Vialle
Drive Clean Power

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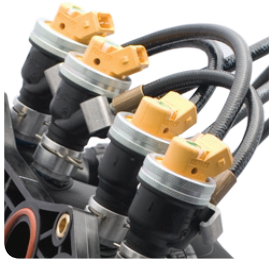
Training manual

LPi®
Liquid Propane Injection
Powered by Vialle



Version 8.13 April 2012

LPi System Training

About this course

More information:
Website www.vialle.nl or email training@vialle.nl

Objectives

At the end of this course, the participant is able to:

- Being able to describe the basic operation of the LPi system.
- Being able to name the various components and describe their function.
- Exercises in reading the electrical wiring schematics of the LPi system.
- Being able to go through the LPi Diagnostic tool.
- Being able to make the first diagnosis on the LPi .

Modifications in this version:

- Removed LPdi from book
- Update colors & logos

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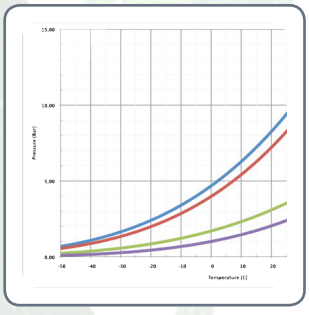


Introduction

Vialle

Import

Vialle is a Dutch company, active in developing and selling LPG systems since 1967. The company was founded in Eindhoven by Mr. Sjef Vialle, one of the Dutch pioneers regarding LPG systems.Vialle started with importing Italian made LPG components which were then adapted by the company and delivered to the Dutch market subsequently.

The LPG installers, mainly garages, purchased components from several suppliers which then had to be fitted as one complete system. This was a feasible operation since the principle of the system was simple. However, since components were not matched in relation to each other, problems started to occur while driving using LPG. This was taken for granted since driving with LPG was a very cheap alternative compared to driving with petrol.

After some time, Vialle started to offer complete systems for various brands and types in order to increase the total quality of the system and make the quality installer-independent.

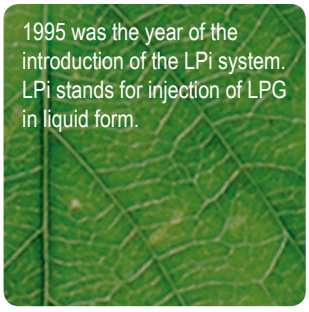
Crisis

The oil crisis in the Seventies made that LPG became very popular. Vialle benefited from this situation. It was during this period that Vialle started it's own developments of LPG systems which were then produced in Eindhoven. This further increased the quality of the product to be sold. Quality and being market leaders are both priorities at Vialle. At the end of the 80's the push for electronically controlled systems started with the introduction of petrol fuel injected engines. The elementary evaporating systems no longer met the high emission standards.

LPi

1995 was the year of the introduction of the LPi system. Vialle terminated the evaporating era with this new system. The LPi system does not contain an evaporator. LPi stands for injection of LPG in liquid form. With the injection of liquid LPG the maximum engine power output is safeguarded and is equal to the output achieved with petrol.

Over the years the LPi system has been continuously improved and has now become the most revolutionary and reliable system we know today.



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R&D

Vialle employs approximately 120 people and next to the assembly and installation department it has its own Research and Development department. This department carries out numerous tests using high tech testing equipment like exhaust emission test benches and engine test benches.

Through the years Vialle has developed international expertise, both in the area of the aftermarket and in working with OE manufacturers, including VW, Ford, Maruti, Hyundai, Kia and Fiat for OEM installation.

Hartge H1-LPi

	Petrol	LPi
v Max (km/h)	290	305
Power (kW)	280	298

Project V300+

LPG in general

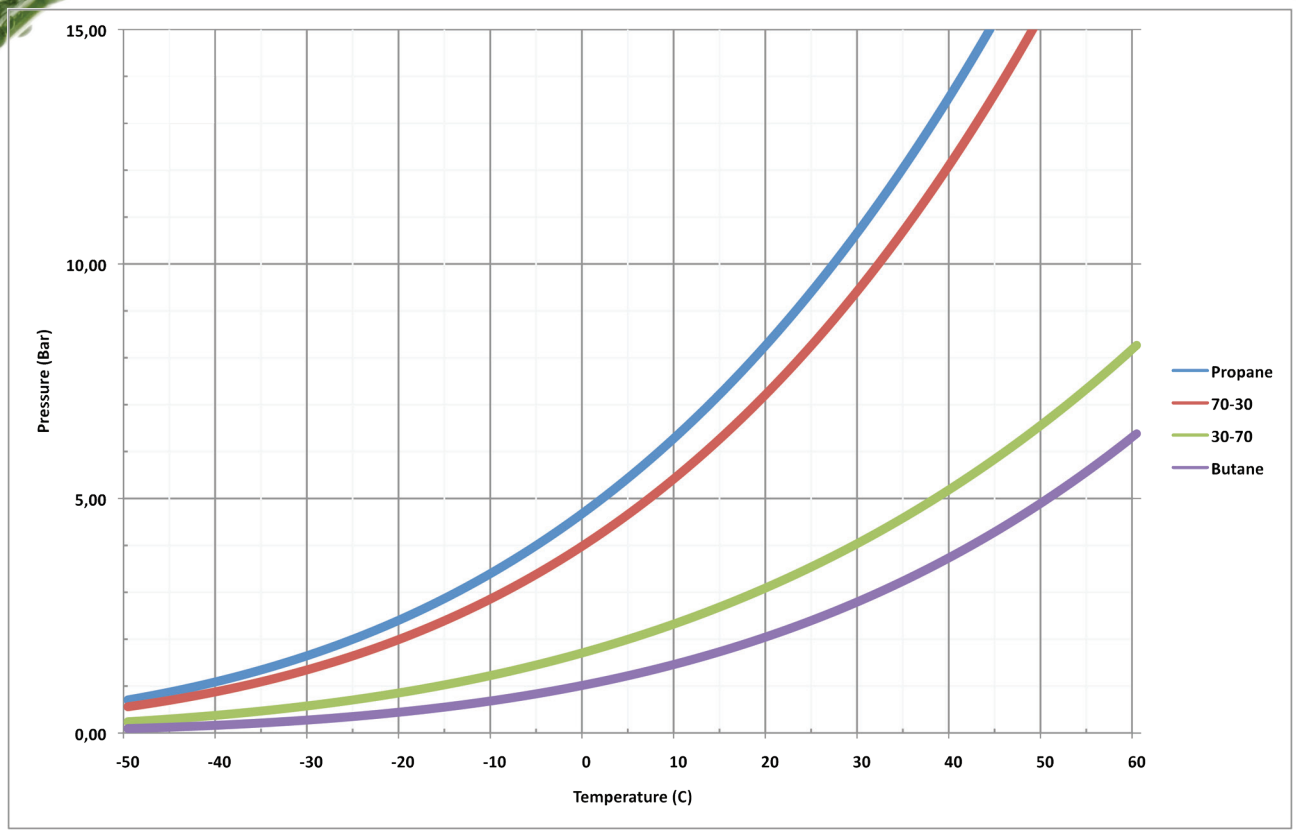
Mixture

LPG is a mixture of hydrocarbons which appears in a vapour form at room temperature and atmospheric pressure. Another characteristic of LPG is that the gas, by temperature decrease and/or pressure encrease, the vapour wil change to liquid due to the low boiling point. This has the significant advantage that LPG can be stored in a tank in liquid form. The only measurement to be taken is to increase the pressure when storing the LPG. The increase in pressure is caused by the vaporization of liquid gas in a sealed container. On average, the volume increases by a factor 250 during vaporization. This depends on the composition and temperature of the LPG.

Vaporization

In case the amount of liquid gas decreases, the remaining volume will be filled with vaporized gas. The vaporization and condensation is a continuous processes that only terminates when the tank is completely empty. The pressure of the vapour (vapour pressure) of the gas again depends on temperature and composition. The vapour pressure graph shows this phenomenon. The pressure in the tank will be constant until the liquid has vaporized.

The vapour pressure graph



Composition

The vapour pressure graph allows us to - quite accurately - determine the pressure of the gases composition with a given specific temperature. The graph also tells us why the composition of LPG changes with the seasons. Butane can, at a temperature of -10 ˚C, no longer escape from the tank since the vapour pressure is too low.

The composition of LPG used in the Netherlands is 70% butane in the summer and 70% propane in the winter. This leads us to the conclusion that the gas always consists of a butane and propane mixture. However, it is not relevant in working with an LPi system to know the composition, since the pressures used in an LPi systems will always keep LPG a liquid under all conditions.

Vapour

To guarantee that the LPG will always be in the liquid phase, the pressure is increased to 3.8 - 4.5 bar. This increase in pressure is accomplished by using a pump together with a calibrated orifice (restrictor) in the return line. The increase in pressure ensures that there is always liquid LPG at the injectors. Therefore vapour should not develop in the system.

The returning LPG temperature is increased by the engine which normally would increase the tank pressure, but due to partial vaporization while entering the tank, will cause a pressure decrease in the tank.

LPi Introduction

Liquid

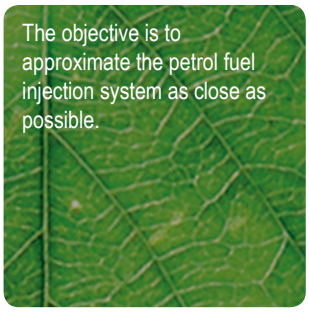
Liquid Propane Injection stands for the injection of LPG in a liquid form. The LPi system stands for another approach towards metering/dosing the LPG/air mixture in a combustion engine. This LPi system was introduced in 1995 and was the successor of the traditional LPG system.

At first, an evaporator/venturi system, possibly in combination with an electronic fine tuning device, determined the mixture dosing. The continuously developed technique required a much more accurate pressure mixture dosing than could be achieved with a pressure regulated system. The objective is to approximate the petrol fuel injection system as close as possible. Therefore, the choice to inject the liquid LPG straight onto the inlet valve is a logical one.

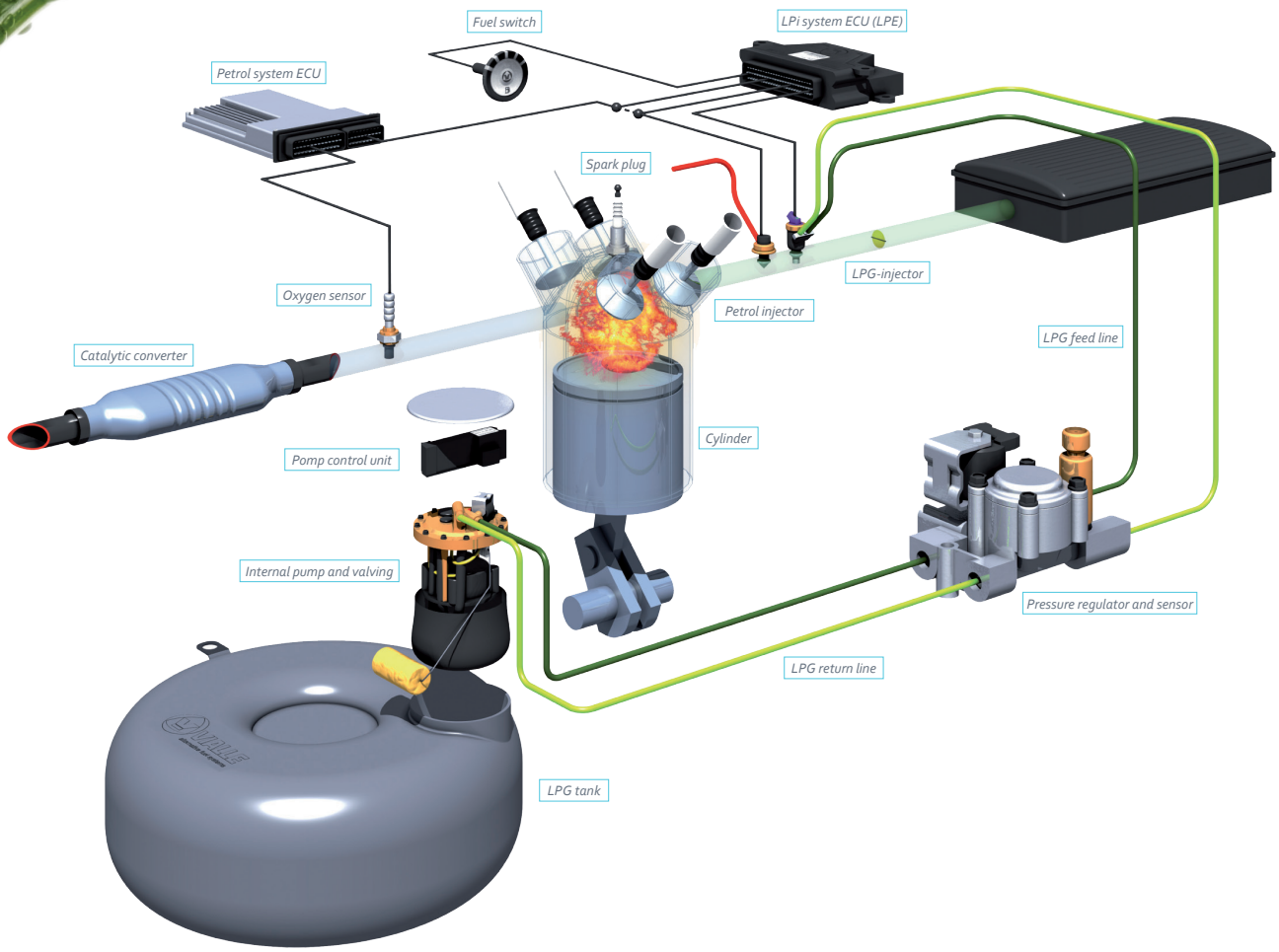
Components

To introduce this completely new system numerous developments have taken place. Almost all components are completely new or have been highly modified in comparison to the components one would find in the evaporator system. The evaporator and gas/air mixture components have been replaced by the coupling block and LPG injectors. Also, the tank is now equipped with a multivalve pump combination to circulate the liquid LPG.

Copper lines were replaced with synthetic lines. Synthetic lines are flexible, making mounting easy. They are also less prone to being damaged. The burst pressure of the lines is 345 bar! The high isolation value reduces the exchange of heat, reducing the warming up of the LPG, preventing vapourisation in the fuel lines.

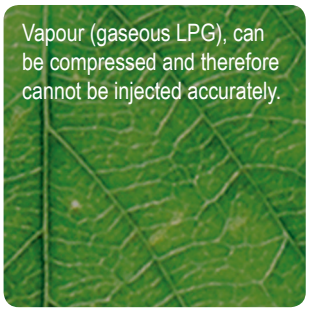


LPi System



Vapour (gaseous LPG), can be compressed and therefore cannot be injected accurately. In order to inject liquid LPG a specified system pressure is necessary. This system pressure is delivered by a membrane pump in the tank. The pump unit pumps the LPG through the coupling block to the LPG injectors. The surplus of LPG then is returned to the tank via the return line through the coupling block.

The system pressure is adjusted to 5 bar above tank pressure by the pressure regulator in the coupling block. This avoids vapour lock in the lines through heating up by, for instance, the engine. The coupling block also contains a cut-off valve which is opened when LPG is selected and is closed when petrol is selected. The illustration shows the schematic overview.



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The Pump Tank Combination (PTC)

The PTC with multivalve

Function

- Safe storage of the liquid LPG.
- Houses the multivalve.

Multivalve

The Pump Tank Combination no longer has a mounting bracket with individual components. The current generation LPi tanks are supplied with a multivalve. The multivalve has been mounted recessed. The fittings casing is sealed air tight by a cover with a rubber ring. The fittings casing also contains all the pumping electronics. The fittings casing has two outlets. One, for the filling line, and one for the wiring and Supply / Return lines. The tank has a number of small magnets in the bottom to catch small metal particles, to avoid them entering the system.

See the attachment for an overview of lpg tanks.

