



**Connection and Programming Manual for
STAG-200, STAG-4 Plus, STAG-4 Eco,
STAG-300 ISA2, STAG-300 Premium
controller**

(also available in the diagnostic software and at www.ac.com.pl)
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1. Set-up

1.1. STAG-200 Connection Diagram

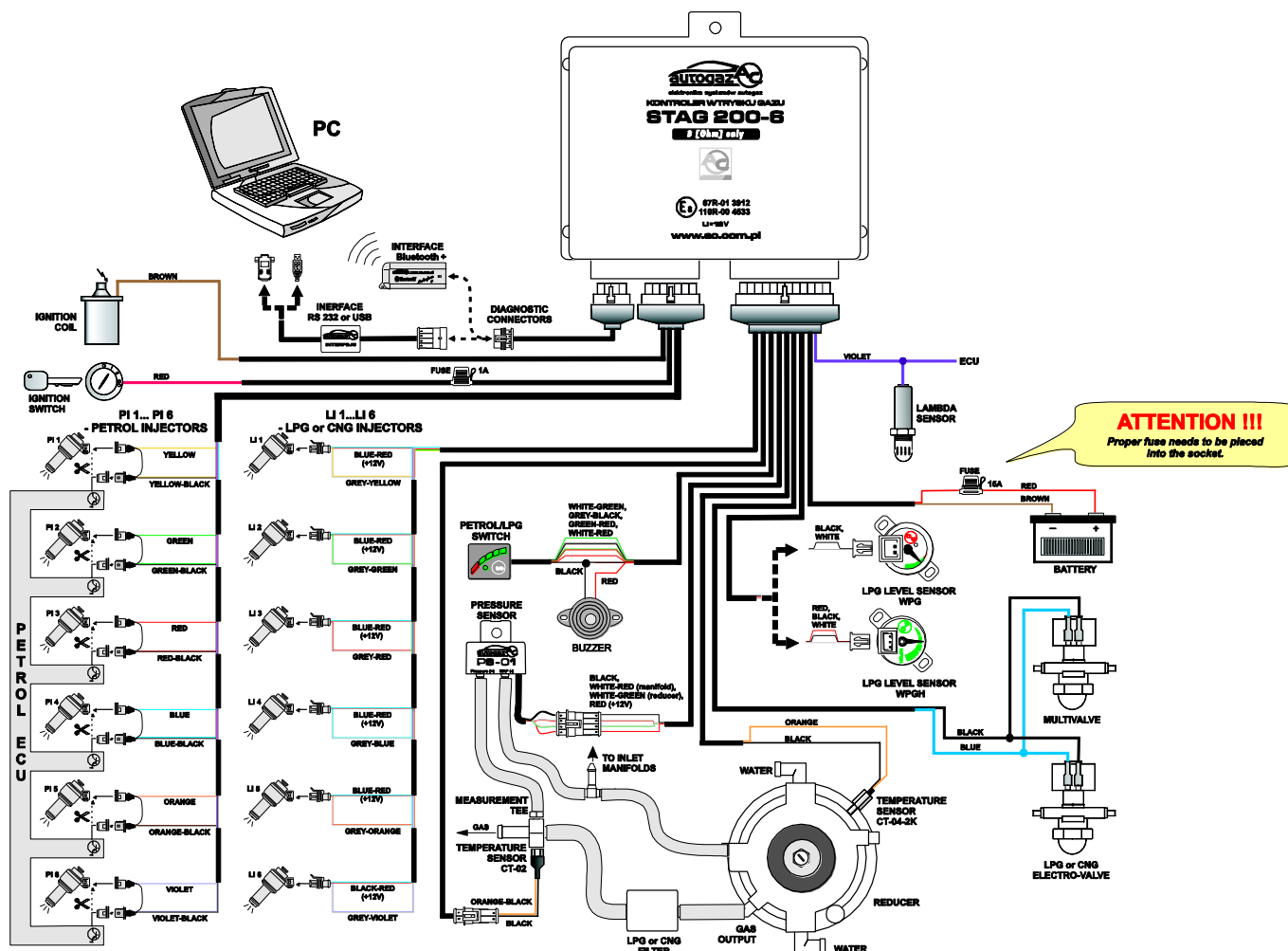


Fig. 1 STAG-200 Connection Diagram for Vehicle Installation



1.2. STAG-4 Plus Connection Diagram.

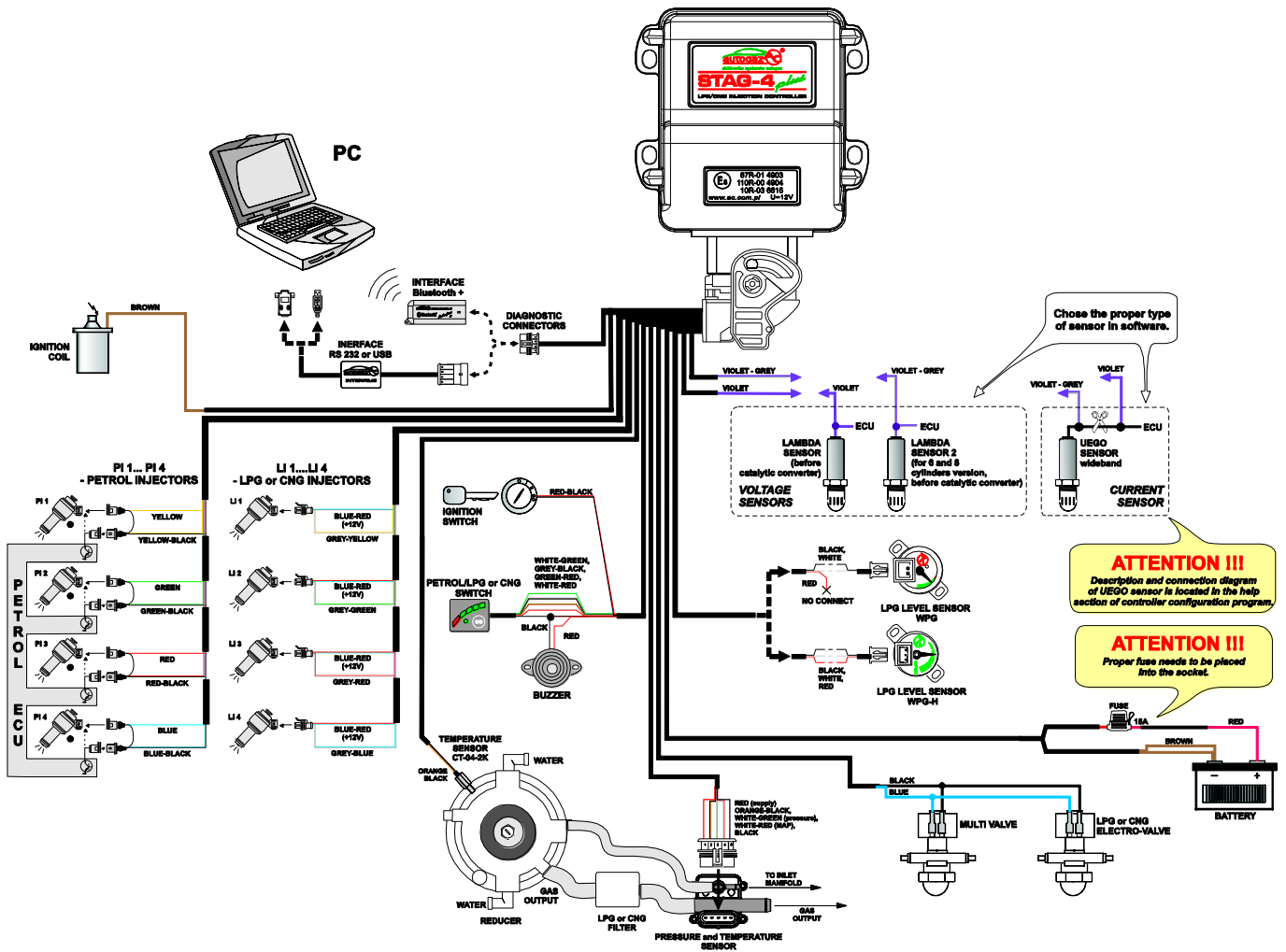


Fig. 2 STAG-4 Plus Connection Diagram for Vehicle Installation



1.3. STAG-4 Eco Connection Diagram.

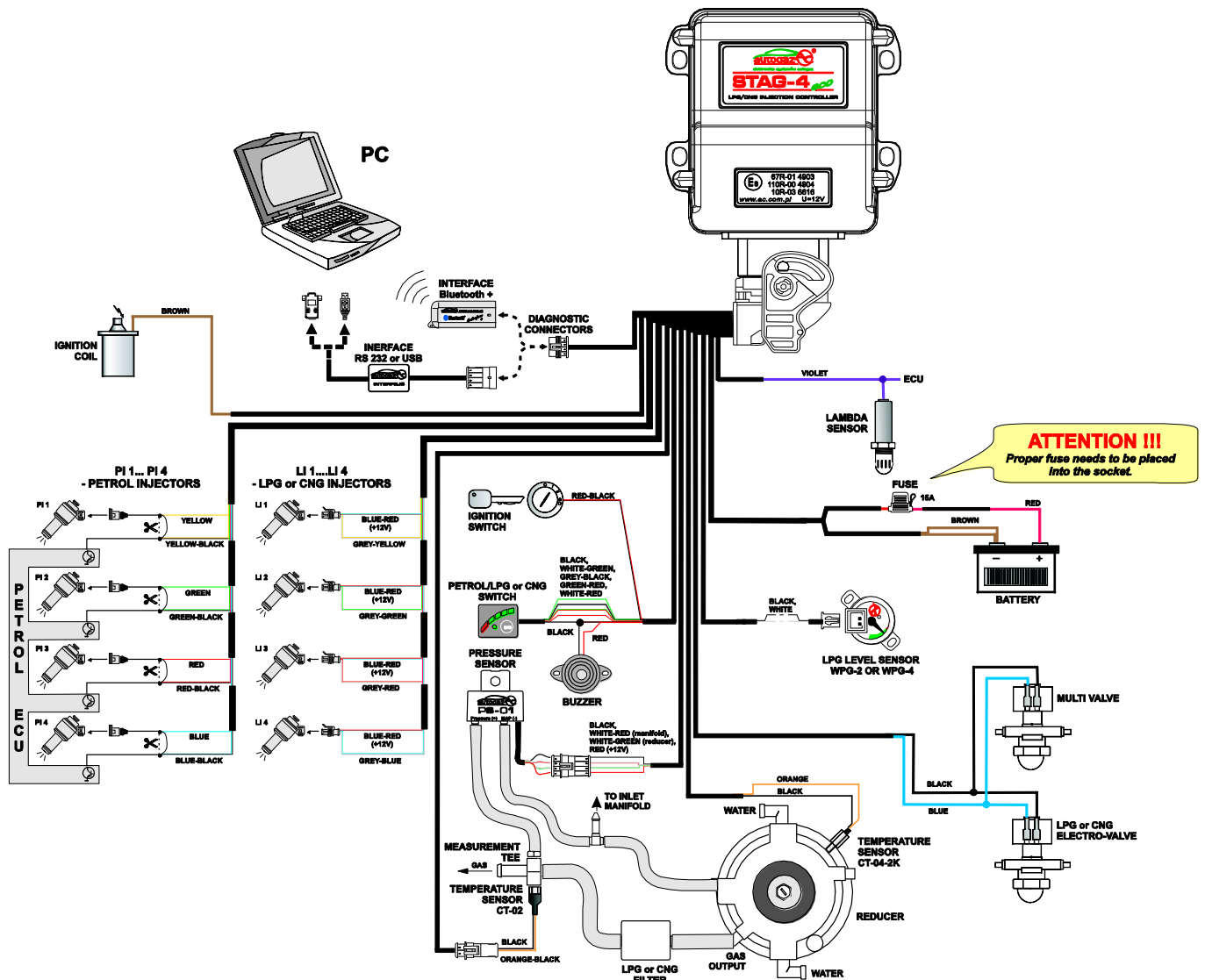


Fig. 2a STAG-4 Eco Connection Diagram for Vehicle Installation



1.4. STAG-300 ISA2 Connection Diagram

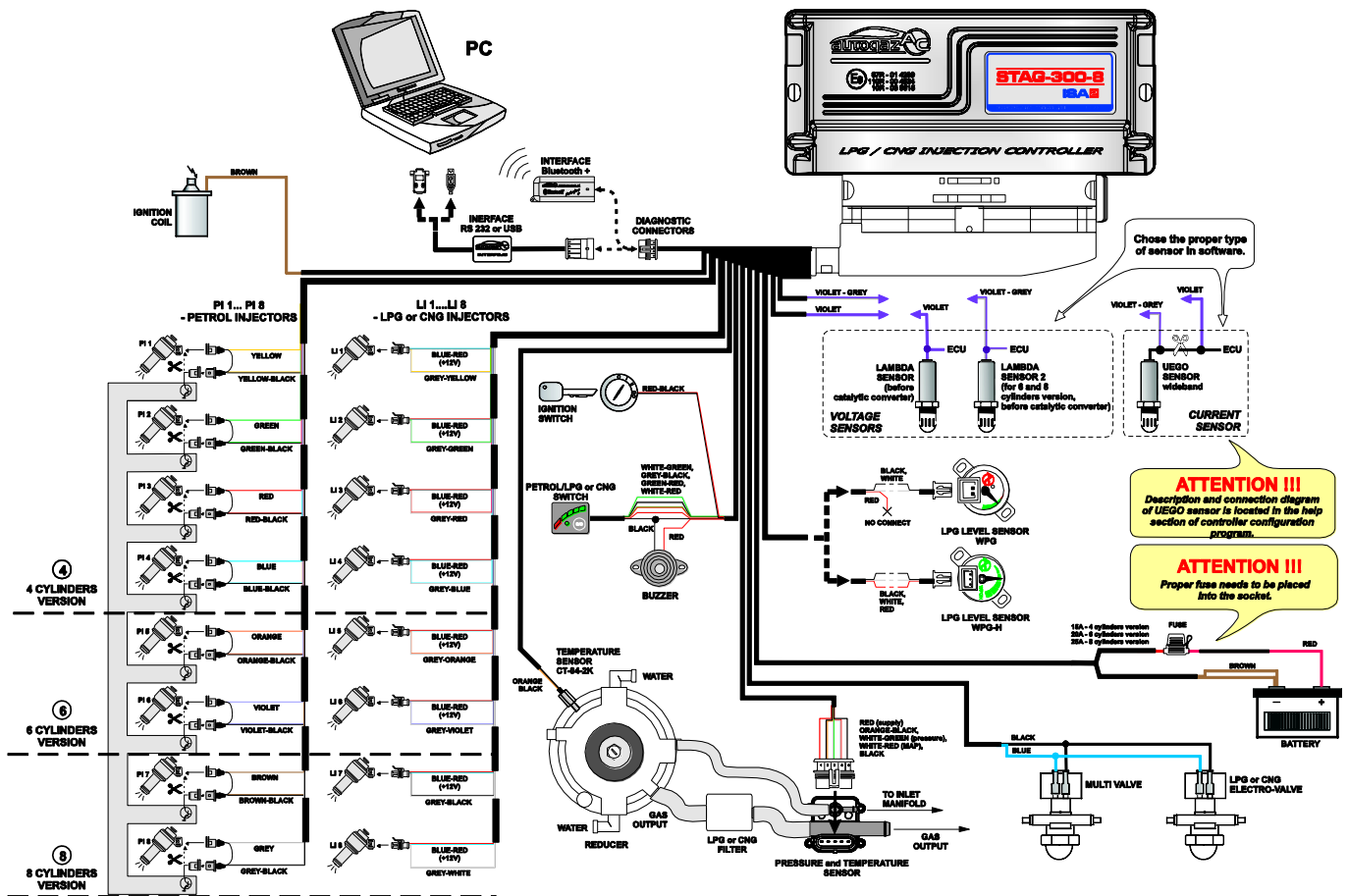


Fig. 3 STAG-300 ISA2 Connection Diagram for Vehicle Installation



1.5. STAG-300 Premium Connection Diagram

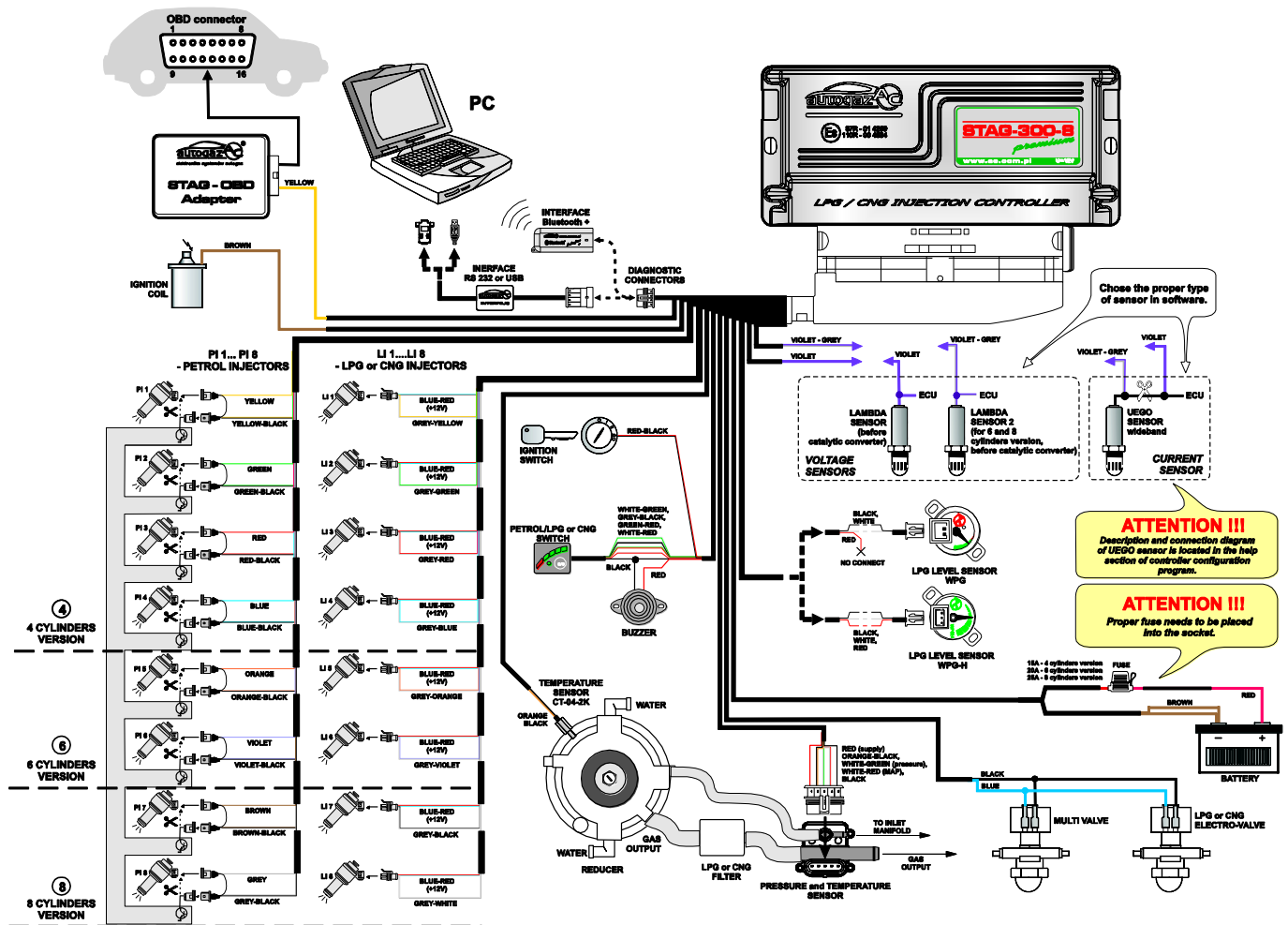


Fig. 4 STAG-300 Premium Connection Diagram for Vehicle Installation



1.6. Wiring Diagram for semi-sequential systems.

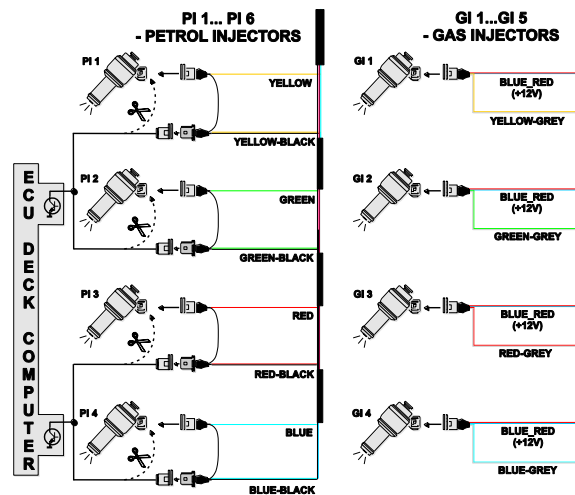


Fig. 5 Connection Diagram for semi-sequential systems.

1.7. Connection Diagram for full-group systems.

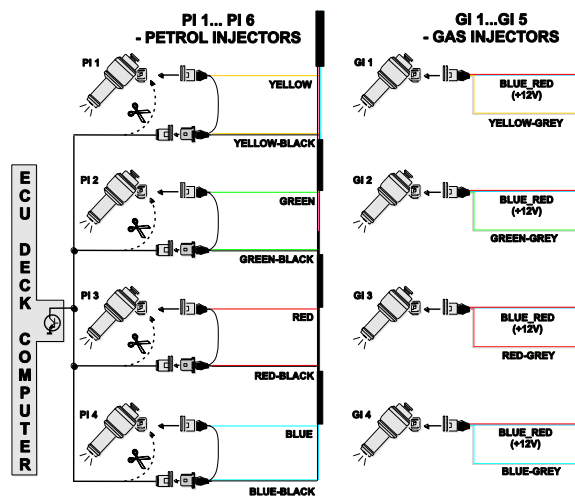


Fig. 6 Connection Diagram for full-group systems.

1.8. STAG-200, STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium ECU Installation Method.

During the STAG-200, STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium installation it is suggested for the wire set to point downwards. Regardless of the type of ECU it is suggested that it is placed in such a way to avoid the negative impact of high temperature and humidity.

1.9. Selection of Pressure Regulator

Install the system according to the connection diagrams (Fig. 1, Fig. 2, Fig. 2a, Fig. 3, Fig. 4). When installing the STAG-200, STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium sequence gas injection systems, it is important to select the proper pressure regulator for given engine power as well as injector nozzles. Improper selection of the pressure regulator in relation to the engine power will result in the pressure regulator inability to ensure nominal LPG pressure, i.e. it will result in



pressure drops when the LPG delivery is high (i.e. when the throttle is fully open). When the LPG pressure drops below the minimum value programmed in the controller, the system will switch to petrol.

1.10. Selection of injector nozzles

The injector nozzles selection should also be based on the engine power. The selection of injector nozzles should ensure that at high engine loads and high rpm, the multiplier for a given injection time should be close to 1. For the majority of engines, the injection times equal roughly 15 [ms]. The table below presents the nozzles' diameters depending on the engine power per 1 cylinder. To select the right diameter of nozzles, the engine power needs to be divided by the number of its cylinders.

Nozzle diameter [mm] Reducer pressure 1 [bar]	Engine power per cylinder [KM]
1,7 - 1,8	11-16
1,9 - 2,2	17 -28
2,3 - 2,5	29 - 34
2,6 - 2,8	35 - 40
2,9 - 3,0	41 - 48
3,1 - 3,2	49 - 55

Note: the above values are estimates only and do not necessarily always reflect the reality.

This can occur e.g. in vehicles with semi-sequential or full group (all injectors activated simultaneously) injection. In such cases, the nozzles' diameters will be smaller than those presented in the table above as in these systems the amount of supplied LPG is higher than in full sequence systems – two times higher for semi-sequential injectors and four times higher for full group injectors. In the event "Injection control mode" parameter is set to (depending on the vehicle type) semi-sequential or full-group, diameter values of injector nozzles should correspond to those indicated in the chart.

