

Service.



**Self-Study Programme 218**

# **The Lupo 3L**

Design and Function



Volkswagen developed the world's first 3-litre car on the basis of the Lupo. This car is now in series production.

The development goal was to design a fully fledged vehicle that achieves a fuel consumption of 3 litres per 100 km.

The Lupo 3L still meets the Volkswagen Group's requirements relating to environmental compatibility, safety and comfort.

This task could only be fulfilled by using the latest technologies and production processes. That is why roughly 80% of all parts used in the standard Lupo have been redesigned.

This Self-Study Programme gives you a general insight into the 3-litre car.



**The following Self-Study Programmes relating to the Lupo 3L are also available:**

- SSP 209** 1.9 l TDI Engine with Pump Injection System
- SSP 216** LUPO 3L Body
- SSP 221** The DS085 Electronic Manual Gearbox
- SSP 223** The 1.2 l TDI Engine
- SSP 225** Electro-mechanical Power Steering Gear

**New**



**Important Note**



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**The Self-Study Programme is not a Workshop Manual.**

Please always refer to the relevant Service Literature for all inspection, adjustment and repair instructions.

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# The trendsetter

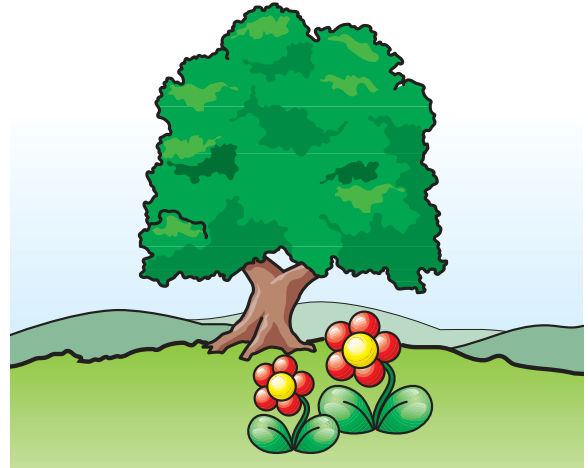


## Towards a new understanding of the motor vehicle

The mass mobilisation of mankind has had a profound effect on the environment.

The issues central to the debate on the environment are:

- economical use of raw materials and energy,
- air and water pollution control
- potential climatic changes.



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The 3-litre car has become a buzzword. The '3-litre car' is an eco-friendly concept embracing all the stages in the life-cycle of a product from manufacturing and utilisation through to recycling.

Volkswagen has responded to this challenge by developing the Lupo 3L.

The resulting vehicle reflects a new trend towards ultra-low fuel consumption without doing without mobility, comfort and safety.



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## The Lupo 3L as a technological pathfinder for future vehicles

The Lupo will also become the trendsetter for other vehicles:

The lightweight design concept and drivetrain technology, for example, will in future not only be reflected in the Lupo 3L.



## The 3-litre concept

The demand for a fuel consumption of 3-litres per 100 km sets high design standards.

### How can these standards be met?

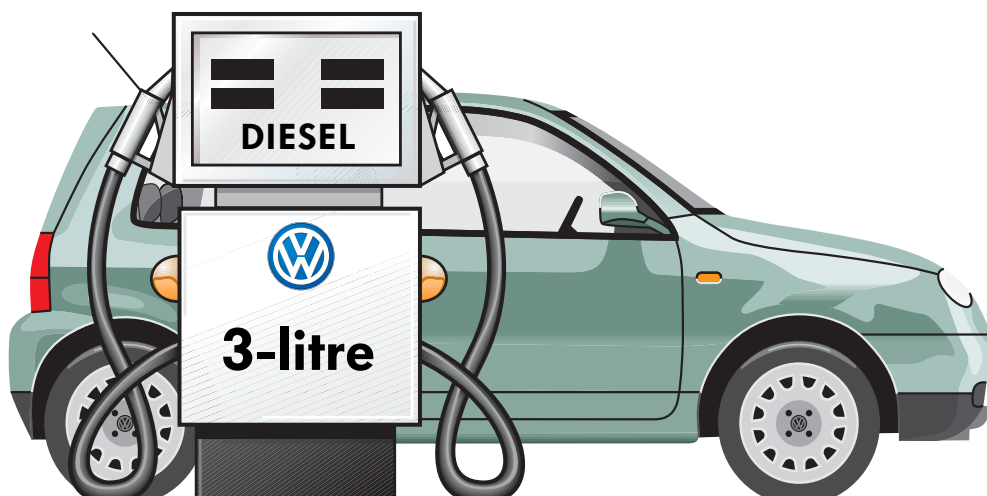
1. By systematically saving weight throughout the vehicle
2. By improving the drivetrain technology
3. By reducing aerodynamic drag
4. By reducing rolling resistance

Only small improvements are achievable with regard to rolling resistance and aerodynamic drag. Weight savings and drivetrain technology are therefore the key factors from a design viewpoint.

There is a conflict between saving weight another aims:

- to maximise safety
- to offer a high level of comfort
- to provide room for four persons
- to keep environmental pollution down to a minimum by selecting appropriate materials and manufacturing processes, and
- to be able to recycle materials sorted into clean material streams

Volkswagen had set itself the goal of designing a vehicle which fulfills all of these conflicting requirements. It was therefore necessary to find the best possible compromise for each of these requirements.



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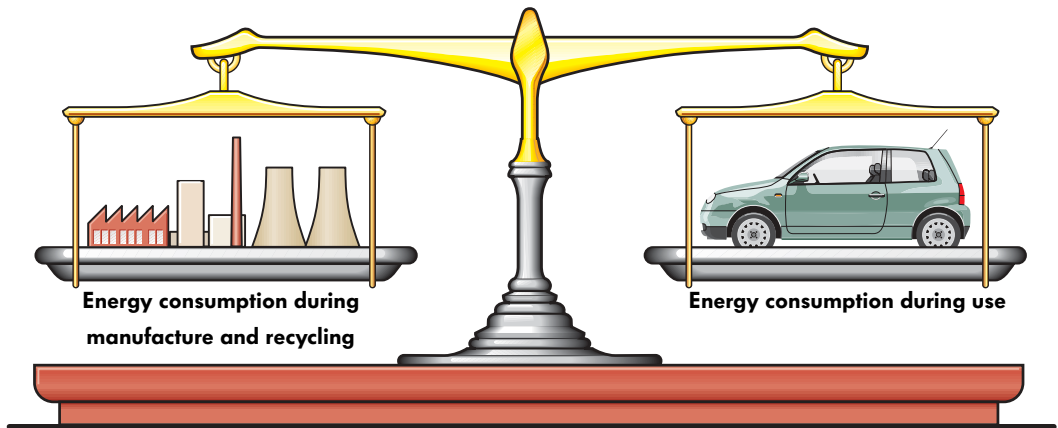
# The trendsetter



## What has weight saving got to do with the energy balance?

### The energy balance of the Lupo 3L

In an energy balance, two energy amounts are compared with one another.



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Energy required for manufacturing:

- Extraction of materials, e.g. aluminium and magnesium
- The energy consumed in the production process

Energy consumption during use of the vehicle:

- Consumption of fuels and lubricants
- Energy consumption during care and maintenance

Product recycling:

- Recycling of materials
- Disposal of materials

### What is the Lupo 3L all about?

A major development goal was to reduce fuel consumption to a low level as part of an eco-friendly integrated concept.

This concept also involved utilising available technology to the full in order to minimise environmental pollution.

In other words, if a vehicle consumes less fuel in operation but a lot more energy during its manufacture, then the environment has effectively gained nothing.

The balance shown above would tip to the left in this case.

During the production of the Lupo 3L, available technology was utilised to manufacture and recycle materials in an ecologically compatible manner.

The result is that the energy balance of the Lupo 3L is positive. The total energy input is much lower than that of other vehicles.



## The light-weight design concept

In comparison with the Lupo SDI, weight has been saved in the following areas:

### Body:

Systematic light-weight construction through the use of light alloys, high-strength sheet-metal panels and window panes of thin-glass construction.

### Engine/gearbox unit:

Installation of a 3-cylinder engine with an aluminium cylinder block and a lighter gearbox (e.g. hollow shafts).

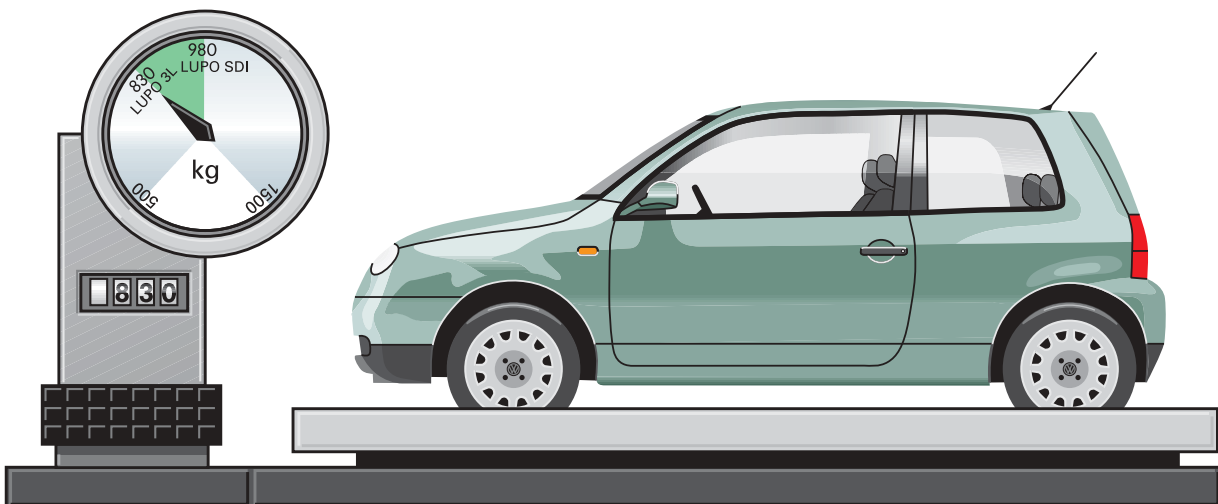
### Running gear:

Use of aluminium (e.g. on the front axle) and magnesium (e.g. for the steering wheel) as a substitute for steel.

### Equipment (trim):

Lightweight design modifications down to the smallest detail (e.g. seats with aluminium frame), as well as weight-saving insulating materials.

As a result, the Lupo 3L now weighs only 830 kg. That's 150 kg less than the Lupo SDI.



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# The trendsetter



## Light-weight body design

The doors, wings and bonnets are made of aluminium

Windows (thin glass)

Tailgate of aluminium/  
magnesium composite  
construction



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Insulating-materials made of  
lightweight materials

Seats with aluminium frame

### The following measures were also taken:

State-of-the-art production and joining systems were used to build the lightweight body. These include:

- The fasteners (bolts, etc.) have coatings which prevent them from coming directly into contact with aluminium and magnesium
- The joints on the bonnet and doors are roll-and-pierce riveted as on the Audi A8
- Clinching is used on the doors
- Laser welding was used to produce high-quality joints, e.g. between the body side panels and the sills, or between the roof outer skin and the upper ends of the A and B pillars.




Please refer to Self-Study Programme No. 216  
"Body of Lupo 3L".



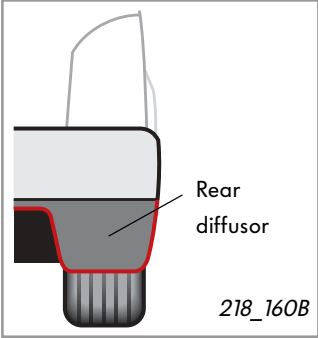
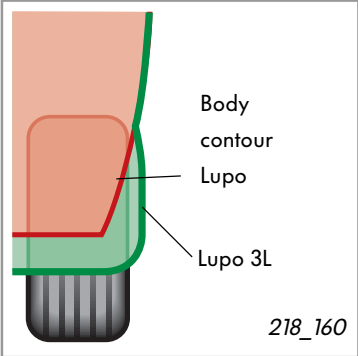





## Aerodynamics

Aerodynamic vehicle contours reduce fuel consumption. For this reason the body of the Lupo 3L has been redesigned to improve:



- Closed radiator grille:  
the cooling air flow enters the engine from below
- Spoiler on front bumper
- The shape of the tailgate
- Rear bumper with integral diffuser
- Side skirt with special air deflectors



### Further measures:

- The enlarged front track width with front wheels flush with the outer body optimise the air stream from the outer skin via the wheel housing,
- The suspension of the Lupo 3L has been lowered by 10 mm to improve air flow on the underside of the vehicle
- The joint dimensions have been reduced still further.

Thanks to these measures, the Lupo 3L has a drag coefficient of 0.29 compared with 0.32 for the standard Lupo SDI. This is an extremely low  $c_d$  figure for a vehicle of this size.

# The trendsetter



## The engine/gearbox unit

At the present level of technological development, an extremely low consumption figure of 3-litres per 100 km can only be achieved using diesel technology.

The engine and the gearbox have been developed hand in hand with one another.

### Engine:

The result of this development work was a 1.2-litre 3-cylinder diesel engine with an aluminium cylinder block, pump injection system, turbocharger and charge air cooler.

Very high injection pressures of up to 2050 bar can be produced by the pump injection system. High fuel combustion efficiency is the result. This in turn means lower fuel consumption and cleaner exhaust emissions.



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### Gearbox:

The Lupo 3L has an electronic manual gearbox. It is derived from manual gearbox 085, and gearshifts are performed automatically.

### Engine and gearbox management system of the Lupo 3L:

To achieve a consumption figure of 3 litres per 100 km, the Lupo 3L has an Economy mode in which the engine and gearbox management systems interact closely.

Driving in Economy mode means:

- the gearbox is operated automatically and the shift points are selected for optimal consumption
- engine power is reduced in order to optimise consumption
- a stop/start function shuts down the engine while the vehicle is stationary, e.g. at traffic lights

A performance-based sport mode and a manually operated Tiptronic function are also available.

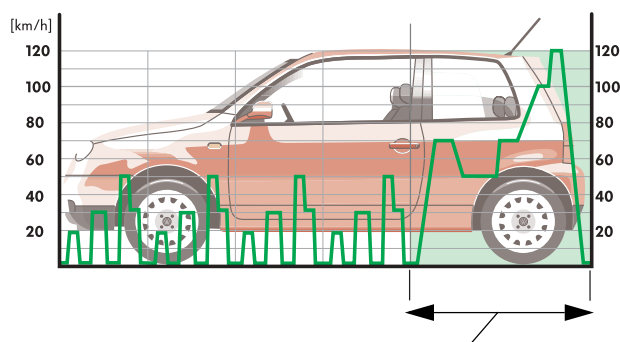


You will find more detailed information under "1.2 l TDI engine" and "The DS085 Electronic Manual Gearbox", as well as in Self-Study Programmes No. 209 and No. 221.

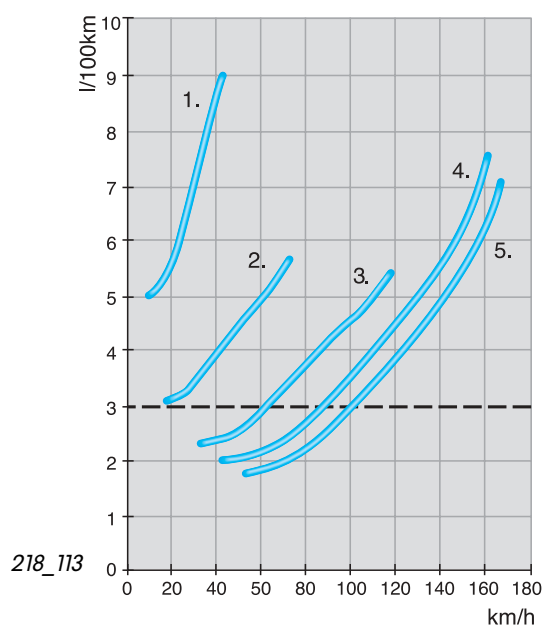


## The outstanding feature

of the Lupo 3L is its low fuel consumption, hence the name '3L'.



This is the part of the MVEG cycle which is used to calculate the vehicle's fuel consumption.



### Fuel consumption in accordance with the MVEG standard

Fuel consumption is tested in accordance with the MVEG (Engine Vehicle Emission Group) standard applicable throughout the EU. This test incorporates a variety of vehicle states which simulate both the urban cycle and the extra-urban cycle. The MVEG test serves to determine the consumption of a vehicle. The test figures are applicable throughout the European Union.

The MVEG consumption figure for the Lupo 3L is 2.99 litres per 100 kilometres. It is therefore the first production 3-litre car in the world.

### Consumption curve:

The diagram shows the momentary consumption of the vehicle at a constant speed as a function of the gear engaged.

The diagram clearly shows that, in addition to road speed, the choice of gear is a key factor in fuel economy.

This is how the Economy mode works: when driving at a constant speed (e.g. 50 kph), upshifts are executed early; to accelerate, the gearbox shifts down again.

