Alfa Romeo MiTo

Alfa TCT Automatic Transmission

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Introduction

The concept of the **Alfa TCT** transmission system develops the objective of previous MTA (**M**echanical **T**ransmission **A**utomatized) versions, i.e. to improve manual mechanical transmission component performance. With this system, the driver does not need to press the clutch pedal or operate the gear shift command but driving pleasure deriving from the possibility of directly controlling the transmission is still guaranteed. Driving safety is also improved by direct control which prevents driver errors and the incorrect control of the transmission system, allowing the driver a more advanced interface with the vehicle.

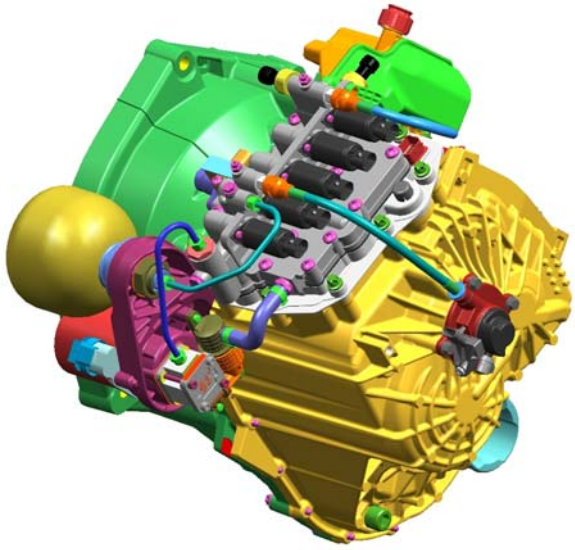


Fig. 1

Furthermore, and here is the innovation, the TCT provides the same advantages in terms of consumption of an MTA (Fig. 2 - horizontal axis) and the same driving comfort (Fig. 2 - vertical axis) of an automatic gearbox. With respect to a normal gearbox, motion is transmitted from the engine to the gearbox through two clutch plates. This allows to reduce consumption and increase driving comfort. The system basically consists of a mechanical transmission, with two dry clutch plates and a synchronised manual gearbox managed by an electrohydraulic robot.

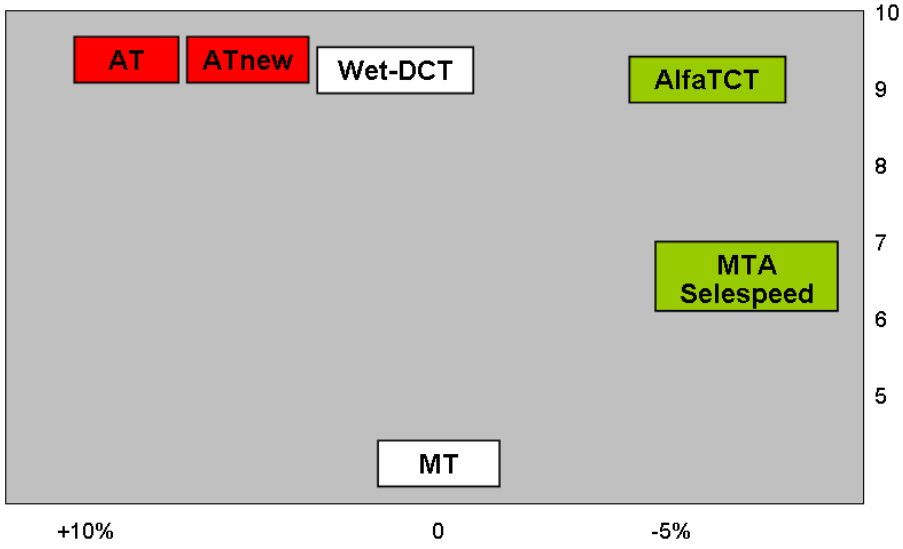


Fig. 2

AT – Automatic transmission**; ATnew –** New-generation automatic transmission
Wet-DCT – Wet dual clutch transmission; **MT** – Mechanical manual transmission
MTA Selespeed – Robotised transmission; **ALFA TCT** – Twin clutch dry transmission

Operation overview

The TCT system for C633 has the following features:

- It improves the performance of manual mechanical transmission components.
- It saves the driver from having to operate the clutch pedal and the conventional gear lever.
- It improves driving safety by implementing a control that prevents driver errors and the incorrect operation of the drive system.
- It is a hydraulic gearbox and clutch power assistance system that offers all the advantages of a dry clutch and manual gearbox (weight, strength and reliability, low energy consumption).
- It is simple to use and makes driving less tiring, especially in towns.
- It provides comfortable gear shifts, comparable to those of an automatic gearbox, by using advanced assistance power logics.
- There is no clutch pedal in the passenger compartment and the gear shift lever is replaced by "**P** (Parking) **R** (Reverse) **N** (Neutral) **D** (Drive)" commands on a joystick located on the dashboard.
- Gear shifts may be suggested in automatic mode, using the lever (TIP) or the buttons (TAP).
- The gearbox may be automatically managed in "AUTO" mode.

There are two Alfa TCT transmission operating modes:

- SEMI-AUTOMATIC MODE (MANUAL): the driver manages gears shifts using the lever located on the tunnel.
- AUTOMATIC MODE (AUTO): the electronic system manages the decision to shift gears.

General diagram with the main components of the Alfa TCT transmission.

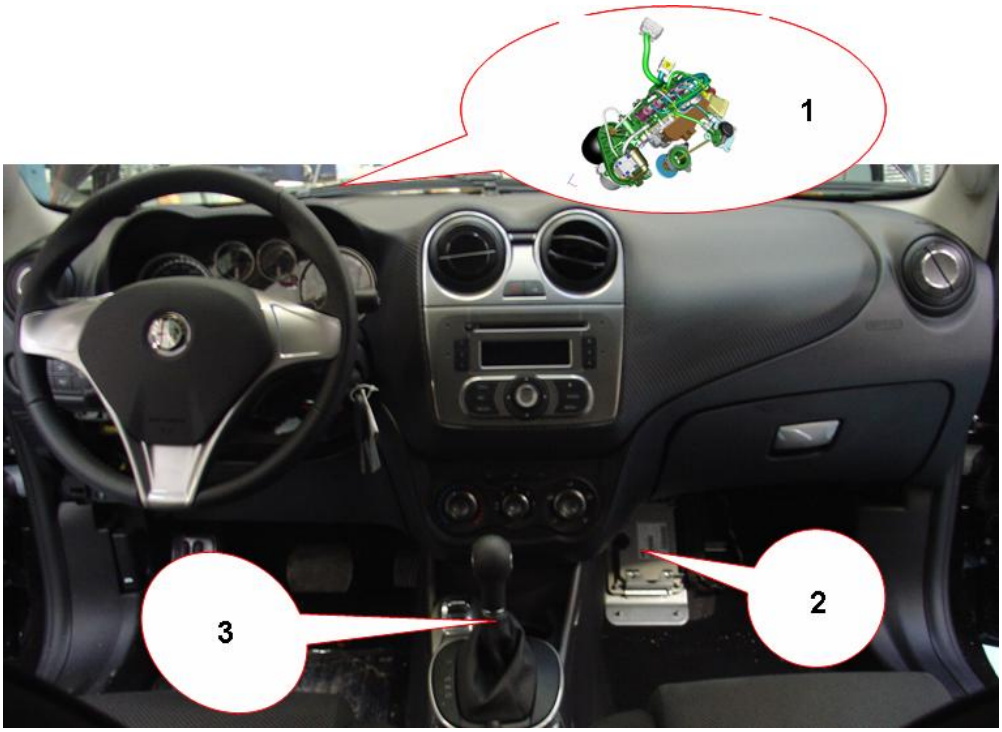


Fig. 3 – Application on Alfa Romeo Mito

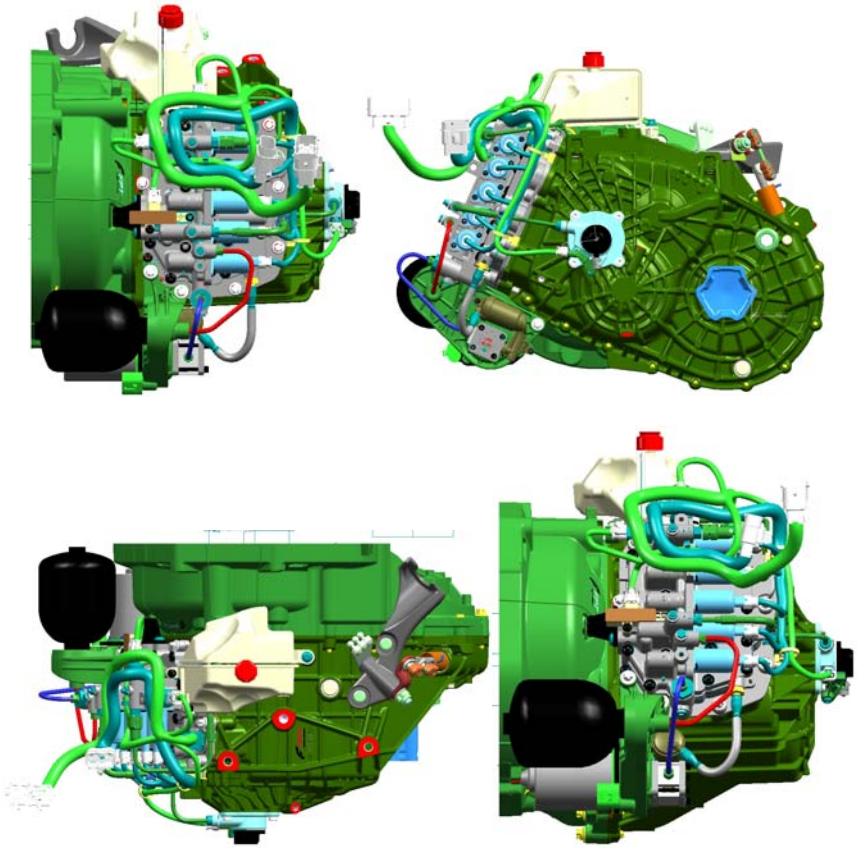
Fig. 4 – Future application on Alfa Romeo Giulietta

The power assistance system consists of an electrohydraulic unit (1) mounted directly on the gearbox casing, which manages the following movements by means of two actuators:

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

The electrohydraulic unit is controlled by five solenoid valves (which receive the required hydraulic power from an electric pump and accumulator).
By identifying the driver's requests according to the position of the lever (3), an electronic control unit TCU (2) autonomously manages gear shifts, by directly controlling clutches, gearbox and engine torque; while shifting, the engine control is interlocked to gearbox control.
The synergy between gearbox and engine considerably improves system performance and saves the driver from any need to synchronise clutch-accelerator movements while shifting. Gears may be shifted with the accelerator pressed.
The system inhibits incorrect gear shift requests and prevents the engine from stalling or over-revving.
In terms of driving assistance, the system also ensures immediate availability of first gear when the vehicle stops and the automatic down-shifting in the case of sudden deceleration.
The selected gear is shown on a display integrated in the instrument panel, along with indications of faults and critical vehicle or gearbox component driving conditions. Warnings and faults are indicated by messages and general or gearbox failure warning lights.

Alfa TCT transmission features



The new Fiat Powertrain Technologies Alfa TCT is a three-shaft transmission capable of transmitting a maximum torque of 350 Nm. It implements innovative technology for combining the comfortable gear shifts of an automatic transmission with lower running costs, better than that of a manual gearbox. By increasing the transmittable torque capacity (which reaches 350 Nm), the Alfa TCT will be fitted on various petrol and diesel B, C and D segment engines. The features of the new transmission include the possibility of acquiring a highly sporty connotation by optimising gear shift times and uninterrupted drive torque delivery to the wheels.
The Alfa TCT transmission is made by combining two aluminium alloy half-casings. It can be installed in front wheel drive, transverse engine layout arrangements. The Alfa TCT has a typical three-shaft layout for additional compactness. A particularity is that the main shaft actually consists of two mutually coaxial driveshafts. Two dry clutches operated by two separate hydraulic actuators are used to transmit torque to the main shaft:

- a traditional one located under the gearbox casing (traditional) to manage the even gear clutch;
- the second one located on the gearbox casing to manage the odd gear clutch.

Gears are engaged and the clutches are managed by an electrohydraulic robot, controlled in turn by a specific transmission control unit (TCU). The electrohydraulic robot is positioned directly on the gearbox casing.

The specific features are:

- 6 synchronised gears
- Max. transmissible torque: 350 Nm
- Three shafts, one input (main) shaft plus two layshafts (upper and lower)
- Main shaft formed by two reciprocally coaxial shafts
- Double dry clutch
- Double hydraulic actuator for the clutches
- Fixed idler manual gearbox
- Synchronised reverse
- Free wheel for reverse engagement
- Helical tooth gears (straight teeth reverse gear)
- Specific differential integrated in the gearbox casing
- Brake on differential for "Parking" function
- Designed for coupling to specific flywheel
- Gearbox housing split in two aluminium half casings
- Electrohydraulic robot for clutch and gear shift control
- Dedicated TCU

Gearbox structure

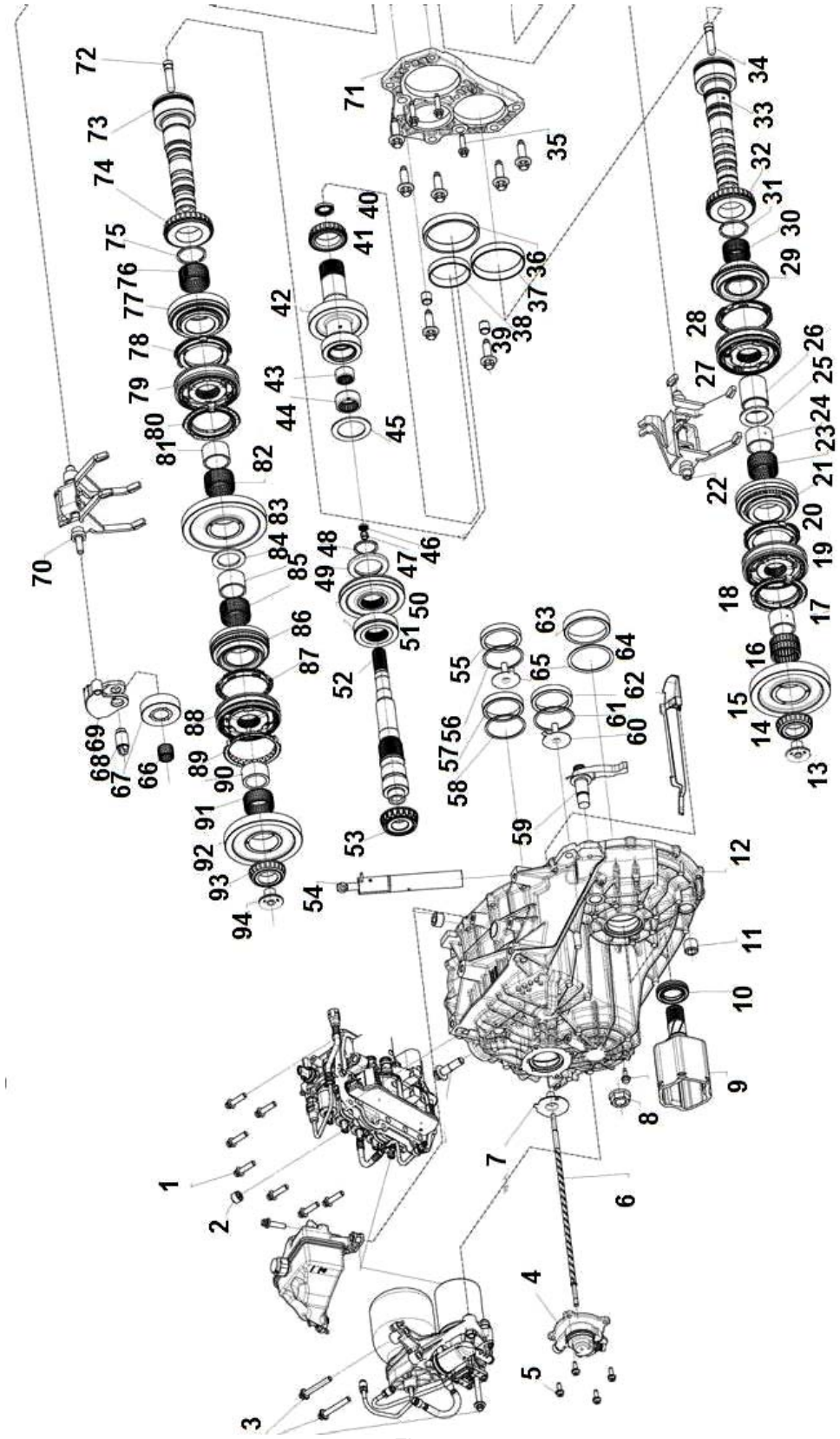


Fig. 5

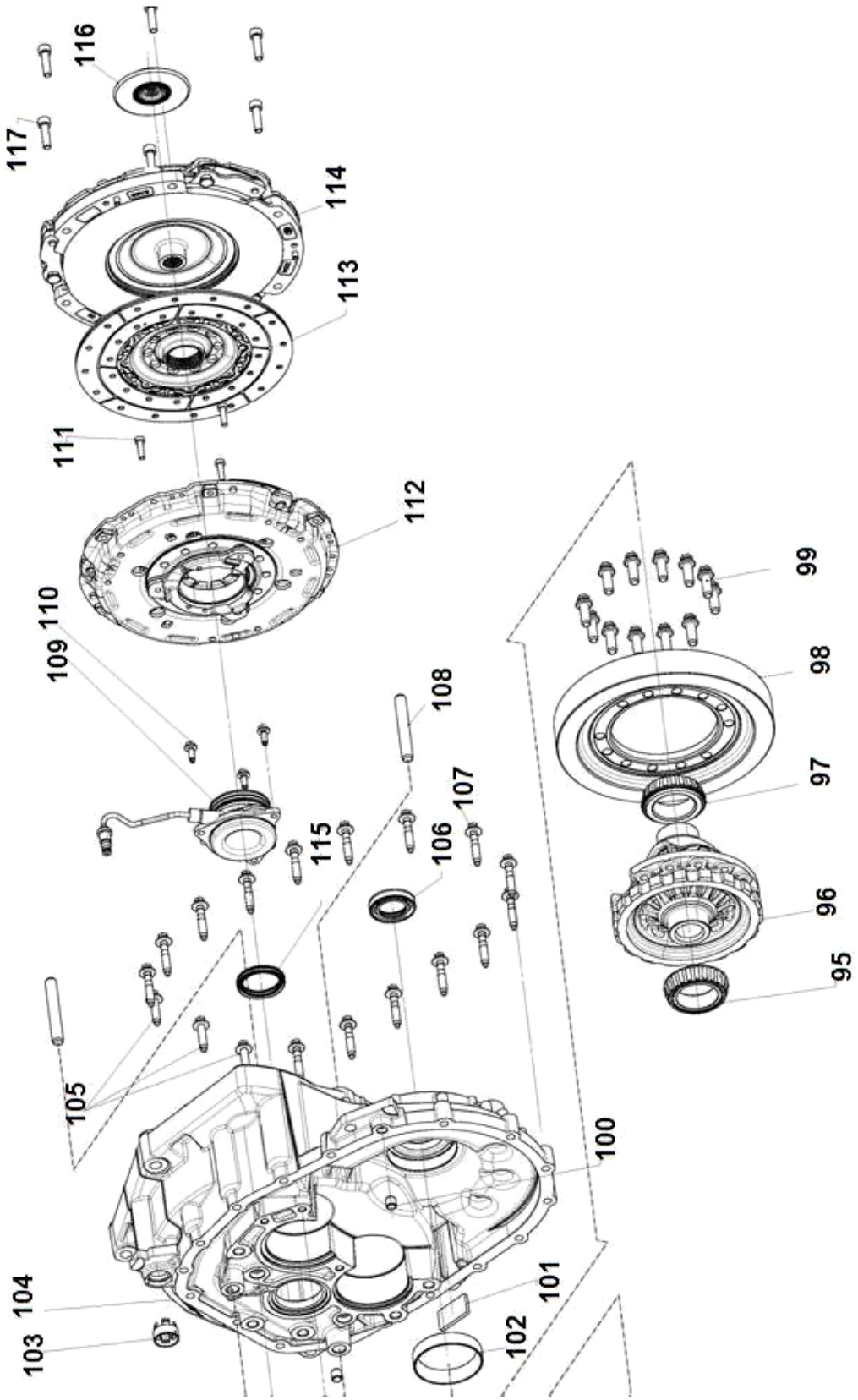

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Fig. 6

Key

1. fixing screws
2. oil breather plug
3. fixing screws
4. complete odd gear clutch release sleeve
5. fixing screws
6. odd gear clutch release rod
7. main rear oil manifold
8. flanged nut
9. left differential shaft
10. left differential shaft oil seal
11. oil drain plug
12. gearbox casing
13. lower layshaft ring nut
14. lower secondary rear bearing inner ring
15. driven gear
16. 1st speed roller cage
17. 1st speed gear bushing
18. 1st speed synchroniser ring
19. 1st-3rd speed sleeve
20. 3rd speed synchroniser ring
21. 3rd speed driven gear
22. 1st-3rd and 6th speed fork
23. 3rd speed roller cage
24. 3rd speed gear bushing
25. 3rd speed thrust washer
26. 6th speed spacer
27. 6th speed sleeve
28. 6th speed synchroniser ring
29. 6th speed driven gear
30. 6th speed roller cage
31. lower secondary front bearing circlip
32. lower secondary front bearing inner ring
33. lower layshaft
34. lower layshaft plug
35. fixing screws
36. upper secondary front bearing outer ring
37. lower secondary front bearing outer ring
38. primary front bearing outer ring
39. plate/support fixing screw and centring dowel
40. inner/outer main shaft seal
41. primary front bearing inner ring
42. outer main shaft
43. front main shaft roller cage
44. rear main shaft roller cage
45. outer main shaft thrust washer
46. inner main shaft front gasket
47. clutch release rod bushing
48. 5th speed gear circlip
49. inner main shaft axial cage
50. 5th speed driven gear
51. 3rd speed driven gear
52. inner main shaft
53. main shaft rear bearing inner ring
54. parking actuator
55. upper layshaft rear bearing outer ring
56. upper layshaft rear bearing adjustment ring
57. main shaft rear bearing outer ring
58. main shaft rear bearing adjustment ring

59. parking ratchet
60. lower layshaft oil manifold cup
61. lower layshaft rear bearing adjustment ring
62. lower secondary rear bearing outer ring
63. rear differential bearing outer ring
64. left differential bearing adjustment ring
65. upper layshaft oil manifold cup
66. reverse idle gear roller cage
67. reverse idle gear
68. reverse shaft
69. reverse control support
70. 2nd-4th and 5th-reverse fork
71. gearbox plate
72. upper layshaft plug
73. upper layshaft
74. upper secondary front bearing inner ring
75. upper secondary front bearing circlip
76. 4th speed roller cage
77. 4th speed driven gear
78. 4th speed synchroniser ring
79. 2nd-4th speed sleeve
80. 2nd speed synchroniser ring
81. 2nd speed gear bushing
82. 2nd speed roller cage
83. 2nd speed driven gear
84. 2nd-5th speed judder thrust washer
85. 5th speed gear bushing and 5th gear roller cage
86. 5th speed driven gear
87. outer reverse synchroniser ring
88. 5th speed sleeve
89. outer 5th speed synchroniser ring
90. reverse gear bushing
91. fixed reverse gear roller cage
92. reverse gear
93. upper layshaft rear bearing inner ring
94. upper layshaft ring nut
95. rear differential bearing inner ring
96. differential gear casing
97. front differential bearing inner ring
98. cylindrical wheel
99. cylindrical ring gear fixing screws
100. gearbox/mount centring dowel
101. magnetic element
102. front differential bearing outer ring
103. clutch/CSC delivery pipe fitting clip
104. gearbox/engine mount support
105. fixing screws
106. right differential shaft oil seal ring
107. fixing screw
108. gearbox/engine stud bolt
109. even gear release sleeve
110. fixing screw
111. screw
112. even gear clutch mechanism
113. even gear clutch driven plate
114. odd gear clutch mechanism
115. thrust bearing plug
116. pint-holder bearing
117. screw

ALFA TCT operating principles - Mechanical part

FPT engineers have designed solutions to allow continuous motion transmission using the C633 manual gearbox. Firstly, the main shaft of the Alfa TCT consists of two mutually coaxial shafts, called outer main shaft and inner main shaft. The junction area houses an axial bearing allowing reciprocal rotation. Both shafts are made of steel. The inner main shaft has a grooved profile for splining 3rd and 5th speed drive gears, while the outer main shaft is made in one piece.
Section view:

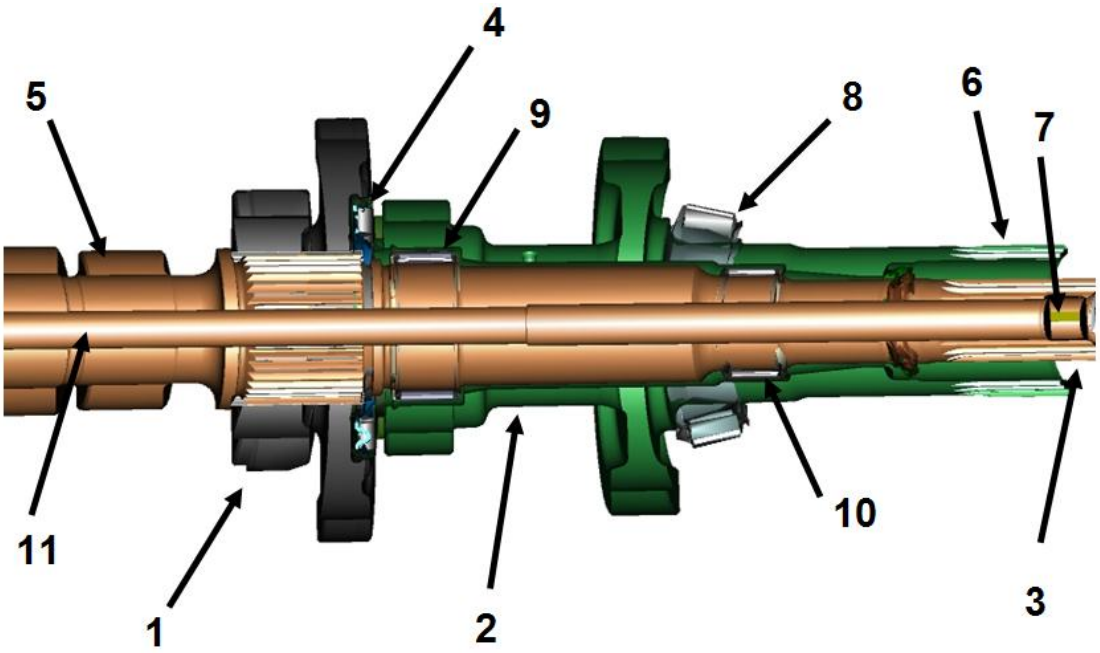


Fig. 7

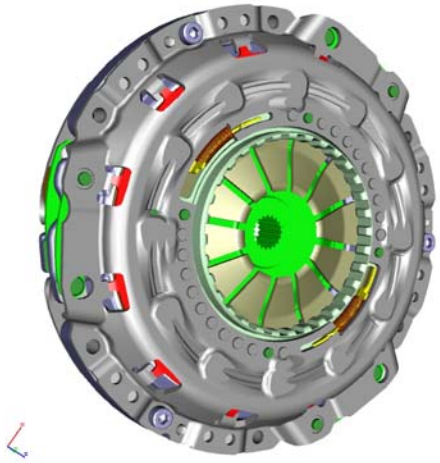
1. 3rd speed drive gear
2. outer main shaft (coupled to clutch K2 – even gears)
3. inner shaft odd gear clutch grooved profile
4. axial bearing
5. inner main shaft (coupled to clutch K1 – odd gears)
6. outer main shaft even gear clutch grooved profile
7. clutch rod bushing
8. outer main shaft bearing
9. roller cage
10. inner main shaft roller cage
11. inner main shaft hole for introducing odd gear clutch rod

The need for two main shafts derives from the fact that two pairs of gears must be meshed to allow continuous motion gearbox. Therefore, two clutches are needed to obtain this without causing mechanical damage, one for odd gears (called K1) and one for even gears (called K2). While travelling, one of the two clutches is closed to transmit motion from one only pair of gears and the other clutch is open to prevent gearbox using the other gear pair. While shifting either up or down, both clutches work in tandem: one closes when the other one opens, and vice versa.

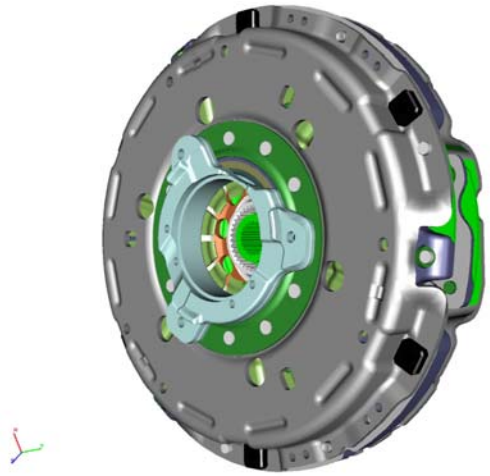
- The even drive gears (2nd, 4th and 6th) are obtained on the outer shaft (coupled to clutch K2), along with the groove for splining the even gear clutch.

- The odd driven gears (1st, 3rd, 5th, reverse) are splined on the inner main shaft (connected to the clutch K1), along with the grooved profile for splining the odd gear clutch.

Clutches



Clutch kit – view from engine side



Clutch kit – view from gearbox side

Fig. 8

The clutch kit is made by LuK and consists of a single body with two clutch plates and retaining mechanisms of the two clutches, such as pressure plate with diaphragm springs and pressure plate retaining springs.
The kit must be coupled to a specific flywheel which is provided with locking grooves visible on the clutch mechanism facing outside (engine side). Disassembling the clutch kit, we can see that odd gear driven plate K1 (normally closed) is positioned facing engine side and differs from the even gear driven plate clutch K2 (normally open) because of the visibly smaller diameter of the main shaft splining grooved profile. The two clutches cannot be replaced individually. The entire unit needs to be replaced in case of problems to either clutch.

