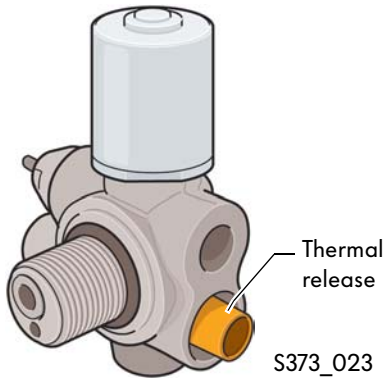
Natural Gas Supply

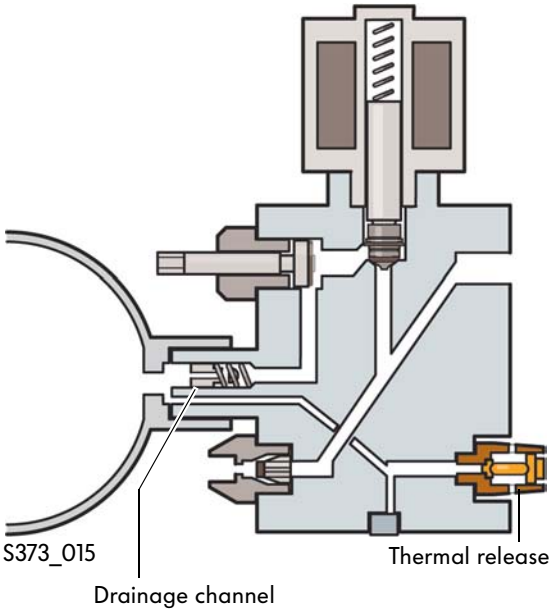
Thermal release

The thermal release is also part of the tank shut-off valve module.

Task

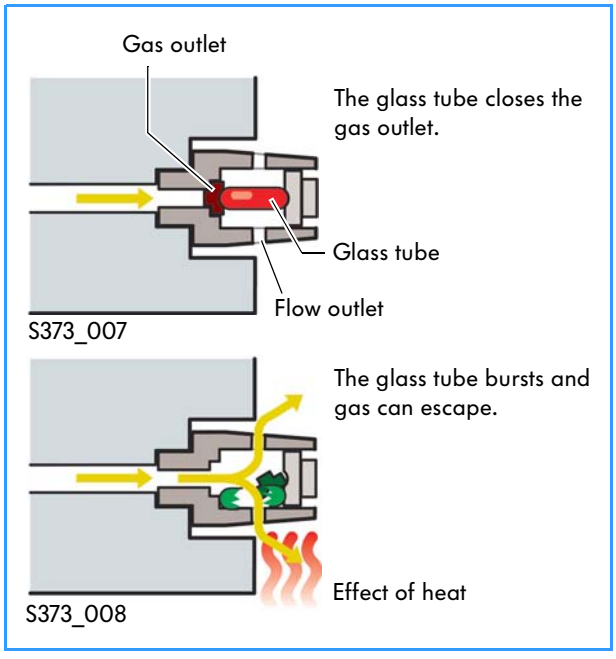
It prevents the natural gas tanks bursting if the pressure rises excessively because of high temperatures. The thermal release is installed in such a way that direct release of the natural gas into the atmosphere is possible.





How it works

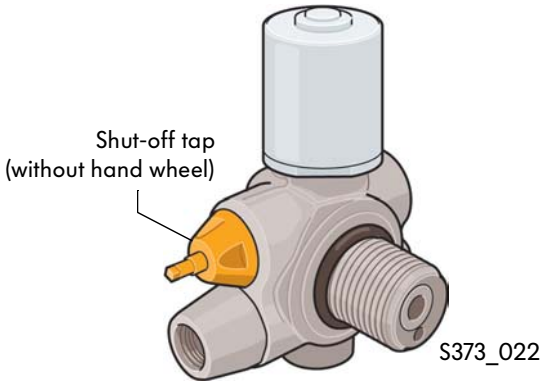
The main part of the thermal release is a small glass tube containing a fluid that seals the gas leak.
At temperatures above 110°C, the liquid in the glass tube will expand and cause it to burst.
The gas outlet can now open. The natural gas escapes from the natural gas tanks into the atmosphere and can be released there in a controlled manner without, for example, a backflash occurring or the natural gas tanks bursting due to high temperatures if the vehicle is on fire.

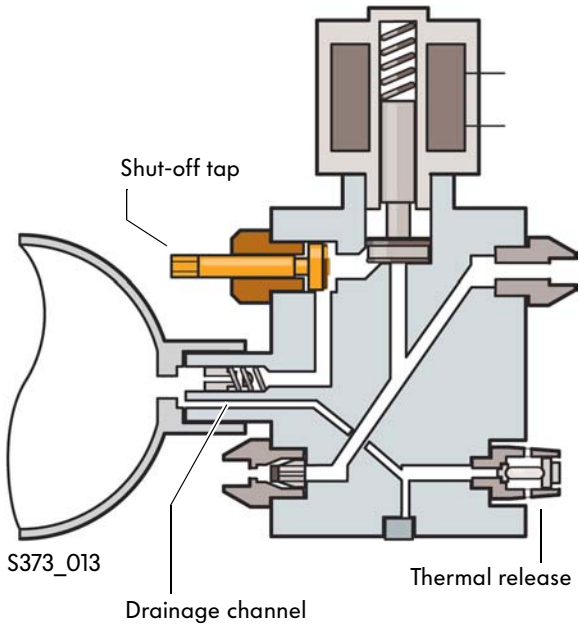


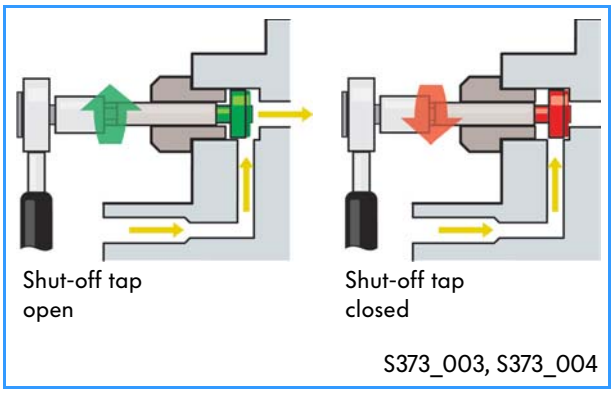
Manual shut-off tap

The mechanical shut-off tap allows you to close the natural gas tank manually with a tool so it is gas-tight. For safety reasons, this is necessary whenever the natural gas tank is removed or fitted again.

The drainage channel for the thermal release is also open when the shut-off tap is closed for safety reasons.







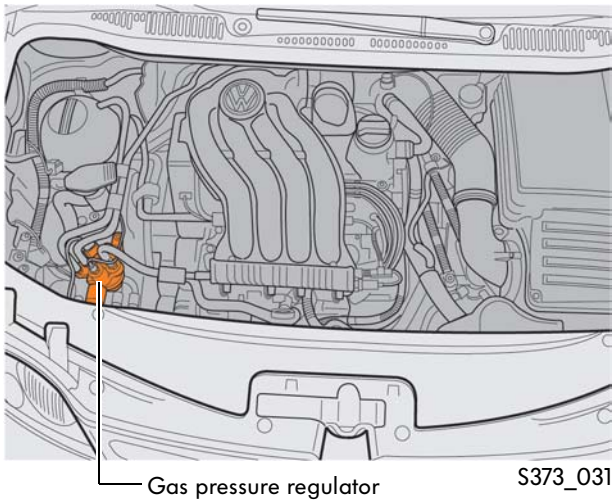
Please see ELSA for more detailed information on repair work.

Natural Gas Supply

From high pressure to low pressure

Gas pressure regulator

The gas pressure regulator is mounted on the longitudinal member at the front right of the engine compartment.



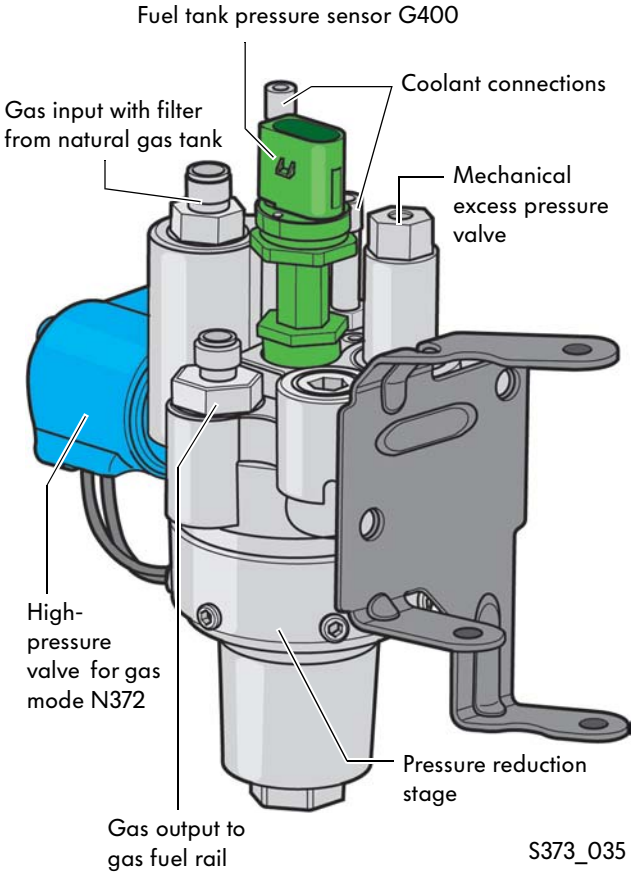
Task

The gas pressure regulator has the task of reducing the natural gas pressure from 200 bar to approx. 6 bar.
The relaxation of the natural gas occurs in the gas pressure regulator in a single pressure reduction stage.
It thus separates the high-pressure side of the natural gas system from the low-pressure side.