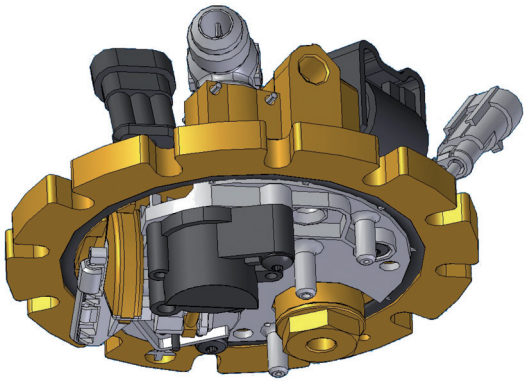
Tank

The tank has a number of small magnets in the bottom to catch small metal particles, to avoid them entering the system.

Multivalve 1/2

Function

- Houses all fittings.
- Allows mounting facilities of the LPG pump unit.
- O-ring provides an air-tight seal between tank and multivalve.



Multivalve bottom

Fittings

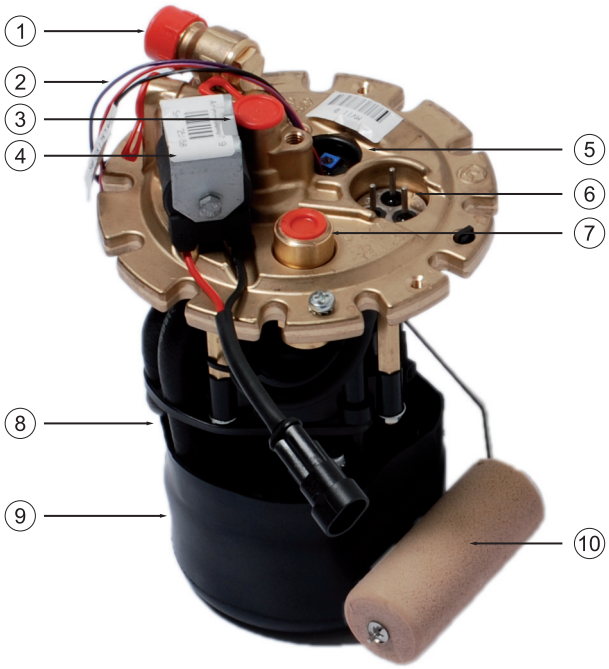
The multivalve contains all tank fittings which in the past were mounted on the tank pad as individual Items. The LPG pump is fitted to the multivalve and circulates the liquid LPG around the system.

Container

At the bottom side of the pump unit where the liquid LPG is sucked in, a buffer container has been placed. This buffer container makes sure that liquid LPG, instead of vapour, is sucked in as long as possible.

MV2

The re-developed multivalve 2 has been developed by Vialle alternative fuel systems and can be recognized by the slitshape holes. The multivalve 2 has the same components as multivalve 1. The major changes are in the 80% filling and the grummet of the pump supply. Also, the airing of the pump has been routed to the outside.



Multivalve 2 with pump

1. Fill hose connection
2. Feed line
3. Return connection
4. Electromagnetic valve
5. Tank content meter (TIM)
6. Electronic feed-through for pump power supply
7. Pressure safety valve
8. Pump
9. Buffer container
10. Tank float

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Tank Contents Gauge (TCG)

Function

- Register contents of tank.
- Deliver voltage signal to the selection switch with tank read out.

Float

The TCG is an electronic transmitter that operates according to the principle of a hall-sensor. The tank float in the tank follows the liquid level in the tank. This deflection supplies - through a lever- a changing magnetic field to the TCG. The hall-sensor in the TCG changes this changing magnetic field into a (sine wave) voltage signal. The TCG sends this voltage signal to the LPE. The highest voltage is approximately ± 3.55 volts, the minimum value is approximately 0,11 volts.

Tank content

The complete sine wave is not used to measure tank content, but only the lower range of the sine. When the tank is full (filled 80%) the voltage generated is 2.50 – 2.55 volts. The voltage is reduced as LPG is consumed. This signal is sent to the LPE which communicates it to the fuel level indicator on the fuel selection switch.

Electrical connections: TCG

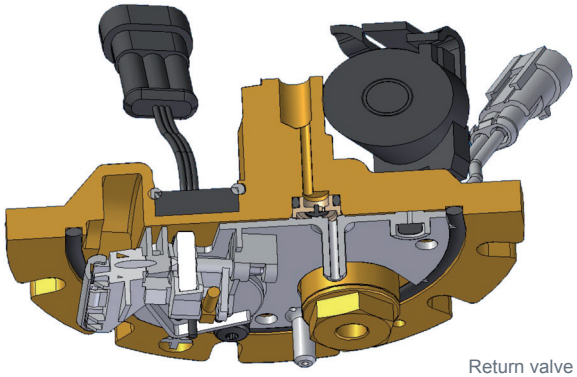
1. Supply 12 volts (red/blue)
2. Signal wire (purple).
3. Ground (black)

Attention! Extended exposure to moist (leak seeking spray) can lead to damage of the TCG!!

The return valve

Function

- In case of line rupture stops LPG escaping from the tank.
- Muffles the sound of returning LPG.



Return valve

Line rupture

The integrated return valve in the return line to the multivalve, safeguards against a line rupture, preventing the LPG escaping from the tank. The valve also cushions the burping sound of returning LPG.

The plunger in the return valve is opened by the returning LPG pressure that comes from the connection unit, against the spring pressure. A slight excess pressure of approximately 0.1 bars is enough to overcome the spring. That's why it can be assumed that the pressure in the return line from the coupling block is equal to the pressure in the tank plus 0.1 bar. In case of significant pressure drop due to a line rupture, the plunger will be pushed against the seat by the spring pressure, -supported by the tank pressure – and immediately will close off the tank.

The PTC pump unit

Function

- Circulate the liquid LPG.
- Build up enough pressure.
- Avoid the generation of heat and vapour.
- Buffer container prevents that vapour is sucked in.

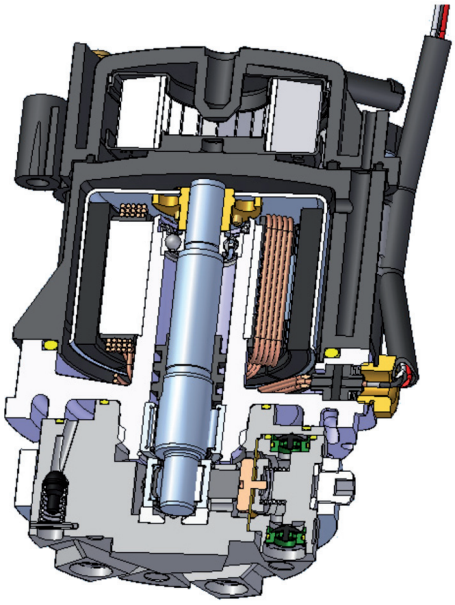
PTC Pump

Pump

A new pump was developed for the PTC. The pump unit is considerably smaller than that of the first generation. The motor is much smaller in size and the large buffer container has been replaced by a smaller rubber buffer container. Currently, even shallow ring tanks with a small height can be equipped with a pump unit.

The advantages of this pump unit are:

- Low power consumption (1-5 A), dependent on the rpm. Also, the start up current is about half of that of the old pump. This reduces the development of heat.
- Less heat-development.
- Less motor noise.
- Smaller size, allowing the pump to placed in a ring tank.



PTC pump cross-section

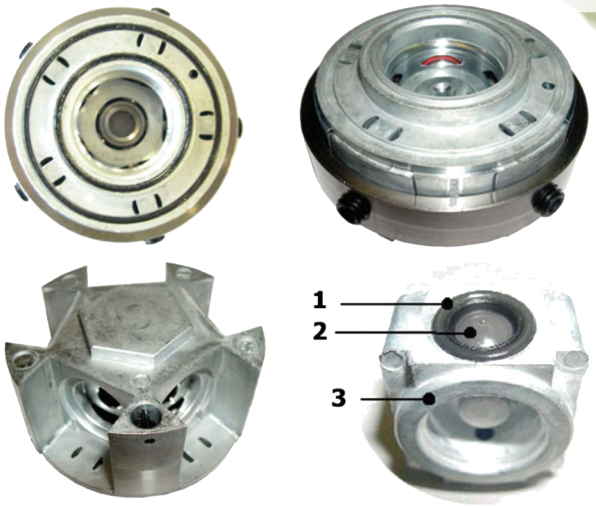
Pump section

Membrane pump

The liquid LPG is circulated by a star shape membrane pump. The pump component is mounted to the driving motor. The pump has 5 pump chambers and each chamber contains a plunger. The 5 plungers are activated by an eccentric cam. The volume of these chambers increases in size during the incoming stroke. By increasing the volume of this chamber the inlet valve will be opened and the LPG flows in. At the end of this volume increase the inlet valve will close. Next, the plunger will reduce the volume of the pumping chamber and the LPG will be pumped to the coupling block via the pressure valve.

Delivery

The delivery of this pump is dependent on rpm. The stroke of the plunger is constant. The pump section also houses an overflow valve. Is the resistance, for instance due to a blockage, too high, the excess pressure safety is activated and the LPG will be pumped through the excess pressure valve (approximately 8 bar over tank pressure).

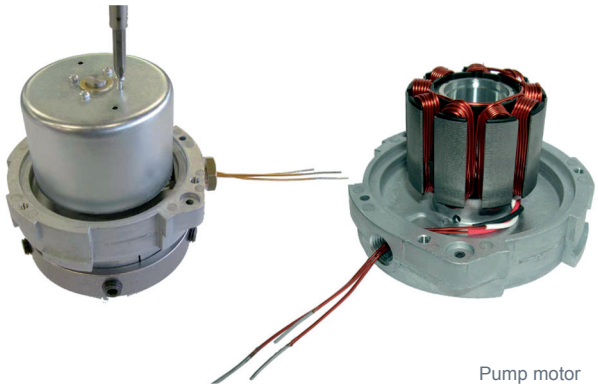


Pump section

Pump motor

AC motor

The pump motor is a brushless alternating current motor. It is fed through a 3-pole connector that is mounted on the electric through lead on the bottom side of the multivalve. The conversion of DC to AC is controlled by the electronics in the fittings cover. The rotor of the motor contains permanent magnets. The stator consists of coils with a soft-iron core. These coils are activated in sequence in star shape.



Pump motor

The current through the coil produces a magnetic field, this will attract the rotor and torque is then produced. The choice of using a rotor with permanent magnets gives a high torque in a compact construction.

5-Speed

The motor can generate 5 different rpm's being 500, 1000, 1500, 2000 en 2800 rpm. These rpm's are generated by activating the electric fields with different frequencies. Dependent on engine load (injection time/engine rpm) the LPE will send a variable duty-cycle to the pump electronics. The pump electronics converts this signal into an electric field with varying frequency, all dependent on engine load. This changes the rpm of the motor. If the signal wire is cut, the pump will go into emergency run with 2000 rpm.

Motor rpm : load dependent.
Emergency rpm : 2000 rpm.

Pump control

Function

- Close off the fittings cover air tight to 0.5 bar.
- Cover contains electronics to change the DC to the necessary AC for the pump motor.
- The signal of the LPE determines the pump rpm.

Duty-cycle

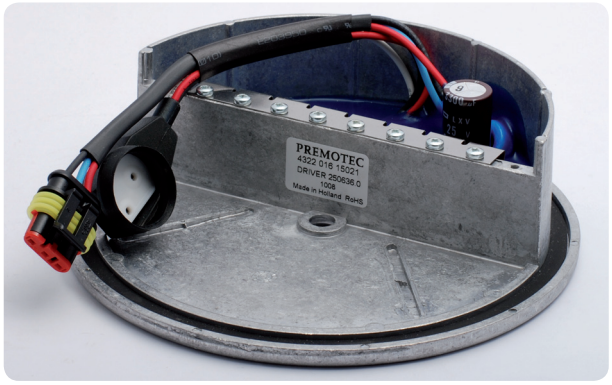
Depending on engine load a specific amount of LPG is required. The LPE sends a signal to the pump control in the form of a duty-cycle. Depending on this duty-cycle the pump control will supply the pump with a certain voltage.
There are 2 variants:

- Amplitude controlled
- Frequency controlled

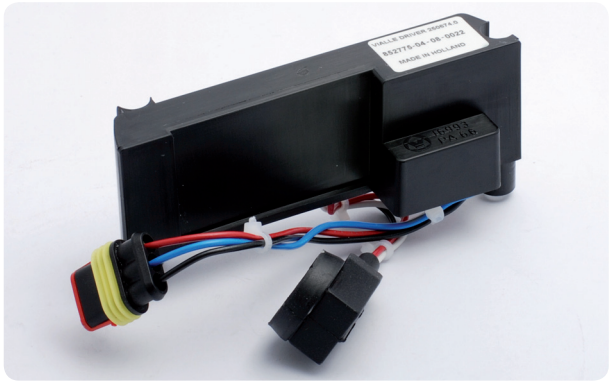
The first pump controllers had a amplitude controlled signal (variable amplitude). These are identifiable by the 2 condensators. In 2007 a new version is developed which has only 1 condensator and is frequency controlled.

New 2008>

From 2008 a new model is available which is also frequency controlled. With this new model the controller is separated from the cover. The old versions can be replaced with this new model in case of faults. Advantage of the new model is a more simple fitting because controller and cover occupy less space.



Pump control >2008



Pump control 2008>

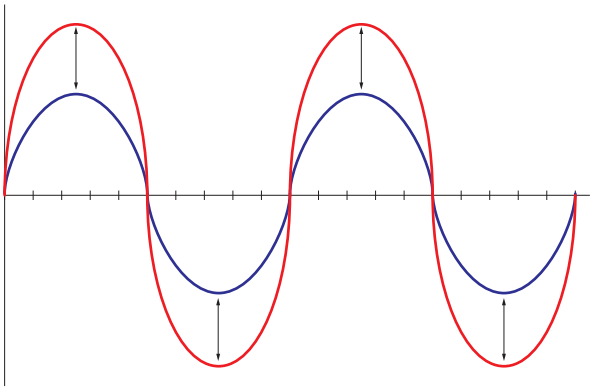
Electrical connections:

Connections to controller:

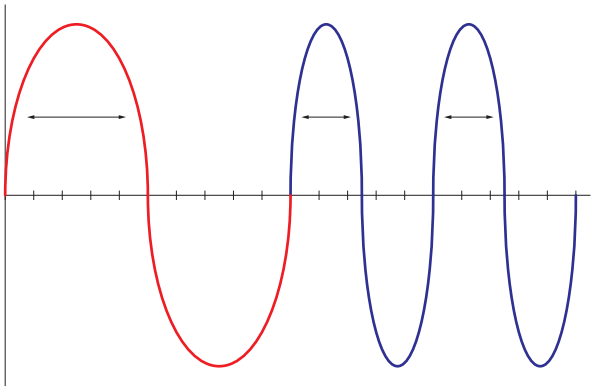
- Supply (12 volts)
- Signal wire (duty-cycle)
- Ground

Connections from controller to motor of LPG pump:

- fase wire red
- fase wire white
- fase wire black



Amplitude controlled



Frequency controlled

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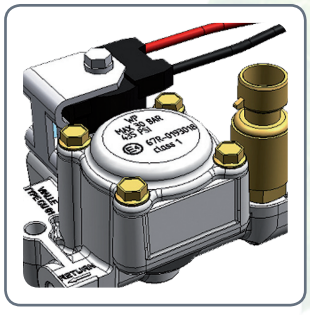


The coupling block

The coupling block

Function
Houses the pressure regulator, pressure sensor and shut off valve.

Connection
The coupling block creates the connection between the tank and injectors and is mounted inside the engine compartment. The coupling block contains an electromagnetic shut off valve that can shut off the supply of LPG. This valve opens at the same time the electromagnetic shut off on the tank is actuated. Also, the pressure regulator and pressure transmitter are mounted in the coupling block.

