Controller User Manual

STAG 500 GO 4

E 8
10R-06 9302
67R-03 9303
110R-04 15003 ”M”

(instruction contained in this manual is also available in the diagnostics software help system and at the www.ac.com.pl website)

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1 Controller installation

To ensure proper and long-lasting operations of STAG Autogas systems in vehicles equipped with START/STOP engine mode, high-durability gas valves are recommended to mount. The proper valve shall be marked with additional "H3" symbols meaning 1,000,000 switching operations endurance, according to paragraph 4.7 of Annex 3 of regulation no. 67, Revision 4.

1.1 Layout diagram STAG 500 GO 4

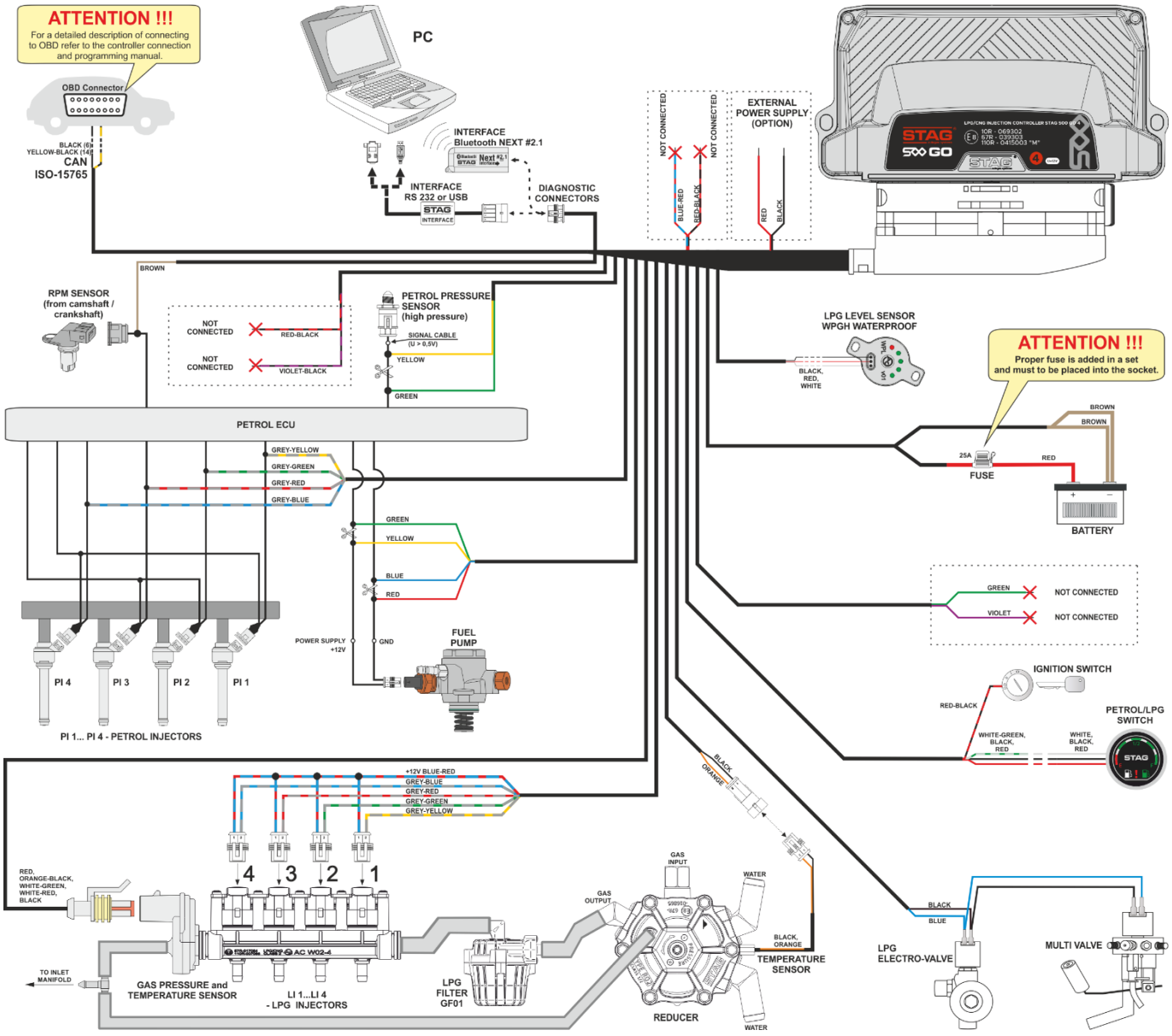


Fig. 1 STAG 500 GO 4 controller installation layout diagram

1.2 Wiring diagram for STAG 500 GO 4 + STAG ISR

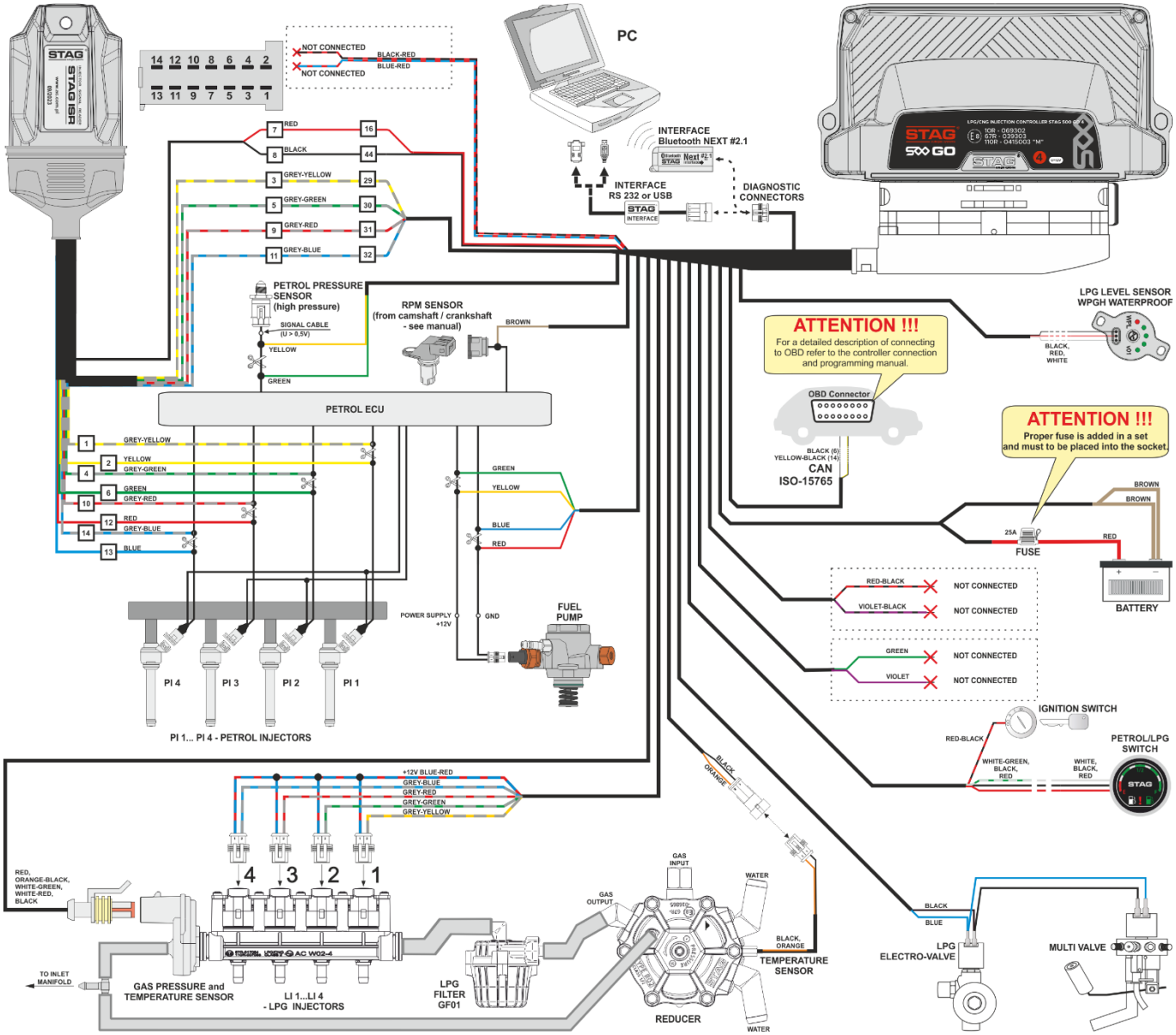
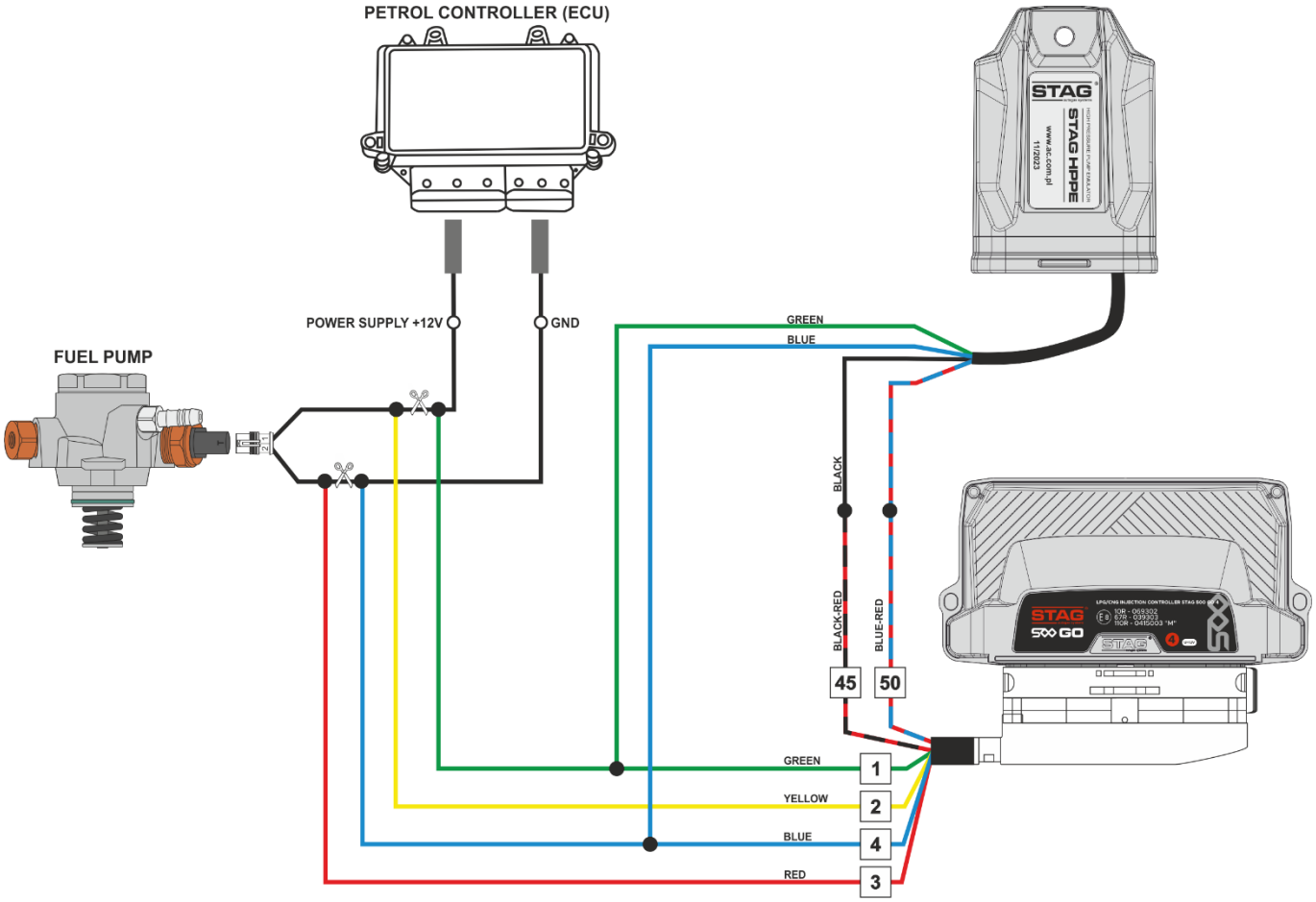


Fig. 2 Wiring diagram for STAG 500 GO 4 + STAG ISR

1.3 Wiring diagram STAG 500 GO 4 + STAG HPPE



STAG 500 GO 4 WIRE COLOUR AND PIN No.		STAG HPPE WIRE COLOUR	
PIN 1 GREEN		GREEN	
PIN 4 BLUE		BLUE	
PIN 45 BLACK-RED		BLACK	
PIN 50 BLUE-RED		BLUE-RED	

Fig. 3 Wiring diagram STAG 500 GO 4 + STAG HPPE

1.4 Diagnostic protocol configuration

The STAG 500 GO 4 controller is equipped with the CAN-ISO 15765 and K-Line diagnostic protocol (compliant with ISO9141 and ISO14230 standards), however, in order to use the K-Line protocol, it is necessary to rewire cables in the STAG 500 GO 4 harness connector according to the following illustrations and descriptions.

