



lo sono il gas

LPG MANUAL

lo. gas srl

Via dell'Edilizia 70/B 36100 Vicenza Italy
Tel. +39-0444-563901 Fax +39-0444-564189
Website: www.lo-gas.com

INDEX

LPG SYSTEM MANUAL

CHAPTER 01	INTRODUCTION	2
CHAPTER 02	LPG (LIQUEFIED PETROLEUM GAS)	3
CHAPTER 03	MAIN CHARACTERISTIC OF LPG.....	4
CHAPTER 04	LPG AS ALTERNATIVE FUEL FOR INTERNAL COMBUSTION ENGINES ...	5
CHAPTER 05	CHARACTERISTICS OF THE PRINCIPAL FUELS	5
CHAPTER 06	OCTANE RATING OF LPG	7
CHAPTER 07	ENGINE LIFE AND ENGINE WEAR	8
CHAPTER 08	DISTRIBUTION OF LPG FOR MOTOR VEHICLES	8
CHAPTER 09	HOW CONVENIENT IS LPG.....	10
CHAPTER 10	LPG SYSTEM COMPOSITION- GENERAL CHARACTERISTICS	11
CHAPTER 11	FILLER VALVE	12
CHAPTER 12	THE MULTIVALVE	13
CHAPTER 13	GAS TIGHT BOX	15
CHAPTER 14	LPG RESERVOIRS	15
CHAPTER 15	LPG SOLENOID VALVE.....	18
CHAPTER 16	PETROL SOLENOID VALVE.....	19
CHAPTER 17	LPG ELECTRONIC PRESSURE REDUCER.....	20
CHAPTER 18	MIXERS	25
CHAPTER 19	GAS SWITCHES AND ELECTRONICS.....	28
CHAPTER 20	ACCESORIES	31
CHAPTER 21	TECHNICAL DICTIONARY: (REF. AUTOMOTIVE LP GAS. 1998)	31

CHAPTER 01 INTRODUCTION

Liquefied Petroleum Gas (LPG) has become one of the most important alternative fuels in the automotive world sector, and it is also becoming one of the most important in the conversions of internal fuel engines.

LPG is being used for automotive use since the early years of the last millennium. Italy has been making extensive use of LPG.

Today many Governments are becoming increasingly aware of the benefits in contributing in energy security, to the economy and to the environment advantages when using LPG.

The installation of an LPG system, even though simple once trained, does require technical expertise. The ability of a well trained technician will guarantee the compliance with the regulations in force with safety and professionalism.

It is necessary for the installer to understand the characteristics of L.P.G. and to have an in-depth knowledge of the components of the system so as to be able to install it correctly and carry out programmed periodic maintenance.

This manual is designed to provide basic knowledge of the **lo. gas s.r.l.** system in order to provide the first approach to our innovative equipment. **lo. gas s.r.l.** guarantees to every installer with the necessary basic information useful to successfully install an LPG system, and to performed its maintenance in a professional way.

CHAPTER 02 LPG (LIQUEFIED PETROLEUM GAS)

LPG (LIQUEFIED PETROLEUM GAS) is a naturally occurring fuel and it is also produced through the cracking or refining process for other hydrocarbons. LPG if compressed or refrigerated can be stores as liquid or at ambient temperatures it can be stored in containers as a liquid under slight pressures.

LPG is the name given to the mixtures of commercial butane and propane.

The LPG is normally composed of Propane and Butane mixed in different proportions. The formulas of Propane and Butane are;

Propane C_3H_8

Butane C_4H_{10}

As mentioned above the composition of LPG at the pump (around the world) can be found in many mixtures ranging from pure Propane through various ratios of Propane and Butane to pure Butane.

Table lists the physical and chemical characteristics of butane and propane.

GAS	PROPANE	BUTANE
Chemical formula	C_3H_8	C_4H_{10}
Molecular weight	44	58
Specific weight	0.510 Kg/l	0.580 Kg/l
Boiling point	-43°C	-0.5°C
Low heat value	11070 Kcal/Kg	10920 Kcal/Kg
Fire point °C	510°C in air	490°C in air
Ignition limits as % of volume	2.1 - 9.5	1.5 - 8.5
Burning velocity (cm/sec)	32 in air	32 in air

CHAPTER 03 MAIN CHARACTERISTIC OF LPG

One of the main characteristics of butane and propane, and the one which determines its use, is their vapour pressure i.e. the pressure of the vapour in equilibrium with the liquid in a closed environment.

For example; the vapour pressure of butane is 0.5 kPa at 0°C and 80 kPa at 15°C, while the vapour of propane is 400 kPa and 600-500 kPa respectively.

This data constitutes a considerable differences in the pressure of the mixture as the proportions of butane and propane vary.

The pressure increases as the temperature increases and thus results into large variations in the volume of the L.P.G. in the liquid state. Therefore, if a reservoir is completely full of L.P.G., in its liquid state, and in the case of temperature rise it will results in a rapid increase in pressure. Creating a situation of high danger. In the worst case, it may even cause the container to burst. Therefore, it is essential to limit the filling with LPG of the reservoir (tank) to 80% of its total volume.

Another important characteristic that differentiates the two gases, butane and propane, is their boiling point. i.e. the temperature at which they pass from a liquid state to a gaseous state are;

Propane will liquefy at -43°C.
Butane will liquefy at 0°C.

In cold climates, the mixtures of the both gases at relatively high proportions of propane will facilitate its gasification properties. In and around the world, however, the climate can differ appreciably from country to country, therefore, LPG for use in internal combustion engines must be mixed in order to give good combustion results in all possible conditions.

It is important to note that LPG can deform natural rubber. Consequently, the hoses and piping used in all LPG system must be made from synthetic materials or metals with an appropriate quality.

CHAPTER 04 LPG AS ALTERNATIVE FUEL FOR INTERNAL COMBUSTION ENGINES

LPG is a fuel with high quality energetic characteristics and can easily substitute petrol and diesel as an alternative fuel.

