

INTRODUCTION

The C635 is a dual clutch automatic transmission, with 6 speeds and electrohydraulic controls.

Thanks to this system, there is no need for driver to control the clutch pedal and the gear lever, maintaining the pleasure of driving that comes from the direct control of the transmission.

It also improves driving safety through a direct control, preventing driver's errors.

The system basically consists of a manual transmission, with a dual dry clutch and manual gearbox, with hydraulic power system, handled by a dedicated control unit TCU (Transmission Control Unit).

For the dual clutch manual transmission description

[See descriptions 2110 MANUAL GEARBOX WITH DIFFERENTIAL](#)

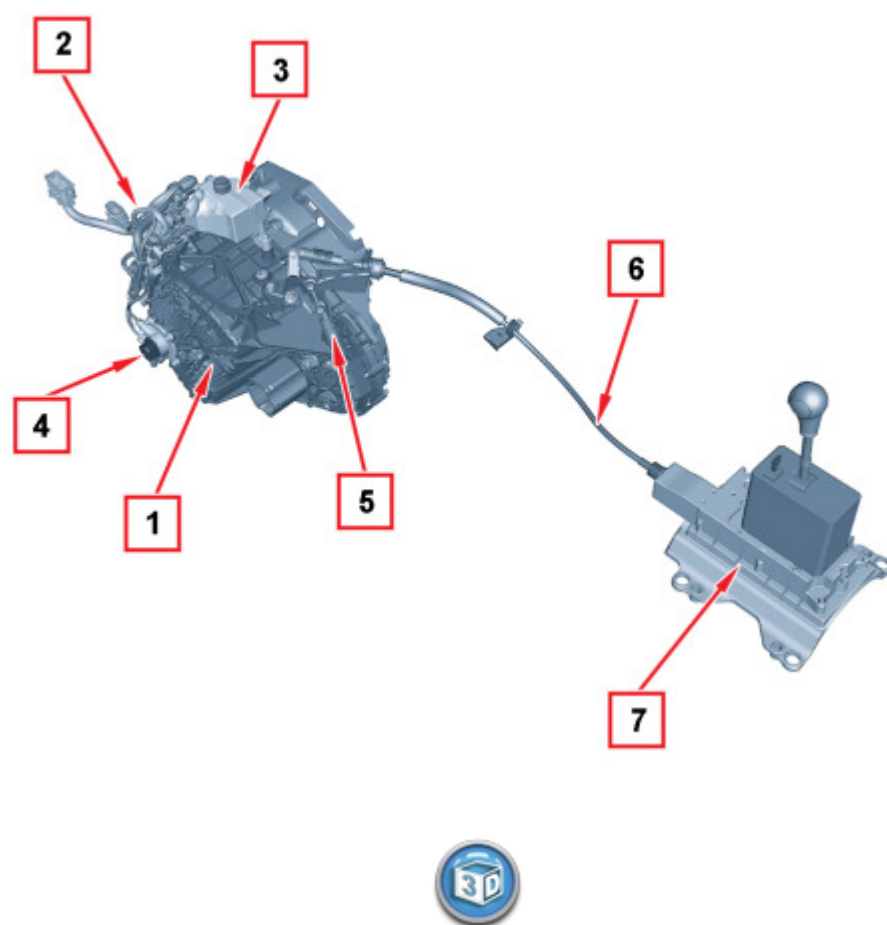
INTRODUCTION

The main features of this dual clutch transmission are the following:

- It ensures comfortable gearshiftings like an automatic transmission, thanks to the advanced power assistance logics.
- reduction in fuel consumption
- improves the performance of the manual mechanical transmission components
- it is a hydraulic power assisted system for gearbox and clutches, which allows all the qualities of a dry clutch and manual gearbox to be maintained (load, strength and reliability, low energy consumption).
- it is simple to use and makes driving less tiring, especially during town driving
- the gearshifting lever is replaced by controls "P" (Parking), "R" (Reverse), "N" (Neutral), "D" (Drive) on a suitable joystick located on the central tunnel
- possibility of gearshifting in automatic mode, by the lever (TIP) and the buttons (TAP) on the steering wheel
- the gearshifting automatic handling can be enabled in "NORMAL/DYNAMIC" mode through the "DNA lever".

There are two operating modes for the transmission:

- semi-automatic mode (MANUAL): the driver engages the gears using the lever located on the tunnel
- automatic mode (AUTO): the electronic system manages the decision to change gears.



1. Gearbox casing
2. Electrohydraulic control unit
3. Fluid reservoir for electrohydraulic control unit
4. Odd gear clutch control actuator
5. "Parking" function mechanical actuator
6. "Parking" function control flexible cable
7. Gear lever support

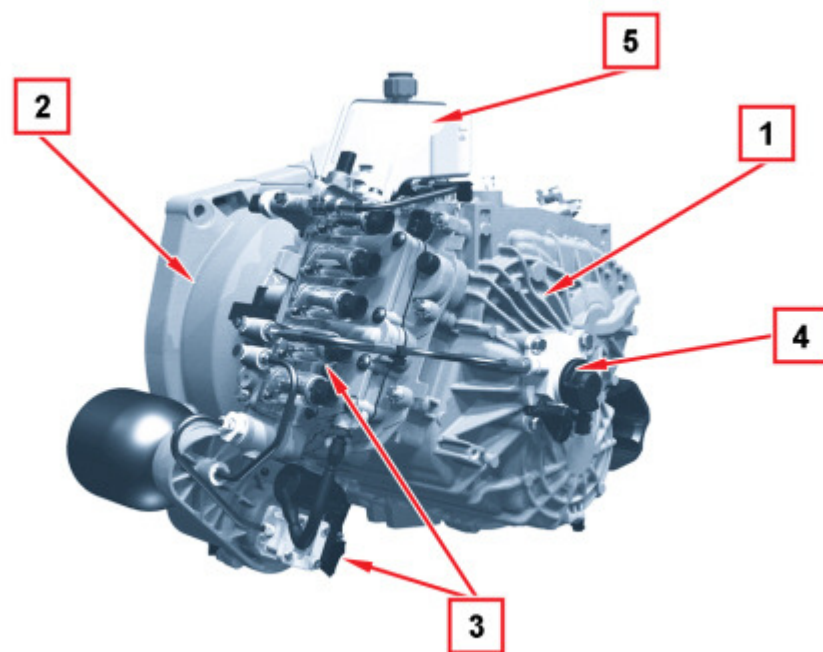
The power assisted system consists of an electrohydraulic unit fitted directly on the gearbox casing which manages the following gearbox movements by means of actuators:

- the gear selection and engagement movement
- the clutch opening/closing control.

The electrohydraulic unit is operated by five solenoid valves controlling the hydraulic power supplied by the accumulator electric pump.

Having identified the driver's requests from the position of the lever, the electronic control unit (TCU) manages gearshifting independently, controlling clutches, gearbox and engine torque directly.

The engine control is governed by the gearbox control during gearshifting.



1. Gearbox casing
2. Clutch casing
3. Electrohydraulic control unit - power unit
4. Odd gear clutch control actuator
5. Fluid reservoir for electrohydraulic control unit

The synergy between gearbox and engine improves the performance of the system considerably and frees the driver from any need to synchronise clutch-accelerator movements during gearshiftings which can be carried out with the accelerator fully depressed.

The system inhibits requests for incorrect gear changes and prevents the engine from stalling or over-revving.

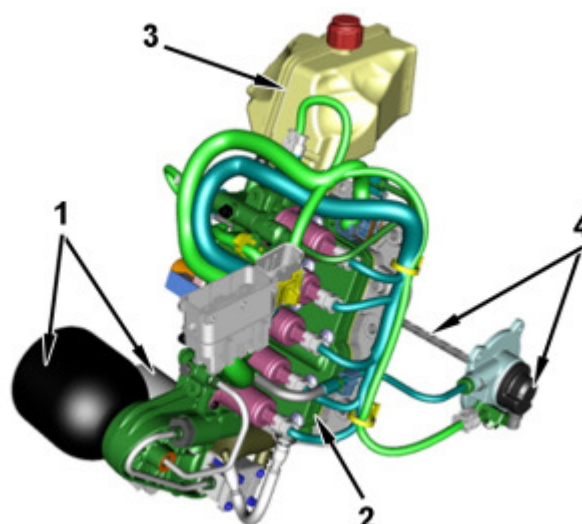
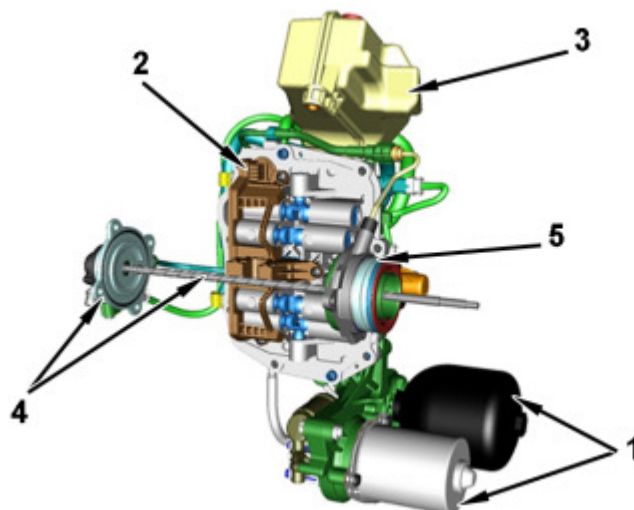
In terms of driving assistance the system also ensures the immediate availability of first gear when the vehicle stops and the automatic changing up through the gears in the event of a strong acceleration.

