SCANIA

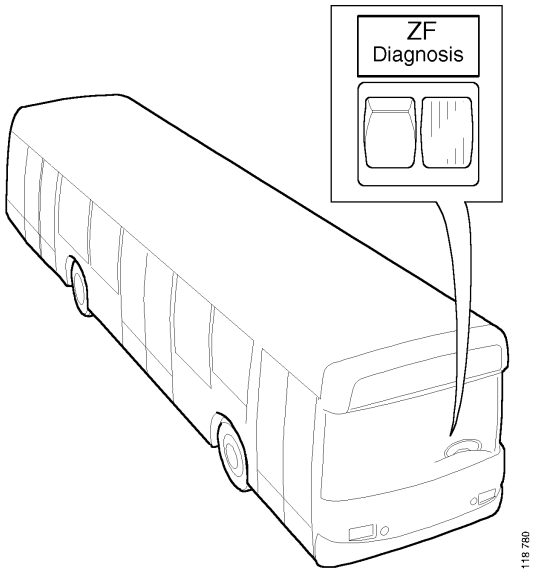
05:08-54

Issue 2 **en**

ZF automatic gearbox

ZF 4/5HP500, 590 and 600

Troubleshooting



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Contents

General

If the gearbox is not shifting or braking correctly, you should carry out the checks specified under "Rectifying functional disorders" first of all.

Then carry out systematic troubleshooting as described on the following pages. This troubleshooting is based on flashing codes but the ZF troubleshooting instrument MOBiDIG 200 and the ZF 55-pin breakout box can also be used. Refer to the ZF workshop manuals.

Start by reading the booklet "Functional description" for the relevant gearboxes in the Workshop Manual, group 5. Make sure you are aware of how sensors, controls, control units and gearboxes work together. It will then be easier to interpret and understand the results of the troubleshooting procedure.

Remember that a fault may have occurred at a completely different location than where it appears. For example, if the retarder is not working, it may be due to the throttle actuation sensor being incorrectly adjusted and not providing an idling signal when the accelerator pedal has been released to idling position. This must not lead you to the conclusion that the retarder is at fault.

Rectifying functional disorders

If the gearbox is not shifting or braking correctly, you should first check the following points:

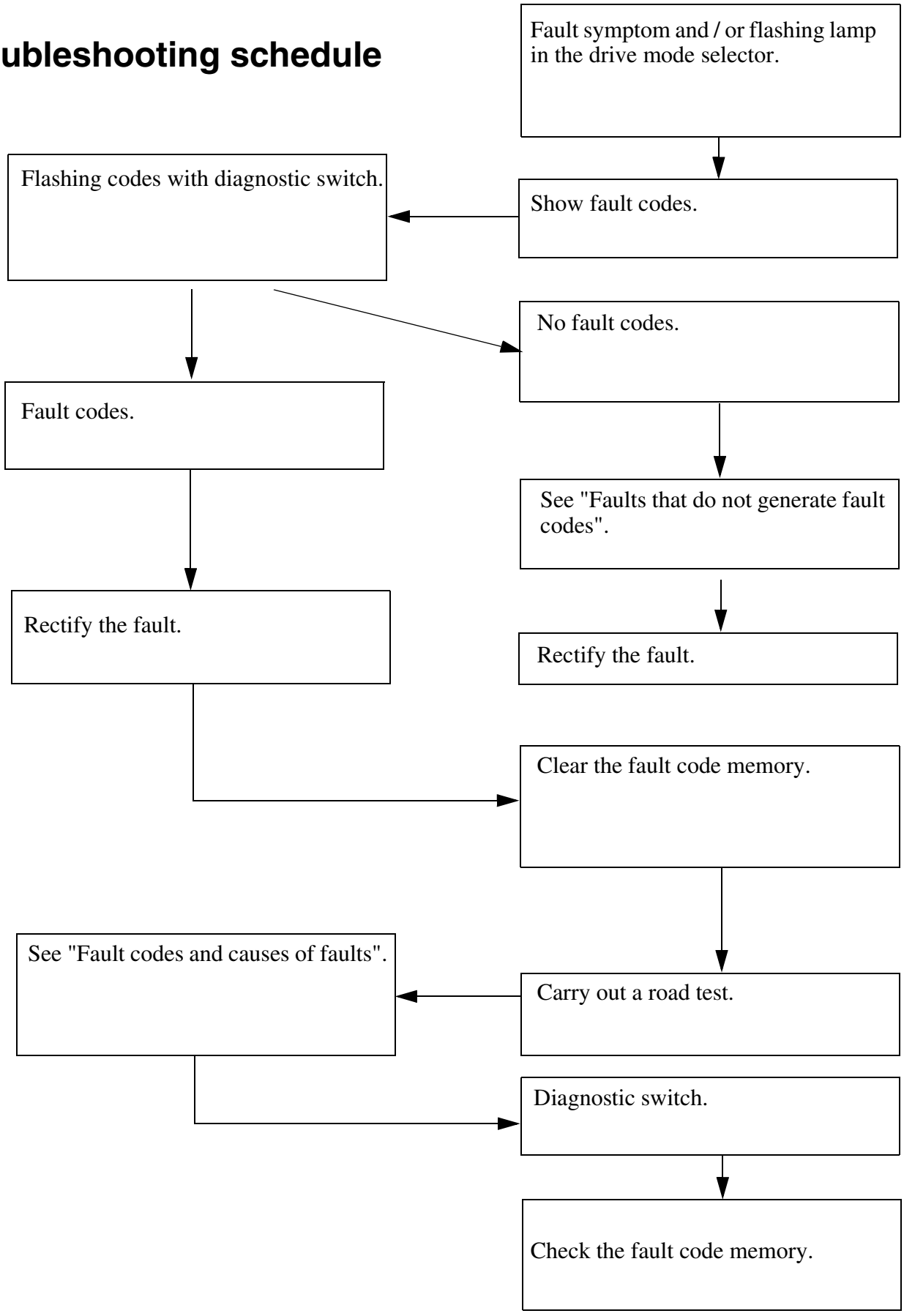
- that the retarder lever for operating the retarder is in position 0 if the vehicle is equipped with a retarder lever. Otherwise, the vehicle brake will be applied as soon as the accelerator pedal is released to idle position.
- that the accelerator pedal returns all the way to idle position when released. Otherwise, the retarder cannot be used.
- that the accelerator pedal sensor and the throttle actuation sensor are correctly adjusted.
- that the oil level has been checked and is correct. Check this as described in Workshop Manual group 5, Automatic gearbox, ZF 4/5 HP 500, 590 and 600, Work description.
- that the oil in the gearbox is the correct grade and that the oil and filter have been changed at regular intervals as instructed in Workshop Manual, group 0. Remember that the oil and filter may require changing more often than normal when driving in severe conditions.