COMPARATIVE PROPERTY OF FUEL

Description	Units	Gasoline	Butane	Propane	NGV
Chemical Structure		C4 to C10	C4H10	C3H8	CH4
H/C Ratio		1.85	2.5	2.67	4
Auto Ignition Temp.	C°	350	225	450	650
Ignition Limits	lambda	0.4 to 1.4	0.36 to 1.84	0.42 to 2.0	0.7 to 2.1
Stoichiometric A/F Ratio	kg/m ³ (0°)	14.7	15.0	15.7	17.2
Boiling Point	C°	30 to 195	-0.5	-42	-162
Heat of combustion HHV	MJ/m ³	3.5x10 ⁷	3.9x10 ⁷	2.5x10 ⁷	9.3x10 ⁶
Heat of combustion LHV	MJ/m ³	3.2x10 ⁷	3.6x10 ⁷	2.3x10 ⁷	8.3x10 ⁶
Octane Number		85.2	89	95.4	120
Cetane Number		10	45	-2	-10
Research Octane	N° RON	n.a.	91.8	112.1	+120
Liquid density	Kg/l	0.755	0.58	0.5	0.42@-162°C
Gaseous density	Kg/m ³ (0°)	n.a.	2.68	2.0	0.717
Lead Content		Very High.	0	0	0
Benzene		Very High	0	0	0
Vapor Pressure	bar	0.5-0.9	2.6	12.1	n.a.
Spec. CO2 Formation	G/MJ	n.a.	65.4	64.7	54.8
Sulphur Content	Ppm mass	n.a.	>50	>50	>5

CHAPTER 05 CHARACTERISTICS OF THE PRINCIPAL FUELS

From the above tables it is clear that petrol fuel compared to LPG have a higher boiling point. Because of this characteristic of LPG it must be stored at a certain higher pressure. The pressure, however, is relatively low, just 200-600 kPa. Although the boiling point of petrol is in theory above the ambient temperature and since it is equally subject to evaporation. Therefore, in today's vehicles it is stored in pressurised fuel tanks. Taking note on the research octane number (R.O.N.) and motor octane number (M.O.N.) it is clearly evident that L.P.G. has a superior anti-detonation power to premium

petrol. If compared to the diesel fuel and petrol, L.P.G. has a better calorific power.

Vehicle fuel consumption, when comparing the fuels, it is clear that LPG has a slightly greater consumption when compared to diesel and petrol. This, however, is true when comparing the fuels in terms of volume.

The "coefficient of theoretical equivalence" is defined as the volume of combustible substances that contains the same quantity of energy as the low heat value of petrol.

The "coefficient of equivalence" is defined as the actual ratio of the consumption of engines. Experimental tests have shown that specific LPG engines have a better performance when compared to engines fuelled with petrol.

It is also to note that since LPG in its gaseous state it mixes with air much better than if compared to petrol.

The air-gas mixture passes easily through the intake, resulting in the engine better performance.

In the case of diesel engines, however, it is difficult to define the coefficient of equivalence. For the reason that it is hardly comparable; in practice, ratios vary from engine to engine.

Table gives the coefficients of equivalence of the most commonly used fuels.

FUEL	COEFFICIENT OF THEORETICAL EQUIVALENCE	COEFFICIENT OF EQUIVALENCE
Petrol 32.32/32.32	1	1
Propane 32.32/23.42	1.38	1.27
Butane-N 32.32/26.55	1.22	1.11
Diesel 32.32/35.62	0.9	0.8

Coefficients of equivalence

The above coefficients are obtained by calculating the ratio of the low heat value of petrol and the low heat value of LPG.

Power of the engine, according to lab tests, in must petrol engines converted to LPG show a power loss of approximately 9%. If the same is compared to diesel engine we find a maximum loss of 30%. This fact, is true because diesel vehicles are equipped with larger capacity engines when compared to the corresponding petrol or supercharged versions.

It is also known that exhaust gases generating from LPG engines are less polluting when compared to diesel or petrol engines. It is a fact that LPG does not emit fumes, particulates, sulphur oxides, lead, lesser carbon dioxides, nitrogen oxides and fewer unburned hydrocarbons.

Furthermore, unburned hydrocarbons emitted after LPG combustion does not contain benzene, 1,3-butadiene, formaldehyde, acetaldehyde and other aromatic polymers which are contained in green petrol. No need to underline that these substances are dangerous and extremely carcinogens.

Type of fuel	Kilogram of CO ₂ per Km.
Petrol	0.26
Diesel	0.21
Propane	0.20
CNG	0.17

CHAPTER 06 OCTANE RATING OF LPG

The octane rating of LPG is higher than the octane rating of petrol, the difference is of about 15 octane number. A higher octane number signifies that LPG has a good anti-knock characteristics and a higher compression ratio. A higher compression ration means an optimise engine providing higher engine efficiency and power to weight ratios.

CHAPTER 07 ENGINE LIFE AND ENGINE WEAR

The cleaner burning characteristics of LPG are considered to reduce maintenance requirements. The advantages offered also include increased oil change intervals, increased spark plug life and generally extended engine life. In sparkignition engines LPG has shown to reduce the soot formation relative to gasoline, therefore reducing abrasion and chemical degradation of the engine oil. Furthermore LPG does not delute the lubricating oil film on the cylinder wal which is important during cooled starts.

It is also important to note that the useage of LPG significantly reduces the engine noise level.

CHAPTER 08 DISTRIBUTION OF LPG FOR MOTOR VEHICLES

The distribution of LPG for motor vehicles is usually made by using an independent distribution infrastructure or combined with the gasoline stations.

The LPG stations are composed of;

- A. The Reservoir (tank).
- B. The Dispenser.
- C. The LPG pump.

The Reservoirs are usually mounted above ground for small capacity LPG stations and underground for larger tanks.

The Dispenser is usually of two types, the mechanical and the digital and are usually equip with one or two filling guns.

The pumps may be of multiple stage and it is becoming very popular the submersible pump.

The distribution of LPG to the filling stations is normally performed by making use of road tankers.

The filling procedure of an LPG vehicles is safe and without the risk of LPG leakage, because it is performed on a closed circuit.



The lo.gas Compact LPG Service Station

CHAPTER 09 HOW CONVENIENT IS LPG

When buying a vehicle it is a good practice to analyse your choice in terms of costs. But, If you also include the ecological advantages of the vehicle to be chosen the preference is LPG.