2. Ac Gas Synchro diagnostic software - description

2.1. Controller-PC connection

Upon installing the STAG-200, STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium controller in the vehicle, connect it to a PC with the AcGasSynchro software installed via an RS or USB interface manufactured by AC SA. Prior to starting the software, turn the ignition on (in order to supply voltage to the controller); this is necessary as the controller switches to sleep mode (when it will not communicate with the PC) after app. 10 minutes without power supply. After starting the software – provided the COM port is selected properly – the controller will establish connection with the diagnostic software and "Connected" will appear in the lower left corner of the screen.

Fig. 7 ,Fig. 7a and Fig. 7b shows the Parameters window.



AC GAS SYNCHRO 8.3.0.3

Port Window Language Controller update Options Documentation Help

Parameters AutoCalibration Errors Map Data recorder AutoAdaptation

Car parameters Gas controller settings Advanced

Number of cylinders: 8 cylinders
Num. of cyl. for coil: single coil
RPM from camshaft sensor: ☐
Number of pulses per revolution: 12
RPM signal: 2.5 [V]
RPM signal filter: ☐
Engine type: Standard
Wankel engine: ☐

Petrol injector driven by + ☐
Lambda type: Voltage [0V means lean]
Type of injection: Standard
Type of petrol inj.: Standard

Readout Save Manufacturer settings

Connected STAG-300-8 ISA2 ver. 8.9 4.0.0 2012-05-31 15:36:50

PRESSURE [Bar]
Gas 1,10
MAP 0,29

INJECTION TIME [ms]
Petrol Gas
P1 3,3 G1 0,0
P2 3,3 G2 0,0
P3 3,3 G3 0,0
P4 3,3 G4 0,0
P5 3,2 G5 0,0
P6 3,3 G6 0,0
P7 3,3 G7 0,0
P8 3,3 G8 0,0

TEMPERATURE [°C]
Gas 17
Red. 38

VOLTAGE [V]
Lambda 1 0,02
Lambda 2 4,68
Battery 13,26

RPM [rpm]
RPM 680

Engine load 1% ☒

Active LPG/CNG injectors
1 2 3 4 5 6 7 8

Petrol

Fig. 7 Parameters window (Car parameters).

AC GAS SYNCHRO 8.3.0.3

Port Window Language Controller update Options Documentation Help

Parameters AutoCalibration Errors Map Data recorder AutoAdaptation

Car parameters Gas controller settings Advanced

Switch-over to gas
Switch-over temp. 30 [°C]
Switch-over threshold 600 [rpm]
Switch-over time 3.0 [s]
Cylinder switch-over 200 [ms]
Hot start ☐

Switch-over to petrol
Min. gas temp. 0 [°C]
Min. gas RPM 0 [rpm]
Max. gas RPM 6000 [rpm]
Max. engine load on gas 100 [%]
Pressure error time 300 [ms]
Switch-off at the first error ☒

Calibration parameters
Gas temp. at calib. 30
Pressure [bar]
Operational 1.00
Minimum 0.60

Fuel type
☒ LPG ☐ CNG

Gas level indicator

Injector type: AC GIAC 01 (3 Ohm)
Injectors heating ☐
Extra-injection switch off threshold 0.0 [ms]

Gas injectors settings

Sensors
Reducer temperature sens. CT-04-2K (included i)
Gas temperature sens. CT-02-2K (included i)

Readout Save Manufacturer settings

Connected STAG-300-8 ISA2 ver. 8.9 4.0.0 2012-05-31 15:36:50

PRESSURE [Bar]
Gas 1,10
MAP 0,29

INJECTION TIME [ms]
Petrol Gas
P1 3,2 G1 0,0
P2 3,2 G2 0,0
P3 3,2 G3 0,0
P4 3,2 G4 0,0
P5 3,1 G5 0,0
P6 3,1 G6 0,0
P7 3,2 G7 0,0
P8 3,2 G8 0,0

TEMPERATURE [°C]
Gas 17
Red. 38

VOLTAGE [V]
Lambda 1 0,02
Lambda 2 4,68
Battery 13,33

RPM [rpm]
RPM 680

Engine load 1% ☒

Active LPG/CNG injectors
1 2 3 4 5 6 7 8

Petrol

Fig. 7a Parameters window (Gas controller settings).