Design

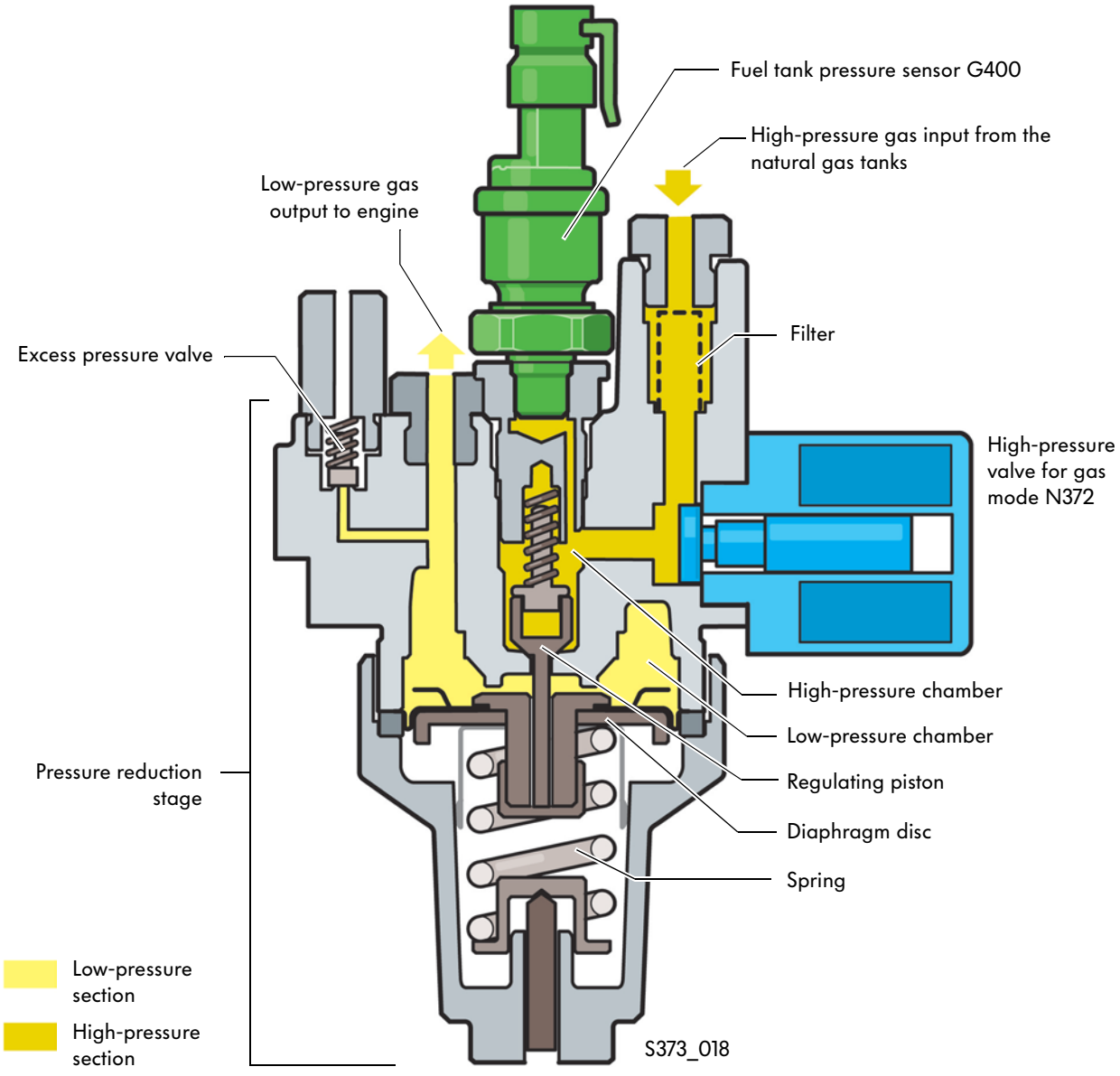
The gas pressure regulator is made up of the following components:

- coolant connections to engine cooling system
- integrated filter on gas input
- fuel tank pressure sensor G400
- high-pressure valve for gas mode N372
- pressure reduction stage
- mechanical excess pressure valve



The reduction stage on the gas pressure regulator consists of:

- the high-pressure chamber with regulating piston
- the low-pressure chamber with mechanical excess pressure valve
- the diaphragm disc
- the spring



Natural Gas Supply

High-pressure valve for gas mode N372

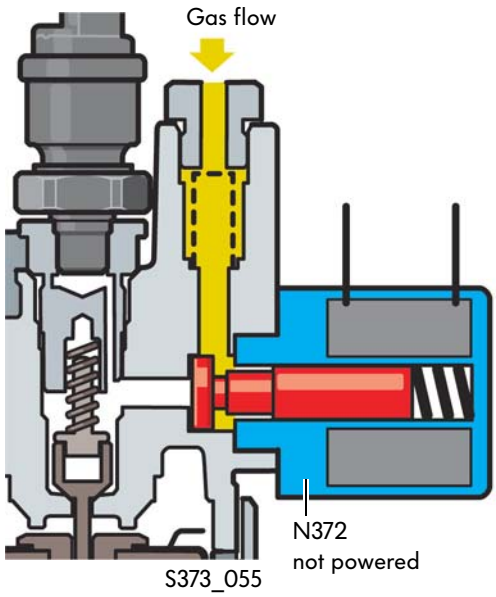
This component is built into the side of the gas pressure regulator.

Task

The high-pressure valve for gas mode closes or opens the access to the reduction stage of the gas pressure regulator. It thus interrupts the connection between the natural gas tank and the engine and thus represents a further safety component in the natural gas system. To perform this task, the high-pressure valve for gas mode is closed in unpowered state.

Effect upon failure

If the high-pressure valve for gas mode cannot be powered by the engine control unit, only back-up petrol mode will be possible.



Fuel tank pressure sensor G400

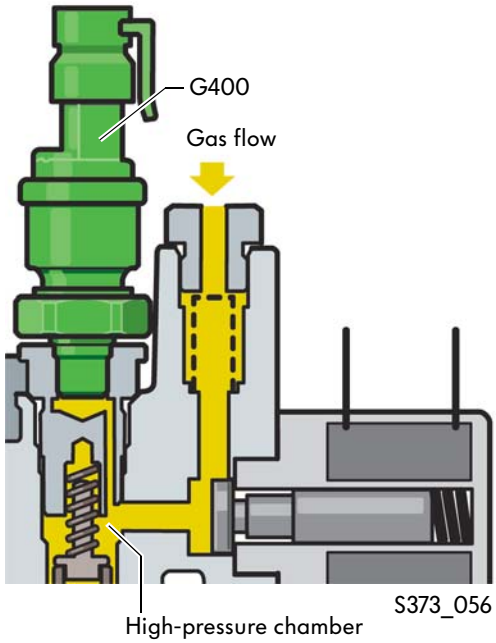
This pressure sensor is screwed from above into the gas pressure regulator.

Task

The tank pressure sensor calculates the current natural gas pressure in the high-pressure side of the natural gas system. Using this value, the engine control unit recognises the filling level of the natural gas tank.

Effect upon failure

If the signal from the tank pressure sensor fails, the fuel gauge for the natural gas tanks will drop to zero. The vehicle will continue to run in natural gas mode as long as a natural gas pressure above 6bar is present at the gas fuel rail sensor G401.



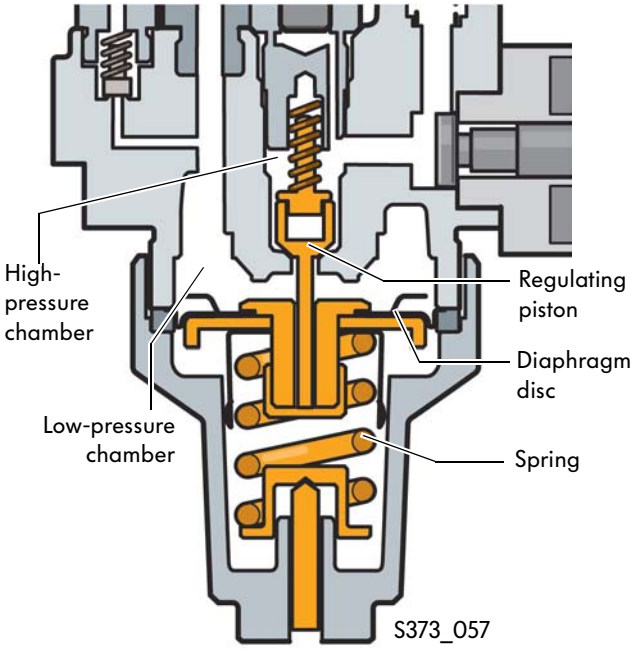
Reduction stage

Task

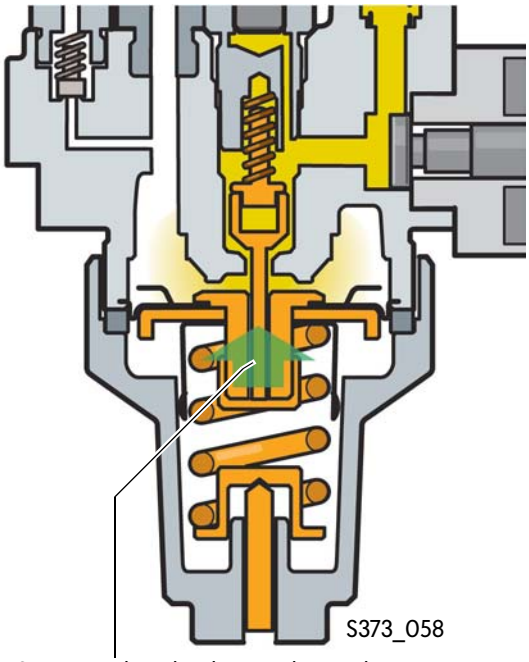
The natural gas pressure is reduced from high pressure to low pressure in the pressure reduction stage.