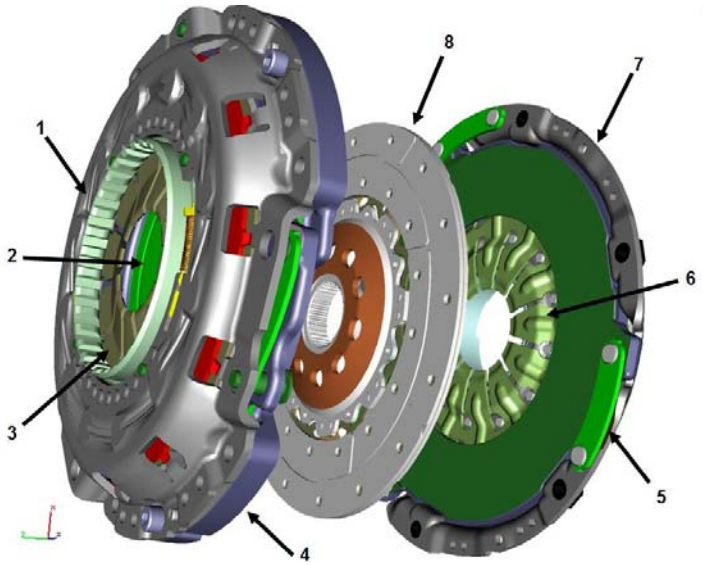


Fig. 9

1. odd gear clutch K1 mechanism lid
2. odd gear clutch K1 driven plate
3. odd gear clutch K1 pressure plate spring
4. intermediate flywheel
5. even gear clutch K2 pressure plate retaining spring
6. even gear clutch K2 pressure plate spring
7. even gear clutch K2 mechanism lid
8. even gear clutch K2 driven plate

Flywheel assembly exploded view - Clutch kit

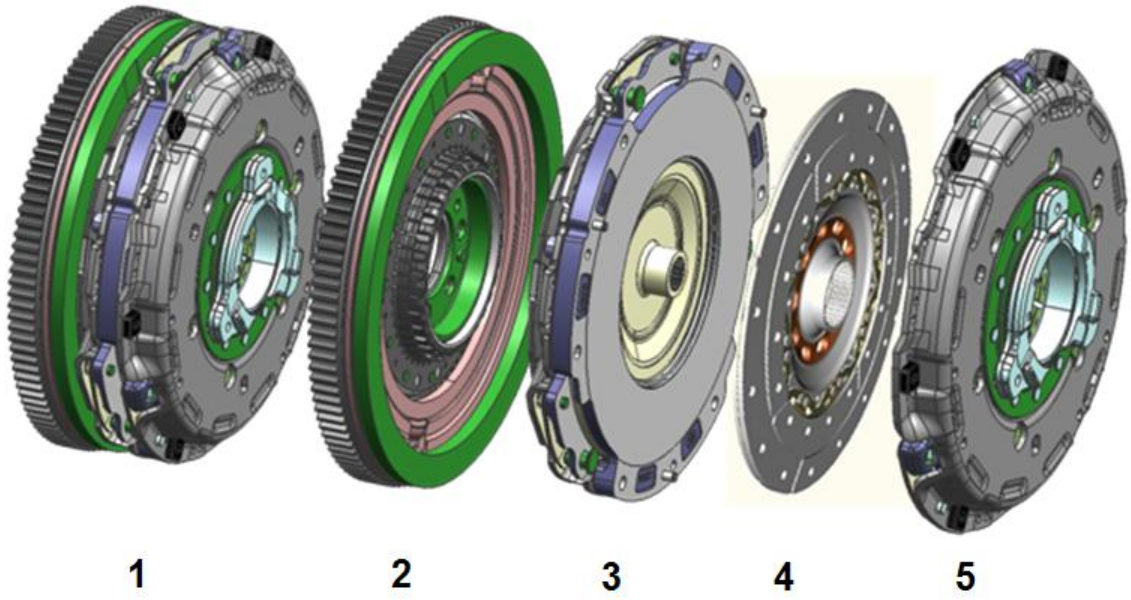


Fig. 10

1. Flywheel assembly - Clutch kit
2. Flywheel
3. Odd gear clutch K1 kit
4. Even gear clutch K2 plate
5. Clutch K2 lid-pressure plate assembly

Clutch unit section view:

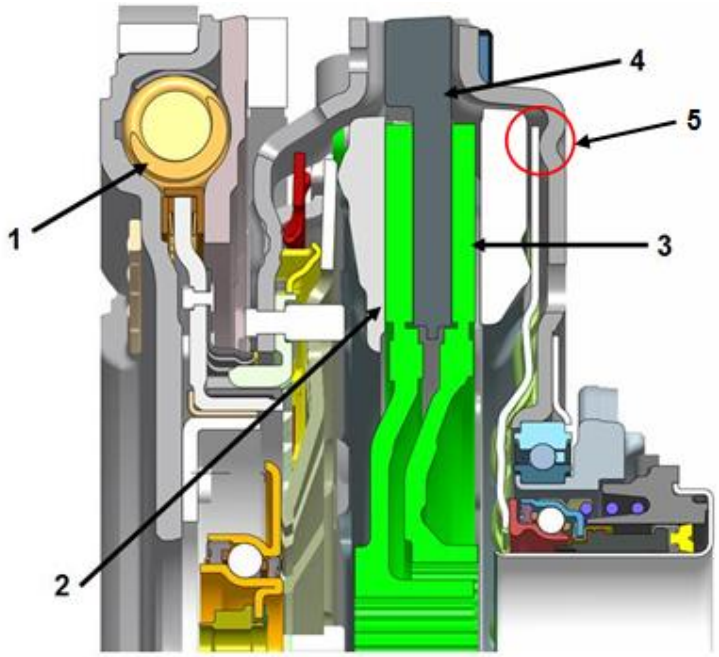


Fig. 11

1. Dual mass engine flywheel assembly
2. Odd gear clutch K1
3. Even gear clutch K2
4. Intermediate flywheel
5. Clutch K2 diaphragm spring pivot

Neither clutch plate K1 nor K2 (Fig. 11) is pressed on the dual mass flywheel surface. On the contrary, they are pressed on the surface of an intermediate flywheel mass between the two plates K1 and K2 and integral with the dual mass flywheel. The odd gear clutch K1 (engine side) operates on one side of the intermediate flywheel mass; the even gear clutch K2 (gearbox side) works on the other side. Clutch K1 is normally closed and provided with automatic clearance recovery mechanism. Clutch K2 is normally open and not provided with clearance recovery mechanism. The diaphragm spring of clutch K2 has a different layout and a different pivoting point than clutch K1: consequently, clutch K2 is normally open.

Clutch control

There are two clutch controls, usually called CSC, which work in tandem. When one clutch is released, the other one is engaged. CSC movement is entirely controlled by the TCU which, by means of the robot on the gearbox, can engage or release the clutches. The oil supply circuit to both CSCs is not separate from the oil circuit used by the robot to actuate the gear engagement and selection actuators. The same hydraulic oil is used.

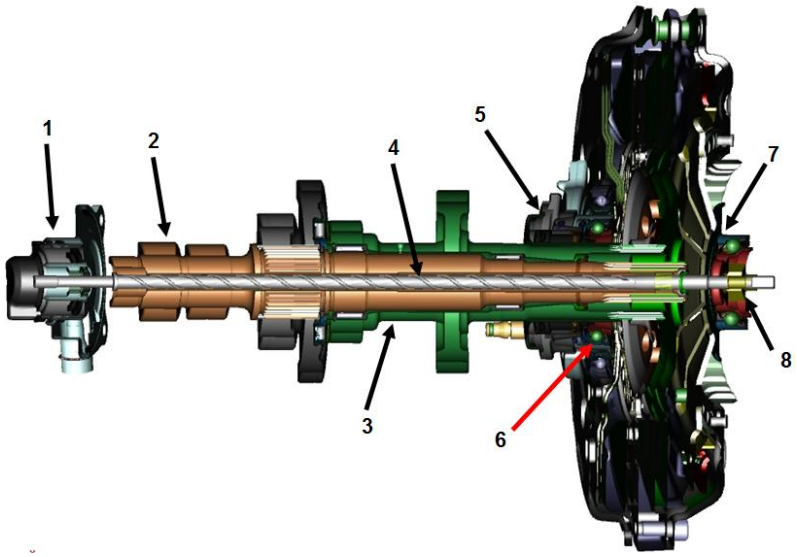


Fig. 12

1. odd gear clutch K1 CSC
2. inner main shaft
3. outer main shaft
4. odd gear clutch K1 thrush bearing control rod
5. even gear clutch K2 CSC
6. even gear clutch K2 thrust plate bearing
7. odd gear K1 clutch thrust bearing
8. odd gear clutch K1 bearing plug

Functional features

The following pictures illustrate the operating features of the clutch during a normal Powershift type gear shift.
We will take shifting from 1st gear to 2nd gear as an example. Remember that:

- The 1st speed drive gear is on the inner main shaft and is connected to odd gear clutch K1.
- The 2nd speed drive gear is on the outer main shaft and is connected to even gear clutch K2.

Travelling in 1st gear

With engine running, the system engages 1st gear when the lever is set to D.
The TCU closes the odd gear clutch K1 when starting off and for the first instants of movement.

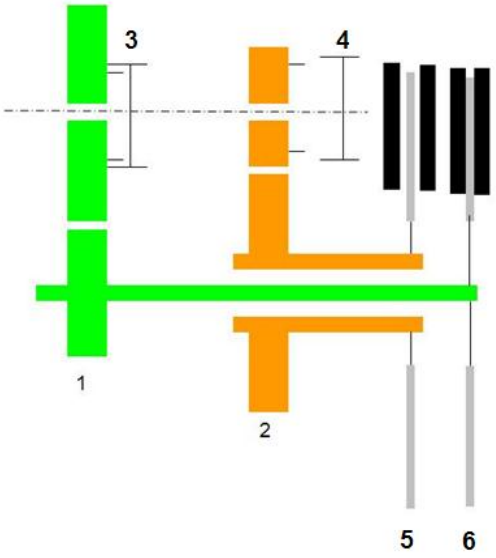


Fig. 13

1. 1st speed drive gear
2. 2nd speed drive gear
3. 1st speed engagement sliding sleeve
4. 2nd speed engagement sliding sleeve
5. Even gear clutch K2
6. Odd gear clutch K1

2nd speed pre-engagement

When travelling in 1st speed, the TCU controls 2nd speed pre-engagement by means of the robot to reduce shifting time and loss of torque caused by the gear shift.
In the picture:
The 2nd speed sliding sleeve engages but with clutch K2 open.

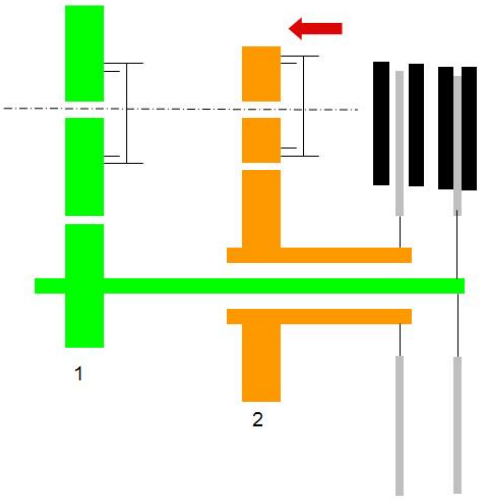


Fig. 14

Cross shifting

After pre-engaging 2nd gear, a cross shifting stage starts when the engine running conditions so require. The TCU controls the robot so that the even gear clutch K2 is gradually closed and the odd gear clutch K1 is gradually opened.

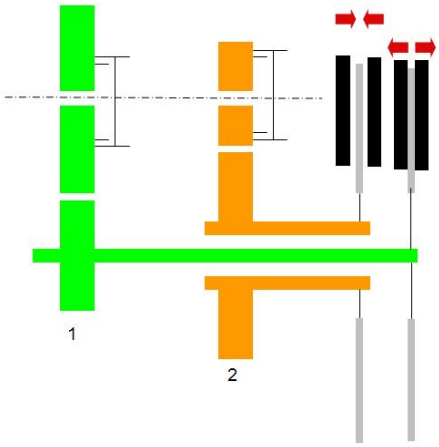


Fig. 15

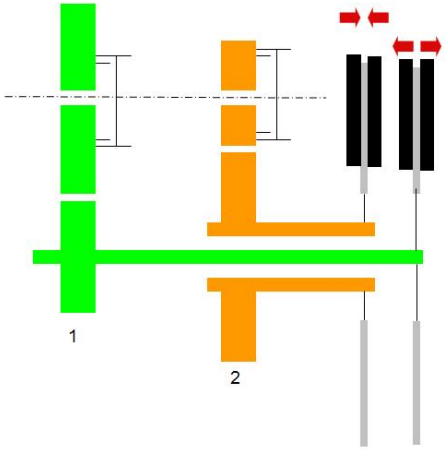


Fig. 16

Therefore, there is a very short time (Fig. 16) during which both clutches are transmitting torque, slipping in either 1st or 2nd gear. The cross shifting stage ends when clutch K1 is all open and clutch K2 is definitely closed.

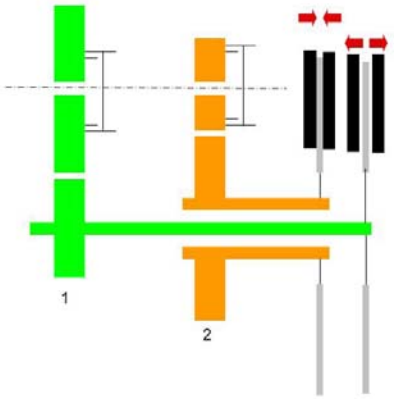


Fig. 17

The gear shift ends when the 1st gear sliding sleeve is released. The driver is not aware of this stage because movement is transmitted to the wheels through clutch K2.

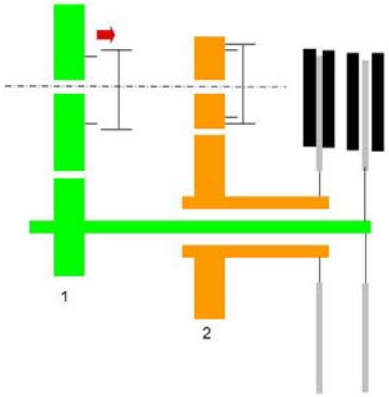


Fig. 18

Even gear CSC

The even gear CSC is a traditional hydraulic cylinder, coaxial to the gearbox main shaft. Its (annular) piston is in contact with the even gear clutch diaphragm spring by means of the thrust bearing. The piston is held in rest position by the reaction of the diaphragm spring. Consequently, the clutch is normally released if there is no pressure from the robot. There is no position sensor. Position is controlled by a pressure sensor fitted on the CSC power line. The signal is appropriately processed by the TCU (see below).

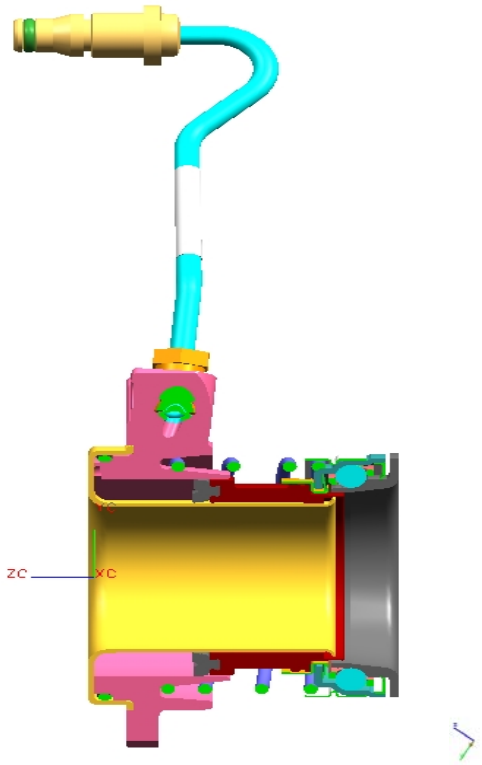


Fig. 19

Fig. 20

Odd gear CSC

The odd gear CSC is all new and specific for this gearbox. The delivery oil flow from the robot causes the movement of the piston (5) running on the guide tube. Low sliding friction is guaranteed by Teflon runners, which also prevent jamming of the piston in the release position. The action of the piston is transmitted by a specific rod (3) which runs inside the main shafts on a specific bushing and seal to the thrust bearing, thus allowing to release the clutch.
When the robot stops sending pressurised oil into the CSC, the diagram spring pushes the thrust bearing, which, by means of the control rod, positions the piston in retracted position, thus restoring engagement conditions and making oil flow towards the reservoir. The lack of compressibility of oil ensures gradual clutch operation because the trapped fluid column prevents the movement of the piston, which therefore maintains its position, when the robot maintains an intermediate position. The TCU controls the position assumed by the piston by means of a Hall effect sensor (1) fitted on the CSC to monitor odd gear clutch release failures and prevent mechanical damage to the gearbox components.

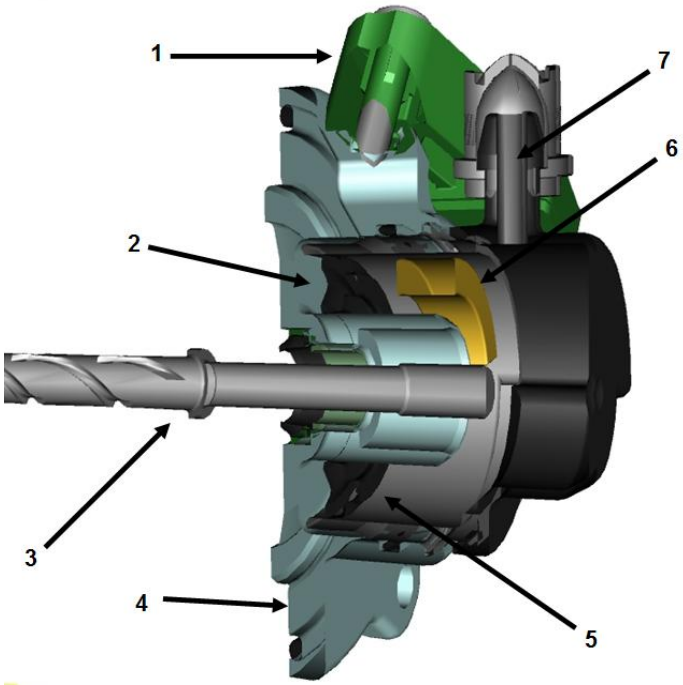


Fig. 21

Sectioned CSC key:

1. position sensor
2. oil inlet chamber
3. bearing control rod
4. CSC support
5. piston
6. magnet
7. air bleed

CSC and thrust bearing

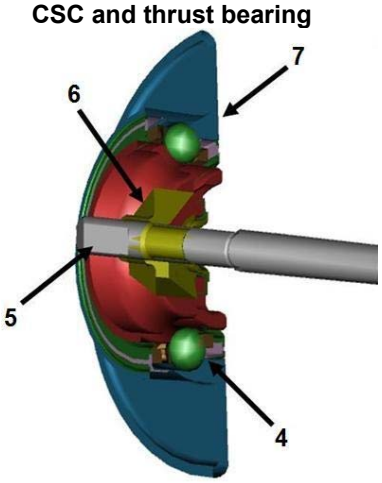


Fig. 22

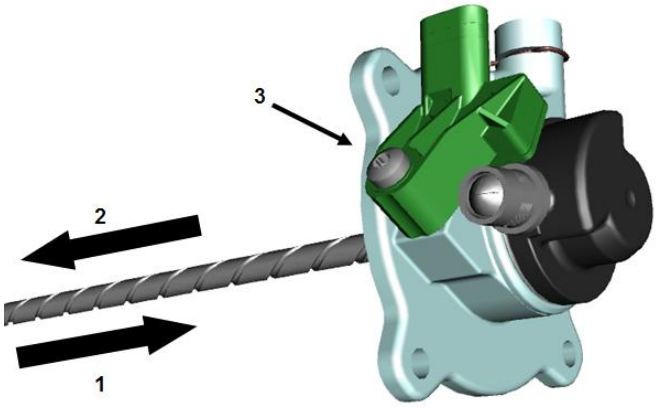


Fig. 23

Thrust bearing section

1. odd gear clutch K1 release movement
2. odd gear clutch K1 engagement movement
3. odd gear clutch K1 CSC
4. odd gear K1 clutch thrust bearing
5. control rod
6. nut
7. thrust bearing contact ring

Upper layshaft

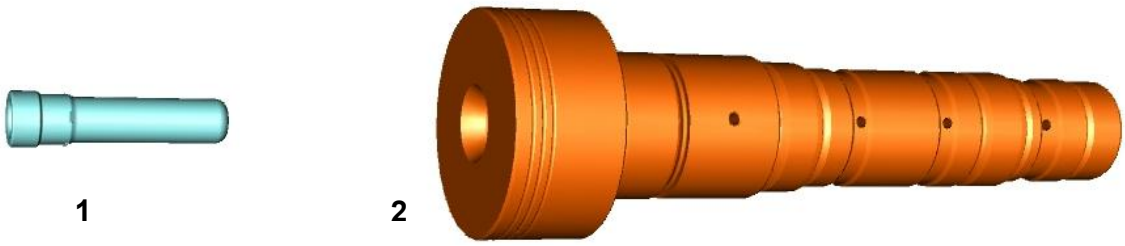


Fig. 24

1. Plastic plug
2. Upper layshaft

The upper layshaft is entirely made of steel; it is hollow so that oil can flow to the appropriate openings for lubricating the driven gear roller bearings. A plastic plug is positioned so that the oil channelled into the shaft can only flow out through the specific openings for lubricating the roller bearings on the shaft inner side. The Alfa TCT upper layshaft is the same as that of the manual gearbox. The difference concerns the position of the gears on the shaft itself. The gears interface with the shaft by means of steel bushings.

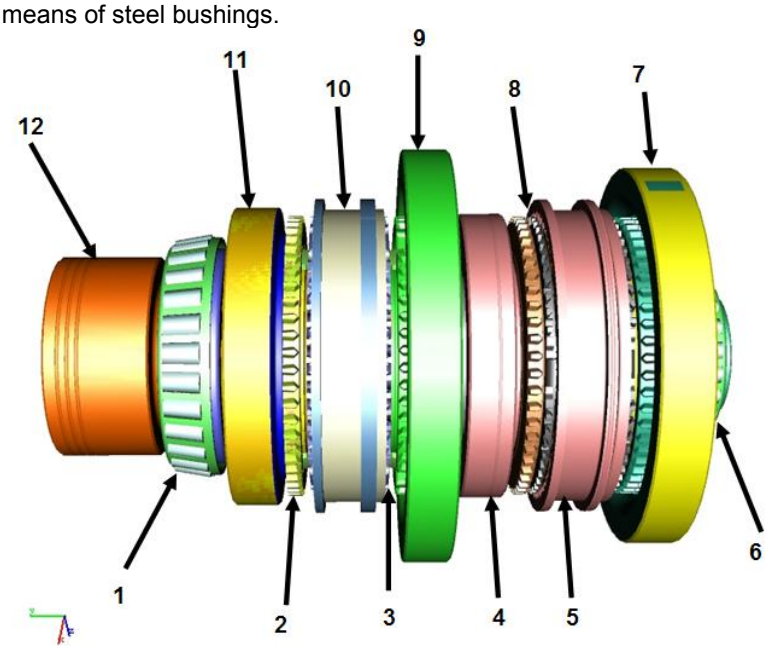


Fig. 25

1. upper layshaft inner bearing
2. 4th speed gear toothed ring
3. 2nd speed synchroniser ring
4. 5th speed gear
5. 5th speed and reverse sliding sleeve
6. upper layshaft outer bearing
7. reverse driven gear
8. 5th speed synchroniser ring
9. 2nd speed driven gear
10. 2nd and 4th speed sliding sleeve
11. 4th speed driven gear
12. motion transfer gear from shaft to differential

Reverse

Motioned is reversed in the Alfa TCT by using a straight tooth idle gear installed in the gearbox and accommodated on a specific support.

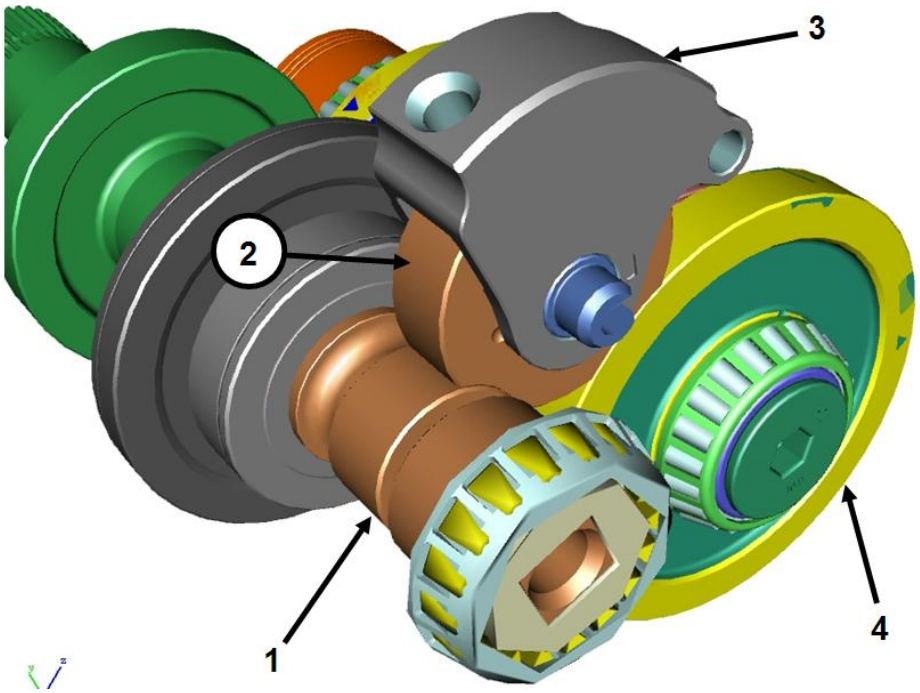


Fig. 26

1. Inner main shaft
2. Idle wheel
3. Idle wheel support
4. Reverse driven gear

Lower layshaft

Fig. 27

1. Plastic plug
2. Lower layshaft

The lower layshaft is entirely made of steel; it is hollow so that oil can flow to the appropriate openings for lubricating the driven gear roller bearings. A plastic plug is positioned so that the oil channelled into the shaft can only flow out through the specific openings for lubricating the roller bearings on the shaft inner side. The TCT upper layshaft is the same as that of the manual gearbox. The difference concerns the position of the gears on the shaft itself. The gears interface with the shaft by means of steel bushings.

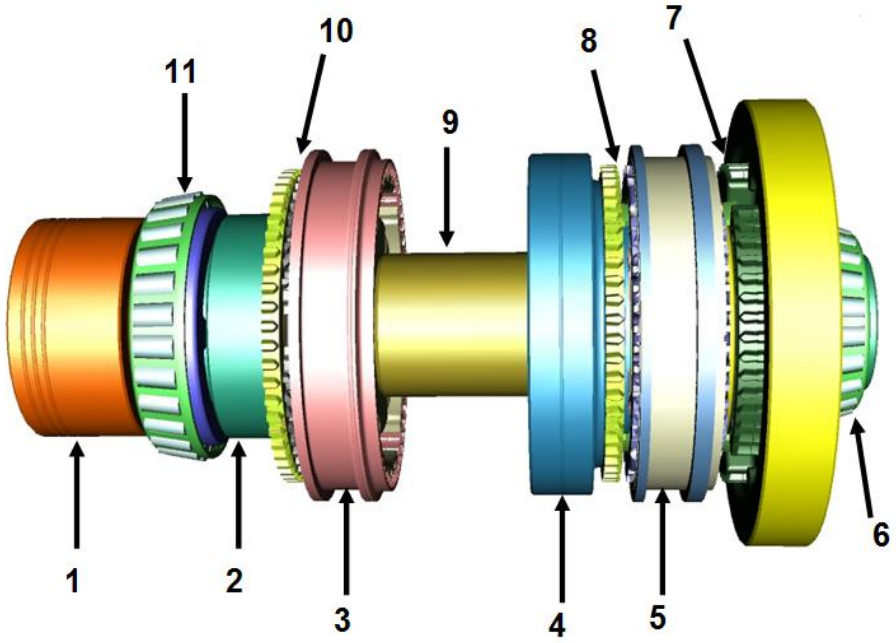


Fig. 28

1. Motion transfer gear from shaft to differential
2. 6th speed driven gear
3. 6th speed sliding sleeve
4. 3rd speed driven gear
5. 3rd and 1st speed sliding sleeve
6. Lower layshaft outer bearing
7. 1st speed toothed ring
8. 3rd speed synchroniser ring
9. 6th speed spacer
10. 6th speed toothed ring
11. Lower layshaft inner bearing

Gear outlet

The gear output of the Alfa TCT is shown in the figures below.
Odd gears are shown in blue. Even gears are shown in green. The inner main shaft is light blue and the outer main shaft is yellow.

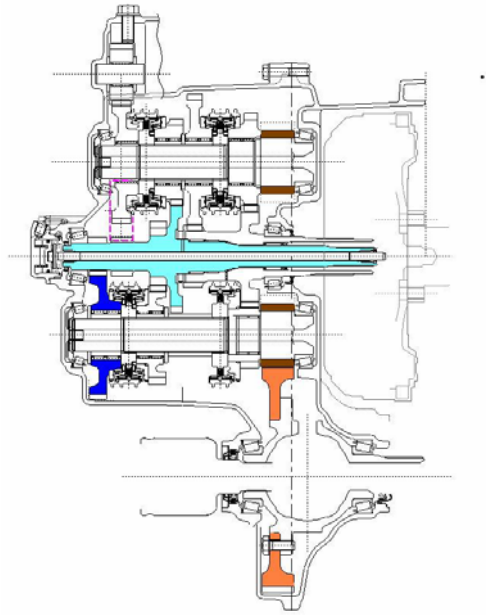


Fig. 29 - 1st gear outlet

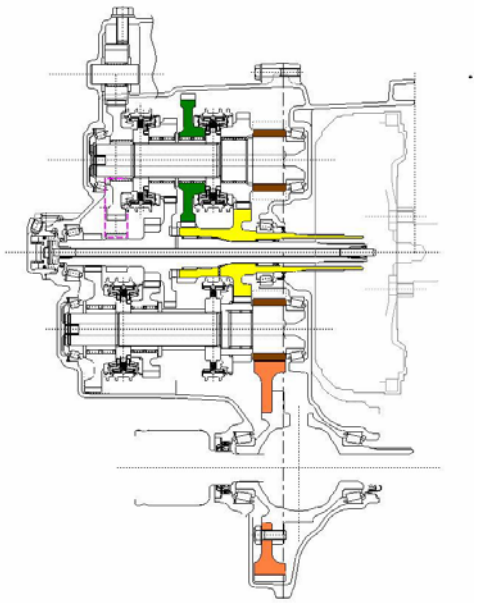


Fig. 30 - 2nd gear outlet

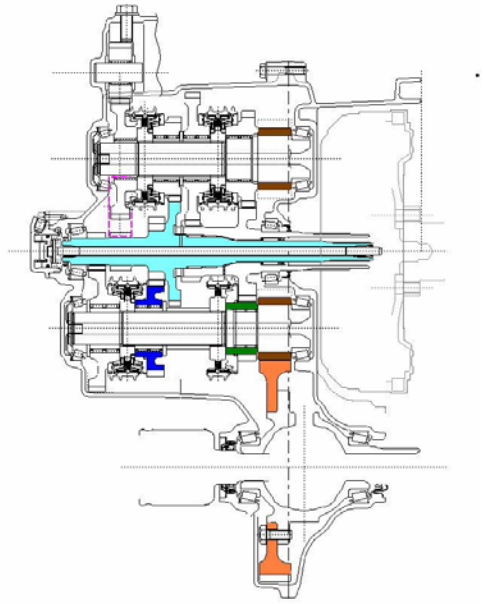


Fig. 31 - 3rd gear outlet

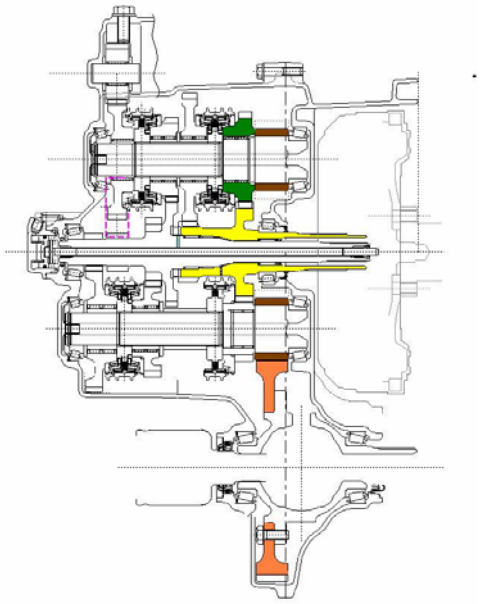


Fig. 32 - 4th gear outlet

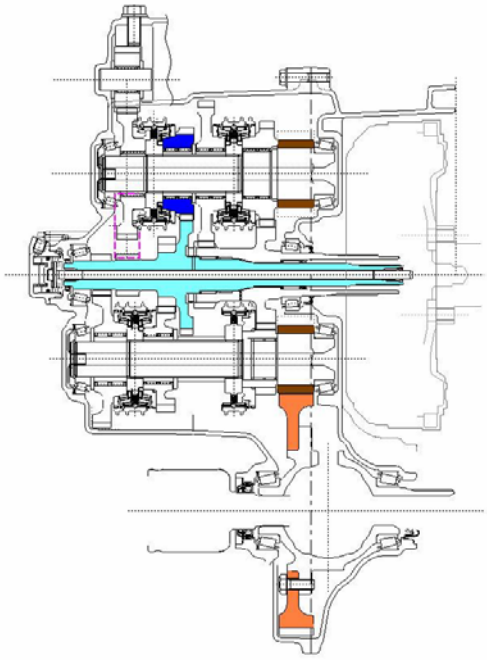


Fig. 33 - 5th gear outlet

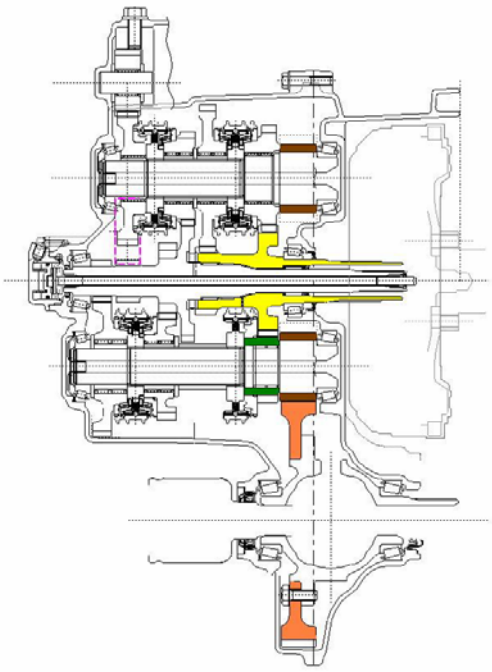


Fig. 34 - 6th gear outlet

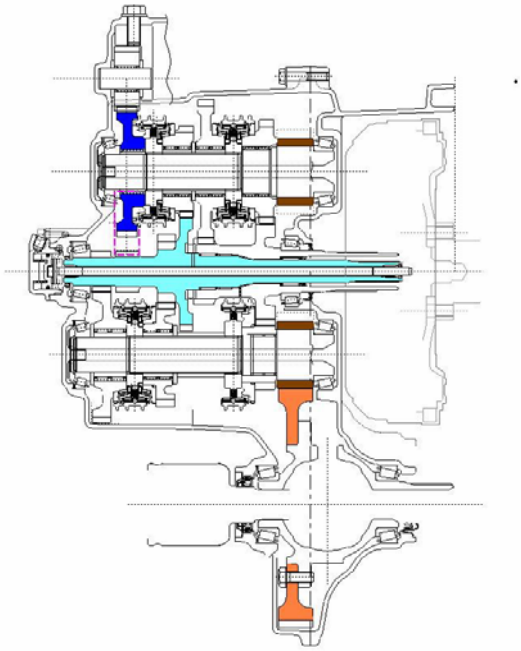


Fig. 35 - Reverse outlet

Gear engagement rods

The robot uses four rods ending in four forks, which are engaged in the sliding sleeves for engaging the gears.

