

ESGI 2 LPG supply system installation manual

Part I



www.esgi.pl

info@esgi.pl

ESGI
GAS INJECTION

SYSTEM DESCRIPTION

We wish to present ESGI 2 sequential gas injection system, which complies with very strict exhaust emission standard EURO-4 and assures full compatibility with EOBD. Unique gaseous injectors control algorithm basing on the control signals from ECU of the engine, simplifies arduous programming aiming at creating a full map of the gas injection.



In ESGI 2 system it is enough to execute a set-up of basic engine parameters and perform simple adjustments. Regardless of the engine type, after a few minutes we get a fully programmed installation. To finish the process of programming, we check the operation and make slight adjustments, if necessary.

A huge advantage of ESGI system is its full compatibility with reducers and gas injectors available on the market. Thanks to the versatility of the controller and software, the ESGI system may

be used in almost any vehicle, no matter if the engine is with sequential fuel injection, half-sequential or full-group. We can also connect any multi-valve with the fuel level indicator making all the necessary adjustments in the software.

1. Control unit



The task of the control unit is to collect and process all the data, and on the basis of that to control particular functions of the system. The unit controls operation of the injectors giving injection length on the basis of the petrol injection time and engine rpm. The casing of the control unit is made of aluminium; it is airtight and high temperature proof. It effectively secures all electronic components located in it against both atmospheric factors and mechanical stresses. The control unit casing protects it also against electromagnetic radiation coming from electric elements of the engine or from other sources (e.g. transmitters, relays, mobile phones). In

case of any sensor connection missing or failure, the unit informs about it displaying corresponding error code in the program. Wiring is connected with the use of a single airtight coupling of FCI type, which connects all necessary signals.

2. Reducer



AT-09 reducer is a single stage regulator, with variable outlet pressure at the level of 1.2 bar of the suction manifold pressure. Inside the reducer, the liquid gas vaporizes in result of thermal exchange with engine cooling agent. The outlet pressure is regulated by the mechanism: spring – membrane – gland, and a special vibration damping system. It must be noted that one side of the membrane is affected by gas pressure and the other side is affected by the pressure from the suction manifold, connected by a rubber hose. As a result, the output gas pressure is not fixed, but it varies according to the suction manifold pressure. For example, when running engine at low speed, the suction manifold

pressure may reach -0.6 bar and the outlet pressure +0.6 bar. However, when pressing acceleration pedal whole way down, the manifold pressure will be around 0 bar (atmospheric pressure), and the gas pressure around +1 bar. In the reducer, there is a temperature sensor, which is responsible for transmitting to ESGI control unit all data necessary for proper flow stream control. Switching from petrol to gas also depends on the temperature of the reducer, what prevents from switching when the gas temperature is too low. Depending on the configuration, different types of reducers may be used.

3. Injector rail



The rail injectors are of bottom feed type. Gas from the rail gets to the bottom part of the injector and when the electromagnet shifts the pivot with the valve, the gas is injected into the suction manifold. The vulcanized rubber on the pivot assures tightness and silent operation of the injector. Difference in pressure affecting the valve keeps the valve closed when the coil is not powered, and the gas does not get into the suction manifold. In order to achieve proper operation of injectors, the right exhaust nozzles must be used according to engine power (see the table).

Injector nozzle diameter	3-cylinder engine Power (kW)	4-cylinder engine Power (kW)	5-cylinder engine Power (kW)	6-cylinder engine Power (kW)	8-cylinder engine Power (kW)
Φ 1.5 mm	Up to 40 kW	Up to 55 kW	Up to 70 kW	Up to 80 kW	Up to 110 kW
Φ 2.0 mm	40 kW – 60 kW	55 kW – 80 kW	70 kW – 100 kW	80 kW – 120 kW	110 kW – 160 kW
Φ 2.4 mm	60 kW – 75 kW	80 kW – 100 kW	100 kW – 125 kW	120 kW – 150 kW	160 kW – 200 kW
Φ 3.0 mm	Over 75 kW	Over 100 kW	Over 125 kW	Over 150 kW	Over 200 kW

Depending on the configuration, different types of injectors may be installed.

4. Gas filter of volatile phase integrated with gas temperature sensor



The integrated gas filter of volatile phase has the size which enables easy installation. It is equipped with high-class filter cartridge manufactured with the use of the latest filtering materials. It is recommended to replace filter cartridge every 10,000 – 15,000 km. When servicing, note if the temperature sensor has been properly sealed after filter replacement.

