Instruction of connection and programming of the OSCAR-N OBD CAN controller

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OSCAR-N OBD CAN

Sequential gas injection controller of IV generation OSCAR-N OBD CAN was mainly destined for modern cars, which have technologically advanced OBD2 system. It might be also used in older types of cars. Thanks to its modern construction and highly efficient CPU it gives possibilities to fulfill strict emission exhaust norms, keeping the driving dynamic and performance identically as on petrol.

OSCAR-N OBD CAN gives possibility of making communication through digital serial bus CAN. It gives possibility of diagnosing OBD of original car's petrol ECU from the level of LPG controller's software.
Besides signals from original's petrol injectors controller uses additionally information from car's OBD system (like vacuum, signals from both lambda probes, short and long term fuel trims) to determine amount of gas needed in the particular moment. Controller reads the parameters of mixture's correctors mentioned above and adjusts gas injectors opening times, to make the „Short Time Fuel Trim'' and „Long Time Fuel Trim'' values oscillate between values expected by the car's manufacturer.

The advance of such solution is possibility of calibrating LPG settings to obtain almost identical characteristics of driving as on petrol. Controller reads the mixture correctors all the time and automatically adjusts them to fulfill the EURO emission standards.

In OSCAR-N OBD CAN controller the unique algorithms of controlling LPG injectors has been used. Injection opening time for each gas injector is being calculated individually, in real time, basing on injection opening time of petrol injector corresponding to it. Thanks to that solution efficiency and dynamics of driving on gas are practically identical like on petrol. Another advantage of that solution is the fact that controllers works without any problems with car's engines like HEMI (part of cylinders are being temporarily turned off during work), Valvetronik (constant value of vacuum in the inlet manifold) and cars which are having opening time differences between individual injectors (Subaru).

New controller advantages:

1) Possibility of connecting to CAN bus thought diagnostic plug (in cars which are having such possibility).
2) Automatically making corrections of LPG injection opening time on base of parameters read from original car OBD (in real time).
3) Calculation of injection opening time individually for particular gas injector basing on opening time of adequate petrol injector.
4) The smallest device on the market of sequential injection gas system, which can control up to 8 cylinders. Aluminum case dimensions are: 130 (length) x 100 mm (width) x 28 mm (thickness).
5) The fastest digital signal processor ever used in sequential injection gas controller. It runs at frequency 120MHz.
6) Automatic detection of petrol injection type signal.
7) Holding up working on gas during temporary lack of RPM signal.
8) Possibility of using temperature sensors with different impedance.
9) Possibility of connecting and reading signals from two separate lambda probes.
10) built in anti-supertensions protection.
11) Advanced digital filtration of all input signals.

New software advantages:

1) Possibilities of reading original OBD parameters from CAN bus, modification of these parameters and erasing OBD errors.
2) Possibility of collecting data for advanced mapping (fine tuning) without necessity of having PC connected to the controller.
3) Extended possibilities of setting up the controller: calibration on idle, modifying the injection opening time regarding vacuum in the inlet manifold, regarding to RPM and regarding to gas pressure rapid changes.
4) Upgraded algorithm of autocalibration at idle (each cylinder calibrated individually).
5) New algorithms of preheating LPG injectors.
6) New algorithms of preventing car's engine from stalling during exits from „cut-off" (for the turbocharged cars).
7) New algorithms which allows to operate in cars where petrol injectors are fully opened on high revs (mainly tuned cars).
8) Wide range of compatible gas injectors.
9) Automatic detection of petrol injectors controlling type (sequence / semi sequence / full-group).
10) Possibility of setting distance remaining to service inspection.
11) Possibility of setting minimal injection opening time value of petrol injector which should be directed to LPG injector.
12) Possibility of setting minimal LPG injector opening time.
13) Possibility of handling the cars controlled with +12V signal configured from the software.
14) List of car models which are capable to connect with OBD system through CAN bus.
15) Very simple and user-friendly software with advanced options (available on password) and built in gas injector nozzle calculator.
16) Possibility of remote help in setting the parameters and calibration of the car through the Internet by our Technical Department.

1. Installation of OSCAR-N OBD CAN sequential gas injection system

1.1 OSCAR-N OBD CAN sequential gas injection system installation diagram
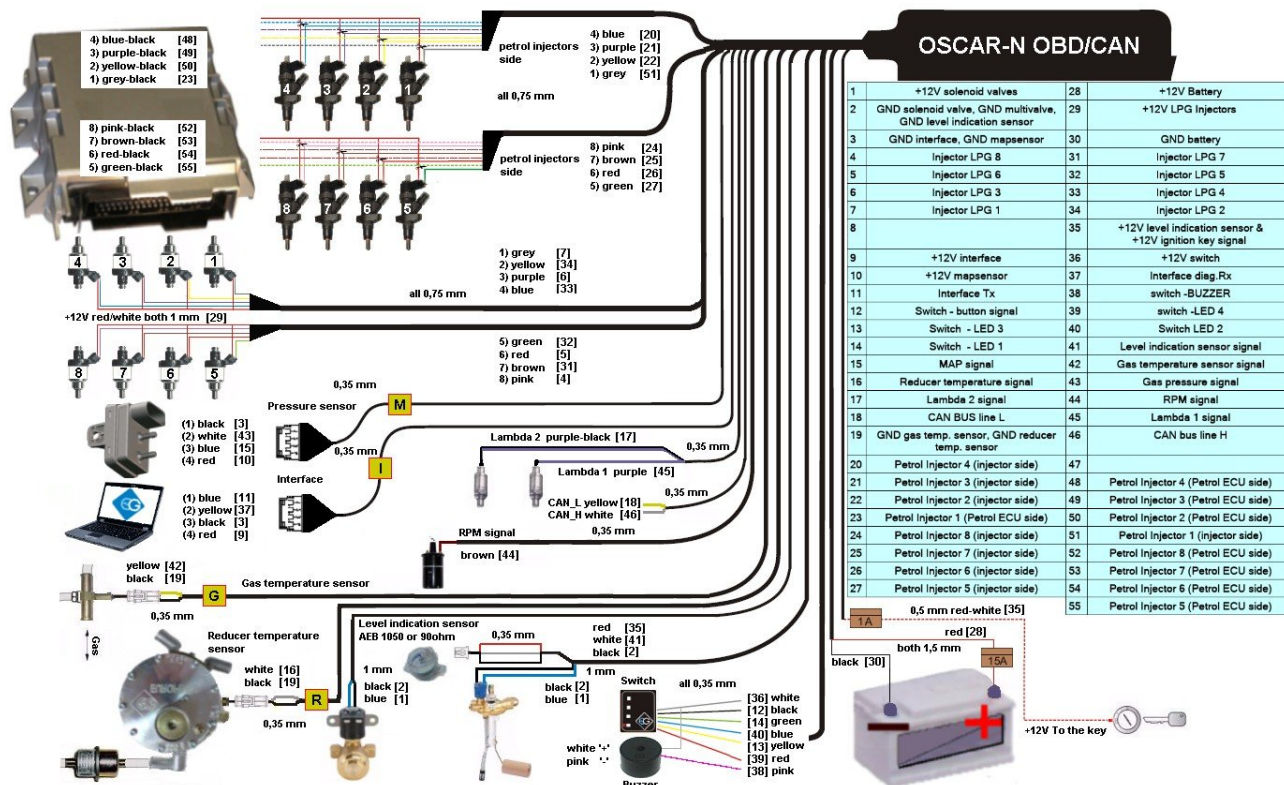
1.2. Proper installation of OSCAR-N OBD CAN ECU

During the installation of OSCAR-N OBD CAN sequential gas injection system it is suggested for the wire set to point downwards. It is also suggested that it should be placed in such a way to avoid the negative impact of high temperature and humidity.

1.3. Selection of pressure regulator

Connection of wiring should be performed according to the connection diagram. During connection of the OSCAR-N OBD CAN 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. For most of the cars the pressure regulator should be regulated close to 1 bar (You can observe the this value in OSCAR-N OBD CAN software).

1.4. Selection of injectors' nozzles diameter

ATTENTION!

Injection rail type RAIL, VALTEK should be calibrated with a special calibration device before installing it in the car. Calibration is needed for checking the piston stroke which must be

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equal for all of the cylinders. For shorter times of injection (2,0 – 2,6 ms) it is recommended setting smaller piston stroke which should be between 0,40 – 0,45 mm. For longer petrol injection timings (3,0 – 4,0 ms) the piston stroke should be between 0,45 – 0,65 mm.

Selection of injectors' nozzles diameter 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 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's pressure 1 [bar]	Power for 1 cylinder [HP]
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 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. For selecting the size of injectors adequate to engine horsepower injection nozzle calculator (built in the software) might be used.

2. OSCAR-N OBD CAN diagnostic program description

## 2.1 Choosing LPG or CNG work mode
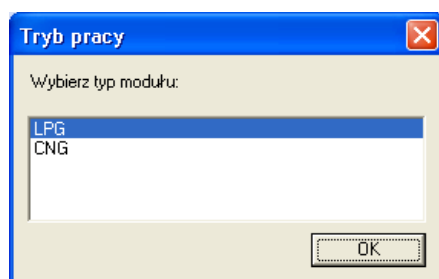
During every start of the software please choose the OSCAR-N OBD CAN ECU work mode **LPG** or **CNG** (depending on the type of installation in the car).

