

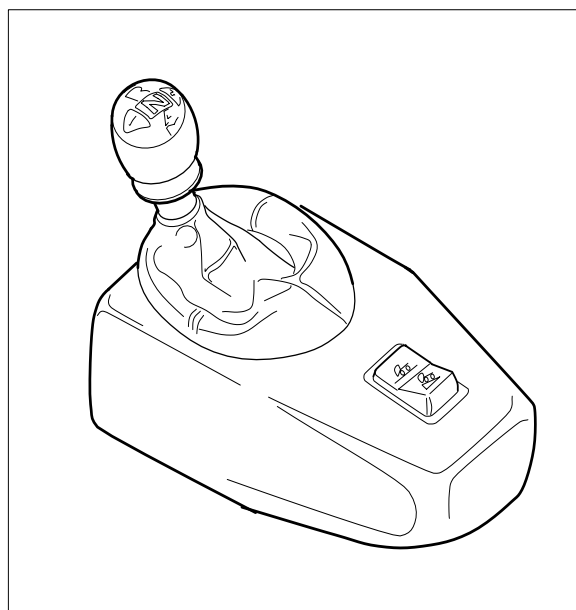
**SCANIA**

**05:05-02**

Issue 1 **en**

## Opticruise

### Description of operation and work description

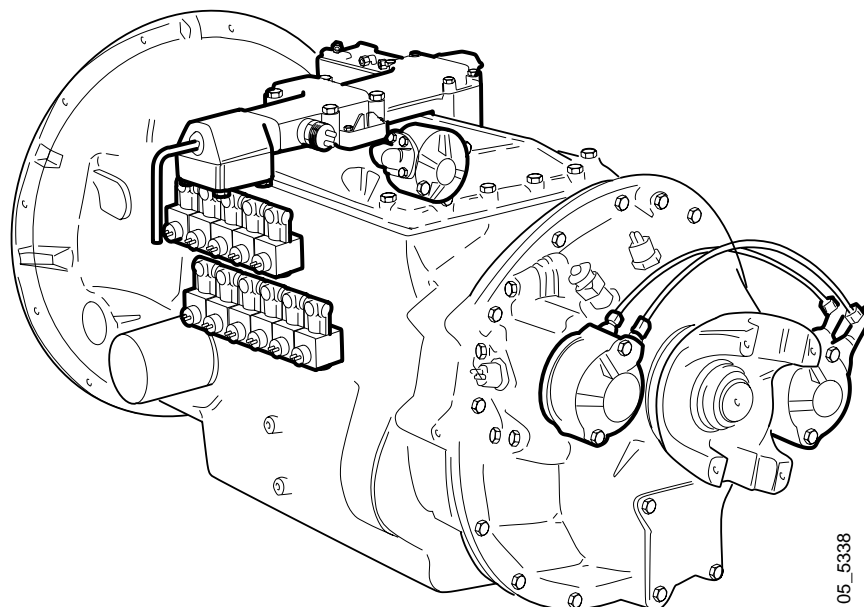


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# Contents

<b>General</b>	Opticruise in brief .....3
	Introduction .....4
	Controls and operation .....6
<b>Description of operation</b>	Gear changing .....7
	Opticruise controls the engine via EDC ..... 7
	Gear changing sequence, description ..... 8
	Engine brake program ..... 9
	Starting gear, programming ..... 9
	Kick-down .....9
	Auxiliary brake system .....9
	EDC cruise control ..... 10
	ABS/TC .....10
	Power take-offs .....10
	Configuration, control unit ..... 11
	Power supply and fuses ..... 11
	Interaction with other systems ..... 12
	Opticruise, design .....14
	Warning system .....16
<b>Fault codes</b>	General .....19
	Faults that do not generate fault codes ..... 19
	Clarifications, new terms ..... 20
	List of fault codes ..... 19-52
<b>Electrical system</b>	References to wiring diagrams ..... 53
	Location of electrical components ..... 54-55
	Control unit signals ..... 56-59
	Driving mode selector .....60
	Test program ..... 61-71
<b>Mechanical work</b>	General .....73
	Instructions for repair and adjustment ..... 73-76
<b>Exploded view drawings</b>	Components on gearbox ..... 77-83

# General



## Opticruise in brief

Opticruise is a system which allows a normal manual gearbox to shift automatically. The clutch is retained but is used only when starting, stopping and shunting.

A control unit collects and processes data from controls, sensors and adjacent systems such as EDC, ABS/TC and auxiliary brake (if fitted).

When it is time to change gear, the control unit actuates the solenoid valves, releasing compressed air to the air cylinders. These air cylinders then change to the required gear.

The control unit has an in-built warning system. Fault codes can either be read on the display or using a PC and the Scania Diagnos program. The latter makes fault diagnosis quicker.

Opticruise requires that the vehicle be fitted with both EDC and ABS/TC, due to the information exchange requirements between the systems.

When changing gear, the engine speed is controlled so that the speeds of the gearbox input shaft and output shaft correspond for the gear to be engaged. Gear changing is only then completed.

When necessary, the exhaust brake is used to make changing up fast and smooth.

## Introduction

Scania Opticruise is an automatic gear changing system for manual gearboxes. Opticruise is constructed in more or less the same way as the Scania CAG system, the major difference being that the driver only needs to use the clutch pedal when starting, stopping and shunting.

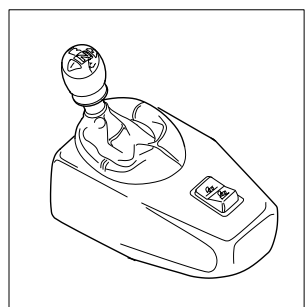
The system is able to change gear automatically without the clutch because the engine is regulated to synchronous speed for the gear that is to be engaged. This means that the electronics adapt both engine speed and torque to exactly the levels required by the gearbox. This makes all gear changing gentle and precise, increasing the service life of the entire powertrain.

Opticruise requires the engine to be equipped with EDC. It would not be possible, using a mechanical injection pump, to control the engine with the speed and precision required for Opticruise to work smoothly. Opticruise also requires the vehicle to be equipped with ABS/TC in order to select the correct gear, even if the drive wheels lose grip on a slippery road surface.

Using Opticruise, the driver can choose to drive with manual or automatic gear selection. In manual gear selection driving mode, the driver selects the gear and when it is changed (depending on road speed and/or engine speed). The control unit decides whether it is possible to change gear without the driver using the clutch. If this is the case, the gear is immediately changed when the driver moves the driving mode selector sideways. Otherwise, the driver has to depress the clutch pedal in order to change gear.

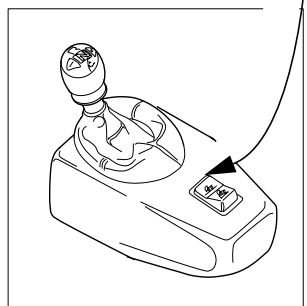
In automatic gear selection driving mode, the control unit calculates which gear is appropriate and carries out this shift when the calculation is complete. In this case, gear changing always takes place without the driver having to use the clutch pedal. If the EDC cruise control is engaged, gear change is automatic without the cruise control being disengaged. This applies until speed is so low that it is a question of stopping or shunting. The clutch must then be used.

In addition to the driving mode selector and its various positions, the driver can choose between two different driving programs. This is done using a program selector beside the driving mode selector. These programs are called Normal and Hill. The Hill program is for steep upward slopes with more than 5 % gradient.



*Normal*

*Hill*



The control unit varies the point at which it changes gear, depending on the position of the program selector. When driving with the program selector set to Hill, gear changing is faster than when the Normal program is engaged. If necessary, the exhaust brake may also be used in order to quickly reduce the speed of the engine.

Like the older CAG system, Opticruise has a selectable starting gear which is programmed in one of the control unit memories. The driver can easily select the starting gear for the average gross train weight of the vehicle combination. The control unit retains this setting, even when power is interrupted. In addition to this, the driver can temporarily select a starting gear other than the one programmed in the memory. This is fully described in the driver's manual.

CLU MODE

LIMPHOME

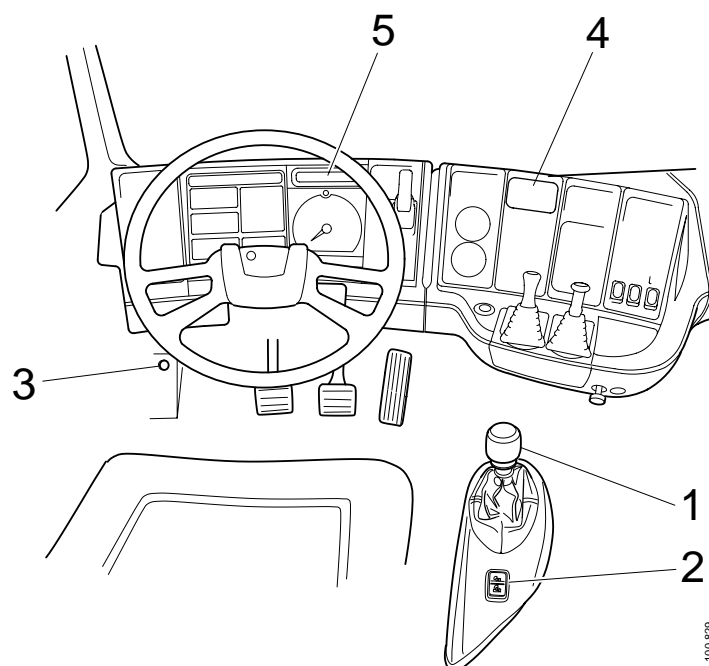
The control unit has a built-in warning system. This has made it possible to reduce the inconvenience in the event of a fault. Opticruise has two built-in emergency driving programs. The first of these, clutch mode, is activated in the case of less serious faults and the driver has to depress the clutch pedal every time a gear is changed. If the driving mode selector is set to automatic, Opticruise still preselects the gear as normal. In this situation, Opticruise works in the same way as Scania CAG.

In the case of more serious faults, the driver should activate a limp home program. This makes it possible to drive the vehicle to a workshop, even if something like a sensor is faulty. This means that the vehicle can be run, even if the emergency driving program feels basic with its manually-requested compressed air gear changes.

The Opticruise system interacts with the braking effect of the diesel engine, the exhaust brake and the Scania retarder, if the vehicle is fitted with this. This reduces brake wear, reducing running costs. In addition, wear to the entire powertrain is reduced as power is transferred more gently than on vehicles with manual gearboxes.

However, the greatest advantage, not least financially, is of course improved driver comfort. Opticruise enables the driver to maintain concentration longer than when driving a vehicle with manual gear changing. This is an advantage for both running costs and road safety.

## Controls and operation



The above drawing shows the controls used for Opticruise. The clutch pedal, controls for EDC cruise control and auxiliary brake control unit also affect the system.

For example, the auxiliary brake may request that the engine brake program be activated in order to increase engine speed and therefore coolant flow. This is essential for optimum retarder performance.

When driving with the cruise control, the system changes gear automatically provided the driving mode selector is set the position A. The cruise control is deactivated using the clutch pedal, brake pedal, retarder lever, cruise control OFF button or using the exhaust brake switch on the floor.

- 1 *Driving mode selector with positions R, N, A and M. The driver is able to command up and downshift by moving the selector lever to the side.*
- 2 *Program selector with Normal and Hill positions. The Hill position is for use on steep slopes, preferably with the driving mode selector set to M (manual).*
- 3 *Switch for activating engine brake program and exhaust brake.*
- 4 *Diagnostics switch*
- 5 *Gear indicator with display and buzzer.*

## Description of operation

### Gear changing

Driving in automatic position A means that the system changes gear automatically in accordance with the driving program set using the program selector, either "Normal" or "Hill".

However, the gear selected automatically can be changed at any time by the driver by moving the driving mode selector to the side. The control unit always checks that the driver's selection is within reasonable limits.

The driver can even preselect a gear that appears completely inappropriate under the circumstances, such as 3rd when driving in 7th. There are two conditions that must be met for this to work.

- The vehicle must lose speed (be retarded).
- The driving mode selector must be set to manual and the program selector to Hill.

The gearbox then starts the shift by first going to neutral. The control unit then prepares itself for the correct splitter level, correct lateral stroke and the correct range before road speed is reduced sufficiently for the particular gear change to be requested.

At the same time, engine speed is automatically increased to high idling, about 2500 rpm. When road speed has decreased sufficiently, the gear is engaged smoothly and gently. When gear changing is complete, control of the engine is returned to the driver.

When driving, the driver can at any time move the driving mode selector to neutral (N) when, for example, approaching a traffic light. If he changes his mind and the vehicle is still moving, it is possible to move the driving mode selector back to one of positions A or M. The control unit then selects a suitable gear, based on the speed of the vehicle and other information from sensors etc. It is not necessary to use the clutch unless speed is too low.

From automatic position A, the driver can at any time move the lever to manual position M and vice versa. This can be useful if you, for example, want to "lock" a gear on a slippery road surface. The same applies if he wants to shift manually, for example on steep hills.

**Note:** On uphill slopes greater than 8 %, it may be necessary to drive with the driving mode selector set to M and with the program selector set to "Hill". This gives the fastest possible gear changing, which means that the vehicle does not lose so much speed during changing.

### Opticruise controls the engine via EDC

Gear changing when driving is done by Opticruise controlling the engine via EDC to synchronous speed for the gear that is about to be engaged, without the driver using the clutch pedal. This means that both engine speed and torque are adjusted to precisely the level required by the gearbox.

In order to make gear changing easier, engine torque is reduced in a controlled manner just before the gear is disengaged.

Gear changing takes place after the speed of the moving parts in the gearbox has been synchronized.

Towards the end of gear changing, engine torque increases in a gentle and controlled manner to the level requested by the driver using the throttle pedal. This means that gear changing is always gentle and precise, increasing the service life of the entire powertrain.

This precise control is made possible by communication between the Opticruise and EDC control systems.

### Description of the gear changing process

- 1 Gear change requested automatically or by the driver.
  - 2 Engine regulated so that there is no torque on the gearbox input shaft.
  - 3 Gearbox set to neutral.
  - 4 Engine regulated to synchronize the speed of the gearbox input shaft and the moving parts for the gear to be engaged.
  - 5 Gear engaged.
  - 6 The engine is regulated to the required torque. The Opticruise then returns control of the engine to the driver.
- During certain upshifts, the exhaust brake is used to more quickly brake the engine to the correct speed in relation to the gear selected.
  - When driving in automatic (A), the control unit continuously calculates which gear is most suitable. When this calculation shows that a gear other than the one engaged would be more suitable, the gear change takes place immediately. This may be either a single change or a block change.

The calculation of appropriate gear is made based on the following data:

- Position of program selector
- Current road speed
- Current acceleration
- Current torque
- Total gear ratio
- Throttle pedal position
- Any request for the activation of the engine brake program from the driver or from the auxiliary brake control unit.



## Engine brake program

The function of the engine brake program is to give optimum engine braking in all driving conditions. The engine brake program has nothing to do with the Normal/Hill program selector, but is controlled by a separate switch on the floor of the cab.

In order to use the engine brake program, the throttle pedal must be fully released.

A short press on the floor switch is all that is required to activate the engine brake program.

This means that upshift is delayed as the control unit maintains the gear for longer before changing up, increasing engine brake output.

However, if the floor switch is held down all the time, the exhaust brake is also engaged and downshift takes place earlier.