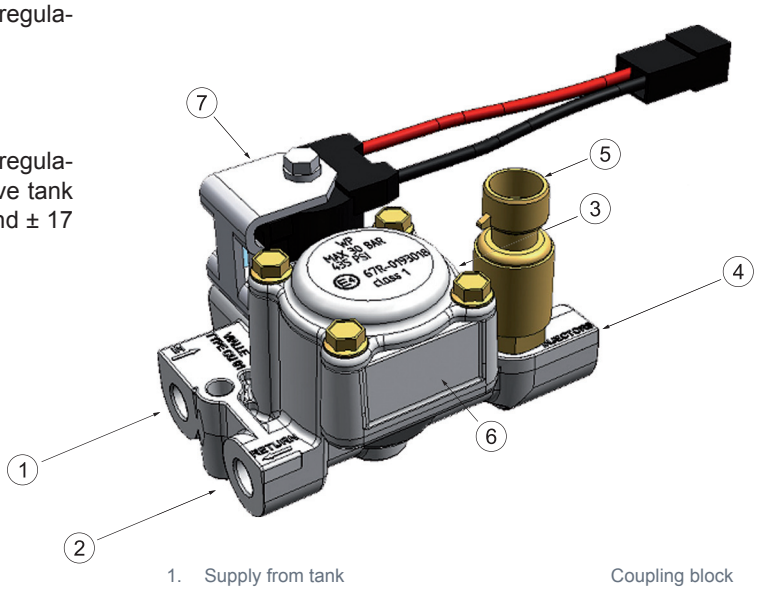
Circuit
The liquid LPG flows to the injectors through the shut off valve. The surplus LPG goes back to the tank via the pressure pick up and pressure regulator.

Pressure regulator
The pressure is trimmed by the pressure regulator on the coupling block and is 5 bar above tank pressure and normally varies between 7 and ± 17 bar.

Fuel lines
On the coupling block four connections for flexible high pressure lines are fitted. The actual connection is made with a banjo and banjo bolt. It is extremely important not to change the connections because of the flowing through of LPG. The pressure regulator allows a flow in only one direction. The direction of flow is indicated on the housing by arrows.

The coupling block should not be disassembled!

Attention!!
There are two versions. The LPE 7 system has a coupling block with modified plug connection.



Coupling block

1. Supply from tank
2. Return to tank
3. Supply to injectors
4. Return from injectors
5. Pressure sensor
6. Pressure regulator
7. Shut off coil

The pressure is trimmed by the pressure regulator on the coupling block and is 5 bar above tank pressure and normally varies between 7 and ± 17 bar.

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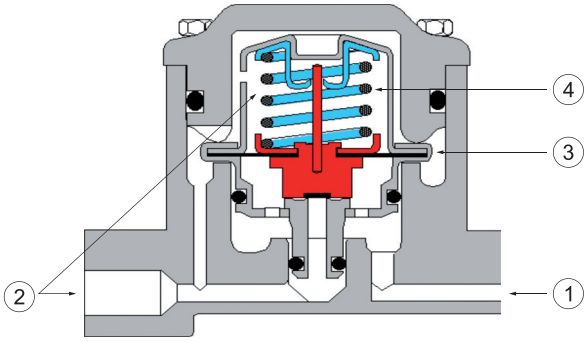
Pressure regulator

Function

Trim system pressure, 5 bar above tank pressure.

Description

The pressure regulator trims the pressure to 5 bar above tank pressure (reference pressure). The tank pressure varies with temperature and composition of the LPG. This can be derived from the vapour/pressure graph. The pump in the tank increases the pressure in the line. The spring loaded membrane valve only clears the return to the tank, once the 5 bar has been reached. There is tank pressure over the membrane. The valve opens once the system pressure is equal to that of tank pressure + the spring pressure of 5 bar.



1. System pressure from injectors
2. Tank pressure
3. Membrane
4. Spring

Pressure regulator

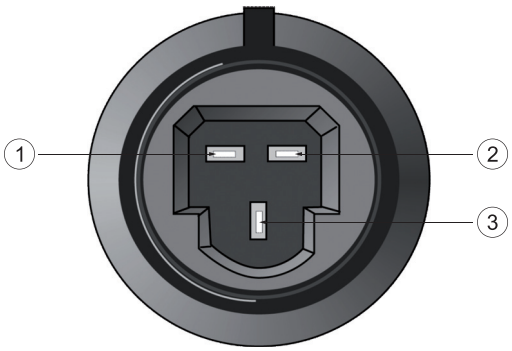
The pressure sensor

Function

- Pick up system pressure.
- Provide signal to LPE.

Description

The pressure sensor is part of the coupling block and measures the system pressure in the return section after the injectors. This guarantees a constant pressure of LPG at the injectors. The pressure sensor has a range of 0 to 30 bar and converts pressure into a 0 to 5 volt voltage. It has three connections; a supply, a signal and ground wires. The 5 volts supply is controlled by the LPE and a calibrated voltage is sent that equates to the system pressure to the LPE. The signal voltage is absolutely essential for the LPE to determine the LPG injection quantity.



Electrical connections:

1. Ground
2. Supply (5 volts from LPE)
3. Signal wire (0-5 volts)

Pressure sensor

Voltage (V)	Pressure (Kpa)		Voltage (V)	Pressure (Kpa)
0.2	0		2.8	1720
0.4	130		3.0	1850
0.6	270		3.2	1980
0.8	400		3.4	2110
1.0	530		3.6	2250
1.2	660		3.8	2380
1.4	790		4.0	2510
1.6	930		4.2	2640
1.8	1060		4.4	2770
2.0	1190		4.6	2910
2.2	1320		4.8	3040
2.4	1450		5.0	3170
2.6	1580			

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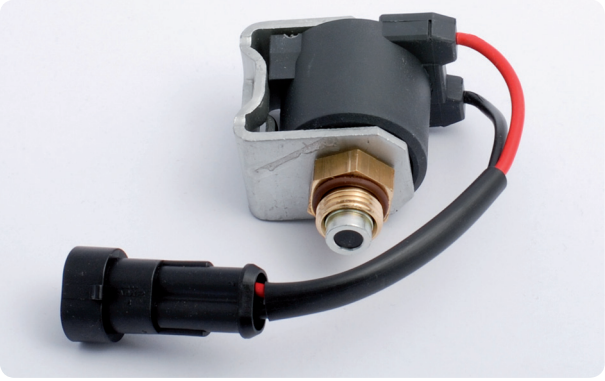
Shut-off valves

Function
Shut-off LPG supply.

Description
The shut off valve is a legally required component that cuts off the LPG supply in case of engine stall or no ignition signal. Both shut-offs are actuated with 12 volts by the LPE when LPG is the selected fuel, even when the engine still runs on petrol.

2 Shut-off valves are available::
- 11 Watt (engine compartment)
- 8 Watt (multivalve)

The shut0off valve on the coupling block requires more power due to the higher pressure of the LPG.



Shut-off valve

Electrical connections:
- Supply (12 volt)
- Ground

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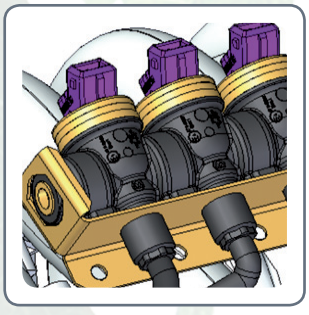


Injectors

Injectors

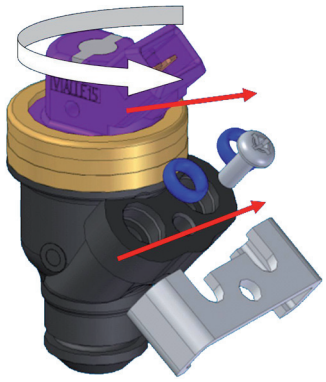
Function
To inject the liquid LPG.

Bottom-feed
Bottom-feed injectors are used to inject the liquid LPG. These injectors have the advantage that the heat produced by the injector coil does not result in the LPG being heated, this is in comparison to top-feed injectors. Also, it leaves little to no LPG to be pumped around in the injector. The injector coil has a resistance of 1.8 Ω.

Filter
The Injector has a liquid filter screen to avoid contaminates entering the pintle seat.
Note: this filter does not require servicing.

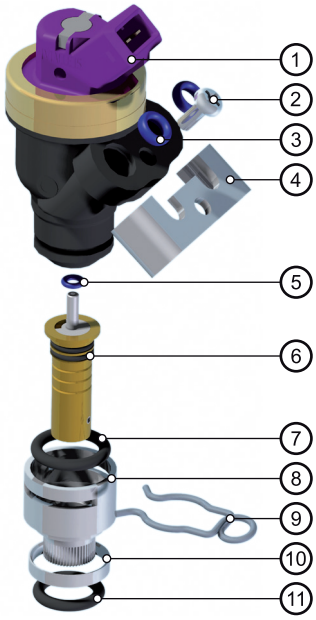
Color codes
The injectors are available in various sizes. Each size has a different color and code, together with a different flow (higher number = more flow).

Injector	Color
Vialle 12	Yellow
Vialle 15	Purple
Vialle 17	Brown
Vialle 20	White
Vialle 28	Dark brown



Connector injector can be rotated

1. Connector
2. Screw
3. O-ring
4. Clamp plate
5. O-ring
6. Discharge pipe with o-rings
7. O-ring
8. Adapter for manifold mounting
9. Safety clip
10. Support ring
11. O-ring



Construction injector

Holder
The injectors are always mounted in a universal injector holder (black housing) The injector is pushed into its holder by a screwed ring and o-rings are used to seal them. The injector holders are made of synthetic material to avoid heat build up of the liquid by the manifold. The LPG is supplied through synthetic lines which are kept in place by a clamping plates. Dependent on the injector position on the manifold, the gas is fed through supply pipes (6). These supply pipes (6) can be pointed in various directions.

Resistance: 1,8 Ω.
Activated: Ground activated.

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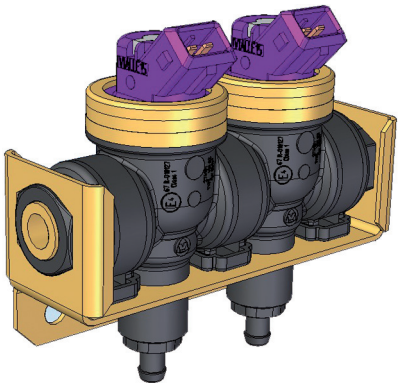
Fuelrail

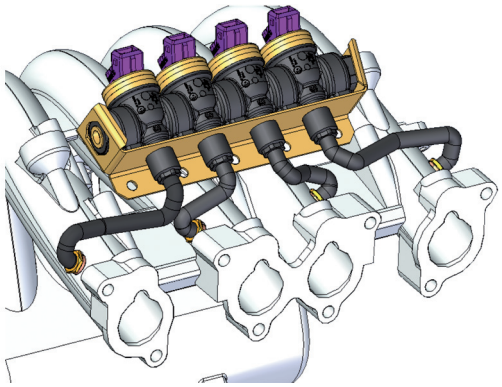
Injector

The next possibility is the fuel rail. The fuel rail consists of a number of injectors which can be connected with one another. In the manifold special discharge pipes are mounted. The connection between adaptor and fuel rail is realized using flexible hoses. This option is used when there is lack of space for the standard mounting of the LPG injectors.

Fuelrail injector



Safety bracket fuelrail



Fitting discharge pipes

Injected fuel outflow angle

Goal

The goal is to inject the liquid LPG onto the inlet valve, or as close as possible to it. Sometimes the injectors can only be fitted further away from the inlet valve and then there is an increased chance, that the fuel will be injected against the manifold wall. This can lead to condition called icing caused by the evaporation of the liquid LPG on the manifold.

Icing

During injection, the liquid LPG will immediately vaporize when Injected. Vaporization requires heat, therefore LPG will draw heat from its environment. This can lead to a icing condition if heat is not available and an accumulation of ice (freezing of condensed water vapor and LPG) if it is spraying against the manifold. When this ice breaks off the manifold and enters the cylinders, the fuel mixture will become too rich and possibly cause the engine to misfire. This icing condition therefore can have a negative influence on drivability.

Teflon

The chance of the icing developing increases with cars with a synthetic manifolds since the transfer of heat is considerably reduced, compared to an aluminum manifold. To avoid icing, the nozzles and discharges lines all have hosing with a non-heat conducting interior, made of teflon. This almost completely prevents the extraction of heat on the discharge side of the nozzle and the liquid LPG will now only vaporize close to the heat source upon exiting.

The chance of the icing developing increases with cars with a synthetic manifolds since the transfer of heat is considerably reduced, compared to an aluminum manifold.

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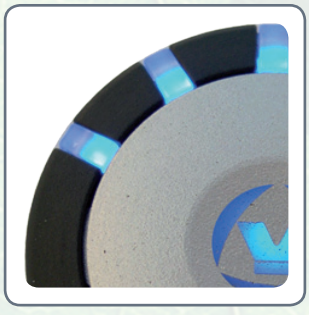
Training manual


Fuel selection switch

Fuel selection switch with tank read out (LPE-7)

Function

- Fuel change over switch.
- Indication of selected fuel.
- Read out of fuel level in LPE tank.
- Indicate condition of LPE system.

Fuel change:
Changing the selected fuel is done by pressing the Vialle logo in the middle of the switch. Pressing the logo will cause a short audible beep to be heard to indicate the fuel has been changed. The illuminated symbol indicates which fuel is selected.

LPG

Petrol

Level:
Reading out the fuel level in the LPG tank.

Empty

Full

Starting up:
During start up all led's on the switch will illuminate briefly, this is a test function. With a cold start (the engine has been off for more than 3 hours) a audible beep will be heard, the engine will always starts on petrol, after meeting the LPE criteria the last selected fuel will be used.

LPG:
If LPG was the last selected fuel after starting, (and the LPE conditions are meet), there is an automatic switch over from petrol to LPG. The blue Vialle logo will flash with a frequency of 3 flashes per second while running on petrol. This is called the "run up time", when the LPE switch's to LPG the Vialle logo will shine continuously.

Run up time

LPG

Petrol:
If petrol was the last selected fuel, the engine will continue to run on petrol. The petrol pump logo will shine continuously.

Petrol

Changing the selected fuel:
Changing from the selected fuel can only be done with the engine running. If the change is made to LPG from petrol the petrol pump logo will go out, and the Vialle logo will flash with a frequency of 3 flashes per second. The LPG system is preparing the change-over (the run up time), the moment the engine run's on LPG, the Vialle logo will shine continuously. If the change is made from LPG to petrol, the Vialle logo will go out and the petrol pump logo will shine. The engine runs on petrol immediately.

Petrol Run up time LPG

If the change is made from LPG to petrol, the Vialle logo will go out and the petrol pump logo will shine. The engine runs on petrol immediately.

Petrol

LPG

Automatic Fuel Switch (AFS):

If the LPG system switches back to petrol because of AFS is activated due to an empty LPG tank, the last level LED will flash with a frequency of 1 flash once per second. The Vialle logo goes out and the petrol tank logo shines continuously. At that point 3 audible beeps will be heard and the LED's will shine brighter for a short period. After the LPG tank has been filled to 30%, or more, then there will be an automatic switch back to LPG.

If the flashing LED is seen as irritating, it can be switched off by activating the switch and changing to petrol. This is seen as a manual selection of fuel (petrol) and will require a manual selection of LPG to be selected after refueling!!

After activating AFS the level led will flash

Petrol

AFS not active:

The option AFS is not active with every vehicle. In that case the switch over at an empty LPG tank has to be done manually. Remark: it is advised not to completely run dry the LPG tank.

Error indications:

If there is a malfunction in the LPG system that influences fuel management, there is an automatic switch over to petrol. The petrol logo then flashes with a frequency of 1 flash per second. If LPG was selected using the fuel selection switch, the Vialle logo will flash with a frequency of 1 flash per second, and the engine will continue to run on petrol.

It is possible that fuel switching operation can be disabled when a malfunction occurs. The switch will be disabled under the following circumstances:

- When the lpg tank has been run empty (after AFS)
- When a malfunction on the feed back connection of the LPG injectors has been changed over to petrol.

Malfunction in the LPG system

Switch off AFS

AFS can be switched off by allocating an extra 20 liters in LDT. The extra volume is than larger than the actual rest volume in the tank. The consequence is that the tank is empty before AFS can become active.

Switching off can also be carried out following the procedure below. A pre-condition is that AFS has been activated, meaning the tank is almost empty.

1. Contact off
2. Press down switch and keep it pressed down.
3. Start engine with switch pressed down.
4. Hold switch for five seconds after start up.

AFS is now switched off. Activating it again can be done using LDT.