5. Wiring



The ESGI system features a single common bundle of all necessary wires (for power supply, control of electrovalves, injectors and signal wires for sensors and the switch). The bundle has an airtight FCI coupling for connecting gas control unit. The wires have appropriate plugs for gas injectors, temperature sensor and P1/MAP sensor, what simplifies installation procedures. To avoid mistakes, the wires are colour-coded as on the installation diagram.

P1/MAP sensor

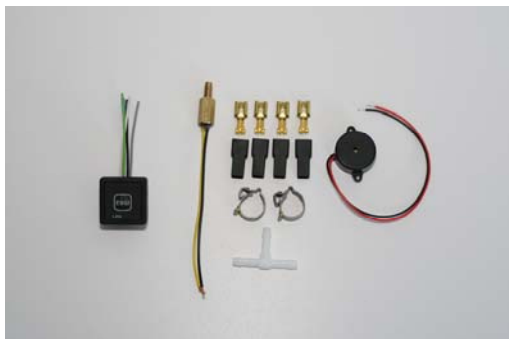


Integrated pressure sensor includes sensor of gas pressure and negative pressure in the MAP suction manifold. Calculating pressure level of gas and MAP, which is the measure of engine load, the control unit selects optimum gas dose assuring comfortable traveling at the lowest gas consumption.

6. Switch and control kit sachet



The switch, located in the vehicle cab, is intended for manual selection of gas system mode. Aesthetic and easy to install in the vehicle. It has a button selecting gas/petrol mode, gas mode indicator and gas level indicator. The switch is placed in the control kit sachet, which holds all necessary parts: reducer temperature sensor, buzzer, P1/MAP sensor adapter, clips and connectors.



7. Copper pipes and rubber hoses



Copper pipe in PCV casing connects the gas tank with the reducer located in the engine compartment. The pipe is fixed to the chassis with assembly clips. The set also includes water hoses to connect reducer to heating circulation, and gas hoses linking reducer with injector rail and the rail with manifold ends.

8. Additional accessories



The set includes assembly sachet with all clips, bands, adapters and nozzles. Each set is supplied with assembly diagram, abbreviated installation manual and system programming manual.

9. Gas tank



System ESGI/115 includes toroidal tank for LPG, which is mounted in the spare wheel well with the provided clamping screws. Air-tight chamber of the tank is closed with a hermetic cover. The chamber has a ventilating hole which leads out of the vehicle. The ventilating hole is also used to conduct copper pipes and electric wires through it. Depending on the system configuration, different types of tanks may be used.

