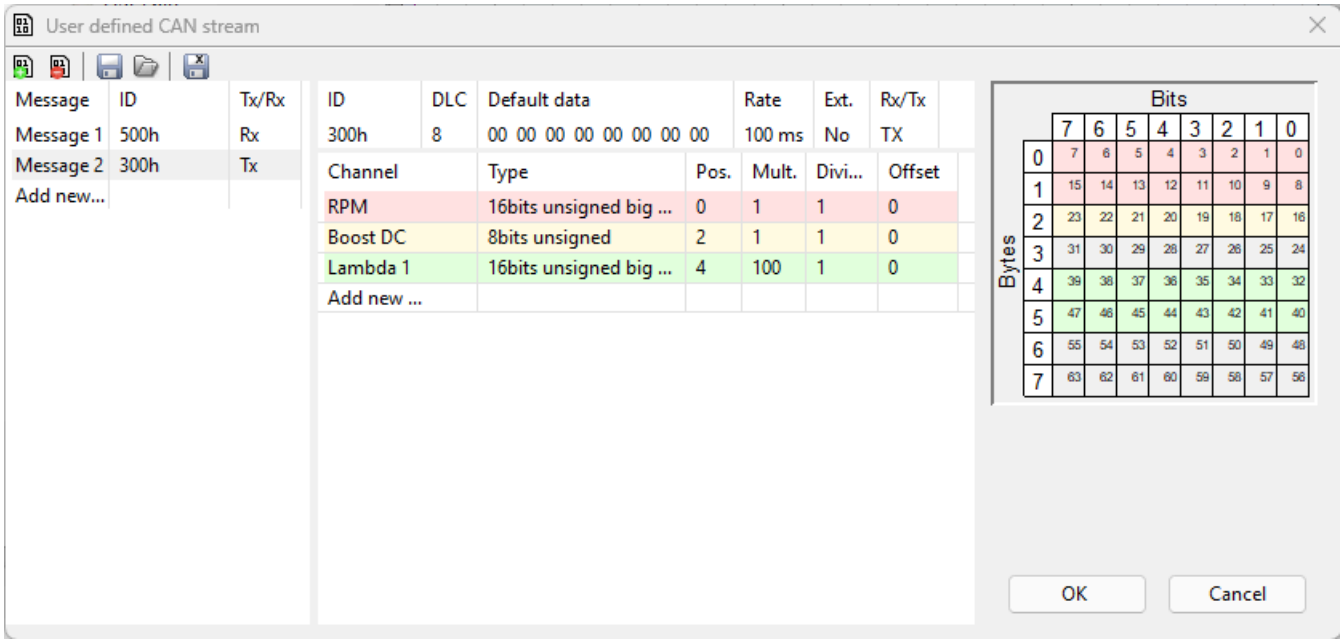
In addition to supporting predefined CAN devices, it is possible to send and receive custom CAN frames via the CAN bus. You can define up to 8 custom frames (Rx, Tx).

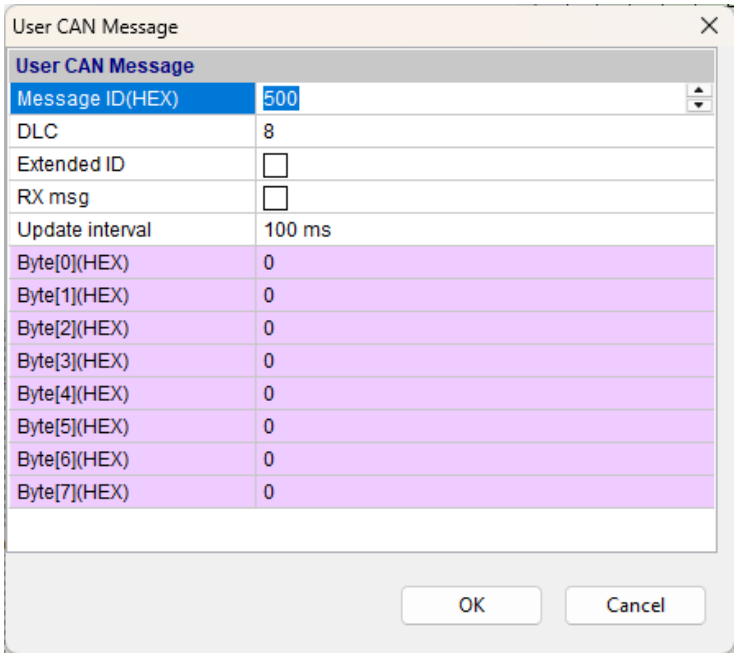
Note:
Unlike in firmware V2, in V3 software it is possible to receive user-defined CAN frames even when the vehicle CAN stream is selected.

The *User Defined CAN stream* window can be opened from the *Tree View* panel or from *Menu / Tools*.

Adding a User Defined CAN Frame

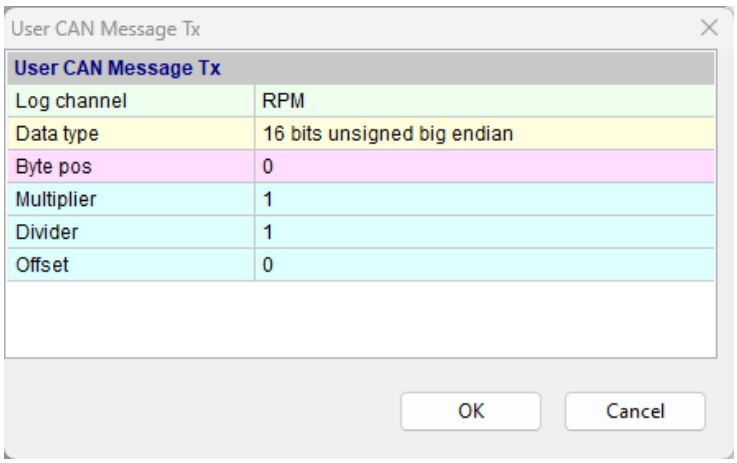
To add a user-defined CAN frame, open the *User Defined CAN Stream* window and select ***Add new...*** **(1)** in the *Message* column.





- **Message ID (HEX)** – the CAN ID in hexadecimal format. The ID must be unique on the bus to avoid collisions.
- **DLC** – frame length in bytes.
- **Extended ID** – choose this option for 29-bit CAN IDs. Standard frames use 11-bit IDs.
- **RX** – defines whether the frame is used for receiving data by the EMU.
- **Update interval** – for Tx frames, specifies how often the frame is transmitted.
- **Timeout** – for Rx frames, defines how long the EMU waits for the next message before reverting to default values.
- **Byte[X] (HEX)** – default byte values of the frame. For Tx, these are used if no channel is assigned. For Rx, they are applied during initialization or after timeout.

After creating the frame, logging channels can be mapped for transmission or reception. Select ***Add new...*** **(2)** in the frame area to define the channel and its format.



Tx Options

Log channel – the log channel to be sent.

Data type – numeric format of the value:

- *8-bit unsigned* – range 0–255 (e.g., Analog In).
- *8-bit signed* – range –127–128 (e.g., IAT).
- *16-bit signed big endian* – range –32767–32768, higher byte first (Motorola).
- *16-bit signed little endian* – range –32767–32768, lower byte first (Intel).
- *16-bit unsigned big endian* – range 0–65535, higher byte first.
- *16-bit unsigned little endian* – range 0–65535, lower byte first.

Byte pos – byte position where the channel value is placed. 16-bit values use two bytes.

Multiplier – scales the channel value before sending.

Divider – divides the channel value before sending.

Offset – value added to the output.

Output Value = (Log channel × Multiplier ÷ Divider) + Offset

Rx Options

For Rx frames, variables are initialized with default values. If a timeout occurs, they revert to defaults until new data arrives.

Input Value = (CAN data × Multiplier ÷ Divider) + Offset

Common input formats:

- Wheel speeds – 1/16 km/h per bit (e.g., 160 = 16 km/h).
- CAN Analog inputs – 1/255 V per bit (e.g., 100 = 1.96 V).
- GPS speed – 2 km/h per bit (e.g., 100 = 200 km/h).
- Driven/Undriven/Vehicle speed – 1/16 km/h per bit.
- Rev limiter target – 1 RPM per bit (e.g., 3000 = 3000 RPM).
- Rotary switch – 1 step per bit (e.g., 6 = position 6).
- Lambda 1 / Lambda 2 – 1/1000 per bit (e.g., 1000 = λ = 1). A value of 0 means invalid Lambda.

11.8. User names

The ***User Names*** feature allows you to assign custom names to *Outputs*, *Analog inputs*, *CAN switches*, and standard *Switches*.
This feature helps you clearly identify the purpose of each element, making it easier to understand system behavior and analyze logs.

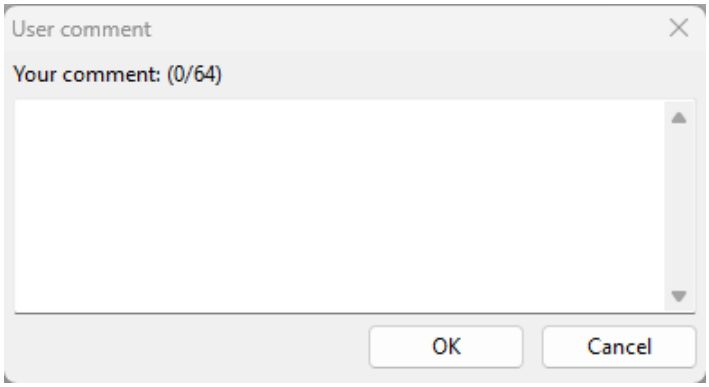
Each name can be freely defined by the user, with a maximum length of 16 characters.
Once assigned, the custom names will appear in the Assigned Outputs and Inputs window as well as in log files, allowing quick identification of signals and functions.

For example, if *Analog Input 2* is connected to an oil pressure sensor, assigning it the name “Oil pressure” makes it immediately clear what this input represents.

The *User Names* windows can be opened from *Menu / Tools*.

11.9. Project Comment

The comment is saved in the device memory and the project, keeping track of changes made.

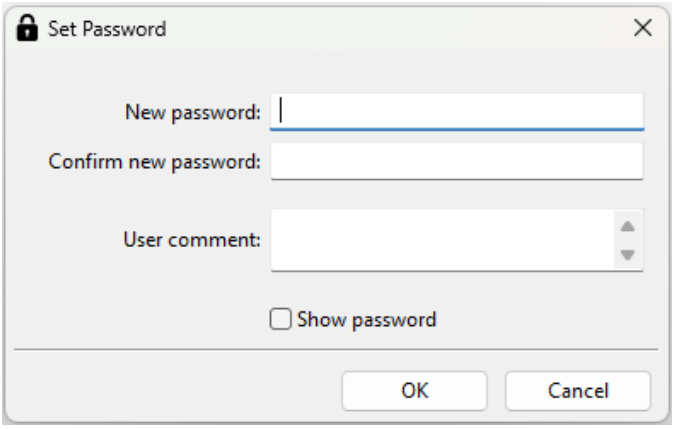


Note:
The comment is limited to 64 characters.

The *Project Comment* window can be opened from the *Tree View* panel or from *Menu / Tools*.

11.10. Device password

To secure the device with a password, you need to go to the *Tools* menu and select the *Device password* option.



After entering the password, the device will be secured, and this will be visible on the status bar in the form of a padlock.

Upon restarting the device, to connect to it, you need to enter the password. Entering the correct password will unlock the device, and it will remain in this state until it is restarted again.

The client software remembers the password during runtime, so subsequent turning on/off of the device will not require re-entering the password.

When the device is password protection the Quick save during Make permanent process is disabled.

During connection to the encrypted device, there are 4 options to choose from:

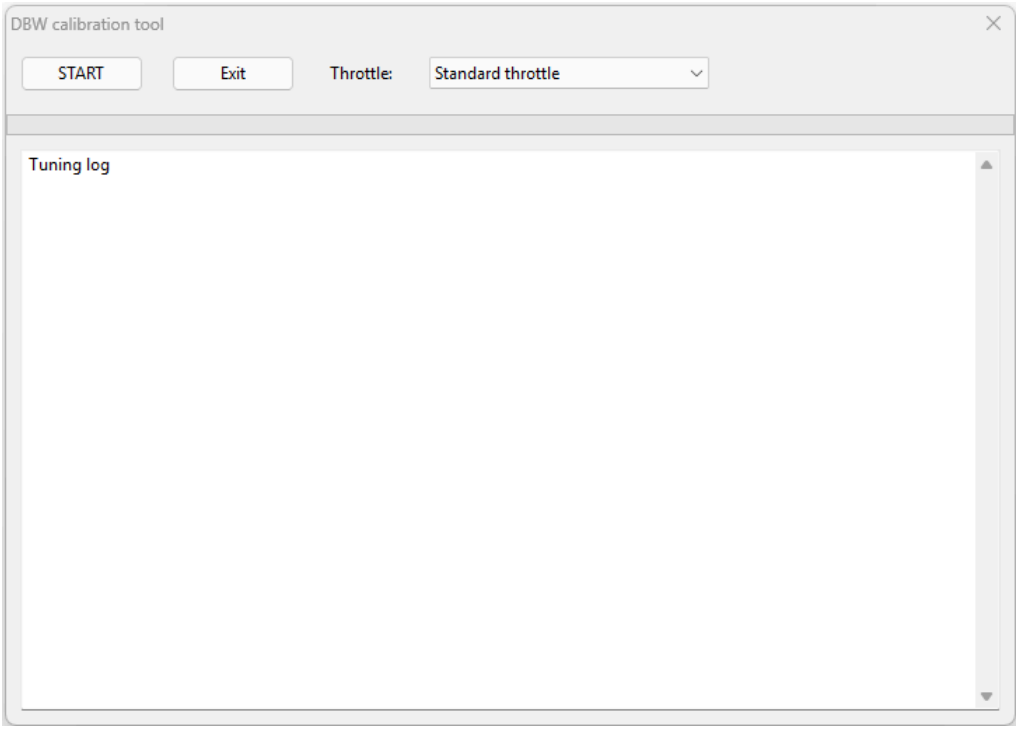
1. **Quit** - exit the program
2. **Enter password** - enter the password.
3. **Load package** - allows loading an encrypted package with settings. If the password with which it was saved is identical to the password in the ECU, firmware, and calibration, it will be saved on the device. This allows sending clients new calibration versions without revealing their contents. This function is not yet available.
4. **Restore to default** - restores the device to factory settings. It removes all data and the password.