2.2. Connecting controller to the PC

If the all the connections are made correctly, connect OSCAR-N OBD CAN to the PC with installed OSCAR-N OBD CAN diagnostic program, by using EUROPEGAS OSCAR-N interface (RS 232 or USB type). **Before starting the program please turn on the ignition and start the car to supply the controller with +12V voltage.** This is necessary because without having power supply the controller goes to the sleep mode, where the communication is impossible. That situation will be signalised as connection error. In this situation software will propose to work in „Demo" mode, which will simulate the work of software as the controller on working car would be connected to the PC.
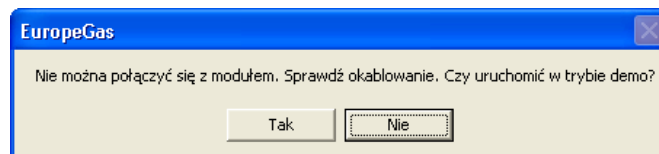
After starting the software automatically is searching all the COM ports. When it finds OSCAR-N OBD CAN controller on one of the ports the communication the communication will be established and software is ready to work. That fact is signalized by "Connected" message in the left upper corner of the program main window. When the communication has been lost the message will change to „No connection". In demo mode the message „DEMO" will appear.
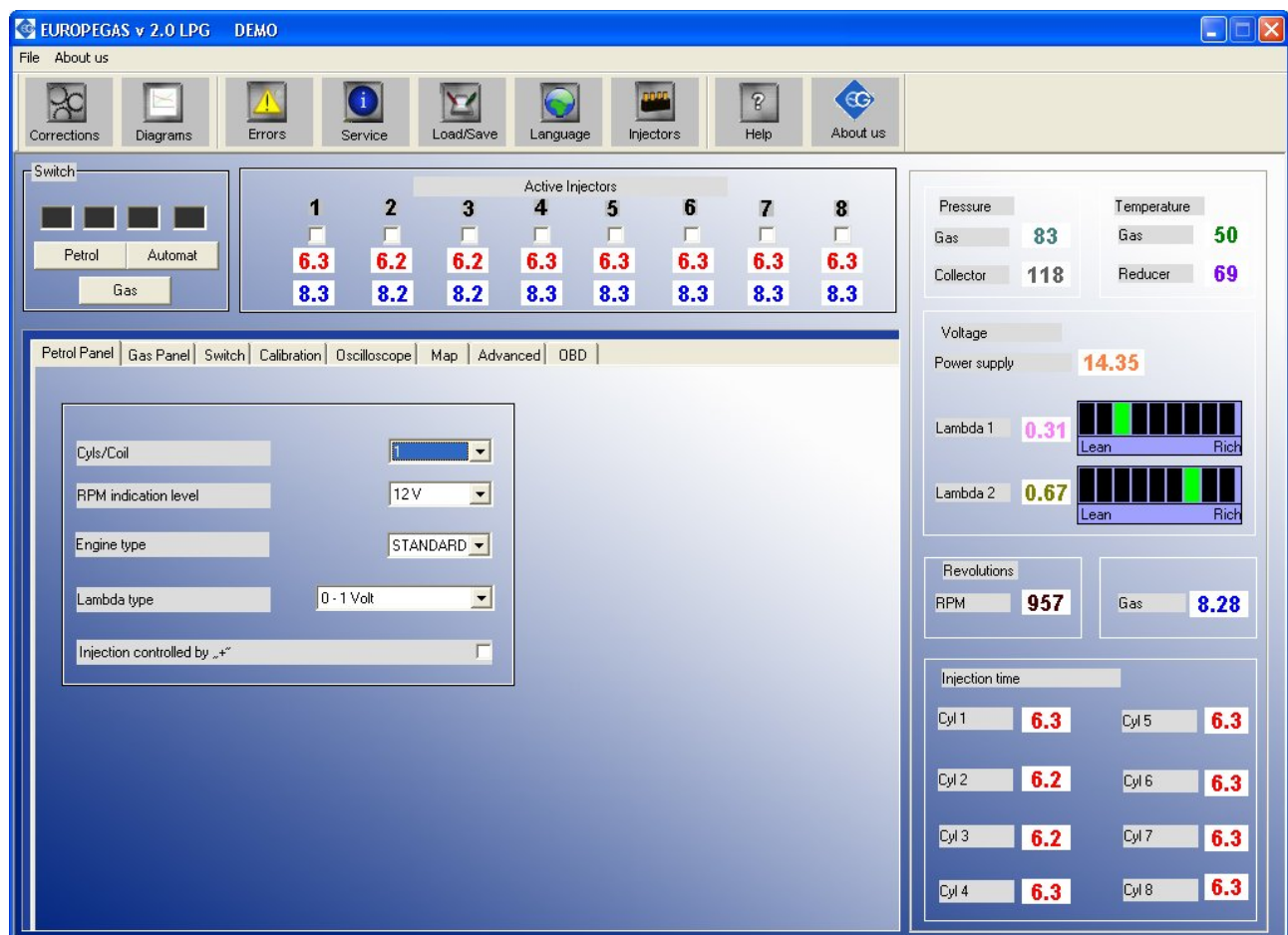
2.3. Main window content

On the top of the main window there is bar with following icons:

Corrections -this option let us to change the time corrections/adjustment (in ms) of particular gas injectors. Thanks to that option it is possible to correct the air/fuel mixture for particular cylinders. Option useful especially for „V" type engines.

***Diagrams* -**enlarges the calibration map and oscilloscope bookmarks to full size of main window

***Errors* -**here we could read and erase list of errors registered in controllers memory.

***Service* -**here we can read the ECU information about the controller like: time of work on petrol and gas, date of last settings modification, service code of PC on which settings modification has been made, time lasting to service inspection etc.

Load / Save -makes possible to read or write from/to *.xset file actual controller's settings, read manufacturers setting and update firmware.

***Languages* -**chooses the language version of software's interface

***Injectors* -**Calculator of gas injectors nozzles for particular car. It bases on power of the engine (in HPs), number of cylinders, injection type and type of fuel (LPG or CNG)

***Help* -**Opens folder which contains controller harness installation diagram and this installation manual in electronic form.

About us -Information about EUROPEGAS Sp. z o.o. company

Between the icons and Panels , on the left top side of the window, there are following groups:

"Active injectors" group - here we can turn off / on active LPG injectors which should be inactive / active during work on LPG. If You disable separate injector by clicking with left mouse button on the tick under the number of injector the adequate petrol injector will start working in its place, while the rest of the cylinders will be working on LPG. This option is very useful for diagnostic purposes. After turning off the ignition on next changeover to gas all gas injectors will be active automatically.

Below the ticks of the active injectors You can find the injection times on petrol of adequate **petrol injectors** (red colour) and calculated **gas injectors** opening time (blue colour) no matter on what type of fuel car works in the moment. The values are read and calculated in real time for each injector.

"Switch" group -the four squares always show the current gas indication level which is shown on the switch in the cockpit. The Gas / Petrol button is used for instant changeover between both fuels. The Auto mode turns controller in auto mode. It means that car will changeover to gas automatically after 10 seconds (3 when "Fast Mode" is active) from fulfilling all the values required for changeover i.e. temperature, RPM level, pressure etc. When the controller is in Auto mode the red diode flashes. When it is on petrol the diodes are off. When it is on gas the diodes are on, showing actual gas level indication set in the software.

On the right side of the OSCAR-N OBD CAN program window You can find actual indication of most important system parameters: Gas pressure, vacuum in the inlet manifold, gas and reducers temperature, voltage of controllers power supply, RPM, time of opening of petrol and gas injectors. 2 horizontal bars visualize the readings of two lambda sensors (if connected). We can enlarge these parameters into full screen by pressing **F10** button twice. In the left bottom part of main window we can find the bookmarks, which groups the configurable system settings.

