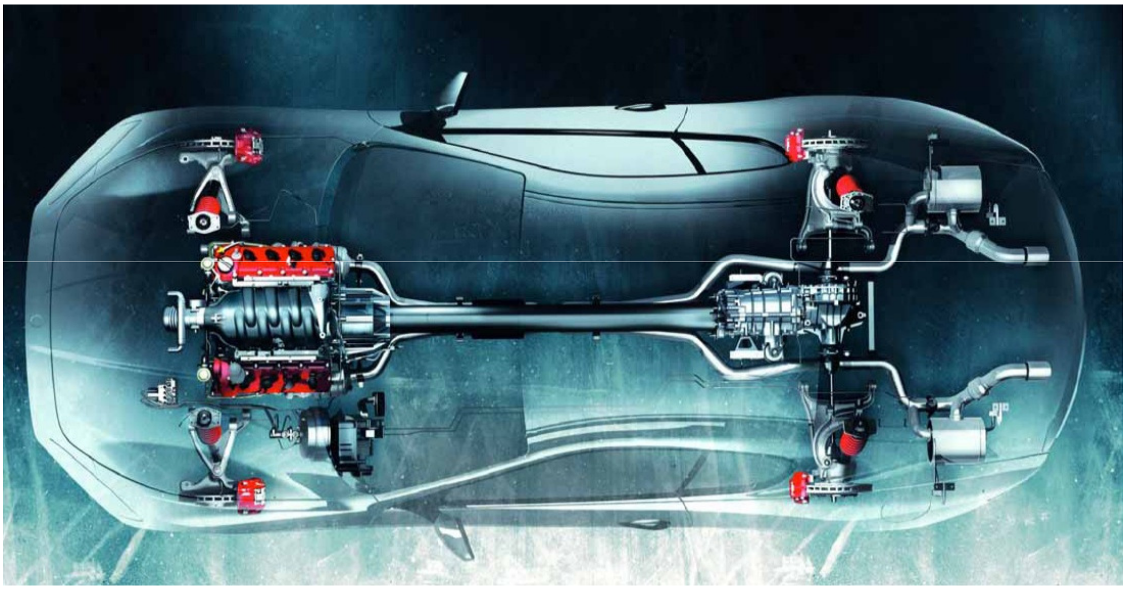
MASERATI
ACADEMY

Advanced Electronics 1

Engine and Power Train



February 2011 Edition

Training Documentation for Maserati Service Network

Advanced Electronics part 1

Engine and Power Train

- **Engine control system (Bosch Motronic)**
- **Robotized gearbox control system (Magneti Marelli)**
- **Automatic gearbox control system (ZF-Bosch)**

Preface

The February 2011 edition of this document contains further improvements over its earlier versions.
The most significant modification is the addition of the Superfast shift 2 gearshift strategy which is applied in the new GranTurismo MC Stradale, Maserati's fastest and technologically most advanced road car.
Apart from this, the layout has been improved, with the use of more clear images and diagrams. Much care has been taken in improving the general quality of this work.

Times are changing, but not for everyone. Maserati MC12 World Champion 2010

Engine Control System

Bosch Motronic

Engine Control System (Bosch Motronic)

Introduction

The management of modern engine control systems must take account of the search for maximum performance while associating this with maintenance of optimal driveability and environmental respect.

Certain types of engine performance are possible only through the integration of electronic systems that acquire and process operating parameters, and this must be achieved in real-time, i.e. as fast as possible. Likewise, activations must be implemented almost instantaneously.

This document gathers together diagnostic elements concerning components of the control systems implemented on our cars in order to provide useful information for rapid and effective troubleshooting, reducing intervention times on the vehicle.

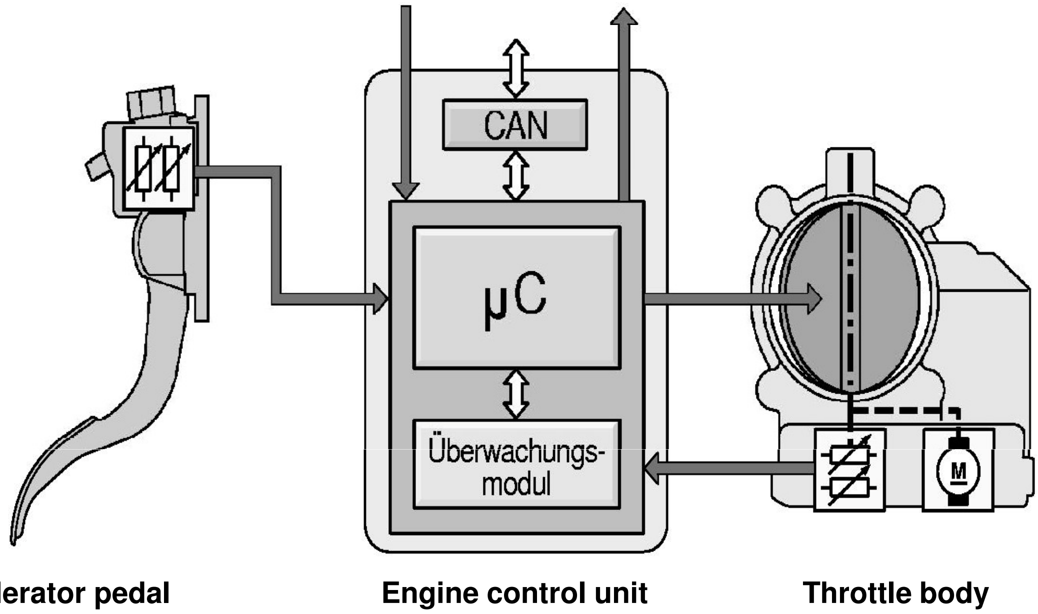
The engine control systems used on the most recent Maserati models are as follows:

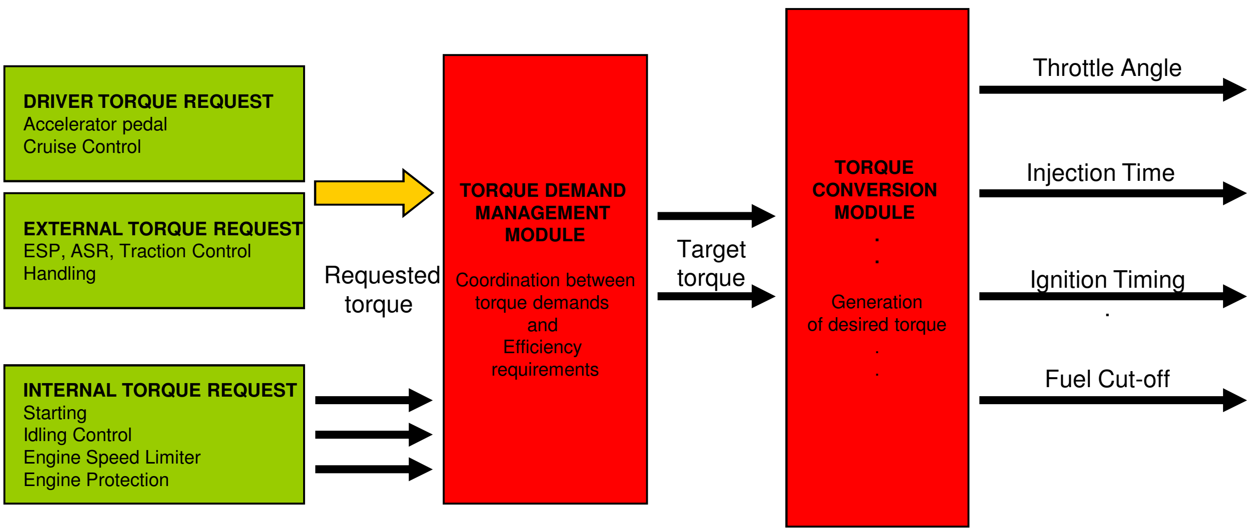
- 3200 GT (M338): Magneti Marelli IAW 4CM
- Coupé, Spyder, Gransport (M138): Bosch Motronic ME 7.1.1
- Trofeo (M138): Bosch Motronic ME 7.1.1
- Trofeo Light (M138): Italtecnica, dedicated to Motorsport
- Quattroporte Duoselect (M139): Bosch Motronic ME 7.1.1
- Quattroporte 4.2L Auto up to MY09 (M139): Bosch Motronic ME 7.1.1
- Quattroporte 4.2L Auto from MY10 (M139): Bosch Motronic ME 9.1.1
- Quattroporte 4.7L Auto (M139): Bosch Motronic ME 9.1.1
- GranTurismo 4.2L Auto up to MY09 (M145): Bosch Motronic ME 7.1.1
- GranTurismo 4.2L Auto from MY10 (M145): Bosch Motronic ME 9.1.1
- GranTurismo 4.7L Auto (M145): Bosch Motronic ME 9.1.1
- GranTurismo S MC-Shift (M145GL): Bosch Motronic ME 7.1.1
- GranTurismo MC Stradale (M145OL): Bosch Motronic ME 7.1.1
- GranTurismo MC Trofeo & GT4 (M145): Bosch Motronic ME 7.1.1, (without air flow sensor)
- GranCabrio 4.7L Auto (M145BD): Bosch Motronic ME 9.1.1
- MC12 road version (M144): 2 x Bosch Motronic ME 7.1.1
- MC12 Versione Corse: 2 x Bosch Motronic ME 7.1.1, (without air flow sensors)
- MC12 GT1: Magneti Marelli, dedicated to motorsport

This manual describes exclusively the Bosch Motronic system.