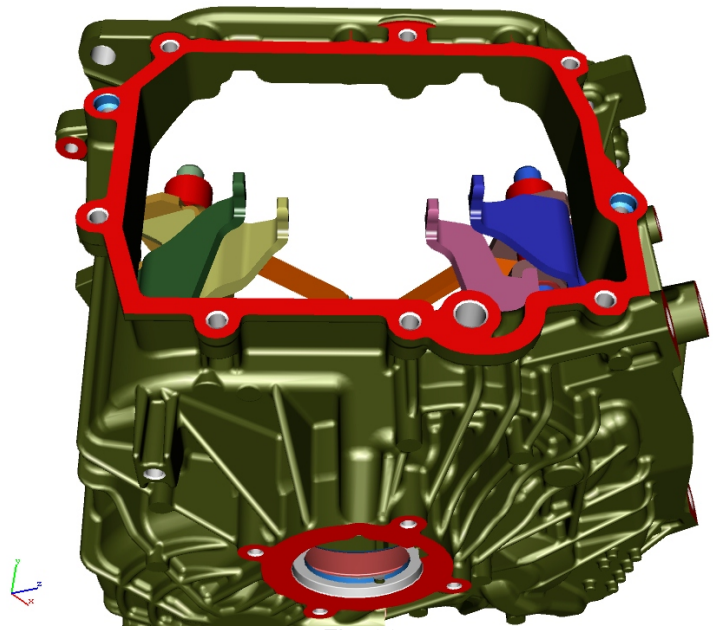


Fig. 36

The rods are positioned in pairs. One pair engages the gear on the upper layshaft, the other pair those on the lower layshaft. The rods are anchored to the gearbox casing by means of two hollow steel shafts, which also allow sliding to move the sliding sleeve. The rods are shown below in gear engagement order:

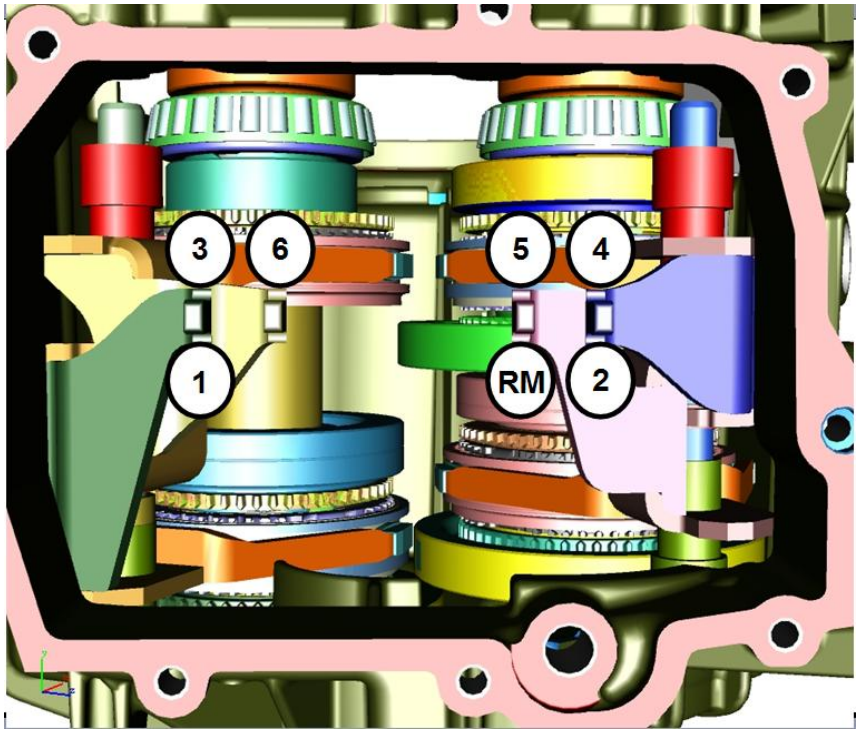


Fig. 37

Differential

The Alfa TCT is equipped with an open differential. The crown is joined to the body of the differential by means of 12 screws.

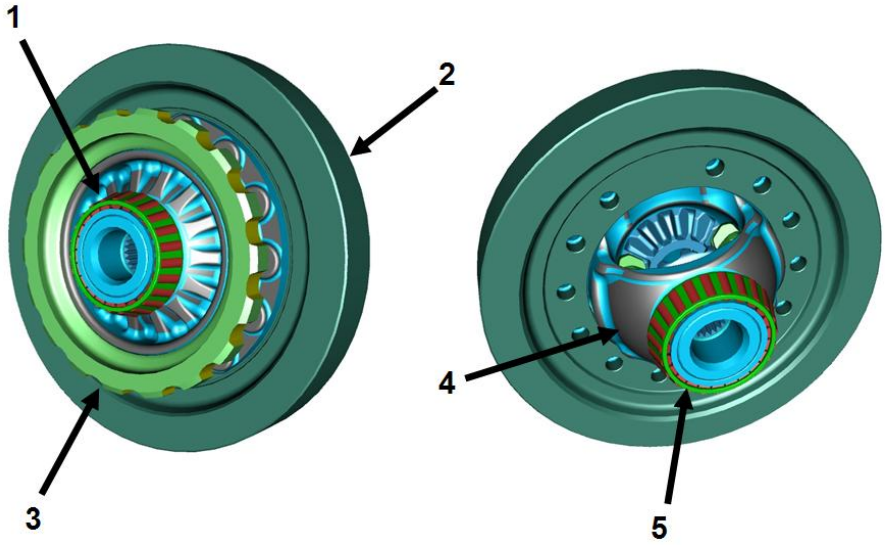


Fig. 38

1. Tapered bearing, left side
2. Cylindrical ring gear
3. "Parking" function ring gear
4. Differential gear casing
5. Tapered bearing, right side

To replicate the “Parking” function of automatic gearboxes, a toothed wheel (3 in the picture above) is inserted on the differential body with the purpose of blocking a ratchet when the selection lever is in the “Parking” position. The ratchet is moved mechanically by means of a Bowden cable, which in turn moves an actuator consisting of a spring and a piston. The movement of the actuator lowers the ratchet due to the contact with the piston.

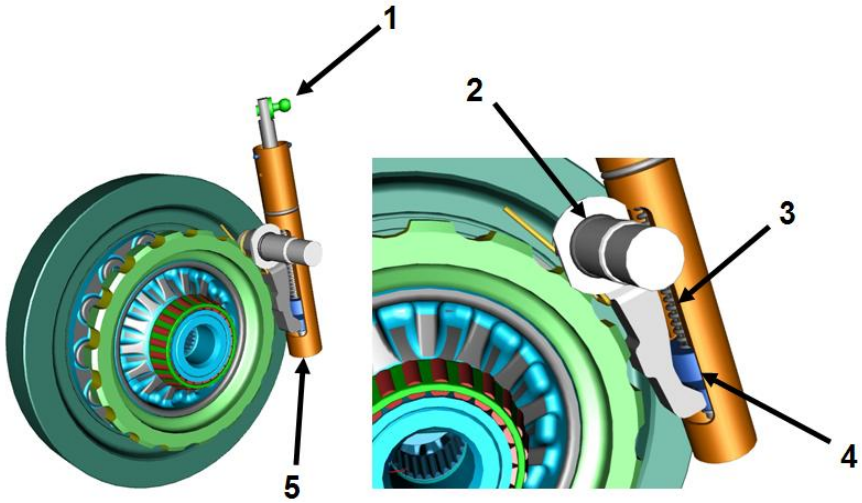


Fig. 39

1. Bowden engagement
2. Parking ratchet
3. Spring
4. Piston
5. Parking actuator

Electrohydraulic kit components

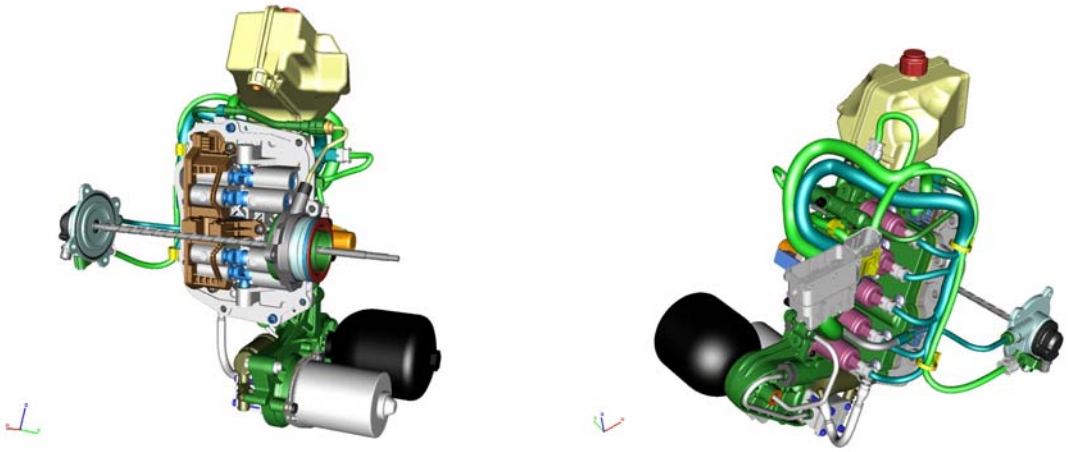


Fig. 40

The electrohydraulic kit is positioned directly on the manual gearbox. It consists of several parts: the reservoir, the hydraulic power unit, the CSCs and the actuator unit (CAM). The unit is called **Complete Actuation System** hence the acronym **CAS**. It comprises:

- The hydraulic power unit with electric pump and accumulator;

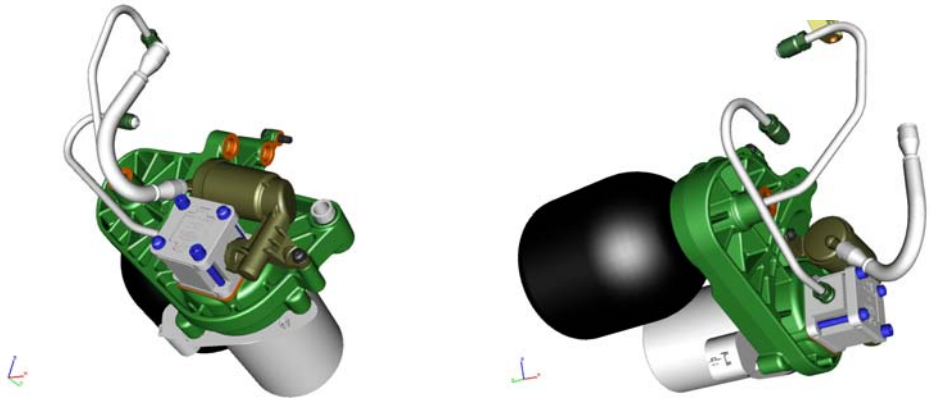


Fig. 41

- The solenoid valve actuating unit, which transforms hydraulic energy into mechanical energy by interfacing engagement pistons and control rods. This unit is called Complete Actuation Module (CAM).

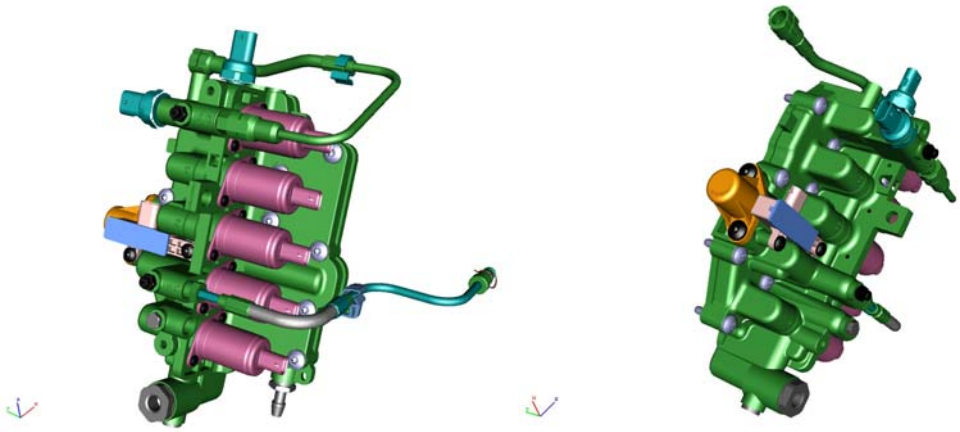


Fig. 42

Power unit

The power unit supplies hydraulic energy for actuating both gear engagement/selection and clutch CSCs. The unit includes an electric pump, high pressure pipes connecting to the solenoid valve unit and a low-pressure, pre-shaped rubber flexible hose, which connects the valve unit to the pump.

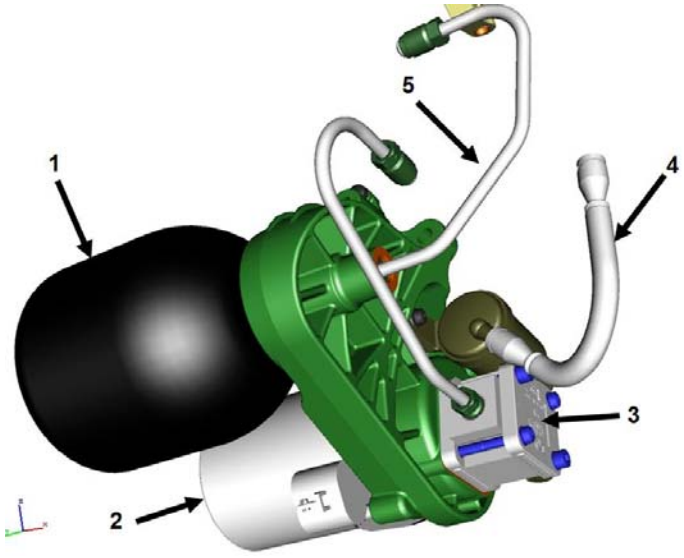


Fig. 43

1. precharged nitrogen accumulator
2. motor
3. oil pump
4. low pressure oil line
5. high pressure oil line

The system works with line pressure at ambient temperature in the range from 44 to 55 bar. The engagement/release pressure thresholds are appropriately reduced at lower temperatures by effect of the lower accumulator precharging to prevent the electric pump from overworking (because the oil is more viscous). At higher temperatures, the engagement/release pressures are appropriately increased to take into account the precharge increase in the accumulator. For example, the system works between 39 and 43 bar at -30°C and between 50 and 58 bar at 120°C in normal conditions. In recovery condition, the system may reach a maximum operating pressure of 70 ± 5 bar.
The electric pump is activated when the pressure drops below 44 bar and is deactivated when the pressure of the circuit reaches 55 bar.

Technical specifications:

- Line pressure at ambient temperature: between 44 and 55 bar
- Operating temperature: between -30°C and +120°C
- Starting possible to a temperature of -30°C
- Pump flow is >1.35 l/min
- Accumulator volume is 480 cm^3, precharged at 30 bar at 20°C

Complete Actuation Module
The module consists of four pressure proportional solenoid valves (PPV), a flow proportional solenoid valves (QPV) for CSC K1, a control pressure sensor for CSC K2, a line pressure sensor, magneto-resistive sensors for controlling movements of the shifter and gear engagement pistons and gearbox input rpm sensors.
The functions of this module are:

- to control and manage clutch position
- to control and manage gear selection and engagement

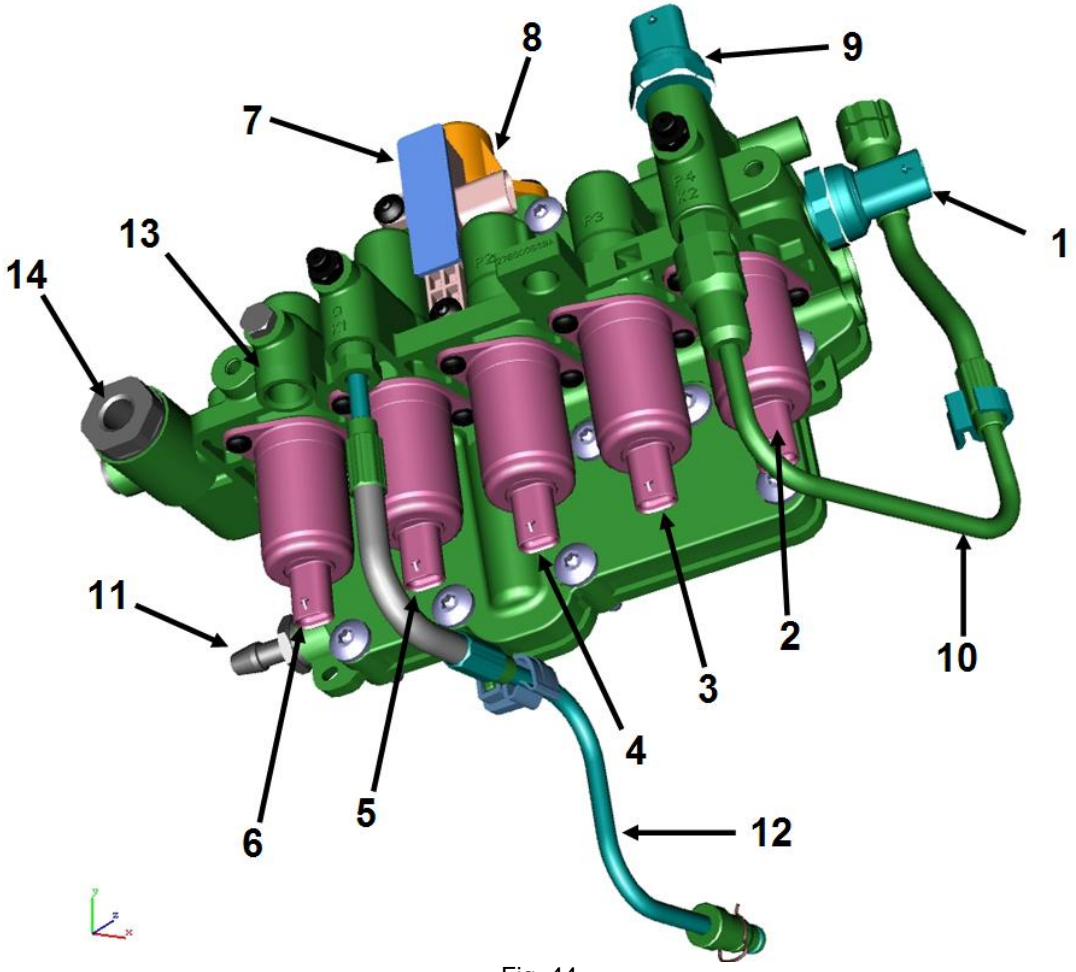


Fig. 44

The Complete Actuation Module includes:

1. Electrohydraulic kit line pressure sensor.
2. Proportional pressure solenoid valve PPV K2 (for even gear clutch control)
3. Proportional pressure solenoid valve PPV-S (shifter)
4. Proportional pressure solenoid valve PPV2 for engagement (engagement of first-sixth-fourth-fifth speed gears)
5. Proportional flow solenoid valve QPV K1 (for odd gear clutch control)
6. Proportional pressure solenoid valve PPV1 for engagement (engagement of third - (seventh) - second - reverse speed gears)
7. Shifter selector position sensor
8. Shifter selector axis
9. K2 CSC pressure sensor
10. K2 CSC oil outlet
11. Low pressure oil outlet towards hydraulic power unit.
12. CSC K1 oil outlet
13. Connection to pressure accumulator.
14. High pressure oil inlet from hydraulic power unit.

Shifter

The shifter is used to select the gears. The range selection solenoid valve PPV-S sends pressurised oil to the selection actuator. The oil pressure moves the hydraulic spool (3) against the load of the spring (4). Under oil pressure, the hydraulic spool goes next to the engagement actuator for the required gear. The hydraulic spool acts as a hydraulic power shifter.

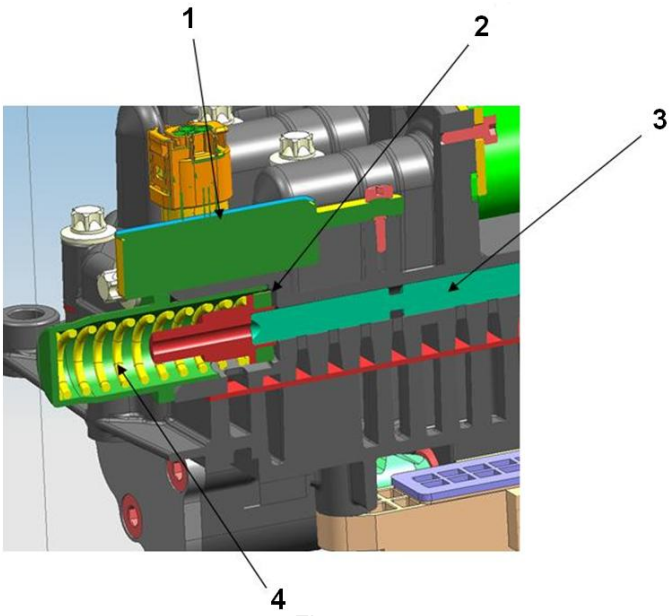


Fig. 45

1. Position sensor
2. Magnetic target on spool
3. Hydraulic selection spool
4. Load simulation spring

Hydraulic labyrinth

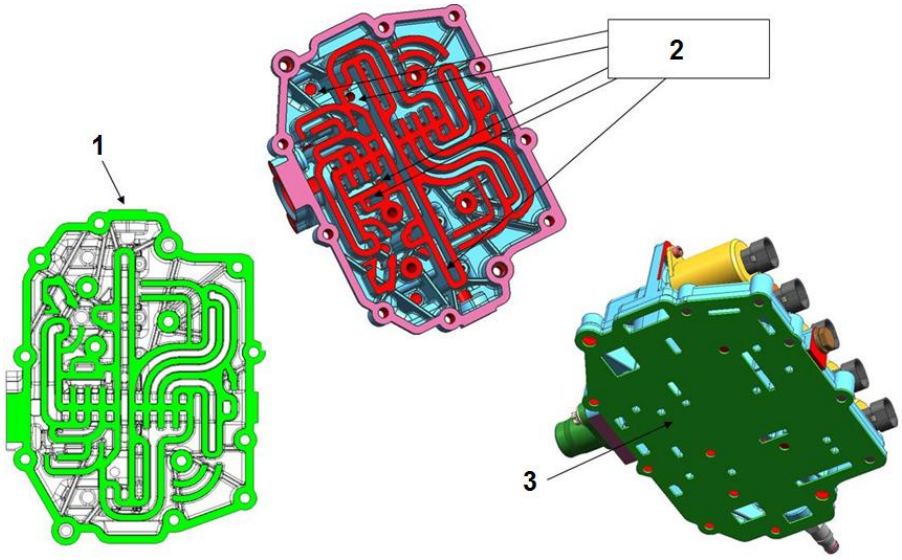


Fig. 46

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

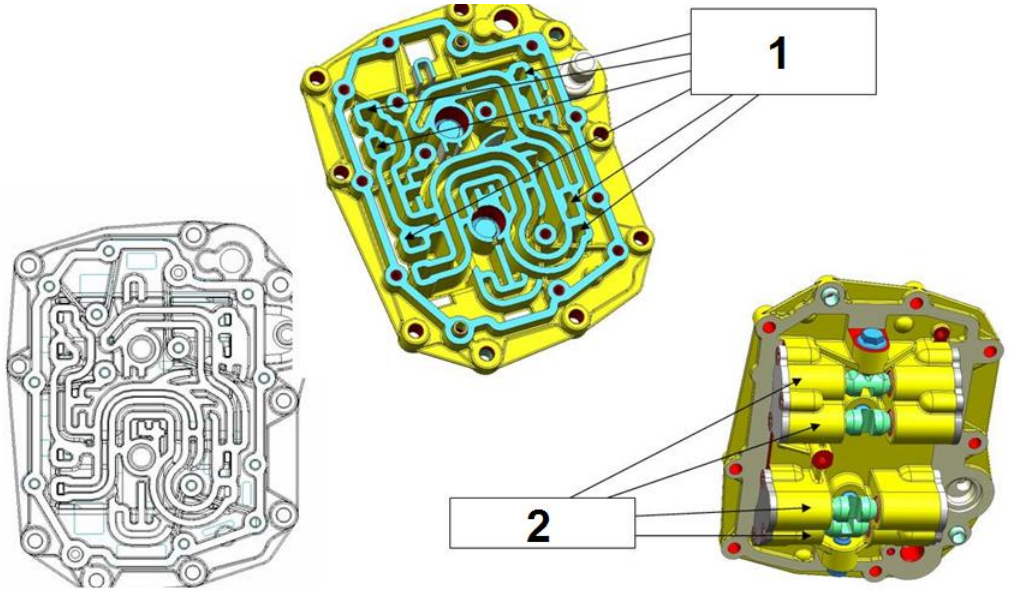


Fig. 47

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

Gear engagement piston

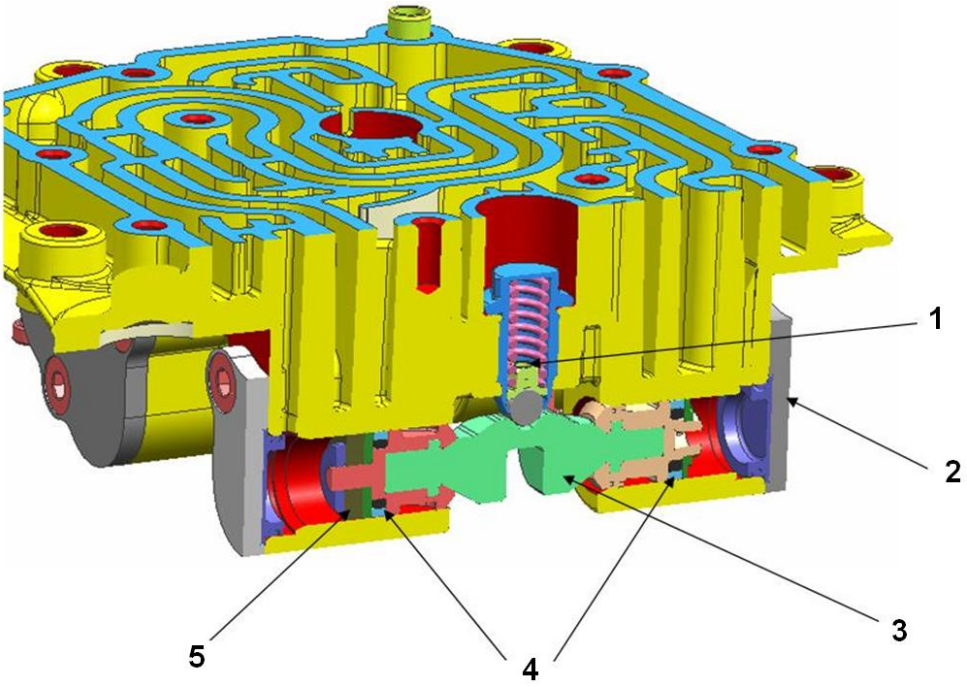


Fig. 48

1. Snap centring stop
2. Piston chamber plug
3. Steel cam
4. Seals
5. Magnetic target

Functional hydraulic diagram

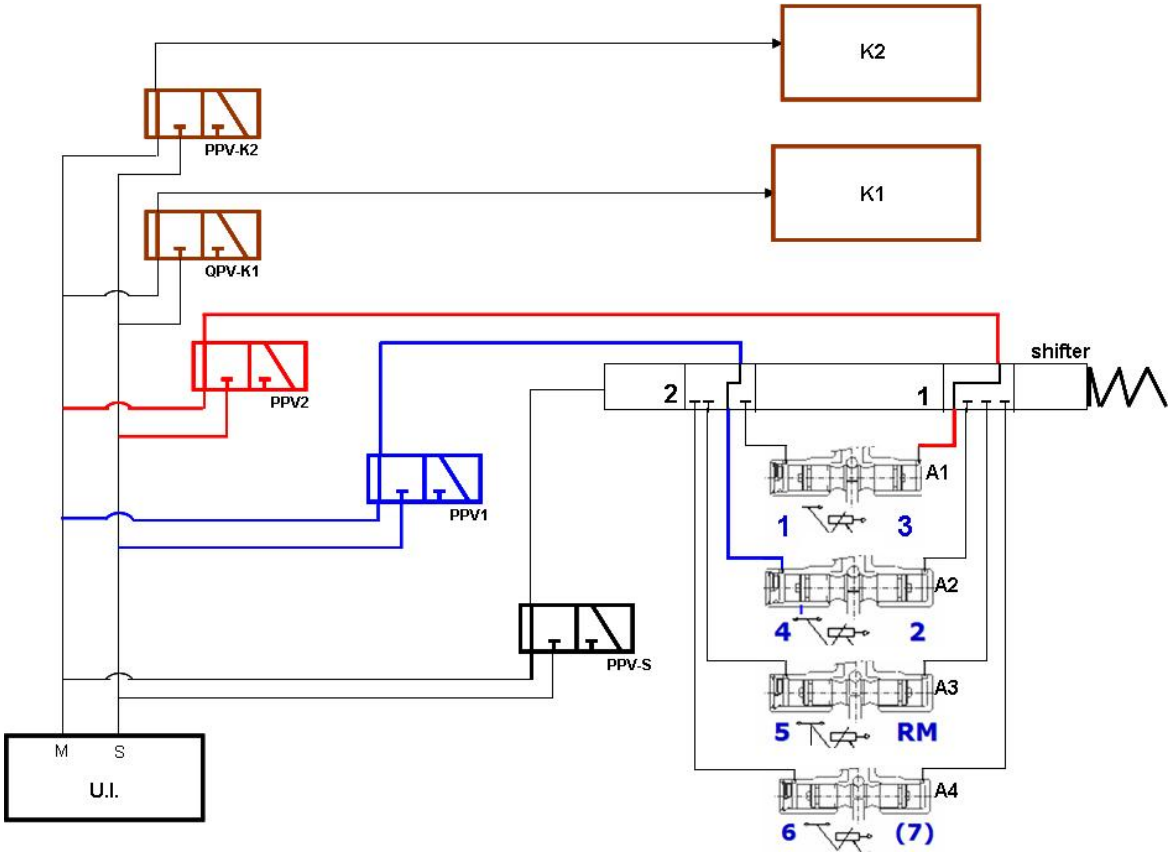


Fig. 49

K1 - CSC odd gear clutch K1
K2 - CSC even gear clutch K2
U.I. – Hydraulic power unit – (M delivery; S exhaust)
A1 – 1st and 3rd gear engagement actuator
A2 – 6th and (7th) gear engagement actuator
A3 – 2nd and 4th engagement actuator
A4 – 5th and reverse gear engagement actuator

The electrohydraulic kit solenoid valves are of the proportional type. There are no on-off type solenoid valves. Clutch K1 is normally closed. The clutch K1 CSC is controlled by flow proportional solenoid valve QPV-K1. Clutch K1 is controlled by means of oil flow. Clutch K2 is normally open. The clutch K2 CSC is controlled by pressure proportional solenoid valve PPV-K2. Clutch K2 is thus controlled by means of action on the oil pressure towards the actuator. As shown in the mechanical description, the main shaft consists of two parts. All even gears (1st, 3rd, 5th, R) are on one of the two parts, connected to the clutch K1, while all the even gears (2nd, 4th, 6th) are on the other part and connected to clutch K2. The engagement plane (range) selection is managed by the proportional pressure solenoid valve PPV-S, which controls the shifter for hydraulic power. Gear engagement is managed by two proportional pressure solenoid valves PPV1 and PPV2. Unlike the traditional robotised gearboxes known until today (M20 and M40, for example), the Alfa TCT does not fit two engagement solenoid valves (e.g. an even gear solenoid valve and an odd gear solenoid valve). The PPV1 solenoid valve controls engagement of both the even gears and the odd gears. The same applies to the PPV2. This is how. With reference to the hydraulic functional diagram in figure 49, we will describe engaging 1st gear and then 2nd gear. The TCU controls PPV-S so to position the shifter in position 1. At the same time, the TCU controls solenoid valve PPV2 to send pressurised oil along the red channel. The shifter moves to position 1, thus putting the red channel into communication with the left part of actuator A1. At this point, oil fills the left chamber of the actuator, shifting it rightwards and engaging 1st speed. Obviously, this happens only after the TCU

- through solenoid valve QPV-K1 - has opened clutch K1 by controlling the corresponding CSC. When 1st gear is engaged, the TCU releases QPV-K1 so as to drain oil from CSC-K1 and close clutch K1. The 2nd gear is pre-selected when transmitting motion in 1st gear. This is how. The TCU controls the slider by means of PPV-S to arrange it in position 2. At the same time, the TCU controls solenoid valve PPV1 to drain pressurised oil from the blue channel. The shifter goes to position 2 and puts the light blue duct into communication with the left side of actuator A3. In this way, pressurised oil pushes actuator A3 rightwards, engaging 2nd speed. The 2nd gear is engaged without TCU controlling solenoid valve PPV-K2 because clutch K2 is already normally open. In this way, drive transmission occurs only through 1st speed (which is engaged) and clutch K1 is closed; at the same time, 2nd speed is also engaged, but neutralised by clutch K2 (which is open). The clutches are simply swapped when the engine operating conditions are such to require motion transmission in 2nd gear. This is carried by gradually closing K2 by means of PPV-K2 and opening K1 by means of QPV-K1. It is important to note that solenoid valves PPV1, PPV2 and PPV-S are not controlled for the entire gear engagement time. The electric control to the solenoid valves is cut off when the gear is engaged. This means, for example, that after having engaged 1st gear, TCU stops supplying power to PPV2 to drain oil from the left of actuator A1. When oil is drained, the TCU stop supplying power also to PPV-S* in order to be able to drain oil from the shifter. This occurs also for the engagement of all other gears. The working channels are coloured in red and blue on the hydraulic diagram along with the shifter ducts inside the labyrinth in the lower part of the valve seat body (figure on page 35). The channels which connect the shifter to the actuators (A1, A2; A3, A4) are obtained in the labyrinth arranged in the upper part of the actuator body (figures on page 36). There is a separation plate between actuator body and labyrinth with a certain number of holes which allow the oil to flow from a labyrinth system to the other.

