PANDA 1.2 8v Introduction - ELECTRO-HYDRAULIC SELECTION. GEARBOX EXTERNAL. CONTROLS

Valid for versions with:Smart gearbox

INTRODUCTION

The new Panda 1.2 8v version has been fitted with a C514 manual gearbox with electrohydraulic unit.
The design of the robotised control system for the C514 gearboxes aims to improve the performance of components of manual mechanical transmission. This system has been designed to automate the controls of the clutch and gear lever of a conventional mechanical gearbox by electrohydraulic power assistance.

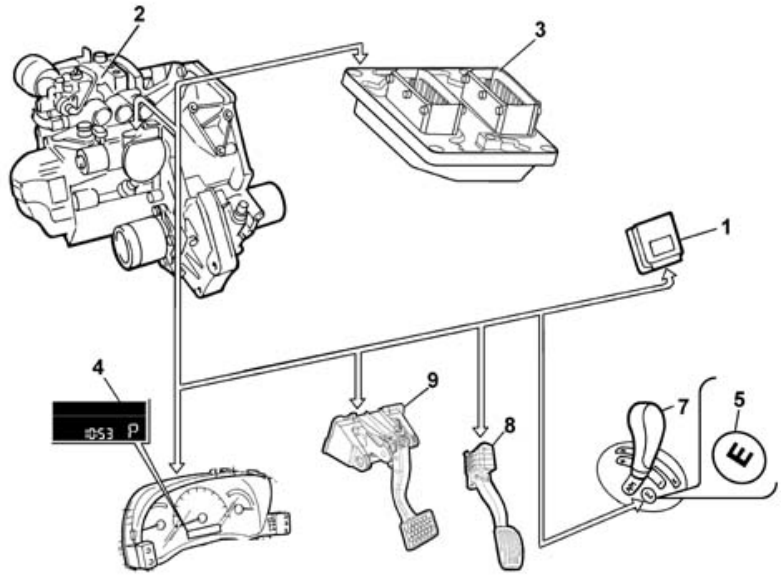
This system:

- Improves the performance of components of manual mechanical transmission.
- It avoids the need for the driver to control the clutch pedal and conventional gearchange control.
- It improves driving safety by the control which prevents driver errors and prevents incorrect manoeuvres of the transmission system.
- Offers the driver a more advanced vehicle interface.
- It is a hydraulic power assistance for the gearbox and clutch which preserves all the advantages of a dry clutch and mechanical gearbox (weights, strength and reliability, low energy consumption).
- It simplifies use and reduces driving fatigue, especially in cities.
- It ensures comfortable or sporty gear changes thanks to the assistance by advanced control logic.
- It does not have a clutch pedal in the interior compartment, and the control lever is replaced by 'Up/Down/Neutral/Retro' controls on a tunnel lever.
- It can enable automatic gearchange management in 'AUTO' mode (by the driver) in two different logics (ECO/NORMAL).

The robotised gearbox has two operating modes:

- SEMIAUTOMATIC MODE (MANUAL): the driver manages gear engagement via the lever located on the tunnel.
- AUTOMATIC MODE (AUTO): the decision to change gears is delegated to the electronic system, in accordance with two strategies, the first aiming for driving comfort (NORMAL), the second aiming to limit fuel consumption (ECO).

General diagram with the main components of the robotised gearbox system



1, TCU (Transmission Control Unit)
2, Electrohydraulic unit with electric pump
3, Engine management control unit
4, Gear display and indicator panel
5, Auto Eco/Normal logic selection button
6, Brake pedal (with double switch)
7, Auto mode and gear selection lever
8, Accelerator pedal (Drive by Wire)

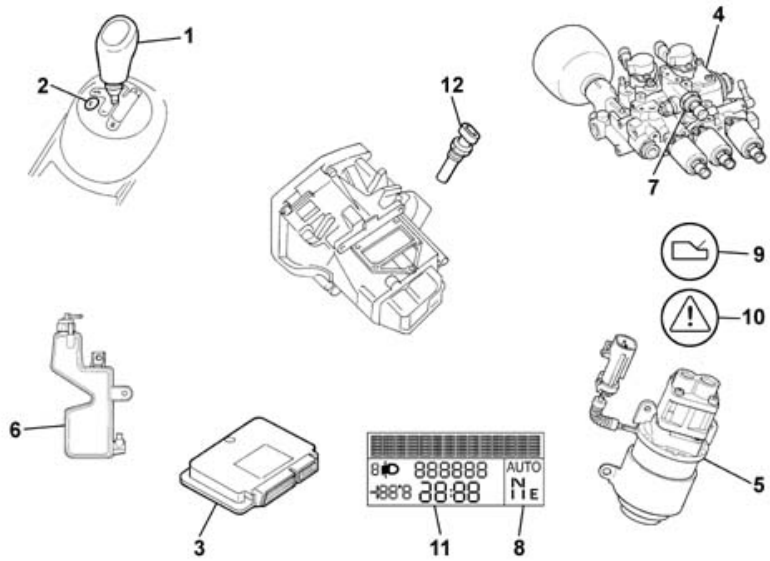
Valid for versions with:Smart gearbox

INTRODUCTION

The power assistance system consists of an electrohydraulic unit (2) mounted directly on the gearbox casing, which manages the following gearbox movements via two actuators:

- the gear selection and engagement movement (double-effect actuator)
- the clutch opening control.

The electrohydraulic unit is controlled by three electromagnetic valves (to which an electric pump and an accumulator supply the required hydraulic power) and a solenoid.
After identifying the driver's requests from the lever position, an electronic control unit (1) manages the gear change autonomously, controllign the clutch, gearbox and engine torque directly. During the gear change, the engine control is subordinate to the gearbox control.
The interfacing between engine and gearbox significantly improves the system's performance and frees the driver from the need to synchronise the clutch-accelerator movements during the gear change, which can be made with the accelerator fully depressed.
The system inhibits incorrect gear change requests and prevents undesired engine stalling.
In terms of driving assistance, it also ensures the immediate availability of first gear when the vehicle stops, and automatic progressive change-down of gears in the case of sudden deceleration.
The indication of the engaged gear is displayed on the instrument panel, as are faults or driving conditions which are critical for the vehicle or for transmission components, with a set of warning messages or actual fault messages associated with the general fault or transmissionfault warning lights.
Robotised gearbox system components

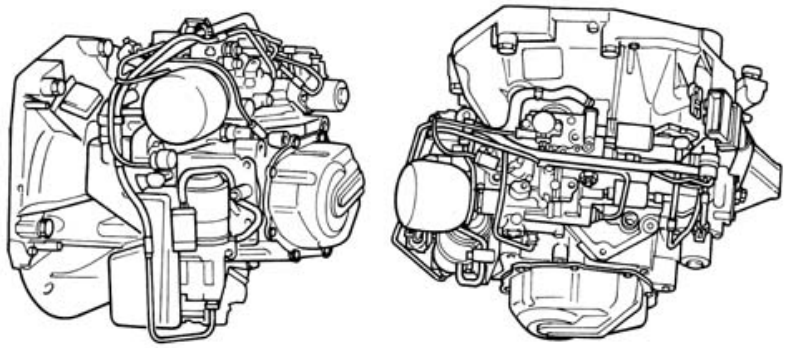


1, Gear selection lever on tunnel
2, ECO/NORMAL button
3, Transmission Control Unit
4, Electrohydraulic unit
5, Pump
6, Reservoir
7, Gearbox mainshaft rpm sensor
8, Gear indication and Auto mode display
9, Gearbox fault warning light
10, General warning light
11, Driver information display
12, Reverse gear switch (on hydraulic kit)

Valid for versions with:Smart gearbox

GEARBOX COMPONENT LAYOUT ELECTROHYDRAULIC KIT

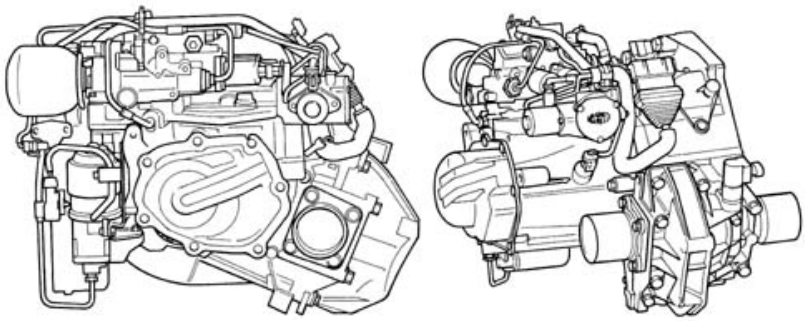
The electrohydraulic unit layout on the C514 gearbox is as shown in the following pictures.
Front and plan view of the C514 gearbox assembly and electrohydraulic kit



Valid for versions with:Smart gearbox

GEARBOX COMPONENT LAYOUT ELECTROHYDRAULIC KIT

Side (left half shaft side) and rear view of C514 gearbox assembly and electrohydraulic kit

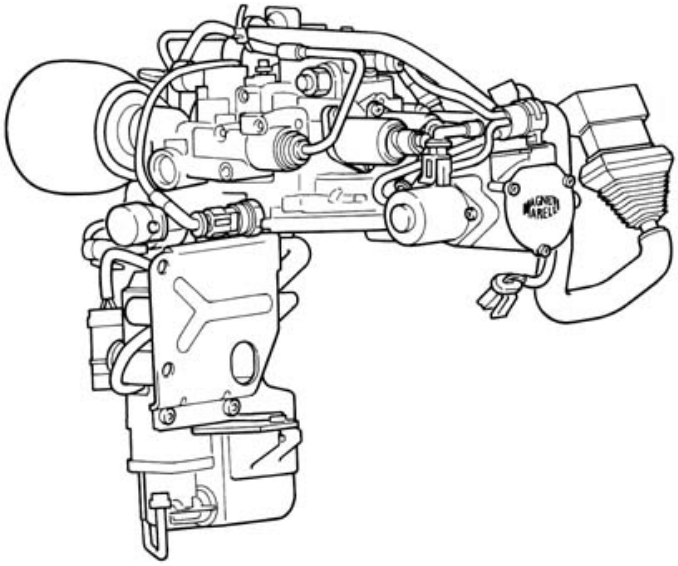


Valid for versions with:Smart gearbox

ELECTROHYDRAULIC KIT COMPONENTS

The electrohydraulic kit is a single unit which combines three main parts:

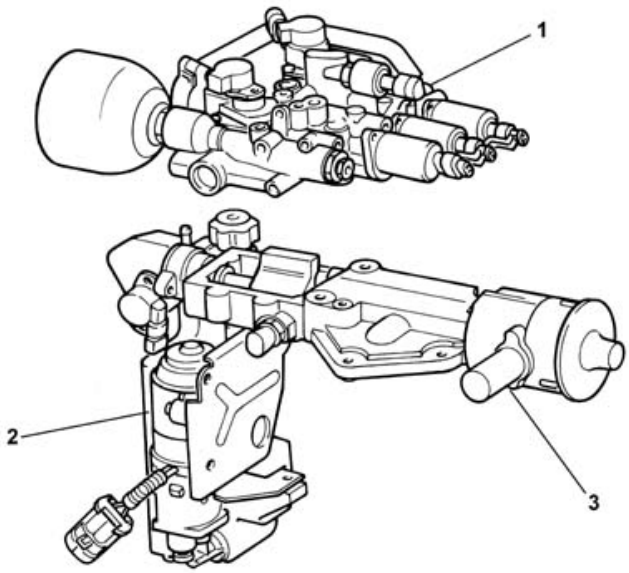
- the mechanical gear control unit which interfaces directly with the geatbox via the opening in the casing which is the same as on the homologous manual mechanical version;
- the solenoids assembly converts the hydraulic energy into mechanical energy through the interface of pistons engaging in the control shaft;
- the power unit comprising an electric pump and hydraulic reservoir.