2.4. Setting the basic parameters

2.4.1. Petrol Panel
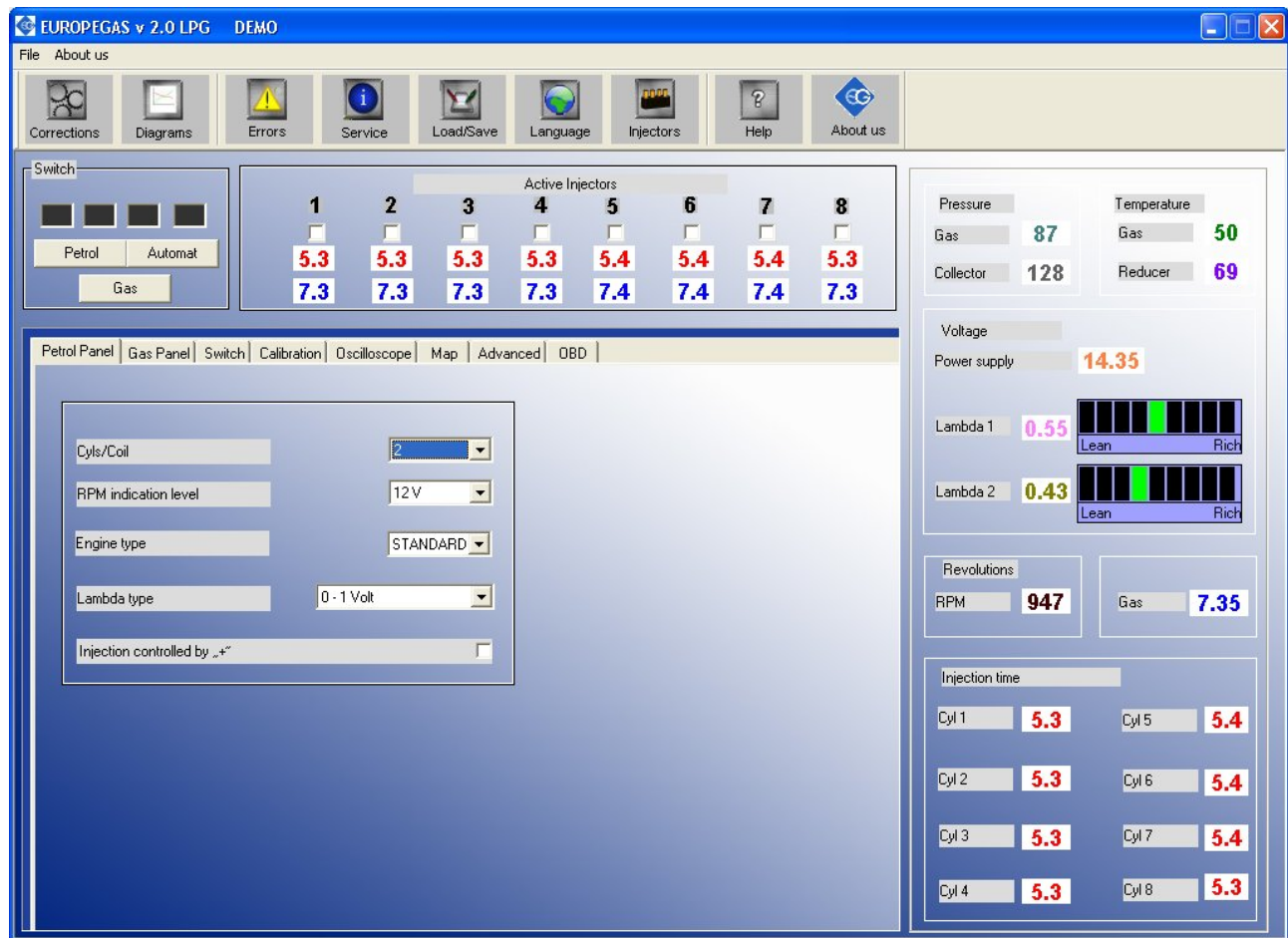
First step after connecting the interface from the computer to OSCAR-N OBD CAN ECU and turning on the program is to set the parameters from the Petrol Panel properly.

- *No. of cylinders for one ignition coil* – number of cylinders for one ignition coil (wrong selection will cause improper indication of RPM signal)

- *Revolutions signal* – revolutions signal source, +12 V – signal from the ignition coil, 5V – signal from the vehicle's ECU

- *Engine type* – engine type, Standard – standard engine without supercharger, Turbo – supercharged engine

- *Lambda Type* -we can choose from 4 types of lambda probe(s)

- *Petrol Injection controlled with „+"* - injection signals reading in systems where signals are "positive". In the most of cars injectors and being controlled by negative signal.

2.4.2. Gas Panel

Second step will be selecting the the proper injector rail type (for RAILGAS 3 Ohm injectors please select VALTEK/RAIL/H2000 3 Ohm), and type of sensors from Gas Panel. Selection of wrong sensor will cause improper sensor indication (i.e. wrong selection of gas temp. sensor may cause showing very low reducer temperature on the screen after the start of warm engine)

Usually in OSCAR-N OBD CAN there are following sensors attached. Standard type of sensors will be selected automatically after first controller connection with the PC (we can bring them up with restoring the manufacurer's settings anytime) :

- Pressure sensor – EUROPEGAS
- reducer temperature sensor – 2,2 kOHM
- gas temperature sensor -2,2 kOHM

Attention: In case of connecting reducer or temperature sensors from Magic Jet or Magic Compact reducer 4,7 kOHM sensors should be selected in field "*reducer temperature sensor* "

Calibration parameters are the parameters automatically set after autocalibration:

"Minimum pressure" is the lowest border of gas pressure value (standard value is 60kPa) which is being set during autocalibration. If the gas pressure will fall below this value, for time longer than value set in „Pressure error time", but the gas level in tank is bigger that 50%, controller will signalize that gas pressure is too low by signal of buzzer, changing over back to petrol and waiting for conditions to changeover back to gas (in „Auto mode"). It is being considered as temporary drop of pressure but not empty tank (there will be no „Low gas pressure" error stored in the controllers memory).

If the pressure drops down to 20kPa (it is being registered as empty gas tank) controller will signalize it by buzzer sound and flashing red diode, and will changeover to petrol permanently. However the user can press the switch changeover button and go back into "Auto mode" again.

"**Working pressure**" is the value of gas pressure during last autocalibration on idle.

2.4.3. Switch Panel

Next stage is the the **Switch** settings group which contains the following parameters:

TO GAS -parameters related with changeover from petrol to gas

- *Temperature* – pressure regulator minimum temperature required for controller's first changeover to LPG. Controller will be waiting with change over to LPG until the gas temperature will reach this level

- *RPM changeover level*-engine RPM required for the controller to changeover to LPG

- *Time* – additional time period which will be added to "changeover to gas" time from cold engine (if reducers temperature is lower than 50 C degree)

- *Changeover delay per cyl.*– time between changeover between subsequent cylinders. In example: when this parameter is set at 0.2 [s] the change over of a 4-cylinder engine from gasoline to LPG or from LPG to gasoline will last 4*0.2[ms]. This option works regardless of the fact that the gasoline injection system is the so-called full sequence or not. When this parameter is set to 0 [ms] all the cylinders will changeover to gas / petrol at the same time.

Attention: During autocalibration this setting is ignored by default. Default value of delay during autocalibration is 0 [ms]. **However if engine stalls during changover of all cylinders to gas at the same time we should increase this value (for example 1,5 s) and <u>check in the field "Use for autocalibration".</u>** It will cause changeover from petrol to gas and from gas to petrol with the entered time delay between subsequent cylinders changeover during autocalibration.

TO PETROL **-**parameters related with changeover from gas to petrol

- *Max RPM* – maximum level of engine's RPM at which car can run on LPG. Exceeding this level will cause changeover to gasoline. When the RPM will fall back below this level the car will go back to gas.

- *Load value* - petrol injection opening time value which, when will be exceeded simultaneously with *Max RPM* value, will cause temporarily the changeover to Petrol.

- *Pressure error time* – time period (in ms) while the LPG pressure could be lower than the "minimum pressure" value. If the pressure error will last longer than this time period the car will change over to gasoline from low gas pressure.

- *Min. gas RPM* -lowest border of engine's RPM at which the car could run on LPG. If the RPM will fall below this level the car will change over to gasoline.

- *Min. gas Temp. 3 C degree* – enabling this option makes the car to temporarily changeover to gasoline for 30 seconds period every time when gas temperature will fall down below 3 C degree (during this changeover the diode flashes constantly once per second). After 30 seconds, if gas temperature will be higher than 3 C degree, car changeovers back to gas.

Attention: Changeover to petrol due to exceeding above parameter's values (besides *Min. gas Temp. 3 C degree*) is being realized by closing the injectors, without closing the solenoid valves. Only visible effect will be temporary turning off the switch diodes (during drive on petrol) and turning them up again (during drive on gas).

Attention: After turning the engine on controller automatically goes into „Auto mode". It means that after turning on, after reaching desired reducer's temperature, controller waits 10 seconds to open the solenoid valves and to open the first injector. Additionally we need to add time of *Changeover delay per cyl.* to full changeover to gas. Controller goes to auto mode automatically after every conditional changeover to petrol. **<u>Time of delay of "Auto mode" can be reduced from 10 downto 3 seconds, by activating "Fast mode" in Advanced bookmark.</u>**

Sensor type -characteristics of level indication sensor installed on the tank's multivalve. We can choose from 6 predefined sensors: 50 kOhom (falling/growing), 0-90 Ohm (growing/falling) level sensors (**RESISTIVE** types) and two types of CNG Hall pressure gauges (**VOLTAGE** types)

By using the sliders below we can also set the levels at which the particular level diodes on the switch will turn on and off. The status of particular diodes depends on the electrical signal readout from the level indication sensor. That value is always shown in the OSCAR-N OBD CAN program, below the sensor type selection field. The setting defined by user will be automatically stored in controllers memory. We can restore the original settings anytime by restoring the manufacturers settings.

Signal of gas level from the sensor is being shown in the software without averaging. On the switch gas level is shown with averaging of 60 seconds, so the change made in the software will be present at the switch dashboard after that period. Thanks to averaging the LPG level is not changing rapidly when car is taking the curves and the multivalve in tank is floating fast up and down very quickly.

