

Service.

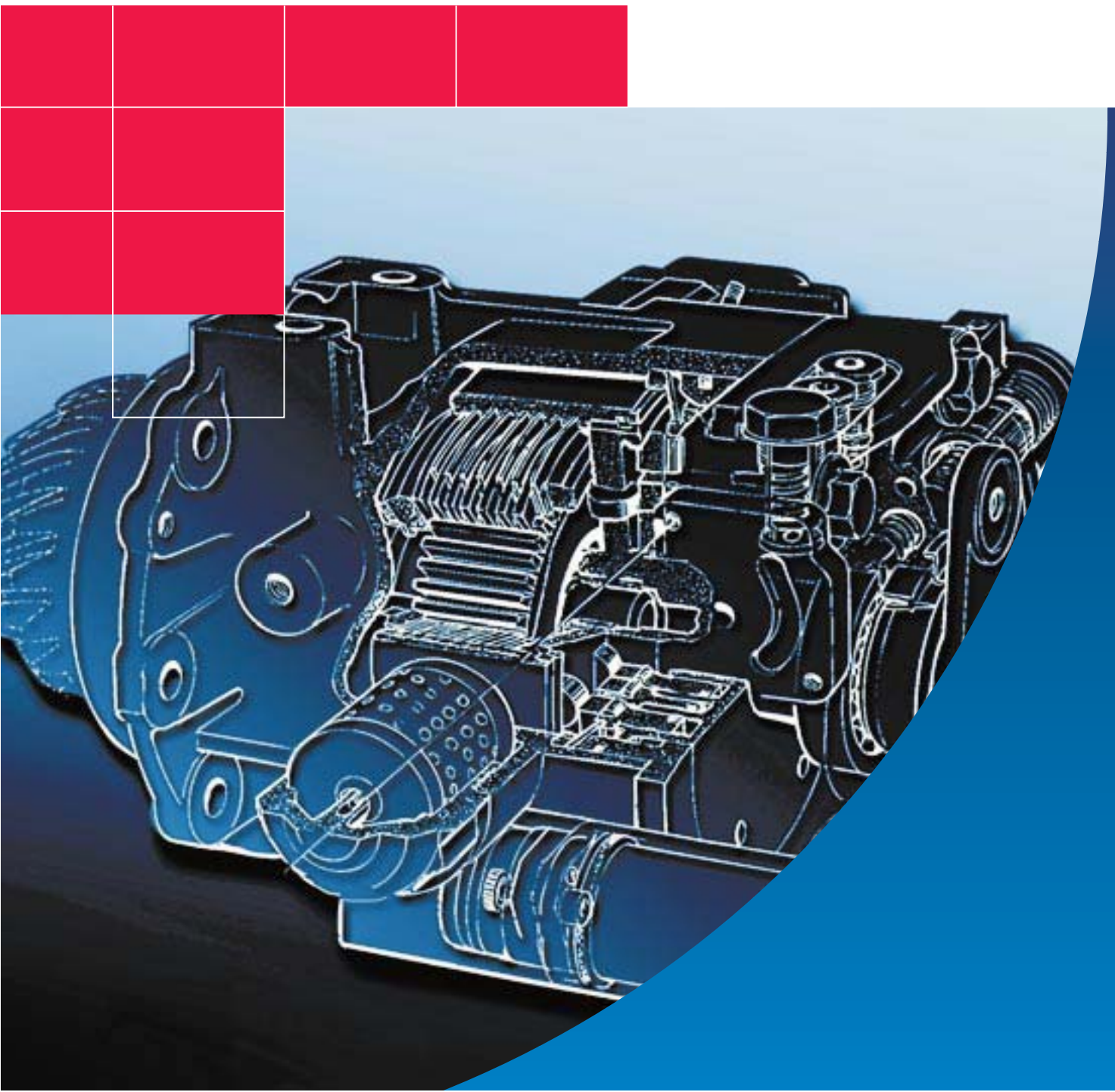


Audi

## Self-Study Programme 206

# Four-Wheel Drive with Haldex Coupling

Design and Function



Volkswagen and Audi have been building permanent four-wheel drive systems for almost 15 years. In Volkswagen's system, a viscous coupling distributes input torque to the rear axle; in Audi's system this job is performed by a Torsen differential.

The slip-recognising system is activated by a difference in speeds between the front and rear axles. Once activated, it distributes input torque to both axles.

The viscous coupling previously used by Volkswagen was able to detect slip alone, but not the cause of it.

The development of the Haldex coupling is a giant step forward in modern four-wheel-drive technology. The Haldex coupling is controllable. A processor also makes allowance for additional information during the control process. Slip is no longer the only decisive factor in the distribution of drive forces; the car's dynamic state is also a factor. The processor accesses the ABS wheel speed sensors and the engine control unit (accelerator pedal signal) via the CAN bus.

This data provides the processor with all the information it needs on road speed, cornering, overrun or traction mode, and can respond optimally to any driving situation.

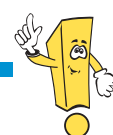
### Advantages of the Haldex coupling

- Permanent four-wheel drive with electronically controlled multi-plate clutch
- Front drive characteristic
- Quick response
- No strain on clutch when parking and manoeuvring vehicle
- Compatible with different tyres (e.g. emergency wheel)
- No restrictions on towing with the axle raised off the ground
- Fully combinable with traction control systems such as ABS, EDL, TCS, EBD and ESP



SSP 206/001

**NEW**



**Important Note**



**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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# Four-wheel drive

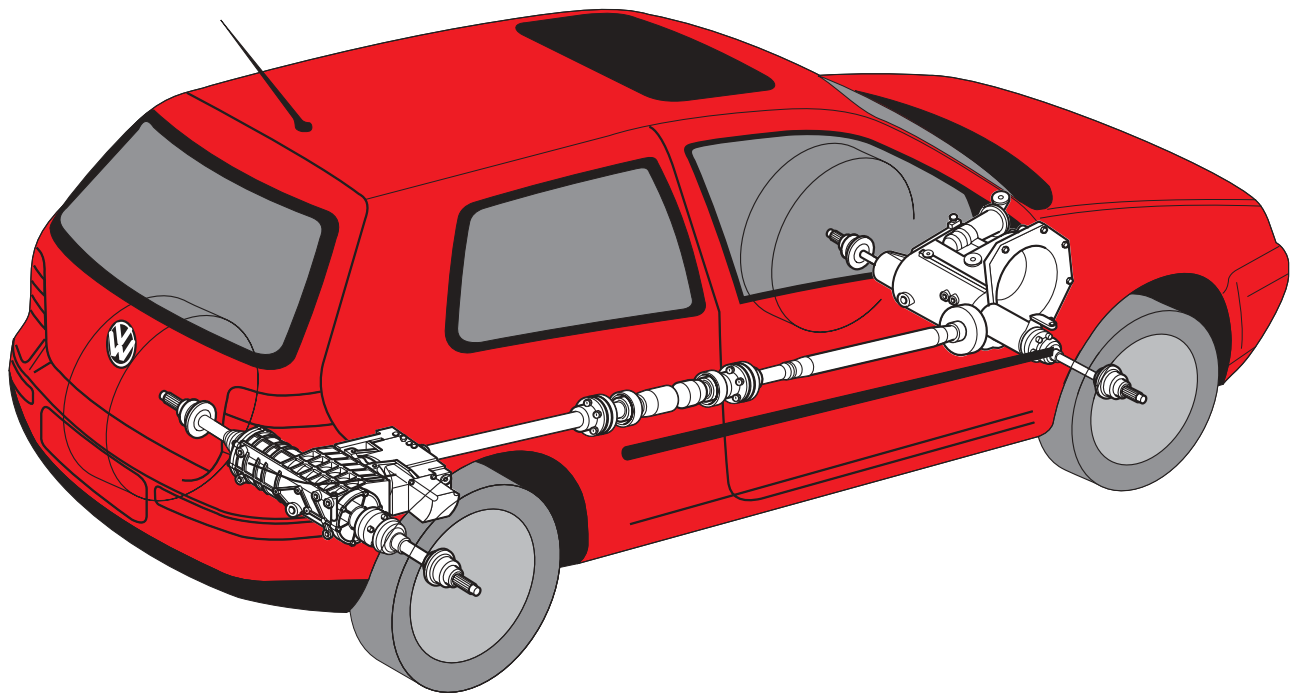
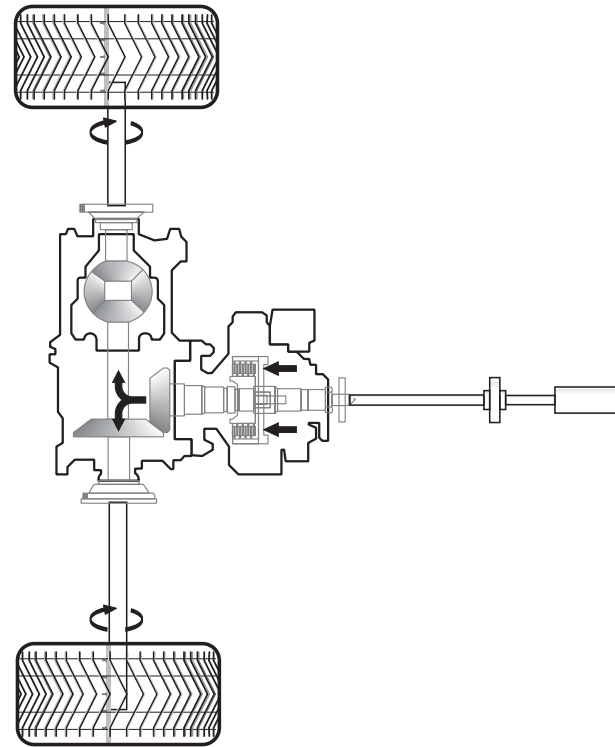


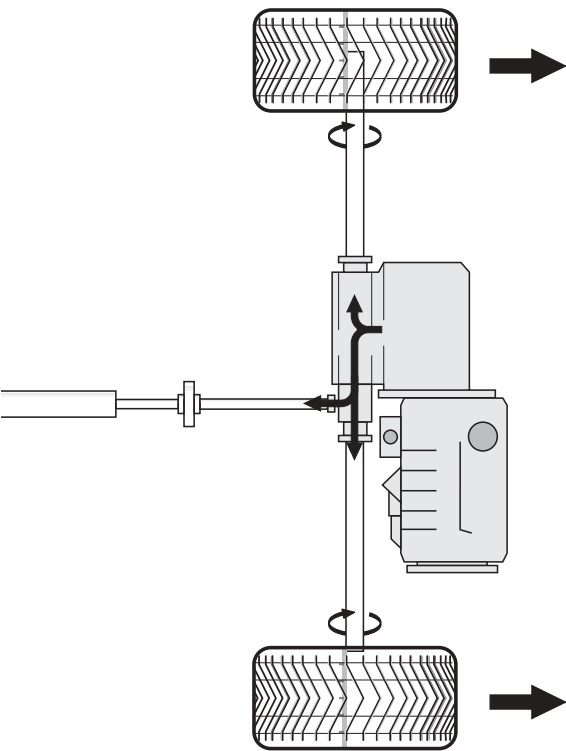
## The four-wheel drive train

The four-wheel drive train was developed with the new multi-plate clutch for Group A platform vehicles with transversely mounted front engines.

The new coupling is a compact module located in the same position as the viscous coupling in the previous drive unit.

It is mounted on the rear axle differential and is driven by the prop shaft.





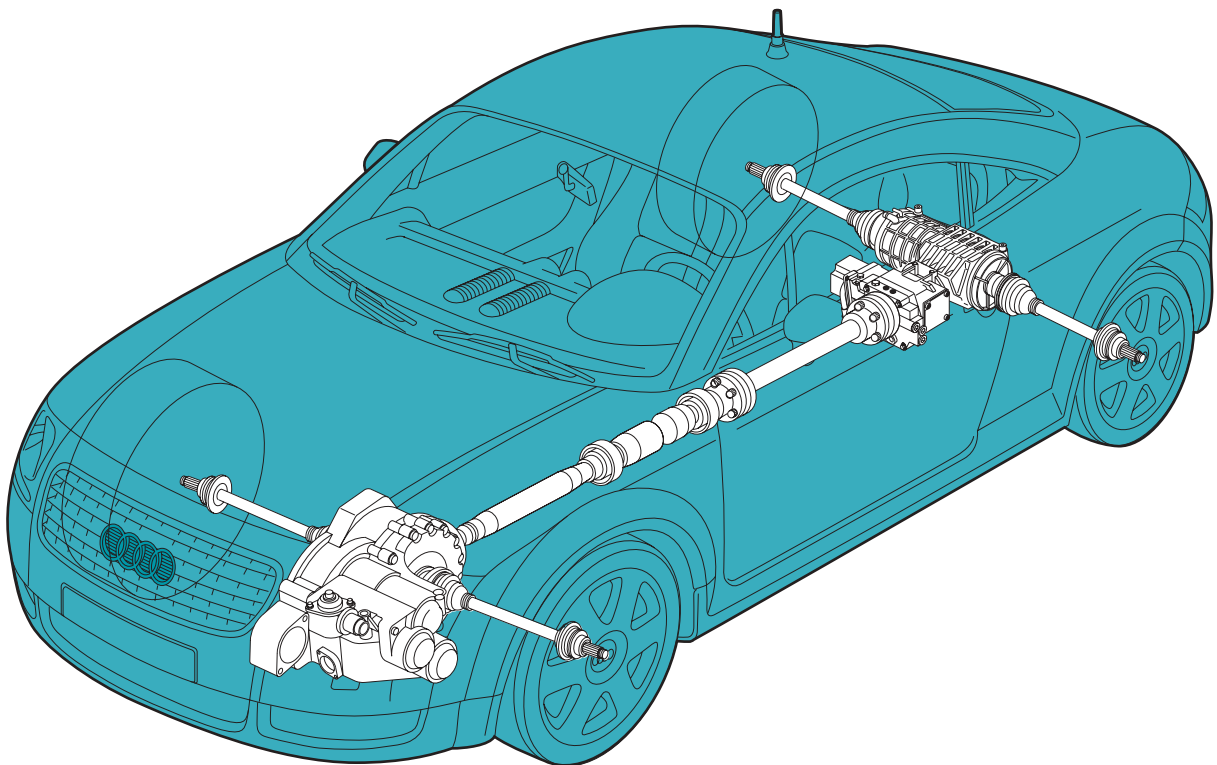
Engine torque is transmitted to the prop shaft through the manual gearbox, the front axle differential and the front axle drive.