Fuel selection switch with tank read out (LPE 4-6)

Function

- Select the fuel to be used by using a pressure switch.
- Indicate fuel quantity using LED's.
- Perform diagnostics using blinking codes.

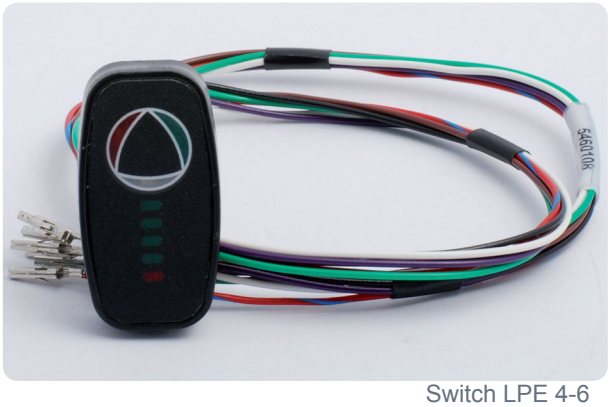
Light sensitive sensor produces brighter green light with higher indicence of light.

From generation LPE-4 onwards it is possible, from a wiring loom point of view, to use the switch with tank read out. Advantages of the switch with tank read-out are:

- Petrol float wire is no longer interrupted.
- No problems in reading the original gauge.
- Both fuel indicators can be read permanently.

See appendix for diagnostic table blinking codes!

Led color	Switch
Red	Petrol
Green	LPG
Blinking green	To LPG



Switch LPE 4-6

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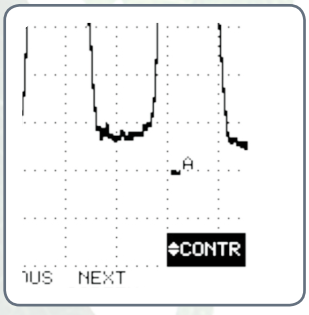


Electrical System

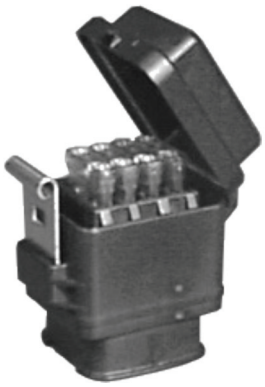
Fuse holder

Function

Provide a moisture-free housing for fuses.

For trouble-free operation, the fuse holder must be adequately secured. When the connectors have been placed in the holder, the inner part of the cover must be pressed firmly into the holder. The inner part of the holder is then pressed into the second safety coupling. As a check one should pull on the wires to see if these have been properly secured.

Mounting: in the engine compartment.



Fuse holder

Pump relay

Function

Dependent on wiring loom application, gives supply to the LPG pump and shut-off valves using a small control current from the LPE.

Wiring loom

Dependent on the wiring loom application, a pump relay is, or is not, used. If used, the relay will be actuated by a control current. By energizing the relay, both the LPG pump and shut-off valves will be fed.

Location:	in the engine compartment
Relay:	5-pole
Control voltage:	12 volts
Max current:	40 amps

Pump relay

Connections to the relay (LPE 4)

Pin	Connection
30 (red)	+ Battery
87 (green)	Switched supply to pump
85 (green)	Energize from LPE
86 (black)	Ground

Connections to the relay (LPE 5)

Pin	Connection
30 (red)	+ Battery (15 amps fused)
87 (green)	Supply to pump
85 (red)	+Battery (5 amps fused)
86 (green/black)	Energize LPE

Main relay

Function

- Signal provided by the engine safety shut-off and ground LPE, then the relay is energized.
- Dependent on the type of wiring loom, injectors, LPE, selection switch and TCG will be fed with power via the main relay.
- In case the engine stall's or the safety shut-off signal fails the engine will be shut down, due to no signal being available to the relay. This is a safety function of the system.

Main relay

Description

As soon as the engine runs, pin 86 will have a signal supply from the engine run shut-off safety. Through pin 85 (ground) a base current then flows, energizing the relay. In case the engine stalls, energizing of the relay is terminated immediately. Dependent on the wiring loom execution, the supply to LPG injectors, LPE, TCG and selection switch with tank read out will be shut off. Since the LPE no longer receives the power supply engine shut-off safety is engaged, which will interrupt the base current to the LPE main system relay immediately as a safety precaution.

Location: in the engine compartment
Relay: 5-pole
Control voltage: 12 volts
Max. current: 40 amps

Pin	Connection
30 (red)	+ Battery
87 (red/blue)	Supply fuse holder
85 (black)	Ground
86 (red/green)	Supply engine run shut-off safety (+ petrol pump)

Injector-interrupt unit (LPE 4-5-6)

Shut off

The petrol injectors must be shut-off the moment the engine switches from petrol to LPG. In order to shut off the petrol injector, a resistor is connected in series. Because of this series resistance, the total resistance (resistance coil and switching resistance) increases.

The current through the injector will therefore decrease with approximately a factor 10. Because of this decrease, the injector will no longer be lifted from its seat; the injector will no longer inject petrol.

This resistor has been integrated into the shut-off relay and is in permanent series with the petrol injector. When driving on petrol, the resistor is bridged by the (NC) relay contacts. The moment LPG is selected, the relay is energized and will the relay contacts open. The series resistances will now trim the current to the injector coils. The

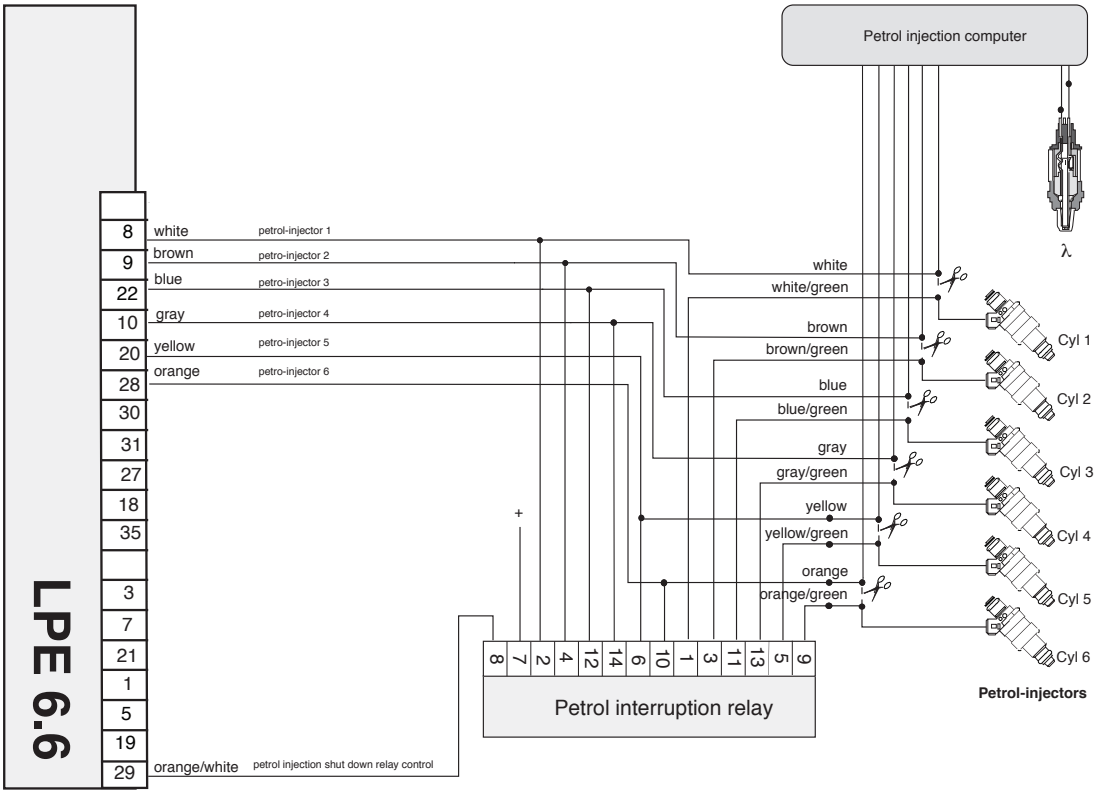
injector-onderbreekunit

injectors remain closed. The petrol ECU does not detect an open circuit and therefore will not generate a fault code in the EOBD.

Function

- Connect petrol-injectors with ECU during petrol operation.
- Pass on fuel injector signals to LPE.
- Activate serial resistance when switching from petrol to LPG.
- Avoid fault codes in EOBD when petrol injectors are switched off.

Attention:
The injector interrupt unit has been integrated in the LPE-7 with the LPE-7 system.



Pen nr.	Description	Plaats onderbreking	Cilinder	Draadkleur
1	petrol interruption	Injector side	1	white/green
2	petrol interruption	ECU/LPE-side	1	white
3	petrol interruption	injector side	2	brown/green
4	petrol interruption	ECU/LPE-side	2	brown
5	petrol interruption	injector side	5	yellow/green
6	petrol interruption	ECU/LPE-side	5	Yellow
7	Supply shut-off relays			Red
8	energizing shut-off relay			orange/white
9	petrol interruption	Injector side	6	orange/green
10	petrol interruption	ECU/LPE-side	6	orange
11	petrol interruption	Injector side	3	bleu/green
12	petrol interruption	ECU/LPE-side	3	bleu
13	petrol interruption	Injector side	4	grey/green
14	petrol interruption	ECU/LPE-side	4	grey

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Electrical System

Petrol EMS

The objective of the LPi system is to obtain maximum use of the available electronics in the petrol engine management system. In fact, the petrol control unit determines how much LPG is injected. The petrol control unit still determines the petrol injection time, even when LPG has been selected. This injection time is then recalculated to an injection time for the LPG injector.

Calculations

The petrol control unit already carried out a great number of calculations in order to obtain the best possible mixture. For instance, quantity of air, air temperature, engine temperature and load are all measured. These calculations therefore do not have to be carried out by the LPE unit.

LPG injectiontime

The LPE calculates, using the petrol injector signal, LPG system pressure, battery voltage and the LPG injector times. Since LPG injectors have a different output to the petrol injectors, the LPE will have to adjust the injection times. Also, the LPG system pressure is very important for calculating the injection quantities (deliveries).

LPE 3/4/5/6

Software

The LPE is always equipped with basic software which is then supplemented with specific brand/type (calibration) software. The LPE 4 t/m 6 has a splash water proof casing, equipped with a 35 pole connector and is placed under the bonnet.

The LPE activates the shut-off valves, fuel pump, the tank content gauge and fuel selection switch, next to the injectors. Also, the LPE is equipped with its own diagnostic system.

It is forbidden to clean the LPE with a high pressure hose. The LPE is only splash water proof.

LPE 3-6

LPE 7

Housing
The LPE-7 housing is made from synthetic material and is a modern design. You are not allowed to open the housing of the LPE because it will void the water proof product warranty. As stated above the housing is waterproof and has a minimum protection classification of IP66.

Connector
The LPE-7 is not interchangeable with LPE-6 and previous LPE's. The LPE-6 and previous versions have a 35-terminal AMP connector. For this version it was necessary to extend the number of pins. The LPE-7 is equipped with a 70-terminal connector.

Wiring loom
For the LPE-7 system a new wiring loom has been developed with an increased protection classification, guaranteeing waterproof operation.

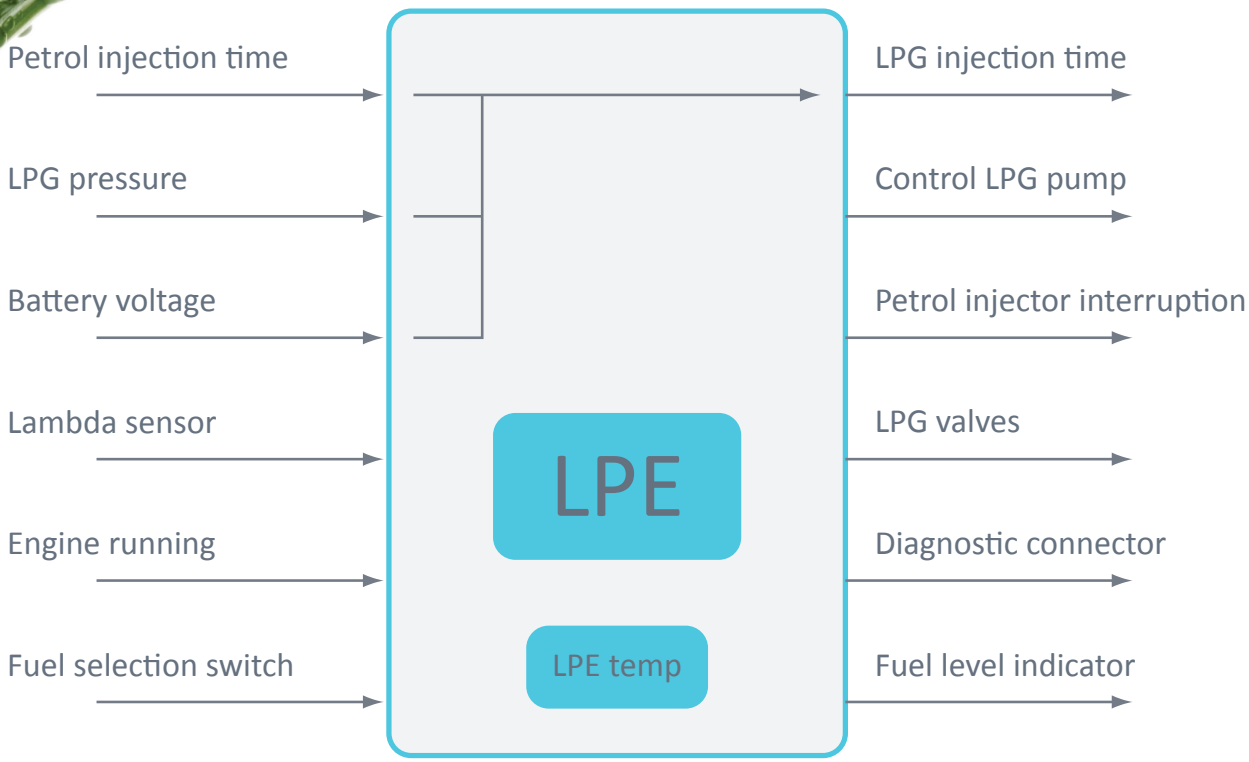
Injector interruption
Quite a number of changes have been carried out, both from software and hardware point of view. The interrupt relay of the LPE-7 has been integrated into the hardware of the LPE-7, reducing the number of components and thus adding to correct operation without malfunctioning.

LPE 7

Software
The LPE is equipped with three forms of software, basic software which is then supplemented with specific Brand/Model (calibration) software. It is also equipped with its own diagnostic system. Both master software as well as Brand/Model specific software files can be updated by the dealer as they become available using the LPE Diagnostic Tool.

CAN
In the future it will also be possible to let the LPE system communicate with the petrol ECU via the CAN-bus network.

Signal processing



Basics

The petrol control unit determines the injection time of the petrol injectors after making numerous calculations, using a number of variables. This injector signal is the ideal basis for calculating the LPG injector injection time.

The injector signal is taken from the control wire on the petrol computer side. During LPG operations a petrol injector (coil) is not used, but a resistor so there is no induction peak in the petrol injector signal. The incoming signal is recalculated by the LPE to the correct injection time for the LPG injector.

Engine temp sensor

With some old systems, use was made of the possibility to hook up a wire to the engine temperature sensor. This option is used to manipulate the temperature during warming up. The petrol computer then calculates a shorter petrol injection time. This allows for a quicker switch to LPG after the initial cold start, resulting in lower emissions and reduced fuel consumption.

Emergency shut-off

The LPi system does not provide a special engine emergency shut-down system which would shut-off the power supply to the pump, the shut-off valves and injectors in case of an engine stall. In order to achieve this, one would have to import the tacho signal of the crank angle sensor of the ignition. Since an engine emergency shut-down is already in place, it is also used for the LPE. This OEM safeguard is taken from the injector supply or the fuel pump supply.

Overview used LPE's

LPE version	Properties
3	• Always in combination with separate driver. • Programmed with software nr. 205901 of 205902. Used for 4, 5 en 6 cylinder engines. • Simultaneous or half sequential injection (depending on petrol injection strategy).

