GENERAL MANUAL
Bora Advance

DATE	01-09-2021
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REV. Nr.	02
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2 Manual updates / revision

Rev. nr	Rev. Date	Subject update
1	24-06-2021	First official release
2	01-09-2021	Changeover switch Pin changes from K2 to G4 in Valve Care overview diagram

This manual was developed by Westport Fuel Systems Italia S.r.l.

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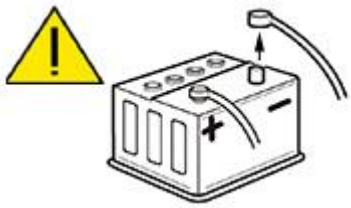
For more information:
Westport Fuel Systems Italia
Via La Morra, 1 – 12062 - Italy

3 General instructions

The installation of the system shall be done in accordance with the installation manual provided by WFS Italia S.r.l.

- This manual is based on Italian regulations; always install the system in accordance with local regulations.
- Fitting and maintenance is only allowed by LPG engineers.
- Failure to follow the instructions in this manual can result in a poor or non-working LPG-installation or a dangerous situation.
- For maintenance instructions filter see the Driver's Guide.
- WFS Italia S.r.l. is not responsible for any damages to people or objects as a result of changes to WFS Italia S.r.l. products.
- Power and fuses:
  - Make sure the ignition key is outside the car / windows open.
  - Be aware of central door locking, radio / telephone memory code and alarm system.
  - Always disconnect the battery when installing the LPG system.



  - Do not place the main fuse into the fuse holder before having completed the installation of the system.
- AFC-3.0 DI
  - The AFC-3.0 DI has to be activated with the Calibration Tool Software.
  - In the unlikely event the AFC-3.0 DI fails, it will automatically switch over to petrol.
  - Never disconnect the AFC-3.0 DI connectors, unless you have removed the main fuse.
  - When +ignition or a 5V wake-up is connected, the engine always can run on petrol. Also without software or installed main fuse.
- Harness and wiring:
  - The wires in the loom are provided with numbers and text.
  - The text on the wire explains the function of the wire.
  - The wire harnesses are mainly not model specific. Therefore it may be necessary to adjust the wire length.
  - Ensure maximum care is taken when connecting the wiring.
  - Ensure that it does not run near any of the ignition components.
  - Make sure there is no stretch on the wire harness.
  - Solder and insulate all electrical connections.
  - Make professional joints using solder and shrink sleeve.

- Hardware installation:
  - Always use the VEHICLE DEDICATED MANUAL for detailed installation instructions.
  - No component of the LPG-system shall be located within 100 mm of the exhaust or similar heat source, unless such components are adequately shielded against heat.
  - Remove any internal burrs after having shortened the copper LPG pipe. (This guarantees the maximum flow through the pipe without pollution.)
  - Threat all drilled holes with an anti-corrosion agent, after removing the chips.
  - Check components for gas leakage with a gas leak detection device after the installation. Also check for air and fluid leakage.

- Up to date information:
  - Regularly check our website the latest for diagrams, certificates, updates, info-bulletins and product information.
  - Homologation information.
  - Technical information
  - Sales information

- Warranty:
  - Register the components for warranty period after installation on the web site **www.zavoli.com**.

- Work safe:
  -  = WEAR SAFETY GOGGLES

4 About this manual

This manual describes:

- Operation of the Bora Advance system
- System and components description
- General diagnostics
- Service and maintenance
- General installation instructions
- Helpdesk procedure

5 Abbreviations and terms

1.1 Abbreviations 5.1

Abbreviations	Out written	Explanation
AD	Analog digital	Sensor input.
AFC	Alternative Fuel Controller	LPG computer.
CAN-bus	Controller Area Network	High speed communication; 2 twisted wires most used for drive line and vehicle communication.
DAC	Digital analog converter	Simulated signal output.
DI injector	Direct injection	Fuel injection in combustion chamber.
DI (AFC)	Digital Input	Input of on / off signal (high / low)
LED	Light Emitted Diode	
LIN-bus	Local Interconnect Network	Low speed communication. 1 wire 0-12V Most used for switches.
LPG	Liquefied Petroleum Gas	
MPI	Multi Point Injection	Fuel injection in inlet manifold.
OBD	On Board Diagnostic	OBD systems gives access to the status of the various vehicle sub-systems and reports errors of these system.
PWM	Pulse Wide Modulation	it is a type of digital modulation that allows to obtain a variable average voltage depending on the ratio between the duration of the positive pulse and the entire period (duty cycle).

5.2 Terms

Terms	Explanation
Free calibration parameters	Calibration parameters which can be changed by the dealer / technician.
Hall sensor	A sensor that is used to measure the magnitude of a magnetic field. Its output voltage is directly proportional to the magnetic field strength through it.
Calibration Tool	Name of the calibration, service and diagnostic program.
Switch back	Switch back from LPG to petrol modes.
Switch over	Switch over from petrol to LPG modes.
Universal Bora Advance kit	Engine conversion kit; without brackets and accessories.

6 General engine features

6.1 Ignition coil

Important factors for a proper combustion include:

- Optimal conditions for ignition

During LPG mode the spark plug and will become warmer. According to measurements, the central electrode will be at least 50 °C warmer than during petrol mode. This is caused by the differences in chemical composition between CNG and petrol.
The electrical resistance of the LPG/air mixture is higher than of the petrol/air mixture. Therefore, igniting a LPG/air mixture requires a 15-20% more power, i.e. the spark tension must be higher. When the ignition capacity is insufficient, driveability problems will arise immediately. Since the ignition of the LPG/air mixture is more critical than of the petrol/air mixture, driveability problems will occur sooner while driving on LPG.

Often worn or bad spark plugs are the source of the failure of the ignition system.

6.2 Spark plugs

Since LPG is harder to ignite than petrol, the requirements for the spark plugs are higher. In addition, LPG is more aggressive than petrol, requiring the use of materials with extremely high load-bearing capacity. When using OEM spark plugs the replacement interval will have to be shortened, in some cases.
WFSI S.rl. recommends using OEM sparkplugs.

Recommendation! In case of ignition problems WFS Italia S.r.l recommends OEM spark plugs.

6.3 Valves and valve seats

LPG contains no additives, so increased wear may occur to the valves and valve seats. The extent of wear strongly depends on the materials used by the manufacturer and the use of the vehicle. High engine speeds and loads will cause rapid wear. To prevent valve wear WFS Italia S.r.l. advices to install the Valve Protection adaptive system.

Since LPG contains neither additives nor sulphur, it has bad lubricating qualities. For some engines it is recommended to use an additive to lubricate and cool the valves.
For this reason WFS Italia S.r.l. has developed Valve Protection. Valve Protection is an additive dosing system compatible with the Bora Advance system. It is suitable for all combustion engines using alternative fuels such as LPG and CNG. Valve Protection is used for the correct dosage of additives which prevent excessive valve and valve seat wear.

Attention! When the valve clearance is too large, it will cause the camshaft load to double, which will have far-reaching consequences.

Recommendation! If possible, always adjust the valve clearance according to the instructions of the car manufacturer. In some cases it is advisable to check the valve clearance more frequently.

6.4 Engine oil

In some cases it may be seen that engine oil is increased. During driving on gas, the engine oil is no longer diluted with petrol. Therefore, the actual oil consumption is determined while driving on gas.

7 Sequent Maestro approval numbers

eVP-500: E4-67R01-0358

Zeta Reducer
E13-67R01-0276

Plastic rail + sensate sensor
E13-67R01-0185

Filter Type 94
E20-67R01-010234

Solenoid valve
E4-67R01-0041

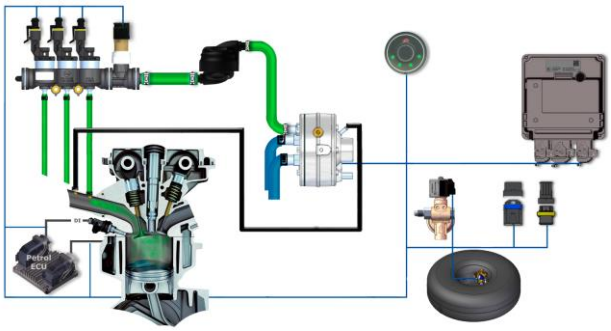
Injector IN03 MY09
E13-67R01-0223

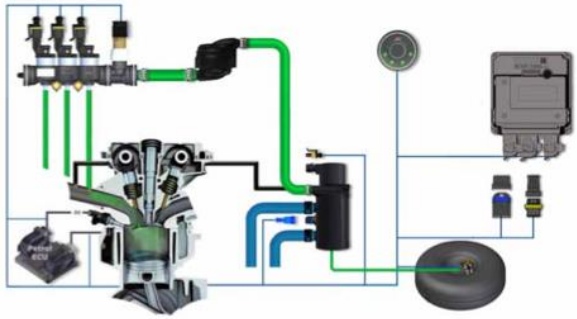
AFC-3.0 DI
E4-67R01-0098
E4-10R-030507

16x25 / 12x19 / 5x10,2
E24-67R01-0018

8 Bora Advance introduction

8.1 Highlights Bora Advance





Bora Advance system
Latest generation system dedicated to the latest direct injection engines.

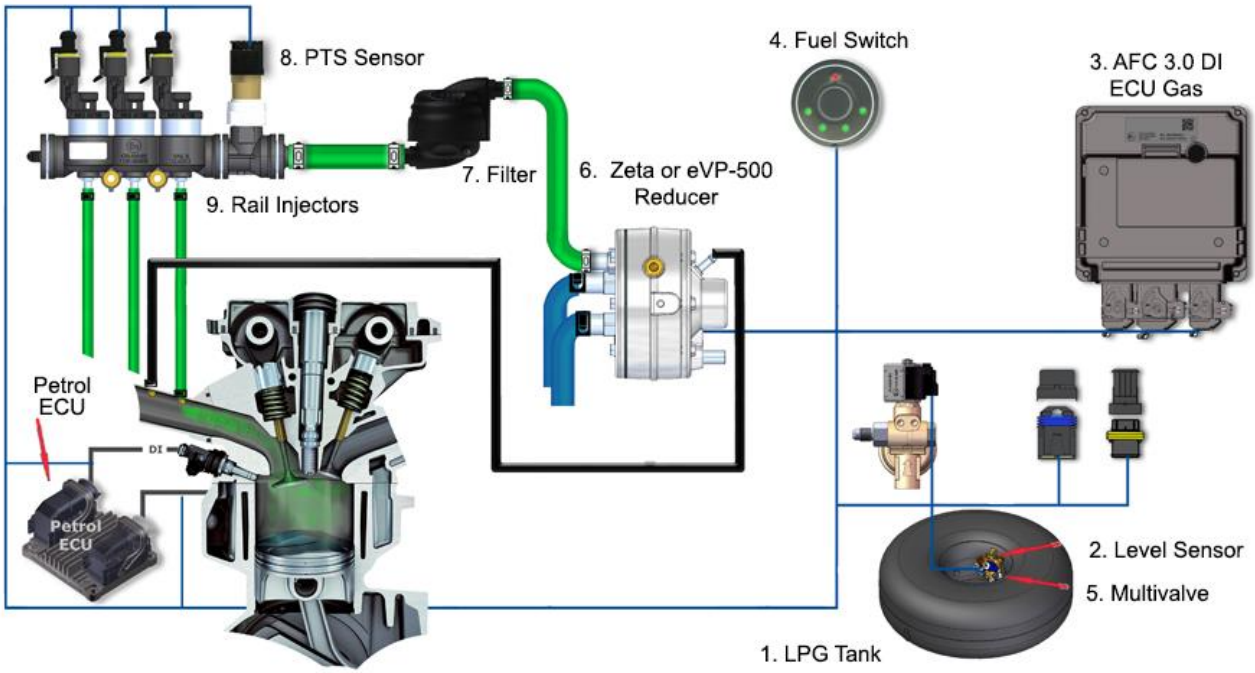
AFC-3.0 DI computer
Advanced ECU with integrated DI injector emulation and full limp-home functionality.

Zeta / eVP-500 reducer
Zeta reducer or eVP-500 reducer manage the fuel pressure. The Genius MB one, provides excellent performance, low consumption and high quality standards. The eVP-500 one is a fully electronic reducer for powers up to 500 HP, able to assure the perfect gas flow in each engine condition for the best driving experience.

8.2 Bora Advance system

- For DI and DI-MPI engine technology
- Minimal petrol consumption **(<5%)**
- Maximum performance, lowest emissions
- For vehicles including latest Euro 6D WLTP technology
- New AFC-3.0 DI computer
- Single AFC for 3 - 6 cylinder
- Master-Slave for 8 - 12 cylinder
- OEM quality LPG components
- **R115/EPA certified**
- Valve Protection (optional)

8.3 Description



Bora Advance has been introduced to run modern vehicles flawlessly on LPG. Advanced engine controls, emission requirements and engine management diagnostic functions require a new generation of gas systems.

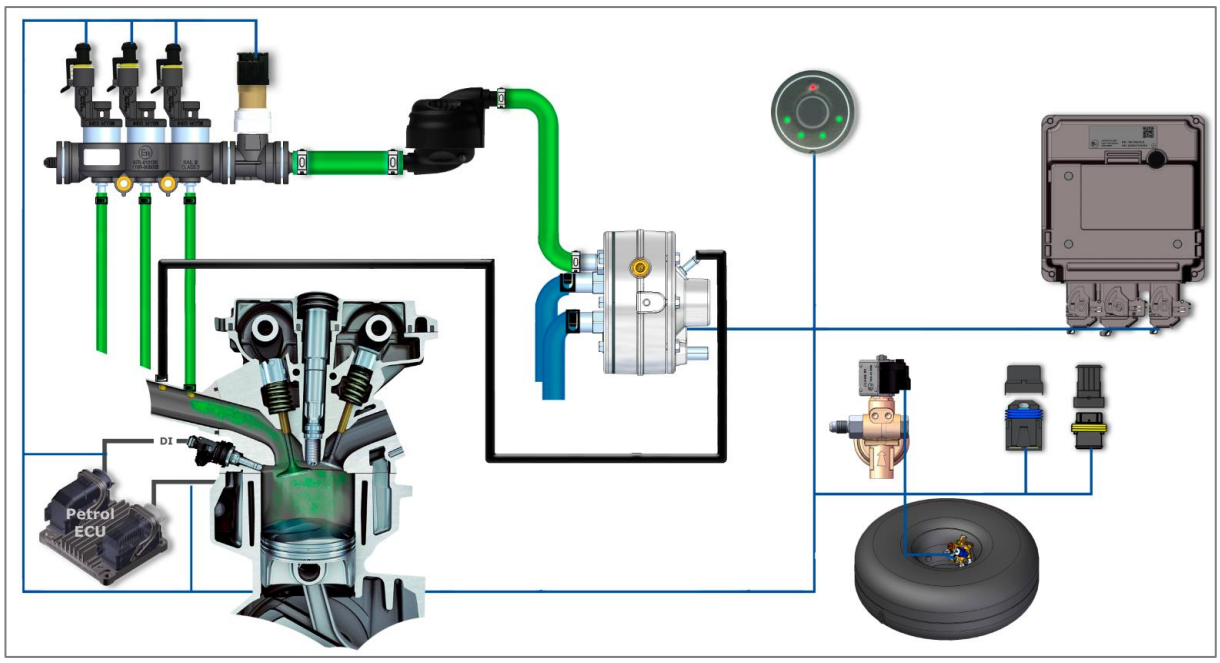
Pressurised Liquid LPG is stored in the tank / LPG fuel tank (1). The tank contains a number of tank accessories for safe storage of LPG. A fuel level sensor (2) is mounted on top of the tank to measure the fuel level and send this information to the AFC-3.0 DI (3). The tank indication LED's on the fuel switch (4) informs the driver about the fuel level.

When LPG mode is selected, the tank Multivalve (5) will be supplied with 12 V or a PWM. By activating the tank Multivalve, the liquid LPG flows to the Zeta/eVP-500 reducer (6).
The engine coolant warms up the liquid LPG inside the Zeta/eVP-500 reducer. The LPG will become vapour. The vaporized LPG will flow through a filter unit (7) is placed between reducer and injectors. It filters the vaporous LPG to prevent contamination of the gas injectors. A combined PT-sensor (8) is installed in the filter unit. This sensor measures the gas temperature and system pressure. These signals are processed by the AFC-3.0 DI (3) to obtain the proper mixture.

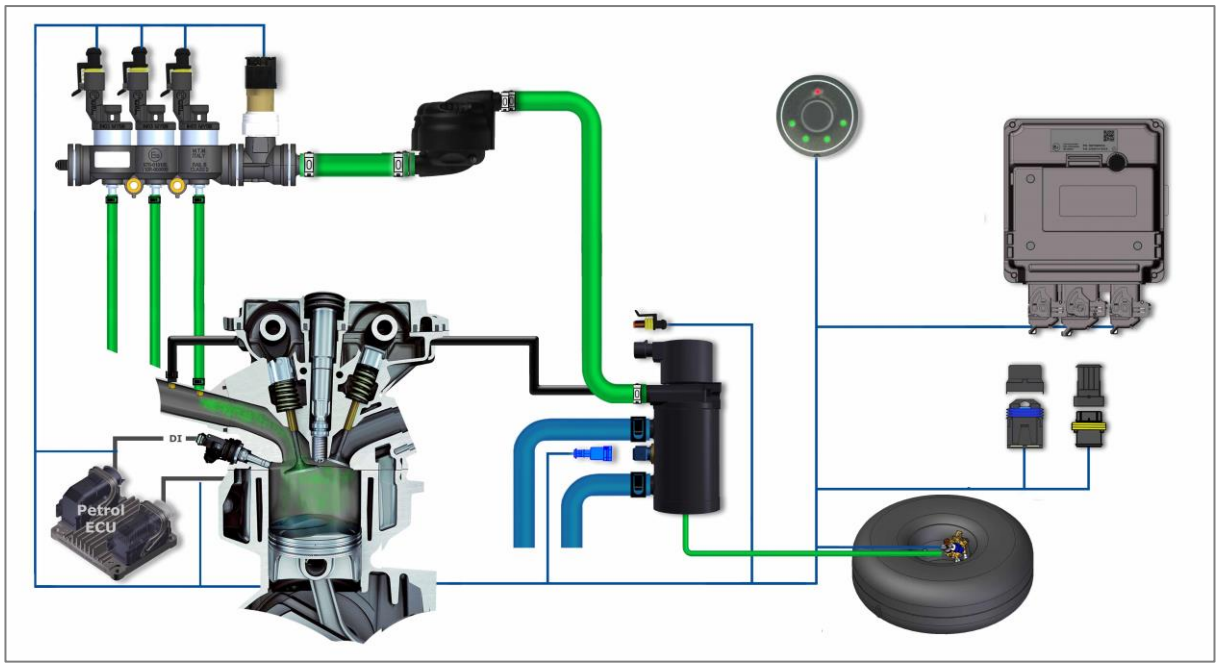
The gas injectors (9) inject the vaporous LPG sequentially into the inlet manifold.
During LPG mode all petrol injectors must be switched off and simulated. All DI and MPI petrol injectors are directly connected to and simulated by the AFC-3.0 DI.

