# *GENERAL MANUAL*

# *OF INSTALLATION*

# *LPG SYSTEM*

# *WITH ELECTRONIC INJECTION IN GASEOUS PHASE*

# *WITH "MASTER/SLAVE" FUNCTIONING*

## *Retrofit System*

## *TYPE:*

# *BORA LPG*

# *GENERAL MANUAL*

# *Part* I

| **MANUAL ID: MT-IGI-NWBRN-LPG.04-E** | | |
|---|---|---|
| **MANUAL REVISIONS** | | |
| **REV.** | **DATE** | **REVIEWED PARAGRAPHS** |
| 0 | 04/09/2012 | FIRST ISSUE |
| 1 | 26/09/2013 | SECOND ISSUE |
| 2 | 29/09/2014 | THIRD ISSUE |
| 3 | 29/03/2017 | FOURTH ISSUE |
| 4 | 15/01/2018 | FIFTH ISSUE |

***Checked and approved by the Technical Manager: R&D***

Dear installer,

**ZAVOLI srl** wishes to thank you for your choice and inform you on a few points regarding phased sequential injection of **LPG or CNG** in gaseous phase ***BORA LPG***. It is a highly developed injection system, result of experience and continuous research of **ZAVOLI** within the manufacturing field of equipment for LPG and CNG systems for automotive, installable on multipoint petrol injection vehicles.
Thanks to the high degree of integration, ***BORA LPG*** can guarantee higher performances without sacrificing ease of assembly.

The purpose of this installation manual is to clearly and exhaustively guide you through system assembly, help you understand its functioning and scrupulously comply with its entire installation and configuration process.

ZAVOLI sends you best regards and reminds you that the **After-Sales Technical Assistance Centre** is at your complete disposal for any inconvenience.

# RETROFIT KIT *BORA LPG*

# INSTALLATION MANUAL

## *FIRST PART*

The installation manual of the BORA LPG retrofit kit is divided into two parts. The first part contains all information of general nature, the second part contains a collection of the specific installation sheets of each individual vehicle.

## MAIN TABLE OF CONTENTS

## *(FIRST PART)*

## MAIN TABLE OF CONTENTS

## CHAPTER 5

# 1. DESCRIPTION OF THE *BORA LPG* RETROFIT KIT

## 1.1. The *BORA LPG* Retrofit System

The new Zavoli srl system is for gas sequential electronic injection fuelling in gaseous phase with “Master/Slave” functioning for controlled ignition engines. The retrofit kit is available with different configurations for better adaptation to every specific requirement. The main components of the retrofit kit that can be supplied:

- Control unit
- Main wiring
- Change-over Switch
- *ZETA* Regulator – vaporiser
- Gas injectors *JET*
- SENSATA Gas pressure sensors
- Filters
- LPG Solenoid valve
- Piping for system hydraulic-pneumatic connection
- Smallware for system assembly.
- Use, maintenance and warranty manual for the system user


Fig.1.1-1

## 1.2. Features of the *BORA LPG* Retrofit Kit

The ***BORA LPG*** system is realised by means of the most recent designing techniques, an accurate study of the used materials, leading to full quality control on production, enabling installation on advanced generation GAS system vehicles. Therefore, the system is designed in full compliance with the most recent European technical Standards and approved according to regulations UNECE R67-01 – UNECE R115-00. The modern electronic management of Gas ECU, makes the system in that it does not amend the original petrol and gas fuelling systems to the engine. The ***BORA LPG*** retrofit system is defined, on the basis of its functioning principles, a “Master/Slave” type system, in that its electronic control unit, Gas ECU (slave), is able to change-over the control strategy of the Petrol ECU (master) to GAS.

### 1.2.1 Until reaching the *BORA LPG*

During the years, the gas fuelling systems have suffered significant changes due to a revolutionary phenomenon of the engine fuelling systems that has in the last ten years, determined the definitive disappearance, for petrol engines, of the old carburettor fuelling systems, to the advantage of the more modern electronic injection systems, more reliable, safe and less polluting, a very important aspect for the entire population.
In the old generation systems, commonly called "of traditional type", the fuel dosing device is made of a mixer that sees to the continuous gas supply, which entity is determined only by the existing depression in the engine inlet manifold and by the position of one of the regulator screws or of a step-by-step motor.
A traditional type system has revealed to be inadequate to equip the modern vehicle provided with the most sophisticated electronic solutions for carburetion control.
This is why electronic injection for gas also has been essential.
The first systems of this type did not, in fact, give a real solution to the problem having a logic substantially similar to that of traditional systems, in that fuel injection happened with continuous flow ("non master/slave" type system), very different from the phased sequential with which the original control unit manages the engine.
until reaching the ***BORA LPG*** kit with “Mater/slave” sequential type fuelling management, that translates in:

- Reliability.
- Performances.
- Greater respect for the environment.

### 1.2.2 Reliability

Another fundamental aspect regarding the conversion of vehicles with gas systems.
The risk of unwanted mix combustions accompany the use of gaseous fuel for its natural tendency to easily and widely diffuse, the greater the possibility that it can store itself inside the engine inlet manifold.
In particular, functioning conditions, such phenomenon can often cause self-ignition of the load with consequent damages to the manifold.
The above is history, in that, as said, the ***BORA LPG*** injection system realises a *sequential* type injection; the amount of injected gas for each engine cycle is that strictly necessary for individual ignition and is introduced inside the manifold through a *sequence* of impulses, perfectly synchronised with the engine *phases*. This prevents any gas storage as the injection nozzles are installed immediately upstream of the inlet valves.

### 1.2.3 Performances

With the use of old generation, traditional type, systems a drop in performances was inevitable. By adding a device (mixer), upstream of the inlet manifold, that reduces the air passage section, with consequent fluid dynamics load loss meaning a more or less sensitive drop of engine performances, both with petrol and LPG fuelling during normal functioning.
The ***BORA LPG*** retrofit kit manufactured by ZAVOLI does not in any way alter the original engine fuelling circuit, therefore its petrol performances. For the same reasons, performances with gas fuelling are significantly higher compared to those achieved with traditional type systems.
In view of the above, the retrofit kit can be considered of "non-intrusive" type compared to the original engine fuelling system.
A system with "master/slave" functioning confers elasticity and quick response to the engine, thus drastically reducing the classic acceleration delays typical of old generation gas systems.

### 1.2.4 Greater respect for the environment

Zavoli srl has always been very attentive and respectful of the anti-pollution regulations.
The European anti-pollution Standards establish increasingly restrictive limits for toxic substances to exhaust. Currently in force is the EURO 5. All newly registered vehicles within the member states must be compliant with such Directive, even if fuelled with alternative ecological fuel which LPG and CNG.
These fuels are a lot less polluting than petrol in that they contain a reduced amount of damaging substances.
In addition to petrol, toxic additives are added to increase the number of octane, something which is not present in the above alternative ecological fuels. Therefore, a vehicle converted to gas has always a minor environmental impact when using this fuel.
The precise gas dosing control realised by the ***BORA LPG*** retrofit kit, allows fuelling with a stoichiometric mix, to have the right mix strength fuelling the engine in its every situation, fundamental to obtain greater reduction of the polluting agents in the exhaust, to guarantee an excellent catalyst functioning such to have maximum decrease of the statutory polluting agents (CO, HC, NOx).

## 1.3. WARNINGS

### 1.3.1 In case of maintenance or repair stop

In case of bodywork stop for repainting in kiln, pre-emptively remove the LPG tank.
In case of repair of vehicle mechanical, electrical, bodywork parts, it is at the discretion of the operating personnel to evaluate the removal or movement of gas system parts.
**Attention: for safety reasons, the movement or removal of parts or of the entire gas system, must only be carried out by a Zavoli authorised installer.**

### 1.3.2 Environmental functioning conditions

The system is designed to work with environmental temperatures between **– 30 °C and + 60 °C**.

### 1.3.3 After an accident

The system must always be checked by a ZAVOLI authorised installer.

## 1.4. Functioning strategies of the Retrofit System

The BORA system is standard with the petrol system, meaning it ensures that during gas functioning it is still the petrol control unit to determine the amount of fuel to send to the engine. It can also be said that BORA is a "passive system" or "slave", or that BORA works as "interpreter" between the petrol system and the gaseous fuel management. The BORA system functioning is based on the fact that the BORA control unit is connected to clamp or clamps of the petrol control unit piloting the injectors (fig. 1). In this way, it recognises the petrol injection time (Ti). (During gas functioning, the injectors signal will be recognised by the presence of injectors emulation integrated in the same system). Thanks to Ti and to engine revs signal, the BORA control unit calculates the petrol capacity that the original control unit intends to supply to the engine, converts it in gas capacity and realises it by opportunely piloting the gas injectors. This is a very important choice because to enable the petrol control unit to be constantly working and to itself pilot the gas dosing, allows to clearly and transparently realise functions such as stoichiometric control, enrichment in full load and cut-off in release according to the criteria envisioned by the manufacturing company, limiting of the maximum rotary speed, consistent management of petrol steam dispelling, correct communication with air conditioning system, etc. All this without faulty error codes arising.

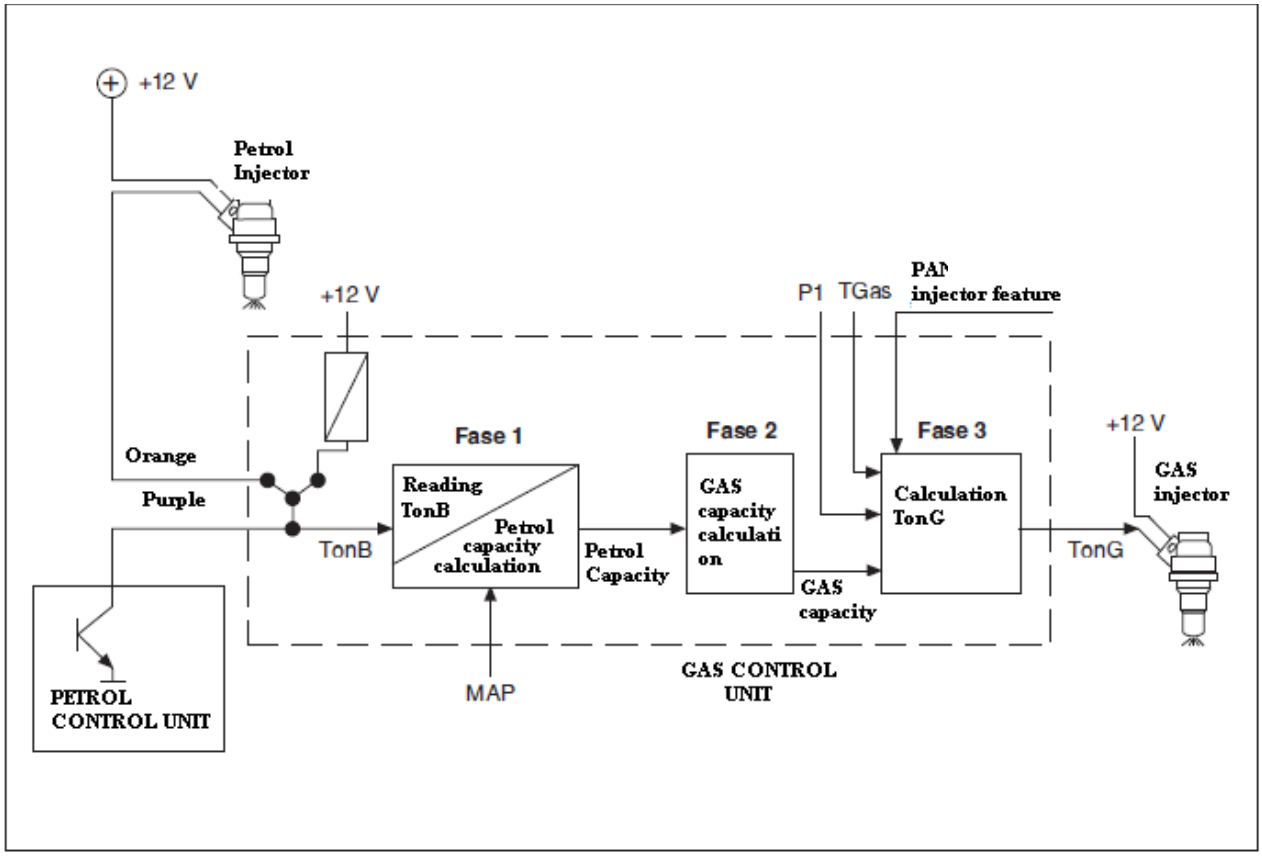



Fig.1.4-1

Master/Slave type functioning layout

Everything remains unvaried with regard to the petrol system, therefore, the eventual appearance of an error message during petrol or gas functioning, is to be considered real and credible. Furthermore, if the vehicle has petrol functioning problems, they also occur in gas functioning. All this is necessary when wanting to also submit gas functioning to the strictest OBD anti-polluting Standards. The low impedance gas injectors are piloted in *peak & hold* mode, bearing in mind the gas physical parameters (temperature and absolute pressure) read by the control unit.
It is important to highlight how Ti is a precise and precious parameter as it is the result of sophisticated calculations implemented by the petrol control unit on the basis of a complete and specific sensor. Given that the gas temperature and pressure conditions can vary depending on the use conditions of the vehicle, the system has adequate temperature and absolute pressure sensors located on the gaseous fuelling of the injectors and on the inlet manifold. The control unit can adjust its calculations in real time and, in particular, can correctly work also in the presence of substantial adrift from said parameters.
The regulators used in the various configurations tend to maintain a practically constant pressure differential between the gas outlet pressure and the inlet manifold, as it happens with many petrol systems. This contributes to optimising the system functioning, but is not essential, in that the control electronics act faster than happens in terms of pressure regulation. For example, following sudden acceleration, the pressure in the regulator rises using a fraction of a second. During this time, the control unit fulfils various calculation cycles and sees to compensating each
delay of mechanical nature. As it can be imagined, the control unit, as well as the general functioning program of the system, must contain the specific car model data on which it is installed (it is a complex set of maps and other mapping-calibration parameters). The personal computer is also used as diagnosis instrument to check the good system functioning or to identify any anomalies.

**Avoid the petrol tank emptying completely. For both the L.P.G. version and the CNG version, it is always necessary to keep an amount of petrol equal to 1/4 or 1/2 tank and periodically refuel it. Please note the importance of always having petrol in the tank also because it is necessary to regularly work the vehicle with petrol, in order to maintain the entire original fuelling system perfectly efficient.**

**In case the vehicle cannot start with petrol (e.g. problems with the petrol pump, etc.), it is possible to start it with GAS and to do this, see par. "change-over switch functioning".**

## 1.5 General description of the components

The ***BORA LPG*** retrofit kit is made of components located on the vehicle as represented in figures 1.5-1.

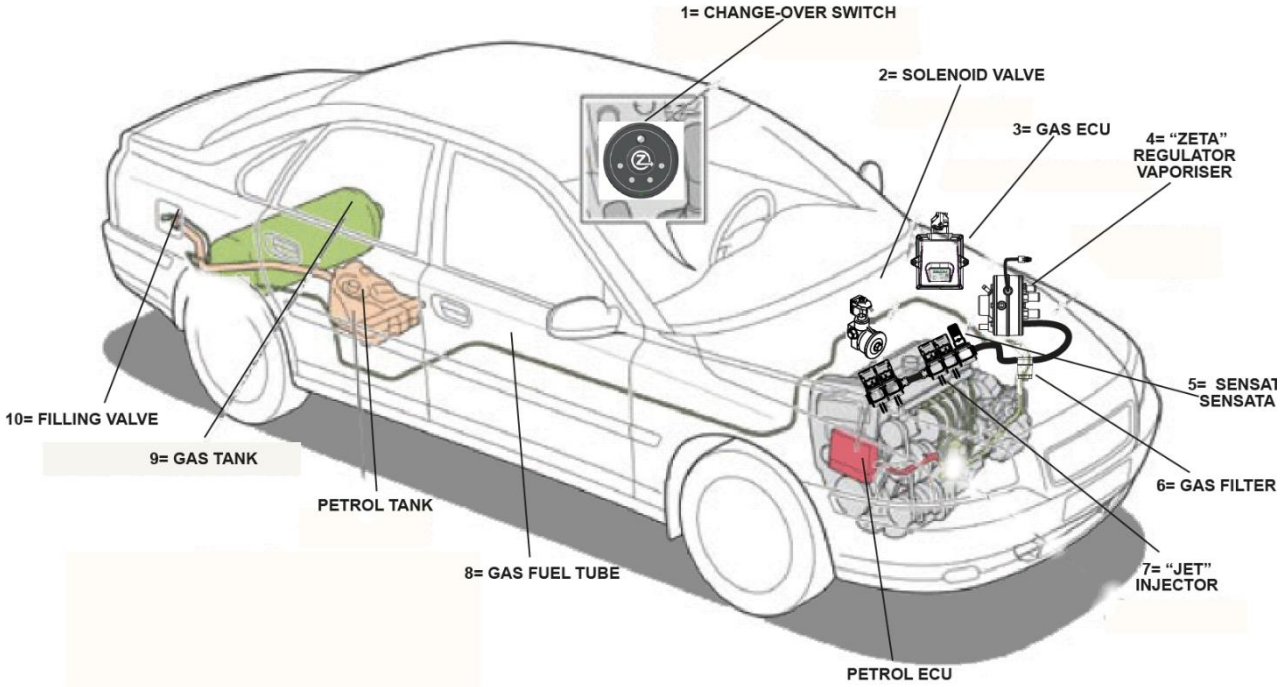



Fig.1.5-1

| BORA LPG RETROFIT KIT<br>MAIN COMPONENTS KEY | |
|---|---|
| **POSITION** | **DESCRIPTION** |
| 1 | CHANGE-OVER SWITCH |
| 2 | SOLENOID VALVE |
| 3 | GAS ECU |
| 4 | ZETA REGULATOR VAPORISER |
| 5 | SENSATA SENSOR |
| 6 | GAS FILTER |
| 7 | JET INJECTORS |
| 8 | GAS FUEL TUBE |
| 9 | GAS TANK |
| 10 | FILLING VALVE |

## 1.5.1 Reducer/Vaporiser

It is the device in which the gas changes from liquid state to gaseous state, with consequent pressure reduction.
The gas coming from the tank reaches the regulator in liquid state. Here it undergoes pressure reduction following lamination, switching from liquid to gaseous state.

### 1.5.1.1 Zeta Reducer

The kit is equipped with regulator/vaporiser called **ZETA**, for managing the working pressure and is available in two versions, **ZETA N** (normal) and **ZETA S** (super). The regulator shown in figure 1.5.1.1-1, is compact-sized and takes up very little space.