The indication of the gear engaged is shown on a display in the instrument panel, in the same way as the signalling of faults or critical driving conditions for the vehicle or the transmission components with a series of warning or failure messages for the system together with the general failure or transmission failure warning lights.

ELECTROHYDRAULIC UNIT COMPONENTS

The electrohydraulic unit comes in one piece which includes the following main components:

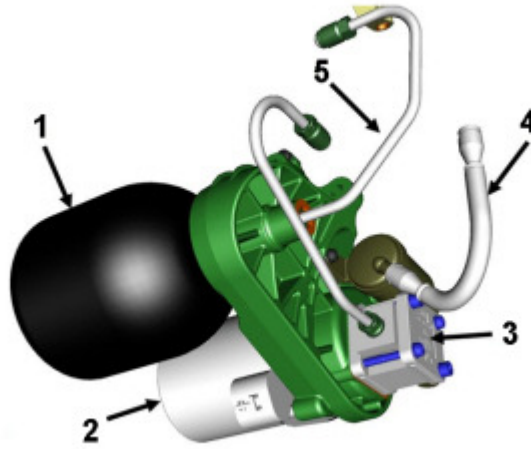
- the power unit (1) comprising electric pump, oil filter and accumulator
- solenoid valve unit for gear and clutch control (2)
- fluid reservoir for electrohydraulic control unit (3)
- odd gear clutch control actuator (4)
- even gear clutch control actuator (5).



Power unit

It supplies hydraulic energy for the activation of both the gear engagement/selection and the two clutch control actuators.

The unit includes an electric pump, high pressure pipes connecting the solenoid valve unit and a low pressure pipe connecting the solenoid valve unit to the oil filter.



1. Accumulator
2. Electric motor
3. Oil pump
4. Low pressure oil pipe
5. High pressure oil pipe

The system operates with a line pressure ranging between 44 and 45 bar.

In the recovery condition, the system reaches a maximum operating pressure of 70 +/- 5 bar.

The electric pump is activated when the pressure goes below 44 bar and is deactivated when the circuit pressure reaches 55 bar.

Technical specifications:

Line pressure at room temperature: between 44 and 55 bar

Operating temperature: between - 30°C and + 120°C

Starting possible down to a temperature of : -30°C

Pump capacity: > 1.35 l/min

Accumulator volume: 480 cc (precharged with nitrogen at 30 bar, temperature 20°C)

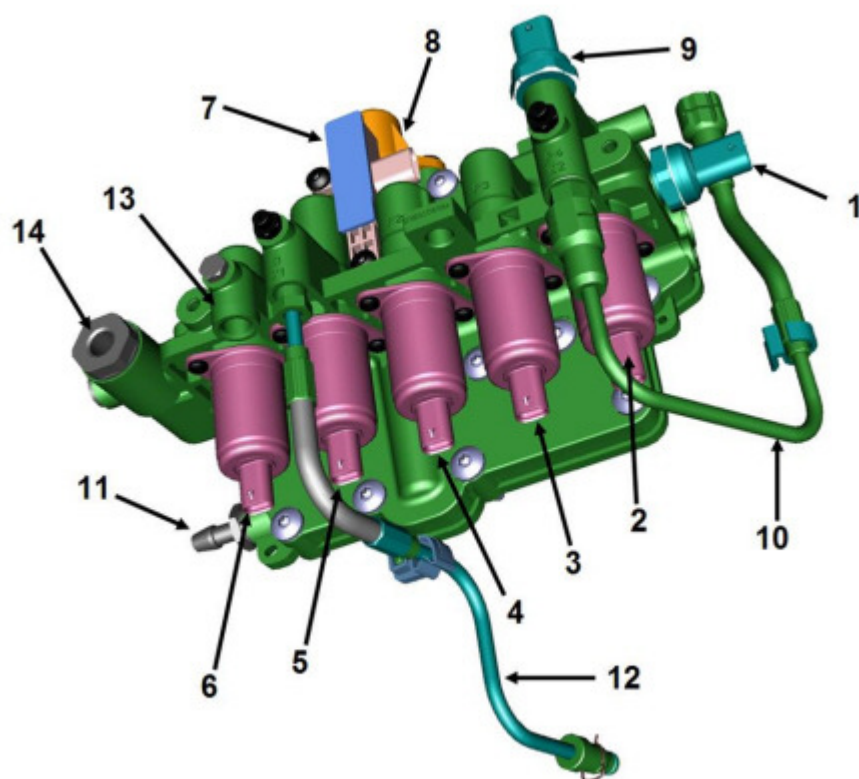
Solenoid unit

The unit is formed by:

- 4 proportional pressure solenoid valves (PPV)
- a proportional capacity solenoid valve (PQV) for odd gear clutch control actuator (K1)
- a control pressure transducer for even gear clutch control actuator (K2)
- magnetic resistive sensors controlling the "shifter" movements and the gear engagement pistons
- gearbox input speed sensors.

The unit has the following functions:

- it controls and manages the position of the clutches
- it controls and manages the gear selection and engagement.



1. Oil pressure transducer for valve unit
2. Proportional pressure solenoid valve PPV - K2 (even gears)

3. Proportional pressure solenoid valve PPV - S (shifter)
4. Proportional pressure solenoid valve PPV1 (engagement of 3 - 2 - reverse gears)
5. Proportional capacity solenoid valve QPV - K1 (odd gears)
6. Proportional pressure solenoid valve PPV2 (engagement of gears 1 - 6 - 4 - 5)
7. Shifter selector position sensor
8. Shifter selector axis
9. Pressure transducer for even gear control actuator
10. Oil delivery pipe to the even gear clutch control actuator
11. Oil deliver connector (low pressure) to the power unit filter
12. Oil delivery pipe to the odd gear clutch control actuator
13. Fitting for connector pipe to oil pressure accumulator
14. High pressure oil inlet pipe connector

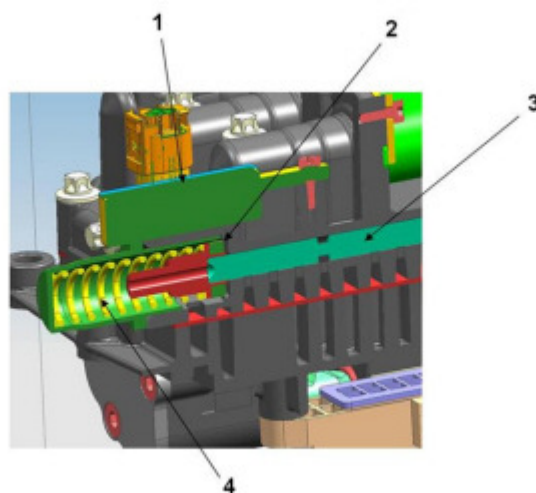
The shifter is used for gear selection.

The selection solenoid valve PPV-S sends pressurised oil to the selection actuator.

Oil pressure moves the hydraulic spool (3) against the load of the spring (4).

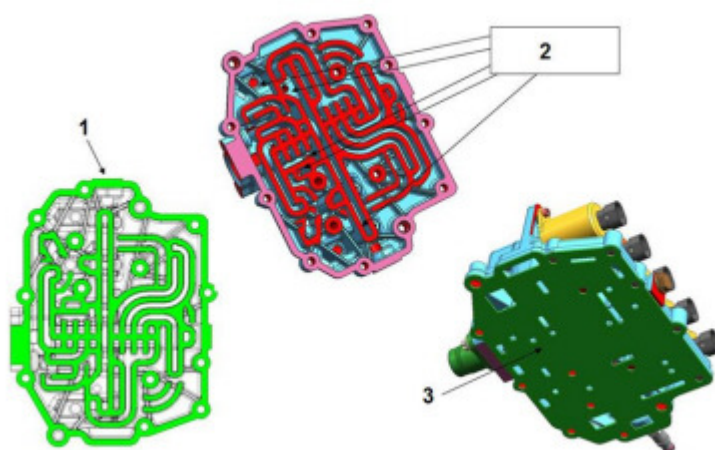
Under oil pressure, the hydraulic spool goes next to the engagement actuator for the required gear.

The hydraulic spool acts as a true distribution box for hydraulic power.



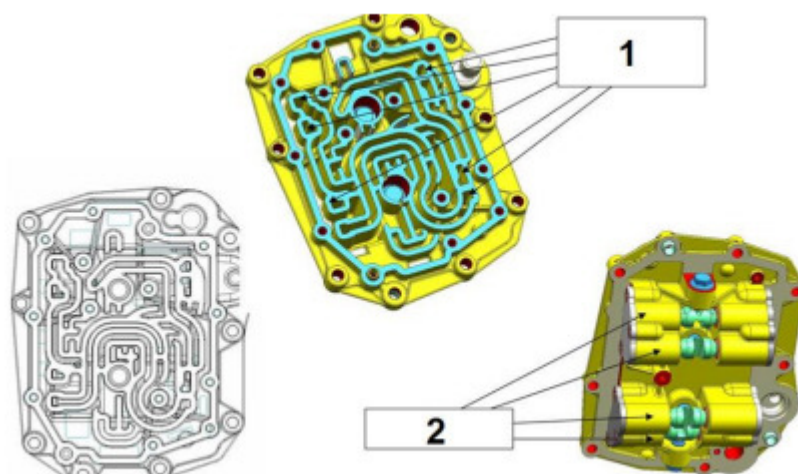
1. Shifter selector position sensor
2. Magnetic end on the spool
3. Hydraulic selection spool
4. Load simulation spring

The solenoid valve hydraulic connection in the plate is shown in the following figures.