Change oil and filter if there is any doubt as to the grade of oil or when it was last changed.

Take the vehicle for a road test afterwards in order to see whether the functional disorder persists.

Troubleshooting

Troubleshooting schedule



Fault codes

A fault in the gearbox will cause a fault code to be stored in the control unit fault code memory. This fault code can be read in two different ways:

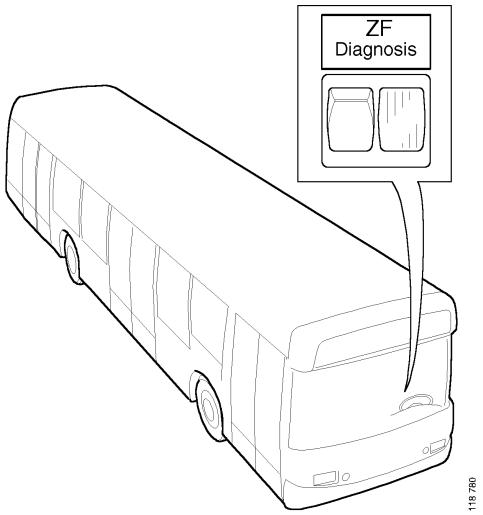
- As a flashing code that can be shown using the diagnostic switch in the vehicle.
- Using the ZF troubleshooting instrument MOBiDIG.

There are also faults that will not cause fault codes. Poor retarder effect, for example, can be caused by low oil level in the gearbox. This will not cause a fault code.

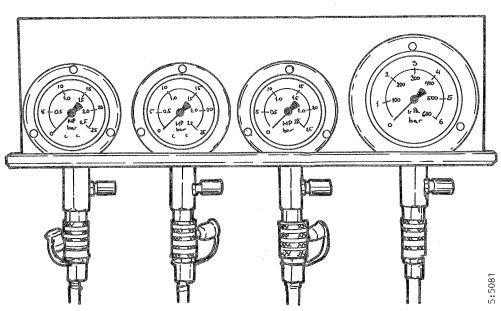
If the gearbox is not functioning normally but a fault code cannot be detected, compare the fault symptoms with those listed in "Faults that do not generate fault codes".

Troubleshooting equipment

Show the flashing codes using the diagnostic switch.



Use the Scania manometer kit 99 217 to measure the hydraulic pressure in the gearbox.

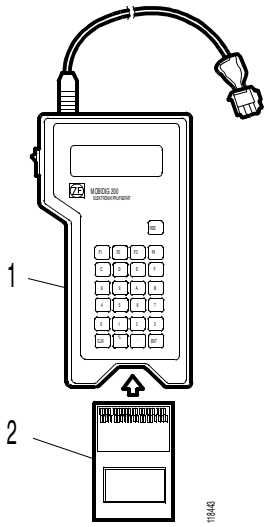


Manometer kit 99 217

Alternative troubleshooting equipment

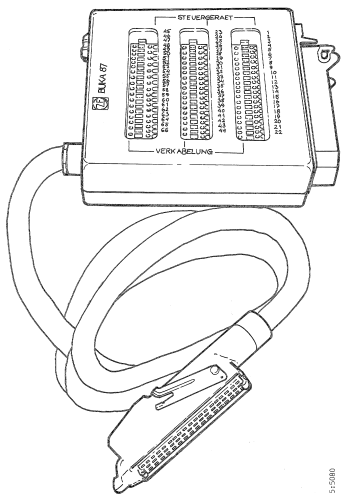
Using the ZF electronic troubleshooting instrument MOBiDIG 200, ZF part number 6008 003 003, it is possible to check the control unit input and output signals from sensors and controls. It is also possible to read fault codes using this instrument.