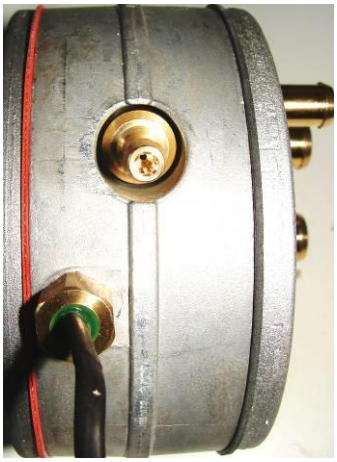

1.5.1.1-1

It is the device in which the gas changes from liquid state to gaseous state, with consequent pressure reduction.
The gas coming from the tank reaches the regulator in liquid state. Here it undergoes pressure reduction following lamination, switching from liquid to gaseous state.
For such transformation to be completed, it is necessary to bring heat taken from the engines' cooling liquid. It also has a pressure relief valve and an integrated water temperature sensor.
Therefore the single stage type **ZETA** regulator, is equipped with a thermal exchange surface such to allow complete gasification even during most extreme use situation (e.g. low ambient temperature, high load for long journeys). For the kit to function correctly, maintain the pressure difference constant between regulator output and engine inlet manifold. As upon increasing of the engine load, the absolute pressure in the inlet manifold increases (called MAP, Manifold Absolute Pressure), therefore, if the regulator outlet pressure is constant the pressure difference would decrease, as would the supplied gas capacity. This is realised by means of a "compensation" circuit, using a rubber tube as communication between the chamber containing the contrast spring and the engine inlet manifold.
All connections on regulator are at the front, figure 1.5.1.1-1, gas inlet, gas outlet, valves for water circulation, whereas at back, figure 1.5.1.1-2 are the fixing screw, the depression valve and in the central part is the screw used to regulate the pressure (use a 4 Allen wrench).

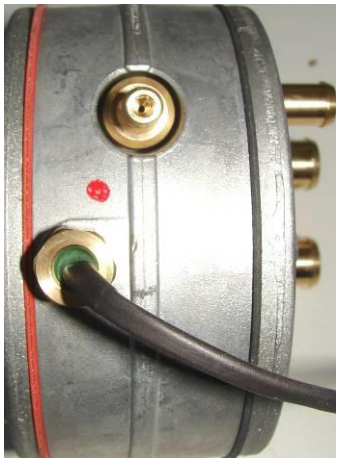

1.5.1.1-2

Figure 1.5.1.1-2 indicates the overpressure valve that must be connected to inlet manifold, according to prescriptions of chapter 2.

To recognise whether the regulator is ZETA N (figure 1.5.1.1-3) or ZETA S (figure 1.5.1.1-4), check the mark near the water temperature sensor. The presence of an N identifies the normal regulator, whereas an S identifies the super regulator. As well as by the S, the super regulator is recognised by a red seal.



1.5.1.1-3



1.5.1.1-4

**IMPORTANT:**
The pressure of the **ZETA N** regulator must be **1,2** atm, whereas that of the **ZETA S** regulator, must be **1,4**, remember to select the used regulator on the program.

## 1.5.1.2 Zeta Plus Reducer

The kit is equipped with regulator/vaporiser called **ZETA PLUS**, for managing the working pressure and is available in two versions, **ZETA PLUS N** (normal) and **ZETA PLUS S** (super). The regulator shown in figure 1.5.1.2-1.


1.5.1.2-1

The new ZETA PLUS lpg regulator for sequential injection systems is able to satisfy the most sophisticated market needs, keeping its installation the easiest possible and combining appealing design with high performances. The ZETA PLUS regulator has been engineered to obtain the most flexible regulator ever, in terms of variety of vehicles and installation options. Its production process is completely automated, thus ensuring large volumes and high accuracy and quality. Multiple, strict tests at the end of the production process guarantee the regulator reliability and performances.
The revolutionary ZETA PLUS regulator, a single stage regulator with membrane mechanism with positive pressure and compensated though a gas-water heating exchange system, is the latest regulator developed by ZAVOLI. It features a very compact design, and so it requires very limited space for its installation.
Additionally, the ZETA PLUS regulator features an integrated solenoid valve (cut-off valve) and a high performance filter. The regulator is fully R67-01 homologated.

**IMPORTANT:**
The pressure of the **ZETA PLUS N** regulator must be **1,2** atm, whereas that of the **ZETA PLUS S** regulator, must be **1,4**, remember to select the used regulator on the program.

### 1.5.2 GAS ECU

1.5.2-1

1.5.2-2

The control unit works as operational control unit controlling the entire system. It is fully realised with automotive components, suitable for supporting the temperature of the engine compartment, even if it must not be installed near scorching devices such as the exhaust manifold. It holds recently conceived components, provided with
greater data processing speed compared to most original petrol control units. The memory holding the program and calibration data is not volatile, therefore, once programmed, the BORA control unit can even be disconnected from the battery without loss of data. It can be repeatedly programmed, for example it can be transferred from one vehicle to another and re-programmed. Certain data acquisition channels are realised so that they
can be connected to different signals from one vehicle model to another (e.g. TPS, MAP, etc.). The task of the control unit is to collect and process all information and consequently check the various system functions.
The Sequent system is able to guarantee best integration at electronic and communication level (through K and CAN BUS serial line), keeping the petrol control strategies unvaried and precisely and quickly "translating" the injection times of the petrol control unit in corresponding gas injection times, automatically adapting to the pressure and temperature variations of the same gas.
Arranged with an efficient and functional diagnosis system on each sensor and actuator of the system, it is suitable for satisfying the OBD regulations.
The control unit is contained inside a fully watertight robust aluminium and plastic body shell, able to support very high temperatures and to protect the electronics inside it from external atmospheric agents and from the mechanical stresses it is submitted to, from the electro-magnetic radiations radiated from the engine electric components or from other sources (transmitters, repeaters, mobile phones, etc.).
Note that the control unit has been designed to resist to prolonged short circuits, towards battery mass and towards positive, on each of its input/output wires (except power supplies and masses).
This allows not to ruin the control unit even when in presence of the more common wiring errors (reverse polarity, incorrect connection of one or more wires, etc.).
Connection to wiring happens through a single connector containing all signals necessary for the various functions performed, limited to the piloting of maximum 4 injectors. Integrated inside the control unit are the following functions, before obtained through installation of different external components:
• “**modular**” function for the interruption and emulation of injectors,
• the control unit contains the main **adapters for lambda probes “in current” and “powered”**, to be assembled externally in the other systems.

## 1.5.3 Gas Injectors

Two types of injectors can be combined with the ***BORA*** retrofit kit.
The first is the rail **JET**, figure 1.5.3-1, whereas the second is the injectors rail **IN03**, figure 1.5.3-2.
The injectors dose the gas coming from the regulator for the individual cylinders opportunely piloted by the gas ECU. Functioning is of electro-magnetic type, made of one or more coils piloting a shutter for the flow opening and closing.
The injector is connected, by means of a fitting, to tube inlet coming from the regulator and, by means of a calibrated nozzle or jets, depending on the used injector type, to tube outlet connected to inlet manifold, near the inlet valve. The section of the outlet nozzle to injectors is opportunely chosen depending on the specific power class of the engine.
The injectors must be installed as close as possible to the inlet manifold leg, using rubber tubes of equal length, and the connection distance between the injectors and the fixing point of the injection nozzle must be as reduced as possible.

1.5.3-1


1.5.3-2

### 1.5.4 Gas temperature and pressure sensors

1.5.4-2

This sensor 1.5.4-2 with compact body and already integrated with connector, is available in the version with P1 pressure sensor and gas temperature sensor.
The gas temperature and pressure measurement is more accurate with this sensor and allows
quickly intervening in gas carburetion corrections.

#### 1.5.4.1 Manifold Absolute Pressure Sensor (Map)

1.5.4.1-1

This sensor (pict. 1.5.4.1-1) is light, small and easy-to-fix to the car body. It has a pressure sensor suitable for both aspirated and turbo-CNG engines, allowing an accurate setting on every kind of vehicle.

### 1.5.5 System hydraulic-pneumatic piping and fittings

The piping is the end part of the retrofit kit fuelling circuit. The gas flows through it near the inlet valve. Its location defines the physical point where gas is delivered to individual cylinder. From here derives the importance of scrupulously complying with the installation methods described below. Connection between the injectors outlet tubes and the inlet manifold, happens by means of brass fittings to be fixed on the inlet manifold.

The retrofit kit is correlated by the following tube diameters, depending on use:

- Diameter 15 water tube with relative joints and strips. Take water from a point where constant flow is guaranteed.
- Diameter 5 tube used for depression connection to regulator.
- Diameter 5 tube, used for connection from injectors to injection fitting on inlet manifold.
- Diameter 10 tube, used for connection between regulator and injectors.

### 1.5.6 Main wiring

The instructions below are generally valid and essential for good understanding of the system. The control units connect with the remainder of the electric system of the BORA LPG system (power supplies, masses, signals, sensors, actuators, etc.) containing all signals necessary for the various functions.
Most of the wires are terminated on pre-wired connectors, thus making it very easy to connect the system elements to the control unit. Also, the conductors are split in more sheaths to simplify installation and acknowledgement
of the various wires.

All connections relating to unterminated wires on connector must be carried out by means of adequate insulation and correct soldering iron. Absolutely avoid carrying out connections by simply wrapping the wires or using other barely reliable systems.

### 1.5.7 Change-over switch

1.5.6-1

It is a change-over switch with separate buzzer, with 4 green LED level indicator to indicate the gas level and
eventual error signals and by a two colour LED (green-red) to indicate functioning with gas or with petrol.
Unlike the change-over switches until now supplied, the One-Touch change-over switch has one position. The fuel variation is acknowledged every time the button is pressed.
The control unit recognises and memorises the fuel state (gas or petrol) the moment the vehicle is switched off, so that the same state is proposed upon subsequent ignition. Therefore, if upon switch-off the vehicle is in gas state, the gas state is memorised upon ignition (the same for petrol state).

## 1.5.8 LPG solenoid valve

The liquid LPG on-off solenoid valve coming from the tank and going to the regulator, is compact-sized and takes up very little space.
It is installed directly on to the regulator or upstream of the same. It is a normally closed device that prevents the passing of the LPG when not electrically powered. Also, the filters replacement and/or cleaning, happens without disconnecting the fuelling tubes.

## 1.5.8.1 Standard LPG Solenoid valve

The liquid LPG on-off solenoid valve coming from the tank and going to the regulator, is compact-sized and takes up very little space. It is installed immediately upstream of the regulator (the basic version of Figure 1.5.9.1-1 the connection to the reducer takes place via the junction of the copper tube diameter 6, for all versions super connection is of diameter 8 Figure 1.5.9.1-2) in compliance with regulation UNECE R67-01. The solenoid valve is made an electro-magnet that opens the valve when activating a shutter, enabling LPG passage. It is a normally closed device that prevents the LPG passage when not electrically powered. Also, the filters replacement and/or cleaning, happens without disconnecting the fuelling tubes.

1.5.9.1-1

1.5.9.1-2

## 1.5.8.2 “ET98 NORMAL” WP LPG solenoid valve

The LPG solenoid valve is of Water Proof type (with watertight connectors), figure 1.5.9.2-1.
Improvements have been made to the filtering system inside the LPG solenoid valve, particularly the iron-magnet particles.
Given the injectors functioning precision, the use of this type of solenoid valve is compulsory.

## 1.5.8.3 “ET98 SUPER” WP LPG solenoid valve

The ET98 Super solenoid valve, figure 1.5.9.3-1, is an LPG on-off device necessary and conceived to give higher performances compared to previous. An improved coil allows a more efficient opening force. This allows having
greater passage sections with consequent greater LPG flow.
In this case also, the solenoid valve has been conceived to allow fuelling of engines with higher power, maintaining a high filtering degree. Equipped with Water Proof connectors, the solenoid valve body is brass coloured without superficial coating, whereas the coil is red.

1.5.9.2-1

1.5.9.3-1

## 1.5.9 Gas filter in gaseous phase

It is a cartridge filter located after the regulator-vaporiser and allows withholding all those impurities (oil, wax, etc.) on which it would not be possible to act otherwise and that would jeopardise the injector functioning. Routine maintenance of the cartridge filter is essential for long lasting efficient filtering.
In the figure (1.5.10-1) the filter Zavoli “400.FILTER” at decantation, in the figure (1.5.10-2) its relative cartridge. In the figure (1.5.10-3) the filter ZWM CZAJA “FL01.

1.5.10-1

1.5.10-2


1.5.10-3

### 1.5.10 Tanks and Accessories

The retrofit kit is designed to function with an LPG tank with gas withdrawal in liquid phase. The tank must be provided with the accessories as listed in relative approval certificate in compliance with Standard UNECE R67-01.
Often certain accessories listed below are grouped in individual multifunctional component called "multi valve", assembled on appropriate tank ring nut:

- Air lock (only in case of accessories located inside the vehicle).
- On-off solenoid valve.
- LPG filling valve (connection for refuelling).
- Filling limit valve at 80% of tank.
- Excess flow valve.
- Overpressure valve.
- Thermal cut-off (if envisioned by tank approval).
- Level indicator sensor (device for detection of LPG level inside tank).

## 1.5.11 High safety standards

The gas systems offer a very high level of safety, equal to the corresponding petrol fuelling system, both during normal use and in case of accident. To guarantee high safety standards, established by the European approval regulations UNECE R67-01 and R115-00, the system must be equipped with the devices described below.

### 1.5.11.1 Air lock

It is an air-tight container used when the tank is installed inside the passenger compartment, it acts as conveyor of eventual outgoing LPG exhausts from the overpressure valve or leaks from components connections. The ventilation housing must directly communicate with the atmosphere outside the vehicle, through flexible pipes and air nozzles.

### 1.5.11.2 On-off solenoid valve

The system is equipped with two LPG on-off solenoid valves:
- Solenoid valve on multi valve or tank valve unit.
- Solenoid valve upstream of regulator.

Both automatically isolate the tank from the remainder of the system. The valves are automatically closed in the following cases:
- With engine off.
- During petrol functioning.
- In case of intervention of "Safety car" function.

### 1.5.11.3 Filling limit valve

The valve unit or multi valve is equipped with a valve that, during gas refuelling, automatically limits filling to 80% of the available volume. The liquid LPG volume tends to significantly increase with the temperature as it has a high volumetric thermal expansion coefficient. The filling limit is used to guarantee the presence of a sufficient gaseous volume inside the tank to allow volumetric expansion, caused by any increases of the ambient temperature. Without such volume, following a temperature increase, the pressure inside the tank would quickly increase until causing the intervention of the overpressure valve.

### 1.5.11.4 Excess flow valve

It is a mechanical valve that, in case of accident the tank gas outlet piping is broken, automatically activates to block the gas leaking.

### 1.5.11.5 Overpressure valve

It is a valve in the valvular unit or in the multi valve, that intervenes in case the pressure inside the tank reaches the intervention threshold, equal to 27 bar ±1 bar, due to ambient temperature increase. It is a spring activated mechanical valve in communication with the gaseous phase of the tank and it can exhaust outside the vehicle, directly into the atmosphere or indirectly through the "air lock". Exhaust is limited to the short period necessary for the pressure value inside the tank to drop below the intervention threshold of the same valve. When the pressure inside the tank reaches the value below the intervention threshold, the valve closes returning to ready for intervention condition.

### 1.5.11.6 Thermal cut-off

Safety device in the valve unit or in the multi valve, that activates in case the vehicle temperature rises (e.g. start of a fire), ensuring that the gas inside the tank leaks out, thus limiting the risk of explosion of the tank. Once the intervention temperature of (120 ± 10) °C is reached, the "fuse" melts allowing regular and complete emptying of the tank. It is an irreversible type device ("one-shoot").

# 2. INSTALLATION INSTRUCTION

The installation instruction in this chapter are of general nature. For specific instructions regard each individual vehicle, refer to the specific installation sheets contained in part II of the manual.

## 2.1 Preparation for the installer

Before installing the ***BORA LPG*** RETROFIT KIT, the technical personnel of the installation workshops must attend a training course, exclusively authorised or held by ZAVOLI srl.

## 2.2 Check and Recommendations

Before installing the system, consult the specific installation sheets in part II of the manual; it is a good rule to check the functioning of the petrol vehicle. In particular, carefully check the state of:

- Air filter efficiency.
- Ignition system (cables, spark plugs, coils).
- Lambda probe efficiency.
- Catalyst efficiency.
- The absence of malfunctionings relating to emissions, of the petrol engine, can be detected using diagnosis instruments.

Carry out the necessary amendments and adjustments and, if necessary, replace the components.

## 2.3 Equipment and consumption material necessary for installation

⇒ Gas exhaust analyser
⇒ Hydraulic ramp
⇒ Bench vice
⇒ Pipe cutter for copper pipe
⇒ Pipe cutter for rubber tube
⇒ Assorted tools spanners
⇒ Male M6x1
⇒ Tap wrench
⇒ Various sized screw drills (from Ø 1.5 to Ø 12 mm)
⇒ Boring machine
⇒ Cordless drill
⇒ Cup wheel cutters Ø 75mm, Ø 32mm
⇒ Multimeter
⇒ Personal computer
⇒ Management/configuration software of the ***BORA LPG*** retrofit kit complete with relative communication interface device.
⇒ Diagnosis instruments for vehicles.
⇒ Soldering iron
⇒ Grease
⇒ Heat shrink tubing

⇒ Insulating tape
⇒ Thread-locking sealer
⇒ Alloy for soft soldering
⇒ Leaks detecting liquid
⇒ Anti-corrosion products

## 2.4 MECHANICAL INSTALLATION

Described in this manual is the installation of the BORA LPG Retrofit kit components, according to conformities prescribed and reported in the UNECE R67-01 Regulation and the UNECE R115-00 Regulation.
The installation of all retrofit kit components must guarantee the best protection against damages caused by the vehicle mobile parts movements, by impacts with load during run or during vehicle load and unload operations, by impacts with ballast, etc.
After having made the holes (e.g. for fixing of regulator or for cable passage), the metal surface must be treat with and anti-corrosion product.
Fix all flexible piping using the provided strips, ensuring there are no contacts or frictions with other mechanical parts.
No kit component must be positioned at less than 100 mm from the engine exhaust pipes or other heat sources. The possibility of reducing such distance, despite being envisioned by circular, must be accompanied by an application study (point 1l attachment 1 and prescription of paragraphs 17.1 and 17.2 of Regulation ONU ECE R67-01).
The tank assembled under the plane must have a minimum distance from the road surface of 200 mm (with vehicle in running order), and must, in any case, be protected by steel sheet in the front and side areas.