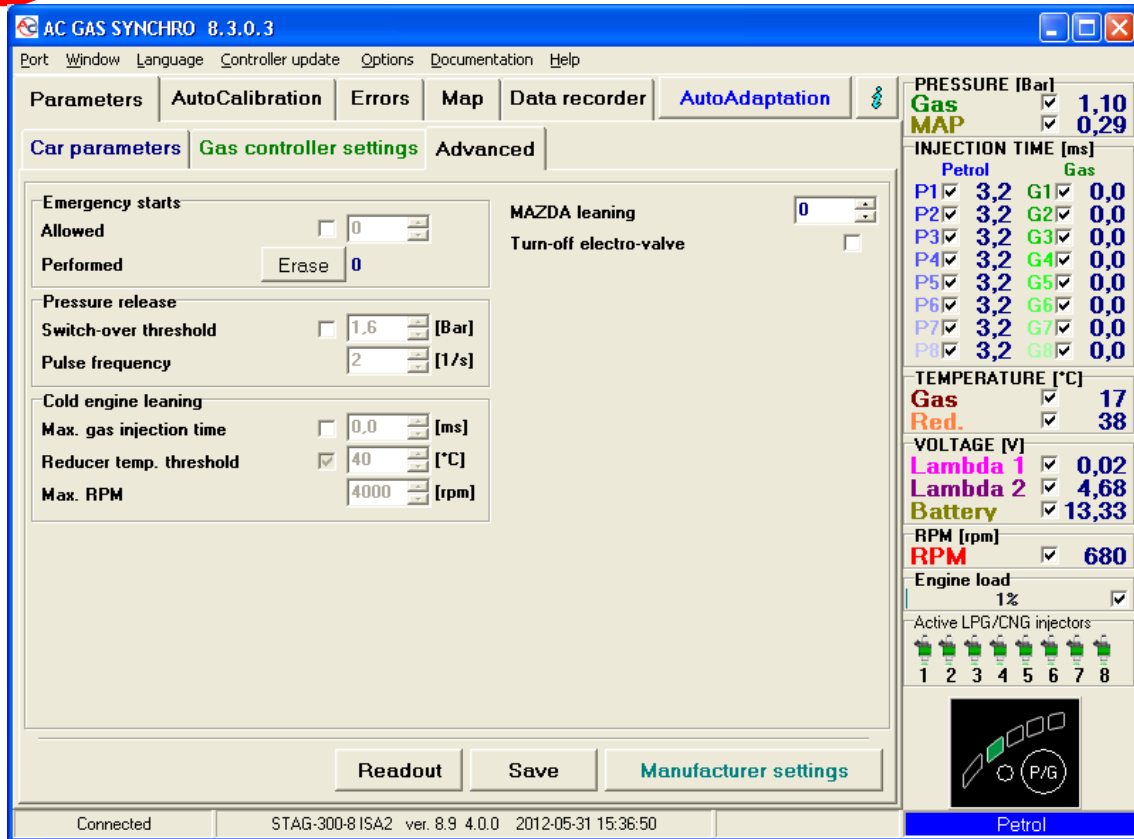


Fig. 7b Parameters window (Advanced).

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.

2.2. Ac Gas Synchro version

When the diagnostic software is open, the top title bar shows the version of the software; Fig. 7 shows the software version 8.3.0.3.

2.3. Main menu

The main menu consists of the following options:

- *Port* – changing the communication port, connecting and disconnecting the controller
- *Window* – selecting the software windows
- *Language* – selecting the required software language version
- *Controller update* – updating the controller firmware
- *Documentation* – opening a folder with available documentation
- *Help* – about the software



2.4. Controller Parameters


The controller firmware version is shown at the bottom of the screen (Fig. 7); „ver.” is followed by the firmware version, where:

STAG-300-8 ISA2 – controller model

8.9 – controller firmware version number

4.0.0 – controller version number

2012-05-31 15:36:50 – date and time of the firmware compilation

Clicking the  button in the upper right corner will bring up the *Controller Info* window. A detailed description of the *Controller Info* window is presented later in this manual.

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.
- *Num. of cyl. for coil* – the number of cylinders for each ignition coil
- *Camshaft RPM* – the source of RPM (revolutions per minute) signal. This option shall be marked if the distribution shaft position sensor is the source of RPM signal. This option is very useful in case of the cars in which cylinders are stopped, and pulses on the ignition coil disappear in the cut-off status. In such cases, if the coil was the source of rotation pulses, the controller would be reading either lower or no rotation. NOTE: the rotation (RPM) measurement input shall be connected only to a digital distribution shaft position sensor.
(this parameter is not available for the STAG-4 Eco controller).
- *Pulses per revolution* – the option is active when the source of rotation signal is the digital sensor of the distribution shaft position. This sensor measures the number of pulses per one engine's revolution. This value shall appropriately be selected for proper reading of the engine's RPM by the controller.
- *RPM signal* – RPM signal source
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 app. 2,5 [V]. For impulses originating from the ignition coil, set the threshold to app. 7 [V].
Nissan Micra is an exception. Its computer ignition impulses equal app. 1,4 [V], in which case the detection threshold needs to be set at app. 1,0 [V].
For some Renault Megan models, the detection setting needs to be set at app. 10 [V]
- *RPM signal filter* – Switching on (YES) and switching off (NO) of RPM signal filtration. In case of cars from the U.S.A., correct reading of RPM value can be difficult, so this option should be switched on. In other cases, it should be switched off. **(this parameter is not available for the STAG-4 Eco controller).**
- *Engine type* – engine type, Standard – normally aspirated engine with no supercharger, Turbo – supercharged engine



- *Wankl engine* – this option shall be marked, when fuel (petrol) injectors are stopped in a car with a Wankl engine.
 - *Petrol Injector driven by „+”* - injection signals reading in systems where signals are “positive”, i.e. grounding is the common signal for all injectors and the controlling signals are up to 12 [V]. **(this parameter is not available for the STAG-4 Eco controller).**
 - *Lambda type* – type of the installed lambda probe:
 - Not connected
 - voltage (0V means lean) – standard voltage probe. Two voltage probes can be connected simultaneously. **(only one voltage sensor can be connected to STAG-4 Eco controller).**
 - voltage inverted (0V means rich) – standard voltage probe. Two voltage probes can be connected simultaneously. **(only one voltage sensor can be connected to STAG-4 Eco controller).**
 - UEGO -> voltage – wide-band UEGO lambda (current).

The controller shows on an oscilloscope values from the probe in the same form as for a voltage probe. Only 1 wide-band lambda can be connected at any given time. **(this parameter is not available for the STAG-4 Eco controller).**
 - UEGO -> full range – wide-band UEGO lambda (current).

The controller shows on an oscilloscope values in Volts. This makes it possible to watch the entire working range of the UEGO probe, i.e. from lean to rich mixtures. Only 1 broad-band probe can be connected at any given time. **(this parameter is not available for the STAG-4 Eco controller).**
- Do not select “UEGO probe” for a voltage probe as this may damage the probe. Refer to the Connection Diagram!!!**
- *Type of Injection* – type of injection used in the car,
 - Standard – standard indirect injection, petrol injectors with no current limit.
 - Renix – indirect injection system, petrol injectors with “Renix” current limit **(this parameter is not available for the STAG-4 Eco controller).**
 - *Type of petrol Inj.* – type of petrol injectors control
 - Standard: each petrol injector is controlled from a separate channel in the petrol controller.
 - Doubling: petrol injectors are controlled in pairs, i.e. 2 injectors are controlled from a single channel in the petrol controller.

The **LPG Controller Settings** window lists the following groups of parameters:

Switchover to gas – parameters related to switching from petrol to LPG.

- *Switchover temp.* – LPG pressure regulator temperature required for the controller to switch to LPG,
- *Switchover threshold* – engine rpm required for the controller to switch to LPG. For rpm set to <700, the controller switches to LPG at idle run.
- *Switchover time* – time after starting the engine when the controller can switch to LPG.



- *Cylinder Switchover*– time elapsing between the switching of subsequent cylinders. E.g. with the setting at 200[ms] for a 4-cylinder engine, the switching from petrol to LPG or LPG to petrol will take 4×200 [ms]. This works regardless of whether the petrol injection system is the so-called full sequence or not. **Setting the switching time to 0 will result in the switching from petrol to LPG or vice versa and turning on and off of the solenoid valves without any delay.**
- *Hot start* – when this option is selected, the car's engine will start on LPG if temperature of the gas reducing valve at the engine starting point exceeds the set "Switch Temperature" value (or 30°C if the Switch Temperature is lower) and LPG temperature exceeds 15°C. This option is particularly useful in vehicles with the "start-stop" function.

Switchover to petrol - parameters related to switching from LPG to petrol.

- *Min. gas temp.* – min. LPG temperature; when lower, the controller will switch over to petrol.
- *Min. gas RPM* – min rpm; when lower, the controller will switch over to petrol.
- *Max. gas RPM* – engine rpm; when higher, the controller will switch to petrol
- *Pressure error time* – amount of time with the LPG pressure lower than minimal before the controller switches to petrol and reports: "LPG pressure too low".
- *Switch-off at the first error* – with this option selected, the controller will switch to petrol when the LPG pressure drop is detected. When unselected, the controller will switch some cylinders to petrol when the LPG pressure is detected to lower LPG usage.
- *"Max. engine load on gas"* – the maximum load value in the LPG mode, above which the controller switches to petrol. This option is very useful for the engines in the case of which petrol injectors can be fully opened. In such a situation, the LPG controller can only open LPG injectors permanently as well. However, corrections, e.g. resulting from changes in the LPG pressure, will be no longer possible. The moment when petrol injectors are fully open corresponds to the load value of 100 [%]. If petrol injectors become fully open, the "*Max. LPG load*" parameter should be set to approximately 95 [%]. This will result in the controller switching to petrol before full opening of LPG injectors.

Calibration parameters – parameters related to controller calibration.

- *Pressure*
 - Operational – 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 – when the pressure is lower than minimum, the controller will switch to petrol if the duration of min. pressure exceeds the **Pressure Error Time**.



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

- *Fuel Type* – type of fuel in the LPG system
- *Gas level indicator*– LED thresholds setting. This button is used to set the low LPG LED on/off threshold settings as well as to select the LPG level sensor (this is explained in more details later in the manual).
- *Injector Type* – type of the LPG injector. Injectors, marked with green colour, have got – registered in the controller – dedicated temperature and pressure characteristics. **Changing the injector type requires re-auto-calibration or multiplier map calibration!!!**
- *Gas Injectors Settings* – calibration of particular LPG injectors.
- *Injectors heating* – enabling this option results in starting the procedure of heating LPG injectors after a longer stopover. Activation of the procedure is indicated in the oscilloscope diagram with a red line and flashing active LPG injectors.
- *Extra-injection switch off threshold* – petrol injection impulses below the set value will be ignored by the controller, meaning that the controller will not generate the LPG injection impulse if the petrol injection impulse is below the set value. **(this parameter is not available for the STAG-4 Eco controller).**

The **Advanced** window lists the following groups of parameters:

- *Emergency starts* – a limitation of the number of emergency start-ups, which are available for the end-user. When the number is exceeded, then the engine will always start either in the petrol or automatic mode. The number of emergency start-ups is always reset during software update. It can also be manually cancelled by the “Erase” button. **(this parameter is not available for the STAG-4 Eco controller).**
- *Pressure release* – in the course of driving, when gas injectors are not controlled (e.g. in the cut-off status), gas pressure in the gas controller may rise. If this option is on, when pressure exceeds the set value (Switch-over threshold), the controller will start a procedure to bring it down. The procedure is switched off when the pressure drops down to 1.5 bar. *Intensity* parameter controls the frequency of the injectors opening. **(this parameter is not available for the STAG-4 Eco controller).**
- *Cold engine leaning* – Function "Cold engine leaning" eliminates "jerking" of cold engine working on gas resulting from the fact that the mixture is too rich. Problem this occurs on some cars. If function is needed, its parameters should be set accordingly:
 - *Max. gas injection time* is set during driving on cold engine, you set it so rapid pressing the accelerator pedal doesn't result in "jerking" and so car dynamic isn't sacrificed
 - *Reducer temp. threshold* should be set to reducer temperature at which "jerking" disappears

NOTE: Deactivation of this property makes Cold engine leaning work in whole temperature range, however caution must be taken to check if mixture on hot engine, under heavy load is rich. Failure to meet this requirement can lead to engine damage!

- *Max. RPM* should be set to rpm value which prevent power drop during high acceleration and provide rich mixture at open loop condition



- *Mazda leaning TM* – in some types of Mazda, the petrol controller can (in some conditions) alter from sequential into semi-sequential controlling. It can be easily noticed by observing the LPG/CNG injection time indicator on the 2D map. When the petrol controller alters from the sequential into semi-sequential controlling (at the same load), the petrol injection time is reduced by approximately 50[%]. The vertical axis indicator (for constant load) changes its injection time value position e.g. from 8 [ms] to 4 [ms]. In the case of such a controlling type in the LPG mode, “jerking” can occur, resulting from the fact that the mixture is too rich for the semi-sequential mode. In order to eliminate the above-mentioned problems, “Mazda leading TM” function should be used. The weakening coefficient should be properly set. According to the research, its value should be approximately 17. However, the value can be different, depending on the engine. **(this parameter is not available for the STAG-4 Eco controller).**

NOTE: setting this parameter at zero value in such engines may preclude proper operation of ISA2 AutoAdaptation (described in another part of these Instructions).

- *Turn-off electro-valve* – Close gas electro-valve when ISA2 switches to petrol. Option is useful when ECU works with TAP (Timing Advance Processor).

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

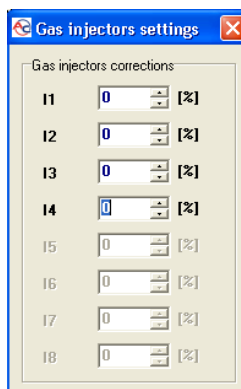


Fig. 8 Gas injectors settings window.

Use this window to calibrate (in %) the LPG injectors. These settings enable a correction of the fuel mixture for each cylinder. This is used e.g. to correct the injection time variations present in a “V” type engine cylinders.