If the brake pedal is held down, the upshift points change. The control unit is informed of this via the brake lamp switch.

The engine brake program is connected until the throttle pedal is next depressed.

If the vehicle is equipped with an auxiliary brake system with Scania retarder, the engine brake program can be automatically engaged (if appropriate) when using the retarder. This is done by the auxiliary brake control unit. The intention is to raise engine speed and thus coolant flow, providing the retarder with maximum braking effect and activation time.

## Programming start-off gear

The system permits free choice of starting gear between 1st and 4th. 1st or 2nd are normally used, but it may be appropriate to use another one in extreme cases.

**Note:** When the vehicle is heavily loaded, 1st or 2nd **must be** used. Otherwise, the clutch will be subjected to excessive wear.

It may sometimes be necessary to start in a gear other than the one programmed. This can be done, irrespective of whether the driving mode selector is set to A or M. Simply move the driving mode selector to the side until the required gear is shown on the display. The vehicle can now be started. The ordinary starting gear remains programmed in the control unit memory. More information can be found in the driver's manual.

## Kick-down

By pressing the throttle pedal from full throttle to kick-down, the gear changing points are raised, usually causing faster downshift.

## Auxiliary brake system

See "Engine brake program".

### EDC Cruise control

When driving with the cruise control, the system automatically change gear if the driving mode selector is set to A. It is however still possible to manually control gear selection in both positions A and M, without disengaging the cruise control.

If the driving mode selector is set to N when the vehicle is being driven with the cruise control activated, engine speed is increased to high idling (i.e. the engine surges). The driver should therefore disengage the cruise control before setting the driving mode selector to N.

The cruise control is disengaged using the clutch pedal, brake pedal, retarder lever, cruise control OFF button or the exhaust brake switch on the cab floor.

### ABS/TC

The Opticruise control unit communicates with the ABS/TC system. If there is wheel lock (causing ABS control) or spin (causing TC control), the Opticruise is very reluctant to change gear and does so according to special criteria. When the driving mode selector is set to A, the Opticruise endeavours to maintain the engaged gear.

### Power take-offs

The control unit is configured for two types of power take-off, PTO EK/ED and PTO EG.

PTO EK/ED provides torque compensation and therefore very smooth gear changing if the vehicle is driven with an engine-driven power take-off engaged (Max. compensation 200 Nm).

If the ED120 is used to drive a hydraulic pump, there may be a lack of space around the longitudinal stroke cylinder. If this is the case, turn the longitudinal stroke cylinder the other way and move the compressed air couplings so that they swap places.

PTO EG is for gearbox-driven power take-offs. If the vehicle is driven with this input signal active, all gear changing is blocked. The text PTO also flashes on the display if the vehicle is driven above a certain speed.

## Miscellaneous

### Control unit configuration

The control unit contains all programming necessary for a number of different Scania versions. So that the control unit fits each Scania, it must first be configured so that it uses the correct program for the particular vehicle. This is equivalent to the code plug in other (less modern) control units, such as for CAG.

The required configuration is fed into the control unit at manufacture using a PC. Configuration may be changed later by qualified personnel.

Configuration must contain the following information:

- Vehicle category (e.g. truck)
- Chassis number
- Part No. for control unit software
- Gearbox type
- Engine type and version
- Rear axle ratio
- Wheel rolling radius
- End-of-line data (date, signature)

### Power supply and fuses

Generally, Opticruise continues to work if a fuse blows while the vehicle is being driven. It may, however, be impossible to start the system the next time.

The control unit is protected by two fuses:

- Fuse 41 is used for 30 supply.
- Fuse 5 is used for 15 supply.

Power to the control unit is usually interrupted using the starter switch. What happens then is that control unit 15 supply to pin 55 is broken. When this happens, important data is transferred from the RAM to the EEPROM and stored there until the next start. The control unit then goes into rest state, despite the fact that 30 supply from the batteries is still applied to pin 19.

- If fuse 41 for 30 supply blows, or if a battery cable is removed, data cannot be transferred from the RAM to the EEPROM and be stored. The control unit "forgets" any newly-programmed starting gear as well as new fault codes.
- If fuse 5 for the 15 supply blows, data is transferred as normal from RAM to EEPROM and stored there. In this situation, the control unit believes that the starter key has been set to position 0. This means that it is not possible to restart Opticruise until the fault has been corrected.

### Interaction with other systems

*The figure opposite shows which other systems are connected to Opticruise and in which directions data is transferred.*

**Any faults are transmitted in the same direction.** This means that a fault in the ABS/TC system can manifest itself in the Opticruise system, but not vice versa.

Where appropriate, the figure applies to all optional equipment affected.

- The Opticruise is coupled to the EDC system to enable synchronous control of the speed of the gearbox input and output shafts. The particular gear change does not take place until these speeds correspond with each other.

The communication between the Opticruise and the EDC covers a wide range of data, such as engine speed, requested and actual torque, throttle pedal position, coolant temperature and cruise control.

Communication is via two CAN leads and is for such things as executing engine-controlled gear changing and determining which gear should be selected at any particular time.

- The Opticruise is coupled to the ABS/TC system to receive information on ABS control, TC control, wheel speeds etc.

The communication between Opticruise and ABS/TC is used for confirming such things as the suitability of the gear selection. If the wheels are spinning or slipping, Opticruise would be “fooled” into selecting the wrong gear. The speed of each wheel is also used to check that other speed signals appear plausible.

Communication is via the two CAN leads.

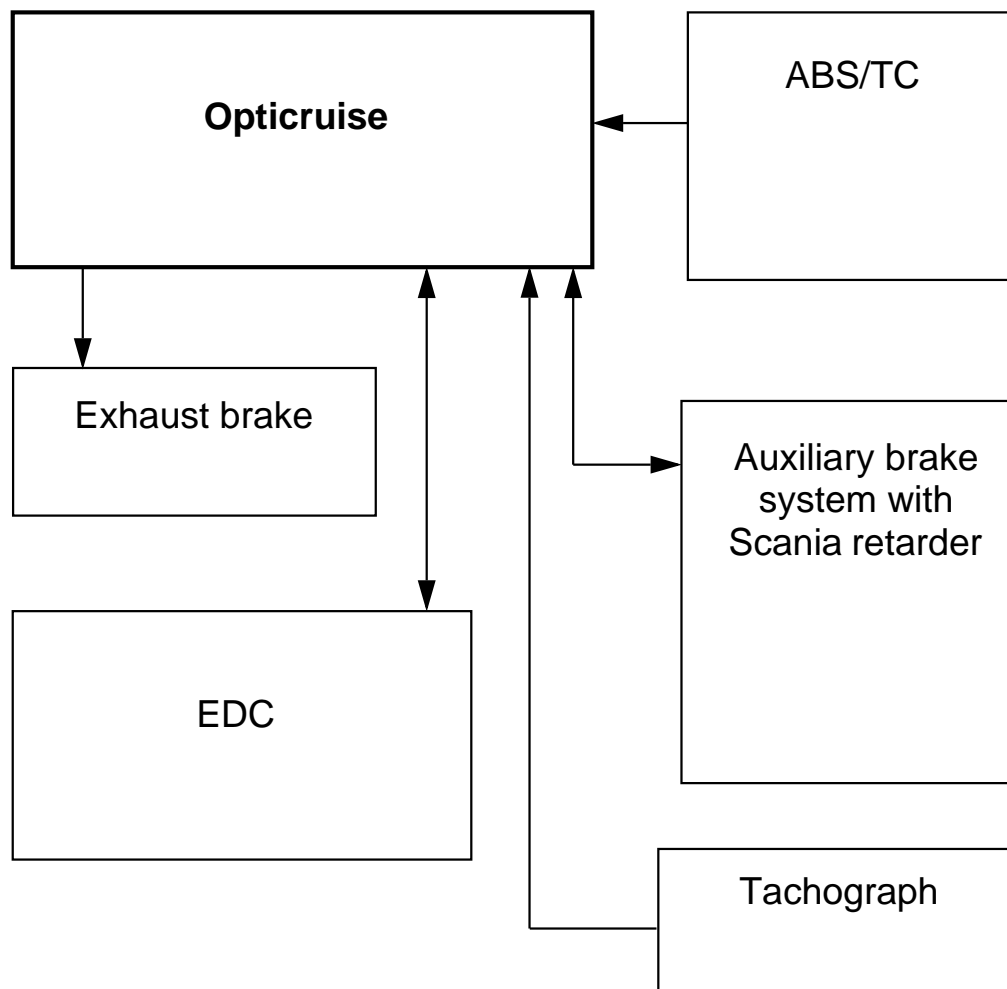
- Opticruise is coupled to the auxiliary brake system to make it possible to engage the engine brake program to optimize the retarder and achieve maximum braking power in kW.

When the auxiliary brake has requested the exhaust brake to retard the vehicle, the Opticruise will still be able to control the exhaust brake for gear changing.

When the gear change is complete, the exhaust brake will again be used to retard the vehicle. Prioritization of the various tasks of the exhaust brake is controlled by the exhaust brake control unit (EEB).

If the vehicle has an auxiliary brake, the Opticruise forwards the speed signal from the speed sensor on the gearbox output shaft to the auxiliary brake control unit.

- Opticruise is connected to the tachograph so that it can use the speed information from this to check that other speed signals are reasonable.



*Signal paths between the Opticruise control unit and other computer-controlled systems that may be in the vehicle.*

*Any faults are transferred from one system to another in the same direction as communication (see arrows).*

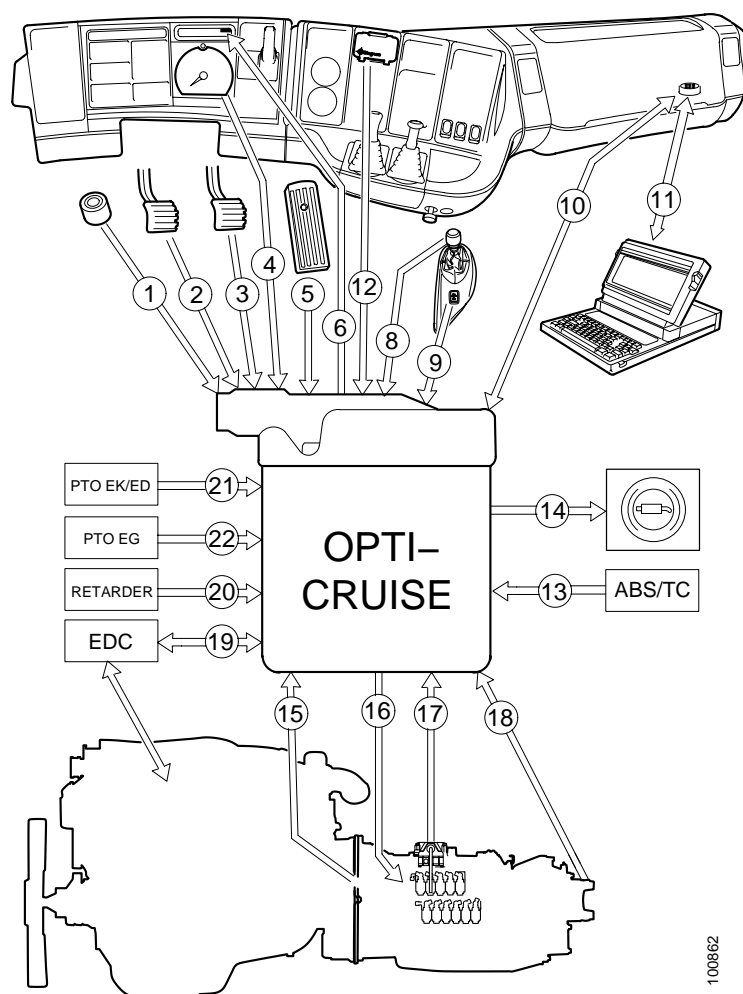
### Opticruise, design

*Item numbers refer to the drawing opposite.*

- 1 The floor switch is used to activate the engine brake program and exhaust brake. In vehicles with no auxiliary brake, the exhaust brake is used in combination with the engine brake program when the floor switch is held down. The signal goes via the auxiliary brake control unit if the vehicle has this. Also see point 14.
- 2 Two switches provide data on the position of the clutch pedal (released, partly or fully depressed).
- 3 EDC informs the control unit that the driver is braking. The engine brake program then uses slightly shifted upshift points.
- 4 The tachograph provides a speed signal which Opticruise compares with the other speed signals. These come from ABS/TC and the gearbox output shaft.
- 5 The throttle pedal sensor provides data on requested throttle and kick-down. The potentiometer signal goes via the EDC control unit.
- 6 The gear indicator with display and buzzer is used to display driving program, which gear is engaged, fault messages etc.
- 8 The driving mode selector informs the control unit about requested driving mode and if the driver wants to actuate the automatic system by commanding a change up or down.
- 9 The program selector has two positions. The Normal position provides optimum fuel economy and the box changes gear calmly and comfortably. The Hill mode provides a faster gear changing cycle at higher engine speed.
- 10 Diagnostic socket for PC via interface (Scania VCI).
- 11 PC with Scania Diagnos 2 fault tracing program provides the fastest result when fault tracing.
- 12 The diagnostic switch is used to activate the test program built into the control unit and for erasing fault codes.
- 13 Opticruise receives information from ABS/TC on speed, slip and possible wheel spin in order to select the correct gear at any moment. In addition, Opticruise must be able to prevent gear change if the drive wheels lose grip. This is for safety.
- 14 Opticruise uses the exhaust brake to adapt engine speed during certain gear changing procedures, but the exhaust brake is normally used to brake the vehicle.

The exhaust brake control unit prioritizes requests depending on driving conditions. The exhaust brake can be activated automatically, manually or by the auxiliary brake control unit.
- 15 The engine speed sensor is used to be able to synchronize the speeds of the gearbox input and output shafts when changing gear. The signal goes via the EDC and through the communications circuit.
- 16 The solenoid valves on the gearbox carry out each gear change by releasing compressed air to the longitudinal and lateral stroke cylinders. In turn, the cylinders activate the gear selector shaft.
- 17 The hall effect sensor and the confirmation switches monitor and confirm gear changing movement.

The drawing below is general and applies to all optional equipment affected. Only relevant sections apply to vehicles with less equipment.



- 18 The speed sensor on the gearbox output shaft is used to calculate vehicle speed and to confirm other speed signals from ABS/TC and the tachograph. A corresponding output signal is relayed to the auxiliary brake control unit.
- 19 Control of engine torque and speed is requested by Opticruise but carried out by EDC. Just when Opticruise is controlling the engine, the control unit continuously checks that actual torque corresponds to the requested level.
- 20 The auxiliary brake system control unit can request Opticruise to activate the engine brake program.
- 21 PTO EK/ED provides torque compensation during engine-controlled gear changing and therefore an excellent level of comfort if the vehicle is driven with an engine-driven power take-off engaged.
- 22 PTO EG is for gearbox-driven power take-offs. When this input signal is active, all gear changing is blocked and the clutch cannot be used.

**Warning system**

The control unit takes various action in the case of faults. This is to prevent the fault having expensive consequences. For example, the control unit has two different emergency gear changing programs. The first of these still provides good drivability while the second requires more from the driver. The intention of this is that minor faults should not cause too much inconvenience.