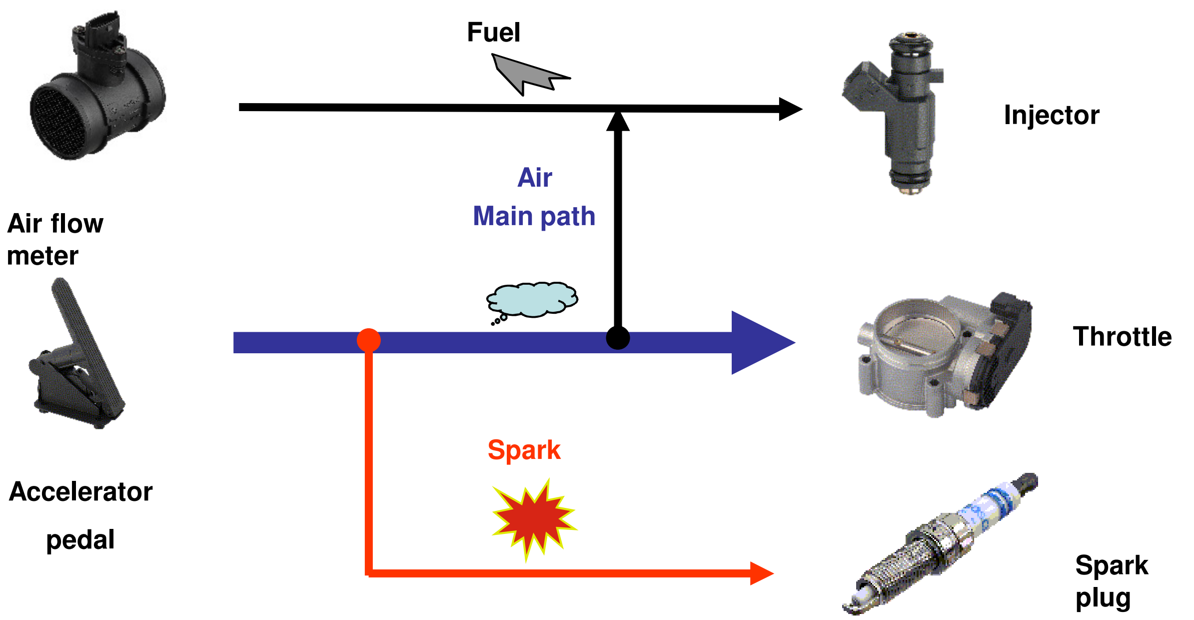
The torque based model:

The main objective of the engine control system is that of delivering a requested engine torque ("Torque based" model). This operating principle is used in all conditions of engine operation. We can identify three different torque request levels: driver torque request, external torque request, and internal torque request.
When the engine is idling the target is a constant engine speed. This rpm target is subsequently transformed by the ECU into a torque target.

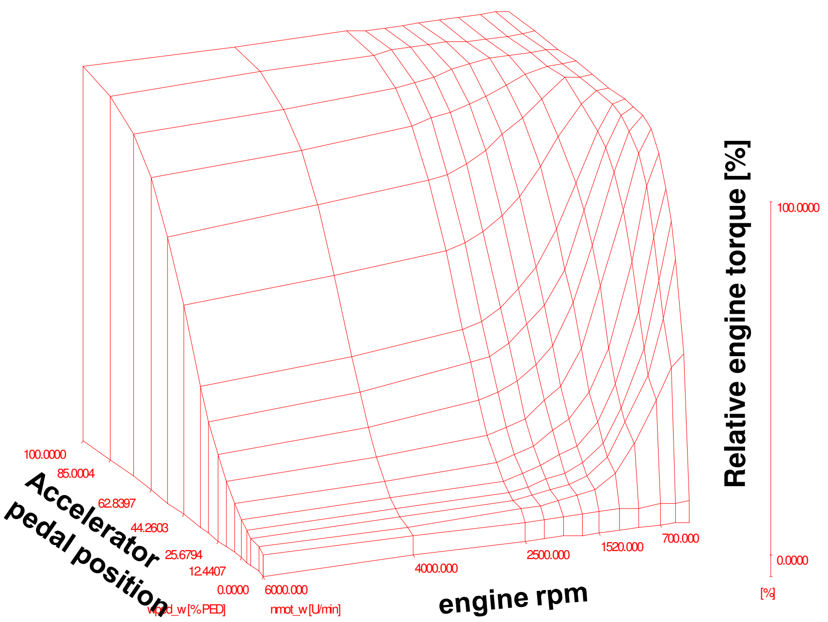




Motronic primary functional structure:



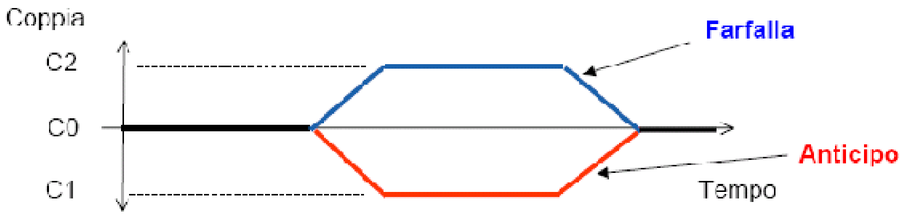
Torque request: the pedal map



The pedal map (which defines the requested engine torque based on the accelerator pedal position at a given engine speed) depends on the individual engine calibration as defined by the manufacturer.
It is specific for different vehicle versions and driving modes (Normal, Sport,..).

Motronic Driveability Strategies

Torque reserve strategy:

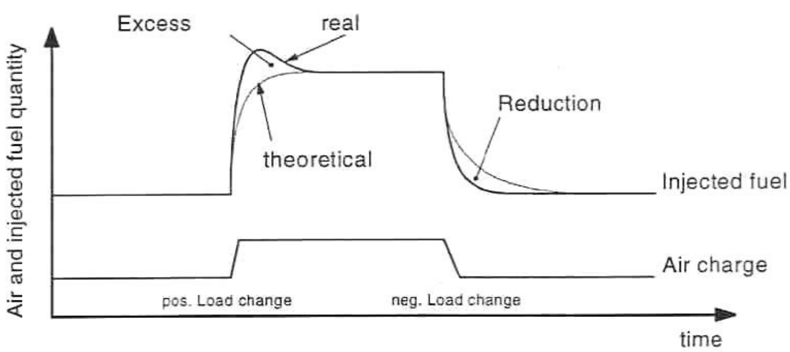


When the engine is idling, sufficient torque must be delivered to overcome friction forces: C0. The same torque C0 can be delivered with less spark advance but more throttle angle: the situation is as though C1+C2=C0 then C2-C0=C0-C1 and is defined as torque reserve.

This makes it possible to exploit:

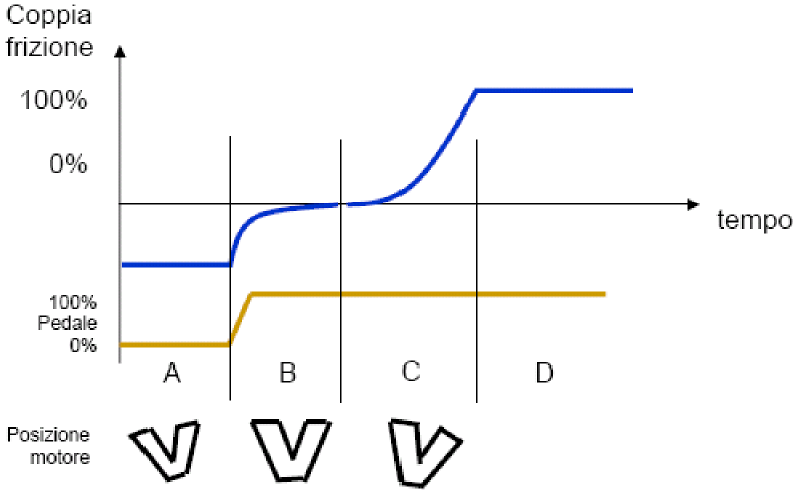
- Fast C0-C1 torque delivery (even though of modest entity) for breakaway acceleration and idle control.
- Hot exhaust gas to heat the catalytic converter (the advance is retarded in C1).
- The negative aspect is that combustion and thus fuel economy is not optimal (non-optimal spark advance).