To calibrate the injectors, use the following procedure: Upon auto-calibration, check the **petrol injection times** for each cylinder when using petrol. Turn the LPG injectors on, one at a time, and observe if there are any differences in the injection times after switching from petrol to LPG. Adjust the % settings **(only when necessary!)** for each injector so that switching to LPG one injector at a time will not result in changing the **petrol injection times**.

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!!!




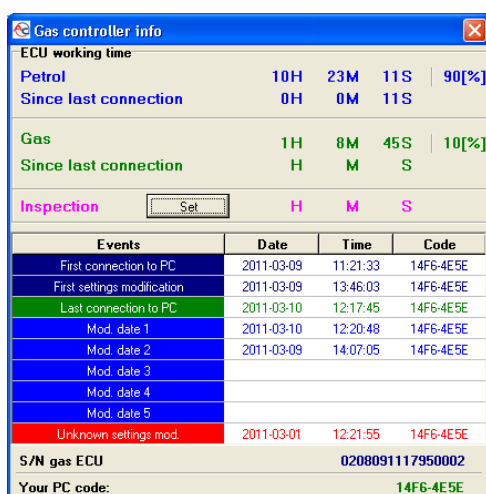
The correction window may be opened regardless of the selected tab, i.e. the map tab may be opened and the correction window on top of it.

There are 3 buttons at the bottom of the Settings tab used to perform the following actions:

- Read – read the controller settings from a file
- Save – save the controller settings to a file
- Default – restore default controller settings

2.5. Controller Info

To bring up the *About gas ECU* window, click the  button in the upper right corner of the screen or select “Gas controller info” in the Help menu.



The screenshot shows the 'Gas controller info' window. It displays ECU working time for Petrol and Gas, with a 'Since last connection' section. There is an 'Inspection' section with a 'Set' button and fields for H, M, and S. Below this is a table of events with columns for Events, Date, Time, and Code. The events include 'First connection to PC', 'First settings modification', 'Last connection to PC', 'Mod. date 1' through 'Mod. date 5', and 'Unknown settings mod.'. At the bottom, it shows the S/N gas ECU as 0208091117950002 and the PC code as 14F6-4E5E.

Gas controller info			
ECU working time			
Petrol	10H	23M	11S 90[%]
Since last connection	0H	0M	11S
Gas	1H	8M	45S 10[%]
Since last connection	H	M	S
Inspection	<input type="button" value="Set"/>		H M S
Events	Date	Time	Code
First connection to PC	2011-03-09	11:21:33	14F6-4E5E
First settings modification	2011-03-09	13:46:03	14F6-4E5E
Last connection to PC	2011-03-10	12:17:45	14F6-4E5E
Mod. date 1	2011-03-10	12:20:48	14F6-4E5E
Mod. date 2	2011-03-09	14:07:05	14F6-4E5E
Mod. date 3			
Mod. date 4			
Mod. date 5			
Unknown settings mod.	2011-03-01	12:21:55	14F6-4E5E
S/N gas ECU	0208091117950002		
Your PC code:	14F6-4E5E		

Fig. 9 Gas controller info window.

The Gas controller info window (Fig. 9) shows the following parameters:

ECU working time:

- *Petrol* – total 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.
- *Inspection* – Service Schedule. When the controller reaches the working time using LPG set in this field, every time the ignition key is switched-off the controller will produce an acoustic signal reminding of the inspection. Clearing the Inspection Schedule is explained below.



To set the Service Schedule, click the “Set” button in the About gas ECU window. The following window will pop up (Fig. 10):

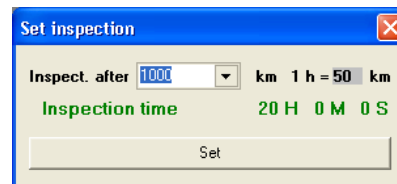


Fig. 10 Set inspection window.

The next service visit time is calculated on the basis of mileage. The default setting is 1 h = 50 km, yet it is configurable. The above window shows the next service visit set to 1000 km, which in this case equals 20 hours of work.

To clear the service schedule, select “Disabled”, in which case the controller will not monitor the service schedule.

Below the working times, the Controller Info lists the following types of registered events:

- *First connection to PC* – date of the first controller-PC connection.
- *First settings modification* – 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.
- *Unknown settings mod.* – This happens when the controller’s settings modification is performed with a date earlier than a previously performed modification.

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:

- *S/N gas ECU* – the serial number of the controller. Not available for older versions of controllers.
- *Your PC code* – The code of the PC on which the AcGasSynchro software is currently used.

2.6. OBD adaptation (for STAG-300 Premium controller only)

In the upper right corner of the screen, AutoAdaptation button is located; when pressed, a window is displayed with OBD-related information. This window will be displayed automatically, once the connection with OBD in the car is established.

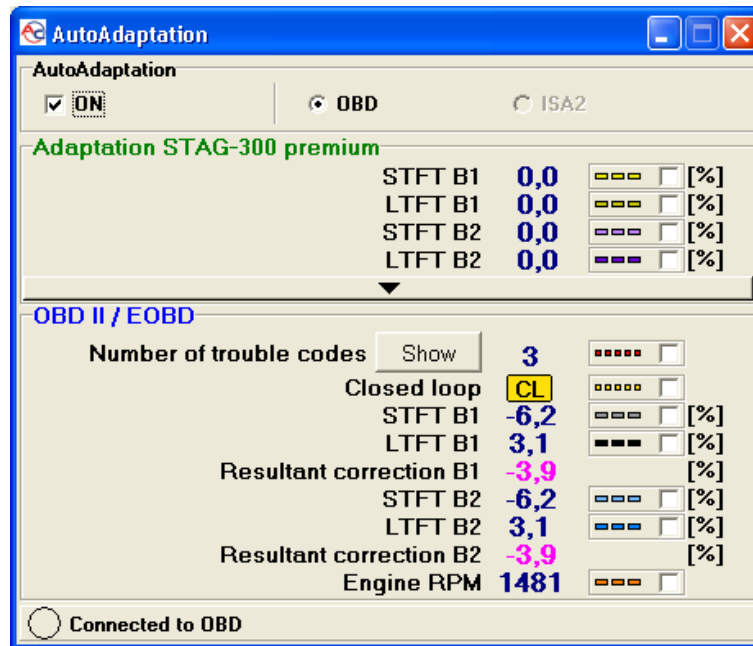


Fig. 11 OBD window.

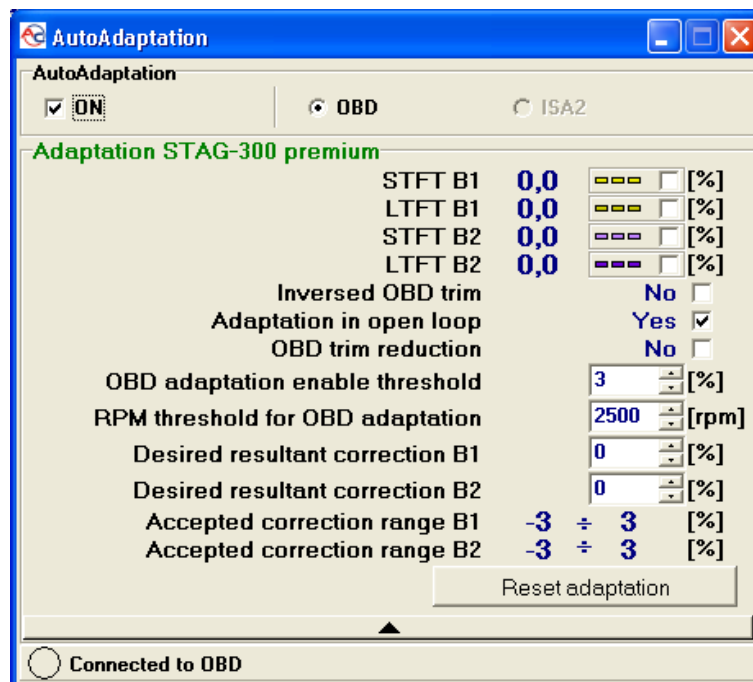


Fig. 11a OBD window.

OBD window displays the following data:

OBD II/EOBD – Data available from fuel ECU via the OBD interface

- **Number of trouble codes** – Number of recorded OBD troubles
- **Closed/Open loop** – the fuel system status (**WARNING: OBD adaptation doesn't work in cars, where "state of fuel system" parameter isn't available through OBDII/EOBD interface**)



- **STFT B1** – Short term fuel trim Bank 1 (ECU fuel)
- **LTFT B1** – Long term fuel trim Bank 1 (ECU fuel)
- **Resultant trim B1** – Resultant trim Bank 1 (ECU fuel)
- **STFT B2** – Short term fuel trim Bank 2 (ECU fuel)
- **LTFT B2** – Long term fuel trim Bank 2 (ECU fuel)
- **Resultant trim B2** – Resultant trim Bank 2 (ECU fuel)
- **Engine RPM** – Engine rpm value

Additionally, after pressing button 'Show', a window containing information on stored trouble codes (ECU fuel) and pending trouble codes (ECU fuel) will be displayed.

The screenshot shows a window titled "OBD" with two main sections: "Stored trouble codes" and "Pending trouble codes". Each section contains a table with columns for "Adress" and "Code". The "Stored trouble codes" table has 10 rows, and the "Pending trouble codes" table has 10 rows. At the bottom of the window, there are three buttons: "Erase", "Refresh", and "Exit".

Fig. 12 Window "ECU fuel trouble codes read from OBD"

STAG-300 Premium – Data related to OBD adaptation

In the basic view, only short- and long-term corrections shall be displayed, calculated by the adaptation process. In order to display and change AutoAdaptation parameters, press the wide button, which is below the displayed corrections. The window will unwind, covering the OBD (on-board diagnostics) data. For return to the previous view, press the same button again.

- **STFT B1** – Short term fuel trim Bank 1(STAG-300 Premium)
- **LTFT B1** – Long term fuel trim Bank 1(STAG-300 Premium)
- **STFT B2** – Short term fuel trim Bank 2(STAG-300 Premium)
- **LTFT B2** – Long term fuel trim Bank 2(STAG-300 Premium)
- **Adaptation on** – Switching on/off of OBD adaptation. In the case of engines with two Banks control systems (e.g. „V” type or „boxer” engines), one has to define in which bank a particular gas injector is located. Detailed information in the chapter 2.8. Matching gas injectors with relevant Bank (for STAG-300 Premium controller only).
- **OBD inversed trim** – in classical fuel dose control systems, OBD correction values become positive in the case of a poor blend and negative – in the opposite instance. This option shall be on in the vehicles with a reversed relationship between the blend status and OBD correction sign.
NOTE: wrong option setting will lead to rapid gas injection correction, which will disable vehicle drive.



- **Adaptation at open loop** – OBD correction values shall be applicable when the engine runs in closed loop. Switching on the option shall enable an additional adaptation, tailored to the open loop status.
- **OBD trim reduction** – this option is applied in the vehicles, in which OBD corrections achieve $\pm 100\%$ values.
- **'Adaptation on' threshold** – value expanding the range of resultant correction. Possible values 0-3%
- **OBD RPM threshold** – the adaptation shall be active only when engine's RPM are above the set value.
- **Desired resultant correction B1/B2** – **Desired resultant correction** is calculated automatically during calibration.
- **Accepted correction range B1/B2** – destined range value of **desired resultant corrections of bank 1 and 2**. Depending on **desired resultant correction B1/B2** and **adaptation activation threshold**. Example: **'Adaptation on' threshold** equals 1% with **desired resultant correction B1** at 3% gives **accepted correction range B1** between 2%-4%. If in given configuration **resultant correction B1** (petrol ECU) remains within above range, adaptation will be stopped because it has reached its target. In case the **resultant correction B1** (petrol ECU) again reaches over the above given range, the adaptation will resume.

A window showing connection status with OBD is presented below.

- Grey icon and text 'No connection with OBD' means that at the moment, the connection with OBD is not possible (no ignition, no OBD adapter)
- Yellow icon and text 'Connecting to OBD' means that the controller is connecting with OBD
- Flashing red icon and text 'Connected to OBD' means that the controller has been connected to OBD.

In order to switch on adaptation, the process of auto-calibration must be performed first (see chapter 3.1. Auto-calibration). After completing auto-calibration, the programming process must be implemented (see chapter 3. STAG-200, STAG-4 plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium controller programming).

WARNING!!! OBD Adaptation is recommended for cars made after 2002.

2.7. ISA2 AutoAdaptation (for STAG-300 ISA2 controller only)

In STAG-300 ISA2 controllers (without OBD support), when the AutoAdaptation button is pressed (in the right-upper corner of the program), a window is displayed with data associated with the AutoAdaptation function, following the ISA2 injection times. ISA2 AutoAdaptation restart shall be possible only after autocalibration.

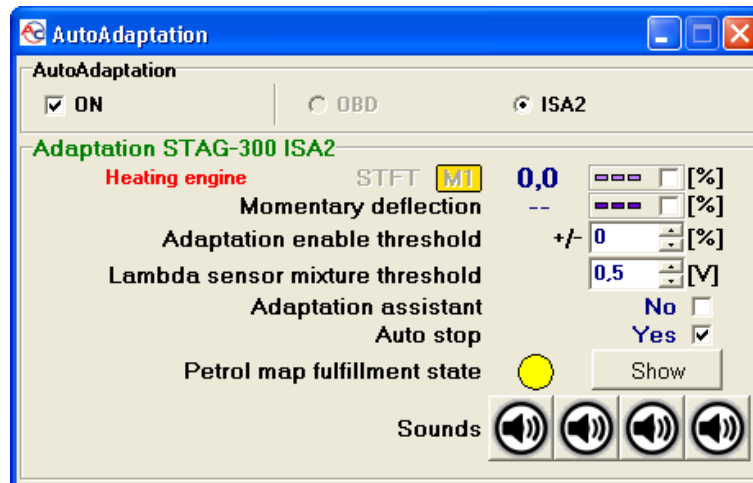


Fig. 13 ISA2 AutoAdaptation window.

