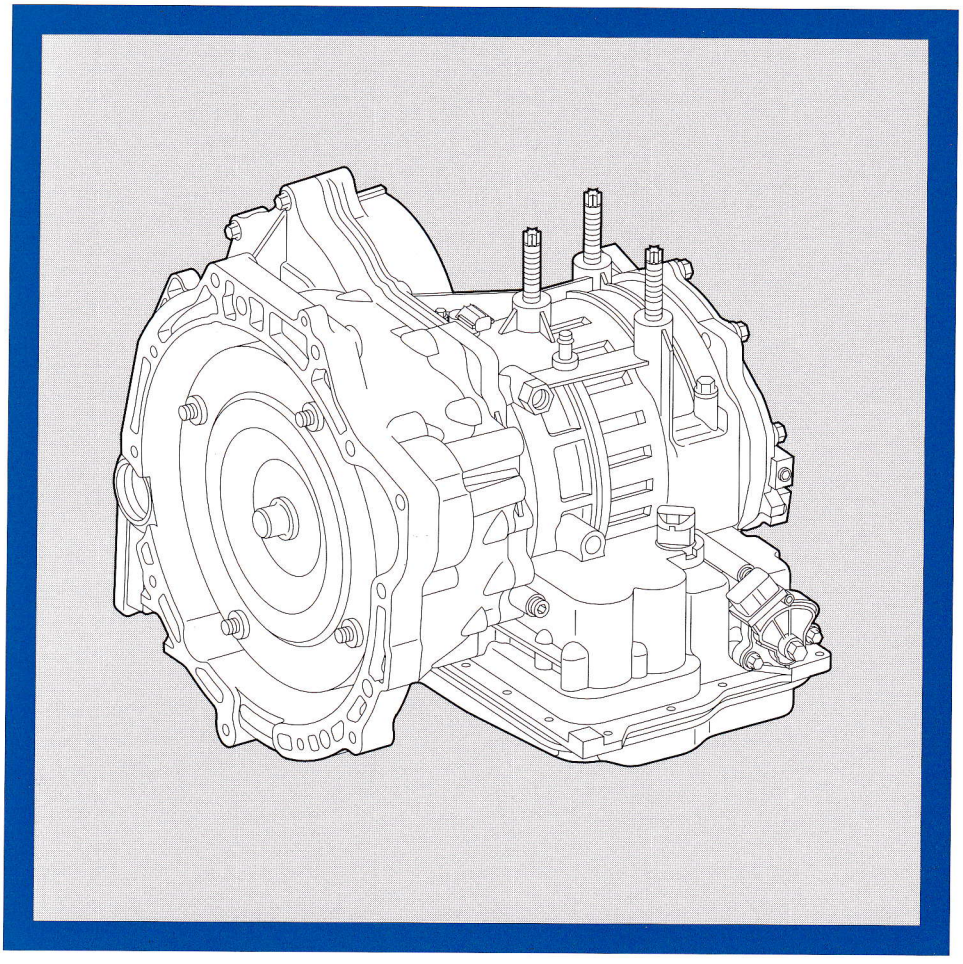
T4

Technical Service Training

Focus

New Product Introduction 00/272

4F27E Automatic Transmission



Student Information

CG 7748/S en 6/98

With the 1999 model year the Escort is superseded by a new generation vehicle, the FOCUS. This new innovative medium-sized vehicle incorporates the latest technical developments and modified components and systems from existing Ford vehicles.
The object of the "FOCUS" course is to present the vehicle and familiarize you with the vehicle components and systems. To this end, the training literature has been split into the following publications based on the main areas:

- New Product Introduction 00/269 "Focus", CG 7745/S
- New Product Introduction 00/270 "Focus – Body", CG 7746/S
- New Product Introduction 00/271 "Focus – 1.8L Endura-DI Turbocharged Intercooled Diesel Engine", CG 7747/S
- **New Product Introduction 00/272 "Focus – 4F27E Automatic Transmission", CG 7748/S**
- New Product Introduction 00/273 "Focus – Overview", CG 7749/S

This New Product Introduction gives an overview of the new four-speed automatic transmission developed for the Focus. The design and operation of the different assemblies of the transmission and the components of the transmission control system are described in detail.

Electronic synchronous shift control (ESSC) is used for the first time in the Focus and guarantees extremely smooth gear shifting over the entire life of the transmission.

The automatic transmission has been designed for front wheel drive vehicles and is available with the new 1.6L Zetec-SE petrol engine from the 1999 3/4 MY onwards.

Please remember that our training literature has been prepared solely for FORD TRAINING PURPOSES. Repair and adjustment operations **MUST** always be carried out according to the instructions and specifications in the workshop literature.
Please make extensive use of the training courses offered by Ford Technical Training Centres to gain extensive knowledge in both theory and practice.

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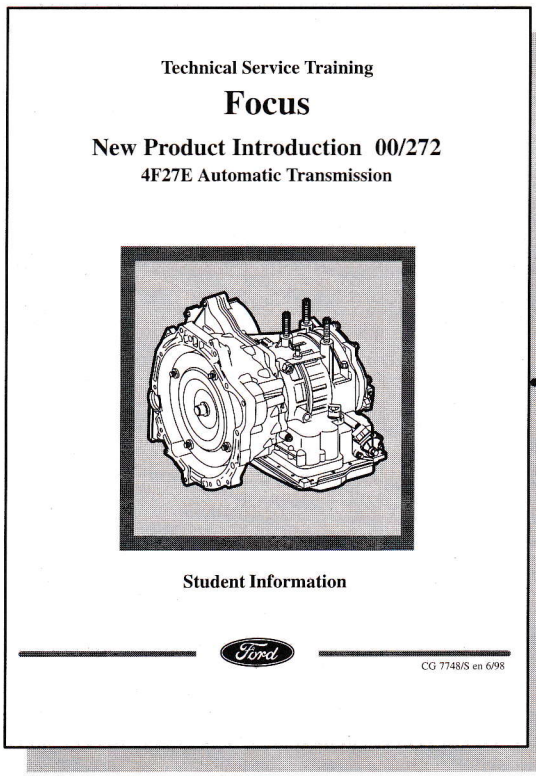


New Product Introduction 00/269
"Focus", CG 7745/S

New Product Introduction 00/270
"Focus – Body", CG 7746/S

New Product Introduction 00/271
"Focus – 1.8L Endura-DI Turbocharged Intercooled Diesel Engine", CG 7747/S

New Product Introduction 00/273
"Focus – Overview", CG 7749/S

Video
"Focus", CG 7751/V

General

- The automatic transmission used in the Focus is a new development.
- It is a fully automatic, electronically controlled four-speed transmission designed for front wheel drive vehicles.
- Its abbreviated designation 4F27E means:

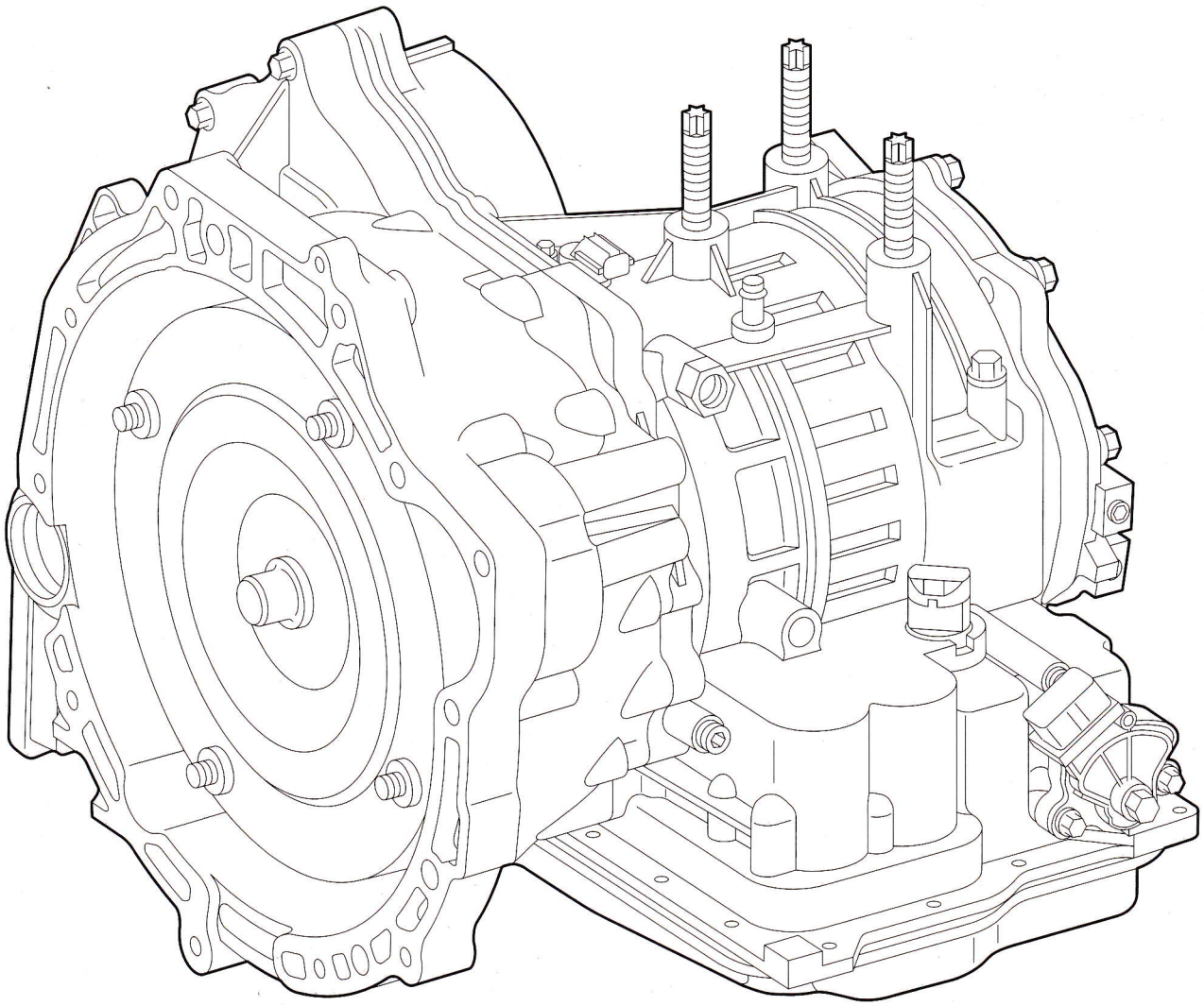
  4 – four-speed transmission

  F – front wheel drive

  27 – maximum input torque after torque converter: 270 lb·ft (365 Nm)

  E – fully electronic control

- Mazda in Japan has developed the transmission specifically for use in the Focus.
- It is produced by Ford in Van Dyke, Michigan (USA).
- From the 1999 3/4 MY it is initially offered solely in conjunction with the 1.6L Zetec-SE engine.
- The individual ratios are achieved through two planetary gear sets connected one behind the other.
- The individual components of the planetary gear sets are driven or locked by means of three multiplate clutches, a multiplate brake, a brake band and a roller one-way clutch.
- The torque is transmitted to the final drive assembly through an intermediate gear stage.
- The transmission fluid is designed to be used for the life of the transmission and must not be changed.
- Initially, no repair operations are planned for the automatic transmission, apart from changing various seals.
- The electrical and hydraulic functions are carried out by a 104-pin EEC V powertrain control module.
- The manual selector lever gives the driver a choice of "P", "R", "N", "1", "2" and "D".
- In drive range "D" it is also possible to operate an O/D switch on the manual selector lever to prevent the transmission shifting into 4th gear or to shift down to 3rd gear.
- To minimize fuel consumption, the torque converter lock-up clutch is closed by the PCM in 3rd and 4th gears depending on the throttle position and vehicle speed.
- The transmission has electronic synchronous shift control (ESSC) which guarantees extremely smooth gear shifting over the entire life of the transmission.
- A hydraulic emergency operating program maintains limited operation in the event of failure of important electrical components.
- The transmission can be tested using FDS 2000 through the data link connector (DLC) in the passenger compartment.



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Transmission design

- Four-speed automatic transmission (for front wheel drive vehicles)
- Two single planetary gear trains connected one behind the other
- The components of the planetary gear trains are driven or locked hydraulically by means of multiplate clutches and brakes, a one-way clutch and a brake band
- Intermediate gear stage and final drive assembly incorporated in the transmission housing
- Electronically controlled, hydraulically closed torque converter lock-up clutch
- Stator made of synthetic resin (to reduce weight)

Ratios in the individual transmission ranges

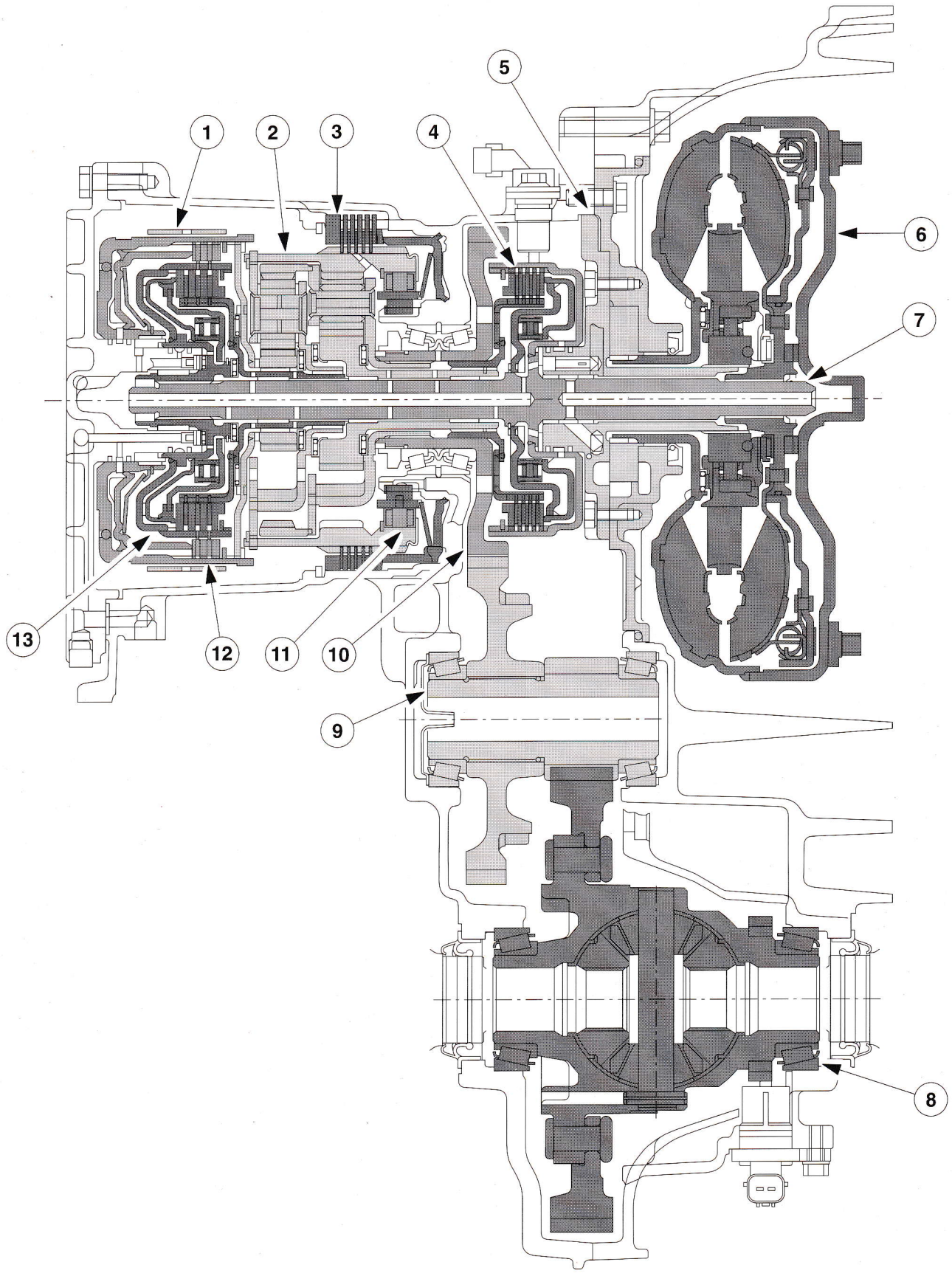
- 1st gear: 2.816 : 1
- 2nd gear: 1.498 : 1
- 3rd gear: 1.000 : 1
- 4th gear: 0.726 : 1
- Reverse gear: 2.649 : 1

Transmission control

- Electronic synchronous shift control (ESSC)
- Integrated in the EEC V PCM
- O/D switch to deselect and select 4th gear

Diagnosis and testing

- Diagnosis and testing with FDS 2000 through the data link connector (DLC) in the passenger compartment



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Key to the illustration opposite

1 2nd/4th gear brake band

2 Planetary gear sets

3 Reverse gear brake

4 1st – 3rd gear clutch

5 Fluid pump and stator support

6 Torque converter

7 Transmission input shaft

8 Differential

9 Intermediate gear stage

10 Transmission output gear

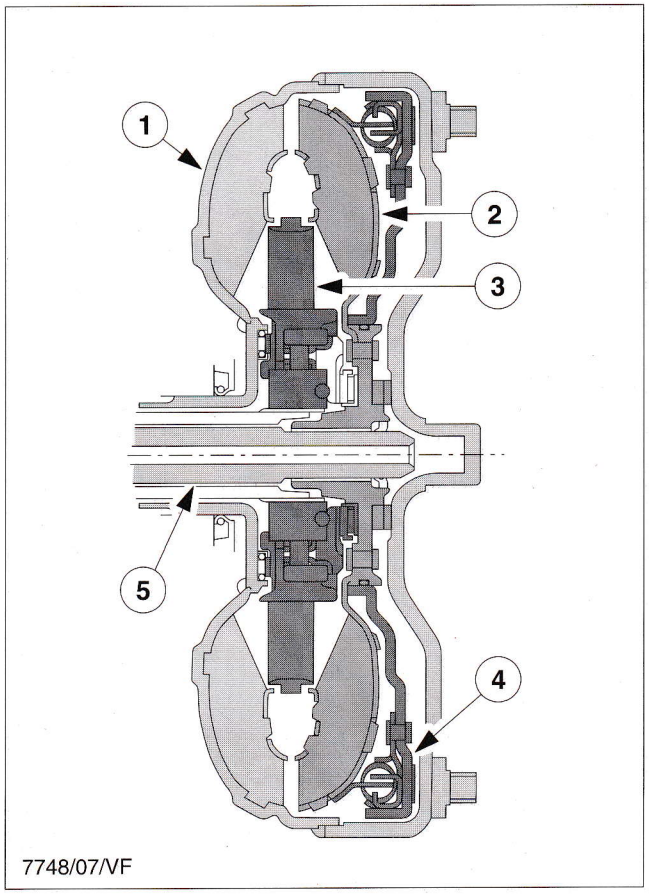
11 1st gear one-way clutch

12 Reverse gear clutch

13 3rd/4th gear clutch

Torque converter and torque converter lock-up clutch

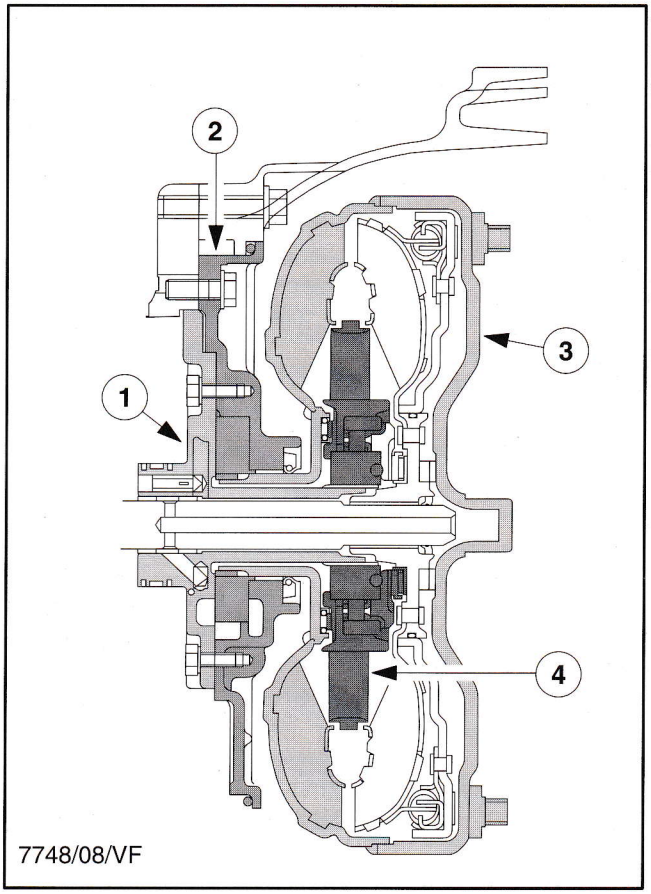
- The torque converter transmits the engine torque hydraulically to the transmission input shaft.
- The stator boosts the torque to the clutch point (approx. 85% difference in speed between the impeller and the turbine).
- The stator is made of synthetic resin to reduce the weight.
- To increase the efficiency of the automatic transmission, the torque converter has a closable torque converter lock-up clutch. When the torque converter lock-up clutch is closed, the torque is transmitted directly from the crankshaft through the torque converter housing to the transmission input shaft.
- The torque converter lock-up clutch is closed hydraulically by the PCM by means of the solenoid valves in the valve body in 3rd and 4th gears depending on the throttle position, vehicle speed and manual selector lever position.