Two versions of the MOBiDIG 200 are available. One version has an optional program card, ZF part number 6008 203 008.



1 MOBiDIG 200
2 Program card

Use the ZF 55-pin breakout box, ZF part number 1P01 137 834, to measure the resistance and voltage of electrical components such as the throttle actuation sensor and solenoid valves.



55-pin breakout box

Test instructions are also supplied with these tools.

MOBiDIG 200:

- ZF part number 6038 756 106b, for MOBiDIG 200 without program card.
- ZF part number 6038 756 108b, for MOBiDIG 200 with program card

55-pin breakout box

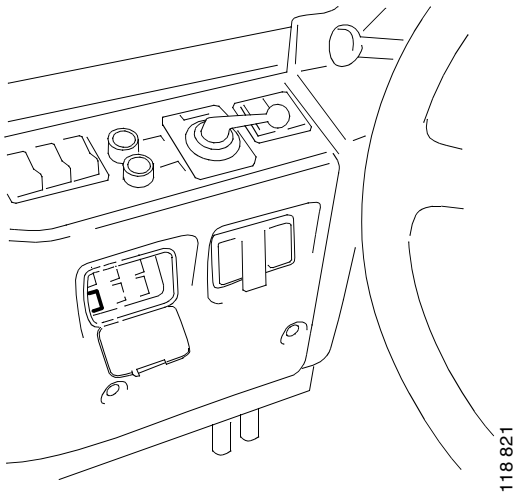
- ZF part number 4139 756 110

Flashing codes

The diagnostic lamp is connected in parallel with the drive mode selector. Therefore, the diagnostic lamp comes on as soon as the voltage is turned on with the starter key.

If there is an active fault, the depressed button on the drive mode selector will flash to warn the driver and consequently so will the diagnostic lamp.

The fault code memory can store a maximum of ten fault codes.



Show flashing codes

1 Turn on the power supply with the starter key.

2 Make sure the drive mode selector is in position N.

3 Press the diagnostic switch for at least three seconds. The diagnostic lamp will go out when the switch is pressed.

4 Release the switch and count the number of flashes.

- The long flashes that are shown first are units of ten.
- The short flashes that follow are units of one.
- If the diagnostic lamp does not flash then no fault codes have been stored.

Example:

The diagnostic lamp flashes slowly twice and rapidly three times. This means 2x10 + 3x1 = 23, i.e. fault code number 23.

5 Press the switch again for at least three seconds. Release it and count the number of flashes. If the same fault code is obtained then there is only one fault present in the system. Otherwise, keep pressing the switch until the first fault code is shown again. Make a note of all the fault codes.

Clear the fault code memory

1 Turn off the power supply with the starter key.

2 Press the diagnostic switch and keep it depressed.

3 Turn on the power supply with the starter key and wait at least three seconds.

Check the function

Take the bus on a road test.

Read the fault code memory.

There should not be any more fault codes stored.

List of fault codes

Fault code no.	Fault in plain text
11	Discs slip when driving.
12	Slip time too long when shifting 1-2.
13	Slip time too long when shifting 2-3.
14	Slip time too long when shifting 3-4.
15	Slip time too long when shifting 4-5.
16	Not used on Scania buses.
17	Not used on Scania buses.
18	Not used on Scania buses.
23	Signal from throttle actuation sensor absent or incorrect.
25	Signal from throttle actuation sensor absent or incorrect.
27	Signal from turbine speed sensor absent or incorrect.
31	Short circuit to earth in current path to solenoid valve G*.
32	Short circuit to earth in current path to solenoid valve F.
33	Short circuit to earth in current path to solenoid valve E.
34	Short circuit to earth in current path to solenoid valve D.
35	Short circuit to earth in current path to solenoid valve C.
36	Short circuit to earth in current path to solenoid valve B.
37	Short circuit to earth in current path to solenoid valve A.
38	Short circuit to earth in current path to solenoid valve WK.
39	Short circuit to earth in current path to solenoid valves V501 and 502.
40	Not used on Scania buses.
41	Short circuit to earth in current path to retarder reduction/shift signal.
42	Not used on Scania buses.
43	Not used on Scania buses.
44	Not used on Scania buses.
45	Not used on Scania buses.
46	Short circuit to earth in current path to H1 warning lamp in drive mode selector.
51	Open circuit or short circuit to +24 V in current path to solenoid valve G*.
52	Open circuit or short circuit to +24 V in current path to solenoid valve F.
53	Open circuit or short circuit to +24 V in current path to solenoid valve E.
54	Open circuit or short circuit to +24 V in current path to solenoid valve D.

