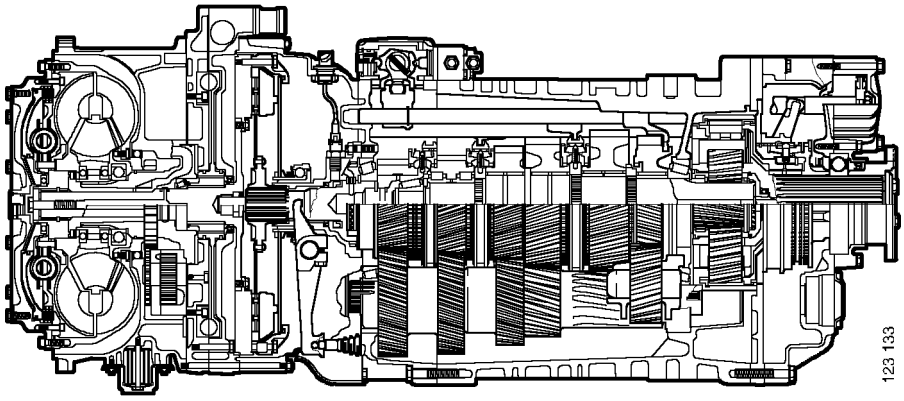
SCANIA

05:09-01

Issue 1 **en**

Manual gearbox with torque converter, ZF

Troubleshooting and work description



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Contents

General

Introduction 4
Torque converter 5
Retarder 6
Clutch 6
Gearbox 7
Overrevving protection 7

Torque converter with lock-up

Test conditions 8
Stalling speed 9
Checking the voltage supply 11
Checking the engine speed for engaging and disengaging the lock-up 11
Functional inspection of lock-up 12
Checking the hydraulic oil pressure 13
Torque limitation 14

Retarder with exhaust brake and brake light

..... 15
Road test 16
Testing the hydraulic pressure 16

Clutch

Clutch control 17
Checking the disc wear 17
Renewing the clutch 18
Renewing the release bearing 20
Fitting 21

Range change gear

Checking the voltage supply 24
Checking the range interlock 25
Checking the solenoid valve circuit for the control valve, V63 26
Checking the solenoid valve circuit for the gate interlock, V1017 26

Splitter gear

Checking the voltage supply 27
Checking the split switch 27
Checking the lower clutch switch 28
Split control valve, V62 28
Split interlock valve and gearshift servo, V64 29

Overrevving protection

..... 31
Function, electronic units 32

Lubrication system

..... 33
Oil change and filter renewal in gearbox 34
Checking oil level 36

Gearbox with extra radiator

Checking oil level 37

Specifications 38

General diagrams 39

General

Introduction

The gearbox is a 16 gear manual gearbox manufactured by ZF. The gearbox has an integrated torque converter and retarder and can be combined with only some of the Scania 16 litre engines.

The gearbox is included in the ZF exchange system and its designation is ZF-Transmatic with torque converter WSK440.

The gearbox has four main components:

1 ZF torque converter WSK440.

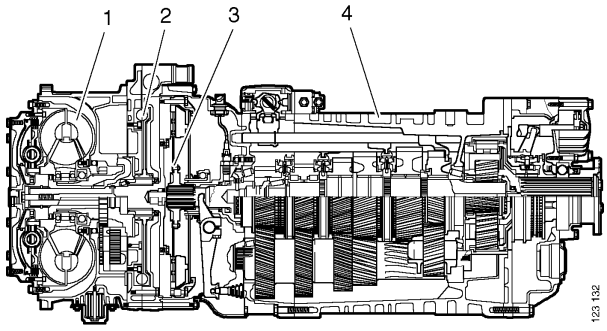
2 Integrated ZF primary retarder

3 Disc coupling

4 ZF Ecosplit gearbox 16S251

All the parts, the gearbox with torque converter and retarder, have a common oil system.

More specific general diagrams are provided under General diagrams.



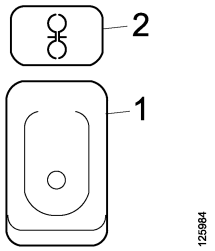
Torque converter

The torque converter provides continuous transmission of the engine torque to the gearbox. The torque is limited to 700 Nm if the clutch is depressed when the torque converter is in operation.

The torque converter has a lock-up clutch which is located between the torque converter and the flywheel in the torque converter housing.

The lock-up clutch is engaged and disengaged automatically. It is controlled by a sensor which reads off the speed on the torque converter turbine rotor and pump impeller. It is engaged at different speeds depending on the load. It is disengaged at 950 rpm.

During a kick-down, the lock-up clutch is disengaged at 1100 rpm unless the driver manually prevents disengagement by using a switch on the instrument panel.



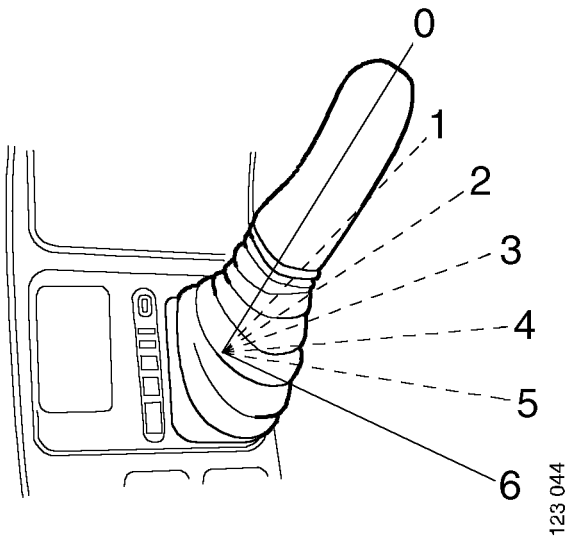
1 Lock-up switch
2 Lock-up warning lamp

Retarder

Unlike Scania retarders which are located at the rear of many gearboxes, this one is located at the front between the torque converter and clutch.

The retarder is activated in the usual way with a hand lever on the instrument panel. The lever has six positions and in position 6 the automatic exhaust brake is obtained if its switch on the instrument panel is activated.

The retarder function is interrupted immediately if the ABS system or clutch pedal upper contact is activated.



Clutch

The clutch is hydraulic and self-adjusting. It has two main components, a pneumatically powered main cylinder, known as a servomaster, and a slave cylinder of the same type which is located on the vehicle with the EK power take-off.

Gearbox

The gearbox comprises a 4 gear main gearbox with a splitter gear and a range gear (planetary gear).