The economic analysis can be calculated then we should calculated as follows:

$$Y = \frac{P}{N \cdot K} + \frac{B}{K} + \frac{A \cdot L}{C_b}$$

- Y kilometre cost (\$ per Km);
- P total cost of the car (including extra cost of diesel or gas system) (\$);
- K annual mileage (Km/year);
- B road tax (\$ per Year);
- A coefficient of equivalence (table 2.2);
- L fuel cost (\$ per litre);
- C_b car petrol consumption (Km per litre of fuel);
- N years of use;

The above formula is composed of three addends:

- 1) purchase cost of the car related to Km;
- 2) cost of road tax for the car related to Km;
- 3) fuel cost related to Km;

The application of the above formula will result in the cost in \$ per kilometre. The above Formula does not take into consideration the interests on the capital financed, insurance costs, maintenance and repair costs.

CHAPTER 10 LPG SYSTEM COMPOSITION- GENERAL CHARACTERISTICS

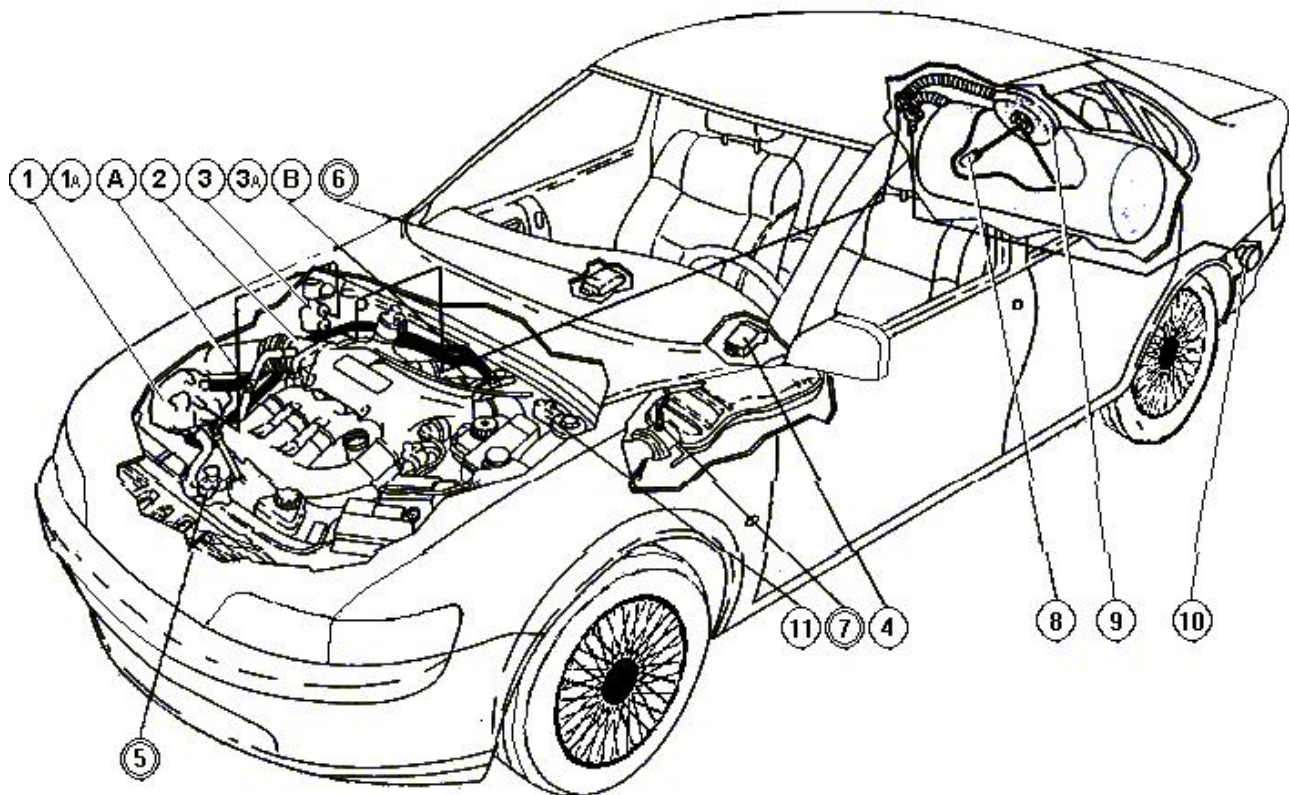
The installation of an L.P.G. fuelling system in a car is subject to local regulations and in many cases are subject of approval.

Herein, we underline a generalized procedures for the installation of the components that make up an LPG kit, required for a correct installation.

In general, local test consists in checking that the actuators have been assembled according to the European regulation ECER 67 R01, and it verifies that the high pressure parts of the system are gas-tight by subjecting them to a 3 MPa hydraulic-test.

It is important to note that a conversion of a petrol fuelled car to LPG does not require modifications to the original engine, but only the installation of specific additional equipment (fig. 5.1).

AN LPG KIT IS COMPOSED



1. Reducer
2. Mixer
3. LPG Solenoid Valve
4. Gas Switch
5. Step motor or a Gas Adjuster.
6. Control Unit
7. Lambda
8. Multivalve
9. Gas Tight Box
10. Filler Valve
11. Emulator.

In general, liquid LPG flows into the vehicle thru the filler valve, into the tank, thru the Multivalve. The Multivalve is protected by a Gas Tight Housing In case of leakage. The LPG is stored with the use of a Reservoir (tank). LPG is feeding to the engine from the Reservoir thru the Multivalve. With the use of a cooper pipes LPG is transferred to the LPG solenoid valve, where the LPG is filtered. The LPG solenoid valve has also the function of stopping the flow of LPG when the engine stops or during engine operation with petrol.

From here the liquid LPG is conveyed to the Vaporiser/Reducer. In the Vaporiser the LPG is vaporised and reduced in pressure. At this point, the LPG, now in its gas state, is conveyed to the engine thru the step motor (not required with carburettor engines) thru the mixer. The mixer is used to input and mix LPG into the engine intake. The mix LPG-Air, once in the engine, will flow into the combustion chamber for final combustion.