Fault code no.	Fault in plain text
55	Open circuit or short circuit to +24 V in current path to solenoid valve C.
56	Open circuit or short circuit to +24 V in current path to solenoid valve B.
57	Open circuit or short circuit to +24 V in current path to solenoid valve A.
58	Open circuit or short circuit to +24 V in current path to solenoid valve A.
59	Open circuit or short circuit to +24 V in current path to solenoid valve WK.
60	Not used on Scania buses.
61	Open circuit or short circuit to +24 V in current path to solenoid valves V501 and V502.
62	Not used on Scania buses.
63	Not used on Scania buses.
64	Not used on Scania buses.
65	Not used on Scania buses.
66	Open circuit or short circuit to +24 V in current path to H1 warning lamp in drive mode selector.
71	Throttle actuation sensor adjusted incorrectly.
73	Defective drive mode selector.
75	Incorrect terminal voltage.
77	Incorrect resistance across D1 valve.**
79	Incorrect voltage supply to throttle actuation sensor.

* Solenoid valve G is present on gearboxes with NBS function only.
These gearboxes can be identified with the 10-digit number on the type plate. If the third digit from the end is a five, e.g. xxxx xxx 5xx, then the gearbox is equipped with NBS.

NBS is described in more detail in the booklet "Functional description" for the relevant gearbox in Service Manual, group 5.

** The D1 valve regulates the modulation pressure.

Note: The following components will not generate fault codes:

Kick-down switch
Switch for various shifting programmes if the vehicle is equipped with such.

Faults that do not generate fault codes

Symptoms of the fault	Possible cause	Check	Action
Rough gear changing in all gears.	Defective control unit.	Test function with working control unit.	Renew the control unit.
Rough gear changing in all gears.	D1 valve defective.	Measure modulation pressure.	If the modulation pressure is higher than 0.5 bar then renew the D1 valve.
Poor or no retarder action.	Gearbox oil level too low.	Check the oil level.	Top up if necessary.
Poor or no retarder action.	Oil foaming	Check the oil level. Check oil.	Top up or drain off oil as necessary. Check retarder solenoid valves and accumulator. Check tightness of gearbox.
No retarder action.	Mechanical fault in solenoid valve V501 and/or V502.	Measure retarder pressure.	Conduct tests no. 1, 2, 3 and 4 in accordance with "Test instructions using the ZF 55-pin breakout box". Renew solenoid valve V501 and/or V502.
Retarder stage 1 and possibly stage 2 not working.	Fault in pneumatic control of retarder solenoid valves.	Check air pressure. Check solenoid valves V501, V503 and V504. Check pressure regulators. Check cables and connections.	Conduct tests no. 1, 2, 3 and 4 in accordance with "Test instructions using the ZF 55-pin breakout box". Renew defective components.
No gear engaged.	Throttle actuation sensor incorrectly adjusted. Idle speed above 900 rpm.	Check throttle actuation sensor setting. Check idle speed.	Set throttle actuation sensor. Set idle speed.
No gear engaged.	Break in current path to external neutral engagment.	Make sure pin 17 on the control unit is supplied continuously with +24 V.	Check cable 698. Repair or renew the cable.
Loud, abnormal noise.	Oil pump heard cavitating. Oil level too low.	Check the oil level. Check the grade of oil.	Top up if necessary. Change oil.

Symptoms of the fault	Possible cause	Check	Action
Engine will not start.	The drive mode selector is not in position N.	Check drive mode selector.	Put the drive mode selector in position N.
	Loose connection / cable break in control unit connection.	Check contacts and cables.	Rectify contacts and cables.
	Relays R2, R505 and R506 defective.	Check relay(s).	Renew relay(s).
Bus cannot be driven.	Control unit indicates a fault.		Turn power off and on again.
	Oil level too low.	Check the oil level.	Fill up with oil.
	Gearbox defective.	Check the gearbox.	Get in touch with the ZF service organisation.
Oil temperature too high.	Oil level too high.	Check oil level.	Drain the oil.
	Retarder braking continuously.	Check controls and components that affect the retarder.	Repair or renew the defective components.
	Internal damage to gearbox.		Get in touch with the ZF service organisation.

Checking and adjusting brake signals

Preconditions

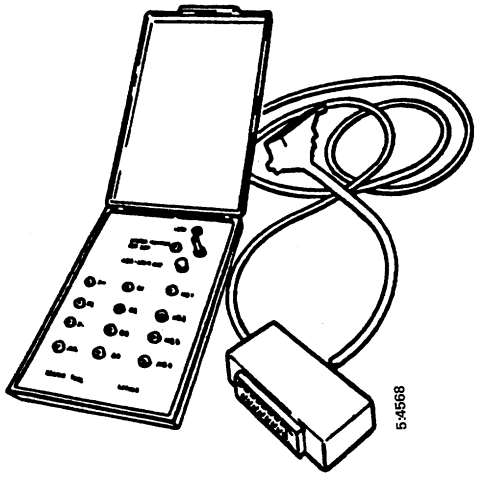
- The compressed air system must be pressurized.
- The switch for automatic retarder operation must be on.