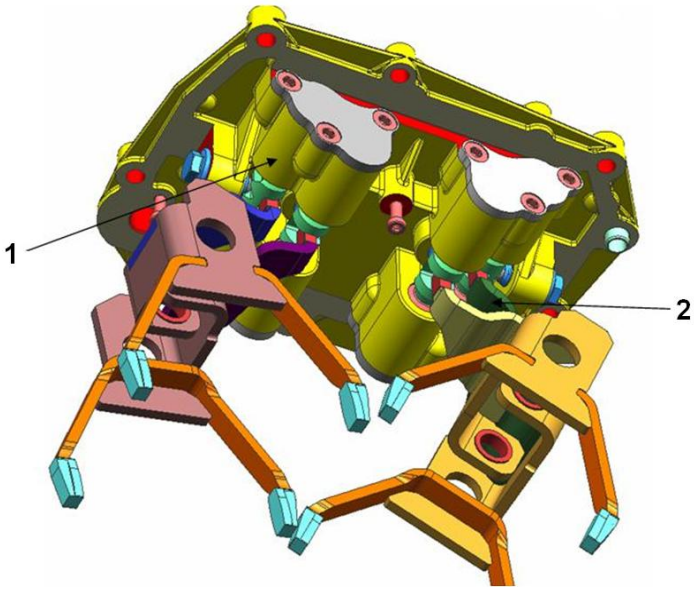


Fig. 50

1. Gear engagement piston unit
2. Control dogs

** Note: After engagement, solenoid valve PPV-S is controlled to cycle the shifter along all ranges and drain residual oil from the actuators.*

Integrated sensor module

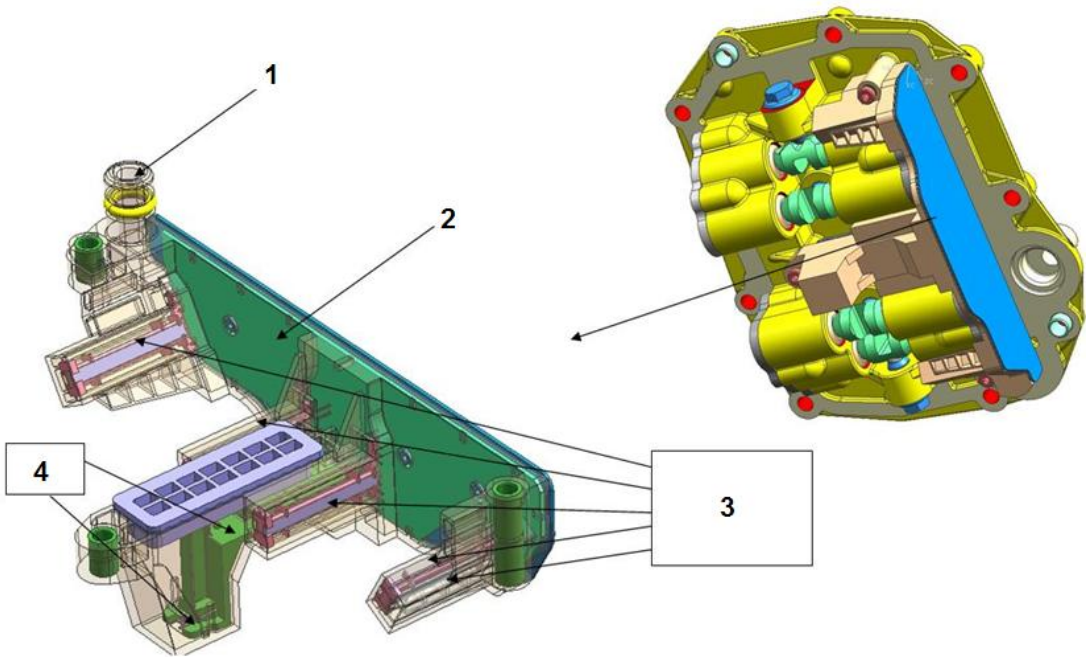
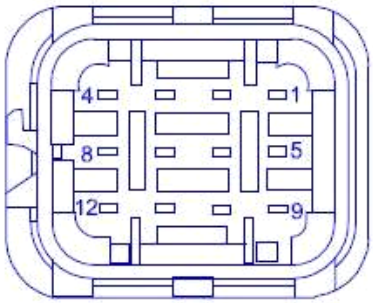


Fig. 51

1. Wire output with oil seal
2. Integrated sensor module
3. Magnetic-resistive position sensor for each engagement piston
4. Clutch K1 and clutch K2 rpm sensor

Integrated sensor module connector



Integrated sensor module pin-out

1 – 6th gear position signal
2 – 5th gear and reverse position signal
3 – 2nd and 4th gear position signal
4 – 1st and 3rd gear position signal
5 – Electronic GND from TCU to position sensors and temperature sensor
6 – CAS temperature signal (actuator assembly)
7 – Integrated sensor module +5 V power (6th gear position sensor and 2nd and 4th gear position sensor)
8 – Integrated sensor module +5 V power (1st/3rd gear position sensor and 5th gear/reverse position sensor)
9 – Odd K1 gear clutch rpm signal
10 – Electronic earth from TCU for odd gear clutch K1 rpm and even clutch K2 clutch rpm sensors
11 – Even gear clutch K2 rpm signal
12 – Integrated sensor module +5 V power (clutch K1 rpm sensor and clutch K2 rpm sensor)

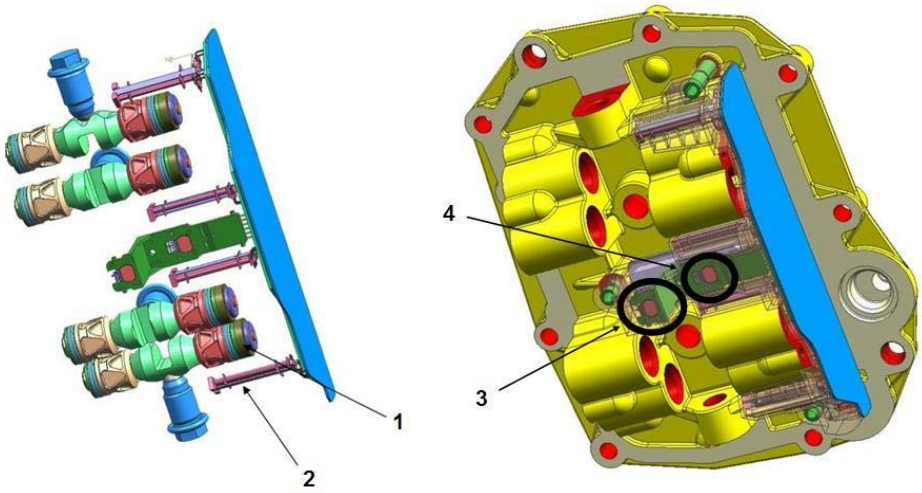


Fig. 52

1. Magnetic target
2. Engagement actuator position sensor element
3. Outer main shaft rpm sensor element
4. Inner main shaft rpm sensor element

Sensor module position in gearbox casing

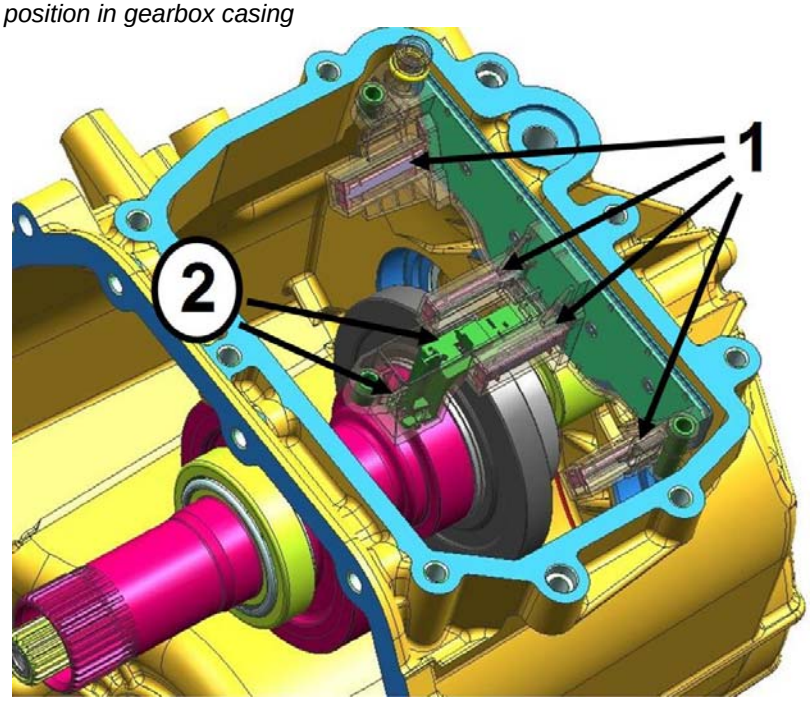


Fig. 53

Actuator position sensors (1):

- PWM output signal (0-5 V), refreshed every 0.5 ms
- 5 V ± 0.5 V power
- Working range: -30°C – 150°C
- Measuring range: 25 – 30 mm

Clutch rpm sensor (2):

- Electromagnetic, Hall effect sensor
- Output signal: square wave, width 0 – 5 V
- Max. measurable speed: 10000 rpm

Shifter position sensor

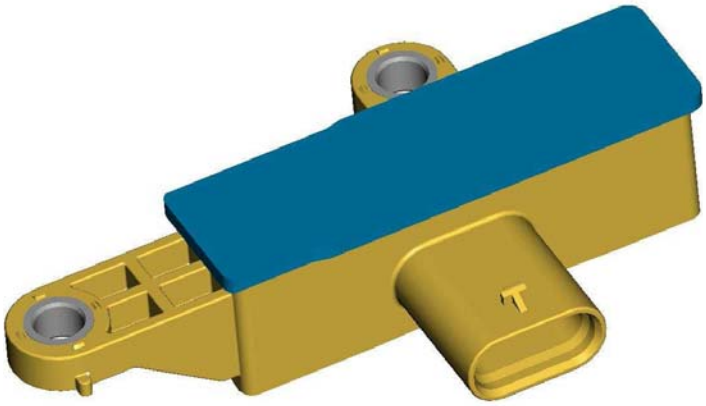


Fig. 54

- PWM output signal (0-5 V), refreshed every 1 ms
- 5 V ± 0.5 V power
- Working range: -30°C – 150°C
- Measuring range: 25 – 30 mm

Clutch position sensor

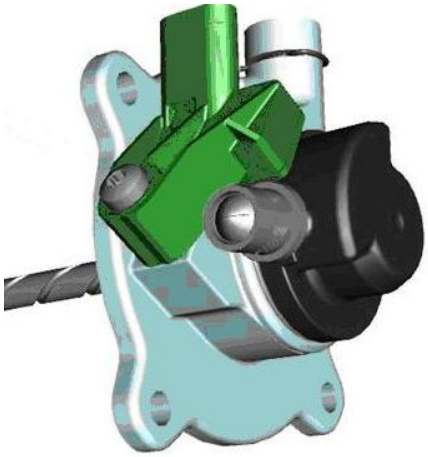


Fig. 55

- PWM output signal (0-5 V), refreshed every 1 ms
- 5 V ± 0.5 V power
- Working range: -30°C – 120°C
- Measuring range: 13 mm

Pressure sensors

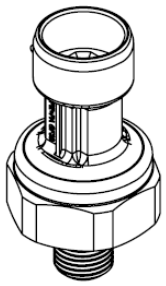


Fig. 56

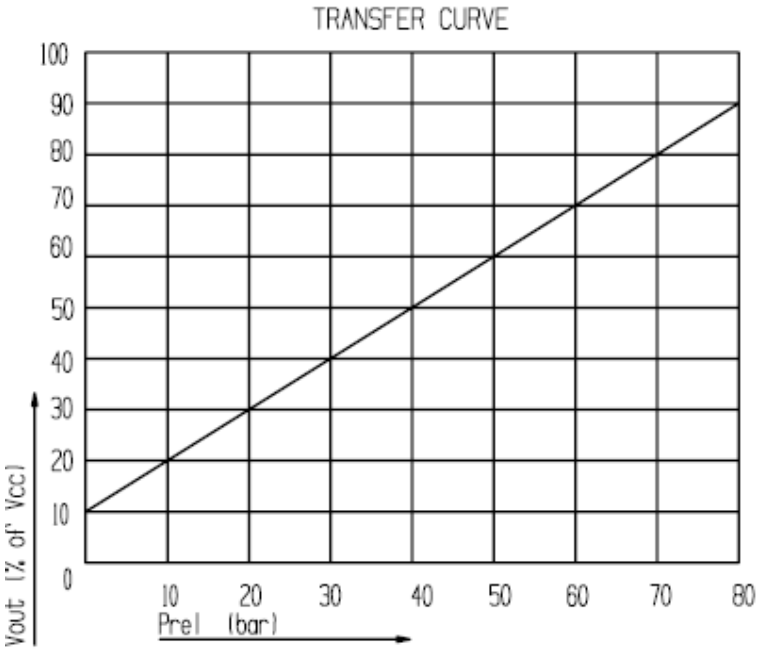


Fig. 57

- Supply power: 4.5 – 5.5 V
- Working range: -40°C – 135°C
- Measurable pressure range: 0 – 80 bar
- Electric resistance: 10 kΩ

Proportional flow solenoid valve

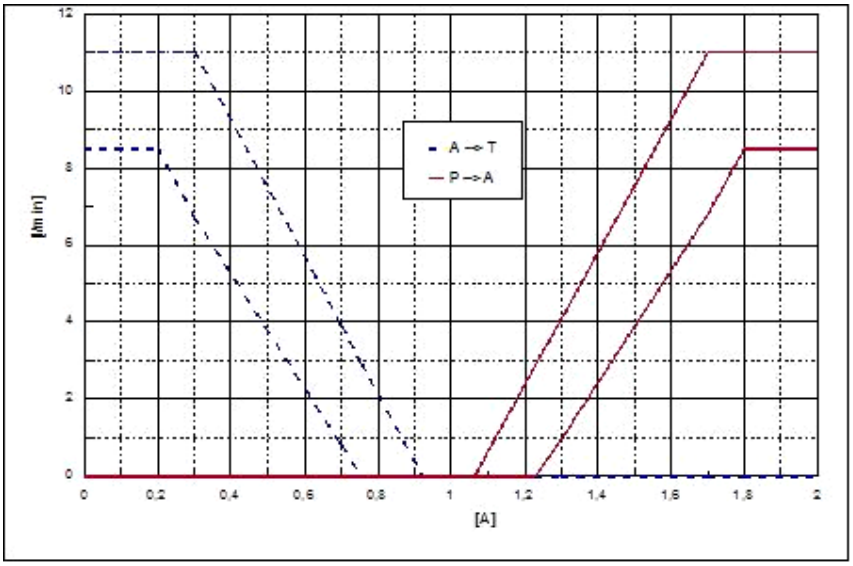


Fig. 58

- max. flow: **11 l/min** (with pressure differential of 10 bar)
- control current: **from 0 to 2 A** (controlled directly by ECU) *[from 0 to 0.8 A approx. valve draining to reservoir; from 0.8 to 1.15 A approx. valve closing; from 1.15 to 2 A valve draining to actuator] [see feature in Fig.]*
- electric resistance of winding: **2.5 Ω ± 6% at 20°C**.

Proportional pressure solenoid valve

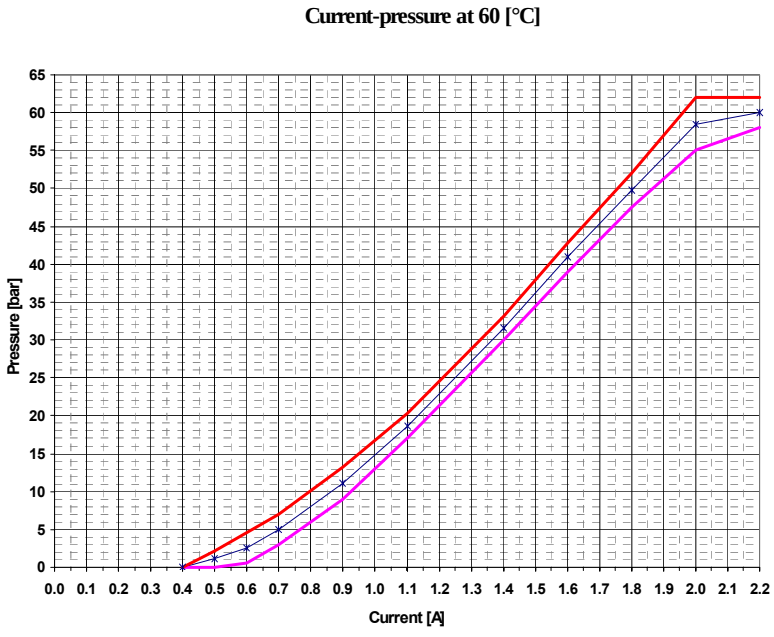


Fig. 59

- max. flow: **12 l/min** (with pressure differential of 10 bar).
- control current: **from 0 to 2.2 A** (controlled directly by ECU).
- electric resistance of winding: **2.6 Ω ± 6% at 20°C**.

General system concepts

- *Gear position on grid and solenoid activation*
- *The notion of "kiss point" and explanation of the existence of two kiss points related to two clutches*
- *Wake-up (SDU presence indication)*
- *Overspeed and underspeed gear shifts*
- *Gearbox limp home and engine limp home, special automatic (even gear only or odd gear only engagement strategies)*
- *Retry*
- *Powerlatch*
- *Description of powershift and gear shifts with torque interruption strategies*
- *Description of creeping*
- *Description of torque tracking and speed tracking*

Gear positions on grid and solenoid valve activation:

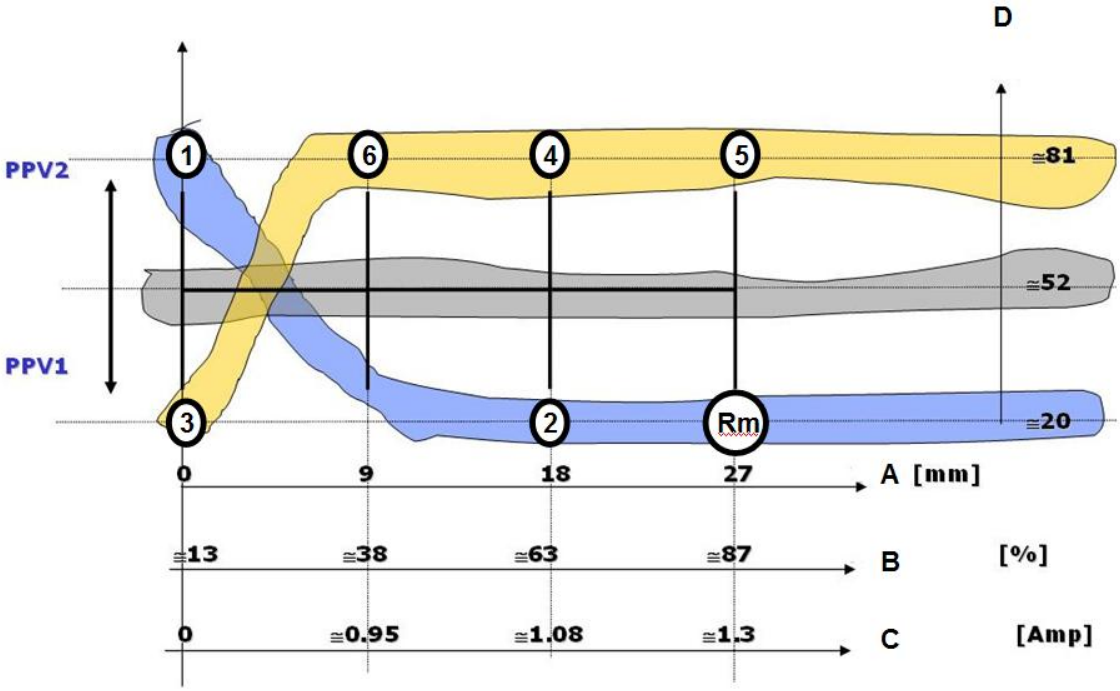


Fig. 60

A. Travel
B. Sensor reading
C. EV Shifter current
D. Engagement sensor reading

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

- For 3rd, 6th, 4th, 5th gears, the sensor reading value is high.
- For the other gears (i.e. 1st, 2nd, reverse and possibly 7th), the sensor reading value is low.
- 1st gear is engaged using PPV2 and 2nd gear is engaged using PPV1 to allow engagement of one of the two start-off gears if either engagement valve is faulty.

The considered features of the selection actuator are:

- selection travel 1st-3rd: 0 mm
- selection travel 2nd-4th: 18 mm
- selection stroke reverse-5th: 27 mm
- selection stroke 6th: 9 mm
- piston diameter: 10 mm
- max. chamber volume: 2.12 cm^3
- thrust area: 0.79 cm^2
- spring pre-load: 58.9 N
- spring stiffness: 5.3 N/mm

x [mm]	F [N]	A [cm2]	P [bar]	V [cm^3]	
27	200,8	0,79	25,6	2,12	V-RM
18	153,5	0,79	19,5	1,41	II-IV
9	106,2	0,79	13,5	0,71	VI
0	58,9	0,79	7,5	0,00	I-III

Fig. 61

Kiss point

The kiss point is calculated after the engine has been started. It is the point in which a clutch starts/stops transmitting torque.

A distinction is necessary:

- Clutch K1: the respective CSC is provided with position sensor, and therefore the kiss point is actually identified by a distance measurement. Similarly, as in robotised gearbox applications, the kiss point position is identified by the distance (kiss delta) from the closed clutch position. In order to learn this position, the clutch opens when the engine is started and the clutch starts closing when the engine rpm curve exceeds a set threshold. The kiss point is detected and the delta kiss is thus calculated.

- Clutch K2: CSC is not equipped with a position sensor and its position is inferred by reading the pressure sensor located on the feeding pipe instead. The kiss point is therefore identified by a pressure value instead of a position delta. This value is normally in the range from 3 to 5 bar when the system is new.

The K1 kiss point is normally learnt only after having started the vehicle with the gearbox in neutral. On the other hand, the K2 kiss point may be learnt with the 1st gear engaged because the clutch is normally open, providing that the K1 kiss point has already been determined.

Wake-up

This system function allows pressure from the hydraulic circuit to escape before key-on when the door is opened.
The TCU is woken up when the door is opened and the pump is activated if the pressure in the hydraulic circuit is too low.
The pump will not start up if the pressure in the circuit is adequate (the pressure must be under the pump pressure threshold level for the pump to be activated) or may be due to a fault (e.g. failed operation of a door switch, a faulty relay or pump fuse, etc.).

SDU (Smart Driver Unit)

With respect to applications with MTA robotised gearbox, electric power supply is only sent to the pump through a device named SDU according to a given law (not in ON/OFF mode) in order to reduce pump noise.

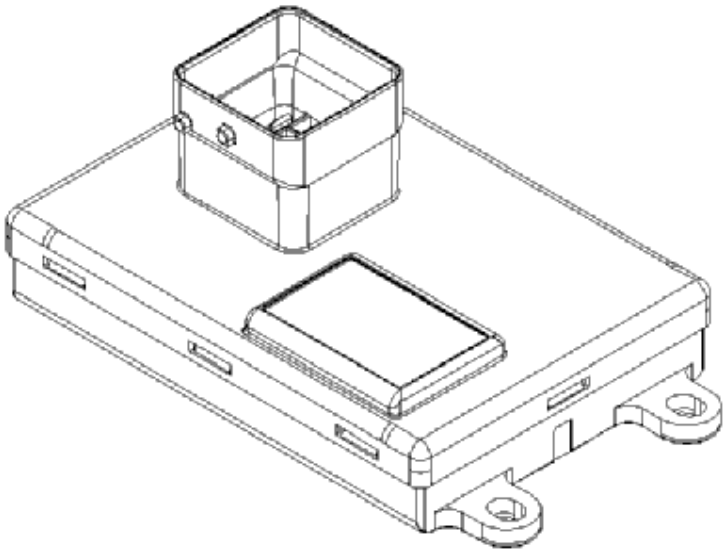


Fig. 62

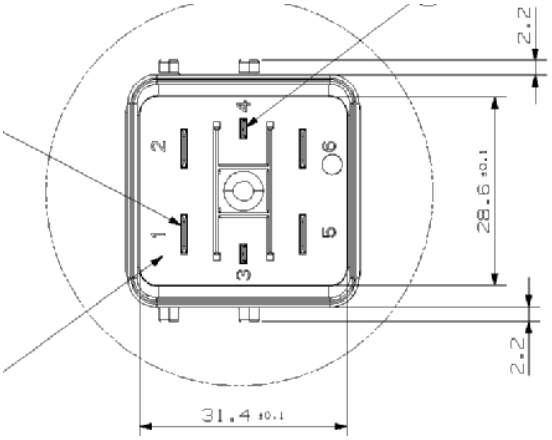


Fig. 63

SDU pin-out

1 – Electrohydraulic unit pump motor power (+)
2 – SDU power (+ 12 V battery)
3 – Diagnosis feedback for TCU control unit
4 – SDU PWM command from TCU control unit
5 – Electrohydraulic unit pump motor earth (-)
6 – SDU earth (body earth)

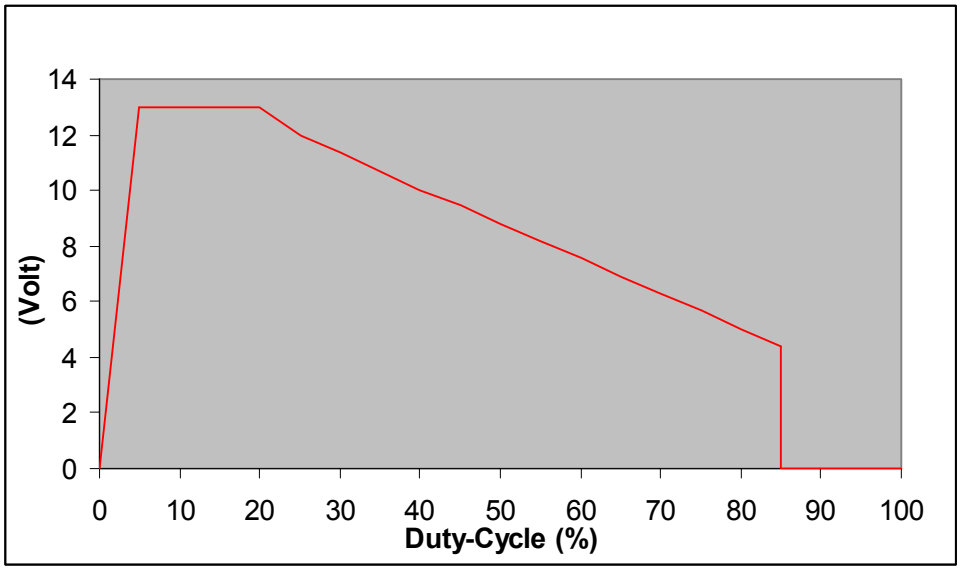


Fig. 64

Horizontal axis - PWM command from TCU control unit
Vertical axis - pump motor supply voltage output from SDU control unit

The SDU receives in input (pin 4, see pin-out) a PWM command from TCU. According to the PWM command duty-cycle, the SDU activates the electrohydraulic pump motor according to a law shown in the graph in Fig. 64. The graph shows the TCU command duty-cycle on the horizontal axis and the voltage sent by SDU to electrohydraulic unit pump motor on the vertical axis.
Specifically:

Duty-cycle from 0% to 5%: switch from 0 V to 13 V (saturation) – switch from off to on.

Duty-cycle from 5% to 20%: 13 V constant power – maximum pump speed.

Duty-cycle from 20% to 30%: pump power switch from 13 V (saturation) to regulation voltage – switch from maximum pump speed to medium pump speed.

Duty-cycle from 30% to 75%: pump motor running at average voltage – average pump speed is maintained.

Duty-cycle from 75% to 85%: pump motor power voltage switch from average value to zero (0 V) - the pump motor is still on in this range.

Duty-cycle from 85% to 95%: pump motor is stopped.

The typical noise of MTA robotised gearboxes, usually heard when the driver's door is opened, has been eliminated as a result of this power law governing the pump motor.

Underspeed gear shifts

An underspeed gear shift occurs when the TCT (in manual mode) automatically shifts down one or more gears (e.g. from 5th to 4th to 3rd) to prevent engine underspeed and stalling. As a result, the vehicle can decelerate without requesting to shift down, because the system shifts down and ultimately engages 1st gear when the vehicle is stationary.

