

SCANIA

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Issue 1 en

Comfort Shift, CS

Description of operation



5-4618

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General



Comfort Shift

Comfort Shift (CS) is an electro-pneumatic gear-changing system devised and developed by Scania to facilitate gear-changing and give added comfort to the driver. The CS lever is similar to the gear lever in a passenger car and is just as easy to operate. Gears can, moreover, be pre-selected.

The control unit and operational functions of the CS system are the same as those in the CS2 in the 3 Series, whereas the gearbox and gear selector housing are the same as those in the Opticruise.

The CS system has a manual gearbox

The CS system is complementary to a manual gearbox in which the gear-changing mechanism has been replaced by control cylinders for engaging and disengaging the gears.

Two control cylinders, one for longitudinal and the other for lateral stroke, are operational in the main box. The high and low ranges of the gearbox are operated by the control cylinders of the GR801 gearbox. The control cylinders in the main box operate in directions that correspond to the pattern of the gear selector.

The control cylinders for longitudinal and lateral stroke have been designed to make gear-changing fast and reliable. A damping device for the longitudinal stroke movement adapts gearbox operations to the process of synchronization.

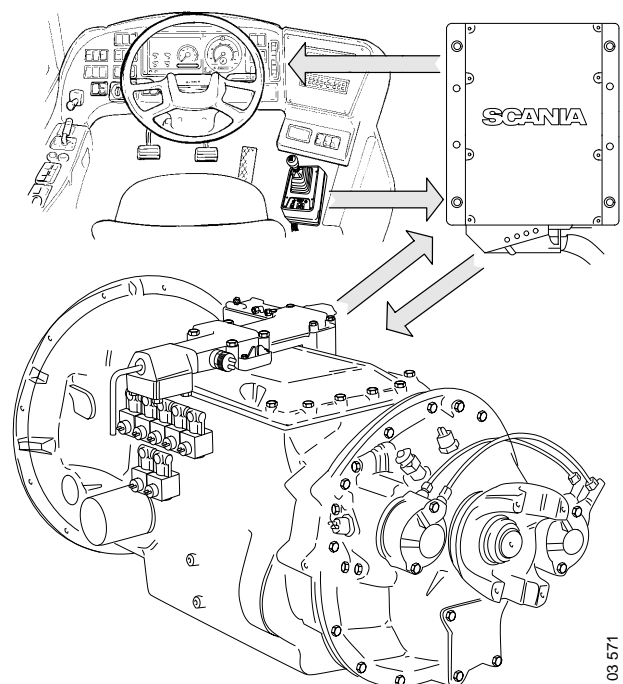
A number of position sensors on the gearbox inform the control unit when each step in the gear-changing process has been completed, and indicate the gear that has been engaged.

There are seven solenoid valves in the CS system, five of which are used for longitudinal and lateral stroke in the main box. The remaining two valves in the standard gearbox are for the high and low ranges.

Control unit

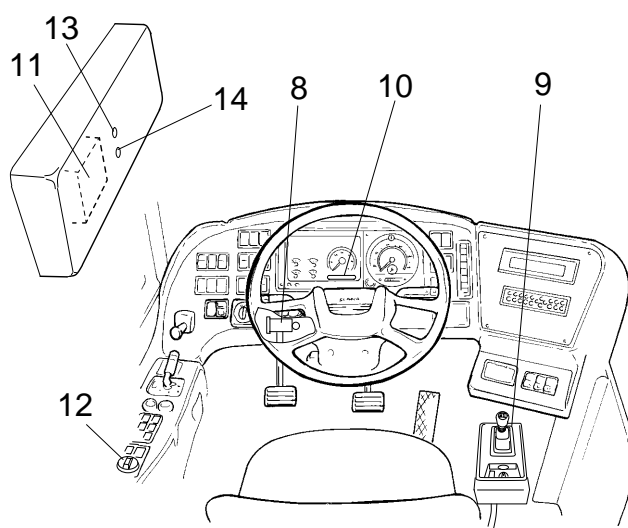
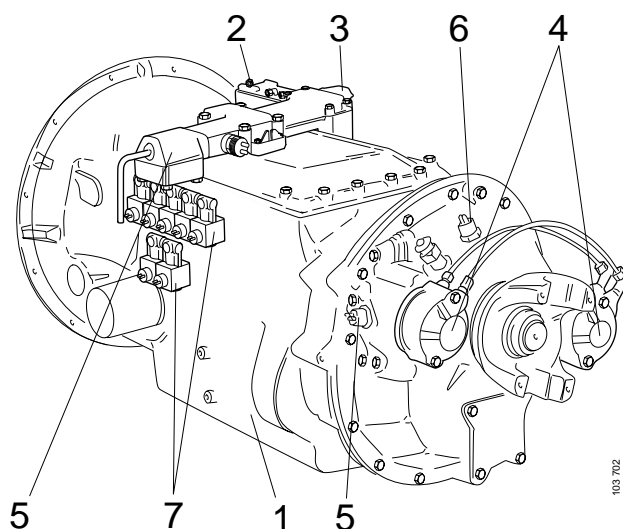
The control unit reads the engine speed and the gear that is currently engaged. When the driver selects a gear with the CS lever and declutches, the control unit changes to the proposed gear by using the compressed air cylinders on the gearbox.

The control unit is programmed for the engine and gearbox installed in the vehicle. Fault diagnosis is performed by using either the integrated fault diagnosis programme or by external test equipment.



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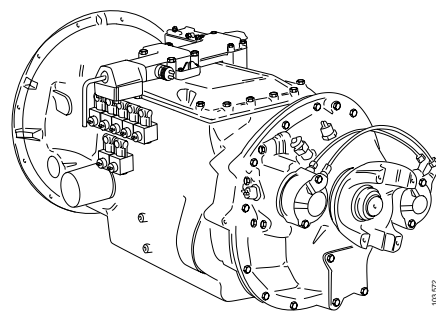
CS system components



- | | | | |
|---|---------------------------------------|----|---|
| 1 | Manual gearbox | 8 | Clutch pedal switches |
| 2 | Longitudinal stroke cylinder | 9 | Gear lever housing |
| 3 | Lateral stroke cylinder | 10 | Gear display and buzzer |
| 4 | Control cylinders for the range gears | 11 | Control unit and code plug |
| 5 | Position sensor | 12 | Diagnostics switch for the test programme |
| 6 | Speed sensor | 13 | Diagnostics socket |
| 7 | Solenoid valves | 14 | Delay relay |

1. Gearbox

The gearbox is of the manual type with compressed air cylinders fitted on to the gear selector housing.