Function

If the high-pressure valve for gas mode is opened by the engine control unit, the natural gas will flow at high pressure to the regulating piston in the high-pressure chamber. The regulating piston is connected to the low-pressure chamber by a spring-loaded diaphragm.



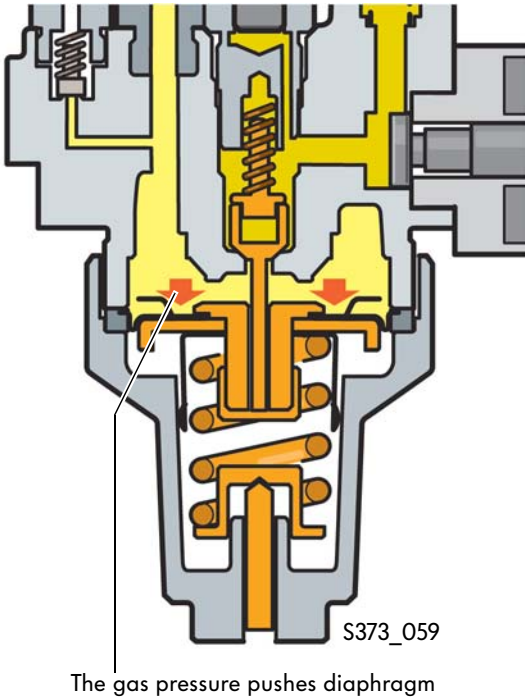
If the natural gas pressure in the low-pressure chamber is lower than 6 bar, the diaphragm and the regulating piston is pressed upwards by the pressure spring. The regulating piston opens the passage to the high-pressure chamber. Natural gas now flows from the high-pressure chamber into the low-pressure chamber.



Spring pushes diaphragm disc and regulating piston upwards.

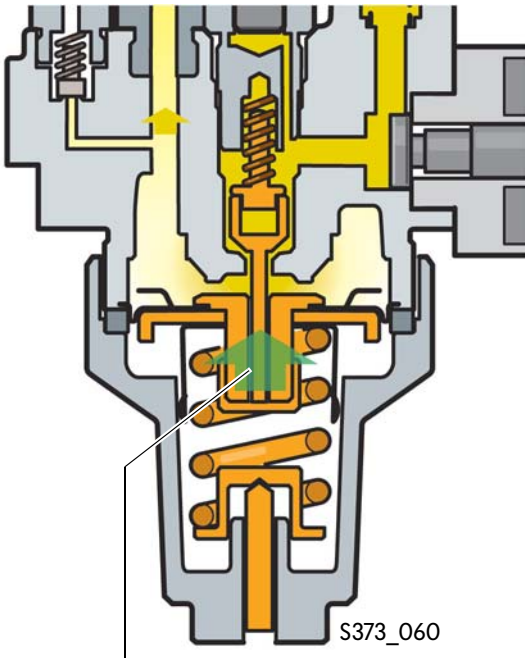
Natural Gas Supply

The pressure in the low-pressure chamber rises due to the incoming natural gas. If the pressure reaches 6 bar, it presses the diaphragm downwards against the spring force. This causes the regulating piston connected to the diaphragm to close the connection to the high-pressure chamber.



The gas pressure pushes diaphragm disc and regulating piston downwards.

When natural gas is consumed by the engine, the natural gas pressure in the low-pressure chamber falls. The spring now pushes the diaphragm disc upwards again, which opens the regulating piston. Natural gas flows into the low-pressure chamber again.



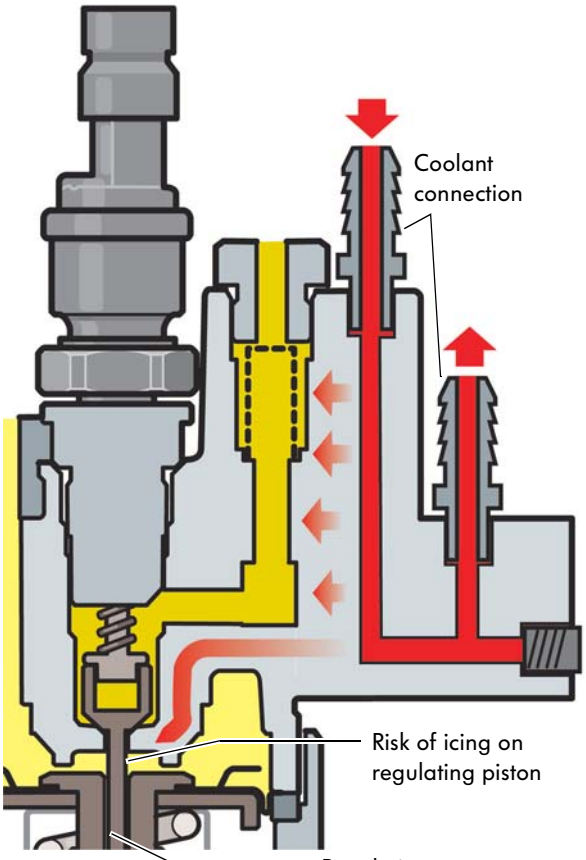
Spring pushes diaphragm disc and regulating piston upwards again.

Coolant connections

If the natural gas is regulated from 200 bar down to 6 bar, the natural gas will expand. It draws thermal energy from its surrounds so the gas and its surrounds cool down.
The process is similar to the behaviour of the coolant in the evaporator of an air-conditioning system.

Task

The gas pressure regulator is connected to the coolant system via the coolant connections. This prevents the gas pressure regulator icing.



S373_105

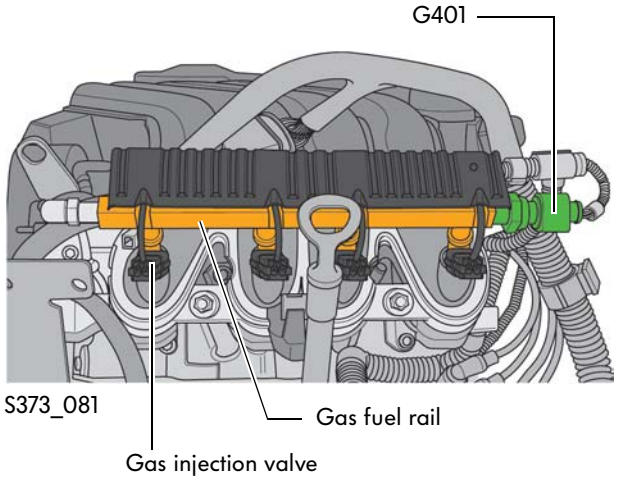
You will find more information on the natural gas mode operating conditions on pages 36/37 of this self-study programme.

Natural Gas Supply

Low-pressure side

Gas fuel rail

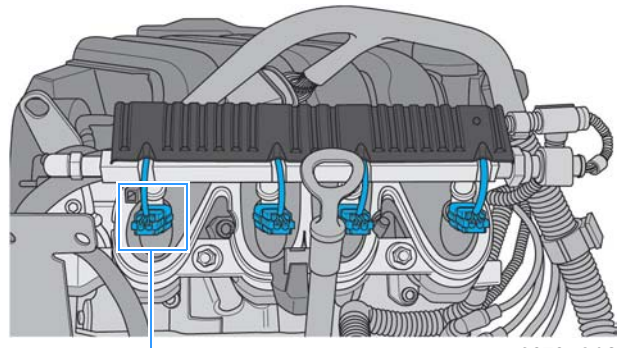
The gas fuel rail is mounted on the upper part of the intake manifold. It has four electrically controlled gas injection valves N366 to N369 as well as the gas fuel rail sensor G401.

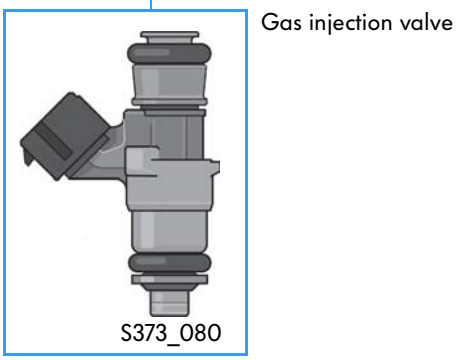


Gas injection valves N366, N367, N368 and N369

The gas injection valves are inserted into the cylinder intake ducts. They are activated by the engine control unit in natural gas mode with a pulse-width modulation signal.
The opening times of the gas injection valves depend on:

- the engine speed,
- the engine load,
- the natural gas quality and
- the natural gas pressure in the gas fuel rail.

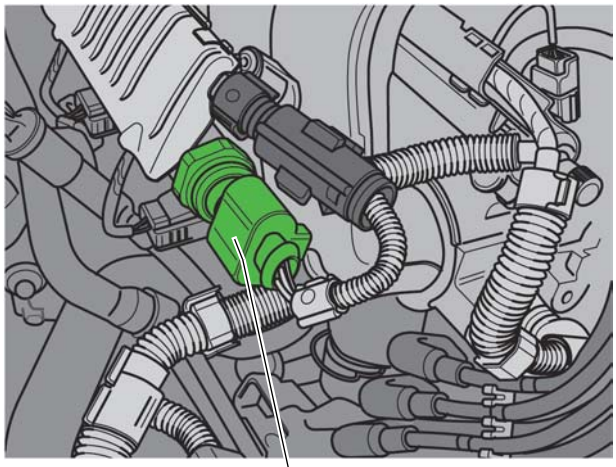




Effect upon failure

As soon as one gas injection valve fails, the engine control unit switches to back-up petrol mode.

Gas fuel rail sensor G401



S373_030

The gas fuel rail sensor is mounted on the left-hand front side of the gas fuel rail. It determines the natural gas pressure in the fuel rail.

Signal use

The engine control unit uses the signal from the sensor to calculate and control the opening times of the injection valves.