11.11. DBW calibration tool

The ***DBW Calibration Tool*** is used for automatic throttle calibration.

The *DBW Calibration Tool* window can be opened from the *Tree View* panel or from *Menu / Tools*.

It helps to correctly set up the throttle and its position sensors (TPS, and PPS).



Before Start

Before starting the calibration, make sure the throttle and position sensor are connected correctly.

We recommend temporarily setting the following inputs to **None**:

- *Sensors and Inputs / TPS, PPS / TPS / Check and Sensors*
- *Inputs / TPS, PPS / PPS / Check Signal Input*

This allows the calibration to run even if the TPS or PPS tolerance tables are not properly set.

Next, enable the DBW strategy by checking the **Enable** option in ***DBW Parameters***.

Then, select the ***PWM signal frequency*** for the throttle motor under *DBW Parameters / Output Frequency*.

If you are not sure about the correct value, leave the default 4000 Hz.

Checking the Throttle Connection

To check if the throttle is connected correctly, open *DBW / Overrides*.

Turn on *Override DC*, and you will be able to control the throttle motor manually.

When you change the *DC Value*, the throttle should move — you can see this in the *TPS channel*.

If throttle movement matches changes in DC Value, the connection is correct.

Selecting the Throttle Type

In the *DBW calibration tool*, there is a dropdown menu to select the throttle type.

This helps the system optimize the calibration process.

- For most standard throttles connected directly to the EMU's H-Bridge, select **Standard throttle**.
- For BMW S54 ITB throttles, select **BMW S54 ITB**.

If everything is connected properly, the automatic calibration should complete without issues.

Error Messages During Calibration

During calibration, the following messages may appear:

- **Make sure the engine is not running**
  Calibration must be done with the engine off.
- **The position of the throttle doesn't move. Please check if the position sensor and electric motor are connected correctly**
  No change detected in the TPS signal. Check the motor wiring and TPS input configuration.
- **Please correct the setting for the PPS check signal as it causes a DBW error!**
  An error was found in the pedal check signal. Set PPS Check to None during calibration.
- **Please correct the settings for the PPS main signal as it causes a DBW error!**
  Error in the main pedal position signal. Check the PPS main status log channel.
- **Please correct the settings for the TPS check signal as it is shorted to the ground / +5V**
  TPS check signal voltage is out of range. Check wiring or set TPS Check Input to None.
- **Please correct the settings for the TPS main and check signal as it reports an error**
  The difference between TPS main and TPS check exceeds tolerance. Review TPS tolerance settings.
- **Please correct the settings for the TPS main signal as it is UNASSIGNED / shorted to ground / shorted to +5V**
  The TPS main input is missing or has incorrect voltage. Check configuration and wiring.
- **The throttle doesn't move from the limp position / from 10% to 90%**
  No throttle movement detected. Check motor connection and TPS input settings.

Parameters Changed by the DBW Wizard

During calibration, the *DBW Wizard* automatically adjusts the following parameters:

- *DBW / Parameters / Enable*
- *DBW / Parameters / Disable when no RPM*
- *DBW / Parameters / TPS limp position voltage*
- *DBW / Parameters / Integrator reset threshold*

- *DBW / Parameters / Throttle plate speed limit*
- *DBW / Parameters / Invert motor direction*
- *Sensors and Inputs / TPS, PPS / Voltage for 0%*
- *Sensors and Inputs / TPS, PPS / Voltage for 100%*
- *DBW / PID above limp position / Proportional, Integral, Derivative gain, Friction factor*
- *DBW / PID below limp position / Proportional, Integral, Derivative gain, Friction factor*

Tables Changed by the DBW Wizard

- *DBW / Spring DC reference*
- *DBW / Friction characteristic*.

11.12. Calibrate WBO circuit

The ***Calibrate WBO Circuit*** function is used to calibrate the internal wideband oxygen sensor controller in the EMU Black.
The *Calibrate WBO Circuit* window can be accessed from *Menu / Tools*.
This calibration improves the accuracy of the lambda sensor readings, especially around Lambda = 1, and is recommended for EMU devices with PCB revisions older than “O”.

To perform the calibration:

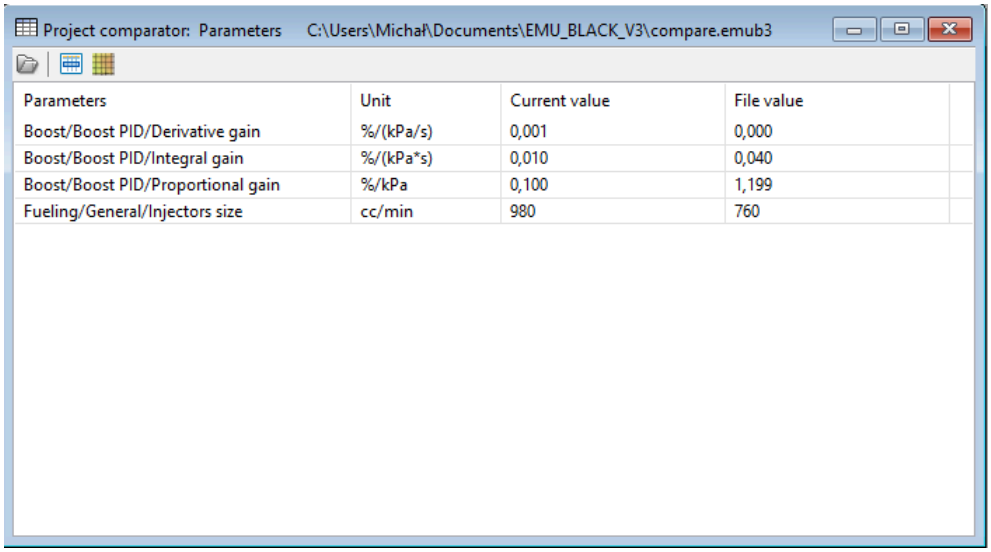
1. **Disconnect** the oxygen sensor plug from the EMU device.
2. In the ***Tools*** menu, select ***Calibrate WBO Circuit***.
3. The calibration will run automatically.

The current calibration value is stored in the Logbook (*Tools / Logbook*) and is independent of the loaded project or firmware.

11.13. Project Comparator

Project Comparator allows you to compare a project saved on disk with the project currently loaded in the Client's memory.

The *Project Comparator* window can be opened from *Menu / File*.



The comparison is performed separately for variables and tables.

When differences are found in variables, you can right-click on a selected item to access an option that lets you update the parameter in memory with the corresponding value from the project file.

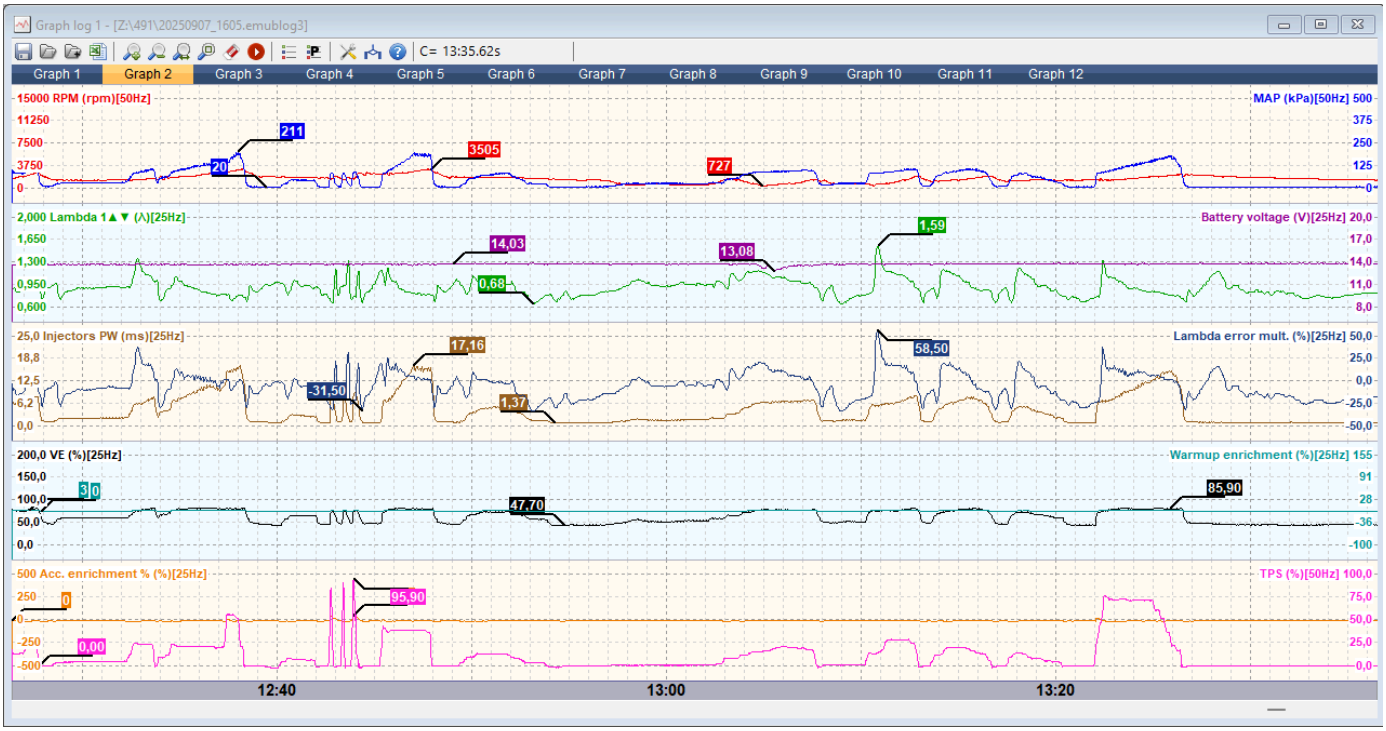
This tool is useful for verifying configuration differences, synchronizing projects between team members, or restoring specific settings without reloading the entire project.

12. Visualization and Analysis

Visualization and Analysis windows include tools for real-time data visualization, logging, and advanced analysis of system parameters and channel behavior. These windows help interpret results and monitor system performance.

12.1. Graph Log

The *Graph Log* window allows both real-time and offline visualization of data sent by the ECU. The *Graph Log* window can be opened from the *Tree View* panel, the toolbar, or *Menu / Tools*, and by pressing F6. All available channels are continuously logged and can be displayed as time-based graphs. This tool is essential for engine calibration, diagnostics, and performance verification.



Logging Channels

Channels are logged at fixed frequencies of 25 Hz, 50 Hz, 100 Hz, or 200 Hz depending on the channel. The logging frequency is always displayed next to the channel name.

The *Graph Log* window contains 12 independent tabs. Each tab can have a custom name, independent logging channels, and separate configuration. This allows grouping channels into functional categories (e.g., Fuel, Ignition, Boost) for easier analysis.

Toolbar

The toolbar in the *Graph Log* window provides quick access to the following functions:

- ***Save log*** – saves the current log data to a file on the PC.
- ***Open log*** – loads a previously saved log file from the PC, including logs recorded with the EDL device.
- ***Append log*** – adds log data from a file to the log currently stored in memory.

- ***Export to CSV*** – exports the log to a CSV text file for further analysis in external software (see more at the end of the chapter).
- ***Zoom In / Zoom Out*** – adjusts the visible time range (keys **Q**/**A** or **arrow up**/**down**).
- ***Zoom full out*** – displays the entire available log within the window.
- ***Zoom extent*** – fits the selected log area to the window (key **Z**).
- ***Clear log*** – removes all logged data.
- ***Pause / Resume log*** – pauses or resumes the display of new log values.
  When paused, you can freely navigate through past data. The pause function does not stop data collection from the device — all channels continue logging in the background. Once resumed, the data recorded during the pause is displayed.
  When connected to the device, pausing is required to inspect earlier data, otherwise the cursor follows the current point.
- ***Logged parameters*** – opens the *Select logged parameters* window.
- ***Log presets*** – displays a list of pre-configured channel layouts. Users can create, rename, delete, and restore presets to their default state.
- ***Channels config*** – opens the *Channel config* window (can also be accessed from the right-click context menu).
- ***Log condition*** – opens *Conditional log* window.
- ***C=*** – current position of the cursor on the time axis (when no range is selected).
- ***S=*** – start time of the selected range.
- ***L=*** – length of the selected range.

Main View

Data is displayed as time-based graphs. Channels can be rendered in two ways:

- **Lines** – linear interpolation between data points,
- **Dots** – exact ECU values at sampling times.

This is especially useful when analyzing low-frequency channels. The display mode can be switched at any time with **Shift + S**.