GR801 gearbox

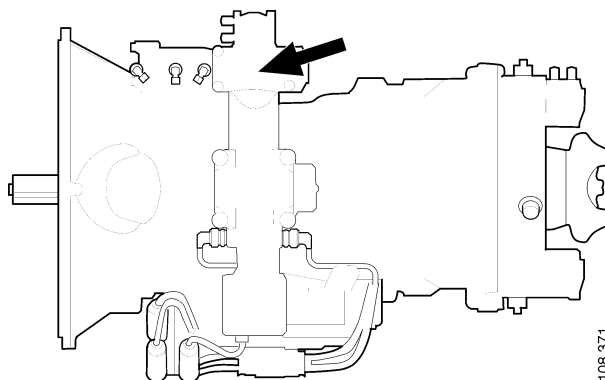
2. Longitudinal stroke cylinder

The longitudinal stroke cylinder performs the longitudinal gear-changing movements. It has a dual-action piston and three air connections for:

- Forward longitudinal stroke
- Backward longitudinal stroke
- Neutral position.

The front and rear air intakes of the longitudinal stroke cylinder are equipped with throttles for smooth engagement of the gears.

The stroke damper is built into the longitudinal stroke cylinder. It adapts the movements when a gear is engaged to the process of synchronization. Damping is from neutral to the forward or backward positions only.



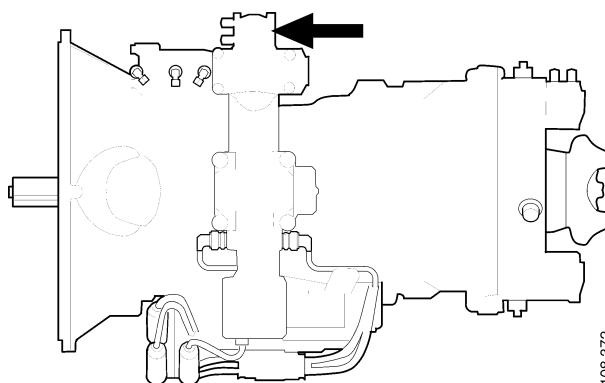
The longitudinal stroke cylinder

3. Lateral stroke cylinder

The lateral stroke cylinder performs lateral gear-changing movements:

- Right-hand lateral stroke
- Left-hand lateral stroke.

The lateral neutral position is obtained with the help of a spring mechanism located in the cover of the lateral stroke cylinder.

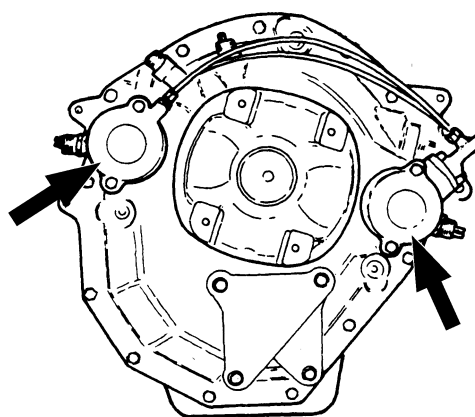


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The lateral stroke cylinder

4. Control cylinders for the range gears

The control cylinders for the range gears change from the high to the low range and vice versa. They are the gearbox cylinders and they work in parallel.



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5. Position sensors

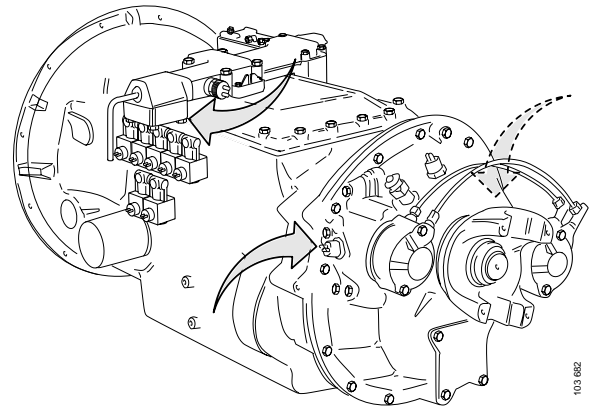
Position sensors inform the control unit when a gear-changing movement has been completed. Changing gear in the main box consists of a maximum of three movements:

- Neutral position - acknowledgement
- Lateral, right/left - acknowledgement
- Longitudinal, forward/back. - acknowledgement.

Gear-changing movements and subsequent acknowledgement are also involved in changing between the high and low ranges.

The gearbox has two different types of position sensor:

- Hall sensors
- Acknowledgement switches for the high and low range gears.



Location of the position sensors

Hall sensors

Hall sensors are a non-contact form of acknowledgement for the gear-changing movements performed in the main gearbox. The acknowledging part of the sensor reacts to and is controlled by a magnetic field. It consists of two parts:

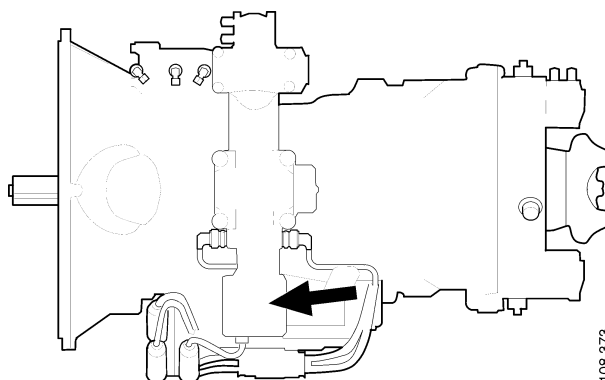
- magnet housing
- sensor housing

The magnet housing is located under the gear selector shaft. The electronic parts of the sensors are cast into the sensor housing. The location of the sensors is such that the control unit can read the movements of the gear selector in the gearbox. See the section on "Gear-changing pattern" for further information.

