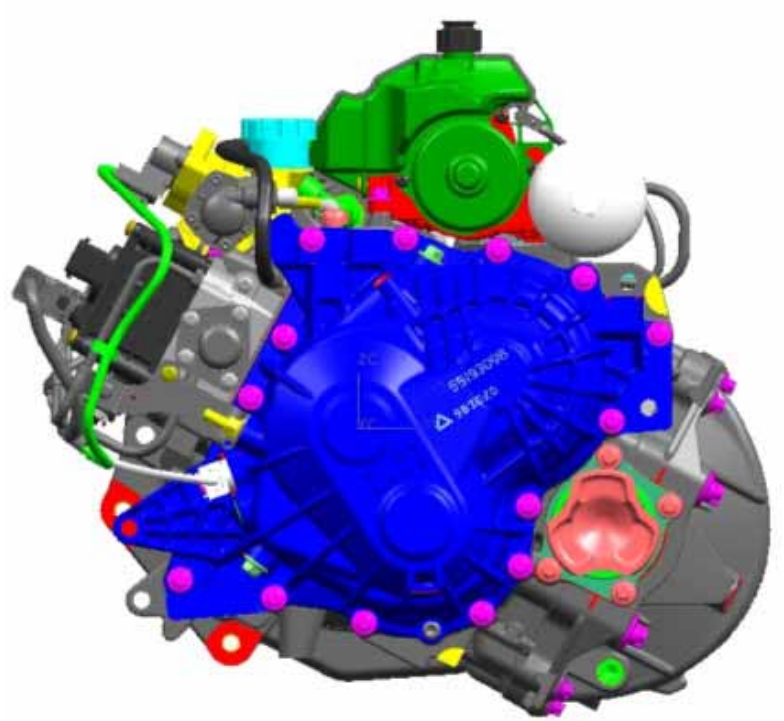


M20 AUTOMATED GEARBOX

DOCUMENT CHANGES / UPDATES			
Date	**Contact**	**File Name**	**Description of change**

CONTENTS

1. BRIEFING

1.1 INTRODUCTION

The automated transmission system (AMT: **A**utomated **M**anual **T**ransmission) for the M20 gearbox was designed with the same objective as the previous versions in mind, that is, to enhance the performance of the components of the manual mechanical transmission; the system frees the driver from the obligation of controlling the clutch pedal and the gear lever without depriving him of the pleasure of driving that comes from the direct control of transmission.
It also improves driving safety through direct control that prevents mistakes made by the driver and incorrect handling of the transmission system, providing him with a more advanced vehicle interface.
The system consists essentially of a mechanical transmission, with a single, dry-plate clutch and synchronized mechanical gearbox, driven by a hydraulic slave cylinder.
As on the previous versions, no modifications have been make to the clutch or the gearbox for the installation of the hydraulic actuators used to control the stroke of the clutch and the gear engaging and selecting movements.

1.2 GENERAL

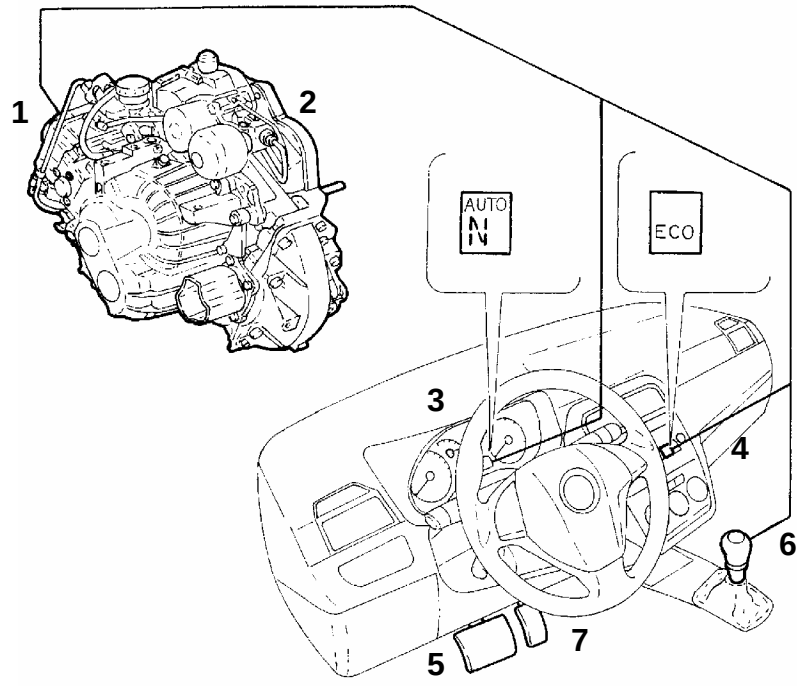
The AMT system for M20 provides the following features:

- It improves the performance of the components of the manual mechanical transmission.
- It frees the driver from the obligation of controlling the clutch pedal and the conventional gear lever.
- It improves driving safety through a control function that prevents mistakes made by the driver and incorrect handling of the transmission system.
- It provides the driver with a more advanced vehicle interface.
- It is a hydraulic gearbox and clutch control system that maintains all the advantages of the dry-plate clutch and mechanical gearbox (weights, strength and reliability, low energy consumption).
- It simplifies use and makes driving less tiring especially in town.
- It ensures comfortable or sporty gear changes through its advanced control logic slave.
- There is no clutch pedal inside the vehicle and the gear lever is replaced by "Up/Down/Neutral/Reverse" controls on a specially designed joystick on the central tunnel.
- It provides automatic gear control in "AUTO" mode (selected by the driver) on the basis of two different logic modes (ECO/NORMAL).

The automated gearbox has two operating modes:

- SEMIAUTOMATIC MODE (MANUAL): the driver controls gear changes using the joystick on the tunnel.
- AUTOMATIC MODE (AUTO): the electronic system decides when to change gears on the basis of two strategies, the first for comfortable driving (NORMAL) and the second for reducing fuel consumption to a minimum (ECO).

Assembly drawing with the main components of the automated gearbox system:



1. TCU (Transmission Control Unit)
2. Electrohydraulic unit with electric pump
3. Gear display and signal board
4. ECO switch
5. Brake pedal (with dual switch)
6. Lever for selecting gears and Auto mode
7. Accelerator pedal (Drive by Wire)

The slave system is made up of an electrohydraulic unit (2) assembled directly on the gearbox which controls the following gearbox movements by means of two actuators:

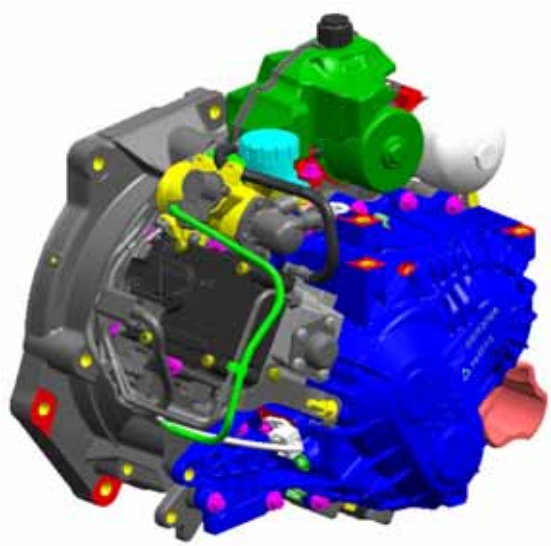
- the gear selecting and engaging movement (dual-effect actuator)
- the clutch release control.

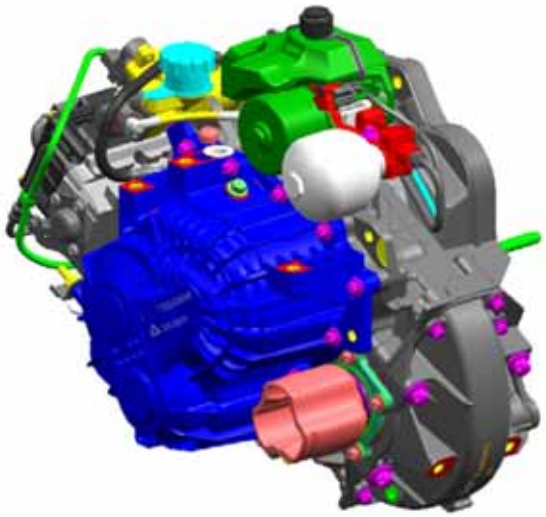
The electrohydraulic unit is controlled by four solenoid valves (supplied with the necessary hydraulic power by a electric pump and an accumulator).
Having identified the driver's requirements from the position of the lever, an electronic control unit (1) controls the gear change autonomously, by directly controlling the clutch, gearbox and motor torque; during the gear change, the engine is under the control of the gearbox.
The combined action of the gearbox and the engine considerably increases the system's performance and frees the driver from having to synchronize the movements of the clutch and accelerator during the gear change, which may be performed without him removing his foot from the accelerator.
This prevents incorrect requests for a gear change and prevents the engine from stalling or reaching excessively high revolutions.
In terms of driving assistance, the system also ensures that first gear is immediately available when the vehicle stops and automatically changes down through the gears when the vehicle decelerates suddenly.
The indication of the gear engaged is shown on a display on the electronic dashboard, as are indications of faults or critical driving conditions for the vehicle or for the components of the transmission; the latter are signalled by a series of warning or system fault messages together with the general fault or transmission fault LEDs.

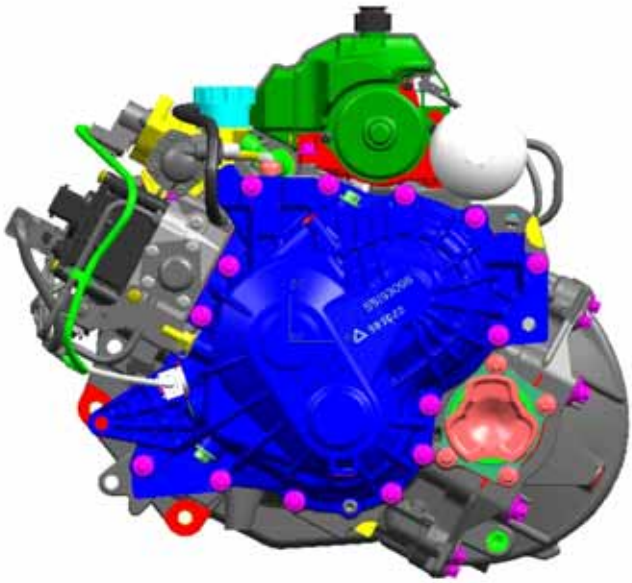
2. CHARACTERISTICS

2.1 LAYOUT OF GEARBOX

The electrohydraulic unit is assembled on the M20 gearbox as shown in the pictures below.



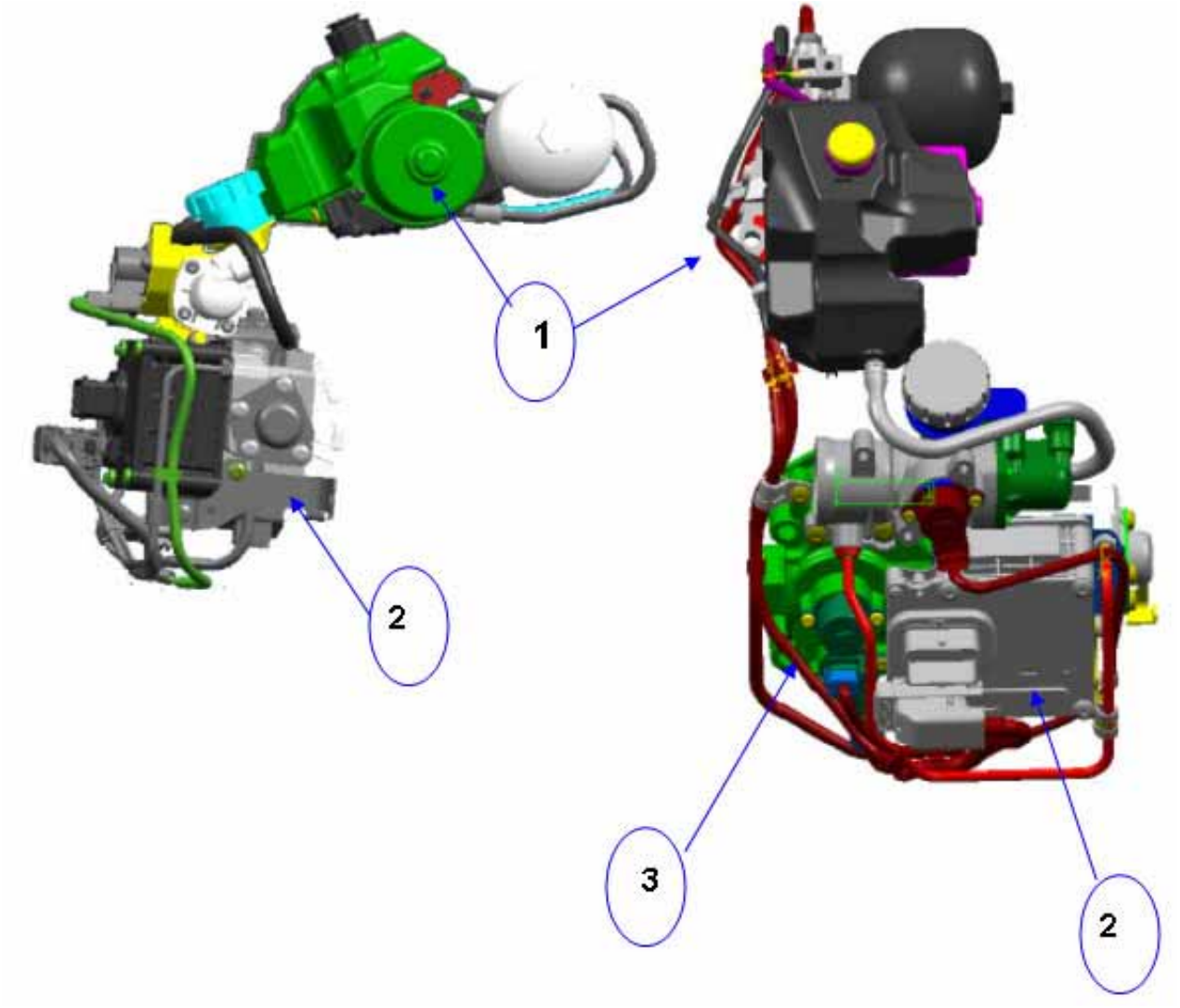




2.2 COMPONENTS OF THE ELECTROHYDRAULIC KIT

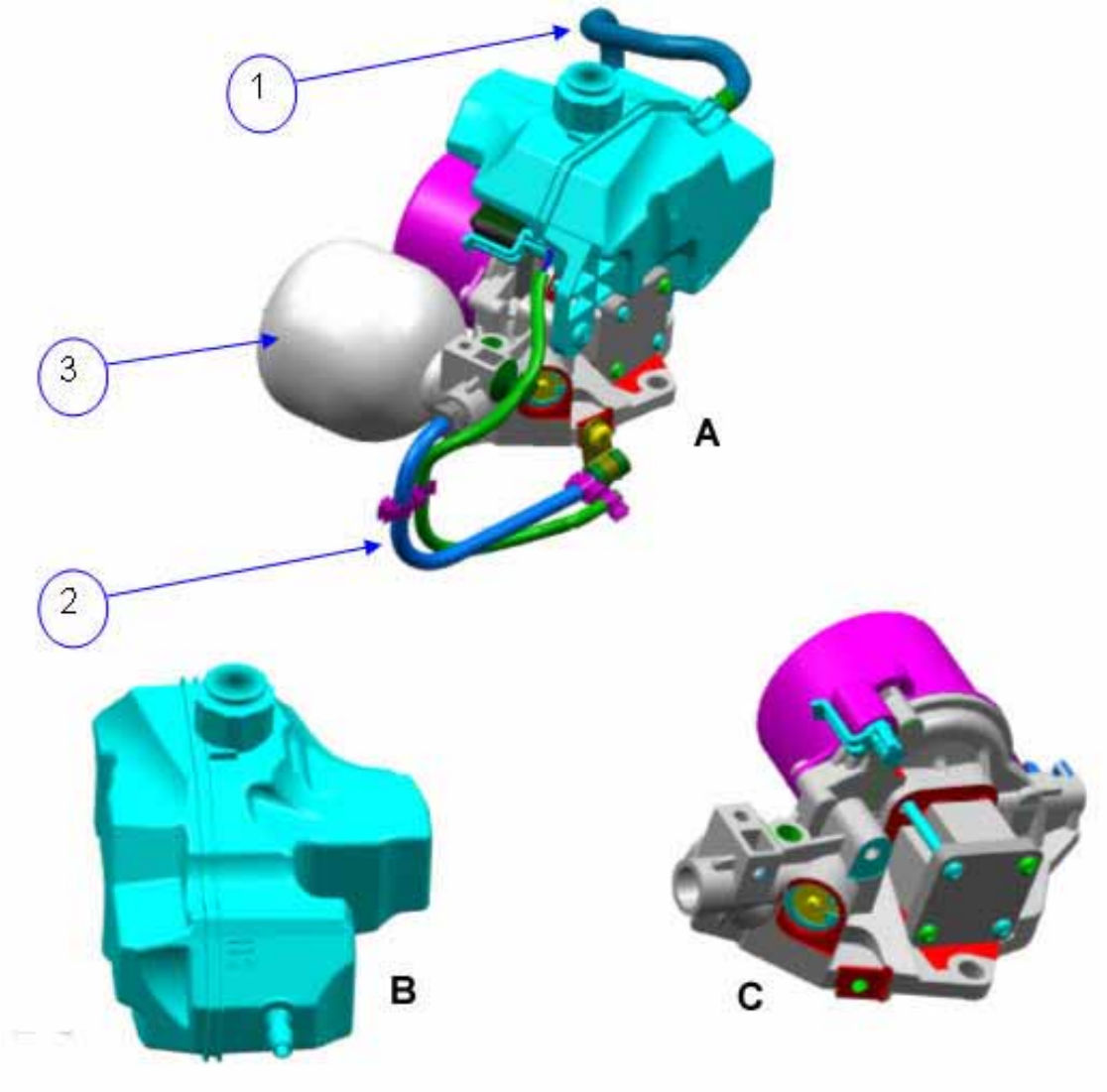
The electrohydraulic kit is a single unit made up of three main parts:

- the power unit made up of a electric pump, accumulator and hydraulic tank (1);
- the solenoid valve unit that converts hydraulic energy into mechanical energy by means of the interface between the engaging pistons and the drive shaft (2);
- the mechanical gear control unit that interfaces directly with the gearbox by means of the opening on the box itself (3).



