



Connection and operating manual

STAG SIGMA ECU

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1. Description of the system

The **SIGMA STAG** controller is an independent electronic control unit (ECU) designed to manage the operation of internal combustion engines with spark ignition. The device allows the fuel and ignition system to be controlled in full-sequence, half-sequence **and** full-group **modes, providing support for power units with a number of cylinders from 1 to 16.**

The fuel injector control system supports two types of control:

- **Peak & Hold,**
- **Saturated Driver** - saturation control.

The use of both control methods allows cooperation with a wide range of fuel injectors available on the market and supports the operation of the engine with various types of fuels, including:

- petrol,
- LPG (propane-butane),
- CNG (metan),
- hydrogen (H₂),
- ethanol,
- methanol,
- multi-fuel mixtures.

The module is equipped with an extensive set of control outputs, allowing to support advanced systems used in modern drive systems, such as:

- two electronically controlled throttle bodies (**ETC**),
- two wideband lambda sensors (**WBO**),
- variable valve timing systems (**VVT, VTC, VANOS**).

In terms of motor protection, the controller performs continuous monitoring of operating parameters by operating:

- two knock combustion sensors,
- two exhaust gas temperature sensors (**EGT**).

In addition, the implemented safety algorithms include a number of configurable limiters and protection functions, controlling the critical operating conditions of the power unit. This solution allows you to maintain operating parameters within a safe operating range, while using the maximum available engine potential in **terms of power and torque**, adequate to the current operating conditions.



Figure 1 STAG SIGMA ECU Controller

1.1. Technical specifications:

Table 1 Technical specifications

Temperature Operating Range:	AEC-Q100 GRADE 1 (-40 to +125°C)
Supply Voltage:	6-30V
Current consumption "sleep" state:	10mA
Driver Weight:	850grams
Dimensions:	225mm x 180mm x 42mm
Driver Connector:	94P 1-1355125-1, 60P 1-1355114-1 (wireharnes side)
Connector pins :	968221-1 , 1241608-1, 1241390-1 (wireharnes side)
Ignition outputs:	8x Active/Passive (Software Configuration)
Fuel injector outputs:	8x saturated/peak&hold controls
WBO Support:	2x lambda Bosch Lsu 4.9
DBW Support:	2x H-Brigde
CKP/CMP inputs:	3x differential inputs (VR-Hall software configuration)
Knock Sensor Inputs:	2x Inputs
Digital Inputs :	4x inputs
Analog inputs:	16x inputs

0V Control Outputs:	6x LS AUX outputs
12V Control Outputs:	2x HS-type AUX outputs
5V Control Outputs:	2x AUX outputs
CAN Communication:	3x CAN configurable lines
LIN/K-line communication:	1x ONE WIRE channel
RS Communication:	1x RX/TX Bus channel (developer communication)
EGT inputs:	2x EGT inputs
AUX Power Supply:	8x 5V power outputs

2. Installation guidelines

The **STAG SIGMA** module must be fixed with four M6 screws in place of the factory engine control unit (OEM ECU) or on a dedicated bracket attached to the vehicle body. It is recommended to use anti-vibration spacers that limit the transmission of vibrations and mechanical loads to the device housing.

Due to environmental conditions and the durability of the electronics, it is important to avoid mounting the controller directly in the engine compartment. In order to ensure optimal heat dissipation, it is recommended to install the controller in a position where the wiring harness connector is facing downwards.

During installation, you should also take into account the appropriate mounting space around the controller connector, allowing the wiring harness to be freely connected and disconnected without having to disassemble the device.

2.1. Electrical harness routing recommendations

The wiring harness should be routed as short as possible, avoiding unwarranted lengthening of the wires. Particular attention should be paid to the power cables, ground wires, signal cables of the motor sensors.

Limiting the length of the cables minimizes voltage drops and the susceptibility of the system to electromagnetic interference (EMI).

For signals from crankshaft position sensors and camshaft position sensors, it is recommended to use shielded cables designed to transmit signals with low voltage and high sensitivity to interference.

To ensure stable and reliable operation of the system, all controller ground cables must be connected in accordance with the installation documentation, ensuring a secure connection to both the vehicle body weight and the engine block. Improper execution of mass connections can lead to control system failures and measurement errors.

In the case of using the CAN (Controller Area Network) bus, it is imperative to use twisted pair cables with appropriate transmission parameters. The bus should be terminated with termination

resistors according to the requirements of the CAN standard and the architecture of the respective system, which ensures signal integrity and reliable communication between devices.

3. Communication

3.1. Diagnostic program description

The software for configuration, diagnostics and calibration of the STAG SIGMA controller is available for download on the manufacturer's website: www.sigmastag.com, in the "SOFTWARE" tab.

A PC equipped with Microsoft Windows 10 or Windows 11 operating system is required for proper installation and operation of the application. The workstation shall meet at least the minimum hardware and software requirements shown in Table 2.

Table 2 PC requirements

Minimum requirements
• Processor (CPU): 1.8 GHz or faster or SoC (System on a Chip)
• RAM: 2 GB (4GB recommended)
• Disk space: 20 GB
• Graphics: DirectX 10 or later compatible with WDDM 1.0 driver (2.0 recommended)
• Display: min: 1024x768 pixel resolution

A STAG USB NEXT **diagnostic interface is required to connect to the controller**. The application does not support the older version of the interface shown in Figure 2 USB interfaces (wrong model on the left, correct model on the right)., so you will not be able to connect to it.

Once the interface is connected to the computer, you should also install the appropriate driver. The driver installation file is available at: [CDM20814_Setup](#)

Once the driver installation is complete, the interface will be ready to work with the application.



Figure 2 USB interfaces (wrong model on the left, correct model on the right).

Connecting the diagnostic connector to the harness consists of properly connecting the diagnostic harness (included in the controller accessories set, Figure 3).

- The wire connected to PIN No. 1 (Figure 3) must be connected to a constant source of +12V supply voltage through a fuse of at least 1A.

- The cable connected to PIN No. 2 (TX) is plugged into the connector of the B controller to PIN31 (Figure 4, TX).
- The wire connected to PIN No. 3 (RX) is plugged into the connector of the controller **B** to PIN 32 (Figure 4, RX),
- The cable connected to PIN No. 4(GND) is plugged into the connector of the controller **B** to PIN 11 (Figure 4, GND).