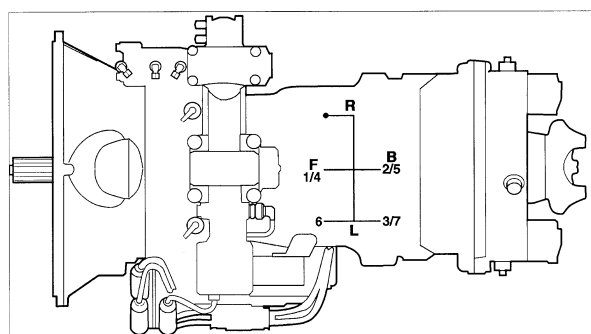
When a gear-changing movement begins, the sensors are activated and the signal line becomes conductive.

The sensor circuit has five signal lines giving nine combinations of signal that the control unit can read: N, NL, NR, F, FL, FR, B, BL and BR. A movement is divided into lateral strokes such as N → NL and longitudinal strokes such as NL → BL.

Note: The gear selector in the GR801 does not have a backward stroke to the right (BR). See the figure below.



Hall sensors

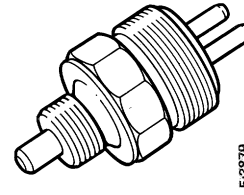


L = Left
R = Right
F = Forward
B = Backward

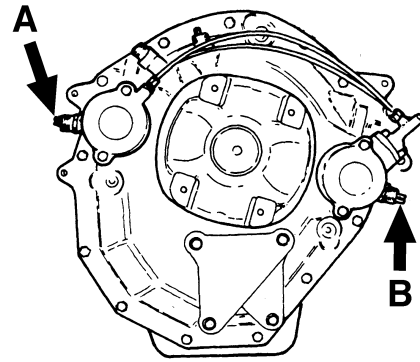
The movement pattern of the gear selector in the GR801

Acknowledgement switches

The movement-sensing electric acknowledgement switches are located on the range section of the gearbox and are closed when not influenced.



Acknowledgement switch

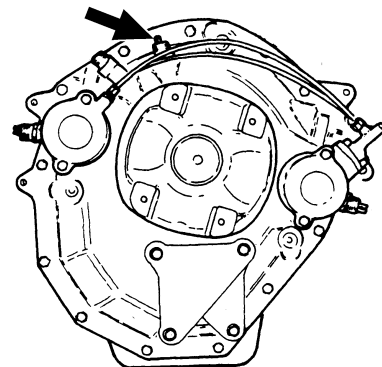


Acknowledgement switch on the range section

A = High
B = Low

6. Speed sensor

A speed sensor reads the speed of the vehicle by reading the rotational movement of a sensor wheel. The signal informs the control unit of the vehicle's speed.



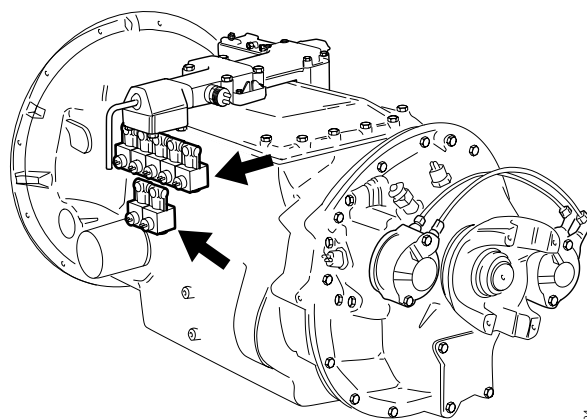
Speed sensor

7. Solenoid valves

The solenoid valves are controlled by signals from the control unit. They regulate the flow of air to the control cylinders.

When a gear-changing movement has been completed, the position sensors inform the control unit and activation is terminated. The control cylinder is then vented by the solenoid valve.

There are seven solenoid valves in the CS system, five of which are used for longitudinal and lateral stroke in the main box. The remaining two valves are used for the high and low ranges.



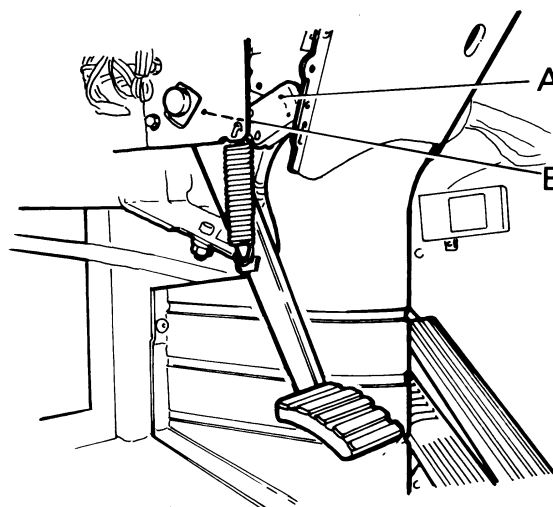
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8. Clutch pedal switches

The position of the clutch pedal is read by an upper and a lower switch.

- The upper switch senses that the clutch pedal is in the released position so that the control unit can check that the road-speed sensor is functioning. When the pedal is depressed, the switch earths a relay which transmits a +24V signal to the control unit.
- The lower switch closes whenever the clutch pedal is fully depressed, which the control unit then senses and activates the solenoid valves.

Both switches have to be closed and the pedal depressed before a gear can be changed.



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Clutch pedal switches

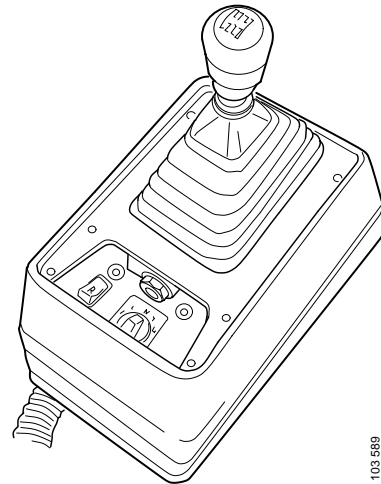
A = Upper switch

B = Lower switch

9. Gear lever housing

The gear lever housing consists of the following:

- the CS lever
- microswitches
- an interlock valve
- a knob for emergency gear-changing.



Gear lever housing

CS lever

The CS lever is used to command the desired gear. There are seven forward gears and one reverse gear. To engage the first and reverse gears, a mechanical catch must first be lifted on the CS lever.

