

Instruction of connection and programming of the Stag-200, Stag-300 controller

(also available from the Help menu and at the site www.ac.com.pl)
ver. 1.2 2006-03-15

1. Connection of wiring

1.1. Stag-200 Connection diagram

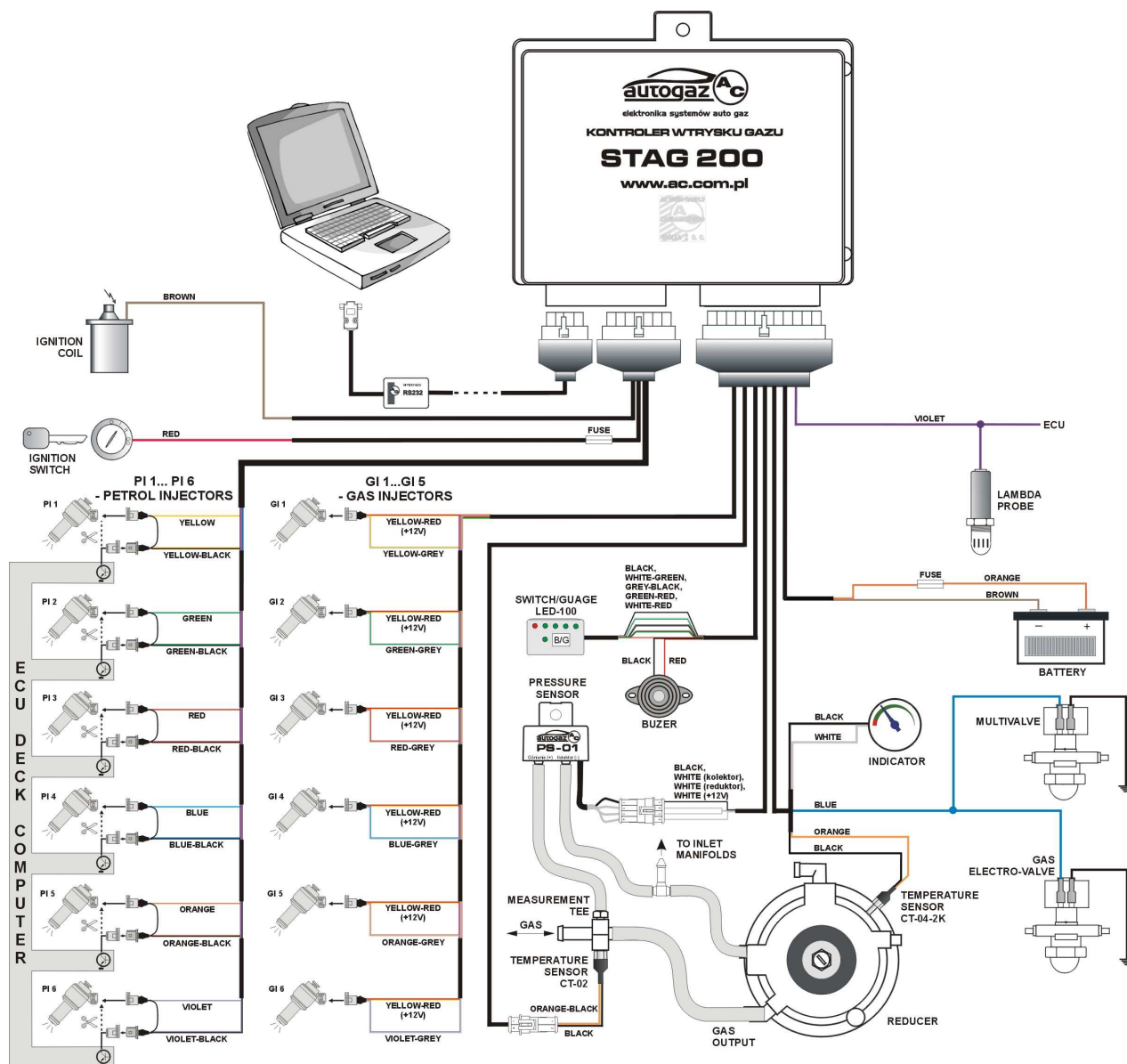


Fig. 1 Stag-200 Diagram of connection to the vehicle wiring.