Description of parameters:

- **STFT** – short-term correction of gas injection time period. “M1” and “M2” markers identify the mode of ISA2 autoadaptation functions (basic and for high loads, respectively).
- **Distortion** – proportion of the actual (petrol) injection time deviation vs. the injection time on model map.
- **Adaptation threshold** – the acceptable value of the actual fuel injection time deviation and the injection time, indicated on model map.
- **Lambda sensor mixture threshold** – voltage value of the lambda probe, above which the fuel mixture will be regarded rich (or lean in case of “reversed” lambda sensor. This information is used by ISA2 autoadaptation in M2 mode.
- **YES/NO adaptation assistant** – activation/deactivation of the map collection assistant. If the assistant is on, switching to gas shall be possible only after acquisition of the 3D petrol map. In the course of petrol driving, a buzzer will be emitting sounds, guiding to the demanded RPM range, facilitating the 3D petrol map acquisition. The assistant switches automatically off at the end point of basic map range acquisition (i.e. up to 3,500 RPM; see chapter 2.17). If necessary, it can be switched on again.
- **YES/NO Auto Stop** – if the option is selected, the engine work points on the multiplier correction map will automatically be blocked when an acceptable deviation is reached. (See “The threshold for adaptation start.”)
- **Petrol map capture state** – graphical indicator. It can take on the following colours:
 - Grey – it means that the model map is not acquired and switching to gas is not possible (provided that ISA2 adaptation and map acquisition assistant are active). The petrol map shall be acquired.
 - Yellow – partially acquired map. Gas drive is possible but at higher RPM ranges, an automatic switching to petrol may occur in order to acquire the missing parts of the map.
 - Green – fully acquired map (i.e. its required range has already been acquired).

When the „Show” button is pressed, the model petrol map acquisition status is displayed.



- **Sounds** – the buttons are used to hear the sounds, which are generated by the map acquisition assistant (buzzer sounds). When a sound button is pressed, a short description of this particular, audible sound shall be displayed, explaining its role in the system.

Both autoadaptation and map acquisition functions are activated only when the engine is warm (the “engine warming” message will disappear).

2.8. Matching gas injectors with relevant Bank (for STAG-300 Premium controller only).

In the case of „V” or „boxer” engines, the controller may have 2 banks Bank 1 and Bank 2 (The trim value STFT B2 and LTFT B2 are different from zero). In this case, an individual gas injector must be set to the relevant Bank.

In order to do that, Press ‘Gas injectors settings’ button in the „Parameters” bookmark. The window “Gas injectors settings” will be displayed.

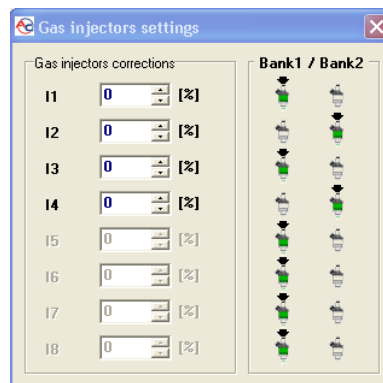


Fig.14 Gas injectors settings window (STAG-300 Premium)

Start the engine, wait for the controller to establish connection with OBD. The engine should operate at low rotation speed with **adaptation off**. Set correction value for all gas injectors to zero. Remember the correction value STFT and LTFT for Bank 1 and Bank 2. Next, perform the following procedure, starting from gas injector 1:

1. In the window „Gas injectors settings” change the correction value of the gas injector from 0 to 25 [%]
2. Observe for which of 2 “Banks” STFT, LTFT corrections change towards lower values.
3. After identifying for which „Bank” corrections change, match a given gas injector with the corresponding “Bank”.
4. Change the value of gas injector correction to 0. After that, the STFT and LTFT should return to the initial values, priori to point 1.

Repeat the procedures described in steps 1 to 4 as many times as there are gas injectors in the system.

After matching gas injectors with banks, **turn auto-adaptation on**, if necessary, and set gas injectors corrections to the initial value.

In the case of controllers with 2 „Banks”, improper realisation of the above described procedure will result in incorrect auto-adaptation function, which may lead to engine damage.



The above described procedure need not be implemented in the engines with controller and 1 „Bank”, as all gas injectors are by default matched with 1 Bank.

2.9. Signals, injectors, switchboard

On the right side of the window (**Fig. 7**) there are the “Signals” and “Injectors” windows. The “Signals” window shows the following signals measured by the controller:

- *Gas pressure [bar]* – LPG/CNG pressure value (the difference in the pressure regulator pressure and the suction collector pressure)
- *MAP pressure [bar]* – pressure inside the suction collector (absolute pressure value)
- *Injection time [ms]* – petrol injection time
 - Petrol 1 – Petrol injection time for Injector 1
 - Petrol 2 – Petrol injection time for Injector 2
 - Petrol 3 – Petrol injection time for Injector 3
 - Petrol 4 – Petrol injection time for Injector 4
 - Petrol 5 – Petrol injection time for Injector 5
 - Petrol 6 – Petrol injection time for Injector 6
 - Petrol 7 – Petrol injection time for Injector 7
 - Petrol 8 – Petrol injection time for Injector 8
- *Injection time [ms]* – Gas injection time
 - Gas 1 – Gas injection time for Injector 1
 - Gas 2 – Gas injection time for Injector 2
 - Gas 3 – Gas injection time for Injector 3
 - Gas 4 – Gas injection time for Injector 4
 - Gas 5 – Gas injection time for Injector 5
 - Gas 6 – Gas injection time for Injector 6
 - Gas 7 – Gas injection time for Injector 7
 - Gas 8 – Gas injection time for Injector 8
- *Gas temperature[°C]* – LPG temperature at the pressure regulator output
- *Red. Temperature [°C]* – liquid temperature at the reducer
- *Lambda 1 voltage [V]* – voltage at the lambda probe 1
- *Lambda 2 voltage [V]* – voltage at the lambda probe 2
- *Battery [V]* – voltage at the controller’s power supply
- *RPM [rpm]* – engine revolutions
- *Engine load* – current engine load value expressed in per cent.

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 colour on the oscilloscope.

Below the signals (**Fig. 7**) there is a field with active LPG/CNG injectors. This is used to turn off selected LPG injectors. E.g. in a 4-cylinder engine, normally 4 LPG injectors are active (green). To turn off a selected injector, click on it and the corresponding petrol injector will be turned on. This is useful in



diagnosing a mechanical damage on an injector. When the power is switched off with the ignition key, all LPG injectors are turned on.

There is a LED switchboard under the Signals and Injectors windows.



Fig.15 LED switchboard

There is a button on the LED switchboard for changing the fuel type. The LED next to the switch signals the controller status:

- off – petrol
- on – LPG/CNG
- blinking – auto mode

The currently used fuel type information is shown under the switchboard. There are 5 LEDs at the top of the switchboard showing current LPG/CNG level in the tank. Click on one of the four LEDs to enter the LED threshold settings.

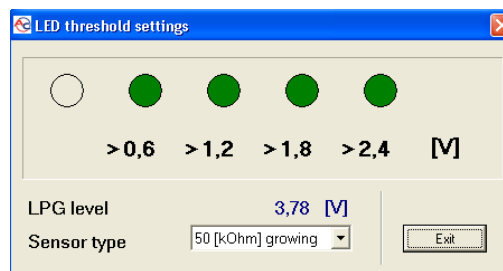


Fig. 16 LED threshold settings

Use this window to set the voltage which will turn on a given LED. (See section 4.2 for the description of automatic set up of threshold voltages.) The LPG level sensor type is also set here as well as the LPG level voltage.

When the “LED threshold settings” window is active, changing the LPG level on the sensor results in immediate change of LEDs status. This is used to check the proper activity of the full tank sensor and the LED bar. When this window is closed (normal activity) the LED level change on the sensor is shown on the LED bar after a very long period of time.

2.10. Auto-calibration

The auto-calibration window is used to calibrate the engine at idle run. Start the calibration after the engine is turned on and the lambda probe begins to work. 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 be automatically switching on selected LPG cylinders. Once the auto-calibration is complete, the



controller displays a message informing the auto-calibration has finished successfully. The following messages may appear during the calibration:

- *Engine rpm too low [rpm]*– engine rpm are too low, please check the “Num. of cyl. for coil” setting
- *No injection at the injector* – no signal at the petrol injector – check the connection of the emulator’s bundle.
- *Collector pressure [bar] incorrect* – the collector pressure may be incorrect, check the collector’s pressure sensor settings.

Available calibration options:

All injectors together– in the case of standard calibration (“*All injectors together*” option is switched off), the controller switches one cylinder to LPG first and then switches the remaining cylinders one by one. If the *All injectors together*” option is switched on, the controller will switch on all injectors at the same time.

This option can be very useful in the case of some “full-group” injection systems, for which it is not possible to separate individual petrol injectors and 4 injectors form a single primed module with two terminals. This option should be switched on as well if fuel strip pressure emulators or “Renix” emulators are used.

If this option is selected, the “Cylinder switchover” parameter will be automatically set to 0.

2.11. Oscilloscope

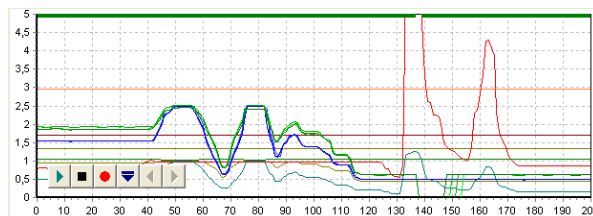


Fig. 17 Oscilloscope view

When the auto-calibration or map tab is selected, the oscilloscope is visible. The oscilloscope shows all the signals described in point 2.5. The control buttons have the following functions (from left to right):




- Start the oscilloscope
- Stop the oscilloscope
- Save current oscilloscope display
- Load saved oscilloscope display
- Decrease the number of displayed points (only for loaded graphs)
- Increase the number of displayed points (only for loaded graphs)

When the controller works with LPG, a continuous line appears at the top of the oscilloscope; its colour corresponding to the LPG ignition time. In case of enforced petrol drive, caused by the ISA2 AutoAdaptation mechanism, the line will turn yellow.



Once oscilloscope file has been loaded an auto searching feature is available. Tool allows examining oscilloscope file for places that match given criteria.

After load of oscilloscope file the control buttons relating to oscilloscope search appear:

-  Show search window
-  Jump to previously found place
-  Jump to next found place

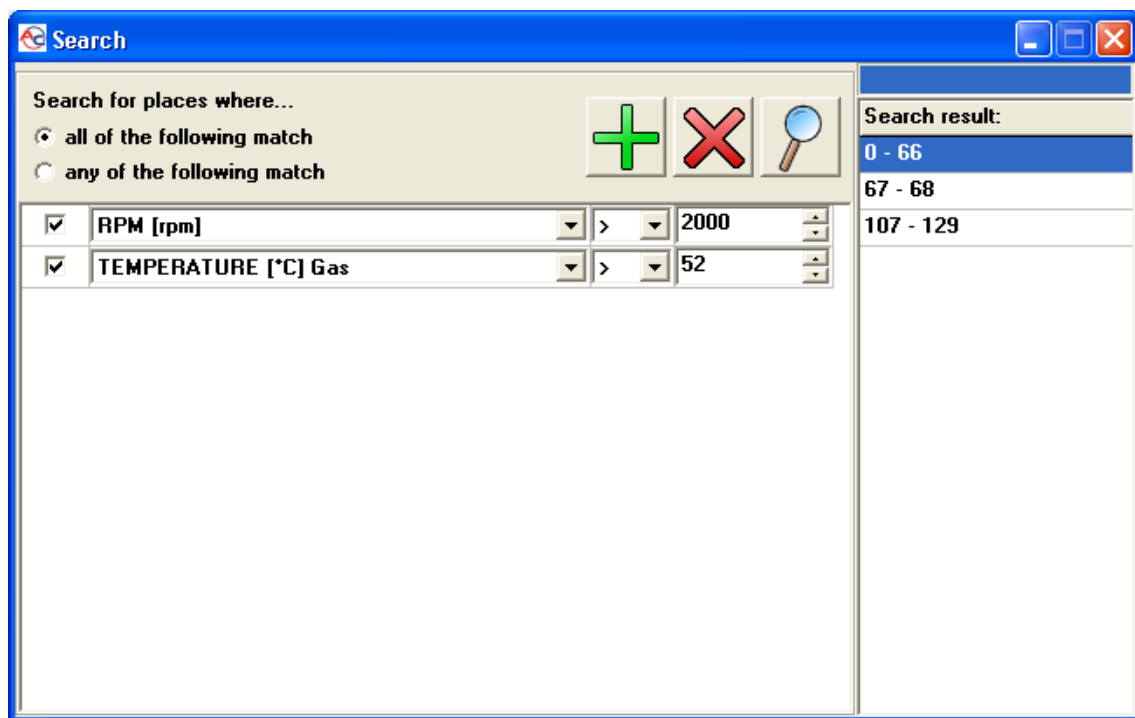





Fig. 17a Search window

Search window gives ability to input searching equations. Button with green cross  adds new condition to the list, button with red cross  remove selected condition. Button with loupe  begins searching procedure.

Searching in long files can take a while, that's why progress bar in top right corner of the window is available. At the end of searching, results are shown in right side of the window. They appear as range of indexes that meet defined conditions. Clicking right mouse button on item from search result list moves oscilloscope cursor to chosen result.

2.12. Errors

The Error window shows the following field:

- Continuous acoustic signal for errors – if selected, acoustic signals will inform of an error until manually turned off by the user. If unselected, the acoustic signals will remain on only for a set amount of time.



The Actual Errors window shows current errors recorded by the controller and the Saved Errors window shows errors recorded during the controller's operation.

The following errors may appear during operation:

- **Injector No. [...] Error** – no LPG injector No. [...] or injector damage
- **Voltage Error** – voltage at the controller's power supply lower than 9 [V]
- **LPG pressure too high**– the LPG pressure has been two times higher than operational pressure for 60 seconds (a reducer problem)
- **LPG pressure too low** – the LPG pressure has dropped under the min. pressure value for a set amount of time.
- **No petrol injection** – the controller has detected a lack of petrol injector signal for one or more petrol injectors.
- **Data error, check settings!** – the controller has detected a settings error, check all controller settings.
- **Power supply voltage too low for LPG/CNG!** – the controller power supply is too low to work with LPG.
- **Working time error** – Controller Info has been damaged and automatically deleted. **In this case, the First PC Connection and First Settings Modifications info will not be shown.**

The following warnings may appear in the Warnings window:

- **LPG injectors fully open!!!** – Check the lambda probe at full engine load – **LPG injection loop, i.e. an LPG injection's started before the previous LPG injection ended. If the lambda probe is "rich" at the time of this message, this warning may be ignored. Otherwise, replace the injectors' nozzles with higher diameter ones to decrease the multiplier.**
- **Inspection of Gas system required!!!** The installation requires a periodical service visit. To delete this message, go to the Controller Info settings, click "Set Inspection" and either set the next service visit in kilometres or select "Off" in which case the service reminder will be inactive.
- **Car runs in emergency mode (on LPG/CNG)**

There is a "Delete" button at the bottom of the screen used to delete all registered errors.