CLU MODE

C

NORMAL

FAILURE

Certain types of less-serious fault cause the control unit to switch from normal operation to the simpler of the two emergency gear changing programs. The text "CLU MODE" (clutch mode) is shown on the gear indicator display. In this case, the driver is required to use the clutch for each gear change. While the control unit is working in this mode, the letter C will be displayed near the left of the display.

If the fault disappears on its own, the control unit immediately returns to normal operation. The display then shows "NORMAL".

In the case of more serious faults, "FAILURE" is displayed. If this happens when driving, the control unit locks the engaged gear. This gear alone is shown on the display. The driver must then stop the vehicle and activate the "LIMPHOME" emergency gear changing program. This process is described in detail in the Opticruise driver's manual.

**Fault code messages**

CHK CODE

ERROR1

ERROR2

CONFIG

When the driver switches off the power, the message "CHK CODE" is displayed if the control unit has stored any fault codes during driving. This message is repeated when the power is switched back on again.

"ERROR1" or "ERROR2" means that the control unit has supplied faulty signals or no signals to the display. A PC must be used to read any fault codes.

"CONFIG" means that the configuration of the control unit is not correct. In this case, change the configuration of the control unit using a PC and Scania Programmer.



## Reading fault codes

Fault codes are read in the first part of the Opticruise test program. This test program is described in full on pages 59 - 69 of this booklet.

However, describing how to read fault codes would be a suitable introduction to the list of fault codes in the next chapter and the method is therefore also shown here.

- 1 Stop the vehicle and switch off the engine.
- 2 Switch on the power using the starter key. Wait for five seconds and then hold the diagnostic switch depressed for at least a half second. Release it. "TESTING" is shown on the display and the buzzer sounds.

TESTING



ECU NO

PROG NO

CHASSNO

F CODES

Do not touch the diagnostic switch for the moment. The test program has now started. All parts of the display light for one second and the buzzer sounds.

- 3 "ECU NO" is displayed, directly followed by the part number of the control unit hardware.
- 4 "PROG NO" is displayed, directly followed by the part number of the control unit software.
- 5 "CHASSNO" is displayed, directly followed by the vehicle chassis number.
- 6 "F CODES" is displayed, directly followed by any fault codes stored. More on this below.

- The fault codes are displayed one at a time, with two seconds between them.
- When all stored fault codes have been displayed, the buzzer sounds briefly. The stored fault codes are then displayed again. This may be repeated any number of times, so there is no danger if you should lose concentration.

E010 003

A

B

The display can, for example, look like the figure to the left. A shows the number of the fault code (10 in this case) and B shows how many times this fault code has been registered (3).

- 7 Make a note of the fault codes. Run through the test program. Press the diagnostic switch to switch between the various stages of the test. See pages 59 - 69.

### Erasing fault codes

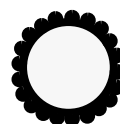
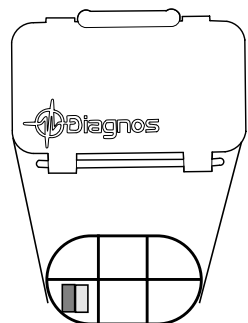
It may be necessary to reset the warning system every now and then. Someone may, for example, have unplugged a cable while the power was switched on. This can easily happen and the control unit will then believe that a genuine fault has arisen.

The warning system is either reset using the diagnostic switch, concealed behind the cover on the instrument panel, or using a PC connected to the vehicle's diagnostic socket in the central electric unit.

Fault codes are extremely useful in the workshop as they facilitate fault diagnosis.

- In the driver's manual, there is an explanation of how to erase fault codes. However, it is also advised that they should not be erased unnecessarily and that it is preferable, if possible, to seek advice at a workshop.

The symbols for the various switches are on the inside of the lid. These can be seen when the lid is opened. The Opticruise symbol is shown to the right.



When the warning system is reset, all fault codes are erased. Proceed as follows:

- 1 Switch off the power using the starter key.
- 2 Press the diagnostic switch and hold it down. Switch on the power.
- 3 The buzzer gives a short signal. When the text "ERASED" is displayed, erasure is complete.

**ERASED!**

# Fault codes

## General

The control unit acts fast and accurately, according to certain instructions. It has no imagination and no judgement. When it discovers a fault, or anything it interprets as abnormal, it reacts immediately and generates fault codes. The warning system is capable of generating around 70 different fault codes.

Despite the advanced and "farsighted" software, a fault can arise which the control unit is unable to distinguish from something which might happen during normal operation. If this is the case, no fault code is generated. There is always a limit to how complete monitoring can be. This applies to all types of control unit.

## Limitations

It is not only "genuine" faults that lead to the generation of fault codes. It is sufficient that someone has unplugged a cable while the power was on. This can easily happen and the control unit will then believe that a fault has arisen.

As for cases of loose contact, the fault may no longer be present, but the fault code is stored in the control unit memory until it is erased. It is at least possible then to see which circuit the fault was in and look for the cause there, even if there is currently no fault.

## Faults that do not generate fault codes

The following are the faults which do not cause a fault code to be generated that we are aware of at the time of going to press.

- Fuse 5 blown (15 supply).
- Break in the diagnostics switch circuit.
- Break in the floor switch circuit.
- Break or continuous signal from program selector (Normal/Hill).
- Break in circuit to the exhaust brake control unit. Fault code 14 is generated in some, but not all, cases.
- Break to gear indicator.
- Broken lamp in gear indicator.

### Explanations

Several new terms are used in the fault code list or in the connection diagram in group 16. These terms are explained below.

**EEPROM:** Stands for electrically erasable programmable read only memory. Memory is retained, even if power is broken using the starter key. The contents can be erased and updated during service, using a PC and Scania Programmer.

This memory contains the control unit configuration, programmed starting gear, any fault codes etc.

**FLASH memory:** This memory contains the complete basic programming of the control unit. The content remains, even if power is switched off using the starter key. The basic program can be changed during service using a PC connected to the diagnostic socket.

**RAM:** Stands for random access memory. The content disappears every time the power is switched off using the starter key or if power is lost for any other reason.

This memory stores and processes the various control unit driving data from such things as sensors, controls and adjacent systems (EDC, ABS and the retarder).

**CAN:** Stands for controller area network. CAN communication is used to reduce the number of cables in the vehicle. This is intended to increase reliability.

Vehicles with Opticruise have a communications circuit consisting of two cables, CAN high (pin 38) and CAN low (pin 20).

In simple terms, CAN communication can be likened to radio technology. Data signals through a CAN cable can be likened to radio waves through the air.

When listening to the radio, the receiver is set so that one radio station is heard at one time. This is the only station that can be heard, despite the fact that there are many radio stations broadcasting at the same time.

A control unit does more or less the same thing with the data coming through a CAN cable. It listens for things such as information from EDC on coolant temperature, receives this value and uses it in calculations.

The control unit receives all CAN signals that are sent through the communications circuit in a special memory. This memory can be likened to a number of radio receivers, set to different radio stations in order to hear several, particular radio programmes at the same time. In this way, the control unit always knows what is happening.

This is nothing that a mechanic needs to worry about. The only thing to remember is that it is not possible to check CAN signals using a multimeter. This is not even necessary as we have precise fault codes.

**Fault code 1**

**Fault:** Fault in integrated control unit memory.

**Cause:** Test calculation of content of FLASH memory did not provide the result the control unit was expecting.

**Comment:** FLASH memory itself contains basic control unit program. The control unit checks that the FLASH memory is working as follows. All memory addresses are added together to provide a sum. This sum is then used in a test calculation which must provide the "correct answer". Otherwise, this fault code is generated.

**Action:** Change control unit.

**Fault code 2**

**Fault:** Fault in integrated control unit memory.

**Cause:** Test calculation of content of EEPROM memory did not provide the result expected by the control unit.

**Comment:** EEPROM memory contains the configuration of the control unit. Configuration controls which parts of the basic program are used for the particular vehicle. When the control unit checks that the EEPROM memory is working, the following happens. All values that are important for configuration are added up to a sum. This sum is then used in a test calculation which must provide the "correct answer". Otherwise, this fault code is generated.

**Action:** Correctly configure the control unit using a PC. If this does not help, change the control unit.

**Fault code 3**

**Fault:** Fault in integrated control unit memory.

**Cause:** The control unit's test of the RAM has shown that some of the memory cells are not working properly.

**Comment:** The RAM is the actual working memory of the control unit. It is here that all calculations are made.

When the control unit checks that the RAM is working properly, the following happens. Firstly, the control unit writes certain values into the RAM and then reads these same values to check that they have not become confused. If the control unit interprets any deviation, this fault code is generated.

**Action:** Change control unit.

### Fault code 4

**Fault:** Break or short in circuit for UX supply.

**Cause:** Control unit has detected that power consumption from pin 36 on the control unit (the so-called UX feed, +24V) is either too low or too high.

**Comment:** The control unit gives UX supply on pin 36 to supply the sensors, controls and display with power. The UX supply enables the control unit to sense both open and short circuits as they cause abnormal power consumption. It is this abnormal power consumption from pin 36 which causes fault code 4 to be generated.

Open circuit: The circuit consumes no current. Short circuit: The circuit consumes high current.

In order for the fault code to be regenerated, power consumption must suddenly change, due to something such as loose contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the UX supply.

High current in the UX circuit can be caused by such things as shorted sensors.

**Action:** Check the UX circuit, wiring and components.

### Fault code 5

**Fault:** Fault in voltage supply in control unit.

**Cause:** Control unit could not confirm its own internal U15 supply when the driver switched on the power using the starter key.

**Comment:** The control unit started working when the power was switched on, despite it not being possible to confirm U15 supply in the test circuit monitoring this.

When this fault arises, it is not possible for the EEPROM to store new information. This means that the control unit "forgets" any newly-programmed starting gear, and any newly-generated fault codes. The number of faults is displayed as 1, even if there are several. It is possible to drive the vehicle, but it should be repaired as soon as possible as certain safety features may be jeopardized.

**Action:** Change control unit.

## Fault code 7

**Fault:** Fault in monitoring feature inside control unit.

**Cause:** The integrated watchdog relay does not activate when the control unit starts working, or this relay is already activated when the driver switches on the starter power (this should not be the case).

**Comment:** The control unit has detected a malfunction in one of its internal safety features. Each malfunction of this type causes the watchdog relay to alarm, generating fault code 7.

If the watchdog relay does not activate, power supply is lost to all control unit outputs. Not even the starter gear can be engaged, making the vehicle unusable.

**Action:** Change control unit.

## Fault code 14

**Fault:** Not possible to regulate engine speed to correct level when changing gear.

**Cause:** The control unit has received a message from the EDC via the communications circuit (pins 20 and 38) which indicated an incorrect response from the engine. The exhaust brake may have been activated during gear changing without the Opticruise requesting this.

**Comment:** Requested torque exceeds permitted value for engine-controlled gear changing when the gearbox has been confirmed to be in neutral. This can happen if a gear is engaged when the control unit is not expecting it. A possible cause of this might be the slider in the gearbox breaking. If this fault arises, the driver must use the clutch for every gear change. CLU\_MODE is displayed.

**Action:** Start by checking the sensor signals for gear position and then the gearbox itself.

## Fault code 15

**Fault:** EDC gives a torque which does not correspond to the requested torque.

**Cause:** When the Opticruise control unit requested a particular torque via the communications circuit (pins 20 and 38), EDC responded with a response which Opticruise considered to indicate impossible values.

*Continued >*

**Comment:** Requested torque from Opticruise is "translated" in this manner to actual control rack position in the injection pump. The Opticruise control unit continuously checks that each response of this type from EDC corresponds with the expected result. If this fault arises, the driver has to use the clutch whenever changing gear. CLU\_MODE is displayed.

**Action:** Check whether the EDC control unit has generated any fault codes. Check that the EDC control unit has the correct part number. Check connectors and wiring. End by checking the position of the control rack in the injection pump.

### Fault code 19

**Fault:** NO signal or impossible signal from driving mode selector.

**Cause:** The control unit has received a signal on at least two of pins 10, 11, 28, 29, 47 and 48 at the same time, or there is no signal at all from the driving mode selector. These signals are provided with UX voltage (+24V).

**Comment:** These signals are impossible as the driving mode selector can only be in one position at a time.

If this fault arises, the control unit does not "obey" the driving mode selector. Either there is no signal at all, or the control unit has received conflicting signals in one of the following combinations:

Upshift and downshift at the same time (pins 10 and 28).

Reverse and automatic position at the same time (pins 48 and 29).

Reverse and manual position at the same time (pins 48 and 47).

Neutral and manual position at the same time (pins 11 and 47).

*Continued >*



**Action:** Check the driving mode selector, connectors and wiring. Use wiring diagrams and a multimeter to check the driving mode selector.

## Fault code 22

**Fault:** Impossible signals from clutch switches.

**Cause:** Control unit has sensed that pin 8 received a signal when there was no signal on pin 45.

**Comment:** The lower clutch pedal switch has been closed despite the upper clutch pedal switch not being closed. It should not be possible for something like this to happen when driving.

When these switches are activated, they are closed to system earth (0V).

The gearbox cannot change gear automatically if this fault has arisen. The vehicle can, however, be operated using the LIM-PHOME emergency gear changing program.

**Action:** Check both clutch pedal switches, connectors and wiring.

## Fault code 23

**Fault:** Uninterrupted signal from the lower clutch pedal switch.

**Cause:** Control unit has sensed that there was a signal for too long on pin 8.

**Comment:** The clutch pedal switch cannot be closed for this long when driving normally.

When this switch is activated, it is closed to system earth (0V).

The gearbox cannot change gear automatically if this fault has arisen. The vehicle can, however, be operated using the LIM-PHOME emergency gear changing program.

**Action:** Check the lower clutch pedal switch, connectors and wiring.

### Fault code 24

**Fault:** Uninterrupted signal from upper clutch pedal switch.

**Cause:** Control unit has sensed that the signal remained for too long on pin 45.

**Comment:** The clutch pedal switch cannot be closed for this long when driving normally, unless the driver rests his foot on the clutch pedal when driving.

When this switch is activated, it is closed to system earth (0V).

The gearbox cannot carry out engine-controlled gear changing in manual position if this fault arises.

**Action:** Check the upper clutch pedal switch, connectors and wiring.

### Fault code 26

**Fault:** Uninterrupted signal from floor switch for engine brake program.

**Cause:** Control unit has sensed that the signal remained for too long on pin 27.

**Comment:** The floor switch cannot be closed for this long during normal driving.

When this switch is activated, it is closed to +24V. Note that the signal to pin 27 does not always come from the floor switch. The retarder control unit can also send the same signal.

If this fault arises, the control unit is forced to use the engine brake program.

**Action:** Check the floor switch, connectors and wiring. Check if there are any fault codes stored in the retarder control unit (if the vehicle has a retarder).

## Fault code 27

**Fault:** Uninterrupted signal from diagnostic switch.

**Cause:** Control unit has sensed that the signal remained for too long on pin 30.

**Comment:** It is not possible for the diagnostic switch to be depressed this long during normal use.

When this switch is activated, it is closed to system earth (0V).

If this fault arises when the driver switches on the power, all fault codes that can be shown on the display will be erased. It may also be impossible to start the test program.

**Action:** Check the diagnostic switch, connectors and wiring.

## Fault code 28

**Fault:** Impossible deviation, vehicle speed compared to tachograph.

**Cause:** The control unit has sensed that the difference in frequency between the signals to pins 31 and 49 (which together generate a frequency in the control unit) and the signal to pin 32 is too great.