The prop shaft is connected to the input shaft of the Haldex coupling.

In the Haldex coupling, the input shaft is separated from the output shaft to the rear axle differential.

Torque can only be transmitted to the rear axle differential via the closed plate set of the Haldex coupling.

SSP 206/002

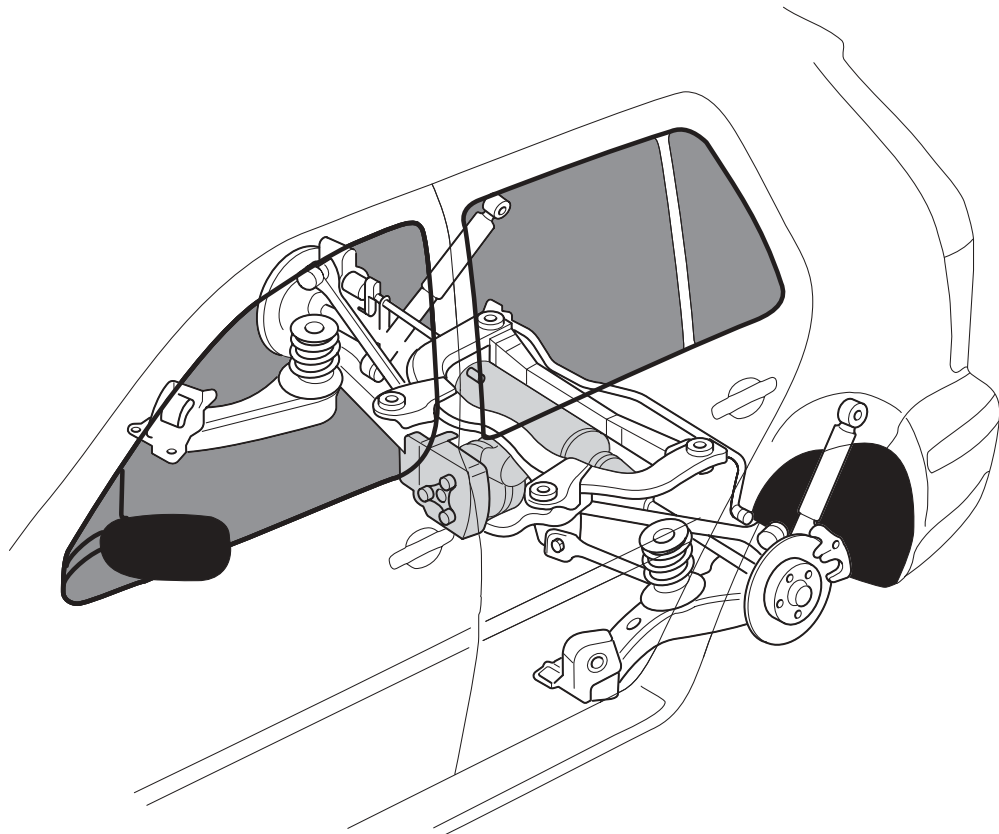


SSP 206/004

# Four-wheel drive

## Modifications to the running gear

A new rear axle and a new rear axle suspension were required to install the four-wheel drive train.



SSP 206/005

### Design

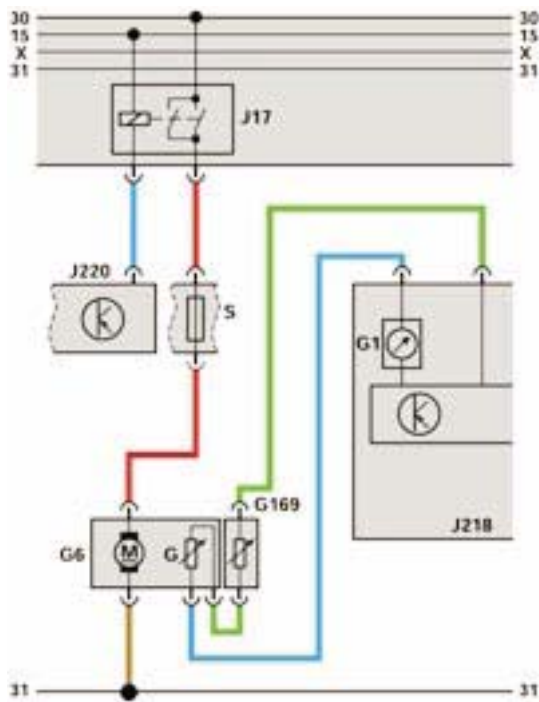
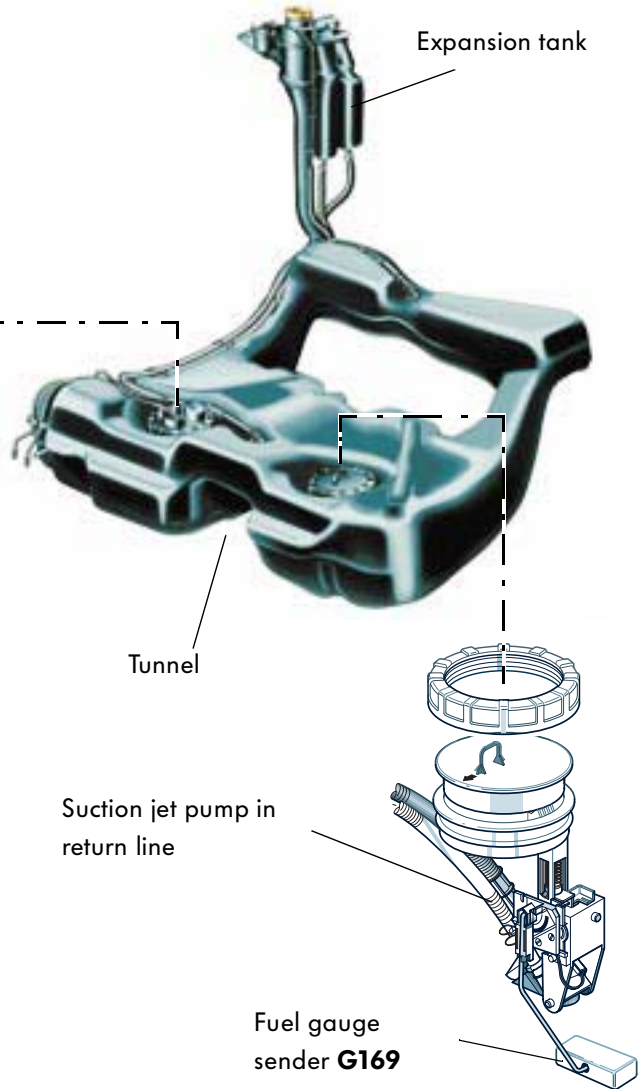
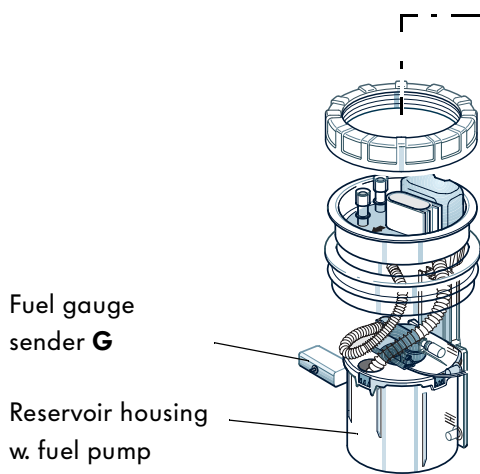
The rear axle subframe has a very flat design to maximise the available space inside the passenger cabin. The separate layout of the springs and shock absorbers preserves the spring characteristic of the front drive vehicle and the interior width.



## Modifications to the fuel delivery system

The fuel tank for four-wheel-drive vehicles was adapted to the space that is more confined than on the front drive vehicle.

A tunnel provides the space required for the prop shaft. The result of this is a "divided tank" construction.



SSP 206/007

A suction jet pump driven by the two-stage fuel pump via the fuel return line pumps fuel from the left half of the fuel tank into the reservoir housing of the fuel pump.

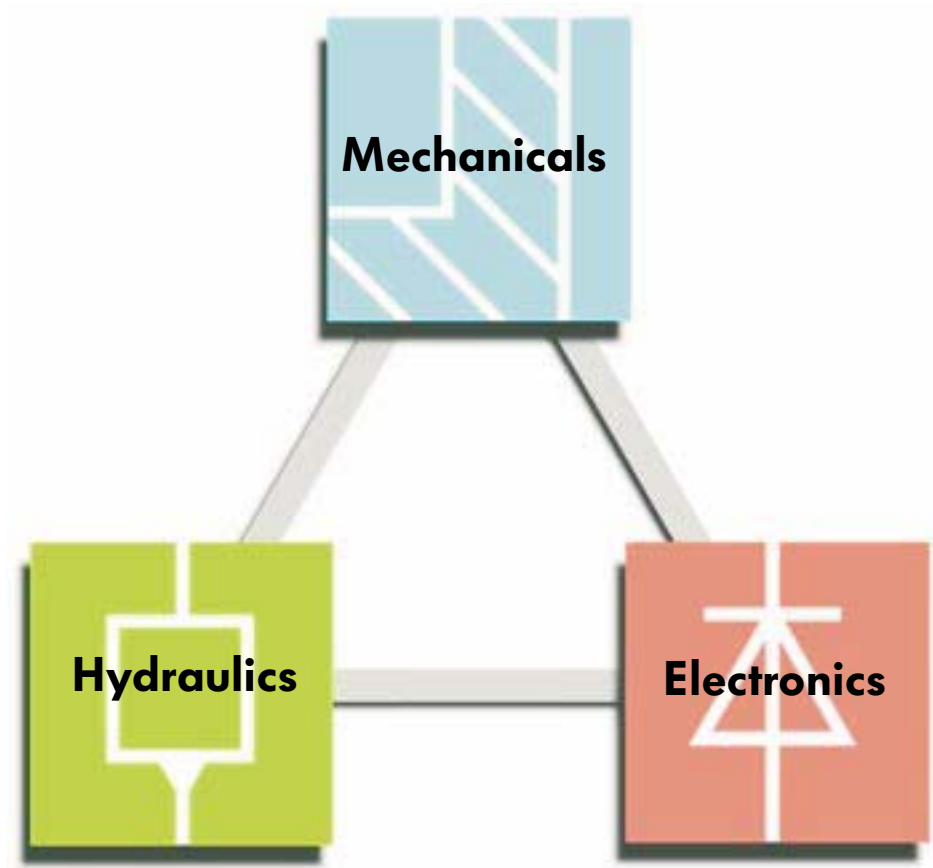
Fuel gauge senders G and G169 are connected in series.

$$R_1 + R_2 = R_{tot}$$

This data is evaluated by the combi-processor of the dash panel insert.




# Haldex coupling

## The Haldex multi-plate clutch



SSP 206/008

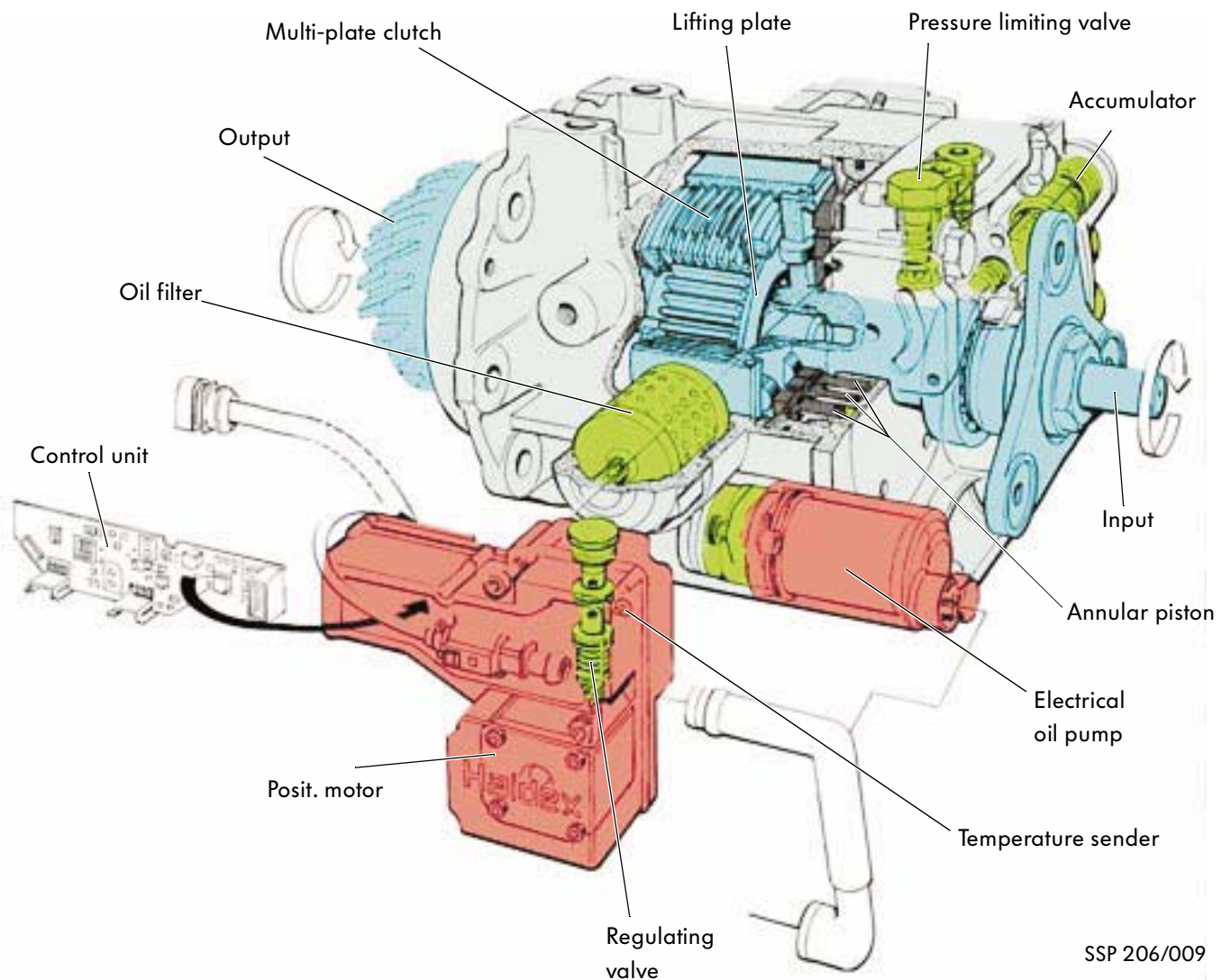
The Haldex multi-plate clutch has three main components:

-  the mechanics
-  the hydraulics
-  and the electronics



The mechanicals essentially comprise rotating and moving parts. These include

- the input shaft
- the inner and outer clutch plates
- the lifting plate
- the roller bearing with annular piston
- the output shaft



The hydraulics essentially comprise

- the pressure valves
- the accumulator
- the oil filter
- the annular piston
- the regulating valve

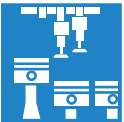
The electronics essentially comprise

- the pump for Haldex coupling
- the regulating valve positioning motor
- the temperature sender
- the control unit

# Mechanicals

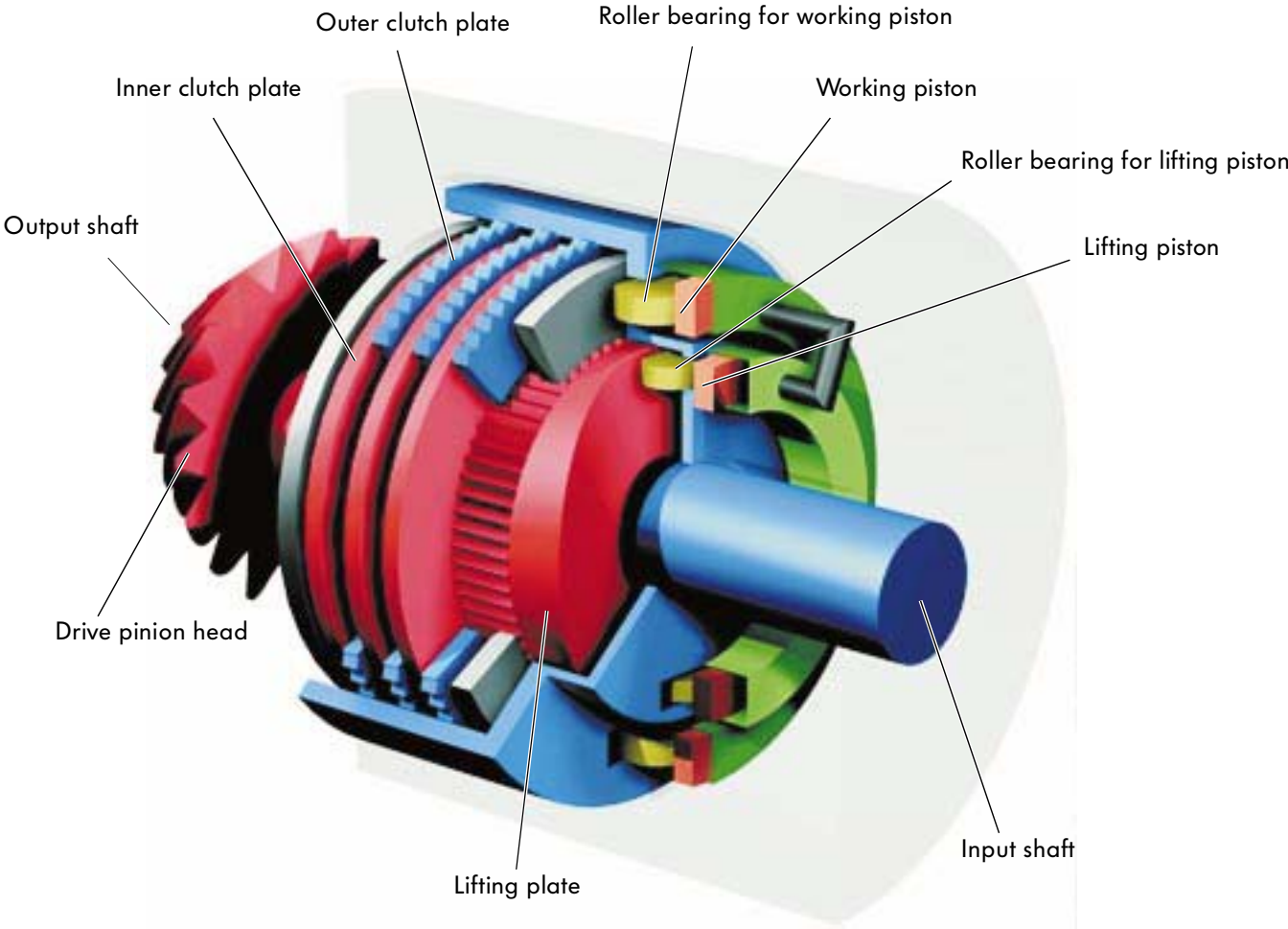
## The multi-plate clutch

The clutch input shaft, indicated in blue in the figure, is connected to the prop shaft. The roller bearings for the lifting piston and the working piston, as well as the outer clutch plates, are entrained when the input shaft rotates.



The lifting and working pistons are annular pistons.

The output shaft, indicated in red in the figure, forms a unit from the lifting plate through to the drive pinion head. The inner clutch plates are also connected to the output shaft via longitudinal tothing.



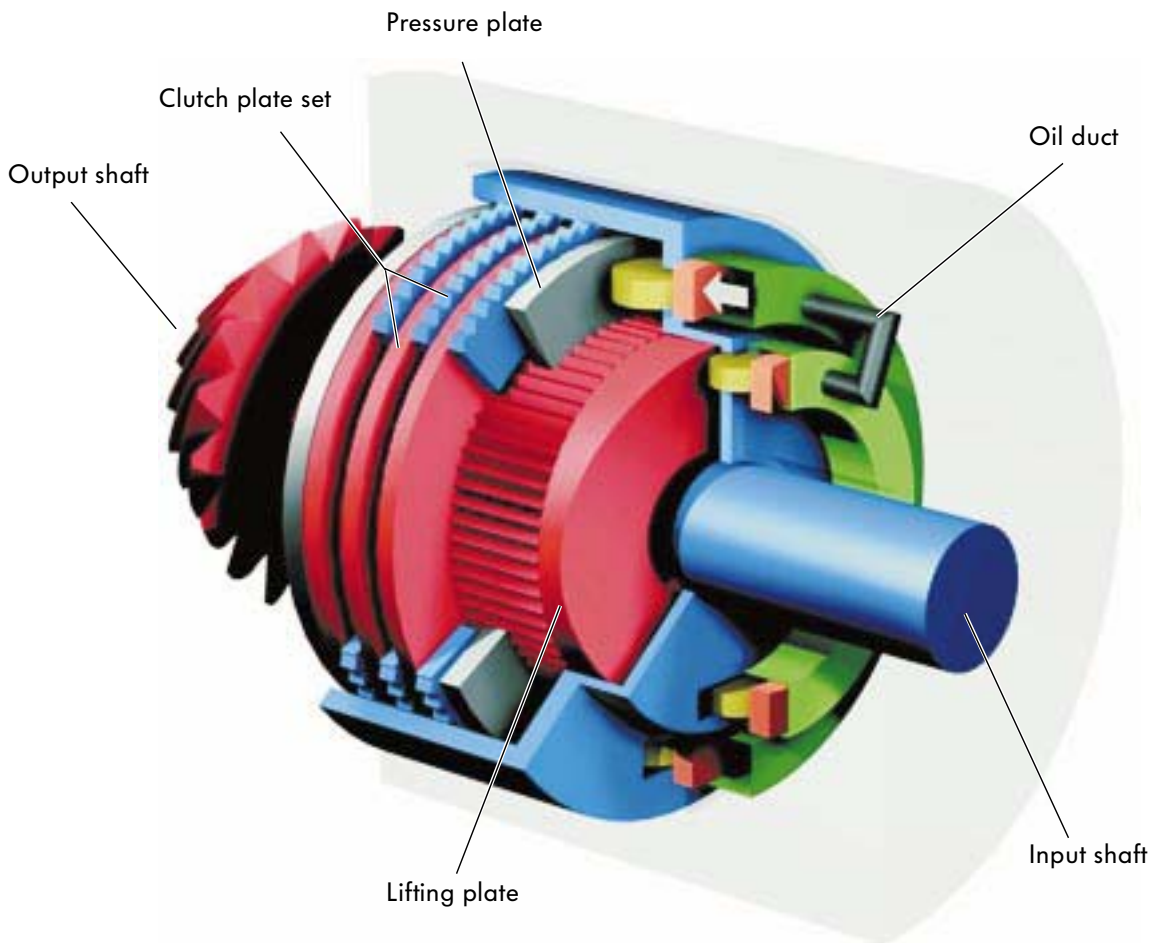
## Function

When the vehicle accelerates, the input shaft, together with the roller bearing of the lifting piston, rotates around the still stationary lifting plate of the output shaft. The roller bearing of the lifting piston tracks along the undulating surface of the lifting plate. The roller transfers these upward and downward movements to the lifting piston. This causes the lifting piston to perform a lift movement, building up an oil pressure.

This oil pressure is diverted via an oil duct to the working piston. The oil pressure forces the working piston to move to the left against the bearing roller and the pressure plate of the clutch plate set.

The clutch plate set is compressed.

The input shaft and the output shaft of the clutch are now interconnected, making four-wheel drive possible.

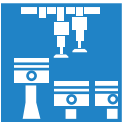


SSP 206/011

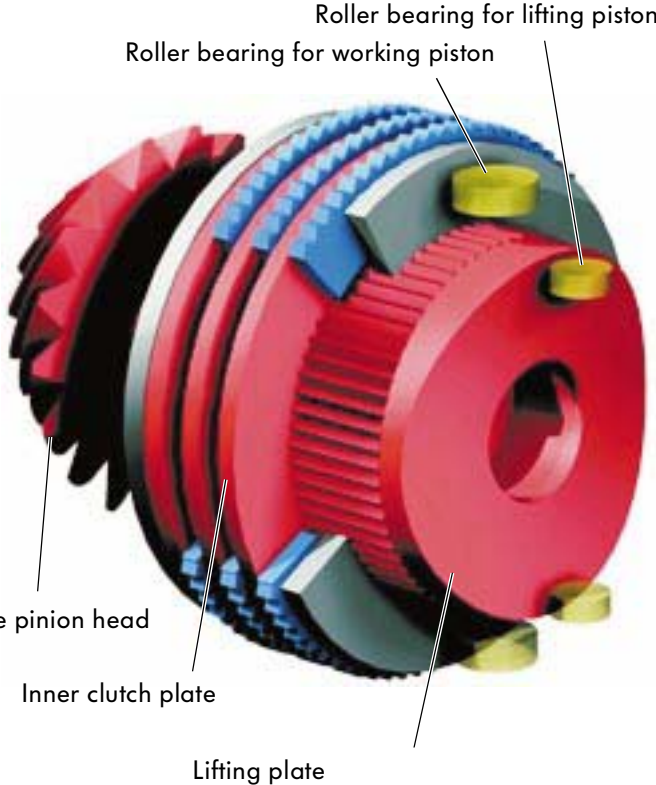


# Mechanicals

When a difference in speeds occurs between the front and rear axles, the outer clutch plate housing, together with the roller bearings, rotates around the output shaft in such a way that the roller bearings of the lifting piston roll off the lifting plate. Due to the shape of the lifting plate, the roller bearings of the lifting piston follow an undulating path and transfer the lifting movement to the lifting pistons in the housing.



For reasons of clarity, we have shown the lifting plate with two cams. In reality, however, there are three cams on the lifting plate. The function remains unchanged.