All the above, simplified process, is controlled by the use of specially designed electronics.

CHAPTER 11 FILLER VALVE

The filler valve is a very simple item and is shaped to couple with the LPG gun and it houses a non return valve (check valve).

The filler valve has the function of maintaining a gas tight condition during refilling procedure. In addition it houses a non returned valve (check valve).

The non return valve has the function of retaining the liquid LPG in order to avoid any leakage in case of the Multivalve malfunction.

CHAPTER 12 THE MULTIVALVE

The Multivalve is the component of the L.P.G. system which is installed on the Reservoir's flange.

Multivalve is available in many sizes. Normally it is available in accordance to the dimensions of the Reservoirs available in the market.

The Multivalve has its name from the fact that its body houses a number of valves with different functions. The main valves are;

- 1) Service manual valve.
- 2) 80% limit filler valve.
- 3) No Return Valve (Check Valve)
- 4) Excess Flow Valve
- 5) Cut off valve (available in the new generation Multivalves)
- 6) Thermal Fuse Valve. (available in the new generation Multivalve).
- 7) Safety Valve (Pressure Valve)

The Multivalve is also equip with a rod system that actuates a magnet, which depending in its position will indicate the level of fuel contained in the reservoir.

Main functions of above mentioned valves:

The Service valve is normally used only during maintenance requirements and in case of accidents. In the case of accidents the Service valve must be closed in order to prevent hazardous conditions.

The 80% limit filler valve has the funtion to limit the filling of the reservoir to 80% of the reservoir maximum filling capacity.

The No Return Valve is positioned in the inlet of the Multivalve and it is connected thru a pipe to the filler valve. Its function is to limit the flow into the Reservoir avoiding the LPG flow to return towards the Filler Valve

The Excess Flow Valve has the function to interrupt the flow of LPG out of the reservoir in the event of accidental breaking of the Copper pipe that feeds the engine.

The cut off valves, this valve is nothing more than an LPG solenoid valve incorporated into the Multivalve and it has the function to stop the flow of LPG when turning the engine's power off. This valve is also useful when performing maintenance to the LPG system.

The Thermal Fuse valve, is a valve used only in the case of fire and it has the function to discharge the reservoir of its LPG content in the case of extreme high temperatures. The discharge of the reservoir, in case of fire, will avoid the explosion of the Reservoir.

The Safety Valve, the function of the safety valve is to release the excess pressure in the reservoir. This valve will come into action only at high temperatures (in case of fire) or in case of over pressure created in extreme conditions. Such as filling the tank to 100% its fuel capacity and with an high external ambient temperature.

IMPORTANT NOTES:

When accidentally filling the tank to its 100% capacity, drive the vehicle for approximately 30 Km. before parking. After running the vehicle to an empty LPG reservoir take the vehicle in a maintenance control and inform the installer of the incident.

The installer is responsible and should check the system after the first filling. It is important to control the Multivalve functionality, in particular during filling.

During the Multivalve installation it is absolutely forbidden to hamper with the float rod. Hampering the Multivalve will compromise its integrity therefore its functionality. It is dangerous to hamper the Multivalve.

The Multivalve is installed to the Reservoir and is connected to the Filler valve and to the LPG Solenoid valve.

CHAPTER 13 GAS TIGHT BOX

The Gas Tight Box is installed on the Multivalve. Its main function is to convey any LPG leaks outside of the vehicle and to keep the Multivalve ventilated at all times.

The secondary function of the Gas Tight Box is to protect the Multivalve from dirt and accidental hits.

The gas tight box is connected to the external of the vehicle thru ventilation hoses.

The ventilation hoses the copper tube that connects the Multivalve to the filling valve on one side and the copper pipe that connects the LPG solenoid valve on the other.

CHAPTER 14 LPG RESERVOIRS

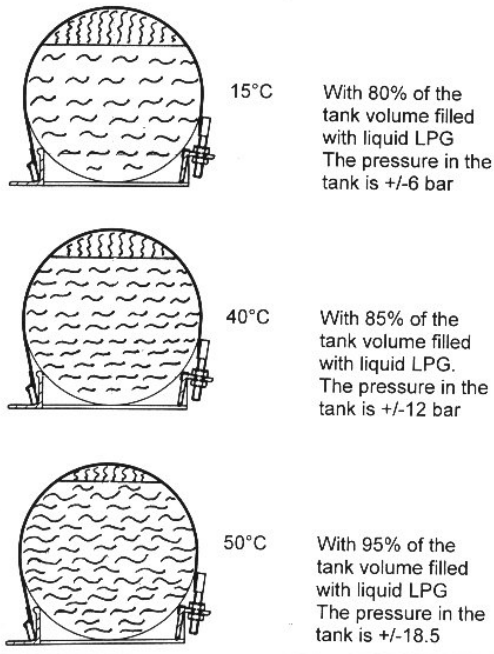
LPG reservoirs for motor vehicles are manufactured in many forms and shapes. The most commonly used shapes are the cylindrical and the toroidal.

The reservoir are most commonly manufactured with special steel alloys. In Europe the reservoirs are manufactured in lots of 100 pieces to a maximum of 200. Reservoir are tested one by one for water leaks at 3 MPa and a destructive testing is performed on one tank for every lot of 100 pieces.

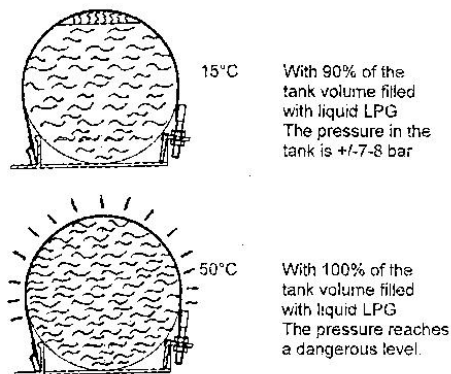
All reservoirs are provided with serial plate indicating the constructor's name, dates of construction certificate number, water capacity in litres and the serial number.

In the vehicle, the reservoir, are normally installed inside the vehicle and in some times under the vehicle. In the last case a protective plate is installed to protect the tank from FOD (Foreigner Object Damage).