10. Multivalve of the LPG tank

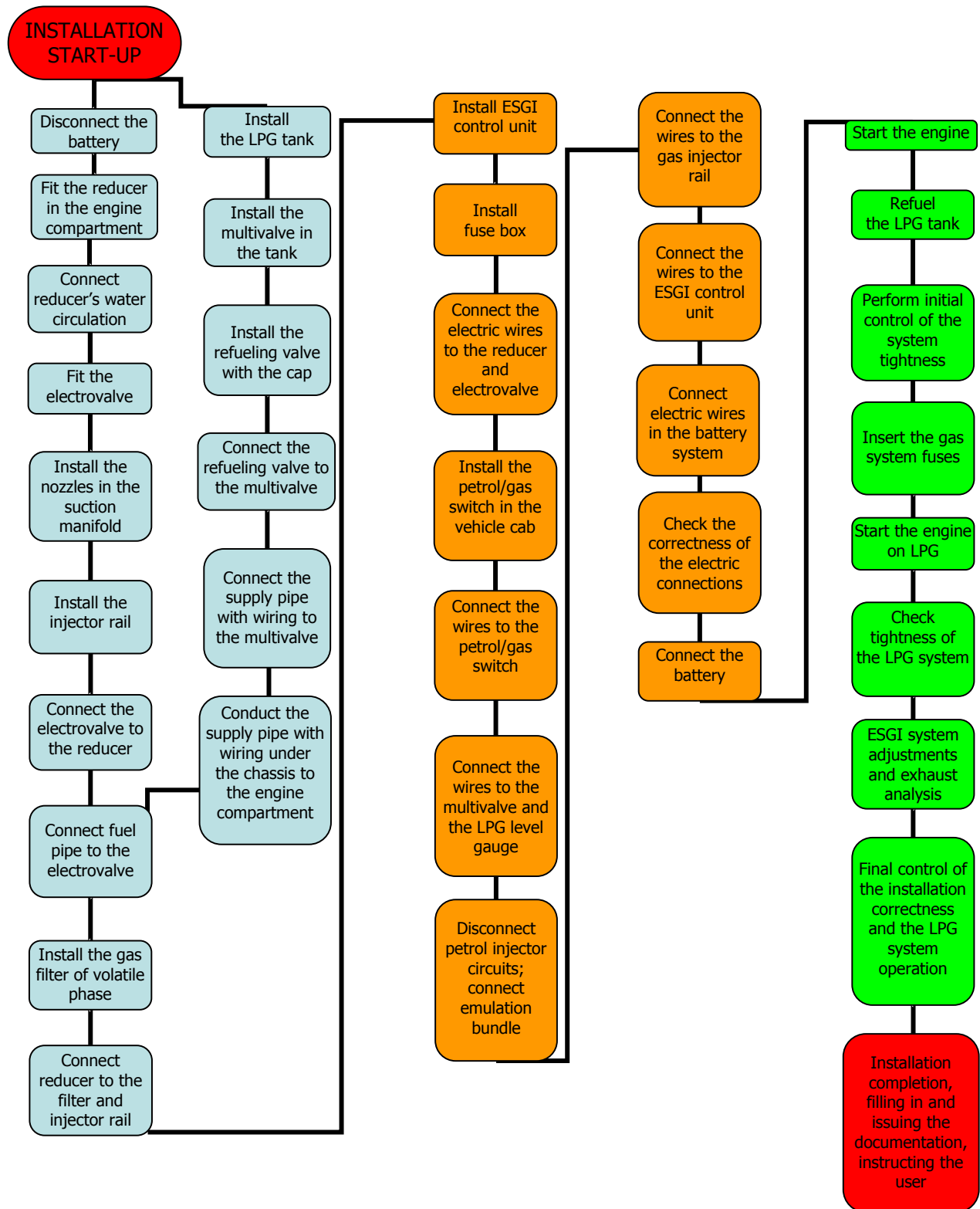


The multivalve installed in the tank opening is a combined device comprising of a valve limiting tank refill up to 80%, a remotely controlled working valve with a device preventing from efflux, a safety-valve preventing from excessive increase of gas pressure in the tank, a thermal protection and a gas level gauge. Gas level is indicated on the gas/petrol switch installed in the vehicle cab. Depending on the configuration, different types of multi-valves may be used.

11. Refueling valve



Refueling valve assures tight connection with dispenser nozzle at the LPG refueling station, and enables safe refilling of the tank with liquid gas. The refueling valve is equipped with a non-return valve, which prevents from uncontrolled efflux of the gas when disengaged from a dispenser nozzle. Additionally, the set includes hole plug securing the refueling valve from impurities. Depending on the configuration, different types of refueling valves may be used.



LPG system installation procedures

1. Before starting the process of installation, the battery must be unconditionally disconnected.

2. Fitting the reducer

- Mount the reducer to the solid part of the body or frame.
- Locate the reducer in a place that would allow for future inspections and adjustments.
- To mount the reducer use brackets and screws designed for the purpose.
- Follow the instructions for reducer installation.



3. Connecting reducer's water circulation

- Connect water pipes to engine cooling system in series, or parallel to vehicle cab heating circulation (Fig.1 and 2).
- When fitting the reducer into the water circulation, pay attention to tightness of the couplings.
- Secure the couplings with metal band clips.



4. Installing injector nozzles in the suction manifold



- Drill and tap the holes for nozzles in the suction manifold only on a suction manifold that has been dismantled and removed from the engine. The suction manifold nozzles should be installed in the manifold at the angle of not less than 45 degrees in the direction of the gas flow (suction). Optimum angle is 45-50 degrees.
- Screw the nozzles into the suction manifold with gap filling adhesive.