**Comment:** The difference between the signal from the inductive speed sensor on the gearbox output shaft and the tachograph signal from the combined instrument was greater than permitted.

**Action:** Check the road speed sensor on the gearbox output shaft, the tachograph signal, connectors and wiring.

### Fault code 31

**Fault:** Defective contact or loss of signal, vehicle speed sensor.

**Cause:** Control unit has sensed that the signals on pin 31 and/or pin 49 are too uneven.

**Comment:** Speed signal from the inductive road speed sensor on the gearbox output shaft has varied more than permitted. Speed must exceed a certain limit for the control unit to register this fault.

**Action:** Check the road speed sensor on the gearbox output shaft, connectors and wiring.

### Fault code 34

**Fault:** Break or short circuit, vehicle speed sensor.

**Cause:** Power consumption too low or too high on pin 31 and/or 49.

**Comment:** This fault can either be due to a break in the wiring or in the actual sensor, or to a cable being shorted to chassis earth or +24V. In this case, the control unit cannot feel that the sensor in question is connected.

**Action:** Check the road speed sensor on the gearbox output shaft, connectors and wiring.

### Fault code 36

**Fault:** Gear changing movement forward on the left-hand side commanded but not confirmed.

**Cause:** No confirmation for forward longitudinal stroke (pin 43) on the left-hand side (pin 42), despite several attempts to activate the solenoid valves which release the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

*Continued >*

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is reaching the solenoid valves. Then check that the confirmation signals from the hall effect sensors are transmitted correctly. Check the solenoid valves for forward longitudinal stroke and left-hand lateral stroke, connectors and wiring.

## Fault code 37

**Fault:** Gear changing movement backward on left-hand side ordered but not confirmed.

**Cause:** No confirmation for rearward longitudinal stroke (pin 6) on left-hand side (pin 42), despite several attempts to activate the solenoid valves which release the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is reaching these solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valves for rearward longitudinal stroke and left-hand lateral stroke, connectors and wiring.

## Fault code 38

**Fault:** Gear changing movement forward in centre position commanded but not confirmed.

**Cause:** No confirmation for forward longitudinal stroke (pin 43), despite several attempts to activate the solenoid valve which releases the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is getting to the solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valve for forward longitudinal stroke, connectors and wiring.

### Fault code 39

**Fault:** Gear changing movement rearward in centre position commanded but not confirmed.

**Cause:** No confirmation for rearward longitudinal stroke (pin 6), despite several attempts to activate the solenoid valve which releases the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is getting to the solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valve for rearward longitudinal stroke, connectors and wiring.

### Fault code 40

**Fault:** Forward gear changing movement on right-hand side ordered but not confirmed.

**Cause:** No confirmation for forward longitudinal stroke (pin 43) on right-hand side (pin 24), despite several attempts to activate the solenoid valves which release the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is getting to the solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valves for forward longitudinal stroke and right-hand lateral stroke, connectors and wiring.

## Fault code 41

**Fault:** Gear changing movement rearward on the right-hand side commanded but not confirmed.

**Cause:** No confirmation for rearward longitudinal stroke (pin 6) on right-hand side (pin 24), despite several attempts to activate the solenoid valves which release the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is getting to the solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valves for rearward longitudinal stroke and right-hand lateral stroke, connectors and wiring.

## Fault code 42

**Fault:** Gear changing movement to the left commanded but not confirmed.

**Cause:** No confirmation for left-hand lateral stroke (pin 42), despite several attempts to activate the solenoid valve which releases the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is getting to the solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valve for left-hand lateral stroke, connectors and wiring.

### Fault code 43

**Fault:** Gear changing movement to the right commanded but not confirmed.

**Cause:** No confirmation for right-hand lateral stroke (pin 24), despite several attempts to activate the solenoid valve which releases the compressed air.

**Comment:** The control unit counts both its own attempts and those of the driver to change gear.

**Action:** Start by checking the air hoses to the solenoid valves and that the correct air pressure is getting to the solenoid valves. Then check that the confirmation signals from the hall effect sensor are transmitted correctly. Check the solenoid valve for right-hand lateral stroke, connectors and wiring.

### Fault code 44

**Fault:** Gear changing movement laterally towards the centre position requested but not confirmed.

**Cause:** The control unit has sensed that a confirmation signal for lateral stroke to the left (pin 42) or a lateral stroke to the right (pin 24) is still present.

**Comment:** When the confirmation signal for the lateral neutral position exceeds 10 V and no solenoid valve is activated, a time count is initiated which then stops when the confirmation signals for lateral stroke are no longer present. This fault code is generated if the time count is not completed within a predetermined time.

**Action:** Start by checking the air lines to the solenoid valves and check that the correct air pressure is reaching the solenoid valves. Then check that the confirmation signals from the Hall-effect sensor are correctly received. Check the venting of the solenoid valves for left and right-hand lateral stroke, the return springs, connectors and wiring.



## Fault code 45

**Fault:** Loss of confirmation, forward stroke.

**Cause:** Control unit has sensed the sudden loss of confirmation signal on pin 43.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check the hall effect sensor, connectors and wiring.

## Fault code 46

**Fault:** Loss of confirmation, rearward stroke.

**Cause:** Control unit has sensed the sudden loss of confirmation signal on pin 6.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check the hall effect sensor, connectors and wiring.

### Fault code 47

**Fault:** Loss of confirmation, right-hand lateral stroke.

**Cause:** Control unit has sensed the sudden loss of confirmation signal on pin 24.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check the hall effect sensor, connectors and wiring.

### Fault code 48

**Fault:** Loss of confirmation, left-hand lateral stroke.

**Cause:** Control unit has sensed the sudden loss of confirmation signal on pin 42.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check the hall effect sensor, connectors and wiring.

### Fault code 49

**Fault:** Loss of confirmation, neutral position.

**Cause:** Control unit has sensed the sudden loss of confirmation signal on pin 7.

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**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check the hall effect sensor, connectors and wiring.

## Fault code 50

**Fault:** No confirmation, neutral position.

**Cause:** Control unit has not received confirmation signal on pin 7 to confirm that the commanded gear change has been carried out.

**Comment:** When the solenoid valve for neutral is activated, time measurement starts which is interrupted when the confirmation signal for neutral position exceeds 10 V. This fault code is generated if time measurement is not carried out within a preset time.

This fault code can only be generated when vehicle speed is greater than 5 km/h or when the clutch pedal is fully depressed.

**Action:** Check control cylinders, solenoid valve for neutral position, compressed air lines, hall effect sensors, connectors and wiring.

## Fault code 51

**Fault:** Continuous confirmation signal, neutral position.

**Cause:** Control unit has sensed that the confirmation signal remained for too long on pin 7.

**Comment:** Confirmation signal may not remain too long after the command for forward longitudinal stroke or rearward lateral stroke has been given. This fault code can be generated if the gearbox is binding, for example in severe cold.

**Action:** Check control cylinders, solenoid valves, compressed air lines, hall effect sensors, connectors and wiring.

### Fault code 52

**Fault:** Impossible confirmation (impossible gear positions).

**Cause:** Simultaneous confirmation from several gears at the same time.

**Comment:** The signals are impossible because the Hall-effect sensor and the confirmation switches should only be able to confirm one gear changing movement at a time.

Any of the following confirmations have come at the same time:

Neutral and forward confirmation (pin 7 and pin 43)

Neutral and rear confirmation (pin 7 and pin 6)

Forward and rear confirmation (pin 43 and pin 6)

Right and left confirmation (pin 24 and pin 42)

Low range and high range confirmation (pin 41 and pin 5)

Low split and high split confirmation (pin 4 and pin 23).

**Action:** Check hall effect sensors, confirmation switches, connectors and wiring.

### Fault code 53

**Fault:** Gear changing movement to low range commanded but not confirmed.

**Cause:** No signal on pin 41.

**Comment:** No confirmation for low range, despite several attempts to activate the solenoid valve which releases compressed air. Each gear changing attempt must take a certain time in order to be counted.

**Action:** Check control cylinders, confirmation switches, the low range solenoid valve, compressed air lines, connectors and wiring.

**Fault code 54**

**Fault:** Gear changing movement towards high range commanded but not confirmed.

**Cause:** No signal on pin 5.

**Comment:** No confirmation for high range, despite several attempts to activate the solenoid valve which releases compressed air. Each gear changing attempt must take a certain time in order to be counted.

**Action:** Check control cylinders, confirmation switches, the high range solenoid valve, compressed air lines, connectors and wiring.

**Fault code 55**

**Fault:** Gear changing movement towards low split commanded but not confirmed.

**Cause:** No signal on pin 4.

**Comment:** No confirmation for low split, despite several attempts to activate the solenoid valve which releases compressed air. Each gear changing attempt must take a certain time in order to be counted.

**Action:** Check control cylinders, confirmation switches, the low split solenoid valve, compressed air lines, connectors and wiring.

### Fault code 56

**Fault:** Gear changing movement to high split commanded but not confirmed.

**Cause:** No signal on pin 23.

**Comment:** No confirmation for high split despite several attempts to activate the solenoid valve which releases the compressed air. Each gear changing attempt must take a certain time in order to be counted.

**Action:** Check control cylinders, confirmation switches, the high split solenoid valve, compressed air lines, connectors and wiring.

### Fault code 57

**Fault:** Loss of confirmation, low range.

**Cause:** The control unit has sensed the sudden loss of confirmation signal on pin 41.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check confirmation switches, connectors and wiring.

**Fault code 58**

**Fault:** Loss of confirmation, high range.

**Cause:** The control unit has sensed the sudden loss of confirmation signal on pin 5.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check confirmation switches, connectors and wiring.

**Fault code 59**

**Fault:** Loss of confirmation, low split.

**Cause:** The control unit has sensed the sudden loss of confirmation signal on pin 4.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check confirmation switches, connectors and wiring.

### Fault code 60

**Fault:** Loss of confirmation, high split.

**Cause:** The control unit has sensed the sudden loss of confirmation signal on pin 23.

**Comment:** For the control unit to be able to check if the signal is lost, a complete gear change must first be completed. Five seconds after the control unit has received confirmation of the completed gear change, it starts to sense whether the confirmation signal continues to be transmitted as it should be. The control unit checks this until it commands the gearbox to carry out the next gear change. This fault code is generated if, for example, the gear is ejected mechanically.

**Action:** Check confirmation switches, connectors and wiring.

### Fault code 61

**Fault:** Solenoid valve for forward longitudinal stroke is live when it should not be.

**Cause:** Control unit output to solenoid valve for forward longitudinal stroke has been powered without the control unit commanding this.

**Comment:** This fault code is generated if the control unit output for the solenoid valve in question has been powered for the wrong reason, for example due to a short circuit to +24 volts (e.g. in wiring). Otherwise, there is a fault in the control unit itself.

**Action:** Disconnect the cable from pin 3 and measure using a multimeter. Then check connectors and wiring.



## Fault code 62

**Fault:** Solenoid valve for rearward longitudinal stroke is powered when it should not be.

**Cause:** Control unit output to solenoid valve for rearward longitudinal stroke has been powered despite the fact that control unit has not commanded this.

**Comment:** This fault code is generated if the control unit output for the solenoid valve in question has been powered for the wrong reason, for example due to a short circuit to +24 volts (e.g. in wiring). Otherwise, there is a fault in the control unit itself.

**Action:** Disconnect the cable from pin 22 and measure using a multimeter. Then check connectors and wiring.

## Fault code 63

**Fault:** Solenoid valve for neutral position is powered when it should not be.

**Cause:** Control unit output to the solenoid valve for neutral position has been powered despite the control unit not commanding this.

**Comment:** This fault code is generated if the control unit output for the solenoid valve in question has been powered for the wrong reason, for example due to a short circuit to +24 volts (e.g. in wiring). Otherwise, there is a fault in the control unit itself.

**Action:** Disconnect the cable from pin 40 and measure using a multimeter. Then check connectors and wiring.

### Fault code 64

**Fault:** Solenoid valve for low range is powered when it should not be.

**Cause:** Control unit output to solenoid valve for low range has been powered despite the control unit not commanding this.

**Comment:** This fault code is generated if the control unit output for the solenoid valve in question has been powered for the wrong reason, for example due to a short circuit to +24 volts (e.g. in wiring). Otherwise, there is a fault in the control unit itself.

**Action:** Disconnect the cable from pin 39 and measure using a multimeter. Then check connectors and wiring.

### Fault code 65

**Fault:** Break or short in circuit to solenoid valve for forward longitudinal stroke.

**Cause:** Power consumption too low or too high from pin 3 on the control unit.

**Comment:** When the solenoid valve for forward longitudinal stroke is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for forward longitudinal stroke, connectors and wiring.

## Fault code 66

**Fault:** Break or short in circuit to solenoid valve for rearward longitudinal stroke.

**Cause:** Power consumption too low or too high from pin 22 on the control unit.

**Comment:** When the solenoid valve for rearward longitudinal stroke is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for rearward longitudinal stroke, connectors and wiring.

## Fault code 67

**Fault:** Break or short in circuit to solenoid valve for right-hand lateral stroke.

**Cause:** Power consumption too low or too high from pin 17 on the control unit.

**Comment:** When the solenoid valve for right-hand lateral stroke is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for right-hand lateral stroke, connectors and wiring.

### Fault code 68

**Fault:** Break or short in circuit to solenoid valve for left-hand lateral stroke.

**Cause:** Power consumption too low or too high from pin 53 on the control unit.

**Comment:** When the solenoid valve for left-hand lateral stroke is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for left-hand lateral stroke, connectors and wiring.

### Fault code 69

**Fault:** Break or short in circuit to solenoid valve for neutral position.

**Cause:** Power consumption too low or too high from pin 40 on the control unit.

**Comment:** When the solenoid valve for neutral position is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for neutral position, connectors and wiring.

## Fault code 70

**Fault:** Break or short in circuit to solenoid valve for low range.

**Cause:** Power consumption too low or too high from pin 39 on the control unit.

**Comment:** When the solenoid valve for low range is activated, the control unit can sense the following cases.

Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for low range, connectors and wiring.

## Fault code 71

**Fault:** Break or short in circuit to solenoid valve for high range.

**Cause:** Power consumption too low or too high from pin 54 on the control unit.

**Comment:** When the solenoid valve for high range is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for high range, connectors and wiring.

### Fault code 72

**Fault:** Break or short in circuit to solenoid valve for low split.

**Cause:** Power consumption too low or too high from pin 2 on the control unit.

**Comment:** When the solenoid valve for low split is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for low split, connectors and wiring.

### Fault code 73

**Fault:** Break or short in circuit to solenoid valve for high split.

**Cause:** Power consumption too low or too high from pin 18 on the control unit.

**Comment:** When the solenoid valve for high split is activated, the control unit can sense the following cases. Break: Circuit not consuming any current. Short circuit: Current in circuit too high.

For the fault code to be regenerated, power consumption must suddenly change, for example due to a defective contact. If the fault remains, the fault code is regenerated each time the control unit attempts to activate the solenoid valve in question.

High current can be caused by such things as shorted windings in the solenoid valve coil.

**Action:** Check the solenoid valve for high split, connectors and wiring.

## Fault code 75

**Fault:** Fault in power supply to control unit.

**Cause:** Control unit has sensed that there was no U30 power supply when the driver switched off the power with the starter switch.