Transition strategy:



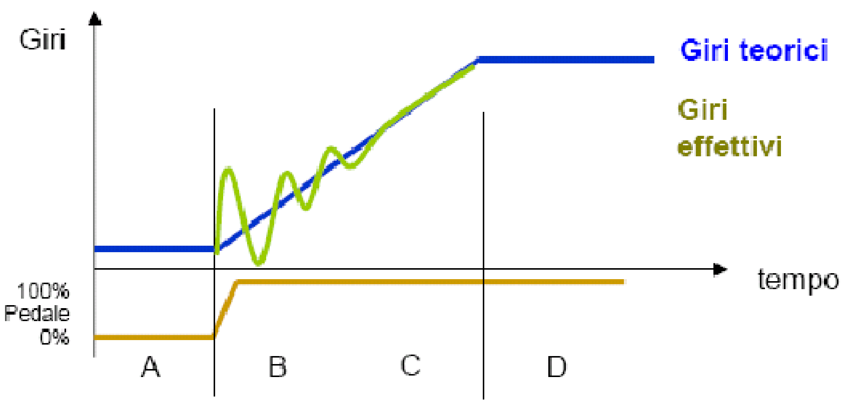
- The concept of a transient refers to the transition between two stable situations.
- There are two types of transients: acceleration and deceleration.
- In acceleration it must be taken into account that part of the fuel will be deposited on the intake ports as a fluid film. It is therefore necessary to inject more fuel than theoretically calculated.
- Vice versa, in deceleration the previously deposited fuel film will detach and enter the combustion chamber. Therefore less fuel must be injected than theoretically calculated.

Torque reversal strategy:



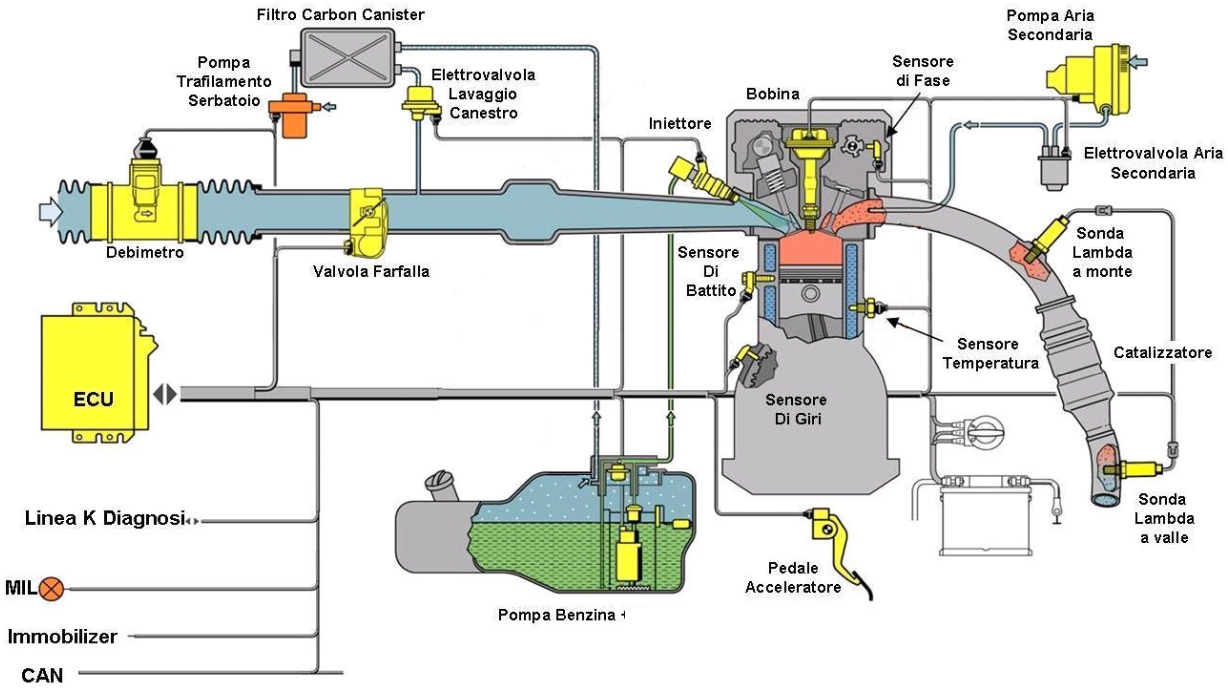
- In A the engine is being driven (drag torque): negative torque at clutch.
- In B the accelerator pedal is pressed: first filter to bring the engine to the neutral position.
- In C the transition of the engine from the neutral position to the torque delivery position is filtered.

“Anti flutter“ strategy:



- When the accelerator pedal is pressed the engine speed should increase uniformly.
- If the effective speed increase curve deviates from the theoretical curve the effect is described as "**flutter**".
- Torque flutter is experienced as longitudinal oscillation of the car.
- The causes of this phenomena include incorrect torque filters, play (transmission, engine), lean engine, etc. To eliminate flutter reduce spark advance in proportion to the deviation of engine speed.

Engine control system overview



In order to run, the engine needs three basic parameters:

1. Air
2. Fuel
3. Spark

The main sub-systems for engine control are as follows:

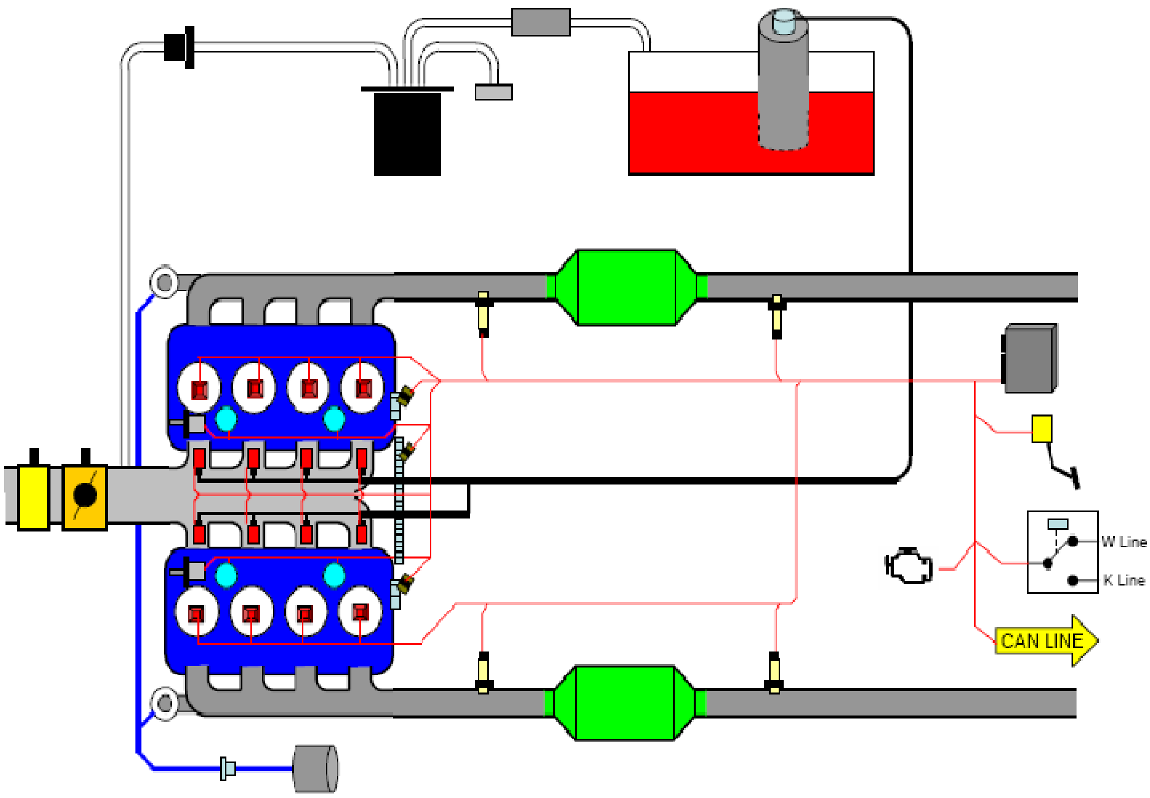
1. Air system (intake and exhaust)
2. Fuel system
3. Ignition system

In practical terms it is also necessary to:

- Scavenge burnt gas by means of the exhaust system.
- Cool the engine by means of the coolant circuit.
- Lubricate the engine with oil and the relative oil lubrication circuit.
- …

The separation of the three basic functions in this document was chosen to create clearly defined topic areas.