Valid for versions with:Smart gearbox

ELECTROHYDRAULIC KIT COMPONENTS

The main units in the electrohydraulic kit fitted on the C514 gearbox are shown below.



1, Solenoids assembly
2, Electric pump and reservoir power unit
3, Mechanical unit

Valid for versions with:Smart gearbox

ELECTROHYDRAULIC KIT COMPONENTS

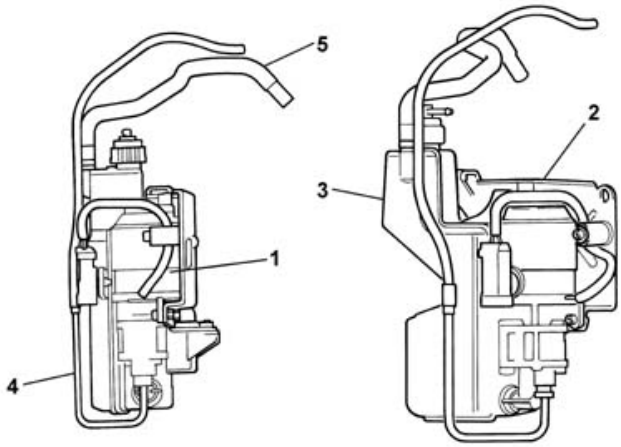
The kit can be dismantled into three basic parts: the top (valves assembly) and bottom (mechanical part) attached to the hydraulic power unit (pump + reservoir).

Valid for versions with:Smart gearbox

POWER UNIT

The power unit supplies hydraulic energy for actuating the gearbox and clutch.

The unit comprises an electric pump (electric motor and gear pump) and fluid reservoir.



1, Electric pump
2, Mounting bracket
3, Reservoir
4, High-pressure supply pipe
5, Low-pressure return pipe

Valid for versions with:Smart gearbox

POWER UNIT

The system's working line pressure range is between 40 and 52 bar.
The subsystem in question has the following technical specifications.
Electric pump: nominal capacity 0.8 l/min. with 13 V supply at 50 bar, fluid temperature 60 ° C and duty cycle 30%; its task is to generate hydraulic energy.
It is secured directly in three places to the mounting bracket on the gearbox. The electric pump consists of a gear pump of about 0.25 cm3/revolution, driven via coupling by a 12V DC electric motor through a relay controlled by the C.F.C228F.01 control unit.
The electric pump is activated when the accumulated pressure is below 40 bar and is switched off when the accumulated pressure is 50 bar.
The electric motor and pump are bolted to each other via a flange.

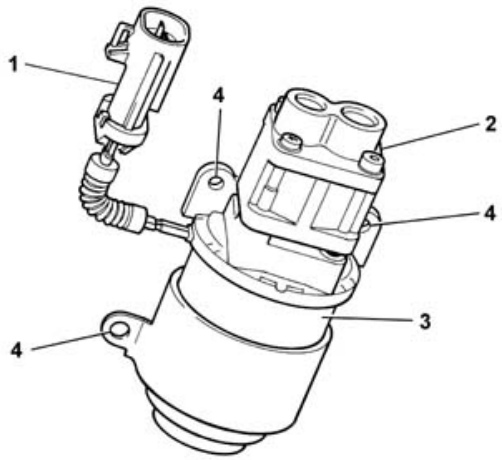
The main technical specifications to be met by the system to ensure correct operation are:

- Operating hydraulic pressure between 41 and 51 bar
- Operating temperature between -30° C and + 125 ° C
- Starting must be possible even at temperature of -30° C
- The pump capacity is 0.7 l/min. at 60 ° C
- The accumulator volume is 280 cm3 preloaded at 27 bar at 25 ° C (important value because it determines the discharge time)

Valid for versions with:Smart gearbox

ELECTRIC PUMP

View of electric pump

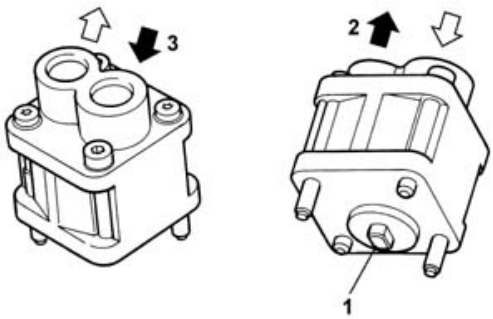


1, Electrical connector
2, Gear pump
3, Electric motor
4, Attachment points to bracket

Valid for versions with:Smart gearbox

ELECTRIC PUMP

Mechanical gear pump

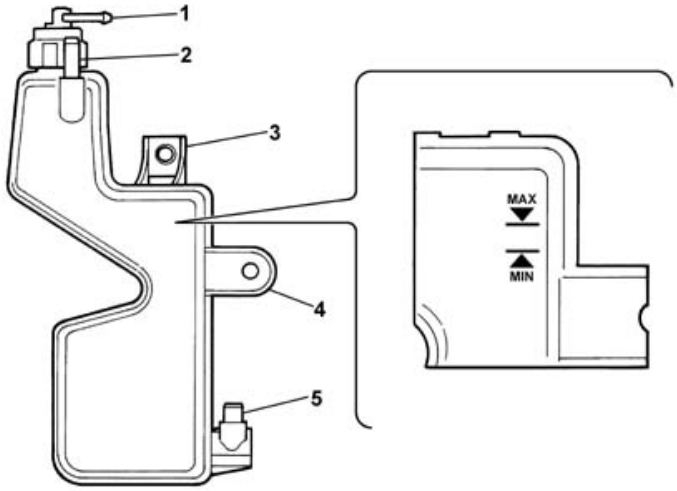


1, Engine coupling
2, High-pressure supply (threaded connection of hp supply semi-rigid pipe)
3, Input from reservoir (direct connection to reservoir)

Valid for versions with:Smart gearbox

ELECTRIC PUMP

Reservoir with filter: approx. 0.5 l and 150 micron filter on outlet



1, Oil recovery connection
2, Low pressure return connection
3, Bracket connection eyelet
4, Electric motor connector support
5, Pump connection

Valid for versions with:Smart gearbox

ELECTRIC PUMP

The insert shows a detail of the indication of the level in the reservoir.

Hydraulic pipes

- 1 semi-rigid high-pressure pipe which connects the electric pump to the valves assembly
- 1 flexible low-pressure pipe, of preformed rubber, which connects the valves assembly to the reservoir.

The connection between reservoir and pump is direct, by means of a pressure fit with O-ring seal.
Bracket securing reservoirr and electric pump to kit and gearbox.
Hydraulic fluid: TUTELA CAR CS SPEED specific fluid with 'ATF Dexron III' additive (viscosity 1800 cPs at -40 ° C; 6.5 cPs at 100 ° C)

Valid for versions with:Smart gearbox

VALVES ASSEMBLY

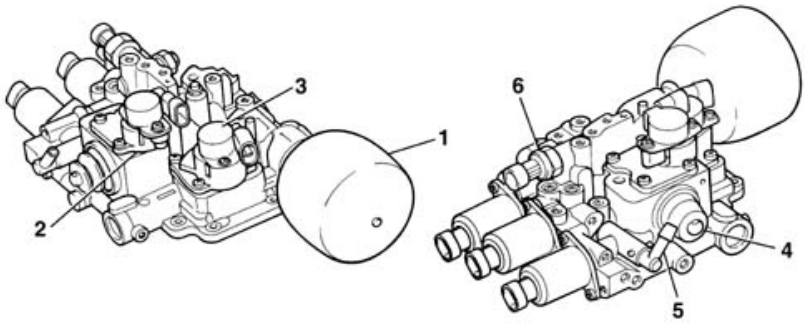
This subsystem performs the following functions:

- Control and actuation of the clutch position.
- Effort control of gear engagement/disengagement and row selection.
- Accumulation of energy/hydraulic power for controlling actuators.

The components used for carrying out these functions must be:

- Electromagnetic valves assembly
- Clutch actuator (single-effect piston).
- Proportional flow electromagnetic valve for controlling clutch actuator.
- Gear engagement actuator (double-effect piston).
- Two proportional pressure electromagnetic valves for controlling the engagement actator: even gear pressure proportional electromoagnetic valve (2 - 4 - R) and odd gear pressure proportional electromagnetic valve (1 - 3 - 5).
- Two potentiometric sensors for detecting the engagement position and clutch travel position
- Accumulator
- Line pressure sensor (0-80 bar)
- Non-return valve

Views of hydraulic unit

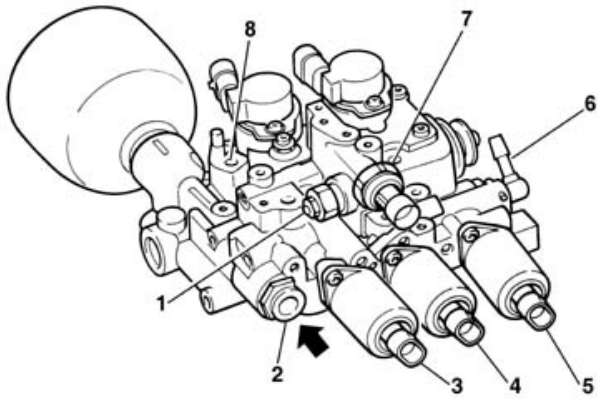


1, Accumulator
2, Clutch travel potentiometer
3, Engagement travel potentiometer
4, Clutch level control pushrod
5, Low pressure fluid discharge connection
6, Pressure sensor