**Comment:** The control unit has been switched off several times in a row without being able to store its data from the EEPROM. This may be because the control unit has been switched off with no U30 supply connected to the control unit. It may also be due to the control unit having been exposed to strong disturbance which has caused the integrated protective features in the control unit to act and restart it repeatedly.

**Action:** Check the fuse for U30 supply to the Opticruise control unit, connectors and wiring.

## Fault code 76

**Fault:** The EDC cannot provide a reliable value for throttle pedal position.

**Cause:** The control unit has received a message from EDC via the communications circuit (pins 20 and 38) which shows that the value from the throttle pedal sensor potentiometer is impossible.

**Comment:** In this case, the communications circuit itself is probably not faulty. Otherwise, the control unit would have generated a different fault code (fault code 82 or 83).

**Action:** Check whether there are any fault codes stored in the EDC control unit.

## Fault code 77

**Fault:** The EDC cannot provide a reliable value for current engine speed.

**Cause:** The control unit has received a message from EDC via the communications circuit (pins 20 and 38) which shows that the value from the engine speed sensor is impossible.

**Comment:** In this case, the communications circuit itself is probably not faulty. Otherwise, the control unit would have generated a different fault code (fault code 82 or 83).

**Action:** Check whether there are any fault codes stored in the EDC control unit.

### Fault code 78

**Fault:** The EDC cannot provide a reliable value for current vehicle speed.

**Cause:** The control unit has received a message from EDC via the communications circuit (pins 20 and 38) which shows that the value of the speed signal is impossible.

**Comment:** In this case, the communications circuit itself is probably not faulty. Otherwise, the control unit would have generated a different fault code (fault code 82 or 83).

**Action:** Check whether there are any fault codes stored in the EDC control unit.

### Fault code 79

**Fault:** The EDC cannot provide a reliable value for brake pedal position.

**Cause:** The control unit has received a message from EDC via the communications circuit (pins 20 and 38) which shows that the value from the brake pedal sensor is impossible.

**Comment:** In this case, the communications circuit itself is probably not faulty. Otherwise, the control unit would have generated a different fault code (fault code 82 or 83).

**Action:** Check whether there are any fault codes stored in the EDC control unit.

### Fault code 80

**Fault:** The EDC cannot provide a reliable value for coolant temperature.

**Cause:** The control unit has received a message from EDC via the communications circuit (pins 20 and 38) which shows that the value from the temperature sensor is impossible.

**Comment:** In this case, the communications circuit itself is probably not faulty. Otherwise, the control unit would have generated a different fault code (fault code 82 or 83).

**Action:** Check whether there are any fault codes stored in the EDC control unit.



**Fault code 81**

**Fault:** Fault in integrated control unit memory.

**Cause:** The control unit test of communications circuit memory has shown that some of the memory cells are not working properly.

**Comment:** The memory for the communications circuit is used as a buffer to store information from adjacent systems (such as EDC and ABS) and then to sort this information before it is used by Opticruise. The control unit starts by feeding specific values into the communications memory and then reads these same values to check that they have not become confused. If the control unit detects any deviation, this fault code is generated.

**Action:** Change control unit.

**Fault code 82**

**Fault:** Fault in communications circuit.

**Cause:** The control unit has sensed that the signal level in the communications circuit has been faulty. This indicates an open or short circuit somewhere beyond pins 20 and 38.

**Comment:** When the signal level fault has ceased, communication starts to work again with no further action.

**Action:** Check connectors and wiring. If these are not at fault, then the control unit is faulty, but there is not much chance of this.

**Fault code 83**

**Fault:** No communications signal from EDC control unit.

**Cause:** There has been an abnormally long delay in the expected signal from EDC via the communications circuit (pins 20 and 38).

**Comment:** The Opticruise control unit continuously receives information from the EDC control unit and "realizes" that communication is working properly. If this information is not present, fault code 83 is generated.

**Action:** Check to see whether there are any fault codes stored in the EDC control unit. Check connectors and wiring in the communications circuit.

### Fault code 84

**Fault:** No communications signal from ABS control unit.

**Cause:** There has been an abnormally long delay in the expected signal from ABS via the communications circuit (pins 20 and 38).

**Comment:** The Opticruise control unit continuously receives information from the ABS control unit and "realizes" that communication is working properly. If this information is not present, fault code 84 is generated.

**Action:** Check to see whether there are any fault codes stored in the ABS control unit. Check connectors and wiring in the communications circuit.

### Fault code 85

**Fault:** Impossible signal from throttle pedal kick-down switch.

**Cause:** Control unit has sensed a signal on pin 44, despite the throttle pedal not being fully depressed.

**Comment:** The kick-down switch closes to earth (0V). If a faulty analog value is received from the throttle pedal sensor, fault code 76 is generated, but the control unit cannot then generate fault code 85.

**Action:** Check whether there are any fault codes stored in the EDC control unit and if the Opticruise control unit has stored fault code 76. Check the kick-down switch in the throttle pedal sensor, connectors and wiring.

## Fault code 86

**Fault:** Incorrect gear ratio in gearbox.

**Cause:** The relationship between the speed of the input shaft and output shaft does not correspond to the gear engaged.

**Comment:** Input shaft speed is taken from the engine speed sensor. This means that the clutch must be fully released for speed comparisons to be made.

This fault code can be generated if the control unit has received confirmation that the clutch is released, but it is still slipping. The fault code can also be generated if there are faulty confirmation signals for gear position.

**Action:** Check if fault codes for gear positions or road speed sensors are stored. Check that the control unit is configured for the correct type of gearbox.

## Fault code 87

**Fault:** Impossible deviation, vehicle speed compared to speed signal from ABS.

**Cause:** Control unit has sensed too great a difference in frequency between the signals to pins 31 and 49 (which together generate a frequency in the control unit) and the signal to pins 20 and 38.

**Comment:** The difference between the signal from the inductive speed sensor on the gearbox output shaft and the speed signal from the ABS control unit was greater than permitted.

**Action:** Check the road speed sensor on the gearbox output shaft, fault codes in the ABS system, connectors and wiring.

---

## Fault code 88

**Fault:** Impossible deviation, tachograph compared to speed signal from ABS.

**Cause:** The control unit has sensed that the difference in frequency between the signals to pin 32 and the signal to pin 20 and 38 was too great.

**Comment:** The difference between the signal from the tachograph and the speed signal from the ABS control unit was greater than permitted.

**Action:** Check the tachograph, fault codes in the ABS system, connectors and wiring.

## Fault code 89

**Fault:** ABS cannot provide a reliable value for vehicle speed.

**Cause:** The control unit has received a message from ABS via the communications circuit (pins 20 and 38) that shows that the speed value is impossible.

**Comment:** In this case, the fault is unlikely to lie with the communications circuit. Otherwise, the control unit should have generated another code (fault code 82 or 84).

**Action:** Check whether there are any fault codes stored in the ABS control unit.

# Electrical system

## References to wiring diagrams

At the time of going to press, no wiring diagrams for the particular fault codes have been produced. We therefore refer to the connection diagram in Group 16 of the Workshop Manual.

### Connection diagram

Publication number: 16:04-21.

### Circuit diagrams

Publication number: No information.

## Control unit configuration

Configuration is briefly covered on page 11.

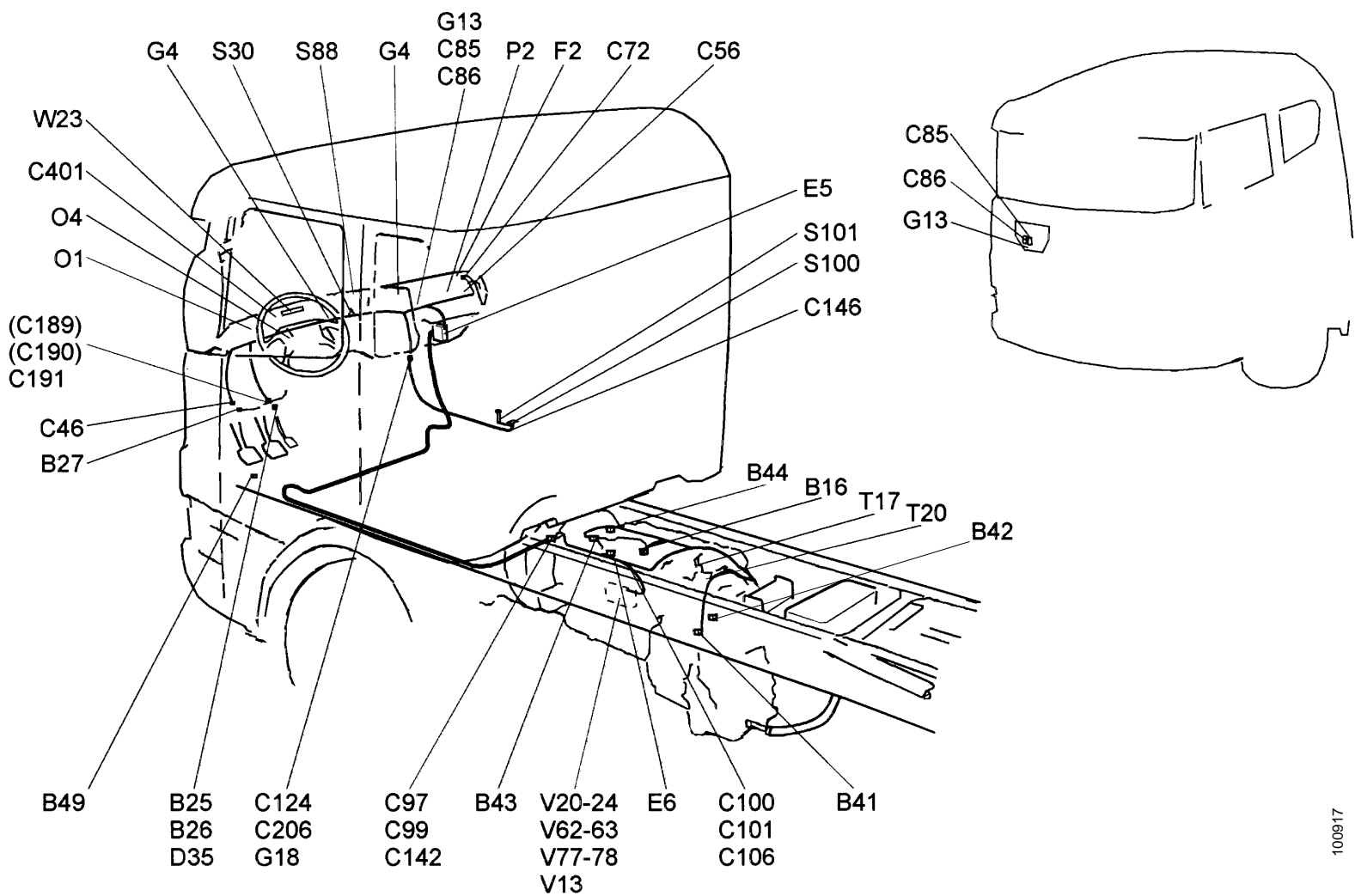
## Location of electrical components.

See overleaf.

**Location of electrical components**

<i>Item</i>	<i>Function</i>
<i>B16</i>	<i>Reversing lights</i>
<i>B25</i>	<i>Throttle actuation<sup>1</sup> (included in D35)</i>
<i>B26</i>	<i>Kick-down (included in D35)</i>
<i>B27</i>	<i>Clutch pedal fully depressed</i>
<i>B41</i>	<i>Confirmation, high range</i>
<i>B42</i>	<i>Confirmation, low range</i>
<i>B43</i>	<i>Confirmation, high split</i>
<i>B44</i>	<i>Confirmation, low split</i>
<i>B49</i>	<i>Exhaust brake and engine brake program</i>
<i>C46-</i>	
<i>C401</i>	<i>Connector</i>
<i>D18</i>	<i>Diode unit for EDC</i>
<i>D35</i>	<i>Throttle pedal sensor</i>
<i>E5</i>	<i>Control unit, Opticruise</i>
<i>E6</i>	<i>Hall effect sensor</i>
<i>E12</i>	<i>Control unit, EDC</i>
<i>F2</i>	<i>Fuse holder</i>
<i>G4</i>	<i>Earth connection, instrument panel</i>
<i>G8</i>	<i>Earth connection, instrument panel</i>
<i>G13</i>	<i>Earth connection, connector panel</i>
<i>G18</i>	<i>Earth connection, connector panel</i>
<i>O1</i>	<i>Instrument cluster</i>
<i>O4</i>	<i>Tachograph</i>
<i>P2</i>	<i>Central electric unit</i>
<i>S17</i>	<i>Exhaust brake (on instrument panel)</i>
<i>S30</i>	<i>Power take-off, EG</i>
<i>(S31)</i>	<i>Power take-off, EK/ED</i>
<i>S88</i>	<i>Diagnostics switch</i>
<i>S100</i>	<i>Program selector</i>
<i>S101</i>	<i>Driving mode selector</i>
<i>T17</i>	<i>Speed sensor, output shaft</i>
<i>T20</i>	<i>Speed sensor, for tachograph</i>
<i>V13</i>	<i>Solenoid valve, EG power take-off</i>
<i>V20</i>	<i>Solenoid valve, right lateral stroke</i>
<i>V21</i>	<i>Solenoid valve, left lateral stroke</i>
<i>V22</i>	<i>Solenoid valve, neutral position</i>
<i>V23</i>	<i>Solenoid valve, rearward longitudinal stroke</i>
<i>V24</i>	<i>Solenoid valve, forward longitudinal stroke</i>
<i>V62</i>	<i>Solenoid valve, low split</i>
<i>V63</i>	<i>Solenoid valve, low range</i>
<i>V77</i>	<i>Solenoid valve, high split</i>
<i>V78</i>	<i>Solenoid valve, high range</i>

1. This switch is not used for the actual Opticruise system.  
It closes at the start of throttle pedal travel.



100917

*This figure applies to both LHD and RHD vehicles and covers all affected optional equipment. Vehicles with less optional equipment are covered where appropriate.*

## Input signals

The tables on this spread show which input signals the control unit can receive.

### Input signals

Function	Source	Signal type	Pin
Confirmation of low split	Confirmation switch, split	+24V UX	<b>4</b>
Confirmation of high range	Confirmation switch, range	+24V UX	<b>5</b>
Confirmation of rearward longitudinal stroke	Hall effect sensor	+18V (supplied from UX)	<b>6</b>
Confirmation of neutral position	Hall effect sensor	+18V (supplied from UX)	<b>7</b>
Gives clutch pedal position	Lower pedal switch	Earthing (0V)	<b>8</b>
Shows whether EK/ED power take-off is activated	Switch	+24V	<b>9</b>
Request for upshift	Driving mode selector	+24V UX	<b>10</b>
Request for neutral position	Driving mode selector	+24V UX	<b>11</b>
Activation of "Hill" program	Program selector	+24V UX	<b>12</b>
Confirmation of high split	Confirmation switch, split	+24V UX	<b>23</b>
Confirmation of right-hand lateral stroke	Hall effect sensor	+18V (supplied from UX)	<b>24</b>
Activates engine brake program	Retarder control unit or floor switch	+24V	<b>27</b>
To request down shift	Driving mode selector	+24V UX	<b>28</b>
To request automatic position	Driving mode selector	+24V UX	<b>29</b>



*Stated readings can vary due to a number of factors such as battery voltage level, length of cables and the condition of cables and contacts.*

## Input signals, contd.

Function	Source	Signal type	Pin
To activate the test program	Diagnostics switch	Earthing (0V)	<b>30</b>
Gives vehicle speed	Sensor on output shaft	Frequency	<b>31</b>
Gives vehicle speed	Tachograph	Frequency	<b>32</b>
Confirmation, low range	Confirmation switch, range	+24V UX	<b>41</b>
Confirms left-hand lateral stroke	Hall effect sensor	+18V (supplied from UX)	<b>42</b>
Confirms forward longitudinal stroke	Hall effect sensor	+18V (supplied from UX)	<b>43</b>
To request kick-down	Kick-down switch	Earthing (0V)	<b>44</b>
Gives clutch pedal position	Upper pedal switch	Earthing (0V)	<b>45</b>
To request manual position	Driving mode selector	+24V UX	<b>47</b>
To request reverse position	Driving mode selector	+24V UX	<b>48</b>
Gives vehicle speed	Sensor on output shaft	Frequency	<b>49</b>
Shows whether EG power take-off is activated	Switch	+24V	<b>50</b>

## Output signals

The table below shows which output signals the control unit can supply.