2.13. 2D Multiplier Map

The Map window shows the LPG controller 2D maps.

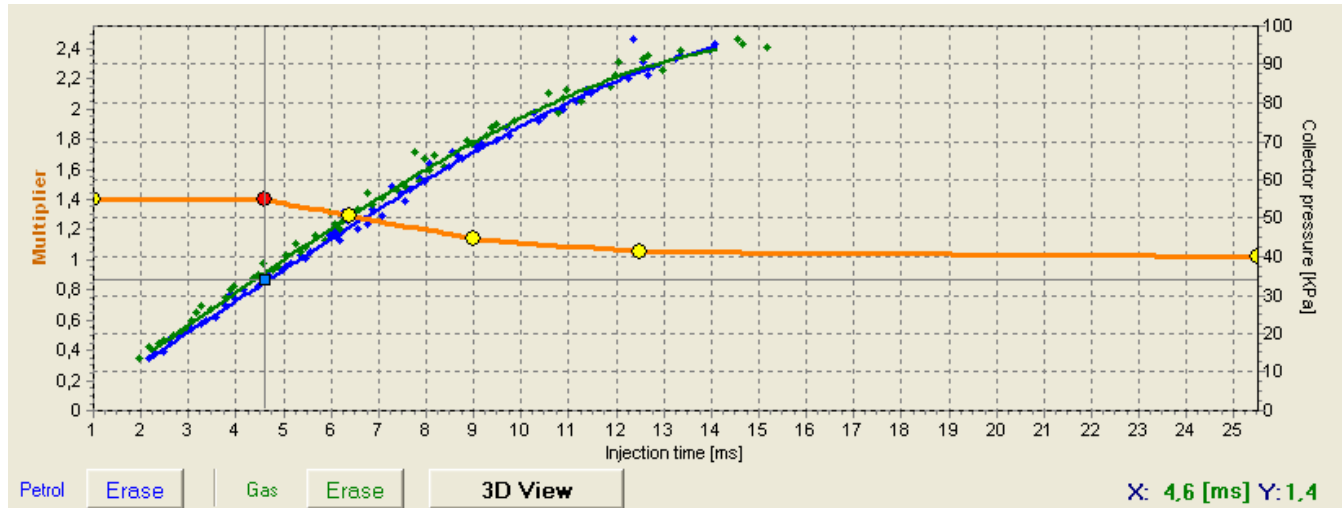


Fig. 18 2D Controller maps

Fig. 18 shows 3 maps:

- Multiplier map - orange
- Petrol injection time map (with petrol) -blue
- Petrol injection time map (with LPG) - green

The multiplier map is orange. The left axis of the co-ordinate system (Multiplier) and the lower axis (Injection time [ms]) 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. Upon auto-calibration, 2 yellow points appear on the left-most and right-most positions with 4 additional points in between. 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 point from the map
- „Page Up” – move the map up
- „Page Down” – move the map down
- „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.



Apart from the multiplier map, there are two other maps in the window. The blue map represents the petrol injection times (with petrol). The right axis Collector pressure [Kpa] and the lower axis Injection Time [ms] relate to this map. The map consists of blue points. After collecting the data, the controller turns these points into a continuous line. The same applies to the so-called LPG map, i.e. the map of petrol injection times (with LPG) which is green.

After the controller collects both maps, i.e. the petrol and LPG maps, the Deflection tab becomes active where a red line shows the difference between petrol and LPG.

The map window in Fig. 18 shows a blue square marker; its position changes vertically depending on the collector pressure and horizontally depending on the petrol injection times. It is very useful during map collection as it shows the load and injection times of the engine.

The “Erase” button is used to delete the petrol and LPG maps.

NOTE – in the case of STAG-300 Premium controller, petrol fuel map is collected only when OBD adaptation is switched off.

2.14. 3D multiplier calibration map (for STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium controller only)

After clicking on the “3D view” button, a 3D multiplier calibration map will open in the “Map” window.

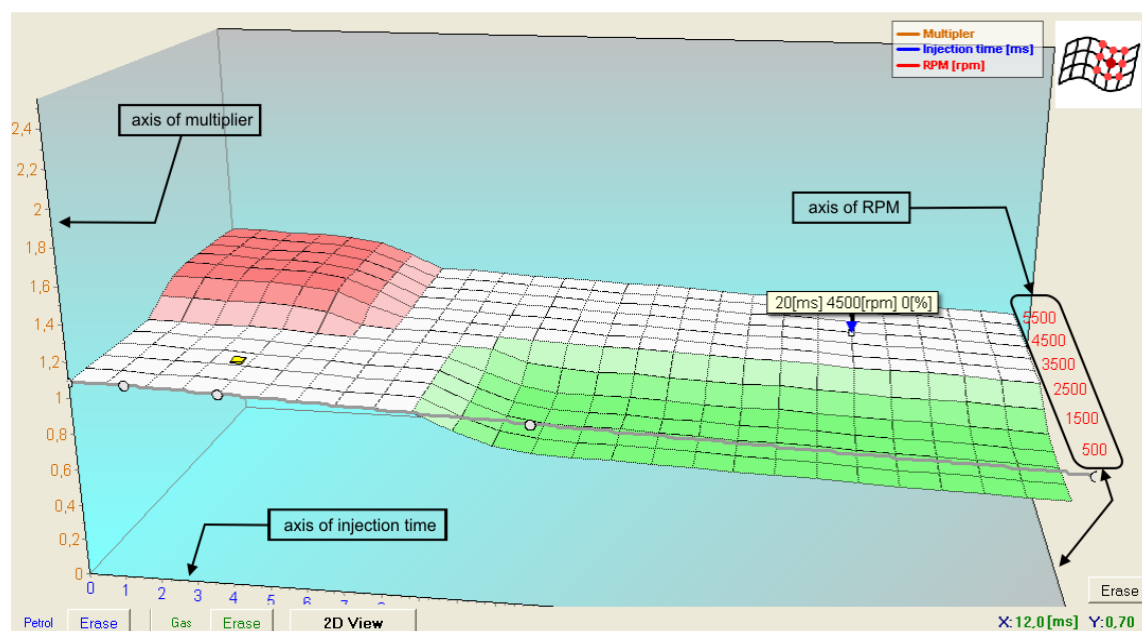


Fig. 19 3D map view

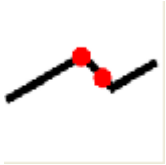
The 3D map shows the multiplier map described in point 0. The multiplier map makes up a plane. One axis of the plane represents the petrol injection time [ms], while the other represents engine revolutions [rpm]. The map makes it possible to calibrate the multiplier depending on engine revolutions. This is shown In Fig. 19. It is possible to enrich/weaken the mixture for a defined petrol injection time and revolutions by means of calibrating the multiplier on the 3D map.



A yellow (square) marker seen in the diagram shows where on the plane the engine currently is. The marker position depends on the current rpm value and of the petrol injection time.

The following working modes are available when using the 3D map:

- Multiplier change



This mode is used to change the multiplier characteristics (plane) by following steps analogous to those in the case of the 2D map. Editing in this mode is analogous to the same function in the 2D map. The mode is activated by means of clicking with the left mouse button beyond the plane marked out by the multiplier map, or by means of pressing the TAB key (switch from the previous mode).

- Multiplier calibration (change in adjacent fields)



This mode is used to calibrate the multiplier for a given range of engine revolutions and of the 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 calibration/richer mixture)
- ↓ Arrow down (lower calibration/leaner mixture)

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

The mode is activated by means of pressing the TAB key (switch from the previous mode).

- Multiplier calibration (no change in adjacent fields)



This mode is used to calibrate the multiplier for a given range of engine revolutions and of the petrol injection time. This mode functions in a way analogous to “Multiplier calibration (change in adjacent fields)”. The difference is that only the marked area undergoes changes while adjacent fields remain unchanged.

The mode is activated by means of pressing the TAB key (switch from the previous mode).



▪ Rotating the diagram

This mode is used to rotate the 3D diagram. In order to rotate the diagram, press the right mouse button and move the mouse so that the desired result is achieved. Another method is to rotate the diagram by pressing the following arrow keys:

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

2.15. Options menu

The “Options” menu can be accessed from the upper menu. Thanks to the “Options” menu, the user can define their own 3D map window view, corresponding to their requirements.

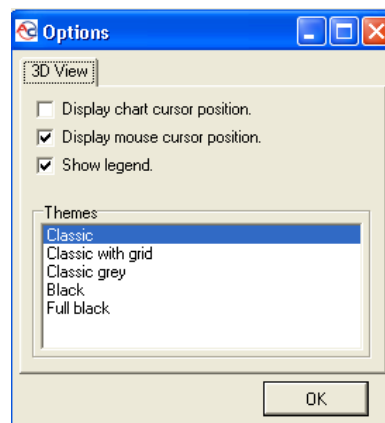


Fig. 20 “Options” menu view

The menu presented above makes it possible for the user to adjust the 3D map display mode. The following 5 display modes are available:

- Classic
- Classic with grid lines
- Classic grey
- Black
- Full black

The following additional options are also available:

- **Display chart cursor position** – rpm and injection time values are displayed for the actual engine status.
- **Display mouse cursor position** – rpm and injection time values corresponding to the actual mouse position are displayed.
- **Show legend** – the legend on the 3D map is shown/hidden.



2.16. 3D petrol injection time map (for STAG-300 ISA2 and STAG-300 Premium controller only)

The 3D view of the map, besides the insight into the multiplier correction map, makes also available the views of petrol injection time maps as functions of the collector pressure and RPM. Selected view activating buttons are grouped in the upper-left corner of 3D view.

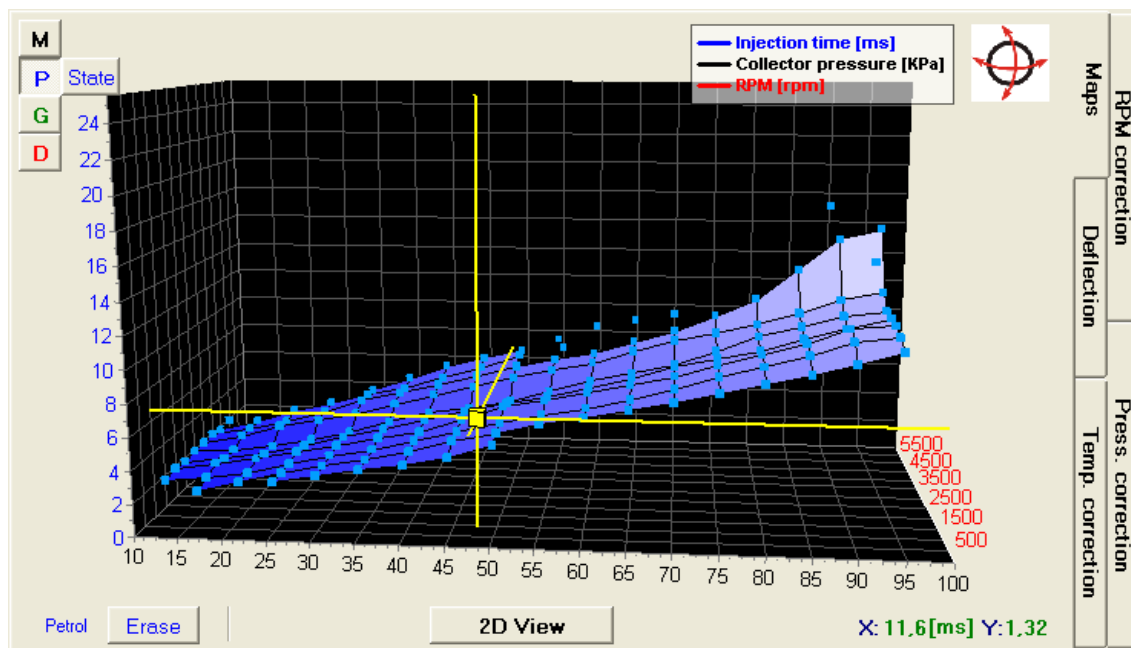


Fig. 21 3D injection time map (petrol)

NOTE – in the case of STAG-300 Premium controllers, the map of petrol injection times (in the petrol mode) is acquired only and exclusively when OBD adaptation is switched off.

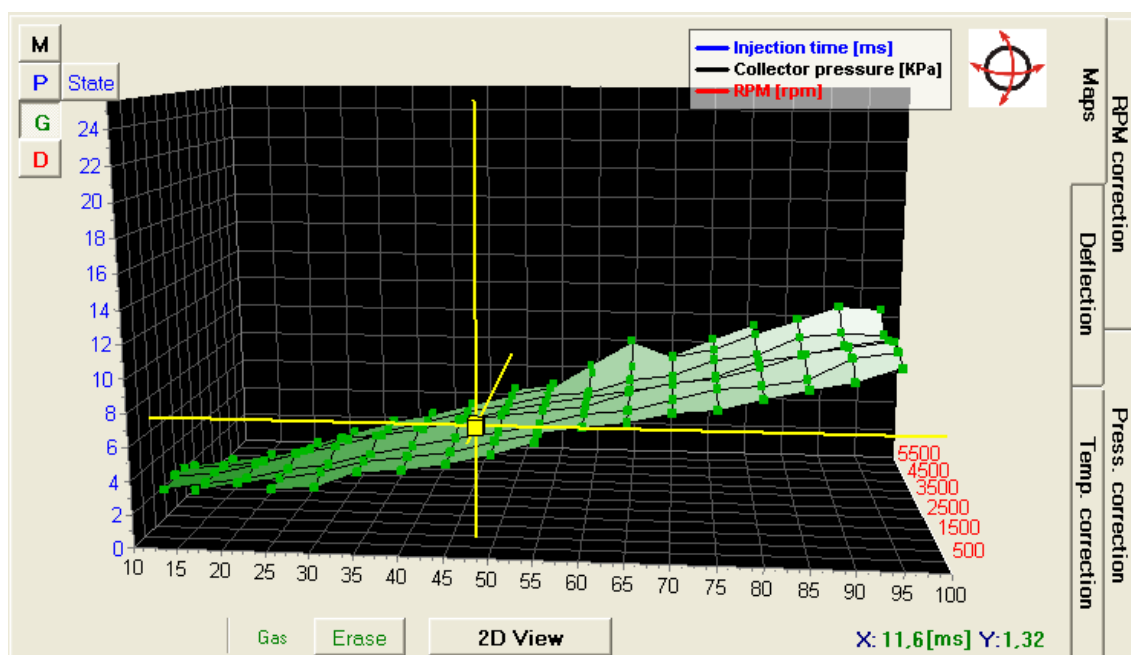


Fig. 22 3D injection time map (gas)



The differences between 3D maps of injection times, recorded during petrol and gas drive, are available through the deviation view.