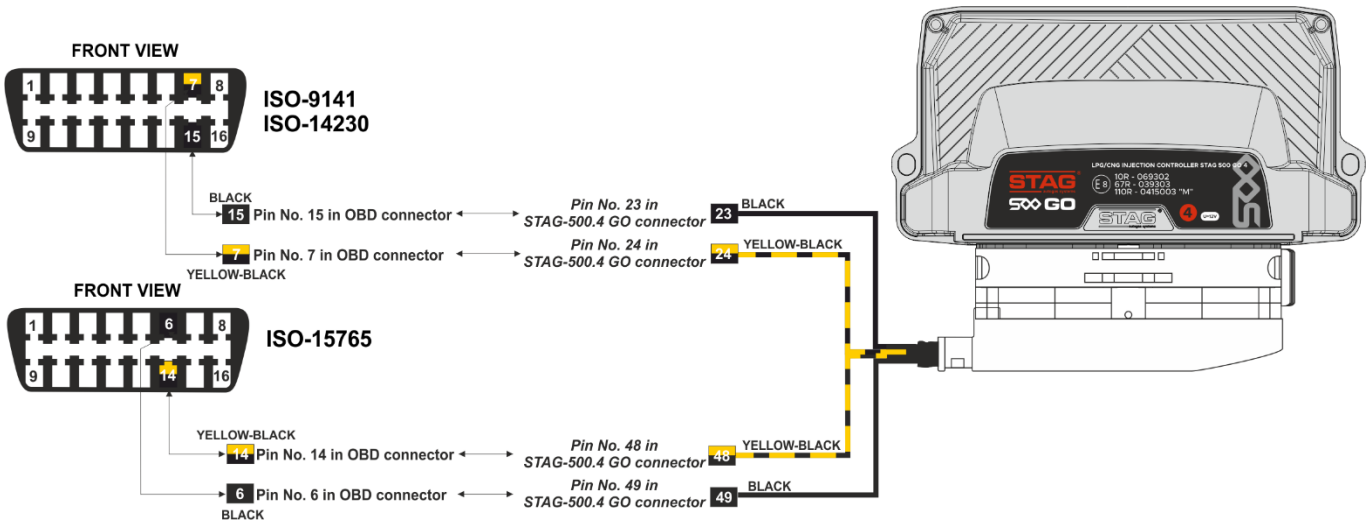


Fig. 4 Configuration of the controller harness of CAN (ISO-15765) diagnostic protocols and K-Line (ISO 9141/ISO-14230)

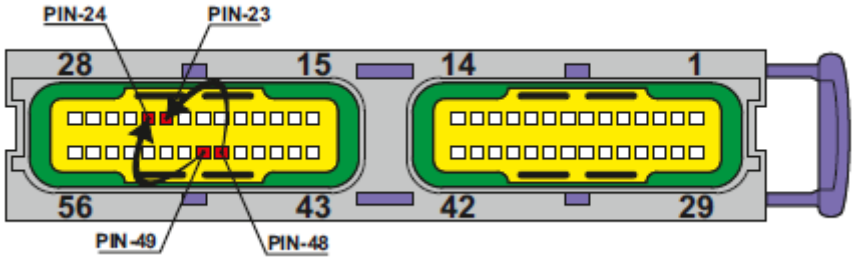


Fig. 5 Changing the connections in the STAG 500 controller plug for the K-Line diagnostic protocol

According to *Fig. 4* and *Fig. 5*, in order to change the diagnostic protocol from CAN to K-Line, the yellow-black wire plugged into pin 49 of the STAG 500 GO 4 controller should be used and plugged into pin 24 of the controller plug, and the black wire, plugged into pin 48 by default, should be moved to pin 23. On the side of the OBD connector, perform the modification by means of transferring the yellow-black wire from pin 6 to pin 7 and the black wire from pin 14 to pin 15, as shown in *Fig. 4*.

1.5 Selection of reducer

Install the controller according to the layout show in *Fig. 1*. In a sequential injection system, pay attention to select a pressure reducer properly matched to the given car engine power and injector nozzles. A pressure reducer that is poorly matched to the car engine power will not be able to provide sufficient supply of gas at large demand (fully open throttle) and to maintain nominal gas pressure within the system. Should gas pressure drop below some preset low threshold, the controller will automatically switch to petrol.

1.6 Selection of injector nozzles

Injector nozzles diameter must also be matched to the given car engine power, see the table below. Power per cylinder is engine power divided by number of cylinders in the engine.

Nozzle diameter [mm] Reducer pressure - 1 [bar]	Power per one cylinder [KM]
1,5 - 1,7	10- 18
1,8 - 2,2	19 - 29
2,3 - 2,5	30 - 39
2,6 - 2,8	40 - 49
2,9 - 3,0	50 - 59
3,1 - 3,2	60 - 70

The above rough values may in some cases not correspond to actual values.

2 The AC STAG diagnostic software

2.1 Controller-computer connection

Using a RS, USB or Bluetooth NEXT link connect the vehicle-installed STAG 500 GO 4 controller with a PC computer on which the AC STAG diagnostic program is preinstalled. Turn the vehicle ignition switch ON to supply the controller with power before launching the program. This step is required since no communication with the controller is possible while it is in sleep mode into which it is automatically turned about 10 minutes after its power is disconnected. As soon as the program is started, the controller links with it (provided the correct COM serial port is selected). Successful communication is confirmed by the „No ignition switch", „Waiting for gas", „Petrol" or „Gas" message displayed at the bottom left corner of the program screen. Parameters window and tabs are presented on *Fig. 6 - Fig. 9*.
If you get the "Controller Error" message and "No connection" appears in the lower left corner of the screen, select a different COM port from the Port menu at the top of the screen.

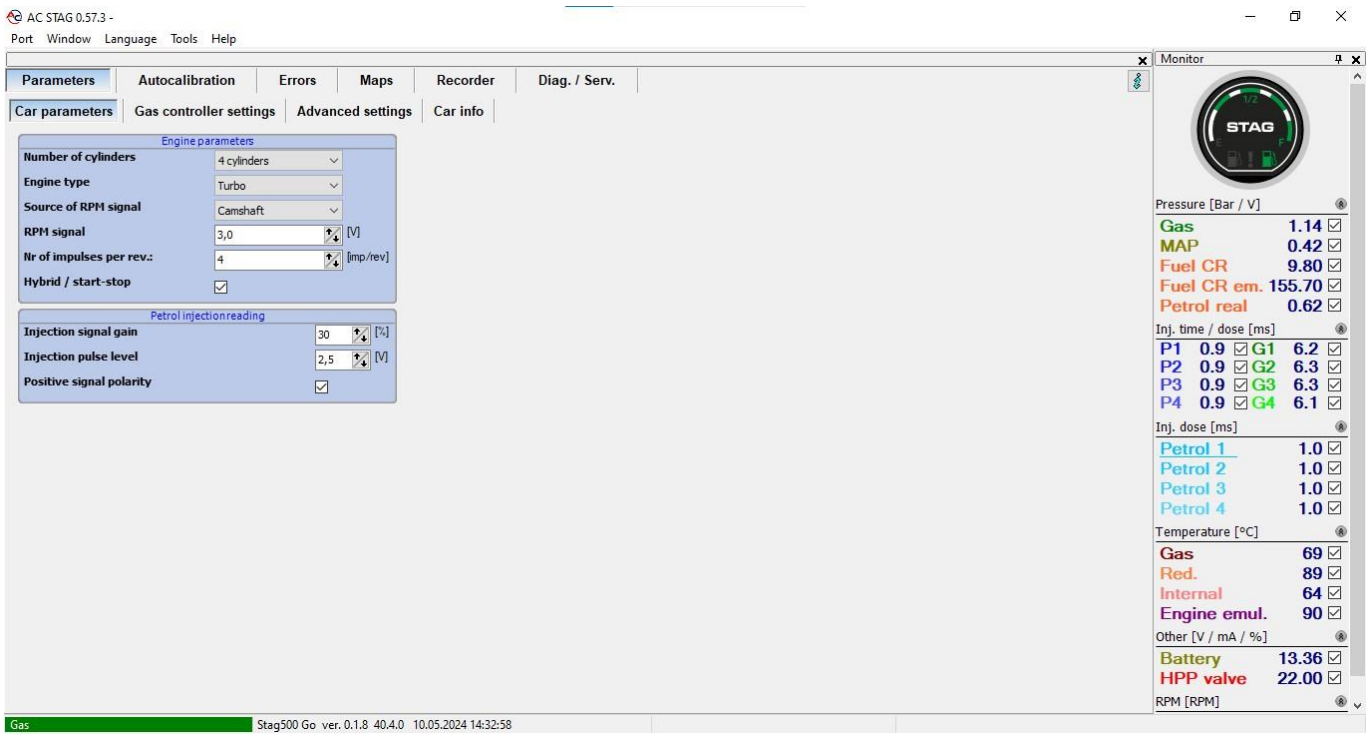


Fig. 6 „Parameters" tab view (Car parameters)

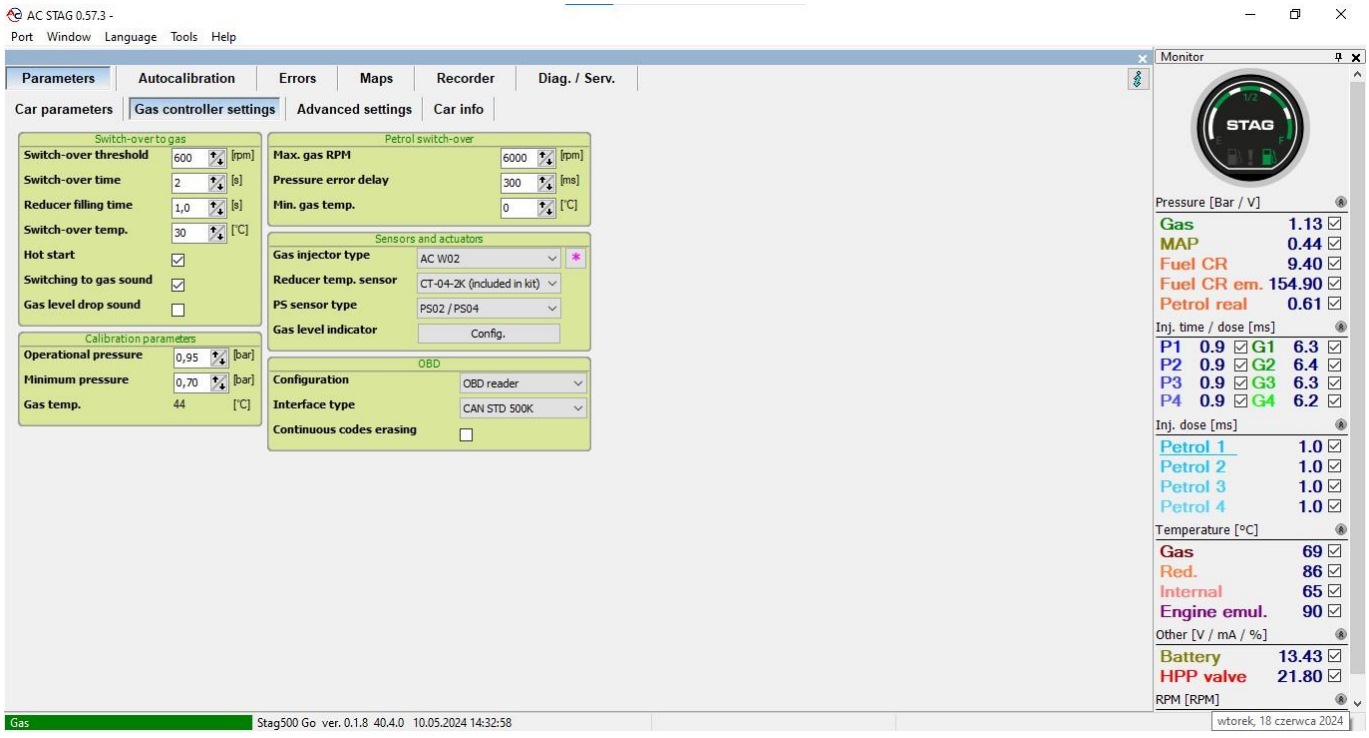


Fig. 7 „Parameters" tab view (Gas controller settings)

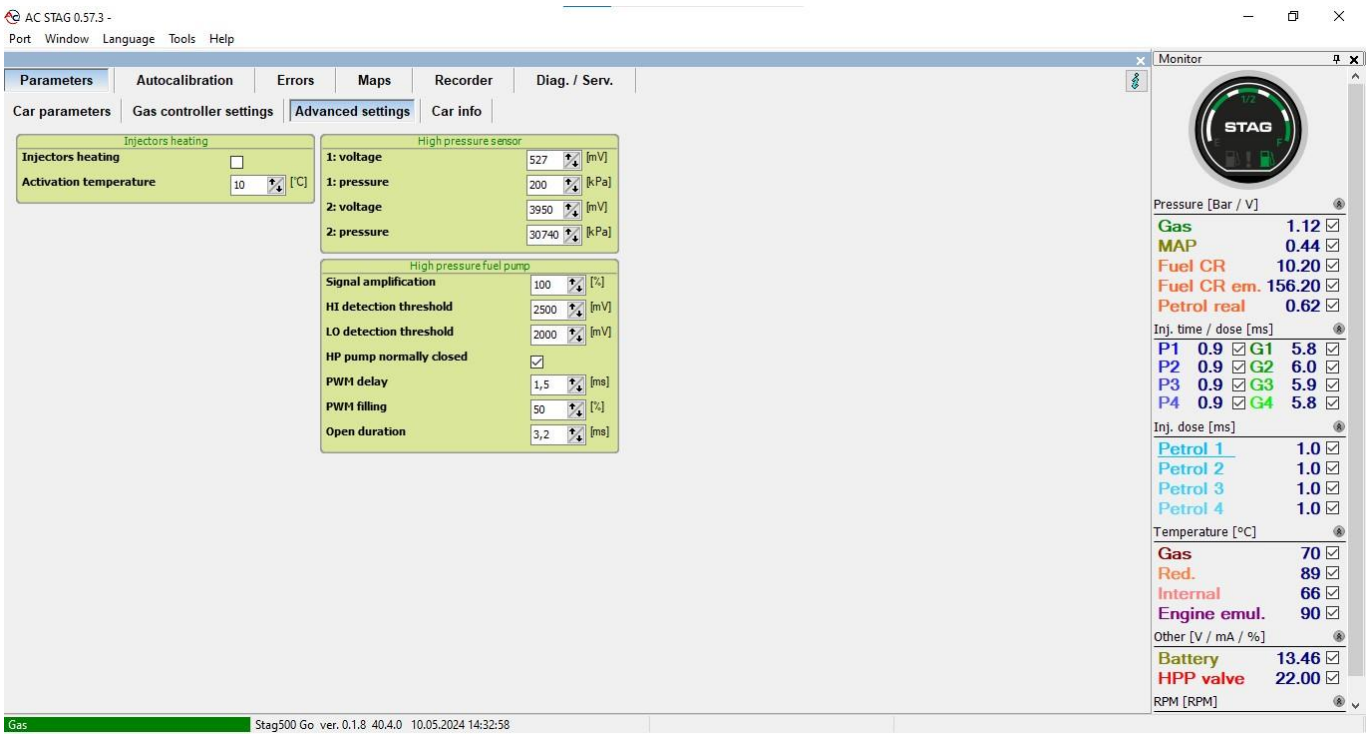


Fig. 8 „Parameters" tab view (Advanced settings)