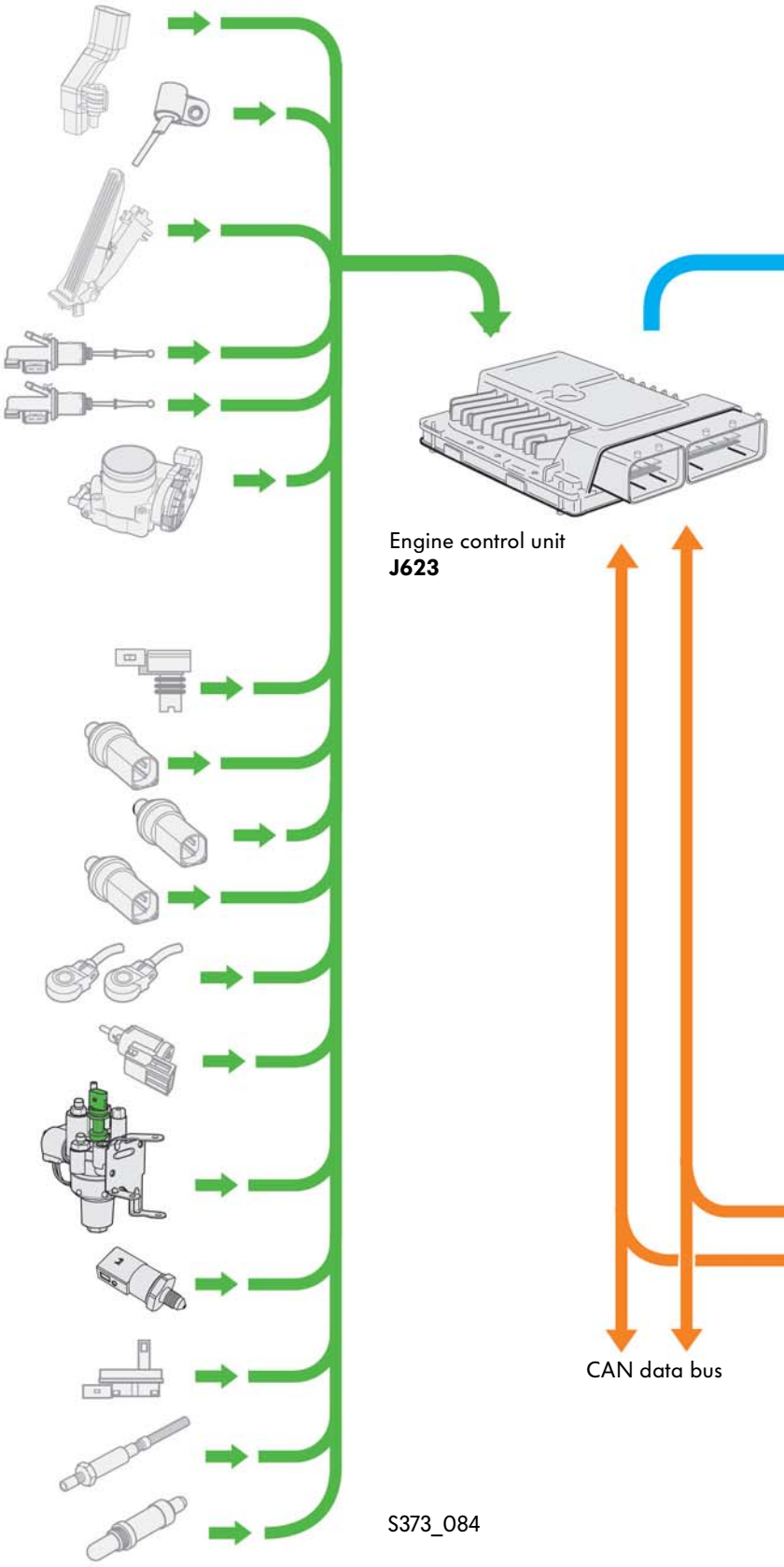
Effects of signal failure

If the pressure in the gas fuel rail rises above the value 10.5bar or if the sensor signal fails, the vehicle will switch to back-up petrol mode.

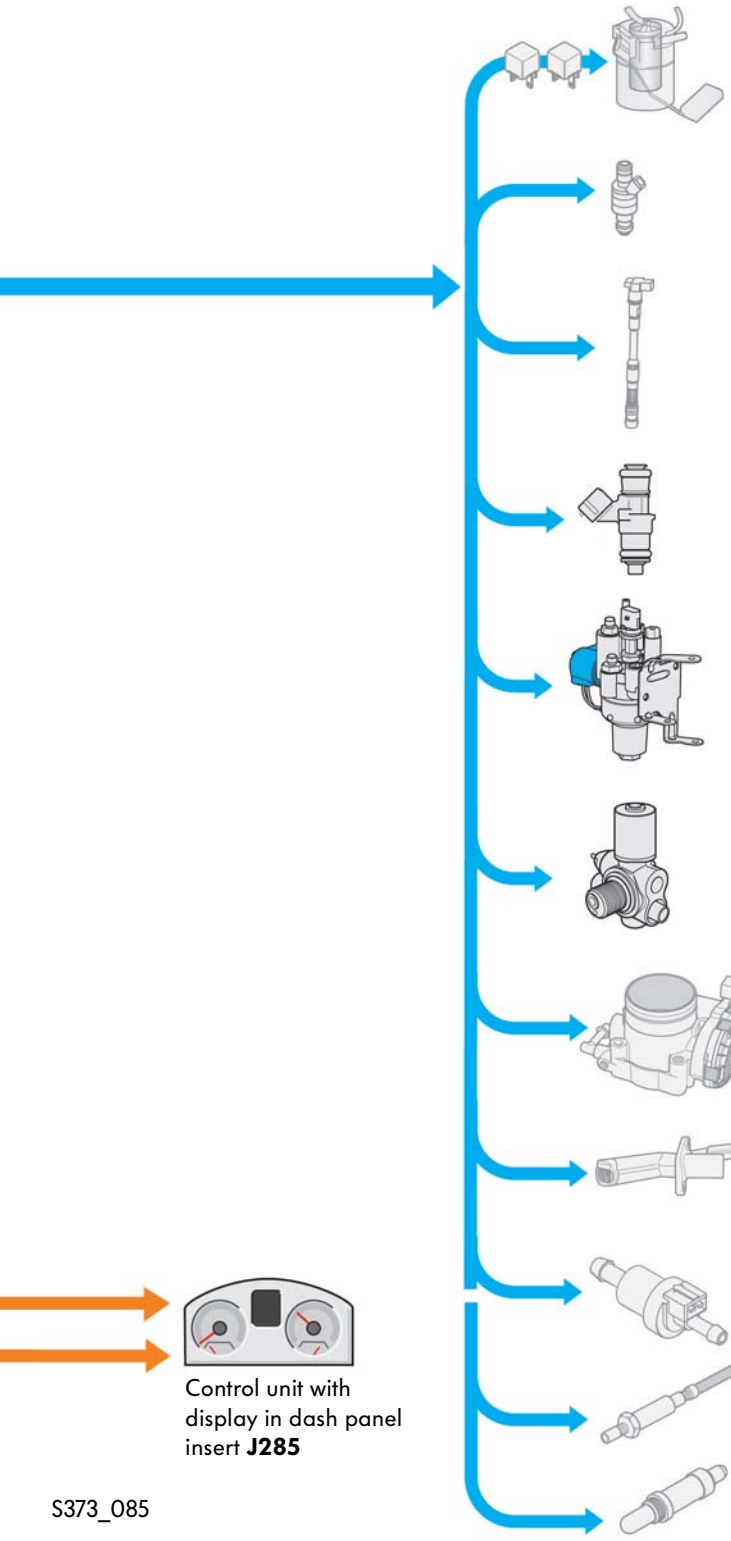
System Overview

With example of Touran

Sensors



Control elements



Fuel pump switch-off relay **J333**
Fuel pump relay **J17**
Fuel system pressurisation pump **G6**

Injectors for cylinders 1-4
N30, N31, N32, N33

Ignition coils 1-4 with output stage
N70, N127, N291, N292

Gas injection valve 1-4
N366, N367, N368, N369

High-pressure valve for gas mode
N372

Valves 1-4 for tank shut-off
N361, N362, N363, N429

Throttle valve module **J338**
Throttle valve drive for electric throttle **G186**

Heater element for crankcase breather
N79

Active charcoal filter system solenoid valve **N80**

Lambda probe heater **Z19**

Lambda probe 1 heater after catalytic converter **Z29**

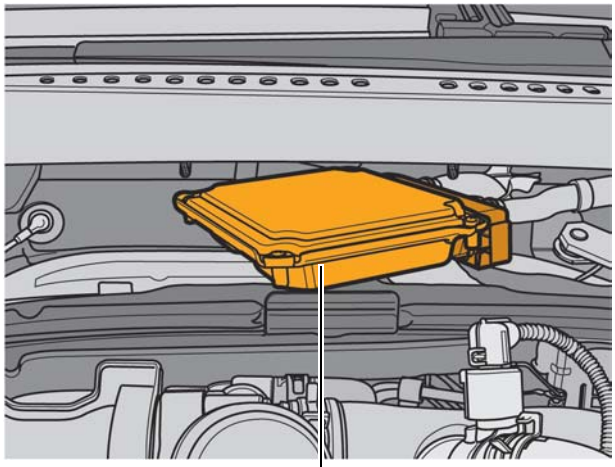
Control unit with display in dash panel insert **J285**

S373_085

Only the sensors and actuators that are required exclusively for natural gas mode are highlighted.

Engine control unit J623

The engine control unit is mounted in the centre of the plenum chamber. It regulates the mixture preparation in natural gas and back-up petrol mode.