Engine control system overview



Moreover, anti-pollution regulations prescribe that:

- Fuel vapours that form in the fuel tank must be recycled to the intake air system and the absence of leaks from the fuel circuit must be guaranteed;
- Oil vapours formed in the crankcase must be routed to the intake air system;
- Catalytic converters reach their operating temperature quickly: Therefore a "Secondary Air" system is used that delivers air into the exhaust system after a cold start in order to complete the reaction of unburned fuel and bring the catalytic converters quickly to their nominal operating temperature.

Engine control system components

- Engine control unit (NCM)
- Air flow meter
- Intake air temperature sensor
- Coolant temperature sensors
- Accelerator pedal module
- RPM sensor
- Timing sensors
- Timing variators with solenoid valves
- Knock sensors
- Oxygen Sensors (pre- and post-cat.)
- Motor-driven throttle with integrated position sensors
- Fuel Injectors
- Ignition coils
- Fuel pump and pressure regulator
- Anti-evaporation system
- DMTL system
- Secondary air system

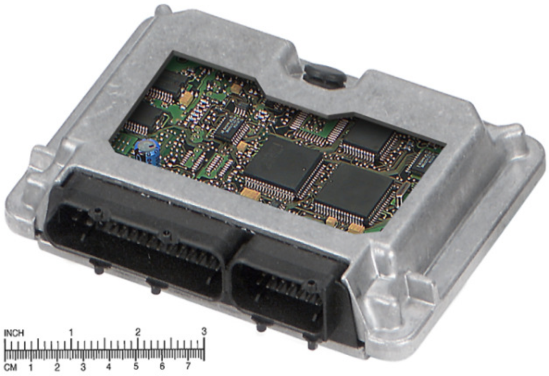
Various engine control system related components for Motronic ME7 and ME9:

System	ME7	ME9
Engine ECU (NCM)	ME7.1.1	ME9.1.1
Air flow meter	HFM5 / HFM7	HFM7
Front oxygen sensors	LSU 4.2	LSU 4.9
Rear oxygen sensors	LSF 4.2	LSF 4.2
Engine speed sensor	DG6	DG6P
Engine timing sensors	PG 3.5	PG 3.8
Ignition coils	Bosch / Eldor	Eldor
Canister purge valve	TEV2	TEV5
Knock sensors	KS1	KS4
Fuel Injectors	EV6 E / EV14 ST	EV14 ST
Accelerator pedal module	FPM-Fiat	FPM-Fiat
Throttle body	DV-E5 80mm	DV-E5 80mm
Temperature sensors water/oil	TF-W	TF-W
Fuel pump	EKPT 14.2 HF	EKPT 14.2 HF
Spark plugs		

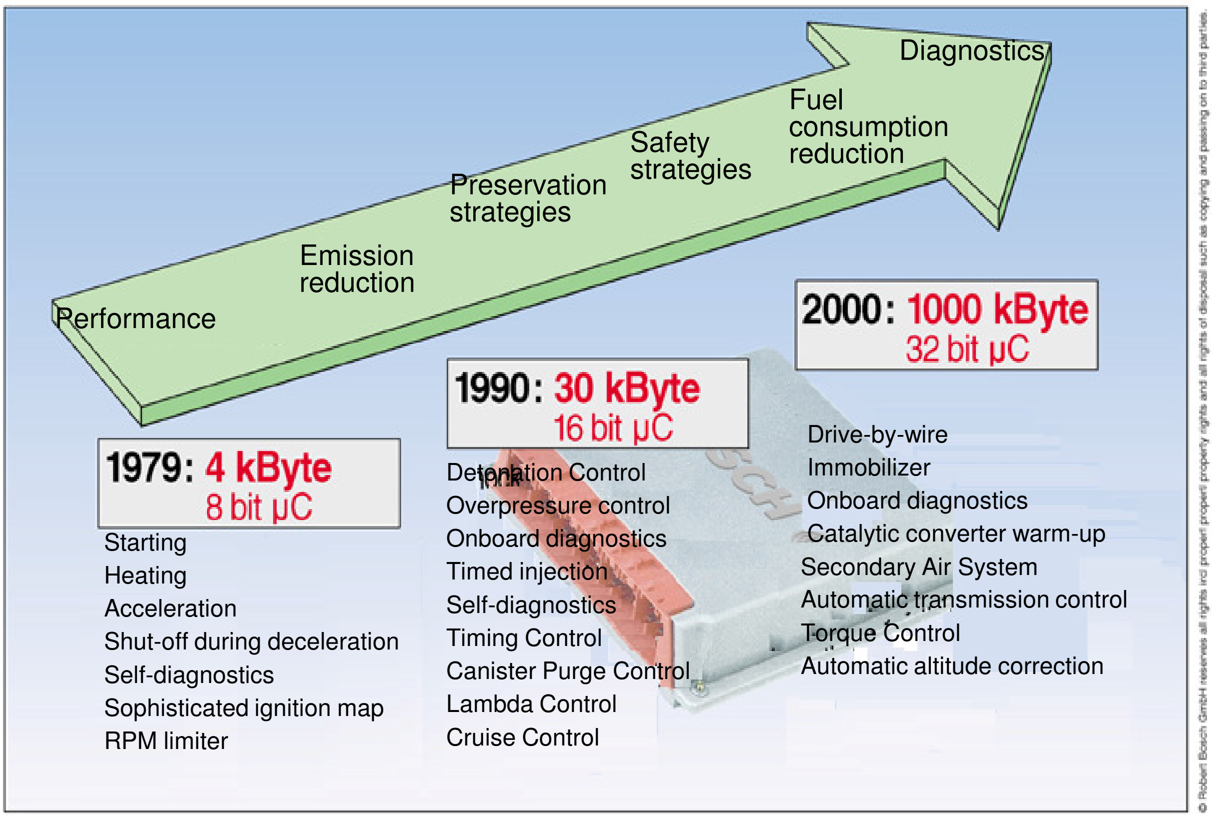
Notes:

- HFM5 air flow meter for 4.2L engines, HFM7 air flow meter for 4.7L engines.
- Bosch ignition coils up to assembly 24274; Eldor coils from assembly 24275 onward.
- EV6 E fuel injector used for M138 and M139 up to 05/2005; EV14 ST fuel injector used from 05/2005 onward.

Bosch Motronic ME7 engine control unit (NCM)



The two main 32MHz microprocessors are located internally in the Motronic ME 7.1.1 control unit used on the F136R/S dry sump engines. An upgraded ECU with two 40MHz processors was introduced with the launch of the new wet sump engines (F136UC/UD).
Engine control system diagnostics functions operate on three levels and is integrated in the two microprocessors. Approximately 60% of the calculation capacity of the control unit is employed for the various diagnostic functions and emissions control, while the remaining 40% is devoted to effective control of engine performance.

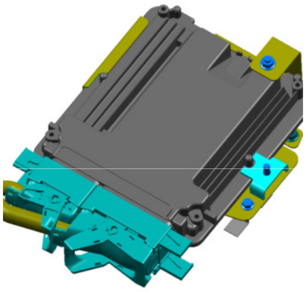


BOSCH

Bosch Motronic ME9 engine control unit (NCM)

With the introduction of the Quattroporte S with the more powerful 4.7L engine (start of production: July 2008), a new generation of engine control system is applied: the Bosch Motronic ME9.1.1. This new ECU is used on all models using the 4.7L engine combined with Automatic transmission, and extended to the 4.2L engines starting from MY10.
Basic operating principles remain unchanged with respect to the previous generation Motronic ME7 system. A number of engine control related components have changed, but their operating principle remains unchanged. Therefore all general principles described in this manual value for both ME7 and ME9. The most important difference concerns the ECU itself.

The Motronic ME9 ECU is located in the engine compartment behind the left hand side wheel arch.
A shield is applied to protect the ECU from heat and possible brake fluid loss



The most important modifications with respect to the ME7 system are the following:

- New, larger cast aluminium ECU housing with new connectors (94 pin vehicle side connector + 60 pin engine side connector) and new pin-out.
- New location of the ECU in the engine compartment to reduce wiring length.
- Increased calculating capacity of the ECU thanks to new, more powerful processor (GreenOak MPC564 64-bit, 56Mhz main processor)
- Eliminating of the K-line for diagnostics. All communication for diagnostics and programming passes through the C-CAN line in compliance with the new ISO 15765-4 standard.
- Immobilizer function is managed by the engine ECU and body computer through the C-CAN line only. The W-line for back up is eliminated.
- New hydraulic VVT actuators with a variation range increased to 60 degrees. The aim is obtaining a more smooth idling and better low-end torque for application in the new Quattroporte S (MY09). The operating principle remains unchanged with respect to the actual 50-degree actuators.

Engine control system software version

Software versions of the engine control system can be different for the various vehicle models and model types, engine types, Model Year versions and market specifications.