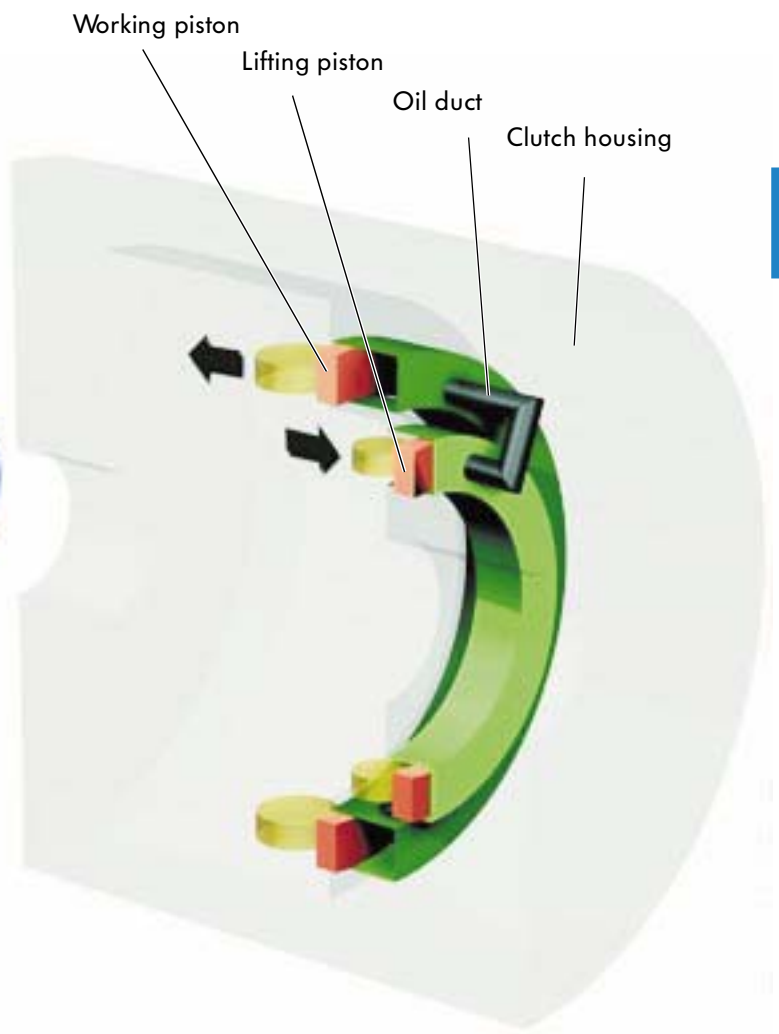
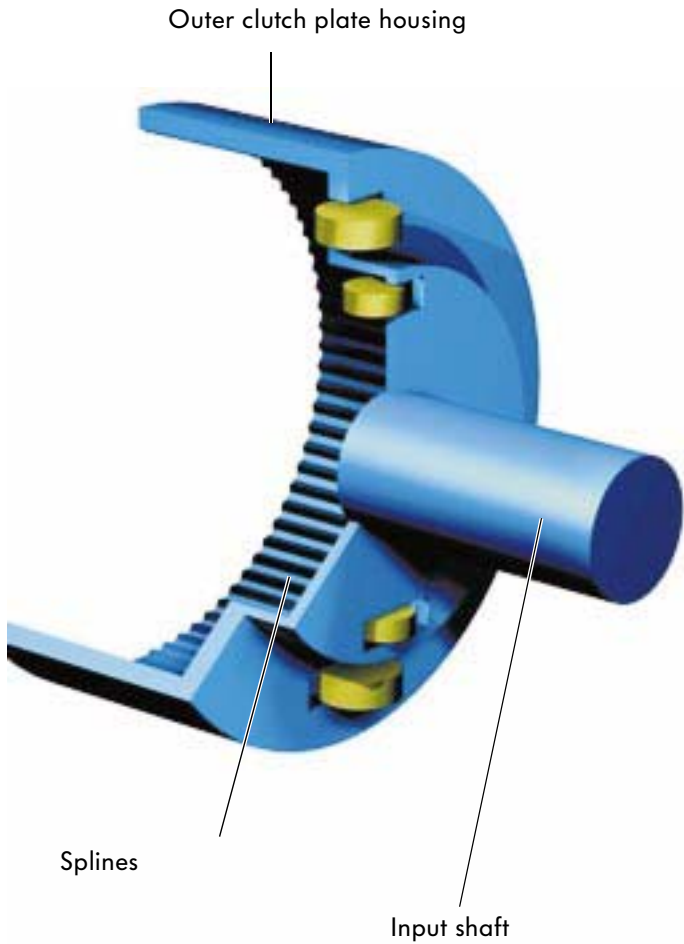


The output shaft, with its splines for the inner clutch plate, combines with the lifting plate and the drive pinion head to form a unit.



The roller bearings are shown here for your information only.





The outer clutch plate housing, together with the splines for the outer clutch plate and the roller bearing form, combines with the input shaft to form a unit.

SSP 206/012



The roller bearings are located in the outer clutch plate housing, as shown here.

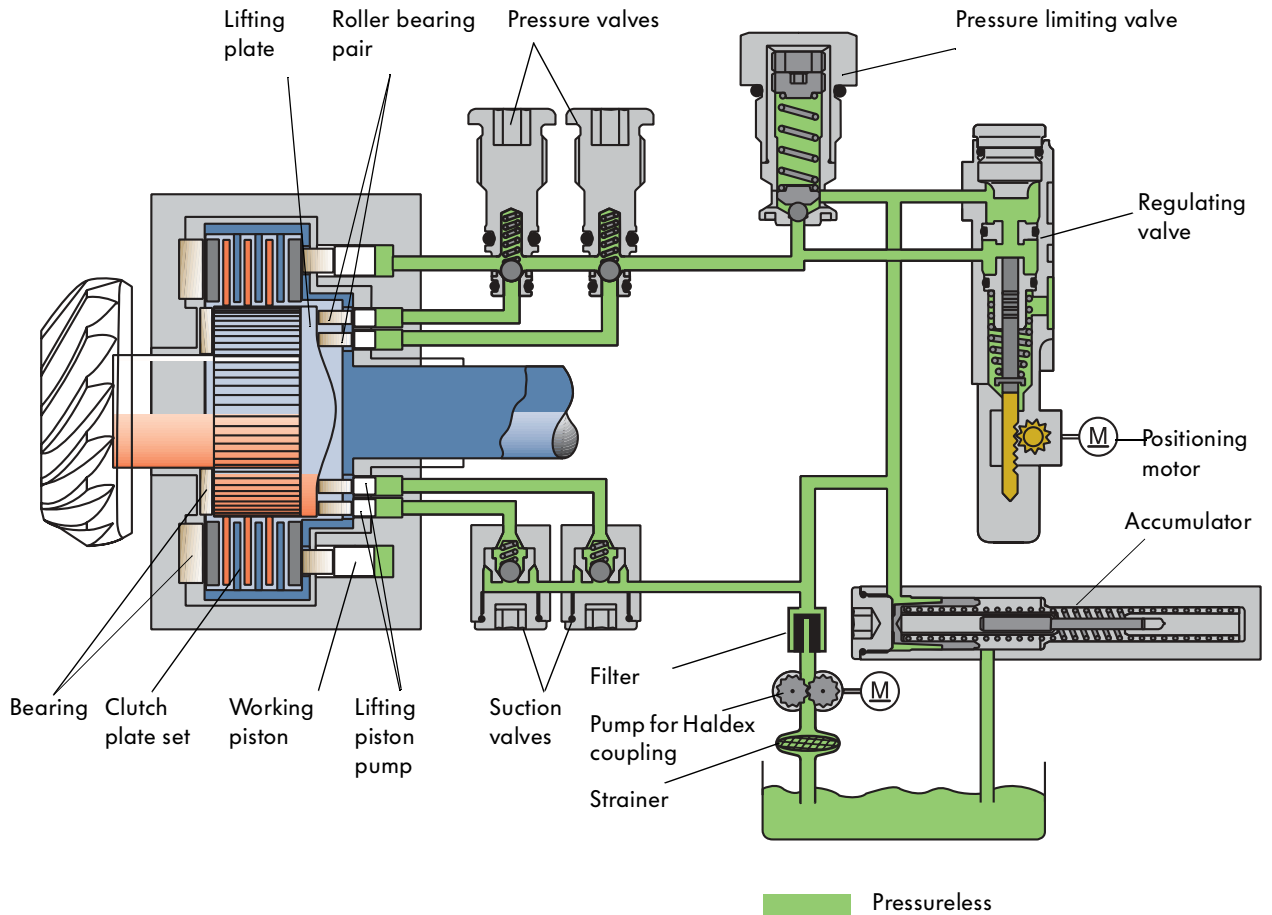
The lifting movement of the lifting piston produces an oil pressure which acts on the working piston via the oil duct and pushes the piston to the left.

The pressure is transferred via a pressure plate to the clutch plate set via the roller bearings of the working piston. The clutch closes and thus interconnects the front and rear axles.



The roller bearings are shown here for your information only.

# Hydraulics



SSP 206/013

## Diagram of pressureless system

The pressure limiting valve determines the maximum pressure on the clutch plates.

The other components are explained on the following pages.

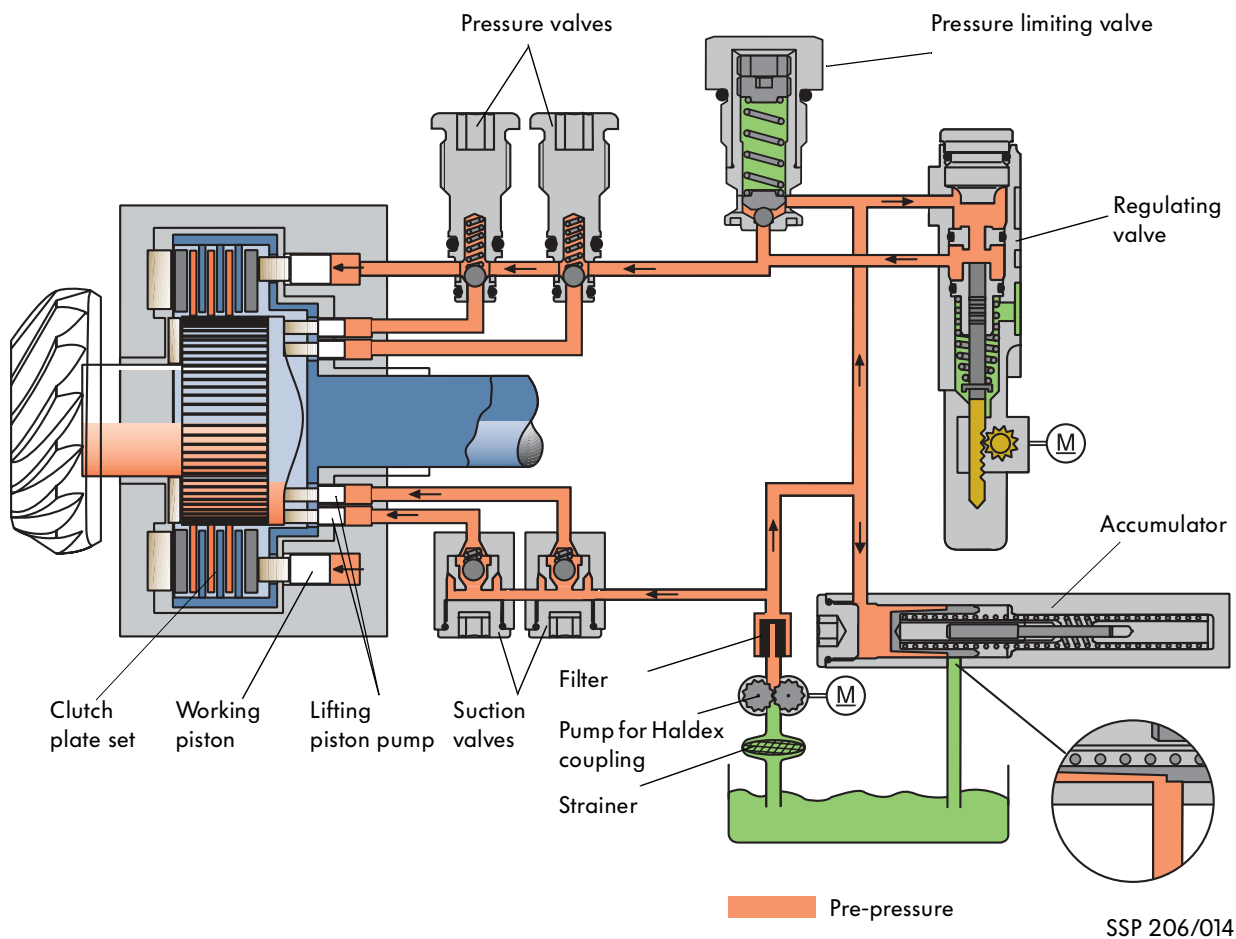
You have already seen how oil pressure is built up at the lifting piston as a result of a difference in speeds between the input shaft (blue) and the output shaft with lifting plate (red).

This oil pressure is regulated by valves. The plate clutch can thus allow a certain amount of slip when open and nearly closed.



For reasons of clarity, we explained the function on the previous pages using a lifting piston by way of an example. In reality, there are two lifting pistons in the clutch housing; these pistons are actuated by roller bearing pairs.

Therefore, two suction valves and two pressure valves are also required.



### Pressure build-up in pump for Haldex coupling (pre-pressure)

An electrical oil pump is activated electrically when the engine speed exceeds 400 rpm.