Figure 3 Diagnostic connector

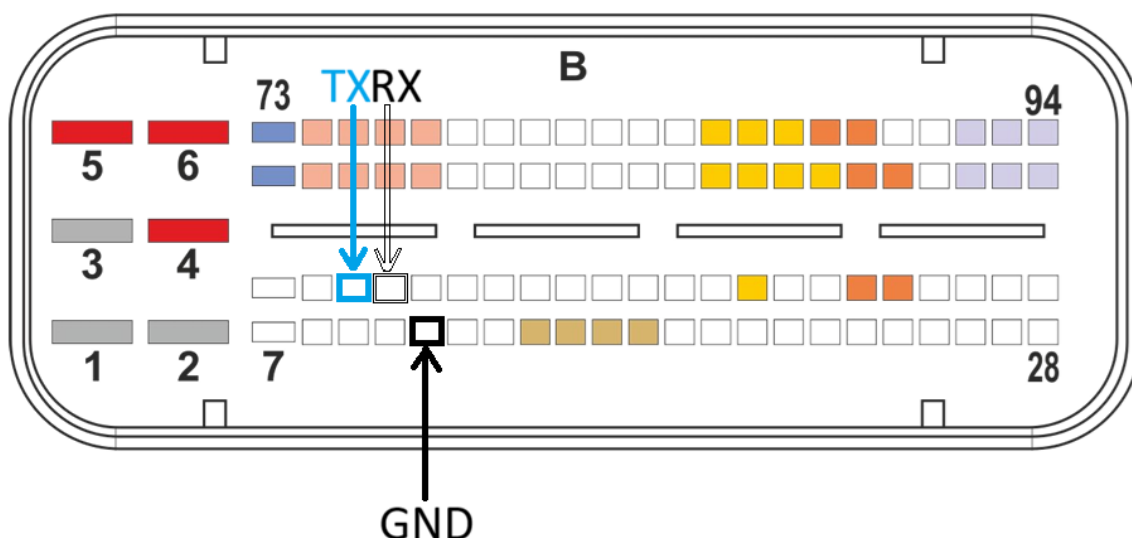


Figure 4 Connector B of the STAG SIGMA controller

3.2. Main menu

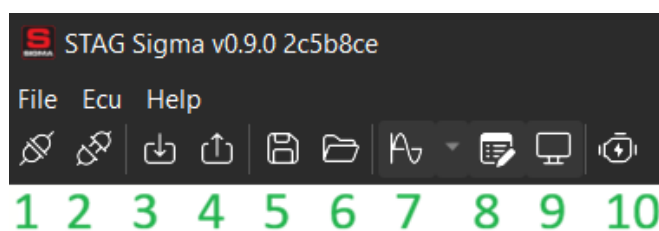


Figure 5 Main panel

The main panel of the application consists of three tabs: **File**, **ECU** and **Help**. The **following functions are available** in the ECU tab:

- **Settings Save** – saves the current driver settings to a file,
- **Settings Load** – allows you to load the settings file into the driver,
- **Auto Calibration ETC** – activates the module responsible for throttle calibration,
- **Update** – used to update the driver software.

A properly performed throttle calibration process results in the result shown in Figure 6.

The correct configuration and correct connection of the throttle are also confirmed by the characteristic **TPS** signal waveform visible in the parameter logger. This waveform should correspond to the characteristics shown in Figure 7 (**GraphLog view with ETC1 channel selected**).

A correctly performed throttle calibration process gives the result visible in Figure 5, the correct configuration and connection of the throttle also generates a specific TPS signal waveform in the parameter recorder in the form of the waveform visible in Figure 5.

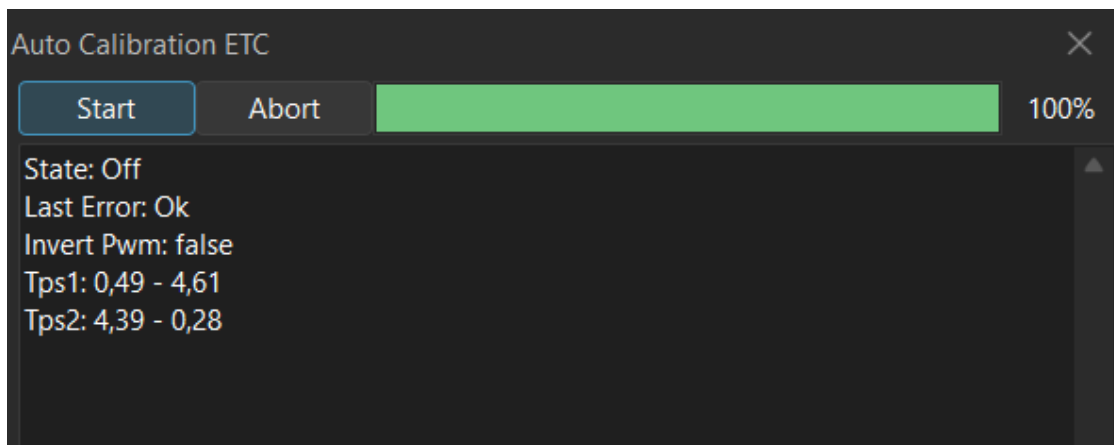


Figure 6 Correct electronic throttle calibration result

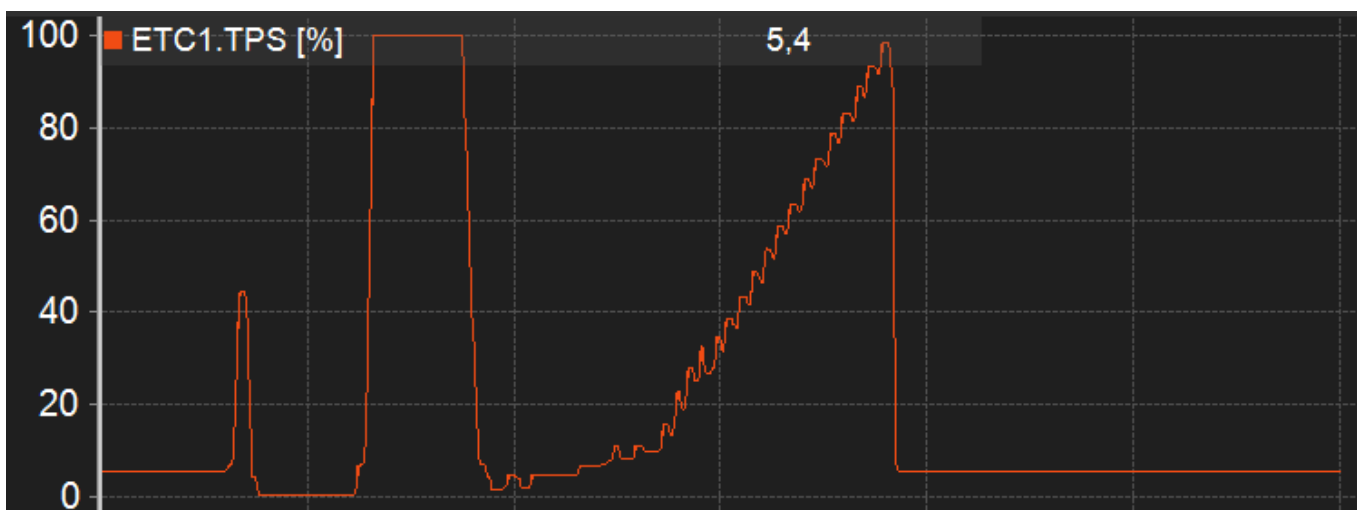


Figure 7 TPS signal waveform during the calibration process

On the main panel of the application (Figure 5) there are function buttons responsible for operating the controller. **Button No. 1** is used to initiate a connection to the controller.