1 Converter housing and impeller
2 Turbine
3 Stator
4 Torque converter lock-up clutch
5 Transmission input shaft

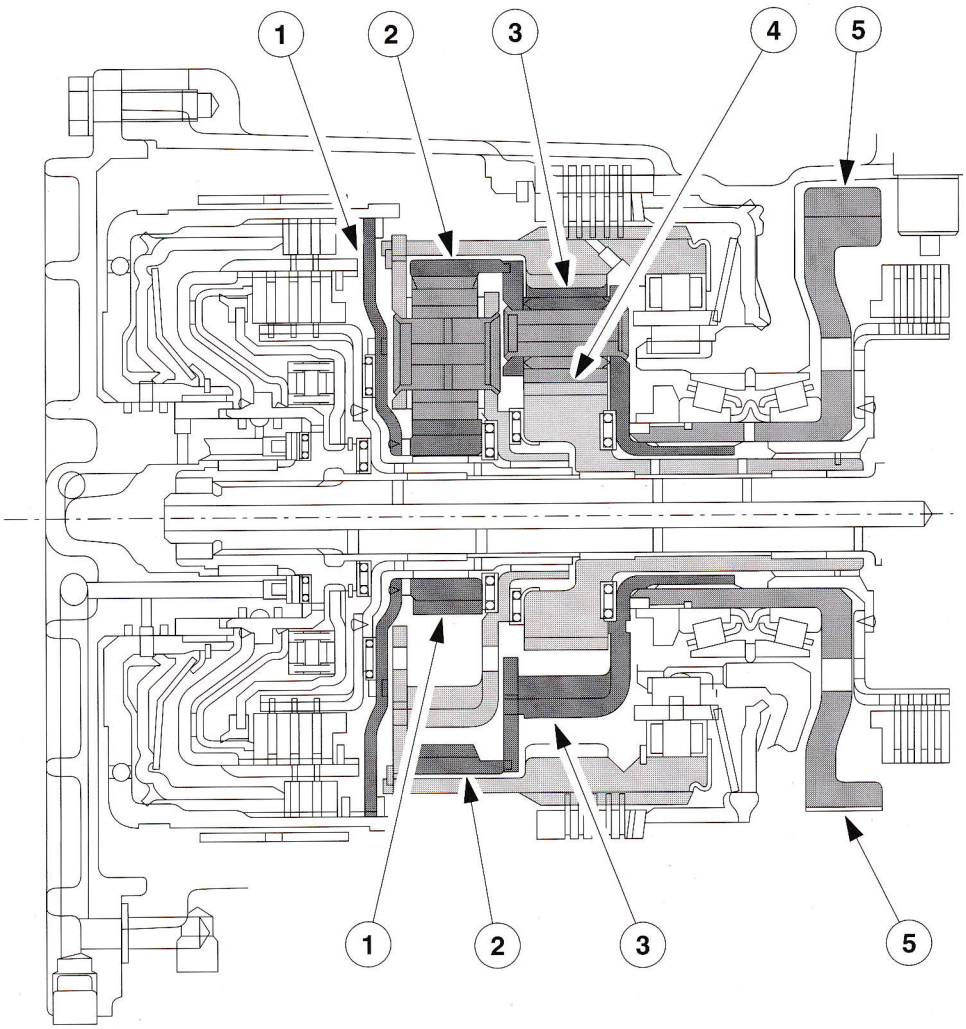
Fluid pump and stator support

- The fluid pump is a crescent gear pump and is driven directly from the crankshaft by means of drivers on the converter housing. The fluid pump is bolted to the transmission housing.
- The stator support is bolted to the fluid pump. It engages by means of splines in the stator and serves as support for this.



1 Stator support
2 Fluid pump
3 Converter housing
4 Stator

Planetary gear sets



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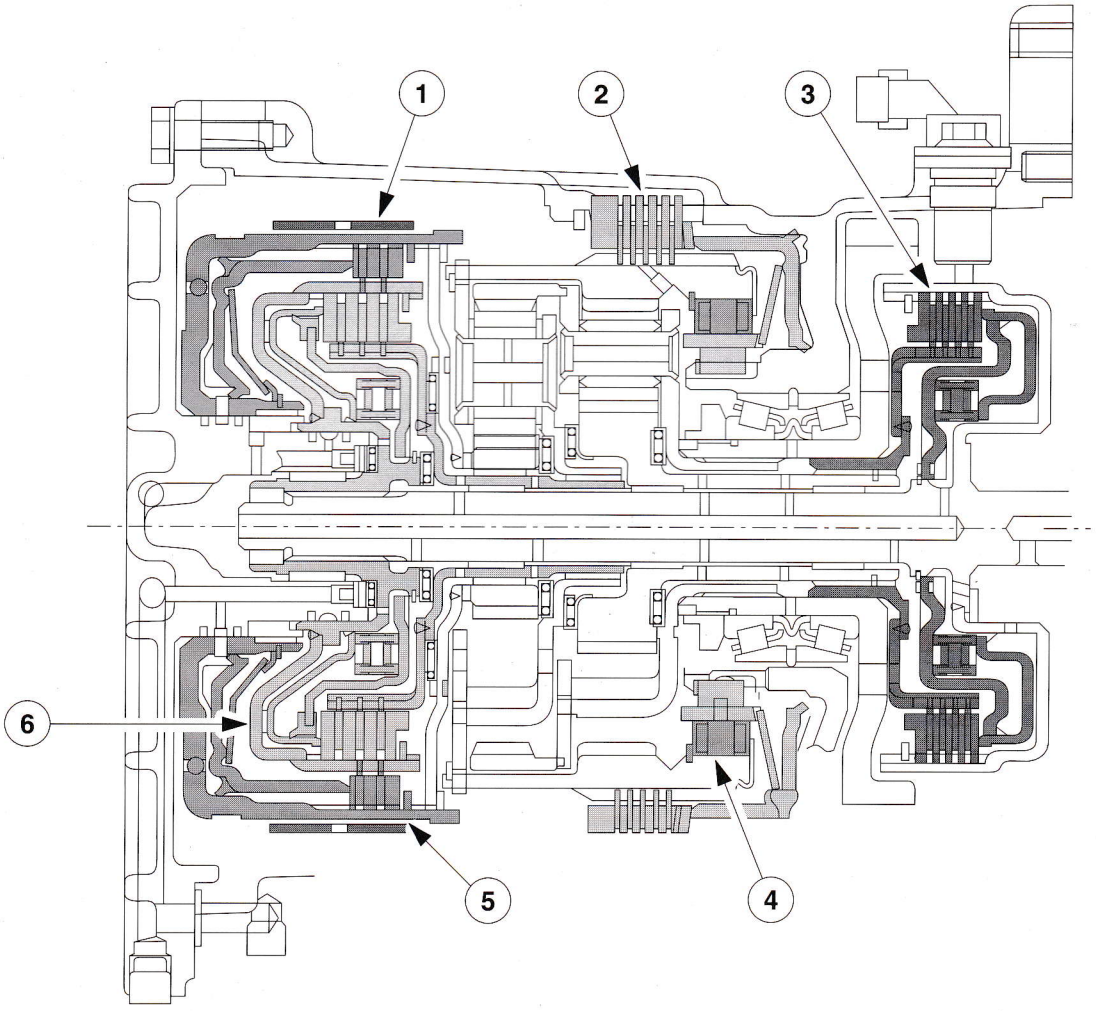
1 Sun wheel (2nd set)
2 Planet carrier (2nd set) and annulus (1st set)
3 Annulus (2nd set) and planet carrier (1st set)
4 Sun wheel (1st set)
5 Transmission output gear

- The individual gears are shifted by means of two planetary gear sets connected one behind the other. The following fixed connections exist between the planetary gear sets:
  - Planet carrier (1st set) – annulus (2nd set)
  - Planet carrier (2nd set) – annulus (1st set)
- At the output end the drive always passes from the planet carrier of the first planetary gear set through the transmission output gear to the primary gear of the intermediate gear stage.

Clutches and brakes



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1 2nd/4th brake band
2 Reverse gear brake
3 1st – 3rd gear clutch
4 1st gear one-way clutch
5 Reverse gear clutch
6 3rd/4th gear clutch

- The individual ratios are selected by means of three multiplate clutches, a multiplate brake, a brake band and a roller one-way clutch.
- The components concerned receive the required pressure from pulse width modulation (PWM) solenoid valves.

1st gear

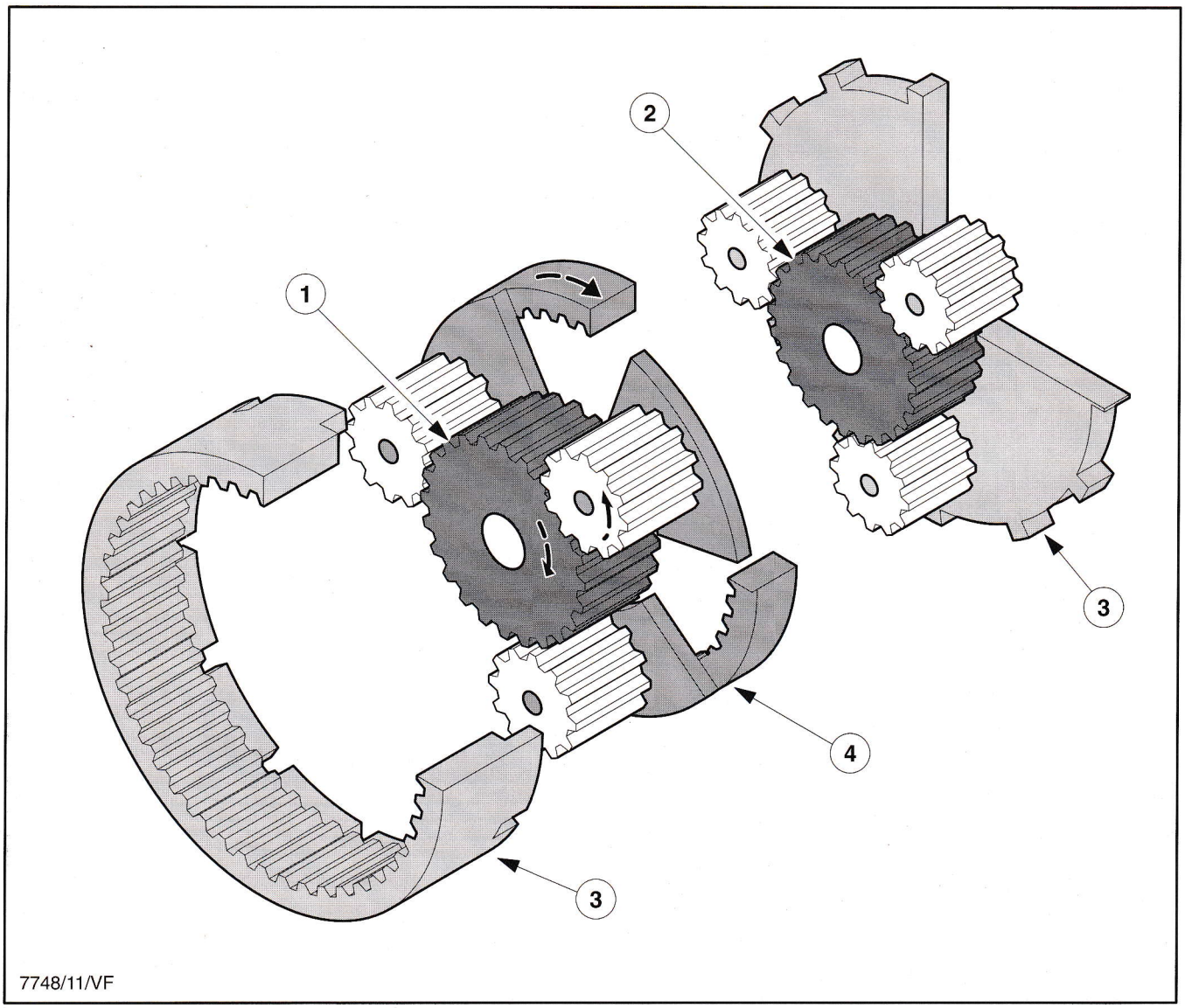


Illustration of principle

1 Sun wheel (1st set)
2 Sun wheel (2nd set)
3 Annulus (1st set) and planet carrier (2nd set)
4 Planet carrier (1st set) and annulus (2nd set)

- At the input end the drive passes through the sun wheel (1st set) (1).
- The annulus (1st set) and planet carrier (2nd set) (3) are locked by means of the 1st gear one-way clutch. No engine braking effect is produced in manual selector lever position "D" in overrun.
- In manual selector lever position "1" engine braking effect is obtained through the additional operation of the reverse gear brake.
- The planet gears roll on the annulus (1st set) (3).
- At the output end the drive (not shown) passes through the planet carrier (1st set) (4).

NOTE: The relative movements in the second planetary gear set have no effect on the gear ratio.

2nd gear

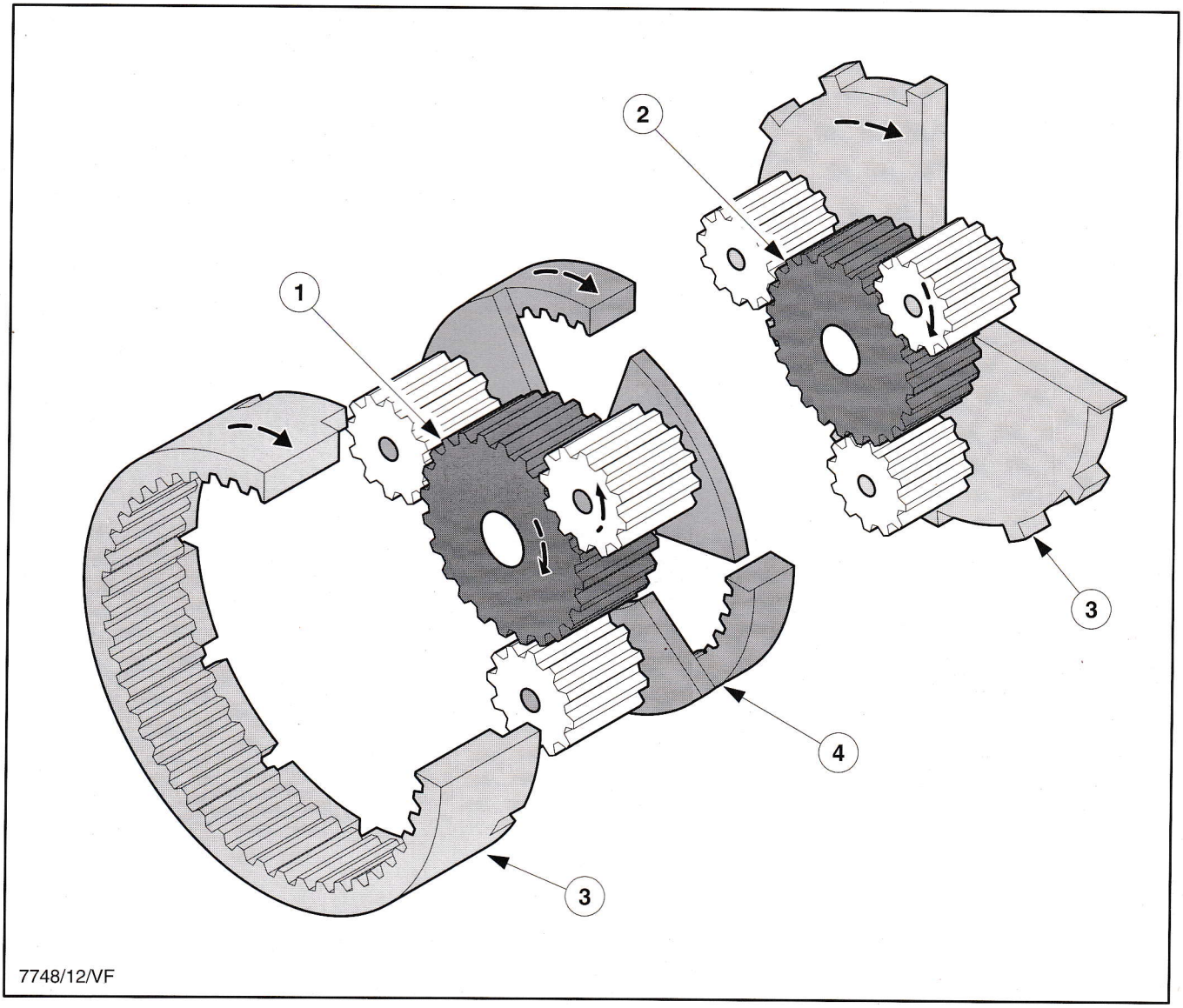


Illustration of principle

1 Sun wheel (1st set)
2 Sun wheel (2nd set)
3 Annulus (1st set) and planet carrier (2nd set)
4 Planet carrier (1st set) and annulus (2nd set)

- At the input end the drive passes through the sun wheel (1st set) (1).
- The planet gears roll on the annulus (1st set) (3). This drives the planet carrier (1st set) and the annulus (2nd set) (4).
- The sun wheel (2nd set) (2) is locked. The planet gears (2nd set) bear on it.
- The planet carrier (2nd set) and the annulus (1st set) (3) are driven.
- As the annulus (1st set) (3) turns in the normal direction of rotation of the engine, the relative movement of the planet gears (1st set) is reduced.
- At the output end the drive (not shown) passes through the planet carrier (1st set) (4).