The diagram cannot show the many factors which influence fuel consumption in real life. These include:

- accelerating or coasting,
- headwind or tailwind,
- uphill gradient or downhill gradient,
- tyre pressure (is it correct or too low?)



### Further information on fuel consumption

- You'll find information on how to drive economically in the Owner's Manual for the Lupo 3L.
- Optional extras such as air conditioning or power steering increase fuel consumption.

# The trendsetter



## Safety features



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The Lupo 3L has adopted the safety equipment and features of the Lupo SDI.

It has inertia-reel seat belts for the driver and front passenger complete with a belt-fastened recognition sensor, belt force limiter and ball-type tensioner.

The rear seat bench has inertia-reel seat belts, and there is a lap belt for the middle seating position.

The Lupo 3L is fitted with driver's and front passenger's airbags as standard.

The airbag module fitted on the driver's and front passenger's sides have volumes of 52 litres and 100 litres respectively.

Two side airbags with a volume of 12 litres each are fitted depending on regional market requirements.



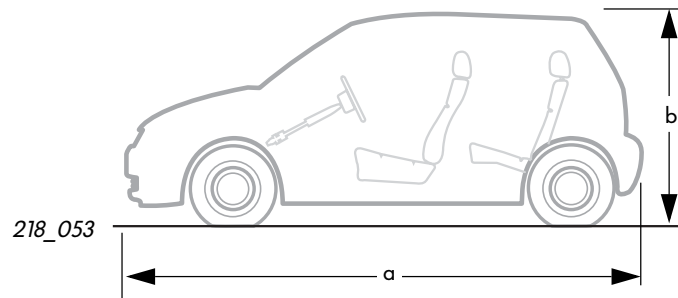
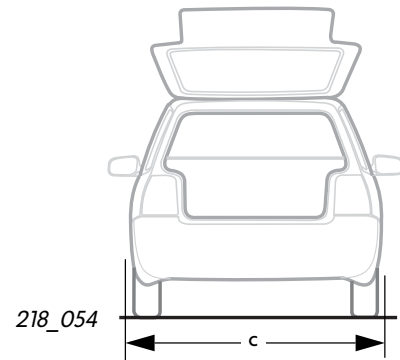
The fixing of the airbag module had to be modified in order to accommodate the new steering wheel.

Please observe the detailed instructions given in the relevant Workshop Manual.

# Specifications

## Lupo 3L and Lupo SDI

The specifications of the Lupo 3L and Lupo SDI in comparison with one another in the table below.



	<b>Lupo SDI</b>	<b>Lupo 3L</b>
Engine power [kW]	44 at 4200 rpm	45 at 4000 rpm
Torque [Nm]	115 at 2200-3000 rpm	140 at 1800 - 2400 rpm
Number of cylinders/displacement [cm <sup>3</sup> ]	4/1716	3/1191
Maximum speed [kph]	157	165
Drag coefficient $c_d$	0.32	0.29
Weight [kg]	980	830
Dimensions [mm]		
Length (a)	3527	3529
Height (b)	1460	1455
Width (c)	1639	1621

# The 1.2-litre TDI engine

## The 1.2 l TDI engine

is a 3-cylinder inline engine based on the 4-cylinder in-line engine with no intermediate shaft.

This engine was designed specially for the Lupo 3L and is the first diesel engine in the Volkswagen Group to have a diecast aluminium cylinder block.

The development goal was to reduce fuel consumption systematically.

This goal was achieved by means of:

- a pump injection system
- weight saving measures, and
- friction reduction measures



You will find more detailed information on 1.2-litre TDI engine in Self-Study Programme No. 223.

## Specifications

Engine code	ANY
Type	3-cylinder in-line engine
Displacement	1191 cm <sup>3</sup>
Bore / stroke	76.5 mm / 86.7 mm
Compression ratio	19.5 : 1
Firing order	1 - 2 - 3
Engine management system	BOSCH EDC 15P
Fuel type	Diesel min. 49 CN or biodiesel (RME)
Exhaust gas aftertreatment	Exhaust gas recirculation and oxidation catalytic converter
The engine conforms to the D3 exhaust emission standard	

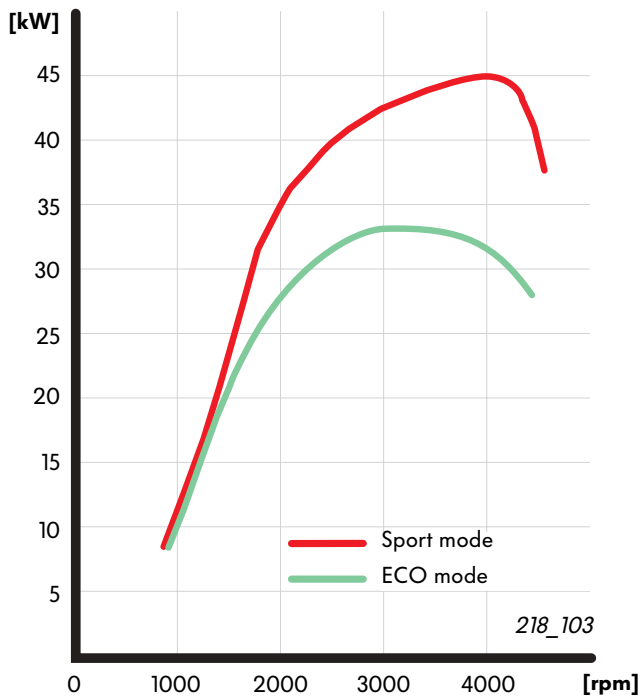
## Power output and torque

As already mentioned in the chapter entitled "Trendsetter", the Lupo 3L can be operated in Economy mode to optimise fuel economy and, alternatively, in performance-based Sport mode.

In Economy mode, the engine control unit reduces engine power output.

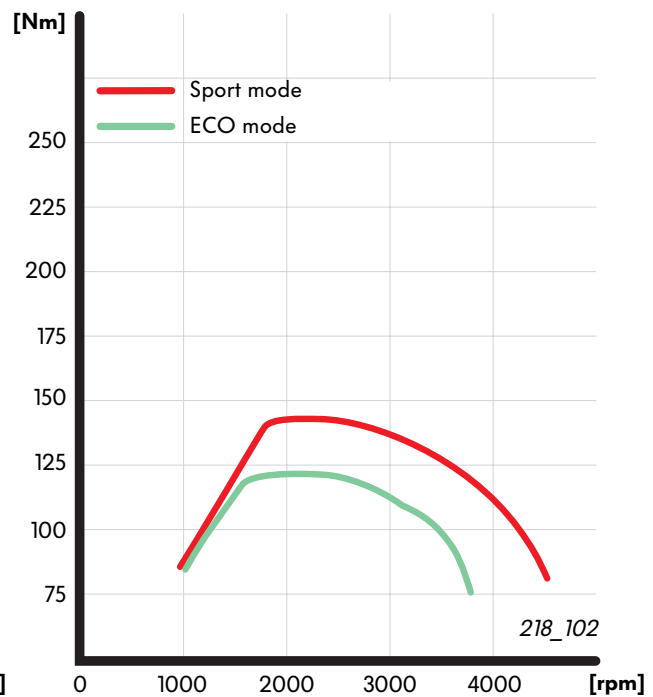


### Comparison of power output curves



As the comparison performance curve shows, maximum power output in Sport mode is 45 kW at 4000 rpm. In Economy mode, maximum power output is 33 kW at 3000 rpm.

### Comparison of torque curves



In Sport mode, maximum torque is 140 Nm at an engine speed of 1800 rpm and is available up to an engine speed of 2400 rpm.

In Economy mode, the maximum torque of 120 Nm is available at engine speeds ranging from 1600 to 2400 rpm.



# The 1.2-litre TDI engine

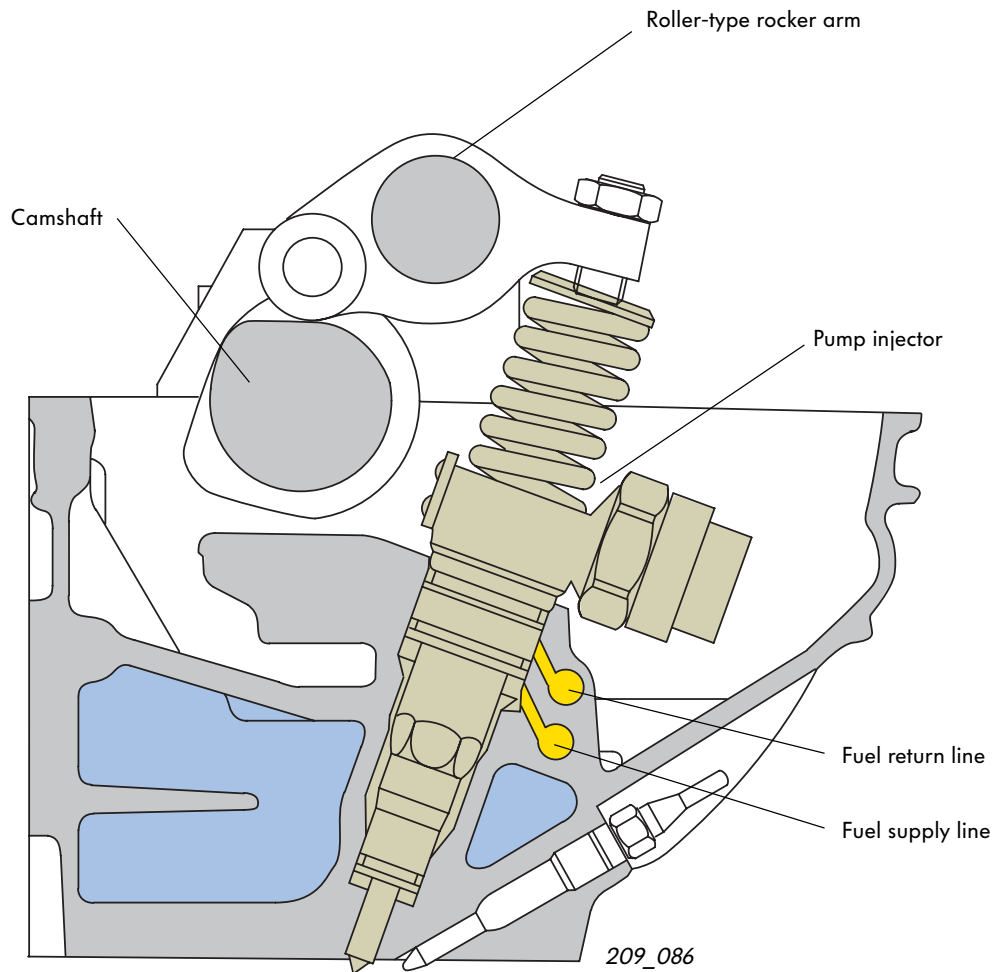
## The pump injection system

The 1.2 l TDI engine is fitted with a pump injection system.

Complete combustion depends on good mixture formation.

To achieve this, the fuel must be injected in the correct quantity and at the correct point in time in a finely atomised form.

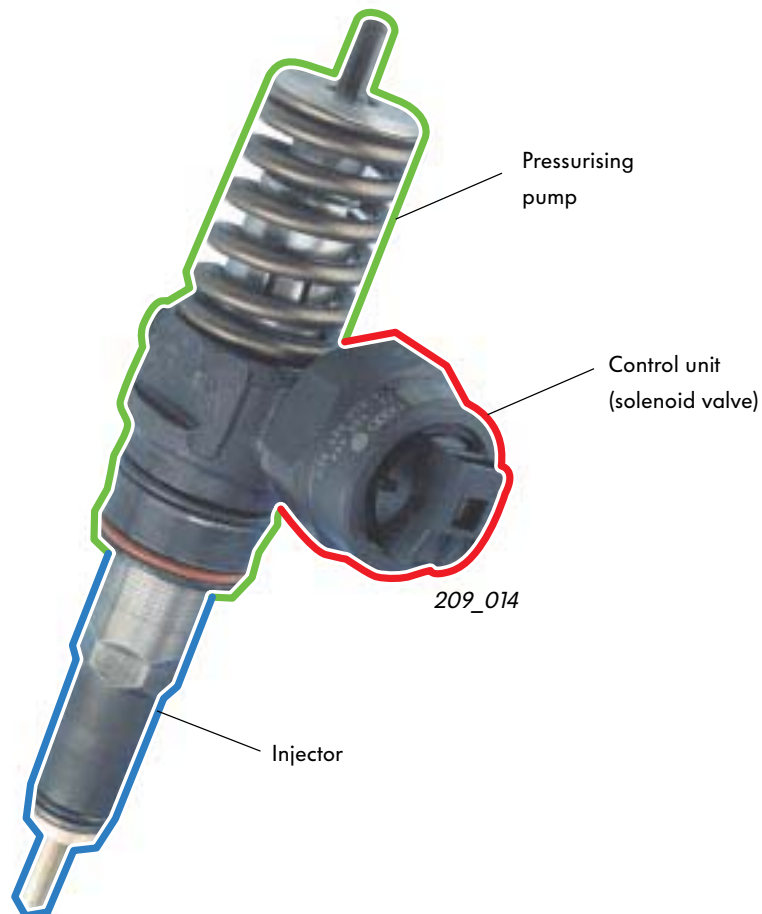
The pump injection system has a pump injector in the cylinder head for each cylinder. These units are driven by an additional cam on the valve camshaft via a roller-type rocker arm.



In the pump injector, the pressurising pump is combined with the injector and the control unit. This compact design results in a low high-pressure volume which makes injection pressures of up to 2050 bar possible. The engine management system controls pressure build-up, the commencement of fuel injection and injection quantity via the solenoid valve.

The pump injection system has the following advantages over a distributor injection pump:

- low fuel consumption,
- lower pollutant emissions,
- high efficiency and
- low combustion noise.



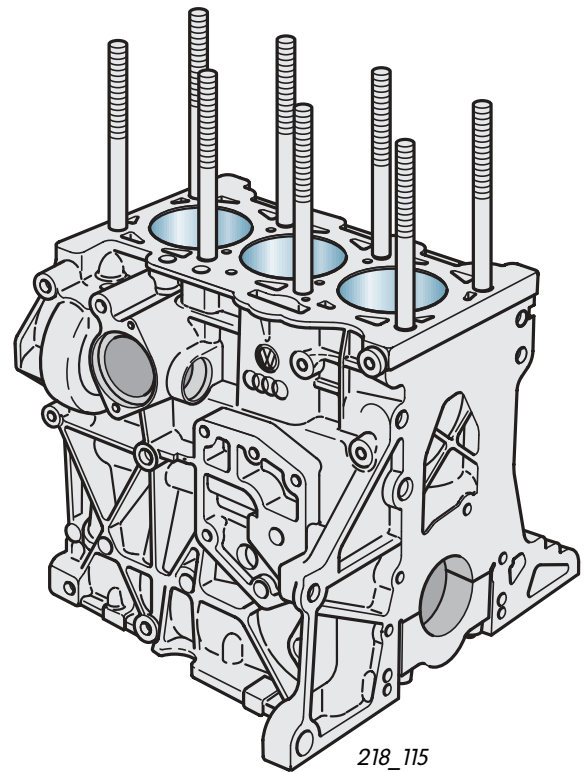
You'll find more information on the design and mode of operation of the pump injection system in Self-Study Programme No. 209.

# The 1.2-litre TDI engine

## Weight-saving measures

### The cylinder block

is made of aluminium and has cast-in grey cast iron cylinder liners.

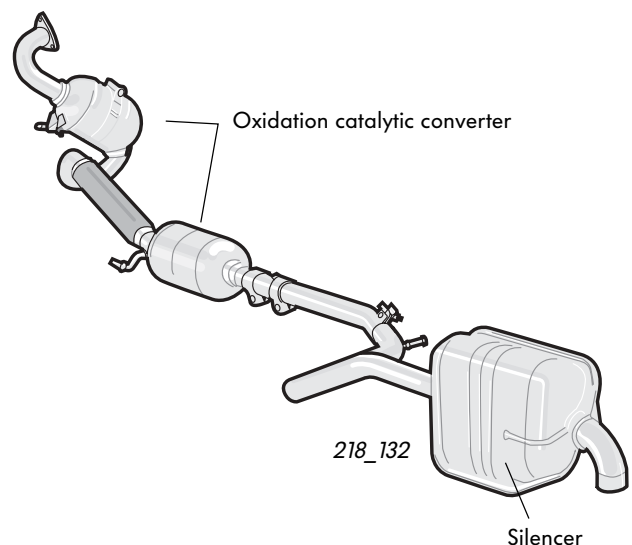


The crankshaft should not be not slackened or removed. Even slackening the bearing cover bolts will cause the aluminium bearing seats to lose shape. If the bearing cover bolts are slackened, the cylinder block must be replaced complete with the crankshaft.