S373_129

Engine control unit functions in natural gas mode

Engine start

- Coolant temperature below 15°C:
  Start in petrol mode
- Coolant temperature over 15°C:
  Start in natural gas mode

Conditions for natural gas mode

- Coolant temperature above 15°C
- Natural gas pressure in the gas fuel rail above 6bar

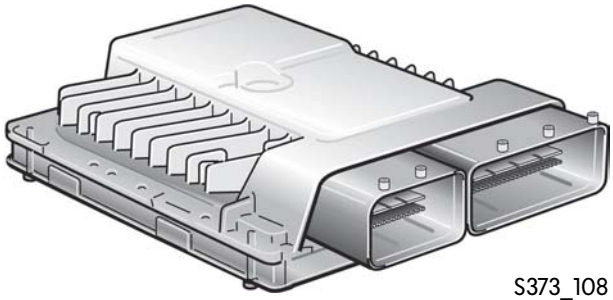
Engine start after filling up with natural gas

Start always in petrol mode.
The switch-over to natural gas mode occurs upon activation of Lambda control or after the engine has been running for 3 minutes at the latest.

Lambda regulation in natural gas mode

The mixture composition is regulated to Lambda 1 by the engine control unit in natural gas and petrol back-up mode.

Depending on the quality of the natural gas used (high or low gas), the engine control unit needs to adjust the mixture. The Lambda probe measures the exhaust gas composition and sends the result as a signal to the engine control unit. Using the signal, the engine control unit calculates the mixture composition that is currently required (air/natural gas). The engine control unit changes the opening times of the gas injection valves to control the mixture composition.



S373_108

Adaptation of the natural gas used

The engine control unit needs to adjust the opening times of the gas injection valves to the natural gas quality used after you fill up with natural gas.
The engine control unit recognised that a filling procedure has occurred using the fuel tank pressure sensor G400.

If the vehicle has been filled up with high gas, a richer mixture results due to the higher proportion of methane in the exhaust gas and accordingly a leaner mixture with low gas. The engine control unit recognises the mixture composition using the exhaust gas quality that is detected by the Lambda probe.
If the exhaust gas quality does not correspond with the current mixture composition, the engine control unit presumes that a different natural gas quality has been filled and adjusts the opening times of the gas injection valves to the current natural gas quality.

On-board diagnose II

The on-board diagnosis checks all components and systems relevant to the exhaust gas while the vehicle is running. It stores the malfunctions and indicates exhaust gas-related errors with a warning lamp (MIL).

Dash panel insert

The following indicators for natural gas mode and for petrol back-up mode are located in the dash panel insert:

- Petrol back-up mode warning lamp
- Petrol level bar indicator
- Analogue natural gas supply gauge

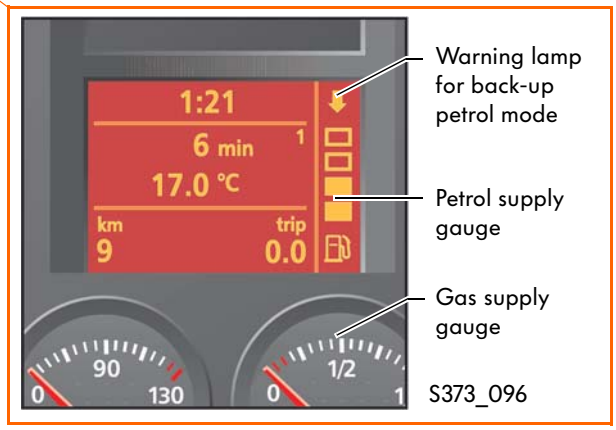
There are two different versions of the dash panel insert:

- one for the Midline versions of the vehicles and
- one for the Highline versions of the vehicles.

Dash panel in Midline version

S373_095

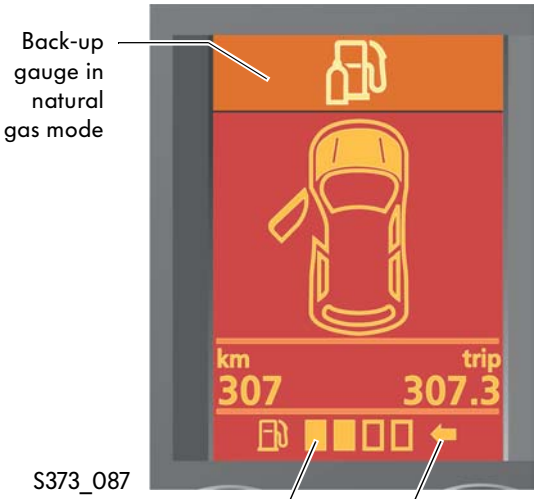
If the arrow next to or above the bar indicator is illuminated, the engine is running on petrol. Once the arrow extinguishes, the vehicle is driving with natural gas again.
The natural gas mode is possible from an engine coolant temperature of over 15°C. The engine control unit switches between gas and back-up petrol mode automatically.



S373_096

Dash panel in Highline version

S373_086



S373_087

Safety Concept

Natural gas system safety

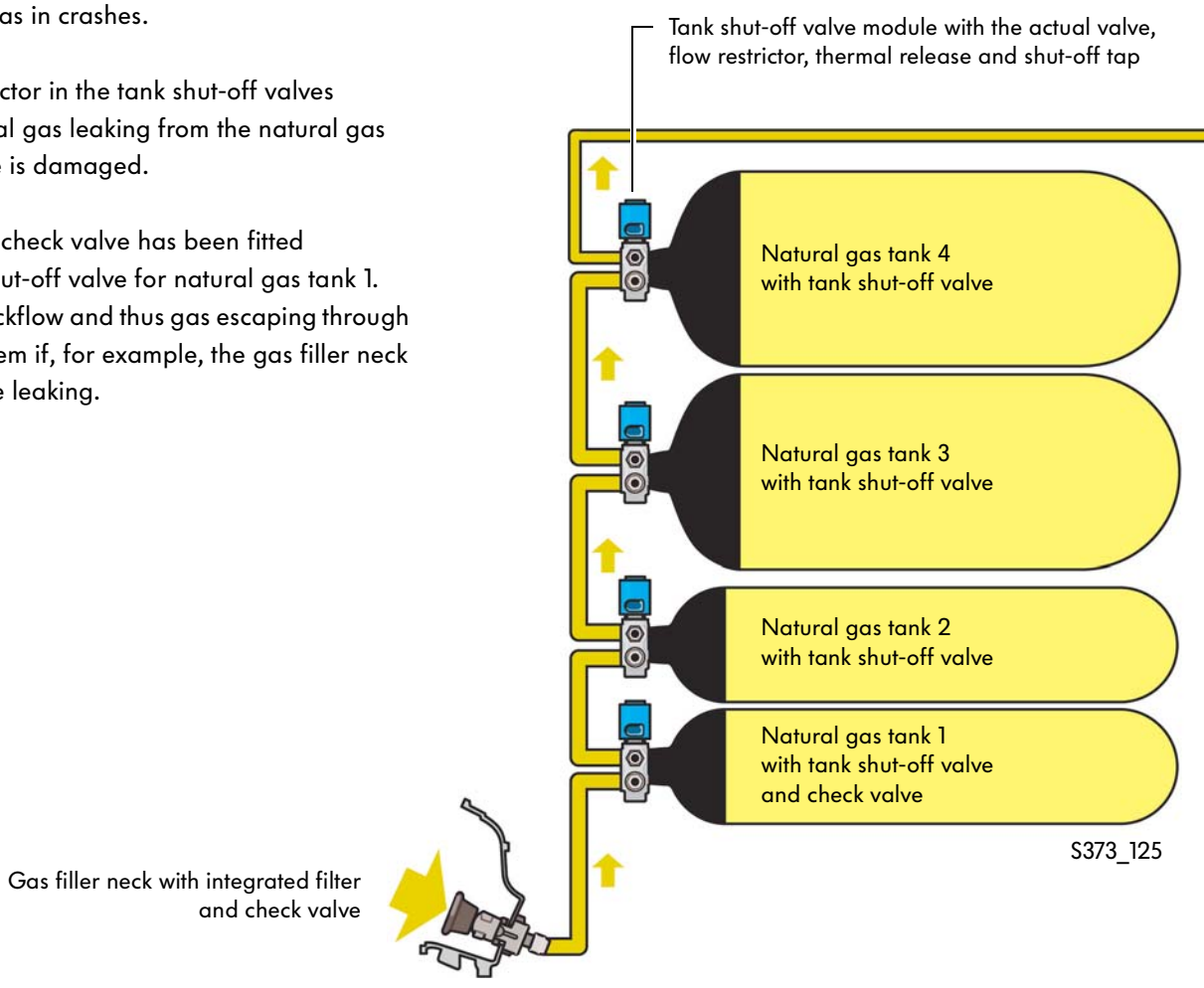
During the development of the two Caddy and Touran EcoFuel natural gas vehicles, particular focus was placed on safety in the area of the natural gas system. To illustrate this, we will summarise the constructive and functional features that influence the safety of the natural gas system for you.

- All high-pressure pipes and connecting elements are made from seamless stainless steel. These components are extremely corrosion-resistant and thus not prone to leaks.