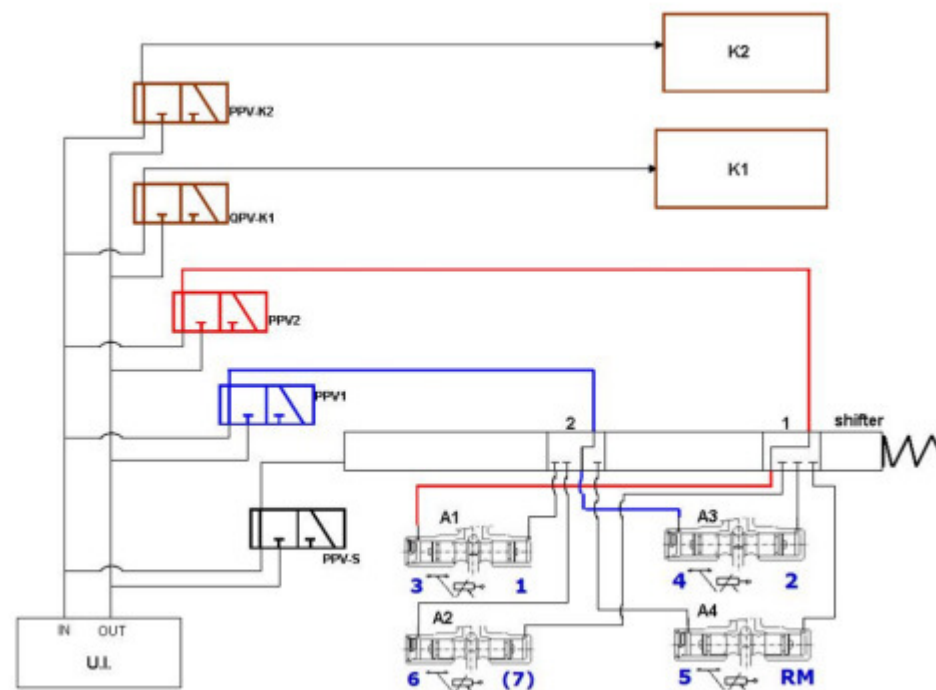
1. Hydraulic labyrinth on valve seat housing
2. Connections between valve seats and labyrinth ducts
3. Functional separation plate

The gear engagement actuator hydraulic connection in the plate is shown in the following figures.



1. Connection between labyrinth ducts and gear engagement actuators
2. Gear engagement actuators

OPERATION HYDRAULIC DIAGRAM



K1 - Odd gear clutch control actuator

K2 - Even gear clutch control actuator

U.I. - Hydraulic power unit

A1 - First-third speed engagement actuator

A2 - Sixth speed engagement actuator

A3 - Second-fourth speed engagement actuator

A4 - Fifth speed-reverse engagement actuator

The clutch K1, normally closed, is operated by the proportional capacity solenoid valve QPV-K1; therefore, the clutch K1 is controlled through oil capacity.

The clutch K2, normally open, is operated by the proportional pressure solenoid valve PPV-K2; therefore, the clutch K2 is controlled through oil pressure towards the actuator.

The selection of engagement planes (range) is managed through the proportional pressure solenoid valve PPV-S operating the distribution shifter for hydraulic power.

Gear engagement is managed by two proportional pressure solenoid valves PPV1 and PPV2.

The solenoid valves PPV1 and PPV2 control the engagement of both even and odd gears.

Considering the operation hydraulic diagram, this example refers to the first speed engagement followed by the second speed engagement.

The TCU control unit operates PPV-S, so that the distribution shifter can be moved to position 1.

At the same time, the TCU controls the solenoid valve PPV2, so that pressurised oil is sent to the red duct.

The distribution shifter goes in 1 and connects the red duct to the left side of the actuator A1.

Now, oil fills the left chamber of the actuator, shifting the same to the right and engaging the first speed.

This happens only after the TCU - through the solenoid valve QPV-K1 - has opened the clutch K1.

When the first speed is engaged, the TCU de-energises the QPV-K1 to drain oil from the relevant actuator and close clutch K1.

During drive transmission in first speed, the second speed is pre-selected as follows:

The TCU controls the distribution shifter through the PPV-S, to position it in 2.

At the same time, the TCU controls the solenoid valve PPV1, so that pressurised oil fills the light blue duct.

The distribution shifter goes in 2 and connects the light blue duct to the left side of the actuator A3.

In this way, pressurised oil pushes the actuator A3 to the right, engaging the second speed.

The engagement of the second speed occurs without any previous control by the TCU on the solenoid valve PPV-K2, as the clutch K2 is already normally open.

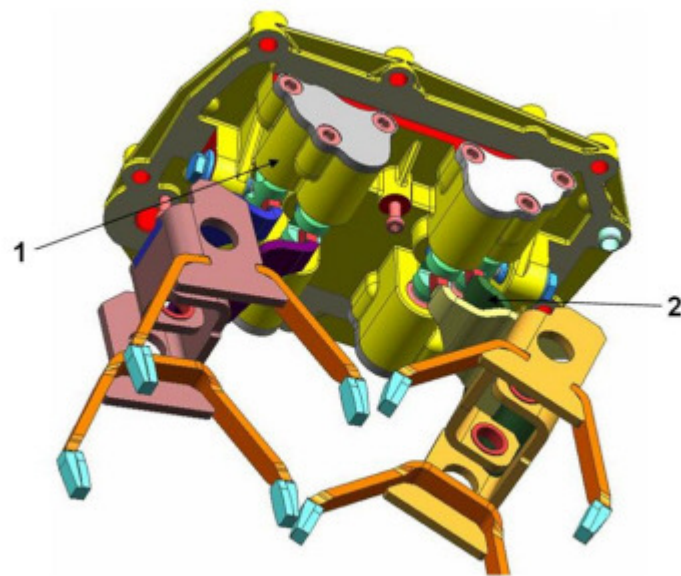
In this way, drive transmission occurs only through the first speed, because it is engaged and the clutch K1 is closed; at the same time the second speed is engaged as well, but it is neutralised by the clutch K2 that is still open.

When the engine operating conditions are achieved, second speed must be engaged, exchanging the clutches: this occurs closing K2 progressively and opening K1.

The electrical control to the solenoid valves PPV1, PPV2 and PPV-S is removed when the gear is engaged.

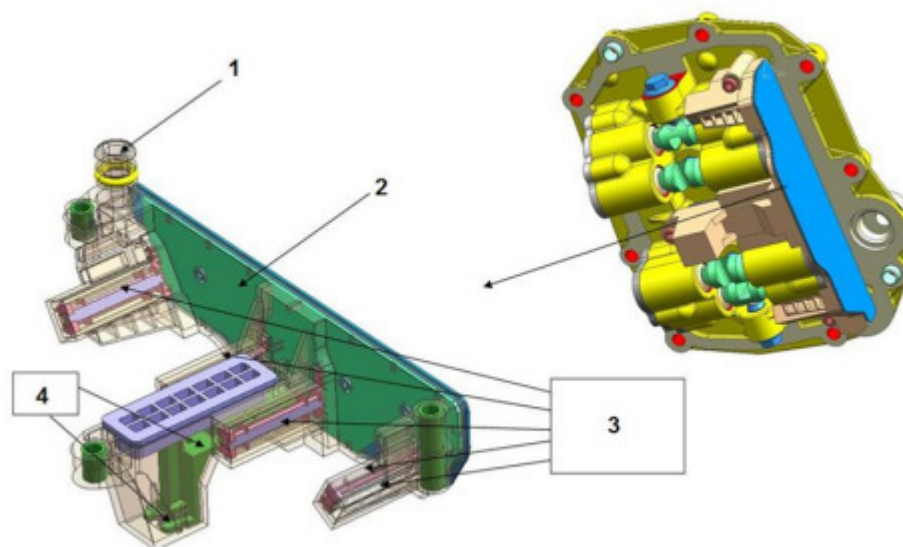
This occurs also for the engagement of all other gears.

GEAR CONTROL RODS



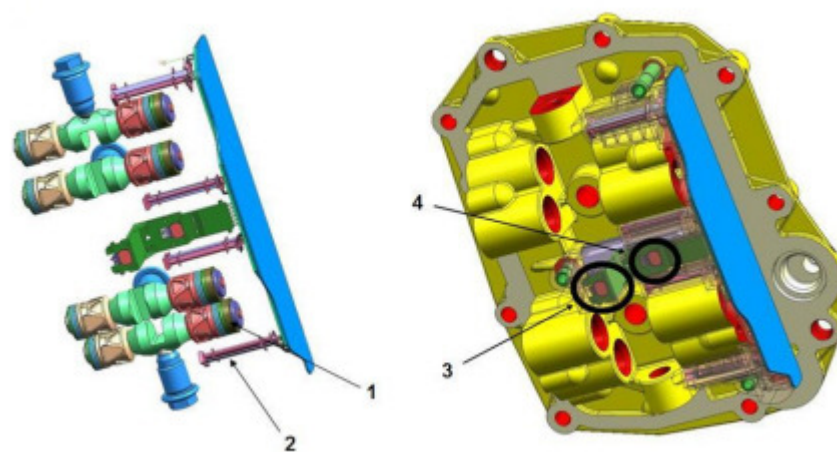
1. Gear engagement piston assembly
2. Control dogs

SENSOR INTEGRATED MODULE



1. Electrical connector
2. Base for electronic circuit
3. Magnetic resistive position sensor for each engagement piston
4. Gearbox input speed sensor