Valid for versions with:Smart gearbox

VALVES ASSEMBLY

Rear view of hydraulic unit

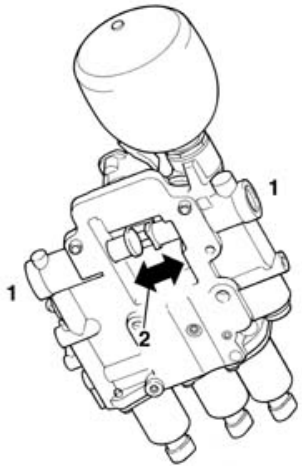


1, Maximum pressure valve
2, High-pressure supply pipe rapid connector
3, Clutch flow proportional electromagnetic valve (ev0)
4, Even gears engagement pressure proportional electromagnetic valve (ev2)
5, Odd gears engagement pressure proportional electromagnetic valve (ev1)
6, Low pressure fluid discharge rubber pipe attachment
7, Pressure sensor
8, Earth point on kit

Valid for versions with:Smart gearbox

VALVES ASSEMBLY

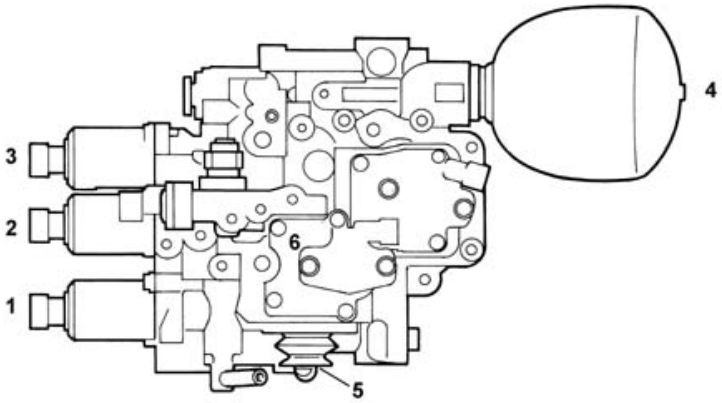
View from below of hydraulic unit: note the double-effect actuator (1) of the connector with the 'fork' (2) for engagement on the control shaft.



Valid for versions with:Smart gearbox

EV1 AND EV2 PRESSURE PROPORTIONAL VALVES

These control the fluid pressure to the two chambers of the double-effect gear engagement-disengagement actuator with two stable mechanical positions depending on the control combination (even gears, odd gears).
They have a maximum capacity of 7 l/min. with a pressure differential of 10 bar.
The control current ranges from 0 to 2.5 A controlled directly by the C.F.C. 228F.01 control unit.
The winding's electrical resistance is 2.5 ohm ± 6% at 20° C.
View of valves assembly from above

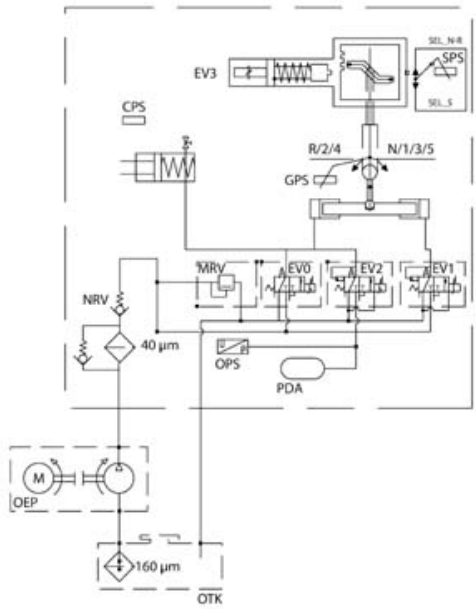


1, Odd gears engagement pressure proportional electromagnetic valve (ev1)
2, Even gears engagement pressure proportional electromagnetic valve (ev2)
3, Clutch flow proportional electromagnetic valve (ev0)
4, Accumulator
5, Self-adjusting clutch pushrod
6, Pressure sensor

Valid for versions with:Smart gearbox

EV1 AND EV2 PRESSURE PROPORTIONAL VALVES

General diagram of electrohydraulic control system



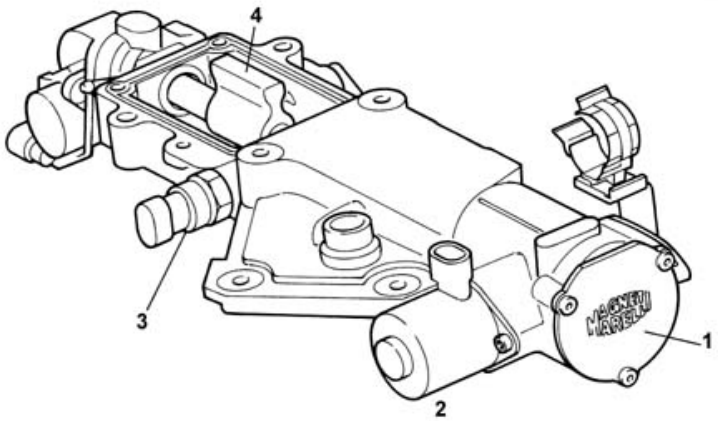
Valid for versions with:Smart gearbox

MECHANICAL UNIT

The mechanical unit has the task of interfacing with the gearbox in order to engage or disengage gears and change row. It comprises:

- Gear selection system ('S' cam)
- Control shaft
- Connection finger to engagement pistons and gear retention system
- Engagement finger
- An on-off electromagnet for controlling gear selection system (brake)
- Reverse gear switch
- Selection potentiometer

View of mechanical unit

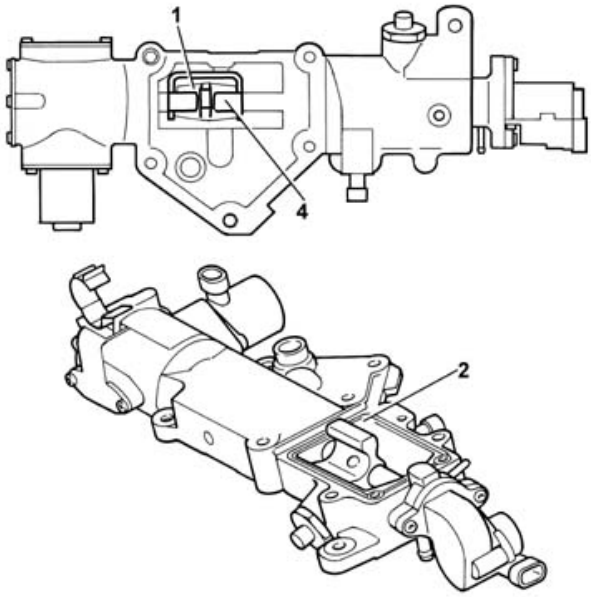


1, Cover of S cam containment chamber
2, On-off electromagnet for locking cam in row change
3, Reverse gear switch
4, Connection finger to engagement pistons

Valid for versions with:Smart gearbox

MECHANICAL UNIT

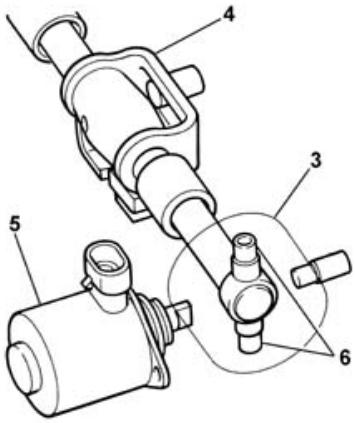
The mechanical system consists of a shaft which comprises, as part of it, a control finger (1), an element (2) for interfacing with the pistons in the hydraulic unit; not rigidly attached to the shaft, there are a drum (3), (comprising two 'S' profiles and 3 grooved seats) and a key (4), which keeps the noses of the gear change control forks aligned and locked; both elements (3) and (4) are held in position by steel pins connected to the casting.
View of mechanical unit: the gear change control finger (1), piston interface element (2) and key (4) are shown



Valid for versions with:Smart gearbox

MECHANICAL UNIT

Diagrammatic view of the mechanical unit: the key (4) and the drum (3) with attachment pins to the aluminium casing are shown. The brake (5) and spider (6) are visible.



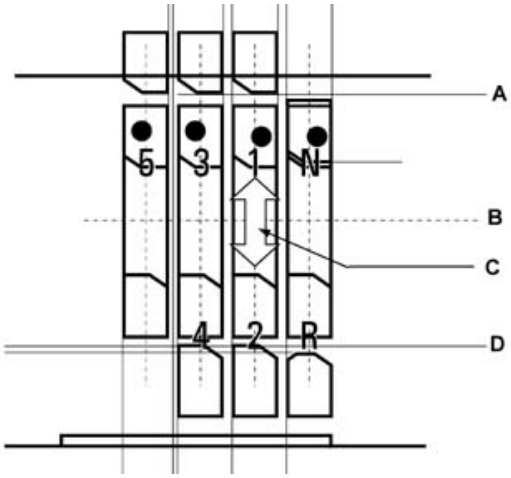
Valid for versions with:Smart gearbox

MECHANICAL UNIT

The principle of operation is based on the conversion of the linear motion of the hydraulic pistons into rotary or rotary-translational motion of the shaft and so of the elements attached rigidly to it.

The purely rotary motion of the shaft (which corresponds to the motion of disengagement of a gear and the engagement of the gear located on the same row) takes place in the following steps:

- 1. one of the two hydraulic pistons moves in translation motion
- 2. by means of the connecting element (2), the shaft is put in rotation
- 3. the electromagnetic brake, not being active, allows the drum (3) to slide, which is moved by the spider (6)
- 4. the key (4) does not make any movement, but keeps the forks not involved in the gear change aligned.

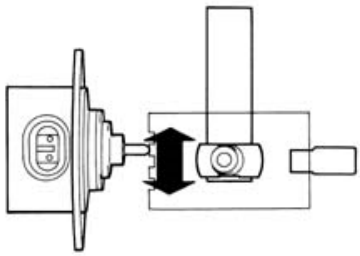


A, Odd gears engagement position
B, Neutral gearbox position
C, Gear change on same row
D, Even gears engagement position

Valid for versions with:Smart gearbox

MECHANICAL UNIT

In gear changes on the same row, the brake is not active so it does not engage in the grooved profiles on the drum; in this way the shaft describes a purely rotary motion around its axis; by means of the spider, it drives the drum in the direction shown by the arrow (see figure).