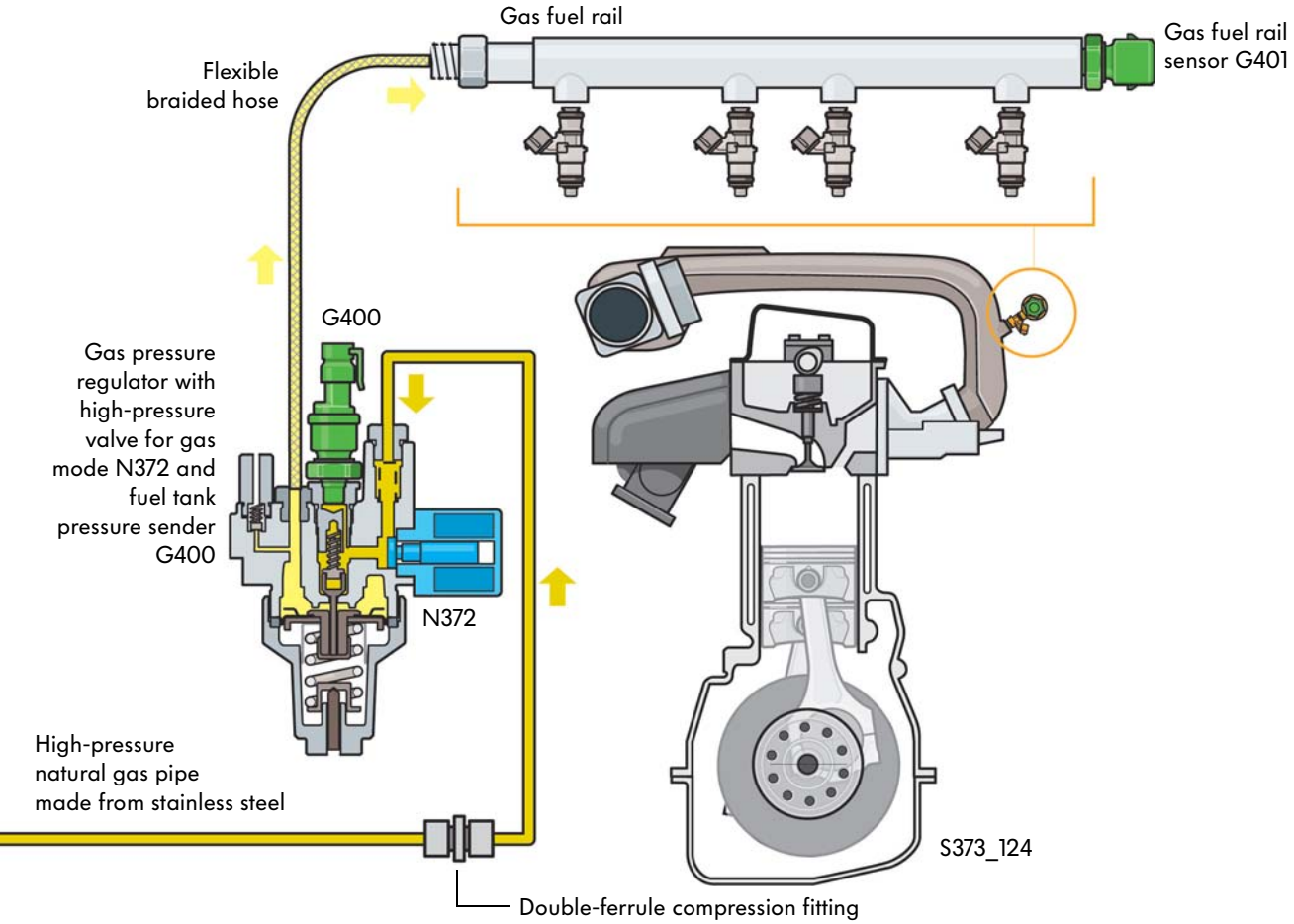
- There is a tank shut-off valve on each of the four natural gas tanks. In addition, the gas pressure regulator has a high-pressure valve for gas mode. These five valves automatically interrupt the gas supply when the engine is not running, in petrol mode as well as in crashes.

- The flow restrictor in the tank shut-off valves prevent natural gas leaking from the natural gas tanks if a pipe is damaged.

- In addition, a check valve has been fitted on the tank shut-off valve for natural gas tank 1. It prevents backflow and thus gas escaping through the filling system if, for example, the gas filler neck happens to be leaking.



The natural gas system on the Touran

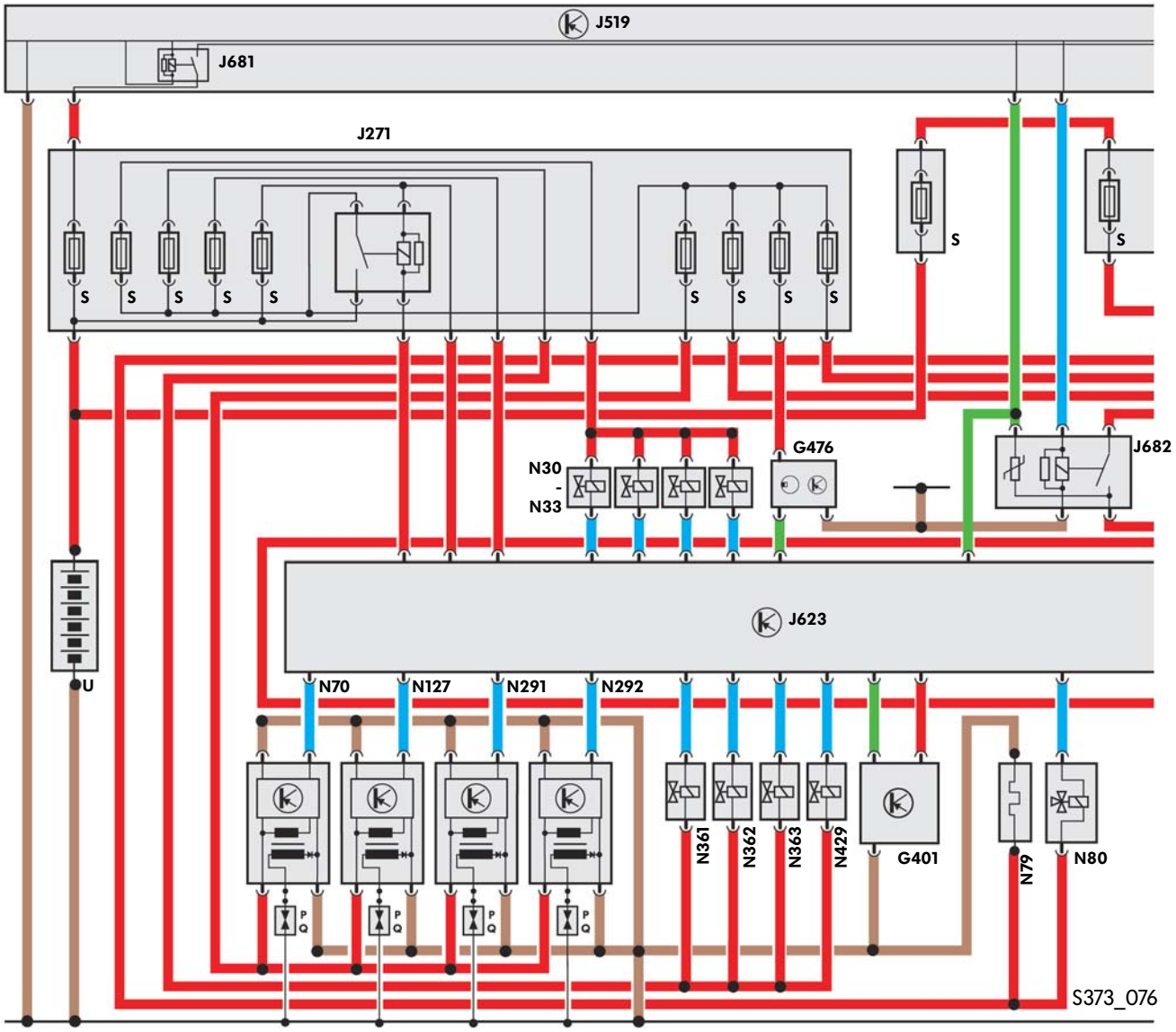


- A flexible braided hose is used between the gas pressure regulator and gas fuel rail.
- The whole natural gas system on both vehicles is installed so that it has the best possible protection against damage.
- All components and mountings were tested in front and rear collisions.

Service and maintenance work on the high-pressure pipes of the natural gas system may only be carried out by specialist technicians. Please make sure you read the latest instructions in ELSA.