Overrevving protection

To prevent overrevving, the gearbox is equipped with two types of overrevving protection.

- Range interlock: Prevents low range from being engaged if the speed is too high.
- Gate interlock: Prevents 1st and 2nd gear from being engaged on the low range if the speed is too high. This is carried out by means of an air cylinder which prevents side travel on the gear lever.

The speed signal for the overrevving protection is taken from the tachograph.

Torque converter with lock-up

General

If the torque converter is not working satisfactorily, various functional tests can be carried out with the torque converter still in the vehicle and with a warmed up engine.

Carry out all functional tests before deciding what action to take.

Test conditions

- Warmed up engine.
- Stationary vehicle.
- Service brake applied during the test.

WARNING!

Place chocks on the wheels to prevent the vehicle from moving. Danger of personal injury.

Stalling speed

Stalling speed is the maximum speed that the engine can attain at full throttle with a stationary vehicle. The maximum gear ratio has been obtained in the torque converter and the entire torque from the engine has been converted to heat in the oil. The torque converter should therefore only be used in this way for a few seconds.

WARNING!

Place chocks on the wheels to prevent the vehicle from moving. Danger of personal injury.

1 Apply the service brake.

2 Engage top gear in high-range.

3 Release the clutch fully.

4 Fully depress the accelerator pedal and read the engine speed when it has stabilised.

WARNING!

Do not carry out the test for more than 10 seconds. The torque converter will become overheated.

Note: The stalling speed may be different from the listed values. This may be due to the energy level of the fuel used. Minor deviations need therefore not necessitate any measures.

Engine type	Stalling speed
DC16-01 (580 Hp)	1405 rpm

Causes

Stalling speed too low:

- Engine fault (engine torque too low).

Stalling speed too high:

- Oil level too low.
- Air pressure too low.
- Air in the oil.
- The freewheel does not lock.
- Slipping clutch.

Checking the voltage supply

The voltage supply for the torque converter lock-up comes from fuses 7 and 10. Check that the fuses are intact.

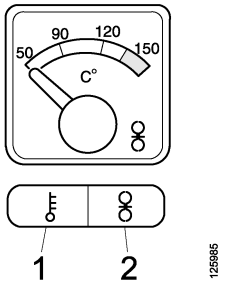
Checking the engine speed for engaging and disengaging the lock-up

1 Pull up the parking brake.

2 Set the gearbox to neutral.

3 Start the engine.

4 Slowly increase the engine speed with the accelerator pedal. The torque converter warning lamp should go out at 1000 r/min.



1 Temperature warning lamp
2 Torque converter warning lamp

5 Slowly reduce the engine speed. The torque converter warning lamp should come on at 950 rpm.

Causes

- Fuses 7 or 10 are defective.
- Cable fault.
- Engine speed sensor.
- Solenoid valve.
- Control unit.
- Jammed control valve.

Functional inspection of lock-up

Fit a cable so that voltage can be supplied to the lock-up clutch solenoid valve (+24V) from the driver area. A suitable point to connect the cable is connector C336-1 which is located in the fire wall.

WARNING!

Place chocks on the wheels to prevent the vehicle from moving. Danger of personal injury.

1 Apply the service brake.

2 Start the engine.

3 Engage top gear in high-range and release the clutch.

4 Allow the engine to idle.

5 Apply voltage (+24V) to the lock-up clutch solenoid valve.

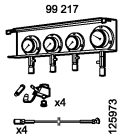
6 The engine should stop after a few seconds.

Causes

- Oil pressure too low.
- Lock-up leaking
- Broken piston rings on the turbine shaft.
- Jammed control valve.
- Slipping clutch.
- Cable fault.

Checking the hydraulic oil pressure

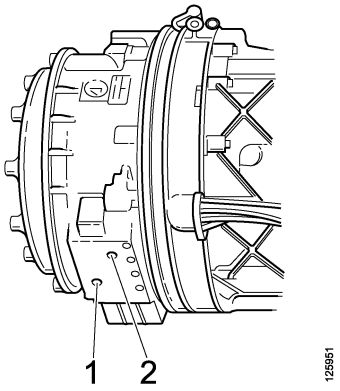
Special tools

Number	Description	Illustration	Tool board
99 217	Hydraulic measuring equipment		

1 Use hydraulic measuring equipment 99 217.

2 Fit the connectors to the Pwa and Pwk test connections on the valve housing.

3 Position the pressure gauges so that they can be read from the driver area.



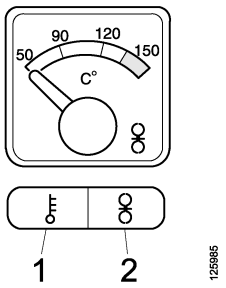
1 Pwk
2 Pwa

4 Apply the parking brake.

5 Set the gearbox to neutral.

6 Start the engine.

7 Increase engine speed to approximately 1000 rpm. The torque converter warning lamp should go out.



1 Temperature warning lamp
2 Torque converter warning lamp

8 Check the hydraulic oil pressure.

Test connection	Pressure (bar)
Pwa	5.5 - 6.0
Pwk	10.5 +/- 0.5

Torque limitation

Relay R1030 controls the torque limitation. When the torque converter is in operation the engine torque will be limited to 700 Nm if the upper clutch switch is activated and a gear is engaged.

During torque limitation, a pin is earthed on the coordinator control unit via connector C271, pin 3, through relay R1030 and the upper clutch pedal switch B32 is activated. Relay R1030 is activated when the neutral switch is closed, i.e. when a gear is engaged.

Checking torque limitation

1 Apply the parking brake.

2 Start the engine and run it at idle speed.

3 Engage top gear in low-range and release the clutch.

4 Accelerate carefully and feel how the vehicle "strains" against the brake.

5 Depress the clutch slightly but not enough to declutch. A transition should now be felt as the torque is limited and the engine speed drops.

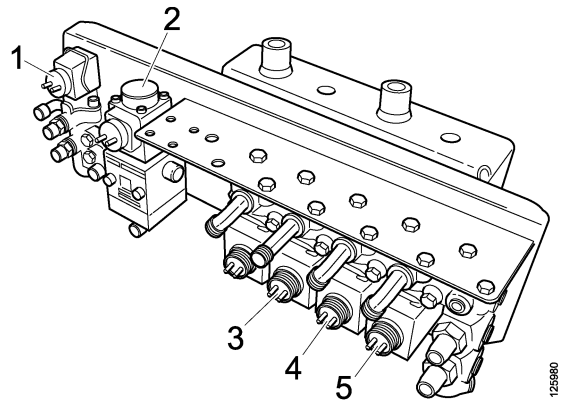
Retarder with exhaust brake and brake light

General

Cable harnesses or similar items rather than the retarder are often the cause of faults. Look for a fault on the auxiliary braking system as a whole, i.e. with the appropriate controls and electrical equipment.