Power unit

The power unit supplies hydraulic energy for driving both the engagement and selection of gears and the clutch cylinder; it is made up of an electric pump (C) and an oil tank (B); there is also a semi-rigid high-pressure tube that connects the accumulator to the solenoid valve unit and a flexible low-pressure tube made of preformed rubber, which connects the valve unit to the tank.



A. Power unit
B. Oil tank
C. Assembly drawing of high pressure oil pump motor
1. Low pressure oil return tube
2. High pressure oil tube
3. Accumulator

The system works with a line pressure ranging from **36.5 to 46 bars** under normal conditions. In Recovery mode, the system will perform to its best at a pressure of 75 bars.
The electric pump is turned on when the pressure drops below 36.5 bars and off when the pressure in the circuit reaches 46 bars.

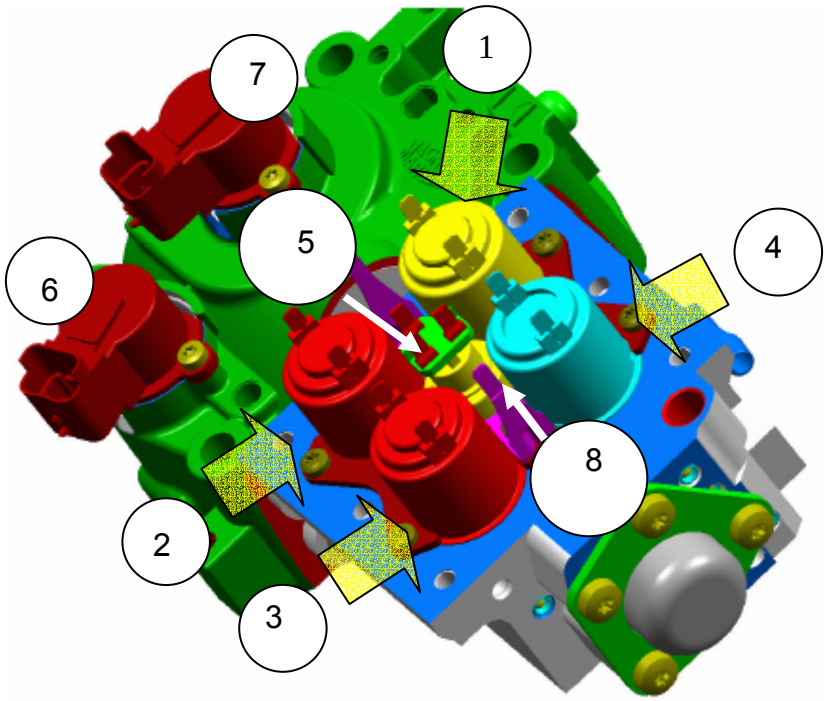
Technical features:

- Line pressure of between 36.5 and 46 bars
- Working temperature of between -30° C and + 105 ° C
- Starting possible down to a temperature of -30° C
- The capacity of the pump is >0.81 l/min at 45 bars, 3,450 rpm and oil at 60 °C
- The volume of the accumulator is 250 cm^3, preloaded to 24 bars at 20 °C

Solenoid valve unit

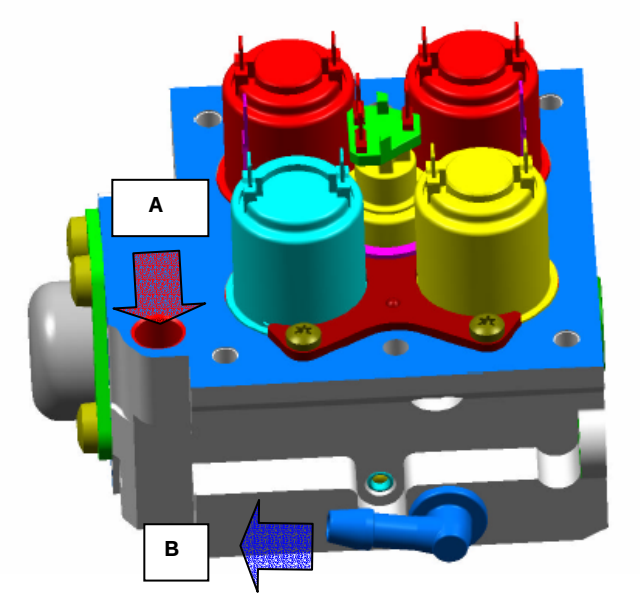
This system performs the following functions:

- Controls and manages the position of the clutch.
- Controls and manages the selection and engagement of gears.



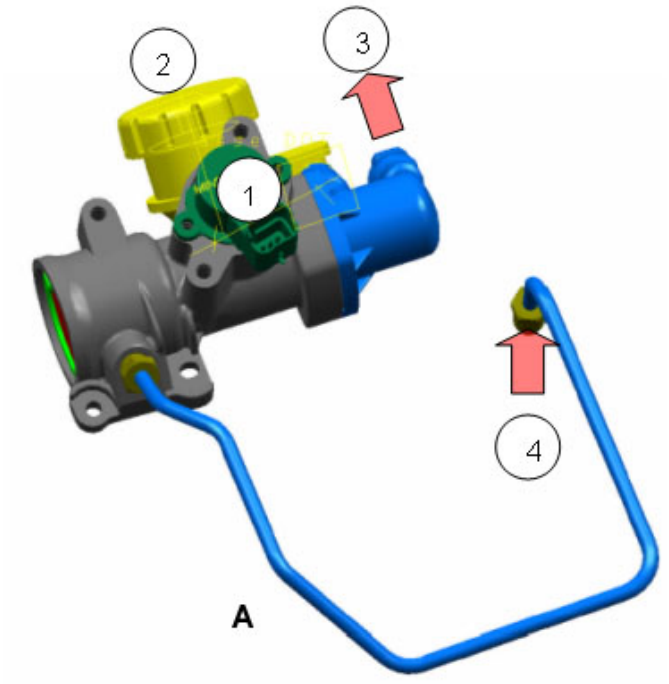
The components used to activate these control functions are:

1. Proportional flow valve for controlling the clutch **(EV0)**
2. Proportional pressure valve for engaging even gears (R - 2 - 4 - 6) **(EV2)**
3. Proportional pressure valve for engaging odd gears (1 - 3 - 5). **(EV1)**
4. On-Off valve for selecting the range **(EV3)**
5. Line pressure sensor (0-70 bars)
6. Hall effect sensor for the engagement position
7. Hall effect sensor for the selection position.
8. Earth points for AMT electronic control unit



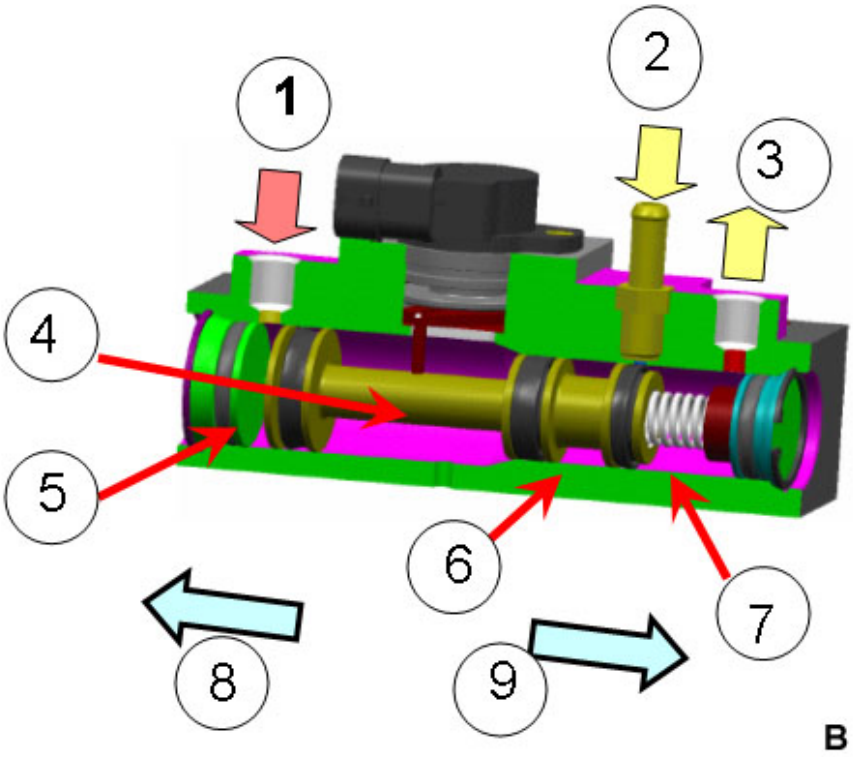
A. Power unit
B. Return to tank

Clutch actuator



1. Clutch position potentiometer
2. DOT4 oil tank
3. Oil outlet for the clutch actuator (CSC inside the gearbox bell housing)
4. Inlet for oil from the solenoid valve unit

The Master-Slave system (fig. A and fig.B) is made up of a cylinder inside which runs a piston that forms three chambers: the first chamber receives the pressurized oil from the hydraulic unit via the solenoid valve EV0; the second and third chambers let the DOT4 oil through and, according to the thrust received by the oil in the first chamber, pressure is applied to the CSC clutch actuator. The advantage of using this solution lies in the fact that the same CSC assembled on the gearbox in the manual version may be used.



B

1. Inlet/outlet of oil from EV0
2. In $_{DOT4}$
3. Out $_{DOT4}$ (to CSC)
4. Piston
5. Chamber 1
6. Chamber 2
7. Chamber 3
8. Clutch closed
9. Clutch open

Operation:

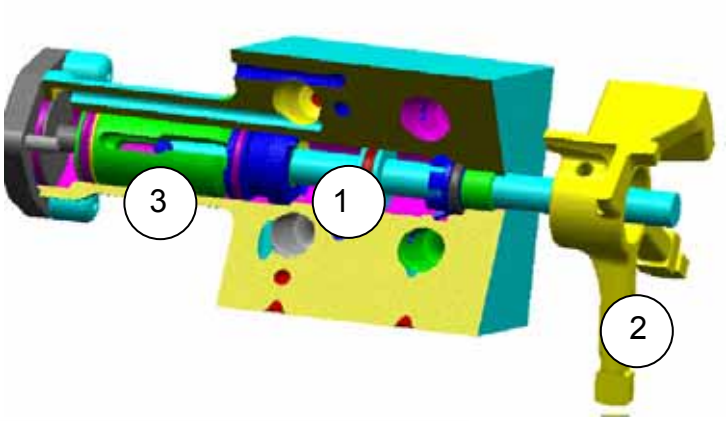
- at rest (with no pressure from EV0 in Chamber 1), IN_{DOT4} and OUT_{DOT4} are directly linked in chamber 3 (7), so chamber 3 fills up with DOT4 oil.

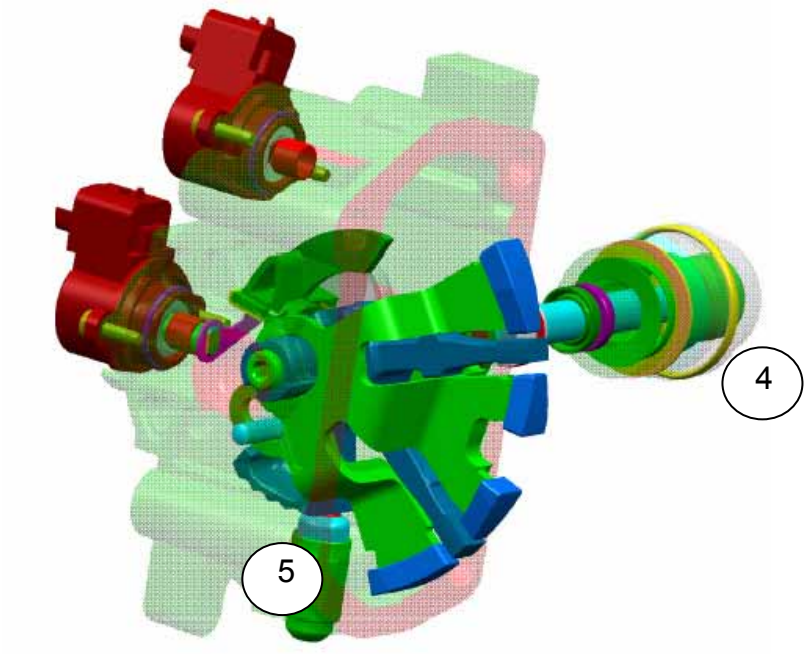
- with oil pressure > 0 bar from EV0 in Chamber 1, the piston moves towards the right: IN_{DOT4} passes into chamber 2 and OUT_{DOT4} into chamber 3; no more oil enters from IN_{DOT4}, while from OUT_{DOT4} there is sufficient thrust to shift the CSC of the clutch. The movement of the clutch is therefore proportional to the movement of the piston inside the cylinder. Everything is handled directly by the AMT control unit via the solenoid valve EV0.

Mechanical unit (gear selector)

The gear selector is used to choose the most suitable gear and thus handles both gear engagement and selection; it is made up as follows:

1. Control shaft
2. Gear control needle
3. "S"-shaped cam
4. Latch
5. Selection centring sphere





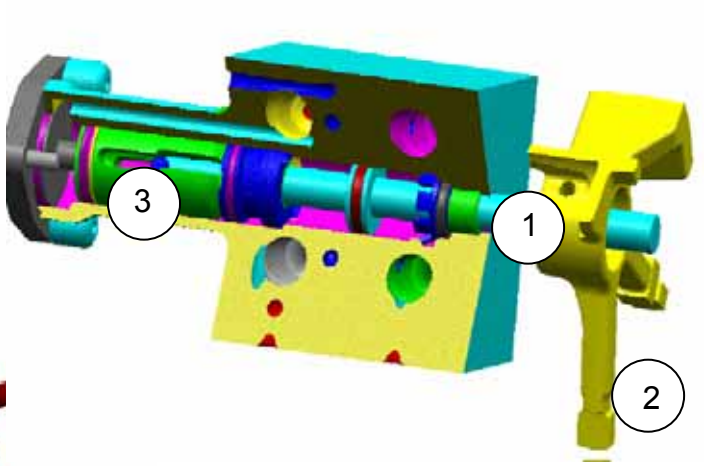
The selector consists of a control shaft (1) which includes a dual selecting needle (2). The latter is capable of selecting gears in the same range and in different ranges. The device called the latch (4) only performs a rotary movement, which is what is required to change selection from a lower range to a higher one and vice versa: the drum with the double "S" slot (3), under the thrust of the oil, provides a rotation resulting from a longitudinal movement of the selecting needle. This forces the needle to change the range of gear selection.

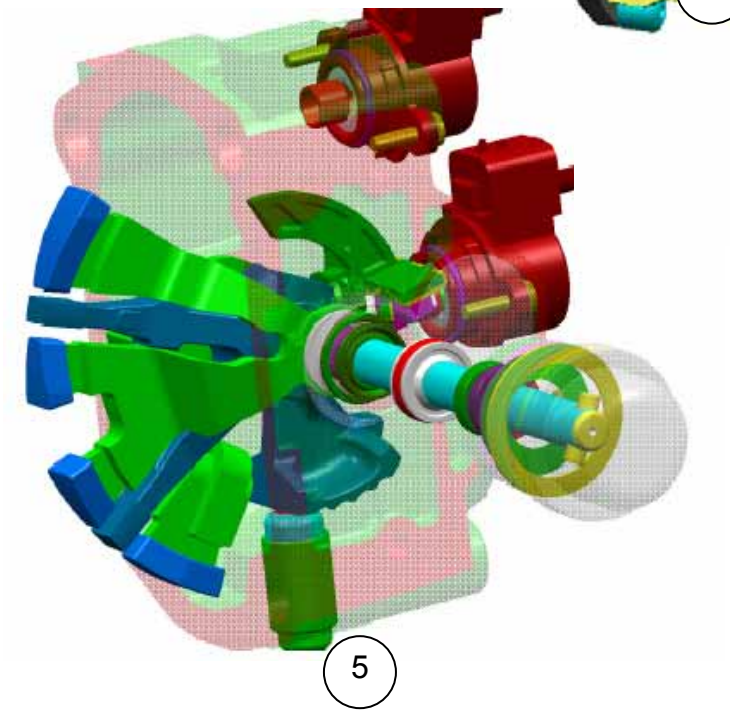
This operating principle is based on the conversion of the linear motion of the hydraulic piston, into longitudinal and rotational movements of the shaft and thus of the parts connected to it.