### 2.4.1 ZETA Regulator/Vaporiser

The following general installation criteria is to be considered valid for both LPG and CNG versions.
The **ZETA** regulator must be securely fixed to the bodywork and such not to be object of vibrations during functioning. With engine under stress, the regulator must not bump against any other device.
The regulator must be installed with the temperature sensor upwards. We recommend containing the length of the pipe connecting the regulator to the injectors (MAX 700 mm) and assemble the regulator so that it is easily accessible in case of adjustment or repair interventions.
Connection with the piping from the tank must be by means of a copper pipe (figure 2.4.1-1A) if the **ZETA** regulator type **"N"** is used. In case of using **ZETA** regulator type **"S"**, connection happens by tightening the solenoid valve on to the gas inlet fitting of the regulator, Fig. 2.4.1-1B.

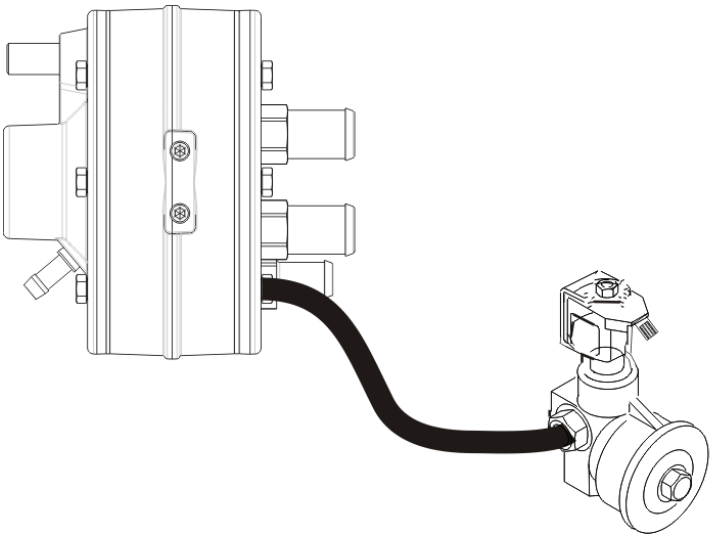


Fig. 2.4.1.-1A

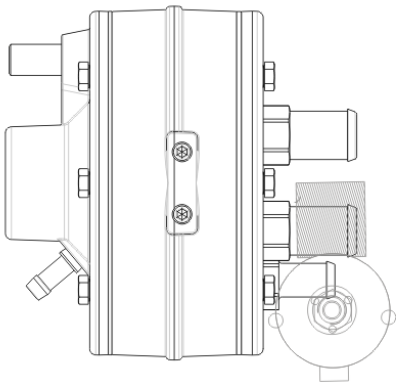


Fig. 2.4.1.-1B

**The tract of copper pipe from the solenoid valve to the ZETA regulator, must not pass through very hot engine compartment areas. The installer must avoid uncomfortable areas in order to be able to easily carry out any maintenance interventions.**

For complete gasification of the LPG, withdraw heat from the engine cooling liquid. The water connection happens in parallel compared to the heating circuit of the passenger compartment, figure 2.4.1-2. Connection is carried out by interrupting the flow and return piping of the passenger compartment heating circuit. Two "Ts" must be used, one on exchanger flow and the other on exchanger outlet.

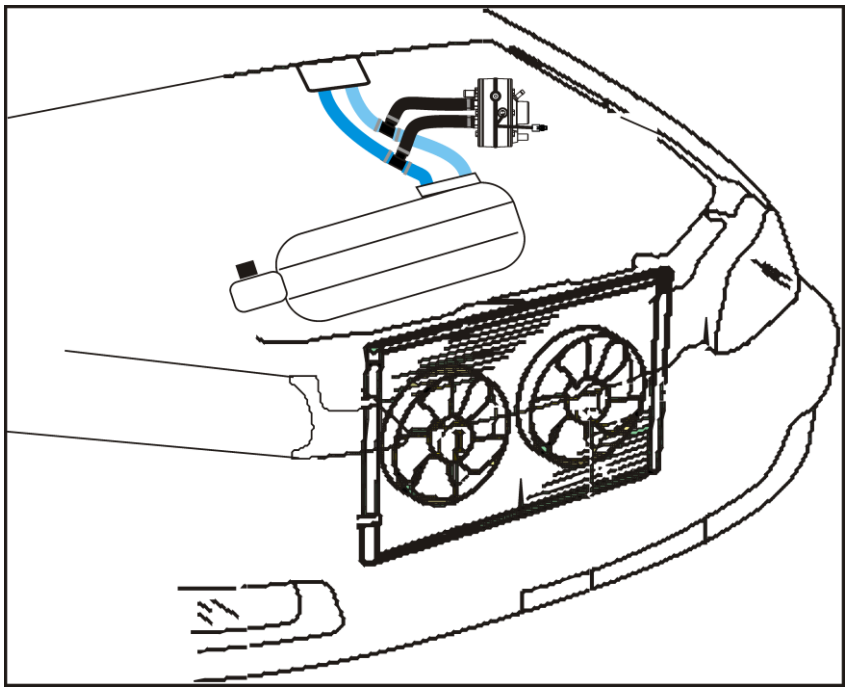


Fig. 2.4.1 -2

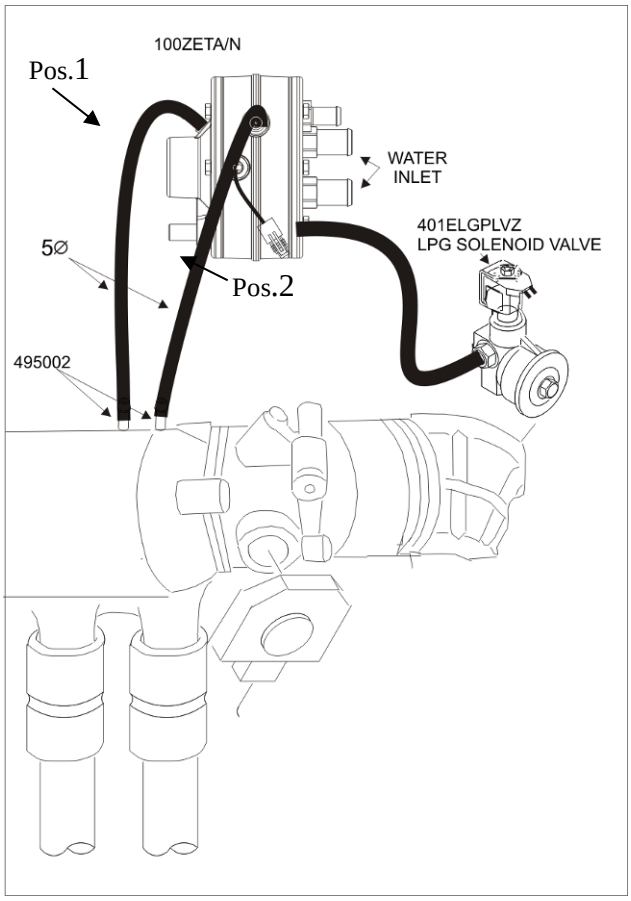



Fig. 2.4.1 -3

For correct functioning of the **ZETA** regulator, as prescribed in previous chapter, compensation must be carried out of the pressure connecting the regulator (figure 2.4.1-3 pos. 1) with the inlet manifold. Such connection happens using a Ø 5 mm rubber tube, one tube end is connected to the regulator fitting, the other end to a provided fitting, to be installed prior perforating and threading on the inlet manifold. The position of the hole must be exactly downstream of the butterfly valve and upstream of the ducts of the inlet manifold directed to the individual cylinders; the tube length must not exceed 700 mm, figure 2.4.1-3.
As well as the compensation fitting, the regulator is supplied with an overpressure valve (figure 2.4.1-3 pos. 2) which must also be connected to the inlet manifold through a Ø 5 mm rubber tube. With the same connection procedure as above.
To guarantee seal of the threaded connection, before assembly, apply thread-locking liquid on the fitting shank. During tightening of the fitting, ensure the thread-locking liquid does not drip, causing blocking of the nozzles. We therefore recommend injecting compressed air jets inside the nozzles at end of operations.

**We recommend that all perforating, masking, tightening of the fitting and manifold cleaning is carried out with inlet manifold dismantled. In case it is not possible to dismantle the inlet manifold, use all possible precautions to minimise the risk of damaging the engine (e.g. grease the nozzles before working, frequently remove the chippings during working).**

### 2.4.2 Connection piping

The pipes must be joint with the fittings supplied inside the kit. Junctions of welded, soldered or stapled tubes are not admitted. The tubes (stiff or flexible) inside the passenger compartment or the luggage compartment, must not be longer than minimum indispensable, the piping must follow the shortest path among the possible ones.
Connections between the tubes must be enclosed by the "air lock" or equivalent protection that conveys any gas leaks into the external atmosphere and cannot be positioned inside the passenger compartment or the luggage compartment.
In case of holes in steel sheet for passage of flexible or stiff tubes, protective material must be applied on the holes edges.
To correctly install the connection tubes, prevent them coming into contact with the bodywork or engine sharp edges, blunt objects and mobile parts (e.g. transmission belts, shock absorbers, exhaust manifold, etc.) and, therefore, producing continuous frictions until wearing of the same. Another rule for correct installation is that the tubes must not be excessively tensioned or be folded, thus reducing the section. Once the kit is installed, all junctions of the liquid or gaseous LPG circuit must be checked during normal gas functioning

of the vehicle, using leaks detecting liquid. The retrofit kit has rubber tubes and copper pipes.
The copper pipes supplied in the Kit must be cut to measure by the installer, using appropriate pipe cutter. Once the pipe is cut, "trim" the inside hole to avoid blocking due to cut residue.
Connections with the copper pipe happen by means of fittings with pressure screws and double cone nose cap. During assembling, manually tighten the pressure screw by at least one turn, thus avoiding damage to threading during the fastening operation. Tighten enough to guarantee seal.
The rubber tubes supplied in the Kit must be cut to measure by the installer using appropriate pipe cutter. After having cut them to size, eliminate any cut residue that might jeopardise functioning of the connected components. It is essential to clean inside the tube before definitive assembly using a jet of compressed air. The connection of the tubes on the relative fittings must be realised using the provided strips.

### 2.4.3 LPG solenoid valve

The liquid LPG on-off solenoid valve coming from the tank and going to the regulator, is compact-sized and takes up very little space. It is installed immediately upstream of the regulator (in basic version, figure 1.5.9-1, connection to regulator happens by means of joining the 6 diameter copper pipe. For 5-8 cylinders version, the solenoid valve is connected directly to regulator, figure 1.5.9-2, and for all super versions, connection is the same as for 5-8 version, except that the diameter of the fuelling pipe is not 6 but 8, figure 1.5.9-3).

### 2.4.4 Filters in gaseous phase

Ensure connecting the pipe coming from the regulator with the filter inlet fitting, and the pipe going to the injectors with the filter outlet fitting. The piping connecting the regulator to the filter is made of rubberised fabric and must be connected on the fittings using the provided metal strips.

### 2.4.5 Injectors

The injectors must be installed securely and as close as possible to the inlet manifold, in that it is very important that the length of the connection pipes from the injectors going to the inlet manifold, do not exceed 150 mm of length. The injectors and relative "Calibrated jet" are mainly chosen based on the specific engine power (power per cylinder in kw/cylinder).

### 2.4.5.1 Rail JET 4 cylinders injectors with sensor (2+2) assembly kit

***New System Bora "Kit Code – 612MKI2+2/B"***

Figure 2.4.5-1 describes the operations for correct assembly, in progressive number.

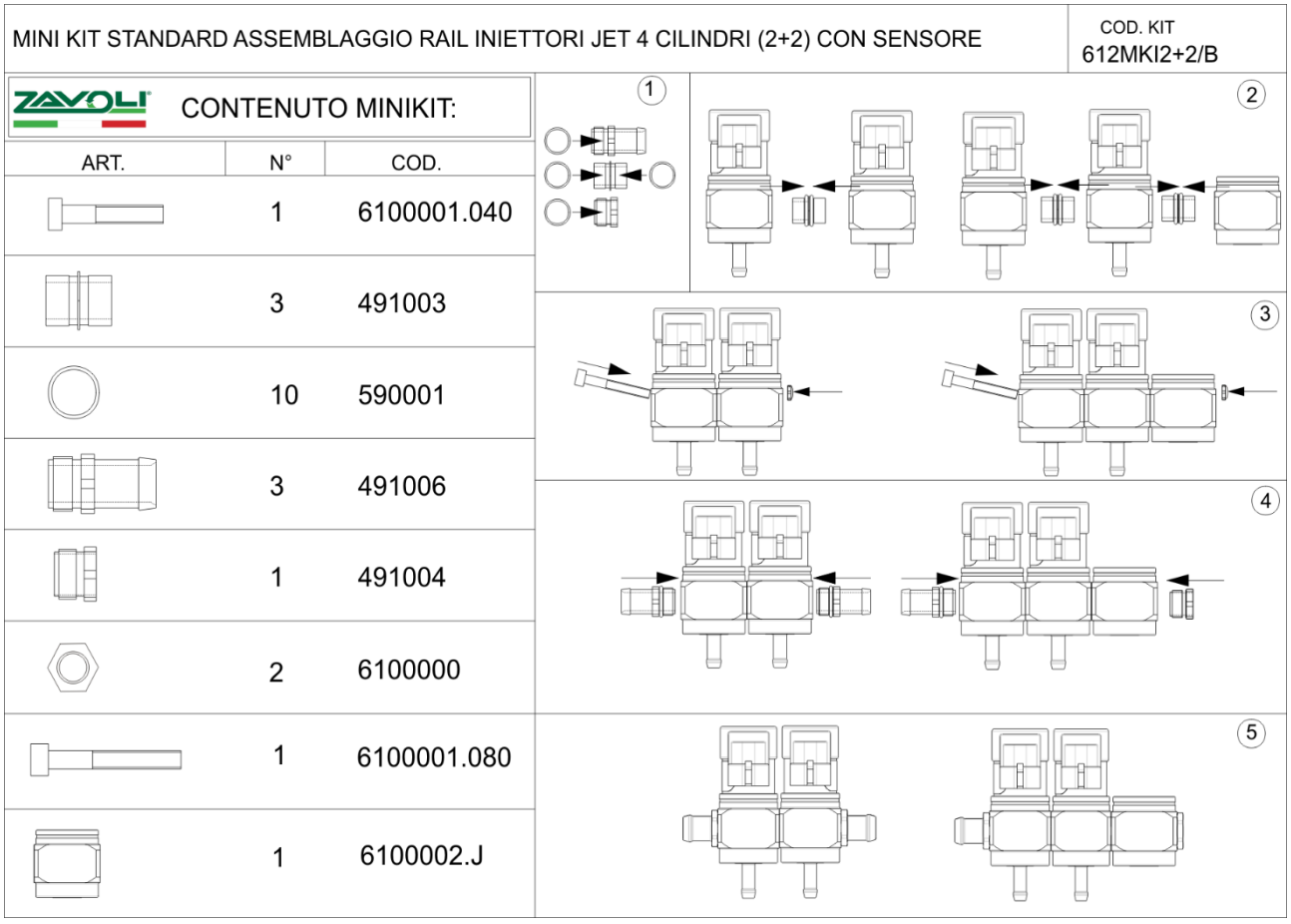



Fig. 2.4.5.1-1

### 2.4.5.2 Rail JET 3 cylinders injectors with sensor (3X1) assembly kit

***New System Bora "Kit Code – 612MKI3/B"***

Described below are the operations for the correct assembly, according to progressive number of Figure 2.4.5.2-1.

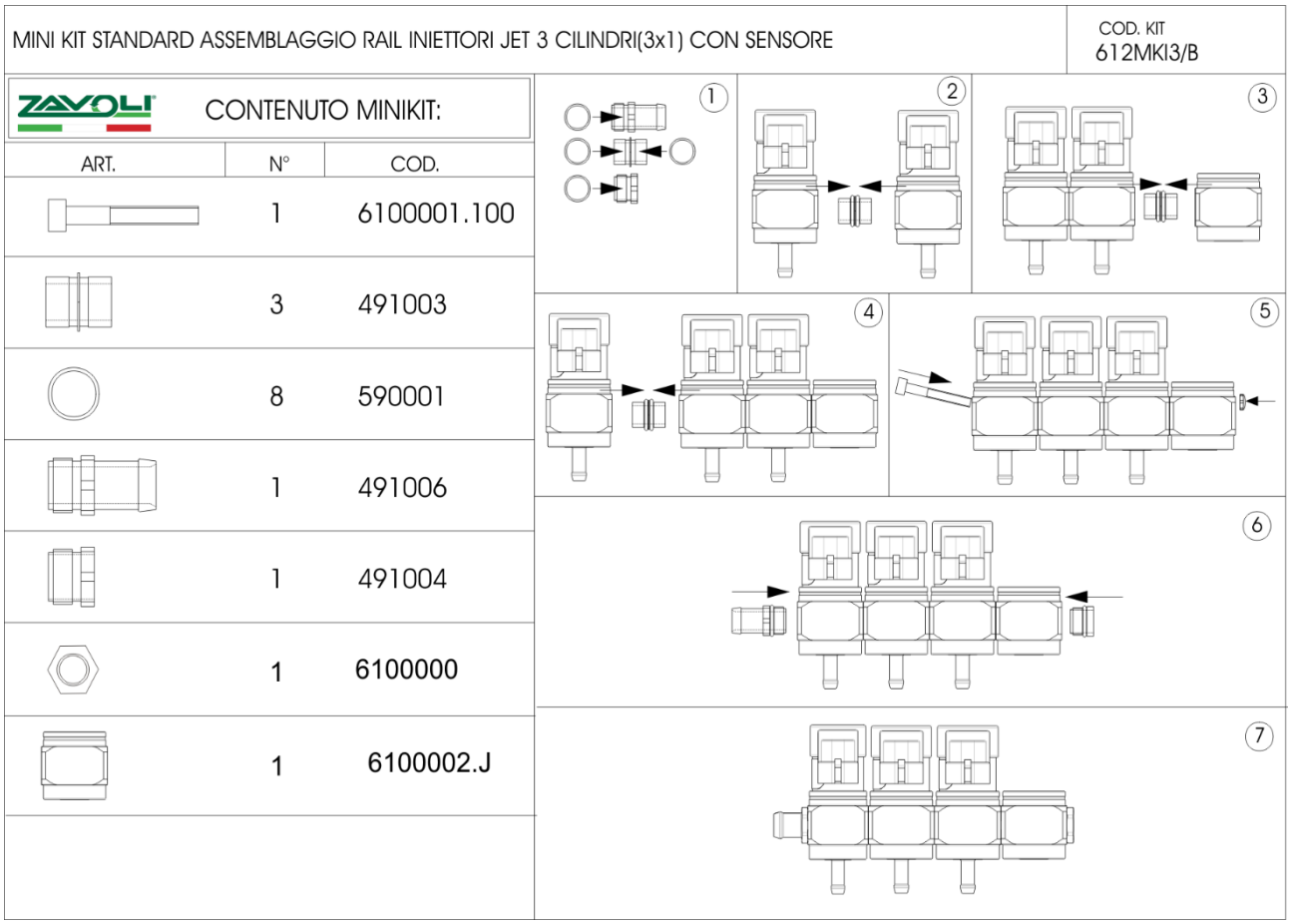



Fig. 2.4.5.2-1

### 2.4.5.3 Rail JET 5 cylinders injectors with sensor (2+3) assembly kit

***New System Bora "Code Kit – 612MKI2+3/B"***

Described below are the operations for the correct assembly, according to progressive number of Figure 2.4.5.3-1.