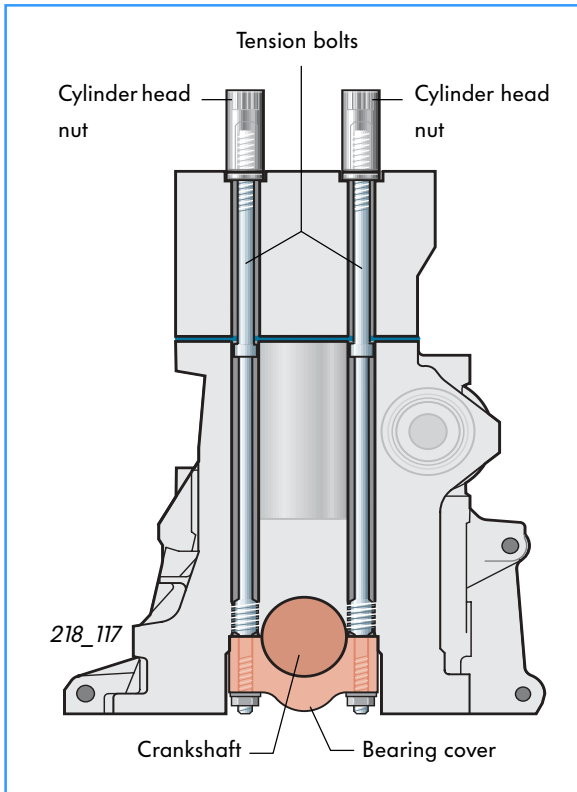
### The exhaust system

comprises two oxidation catalytic converters and a single silencer.

To reduce weight, the wall thicknesses of the exhaust pipes have been reduced. The exhaust manifold is a diecasting, but it is manufactured from sheet steel. Only one silencer is needed due to the low engine displacement. The exhaust system is made of stainless steel in order to inhibit corrosion.



## Friction-reducing measures



### The tension bolts

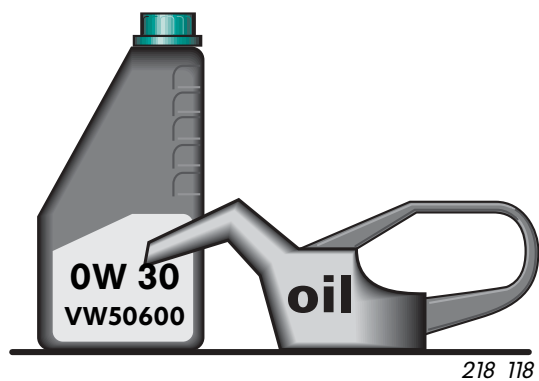
Steel pins are used as tension bolts. They join the cylinder head, the aluminium cylinder block and the crankshaft bearing cover.

Aluminium is not as strong as grey cast iron. Due to the high combustion pressures which build up inside this engine, use of a conventional threaded connection for the cylinder head in the cylinder block is risky because the threaded connection may become undone.

For this reason, the cylinder head and the cylinder block are joined by means of tension bolts. Tension bolts allow a continuous flow of force from the cylinder head to the bearing cover. This ensures a safe threaded connection and reduces stresses in the cylinder block.



For installation, the tension bolts are screwed into the cylinder block and fixed in place using "Loctite" locking fluid. They cannot be replaced.



### The engine oil

The 1.2 l TDI engine is filled with VW 50600 engine lube oil. This oil has the specification 0W30, which means it produces less friction than the engine oil used previously.

Further advantages of this oil grade are that it can withstand higher thermal stresses and has better cleaning properties.



The engine oil may not be mixed with other oils so as not to impair its lubricating properties. Please observe the instructions given in the Workshop Manual.



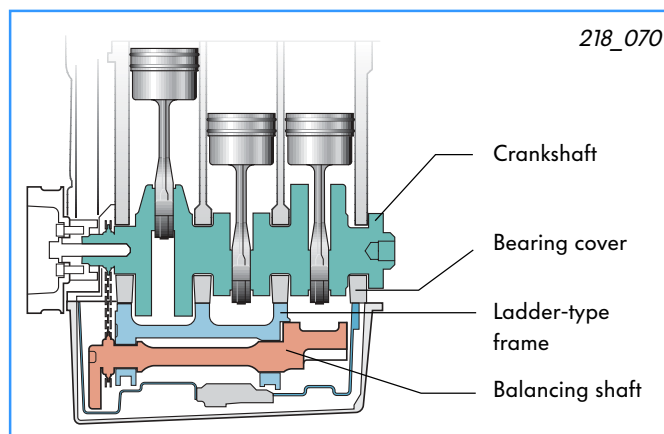
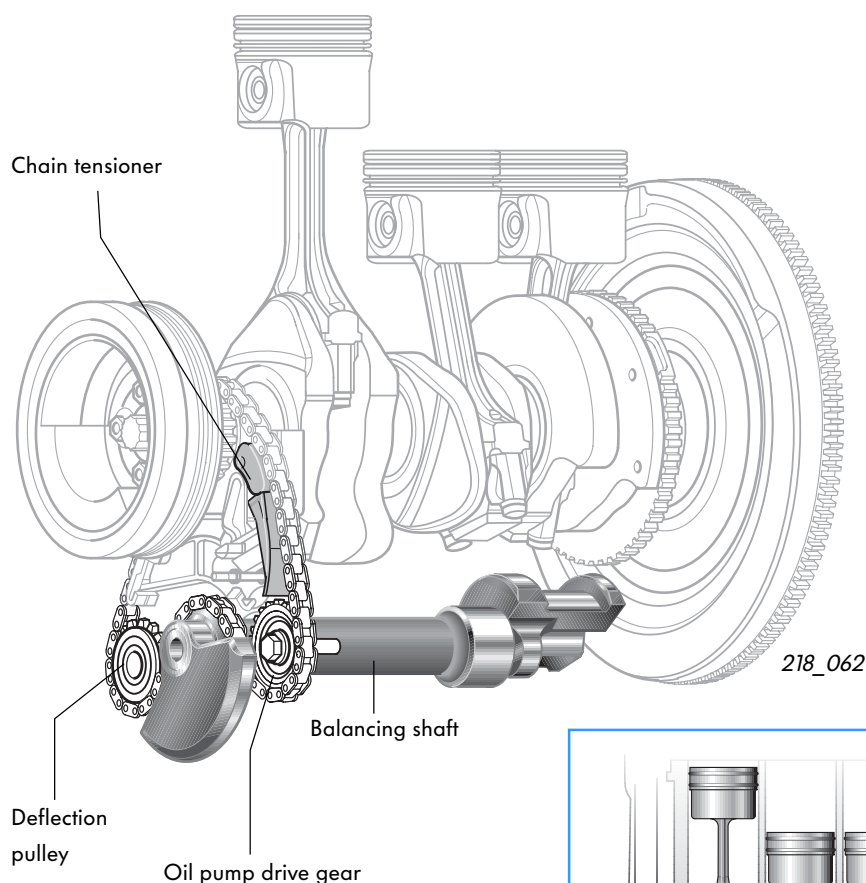
# The 1.2-litre TDI engine

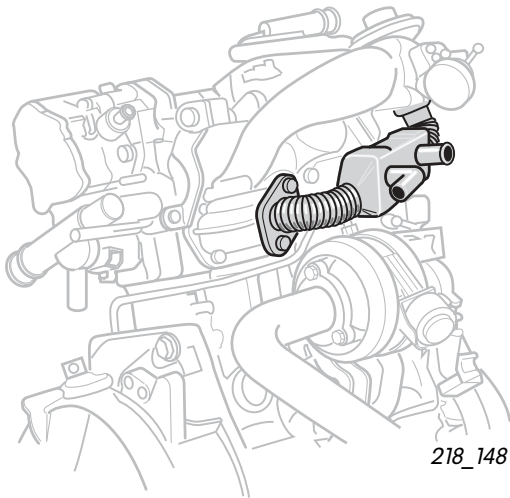
## Further technical features

### The balancing shaft

has the task of reducing engine vibration. The upwards and downwards movements of the piston and conrod in the engine crank drive produce forces which act upon the crankshaft. The layout of the crank pins in a 3-cylinder inline engine is such that these mass forces are not compensated and cause vibration.

To make the engine run smoothly, the balancing shaft rotates in the opposite direction to the engine. The balancing shaft is driven by the crankshaft via a chain and is secured to a ladder-type frame. The chain also drives the oil pump and is tensioned by a hydraulic chain tensioner.

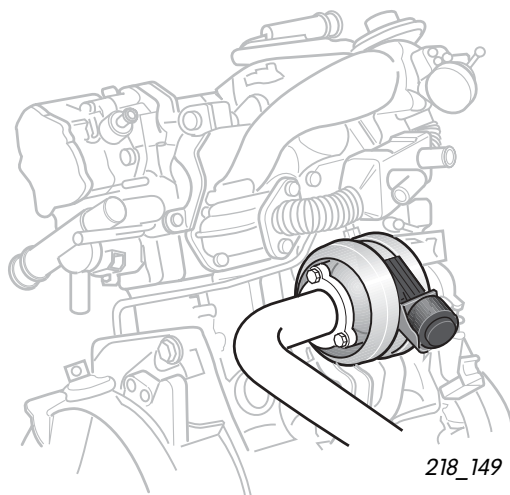




### The cooler for exhaust gas recirculation

The engine has a cooler for exhaust gas recirculation. It is connected to the coolant circuit.

Cooling the recirculated exhaust gases allows a higher volume of exhaust gas to enter the combustion chamber. As a result, the combustion temperature drops and fewer nitrogen oxide emissions are produced.

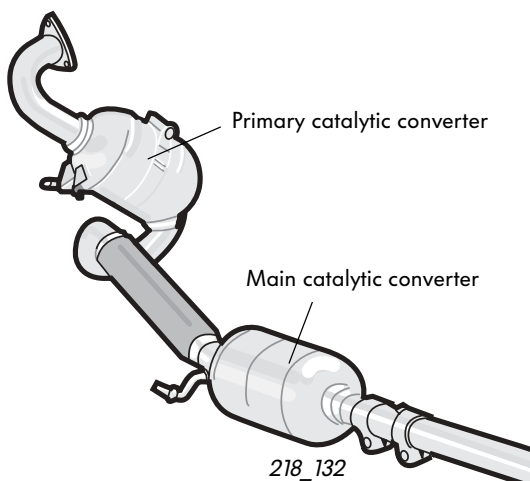


### Variable turbine geometry

The variable turbine geometry has quick response at low engine speeds and reduces backpressure in the exhaust in the part-throttle range. The result is improved bottom-end torque and lower fuel consumption.



The variable turbine geometry is described in Self-Study Programme No. 190.



### Oxidation catalytic converter

The Lupo 3L has a primary catalytic converter and a main catalytic converter. The primary catalytic converter is positioned close to the engine so that it can heat up quickly and reach its operating temperature early. These measures help to reduce pollutant emissions.

# Electronic manual gearbox 085

The 085 electronic manual gearbox was developed specially for the Lupo 3L and is operated by means of an electronic gate selector lever. The development goal was to reduce fuel consumption. This gearbox is based on conventional manual gearbox 085 which was revised to incorporate several weight-saving measures.

## To save weight:

- the shafts were drilled hollow
- the crown wheel was drilled
- the 5th gear is spoked
- the cheeks of the gear wheels were recessed to make them lighter
- oil capacity was reduced by 0.2 litres while maintaining the same oil level by modifying the housing

## A manual gearbox with the characteristics of an automatic gearbox

There is no clutch pedal. The manual gearbox is operated automatically via a hydraulic selector lever.

A control unit decides what gear is to be engaged by means of the selector. As a result, the engine operates in the optimal torque range with regard to fuel economy.

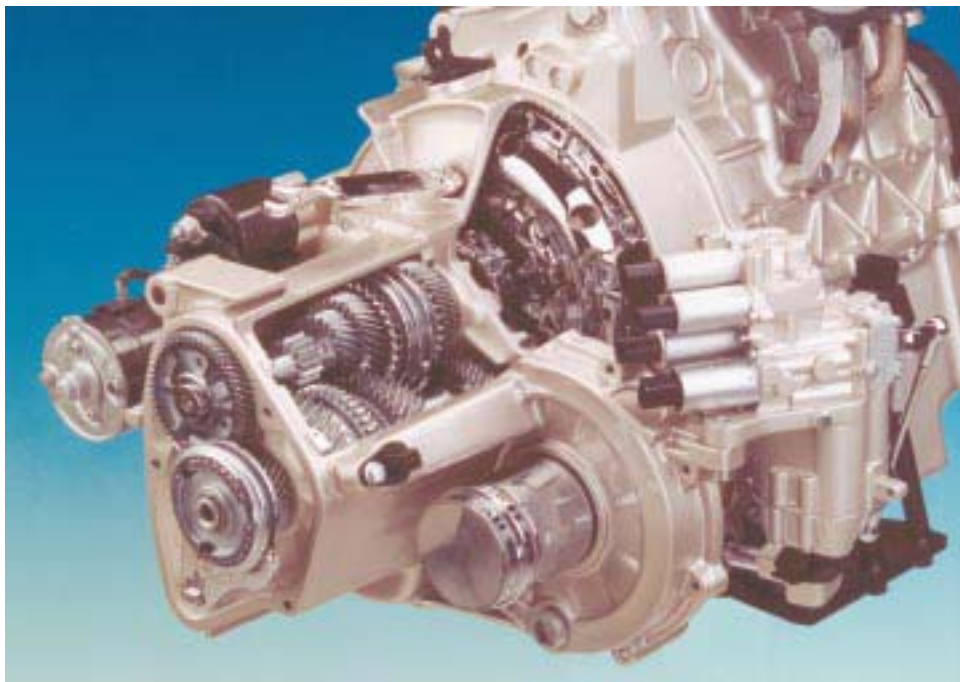
## Why a manual gearbox?

A manual gearbox has the following advantages over an automatic gearbox:

- it is lighter, and
- it is more efficient

Despite having the characteristics of an automatic gearbox, the manual gearbox still provides a choice of automatic or manual gear-changing.

The manual gear-changing mechanism is the same as in the Tiptronic.



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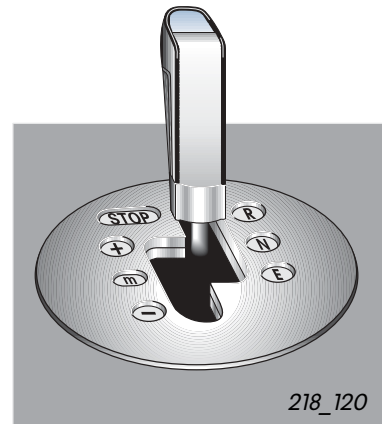


## The gear change system

The driver can move the electronic gate selector lever into two selector gates.



**The 'Stop' position is not equivalent to the 'Park' position in an automatic gearbox. It is also necessary to apply the handbrake. If the handbrake is not applied, a warning lamp on the dash panel will flash for up to 5 minutes.**



The engine is shut down automatically when the vehicle is stationary and first gear is selected. The can be started as soon as the driver's door is closed and the brake pedal is pressed.



### Manual gearshifts

In Tiptronic mode, each gear is engaged individually.

Upshifts



Middle position



Downshifts



### Automatic gearshifts

To put the vehicle in reverse, press the Lock button at the head of the gate selector lever and the brake.

In the neutral position, it is possible to start the engine when the driver's door is closed and the brake is pressed at the same time.

In this position, gears are engaged automatically. In Economy mode, the stop/start function is deactivated and the vehicle runs very economically.



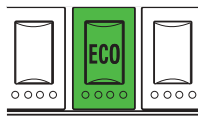
Even in Economy mode, the driver can still utilise the engine's full power by means of a kickdown function.