When logging is paused, new data continues to be collected in the background and will be displayed once logging is resumed.

Elements of the *Graph Log* panel:

1. **Channel panel** – displays the channels shown on a given chart along with the values indicated by the cursor. A channel can be selected either by right-clicking on the chart and choosing *Set log channel* from the context menu, or by double-clicking a channel name to open the *Channel config* window directly.
2. **Cursor**
3. **Value axis** – a single chart can display a maximum of two channels. One channel is shown with its name, axis, and values on the left side, while the second channel is shown on the right side.
   When ***Autoscale*** is enabled, the max and min values of displayed channels are calculated automatically. Two small triangles next to the channel name indicate that autoscaling is active. When disabled, no triangles are shown. Autoscale can be enabled or disabled in the *Channel config* window.
4. **Time axis** - shows time elapsed from the beginning of the log.

Navigation in the *Graph Log* panel

Selecting an area – click and hold the left mouse button, then drag to select a time range. Release to complete the selection. If a selection exists, holding Shift and using the arrow keys moves the selection along the time axis without changing its width.

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

Command	Description
Set log channel	Replace the selected channel
Setup channel	Display the *Channel config* window for the channel
Change preset	Allows the user to quickly change all channels in the current graph tab to a preconfigured setup. The presets can be modified by the user.
Zoom	Includes zoom in, zoom out, zoom full out, and zoom extent functions. Allows focusing on the selected part of the log.
Crop to selection	Cuts the log to the selected part. The cropped log can be saved.
Change line style	Toggle line style (continuous / discrete) (key **Shift + S**)
Hide	Removes channel from graph
Create dyno graph	Requires a selection; creates a dyno graph from the selected data.

Channel config

Parameter	Description
Log channel	Name of the edited channel
Min value	Minimum value of the axis (used when *Autoscale* is disabled))
Max value	Maximum value of the axis (used when *Autoscale* is disabled))
Redline	Redline used on gauges
Condition	Condition specifying alarm activation for values: ***Greater*** - greater than ***Alarm value*** ***Lower*** - smaller than ***Alarm value***
Enable alarm	Checking the box will activate the alarm (displayed on the application toolbar) if the condition defined in the ***Condition*** and ***Alarm value*** fields is met at the cursor position
Alarm value	Alarm value
Autoscale	This option causes the range of values to be calculated automatically based on the logged data

If a new channel is added or an existing channel is changed, the channel selection window appears. For easier searching, enter the channel name in the search field to filter available channels (e.g., typing “rpm” shows only channels containing “rpm”).

Log presets

The Log presets function displays a list of pre-configured channel layouts.

In the Manage presets window, users can rename, reorder, delete, or restore presets to their default state.

Export to CSV

The Export to CSV function allows saving log data to a CSV file with customizable options.

Note that the CSV file size may be significant (approximately 5 MB per 1 minute of logging).

If a range of the log is selected, only that range will be exported.

After clicking the Export to CSV icon, a selection window appears with the following options:

- Export – choose whether to export only visible channels (*Only visible*) or all available channels (*All channels*).

- Frequency – defines the export frequency. Channels with a native logging frequency equal to or higher than the selected value (e.g., RPM, Analog inputs) are exported at that rate. All other channels are exported at 25 Hz. Higher frequency results in a larger file size.
- Estimated file size – displays the approximate size of the resulting CSV file in MB.

Keyboard Shortcuts

Shortcut	Description
0–9 or **Ctrl +** ← / →	Switch between tabs
↑ / ↓ or **Q / A**	Zoom in / zoom out
Z	Zoom to selected area
Shift + S	Toggle line style (line / dots)
M	Place a flag marker (red dot on the axis) in the log at the current moment (only when logging is active)
←/→	Shifts the graph left or right by a small step, while the cursor stays in a fixed position
Shift + ←/→	Shifts the graph left or right by a large step, while the cursor stays in a fixed position
Home	Moves to the start of the log
End	Moves to the end of the log

General Options – Logging configuration

In the *General Options* window (available from the main menu or the application toolbar), you can configure global settings for logging:

Parameter	Description
Stop logging when paused	When disabled, even if the log is paused, the EMU Black continues recording data in the background. When unpaused, all pending samples are then drawn on the graph.
Auto save logs	Automatic saving of logs onto the hard drive
Display system time	If enabled, displays system time (hour, minute, second) on the graph log x-axis. Otherwise, shows time from the start of logging.
Display min values marks	Displays the moments and values of minimum points on the log.

Parameter	Description
Display max values marks	Displays the moments and values of maximum points on the log.

12.2. Scope

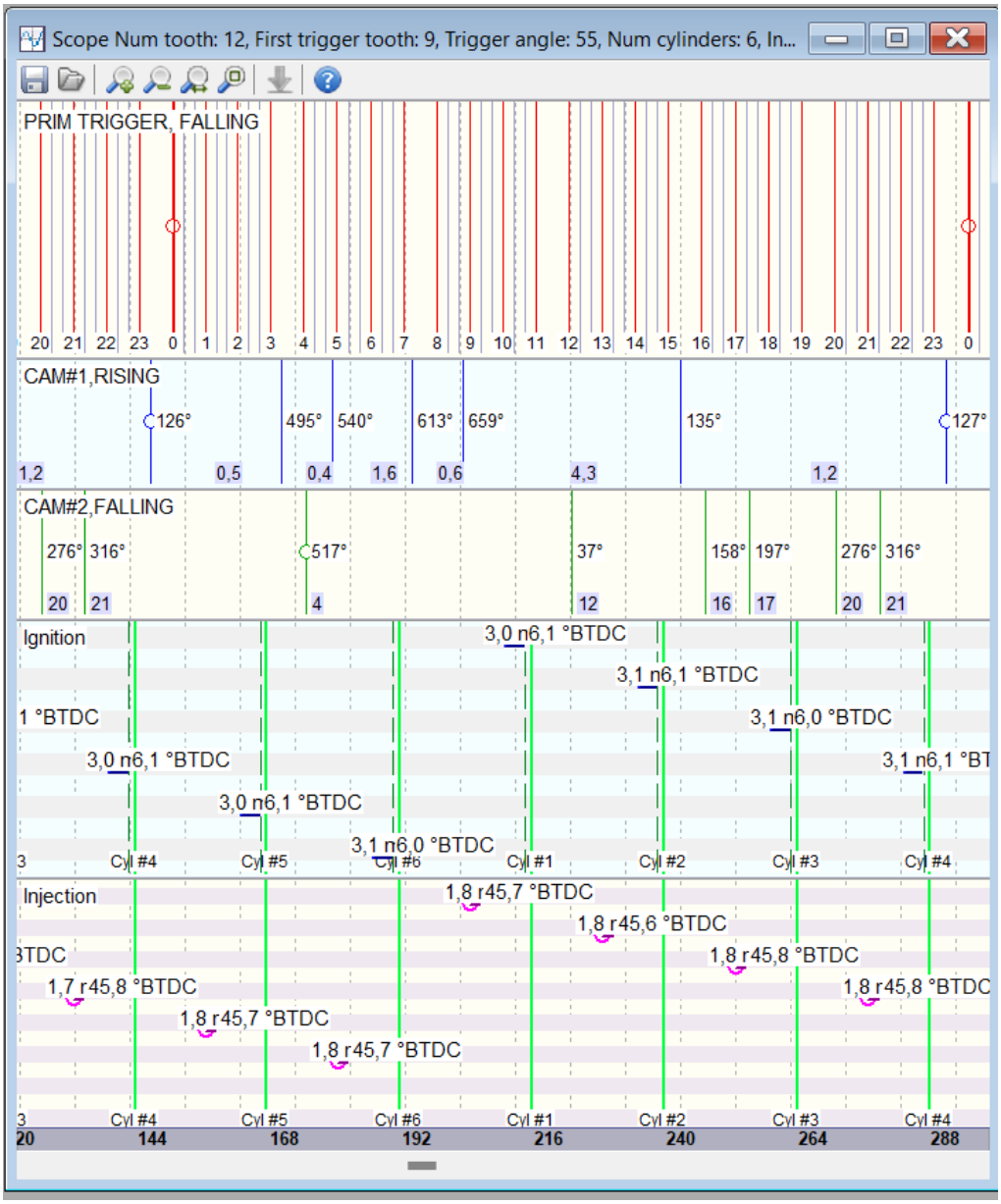
The ***Scope*** tool allows visualization of pulses from the **Primary Trigger**, **CAM1**, and **CAM2** sensors for diagnostics, technical support, and verification of correct configuration.
The *Scope* window can be opened from the *Tree View* panel, the toolbar, or *Menu / Tools*, and by pressing F5.
It also assists with configuring the **VVTi system**.

Additionally, Scope enables visualization of:

- Ignition system operation (dwell time, spark angle)
- Fuel system behavior (injector opening times and moments)

The captured data also includes:

- Number of cylinders
- Primary Trigger configuration
- Firing order
- Selected signal edge details



Toolbar

The toolbar icons and their functions are described below:

- ***Save scope*** – save current scope data to file
- ***Open scope*** – open previously saved scope data from file
- ***Zoom In*** – zoom in the view (key **Q** or **arrow UP**)
- ***Zoom Out*** – zoom out the view (key **A** or **arrow DOWN**)
- ***Zoom full out***
- ***Zoom extent*** – zoom selected area (**Z** key)
- ***Get scope data*** – start to gather the data
- ***Help*** – displays a contextual description for the currently selected *Scope* section or function

Acquiring Scope Data

1. Configure the trigger system, including sensor types and trigger settings.
2. Click the **blue arrow** in the Scope toolbar.
3. A progress window will appear indicating data acquisition.
4. Start cranking the engine.
5. The progress bar shows the buffer filling; when complete, collected data is displayed automatically.
6. You may click **Cancel** at any time – data collected up to that point will be shown.

If the progress bar does not move, EMU is not detecting pulses on the Primary Trigger, CAM1, or CAM2 inputs.

Scope Window Sections

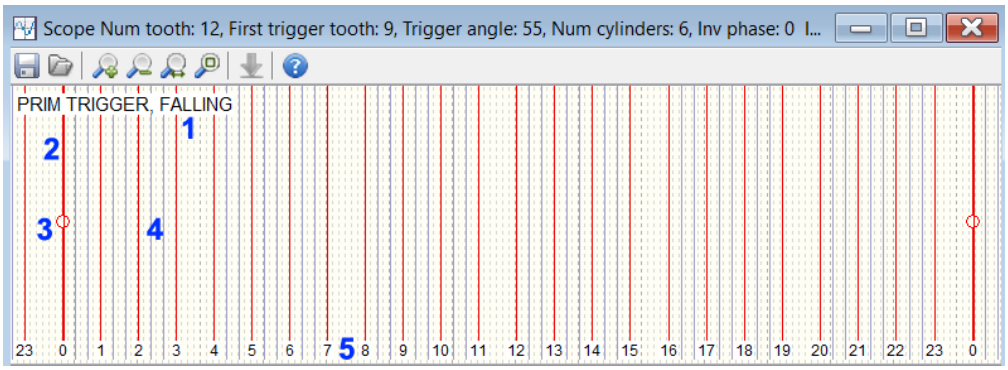
Below is a sample scope capture from a Nissan VQ35 engine. The scope window is divided into five separate sections, each visualizing the following signals:

- Primary trigger pulses
- CAM#1 pulses
- CAM#2 pulses
- Ignition outputs
- Injection outputs

Additional information is displayed in the title bar of the scope window. The title bar contains the following information:

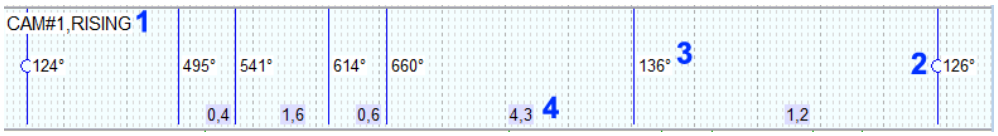
- Number of defined teeth
- First trigger tooth
- Trigger angle
- Number of cylinders
- Phase inversion
- Defined firing order
- Ignition angle (ignition angle at the moment the data was captured)
- File path (if the data was opened from a saved file)

The picture below shows the **Primary trigger** section of the scope.



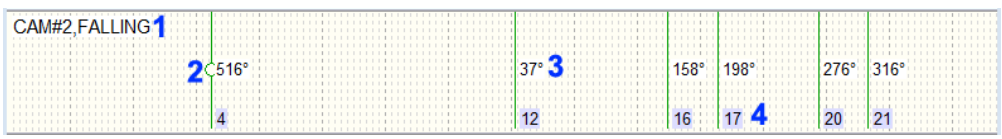
1. Selected trigger edge – indicates whether the rising or falling edge is used (Falling, Rising).
2. Thick red line – marks the synchronization point of the trigger decoder (e.g., missing tooth).
3. Red circle on the red line – indicates the cycle synchronization point.
4. Red lines – represent trigger pulses. Gray lines – represent ignored pulses (for multitooth-type triggers). To capture these, the Take skipped edges on scope option must be enabled in the Primary trigger settings.
5. Primary tooth index (full cycle) – shows the index number of each tooth within the complete engine cycle

The picture below shows the **CAM#1** section of the scope.