MINI KIT STANDARD ASSEMBLAGGIO RAIL INIETTORI JET 5 CILINDRI(2+3) CON SENSORE

COD. KIT 612MKI2+3/B

ZAVOLI CONTENUTO MINIKIT:

| ART. | N° | COD. |
|---|---|---|
| | 2 | 6100001.070 |
| | 4 | 491003 |
| | 12 | 590001 |
| | 3 | 491006 |
| | 1 | 491004 |
| | 2 | 6100000 |
| | 1 | 6100002.J |

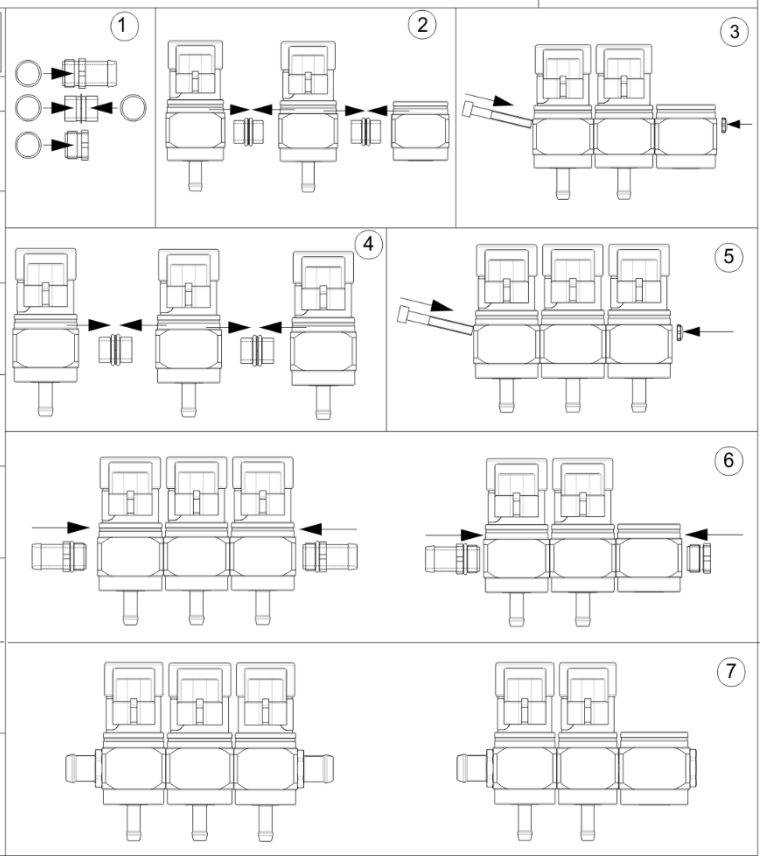



Fig. 2.4.5.3-1

### 2.4.5.4 Rail JET 6 cylinders injectors with sensor (3+3) assembly kit

***New System Bora "Code Kit – 612MKI3+3/B"***

Described below are the operations for the correct assembly, according to progressive number of Figure 2.4.5.4-1.

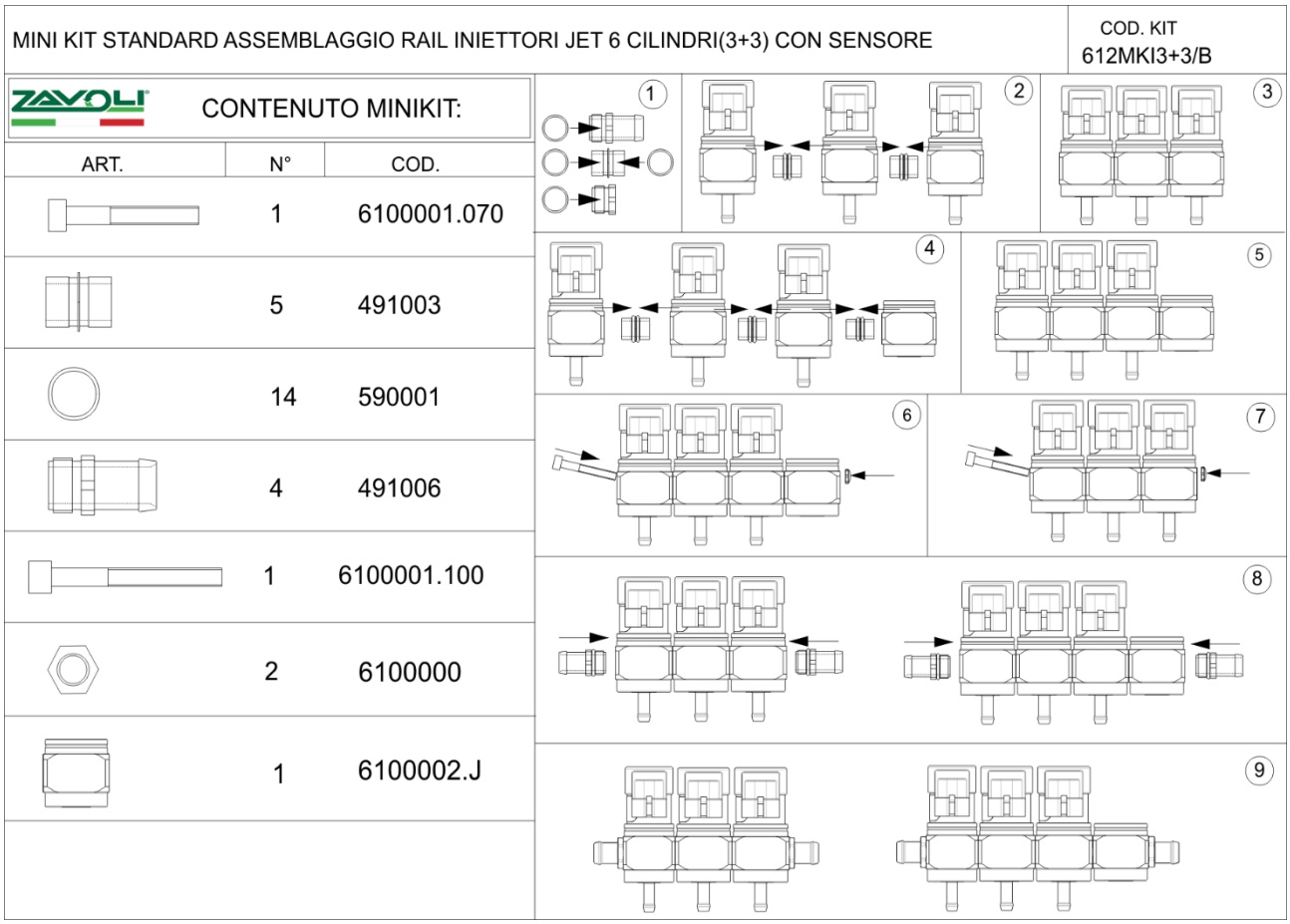



Fig. 2.4.5.4-1

### 2.4.5.5 Rail JET 8 cylinders injectors with sensor (2X4) assembly kit

***New System Bora "Code Kit – 612MKI2X4/B"***

Described below are the operations for the correct assembly, according to progressive number of Figure 2.4.5.5-1.

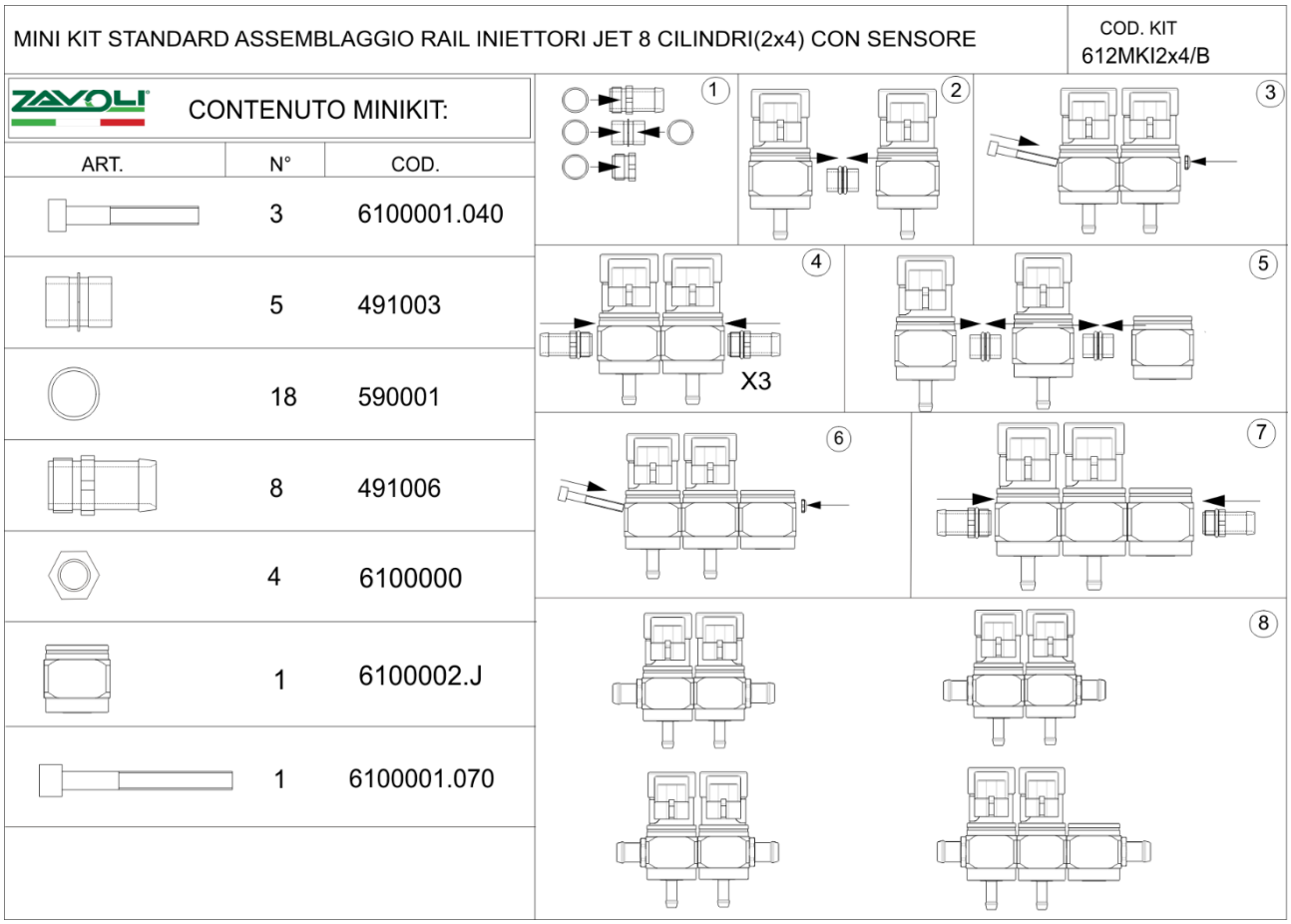



Fig. 2.4.5.5-1

### 2.4.5.6 Rail JET 4 cylinders injectors with sensor (1x4) assembly kit

***New System Bora "Code Kit – 612MKI1x4/B"***

Described below are the operations for the correct assembly, according to progressive number of Figure 2.4.5.6-1.

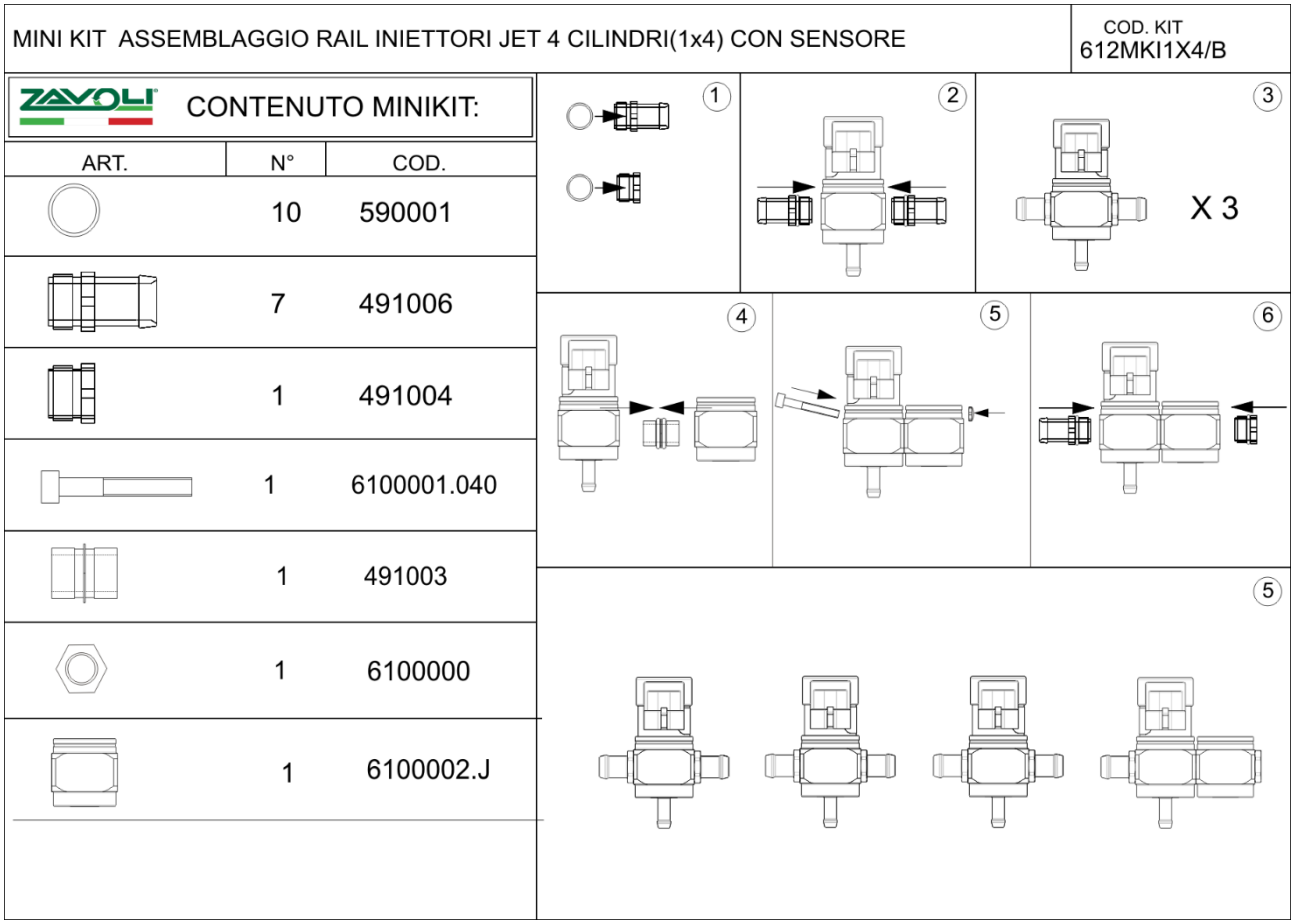



Fig. 2.4.5.6-1

**We recommend paying attention to any bends in the inlet manifold-injectors connection pipes, ensuring such bends are "smooth", with wide bending range, so that there are no "crushings" (choking) preventing the correct functioning of the system.**

### 2.4.6 Injection nozzles installation

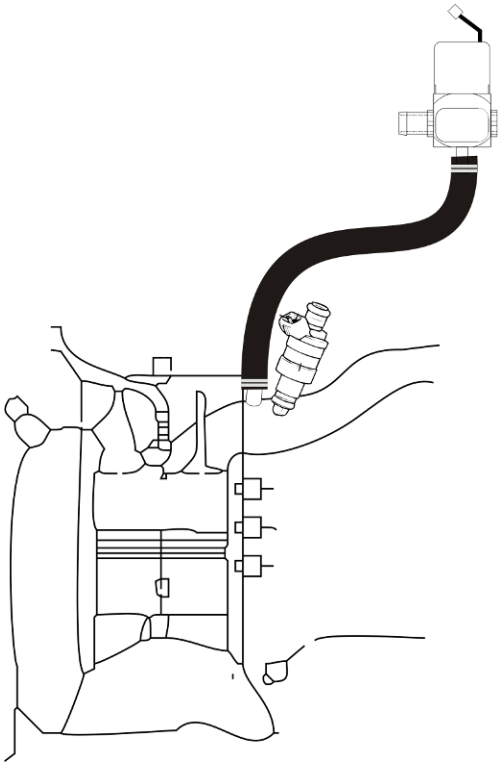


Fig 2.4.6-1

This section of the manual constitutes one of the most important phases of the entire work.
We recommend clearly identifying all manifold points that must be
perforated, before starting perforation. Perforation must happen very close to the engine head, figure 2.4.6-1, but keeping the same distance on all manifold legs and the same direction of the nozzles. Each nozzle must be perpendicular to the inlet duct axis or form an angle such to direct the flow towards the engine and not towards the butterfly. After having accurately marked the perforation holes using a felt-tip marker, before starting perforation, use the screw drill to check that there is nothing preventing the correct perforation of all legs, according to the wanted direction. Before perforating the manifold, also check that the chosen position of the nozzles allows disposing the connection pipes to the injector, so that their lengths do not exceed the maximum admitted (150 mm). Punch mark and then perforate. Perforation must be made using Ø 5 mm screw drill, threading using M6 male. Given the extremely delicate operation, due to the risk that the perforation chippings may deposit inside the manifold therefore be sucked by the engine during functioning.
We recommend perforating, masking, greasing the point during the last phase of wall perforating, so that chippings remain stuck to the point. Also, slowly perforate the last part of the wall so that chippings are very fine: thus better sticking to the point and, should some fall inside, not cause damages. Also during M6 threading it is necessary to grease, remove and clean the male. Pay utmost attention in correctly introducing the nozzles, avoiding excessive tightening to prevent stripping them. We recommend always using an adequately sized spanner during fastening. Do not amend the internal diameter of the nozzles or their external shape. To guarantee watertightness of the threaded connection, before assembly, apply thread-locking liquid on the fitting shank. During tightening of the fitting, ensure the thread-locking liquid does not drip, causing blocking of the nozzles. We therefore recommend injecting compressed air jets inside the nozzles at end of operations.