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# The electronic manual gearbox 085

## System overview

Switch for electronic manual gearbox  
**E262**

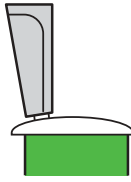


Potentiometer for selector lever forwards/backwards  
**G272**

Switch for gate recognition, selector lever  
**F257**

Switch for N-recognition, selector lever  
**F258**

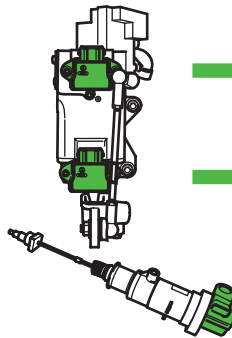
Switch for stop recognition  
**F259**



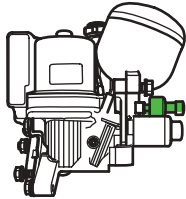
Potentiometer -2- for gear recognition  
**G240**

Potentiometer -1- for gear recognition  
**G239**

Clutch movement sender  
**G162**



Sender for hydraulic pressure  
**G270**



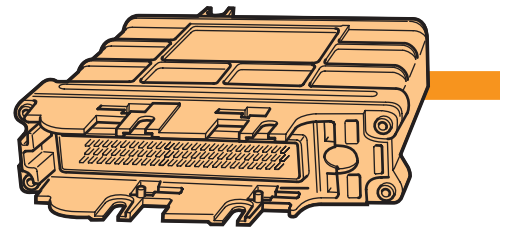
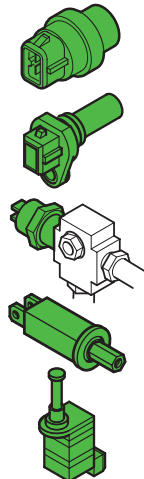
Gearbox speed sender  
**G38**

Coolant temperature sender  
**G62**

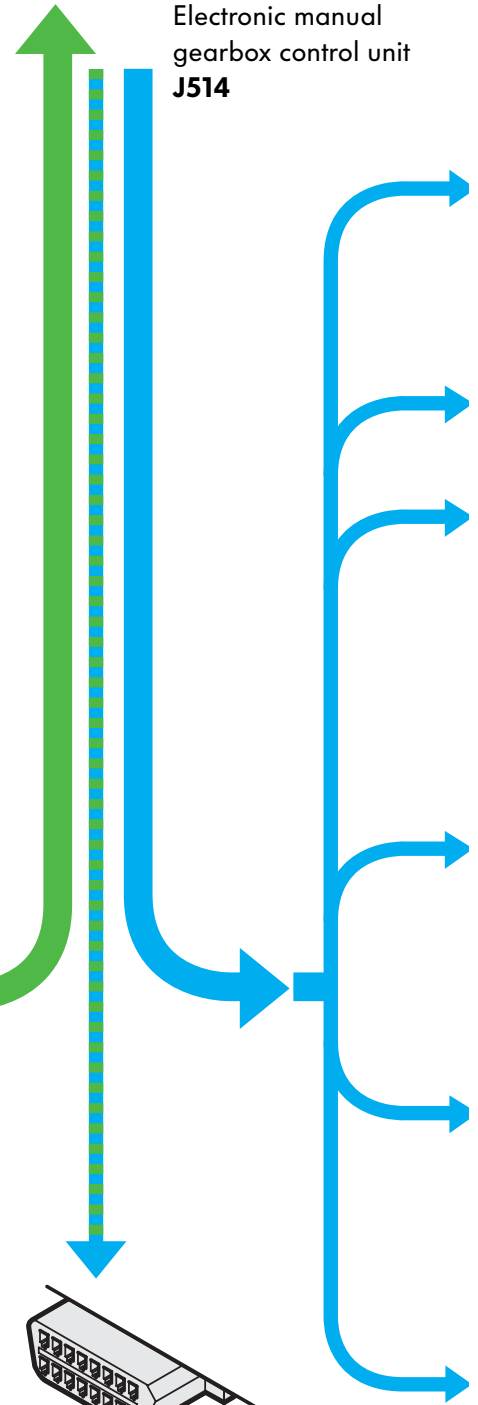
Brake pressure switch  
**F270**

Door contact switch, driver's side  
**F2**

Bonnet switch  
**F207**



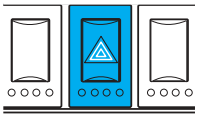
Electronic manual gearbox control unit  
**J514**



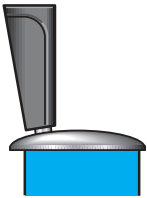
Diagnostic connection



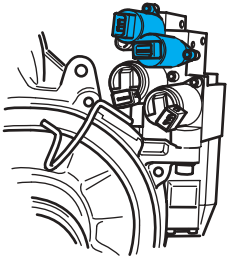
CAN databus



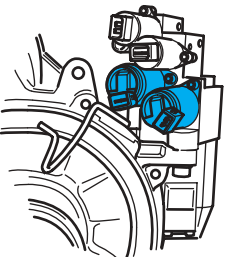
Handbrake warning lamp  
**K14**



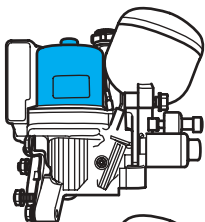
Selector lever lock solenoid  
**N110**



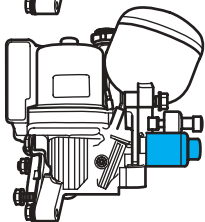
Valves 1 + 2 for  
selector lever **N286, N287**



Valves 3+ 4 for  
selector lever **N284, N285**



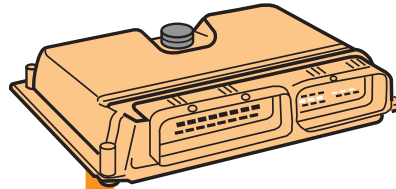
Hydraulic pump



Clutch positioner valve  
**N255**

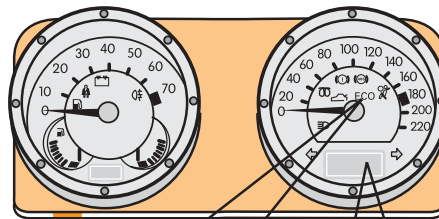
218\_131

Diesel direct injection system  
control unit **J248**



e.g.  
coolant temperature signal  
accelerator pedal position signal

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



Warning lamp  
for Economy  
mode



Gearshift  
indicator



ABS control unit



# Electronic manual gearbox 085

## System design

The electronic manual gearbox comprises three main elements:

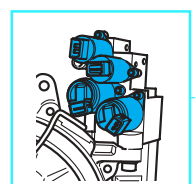
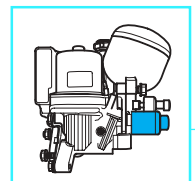
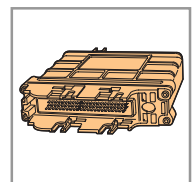
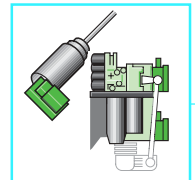
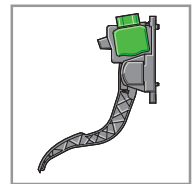
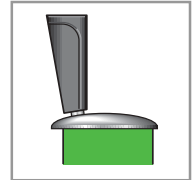
- the electrics
- the hydraulics, and
- the mechanicals

### The electrics

comprise sensors, actuators and the gearbox control unit. The control unit can recognise the actual state of the system, e.g. what gear is currently engaged, from the signals which the sensors generate. The input signals are processed in the gearbox control unit. The output signals for activating the actuators are then calculated, e.g. for a gearshift operation.

The components the electrical system are:

- The **electronic gate selector lever**  
A single potentiometer and three micro-switches on the gate selector lever determine the position of the selector lever and transmit this information to the gearbox control unit.
- The **electronic accelerator pedal**  
transmits the current position of the accelerator pedal to the engine control unit. The engine control unit then transmits a corresponding signal along the CAN databus to the gearbox control unit.
- **Potentiometer on selector and clutch actuator**  
One potentiometer recognises the selector gate position.  
The second potentiometer recognises the gear row, e.g. 3rd or 4th gear.  
The potentiometer on the clutch actuator recognises the current clutch position.
- The **gearbox control unit**  
calculates the optimal gear position on the basis of this information and activates the gearshift operation.
- An **electro-hydraulic valve for the clutch actuator**  
is activated when the clutch is activated via the hydraulics.
- Four **electro-hydraulic valves on the selector lever**  
admit the system pressure to the hydraulic piston in the gear selector depending on requirements and activate a gear operation.



## The hydraulics

The system utilises the hydraulics to execute the necessary movements, e.g. clutch engagement/disengagement or gearshift operations

The components the hydraulics are:

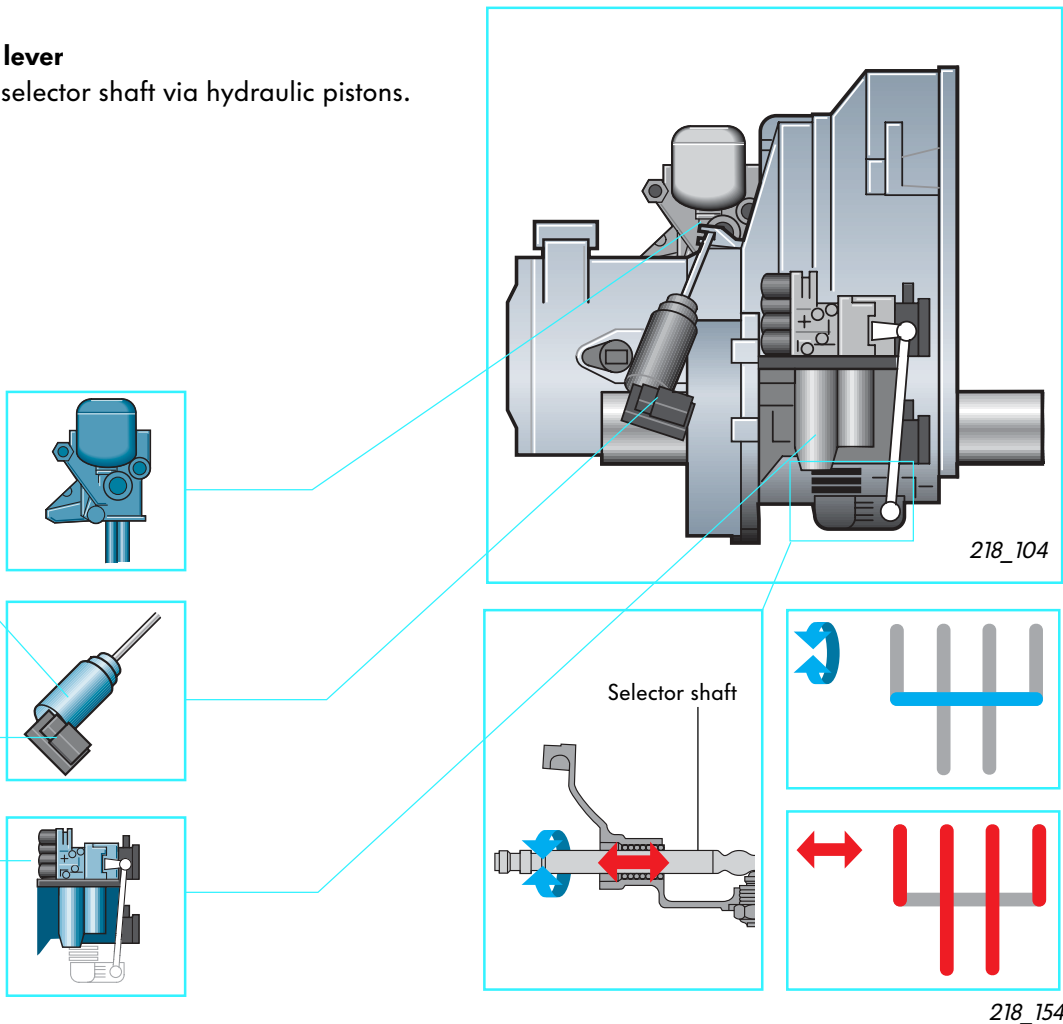
- A **hydraulic pump and pressure accumulator** generates the system pressure which is required in order to be able to perform gearshifts and operate the clutch. The pressure accumulator keeps sufficient oil and pressure in reserve to allow a quick response.
- A **clutch actuator** engages and disengages the clutch during gearshift operations.
- A **selector lever** moves the selector shaft via hydraulic pistons.

## The mechanicals

are the same as in manual gearbox 085

The individual gears are engaged via the selector shaft:

- The selector gate is selected through rotation of the selector shaft
- A gear is selected through backwards and forwards movements of the selector shaft.



# Electronic manual gearbox 085

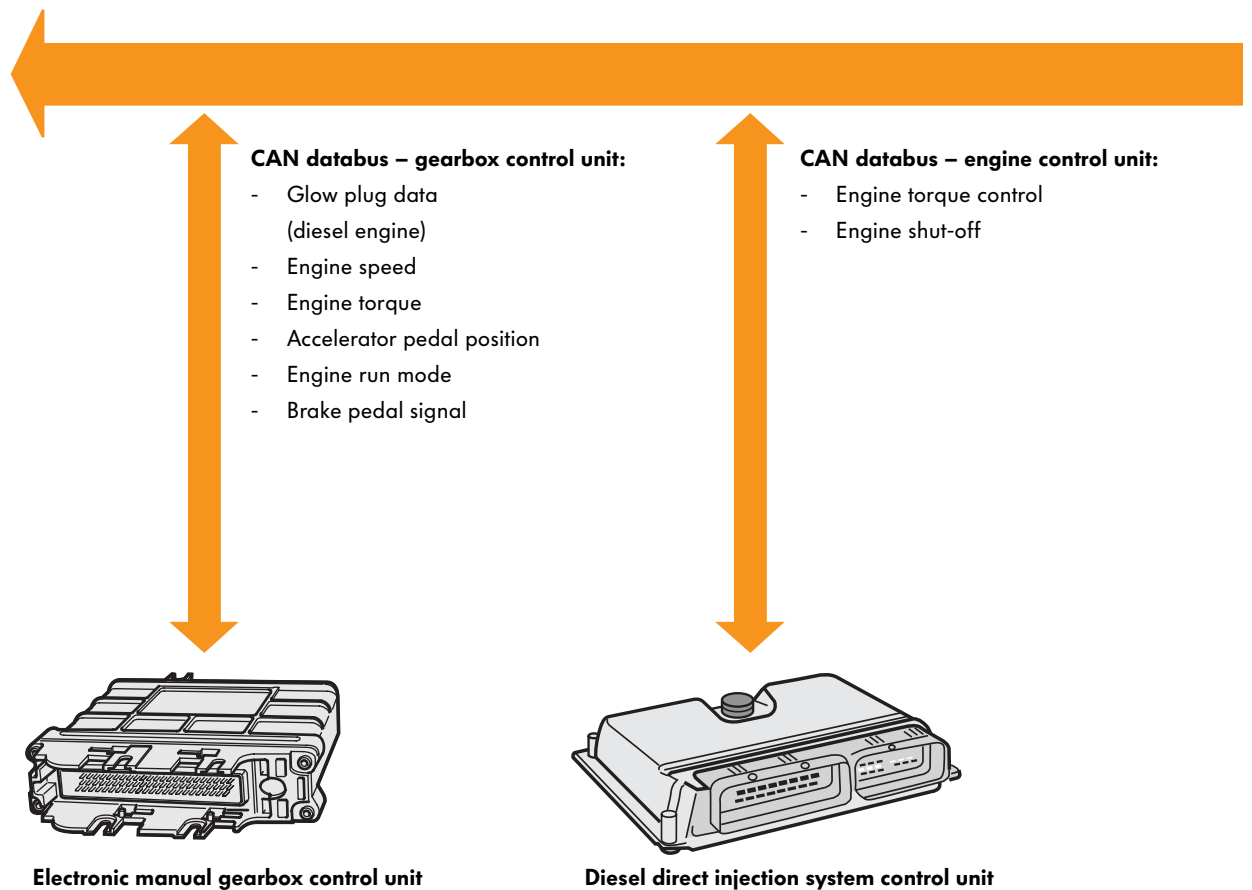
## CAN databus

CAN means: **C**ontroller **A**rea **N**etwork.

The gearbox control unit connected to the diesel direct injection control unit, the ABS control unit and the dash panel insert via the CAN databus.

The control units exchange information along the CAN databus. As a result, multiple control units can process the information generated by a sensor and activate their actuators accordingly.

Then gearbox control unit controls the gearshift operations depending on the data acquired, e.g. engine speed, wheel speed, engine load, brake activation etc.