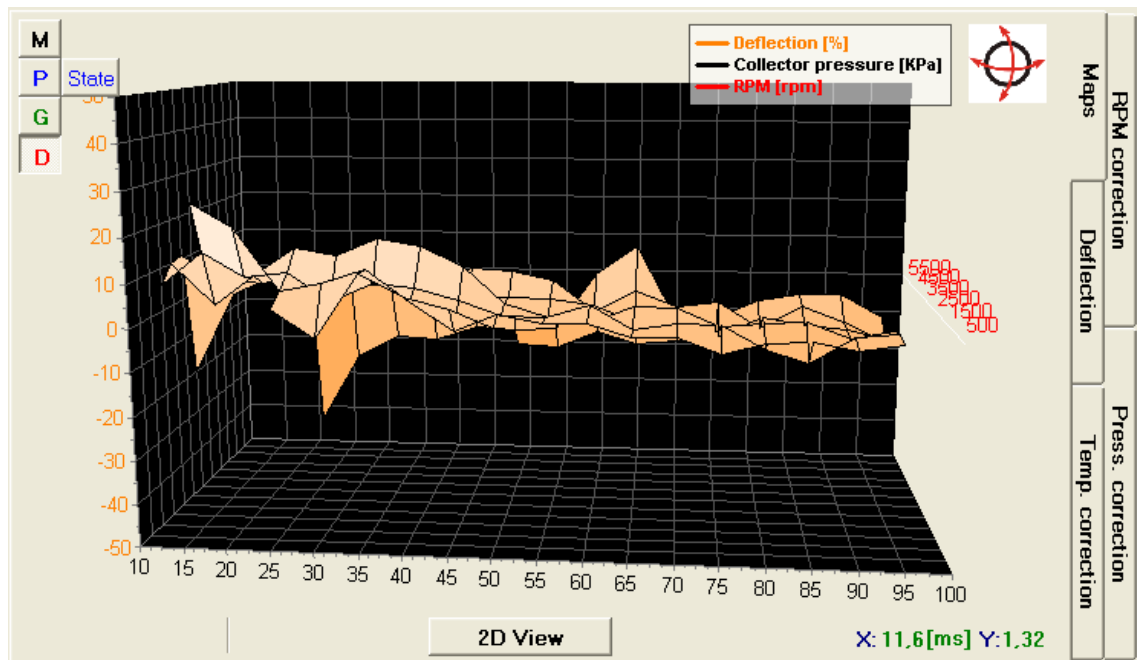


Fig. 23 Deviation of 3D injection time maps

2.17. The status of 3D injection time map acquisition (for STAG-300 ISA2 controller only)

The 3D injection time map recorded during petrol drive is a model petrol map for the ISA2 AutoAdaptation mechanism. The AutoAdaptation process is carried out via continuous comparing of the engine's run at definite parameters (load and RPM), with acquired model map. An additional task shall comprise its correct acquisition. In order to monitor the map data acquisition process, the application has been provided with a special view of the petrol map acquisition status, available via the „State” button.

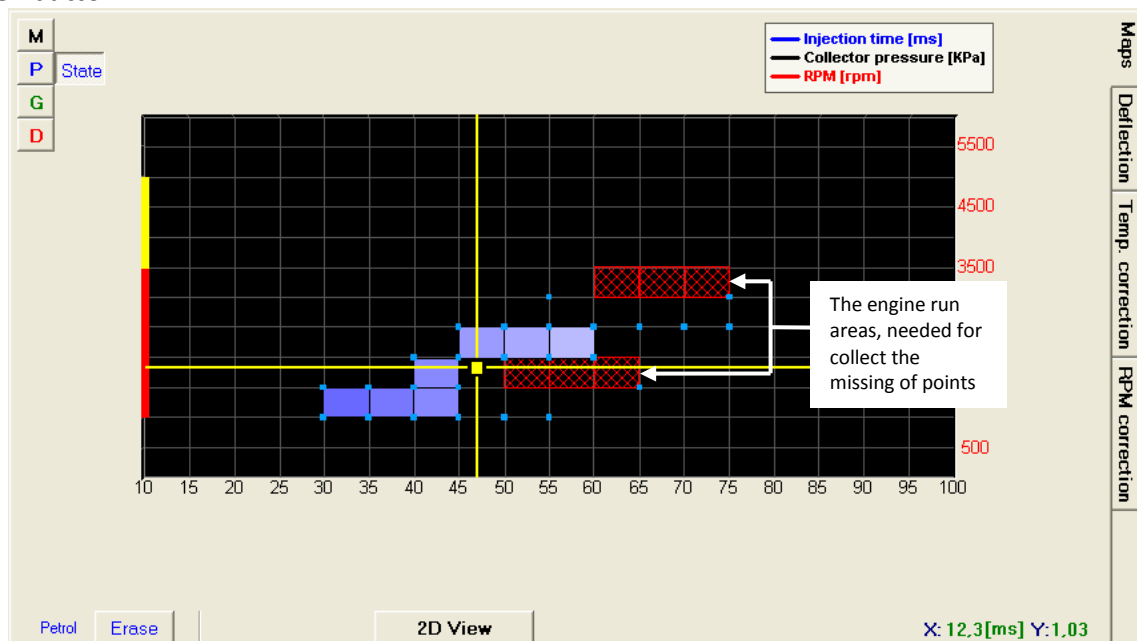


Fig. 24 Petrol map acquisition status



In the course of drive, the controller interprets in real time the status of acquisition of map points. The engine run areas, required for the acquisition of points, such that the data acquisition could be regarded complete, are displayed as chequered rectangles. The vertical line, visible on the left side of the view, indicates the required RPM range. The red part represents the basic range from 1000 through 3500 RPM, within which the map has to be acquired for the adaptation to be effective. The yellow part designates an extended range of the map, necessary to be acquired, when the engine is often highly loaded.

2.18. 3D multiplier calibration map “digital” (for STAG-300 ISA2, STAG-300 Premium controller only)

Upon pressing the “RPM calibration” tab, a digital multiplier calibration map is displayed in the map window. This map is a different method of visualising the 3D map described in 2.14. The digital map offers new possibilities presented below.

Parameters	AutoCalibration				Errors		Map		Settings																					
RPM\[ms]	0,0	1,9	3,6	4,7	5,1	5,6	6,2	6,9	7,7	8,4	9,3	10,1	11,1	12,0	12,9	13,9	14,9	16,0	17,0	18,1	19,2	20,3	21,5	22,6	23,8	25,0				
6000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
4000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
3400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
2800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
2300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
1700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
<div><div><input checked="" type="checkbox"/> Changing value change neighbour too</div><div><input checked="" type="checkbox"/> Show values</div><div>Erase</div></div>																														

Fig. 25 “Digital” multiplier calibration map view.

Thanks to the “digital” multiplier calibration map shown above, it is possible to modify the multiplier according to rpm in the same manner as in the case of a “graphic” 3D map, also as regards the method of operating it by means of a keyboard. All changes to the “graphic” map will be represented in the “digital” map and vice versa because physically there is only one map in the controller memory, only the method of presentation is different.

A far as map modifications are concerned, the following additional options are also available:

- “Changing value change neighbour too” – (if selected) in the case of modifying the selected area, the neighbouring fields are modified as well.
- “Show values” – (if selected) the controller displays calibration values in per cent.

In this display mode, the “Erase” button can be seen. By pressing this button, all map settings can be deleted (the map can be reset).



The vertical axis shows rpm values for individual intervals on the map. The red border marks the boundary between the first and the second rpm interval. If intervals are set as presented in Fig. 25 , the second interval operates from 300 to 500 rpm, while the third interval operates from 500 to 600 rpm.

The boundaries between individual intervals can be regulated by clicking on the correct field and entering a new interval boundary value. Thanks to this option, it is possible to adjust the mixture composition to precisely defined rpm range and injection time. The user is not limited by preset intervals. For example, the operating range of the third interval can be modified to 500-800 rpm.

The blue square which can be seen in the map changes its position within the horizontal axis depending on the actual petrol injection time value and within the vertical axis depending on the actual rpm value.

2.19. Automatic change of 3D multiplier correction (for STAG-300 ISA2 controller only)

Long-term ISA2 correction is demonstrated as an automatic change of field values on the 3D multiplier correction map. It also enables matching of both controller maps (petrol and gas), providing for optimal engine performance.

If the automatic modification of multiplier correction map in certain run stages undesirable, then these stages can be switched off from the AutoAdaptation process. In order to achieve it, encircle a selected map area with a mouse and click with the right button with the cursor on the area. A concise menu will open with the following options: „Turn ON AutoAdaptation” and „Turn OFF AutoAdaptation”. If ISA2 autoadaptation is active and the “Auto Stop” option is on, the points, at which autoadaptation achieves its goal, will also be switching off (automatically). Correction values in the disabled areas shall be displayed in grey colour. It should be kept in mind that if the “Show values” option is marked off, then the disabled areas will not be distinctive either.

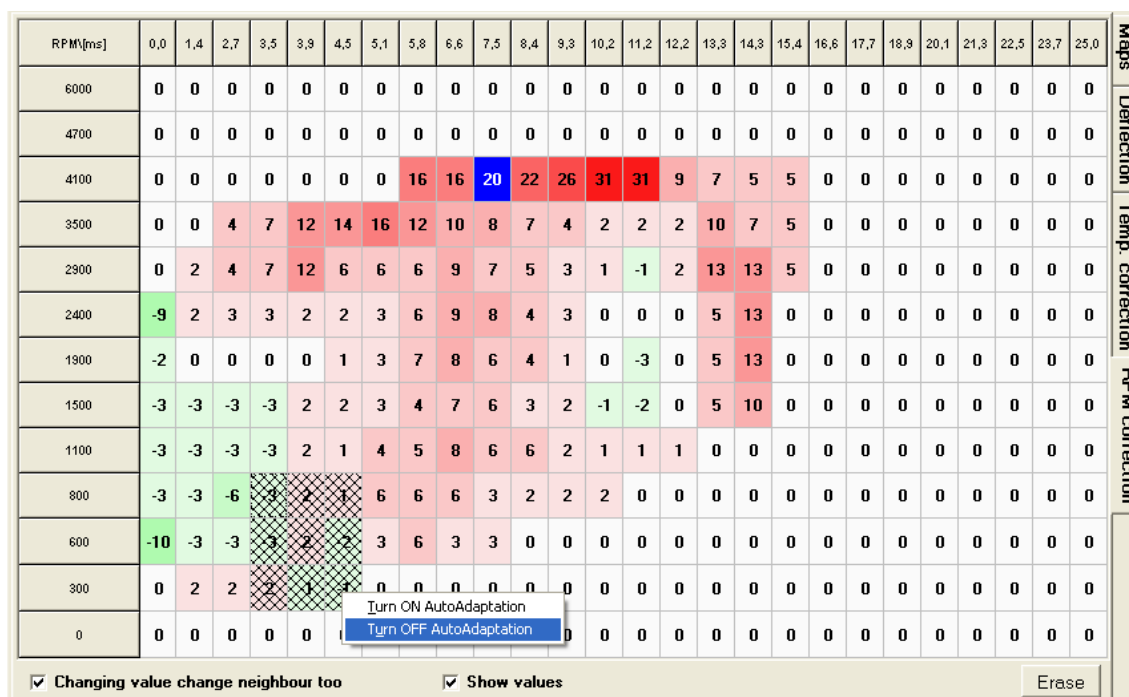


Fig. 26 Disabling of 3D map area ISA2 AutoAdaptation process



2.20. Gas temperature calibration map (for STAG-4 Plus, STAG-300 ISA2, STAG-300 Premium controller only)

The Gas calibration map opens in the Map window after selecting the “Temperature calibration” tab.

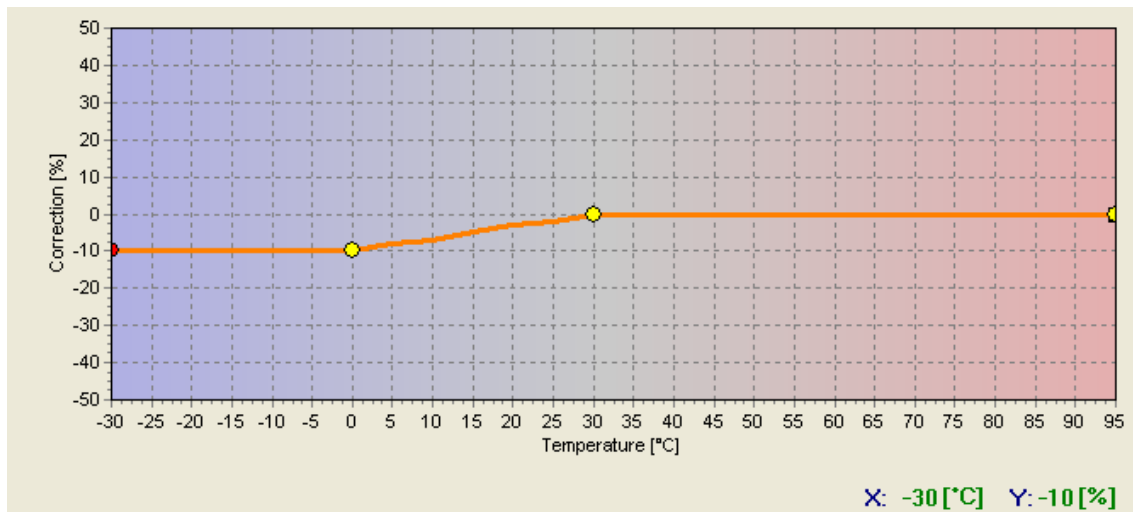


Fig. 27 Gas temperature calibration map view.