### Output signals

Function	Destination	Signal type	Pin
To request low split	Solenoid valve, low split	+24V	2
To request forward longitudinal stroke	Solenoid valve, forward longitudinal stroke	+24V	3
Gives vehicle speed	Retarder control unit via C56	Frequency (+24V)	14
To request right-hand lateral stroke	Solenoid valve, right-hand lateral stroke	+24V	17
To request high split	Solenoid valve, high split	+24V	18
To request rearward longitudinal stroke	Solenoid valve, rearward longitudinal stroke	+24V	22
To activate buzzer	Buzzer	Earthing (0V)	33
Provides power supply	Sensor, controls, display	+24V	36
To request low range	Solenoid valve, low range	+24V	39
To request neutral position	Neutral solenoid valve	+24V	40
To request activation or disconnection of exhaust brake	Exhaust brake control unit	PWM Signal	52
To request left-hand lateral stroke	Solenoid valve, left-hand lateral stroke	+24V	53
To request high range	Solenoid valve, high range	+24V	54

## Other connections

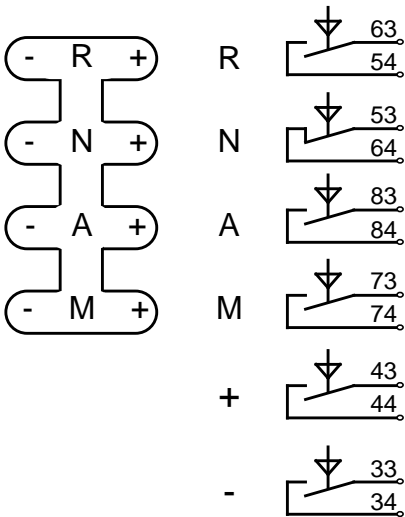
The table below shows the control unit connections for power supply, system earth, communications lines etc.

### Other connections

Function	Source or destination	Signal type	Pin
Earth for control unit	G13	Earthed (0V)	<b>1</b>
Power supply in	From batteries, fuse 41	+24V (U30)	<b>19</b>
Communication	EDC, ABS/TC etc	Data	<b>20</b>
Communication	Diagnostic socket for PC	Data	<b>25</b>
Communication	Diagnostic socket for PC	Data	<b>35</b>
Communication	EDC, ABS/TC etc	Data	<b>38</b>
Communication	Digital display	Data	<b>51</b>
Power supply in	Via starter switch, fuse 5	+24V (U15)	<b>55</b>

Driving mode selector

- The figure to the right shows the internal connection of the driving mode selector when in neutral position.
- The lower figure shows which contacts are closed when the driving mode selector is in its various positions.



Position	Input pin (UX supply)						Output pin					
	33	43	53	63	73	83	34	44	64	54	74	84
R +												
R -												
R												
R ↔ N												
N +												
N -												
N												
N ↔ A												
A +												
A -												
A												
A ↔ M												
M +												
M -												
M												

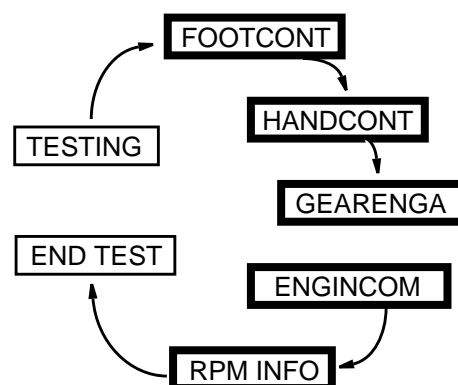
———— = Connection between each terminal pin

## Test program

- The vehicle must be stationary and the engine be switched off, unless otherwise stated in the particular test stage.
- Power should be on (starter key to drive position)
- The test program is controlled using the diagnostic switch, concealed under a cover on the instrument panel.

The test program consists of start, five test stages and end. The test program only runs in one direction, but can be repeated any number of times. The diagnostic switch is used to proceed to the next stage.

The figure to the right shows the gear indicator display before each test stage. This is explained in more detail in the table below.



### Various phases of test program

Display	Intention of test
---------	-------------------

### Various phases of test program

TESTING	Test program starts. Presentation of chassis number and control unit part numbers for hardware and software. Then any fault codes.
FOOTCONT	Testing foot controls
HANDCONT	Testing hand controls
GEARENGA	Testing changing movements and confirmation signals
ENGINCOM	Testing engine communication
RPM INFO	Testing engine speed sensors and road speed sensors
END TEST	Test program ended

General

The test program should no be used when driving. Generally, the vehicle should be stationary, with the engine switched off before testing starts.



**The vehicle may only be driven with the test program running when this is demanded in the test instructions. Under no other circumstances.**

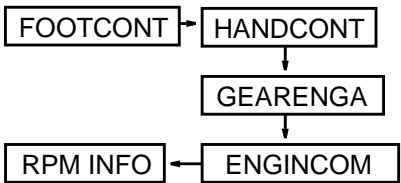
If the control unit registers a road speed or engine speed during testing, the test program is interrupted. The control unit then returns to normal operation. The intention of this is to avoid the danger of an unsuitable gear being engaged.

There are however two test stages which require the vehicle to be driven and this is when road speed or engine speed are to be checked. This is explained in the particular test stages (RPM INFO and ENGINCOM).

END TEST

Text in display

For each test stage, a "heading" is shown in the display. At the same time, the buzzer gives a short signal. This reduces the danger of confusing the various test stages.



As the gear indicator display is limited to a certain size, letters are used as symbols for the various signals etc in the different test stages. These symbols are explained in each test stage.

E K

**TESTING****Starting the test program**

Fault codes are read at the beginning of the Opticruise test program. This is also described on pages 16 and 17 in this booklet. Here, the test program is described in full.



ECU NO

PROG NO

CHASSNO

FCODES

E010 003

A

B

1 The vehicle should be stationary with the engine switched off.

2 Switch on the power with the starter key. Wait for five seconds and then press the diagnostic switch for at least half a second. Release it. "TESTING" appears in the display and the buzzer sounds.

Leave the diagnostic switch for the moment. The test program has now started. All parts of the display light for one second. The buzzer sounds.

3 "ECU NO" is displayed, directly followed by the part number of the control unit hardware.

4 "PROG NO" is displayed, directly followed by the part number of the control unit software.

5 "CHASSNO" is displayed, directly followed by the vehicle chassis number.

6 "F CODES" is displayed, directly followed by any fault codes stored. More on this below.

- The fault codes are displayed one at a time, with two seconds between them.
- When all stored fault codes have been displayed, the buzzer sounds briefly. The stored fault codes are then displayed again. This may be repeated any number of times, so there is no danger if you should lose concentration.

The display can, for example, look like the figure to the left. A shows the number of the fault code (10 in this case) and B shows how many times this fault code has been registered (3).

7 Note the fault codes. Proceed to the next test stage. See next page.

## **FOOTCONT**

### **Foot controls**

The gearbox cannot be operated as long as the control unit is occupied with this test stage.

- 1 Preconditions: Stationary vehicle, engine switched off and power on.
- 2 Press the diagnostic switch for at least a half second and release it. "FOOTCONT" is displayed.
- 3 Test the controls in order. When each letter is displayed, the particular signal is active. Use the table below for clarification.

### **Signal designation**

---

<b>E</b>	Floor switch for engine brake program (and exhaust brake)
<b>U</b>	Upper switch for clutch pedal
<b>D</b>	Lower switch for clutch pedal
<b>B</b>	Brake pedal switch
<b>K</b>	Kick-down switch (integrated in throttle pedal sensor)

---

- 4 When the test has ended, proceed to the next test stage.



**HANDCONT****Hand controls**

The gearbox cannot be operated as long as the control unit is occupied with this test stage.

- 1 Preconditions: Stationary vehicle, engine switched off and power on.
- 2 Press the diagnostic switch for at least one half second and release it. "HANDCONT" is displayed.
- 3 Test the controls in order. When each letter is displayed, the particular signal is active. Use the table below for clarification.

**Signal designation**

R

N

A

M

D

U

H

1

1 / 2 / X

R Driving mode selector to reverse position

N Driving mode selector to neutral position

A Driving mode selector to automatic position

M Driving mode selector to manual position

D Driving mode selector to downshift position

U Driving mode selector to upshift position

H Program selector for normal driving or for steep uphill slopes<sup>1</sup>

1 1 = Switch for power take-off (PTO EK/ED)

2 2 = Switch for power take-off (PTO EG)

X X = Both power take-offs activated simultaneously

1. When the driving mode selector is set for steep uphill slopes, the letter H should be displayed.

- 4 When the test has ended, set the driving mode selector to neutral and proceed to the next test stage.

GEARENGA

 **WARNING!**

Engine must be switched off during testing.

**Gear changing movements and confirmation signals**

In this case, we force the solenoid valves which release compressed air for the shift cylinders and read the confirmation signals. In this way, it is possible to check that each gear changing cycle works properly.

If there are fault codes stored which indicate loss of or impossible road speed signals, this test stage cannot be used for safety reasons.

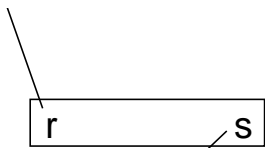
- 1 Preconditions: Stationary vehicle, engine switched off, compressed air in air system and power on.
- 2 Press the diagnostic switch for at least half a second and then release it. "GEARENGA" is displayed.
- 3 Hold the clutch pedal depressed and try the positions of the driving mode selector in turn. This is described on the following pages. Use the table below for clarification.

**Signal designation**

- |   |  |
|---|--|
| r | Range confirmation, where L=low range, H=high range and X=both low range and high range at the same time |
| L | Confirmation for left-hand lateral stroke  |
| B | Confirmation for rearward longitudinal stroke  |
| N | Confirmation for neutral position  |
| F | Confirmation for forward longitudinal stroke   |
| R | Confirmation for right-hand lateral stroke   |
| S | Split confirmation, where L=low split, H=high split and X=both low split and high split simultaneously   |

- 4 When the test has ended, check that the gearbox is in neutral and proceed to the next test stage.

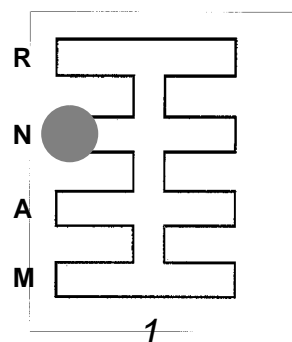
*Range gear position is always displayed on the far left of the display, as L, H or X.*



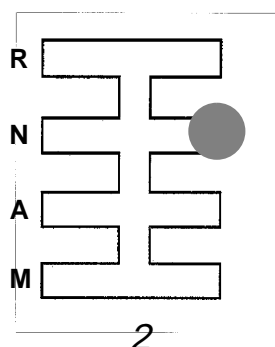
*Split gear position is always displayed on the far right of the display, as L, H or X.*

**Low split and low range simultaneously**

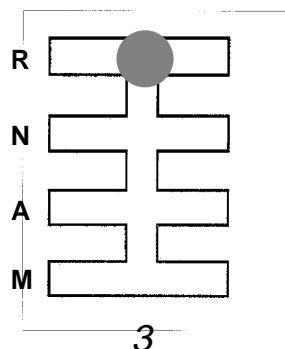
- 1 Set the driving mode selector as in fig. 1.
- 2 Check that LNL is displayed.

**High split and high range simultaneously**

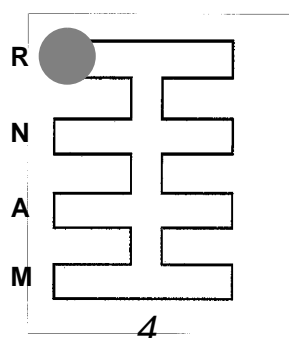
- 3 Set the driving mode selector as in fig. 2.
- 4 Check that HNH is displayed.

**Left lateral stroke**

- 5 Set the driving mode selector as in fig. 3.
- 6 Check that HLNH (or LLNL) is displayed.

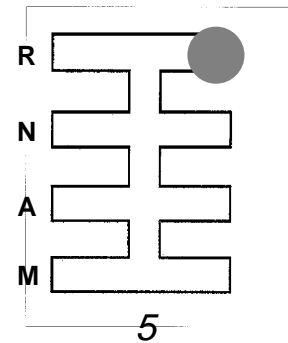
**Rearward longitudinal stroke on left-hand side**

- 7 Set driving mode selector as in fig. 4.
- 8 Check that HLBH (or LLBL) is displayed.



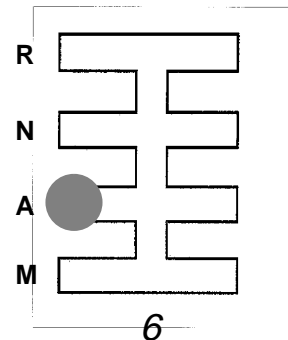
### Forward longitudinal stroke on left-hand side

- 9 Set driving mode selector as in fig. 5.
- 10 Check that HLFH (or LLFL) is displayed.



### Rearward longitudinal stroke in centre position

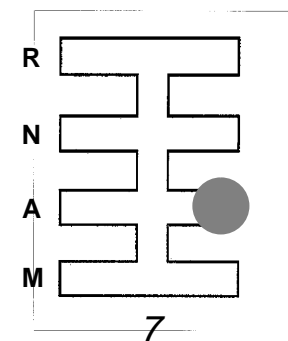
- 11 Set driving mode selector as in fig. 6.
- 12 Check that HBH (or LBL) is displayed.



### Forward longitudinal stroke in centre position

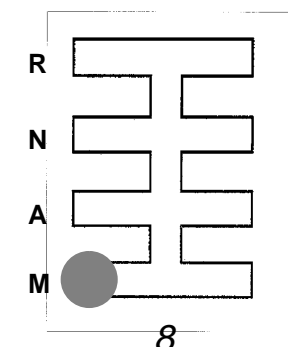
(Only applies to GR gearbox, not GRS)

- 13 Set driving mode selector as in fig. 7.
- 14 Check that HFH (or LFL) is displayed.



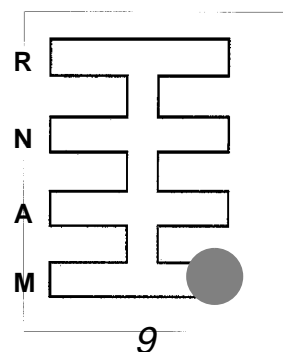
### Rearward longitudinal stroke on left-hand side

- 15 Set driving mode selector as in fig. 8.
- 16 Check that HBRH (or LBRL) is displayed.