1. Selected trigger edge – indicates whether the falling or rising edge is used.
2. Blue circle on blue line – represents the CAM #1 synchronization point.
3. The pulse angle (0–720) – indicates the angle position of the pulse within the full engine cycle.
4. Factor value – the ratio of times between consecutive CAM teeth. This value is used in the configuration of CAM #1 patterns, such as: Shorter than factor, Longer than factor, Factors sequence

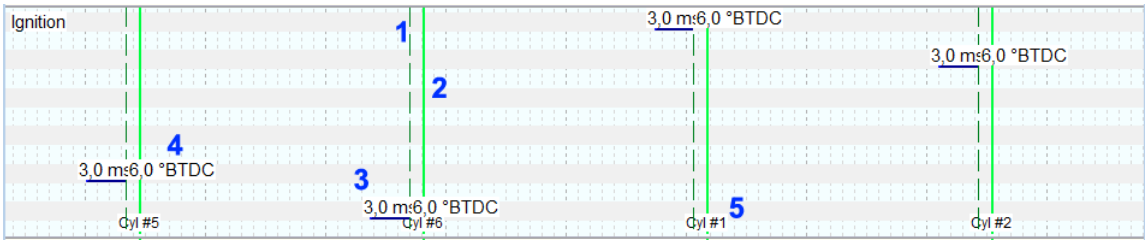
The picture below shows the **CAM#2** section of the scope.



1. Selected trigger edge – indicates whether the falling or rising edge is used.
2. Green circle on green line – marks the CAM #2 synchronization point.

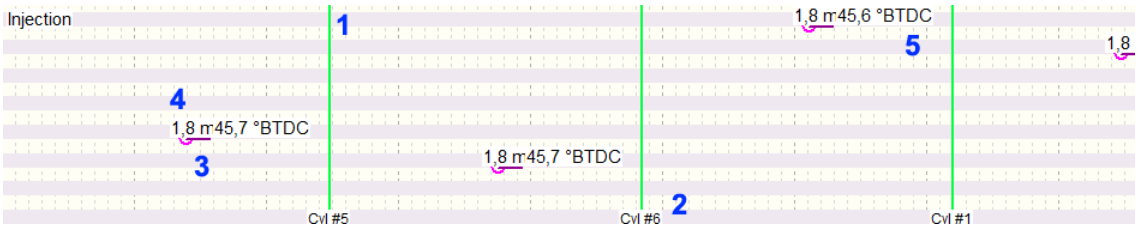
3. Scope pulse angle (0–720) – indicates the angle of the pulse within the full engine cycle.
4. Nearest primary tooth – shows the closest primary trigger tooth. This information is useful when configuring the Primary Teeth Window pattern.

The picture below shows the **Ignition** section of the scope.



1. Dashed line – indicates the expected spark angle.
2. Green line – marks the Top Dead Center (TDC) of the corresponding cylinder.
3. Blue line – represents the dwell time, with the dwell duration value displayed.
4. Real spark angle – shows the actual ignition timing at which the spark occurred.
5. Cylinder index – indicates the cylinder number for the corresponding ignition event.

The picture below shows the ***Injection** section of the scope.

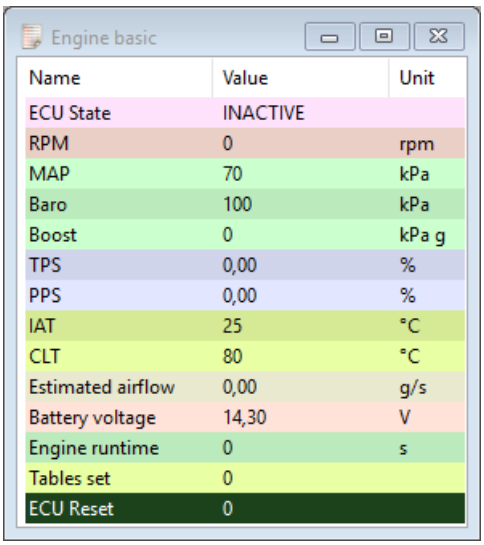


1. Green line – marks the Top Dead Center (TDC) of the corresponding cylinder.
2. Cylinder index – indicates the cylinder number.
3. Line indicates injection duration – a horizontal line showing the injector opening period; the purple circle marks the Start of injection.
4. Injection time (ms) – displays the injection duration in milliseconds.
5. Injection end angle – indicates the angle in degrees before TDC at which the injection ends.

The Scope tool is an essential diagnostic feature that helps verify trigger setup, ignition and injection timing, as well as VVTi configuration.

12.3. Text Log

The ***Text Log*** allows real-time monitoring of selected engine parameters. This window can be opened from the corresponding category in the *Tree View* panel. Parameters are grouped according to their function, making it easier to track the operation of specific systems, such as *Idle Control*. The *Text Log* window displays channel values in a table format.



When the EMU is connected, the Text Log can display either Live data or Cursor values, depending on the cursor position in the Graph Log. Both modes work the same way whether the Graph Log is paused or running:

- **Live data** - shown when the cursor is not pointing at the *Graph Log* (i.e. outside of the graph area).
  Text is displayed with standard (regular) font.
- **Cursor values** - shown when the cursor is placed on a specific point in the *Graph Log*.
  Text is displayed in italic font.

Once the cursor is moved away from the *Graph Log*, the *Text Log* automatically switches back to showing live data.

Each row in the table shows:

- Channel name
- Value
- Unit

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

Command	Description
Add to Custom	Adding a channel to *Custom* panel

Custom Text Log

The user can create three separate custom logging groups. Any channel can be assigned to one or more of these groups: ***Custom 1***, ***Custom 2***, and ***Custom 3***.

Adding a Channel to a Custom Group:

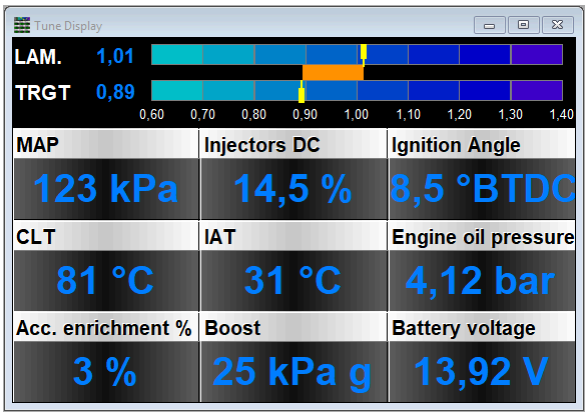
1. In any *Text Log* window, right-click on the desired channel.
2. Select *Add to Custom*, then choose the appropriate group (*Custom 1, Custom 2,* or *Custom 3*).

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

Command	Description
Add to Custom	Adding a channel to another *Custom* panel
Remove from Custom	Removing a channel from the *Custom* panel
Move up	Moving the selected row up (***Alt + Up***)
Move down	Moving the selected row down (***Alt + Down***)

12.4. Tune Display

This window allows you to view and analyze relevant engine channels in real time, providing an overview of the current tuning status and helping to monitor adjustments during operation.
The *Tune Display* window can be opened from the *Tree View* panel, the toolbar, or *Menu / Tools*, and by pressing F7.



When the EMU is connected, the *Tune Display* shows either:

- **Live data** (displayed in green) – shown when the cursor is not pointing at the *Graph Log*.
- **Cursor values** (displayed in blue) – shown when the cursor hovers over a specific point in the *Graph Log*.

This works the same whether the *Graph Log* is paused or not. Once the cursor is moved away from the *Graph Log*, the *Tune Display* automatically switches back to showing live data.

Lambda target with companion of lambda sensor readout in graphical form is displayed on the of the window.

Context menu

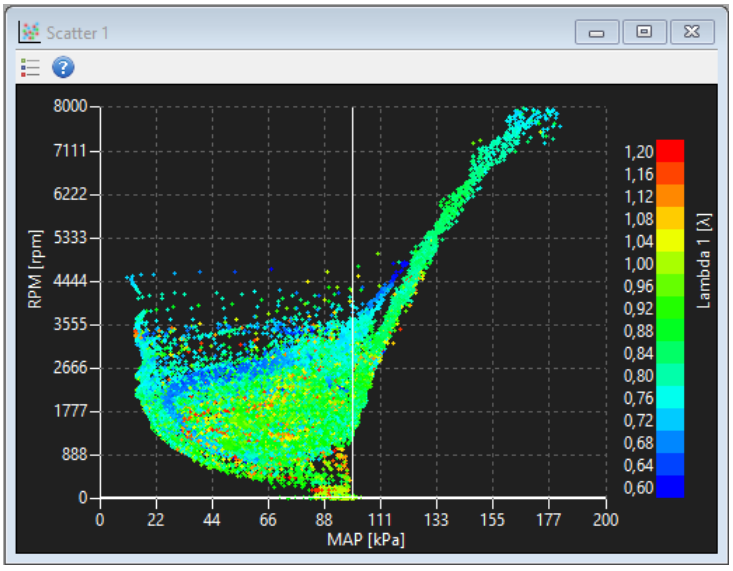
Right-clicking on the grid area opens the context menu. The following options are available:

Command	Description
Grid size	Adjusts the size of the grid cells.
Set log channel	Assigns a specific log channel to the selected grid cell.
Channel	Opens the *Channel config* window, allowing you to configure or change the properties of the selected channel.

12.5. Scatter Plot

The Scatter Plot is a powerful diagnostic and visualization tool. The *Scatter Plot* window can be opened from the *Tree View* panel. It allows you to display logged data points on a 2D chart with an optional third dimension represented by color.

- The X and Y axes can be assigned to any available log channels (e.g., RPM, MAP, IAT, Throttle Position).
- The Z axis is represented by a color gradient, allowing for visualization of a third parameter such as Lambda, Knock Level, or Ignition Angle.



For each logged data sample, a single point is plotted on the chart. Over time, this creates a cloud of points that illustrates how the engine operated across the selected parameters.

Example usage:

- RPM vs. MAP with color representing Lambda to analyze fueling consistency.
- TPS vs. RPM with color showing Ignition angle to review spark advance strategy.
- IAT vs. RPM with color for Knock level to evaluate detonation sensitivity under varying temperatures.

Configuration

- **X,Y,Z Axis channel** - specifies the log channel assigned to the X, Y, or Z axis of the scatter plot. The range (minimum and maximum values) for each axis is taken automatically from the graph log configuration for the selected channel.
- **X,Y,Z Axis filter samples** -specifies the number of samples used in the moving average filter for the X, Y, and Z axis channels. This filter smooths the displayed data by averaging a specified number of recent log samples, helping to reduce noise and fluctuations in the scatter plot.
- **Point size** - defines the size of the points displayed in the scatter plot. Increasing point size can reduce rendering performance, especially when displaying a large number of points.

Displayed data range

The range of data shown in the scatter plot depends on the selection made in the Graph Log window:

- If a region is selected in the graph log, only the points within that selection will be displayed.
- If no selection is made, all logged data points will be shown.

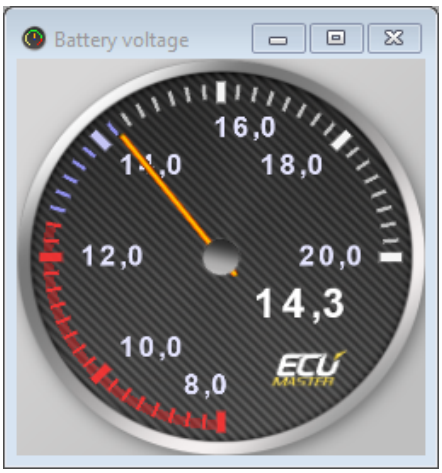
Note:

Displaying all points from large logs may negatively impact application performance. For optimal responsiveness, it is recommended to work with selected data ranges when analyzing large logs.

This behavior allows for flexible and efficient data inspection, especially when focusing on specific events or operating conditions.

12.6. Gauge

The ***Gauges*** tool provides real-time information on selected parameter values. The *Gauge* windows can be accessed from the *Tree View* panel. In addition to the analog display with a needle on a 270-degree scale, the gauge also shows the exact value in digital form. Examples are shown in the picture below.



When the EMU is connected, the *Gauge* shows either:

- Live data – shown when the cursor is not pointing at the *Graph Log* (i.e. the cursor is outside of the graph area).
  (For Value and Bar type gauges, live data is highlighted in green. For the Round type gauge, live data is shown in the standard form - no color highlight).
- Cursor values – shown when the cursor hovers over a specific point in the *Graph Log*.
  (Displayed in blue for all gauge types.)

This works the same whether the *Graph Log* is paused or not. Once the cursor is moved away from the *Graph Log*, the *Gauge* automatically switches back to showing live data.

Context menu

Right-clicking on the *Gauge* area opens the context menu. The following options are available:

Command	Description
Gauge type	Selects the type of gauge: **Round** - analog needle with digital value **Value** - numeric display **Bar** - bar indicator
Size	Resizes the gauge to one of three predefined sizes: **Small** - 128 px

Command	Description
	Medium - 196 px **Big** - 256 px Optimal aspect ratio is applied for each type.
Channel properties	Opens the *Channel config* window, allowing you to configure or change the properties of the selected channel.

General Options – 3D tables configuration

In the *General Options* window (available from the main menu or the application toolbar), you can configure global settings for Gauges:

Parameter	Description
Default gauge size	Defines the default size of newly created gauges: Small, Medium, Big.
Default gauge type	Defines the default type of newly created gauge: **Round** (analog needle with digital value), **Value** (numeric display), **Bar** (bar indicator).
Round gauge style	Defines the default visual style of round gauges: Standard, Deep Ocean, Amber Gold.

12.7. Dyno

A built-in **Dyno feature** allows users to generate a power and torque graph based on a road test. The *Dyno* window can be opened from the *Tree View* panel. This function is useful when a professional chassis dynamometer is not available.