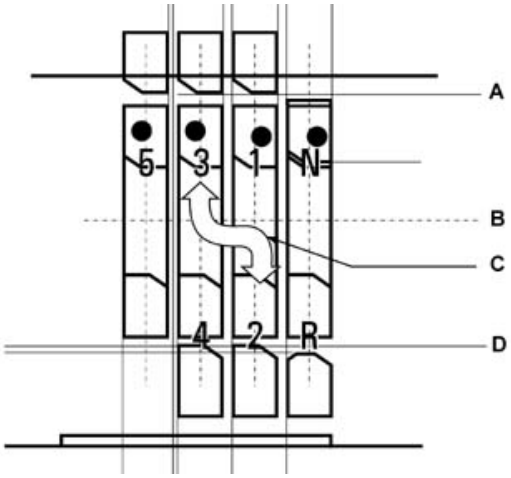


Valid for versions with:Smart gearbox

MECHANICAL UNIT

The rotary-translational motion (which corresponds to the motion of disengagement of a gear and engagement of the gear located on an adjacent row) takes place in accordance with the following steps:

- 1. one of the two hydraulic pistons moves in translation motion
- 2. by means of the connecting element (2), the shaft is put in rotation
- 3. the electromagnetic brake is active: the spider (6) is obliged to travel along te 'S' profile on the drum which in this case is fixed and joined to the aluminium casing; in this way the shaft (and so the control finger (1)) is obliged to rotate by an angle, translate and then again rotate an angle.
- 4. the key (4) carries out a sliding movement because it is driven by the shaft in translation; its task is to limit the recall of the nose of the outgoing gear in the rest position and to keep it in line with the others not affected by the gear change.

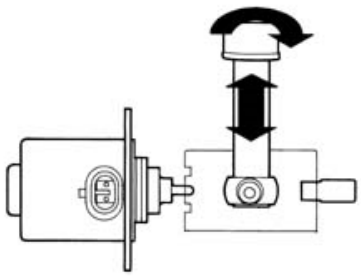


A, Odd gears engagement position
B, Neutral gearbox position
C, Gear change on adjacent rows
D, Even gears engagement position

Valid for versions with:Smart gearbox

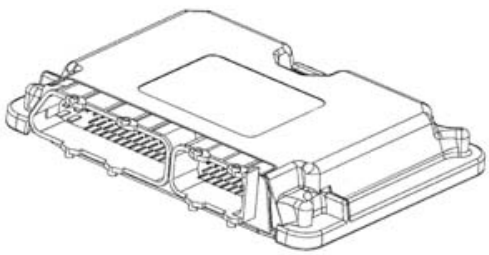
MECHANICAL UNIT

In gear changes on different rows, the brake is active so it engages in the grooved profiles on the drum, joining it to the casing; in this way the shaft describes a rotary-translational motion around its axis as in this case the spider is obliged to describe the 'S' profile on the drum.



Valid for versions with:Smart gearbox

The transmission control unit is located in the interior compartment under the floor trim, in the passenger floor well. The control unit is housed on a steel plate bracket which in turn is secured by another bolted bracket. The vehicle front wiring reaches the control unit with two Siemens 80-pin socket-carrying plug connectors.



Valid for versions with:Smart gearbox

GENERAL TECHNICAL DESCCRIPTION

Type CFC228F
Siemens V23542-A1280-B300 80-pin plug connector

Ambient working T:

- 30 a +65 ° C continuous
- 40 a +85 ° C not operating

Working voltage

- 0 to 6.2 V TCU in reset
- 6.2 to 9 V [V] logic operations
- 9 to 16 [V] in full operation
- 16 to 24 [V] logic operations for 1 minute

Maximum overvoltage 40 V

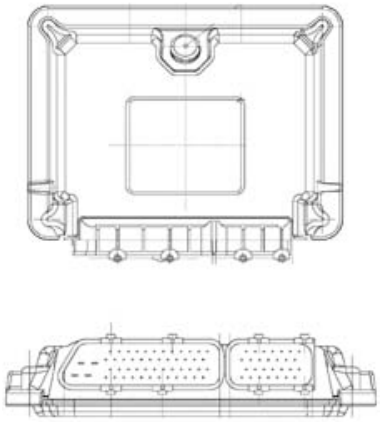
Communication lines:

- K line diagnosis
- Communication: CAN 500 kbytes

Special HW functions:

- TCU power latch relay (internal)
- TCU wake up via driver's door switch

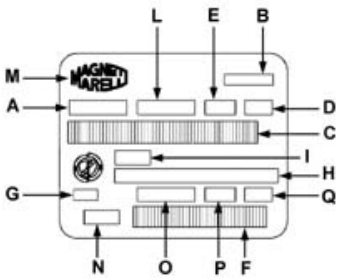
On the top cover, there is the identification plate with the basic identification data stamped on it, i.e. control unit number, reference drawing and identification of the SW version and calibration.
Below is a view of the top of the control unit and a detail of the data shown on the label.



Valid for versions with:Smart gearbox

GENERAL TECHNICAL DESCCRIPTION

Below are details of the data shown on the label.



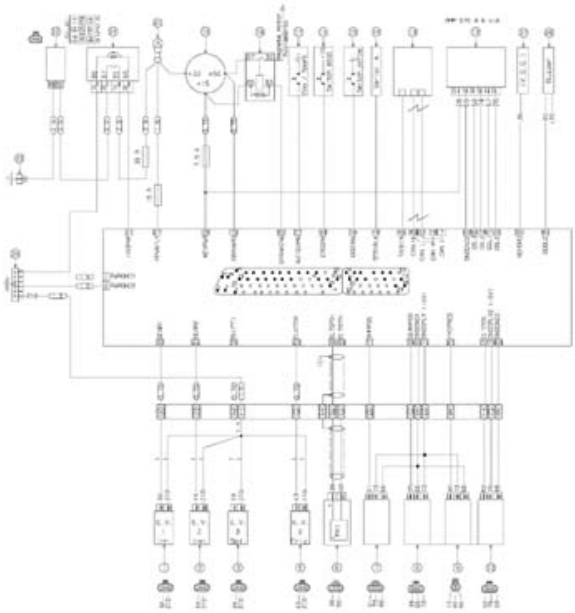
A, FIAT drawing number
B, Date
C, Bar code with customer information
D, Supply voltage
E, Type of EPROM mounting (E = Soldered, Z = Socket base, M = Masked, F = Flash)
F, Marelli code in bar code
G, Supplier's code

H, Name of application
I, Software version and calibratioin
L, Supplier's registration number
M, Manufacturer's logo and supplier's logo
N, Homologation code
O, Marelli code
P, Production batch
Q, Year of production

Valid for versions with:Smart gearbox

GENERAL TECHNICAL DESCCRIPTION

Below is a wiring diagram of the TCU interface



1 Engagement solenoid 1
2 Engagement solenoid 2
3 Selection solenoid 3
5 Clutch solenoid
6 Gear change input speed pick-up
7 Gear selection potentiometer
8 Gear engagement potentiometer
9 Pressure transducer
10 Clutch position sensor
12 Robotised gearbox gear selection lever
13 Engine management control unit
14 K serial line connection
15 Connection to driver's door open indicator button
16 Connection to brake pedal switch
17 ECO/SPORT function activation button
18 Engine start enablement relay
19 Vehicle supply block
20 Direct connection to battery positive
21 Robotised gearbox pump control relay
22 Robotised gearbox pump
23 Pump earth connection
24 Connection for control unit and solenoids earth
26 Dedicated buzzer
27 Vehicle speed sensor

Valid for versions with:Smart gearbox

GENERAL TECHNICAL DESCCRIPTION

The following table shows the Pin Out of the robotised gearbox control unit

Pin	Signal description	Signal characteristics
28	+ 15	Fuel system

49	Line K	Input/Output
45	C-CAN H line	Input/Output
33	C-CAN L line	Input/Output
48	Engine rpm	Input
38	Clutch speed positive signal	Input
50	Clutch speed negative signal	Input
78	Door signal	Input
76	+ 50 starting	Input
69	Brake pedal signal	Input
77	AUTO button signal	Input
52	Clutch position signal	Input
39	Gearbox position signal	Input
51	Control lever position signal	Input
40	Pressure sensor	Input
26	Lever signal	Input
67	Lever signal	Input
74	Lever signal	Input
68	Lever signal	Input
27	+ 30	Fuel system
43	EV 0 control clutch	Output
44	EV 1 control clutch	Output
32	EV 2 control clutch	Output
36	Vehicle speed signal	Input
29	EV 3 control clutch	Output
42	Starting relay enablement	Output
31	Pump relay control	Output
80	Buzzer control	Output
73	Supply to engagement power	Output
79	Supply to clutch power	Output
relay	Power earth	Fuel system
relay	Power earth	Fuel system
66	Potentiometer earth	Fuel system
65	Gear lever earth	Fuel system

59	Shielding	Fuel system

Valid for versions with:Smart gearbox

SYSTEM INPUT SIGNALS

For the logic operation, the system must use the following signals coming from specific sensors or other vehicle systems:

- Specific sensors for robotised gearbox
- Clutch rpm sensor (mainshaft)
- Position sensors for: clutch, engagement and selection actuator (potentiometric type).
- Individual signals coming from other vehicle systems.
- Engine speed (frequency signal coming from the engine management control unit and from C-CAN network).
- Brake pedal switch (duplicate, both discrete and on C-CAN line).
- Driver's door switch (discrete).
- Ignition key (stable position and starting discrete)

Other main signals coming from the vehicle system via CAN are:

- Accelerator pedal position.
- Engine torque, vehicle speed, water temperature, etc.

Valid for versions with:Smart gearbox

USER - SYSTEM INTERFACES

The driver interfaces with the system through the following commands:
Accelerator pedal, this signal will be sent to the system via CAN and comes from the engine management control unit.
Brake pedal, comes directly from the brake switch (dedicated signal) and via CAN.
Request to change gear or select mode, reaches the TCU through a specific electromechanical lever with three stable positions and three unstable positions via 4 signals which convert the electrical signals of the 10 Hall-effect sensors located inside the lever (the signals must be read by the control unit as analogue inputs for safety reasons).
'ECO/NORMAL' logic (the signal is a switch directly connected to the TCU)

Via the multifunction display which can be reconfigured, the system supplies the following information to the driver:

- Engaged gear (the display is situated/integrated in the instrument panel and connected via CAN).
- 'AUTO' mode selected (information on instrument panel-display via CAN).
- 'ECO/NORMAL' logic in use: the information is displayed near the indication of the engaged gear, by the letter 'E' being lit up.
- Malfunctions of the system are indicated by a warning light (connected to the instrument panel via CAN).

Acoustic signals via Buzzer: connected directly and via CAN, it must give the driver acoustic warning of the following:

- improper use of the vehicle (associated with warning messages)
- potential critical situation for the system/vehicle
- system failure
- engagement of reverse gear

 during automatic operation, the system displays the information of which gear is currently engaged.

Valid for versions with:Smart gearbox

PRESSURISATION OF THE HYDRAULIC CIRCUIT

As the pressure is below the minimum operating pressure, the hydraulic circuit is pressurised in two different ways:

- when the driver's door is opened, the system automatically pressurises the hydraulic system up to the maximum pressure, to allow a gear change, if requested, without having to wait for the hydraulic system to become charged
- with the ignition ON: the system control unit is supplied (and will be supplied until the ignition is turned OFF and the engine and vehicle speeds are 0).