The connection status can be read at the bottom of the application window, in the lower left corner. Details are shown in Figure 8.

In the same place, information about the connected driver is also displayed, such as:

- Driver software version (**FMW**)
- Controller serial number (value in parentheses)
- hardware version.

In the example shown, the driver works with **FMW 1.6.0** software. With this information, the user can verify that the connection is correct and identify the version of the hardware and software installed in the driver.

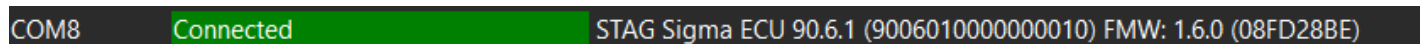


Figure 8 Connection status and controller data

Button No. 2 (Figure 5) is used to disconnect the connection to the controller.

Buttons 3 and 4 are responsible for reading the settings from the controller and saving the current settings to its permanent memory.

Buttons 5 and 6 allow you to save settings to a file and load settings from a previously saved file.

Another button opens the context menu, where you can change the layout of the app's view. The user can, among other things, hide the **Graph Log** window and launch the **State Analyzer** function.

The **State Analyzer module** is responsible for recording signals from the crankshaft position sensor and camshaft position sensors. It allows for the analysis of the operating states of the controller and the verification of the synchronization points of the signals used to determine the position of the motor.

Buttons 8 and 9 are responsible for showing and hiding the **Toggle Workspace** and **Monitor panels**. These features allow you to customize the appearance of the application to your individual preferences by changing the layout and visibility of individual modules.

Button No. 10 starts the driver diagnostic module shown in Figure 9. This module allows you to monitor the operating status of the controller and read diagnostic information and system errors.

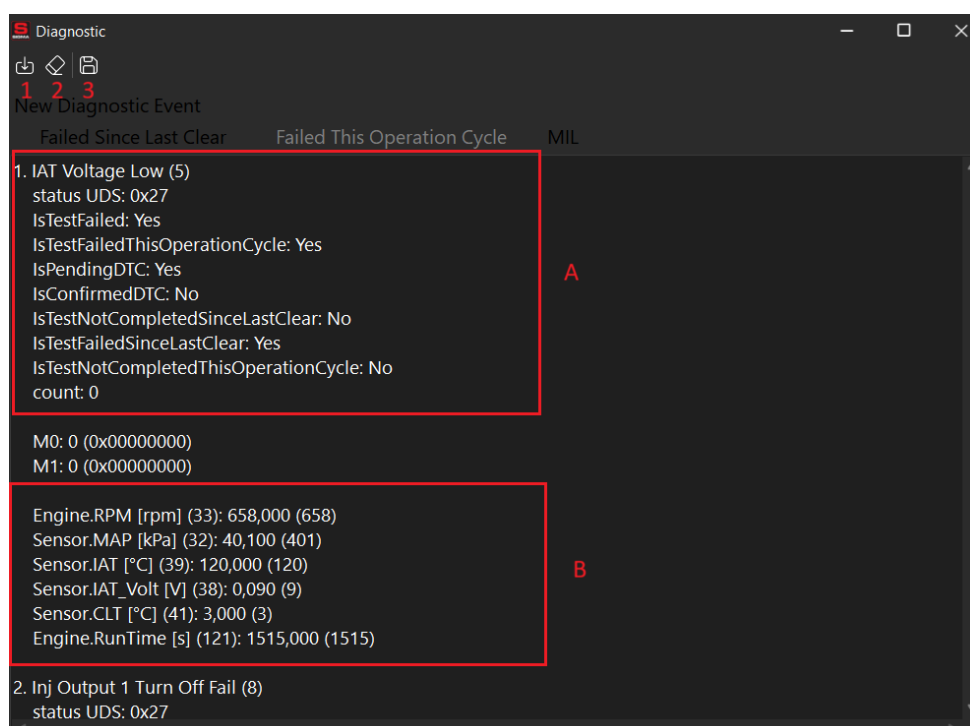


Figure 9 Diagnostic module view

There are three function buttons at the top of the diagnostic module:

- Button No. **1** – reading the driver's error memory,
- Button no. **2** – deleting saved driver errors,
- Button no. **3** – saving the current list of errors to the file.

In the area marked with the letter **A**, descriptions of the logged errors are displayed.

In the area marked with the letter **B**, the diagnostic data from the time of the error (**Freeze Frame Data**) is presented. This information includes the values of selected controller operating parameters stored at the time of detecting a fault, which makes it easier to identify the cause of the problem and analyze the conditions of its occurrence.

3.3. GRAPH LOG

This tool is used to analyze engine operating parameters both in **real time (online)** and on the basis of previously recorded data.