The Dyno system consists of two parts:

- **Dyno Window** – displays the generated graph. Here, you can view and analyze relevant information.
- **Dyno Parameters** – the configuration window where vehicle parameters and calculation settings are defined.

How it works

1. Define the vehicle parameters in the Dyno Paramblock.
2. Perform a full-throttle acceleration run on a flat road using a single gear (typically 3rd or 4th).
3. Record the log.
4. In the Log Window, select the region where engine speed increases steadily (no wheel slip, clutch slip, or gear shift).

5. Right-click the selection and choose *Create dyno graph*.
6. The program generates a separate Dyno Window with calculated power and torque curves.
7. Optionally, overlay additional logged channels such as Lambda, Boost, or Intake Air Temperature (IAT).

Note:
Always perform tests on a safe, closed, and flat road.
Use a single gear without shifting during the measurement.
Ensure there is no wheel slip for accurate results.
Accuracy strongly depends on correct vehicle parameters and environmental conditions (wind, slope, tire pressure).
This function is intended for tuning and comparison purposes only. For certified measurements, use a professional chassis dynamometer.

Dyno configuration

Parameter	Description
Coefficient of drag	Aerodynamic drag coefficient (Cd) of the vehicle body.
Frontal area	Vehicle frontal area in square meters (m²).
Car mass	Vehicle total mass including driver and fuel (kg).
Drivetrain efficiency	Efficiency factor (0–1), accounting for mechanical losses between the engine and driven wheels.
Vehicle speed	Defines whether the calculation uses measured vehicle speed or derives it from engine RPM and gear ratio.
Vehicle speed at 3000 RPM	If the option to calculate vehicle speed from engine RPM is selected, this parameter defines vehicle speed at 3000 RPM in the selected gear.
Min RPM / Max RPM	Lower and upper RPM boundaries used for calculation; data outside this range is ignored.
Show IAT	Enables/disables overlay of Intake Air Temperature on the Dyno graph.
Show mixture	Displays the mixture channel (Lambda or AFR) on the Dyno graph.
Show pressure	Displays intake pressure (MAP) or Boost on the Dyno graph.
Show AFR / Show MAP	Additional options to overlay mixture or pressure channels.
RPM ratio	Used for speed calculation when deriving vehicle speed from RPM.

Parameter	Description
Filter power	Smooths the calculated power curve.
Aero correction	Adjusts results for aerodynamic drag.

13. Software Setup

Software Setup windows include tools for configuring general software settings, customizing the user interface, and managing available strategies. These windows simplify software configuration and provide easy access to help information.

13.1. General Options

The *General Options* window can be opened from the toolbar or from *Menu / Tools*.
The *General Options* window contains the following settings:

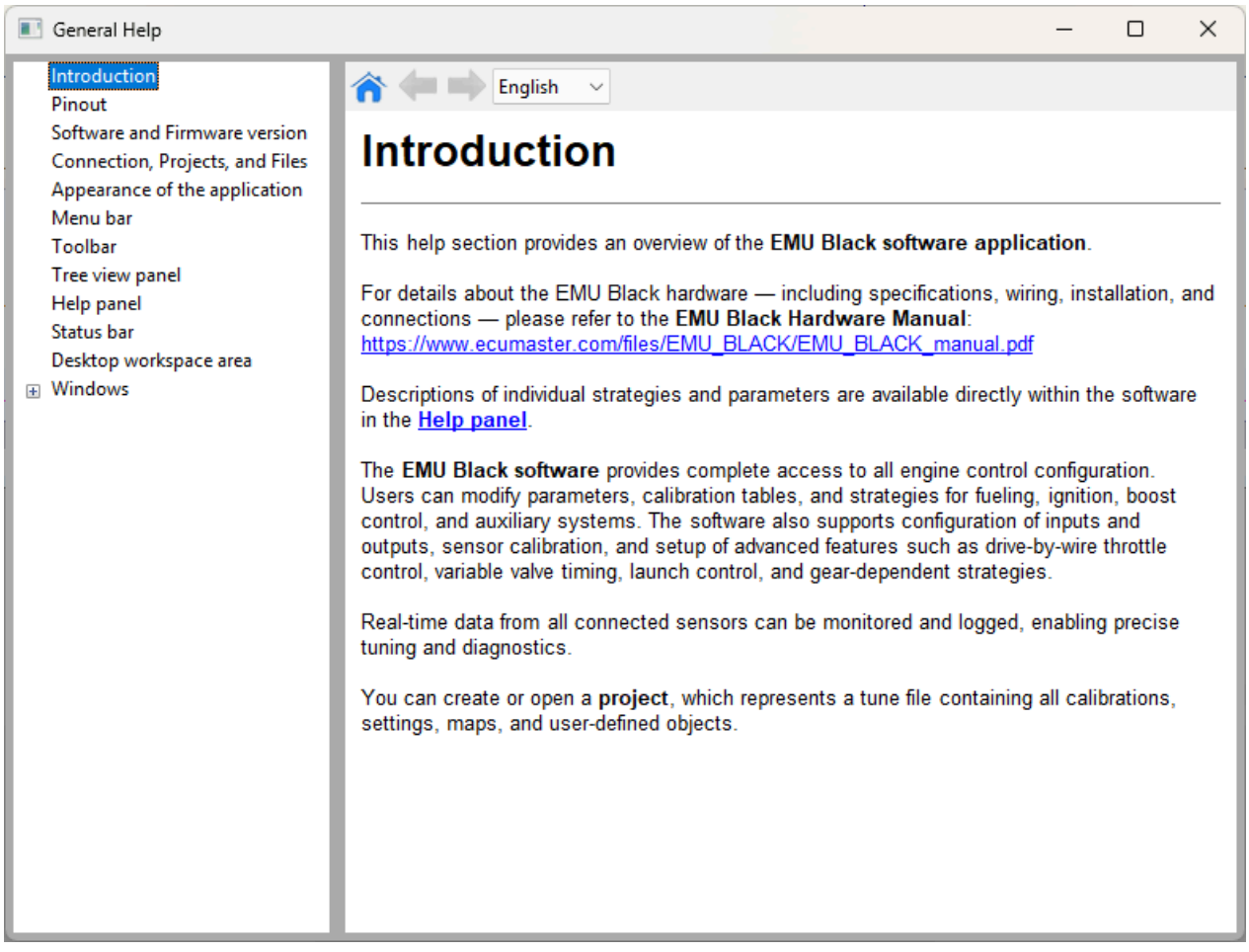
Option	Description
Appearance	Defines the default appearance of the application: **Standard** (light mode) or **Dark mode** (dark interface).
Units	***Metric*** - default units system ***Imperial*** - imperial units system (°F, mph, psi ...)
Parameters panel size	Sets the size of the *Tree view* panel. It can be changed here or by dragging the panel edge.
Show toolbar	Show/hide main application toolbar.
Mark modified cells	When a cell value is changed in the table, it is marked with a yellow triangle.
Load ECU desktops	Loads the desktops last used with the ECU.
New 2D table size	Defines the default size of a newly created 2D table: Small, Medium, Big.
Tables colour	Defines the color scheme of the 2D table graph. Available options: Standard, Blue-Violet, Blue-Green-Red.
Color scheme	Defines the color scheme of the 3D tables. Available options: Standard, Blue-Violet, Blue-Green-Red.
Load on Y axis	Sets the load axis direction in VE, AFR, and IGN tables

Option	Description
Display square tables	Makes rectangular tables appear more square by increasing cell height
New 3D table appearance	Defines how newly created 3D tables are displayed: **Table and Graph** shows both views; **Only Table** displays numerical data only.
New 3D table size	Defines the default size of a newly created 3D table: Small, Medium, Big.
Cubic 3D graph	3D table visualization is displayed with constant aspect ration instead of filling all available space.
Stop logging when paused	When disabled, even if the log is paused, the EMU Black continues recording data in the background. When unpaused, all pending samples are then drawn on the graph.
Auto save logs	Automatic saving of logs onto the hard drive
Display system time	If enabled, displays system time (hour, minute, second) on the graph log x-axis. Otherwise, shows time from the start of logging.
Display min values marks	Displays the moments and values of minimum points on the log.
Display max values marks	Displays the moments and values of maximum points on the log.
Default gauge size	Defines the default size of newly created gauges: Small, Medium, Big.
Default gauge type	Defines the default type of newly created gauge: **Round** (analog needle with digital value), **Value** (numeric display), **Bar** (bar indicator).
Round gauge style	Defines the default visual style of round gauges: Standard, Deep Ocean, Amber Gold.
RTA algorithm	Defines the method used to calculate the corrected value for the current VE cell during Real-Time Auto-tuning.

Option	Description
RTA delay(ms)	Specifies the time interval (in milliseconds) between consecutive lambda re-evaluations for the selected cell. This delay helps ensure that each VE adjustment is based on a stable, settled lambda value.
RTA power factor(%)	Determines what percentage of the newly calculated theoretical VE value is applied to the current VE cell. Example: If the current VE is 40, the algorithm calculates a target of 50, and the RTA Power Factor is set to 50%, the updated VE cell value will become 45.
Don't ask at app exit	Decide if you want to see the "*Are you sure you want to exit the application?*" message.

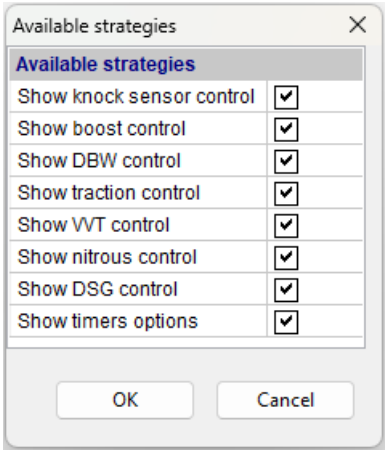
13.2. Help

The General Help window provides information about the software (pinout, main menu, desktops, etc.) and can be accessed from the main menu or by pressing F1.



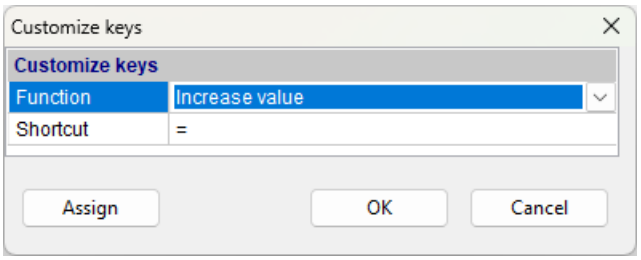
13.3. Available strategies

The list of available strategies. The *Available Strategies* window can be opened from the toolbar or from *Menu / Tools*. When the strategy is unchecked, it disappears from the parameters tree view. This helps to simplify navigation in the *Tree view* panel when a strategy is not used.



13.4. Customize keys

The *Customize keys* that allows user to change default keys assignment.
The *Customize Keys* window can be opened from the toolbar or from *Menu / Tools*.



To assign new keys combination, select function, press Assign button and then press the keys.

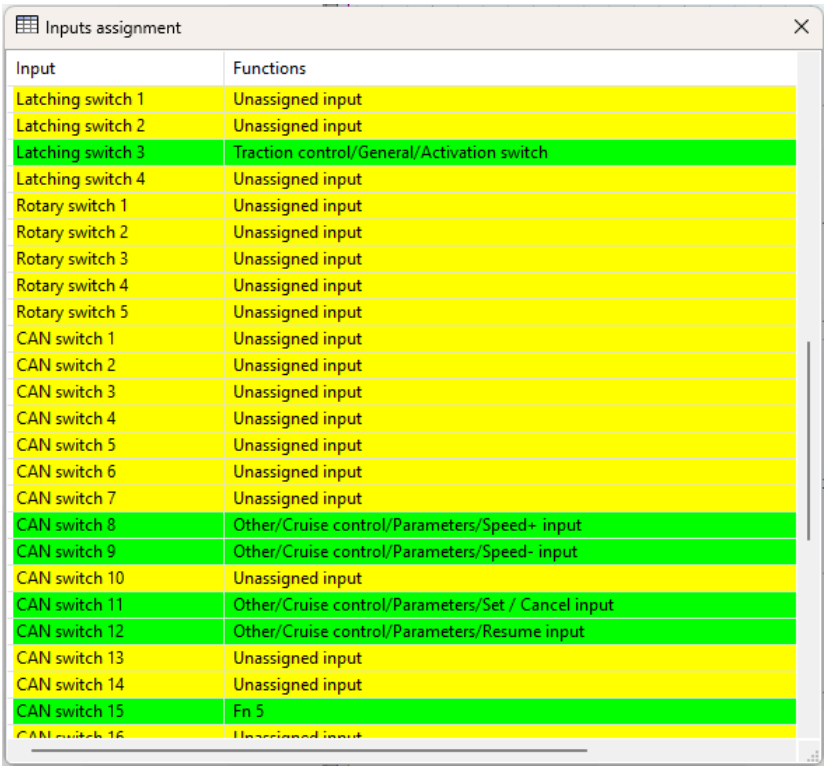
14. Tools

Tools windows include utilities and service tools for testing, assigning inputs and outputs, logging data, and performing diagnostic tasks. These windows support configuration, monitoring, and troubleshooting.

14.1. Inputs assignment

The *Inputs assignment* window shows the assignment of all EMU inputs to the corresponding functions and pins.

The *Inputs Assignment* window can be opened from the toolbar or from *Menu / Tools*.