The following are the possible reservoir internal pressure conditions:



The above shows the pressure variation according to a rise in temperature from 15°C to 50°C during filling inside a 60 l. tank filled to 80% an over.



The above shows the pressure difference resulting from an increase in temperature from 15°C (temperature of liquid during filling) to 50°C, inside a 60 l. tank filled from 90% to 100%.

Note for the installers; The reservoir, no matter the type or size, must be installed firmly and secure, at all times, in order to avoid displacement.

CHAPTER 15 LPG SOLENOID VALVE

The LPG Solenoid Valve is an electromagnetic device that stops the flow of LPG when the engine is stopped or operated with petrol.

The solenoid LPG Valve is composed of;

- 1- NBR seals to guarantee absolute safety
- 2- High thermal induction coil wire to render its working life virtually unlimited
- 3- Self extinguishing coil covering resin
- 4- Gas filter made with a fine filter paper material.
- 5- Vibration resistance.
- 6- Multiple fitting position.



The lo. gas LPG Solenoid Valve with filter

Installation instructions:

- 1- Install the LPG Solenoid valve in the engine compartment away from heat sources such as manifolds, exhaust pipes etc..
- 2- Place as close as to the LPG reducer as possible.
- 3- Mount with the provided brackets and bolts

- 4- Adhere to the flow directions indicated on the body of the LPG Solenoid Valve.

Maintenance instructions:

- 1- Close manual service taps at the tank's multivalve.
- 2- Disconnect the gas service lines
- 3- Remove the Solenoid valve
- 4- Disassemble the valve
- 5- Remove the filter, clean thoroughly all parts and change the carton filter.
- 6- Use new rings when assembling the solenoid valve.

In order to ensure a long life of this component you should follow the above instructions with special emphasis to the maintenance procedures.

CHAPTER 16 PETROL SOLENOID VALVE

The Petrol Solenoid Valve is an electromagnetic device widely used in carburettor vehicles. Its function is to stop the flow of Petrol when vehicle is running with LPG and vice versa when the vehicle is operated with Petrol.

The petrol Solenoid valve is installed in the line of Petrol fuel near the engine compartment.

The Petrol Solenoid valve is normally closed when electricity is switched off.



Petrol Solenoid Valve

The petrol Solenoid Valve is basically composed of a shutter operated by a magnetic coil and two nipples. It is also equip with an emergency device to manually reset the petrol flow in case of a break down in the electrical system.

The Petrol Solenoid valve is normally closed when electricity is switched off.

CHAPTER 17 LPG PRESSURE REDUCERS

LPG ELECTRONIC REDUCER

The pressure reducer-vaporizer has the main function to converts LPG from its liquid state to a gaseous state and regulating the LPG pressure in the process. The reducer is a device with two Gas compartment and a water circuit for heat exchange.

The vaporization and the reduction of pressure of the LPG takes place in 1st stage chamber (B). The heat transfer necessary to convert liquid LPG into its gaseous state is provided and guaranteed by engine's cooling water system.



Section through pressure reducer-vaporizer

Liquid LPG arriving from the LPG solenoid through a copper pipe enters the LPG Pressure reducer, to its 1st stage vaporization-reduction chamber. In the first stage LPG is firstly vaporized and successively reduced in pressure. During vaporization the LPG pressure could reach up to 800 kPa and this pressure is reduced to approx. 50 kPa. The pressure reduction is possible by exploiting the pressure exerted by the gas on the membrane which is connected to the lever that closes the feed orifice.

Heat transfer from the engine cooling system is circulated in a special separate chamber and it has the function to compensate the heat loss when the gas is expanding.

The second stage chamber is very sensible to the vacuum pressure. The vacuum pressure causes the flow of LPG to the engine to increase or decrease depending on the pressure difference.

Any pressure difference is transferred to the second stage chamber and the membrane will allow for a greater flow of gas to enter the engine.

The following indications must be observed for correct installation of the LPG pressure reducer:

- 1-** Install the LPG Reducer in the engine compartment away from heat sources such as manifolds, exhaust pipes etc.
- 2-** Place as close as to the LPG Solenoid Valve as possible.
- 3-** Install with the provided brackets and bolts.
- 4-** Locate the LPG Pressure reducer accessible for ease regulation and maintenance;
- 5-** Always position the LPG pressure reducer in a lower position compared to the radiator's water level;
- 6-** The oil drain plug must not be over the distributor or the ignition coil;
- 7-** Prior to installation clean the L.P.G. tubing to avoid impurities in the system;
- 8-** After the installation of the system always check for gas leaks;

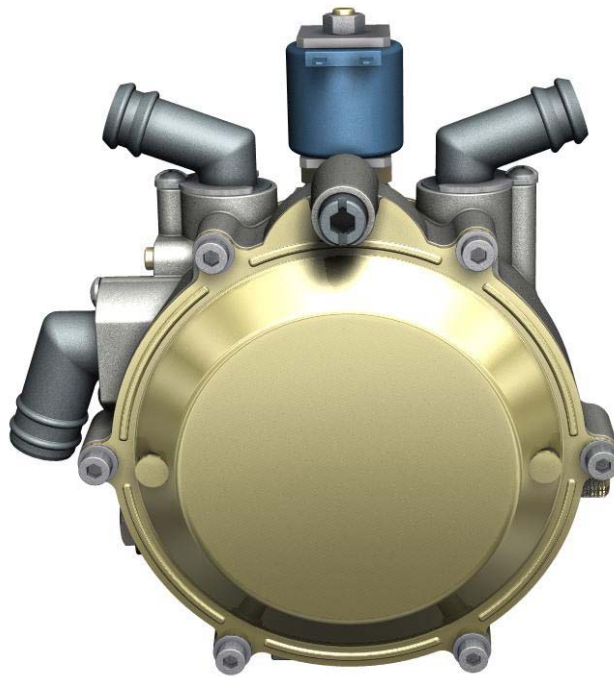
THE NEW LPG ELECTRONIC PRESSURE REDUCER

The NEWLY designed **lo. gas** electronic reducer, was developed keeping in mind the installer. In fact this new product is designed to be easily installed and to allow ease of maintenance.