3rd gear

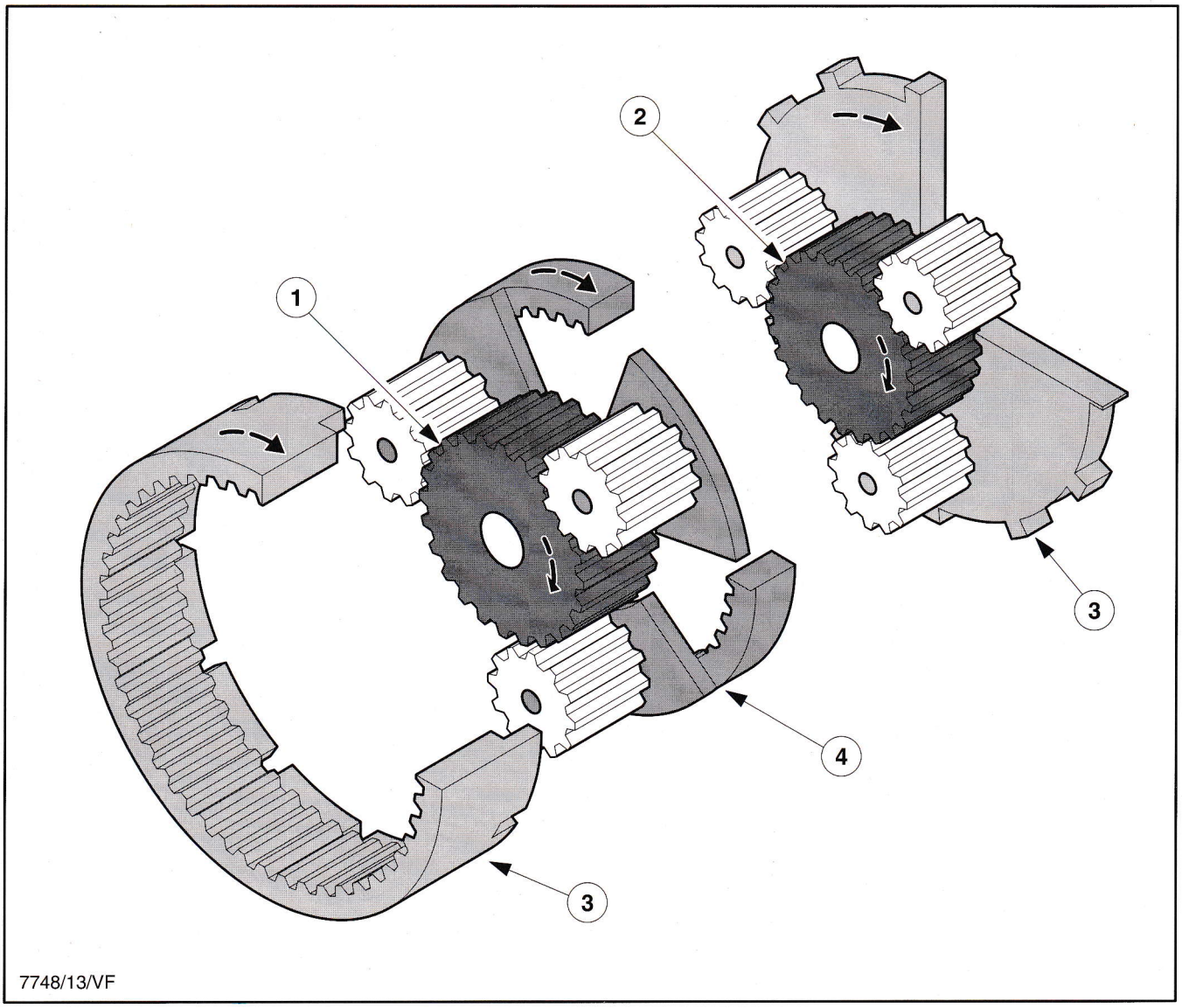


Illustration of principle

1 Sun wheel (1st set)
2 Sun wheel (2nd set)
3 Annulus (1st set) and planet carrier (2nd set)
4 Planet carrier (1st set) and annulus (2nd set)

- At the input end the drive passes firstly through the sun wheel (1st set) (1) and secondly through the planet carrier (2nd set) and the annulus (1st set) (3).
- At the input end the drive in the first planetary gear set passes simultaneously through two components. Therefore, no relative movements take place. The planetary gear set turns as a whole.
- At the output end the drive (not shown) passes through the planet carrier (1st set) (4).

4th gear

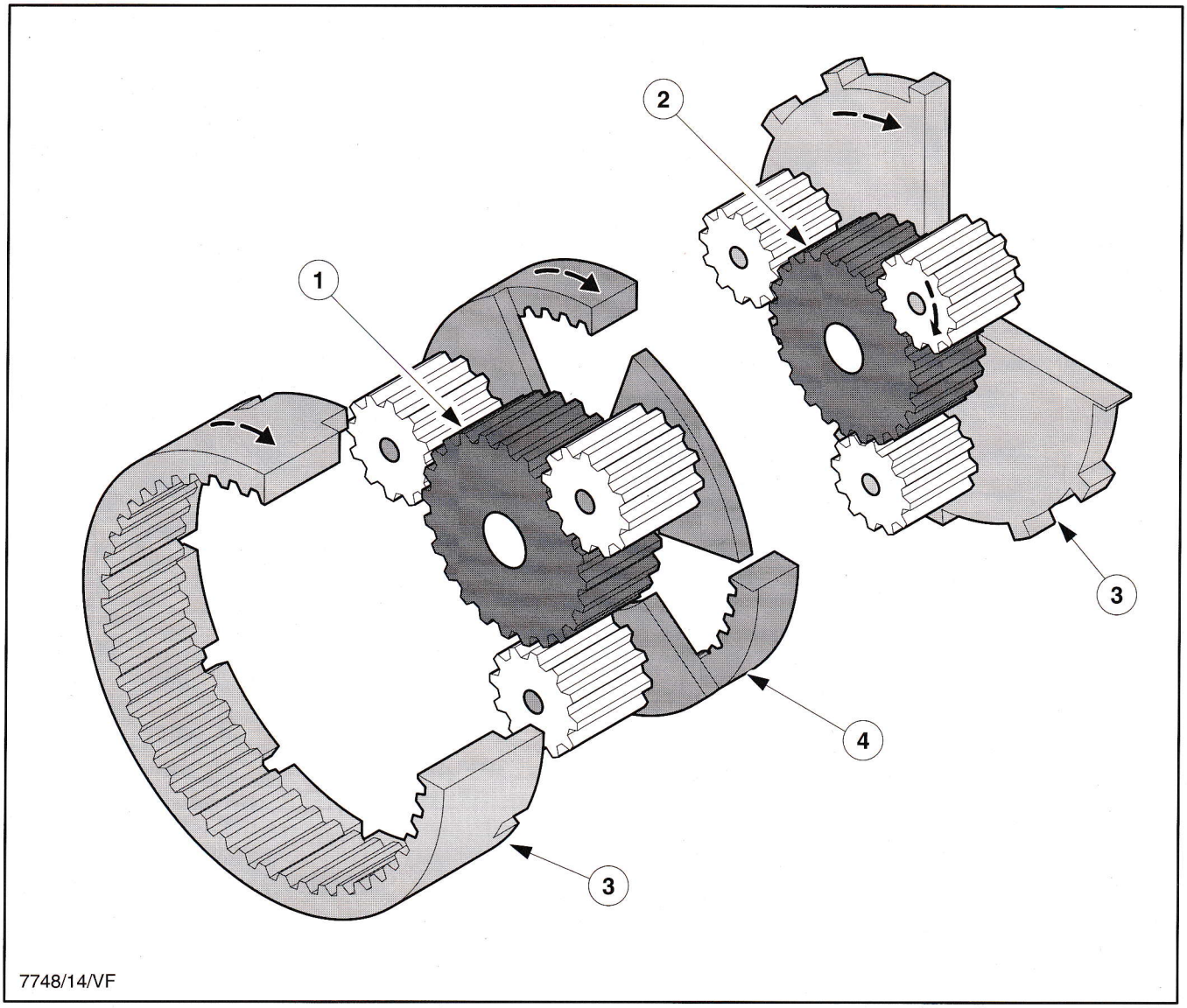


Illustration of principle

1 Sun wheel (1st set)
2 Sun wheel (2nd set)
3 Annulus (1st set) and planet carrier (2nd set)
4 Planet carrier (1st set) and annulus (2nd set)

- At the input end the drive passes through the planet carrier (2nd set) and the annulus (1st set) (3).
- The sun wheel (2nd set) (2) is locked.
- The planet gears roll on the sun wheel (2nd set) (2) and drive the annulus (2nd set) and the planet carrier (1st set) (4).
- At the output end the drive (not shown) passes through the planet carrier (1st set) (4).

NOTE: The relative movements in the first planetary gear set have no effect on the gear ratio.

Reverse gear

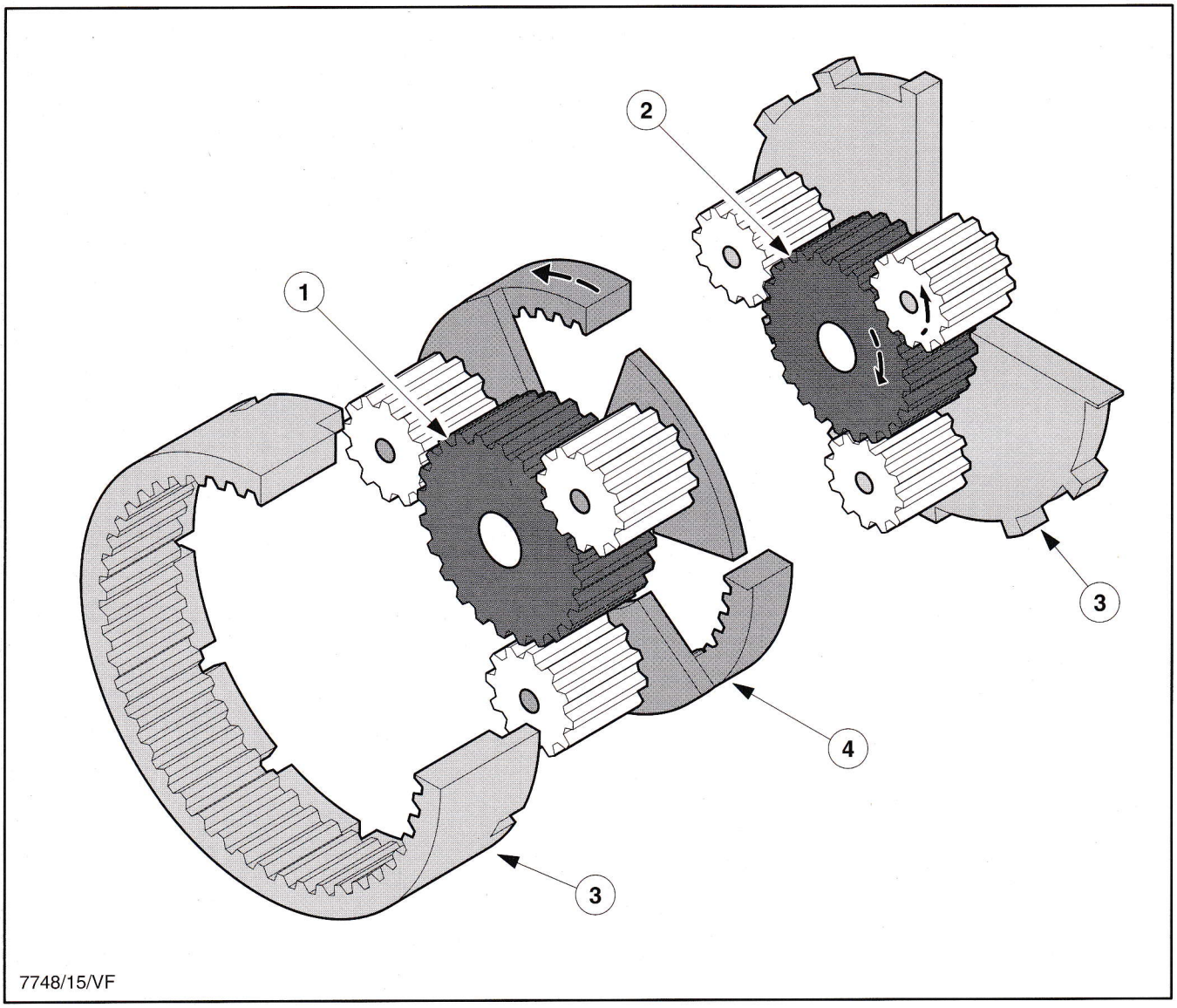


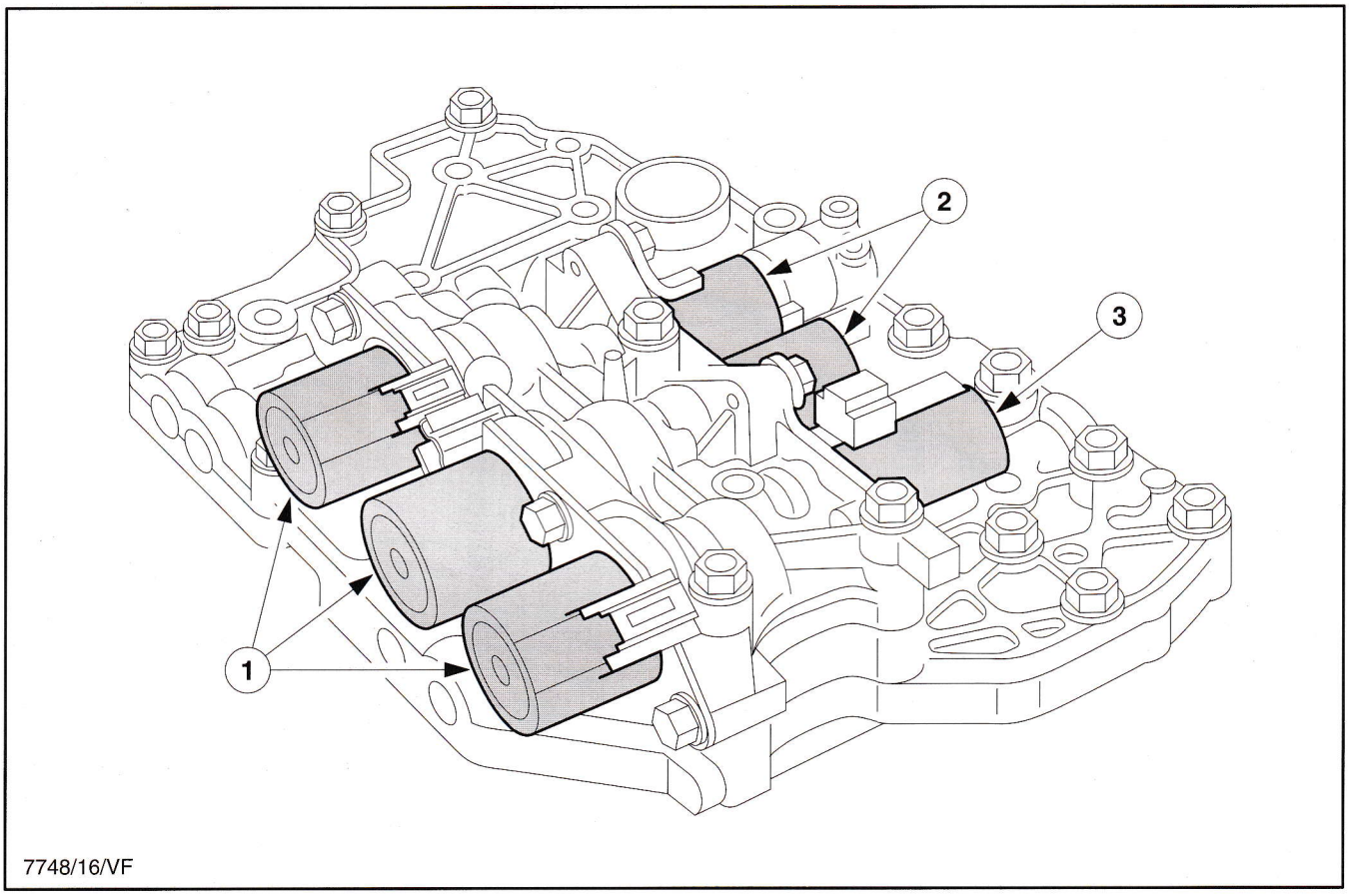
Illustration of principle

1 Sun wheel (1st set)
2 Sun wheel (2nd set)
3 Annulus (1st set) and planet carrier (2nd set)
4 Planet carrier (1st set) and annulus (2nd set)

- At the input end the drive passes through the sun wheel (2nd set) (2).
- The annulus (1st set) and the planet carrier (2nd set) (3) are locked.
- The planet gears of the second planetary gear set drive the annulus (2nd set) and the planet carrier (1st set) (4) counter to the normal direction of rotation of the engine.
- At the output end the drive (not shown) passes through the planet carrier (1st set) (4).

NOTE: The relative movements in the first planetary gear set have no effect on the gear ratio.

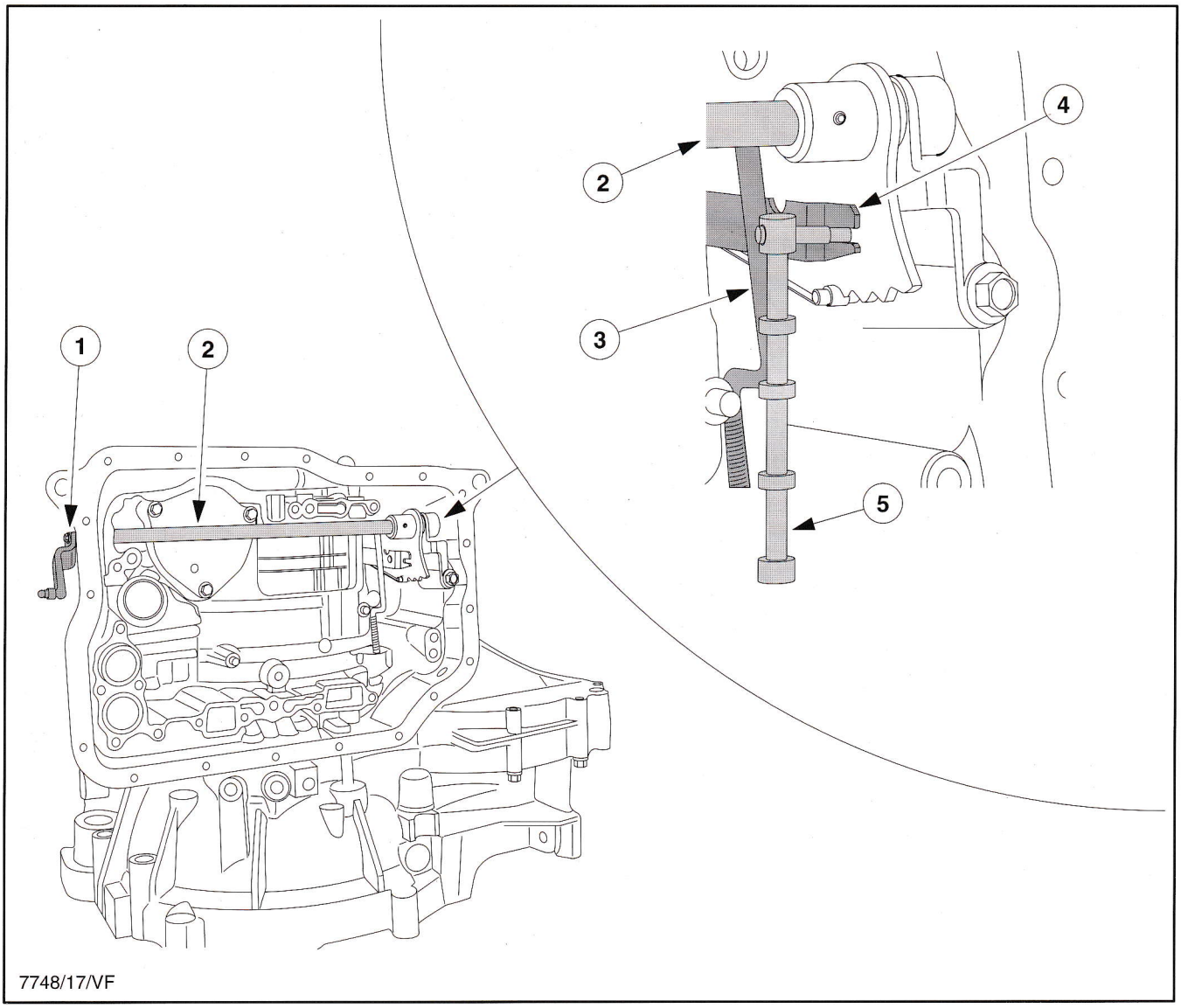
Valve body



1 PWM solenoid valves
2 Shift solenoid (on/off) valves
3 Main regulating valve (variable force solenoid – VFS)

- The valve body contains six solenoid valves:
  - three PWM solenoid valves (pulse width modulation solenoid valves),
  - two shift solenoid (on/off) valves,
  - one main regulating valve (variable force solenoid).
- The individual clutches and brakes are supplied with pressure with the PWM solenoid valves and the shift solenoid (on/off) valves and thus the gears are shifted.
- The PWM solenoid valves allow direct actuation of the clutches and brakes to be switched and ensure extremely smooth gear shifting through precise pressure regulation.
- The shift solenoid (on/off) valves switch the hydraulic path to the clutches and brakes. They reduce the number of modulating valves required.
- The main regulating valve (variable force solenoid) ensures that sufficient hydraulic pressure is available in all operating conditions.