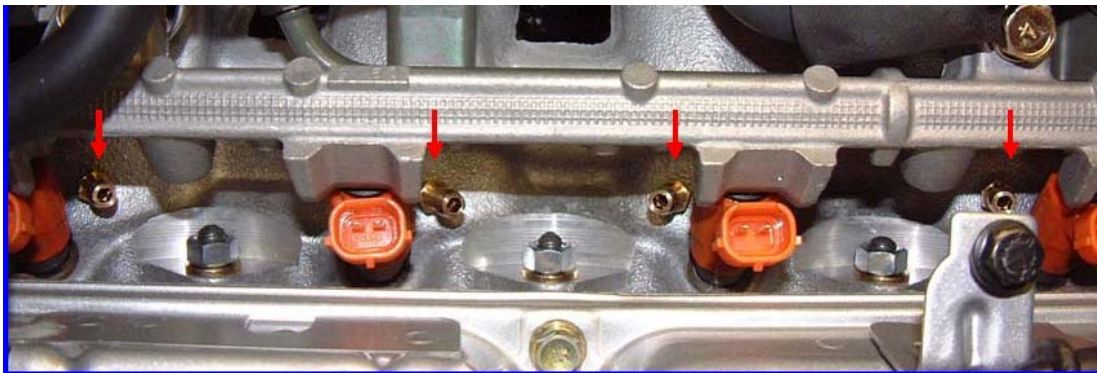


It is acceptable to install injector nozzles on an assembled suction manifold. In that case it is especially important to clean the manifold from all filings.

- Drill the holes close to the engine suction valves and screw stub pipes (nozzles) in it, through which the gas will flow. The nozzles should incline towards the valves.
- Connect all the fitted nozzles to the electrovalves stub pipes of the injector rail with the use of high-pressure rubber hoses.
- Secure the connections with metal band

clips. Make sure that the length of the rubber hoses is identical and possibly the shortest.

- Connect the power and control wires from the control unit to the injector rail coils.
- For V-type engines apply the same procedures remembering to fit gas nozzles close to the petrol injectors, close to inlet valves in both heads of the V engine.



5. Injector rail installation

- Install the injector rail on the engine casing as close to the suction manifold as possible.
- Secure the connections with metal band clips. Make sure that the length of the rubber hoses is identical and possibly the shortest.
- Connect the power and control wires from the control unit to the injector rail coils.
- Installing the injector rail with the outlets upwards is unacceptable.
- For V-type engines, you may use two identical rails arranged symmetrically according to the principles presented above.



6. Connecting injector rail to the injectors in the suction manifold

- Connect the injector rail to the nozzles in the suction manifold by means of a rubber hose of the diameter appropriate for the nozzles. The hose should meet the standard E 67 R 01 Class 2 for LPG, and it should not be longer than 250 mm. After connecting the rail with the stub pipes, check carefully the quality and air-tightness of the connections.

7. Connecting gas reducer to the injector rail



- Connect the injector rail to gas reducer by means of a gas hose of 12 mm in diameter, that complies with the standard E 67 R 01 Class 2 for LPG.

- After connecting, check carefully the quality and air-tightness of the connections.

8. Installing gas filter and P1/MAP sensor in the arrangement: reducer – filter – injector rail



- Install gas filter with temperature sensor between the gas reducer and injector rail on the rubber hose of 12 mm in diameter. Secure the connections with metal band clips and check the quality and air-tightness of the connections.

- Connect the temperature sensor to the bundle of electric wires.
- Install the gas filter as close to the injector rail as possible, in a place that is easily accessible for check-up or replacement.
- The gas filter is supplied along with the control set and constitutes its integral whole. You must not use a substitute not originating from the ESGI set.
- Mount MAP sensor to the body.
- Connect stub pipe of the P1 sensor to the stub pipe in the gas filter of volatile phase by means of a hose.
- Secure the connections with the supplied CLICK bands.
- Connect the MAP stub pipe to the high-pressure hose connecting reducer with the suction manifold.
- Connect P1-MAP sensor to do the gas bundle.