**We recommend that all perforating, masking, tightening of the fitting and manifold cleaning is carried out with inlet manifold dismantled. In case it is not possible to dismantle the inlet manifold, use all possible precautions to minimise the risk of damaging the engine (e.g. grease the nozzles before working, frequently remove the chippings during working).**

### 2.4.7 Tanks and accessories fixing prescriptions

The tank must be installed on the vehicle in compliance with the installation requisites in Regulations UNECE R67-01 and R115-00.
Main requisites:
1. Tank installation must be compliant with the prescriptions reported in the specific installation sheet of the vehicle.
2. The tank must be permanently installed on the vehicle and never in the engine compartment.
Protective material, such as felt, leather or plastic, must be interposed between the fuel tank and the fixing strips.

1. In case the tank is installed underneath the vehicle plane, it must distance at least 200 mm from the road surface, with vehicle in running order. Regulation envisions being able to go below this quota, as long as a real and proper protection structure is installed, suitably studied for individual application.
2. The tank must be anchored to the vehicle body shell using appropriate fixing structure. The following assembly conditions must be complied with.

    - The tank must be bound using at least two strips to the fixing structure;
    - the strips must guarantee that the tank does not slide, rotate or be moved from its seat;
    - the fixing structure must envision at least 4 bolts;
    - if the ends of the anchoring structure to the vehicle body shell are in correspondence with the single shim steel sheets, use a suitably sized back-up washer.

The sizes of the strips, the bolts and the back-up washers must be chosen according to that specified in the following table. Such table is valid if the strips and back-up washers are in EN 10025-S232 steel and the bolts in class 8.8 steel.

| Tank capacity (litres) | Minimum sizes of the washers or plates (mm) | Minimum sizes of the strips (mm) | Minimum sizes of the bolts (mm) |
|---|---|---|---|
| Up to 85 | Ø 30 × 1.5<br>Ø 25 × 2.5 | 20 x 3<br>30 x 1.5 | 8 |
| 85 – 100 | Ø 30 × 1.5<br>Ø 25 × 2.5 | 30 x 3<br>20 x 3 * | 10<br>8 * |
| 100-150 | Ø 50 × 2<br>Ø 30 × 3 | 50 x 6<br>50 x 3 ** | 12<br>10 ** |
| Over 150 | They must comply with the requisites of Regulation N. 67, series of amendments 01, in LPG tanks and Regulation N. 110 in CNG tanks | | |

* In this case, the tank must be fixed using at least three strips
** In this case, the tank must be fixed using at least four strips

1. If the tank is installed behind a seat, minimum total distance of 100 mm in longitudinal direction of the vehicle must be respected. Said distance can be shared between the tank and the rear panel and between the seat and the tank.

2. In case of cylindrical tanks installed "longitudinally" compared to the vehicle axis, the fixing structure must have a "beam" positioned in front of the tank, on the running direction side. For “longitudinally” installed tank compared to vehicle axis, means that its longitudinal axis can form an angle between 0° and 30° with the vehicle longitudinal axis.

The above "beam" must satisfy the following three requisites:

- It must have the same thickness as the remainder of the fixing structure.
- It must be fixed as close as possible to the tank bottom.
- It must be at least 30 mm high and the upper surface must protrude at least 30 mm compared to the lower part of the tank casing.

### 2.4.8 Air lock

The air lock must communicate with the external environment by means of one or more openings that must assure a free area (subtracted the space taken up by pipes and wires) of 450 $mm^2$ (point 3i attachment 1). The inlet openings must face downwards and never the wheelhouse or heat sources (point 3h attachment 1 and prescription of paragraphs 17.7 – 17.8 – 17.9 – 17.10 – 17.11 – 17.12 of the ece/onu n.67/01 regulation).

### 2.4.9 Filling Valve

The filling valve must be positioned outside the vehicle. The filling valve must be installed so that it cannot rotate and be protected from dirt and water.

## 2.5 Electric connections

The instructions below are generally valid and essential for good understanding of the system. The control units connect with the remainder of the electric system of the BORA system (power supplies, masses, signals, sensors, actuators, etc.) containing all signals necessary for the various functions.
Most of the wires are terminated on pre-wired connectors, thus making it very easy to connect the system elements to the control unit. Also, the conductors are split in more sheaths to simplify installation and acknowledgement of the various wires.
All connections relating to unterminated wires on connector must be carried out by means of adequate insulation and correct soldering iron. Absolutely avoid carrying out connections by simply wrapping the wires or use other barely reliable systems.

### 2.5.1 Gas ECU

Gas ECU must be fixed to the vehicle frame. Use the fixing holes realised on the aluminium body shell avoiding submitting the structure to excessive stresses (e.g.: do not fix the control unit on to a convex surface, wanting to fully tighten the bolts and level everything). Figure 2.5.1-1 highlights the correct assembly position of the Gas ECU. Avoid excessively hot areas and subject to strong thermal irradiation. Despite the control unit being watertight, avoid installation in areas subject to continuous dripping in case of rain, so that water does not filter and stagnate in the wiring and relative sheaths. It is important that the cable from the Gas ECU and that connects with the computer, is placed in an easily accessible place and protected from the cap by possible water infiltrations.

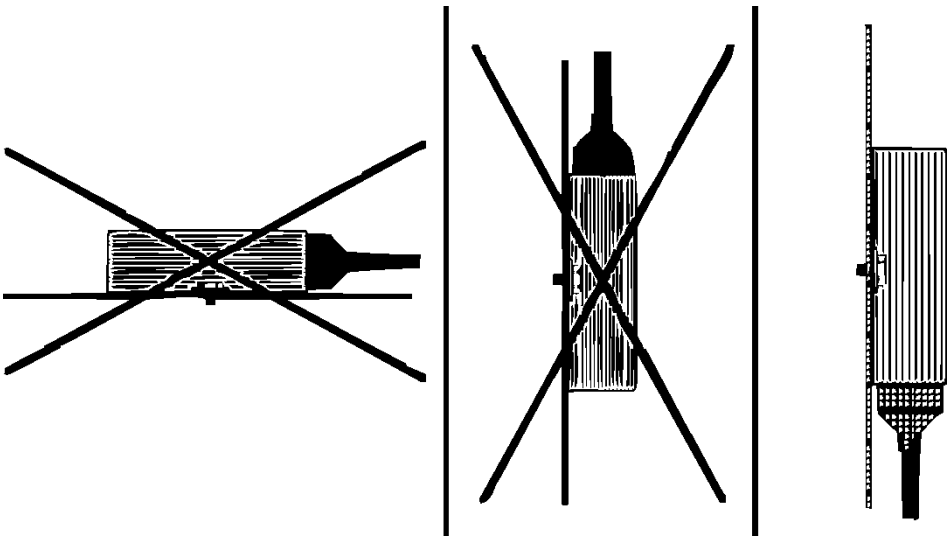


Fig. 2.5.1-1

**The Gas ECU box must never be opened, in particular with engine running or panel switched on, to avoid irreparable damages.**
**ZAVOLI srl declines every responsibility for damages to things and persons deriving from the tampering with the device by unauthorised personnel, with the consequent loss of the warranty.**

### 2.5.2 Main wiring

As the wiring is a complex electric components, made of a significant number of thin wired joined to stiff connectors, it must be handled with care during installation.

During installation be careful to:

- Arrange the wiring at a suitable distance from the spark plugs cables.
- When the wiring crosses a hole in the steel sheet, mount cable glands on the sharp edges of the hole, prior their trimming.
- Connect the ground wires somewhere that guarantees good electric contact (battery negative).
- The ignition power supply wire (positive) must be connected to a power supply source that guarantees a constant voltage of 12 V.
- do not force the connectors coupling, they are of "polarised" type, meaning provided with single coupling direction. In connections without connector (lambda signals, ignition, battery positive and negative), the connection must be carried out with soft soldering (soldering iron) and suitably insulated according to the supplied general installation prescriptions.
- Position the fuse so that it is easily accessible.
- Warn the customer that, in case of rupture of the gas system fuse, the system restores connections of the devices to which it is connected. We recommend not replacing the fuse with another with higher amperage, as this can cause irreparable damages.

A schematic representation of the main wiring with relative connections to kit components and to certain components of the vehicle, is reported in figure 2.5.2-1 for version with 3 cylinders wiring, figure 2.5.2-2 for version with 4 cylinders, with relevant key.

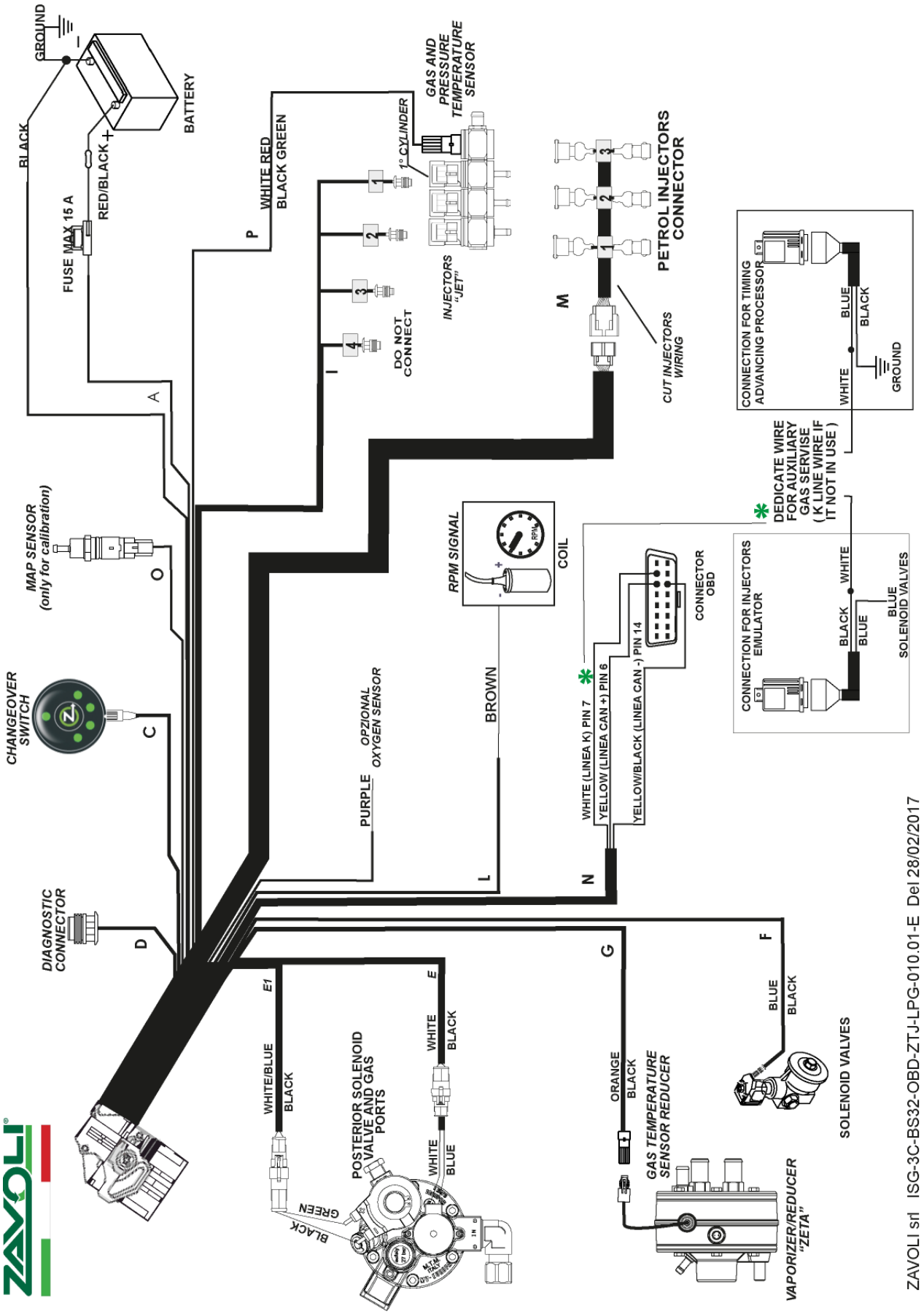

GROUND
BATTERY
BLACK
RED/BLACK +
FUSE MAX 15 A
WHITE RED
BLACK GREEN
1° CYLINDER
GAS AND PRESSURE TEMPERATURE SENSOR
INJECTORS "JET"
DO NOT CONNECT
PETROL INJECTORS CONNECTOR
CUT INJECTORS WIRING
CONNECTION FOR TIMING ADVANCING PROCESSOR
BLUE
BLACK
WHITE
GROUND
DEDICATE WIRE FOR AUXILIARY GAS SERVISE ( K LINE WIRE IF IT NOT IN USE )
MAP SENSOR (only for calibration)
CHANGEOVER SWITCH
RPM SIGNAL
COIL
CONNECTOR OBD
WHITE (LINEA K) PIN 7
YELLOW (LINEA CAN +) PIN 6
YELLOW/BLACK (LINEA CAN -) PIN 14
CONNECTION FOR INJECTORS EMULATOR
BLACK
WHITE
BLUE
BLUE SOLENOID VALVES
OPZIONAL OXYGEN SENSOR
PURPLE
BROWN
DIAGNOSTIC CONNECTOR
WHITE/BLUE
BLACK
POSTERIOR SOLENOID VALVE AND GAS PORTS
WHITE
BLACK
WHITE
BLUE
GREEN
BLACK
ORANGE
BLACK
GAS TEMPERATURE SENSOR REDUCER
BLUE
BLACK
SOLENOID VALVES
VAPORIZER/REDUCER "ZETA"
ZAVOLI srl ISG-3C-BS32-OBD-ZTJ-LPG-010.01-E Del 28/02/2017

Fig. 2.5.2-1

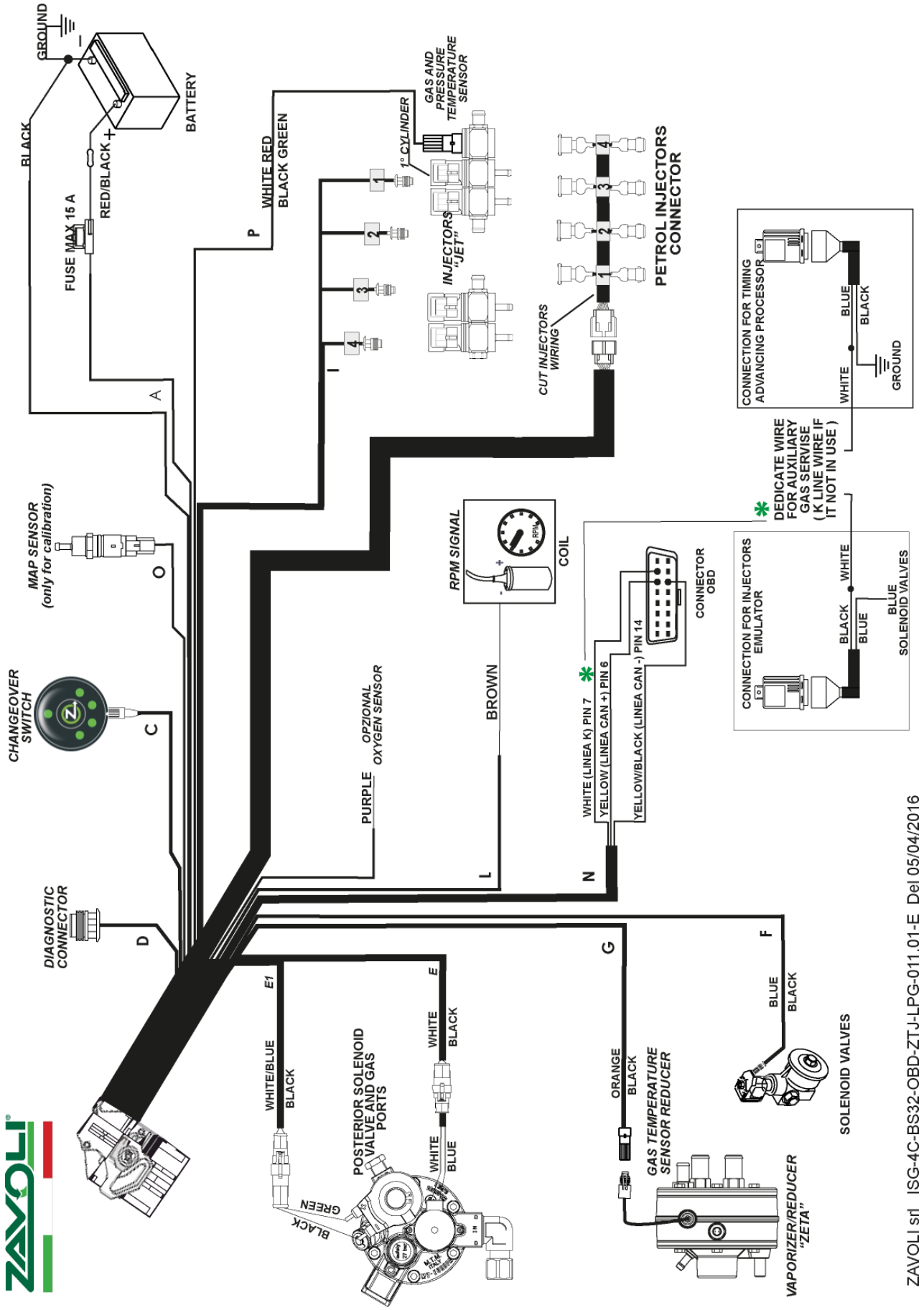
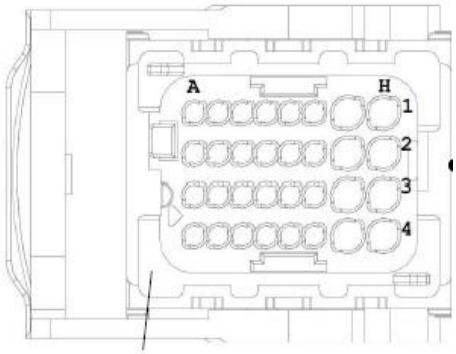