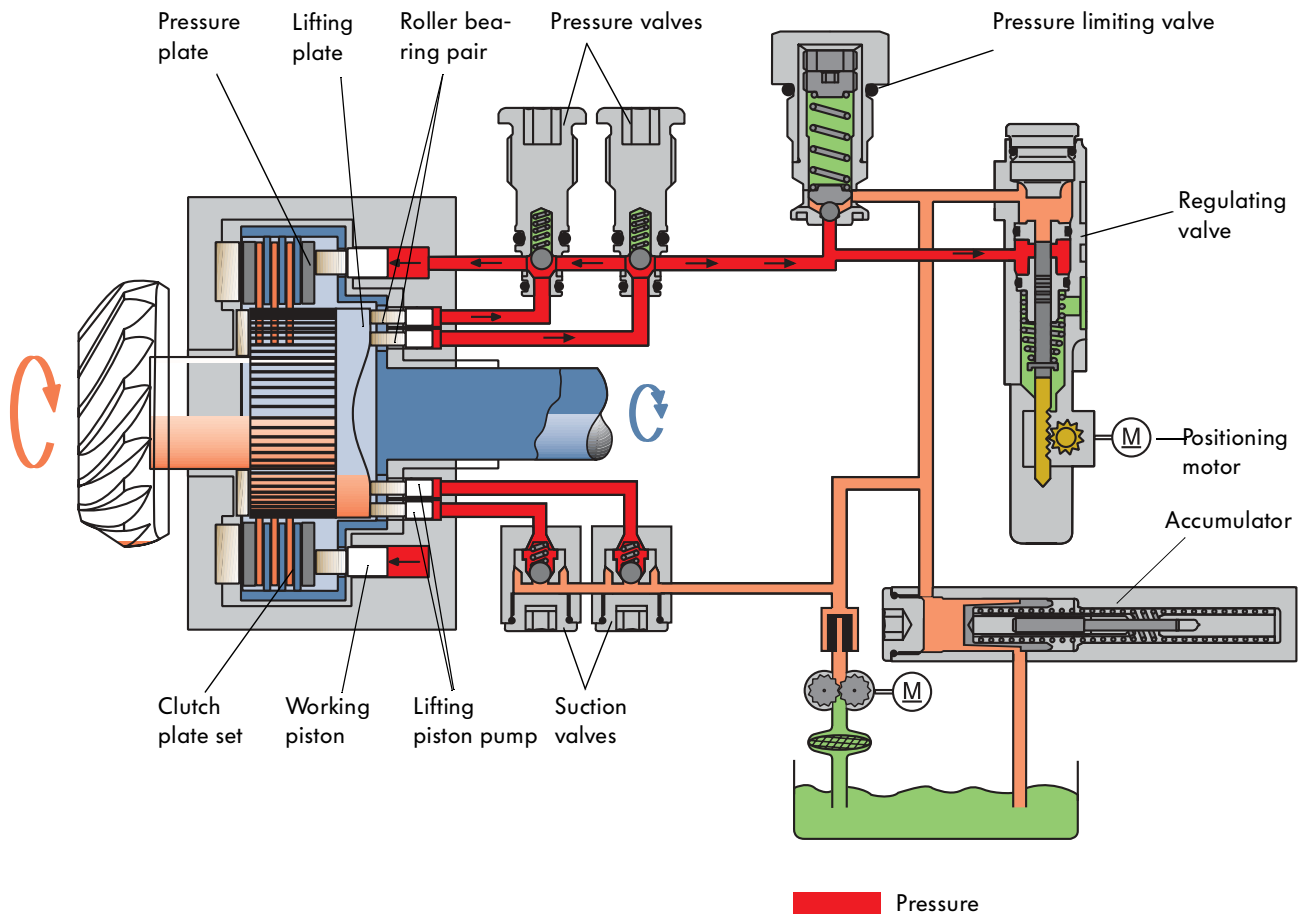
The electrical oil pressure pump extracts hydraulic fluid from the depressurised chamber of the clutch housing through a strainer and pumps the oil through a filter via the suction valves on the lifting piston.

The lifting pistons are thus supplied with oil and simultaneously brought into contact with the lifting plate via the roller bearings.

At the same time, oil is supplied to the working piston via the regulating valve and through the pressure valves; the working piston is also brought into contact with the lifting plate. This pre-pressure eliminates play in the clutch plate set, permitting a quick clutch response.

The pre-pressure of 4 bar is determined by the accumulator. An additional task of the accumulator is to smooth out pressure fluctuations.

# Hydraulics



SSP 206/015

## Pressure build-up via the lifting pistons (regulating valve closed)

The oil pressure produced by the lifting pistons is transferred to the working piston via the pressure valves.

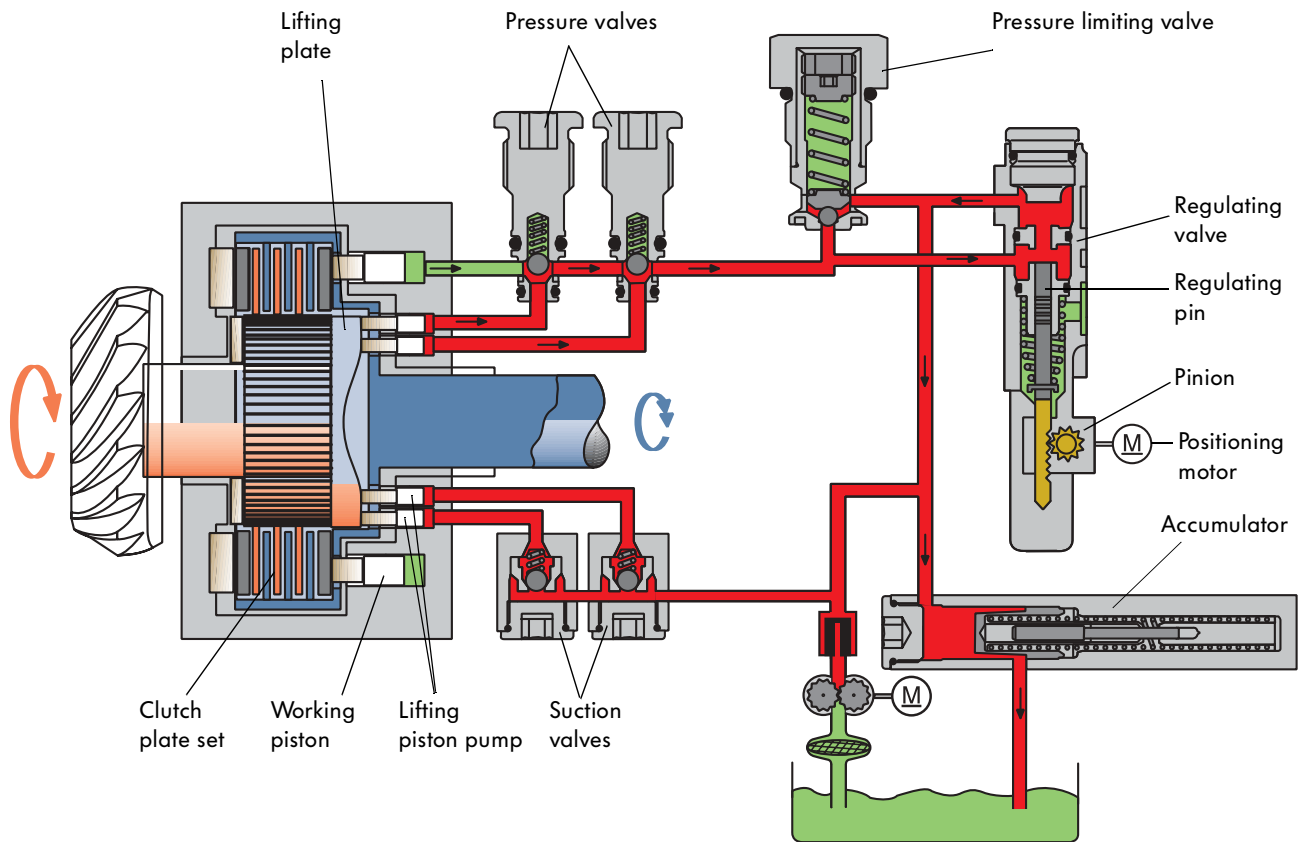
The clutch plate set is closed and thus establishes a connection between the input shaft (blue) and the output shaft (red).

The pressure on the plates is determined by the regulating valve. The positioning motor, which is driven by the Haldex coupling control unit, adjusts the regulating valve. If the regulating valve is closed, the maximum pressure acts on the clutch plates. The maximum pressure is determined by the pressure limiting valve.





# Hydraulics



SSP 206/017

## Pressure build-up via lifting piston (regulating valve open)

The regulating valve is open, allowing the oil to flow back into the oil sump via the accumulator.

As a result, no pressure is built up at the working piston. The plate clutch is open, and no torque transmission takes place.

The accumulator maintains the pre-pressure in the return line of the regulating valve.



There is pre-pressure (4 bar) in the regulating valve return line routed to the accumulator.

# Test your knowledge

## 1. What are the outstanding features of the Haldex coupling?

- A Permanent four-wheel drive with electronic regulated plate clutch
- B Directionally stable acceleration (front drive characteristic)
- C Delayed response
- D Quick response
- E Compatible with different tyre sizes (e.g. emergency wheel)
- F Utilises CAN signals
- G No restrictions on towing with axle raised off the ground

## 2. The Haldex coupling has three main elements. What are they?

- A Electronics
- B Pneumatics
- C Hydraulics
- D Mechanicals

## 3. What components are connected to the three main component parts of the clutch?

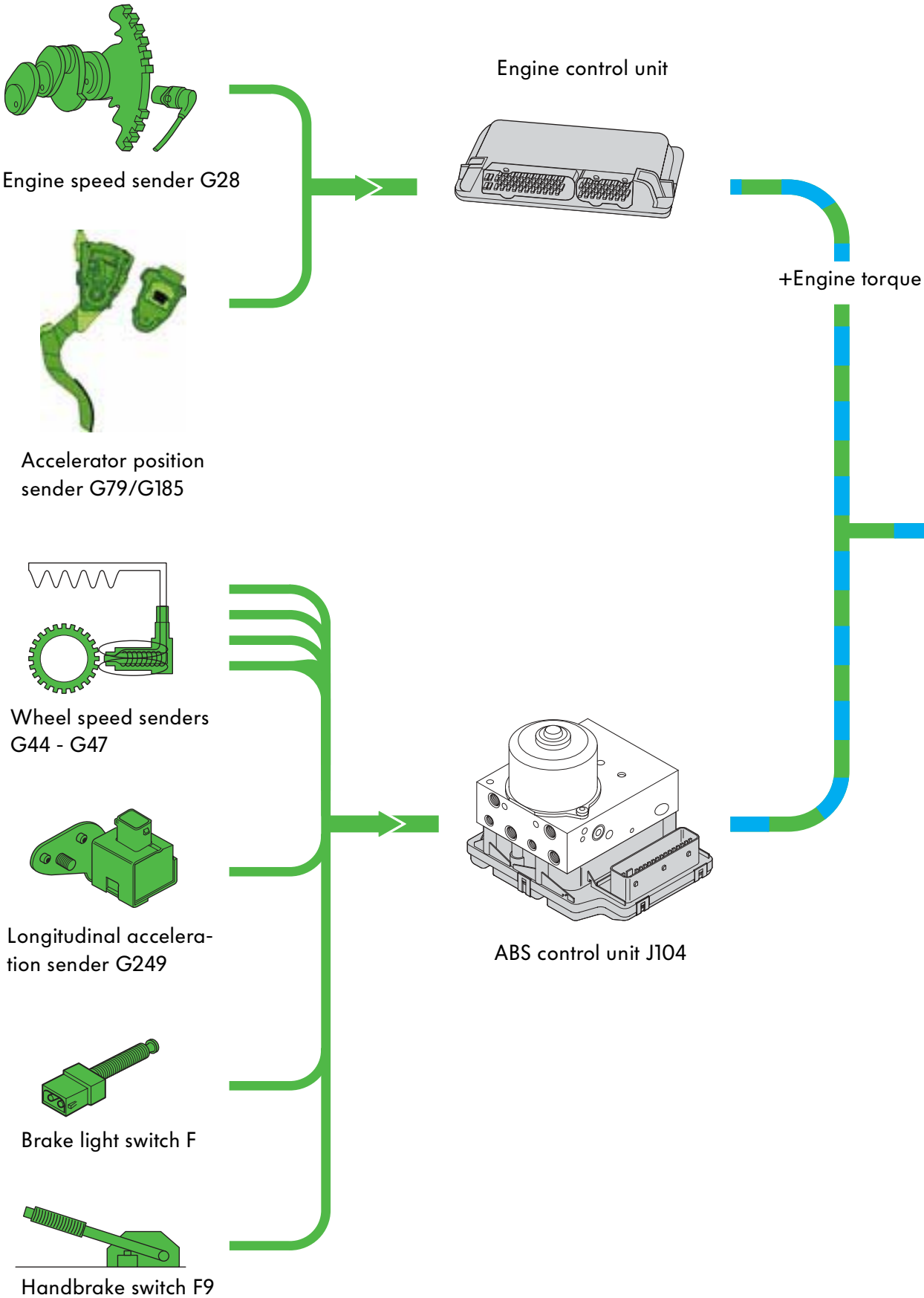
- A Output shaft: ....., ....., .....
- B Input shaft: ....., .....
- C Clutch housing: ....., .....