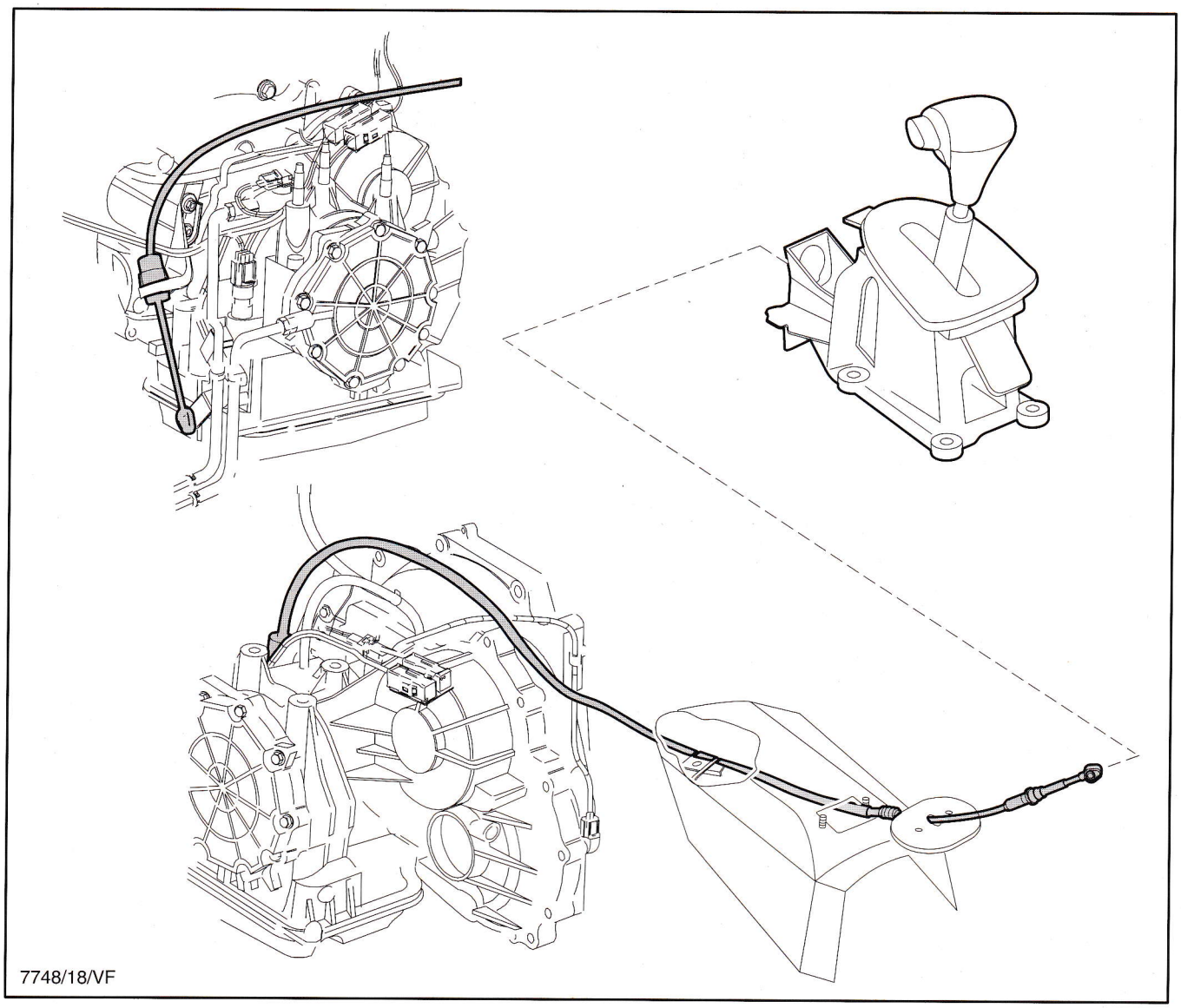
Internal shift mechanism



1 Lever on shift shaft
2 Shift shaft
3 Parking pawl engaging lever
4 Actuating lever of manual selector slide
5 Manual selector slide (in valve body which is not shown)

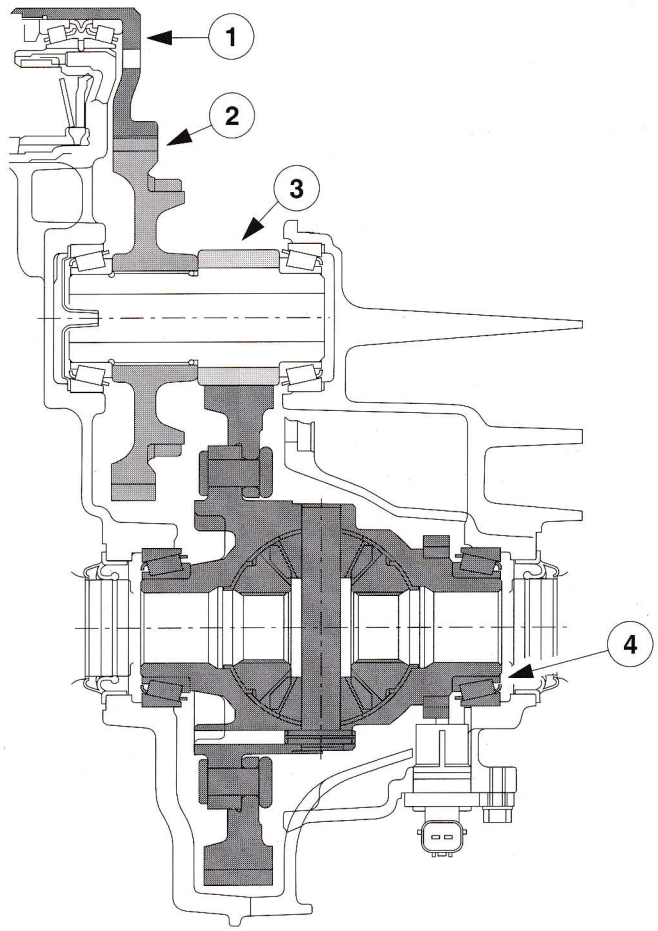
- The shift shaft lever is secured on a square on the shift shaft. Axial movement of the selector lever cable is changed into rotation of the shift shaft.
- The transmission range (TR) sensor is seated on the outer part of the shift shaft.
- In the transmission the shift shaft operates firstly the parking pawl engaging lever and secondly the actuating lever of the manual selector slide.
- The manual selector slide, a valve operated entirely manually, is moved by means of the manual selector slide actuating lever in the valve body.
- The manual selector slide guarantees the functions during hydraulic emergency operation.

External shift mechanism



- At the transmission end the manual selector lever cable is attached to a ball on the lever on the shift shaft through the TR sensor.
- The cable abutments are secured firstly to the transmission housing and secondly to the bracket of the manual selector lever.
- The adjuster for the manual selector lever cable is located at the transmission side of the sheath.
- At the manual selector lever end the cable is clipped onto a ball.

Intermediate gear stage and final drive assembly



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1 Automatic transmission output gear
2 Primary gear of intermediate gear stage
3 Secondary gear of intermediate gear stage
4 Differential

- The automatic transmission output gear is splined to the planet carrier of the front planetary gear set and drives the primary gear of the intermediate gear stage.
- The secondary gear of the intermediate gear stage drives the final drive assembly.
- The torque is transmitted to the halfshafts through the final drive assembly.
- The differential offsets differences in the speed of rotation of the halfshafts.
- The intermediate gear stage is designed so that the final drive ratio can be adapted to requirements when the automatic transmission is used in conjunction with different engine variants.

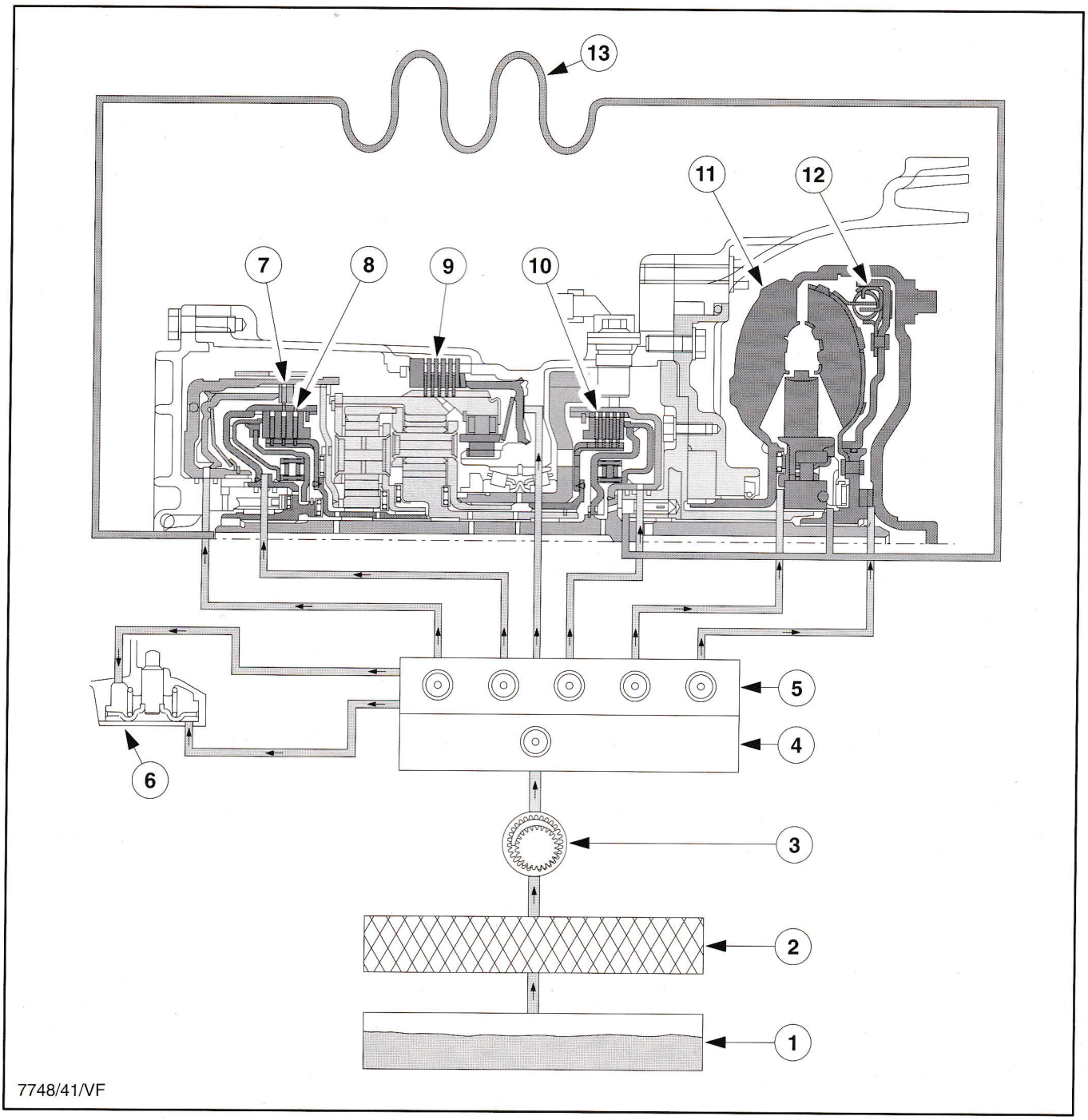
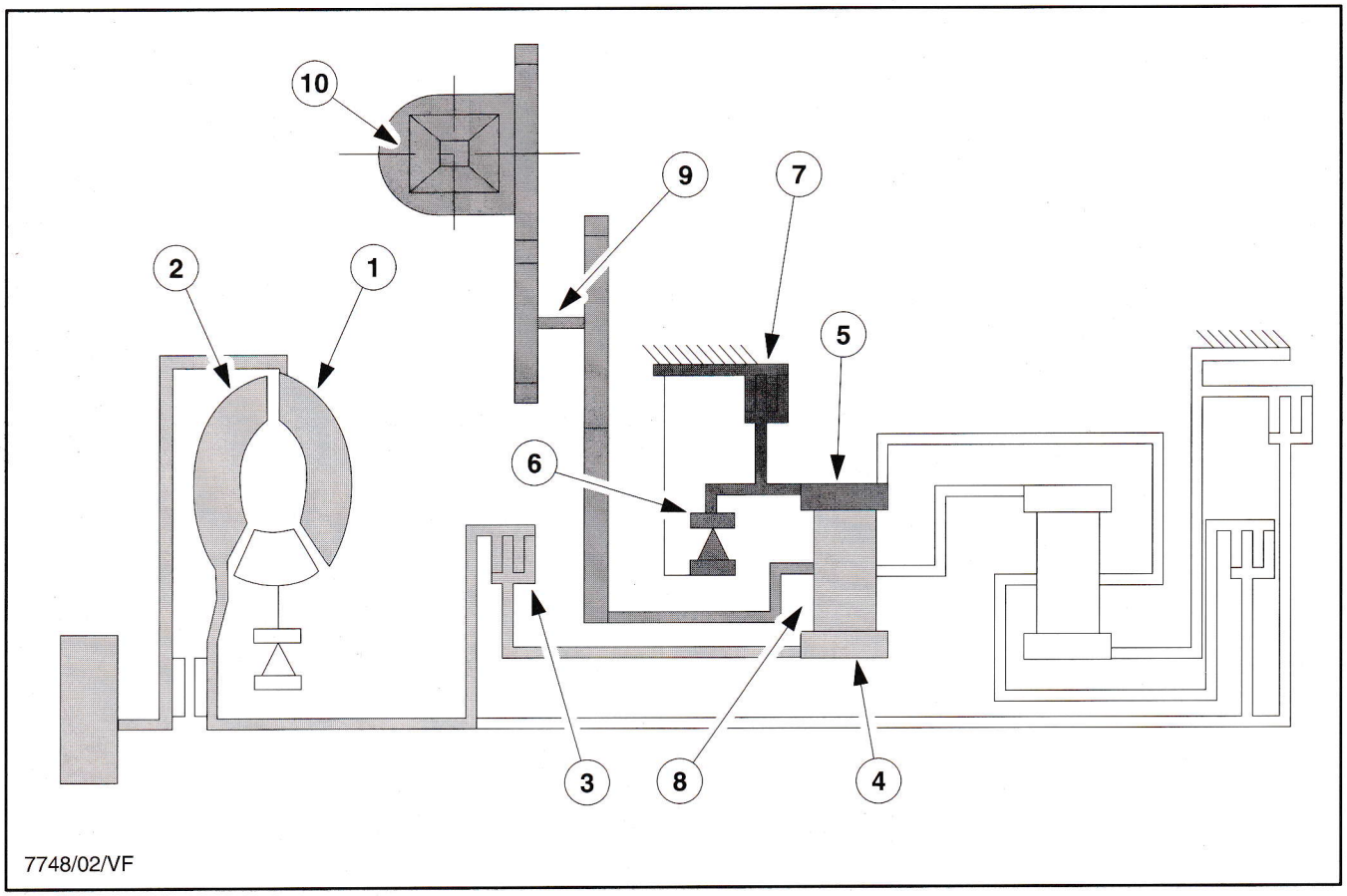


Illustration of principle

1 Fluid pan
2 Fluid filter
3 Fluid pump
4 Main regulating valve (variable force solenoid) in the valve body
5 PWM solenoid valves and shift solenoid (on/off) valves in the valve body
6 Servo piston for 2nd/4th gear brake band
7 Reverse gear clutch
8 3rd/4th gear clutch
9 Reverse gear brake
10 1st – 3rd gear clutch
11 Torque converter
12 Torque converter lock-up clutch
13 Fluid cooler

1st gear

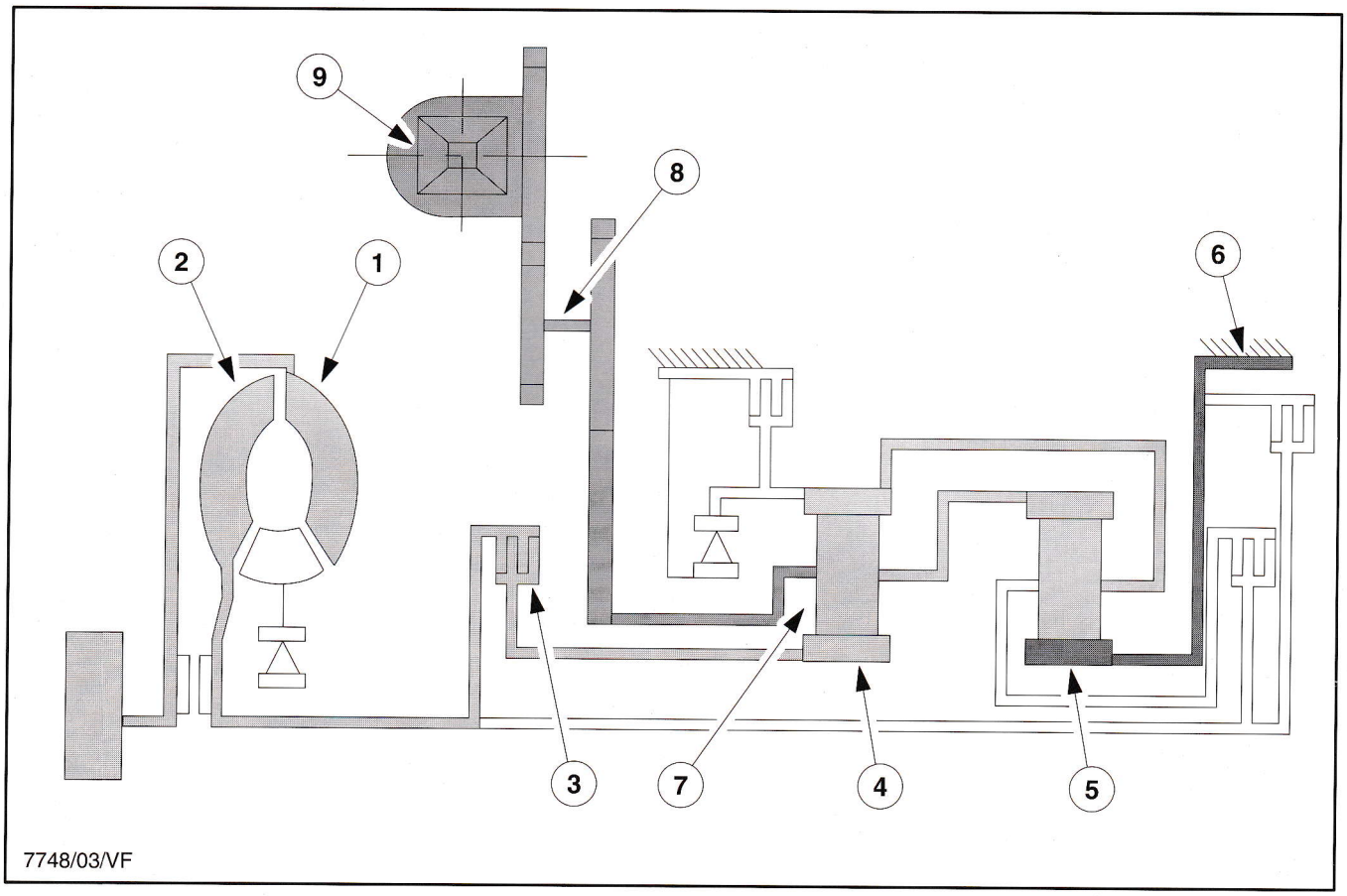


- Impeller (1)
  - ➥ turbine (2)
    - ➥ 1st – 3rd gear clutch (3)
      - ➥ drives the sun wheel (1st set) (4)

- The annulus (1st set) (5) bears on the 1st gear one-way clutch (6) (no engine braking effect).
- In manual selector lever position "1" the reverse gear brake (7) is also actuated (engine braking effect).
- At the output end the drive passes through the planet carrier (1st set) (8) to the intermediate gear stage (9) and the final drive assembly (10).

NOTE: As no component in the secondary planetary gear set is locked, this has no effect on power transmission.