8.4 General system overview Sequent Maestro

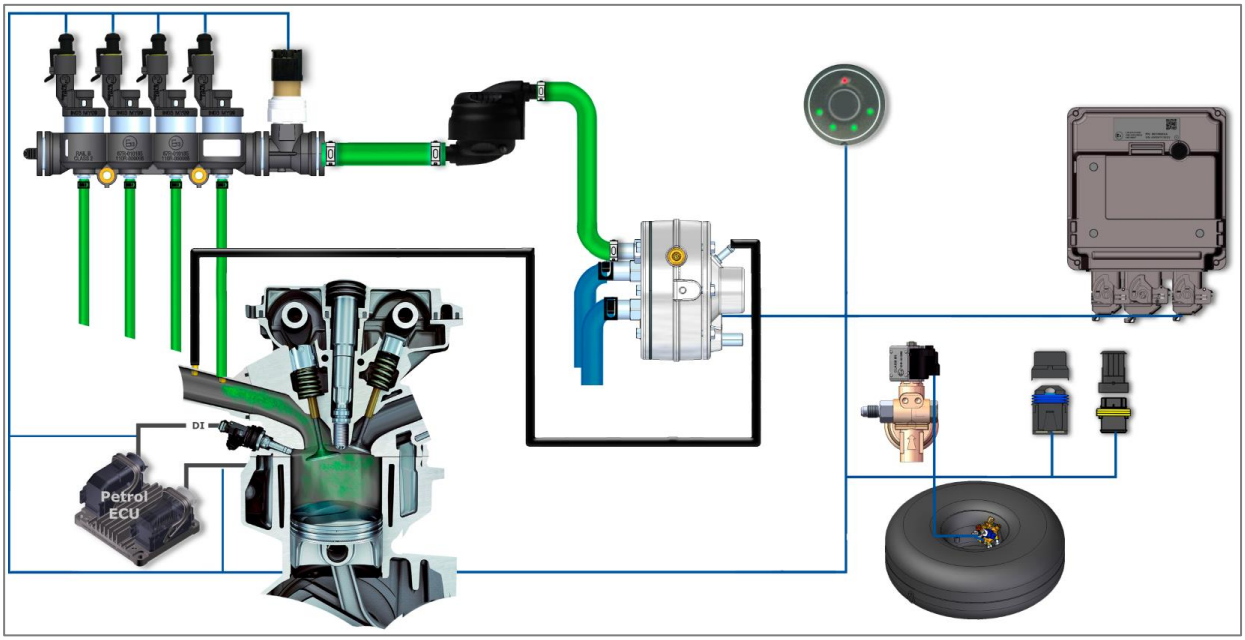
8.4.1 LPG DI-engines



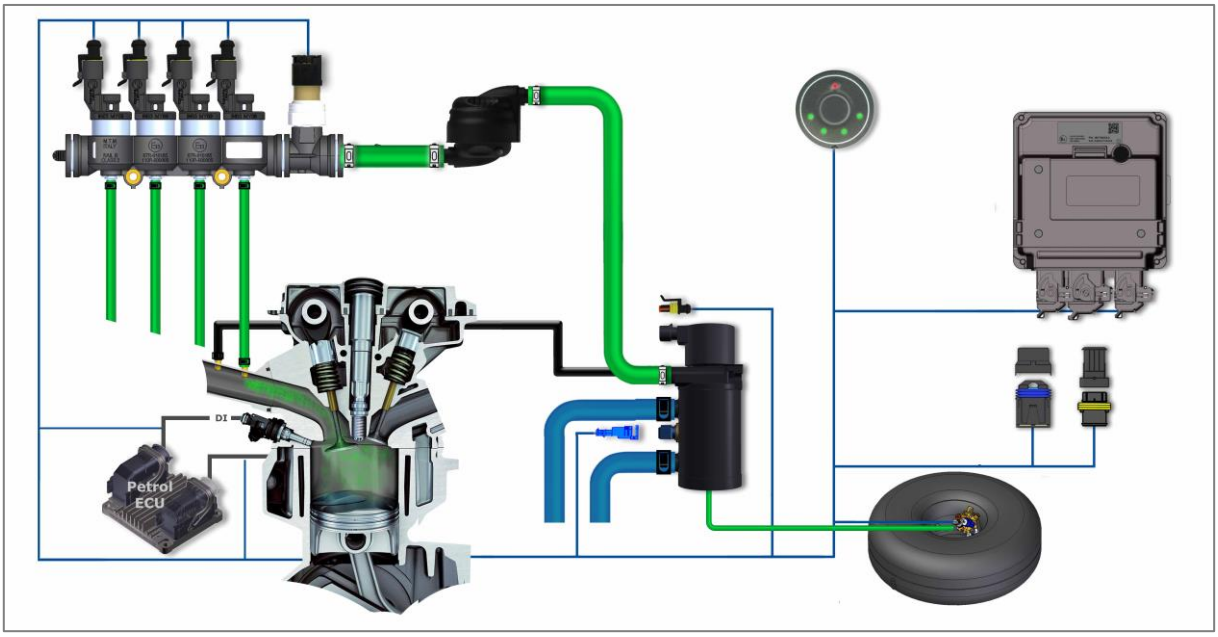
3-cyl – Zeta



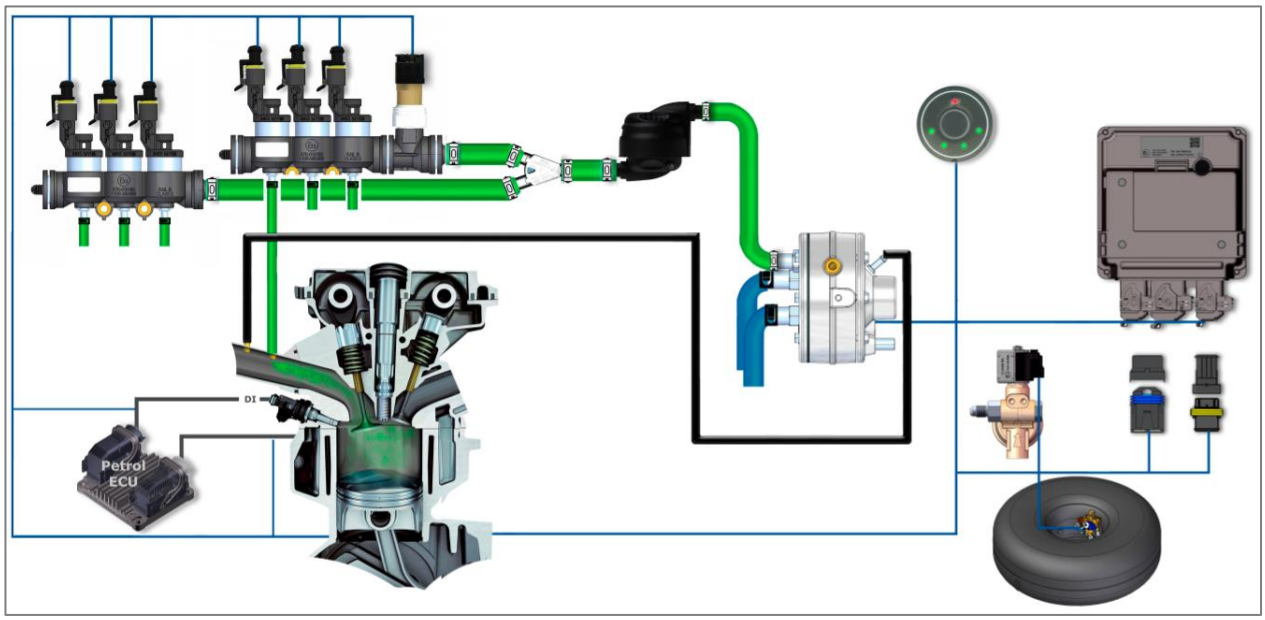
3-cyl – eVP-500



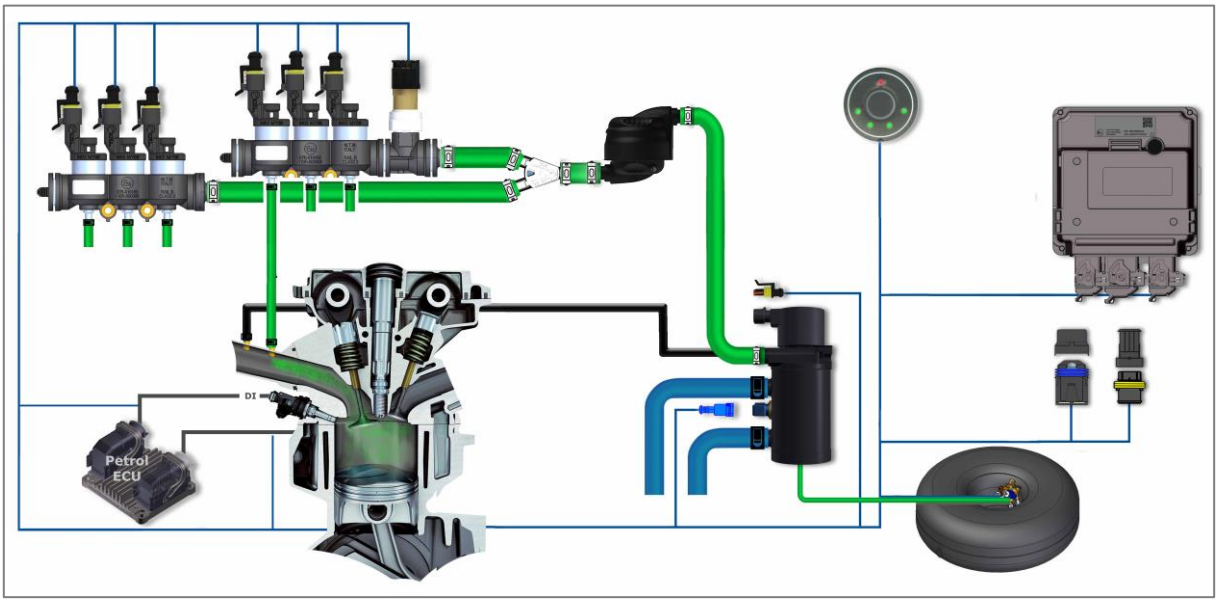
4-cyl – Zeta



4-cyl – eVP-500

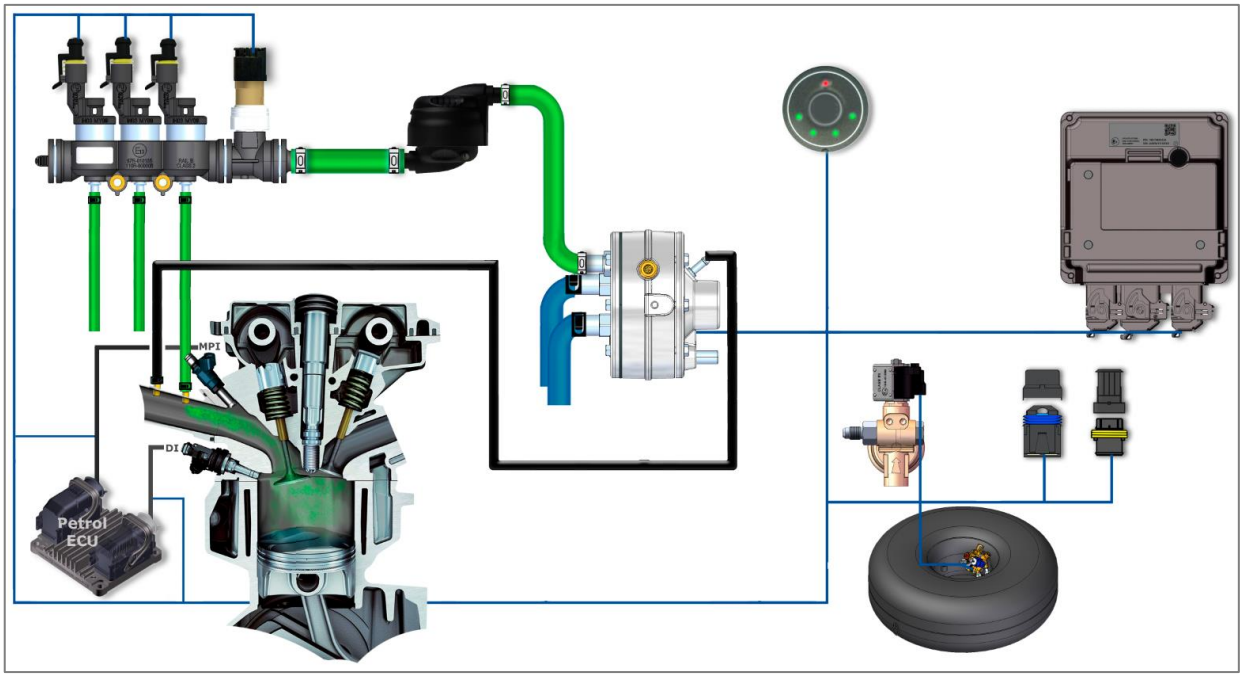


6-cyl – Zeta

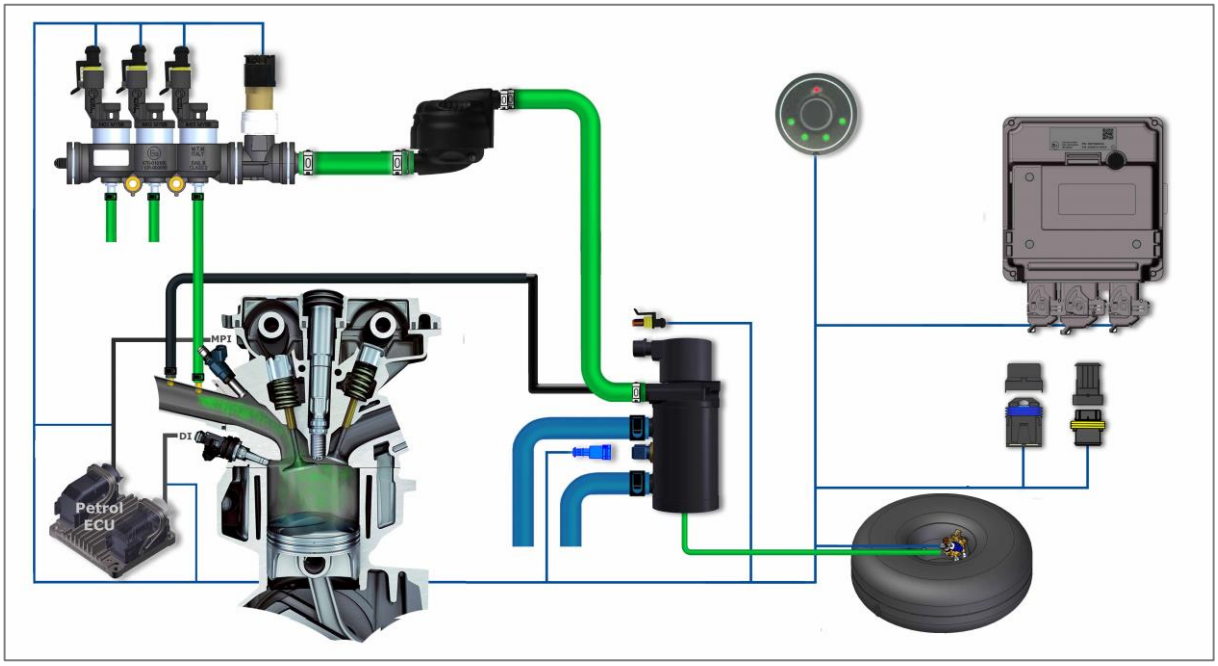


6-cyl – eVP-500

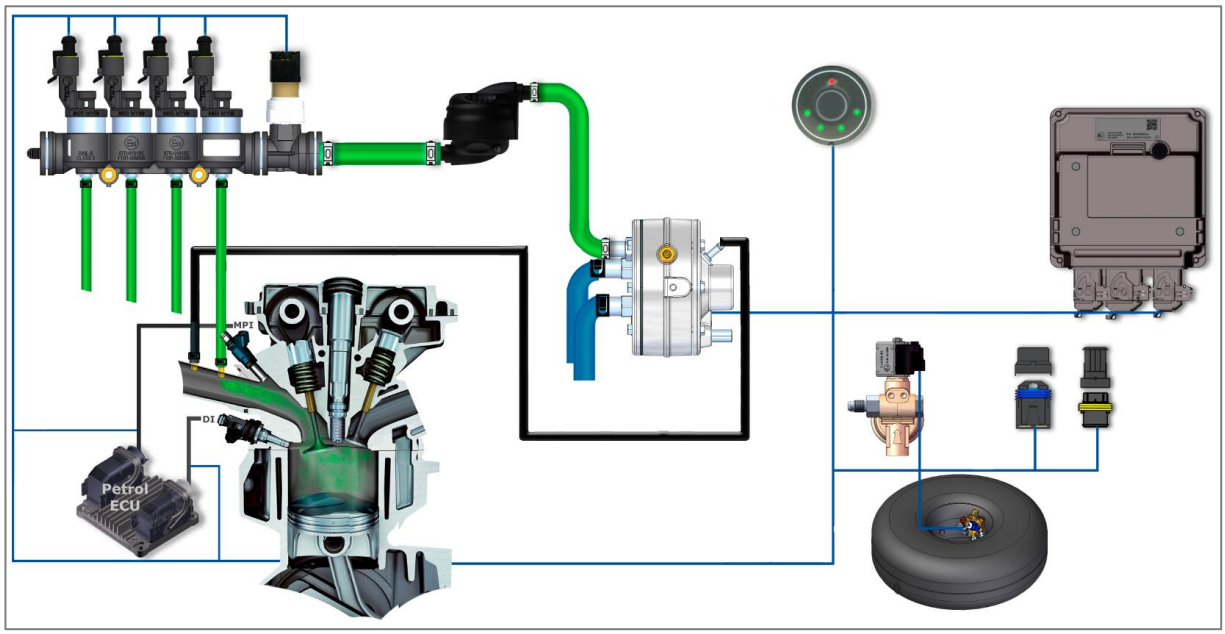
8.4.2 LPG DI-MPI -engines



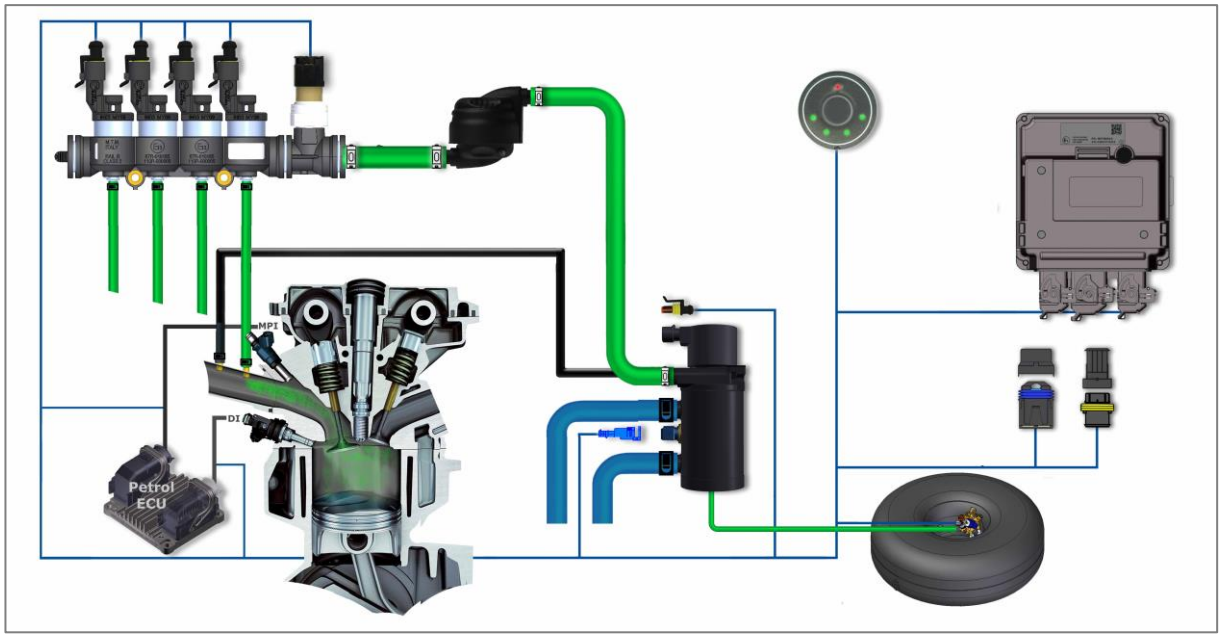
DI-MPI LPG 3-cyl – Zeta



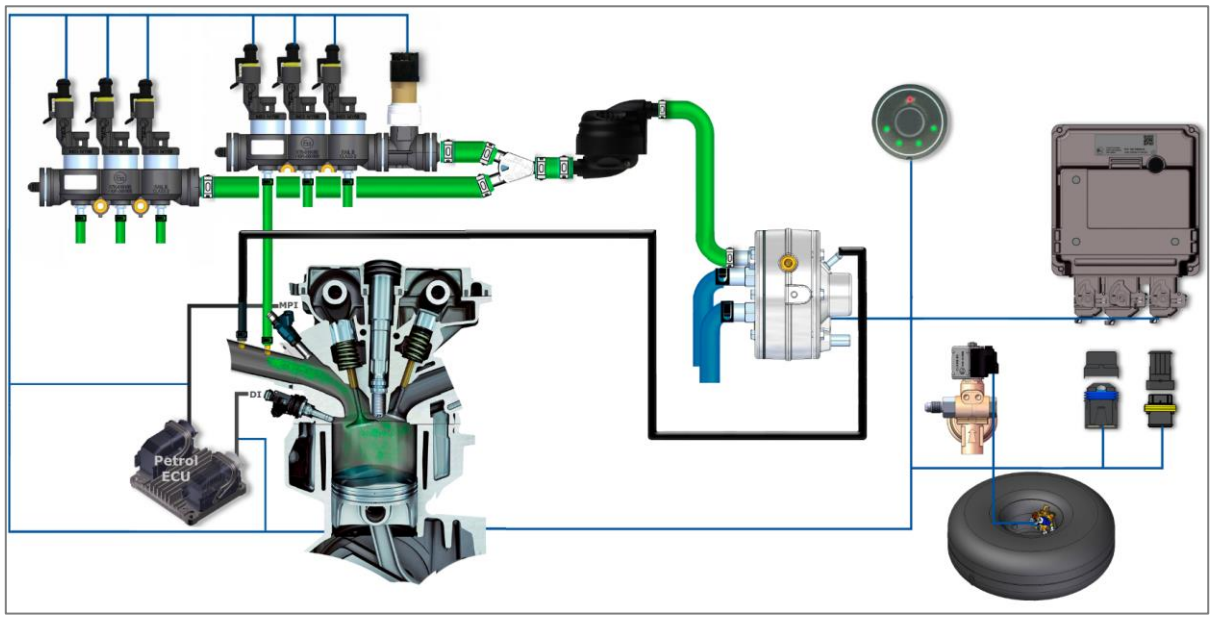
DI-MPI LPG 3-cyl – eVP-500



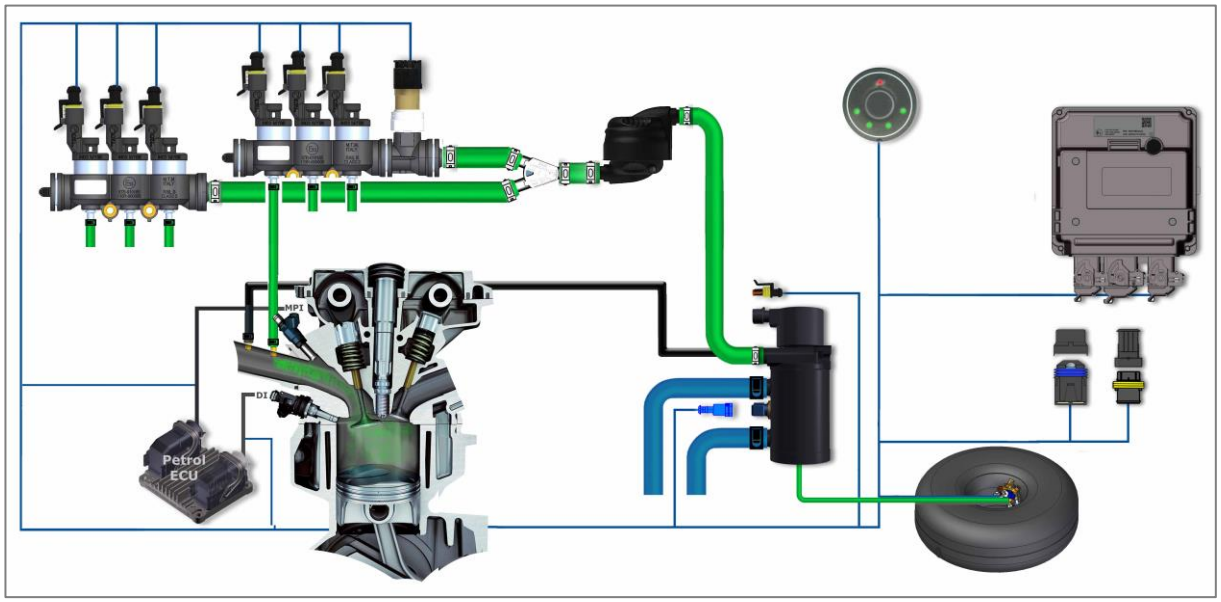
DI-MPI LPG 4-cyl – Zeta



DI-MPI LPG 4-cyl – eVP-500



DI-MPI LPG 6-cyl – Zeta



DI-MPI LPG 6-cyl – eVP-500

9 Bora Advance Components

9.1 AFC-3.0 DI

9.1.1 Highlights

- 3 Versions:
  - 3 Cylinder DI+MPI [DE825003Z]
  - 4 Cylinder DI+MPI [DE825004Z]
  - 6 Cylinder DI+MPI [DE825006Z]
- DI-MPI compatibility
- Full limp-home functionality mode
- Future proof I/O design
- OBD-CAN gateway
- Flexible mounting system

9.1.2 Function

- Measures and processes all input signals
- Simulates various OEM sensors
- Controls two tank lock-off valves and the reducer
- Controls the LPG injectors
- Interrupts/simulates the DI and MPI petrol injectors
- Control fuel switch
- Monitors the gas system and generates trouble codes in case of errors
- Communicating with Calibration Tool software application

9.1.3 Specifications

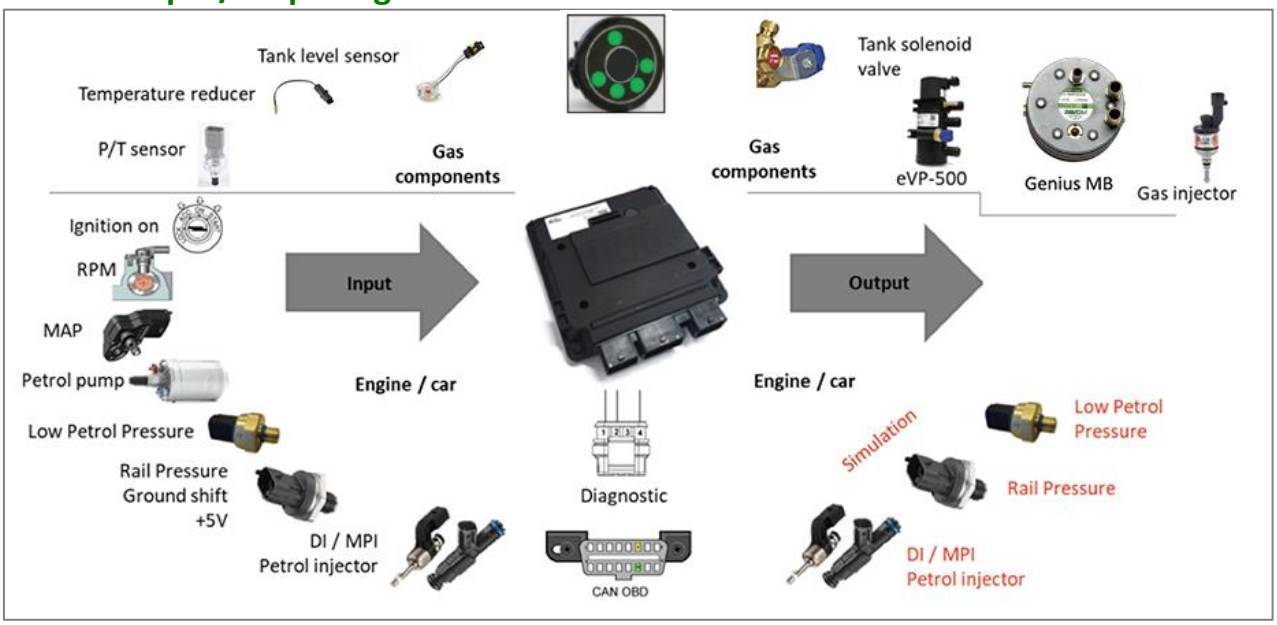
Item	AFC-3.0 DI
Types	3, 4 Cylinder & 6 Cylinder
Colour	Black
Environment	Engine compartment or interior, -40˚C to +120˚C
Homologations	R67, R110, R10
Housing	Plastic top with ventilation plug - Aluminium bottom with cooling fins covers - IP69K
Dimensions box (mm)	208 x 180 x 44
Weight (gr)	1200
Operating voltage	7,5V to 15V, reverse voltage and ISO pulse protected (limp home 5V)
Connector	3 Connectors - Molex
Inputs	Analog sensors - Digital OEM sensors - Digital inputs
Petrol injectors	DI and MPI 2-3-4 or 5-6 cylinder
MPI petrol injector types - simulator	High impedance saturated – Internal Emulation
DI petrol injector - simulator	Coil - Integrated Variable GDI Emulation
Outputs	High powered outputs - 6x Gas Injectors
Gas injector drivers	6 Amp(max) Peak mode - 1.5 Amp hold mode with current feedback and plunger movement detection
Current consumption	Standby current 27 mA @ 12V - sleep current < 0,50 mA @ 12V
Communication Interfaces	3x CAN, 1x LIN-bus
Flexibility	ECT sensor or OEM - analog or digital OEM sensors - selectable RPM input range

9.1.4 Description

The AFC-3.0 DI computer is the heart of the Bora Advance system.
The housing is made of plastic cover and aluminium back plate with heat ridges. For heat dissipation it's important to place it in the relative cool location in the engine compartment with unblocked heat ridges.

The AFC-3.0 DI is one of the key components to run the engine on an alternative fuel. It ensures that the petrol injectors are interrupted and gas is injected. Injection of gas must not affect the functioning of the engine and the engine management. Trouble-free operation on alternative fuel functions is an increasing challenge for modern engines. Especially interrupting the petrol injectors and the petrol pressures deviate while driving on an alternative fuel. When driving on gas, the sensors of the petrol system react differently than expected by the engine management.

9.1.5 Input/output signals



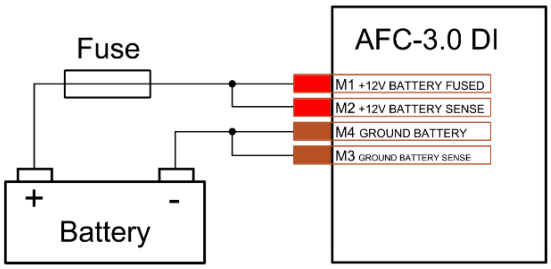
Various signals are measured to calculate the correct amount of the fuel and flawless drivability without engine management errors. The AFC-3.0 DI can manage analogue, digital and communications signals.
All engine components connected to the AFC-3.0 DI are explained in the chapter 'Engine Sensors and Actuators'.

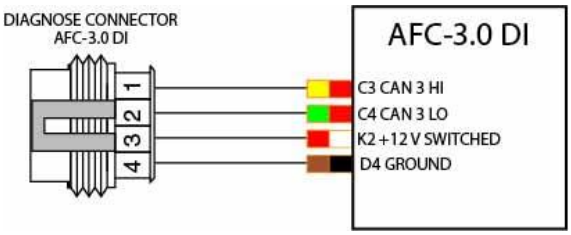
Input signals:	Explanation
DI-MPI Injector signals	Basic information to calculate the gas injection timing
Petrol high rail pressure	To measure the actual pressure and simulations strategy
Petrol Low pressure	To measure the actual pressure and simulations strategy
Petrol pump signal	Measure the petrol pump load for simulations strategy
RPM signal	Activate lock-off valves and calculations
Manifold pressure (MAP)	Create MAP related dynamic gas system pressure
Coolant temperature	Switch over temperature
Lambda sensor	Correct fuel mixture
+ Ignition	Wake up and for simulations strategy
5V Wakeup ECM	Wake up and shut down at same time as ECM
LPG System pressure	Correct gas injection time
LPG System temperature	Correct gas injection time
LPG Tank level	Tank level information

Output signals:	Explanation
Gas injector timing	Activate the gas injectors
LPG tank lock-off valve	Supply the coil and open the tank lock off valve
eVP-500 reducer actuator	Variable voltage for coil to manage the gas system pressure and flow
DI-MPI Petrol injector	To simulate the interrupted petrol injectors
Simulation of engine sensors	Pressures deviate on gas. simulation ensures correct values for ECM
5V sensor supply	Supply gas system sensors

Communication signals:	Explanation
OBD CAN-Bus	Extra information for calculations and strategies
Fuel selector switch [LIN-bus]	Switch over/back and inform driver
Calibration Tool	Flash, change setting and diagnose

9.1.6 Electrical connection





Brown connector Electrical connection 48 pin	AFC
+ 12 V Battery fused	M1
+ 12 V Battery fused	M2
Ground battery	M4
Ground battery sense	M3

Brown connector Electrical connection 48 pin	AFC
CAN HI	C3
CAN LOW	C4
+ 12 V Switched	K2
Ground	D4

9.1.7 Diagnostics

Engine does not run on LPG, Fuel selector switch does not lit, and no communication with the Calibration Tool Software
Check / insert the main fuse. The fuse is not installed when the wiring harness is delivered.

No communication with Calibration Tool Software
Check the main fuse and +12 V ignition.
Check if the Diagnostic Tool (Communication interface) is active.

The system automatically detects the right communication port. This operation is only carried out at the first connection; then the system records the communication port used.
Warning: if you change communication cable position, the system will automatically search the new one.

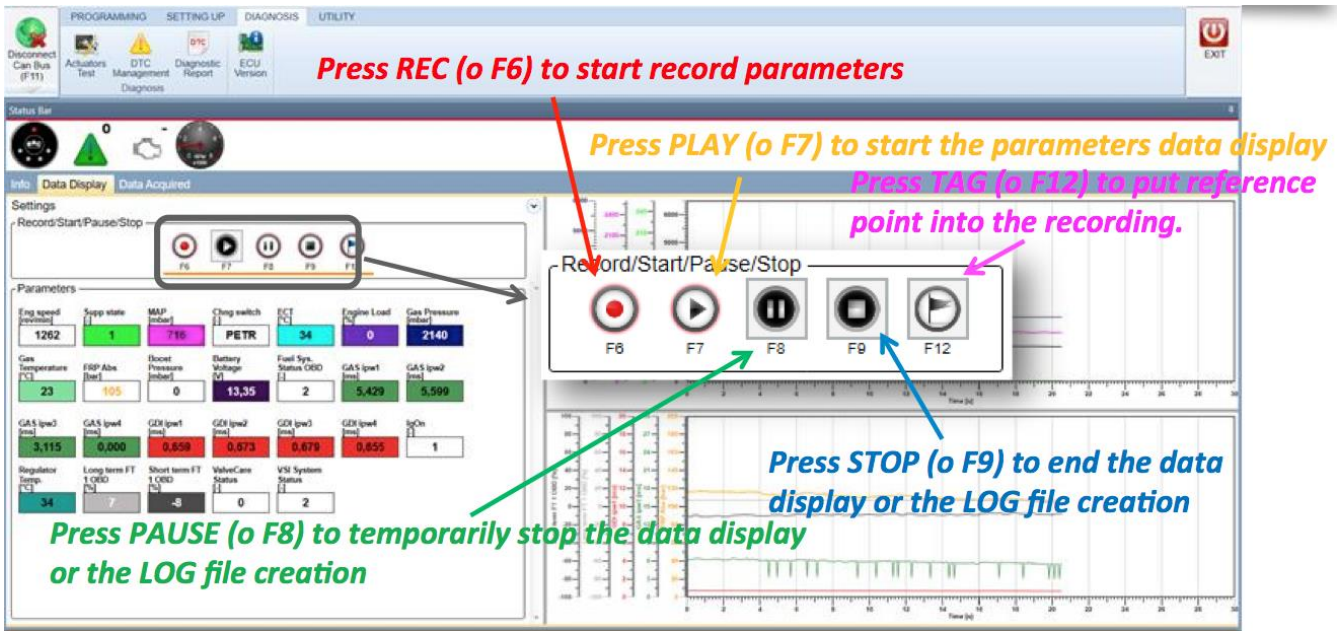
When communication with ECU is ok, the button top left is green. 

Bottom of the screen, the status bar informs that ECU communication are connected.

9.1.8 Calibration Tool Software

Process parameters

Click on Data Visualisation in the starting page “Data Display”



This section has been divided into two parts, the right one is dedicated to visualization graphs and the left one is dedicated to numerical visualization of system variables, profiles management and data acquisition.

9.2 Bora Advance System Status

Different AFC statuses are possible. The most common statuses will be described:

Status	Type	Description
	Sleep mode	n order to minimize the power consumption when the car is not used, the AFC is switched to sleep mode. The AFC goes to sleep mode shortly after ignition + and the 5V sensor wake up signal are not present any more. The communication status bar will be coloured red.
0	**Engine off [0]**	is active when + contact and/or the 5V wake-up is active without running engine. Normally this is during ignition on and when the engine management is active. The communications start between the AFC and Calibtration Tool. The communication status bar will be coloured green.
1	**PETROL SELECTED**	The engine runs on petrol and the fuel status LED is RED. All petrol injectors are active and engine signals are read by the AFC and unmodified send to the engine management.
2	**PETROL**	WAIT FOR SWITCHING
3	**PETROL SV OPENED**	The tank solenoid valve will be active and the reducer pressurizes the gas injectors. During pre-opening
11	**SWITCH_OVER_SV_OPENED**	The fuel selector switch has been pressed to select gas. This signal is send to the AFC and it starts the switch over to gas procedure/
69	**SWITCHING_OVER_GAS**	The system switches over from petrol to gas when all . The engine can run on both fuels for a few injections. Often the switch over is managed per cilinder. The simulation of the connected engine sensors starts.
192	**GAS**	The engine runs on gas. The status LED is GREEN of the fuel selector switch is active. The gas injectors are active. The petrol injectors are inactive and simulated. The petrol rail pressure is read and simulated to the engine management. The low petrol pressure can also be simulated when needed. This depends on the strategy of the engine management.
64	**SWITCHING_OVER_PETROL**	The fuel selector switch has been pressed to select gas. This signal is send to the AFC and it starts the switch over to gas procedure/
4	**TANK_EMPTY**	The system monitors the gas system pressure with the P/T sensor in the filer unit between the reducer and the gas injector rail. When the system pressure becomes too low, the system will switch back to petrol.
21	**GAS_NOT_ALLOWED**	The system can switch back to petrol automatically. When a device is connected to the OBD-system, the system will switch back to petrol and with the system status 'Gas not allowed'. Gas not allowed will also be active when the hardware of the AFC gets too hot. Some applications use 'Gas not allowed' during, manoeuvring or other situations for the best drivability, comfort and performance.
128	**GAS_START_SV_OPENED**	The system switches over from petrol to gas when all . The engine can run on both fuels for a few injections. Often the switch over is managed per cilinder. The simulation of the connected engine sensors starts.
199	**GAS_STARTING**	
5	**TANK_EMPTY_RETRY**	During a Tank empty status the engine runs on petrol. Within a minute the system tries to twitch over to gas to check if the system pressure is really too low. The system pressure can be too low during different circumstances, like cold weather, to small tank valve or other blockage. With sufficient system pressure, the system switches to over gas to gas. With insufficient system pressure, the engine will continue to run on petrol.

These statuses are shown in the lower right side of the Calibration Tool in the Data Visualisation in 'STATUS'.

9.3 Wiring harness

Black [3]
32 pin

Brown [2]
48 pin

Grey [1]
32 pin

9.3.1 Highlight

- 3 Connectors – 112 pin header
- GAS injectors / Reducer / Tank -> Grey [1]
- Supply / Ground / OEM sensors -> Brown [2]
- DI - MPI Petrol injectors -> Black [3]
- Simple – clean – efficient routing
- Modular wiring harness system

9.3.2 Description

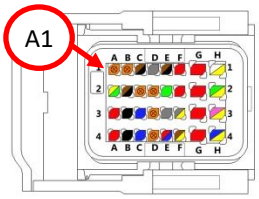
The AFC-3.0 DI is equipped with three Molex connectors, grey [1], brown [2] and black [3].
Each connector has its own main function.
All wire numbers correspond with the position numbers on the connector (see wiring diagram).
Example: wire number L3 can be found on connector position number L3.
The wires have a colour, a number and text description. The text refers to the function of the wire and is identical as the description in wiring diagram.