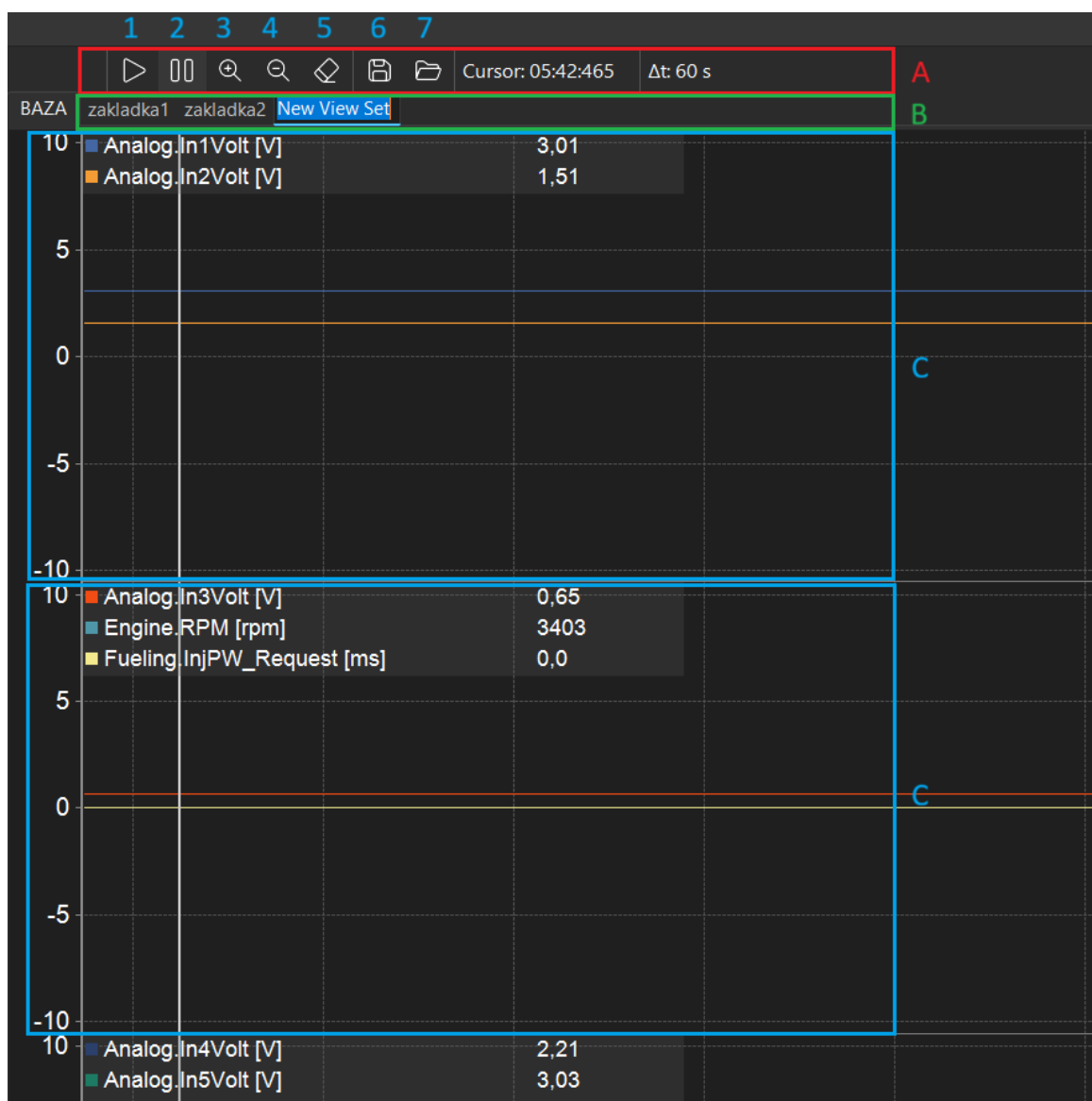


Figure 10 View of the Graph Log panel

Figure 10 shows the parameter recorder panel. In the area marked with the letter **A**, there is a support panel for the **Graph Log module**.

The individual buttons have the following functions:

- Button no. **1** – start data registration,
- Button no. **2** – stop (pause) scrolling the graph while continuing to save data,
- Buttons **3 and 4** – zooming in and out of the chart in the timeline, respectively,
- Button no. **5** – delete the recorded data from the chart,
- Przycisk nr **6** – zapis zarejestrowanych danych do pliku,
- Button no. **7** – loading previously saved signal waveforms from the file.

Right-clicking in the charts area displays the additional context menu shown in Figure 11. This menu allows you to perform additional operations related to the presentation and analysis of the recorded signals.

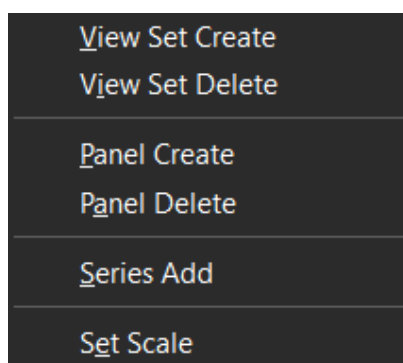


Figure 11 Graph Log context menu.

The **View Set Create** operation creates a new tab in the panel, visible in the area marked with the letter **B** in Figure 10. Use the **View Set Delete** option to delete the currently selected bookmark.

The **Panel Create** function allows you to add a new measurement panel in the current tab, while the **Delete Panel** deletes the selected measurement panel.

Selecting the **Series Add** option allows you to add a selected parameter from the list of available signals to the measurement panel. This allows the user to configure the displayed graphs according to current diagnostic needs.

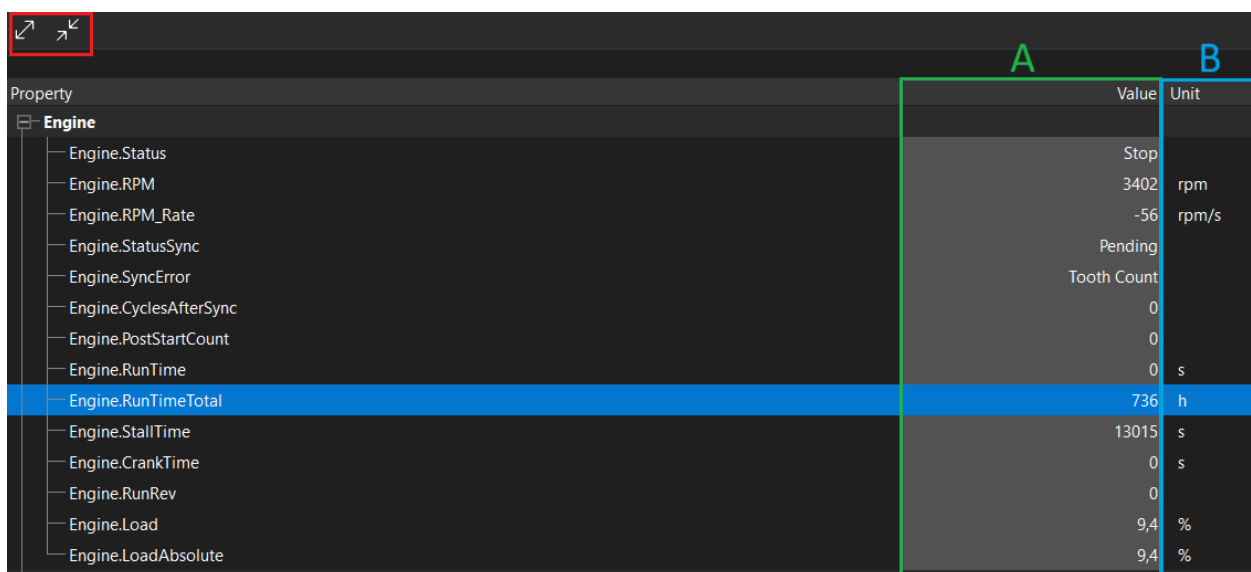
3.4. LIVE PARAMS

In the central part of the application there is a **Workspace** area. One of the basic modules available in this area is **Live Params**, which allows you to view all current parameters of the controller in real time.