1.2. Stag-300 Connection diagram

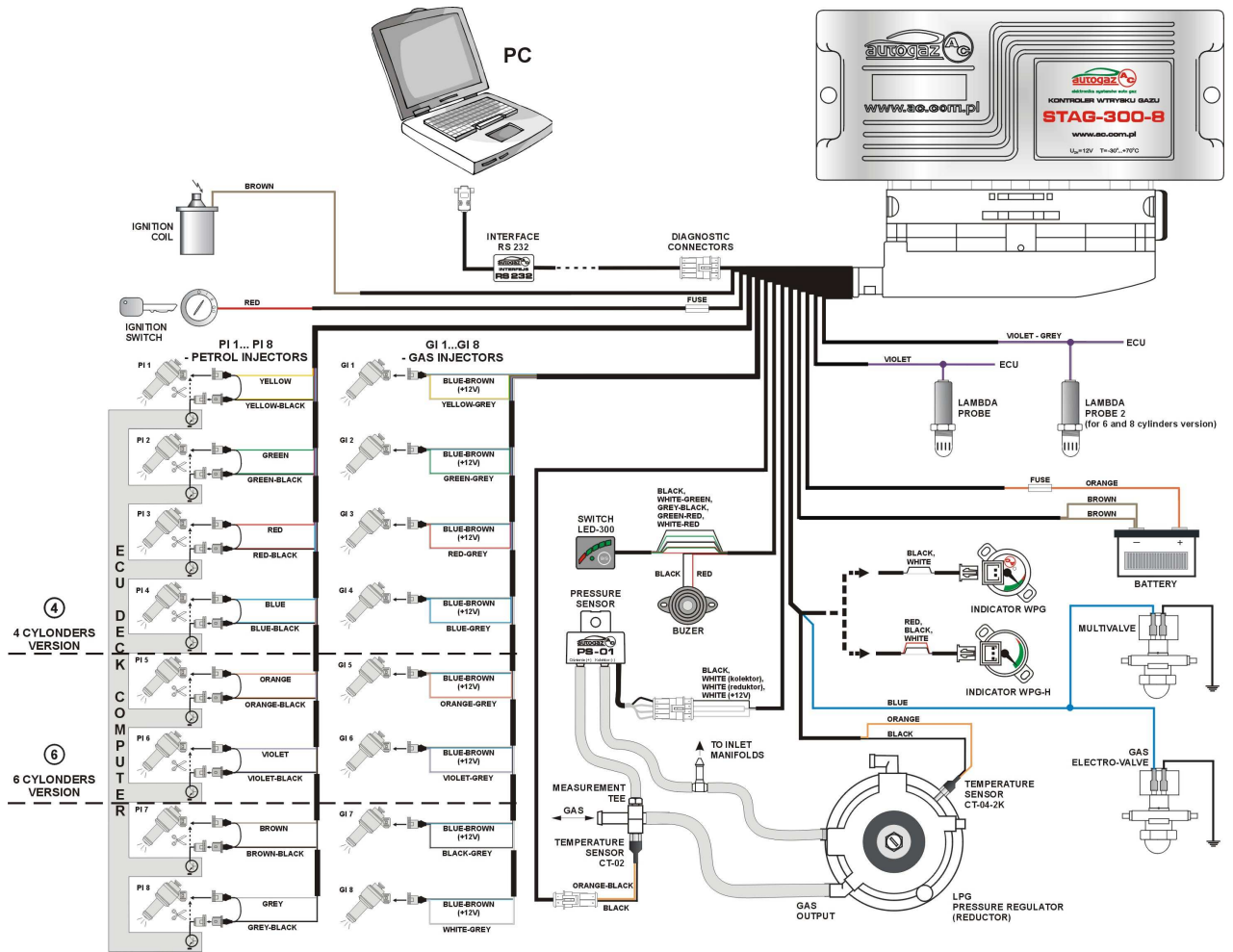
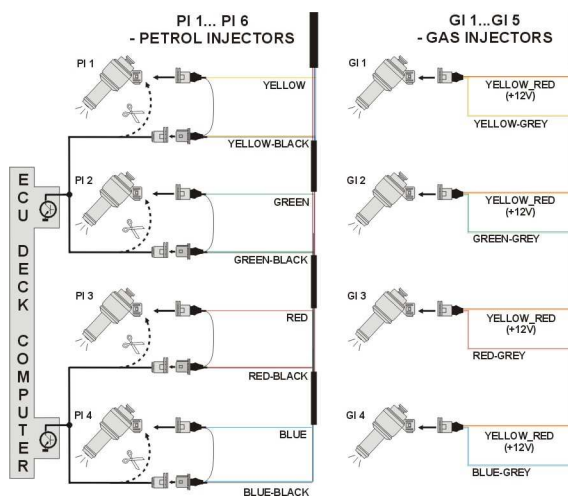