The system pump may be supplied to pressurise the system.
When the pressure reaches the minimum value, the system may start to accept a request to change gear.

Valid for versions with:Smart gearbox

IGNITION/STARTING VEHICLE

This must take place by turning the ignition key: the engine will be started by the starting relay being controlled directly by the system.
When the driver turns the ignition key to the unstable 'cranking' position, the system TCU must check whether the driver has pressed the brake pedal; if so, the system positions the gearbox in 'N' and enables starting by energising the relay (<0.5 s).

Emergency starting is possible: if the battery is not capable of starting the engine, but the system is correctly pressurised, the vehicle may be pushed (with clutch open) and when sufficient speed is reached, the engagement of a gear is requested via the gear selector lever; the gear engagement system (> or equal to 2^{nd}) so as to start the engine (it is up to the driver's discretion to request the engagement of a gear when the vehicle is moving sufficiently fast to start the engine).

Valid for versions with:Smart gearbox

OPERATION WITH ENGINE OFF

For safety reasons, any gear change request from the lever (including neutral) is only accepted if the driver holds the brake pedal pressed down.
All available gears can be engaged with the engine off and with electrical services on (on K15).

Valid for versions with:Smart gearbox

SETTING OFF OF VEHICLE

The gears that can be engaged, with the engine on and vehicle stopped, in order to set off are:

- 1^{st} , 2^{nd} and reverse; these ratios in these conditions can only be requested by operating the lever.

To request their engagement, it is essential, for safety reasons, to keep the brake pedal pressed.
To engage reverse gear, in addition to the above conditions, it is also necessary for the vehicle to be stopped (gearbox input rpm measured = 0).
The vehicle only sets off if the driver presses the accelerator pedal (releasing the brake pedal); at this point, the system gradually engages the clutch to start off the vehicle.
The driver can regulate the torque transmitted by the clutch by modulating the accelerator position.
When the accelerator is released, the clutch must be engaged gradually when a minimum engine rpm threshold is reached.
When the system detects that the engine rpm and clutch rpm are synchronised, it fully engages the clutch (pack closure).
For each of the three gears enabled for setting off, a specific clutch engagement map is implemented.
During setting off, the driver may request a gear change; during this manoeuvre, the system can manage the request.

Valid for versions with:Smart gearbox

AUTOMATIC ENGAGEMENT OF THE CLUTCH DOWNHILL WITH ACCELERATOR PEDAL RELEASED.

If the vehicle witih engaged gear, accelerator released and engine started, picks up speed because it is going downhill, when a pre-established speed is reached, it automatically re-closes the clutch to provide engine braking.
If the driver presses the accelerator pedal at this stage, the control of the torque transmitted by the clutch returns to the direct control of the driver.
This automatic engagement of the clutch is interrupted if the vehicle moves in the opposite direction to the engaged gear.

Valid for versions with:Smart gearbox

SLOWING DOWN OF VEHICLE

During slowing down, for example with a gear engaged and accelerator pedal released, the system automatically disengages the clutch to avoid the engine stalling when the engine approaches idle speed.
This disengagement takes place at an engine speed that depends on the deceleration and driver's commands (brake pressed or not). During slowing down, if the engaged gear is higiher than 2^{nd}, the transmission automatically shfts down.
When the vehicle stops, 1st gear is engaged automatically.

Valid for versions with:Smart gearbox

GEAR SHIFT FROM LEVER (SEMIAUTOMATIC OPERATING MODE)

With the vehicle moving and clutch fully engaged, the driver's Up or Down request via the gear change lever causes a gear shift.
The requests are only accepted by the system if they are compatible with the engine's under revving and over revving limits.
A request via the lever usually only brings about one gear change up or down, however in some operating situations, the gear shift may be more than one gear if the driver so requests with a double quick command.

The gear change manoeuvre made by the driver without releasing the accelerator pedal for an 'up' reaeust, once accepted by the system, is carried out with an automatic phase sequence which backs up the driver's behaviour:

- reduction of engine torque by a command sent by the system to the engine management and simultaneous clutch disengagement;
- modulated clutch engagement and simultaneous gradual return to the max. torque that can be delivered by the engine at the new rpm, when the system detects that the engine rpm and clutch rpm are synchronised, it controls the total disengagement of the clutch;
- disengagement, selection and engagement of the new gear, the engine control is managed at the same time as the gear change to try to ensure that the engine reaches the same rpm as the clutch after engagement of the new ratio.

The new gear is engaged in accordance with:

- estimated performance requested by the driver
- estimated temperature of the transmission.

A gear change can be interrupted at any moment during its performance by another request from the driver, provided it is acceptable (i.e. compatible with the engine under revving and over revving limits).
The actuator control sequences during the gear change have timeouts; i.e. if the gear change is not successful, it is repeated once starting from neutral, then the next gear up from the requested gear is engaged.

Valid for versions with:Smart gearbox

AUTOMATIC GEAR CHANGE ('AUTO' MODE)

The robotised gearbox has a automatic operating mode, very similar to that present on conventional automatic transmissions.
The choice of ratio to be engaged is made on a map (double) which correlates the accelerator pedal position, the speed of operation of the accelerator pedal, the vehicle speed and the optimum gear.
The double map is associated with the fact that in AUTOMATIC mode it is possible to select from a specific button on the tunnel) double management of the modes defined as ECO (fuel saving) and NORMAL which favours lively driving.
If the accelerator pedal is released, the system does not prolong the gear, under some conditions, to maintain engine braking.
The gear change method is the same as for semi-automatic operation with the lever, and uses the same gearbox and engine actuator control parameters.
Automatic is only engaged when the lever is positioned in an unstable manner in a specific position; disengagement takes place by replicating the engagement manoeuvre.

Valid for versions with:Smart gearbox

REQUEST TO PLACE THE GEARBOX IN NEUTRAL

This request takes priority over all other gear requests, and is only carried out via the lever.
With the engine off, the brake pedal must be kept pressed.
With the vehicle moving, this neutral request in only accepted under a pre-established vehicle speed threshold (80 km/h).

Valid for versions with:Smart gearbox

TURNING OFF THE ENGINE AND SYSTEM

When the ignition is turned OFF, the engine is switched off and the system maintains whatever gear is engaged.
The system is deactivated only after seeing three zero speeds: engine, gearbox input and gearbox output, and after it has saved the operating and diagnostic data in the control unit's stable memory (EEPROM).
The system switches off about 5 s maximum after the vehicle has stopped with the engine off.
If the ignition is turned OFF when the gearbox is in neutral, the system warns the driver by means of the second buzzer.

Valid for versions with:Smart gearbox

INFORMATION TO THE DRIVER (DISPLAY AND BUZZER)

The system must inform the driver via:

- display: operation in 'Manual' and gear engaged, operation in 'Auto', ECO or SPORT mode and current gear, system fault
- buzzer: improper use of the vehicle, vehicle not safe system fault.

Some examples of improper use are listed below:

- of setting off with clutch overheated;
- if the system is switched off with the vehicle in neutral, the buzzer has to indicate the danger of leaving the vehicle turned off without the park gear engaged.

Valid for versions with:Smart gearbox

Self-calibrations allow the system to be initialised so as to operate correctly.

Valid for versions with:Smart gearbox

END-OF-LINE/SERVICE SELF-CALIBRATIONS

There are the following self-calibrations:

- Engagement and selection position thresholds for gear change management
- Calibration of ISP (incipient skid point):
- in the factory, the ISP is calibrated in accordance with the standard procedure and checked by end-of-line instruments

- Calibration of clutch degradation index:
- In the factory a single setting-off manoeuvre is carried out in accordance with a standard procedure; the system informs the end-of-line tester that self-calibration has been carried out; the tester informs the operator by an acoustic signal that the operation has been completed.

Valid for versions with:Smart gearbox

PROCEDURE

The system carries out:

- diagnosis on the inputs/outputs (I/O) of the electronic control unit (TCU)
- diagnosis of plausibility of commands/system actuations in potentially dangerous situations
- diagnosis with diiagnostic instrument (K line)
- fault diagnosis on main microprocessor

Valid for versions with:Smart gearbox

INPUTS/OUTPUTS (I/O) OF THE ELECTRONIC CONTROL UNIT (TCU)

The following Input/Output signals are excluded from the diagnosis:

- brake pedal
- automatic and door open switches
- all the signals supplied by the engine management on the CAN network
- serial line for display
- buzzer control
- Fiat tester serial line
- signals for key, +50 starting, +30 battery supply, all the earths for control unit CAN network electrical connection.

For the frequency input signals, diagnosis concerns the two rpm and gearbox input sensors and consists of checking the signal absent fault.

On the analogue inputs, diagnosis is carried out by checking the following types of fault:

- outside signal's electrical field
- outside signal's dynamic field

The diagnoses of the control unit outputs concern the three proportional solenoids, the two on-off switches and the two pump and engine starting enablement relays; the types of fault checked are:

- for proportional solenoids, short to earth, or open circuit or short to Vbatt (not distinguished)
- for electromagnetic brake, short to earth and pump relay ciruit open or short to Vbatt
- for the starting enablement relay, short circuit to earth or open circuit (not distinguished)

These I/O diagnoses are carried out with the following criteria and validation, de-validation and error memorisation stages:

- the error becomes validated and so also memorised and can be displayed on the Examiner only at the end of the validation process
- the memorised error is automatically svaed in EEPROM when the system is switched off (vehicle ignition off) and so can be viewed on the Fiat Tester
- in parallel with the validation process, there is the de-validation process which can lead to the deletion of the validated error, but not the memorised error
- the error validation process includes the stages of: error running (as soon as it appears), filtered error and then validatd error
- recoveries (reconfiguration of robotised gearbox system operation) are activated when the error is validated

When there is a validated fault, the fault warning light also comes on, the relevant message is sent and the buzzer sounds for a predetermined time.

Valid for versions with:Smart gearbox

PLAUSIBILITY OF COMMANDS/SYSTEM ACTUATIONS IN POTENTIALLY DANGEROUS SITUATIONS.

These diagnoses are carried out basically to check the plausibility between the command status and the status of the system responses
If implausibility is verified between commands and outputs, the making safe of the system is ordered.

The system diagnoses are as follows:

- gear engagement has not taken place
- engagement of opposite gear
- incorrect selection during gear change
- undesired clutch re-closing during gear change
- clutch rpm out of range during gear change
- rapid clutch closure (< 0.05 s) during starting off / awaiting starting off

Valid for versions with:Smart gearbox

DIAGNOSIS WITH DIAGNOSTIC INSTRUMENT

The control unit dialogues with the diagnostic instrument via the k ISO 9141 line.
The dialogue protocol is Keyword 2000.

The diagnoses are:

- 'passive', display of variables/operating parameters in accordance with a pre-defined menu
- 'active', used to activate the end-of-line self-calibration procedures and for testing the open-loop engagement of all the gears for Service diagnosis.