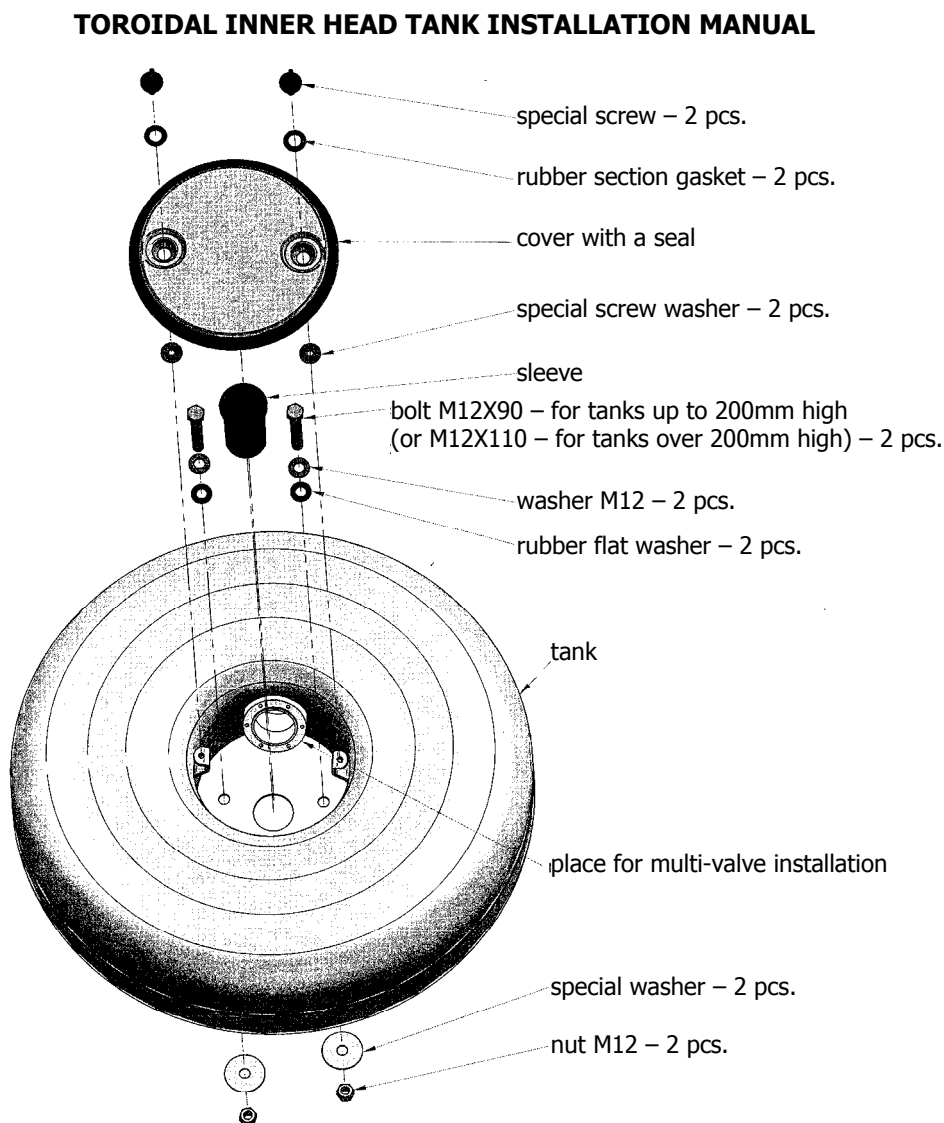
9. LPG tank installation (extract from regulation 67R 01)



LPG tank:

- cannot be located in the engine compartment
- should be safely mounted to the vehicle
- should be mounted in the correct position, according to the instructions designed by the tank manufacturer and in accordance with R67 and R115.

LPG tank should have fixed points of installation to the vehicle, or should be mounted to the vehicle only by means of screws, washers and nuts or special frame and clamping rings supplied in the set by the tank manufacturer. The LPG tank should be installed so that there is no other contact of metal with metal than in the fixed points of installation designed by the manufacturer. When the vehicle is fully loaded, the LPG tank should not be lower than 200 mm above the road surface, unless it is appropriately secured at the front and at both sides and no part of the tank stands out below the protective structure.



Note:

Installation of tanks outside the vehicle is acceptable, providing that anticorrosion covers are applied.

Multivalve:

Should be suitable for particular LPG tank and installed in conformity with the standard 67R 01.

Gas level indicator:

Indicator should be suitable for particular multivalve and installed in the right position assuring its proper operation.

**Gas-tight casing:**

Gas-tight casing should be installed over the LPG tank accessories, unless the tank is installed outside the vehicle and its accessories are sheltered against impurities and water.

The gas-tight casing should be vented through a ventilation pipe leading outside the vehicle.

The ventilation pipe should be downward at the outlet. However, it should not exit into the wheel housing or aim at a heat source, such as exhaust system.

The internal cross-sectional area of the ventilation pipe should be at least 450 mm².

If a gas pipe, a hose or electric wires are placed inside the ventilation pipe, the clear area of the ventilation pipe should also be 450 mm². The ventilation pipe should be well fastened to secure its tight connection with the gas-tight casing.