2.4.4 Calibration Panel
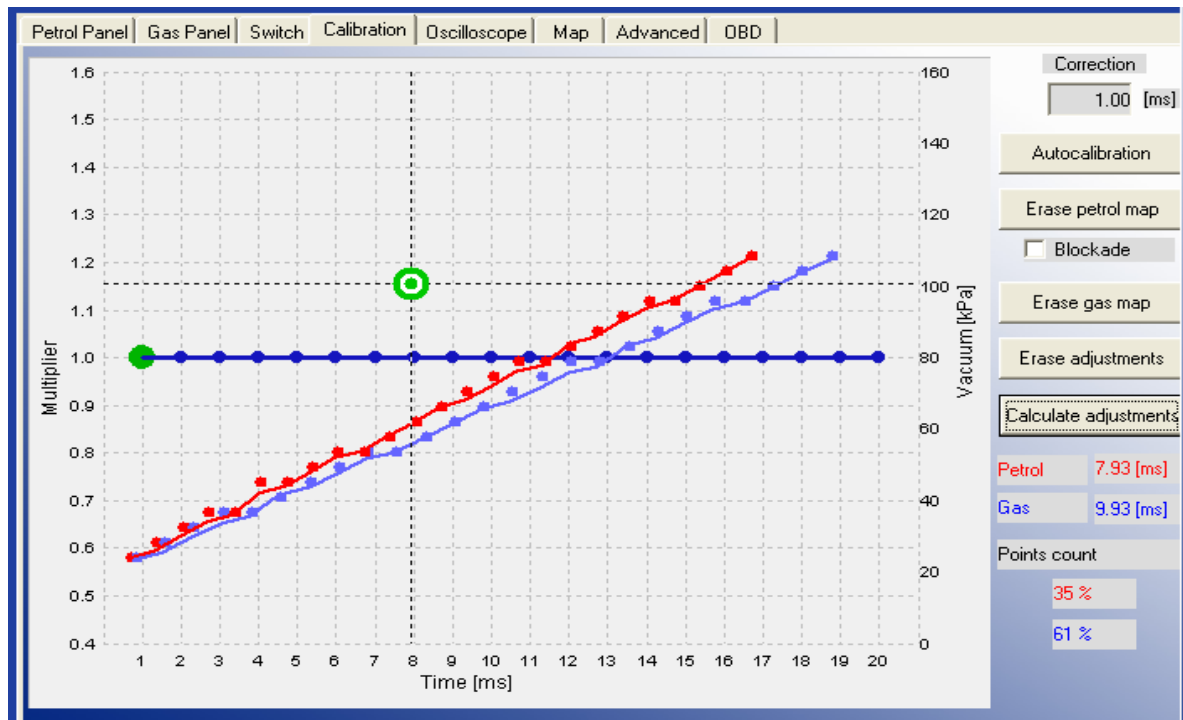
In **Calibration** panel there is map of gas controller showing dependency of petrol injectors opening time on petrol (red points) and on gas (blue points) [ms] related to value of pressure (vacuum) in the inlet manifold of the car [kPa]. On the right side of the screen we can see the first petrol (red colour) and first gas injector (blue colour) opening time value [ms] and progress bar of autocalibration. Green square on the map shows the actual values of pressure and petrol injectors opening time.

Left axis is the for the Multiplier line (blue) which sets the elongation of injection opening time of petrol injector on gas (light blue points)

The following buttons are available:

· **Autocalibration** -calculates the time correction for gas injectors on idle. Function described more precisely in Chapter 3 of this manual.

· **Erase petrol -**erases the map of petrol injection opening times on petrol from controller's memory.

· **Blockade** -from the moment of turning that option on, no more points will be collected on the petrol map.

· **Erase gas -**erases the map of petrol injection opening times on gas from controller's memory.

· **Erase adjustments** -automatically sets value for all points of multiplier to 1.0.

· **Calculates adjustments** -automatically calculates and sets the line of multiplier to level the difference between petrol and gas maps.

Attention: Below we can find values of filling percentage of petrol and gas map buffers in ECU memory. When these values are above 100% no more points for petrol / gas will be collected in the application screen. **It is reccomended to erase the petrol and gas map after each autocalibration and to erase the gas map after every change of multiplier. Before every another autocalibration it is strongly recommended to erase all eventual earlier multiplier corrections, by pressing the „Erase adjustments" button, otherwise the main correction from Autocalibration might be not calculated properly.**

2.4.5 Oscilloscope Panel
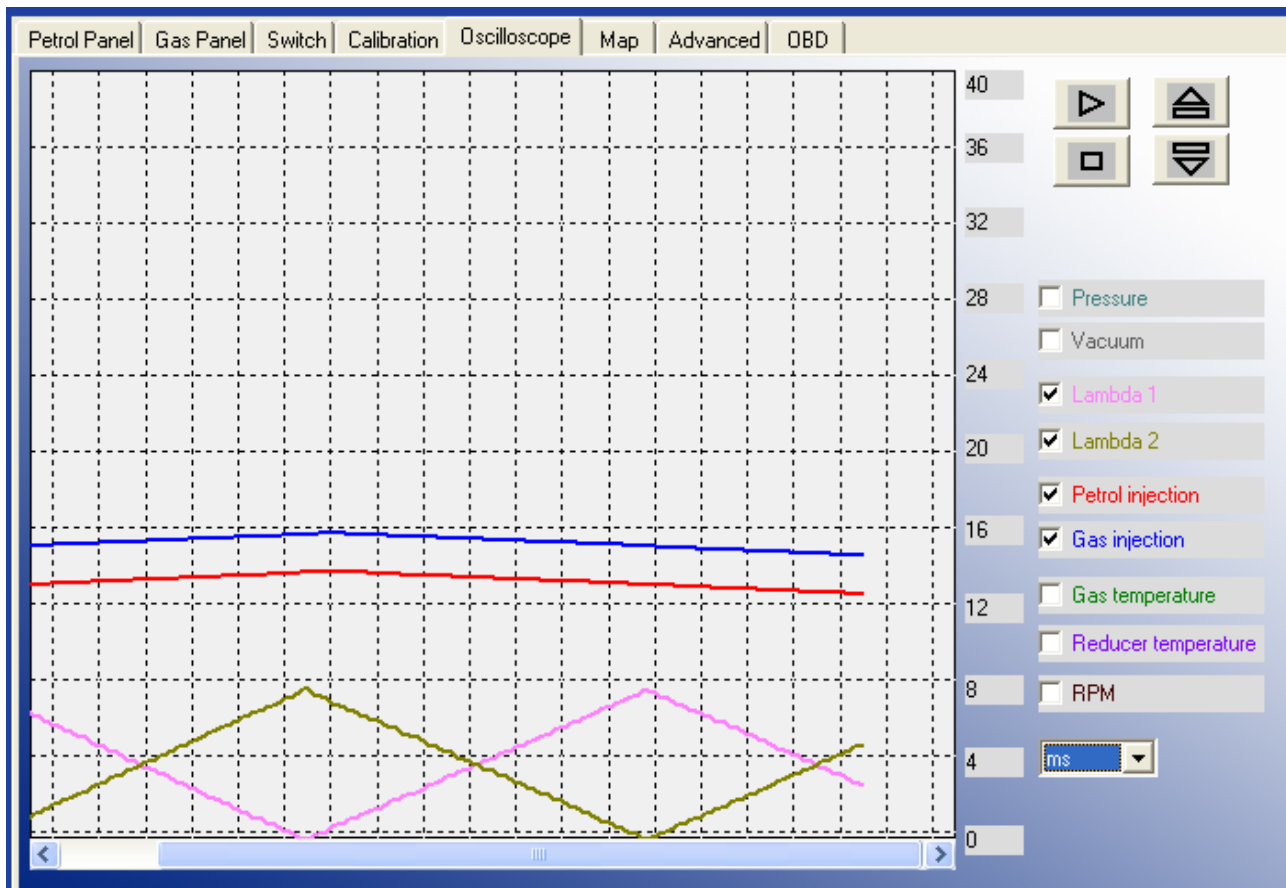
On the right side of this panel we can select which signals measured by the controller we would like to see on oscilloscope and the buttons for Load, Save, Start and Stop the oscilloscope. We can work with following signals:

- *Gas pressure* – LPG pressure value (pressure difference between the pressure regulator and the suction collector)

- *Vacuum – MAP* -pressure value within the inlet manifold (the absolute pressure value)

- *Lambda 1 voltage* – voltage at the lambda 1 probe

- *Lambda 2 voltage* – voltage at the lambda 2 probe

- *Petrol injection* – petrol injection opening time

- *Gas injection* -gas injection opening time

- *Gas temperature* – LPG temperature at the pressure regulator outlet

- *Reducer temperature* – temperature of the liquid gas within the pressure regulator

- *RPM [rev/min]* – engine revolutions per 1 minute

All signals described above are visible on the oscilloscope and can be turned on and off anytime. After pressing "Pause" button the lines stop being drawn. This option can be used for checking what were earlier indications of signal. Below we can turn on the values of measurement for the parameters which we would like to see the values in particular moment (on the screen above we can see injection opening time of petrol and gas in ms)

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## 2.5 Other features available in the main window

2.5.1 Gas injectors corrections
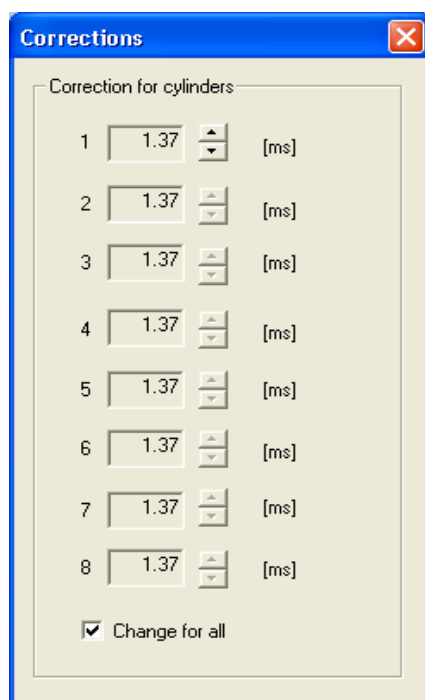
In this window we can read and adjust time corrections calculated for each injector during autocalibration. These settings enable a correction of the fuel mixture for each cylinder. When option „Change for all" in unchecked we can use it to correct the injection time variations present in a "V" type engine cylinders. To calibrate the injectors, use the following procedure: Upon auto-calibration, check the **gasoline injection times** for each cylinder when using gasoline. Turn the LPG injectors on, one at a time, and observe if there are any differences in the injection times after switching from gasoline to LPG. Adjust the correction time [ms] settings **(only when necessary!)** for each injector so that switching to LPG one injector at a time will not result in changing the **gasoline injection times.**

ATTENTION !!! 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!!!