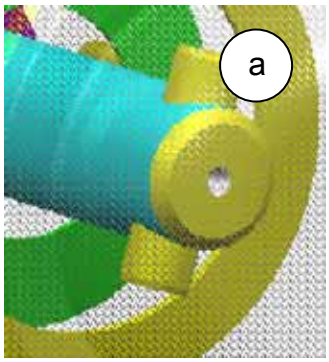
How the gear selector works

The longitudinal movement of the shaft (which corresponds to the gear change within the same range) is activated in two simple steps:

- When EV1 or EV2 is activated, the hydraulic piston moves straight in a single direction
- EV1 engages odd gears (1-3-5) and EV2 engages even gears (R-2-4-6).





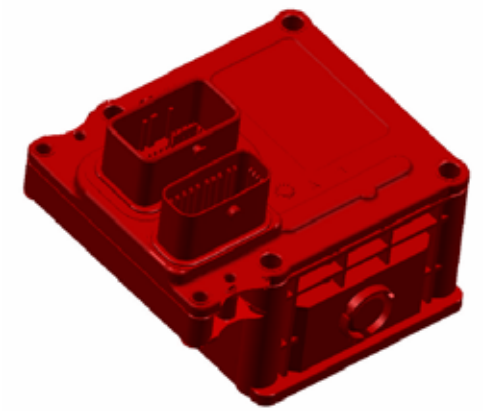


The motion used to change from one row of gears to another is activated in three steps:

- the hydraulic brake is activated (pressure is applied to EV3 and the drum is blocked);
- When either of the chambers created by the piston in the hydraulic cylinder is subjected to pressure and moves with linear motion, the Key (a) follows the "S"-shaped profile of the drum: in this way, the shaft and the selecting needle (2) is forced to perform a "longitudinal-rotational-longitudinal" movement, which enables both a gear engagement and a gear branch selection to be changed.
- The row is kept in the right position by a centring sphere (5) which acts on a surface with 4 preshaped channels that correspond to the 4 gear branches.

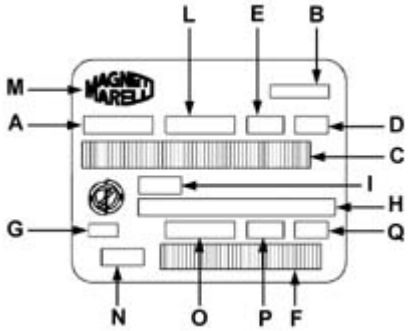
Electronic control unit

The control unit of the system is assembly directly on the solenoid valve unit of the gearbox; the engine cable is connected to the control unit by means of a connector.



On the control unit there is a label bearing its identification data: spare part number, software version, software calibration.

A complete view of the identification label is shown below:



A. Manufacturer's drawing number
B. Date
C. Bar code with manufacturer's information
D. Working voltage
E. Type of EPROM assembled (E = welded, Z = Socket base, M = Masked, F = Flash)
F. Marelli code on bar code
G. Supplier's code
H. Name of application
I. Software version and calibration
L. Supplier's registration number
M. Manufacturer's logo
N. Type approval code
O. Marelli code
P. Production block
Q. Year of production

Technical Characteristics

Type: CFC300F01
Connector: 28-pin

Working ambient temperature:

- -40°C to +110° C (operating)

Working voltage:

- Minimum working voltage, V_{BAT}_min: 6.0 V
- Maximum working voltage, VBAT_max: 16.0 V
- Rated working voltage, VBAT_typ: 12.0 V
- Rated voltage test, VBAT_test: 13,5 V +/- 0,2 V
- Overvoltage range 26.0 V < V_{BAT}_ovld < 40.0 V

Communication network:

- C- CAN (500 kbytes/sec)

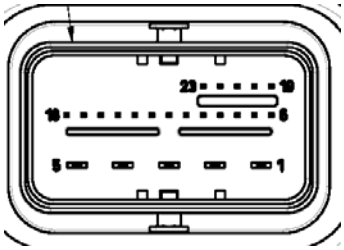
Special hardware functions:

- Power latch relay (internal)
- TCU – "woken up" by the driver's door opening switch.

Pin out of control unit

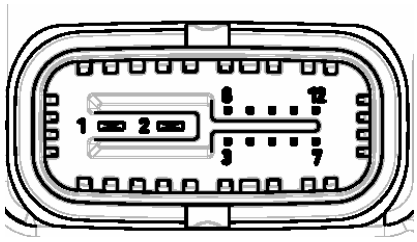
1. Vehicle connector
2. System connector

VEHICLE CONNECTOR:



PIN	DESCRIPTION
1	n.c.
2	Driver's door switch signal
3	Vbat for TCU
4	Reverse light output signal
5	Vbat for pressure pump
6	n.c.
7	Position 3 of selecting lever
8	n.c.
9	Brake pedal signal
10	TCU activation signal (key-on: +15)
11	Position 2 of selecting lever
12	Position 1 of selecting lever
13	Earth of selecting lever
14	n.c.
15	n.c.
16	Position 4 of selecting lever
17	ECO switch
18	n.c.
19	CAN L (high speed)
20	CAN L (high speed)
21	n.c.
22	CAN H (high speed)
23	CAN H (high speed)
24	n.c.
25	n.c.
26	n.c.
27	n.c.
28	n.c.

SYSTEM CONNECTOR:



PIN	DESCRIPTION
1	Pump motor control
2	n.c.
3	Gearbox speed sensor (-)
4	Power supply for engagement sensor and selection sensor (+5V)
5	Engagement position signal
6	Engagement, selection and position sensor earth reference
7	n.c.
8	Gearbox speed sensor (+)
9	Power supply for clutch position sensor (+5V)
10	Clutch position signal
11	Clutch earth reference
12	Selection position signal

Input signals

For logical operations, the system must use the following incoming signals from other systems of the vehicle:

- Specific sensors of the automated gearbox
- Clutch revolution sensor (the value is read from the primary shaft of the gearbox)
- Position sensor for: clutch, engagement and selection.
- Single signals coming from other vehicle systems
- Number of engine revolutions (incoming signal from the engine control unit via the C-CAN network).
- Brake pedal switch (two signals: one separate - pin 9 of vehicle connector, the other via the C-CAN network).
- Driver's door opening switch (separate).
- Key-on (stable position and separate starting)

Signals coming from other systems via the CAN network are:

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

Output signals

The reverse light activating signal is no longer managed by a switch set on the gearbox, but is activated directly by the AMT control unit on pin 4 of the vehicle connector.

User interface

The user interfaces with the system using the following controls:

- Accelerator pedal via CAN from the engine control node.

- Brake pedal through two signals: one separate and the other via C-CAN.

- Request for a gear change or mode selection using a specially designed multi-stable electromechanical lever with three stable positions **(NEUTRAL, REVERSE and TIP)** and three unstable positions **(UP, DOWN, AUTOMATIC/MANUAL)** by means of 4 signals that convert the electrical signals of the 10 Hall-effect sensors located inside the lever itself (the signals must be read by the control unit as analogue inputs for safety reasons).

- "ECO" mode (the signal is given by a switch connected directly to the AMT control unit)

Through the multi-function display, the system provides the driver with the following indications:

- Display of gear engaged (via CAN)
- Selection of "AUTO'" mode (via CAN).
- Current mode: "ECO" (through the display of the letter **"E"** on the display.
- System faults (through a dedicated LED being lit via the CAN).
- Audible signal from the buzzer of the instrument panel: connected via the CAN, it warns the driver that there is a critical problem on the vehicle/system

NB.: while operating in AUTO mode, the display shows the current gear.

3. OPERATING LOGIC

3.1 SYSTEM OPERATION

Pressurization of the hydraulic circuit

When the pressure drops below the minimum working threshold, the hydraulic circuit is pressurized in two different ways:

- When the door on the driver's side is opened, the system automatically applies pressure to the hydraulic system to allow a gear to be changed without having to wait for the hydraulic circuit to be filled (timing of fixed pump activation)

- With the key set to start: the system control unit is powered (and will be so until the power key is set to OFF and the engine and vehicle speeds drop to zero).

The electric pump of the system is also powered to apply pressure to the unit when the pressure reaches the minimum value (**about 36.5 bars**).

When the driver turns the starter key to the unstable "cranking" position, the AMT control unit:

- If the gearbox is set to "N", allows the engine to be started.

- If the gearbox is not in "N", only allows the engine to be started if the brake pedal is pressed.

Turning on/starting the vehicle

This is done by turning the starter key: the engine is started by activating the starter switch directly from the engine control unit, once the AMT control unit has given its consent.

There is an emergency starting system: if the battery cannot start the engine but the system is correctly pressurized, the vehicle can be pushed (with the clutch released) and when a sufficient speed is reached the gear selecting lever is used to engage a gear; the system engages the gear best suited to the speed of the vehicle so as to start the engine (the driver must make sure the vehicle is moving quickly enough to start the engine when he requests to engage a gear).

Operation with the engine off

For safety reasons, any request to change gear from the lever (including neutral) is only accepted if the driver keeps the brake pedal pressed .
All available gears may be engaged with the engine off and the electric devices running.

Pick-up

The gears that may be engaged with the engine started and the vehicle at a standstill for the pick-up phase are:

- 1st, 2nd and Reverse; these gears under these conditions may only be requested by moving the lever.

To engage the gear, for safety reasons, the driver must keep the brake pedal pressed. To engage Reverse gear, in addition to the conditions indicated above, the vehicle must also be at a standstill (gearbox input revolutions detected = 0).
The vehicle pick-up only occurs if the driver presses the accelerator pedal (with the brake pedal released); at this point, the system gradually engages the clutch to set the vehicle in motion. The

driver can adjust the torque transmitted by the clutch by modulating the position of the accelerator pedal; when the accelerator is released, the clutch must be gradually released when the minimum threshold of engine revolutions is reached. When the system detects that the engine revolutions are synchronized with the clutch revolutions, it engages the clutch completely (package closure). For each of the three gears in which the pick-up may be executed, a special clutch engagement map is implemented. During the pick-up phase, the driver may only request a gear change when the number of clutch revolutions corresponds to the number of engine revolutions (that is, the vehicle is at the end of the pick-up phase); during this manoeuvre, the system will satisfy the request.

Automatic engagement of the clutch downhill with the accelerator pedal released

If the vehicle with a gear engaged, the accelerator pedal released and the engine started gains speed as it is going downhill, having reached a preset speed, it automatically engages the clutch to slow the vehicle's engine down. If, during this phase, the driver presses the accelerator pedal, the control of the torque transmitted by the clutch returns under the driver's direct control. This automatic engagement of the clutch is interrupted if the vehicle is moving in the opposite direction to the gear engaged.

Slowing down the vehicle

When slowing down, for example, with a gear engaged and accelerator pedal released, the system automatically disengages the clutch so that the engine does not stall when it approaches its minimum revolution level. The gear is disengaged in this way at an engine speed that depends on the level of deceleration and the controls operated by the driver (whether the brake is pressed or not). During the slowing down phase, if the gear engaged is higher than 2nd, the vehicles moves down through the gears. When the vehicle stops, the 1st gear is engaged automatically.

Changing gear with the lever (semiautomatic operating mode)

With the vehicle moving and the clutch fully engaged, an UP or Down shift request made by the driver using the gear control lever causes a gear change. The requests will only be accepted by the system if they are compatible with the engine's minimum and maximum revolution limits. The activation of the lever normally moves up or down one gear only, but, under some operating conditions, the gear shift may be more than one if requested by the driver by pushing it quickly twice. The gear change requested by the driver without releasing the accelerator pedal to move "up" a gear, once accepted by the system, will be executed in an automatic sequence of phases that will depend on the driver's behaviour:

- the engine torque is reduced by means of a command sent by the system to the engine control and the clutch is released at the same time.

- The clutch is released, the new gear is selected and engaged and, at the same time as the gear change, the engine is controlled in such a way that the engine reaches the same number of revolutions as the clutch will have after the new gear has been engaged.

- The clutch is regulated and a gradual return is made to the maximum torque that can be supplied by the engine at the new level of revolutions. When the system detects that the engine revolutions are synchronized with those of the clutch, it releases it completely.

The three steps described above are managed as a function of:

- Estimated performance requested by the driver
- Estimate of the transmission temperature

A gear change in progress made can be interrupted at any time by another request from the driver providing it is an acceptable request (that is, compatible with the minimum and maximum engine revolution limits).
The actuator control sequences during the change of gear have timeouts; that is, if the gear

change is not made successfully, it is repeated once starting from neutral, and then the next gear up from the one requested is engaged.

Changing gear in automatic mode ("auto" mode)

The automated gearbox has an automatic operating mode very similar to that present on conventional automatic gearboxes. The choice of the gear to be engaged is made on the basis of two maps that correlate the position of the accelerator pedal with the vehicle speed. The reason why there are two maps is that in AUTOMATIC mode, the driver can select (by pressing a button on the dashboard) management of two modes defined initially as ECO (energy-saving) and NORMAL for sportier driving. If the accelerator pedal is released, under certain conditions, the system does not increase the gear so that the engine slows down. Gear changes are made in exactly the same way as in semiautomatic operating mode using the lever and the same control parameters for the gearbox and engine actuators are used. Automatic mode is selected by setting the lever unstably into a specific position and is deselected by repeating this operation.
N.B.: if the lever is faulty, the system switches to AUTOMATIC mode.

Request to put the gearbox in neutral

This request has priority over all other gear change requests and is made using the lever only. With the engine off, as mentioned previously, the brake pedal must be kept pressed. With the vehicle in motion, this request to enter neutral is always accepted.

Turning the engine and the system off

By turning the key of the vehicle to the OFF position, the engine is turned off and the system maintains the gear engaged. The system is not deactivated until it detects the engine, gearbox and vehicle speeds as zero and has saved the functional and diagnostic data to the stable memory of the control unit (EEprom). The system is turned off at most 5 [s] after the vehicle was stopped and the engine was turned off. If the starter key is turned to the OFF position when the gearbox is in neutral, the system warns the driver by means of an audible signal emitted by the buzzer in the instrument panel.
Information for the driver (display and buzzer)
The system informs the driver by means of a:

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

A couple of examples of incorrect use are listed here below:

- pick-up with overheated clutch.
- If the system is turned off with the gearbox in neutral, the buzzer must signal the risk of leaving the vehicle off without a gear engaged.

3.2 SELF-ADJUSTMENTS

The self-adjustments reset the system so that it ensures correct operation, and are as follows:

- *Clutch bleeding*
- *Accumulator depressurizing*
- *Clutch self-adjustment*
- *End of line/service self-adjustment*
- *New actuators*
- *Clutch wear index calculation*
- *Statistical data deletion*
- *Control unit rewriting*

Clutch bleeding

The procedure should always be carried out following the guidelines listed here below:

When it has to be performed:

- when filling after completely emptying to repair the hydraulic KIT.
- having repaired the hydraulic KIT after replacing hydraulic components (valves, pump, pressure sensor, delivery tube …)
- during general servicing of hydraulic KIT

Why it has to be performed:

- The aim of this routine is to eliminate any air present in the hydraulic circuit after replacing the components listed above, by executing 15 clutch opening / closing cycles with the oil pump running.

Equipment required:

- Examiner SMART/Plus

NOTES:

The procedure takes about 1 min..
The Power latch phase lasts about 15 s.
Having activated the procedure, you will hear when the clutch solenoid valve and the selespeed pump are activated.

The procedure is to be carried out under the following conditions:

- engine off
- brake pedal pressed
- key set to start
- clutch position sensor OK
- clutch actuator OK

If any of these conditions are not respected, the procedure will end without any error code.

Accumulator depressurizing

The procedure should always be carried out following the guidelines listed here below:

When it is to be performed:

- Before repairing the KIT to replace hydraulic components (valves, pressure sensor, delivery tube …)

Why it has to be performed:

- The aim of the routine is to empty the hydraulic circuit by conveying the oil towards the tank of the KIT to enable the components indicated above to be replaced, by executing 15 clutch opening / closing cycles with the oil pump deactivated. This entails eliminating the pressure inside the hydraulic unit.
- To check the oil level

Equipment required:

- Examiner SMART/Plus

NOTES:

The procedure takes about 1 min..
The Power latch phase lasts for about 15 s.
When the procedure is started, you will hear the clutch solenoid valve being activated.
Check (by reading the parameter with Examiner) that the pressure in the hydraulic circuit has dropped below the accumulator preloading threshold (about 2-3 Bars).
The procedure should always be carried out under the following conditions:

- engine off
- brake pedal pressed
- key set to start
- clutch position sensor OK
- clutch actuator ok

If any of the previous conditions are not respected, the self-adjustment will be aborted and an error message will be displayed on examiner.

Clutch self-adjustment

The procedure should always be carried out following the guidelines shown here below:

When it should be performed:

- When the vehicle reaches the end of the line
- after replacing the AMT control unit
- after replacing/removing the gearbox
- after replacing/removing the KIT (detachment)
- after replacing the clutch

Why it should be performed:

- The purpose of the routine is to quickly recalculate the "Kiss point", i.e. the position at which the clutch starts to transmit engine torque.