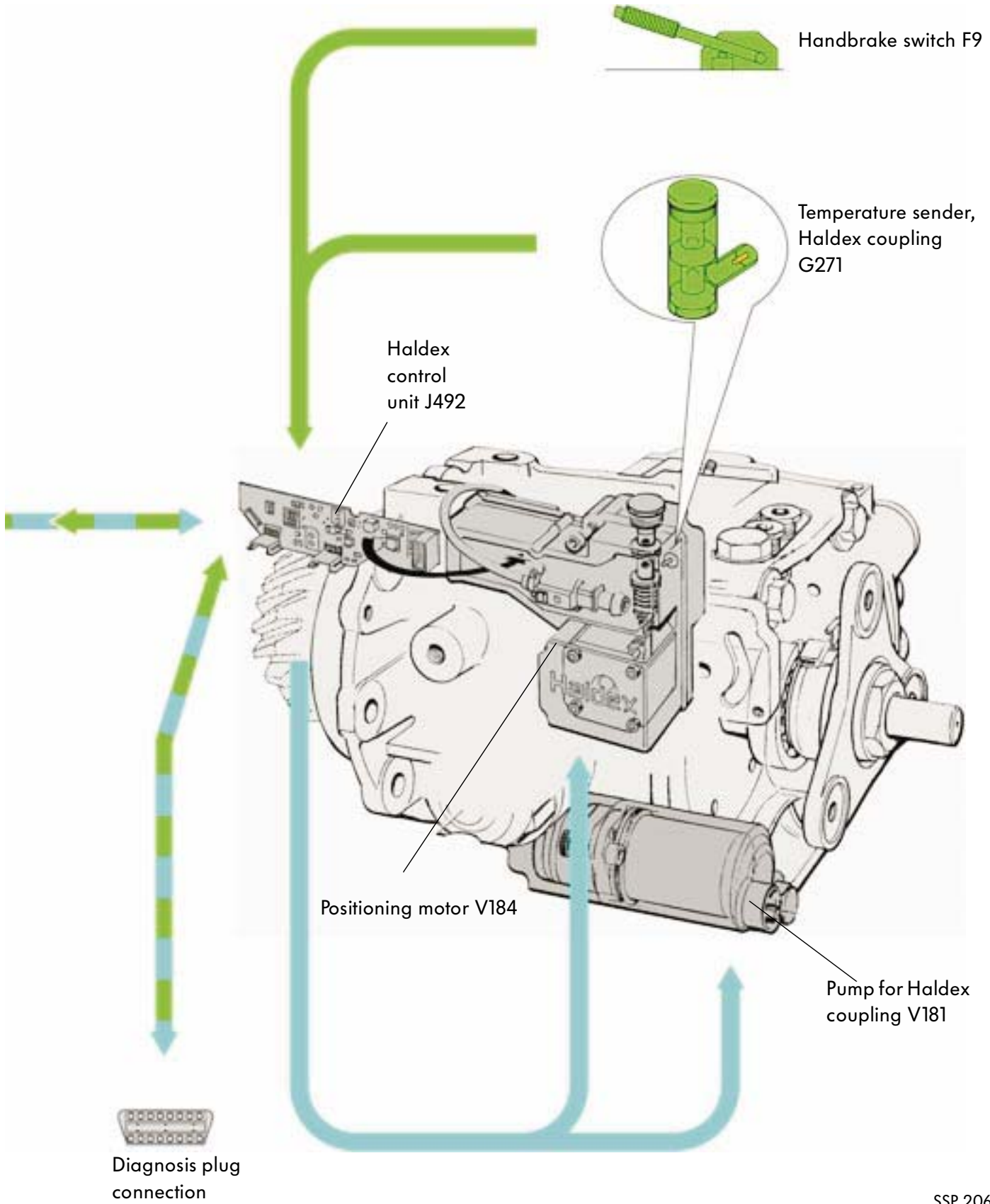
## 4. The pump for Haldex coupling is electrically activated when the engine speed

- A is greater than 400 rpm.
- B is less than 400 rpm.



# System overview





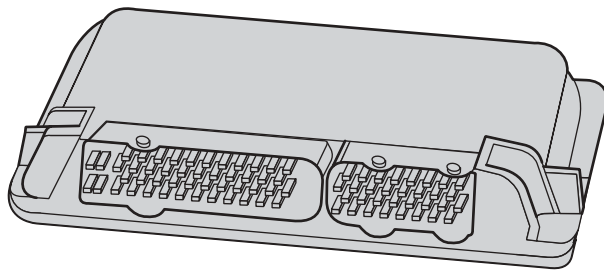
# Electrics

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## The engine control unit

The engine control unit is mounted differently on the various engines, but is normally accommodated in the plenum chamber.

The operating mode of the engine control unit is torque-oriented; the new EPC function has made this possible.



SSP 206/023



## Signal utilisation for the four-wheel-drive electronics

The engine control unit provides the following signals along the CAN bus.

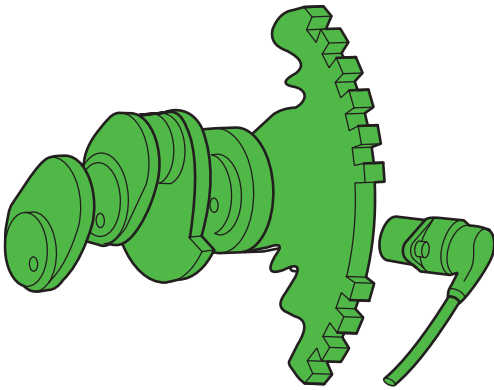
- Engine speed
- Accelerator pedal position
- Engine torque

## Effects of signal failure

- Engine not running

## Engine speed sender G28

The engine speed sender is an inductive sender, and is installed in the vicinity of the oil filter on the left-hand side of the engine.



SSP 206/019

### Signal utilisation

The sender records the exact angular position of the crankshaft to determine the ignition and injection point, as well as engine speed.

### Engine speed

As soon as the engine turns, the sender wheel moves past G28 and generates an AC voltage the frequency of which changes as a function of engine speed.

The control unit calculates the engine speed from the frequency of the AC voltage.

### Ignition point

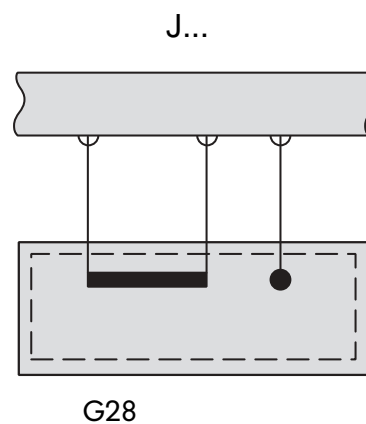
For recognising the crankshaft position, the sender wheel has a tooth gap of two teeth which serves as a reference mark.

### Effects of signal failure

If the engine speed signal supplied by the engine speed sender fails, the engine cannot be started or run.



### Electrical circuit



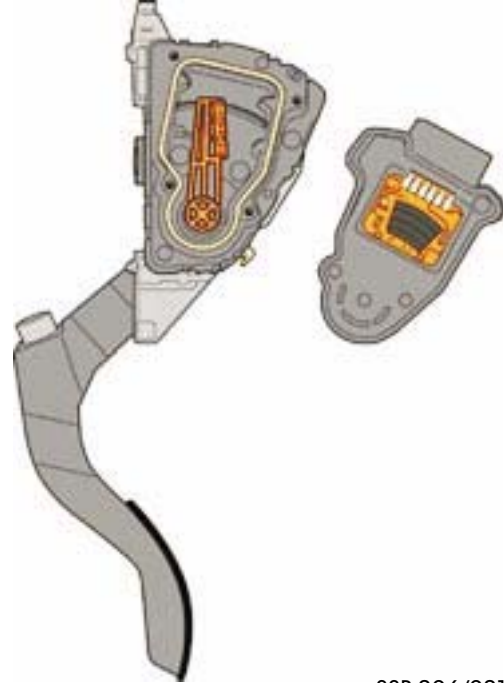
SSP 206/020

# Electrics

## Accelerator position sender G79/ G185

Accelerator position sender G79/G185 serves to transfer the driver input to the engine control unit.

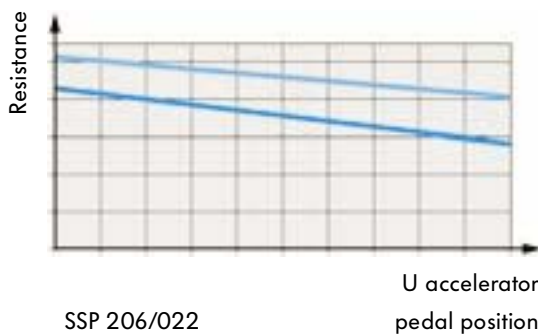
The accelerator position sender sends an analogue signal corresponding to the accelerator pedal position to the Motronic. To back up the EPC function, the accelerator position sender has two independent potentiometers (G79 and G185).



SSP 206/021



### The control unit



SSP 206/022

U accelerator  
pedal position

The control unit monitors senders G79 and G185 for proper functioning and plausibility; their characteristic curves are different (refer to diagram). If one of these two senders fails, the other sender acts as a back-up and fault warning lamp K132 for the electrical throttle control in the combi-instrument comes on.



EPC: Electrically activated throttle valve

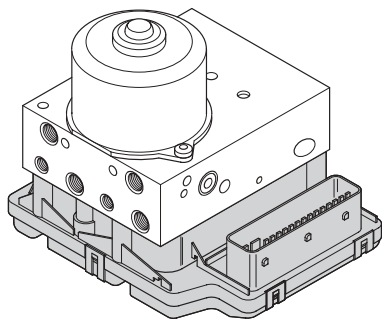
The mechanical throttle cable is replaced by an electronic throttle control.

For more detailed information, please refer to Self-Study Programme 210.



## ABS control unit J104

The control unit (by ITT Automotiv) is combined with the hydraulic unit as a module and mounted in the engine compartment on the left-hand side.



SSP 206/031

When the ignition is turned on, the control units carry out a self-test. The control unit consists of two processor systems. This ensures a high level of fail-safety. In addition to monitoring individual components, the two processor systems monitor each other.

### Signal utilisation for four-wheel-drive electronics

The following signals are supplied to the Haldex control unit along the CAN bus:

- Wheel speed sender
- Brake light switch
- Handbrake switch
- Longitudinal acceleration sender

If the vehicle also has ESP, then ESP control takes precedence over the four-wheel drive function.

### Effects of signal failure

In the unlikely event of total failure of the control units, the driver will only have the standard brake system without closed-loop brake control and four-wheel-drive control at his disposal.

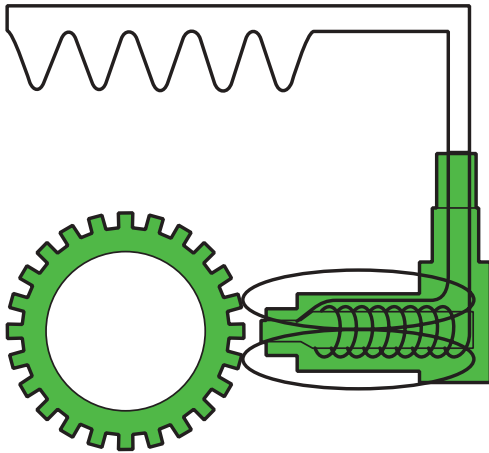


# Electrics

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## Wheel speed senders G44 - G47

The wheel speed sender detects the change in speed of the wheel and sends this information to the control unit in the form of engine speed information.



SSP 206/024

The wheel speed sender is mounted in the vicinity of the axle flange. A toothed wheel is positioned on the axle flange in such a way that it moves past the top end of the engine speed sender when the wheel rotates. Magnetic lines of force between the tooth and tooth gap of the toothed wheel are distorted. This induces a sine-wave AC voltage in the coil of the engine speed sender. The frequency in the coil is dependent on the wheel speed.

The control unit calculates the momentary speed of individual wheels from the frequency.

### Effects of signal failure

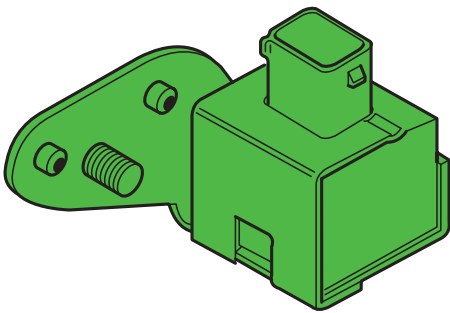
- No ABS control
- No four-wheel-drive control

The failure of a wheel sensor does not cause any restrictions to four-wheel drive.



## Longitudinal acceleration sender G249

Longitudinal acceleration sender G249 is attached to the A pillar on the right.



SSP 206/025

When the Haldex coupling is closed, the front and rear wheels are coupled rigidly.

The true vehicle road speed is calculated from the data supplied by the individual wheel speed senders. This value, under certain circumstances, may be too inaccurate at low coefficients of friction and when the Haldex coupling is closed.

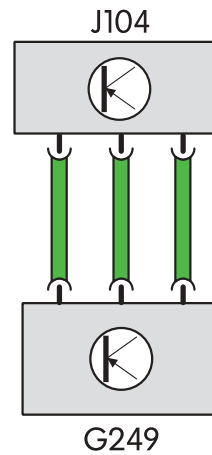
The measured longitudinal acceleration serves to back up the theoretically determined vehicle road speed.

### Effects of signal failure

Without the additional measurement of longitudinal acceleration, it is not possible to determine the true vehicle road speed exactly in unfavourable conditions. The ESP and TCS functions fail.

When ESP is activated, the Haldex coupling is opened.

### Electrical circuit



SSP 206/026

The longitudinal acceleration sender is connected to the control unit J104 via three lines.



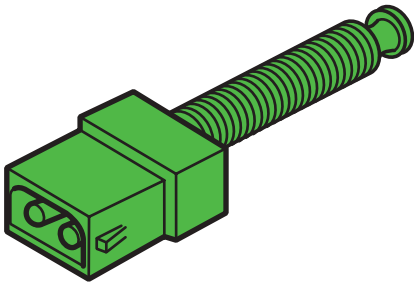
For details of its design and function, please refer to Self-Study Programme 204.



# Electrics

## Brake light switch F

Brake light switch F is located at the upper end of the brake pedal and is secured to the pedal support.