Valid for versions with:Smart gearbox

MAIN MICROPROCESSOR FAULT DIAGNOSIS

The control unit has a second microprocessor which checks that the main microprocessor is functioning. The second microprocessor checks the number of pulses sent to it from the main microprocessor over a pre-established time, and if there is an error, it warns the driver and makes the system safe as described below.

Valid for versions with:Smart gearbox

Strategies which manage incorrect commands prevent operating situations which are potentially dangerous or critical for the transmission/vehicle.

Valid for versions with:Smart gearbox

INCORRECT COMMANDS

Engagement of reverse gear: must not be accepted if the vehicle is moving (over 2 km/h).
Gear change with vehicle moving and clutch closed: the driver's request must not be accepted if it can cause the engine to under rev or over rev.
Gear change with vehicle stopped and engine started: only the gears enabled for setting off may be accepted (1^{st},2^{nd} and reverse gear).
Simultaneous gear request from lever and from steering wheel buttons: the command from the lever takes priority.
Switching off the ignition with the vehicle moving: the system must manage the gear change for as long as all the monitored speeds are not zero (engine, gearbox input and gearbox output).
Engine starting: must be disabled if a gear is engaged and the brake pedal is not pressed.
Engine startign with gear engaged: must be possible only with the vehicle stopped, accelerator pedal released, brake pedal pressed and no faults.
The system must first put the gearbox into neutral automatically and then enable engine starting.
With the vehicle stopped (or nearly stopped), the gear change requests must only be accepted if the brake pedal is pressed.
This avoids dangerous situations in the case of lever/steering wheel buttons commands by passengers in the vehicle or persons outside the vehicle (e.g. through the window!) or an undesired command by the driver on the gear lever when the vehicle is parked on a slope.
Inhibition of neutral control beyond a pre-established speed.
Eliminates the risks of incorrect driver commands in critical situations (e.g. downhill) or improper commands by passengers.

Automatic placing into neutral of the gearbox and acoustic warning to driver (buzzer active for 1 s) when:

- the oil pressure is insufficient to manage the clutch
- with the engine started, if the driver opens the door to leave the vehicle (setting off with the door open is permitted, as the driver's action on the brake or accelerator pedal is detected): putting into neutral 1 s after the door has opened
- with the engine started, gear engaged and vehicle stopped, accelerator and brake commands not detected for at least 3 min. with engine started, gear engaged and acdelerator released and brake pedal pressed for at least: 10 min with engine started, gear engaged and brake pedal pressed.
- Automatic prolonging of gear when the driver keeps the accelerator pedal pressed and the engine speed exceeds the regulator range speed, a manoeuvre called AUTOUP (6450 rpm).
- Limitation of full operation of the vehicle if there are faults which reduce the system's safety level (e.g. limitation of gears to 1^{st} , 2^{st} , reverse gear when there is a fault in rpm or in the engaged gear sensors).

Valid for versions with:Smart gearbox

VISUAL/ACOUSTIC INFORMATION TO THE DRIVER

The driver must concern:

- the operating state of the drive system/vehicle (gear display, fault warning light, buzzer)
- notification of 'completion' of gear change requests made by the driver (limited to situations of vehicle almost stopped: vehicle parking).
- Acoustic indication by buzzer and continuous visual indication by fault warning light (associated with specific message), if a fault is detected in the system I/O which reduces the safety level.
- Information to the driver by displaying the engaged gear
- Acoustic indication of implausibility between engaged gear and the direction in which the vehicle is travelling; in this situation clutch self-closing must be cancelled when going downhill and an acoustic warning must be given (intermittent 'danger' buzzer throughout the duration of re-opening of the clutch).
- Indication if the driver has turned the engine off with the gearbox in neutral, and so the vehicle could move by itself: acoustic and visual warning (flashing of 'N' on display) for at least 4 s.

- Acoustic and visual indication (on display) if the system has intervened by automatically setting the gearbox to neutral.
- Indication of clutch overheating (must be limited to when the setting off manoeuvre is being carried out): specific warning on reprogrammable multifunction display and buzzer.
- Acoustic and visual indication (on display) if, following a 'failed' engine starting manoeuvre, the gearbox is in neutral.
- Additional driver's information that reverse gear has been engaged: specific acoustic warning ('courteous' intermittent buzzer).


A gear change request may not always be accepted by the system (brake pedal not pressed, request for reverse with vehicle travelling at over 2 km/h, etc.).

Valid for versions with:Smart gearbox

The system must be able to interact with other vehicle systems in accordance with the following logics:

Valid for versions with:Smart gearbox

INTERACTION WITH ENGINE MANAGEMENT

During driving, the two systems do not interact, because the system does not do any work, so there is only an exchange of information and signals (as per 'CAN INTERFACE SPECIFICATION' and control unit diagram.
When a gear change is being made, the system must be master over engine management, i.e. the gear change control system must make a request to engine (via the CAN network) as to what the engine torque must be (decrease while the clutch is opened and increase when the gear change has been completed and the clutch is closing).
If the engine is turned off and the system reads a fault in the engine rpm or clutch rpm, the system, even though it is in recovery, must allow the engine to start even with a gear engaged; if both signals are at fault, the strategy is no longer valid.

Valid for versions with:Smart gearbox

INTERACTION WITH CRUISE CONTROL (CC) (FOR TYPES/VERSIONS OF VEHICLE FITTED WITH IT)

The CC operates irrespective of the operation of the gearbox control system:

- when the CC is on, the gearbox control system is in manual mode; when the gear change request is made, it will be deactivated
- when the CC is on, the gearbox control system is in automatic mode; when the request is made to change gear by the system or suggested by the user with the gear lever, it will not be deactivated.

Valid for versions with:Smart gearbox

INTERACTION WITH ABS (FOR TYPES/VERSIONS OF VEHICLE FITTED WITH IT)

The system must not have any logic for operative interaction.

Valid for versions with:Smart gearbox

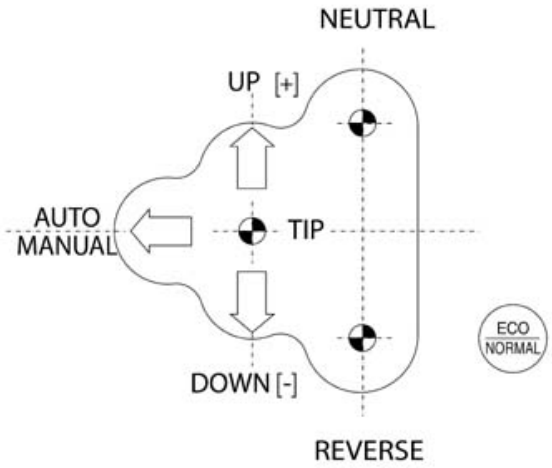
VDC-ASR-MSR INTERACTION (FOR TYPES/VERSIONS OF VEHICLE FITTED WITH IT)

When the ASR is active, the system must inhibit 'SPRINT' departures
During intervention of the ASR or VDC, the system must inhibit the 'AUTO UP SHIFT' manoeuvre.

Valid for versions with:Smart gearbox

DESCRIPTION OF MULTISTABLE LEVER

The gear selector lever fitted to the Fiat Punto robotised gearbox is of the multistable type, i.e. with three stable positions and three unstable positions.
With reference to the following diagram, the three stable positions are those corresponding to NEUTRAL (N), REVERSE (R) and the TIP position (located between the unstable UP (+) and DOWN (-) positions).
The unstable positions, positions which are abandoned by the lever as soon as it is released, are the positions for requesting a higher gear [UP (+)], a lower gear [DOWN (-)] and automatic mode (A/M); the return to manual mode is achieved by returning the lever to the A/M position.



Valid for versions with:Smart gearbox

DOOR OPENING

With the vehicle stopped, when the door is opened the instrument panel comes on and various items of information concerning the vehicle are displayed for a variable period (time lag of about 5/10 s); the engaged gear is not displayed.
The pump may come on to pressurise the circuit and allow the system to be active at the time of the request to start.

Valid for versions with:Smart gearbox

MISUSE BEFORE KEY ON

With the vehicle stopped and ignition-dependent electrical services off, it is possible to move the gear selector lever with or without the brake pedal pressed.
The system will not carry out any action following the operation of the lever, so the gear engaged before the request from the lever or with the engine running or the ignition at +15 will remain unchanged.

Valid for versions with:Smart gearbox

KEY ON (+15)

With the vehicle stopped and key at the on position (ignition-dependent electrical services on), the instrument panel must display the engaged gear, the operating mode (automatic = AUTO or manual = NO DISPLAY) and the logic (economy = E or normal = NO DISPLAY).
With regard to the cases of consistency between the position assumed by the lever and the gear actually engaged in the gearbox, the following three cases may exist:

LEVER POSITION	ENGAGED GEAR	DISPLAY	WARNING ON PANEL	ACOUSTIC WARNINGS
TIP	1^{st} 2^{nd} 3^{rd} 4^{th} 5^{th}	[1] [2] [3] [4] [5]	NONE	NONE
NEUTRAL	NEUTRAL	[N]	NONE	NONE
REVERSE	REVERSE GEAR	[R]	NONE	NONE

at key on, the system must repropose the mode (MANUAL or AUTOMATIC) and logic (ECO or NORMAL) active before the vehicle was turned off

at key on (+15) and so with the vehicle stopped and engine off (only the ignition-dependent electrical services on), THE REVERSE BUZZER IS NOT ACTIVE.

Valid for versions with:Smart gearbox

MISUSE AFTER KEY ON (+15)

With the vehicle stopped and key at the on position (ignition-dependent electrical services on), the instrument panel must display the engaged gear, the operating mode (automatic = AUTO or manual = NO DISPLAY) and the logic (economy = E or normal = NO DISPLAY).

If the lever is operated without the brake pedal being pressed, any gear change request is not implemented by the system. The following causes of implausibility may arise after the lever has been operated without the brake pedal being pressed.

FINAL LEVER POSITION	ENGAGED GEAR	DISPLAY	WARNING ON PANEL	ACOUSTIC WARNINGS
TIP	NEUTRAL	[N]	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NONE
TIP	REVERSE GEAR	[R]	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NONE
NEUTRAL	REVERSE GEAR	[R]	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NONE
NEUTRAL	1^{st} 2^{nd} 3^{rd} 4^{th} 5^{th} (*)	[1] [2] [3] [4] [5]	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NONE
REVERSE	NEUTRAL	[N]	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NONE
REVERSE	1^{st} 2^{nd} 3^{rd} 4^{th} 5^{th} (*)	[1] [2] [3] [4] [5]	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NONE

(*) This case is possible because at key on, with the brake pressed, it is possible to request all the available gears.