Equipment required:

- Examiner SMART/Plus

NOTES:
The procedure takes about 1 min..
The Power latch phase lasts for about 15 s.
The procedure should be performed before starting the engine, with the key set to ON and the gearbox in neutral. Then the engine can be started.
A time of 10 s should pass between one activation cycle and the next. The activation cycles should be executed in the same driving cycle.
The procedure should always be carried out under the following conditions:

- key set to start
- no request for gear change
- clutch position sensor OK
- engagement actuators OK
- power supply for sensors/actuators/ECU OK

If any of these conditions are not respected, the procedure ends (self-adjustment KO) with an error message.

End of the line-service

The procedure should always be carried out following the guidelines here below:

When it should be performed:

- At end of line (where necessary)
- After replacing the gearbox
- After replacing/removing the KIT
- After replacing any selection or engagement potentiometer
- After replacing the control unit

Why it should be performed:

- The purpose of the routine is to save the thresholds of the gear change grid.

Equipment required:

- Examiner SMART/Plus

NOTES:
The procedure takes about 5 minutes
The procedure should be requested with the engine OFF and the key set to ON.
The hydraulic pressure should be above the gear change acceptability threshold (36.5÷46 bars)
The battery voltage should be within the preset limits (vehicle operating range)

To save the values to the control unit, turn the Key to OFF and terminate the "power-latch"; the power-latch phase takes about 15 s.

The procedure entails activating the following functions automatically:

- Fast self-adjustment of closed clutch position
- Clutch stroke test.
- Clutch bleeding
- Self-adjustment of clutch valve current.
- Self-adjustment of grid

If the procedure is not completed successfully, one of the codes indicated in the table below will be shown, to indicate the actual causes of the fault (the corresponding error is indicated in the control unit diagnostics):

Description of self-adjustment error codes:

Value Hex	Comment
00	Self-adjustment not yet performed
01	Plausibility error in selecting F/Reverse
02	Plausibility error in selecting 1st-2nd
03	Plausibility error in selecting 3rd-4th
04	Plausibility error in selecting 5th
05	Plausibility error in selecting NEUTRAL
06	Plausibility error in engaging 1st
07	Plausibility error in engaging 2nd
08	Plausibility error in engaging 3rd
09	Plausibility error in engaging 4th
0A	Plausibility error in engaging 5th
0B	Plausibility error in engaging 6th
0C	Plausibility error in engaging Reverse
0D	Manoeuvre aborted due to invalid general conditions
0E	Insufficient clutch stroke
0F	Self-adjustment OK

The procedure should always be carried out under the following conditions:
- battery voltage within specified range
- key set to start
- hydraulic pressure above threshold

If any of the previous conditions are not respected, the procedure ends with a self-adjustment KO and its error.

The procedure may also be aborted for the following reasons:
- error on engagement, selection and clutch sensors
- error on engagement, selection and clutch actuators
- error on actuator drivers
- error on sensor/actuator/ECU power supply

New actuators

The procedure should be carried out following the guidelines indicated here below:

When it should be performed:

- After replacing the hydraulic KIT
- After replacing the clutch, selection and/or engagement solenoid valve

Why it should be performed:

- The purpose of the routine is to force the solenoid valve losses to the values of new solenoid valves.

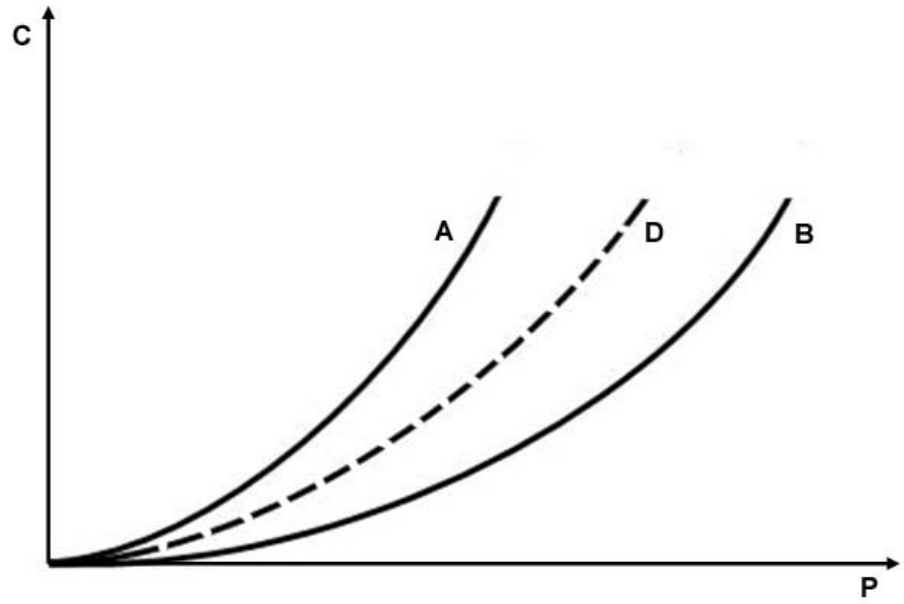
Equipment required:

- Examiner SMART/Plus

NOTES:
The procedure takes about 5s.
The Power latch lasts for about 15 s.
The procedure should be activated with the engine OFF and the key set to ON.
To save the values to the ECU, the key should be removed and the power latch terminated.

Calculation of the clutch wear index

This procedure enables the AMT gearbox control unit to calculate the clutch wear index with the aid of the engine control unit which saturates the desired percentage of the accelerator pedal via SW and provides the corresponding engine torque.
The clutch wear index calculating procedure is required by the AMT control unit in that it saves the characteristic values for each specific clutch in Eeprom, taking into consideration the normal wear of the clutch in time.



C: TORQUE TRANSMITTED
P: POSITION OF CLUTCH
A: NEW CLUTCH
B: WORN CLUTCH
D: WORKING CURVE

Equipment required:

- Examiner SMART/Plus

NOTES:
Procedure:

1. ***Delete the statistics***
2. Repeat the kiss point self-learning procedure as described in ***clutch self-adjustment***
3. Perform the ***end of line/service self-adjustment***
4. The clutch wear index will then be self-learnt automatically using the procedure followed at the factory.

The new procedure is used to reset the clutch parameters selectively and thus facilitates a more precise learning procedure.

N.B.: in view of the availability of this new procedure, the old clutch wear index calculation should simply be considered as a back up method.

Deleting the statistics

The procedure should be performed following the guidelines indicated here below:

When it is to be performed:

- When replacing the clutch assembly
- When replacing the kit
- When replacing the gearbox
- When replacing the lever
- When replacing the levers on the steering wheel
- When replacing the pump
- When replacing the accumulator only
- When replacing the pump relay
- When replacing the auto key (to be used when replacing the AUTO switch only)
- When replacing the sport key
- When resetting the statistics

Why it should be performed:

The system will continue to work even if this procedure is not carried out.
The following counters describe the history of each individual component, so when one of the components listed above is replaced, the data set associated with it must be reset or restored to their default values The information provided by these counters also enables the number of manoeuvres and faulty conditions the system found itself in when an error was validated to be identified.

Equipment required:

- Examiner SMART/Plus

Rewriting the control unit

The procedure should be carried out following the guidelines indicated here below:

When it should be performed:

The procedure should only be carried out after replacing the TCU.

Why it should be performed:

The system will continue to work even if this procedure is not carried out.
The following procedure enables the history of the system (gearbox and kit) to be traced by transferring the data from one TCU to another.
This operation may be performed if the devices required to perform it are working; in other words, if the TCU to be replaced does not allow the data to be read, the procedure will not be carried out successfully. As mentioned previously, the system will however continue to work.
If the TCU and any other component subjected to the data set deleting procedure are replaced at the same time, the values of the statistical data should be written down before deleting the dataset of the component to be replaced.

Equipment required:

- Examiner SMART/Plus

4. FUNCTIONAL INTERACTION WITH OTHER SYSTEMS

4.1 INTERACTION WITH ENGINE CONTROL

During motion, the two systems do not interact because the system does not perform any function, so there is only an exchange of information and signals over the network.
When a gear change is in progress, the system is the "master" of the engine control, that is, the gearbox control system instructs the engine (via the CAN) as to what engine torque should be applied (decrease while the clutch is being released and increase when the gear change has been completed and the clutch is being engaged); in addition, the engine revolutions are adapted to the gearbox revolutions so as to reduce the stress applied to the clutch to a minimum.

4.2 INTERACTION WITH CRUISE CONTROL

CC is a system that is not influenced by the presence of the AMT system, but can only be deactivated in MANUAL mode and not in AUTO mode.

4.3 INTERACTION WITH ABS

The system has no functional logic for interaction with the ABS.

4.4 INTERACTION WITH ESP-ASR-MSR

When the ASR is active, the system inhibits the "SPRINT" start.
During the activation of the ASR or the ESP, the system inhibits the "AUTO UP SHIFT" manoeuvre.

5. SAFETY DEVICES AND FUNCTIONS IN CASE OF A BREAKDOWN

Strategies that handle incorrect manoeuvres prevent potentially dangerous operating conditions for the transmission/vehicle

5.1 INCORRECT MANOEUVRES

- Engagement of reverse gear: not accepted with the vehicle in motion (over 3.5 km/h).
- Gear change with vehicle in motion and clutch engaged: the driver's request is not accepted if it may generate an excessively high or low number of engine revolutions.
- Gear change with the vehicle at a standstill and with the engine started: only the gears "enabled for pick-up" (1st, 2nd and Reverse) are accepted
- Engine turned off using key with vehicle in motion: the system should handle the gearbox until all the speeds monitored (engine, gearbox input and output) are zero.
- Engine starting: disabled if a gear is engaged and the brake pedal is not pressed.
- Engine starting with gear engaged: this can only be done when the vehicle is at a standstill, with the accelerator pedal released, brake pedal pressed and no faults.
- The system should put the gearbox in neutral first and then allow the engine to be started.
- With the vehicle at a standstill (or almost), gear change requests are only enabled if the brake pedal is pressed.
  This prevents dangerous situations caused by the gear lever being shifted by passengers in the vehicle or persons from outside the vehicle (e.g. through the window!) or accidentally by the driver himself when the vehicle is parked on a slope.
  It eliminates the risks of incorrect manoeuvres by the driver under critical conditions (e.g. downhill) or by the passengers.

The gearbox is put automatically in neutral and an audible warning is emitted for the driver:

- When the oil pressure is not sufficient to manage the clutch.
- If the driver opens the door to get out of the vehicle with the engine running (the pick-up with the door open is allowed in that the driver's foot on the brake or accelerator is detected), the gearbox is put into neutral 1,5 s after the door is opened.
- When the driver does not accelerate or brake for at least 3 minutes with the engine running, gear engaged and vehicle stationary
- With the engine running, gear engaged and accelerator released and brake pedal pressed for at least 10 minutes.

If faults that reduce the System's Safety Level take place, the vehicle's functions are limited (e.g.: limitation of gears to 1st,2nd, Reverse when there is a fault in the revolutions or the engaged gear detecting sensors).

5.2 AUDIOVISUAL INFORMATION FOR THE DRIVER

The information will concern:

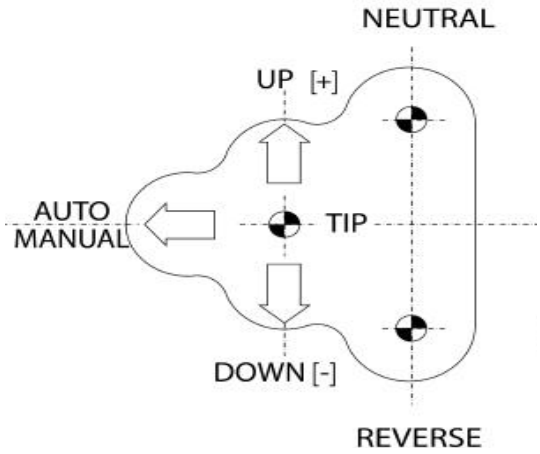
- The functional status of the drive/vehicle system (gear display, fault LED, buzzer)
- A "gear change completed" message following requests made by the driver (only when the vehicle is almost stationary: while the vehicle is being parked);
- A continuous audiovisual signal from the buzzer and the fault LED (associated with the specific message), when a system fault that reduces the safety level is detected;
- A indication on the display informing the driver of the gear engaged;
- A warning when the engine is turned off by the driver (key off) with the "gearbox in neutral " (when the vehicle could move on its own); when this happens, the audiovisual signal (the letter "N" blinking on the display) will last for at least 4 s;
- An audiovisual signal (display) to indicate that the system has automatically put the gearbox in neutral;
- A clutch overheated signal (only during pick-up); a specific warning appears on the reprogrammable multifunction display and an audible signal is emitted by the buzzer;
- The audiovisual signal (display) when, after a "failed" engine starting manoeuvre, the gearbox is put in neutral.

NOTE: A request for a gear change cannot always be accepted by the system (e.g. with brake pedal released or a request to enter Reverse with the vehicle travelling at more than 3.5 km/h, etc).

6. MULTISTABLE LEVER

6.1 DESCRIPTION

The gear selecting lever of the automated gearbox system is of the multistable type, that is, it has three stable and three unstable positions. With reference to the drawing below, the three stable positions are NEUTRAL (N) REVERSE (R) and TIP [located between the unstable positions UP (+) and DOWN (-)].
The unstable positions, which are positions that are left by the lever as soon as the pressure applied to it is released, are, as mentioned previously, the positions for shifting up a gear [UP (+)], down a gear [DOWN(-)] and entering automatic mode (A/M); the gearbox is returned to manual mode by setting the lever to the A/M position again.



6.2 SYSTEM BEHAVIOUR WITH THE VEHICLE STATIONARY AND THE ENGINE OFF

Opening the door

When the door is opened with the vehicle stationary, the instruments panel is turned on and the vehicle information is displayed: the gear engaged is not however displayed. The hydraulic pump of the AMT assembly is activated to apply pressure to the circuit and enable the system to be operational when the driver starts the vehicle.

Behaviour before the key is turned on

With the Key Off (vehicle stationary with the key-controlled electric devices disabled), the gear lever may be moved with or without the brake pedal pressed. The system will not engage any gear when the lever is moved, so the gear engaged before the lever was moved, with the engine running or with the key set to +15, will remain the same.

6.3 KEY ON (+15)

With the vehicle stationary and the key in the on position (key-controlled electric devices enabled), the instrument panel shows the gear engaged, the indication of the operating mode (automatic = AUTO or manual = NO INDICATION ON DISPLAY) and the logic (economy = E or normal = NO INDICATION ON DISPLAY): the letter "E" is only displayed in "Automatic" mode.
All gears may be engaged using the lever ***with the brake pedal pressed***.
When the lever is moved ***without the brake pedal pressed***, the system will not make some gear of the changes requested.
The following situations may arise ***when the lever is moved without the brake pedal pressed:***

when the vehicle is in the gear indicated in the "gear engaged" column (and the display shows the corresponding gear), and the gear lever is shifted, **without pressing the brake pedal,** to the position shown in the "final position of lever" column; the request will be denied and the warnings indicated in the table below will be displayed for the driver.

GEAR ENGAGED	DISPLAY INDICATION	FINAL POSITION OF LEVER	WARNING ON PANEL	AUDIBLE SIGNAL	Yellow LED (GENERAL FAULT)
NEUTRAL	[N]	TIP	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NO	NO
REVERSE	[R]	TIP	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NO	NO
REVERSE	[R]	NEUTRAL	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NO	NO
1st 2nd 3rd 4th 5th 6th	[1] [2] [3] [4] [5] [6]	NEUTRAL	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NO	NO
NEUTRAL	[N]	REVERSE	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NO	NO
1st 2nd 3rd 4th 5th 6th	[1] [2] [3] [4] [5] [6]	REVERSE	PRESS BRAKE PEDAL AND REPEAT MANOEUVRE	NO	NO

Repeating the manoeuvre means returning the lever to the position corresponding to the gear actually engaged; the lever simply has to be returned to the position it was in before the gear change was requested and the same request has to be made with the brake pedal pressed: in this way the system will accept the gear change.
In addition, the TIP position (central stable position between UP and DOWN) corresponds to the first gear if the request is made with the lever in NEUTRAL and the brake pedal pressed or with the gear lever in REVERSE and reverse gear engaged.

6.4 SYSTEM BEHAVIOUR WITH THE ENGINE RUNNING AND/OR THE VEHICLE IN MOTION

Start-up (+50)

When the vehicle has been turned off with the gearbox in "N":

the engine may be started irrespective of whether the brake pedal is pressed or not.
As well as indicating the current operating mode and the logic available with the key in +15, the instrument panel shows neutral [N] when the engine is started.

When the vehicle has been stopped with the gearbox in any gear OTHER THAN "N":

Without the brake pedal pressed:

- The system warns the driver by showing the "PRESS BRAKE" message on the display and does not allow the engine to be started; to start the engine, simply repeat the manoeuvre with the brake pedal pressed or simply press the brake pedal without moving the key from the START position;

With the brake pedal pressed:

- The engine starts and the system automatically puts the gearbox in "N".

As well as indicating the current operating mode and the logic available with the key in +15, the instrument panel shows neutral [N].