Functional Diagram

Touran functional diagram



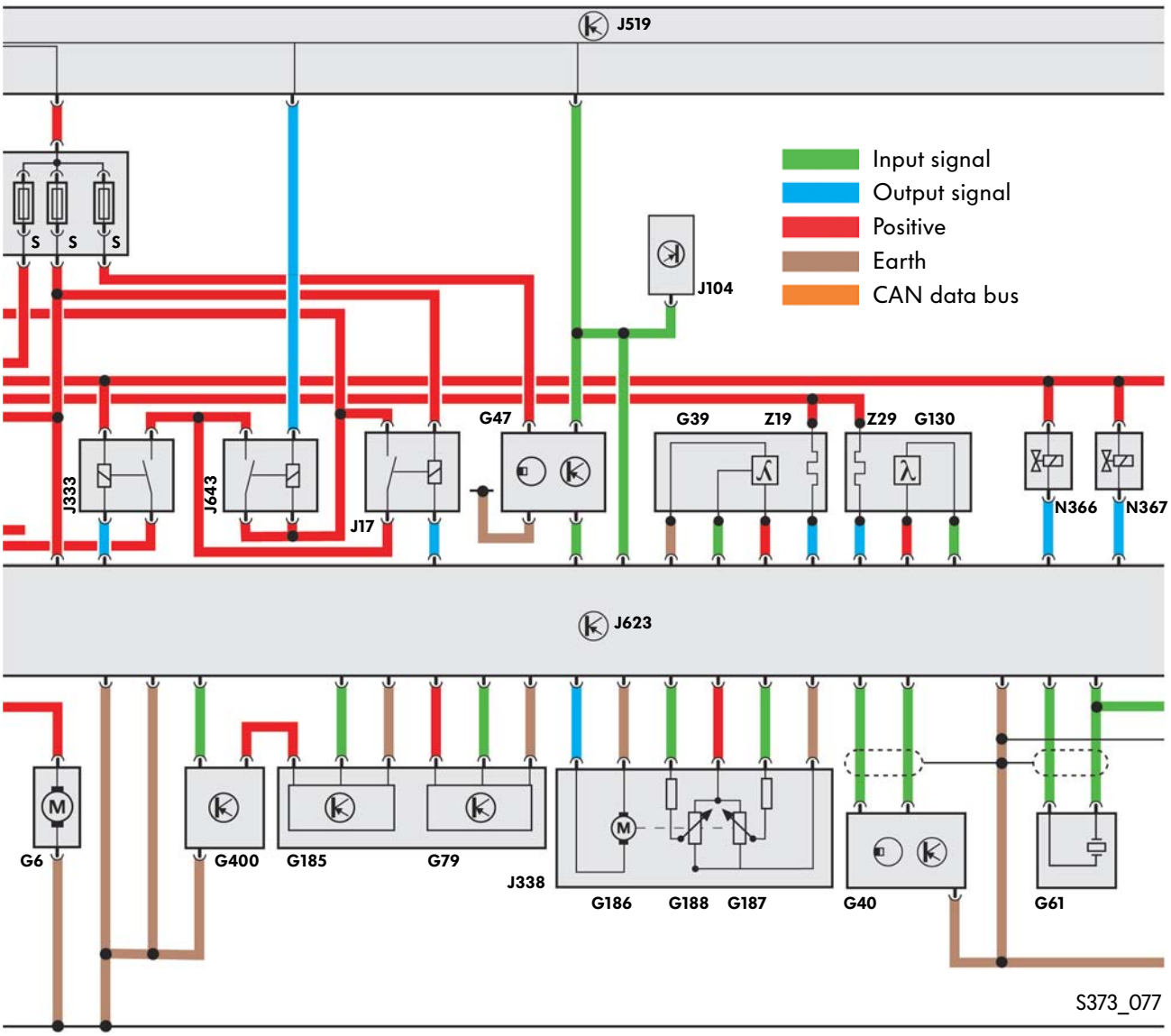
G476 Clutch position sender

J271 Motronic current supply relay, on E-box, on left-hand side of engine compartment
J519 Onboard supply control unit
J623 Engine control unit
J681 Terminal 15 voltage supply relay
J682 Terminal 50 voltage supply relay

N30 Injector for cylinder 1
N31 Injector for cylinder 2
N32 Injector for cylinder 3
N33 Injector for cylinder 4
N70 Ignition coil 1 with output stage
N79 Heater element for crankcase breather
N80 Active charcoal filter system solenoid valve 1
N127 Ignition coil 2 with output stage
N291 Ignition coil 3 with output stage
N292 Ignition coil 4 with output stage
N361 Valve 1 for tank shut-off
N362 Valve 2 for tank shut-off
N363 Valve 3 for tank shut-off
N429 Valve 4 for tank shut-off

S Fuse

U Battery



G6 Fuel pump
G39 Lambda probe
G40 Hall sender
G61 Knock sensor 1
G79 Accelerator pedal position sender
G130 Lambda probe after catalytic converter
G185 Accelerator pedal position sender 2
G186 Throttle valve drive for electric throttle
G187 Throttle valve drive angle sender 1 for electric throttle
G188 Throttle valve drive angle sender 2 for electric throttle
G400 Fuel tank pressure sensor
G401 Gas fuel rail sensor

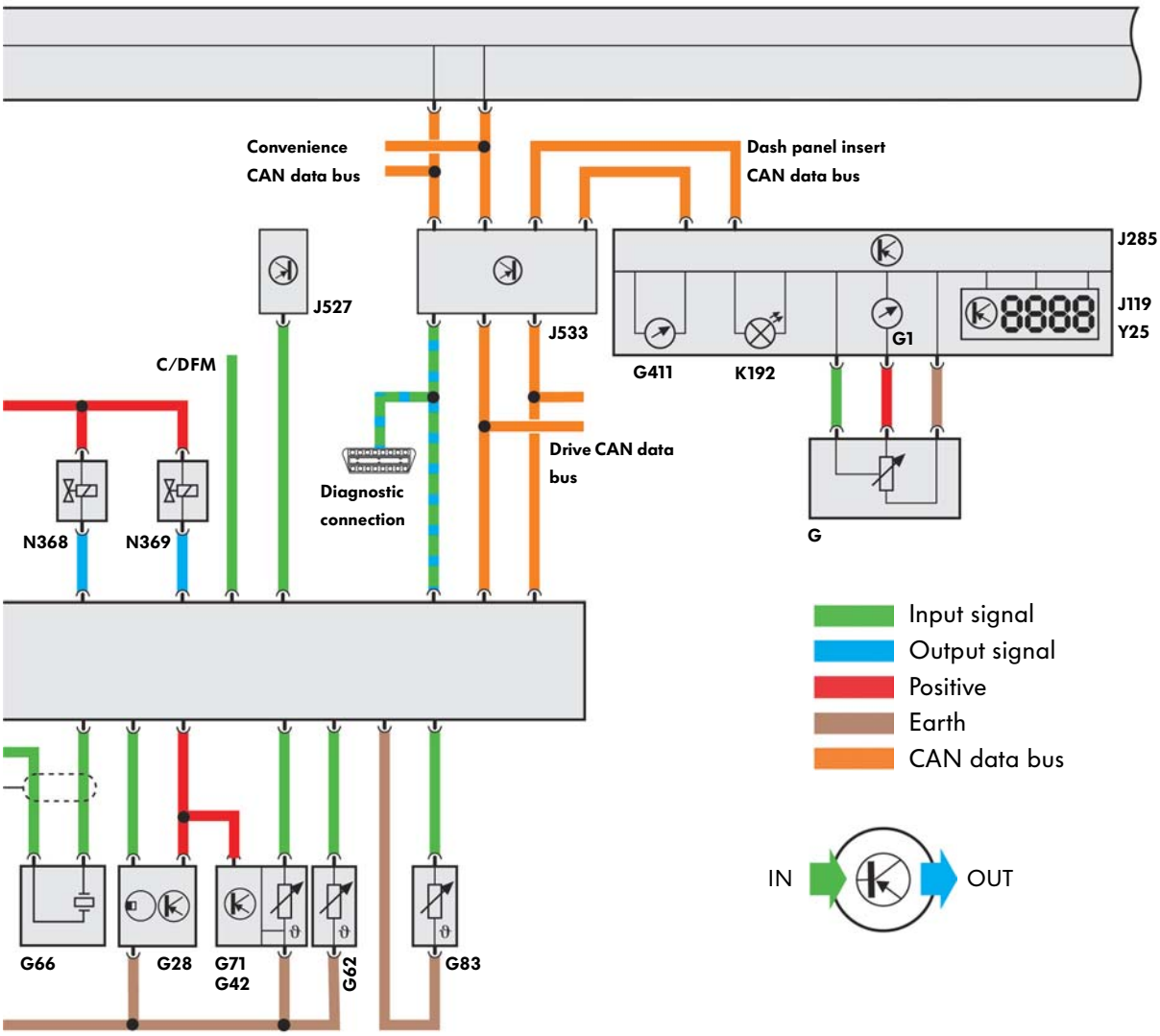
J17 Fuel pump relay on relay carrier on left under dash panel

J104 ABS control unit
J333 Fuel pump switch-off relay
J338 Throttle valve module
J519 Onboard supply control unit
J623 Engine control unit
J643 Fuel supply relay
J681 Terminal 15 voltage supply relay

N366 Gas injection valve 1
N367 Gas injection valve 2

Z19 Lambda probe heater
Z29 Lambda probe 1 heater after catalytic converter

Functional Diagram



S373_078

G Fuel gauge sender
G1 Fuel gauge
G28 Engine speed sender
G42 Intake air temperature sender
G62 Coolant temperature sender
G66 Knock sensor 2
G71 Intake manifold pressure sender
G83 Radiator outlet coolant temperature sender
G411 Natural gas gauge

J119 Multifunction display
J285 Control unit with display in dash panel insert
J519 Onboard supply control unit
J527 Steering column electronics control unit
J533 Data bus diagnostic interface
J623 Engine control unit
J681 Terminal 15 voltage supply relay

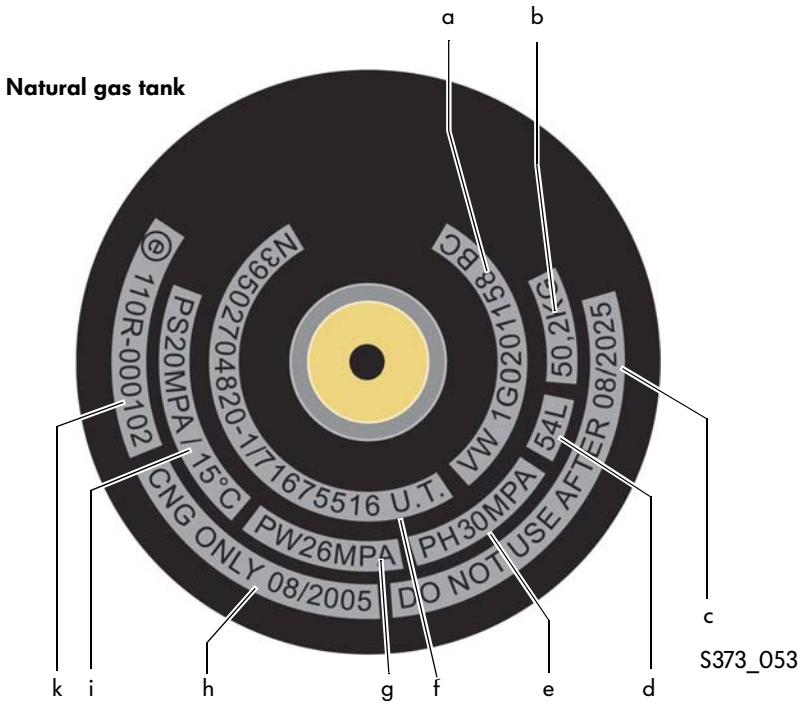
K192 Natural gas mode warning lamp

N368 Gas injection valve 3
N369 Gas injection valve 4

Y25 Segment display in dash panel insert

C/DFM Alternator field monitor
(engine control unit adjusts the alternator output to the voltage requirement using the engine speed.)