The NCM makes part of a fully integrated electronic vehicle architecture (Florence) and interfaces with a large number of other ECU's and nodes (NCR, NCA, NFR, NCS, NBC,...). It is therefor of the upmost importance that the NCM of a specific vehicle contains its correct software version.

NCM software updating with Maserati Diagnosi

The software updating of the engine control node (NCM) can be performed, just like for most other vehicle nodes, by means of a simple procedure involving the Maserati Diagnosi diagnostic tester.

Proceed as follows:

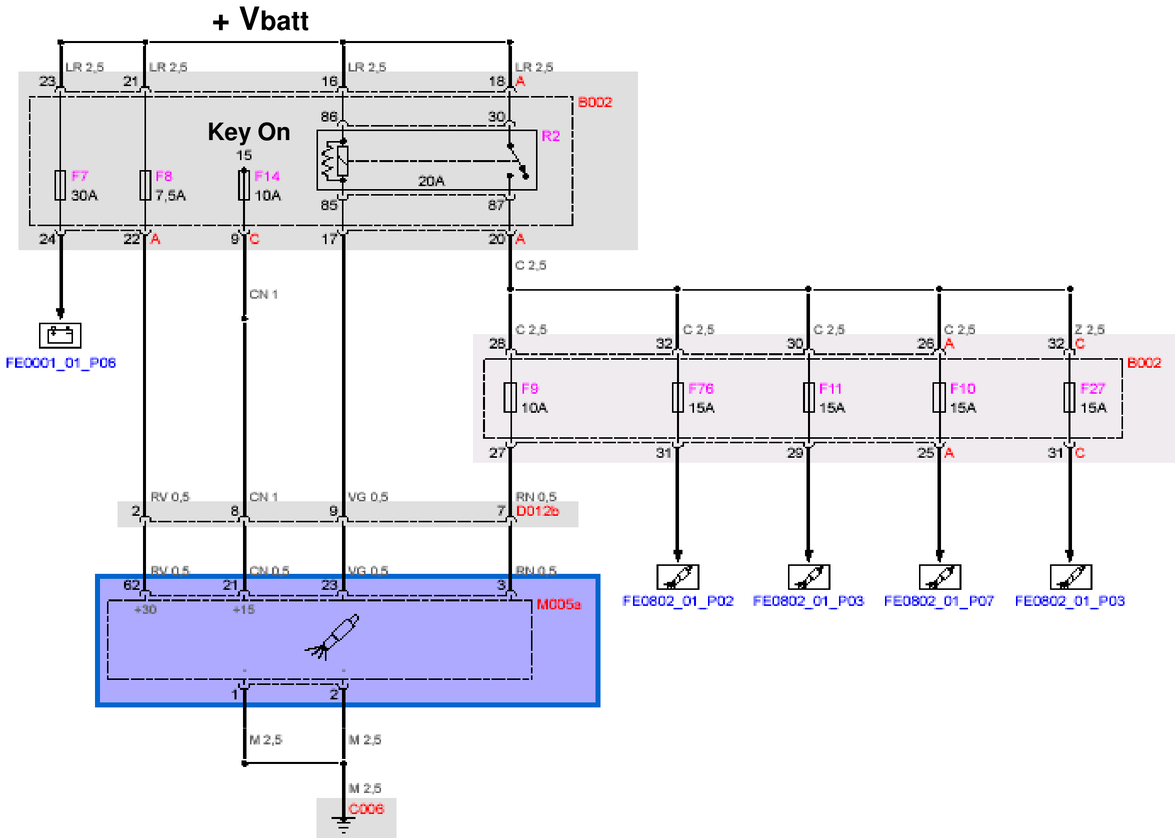
- Switch on Maserati Diagnosi and make sure it is online (connected to the Maserati Service Department support server)
- Make sure that the vehicle's battery is fully charged (or a battery charger is connected), as well as the battery of the tester unit.
- Establish connection to the vehicle and select NCM in the ECU selection menu.
- Select the Software Update menu and follow the indications on the screen.

Through the recognition of the vehicle's VIN and the connection to the Maserati support server, Maserati Diagnosi will automatically select and transfer the correct software patch for the specific node and the specific vehicle involved.
No manual software selection is required.

The software version present in a node can at any time be verified by selecting the ECU Identification menu in Maserati Diagnosi.

NCM and engine control system power supply

Example: ME7



The engine control system is supplied with 12V from the car battery. The Motronic ME 7.1.1 control unit is connected to ground (pin1 and pin2) and Vbatt (pin62).
At the time of Key On, the control unit receives +12V (pin21) and consequently triggers the main relay by means of an "active low" mode signal (pin23). The main relay provides the main power supply to the control unit and to the various engine control devices that require a 12V power input. This serves to activate the engine control system.
The presence of Vbatt (pin62) is used for the KAM memory (for example: throttle self-learning, fuel adaption self learning) and for activation of certain subsystems that are active in Key OFF conditions (e.g.: DMTL system).

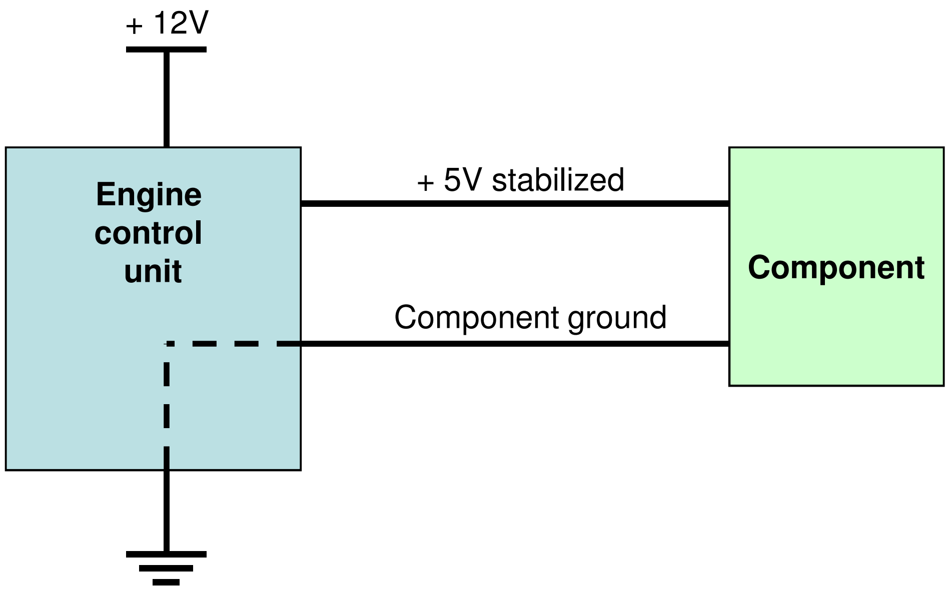
Influence of battery voltage:

Injection system: the speed of injector opening and closing depends on the battery voltage. The ECU corrects the injection time to compensate for voltage variations.

Ignition system: when the battery voltage is low, the ECU extends the coil activation time to ensure sufficient charging.

The Motronic ECU retains the error codes detected during the self-diagnostic routine in its internal Eprom memory. Even when the battery is disconnected the ECU retains the errors in the memory, which is of the "flash Eprom" type.

Regulated power supply for sensors



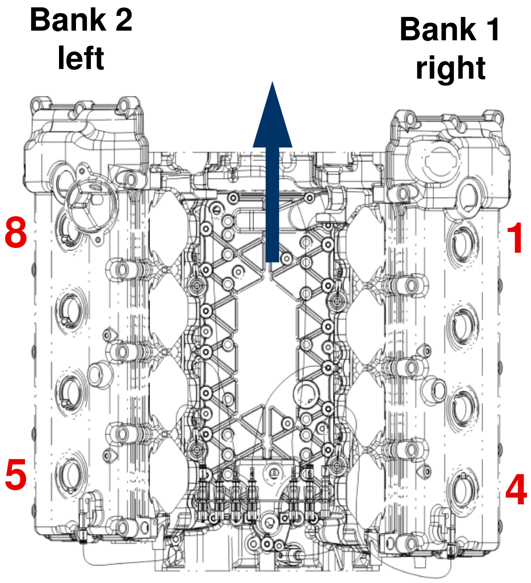
Various engine control system sensors use a regulated 5V power supply. This power supply is regulated with respect to a specific reference ground for the components in question. This solution is necessary for two reasons:

- **Operational accuracy:** all voltage fluctuations are filtered out.
- **Short-circuit protection:** thanks to a specific ground circuit that is electrically isolated from the vehicle ground.

During checking and diagnostics of components: always measure the power supply voltage with respect to the component ground and not with respect to the vehicle ground!