### Forward longitudinal stroke on right-hand side

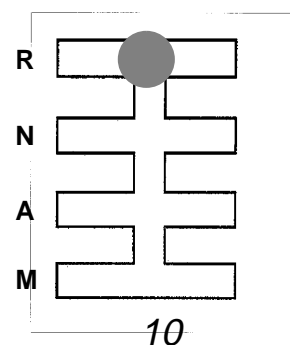
- 17 Set driving mode selector as in fig. 9.
- 18 Check that HFRH (or LFRL) is displayed.



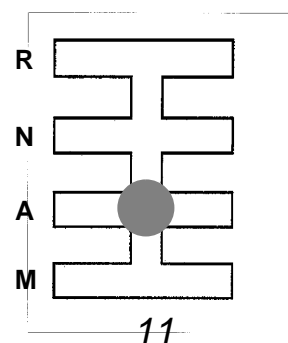
### Neutral position

Neutral position often, but not always, arises in combination with another confirmation signal.

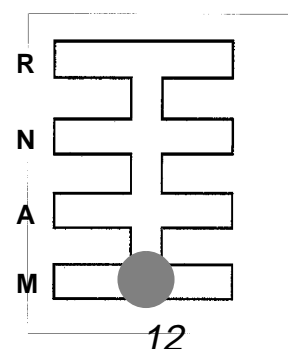
- 19 Set driving mode selector as in fig. 10.
- 20 Check that HLNH (or LLNL) is displayed.



- 21 Set driving mode selector as in fig. 11.
- 22 Check that HNH (or LNL) is displayed.



- 23 Set driving mode selector as in fig. 12.
- 24 Check that HNRH (or LNRL) is displayed.



ENGINCOM

Engine communication

In this test stage, we check the kind of data that Opticruise must have from the EDC system. In this way, it is possible to check whether sensors, EDC control unit data processing and the actual communications circuit are working properly.

During this test, the display gives the test result instead of gear position and the like. In addition, the vehicle can be driven as normal.

- 1 Preconditions: Initially stationary vehicle, engine switched off and power on. The vehicle should be driven when the actual test stage has been initiated.
- 2 Press the diagnostic switch for at least one half second and release it. "ENGINCOM" is displayed.
- 3 Start the engine and drive the vehicle. Drive at an even speed and check that the values displayed seen plausible. Use the table below for clarification.

Signal designation

gg

Requested throttle

ee

Actual torque

dd

Requested torque

tt

Engine temperature

gg	Requested throttle as percentage of full throttle (0 - 99 %)
ee	Actual torque (x 100 Nm)
dd	Requested torque (x 100 Nm)
tt	Engine temperature (0 - 99 °C)

- 4 When the test has ended, proceed to the next test stage.

**RPM INFO****Speed sensors**

Here, we check the various speed information which is compared by Opticruise. In this way, it is possible to check that both sensors and their wiring are working properly.

During this test, the display gives the test result instead of gear position and the like. In addition, the vehicle can be driven as normal.

- 1 Preconditions: The vehicle should be driven when the actual test stage has been started.
- 2 Press the diagnostic switch for at least one half second and release it. "RPM INFO" is displayed.
- 3 Drive the vehicle at an even speed and check that the values displayed seem plausible. Use the table below for clarification

**Signal designation**

nn

*Engine speed*

nn Engine speed (x 100 rpm)

v\_1 Propeller shaft speed from sensor on gearbox output shaft (x 10 rpm)

v\_2 Speed signal from tachograph, recalculated to propeller shaft speed (x 10 rpm)

v\_1

*Propeller shaft speed*

- 4 When the test has ended, press the diagnostic switch to end the test program. When this has been done, "END TEST" is displayed and the control unit returns to normal operation.

See pages 16 to 17 for description of any fault messages which have arisen during test driving.

v\_2

*From tachograph*





# Mechanical work

## General

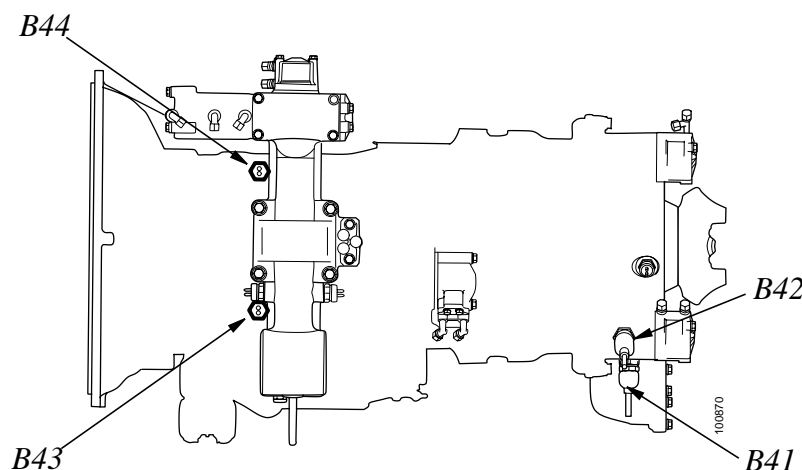
Internally, the gearbox is standard. Its operating system is similar to the corresponding one for 3 series CAG 2, but with the difference that the stroke damper for Opticruise is now built into the longitudinal stroke cylinder. The gearshift housing, located on the top of the gearbox is also changed. The design is more compact than in previous models.

## Hall effect sensor and shift cylinders

Mechanically, Opticruise has no great changes. We therefore concentrate on changing and setting the hall effect sensor and changing the shift cylinders. This is described on the following pages.

## Confirmation switches

The four confirmation switches are of the same type; normally closed. Tightening torque: 20 Nm. Their location is shown in the figure below, with the gearbox shown viewed from above. On older gearboxes, B42 is located on the right-hand side. Designations are explained on page 54.

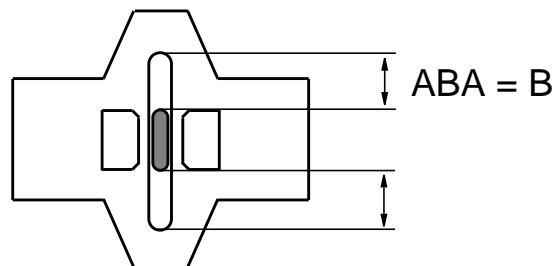


## Hall effect sensor, adjusting and replacement

Use the control unit's integrated test program or a PC to detect faults in the hall effect sensor, and to verify that faults have been corrected when a repair is completed.

### Removal

- 1 Set the driving mode selector to the neutral position.
- 2 Detach the air hoses from the longitudinal stroke cylinders and the lateral stroke cylinders. Unplug the connector to the hall effect sensor wiring from the sensor housing.
- 3 Detach the gearshift housing from the gear-box and place it upside down on the work-bench.
- 4 Detach the sensor housing from the gear-shift housing.
- 5 Blow compressed air into the centre air connection on the longitudinal stroke cylinder. This sets the gear shift shaft to the neutral position. Check that the stop on the lever is in the centre of the coulisse as in the figure above to the right.



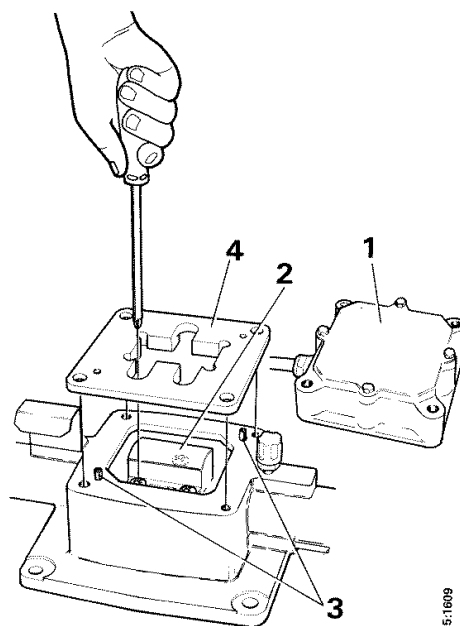
### Checking and adjusting

- 6 Remove both the guide pins from guide plate 99 150 (these are not needed). Fit the guide plate in the place of the sensor housing. Check that the magnet housing is in the correct position.
- 7 When adjusting: Undo the magnet housing bolts enough to move the housing, but no further.

**Note:** The bolts are locked with locking compound, but do not heat the magnet housing. This may damage the magnet.

- 8 Adjust the position of the magnet housing using the guide plate. Then lock the bolts with locking compound 561 029 and screw them fully down.

*Continued >*



- 1 Sensor housing
- 2 Magnet housing
- 3 Spring pins
- 4 Guide plate 99 150

(Figure shows series 3 design)

## Hall effect sensor, fitting

- 9 Fit the sensor housing to the gear shift housing.

Refit the gear shift housing to the gearbox.

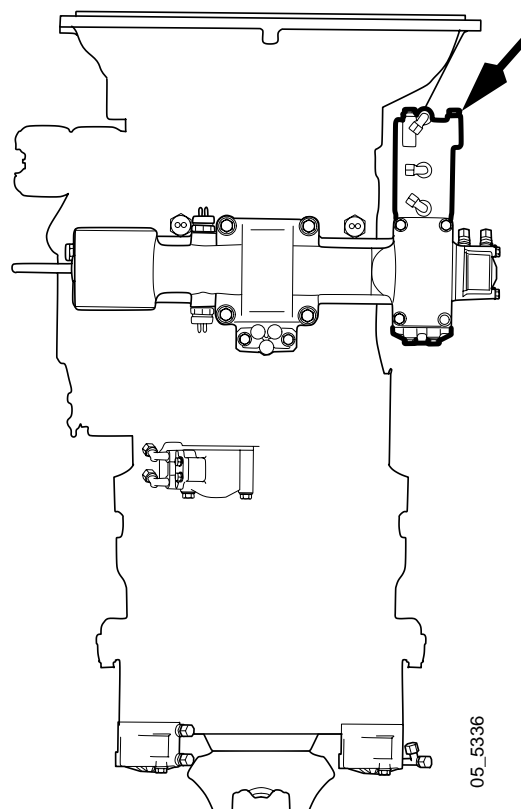
## Changing the longitudinal stroke cylinder

The vehicle's compressed air system must be pressurized for the longitudinal stroke cylinder to be set to the correct position before it is removed.

- 1 Switch on the power. Set the driving mode selector to neutral. The longitudinal stroke cylinder is set to neutral.
- 2 Cut the power. Disconnect the three air hoses from the longitudinal stroke cylinder.
- 3 Undo the four securing bolts and remove the cylinder.
- 4 Fit the new cylinder. Blow compressed air into the centre connector, setting the cylinder to the neutral position. Make sure that teeth on the gearshift shaft are engaged in the centre position.
- 5 Fit the air hoses.
- 6 Remove the level plug. Fill with ATF fluid up to the hole (about 0.27 litres).
- 7 Switch on the power and check the gear changing movements using the test program (test stage "GEARENGA").

The longitudinal stroke cylinder can be turned if extra space is required. If this is done, the compressed air couplings must also be switched.

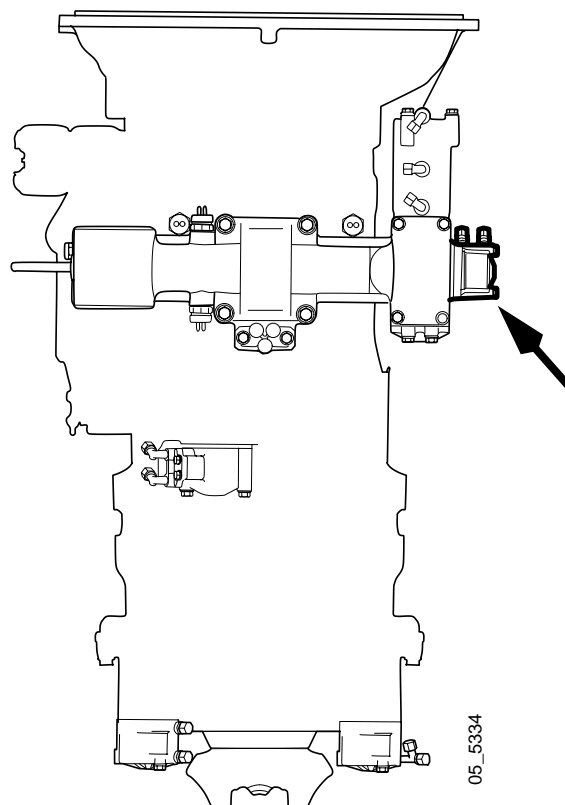
**Hint:** Remove the gear selector housing from the gearbox if turning the cylinder. this makes the task easier.



## Changing the lateral stroke cylinder

It is not necessary for the compressed air system to be pressurized in order to remove the lateral stroke cylinder.

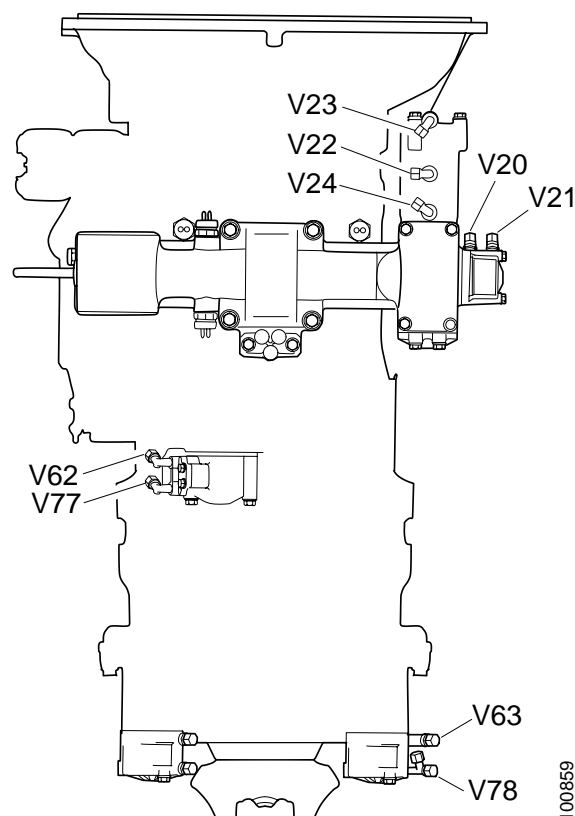
- 1 Switch on the power. Set the driving mode selector to neutral position.
- 2 Cut the power. Disconnect the hoses from the lateral stroke cylinder.
- 3 Undo the securing bolts and remove the cylinder.
- 4 Lubricate the piston with brake grease, part No. 319 308.
- 5 Fit the new cylinder.
- 6 Fit the air hoses.
- 7 Switch on the power and check the gear changing movements using the test program (test stage "GEARENGA").



## Location of compressed air cylinders

- The figure to the right shows which solenoid valve the various compressed air couplings belong to.
- The figure applies to standard vehicle versions.
- The longitudinal stroke cylinder can be turned. This is sometimes necessary to allow sufficient clearance for e.g. a hydraulic pump.