2.5.2 Diagrams
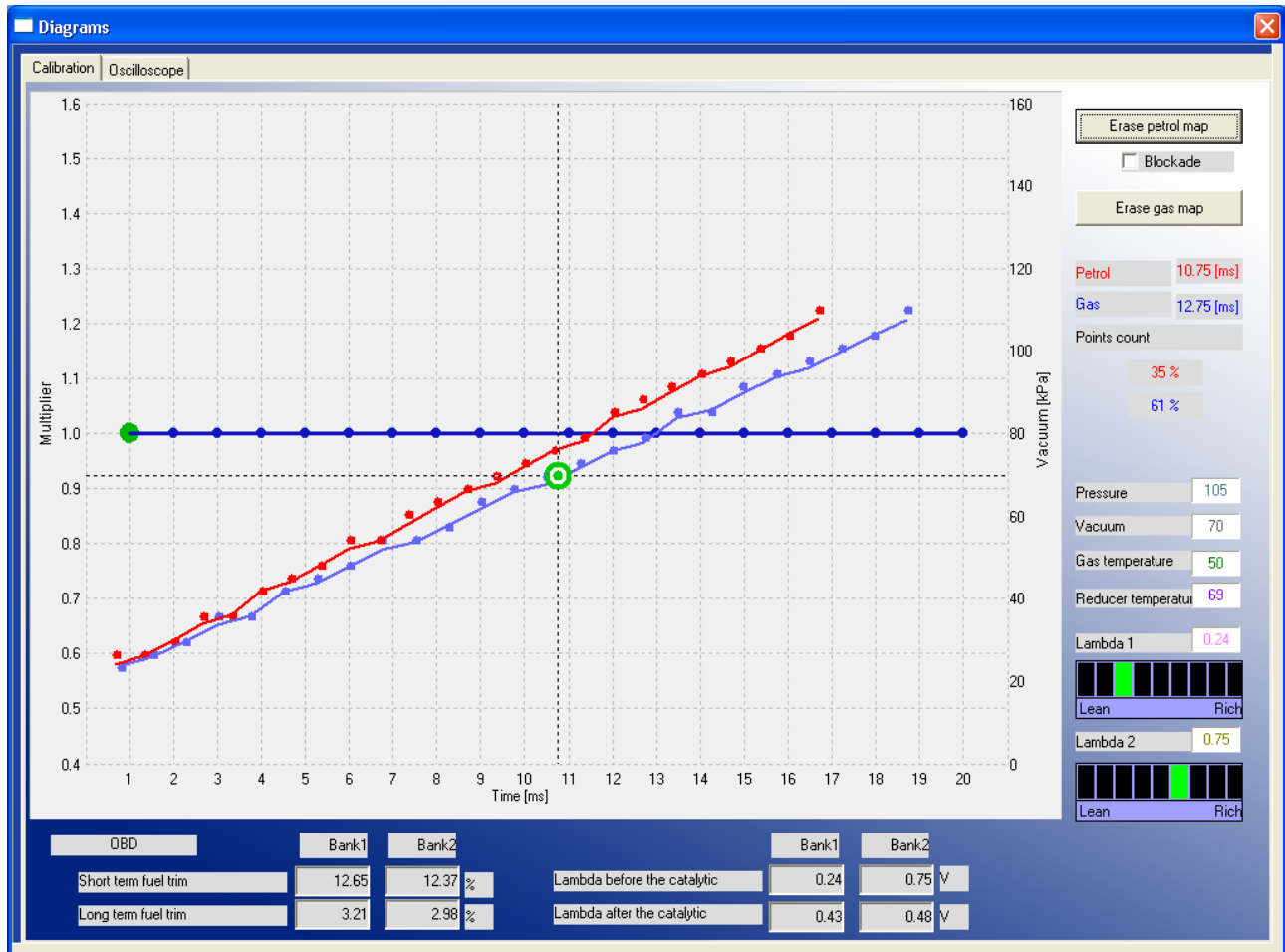
This function makes available to work with **Map** and **Oscilloscope** bookmark maximized to the size of main window. This feature is recommended during collection of petrol and gas map.

2.5.3 Errors

Error appearance is signalized by beeping from a buzzer (if connected) and changeover back to petrol. The diode on the switch will start blinking. In the software window the red dot will appear on the *"Errors"* icon. After clicking that icon by left mouse button the *"Errors"* window will appear. The Error window shows the following fields:

- *"Erase Errors"* -this option makes available to erase errors which have occurred
- *„Continuous signal for errors"* – if selected, acoustic signals will inform of an error until manually turned off by the user. If unselected, the acoustic signal will appear only once for a short period of time.

List of errors which might occur:

„Pressure sensor error" -pressure error is being signalized when the pressure drops down below the value of 20 kPa. Situation like this happens when the gas tank is nearly empty. In case if the value of pressure is not that low, but it's below the „Minimum pressure" value set in the application (default it's being set at 60 kPa) it is being considered as end of gas, and controller changeovers to petrol, but it is not registered as pressure error.

Attention: „Pressure sensor error" is the the only error which is being signalized by buzzer.

„No RPM signal" -In case of lack of RPM signal for short duration (below 4 seconds), the gas injectors are being closed and car automatically goes back to petrol. Error of *„No RPM signal"* is being registered in the controller. If the RPM signal will appear again before the 4 seconds period, the car will automatically go back to gas. If after 4 seconds there still won't be RPM signal, the solenoid valves will shut off. After receiving RPM signal again the controller will go in „Auto mode" (waiting for changeover to gas).

„Gas temperature sensor error" -happens in case of reading to value our of range from gas temperature sensor (might be caused by disconnected or damaged sensor).

„Reducer temperature sensor error" -happens in case of reading to value our of range from gas temperature sensor (might be caused by disconnected or damaged sensor).

„Power voltage supply too low" -the controller power supply has fallen below 9 [V] and it's too low to work on LPG. It is recommended to check the +12V ignition and battery connection (especially both fuses). The controller will not changeover to gas.

„EEPROM memory Read/Write Error" -doesn't cause changeover to petrol.

2.5.4 Service

Shows the amount of time that controller has been driving on petrol/gas. Makes possible to set time remaining to the next system inspection. Exceeding that time will be signalized by beeping of the buzzer and switch LED's blinking after each turning on the controller in Auto mode until next system inspection will be set by the installer.

All service numbers of the PCs connected to the ECU and changing its settings will be written in its memory. This feature makes possible to detect easily interference of PC other than used by service.

2.5.5 Load/Save
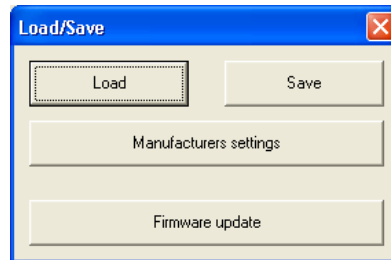
Makes possible to *"Save"* current program settings in a *.xset file. All the settings like the multiplier values, sensor types etc. can be saved on disk and easily restored in any moment by pressing the *"Load"* button. In any moment we can restore original values of the controller by pressing the *„Manufacturers settings"* button. It is also possible to update the controller's firmware.

2.5.6 Languages

There are following software interface languages available to choose from:

- Polish
- English
- Russian
- German
- Turkish
- Czech
- Slovakian
- Spanish
- Portuguese
- Italian
- Lithuanian
- Croatian
- Slovenian
- Thai

2.5.7 Calculator of injectors' nozzle diameter
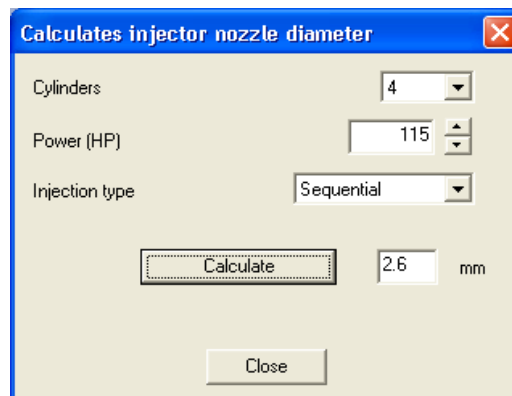
This function makes possible to calculate injection nozzle's diameter according to amount of BHP to one cylinder and injection opening strategy type.

Attention: Algorithm assumes that reducer's pressure has been set at 1 bar (for LPG reducer) or 1,8 bar (for CNG reducer). **Calculated values are only approximate values and it is recommended to drill the injector nozzles from a diameter smaller from calculated one by 0,2mm** and depending on the communicates during autocalibration eventually increasing it by step of 0,2mm.

2.5.8 Help

Opens directory including this manual and controller's harness wiring diagrams.

2.5.9 About us

Some information about "Europegas" Sp. z o.o. Company divisions in Poland with all addresses, e-mails and other contact information.