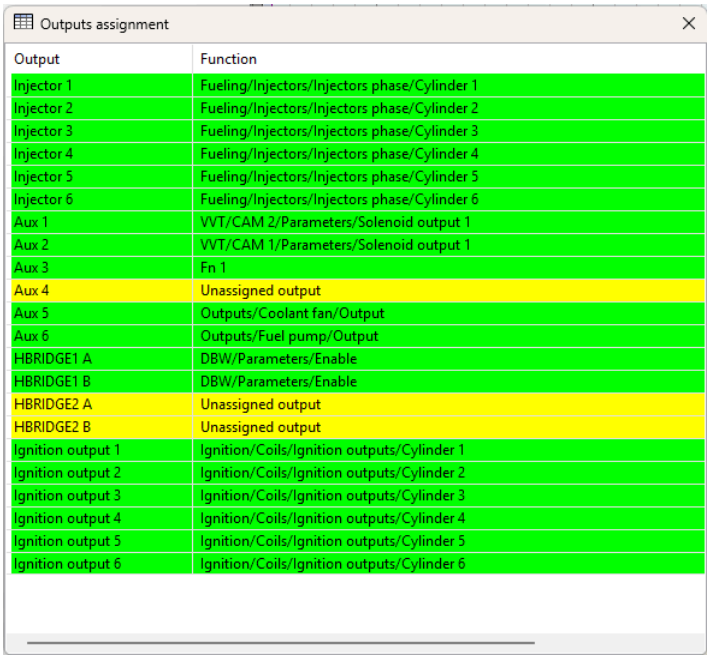
The colors indicate the status of each output:

- **Green** – input is used
- **Yellow** – input is unused
- **Red** – more than one function is assigned to the same input

14.2. Outputs assignment

The *Outputs assignment* window shows the assignment of all EMU outputs to the corresponding functions and pins.

The *Outputs assignment* window can be opened from the toolbar or from *Menu / Tools*.



The colors indicate the status of each output:

- **Green** – output is used
- **Yellow** – output is unused
- **Red** – more than one function is assigned to the same output

14.3. Test outputs

> **Note:**
> This feature is intended only for testing outputs and checking connections. Timing is approximate and does not follow the normal operation.

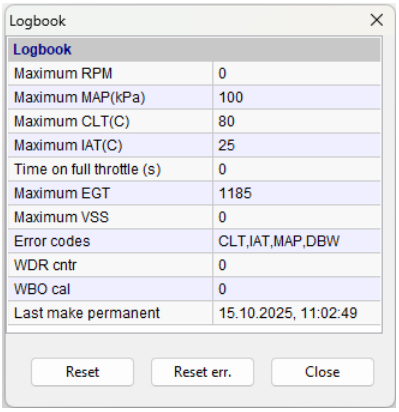
The *Test Outputs* window can be opened from the toolbar or from *Menu / Tools*.

Outputs test window allows to manually pulse the selected output. In the case of coils output, the signal polarity follows ignition output coil type settings. The maximum coil dwell time is limited to 20 ms per cycle, to prevent coil from damage. To perform the test, setup output, on/off times and press the Test button.

Parameter	Description
Output	Output to be tested
Num cycles	Number of on / off cycles during the test
Cycle on time	The time in ms during the output is activated
Cycle off time	The time in ms during the output is inactive

14.4. Logbook

Logbook stores the selected parameters in internal flash memory of the device. The *Logbook* window can be opened from the toolbar or from *Menu / Tools*. It can be a very good source of critical information like maximum registered coolant temperatures or maximum engine RPM (especial in the case of engine failure).



Parameter	Description
Maximum RPM	Maximum RPM registered
Maximum MAP (kPa)	Maximum MAP registered
Maximum CLT (C)	Maximum CLT registered
Maximum IAT (C)	Maximum IAT registered
Time on full throttle (s)	Total time spent with full throttle
Maximum EGT	Maximum EGT registered
Maximum VSS	Maximum vehicle speed registered
Error codes	Error codes registered since the last reset. More information is available in the Status bar *(on page 17)* section under *Check engine error codes (CEL).*
WDR cntr	Watchdog reset count
WBO cal	Value set by WBO sensor calibration
Last make permanent	Date/Time of last Make permanent operation

14.5. Set EDL-1 datalogger time

When using the EDL-1 data logger, the *Set EDL-1 datalogger time* function copies the PC time to the logger's internal clock.

The *Set EDL-1 datalogger time* window can be accessed from *Menu / Tools*.

14.6. Diff. oil bleed

The ***Diff. oil bleed*** function is used for bleeding the differential system. The *Diff. oil bleed* window can be accessed from *Menu / Tools*. It activates the differential pump while the bleed screw is open, allowing trapped air to be released. When the engine is off, the pump runs for a short, predefined period (e.g. 3 seconds) and then stops. The user can then release the pressure, close the bleed screw, and repeat the cycle as needed.

The function allows configuring the number of cycles and the off-time between them, similar to output testing. The operation is automatic and does not require an auxiliary output to be assigned.

14.7. Vehicle VIN

The *Vehicle VIN* option allows assigning a Vehicle Identification Number (VIN) to the ECU so that diagnostic OBD scanners can correctly read it.
The *Vehicle VIN* window can be accessed from *Menu / Tools*.

The VIN number is stored in a dedicated memory area inside the ECU and is not part of the project file — it is not saved or loaded together with the project.

14.8. Decode VW coding

In VW platforms (such as PQ35 and MQB), the ECU must transmit a specific coding structure to ensure full compatibility with other vehicle modules. The *Decode VW Coding* window can be accessed from *Menu / Tools*. This coding describes parameters such as the CAN stream version, gearbox type, engine code, and other vehicle configuration data.

If the coding of other modules (e.g. dashboard, ABS, DSG) does not match the coding of the engine ECU, some systems may not operate correctly or may trigger communication errors.

Before replacing the original ECU, it is therefore recommended to record the CAN traffic from the stock ECU using the USBtoCAN interface and the Light Client software.

The *Decode VW Coding* tool analyzes the recorded CAN data and extracts key configuration information, such as:

1. CAN version
2. Engine version
3. Gearbox code

4. MDI torque configuration
5. Number of cylinders
6. Engine type
7. Other relevant identifiers

After decoding, the tool can automatically populate the corresponding parameters in the VW CAN Stream configuration within the EMU software, ensuring proper communication and feature compatibility with vehicle systems.

15. 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.

16. Document history

Version	Date	Changes
1.0	2025.11.12	Initial release
1.1	2025.11.17	Corrected software version

17. Appendix A - How-to Prepare Files in EMU Black

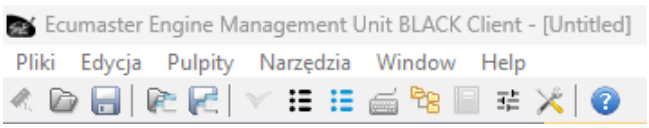
17.1. Introduction

Project, log, and scope files are essential when diagnosing issues or tracking changes made to an ECU setup. A project file stores all ECU settings, while log and scope files capture engine behavior during operation. These files can help compare configurations, identify issues, and share data for support or analysis. This guide applies to EMU Black V2 and V3 software.

17.2. ECU project file

ECU project files contain the current configuration of the ECU and are saved with the extension **.emub** or **.emub3** (for EMU Black V3).

To save the ECU project file (the current ECU configuration):
1. Click ***File*** in the main window toolbar or press **Ctrl + S**.
Alternatively, click the Save icon in the toolbar.



2. Choose the folder where you want to save the file and enter a project name.

17.3. Log file

A log file contains recorded channel data over time and is saved with the extension **.emublog** or **.emublog3** (for EMU Black V3). Although the *Graph Log* window displays only selected channels, all available data is recorded during logging and can be saved for future analysis.

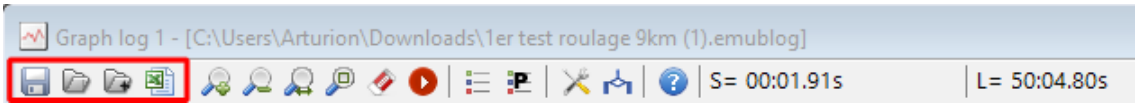
Note:
Data is temporarily stored during logging. If the file is not saved manually, the data will be lost.

Opening the *Graph Log* window

You can open the *Graph Log* window using one of the following methods:

- Via ***Treeview***: ***Log*** / ***Graph 1***
- By clicking the **Log graph icon** in the main toolbar
- From the menu: select ***Tools*** → ***Loggraph*** (or shortcut: **F6**) - available only in **EMU Black V3**

Graph Log toolbar icons

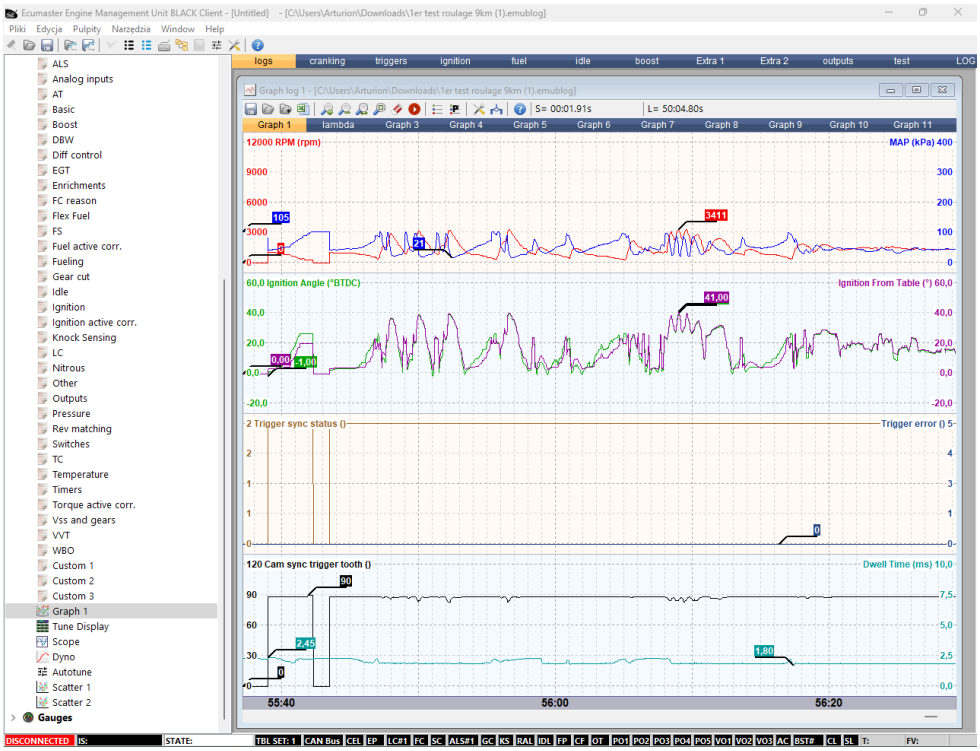


The toolbar in the Graph Log window includes the following icons:

- **Save log** – saves the currently recorded log data to a `.emublog` or `.emublog3` file
- **Open log** – opens a previously saved log file
- **Append log** – appends new data from an additional logging session to an existing log file
- **Export to CSV** – exports the log data to a `.csv` file for further analysis (e.g. in Excel)

To save a log file:

1. After logging the desired data, click the **Save icon** (floppy disk symbol) in the toolbar of the *Graph log* window.



2. Select the folder where you want to save the file and enter a file name.

17.4. Scope file

The scope file contains the decoded signals from the crankshaft, cam sync, and cam #2 sensors, which are displayed as lines in the ***Scope*** window. These files are saved with the extension **.emubscp** or **.emubscp3** (for EMU Black V3).

1. **Enabling Scope data capture**

In the *Treeview: Ignition / Triggers / **Primary trigger*** parameters window, enable the '**Enable scope**' option.

> **Note:**
> In **EMU Black V3**, the 'Enable scope' option is not available because Scope is always enabled.

2. **Opening the *Scope* window**

There are several ways to open the *Scope* window:

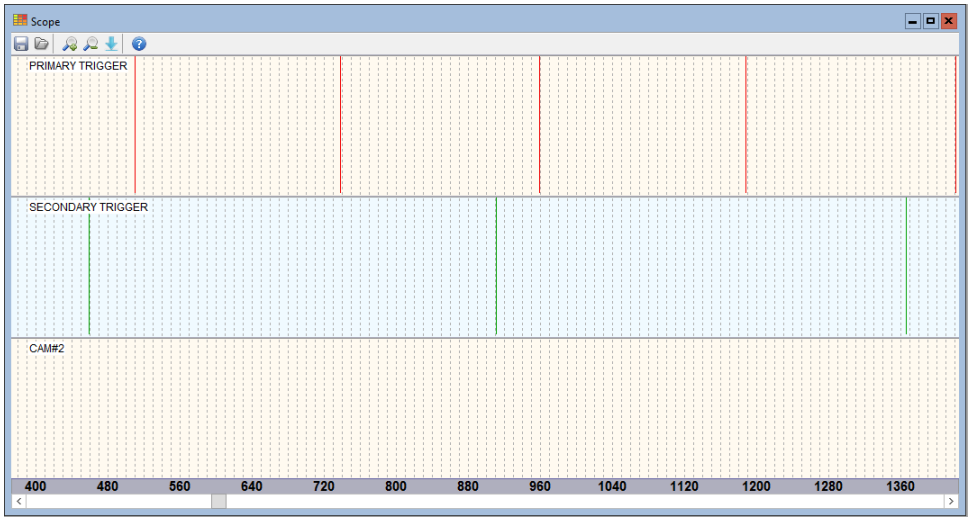
- Via ***Treeview***: ***Log / Scope***
- By clicking the **Scope icon** in the main toolbar
- From the menu: ***Tools*** → ***Scope*** (shortcut: **F5**) - available only in **EMU Black V3**

3. **Using the *Scope* window**

Using the *Scope* window

The *Scope* window is divided into three parts, each displaying the decoded signal from a specific sensor:

- PRIMARY TRIGGER – crankshaft sensor signal
- SECONDARY TRIGGER – cam sync sensor signal
- CAM#2 – secondary camshaft sensor signal

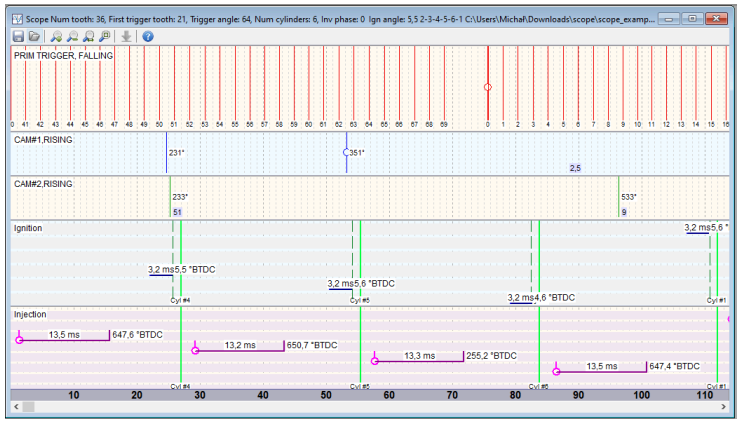


In EMU Black V3

Scope in EMU Black V3 additionally shows the signals from ignition and injection outputs.