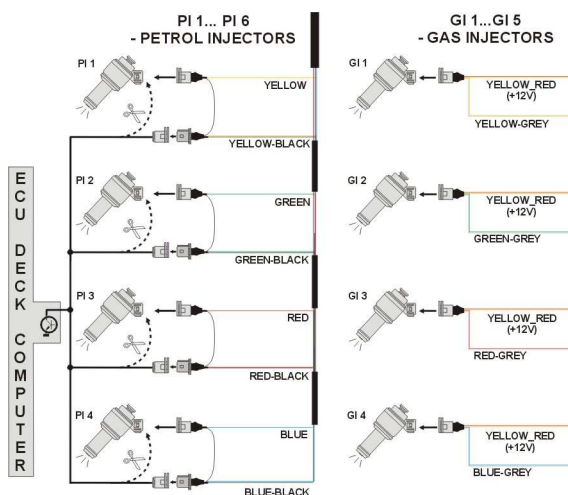
Fig. 2 Stag-300 Diagram of connection to the vehicle wiring.

1.3. Connection of wiring to the semi-sequential systems.



Rysunek 3 Diagram of connection to the semi-sequential systems.

1.4. Connection of wiring to the full-group systems.



Rysunek 4 Diagram of connection to the full-group systems.

1.5. Selection of pressure regulator

Connection of wiring should be performed according to the connection diagram (Fig. 1, Fig. 2). During connection of the Stag-200, Stag-300 sequence gas injection system pay special attention to proper selection of a pressure regulator for given engine power and injectors' nozzles. Improper selection of the pressure regulator in relation to engine power will cause that when the LPG delivery is high (i.e. the throttle fully opened) the pressure regulator will be not able to ensure nominal LPG pressure and the pressure in the system will drop. If the LPG pressure will drop below the minimum value set at the controller the system will switch over to supply with gasoline.

1.6. Selection of injectors' nozzles

Selection of injectors' nozzles depends also on the engine power. The injectors' nozzles should be selected in such way so that at high engine load and high rpm the multiplier for given injection time should be close to 1. Most engines have injection times amounting to ca. 15 [ms]. The table below contains list of nozzle diameters depending on power for 1 cylinder. To read out the nozzle diameter for given engine correctly it is necessary to divide the engine power by number of cylinders.

Nozzle diameter [mm]	Reducer pressure 1 [bar]	Power for 1 cylinder [KM]
1,8-2		12 – 17
2,1-2,3		18 – 24
2,4-2,6		25 – 32
2,7-2,9		33 – 40
3,0		41 – 48

Pay special attention that the figures in table are only rough values and in some cases may not agree with real ones.

Such situation can appear in e.g. vehicles fitted with semi-sequential or full group (all injectors activated simultaneously) injection. In such vehicles nozzle diameters will be smaller than these given in the table due to the fact that in such type of LPG supply control the volume of supplied LPG is greater than for full sequence – twice for the semi-sequential and four times for full group injectors.

2. Description of the Ac Gas Synchro diagnostic program

2.1. Connection of the controller to a PC

If the controller is connected correctly, connect the Stag-200, Stag-300 to a PC with installed Ac Gas Synchro diagnostic program with help of an RS interface manufactured by the AC BHZ. **Prior to starting the program turn the ignition** (supply the controller with voltage); this is necessary because after ca. 10 minutes without power supply from the ignition switch the controller goes to the sleep mode, where the communication is impossible. After start of the program – if the serial port COM is selected properly – the controller should establish connection with the diagnostic program, what is signalled with the message “Connected” in the left lower corner of the program window. The **Parameters** window is shown at the Fig. 5.