Detailed wiring harness information is explained in chapter 'Electrical installation instructions'.

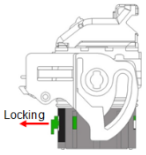
LPG system components	Grey [1]
LPG injectors	
Pressure & Temperature sensor on Rail	
eVP-500 reducer actuator or EV	
eVP-500 or Zeta - coolant temperature sensor	
Tank lock of valve(s)	
Tank level sensor(s)	
NOT the fuel selector switch	

Attention!

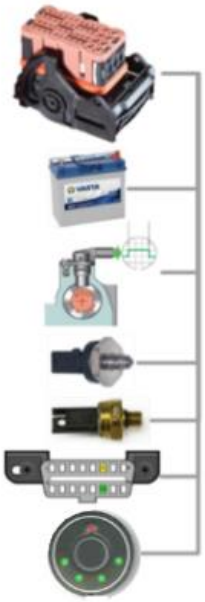
Numbering of grey connector pinning rotated 180 degrees.

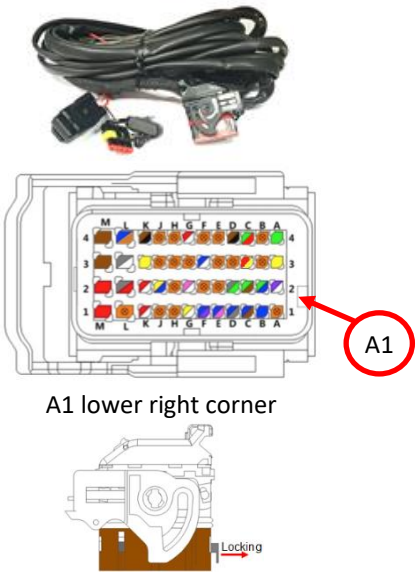


A1 upper left corner



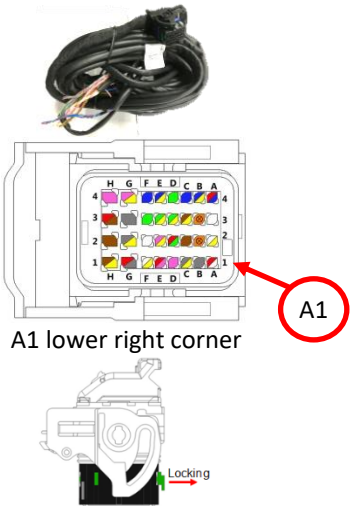
Supply / ground / engine	Brown [2]
Battery voltage and ground Fuse Ignition + Engine management wake-up Fuel selector switch [LIN-bus] OBD CAN-bus Diagnostic connection Inlet manifold pressure High pressure petrol rail pressure sensor input and simulated output Low pressure petrol pressure sensor input and simulated output Petrol pump signal Lambda sensor Various optional signals	





A1 lower right corner

DI-MPI Petrol injectors	Black [3]
DI Petrol injectors interruption DI Petrol injectors simulation MPI Petrol injectors interruption MPI Petrol injectors simulation	



A1 lower right corner

9.4 Fuel selection switch

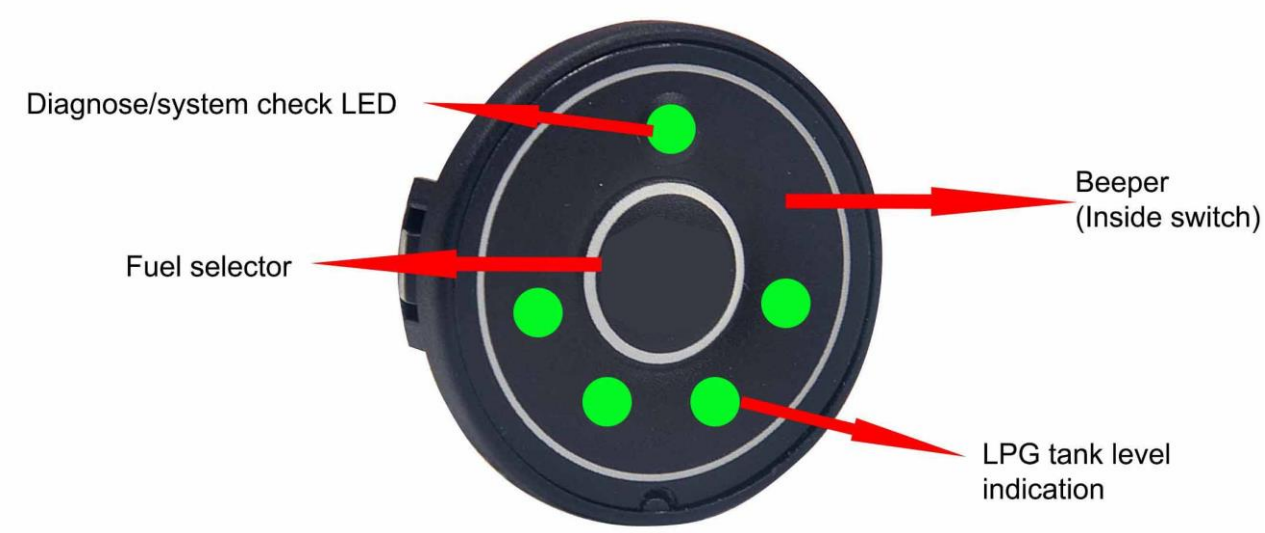
9.4.1 Features

- Small and compact design suits all interiors
- Fuel selection via smart touch control
- Informs operator on LPG tank content
- Audible buzzer to alert for an empty tank or fault codes
- Illuminated fault code warning with LED

Attention! Ensure that the correct tank gauge is programmed!

9.4.2 Description

The fuel selection switch is controlled by a touch control button. When pushing the button, the computer receives a switch-over signal. The computer will change the actual fuel selection.

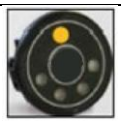


The switch also features four tank indicator LED's that indicates the current tank level.

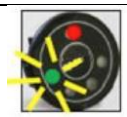
When the gas system pressure is too low (empty LPG tank), the system will automatically switch back to petrol mode. A beep signal informs the driver of empty tank and switch back to petrol mode. Now, tank should be refilled to run on gas again.

9.4.3 Operation mode

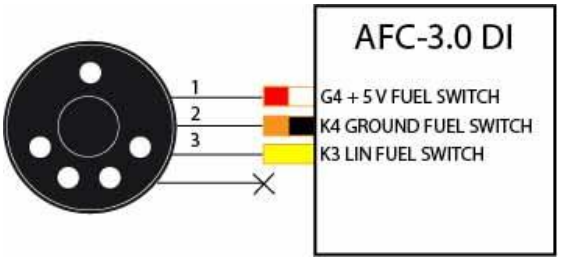
Normal operation modes

 Petrol mode	 From Petrol to gas. The round LED informs user that changeover has occurred, by becoming first orange and then green
 Gas mode (full tank) - 4 LEDs =4/4	 Gas mode - 3 LEDs =3/4
 Gas mode - 1 LED =1/4	 Fuel reserve indication is given by the first green LED blinking

Fault situations

 Petrol mode – Tank empty (LED blinking + Buzzer sound)	 Communication problems between ECU and changeover switch (Orange LED + 2 central LEDs blincking)
 Gas error storage (Red LED blinking + Buzzer sound)	

9.4.4 Electrical connections



Brown connector Electrical connection	AFC
Supply	G4
Ground	K4
LIN-bus data	K3

9.4.5 Diagnostics

Inactive switch

When the switch does not light up, check the fuse and small four pole connector.

9.5 LPG fuel tank

9.5.1 Function

- Safe storage of liquefied LPG
- Providing housing for all fittings

9.5.2 Description

LPG tanks are available in various shapes and sizes. LPG tanks have been tested up to 30 bar.
Production date and homologation information can be find on the tank.

For homologation, legislation and installation information, refer the www.zavoli.com site.

Attention! Always refer to the installation instructions of the tank manufacturer and local installation regulations

9.6 LPG Lock-off valve (tank)

9.6.1 Function

- Stops the LPG flow from tank to reducer
- Limits the LPG flow in case of a broken pipe

9.6.2 Specifications

- Coil with water-proof housing
- Complies with R67-01 regulations

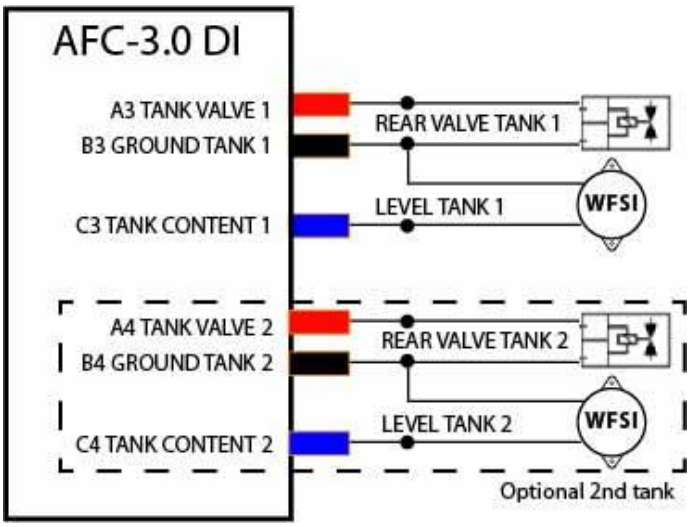
9.6.3 Description

The lock-off valve is a legally required component which shuts off the LPG flow in case the engine speed/ignition signal is missing.
The LPG lock-off valve is mounted on the tank.
The LPG lock-off valve is activated by the AFC-DI 3.0 when LPG is selected as fuel and no system errors are present.
The supply from the LPG tank to the other LPG components is shut off when switching back to petrol mode, when stopping the engine and in case of system errors.

9.6.4 Variants

Different types of tank valves can be found on the tank.

9.6.5 Electrical connection

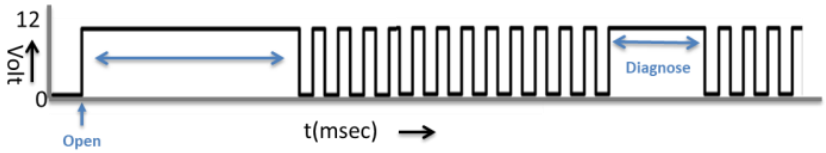


Grey connector Electrical connection	Tank 1	Optional Tank 2
Supply	A3	A4
Ground	B3	B4
Level sensor signal	C3	C4

Coil	Min.	Max
Current (A)	0,5	2
Power (W)	6	24

The solenoid valve for tank 1 is standard wired on the grey connector. An optional 2nd tank wiring module can be ordered via the Commercial dept.
The ground is also used for the tank level sensor(s).

The AFC-3.0 DI supplies the solenoid of the tank lock off valve, connected to the Grey connector A3 Pin. To reduce the temperature of the solenoid valve is powered with a Pulse Width Modulation voltage (PWM) as default. During opening of the valve a constant 12 V is supplied. After a few seconds, the constant 12 V is changed to a PWM supply. Sequence will be repeated after 60 seconds. The current through coil is diagnosed during 12 V constant. When it get too high a fault code will be generated.



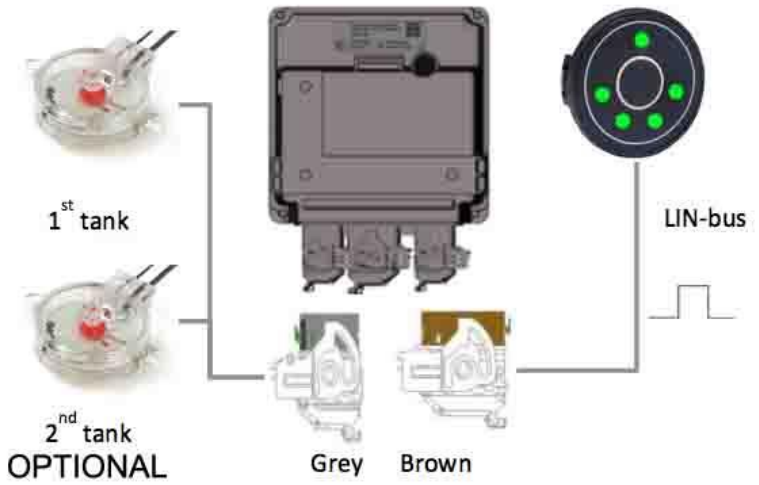
9.6.6 Diagnostics

Whispering buzzing noise
The solenoid valve may produce a buzing noise due to the 12V PWM supply.

DTC Code	Description
P2667	Front Fuel Shutoff Solenoid Valve Control Circuit High Voltage
P2666	Front Fuel Shutoff Solenoid Valve Control Circuit Low Voltage
P0007	Rear Fuel Cut-Off Solenoid Valve Control Circuit High Voltage
P0006	Rear Fuel Cut-Off Solenoid Valve Control Circuit Low Voltage

9.7 Tank level sensor

9.7.1 Function



- Measures the LPG fuel level of the tank(s)
- Sends voltage signal to AFC3.0 DI
- AFC-3.0 DI sends total tank

9.7.2 Specifications

- AFC supports Hall sensors and low resistance level sensors
- AFC supports two level sensor simultaneously

9.7.3 Description

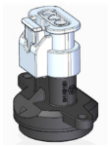
The fuel level is measured by a sensor mounted to the tank. This sensor informs the AFC-3.0 DI the actual fuel level with a voltage. The fuel selector switch receives the tank level information via LIN-bus from the AFC. To prevent a nervous tank indication, a damping / delay is applied.
Only low resistive and Hall level sensor types are supported.

Two tank level sensors can be connected directly to the AFC-3.0 DI. The actual volume of both tanks is calculated and is send to the switch. Both sensors need to be the same type.
Refer to the diagrams for the relation between the tank level and tank level sensor voltage generated by the tank level hall sensor.
Order the 'Second tank wiring module' via the Commercial dept.

9.7.4 Variants

Livello 0-95Ω

AEB 1090 10-90 Ω



Hall Sensor
WFS Italia

Prins Hall

0-90 Sensor
WFS Italia

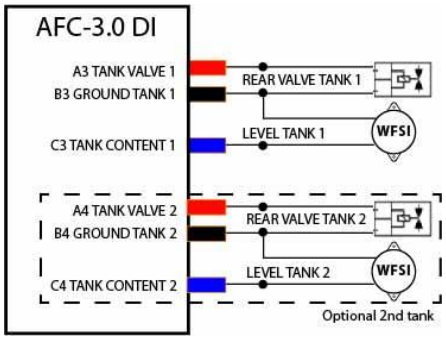
38-1500
Sensor WFS Italia

Most common tank level sensors are supported by the AFC-3.0 DI.

- Low resistive [10-90 Ω – 0-95 Ω pre selectable]
- Hall
- User defined Low resistive [0-10 V]
- High resistive level sensors are not supported. [75 K-0.1 K – 0-KΩ]

Attention! Set the parameters with the Calibration Tool Software.

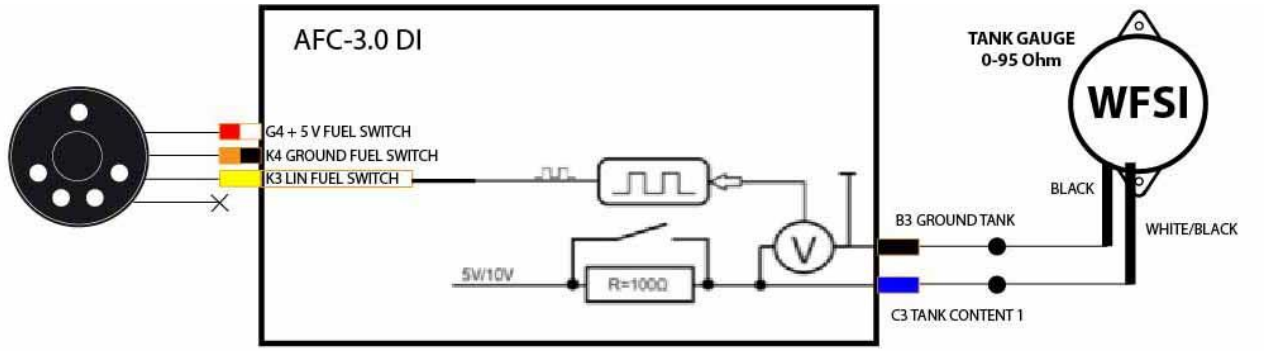
9.7.5 Electrical connection



Grey connector Electrical connection	Tank 1	Tank 2 OPTIONAL
Supply	A3	A4
Ground	B3	B4
Level sensor signal	C3	C4

Both tank level wires are located on the grey connector.
The ground is also used for the tank solenoid valves.

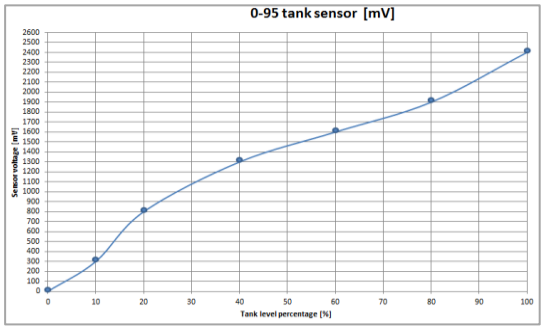
Pull-up



The fuel level is measured by a sensor mounted to the tank. This sensor informs the AFC-3.0 DI the actual fuel level with a voltage. The fuel selector switch receives the tank level information via LIN-bus from the AFC.
Low resistive and Hall level sensor types are supported. High resistive level sensors cannot be used; 20 K or 75 K level sensors. The internal pull-up resistor in the AFC-3.0 DI has a value of 100 Ω. Only use level sensors with a value of less than 1 K (1000 Ω). The sensor of a second tank can be directly connected to the grey connector.

Resistive Livello 0-95 Ω

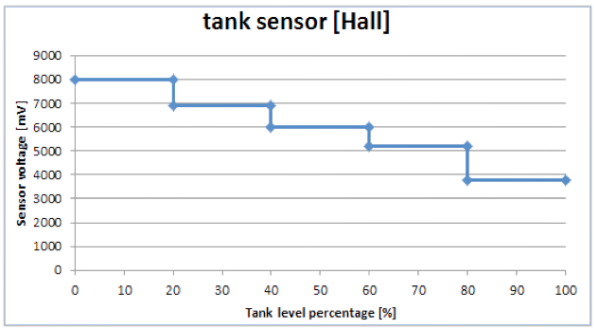
- Resistive type
- 6 level indication levels on fuel selector switch
- Analog signal
- 2 wire – 3 wire support
- AFC Internal pull-up 100 Ω



Tank level (%)	Sensor voltage (mV)
0	0
10	300
20	800
40	1300
60	1600
80	1900
100	2400

Hall sensor

- Operation according to Hall sensor principle
- Long life span / no wear
- 100% water-resistant
- 5 indication levels
- 2-wire 0-10V
- 3-wire 5V



Tank level (%)	Sensor voltage (mV)
0 - 20	8000
20 - 40	6950
40 - 60	6000
60 - 80	5100
80 - 100	3800

9.7.6 Diagnostic

Wrong indication

Different pre-defined sensors can be selected by the calibration parameters. Always check the settings and voltage of the sensor signal.

DTC Code	Description
P01B1	Alternative Fuel Level Sensor Low Voltage
P01B2	Alternative Fuel Level Sensor High Voltage

9.8 LPG high pressure line and fittings

HIGH pressure flexible pipe

Fittings

9.8.1 Function

- The line transports LPG in a safe way from the tank to the reducer
- Fittings ensure gas-tight connections

9.8.2 Specifications

- According ECE R067.01
- Reinforced Light weight thermoplastic
- 30% more flow compared to copper pipe
- Environment temperate range -40°C - 120°C [-40°F - 248°F]
- Maximum operation pressure 30 bar
- Maximum burst pressure 200 bar
- Easy to install and assemble
- Cut to length
- Fittings for LPG tanks

9.8.3 Description

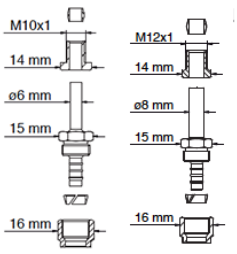
The LPG high pressure line is called the flexible pipe. It transports the LPG from tank to reducer in a safe way. The reinforced thermoplastic line is easy to bend and install. Always use the WFSI mounting parts to avoid damaged flexible pipe. Avoid mounting the flexible pipe in a hot area. Use a heat shield to protect it.
Cut the flexible pipe to the required length and install the fittings like described in the 'Installation chapter'.

9.8.4 Variants

Flexible pipe

Two different flexible pipe are available, each with a different diameter. Beware of the minimum radius during assembly. Straight and 90-degree fittings available. Flexible pipe is not provided, to buy separately.

	Inside diameter (mm)		Application
LPG flexible pipe	6	M 10x1	Genius MB 800 – Genius MB 1200
	8	M 12x1	Genius MB 1200 – Genius MB 1500 – eVP-500



9.8.5 Diagnostics

Too low system pressure or lack of power can be caused by a kink in the line.

9.9 eVP-500 reducer

9.9.1 Function

- Vaporizing liquid LPG
- Absorbing sufficient heat to vaporize the required amount of LPG
- Create a Flow and Pressure regulation
- Providing the engine with sufficient vaporous LPG across its entire load range

9.9.2 Specifications

- Unique, next-generation concept
  - High performance (>370kW / 500hp)
  - No diaphragm
- Housing
  - Compact and light weight design
  - Lock-off valve integrated
  - Integrated safety pressure relief valve
- System pressure
  - Fully dynamic output pressure
  - Pressure adjustment by software
  - No pressure loss even at higher flows
  - No pressure drift over time
  - No pressure peaks during fuel cut-off
- Service and Maintenance
  - Replaceable filter
  - Easily accessible from top
- Installation / calibration
  - MAP connection not required / Via optional MAP sensor
  - Special calibration parameters
  - Standard coolant temperature sensor
  - Two pole Superseal connector for actuator

9.9.3 Technical Specifications

- Single stage full electronic LPG pressure reducer
- Liquefied Petroleum Gas (LPG)
- Engine compartment installation
- 800 g total weight
- Ø 56 mm x 142 mm dimensions
- 300-2500 kPa input pressure (Abs.)
- 0- 550 kPa adjustable output pressure (Abs.) (software limited between 50-380kPa)
- >100 kg/h Max Fuel flow rate [at 60°C ECT]
- 585 ±50 kPa pressure relieve valve (acc.to R67-01)
- -40 to +120°C operating temperatures
- M12x1 Gas inlet
  - Various adapter ¼ NPT available)
- 16 mm gas outlet
- 16mm coolant connections
  - no flow direction specified
- Temperature sensor
  - R-ntc at 20 ˚C is 2500 Ω
  - IP 54 A Connector
- Software controlled MAP Reference

9.9.4 Description

eVP-500 is the abbreviation of electronic Variable Pressure 500Hp
It is a state of the art full electronic reducer for the LPG market. It does not only surpass competitors in terms of capacity (500hp), it also extends the benefits of an electronic controlled LPG system with the possibility to fully control the system pressure.
The actuator has two functions, to stop the gas flow (lock off valve) and to manage the gas flow and pressure. The coil is supplied by a PWM.

The system pressure is managed by the calibration settings. The gas system pressure can be set by different strategies

1) Constant pressure
2) Pressure related to the inlet manifold (Delta pressure)
3) Related to engine load / speed
4) Combination of delta pressure and engine speed / load

When the system pressure is related to the inlet manifold, the electronic MAP signal is used to manage the system pressure. The hose connection to the inlet manifold is used for the Pressure Relief Valve. No extra connection to the inlet manifold is needed to manage a Delta pressure.

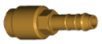
9.9.5 Parts description

eVP-500

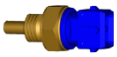
Actuator

Filter
type 2

Body



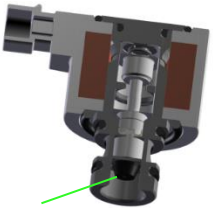
PRV
(pressure relief valve)



ECT

fitting M12x1 straight and angled

Heat exchanger

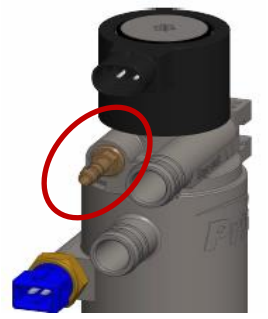


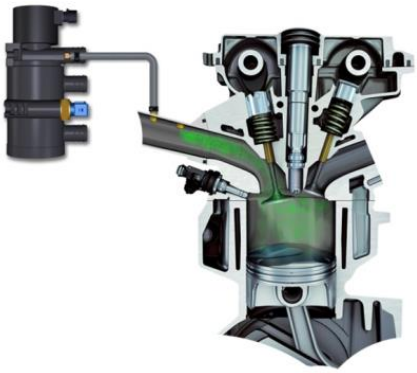
Plunger
(O-ring above the
thread)

9.9.1 LPG lock-off valve / Actuator (reducer)

The lock-off valve is integrated in the actuator of the eVP-500 reducer. The actuator completely closes during engine off, driving on petrol and during fuel cut off.

9.9.1 Pressure relief safety valve (PRV)





Reducers must be equipped with a pressure relief valve to prevent excessive pressure, according to the 67R-01 regulations. The pressure relief valve lowers the system pressure when it gets too high.

The pressure relief valve is integrated next to the LPG outlet. It has to be connected to the inlet manifold of the engine with a 5 mm hose. The gas is relieved directly into the engine. It's not allowed to relief the gas into engine compartment or into the environment.

The maximum relief pressure is 2.25 x 'maximum system pressure' =>. 2.25 x 2.8 bar = 6.3 bar ± 0.5bar

When the PRV is connected to MAP the opening pressure may be variable. This depends on the pressure in the inlet manifold.

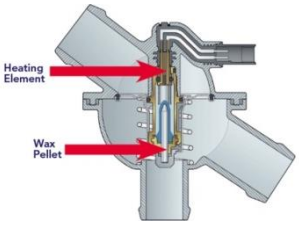
9.9.1 Coolant connections

The reducer is connected to the coolant system with two 16 mm heater hoses.

Modern heating systems are getting more complex. The can be equipped with a thermal engine management.
The temperature of different engine parts and heater are controlled by an electronic thermostat, valves or electrical coolant pumps. The warmup time can be longer than expected.

Use the (semi-) dedicated installation instructions for the correct coolant connections. When the information is not available, connect the reducer to a constant coolant flow hose.

Electronic coolant pump

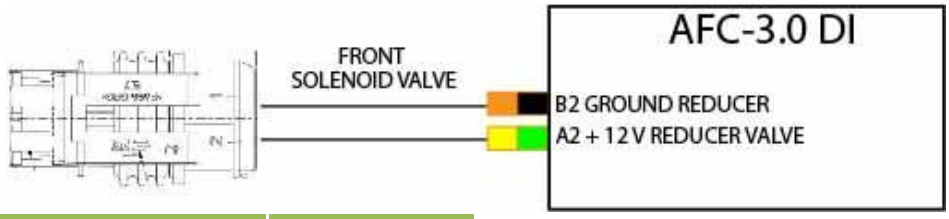


Electronic thermostat

Schaeffler Thermal Management Module

Coolant valves

9.9.2 Electrical connections Reduce Valve eVP-500



Grey connector Electrical connection	eVP-500
Supply (PWM)	A2
Ground	B2

eVP-500		
Coil	Min.	Max
Current (A)	-	4
Power (W)	0	48

9.10 Zeta Reducer

9.10.1 Function

- Vaporizing liquid LPG
- Absorbing sufficient heat to vaporize the required amount of LPG
- Create a Flow and Pressure regulation
- Providing the engine with sufficient vaporous LPG across its entire load range

9.10.2 Specifications

- Housing
  - Compact and light weight design
  - Integrated safety pressure relief valve
- Installation / calibration
  - Special calibration parameters
  - Standard coolant temperature sensor

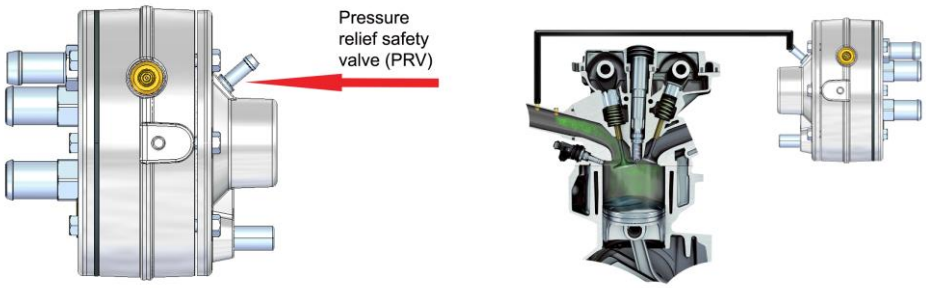
9.10.3 Technical Specifications

ITEM	DETAIL
Working Pressure	45 bar
Outlet gas Pressure	1,2 bar
Number of Stages	1
Inlet gas Pressure	M12 x 1
Outlet gas Fitting	Rubber hose Ø 10 mm
Water Coolant Port	Rubber hose Ø 16 mm
Map Port	Rubber hose Ø 5 mm
T range	- 20/ +120° C
Homologation	67R-01 / 10R-03

9.10.4 **Description**

Positive pressure single stage diaphragm type vaporizer-regulator, compensated with water-gas heat exchanger and internal overpressure valve. Available in two different versions, ZETA N (standard) and ZETA S (super). Extremely compact, with limited overall dimensions.
Reducer is equipped with a water temperature sensor on its body, with the task to supply to the gas ECU all information necessary to obtain the right petrol-gas changeover management, in order to avoid passage of LPG not completely vaporized.
To recognise whether the regulator is ZETA N (figure 1.5.1.1-3) or ZETA S (figure 1.5.1.1-4), check the mark near the water temperature sensor. The presence of an N identifies the normal regulator, whereas an S identifies the super regulator. As well as by the S, the super regulator is recognised by a red seal.