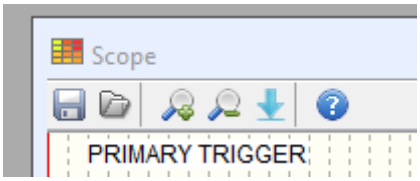
The title bar contains the following information:

- Number of defined teeth
- First trigger tooth
- Trigger angle
- Number of cylinders
- Phase inversion
- Defined firing order
- Ignition angle (ignition angle at the moment the data was captured)
- File path (if the data was opened from a saved file)



The toolbar in the *Scope* window includes the following icons:

- Save scope – saving the current scope data
- Open scope – loading a previously saved scope file
- Zoom In/Out – zooming in/out on the signal graph
- Get scope data (blue arrow icon)
- Help – opening help documentation



4. **Collecting data**

Signals will not appear automatically. To collect data:

1. Preconfigure the trigger system, including sensor types, trigger settings, etc.
2. Click the blue arrow located on the toolbar of the Scope window.
3. Start cranking the engine.

When the setup is correct, signals will appear in the graph.

Troubleshooting Scope data

If signals do not appear in the *Scope* window:

- Ensure that the sensors are wired correctly.
- Verify sensor type and polarity in the trigger settings.
- Check pull-up or pull-down resistor configurations.
- Confirm that 'Enable scope' is selected in the *Primary Trigger* parameters. *(only in EMU Black V2)*

Note:

Note: Without a valid *Primary trigger* (crankshaft) signal, the other sensors will not function (the cam sync and cam #2 signals will not be displayed).

17.5. Document history

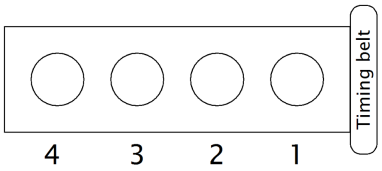
Revision	Date	Changes
1.0	2025.07.03	Initial release

18. Appendix B - How-to Configure Trigger in EMU Black

18.1. Ignition set up procedure

This guide covers the ignition setup procedure in EMU BLACK for both V2 and V3 software. Differences specific to V3 are marked with *In EMU Black V3*.

1. Set the engine to top dead center (TDC) on cylinder number 1. In most inline engines, cylinder number 1 is the cylinder closest to the timing belt/chain. In the case of V-engines, refer to the manufacturer's manual to accurately identify cylinder 1.



2. Make a mark on the timing belt/chain cover and the crankshaft pulley with the engine set at TDC. Use white paint or a corrector to create reflective marks for the timing light. If the engine is equipped with factory marks, ensure they match each other and use paint to make them more visible.
3. Connect the timing light to the high tension (HT) leads that connect the ignition coil to the spark plug in cylinder number one. If the engine is equipped with coil-on-plug ignition and there are no HT leads, remove the coil from cylinder number one and extend it with a spare HT lead to the spark plug. Secure the connection between the coil and HT lead with insulating tape.

> **Attention:**
> Do not connect the timing light inductive probe to the loop on the ignition signal wire to the coil. This mistake will lead to incorrect ignition timing settings.

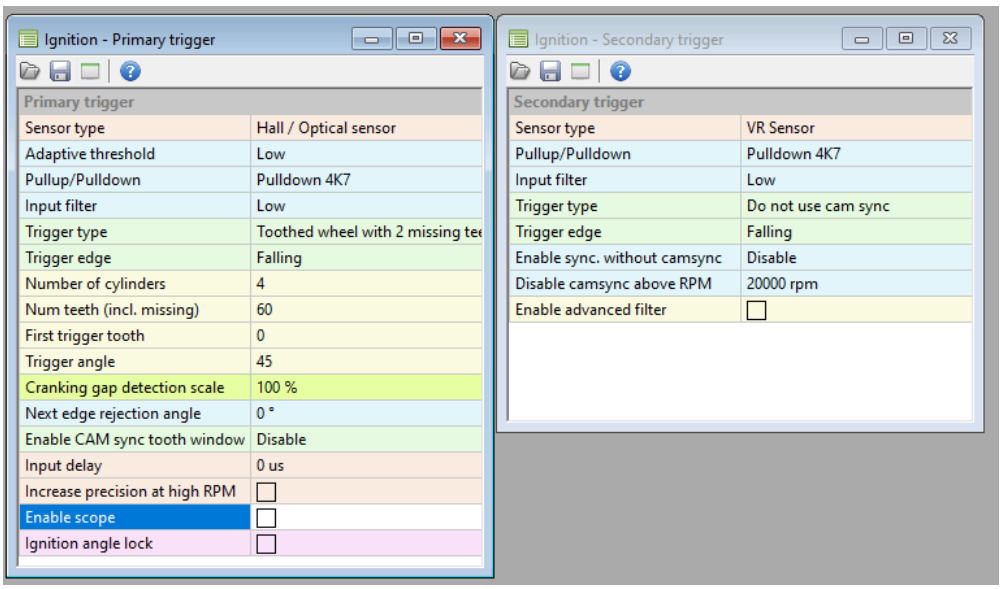
4. Open the EMU Black software and, from the *Tree View*, choose *Ignition* / *Coils* / ***Ignition Outputs***. Select spark distribution and the appropriate coil type. If the engine is equipped with passive coils, select *Coils without amplifier*. If the engine is equipped with active coils or an ignition module, select *Coils with built-in amplifier*.
5. Open the EMU Black software and navigate to *Tools* / ***Output Test***.
   Select: *Output* / *Ignition Out 1* and press the *Test* button.

If the coil type is selected correctly, the strobe lamp should flash when the trigger is pressed and a spark is generated. If the strobe lamp does not flash, remove the spark plug from the cylinder head, ground the spark plug electrode, and run the test again. Observe the spark plug for a spark. If no spark appears after pressing the *Test* button, check the selected coil type in the options, as well as the power supply and grounding.

6. With the timing light flashing when a spark is generated, open the *Ignition / Triggers / **Primary*** and ***Secondary Trigger*** configuration windows.
   Select the correct sensor type for the primary and secondary triggers.

   For the trigger type, select:
   - Primary: Multi-tooth
   - Secondary: 1 tooth

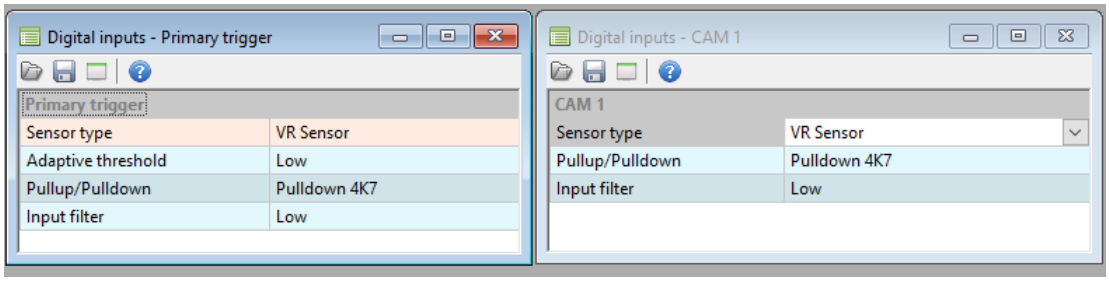
   Finally, enable the *Scope* window.



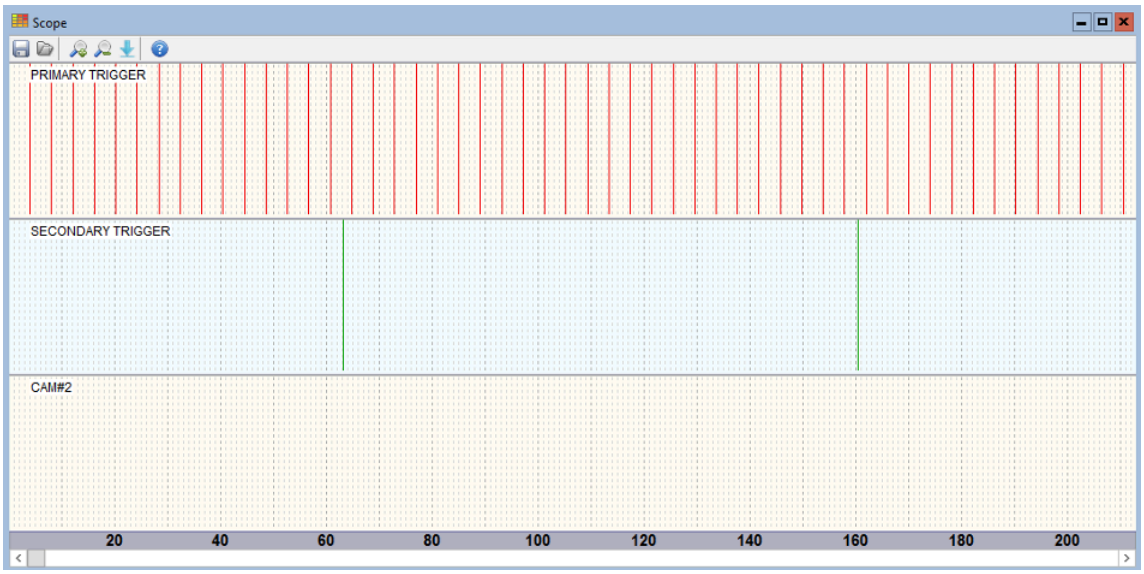
In EMU Black V3

The sensors setup for secondary and primary triggers is defined in *Sensors and inputs / Digital inputs / **Primary Trigger*** and ***CAM 1***

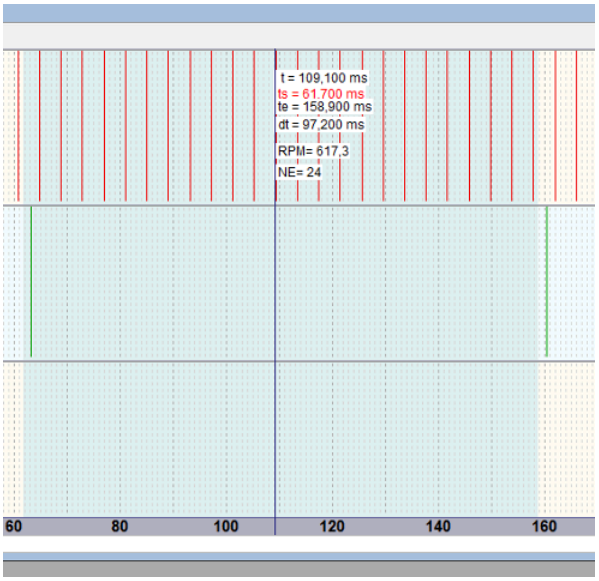
Other settings remain the same, except that the *Enable scope* parameter is no longer present, as the scope is always enabled.



7. From the *Tree View*, open *Log* / ***Scope*** Window.
   During engine cranking, press the blue arrow. If the triggers are set correctly, lines from the decoded wheels should appear.



8. Press the left mouse button and select the distance from the first edge of the secondary trigger signal to the last edge of the primary trigger signal, just before the next edge of the secondary trigger signal. The selected area will provide information about the trigger type used on the crankshaft (primary trigger). In the example screen, the primary trigger type is a 12-tooth wheel on the crankshaft. The crankshaft rotates twice during the entire engine cycle, so 12 times 2 equals 24.



9. The *First Trigger Tooth* setting determines which signal after the secondary trigger will start the new engine cycle. The *Trigger Angle* defines how much the crankshaft must rotate after the first trigger tooth appears to get the TDC of the cylinder. The maximum ignition advance cannot exceed the trigger angle.

   The engine rotates 360 degrees every half cycle. In this example, the trigger wheel divides 360 degrees into 12 equal parts, so each tooth represents 30 degrees of rotation.

   If the ignition table is set to 0 and *First Trigger Tooth* is set to 3 with a *Trigger Angle* of 0, the ignition event occurs at TDC (Top Dead Center) on cylinder 1. This configuration allows the ignition event to start at or after TDC, meaning only ignition retarding is possible.