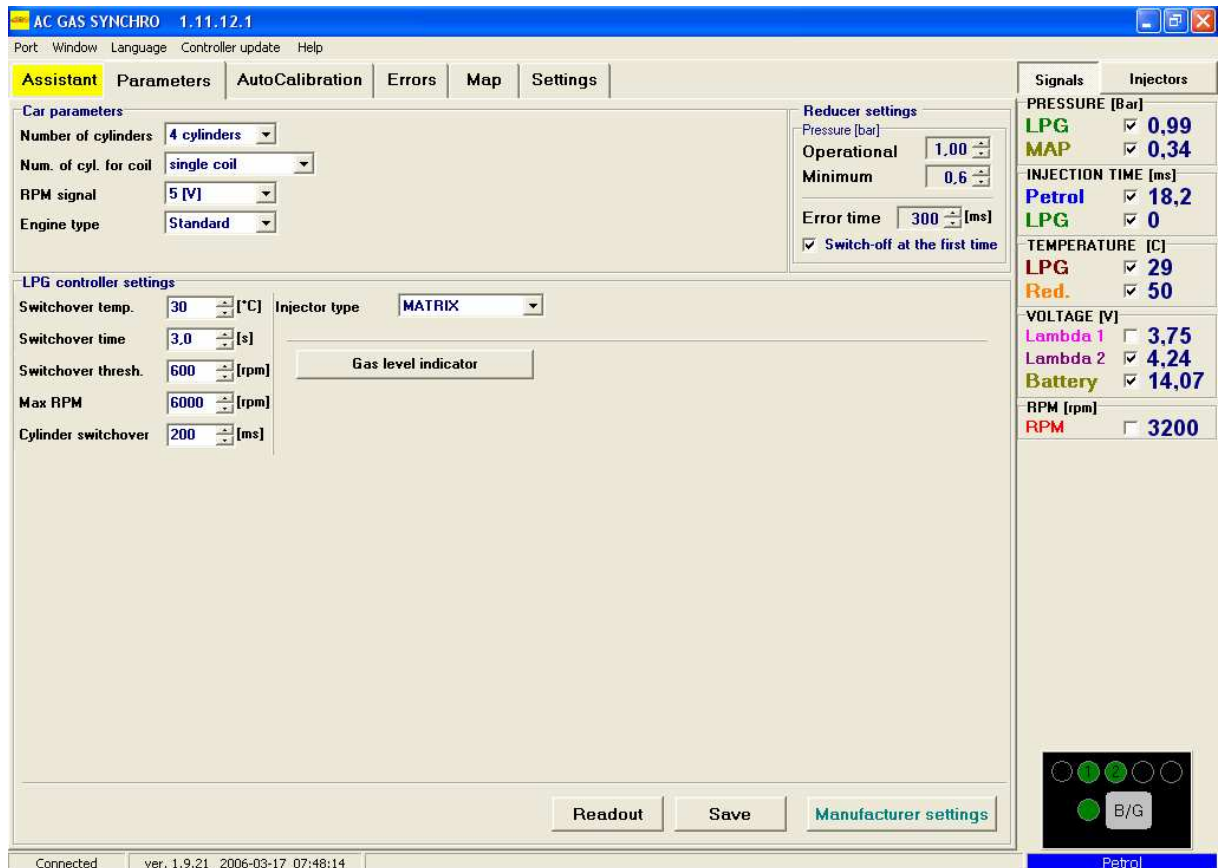


Fig. 5 Parameters window

If the message „Controller error” appears and in the left lower corner appears the message „No connection” select another port from the **Port** menu at the top of the screen.

2.2. Version of the AC GAS SYNCHRO diagnostic program

When the diagnostic program is started, at the bar in the top of the screen is visible the program version number. The Fig. 5 shows the program version 1.11.12.1 .

2.3. Main menu

Main menu contains following options:

- *Port* – for change of the communication port, connection, disconnection from the controller
- *Window* – selection of program window
- *Language* – selection of language
- *Controller update* – update of the controller software
- *Help* – information about the program

2.4. Controller parameters

In the bottom of the screen is visible the version number of the program installed in the controller (Fig. 5), after the figure „ver.” is given the program version, where:

1.9 - PCB version number for the controller (necessary for controller update)
21 - Number of software version installed in the controller
2006-03-17 07:48:14 – Date and hour of software compilation for this version

The Parameters window contains three groups of settings. The group **Vehicle parameters** contains:

- *Number of cylinders* – number of engine cylinders
- *No. of cylinders for one ignition coil* – number of cylinders for one ignition coil
- *Revolutions signal* – revolutions signal source, 12 V – signal from the ignition coil, 5V – signal from the vehicle’s computer
- *Engine type* – engine type, Standard – standard engine without supercharger, Turbo – supercharged engine

The group **LPG controller settings** contains following parameters:

- *Switchover temperature* – the LPG pressure regulator temperature required for controller’s switchover to LPG
- *Switchover time* – time after starting the engine, when the controller can switch over to LPG.
- *Switchover threshold* – engine rpm required for the controller to switch over to LPG. For the rpm threshold <700 switchover occurs at idle run.
- *Max rpm* – engine rpm required for the controller to switch over to gasoline
- *Cylinder switchover* – time between switchover of subsequent cylinders; when the setting is e.g. 200[ms] the switchover of a 4-cylinder engine from gasoline to LPG or from LPG to gasoline will last 4*200[ms]. This option works regardless of the fact that the gasoline injection system is the so-called full sequence or not.
- *Injector type* – type of the LPG injector. **In the case of controllers with the software version 18 or lower, if the injectors menu appears with following items: other, matrix, koltec, the matrix injector will be selected by default, what is quite common symptom of controller’s operation; this setting must not be changed.**

The push button “LPG level indicator” is designed for setting of activation threshold of the LED at the switchboard and for selection of LPG level sensor, what is described further below.

The group **LPG pressure regulator parameters** contains following items:

- *Operational pressure* – LPG pressure during controller’s calibration
- *Minimum pressure* – lowest LPG pressure causing switchover to gasoline.