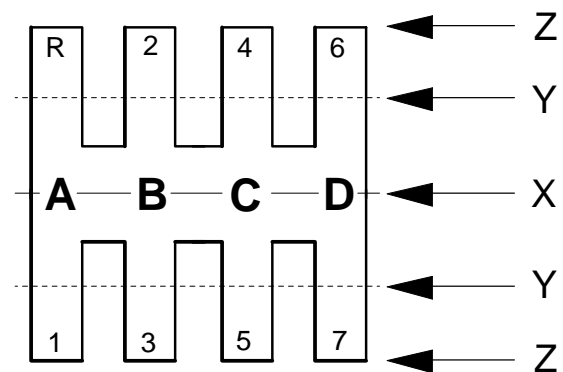
The CS lever has four lateral and five longitudinal positions (see the illustration).

When the driver moves the lever to the desired gear, the CS lever stops in the gear-changing position. When the change has been completed in the gearbox, the driver moves the CS lever to the drive position to complete the gear-changing operation.

Microswitches

The CS lever activates seven microswitches, four lateral (A-D) and three longitudinal (X-Z). See the illustration.

The microswitches read the position of the CS lever and transmit information on the desired gear to the control unit.



A-D. Lateral positions

X. Neutral

Y. Gear-changing position

Z. Drive

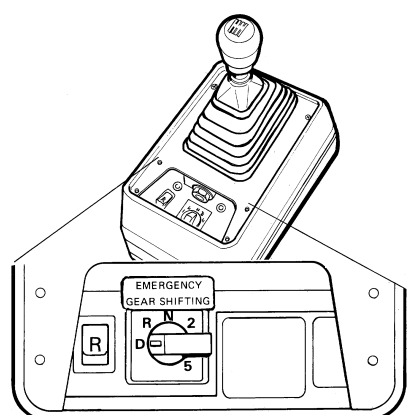
Interlock valve

The interlock valve keeps the CS lever in the gear-changing position until the gear-changing operation has been completed in the gearbox. The lock is then released and the driver can proceed to move the lever into the drive position.

If the driver should move the CS lever too fast and the interlock valve not manage to lock the lever in time, a mechanical key in the gear lever housing will prevent the CS lever from entering the next drive position until the gearbox has managed to complete the gear-changing operation.

Knob for emergency gear-changing

A hatch is located behind the CS lever. Under the hatch there is an emergency knob for changing gear and a switch for the reverse gear.



10. Gear display and buzzer

The gear display is part of the instrument cluster. It consists of four parts:

- an eight-character display
- a buzzer
- background lighting
- an indicator lamp (does not influence the system functions)

The gear display performs two functions during driving:

Indicates the gear selected

A number or letter in the middle of the indicator shows in a steady light the gear currently engaged.

Reports malfunctioning with a code

See the section on "Integrated safety features".

Signals from the buzzer

The buzzer is controlled by the control unit. Its function is to inform the driver by means of various audible signals that the control unit has discovered a fault in the system or that the driver has done something wrong, such as selecting a gear that is too low.

See the section on "Integrated safety features".



Gear display

Background lighting

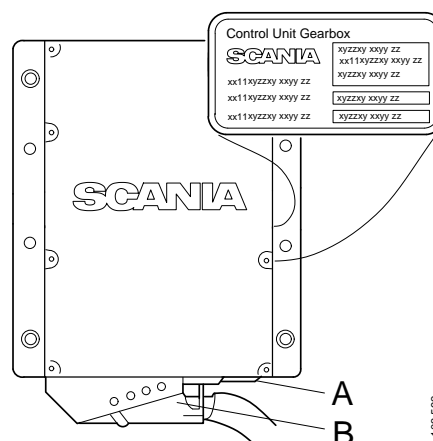
The gear display has background lighting to ensure its visibility. When the light switch is at 0, the background lighting is at full strength; when it is in the position for parking or for main or dipped beam, the background lighting follows the rheostat for the instrument lighting.

Note: The lamp for the background lighting must be whole if the gear display is to work.

11. Control unit

The control unit receives information from the CS lever and controls the choice of gear. It also controls the gear-changing process in the gearbox via the solenoid valves and the position sensors.

Adaptation to the relevant power train is made via a code plug that programmes the control unit for the engine and gearbox in question, (see the table under "Specifications" in the Work description. There is a 55-pole connector on the control unit that connects the various components in the CS system. The control unit has an integrated test programme.



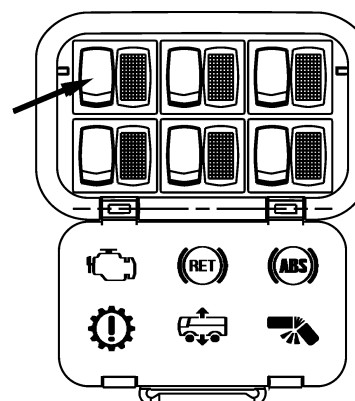
Control unit

A = Code plug
B = Connector

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12. Diagnostics switch for the test programme

The control unit has an integrated test programme that is activated via a switch in the central electric unit (the vehicle must be stationary). The programme quickly locates any faults.



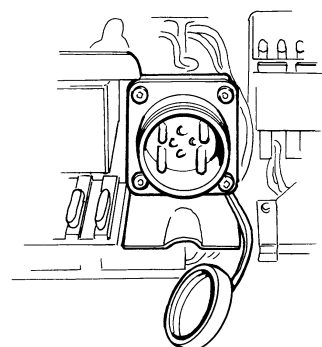
Switch for the integrated test programme

13. Diagnostics socket

At the time of writing, there is no diagnostics programme available for the CS in a 4-Series bus.