GROUND
BATTERY
BLACK
RED/BLACK +
FUSE MAX 15 A
WHITE RED
BLACK GREEN
P
1° CYLINDER
GAS AND PRESSURE TEMPERATURE SENSOR
INJECTORS "JET"
CUT INJECTORS WIRING
PETROL INJECTORS CONNECTOR
CONNECTION FOR TIMING ADVANCING PROCESSOR
BLUE
BLACK
WHITE
GROUND
DEDICATE WIRE FOR AUXILIARY GAS SERVISE ( K LINE WIRE IF IT NOT IN USE )
MAP SENSOR (only for calibration)
O
RPM SIGNAL
COIL
CONNECTOR OBD
WHITE (LINEA K) PIN 7
YELLOW (LINEA CAN +) PIN 6
YELLOW/BLACK (LINEA CAN -) PIN 14
CONNECTION FOR INJECTORS EMULATOR
BLACK
WHITE
BLUE
BLUE SOLENOID VALVES
CHANGEOVER SWITCH
C
OPZIONAL OXYGEN SENSOR
PURPLE
BROWN
L
N
DIAGNOSTIC CONNECTOR
D
A
I
E1
E
WHITE/BLUE
BLACK
WHITE
BLACK
POSTERIOR SOLENOID VALVE AND GAS PORTS
WHITE
BLUE
GREEN
BLACK
G
F
ORANGE
BLACK
BLUE
BLACK
GAS TEMPERATURE SENSOR REDUCER
SOLENOID VALVES
VAPORIZER/REDUCER "ZETA"
ZAVOLI srl ISG-4C-BS32-OBD-ZTJ-LPG-011.01-E Del 05/04/2016

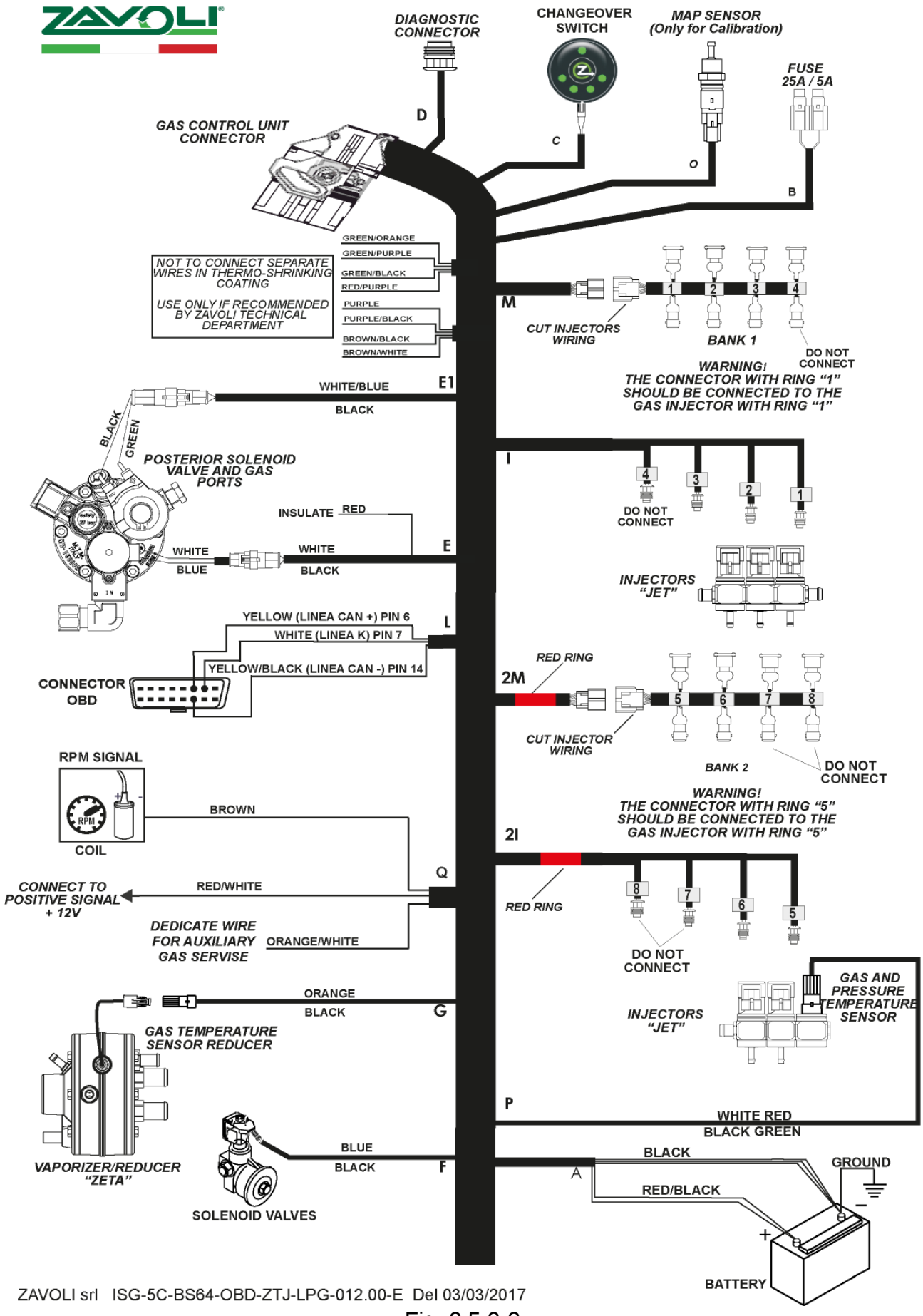
Fig. 2.5.2-2

# PIN OUT CABLE BORA S32



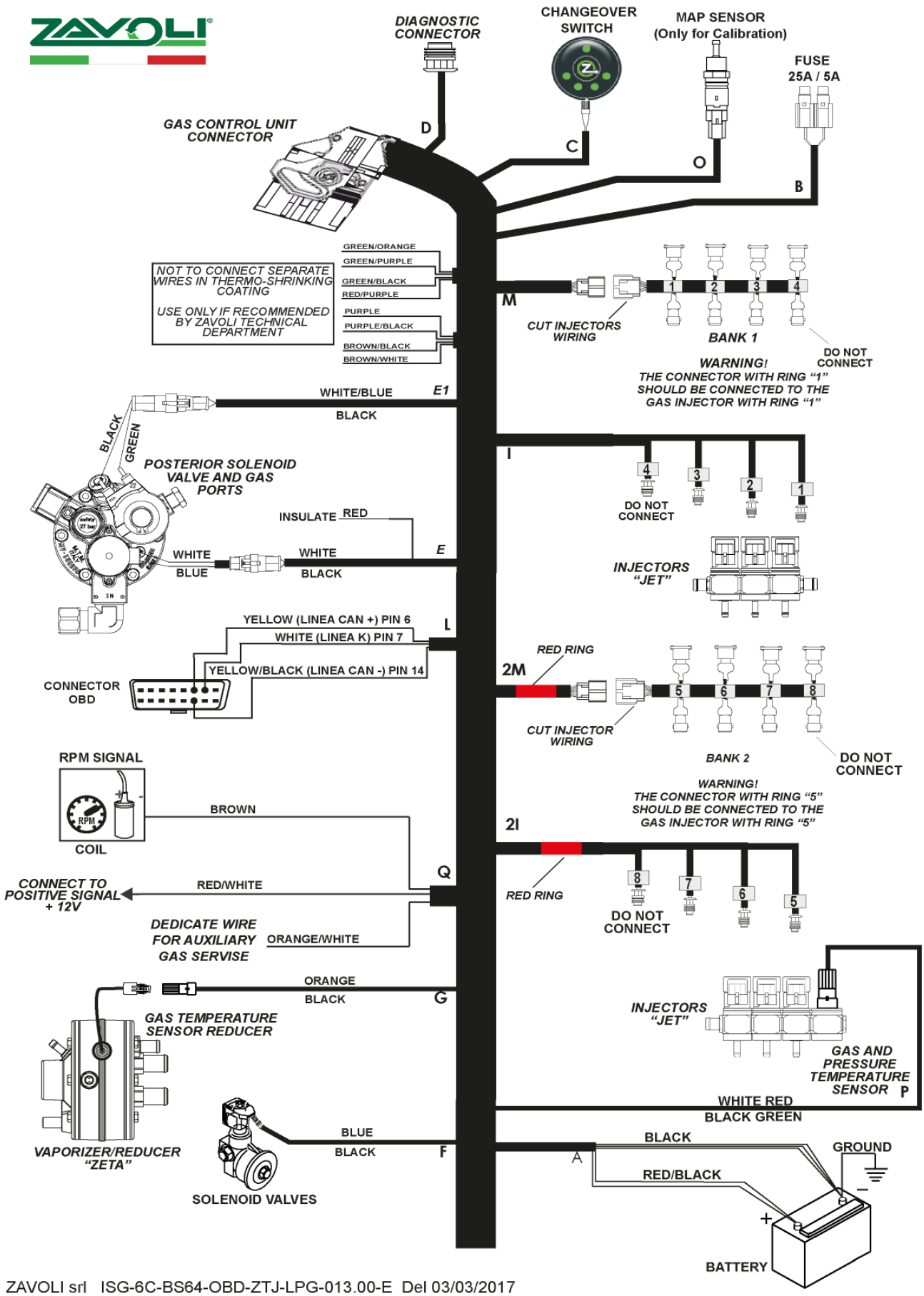

| PIN | DESCRIPTION | COLOUR | SIGNAL |
|---|---|---|---|
| 1A | Petrol Injector Cyl. 3 Side Injector | GREEN | → |
| 1B | Petrol Injector Cyl. 3 Side Petrol Ecu | GREEN/BLACK | ← |
| 1C | Petrol Injector Cyl. 4 Side Injector | YELLOW | → |
| 1D | Petrol Injector Cyl. 4 Side Petrol Ecu | YELLOW/BLACK | ← |
| 1E | Connection Obd Linea K | WHITE | ↔ |
| 1F | Rpm | BROWN | ← |
| 1G | Power Supply Battery | RED/BLACK | → |
| 1H | Positive Solenoid Valve | BLUE | → |
| 1H | Positive Gas Injector | RED/GREEN | → |
| 2A | Petrol Injector Cyl. 2 Side Petrol Ecu | RED/BLACK | ← |
| 2B | Signal Map Sensor | WHITE | ← |
| 2C | Signal Temperature Gas Sensor | WHITE | ← |
| 2D | Signal Pressure Gas Sensor | GREEN | ← |
| 2E | Changeover Switch and Socket Diagnostic | GREEN | → |
| 2F | Positive Signal + 12V | WHITE/RED | ← |
| 2G | Power Supply Battery | RED/BLACK | → |
| 2H | Positive Posterior Solenoid Valve | WHITE/BLUE | → |
| 2H | Positive Gas Injector | RED/GREEN | → |

| PIN | DESCRIPTION | COLOUR | SIGNAL |
|---|---|---|---|
| 3A | Petrol Injector Cyl. 2 Side Injector | RED | → |
| 3B | Signal Temperature Water Sensor | ORANGE | ← |
| 3C | Signal Sonda Lambda | PURPLE | ← |
| 3D | Connection Obd Can Bus | YELLOW/BLACK | ↔ |
| 3E | Connection Obd Can Bus | YELLOW | ↔ |
| 3F | Positive 5V Level Sensor | RED | → |
| 3G | Ground | BLACK | ← |
| 3H | Positive 12V Socket Diagnostic | RED | → |
| 4A | Petrol Injector Cyl. 1 Side Petrol Ecu | BLUE/BLACK | ← |
| 4B | Petrol Injector Cyl. 1 Side Injector | BLUE | → |
| 4C | Negative Injector Gas 1 | YELLOW | → |
| 4D | Negative Injector Gas 2 | ORANGE | → |
| 4E | Negative Injector Gas 3 | RED | → |
| 4F | Negative Injector Gas 4 | BROWN | → |
| 4G | Ground | BLACK | → |
| 4G | Negative Solenoid Valve | BLACK | → |
| 4H | Negative Posterior Solenoid Valve | BLACK | → |



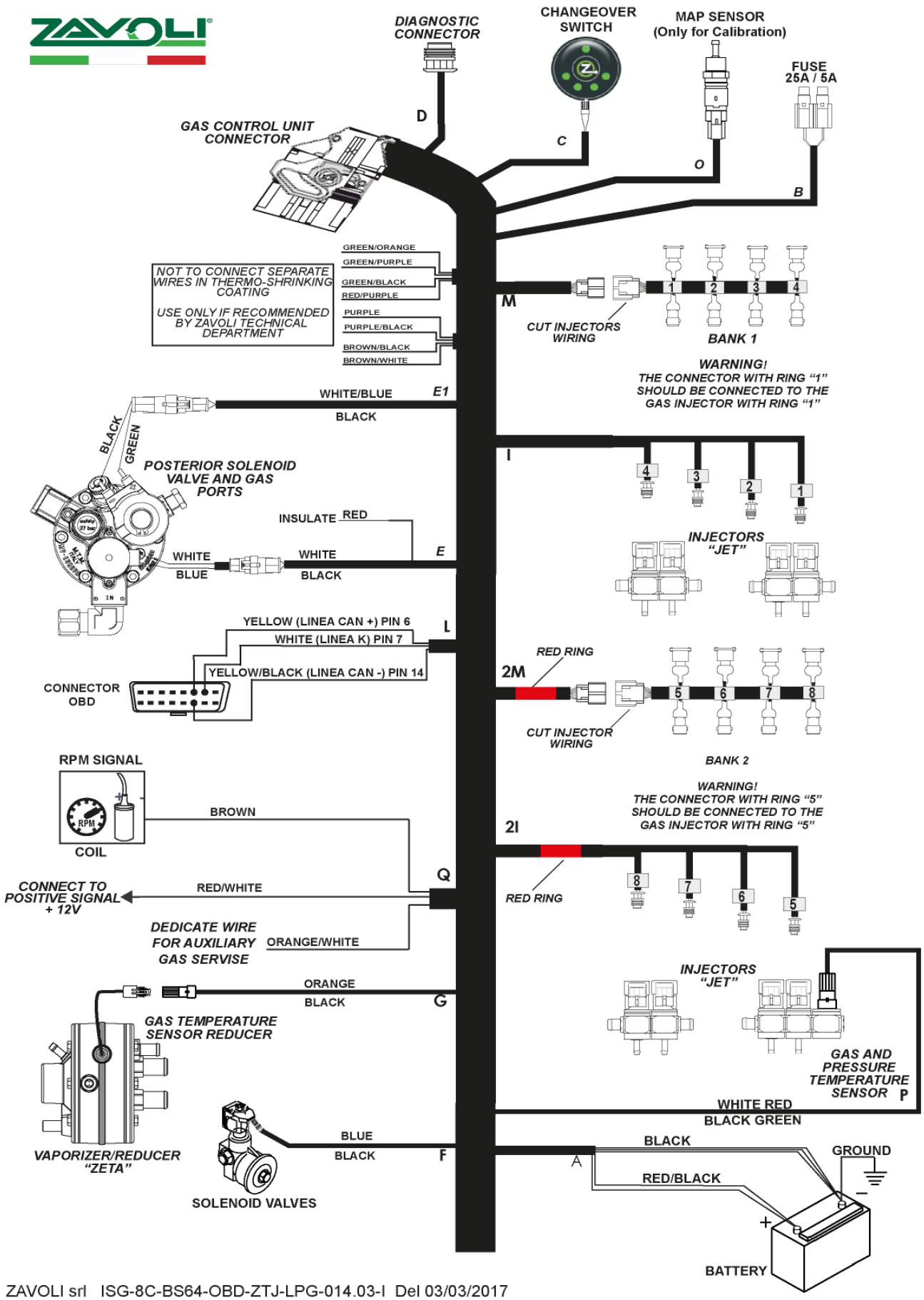

ZAVOLI srl ISG-5C-BS64-OBD-ZTJ-LPG-012.00-E Del 03/03/2017

Fig. 2.5.2-3




ZAVOLI srl ISG-6C-BS64-OBD-ZTJ-LPG-013.00-E Del 03/03/2017

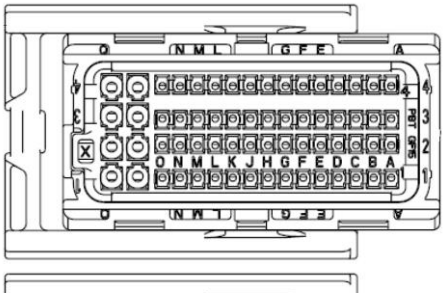
Fig. 2.5.2-4




ZAVOLI srl ISG-8C-BS64-OBD-ZTJ-LPG-014.03-I Del 03/03/2017

Fig. 2.5.2-5

# PIN OUT CABLE BORA S64




| PIN | DESCRIPTION | COLOUR | SIGNAL |
|---|---|---|---|
| 1A | Power Supply Battery | RED | → |
| 1B | Changeover Switch | GREEN | → |
| 1C | Signal Temperature Water Sensor | ORANGE | ← |
| 1D | Connection Obd Can Bus | YELLOW | ↔ |
| 1E | Signal Sonda Lambda 2 | PURPLE/BLACK | ← |
| 1F | Signal Petrol Pressure IN | GREEN/ORANGE | ← |
| 1G | \\ | \\ | \\ |
| 1H | Ground | BLACK | ← |
| 1J | Rpm | BROWN/GREY | ← |
| 1K | Rpm | BROWN | ← |
| 1L | \\ | \\ | \\ |
| 1M | Rpm | BROWN/WHITE | ← |
| 1N | Connection Obd Linea K | WHITE | ↔ |
| 1O | Signal Petrol Pump PWM | RED/PURPLE | ← |
| 1P | Power Supply Battery | RED | → |
| 1Q | Power Supply Battery | RED | → |

| PIN | DESCRIPTION | COLOUR | SIGNAL |
|---|---|---|---|
| 2A | Positive 12V Socket Diagnostic | RED | → |
| 2B | Socket Diagnostic | GREEN | → |
| 2C | Signal Map Sensor | WHITE | ← |
| 2D | Connection Obd Can Bus | YELLOW/BLACK | ↔ |
| 2E | \\ | \\ | \\ |
| 2F | Signal Petrol Pressure OUT | GREEN/PURPLE | ← |
| 2G | Signal Temperature Gas Sensor | WHITE | ← |
| 2H | Signal Pressure Gas Sensor | GREEN | ← |
| 2J | Positive Sensor 5V | RED | → |
| 2K | \\ | \\ | \\ |
| 2L | Power External Services 12V | WHITE/ORANGE | → |
| 2M | \\ | \\ | \\ |
| 2N | Signal Sonda Lambda 1 | PURPLE | ← |
| 2O | Power External Relè 12V | GREEN/BLACK | → |
| 2P | Positive Gas Injector | RED/GREEN | → |
| 2Q | Positive Gas Injector | RED/GREEN | → |