Limp home

Limp home is low-performance mode used in presence of a system failure. Only 1st, 2nd and 3rd gear and reverse can be engaged in this mode which can be used for some faults only. System performance in limp home conditions is obviously worse than normal (gear shifts are slower). Engine limp home can be requested in some cases. This mode limits engine rpm.
Special automatic maps may be activated in some recovery conditions (automatic even gear strategy and automatic odd gear strategy). The objective is to be able to drive the vehicle while cutting out the faulty gearbox part.

Retry

The retry strategy attempts to engage a gear which, having been previously requested, was not engaged because of a problem. After recognising that gear engagement is impossible, the system attempts to engage the gear again (starting from neutral). It tries twice more if the second attempt fails. Neutral is engaged if all attempts fail.
The distinction explained below is needed to understand how the system works after the third failed engagement attempt:

- **Powershift**: the shifting operation has not been completed and therefore the previous gear is still engaged and the corresponding clutch is still transmitting torque. The driver is unaware of problem because traction is maintained. Another set of three attempts can be made, if a new gear shift is required. If this behaviour is systematic, after a given series of consecutive events, the gearbox part of the gear concerned by the failure is cut out by and appropriate recovery strategies are implemented (automatic even or odd gear strategy).

- **Gears shifts with torque interruption:** ISO MTA management logic will be applied, i.e. the system will attempt to engage the highest gear compatible with speed.

  There are special cases:

  - the gearbox will be placed in neutral if retry fails when 1st gear is requested and the vehicle is stationary
  - the gearbox will be placed in neutral if retry fails when reverse is requested and the vehicle is stationary

Power latch

Power latch is the TCU shut-down procedure. This procedure starts at key-off (+15 off) if certain conditions are present:

- No gear shift in progress
- Engine speed below 400 rpm
- Clutch speed equal to 0
- Clutch K1 closed
- Key signal + 15 at 0.

The shut-down procedure starts one second after "K15 off" if these conditions are present. During this procedure, the TCU is self-powered at +30 (see pin-out) and saves a number of parameters (clutch adjustment parameters, system counters, such as gear engagement counters, etc.) in the flash memory.

The power latch procedure cannot be run (TCU will shut down at +15 off) if +30 TCU power is not present.
The power latch procedure lasts about 5 seconds.

Description of powershift and gear shifts with torque interruption strategies

In Powershift mode there is no interruption of torque transmission to drive wheels during the gear shift (see cross-shifting clutch logic described on pages 20 and 21). Alfa TCT normally shifts all gears in this manner, but there are some exceptions in which an interrupted torque shifting method is used. These are:

- Multiple gear shifts concerning the same clutch
- Activation of recovery procedures required for safety reasons

Interrupted torque gear shifts are made according to a logic already implemented on robotised MTA transmissions, i.e.:

1. both clutches are opened
2. the engaged gear is released
3. a new gear is engaged
4. only the clutch of the engaged gear is closed

Description of creeping

On vehicles with transmission and torque converter, creeping mode which allows the vehicle to advance in D or R simply by releasing the brake. This behaviour is intrinsic.
On vehicles equipped with Alfa TCT, this function is obtained by releasing the brake and engaging a gear. Clutch K1 is slightly closed enough to allow the forward/backward movement of the vehicle. This function is extremely useful while parking or moving forward in a queue at a very slow speed.

Description of torque tracking and speed tracking

- As known, clutch K2 is normally open. The hydraulic unit must keep oil pressurised in the corresponding CSC to close clutch K2 when an even gear is engaged. Due to its construction, the Belleville cup spring of clutch K2 cannot be pressed at loads higher than a given value. The torque tracking strategy obtains this objective by closing K2 and applying a transmissibility margin with respect to the currently transmitted engine torque. For example, if the engine is transmitting 100 Nm (information received from ECU through CAN), the clutch is closed so that 120 Nm can be transmitted (with a transmissibility margin of 20 Nm).

- We will now consider the case of the vehicle is moving forward with an odd gear and no even gear engaged. Because clutch K2 is normally open, the respective gearbox part will stop turning. The speed tracking strategy is applied by slightly closing the clutch K2 to keep it turning.

Operating logics

Hydraulic circuit pressurisation

When the pressure is under the minimum operating threshold, the hydraulic circuit is pressurised in two different ways:

- when the driver's door is opened, the system automatically pressurises the hydraulic system to allow, if requested, a gear shift without needing to wait for the hydraulic circuit to be charged (fixed pump activation timing)
- at key-on: the system ECU is powered (and will remain powered until the key is turned off and the vehicle and engine speed is zero).

The electric pump is also powered to pressurise the unit when the minimum pressure (**approximately 44 bar**) is reached.

When the driver turns the key to the unstable cranking position, TCU allows to crank the engine if the lever is at P or N:

Cranking/starting off

The engine ECU directly controls the starter relay to start the engine when the ignition key is turned and after receiving an authorisation from the TCU.

Operation with engine off

The available gears with the engine off are Reverse, 1st and N.

Setting off

The engageable gears, with the engine on and the vehicle stationary, for setting off are:

- 1st and R; these gears in these conditions can be requested only by moving the lever.

The vehicle only sets off if the driver presses the accelerator pedal (releasing the brake pedal); at this point, the system gradually engages clutch K1 to set off. The driver can control the torque transmitted by clutch K1 by modulating the position of the accelerator pedal; when the accelerator is released, clutch K1 must gradually release when a minimum engine rpm is reached. When the system detects synchronisation between the engine and clutch rpm, it completes engaging the clutch (fully closed). A special clutch engagement map is implemented for each of the two gears used for setting off. When setting off, shift up may be requested if rpm is equal to engine rpm.

Setting off in 2nd gear is possible when the vehicle is moving slowly.

Automatic clutch engagement downhill with accelerator pedal released

If the vehicle picks up speed when travelling downhill with gear engaged and accelerator released, the clutch is automatically closed when a pre-set speed is reached to supply engine brake function. If the driver presses the accelerator pedal, the torque transmitted is once again controlled directly by the driver. Automatic clutch engagement is interrupted if the vehicle moves in the opposite direction to the engaged gear.

Deceleration

When decelerating, e.g. with gear engaged and accelerator pedal released, the system automatically releases the clutch to prevent engine stalling when approach idling speed. The release occurs at an engine speed which depends on the deceleration level and driver's controls (brake pressed or not). However, the gearbox automatically shifts down if a gear higher than 2nd gear is engaged during deceleration. 1st gear is automatically engaged when the vehicle stops.

Gear shift using lever (semi-automatic operating mode)

When the vehicle is moving and the clutch is completely engaged, an up or down request from the driver by means of the gear control lever will cause a gear shift. The requests are accepted by the system only if they are compatible with engine under-revving and over-revving limits. As a rule, operating the lever causes to shift only one gear up or down. In some operating conditions, however, more than one gear can be shifted by quickly double-tapping the control. The gear can be shifted up by the driver without releasing the accelerator pedal. Once the control is accepted by the system, an automatic sequence of steps is run to follow the driver's behaviour.
A gear shift may be interrupted at any time by another request from the driver providing the second request is acceptable (that is, compatible with engine under-revving and over-revving limits).

Automatic gear shift (auto mode)

The Alfa TCT is equipped with an automatic operating mode, very similar to that of a conventional automatic transmission. The gear to be engaged is selected using a (double) map which correlates the power required by the driver and the car speed. A double map is needed because two AUTOMATIC control modes named Normal & Dynamic can be selected by pressing a button in the dashboard. If the accelerator pedal is released in Dynamic mode, the system does not shift up to maintain engine brake function. In Normal mode, instead, the gear is shifted up (if allowed) when the accelerator is released to the benefit of consumptions. The gear shift mode is identical to that of semi-automatic operation using the lever but transmission and engine actuator control parameters dedicated to each mode are used. Automatic mode is selected by tipping the lever to the corresponding toggle position. It is turned off in the same way.
N.B.: the system switches to AUTOMATIC if the lever is faulty.

Neutral request

This request takes priority over all the other requests and is possible using the lever only. As mentioned, the brake pedal must be pressed when the engine is off. Neutral request is always accepted when the vehicle is moving.

Information for the driver (display and buzzer)

The system informs the driver by means of:

- display: "Manual" mode operation and gear engaged, "D" operation and gear engaged, system failure
- buzzer: vehicle misuse, unsafe conditions, system failure.

Some examples of misuse are listed below:

- setting off with overheated clutch

if the system is shut down with gearbox in neutral, the buzzer must indicate the danger of leaving the engine off without having engaged a gear.

Self-calibrations

Clutch bleeding procedure

The guidelines of the procedure are illustrated below:

When?

- After CAM (Complete Actuation Module) repairs, after replacing hydraulic components (valves, pump, pressure sensor, delivery pipe, etc.) or generic CAM intervention.

- For filling after draining needed for CAM repairs.

Why?

The objective of this self-calibration procedure is to eliminate air from the hydraulic circuit after replacing one of the aforesaid components. A customisable number of clutch K1 and K2 opening/closing cycles is run with the electric pump on.

What tools are needed?

Examiner diagnosis instrument

NOTES:
The procedure takes approximately 1 minute.
Power latch takes approximately 15 seconds.
The procedure must be run in the following conditions:

- key on
- engine off (not stopped by S&S)
- lever at parking
- clutch K1 position sensor OK
- clutch K1 actuator OK
- clutch K2 pressure sensor OK
- clutch K2 actuator OK

The procedure will end without indicating an error code if any one of the conditions listed above does not occur.

Accumulator depressurisation

The guidelines of the procedure are illustrated below:

When?

Before CAM (Complete Actuation Module) repairs for replacing hydraulic components (valves, pressure sensor, delivery pipe, gearbox-hydraulic kit separation, etc.) or generic CAM interventions.

Why?

The objective of this self-calibration procedure is to drain the hydraulic circuit, by sending CAM oil to the reservoir to allow replacement of the aforesaid components. It consists in running a customisable number of clutch K1 and K2 opening/closing cycles with the electric pump off.

To check oil level.

What tools are needed?

Examiner diagnosis instrument

NOTES:
The procedure takes approximately 1 minute.
Power latch takes approximately 15 seconds.
Check (read hydraulic pressure) that the pressure in the hydraulic circuit is under the accumulator pre-charge threshold *(approx. 2-3 bar).*

The procedure must be run in the following conditions:

- key on
- engine off (not stopped by S&S)
- lever at parking
- clutch K1 position sensor OK
- clutch K1 actuator OK
- clutch K2 pressure sensor OK
- clutch K2 actuator OK

The procedure will end with self-calibration KO if any one of the conditions listed above does not occur.

Clutch self-calibration enabling
The guidelines of the procedure are illustrated below:

When?

- At vehicle end of line
- After replacing ECU during Service
- After replacing/removing gearbox
- After replacing/removing (disconnecting) CAM
- After replacing clutch pack
- After replacing clutch sensors

Important: Run the “Data Set Deletion” before running the self-calibration procedure described here if a component is replaced.

Why?

The objective of the procedure is to quickly recalculate the kiss point, i.e. the point in which the clutches start transmitting torque.

What tools are needed?

Examiner diagnosis instrument

NOTES:
The procedure takes approximately 1 minute.
Power latch takes approximately 15 seconds.
The procedure must be requested before starting the engine, with key-on and gearbox in neutral. The engine can then be started.
The procedure can also be requested after starting the engine providing the gearbox is in neutral. If the gearbox is not in neutral, the request remains pending until neutral is engaged (see below)

Wait for the TCU to end testing the two clutches before key-off.
The procedure can start in the following conditions:

- key on
- engine on
- lever at parking
- no gear shift in progress
- engine running

The instrument will hang until at least one of the previous conditions occurs. The procedure will be run as soon as the aforesaid conditions occur.

The following conditions are monitored during the procedure:

- key on
- transmission in neutral
- clutch K1 position sensor OK
- clutch K2 pressure sensor OK
- engagement actuators OK
- sensor/actuator/ECU power supply OK

The procedure will be aborted (self-calibration KO) if even only one of these conditions is not true.
Examiner cannot request to interrupt the procedure. It will be concluded after having been started.

End-of-line service self-calibration

The guidelines of the procedure are illustrated below:

When?

- At end of line (when necessary)
- After replacing the transmission
- After replacing/disconnecting CAM
- After replacing any selection or engagement sensor
- After replacing the TCU

Important: Run the “Data Set Deletion” before running the procedure described here if a component is replaced.

Why?

The objective of the procedure is to store the gear shift grid thresholds.

What tools are needed?

Examiner diagnosis instrument

NOTES:

The procedure takes approximately 1 minute.
The procedure must be requested with engine off and key on.
Hydraulic pressure must be above the gear shift acceptability threshold (42÷51 bar range).
Battery voltage must be within the set limits (vehicle operating range).
Turn key-off and complete power latch (15 sec) to store values in TCU.
Power latch takes approximately 15 seconds.
The following functions must be automatically activated for the procedure:

- Clutch K1 closed position quick self-calibration
- Clutch bleeding
- EV clutch K1 current self-calibration
- Clutch K1 travel test
- K2 current characterisation test
- Shifter calibration (position and current calculation)
- Engagement grid self-calibration

The procedure must be run in the following conditions:

- engine off (not stopped by S&S)
- lever at parking
- battery voltage in a range
- K15 on
- hydraulic pressure over threshold

The procedure will end with self-calibration KO if any one of the conditions listed above does not occur.

Furthermore, the procedure may be aborted for the following reasons:

- engagement, selection, clutch sensor error
- selection, engagement driver/solenoid valve, clutch error
- sensor/actuator/TCU power supply error

New actuators

The guidelines of the procedure are illustrated below:

When?

- After replacing CAM
- After replacing clutch selection and/or engagement solenoid valve

Why?

The objective of the procedure is to force the solenoid valve offset values to those of new solenoid valves.

What tools are needed?

Examiner diagnosis instrument

NOTES:

The procedure takes approximately 5 seconds.
Power latch takes approximately 15 seconds.

- key on
- engine off (not stopped by S&S)

The procedure must be requested with engine off and key on.
Turn key-off and complete power latch to store values in TCU.

Data Set Deletion

The guidelines of the procedure are illustrated below:

When?

- Replacing the hydraulic kit
- Replacing the transmission
- Replacing the clutch pack
- Replacing the sensor module
- Replacing the pump
- Replacing the accumulator only
- Replacing SDU
- Replacing clutch K1 position sensor
- Replacing K2 pressure sensor
- Resetting statistic data

Important: The "Data Set Deletion" procedure must be carried out after the "Historical Data" rewriting procedure if the TCU is replaced at the same time as one of the components listed above.

Why?

Failure to run the procedure will not effect system operation.
The following counters describe the history of each single part. This is why the associated data must be reset or set to default values when one of the aforesaid components is replaced. Furthermore, the following counters can be used to identify the number of incorrect manoeuvres or conditions of the system when an error was validated.

What tools are needed?

Examiner diagnosis instrument

Gear engagement procedure

This Active Diagnostic procedure is used to engage all gears with the vehicle stationary. The procedure must be used to diagnose problems concerning the solenoid valves.
The procedure engages all the gears. Steps include centring neutral, keeping both clutches open, operating the shifter, appropriately controlling the engagement valve and switching back to neutral.

NOTES:

The procedure must be run in the following conditions:
- key on
- engine off (not stopped by S&S)
- gear lever in N

Longitudinal accelerator sensor learning procedure

The guidelines of the procedure are illustrated below:

When?

- End of line
- After replacing the gearbox ECU
- After replacing the longitudinal accelerator sensor

Important: Run the “Data Set Deletion” before running the procedure described here if a component is replaced.

Why?

The following procedure is used to learn the longitudinal acceleration offset transmitted by NYL (yaw sensor node).
Failure to perform the procedure will affects system operation. For this reason, if must be carried out at end of line and during service.

What tools are needed?

Examiner diagnosis instrument

Conditions:

key on
engine off
vehicle on level ground

"HISTORICAL DATA" rewriting procedure

The guidelines of the procedure are illustrated below:

When?

This procedure must only be run after replacing the TCU.

Why?

Failure to run the procedure will not effect system operation.
This procedure is used to save the system history records (transmission and CAM) for transferring data from one TCU to another.
This operation is possible if the services necessary for running it are not affected. In other words, the procedure cannot be run if the data cannot be read from the TCU to be replaced. As mentioned, in this case the system operation is not affected.
If the TCU and any other component subject to the "Data Set Deletion" procedure are replaced at the same time, the historical data of the component to be replaced must be deleted before copying the records.

What tools are needed?

Examiner diagnosis instrument

Kiss Point learning and clutch gearbox curve fine-tuning procedure

The following two cases may occur with regards to the on-vehicle kiss point and transmission curve fine-tuning learning procedures:

- Cases in which both kiss point and transmission curve fine-tuning learning procedures must be run
- Cases in which only the kiss point learning procedure must be run

The cases are illustrated in the following table:

Cases in which both kiss point and transmission curve fine-tuning learning procedures must be run	**Cases in which only the kiss point learning procedure must be run**
When replacing the TCU (for 955 application (Mito) only, remember than in this case the longitudinal accelerometer offset procedure must also be run)	When hydraulic unit is replaced
When replacing the gearbox	When replacing the sensor module
When replacing clutch K1 or K2 CSC or both CSCs	When replacing clutch K2 pressure sensor
When replacing the clutch pack	
Whenever the following "Data Set Deletion" functions are started in TCU even without having replaced the corresponding component: • Gearbox replacement • Clutch unit replacement • Clutch K1 position sensor replacement • Statistic data reset	

Starting the clutch parameter reset service (DATA SET DELETION) which resets the following parameters:

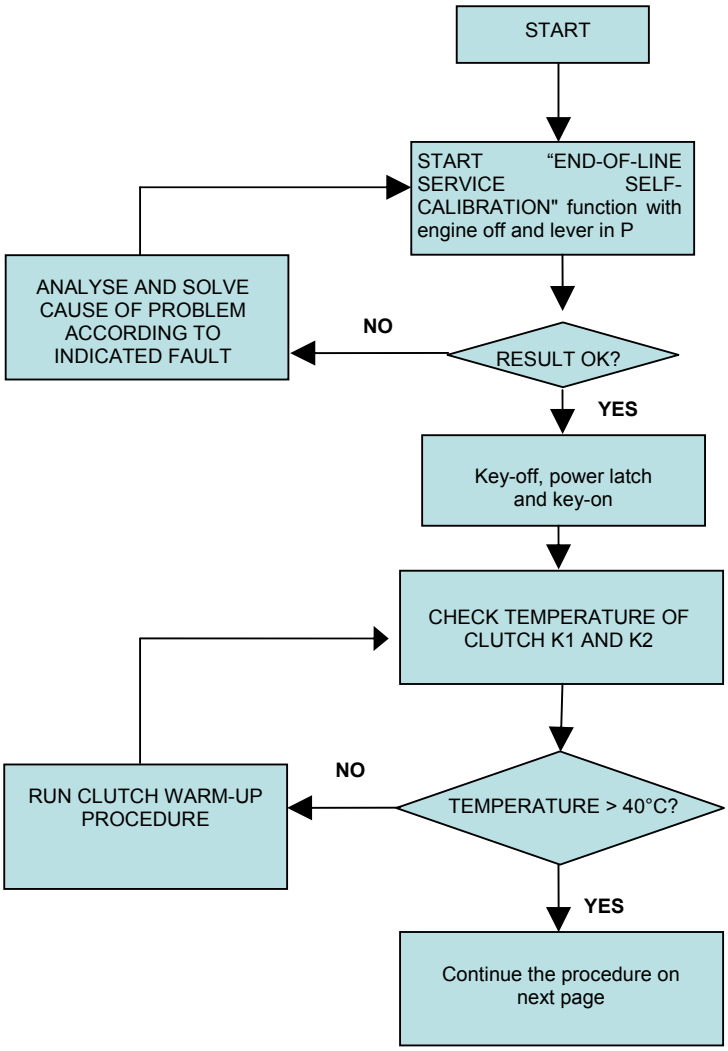
Clutch pack replacement data
Self-calibrated clutch closed position
All closed even clutch pressure
Self-calibrated clutch slip starting position delta (PIS)
Even clutch calculated pressure
Odd clutch plate temperature (maximum between temperatures of surfaces S1 and S2)
Even clutch plate temperature (maximum between temperatures of surfaces S1 and S2)
Clutch K1 transmissibility index
Clutch K2 transmissibility index
Clutch K1 overheat permanence time
Clutch K2 overheat permanence time
Self-calibrated kiss point K1
Self-calibrated kiss point K2
Clutch K1 closed position
Clutch K2 feature
Shifter OK calibration
Launch Control counter

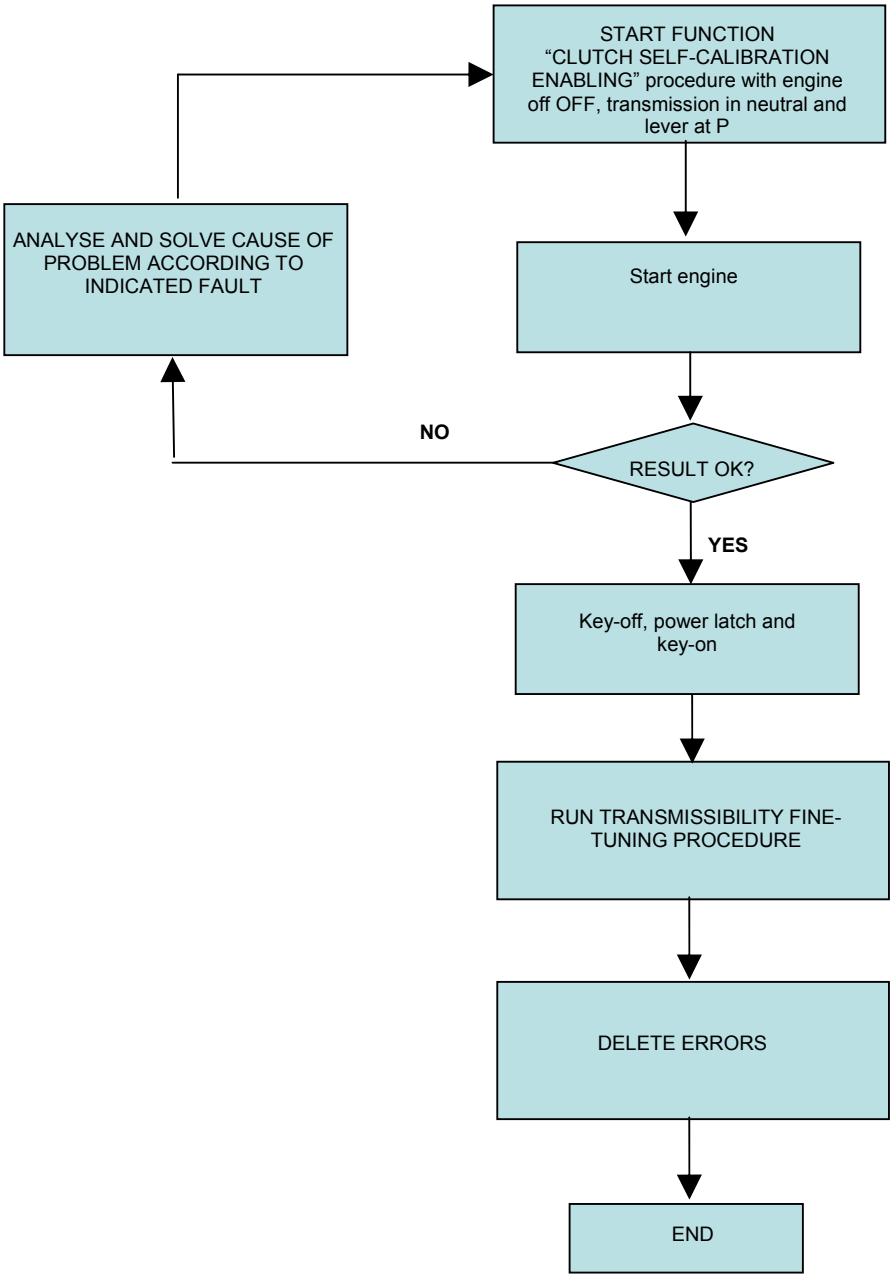
The warning light will be on and two errors will be present:

- End-of-line service self-calibration procedure error (P290D)
- Not calibrated kiss points error (P290E)

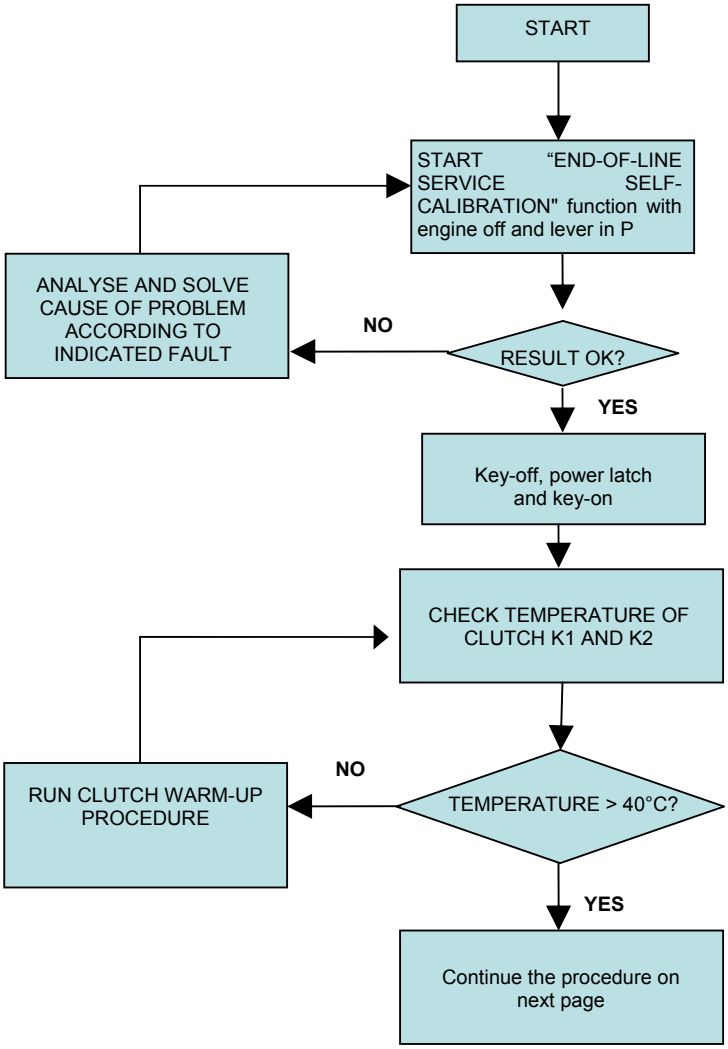
The “END-OF-LINE/SERVICE SELF-CALIBRATION” and “CLUTCH SELF-CALIBRATION ENABLING” functions must be started in the order shown below to resume correct system operations.

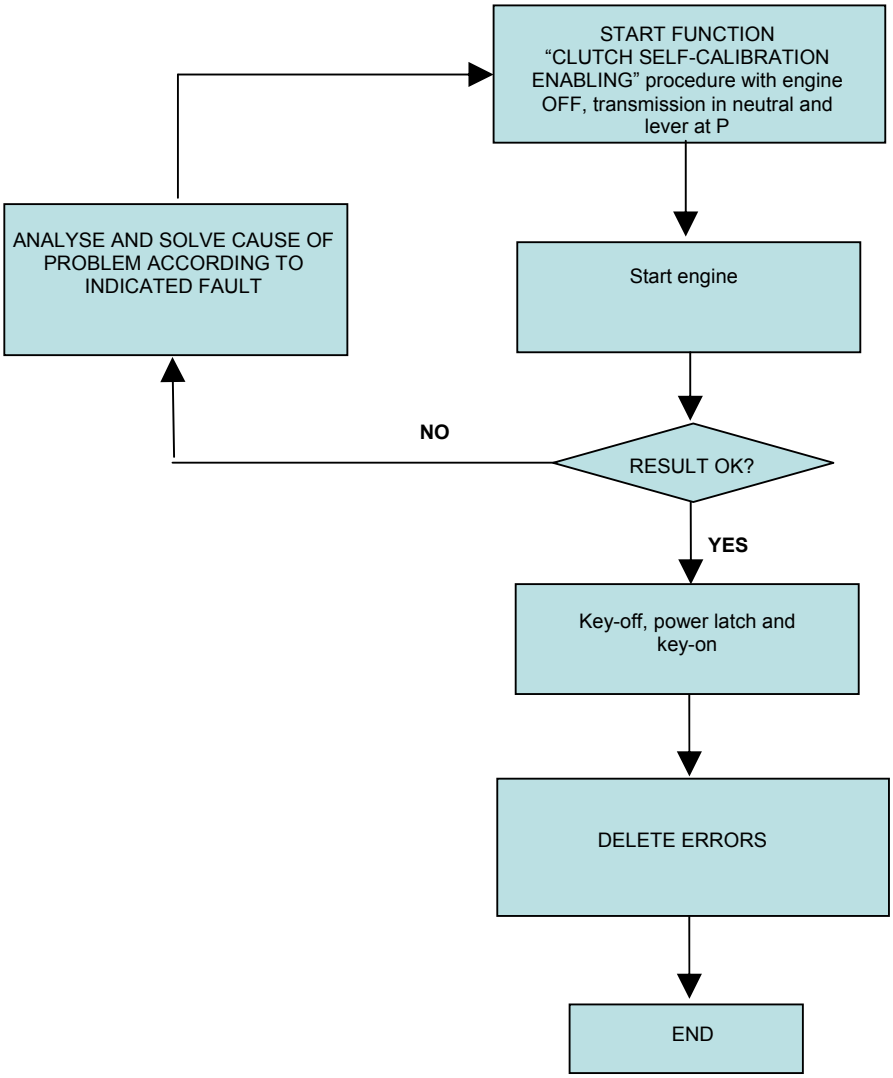
Kiss point and transmissibility curve fine-tuning learning procedure operating flows




START FUNCTION “CLUTCH SELF-CALIBRATION ENABLING” procedure with engine off OFF, transmission in neutral and lever at P
Start engine
RESULT OK?
NO
ANALYSE AND SOLVE CAUSE OF PROBLEM ACCORDING TO INDICATED FAULT
YES
Key-off, power latch and key-on
RUN TRANSMISSIBILITY FINE-TUNING PROCEDURE
DELETE ERRORS
END

Kiss point learning procedure operating flow




START FUNCTION “CLUTCH SELF-CALIBRATION ENABLING” procedure with engine OFF, transmission in neutral and lever at P
Start engine
RESULT OK?
NO
ANALYSE AND SOLVE CAUSE OF PROBLEM ACCORDING TO INDICATED FAULT
YES
Key-off, power latch and key-on
DELETE ERRORS
END

CLUTCH HEATING PROCEDURE

Check clutch temperatures ("Odd clutch plate temperatures" and "Even clutch plate temperatures, respectively).
Run the following procedure if these temperatures are lower than 40°C:

1. Select manual mode.
2. Engage 1st gear and set off in 1st gear with pedal in middle/low position.
3. After reaching a sufficient engine rpm, shift to 2nd gear.
4. Drive for a short distance to make sure that the even gear clutch is closed, then slow down until almost reaching the automatic shift-down threshold, then press the accelerator (pedal in middle/low position) to set off in 2nd gear. This will cause the K2 clutch to slip and heat it up.
5. Check K1 and K2 clutch temperatures again. If at least one is lower than 40°C, repeat the procedure from point 2; otherwise proceed according to the sequence shown in the flow chart.

TRANSMISSIBILITY CURVE FINE-TUNING PROCEDURE

Wait for the engine to warm up before starting the procedure: engine water temperature higher than 90°C (an empiric indication is to wait for the cooling fan to start up for the first time).

1. Select manual mode.
2. Engage 1st gear and set off in 1st gear with pedal in middle position.
3. After reaching a sufficient engine rpm, shift to 2nd gear.
4. Drive for a short distance to make sure that the even gear clutch is closed, then slow down until almost reaching the automatic shift-down threshold, then press the accelerator (pedal in middle position) to set off in 2nd gear.

5. Engage 1st gear and set off with the pedal in middle-high position.
6. After reaching a sufficient engine rpm, shift to 2nd gear.
7. Drive for a short distance to make sure that the even gear clutch is closed, then slow down until almost reaching the automatic shift-down threshold, then press the accelerator (pedal in middle-high position) to set off in 2nd gear.

8. Engage 1st gear and set off in 1st gear with pedal in low position.
9. After reaching a sufficient engine rpm, shift to 2nd gear.
10. Drive for a short distance to make sure that the even gear clutch is closed, then slow down until reaching the automatic shift-down threshold, then press the accelerator (pedal in low position) to set off in 2nd gear.