SENSOR POSITIONING



1. Magnetic end
2. Engagement actuator sensor element
3. Rpm sensor element for outer main shaft
4. Rpm sensor element for inner main shaft

Technical specifications

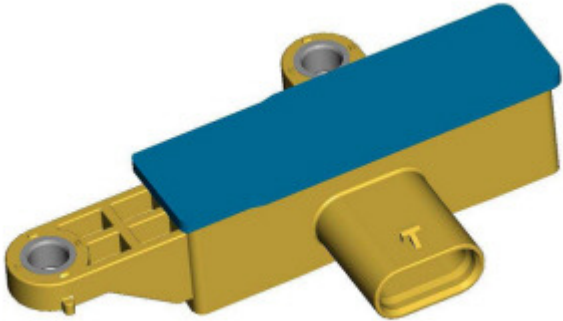
Actuator position sensors:

- PWM outlet signal (0-5 V), with refresh every 0.5 ms
- power supply 5 V +/- 0.5 V
- operating temperature: from - 30°C to 150°C
- measuring range: from 25 mm to 30 mm

Clutch rpm sensor:

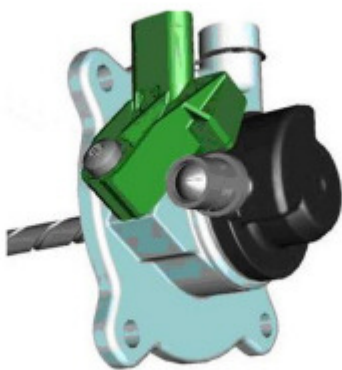
- electromagnetic, Hall effect sensor
- square wave output signal with width: from 0 to 5 V

- max. measuring speed: 10000 rpm
- SHIFTER POSITIONING SENSOR**



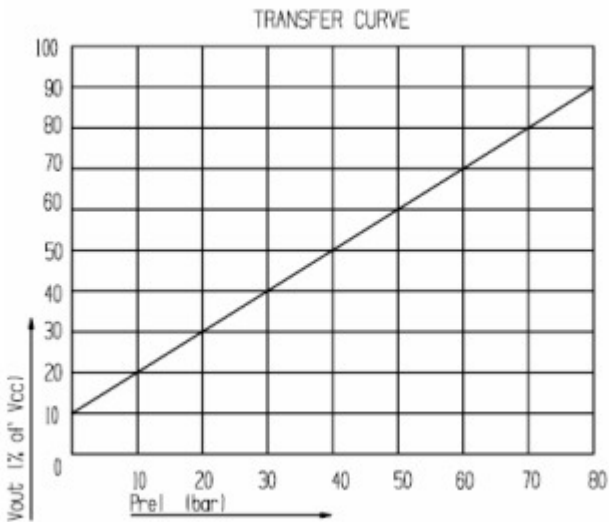
- Technical specifications**
- PWM outlet signal (0-5 V), with refresh every 1 ms
 - power supply 5 V +/- 0.5 V
 - operating temperature: from - 30°C to 150°C
 - measuring range: from 25 mm to 30 mm

POSITION SENSOR FOR ODD GEAR CLUTCH CONTROL ACTUATOR

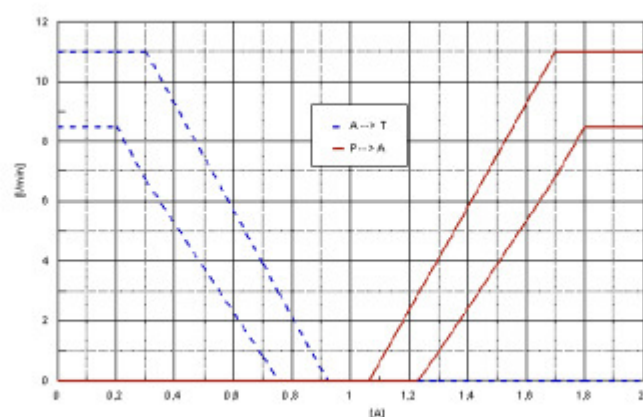


- Technical specifications**
- PWM outlet signal (0-5 V), with refresh every 1 ms
 - power supply 5 V +/- 0.5 V
 - operating temperature: from - 30°C to 120°C
 - measuring range: 13 mm

PRESSURE SENSORS



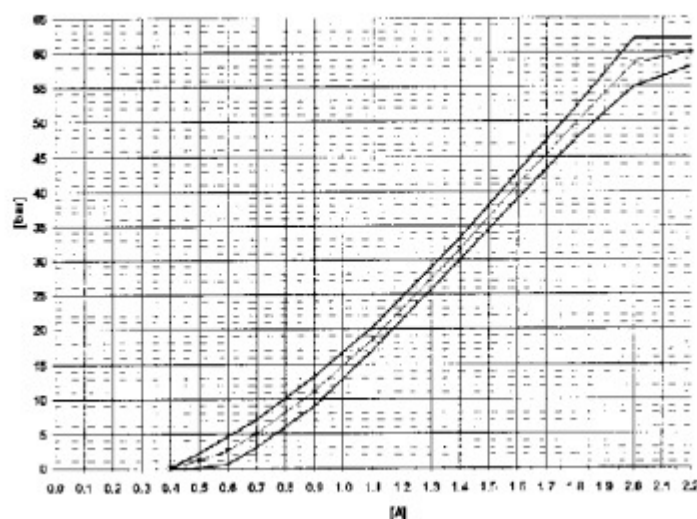
- Technical specifications**
- supply voltage 4.5 V - 5.5 V
 - operating temperature: from - 40°C to 135°C
 - measuring pressure range: from 0 to 80 bar
- PROPORTIONAL CAPACITY SOLENOID VALVE**



Technical specifications

- max. capacity: 11 l/min (with differential pressure of 10 bar).
- control current: from 0 to 2 A (directly controlled by the control unit)
- electrical winding resistance at 20°C: 2.4 Ω +/- 6%

PROPORTIONAL PRESSURE SOLENOID VALVE



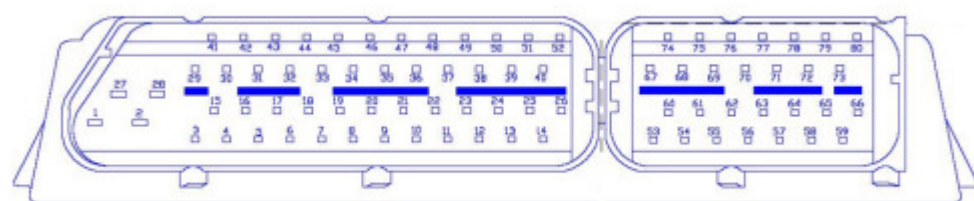
Technical specifications

- max. capacity: 12 l/min (with differential pressure of 10 bar).
- control current: from 0 to 2.2 A (directly controlled by the control unit)
- electrical winding resistance at 20°C: 2.6 Ω +/- 6%

TCU ELECTRONIC CONTROL UNIT

The control unit 8TDF type is located in the passenger compartment, under the floor cover, next to the area dedicated to the passenger's feet. The vehicle front wiring is sent to the control unit with two 52 and 28 pin connectors.

Pin out



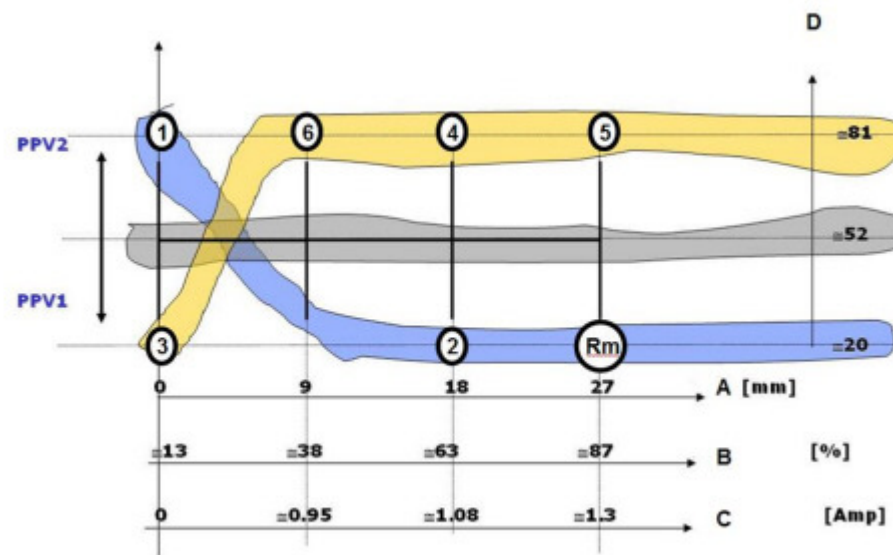
52 pin connector

1. Power earth
2. Power earth
3. +12 V - direct supply from battery
4. Not connected
5. Not connected
6. Not connected
7. Not connected
8. Parking sensor
9. Not connected
10. Not connected
11. Not connected
12. Not connected
13. Not connected
14. Not connected
15. Not connected