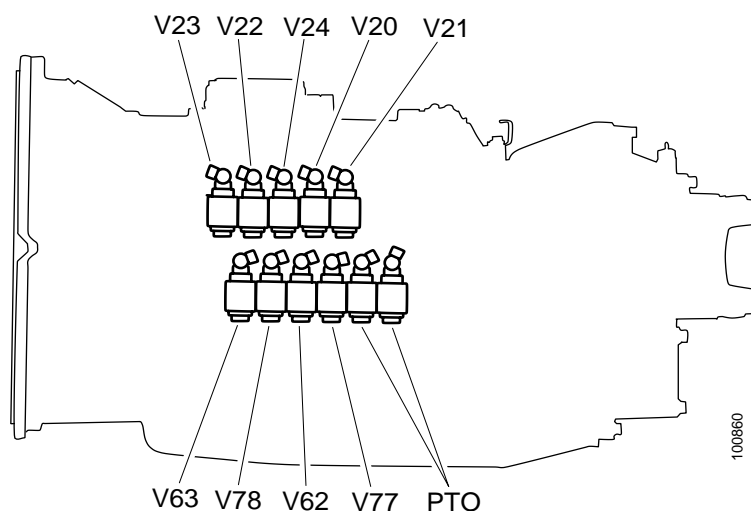
If this is the case, the air lines for V23 and V24 must be swapped. This allows the longitudinal stroke cylinder to work in the right direction when it has been turned.



## Exploded view drawings

This chapter shows the exploded view drawings for the most important Opticruise components on the gearbox. Part numbers are given in our spare parts catalogues.

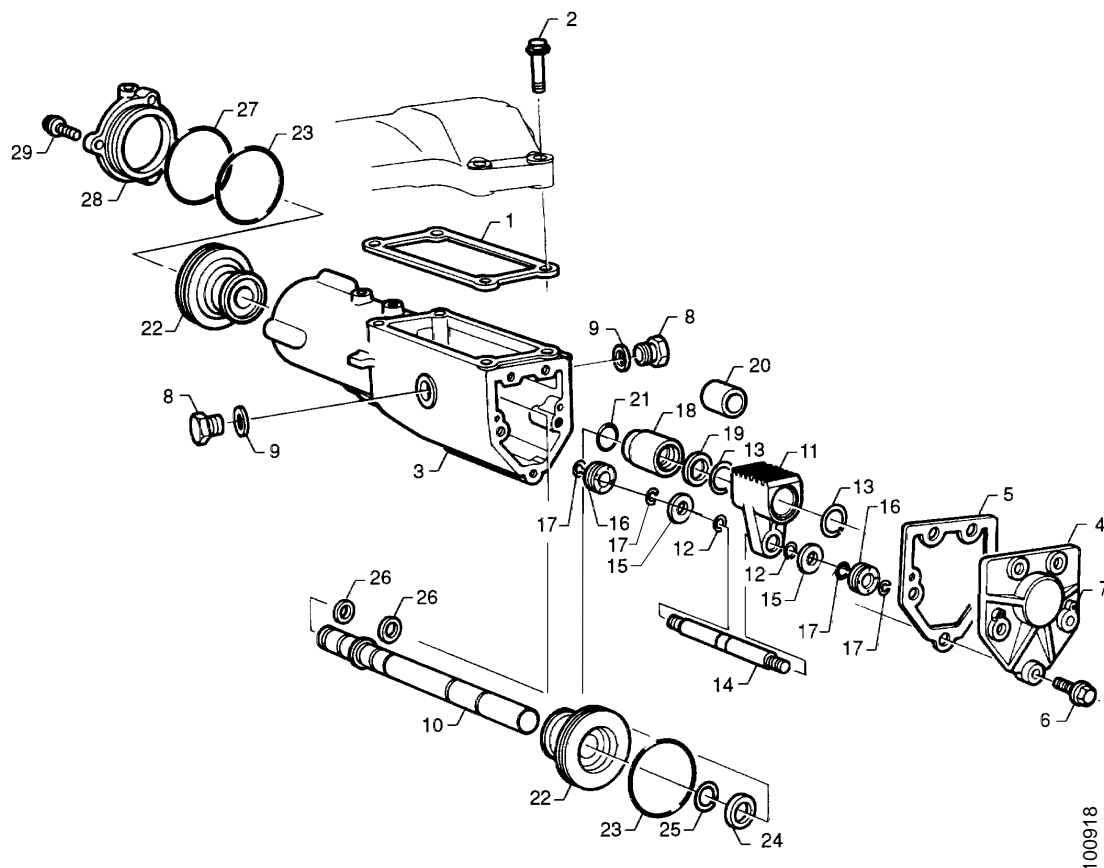
The drawing below shows the location of solenoid valves for Opticruise. Designations are explained on page 54. The location of air lines is shown on page 76.



*Location of solenoid valves on gearbox. The two PTO solenoid valves are for the power take-offs.*

**Longitudinal stroke  
cylinder**

<i>Item</i>	<i>Quantity</i>	<i>Designation</i>
<i>1</i>	<i>1</i>	<i>Gasket</i>
<i>2</i>	<i>4</i>	<i>Screw</i>
<i>3</i>	<i>1</i>	<i>Housing</i>
<i>4</i>	<i>1</i>	<i>End plate</i>
<i>5</i>	<i>1</i>	<i>Gasket</i>
<i>6</i>	<i>5</i>	<i>Screw</i>
<i>7</i>	<i>2</i>	<i>Spring pin</i>
<i>8</i>	<i>2</i>	<i>Plug</i>
<i>9</i>	<i>2</i>	<i>Gasket</i>
<i>10</i>	<i>1</i>	<i>Piston rod</i>
<i>11</i>	<i>1</i>	<i>Rack</i>
<i>12</i>	<i>2</i>	<i>Retaining ring</i>
<i>13</i>	<i>2</i>	<i>Retaining ring</i>
<i>14</i>	<i>1</i>	<i>Piston rod</i>
<i>15</i>	<i>2</i>	<i>Washer</i>
<i>16</i>	<i>2</i>	<i>Piston</i>
<i>17</i>	<i>4</i>	<i>Retaining ring</i>
<i>18</i>	<i>1</i>	<i>Bearing sleeve</i>
<i>19</i>	<i>1</i>	<i>V-ring</i>
<i>20</i>	<i>2</i>	<i>Bearing</i>
<i>21</i>	<i>1</i>	<i>O-ring</i>
<i>22</i>	<i>2</i>	<i>Piston</i>
<i>23</i>	<i>2</i>	<i>O-ring</i>
<i>24</i>	<i>2</i>	<i>Washer</i>
<i>25</i>	<i>2</i>	<i>Retaining ring</i>
<i>26</i>	<i>2</i>	<i>Seal</i>
<i>27</i>	<i>1</i>	<i>O-ring</i>
<i>28</i>	<i>1</i>	<i>Cylinder cover</i>
<i>29</i>	<i>3</i>	<i>Screw</i>



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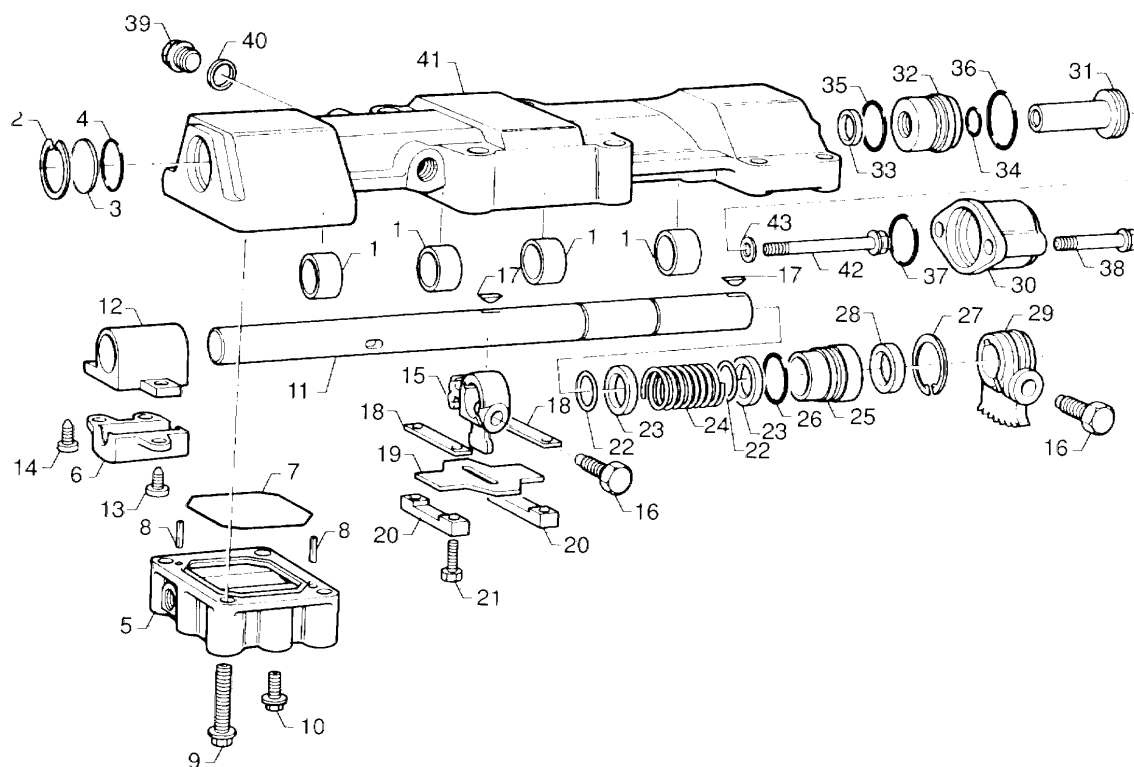
*Component parts of the longitudinal stroke cylinder. Part numbers are listed in our spare parts catalogues.*

*Remember to swap the compressed air couplings if it is necessary to turn the cylinder to increase available space.*

**Gear shift housing with  
lateral stroke cylinder**

<i>Item</i>	<i>Quantity</i>	<i>Designation</i>
1	4	Bushing
2	1	Retaining ring
3	1	Filter disc for venting
4	1	O-ring
5	1	Sensor housing assembly
6	1	Magnet housing
7	1	O-ring
8	2	Spring pin
9	4	Screw
10	4	Screw
11	1	Gear shift shaft
12	1	Magnet holder
13	1	Screw
14	3	Screw
15	1	Lever
16	2	Screw
17	2	Key
18	2	Spacer
19	1	Coulisse
20	2	Cap
21	4	Screw
22	2	Retaining ring
23	2	Washer
24	1	Spring
25	1	Spacer
26	1	O-ring
27	1	Retaining ring
28	1	V-ring
29	1	Lever
30	1	Cylinder
31	1	Piston
32	1	Spacer
33	1	V-ring
34	1	O-ring
35	1	O-ring
36	1	O-ring
37	1	O-ring
38	2	Screw
39	2	Plug
40	2	Gasket
41	1	Housing
42	1	Screw
43	1	Washer





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*Component parts of the gear shift housing and lateral stroke cylinder. Part numbers are listed in our spare parts catalogues.*

**Compressed air parts  
on gearbox**

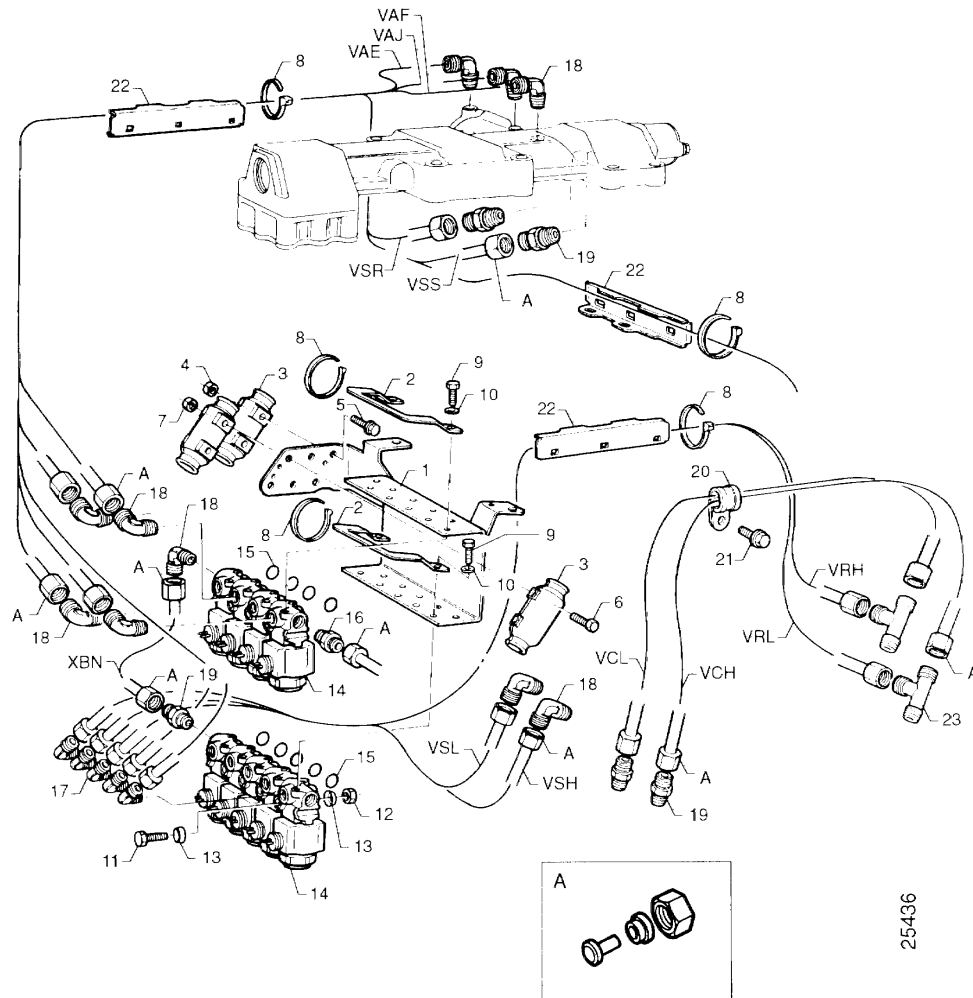
<i>Item</i>	<i>Quantity</i>	<i>Designation</i>
1	1	Bracket
2	2	Bracket <sup>1</sup>
3	3	Holder
4	2	Nut
5	2	Screw
6	2	Screw
7	2	Nut
8	11	Strap
9	22	Screw
10	22	Washer
11	7	Screw
12	7	Nut
13	14	Cone
14	9	Solenoid valve <sup>2</sup>
15	7	O-ring
16	2	Union
17	10	Elbow union
18	5	Elbow union
19	4	Union
20	1	Clip
21	1	Screw
22	4	Bracket
23	2	T-union
VAE	M <sup>3</sup>	Plastic pipe
VAJ	-"-	Plastic pipe
VAF	-"-	Plastic pipe
VSR	-"-	Plastic pipe
VSS	-"-	Plastic pipe
XBN	-"-	Plastic pipe
VRH	-"-	Plastic pipe
VRL	-"-	Plastic pipe
VCH	-"-	Plastic pipe
VCL	-"-	Plastic pipe
VSH	-"-	Plastic pipe
VSL	-"-	Plastic pipe
A	ERF <sup>4</sup>	Union nut Ferrule Insert sleeve

1. Drawing shows early version

2. See page 77 for locations

3. M = By the metre

4. ERF = Whatever quantity is required



*Compressed air parts on gearbox. Part numbers are listed in our spare parts catalogues.*