3. Autocalibration
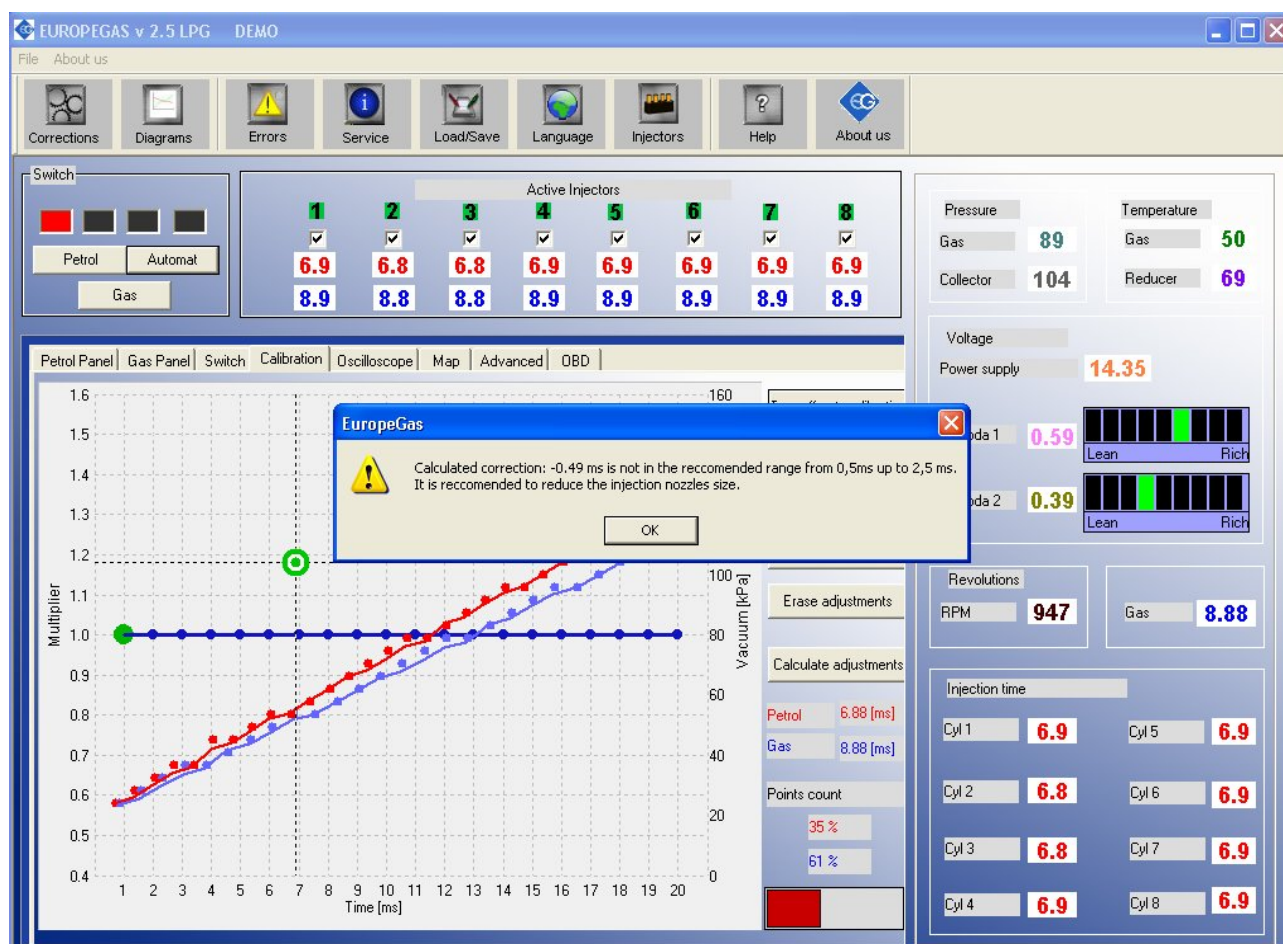
In *Calibration* bookmark there are three maps:
- Multiplier's map -blue colour
- Petrol injection opening times (on petrol) -red colour
- Petrol injection opening times (on gas) -blue colour

Left vertical axis (*Multiplier value*) and bottom horizontal axis (*Time*) [ms] are assigned to the multiplier map. Multiplier map is used to set the multiplier for particular injection opening time. That function is being realized by the blue points placed on the whole map with interval of one second. To move the active multiplier point (green one) it should be selected by clicking it by the left mouse button and drag it up and down. To adjust the multiplier we can also use following keys:

← - left arrow -changes active point to previous one by 1 ms (changes active petrol injection opening time).
→ - right arrow -changes active point to subsequent one by 1 ms (changes active injection opening time).
↓ - bottom arrow -decreases the multiplier for particular injection opening time. In example changing the multiplier value from 1,0 to 0,8 will cause shortening of gas injection opening time by 20%.
↑ -upper arrow -increases the multiplier for particular injection opening time. In example changing the multiplier value from 1,0 to 1,2 will cause elongation of gas injection opening time by 20%.
„Page Up" – moves the whole multiplier line up.
„Page Down" -moves the whole multiplier line up.

Besides the multiplier map there are two other maps present in that window. Red colour points create the map of petrol injection opening times (on petrol). Blue colour points create the map of petrol injection opening times (on gas). Right vertical axis (vacuum) [*kPa*] and bottom horizontal axis (*Time*) [ms] are assigned to these maps. When enough points has been collected the controller's software draws continuous lines between these points.
On the map we can also find green marker created by two crossed lines, 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 the engine works.
Buttons **"Erase petrol map" "Erase gas map"** are used for erasing gasoline and LPG maps. Nearby the buttons is situated the selection field "Blockade", which is locking the gasoline map i.e. the controller having collected the gasoline map (when the map is drawn with a continuous line) will not modify it in application after checking that field.

In the „**Map**" bookmark there is „**Auto-calibration**" button which You should press for starting the autocalibration. On the bottom right side of the window a progress bar of calibration process will appear. Prior to starting autocalibration, start the engine and wait until the lambda probe starts to work. **To start autocalibration the reducer's temperature must be at least 50 C degree**.
During auto-calibration the engine should work on idle. Do not increase RPM, switch off air-conditioning and lights, do not turn the steering wheel, because this may cause errorous action of the autocalibration. Please notice that during the autocalibration all other program functions remain inactive (Only "**Turn-off auto-calibration**" is available in case of any problems with the engine).

During autocalibration controller is changing over the fuel type from petrol to LPG several times in order to calculate main time correction between petrol and gas injectors opening time. Calculated correction is constant value [ms] which is the difference between petrol injector opening time and gas injector opening time. It is always visible on the top right side of Calibration Panel.
 If the gas pressure and injection nozzle diameter has been selected adequate to particular car engine's power **main correction should be between 0,5 [ms] and 2,5 [ms] (recommended value is between 0,5 [ms] and 1,5 ms [ms]).**
If the main correction is lower than 0,5 ms, it means that the **injectors nozzle should be changed to smaller ones** or reducer's pressure should be lowered (it is not recommended to set the reducer's pressure lower than 1 bar).
If the main correction is higher than 2,5 ms, it means that the **injectors nozzle should be**

changed to bigger ones or reducer's pressure should be higher.

Attention: When the injection nozzle diameter is far from the proper value, some of the cars might stall while the car is changing over from petrol to gas during autocalibration. In this case if we want to finish autocalibration to see the correction it is possible to run the autocalibration on higher revs. To do this we need to increase the revs up to constant value (like 2500-3000 RPM) and keep it like this till the autocalibration ends. However after checking calculated corrections we need to change injection nozzle diameter or/and reducers pressure and run the autocalibration again.
Attention: Before running every another autocalibration we need to set the main correction back to 1,0 ms and use the button "Erase the adjustments" (in Calibration bookmark)

3.1 Collecting the gasoline injection map with gasoline (gasoline map)

If autocalibration has finished and calculated proper main correction **we should erase petrol and gas map** so can switch over the vehicle to gasoline and drive about 15-20 minutes to collect the gasoline map.
Attention: In case if we won't erase petrol/gas map before mapping during the drive, and the car has worked for a long time on idle on petrol/gas, so the buffer of petrol/gas is near to 100%, we could have problem with collecting map in whole range of injection opening time.

During collection of the map try to drive without changing gears i.e. at the 4th gear and in such way so that the lambda probe "works" (changes its mode from weak to rich). During driving red points should start appearing on the map. 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 without PC connected**. 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 recognize that the number of collected red points is sufficient, the map will be drawn with a continuous red line. The accuracy of drawn line depends on the density of points collected in given area. The more points will be collected in given area, the more accurate the petrol map line will be.

Attention: It is recommended to collect 100% of petrol map.

3.2 Collecting the gasoline injection map with LPG (LPG map)

Having collected the gasoline map vehicle can be switched to LPG so we can start to collect the LPG map. The LPG map should be collected in the same road conditions and with similar loads as the gasoline map. The LPG map is drawn with blue points. Having collected sufficient number of points the map will be drawn with a continuous blue line. The accuracy of drawn line depends on the density of points collected in given area. We can say that the LPG map has been collected with enough accuracy when there won't be narrow curves in its horizontal axis. The more points will be collected in given area, the more accurate the gas map line will be.