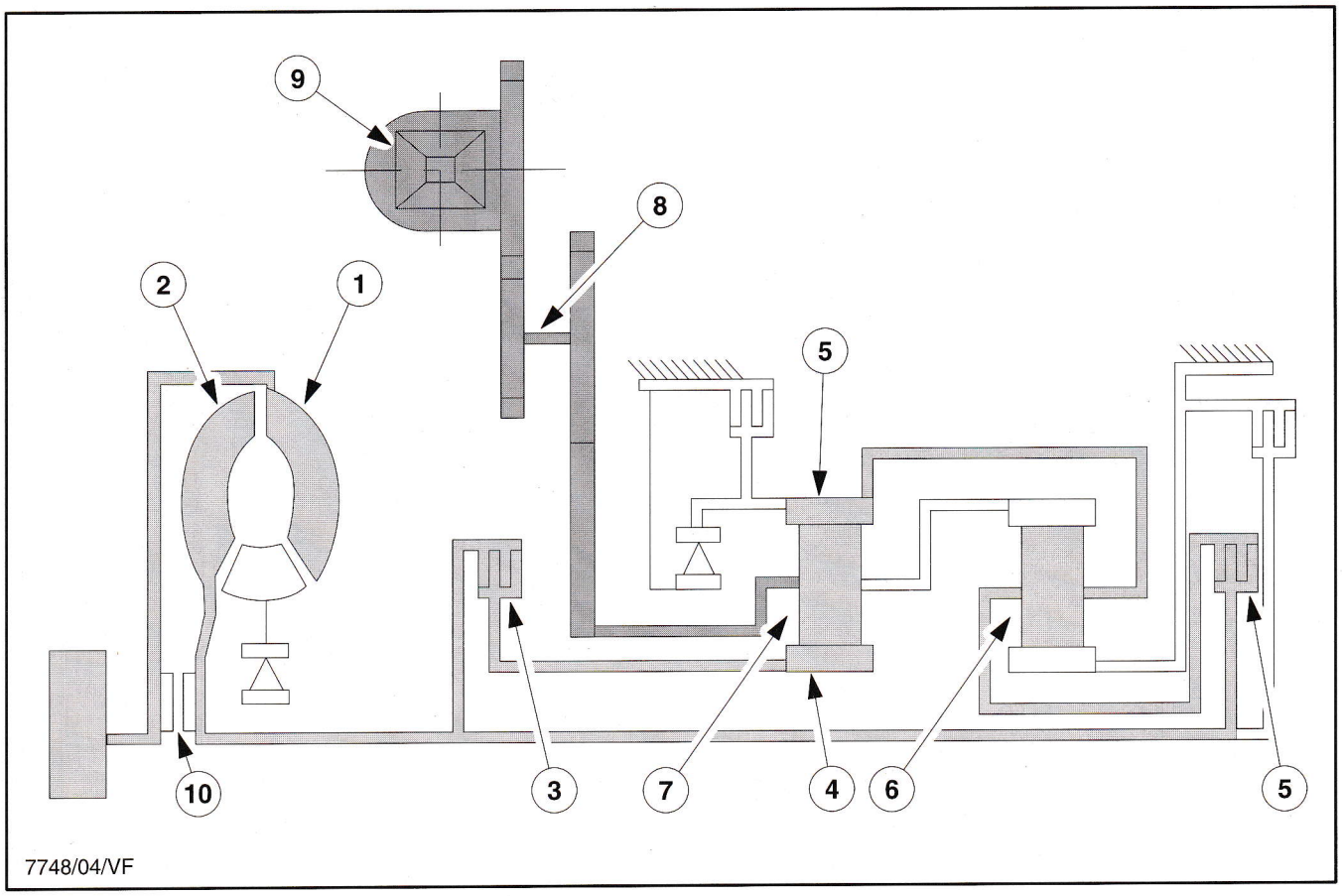
2nd gear



- Impeller (1)
  - ➥ turbine (2)
    - ➥ 1st – 3rd gear clutch (3)
      - ➥ drives the sun wheel (1st set) (4)

- The sun wheel (2nd set) (5) is held by the 2nd/4th gear brake band (6).
- At the output end the drive passes through the planet carrier (1st set) (7) to the intermediate gear stage (8) and the final drive assembly (9).

3rd gear



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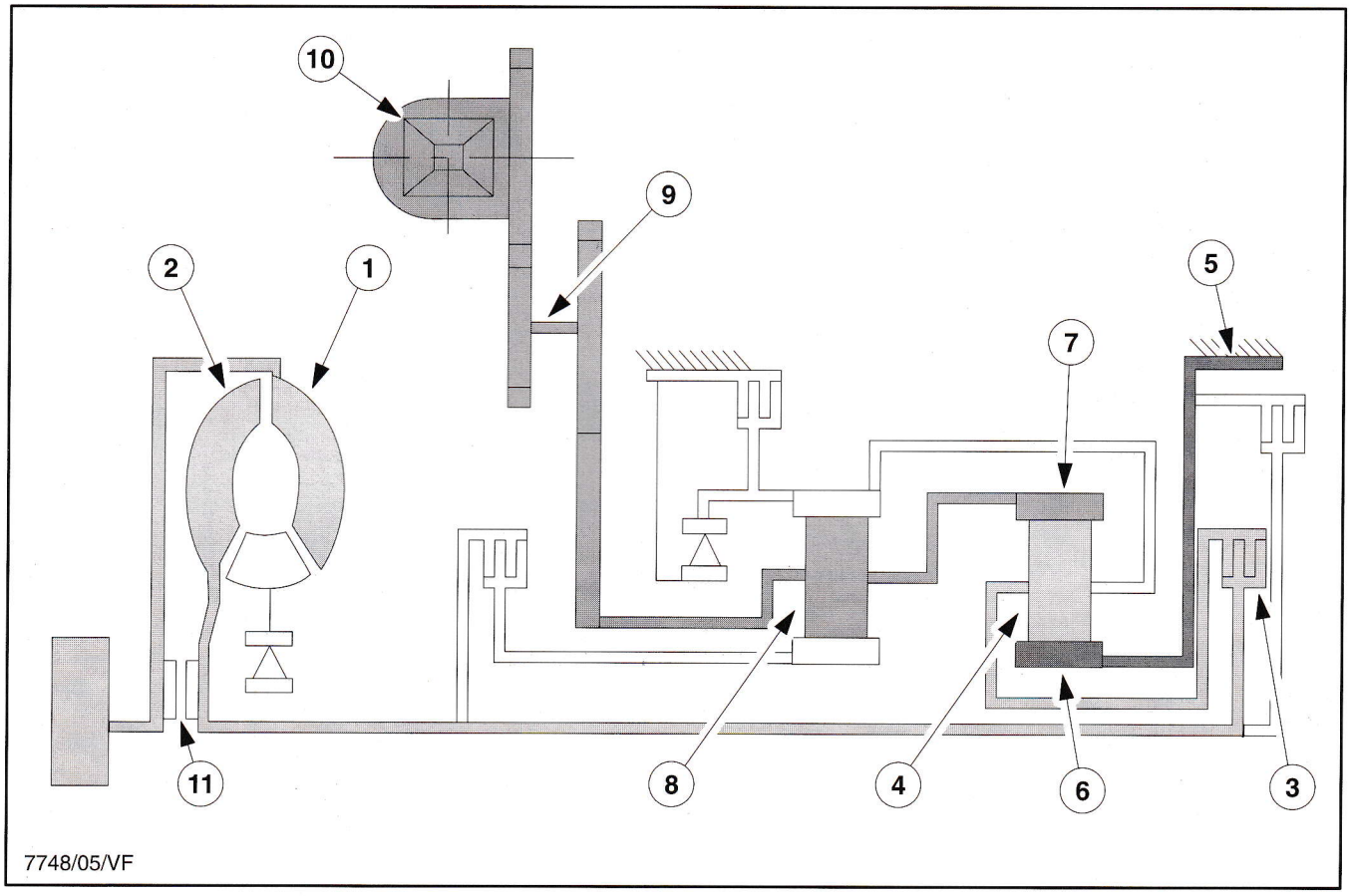
- Impeller (1)
  - ➥ turbine (2)
    - ➥ 1st – 3rd gear clutch (3)
      - ➥ drives the sun wheel (1st set) (4)
    - ➥ 3rd/4th gear clutch (5)
      - ➥ drives the planet carrier (2nd set) (6)

- At the output end the drive passes through the planet carrier (1st set) (7) to the intermediate gear stage (8) and the final drive assembly (9).

NOTE: As two components are driven simultaneously in the first planetary gear set, the planetary gear set turns as a complete unit.

NOTE: If the torque converter lock-up clutch (10) is closed, the power flow from the torque converter housing passes directly through the transmission input shaft to the 1st – 3rd gear clutch (3) and to the 3rd/4th gear clutch (5).

4th gear



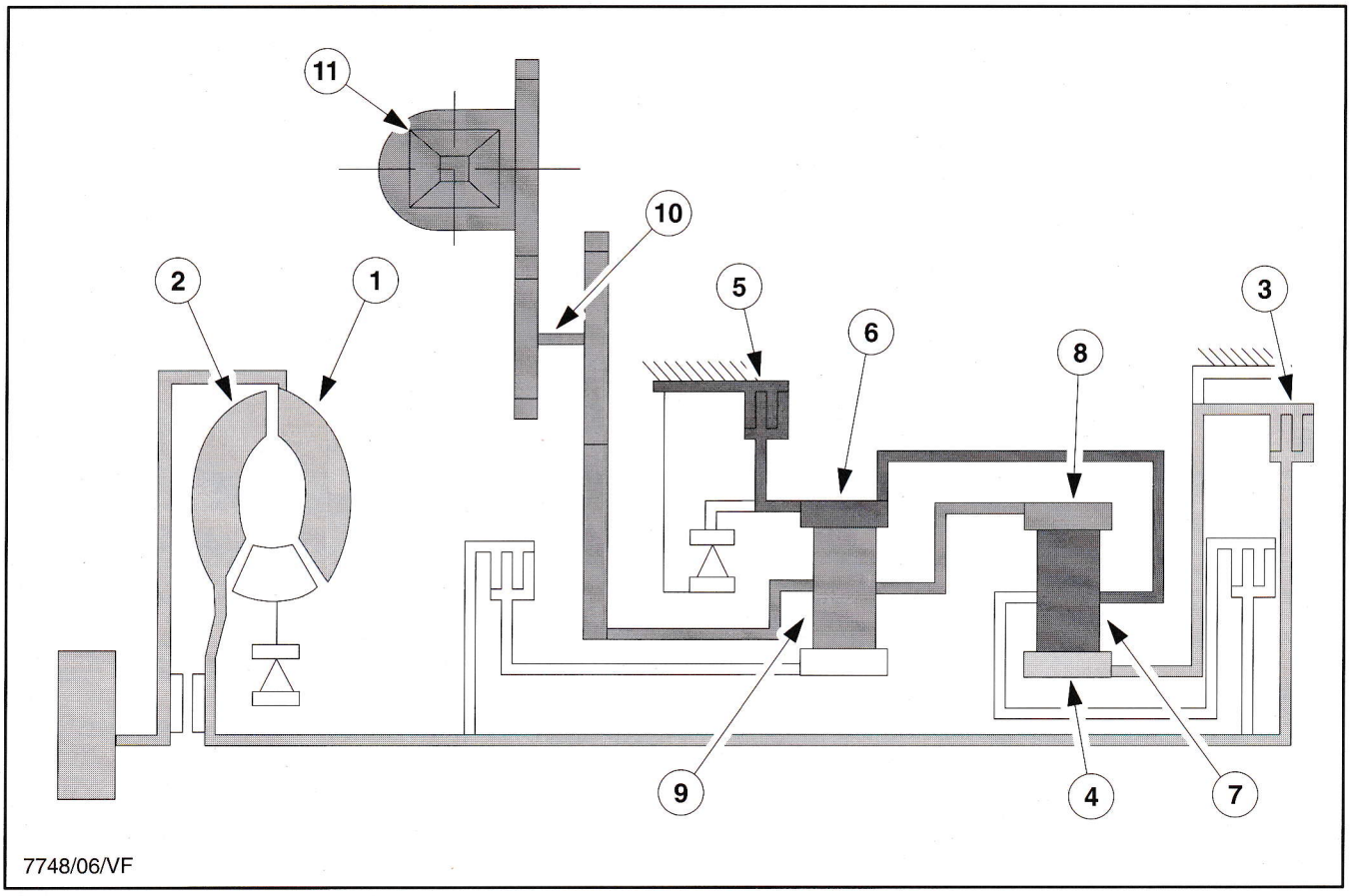
- Impeller (1)
  - ➥ turbine (2)
    - ➥ 3rd/4th gear clutch (3)
      - ➥ drives the planet carrier (2nd set) (4)

- The 2nd/4th gear brake band (5) holds the sun wheel (2nd set) (6).
- At the output end the drive passes through the annulus (2nd set) (7) and the planet carrier (1st set) (8) to the intermediate gear stage (9) and the final drive assembly (10).

NOTE: As no component is locked in the 1st planetary gear set, this has no effect on the power transmission.

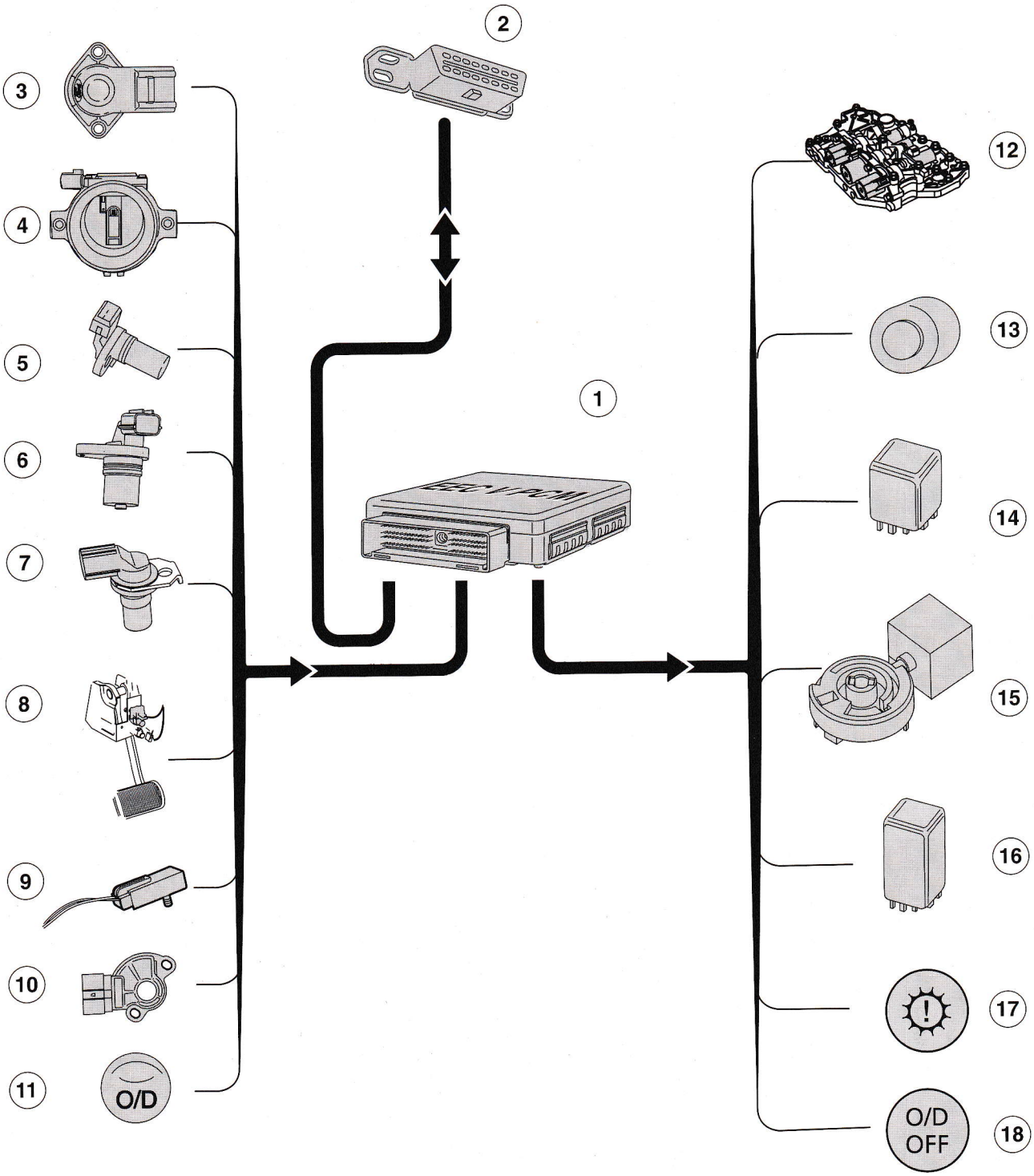
NOTE: If the torque converter lock-up clutch (11) is closed, the power flow passes directly from the torque converter housing through the transmission input shaft to the 3rd/4th gear clutch (3).

Reverse gear



- Impeller (1)
  - ➥ turbine (2)
    - ➥ reverse gear clutch (3)
      - ➥ drives the sun wheel (2nd set) (4)

- The reverse gear brake (5) holds the annulus (1st set) (6) and the planet carrier (2nd set) (7).
- At the output end the drive passes through the annulus (2nd set) (8) and the planet carrier (1st set) (9) to the intermediate gear stage (10) and the final drive assembly (11).



7748/38/VF

1 EEC V PCM

2 Data link connector (DLC)

3 Throttle position (TP) sensor

4 Mass air flow (MAF) and intake air temperature (IAT) sensors

5 Crankshaft position (CKP) sensor

6 Turbine shaft speed (TSS) sensor

7 Vehicle speed sensor (VSS)

8 Stoplamp switch

9 Transmission fluid temperature (TFT) sensor

10 Transmission range (TR) sensor

11 Overdrive (O/D) switch

12 Solenoid valves in the valve body

13 Selector lever shift lock solenoid

14 Starter inhibitor relay

15 Ignition key lock solenoid

16 Air conditioning relay

17 Powertrain warning indicator in instrument cluster

18 O/D indicator in instrument cluster

Location

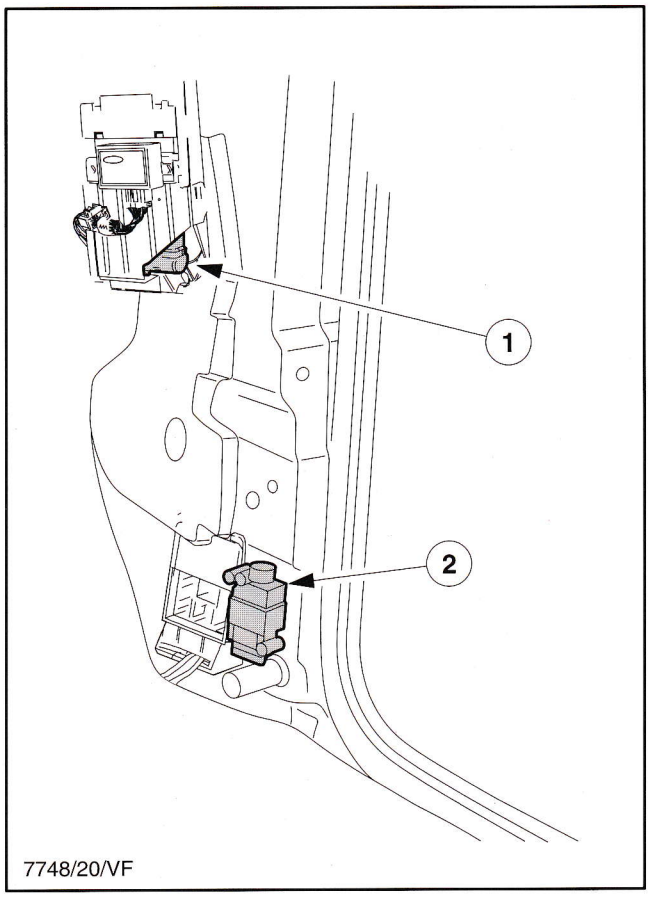
- The PCM is located under the trim panel on the right-hand A-pillar.

Function

- On vehicles with automatic transmission the EEC V PCM controls the transmission in addition to the engine management system. In this case a module with 104 pins is used.
- The PCM evaluates the incoming signals from the individual sensors and actuates the solenoid valves in the valve body of the transmission directly according to the operating state.

Diagnosis and testing

- Diagnostic checks can be carried out the transmission through the data link connector (DLC) above the central junction box (CJB).



1 EEC V PCM
2 Inertia fuel shutoff (IFS)

Emergency operating program

- If correct gear shifting can no longer be guaranteed due to failure of certain signals, the PCM changes to an emergency operating program.
- The driver is informed of the operation of the emergency operating program by the illumination of the powertrain warning indicator in the instrument cluster.
- Continued motoring is guaranteed in the following limited conditions:
  - maximum main line pressure,
  - 3rd gear in manual selector lever positions "D", "2" and "1" without the torque converter lock-up clutch,
  - reverse gear in manual selector lever position "R".

Manual selector lever position "1"

- In manual selector lever position "1" only first gear is selected.
- In addition to the 1st gear one-way clutch the transmission control closes the reverse gear brake to produce engine braking effect in overrun.
- If the manual selector lever is moved to position "1" at an excessive vehicle speed for 1st gear, the transmission control only allows the downshift to take place when the corresponding vehicle speed has been reached.

Manual selector lever position "2"

- In manual selector lever position "2" only 2nd gear is selected. The transmission control does not allow shifting into 1st gear.
- If the manual selector lever is moved to position "2" at an excessive vehicle speed for 2nd gear, the transmission control only allows the downshift to take place when the corresponding vehicle speed has been reached.

Manual selector lever position "D"

- In manual selector lever position "D" and when the O/D switch is not pressed, the transmission control allows all the gears to be selected.
- When the O/D switch is pressed, shifting into 4th gear is prevented or the transmission shifts down to 3rd gear.

Manual selector lever position "N"

- In manual selector lever position "N" no gear is selected.
- The drive line is not locked.