Solenoid valve V76 provides an unreduced air pressure to the proportional valve and is controlled by the control unit. The control unit supplies a current, whose strength corresponds to the required brake torque, to the proportional valve. This then delivers air pressure to the control valve which creates the oil pressure necessary to achieve the required brake torque.

The task of the oil accumulator is to fill the retarder rapidly when braking starts. It is activated with compressed air from solenoid valve V75.



1 V63 - Low-range, high-range
2 V76 - Proportional valve
3 V64 - Split interlock valve
4 V62 - Low split, high split
5 V1017 - Gate interlock

The control system continuously reduces the braking effect of the retarder so that the oil temperature never exceeds 150° (if nothing breaks down). Refer to Lubrication system for more information.

When the retarder is activated, the brake light comes on via a separate relay known as the Retarder brake light relay, R1029. If the automatic exhaust brake button is pressed, the exhaust brake is activated when the retarder lever is in position 6 or when the brake pedal is depressed.

Road test

When the vehicle is test driven to check the braking capacity, the following applies:

1 Drive the vehicle at a speed of at least 60 kph

2 Select a gear so that the engine speed is at least 1500 rpm.

3 Brake with the retarder lever in position 6 (maximum position). Also test the automatic exhaust brake button.

If the braking effect is poor, check the following

1 Oil level. The oil system is the same in the gearbox, torque converter and retarder.

2 Proportional valve.

3 Oil accumulator.

4 Oil pressure.

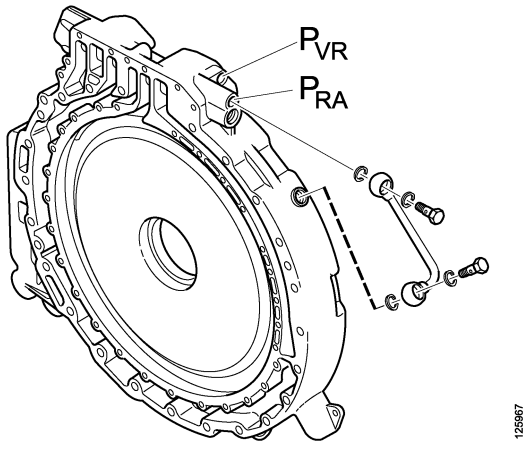
5 Oil filter.

Testing the hydraulic pressure

Since the gearbox is located after the retarder, a load test can be carried out on the retarder with the gearbox in neutral.

Connect a pressure gauge to test connections PVR and PRA.

Start the engine and measure by braking with the retarder lever.



Test connection	Pressure
PVR	2.0 bar +/- 0.5/600 rpm
PRA	Max. 4.5 bar +/- 0.5

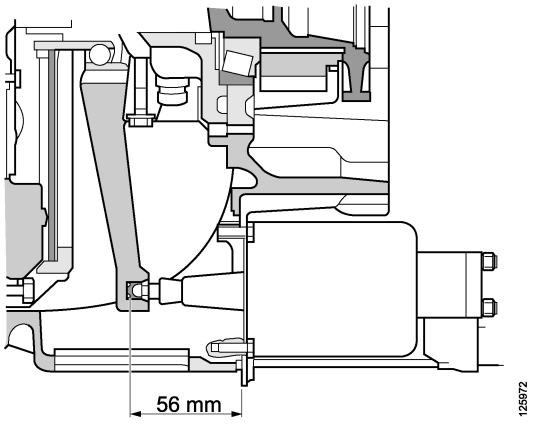
Clutch

Clutch control

The clutch control is hydraulic and self-adjusting and is the same as on vehicles with the EK power take-off. Refer to Workshop manual main group 4, Clutch and clutch control, Work description.

Checking the disc wear

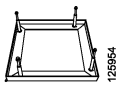
To check the disc wear, the slave cylinder must be removed and the distance to the clutch lever must be measured. If the distance is less than 56 mm from the clutch cylinder contact surface to the clutch lever, the clutch disc is worn and must be renewed.



If the distance is less than 56 mm, the clutch disc must be renewed. 85 mm is the distance when the clutch disc is new.

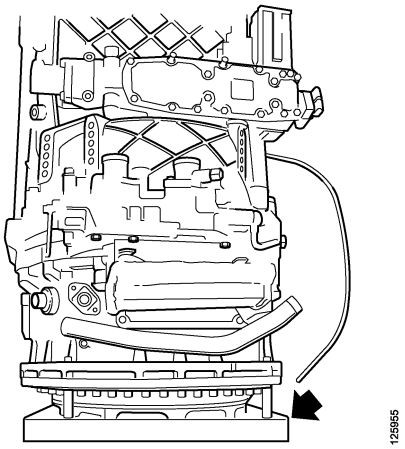
Renewing the clutch

Special tools

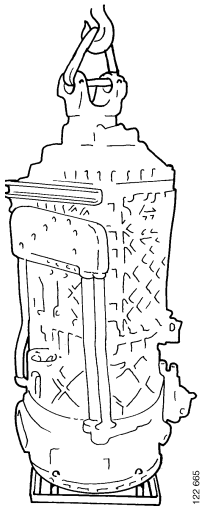
Number	Description	Illustration	Tool board
99 423	Fixture		

Remove the gearbox.

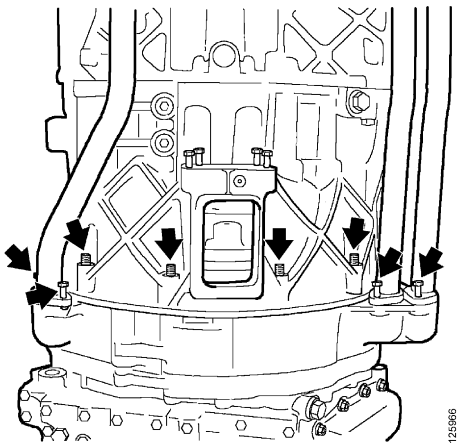
1 Fit fixture 99 423 to the torque converter.



2 Fit clamps on the end yoke. Attach a lifting strap to the end yoke. Lift the gearbox into an upright position and place it on the support plate.