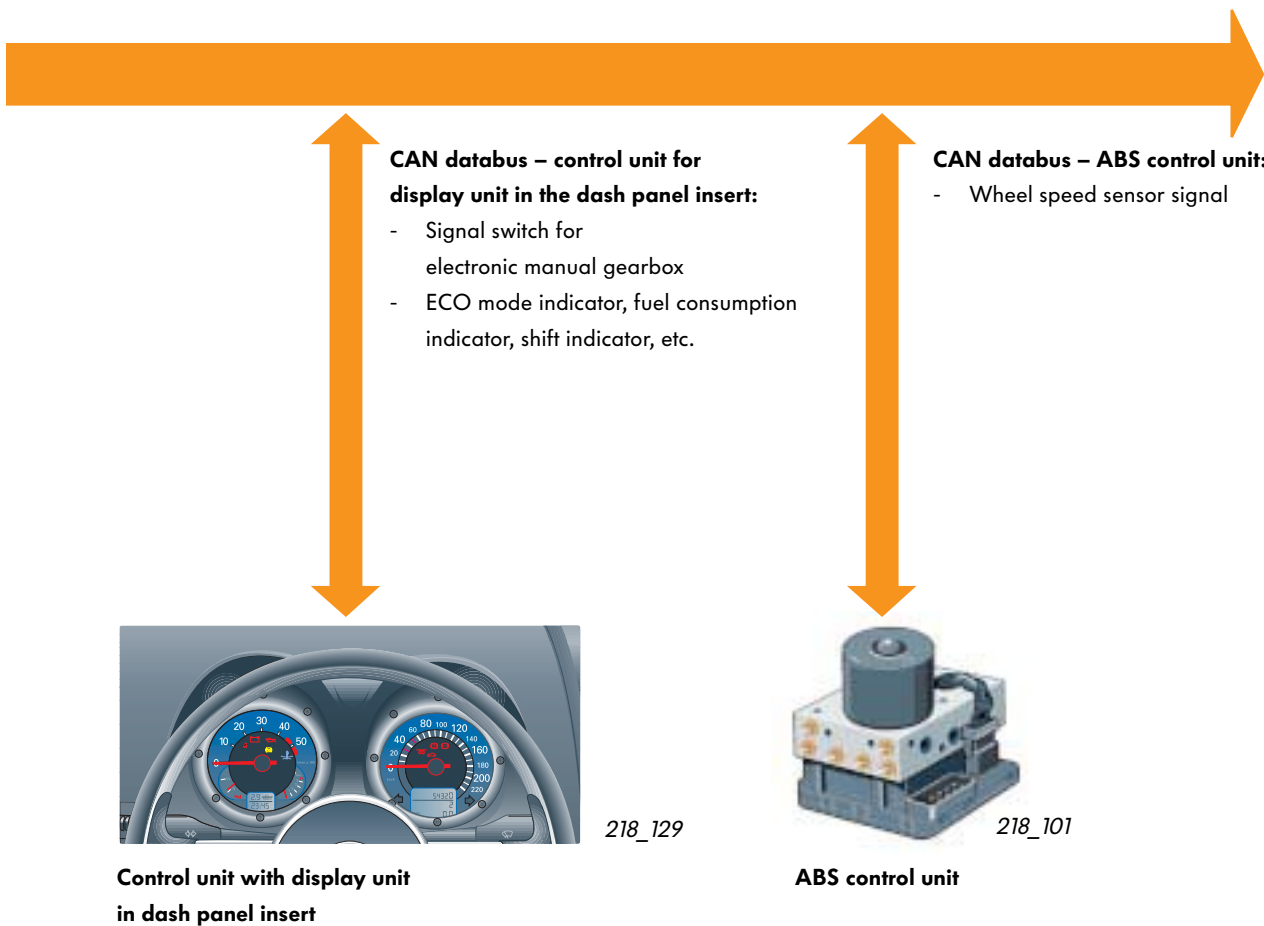




For example, the gearbox control unit informs the engine control unit that engine torque has been reduced when the clutch is engaged/disengaged.

The control unit for the dash panel insert obtains the position of the gate selector lever and whether the vehicle is currently being driven in Economy mode from the gearbox control unit via the CAN databus.

This is indicated by warning lamps in the dash panel insert.





# Electronic manual gearbox 085

## The stop/start function

The Lupo 3L has a stop/start function in Economy mode.

### What does this mean?

In stationary phases, the engine is shut down in order to avoid unnecessary fuel consumption. This happens when the foot brake is kept pressed down for longer than three seconds.

### What conditions must be met before the engine is shut down automatically?



1.



The gate selector lever is in position E.

6a.



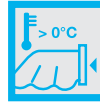
The coolant temperature must be higher than 17°C.

2.



Economy mode is active.

6b.



The intake air temperature must be higher than 0°C.

3.



The brake must be kept pressed down for at least three seconds.

6c.



The auxiliary heater must not be switched on.

4.



The brake pressure switch indicates that a certain brake pressure is being applied to the brakes.

6d.



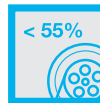
The headlights must be switched off.

5.



The ABS wheel speed sensor, as well as the gearbox speed sender and the speedometer sender signal to the system that the vehicle is stationary.

6e.



The alternator load factor must not exceed 55%.

## How does the vehicle resume operation?

1.



The driver releases the brake pedal.

4.



The gearbox control unit activates the clutch and engages first gear.

2.



The gearbox control unit starts the engine.

5.



The driver presses the accelerator pedal. The vehicle accelerates.

218\_150

3.



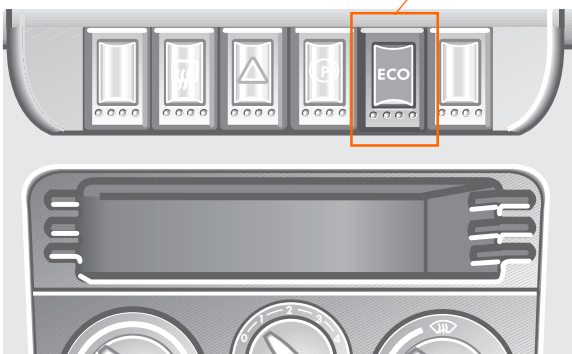
The gearbox control unit ends the starting cycle and allows the starter to disengage.



218\_147B

### The switch for electronic manual gearbox E262

is integrated in the dash panel. The ECO mode can be activated and de-activated with this switch.



218\_147A

# The running gear

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The running gear is also a factor contributing to the Lupo 3L's consumption of 3 litres per 100 km.

Weight was saved by using light alloys e.g. for the subframe.

The running gear also influences the vehicle's aerodynamic characteristics.

The running gear was improved compared to the Lupo SDI by

- lowering the vehicle 10 mm, and
- streamlining the outer contour of the rims

The wheel bearings, the brake system and the low-friction tyres developed by Bridgestone specially for the Lupo 3L also affect fuel consumption.

The following features are presented next pages:

- the lightweight front axle
- the wheel bearing
- the rear axle
- the steering
- the electro-mechanical power steering
- the brakes
- the active wheel sensor, and
- the puncture repair set



218\_040

## The lightweight front axle

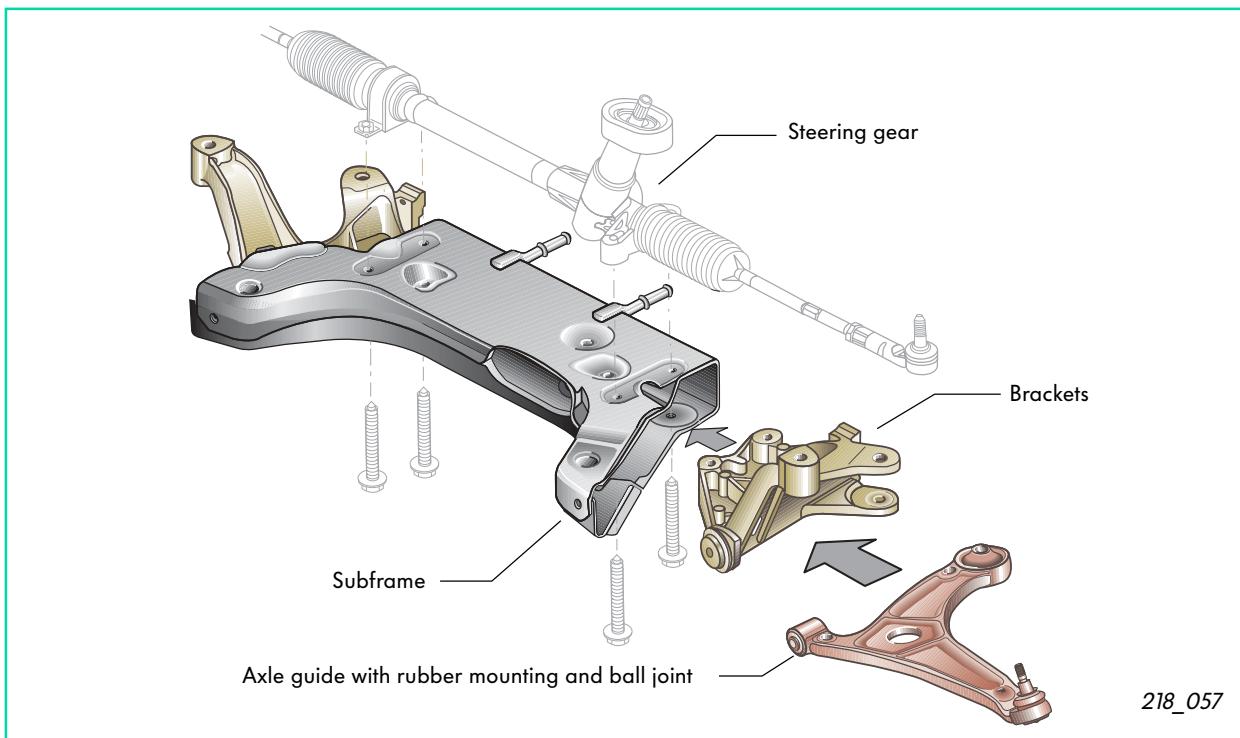


218\_015

The Lupo 3L has a front axle with McPherson suspension struts. They comprise aluminium dampers and coil springs made of high-tensile steel.

The following are also new developments:

- the subframe
- the brackets
- the axle guide with integrated guide links



218\_057

The subframe and the axle guide are made of aluminium. The brackets are diecastings. As a result, the axle on the Lupo 3L weighs 25% less than the standard Lupo axle.

Four bolts join the brackets and the steering gear to the subframe.

The track width of the front axle was enlarged by 33 mm compared to the Lupo SDI. As a result, the wheels are flush with the outer body. This flushness with the outer body improves the vehicle's aerodynamics.

The larger track width improves the vehicle's cornering ability.

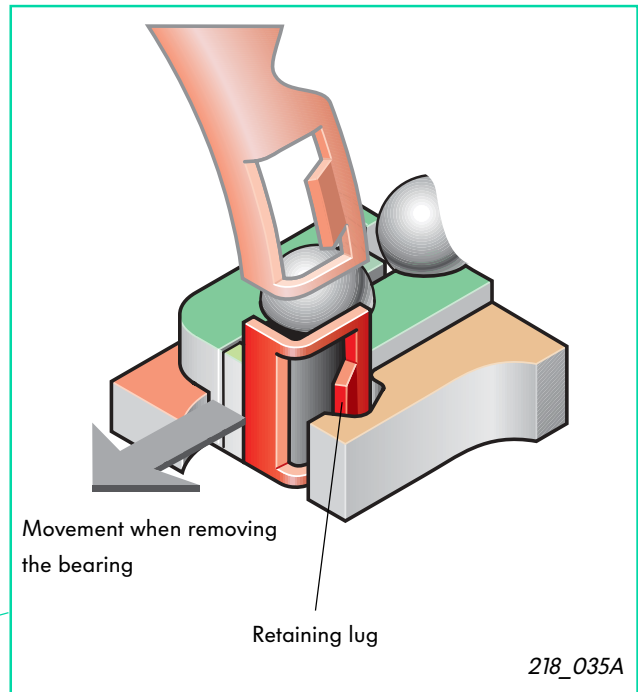
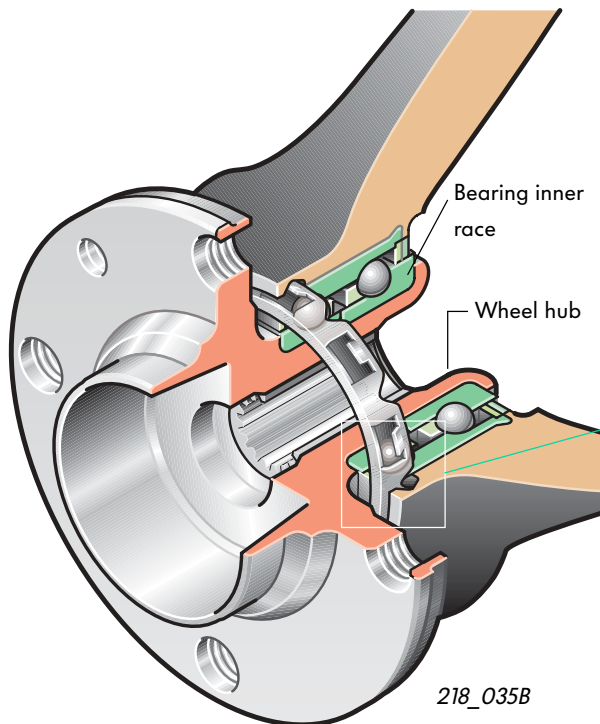


# The running gear

## The wheel bearing

The wheel bearing is a two-row angular continuous ball bearing with integrated wheel hub.

The pretension on the wheel bearing is provided by flanging the bearing inner race with the wheel hub. A ring with 10 retaining lugs is fitted on the wheel bearing. These lugs lock into a groove on the wheel bearing housing when pressed in and hold the wheel bearing in position.



When removing the wheel bearings, the retaining lug will break off and a new wheel bearing has to be fitted.



You require special tool T 10064 in order to install the wheel bearing. Also refer to page 52 in the chapter entitled "Service".



218\_016

## The rear axle

The rear axle has the same design as the rear axle of the Lupo SDI. As with all suspension parts, the rear axle has been adapted to meet the weight-oriented requirements of the Lupo 3L.

The coil springs and the shock absorbers are laid out separately in order to maximise the loading width.

The suspension springs are made of high-tensile steel and are shorter than the springs used in the Lupo SDI.

The twin-sleeve shock absorbers are made of aluminium.



218\_018

## The steering

The steering column is the safety steering column.

It prevents upward intrusion of the steering wheel into the occupant cell during a crash and optimise the position of the airbag relative to the occupants.

The steering wheel is made of magnesium. The steering wheel rim is padded and the spokes are painted. The paintwork reduces the temperature of the steering wheel spokes when exposed to direct sunlight.

# The running gear

## The electro-mechanical power steering

The Lupo 3L can be equipped with power steering. As power steering increases fuel consumption, Volkswagen has developed a new electro-mechanical power steering system in association with Delphi.

With this system, the vehicle consumes less fuel than a vehicle with hydraulic power steering.

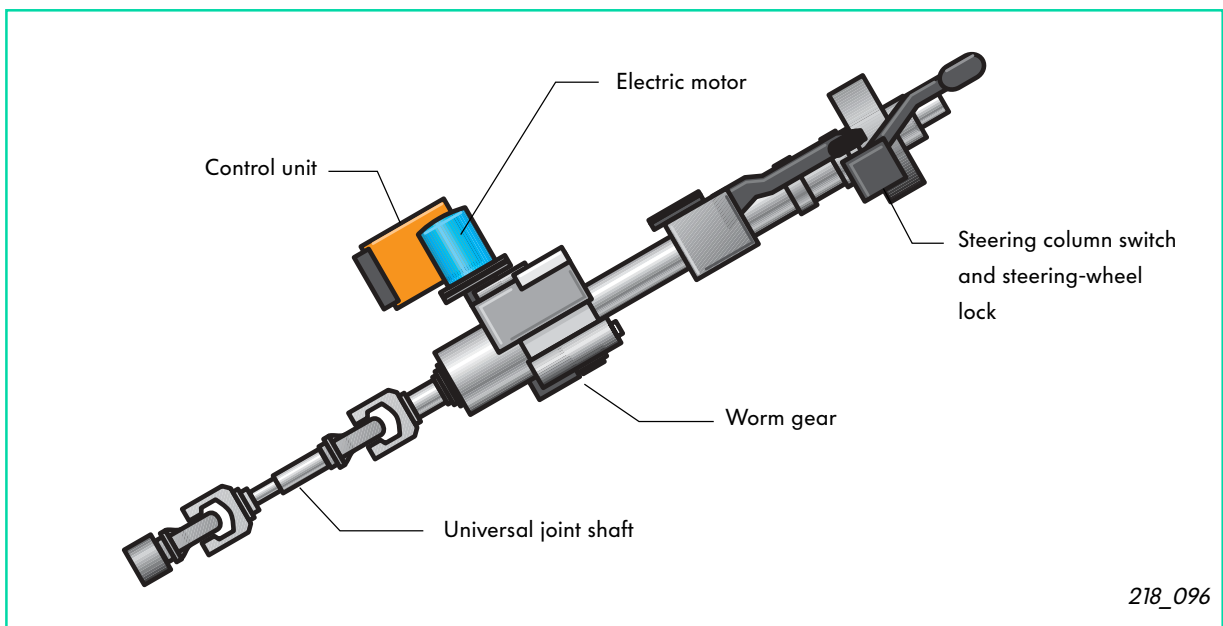
The Lupo 3L has an electronic power-assisted steering system based on the steering system used in the Lupo SDI. Its advantage over a hydraulic power steering system lies in the fact that it is lighter and only operates when required by the driver.

The steering system is made up of the following component parts:

- steering column switch and steering-wheel lock
- steering column
- electric motor
- worm gear with torque and wheel angle sensors
- control unit, and
- universal joint shaft



A description of the electro-mechanical power steering can be found SSP 225.



Vehicles with electronic power steering do not have a stop/start function.



## The brake system



218\_042

### Front brakes (239 mm x 15 mm)

The front wheel brakes are ventilated and 4 kg lighter than the brakes in the Lupo SDI. The brake caliper is made of aluminium.

The brake disc is made of gray cast iron and is coated with a zinc-aluminium alloy. This material is known by the name 'Geomet' and has excellent corrosion inhibiting properties.