- *Error time* – time, when the LPG pressure is lower than the minimum value, required for switchover to gasoline.
- *Switch-off at the first time* – car will switchover to gasoline at the first time when pressure is lower than minimum.

In the bottom of the window there are three push buttons with following functions:

- Readout – readout of controller settings from a file
- Save – saving of controller settings to a file
- Default – restoration of default (manufacturer's) controller settings

2.5. Signals, injectors, switchboard

On the right side of the window (Fig. 5) there is the window **Signals** and the window **Injectors**. The window **Signals** contains following signals measured by the controller:

- *LPG pressure [bar]* – LPG pressure value (pressure difference between the pressure regulator and the suction collector)
- *Pressure MAP [bar]* – pressure value within the suction collector (the absolute pressure value)
- *Injection time gasoline [ms]* – injection time for gasoline (for the first injector)
- *Injection time LPG [ms]* – injection time for LPG (for the first injector)
- *LPG temperature [°C]* – LPG temperature at the pressure regulator output
- *Pressure regulator temperature [°C]* – temperature of the fluid within the pressure regulator
- *Lambda 1 voltage [V]* – voltage at the lambda 1 probe
- *Lambda 2 voltage [V]* – voltage at the lambda 2 probe
- *Power supply voltage [V]* – voltage at the controller's power supply
- *RPM [rev/min]* – engine revolutions

All described signals are visible also on the oscilloscope. It is possible to switch out given signal so that it is not visible on the oscilloscope. For this purpose click on the signal's value to mark it; when marked, the signal's colour can be changed.

To enter the **Injectors** window press the push button **Injectors**.

Signals	Injectors
Petrol injection [ms]	
Inj. 1	18,3
Inj. 2	18,3
Inj. 3	18,3
Inj. 4	18,3
Inj. 5	18,3
Inj. 6	18,3
Inj. 7	18,3
Inj. 8	18,3
LPG active	
1	<input checked="" type="checkbox"/>
2	<input checked="" type="checkbox"/>
3	<input checked="" type="checkbox"/>
4	<input checked="" type="checkbox"/>
5	<input type="checkbox"/>
6	<input type="checkbox"/>
7	<input type="checkbox"/>
8	<input type="checkbox"/>

Fig. 6 The Injectors window.

The window shows times of gasoline injection for individual injectors. Below are shown active LPG injectors. This option is designed for switching out individual LPG injectors. For example, in a 4-cylinder engine usually 4 LPG injectors are active (green colour). To switch out given injector click on its image, what causes switching out of this injector and switching on the adequate gasoline injector. This option makes possible diagnostic of mechanical damage of an injector. When the voltage at the ignition switch is

off all LPG injectors become on.

Below the **Signals** and **Injectors** windows there is the LED switchboard.

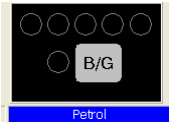


Fig. 7 The LED switchboard

In the switchboard is situated the switch for change of fuel type. The LED nearby the switch informs about controller’s working mode:

- Off – gasoline
- On – LPG
- Blinks – automatic mode

Under the switchboard is shown the present fuel type. In the top of the switchboard there are 5 LEDs informing about the LPG level in the tank. By clicking one of four LEDs we enter the LED threshold setting window.



Fig. 8 LED threshold setting

In this window we can set voltage causing switching on of individual LEDs. We select also the LPG level sensor type. The LPG level voltage is also displayed.

2.6. Auto-calibration

The auto-calibration window is designed for calibration of a vehicle at idle run. When the engine is on and the lambda probe works we switch the auto-calibration on. During auto-calibration the engine should work at idle run. Switch off the air conditioning and lights; do not turn the steering wheel. The controller switches over from LPG to gasoline a few times. When the calibration is finished the controller displays message that the calibration has finished successfully. During calibration may appear following messages:

- Engine rpm to low – engine rpm are to low – check the setting “Number of cylinders for one ignition coil”
- No injection at the injector: - no signal at the gasoline injector – check connection of emulator’s bundle.
- Collector pressure [bar] incorrect – the collector pressure may be incorrect – check settings of the collector pressure sensor.

2.7. Oscilloscope



Fig. 9 Oscilloscope

When the bookmark **Auto-calibration, map** is selected the oscilloscope is visible. The oscilloscope displays all signals described in 2.5. Visible control

push buttons have following functions (from l to r):

- Oscilloscope start
- Oscilloscope stop
- Save current oscilloscope
- Load oscilloscope
- Decrease number of displayed points (only for graph load)
- Increase number of displayed points (only for graph load)

If the controller works with LPG, in the top of the oscilloscope appears a continuous line of the same colour as the LPG ignition time line.