Once the engine has been started and until the lever is set in the "N" position with the brake pedal pressed, the system will warn the driver of the inconsistency between the gear engaged (neutral = "N") and the position of the lever by means of an audible signal.

Starting the vehicle when stationary

Once started, the vehicle is considered to be in motion, at a speed V= 0 km/h, gearbox in neutral (N) and selecting lever in N or TIP/R.
The driver should choose whether to start moving forwards or backwards.
The instrument panel shows the neutral gear N, as well as the operating mode and the logic.
Irrespective of the mode (Auto/Manual) and operating logic (Eco/Normal) chosen to engage the first or second gear, the driver must press the brake pedal and:

 move the lever to TIP if he decides to pick up in 1st gear or, still with the brake pedal pressed, request 1st gear by moving the lever towards TIP+ if he has not returned the lever to N following the warning described previously; it should be borne in mind that, when the gearbox is in N, the position of the lever in TIP corresponds to 1st gear;

 move the lever to TIP and then towards TIP+ (still with the brake pedal pressed) if he wants to pick up in second gear when starting on a slippery road surface.

Changing gear with the vehicle in motion

There are two ways of changing gear according to the system operating modes: MANUAL = No indication on display, or AUTOMATIC = AUTO.

Engine started

The vehicle starts to move (pick-up) when the accelerator pedal is pressed.

Once the engine is started, the only gears that may be engaged are: "1st", "2nd" or "R".
Gears may only be engaged with the brake pedal pressed.
NOTE: No AUDIBLE SIGNAL is emitted when reverse gear "R" is engaged

NOTE: when the gearbox is in "N" or "R", the TIP position corresponds to the 1st gear. Any TIP– request made is not considered by the system as it is not a plausible request.

When the driver requests a gear change with the vehicle stationary but without pressing the brake pedal, the request will be denied by the system, which will warn the driver by showing the "PRESS BRAKE AND REPEAT MANOEUVRE" message on the display and emitting an audible signal (the audible signal is turned off when the consistency between the lever position and engaged gear is restored).

6.5 CHANGING GEAR WITH THE VEHICLE IN MOTION

Changing gear in manual mode

All requests for moving **up a gear** are made by shifting the lever to the UP (+) position.
The requests are only accepted if, having made the gear change, the engine revolutions are sufficient to prevent the engine stalling.

If the request is accepted by the system:
once the gear change has been made, the display will show the new current gear.
NOTE: the system display shows 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 gear engaged before the request was made and will show the "ILLEGAL MANOEUVRE" message accompanied by an audible signal.

Similarly, the driver may request to change **down a gear** by shifting the lever to the DOWN (-) position. In this case, the system will only accept the request if the engine revolutions after the gear change do not exceed the maximum limit allowed for the engine.

The system also selects the lower gear automatically if the driver maintains the current gear and the engine is about to stall (AUTODOWN manoeuvre).
In the manoeuvres described above, the lever is set in the TIP position.

Changing gear in automatic mode

The display will show AUTO above the indication of the gear engaged

Even if the mode is automatic, to put the vehicle in motion (forwards or backwards), the driver must request one of the two available pick-up gears (1st or 2nd) or Reverse with the brake pedal pressed (the system will remain in automatic mode).

In this mode, the system also accepts requests made using the lever (both TIP+ and TIP-), which keep it in automatic mode (AUTOMATIC GEAR PROMPTING strategy); in fact, having accepted the request made by the driver, the system continues to run in a fully automatic way.

The **Kick Down function is also available**: when the accelerator pedal is pressed suddenly to the end of its stroke, the system recognizes the request for maximum torque and thus moves down one, two or three gears according to the vehicle's operating conditions.

ECO/ NORMAL Logic

- If the system is in automatic mode, the letter "E" will also appear on the display when the E key is pressed. When the E key is pressed again, the Economy logic is disabled (the letter "E" will disappear from the display (Normal logic)).

- If the system is in manual mode, pressing the E/N key has no effect (no indication will appear on the display).

- If the system is in automatic mode (in Economy or Normal logic), when the lever is set in A/M, it enters Manual mode and the "AUTO" and "E" indications will disappear from the display.

- If the system is in manual mode, when the lever is set to A/M, Automatic mode will be enabled and the display will show the word "AUTO" (the system also restores the most recently selected logic (Eco or Normal) saved before Manual mode was enabled).

6.6 REQUESTING NEUTRAL WITH THE VEHICLE IN MOTION

- If Neutral is requested with the ACCELERATOR PEDAL RELEASED:

irrespective of whether the BRAKE pedal is pressed or not

the system accepts the request and the display shows neutral N as well as the operating mode and logic.

- If the neutral gear N is requested with the ACCELERATOR PEDAL PRESSED:

irrespective of whether the BRAKE pedal is pressed or not

the system denies the request and maintains the current gear; in addition, as the lever is in a different position from the gear actually engaged in the gearbox, the display shows the "MANOEUVRE NOT ALLOWED" message accompanied by an audible signal.

Whether the system is in AUTOMATIC or MANUAL mode, the return from "N" (neutral) is executed by shifting the lever to the stable TIP position: THE BRAKE PEDAL DOES NOT HAVE TO BE PRESSED.

The manoeuvre returns the gearbox to the most suitable gear.

6.7 REQUESTING REVERSE GEAR WITH THE VEHICLE IN MOTION

Reverse gear may only be engaged under the following conditions:

- Brake pedal pressed
- Vehicle speed close to 0 km/h.

If the driver attempts to engage reverse (R) gear without pressing the brake pedal and with a vehicle speed of up to about 10 km/h, the system engages neutral (N) automatically and the display shows the "PRESS BRAKE PEDAL – REPEAT MANOEUVRE" message; an audible signal is also emitted.

If reverse gear (R) is engaged again, irrespective of whether the brake pedal is pressed or not and with a speed of over 10 km/h, the system takes no action and the display shows the "ILLEGAL MANOEUVRE" message; an audible signal is also emitted.

NOTE: with the brake pedal pressed, reverse gear will only be engaged if the vehicle stops within a time of about 3 seconds.

Disengagement of reverse gear (or engagement of 1st gear):

The system engages 1st gear when the lever is set in TIP so, with the brake pedal pressed and the vehicle speed close to 0 km/h, the system accepts the gear change.

If the driver attempts to engage first gear without pressing the brake pedal and with a vehicle speed of up to 10 km/h, the system automatically engages neutral (N) and the display shows the "PRESS BRAKE PEDAL – REPEAT MANOEUVRE " message; an audible signal is also emitted.

If the driver attempts to engage first gear with the brake pedal pressed and with a vehicle speed of over 10 km/h, the system does not change gear and the display shows the "ILLEGAL MANOEUVRE" message (the display continues to show the indication "R" (gear currently engaged)); an audible signal is also emitted.

Detailed specifications:

Request for reverse gear at a speed of over 10 km/h:

A. if, within a time set, the vehicle speed reaches a speed at which reverse gear is accepted, the request is accepted by the system which engages reverse gear (providing the driver does not release the brake pedal)

B. if, within the time set and indicated in point A, the vehicle speed remains above 10 km /h, the request is denied by the system and the driver is warned by the ILLEGAL MANOEUVRE message (irrespective of whether the brake is pressed or not); the system maintains the initial gear

C. if, within the time set and indicated in point A, the vehicle speed remains below 10 km/h, but above 5 Km/h, the request (WITHOUT THE BRAKE PEDAL PRESSED), the request is denied by the system, which engages neutral gear N and the driver will be warned by the ILLEGAL MANOEUVRE message (DO NOT PRESS BRAKE AND REPEAT MANOEUVRE)

D. If, within the time set and mentioned in point A, the vehicle speed remains below 5 km/h, but above the speed at which reverse gear is accepted, the request (WITHOUT THE BRAKE PEDAL

PRESSED) is denied by the system, which will engage neutral N and the driver will be warned by the PRESS BRAKE AND REPEAT MANOEUVRE message.

In any case, all requests to engage reverse gear below a speed of 5 km/h without the brake pressed result in neutral N being engaged and the PRESS BRAKE AND REPEAT MANOEUVRE message being displayed.

In any case, when the lever is shifted to R at any speed and left in this position, without pressing the brake, the system will engage neutral as soon as the vehicle has come to a standstill.

6.8 SYSTEM SAFETY DEVICES

A) **VEHICLE STATIONARY, ENGINE RUNNING, GEAR ENGAGED (typically 1st, 2nd or R):**

If the brake and/or accelerator pedal is pressed and then the driver's door is opened, the system maintains the current gear. The instrument panel will continue to display the mode, the logic and the current gear; no audible signal will be emitted.

B) **VEHICLE STATIONARY, ENGINE RUNNING, GEAR ENGAGED (typically 1st, 2nd or R):**

If neither the brake pedal nor the accelerator pedal is pressed and the driver's door is opened, the system engages N after a time of about **1.5** s.
The instrument panel will continue to display the mode, the logic and **N**.
As the lever may be in TIP or R, the change to N activated by the system creates an inconsistency between the position of the lever and the gear engaged in the gearbox, the manoeuvre will therefore be accompanied by an inconsistent audible signal **(the buzzer is activated in all cases of automatic engagement of N].**

C) **VEHICLE STATIONARY, ENGINE RUNNING, GEAR ENGAGED (typically 1st, 2nd or R):**

If no action is taken for a time of more than **3** minutes (that is, neither the brake pedal nor the accelerator pedal has been pressed, and the lever is not shifted in any direction (e.g. when the vehicle has stopped at the traffic lights)), the system automatically selects N.
The instrument panel will continue to display the mode, logic and **N**.
As the lever may be in TIP or R, the change to N executed by the system can create an inconsistency between the position of the lever and the gear engaged in the gearbox, so the manoeuvre will be accompanied by an audible error signal.

D) **VEHICLE STATIONARY, ENGINE RUNNING, GEAR ENGAGED (typically 1st, 2nd or R):**

When the brake pedal is pressed and no other action is taken for a time of more than **10** minutes, the system automatically selects neutral N.
The instrument panel will continue to show the mode, the logic and **N**.
As the lever may be either in TIP or in R, the shift to N executed by the system entails an inconsistency between the lever and the gear engaged in the gearbox, the manoeuvre will therefore be accompanied by an audible error signal.

E) **VEHICLE STATIONARY, ENGINE RUNNING, change to neutral (N), KEY-OFF procedure:**

If the engine is turned off, the instrument panel continues to display the mode, the logic and the **N blinking** for about 4 sec., accompanied by an audible signal indicating that the driver has left the vehicle with the gearbox in neutral (N).

F) **VEHICLE STATIONARY, ENGINE RUNNING, gear engaged OTHER than neutral (N), KEY-OFF procedure:**

If the engine is stopped, no information about the gearbox will be displayed.

NOTES:

changes compared to previous systems:

- *No generic fault LED*
- *Acceptance of neutral at all speeds with accelerator released*
- *The contacts for the stable and unstable positions are no longer served by simple switches, but are magnetic contacts of the Hall-effect sensor type, so the continuity of the contact cannot be checked using the multimeter, except by using the instrumental diagnosis provided by EXAMINER SMART to analyse the corresponding parameters.*

7. CHARACTERISTIC DATA

7.1 GEAR RATIOS

Type	**M20**	
Transmission ratios	I	3.818
	II	2.053
	III	1.302
	IV	0.959
	V	0.744
	VI	0.614
	RM	3.545

7.2 FLUIDS AND LUBRICANTSI

Recommended product features

	Type	Quantity	Maintenance
Hydraulic unit oil	Selenia CS Speed (ATF DEXRON III)	0.505 litres	Check-up every 30,000 Km
Clutch cylinder oil	DOT4	38 cc (0.038 litres)	Check-up every 30,000 Km Replacement every 2 years or 60,000 Km

7.3 AUTOMATED GEARBOX CONTROL UNIT

Type: CFC300F01
Connector: 28-pin

Working environment temperature T:

- From -40°C to +110° C (in activity)

Working voltage:

- Minimum working voltage, VBAT_min: 6.0 V
- Maximum working voltage, VBAT_max: 16.0 V
- Rated working voltage, VBAT_typ: 12.0 V
- Rated voltage test, VBAT_test: 13,5 V +/- 0,2 V
- Overvoltage range 26.0 V < VBAT_ovld < 40.0 V

Communication network:

- C- CAN (500 kbytes/sec)

Special hardware functions:

- Power latch relay (internal)
- TCU - wake up by driver's door opening switch

7.4 GENERAL SYSTEM FEATURES

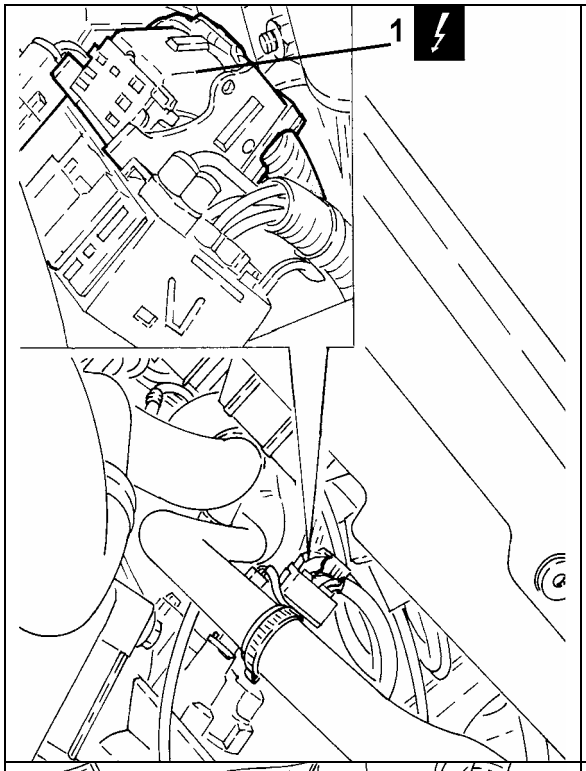
Technical characteristics:

- Line pressure between 36.5 and 46 bars
- Working temperature of between -30° C and + 105 ° C
- Starting allowed down to a temperature of -30° C
- Capacity of the pump >0.81 l/min at 45 bars, 3,450 rpm and oil at 60 °C
- The volume of the accumulator is 250 cm3, preloaded to 24 bars at 20 °C

8. PROCEDURES

The procedures for repairing the M20 AMT system are listed below:

2127C40 – HYDRAULIC CONTROL UNIT OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

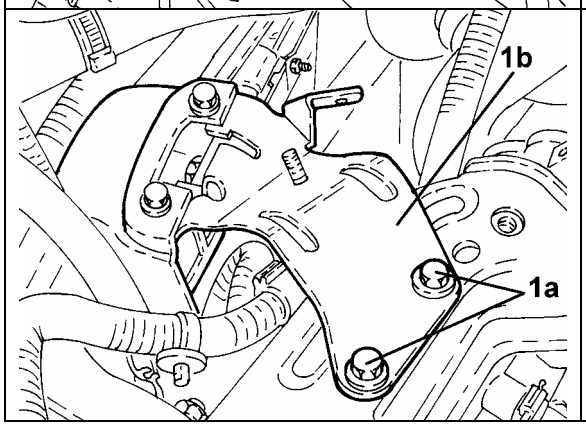
<table>
<tr>
<td> 
</td>
<td>Removal

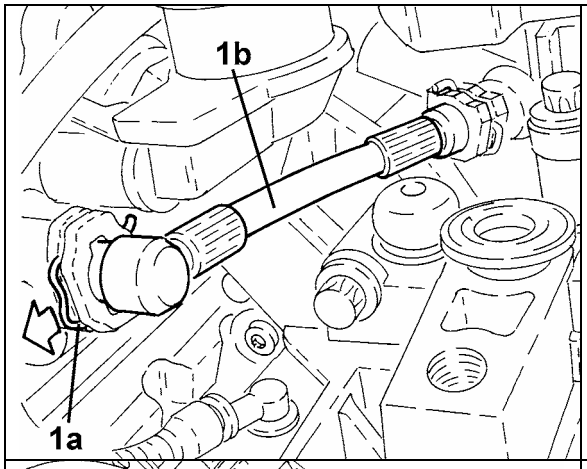
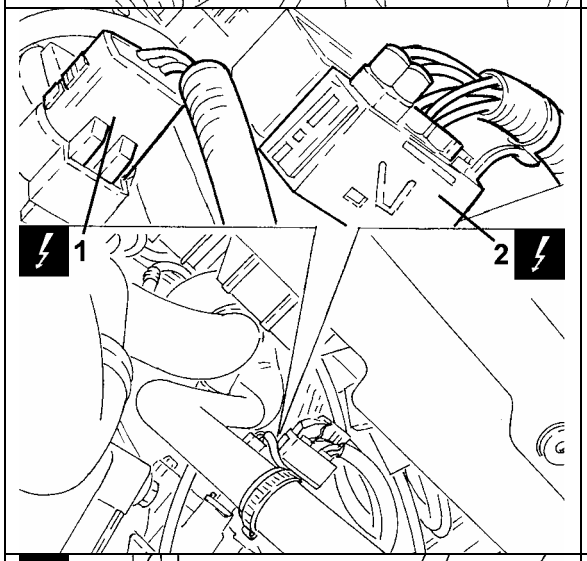
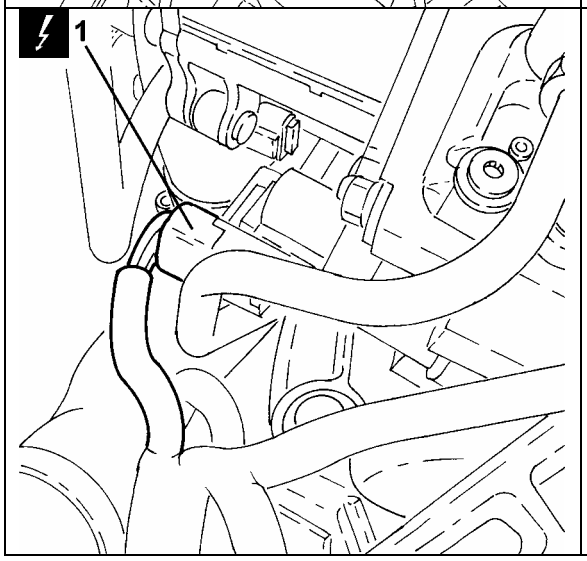
- Put the vehicle on the ramp.
- Remove the guard below the engine.