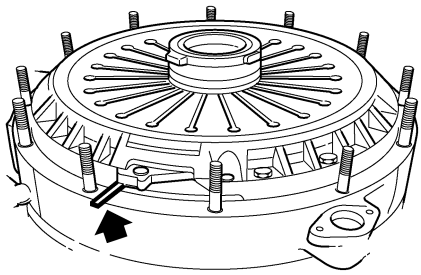
3 Remove the oil pipe bolts and nuts which hold together the gearbox and torque converter parts.



4 Carefully remove the gearbox.

Note: Make sure that the clutch lever comes free from the release bearing.

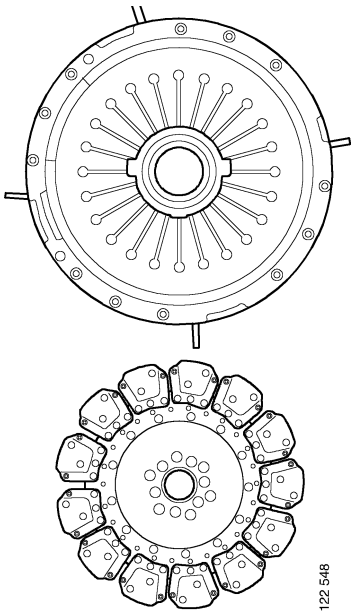
5 Make four separator plates (4 x 8 x 55 mm). Fit the separator plates as illustrated.



Separator plate

6 Remove the pressure plate with release bearing and clutch disc by undoing the bolts alternately.

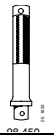
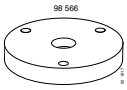
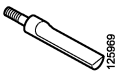
7 Clean the flywheel and check it for thermal cracks and wear.



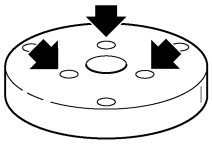
8 Check the pressure plate. Refer to Clutch and clutch control, section Checking the pressure plate, in Workshop manual main group 4.

Renewing the release bearing

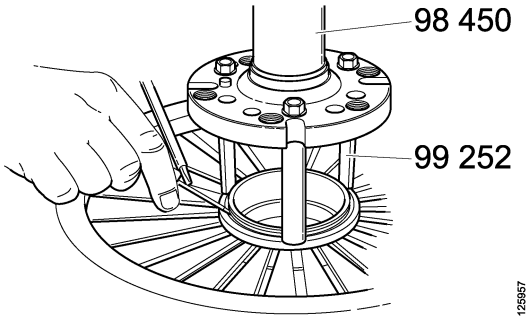
Special tools

Number	Description	Illustration	Tool board
98 450	Shank		R2
98 566	Drift		R1
99 252	Press drift x 3		R1

1 Modify tool 98 566 by drilling a new bolt circle with a radius of 50 mm.



2 Place the pressure plate in the press with the bearing facing downwards and carefully press together the pressure plate as illustrated. Remove the snap ring.



3 Assemble in reverse order.

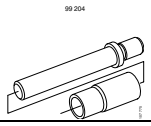
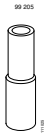
Fitting

Specifications

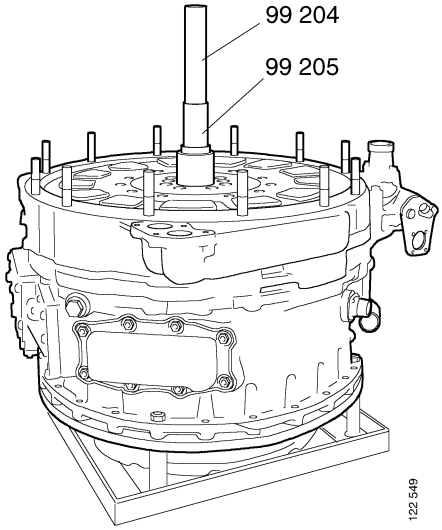
Tightening torques

Pressure plate	47 Nm
Nuts in housings	90 and 43 Nm
Oil pipe bolts	23 Nm

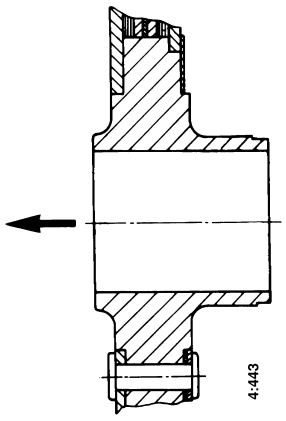
Special tools

Number	Description	Illustration	Tool board
99 204	Mandrel		D4
99 205	Sleeve		

1 Fit mandrel 99 204 into the flywheel bearing. Fit the sleeve 99 205 to the mandrel and fit the clutch disc onto the sleeve.

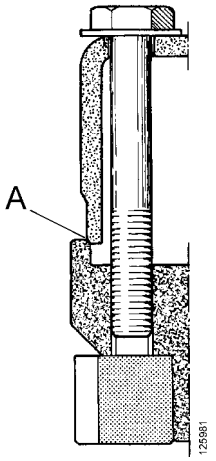


Note: Turn the clutch disc, as illustrated, with the arrow towards the flywheel.



IMPORTANT! To enable the pressure plate to lie completely flat and even against the contact surface of the flywheel, the guide edges of the pressure plate and flywheel must be thoroughly cleaned.

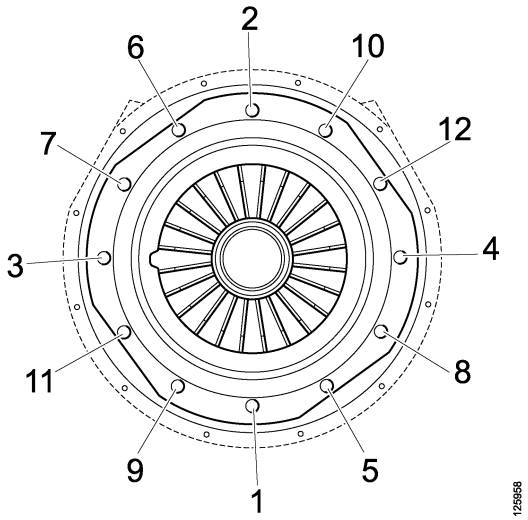
2 Fit the pressure plate so that the guide edge of the pressure plate rises up with the flywheel guide edge A level around it.



Flywheel guide edge

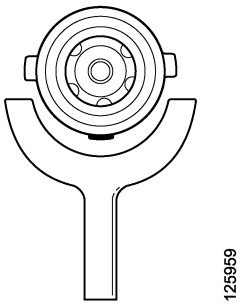
3 Check that the pressure plate is completely flat around it.