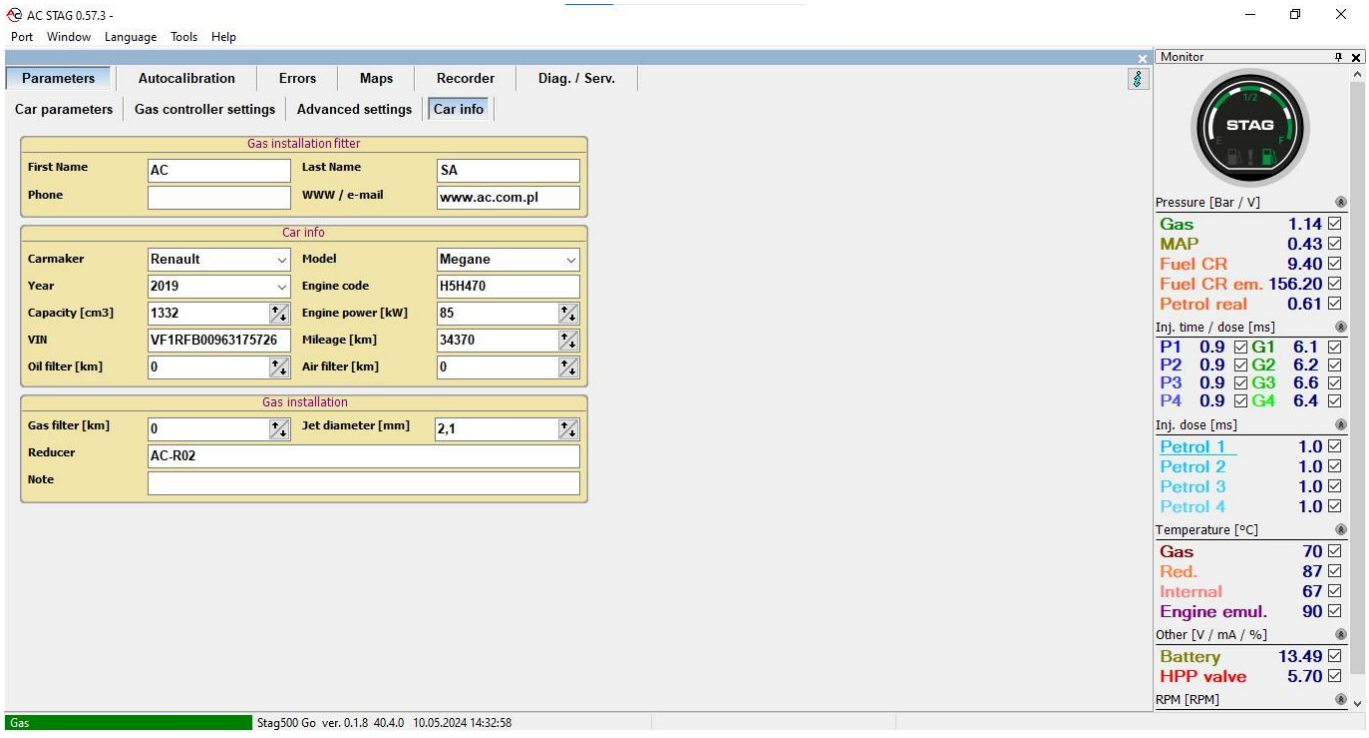


Fig. 9 „Parameters" tab view (Car info)

2.2 AC STAG firmware version

After the diagnostic application startup, the version info is presented on its top bar; the examples (*Fig. 6* - *Fig. 9*) present version 0.57.3.

2.3 Main menu

The main menu consists of the following options:

- ***Port*** – options may be used to select a COM port, set-up the communication link, terminate communication with the controller,
- ***Window*** – options may be used to open program screens (such as: oscilloscope, monitor parameters, monitor auto-adaptation, reader OBD, digital recorder) if they have been closed,
- ***Language*** – options may be used to select user interface language version,
- ***Tools*** – option may be used to update hardware devices, setup program settings, load store settings , store modified settings , restore default (factory) settings ,
- ***Help*** – options may be used to display info on the program/the controller and documentation (including this manual).

To bring up the About gas ECU window, select “Gas controller info” in the Help menu”.

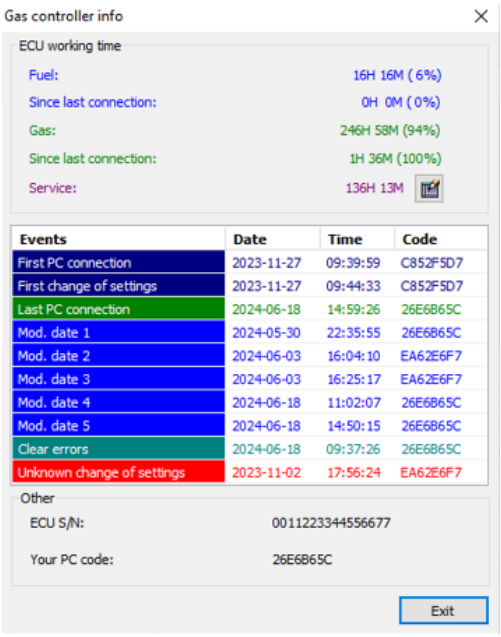


Fig. 10 Gas controller info window

The Gas controller info window (*Fig. 10*) shows the following parameters:

ECU working time:

- ***Fuel*** – working time of the controller using petrol listed in the following format: H – hours, M – minutes, S – seconds.
- ***Since last connection*** – working time of the controller using petrol since its last connection with a PC.
- ***Gas*** – total working time of the controller using LPG.
- ***Since last connection*** – working time of the controller using LPG since its last connection with a PC.
- ***Service*** – set service time. When the time of the controller work will approach the service time, the controller every time you turn the ignition switch on will turn on an acoustic signal about needed system service. In the case of the service "the millage" only gas working time is counted, and the signal will begin after the expiry of 90% of the set time. In the case of the review "by date", signaling begin two weeks before the set time.

Clearing the Inspection Schedule is explained below.

To set the Service Schedule, click the  button in the About gas ECU window. The following window will pop up (*Fig. 11*):

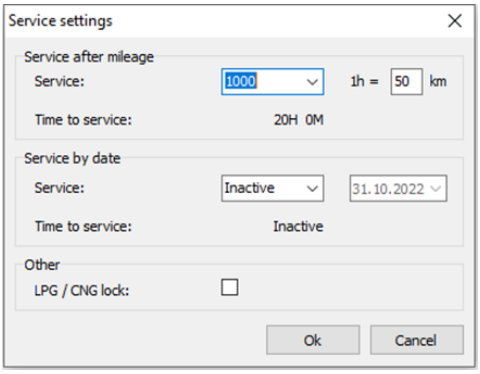


Fig. 11 Service window

In that window you can set up the time to inspection. The time to inspection is computed on the basis of the selected mileage, after which the inspection is to be carried out. Default conversion rate is 1h per 50 km, but you can modify it. In the example shown in the figure 1000 km and the 1 h per 50 km conversion rate translate into 20 hours of operation to the nearest inspection. An alternative method of inspection set-up is an option of "inspection by date", where the date of scheduled inspection is specified instead of a mileage limit.
To clear the service schedule, select “Inactive”, in which case the controller will not monitor the service schedule. Selecting the option "LPG / CNG lock" prevent driving on the gas beyond the set time of the inspection.

Below the working times, the Controller Info (*Fig. 10*) lists the following types of registered events:

- ***First PC connection*** – date of the first controller-PC connection.
- ***First change of settings*** – date of the first modification of the controller settings.
  If these fields do not show dates but instead the „???” symbols, it means an error occurred in the Controller Info. Time information has been lost and the controller will start counting the times from the beginning.
- ***Mod. date 1 ÷ Mod. date 5*** – a list of controller settings modifications. From the most recent ones till the oldest.
- ***Clear errors*** – Time stamp showing when controller error was cleared.

Each event is also accompanied by a “code” linked to the PC on which the modification was made. Thus knowing the modification date as well as the PC code, it is easy to determine whether any modifications have been performed by anyone else. The bottom of this window shows additional information:

- ***ECU S/N*** – the serial number of the controller,
- ***Your PC code*** – The code of the PC on which the AC STAG software is currently used.

2.4 Controller parameters

The controller firmware version is shown at the bottom of the screen (*Fig. 6*) - a description of the designations is given below:

Stag500 Go – controller model,
0.1.8 – controller firmware version number,
40.4.0 – controller version numer.

The Parameters window lists a number of parameters which need to be set individually for each vehicle. The **Car parameters** group contains:

- ***Number of cylinders*** – number of engine cylinders,
- ***Engine type*** – engine type: Standard – normally aspirated engine without turbocharger, Turbo – engine equipped with turbocharger/supercharger,
- ***Source of RPM signal*** – engine speed signal source:
  - *Camshaft:* select this option if the source of the RPM signal is the camshaft position sensor. **It is very important to connect to the sensor which is located on the drive shaft of the high pressure pump.**
  - *Crankshaft:* select this option if the camshaft position sensor is not present on the drive shaft of the high pressure pump, in this case the crankshaft position sensor must be connected, example *TSI EA 888* engines,
- ***RPM signal***– RPM detection threshold in Volts. Set the detection threshold to a value ensuring proper revolutions reading from the controller. E.g. for impulses originating in a petrol engine usually equal app. 5 [V], set the detection threshold to approx. 2,5 [V].
- ***Number of pulses per revolution –*** the value of this parameter is set so that the number of engine revolutions coincides with the values shown in the OBD reader,
- ***Start-stop function*** – if enabled on, the solenoid valve remains open for 3 minutes maximum after the engine speed reaches 0 rpm and the ignition switch remains on,
- ***Injection signal amplification*** – a circuit parameter that forms the shape of the injection signal 'as seen' by the microcontroller. Its value should be set as high as possible, usually 100%. However, if during petrol operation, the petrol controller displays errors related to the injector circuits, the gain should be reduced to a value at which these errors cease to occur,
- ***Injection pulse level*** – the detection threshold for petrol injection pulses. The digital recorder is very useful for setting it ('Window' menu). Set the value to correctly read the injection pulse time, eliminating 'false' pulses,
- ***Positive signal polarity*** – Parameter used when using the STAG ISR device to read petrol injection pulses. The signal at its output is 'inverted' in relation to the input signal, i.e. when the injector is powered/open, the voltage signal at the controller's input is positive.

  Example settings when using STAG ISR:
  1. Injection signal amplification: 30%,
  2. Injection pulse level: 2.5 V,
  3. Positive signal polarity: marked.

Switch-over to gas – parameters related to switching from petrol to LPG. The **Gas controller settings** window lists the following groups of parameters:

- ***Switch-over threshold*** – engine rpm required for the controller to switch to LPG. For RPM set to <700, the controller switches to LPG at idle run,
- ***Switch-over time***– time after starting the engine when the controller can switch to LPG,

- ***Reducer filling time*** – delay between opening solenoid valve and gas injectors. The function used to pre-fill the system with gas,
- ***Switch-over temp.*** – minimum temperature of reducer when the controller can switch to LPG,
- ***Hot start*** – if checked, warm engine may be started directly from LPG. Check that option also in vehicles equipped with the **Start/Stop** function, e.g. Fiats. The option is used if the engine is started with the reducer temperature equal to or lower than the switching temperature (but not lower than 20°C) and gas temperature not lower than 10°C,
- ***Switching to gas sound*** – checking the option will result in a beep upon switching to gas fueling,
- ***Gas level drop sound***– when selected, each displayed decrease the gas level will be accompanied by a short beep.

Petrol switch-over **-** parameters related to switching from LPG to petrol:

- ***Max gas RPM*** – engine rpm; when higher, the controller will switch to petrol,
- ***Pressure error delay*** – amount of time with the LPG pressure lower than minimal before the controller switches to petrol and reports: “LPG pressure too low”,
- ***Min gas temp.*** – min. LPG temperature; when lower, the controller will switch over to petrol.

Calibration parameters **–** parameters related to controller calibration:

- ***Operational pressure*** – LPG pressure at which the controller was calibrated. This setting can be altered manually. **However, each change of the operational LPG pressure requires multiplier map calibration!!!,**
- ***Minimum pressure*** – when the pressure is lower than minimum, the controller will switch to petrol if the duration of min. pressure exceeds the ***Pressure error delay,***
- ***Gas temp.*** – gas temperature at which the controller was calibrated. It is impossible to manually change this parameter.

Other parameters in the **LPG Controller Settings** group:

- ***Gas injector type*** – type of the LPG injector. **Changing the injector type requires re-auto-calibration or multiplier map calibration!!!**

  Clicking the *Gas Injectors Settings* button  will open up the following window (*Fig. 12*) in which the LPG injectors can be calibrated:

Fig. 12 Gas injectors settings window

- ***Bank 1/2*** – the option allows assignment of injectors to banks,
  - ***Auto.*** – automatic assignment of gas injectors to Banks 1 and 2,
- ***Gas injectors corrections/Flow corr.*** – percent correction of gas-air mixture injected by gas injectors to each engine cylinder.

- ***Test*** – automatic testing of the flow on individual gas injectors,

➢ ***Injector opening correction/Open corr.*** – the window allows configuration of very precise, absolute correction of gas injector. Unlike the percentage correction, it is constant and not dependent on time. It is ideal for compensating differences in performance of injection rails resulting from their mechanical properties.

WARNING!!! Use this option as a last resort, i.e. when sure that the installation was performed properly, all mechanical issues have been eliminated and injection times variations for given injectors are still present when using LPG.

Do not ever use injection strip-collector pipes of different lengths and then the injectors' calibration to accommodate this difference!!! Also never use this option when the system is not in a perfect working condition or when some of its elements have worn out. Using this option in a manner not consistent with the above instructions may result in damage to the car!!!