Repeating the manoeuvre consists of returning the lever to the position relating to the gear actually engaged (it is sufficient for the lever to be taken out and then put back into the position before the request) and repeating the request with the brake pressed.
In addition the TIP position (stable central position between UP and DOWN) corresponds to first gear if the request is made with the brake pedal pressed, starting with the lever in NEUTRAL and gearbox in neutral or with the lever in REVERSE and reverse gear engaged.

With the engine off and vehicle stopped, the presence of implausibility between the position assumed by the lever and the gear actually engaged in the gearbox is indicated to the driver only by a message on the display, so the warning buzzer will not sound in these circumstances.

Valid for versions with:Smart gearbox

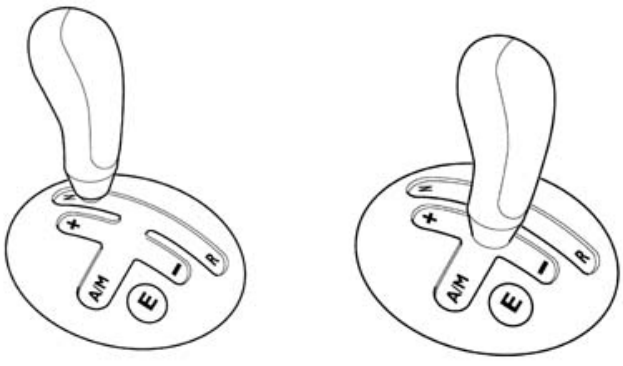
STARTING (+30)

The starting request must be made in accordance with the following safety requirement.
Brake pedal pressed (*)
The instrument panel, in addition to displaying the operating mode and logic already availabe with the key +15, will display neutral [N] at the same time as the request to start up: the engine starts.
If the request to start is made with the selector lever at N (but gearbox in a gear other than N) but without pressing the brake pedal, the system will warn the driver with the following message on the display: PRESS BRAKE AND REPEAT MANOEUVRE (*)
The condition for permitting engine starting is GEARBOX IN NEUTRAL POSITION; if it is already in this position, it is not necessary to press the brake because when the engine starts, the vehicle will not lose braking due to the clutch opening; if instead a gear is engaged with the brake pressed, the fast starting procedure is enabled with automatic disengagement of the gear.
(*) This case is possible because at key on (+15), with the brake pressed, it is possible to request all the available gears; So it is possible that the user may have selected any gear with the engine off but with key +15, and subsequently left the vehicle with key off and the lever in any position not relating to the last engaged gear.
After starting, if the lever is not moved to the [N] position, the system will warn the driver of the inconsistency between the gear engaged in the gearbox (neutral = [N] and lever position with the following message: PRESS BRAKE AND REPEAT MANOEUVRE.
In addition, the buzzer will warn the user with an acoustic signal that the request has not been implemented.

Valid for versions with:Smart gearbox

STARTING THE VEHICLE FROM A STANDSTILL

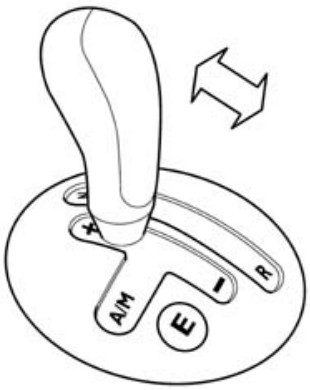
After completing the starting procedure, the vehicle is on, with speed V = 0 km/h, gearbox in neutral and selector lever at N or TIP.



Valid for versions with:Smart gearbox

STARTING THE VEHICLE FROM A STANDSTILL

The figure shows the lever in the stable position N (left picture) and in the TIP central position (right picture).
The driver can naturally choose whether to set off forwards or backwards.
The instrument panel displays neutral N as well as the operating mode and logic.
To engage first or second gear, it is necessary to press the brake pedal and move the lever to TIP if you wish to set off in 1st, or to request 1st gear by moving the lever to TIP + if the driver has not reset the lever to N following the warning described in the above paragraph; remember that coming from N, the TIP lever poition corresponds to 1st gear; move the lever to TIP and set it to TIP + if you wish to set off in second gear in order to depart on a low-grip surface, corresponding to the engagement of 2nd gear.



Valid for versions with:Smart gearbox

STARTING THE VEHICLE FROM A STANDSTILL

The figure shows the lever in the monostable position UP (+).
The vehicle starts to move (sets off) simply when the accelerator is pressed: the torque delivered is proportional to the percentage of accelerator pedal pressed.
This procedure is irrespective of the operating mode or logic selected.

As described, for safety reasons, any request with vehicle stopped (engine running) must be made with the brake pedal pressed; this is to prove the driver's real wish (in this way the vehicle cannot be put into a forward or reverse gear accidentally in the driver's absence). In particular the system accepts the requests even if the double action of pressing the brake and operating the lever is not done simultaneously: the maximum delay permitted between the two actions is t = 500 ms provided that the lever remains in the request position (TIP + or R) until the end of the delay.

coming from N, the TIP position corresponds to 1st gear. Every TIP (-) request is not considered by the system because it is not a plausible request.

the request for reverse gear from stopped vehicle is accompanied by the warning buzzer sounding for 4 s.

coming from R, the TIP position corresponds to 1st gear. Every TIP (-) request is not considered by the system because it is not a plausible request.

Every gear request with the vehicle stopped, made by the driver without pressing the brake pedal, is rejected by the system which warns the driver with a message on the display: PRESS BRAKE AND REPEAT MANOEUVRE.
In addition in these cases, the buzzer will warn the driver that the request has not been implemented, with an acoustic signal lasting 5 s.

Valid for versions with:Smart gearbox

GEAR CHANGE WITH VEHICLE MOVING

There are two possibilities for changing gear depending on the system's operating mode (MANUAL = No display, or AUTOMATIC = AUTO).

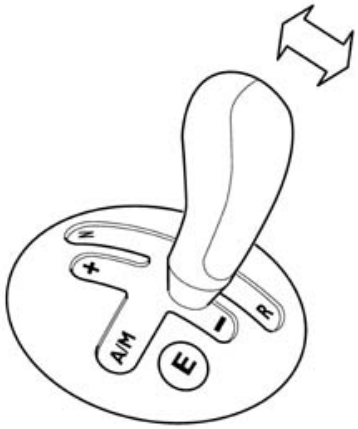
Valid for versions with:Smart gearbox

GEAR CHANGE IN MANUAL MODE

At the end of the setting off stage, the vehicle is in first gear. Each request to change to the next gear up is made by moving the lever to the UP (+) position.
Requests are only accepted if the gear change is completed, the engine rpm is such as to avoid engine stalling (the system assesses the engine rpm after the gear change and judges it to be acceptable in relation to a pre-established threshold).
If the request is accepted by the system, after completing the gear change, the display will show the new current gear.

The system displays the gear actually engaged and not the gear requested by the driver.

If the request is not accepted by the system, the display will continue to show the engaged gear before the request and will also show the warning: ILLEGAL MANOEUVRE
The buzzer will also inform the driver that the request has not been implemented, with an acoustic signal lasting 5 s.
Similarly, the driver may request lower gears by setting the lever to DOWN (-).



Valid for versions with:Smart gearbox

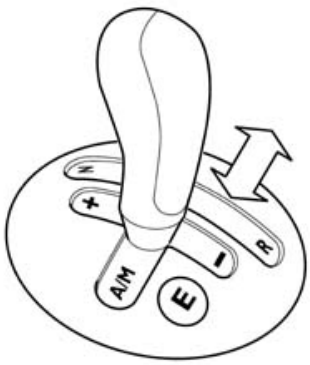
GEAR CHANGE IN MANUAL MODE

The figure shows the lever in the monostable DOWN (-) position.
In this case too the requests are accepted by the system following the same logic as that described for accepting requests for a higher gear, with the only difference that in this case, the system will only accept the request if the engine rpm, after the gear change, will not exceed the maximum permitted engine rpm.
This threshold value (gear shift acceptability threshold) also depends on the fact that the request is made with the brake pressed (assessment of vehicle deceleration) or with the brake pedal released.

Valid for versions with:Smart gearbox

GEAR CHANGE IN AUTOMATIC MODE

The system also has a fully automatic operating mode, in which it autonomously selects the most suitable gear in accordance with the signals coming from the interface and the driver's requests typically expressed by the action on the accelerator pedal.
The change from MANUAL to AUTOMATIC mode is made by moving the lever to the unstable position AUTO/MANUAL, on the left of the grille.



Valid for versions with:Smart gearbox

GEAR CHANGE IN AUTOMATIC MODE

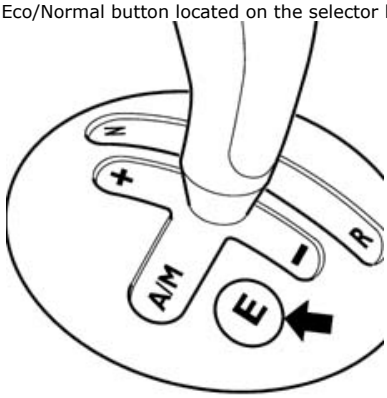
The figure shows the lever in the monostable AUTO/MANUAL position.
The display shows the word AUTO above the indication of the engaged gear.
In this way, the driver has available two different operating logics: one aimed at reducing consumption (ECO) and one which replicates the gear change the driver would carry out in manual under normal driving conditions.

The ECO logic implemented by the system to reduce consumption, selecting the higher gears as soon as conditions so permit.
As mentioned, the system indicates the selected logic by showing the letter E on the display to indicate to the driver the change from NORMAL logic to ECONOMY logic.
The gear change will thus be carried out fully independently by the system.
When the vehicle starts, the system re-proposes to the driver the last mode and logic selected before the vehicle was turned off.
The starting procedure is always the same, so to set the vehicle in motion (in forward or reverse gear) even if the mode is automatic, the driver must request the two possible setting-off gears (1^{st} or 2^{nd}) or reverse gear with the brake pressed: the system will naturally remain in automatic mode.
In this mode the system also accepts requests from the lever (both requests for higher gears by moving to TIP + and requests for lower gears, TIP -), remaining in automatic mode, (strategy of GEAR SUGGESTION IN AUTOMATIC); after accepting the request made by the driver, the system continues to operate totally independently.
In this way the system also offers the driver the Kick Down function; if the accelerator pedal is suddenly pressed to the floor, the system recognises the request for maximum torque (for example for overtaking) and shifts down one, two or three gears if conditions so permit.
The strategy operates by assessing the derivative of the speed of movement of the accelerator pedal, and is activated when a threshold is reached (pedal percentage value).
You can only exit from automatic mode by operating the lever and moving it to the unstable A/M position.

Valid for versions with:Smart gearbox

MANAGEMENT OF ECO/NORMAL KEY: BEHAVIOUR OF THE SYSTEM

As mentioned, the system can manage two different operating logics only when it is in AUTOMATIC mode.
To change from one logic to the other, press the Eco/Normal button located on the selector lever embellishment.