- 16. Not connected
- 17. Driver's door switch
- 18. Not connected
- 19. SDU diagnosis feedback
- 20. Not connected
- 21. D TIP signal
- 22. Not connected
- 23. Not connected
- 24. Not connected
- 25. Not connected
- 26. Not connected
- 27. + 12 V - battery power supply
- 28. + 12 V - battery power supply
- 29. Not connected
- 30. Reverse light 1 control
- 31. Reverse light 2 control
- 32. Not connected
- 33. Not connected
- 34. + 15 V - key-operated supply
- 35. Not connected
- 36. SDU control
- 37. Not connected
- 38. Not connected
- 39. C-CAN H (OUT)
- 40. C-CAN L (OUT)
- 41. Not connected
- 42. Not connected
- 43. Brake pedal signal
- 44. Not connected
- 45. Not connected
- 46. Not connected
- 47. Not connected
- 48. Not connected
- 49. Serial line K (preparation)
- 50. C-CAN H (IN)
- 51. C-CAN L (IN)
- 52. Not connected
- 28 pin connector**
- 53. + 5 V - line pressure sensor supply
- 54. Not connected
- 55. PPVS solenoid valve earth
- 56. PPV2 solenoid valve earth
- 57. QPV-K1 solenoid valve earth
- 58. PPV1 solenoid valve earth
- 59. PPV-K2 solenoid valve earth
- 60. Electrohydraulic unit temperature sensor signal
- 61. Clutch K2 pressure sensor signal
- 62. + 12 V PPV-S solenoid valve power supply
- 63. + 12 V PPV2 solenoid valve power supply
- 64. + 12 V QPV-K1 solenoid valve power supply
- 65. + 12 V PPV1 solenoid valve power supply
- 66. + 12 V PPV-K2 solenoid valve power supply
- 67. Clutch K1 position sensor signal
- 68. Fifth speed and reverse position sensor signal
- 69. Second-fourth speed position sensor signal
- 70. Clutch K2 revolution sensor signal
- 71. Supply to odd gear engagement position sensors and clutch K1
- 72. Supply to even gear engagement position sensors, pressure for clutch K2 and selection sensor
- 73. Clutch revolution sensor and line pressure supply
- 74. Clutch K1 revolution sensor signal
- 75. Selection position sensor signal (shifter)
- 76. First and third speed position sensor signal
- 77. Sixth speed position sensor signal
- 78. Sensor module and clutch K2 pressure sensor earth
- 79. Line pressure sensor and clutch K1 position sensor earth
- 80. Clutch K1 revolution sensor module and clutch K2 earth

DUAL CLUTCH SYSTEM FEATURES

Gear positions on the gearbox grid and solenoid valve activation



- A. Travel
- B. Sensor reading
- C. Shifter solenoid valve current
- D. Engagement sensor reading

The coloured areas represent the reading value of the gear engagement sensor.

- For third, fourth, fifth and sixth gears, the sensor reading has high values.
- For the other gears, first, second and reverse, the sensor reading has low values.
- The first gear is engaged using PPV2 and the second gear is engaged using PPV1, to engage one of the two setting off gears, if one of the two engagement valves is faulty.

The characteristics for the selection actuator are:

- selection travel for first - third gear: 0 mm
- selection travel for second - fourth gear: 18 mm
- selection travel for reverse - fifth gear: 27 mm
- selection travel for sixth gear: 9 mm
- piston diameter: 10 mm
- chamber max. volume: 2.12 cc
- pushing area: 0.79 cm²
- spring pre-charge: 58.9 N
- spring stiffness: 5.3 N/mm

Kiss point

It is the position where a clutch starts/stops transmitting torque and it is calculated after the engine has been started.

- The odd gear clutch K1 control actuator has a position sensor detecting the distance (delta kiss) from the closed clutch position.
- When engine is started, the clutch opens; the clutch starts closing when the engine rpm curve exceeds a set threshold; the kiss point is detected and thus the delta kiss is calculated.
- The even gear clutch K2 control actuator has no position sensor, therefore its position is calculated through the reading of oil pressure in the supply duct.

Usually, when the system is new, this value ranges between 3 and 5 bar.

The kiss learning for clutch K1 occurs only after the engine has been started and when the gearbox is in neutral.

The kiss learning for clutch K2 - being it normally open - can occur also when the first gear is engaged, but only if clutch K1 kiss has been made.

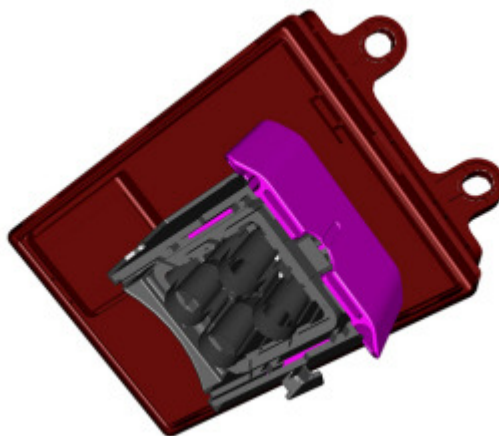
Wake up

It increases the pressure of the hydraulic circuit before switching on the instrument panel and is operate when the door is opened.

The failed activation of the pump is due to an insufficient pressure value in the hydraulic circuit, or to a possible failure (door switch, pump fuse, etc.).

The electric pump noise is reduced, by an "SDU" device adjusting the supply voltage, according to a gradual growth law.

The SDU is installed on a suitable bracket located next to the front left headlamp.



Gearshiftings for underspeed

This occurs when the system (in manual mode) makes one or more downshifting movements automatically, to prevent the engine revolutions from

being too low and the engine switching off.

The car can be slowed down, without any downshifting, because the system does it automatically, until engaging the first gear when the car is stopped.

Limp home

This is a driving mode that operates in the event of system failure.

For some failures, only the first, second, third and reverse gear can be engaged.

In some cases, an engine Limp Home can be requested corresponding to a revolution limiting.

In some recovery conditions, special "automatic maps" can be activated: even and odd speed gear automatic.

Retry

It is a strategy that tries to engage the previously requested gear, that was not engaged due to a possible fault.

During the retry movement, the system, after recognising the impossibility of gear engagement, makes a new engagement attempt (starting from neutral); if this is still impossible, it makes two further attempts. If these attempts are still negative, it engages the neutral.

After the third failed engagement attempt, the system reacts according to the following conditions:

- power shift gearshifting: the gearshifting has not been completed, therefore the previous gear is still engaged, the relevant clutch is still transmitting the torque; for this reason, the car has no traction. Three further attempts can be made, if a new gearshifting is required. If the behaviour is systematic, after a given series of consecutive events, the gearbox part with the involved speed gear is excluded (even or odd speed gear automatic).
- interrupted gearshifting: the system handling logic tries to engage a longer gear compatibly with the car speed. With stopped car, at the request of first gear or reverse, if the retry fails, the gearbox sets in neutral.

Power-latch

It is the switching off procedure for the TCU control unit, starting when the control panel is switched off (+ 15 OFF), if the following conditions occur:

- no gearshifting in progress
- engine speed lower than 400 rpm
- clutch speed equal to 0
- clutch closed
- key signal + 15 at 0.

If these conditions occur, after a second from the control panel switching off, the TCU switching off procedure is operated.

During this procedure, the TCU is self-powered (+ 30) and saves a set of parameters in the flash memory, for about 5 seconds.

Power shift gearshifting and interrupted gearshifting

During Power Shift gearshifting, the torque transmitted to the drive wheels is not interrupted, with the exception of the following cases:

- multiple gearshiftings concerning the same clutch
- activation of recovery procedures required for safety reasons.

The "interrupted" gearshiftings occur following this sequence:

- both clutches open
- the engaged gear is released
- a new gear is engaged
- only the clutch involved by the engaged gear is closed.

Creeping

Lets the vehicle move in "D" or "R" by simply releasing the brake.

This function is obtained with released brake and engaged gear, approaching the clutch K1 just enough to make the car move (forward or backward) at a very slow speed.

This function is extremely useful while parking or moving forward in a queue at a very slow speed.

Torque tracking and speed tracking

When an even gear is engaged, to close the clutch K2 the hydraulic unit keeps oil pressurised in the relevant control actuator.

The cup spring of clutch K2, for manufacturing reasons, cannot be pressed for loads above a given value.

The torque tracking strategy achieves it, closing the clutch K2 with a torque transmission margin vs. the one supplied by the engine.

If the vehicle is moving forward with an odd gear and no even gear is engaged, being clutch K2 normally open, the connected gearbox side tends to stop rotating; to keep it rotating, the speed tracking strategy is operated, that is the clutch K2 is approached.

OPERATING LOGICS

Pressurisation of the hydraulic circuit

When the hydraulic pressure is below the minimum operating threshold, the pressurisation occurs as follows:

- opening the driver's side door
- with key on "MAR-ON", engine switched off and car stopped.

The actuation system electric pump also receives supply to pressurise the hydraulic unit when the pressure reaches the minimum value of around 44 bar.

The TCU control unit starts the engine only when the gear lever is in "P" or "N" position.

Engine starting

Rotating the ignition key, the engine is started with the starting relay switch controlled directly by the engine management control unit after the

enabling from the TCU control unit.

Operation with engine off

The gears available with the engine off are first, reverse and N.

Vehicle takeoff

With engine running and car stopped, first gear and reverse are available to get the setting off.

The vehicle setting off is only possible if the driver operates the accelerator pedal and releases the brake pedal; now, the system gradually engages the clutch to start the vehicle.

The driver is capable of administering the torque transmitted by the clutch by varying the accelerator pedal.

When the accelerator is released, the clutch automatically releases when the minimum engine revolution threshold is reached.

When the system detects compatibility between engine and clutch revolutions, it closes the clutch completely.

For each of the three gears used for setting off, a special clutch engagement map is implemented.

During setting off, a higher gearshifting can be required, even if the clutch revolutions are not compatible with the engine speed.