Manual selector lever position "R"

- In manual selector lever position "R" reverse gear is selected.

Manual selector lever position "P"

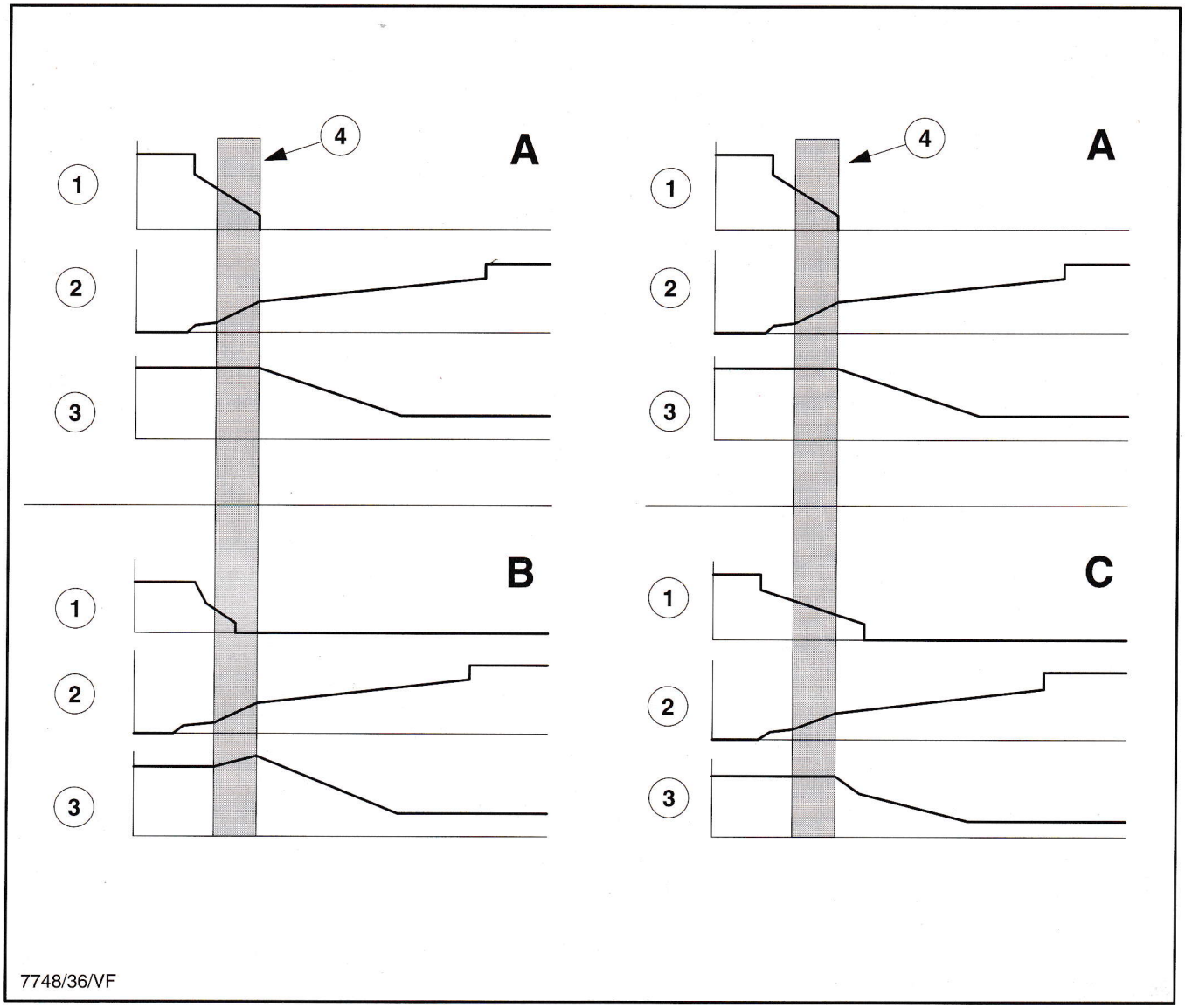
- In manual selector lever position "P" no gear is selected.
- The parking pawl is engaged manually by the manual selector lever cable and the shift shaft.

Control of shift operations

- During a shift operation certain shift elements are released while others are actuated with pressure. Ideally this process takes place simultaneously (synchronously) to avoid jerky gear shifting (refer to diagram **A** opposite).
- Where possible the time for the shift operation should remain within the time limits provided.
- When the shift operation is controlled conventionally, the pressure build up and reduction at the shift elements are set and defined for ideal conditions (synchronous shifting).
- As there is no way of influencing the control in the event of different levels of wear in the shift elements, when the transmission has been used for a fairly high mileage it is possible that the pressure build up and reduction may no longer be synchronous.
- The result of premature pressure reduction (**B**) at the element to be switched off is an unwanted rise in the turbine shaft speed as the element to be switched on cannot transmit the input torque.
- The result of delayed pressure reduction (**C**) at the element to be switched off is an unwanted decrease in the turbine shaft speed as both shift elements transmit the input torque. In the process the torque is transmitted to the transmission housing through internal locking.
- In both cases a jerk will be felt during the shift operation.
- In addition, wear in the shift elements leads to a lengthening of the shift operation. Therefore, shifting takes longer when the transmission has covered a higher mileage.

Control of shift operations with ESSC

- In the 4F27E automatic transmission electronic synchronous shift control (ESSC) is used.
- ESSC monitors the shift operations and is able to adapt these to the wear in the shift elements over the life of the transmission.
- This is possible since the individual shift elements are actuated by means of the modulating valves directly or through accumulators.
- The system monitors firstly the shift time and secondly whether the shift operation is synchronous.
- If the PCM detects a deviation from the stored values for the shift time and synchronisation of the shift operation, the pressure build up or reduction is adapted accordingly.



Shift operation

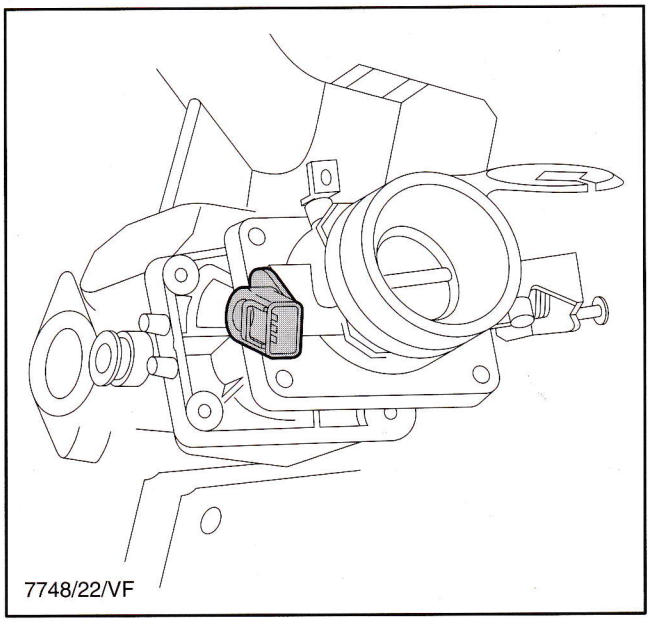
1 Pressure of component to be switched off
2 Pressure of component to be switched on
3 Turbine shaft speed
4 Synchronisation range of shift operation

A Synchronous gear shift
B Non-synchronous gear shift (premature reduction of pressure at element to be switched off)
C Non-synchronous gear shift (delayed reduction of pressure at element to be switched off)

Throttle position (TP) sensor

Location

- The TP sensor is located on the throttle body.

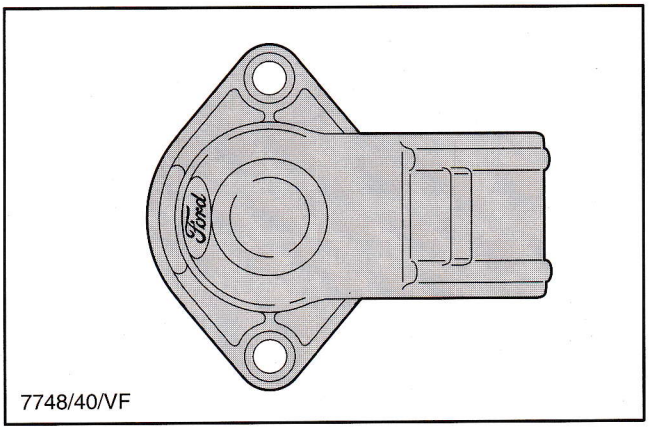

7748/22/VF

Function

- It supplies the PCM with information about the position of the throttle plate.
- It also detects the speed of actuation of the throttle plate.

Signal use

- The PCM uses the signals for the following functions among other things:
  - to determine the shift timing,
  - to control the main line pressure,
  - to control the torque converter lock-up clutch,
  - for kickdown.


7748/40/VF

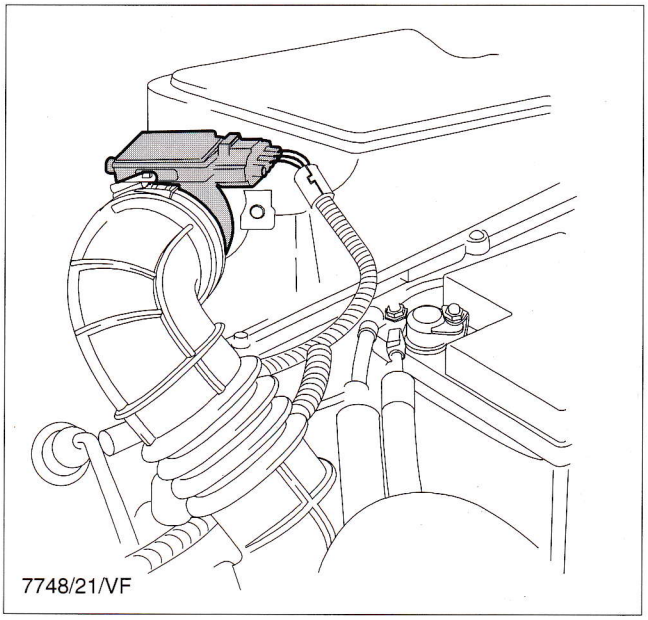
Substitute signal

- In case of absence of the TP signal the engine control uses the signals of the MAF and IAT sensors as a substitute signal. The main line pressure is increased and hard shifts may occur.

Mass air flow (MAF) and intake air temperature (IAT) sensors

Location

- The MAF sensor is located between the air cleaner housing and the air intake hose leading to the throttle housing.
- The IAT sensor is incorporated in the housing of the MAF sensor.

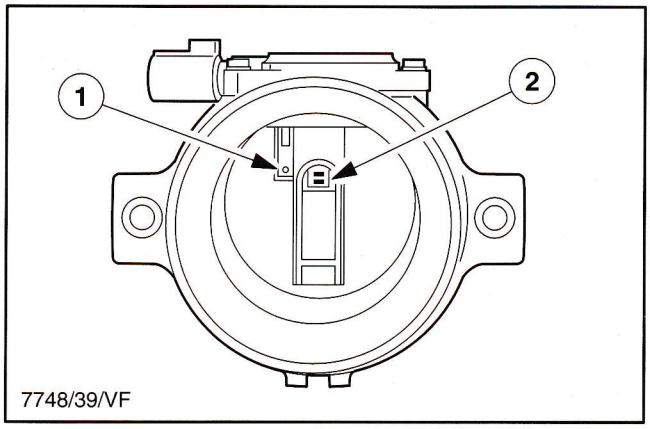


Function

- The MAF sensor in conjunction with the IAT sensor provides the PCM with the primary load signal.

Signal use

- The PCM uses the signals for the following functions among other things:
  - to control the shift operations,
  - to control the main line pressure.



1 Intake air temperature (IAT) sensor
2 Mass air flow (MAF) sensor

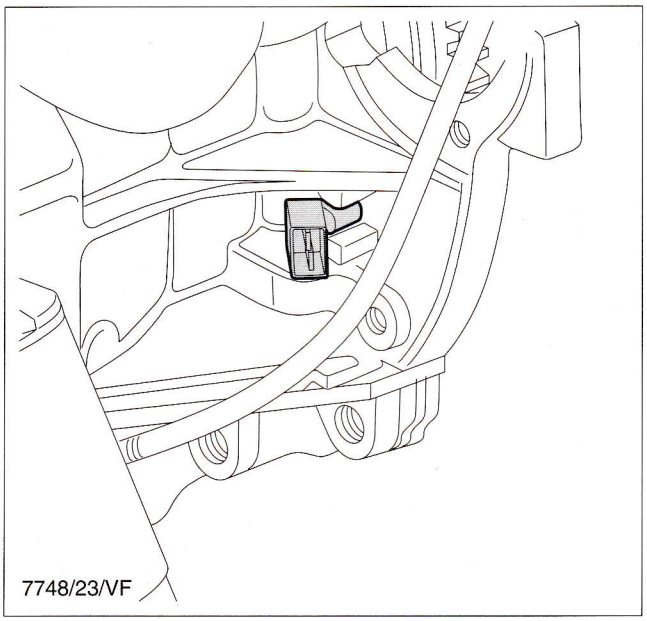
Substitute signal

- If the MAF sensor fails, the signal of the TP sensor is used as a substitute.

Crankshaft position (CKP) sensor

Location

- The CKP sensor is located on the engine/transmission flange.



Function

- The CKP sensor is an inductive sensor which provides the PCM with information about the engine speed and position of the crankshaft.

Signal use

- The signal is used for the following functions among other things:
  - to control the torque converter lock-up clutch,
  - to check the torque converter slip,
  - to control the main line pressure.

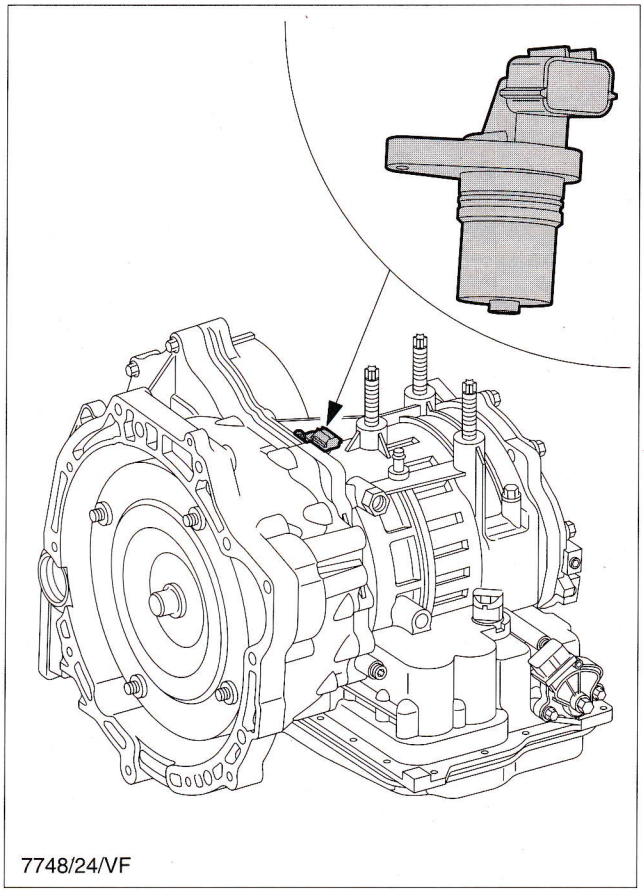
Substitute signal

- No substitute signal is available for the CKP sensor. If the signal is not present, the engine stops.

Turbine shaft speed (TSS) sensor

Location

- The TSS sensor is located in the transmission housing over the transmission input shaft.


7748/24/VF

Function

- The TSS sensor is an inductive sensor which senses the speed of rotation of the transmission input shaft.

Signal use

- The signal is used for the following functions:
  - to control the shift operations,
  - to control the torque converter lock-up clutch,
  - to check the torque converter slip.

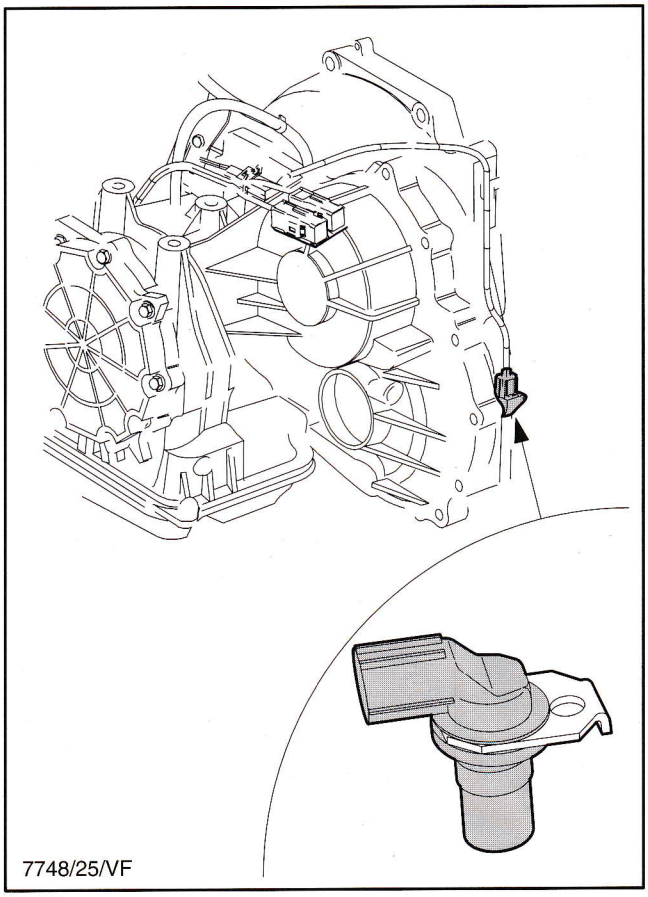
Substitute signal

- If the TSS sensor fails, the signal of the vehicle speed sensor (VSS) is used as a substitute signal.

Vehicle speed sensor (VSS)

Location

- The VSS is located in the transmission housing above the rotor in the differential.



Function

- The VSS is an inductive sensor which detects the vehicle speed by means of a rotor on the differential.

Signal use

- The signal is used for the following functions among other things:
  - to determine the shift timing,
  - to supply the vehicle speed input signal for the PCM.

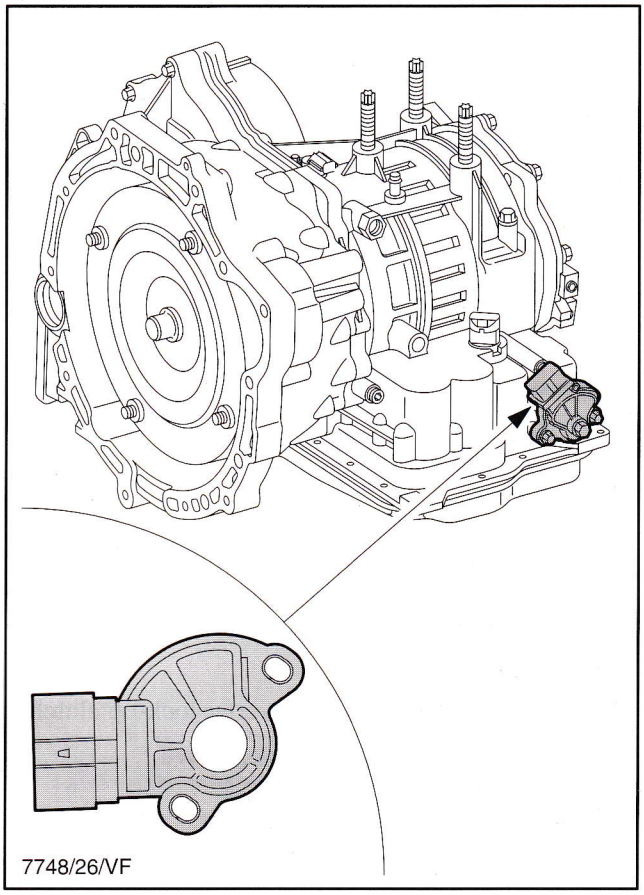
Substitute signal

- If the VSS fails, the signal of the TSS sensor is used as a substitute signal.

Transmission range (TR) sensor

Location

- The TR sensor is located on the shift shaft on the transmission housing.



Function

- When the shift shaft is moved by means of the manual selector lever cable, an engagement pin in the inner ring of the TR sensor moves through the different positions. The signals are transmitted to the PCM, the reversing lamps, the starter inhibitor relay and the ignition key lock relay.

NOTE: Correct operation of the TR sensor is only guaranteed when the manual selector lever cable is adjusted correctly.