# PIN OUT CABLE BORA S64

| PIN | DESCRIPTION | COLOUR | SIGNAL |
|---|---|---|---|
| 3A | Petrol Injector Cyl. 1 Side Petrol Ecu | BLUE/BLACK | ← |
| 3B | Petrol Injector Cyl. 3 Side Injector | GREEN | → |
| 3C | Petrol Injector Cyl. 3 Side Petrol Ecu | GREEN/BLACK | ← |
| 3D | Petrol Injector Cyl. 4 Side Injector | YELLOW | → |
| 3E | Petrol Injector Cyl. 4 Side Petrol Ecu | YELLOW/BLACK | ← |
| 3F | Petrol Injector Cyl. 7 Side Petrol Ecu | GREEN/BLACK | ← |
| 3G | Petrol Injector Cyl. 7 Side Injector | GREEN | → |
| 3H | Petrol Injector Cyl. 8 Side Petrol Ecu | YELLOW/BLACK | ← |
| 3J | Petrol Injector Cyl. 4 Side Injector | YELLOW | → |
| 3K | Positive Signal + 12V | WHITE/RED | ← |
| 3L | Negative Injector Gas 4 | BROWN | → |
| 3M | Negative Injector Gas 3 | RED | → |
| 3N | Negative Injector Gas 2 | ORANGE | → |
| 3O | Negative Injector Gas 1 | YELLOW | → |
| 3P | Positive Posterior Solenoid Valve | WHITE/BLUE | → |
| | Positive Gas Injector | RED/GREEN | → |
| | Positive Solenoid Valve | BLUE | → |
| 3Q | Ground | BLACK | ← |

| PIN | DESCRIPTION | COLOUR | SIGNAL |
|---|---|---|---|
| 4A | Petrol Injector Cyl. 1 Side Injector | BLUE | → |
| 4B | Petrol Injector Cyl. 2 Side Petrol Ecu | RED/BLACK | ← |
| 4C | Petrol Injector Cyl. 2 Side Injector | RED | → |
| 4D | Petrol Injector Cyl. 5 Side Petrol Ecu | BLUE/BLACK | ← |
| 4E | Petrol Injector Cyl. 5 Side Injector | BLUE | → |
| 4F | Petrol Injector Cyl. 2 Side Petrol Ecu | RED/BLACK | ← |
| 4G | Petrol Injector Cyl. 6 Side Injector | RED | → |
| 4H | Negative Posterior Solenoid Valve | BLACK | → |
| 4J | Negative Solenoid Valve | BLACK | ← |
| 4K | Positive Signal + 12V | WHITE/RED | ← |
| 4L | Negative Injector Gas 8 | BROWN | → |
| 4M | Negative Injector Gas 7 | RED | → |
| 4N | Negative Injector Gas 6 | ORANGE | → |
| 4O | Negative Injector Gas 5 | YELLOW | → |
| 4P | Ground | BLACK | ← |
| 4Q | Ground | BLACK | ← |

## 2.5.3 Solenoid valves connections

No end of the solenoid valve is permanently connected to mass, but a wire comes from +12V battery (through fuse and relay), whereas the other is controlled by the control unit.
**Avoid connecting the solenoid valve ends directly to mass: this would cause a short-circuit that would burn the wiring fuses and/or jeopardise the correct functioning of the system.**
Separate piloting wires have been envisioned for the front and rear solenoid valve. This separation allows the control unit to understand whether, and eventually which, of the two solenoid valves is burnt or in short-circuit. Therefore, the solenoid valves must not be connected in parallel: this would jeopardise the diagnosis function of the control unit.

## 2.5.4 Power supplies and masses from battery

Contained in the sheath indicated with an “A” see figure above are two red wires and three black wires that must be connected to the car battery: the red wires to positive and the black to negative. It is important to connect the wires as they are, letting them individually reach the battery clamps, without joining the same coloured wires in a single wire or connecting them together along the wiring.
**Masses must always be connected to battery negative, and not to body work, engine mass or other masses on the vehicle.**

## 2.5.5 Fuses and relay

The two fuses equipping the BORA system, are represented at sheath “B” output by 15A and 5A. Wiring is supplied with two fuses of correct amperage, introduced in correct place. Do not invert their position. Fuse 5A must be inserted in fuse holder with small section wires, whereas fuse 25A must be inserted in fuse holder with larger section wires.
A relay is also represented at sheath "B" output, used by the system to interrupt the battery positive reaching the actuators.
Once connections are terminated, we recommend suitably fixing and protecting the fuses and relay.

## 2.5.6 Onetouch change-over switch

The 5 poles “C” multipolar cable inside the wiring, terminated on 4-ways connector, is used to connect the control unit to the One-Touch change-over switch inside the passenger compartment.
The cable 2-ways connector, is used to connect the control unit to the buzzer that, due to reduced dimensions, for this type of change-over switch, is separate.

## 2.5.7 Diagnosis valve

The computer connection to the control unit is based on a diagnosis valve directly coming out from wiring “D”. It is the diagnosis valve with 3-ways connector (female port on wiring), equipped with protection plug. The diagnosis valve is usually near the connector of the control unit.
For connection with PC, use appropriate cable code 800DE512114 or USB cable code 800DE512522.

## 2.5.8 Level sensor

The level sensor of the resistive type is connected to the wiring using the wires black and white will find that the inside (sheath "E") 3-way. Otherwise if you mount a level sensor of pressure sensible goes also connected to the red wire.

## 2.5.9 Solenoid valves

The solenoid valves are connected to wiring through pre-wired connectors connected to the wires inside sheaths "E1" and "F".
The front solenoid valve must be connected to sheath "F" connector, whereas the rear one must be connected to sheath "E1" connector.

## 2.5.10 Injectors disconnection wiring

**ATTENTION: the +12 volt injectors on certain vehicles may be timed therefore, after a few seconds from panel switch-on, it could fail. We recommend checking polarity of all injectors wiring manifolds, to ensure they are all equally polarised.**

In certain cases, during injectors disconnection wiring installation, the possibility of using manifolds of the supplied wiring may be required, in that the petrol injectors manifolds may be incompatible with those of the supplied emulators wiring.
In such case, the wires must be directly connected with appropriate universal wiring.
An example is shown in figure 2.5.3-1 and figure 2.5.3-2;
**naturally, for correct installation, refer to the installation sheet of the specific car.**

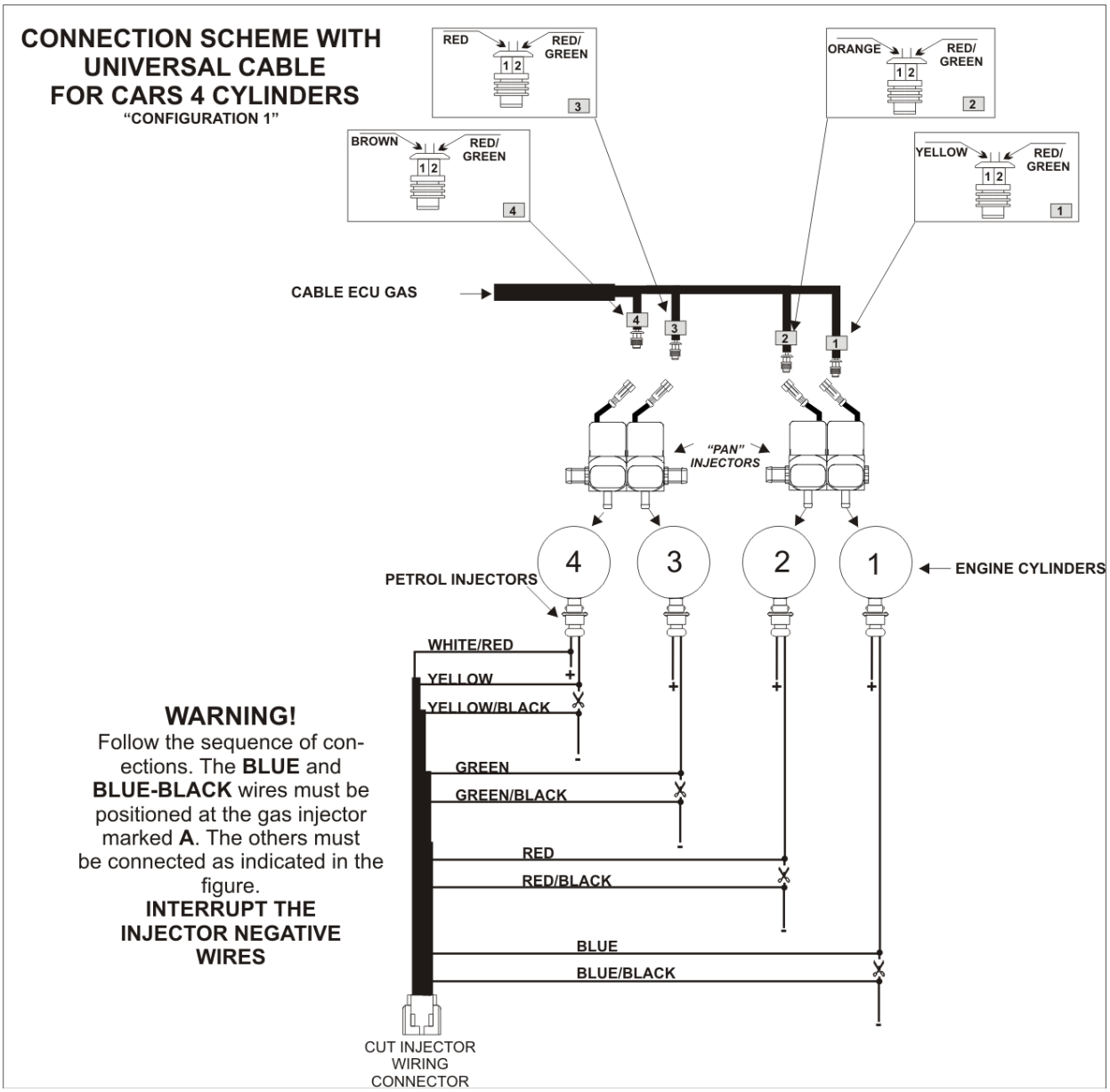



figure 2.5.3-1

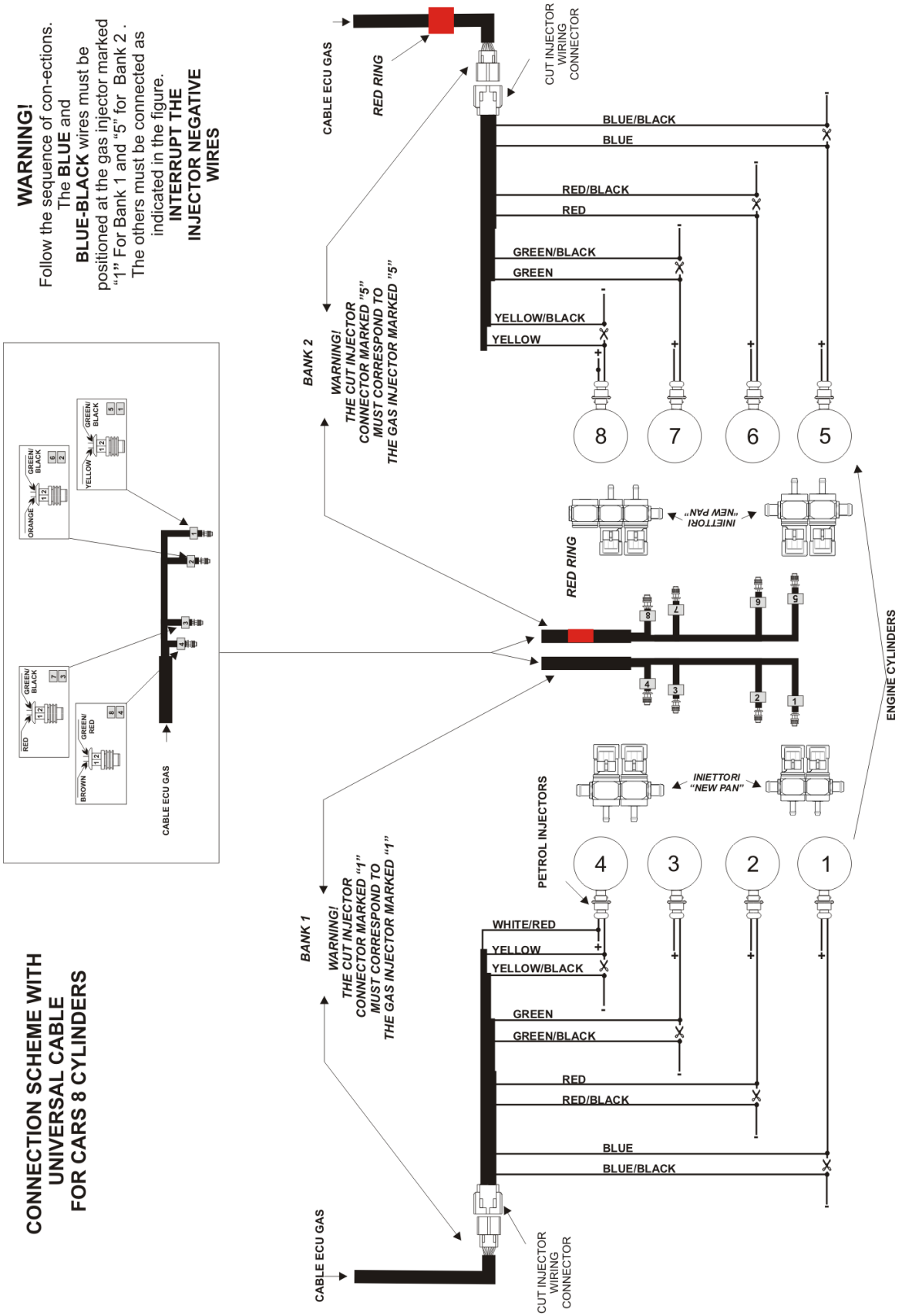



Fig. 2.5.3-2

To install this wiring, cut the negative wires of the petrol injectors, following the order reported in figures 2.5.3-1 and 2.5.3-2.

**The direction of your connections is very important. BLACK wires should be heading toward the petrol injection control unit, while the other wires should be pointing toward the injectors.**

### 2.5.11 Connection of the Gas Injectors

In order to install the gas injector cables correctly, please follow the order of the emulator cables very carefully. Gas injector outlets and cables are individually identified by letters (1, 2, 3, 4). For 5-6-8-cylinder vehicles, cables include two extra connectors and two extra sheaths (marked by two red bands) to allow for the second bench to be connected. The sheaths of the gas injector cables are identified by letters 5, 6, 7 and 8. In the above charts, the individual connectors of the emulator cables for the petrol injectors are identified in the same way (fig. 2.5.3-1). Remember to always identify each individual connector exactly – refer to the color of the wires connected to it.

- ***1-band sheath:*** **it must be connected to the gas injector on the petrol injector (disconnected) through the BLUE and BLUE/BLACK wires of the injector cut-off device.**
- ***2-band sheath:*** **it must be connected to the gas injector on the petrol injector (disconnected) through the RED and RED/BLACK wires of the injector cut-off device.**
- ***3-band sheath:*** **it must be connected to the gas injector on the petrol injector (disconnected) through the GREEN and GREEN/BLACK wires of the injector cut-off device.**
- ***4-band sheath:*** **it must be connected to the gas injector on the petrol injector (disconnected) through the YELLOW and YELLOW/BLACK wires of the injector cut-off device.**

**The main wiring system for 5-6-8-cylinder vehicles includes two Red bands (see fig. 2.5.2-5), which should be connected to Bench n.2. Connect the first one to the connector for the injector cut-off cables, and the other to the connector sheath. For the connection of other gas injectors, these cables must always be connected to their corresponding connectors.**

### 2.5.12 Lambda probe signal

The VIOLET wire is in sheath “H”, to be **eventually** connected to the wire of the Lambda probe signal, located before the catalyst. Such wire must not be cut but only stripped, welded with BORA LPG wiring wire and insulated.
Connection of the VIOLET wire allows quicker self-adjustment by the control unit and is very useful in cases where self-mapping phase requires a further refining of the map.

## 2.5.13 Positive ignition

The White/Red wire contained in sheath "M" of the BORA LPG system, must be connected to the positive ignition signal of the original system.
Such wire must not be cut but only stripped, welded with BORA LPG wiring wire and insulated.

## 2.5.14 Gas temperature and pressure sensor

The gas temperature and pressure sensor. Connection with wiring happens through appropriate 4-ways connector (male port on wiring) on which the 4 wires contained in the wiring "P" sheath are terminated.

## 2.5.15 MAP absolute pressure sensor

The newly conceived MAP pressure sensor is connected to wiring through opportune pre-wired connector, connected to wires contained in sheath "O".

## 2.5.16 EOBD diagnosis valve connection

Through the sheath "N" wires, it is possible to pick-up signals from the EOBD diagnosis valve for better system integration with the strategies of the petrol injection.
The White wire or the Yellow and Yellow/Black wires must be connected to the EOBD diagnosis valve and not all three simultaneously.

### 2.5.17 Change-over switch installation

The One-Touch change-over is available in two versions, with or without the circular frame. This is why the assembly operations must be the following: built-in fixing: make a 23 mm hole and introduce the change-over switch without its circular frame, external fixing: make a 14 mm hole allowing cable passage and glue the change-over switch with its circular frame.