For each parameter, its current value and unit of measurement are displayed. The **Value column** (Figure 12, Area **A**) shows the current value of the selected parameter, while the **Unit column** (Figure 12, Area **B**) displays the unit in which the parameter is presented.

In Figure 12, two icons are selected in the red box to manage the visibility of parameter groups. The first one allows you to expand all groups of parameters, while the second one collapses all currently expanded groups.

Left-clicking on the selected parameter adds it to the **Monitor** window, located in the far right part of the application. This function allows you to quickly track selected parameters without having to search for them in the **Live Params list every time**, which significantly facilitates diagnostics and analysis of the controller's operation.



Property	Value	Unit
Engine		
Engine.Status	Stop	
Engine.RPM	3402	rpm
Engine.RPM_Rate	-56	rpm/s
Engine.StatusSync	Pending	
Engine.SyncError	Tooth Count	
Engine.CyclesAfterSync	0	
Engine.PostStartCount	0	
Engine.RunTime	0	s
Engine.RunTimeTotal	736	h
Engine.StallTime	13015	s
Engine.CrankTime	0	s
Engine.RunRev	0	
Engine.Load	9,4	%
Engine.LoadAbsolute	9,4	%

Figure 12 Window Live Params

3.5. EDITOR

The **Workspace Editor** tab contains controller settings that need to be defined in order to start and operate the engine properly, and it also contains a number of parameters that can be defined as part of the control of accessories and external systems.

ENGINE Group:

- Displacement - engine capacity in cm³
- Cylinder Count – number of cylinders
- Fueling Load Type – fuel algorithm model
- Load Type – Load Source
- Control Mode – a type of power supply system full-group/semi-full sequence
- Firing offset – selection of ignition offset and ignition sequence

TRIGGER Group:

- Crank Pattern – crankshaft phonic wheel pattern
- Crank Count – the total number of teeth on the crankshaft phonic gear
- TDC1 Angle – Synchronization Starting Angle for Cylinder No. 1 TDC
- Home Source – Sync signal source for the full sequence
- Inputs – definitions of CKP and CMP sensors
- Inlet Cam, Exhaust Cam – assignment of camshaft sensors

IGNITION Group:

- Config – configuration of ignition activation in override mode
- Override target – the ignition angle of override
- Coil Type - Coil Type

Outputs – assignment of cylinders to ignition outputs

FUELING Group:

Fueling – definitions of the type of fuel injector control and determination of the type of fuel, its physico-chemical and pressure characteristics

Outputs – assignment of cylinders to injector outputs

Close Loop – configuration of mixture control parameters in a closed loop

STFT/LTFT – Definition of Parameters of Closed-Loop Mixture Control Controllers

SENSORS Group:

In this group, it is necessary to define in detail the characteristics for the given sensors, the minimum and maximum correct value for a given sensor, the Fail Safe value, i.e. the one that the controller will accept as a safe constant for the motor in case of exceeding the previously defined thresholds, then assign the appropriate input for a given sensor.

ANALOG INPUTS Group:

In this area, we define the type of input by selecting the pull-up or pull-down input signal, or we select HZ in order to avoid the above interference with the input signal.

DIGITAL INPUTS Group:

Input pull-up or pull-down is determined, or selecting HZ means no interference with the input signal.

OUTPUTS Group :

- a) The definitions for this group allow you to specify the parameters and conditions for initializing the output signal data:
- b) Main Relay – output for switching on the main relay that powers peripherals and accessories
- c) Fuel Pump – output for fuel pump control with fuel system filling/flushing time set
- d) Tacho- output adjustable to the engine speed indicator on the dashboard
- e) Speedometer – output adjustable to the vehicle speed indicator on the dashboard
- f) Thermostat – output for operating active thermostats of the cooling system
- g) Coolant Fan 1, Coolant Fan 2 – Cooling Fan Fan Outputs
- h) Oil fan – output activated to control the engine oil cooler cooling fan
- i) Swirl flap – output to the active flap control system changing the geometry of the engine intake manifold airflow

BOOST Group:

On the basis of selected parameters of this group, we influence the control of the boost pressure by selecting the values of the PID regulator, selecting the limit values of the MAP and revolutions, and determining the control signals of the valve, such as signal frequency, its polarization or maximum and minimum values of the control current (DC max/min).

VVT Group:

Variable valve timing systems (VVT, VTC, Vanos) require the definition of parameters that should be described in this group, the most important is the selection of the type of control ON/OFF or Linear, the control conditions and the selection of parameters of the variable phase regulator. It

is recommended to consult technical support to properly tune the system, reducing the risk of damage to the control valves or engine head failures.

ACC/DCC Group:

In this area, the conditions of the algorithm for enrichment and depletion of the mixture during rapid acceleration and braking by the engine are determined, here it is necessary to properly select the parameters of sensitivity and intensity of the function by experimentally selecting them and obtaining the level of smoothness of the system's response to changes in engine loads in accordance with the intended effects.

LIMITER Group:

The parameters that we define in this group are responsible for the limitations of the maximum engine speed and the maximum pressure of the intake manifold, and the parameter values and activated functions are used to determine the nature of the engine behavior when the limiter conditions are reached.

OVERRUN Group:

The operating conditions of the engine without load in the event of a complete lack of tilting of the accelerator pedal are defined by specifying the parameters in this group, we parametrically decide on the value of the manifold pressure in which the overrun is detected, the position of the TPS sensor and the engine speed thresholds. In the Mode option, we select the source of detection of TPS or APP conditions, the Ign Override function activates the ignition advance angle lock in the overrun mode detection mode.

STARTUP Group:

RPM Cranking the setting responsible for detecting the engine start, determines the threshold that exceeds which means that the controller switches from the Cranking state to Idle (idle mode), after start cycles means how many cycles the controller will wait before changing the above states, similarly the Delay function, only in this case the delay is specified in seconds. Cranking ignition advance is the value of the ignition advance angle of the receiving ignition during the engine starting process.