SSP 206/027

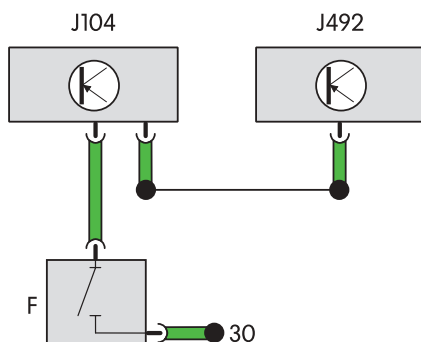
### Signal utilisation

The brake light switch sends the "brake activated" signal to ABS control unit I104.

The control unit informs the Haldex control unit along the CAN bus. When the brake is applied, the Haldex control unit immediately opens the pressure regulator via the positioning motor and the Haldex coupling is depressurised.



### Electrical circuit



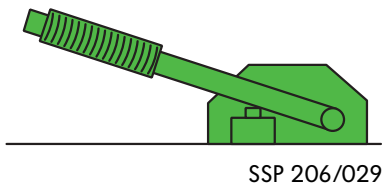
SSP 206/028

### Effect of signal failure

The information provided by the CAN bus is used as an alternative.

## Handbrake switch F9

Handbrake switch F9 is located under the handbrake lever.



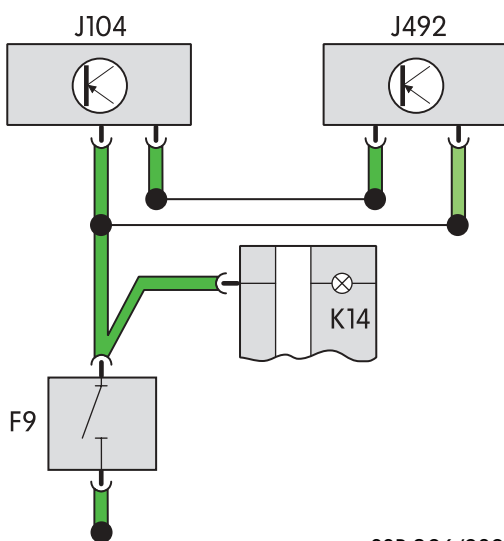
### Signal utilisation

The handbrake switch sends the "handbrake engaged" signal to the ABS control unit J104 and simultaneously to the Haldex control unit J492. Whereas the ABS control unit transfers this information to the Haldex control unit in "filtered" form along the CAN bus, the Haldex control unit receives the information directly from the handbrake switch.

If the signal generated by handbrake switch F9 is picked up, the Haldex coupling is opened.



### Electrical circuit



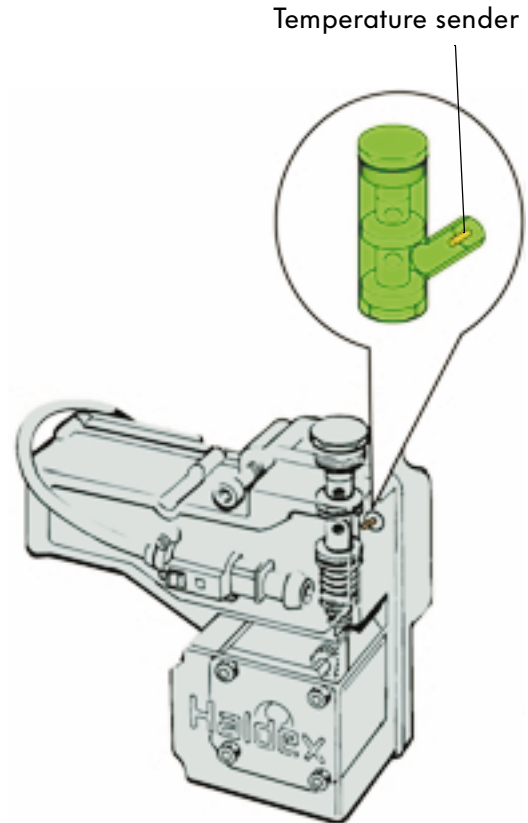
### Effects of signal failure

- No four-wheel drive control and restrictions on ABS control

# Electrics

## Haldex coupling temperature sender G271

The Haldex coupling temperature sender is installed in the vicinity of the regulating valve in the Haldex control unit housing and is immersed in hydraulic fluid.



SSP 206/032

### Signal utilisation

The temperature sender senses the momentary hydraulic oil temperature and sends this information to the Haldex control unit.

This information is used for adapting to the changing viscosity of the hydraulic fluid.

Temperature	Hydraulic fluid/viscosity	Regulating valve
in the minus range	high viscosity	slightly more open
normally 20°C	normal	normally open
over 20°C	low viscosity	slightly less open

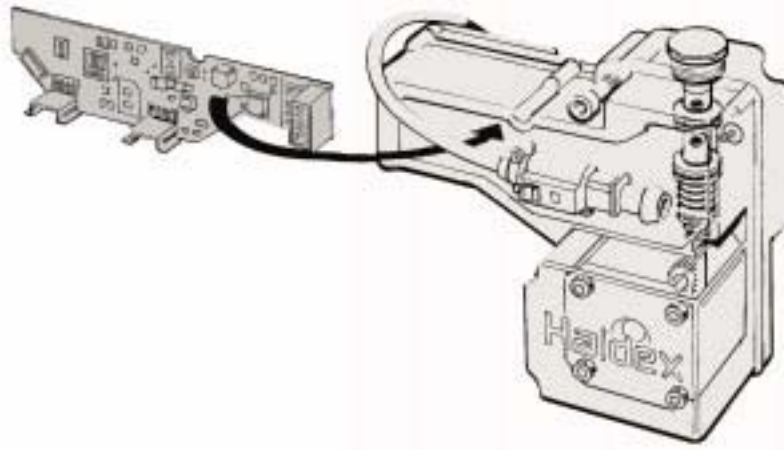
If the hydraulic fluid temperature exceeds 100°C, the clutch is depressurised. If the temperature of the hydraulic fluid drops below 100°C, the clutch is again pressurised.

### Effects of signal failure

- Four-wheel drive is shut off

## Haldex control unit J492

The Haldex control unit is mounted directly on the housing of the Haldex coupling and combines with the positioning motor and the regulating valve to form a unit.



SSP 206/033

### Design and function

The Haldex coupling control unit is connected to the engine and the ABS control unit via the CAN bus. From the signals that are generated by the control unit sensors, the Haldex control unit decides what oil pressure to apply to the plates of the Haldex coupling.

The oil pressure acting on the plates of the Haldex coupling determine what torque is to be transmitted to the rear axle.

### Effects of signal failure

- No four-wheel drive



In vehicles with an automatic gearbox, signals are exchanged between the engine control unit and the automatic gearbox control unit via the CAN bus.



# Electrics

## Positioning motor V184

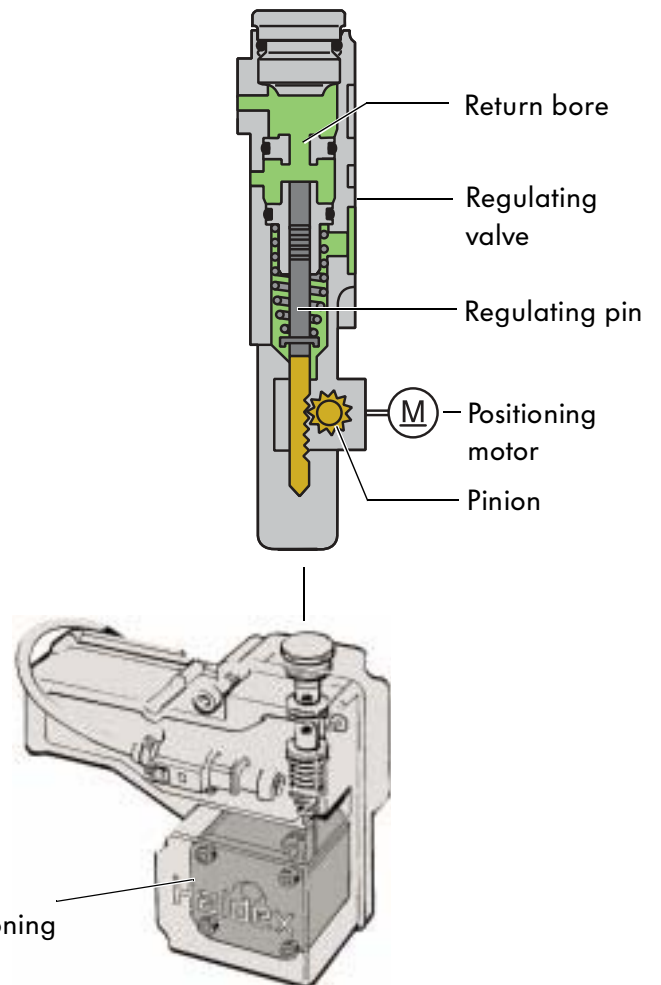
The positioning motor is integrated in the Haldex control unit housing.

### Design and function

The positioning motor is supplied with voltage by the Haldex control unit and functions as a stepping motor.

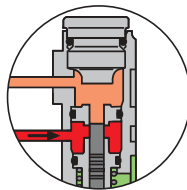
At the command of the Haldex control unit, the positioning motor changes the level of the regulating pin in the pressure regulator via a small pinion gear.

The level of the regulating pin changes the cross-section of a return bore in the pressure regulator. The pressure acting on the working piston of the clutch plates is calculated in this way.

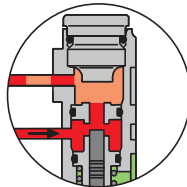


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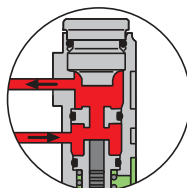
Regulator closed:  
maximum pressure  
on clutch plates



Regulator partially open:  
reduced pressure  
on clutch plates



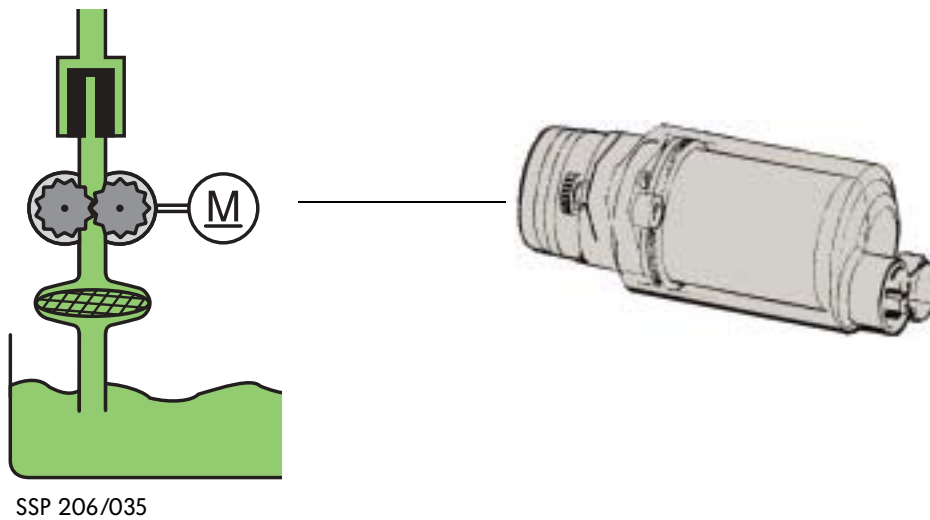
Regulator fully open:  
no pressure on clutch plates





## Pump for Haldex coupling V181

The pump for the Haldex coupling is attached to the Haldex coupling housing.



### Design

After the engine has been started, the pump for the Haldex coupling is supplied with voltage by the Haldex control unit as soon as the engine speed exceeds 400 rpm.

### Function

The pump for the Haldex coupling conveys oil to the lifting piston and brings the lifting piston into contact with the lifting plate via roller bearings.

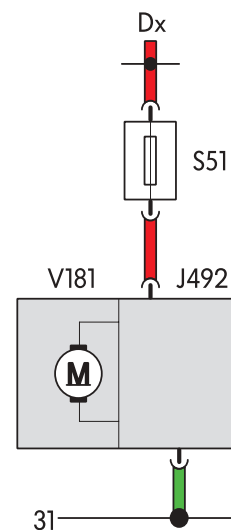
At the same time, oil reaches the working piston. This eliminates any play from the clutch plate set and ensures quick clutch response.

### Effects of signal failure

- No four-wheel drive

### Electrical circuit

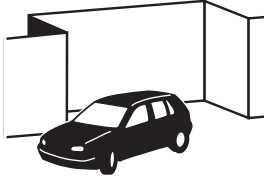
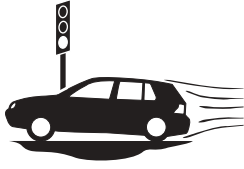

The pump for the Haldex coupling is directly supplied with voltage by the Haldex control unit.