14. Delay relay

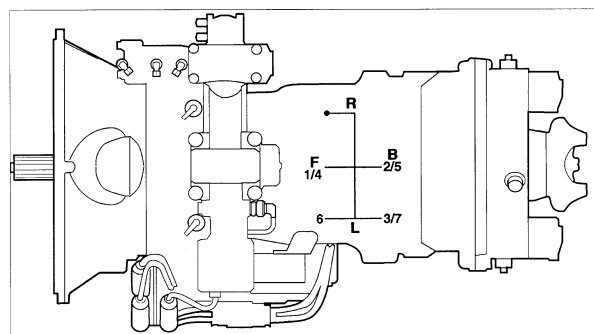
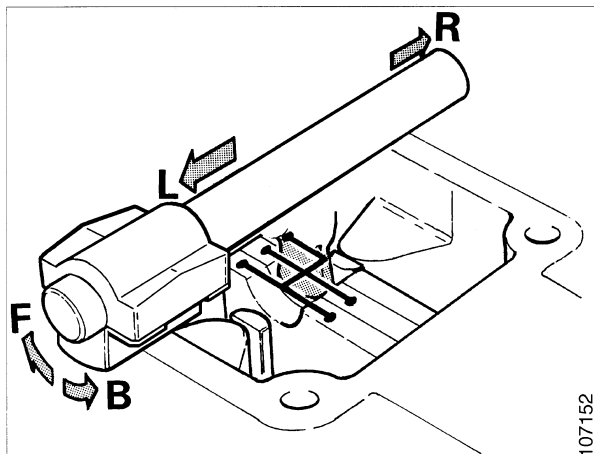
If a gear is still engaged when the engine is switched off with the starter key, the delay relay maintains the supply voltage for a further ten seconds. The delay enables the control unit to warn the driver that a gear is still engaged and enable him to disengage it without having to turn the power on again to do so.



Diagnostics socket

Gear-changing pattern

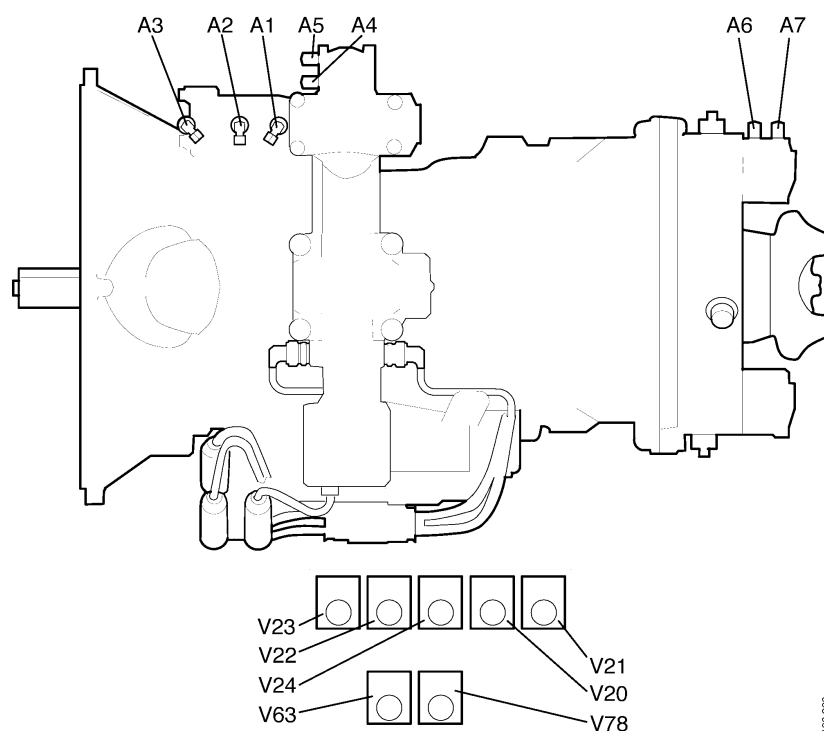
A vehicle equipped with the CS system has a manual gearbox. The positions of the gears correspond, therefore, to the movement pattern of the gear selector.



L = Left
R = Right
F = Forward
B = Backward

The movement pattern of the gear selector in the GR801

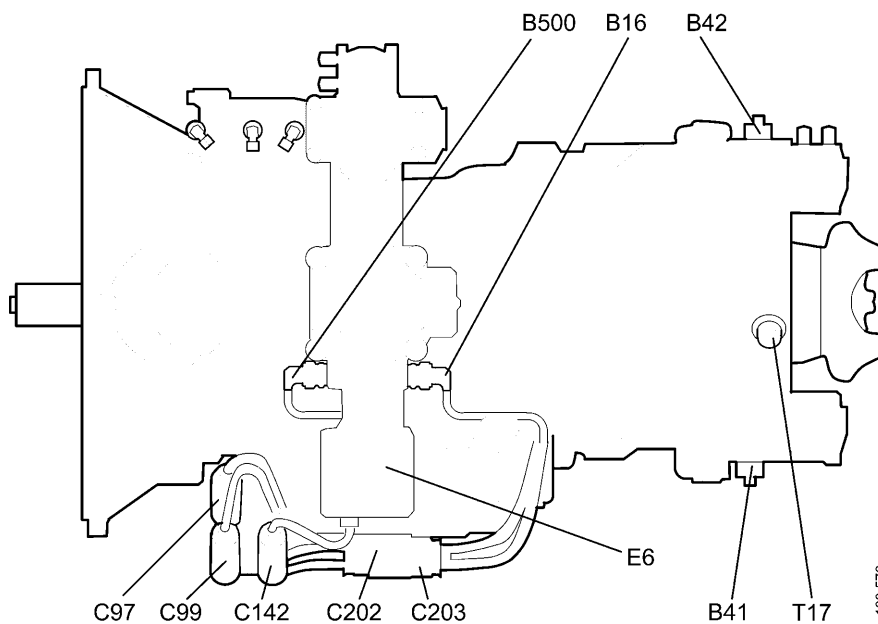
Location of gearbox components



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Solenoid valves

Designation	Function	Connection
V20	Lateral stroke, right	A5
V21	Lateral stroke, left	A4
V22	Longitudinal stroke, neutral	A2
V23	Longitudinal stroke, backward	A1
V24	Longitudinal stroke, forward	A3
V63	Low range	A6
V78	High range	A7



Switches

Designation	Function
B16	Reversing lights
B500	Neutral - gearbox

Connectors

Designation	Function
C97	7-pole
C99	10-pole
C142	7-pole
C202	2-pole
C203	2-pole

Position sensors

Designation	Function
E6	Right
	Left
	Backward
	Neutral
B41	Range, high
B42	Range, low

Speed sensor

Designation	Function
T17	Speed sensor

Integrated safety features

Overrevving protection

Overrevving protection prevents a gear from being selected that is too low in relation to the speed of the vehicle.

If the desired gear were to give the engine a speed above 3000 rpm, the gear will not be engaged and the buzzer will sound. The buzzer switches off when the lever is placed in neutral or the vehicle loses speed.