9.10.5 **Pressure relief safety valve (PRV)**



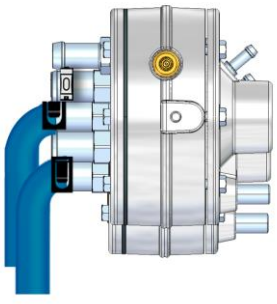
Reducers must be equipped with a pressure relief valve to prevent excessive pressure, according to the 67R-01 regulations. The pressure relief valve lowers the system pressure when it gets too high.
The pressure relief valve is integrated next to the LPG outlet. It has to be connected to the inlet manifold of the engine with a 5mm hose. The gas is relieved directly into the engine. It's not allowed to relief the gas into engine compartment or into the environment.
When the PRV is connected to MAP the opening pressure may be variable. This depends on the pressure in the inlet manifold.

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

9.10.6 **Coolant connections**

The reducer is connected to the coolant system with two 16 mm heater hoses.

Use the vehicle dedicated installation instructions for the correct coolant connections. When the information is not available, connect the reducer to a constant coolant flow hose.



Coolant Connections

Reducer Coolant Temperature sensor (ECT)

9.10.7 **Function**

- Measures the coolant temperature inside the LPG reducer
- Reducer temperature / flow monitoring
- Switch-over strategy based on this temperature

9.10.8 **Specifications**

- The NTC thermistor has a negative temperature coefficient; the electrical resistance lowers when the temperature rises
- The sensor is equipped with a sealing ring

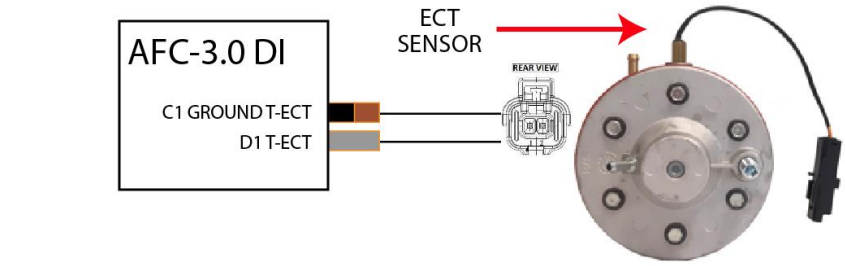
9.10.9 **Description**

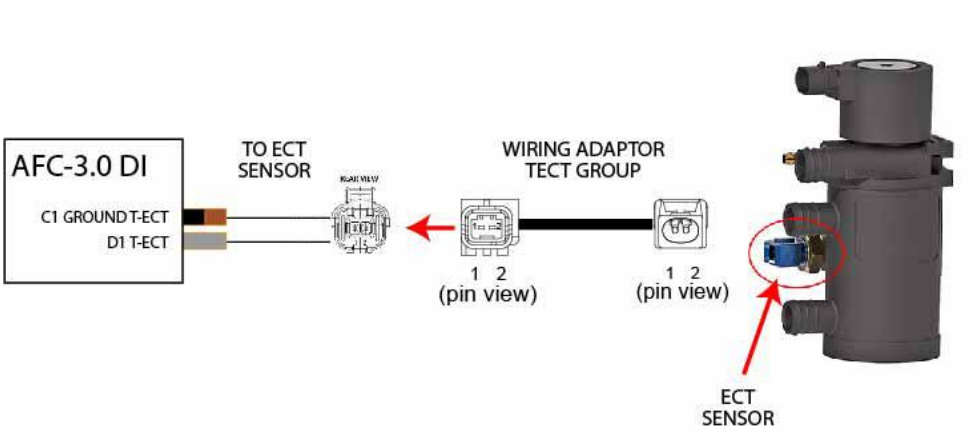
A coolant temperature sensor has been integrated in the coolant section of the body of the reducer. The signal is used to monitor the reducer temperature and to control the switching over timing from petrol to LPG. The switch over moment is reached as soon as the coolant temperature reaches the minimum switch over temperature (adjustable). This temperature normally varies from 30 to 50°C.
The engine runs on petrol at temperatures below the minimum switch over temperature and switches over to LPG when the coolant has heated up. When a hot engine is started, the engine will run on LPG almost directly from the start.

The coolant temperature sensor measures the temperature based on changes in resistance.
A NTC resistor is applied. The higher the temperature of the coolant, the lower the NTC resistance will become.

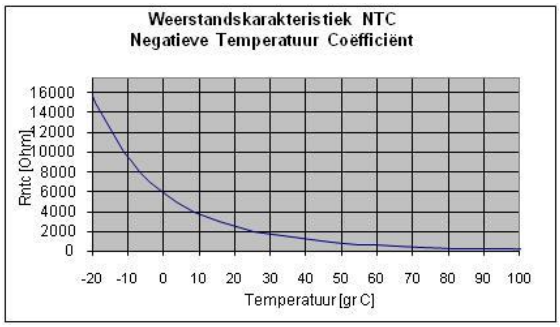
Most applications / calibration make use of the reducer temperature to switch over. In rare cases, the OBD engine temperature is also used for the switch over strategy.

9.10.10 Electrical connections T-ECT - eVP-500 and Zeta





ECT sensor resistance values at various temperatures



Grey connector Sensor	AFC
Signal	D1
Ground	C1

9.10.11 Diagnostics

Reducer does not heat up

Compare the OBD temperature with the reducer temperature. Check the used coolant hose temperature of the engine.

9.11 Solenoid Valve

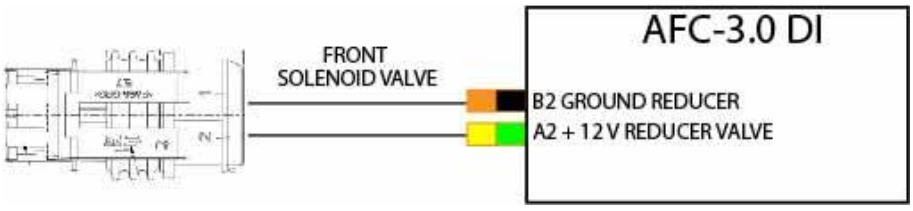
9.11.1 Description

The liquid petroleum gas on-off solenoid valve is a device positioned between the tank and the regulator to stop the LPG flow during petrol-fuelled operation and while the engine is off. Compact sized, taking up very little space, this device is available in a standard and an oversized version; it is equipped with a replaceable filter; filter replacement and/or cleaning is carried out without having to disconnect the feeding tubes.

9.11.2 Technical Specifications

Material	Brass
Available applications	LPG
Max. working pressure	3 MPa (30 bar)
Working temperature	-20°C +120°C
Approval	ECE R67-01 UL standard 429 AGA Australia ECE R10-03
Flow rate with air [nl/h] varying pressure at ambient temperature	Standard 7400 @ 1 bar - 11100 @ 2 bar / BFC 8600 @ 1 bar - 11500 @ 2 bar
Fixing Coil armature with holes	Ø 5,5 mm - Ø 6,5 mm - Shut-off body with hole M5
Coil type Big 12 V – 11 W	Lucar Plugs connection
Coil type Big 12 V – 8 W	-Lucar plugs and ground connector
Coil type Small 24 V – 11 W	AMP SUPERSEAL 1.5 connection

9.11.3 Electrical connections Solenoid Valve



Grey connector Electrical connection	Solenoid Valve
Supply (PWM)	A2
Ground	B2

9.12 Filter unit

9.12.1 Function

- Filters the vaporized LPG
- Distributes the vaporized LPG over several injector rails

9.12.2 Specification

- Glass fiber cartridge
- Version for eVP-500: 16 mm gas inlet and 12,5 mm outlet
- Version for Zeta: 12,5 mm gas inlet and 12,5 mm outlet

9.12.3 Description

The filter unit protects the gas injectors against pollution. It filters the vaporized LPG/CNG supplied from the reducer. The internal filter cannot be replaced, replace the complete filter unit

9.12.4 Diagnostics

A clogged filter may cause a too low system pressure and / or lack of engine power.

9.13 Combined pressure/temperature sensor into the rail

9.13.1 Function

- Measures
  - Gas pressure
  - Gas temperature

9.13.2 Features

- P/T sensor
- Temperature range: -40 ˚ C and 130 ˚ C.
- Standard pressure range: 0.5 and 4.0 bar
- Power supply voltage 5 V
- Ensure a tight seal between the sensor and the rail

9.13.3 Description

This sensor is integrated with connector and installed into the gas injector rail, allowing the system to detect pressure and temperature and to intervene more quickly and precisely in gas carburation mixture modifications required by the engine.

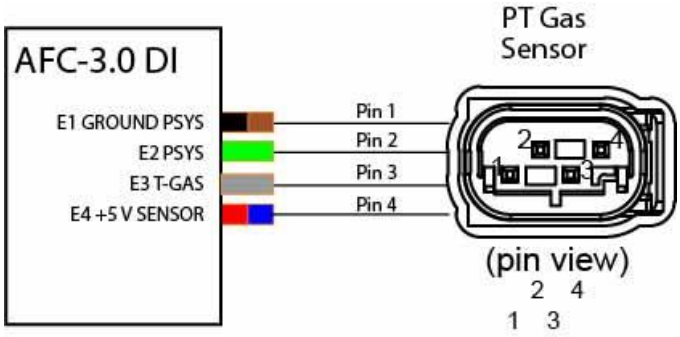
The gas system pressure has to be measured to:

- Adapt the LPG injection times.
- Detect an 'Empty tank'; low gas system pressure detection.

The gas temperature has to be measured to:

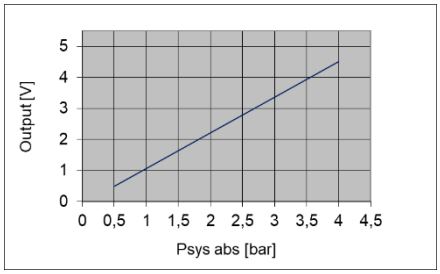
- Adapt the LPG injection times.
- The LPG density (energy) varies to the LPG temperature; the colder the LPG is, the higher the density of the LPG. The energy flow (gas volume) to the engine varies approx. 12% over a temperature range from 20 to 60°C.

9.13.4 **Electrical connections**

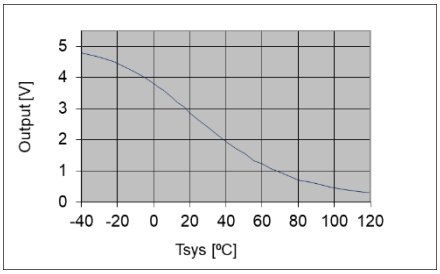


Grey connector Electrical connection	AFC 3.0 DI	P/T Sensor
Ground	E1	1
Gas pressure	E2	2
Gas temperature	E3	3
Supply (PWM)	E4	4

4 bar sensor



Absolute system pressure



System Temperature

9.13.5 **Diagnostics**

DTC Code	Description
P01A6	System pressure signal too high
P01A5	System pressure signal too low
P01B7	Gas temperature signal too high
P01B6	Gas temperature signal too low

9.13.6 **IN03 Injector rail**

9.13.7**Function**

- Compact assembly of gas injectors
- Distributing the gas over the various injectors
- Fixing the injectors in the various cylinder configurations
- Proper mounting onto the engine

9.13.8**Specification**

- R67-01, R110 & CSA homologated
- Light weight and compact
- Available in 2, 3, 4 en 5 cylinder versions

9.13.9**Description**

The LPG injectors are mounted in a common rail.
The injectors are held in the rail by two studs and M8 bolts to clamp the injectors between the strip and the common rail.
The injectors can be rotated in the rail (180 degrees) for left or right gas inlet configuration.
The injector rail can be mounted to the engine by an injector rail bracket.
The hose between filter unit and LPG injector rail provides all injectors with sufficient LPG. 5 mm hoses are connected between injector outlets and intake manifold nipples.
Spare parts codes for rail available on BRC Gas Equipment catalogue.

9.14 IN03 Injector

9.14.1 Function

- Inject vaporized gas into the inlet manifold
- Ensure the quick opening and closing of the injector plunger
- Shut off the gas supply, when deactivated

9.14.2 Specification

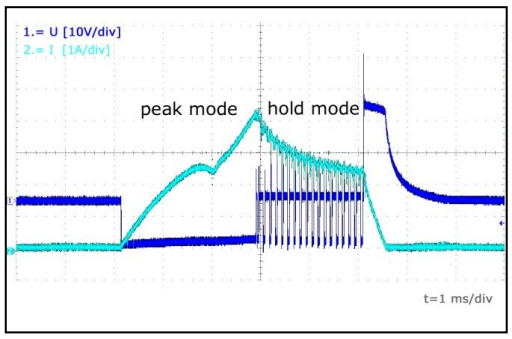
- Floating shutter with ultra low friction
- Impedance: 1,66 / 1,7 mH a 20 °C
- Temperature: -15°C ÷ 120 °C
- Voltage: 6 V ÷ 16 V
- Seal: Rubber on metal
- Approval: R67-01 and R11

9.14.3 Description

The functioning of the LPG injectors can be compared to the functioning of the petrol injectors. The dosing of the injected LPG during the four stroke cycle is adapted by controlling the injection time for each of the gas injectors. Consequently, the activation time of the injector varies from idle to full load and thus the amount of gas that is injected.

The gas injectors have to deal with a far higher flow than petrol injectors. This requires a bigger injector plunger and an increased lifting height.
To guarantee a fast open and close behaviour of this injector, the injector power must be very high. The coil has a low resistance (1.5 Ω), resulting in a fast current build up and a strong magnetic field.
The current is reduced as soon as the injector is fully open, to prevent the injector from overheating. This control is also known as 'peak and hold'.

Refer the diagram for the **peak and hold phases** in the LPG injection cycle.



AFC-3.0 DI control

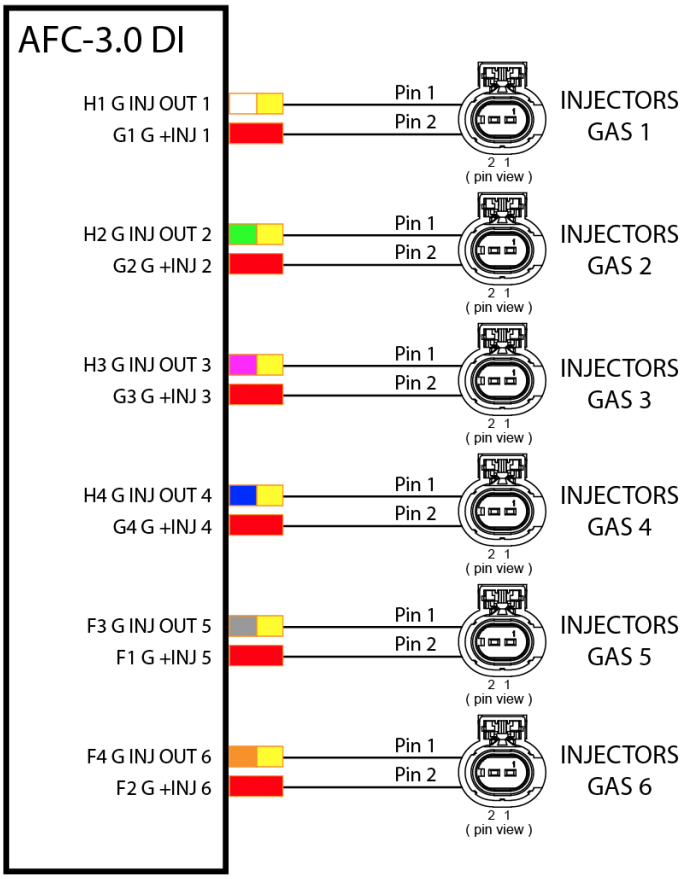
The petrol injector will be deactivated by the AFC-3.0 DI during LPG mode and the LPG injectors will be active. The AFC-3.0 DI monitors the petrol injector control strategy and calculates the gas injection duration and injection timing. It is possible that the gas injector will start earlier than the petrol injector would actually do.
At the moment the petrol injectors are switched off (end TI petrol) the AFC calculates the active time and timing for gas injector.
In this calculation, different corrections are taken into account:

- difference in injector flow size
- injector opening and closing behaviour
- engine speed
- engine load
- calorific value difference
- gas system pressure
- gas temperature
- reducer temperature
- battery voltage
- etc.

9.14.4 Variants

There are three different types of gas injectors, Normal - Blue, Max - Orange and Super Max - Yellow, each with a different gas outlet volume. The greater the power per cylinder, the greater the output volume required.
WFS Italia S.r.l. provides the correct injector in the kit ordered for the vehicle to be transformed.

9.14.5 Electrical connection



The gas injector number corresponds to the cylinder of the engine. Respect the cylinder numbering of the engine. These cylinder order and firing order orders can deviate per brand, model and engine series.

9.14.6 Diagnostic

Gas injection time
The gas injection time should not be less than 2.8 ms. During high idle the lowest injection time can be found.
Often the gas injections time is longer than the petrol injection time.
Check the system pressure and compare it with the target pressure.

Check correct connection
Run the Injector - Actuator test to check if the relation between the petrol injectors and gas injectors. This test deactivates the petrol injector and activates the gas injector. When the engine runs smooth, the gas injector and petrol injector are paired well. With an irregular running engine the connectors can be installed incorrect. Other cause are also possible, like blocked hoses, incorrect soldered wires, incorrect drilled injector couplings or hardware failure.

9.14.7 Calibration Tool Software

Diagnostic – Actuator Test - Injector
Check the correlation with the actuator test – Injector

Diagnostics – calibration parameters

DTC Code	Description
P22DA	Gas Injector 1 short to ground
P22DE	Gas Injector 2 short to ground
P22E2	Gas Injector 3 short to ground
P22E6	Gas Injector 4 short to ground
P22EA	Gas Injector 5 short to ground
P22EE	Gas Injector 6 short to ground
P22F2	Gas Injector 7 short to ground
P22F6	Gas Injector 8 short to ground
P22D9	Gas Injector 1 no load
P22DD	Gas Injector 2 no load
P22E1	Gas Injector 3 no load
P22E5	Gas Injector 4 no load
P22E9	Gas Injector 5 no load
P22ED	Gas Injector 6 no load
P22F1	Gas Injector 7 no load
P22F5	Gas Injector 8 no load
P1032	Gas Injector Driver cylinder 1 and 2 fault
P1033	Gas Injector Driver cylinder 3 and 4 fault
P1034	Gas Injector Driver cylinder 5 and 6 fault
P1035	Gas Injector Driver cylinder 7 and 8 fault
P1104	Gas injector 1 malfunction
P1105	Gas injector 2 malfunction
P1106	Gas injector 3 malfunction
P1107	Gas injector 4 malfunction
P1108	Gas injector 5 malfunction
P1109	Gas injector 6 malfunction
P1110	Gas injector 7 malfunction
P1111	Gas injector 8 malfunction
P22DB	Gas Injector 1 over-load
P22DF	Gas Injector 2 over-load
P22E3	Gas Injector 3 over-load
P22E7	Gas Injector 4 over-load
P22EB	Gas Injector 5 over-load
P22EF	Gas Injector 6 over-load
P22F3	Gas Injector 7 over-load
P22F7	Gas Injector 8 over-load

9.15 Inlet couplings

9.15.1 Function

- Inject gas into the engine

9.15.2 Description

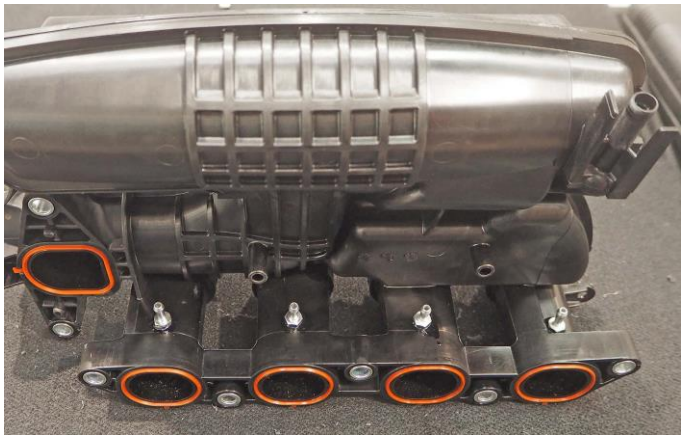
The LPG injectors are connected to the inlet manifold by 5 mm hoses. PTFE hoses are applied when the inlet coupling are not close to the petrol injector or inlet valve. The gas needs to be injected as close to the inlet valve.

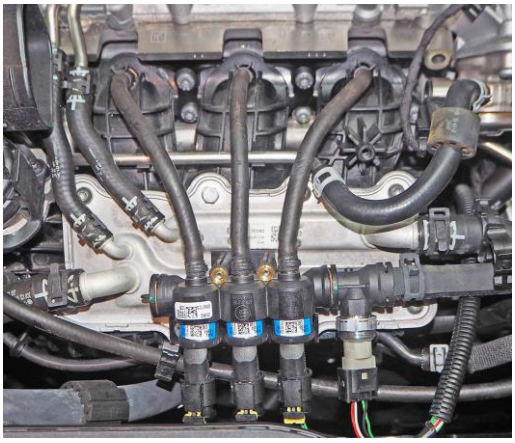
9.15.3 Variants

This can be done in various ways:

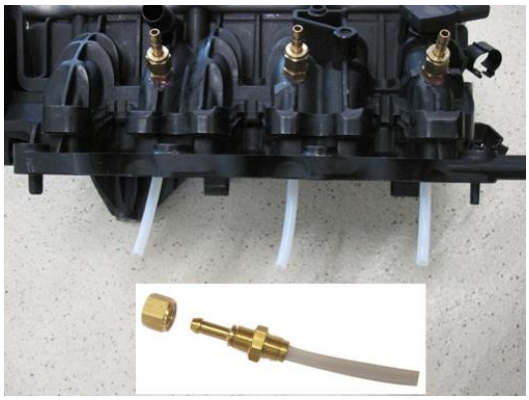
1. M6x1 - Rubber hoses
   Applied when the inlet coupling are located nearby the original petrol injector or inlet valve.
2. M10x1 – PTFE hoses
   Applied with enough installation space.

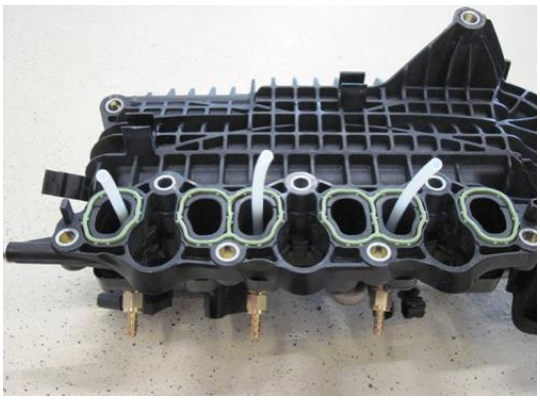
M6x1 - Rubber hoses





M10x1 – PTFE hoses





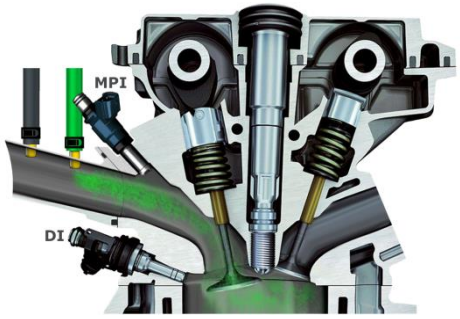
9.15.4 Diagnostics

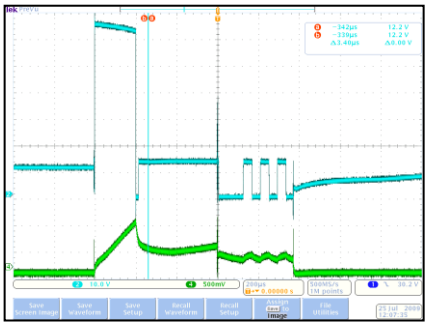
Deviating fueltrims / misfire / bad response / bad idle / lack of power

- False air -> use brake cleaner to find the leakage
- Kink in the hose(s) -> Use the actuator test - Injector
- Swapped injector hoses. (exp. cilinder 1 switched with 2) -> Check the correlation with the actuator test - Injector
- Injector hose wrong in manifold (direction throttle instead of the inlet valve) – Inspect the manifold internally

10 Engine Sensors / actuators

10.1 DI Injector signals





10.1.1 Function

- Stop petrol injection
- Measuring the DI petrol injection time and timing
- Connected directly to the AFC-3.0 DI
- Prevents EOBD trouble codes during LPG mode

10.1.2 Specifications

- AFC 3.0 DI 4 and 6 cylinder version
- Only coil type DI injectors
- DI Petrol injectors active when AFC 3.0 DI power supply is missing
- Connected in the black connector

10.1.3 Description

The interruption of the coil type Direct Injectors is integrated inside the AFC-3.0 DI and is used to deactivate the DI petrol injectors. The gas injectors can take over the fuel injection. Since the engine management system detects whether any injectors are controlled, the injectors cannot be disconnected physically. A dummy coil is used to simulate the DI petrol injector. A special strategy is needed to simulate the voltage and current trough the dummy coil. The programmable simulation strategy will limit the current through the injector coil. As a result the DI petrol injector needle will not open.
The simulation strategy is set in the firmware.

Engine management systems will apply trouble code detection to the voltage levels and current through the DI petrol injectors.

Attention! The simulation strategy is set in the firmware. Always select the correct online firmware.

DI injector can be in-active with MPI-DI engines during normal running mode

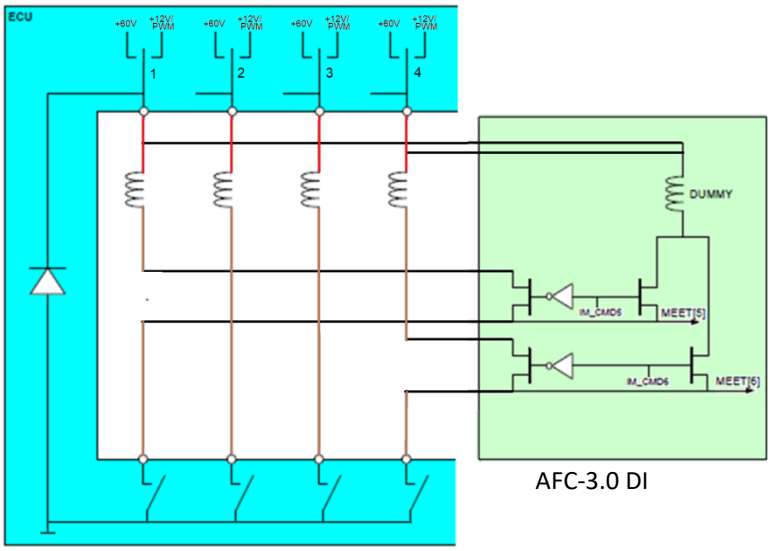
- MPI in general during lower load
- MPI in general during warmer engine conditions
- DI during higher load
- DI during colder engine conditions

10.1.4 Variants

Endless variant have been used by engine manufacturers. The AFC-3.0 DI can handle most of the DI petrol coil injectors.

10.1.5 Electrical connections

Engine management



AFC-3.0 DI

For detailed wiring diagram information please used chapter ‘Basic wiring diagram’.

Unlike the MPI injectors, a real coil is used as a dummy for the DI injectors. Therefore it is necessary to connect the + 65 V / 12 V and the mass of all injectors. Due to the hardware layout in the AFC, it is necessary to connect all +65 V / 12 V injector wires.

Normally a dummy injector simulates 2 DI petrol injectors, except a 3 cilinder engine.

- 3 cilinder engine
  - Each DI injector has an own dummy injector motor.
  - 6 cylinder AFC is used.
  - Injector 3 is connected to row G.

- 4 cylinder engine with firing order 1-3-4-2.
  - Dummy injector 1 simulates DI petrol injector 1 and 4.
  - Dummy injector 2 simulates DI petrol injector 3 and 4.

- (V)6 cilinder engine,
  - Dummy injector simulates two DI injectors.
  - Different DI petrol injector groups possible with a six-cylinder engine. This depends on the cylinder sequence and on the ignition sequence.
  - For example or firing orders:
    - 1-4-2-5-3-6
      Dummy injector 1 -> cilinder 1 and 5.
      Dummy injector 2 -> cilinder 4 and 3.
      Dummy injector 3 -> cilinder 2 and 6.
    - 1-2-3-4-5-6
      Dummy injector 1 -> cilinder 1 and 4.
      Dummy injector 2 -> cilinder 2 and 5.
      Dummy injector 3 -> cilinder 3 and 6.