Valid for versions with:Smart gearbox

MANAGEMENT OF ECO/NORMAL KEY: BEHAVIOUR OF THE SYSTEM

The driver may check the requests and resulting actions made by the system described below:
The system is in manual, pressing the E/N button has no effect;

the change to AUTOMATIC mode may involve a gear change (UP or DOWN) becuase of the transition from manual mode to the automatic map.

The entry into automatic mode is achieved by operating the lever: the system will re-propose the last logic memorised (if the last logic in automatic was ECO, when changing from MANUAL to AUTOMATIC the system will propose the Economy logic, and vice versa Normal).
Subsequently pressing the E/N button maintains the AUTOMATIC operating mode, but sets it to NORMAL or ECO logic depending on the logic in current use.
The change back to manual mode whether the logic is ECONOMY or NORMAL is obtained by setting the selector lever to A/M. The instrument panel will indicate the operating mode (automatic = AUTO), the logic (NORMAL = no display) and the current gear, starting from either AUTO ECO or AUTO NORMAL.
The operation described above is summarised in the following tables:

Current mode	Mode after pressing E/N button	DISPLAY	LEVER POSITION
MANUAL	MANUAL	[1] [2] [3] [4] [5] [R]	TIP
AUTO ECO	AUTO NORMAL	[1] [2] [3] [4] [5] [R] /AUTO	TIP
AUTO NORMAL	AUTO ECO	[1] [2] [3] [4] [5] [R] /AUTO + E	TIP
Current mode	Mode after moving lever to A/M	DISPLAY	LEVER POSITION
MANUAL	AUTO AND LAST LOGIC BEFORE CHANGING TO MANUAL	[1] [2] [3] [4] [5] [R] /AUTO + INDICATION OF LOGIC BEFORE CHANGING TO MANUAL	TIP
AUTO ECO	MANUAL	[1] [2] [3] [4] [5] [R]	TIP
AUTO NORMAL	MANUAL	[1] [2] [3] [4] [5] [R]	TIP

Valid for versions with:Smart gearbox

REQUEST FOR NEUTRAL WHILE VEHICLE IS MOVING: BEHAVIOUR OF THE SYSTEM

For safety reasons, the request for neutral while the vehicle is moving is only possible in certain conditions. The possible manoeuvres implemented in MANUAL or AUTOMATIC mode, and the system's reactions, are listed below:
1 - The driver requests neutral with the accelerator pedal released during braking at any speed. The system accepts the request: the display shows not only the operating mode and logic, but also neutral N.
2 - The driver requests neutral with the ACCELERATOR PEDAL RELEASED BUT WITHOUT PRESSING THE BRAKE PEDAL. The system only accepts the request if the vehicle speed is V = 80 km/h: the display shows not only the operating mode and logic, but also neutral N. If this manoeuvre is carried out with V = 80 km/h, the system does not accept the request, it maintains the current gear and as the lever is in a position which is not consistent with the gear actually engaged in the gearbox, the message: 'ILLEGAL MANOEUVRE' is displayed.
The system gives further warning by means of an acoustic signal.
3 - The driver requests neutral with ACCELERATOR PEDAL PRESSED BUT PRESSING THE BRAKE PEDAL: the system does not accept the request, it maintains the current gear and as the lever is in a position which is not consistent with the gear actually engaged in the gearbox, the message 'ILLEGAL MANOEUVRE' is displayed.
The system gives the driver further warning means of an acoustic signal.
4 - The driver requests neutral with ACCELERATOR PEDAL PRESSED AND WITHOUT PRESSING THE BRAKE PEDAL. The system accepts the request only if the vehicle speed is V = 80 km/h: the display not only shows the operating mode and logic, but also neutral N.
If this manoeuvre is carried out with V = 80 km/h, the system does not accept the request, it maintains the current gear and as the lever is in a position which is not consistent with the gear actually engaged in the gearbox, the following message is displayed:

Valid for versions with:Smart gearbox

PRESS BRAKE PEDAL AND REPEAT MANOEUVRE

The system gives the driver further warning means of an acoustic signal.
The return from neutral, with the system in either AUTOMATIC or MANUAL, is achieved by returning the lever to the stable TIP position. THE BRAKE PEDAL NEED NOT BE PRESSED.
The manoeuvre returns the gearbox to the most suitable gear in accordance with the signals coming from the vehicle (vehicle speed, engine rpm, etc.) and established by an appropriate map.
The display shows the operating mode and logic and the engaged gear. Naturally the engagement of reverse with the vehicle moving forwards is not accepted unless the operating conditions described in the following paragraph arise.

Valid for versions with:Smart gearbox

REQUEST FOR REVERSE GEAR: BEHAVIOUR OF THE SYSTEM

The engagement of reverse gear is permitted by the system only if two conditions are present, which are fundamental to safety and to protect the gearbox. In fact on the C514/C510, the reverse gear has no synchromesh.
The conditions are:
1 - brake pedal pressed
2 - vehicle speed V = 5 km/h
So with the vehicle moving at a speed below the set threshold and brake pedal pressed, the system accepts the request. The display indicates the operating mode and logic and R.
This manoeuvre is valid whether the system is in MANUAL or in AUTOMATIC. - WHEN REVERSE IS ENGAGED, THE DRIVER IS ALSO WARNED BY THE SYSTEM BY AN ACOUSTIC SIGNAL LASTING 4 S.
If the driver requests reverse without fulfilling the first condition, the system will not accept the request, it will engage neutral [N] and will send the user the messages described below, depending on the case:
1 - At the request for reverse in AUTOMATIC or MANUAL mode without the brake pedal pressed but at a speed below or up to the set threshold, the system will not make the gear change, it will engage neutral and will inform the driver by displaying the following message: PRESS BRAKE AND REPEAT MANOEUVRE.
This message is shown because the lever is in the stable position R but the vehicle will have engaged N gear. The display shows the operating mode and logic and N (current gear). The message is accompanied by the implausibility buzzer sounding.
2 - At the request for reverse in AUTOMATIC or MANUAL mode, with the brake pressed but at a speed higher than the set threshold, the system does not make the gear change and informs the driver by displaying the following message: ILLEGAL MANOEUVRE.
This message is accompanied by an implausibility acoustic signal as the lever is in the stable position R but the vehicle will still have the current gear engaged.
The display shows the operating mode and logic and the current gear.


As the reverse manoeuvre is statistically demanding for the driver, the request for the simultaneous action of the lever being set to R and pressing the brake pedal is accepted if the delay between the two actions is 300 ms. In addition with the brake pressed, the request is accepted if the speed threshold value (5 km/h) is met within a set time period (3 s).

The 'return from reverse', i.e. the manoeuvre to engage 1st gear is managed by the system under the same conditions as those seen above; as mentioned for the case of the manoeuvre to 'return from neutral', the system engages 1st gear when the lever is simply set to TIP.
So with the brake pressed, and the vehicle speed below the threshold, the system accepts the driver's request. The display shows the operating mode and logic and 1st gear.
The possible cases of non-acceptance of the driver's request may be as follows:
3 - At the request for 1st in AUTOMATIC or MANUAL mode without the brake pressed but at a speed of below or up to the set threshold, after the same timeouts have elapsed as for the case of change from first gear to reverse, the system does not make the requested gear change, it engages neutral and warns the driver by displaying the following message: PRESS BRAKE AND REPEAT MANOEUVRE.
This message is accompanied by an implausibility acoustic signal as the lever is in the TIP stable position but the vehicle will have engaged neutral. The display shows the operating mode and logic and N (current gear).
4 - At the request for REVERSE GEAR in AUTOMATIC or MANUAL mode with the brake pressed but speed above the set threshold, so that despite the brake being pressed and after the timeout has elapsed this threshold is not reached, the system will not make the gear change and will warn the driver by displaying the following message: ILLEGAL MANOEUVRE.
This message is accompanied by an implausibility acoustic signal as the lever is in the TIP stable position but the vehicle will still have reverse gear engaged. The display shows the operating mode and logic and R (current gear).

Valid for versions with:Smart gearbox

SYSTEM SAFETY FEATURES

The safety features associated strictly with the gearbox management are designed to make the system, and so the vehicle, safe in the event of actions considered not to be made voluntarily by the driver, or in the absence of activity for a period of time considered to be prolonged if compared with the technical times which usually elapse between two actions made by the driver with the engine running or the vehicle moving.

1 - VEHICLE STOPPED, ENGINE RUNNING GEAR ENGAGED (typically 1st, 2nd or reverse). When the driver's door is opened, if the brake and/or accelerator pedals are pressed, the system recognises that the action is voluntary and maintains the current gear. The instrument panel will continue to display the mode, logic and current gear; no acoustic signal.

2 - VEHICLE STOPPED, ENGINE RUNNING GEAR ENGAGED (typically 1st, 2st or reverse gear). When the driver's door is opened, if the brake and accelerator pedals are not pressed, the system engages neutral after a period of 3-5 s. The instrument panel will continue to display the mode, logic and N. As the lever may be in TIP or R, the change controlled by the system to neutral comprises a situation of implausibility between the lever position and the gear engaged in the gearbox, so the manoeuvre will be accompanied by an implausibility acoustic signal (the buzzer will always sound in all cases of automatic engagement of neutral).

3 - VEHICLE STOPPED, ENGINE RUNNING GEAR ENGAGED (typically 1st, 2nd or reverse). If no action is carried out (stopped at traffic lights) for a period of 5 min., the system autonomously selects neutral. The instrument panel will continue to display the mode, logic and N. As the lever may be in TIP or R, the change controlled by the system to neutral comprises a situation of implausibility between the lever position and the gear engaged in the gearbox, so the manoeuvre will be accompanied by an implausibility acoustic signal.

4 - VEHICLE STOPPED, ENGINE RUNNING GEAR ENGAGED (typically 1st, 2nd or reverse). If the driver, with the brake pressed, does not carry out any actions (waiting) for a period of 10 min., the system autonomously selects neutral. The instrument panel will continue to display the mode, logic and N. As the lever may be in TIP or R, the change controlled by the system to neutral comprises a situation of implausibility between the lever position and the gear engaged in the gearbox, so the manoeuvre will be accompanied by an implausibility acoustic signal.

5 - VEHICLE STOPPED, ENGINE RUNNING GEAR ENGAGED (typically 1st, 2nd or reverse): KEY OFF PROCEDURE At key off, the instrument panel will continue to display the mode, logic and current gear for 4 s (the lever may be in TIP or R).

6 - VEHICLE STOPPED, ENGINE RUNNING GEARBOX IN NEUTRAL: KEY OFF PROCEDURE. At key off, the instrument panel will continue to display the mode, logic and N flashing for 4 s. During these 4 s, the display will be accompanied by an acoustic signal warning that the vehicle is being left with gearbox in neutral.