Rigid and flexible gas pipes:

Rigid gas pipes, made of mild steel, should have anticorrosion protective coating.

Weldless rigid gas pipes, made of copper, should have rubber or plastic protective casing.

Using flexible gas pipes is also acceptable.

Fasten the metal pipes in such a manner that they are not exposed to excessive vibrations or stresses.

Gas pipes should have protective casing in places of fastening to prevent damages resulting from abrasion.

Gas pipes should never be located in the vicinity of the jack points in the car.

Gas pipes should be fastened by means of clamping rings to the main vehicle structure or to the elements rigidly joined to the main vehicle structure.

Holes in the vehicle body, through which rigid or flexible gas pipes are conducted, should be secured with fairleads. Diameter of the holes should be at least 1.5 of the diameter of the rigid or flexible pipe passing through that hole.

Connections between components of LPG system:

Soldered or welded connections are unacceptable.

Connect rigid gas pipes with appropriate connectors made of the same material as the pipe. Design pressure should be the same as the pressure specified for the gas pipe, or higher. Multiple joins should be made of corrosion resistant material.

Number of the connections should be possibly the smallest and they should be located in places where they may be inspected. Rigid or flexible gas pipe in the passenger compartment or in the closed luggage compartment should not be longer than it is necessary for safe installation.

There should be no connections in the passenger compartment or in the closed luggage compartment, except:

- connections inside the gas-tight casing or on it,
- connections between gas pipe and fuel inlet, if the connection is covered with LPG resistant material with ventilation going directly outside the vehicle.

If the LPG installation requires a return conductor, its connection with LPG tank should be equipped with a check valve.

Flexible pipes for LPG under pressure should be equipped with mechanical connection suitable for multiple usage.

Additional accessories, others than those required by PN-EN 12806, which are necessary for proper engine operation, should be installed only to those components of LPG system, where pressure is lowered than 20 kPa.

Electronically controlled power valve:

Electronically (remotely) controlled power valve should be installed on a rigid gas pipe, between the LPG tank and the reducer/vaporiser, as close to the reducer/vaporiser as possible. The valve should be of such a type that its normal position is closed.

If a fuel return system is applied between the reducer and the LPG tank, the electronically controlled power valve should be installed in the engine compartment, in the place indicated by the manufacturer of LPG system.

The electronically controlled power valve may be integrated with the reducer.

The electronically controlled power valve should operate in such a manner that the fuel intake is shut when:

- the ignition is off
- other type of fuel was selected in dual-fuel vehicles.

Thermal safety valve:

Thermal safety valve should be installed in the LPG tank or on it, so the gas bleeding is directed to the atmosphere or into the gas-tight casing, if applicable.

Tank inlet:

Tank inlet should be secured against twisting and protected against water.

Tank inlet should be located outside the vehicle in accordance with the current regulations.



10. Installing control unit (ECU)

- Install the control unit in an easily accessible place, away from heat sources and not exposed to humidity.

- Take utmost attention to make good electric insulation of the wires.

- Secure connections and wires at full length against damage and moisture.

The manufacturer shall not be liable for any damage resulting from improper installation of the system or from the use of inappropriate materials or components.



12. Connecting electric wires to the battery

- Remove the main fuse.
- Connect the power leads (red and brown with a loop $\Phi 8$) according to the electrical diagram directly to the battery clamps using ready installation elements.

13. Connecting electric wires of the gas reducer temperature sensor to the vehicle electric system.

- The temperature sensor installed in the reducer should be connected to the wires (yellow and black) of the gas control unit according to the supplied diagram.

14. Connecting the switch and buzzer



- Install the switch inside the vehicle in a place well visible for the driver – drill $\Phi 14$ hole.
- While installing the indicator, carefully fit it by pushing it delicately into the drilled $\Phi 14$ hole.
- Gas level indicator works with a sensor 0 to 90 ohm.
- Install the buzzer in such a place that its alarm is audible for the driver, and connect the wires (red and black) observing polarity.
- After installing the switch, connect the bundle of wires to it (green, blue, white, grey and black). The black wire is the common earth for the switch and the buzzer.

15. Connecting reducer's electrovalve and multivalve at the gas tank

- Connect wires (blue and black) which supply power for electrovalve at reducer and multivalve at the tank.