4 Torque tighten bolts 1-12 to 47 Nm in the order shown in the illustration.



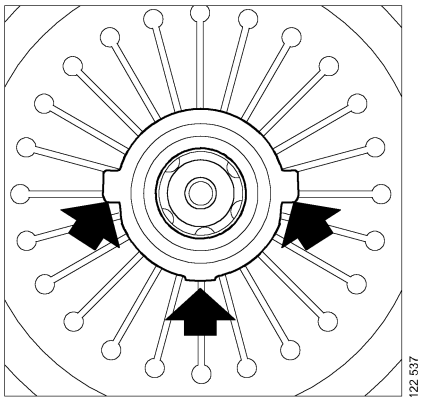
5 Remove the mandrel, sleeve and the four separator plates.

6 Fit a new gasket and new O-rings on the oil pipes.



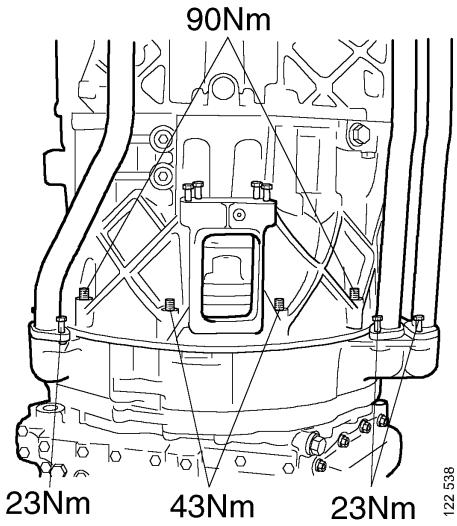
7 Fit the gearbox on the torque converter parts.

Note: Press the fork correctly into the release bearing.



8 Fit the nuts and torque tighten as illustrated.

IMPORTANT! The nuts which have to be tightened to 43 Nm should not be tightened more than this, otherwise the gearbox housing may break.



9 Fit the gearbox.

Range change gear

General

The gear area for range is preset with the range switch. Gear changing between high-range and low-range takes place when the gear lever passes neutral position when the neutral position valve provides the range control valve with operating air. The neutral position valve is actuated by the gear selector in the gearbox housing and, when the gear is in neutral, operating air passes through the valve and on to the range control valve. When a gear is engaged, the air supply is interrupted.

Checking the voltage supply

The range and split circuits have a common voltage supply. Check that fuse 5 is not blown.

Checking the range interlock

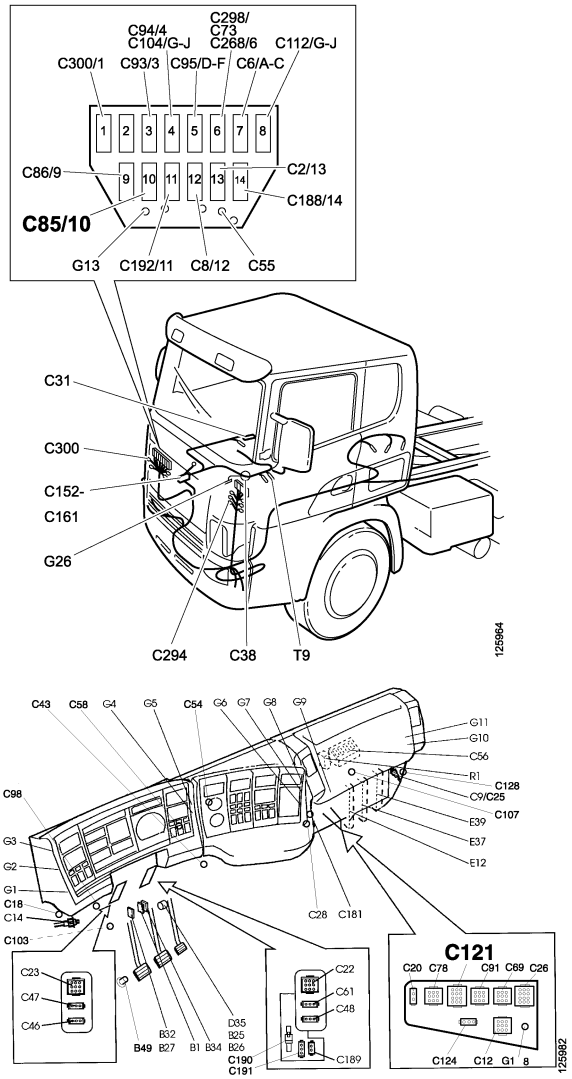
1 Disassemble connector C85 and turn the ignition key to the drive position.

2 Measure the voltage between pin 2 and earth on the fixed part of the connector.

- The voltage in low-range should be equal to battery voltage.
- The voltage in high-range should be equal to 0.

or

3 Disassemble connector C121 and measure between pins 1 and 3 with a resistance tester that there is contact in the low-range position. Measure on the loose part of the connector.



Checking the solenoid valve circuit for the control valve, V63

1 Disassemble connector C85.

2 Measure the resistance between pins 2 and 3 on the loose part of the connector. The correct value is 195 - 250 ohms.

3 Measure pins 2 and 3 against earth at G13 on the fixed part of the connector. There should be no connection to earth.

Checking the solenoid valve circuit for the gate interlock, V1017

1 Measure on connector C85 when the ignition is on.

Note: Do not separate the connector.

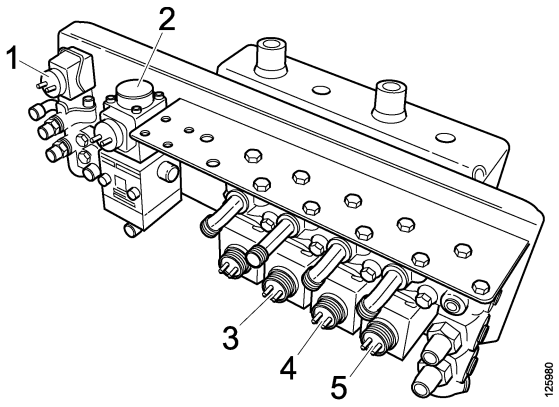
2 Measure the voltage between pin 4 and earth at G13 on the fixed part of the connector. If low-range is engaged, the correct value should be equal to battery voltage.

3 If there is a fault, check the cable harness, locking switch B41 and solenoid valve.

Splitter gear

General

The gear area for split is preset with the split switch. Gear changing takes place during declutching and the lower clutch pedal switch closes and supplies current to the interlock valve (V64). The interlock valve then passes air to the control valve and gear changing can take place in the split valve.