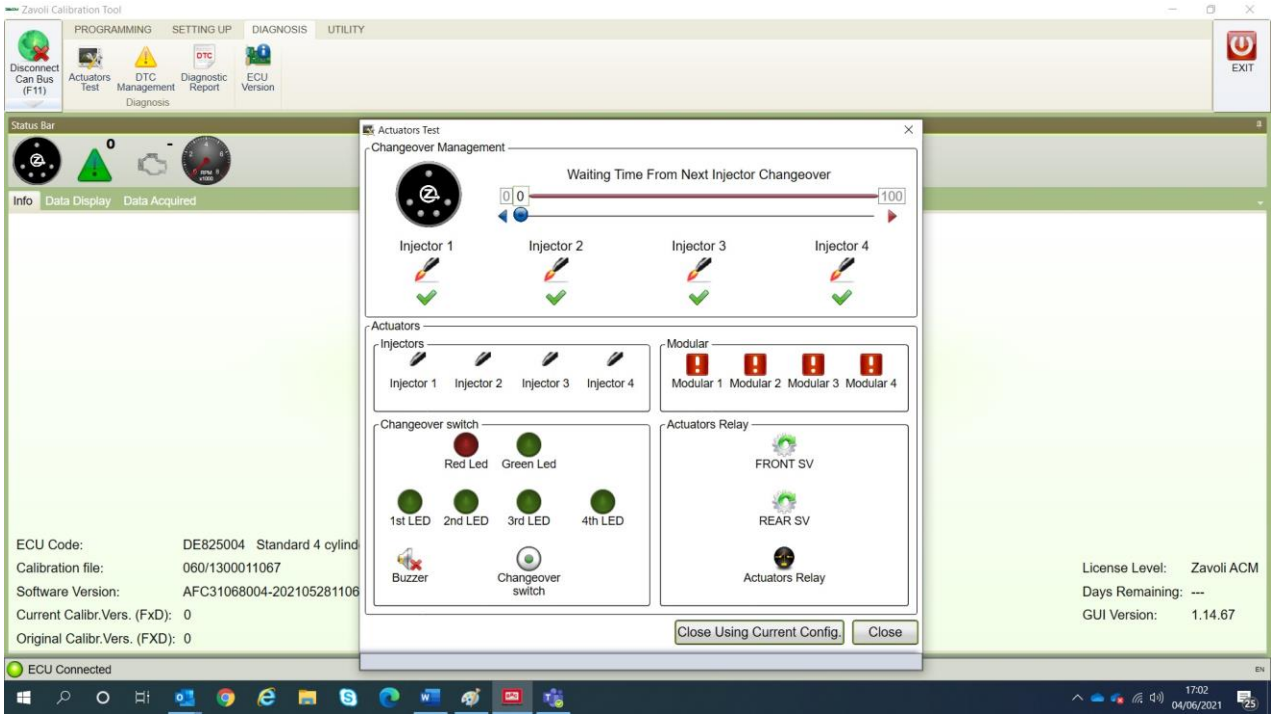
Attention! All ‘injector high’ wires need to be connected to the AFC-3.0 DI.

10.1.6 **Diagnostics**

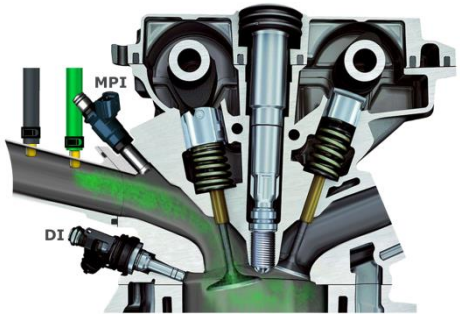
Check the firing order with the Calibration Tool Software and compare it with the firing order described in the vehicle installation manual.
Run the actuator test for correlation check.

10.1.7 **Calibration Tool Software**

Diagnostic - Actuator test
Check the correlation with the actuator test – Injector



10.2 MPI Petrol injector



10.2.1 Function

- Stop petrol injection
- Measuring the MPI petrol injection time and timing
- Connected directly to the AFC-3.0 DI
- Prevents EOBD trouble codes during LPG mode

10.2.2 Specifications

- 4 and 6 cylinder version
- DI Petrol injectors active when AFC-3.0 DI power supply is missing
- Connected in the black connector

10.2.3 Description

The internal injector module is used to deactivate the MPI petrol injectors so the gas injectors can take over the fuel injection. The engine management system detects whether any injectors are controlled. During gas mode power resistors or coils are connected in series with the petrol injectors. This will limit the current through the injector coil. As a result the petrol injector needles will not open.

MPI injector can be active with MPI-DI engines during normal running mode

- MPI in general during lower load
- MPI in general during warmer engine conditions
- DI during higher load
- DI during colder engine conditions

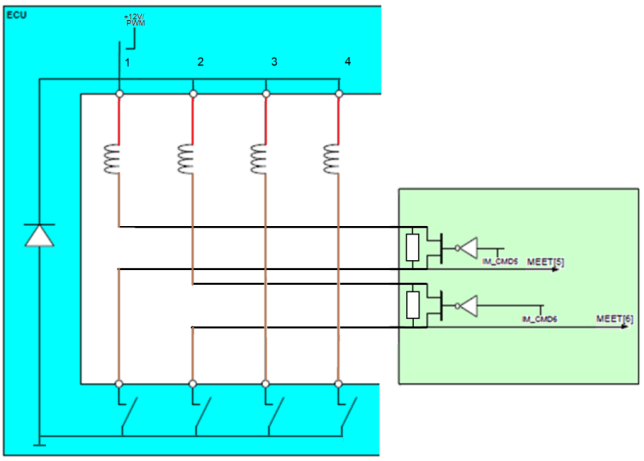
DI-MPI engines use in most cases combines a variable low pressure fuel system to prevent vapor lock.

10.2.4 Variants

Endless variant have been used by engine manufacturers. The AFC-3.0 DI can handle most of the MPI petrol injectors.

10.2.5 Electrical connections

Engine management



AFC-3.0 DI

For detailed wiring diagram information please use chapter ‘Basic wiring diagram’.

A resistor for each MPI injector is used to deactivate the petrol injection. It is switched in series, therefor it is only needed to interrupt and connect the ground wires to the AFC-3.0 DI. The MPI injector wiring text corresponds with the actual cylinder of the engine.

10.2.6 Diagnostics

The MPI injectors are called secondary injectors in the diagnosis tool.
Check the secondary firing order with the Calibration Tool Software and compare it with the firing order described in the vehicle installation manual.

Engine behaviour
Irregular running engine
Stalling engine

10.3 RPM signal

10.3.1 Function

- Safety Signal to switch over to gas.
- Used for calculations and strategies.

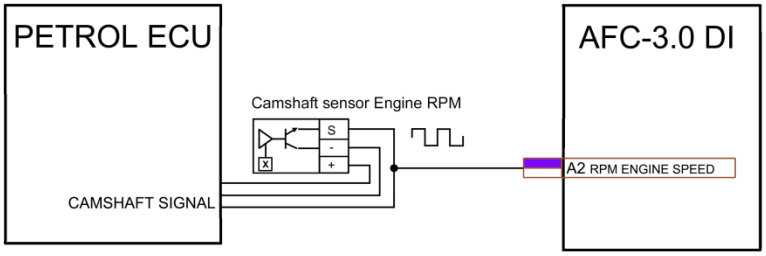
10.3.2 Description

The AFC-3.0 DI uses the engine speed (RPM) to switch over to LPG, for calculations and strategies. Based on this signal the AFC-3.0 DI detects a running engine. When the engine runs and all switch-over conditions have been met, the AFC-3.0 DI activates the tank lock-off valve, the eVP-500 actuator and starts LPG injection. When the engine speed signal is missing, the system will switch to petrol; the LPG lock-off valve and eVP-500 are no longer activated.

10.3.3 Variants

In most cases the engine speed signal is derived from the camshaft sensor or ignition coil signal.

10.3.4 Electrical connections



Brown connector Electrical connection	AFC
RPM Engine signal	A2

10.3.5 Diagnostics

Hall sensor

A hall sensor is often used to measure the camshaft signal. This has 3 connections on the connector.

1) + 5V (measures 5 V relative to battery mass)
2) Block signal (measure relative to sensor mass)
3) Ground (measure 12 V to battery)

Ignition coil signal

Sometimes the ignition of the ignition coil is used. The connection of the ignition coil can have 2 or three connections on the connector.

1) + 12V (measure 5 V relative to battery mass)
2) Controlled mass (measure frequency relative to battery)
3) Ground (measure 12 V relative to battery)

No engine speed signal or wrong value

Check the wiring and terminals. Check with an advanced multi the voltage and the frequency of the signal.
Use the Calibration Tool Software to read out and compare the engine RPM and the OBD_engineSpeed.

10.4 Manifold pressure (MAP)

10.4.1 Function

- Measures the engine load
- For calculation and strategies
- Input for MAP related gas system pressure
- Input for engine load related gas system pressure
- Analog and digital sensor supported

10.4.2 Description

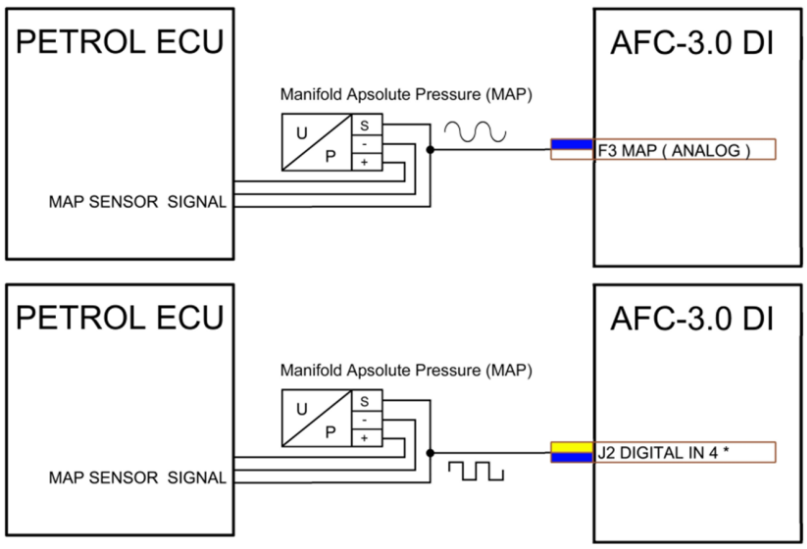
The manifold absolute pressure sensor provides manifold pressure information to the engine management system. The data is used to calculate air density and determine the engine's air mass flow rate, which in turn determines the required fuel metering for optimum combustion and influence the advance or retard of ignition timing.
The AFC-3.0 DI measures the engine load via the original MAP sensor from the engine. It is used for manage strategies, calculation and variable gas system pressure.

10.4.3 Variants

Analog and digital sensors
For a long time analog sensors have been used in the automotive industry. They provide the engine management with an analog signal between 0,5 and 4,5 Volt. An analog sensor requires a separate wire to the ECU for each reading. A digital sensor is equipped with microelectronics and communicates with the ECU via a data line. It can transmit multiple measurements across the data line. Fewer wires are needed despite the transmission of multiple signals. Another advantage of the digital sensor is that it self-diagnoses.

The settings are programmed in the firmware for the AFC-3.0 DI.

10.4.4 Electrical connections



Brown connector Electrical connection	AFC
Analog MAP signal	F3
Digital MAP Signal	J2

10.4.5 **Diagnostics**

Analog sensor
The analog MAP sensors can have 3 or 4 wires.

- 3 wires:
  - +5V sensor supply
  - Pressure signal (0,5 V – 4,5 V)
  - Ground
- 4 wires:
  - +5 V sensor supply
  - Pressure signal (0,5 V – 4,5 V)
  - Temperature (0,5 V – 4,5 V)
  - Ground

Digital sensor
The digital sensor has 3 wires

- +5 V sensor supply
- Data line (0 V – 5 V)
- ground

No signal or wrong signal
Check the wiring and terminals. Check with an advanced multi the voltage and the frequency of the signal.
Use the Calibration Tool Software to read out and compare the engine MAP and the OBD_MAP.
Normally the analog signal voltage becomes higher when the pressure rises. Normal voltage range is 0,5 V to 4,5 V.

10.5 Ignition + (12 V)

10.5.1 Function

- Signal wakes up and shuts down the AFC-3.0 DI
- Start of simulation strategies

10.5.2 Description

The AFC-3.0 DI wakes up and becomes active when 1 of the 2 wake-up signals is present.
The two wake-up signals are:

1) Ignition +
2) Wake up (5V sensor supply rail pressure petrol)

The Ignition + needs to be a 12 V signal during ignition on cranking.
The wake-up signals are also used for limp home mode. If these signals are present, the motor can run without loaded firmware and / or main fuse.

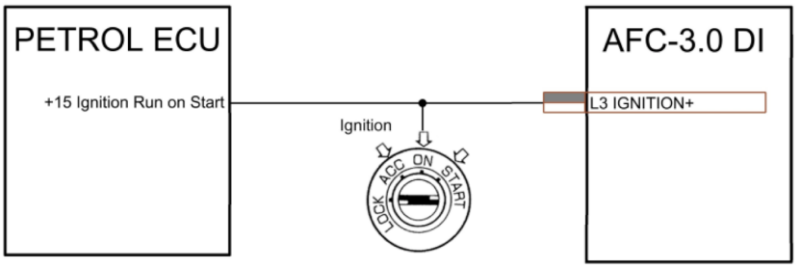
10.5.3 Variants

Different Ignition + signals can be used to wake up the system.

- Supply of the ignition coil
- +12 V ignition switch
- +12 V engine management supply
- Other +12 V source during ignition on and cranking

Attention! Always connect the Ignition + according the vehicle installation manual.

10.5.4 Electrical connections

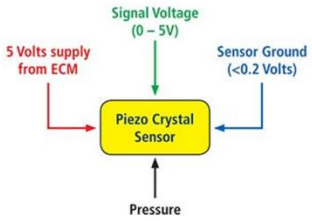


Brown connector Electrical connection	AFC
+12 V ignition signal	L3

10.5.5 Diagnostics

No signal of intermitted signal
Check the wiring and terminals. Check the voltage with a multi meter.
Disconnect the wire from the car wire and make a temporary connection to the car battery. The status of the value in the Calibration Tool Software needs to change to 1. Also AFC -3.0 DI needs to wake-up by car battery signal. Otherwise the wiring or terminals are suspected.

10.6 Petrol high rail pressure sensor



10.6.1 Function

- To measure the actual petrol fuel rail pressure
- Input for simulation strategy
- Analog and digital sensor supported

10.6.2 Description

The petrol rail pressure is measured from the petrol rail pressure sensor. While driving on gas, no petrol is injected and the pressure in the rail will increase. Normally, the engine management system would generate an error code and the engine would go into limp home mode. The AFC-3.0 DI simulates the correct petrol pressure to prevent fault codes. Hence an interruption of the signal wire is necessary. The AFC-3.0 DI reads the signal and sends the desired signal to the engine management system.
During petrol modes, the original pressure is sent to the engine management system.

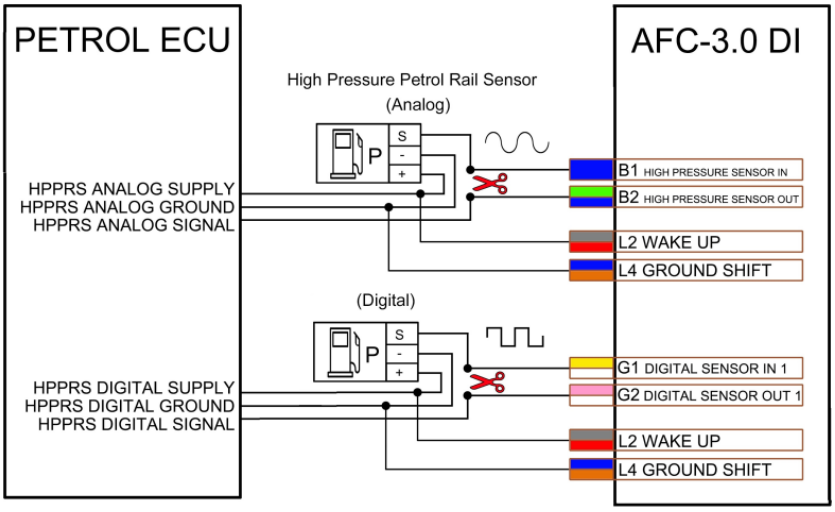
The +5 V wake-up and the ground is also measured from the sensor. These signals are explained in the next chapters.

10.6.3 Variants

Analog and digital sensors
For a long time analog sensors have been used in the automotive industry. They provide the engine management with an analog signal between 0,5 and 4,5 Volt. An analog sensor requires a separate wire to the ECU for each reading. A digital sensor is equipped with microelectronics and communicates with the ECU via a data line. It can transmit multiple measurements across the data line. Fewer wires are needed despite the transmission of multiple signals. Another advantage of the digital sensor is that it self-diagnoses.

The correct settings and sensor are programmed in the online firmware for the engine / AFC-3.0 DI.

10.6.4 Electrical connections



Brown connector Electrical connection	AFC
Analog sensor pressure IN	B1
Analog sensor pressure OUT	B2
Digital sensor pressure IN	G1
Digital sensor pressure OUT	G2
+5 V wake up	L2
Ground shift	L4

10.6.5 **Diagnostics**

Respect

- Wire connections located in installation manual
- OEM pin position in installation manual
- Correct sealing of battery / ground connections

Analog sensor

The analog sensors can have 3 or 4 wires.

- 3 wires:
  - +5 V sensor supply
  - Pressure signal (0,5 V – 4,5 V)
  - Ground
- 4 wires:
  - +5 V sensor supply
  - Pressure signal (0,5 V – 4,5 V)
  - Temperature (0,5 V – 4,5 V)
  - Ground

Normally the signal voltage becomes higher when the pressure rises. Normal voltage range is 0,5 V to 4,5 V.

Digital sensor

The digital sensor has 3 wires

- +5 V sensor supply
- Data line (0 V – 5 V)
- ground

No signal

Check the wiring and terminals. Check with an advanced multi the voltage and the frequency of the signal.
When all connections are good, contact the technical helpdesk via the Support System

Wrong signal

Check the sensor pressure and OBD pressure during petrol mode. These signals need to be the same.
Often the sensor wires are mixed up or the wrong signal wire is cut through and connected to the AFC-3.0 DI.
Normally the analog signal voltage becomes higher when the pressure rises. Normal voltage range is 0,5 V to 4,5 V.
Check chapter How to connect petrol emulation for the procedure to connect sensor wires.

Common conversion issues

- HPP rattle due to too high pressure
- OEM rail pressure DTC's
- WFS Italia S.r.l. sensor DTC's

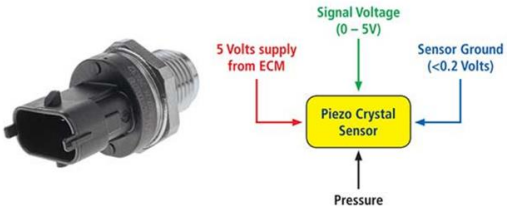
Injector DTC's

- Engine behaviour
- Irregular running engine
- Stalling engine
- Deviation of injection time

Check

- State of power/ground connections
- According to manual
- Water intrusion in harness / AFC-3.0 DI

10.7 Wake up (+5V)



10.7.1 Function

- Signal wakes up and shuts down the AFC-3.0 DI
- Start of simulation strategies
- Sensor voltage value correction

10.7.2 Description

The AFC-3.0 DI wakes up and becomes active when 1 of the 2 wake-up signals is present.
The two wake-up signals are:

1) Ignition +
2) Wake up (5V sensor supply rail pressure petrol)

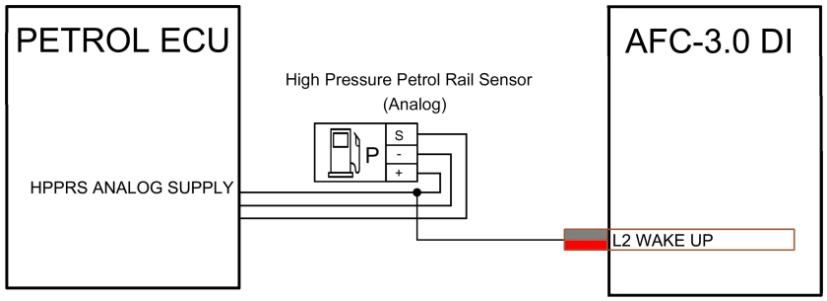
The Wake up is always connected to the +5 V of the petrol rail pressure sensor.

The wake-up signals are also used for limp home mode. If these signals are present, the motor can run without loaded firmware and / or main fuse.

10.7.3 Variants

The Wake up is always connected to the +5 V of the petrol rail pressure sensor.

10.7.4 Electrical connections

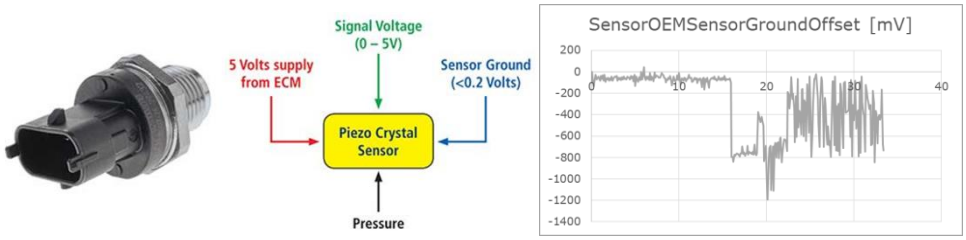


Brown connector Electrical connection	AFC-3.0 DI
+5 V wake up	L2

10.7.5 Diagnostics

No signal of intermitted signal
Check the wiring and terminals. Check the voltage with a multi meter.
Disconnect the wire from the car wire and make a temporary connection to the car battery. The status of the value in the Prins AFC Software v2 needs to change to 1. Also AFC needs to wake-up by car battery signal. Otherwise the wiring or terminals are suspected.
Often the wrong sensor wire is connected to the AFC.
Check chapter How to connect petrol emulation for the procedure to connect sensor wires.

10.8 Ground shift



10.8.1 Function

- Eliminate ground difference between engine management and AFC-3.0 DI

10.8.2 Description

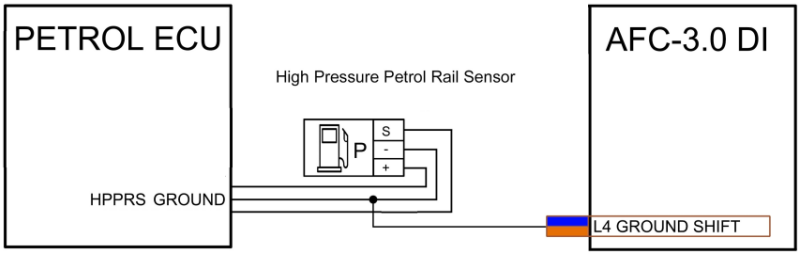
The AFC-3.0 DI measures various engine sensor signals, like MAP, fuel rail pressure and petrol low pressure. These sensors are connected to the engine management with its own ground connection to the vehicle. The ground of the AFC-3.0 DI is often connected to the vehicle battery. This causes a small voltage difference between the measured signals. Normal value with a running engine is +/- 0-100 mV. Failures in Ground shift signal have extra effect negative effect on emulated signals

For example, a voltage difference of 0.1V is a difference of 7.5 bar petrol rail pressure. Therefore, it is necessary to eliminate the mass difference.

10.8.3 Variants

The Ground shift wire is always connected to the sensor ground of the petrol rail pressure sensor.

10.8.4 Electrical connections



Brown connector Electrical connection	AFC
Ground shift	L4

10.8.5 **Diagnostics**

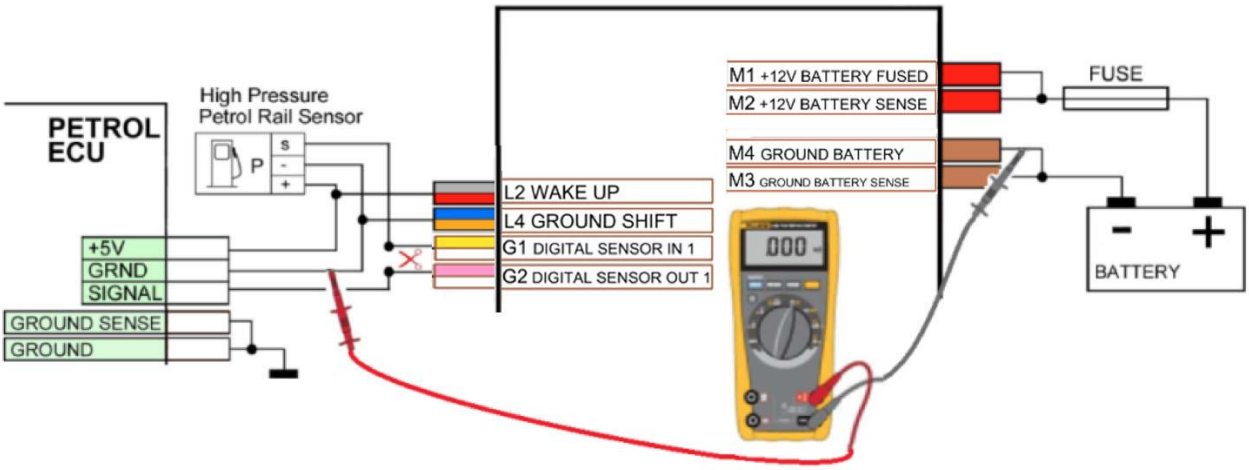
No signal or wrong signal

Check the voltage with the Calibration Tool Software.

Check

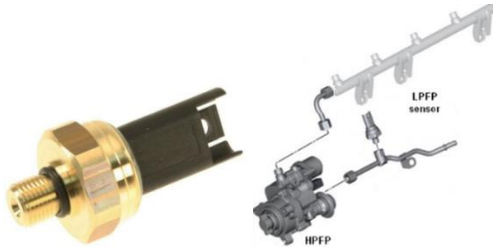
- Wiring connection and terminals.
- Ground shift connection
- Supply / grounds

Check chapter How to connect petrol emulation for the procedure to connect sensor wires.



Always respect the ground locations as described in the vehicle installation manual. Wrong locations of ground connections can cause an irregular running engine or drivability issues.

10.9 Petrol Low pressure



10.9.1 Function

- To measure the actual low petrol pressure from the petrol ltank
- Input for simulation strategy
- Analog and digital sensor supported
- Petrol low pressure emulation with the AFC-3.0 DI
- Best hardware solution
- No fuel line modification needed
- Provide a normal mixture during high loads (otherwise too lean)
- The best drivability

10.9.2 Description

While driving on gas, no petrol is injected and the low petrol pressure from the petrol tank will rise.
When the engine management generates and error during gas mode, the pressure sensor needs to be simulated.
The petrol tank pressure is measured from the petrol low pressure sensor of the vehicle. The AFC-3.0 DI simulates the correct petrol pressure to prevent fault codes. Hence an interruption of the signal wire is necessary. The AFC reads the signal and sends the desired signal to the engine management system.
During petrol modes, the original pressure is sent to the engine management system.
When the tank pressure needs to be simulated, also the signal of the tank petrol pump (driver) needs to be read out.

The petrol low pressure simulation prevents

- Vapour lock in the petrol line and rail
- Invalid petrol fuel pressure during gas and petrol mode
- Invalid learning of petrol pump driver
- Invalid fuel trims during petrol mode

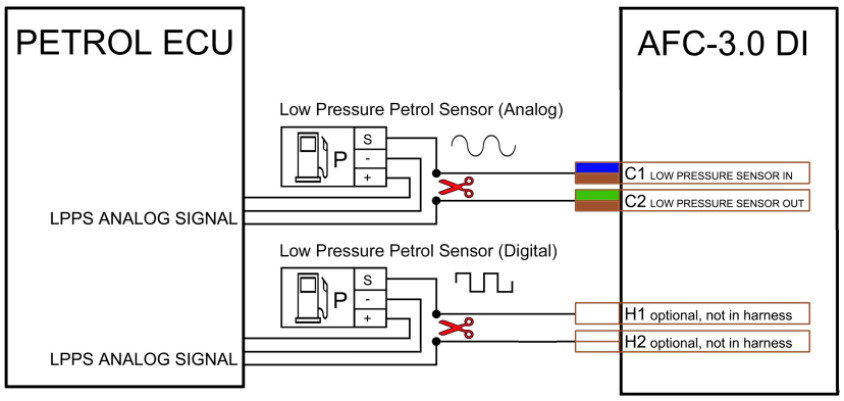
For some applications, reading the pressure is sufficient.
The location of the sensor can differ per brand and type. Often it can be find in the engine bay or under the vehicle.

10.9.3 Variants

Analog and digital sensors
For a long time analog sensors have been used in the automotive industry. They provide the engine management with an analog signal between 0,5 and 4,5 Volt. An analog sensor requires a separate wire to the ECU for each reading. A digital sensor is equipped with microelectronics and communicates with the ECU via a data line. It can transmit multiple measurements across the data line. Fewer wires are needed despite the transmission of multiple signals. Another advantage of the digital sensor is that it self-diagnoses.

The correct settings sensor are programmed in the firmware for the AFC-3.0 DI.

10.9.4 Electrical connections



Brown connector Electrical connection	AFC-3.0 DI
Analog sensor pressure IN	C1
Analog sensor pressure OUT	C2
Digital sensor pressure IN	H1
Digital sensor pressure OUT	H2

10.9.5 Diagnostics

Analog sensor

The analog sensors can have 3 or 4 wires.

- 3 wires:
  - +5V sensor supply
  - Pressure signal (0,5 V – 4,5 V)
  - Ground
- 4 wires:
  - +5V sensor supply
  - Pressure signal (0,5 V – 4,5 V)
  - Temperature (0,5 V – 4,5 V)
  - Ground

Normally the signal voltage becomes higher when the pressure rises. Normal voltage range is 0,5 V to 4,5 V.

Digital sensor

The digital sensor has 3 wires

- +5 V sensor supply
- Data line (0 V – 5 V)
- ground

No signal

Check the wiring and terminals. Check with an advanced multi the voltage and the frequency of the signal.
When all connections are good, contact the technical helpdesk via the Support System.

Wrong signal

Check the sensor pressure and OBD pressure during petrol mode. These signals need to be the same.
Often the sensor wires are mixed up or the wrong signal wire is cut through and connected to the AFC-3.0 DI.
Normally the analog signal voltage becomes higher when the pressure rises. Normal voltage range is 0,5 V to 4,5 V.
Check chapter How to connect petrol emulation for the procedure to connect sensor wires.

10.10 Petrol pump signal

10.10.1 Function

- To control fuel pressure
- Measures the load of the tank petrol pump
- Input for petrol pressure simulation strategy
- Direct signal from pump or signal to pump driver supported

10.10.2 Description

The load of the petrol pump is needed, for a correct simulation of the petrol pressures. The PWM control of the pump is measured by the AFC-3.0 DI.