The retarder control unit is located in the central electric unit on the body.

Check:

1 Turn off the power supply with the starter key.

2 Connect test instrument 639 802 in series with the connector between the retarder control unit and the connector on the cable.



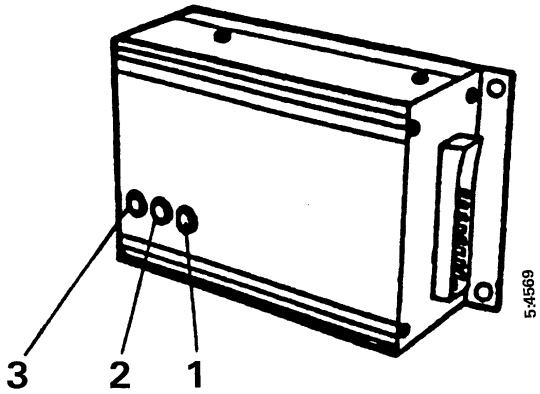
Test instrument 639 802.

3 Turn on the power supply with the starter key.

Connect a manometer to the service brake circuit test connection by the front wheel.

4 Adjust the brake signal B2 with the trimming potentiometer for B1+B2 so that warning lamps B1 and B2 come on when the brake pedal is depressed approximately 10 mm. Measure from the front edge of the pedal.

Note: Brake signal B1 is not used for ZF gearboxes but is activated with B2 during automatic operation. The potentiometer is therefore denoted B1 + B2.



1 Trimming potentiometer for B1 + B2
2 Trimming potentiometer for B4
3 Trimming potentiometer for B3

5 Press the brake pedal until an air pressure of 0.5 bar is attained in the service brake circuit. Brake signal B4 should now be obtained. Adjust the trimming potentiometer if necessary.

6 Adjust brake signal B3 with its trimming potentiometer so that the signal is obtained with the brake pedal in a position between B1 + B2 and B4.

If the brake signal cannot be adjusted with the retarder control unit, it may be necessary to adjust the basic setting of the service brake valve potentiometer. See Workshop Manual, group 5. Automatic gearbox ZF, ZF 4/5 HP500, 590 and 600, Work description.

7 Turn off the power supply with the starter key.

8 Remove the test instrument. Connect the connector to the retarder control unit.

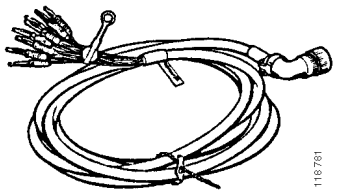
Checking solenoid valves

Special tools

Number	Description
588 094	Multimeter kit
ZF 1P01 137 002	Test cable

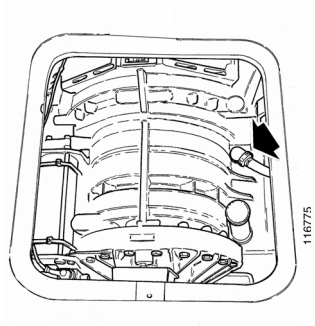
Measuring resistance of solenoid valves and speed sensors via electric connection (Cannon connector) on gearbox.

IMPORTANT! Test cable ZF 1P01 137 002 must be used only on a stationary vehicle with engine and power supply turned off.

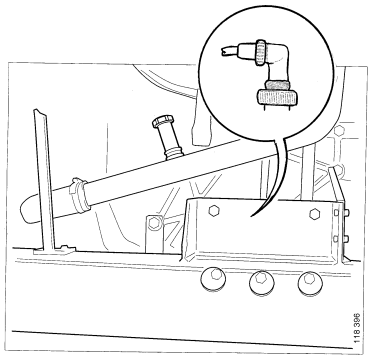


Test cable ZF 1P01 137 002

1 Disconnect the electric connection (Cannon connector) and connect test cable ZF 1P01 137 002.

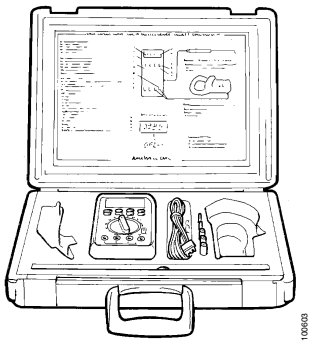


Cannon connector location on K/L buses.



Cannon connector location on N buses.

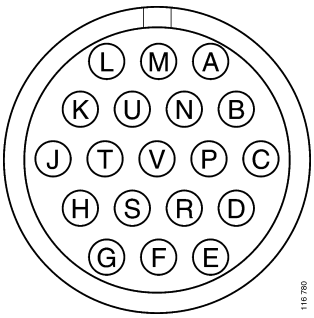
2 Use multimeter kit 588 094 and connect the multimeter to test cable ZF 1P01 137 002.



Multimeter kit 584 094.

Note: The resistance of solenoid valves M1 – M8 rises by approximately 74 ohms at operating temperature. The resistance of speed sensors rises to approximately 1350 ohms at operating temperature.