When the car is moving, setting off can be made also in second gear.

Clutch automatic engagement

If the car, with gear engaged, accelerator released and engine started, picks up speed because it is going downhill, when a pre-set speed is reached, the system automatically closes the clutch to provide the car with engine braking.

The control of the torque transmitted by the clutch is directly under the driver's control as soon as the accelerator pedal is pressed.

The clutch automatic engagement is interrupted if the car is moving in the opposite direction to the gear engaged.

Vehicle slowing down

With gear engaged and accelerator pedal released, the system automatically releases the clutch to prevent engine switching off next to the idling speed.

The clutch release occurs at an engine speed which depends on the deceleration level and driver's controls (brake possibly pressed).

Whilst slowing down, if the gear engaged is higher than the second, a downshifting is controlled automatically.

When the vehicle stops, first gear is engaged automatically.

Gear change by lever (semi-automatic operating mode)

With moving car and fully engaged clutch, gearshifting requests through lever are accepted by the system only if compatible with the under revving and over revving thresholds of the engine.

The gearshifting control from the lever causes an increase or decrease of a single gear ratio.

Only in some operating conditions the gear jump may be more than one, if requested by the driver, with a quick double control.

The upshifting manoeuvre is required by the driver without releasing the accelerator pedal; once accepted by the system, it is carried out automatically with a sequence of stages that comply with the driver's behaviour:

A gearshifting in progress can be interrupted at any time by another request from the driver, on condition that it is compatible with the engine revolutions.

Automatic gear change (auto mode)

The transmission is equipped with an automatic operating mode, very similar to the one of traditional automatic transmissions.

The selection of the ratio to be engaged is made on a (double) map which correlates the power required by the driver and the car speed.

The double map is connected to the possibility of selecting a "NORMAL" or "DYNAMIC" handling through the "DNA lever".

If the accelerator pedal is released and the system is in "DYNAMIC" mode, under some conditions the system does not lengthen the gear, to keep engine braking.

In "NORMAL" mode, when the accelerator pedal is released, the system tends to lengthen the gear ratio (where allowed), to reduce consumption.

The gearshifting implementing mode is identical to that provided for semi-automatic operation by a lever, though it uses control parameters for the gearbox and engine actuators, dedicated to each mode.

If the gear lever is faulty, the system shifts to AUTOMATIC.

Request to put the gearbox in neutral

This request takes priority over all the others and is only done by means of the lever.

With the engine off, the brake pedal needs to be pressed.

This request for neutral is always accepted with the car moving.

Information for the driver (display and buzzer)

The system informs the driver by means of:

- display: "MANUAL" operation and gear engaged, "D" operation and gear engaged, system failure

- buzzer: incorrect use of the car (setting off with overheated clutch), unsafe car (engine off without engaged gear), faulty system.

AUTO CALIBRATIONS

Clutch bleeding procedure

This procedure must be carried out using the Examiner diagnosis instrument, following these guidelines:

- after repairing the electrohydraulic unit, after a hydraulic part replacement (valves, pump, pressure sensor, delivery pipe...)
- in the event of filling, after emptying the system for a electrohydraulic unit repair.

The self-calibration is designed to eliminate the possible presence of air in the hydraulic circuit after the replacement of one of the above mentioned components, carrying out a preset number of clutch K1 and K2 opening/closing cycles, with the electric pump activated.

Oil accumulator depressurisation

This procedure must be carried out using the Examiner diagnosis instrument, following these guidelines:

- before repairing the electrohydraulic unit, replacing hydraulic parts (valves, pressure sensor, supply pipe, electrohydraulic unit/gearbox separation,...)

This self-calibration is used to drain the hydraulic circuit, sending oil to the reservoir, to replace the above components, with a preset number of clutch K1 and K2 opening/closing cycles and deactivated electric pump.

Enabling clutch auto calibration

If a component is replaced, the self-calibration must be made after the "Data Set Deletion".

The procedure is designed to quickly recalculate the kiss point which is the position at which the clutches start to transmit drive torque.

Service end of line self-calibration

This procedure must be carried out using the Examiner diagnosis instrument, following these guidelines:

- at the end of the line
- after replacing the gearbox
- after replacing/separating the electrohydraulic unit
- after replacing any selection or engagement sensor
- after replacing the TCU.

If a component is replaced, first of all carry out the "DATA SET DELETION".

This procedure is designed to store the gearshifting grid thresholds.

New actuators

This procedure must be carried out using the Examiner diagnosis instrument, following these guidelines:

- after replacing the electrohydraulic unit
- after replacing the clutch selection and/or engagement solenoid valve.

The procedure is designed to force the solenoid valve drift values to values corresponding to new solenoid valves.

Data set deletion

This procedure must be carried out using the Examiner diagnosis instrument, following these guidelines:

- electrohydraulic unit replacement
- gearbox replacement
- clutch unit replacement
- sensor module replacement
- electric pump replacement
- oil accumulator replacement
- voltage regulator (SDU) replacement
- clutch K1 position sensor replacement
- replacement of oil pressure sensor for clutch K2
- statistic data reset
- OFFSET value reset.

In case of simultaneous replacement of the TCU control unit and of one of the above components, the "DATA SET DELETION" must be performed after the "HISTORICAL DATA REWRITING" procedure.

This procedure must be performed to reset or bring back to default values the set of data associated to the replaced component.

The information also makes it possible to identify the number of manoeuvres and incorrect conditions of the system finds when an error is validated.

Gear engagement procedure

The procedure must be made with the Examiner diagnosis instrument, to diagnose possible problems linked to the solenoid valves.

This procedure must be followed to engage all gears, with the following stages:

- neutral centering
- keeping both clutches open
- shifter control.

Longitudinal accelerator sensor learning

This procedure must be carried out using the Examiner diagnosis instrument, following these guidelines:

- end of line
- TCU control unit replacement
- replacement of the longitudinal acceleration sensor (yaw).

If a component is replaced, the above procedure must be made after the "DATA SET DELETION".

By this procedure the system learns the longitudinal acceleration value sent by the yaw sensor.

If this procedure is not performed, the system operation can be affected; therefore it must always be carried out.

"historical data" rewriting

The procedure must be carried out with the Examiner diagnosis instrument, only following the TCU control unit replacement. The procedure allows the system history to be stored (gearbox and electrohydraulic unit), transferring data from one TCU control unit to another. This operation is feasible if the services necessary for its execution are not affected. If the TCU control unit to be replaced does not give the possibility of reading data, the procedure cannot be carried out and the system operation is not affected. If the TCU control unit and any other component subject to a "DATA SET DELETION" procedure are replaced simultaneously, the "HISTORICAL DATA" must be copied and then the "DATA SET DELETION" must be carried out for the component to be replaced.

FUNCTIONAL INTERACTION WITH OTHER SYSTEMS

Interaction with engine management

When driving, the two systems do not interact, because the system does not perform any work, then only one information and signal exchange persists through network.

When a setting off manoeuvre is to be made, or during gearshifting, the TCU control unit becomes master over the engine management control unit and excludes all the safety conditions that should always be managed by the engine: the engine is managed only through the TCU control unit.

This control ends after the above manoeuvres.

After the introduction of the Start&Stop operating logics, further information is exchanged between the TCU control unit and the engine management control unit.

By way of example, let's imagine that the car is approaching red traffic lights:

- when the car stops, the engine switches off (the driver presses the brake pedal)
- the driver releases the brake pedal
- the engine management control unit asks the TCU control unit to place the gearbox in neutral
- with gearbox in neutral, the TCU control unit informs the engine management control unit that the gearbox is in safety conditions
- the engine management control unit can start the engine
- the engine management control unit starts the engine and, at the same time, asks the TCU control unit to re-engage the previously released gear.

Interaction with the cruise control

The Cruise Control system is not affected by the presence of the dual clutch actuation control.

Safety and functions in case of failure

Strategies which manage incorrect commands creating potentially dangerous or critical operating conditions for the transmission/car.

Key-lock

After switching the engine off, two situations can occur:

- the driver placed the lever in "P"
- the driver placed the lever a position other than "P".

In the first case, the driver can take out the key without any problem; in the second case, the key cannot be removed, informing the driver that the car is not in safety conditions.

The following actions can be made:

- the driver turns the ignition key again and places the lever in "P"
- the driver knows that the car is not in safety conditions, but takes out the ignition key manually, using the suitable mechanical release control. This operation should be carried out only in extremely critical situations.

GEARBOX CONTROLS

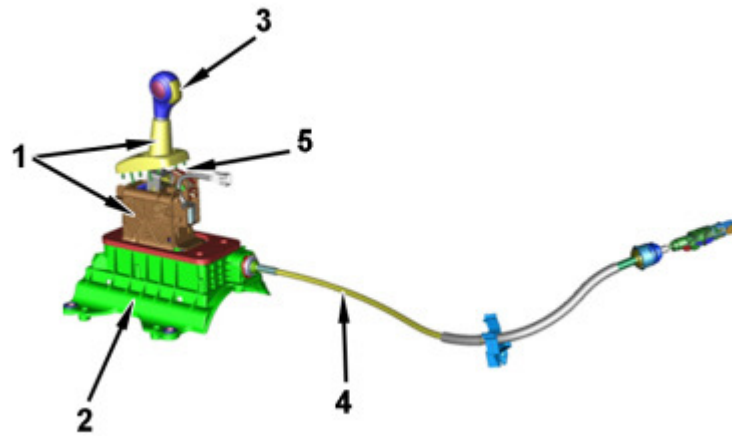
The gearshifting request may take place in the following ways:

- sequential (manual) or automatic through the selector lever
- sequential (manual) through the steering wheel controls (where present).