2.8. Errors

In the window **Errors** appears the field:

- continuous signal for errors – marking of this field activates acoustic signalling of an error; the signal must be switched off by the user. If this option is off the acoustic signal sounds only for previously set time.

The window **Current errors** contains current errors recorded by the controller; the window **Recorded errors** displays errors recorded during controller's operation.

During operation may appear following errors:

- Injectors error – no LPG injector or injector damaged
- Voltage error – voltage at the controller power supply drops below 9 [V]
- LPG pressure too high – the LPG pressure is twice higher than the operational one for 5 seconds (troubles with the pressure regulator)
- LPG pressure too low – the LPG pressure drops below the minimum value for previously set time.
- Data Error, check settings ! – controller detect error in settings, check all settings.
- Brak wtrysku benzyny – controller detect no petrol injection in one or in a few petrol injector.

In the **warnings** window may appears following warnings:

- **LPG injectors full open !!, - Check lambda sensor in full engine load – LPG injection loop i.e. during LPG injection occurs next injection. If during warning's appearance the lambda probe is "rich" then the warning can be ignored, otherwise replace injector nozzles with greater ones, what causes decrease of the multiplier.**

In the bottom of the **Errors** window there is the button "Delete errors" designed for deletion of recorded errors.

2.9. Map

The windows **Map** contains maps of the LPG controller:

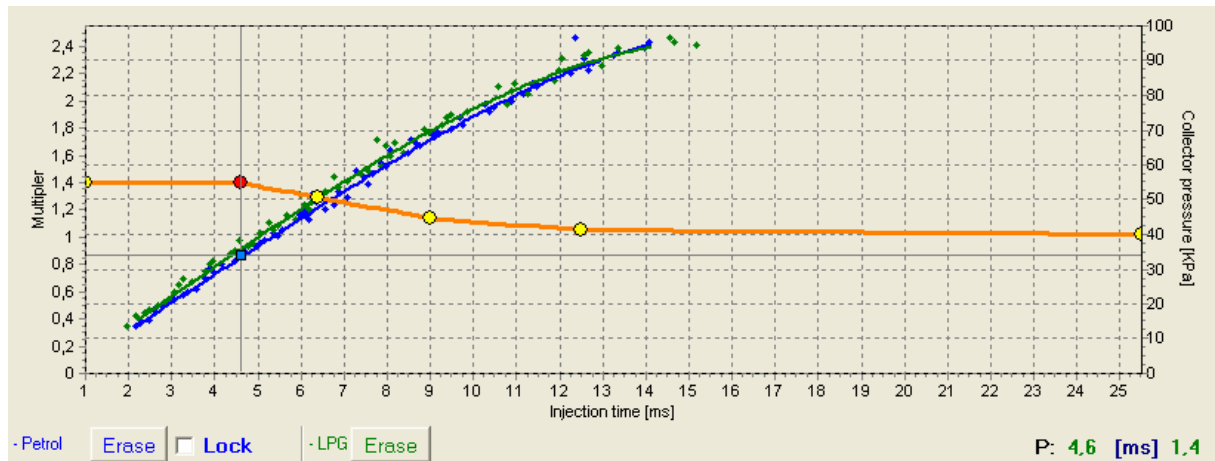


Fig. 10 Controller map

The Fig. 10 shows 3 maps:

- Multiplier map - orange
- Gasoline injection time map (with gasoline)- blue
- Gasoline injection time map (with LPG) - green

The multiplier map is coloured orange. The left axis of co-ordinates (i.e. Multiplier) and the lower axis of co-ordinates (i.e. Injection time in [ms]) is subordinated to this map. The multiplier map is designed for setting of the multiplier for given gasoline injection time. Points situated at the map (yellow) are used for setting of the multiplier. After auto-calibration at the map appear 2 extreme points and additionally 4 points in the centre of the map. To shift a point, first mark it by a click. The value of marked point is displayed in the lower right corner of the map. Points can be shifted on the map with following keys:

- ← - arrow left – shifts the point left (change of injection time for given point)
- → - arrow right 0 shifts the point right (change of injection time for given point)
- ↓ - arrow down – decrease of the multiplier for given injection times
- ↑ - arrow up - increase of the multiplier for given injection times
- „Insert” (when a point is active) or left mouse click – adds new point
- „Delete” – deletes a point from the map
- „Page Up” – shifts the map upwards
- „Page Down” – shifts the map downwards
- „Ctrl” + ← , or „Ctrl” + → change of the active point

With „Shift” pressed the shift is multiplied by 10 (quicker shift). If no point of the map is active, arrows ↑ ↓ shift the entire map.