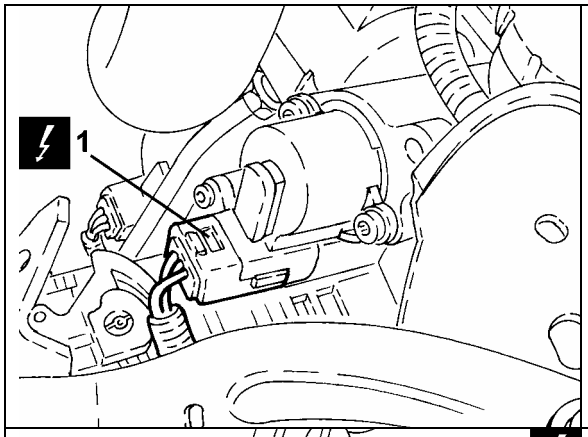
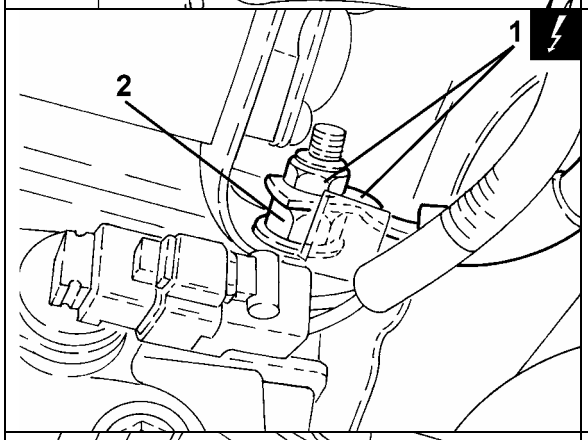
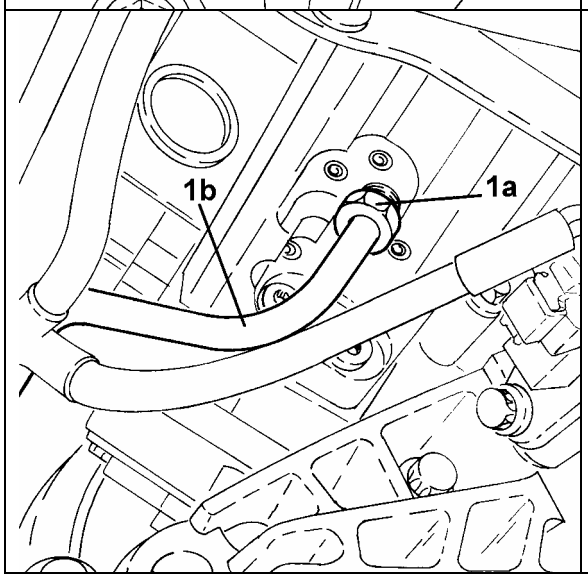
Depressurizing the system

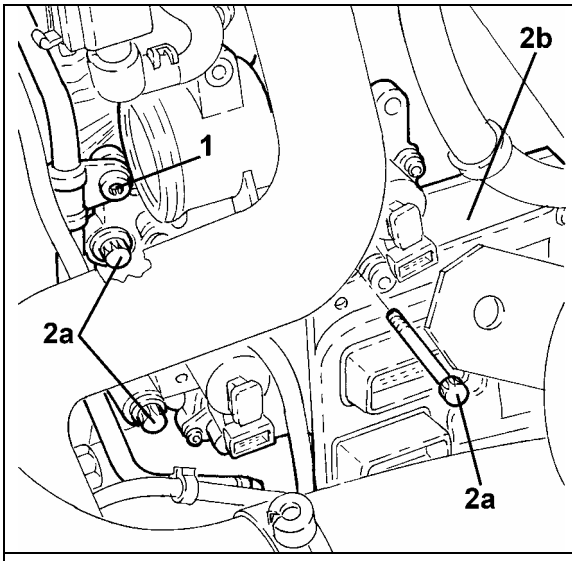
- Detach the electrical connection of the electronic control unit.

- Connect Examiner and carry out the depressurizing procedure.

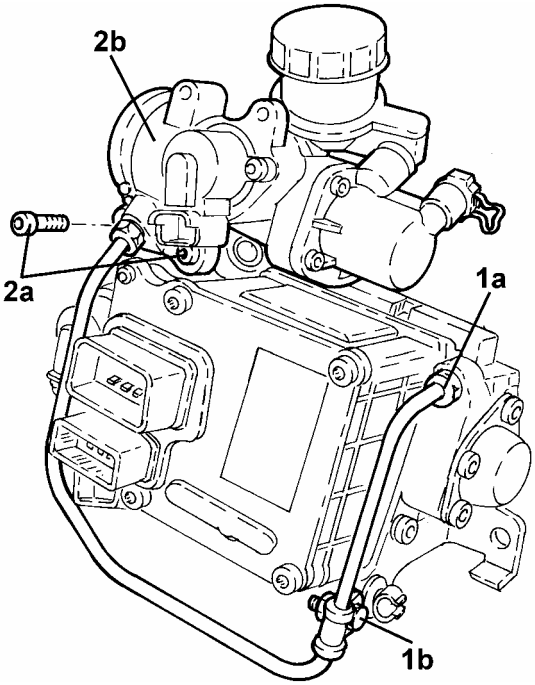
- Remove the battery and the battery holder.</td>
</tr>
<tr>
<td> 
</td>
<td>- Loosen the screws (1a) and move the bracket complete with the spark plug preheating unit (1b) to one side.
- Remove the tube leading from the hydraulic unit to the tank.</td>
</tr>
</table>

	- Move the spring (1a) back and detach the tube from the master cylinder with a three-way connection (1b), on the master cylinder side.
	- Detach the electric connection of the gear selection position potentiometer. - Detach the remaining electrical connection of the control unit.
	- Detach the electrical connection of the gear engagement position sensor.

	- Detach the electrical connection of the clutch position sensor.
	- Loosen the nut and remove the ground cable. - Loosen the dual-shank screw securing the bracket supporting the hydraulic unit.
	- Loosen the connection (1a) of the tube supplying oil to the valve unit (1b), on the valve unit side.



- Loosen the screw of the intermediate bracket securing the rigid oil delivery tube to the valve unit.
- Loosen the screws (2a) and remove the complete hydraulic unit (2b).

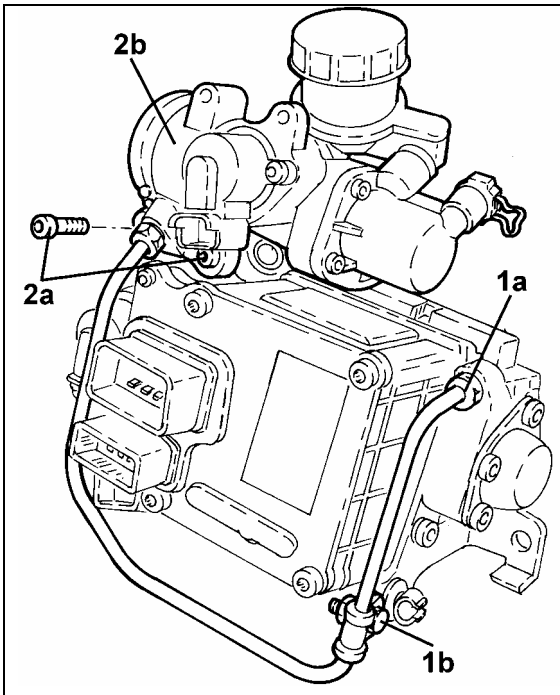


- Loosen the connection (1a) of the rigid tube leading from the valve unit to the master cylinder and the screw (1b) securing the supporting bracket.
- Loosen the screws (2a) and remove the complete master cylinder (2b).

Reassembly

- Put the master cylinder back in place and tighten its screws to the specified torque. (**Torque 1 daNm**)
- Tighten the connection of the rigid tube from the valve unit to the master cylinder and the intermediate bracket securing screw.
- Put the complete hydraulic unit back in place and tighten the screws to the specified torque.
- Tighten the screw on the intermediate bracket for securing the rigid oil delivery tube to the valve unit.
- Tighten the connection of the oil delivery tube to the valve unit, on the valve unit side.
- Tighten the dual-shank screw securing the bracket supporting the hydraulic unit.
- Put the ground cable back in place and secure it using its nut.
- Attach the electrical connection of the clutch position sensor.
- Attach the electrical connection of the gear engagement position sensor.

- Attach the electrical connection of the gear selection position potentiometer.



- Connect the tube from the master cylinder with a three-way connection on the master cylinder side and close its spring.

- Connect the tube from the hydraulic unit to the tank.

- Replace the bracket complete with the spark plug preheating unit into its seat and fix it with its screws.
- Attach the electrical connections of the engine control unit.

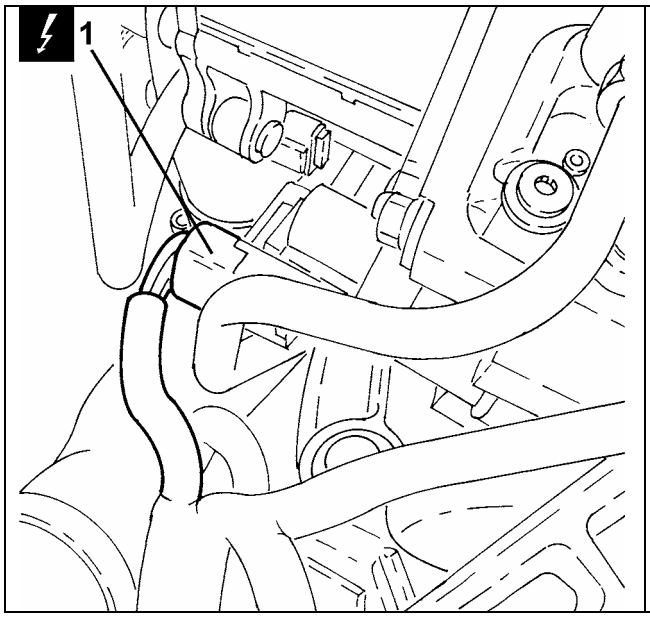
- Reassemble the battery holder, the battery and the guard below the engine

- With Examiner, the following steps should be taken:
- clutch self-adjustment
- end of line – service adjustment
- new actuator adjustment (only when replacing the hydraulic actuator unit)

- Remove the vehicle from the ramp

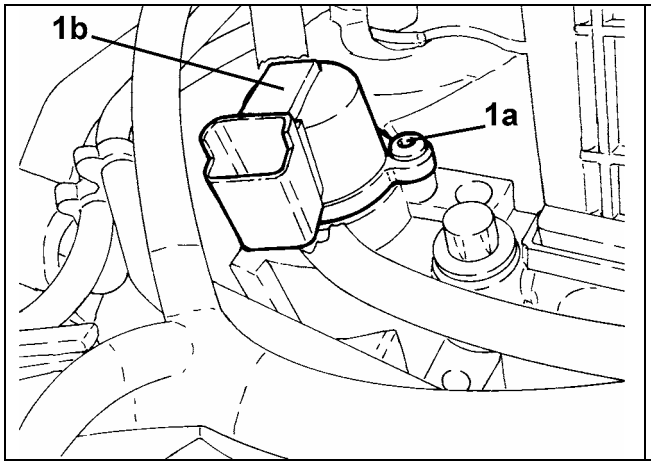
2127E42 – GEAR ENGAGEMENT POSITION SENSOR OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

Removal



- Remove the guard under the engine

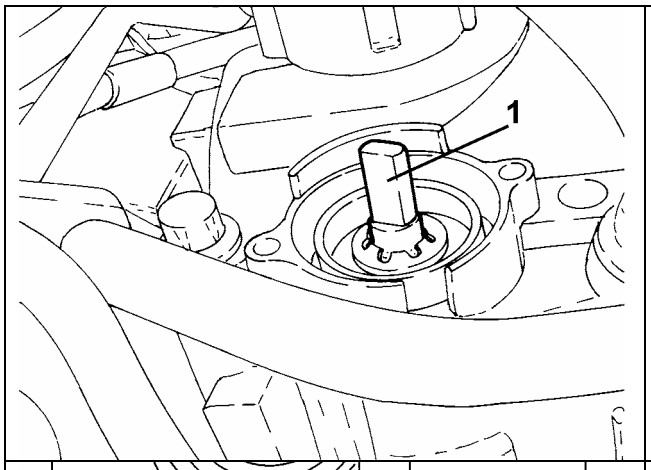
- Detach the electrical connection of the gear engagement position sensor.



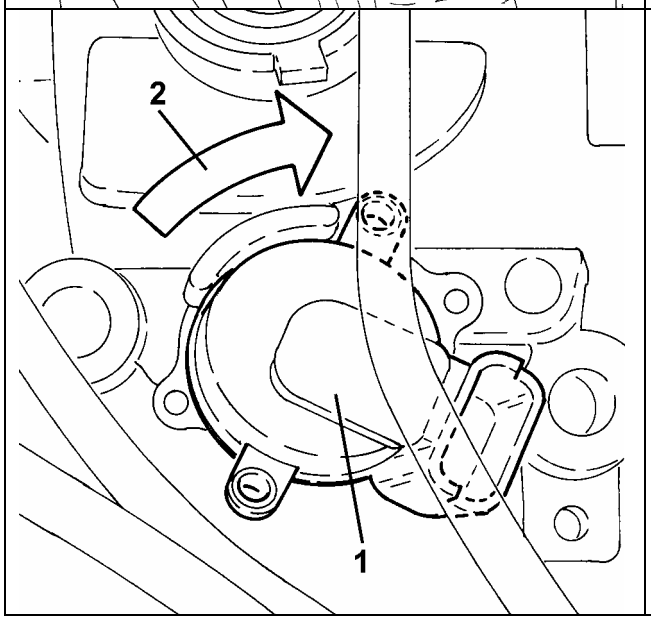
- Loosen the screws (1a) and remove the gear engagement position sensor (1b) complete with its O-ring.

Reassembly

NOTE: The gear engagement position sensor should be preloaded during assembly and so the following steps should be taken

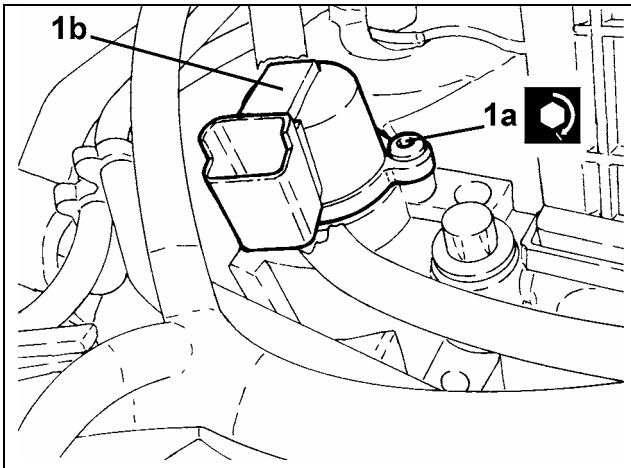


- Turn the engagement pin clockwise to its stroke end.



- Position the sensor complete with its O-ring as shown on the figure so as to engage the pin set previously in line with the mark on the sensor.

- Turn clockwise (preload) until the locking holes are aligned and then press the sensor back in place.



- Tighten the screws (1a) securing the gear engagement position sensor (1b) and tighten them to the specified torque. (**0.4 daNm**)
- Attach the electrical connection of the gear engagement position sensor.