Selector lever

The gear selector lever in the compartment central tunnel can be placed in the following positions:

- P: park
- R: reverse
- N: neutral
- D: drive (automatic forward gear)
- TIP: manual gearshifting (lever fully to the left from position D)
- "+": sequential shift to higher transmission ratio
- "-": sequential shift to lower transmission ratio



1. Selector lever assembly
2. Mount
3. Lever moving button
4. Parking function flexible cable
5. Selector lever manual release

Selector lever manual release

In emergencies (breakdowns, battery flat, etc.) the selector lever can be moved from position P using the lever under the gaiter, on the left side, as shown.



Ignition key removal in emergency situations

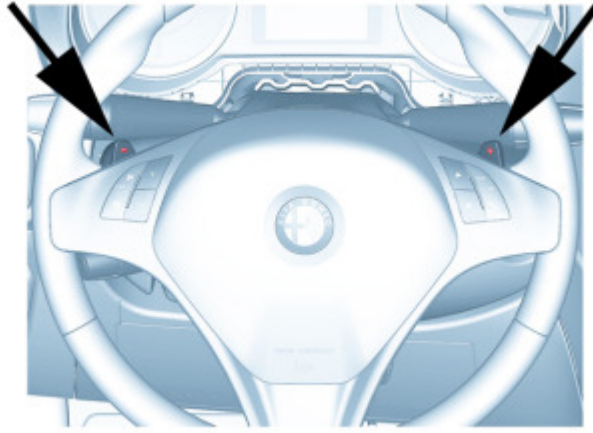
If the battery is flat, the ignition key is locked in position.

To remove the key, proceed as follows: pull the handbrake and fit the supplied screwdriver in the hole, shown in the figure, slightly pressing, until the ignition key can be removed.



Manual sequential control from the steering wheel

Gearshifting can be managed sequentially through the controls on the steering wheel as shown.



Operating the "+" lever on the steering wheel engages a higher ratio
 Operating the "-" lever on the steering wheel engages a lower ratio

System behaviour with car stationary and engine off

Door opening

With the vehicle stationary, when one of the doors is opened the instrument panel is activated and various information relating to the vehicle is displayed: the gear engaged is not displayed, however.

The electric pump is activated to bring pressure to the circuit and allows the system to be on when ignition is requested.

Procedures before key-on

At the key-off (vehicle stationary with ignition-operated electrical services deactivated):

- if the lever is in P, it cannot be moved even though the brake pedal is pressed, or released, not even by the button on the knob (no displaying)
- if the lever is in R/N/D/TIP, it can be moved pressing the button on the knob up to position P; then, it is mechanically locked.

The system stops communication on CAN network at the key-off (the vehicle is stationary).

The gear lever engages the Parking lock and displays P position only if the same lever is moved within 5 seconds from key-on to key-off.

After 5 seconds, the Parking lock can be engaged, but the displaying cannot be handled.

The transmission keeps the gear engaged before the key-off; at the following key-on the gear consistent with the lever position is displayed.

Key-on (+15)

The icon on the gearbox trim corresponding to the lever position is lighted.

When the lever is faulty, all the icons are lighted and flash.

With the vehicle stationary and key in ON position (ignition-operated electrical services activated), the instrument panel must display a gear consistent with the position of the control lever.

The lever operation logics on this application are handled by the body computer through a special signal.

All the logics can be set by the lever, both in Automatic and Manual conditions.

Shift lock

When the car is stationary, moving the lever from position P (corresponding the neutral) is only possible if the brake pedal and button on the knob are pressed.

Moving the lever

All movements must be performed with car stationary and engine idling only.

The drive wheels are mechanically locked in position P.

- Shifting from P to R is possible pressing the brake pedal and the button on the knob
- shifting from R to N is free
- shifting from N to D is free
- shifting from D to TIP is free
- shifting from TIP to D is free
- shifting from D to N is free
- shifting from N to R is possible pressing the button on the knob
- shifting from R to P is possible pressing the button on the knob.

In case of inconsistency between lever position and gear engaged, on the gear lever trim the icon corresponding to the required gear switches on steadily (lever final position) and flashes if the transmission cannot engage the required gear.

The centre position for TIP (stable between "+" and "-") corresponds to first gear.

In case of retry (lever position D or TIP, but N gear engaged), using the "+" lever control on the steering wheel the first gear can be engaged (with or without pressing the brake pedal).

System behaviour with the engine started and/or car moving

STARTING: (+50)

Starting is only permitted with lever in position N or P (with or without brake pedal pressed) and neutral engaged.

 The gear engaged and lever position may not coincide.

If the lever is in D, R or TIP, the engine starting is not allowed and no warning message is displayed.

At starting, the system is in N or P (the latter corresponds to transmission neutral, but the car's wheels are mechanically locked).

In any operation mode (Dynamic/Normal/All Weather) the instrument panel displays the gear engaged at the request for car starting.

STARTING THE VEHICLE FROM STATIONARY

After the starting procedure, the engine is running and the car is stationary, with gearbox in neutral and selector lever in N or P.

To move the lever from position P, press the brake pedal and the button on the knob: the system activates the shift lock coil and unlocks the lever.

The driver can decide whether starting in first gear (lever in D or TIP) or in reverse (lever in R).

The instrument panel displays the gear engaged.

The request for engaging the second gear (by TIP+) is not accepted by the system (with or without brake): no message is displayed.

ENGINE STARTED

The car starts moving forward or backward as soon as the gear is engaged (no need to press the accelerator).

This creeping strategy is activated by the system as default if the following conditions occur:

- first gear or reverse engaged
- handbrake released

- recovery for deactivating the creeping not working (for example: clutch not overheated)
- brake pedal released
- accelerator pedal released.

The creeping is automatically deactivated/reduced (with first or reverse gear engaged) if the following conditions occur:

- handbrake operated
- road slope over 5%: the creeping torque is gradually switched off
- the clutch temperature is higher than a threshold (firstly set as "out of range")
- the creeping torque is steady (higher than a given threshold) for about 4 seconds: for example, if the car hits the pavement, creeping is progressively deactivated until reaching a zero clutch torque. Then, the creeping is reactivated when the accelerator or brake pedal are pressed again.

When the engine is running, only first or reverse gear speeds can be engaged (apart from neutral).

When R is engaged there is no acoustic warning.

The TIP position corresponds to the first gear if the lever comes from D, N or R.

Every TIP - request is not considered by the system because it is not a plausible request.

With the START&STOP mode not activated, if the car stops with engine running, in neutral, after a calibrated time, the system closes the clutch K1.

AUTOMATIC STARTING

The TCU control unit sends to the engine management control unit information about the clutch conditions and the gear engaged.

The automatic starting is activated by the engine management control unit, after an automatic switching-off, according to the START&STOP strategies.

The engine switches off, according to the START&STOP strategy, when the brake pedal is pressed if the lever (not the gear engaged) is in a position other than TIP+, TIP- or reverse.

The engine asks the transmission to carry out an automatic starting if:

- the brake pedal is released and the lever is not in N or P
- the lever is moved from TIP+, TIP- or reverse position
- the lever is moved into TIP from D position.

Placing the lever in N or P, with brake pedal pressed and engine switched off automatically, the following brake pedal release does not cause the automatic engine starting.

After an automatic starting request from the engine management control unit, the TCU control unit engages the N gear and automatic starting can occur.

The display shows the passage:

- D - N - D: if the engine was switched off with lever in D (automatic mode)
- First - N - first: if the engine was switched off with lever in TIP (manual mode).

After engine starting, the TCU control unit can reactivate the creeping function.

Selector lever management - start&stop system

The TCU must inform - through CAN - the engine management control unit about the conditions of the lever, meant as gear shifting request.

In case of automatic engine stopping, the system usually finds the lever in TIP - D and the transmission in first speed, or lever in N and transmission in neutral.

MOVING THE LEVER FROM D TO N (with brake pedal pressed, otherwise the engine restarts immediately)

- the TCU must communicate the updated conditions of the lever (neutral)
- the TCU must bring the transmission in stable neutral
- the TCU must keep the clutch open
- the engine management control unit does not operate the engine restarting.

 With transmission in neutral, the START&STOP strategy does not ask for the condition of brake pedal pressed to keep the engine off, therefore the driver can release the brake pedal without any new engine starting being operated.

MOVING THE LEVER FROM N TO D

- the TCU must communicate the updated conditions of the lever (Drive)
- the engine management control unit must handle the information and operate the engine starting independently of the brake pedal position
- the TCU waits until the engine is started and keeps the clutch K1 open (in N)
- the TCU engages the first gear and then resumes control over the clutch K1, according to the standard creeping strategies (accelerator pedal released) or setting off ones (accelerator pedal pressed).

MOVING THE LEVER FROM TIP+ OR TIP- (with brake pedal pressed, otherwise the engine restarts immediately)

- the TCU must communicate the updated conditions of the lever
- the engine management control unit operates the engine restarting
- the TCU controls gear release and waits until the engine is started keeping the clutch K1 open (in N)
- the TCU engages the first gear and then resumes control over the clutch, according to the standard creeping strategies (accelerator pedal released) or setting off ones (accelerator pedal pressed).

MOVING THE LEVER FROM D OR N TO R (even without brake pedal pressed if it comes from N)

- the TCU must communicate the updated conditions of the lever
- the engine management control unit operates the engine restarting
- the TCU controls gear release and waits until the engine is started keeping the clutch K1 open (in N)
- the TCU engages the reverse and then resumes control over the clutch, according to the standard creeping strategies (accelerator pedal releases) or setting off ones (accelerator pedal pressed).