Besides of the multiplier map, the window contains two other maps. The blue map is the map of gasoline injection times (with gasoline). The right (Collector pressure [MPa]) and the lower (Injection time [ms]) axes are subordinated to this map. The map consists of blue points. After collection of data the controller draws the map with a continuous line. The same procedure concerns the so-called LPG map i.e. the map of gasoline injection times (with LPG), which is of green colour.

When the controller collects two maps i.e. gasoline and LPG maps, it is possible to enter the bookmark **Deviation**, where the red line shows difference between gasoline and LPG.

Depicted map window (Fig. 10) shows also the square blue marker, which position changes depending on the collector pressure and gasoline injection times. It is very useful during collection of the map because it shows at which load and injection time works the engine.

At the map there are also the buttons “Delete” used for erasing of gasoline and LPG maps. Nearby the buttons is situated the selection field “Lock”, which is designed for locking of the gasoline map after its collection i.e. the controller having collected the gasoline map (when the map is drawn with a continuous line) will not modify it.

2.10. Assistant

Using the option **Assistant** it is possible to set all options required for setting of the controller, including the auto-calibration.

2.11. Controller settings

The window **Controller settings** allows to change the sensor type for:

- LPG pressure (default PS-01)
- Collector pressure (default PS-01)
- Pressure regulator temperature (default CT-04-2K)
- LPG temperature (default CT-02-2K)

Also available is here the option:

- Controlled gasoline injection + - gasoline injectors controlled with positive pulses (in some vehicles injectors are controlled with positive pulses and not – as for most cases – with negative ones).

2.12. Controller update

To update the controller it is necessary to connect the controller with a diagnostic program and switch off the engine. Select from the main menu the option “Controller update”. On the screen appears the window **Controller update**. The frame “Controller parameters” displays information about the software version. Press the button “Load update” and select the update file adequate to the PCB (board) controller version. The PCB controller version is defined by first two digits of the version code i.e. the controller with the version code 1.6.18 has:

- 1.6 – board (PCB) controller version
- 18 – controller software version

For above example the update file should be marked 1.6.x, where x means version of updated software.

Having loaded the update file press „Update”. When the update progress bar reaches 100 % the controller will disconnect for a moment and then should connect anew. In the bottom of

the screen should be visible the new number of controller software version compatible with the loaded update file.

If in the course of update occurs an error and there is no possibility of connection with the controller, then it is necessary to **(for the 19 firmware version and older)**:

- Close the diagnostic program
- Switch the ignition switch off
- Disconnect the RS-232 interface from the PC
- Start the diagnostic program (the program sends the message: no LPG controller)
- Connect the interface to the PC
- Remove the main fuse and put it back (the LED at the switchboard should come on)
- Before the LED comes off press the button at the switchboard (the led should come off)
- Enter the options of controller update, select the update file and press "Update"
- When the update progress bar reaches 100 % the controller should connect automatically to the diagnostic program.

(For the 20 firmware version and newer):

Diagnostic program will detect error at the controller update and after connecting with controller will open controller update window. You should repeat update process once again.

3. Programming of the Stag-200, Stag-300 controller

Programming of the Stag-200, Stag-300 controller can be performed with help of two methods:

- **Programming with help of gasoline and LPG maps.** *See 3.1 to 3.4*
- **Manual setting of the controller.** *See 3.5*

Programming with help of LPG and gasoline maps can be divided into following stages:

- Auto-calibration of the Stag-200, Stag-300 controller
- Collection of the map of gasoline injection times with gasoline (gasoline map)
- Collection of the map of gasoline injection times with LPG (LPG map)
- Check if both maps agree; verification of deviations

3.1. Auto-calibration

Prior to starting the auto-calibration start the engine and wait until the lambda probe starts to work. During auto-calibration the engine should work at idle run; do not increase rpm, switch off air-conditioning and lights, do not turn the steering wheel, because this may cause erroneous action of the auto-calibration. During auto-calibration watch carefully gasoline and LPG injection times. If LPG injection times are shorter than gasoline injection times, the injector nozzles may be too great and should be replaced with smaller ones. When the auto-calibration is finished on the multiplier map should appear 2 extreme points and 4 points in the middle of the 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 1.2 and 1.6; if the value is greater than 1.6 then longer times of gasoline injection i.e. greater load and high rpm may cause overlapping of injection times i.e. during the LPG injection comes the next one (loop of injection times). In such case the controller sends the error message „injection time too long”. **However, in such case it is necessary to check 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 gasoline injection map with gasoline (gasoline map)

Having made the auto-calibration switch over the vehicle to gasoline and drive ca. 4 km to collect the gasoline map. During collection of the map try to drive without changing gears e.g. at the 4th gear and in such way so that the lambda probe “works” i.e. changes its mode from weak to rich. During collection of the map should appear blue points. To collect the map quicker select vehicle load in such way so that collect points in places, which are empty until now. **Collection of maps is performed without participation of the diagnostic program, thus can be done with disconnected computer.** However, while performing this action with connected computer and diagnostic program we can do it much quicker and we see accurately, what happens to the vehicle. When the controller recognises that the number of collected points is sufficient, the map will be drawn with a continuous line. In this very moment collection of the gasoline map is finished.