Signal use

- The signals of the TR sensor are used for the following functions:
  - to recognise the manual selector lever position,
  - to actuate the starter inhibitor relay,
  - to actuate the reversing lamps,
  - to actuate the ignition key lock.

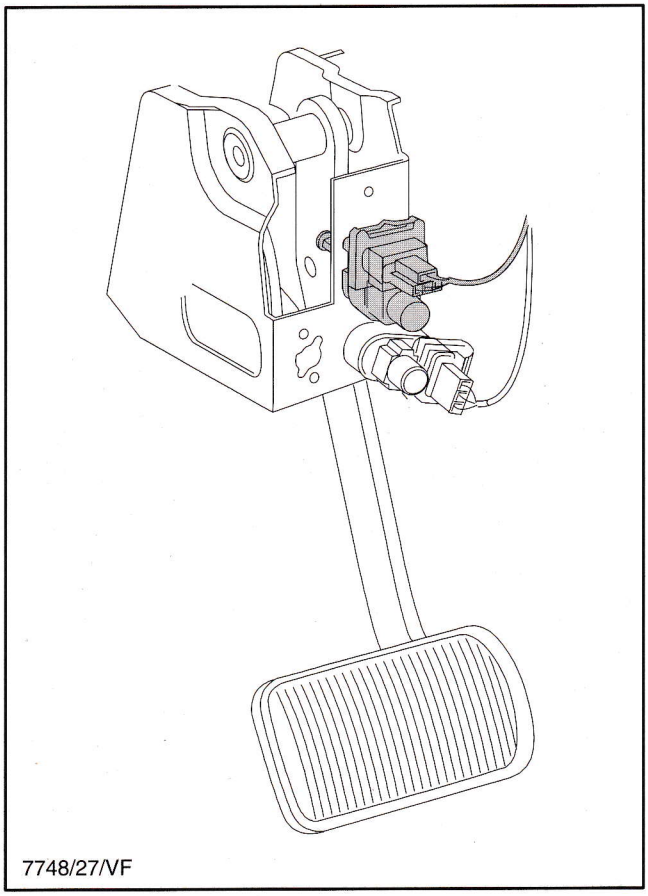
Substitute signal

- No substitute signal is available for the TR sensor.
- If the connection is cut the vehicle cannot be started.

Stoplamp switch

Location

- The stop light switch is mounted on the brake pedal bracket.



Function

- It switches the stoplights on and tells the EEC V PCM when the brakes are applied.

Signal use

- The signal of the stoplamp switch is used by the PCM for the following functions:
  - to release the torque converter lock-up clutch when the brake pedal is depressed,
  - to switch off the manual selector lever shift lock when the brake pedal is depressed in "P".

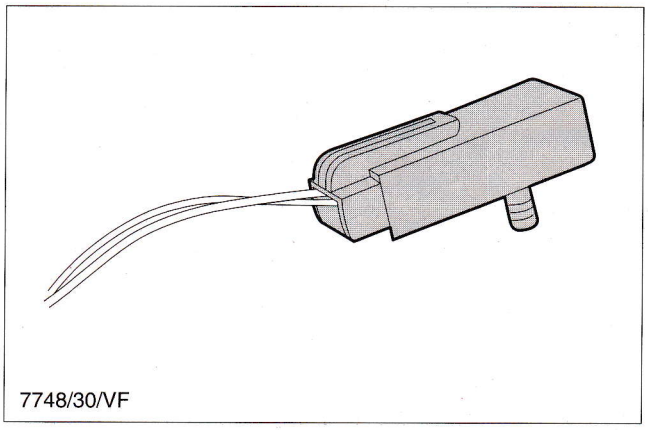
Substitute signal

- No substitute signal is available for the stoplamp switch.
- If the connection to the stoplamp switch is cut the manual selector lever cannot be moved out of "P".

Transmission fluid temperature (TFT) sensor

Location

- The TFT sensor is located on the internal wiring harness to the solenoid valves in the fluid pan.


7748/30/VF

Function

- It is an NTC resistor and measures the transmission fluid temperature.

Signal use

- The transmission fluid temperature is used by the PCM for the following functions:
  - closure of the torque converter lock-up clutch is not permitted until the transmission fluid reaches a certain temperature,
  - engagement of 4th gear is prevented in extreme sub-zero temperatures until the normal operating temperature is reached,
  - if the transmission fluid temperature is excessive, a pre-set fixed shift curve is selected and the torque converter lock-up clutch is closed in "2", "3" and "4"; if the transmission fluid temperature continues to rise, the transmission warning indicator is activated.

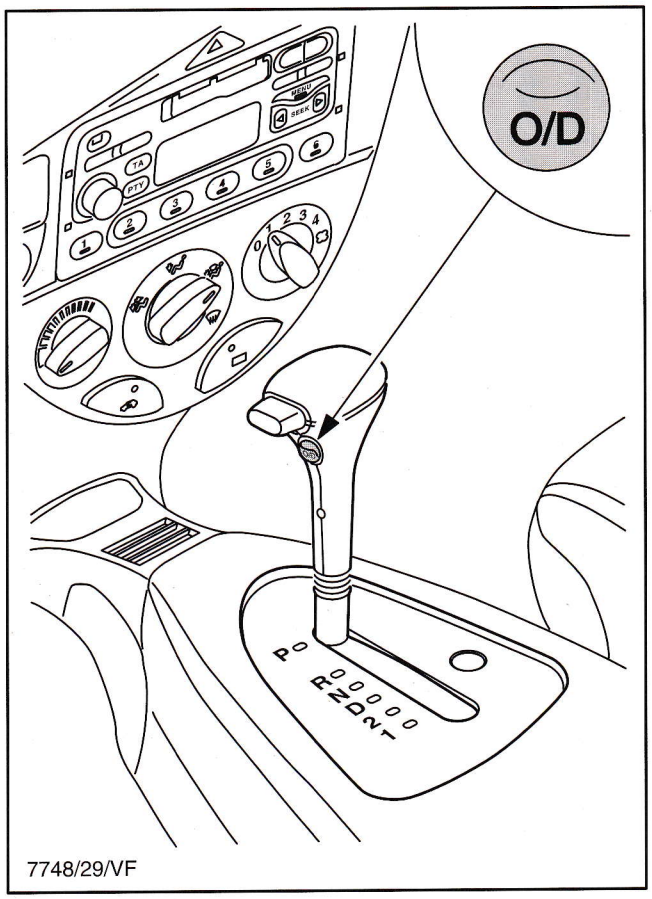
Substitute signal

- No substitute signal is available for the TFT sensor.

Overdrive (O/D) switch

Location

- The O/D switch is located on the side of the manual selector lever.



7748/29/VF

Function

- The O/D switch transmits a signal to the PCM to select or suppress 4th gear in manual selector lever position "D".

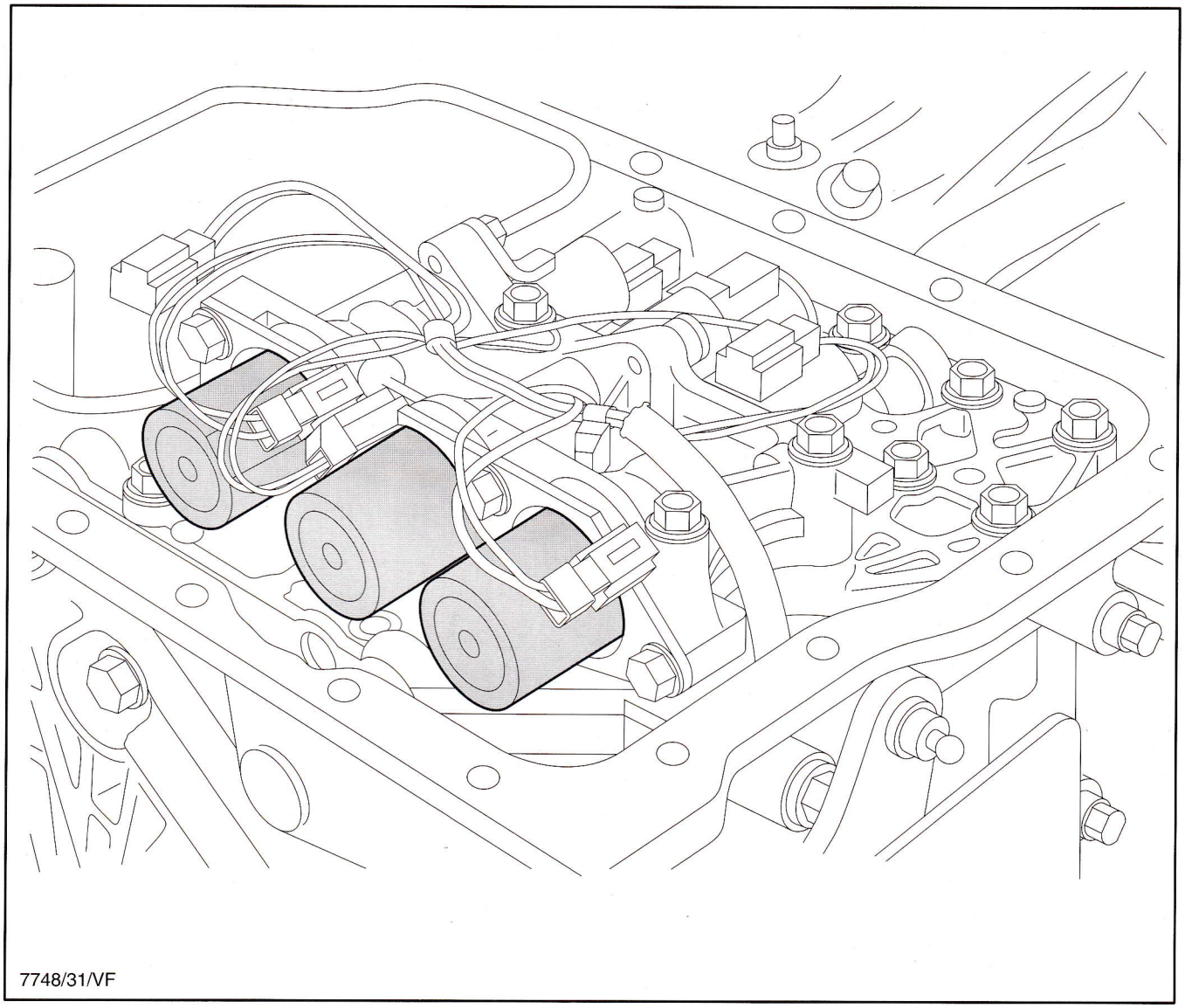
Signal use

- The signal of the O/D switch is used for the following functions:
  - as an input signal to convey the drivers' wishes to the PCM,
  - to display the drivers' wishes with the O/D indicator in the instrument cluster.

Substitute function

- No substitute signal is available for the O/D switch. If it should fail, it is always possible to shift into 4th gear in manual selector lever position "D".

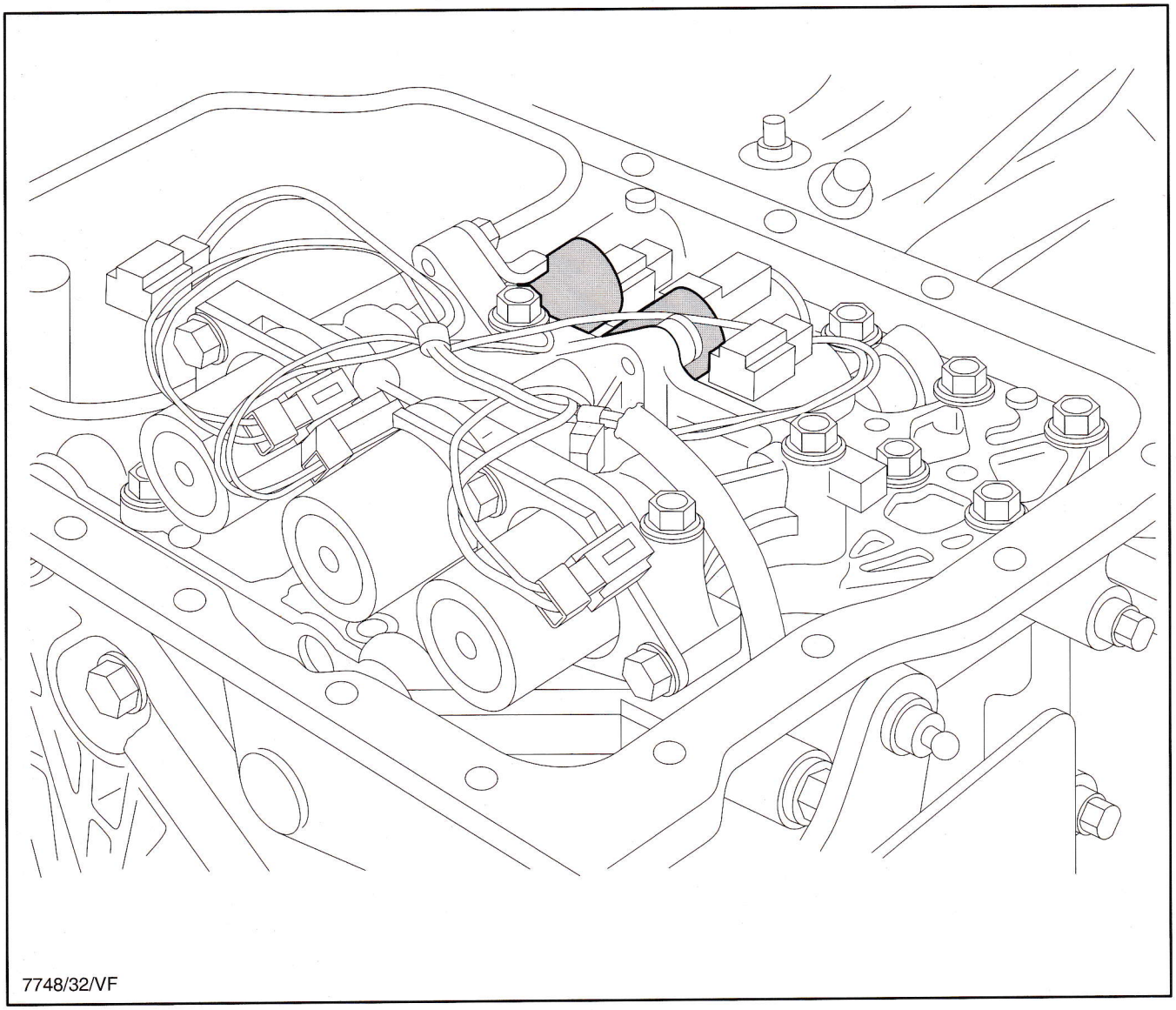
PWM solenoid valves 1 – 3



7748/31/VF

- PWM solenoid valves 1, 2 and 3 control the pressure to the brakes and clutches.
- They alter the pressure by pulse width modulation. This means that the current is determined by the PCM by grounding pulses.
- The pressure acts either directly on the clutches and brakes or is smoothed by accumulators.

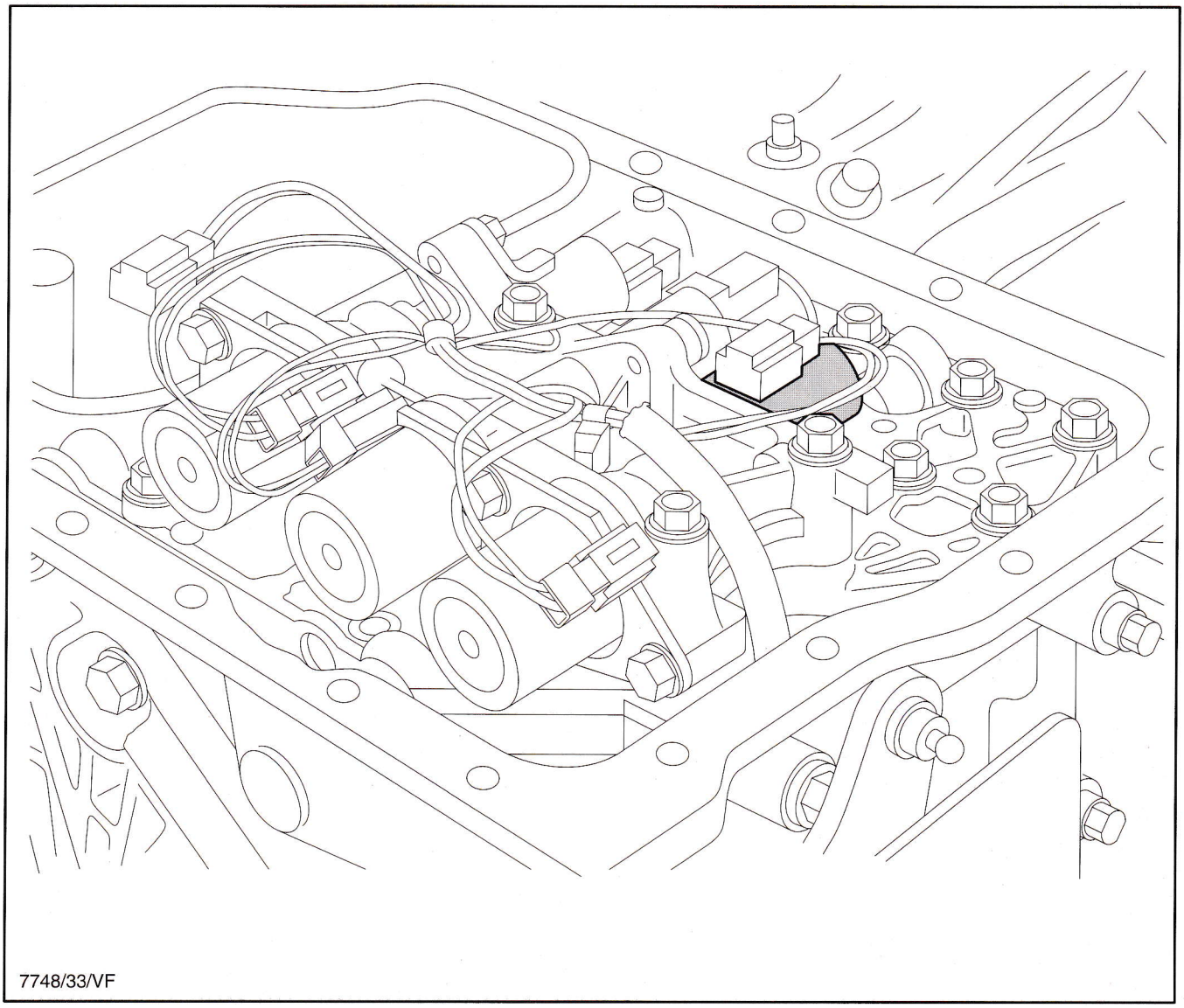
Shift solenoid (on/off) valves 1 and 2



7748/32/VF

- The shift solenoid (on/off) valves switch the different oil passages in the valve body to direct the pressure to the individual clutches and brakes.
- The use of the shift solenoid valves means that only three PWM solenoid valves are needed for direct actuation of the individual clutches and brakes.

Main regulating valve (variable force solenoid – VFS)



7748/33/VF

- The main regulating valve (variable force solenoid) controls the required main line pressure for the individual transmission ranges.
- The main line pressure is controlled dependent on the current engine load.

Manual selector lever shift lock solenoid

Location

- The manual selector lever shift lock solenoid is located in the manual selector lever bracket.

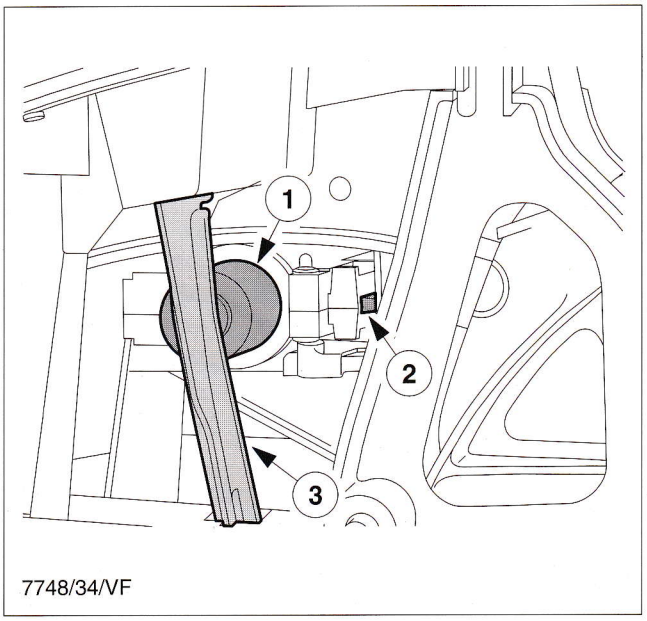
Function

- When the ignition is switched on, the manual selector lever shift lock solenoid is actuated by depressing the brake (signal from the stoplamp switch). This retracts the locking pin so that the manual selector lever can be moved out of position "P".