11. Select automatic mode.
12. Drive about 5 km, possibly on a mixed urban/extra-urban route, shifting gears in different accelerator pedal conditions.

The transmissibility curve self-learning procedure must be run during a dynamic test because the TCU must fine-tune the transmissibility curve in its memory according to the features of the new clutch unit (if the latter was replaced and is therefore new). If the TCU is replaced, the latter will store a standard transmissibility (default) curve which must be fine-tuned according to the features of the clutch unit (which is already present on the gearbox and not replaced). The self-learning procedure must be run also when a component which interfaces with the clutch pack is replaced (CSC K1 or CSC K2; gearbox).

Procedure summary.

1) Clutch bleeding procedure

The objective of this self-calibration procedure is to eliminate air from the hydraulic circuit after replacing/repairing one of the CAM components. A customisable number of clutch K1 opening/closing cycles is run with the electric pump on.

2) Accumulator depressurisation procedure

The objective of this procedure is to drain the hydraulic circuit, sending CAM oil to the reservoir to allow replacement of the CAM components. It consists in running a customisable number of clutch K1 opening/closing cycles with the electric pump off.

3) Clutch self-calibration enabling procedure

The objective of this procedure is to autonomously calculate the kiss point for clutches K1 and K2.

4) End-of-line Service self-calibration procedure

The objective of this procedure is to automatically calculate the engagement and selection thresholds.

5) New actuator procedure

The objective of this procedure is to write the solenoid valve leakage value in ROM.

6) Data Set Deletion procedure

The objective of this procedure is to clear gearbox or CAM component data for replacement.

7) Gear engagement procedure

The objective of the procedure is to engage the required gears using the FIAT protocol.

8) Longitudinal acceleration sensor learning

The objective of the routine is to calculate and store the longitudinal acceleration value.

9) "HISTORICAL DATA" rewriting procedure

The objective of the procedure is to rewrite system data records for TCU replacement.

10) Clutch transmissibility index self-learning

The objective of the transmissibility index learning procedure is to model the TCU transmissibility curve according to the features of the clutches.

Functional interaction with other systems

Interaction with engine control

The two systems do not interact while travelling, because the system has no task to perform. Therefore, data and signals are only exchanged on the network.
Unlike robotised gearbox, when setting off or shifting TCU is master with respect to the engine control unit, and therefore cuts out all the safety conditions that are always managed by the engine. The engine is managed only by the TCU. This control ends after setting off or shifting.
With the introduction of S&S operating logics, further information is exchanged between the transmission and engine control units. All the possible cases are described below. To understand what occurs, we will consider the example of a driver approaching a red light:

- The engine stops when the car stops (the driver is pressing the brake pedal).
- As soon as the driver releases the brake pedal:
- ECU asks TCU to set the transmission in neutral.
- Once the transmission is in neutral, TCU informs ECU that the transmission is secured.
- ECU can restart the engine.
- ECU restarts the engine and at the same time asks TCU to engage the previously released gear.

Interaction with Cruise Control

The CC system is not affected by the presence of the TCT system. There is no function interaction logic with the system.

Safety and functions in case of failure

These strategies manage incorrect commands to prevent potentially dangerous situations or critical conditions for the transmission or the vehicle.

Key lock

Two situations can occur after stopping the engine:

- The driver positions the lever in P
- The driver positions the lever a position other than P

In the first case, the driver can remove the key from the dashboard without any problem; in the second case, the key cannot be removed because the vehicle is not safe. The following operations are possible:

- The driver turns the key again and positions the lever in P
- Despite knowing that vehicle conditions are not safe, the driver removes the ignition key manually, using the mechanical release control.

Obviously, the second option may only be used in genuinely critical cases.

P-R-N-D LEVER OPERATION

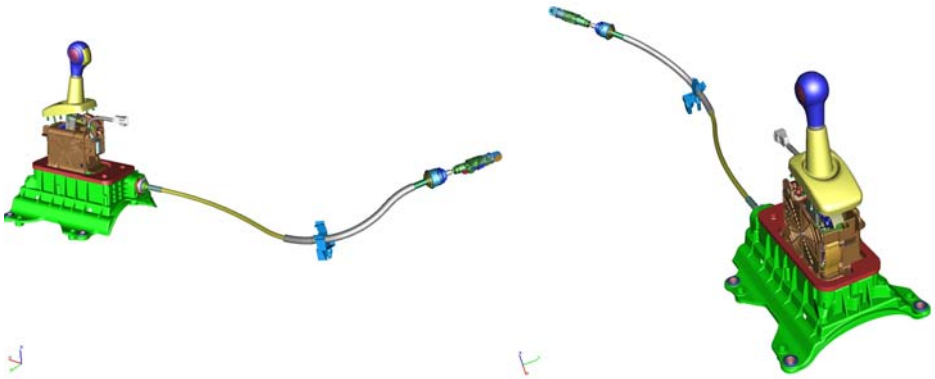


Fig. 64

P-R-N-D lever configuration

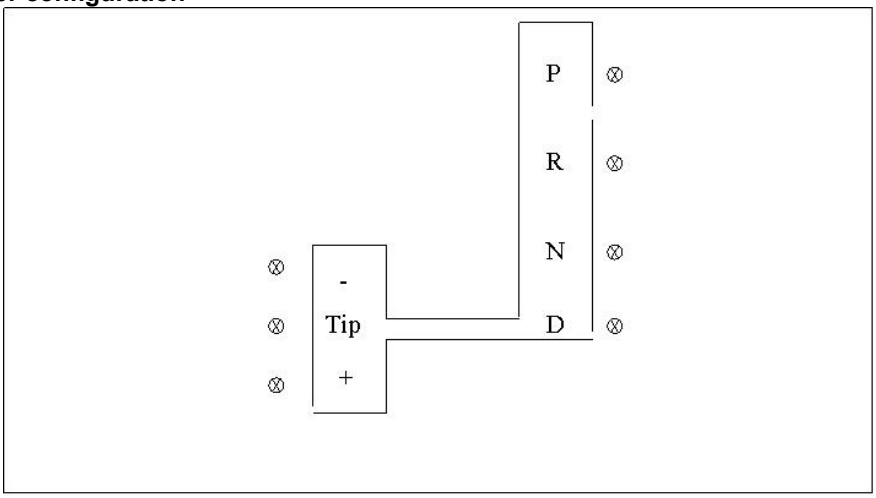
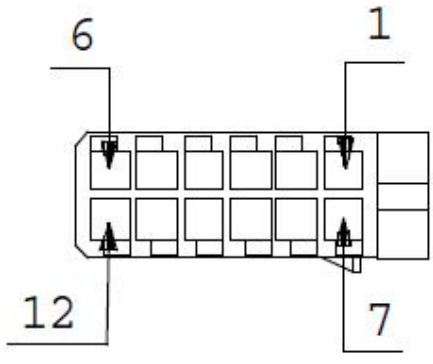


Fig. 65

- Backlit fretting fixed at +key
- Steering wheel paddles (opt)

Lever connector pin-out

Pin	Description
1	+30 direct battery power
2	+15 key-operation power
3	Earth
4	D Tip position signal to TCU (A21)
5	Parking Lock signal to TCU (A8)
6	Key lock signal
7	CCAN H (in)
8	CCAN H (out)
9	CCAN L (in)
10	CCAN L (out)
11	Steering wheel controls earth signal
12	Steering wheel controls earth signal



Engine off and vehicle stationary

Door open
With the vehicle stationary, the instrument panel is turned on when the door is opened and various vehicle-related information is displayed. The engaged gear is however not displayed.
The electric pump of the hydraulic unit is activated to pressurise the circuit and allow the system to be activated when starting is requested.

Measures before key-on

At key-off

(vehicle stationary with key-operated power off):

- if the lever is at P: the gear lever cannot be moved neither with the brake pedal released, nor with the brake pedal pressed, nor by pressing the lever lock button on the knob (nothing is displayed)
- if the lever is at R/N/D/TIP: the gear lever can be moved to position P (by pressing the button on the knob), after which the lever is mechanically locked in P (see previous case).

TCT stops communicating on CAN at the key-off (the vehicle is stationary).
The gear lever engages the parking lock and displays P position only if the lever is moved to P within 5 seconds from key-on → key-off
After 5 seconds, the parking lock can be engaged, but the indication will not appear on the display.
Alfa TCT keeps the gear prior to key-off engaged; at the following key-on the gear selected by the lever position is displayed.

Key on (+15)
The icon on the gearbox trim corresponding to the lever position lights up.
When the lever is faulty, all the icons are lit and blink. With the vehicle stationary and key on (key-operated power on), the instrument panel must display the gear selected by the lever position.
Operating logics (Dynamic, Normal and All Weather) of this application are managed by the Body Computer using a specific signal. All the logics can be set using the "lever", both in Automatic and Manual conditions.

Shift lock
When the car is stationary, the lever can only be shifted from position P (corresponding to neutral) when the brake pedal and knob button are pressed.

Shifting the lever
All shifts must be performed exclusively with car stationary and engine idling.
The drive wheels are mechanically locked in position P.

- Shifting from P→R is only allowed with the brake pedal pressed and the lever button pressed.
- Shifting from R → N is free.
- Shifting from N → D is free.
- Shifting from D → Tip is free.
- Shifting from Tip → D is free.
- Shifting from D → N is free.
- The lever button must be pressed to shift from N to R.
- Shifting from R → P is possible with the gear lever button pressed.

These shifts are summarised in the following table:

		Final lever position				
		P	R	N	D	TIP
Lever initial position	P		Brake pressed + Lever button			
	R	Lever button		Free		
	N		Lever button		Free	
	D			Free		Free
	TIP				Free	

Fig. 66

Steering wheel paddles: they work with the lever at Tip or D with +15
Operate the lever as indicated above to have the system actuate the gear shift requests.
The engaged gear is shown on the display (1, 2,…6) with the lever at TIP: only 1st gear can be engaged at key-on, engine off or and speed = 0 km/h .
The following lever-gear inconsistencies may occur after moving the lever.

INITIAL LEVER POSITION AND GEAR ENGAGED	**INITIAL INDICATION ON DISPLAY**	**FINAL LEVER POSITION**	**FINAL INDICATION ON DISPLAY**	**WARNINGS IN PANEL AND ACOUSTIC WARNINGS**	**Warning messages**
NEUTRAL N	[N]	D/Tip	[N]	Yes	No

This situation occurs in retry mode. The gearbox cannot engage first gear.
In these lever-gear inconsistency situations, the icon of the requested target will light up fixed on the gear lever trim (final lever position). The icon will start blinking (operated by TCU) if the transmission cannot engage the requested gear after a Tout.
A buzzer must be operated for a predetermined time in these cases.
TIP position (central stable position between UP (+) and DOWN (-)) corresponds to first gear.
In case of retry (lever position D or TIP, but N gear engaged), the "+" lever control on the steering wheel can be used to select 1st gear (with or without pressing the brake pedal).
(D position with vehicle stationary corresponding to gear request consistent with vehicle speed; TIP position on SW level instead does not correspond to any request (it is interpreted as meaning that the lever is released). The lever must cross position D to reach TIP. Position D is therefore always detected and therefore the gear is always engaged.

Engine running and/or vehicle moving

First starting: from key (+50).

Starting is only allowed with lever in position N or P (with or without pressing the brake pedal) and neutral engaged.
N.B.: The gear engaged and lever position may not coincide.
The engine cannot be started with the lever in D, R or TIP. No warning message is shown on the display.
The system is in N or P for starting (the latter corresponds to neutral, but the vehicle wheels are mechanically locked).
The instrument panel displays the gear engaged when the starting request is made in any operation mode (Dynamic/Normal/All Weather).
The lever position and indication on display will be consistent after starting.

Starting the vehicle from stationary

At the end of the starting procedure, the engine is running, the vehicle speed V is 0 km/h, the gearbox in is neutral (N) and selector lever is in N or P.
To shift the lever from position P: press the brake pedal and the button on the knob. The system activates the shift lock coil and releases the lever.
The driver can choose to select 1st gear (lever at D or TIP) or reverse (lever at R).
The instrument panel displays the engaged gear.
The request for engaging 2nd gear (by TIP+) is not accepted by the system (with or without brake): no message is displayed.

Engine started

The vehicle starts moving either forwards or backwards as soon as the gear is engaged (no need to press the accelerator).
This creeping strategy is activated by the system by default in the following conditions:

- 1st gear or reverse engaged
- Handbrake released
- Creeping deactivation recovery strategy not working (e.g. clutch not overheated)
- Brake pedal released
- Accelerator pedal released

Creeping is automatically deactivated/reduced (with 1st gear or R engaged) in the following conditions:

- Handbrake applied
- Road slope over 5%: creeping torque is gradually switched off
- Clutch temperature is higher than a threshold (firstly set as "out of range")
- Creeping torque is constant (higher than a given threshold) for a given time (Tcreep = approx. 4 sec): e.g. if the vehicle knocks into the kerb or stalls, on gradient after Tcreep creeping is gradually cut out by applying a ramp (to clutch torque = 0). Afterwards, creeping is reactivated when the accelerator or brake pedal are pressed again.

(In general, the creeping torque is gradually reduced to pre-start-off torque while creeping by pressing the brake pedal. After a given time in this condition, creeping condition is gradually cut off and "waiting for start-off" condition is selected).

When the engine is running, only 1st or R gear speeds (apart from neutral) can be engaged.

NOTE: There is NO ACOUSTIC WARNING when “R” is engaged.
NOTE: TIP position corresponds to 1st gear from D, N or R.
Any TIP- request is ignored by the system because it is not a plausible request.
NOTE: With S&S mode off, the system closes clutch K1 after a given time if the vehicle is standing with engine running in neutral.

Automatic restart

TCT sends the clutch state and the engaged gear signal to CAN.
Automatic start-up is actuated by the engine ECU after automatic stop according to Start&Stop strategies without any intervention by the driver using the key.
The engine will be stopped by S&S when the brake pedal is pressed **if the lever** (not the engaged gear) is in position **other than up, down or reverse.**
The engine asks the gearbox to enable automatic starting if:

- the brake pedal is released and the lever is neither in N nor P

- the lever is moved to up, down or reverse position

When the lever is in N or P, with brake pedal pressed and engine stopped by S&S, the engine will not be restarted when the brake is released.
Following starting request from engine, Alfa TCT engages neutral and consequently updates the engaged gear signal on CAN thus allowing to restart the engine.
The following shifts will appear on the display:

- D → N → D: if engine is stopped with lever in D (automatic mode)
- 1 → N → 1: if the engine is stopped with lever in TIP (manual mode)

The gearbox will keep managing signals related to lever position and displayed gear on CAN in parallel and coherently in both modes (automatic/manual).
TCU can reactivate creeping function after starting the engine.

Steering wheel controls

On some versions, gears can be shifted using the controls on the steering wheel (Fig. 67). To use the steering wheel controls, the gear lever must be in Sequential position:
- steering wheel paddle +: to shift up
- steering wheel lever -: to shift down

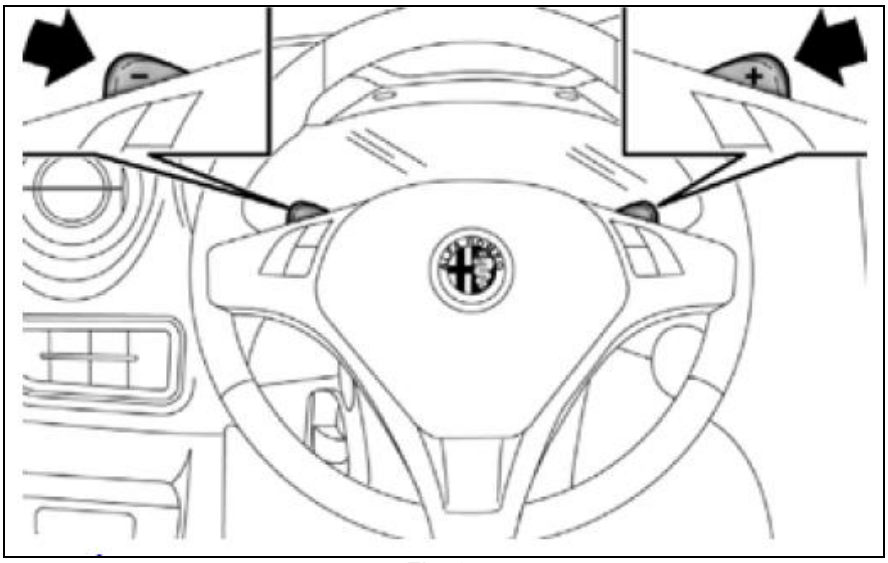


Fig. 67

TCT LEVER MANAGEMENT

TCT must send the lever status (i.e. the gear shift request) through CAN to the engine control by means of an appropriate signal (even if rejected).
If the engine is automatically stopped, the lever is usually in TIP - D and the gearbox in 1st gear, or the lever is in N and transmission is in neutral. Later:

- If the lever is shifted from DRIVE to N (with brake pressed because if it is released the engine will start up immediately)
    - TCU must communicate the updated conditions of the lever (neutral)
    - TCT must go to stable idling
    - TCT must continue to keep clutch K1 open
    - ECM in this case does not start the engine

Note: if the gearbox is in neutral, the Stop&Start strategy does not need the brake to be pressed to keep the engine stopped, and the driver may therefore release the brake pedal without restarting the engine.

- If the lever is moved from N to DRIVE
    - TCU must communicate the updated conditions of the lever (DRIVE)
    - ECM must manage the information like a re-crank request and restart the engine regardless of the brake pedal position.
    - TCU waits until the engine is started and keeps the clutch K1 open (in N).
    - TCU engages 1st gear and then resumes control over clutch K1, according to normal creeping strategies (accelerator pedal released) or start-off strategies (accelerator pedal pressed).

- If the lever is shifted from TIP to UP or DOWN (with brake pressed because if it is released the engine will start up immediately).
    - TCU must communicate the updated conditions of the lever (UP or DOWN).
    - ECM restarts the engine.
    - TCU releases the gear and waits until the engine is restarted keeping clutch K1 open (in N).
    - TCU engages 1st gear and then resumes control over clutch K1, according to normal creeping strategies (accelerator pedal released) or start-off strategies (accelerator pedal pressed).
- If the lever is shifted from DRIVE or N → to R (also without pressing the brake if from N)
    - TCU must communicate the updated conditions of the lever (Reverse).
    - ECM restarts the engine.
    - TCU releases the gear and waits until the engine is restarted keeping clutch K1 open (in N).
    - TCU engages R gear and then resumes control over clutch K1, according to normal creeping strategies (accelerator pedal released) or start-off strategies (accelerator pedal pressed).

- If the lever is shifted from DRIVE to TIP (with brake pressed because if it is released the engine will start up immediately).
    - TCU must communicate the updated conditions of the lever (TIP).
    - ECM may restart the engine (if enabled by specific calibration parameter).
    - If there is an engine start command:
        - TCT releases the gear and waits for the engine to be started while maintaining the clutch open
    - TCU engages 1st gear and then resumes control over clutch K1, according to normal creeping strategies (accelerator pedal released) or start-off strategies (accelerator pedal pressed).
    - If there is no engine start command:
        - TCT remains with 1st gear engaged and clutch open.

- If the lever is shifted from TIP to DRIVE (with brake pressed because if it is released the engine will start up immediately).
    - TCU must communicate the updated conditions of the lever (DRIVE).
    - In this case, the engine cannot be restarted.
    - TCT remains with 1st gear engaged and clutch K1 open.

- If the lever is shifted from DRIVE or N to PARKING:
    - TCU must communicate the updated conditions of the lever (PARKING).
    - TCT sends information concerning the engaged gear: neutral
    - In this case, the engine cannot be restarted even if the brake pedal is released.
    - TCT engages parking mode when the engine is off.

The lever crosses position P to shift: if it is paused in position R for longer than a given time (200 ms) the engine is restarted as described above.

- If the lever is shifted from PARKING to N or R or DRIVE:
    - TCU must communicate the updated conditions of the lever (Neutral, Reverse or Drive).
    - ECM restarts the engine.
    - Transmission can engage N, R or 1st gear depending on the final position of the lever; then TCU resumes control over clutch K1 according to normal creeping strategy (accelerator pedal released) or start-off strategy (accelerator pedal pressed).

With lever in R, the engine does stop in START&STOP mode.

Lever failure

In case of lever failure, TCU must set lever position signal = Not Available: this will make exit Stop&Start strategy.

Steering wheel paddle management

For versions with paddles, restarting can be requested by the paddle with the lever at TIP or D, as described for the UP/DOWN lever.

Indication on display

If the engine is stopped by the Start&Stop function, information concerning the engaged gear is still displayed on the instrument panel by means of the usual the "lever position" and "displayed gear" signals.
Shifting through N must be displayed when the engine is automatically restarted.
NOTE: only after neutral request from engine will the “lever position” signal and the “displayed gear” signal transmitted by the transmission be **temporarily** linked to the requested gear (variable target gear in TCU) instead of the gear actually engaged (current gear).
D/N/A logic engagement/release will be managed as normal, regardless of whether S&S is on or not.

Gearshifting with the vehicle moving

Gearshifting in manual mode: lever at Tip

Each **shift up** request is made by tipping the lever to the position UP (+) position or pressing the steering wheel “+” paddle (lever in TIP position).
Requests are only accepted if shifting is over and engine rpm are sufficient to prevent engine stalling.
If the request is accepted by the system:
the new current gear will appear on the display which the gear shift is over.

NOTE 1: the system displays the actually engaged gear on the display and not the gear requested by the user.
If the request is not accepted by the system:
The gear engaged before the request will remain on the display and a buzzer will sound (for approximately 500 ms).
Similarly, the driver may request **shift downs** by tipping the lever to DOWN (-) or pressing the “-” paddle on the steering wheel (the lever is at Tip).
In this case, the system will only accept the request if the engine rpm after shifting does not exceed the maximum rotation speed permitted for the engine. If the request is not accepted, the system behaves as it does when the shift up request is not accepted.
Furthermore, the system will autonomously select the lower ratio if the driver keeps the current ratio on engine stalling limit (AUTODOWN).
The lever is located in the TIP position in the operations described above.
NOTE 2: autoup/autodown are functional, not safety functions. The safety function is provided by the limiter only.

Gearshifting in automatic mode: lever at D

Letter D will be appear on the display instead of the engaged gear.
Starting from N lever position, the driver must request setting-off gear (1st = lever at D) or R with the knob button pressed to set off (forwards or reverse). The system will maintain automatic mode.

The system accepts requests using the steering wheel levers (both TIP+ and TIP-) with the lever at D in this mode:

Automatic gear shift suggestion strategy.

Upon request by the driver, the system starts working manually. The engaged gear is displayed for certain time (approximately 5 seconds).
After this interval of time, the system goes back to working in Automatic mode (D appears on the display).
Manual mode is displayed even if the request is not accepted.

The **Kick Down** function is also available: if the driver presses the accelerator to end of travel the system recognises this as a request for maximum torque and shifts down one, two or three gears, if conditions allow.

Dynamic/Normal/All Weather logic

The operation logic can always be selected - either automatically or manually - using the "lever". The following settings are activated:

- in AUTOMATIC mode:
  - **Dynamic**: “Sport” shift calibration map is used
  - **Normal**: “Economy” shift calibration map is used
  - **All Weather**: “Economy” shift calibration map is used
- in MANUAL mode:
  - no effect on shift calibration maps

Neutral or R/1st gear request with vehicle moving:

N.B. **Reverse can only be engaged** in the following conditions:
- vehicle speed close to 0 km/h

Setting: Sthreshold (= 5 km/h)

- **D/TIP → N** shift: accepted for all speeds
- **D/TIP → R** shift (crossing N: this also applies to N → R):
  - → S < Sthreshold: accepted (R is engaged)
  - → S > Sthreshold: not accepted: accepted only to N request and then leaves N engaged: if within a time from the beginning of request S becomes < Sthreshold →OK R is engaged, otherwise N is left. If acceptance fails and lever is shifted to D, → see **note.**
- **R → N** shift: accepted for all speeds
- **R → D/TIP** shift (crossing N: this also applies to N → D/TIP):
  - → S < Sthreshold: accepted (1st is engaged)
  - → S > Sthreshold: accepted or not accepted →see **note**

Note

R → N → D/TIP shift with S > Sthreshold

A) If R → D/TIP shift is fast without and crossing of N is not recognised, the direct D/TIP→ R shift strategy will be used, i.e. N will be engaged.
B) If the R → D/TIP shift is slow, and crossing of position N is recognised, the shift will be treated as two separate shifts:
1) R → N shift: always accepted.
2) N → D/TIP shift: always accepted.

In this case, although starting from position R, the D/TIP shift will be accepted and 1st gear (or a more suitable gear) will be engaged, regardless of speed.
The calibration confirmation time for acknowledging lever stably in N position is currently 200 ms.
If shifting is not accepted, the message NOT ALLOWED will be displayed for a certain time + buzzer.

Parking request with vehicle moving:

The mechanical lock will not be engaged if the lever is positioned at P at speeds other than 0 km/h. The system shifts to neutral and the lever remains locked in P. The gearbox control unit must send the “Lever release request” on CAN to release the lever.

Launch Control strategy

The launch strategy can be activated in Dynamic mode and speed = 0 km/h:

1. **To arm launch control:**
    a. press the brake pedal without releasing it
    b. press the accelerator pedal without releasing it (even partially)
    c. tip DOWN (“-“) with paddle only if lever is in D position or from paddle or lever with lever in TIP position.
2. **For launching (after arming the strategy):**
    a. release the brake pedal holding the accelerator pedal pressed
3. **For aborting launch (after arming the strategy):**
    a. release the accelerator pedal.

System safety functions

Vehicle stationary, engine running, gear engaged (typically 1st or R)

Press the brake pedal and/or accelerator, then open the driver door:
the system keeps the current gear. The instrument panel will continue to display mode, logic current gear.
The buzzer will always sound when the door is open, the key is on, the engine is running and the lever is not in P.

Vehicle stationary, engine running, gear engaged (typically 1st or R)

Do NOT press the brake pedal or the accelerator pedal, then open the driver's door:
the buzzer will sound for 5 seconds if the lever is in position other than P (even if the brake pedal is pressed).
Currently, the buzzer will always sound when the door is open, the key is on, the engine is running and the lever is not in P.

if creeping is off (e.g. handbrake applied or creeping recovery mode):

- the system engages N (neutral) after approximately **1.5 sec**.
- The instrument panel will continue to display mode, logic and **N**.

Since the lever may be at D/TIP or R, the shift to N (neutral) operated by the system will create an inconsistency between lever position and engaged gear. Therefore, the buzzer will sound.
the buzzer will continue until consistency is restored.
(To engage 1st gear again (with the lever in D/TIP) the steering wheel paddles may also be used, with the brake pressed).
NOTE: **the buzzer is used whenever N is engaged automatically.**

Vehicle stationary, engine running, gear engaged (typically 1st or R)

Wait for longer than **3 minutes** before starting any operation. In other words, do not press the brake pedal or the accelerator and do not shift the lever (e.g. when standing at a traffic light):
if creeping is off (e.g. handbrake applied or creeping recovery mode):

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

Since the lever may be at TIP or R, the shift to N (neutral) operated by the system will create an inconsistency between lever position and engaged gear. Therefore, the buzzer will sound.
the buzzer will continue until consistency is restored.

Vehicle stationary, engine running, gear engaged (typically 1st or R)

Keep the brake pedal pressed without operating (standing) for longer than 10 minutes:

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

Since the lever may be at TIP or R, the shift to N (neutral) operated by the system will create an inconsistency between lever position and engaged gear. Therefore, the buzzer will sound.
the buzzer will continue until consistency is restored.

Vehicle stationary, engine running, gearbox in neutral (lever in at P): key-off procedure
Turn the engine off:
P will blink on the display and the buzzer will sound indicating that the vehicle is about to be left with the lever not in P: P will blink and the buzzer will sound for approximately 5 seconds (controlled by the gearbox lever).
The buzzer and blinking will last for 5 seconds. After 5 seconds, the systems go to power-off. If the lever is not moved to P within 5 seconds, the key will remain locked after power-off. The Parking function is only mechanical and can therefore be engaged even after 5 seconds. The lever will remain locked after it is placed at P.

Vehicle stationary, engine running, lever at P): key-off procedure
Turn the engine off:
no gearbox information will be displayed and the buzzer will not sound.

Manually releasing the lever
In an emergency (breakdown, flat battery, etc.) the lever can be moved from position P using the lever under the boot, on the left side, as shown in fig. 68.

Fig. 68

Remember that the starter key (if inserted) will remain locked if the battery is flat. The key may be extracted mechanically by inserting a screwdriver in the hole under the dashboard (Fig. 69) and pressing slightly to extract the key.

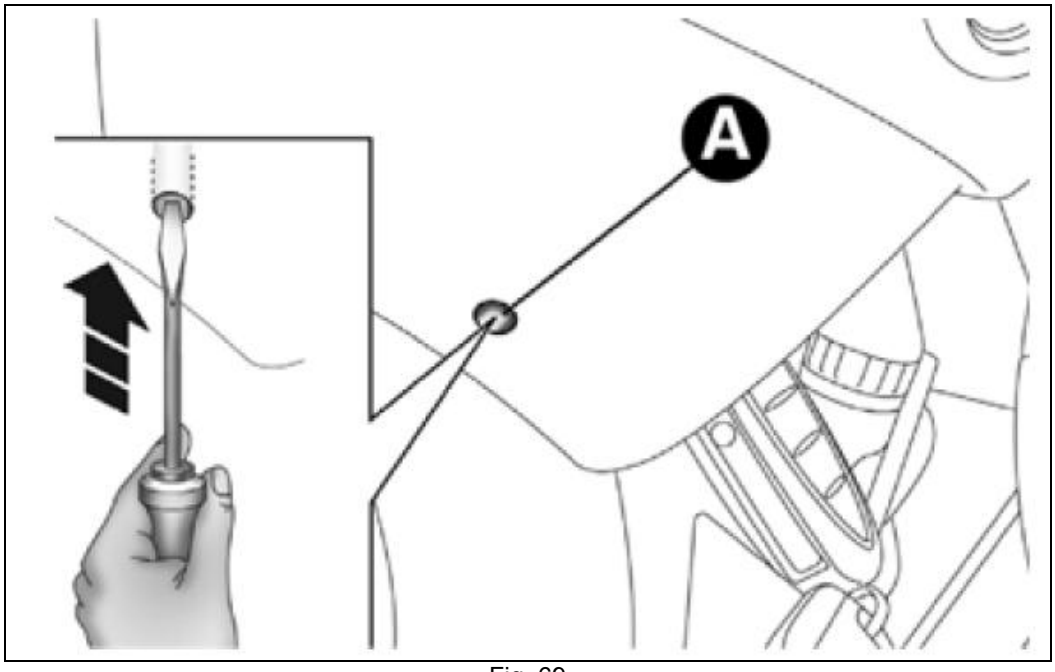


Fig. 69

Summary of messages sent by TCT to instrument panel

EVENT	CONTROL	WARNING MESSAGE	BUZZER
	action	**present**	**present**
Lever position-engaged gear inconsistency	Lever inconsistency may be due to the impossibility to engage a requested gear or caused by automatic safety neutral selection procedures	no	yes
Manual shift UP/DOWN not accepted		no	yes
Door open with engine running and lever not in P		no	yes
R engaged		no	yes
Request to engage 2nd gear from stationary with engine running		Yes NOT ALLOWED	yes
D->R R->D request while moving not allowed	Automatic neutral selection if shift request is over an acceptable speed threshold for a maximum timeout	Yes NOT ALLOWED	yes
Clutch overheating		Yes OVERHEATED CLUTCH	yes
Manual recovery deactivation		Yes MANUAL MODE NOT AVAILABLE	no
Manual recovery deactivation		Yes AUTOMATIC MODE NOT AVAILABLE	no
Gear request not available		Yes GEAR REQUEST NOT AVAILABLE	yes

SPECIFICATIONS

Gear ratios.

Type		Alfa Romeo MiTo	
Transmission ratios	1st	3.900	
	2nd	2.269	
	3rd	1.522	
	4th	1.116	
	5th	0.915	
	6th	0.767	
	R	4.000	
	FR	4.118	

Clutches

K1	Dry, single plate and pressure plate with automatic wear take-up device
K2	Dry, single plate and pressure plate without automatic wear clearance take-up device
Operation	Pressure

Fluids and lubricants

Recommended products specifications

	Type	**quantity**	**maintenance**
Hydraulic unit oil	Tutela Car CS Speed (ATF DEXRON III) viscosity 1800 cPs at -40°C; 6.5 cPs at 100°C)	0.76 litres	Check every 120000 km.