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

Having collected the gasoline map we switch the vehicle to LPG and start to collect the LPG map in the same way as for the gasoline map. The LPG should be collected in the same road conditions and with similar loads as for the gasoline map. The LPG map is drawn with green points. Having collected sufficient number of points the map will be drawn with a continuous line. If the controller is properly set (multiplier characteristic selected properly) the gasoline and the LPG maps should agree. If the maps do not agree, the multiplier characteristic should be corrected in the points, where the maps do not agree (the lower axis of co-ordinates for injection times). During collection of the LPG map, if the computer is connected and the diagnostic program started, we can immediately correct the multiplier characteristic when we see that collected green points do not agree with the gasoline map. It is even strongly recommended, because if the multiplier characteristic differs strongly from the required one, the controller starts to switch over and – in the extreme case – can activate the signalling lamp “check”. During current correction of the multiplier characteristic the points of the LPG map should agree with the gasoline map. If we manage to agree both maps, we can affirm that the characteristic is properly selected.

3.4. Check if maps agree; verification of deviations.

Having collected the gasoline and the LPG maps (both maps drawn with continuous lines) we can check the deviation between the gasoline and the LPG maps. In the window **Map** there is the button “Deviation” situated on the right. When pressed, appears the deviation graph drawn with red line. If the deviation fits the range $\pm 10\%$, we can assume that the controller is programmed correctly; otherwise the multiplier characteristic should be corrected in points, where maps do not agree.

3.5. Manual setting of the controller.

The controller can be also set manually; this type setting – if performed with proper skill – can last shorter than the method described above.

We start the setting of the controller – as for the previous method – with auto-calibration (it is indispensable for correct operation of the controller, see 3.1). Then, if the auto-calibration has been finished successfully and multiplier values for the calibration point are correct, we switch over the vehicle to gasoline and drive it for the test. The setting of the multiplier characteristic should be performed as follows:

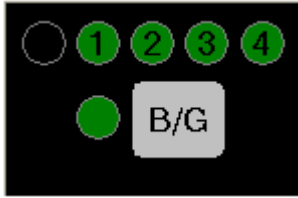
We drive the vehicle using gasoline, we make efforts to keep the constant engine load i.e. gasoline injection times should be stable. We match the load so that the gasoline injection time was e.g. ca. 5 [ms]. Evaluation of gasoline injection times will be easier with help of the blue marker, which vertical position at the horizontal axis depends on injection time. Now we switch over the vehicle to LPG and watch, if the blue marker will not change its position at the injection time axis i.e. the gasoline injection time has not changed. If the gasoline injection time became shorter (the marker has shifted to the left), this means that for given gasoline injection times the multiplier is too high (the mixture is too rich). In such case correct the multiplier – in our case for the time 5 [ms] - downwards. If after switchover from gasoline to LPG the marker goes to the right, this means that the mixture is too weak and the multiplier map should be shifted upwards for given injection times.

The procedure described above should be performed for a few injection times beginning from the calibration point as far as to injection times for great load. We can check the multiplier map e.g. every 2 [ms] beginning from the calibration point. If necessary, we can add a point at the multiplier map to set it more precisely.

After execution of described manual setting both maps – gasoline and LPG – should agree.

4. Operation of the LED switchboard and acoustic signals (user manual)

4.1. LED switchboard



The LED switchboard consists of:

- The LED line indicating the LPG level
- The LED indicating the fuel type
- Push button

LED line – displays current LPG level in the tank after switchover to LPG. Four green LEDs mean that the tank is full, the red one means reserve.

LED – shows current operational mode:

- Off – the vehicle uses gasoline
- Slow blinking (once a second) – waiting for the engine temperature
- Normal blinking (twice a second) – the controller in the auto mode (waiting for rpm required for switchover to LPG)
- Quick blinking (4 times a second) – controller error (switching off due to lack of LPG in the tank)
- On – the vehicle uses LPG

Push button – for change of fuel type

Programming of fuel type:

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

Caution:

In older controller software versions setting of the controller status is performed when the ignition key is turned on and engine off; then the set controller operation mode is saved. Fuel change when the engine works is just momentary and will not be saved.

4.2. Acoustic signals

The controller generates following acoustic signals:

- Triple acoustic signal – during switchover to gasoline if the LPG level in the tank is too low.
- Three short and one long acoustic signals – if a controller error occurs.