218\_041

### Rear brakes (180 mm x 30 mm)

The brake drums used in the Lupo 3L are made of a special aluminium alloy. As a result, they are the lightest brake drums in the world.



## The brake system

has ABS as standard. The hydraulic unit and the control unit are combined in the ABS unit.

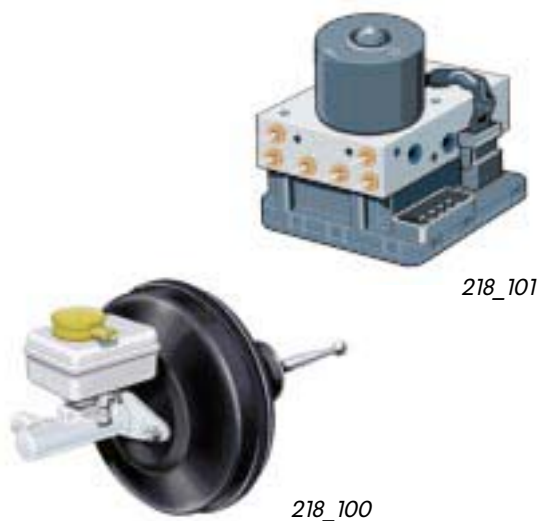
The brake system has the designation Teves Mark 30 and is largely identical to the Teves 20IE system.

The difference between the two systems is that rear axle valves in the Teves Mark 30 are smaller and do not have a switching orifice function.

The hydraulic pump motor and the control unit are identical to those used in the Mark 20 system.

The system includes EBD, ESBS and EBC functions.

The 9-inch brake servo with aluminium housing operates according to the proven vacuum booster principle.



218\_101

218\_100

# The running gear

## The active wheel sensors

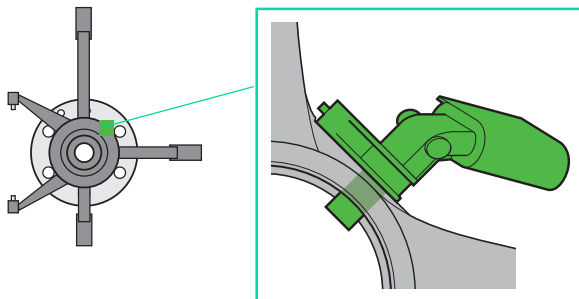
A sensor is referred to as being 'active' if it requires an external voltage supply. If it did not have this voltage supply, the sensor would not be able to supply signals.

To measure the engine speed, the active ABS sensor mounted securely in the wheel bearing housing requires counterpart which rotates with the wheel hub. This counterpart is known as the 'signal sender disc'. The resistance of a magnetoresistive element varies depending on the magnetic field lines.

A signal sender disc with a reader track is used in the Lupo 3L. It is an integral part of the wheel bearing seal and is press-fitted in the wheel bearing.

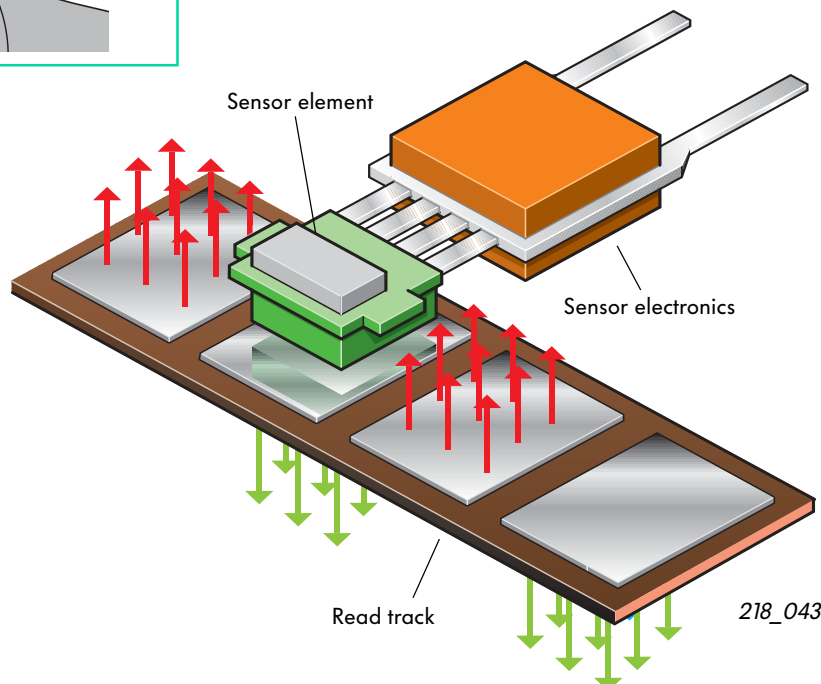
The advantages of this technology are:

- speeds upwards of 0 kph can be measured
- little installation space is required
- it is highly corrosion resistant, and
- there is little interference since the air gap remains almost constant

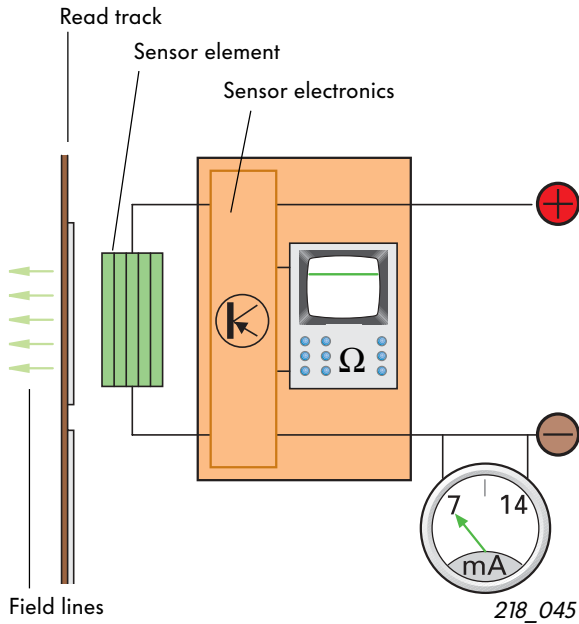


The active sensor is installed in the wheel bearing housing

The structure of the signal sender disc can be portrayed in simplified terms by imagining that small areas adjacent on the read track are magnetised differently according to north pole and south pole. When the wheel bearing rotates, these areas run closely past the active sensor.



218\_043

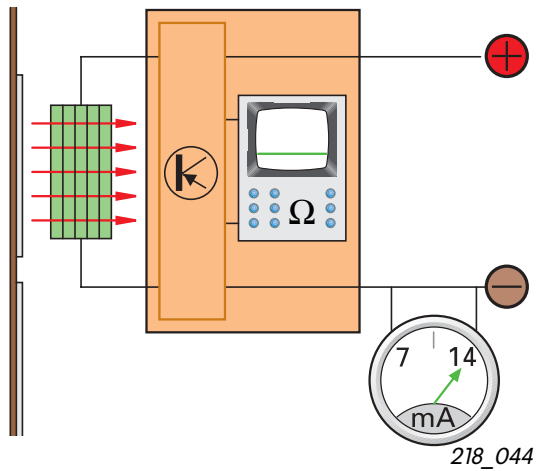


### Functional principle of the active sensor

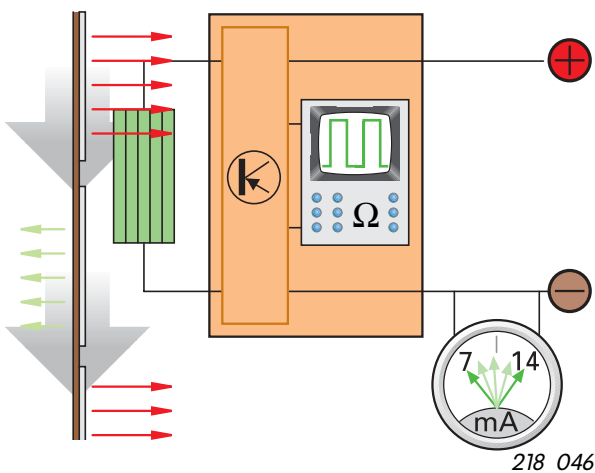
The magnetic field lines on the read track are arranged vertically in the immediate vicinity of the magnetised areas. Depending on polarity, these lines run either away from the track or towards it. Since the read track runs very closely past the sensor, the field lines also penetrate the sensor and affect its resistance.

An electronic amplifier/trigger circuit integrated in the sensor transduces the change of resistance to two different current levels.

If the resistance of the sensor element increases due to the direction of the magnetic field lines passing through it, the current will drop.



If the resistance of the sensor element decreases due to a reversal in the direction of the field lines, the current will rise.



This alternation of north and south poles on the read track results in a square-wave pulse whose frequency is a measure of engine rpm.



# The running gear

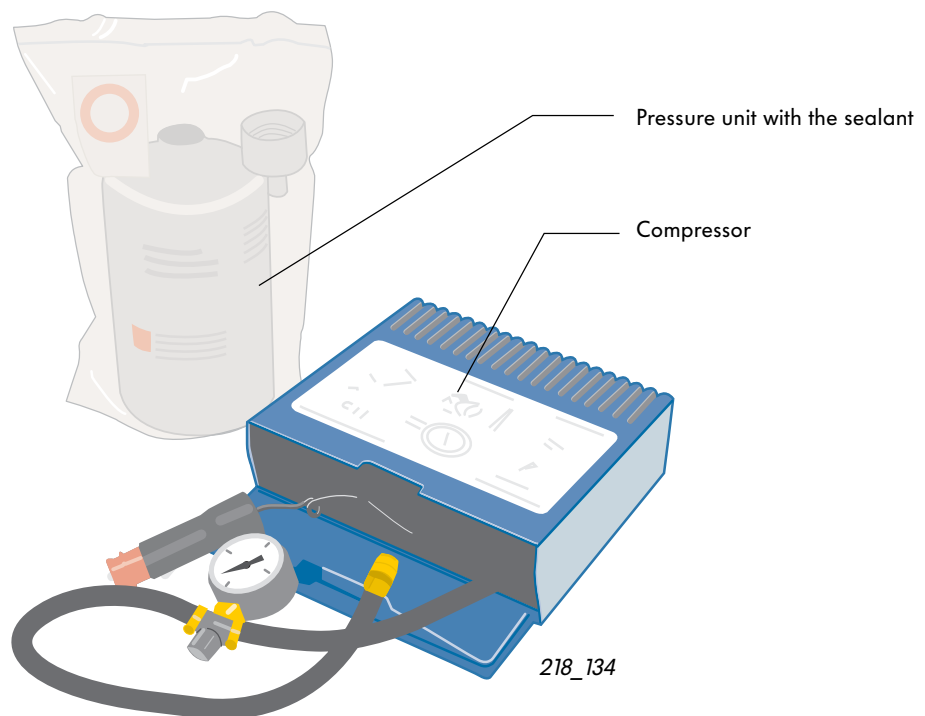
## The puncture repair set

To save weight, the spare wheel has been replaced by a puncture repair set. It comprises a pressure unit with a tyre sealant and a compressor which receives its power via the cigarette lighter.

In the event of a breakdown, the sealant is pressed out of the pressure unit and through the tyre valve into the tyre. The tyre is then reinflated using the compressor.

The rolling motion of the tyres allows an even distribution of sealant inside the tyre. The heat which is generated while driving is sufficient to galvanise the sealant and the tyre.

In the event of minor damage, the tyre can be made serviceable using the puncture repair set to the extent that the vehicle can reach next workshop.



The puncture repair set is not available in every country. Vehicles can also be equipped with space-saver spare or a fully fledged spare instead of the puncture repair set depending on national legal requirements.

# The electrical system

## The control units

The fitting locations of the individual control units are the same as in the Lupo. However, two new control units have been added:

- The electronic manual gearbox control unit and
- an electrical powersteering control unit with the power steering option

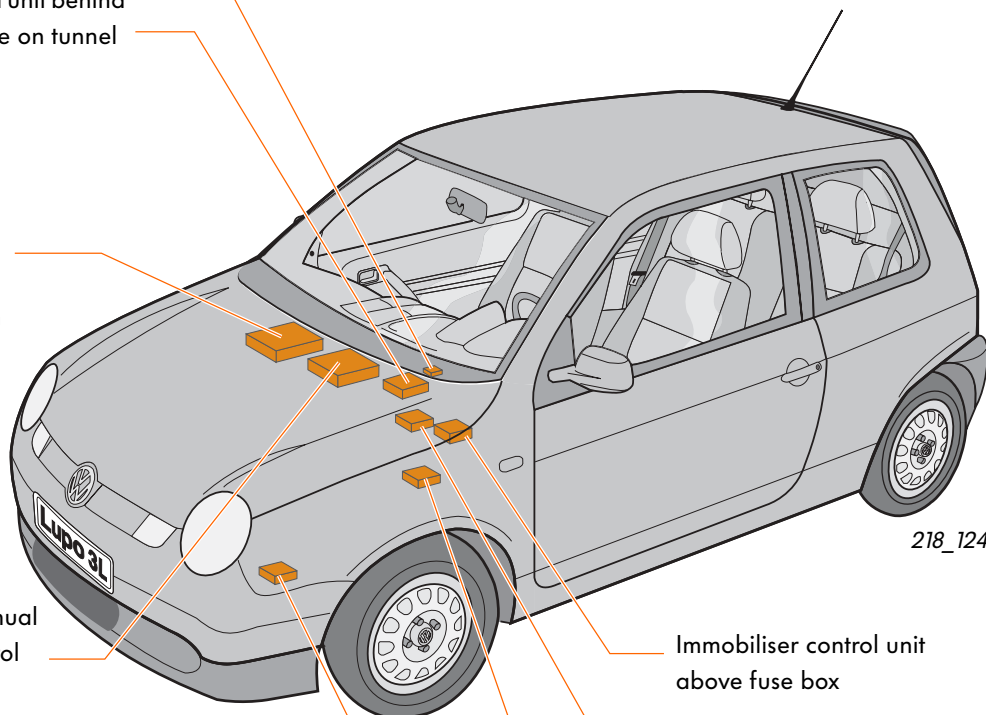
## The layout the control units:

Diagnosis plug

Airbag control unit behind central console on tunnel

Diesel direct injection system control unit in plenum chamber

Electronic manual gearbox control unit in the plenum chamber



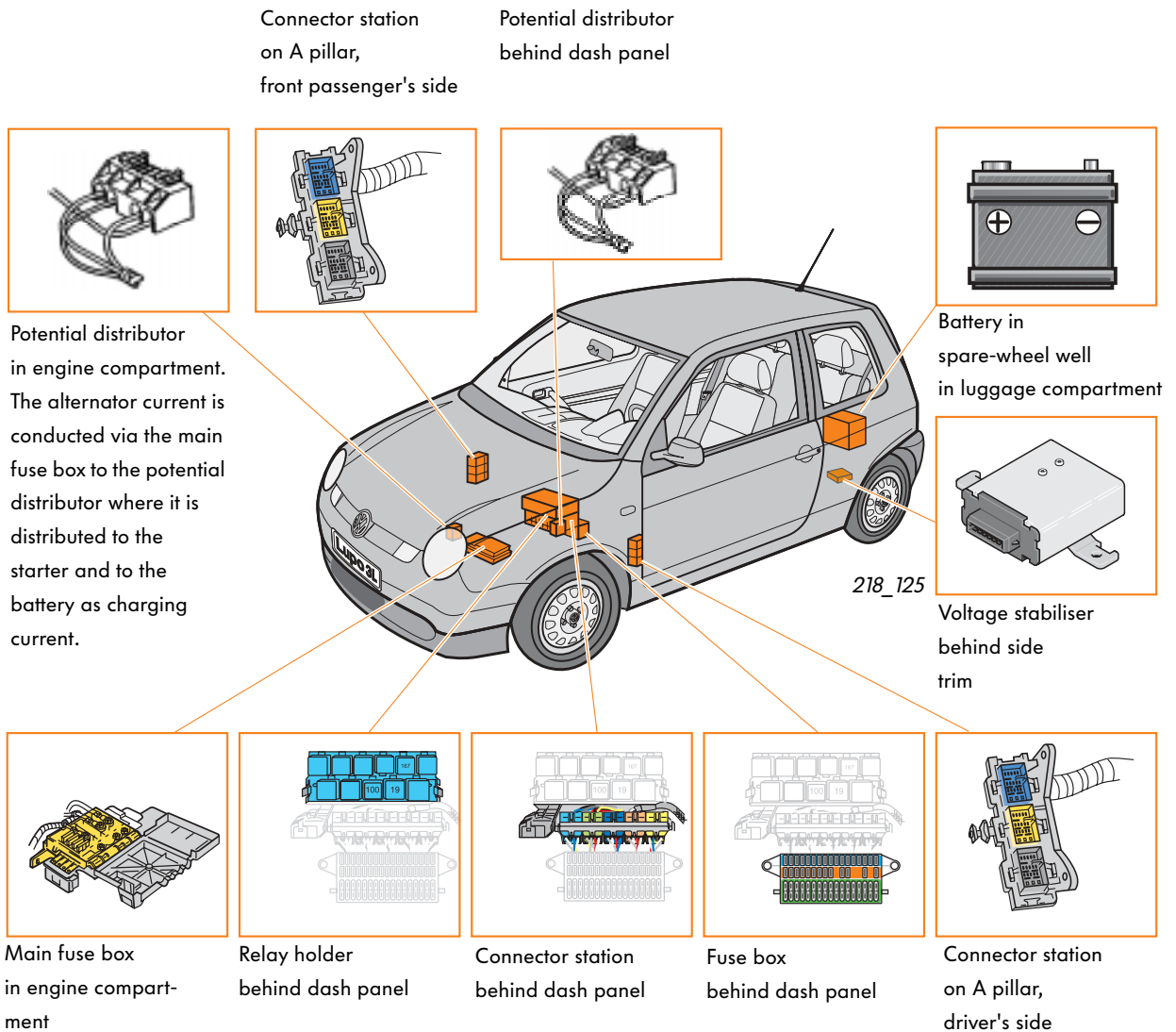
218\_124



# The electrical system

## The vehicle electrical system

The vehicle electrical system has a decentralised configuration like in the Lupo. The main components are:



The battery is fitted in the engine compartment when the Lupo 3L starts production. The battery will be fitted exclusively in the spare-wheel well in the luggage compartment at a later date.