Gearbox control unit

8TDF
80 pin connector
Ambient working temperature T:

- From -30°C to +100°C (while working)

Working voltage:

- Minimum working voltage VBAT_min: 6.0 V (4.5 V while cranking)
- Maximum working voltage VBAT_max: 16.0 V
- Nominal working voltage VBAT_typ: 12.0 V
- Nominal 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 kbyte/sec)

Special hardware functions:

- ECU – wake-up from driver's door opening switch

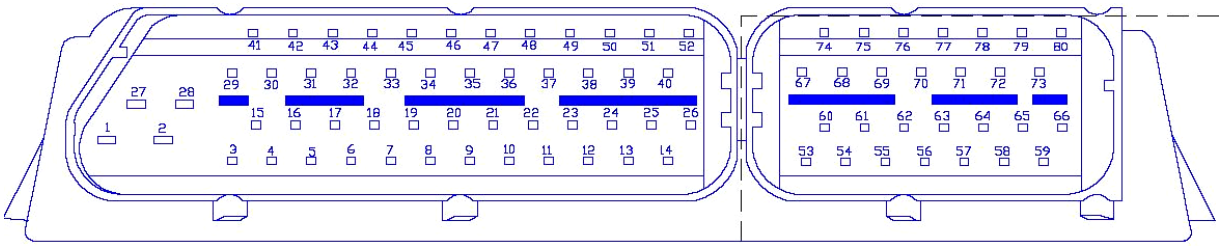


Fig. 70

Gearbox ECU pin-out

Pin	***Description***
A1	GND – power earth
A2	GND – power earth
A3	+12 V - direct battery supply
A4	N.C.
A5	N.C.
A6	N.C.
A7	N.C.
A8	Parking sensor
A9	N.C.
A10	N.C.
A11	N.C.
A12	N.C.
A13	N.C.
A14	N.C.
A15	N.C.
A16	N.C.
A17	Driver's door switch
A18	N.C.
A19	SDU diagnosis feedback
A20	N.C.
A21	D TIP signal
A22	N.C.
A23	N.C.
A24	N.C.
A25	N.C.
A26	N.C.

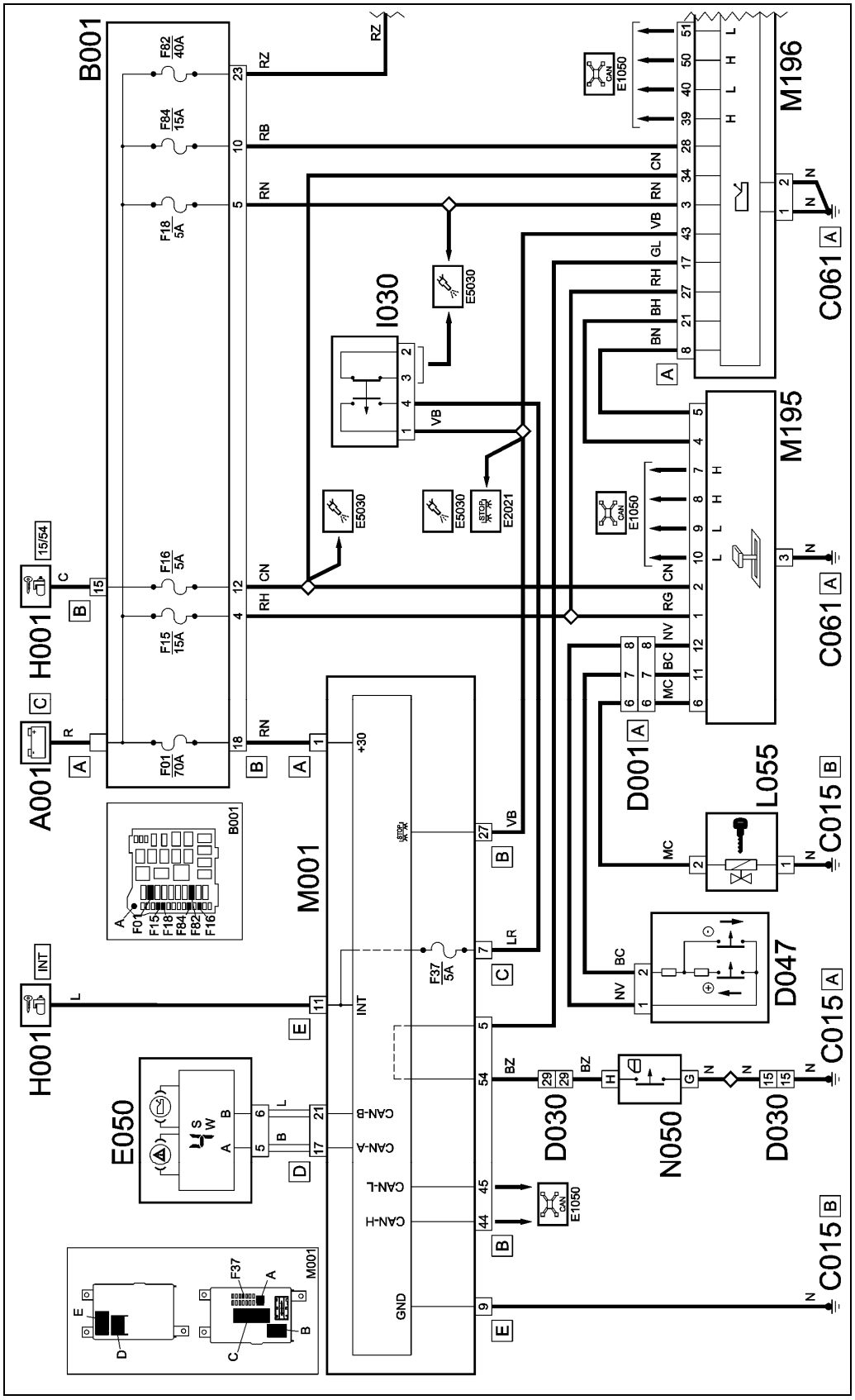
A27	+ 12 V - battery power
A28	+ 12 V - battery power
A29	N.C.
A30	Reverse light control 1 (optional)
A31	Reverse light control 2
A32	N.C.
A33	N.C.
A34	+ 15 – key-operated power supply
A35	N.C.
A36	SDU control
A37	N.C.
A38	N.C.
A39	CCAN H (out)
A40	CCAN L (out)
A41	N.C.
A42	N.C.
A43	Brake pedal signal
A44	N.C.
A45	N.C.
A46	N.C.
A47	N.C.
A48	N.C.
A49	Serial line K (preparation)
A50	CCAN H (IN)
A51	CCAN L (IN)
A52	N.C.
28 pin connector	
Pin	***Description***
A53	+ 5 V Line pressure sensor power
A54	N.C.
A55	GND - PPV-S (shifter) solenoid valve earth
A56	GND - PPV2 (engagement) solenoid valve earth
A57	GND - QPV-K1 (odd gear clutch) solenoid valve earth
A58	GND - PPV1 (engagement) solenoid valve earth
A59	GND - PPV-K2 (even gear clutch) solenoid valve earth
A60	Electrohydraulic unit temperature sensor signal
A61	Even gear clutch K2 pressure sensor signal
A62	+ 12 V PPV-S solenoid valve power
A63	+12 V PPV2 (engagement) solenoid valve power
A64	+12 V QPV-K1 (even gear clutch) solenoid valve power
A65	+12 V PPV1 (engagement) solenoid valve power
A66	+12 V PPV-K2 (even gear clutch) solenoid valve power
A67	Odd gear clutch K1 position sensor signal
A68	Position 5/R sensor signal
A69	Position 2/4 sensor signal
A70	Clutch K2 rpm sensor signal
A71	Odd gear engagement position sensors and clutch K1 power
A72	Even gear engagement position sensors, clutch K2 pressure and selection sensor power
A73	Clutch rpm sensor and line pressure power
A74	Odd clutch rpm sensor signal
A75	Selection (shifter) position sensor signal
A76	Position 1/3 sensor signal
A77	Position 6 sensor signal
A78	Sensor module and clutch K2 pressure sensor earth
A79	Line pressure sensor and clutch K1 position sensor earth
A80	Clutch K1 and clutch K2 rpm sensor module earth

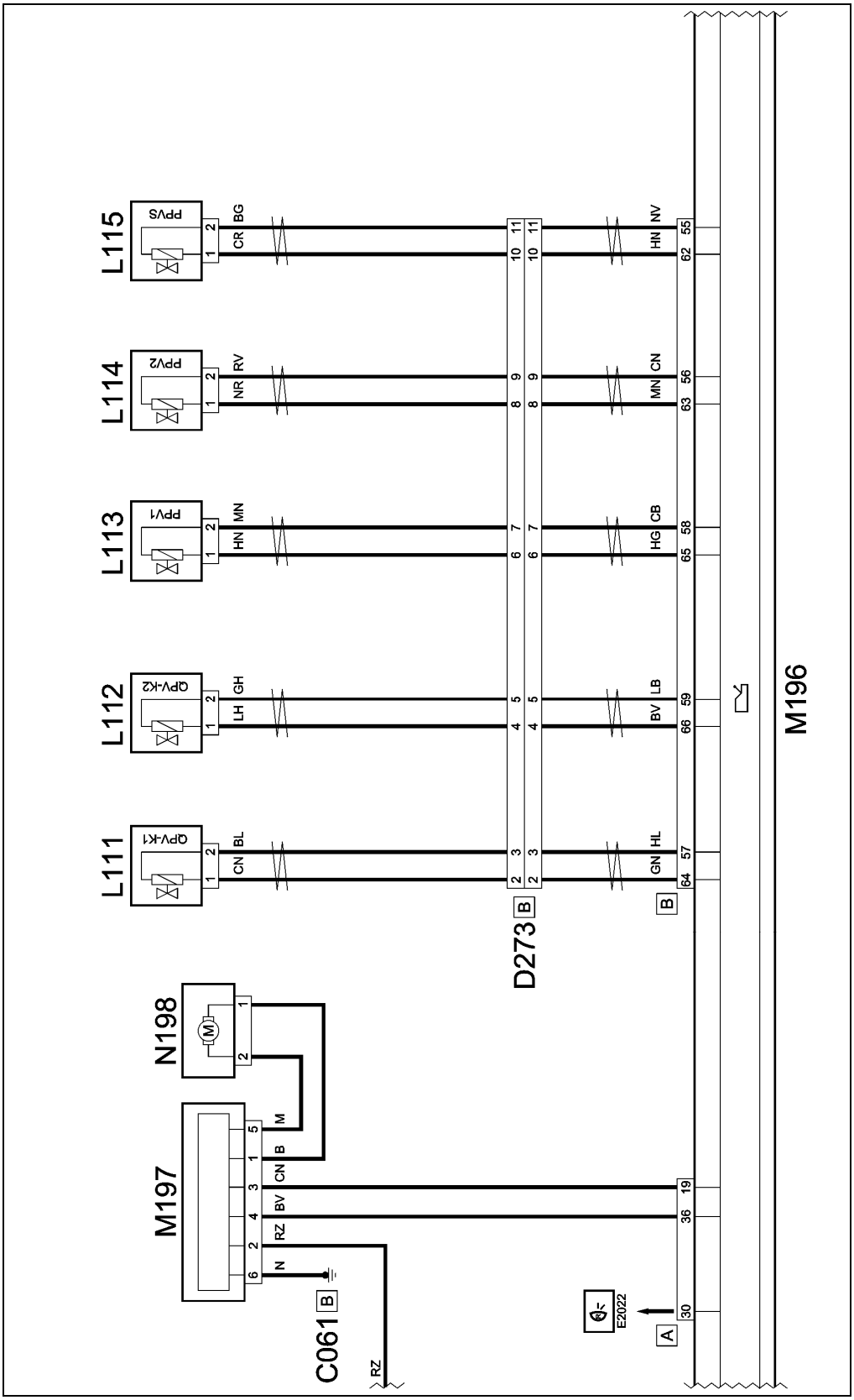
DTC error code list

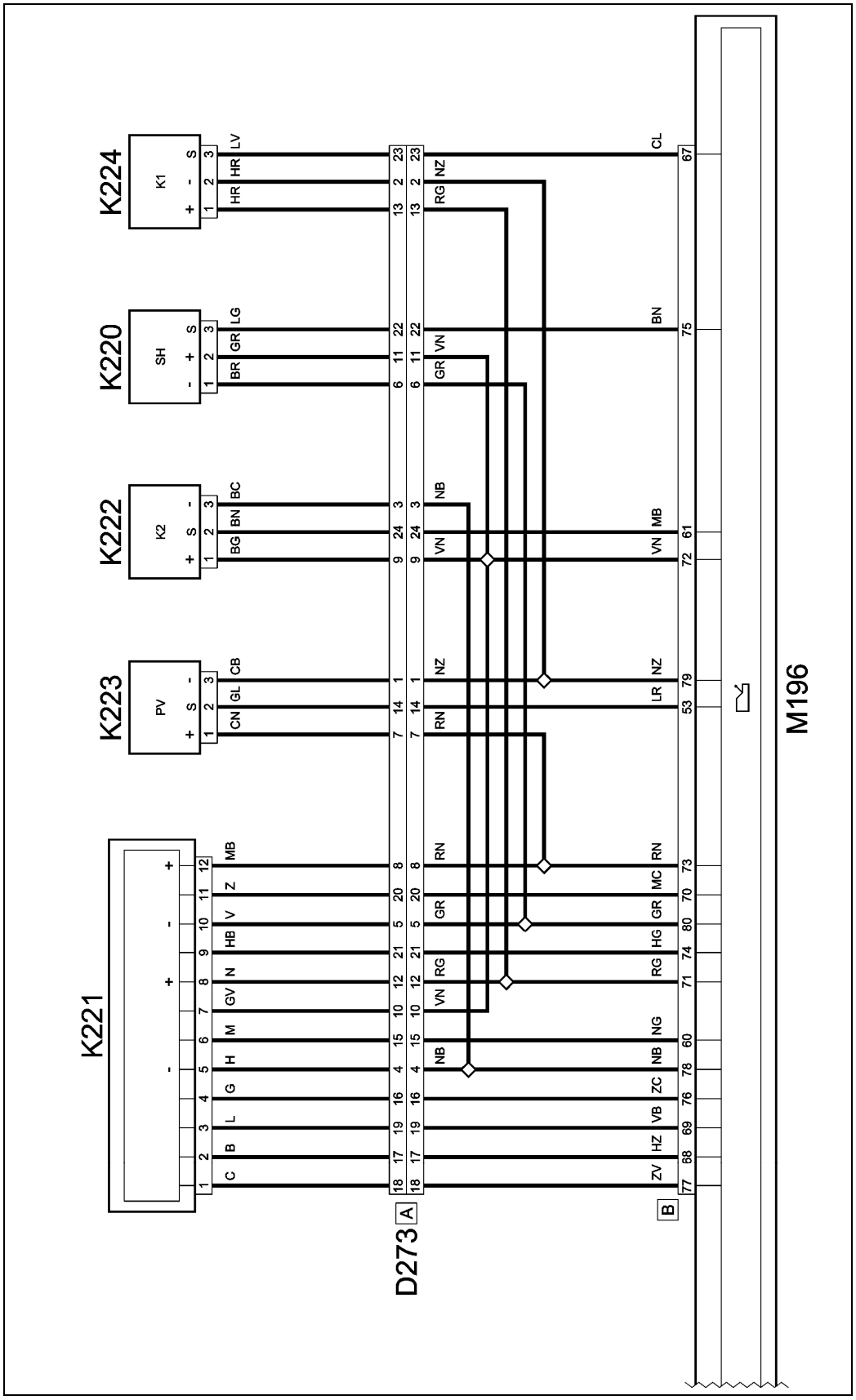
P0571	Service brake switch (from CAN)
P0604	ECU fault (RAM)
P0605	ECU fault (ROM)
P062F	ECU fault (EEPROM)
P0641	Even clutch position/hydraulic pressure sensor earth
P0666	ECU temperature
P0667	ECU temperature
P0703	Service brake switch (from CAN)
P0715	Odd gear clutch plate speed
P0716	Even gear clutch plate speed
P0719	Brake switch
P0726	Engine rpm control
P0805	Even clutch position sensor
P0817	Power supply (+15)
P081C	Parking sensor
P0900	Even gear clutch solenoid valve
P0901	Even gear clutch solenoid valve
P0902	Even gear clutch solenoid valve
P0904	Selection sensor
P0905	Odd gear clutch solenoid valve
P0906	Odd gear clutch solenoid valve
P0907	Odd gear clutch solenoid valve
P0914	1st/3rd gear engagement position sensor
P0915	6th gear engagement position sensor
P0916	2nd/4th gear engagement position sensor
P0917	5th/reverse gear engagement position sensor
P0932	Hydraulic circuit pressure sensor
P0933	Odd gear clutch pressure sensor
P0942	Hydraulic circuit pressure
P1215	Driver's door
P1771	Electric pump temperature
P2901	Drain oil accumulator
P2903	No accelerator pedal information
P2904	Outside temperature
P290A	Even gear engagement sensor and even gear engagement clutch power
P290B	Even gear clutch engagement/pressure sensor and selection sensor power
P290C	Clutch revolution and hydraulic pressure sensor power
P2910	Engine torque (from NCM)
P2911	Requested engine torque not reached
P2912	Maximum engine torque (from CAN)
P2913	Engine torque
P2916	Engine temperature (from NCM)
P2918	Atmospheric pressure
P291B	Parking brake (from CAN)
P291E	Key lock
P2920	Parking switch (inconsistency)
P2921	Lever lock solenoid

P2922	Lever lock solenoid
P2923	Lever lock solenoid
P2927	Wheel circumference (from CAN)
P2928	Pressure (master cylinder)
P292B	Failed gear selections
P292C	Failed gear selections (total)
P292D	1st/3rd/5th gear release
P292E	Reverse release
P292F	2nd/4th/6th gear release
P2930	Impossible gear release on both ranges
P2931	1st/3rd gear engagement
P2932	5th engagement
P2933	2nd/4th gear engagement
P2934	6th gear engagement
P2935	Failed gear engagements (total)
P2936	Impossible gear engagement on both ranges
P2937	Engaged gear release
P2938	Engaged neutral gear release
P293F	Odd gear clutch
P2940	Sensor module temperature
P294B	Selespeed electric pump
P294C	Selespeed electric pump
P294D	Selespeed electric pump
P0560	Battery voltage
P0561	Battery voltage
P0562	Battery voltage
P0606	Control unit fault (microprocessor)
P0720	Vehicle speed
P0725	Engine speed
P0813	Reverse light control
P0856	VDC messages (from CAN)
P0857	VDC messages (from CAN)
P290D	End of line/service self-calibration
P290E	Clutch self-calibration enabling
P290F	Yaw/side acceleration node (NYL)
U0001	NCR node fault
U1700	CAN (NCR - NBC)
U1701	CAN (NCR - NCM)
U1706	CAN (NCR - NFR)

WIRING DIAGRAM




L115
PPVS
BG
CR
L114
PPV2
RV
NR
L113
PPV1
MN
HN
L112
QPV-K2
GH
LH
L111
QPV-K1
BL
CN
D273
B
M196
HN
NV
MN
CN
HG
CB
BV
LB
GN
HL
M197
N198
M
B
CN
BV
RZ
N
C061
B
RZ
E2022
A


K224
K1
K220
SH
K222
K2
K223
PV
K221
D273
A
B
M196
CL
BN
MB
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LR
RN
MC
GR
HG
RG
NG
NB
ZC
VB
HZ
ZV
LV
HR
LG
GR
BR
BC
BN
BG
CB
GL
CN
Z
V
HB
N
GV
M
H
G
L
B
C

Key

A001 BATTERY
B001 JUNCTION UNIT UNDER DASHBOARD
C015 BODY EARTH
C061 CENTRAL TUNNEL BODY EARTH
D001 CENTRAL TUNNEL CONNECTOR
D030 INTERMEDIATE JUNCTION UNDER DASHBOARD
D047 GEARBOX CONTROLS ON STEERING WHEEL
D273 ENGINE COMPARTMENT INTERMEDIATE JUNCTION
E050 INSTRUMENT PANEL
H001 IGNITION SWITCH
I030 BRAKE SWITCH
L055 LEVER RELEASE ELECTROMAGNET
L111 ODD GEAR CLUTCH K1 FLOW PROPORTIONAL SOLENOID VALVE
L112 EVEN GEAR CLUTCH K2 PRESSURE PROPORTIONAL SOLENOID VALVE
L113 PPV1 ENGAGEMENT PRESSURE PROPORTIONAL SOLENOID VALVE
L114 PPV2 ENGAGEMENT PRESSURE PROPORTIONAL SOLENOID VALVE
L115 PPV-S SELECTION PRESSURE PROPORTIONAL SOLENOID VALVE
M001 BODY COMPUTER NODE
M195 GEARBOX LEVER
M196 ALFA TCT TRANSMISSION TCU
N198 ELECTROHYDRAULIC KIT HYDRAULIC POWER UNIT PUMP
K220 SHIFTER POSITION SENSOR
K221 ELECTROHYDRAULIC KIT SENSOR MODULE
K222 EVEN GEAR CLUTCH K2 PRESSURE SENSOR
K223 LINE PRESSURE SENSOR
K224 ODD GEAR CLUTCH K1 POSITION SENSOR

Special tools
The following special tools are needed for mechanical overhaul of ALFA TCT:

2000035500	C 635 transmission overhaul kit
2000035501	C 635 transmission
2000035502	C 635 transmission
2000035503	C 635 transmission
2000035504	C 635 transmission
2000035505	C 635 transmission
2000035506	C 635 transmission
2000035507	C 635 transmission
2000035508	C 635 transmission
2000035510	C 635 transmission
2000035511	C 635 transmission

2000036099	Alfa TCT automatic transmission overhaul kit
2000036100	Alfa TCT
2000036200	Alfa TCT
2000036300	Alfa TCT
2000036400	Alfa TCT
2000036500	Alfa TCT
2000036600	Alfa TCT
2000036700	Alfa TCT
2000036800	Alfa TCT

LIST OF ACRONYMS

The following list shows most of the acronyms used to identify electric system components. Some may not be specifically used in this training manual because the corresponding devices are not fitted.

ACRONYM	DESCRIPTION
ACC	Adaptive Cruise Control
ACU	Automatic Climate Unit
AFLM	Adaptive Front Light Module
AFLM:	Adaptive Front Lighting Module
AHCU	Additional Heater Control Unit
AHM	Additional Heater Module
AL:	Automotive Lighting
AM-ASU	After Market Alarm System Unit
ASM	Air Suspension Module
ASU	Alarm Siren Unit
ATSM	AntiTilt Sensor Module
AVAC:	Automatic Vehicle Aim Control (levelling, vertical)
BAM	Brake Assistant Module
BCM	Body Control Module
BDU	Battery power Distribution Unit
BLS	Brake Lights Switch
BSM	Braking System Module
C3CM	Convergence C3 Command Module
CCM	Controlled Clutch Module
CDC	Co - Driver Door Commands
CSM	Column Switch Module
CSS	Central Stack Switches
CSS:	Central Stack Switches
CTCU	Chrono Tachograph Control Unit
CTM	Convergence Telematic Module
DBL:	Dynamic Bending Light (horizontal)
DCM	Dumping Control Module
DDC	Driver Door Commands
DDM	Driver Door Module
DIAG TEST	Diagnostic Tester
DLC	Diagnostic Link Connector
DMM	Door Management Module
DMMU	Driver Mirror Movement Unit
DMU	Door Management Unit
D-PDU	Dashboard Power Distribution Unit
DSHS	Driver Seat Heater System
DSM	Driver Seat Module
DSU	Dynamic Selector Unit
ECC	Electronic Climate Control
ECD	Electronic Climate Device
ECM	Engine Control Module
EEMS	Electric Energy Management System
EMC	External Mirror Adjustment Commands
EPB	Electric Parking Brake
EPS	Electric Power Steering
ESCM	Engine Signal Converter Module
ESL	Electric Steering Lock

FCLU	Front Ceiling Light Unit
FDM	Front Door Module
FDU	Front Distribution Unit
FIS	Fire Intervention System
FMM	Fuel Methane Module
FWL	Front Window Lifter
GCLU	Glove box Ceiling Light Unit
GSM	Gearbox Selector Module
HALF	Heptic Lane Feedback
HS:	Half Step[s]
IPC	Instrument Panel Cluster
ITM	InfoTainment Module
LHDU	Left Headlamp Discharge Unit
LHDU:	Left Headlamp Discharge Unit
LHL	Left HeadLamp Levelling
LHRCLU	Left Hand Rear Ceiling Light Unit
LSS	Left Stack Switches
MCD	Manual Climate Device
MHD	Manual Heater Device
ML:	Motorway Light
MMI	Man Machine Interface)
MTA	Manual Transmission Automatized
N/A:	Not Applicable
NBC:	Body Computer Node
NCM:	Engine Control Module
NCR:	Robotized Gearbox Module
NFA:	Adaptive Front Lighting Module
NFR:	BSM, Braking System Module
NGE:	EPS, Electric Power Steering
NQS:	IPC, Instrument Panel Cluster
O-PDU	Optional Power Distribution Unit
PAM	Parking Aid Module
PCU	Passenger Control Unit
PDM	Passenger Door Module
PEM	Passive Entry Module
PMMU	Passenger Mirror Movement Unit
PSHS	Passenger Seat Heater System
PSM	Passenger Seat Module
RAC	Roof Area Commands
RAM	Roof Area Module
RCLU	Rear Ceiling Light Unit
RCM	Roll Control Module
RDU	Rear Distribution Unit
RHDU	Right Headlamp Discharge Unit
RHDU:	Right Headlamp Discharge Unit
RHL	Right HeadLamp Levelling
RHRCLU	Right Hand Rear Ceiling Light Unit
RLDC	Rear Left Door Commands
RLS	Rain Light sensor
RMN	Radio Map Nav
RRDC	Rear Right Door Commands
RRM	Radio Receiver Module

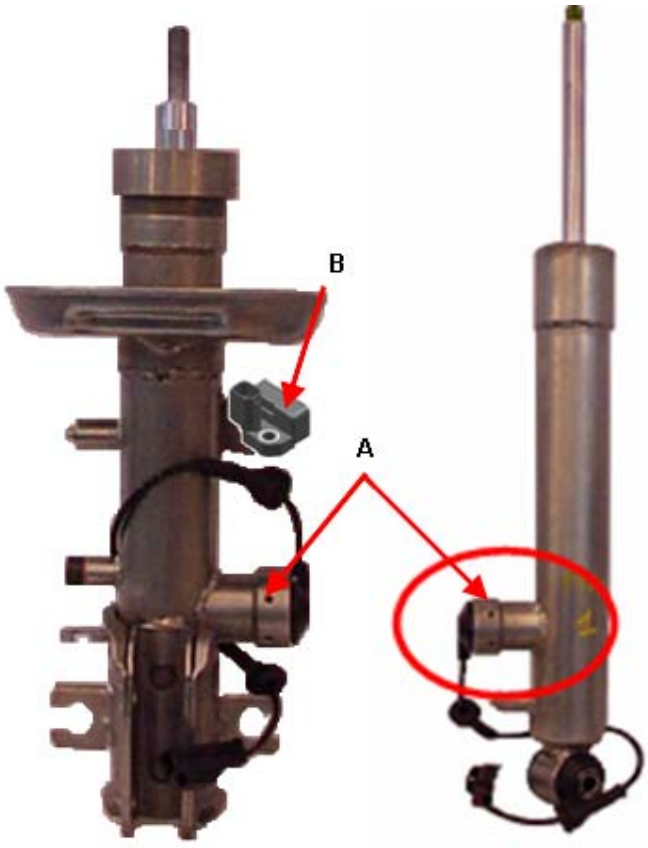
SAS	Steering Angle Sensor
SAU	Stereo Amplifier Unit
SBDU	Supplementary Battery power Distribution Unit
SBR	Seat Belt Reminder and Child Rating
SCD	Sensor Cluster Device
SCM	Sensor Cluster Module
SDM	Sensing and Diagnostic Module
SMM	Starter Management Module
SPM	Semi-automated Parking aid Module
SRU	Sun Roof Unit
SSCU	Servo Steering Control Unit
SSM	Steering Switch Module
SWC	Steering Wheel Commands
TAM	Trunk Area Module
TCLU	Trunk Ceiling Light Unit
TCM	Transmission Control Module
TPM	Tyre Pressure Module
TRM	Teg Reader Module
TRU	TEG Reader Unit
TSM	Tunnel Stack Module
UAM	Ultrasonic & Antitilt Module
UCM	Unlatch Control Module
UDM	Unique Door Module
VPAS	Video Parking Aid System
WCU	Wiping Control Unit
WLU	Window Lifter Unit
WSU	Weight Sensor Unit
YRS	Yaw Rate Sensor
TCU	Transmission Control Unit
CAS	Complete Actuation System
CAM	Complete Actuation Module
PPV	Pressure Proportional Valve
QPV	Quantity Proportional Valve
DS	Dynamic Suspension

APPENDIX

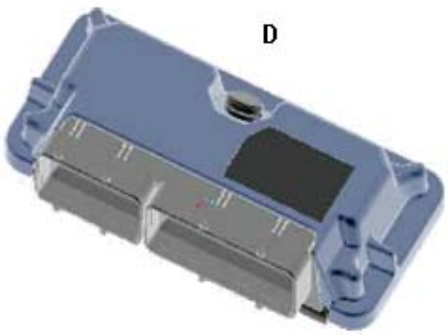
An additional technology feature fitted on Alfa Romeo Mito is the electronic controlled shock absorber system. Operation is described on the following pages.

DYNAMIC SUSPENSION (DS)

The shock absorber stiffness is varied by an electrohydraulic unit which adjusts the oil flow in the damping system. The oil flow is adjusted by a solenoid valve (A) integrated in each of the four shock absorbers.

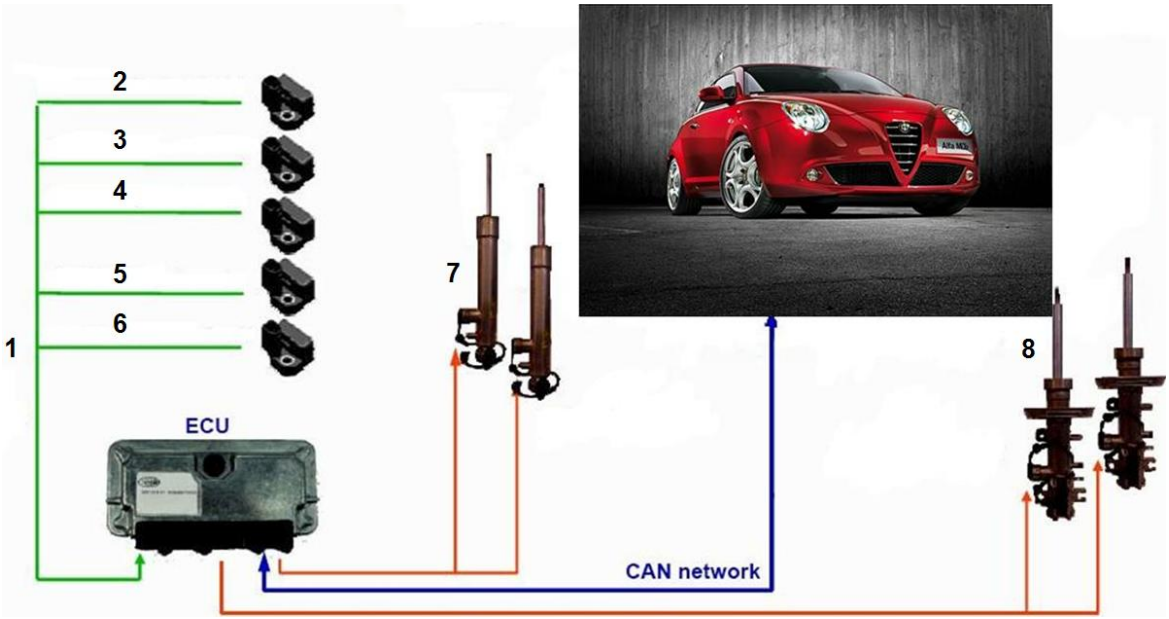


The solenoid valves are controlled by an electronic control unit (D), which processes signals from vehicle and from specific accelerometers (B) located on the vehicle body. The ECU is a node connected to the C-CAN located on the rear left wheel arch inside the boot.