➢ ***Injection sequence/Inj. seq.*** – configuration of the injection sequence (which petrol injector is to control respective gas injector),

- ***Configuration*** – the new window *(Fig. 13) allows automatic checking and automatic change of the gas injection sequence. Each time the button "@xx" button is pressed,* the injection sequence timing will be advanced by a given angle of "*xx*" with respect to the current setting. This operation accounts for the real order of petrol injectors and configuration of cylinder banks. If the "@*xx*" button is inactive, it means that the controller did not detect the order of petrol injectors or the engine is off, or, it is a sequential injection engine,

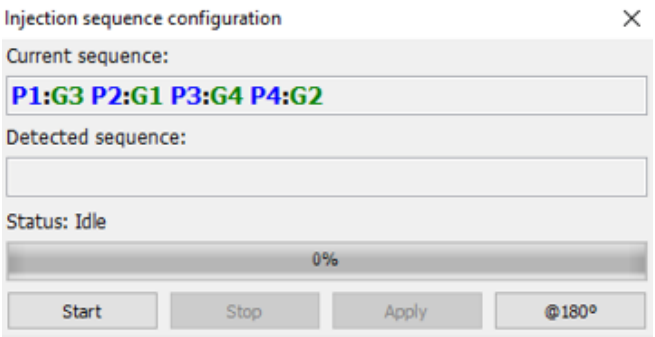


Fig. 13 Automatic configuration of the injection sequence

➢ ***Cycle counter*** **–** a series of counters to count the operating cycles of individual gas injectors. These values are saved in the nonvolatile memory of the controller, but they are not saved in the "*set*" file with settings. The counters should be reset after injector replacement. They are used for information purposes only,

- ***Reducer temperature sensor*** – pressure reducer temperature sensor type selection,
- ***PS sensor type*** – the selection window for the vacuum pressure, LPG pressure, and LPG temperature sensors installed in the intake manifold,
- ***Gas level indicator*** – see **Section 2.5** for details.

Parameters in the **OBD** group – settings of the connection between the controller with the onboard diagnostic interface:

- ***Configuration*** – selecting the "OBD reader" option results in an attempt to connect to the onboard diagnostic interface after each key switching, if the controller operates in Auto mode,
- ***Interface type*** – indicates OBD2/EOBD communication type available in the vehicle. The default AUTO mode enables scanning and automatic selection of proper OBD interface. If, despite of AUTO mode selected, no OBD communication can be established, an appropriate interface type shall be selected individually,
- ***Continuous codes erasing –*** continuously deletes the DTCs added to the Automatic DTC Deletion list (this happens as soon as the gasoline ECU logs a DTC). If left unchecked, the ECU will delete the DTCs during the next ignition off-on cycle.

The **Advanced settings** group offers the following options:

- ***Injectors heating*** – marked activates the procedure of heating gas injectors after a long car standstill when the reducer temperature is lower than the set **activation temperature**,
- ***High Pressure Sensor*** - the high fuel pressure values stored in (kPa) and (mV) are adjusted during the Autocalibration process:
  - *1:VOLTAGE* – minimum petrol pressure value stored during calibration (mV),
  - *1:PRESSURE* – minimum petrol pressure value stored during calibration (kPa),
  - *2:VOLTAGE* – maximum petrol pressure value stored during calibration (mV),
  - *2:PRESSURE* –maximum petrol pressure value stored during calibration (kPa).
- ***Petrol high pressure pump*** – control values for the high-pressure pump, are adjusted during autocalibration, This group contains settings for both reading and generating pump control pulses:
  - ***Signal amplification*** – analogous as „*Injection signal amplification*",
  - ***HI detection threshold*** – option not used,
  - ***LO*** detection threshold – analogous as „*Injection pulse level*",
  - ***HPP NC.*** – this parameter determines whether feeding the valve closes or opens the petrol supply to the pump. If, during petrol operation, the pressure drops after disconnecting the plug from the pump, this means that the pump is 'normally closed' (checkbox checked). If the pressure rises to high values, this means that the pump is 'normally open' (checkbox not checked). This setting is set automatically during autocalibration,
  - **PWM delay** and **PWM filling** – the Peak & Hold parameters of the pulse that STAG 500 will control the pump with. They are set automatically during autocalibration,
  - **Opening time** –the minimum pump control pulse time. This parameter is set automatically during autocalibration.

The **Car info** window lists the following groups of parameters:

- ***Gas installation fitter*** – contact details of the installation of a gas fitter,
- ***Car info*** – car data, which was mounted the gas installation,
- ***Gas installation –*** general information about the components of the gas installation.

2.5 Signals, injectors, LED switchboard

On the right-hand side of the programme window is the 'Monitor' tab. In this tab, a preview of the values of the signals measured by the controller is available:

1. ***Gas pressure [bar]*** – LPG pressure value (the pressure difference between reducer and intake manifold),
2. ***MAP pressure [bar]*** – pressure in intake manifold (absolute pressure value),

3. ***Petrol CR [Bar] –*** *actual pressure in the fuel rail,*
4. ***Petrol CR emu. [Bar] –*** *pressure emulated in the fuel rail,*
5. ***Petrol actual [V] –*** *actual voltage of the fuel rail pressure sensor [V],*
6. ***Injection time [ms]*** – petrol injection time,
   - P1 ÷ P4 – petrol injection time for injector 1 ÷ 4,
7. ***Gas injection dose [ms]*** – gas injection time,
   - G1 ÷ G4 – gas injection time for injector 1 ÷ 4,
8. ***Petrol dose [ms]*** – calculated petrol injection time of the petrol injectors,
9. ***Gas temperature [° C]*** – LPG temperature at the pressure reducer output,
10. ***Reducer temperature [° C]*** – liquid temperature at the reducer,
11. ***Internal temperature [° C]*** – internal temperature in controller,
12. ***Emulated engine temperature [° C]*** – estimated engine temperature,
13. ***HPP [%]*** – percentage control of the high pressure pump valve,
14. ***Battery [V]*** – voltage at the controller's power supply,
15. ***RPM [rpm]*** – engine revolutions.

All the above described signals are also visible on the oscilloscope. To turn off a given signal on the oscilloscope, click on it. By clicking on the name of a given signal you can change its color on the oscilloscope.

The LED-600 switchboard is shown at the top of the "Monitor" tab (*Fig. 14*).

Fig. 14 LED 600 switchboard

There is a button on the LED switchboard for changing the fuel type (press STAG label). The LED-600 LPG/gasoline switch indicates the operation with the fuel pump indicator backlight.

Basic LED status readings are indicated as follows:

- ***Off / white fuel pump backlight on*** – the ECU enables gasoline supply,
- ***On / green fuel pump backlight on*** – the ECU enables LPG supply ,
- ***Flashing / green fuel pump backlight flashing*** – the ECU automatically switches between the fuel types.

The LED-600 LPG/gasoline switch indicates the LPG level with a ring of five LEDs around the switch. The low LPG level is indicated by the LED-600 switchboard with a red LED ring display.

After right-clicking on the LED switchboard view, its settings window is displayed (*Fig. 15*). Alternatively, use the "*Gas level indicator configuration"* button on the "*Gas controller settings*" tab.

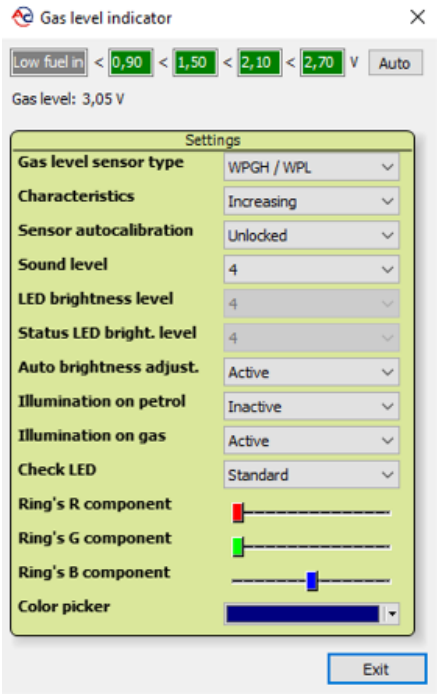


Fig. 15 Gas level indicator configuration window

Basic operations include configuring the type of indicator and setting the voltage values, according to which LED diodes will be lit to indicate the gas level on the switch panel (automatic settings of threshold voltages described in **Section 3.4**). Having applied the minimum (back-up) and maximum (full indication) voltage, you can use the AUTO button, which automatically calculates and populates the remaining two voltage thresholds.

Select the type of gas level sensor and sensor characteristics. The current voltage read from the gas level sensor is also displayed. With the “LED thresholds setting” window displayed, gas level change on the sensor results in immediate indication of the LED diodes. It is also used for checking the correct operation of the indicator and the switch. When the window is closed (normal operation), changes in gas level are updated on the LED switch with a delay.

The LED-600 switchboard feature buzzer volume control (1 – low volume, 4 – maximum volume) and LED indicator brightness control (1 – low brightness, 4 – high brightness). Led-600 switchboard can provide automatic LED indicator brightness control depending on settings. The LED indicator can be set to flash in sync with the buzzer modulation to indicate a fault. The LED-600 LPG/gasoline switch has configurable colours of the LED ring display.

2.6 Auto-calibration

The auto-calibration window is used to calibrate the engine at idle run. After starting and warming up the engine, when status in OBD reader is in “CL” mode (*Fig. 16*), start the auto-calibration. During the auto-calibration the engine should work at idle run. Switch off air-conditioning and lights and do not turn the steering wheel. During the calibration, the controller will automatically switch from petrol to LPG. The controller will learn the setting of the high-pressure pump and, in the final calibration phase, switch all cylinders to gas supply. Once the auto-calibration is complete, the controller displays a message informing the auto-calibration has finished successfully.

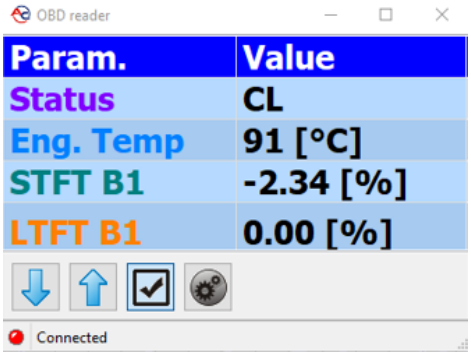


Fig. 16 OBD reader window

The following messages may appear during the calibration:

- ***No ignition switch*** – check the connection of the ignition switch,
- ***High/low RPM***– engine rpm is to hhigh/low; check the rpm settings,
- ***No injection pulses*** – no signal from the petrol injector; check the connection of the emulator's wire,
- ***Intake manifold pressure too high*** – intake manifolf pressure may be not correct; chack the connection of the manifold pressure sensor,
- ***Unstable engine operation*** – manifold pressure and/or rpm signals show excessive variations. Verify if the selected injectors match engine power, check system tightness and make sure that air-conditioning is off.

2.7 Oscilloscope

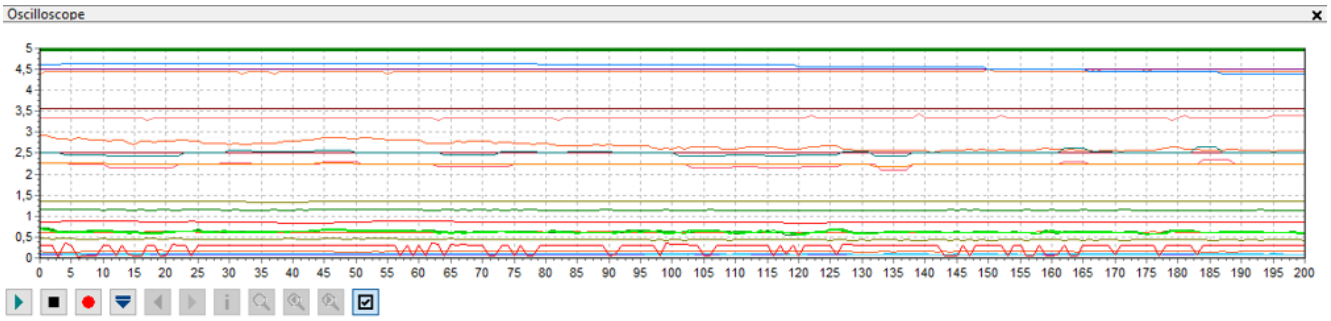


Fig. 17 Oscilloscope window

On each tab, except the parameters tab, there is the oscilloscope window attached to present the changing monitor parameters (described in **Section 2.5**). In the bottom left part, there are control buttons with the following functions (from the left):

- **Start the oscilloscope**,
- **Stop the oscilloscope**,
- **Save current oscilloscope display**,
- **Load saved oscilloscope** *(from file),*
- **Decrease the number of displayed points** (*only for loaded graphs*),
- **Increase the number of displayed points** (*only for loaded graphs*),
- **Display oscilloscope file information** *(data logging start/stop, total number of stored samples, application version, controller version, controller serial number),*
- **Search** – this feature can find a parameter (*event*) in the waveform display, e.g. and LPG pressure or LPG evaporator temperature drop below a specified threshold,

- **Search previous** – searches the waveform display in reverse for the user-defined event,
- **Search next** – searches the waveform display forward for the user-defined event.

Continuous green line is displayed at top of the oscilloscope screen while the controller operates in the LPG mode (red line indicates operation of the “injectors heating” function).
The oscilloscope is an excellent tool to analyze vehicle working conditions. Recorded parameters can be saved and reviewed. In order to make the analysis of records easier, the window includes navigation tools for effortless searching of the contents. The curve is moved with the cursor on the oscillator window bottom, cursor buttons and clocking on the left or right side of the window.

2.8 Errors

The tab is split into areas (*Fig. 18*) by the type of displayed information:

- Gas controller errors and messages:
  - Actual,
  - Registered.
- Engine controller errors:
  - Pending,
  - Registered.

Fig. 18 The view of „Errors” tab

2.8.1 Errors of the gas controller

Detection of events that restrict or prevent correct operation of the autogas system is indicated by messages with descriptions in red.

Section “Active errors” lists the codes of current faults detected by the controller. If the cause of the fault is eliminated, the entry is moved to the “Error records” section. In other words, this means that a defect had been detected, but it is not currently active. A “Delete” button for erasing recorded controller errors from the memory is located in the bottom part of the “Errors” tab, below the “Error records” section.
The following errors may appear during operation:

AC STAG application description	Meaning
Gas injector missing	Open circuit or fault of the specified gas injector
Low gas pressure	Gas pressure dropped or kept below the allowed low limit within the specified time
High gas pressure	Gas pressure 2x higher than the operating pressure for 60 seconds (usually associated with reducer problems)

Supply voltage too low	Controller supply voltage decreased below 9[V] (usually associated with a failing battery)
Gas temperature sensor missing	Disconnected or disrupted circuit of the gas temperature sensor
Reducer temperature sensor missing	Disconnected or disrupted circuit of the reducer temperature sensor
Gas temperature sensor circuit shorted	Gas temperature sensor shorted to vehicle ground
Reducer temperature sensor circuit shorted	Reducer temperature sensor shorted to vehicle ground
Injector supply circuit failure	Controller's circuit for injectors supply failed
Solenoid valve supply circuit failure	Overloaded or defective circuit or solenoid supply
Solenoid valve missing	Disconnected or disrupted circuit of the solenoid supply
Peripherals supply circuit failure	Overloaded circuit of peripherals supply (PS-04 sensor, WPG-H gas level indicator)
Connection with the switch failed	LED 600 switch not connected
Communication with the switch lost	Connection with LED 600 switch interrupted
Short-circuit or failure of the supply circuit for gas level indicator[5]	Gas level indicator (WPG) circuit is overloaded or short-circuited to the ground (connected load is too high).
Short-circuit in manifold pressure sensor	Manifold pressure sensor shorted to vehicle ground.
No manifold pressure sensor	Not connected or open circuit of manifold pressure sensor.