Heat transfer from the engine cooling system is optimised with a preheating of the gas whistle entering the reducer's expanding chamber. During vaporization the LPG pressure could reach up top 800 kPa and this pressure is reduced to approx. 50 kPa. The pressure reduction is possible by exploiting the pressure exerted by the gas on the membrane which is connected to the lever that closes the feed orifice.

The second stage chamber is very sensible to the vacuum pressure. The vacuum pressure causes the flow of LPG to the engine to increase or decrease depending on the pressure difference.

Any pressure difference is transferred to the second stage chamber and the membrane will allows for a greater flow of gas to enter the engine.



The new lo-gas electronic LPG reducer

LPG VACUUM PRESSURE REDUCER

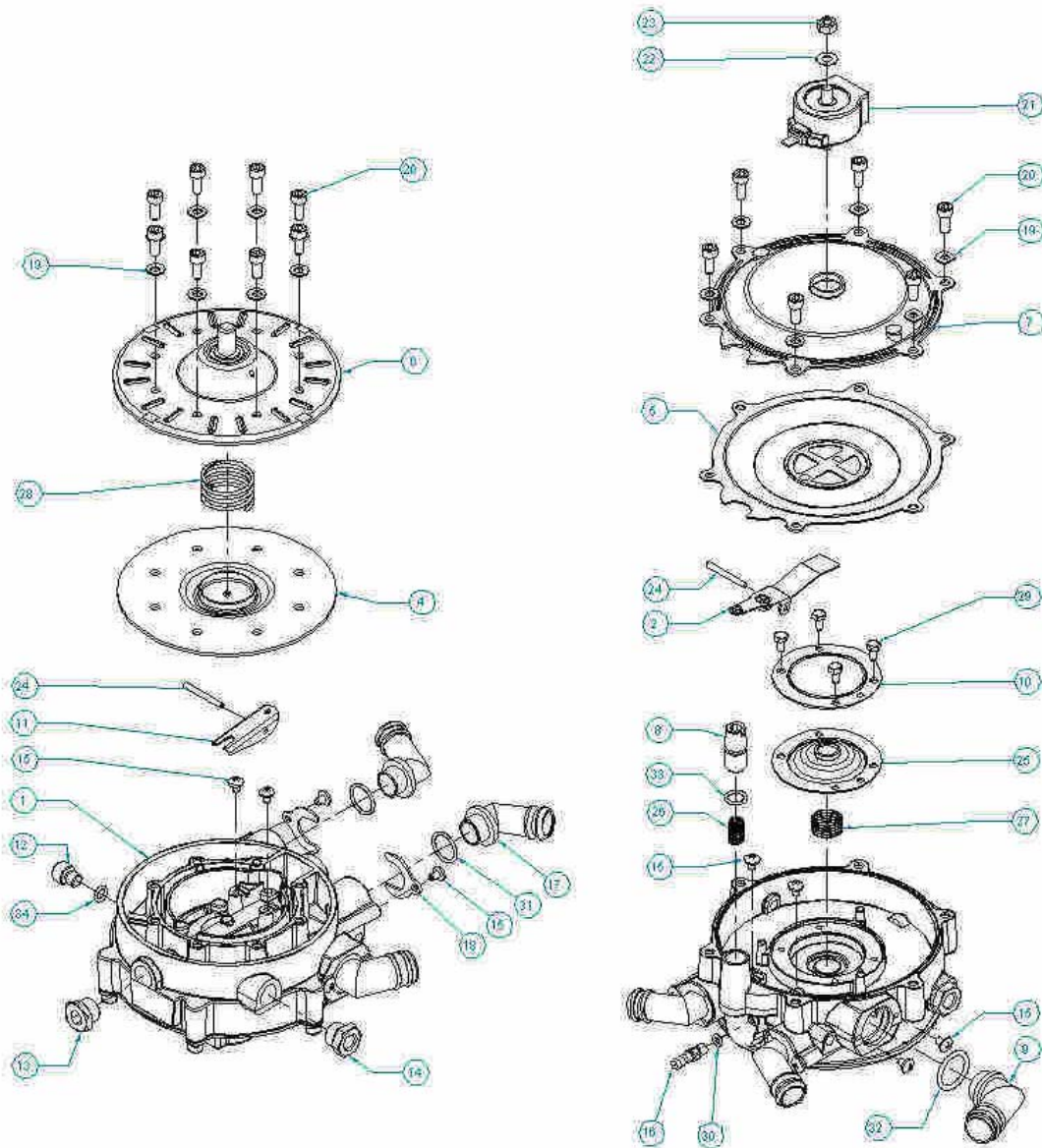


The New LPG vacuum reducer has been designed to be installed in all carburettor vehicles. As for the electronic reducer the vacuum reducer the liquid LPG arriving from the LPG solenoid through a copper pipe enters the LPG Pressure reducer, to its 1st stage vaporization-reduction chamber. In the first stage LPG is firstly vaporized and successively reduced in pressure. During vaporization the LPG pressure could reach up top 800 kPa and this pressure is reduced to approx. 50 kPa. The pressure reduction is possible by exploiting the pressure exerted by the gas on the membrane which is connected to the lever that closes the feed orifice.

Heat transfer from the engine cooling system is circulated in a special separate chamber and it has the function to compensate the heat loss when the gas is expanding.

The second stage chamber is very sensible to the vacuum pressure. The vacuum pressure causes the flow of LPG to the engine to increase or decrease depending on the pressure difference.

Assembly view of vacuum reducer



Any pressure difference is transferred to the second stage chamber and the membrane will allow for a greater flow of gas to enter the engine. The small coil mounted on top of the second stage cover is used for the function of choke. That is to allow small quantities of LPG prior to cool engine start.

LPG VACUUM PRESSURE REDUCER WITHOUT WATER SYSTEM.

It has the same working principal as for the LPG VACUUM REDUCER with the only difference of not having a hot water circulating for the purpose of heat transfer. In fact the liquid LPG is vaporised in the reservoir prior to entering the LPG REDUCER.



The new LPG reducer without water heat exchange.

CHAPTER 18 MIXERS

The mixer is an important part of the L.P.G. system. The mixer has the function of providing the correct AIR-FUEL ration suitable for a correct combustion.