Operating strategies

The node uses information from five accelerometers located in five strategic areas of the car (see Fig. 1) and other parameters to determine operating strategy, according to the following criteria:



1. Sensors
2. Accelerometer on front left side body.
3. Accelerometer on front right side body.
4. Accelerometer on front left side hub.
5. Accelerometer on front right side hub.
6. Accelerometer on rear left side body.
7. Rear shock absorbers with electronically controlled valve.
8. Front shock absorbers with electronically controlled valve.

In order to work and obtain maximum efficiency, DS must exchange information with the following nodes on C-CAN:

NCM (ECU)
NCR
NFR
EPS
NBC

To get information about:

Brake pressure signal, ABS/ASR/VDC intervention, vehicle speed, side acceleration, yaw speed, brake and accelerometer pedal position, steering wheel angle, engine torque, engine rpm, external temperature and other vehicle data to optimise control logics, according to vehicle type and to what is happening.

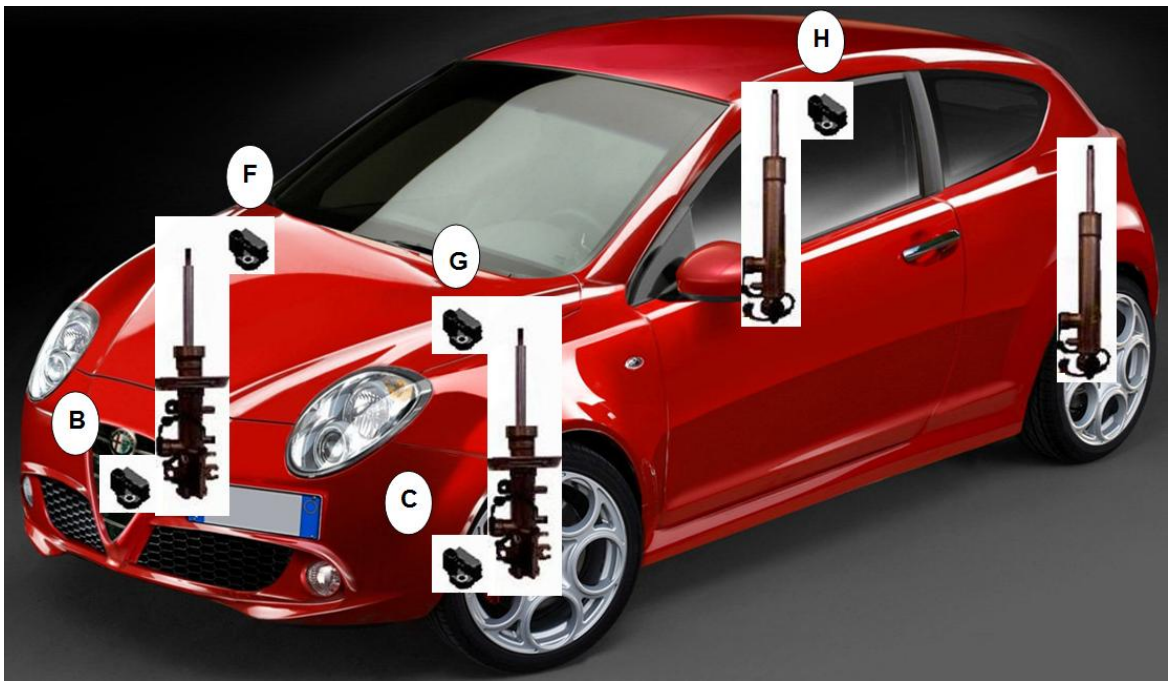
System operating strategy

Sky Hook: three sensors (F, G, H) identify body movements so that the system can dampen vertical movements.

Hole/road roughness recognition: two sensors on front shock absorbers (B, C) recognise the presence of irregular road surface to reduce annoyance.

Longitudinal Dynamics: body movements are damped during acceleration, braking and gearshifting.

Side dynamics: this function works when cornering making reaction sharper and while bearing on outer wheels for additional stability.



The DS intervention mode can be adjusted using the dna lever on the central tunnel:

1. In “Normal” and “All weather” modes

    - The active shock absorbers adjust vehicle damping to the type of road and driving stress to considerably improve riding comfort on rough and slippery roads for increased safety.

2. In “Dynamic” mode

    - The function produces a sporty driving set-up with responsive acceleration and steering assistance to provide a suitable driving feeling. Furthermore, the shock absorber damping action is correctly adjusted and split to increase precision and reactiveness while maintaining an adequate comfort level in all cases. The driver feels the car sharper while cornering and faster in changing directions.

System failure and service interventions

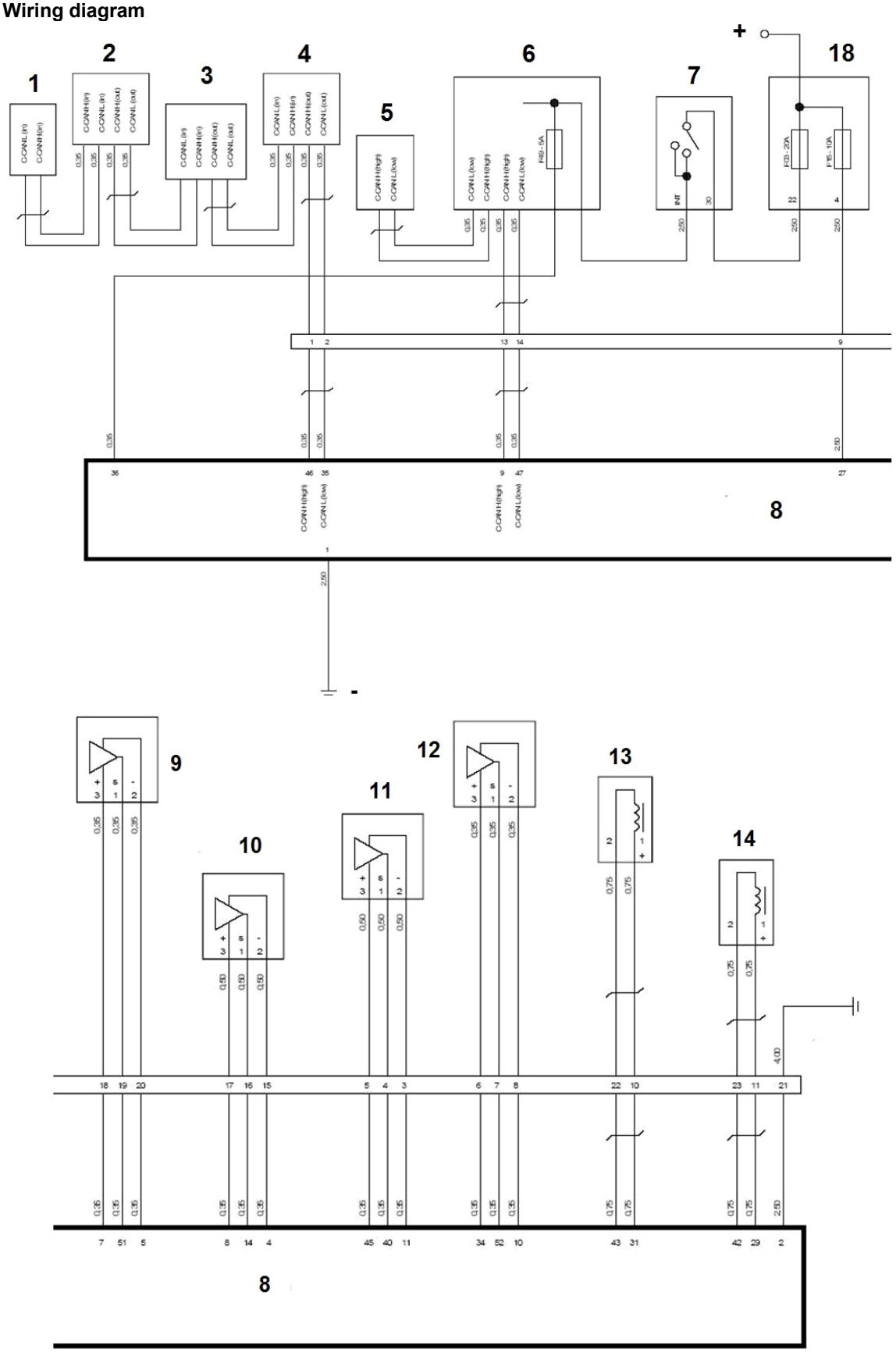
DS system failure

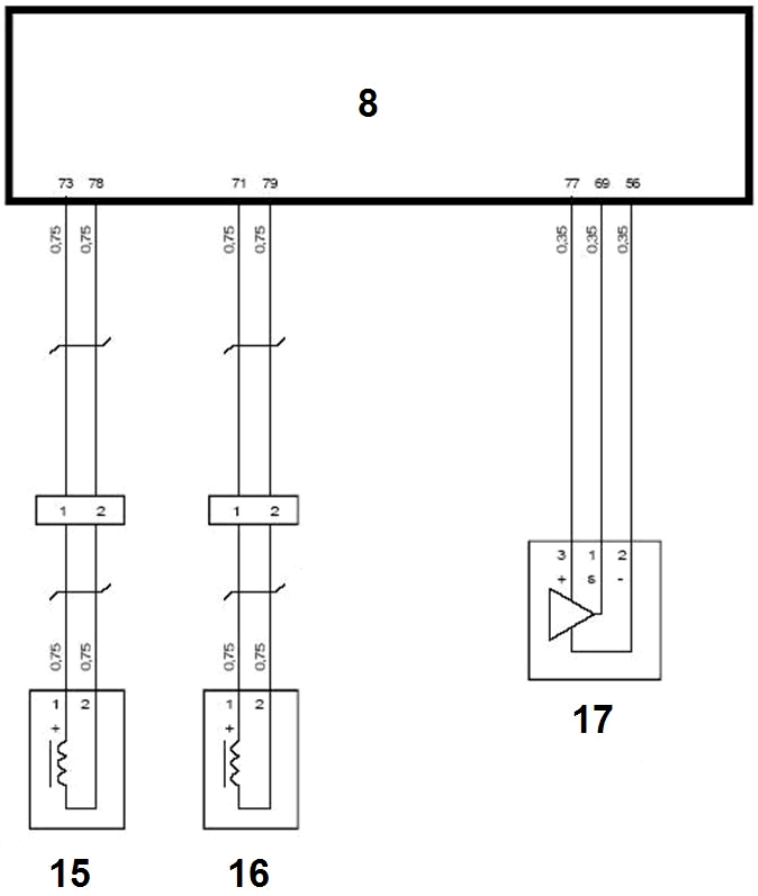
In case of faults, the system informs the driver by switching on the  amber warning light on the instrument panel display.

In case of failure/fault of one accelerometer only, the system keeps working using the signals from other accelerometers. The warning light does not come on.

Run the proxy alignment and calibration procedure using Examiner if the control unit is replaced.
No procedure is required if one of the shock absorbers or accelerometers is replaced.

Wiring diagram





1. NCM
2. NFR
3. NYL
4. EPS
5. DIAGNOSTIC SOCKET
6. NBC
7. IGNITION SWITCH
8. DYNAMIC SUSPENSION NODE
9. LEFT FRONT DOME ACCELEROMETER
10. LEFT FRONT WHEEL ACCELEROMETER
11. RIGHT FRONT WHEEL ACCELEROMETER
12. RIGHT FRONT DOME ACCELEROMETER
13. LEFT FRONT SHOCK ABSORBER SOLENOID VALVE
14. RIGHT FRONT SHOCK ABSORBER SOLENOID VALVE
15. LEFT REAR SHOCK ABSORBER SOLENOID VALVE
16. RIGHT REAR SHOCK ABSORBER SOLENOID VALVE
17. LEFT REAR DOME ACCELEROMETER
18. CVM

ECU pin-out

CONNECTOR A	
PIN	**FUNCTION**
A1	N.C.
A2	Battery terminal earth
A3	N.C.
A4	Left front wheel accelerometer earth
A5	Left front dome accelerometer earth
A6	N.C.
A7	Left front dome accelerometer 5V voltage
A8	Left front wheel accelerometer 5V voltage
A9	C-CAN High
A10	Right front dome accelerometer earth
A11	Right front wheel accelerometer earth
A12	N.C.
A13	N.C.
A14	Accelerometer signal on left front wheel
A15	N.C.
A16	N.C.
A17	N.C.
A18	N.C.
A19	N.C.
A20	N.C.
A21	N.C.
A22	N.C.
A23	N.C.
A24	N.C.
A25	N.C.
A26	N.C.
A27	Battery voltage
A28	N.C.
A29	Right front shock absorber valve positive
A30	N.C.
A31	Left front shock absorber valve positive
A32	N.C.
A33	N.C.
A34	Right front dome accelerometer 5 V voltage
A35	C-CAN Low
A36	KL 15
A37	N.C.
A38	N.C.
A39	N.C.
A40	Right front wheel accelerometer signal
A41	N.C.
A42	Right front shock absorber valve earth
A43	Left front shock absorber valve earth
A44	N.C.
A45	Right front wheel accelerometer 5 V voltage
A46	C-CAN High
A47	C-CAN Low
A48	N.C.
A49	N.C.
A50	N.C.
A51	Left front dome accelerometer signal
A52	Right front dome accelerometer signal

CONNECTOR B	
PIN	**FUNCTION**
B53	N.C.
B54	N.C.
B55	N.C.
B56	Left rear dome accelerometer earth
B57	N.C.
B58	N.C.
B59	N.C.
B60	N.C.
B61	N.C.
B62	N.C.
B63	N.C.
B64	N.C.
B65	N.C.
B66	N.C.
B67	N.C.
B68	N.C.
B69	Left rear dome accelerometer signal
B70	N.C.
B71	Right rear shock absorber valve positive
B72	N.C.
B73	Left rear shock absorber valve positive
B74	N.C.
B75	N.C.
B76	N.C.
B77	Left rear dome accelerometer 5 V voltage
B78	Left rear shock absorber valve earth
B79	Right rear shock absorber valve earth
B80	N.C.

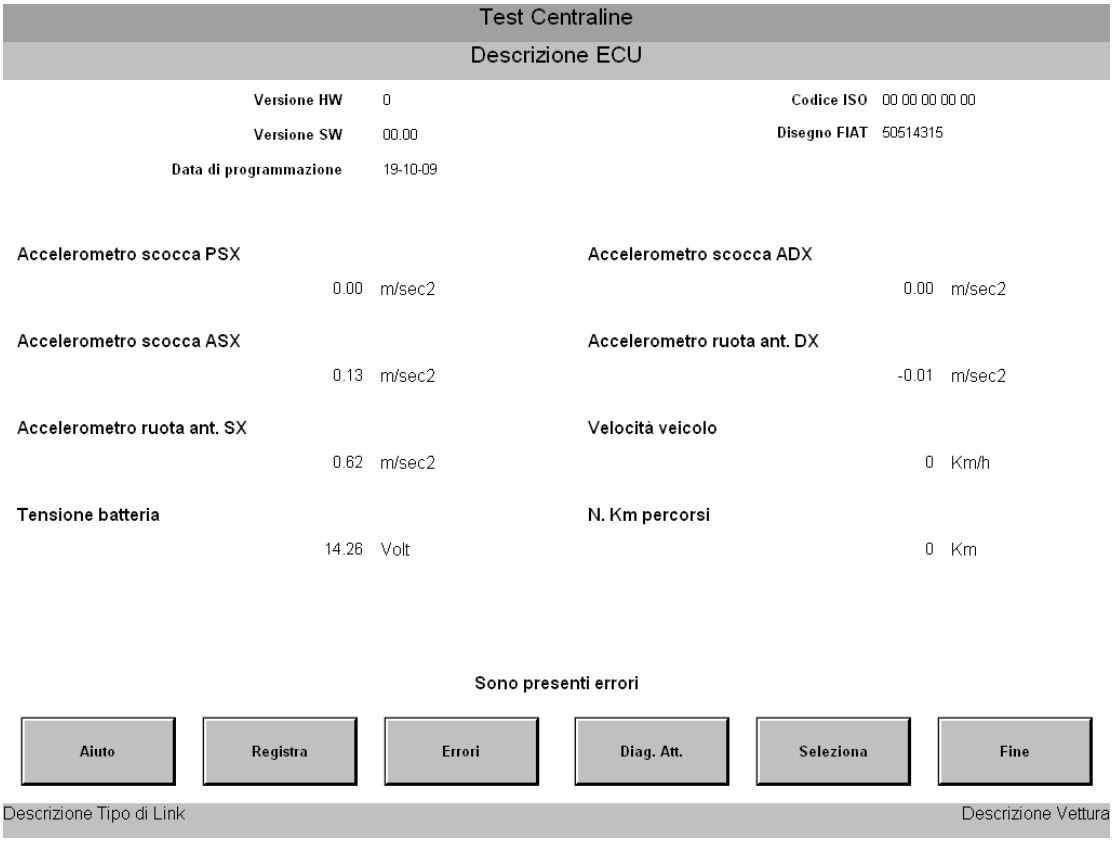
ACCELEROMETER CONNECTOR	
PIN	**FUNCTION**
1	Signal output
2	Earth
3	5 V power supply

SOLENOID VALVE CONNECTOR	
Pin	**Function**
1	Positive
2	Earth

DIAGNOSTICS

ECU parameters

Example of main page



List of selectable parameters and corresponding status

Description	Unit of measure/Status value
PSX body accelerometer	m/sec^2
ADX body accelerometer	m/sec^2
ASX body accelerometer	m/sec^2
Front right wheel accelerometer	m/sec^2
Front left wheel accelerometer	m/sec^2
Vehicle speed	km/h
Battery voltage	V
km covered	km
Outside temperature	Degrees centigrade
Vertical acceleration	m/sec^2
Lateral acceleration	m/sec^2
Failure warning light	OFF

Description	Unit of measure/Status value
	ON
Front left valve	recovery
	Minimum limit
	Maximum limit
Front right valve	recovery
	Minimum limit
	Maximum limit
Rear left valve	recovery
	Minimum limit
	Maximum limit
Rear right valve	recovery
	Minimum limit
	Maximum limit
Key status	Stop
	Park
	ON
	Crank requested
	No signal
Dynamic control selector	Normal
	City
	Sport
	Ice
Number of settings	-
Operating time	min.
Time since key-on	sec
Operating time (EEPROM) (not used)	min.
Time since key-on (EEPROM) (not used)	sec
Start-up counter	-
Time since first fault	min.
Key-on time since first fault	sec
Key-on counter alignment	-

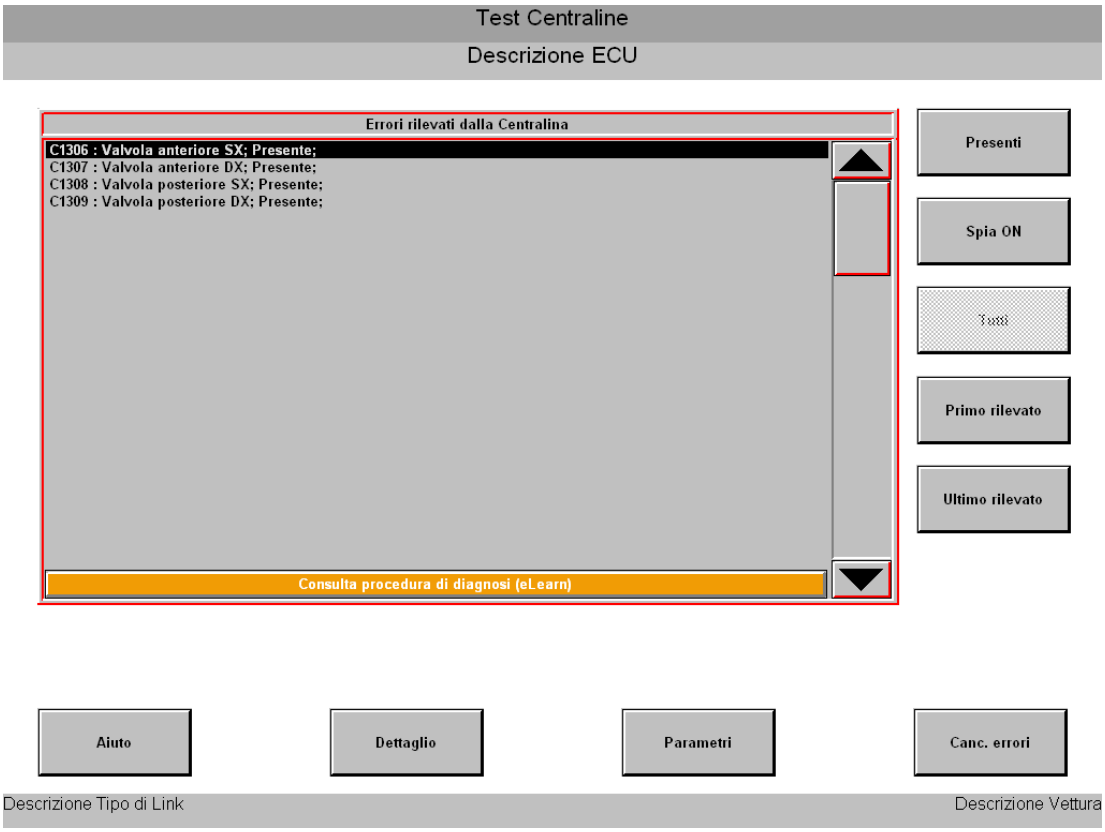
Parameter help

Parameter	Help
Battery voltage	BATTERY VOLTAGE: this indicates the supply voltage to the control unit.
Right front vertical acceleration	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Left front vertical acceleration	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Rear vertical acceleration	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Right front vertical accelerometer	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Left front vertical accelerometer	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Rear vertical accelerometer	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Battery voltage	BATTERY VOLTAGE: it indicates the supply voltage to the control unit.
Right front vertical acceleration	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.

Parameter	Help
Left front vertical acceleration	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Rear vertical acceleration	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Right front vertical accelerometer	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Left front vertical accelerometer	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Rear vertical accelerometer	ACCELERATION/LEFT-RIGHT-REAR ACCELEROMETER: this refers to the sensor which measures the vertical body acceleration.
Battery voltage	BATTERY VOLTAGE: this indicates the supply voltage to the control unit.

Displays of errors detected by ECU

Example of error page



DTC table

Value (hex)	Description 1	Description
C1300	2 or more faulty accelerometers	Not plausible signal
C1301	Front left wheel accelerometer	S.C. to +Vbatt
		S.C. to earth/O.C.
		Plausibility
C1302	Front right wheel accelerometer	S.C. to +Vbatt
		S.C. to earth/O.C.
		Plausibility
C1303	ASX body accelerometer	S.C. to +Vbatt
		S.C. to earth/O.C.
		Plausibility
C1304	ADX body accelerometer	S.C. to +Vbatt
		S.C. to earth/O.C.
		Plausibility
C1305	PSX body accelerometer	S.C. to +Vbatt
		S.C. to earth/O.C.
		Plausibility
C1306	Front left valve	S.C. to earth
		S.C. to +Vbatt
		Open circuit
C1307	Front right valve	S.C. to earth
		S.C. to +Vbatt
		Open circuit
C1308	Rear left valve	S.C. to earth
		S.C. to +Vbatt
		Open circuit
C1309	Rear right valve	S.C. to earth
		S.C. to +Vbatt
		Open circuit
C130A	Battery voltage	Under minimum threshold
		Over maximum limit
C130C	Faulty ECU	Inner error
C130D	End-of-line configuration error	No info
C130E	No end-of-line configuration	Not configured
C130F	ASX chassis and ADX wheel accelerometer power	Electric error
C1310	Dynamic control selector	Invalid signal
C1311	Brake node	Invalid signal
C1312	EPS electric steering (NGE)	Invalid signal
C1313	Engine ECU	Invalid signal
C1314	Vehicle speed signal (from NFR)	Invalid signal
C1315	Steering angle sensor (NGE)	Invalid signal
C1316	Yaw sensor	Invalid signal
C131A	ASX wheel and ADX chassis accelerometer power	Electric error
C131B	ADX body accelerometer	Electric error
U0001	C-CAN line error	Mute
		BUS off
U1700	Body Computer (NBC)	Error
		No communication
U1701	Engine ECU	Error
		No communication
U1702	EPS	Error
		No communication
U1706	Brake node	Error
		No communication
U1715	Yaw sensor	Error
		No communication

Error detail reading

Environmental parameters table

Parameter/Status description	Unit of measure/Status value
Fault presence time (Stamps RAM)	minutes
Time elapsed with MIL ON (Stamps KeyOn RAM)	seconds
Key-on error counter	-
Code error (failure type)	-
Battery voltage	V
Vehicle speed	km/h
Outside temperature	Degrees centigrade
Vertical accelerometer/rough road	m/sec^2
Lateral acceleration	m/sec^2
Km covered	km

Probable causes of error

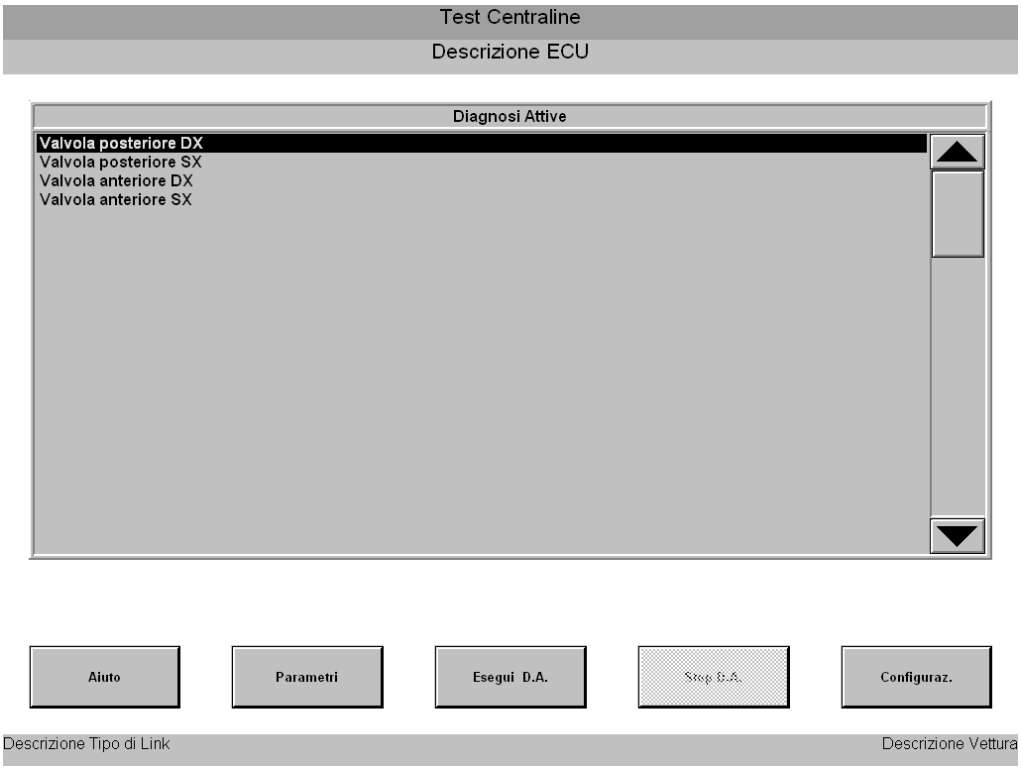
DTC	DTC Description	Probable Cause
C1300	2 or more faulty accelerometers	Faulty accelerometer
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1301	Front left wheel accelerometer	Faulty accelerometer
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1302	Front right wheel accelerometer	Faulty accelerometer
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1303	ASX body accelerometer	Faulty accelerometer
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1304	ADX body accelerometer	Faulty accelerometer
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1305	PSX body accelerometer	Faulty accelerometer
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1306	Front left valve	Faulty solenoid valve
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1307	Front right valve	Faulty solenoid valve Faulty wiring Wiring insulation Faulty control unit
C1308	Rear left valve	Faulty solenoid valve Faulty wiring Wiring insulation Faulty control unit

DTC	DTC Description	Probable Cause
C1309	Rear right valve	Check engine control unit diagnosis
		Faulty solenoid valve
		Faulty wiring
		Wiring insulation
		Faulty control unit
C130A	Battery voltage	Faulty battery
		Faulty wiring
		Wiring insulation
		Faulty control unit
C130C	Faulty control unit	Faulty connections
		Faulty wiring
		Wiring insulation
		Faulty control unit
C130D	End-of-line configuration error	System configuration error
		Not configured (control unit code)
C130E	No end-of-line configuration	System configuration error
		Not configured (control unit code)
C130F	ASX chassis and ADX wheel accelerometer power	Sensor power
		Faulty wiring
		Wiring insulation
		Faulty control unit
C130F	Dynamic control selector	Faulty manual operation selector
		Faulty wiring
		Wiring insulation
		Faulty control unit
C1311	Engine Casing (BSM)	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
C1312	EPS	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
C1313	ECM	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
C1314	WHEEL speed signal (from BSM)	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
C1315	Steering angle sensor (ESP)	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
C1316	YRS	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit

DTC	DTC Description	Probable Cause
C131A	ASX wheel and ADX chassis accelerometer power	Sensor power
		Faulty wiring
		Wiring insulation
		Faulty control unit
U0001	C-CAN line error	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
U1700	NBC	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
U1701	ECM	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
U1702	EPS	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
U1706	BSM	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit
U1716	YRS	Faulty CAN line wiring
		Errors are present in specified control unit or sensors
		Wiring insulation
		Faulty control unit

Active diagnosis
The active diagnosis for the system are:

Rear right valve
Rear left valve
Front right valve
Front left valve



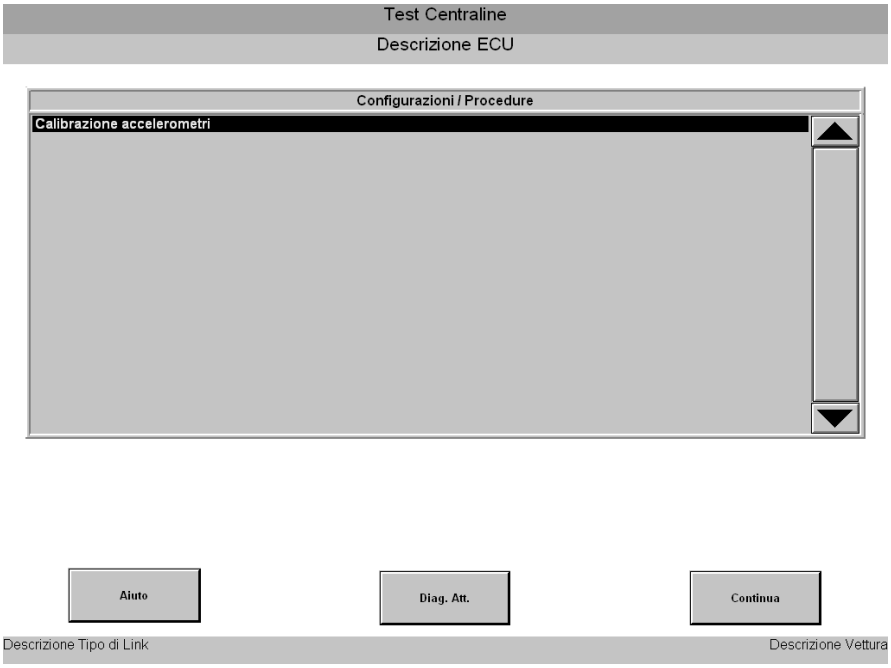
Active diagnosis help

Active diagnosis	**Help**
Rear right valve	Check solenoid valve operation
Rear left valve	Check solenoid valve operation
Front right valve	Check solenoid valve operation
Front left valve	Check solenoid valve operation

Configuration

The system configurations are:

Accelerometer calibration



The respective error message will appear if errors are present in memory at the end of the procedure.

The respective error message is displayed if an ACCELEROMETER is faulty:

List of accelerometers which can be displayed in case of error:

ASX body accelerometer
ADX body accelerometer
PSX body accelerometer
Front left wheel accelerometer
Front right wheel accelerometer

The respective page will appear if the result is positive:

Procedure/configuration help

Procedure	**Help**
Accelerometer calibration	This procedure is used to calibrate the suspension system accelerometers.