## The dash panel insert

The dash panel insert of the Lupo 3L has newer displays and warning lamps than the Lupo SDI. The control unit in the dash panel insert also communicates with the diesel direct injection system control unit, the electronic manual gearbox and ABS along the CAN databus.

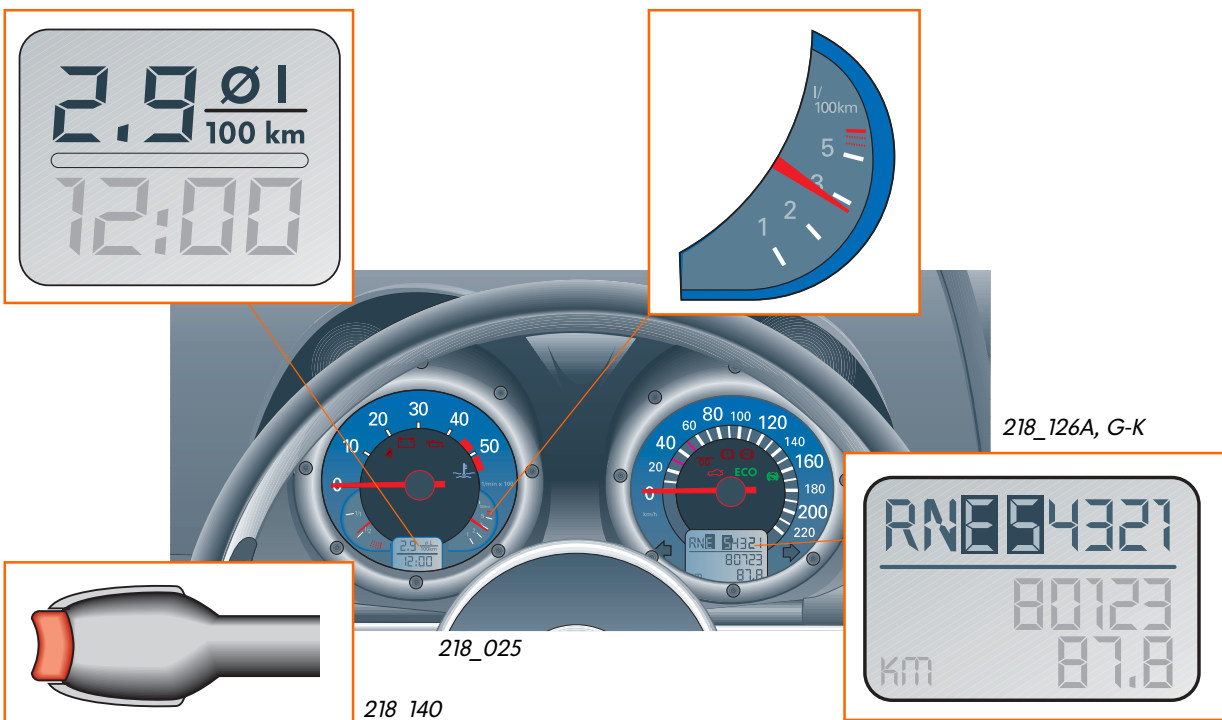
The following displays have been added:

### The average consumption indicator

in the rev counter shows the average fuel consumption in litres per 100 km. It is an LC display.

### The current consumption indicator

in the rev counter shows the momentary fuel consumption. For this purpose, the control unit in the dash panel insert receives a consumption signal from the engine control unit.



### The Reset button

on the steering column switch zeroes the average fuel consumption indicator.

### The shift indicator

in the speedometer shows the position of the gate selector lever and the selected gear. This information is supplied by the electronic manual gearbox control unit. It is also an LC display.

# The electrical system

The following warning lamps have been added:

## The "tailgate opened" warning lamp

is lit when the tailgate is open. This information is supplied by a microswitch integrated in the tailgate lock.

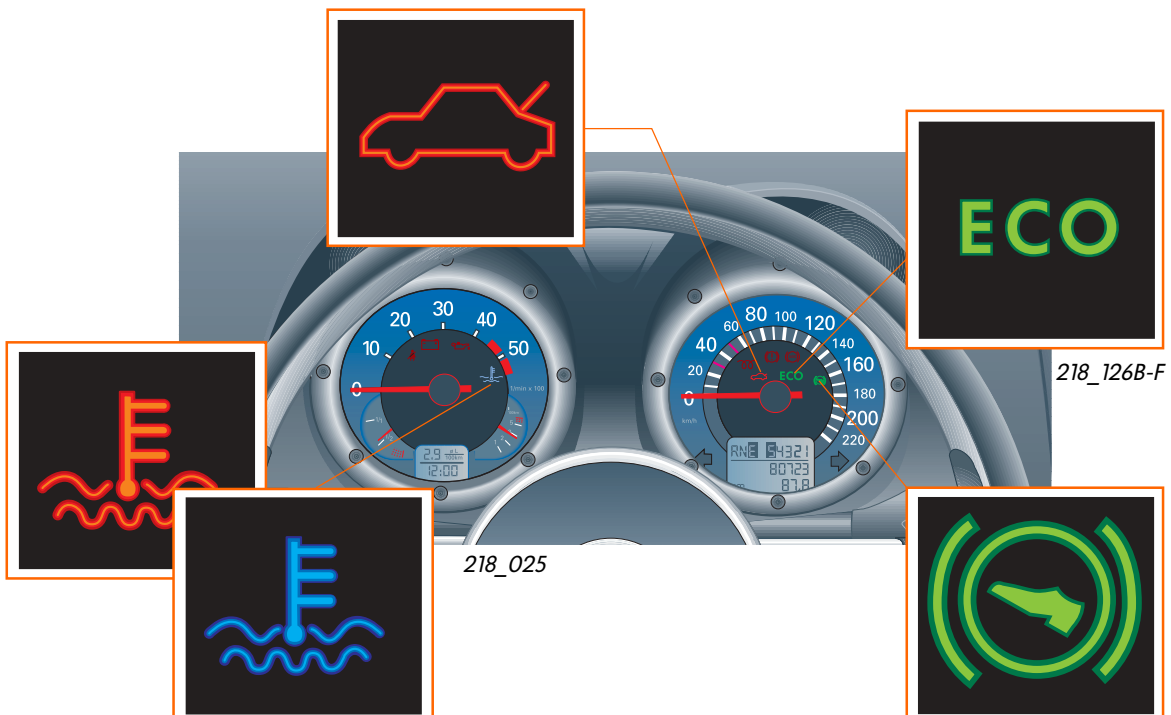
When the tailgate is open, there is a risk of exhaust gases entering the vehicle interior.

## The ECO warning lamp

indicates whether the vehicle is driving in Economy mode or not. If the ECO warning lamp is lit, the Economy mode is active.

In ECO mode,

- the vehicle is operated in the optimal rev range with regard to fuel economy and
- when the foot brake is pressed while the vehicle is stationary, the engine is shut down after three seconds (stop/start function). The control unit in the dash panel insert receives this information from the electronic manual gearbox control unit.



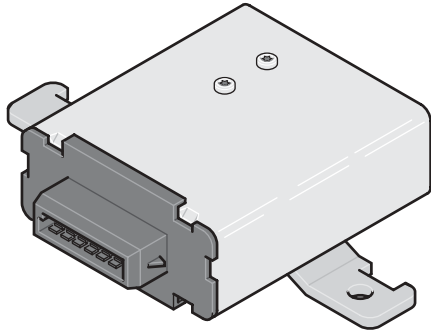
## The "coolant temperature" warning lamp

is lit (blue LED) during the engine warm-up period and goes off when the engine reaches its operating temperature. If the coolant temperature is too high, the red LED of the warning lamp is lit.

## The "selector lever lock" warning lamp

indicates that the gate selector lever is inhibited in its current position. To engage another selector lever position, the foot brake must be pressed. This information is supplied by the electronic manual gearbox control unit.





## Voltage stabiliser J532

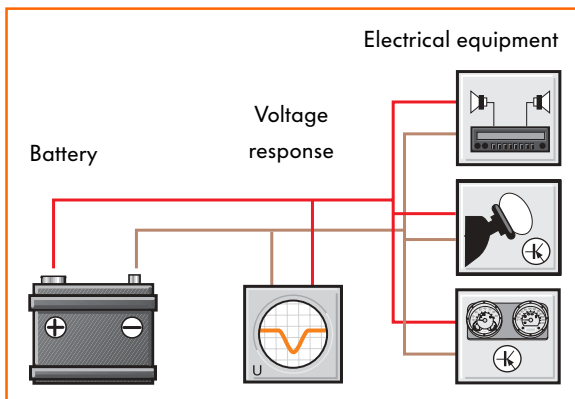
is fitted behind the left side trim next to the rear seats.

It provides:

- the radio
- the dash panel insert, and
- the airbag control unit

with a stable voltage supply while the engine is being restarted in Economy mode.

This is necessary because the items of electrical equipment specified above are not switched off via the X contact.

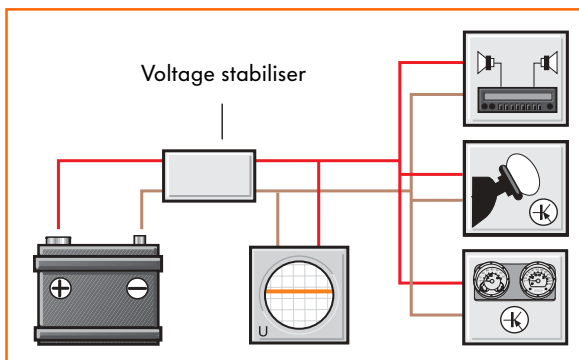


218\_155

### If the voltage stabiliser is not installed,

the electrical equipment would be subject to excessive voltage fluctuations which would cause the equipment to malfunction.

In this case, the fault memory of the electrical equipment would register a malfunction such as "Vehicle power supply, signal too low".



218\_156

### If the voltage stabiliser is installed,

the voltage is stabilised for the electrical equipment during the restart.

As soon as the voltage drops during the restart due to the high starter current, the voltage dip is equalised for the electrical equipment. The voltage is kept at a constant approx. 12.5 volts. This way malfunctions are avoided.

# Heating and air conditioning

Two equipment variants are available for heater and air conditioner operation in the Lupo 3L:

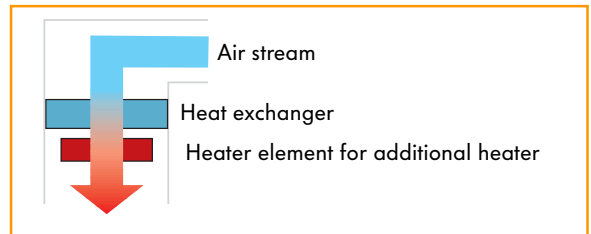
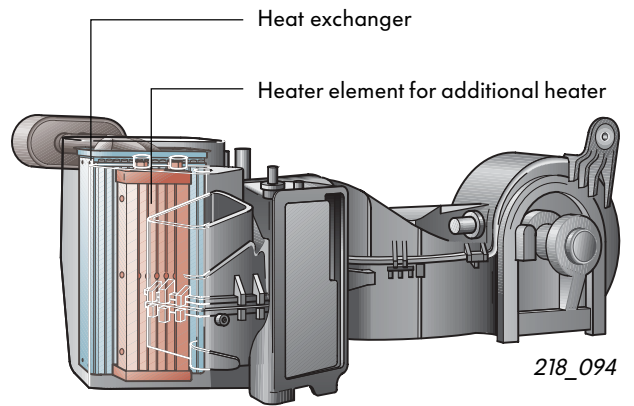
- Heating + fresh air/air recirculation mode
- Manual air conditioning

The design and function of both variants are identical to those of the systems fitted in the Golf 98 and Lupo. Also, the heater and air conditioner have been combined with an heater element for additional heater.

## The heating

The heater element for additional heater is in the air stream behind the heat exchanger. Powered by the vehicle electrical system, it heats up the air fed into the vehicle interior. The 1.2-litre TDI engine does not supply enough waste heat during the warm-up period and at low ambient temperatures to heat up the vehicle interior.

This is why the heat exchanger is combined with an heater element for additional heater.



218\_167

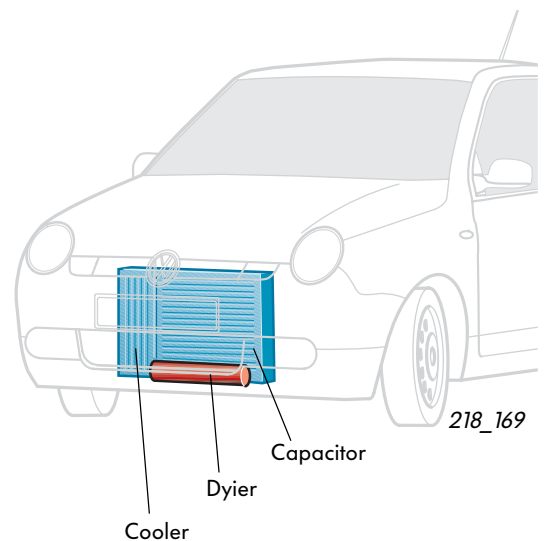


## The manual air conditioning system

The liquid tank with drier is installed horizontally in front of the condenser due to the constraints on space.

Its dimensions and drier volume have also been reduced.

The amount of refrigerant has been adapted accordingly.



## Heater element for additional heater Z35

heats up the passenger cabin quickly.

When the heater element for additional heater is connected, an electrical current flows through ceramic PTC resistors. These resistors can reach a temperature of up to 160°C in the process.

PTC resistors have a self-regulating property. As the temperature rises, the resistance increases, thereby reducing the current flow. The PTC resistor is prevented from overheating in this way.

### The design

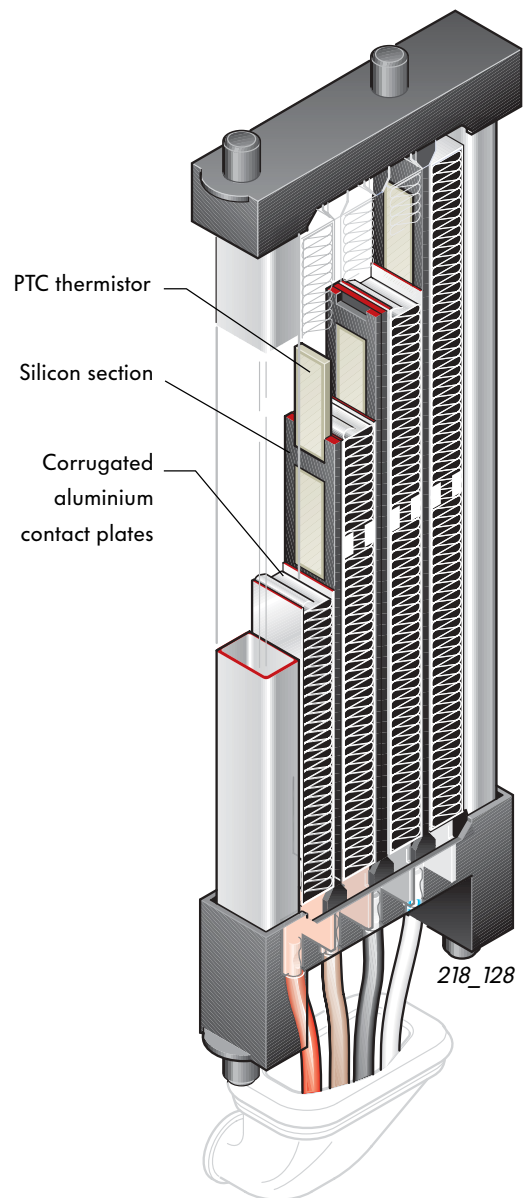
Corrugated aluminium contact plates, silicon sections and ceramic PTC thermistors are the main components of the heater element for additional heater.