1 V63 - Low-range, high-range
2 V76 - Proportional valve
3 V64 - Split interlock valve
4 V62 - Low split, high split
5 V1017 - Gate interlock

Checking the voltage supply

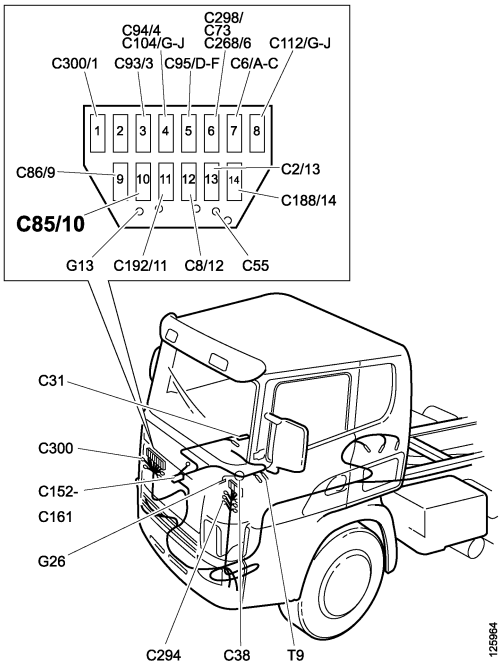
The range and split circuits have a common voltage supply. Check that fuse 5 is not blown.

Checking the split switch

1 Disassemble connector C85 and turn the ignition key to the drive position.

2 Measure the voltage between pin 6 and earth at G13 on the fixed part of the connector.

- The voltage in the low-split position should be equal to battery voltage.
- The voltage in high-split position should be equal to 0.



Checking the lower clutch switch

1 Disassemble connector C85 and turn the ignition key to the drive position.

2 Measure the voltage between pin 7 and earth at G13 on the fixed part of the connector.

- With the clutch depressed, the voltage should be equal to battery voltage.
- With the clutch pedal released, the voltage should be equal to 0.

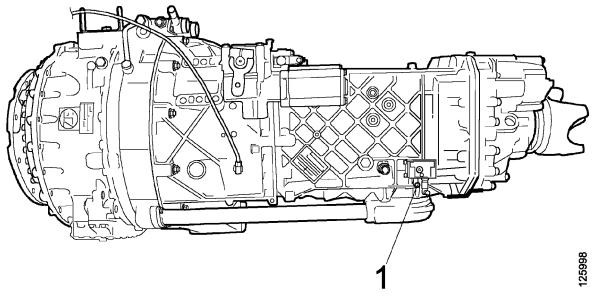
Split control valve, V62

When the split button is in the low position, solenoid valve V62 should pass air to the control valve.

1 During troubleshooting, the compressed air system must be at operating pressure and the ignition key must be in the drive position.

2 Allow the clutch pedal to be released.

3 Disconnect control cable 1. In the low-split position, air should be released and in the high-split position it should be sealed off.



1 Control cable for control valve

Checking the solenoid valve circuit for the split control valve (V62)

1 Disassemble connector C85.

2 Measure the resistance between pin 6 and earth on the fixed part of the connector. The correct value is 53 - 64 ohms.

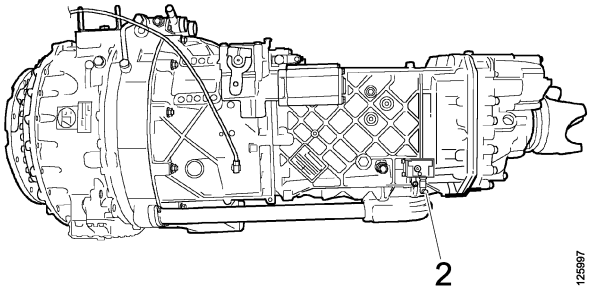
3 If there is a fault, check the cable harness, connector and control valve.

Split interlock valve and gearshift servo, V64

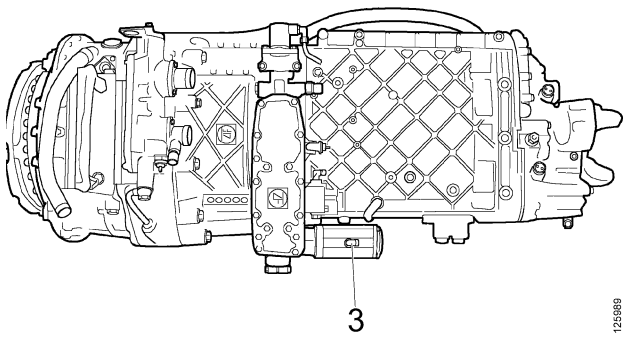
When the clutch pedal is released, the interlock valve should vent (hiss). Otherwise, it should not release air through to the control valve or gearshift servo.

1 During troubleshooting, the compressed air system must be at operating pressure and the ignition key must be in the drive position.

2 Disconnect control cable 2 (supply pressure) or control cable 3 (gearshift servo).



2 Control cable for supply pressure



3 Control cable for gearshift servo

3 When the clutch pedal is depressed, the interlock valve should release air through to the control valve or gearshift servo.

4 The interlock valve should not release air when the clutch pedal is released.

Checking the solenoid valve, split interlock valve and gearshift servo (V64)

1 Disassemble connector C85.

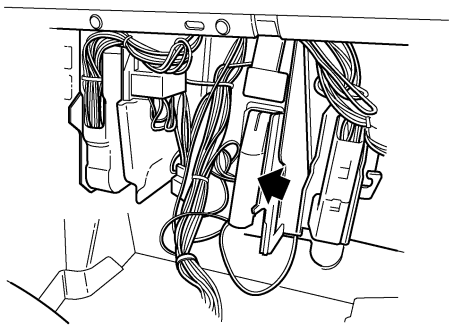
2 Measure the resistance between pin 7 and earth on the fixed part of the connector. The correct value is 53 - 64 ohms.

3 If there is a fault, check the cable harness, connector and solenoid valve.

Overrevving protection

General

The gearbox is equipped with protection against overrevving. The protection consists of two electronic units located under the instrument panel on the passenger side.



Range interlock:

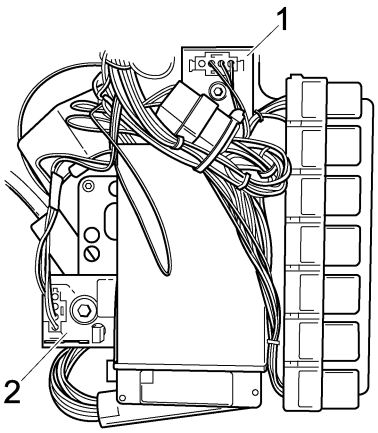
Prevents low range from being engaged if the speed is too high.