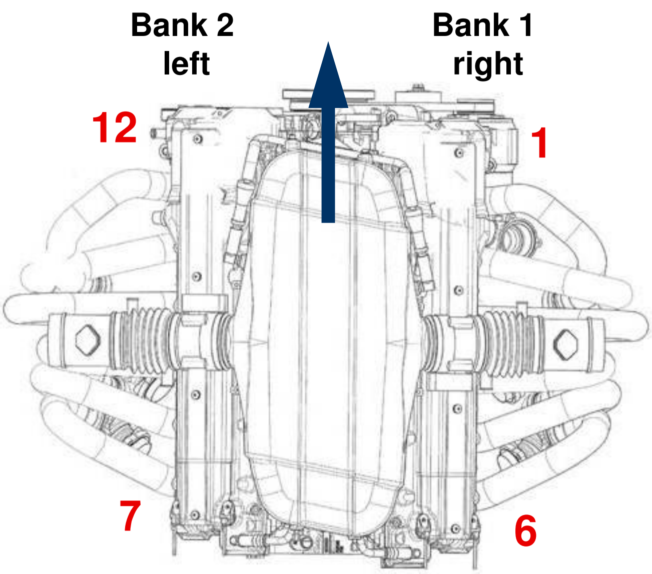
The regulated 5V power supply is internally in the Motronic ECU created by two separated power stages (stabilized sensor voltage 1 and stabilized sensor voltage 2) for ME7 and three (1,2,3) for ME9. Each of them are providing 5V to specific components.

Cylinder arrangement



MC12: 2 x Bosch Motronic ME 7.1.1 ECU's

ECU 1 (right-hand bank) = **Master**
ECU 2 (left-hand bank) = **Slave**
(The 12 cylinder engine of the MC12 has two RPM sensors)



The MC12 engine has 4 oxygen sensors: one pre-cat oxygen sensor and one post-cat oxygen sensor per bank.

Additional functions of the NCM:

In addition to control of the engine and engine diagnostics, the Motronic ECU (NCM) monitors several functions. The NCM also uses a series of inputs from various vehicle systems that do not form part of the engine control system.

Fuel cut off:
In the event of collision, the NCM sees the ground signal from the inertia switch interrupted and consequently cuts off the fuel supply for safety reasons.

Immobilizer:
The NCM communicates with the Body Computer for the passive anti-theft strategy. The NCM prevents the engine from being started until the correct key code has been acknowledged.

Fuel level:
The Body Computer informs the NCM on the CAN line of the fuel level in such a way that possible engine delays are not stored as misfiring errors. The fuel level information is required also for operation of the DMTL system.

Clutch pedal switch (M138 with manual transmission):
Utilised in the gear change strategy (diagnostics during gear changes).

Brake pedal switch:
Used for torque modulation during engine braking.

Vehicle speed signal:
The vehicle speed signal (received by the CAN network) is required for monitoring of the Cruise Control function and for various self-learning and self-diagnostic functions of the NCM.

Climate control:
The NCM receives information of activation of the climate control system for activation of the air conditioner compressor relay and correct adjustment of engine idling speed.

Ambient temperature:
The NCM receives the ambient temperature signal from the Body Computer on the CAN network. The NCM uses this information to enable or disable various functions and for diagnostics (e.g. catalytic converter diagnostics, canister purging, DMTL, exhaust gas temperature model, VVT system,...).

ASR / MSR:
The NCM receives the activation request for anti slip regulation (ASR) and engine drag torque control (MSR) from the NFR on the CAN line. These strategies are integrated in the calculation of total engine torque (Torque Based model).

Gearshift operation strategy:
For vehicles fitted with a robotized transmission system as well as vehicles fitted with automatic transmission, the transmission control unit receives engine torque information from the engine control unit to use for its gearshift strategy. In case the transmission ECU does not receive correct engine torque information, it will store an “Engine torque plausibility” error code.

Torque reduction during gear changes:
The Engine Control Unit (NCM) and the Transmission Control Unit (NCR/NCA) communicate over the C-CAN network for management of the engine torque during gear changes.

"Sport" button:
The NCM is notified of activation of Sport mode by the Body Computer on the CAN line. The Motronic adapts the accelerator response map for a more dynamic driving style and adapts the strategy of the by-pass valves for a more sports type sound (function only present on certain models).

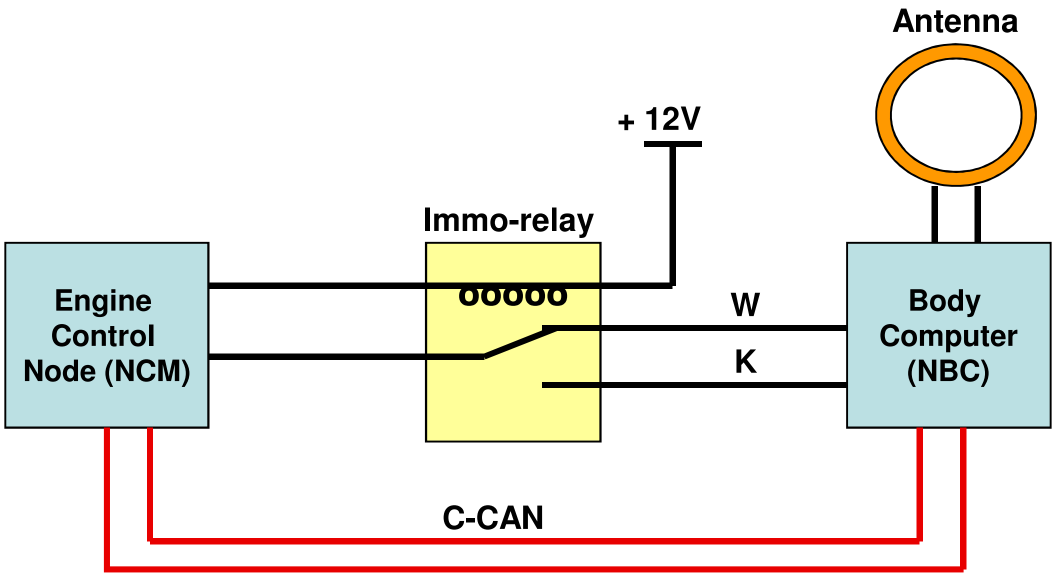
Cooling fans:
The NCM manages activation of the two fans (low and high speed) in accordance with the water temperature and activation of the aircon compressor.

Cruise Control:
Cruise control related driver commands are connected directly to the Engine Control Unit. The NCM modulates engine torque in accordance with the requested road speed.

Minimum oil level and pressure:
The NCM measures the engine oil pressure and level by means of two specific sensors. This information is transmitted to the Body Computer on the CAN network to activate the relative warning light on the dashboard.

Exhaust by-pass valves (depending on the vehicle model):
The NCM regulates activation of the exhaust silencer by-pass valves, which are pneumatically activated by means of a solenoid valve, on the basis of the selected driving mode (Normal, Sport, Race) and a specific map (throttle angle, engine speed). The activation strategy can be specific for the various model variants.

Immobilizer function

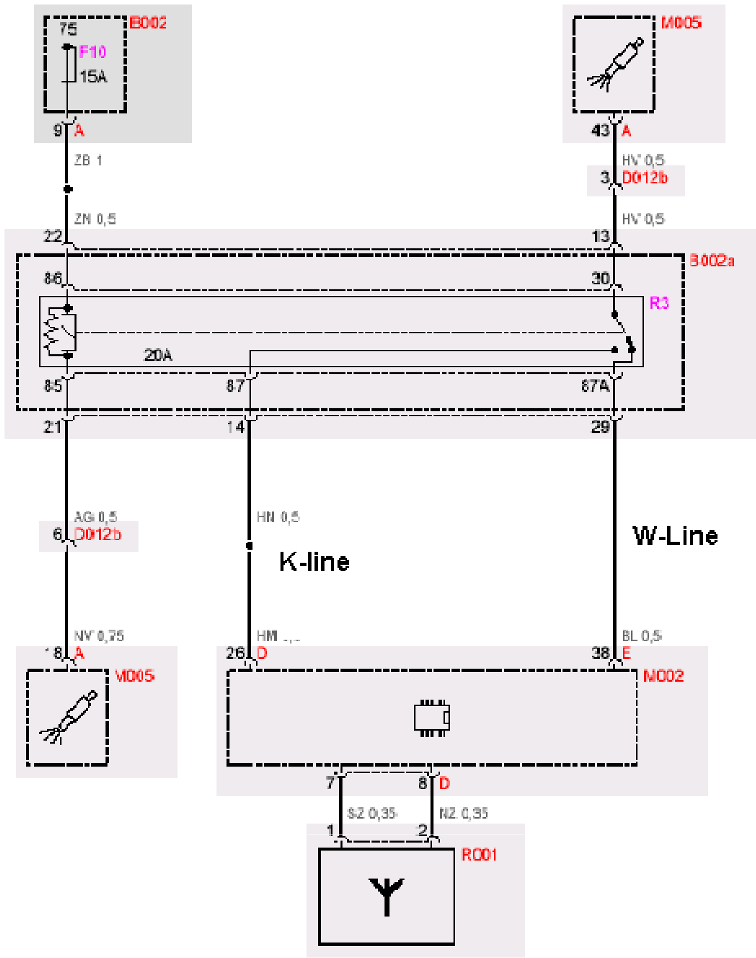


- The above diagram represents the immobilizer system as used on vehicles using the Florence architecture (M139 and M145) and fitted with Motronic ME7.1.1 system.
- After reading the key code from the ignition key, the body computer asks confirmation of the key code to the engine control unit over the C-CAN line.
- The W-line (ISO 9141) is used as a back up safety line for the immobilizer system.
- At ignition On, the body computer performs a check of the integrity of the W-line.
- Shortly after, the engine control unit activates the immobilizer relay to connect to the K-line (ISO 9141), enabling by this way the possibility for diagnostics read out.