10.10.3 Variants

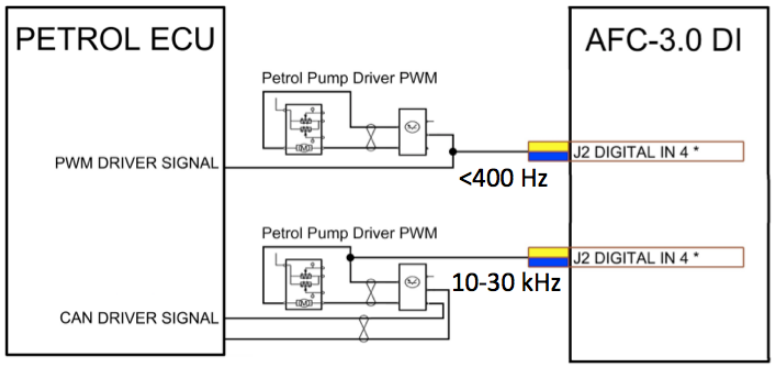
PWM control between engine management and pump driver

Most of the applications use this signal. The engine management sends a PWM signal to the pump driver. When the duty cycle gets higher, the current through the pump will be higher.

PWM control direct on petrol pump

When the pump driver communicates via CAN-bus with the engine management, the PWM signal is measured direct on the petrol pump.

10.10.4 Electrical connections



Brown connector Electrical connection	AFC-3.0 DI
PWM petrol pump	J2

Frequency:

- Engine management to pump driver: <400Hz
- Direct on petrol pump: 10-30 kHz

10.10.5 Diagnostics

No signal

Check the wiring and terminals. Check with an advanced multi the voltage and the frequency of the signal. When the flow increases, the duty cycle will get higher.

Frequency:

1) ECM to pump driver [<400Hz]
2) Direct on petrol pump [10-30 kHz]

When all connections are good, contact the technical helpdesk via the Support System

Engine behaviour

- OBD-DTC's
- Extreme rich or lean mixture
- Vapour lock complaints (High pressure fuel rail DTC's)
- Stalling

10.11 Lambda

10.11.1 Function

- Monitors the mixture
- Corrects the mixture when needed

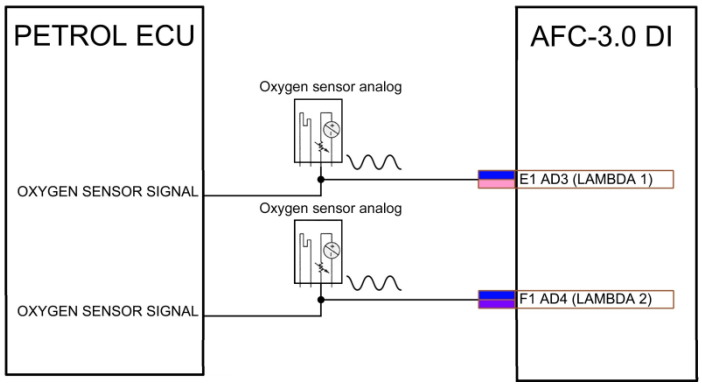
10.11.2 Description

The system uses the lambda signal to monitor the fuel mixture. It monitors during high load (open loop control) whether and how long the mixture is lean.
When the mixture is too lean for too a too long period, it may cause damage to the catalytic converter and engine. If this situation is detected, a trouble code will be generated and the system will automatically switch to petrol.
The system can also use the lambda signal for emission corrections.
Some engines have more than one bank. In this case, one or more lambda probes per bank will be used. The AFC-3.0 DI can process two small band lambda signals.

10.11.3 Variants

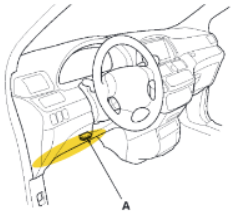
Only small band lambda sensors are supported by the AFC-3.0 DI.
Wideband lambda sensors cannot be readout by a wiring input.

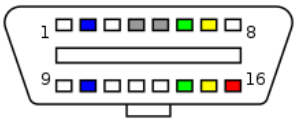
10.11.4 Electrical connections



Brown connector Electrical connection	AFC
Lambda 1 signal AD3	E1
Lambda 2 signal AD4	F1

10.12 OBD CAN-Bus





10.12.1 Function

- Readout OBD information for calculations and strategies
- Information for diagnostics
- Reset fuel gauge level (PSA models)

10.12.2 Description

On-board diagnostics (OBD) is the term referring to the vehicle's self-diagnostic and reporting capability. Modern OBD implementations use a standardized digital communications port to provide real-time data in addition to a standardized series of vehicle information and diagnostic trouble codes (DTC).
The AFC-3.0 DI CAN wires need to be soldered to the vehicles OBD CAN-bus wires. It uses the OBD information for calculation and system strategies.

Calibration Tool Software OBD reader
An OBD reader is integrated in the Calibration Tool Software. Use the software instead of an external OBD-tester.
When an external OBD tester is connected to the OBD socket, the system will switch back to petrol and the engine will not run on gas anymore.

11 Hardware installation instructions engine kit

11.1 Required equipment / tools / materials

- Complete workshop toolbox (wrenches, screwdrivers, cutters, pliers, ratchet, sockets)
- Car lift
- Portable computer
- Vehicle fuel system scan tool or OBD scan tool WFS Italia S.r.l.
- Exhaust gas analyser
- Multi-meter
- Oscilloscope
- Calibration Tool diagnostic software
- Diagnostic Tool
- Torque wrench (5-50Nm)
- Torque wrench (200-250Nm)
- Portable light
- Assortment drill bits Ø4 to 12 mm
- Assortment cutters (Ø20, 30, 50, 70 mm)
- Portable drill or pneumatic drill
- Thread cutting device (male M6x1, M8x1, M10x1)
- Air gun
- Vacuum cleaner
- Safety goggles
- Hot air gun
- Soldering iron, soldering tin
- Wire-stripping pliers
- Adhesive tape
- Adhesive sealant
- Thread locking compound
- Anti-corrosion agent / black body coating
- Gas leak detection device or foam leak spray
- Shrink sleeves

11.2 Tightening moments

Connection	Nm	Spanner mm
M5	6.5	8
M6	11.3	10
M8	27.3	13
M10	52	17
M12	54	19
LPG manifold nipple	1	10
P/T sensor filter unit	2.5	10
eVP bolts – bracket	10	10
Genius bolts – bracket	15	13
Solenoid valve - bracket	10	10
Solenoid valve - Genius	20	17 (F) 14 (M)
Rail - bracket	10	10
Fuel line nut	20	13
Filling hose connections	50	22

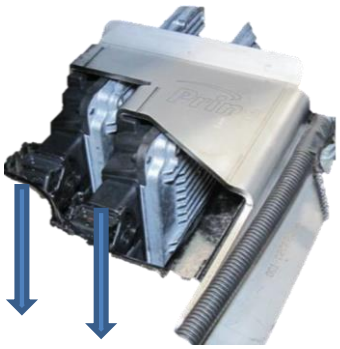
11.3 AFC-3.0 DI

11.3.1 Hardware

For heat dissipation it's important to place it in the relative cool location in the engine compartment with unblocked heat ridges.

Attention! Install the AFC-3.0 DI at a location with least heat build-up. If the AFC reaches an internal temperature of more than 90 degrees, it will automatically switch back to petrol.

Preferred installation positions



Wiring downwards

Connectors downwards

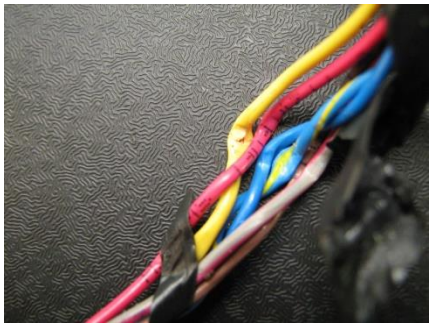
11.4 Wiring harness

11.4.1 Description

Universal harnesses are supplied in the universal engine kits. Most (engine) connections need to be soldered with universal harnesses.

11.4.2 Installation of wiring harness

- Use the vehicle installation instruction for the correct electrical connections.
- Use the correct electric connections:
  - Solder connections
  - Wire clamps.
- Isolate all the connections with
  - The supplied shrink-sleeves, or
  - Moisture sealing electrical tape
- Install the connected wires at a suitable place. This includes fixation at sufficient places and positioning out of the reach of heat sources, e.g. EGR supply lines;
- Ensure that the wires are not stressed when the engine tilts
- Try to integrate the LPG wires into the petrol wiring as much as possible.
- Mount the system fuse according to the instructions at a place which can easily be accessed.
- Respect the ground position as described in the (semi-) dedicated installation instruction. A deviation can create drivability issues and engine management errors.

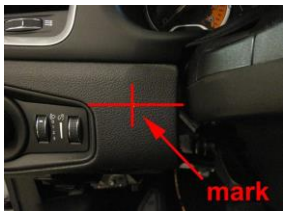


11.5 Fuel selection switch

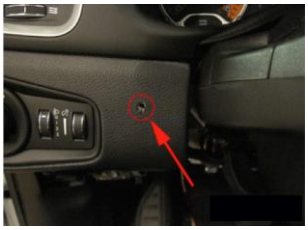
11.5.1 Hardware installation

Standard version
Drill a hole Ø 23 mm for the switch. Mount the switch.

Switch



Mark Hole



Drill ø 23 mm

Version with ring
Drill a hole Ø 26 mm for the switch. Mount the switch.

Switch

Mark Hole – Drill ø 26 mm

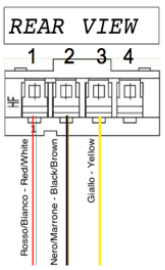
Attention!

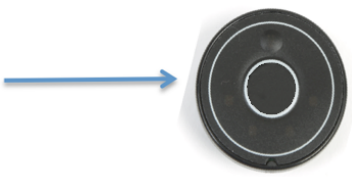
Beware of any electrical wiring or other components when locating the hole.

11.5.2 Electrical installation

4-pole micro connector			
G4	+12 V fuel switch		*Red/White*
K4	Ground fuel switch		Marrone-nero *Brown/Black*
K3	LIN fuel switch		Giallo/*Yellow*
	-		-

1= Red-white
2= Black/Brown
3= Yellow
4= -





11.6 Fuel supply hose XD

HIGH pressure flexible pipe

Fittings

11.6.1 Hardware installation

Mounting the flexible pipe

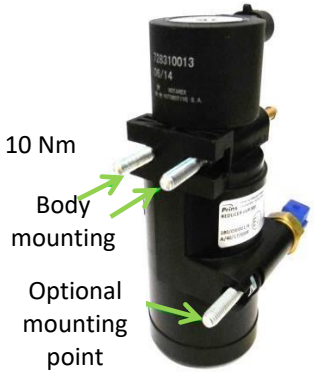
- Use the supplied clamps and mounting hardware
- Maximum distance of 400 mm between each clamp
- Temperature min -40 °C max 120 °C.
  - WFS Italia S.r.l. advices to use a heatshield when the distance between the hose and exhaust is less then 100mm. (or other heat source)
- Follow your local installation regulation for proper mounting.
- It is not permitted to have LPG tubes routed through the passenger compartment or a closed cargo space.
- Note the jack supporting points and moveable parts when mounting the LPG line.
- Remove the inner burrs after shortening the LPG line (to prevent the flow from being reduced).
- The number of joints shall be limited to a minimum.
- In a passenger compartment or enclosed luggage compartment the gas tube or hose shall be no longer than reasonably required; this provision is fulfilled when the gas tube or hose does not extend further than from the fuel LPG fuel tank to the side of vehicle.
- There shall be no gas-conveying connections in the passenger compartment or enclosed luggage compartment with the exception of:
  - The connections on the gas-tight housing;
  - And the connection between the gas tube or hose and the filling unit if this connection is fitted with a sleeve which is resistant against LPG and any leaking gas will be discharged directly into the atmosphere.

11.7 eVP-500 reducer

11.7.1 Hardware installation

Mount the reducer:

- In the engine compartment as shown on the images below
- According to local regulations.
- With use of the two upper mounting points.
  Use the third mounting point if the reducer suffers from vibration.
- With use of the M6 bolts, nuts and spring lock washers.



Attenzione! 10 Nm Do not Exceed torque, this may cause damage

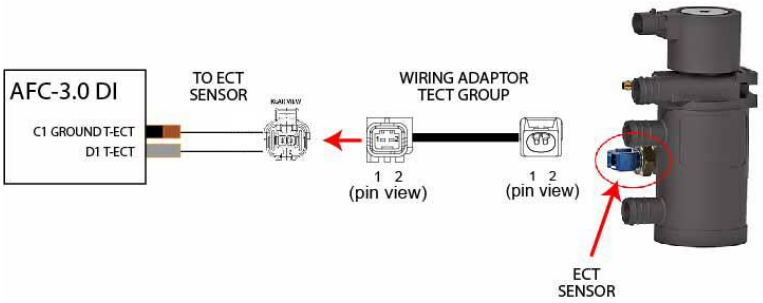
Tightening torques	Nm
Body mounting bolts	10
Actuator	15
Pressure Relief Valve	4
ECT sensor	4

11.7.2 Electrical installation

Connect the black 2 pole connector to the actuator

Connect the wiring adaptor 2 pole connector to the bleu regulator coolant sensor

- Standard sensor
- NTC resistor
- R20˚C ≈ 2500 Ω
- IP 54A Connector



11.7.3 Hoses installation

Coolant

Connect the coolant hoses to the coolant system of the vehicle.

- Fast temperature rising vehicle coolant hose
- No flow direction specified

LPG supply from tank

Connect the flexible pipe fuel supply hose at the bottom of the reducer.

- straight / flare 90°

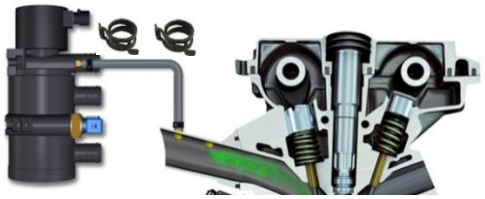
Gas output to filter

Connect the gas hose to the Gas-out and the inlet of the filter. Use the supplied clamps.

Try to install the filter unit as close as possible to the injector rail.

Pressure Relief Valve

Connect the gas hose to the Pressure Relief Valve and the inlet manifold



Attention!

Ensure a kink-free routing of the coolant hoses. Make sure hose clamps are properly tightened
Check the coolant level, top up if necessary and bled the coolant system
Check after the installation if the reducer and interior heater heats up quickly (normal operating temperature of motor is 85 ±5°C)
The coolant temperature must be 55°C within 10 minutes.

11.8 Genius MB reducer

11.8.1 Hardware installation

Mount the reducer:

- In the engine compartment as shown on the images below
- According to local regulations.
- With use of the two upper mounting points.
- With use of the M6 bolts, nuts and spring lock washers delivered in the kit.

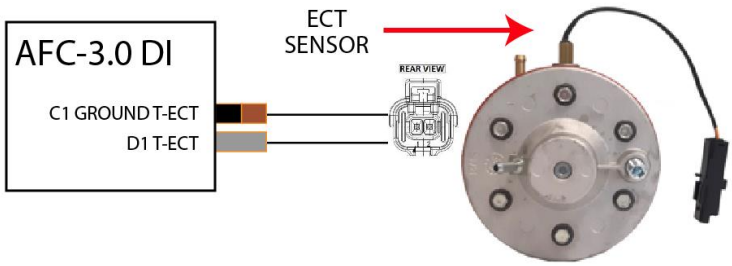
15 Nm Do not Exceed torque, this may cause damage

Tightening torques	Nm
Body mounting bolts	15
Banjo bolt / LPG hose	10
Pressure Relief Valve	4
ECT sensor	4

11.8.2 Electrical installation

Connect the 2 pole connector to the T-ECT sensor

- Standard sensor
- NTC resistor 3K3
- IP 54A Connector



11.8.3 **Hoses installation**

Coolant

Connect the coolant hoses to the coolant system of the vehicle.

- Fast temperature rising vehicle coolant hose
- No flow direction specified

LPG supply from tank

Connect the flexible pipe fuel supply hose at the bottom of the reducer.

- straight / flare 90°

Gas output to filter

Connect the gas hose to the Gas-out and the inlet of the filter. Use the supplied clamps.

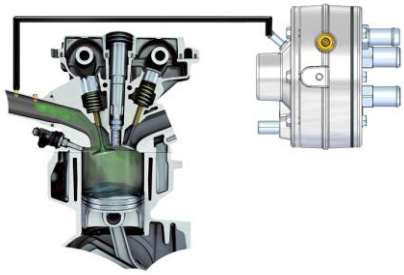
Try to install the filter unit as close as possible to the injector rail.

Attention!

Ensure a kink-free routing of the coolant hoses
Make sure hose clamps are properly tightened
Check the coolant level, top up and bleed the system if necessary.
Check after installation if the gearbox heats up (the normal operating temperature of the motor is 85 ± 5 ° C).
The coolant temperature should be 55 ° C within 10 minutes.

Pressure Relief Valve

Connect the gas hose to the Pressure Relief Valve and the inlet manifold



11.9 Filter unit

11.9.1 Hardware installation

11.9.2 Hoses installation

Connect the gas hose to the Gas-out and the inlet of the filter. Use the supplied clamps.

Try to install the filter unit as close as possible to the injector rail.

Connect the gas hose(s) to the outlet and the injector rail. Use the supplied clamps.

11.10 Injectors / rail

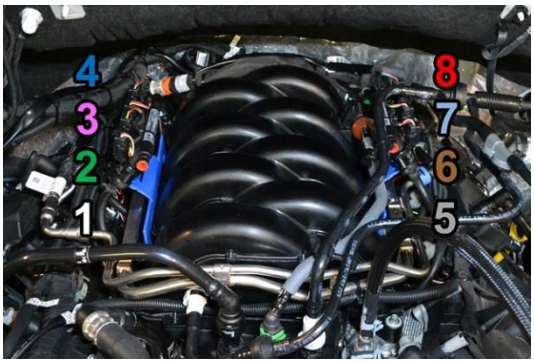
11.10.1 Hardware installation

Use the vehicle installation instruction for correct installation.

Always install the injector rail in a positive angle.

11.10.2 Electrical installation

Gas injector wire / connector identification



Connect the black 2 pole connector to the injector according to the vehicle Instruction manual.

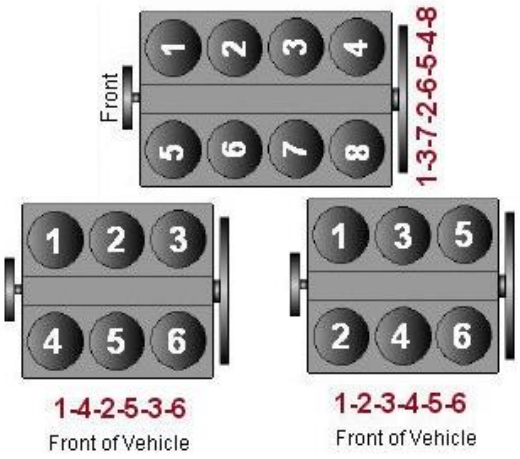
Connector / color		Wire color	
Gas injector 1	2-pole Black	White	yellow
		Red	
Gas injector 2	2-pole Black	Green	yellow
		Red	
Gas injector 3	2-pole Black	Pink	yellow
		Red	
Gas injector 4	2-pole Black	Blue	yellow
		Red	
Gas injector 5	2-pole Black	Grey	Yellow
		Red	
Gas injector 6	2-pole Black	Brown	Yellow
		Red	

Numbering of cilinders and firing order

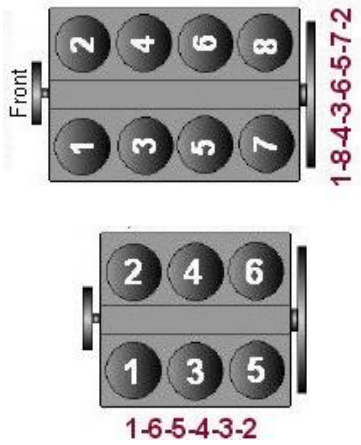
Respect the cilinder numbering of the engine. These cilinder order and firing order orders can deviate per brand, model and engine series.

Common 4 cilinder numbering

Example of PSA cilinder numbering
Beware: First cilinder at gearbox side.



Example of Ford cilinder numbering



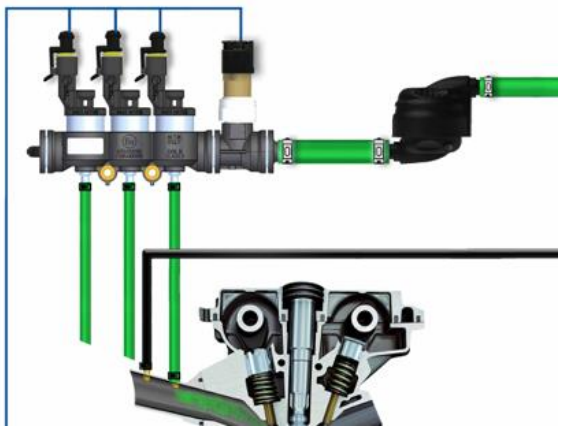
Example of GM cilinder numbering

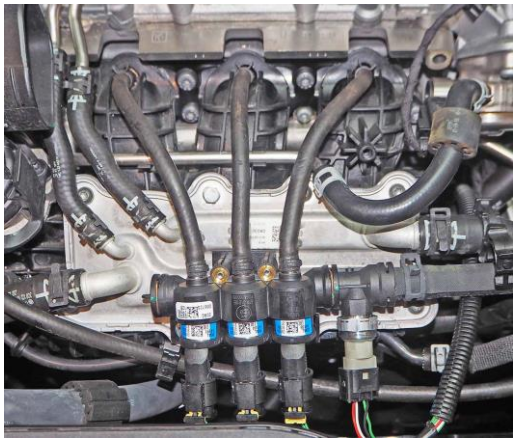
11.10.3 Hoses installation

Connect the gas hose to the inlet of the injector rail. Use the supplied clamps.

Connect the gas hose(s) to the gas injector and the corresponding inlet coupling of hose. Use the supplied clamps.

Make sure that the gas hoses between the intake manifold nipples and the gas injectors have the length mentioned in the vehicle instruction manual.





M6x1 - Rubber hoses

M10x1 – PTFE hoses

11.11 Inlet couplings

11.11.1 Hardware installation

Use the (semi-) dedicated installation instruction for correct installation

Attention!

Work very carefully while installing the couplings
Always use hose clamps
If installed wrongly, leaks may occur (air and gas)
After installation always check for gas or air leaks and whether the 5mm hoses are mounted properly without jams or bends
Make sure that hose lengths do not exceed 40 cm
Make sure that the hoses have the same lengths according the vehicle manual

11.11.2 General tools and material

Pipe Sealant

Drill

Hand cutting tool

Vacuum cleaner

Air gun

Ratchet set

Clamps

Hose clamp pliers

5 mm hose

clamp pliers

2x Wrench 12

Basic workshop equipment/tools

11.11.3 M6x1 - Rubber hoses 5 mm

TOOLS AND MATERIAL

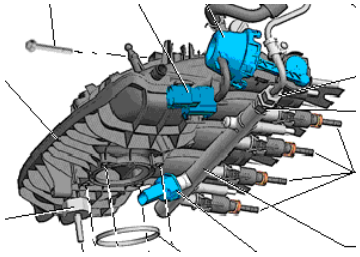
Long cutter M6x1

Long drill Ø 5 mm

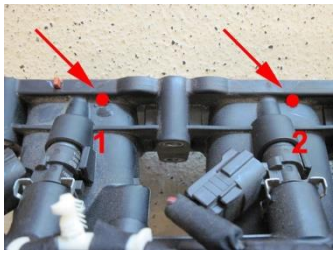
Allen torque wrench

Inlet nipples

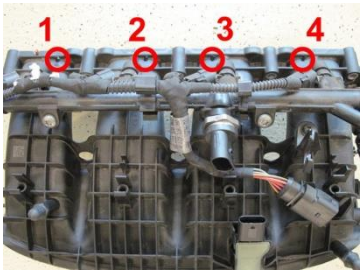
Installation process M6x1 - Rubber hoses 5mm



1. Always remove the inlet manifold.

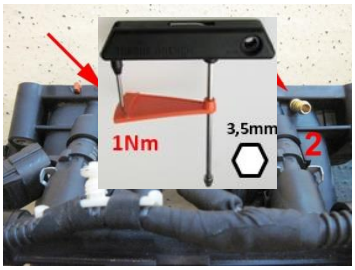


2. Mark and drill 5 mm holes according the vehicle installation manual.

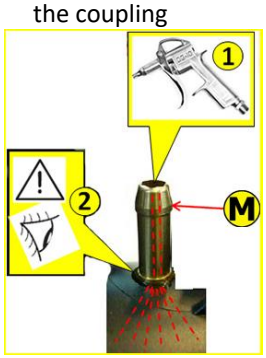


3. Cut **M6** thread in these holes.

4. Add locking compound to the coupling

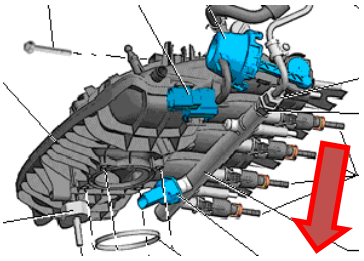


5. Place the couplings in the inlet manifold.
6. Tightening to 1 Nm



7. Make sure NO sealant blocks the coupling.

8. Install the hoses Ø 5 mm with supplied clamps



9. Clean and
10. Install the manifold

M10x1 – PTFE hoses

TOOLS AND MATERIAL

Long cutter M10x1

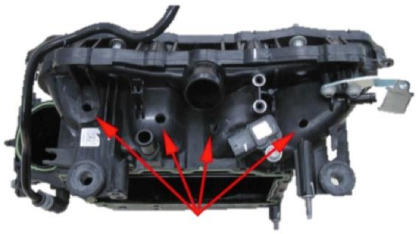
Long drill Ø 8,5mm

PTFE Inlet nipples

PTFE hose

Installation process M10x1 – PTFE hoses

1. Always remove the inlet manifold.



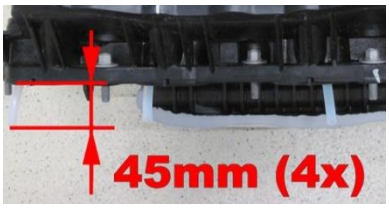
2. Mark and Drill the holes Ø 5mm and cut M6x1 according the vehicle dedicated installation manual.

3. Add locking compound to the coupling

4. Place the couplings in the inlet manifold.
5. Make sure NO sealant blocks the coupling.

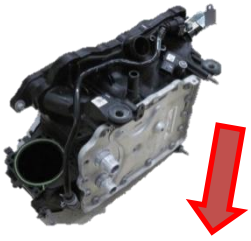
6. Cut the hose to the length described in vehicle dedicated installation manual.
7. Install the PTFE hose over the hose-coupler

8. Mount the PTFE hose with the nut to the manifold couplings



9. Cut / Check the described length as mentioned in the vehicle dedicated installation manual.

10. Install the hoses Ø 5mm with supplied clamps over the PTFE coupling.



Clean and
11. Install the manifold

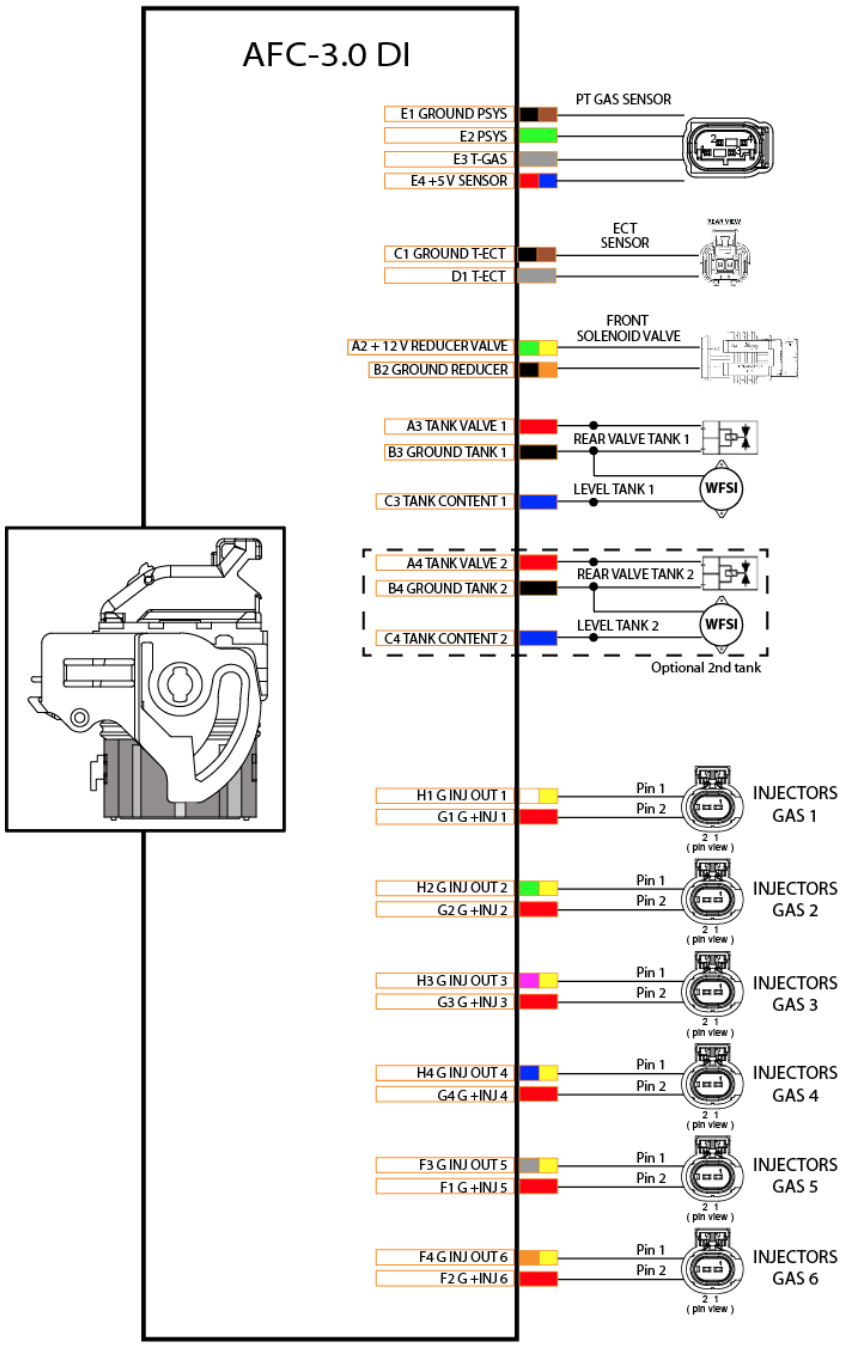
12 Electrical installation instructions

This chapter describes the wiring diagram, connector layout and installation of the electrical parts. For harness routing use the chapter Hardware installation instructions engine kit.