Gate interlock:

Prevents 1st and 2nd gear from being engaged if you have forgotten to switch over the range button to the high position when changing from 4th to 5th gear. An air cylinder prevents side travel on the gear lever if the speed is too high.

Function, electronic units

- The electronic unit (E1003) for range interlock interrupts the earth to the solenoid valve (V63) if the vehicle speed is too high and therefore prevents low range from being engaged.
- The electronic unit (E1004) for gate interlock earths the solenoid valve (V1017) via the connection (B41) if it is closed (closed on low-range) and if the vehicle speed is high enough for there to be a risk of overrevving. Compressed air is then released to the cylinder preventing side travel of the gear lever.



1 E1004
2 E1003

Lubrication system

General

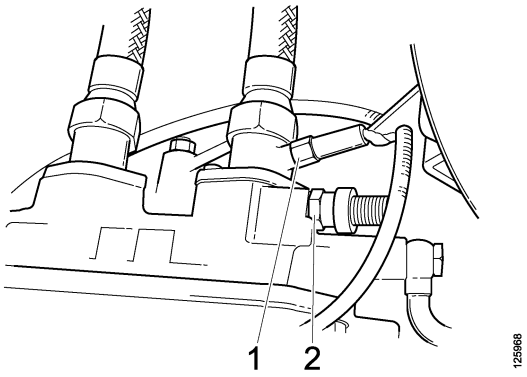
The gearbox with retarder and torque converter has a common oil system with an oil cooler which is cooled by the engine's coolant system.

The gearbox has two oil temperature sensors. One oil temperature sensor (ZF sensor) provides information to the gearbox control unit. When the cooling system is unable to cool the heat and it rises to 150°C, the retarder braking effect will be gradually reduced by the control system.

If the oil temperature exceeds 150°C, the control unit will activate the warning lamp and buzzer.

When the oil temperature falls, the retarder gradually regains its original braking capacity.

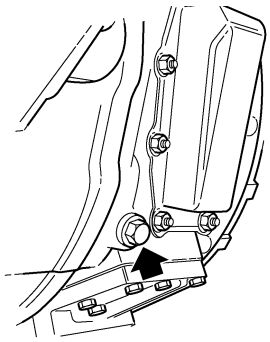
The other oil temperature sensor (T1011) provides information to the indicating instrument.

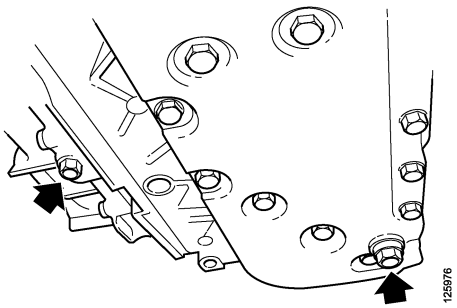


1 ZF sensor
2 T1011

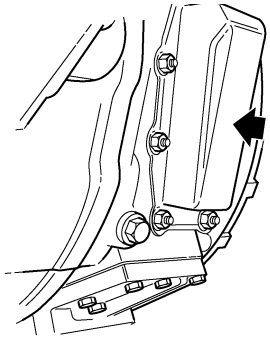
Oil change and filter renewal in gearbox

1 Drain the oil through the three plugs.

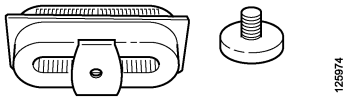




2 Remove the filter housing.

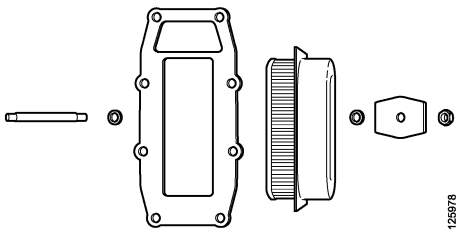


3 Remove the bolt holding the filter and remove the filter.

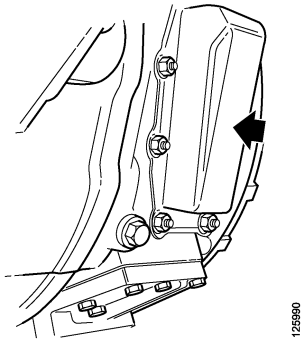


4 Clean the filter housing.

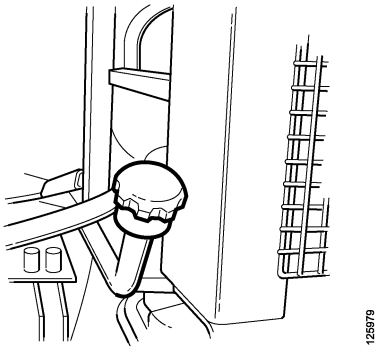
5 Fit a new gasket, new filter and the cleaned filter housing.



Note: Make sure that the filter housing is the right way round.



6 Top up with oil. The oil tank holds 43 litres.



Checking oil level

Note: Check the oil level when the gearbox is warm.

1 Place the vehicle on the level.

WARNING!

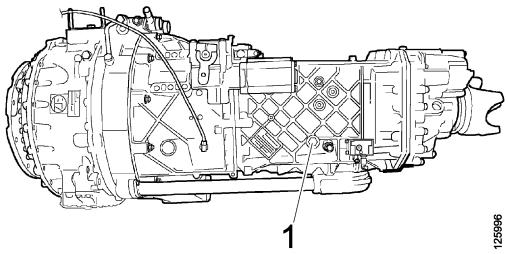
Place chocks on the wheels and apply the parking brake to prevent the vehicle from moving. Danger of personal injury.

2 Start the engine and run it at idling speed for 2 - 3 minutes. Engage top gear (8H).

Note: Top gear must be engaged, so that the engine will not generate too much power. The gear must be engaged so that the oil level will be remain level.

3 Release the clutch.

4 Remove the level plug and check the oil level through the level hole.



1 Level hole

5 Top up with more oil if necessary.

6 Engage neutral gear and switch off the engine.

7 Tighten the level plug.

Gearbox with extra radiator

General

Some gearboxes are equipped with an extra radiator and a hydraulic cooling fan.

The cooling fan is hydraulically driven. The fan's hydraulic motor is driven by a hydraulic pump.