ETC Group:

The parameters necessary to define in this group are TPS1 Input and TPS2 Input and the selection of the throttle control output: H-Bridge 1 or H-Bridge 2, the remaining values will be saved by the controller during throttle calibration. For test purposes, the Override DC function is also available, by activating it, we set the set value of the throttle tilt defined in the field: Override Target.

IDLE Group:

Idle control is carried out by tilting the throttle (Ariflow) and selecting the appropriate ignition advance angle by the controller (Igniton), in this group we select control methods and describe the parameters of the regulators to achieve optimal control.

APP Group :

The group is responsible for defining the inputs (APP1 input, APP2 input) and signal parameters from the accelerator pedal position sensor, we also specify error tolerances (usually

5%) and the Fail Safe value (the controller assumes a set value when the limit values are exceeded or the error tolerance is exceeded).

KNOCK Group:

The content of functions and parameters in this part of the editor is responsible for detecting knocks in the motor and determines the conditions under which the controller monitors the signal. Bandpass Freq is the frequency of the band around which the knock sensor signal is analyzed, in order to determine the value, you can use an online calculator by entering the cylinder diameters in [mm]: <https://strikeengine.com/engine-knock-frequency-online-calculator/>

Determining the correct level of signal gain from the knock sensor is done by changing the Gain setting, the selection of values is done by reducing the value, thus separating the natural sounds of the engine from the actual occurrence of knock combustion, it is recommended to use gain calibration using external tools from knock detection for this purpose. Integrator time is the time constant of the Gain amplifier, we will use it in conjunction with the channel gain setting to get the correct reference measurement setting. A higher time constant results in a lower knock burn reading. For the highest accuracy, maintain a time constant between 100 and 150µs and use lower gain settings. The Windows Start and End functions specify the measurement window in angular degrees of rotation of the crankshaft ATDC (After Top Dead Center).

LAMBDA Group:

At this point, we configure the control lambda sensors, the selection of Internal controllers 1 and 2 refers to the LSU 4.9 wideband sensor control systems built into the controller, changes to the filter settings include stabilization of the probe reading, and the Start When Ign ON setting allows you to select the moment to turn on the built-in probe heater when the "ignition" is turned on or when the engine starts working.

GEARBOX Group:

In order for the controller to detect the engaged gear in the gearbox, the gearbox ratios must be defined in the Gearbox area, and the vehicle speed sensor must be connected and calibrated correctly. In the case of reverse gear, it is possible to connect the input signal to the selected channel and define it in this area.

PROTECTION Group:

Oil press is a protection of the engine in the event of a loss of oil pressure, it also gives the possibility of limiting the maximum pressure, the Reset option determines the possibility of removing the failure state by returning to the minimum pressure or only by stopping the engine and restarting it. The engine runtime sets the maximum runtime of the engine with reduced oil pressure.

CAN Group:

We define how on the available CAN2 channel, the controller takes over external communication, e.g. sending data to the Dash display, communication with the vehicle's factory clocks.

AIR CONDITIONING Group:

Activation is responsible for determining the conditions and input/output signals for activating the air conditioning system in the vehicle.

ECU Group :

The available parameters are the Battery filter, which is responsible for stabilizing the driver's power supply voltage, and Sleep Delay, which is the time after which the controller will go to sleep after turning off the motor.

3.6. FUELING

The Fueling tab is responsible for tuning maps related to fuel dosage, the key map for tuning the engine is the VE (Volumetric Efficiency) map, the values entered in the cells are responsible for determining the percentage of filling the cylinder with mixture. By default, the base of the horizontal load axis is the manifold pressure (Sensor.MAP [kPa]), and the vertical axis is the engine speed (Engine.RPM [rpm]). You can edit these signals by right-clicking on the axis, then an additional Fueling.VE Settings menu opens (Figure 11), giving you the ability to select any parameter from the FormSelectId list in the Axis X and Axis Y fields, and modify the map sizes in the Size X and Size Y fields, where the numbers you enter will determine the number of cells in the column and rows of the map.

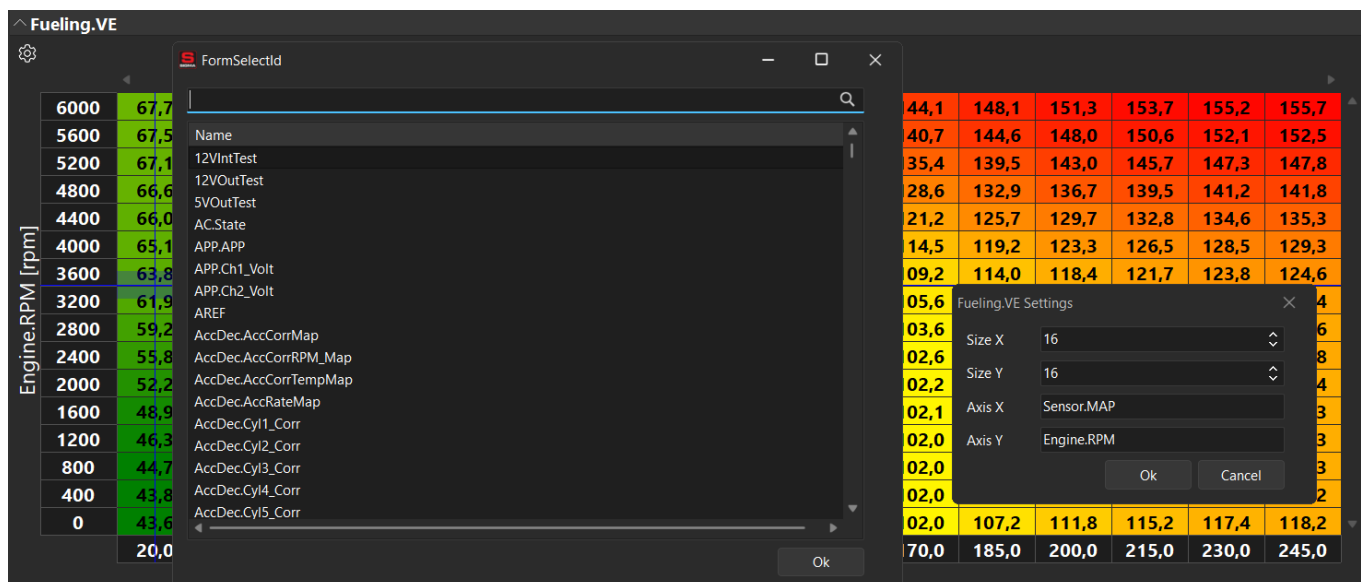


Figure 13 View of the VE map, the Settings Fueling.VE menu and the FormSelectId list