The mixer is connected to the LPG pressure reducer by a gas hose thru an adjuster or in the case of a fuel injected vehicle thru a step by step motor.

The way the mixer is installed is very important and its correct positioning is fundamental for a successful L.P.G. system.

Given the level of specialisation and function that has been achieved in the car industry, it is clear that mixers are subject to continuous development.

Mixers for cars with carburettors;

The mixer in car with carburettor has an extremely importance. The right AIR-FUEL ration depends on the mixer and this is the reason for the existence of so many versions bearing so many shapes.

The mixer for vehicles equip with a carburettor may be manufacturing a specific Venturi or by implanting a nozzle in the proximity of the carburettor original Venturi.

The nozzle system type mixer can perform very well if executed with care and knowledge. In any way, is good to remember, that this system is not always possible to adapt to all carburettors and if not properly installed it may create irreversible damages to the carburettor. Therefore, it is advisable obtain proper training prior any installation of this type.

Another system is the fork system. The fork system is easier to apply if compared to the above nozzle pipe system. It is placed above the carburettor and it is necessary to pay attention to the exact height in which this mixer must be positioned.

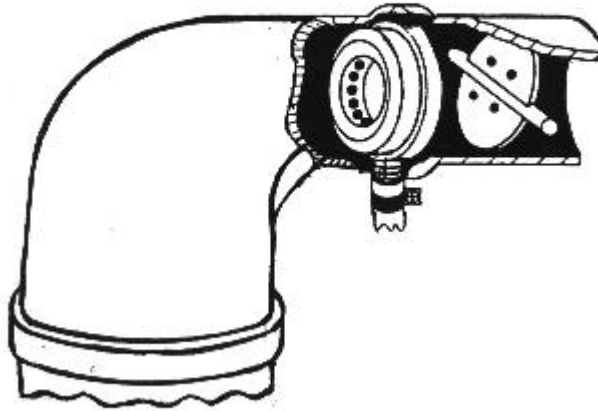
The most widely used mixer is the round or Ventury type mixer. It can be installed very fast and is very effective.

The plate mixer is another mixer easy to install. The plate mixer is installed under the throttle body.

FUEL INJECTION VEHICLES

On vehicles with electronic MPI (Multi Point Injection) and SPI (Single Point Injection) can use the traditional mixers and plate mixers.

These mixers can be installed between the monoinjector and the throttle body.



Mixer for L-JETRONIC, MOTRONIC and MONO-JETRONIC fuel injection system. How does mixer work.

The Purpose of the mixer is to guarantee a constant LPG-AIR ratio in order to ensure efficient combustion.

In order to achieve the above functions it is necessary; to measure the flow of air and to provide the exact quantity of fuel

The formula used to establish the air flow is the following:

$$\text{Air Flow} = K \times (\Delta P \times A\rho)$$

where:

Ka = Air constant of proportionality

ΔP = pressure drop in the narrow section of the Venturi tube

A ρ = air density

The second function, comes about when the pressure drop in the Venturi tube draws a flow of gas related to the pressure drop:

$$\text{Gas Flow} = K_g \times (dP \times m_g)$$

where:

K_g = Gas constant of proportionality

G_p = Gas density

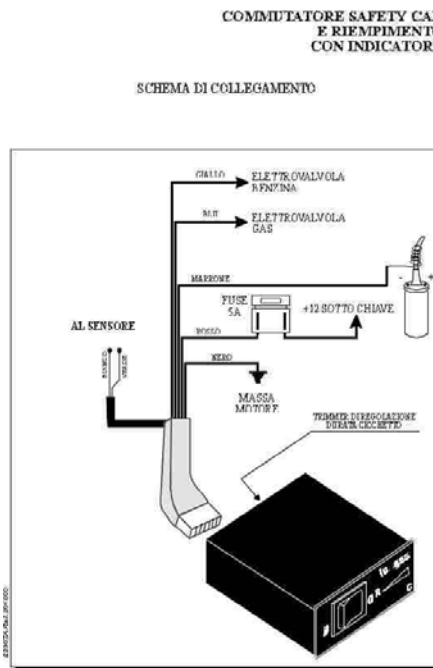
Making R the gas-air ratio:

$$R = K_a (A_p) / K_g (G_p)$$

CHAPTER 19 GAS SWITCHES AND ELECTRONICS

LPG Carburation Systems, in countries where vehicles have requirements to meet emissions standards for conventional carburettor vehicles a conventional LPG can be effectively used.

Besides the described mechanical description above it is important to to make use of the correct electronics.



Commutator connecting schema

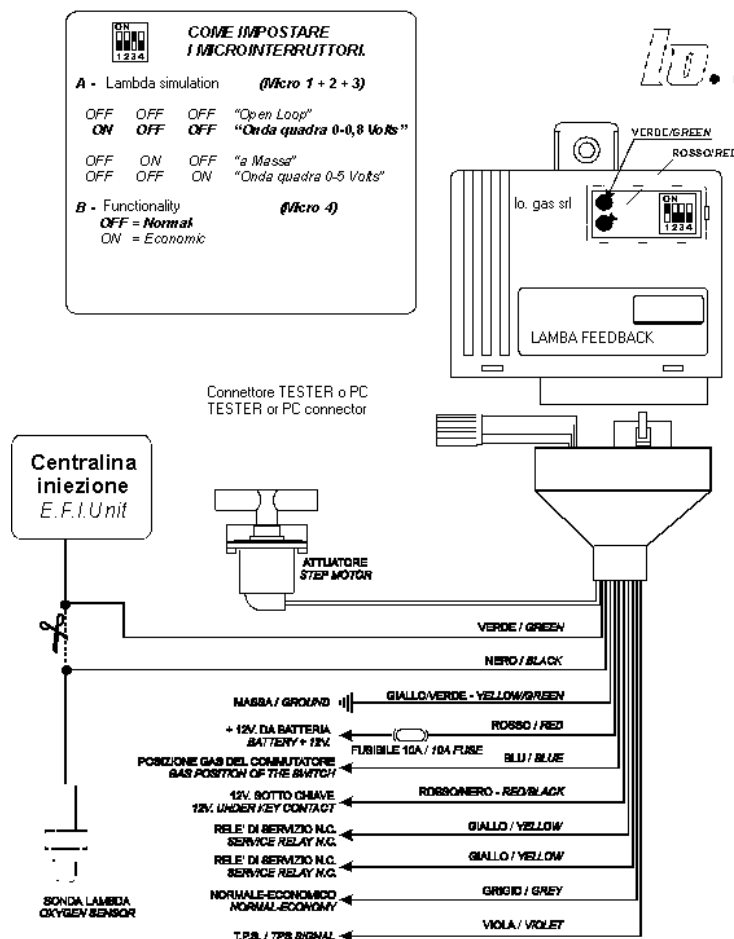
In the case of a Carburettor system, the electronics used is limited to the gas switch. The electronics used must be equip with a three position switch. The first position is PETROL and the second is LPG. Obviously when positioning the switch on petrol the switch will close the LPG Solenoid Valve and it will open the Petrol Solenoid Valve and vice versa is done when positioning the