Upon error detection, the controller records its conditions, i.e. operating parameters of the gas system, including: pressure, gas temperature, reducer temperature, engine rpm, manifold negative pressure, petrol injection pulses and gas dose. Such data is normally called a frozen frame of the error and allows analyzing and detecting problems in gas system operation.

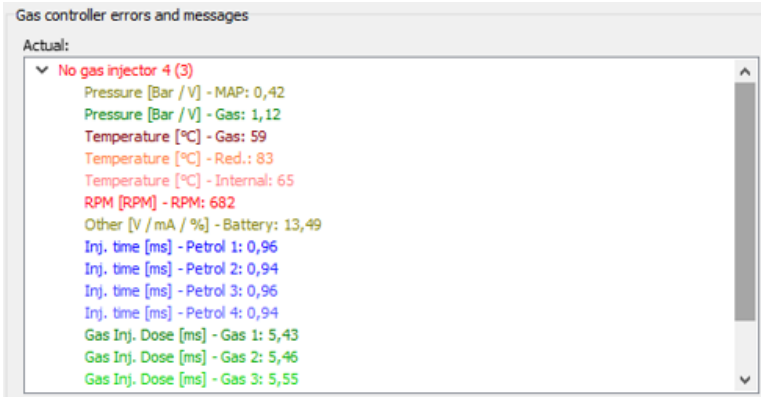


Fig. 19 „Frozen frame" of injector error

2.8.2 Gas controller message

Messages are prompts that are not necessarily related to detection of events limiting or preventing the operation of the autogas system, but signal the required verification of the configuration. Unlike the errors, message prompts are displayed in blue.

The controller can generate the following messages:

AC STAG application description	Meaning
Gas injectors fully open! Check the Lambda sensor at maximum load	Looping of gas injection, i.e. one gas injection pulse is overlapped by another pulse. If the Lambda sensor during the message display works in a “rich” mode, the error can be ignored; otherwise, use larger injector nozzles to reduce the multiplier.
LPG / CNG locking: review	The gas installation requires a service inspection. “Lock LPG/CNG” option checked. The controller will not operate in gas fueling mode until the service message is erased.
New settings	The controller indicates new settings. The message is usually displayed when new firmware is installed to remind about the new options.
Low gas temperature	Low gas temperature detected in gas fueling mode. Check the condition and method of reducer installation.
Ignition switch signal missing	The controller detects injection pulses with the missing ignition switch signal. Check the connection of the ignition positive wire.
Ignition switch signal unstable	The controller detected a brief loss of the ignition switched positive signal. Check if the ignition positive wire is connected in the correct point.
No rotation	The controller can "see" the impulses of petrol injection, but does not "see" RPM signal.
No petrol injection pulses, channel *n*	Despite running engine controller has not registered petrol injection pulses on the specific channel.

2.8.3 ECU fault codes

The controller is equipped with a OBD adapter capable of continuous monitoring of recorded and pending faults with the use of the onboard OBD2/EOBD interface. The errors are displayed as codes according to OBD2/EOBD notation system with descriptions.

If an error occurs, the “Delete” button can be used to erase OBD fault codes, which is equivalent to error acknowledgement (MIL lamp) via an external OBD scanner.

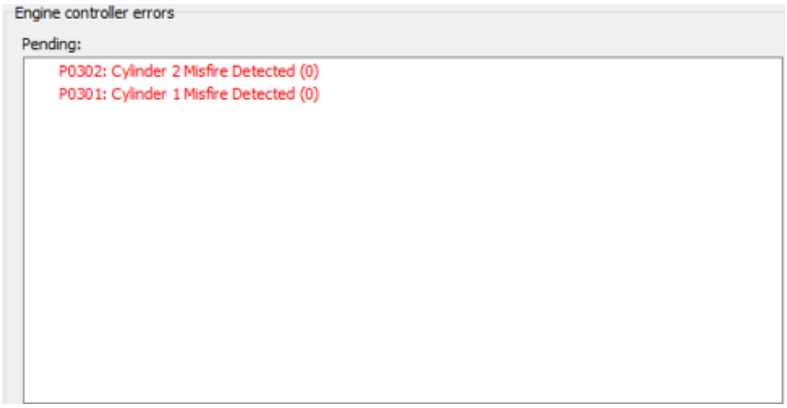


Fig. 20 The view of Errors tab – OBD faults

"Auto clear list" button allows configuration and activation of automatic clearing of OBD2/EOBD errors. The configuration window is split into two panels. The left one contains a list of all errors that can be cleared. In order to activate the automatic clearing function, move the selected errors to the right panel by using the Select button. Errors from the right panel can be removed only with the "Clear selected" button.

The errors will be cleared when the ignition is put to the ignition switch, on the condition that there are recorded errors displayed in the right panel of the automatic clearing configuration window.

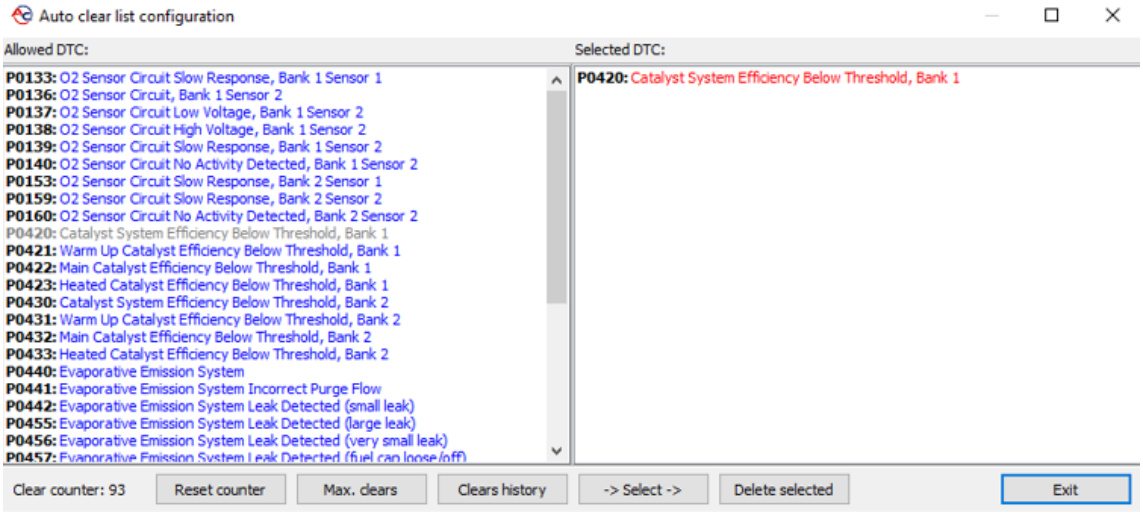


Fig. 21 The view of the OBD error clearing configuration window

If there are other errors recorded for the vehicle, besides those configured in the auto clearing tool, clearing will not be executed for safety reasons. Additionally, when engine startup is too fast, automatic clearing may fail due to the fact that not all vehicles allow error clearing when the engine is running.

2.9 Multiplier map

The 'Maps' tab contains the multiplier map of the gas controller. *Fig. 22* shows the 1D multiplier map:

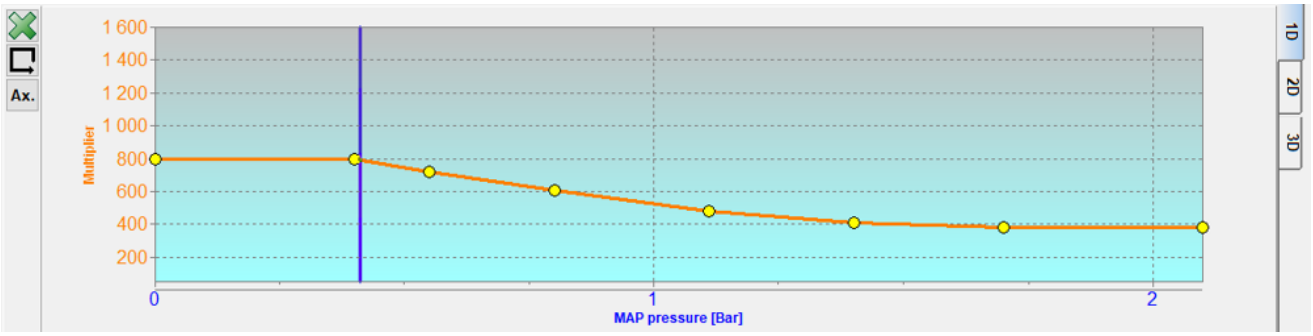


Fig. 22 Multiplier map

The multiplier map is displayed in orange. The left axis of the co-ordinate system (Multiplier) and the lower axis (MAP pressure [bar]) relate to the multiplier map. The multiplier map is used to set the multiplier for a given petrol injection time. The yellow points visible at the map are used to set the multiplier. To move a given point, select it by clicking on it. The value of a selected point is displayed at the lower right corner of the map. To move the points on the map, use the following keys:

- ← - left arrow moves the point to the left (change of the injection time for a given point)
- → - right arrow moves the point to the right (change of the injection time for a given point)
- ↓ - down arrow decreases the multiplier for given injection times
- ↑ - up arrow increases the multiplier for given injection times
- „Insert" (when a point is active) or right mouse button– add a new point
- „Delete" – delete a selected point on the map
- „Page Up" – Rising a selected point by 10 units, or the entire map, if no points are selected
- „Page Down" – lowering a selected point by 10 units, or the entire map, if no points are selected
- „Ctrl" + ← , or „Ctrl" + → change the active point (move to the next one).

When the „Shift" key is pressed in, the map movement speed is multiplied by 10 (fast movement). When no point is selected, the ↑ ↓ arrows move the entire map.

After pressing button "autoselection" became active, which means, that the multiplier points will be selected automatically so that the point next to the cursor becomes active. Maps can be deleted with buttons (petrol injection time map), (gas injection time map).

During the drive, pressing the SPACE key select the point closest to the current cursor position.

The 2D multiplier map is a more precise way of adjusting the gas injection rate, vertical axis RPM [rpm], horizontal axis MAP pressure [bar]. It is always advisable, after autocalibration and setting the 1D multiplier, to correct the 2D map values at idle and while driving.

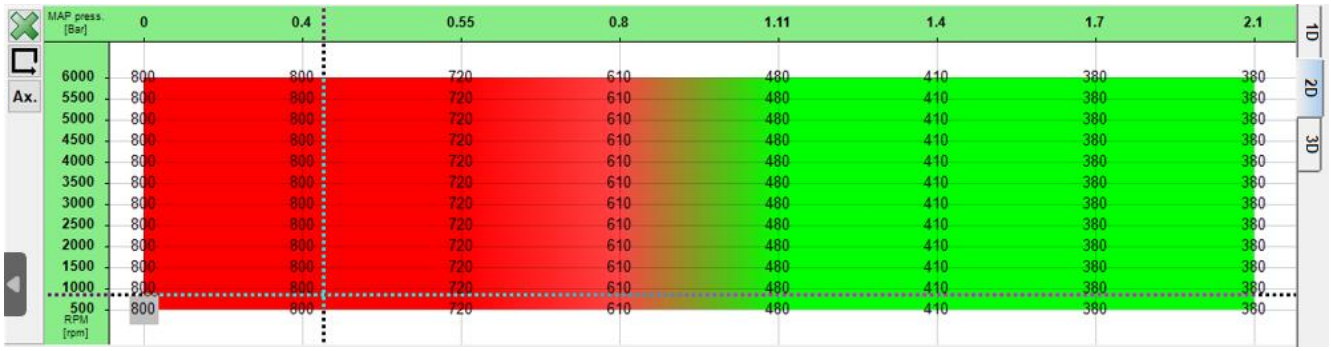


Fig. 23 Multiplier map - 2D view

The 3D multiplier map is a combination of 1D and 2D multiplier maps. Adjustment should be made by selecting the calibration area with the left mouse button, and using the ctrl+ up arrow or down arrow to modify the gas dose.

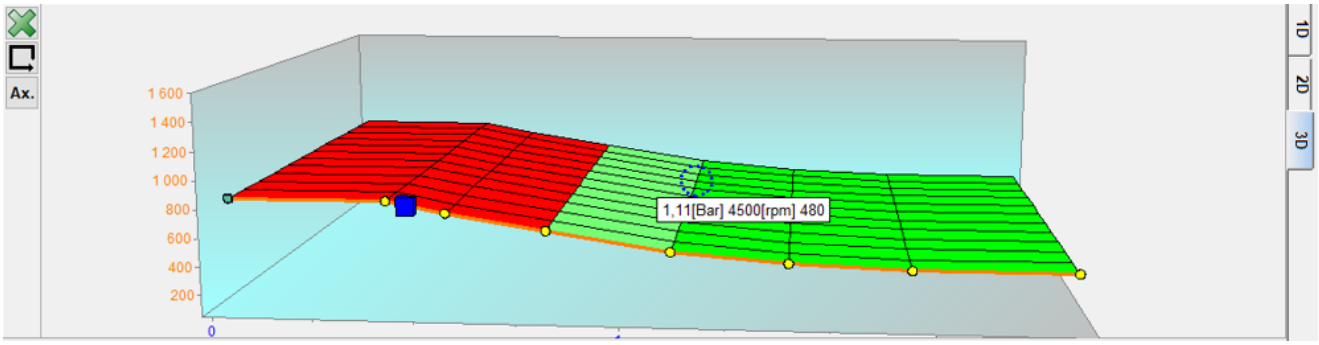


Fig. 24 Multiplier map - 3D view

2.10 RPM correction map

In the “RPM correction" tab, an additional correction map is displayed to supplement the multiplier map.