IMPORTANT! Measure the resistance of the solenoid valves and proportional valve to the mark N = earth and the speed sensors to mark M = earth.



Component	Description	Mark	Resistance at 20°C
Solenoid valve M7	Clutch A	A	approximately 67 ohms
Solenoid valve M6	Clutch B	B	approximately 67 ohms
Solenoid valve M5	Clutch C	C	approximately 67 ohms
Solenoid valve M4	Clutch D	D	approximately 67 ohms
Solenoid valve M3	Clutch E	E	approximately 67 ohms
Solenoid valve M2	Clutch F	F	approximately 67 ohms
Solenoid valve M1	Clutch G	G	approximately 67 ohms
Solenoid valve M8	Clutch WK	H	approximately 67 ohms
Proportional valve	D1	U	approximately 8,6 ohms
	earth	N	
Speed sensor	Turbine wheel	T	approximately 1080 ohms
Speed sensor	Output shaft	V	approximately 1080 ohms
	earth	M	

Stalling speed test

A stalling speed test should be conducted when the vehicle is not operating satisfactorily and it is necessary to determine whether the fault is in the engine or the gearbox. Conduct the test outdoors if possible as it is necessary to provide free space in front of the bus in case the brake force is insufficient.

The engine stalling speed when under load should be compared with the values in the table below.

1 Warm up the bus to normal operating temperature so that the gearbox oil temperature is 80-90°C.

2 Remove brake light relay R6 from the central electric unit so that the engine can be revved up while the footbrake is depressed.

3 Turn off the automatic retarder operation.

4 Apply the parking brake. Hold down the footbrake.

5 Connect a reliable tachometer. The vehicle tachometer is not sufficiently precise and may give the wrong reading.

Requires two persons

6 Put the drive mode selector in position D.

IMPORTANT! Run the engine at full throttle for maximum 20 seconds or the gearbox can be overheated.

7 Fully depress the accelerator pedal and read the engine speed when it has become stable.

8 The gearbox must be cooled down before repeating the test. Put the drive mode selector in position N and maintain an engine speed of 1500 rpm for 2-3 minutes.

The following values are nominal and apply only if the engine and gearbox are in good condition.

Engine type	Stalling speed, +80/-50 rpm	Gearbox
DSC915, DSC913	1607 rpm	HP600
DSC912	1661 rpm	HP590
DSC911	1545 rpm	HP500
DSI9E01	1585 rpm	HP500
OSC9G01	1577 rpm	HP500

The stalling speed may deviate slightly from the specified values. This can be caused by e.g. the energy content in the fuel. Minor deviations need therefore not necessitate any measures.

If the stalling speed falls below the specified speed by more than 150 rpm, there may be something wrong with the engine.

If the stalling speed exceeds the specified speed by more than 150 rpm, there may be something wrong with the gearbox. This may be due to a slipping disc coupling or a fault in the torque converter. Get in touch with your ZF dealer if this should occur.

Pressure measuring

Pressure measuring should be regarded as a supplement to troubleshooting. If the gearbox does not behave as it should and the fault cannot be traced in any other way, this may be caused by incorrect basic pressure, modulation pressure, torque converter pressure or retarder pressure. Check also the lubrication pressure.

The basic pressure is the pressure the gearbox oil pump delivers.

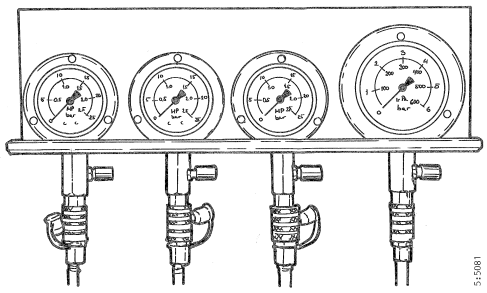
The modulation pressure regulates the slip time.

The torque converter pressure is important when the engine torque is transferred through the torque converter.

The retarder pressure is important when braking with the retarder. Refer to the ZF manuals.

The lubrication pressure is important in providing sufficient lubrication to the gearbox.

Use Scania manometer kit 99 217 to check these pressure values.



Scania manometer kit 99 217

Pressure measuring

Preconditions

Requires two persons!