Natural gas tank labelling

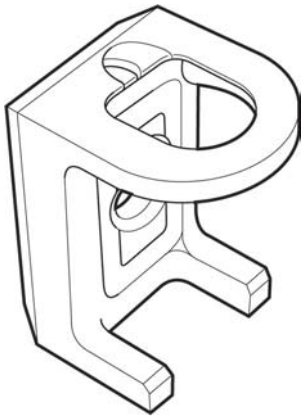
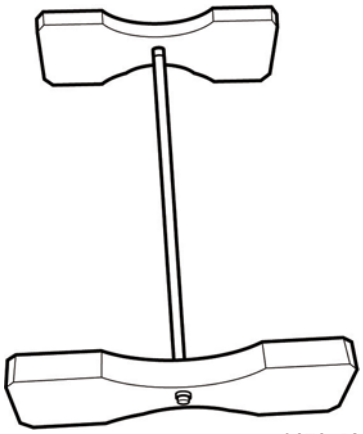


Legend and meaning of stamped labels

a	VW 1G0201158 BC (example)	Item number
b	50.2kg	Curb weight
c	Do not use after 08/2025	Indication of life of natural gas tank (expiry date)
d	54l	Capacity
e	PH 30MPA	Test pressure of 30MPA (30 MegaPascal = 30,000,000 Pascal = 300bar)
f	71675516 U.T.	Test code
g	PW26MPA	Max. filling pressure of 26MPa (260bar)
h	CNG only 08/2005	Filling note with date of manufacture
i	PS 20MPA / 15°C	Operating pressure of 20MPa (200bar) at a temperature of 15°C
k	(E) 110R-00102	ECE norm

The natural gas tanks have to be replaced after 20 years.
Information on the year of manufacture is given on the stamped test label on the natural gas tanks.

Special tools

Name	Tool	Application
T10349 Magnetic release tool	 S373_128	The magnetic release tool is used to empty the natural gas tank when the tank shut-off valve is not powered.
T10350 Special wrench	 S373_127	Wrench for removing and fitting the tank shut-off valves
T10351 Holder for natural gas tank	 S373_126	The holder is used to prevent the natural gas tanks rolling away while they are being fitted or removed. The holder has different radii on the top and bottom for the different sized natural gas tanks.

Which answers are correct?
One or several of the answers could be correct.

1. At what pressure are the natural gas tanks filled?

- [ ] a) 15bar
- [ ] b) 200bar
- [ ] c) 6bar

2. Which valve is also fitted on the tank shut-off valve for the first natural gas tank?

- [ ] a) An electromagnetic valve
- [ ] b) A check valve
- [ ] c) A mechanical shut-off valve

3. The pressure in the gas fuel rail is ...

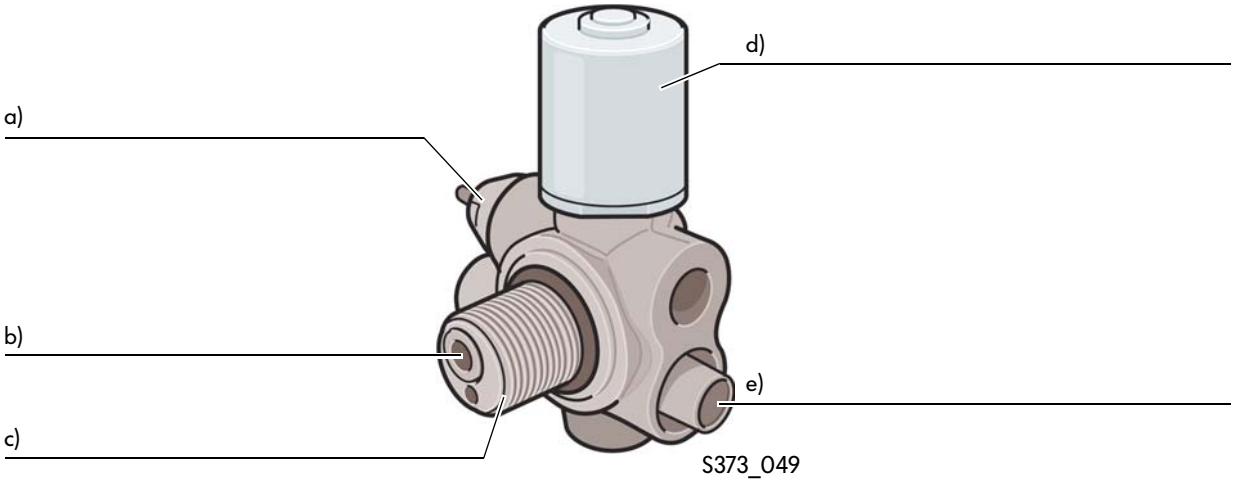
- [ ] a) 10bar
- [ ] b) 9bar
- [ ] c) 6bar

4. How high is the anti-knock index of natural gas?

- [ ] a) 130RON
- [ ] b) 95RON
- [ ] c) 110bar

Test Yourself

5. Name the main components of the tank shut-off valve.



6. Who may carry out work on the high-pressure side of the natural gas system?

- ☐ a) Service technician
- ☐ b) Any mechanic
- ☐ c) Only a trained person with proof of qualification

7. What safety system prevents the natural gas tank bursting in a fire?

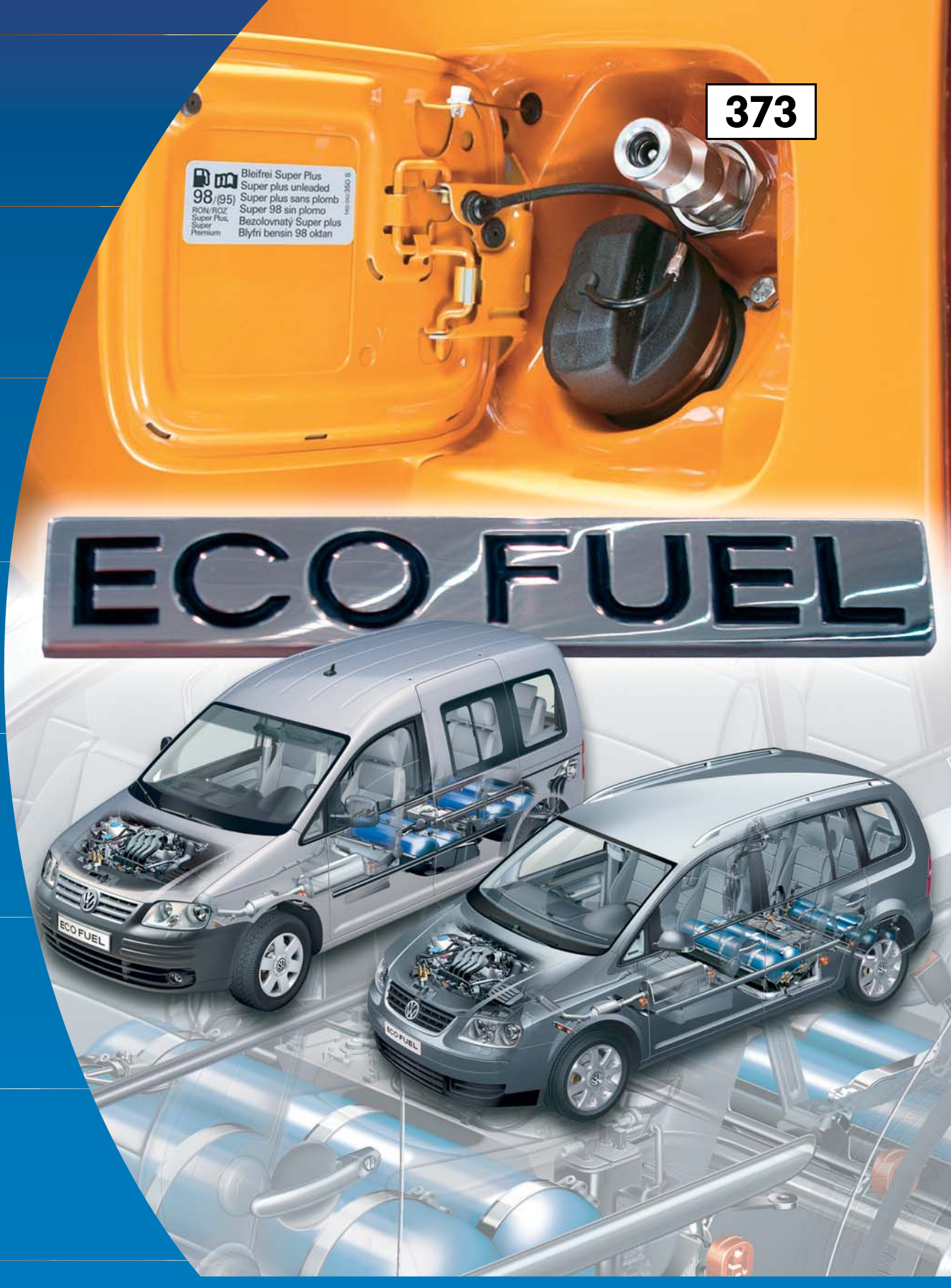
- ☐ a) The gas pressure regulator
- ☐ b) The thermal release
- ☐ c) The tank shut-off valve

8. What should you observe when carrying out repairs on the natural gas tanks?

- ☐ a) The mechanical shut-off taps should be closed on the tank shut-off valves.
- ☐ b) The natural gas tanks need to be checked for leaks and damage.
- ☐ c) The thermal fuses should always be replaced.

Notes

Answers
1. b); 2. b); 3. c); 4. a); 5. a) Shut-off tap, b) Flow restrictor, c) Natural gas tank connecting thread, d) Tank shut-off valve, e) Thermal fuse; 6) c; 7) b; 8) a, b



000.2811.80.20 Technical status 05/2006

Volkswagen AG
Service Training VSQ-1
Brieffach 1995
38436 Wolfsburg

❀ This paper was manufactured from pulp that was bleached without the use of chlorine.