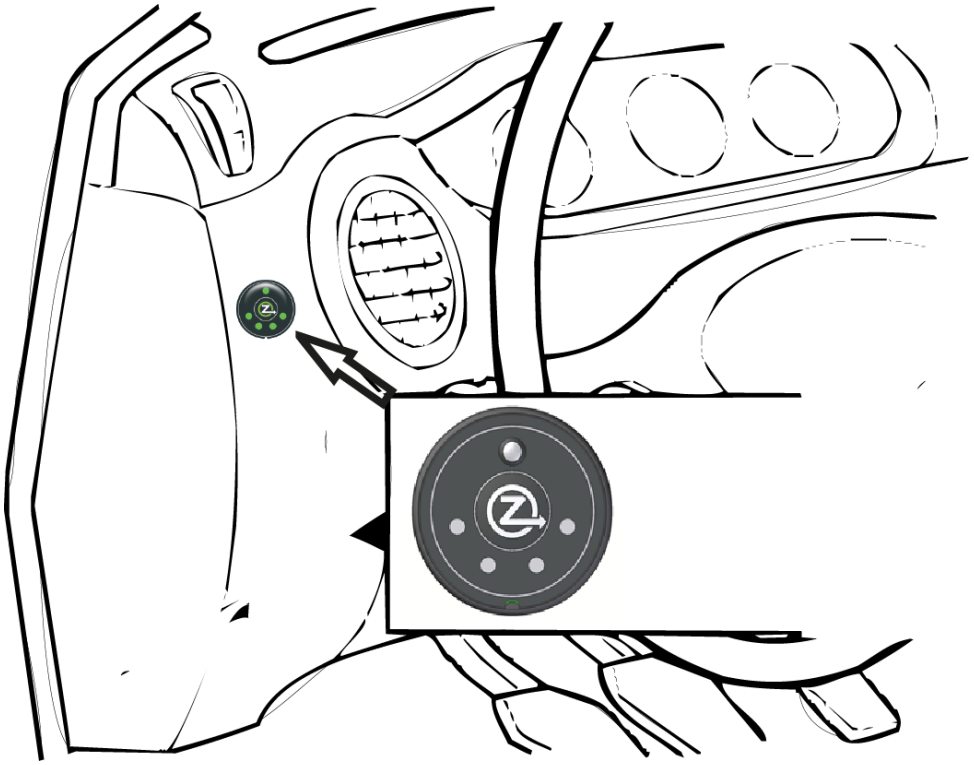


Fig. 2.5.5-1

## 2.6 Approval mark

Once the retrofit kit installation is completed, apply a plate, figure 2.5.6-1, permanently on the vehicle reporting legible and indelible approval data of the kit and of its main components. The plate must be applied in compliance with the installation specifications, reported on the installation sheet of the individual vehicle.

.

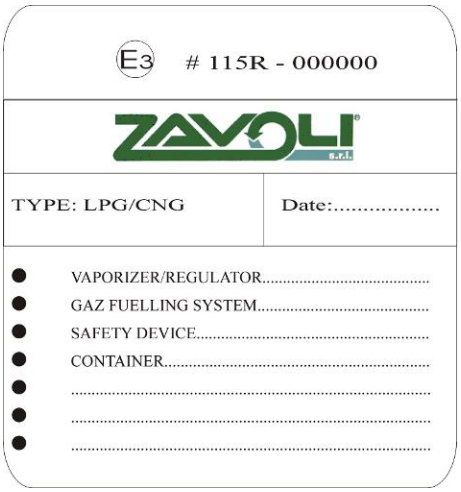



Fig. 2.5.6-1

# 3 START-UP PROCEDURE

## 3.1 Start-up and change-over

This vehicle is equipped with change-over switch with buzzer, integrating a gas level indicator with 4 green LED. The change-over switch called "one touch" has only one position. The fuel to be used (gas or petrol) is chosen every time the button is pressed.
The control unit recognises and memorises the fuel state (gas or petrol) the moment the vehicle is switched off, so that the same state is proposed upon subsequent ignition.

## 3.2 Petrol fuel state

The user is informed of this state by the red round LED on. No information on the gas level is displayed, meaning the four green level LED are off.

## 3.3 Gas fuel state

In this position the vehicle starts with petrol. The red round LED is on, as are the gas level LED in equal number to the gas level present inside the tank.
Once the pre-set change-over conditions are reached, the vehicle automatically changes to gas. The user is informed of the occurred change-over by the round LED, that from orange becomes green.

## 3.4 Gas-petrol automatic change-over

The system is able to recognise the impossibility of correctly fuelling the engine due to gas exhaustion or low gas fuelling pressure. In such situation, with the button in "gas fuel state", an automatic passage from gas to petrol is implemented (in such situations, the vehicle can work for short periods with petrol). The system automatically goes back to functioning with gas if it acknowledges to be able to correctly fuel the engine. On the contrary, the system acknowledges not to be able to fuel the engine with gas, the driver is warned by a repeated buzzing and by the switching on of the red LED on the change-over switch. The buzzer can be deactivated by pressing the "petrol fuel state" button. It is now necessary to refuel and position the button in gas fuel state to again obtain the normal vehicle running with gas.

## 3.5 Diagnostic

In case of LPG system malfunctioning, detected by the same system diagnostic, the change-over switch buzzer will emit three sounds every 50 seconds together with a flashing of the red petrol fuel state LED. In such situation, the vehicle runs with petrol. To interrupt the sound and flashing sequence, press the change-over switch. Contact a Zavoli after-sales assistance centre for diagnosis and solution of the eventual fault.

## 3.6 Level indicator

The indication of the amount of gas present inside the tank happens through gradual switching on of the four green LED on the change-over button.
As the amount of gas available is consumed, the LED gradually switch-off.
The reaching of the gas fuel reserve is signalled by the flashing of the first green LED. As well as indicate the level, the four LED also indicate the vehicle functioning state: with petrol the

LED are off and with gas the LED are on, in proportional number with the amount of gas available.

### 3.7 Configuration of the Retrofit Kit *BORA LPG*

Once kit installation is completed, configuration must be carried out to guarantee correct functioning of the gas system.
Configuration happens with the use of suitable interface software. Refer to specific instruction manual for correct use of software. Furthermore, configuration must be checked every time maintenance interventions are carried out on the system.

### 3.8 Useful information for the system user

When installing the vehicle, the installer must:

- Train the user on the basic system use procedures.
- Hand the gas system user manual in the retrofit kit to the user.

## 4. MAINTENANCE AND TROUBLESHOOTING PROGRAM

The maintenance of the ***BORA LPG*** kit devices, as well as other vehicle components, is essential to guarantee the efficiency and safety of the gas system. The maintenance interventions extend the duration and functionality of all devices, contributing to the reduction of management costs of the vehicle. Normally the maintenance costs specific for the gas system are very contained compared to the saving in fuel costs deriving from the use of gas instead of petrol.

**Recording of the maintenance coupons on the manual supplied to the user is required to enable the latter to use the offer warranty. Therefore, the installer performing the coupon will record the various performed maintenance interventions on the user manual (in appropriate spaces reserved for "recording of maintenance interventions" in the last pages).**

## 4.1 System maintenance

The perfect functioning of the system is assured by routine maintenance to be carried out by a **ZAVOLI s.r.l.**, approved garage, in the pre-established intervals.
The first check (free) must be carried out after 1000Km.
The following checks will have an interval of 20.000Km each and will entail the routine maintenance. The omitting of the pre-established coupons entails the lapsing of the product warranty.
Periodically carry out the checks as indicated in the User Manual.

| **ROUTINE MAINTENANCE** | | | | | | |
|---|---|---|---|---|---|---|
| **Description of the interventions to be carried out** | **Thousands of Miles** | | | | | |
| | **1** | **20** | **40** | **60** | **80** | **100** |
| Visual check of the system | √ | √ | √ | √ | √ | √ |
| Junction fittings seal check | √ | √ | √ | √ | √ | √ |
| Gas and water piping check | √ | √ | √ | √ | √ | √ |
| Electric connections check | √ | √ | √ | √ | √ | √ |
| Regulator pressure check | √ | √ | √ | √ | √ | √ |
| Fastening check of the tank fixing strips | | √ | | √ | | √ |
| Gas fuelling system parameters check (with self-diagnosis connector) | √ | √ | √ | √ | √ | √ |
| Gas filters replacement | | √ | √ | √ | √ | √ |
| Regulator inspection | | | | | √ (*) | |
| Gas injectors inspection | | | √ (*) | | √ (*) | |

(*) the indicated journey is to be considered **recommended**.

**The routine maintenance interventions may be subject to alterations. For example, the replacement of the LPG filters, the injectors inspection, the regulator inspection, may be requested at shorter time intervals than those envisioned. This may be due to the use of gas with high impurity content, such to cause premature clogging of the system components.**

Reported as an example in Fig. 4.1-1 the fac-simile of the first two maintenance coupons modules.

| *1st Free Maintenance coupon* **1.000 Km** *from Installation* | | |
|---|---|---|
| ***Performed Work:*** | ***YES*** | ***NO*** |
| Visual check of the system | ☐ | ☐ |
| Junction fittings seal check | ☐ | ☐ |
| Gas and water piping check | ☐ | ☐ |
| Electric connections check | ☐ | ☐ |
| Regulator pressure check | ☐ | ☐ |
| Fastening check of the tank fixing strips | ☐ | ☐ |
| Gas f elling system param ters check (with self- iag osis connector) | ☐ | ☐ |
| | | |

| *2nd Maintenance coupon* **20.000 Km** *from Installation* | | |
|---|---|---|
| ***Perfo med Work:*** | ***YES*** | ***N*** |
| Visual check of the yst m | ☐ | ☐ |
| Junction fitt ngs seal check | ☐ | ☐ |
| Gas and water piping check | ☐ | ☐ |
| Electric connections check | ☐ | ☐ |
| Regulator pressure check | ☐ | ☐ |
| Fastening check of the tank fixing strips | ☐ | ☐ |
| Gas fuelling system para eters check (with s lf-diagnosis connector | ☐ | ☐ |
| Gas filters replac ment | ☐ | ☐ |
| | | |

| Other interventions: | |
|---|---|
| DATE:_____- Km:_____- | Stamp and Signature: |

| Other interventions: | |
|---|---|
| DATE:_____- Km:_____- | Stamp and Signature: |



Fig. 4.1-1

## 4.2 Zavoli After-Sales Technical Assistance request

Should the installer require support by the ZAVOLI after-sales assistance network, it is essential that the **"after-sales assistance request form**" be sent firstly, filled in its every part. All form requested data is essential to satisfy the after-sales assistance request.

## 4.3 Troubleshooting

| Problem symptom | Cause | Solution |
|---|---|---|
| After approx. 10 sec from start-up the change-over switch switches off | The revs signal (black wire) is incorrectly connected | Check connection |
| The change-over switch does not light-up. | The fuse on red wire is burnt. | Replace the fuel with one of equal capacity. |
| | Incorrect wiring installation. Petrol injectors exclusion. | Assemble adequate wiring. |
| | The change-over switch cable is damaged. | Replace or repair wiring. |
| | The change-over switch is faulty. | Replace the change-over switch. |
| The engine switches off during Petrol/Gas change-over. | Empty gas tank. | Check the presence of gas inside tank. |
| | No gas to gas injectors. | Check correct opening of the gas solenoid valve. |
| | No power supply. | Check presence of 12v ignition. |
| The petrol injection time is not displayed by the software. | The injectors disconnection wiring has been incorrectly installed. | Check that the wires have been connected in correspondence of the injectors negative. |
| The engine does not work with all gas cylinders. | Gas injectors connectors connection. | Check that the gas injectors connectors have not been interrupted or removed from the gas ECU connectors or from the gas injectors connectors. |
| | Obstructed injection nozzle fitting. | Check whether the injection nozzle fitting is obstructed or if the connection pipe is obstructed or choked. |
| | Calibrated fitting on injectors. | Check whether all calibrated fittings on injectors are of the same diameter. |
| | Gas ECU injectors control problem. | Check that the gas ECU sends the correct signal to the injectors. |

<table>
<tr><td rowspan="6">MI light on (EOBD)<br><br>The MI light on signals functioning anomalies that affect the polluting emissions. Each anomaly is memorised by the EOBD and can be subsequently detected by means of suitable diagnosis instrument that is connected to appropriate petrol ECU "diagnosis valve". The functioning anomalies affecting the emissions during gas functioning causing a switch-back, are memorised in the gas ECU and can be subsequently detected by means of Alisei management software connected to gas ECU. Knowing the various anomalies it is possible to determine the solution to use to eliminate them. Some of these anomalies that might occur even during gas system functioning are listed at the side.</td><td rowspan="2">“No ignitions” or codes P0300, P0301, P0302, etc. The most probable causes determining the "no ignition" in the cylinders can be:</td><td>Non correspondence between injectors sequence and relative injectors emulator connectors sequence.</td></tr>
<tr><td>Insufficient gas fuelling to engine that also causes the "poor mix" anomaly.</td></tr>
<tr><td rowspan="4">"Carburetion error" or code (P0170); "poor mix" or codes (P0171, P0173); "rich mix" or codes (P0172-P0174).<br>Such functionings, in particular, "rich mix" and "poor mix", are concomitant with an excessive difference between the values of certain "parameters" ("injection times" and "lambda correctors” (*), detectable with the diagnosis instruments) in gas functioning, compared to those in petrol functioning. Usually, during correct functioning, the values of such parameters in gas functioning must be similar to those in petrol functioning.<br>When one or more of such malfunctionings are detected, the most probable causes can be:</td><td>Excessive length of the pipes between injectors and injection nozzles. The length of the injection pipes must always be the minimum possible. Maximum admitted length, 150 mm.</td></tr>
<tr><td>Obstructions due to injection pipes bends.</td></tr>
<tr><td>Incorrect position of the injection nozzle coupling holes, made on the inlet manifold. Where possible, the holes must be made as close as possible to the engine inlet valves, with slight inclination towards the same valves.</td></tr>
<tr><td>Bad gas filters state, both in liquid phase and in gaseous phase.</td></tr>
<tr><td></td><td>Inadequate injectors calibrated nozzles. Usually, for the vehicle in question, in case of "poor mix", they are underdimensioned (small), in case of "rich mix" they are overdimensioned (large).</td></tr>
</table>

| | | |
|---|---|---|
| | | These conditions can be detected by connecting to gas ECU through Alisei management software and looking at the correction coefficients in the "map" window. Coefficients too high, small calibrated nozzles, in opposite case coefficients too low, large calibrated nozzles. |
| *(1)ATTENTION: depending on the used diagnosis instruments, the "lambda correctors" assume other names like "immediate mix adaptors", "immediate mix regulators", etc.* | | |

## 5. Glossary of the terms and acronyms used in the manual

| Terms | Meaning |
|---|---|
| Wiring | **It is the set of cables that go from the connector to which the control unit is connected to reach all other electric system points of the system.** |
| CAN Bus | **Communication system between control units and devices assembled on the vehicle.** |
| Catalyst | Device assembled on to the exhaust duct with the aim of reducing the polluting emissions. |
| CO, HC, NOx | CO (carbon monoxide), HC (unburned hydrocarbons), NOx (nitrogen oxides) are the gaseous pollutants currently regulated in the anti-pollution regulations. |
| Change-over switch | It is the device inside the passenger compartment enabling the driver to choose the type of wanted fuel (gas or petrol). |
| Connector | Device with the aim of connecting wiring parts with others or with electric devices. |
| Cut-off | Electronic fuel saving device that automatically interrupts supply of petrol when the accelerator pedal is completely lifted and the engine runs above a certain speed. |
| Diagnosis | Causes identification based on the malfunctionings and instrumental and technical reviews. |
| Display | Screen, video, that visually represents the data supplied or processed by electronic equipment. |
| Duty Cycle | It is the ratio in a rectangular wave form between the high level duration and the period of the same wave form. In formulas, if Ton is the high level duration and Toff is the duration of the same level, then Tp = Ton + Toff is the period and DC = Ton/Tp = Ton/(Ton+Toff) is the Duty Cycle. |
| ECU (CONTROL UNIT) | Electronic Control Unit, electronic module in charge of checking the functioning parameters and send controls to mechanically operational systems. |
| Electro-injector | See injector |
| Solenoid valve | Electro-mechanical device with the aim of interrupting the liquid flow. |
| EOBD | (European On Board Diagnostic),Monitoring system of all or certain inputs and control |

| | |
|---|---|
| | signals of the control unit. If it is detected that one or more signals are out of the pre-fixed limits, malfunctioning of the system or correlated systems is detected, signalled and memorised. |
| LPG | Gas from Liquefied Petroleum. It is a fuel, a mix of hydrocarbons, made mainly from butane and propane in variable proportions between them. Such mix in moderate pressure and ambient temperature condition is in liquid state. |
| Sequential injection | Multipoint injection system, characterised by independent activation of each injector compared to others in synchrony with the opening of the inlet valve of the relative cylinder. |
| Injector | Device with the aim of supplying dosed amounts with good pressured fuel precision, injecting it in the inlet manifold. |
| ISO | (International Organisation for Standardisation) it is an international Standards defining organism, represented by national bodies, producing global industrial and commercial Standards. |
| Retrofit kit | Agreement to UNECE regulation is the set of components constituting the gas system, each realised in compliance with the UNECE R67-01 regulation. |
| Led | Initials identifying luminous diodes (Light Emitting Diode). |
| MAP | (Manifold Absolute Pressure), Absolute pressure that governs the engine inlet manifold. |
| Master/slave | If the gas ECU is able to translate the control strategy of the petrol ECU so as to be able to use it for gas system functioning. |
| MI (Malfunction Indicator) | Luminous light signalling the anomalous functioning to the driver of one of the components relating to the emissions or the same OBD system. |
| One-shoot | One-shot. The one-shot devices can only be used once, then they must be replaced. |
| Ignition positive | It is a positive power supply wire coming from the battery, intercepted downstream of the vehicle ignition key. |
| Battery positive | Pole with electric power greater than vehicle battery. Usually at a voltage between 8 and 16V compared to mass. |
| Absolute pressure | It is the measured pressure compared to absolute vacuum pressure having null value. |

| | |
|---|---|
| RPM | Revolutions per minute. Usually used to indicate the rotary speed of the engine shaft. |
| Lambda probe | Also called oxygen sensor supplying the control unit controlling engine fuelling, information relating to amount of oxygen in the exhaust gases. In this way the electronics can maintain an excellent composition of the air-petrol mix. |
| Diagnosis instrument | Device compliant with Standard SAE J 1978 that, connected to the original diagnosis valve of the vehicle, is able to detect malfunctioning codes memorised by the OBD. Such instrument is also know as OBD II SCAN TOOL or TESTER DIAGNOSTIC. |
| Switch-back | It is the automatic change-over function from gas to petrol worked by the gas ECU in case of fault of a gas system component affecting the polluting emissions. |
| UNECE | United Nation Economic Commission for Europe. It is an international organisation committed to promoting the sustainable economic development between its member countries. In this regard, it supplies the international legal instruments for the trade, transport and environmental sectors. |
| Butterfly valve | Valve regulating the air capacity pumped by the engine. It is usually controlled by the accelerator pedal but becoming increasingly frequent to be controlled directly by the petrol control unit. |