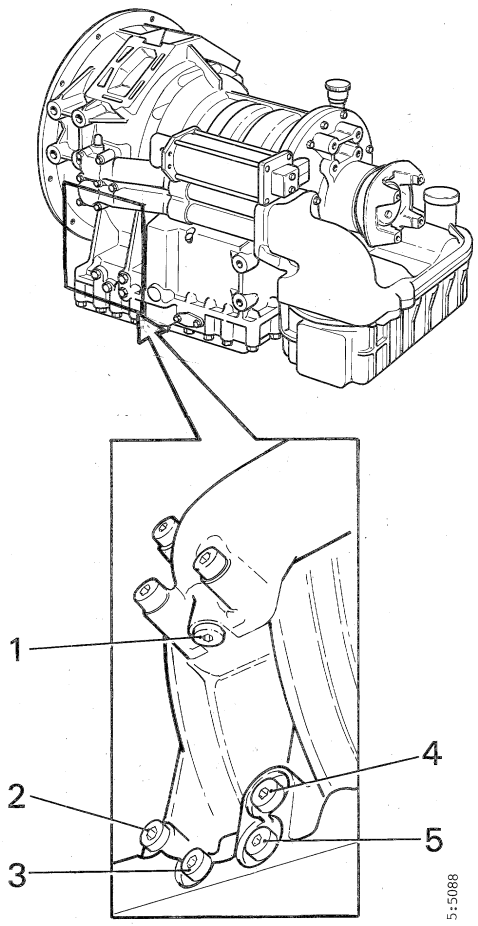
- Pressure measuring is partly carried out while driving and it is not possible to drive and read instruments at the same time.
- Start pressure measuring when the engine and gearbox have a temperature of 20-40°C. Then drive the bus until the engine and gearbox have attained operating temperature and continue pressure measuring.

1 Switch off the engine.

2 Turn off the power supply with the starter key.

IMPORTANT! Observe the utmost cleanliness. The gearbox is extremely sensitive to impurities.

3 Clean around the test connections.



1 Test connection for lubrication pressure
2 Test connection for basic pressure
3 Test connection for retarder pressure
4 Test connection for torque converter pressure
5 Test connection for modulation pressure

Additional connections may be present on later versions of generation 1.

WARNING!

Use gloves when working with ATF.

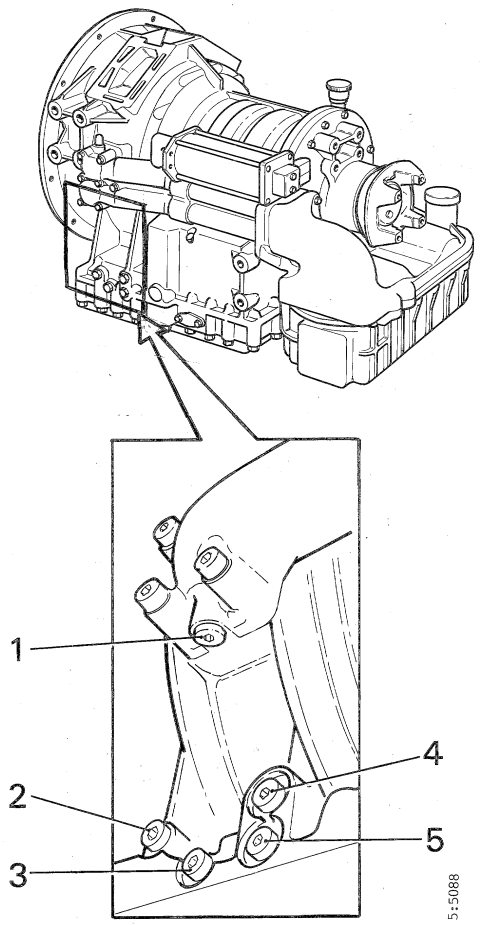
4 Remove the plugs from the test connections.

5 Connect the manometer to the test connections.

6 When conducting pressure measurement while driving, remove the cover in the floor over the gearbox and apply the manometer in the bus that way. In this way, one person can read the manometer while the other drives the bus.

7 Read and note the pressures at the various test connections according to "Report for pressure measuring".

8 Compare the pressure readings with the table.



1 Test connection for lubrication pressure

2 Test connection for basic pressure

3 Test connection for retarder pressure

4 Test connection for torque converter pressure

5 Test connection for modulation pressure

Additional connections may be present on later versions of generation 1.

Report for pressure measuring

Get in touch with your ZF retailer if the pressure readings are not correct. The disc couplings can be seriously damaged if the basic pressure is too low.

Note: The retarder pressure can vary depending on the gearbox specification. Get in touch with the ZF service organisation.

Cold oil, temperature 20-40°C

Basic pressure

Acceleration	Position/Gear	Clutch WK (lock-up)	Engine speed	Basic pressure	Pressure reading
Idle speed	N	Released	550 rpm	8-10 bar	
Idle speed	Gear change N to D and N to R	Released	550 rpm	8-10 bar	
Full throttle	N	Released	2000-2500 rpm	8-21 bar	
Full throttle	D	Applied	2000-2500 rpm	10-12 bar	

Modulation pressure

Acceleration	Position/Gear	Clutch WK (lock-up)	Engine speed	Modulation pressure	Pressure reading
Idle speed	N	Released	550 rpm	6,0-7,0 bar	
Idle speed	Gear change N to D and N to R	Released	550 rpm	0,5-1,0 bar	
Full throttle	N	Released	2000-2500 rpm	*)	
Full throttle	D	Applied	2000-2500 rpm	*)	