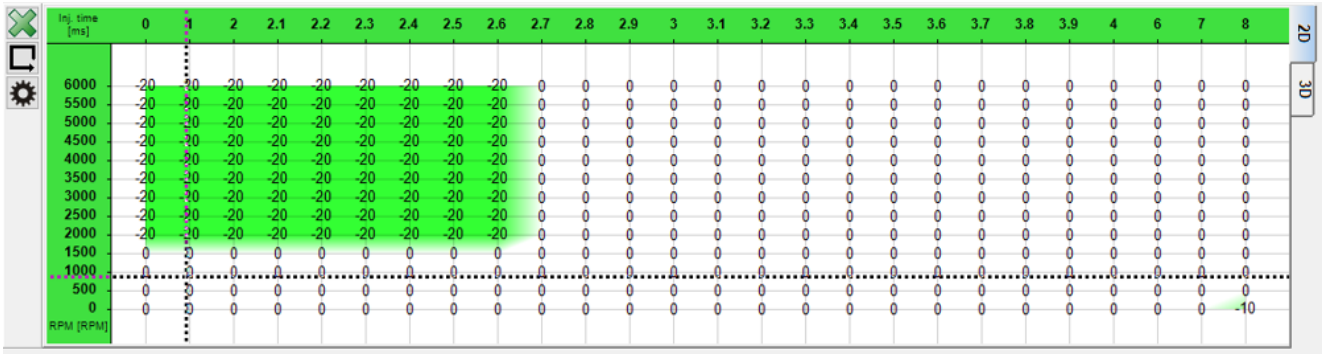


Fig. 25 The view of the RPM correction map

The RPM correction map forms a plane. One axis of the plane represents the petrol injection time [ms], while the other represents engine revolutions [rpm]. The map makes it possible to calibrate the multiplier depending on engine revolutions. This is shown in *Fig. 25*. It is possible to enrich/weaken the mixture for a defined petrol injection time and revolutions.

The visible cursor indicates where the engine is running. The position of the cursor depends on the current rpm and petrol injection time.

In order to calibrate the multiplier, the area which is to be calibrated must be selected by moving the mouse with the left button pressed over this area. Another method is to press the SHIFT key and, while holding it, to select the appropriate area by pressing arrow keys:

- ← Left arrow
- ↑ -Up arrow
- → Right arrow
- ↓ Down arrow.

Having marked the area which is to be calibrated, specified actions can be performed by using the combination of the CTRL key and one of the keys below:

- ↑ Arrow up (higher correction/richer mixture),
- ↓ Arrow down (lower correction/leaner mixture).

Pressing the SHIFT key in the course of the multiplier calibration will multiply the required step by 10.

The “3D” tab seen on the right side of the RPM correction map windows allows activation of a 3D view. Return to the classic two-dimensional view is made through the “2D” tab.

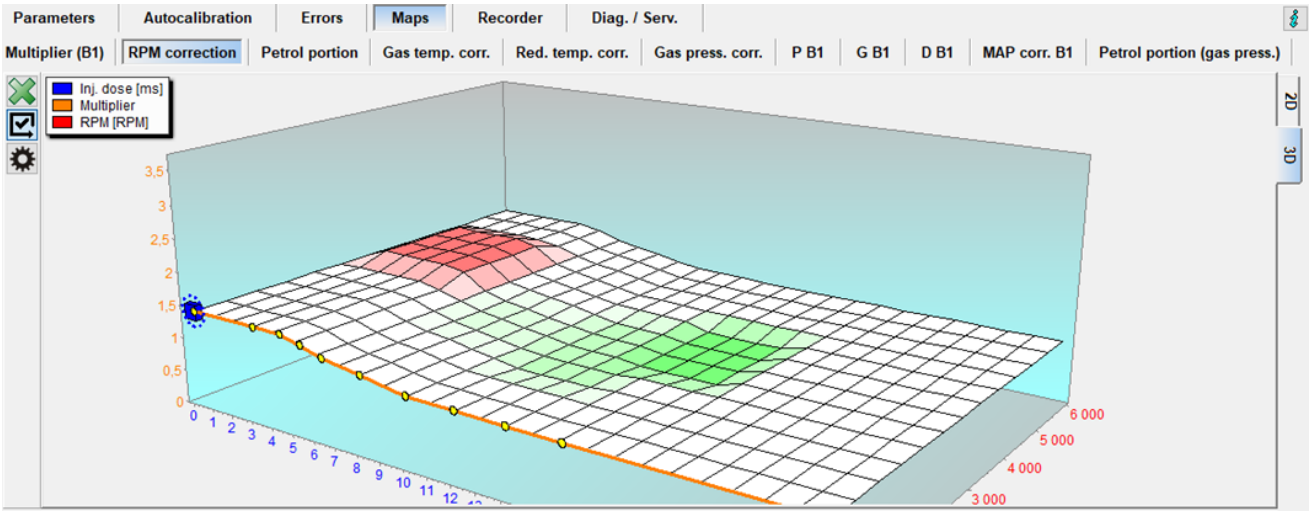


Fig. 26 RPM map correction – 3D view

The 3D view is a spatial display of the two-dimensional map. You can rotate the 3D map dragging it with the right mouse button. Other editing operations may be performed identically as in the 2D map.

2.11 Gas temperature correction map

The controller is provided with automatic gas injection time correction based on gas temperature. The “Gas temperature correction map” allows the user to enter manually an additional percentage correction based on gas temperature. Entering modifications is just like on the multiplier.

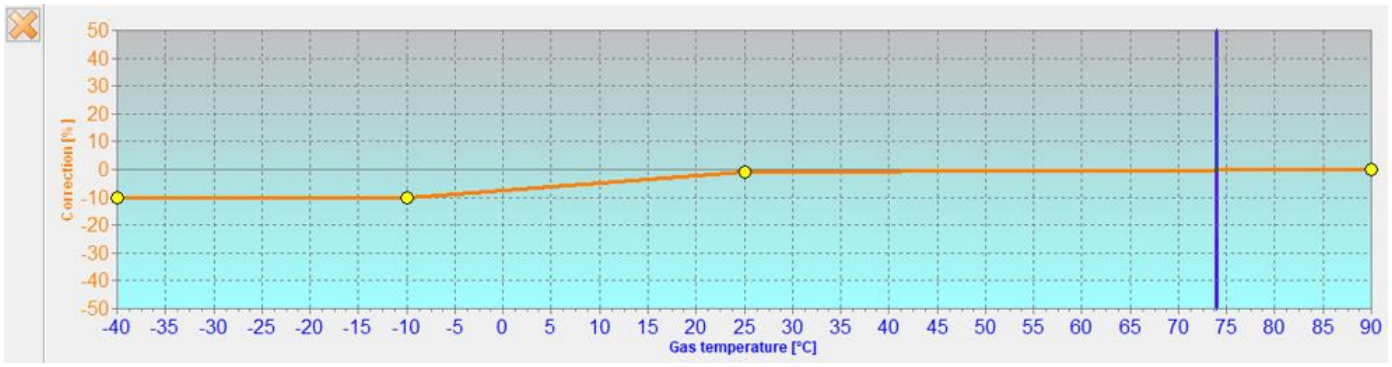


Fig. 27 Gas temperature correction map

2.12 Gas pressure correction map

The controller is provided with automatic gas injection time correction based on gas pressure. The “Gas pressure correction map” allows the user to enter manually an additional percentage correction based on gas pressure. Entering modifications is just like on the multiplier.

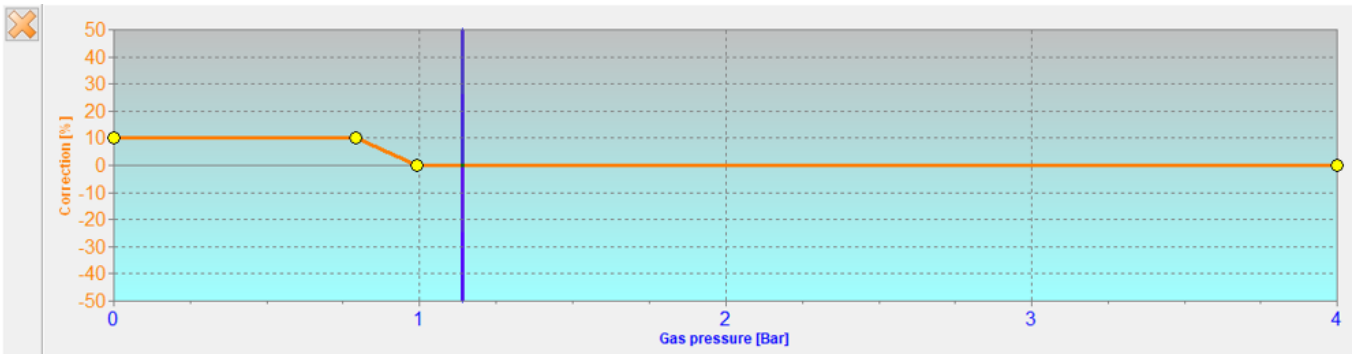


Fig. 28 Gas pressure correction map view

2.13 MAP correction map (autoadaptation map)

Autoadaptation systems is provided with dedicated maps of correction with rpm and load (MAP negative pressure) axes to make the corrections more natural and precise. The map view can be accessed through the “MAP correction Bx” tab. If autoadaptation is inactive, the map can be used for additional, manual corrections of gas fuel dosing.

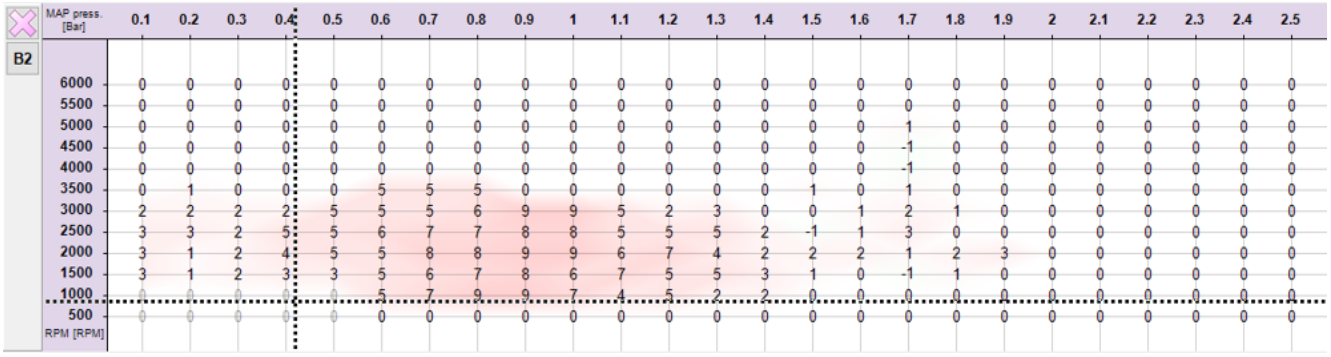


Fig. 29 MAP correction map

If autoadaptation is active but it is not desired in certain ranges of engine operation, it is possible to deactivate such ranges in the autoadaptation process. Select an area of the map with a mouse and click

the right button after selection. A context menu with “Autoadaptation lock” and “Autoadaptation unlock” commands is displayed. Locked areas are marked with grey correction values.
Controller STAG 500 offers two MAP correction maps, one for each bank. The maps can be switched with B1/B2 buttons under the map clearing button .

2.14 Injection delay

In injection delay map (*Fig. 30*), it is possible to delay the gas injection timing; the value given is the angle by which the gas injection is delayed in relation to the preceding injection; this option allows the gas dose to be more precisely adjusted to the cylinder's duty cycle - vertical axis [rpm], horizontal axis MAP [Bar].

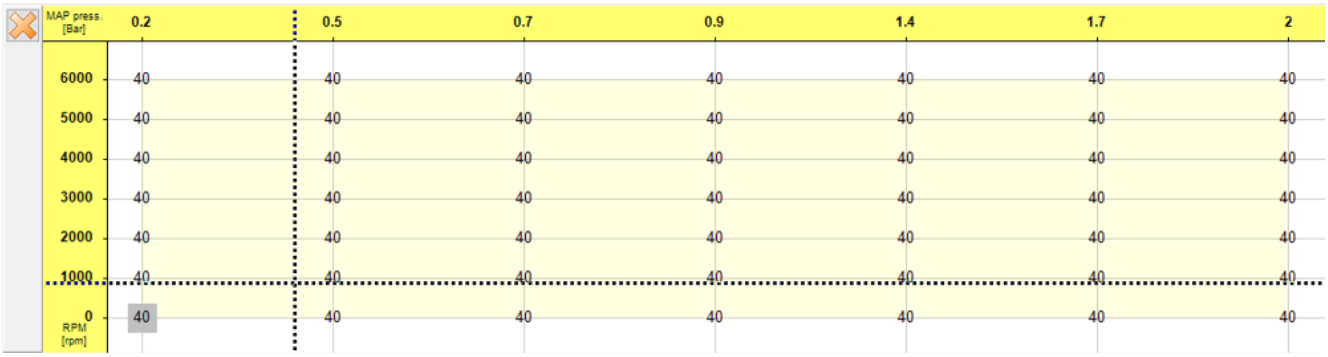


Fig. 30 Injection delay

2.15 Pressure in injection rail

The injection rail pressure map is shown in *Fig. 31*. Changing the value in the rail pressure map (modifiable from 0 upwards) causes the high-pressure pump to be activated in such a way that the petrol pressure in the rail is maintained at the level set in the map.

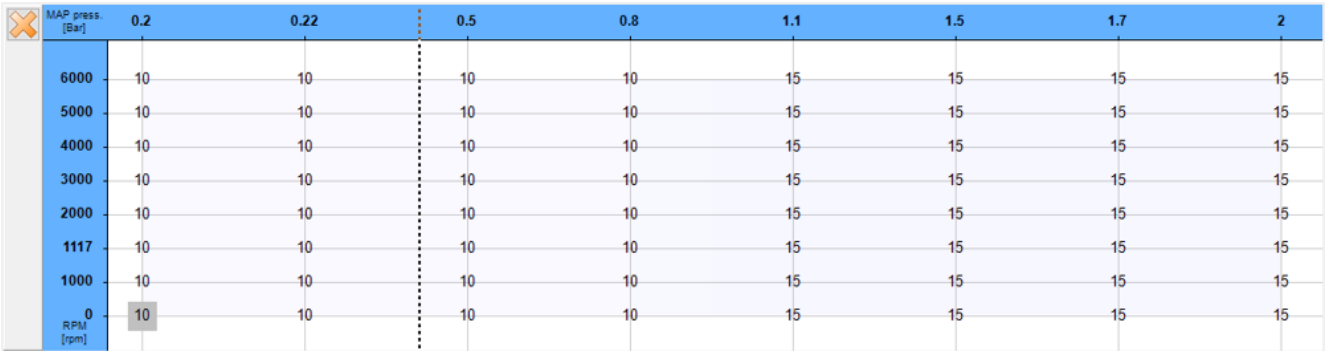


Fig. 31 Pressure in injection rail

The injection rail pressure map must be corrected when the proportion of petrol consumption is too low, the option prevents damage to the petrol injectors.