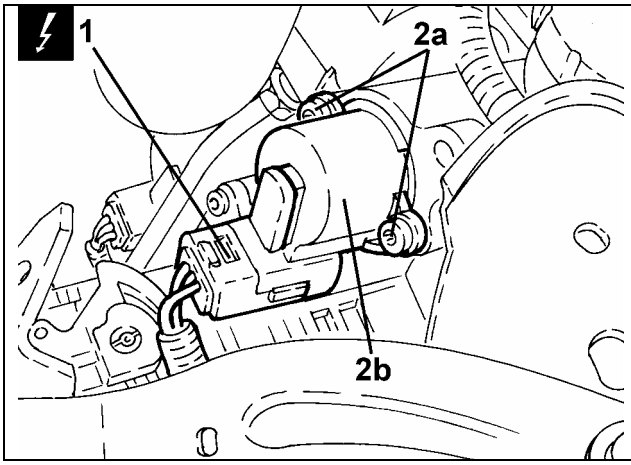
- Reassemble the guard under the engine

If the sensor is being replaced *with Examiner, the following steps should be taken:*

- enable the end of line-service

2127E44 – CLUTCH POSITION SENSOR OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

Removal

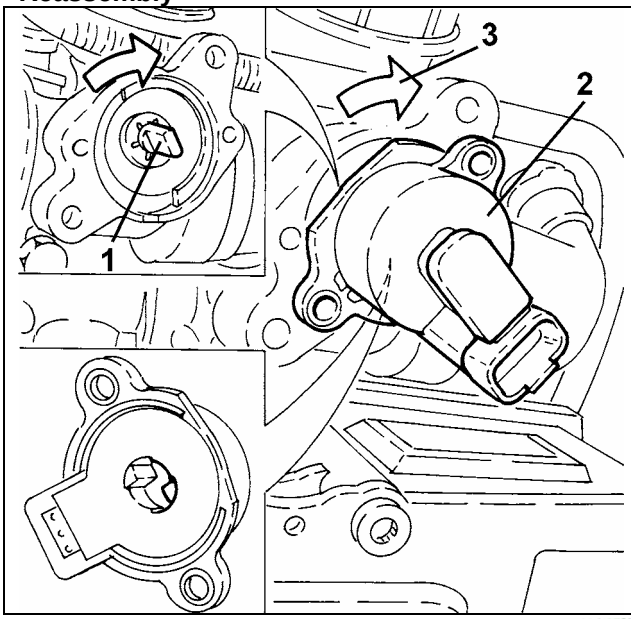


- Remove the battery and the battery holder.

- Detach the electrical connection of the clutch position sensor.

- Loosen the screws (2a) and remove the clutch position sensor (2b).

Reassembly

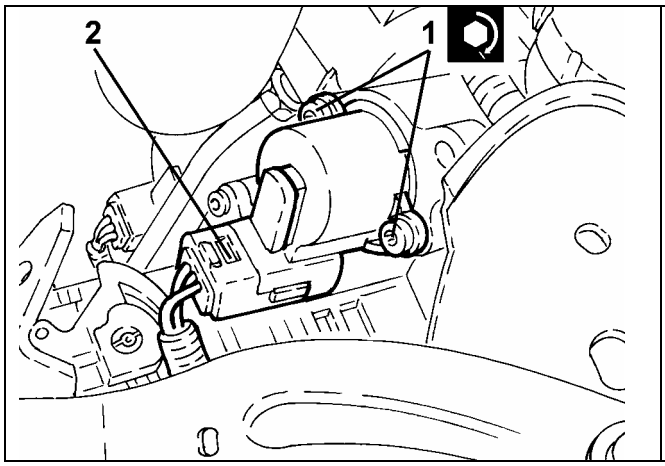


NOTE: The clutch position sensor should be preloaded during assembly and so the following steps should be taken.

- Turn the engagement pin clockwise to its stroke end.

- Position the sensor as shown on the figure so as to engage the pin set previously in line with the mark on the sensor.

- Turn clockwise (preload) until the locking holes are aligned and then press the sensor back in place.



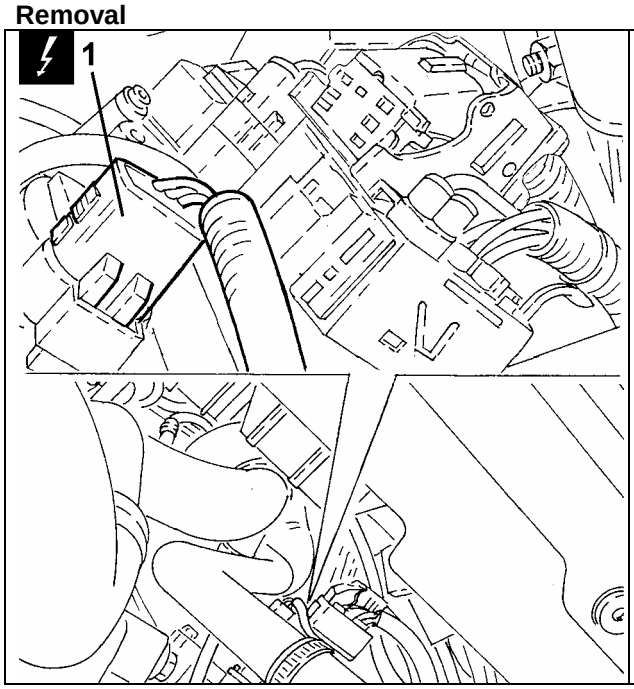
- Insert the clutch position sensor securing screws and tighten them to the specified torque. (**0.4 daNm**)

- Attach the electrical connection of the clutch position sensor.

- Reassemble the battery holder and the battery.

2127E40 – GEAR SELECTION POSITION SENSOR OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

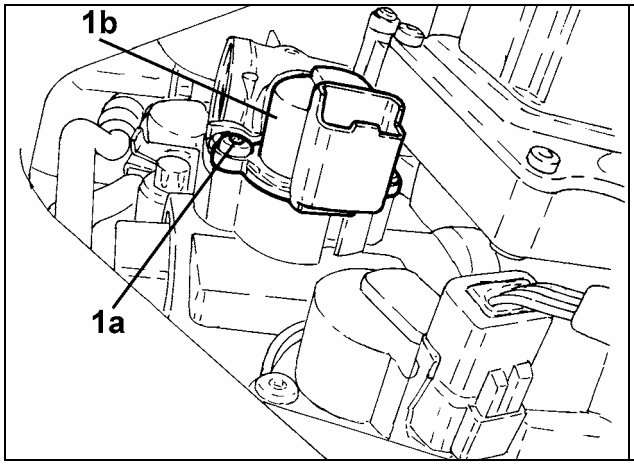
Removal



- Remove the guard under the engine.

- Remove the tube leading from the valve unit to the master cylinder.

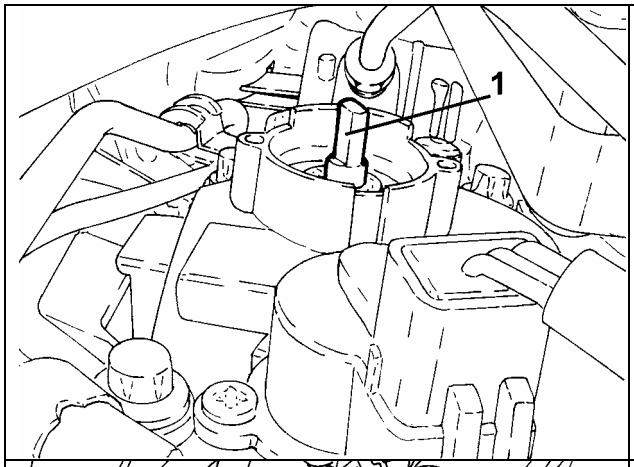
- Detach the electrical connection of the gear selection position potentiometer.



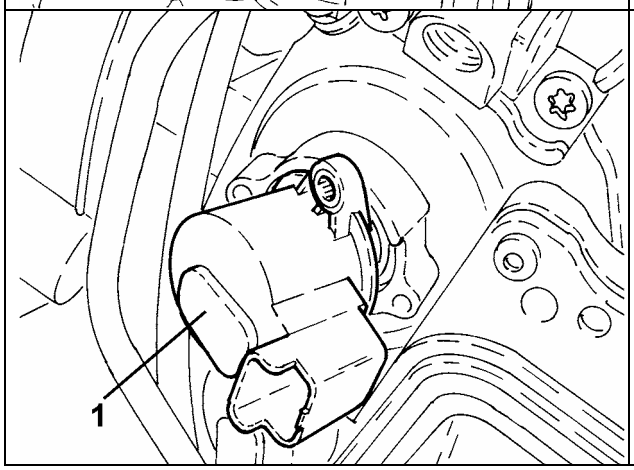
- Loosen the screws (1a) and remove the gear selection position sensor (1b) complete with its O-ring.

Reassembly

NOTE: The gear selection position sensor should be preloaded during assembly and so the following steps should be taken.

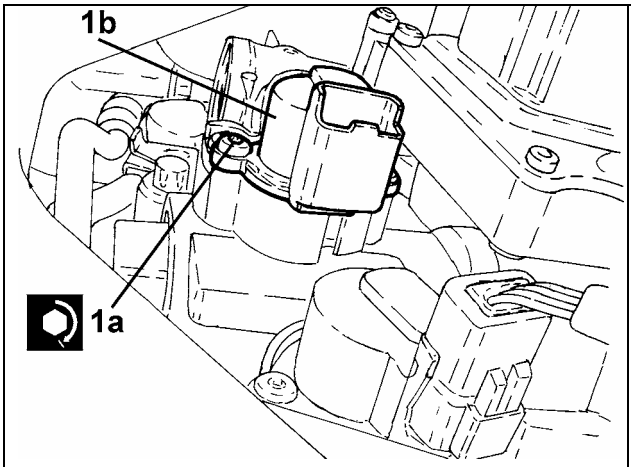


- Turn the engagement pin clockwise to its stroke end.



- Position the sensor complete with its O-ring as shown on the figure so as to engage the pin positioned previously in line with the mark on the sensor.

- Turn clockwise (preload) until the locking holes are aligned and then press the sensor into in place.



- Insert the screws (1a) for securing the gear selection position sensor (1b) and tighten them to the specified torque. (**0.4 daNm**)

- Attach the electrical connection of the gear selection sensor.

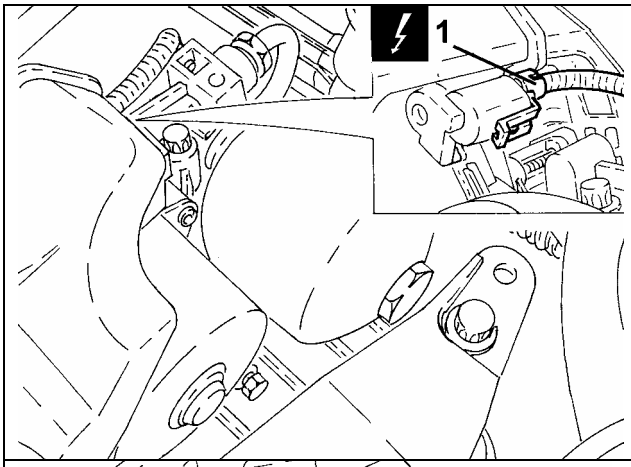
- Reassemble the tube leading from the valve unit to the master cylinder
- Reassemble the guard under the engine

If the sensor is being replaced ***With Examiner, the following steps should be taken:***

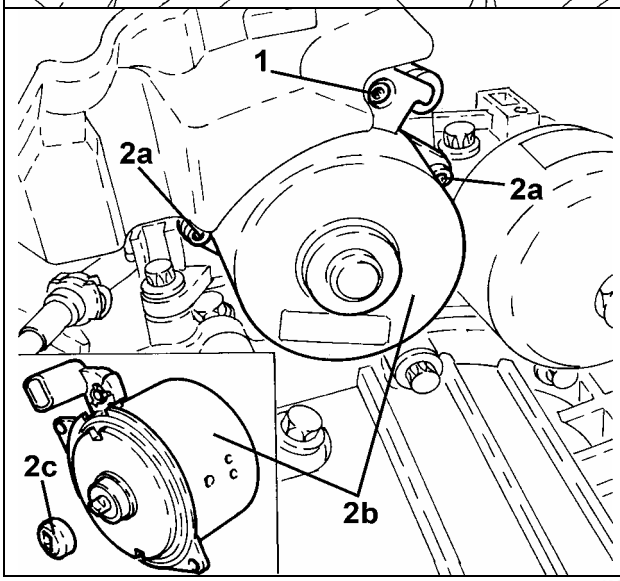
- end of line-service adjustment

2127C30 – ELECTRIC PUMP OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

Removal



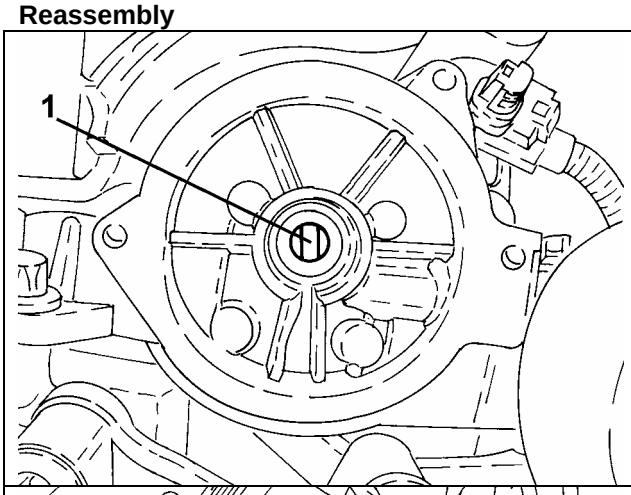
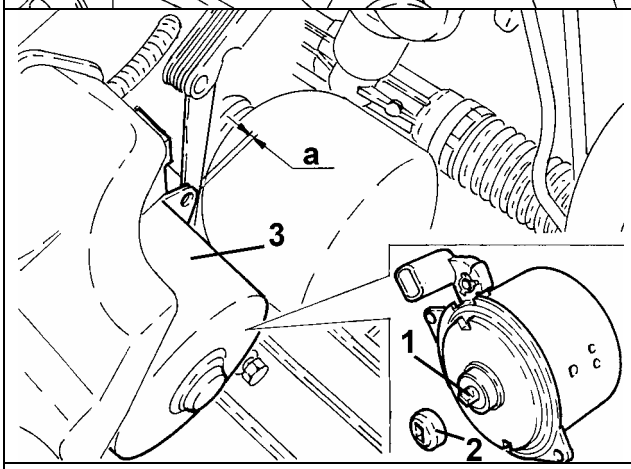
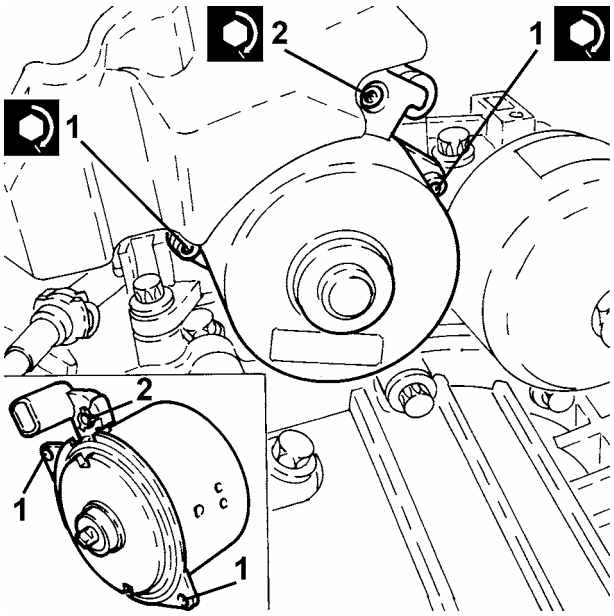
- Put the vehicle on the ramp.
- Remove the guard under the engine
- Remove the battery
- Remove the battery holder.
- Remove he elastic dowel on the gearbox side
- Remove the rigid support on the gearbox side
- Detach the electrical connection of the electric pump.



- Loosen the screws on the electric pump securing connector side.
- Loosen the two remaining screws (2a) and remove the electric pump (2b) with its seal (2c).

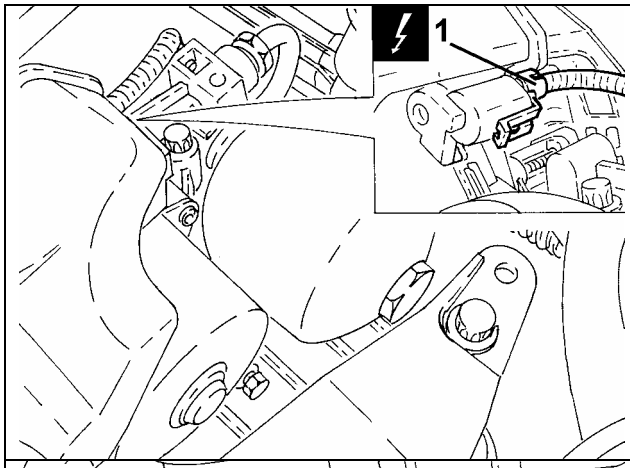
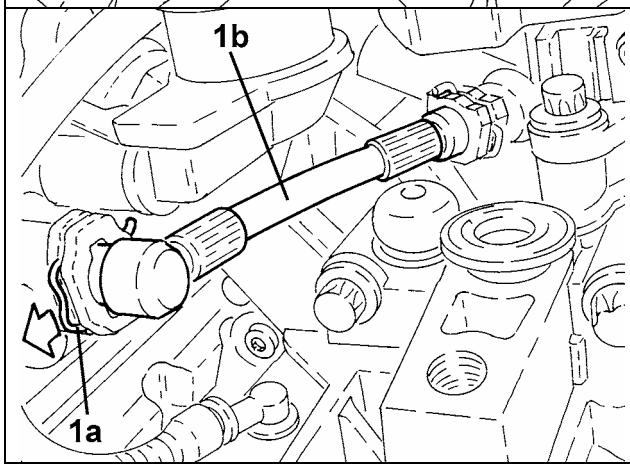
NOTE: When removing the electric pump, pull along the axis with extreme caution without using any tools to prevent all risk of damage.