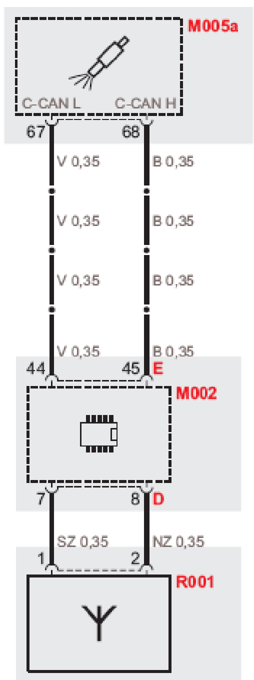
On the M138 model, which has no C-CAN line, the W-line is the main communication medium for the immobilizer function.

On vehicles using the Motronic ME9 engine control system, the K-line to the engine control unit and the W-line have been dropped. Immobilizer function is using C-CAN only for communication between the body computer and the engine control unit. Consequently the immobilizer relay has been dropped also.

Immobilizer ME7:

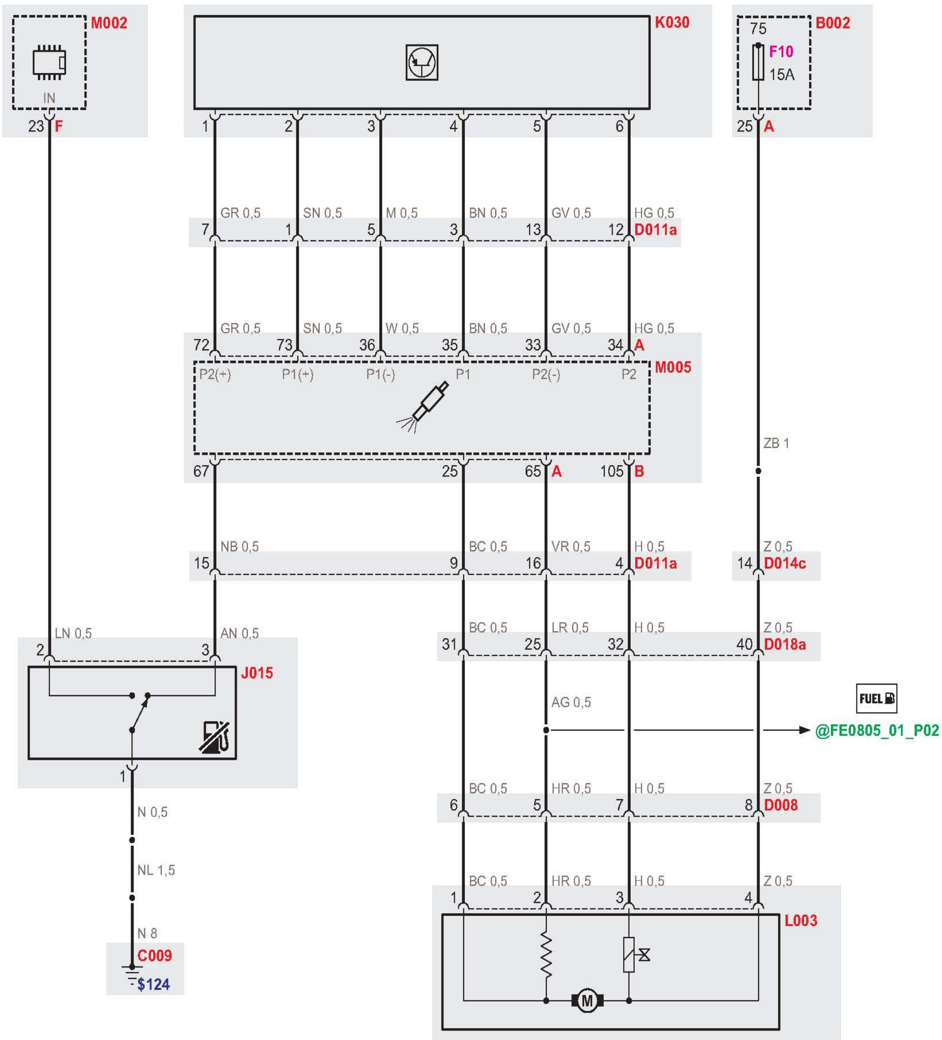


Immobilizer ME9:



Inertia switch

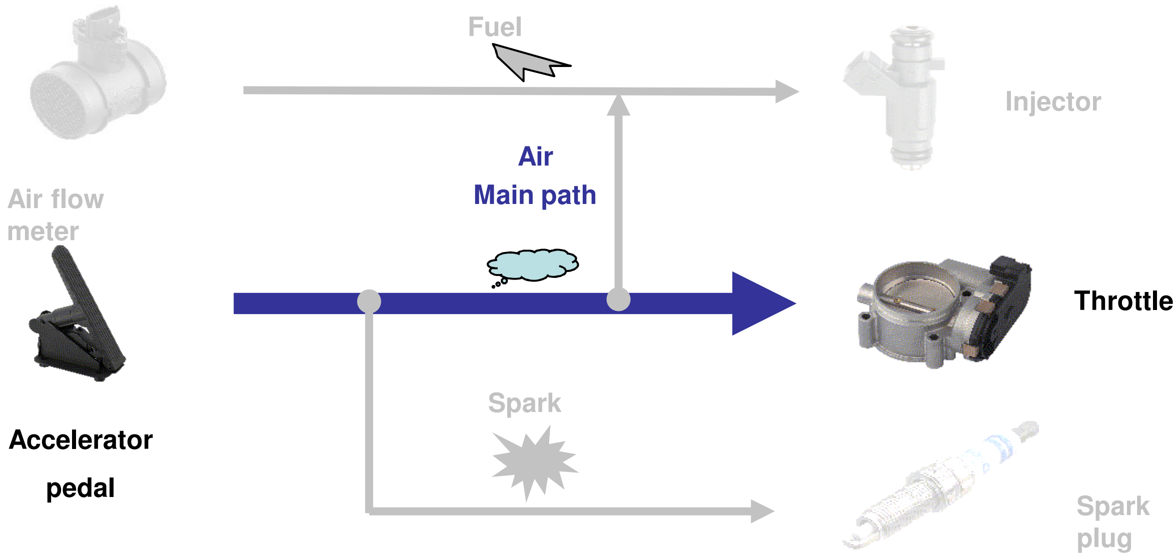
The operating logic of the inertia switch involves management of a common NCM and NBC/NVB ground connection in the event of collision.
When triggered, the inertia switch cuts the ground connection (C009) with the NCM and "routes" the connection to the NBC (M145 and M139 from MY07) or to the NVB (M139 up to MY06). This triggers the NCM to suspend activation of the fuel pump and the fuel injectors and, thanks to the intervention of the NBC/NVB, the doors are unlocked and the hazard warning lights and the interior courtesy lighting are activated to facilitate the action of rescue crews (if required).