Torque converter pressure

Acceleration	Position/Gear	Clutch WK (lock-up)	Engine speed	Torque converter pressure	Pressure reading
Idle speed	N	Released	550 rpm	4,0-5,5 bar	
Idle speed	Gear change N to D and N to R	Released	550 rpm	4,0-5,5 bar	
Full throttle	N	Released	2000-2500 rpm	6,0-8,5 bar	
Full throttle	D	Applied	2000-2500 rpm	6,0-8,5 bar	

Lubrication pressure

Acceleration	Position/Gear	Clutch WK (lock-up)	Engine speed	Lubrication pressure	Pressure reading
Idle speed	N	Released	550 rpm	0,8-1,8 bar	
Idle speed	Gear change N to D and N to R	Released	550 rpm	0,8-1,8 bar	
Full throttle	N	Released	2000-2500 rpm	1,8-2,5 bar	
Full throttle	D	Applied	2000-2500 rpm	1,8-2,5 bar	

Warm oil, oil temperature 80-90°C

Basic pressure

Acceleration	Position/Gear	Clutch WK (lock-up)	Engine speed	Basic pressure	Pressure reading
Idle speed	N	Released	550 rpm	8-10 bar	
Full throttle	N	Released	2000-2500 rpm	17-20 bar	
Full throttle	D	Applied	2000-2500 rpm	10-12 bar	

Modulation pressure

Acceleration	Position/Gear	Clutch WK (lock-up)	Engine speed	Modulation pressure	Pressure reading
Idle speed	N	Released	550 rpm	*)	
Full throttle	N	Released	2000-2500 rpm	*)	
Full throttle	D	Applied	2000-2500 rpm	*)	

*) The modulation pressure varies depending on the gearbox specification. Get in touch with the ZF service organisation.

Torque converter pressure

Acceleration	Position/ Gear	Clutch WK (lock-up)	Engine speed	Torque converter pressure	Pressure reading
Idle speed	N	Released	550 rpm	3,0-4,5 bar	
Full throttle	N	Released	2000-2500 rpm	6,0-8,5 bar	
Full throttle	D	Applied	2000-2500 rpm	6,0-8,5 bar	

Lubrication pressure

Acceleration	Position/ Gear	Clutch WK (lock-up)	Engine speed	Lubrication pressure	Pressure reading
Idle speed	N	Released	550 rpm	0,1-0,8 bar	
Full throttle	N	Released	2000-2500 rpm	1,8-2,5 bar	
Full throttle	D	Applied	2000-2500 rpm	1,8-2,5 bar	

Cease pressure measuring

WARNING!

The engine must be switched off. Otherwise, hot oil will spurt from the manometer connections when the manometer is removed.

1 Switch off the engine and leave the power off.

2 Remove the manometer.

3 Fit new copper washers to the plugs and refit the plugs.
Torque tighten to 15 Nm.

Test instructions

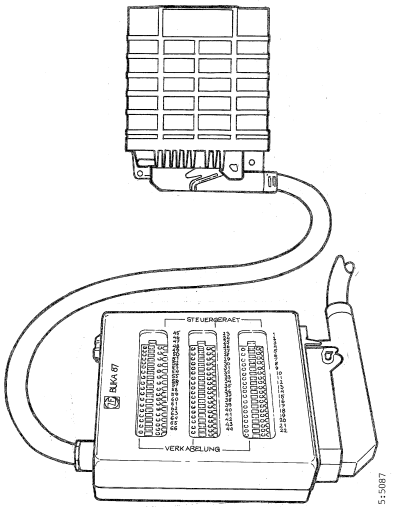
Test instructions using the ZF 55-pin breakout box

IMPORTANT! Make sure the power has been turned off with the starter key before disconnecting the control unit connector

1 Disconnect the connector from the gearbox control unit.

2 Connect the 55-pin connector to the breakout box.

3 Connect the breakout box connector to the control unit.



Test no. 1

Note: Measuring voltage.

Component

- Switch for automatic retarder operation.

Precondition

- Power turned on with starter key. Switch in on position.

Connection

- +33 and –37.

Correct measurement

- 24 V.

Cause

- Burnt fuse.
- Loose connection or broken cable.
- Defective switch

Test no. 2

Note: Measuring voltage.

Component

- Switch for automatic retarder operation.

Precondition

- Power turned on with starter key. Switch in off position.

Connection

- +33 and –37.

Correct measurement

- 0 V.

Cause

- Short circuit.
- Defective switch.

Test no. 3

Note: Measuring resistance.

Component

- Retarder solenoid valves V501 and V502.

Precondition

- Power turned off with starter key.

Connection

- +49 and -19.

Correct measurement

- 35 - 36 ohms.

Cause

- Short circuit.
- Loose connection or broken cable.
- Solenoid valve V501 defective.
- Solenoid valve V502 defective.

Test no. 4

Note: Make the connections before testing.

Component

- Retarder solenoid valves V501 and V502.

Precondition

- Power turned on with starter key. Test no. 3 carried out and rectified.

Connection

- 49 and 20.

Correct measurement

- Solenoid valves V501 and V502 operating.

Cause

- Short circuit.
- Loose connection or broken cable.
- Solenoid valve V501 defective.
- Solenoid valve V502 defective.