The controller has the gas temperature multiplier calibration value permanently set. The gas temperature calibration map enables percentage adjustments of this calibration value. Editing the gas calibration map is analogous to the same function performed in the case of the multiplier map.

2.21. The map of gas pressure-dependent corrections (available only for STAG-4 Plus, STAG-300 ISA2 and STAG-300 Premium controllers).

When the “Pressure correction” tab is pressed in the Map window, the map of gas pressure-dependent corrections opens.

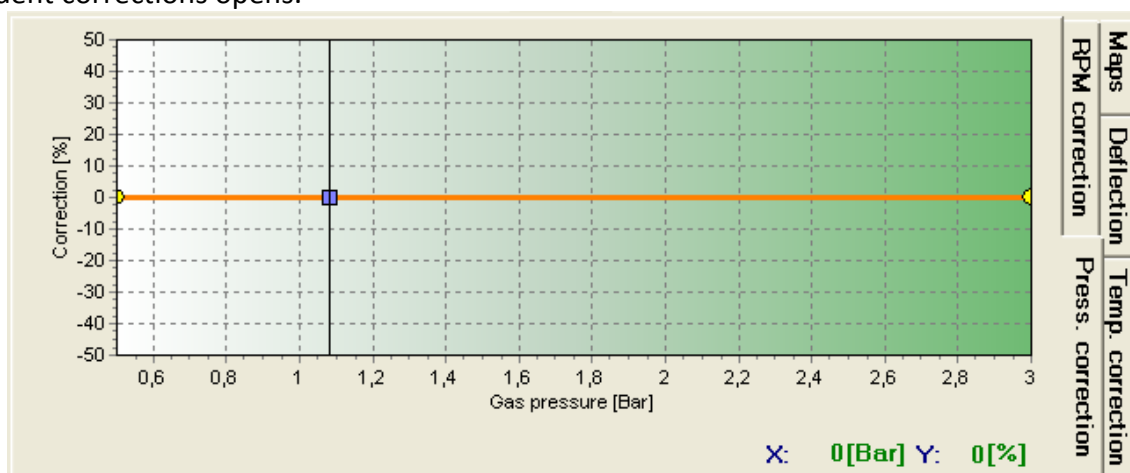


Fig 28 Gas pressure-dependent corrections map view.

The controller has got registered multiplier corrections related to gas pressure. The map of gas pressure-dependent corrections allows plotting adjustments proportional to this correction. The edition of the map of gas pressure-dependent corrections is analogous to multiplier map addition.



2.22. Controller update

To update the controller, connect it to the diagnostic software and turn the engine off. Select “Controller update” from the main menu and select (STAG-200, STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium), depending on the connected controller type. The “Controller update” window will pop up. The “Controller Parameters” window shows the information on current controller firmware version. The “Available actualizations” window includes a list of updates available for the connected controller. Loading an update not included in the program directory requires clicking “Load 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.

2.23. Update of STAG – OBD Adapter

In order to update a controller, connect it to a diagnostics program, **turn the ignition on**. Select option „Controller update” from the main menu and select STAG – OBD Adapter. Next, select an update from the list and press „Update” button. After successful completion of the update, an appropriate confirmation window should be displayed. If not, repeat the update process. Next, turn off the engine and restart; after approximately 30 seconds a connection with OBD should be established.



3. STAG-200, STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium controller programming

There are two ways to program the STAG controller:

- **Programming with the petrol and LPG maps.** *See 3.1 to 3.4*
- **Manual programming of the controller.** *See 3.5.*

Programming with the petrol and LPG maps consists of the following stages:

- Auto-calibration of the STAG controller
- Collection of the petrol injection times with petrol (petrol map)
- Collection of the petrol injection times with LPG (LPG map)
- Making sure both maps match and checking deviations

STAG-300 ISA2 and STAG 300 premium controllers are provided with mechanisms automatically adapting blend contents, depending on current engine operation conditions. Having these functions in the system allows improvement of gas driving parameters with simultaneous considerable facilitation of controller calibration process by the fitter:

- OBD AutoAdaptation (STAG 300 Premium) controls gas injection time, following the data from the vehicle's petrol controller.
- ISA2 AutoAdaptation (STAG 300 ISA2) controls gas injection time, following the recorded engine operation characteristics in the petrol mode. It requires the model petrol map to be recorded. See section 3.8

3.1. Auto-calibration

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. During the auto-calibration, watch carefully petrol and LPG injection times. If LPG injection times are shorter than petrol injection times, the injector nozzles may be too large and should be replaced with smaller diameter ones. When the auto-calibration is complete, 2 extreme yellow points and 4 additional points in between will show up on the multiplier map. The second left point is the point of engine operation at idle run i.e. the point of operation during auto-calibration. The multiplier's value for this point should be between 1.1 and 1.6; if the value is greater than 1.6, longer times of petrol injection i.e. greater load and high rpm, may cause overlapping of injection times i.e. one LPG injection will begin before the previous one ends (looped injections). In such a case, the controller will display the „Too long injection time” error message. **However, in such a case, check the operation of the lambda probe; if it is in the “rich” mode and the vehicle drives without problems, the error can be ignored.**



3.2. Collection of the petrol injection map with petrol (petrol map)

Having finished the auto-calibration, switch over to petrol and drive the vehicle for app. 4 km to collect the petrol map. During the collection of the map try to drive without changing gears e.g. at the 4th gear and in a way making the lambda probe to “work” i.e. changing its mode from weak to rich. Blue points should appear during the collection of the map. To collect the map quicker, adjust vehicle load in such a way causing new points to be collected in places which are still empty. **Collection of maps is performed without participation of the diagnostic software, thus can be done with the PC disconnected.** However, collecting the map while the PC is connected and the diagnostic software running is quicker and enables the operator to see what is actually happening to the vehicle. When the controller collects sufficient number of points, the map will be drawn with a continuous line and the petrol map collection is finished.

3.3. Collection of the petrol injection map with LPG (LPG map)

Having collected the petrol map, switch to LPG and collect the LPG map in the same way the petrol map was collected. The LPG map should be collected in the same road conditions and with similar loads as the petrol map. The LPG map is drawn with green points. Having collected sufficient number of green points, the map will be drawn with a continuous green line. If the controller is set properly (the multiplier characteristics selected properly), the petrol and the LPG maps should match. If the maps do not match, the multiplier characteristic should be corrected at the points where the maps do not match (the lower axis of co-ordinates for injection times). If the LPG map is collected with the PC connected and the diagnostic software running, it is possible to immediately correct the multiplier characteristics when the collected green points do not match with the petrol map. It is even strongly recommended to use the PC in this way as if the multiplier characteristics differ strongly from the required ones, the controller starts to switch over and – in the extreme case – can activate the “check” signal lamp. When correcting the multiplier characteristics, make the points on the LPG map match with the petrol map. Once both maps match, the characteristics are properly set.

3.4. Checking if maps match, verification of deviations

Having collected the petrol and LPG maps (both maps drawn with continuous lines) check the deviation between them. In the **Map** window there is the “Deflection” button located on the right. Press it to see the deviation graph drawn with a red line. If the deviation fits within $\pm 10\%$, the controller is programmed properly; otherwise, the multiplier characteristics should be corrected at points where maps do not match.

3.5. Controller manual setting

The controller may also be set up manually, which – provided sufficient experience has been gained – may prove quicker than the above described procedure.

Start with the auto-calibration in the same way as described above (this is necessary to ensure the controller works properly, see 3.1). If the auto-calibration finishes properly and the multiplier values are correct for the calibration point, switch the engine to petrol and take it for a ride. The multiplier characteristics need to be set in the following way:



Drive the car with a constant load, i.e. the petrol injection times should be stable. Adjust the engine loads so that the injection times equal e.g. app. 5 [ms]. The blue marker will help determine the injection times as its location on the horizontal axis is determined by the injection times. Next, switch the car to LPG and watch the blue marker for variations in injection times when compared with the earlier petrol injection times. If the injection times decreased (the marker moved to the left) it means that for the selected injection times the multiplier is too high (the mixture is too rich). In this case, lower the multiplier value for the 5 [ms] injection time (in our case). If upon switching to LPG the blue marker moves to the right, it means the mixture is not rich enough and the multiplier needs to be brought up for given injection times.

The procedure described above should be performed for a few different injection times, starting at the calibration point all the way until heavy load injections. You can check the multiplier map e.g. every 2 [ms] starting at the calibration point. If necessary, add a point at the multiplier map to set it more precisely.

Once the manual setting is complete, both maps – petrol and LPG – should match.

3.6. Multiplier map calibration – 3D map (for STAG-4 Plus, STAG-4 Eco, STAG-300 ISA2, STAG-300 Premium controller only)

Having performed auto-calibration and having set the multiplier map while driving, additional calibration of the multiplier depending on the engine revolutions can be performed using the 3D map (see 2.14). If there are any differences in injection times for a given range of the petrol injection time and the engine revolutions after switching from petrol to LPG, such differences must be calibrated by means of enriching/weakening using the 3D map. The rule is the same as in the case of setting the multiplier, i.e. if the injection time value is bigger after switching from petrol to LPG, it means that the mixture is too lean at a given point within the map (the petrol computer lengthens the petrol injection time). Thus, the mixture must be enriched for this point using the 3D map. In a reverse situation, i.e. when the petrol injection time is shorter after switching from petrol to LPG, the mixture must be weakened.

3.7. LPG temperature correction (for STAG-4 Plus, STAG-300 ISA2, STAG-300 Premium controller only)

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 2.20). **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.



3.8. Model petrol map acquisition (for STAG-300 ISA2 controller only)

Proper ISA2 AutoAdaptation performance requires **correct** model (petrol) map acquisition. When the map is missing, no switching to gas shall be possible (see the appropriate messages, displayed in the AC Gas Synchro application). The term “correctly acquired map” shall be understood as map acquired in the course of normal engine operation conditions (heated engine, no defects reported by the engine’s ECU (engine control unit)).

Map acquisition consists in recording injection times for various engine operation parameters (RPM and overload). The so-called **map acquisition assistant** has been designed to facilitate the task. The tool, by means of sound signals (from a buzzer), prompts the fitter to appropriate engine RPM range and informs when the engine runs at required point of operation. Completed map acquisition is also sound-signalled.

Taking into account driving style differences among individual drivers, the map has been divided into two sub-ranges:

- the first range covers 1000-3500 RPM (the red vertical line in the petrol map acquisition view) and is absolutely required to switch car driving into gas.
- the second range covers RPM > 3500 (the vertical yellow line in the petrol map acquisition view). If in the course of driving, the engine operation point moves into the not acquired part of the map and stays there for approximately 3 seconds, the car will automatically switch to petrol, in order to acquire a model map for this point (the sound assistant is also activated). A return of the engine operation point to the acquired map area will cause a switch to gas drive again (with some delay of approximately 10 seconds).

A short drive in full rotation and load ranges to determine engine run characteristics is recommended as the first step in model map recording.

The model (petrol) map is always acquired during petrol driver (when certain conditions are fulfilled, including, among others, gas reducer temperature > 50°C); however, the map acquisition assistant is active only when the controller is in the “automatic” mode. No sounds will be generated in the “petrol” mode.



4. LED switchboard operation and acoustic signals (User Manual)

4.1. LED switchboard



The LED switchboard consists of:

- LED line indicating LPG level
- the LED indicating type of fuel
- button

LED line— shows current LPG level in the tank. 4 green LEDs indicate a full tank; a red LED indicates “reserve”.

The LED – shows current operating status:

- off – the engine runs on petrol
- slow blinking (once per second) – awaiting engine temperature reading
- normal blinking (twice per second) – the controller is in the auto-mode (waiting for required rpm before switching to LPG)
- fast blinking (4 times per second) – controller error (no LPG in the tank)
- on – the engine runs on LPG

Push button – for switching from one fuel type to another

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

In order to start the engine on LPG (e.g. when the petrol pump is damaged), press in and hold the button on the LED switchboard while turning the ignition on. The LED should come on. When the engine revolutions are detected, the controller turns the solenoid valves on and the engine starts on LPG.

In this mode, it is not possible to turn back to petrol. Turn the ignition off to turn this special mode off.

4.2. 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:

1. Press and maintain the switchboard push button.
2. Switch off the ignition switch.
3. Depress the switchboard push button.



At this time point, the controller initiates the calibration procedure, which is signalled by a series of triple, short flashes of the gas level LED.

When the tank filling is over, switch on the ignition switch, thus terminating the calibration procedure. Successful calibration is signalled 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.

NOTE – LED 300/400 switchboard does not signal calibration process.

4.3. Acoustic signals

The controller generates the following acoustic signals:

- Three acoustic signals – when switching from LPG to petrol because of low LPG level in the tank
- Three short acoustic signals followed by a long one – when a controller error occurs
- When switching the ignition on – two short signals followed by a long one indicate a scheduled service visit. Visit a service station to have your system checked.
- Three long signals repeated every minute – the car started in the emergency mode.

5. Specification

Power supply voltage	12[V] -20% ÷ +30%
Maximum power supply current value for 8 cylinder controller, LPG injectors 1[Ω]	25 [A]
Current input in the standby mode	< 10 [mA]
Operating temperature	-40 - 110 [°C]
Protection class	IP54

6. Limited warranty / exclusions

The warranty shall not cover the following:

1. Damage resulting from installing the unit inconsistently with applicable installation diagram.
 - in particular, damage resulting from connecting signal wires to other connections than those indicated in the installation manual.
2. Damage resulting from installing the unit in locations inconsistent with the installation manual as well as locations in which the unit may be affected by water, high temperature or car battery vapour.
3. Systems modified or repaired by unauthorised parties.
4. Mechanical damage resulting from the customer's fault, in particular:
 - connections damage,
 - connections damage resulting from application of chemical cleaning substances,
 - casing damage,
 - PCB damage,
5. Systems damaged electrically due to connecting communication interfaces other than those recommended in the installation manual.