Substitute function

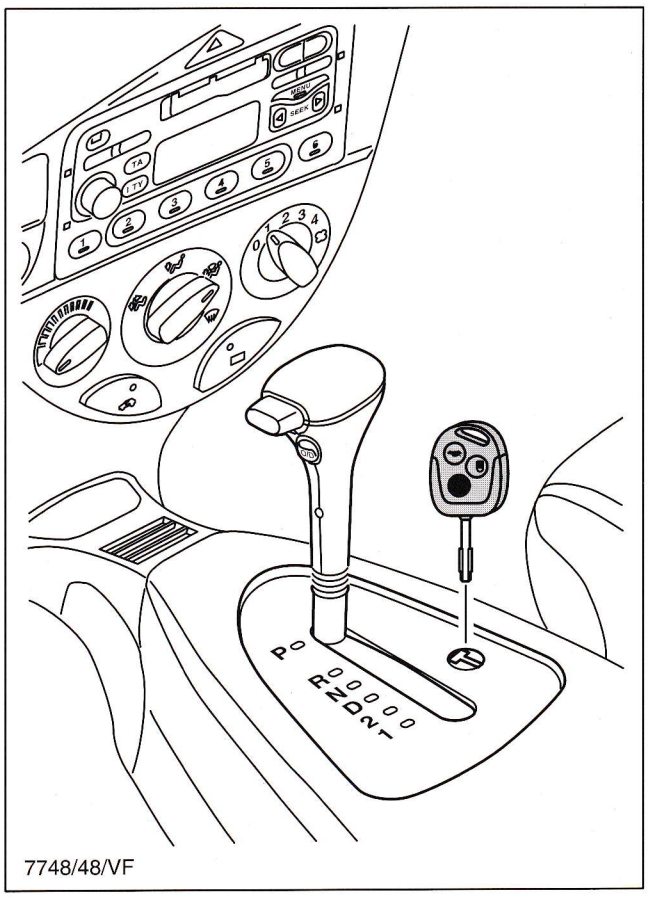
- If the brake signal should fail due to a malfunction, manual unlocking is possible.
- For this the cover of the release mechanism must be removed and a suitable object (ignition key) pressed into the opening until the manual selector lever can be moved out of position "P".

NOTE: If "P" is selected again the manual selector lever is locked again.



7748/34/VF

1 Solenoid
2 Locking pin
3 Manual release mechanism



7748/48/VF

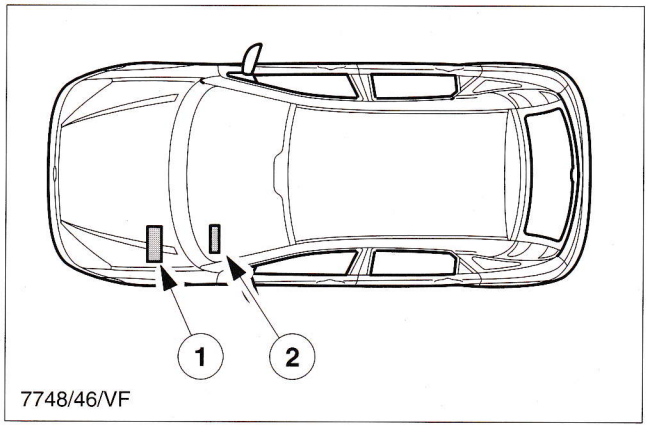
Air conditioning relay

Location

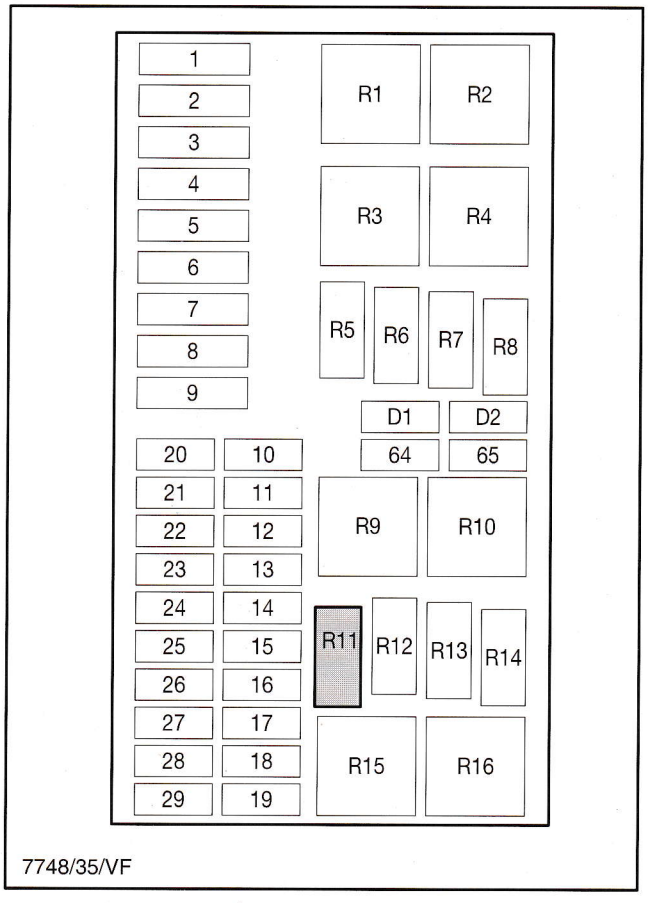
- The air conditioning relay is located in the battery junction box (BJB) in the engine compartment.

Function

- If the PCM registers a kickdown signal (WOT, throttle plate opened 95%), the air conditioning is switched off for a maximum of 15 seconds.



1 Battery junction box (BJB)
2 Central junction box (CJB)



Battery junction box (BJB)

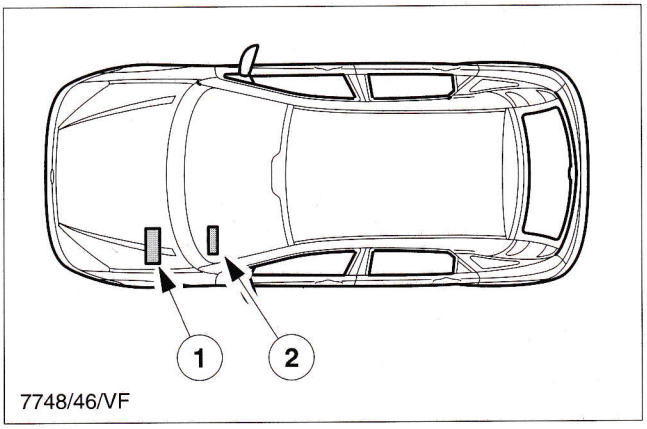
Starter inhibitor relay

Location

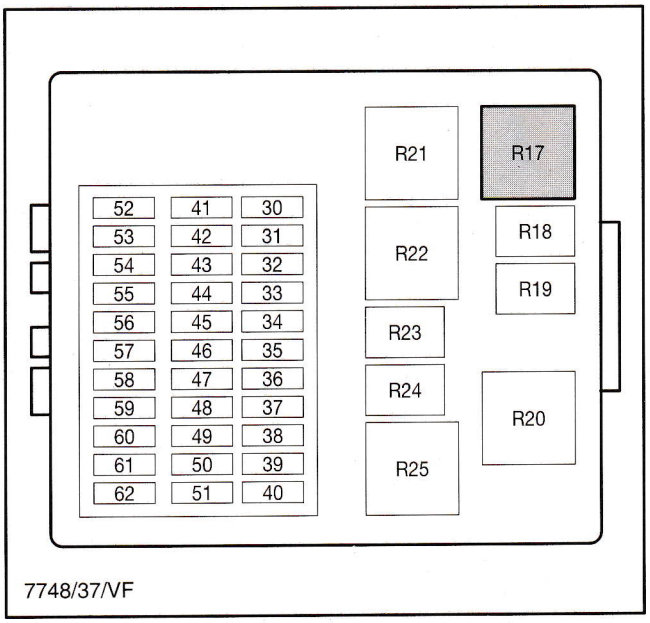
- The starter inhibitor relay is located in the central junction box (CJB).

Function

- The relay prevents the engine starting in manual selector lever positions "R", "D", "2" and "1".
- The relay obtains the information about the position of the selector lever direct from the TR sensor.



1 Battery junction box (BJB)
2 Central junction box (CJB)



Central junction box (CJB)

Ignition key lock solenoid

Location

- The solenoid is incorporated in the ignition lock.

Function

- In manual selector lever position "P" the ground connection to the solenoid is cut. The locking pin does not engage in the ignition lock.
- In all the other manual selector lever positions the ground connection to the solenoid is closed and the locking pin engages in the ignition lock.
- When the manual selector lever is not in position "P", removal of the ignition key is prevented.

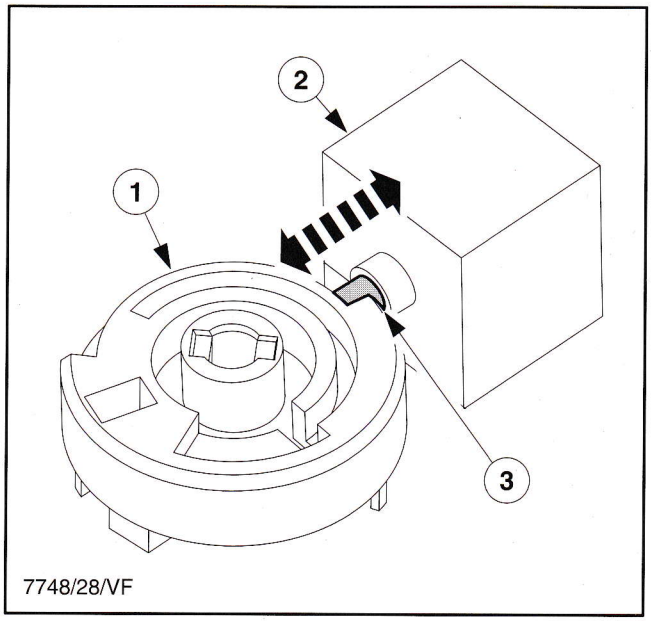


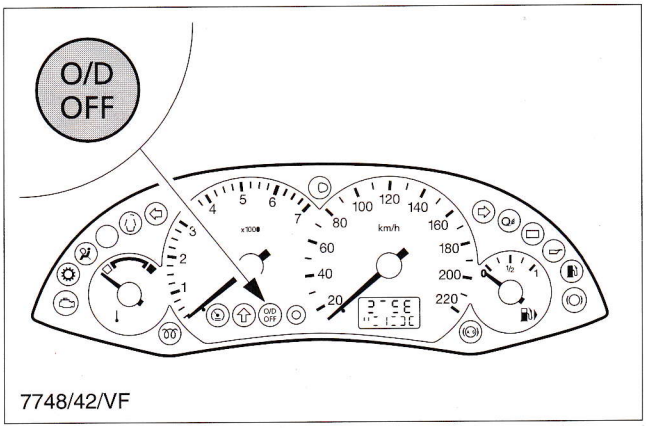
Illustration of principle

1 Rotor
2 Solenoid
3 Locking pin

O/D indicator

Location

- The O/D indicator is located in the instrument cluster and is coloured green.



7748/42/VF

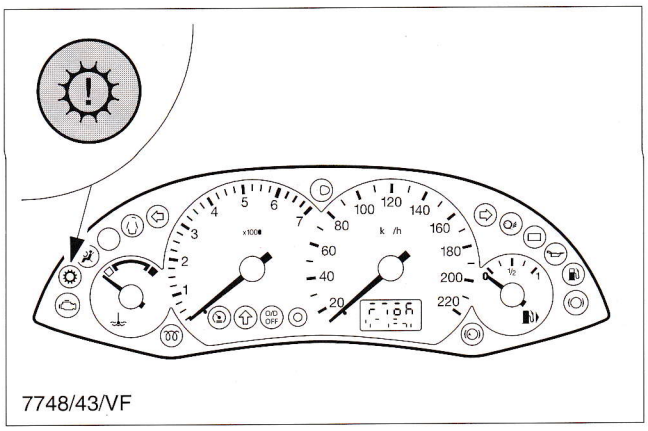
Function

- The O/D indicator is actuated by the O/D switch on the manual selector lever. It tells the driver that shifting into 4th gear is prevented by the transmission control.

Powertrain warning indicator

Location

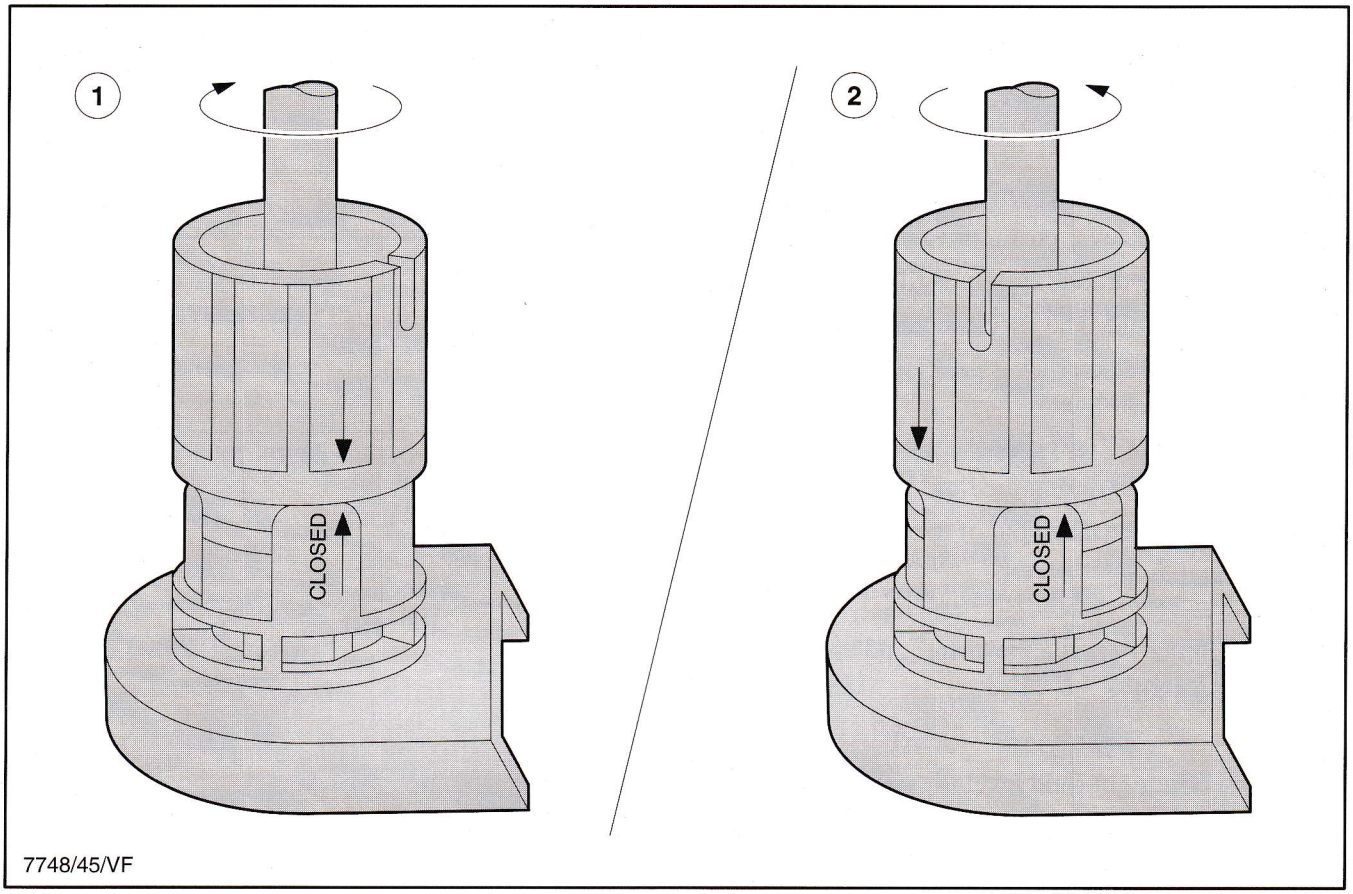
- The powertrain warning indicator is located in the instrument cluster and is coloured orange.


7748/43/VF

Function

- It flashes to tell the driver that the transmission control has switched to the emergency operating program or that the transmission fluid temperature is too high.

Manual selector lever cable adjustment



Manual selector lever cable adjuster

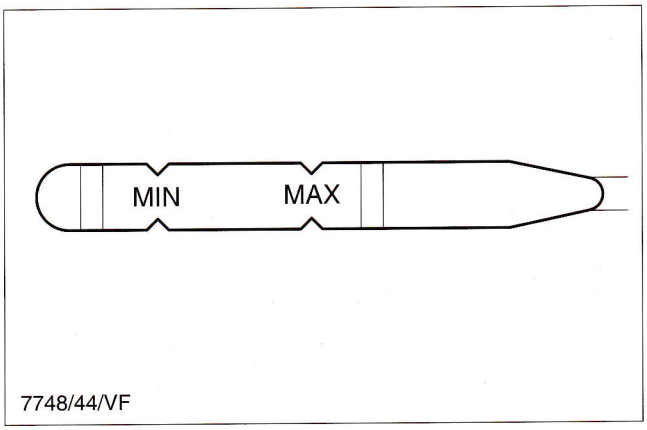
1 Adjuster in closed position; turn in the direction of the arrow to open

2 Adjuster in open position; turn in the direction of the arrow to close

- A quick-release fastening on the manual selector lever cable allows adjustment of the cable relative to the conduit.
- Adjustment is required if the transmission or the manual selector has been removed, if the engine does not start in "P" or "N" or in case of shift quality concerns.
- To adjust the manual selector lever cable the manual selector lever must be in position "D".
- First open the manual selector lever cable adjuster (see illustration).
- To make sure the transmission is in position "D" the cable should be removed from the lever on the shift shaft, the transmission should be shifted in "D" and the manual selector cable should be clipped again onto the lever on the shift shaft.
- The manual selector lever cable must not be stressed. This can be checked through smooth shaking of the shift shaft lever.
- The manual selector lever cable is locked by turning the cable adjuster (see illustration) after making sure again the shift mechanism is in "D".

Fluid level check

- The transmission fluid level is checked while the engine is running.
- With the brakes applied, the manual selector lever should be moved slowly through all the manual selector lever positions to make sure that the complete hydraulic system is filled with transmission fluid. The check should be carried out in manual selector lever position "P".
- The transmission fluid temperature must lie in a determined range during the fluid level check. The range is to be taken out of the current service literature.
- The difference between the "Min" and "Max" marks is 0.4 liters.



NOTE: The right fluid level is essential for correct operation of the transmission.

NOTE: The transmission fluid is designed for lifetime use and must not be changed.

Towing

- The vehicle may be towed up to a speed of 50 km/h (30 mph).

⚠ **CAUTION:** The vehicle must only be towed in the normal direction of travel. If towed in the reverse direction, transmission lubrication is no longer guaranteed and may result in transmission damage.

The abbreviations conform to the standard SAE J1930 with the exception of those marked with an asterisk (*).

BJB*	**B**attery **J**unction **B**ox
CJB*	**C**entral **J**unction **B**ox
CKP	**C**rank**s**haft **P**osition
DLC	**D**ata **L**ink **C**onnector
EEC V*	**E**lectronic **E**ngine **C**ontrol, 5th Generation
ESSC*	**E**lectronic **S**ynchronous **S**hift **C**ontrol
FDS*	**F**ord **D**iagnostic **S**ystem
IAT	**I**ntake **A**ir **T**emperature
IFS	**I**nertia **F**uel **S**hutoff
MAF	**M**ass **A**ir **F**low
MY*	**M**odel **Y**ear
NTC*	**N**egative **T**emperature **C**oefficient
O/D*	**O**ver**d**rive
PCM	**P**owertrain **C**ontrol **M**odule
PWM	**P**ulse **W**idth **M**odulation
TFT	**T**ransmission **F**luid **T**emperature
TP	**T**hrottle **P**osition
TR	**T**ransmission **R**ange
TSS	**T**urbine **S**haft **S**peed
VFS*	**V**ariable **F**orce **S**olenoid
VSS	**V**ehicle **S**peed **S**ensor
WOT	**W**ide **O**pen **T**hrottle