2.16 OBDII/EOBD reader

STAG 500 GO 4 is equipped with an integrated reader of parameters and faults based on the OBDII/EOBD interface. It is not necessary to connect an external adapter – all required circuits are integrated with the controller board.

The tool supports the following standards:

- ISO 15765 (ext. std. 250/500Kbits) – commonly referred to as "CAN";
- ISO 14230 (5Baud, Fast init);
- ISO 9141 – commonly referred to as "K-line".

The reader is initiated by selecting the "OBD reader" option on the gas settings tab. If the controller operates in auto mode, it will attempt to connect to the OBDII/EOBD diagnostic system upon activation of the ignition switch.

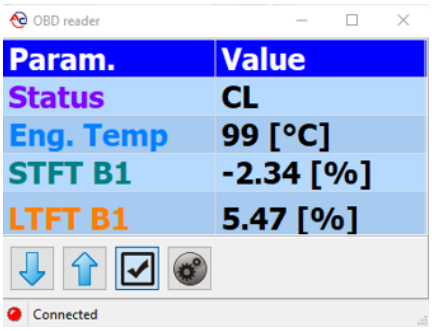


Fig. 32 OBD2/EOBD reader

The reader window can display maximum 7 parameters at the same time. Navigation is realized with buttons  , which are used to scroll through the parameters read via OBDII/EOBD. For showing or hiding the parameters of OBD reader on the oscilloscope in the application use the button  .

The button  opens the parameters configuration window (*Fig. 33*), which allows creating any sets of displayed parameters thanks to which it is possible to display a set including only parameters that are required for system calibration (such as fuel loop status, STFT and LTFT trims, results of a wide-band oxygen sensor). The window displays a set of 96 parameters available in OBDII/EOBD standard. Parameters unavailable in a given vehicle are grey. In order to add or remove a parameter from the reader, select it or deselect it in the field on the left side, next to its description.

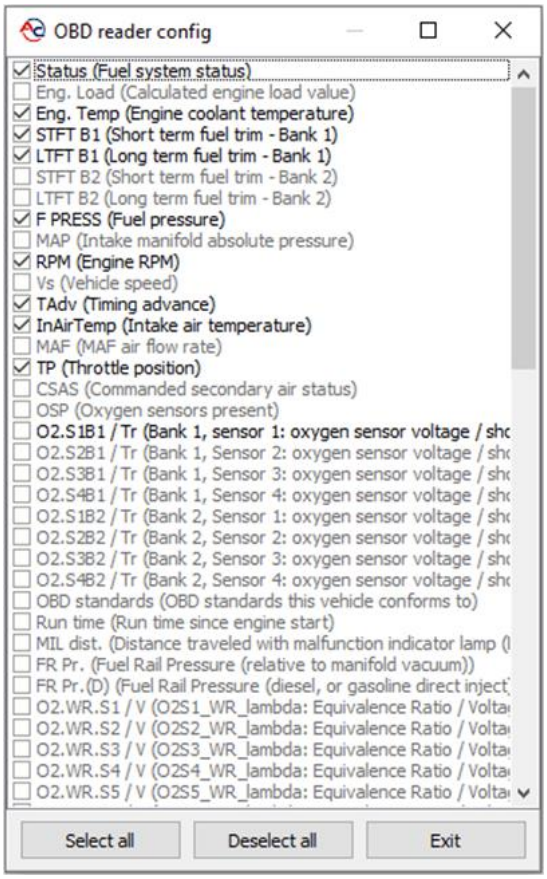


Fig. 33 OBD2/EOBD reader configuration

If it is necessary to diagnose the vehicle with an external scanner, where STAG 500 GO 4 controller is mounted and an active OBD interface is available, switch the system to petrol fueling, switch off and switch on the ignition. OBD connection will not be active in petrol fueling mode.

Activation of autoadaptation (OBD) results in automatic configuration of OBD2/EOBD reader parameters.

2.17 Digital recorder

Advanced functionality of STAG gas controller, allowing observation of the electrical pulse curves in the monitor window. This function records the real pulsing of petrol injectors, gas injectors or rpm signals vs. time, like in advanced measuring tools, e.g. an oscilloscope.

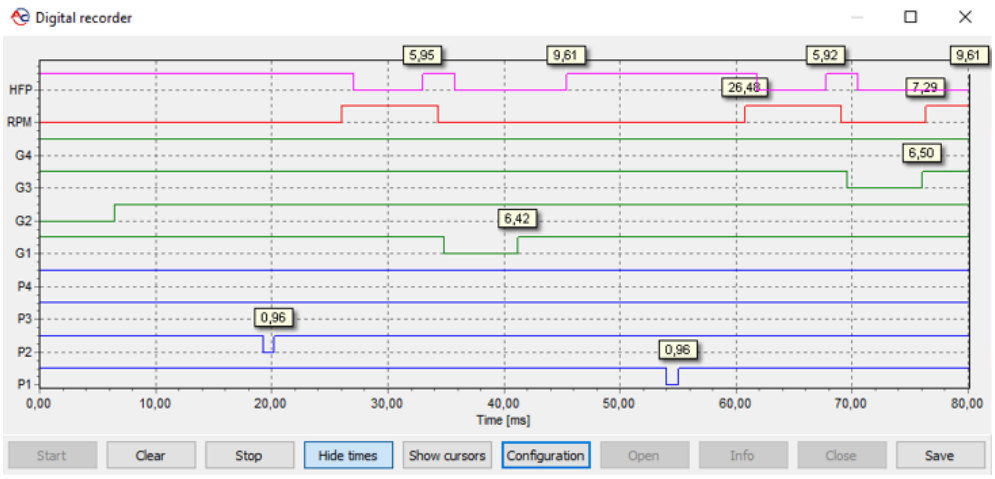
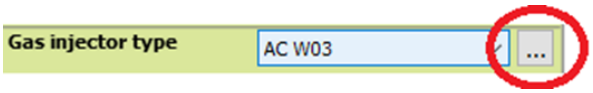


Fig. 34 Digital recorder window

2.18 Assignment of gas injectors to banks

In engines, where the controller can include 2 banks - Bank 1 and Bank 2 (correction values for OBD STFT B2 and LTFT B2 are different than zero), the gas injectors should be assigned to proper banks.

Press the gas injectors configuration button in the gas controller settings tab, group “Sensors and actuating devices”.



The “Gas injectors settings” will be displayed.

Fig. 35 Gas injectors bank assignment

The “Auto.” button enables automatic assignment of injectors to a specific bank. However, if the procedure fails or it is assumed that the results of previous automatic assignment are incorrect, manual identification is required. Start the engine and wait to establish communication between the controller and the OBD interface. The engine should work on idle speed without active adaptation. Reset the value of correction to zero for all gas injectors. Save the STFT and LTFT correction values for Bank 1 and Bank 2. Next, perform the following procedure, starting from the 1st gas injector:

1. Change the trim value for gas injector from 0 to 25 in the “Gas injectors settings” window.
2. Observe which of the 2 banks shows changing STFT/LTFT trims to lower values.
3. Having identified the bank with changing trims, assign the respective injector to the bank.
4. Set the injector correction value to 0. After this, STFT and LTFT trims should restore the initial values (observed before stage 1).

Repeat the described procedure (steps 1 to 4) for the remaining gas injectors in the system. After the assignment of gas injectors to the bank, **activate autoadaptation**, if necessary, set the initial gas correction values.

In control systems with two banks, failure to perform the above-mentioned procedure will result in incorrect autoadaptation, which may lead to engine damage.

In engines with 1 bank in the control system, it is not required to perform the described procedure, as all gas injectors are assigned to bank 1 on default.

2.19 Autoadaptation

STAG 500 GO 4 controller is provided with a mechanism that corrects gas dosing in real time, during driving. Activation, selection of autoadaptation mode and configuration is performed in the Autoadaptation window accessed through the Window menu:

- **OBD** – Correction of gas dosage is based on the readings of parameters from the on-board diagnostic interface compliant with the OBD2/EOBD standard.

The current engine temperature is estimated on the basis of the built-in algorithm in the controller, or read directly from the OBD if its reading is enabled (see Section 2.16).

If the vehicle is equipped with an OBDII/EOBD diagnostic system, it is recommended to connect and configure the OBD reader to retrieve information about the status of the fuel dosage control system. This makes it possible to accurately determine the engine's open-loop operating areas and precise adaptation.

2.19.1 OBD mode

With OBD selected, the following settings and parameters can be configured and viewed:

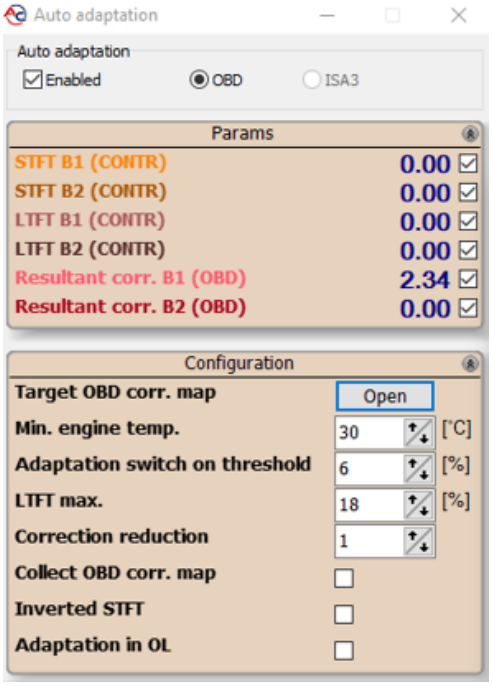


Fig. 36 Configuration of OBD adaptation

- **The map of OBD target corrections** – Press the Open button to display the configuration window, in which the resulting OBD corrections for each bank are displayed as a map with rpm and negative pressure axes. Map content is also automatically refreshed during controller autocalibration.

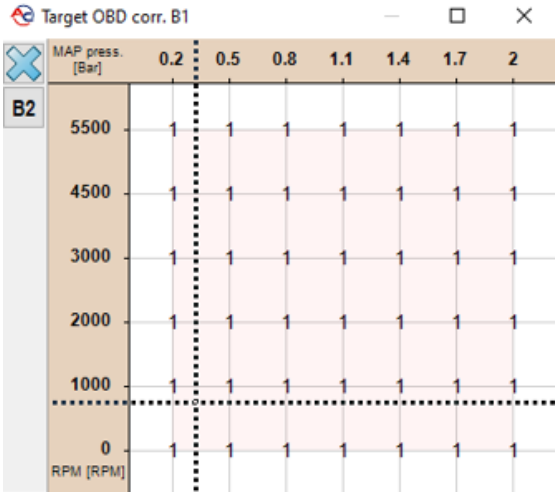


Fig. 37 OBD target correction map

- **The minimum engine temperature** – Engine temperature threshold (read through OBD2/EOBD or emulated by the controller), above which it is allowed to correct the gas dose.
- **Adaptation switch on threshold** – a value that extends the range of acceptable resultant target correction. For example, a threshold of 4% with target correction of 0% (on the map) means the range of -4% +4% of the OBD resulting correction, within which the adaptation procedure will not correct gas doses.

- **LTFT max.** - a limit, maximum trim value that the OBD autoadaptation can make.
- **Correction reduction** – a correction value divider read from the vehicle OBD. Enter a setting so that it results in the rescaled maximum values within ±25%.
- **Collect OBD correction map** – Activation results in automatic filling of target correction maps when driving on petrol.
- **Inverted STFT** – In conventional fuel dose control systems, OBD correction values are positive for the lean mixture and negative for the rich mixture. The option should be active in vehicles, in which the relation between the mixture and OBD correction positive/negative status is reversed.
- **Adaptation in OL** – OBD correction values are used if the engine open loop control is applied. Activation of the option allows additional adaptation, adjusted to the status of the open loop. In order for the function to be activated by the controller, a Lambda probe must be connected or Lambda value must be read by the OBD2/EOBD reader.

Incorrect setting of the Reversed STFT will cause an abrupt gas pulse correction that prevents from further driving.

Limitation of the OBD auto-adaptation depending on engine rpm is implemented with the "Adaptation lock" option accessible through the context menu on the MAP correction map tab (see Section 2.13).

2.20 Controller update

To update the controller, connect it to the diagnostic software and turn the engine off. Select "Tools" - "Devices update" from the main menu. All available devices are automatically found. The "Devices update" window will pop up. The "Devices Parameters" window shows the information on current controller firmware version. The "Available updates" window includes a list of updates available for the connected controller. Loading an update not included in the program directory requires clicking "Read update" and selecting the update file. Loaded update should be included in the list of available updates. Click "Update" once the update file has been selected from the list. When the progress bar reaches 100%, the controller will disconnect and then re-connect. The new version number should appear at the bottom of the screen and should reflect the version number of the update file.

Should the update go wrong the update window will be opened automatically upon connecting with the controller. Perform the update procedure again.