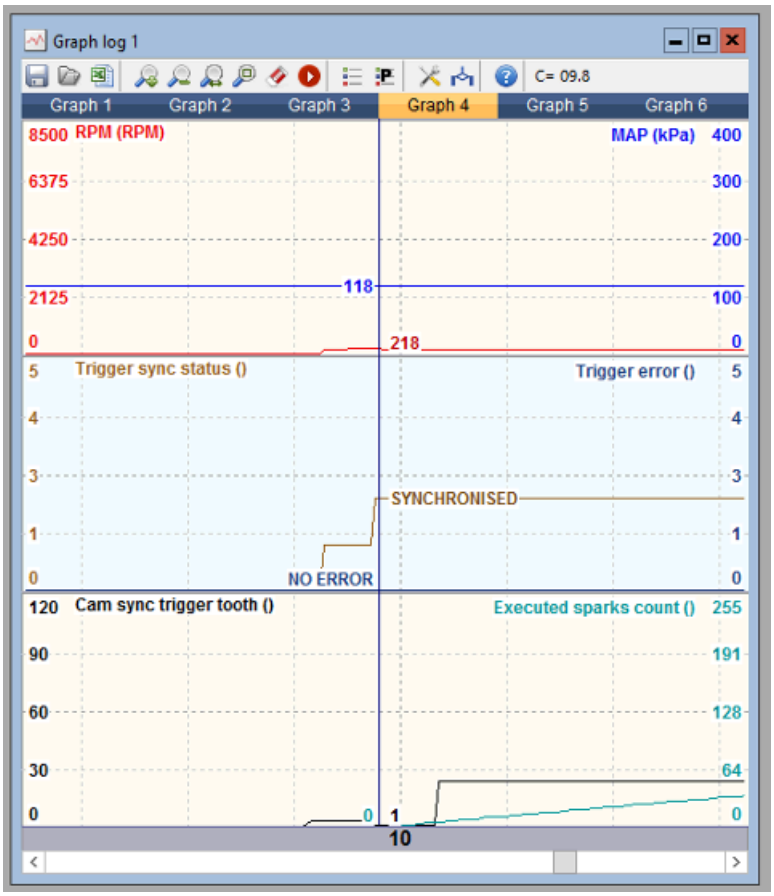
   If you set *First Trigger Tooth* to 2 and the *Trigger Angle* to 30, the spark will occur at TDC on cylinder 1. With 10 degrees of advance set in the ignition map, the ECU will trigger the ignition 20 degrees after the trigger tooth. The maximum possible advance in this setup is 30 degrees.

   If *First Trigger Tooth* is set to 1 and *Trigger Angle* to 60, the spark will again occur at TDC on cylinder 1. For a 35-degree ignition advance, the ECU will calculate that the ignition event should occur 25 degrees after the first trigger tooth appears (60 - 35 = 25).

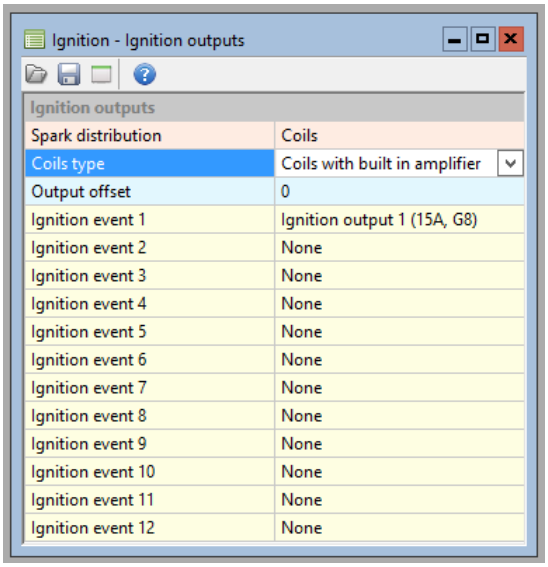
10. Open the graph log from the *Tree View* and select the following channels:
    - RPM
    - MAP
    - Trigger Sync Status

- Trigger Error
- Cam Sync Trigger Tooth
- Executed Sparks Count

During cranking, the parameters on the graph will change. When the settings for the primary and secondary triggers are correct, the Trigger Sync Status will change from *No Sync* to *Synchronized*. Once the ECU is in a synchronized state, spark and injector pulses are generated.

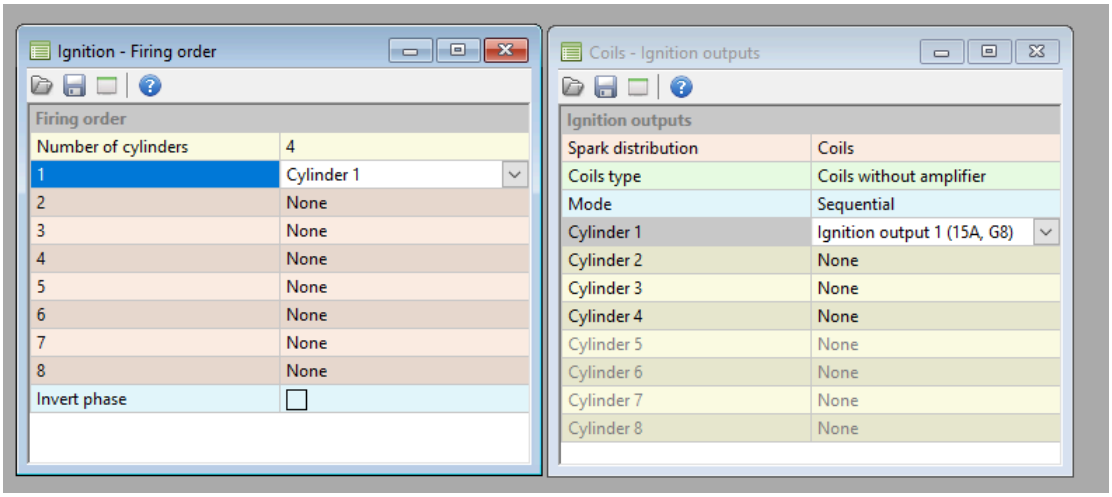


11. Open the *Ignition / Coils / **Ignition Outputs*** window from the *Tree View*. Assign Ignition Output #1 to *Ignition Event 1* (the coil for cylinder number one is connected to Output #1).

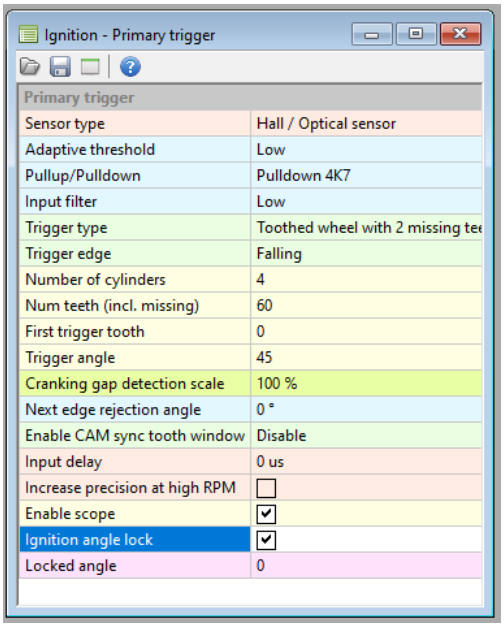

Ignition - Ignition outputs
Ignition outputs
Spark distribution
Coils
Coils type
Coils with built in amplifier
Output offset
0
Ignition event 1
Ignition output 1 (15A, G8)
Ignition event 2
None
Ignition event 3
None
Ignition event 4
None
Ignition event 5
None
Ignition event 6
None
Ignition event 7
None
Ignition event 8
None
Ignition event 9
None
Ignition event 10
None
Ignition event 11
None
Ignition event 12
None

In EMU Black V3

Configuring ignition outputs is split in V3. First, open *Ignition / **Firing order*** and assign *1 - Cylinder 1*. Then, in *Ignition / Coils / **Ignition Outputs***, assign the correct output for *Cylinder 1*.



Open the *Ignition / Triggers / **Primary Trigger*** window and select the *Ignition Angle Lock* option. Set the Locked Angle to 0 degrees. Configure the proper number of cylinders and the number of teeth on the primary trigger. Set the *First Trigger Tooth* to 2 and the *Trigger Angle* to 60 degrees. These settings are theoretical and will be adjusted during testing with a timing light.



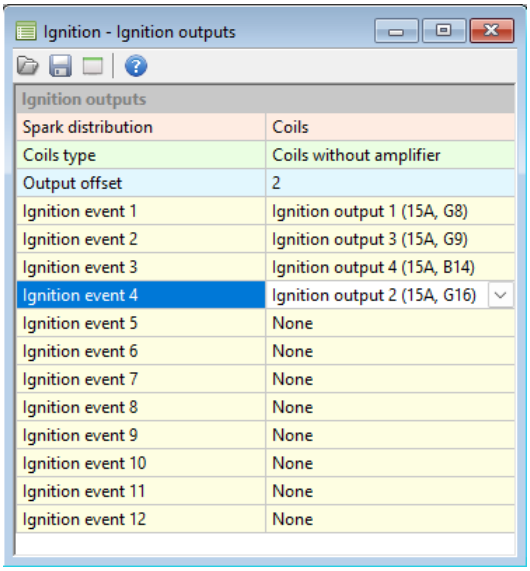
12. Aim the timing light at the TDC mark you created on the timing belt/chain cover. Crank the engine and observe if the crankshaft pulley mark aligns closely with the mark on the timing cover. If the mark on the pulley is not present and the timing light is flashing, change the *First Trigger Tooth* to a value of 3 and repeat the test with the timing light.

    Continue adjusting the *First Trigger Tooth* until the crankshaft pulley mark is as close as possible to the mark on the timing cover. Each trigger tooth adjustment changes the ignition angle by 30 degrees. Increasing the trigger tooth value will retard the ignition, while decreasing it will advance the ignition.
13. For fine-tuning the primary trigger settings, use the *Trigger Angle* option. Crank the engine and adjust the *Trigger Angle* value to align the marks on the pulley and the timing cover. Increasing the angle will retard the ignition, while decreasing the angle will advance the ignition.
14. When the *First Trigger Tooth* and *Trigger Angle* are set correctly, select a different value for the *Ignition Lock Angle*, such as 10 degrees, to perform an additional check. During cranking, the ignition angle will be advanced by 10 degrees.

    > **Warning:**
    > Remember to uncheck the *Ignition Lock* option after adjustments are finished to prevent a permanent ignition lock during engine mapping.

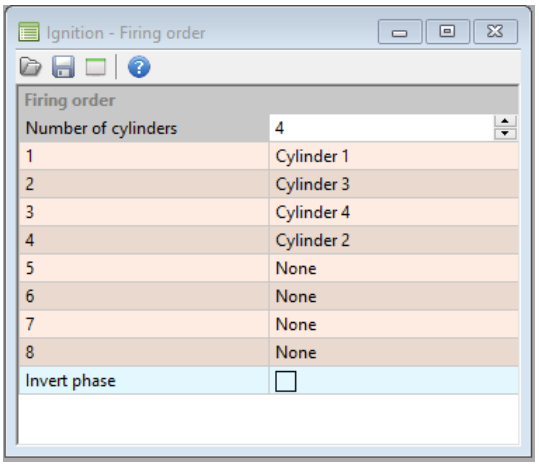
15. After the trigger settings are finished, assign the remaining ignition outputs. A typical 4-cylinder inline engine has a firing order of 1–3–4–2. When the ignition output number

matches the cylinder number, the ignition outputs will be assigned to the ignition events as follows:

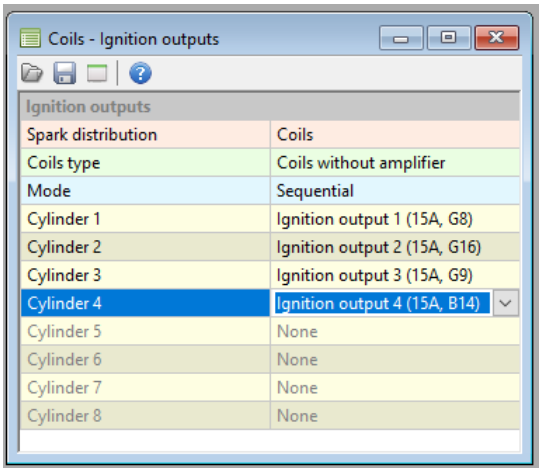


In EMU Black V3

The firing order in V3 software is set up in *Ignition* / ***Firing order*** for a 1-3-4-2 sequence:



The next step is assigning the cylinders to the ignition outputs of the ECU. Unlike in EMU Black V2, the wiring does not need to match the firing order. For example, you can wire Cylinder 1 to Ignition output 1, and so on.



The crankshaft in a 4-stroke engine completes two rotations for the entire engine cycle. This means that the piston reaches the top dead center (TDC) twice per cycle. It's possible for the spark to be triggered when the cylinder is in the intake stroke, in which case the engine won't start. Common symptoms of this issue include backfires in the exhaust or intake system, or the engine stalling during cranking.

In such cases, you need to reverse the engine phase. For a 4-cylinder engine with a firing order of 1-3-4-2, the easiest way to do this is by changing the ignition event offset from 0 to 2.

In EMU Black V3

To reverse the engine phase, enable the *Invert phase* setting in *Ignition* / ***Firing order***.

18.2. Document history

Revision	Date	Changes
1.0	2024.11.05	Initial release