Attention: After making any changes to multiplier line it is recommended to erase the gas map and collect in again. In this way we can update the map quicker on in the application (especially when the percentage of gas map buffer is near to 100%)

3.3 Making correction to map by using multiplier. Calculating the corrections.
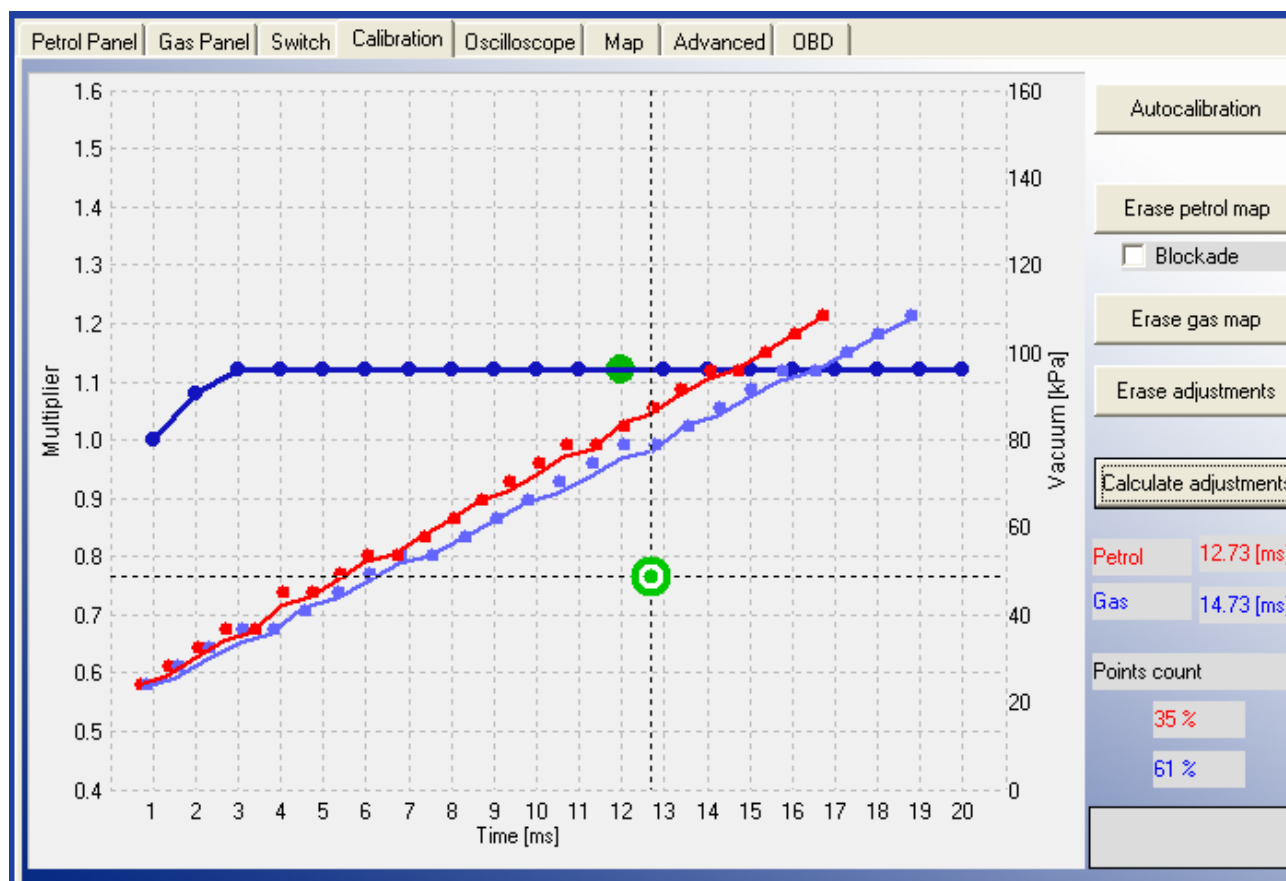
If the injectors nozzle diameter and reducers pressure has been selected properly (which will be confirmed by proper main correction calculated during autocalibration) the petrol and gas map should agree. In case if there are big differences between both lines we can use **"Calculate adjustments"** option. Gas injectors opening time will be automatically corrected where the distance between both maps (for the same petrol injection opening time) will be too big.

After saving the calculated adjustments into controllers memory we could erase gas map and collect it again. Both maps should agree from now on.

During collection of gas map with PC connected we can adjust the multiplier adjustments manually in the places where we see that blue line is not agreeing with red one.

3.4 Setting multiplier's corrections manually

The controller can be also set manually. We start the setting of the controller – as for the previous method – with autocalibration (it is indispensable for correct operation of the controller, see point 3). Then, if the autocalibration has been finished successfully and correction values for the gas injectors 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 i.e. about 5 [ms]. Evaluation of gasoline injection times will be easier with help of the green marker, which

vertical position at the horizontal axis depends on injection time. Now we switch over the vehicle to LPG and watch, if the green 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 to high (the mixture is too rich). In such case correct the multiplier – in our case for the time 5 [ms] - downwards. If after changeover 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 with leap of every 2 [ms] starting from idle revs injection opening time point.

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

3.5. LED switchboard

The LED switchboard consists of:
- LED line indicating gas level
- button for changeover between both fuels. Push to change between petrol and gas (**Auto mode**)

LED line– shows current LPG level in the tank. 3 green LEDs indicate a full tank; a red LED indicates "reserve".

The LED – shows current operating status:
- off – the engine runs on gasoline
- slow blinking (once per second) – Controller is in Auto mode and when the temperature of reducer is lower than 50 C degree, it's awaiting for reducer to reach minimal temperature set in the Switch Panel. If reducer temperature has reached temperature of 50 C degree, if the required RPM level was reached, from that moment after 10 seconds solenoid valves are going to be opened and gas injectors are going to be opened.
- Fast blinking (twice per second) – If reducer's temperature is lower than 50 C degree, after reaching required reducer's temperature (set in Switch Panel), controller opens the solenoid valves and waits with changeover until required time amount will pass (set in Time parameter from Switch Panel). If reducer's temperature is lower than 50 C degree, controller will wait additionally for the time required for preheating gas injectors (if option has been turned on in Advanced Panel). After that total amount of time, if the proper RPM level (set in Switch Panel) has been reached the controller will changeover to gas.
  Attention: If buzzer signal has been activated fast blinking means controller error (changeover to petrol due to low gas level in the tank)
- on – the engine runs on gas

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 gasoline 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 gasoline. Turn the ignition off to turn this special mode off.

4. Injection map correction depending on engine's RPM

ms\RPM	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500
< 2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
7	0%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
8	0%	5%	5%	5%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
9	0%	5%	5%	5%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
10	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
11	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
12	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
13	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
14	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
15	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
16	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
17	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
18	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
19	0%	5%	5%	5%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%	10%
20	0%	5%	5%	5%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

OSCAR-N OBD CAN controller makes possible to adjust the composition of air/fuel mixture in the whole range of engine load. To do this we can use Corrections map placed in the "**Map**" bookmark (feature protected by password).

On the picture above we can see map of corrections for petrol injection opening time depending on RPM level. In the screenshot above the opening time of gas injectors has been elongated by 15% in range of high revs. Thanks to that map we can adjust mixture by shortening or elongating the gas injectors opening time in range from –**50%** up to **+50%.**

Editing of the map cells can be done in following way:

1) With right mouse button we mark the area in which we would like to enter the percentage correction of gas injectors opening time.

2) With left mouse button we click on any of cells marked by us.

3) Pop-up menu will show up, with following options:

      a) **"Add"** -adds value written from keyboard to all the cells selected.

      b) **"Subtract"** -subtracts value written from the keyboard from all the cells selected.

      c) **"Set"** -sets the value written from the keyboard to all the cells selected.

      d) **"Clear corrections"** -sets the 0 value to all the cells selected.

After selecting the area on the map it is possible to modify it with usage of *Page Up* and *Page Down* keys.

Page Up – increase value by 1%

Page Down – decrease value by 1%

Attention: <u>Main time correction [ms], correction of the multiplier [%] (from Calibration bookmark) and correction from RPM [%] (from Map bookmark) summed together give total gas injectors opening time</u>

Attention: <u>If the RPM/ms map has been modified before running every another autocalibration we need to use the button "Clear corrections" to sets the 0 value to all the cells selected.</u>

5. Advanced settings
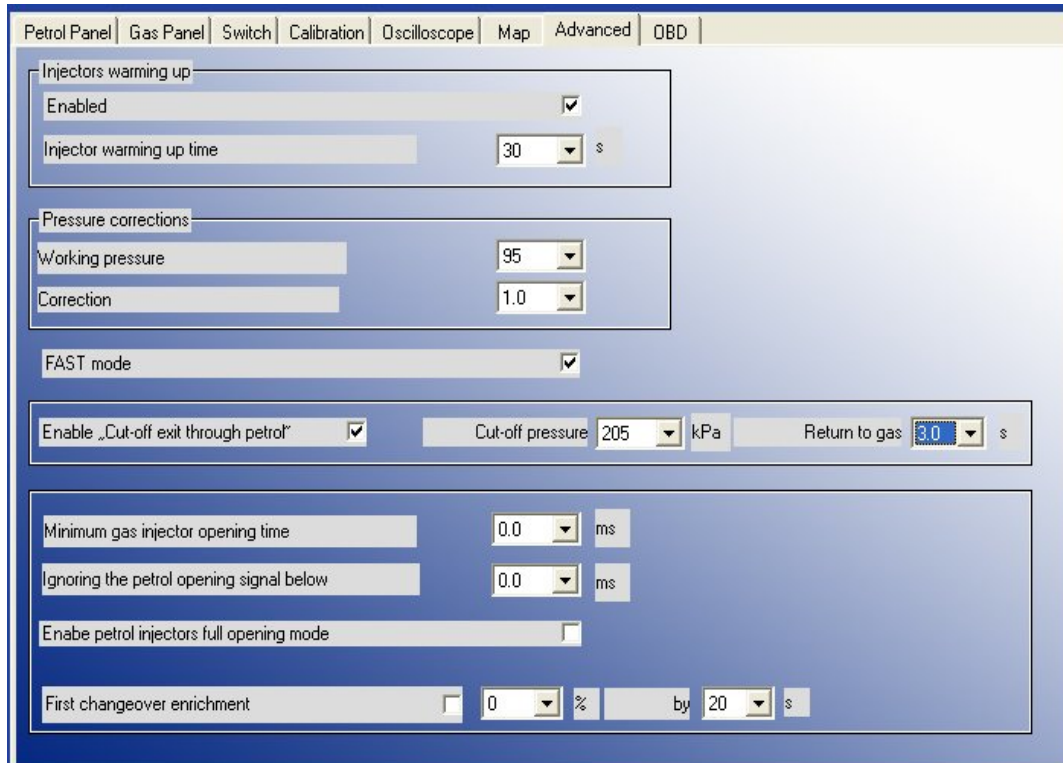
In *Advanced* bookmark we can find following features (protected by password)

1) **"Injectors warming up"** -After enabling that options we can set period of time for which the gas injectors coils should be preheated by single pulses from ECU (properly shortened so they won't cause opening of injector) before first changeover to gas **(function works only if the reducer temperature is less than 50 C degree)**. The length of pulse is being set automatically depending on the type of selected injector from injection rail in *Gas Panel*.