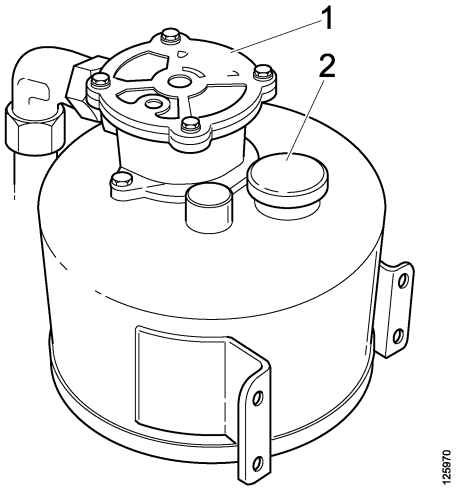
The flow rate to the hydraulic motor is regulated by a thermostatically-controlled control valve with a thermostat which senses the coolant temperature when it passes the radiator.

There is an oil reservoir with filter in the return line between the control valve and hydraulic pump.

If there are problems, refer to Workshop manual main group 2, Bus Cooling system, Cooling fan or Bus Cooling system, Hydraulic system.

Checking oil level

- The engine must be warm and switched off.
- Check oil level and top up with oil as necessary.



1 Filter cover
2 Oil dipstick and filling

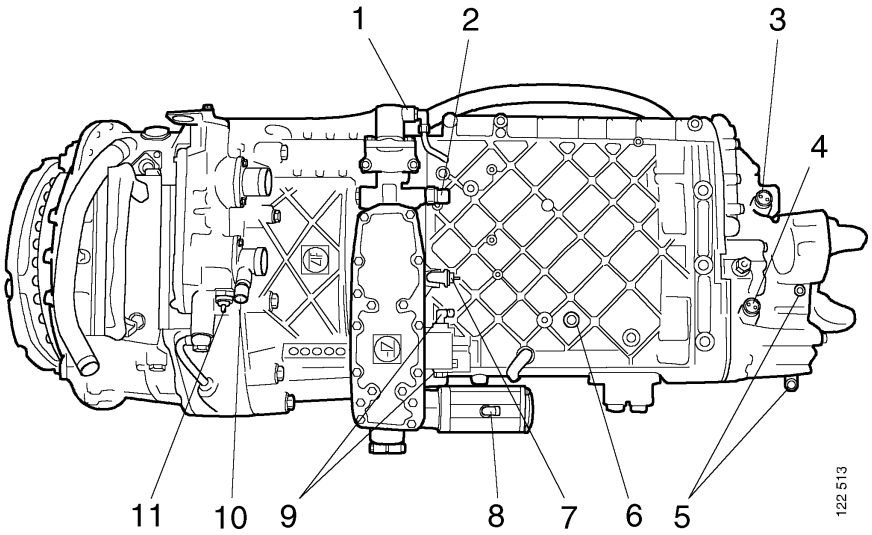
Specifications

Number of gears	16 forward and 4 reverse
Gear ratio	13.80 - 0.84
Total weight	595 kg
Oil capacity	43 l
Oil type	Monograde, viscosity SAE30
Torque converter return pressure, Pwk	5.5 bar
Lock-up clutch closing pressure, Pwa	10.5 ± 0.5 bar
Maximum incoming torque	2700 Nm
Retarder, performance	1600 Nm
Retarder return pressure, PVR	2.0 ± 0.5 bar
Retarder output pressure, PRA	Max. 4.5 ± 0.5 bar
Stalling speed DC16-01 (580 Hp)	1405 rpm
Clutch disc wear limit	85 +2/-8 mm (New clutch disc)
	56 mm (Worn clutch disc)

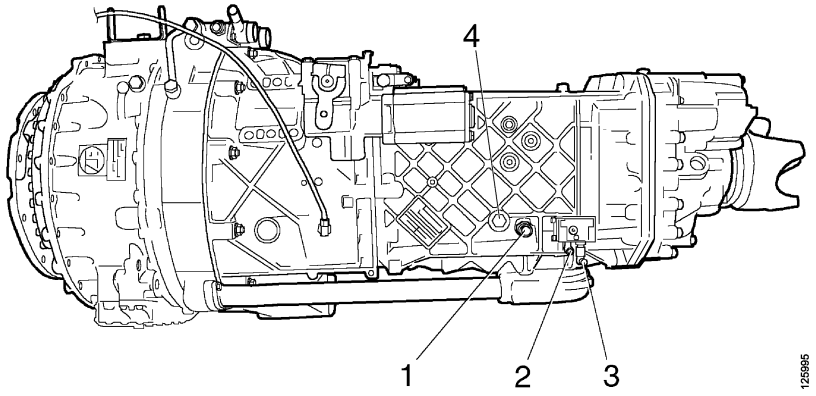
Tightening torques

Pressure plate	47 Nm
Gearbox housing nuts	90 and 43 Nm
Oil pipe bolts	23 Nm

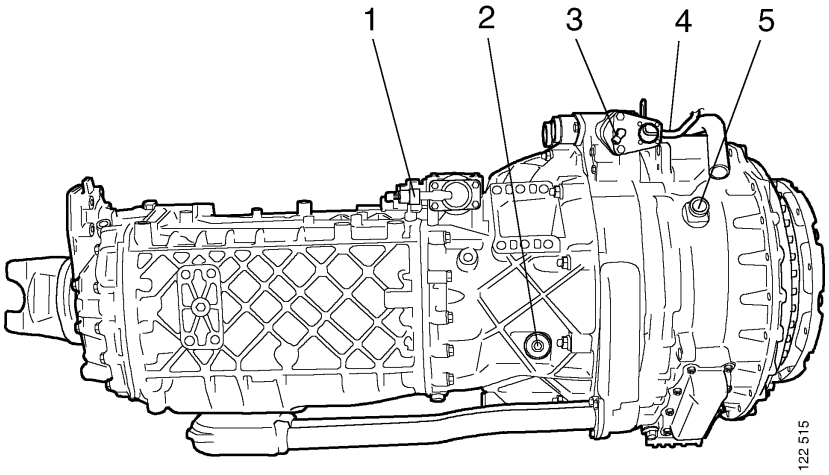
General diagrams



1 Air for gate interlock
2 Reverse neutral
3 Speed sensor
4 Connection for high and low range (B41)
5 Air for range
6 Reversing light switch
7 Neutral position sensor
8 Air for gearshift servo
9 Air for neutral position sensor
10 ZF oil temperature sensor
11 Indicating instrument oil temperature sensor



1 Split switch
2 Governing pressure for split
3 Supply pressure for split
4 Oil level plug



1 Air for gate interlock
2 Inductive sensor for N.turbine
3 Air for proportional valve
4 Connection for cable harness
5 ZVK switch