switch to LPG. The Mid position of the switch (third position) is use to maintain the LPG and the Petrol Solenoid valves in the OFF position until the carburettor uses the small Petrol reserve. With a carburettor engine gas switching is always done manually. The switch for carburettor engines also has a safety feature, it stops the gas flow to the engine when engine accidentally stops.

Fuel Injection or electronically controlled LPG carburetion systems;

With increasingly stringent requirements for emission requirements it has greatly improved LPG conversion technology.

Electronics, such as Lambda control systems, have helped to overcome some shortcomings of conventional LPG systems it has lead to the development of the step by step motor for metering and electronically control the gas flow to the engine. The Lambda system is used in all vehicle TBI (Throttle body injection) petrol system and closed loop 3 way catalyst.

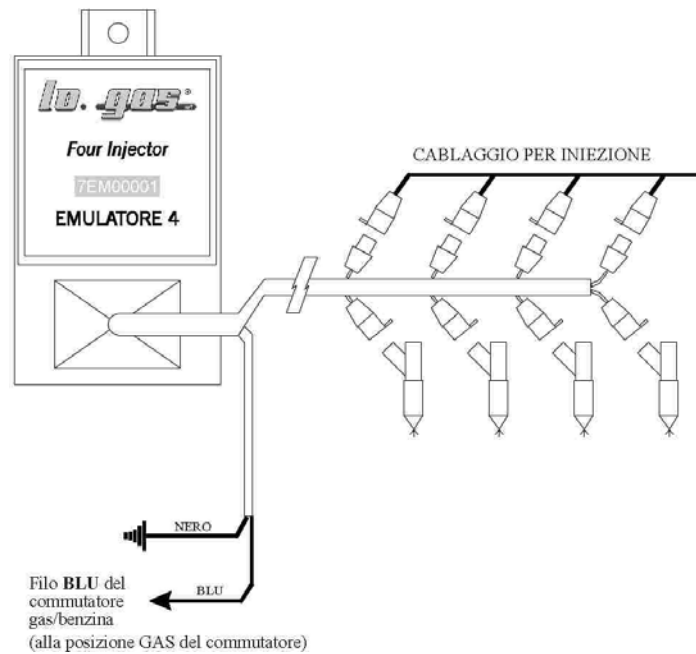


Flash's general installation schema

The input signals of the electronic unit are derived from engine RPM, TPS and lambda sensors signals.

Basically the system controls the unit control and the stepper motor which adjusts the main gas stream.

INJECTOR EMULATOR



Electrical drawings of emulator four cylinder

CHAPTER 20 ACCESSORIES

Copper Pipes: Copper piping is normally accepted as the most suitable high pressure piping to convey liquid LPG. Copper pipe 8x1mm is used to connect the filler valve, to the Multivale and 6x1mm copper pipe is used to connect the Multivale to the LPG solenoid valve, and from the LPG solenoid valve to the LPG Pressure Reducer. Copper pipe is certified to withstand a working pressure of 3 MPa. During its installation, copper pipe can be handled easily.

Rubber hose: Rubber hoses are always installed in conditions of low pressure part of the system. Usually, installed on the vacuum part of the system. The rubber hoses are used to connect the LPG pressure reducer to the step motor and from the step motor to the Mixer. The sizes of the rubber hoses can vary depending on the type of mixer used.

Vent Hose; Vent hoses are used to connect the Gas Tight housing to the external of the vehicle. Normally it is used 30mm diameter.

Other accessories are requested but very specific for each and every conversion and the details can be found in the instructions of each **lo. gas** kit or box.

CHAPTER 21 TECHNICAL DICTIONARY: (REF. AUTOMOTIVE LP GAS. 1998)

Lambda electronic control FLASH; Is the computer that controls the fuel quantity and is able to correct fuel ratios.

Catalyst: A catalyst is a device in the exhaust of the engine that envelopes a chemical reaction between the exhaust gasses, thus limiting the emission of harmful fumes and unwanted components. Also known as the catalytic converter.

Closed Loop control: Closed loop is a term used to indicate the relative air/fuel ratio is determined from the exhaust gas and adjusted through the feeding when necessary.

ECU: Electronic control unit.

Lambda sensor; is a device that establishes the relative air/fuel ratio from the measurement of oxygen content in the exhaust gases. It serves to establish a closed loop in the case of stoichiometrically operating engine at $\lambda=1.0$.

OEM; Original equipment manufacturer.

OBD; On board diagnostic, is a system that performs constant for engine monitoring. OBD I checks for simple malfunction. OBD II (USA) and E-OBD (Europe) checks for emission performance of the engine.

Open Loop; Open loop is the situation where a process is only regulated through forward control and without measurement of the end result to readjust the control. In the case of a catalyst it indicates the situation where the air/fuel ratio is not readjusted on the basis of a gas measurement.

Stoichiometric, it indicates a chemically correct air/fuel ratio, and it corresponds to $\lambda=1.0$.

TBI (Throttle body Injection) is a single point injection that is combined with the throttle valve assembly.

3-way catalyst; is a term used to indicate a catalyst that limits the emissions of the three regulated exhaust gas components, by promoting both oxidising and reducing reactions at the same time. In order for a 3-way catalyst to work it must operate strictly stoichiometrically.