2) **"Pressure corrections"** -options which makes possible making following correction depending on value of differential pressure:

· **"Working pressure"** -gas pressure at the gas injectors during autocalibration, during work on idle. Default set at 100 kPa (and reducer should be set at this value before running autocalibration).

· **"Correction"** -Describes how the mixture should be enriched (by elongating the injectors opening times) when the pressure at the injector rail will start falling (to compensate the mixture impoverishment).

Examples:

a)Working pressure -100kPa, *Correction* -1.0 → during change of pressure down to 90kPa, times of gas injection will be elongated by 10%

b)Working pressure -100kPa, *Correction* -0.2 → during change of pressure down to 90kPa, times of gas injection will be elongated by 2%

a)Working pressure -100kPa, *Correction* -1.0 → during change of pressure down to 95kPa, times of gas injection will be elongated by 5%

a)Working pressure -100kPa, *Correction* -0.2 → during change of pressure down to 95kPa, times of gas injection will be elongated by 1%

    If the injector nozzle's diameter has been selected properly the default correction value is 1.

3) **"Fast mode"** -enabling this feature reduces the time of changeover to gas in "Auto mode" from

10 down to 3 seconds.

4) *"Enable "Cut-off exit throught petrol"* -this feature might be especially usefeul when installed reducer(s) are making very high pressure at the outlet during cut-off conditions. If the reducer's gas pressure (differential) will exceed value given in the field "*Cut-off pressure*" the controller closes the gas injectors and turnover back to petrol. After the amount of time [s] given in field "Return to gas" the controller is going back to "Auto mode".

5) *"Minimum gas injector opening time"* -this parameter set minimum time of the LPG injectors opening time. Might be used when the short petrol injection opening times, the times of LPG injection opening time are close to minimum value of LPG injectors opening time, which may cause engine stalling (in example: during exit from cut-off). In example: when we set this parameter at 3,1 ms, if the controller has calculated gas injector opening time less than 3,1 ms (like 2,8 ms) its opening time will be not less than 3,1 ms.
Attention: For VALTEK type injectors the parameter shouldn't be higher than 3,8 [s].

6) *"Ignoring the petrol opening below"* -this parameter sets the minimum value of petrol injectors opening time which will be moved onto LPG injectors. This option should be enabled when petrol injection controller generates very short pulses on petrol injectors (from 0,3 [ms] up to 1 [ms]), which normally doesn't cause dosage of fuel but after summing with all the corrections (main correction, multiplier correction and map correction) might cause unnecessary gas injection (partial cut-off). Default value "0" means that every pulse from petrol injector will be moved onto LPG injectors.
Attention: Maximum value of this parameter is "1,9" [ms].

7) *"Enable petrol injectors full opening mode"* -this option should be enabled only with cars where the injectors during high revs are fully opened. This can cause engine stalling during drive on gas. These happens mainly to tuned cars.

8) *"First changeover enrichment"* -After activating that feature it is possible to enrich the mixture once after first changeover from petrol to gas. After first changeover the gas injection opening time will be elongated by selected value (in *%*). During desired time period (in *sec.*)the enrichment will be decreasing linearly downto 0%. For an example after setting the enrichment to 20% for 20 sec. Period, after 10 sec. From changeover enrichment value will be 10%, after 15 sec. It will be 5% and after 20 sec. 0%.

6. Reading OBD correction using CAN bus

In OSCAR-N OBD CAN controller it is possible to connect directly to CAN bus and to read actual car's OBD work parameters and errors. To use this feature it is necessary to connect to the car's OBD connector with **CAN Low** i **CAN High** wires from harness of OSCAR-N OBD CAN controller.

After connecting to OBD CAN bus and turning on the option **"OBD connected"** we can watch selected parameters in application.

After clicking the button **"Read OBD errors"** it is possible to read the OBD errors written in original car's petrol controller. We can erase these errors from its memory by pressing button **"Erase OBD errors".**

By enabling option *"Reading corrections from OBD"* we have possibility of correcting gas injectors opening time according to actual readings of *"Short Term Fuel Trim"* and *"Long Term Fuel Trim"*. The time interval of reading the corrections can be set in parameter *"Adjusting OBD corrections".* Thanks to above feature the work of gas injection controller is self-adapting itself to car's original OBD in real time. If elements rest of sequential gas injection system has been chosen and installed properly it makes possible to eliminate **MIL** ("check engine" light) during drive on gas. To fulfill the emission norms used by manufacturers of most modern cars it is necessary to use injectors of highest precision of gas dosing and reducers with power adequate to particular car engine's BHP.

Attention: Feature *"Reading corrections from OBD"* might be used only in cars which are having OBD on CAN bus, because only this type of data bus is capable to ensure proper communication quality with the controller. Another condition needed to fulfill for this feature to work is the fact of previously making autocalibration on idle, and making corrections to the multiplier properly.

Recommended value for *"Adjusting the ODB corrections"* parameters is 5 seconds. This parameter

sets the time interval after which the averaged value of *Long Time Fuel Trim* is being read.

Parameter **"Maximum correction from OBD"** shouldn't be bigger than 15%. This parameter sets the maximum value of *Long Time Fuel Trim* which gas controller will try to adjust by changing gas injection opening time. In example, when this parameter will be 15% and the LTFT value will be ± 25%, the OSCAR-N OBD CAN controller will be trying to adjust the injection opening time just like for the ±15% value.

OSCAR-N OBD CAN controller reads the value of mixture correctors from OBD and sets the amount of gas injected so the *„Short Time Fuel Trim"* (STFT) i *„Long Time Fuel Trim"* (LTFT) will be oscillating as close to expected car's manufacturers default values as possible.

STFT and LTFT mixture correctors are referring to the corrections dynamically imported to table of injection opening times in original petrol ECU. These corrections are being made all the time to obtain the ideal proportions of stoichiometric value of air/fuel mixture (14,7 : 1). STFT are referring to temporary conditions of driving (like accelerating, braking etc.). LTFT are referring to long lasting conditions (like work the engine on idle) and they are being an averaged value from STFT.

Corrections are showed up as a percentage. Positive value means that in that particular moment the mixture is too lean and petrol ECU is trying to elongate the petrol injectors opening time to enrich it. Negative value means that mixture is too reach and petrol ECU is trying to shorten the injection opening time to make it leaner.

The concept of *banks* is referring to "V" type engines. Cylinder marked as no. 1 should be always in bank no. 1. "V" type engines should always have one side assigned to bank no. 1 (cylinders with numbers from 1 to 3 or from 1 to 4) and another side to bank no. 2 (cylinders with numbers from 4 to 6 or from 5 to 8). Straight type engines should have all the cylinders assigned to bank no. 1.

Algorithm of controller's adaptation in dependency of OBD corrections is basing on reading actual values of STFT and LTFT and depending on these values elongating or shortening gas injection opening times. In result of such actions mixture is being enriched or leaned to keep the STFT and LTFT in desired range.

In example: if LTFT are going too far in positive direction (they are growing), algorithm is increasing the gas injection opening time to enrich the mixture, so finally the LTFT are going in negative direction (they are falling).

If the LTFT are going to far in negative direction (they are falling), algorithm is shortening the gas injection opening time to lean the mixture, so finally the LTFT are going in positive direction (they are growing).

Acutal value of calculated corrections we should control from time to time. To big absolute value of these correction mean that some mechanical part might be worn out and we should make some mechanical adjustments to some parts of sequential gas injection system.

6.1 OBD connector's description
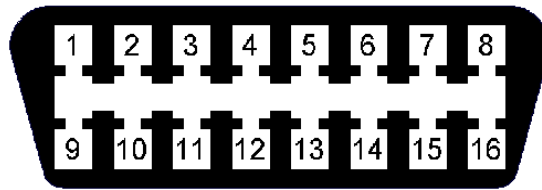
Pin 4 - GND
Pin 5 - GND
Pin 6 - CAN High (J-2284)
Pin 14 - CAN Low (J-2284)
Pin 16 - +12V

If the car has OBD on the CAN bus then on pins no. 6 and no. 14 should be +2.5V voltage regarding the GND.

OBD system on CAN bus has been introduced in United States. At the beginning it was installed only in some cars manufactured after year 2003. From year 2008 it is obligatory for all the vehicles manufactured on US market. In European cars there is no such requirement yet (beginning of year 2008) and from the cars being sold on European market only vehicles manufactured by Japanese and Korean concerns have the OBD on CAN bus.