4	• Programmed with software versions:
	  * 205903, 205904 programmable e-prom.
	  * 205906, 205908, 205909, 205910, 205911 PC programmable.
	• For 4 cylinders (fixed EPROM).
	• For 5 en 6 cylinders in combination with separate driver.
	• Simultaneous or half sequential injection (depending on petrol injection strategy).

5.4	• (LPE) Programmed with software nr. 205912. • For 4 cylinders. • Full sequential injection.
5.6	• (LPE) Programmed with software nr. 205913. • For 5 en 6 cylinders. • Full sequential injection.
6.4	• (LPE) Programmed with software nr. 205912. • For 4 cylinders. • Full sequential injection. • Hardware adaptation in comparison to 5.4.
6.6	• Programmed with software nr. 205913. • For 5 en 6 cylinders. • Full sequential injection. • Hardware adaptation in comparison to 5.6.
7	• (LPE) Programmed with software nr. 205917->. • Up to 6 cylinders. • Full sequential injection. • Integrated shut-off relay. • Splash proof synthetic housing. • Can be programmed by dealer. • 70 pole connector.

Injector energizing strategy

Fuel dosing

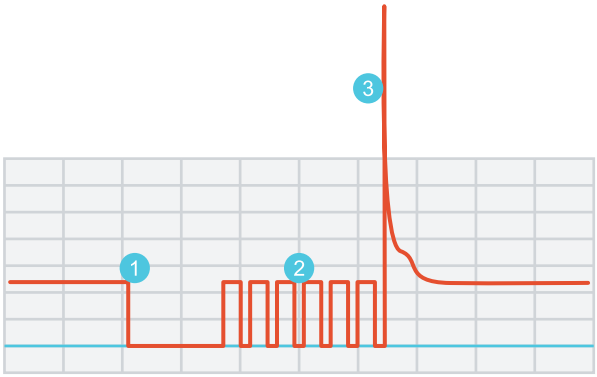
The most important function of the LPE is to calculate the LPG injection time and to energize the injectors. The LPi system follows the injection strategy of the petrol injection computer. Meaning that the fuel dosing of the LPG follows the petrol dosing exactly. All options like fuel cut off (during misfiring and rpm limitation), altitude correction, full load enrichment and Lambda = 1 are also carried out on LPG.

The injector energizing is ground-switched, the earth side of the injector is connected to ground by the LPE. In order to be able to open the injector, also at high system pressures, a large current is needed. Since there is a continuous system voltage, a high opening current is obtained by using a low Ohm injector (1.8Ω).

Current control

Current Control is the principle of switching the current on and off during the injection cycle to the injector. After initially opening, (point 1) and a short delay the injector current Is then pulsed on and off very quickly (point 2) to maintain the open time before finally closing (point 3). The supply of power can be controlled quite easily, switching it as described above. This has the advantage that there is less generation of heat at the LPE ECU driver. However, with each switch-off, a peak voltage occurs that can influence other electrical circuits within the LPE. To avoid this potential problem, a so called free-loop circuit has been switched over the injector coil. Now the peak can be cushioned and the energy of this peak can be re-used.

When one observes the energizing of the injector and the injector patterns on the scope, the peak voltage can clearly be seen. This peak voltage is caused by the induction of the injector coil during opening of the circuit (closing of the injector).



Injector energizing strategy:

1. Electrical energising
2. Current control
3. End of injection

Injector off-set

Delay

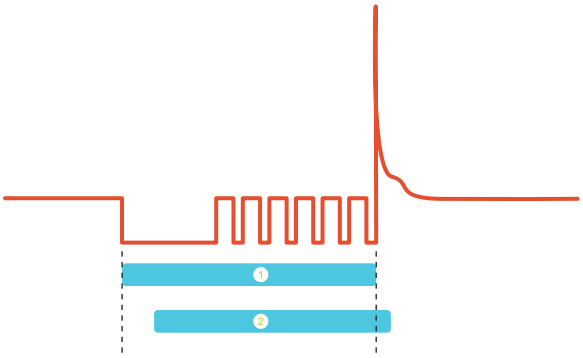
The opening and closing of an injector is a mechanical reaction to an electrical signal. The injector needle has a certain ground sluggishness that makes a response time necessary to open and close the needle. The needle lags, both during opening and closing after the electrical energizing.This lag can be divided into energizing delay and closing delay. Together, they determine the difference between energizing time and actual injection time. The difference between both is known as injector off-set.

Responce time

For an accurate dosing of LPG fuel the offset must be known. The response time depends on two inputs, the battery voltage and the fuel pressure (illustrated below). The closing delay depends on the strength of the spring behind the injector needle; this pressure does not change. The LPE makes provisions for changing signals like battery voltage and LPG pressure when calculating the injectiontime.

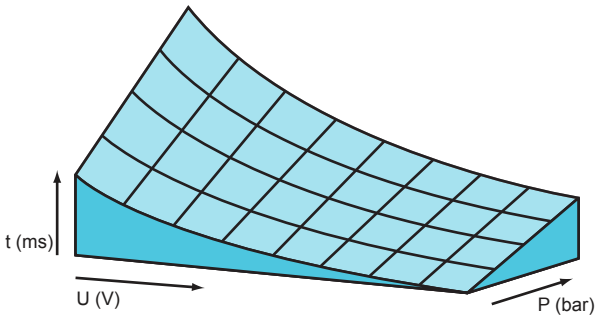
Battery voltage

At lower battery voltages the response delay is higher and reduces the amount of fuel to be injected. The electrical energizing time therefore has to be increased in order to achieve the same delivery. When the LPG pressure is higher, the LPG delivery will be increased too, asking for a reduction in injection time. But because of the higher pressure, the response time is longer. Consequence: less delivery, so the injection time will extend some (see illustration mapping field injector governing).



Injector off-set:

1. Electrical energizing time.
2. Actual mechanical injection time.



Injector off-set table

Fuel switching

Starting

All LPi cars start on petrol. After starting up, the engine will run on petrol for some time before switching to LPG. The objective is to let the LPE recalculate the petrol injection time to the correct LPG injection time. The injection time calculated by the ECU is recalculated to the LPG injection time. This strategy is used for all situations, including the cold start. If the petrol injection ECU applies mixture enrichment, It will do the same for LPG, it depends on engine temperature and load.

The most important arguments for enriching petrol engines are:

- The increased friction resistance.
- Precipitation of fuel on the cold cylinder walls and valves.

The last argument does not apply to LPG because of the low boiling point, even at low temperatures, guarantees good vaporization. The injected amount of LPG would be too rich during the cold enrichment phase which could result in engine hesitation. Therefore, the switch over has been made dependent on the following data:

- The ambient temperature of the LPE (NTC- resistance in the LPE) (NTC = Negative temperature coefficient).
- The signal of the Lambda-probe.
- In some cases the engine temperature (LPE 4 & 5).

Ambient temperature

An NTC-resistor in the LPE measures the ambient LPE temperature. This parameter provides us, indirectly, with the engine temperature when it is cold.

Cold engine

If the engine has not run for three hours or more, the switch over time is only dependent on the ambient temperature and the the λ-probe signal. The switch over time is longer for a cold engine than a warm engine.

Example Euro 5 engines:

Ambient temperature (°C)	Switch over time
-20	240 seconds
0	120 seconds
20	60 seconds
40	20 seconds

Warm engine

The engine has not been turned off for more than 0.5 hour. There is a fixed switch over time, programmable for each application: in ± 20 seconds. The λ-probe has no influence on the switch over time.

Partially warmed up engine

The switch over time is now variable between 5 seconds; the cold start time is affected by:

- ambient and/or engine temperature.
- signal of λ-probe.
- time the engine was used during previous trip.
- time of engine has been switched off.
- load during previous trip (for instance running at idle only, instead of 120 mph flat for some time).

AFS (Automatic Fuel Switch)

General

The AFS system is a software function that changes the engine automatically back to petrol once the LPG supply has reached a minimum preset LPG level in the tank. For drivability reasons this function is used to avoid vapour being pumped instead of liquid LPG. Pumping vapour can lead to a very lean mixture in the engine that may cause engine misfire and log a code in the petrol ECU. The petrol ECU could than switch off the misfiring cylinder and the check engine light could be illuminated.
AFS is activated standard with LPE-7.

Operation

During the installation of a new system, AFS has to be activated only once. This takes place automatically while fuelling the LPG tank for the first time, once the TCG has supplied a voltage signal of more than 0.8 volts (aprox 30% tank capacity). This will then activate the LPG system. The signal to switch over to petrol while driving on LPG is 0.28 volts (lower calibration point) supplied by the TCG. This value is an average value.

Rest volume

After reaching the lower calibration point a few litres remain unused in the tank. The number of unused litres is dependent on the tank size used. The larger the tank the more litres remain unused. This would not be beneficial to the usable LPG capacity. To Increase the usable LPG capacity it is possible to delay the switch over, after reaching the lower calibration point. In LDT (extra F8) a number of litres of LPG can be entered, indicating how many litres can be used after reaching the lower calibration point. This is done by simply choosing the installed tank from a list. These liters are called the “Extra Volume”.

During installation, the Extra Volume always must be entered! If more litres are entered than recommended, this will void the system warranty.

Resume: by increasing the “extra volume” the “rest volume” is reduced and the usable LPG capacity is increased.

The way in which the fuel selection switch reacts during switching over etc is illustrated in the chapter “Fuel selection switch with tank read out”.

Switching off AFS

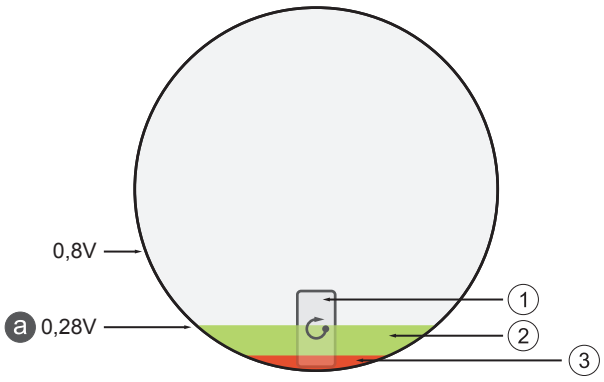
AFS can be switched off by manually entering the extra volume of 20 liters. The extra volume is than larger than the rest volume. The consequence is that the tank will be empty before AFS can become active. Following this procedure the tank can be driven empty completely.

Switching off can also be carried out, using the following procedure and the fuel selection switch. Pre-condition is that AFS has become active and that the tank is almost empty.

1. Ignition off.
2. Press down switch and keep it pressed down.
3. Start engine with switch pressed down.
4. Hold switch pressed down for five seconds.

AFS is now de-activated. Activating it again can be done using the LDT in the screen F8.

Attention with systems older than LPE-7: When the LPE is reset via LDT, DPP or through the switch, all variables will be lost. AFS will be activated again and the extra volume will be reset to 0 liters.



a. Lower Calibration point
1. Pump
2. Extra Volume
3. Rest Volume

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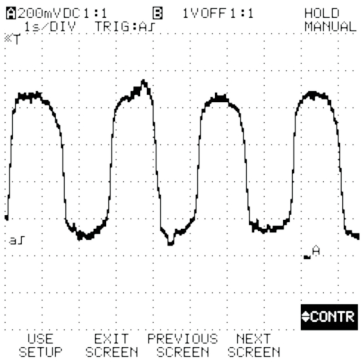
Lambda probe signal

Switching over

If a changing λ-signal is observed one can assume that the mixture is in closed loop mode and is active. Under these conditions the switch to LPG can be made and the LPE recognizes the switching signal.

When the LPE has registered the switching approximately 5 times - as far as the λ-signal is concerned - the change over signal can be activated. If no λ-signal is observed by the LPE, there will be a fixed change over time varying from 3 to 5 minutes.



Lambda probe signal

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Control and supply of the LPG pump unit

Power supply

The power supply of the pump unit is connected to the fittings casing with pump electronics as a direct current from the battery. The direct current is changed to alternating current by the pump control in the fittings cover. This feeds the pump engine using a 3-pole lead-through in the fittings cover. The condenser suppression condenser has been integrated into the pump electronics.

5-Speed

Five different pump rpm's are possible, being: 500, 1000, 1500, 2000 en 2800 rpm. Dependent on engine load (injection time), the LPE sends a variable duty cycle to the pump electronics. The pump electronics converts this into an electric field with different frequencies. This other frequency increases or decreases the pump rpm. The supply of the pump has been fused with a 15 A fuse. The ground that is only available for the pump electronics leads from the fittings plate through the wiring loom to the ground junction LPE-ground engine block in the engine compartment.

Vapour

The pump is only active when LPG is the used fuel. Also when the engine still runs on petrol after starting, up and LPG has been selected. Turning on the ignition will let the pump run at a higher rpm (programmed into the LPE). This is done to remove any possible vapour in the LPG circuit in response to the observed engine run signal (activation petrol pump) when the ignition is turned on.

The option to activate 5 rpm's will not always be utilized; this depends on the amount of delivered LPG. The activated rpm is determined by the LPE using the injection time (engine load).
Switching over therefore is load dependent. When the control wire is loose, the electronics will send the pump into "emergency mode" (2000 rpm).

Control of the LPG shut-off valves

The LPG shut-off valves of both the tank and connection unit are activated simultaneously. When LPG has been selected as the fuel to be used, the LPE will always supply the shut-off valves with power, even when the engine is initially running on petrol. The shut-off valves looses power when the engine run safety is activated (for instance when losing the ignition signal).

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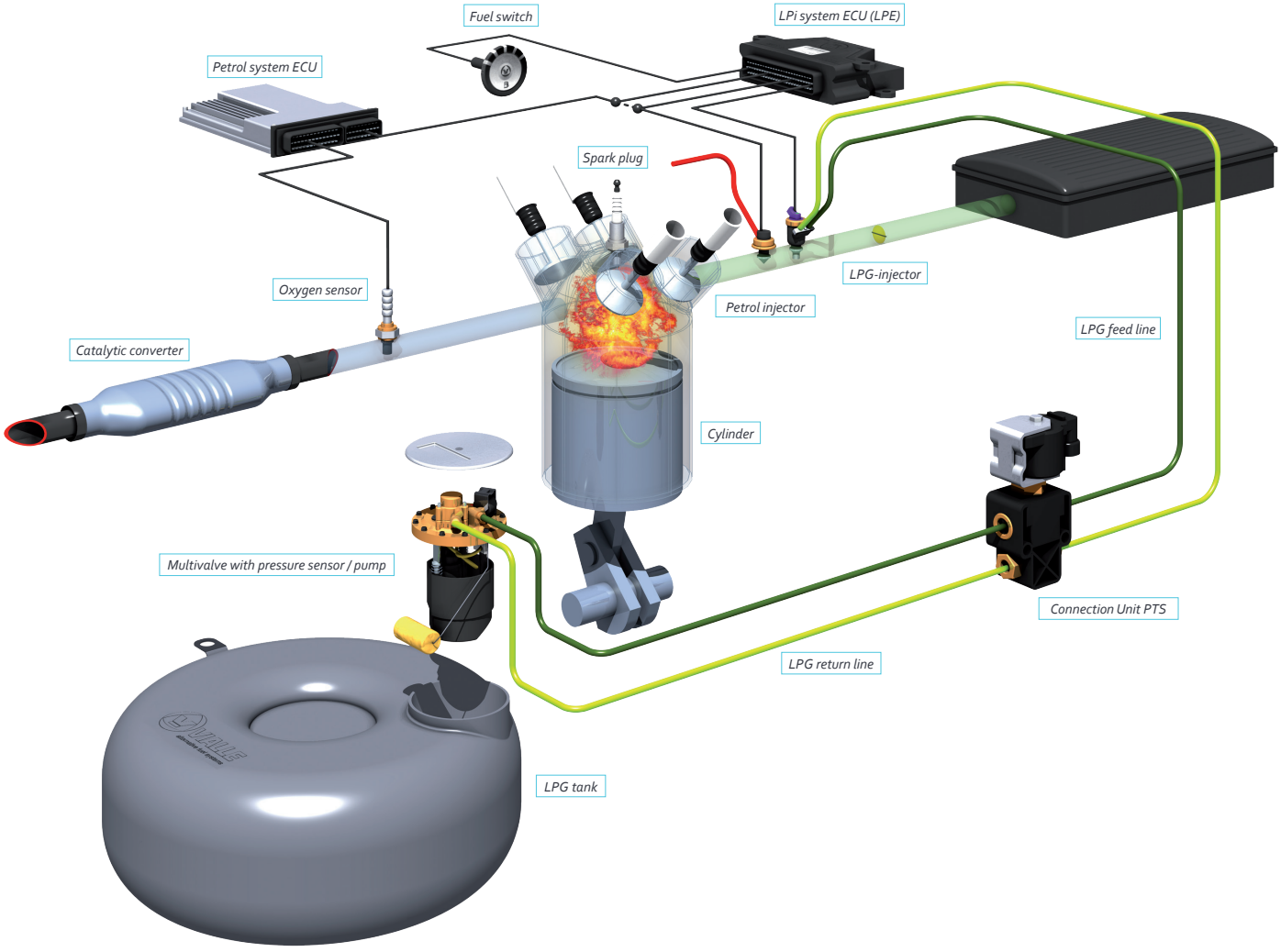
Training manual