Monitoring road speed

Road-speed sensor

A control function in the control unit monitors the road speed. If the clutch is in the released position and a gear with a gear ratio of less than 8:1 is engaged (e.g., gears 2 to 7 in the GR801), the control unit will expect the speed to be registered by the road-speed sensor.

If the reading is incorrect or is interpreted as zero by the control unit for a period of ten seconds, the buzzer will issue an alarm and the selection of a higher gear or neutral only will be permitted. The fault can be due to a short circuit or break.

Clutch pedal switches

An upper and a lower switch are located by the clutch pedal. They inform the control unit by signal whether the pedal is in the released or depressed position.

Both switches must be functioning correctly for a gear-changing operation to be permitted. If one of them is issuing a faulty signal, changing to a higher gear or neutral only will be allowed.

The upper switch registers even slight depressions of the clutch which means that erroneous information can be transmitted to the control unit if the driver is driving with his foot on the clutch pedal.

If there is a break in one of the clutch pedal switches it will not be possible to change gear.

To restart the control unit:

- Switch off the engine.
- Restart the engine.

Time delay for reverse gear

When the driver selects the reverse gear, there is a delay of three seconds before the gear is engaged in order to protect the gearbox.

Gear lock

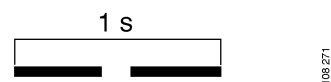
An interlock valve in the gear lever housing locks the CS lever in the drive position if the engine is switched off when a gear is still engaged. To engage neutral in the gearbox, the driver must first declutch and place the CS lever in the neutral position. If this is not done, low air pressure can make it difficult to depress the clutch pedal when the engine is restarted.

Protection against emergency gear-changing in normal conditions

If the emergency gear-changing function is used in normal driving conditions, the control unit will command the gearbox to engage neutral and remain there for as long as the vehicle is moving. The control unit will then disconnect itself permitting only the emergency gears to be used. If the control unit is to resume its operational functions, the power supplied to the control unit must be broken and the knob placed in position D.

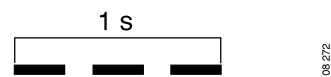
Buzzer signals

Short buzzer signals warn the driver not to leave the vehicle with a gear engaged and the engine switched off. Because the clutch is worked by compressed air, it will become difficult to operate if the vehicle stands sufficiently long for the compressed air system to lose all pressure. The signal is emitted for ten seconds.



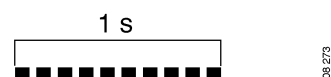
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Rapid signals are a warning that the road-speed reading is incorrect.



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Ultra-rapid buzzer signals inform the driver that the overrevving protection has been connected.



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Fault messages

Some fault messages appear on the gear display when the vehicle is on the road.

- ”CODEPLUG” The code plug is faulty, missing or undefined.¹⁾
- ”BLACKBOX” Internal fault in the control unit.¹⁾
- ”ERROR1” The display is receiving faulty signals from the control unit.²⁾
- ”ERROR2” The display is not receiving any signals from the control unit.²⁾

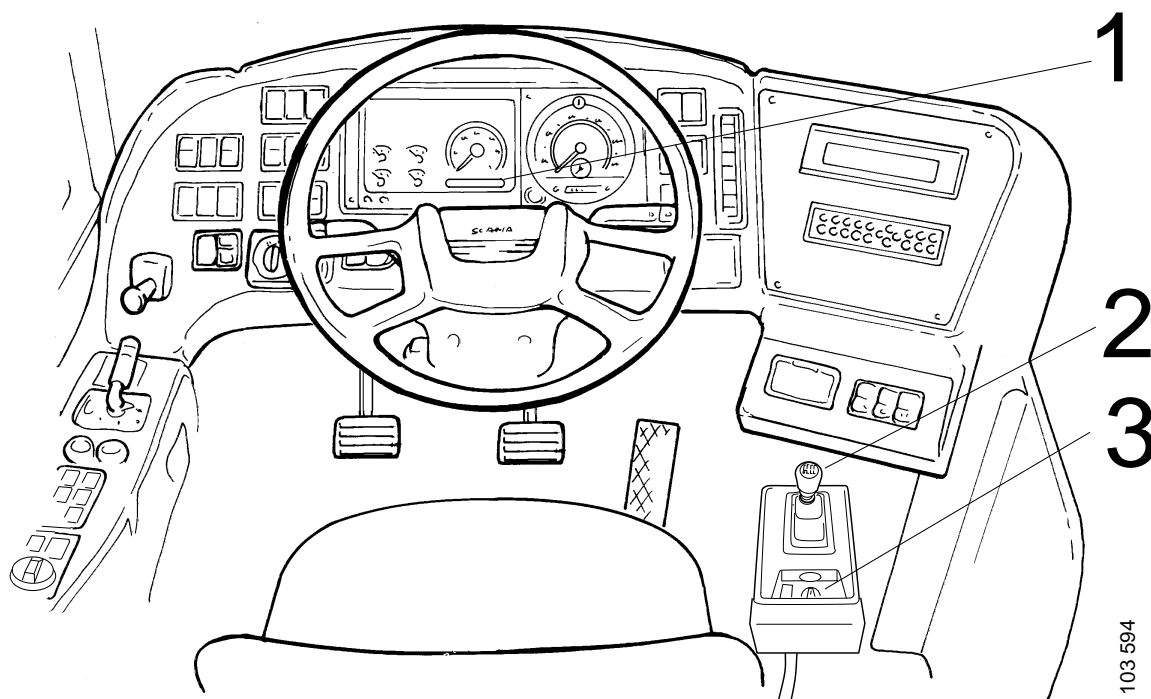


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¹⁾ The vehicle cannot be driven without engaging the emergency gear-changing function.

²⁾ The control unit is working normally but the driver is not receiving information concerning the gear engaged.

Location of controls



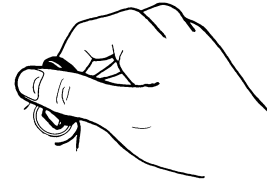
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- 1 Gear display and buzzer
- 2 CS lever
- 3 Emergency gear-changing knob

Driving

Starting the engine

- 1 Turn the starter key to the drive position.
- 2 Declutch if the gear display doesn't show N.
Move the gear lever into neutral.