16. Connecting electric installation bundles

Electric components of the LPG system should be protected against overload. Installation is equipped with fuses, whose minimal value after change should be identical with value specified in the supplied documentation.

Locate the main fuse in a visible place accessible without the use of any tools.

Electric wires should be appropriately protected against damage. Electric connections inside the boot or in passenger compartment should comply with protection type IP40 according to EN 60529. All the other electric connections should comply with protection type IP54 according to EN 60529.

Electric components and their connections located inside the gas-tight casing should have construction that do not produce any sparks.

Electrical connections, except earth connection, should be insulated. Using uninsulated wires is unacceptable. Never install any fuses inside the gas-tight casing.

- Connecting 12 V power supply through ignition:

Connect appropriate wire (red) to the place where supply voltage appears after turning the key into the ignition position. It may be feeding petrol injectors or feeding injection module.

- Connecting RPM signal:

To determine rotational speed of the engine crankshaft, the control unit uses RPM signal sent by ignition module (ignition coil WN or an integrated ignition module DIS) or from the engine ECU. Use impulse probe or oscilloscope to find the electric wire with the signal. Connect the brown wire from the gas control unit bundle to the wire. The frequency of impulses sent to the petrol control unit increases as the engine rpm increases, therefore the frequency of the signal on the screen of the oscilloscope also increases.

- Connecting the lambda probe:

To connect the lambda probe, first find the probe wire, remove the insulation and solder the control unit wire to it (purple – probe 1, grey – probe 2).

- Connecting the gas level sensor

Solder the signal wires from the gas tank level sensor to the wires (grey and black) of the gas control unit.

- Electric connections of the petrol injectors

- Version with plugs:

Disconnect petrol injector plugs. Connect the plugs of the gas control unit to the petrol injectors and to the control wires from the engine ECU according to the installation diagram and the markings on the gas bundle.

- Version "with cutting"

Remove insulation from the petrol injector wires. Cut the wires linking petrol injectors with the engine ECU. Solder appropriate wires from the gas bundle according to the diagram. Connect the single-colour wire from the injector's side, and solder the wire with the black stripe to the wire from the engine ECU's side. After soldering and checking the right sequence of the wires, carefully insulate the connections.

NOTE

With full-group and half-sequential systems, disconnect circuits of petrol injectors and connect them to appropriate wires from the gas bundle according to the installation diagram. Never connect joined wires from the gas bundle to the common control wires of the petrol injectors from the engine ECU. Such connection makes proper adaptation impossible, blocks sequential switching from petrol to gas and does not allow switching between particular cylinder injectors for diagnosis.

17. Careful examination of the quality of electrical connections

All the wire connections must be permanently soldered and properly insulated and checked before connecting to the power supply (battery).

Check the quality of electrical connections, their protection and conformity with the installation diagram.

18. Connecting power supply (battery)

Having performed all the procedures of checking installation and being assured that the connections are appropriate in terms of quality of wire connections, connectors, etc. and in accordance with the wiring diagram, switch on the battery by inserting the main fuse in the socket.

19. Starting the engine and making installation adjustments

- After checking all the connections and fastenings, and connecting battery, but before inserting fuses into the gas system fuse socket, you may start the engine on petrol.
- After filling the gas tank with LPG that complies with gas quality standard, check tightness of all connections in reducer's water circulation and, **in particular, of the connections in gas system** (connections in the tank, connections in the engine compartment, connections on flexible hoses) with the use of a tightness tester.
- Appropriately adjust LPG system according to the procedures listed in the ESGI preparation and programming manual enclosed below.
- Perform final examination of exhaust composition by means of 4-gas analyser and make necessary adjustments.

20. Completing installation

- Perform final visual examination for the conformity of the installation with R67 and R115
- Remove any contamination produced during installation from the inside of the vehicle, the engine compartment and the boot.
- Stick the rating plate of the additional LPG supply system in the place indicated in the manual.
- Fill in the guarantee book and documents necessary for proper vehicle registration.

(E20) #115 R - 00 0000	
NAME OF TRADEMARK: ESGI	
TYPE: LPG	ESGI 4
- VAPORIZER / REGULATOR:..... AT - 09	
- GAZ FUELLING SYSTEM:..... AT - 02	
- SAFETY DEVICE:..... 67R 01	
- CONTAINER:..... TW 200	
- INJECTOR / RAIL :..... Type 30	
- FILTER:..... FL - 01	