PTS system

System Overview PTS



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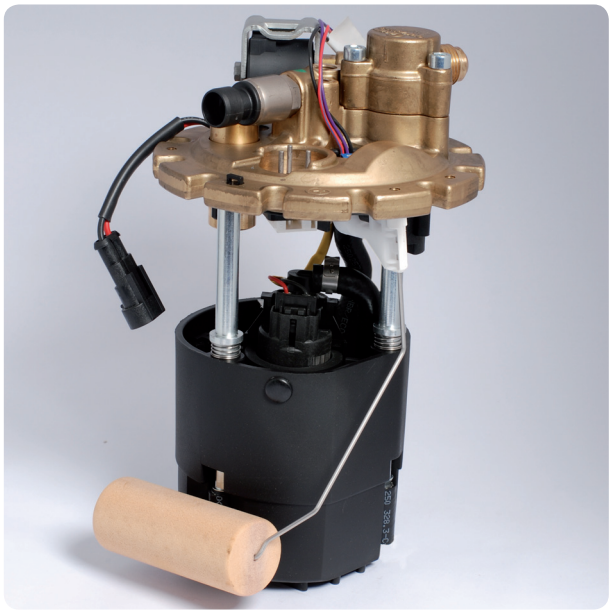
MultiValve S

Compared to the PTC system, the PTS system has a number of component changes. For starters, the pressure regulator is removed and there is a new type of multivalve fitted: the Multivalve 3.

The operating principle of PTS is different than that of the PTC system. The PTC pump works with varying speeds, always with 5 bar above the tank pressure. This is done in combination with a pressure regulator. The PTS system is different. The pressure is determined by the amount of gas exitting the pump and a caliber in the return connection of the Multivalve S. The pump is running at one speed and delivers its maximum pressure at engine idle speed.

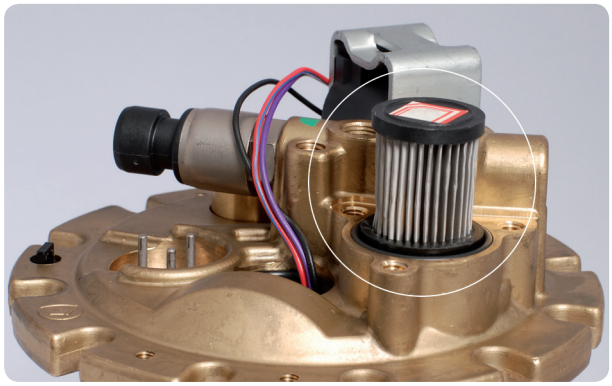
The PTS system was introduced to the market in October 2007. At that time only the Seat Leon 1.6 was equipped with PTS, but by now it has grown to include multiple models.



Multivalve S

LPG filter

The construction of the Multivalve S is almost equal to that of the Multivalve 2. However, a number of components have changed or have been added. The filter that previously was installed inside the pump motor is now mounted on top of the Multivalve S. This filter is placed in a housing under the filling connection and filters the incoming LPG of any particles. This filter is very fine (10 µ) and can easily be replaced. A non-return valve beneath the filter ensures that during replacement no LPG can escape from the tank. Under normal circumstances this filter does not need to be replaced unless the filling time increases noticeably. This is possible without draining the tank.



LPG filter

Return Line Restrictor

Under the return connection at the multivalve a restrictor (calibrated orifice) is fitted and in combination with the pump, determines the system pressure. For the various pumps, various calibres are used.

Caliber

Pressure Sensor

The pressure sensor which was previously placed in the coupling block is now housed in the multivalve. This is placed behind the return connection and measures the system pressure in the return line before the caliber. The pressure sensor can not be exchanged with that of the coupling block. The operation however is similar.

Under normal circumstances this filter does not need to be replaced unless the filling time increases noticeably. This is possible without draining the tank.

Pump PTS

Models

The Multivalve S can be equipped with 2 different pumps. These differ in their capacity. Because of the higher fuel demand for higher performance engines, a pump with a high capacity is chosen. The other pump is suitable for all other engine types.

When the multivalve is installed, on the basis of an engraved code on the multivalve is to be determined which type of pump is mounted.

- 10 = PTC
- 20 = PTC-EL (new version 2008)
- 30 = PTS
- 50 = PTS (High capacity)

The turbine pump

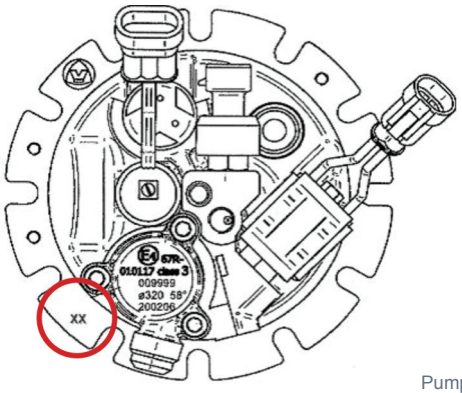
The PTS pump is a turbine pump. The turbine pump is equipped with a DC motor which driven by battery voltage. It always runs at maximum speed all the time. The advantage of a turbine pump is that it is very compact. The pump section consists of a turbine wheel that rotates in a turbine housing. The rotating movement of the turbine wheel inside the turbine housing, will cause the liquid LPG to be transported. The capacity of this pump depends on the pump speed, and the composition and temperature of the LPG. The intake side of the pump housing has a filter. This filter protects the system against any contaminates that can occur during the production of the tank and because the filling connection has a very fine filter installed, in principle, the pump filter will not become contaminated and will not need replacing.

30 Pump

50 Pump

Pressure relief valve

The pressure of both PTS pumps is limited by a pressure relief valve. In the 30 pump a pressure relief valve is integrated in the pump itself and limits the pressure at 4.5 Bar above tank pressure. Practically however, the pressure can get higher because the LPG consumption at idle speed is very low and the pressure relief valve only has a certain capacity.



Pump code

The 50 pump has no internal pressure relief valve. To prevent overloading of the pump due to the very high capacity, it is equipped with an external pressure relief valve which limits the pressure at 3.8 Bar above tank pressure.

If while driving the pressure in the system decreases as more LPG is injected, the pump will, due to the pressure loss, adopt to a higher speed and more LPG can be delivered.

We can conclude that the system pressure is dependent on:

- Pump capacity
- Pressure relief valve
- LPG consumption of injectors
- Restrictor diameter

Lubrication

The turbine pump makes oil lubrication unnecessary. The pump is cooled by liquid LPG while suppling the system. It is therefore essential that the pump is in liquid LPG at all times. If this is not the case, within a few minutes, the pump will be irreparably damaged. To prevent this, the LPE software is programmed to see a pressure rise in a predetermined time and if this is not registered, the pump is turned off. One example of this is after a system installation, LPG is chosen before the tank is filled. The system will activate AFS (Automatic Fuel Switch) which ensures the pump can not be activated. After AFS is activated you can not activate the pump using the LDT software (with a PTC pump this is possible).

Buffer container

The buffer container is similar in operation to the swirl pot in the petrol injection system which is to maintain a usable level of fuel during surge situations. The buffer container and the pump of the multivalve is mounted on springs, which has these 2 advantages:

- The tank can be run almost empty because the buffer container is always pressed to the bottom of the tank. Therefore the pump is always at the lowest possible point.
- The cross on the bottom of the buffer container is forced to the bottom of the tank to ensure the buffer container stays in contact with the tank bottom and ensures optimum filling of the container.

Cross buffer container

The formed cross on the bottom of the container is situated right in the middle of the one way valve at the bottom of the buffer container. When the liquid in the tank moves backwards and forwards it is pushed in to the corners of the cross and forced through the one-way valve, upwards, inside the buffer container. Because of this, the LPG level inside the buffer container is always higher than the LPG level in the tank.

The guide pins for the buffer container, have a small length of rubber hose pushed over each of them to ensure that the container remains parallel to the guide pins and keeps the buffer container flat on the bottom of the tank. If the buffer container does not maintain contact with the bottom of the tank then the one way valve in the bottom of the buffer container will not operate correctly.

Tank content measurement

De tank content measurement of the Multivalve S is the same as the Multivalve 2.

Pump controll

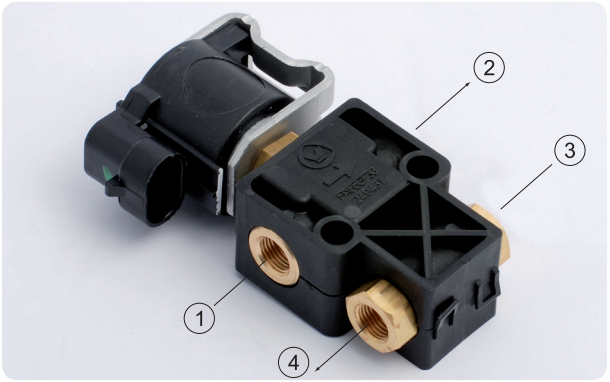
Because a DC motor is used, the pump controller, as it is known in the PTC pump, is not used. Because the turbine pump is fed with board voltage, it always runs on one speed, maximum speed.

Shutt-off valve

The shutt-off valve of the Multivalve S equals the one of the Multivalve.

Connection Unit PTS

The PTS system has no pressure regulator. To connect the fuellines a new connector is developed which is called Connection Unit PTS. It contains a valve and a line connector. The Connection Unit creates the connection between the tank and injectors and is mounted inside the engine compartment. It contains an electromagnetic shut off valve contained in a synthetic block with four brass connectors, for flexible high pressure lines. The actual connection is made with a banjo and banjo bolt. It is important not to change the direction due to the leak back design of the lock-off valve. The direction of flow is indicated on the housing by arrows.



1. Shutter, LPG supply from pump
2. Shutter, supply to injectors
3. Line connector, return from injectors
4. Line connector, return to tank

Connection Unit PTS

Because a DC motor is used, the pump controller, as it is known in the PTC pump, is not used. Because the turbine pump is fed with board voltage, it always runs on one speed, maximum speed.

Diagnosis

Pump pressure

The pressure in the PTS system will be less than we are used to with the PTC pump which regulates the pressure to 5 bar above the tank pressure. At idle speed, the turbine pump deliver a minimum of 3.8 bar above the tank pressure. There is no pressure regulator in the system therefore the pressure will vary. When a sudden demand for LPG is requested, (example:- during acceleration), the pressure will drop, and the LPE will compensate for this by extending the injection time to ensure that sufficient LPG is injected.

Diagnosis of the turbine pump has become a lot easier. Unlike the PTC pump it is no longer necessary to measure currents. At idle speed the pump will deliver its highest pressure, this will be the only thing that requires checking. When the car is forced to run on petrol, via the LDT software, the tank pressure can be recorded and then switching to LPG the pressure should increase to minimum of 3.5 bar. If this pressure is ok, then the pump is functioning properly.

Pump type	Minimal pump pressure at idle speed
30	3,0 bar above tank pressure
50	3,5 bar above tank pressure

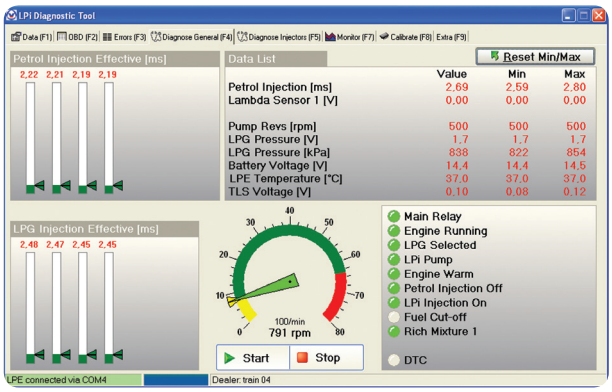
Filling time

When the refueling time increases, this may indicate a dirty filter under the filling connection of the multivalve.

! Note: Refueling after a long drive where the tank has warmed up (higher tank pressure) may also affect the filling time.

LDT

Because the lack of a pump controller, in F4-Diagnosis General the text “Pump Speed” is replaced by “Pump Control”. Nonetheless, currently a pump controller is not used in combination with PTS. This is always a fixed value. The flag “LPI pump (LPI-S)” also identifies that a PTS pump is installed.



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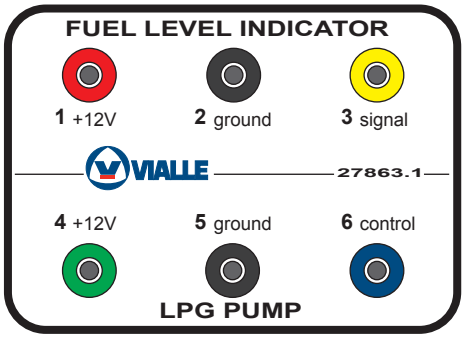
Attachments

Manual diagnostic cable PTC

In order to carry out measurements on the PTC tank, Vialle has developed a special diagnostic cable. This diagnostic cable makes measuring the PTC tank a responsible and easy job. With the diagnostic cable two components of the PTC can be checked, being:

- The fuel level indicator (Tank Contents Gauge).
- The LPG pump.

Position	Color	Signal
1	red	Power supply fuel level indicator (+12 V).
2	black	Ground fuel level indicator.
3	yellow	Signal fuel level indicator.
4	green	Supply pump (+12 V).
5	black	Ground pump activation
6	blue	Lead wire pump rpm.



Hooking up diagnostic cable

1. Turn the ignition of the car to “off”.
2. Open the fittings casing (don’t move wires to cover).
3. Disconnect the two 3-pole connectors.
4. Hook up the diagnostic cable:
5. Labels “LPG tank” to tank side.
6. Labels “wire loom” to wire loom side.
7. Put the green and blue banana plug in the corresponding coupling socket (being pos. 4 and pos. 6).
8. Start the engine, the LPG pump and fuel level indicator should operate to satisfaction.

Checking fuel level indicator

- Measure supply voltage between pos.1 (red) and pos. 2 (black).
- Measure signal voltage between pos.2 (black) and pos.3 (yellow).

Voltage	LPE 6	LPE7
2,0 – 5,0 ± 0,1 V	4 green LEDs	5 LEDs
1,4 – 2,0 ± 0,1 V	3 green LEDs	4 LEDs
1,0 – 1,4 ± 0,1 V	2 green LEDs	3 LEDs
0,3 – 0,1 ± 0,1 V	1 green LED	2 LEDs
0,0 – 0,3 ± 0,1 V	1 red LED	1 LED

If the connector of the fuel level indicator is disconnected at the wire loom side, four green LED’s should brighten up.

Checking LPG pump

Measuring power supply:

- Measure supply voltage between pos.4 (green) and pos.5 (black). Attention: the green banana plug should remain in pos. 4.

Measuring pump current:

1. Put the contact switch of the car to “off”.
2. Disconnect the green banana plug and put an amps meter between the green connector and pos.4. The pump now goes to emergency run and measure the current.
3. When the blue plug is put into the corresponding female plug (pos 6), the pump should run with the low rpm (at idle running engine).

Measuring the voltage of the lead wire:

If the pump rpm does not drop with connected lead wire, the voltage on pos. 6 should be checked in relation to pos. 5 (with the blue banana plug disconnected, and the green banana plug in pos. 4).