2.21 Diagnostics and service

2.21.1 Diagnostics (test actuators)

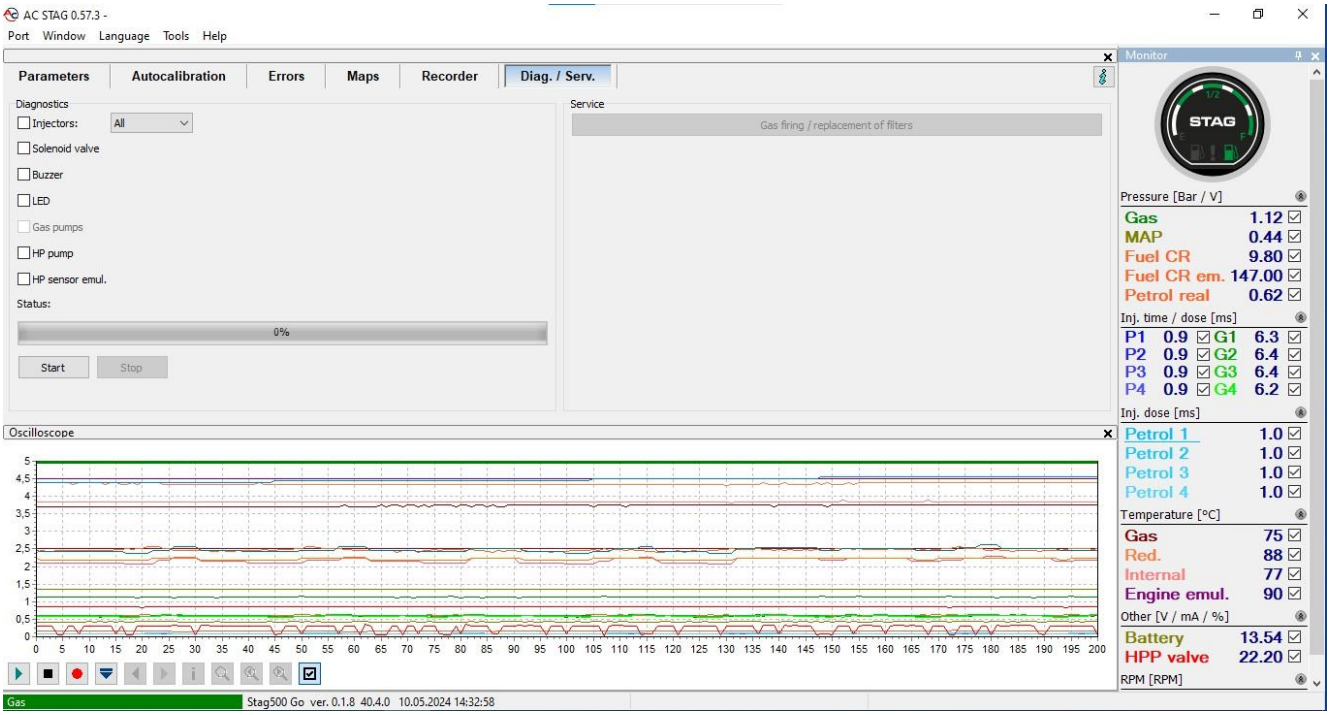


Fig. 38 Diagnostics/Service window

The "Diagnostics" allows you to perform basic tests of selected components. The test is as follows:

- **Injectors** – controller opens the selected injector for 4ms every second. The test lasts for 5 seconds. If the selected option is "All", injectors are tested sequentially from the first to the last, every for 5 seconds,
- **Solenoid valve** – controller opens solenoids for 5 seconds,
- **Buzzer** – controller emits beeps (maximum for 3 seconds),
- **LED** – controller enables another LED at short intervals,
- **High pressure pump** - the controler takes control of the pump for a few seconds, but controls it according to the pulses seen from the petrol ECU. So if:
  - the pump is connected correctly,
  - the controller reads the impulses from the ECU correctly,
  - the parameters of the pump control pulse are set correctly,

  the pressure in the injection rail should remain unchanged during the test,

NOTE - it may happen that the petrol ECU detects/reports an error in the pump circuit, which we are not able to eliminate with gain and detection threshold. In such a situation, an additional device - STAG HPPE - should probably be fitted.

- **High pressure sensor emulation** – The controller disconnects the high pressure sensor from the petrol ECU for a few seconds, and during this time emulates the same value it reads from the sensor. So if the connection is correct, the petrol ECU should not detect any anomaly and the pressure in the trim should not change.

2.21.2 Service

The "Service" allows the burning of gas from the system before replacing the filters. Option inactive by default.

3 STAG 500 GO 4 controller programming

Programming the controller can be divided into the following stages:

1. Auto-calibration of the STAG controller (at idle speed),
2. Adjustment of multiplier under load while driving (adjustment based on OBD STFR and LTFT corrections).

3.1 Auto-calibration and manual controller setting

Prior to starting the auto-calibration, start the engine and wait until the lambda probe begins to work. During the auto-calibration the engine should work at idle run; do not increase rpm, switch off air-conditioning and lights and do not turn the steering wheel as this may cause errors during the auto-calibration. If LPG injection times are shorter than 2ms, the injector nozzles may be too large and should be replaced with smaller diameter ones. When auto-calibration is completed, the multiplier map will be preset, but the multiplier map should be corrected during the test run if necessary, **and check that the Lambda sensor indicates a rich fuel mixture at maximum load.**

3.2 LPG temperature correction

If the petrol injection time changes when the LPG temperature is changed in the LPG mode, the LPG temperature calibration must be corrected. The correction may be made by means of the “LPG temperature calibration map” (see **Section 2.11**). **However, it must be remembered that this operation may be performed if the auto-calibration and the multiplier setting while driving have been carried out correctly.** In order to make the correction in a proper way, the car must be started with a cold engine. Then, beginning with the temperature of switching to LPG, the petrol injection time must be checked and after switching to LPG the petrol injection time should be compared. If the petrol injection time value is bigger after switching to LPG, the positive correction must be made for this LPG temperature value (the LPG temperature calibration map must be brought up). If the petrol injection time value is lower after switching to LPG, the calibration map for a given LPG temperature value must be brought down. The calibration map must be set in such a way as to ensure that the petrol injection time remains the same after switching from petrol to LPG. In order to set the LPG temperature calibration map correctly, the procedure described above must be repeated for the full range of LPG temperature values in 5 [°C] steps.

3.3 LED-600 switchboard

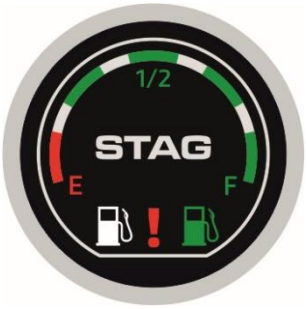


Fig. 39 LED-600 switchboard

The LED-600 LPG/gasoline switch includes:

- **LED indicator –** displays the current LPG tank level. The low LPG level is indicated with the red LED coming on in the LED ring which features the four green LEDs for the tank level percentage.
- **STAG logo switch actuator –** operated to switch between the LPG and gasoline fuel supply,
- **Status LEDs (fuel pump icons) –** read the current operating status:
  - White fuel pump icon on, green fuel pump icon off – the engine operates on gasoline supply.
  - Green fuel pump icon flashes slowly (1/sec.), white fuel pump icon off – the engine operates on gasoline delivery; when the parameter settings are achieved, the LPG delivery system will automatically switch over to LPG supply.
  - Green fuel pump icon flashing normally (2/sec.), white fuel pump icon off – the LPG delivery system is switching over to LPG supply. This condition is transient and may last up to 10 seconds, depending on the actual engine performance parameters.
  - Green fuel pump icon flashing fast (4 sec. with modulated buzzing – FAILURE mode), white fuel pump icon off – the LPG/ LPG delivery system has detected an event which prevents further operation of the engine on LPG supply, e.g. the LPG tank is empty, there is an LPG delivery system fault, or the engine has been switched to gasoline supply.
  - Green fuel pump icon on, white fuel pump icon off – the engine operates on LPG supply.
- **Fault LED –** comes on to indicate an active fault in the LPG delivery system. Once the fault is on, the LED light remains steady (red). The LED can also provide notifications (by flashing in sync with the buzzer modulation).
- **LED ring glow –** a parade feature which is optional (the user may select an RGB colour). Operating statuses:
  - normal light (e.g. for the LPG mode),
  - shines with dimmed light (e.g. for PETROL mode),
  - off.

The following features are available with the LPG ECU connected to the LED-600 LPG/gasoline switch:

- LPG/gasoline switch buzzer volume control (4 volume levels).
- LED indicator brightness control (4 brightness levels) – available if Auto LED Brightness is enabled.
- Status LED indicator (the fuel pump icons) brightness control (4 brightness levels) – unavailable if Auto LED Brightness is disabled.
- The LPG/gasoline switch LED brightness can be adjusted to ambient light.
- The LED ring can be set to come on when the engine operates on gasoline supply.
- The LED ring can be set to come on when the engine operates on LPG supply.
- The LED ring parade light mode color can be chosen from the RGB color palette.
- The fault LED indicator can be set to provide notifications (light indications in sync with the buzzer modulation activated by the LPG/gasoline switch). If Buzzer is enabled, the fault LED indicator flashes in sync with the buzzer modulation; this is a convenience feature for the hearing impaired.
- Automatic LPG/gasoline switch type recognition. If the LED-600 LPG/gasoline switch is connected, the application will identify it as the LED-600.

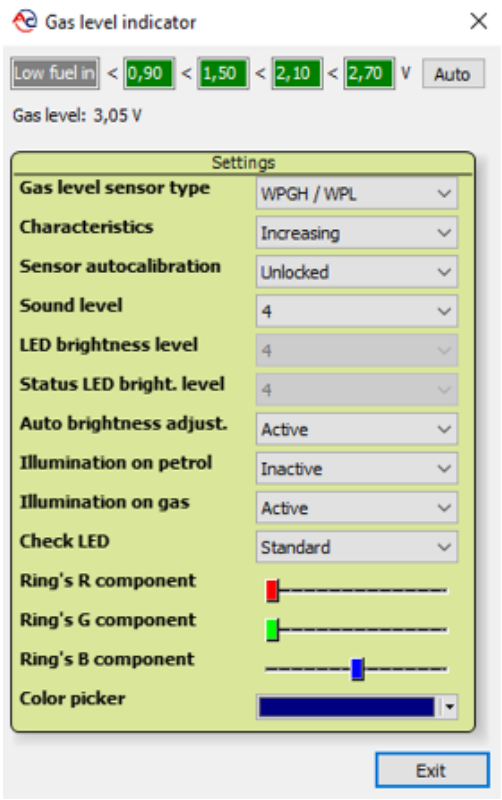


Fig. 40 LED-600 configuration window

The controller "remembers" the last fuel type setting before switching the ignition switch off.

3.4 Automatic calibration of LPG level indicator

The automatic calibration of LPG level indicator should be carried out when an empty tank is being filled with gas. The indicator type should already be set, but, if necessary, the procedure itself may change its type, e.g. from ascending to descending.

The calibration procedure is as follows:

- Press and maintain the switchboard push button,
- Switch off the ignition switch (during to three seconds after pressing push button),
- Depress the button when the switch initiates level indicator calibration.

Process of calibration is signalized on the LED in form of continuously increasing gas level. When the tank filling is over, switch on the ignition switch, thus terminating the calibration procedure. Successful calibration is signaled by smooth ascending, followed by smooth descending of the gas level indication on the LED line from fuel reserve to maximum fuel level and back (twice). In the case of calibration failure, the level indication on the LED line will change five times from reserve to maximum.

3.5 Acoustic signals

The controller may emit the following acoustic signals:

- Three beeps if it had to switch over to petrol because of a too low level in LPG tank.
- Three short beeps and one long beep in case of a controller error.
- Two short beeps and one long beep each time the ignition switch has just been turned on is a warning that the system needs to be inspected.

- Three long beeps repeated every minute is a reminder that the engine is operating in emergency mode.

4 Bluetooth communication interface

Since the Bluetooth interface can be permanently connected the controller, there is a risk of connecting and changing the controller settings by unauthorized personnel. Therefore, it is possible to set the password for interface pairing. Additionally, interface name can be changed to facilitate its identification on the list of devices available in the system.

The window allowing the above-mentioned operations is opened by selecting "Port" → "Bluetooth Configuration" from the main menu.

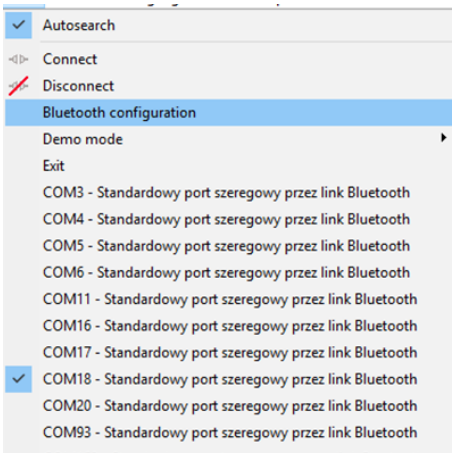


Fig. 41 The view of the „Port" tab in the Menu bar

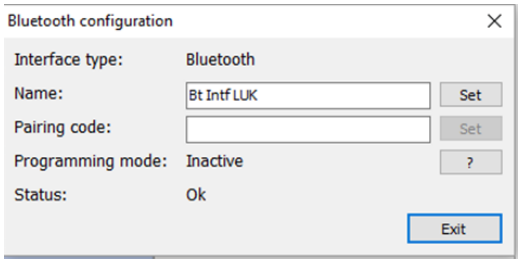


Fig. 42 Bluetooth configuration window

In order to ensure that no configuration changes are made by a third party, it is required to activate the programming function from the cabin – pressing the B/G switch button five times. Programming mode is automatically deactivated after 30 seconds.

After changing the pairing code it is required to re-pair the BT interface in the system.
Every successful change in the interface configuration is confirmed with three long sounds.

**If you forget the pairing code saved previously, it is possible to restore the "bt" default code. This is possible within 60 seconds after powering the controller – press the switch button five times within this time.
Successful operation will be confirmed with three long sounds.**

After each connection to the diagnostic application and reduction in engine speed, the controller generates three long sounds. These are used to remind the fitter that the fitter's interface in the customer's car.

5 Technical specifications

Power supply voltage	12[V] -20% ÷ +30%
Maximum power supply current for a 4-cylinder engine controller, 1 [Ω] gas injectors	12,5 [A]
Current load in the sleep mode	< 20 [mA]
Operating temperature range	-40 - 110 [° C]
Protection class	IP54

6 Warranty, restrictions, exclusions

Warranty does not cover:

1. Damage resulting from installing the controller not in line with the recommended layout diagram, in particular from hooking signal cables up to other terminals than those specified in installation guidelines.
2. Damage resulting from installing the controller in places incompatible with installation guidelines or from exposition to water, high temperatures, vehicle battery vapors.
3. Devices tampered with / repaired without proper authorization.
4. Mechanical damage through Customer’s fault, in particular damage of:
   - connectors (including damage caused by use of inappropriate chemical cleaning agents),
   - controller housing,
   - electronics PCB.
5. Electrical damage of circuitry brought about by hooking communication interfaces up not in line with installation guidelines.