12.1 Basic wiring diagram

12.1.1 Grey connector – 32 Pin

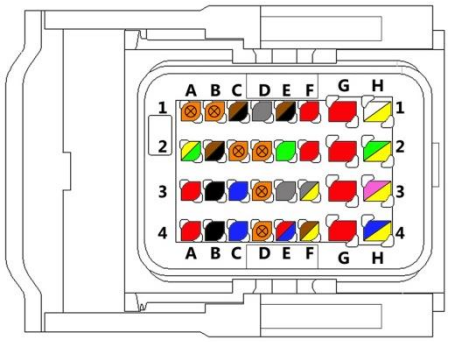
The Grey connector contains most of the LPG related in- and outputs. It can be divided into 2 parts, gas sensors and actuators gas injectors.

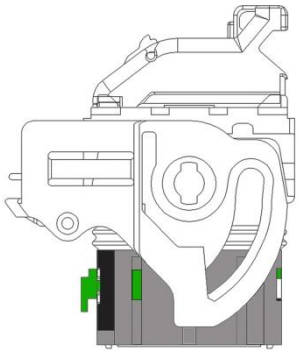


Gas sensors and actuators

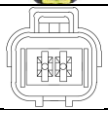
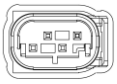
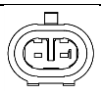
Gas injectors (injector numbering corresponds with the actual cilinder)

12.1.2 Grey 32P connector – Wires description

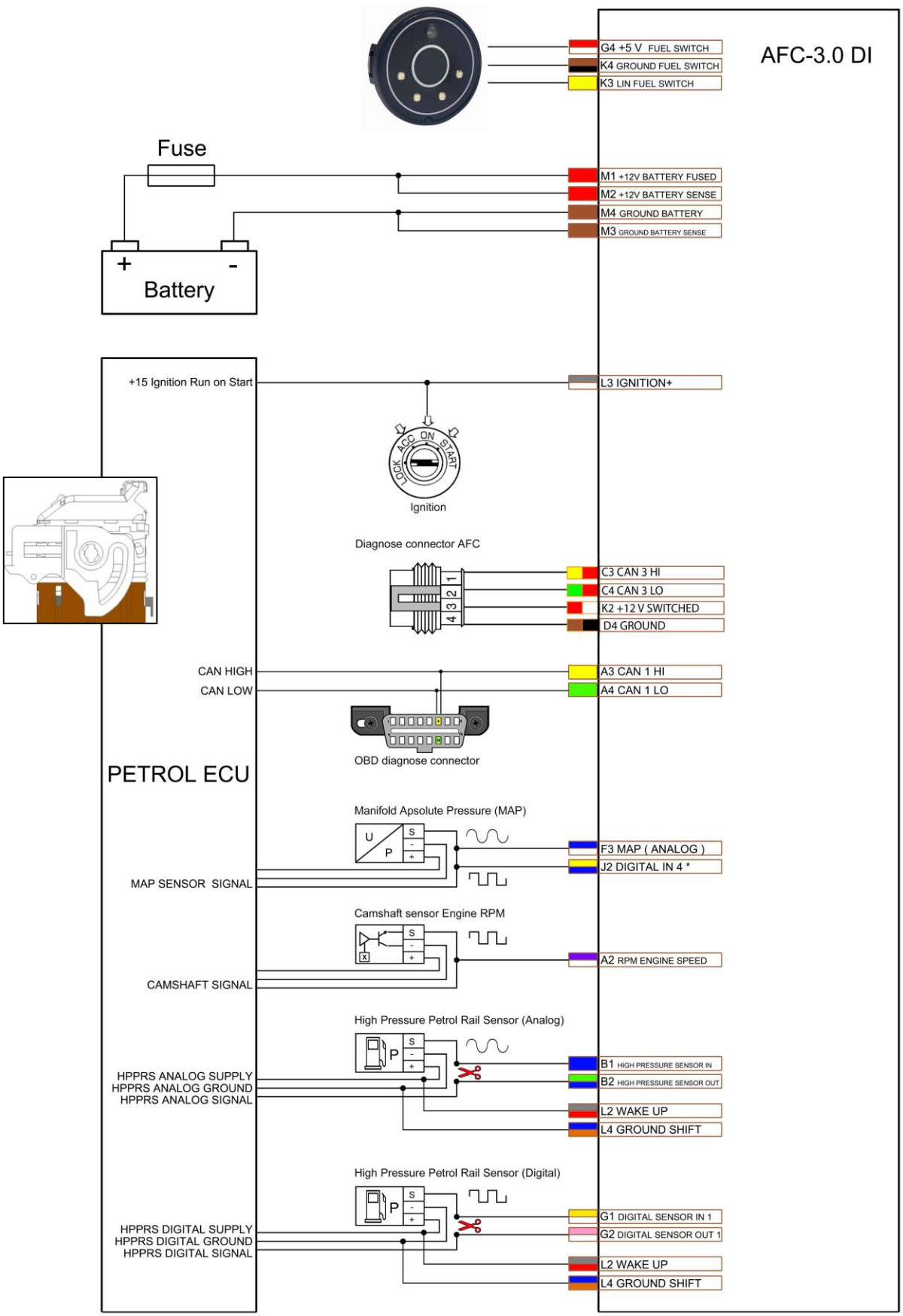


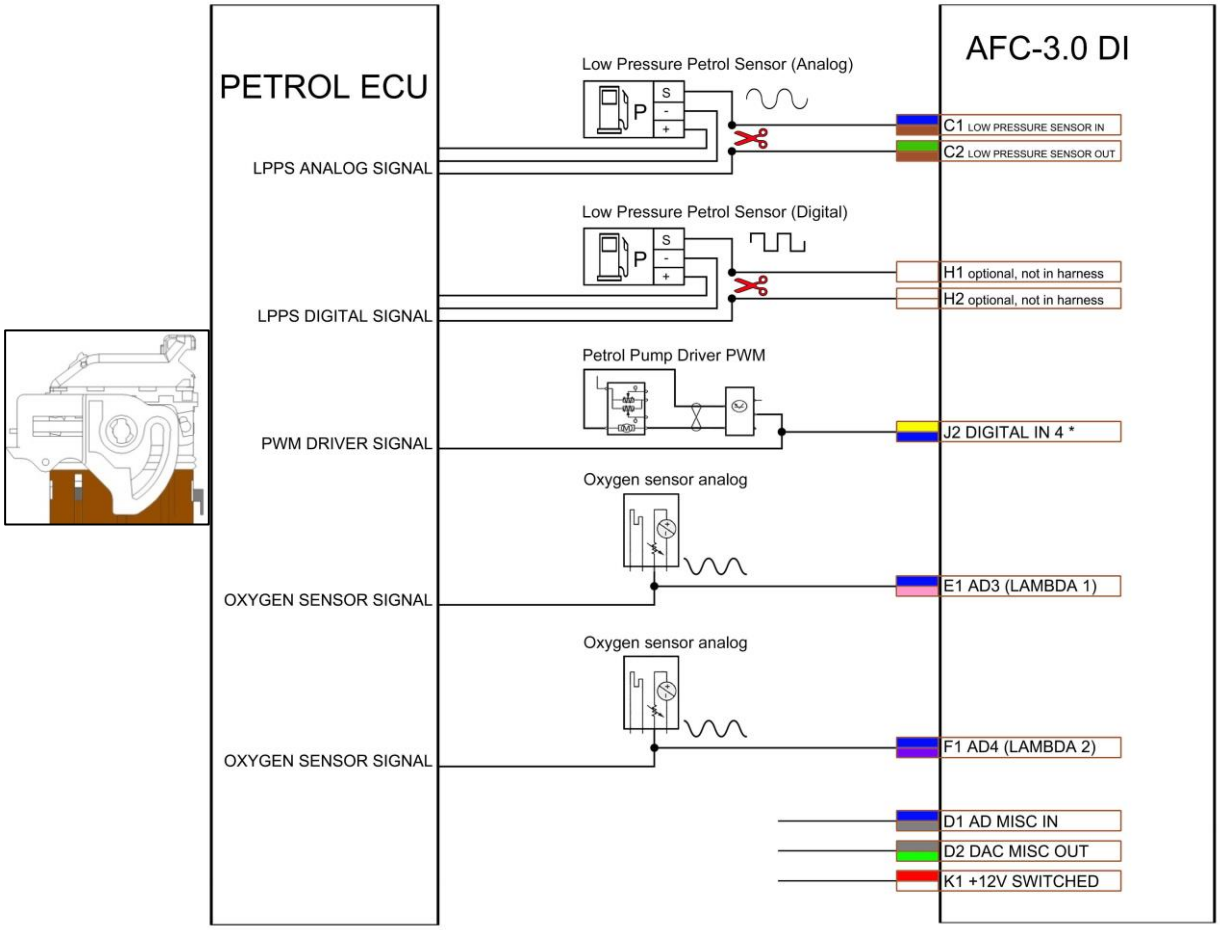


Gas system components excluding the fuel selector switch

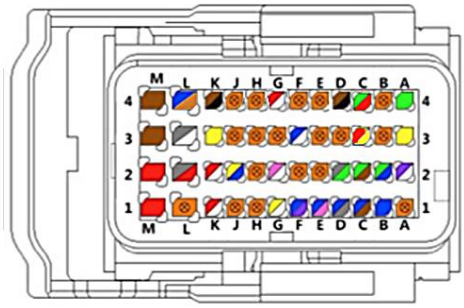
Component	Connector	Pos.	Wire color		Wire code		Comment
Gas injector 1		1	White	yellow	H1	G INJ OUT 1	
		2	Red		G1	G + INJ 1	
Gas injector 2		1	Green	yellow	H2	G INJ OUT 2	
		2	Red		G2	G + INJ 2	
Gas injector 3		1	Pink	yellow	H3	G INJ OUT 3	
		2	Red		G3	G + INJ 3	
Gas injector 4		1	Blue	yellow	H4	G INJ OUT 4	
		2	Red		G4	G + INJ 4	
Gas injector 5		1	Grey	Yellow	F3	G INJ OUT 5	
		2	Red		F1	G + INJ 5	
Gas injector 6		1	Brown	Yellow	F4	G INJ OUT 6	
		2	Red		F2	G + INJ 6	
Reducer temperature sensor		1	Brown	black	C1	Ground T-ECT	
		2	Grey		D1	T-ECT	
eVP-500 Solenoid Valve		1	Brown	black	B2	Ground reducer valve	
		2	Yellow	green	A2	+12V Reducer valve	
Gas system pressure and temperature		1	Brown	Black	E1	Ground Psys	
		2	Green			T-Gas	
		3	Grey		E4	+5 Volt sensor	
		4	Red	Blue	Blu	Psys	
Lock-off valve 1		2	Red		A3	Tank Valve	
Tank 1 Ground	Splice 9		black		B3	To Fuel Tank > Ground Tank	
Tank 1 level		2	Blue		C3	Tank content	
Lock-off valve 2	-------		Red		A4	-	-------
Tank 2 Ground	-------		black		B4	-	
Tank 2 level	-------		Blue		C4	-	

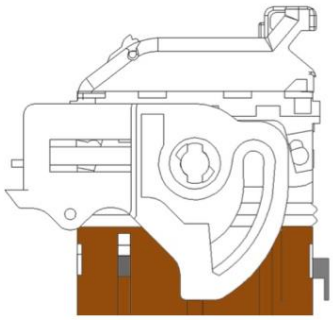
12.1.3 **Brown connector – 48 Pin**




PETROL ECU
AFC-3.0 DI
Low Pressure Petrol Sensor (Analog)
LPPS ANALOG SIGNAL
C1 LOW PRESSURE SENSOR IN
C2 LOW PRESSURE SENSOR OUT
Low Pressure Petrol Sensor (Digital)
LPPS DIGITAL SIGNAL
H1 optional, not in harness
H2 optional, not in harness
Petrol Pump Driver PWM
PWM DRIVER SIGNAL
J2 DIGITAL IN 4 *
Oxygen sensor analog
OXYGEN SENSOR SIGNAL
E1 AD3 (LAMBDA 1)
Oxygen sensor analog
OXYGEN SENSOR SIGNAL
F1 AD4 (LAMBDA 2)
D1 AD MISC IN
D2 DAC MISC OUT
K1 +12V SWITCHED

12.1.4 Brown 48P connector – Wires description



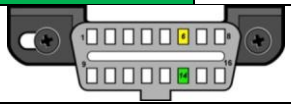


Ground, supply, communication & switched output

Component	Connector	Pos	Wire color		Wire code		Comment
+12 V Battery	Wire		Red		M1	+12 V Battery	Connect battery +
			Do not place the fuse in the holder before having completed the installation of the LPG system.				
Ignition +	Wire		Grey	White	L3	IGNITION+	12 V switched input
Ground AFC-3.0 DI	Wire		Brown		M3	Ground battery sense	Connect to battery -
	Wire		Brown		M4	Ground battery	
Fuel selector switch	4 3 2 1	1	Red	white	G4	+5 V fuel switch	
		2	Brown	black	K4	Ground Fuel switch	
		3	Yellow		K3	LIN fuel switch	
Diagnose Connector		1	Yellow	red	C3	CAN 3 HI	
		2	Green	red	C4	CAN 3 LO	
		3	Red	White	K2	+12 V SWITCHED	
		4	Brown	black	D4	Ground	
Output 12 V switched	Wire		Red	White	K1	+12V SWITCHED	Output 12 V switched

CAN-bus connections

EOBD diagnose connector	wire		Yellow	A3	CAN1 High	OBD Pin : 6
	wire		Green	A4	CAN1 Low	OBD Pin : 14

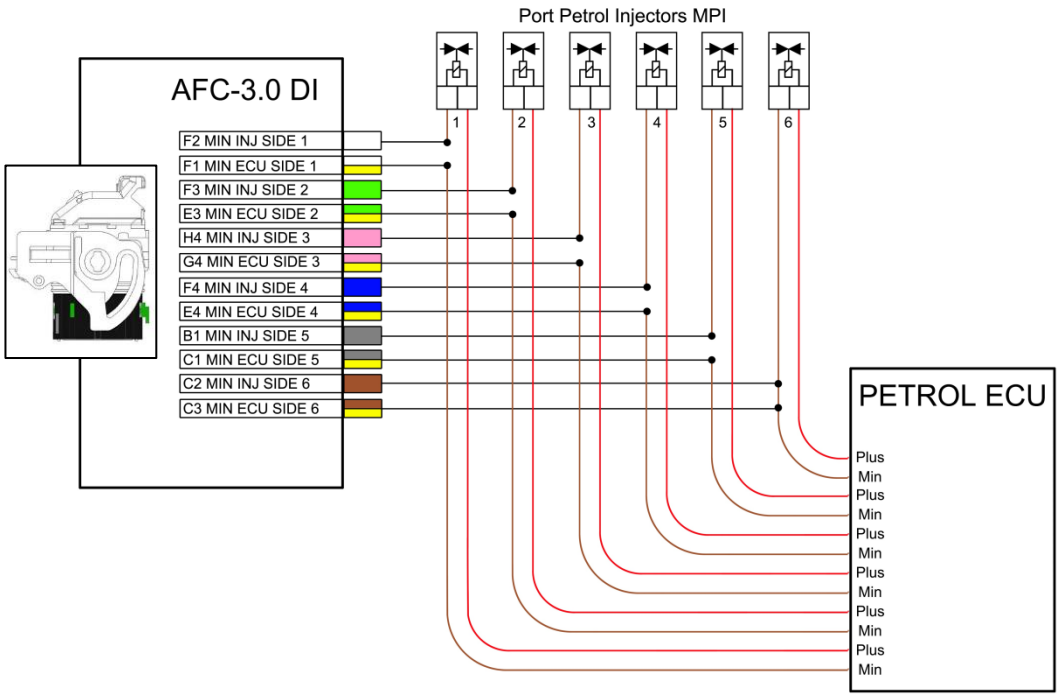


Engine signals

Component	Connector / color	Pos	Wire color		Wire code		Comment
Camshaft sensor / Ignition coil	Loose wire		Purple	white	A2	RPM ENGINE SPEED	
Petrol high pressure sensor analog (rail pressure)	Loose wire		Blue		B1	HIGH PRESSURE SENSOR IN	Sensor side
	Loose wire		Green	blue	B2	HIGH PRESSURE SENSOR OUT	Ecu side
	Loose wire		Grey	red	L2	WAKE UP	5V sensor supply
	Loose wire		Blue	orange	L4	GROUND SHIFT	Sensor ground
Petrol low pressure sensor analog	Loose wire		Blue	brown	C1	LOW PRESSURE SENSOR IN	Sensor side
	Loose wire		Green	brown	C2	LOW PRESSURE SENSOR OUT	Ecu side
MAP signal analog (OEM engine)	Loose wire		Blue	white	F3	MAP	Sensor signal
Petrol pump tank or MAP signal digital	Loose wire		Yellow	Blue	J2	DIGITAL IN 4 Tekst wordt anders in def kabelboom	Digital signal
Sensor signal analog	Loose wire		Blue	pink	E1	AD3 (LAMBDA 1)	Spare input for analog sensor
Sensor signal analog	Loose wire		Blue	purple	F1	AD4 (LAMBDA 2)	Spare input for analog sensor
Spare digital sensor interruption	Loose wire		Yellow	white	G1	DIGITAL SENSOR IN 1	Sensor side
	Loose wire		Pink	white	G2	DIGITAL SENSOR OUT 1	Ecu side
Spare analog sensor signal interruption	Loose wire		Blue	grey	D1	AD MISC IN	Sensor side
	Loose wire		Grey	green	D2	DAC MISC OUT	Ecu side

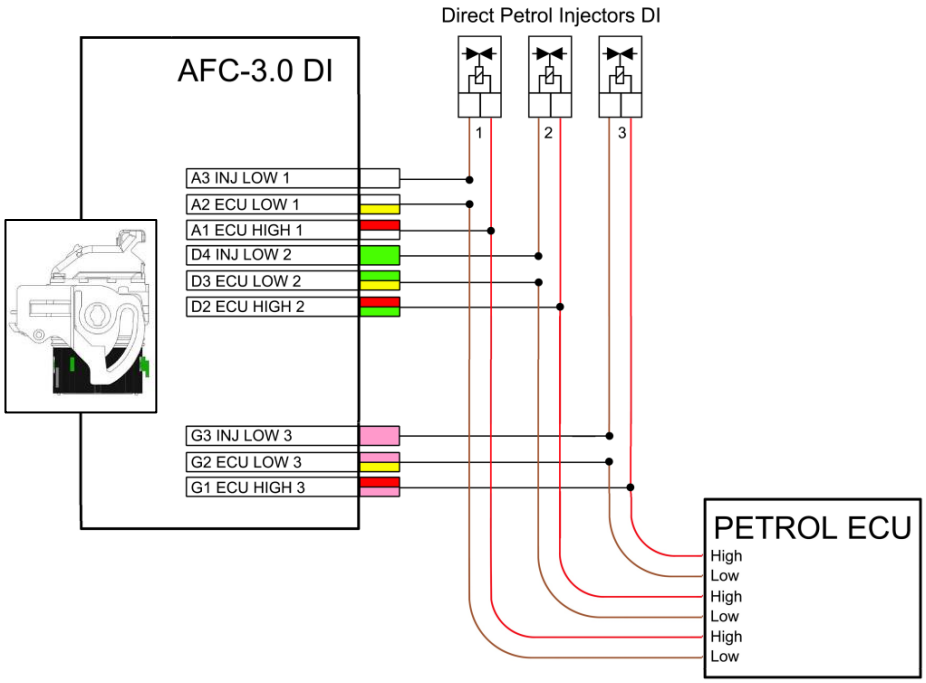
12.1.5 **Black connector - 32 Pin**

MPI injectors



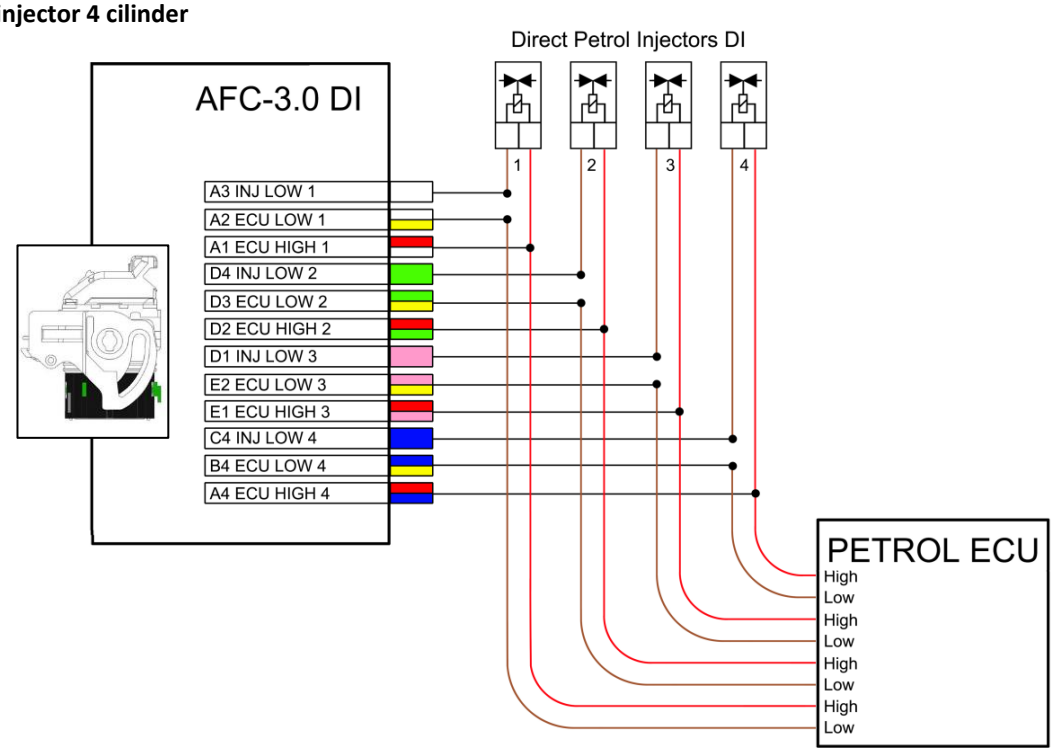
MPI injector
Injector numbering corresponds with the actual cylinder

DI injector 3 cilinders

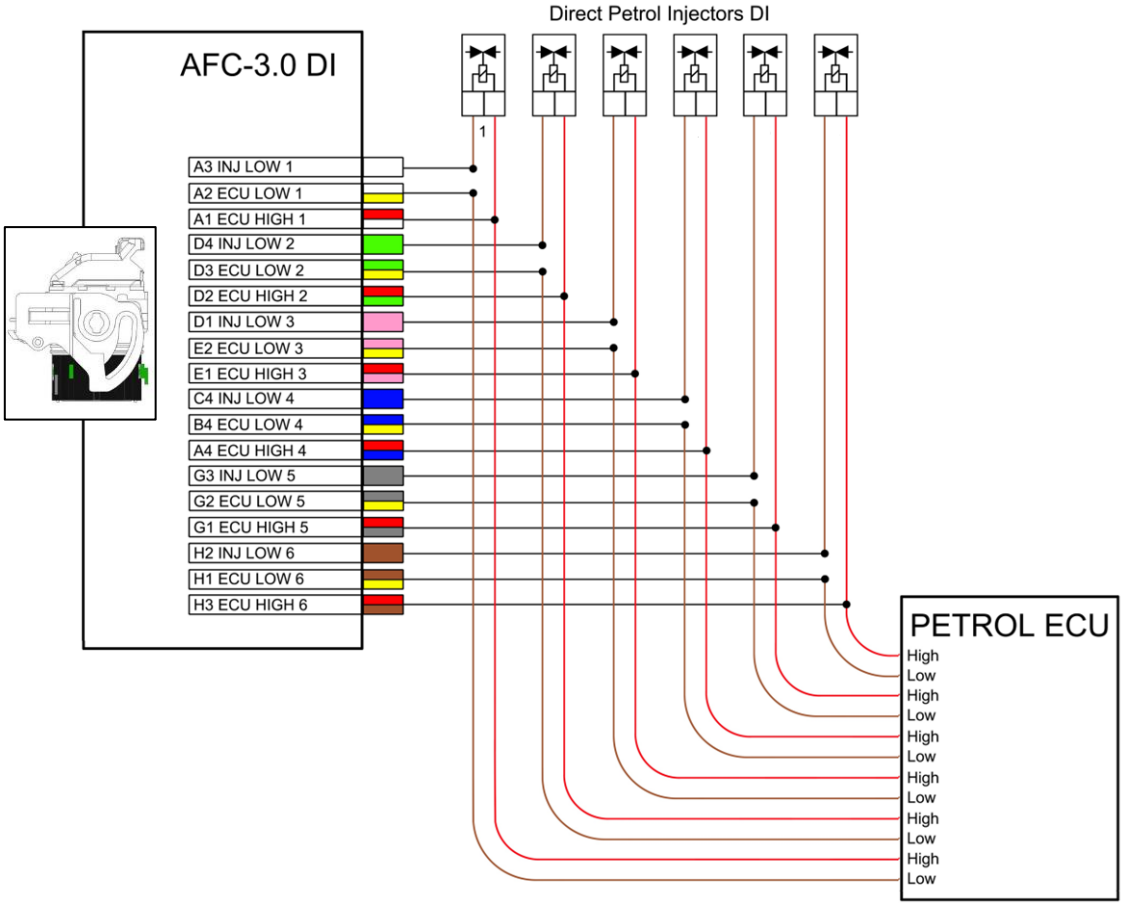


Attention! The 3rd DI injector pinned in row G.