Table measurements PTC pump

Lead wire connected or disconnected

RPM pomp	Current pump	Description
0	Ca 1,5 A	Blocked pump
0	Ca 0,5 A - 7 A varying	Blocked pump (Pump control with 1 condensator or new black pump control)

Lead wire connected

RPM pomp	Current pump	Description
500	± 0,1 A	Vapour in pump (no load condition)
500	± 0,8 A	Normal operation
500	± 1,3 A	Flow through blocked or runs 1000rpm
500	± 2 A	Pump with mechanical defect

Lead wire disconnected

RPM pomp	Current pump	Description
2000	± 0,4 A	Vapour in pump (no load condition)
2000	± 2,6 A	Normal operation
2000	± 3,5 A	Through flow blocked. If current continues to fall, check pump aeration
2000	± 4 A	Pump with mechanical defect

! If measured at the coupling block + 0.6 amp (current shut-off valve).
! Margin ± 25%

PTC control signal

Pump rpm.	Duty cycle	U average
500	67%	8,1 V
1000	50%	6,4 V
1500	33%	3,3 V
2000	17%	1,7 V

PTC tank diagnosis wiring set

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Overview of LPG tanks used

STAKO ring tanks

Tank	Gross volume (l)	Ø mm	Height (mm)	MV-1 Extra volume (l)	MV-2 Extra volume (l)	Ordernr	Mounting CF
Ring 47l D600 H230	47	600	230	4.0	6.5	3982347.0	
Ring 51l CF D600 H230	51	600	230	4.0	6.5	3982351.0	top
Ring 52l D600 H250	52	600	250	4.0	6.5	3982552.0	
Ring 52l D630 H230	52	630	230	4.5	7.0	3982352.2	
Ring 55l CF D630 H230	55	630	230	4.5	7.0	3982355.2	bottom
Ring 55l D650 H230	55	650	230	4.5	7.5	3992355.0	
Ring 56l CF D630 H230	56	600	250	4.0	6.5	3982556.0	top
Ring 58l D630 H250	58	630	250	4.5	7.0	3982558.0	
Ring 59l CF D650 H230	59	650	230		7.5	3982359.0	bottom
Ring 61l D650 H250	61	650	250	4.5	7.5	3982561.0	
Ring 62l CF D630 H250	62	630	250	4.5	7.0	3982562.0	bottom
Ring 65l CF D650 H250	65	650	250	4.5	7.5	3982565.0	bottom
Ring 67l D650 H270	67	650	270	4.5	7.5	3982767.0	
Ring 72l CF D650 H270	72	650	270	4.5	7.5	3982772.0	bottom
Ring 83l D720 H270	83	720	270	5.0	9.0	3982783.0	
Ring 88l CF D720 H270	88	720	270	5.0	9.0	3982788.0	bottom
Ring 88l CF D720 H270	88	720	270	5.0	9.0	3982788.5	top

* **CF** = Centre Filled

STAKO cilinder tanks

Tank	Gross volume (l)	Ø mm	Length (mm)	MV-1 Extra volume (l)	MV-2 Extra volume (l)	Ordernr
Cil 50l D360 L582	50	360	582	6.0	6.0	3983650.1
Cil 55l D360 L632	55	360	632	7.0	7.0	3983655.1
Cil 60l D320 L869	60	320	869	10.5	10.5	3983260.1
Cil 60l D360 L686	60	360	686		8.0	3983660.1
Cil 70l D320 L1004	70	320	1004	12.5	12.5	3983270.1
Cil 70l D360 L789	70	360	789	9.0	9.0	3983670.1
Cil 85l D360 L958	85	360	958	11.0	11.0	3983685.1
Cil 100l D360 L1099	100	360	1099	13.0	13.0	3983610.1
Cil 118l D450 L861	118	450	861		8.5	3964512.1
Cil 130l D360 L1411	130	360	1411	17.0	17.0	3983613.1
Cil 158l D450 L1119	158	450	1119		11.5	3964516.1
Cil 178l D450 L1248	178	450	1248		13.0	3964518.1

Diagnostics using the selection switch (LPE 3-6)

	LED indication	Cause	Solution	Remark
	Green led lights up immediately (does not flash) and car runs on petrol.	At start up an injector signal was not observed.	Check injector signals with LDT.	The single colored wires of the interrupt relay must be connected to the ecu side. Volvo en Saab 900 have no-blinking led programmed.
	Green led lights up immediately and has maximum petrol running.	LPE probably has been re-programmed.	Check LPE number with LDT, it should correspond with number on.	
	Green led flashes always a minimum of three minutes after start up.	LPE does not recognize lambda control.	Check lambda control with LDT.	Pin 2 is ground and pin 4 is signal.
	Green led keeps blinking, even after 5 minutes.	A petrol injector signal was observed but that signal later was omitted.	Check supply, ground and injector signals with LDT. Reset LPE.	
	Red led flashes and automatically changed over to petrol operation.	LPE detected a system pressure over 28 bar.	Check the pressure with the LDT and check the wiring between the LPE and the pressure sensor.	
	Led flashes in color of chosen fuel with a low frequency.	Diagnostics detected a mixture control fault.	Check the lambda control with LDT.	Pin 2 is ground and pin 4 is the signal.
	Led keeps remaining same color, selection switch does not react.	Defective selection switch or watchdog not active.	Check if Watchdog is on, using DDP in menu LPE.	If Watchdog not active, the LPE is defective. Otherwise, check selection switch on functional operation.
	Leds don't illuminate at all and engine does not switch to LPG.	Fault in 5 volts circuit or engine run signal or supply-ground.	Check the 5 volt circuit between pin 1 and 27, engine run signal between pen 25 and 27 and supply-ground between pin 26 and pin 27 of the LPE.	If no deviation: check selection switch for functional operation.

Note:

- If engine run signal is connected to the minus of the ignition coil the switch will become defective.
- In case of strange switching situations: check supply and ground of the LPE and the ignition for spark cross over at spark plugs and ignition coil.

Checking gas-tightness

After the gas installation has been completed, the following must be checked for leaks:

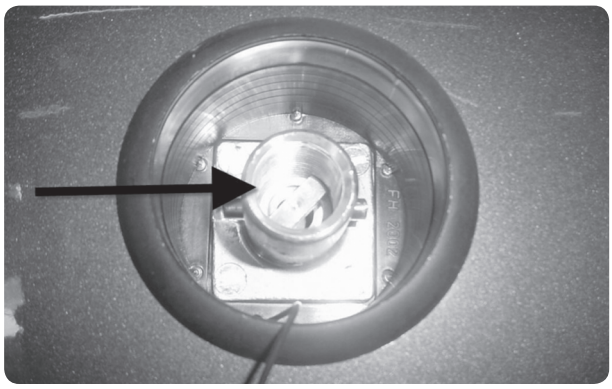
- the gas-carrying connections between the LPG components.
- the seals.

Types of checks:

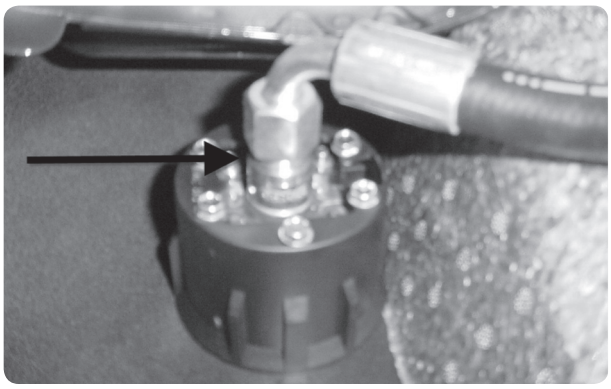
- by means of visual checking and;
- by means of a suitable measuring tool;

The measuring tool and the measurement method must both be approved and comply with the regulations valid in the country in which the inspection takes place. Use preferably a digital leak tester! The TIM can not come into contact with water or leakspray!

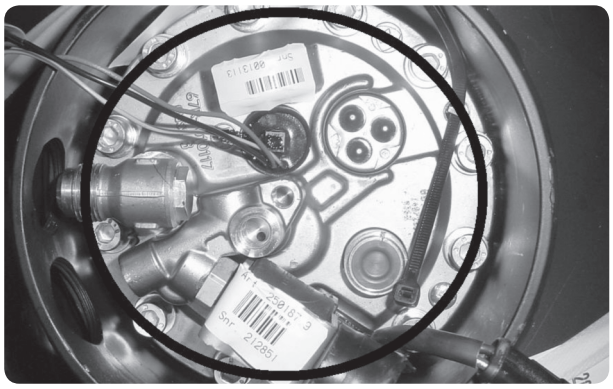
Points to check:

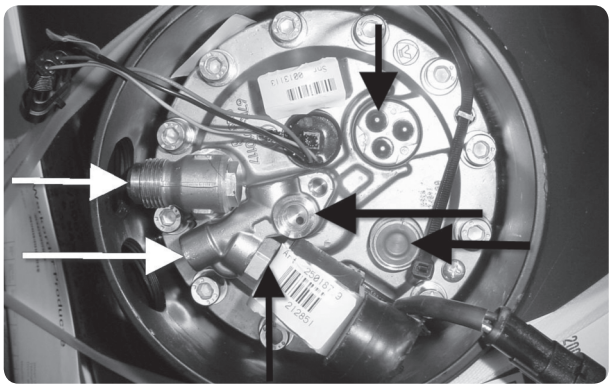


Filling hose

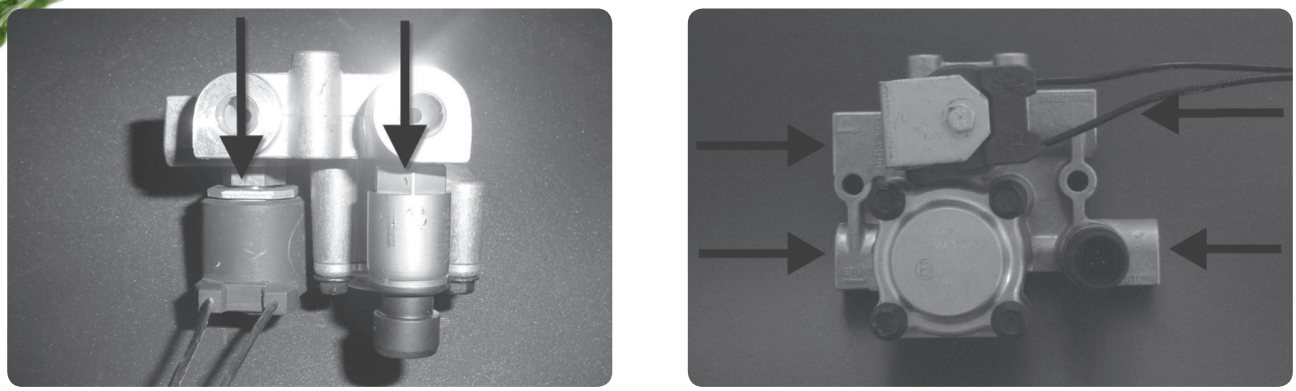


External filler

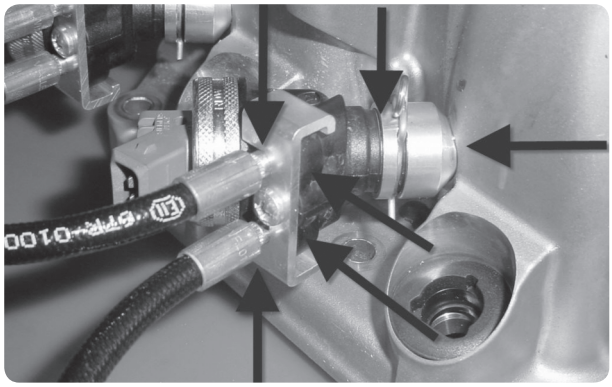




Tank: sealing between the MV / tank and connection points



Coupling block incl. connections of the pressure sensor and valve



Lines between coupling block – injectors

Adjusting the TIM (MV-2)

There are certain situations in which a TIM has to be adjusted in an MV II:

1. MV installed in the tank (ring and cilinder)
   a. System with AFS
   b. System without AFS
2. Adjusting loose MV for ring tank

1a MV installed in the tank, with AFS

Accurate adjustment (essential if the AFS is active).

Attention: Keep steel tools away from the MV while reading the TIM voltage.

- Pump the tank empty.
- Fill the tank with the LPG quantity that has to be filled as Extra Volume + 1 litre. For the Extra Volume values, refer to the Info bulletin ALG05007.
- Install the new TIM with wires at the central threaded hole (see fig. 1), O-ring loose in the groove.
- Turn the potentiometer at the centre of the TIM fully to the left.
- Turn the TIM (housing) to the right until the voltage increases above 0.5 V. Then turn the TIM to the left until the voltage is 0.28 V.
- Then fill the tank to 80%.
- Adjust the voltage to 2.5 ± 0.05 V using the potentiometer.
- Press the O-ring firmly into the groove.
- Seal the TIM and the potentiometer.

1b MV installed in the tank, without AFS

Less accurate adjustment (may be used if the AFS is not active).

Attention: Keep steel tools away from the MV while reading the TIM voltage.

- Fill the tank to 80%
- Install the new TIM with wires at the central threaded hole (see fig. 1), O-ring loose in the groove.
- Turn the potentiometer at the centre of the TIM fully to the left.
- Turn the TIM (housing) until the maximum voltage is obtained (turn max. + 90 º)
- Using the potentiometer at the centre of the TIM, adjust the voltage to 2.7 V + 0.05 V.
- Then turn the TIM (housing) to the left until a voltage of 2.5V + 0.05 V is obtained.
- Press the O-ring firmly into the groove.
- Seal the TIM and the potentiometer.

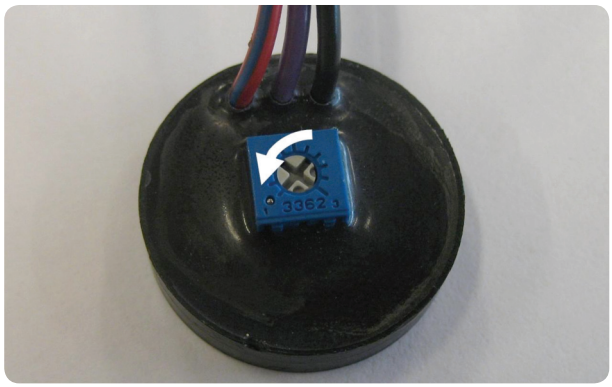
2. Adjusting loose MV for ring tank.

Attention: Keep steel tools away from the MV while reading the TIM voltage.

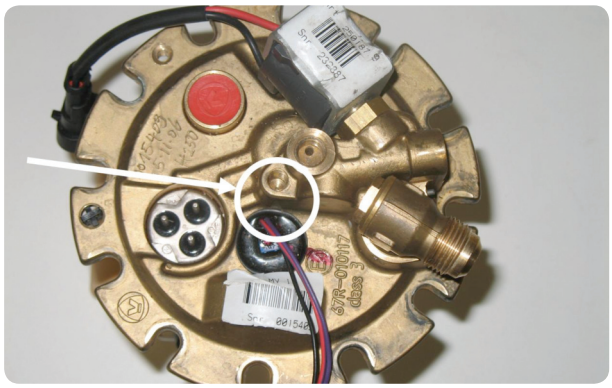
Required:

- Power supply
- Voltmeter or multimeter
- Break-out box
- Ruler/line
- Locking device
- Compressed air

1. Remove the locking device from the TIM and turn the potentiometer fully to the left.

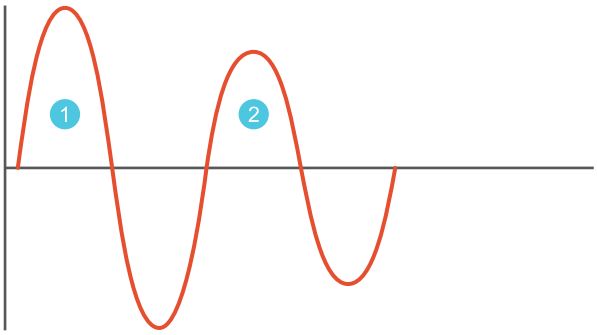


2. (If necessary) install the new TIM with wires at the central threaded hole (see fig.), O-ring loose in the groove.