All in all, the heater element for additional heater is subdivided into three heating elements with a total of fifteen PTC resistors.

There is one silicon section holding five PTC resistors per heating element. The section also functions as an electrical isolator between the contact plates.

The contact plates heated by the PTC resistors conduct their heat to the corrugations.

The electrical terminals are brazed to the additional heating element.



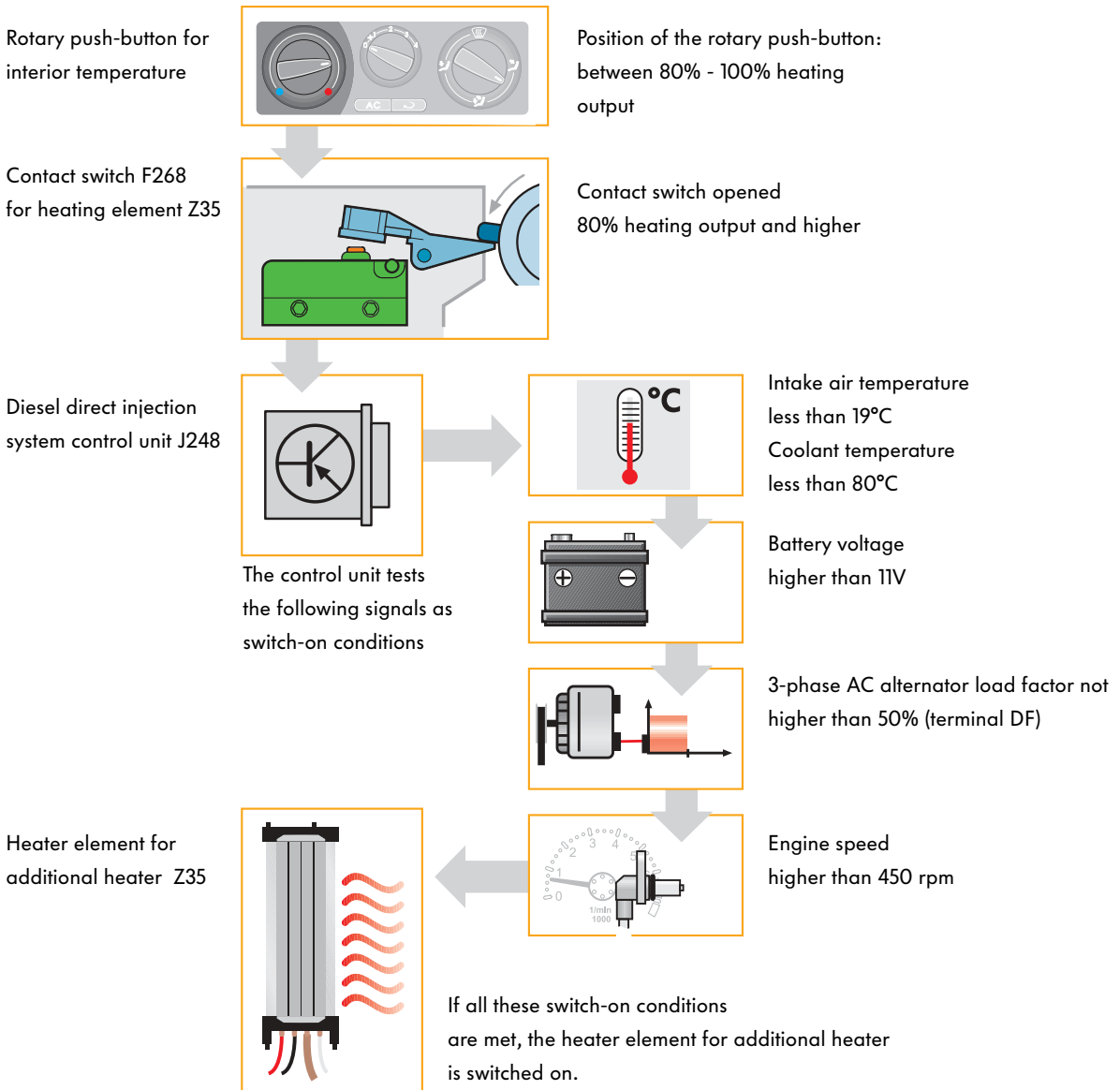
# Heating and air conditioning

## The heating output control

About 10 seconds after starting the engine, the diesel direct injection system control unit enables the heater element for additional heater for heating. This ensures that the engine runs properly straight away.

If the rotary push-button for interior temperature is in the position for 80% heating output and higher, the heater element for additional heater will now be switched on under certain conditions.

### Switch-on conditions



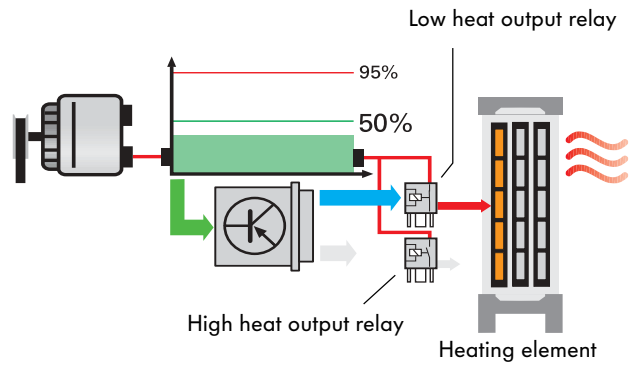
218\_135



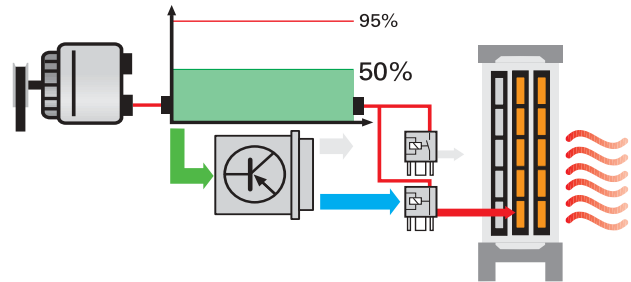
The engine control unit switches the three heating elements on and off in steps via relays. The relays for low and high heating output are located behind the relay carrier.

If the switch-on conditions are met, the relays are activated in the following order:

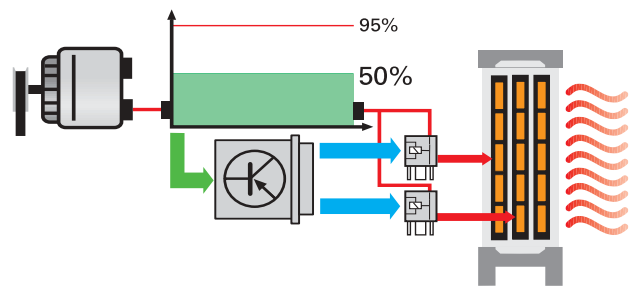
First, the low heat output relay is activated. It switches on a heating element with five PTC resistors.



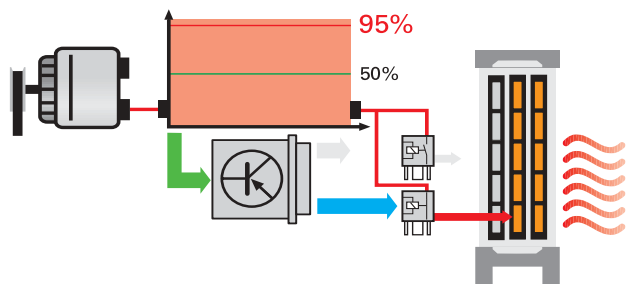
If the load factor of the 3-phase AC alternator is subsequently below approx. 50%, the high heating output relay will be activated and two heating elements will be switched on. The low heating output relay cuts out at the same time.



If the load factor of the 3-phase AC alternator now remains below approx. 50%, the low heating output relay cuts in again and all heating elements are switched off.



The heating elements are switched off step-by-step in the reverse order when the load factor of the 3-phase AC alternator is permanently above 95%.



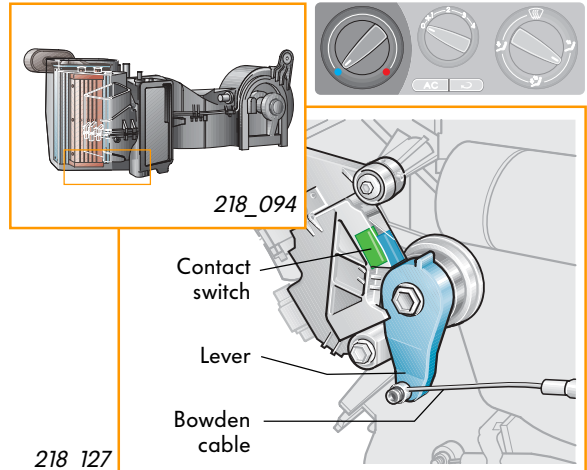
218\_143 - 146



# Heating and air conditioning

## Contact switch F268 for heating element Z35

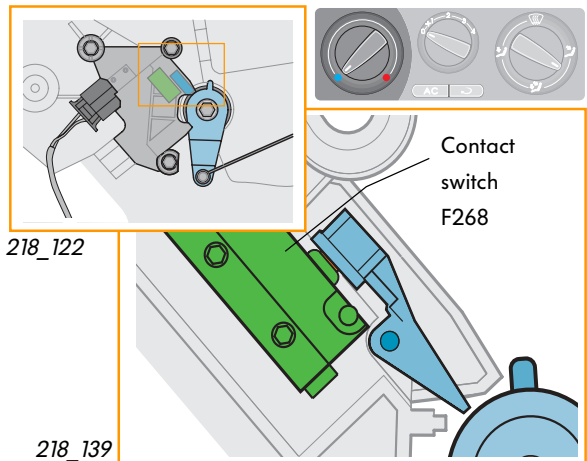
The contact switch is located on the housing of the heater or air conditioner. The rotary push-button for interior temperature moves the lever of the temperature flap by means of a Bowden cable. A cam on the lever activates the contact switch.



### Contact switch closed

The contact switch is closed in the operating range 'Cooling' and up to 80% heating output. When the contact switch is closed state, signal earth is present at the engine control unit.

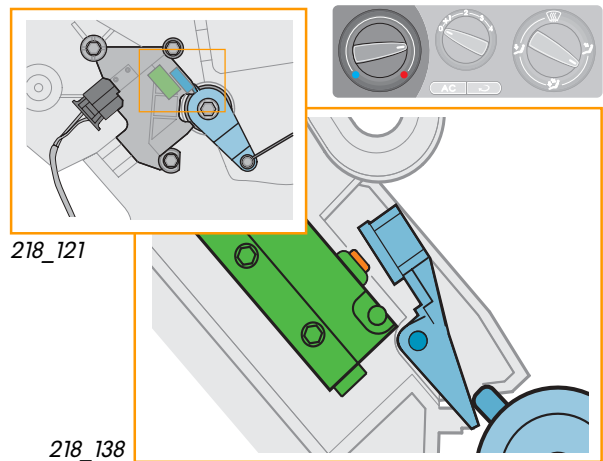
The heater element for additional heater does not cut in in this operating range.



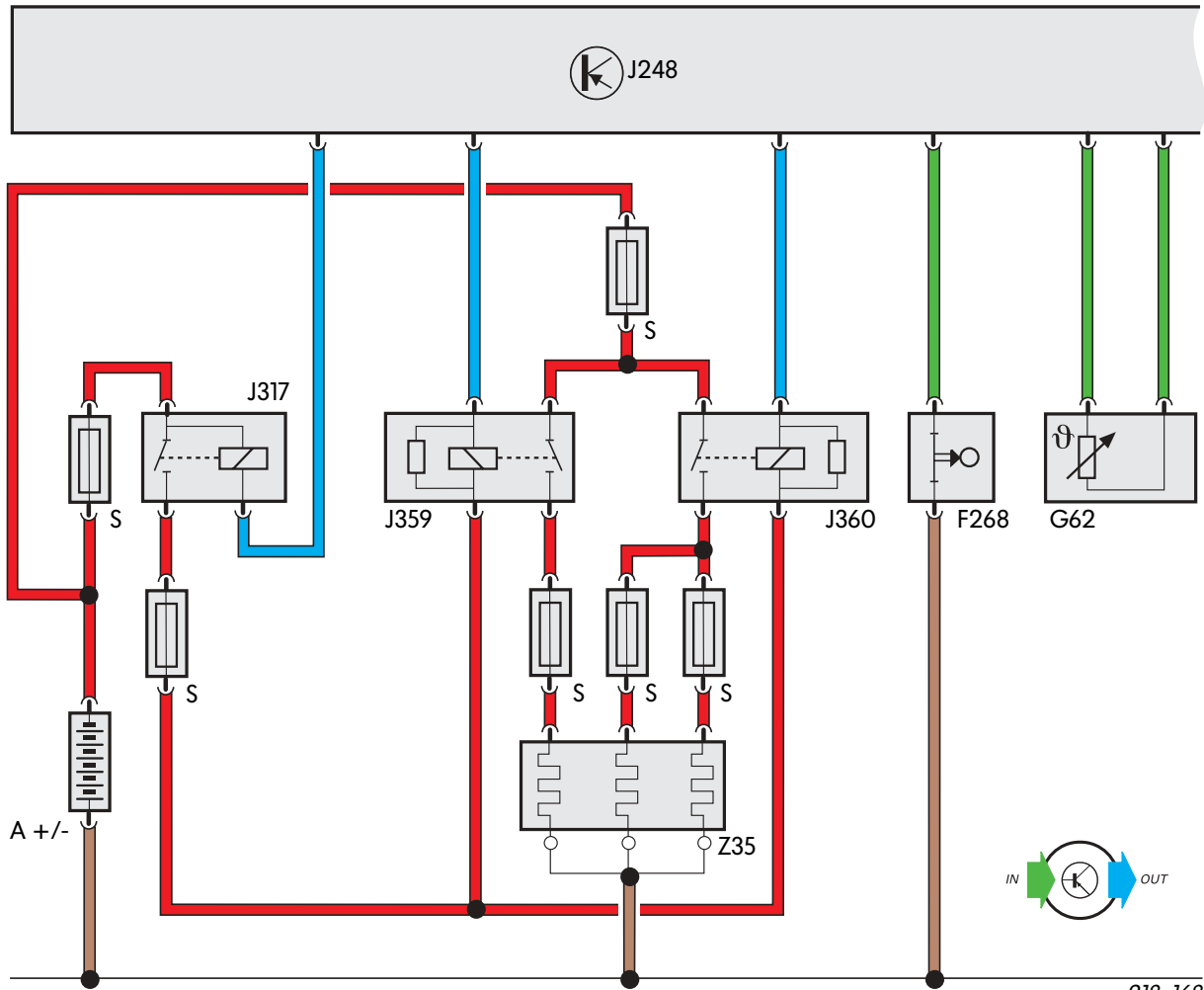
### Contact switch open

If the position of rotary switch is for between 80%-100% heating output, the lever is moved until the cam opens the contact switch. This breaks the signal earth contact to the engine control unit.

If all switch-on conditions are met, the heater element for additional heater cuts in.



## Function diagram



218\_168

### Components

A +/- Battery

J317 Voltage supply relay,  
terminal 30

J248 Diesel direct injection system control unit

J359 Low heat output relay

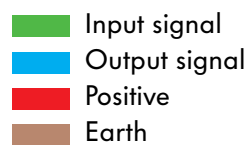
J360 High heat output relay

F268 Contact switch for heater Z35

G62 Coolant temperature sender

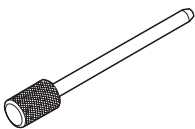
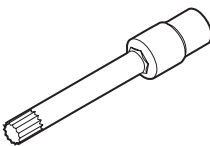
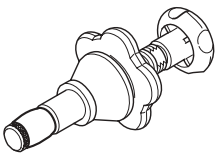
S Fuse

Z35 Heater element for additional heater



# Service

## Special tools

T 10060	Drift		For arresting the tensioning device for the ribbed V-belt. It replaces special tool 3209.
T 10061	Socket insert		For undoing and tighten the cylinder head nuts, as well as the fastening bolts for the balancing weight.
T 10063	Centring tool		For centring the clutch disc.
T 10064	Fitting tool		For fitting the wheel bearing
3282/28	Adjustment plate		For adjusting the gearbox mount 3282
3282/29	Bolt		Accessories for adjustment plate 3282/28



### Engine oil

Please note that the 1.2 l. TDI engine may only be filled with engine oil VW 50600 with the specification OW30.



### General body repairs

When working on the light-alloy body parts, it is absolutely necessary to use tool set V.A.G. 2010/2, since corrosion damage can occur when work is performed incorrectly. To avoid mixing up the aluminium tools with the conventional steel tools, the aluminium tools are colour-coded red.





# Notes

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# LUPPO 3L



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940.2810.37.20 Technical status: 5/9

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