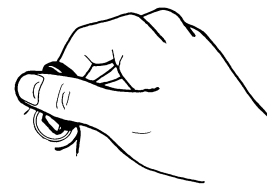
The gearbox will engage neutral providing there is sufficient air pressure.

If the air pressure is insufficient, depress the clutch pedal when starting the engine. The pedal will be difficult to operate if there is no pressure in the system.

- 3 The gear display shows N.

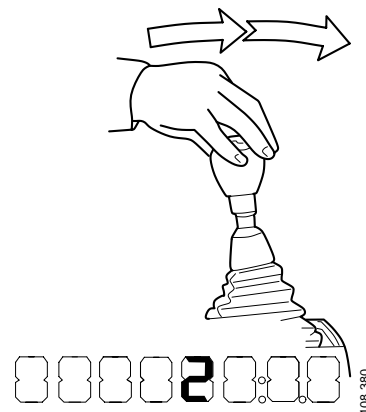


- 4 Start the engine.



Starting the vehicle

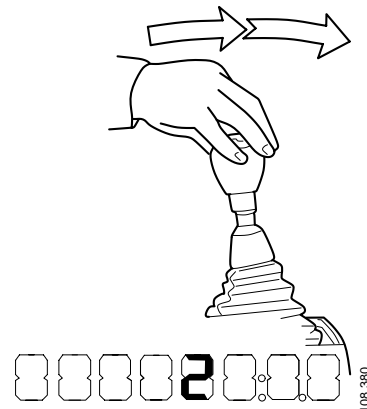
- 1 Declutch.
- 2 Select the starting gear with the CS lever.
When the movement is completed an acknowledgement is sent to the control unit which then sends a signal to the gear lever. The lock is released and the CS lever can be moved into the drive position.
- 3 Release the parking brake.
- 4 Release the clutch and accelerate.



Changing gear

Changing gear without pre-selection

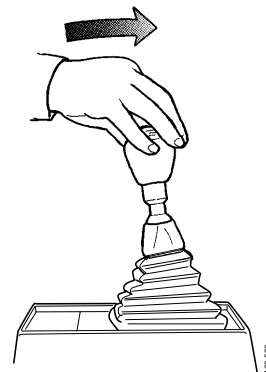
- 1 Declutch.
- 2 Move the gear lever into the desired gear-changing position. When the change has been completed in the gearbox, the CS lever can be moved into the drive position.
- 3 Release the clutch.



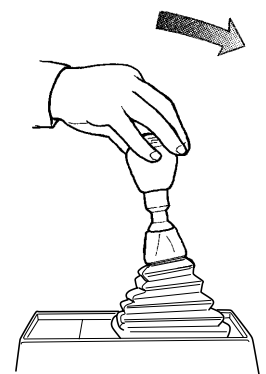
Changing gear with pre-selection

When a gear has been engaged, the CS lever can be moved out of the drive position without depressing the clutch and moved into another gear-changing position for pre-selection.

- 1 Move the CS lever into the desired gear-changing position. Hold the lever in place or else it will return to the neutral position.



- 2 Declutch, after which the gear engages in the gearbox and the CS lever can be moved into the drive position.
- 3 Release the clutch.

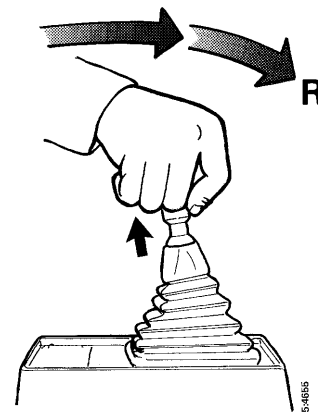
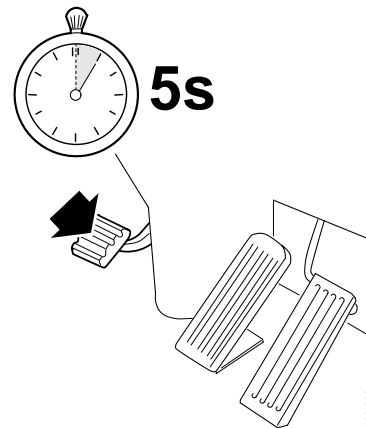


Reversing

Changing gear without pre-selection

Note: observing the correct order is important. The vehicle must be stationary, otherwise the gearbox can become damaged.

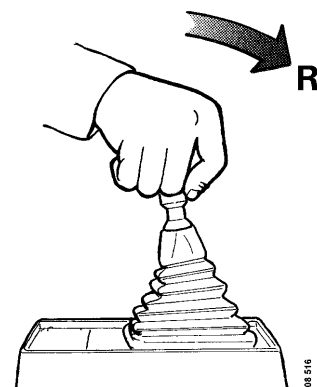
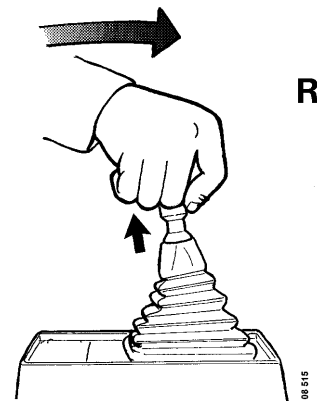
- 1 Declutch and wait five seconds.
- 2 Lift the sleeve under the CS lever and move the lever into the reverse gear-changing position.
- 3 When reverse has been engaged and the lock released, move the CS lever into the drive position.
- 4 Release the clutch and accelerate.



Changing gear with pre-selection

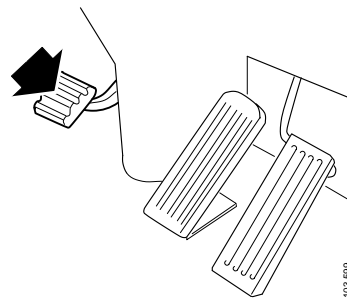
The vehicle must be stationary, otherwise the gearbox can become damaged. The gearbox should be in neutral.

- 1 Lift the sleeve under the CS lever and move the lever into the reverse gear-changing position.
- 2 Declutch. After three seconds, the gear engages in the gearbox, the lock is released and the CS lever can be moved into the drive position.
- 3 Release the clutch and accelerate.