This position is important in order to ensure correct operation!

The TIM gives out a sinusoidal signal. Depending on the TIM positioning in the MV, there is a high or a low sinus (see fig.). The LPi system uses the high positive sinus (1).



If the TIM is not positioned correctly, the incorrect sinus will be used, and the TIM will not be able to reach the maximum voltage. Sinus 2 is therefore not used.

3. Pressurise the filling connection.

4. Check the 80% adjustment.
Move the float upwards to the point where the air intake is sealed off.

If necessary, bend the arm of the float at the level of the arrow to ensure that the bottom of the float corresponds to the bottom of the MV body.

5. Move the float downwards.

Keep the bottom of the float level with the top of the socket head screw of the pump. Now turn the TIM housing to the right until the voltage increases above 0.5 V. This is done to ensure that the correct TIM signal sinus is used.

Then turn the TIM housing to the left until a voltage of 0.28 V is obtained.

The last LED switches off at this point. This is also the point at which an AFS system switches over to petrol (if a remaining volume of 0 litre has been indicated).

6. Position the float at the 80% switch-off point. Set the maximum TIM voltage to 2.50 ± 0.01 volts using the potentiometer. (See fig.)

7. Check the setting once again.

If everything is correct: Press the O-ring firmly into the groove.

Seal the TIM and the potentiometer with the locking device.

Extra fuel consumption of LPG

Heat of combustion

As a result of photosynthesis, fuels have a particular energy value. This energy value is different for each fuel, and is indicated in joules per kilogram. In order to be able to compare them to each other, a number of average values are shown below.

The fuel is supplied in litres at the pump. We therefore convert the combustion value from kg to litre. To do this, we use the density of each fuel.

Fuel (liguid)	Heat of combustion MJ/kg	Density	Heat of combustion MJ/Ltr
Petrol	42,7	0,74	31,6
Butane	45,6	0,58	26,45
Propane	46,3	0,51	23,61
LPG	46,1	0,54	24,89
Diesel	42,5	0,84	35,49

We now see that we obtain less energy for 1 litre of LPG than for 1 litre of petrol. A certain quantity of energy is required to travel a certain distance. This distance therefore requires more LPG (in litres) than petrol. If we assume that petrol = 100%, the following applies for the following fuels:

Fuel	Heat of combustion MJ/kg	Difference
Petrol	42,7	100 %
Butane	45,6	119,47 %
Propane	46,3	133,82 %
LPG	46,1	126,93 %
Diesel	42,5	89,04 %

Theory vs practice

In theory, the consumption of LPG should be almost 27% higher than petrol. In practice, this appears to be different for the following reasons:

- Cold start and warm-up takes place on petrol.
- There is a better LPG mixture, whereby the combustion is more complete.
- No evaporation loss with LPG.
- The stoichiometric air/fuel ratio is different. This causes a lower output in many applications (not in an LPI system). A lower output is equal to lower consumption.

Measuring fuel consumption

Several factors must be taken into account in order to measure the actual fuel consumption accurately. Among the most important factors are:

- Driving style
- Route / other traffic
- Cold start(s) / additional consumers (i.e. air conditioning)
- Temperature / weather
- Distance

A comparison is only possible if the measurement of the two fuels is carried out under more or less equal conditions. The accuracy increases if this is done over a longer period of time and over a longer distance.

Remark:
Never compare the LPG or petrol fuel consumption to the consumption data provided by the manufacturer. This data is determined using a predetermined drive cycle on a chassis dynamometer. The starting temperature here is 20°C, for example, and there are no additional consumers switched on. The consumption will therefore always be lower than in actual daily traffic.

Work and safety

General

The LPG tank is a pressure vessel filled with gas, and cannot therefore be compared to the petrol tank of a car. When carrying out work on an LPG installation, ensure that you are familiar with the properties and dangers of LPG, and take all possible safety precautions.

Transporting LPG tanks

Transporting full LPG tanks is considered to be hazardous transportation. Your forwarding agent requires a specific licence for this type of transport.

Disconnecting LPG lines

The previous diagnostic program “DDP” used the “drive till empty mode” here. This function has now been cancelled in LDT; please use the method below.

The quantity of LPG that escapes when the lines are being disconnected can be reduced by closing the valve to the tank during LPG mode. The supply line gas will then be “consumed”. Attention: The car will possibly indicate an error because of misfires being detected by the petrol ECU. Check in advance whether you can reset this type of error.

Emptying and de-pressurizing LPG tanks

If it is necessary to empty and de-pressurize the tank: Make sure you are familiar with the local laws that apply here. There are specialised firms that could carry this out for you.

A method for emptying and de-pressurizing LPi tanks is described below. Attention: This does not apply to ABI tanks! ABI tanks can be recognized by the rectangular ancillary box.

1. Emptying (MV-1 & MV-2)

- Connect an LPG line to the pressure connection of the tank to be emptied.
- Connect this line to the return connection of an empty tank.
- Open the valve of the tank to be emptied using a magnet.
- The LPG will flow across until the pressure is equal in both tanks.
- The tank to be emptied is probably not yet empty.
- Repeat the above with empty tanks until the tank to be emptied is completely empty.

Attention:

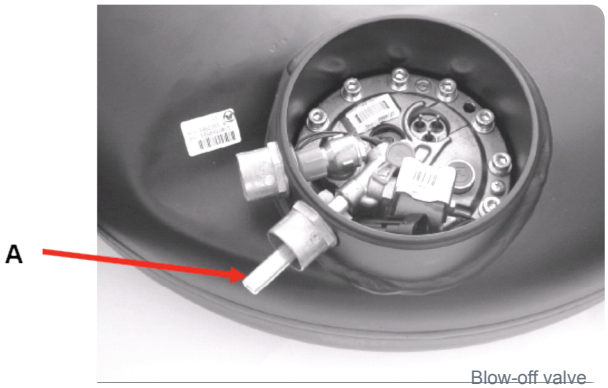
Even if the tank is emptied, some residual LPG will always remain behind. This therefore means that the tank will still be under pressure! The tank must therefore first be de-pressurized before the MV can be dismantled.

2. De-pressurizing (MV-1 & MV-2)

- The residual LPG that remains in the tank can be blown out in a controlled manner using blow-off valve 27894.0 (Fig.: see A).
- It is essential that the MV-2 is not de-presurized using the return valve!
- Install the blow-off valve at the location of the discharge line.
- Open the valve with a magnet in order to blow-off the residual LPG.

Attention:

The tank is now de-pressurized, but nevertheless still not completely free from LPG! When dismantling the Multivalve, oil may leak from the pump. If you re-install the same pump,fill up with ± 20 cc Madrela oil through the ventilation connection on the pump.



Blow-off valve

Dismantling and installing (MV-1 & MV-2)

Condition: The tank must be completely de-gassed!

Preperation:

- Dismantle the control.
- Ensure that the tank is completely de-gassed.

Dismantling the Multivalve:

- Unscrew the twelve bolts (hexagon socket 6 mm).
- Lift the Multivalve from the tank. Pay attention to the float.
- Remove the O-ring; do not re-use it!

Preparing the tank:

- Clean the bottom and the four magnets.
- Replace the magnets again:
  - Not underneath the pump.
  - Not in the area of the float movements.

Preparing the Multivalve:

- Lubricate the new O-ring with Vaseline and insert it into the groove.
- Position the rubber cover according to the diagrams below.

Attention:

There are two types of hoses, which must not be interchanged and which belong to the respective Mulitivalve type.

Installing the Multivalve:

- First, place the float in the tank opening.
- Afterwards, place the complete Multivalve, whereby fill and discharge are already in the correct positions. Do not use force!
- Check if the Multivalve is level.
- Tighten the 12 bolts cross-wise with a 25 Nm torque.

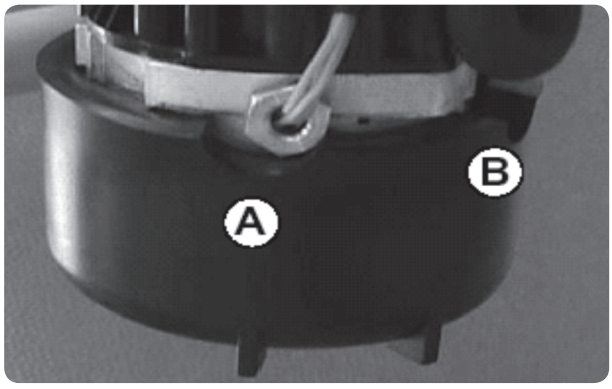


Fig. old

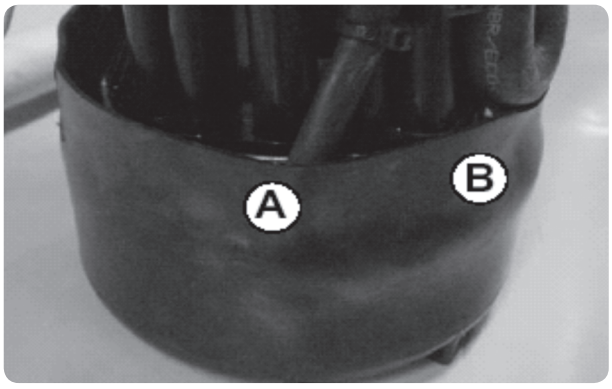


Fig. new

Vialle
Drive Clean Power

Pin configuration LPE 7

Pin	Pin	Pin	Discription	Direction
2			Supply ECU	VBatt
		49	Safety relay	In
	26		Ground ECU	
3			+5 Volt	Out
		50		
	27			
4			Signal ground LPG pressure	In
		51		
	28		Signal LPG pressure (+)	In
5			Signal LPG pressure (-)	In
		52	Analog (-)	In
	29		Analog (+)	In
6			Signal Lambdasonde (-)	In
		53	Signal Lambdasonde (+)	In
	30		Signal Lambdasonde 2 (-)	In
7			Signal Lambdasonde 2 (+)	In
		54	Signal Lambdasonde 3	In
	31		Signal Lambdasonde 3	Out
8			Signal Lambdasonde 4	In
		55	Signal Lambdasonde 4	Out
	32		Lpg level (TIM)	In

Pin	Pin	Pin	Discription	Direction
9			Signal ground LPG level	In
		56		
	33			
10			GND for valve, pump	Ground
		57		
	34		Pump control	Out
11			Injectorswitch relay control	Out
	35		LPG valve	Out
12				
		59		
	36			
13			Fuel selection switch	In / Out
		60		
	37			
14				
		61	RXD	In
	38		TXD	Out
15				
		62	Gnd for Communication	
	39			
16			Gasoline injector cylinder #6	In
		63	Gasoline injector cylinder #6	Out
	40		Gasoline injector cylinder #5	Out

Monitor variables LDT

Name	Explanation
Petrol 1	Mechanical petrol "on" time, Cylinder 1
Petrol 2	Mechanical petrol "on" time, Cylinder 2
Petrol 3	Mechanical petrol "on" time, Cylinder 3
Petrol 4	Mechanical petrol "on" time, Cylinder 4
Petrol 5	Mechanical petrol "on" time, Cylinder 5
Petrol 6	Mechanical petrol "on" time, Cylinder 6
Petrol injection	Electrical petrol “on” time
LPG 1	Mechanical LPG "on" time, Cylinder 1
LPG 2	Mechanical LPG "on" time, Cylinder 2
LPG 3	Mechanical LPG "on" time, Cylinder 3
LPG 4	Mechanical LPG "on" time, Cylinder 4
LPG 5	Mechanical LPG "on" time, Cylinder 5
LPG 6	Mechanical LPG "on" time, Cylinder 6
Rpm	Engine revolutions per minute
LPG pressure	LPG pressure in kPa
Pump rpm	LPG pump revolutions per minute
Supply voltage	Voltage (V) measured by the LPE
Lambda 1	Voltage λ-signal 1 (V)
Lambda 2	Voltage λ-signal 2 (V)
LPE temperature	Temperature of the LPE
LPG pressure V	LPG pressure (V) at LPE 5/6/7
LPG pressure V LPE3/4	LPG pressure (V) at LPE 3/4/7
Selected fuel	0 = petrol 1 = LPG
Flags	Binary number indicating the LPG system status
Warming up	Degree to which the engine has been warmed up (s). Max. 10800 s.
Time Contact off	Time the contact is switched off. Warming up counts backwards.
Engine Warm	Signal λ warm. Clear to switch over by λ.
Time Engine Warm	Time the engine is warm
Time	Measured time from “contact on”.
Tank content	LPG level (V)
Petrol injection counter	Total number of petrol injections (0 - 255)
Engine load	Current engine load (%)
Lambda 1 enhanced	Additional enhancement λ sensor 1 mixture (1 = additional enhancement)
Lambda 2 enhanced	Additional enhancement λ sensor 2 mixture (1 = additional enhancement)
Additional Input	Additional signal (V) that may vary depending on calibration
Lambda 3	Flow probe 1 signal (V)
Lambda 4	Flow probe 2 signal (V)

Error codes

Error code Serious error:	Discription	Posible causes
1.1.1.3	LpgKpaToChassis	Signal from the pressure sensor causes short circuit to earth, or is interrupted.
1.1.2.3	LpgKpaToPower	Signal from the pressure sensor causes short circuit to the power supply.
1.1.1.4	LambdaToChassis	Open connection between both pins of the lambda sensor or short circuit to earth. If G3: lambda probe not connected.
1.1.2.4.	LambdaToPower	Lambda sensor signal shortcut to power.
1.2.1.1	InjToChassis 33	Short circuit to earth, or is not connected}
1.2.1.2	InjToChassis 34	Short circuit to earth, or is not connected}
1.2.1.3	InjToChassis 16	Short circuit to earth, or is not connected}
1.3.2.2	InjToChassis 17	Short circuit to earth, or is not connected}
1.2.1.4	ErrorInj/Driv 33	Error in injector / output stage combination, pin 33
1.2.2.1	ErrorInj/Driv.34	Error in injector / output stage combination, pin 34
1.2.2.2	ErrorInj/Driv.16	Error in injector / output stage combination, pin 16
1.3.2.3	ErrorInj/Driv.17	Error in injector / output stage combination, pin 17
1.2.2.3	Inj I Hold 33	Holding current, injector pin 33 is incorrect}
1.2.2.4	Inj I Hold 34	Holding current, injector pin 34is incorrect}
1.3.1.1	Inj I Hold 16	Holding current, injector pin 16s incorrect}
1.3.2.4	Inj I Hold 17	Holding current, injector pin 17s incorrect}
1.4.1.1	Default EEP	Non-programmed LPE, replace the LPE if this error code recurs after resetting the LPE. If this error code appears, code 2.4.1.2 “Route EEP error” will also appear.

Error code:	Discription	Posible causes
2.1.1.3	LpgKpaTooSmall	LPG pressure sensor signal is too small; this error code is only reliable if it is certain that the tank is not empty.
2.1.2.3	LpgKpaTooHigh	LPG pressure sensor signal is too high; the LPE shifts to petrol and the switch will start blinking red when the pressure is higher than 28 bar, from software version 205912.
2.1.1.4	UniAnTooSmall	UniAnTooSmall Only for LPE 5.4 and 5.6, second lambda sensor.
2.1.2.4	UniAnTooHigh	UniAnTooHigh Only for LPE 5.4 and 5.6, second lambda sensor.
2.2.1.1	BatVltTooSmall	BatVltTooSmall Battery voltage signal is too low}
2.2.1.2	BatVltTooHigh	BatVltTooHigh Battery voltage signal is too high}
2.3.2.3	NoLambda	No reaction from the lambda probe to the LPE.
2.3.2.4	Basic EEP Error	Basic EEP Error Error in the first set of data}
2.4.1.1	Check EEP Error	Error in the second set of data}
2.4.1.2	Route EEP Error	Error in the routine, the app. routine was not carried out. Replace the LPE.

Error code Minor error:	Discription	Posible causes
3.1.1.1	TaskOverflow	TaskOverflow Processor overload during a calculation.
3.1.1.3	RpmTooHigh	Rpm signal too high.

Error codes are only re-stored in the LPE memory after ten start-ups following the resetting of the LPE.