Reassembly

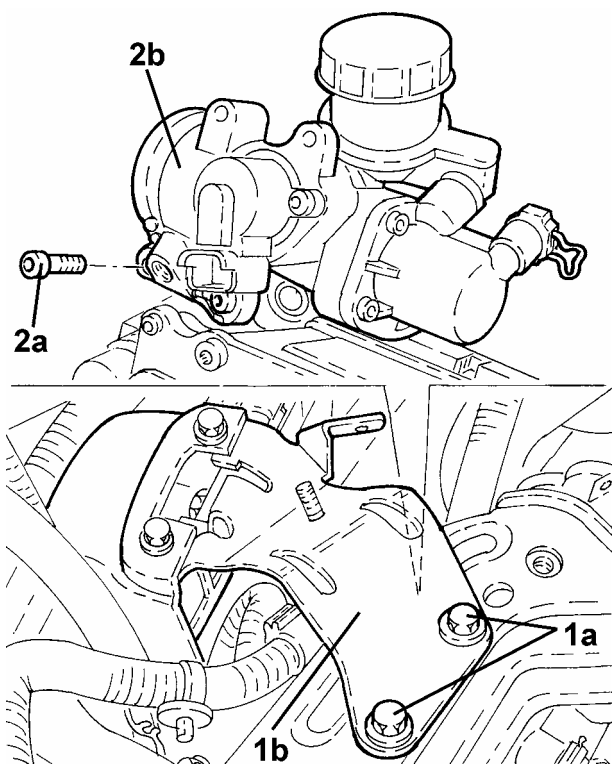
	- Position the shaft of the pump with the bevels set vertically as shown on the figure.
	- Position the shaft of the electric pump with the bevels in a horizontal position as shown on the figure. - Fit the seal. - Put the electric pump back in place, setting it on the same axis as the support and check that there remains a clearance **a = 0.3 - 0.6 mm**.
	- Insert the side screws for securing the electric pump to its support without tightening them. - Insert the screw for securing the electric pump on the connector side without tightening it. - Tighten the side screws (1) for securing the electric pump set in position previously to the specified torque. (**0.6 daNm**) - Tighten the screw on the connector side (2) for securing the electric pump positioned previously to the specified torque. (**0.6 daNm**) - Attach the electrical connection of the electric pump. - Reassemble the rigid support on the gearbox side - Reassemble the elastic dowel on the gearbox side - Reassemble the battery holder - Reassemble the battery - Reassemble the guard under the engine - Take the vehicle off the ramp.

2127C45 – CLUTCH MASTER CYLINDER OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

Removal

<table>
<tr>
<td> 
</td>
<td>- Put the vehicle on the ramp.
- Remove the guard under the engine
- Remove the battery
- Remove the battery holder
- Removal the rigid tube for delivering oil to the master cylinder
- Remove the return tube to the tank
- Detach the electrical connection of the clutch position sensor.</td>
</tr>
<tr>
<td> 
</td>
<td>- Move the spring (1a) back and disconnect the tube from the master cylinder with the three-way connection (1b), on the master cylinder side.

NOTE: Collect the oil that flows out in a suitable container.</td>
</tr>
</table>



- Loosen the screws (1a) and move the spark plug control unit supporting bracket (1b).
- Loosen the screws (2a) and remove the complete master cylinder (2b).

NOTE: The oil tank cannot be separated from the master cylinder and is therefore not managed in Spare parts.

Reassembly

- Put the complete master cylinder back in place and fix it using the relevant screws with the specified torque. (**1 daNm**)
- Replace the spark plug control unit supporting bracket and secure it to the chassis using the relevant screws.
- Connect the tube from the master cylinder with the three-way connection and fix it with its retaining springs.
- Attach the electrical connection of the clutch position sensor.

- Reassemble the return tube to the tank
- Reassemble the rigid tube for delivering oil to the master cylinder
- Reassemble the battery holder
- Reassemble the battery
- Reassemble the guard under the engine

- Take the vehicle off the ramp.

0010T48 – HYDRAULIC UNIT OF THE ELECTROHYDRAULIC SELECTION GEARBOX – BLEEDING THE UNIT

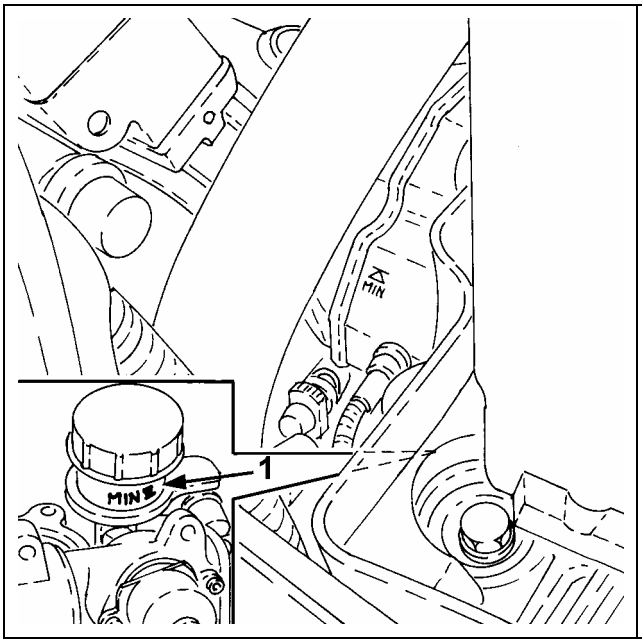
NOTE: This procedure is to be performed if tubes or components of the hydraulic circuit have been removed/reassembled.

- The brake pedal should be pressed from the start through the end of the operation.

- Connect the Examiner diagnostic instrument and perform the operations indicated in the specific procedure for bleeding air from the hydraulic unit of the electrohydraulic selection gearbox.

0010T6B – CLUTCH OIL FOR THE ELECTROHYDRAULIC SELECTION GEARBOX – CHECKING THE LEVEL AND TOPPING IT UP

NOTE: The clutch oil level should be checked with the vehicle on a flat surface and with the engine cold and therefore at a standstill.



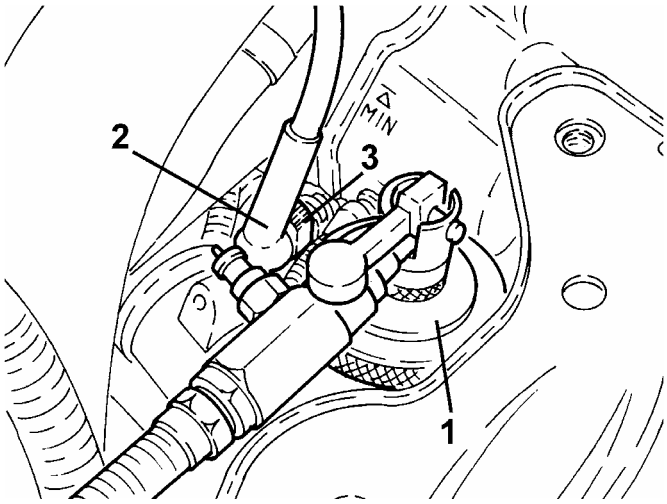
- Check that the level is in line with the MIN notch on the tank.

- If the level is below the MIN reference, top up and bleed the system

0010T6A – HYDRAULIC CLUTCH UNIT OF THE ELECTROHYDRAULIC SELECTION GEARBOX – BLEEDING THE UNIT

TO BE DONE WHEN ONE OF THE FOLLOWING OPERATIONS IS PERFORMED:

- ***2127C23*** *(tube from clutch master cylinder to three-way connection)*
- ***2127C24*** *(tube from valve unit to clutch master cylinder)*
- ***2127C35*** *(whole hydraulic unit)*
- ***2127C45*** *(Clutch master cylinder)*
- ***1820B38*** *(Coaxial clutch actuator)*



- Remove the battery
- Remove the battery holder
- Connect the battery without putting it in the engine compartment.
- For the bleeding procedure, use special pneumatic equipment, selecting the relevant cap to be applied to the clutch actuator tank.
- Remove the cap from the clutch actuator oil tank and connect suitable equipment to the tank itself.
- Remove the protective cap and connect the recovery device (tube and tank) to the bleed valve on the three-way connection of the hydraulic/coaxial clutch actuator.
- Open the bleed valve on the three-way connection of the hydraulic/coaxial clutch actuator.
- Open the tap of the equipment's tank slowly.
- Wait for all the air inside the hydraulic clutch disengaging system to flow out and then close the tap of the equipment's tank.
- Close the bleed valve on the three-way connection of the hydraulic/coaxial clutch actuator and put the protective cap back in place.

Checking the bleed operation:

- Connect Examiner and carry out the clutch bleed procedure.
- Open the bleed valve on the three-way connection of the hydraulic/coaxial clutch actuator.
- Open the tap of the equipment's tank slowly.
- Wait for all the air inside the hydraulic clutch disengaging system to flow out and then close the tap of the equipment's tank.

NOTE: *The "bleed check" should be carried out in the following cases:*

- once when the clutch fluid is being replaced

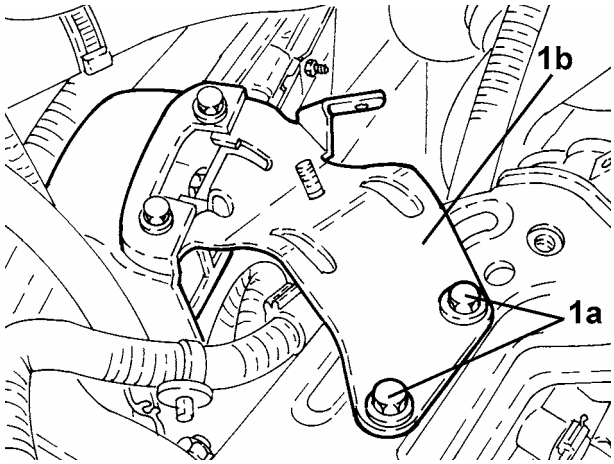
- three times at the end of operations 2127C23, 2127C24, 2127C35, 2127C45.

- four times during operation 1820B38

- Close the bleed valve on the three-way connection of the hydraulic/coaxial clutch actuator and put the protective cap back in place.
- Remove the clutch bleed equipment.
- Disconnect Examiner.
- Reconnect the battery holder and the battery

2127E10 – ELECTRONIC CONTROL UNIT OF THE S.R. ELECTROHYDRAULIC SELECTION GEARBOX

Removal



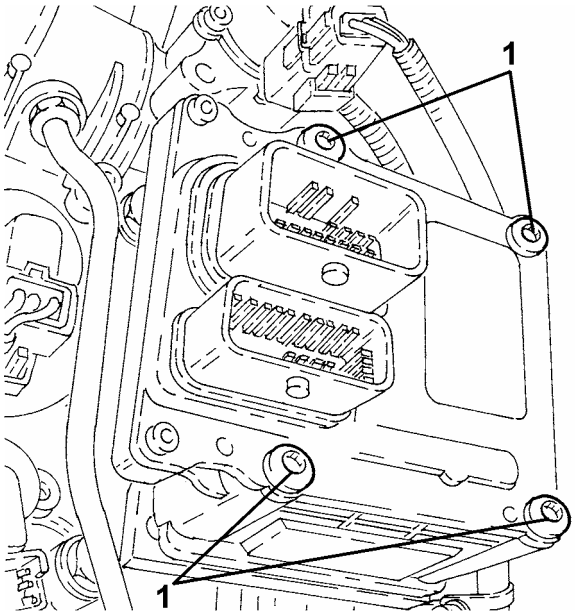
- Remove the guard under the engine

- Remove the battery and the battery holder

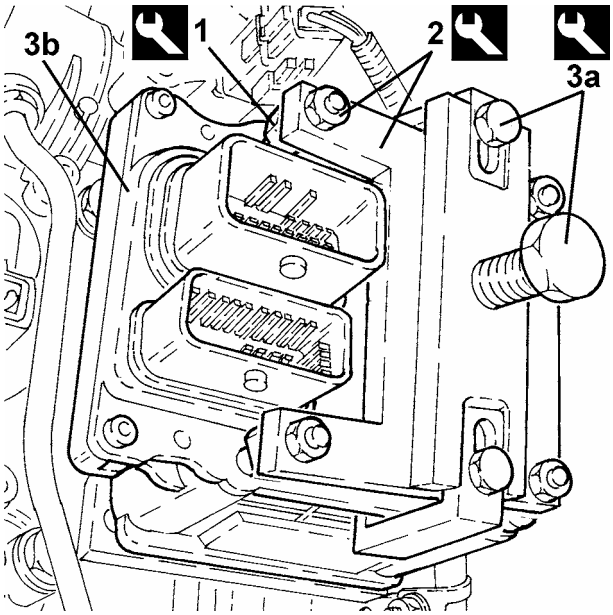
- Loosen the screws (1a) and put the bracket complete with the spark plug preheating unit (1b) to one side.

Detach the electrical connections of the control unit.

NOTE: During the removal operations, cover the pins of the control unit connectors so as to protect them against accidental contacts and prevent electrostatic discharge and mechanical damage.



- Loosen the control unit securing screws.



- Assemble the tool (N. **2000017800**: stud bolts + plate + extractor) for removing the control unit as follows:

- Tighten the stud bolts in the control unit locking holes

- Assemble the reaction plate and fix it to the stud bolts with its nuts

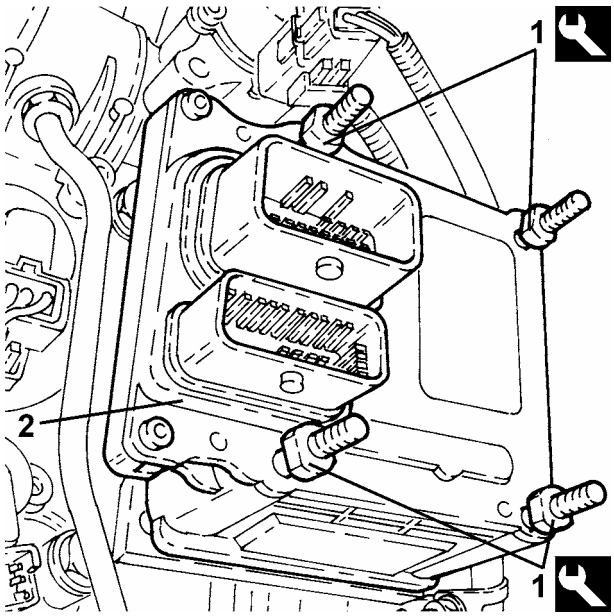
- Assemble the extractor (3a), tighten the screw to detach the control unit (3b) from the contact strips of the solenoid valves.

NOTE: Use only the special tool for removing the control unit. NEVER use other tools, such as screw drivers, to pry open and lift the control unit because the operation of the valve unit and the control unit itself could be seriously damaged.

- Remove the complete tool together with the control unit.

Reassembly

NOTE: Check that the contact strips of the solenoid valves are positioned correctly.
To avoid damaging the contact strips of the solenoid valves while assembling the control unit, centre it on the stud bolts of the tool **N. 2000017800***.*



- Replace the seal set between the control unit and the valve unit.

- Replace the stud bolts of the tool N. 2000017800 in the control unit locking holes.

- Insert the stud bolts in the four holes in the control unit support and screw them in loosely.

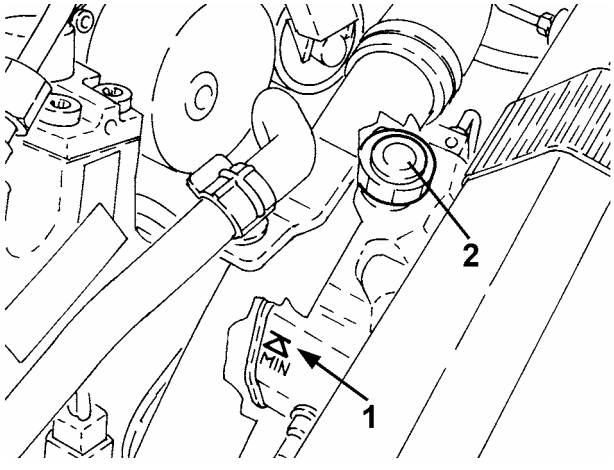
- Assemble the control unit onto the contact strips of the solenoid valves.

- Loosen and remove the stud bolts, fix the control unit by tightening the screws to the specified torque. (**1.0 daNm**)

- Attach the electrical connections of the control unit.
- Replace the bracket complete with the spark plug preheating unit and fix it in position with its screws.
- Reassemble the battery holder and the battery itself
- Reassemble the guard under the engine

0010T47 – HYDRAULIC UNIT FLUID OF THE ELECTROHYDRAULIC SELECTION GEARBOX – CHECKING THE LEVEL AND TOPPING UP

NOTE: The oil level of the automated gearbox is to be checked with the vehicle on a flat surface and the engine cold and therefore at a standstill.



- Apply pressure to the hydraulic circuit of the automated gearbox by opening the door on the driver's side, so as to activate the electrohydraulic pump.

- Open the bonnet and check that the level corresponds to the MIN notch on the tank.

- If the level is below the MIN market, remove the cap and add the relevant fluid (product table) until it reaches the MIN. notch

NOTE: The consumption of oil in the electrohydraulic selection gearbox is very low. If the level is below the MIN notch, the whole circuit should be checked for leaks.