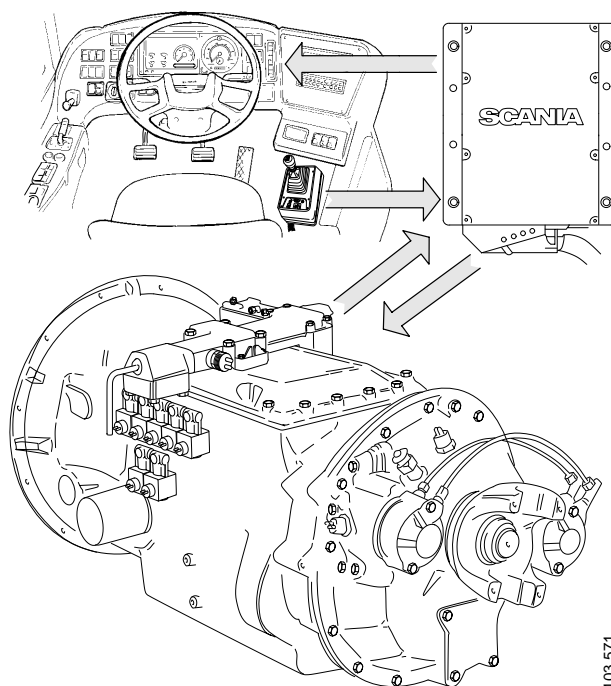
Parking

- 1 Declutch.
- 2 Place the CS lever in neutral. The gear display shows N.
- 3 Apply the parking brake.
- 4 Short buzzer signals warn if the gearbox is not in neutral when the engine is switched off. The signals are emitted for ten seconds.



Signal paths

The control unit receives information from various functions. Gear selection is controlled by the CS lever. When the clutch pedal is depressed, the control unit receives an order to change gear. The signal is sent to the solenoid valves which perform the operation using compressed air. A lock in the CS lever indicates that the gear-changing operation is completed. The buzzer in the gear display warns of any malfunctioning.



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Signal to the control unit from:	The control unit notes:
The road-speed sensor	Current road speed.
The position sensors	Gear engaged and gear-changing movements completed.
The CS lever	The control unit notes the gear selected.
The clutch pedal switches (2)	The position of the clutch pedal.

Signal from the control unit to:	Results in:
The gear display	A symbol in the middle in a steady light - gear engaged.
The buzzer	Gives warning of malfunctioning.
The solenoid valves	Control the gear-changing process.
The interlock valve in the CS lever	Marks the completed gear-change.

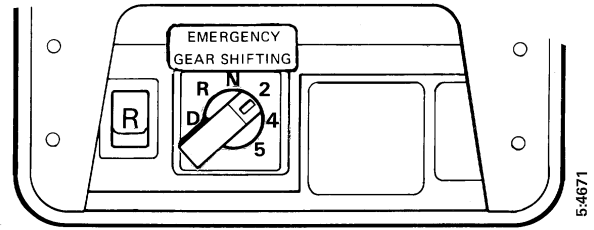
Emergency gear-changing

If the CS system is not working, the emergency gear-changing system can be used instead.

It can be used if there is a fault in the CS lever, control unit or position sensors. However, the compressed air system, compressed air cylinders and solenoid valves must all be working.

Switching to the emergency gear-changing function is made via a knob located under a hatch in the gear lever housing. Reverse (R) and three forward gears (2, 4 and 5) are accessible.

If the emergency function is not working due to a fault in the control unit then the control unit must be disconnected by detaching the 55-pole connector.

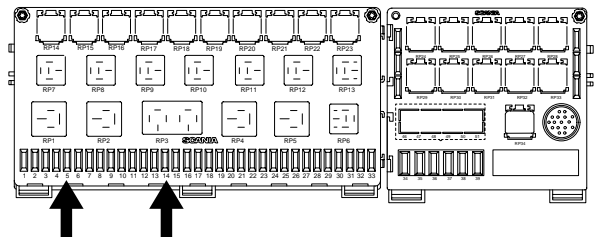


Gear display

Because the emergency gear-changing function is used when there is a fault in the CS system, it is possible that the information shown in the gear display regarding the gear engaged is not correct.

Preparations for emergency gear-changing

Check fuses 5 and 14 and replace them if necessary.



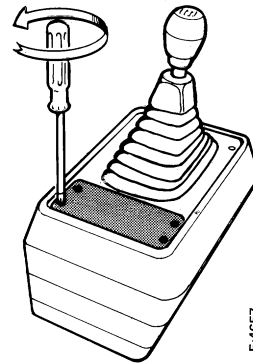
Driving with the emergency gear-changing function

Unscrew the hatch behind the CS lever.



WARNING!

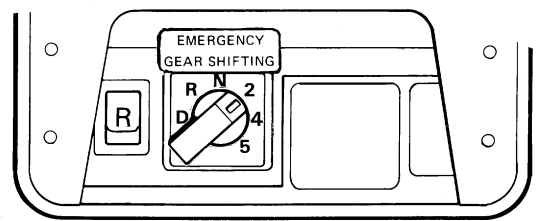
The emergency function is not equipped with overrevving protection. Exercise great care when changing gear.



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Driving forward

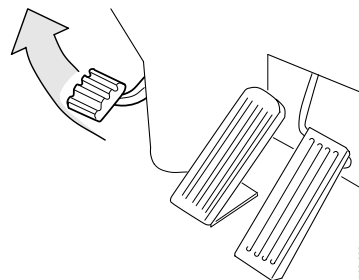
- 1 Declutch.
- 2 Turn the knob to position 2.



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- 3 Release the clutch and accelerate.

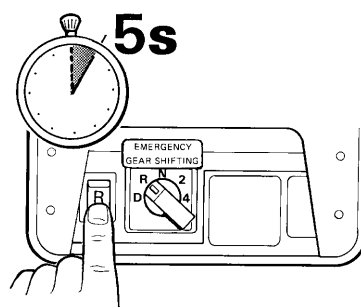
Select the other gears using the emergency knob and declutch as usual.



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Reversing

- 1 Declutch.
- 2 Turn the knob to position R.
- 3 Press the switch to the left of the knob and keep it pressed for five seconds.
- 4 Release the clutch and accelerate.



After driving with the emergency gear-changing function

IMPORTANT! The knob should be in position D when the emergency gear-changing function is not in use.