DI injector 4 cilinder

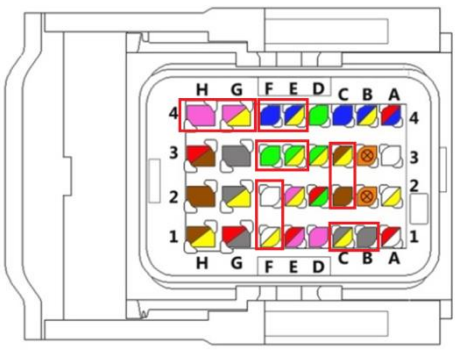


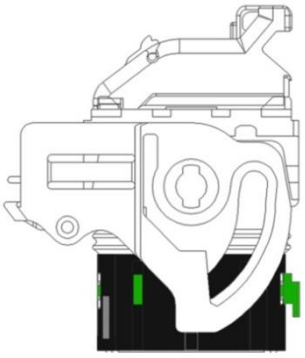
DI injector 6 cilinder



12.1.6 Black 32P connector – Wires description

MPI-INJECTORS

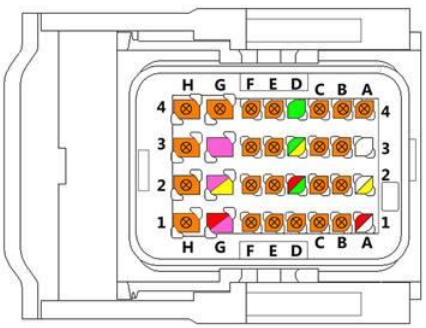




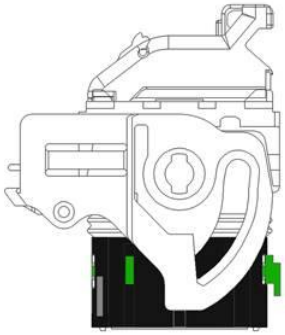
MPI-INJECTORS

Component	Connector	Pos	Wire color		Wire code		Comment
MPI Petrol injector 1	wires		White		F2	INJ LOW 1	Injector side cil. 1
			White	yellow	F1	ECU LOW 1	ECU side cil. 1
MPI Petrol injector 2	wires		Green		F3	INJ LOW 2	Injector side cil. 2
			Green	yellow	E3	ECU LOW 2	ECU side cil. 2
MPI Petrol injector 3	wires		Pink		H4	INJ LOW 3	Injector side cil. 3
			Pink	yellow	G4	ECU LOW 3	ECU side cil. 3
MPI Petrol injector 4	wires		Blue		F4	INJ LOW 4	Injector side cil. 4
			Blue	yellow	E4	ECU LOW 4	ECU side cil. 4
MPI Petrol injector 5	wires		Grey		B1	INJ LOW 5	Injector side cil. 5
			Grey	yellow	C1	ECU LOW 5	ECU side cil. 5
MPI Petrol injector 6	wires		Brown		C2	INJ LOW 6	Injector side cil. 6
			Brown	yellow	C3	ECU LOW 6	ECU side cil. 6

3-CYLINDER CONNECTOR



Top view 32P black connector

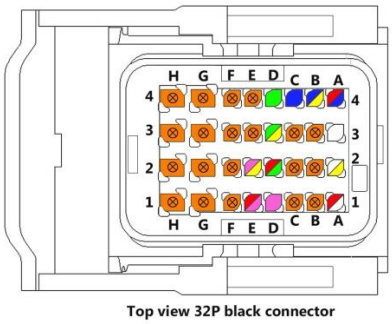


3-CYLINDER CONNECTOR

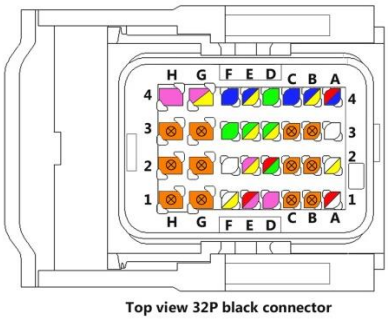
Component	Connector	Pos	Wire color		Wire code		Comment
DI Petrol injector 1	Wires		White		A3	INJ LOW 1	Injector side cil. 1
			White	yellow	A2	ECU LOW 1	ECU side cil. 1
			Red	white	A1	ECU HIGH 1	Injector high 1 65/12V 1
DI Petrol injector 2	Wires		Green		D4	INJ LOW 2	Injector side cil. 2
			Green	yellow	D3	ECU LOW 2	ECU side cil. 2
			Red	green	D2	ECU HIGH 2	Injector high 2 65/12V 2
DI Petrol injector 3	Wires		Pink		G3	INJ LOW 3	Injector side cil. 3
			Pink	yellow	G2	ECU LOW 3	ECU side cil. 3
			Red	pink	G1	ECU HIGH 3	Injector high 3 65/12V 3

Attention! The 3rd DI injector pinned in row G. This is a separate high group

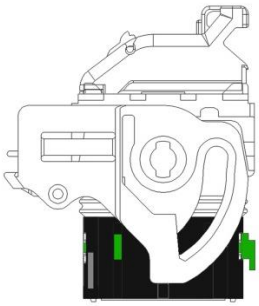
4-cylinder connector



DI lay-out



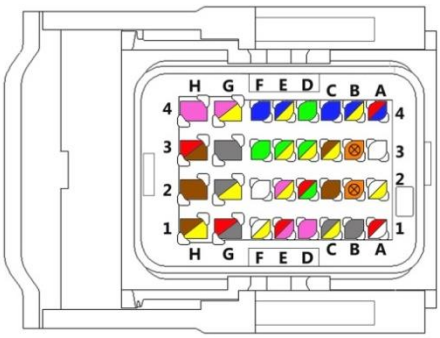
DI-MPI lay-out

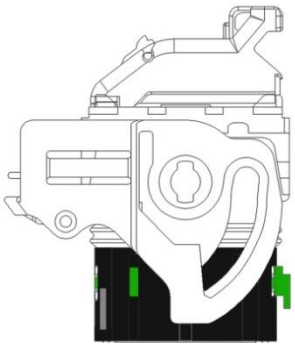


DI-injectors 4-cylinder

Component	Connector	Pos	Wire color		Wire code		Comment
DI Petrol injector 1	Wires		White		A3	INJ LOW 1	Injector side cil. 1
			White	yellow	A2	ECU LOW 1	ECU side cil. 1
			Red	white	A1	ECU HIGH 1	Injector high 65/12V cil. 1
DI Petrol injector 2	Wires		Green		D4	INJ LOW 2	Injector side cil. 2
			Green	yellow	D3	ECU LOW 2	ECU side cil. 2
			Red	green	D2	ECU HIGH 2	Injector high 65/12V cil. 2
DI Petrol injector 3	Wires		Pink		D1	INJ LOW 3	Injector side cil.3
			Pink	yellow	E2	ECU LOW 3	ECU side cil. 3
			Red	pink	E1	ECU HIGH 3	Injector high 65/12V cil. 3
DI Petrol injector 4	Wires		Blue		C4	INJ LOW 4	Injector side cil.4
			Blue	yellow	B4	ECU LOW 4	ECU side cil. 4
			Red	Blue	A4	ECU HIGH 4	Injector high 65/12V cil. 4

6-cylinder connector





DI-injectors 6-cylinder

Component	Connector	Pos	Wire color		Wire code		Comment
DI Petrol injector 1	Wires		White		A3	INJ LOW 1	Injector side cil. 1
			White	yellow	A2	ECU LOW 1	ECU side cil. 1
			Red	white	A1	ECU HIGH 1	Injector high 65/12V
DI Petrol injector	Wires		Green		D4	INJ LOW 2	Injector side cil. 2
			Green	yellow	D3	ECU LOW 2	ECU side cil. 2
			Red	green	D2	ECU HIGH 2	Injector high 65/12V
DI Petrol injector	Wires		Pink		D1	INJ LOW 3	Injector side cil. 3
			Pink	yellow	E2	ECU LOW 3	ECU side cil. 3
			Red	pink	E1	ECU HIGH 3	Injector high 65/12V
DI Petrol injector	Wires		Blue		C4	INJ LOW 4	Injector side cil. 4
			Blue	yellow	B4	ECU LOW 4	ECU side cil. 4
			Red	Blue	A4	ECU HIGH 4	Injector high 65/12V
DI Petrol injector	Wires		Grey		G3	INJ LOW 5	Injector side cil. 5
			Grey	yellow	G2	ECU LOW 5	ECU side cil. 5
			Red	grey	G1	ECU HIGH 5	Injector high 65/12V
DI Petrol injector	Wires		Brown		H2	INJ LOW 6	Injector side cil. 6
			Brown	yellow	H1	ECU LOW 6	ECU side cil. 6
			Red	Brown	H3	ECU HIGH 6	Injector high 65/12V

12.2 Molex connector

12.2.1 Wire module installation

Tools and material

Wire module

Wire cutter

Strap

Instructions

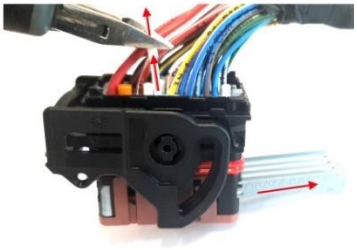
1. VSI-3.0-DI Molex connector

2. Remove strap

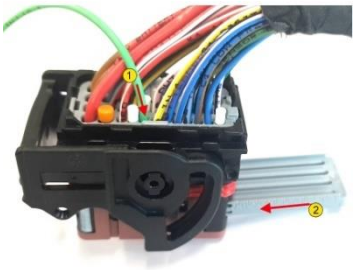
3. Push outside

4. Push outside

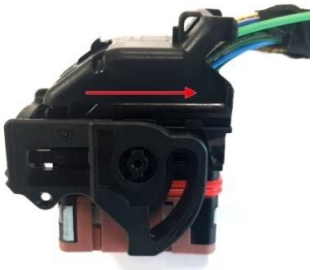
5. Slide cover



6. Pull out locking and plug



7. Insert wire with terminal
8. Slide back locking



9. Slide on cover

10. Secure wire with new strap

12.2.2 Remove wire and add blind plug into connector

Tools and material

Removal tool

Wire cutter

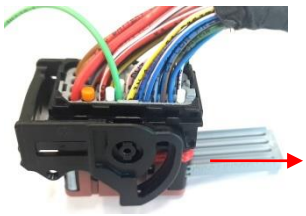
Strap

Blind plug small (white)

Blind plug large (orange)

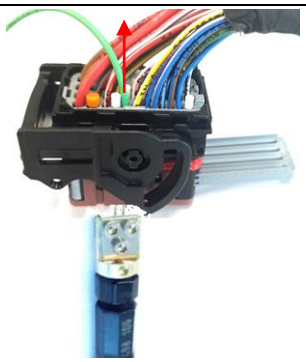
Instructions

1. Remove cover as described in previous chapter

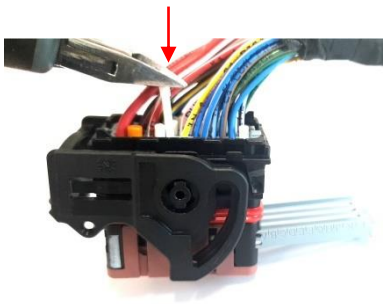


2. Pull out locking

3. Use the removal tool to remove the wire



4. Use the removal tool to remove the wire



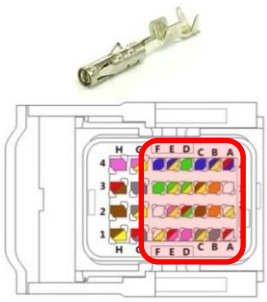
5. Insert the blind plug

6. Slide on cover and secure wire with new strap

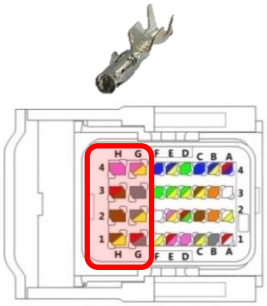
12.2.3 **Add terminals to wire**

Crimping terminals to a single wire is a delicate and precise procedure.

Tools and material



Small terminal
0.5mm²
0.75mm²



Large Terminal

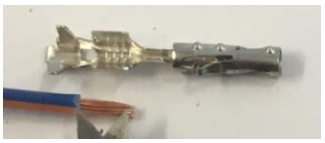
Wire stripper

Hand crimper
Small terminals

Hand crimper
Large terminals

Wire cutter

Instructions small terminal



1. Strip wire for 3 mm
2. Crimp terminal

OK

Not OK
Inspect crimping

Instructions large terminal

1. Strip wire for 5 mm
2. Crimp terminal

OK

Not OK

Inspect crimping

12.3 Soldering and shrinking wires

Conductor splices and connections are an essential part of the electrical circuit. When conductors join each other or connect to a load, splices or terminals must be used. Therefore, it is important that they be properly made. Any electrical circuit is only as good as its weakest link. The basic requirement of any splice or connection is that it be both mechanically and electrically as sound as the conductor or device with which it is used.

Quality workmanship and materials must be used to ensure lasting electrical contact, physical strength, and insulation. The most common methods of making splices and connections in electrical cables is explained in the discussion that follows.

Without good sealant, moisture will penetrate into the wiring. This will harm the harness and affect the connections, with a result of malfunction of the gas system.

After soldering or scrimping eye terminals, the connections need be insulated with adhesive lined heat shrink tubing. Also not-used wires need be insulated with adhesive lined heat shrink tubing, to prevent moisture into the wires.

When it's not possible to heat shrink the wires, apply vulcanization sealing tape to seal the connection.

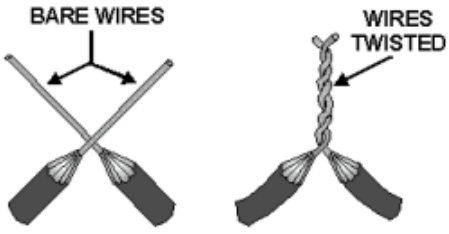
It's not recommended to use solder splice connectors.
The connection cannot be checked very well.

12.3.1 Splices and joints

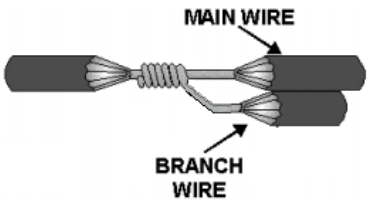
Three different types of splices are recommended.

Western Union Splice

Rattail Joint



Tap Joint



12.3.2 **Soldering and shrinking wires**

Tools

Wire cutter

Wire stripper / crimper

Solder torch / gun

Electrical solder

Heat gun

Heat shrink

Eye terminal

1. Strip the wire

2. Crimp the eye terminal

3. Cut and install the tubing

4. Shrink the tubing until glue comes out of both ends.

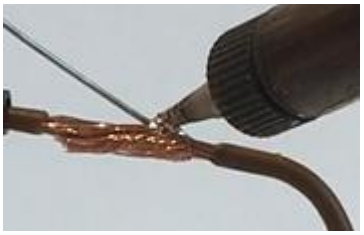
5. Cool down the tubing until the glue is solidified.

6. Detail of correct insulation.

Solder wires

Clean the surface of the solder torch

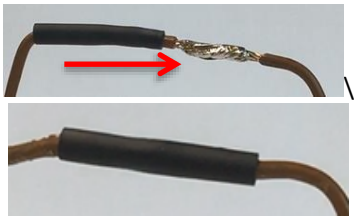
7. Slide over the shrink tubing



8. Hold the iron tip and solder together on the wire until the solder begins to flow

9. Move the soldering iron to the opposite side.

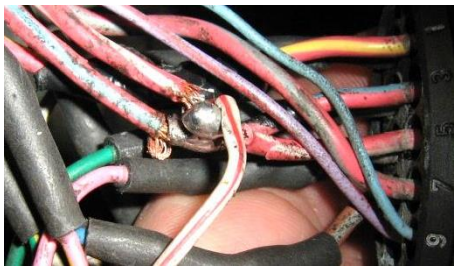
10. Make sure the tin has completely flowed through

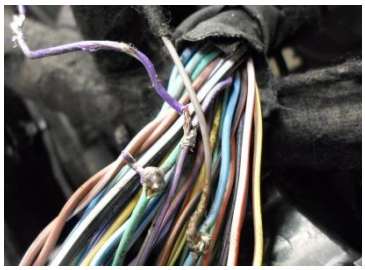


11. Slide over the shrink tubing over soldered wires

12. Shrink the tubing until glue comes out of both ends.

Bad soldering connections





Bad soldering connections

12.3.3 **Vulcanized connections**

Always resect the instructions of the supplier of the vulcanization tape.

Tools and material

Wire cutter

Moisture sealing electrical tape

vinyl electric tape

Vulcanize soldered wires

1. Solder the wires

2. Stretch the tape to 3/4 of its original width during application

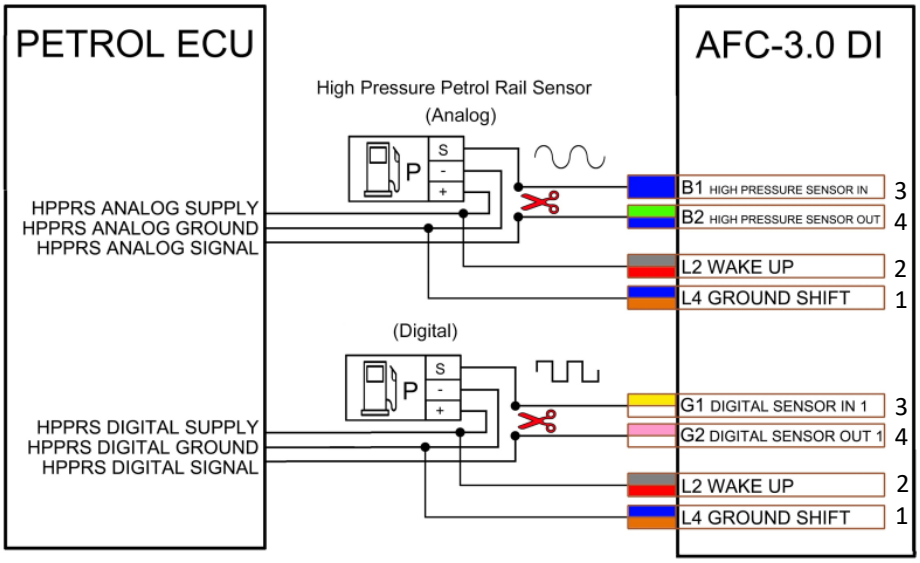
3. Applied 4 half–lapped layers

4. Apply 2 half lapped layers of vinyl electric tape for mechanical protection

5. End result

12.4 How to connect petrol pressure emulation

12.4.1 Petrol High Pressure emulation



1) Find sensor ground with Ω multi meter
    a. Connect wire L4 Ground shift (brown connector)

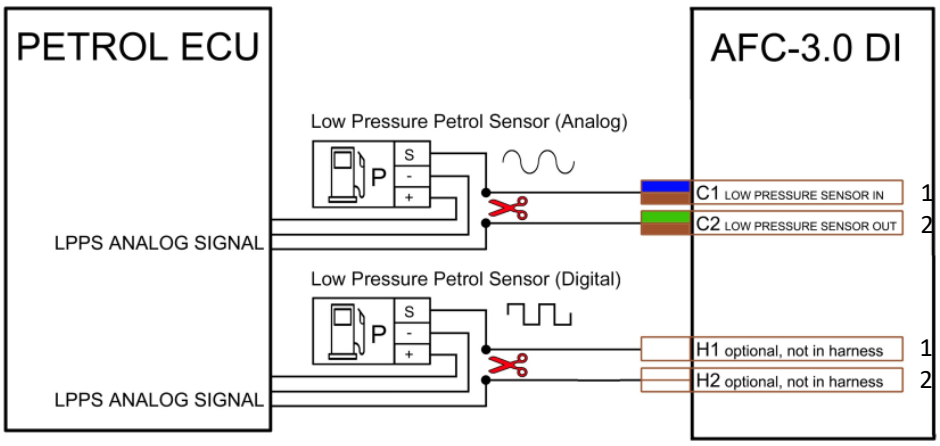
2) Use the multi meter to find the 5V sensor supply
    a. connect wire L2 (brown connector)

3) Find the signal wire of the sensor. Start the engine and read out the pressure.
    a. Analog: [1,5 -3,5V] Use wire B1 (brown connector)
    b. Digital: Use wire G1 (brown connector)

4) Cut sensor wire at ECU side and connect to:
    a. Analog: B2 (brown connector)
    b. Digital: G2 (brown connector)

5) Road test with the acquisition in the following conditions:
    a. On petrol mode
    b. Different loads and RPM

12.4.2 Petrol Low Pressure emulation



1) Find the signal wire of the sensor. Start the engine and read out the pressure.
    a. Analog: [1,5 -3,5V] Use wire C1 (brown connector)
    b. Digital: Use wire H1 (brown connector)

2) Cut sensor wire at ECU side and connect to:
    a. Analog: C2 (brown connector)
    b. Digital: H2 (brown connector)

3) Road test with the acquisition in the following conditions:
    a. On petrol mode
    b. Different loads and RPM

13 Commissioning

13.1 Checklist after installation

1) When working on the car, beware of moving, rotating parts and hot parts.

2) Fill-up the tank to a minimum tank level of 20%
3) Install the main fuse; turn the ignition key in the ON position.
4) Calibration Tool
   a) Connect and run the Calibration Tool Software.
   b) Flash the correct firmware into the AFC
   c) Start vehicle on petrol (system status "**PETROL**")
   d) Check the engine signals, petrol injection time, RPM, ECT, MAP signal and petrol pressure signals.
   e) The system may switch over to LPG as soon as the temperature of the coolant becomes higher than the temperature selected.

5) Check all components and connections for any gas and fluid leakage (use a LPG leak detector device or a fluid detection like soap). Caution for moving and rotating parts in the engine compartment!

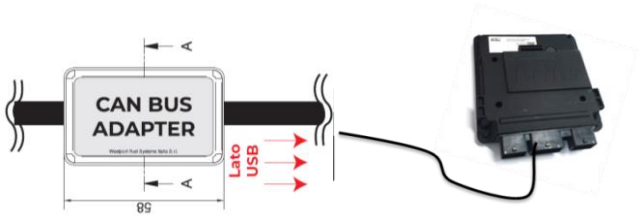
6) Let the engine run warm on petrol >80°C.
7) Check if the reducer heats up.

8) Check the vehicle and gas system for error codes and solve these, if required.
9) Create a log file during the test drive and judge the drivability on LPG and petrol.
   a) Switch over behaviour Petrol -> LPG -> Petrol
   b) Engine behaviour running cold and warm.
   c) Shifting / changing gears.
   d) The engine behaviour during and after a "fuel cut off", especially when falling back to idle rpm.
   e) Stable idle, when pushing power steering to maximum limit and when shifting from park/neutral to gear and backwards.

10) Final check:
    a) OBD- and AFC fault codes.
    b) All installed components [hoses, wirings components].
    c) Coolant level and the coolant connections, reducer and T-splices.
    d) Gas & petrol leakages.
    e) Disconnect the Calibration Tool software and place the protection connector on the diagnostic connector.

11) Fill in the Drivers Guide.
12) Handover the car, Drivers Guide.

13.2 Flash AFC-3.0 DI



Make use of the Calibration Tool and flash the AFC-3.0 DI with the correct Firmware.
Available online the Bora Advance firmware can be identified with 060/…. and with Bora Advance at the end of the line.

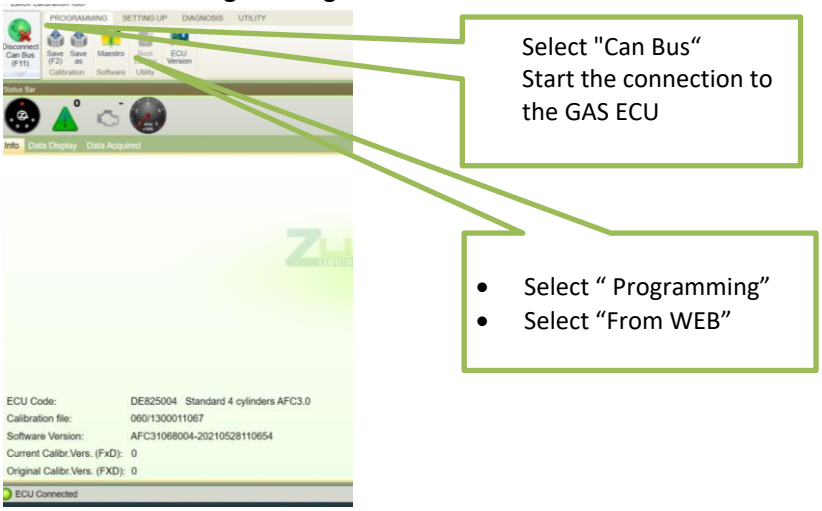
1) How to select the correct firmware for the vehicle?

Always check this vehicle information

- Car brand and model type
- Engine Manufacturer
- Engine displacement
- Engine code / Number - Output
- Firing order
- Transmission
- Petrol ECU manufacturer / Code
- Model Year: (10th digit of the VIN)

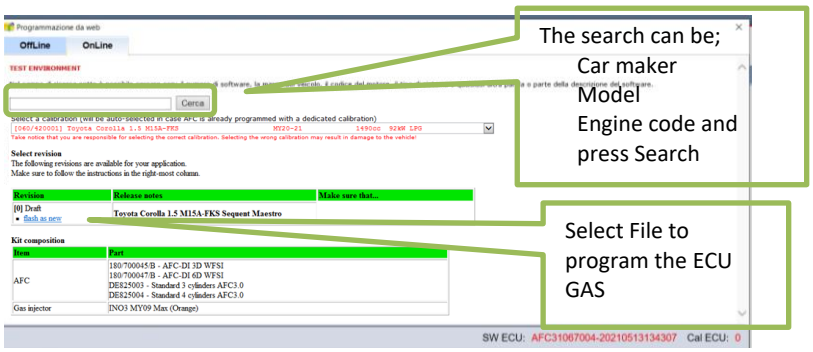
Calibration Tool – Programming ECU GAS

- Select “From Web” from the program menu.”.



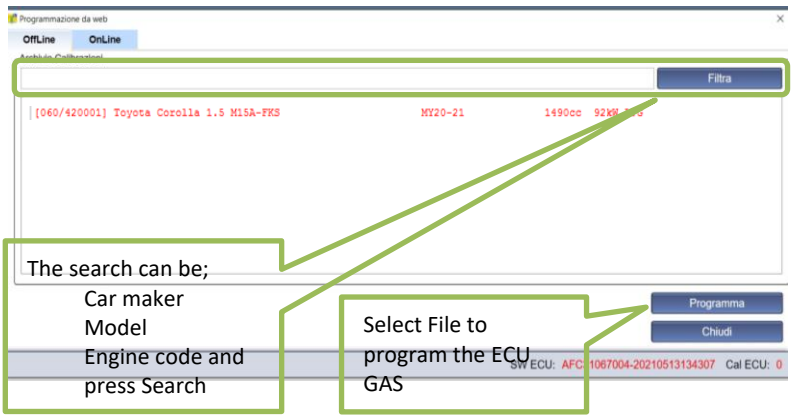
Programming from WEB On-Line

- Use the search box or via calibrations to find the correct calibration

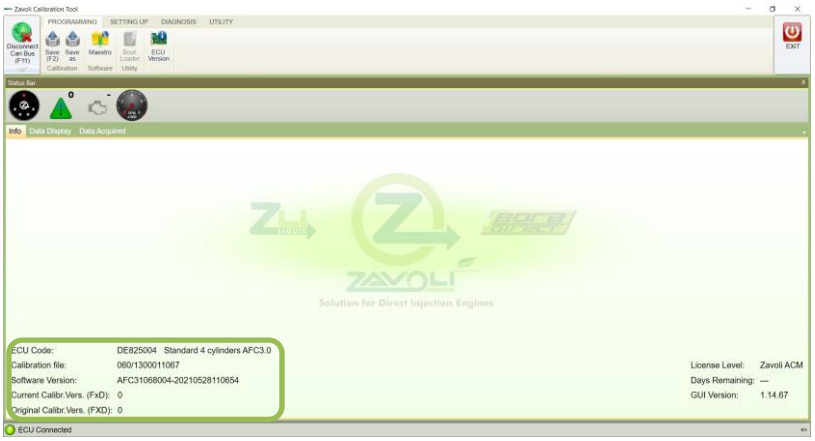


Programming from WEB Off-Line

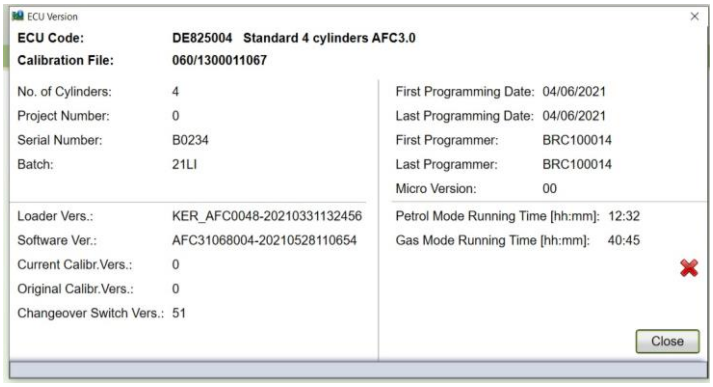
- Select Off-Line to program in "Off-Line" mode.



- At the end of the programming, the information will be available:
- ECU code
- Calibration file
- Software Vers
- Vers. Calibration



Click DIAGNOSTICS > ECU Version, or UTILITY > ECU Version from the main menu to access the page below, which shows the parameters regarding ECU, software, calibration and programming.



14 Service and maintenance

The Sequent Maestro system uses 2 filters which need to be replaced according the service interval to assure the performance of the system. One filter is mounted inside the eVP-500. The filter is installed in the filter unit. The filter unit needs to be replaced completely. The interval depends on the gas quality and the amount of pollution inside the LPG tank.

14.1 Interval and filter change

 eVP-500 filter	Every 20.000 km
 Filter unit	Every 20.000 km

* Depends on local conditions and gas quality.

14.2 Service items

Filter change:

- eVP-500
- Filter unit.

Check:

- Hoses:
  - Damage
  - Gas leaking
  - Engine coolant leakage
  - Petrol leakage
- Fastening of components.
- Electrical connections and wiring.
- Sequent Maestro system error codes.
- Engine:
  - Error codes
  - Exhaust emissions.
  - Valve clearance
  - Ignition plugs
  - Ignition cables

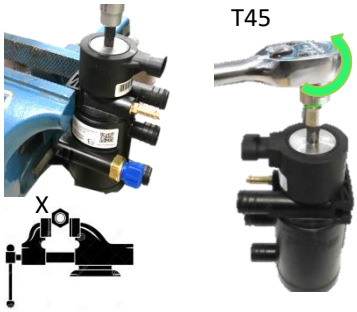
14.3 Parts Replacement kit eVP-500 filters

Type	Picture example	Replacement filters eVP-500 and filter unit	
Type 2		EVP filter	**E591089**
		VK03.KTR.01 Electrovalve filter 3-4 cyl.	**VK03.LPG.04/24**
		VK07.KTR.03 Electrovalve filter - Max	**VK03.KTR.01**
		FILTER INØ16 OUTØ 12	VK94.PPM.20
		FILTER INØ12.5 OUTØ 12,5	VK94.PPM.19

14.4 How to replace the eVP-500 filter

1. To prevent serious injury, release het gas pressure.

2. Remove dirt and dust
Use low pressure water, brake cleaner and/or compressed air



3. Torx: T45

4

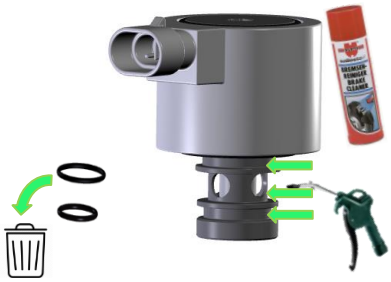
4. Remove actuator with filter

5

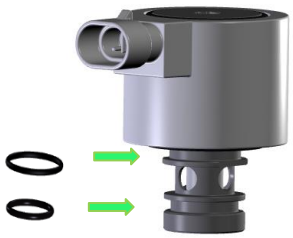
5. Clean thread and O-ring grooves thoroughly

6

6. Clean area and remove filter



7. Remove O-rings
Clean grooves thoroughly



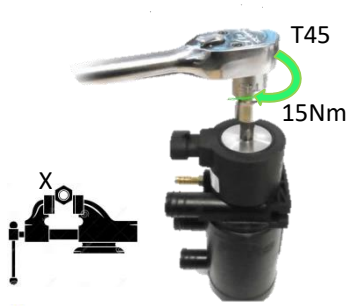
8. Lubricate rings with O-rings grease

9. Install O-rings

10

10.

11



11. Do not exceed torque, this may cause damage to the actuator

12

12. Check for gas leakage.

15 Valve Care-DI

Some vehicles equipped with Bora Advance may require the system Valve Care-DI code E5911007, that must be purchased separately, as well as the Relay code DE546006.

NOTE: please check vehicles dedicated instructions to see if the optional system is required.

Valve Care-DI system measures out the additive electronically, sequentially calibrated, on petrol direct injection engines converted to gas.

Together with the highly effective additive, the system will help to keep combustion chamber cleaner and to reduce wear of valves and valve seats.

NOTE: for more details about mechanical and electrical parts, please make reference to the dedicated manual code TA01Z224 and specific vehicles instructions.