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# Driving situations

	 <b>Parking</b>	 <b>Acceleration</b>	 <b>High-speed driving</b>
<b>Difference in speed between front and rear axles</b>	low	high	low
<b>Torque required at rear axle</b>	low	high	low
<b>Condition of multi-plate clutch</b>	low contact pressure	high contact pressure, up to maximum, EDL control system can increase contact pressure	closed, as required
<b>Input signals</b>	<ul style="list-style-type: none"> <li>- engine torque</li> <li>- engine speed</li> <li>- accelerator pedal position</li> <li>- four-wheel sensors</li> </ul>	<ul style="list-style-type: none"> <li>- engine torque</li> <li>- engine speed</li> <li>- accelerator pedal position</li> <li>- four-wheel sensors</li> </ul>	<ul style="list-style-type: none"> <li>- engine torque</li> <li>- engine speed</li> <li>- accelerator pedal position</li> <li>- four-wheel sensors</li> </ul>



 <p><b>Driving on a slippery surface</b></p>	 <p><b>Driving with the emergency wheel fitted</b></p>	 <p><b>Braking</b></p>	 <p><b>Towing</b></p>	 <p><b>Brake test (roller dynamometer)</b></p>
fluctuates between low and high	normal to high	normal to high	high	high
fluctuates between low and high	low	0	0	0
closed, up to maximum	open or slightly closed	open	open, electrical pre-pressure pump OFF (when ignition is OFF)	open, electrical pre-pressure pump OFF (when ignition is OFF)
<ul style="list-style-type: none"> <li>- engine torque</li> <li>- engine speed</li> <li>- accelerator pedal position</li> <li>- four-wheel sensors</li> <li>- CAN correspondence</li> </ul>	<ul style="list-style-type: none"> <li>- four-wheel sensors</li> <li>- via ABS control unit</li> </ul>	<ul style="list-style-type: none"> <li>- four-wheel sensors</li> <li>- via ABS control unit</li> <li>- brake light switch</li> </ul>	engine speed < 400 rpm	engine speed < 400 rpm

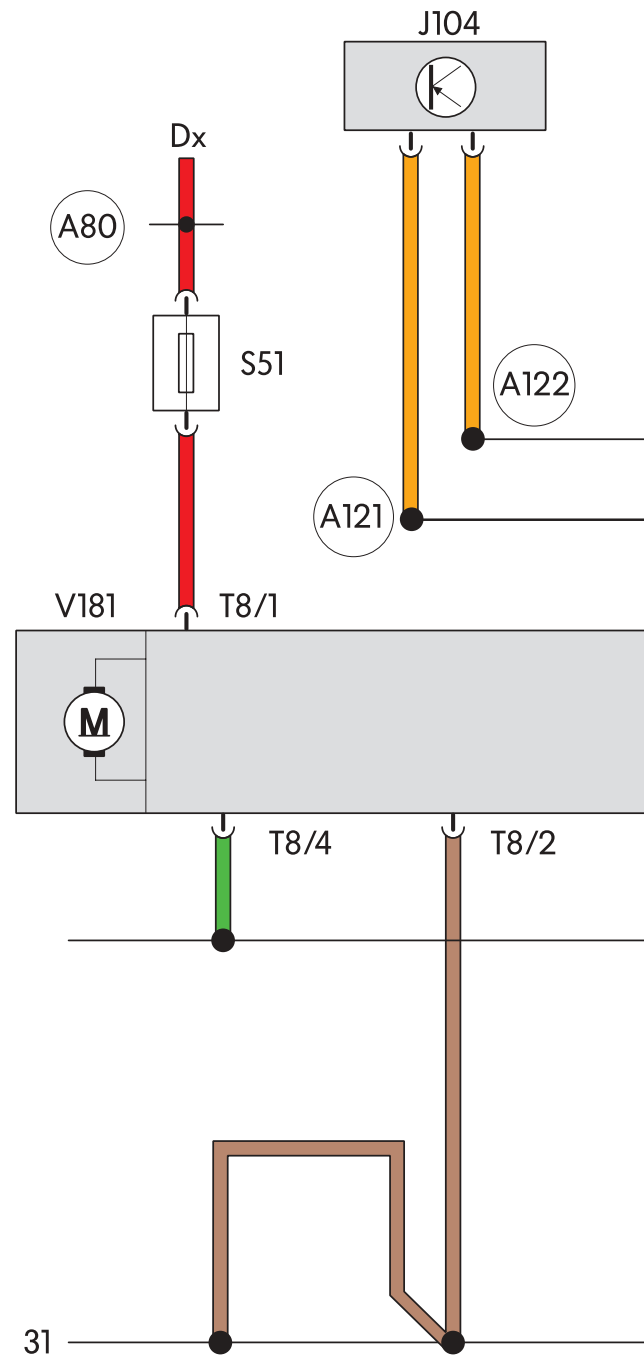


# Function diagram

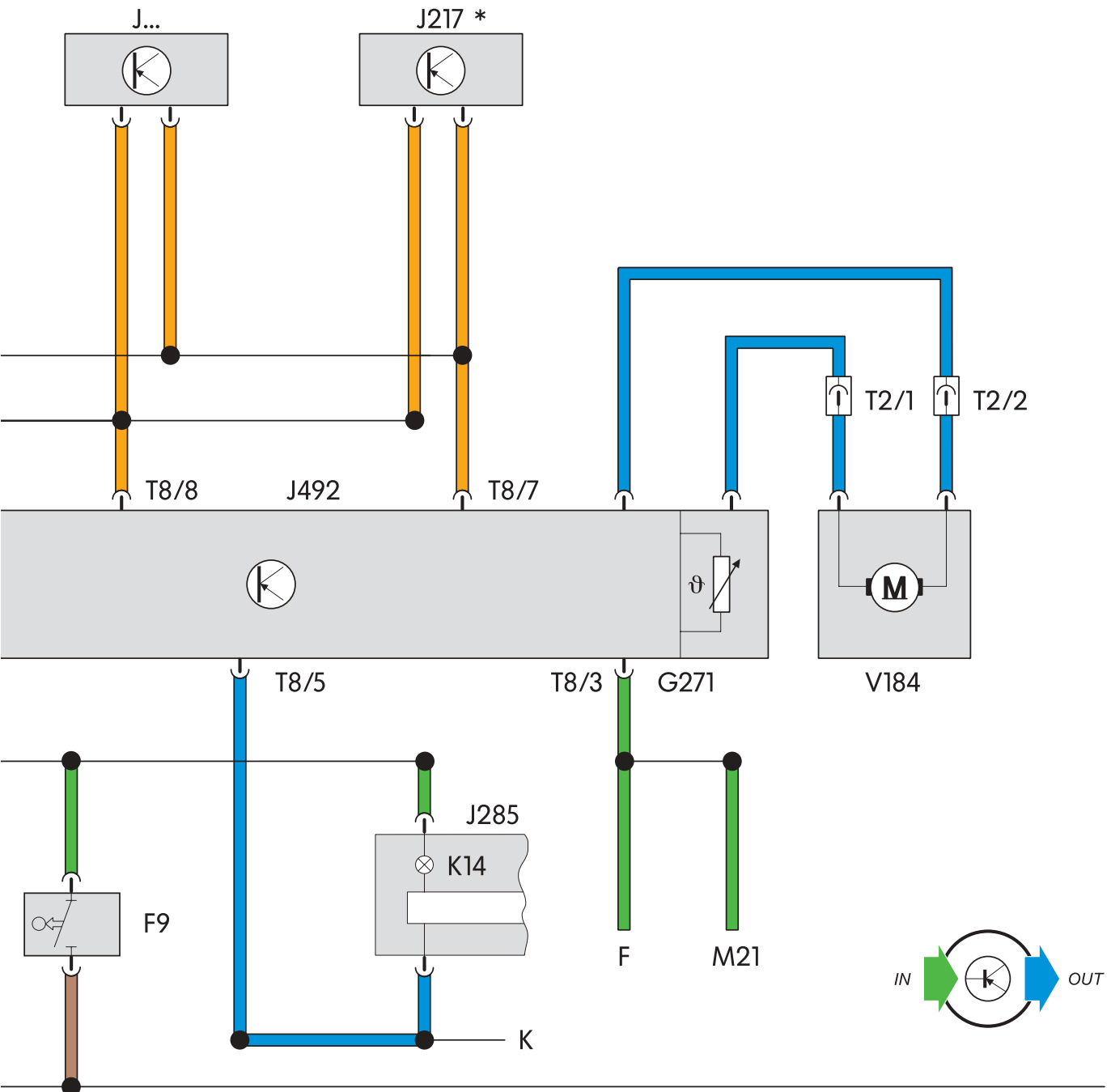
- Input signal
- Output signal
- Positive
- CAN
- Earth

## Components

- D Ignition switch
- F Brake light switch
- F9 Handbrake warning switch
- G271 Hydraulic temperature sender
- J... Engine control unit
- J104 ABS control unit with EDL/TCS/ESP in the engine compartment at the left
- J217 Control unit for automatic gearbox in the plenum chamber at the centre
- \* applies to vehicles with automatic gearbox only
- J285 Control unit with display unit in the dash panel insert
- J492 Control unit for four-wheel drive (located near the rear axle differential)
- K Connection (K-wire (diagnosis))
- K14 Handbrake warning lamp
- M21 Bulb for left rear brake
- S51 Fuse
- V181 Pump for Haldex coupling
- V184 Positioning motor for oil pressure
- A80 Connection -1- (x) in dash panel wiring harness
- A121 Connection (Hi bus)
- A122 Connection (Low bus)



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# Self-diagnosis

## Self-diagnosis

The self-diagnosis electrically monitors

- the signals generated by the sensors
- activation of the positioning motors
- the control unit by carrying out a self-test

If the control unit detects a fault, it calculates a substitute value from other signals and makes an emergency running program available.

In the data transfer facility, the following functions can be read out under the address word 22 "4-wheel-drive electronics" with the

- VAS 5051 testing and information system:

- 01 Interrogate control unit version
- 02 Interrogate fault memory
- 03 Positioning motor diagnosis
- 04 Basic adjustment
- 05 Erase fault memory
- 06 End of output
- 07 Encode control unit
- 08 Read measured value block



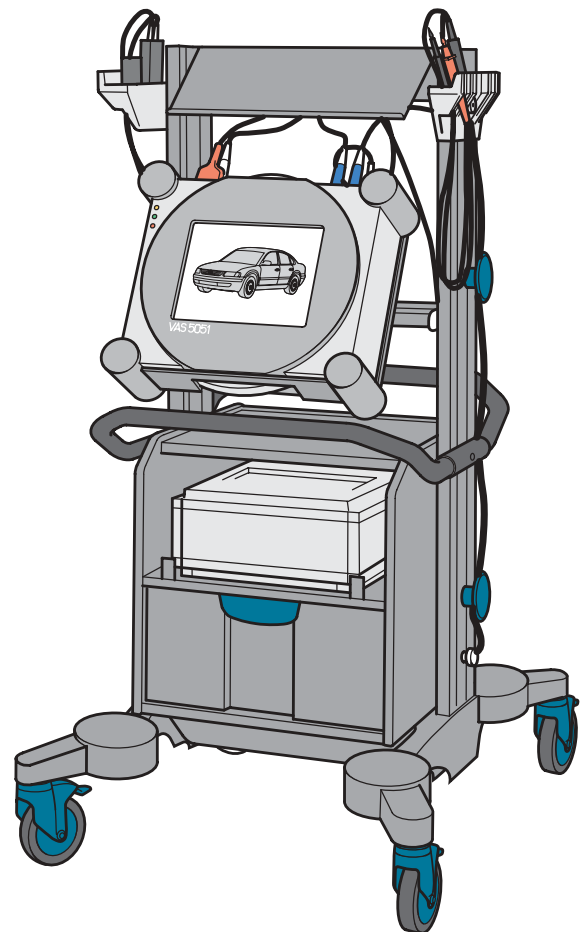
For more detailed information, please refer to the relevant Workshop Manual.



When storing faults, the control unit differentiates between constant and sporadic faults. If a fault occurs only once during several driving cycles, it is stored as a sporadic fault.

If the fault subsequently remains undetected over a distance of approx. 1000 km, it is erased from the memory automatically.

If the fault persists throughout the driving cycles stored in the control unit, it is stored to the control unit memory as a constant fault.





# Test your knowledge

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**5. The roller bearing pairs of the lifting piston follow an undulating path on the lifting plate when a difference in speed is detected between the front and rear axles. In this way, the lifting pistons build up a pressure.**

**Which of the following statements are true?**

- A The pressure reaches the working piston via the pressure valves.
- B The pressure is limited by the accumulator.
- C The pressure is limited by the pressure limiting valve.
- D The pressure is influenced by the regulating valve.
- E The pressure acts on the clutch plates via the working pistons.

**6. The accumulator**

- A determines the maximum pressure.
- B determines the pre-pressure of 4 bar.
- C acts as a damper to smooth pressure fluctuations.

**7. The positioning motor is supplied with voltage by the Haldex control unit and activates the regulating pin in the regulating valve via a pinion. As a result, the return bore is more or less closed. Which of the following statements is true?**

- A Return bore in regulating valve closed = no pressure on clutch plates
- B Return bore in regulating valve open = maximum pressure on clutch plates
- C Return bore in regulating valve open = no pressure on clutch plates
- D Return bore in regulating valve closed = maximum pressure on clutch plates





**8. Which two sensor signals are sent directly to the Haldex control unit from the outside?**

- A Longitudinal acceleration sender
- B Handbrake switch
- C Brake light switch
- D Haldex coupling temperature sender

**9. The Haldex coupling temperature sender is integrated in the Haldex control unit housing and senses the momentary hydraulic oil temperature. What does the Haldex control unit use this information for?**

- A For adapting to the changing viscosity of the hydraulic fluid by means of the pressure regulator.
- B for emergency running.
- C To depressurise the clutch when a temperature of 100°C is reached.

**10. If there is a large difference in speed between the front and rear axles, e.g. under acceleration**

- A the torque to be transmitted to the rear axle is .....
- B the contact pressure on the plate clutch is .....

**The following input signals are relevant:**

- c .....
- d .....
- E .....
- F .....



## Solutions

1. A, B, D, E, F, G.
2. A, C, D.
3. A: drive pinion head, lifting plate, inner clutch plates, pressure plate.  
B: outer clutch plate housing, outer clutch plates, roller bearing.  
C: lifting piston, working piston, oil duct.
4. A.
5. A, C, D, E.
6. B, C.
7. C, D.
8. B, D.
9. A, C.
10. high, high, engine torque, engine speed, accelerator pedal position, 4 wheel sensors.





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