The next map is **Fueling.MixtureTarget** which contains data on the target lambda value to which the controller follows as a starting value to calculate the appropriate fuel dose for specific engine operating conditions, the default axes of this map are **Fueling.Load [%]** and **Engine.RPM [rpm]**. The next maps in this section are the **Fueling.InjectionAngle** injection angle map, the values describe the angular advance of the fuel injector opening relative to the TDC of the cylinder in question. **Fueling.injectorDT** describes in milliseconds the "dead" opening time of the injector in relation to the supply voltage, this is the value obtained from the manufacturer of a given fuel injector. **Fueling.FuelDensity** characterizes the density of the fuel relative to the temperature, **Fueling.FuelCorrFirstCrank** should be empirically set as a correction of the fuel dose at start-up, obtaining the optimally selected fuel dose at different engine temperatures (**Sensor.CLT [°C]**), similar to the map **Fueling.FuelCorrCrankig**, **Fueling.FuelAfterStart**, **Fueling.FuelWarmUp**, **Fueling.ChargeTempAprox**. In addition, there is a **Fueling.FuelCorrCustom** map, which gives

the possibility of customizable fuel correction from any selected signal input from the **FormSelectId** list.

3.7. CLOSE LOOP

Assumes a Close loop, is responsible for the parameters of the mixture control in closed loop mode, the **Fueling.CloseLoopLambdaDelay** map contains the default values of the delays of the system's response to changes in the lambda probe signal in milliseconds [ms] relative to the exhaust flow value in the exhaust manifold calculated by the controller in grams per second [g/s].

The **Fueling.CloseLoopBank1_LTFT** and **Fueling.CloseLoopBank2_LTFT** maps allow you to view the values of the long-term fuel adjustments of the mixture control system, in a situation where values above 20% are observed on these maps, it means that the fuel system may have degraded the parameters of the fuel system components or the fuel maps were not adjusted with due precision.

3.8. IGNITON

The **Ignition.Advance** map is the base map of the ignition advance angle, it is suggested to set the value of this map using external tools to listen to the engine knock and control the exhaust gas temperature using EGT sensors. **Igniton.DwellTime** is responsible for determining the control characteristics of the passive type ignition coil as a function of the supply voltage, in the map cells the control time in microseconds [us] (1000us=1ms) should be entered. In the following maps **Ignition.AdvanceIAT_Corr** and **Ignition.AdvanceCLT_Corr**, let's make adjustments to the ignition advance angle in relation to the intake air temperature (IAT) and the engine coolant temperature (CLT), respectively.

3.9. IDLE

The module is designed to set parameters related to idle speed control.

The **Idle.Target** map specifies the target RPM level of the motor relative to the engine temperature. **Idle.RunTimeCorrection** contains rotation corrections by a set value (relative to the target) after starting the engine, where the vertical axis shows the engine operating time in seconds, and the horizontal axis determines the engine temperature.

Idle.AirFlowFeedForward is the map responsible for the base value of the airflow through the throttle in the case of RPM control by ETC (ElectronicThrottleControl - electronic controlled throttle). The correct setting of the values on this map consists in disabling the idle control by the ignition and throttles, for this purpose in the **Control Mode** module, **Ign Angle** is set to **OFF**, **Air Flow** is set to **Close Loop** and on **AirFlow PID** maps we set the values to zero as in Figure 12.



Figure 14 AirFlow PID maps, set to adjust AirFlowFeedForward

Then, at certain engine temperatures, by changing the target idle, we set the values of the **Idle.AirFlowFeedForward** map, so that the engine reaches the set target in the shortest possible time. If the target RPM is a specific value, e.g. 800rpm, then it is suggested to carry out a chart adjustment cycle for RPM in the range from 600rpm (75% of the target) to 1600rpm (200% of the target), which will allow the system to optimally control the idle control.

Idle.FlowBatteryCorrection is responsible for correcting idle speed in relation to the supply voltage, **Idle.FlowCranking** determines the throttle tilt during starting the starter, **Idle.IgnitonAdvance** is the base map of the ignition advance angle values at idle.

3.10. BOOST

In the **Boost** tab, you will find parameters and maps that affect the boost pressure adjustments in the case of the use of electrical actuators that have a direct impact on the turbocharger or compressor. On the **Boost.Target** map, we specify the set value of the boost pressure, by default on the horizontal axis there is a signal from the throttle position sensor, on the vertical axis there is an engine speed speed sensor, **Boost.TargetCorr** is a boost pressure target limitation map depending on the engine temperature by default. **Boost.FeedForward** is responsible for adjusting the control signal and empirical tests of the value of this signal should be performed in comparison with the obtained boost pressures under specific engine operating conditions, taking into account the correction from the engine temperature on the **Boost.FeedForwardCorr** map.

The following maps of the tab are used to enter the boost pressure limit depending on: **Boost.limitCLT** – coolant temperature, **Boost.LimitEGT** – exhaust gas temperature, **Boost.LimitOilTemp** – oil temperature, **Boost.LimitOilPress** – engine oil pressure.

3.11. VVT

The variable valve timing control systems supported by the Stag Sigma controller are systems in which hydraulic valves operate linearly and provide the ability to control variable fill signals, and systems with only two-state ON/OFF control. The system has two intake and exhaust shaft adjustment maps: **VVT.InletCAM_target**, **VVT.ExhaustCAM_Target**, where the values entered on these maps are the set camshaft offset angles in the range of $\pm 50^\circ$.

3.12. LIMITER

In this area are the RPM and MAP limiter settings and the engine speed limit map relative to engine temperature (**Limiter.RPM_Limit**) and the throttle tilt limiter (**limiter_ETC**) map to the rev limiter deviation error, which is used to ensure smooth operation of the rev limiter.

3.13. OVERRUN

The section with the **Overrun.DBW_Override** map allows in the conditions of the engine transition to overrun to omit the calculated throttle angle and force the set value of the ETC tilt angle in accordance with the set value from this map as a function of engine speed, the function allows the so-called flushing.

3.14. KNOCK

In this module, we define the configuration described in the section of the **Parameter Editor** related to reading and knock control algorithm and specify the **KNOCK** map. The limit responsible for the critical value of the knock level, above which the system begins to make the corrections described above.