MOVING THE LEVER FROM D TO TIP (with brake pedal pressed, otherwise the engine restarts immediately)

- the TCU communicates the updated conditions of the lever
- the engine management control unit controls the engine restarting (if enabled by a special calibration parameter)
- if the engine starting is operated, the TCU releases the gear and waits until the engine is started, keeping the clutch open; the TCU engages the first gear and then resumes control over the clutch according to the standard creeping strategies (accelerator pedal released) or setting off ones (accelerator pedal pressed)
- if the engine starting is not operated, the transmission has first gear engaged and clutch open.

MOVING THE LEVER FROM TIP TO D (with brake pedal pressed, otherwise the engine restarts immediately)

- the TCU communicates the updated conditions of the lever
- in this case, the engine cannot be restarted
- the transmission has the first gear engaged and the clutch open.

MOVING THE LEVER FROM D OR N TO P

- the TCU communicates the updated conditions of the lever

- the engine management control unit operates the engine starting
- the transmission can engage N, R or the first gear depending on the final position of the lever; then the TCU resumes control over the clutch K1 according to the standard creeping strategies (accelerator pedal released) or setting off ones (accelerator pedal pressed).

 With lever in R, the engine does not switch off in START&STOP mode.

 If the lever is faulty, the START&STOP strategies are cancelled.

STEERING WHEEL CONTROLS

With lever in TIP or D, the engine can be restarted by the gearshifting controls on the steering wheel.

For the management strategy, see the description for the lever in TIP+ and TIP-.

DISPLAYED INFORMATION

In case of automatic engine switching off, the information about the engaged gear is still displayed on the instrument panel by the "lever position" and "gear engaged" signals.

When the engine is automatically restarted, shifting through N must be displayed.

 Only after a request of neutral engagement from the engine, the position of the lever and the gear displayed are temporarily connected to the gear requested instead of the currently engaged one (current gear).

The DNA logic engagement/release is managed as usual, independently of the activation of the START&STOP function.

Gear change with vehicle moving

LEVER IN TIP (manual mode)

Every upshifting request takes place by moving the lever to the "+" position or using the pivoting lever "+" on the steering wheel.

The gearshifting requests are accepted only if the engine speed allows it.

If the request is accepted by the system, the display shows the gear engaged.

 The system shows the gear actually engaged on the display and not the gear requested.

If the request is not accepted by the system, the display still shows the gear engaged before the request and makes an acoustic signal.

In the same way, the request for downshifting is possible by moving the gearshifting lever on "-" or operating the pivoting lever "-" on the steering wheel.

In this case the system will only accept the request if the engine speed, after the gear change, does not exceed the maximum rotation speed permitted for the engine.

If the request is not accepted, the system behaves like it does when the upshifting request is not accepted.

The system automatically selects a lower gear if the driver keeps the current gear at the engine speed limit.

LEVER IN D (automatic mode)

The letter D will be displayed instead of the indication of the gear engaged.

With gear lever in N, to start the car (forward gear or reverse), even in automatic mode, the driver must ask the gear for setting off (first gear, corresponding to the lever position in D) or R, with button on knob pressed (the system keeps the automatic mode).

 With gear lever in D, the system also accepts requests for gearshifting by the pivoting levers on the steering wheel.

AUTOMATIC GEARSHIFTING RECOMMENDATION STRATEGY

Upon request by the driver, the system starts working manually, displaying the gear engaged for about 5 seconds.

When this time interval has elapsed, the system works again automatically and the display shows "D".

Even if the request is not accepted, the manual mode is displayed anyway.

The Kick Down function is also available: following a sudden action on the accelerator towards the end of travel position, the system recognises the request for maximum torque and shifts down by one, two or three gears if conditions allow.

DNA logic (Dynamic/Normal/All Weather)

The operation logic can be selected - automatically or manually - from the "lever", activating the following calibrations:

IN AUTOMATIC MODE:

- Dynamic, gearshifting calibration with "Sport" map
- Normal, gearshifting calibration with "Economy" map
- All Weather, gearshifting calibration with "Economy" map.

IN MANUAL MODE:

- no effect on gearshifting maps

Request of N - R - first speed with moving vehicle

Reverse can be engaged only when the car speed is close to zero.

- Movement from D/TIP to N: accepted at any car speed
- Movement from D/TIP to R (passing through N; it is valid also to pass from N to R):

with speed lower than 5 km/h, the request is accepted and R is engaged;

with speed higher than 5 km/h, the request is not accepted (the system only accepts until the request of N, that is left engaged until speed decreases, then R is engaged, otherwise N is left engaged). After a non acceptance, if the lever is positioned in D again, see "Explication note".

- Movement from R to N: accepted at any car speed

- Movement from R to D or TIP (passing through N; it is valid also to pass from N to D/TIP):

with speed lower than 5 km/h, it engages the first speed

with speed higher than 5 km/h, it is accepted or not (see "Explication note").

Movement from R to N to D/TIP with speed higher than 5 km/h:

a) if shifting from R to D/TIP occurs "quickly" without acknowledging the passage through N, the handling for direct movement from D/TIP to R is used, that is N is engaged;

b) if the passage from R to D/TIP occurs "slowly", to acknowledge the positioning of the lever in N, the passage is handled as two different

 movements:

- 1) passage from R to N always accepted
- 2) passage from R to D/TIP always accepted.

In this case, although it comes from position R, the passage to D/TIP with engagement of the first speed is accepted independently of the car speed (or a more suitable gear). The confirmation time for acknowledging the lever in N position currently is set at 200 ms.

As a result of non acceptance of the movement, the message "MANOEUVRE NOT PERMITTED" is displayed, followed by an acoustic signal.

Request for Parking with vehicle moving

If the lever is placed in P, with vehicle moving, the mechanical lock does not engage, the system engages neutral and the lever is locked in P.

To move the lever from position P, the TCU control unit must operate the signal through CAN for "lever release request".

Launch Control strategy

With the Dynamic mode engaged through the DNA handle and car stopped, the "launch start" strategy can be activated.

1. PRELIMINARY PROCEDURES TO OPERATE THE STRATEGY

- Press and do not release the brake pedal
- Press and do not release the accelerator pedal (even partially)
- Operate the "-" pivoting lever on the steering wheel, with gear lever in position D or with gear lever in position TIP, operate TIP-

2. STRATEGY IMPLEMENTATION

- Release the brake pedal holding the accelerator pedal pressed



After the preliminary steps, the strategy can be cancelled by releasing the accelerator pedal.

System safety

Vehicle stationary, engine running, gear engaged (usually first or reverse)

Press the brake and/or accelerator pedal, then open the driver's side door: the system keeps the current gear.

The instrument panel will continue to display the mode, the logic and current gear.



When the door is opened, with key-on, engine started and lever in a position other than P, the buzzer is always operated.

Vehicle stationary, engine running, gear engaged (usually first or reverse)

Do not press the brake or accelerator pedal, open the driver's side door: a buzzer is heard for 5 seconds if the lever is in a position other than P (even with brake pedal pressed).



When the door is opened, with key-on, engine started and lever in a position other than P, the buzzer is always operated.

IN CASE OF CREEPING NOT WORKING (HAND BRAKE PULLED OR CREEPING RECOVERY):

- after 1.5 seconds, the system engages N
- The instrument panel will continue to display the mode, the logic and N.

Since the lever may be in D/TIP or R, the shift to N requested by the system involves a situation of inconsistency between lever position and gear engaged, therefore the manoeuvre is accompanied by an acoustic inconsistency signal.

The buzzer continues until the failure is restored.

To engage the first gear again (with the lever in D/TIP) the pivoting levers on the steering wheel can be used, with the brake pressed.



The use of the buzzer is planned for all cases where N is engaged automatically.

Vehicle stationary, engine running, gear engaged (usually first or reverse)

Do not make any action for at least 3 minutes (that is do not press brake or accelerator pedals and do not move the gear lever):

IN CASE OF CREEPING NOT WORKING (HAND BRAKE PULLED OR CREEPING RECOVERY):

- the system independently selects N
- The instrument panel will continue to display the mode, the logic and N.

Since the lever may be in TIP or R, the shift to N requested by the system involves a situation of inconsistency between lever position and gear engaged, therefore the manoeuvre is accompanied by an acoustic inconsistency signal.

The buzzer continues until the failure is restored.

Vehicle stationary, engine running, gear engaged (usually first or reverse)

Keep the brake pedal pressed and do not take any action for at least 10 minutes:

- the system independently selects N
- the instrument panel will continue to display the mode, the logic and N.

Since the lever may be in TIP or R, the shift to N requested by the system involves a situation of inconsistency between lever position and gear engaged, therefore the manoeuvre is accompanied by an acoustic inconsistency signal.

The buzzer continues until the failure is restored.

Vehicle stationary, engine running, gearbox in neutral (lever in a position other than P): key-off procedure

Switch the engine off: P on the display flashes, with an acoustic signal (for about 5 seconds) if the vehicle is left with lever in a position other than P.

After these 5 seconds, the systems go in power-off.

If the lever is not moved to P within 5 seconds, the key will remain locked after power-off.

Being the Parking function only mechanical, it can be engaged even after 5 seconds.

Once placed in P, the lever will be locked.

Vehicle stationary, engine running, lever in P: key-off procedure

Switch the engine off: no information about gearshifting is displayed and no buzzer is operated.