3.15. ACCDEC

In this part of the application, there are settings responsible for correcting the fuel dose (enrichment and depletion of the mixture) in the event of rapid changes in loads. The selection of individual parameters should be carried out through empirical road tests, observation of the correctness of the expected engine responsiveness and analysis of instantaneous lambda signal values. Both **ACC** (acceleration) and **DEC** (deceleration) characteristics are defined by maps, where: **Rate** - determines the intensity of the function, **Corr** - correction from manifold pressure, **RPM_Corr** - correction from engine speed, **Temp_Corr** - correction from engine temperature.

3.16. SENSOR

The sensors used in the system require configuration in the **SENSOR** tab, the input for a specific sensor must be defined, the reliable voltage range **Valid Volt Min/ Valid Volt Max** and the **Fail Safe** value, which the controller will accept as constant in case the signal from the sensor exceeds the defined reliable values. Individual sensors should also have their voltage characteristics defined on the maps available in this section.

3.17. ETC

ETC1.Target is a map that specifies the target ETC [%] relative to the position of the accelerator pedal **APP** [%], it gives the possibility to limit the position of the throttle relative to the preset value of the accelerator pedal position. The other throttle control characteristics are automatically completed during the throttle auto-calibration (**Auto Calibration ETC**).

3.18. OUTPUTS

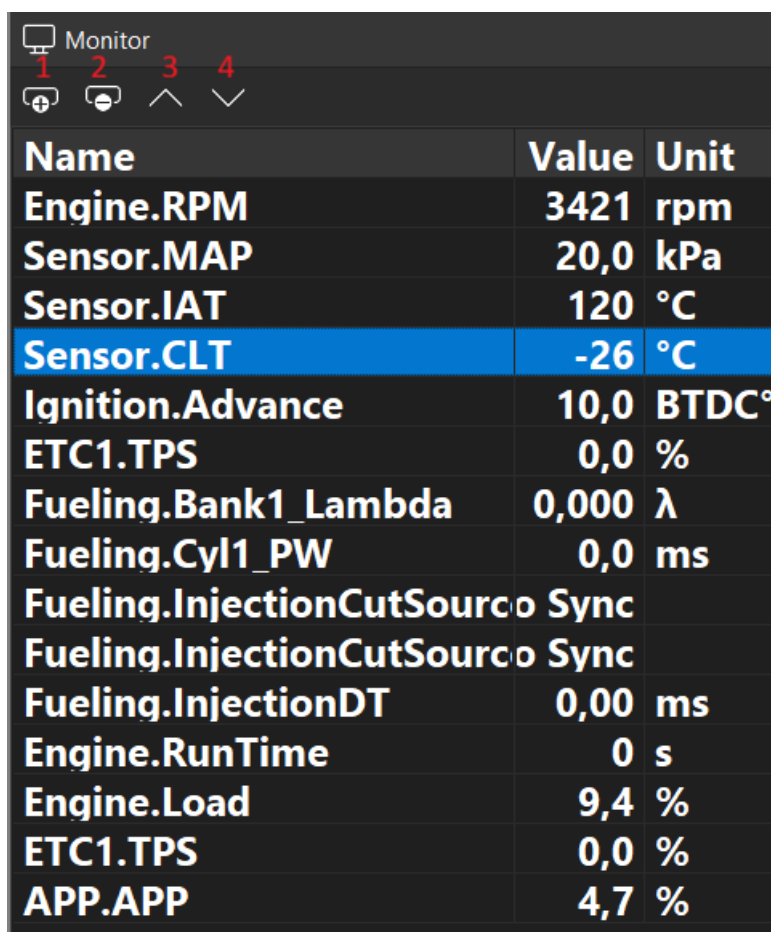
A tab in which we define the parameters of the control outputs and specify the characteristics of individual maps: **Engine.CoolantTempTarget** – target engine temperature as a function of rotational speed and manifold pressure, **Outputs.CoolantFan1/2.DC** – current control of coolant fans as a function of engine temperature and revolutions, **Outputs.OilFanDC** – current control of the oil cooler fan as a function of engine temperature and engine speed, **Outputs.SwirlFlapsDC** – control current of the vortex damper motor as a function of engine rotation and TPS target.

3.19. PROTECTION

This module contains the minimum oil pressure [kPa] characteristics as a function of engine speed, which is responsible for triggering the procedure to protect the engine from damage.

3.20. MONITOR

The controller operating parameter monitor is used to view selected parameters in real time.



Name	Value	Unit
Engine.RPM	3421	rpm
Sensor.MAP	20,0	kPa
Sensor.IAT	120	°C
Sensor.CLT	-26	°C
Ignition.Advance	10,0	BTDC°
ETC1.TPS	0,0	%
Fueling.Bank1_Lambda	0,000	λ
Fueling.Cyl1_PW	0,0	ms
Fueling.InjectionCutSource	Sync	
Fueling.InjectionCutSource	Sync	
Fueling.InjectionDT	0,00	ms
Engine.RunTime	0	s
Engine.Load	9,4	%
ETC1.TPS	0,0	%
APP.APP	4,7	%

Figure 15 Parameter monitor window

In the left column of the monitor, we read the name of the selected parameter, in the middle column there are instantaneous values of this parameter, and in the right column the unit in which this parameter is presented. To change the order in which the parameters are displayed, use buttons **3** and **4** visible in Figure 13. Buttons **1** and **2** are used to add parameters from the

FormSelectId list. If the **Graph Log** recording waveform is stopped (paused), the values read on the monitor are the values indicated on the signal waveform by the mouse/touch pad cursor. You can also add a selected signal from the **Live Params** tab to the parameter monitor by double-clicking the cursor on the selected parameter.

4. WARRANTY/LIMITATIONS

The warranty does't cover:

1. Damage caused by connecting the system not in accordance with the applicable assembly diagram.
 - In particular the connection of signal cables in places other than those provided for in the installation instructions
2. Damage as a result of installation, in places not in accordance with the installation instructions and in places where they are exposed to water, high temperature, battery fumes.
3. Systems that have been modified or repaired by ourselves.
4. Systems mechanically damaged due to the customer's fault, in particular:
 - damage to the joints,
 - damage to joints as a result of the use of chemical cleaning preparations,
 - damage to the housing,
 - damage to the electronics board
5. Systems that are electrically damaged as a result of connecting communication interfaces that do not comply with the installation instructions.

Restrictions:

1. The Stag Sigma controller is not intended for use on public roads.
2. All tests and settings should be done under safe conditions, in closed track facilities, chassis or engine dynos
3. It is suggested during key settings such as:
 - a) critical knock level map
 - b) maximum exhaust gas temperatures levels
 - c) engine oil pressure map

Use of pre-calibrated external instruments to ensure a full level of engine protection against damage.