The status of the inertia switch can be checked by means of Maserati Diagnosi (parameters environment): "Inertia switch status" (NVB and NCM) and "FIS input" (NBC)

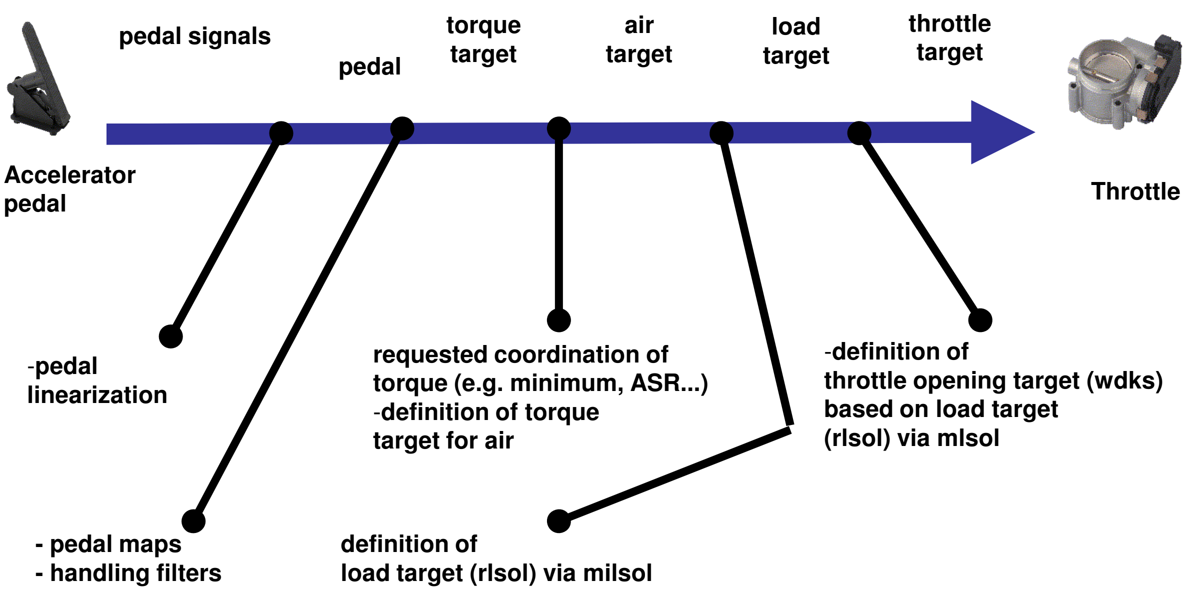
1st Fundamental Parameter of engine control: AIR

Air path:



Air calculation:

- The objective of the air calculation is to determine the necessary throttle opening to allow the engine to deliver the requested target torque.
- In the test room the air flows and torque values corresponding to given throttle opening angles are mapped.
- These maps make it possible to establish the opening angle required of the throttle to obtain the required air flow and torque.



Accelerator pedal module

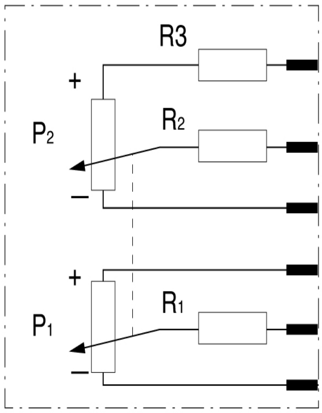
The accelerator pedal module is composed of two independent potentiometers.

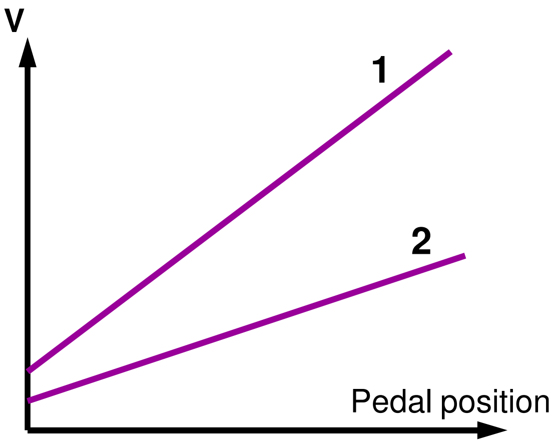
The signal value of one potentiometer is half that of the other. This strategy allows the engine control system to perform a plausibility check on the pedal's operation.

Reference values

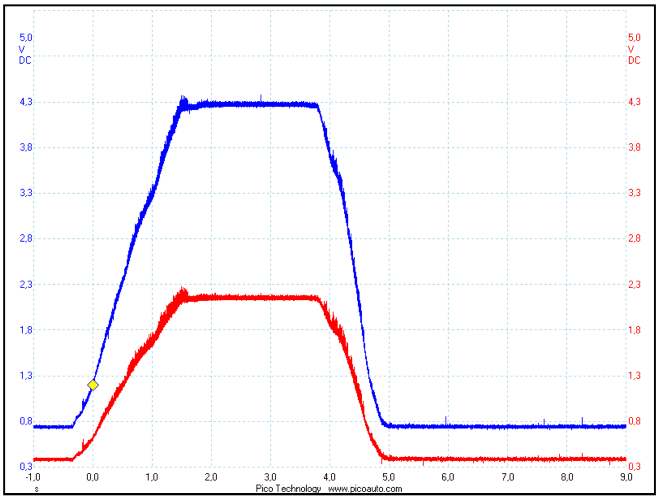
Potentiometer 1
- Rest position **= 0.65 ÷ 0.85 V**
- Max. position **= ÷ 4,2 V**

Potentiometer 2
- Rest position **= 0.33 ÷ 0.42 V**
- Max. position **= 1.85 ÷ 2,1 V**





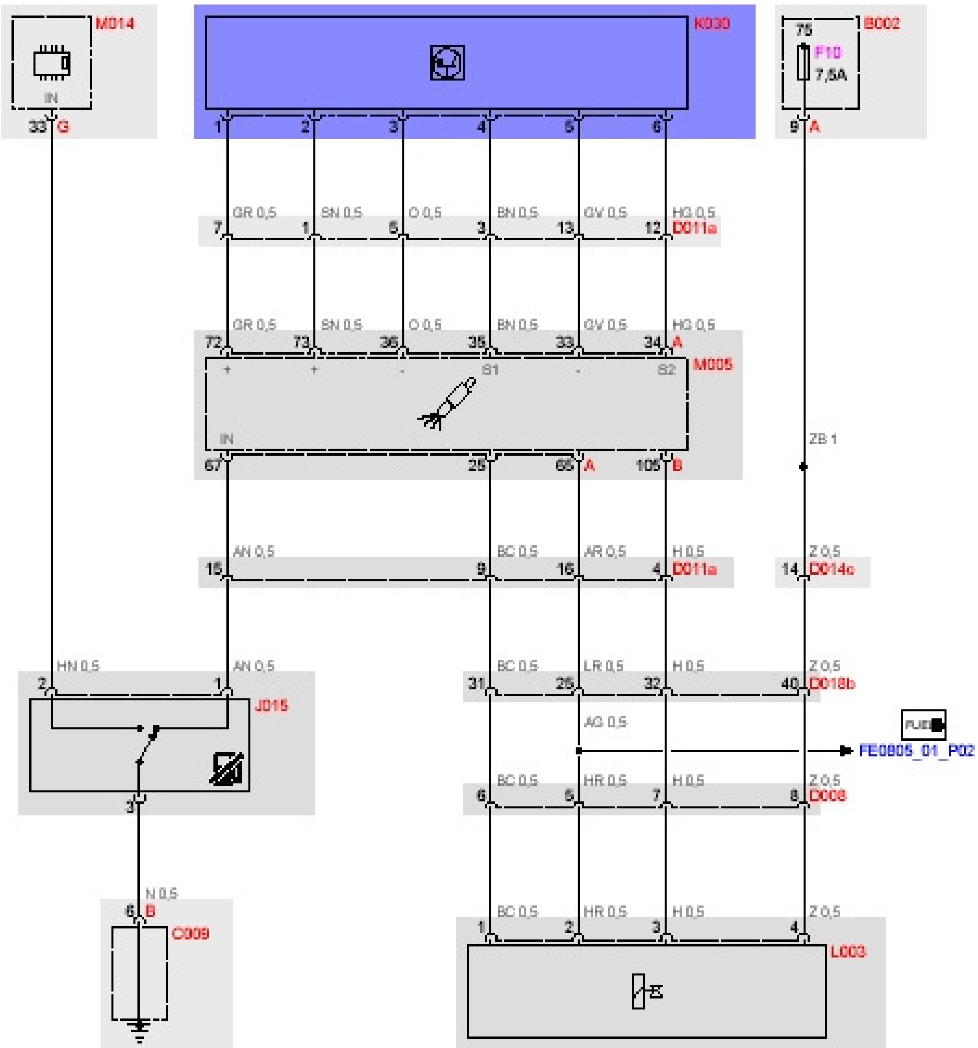
Potentiometer 1 = main
Potentiometer 2 = secondary

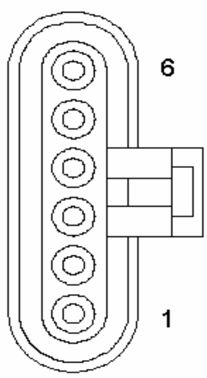


Accelerator pedal position sensors signal scope view

Both potentiometers integrated in the accelerator pedal module are independent and electrically completely separated, by this way providing a redundant signal for safety reasons. Each sensor has a specific ground and is supplied by a specific 5V power supply (stabilized sensor voltage 1 and stabilized sensor voltage 2). The recovery strategy in the event of a fault is different for the two potentiometers.

Accelerator pedal circuit diagram:



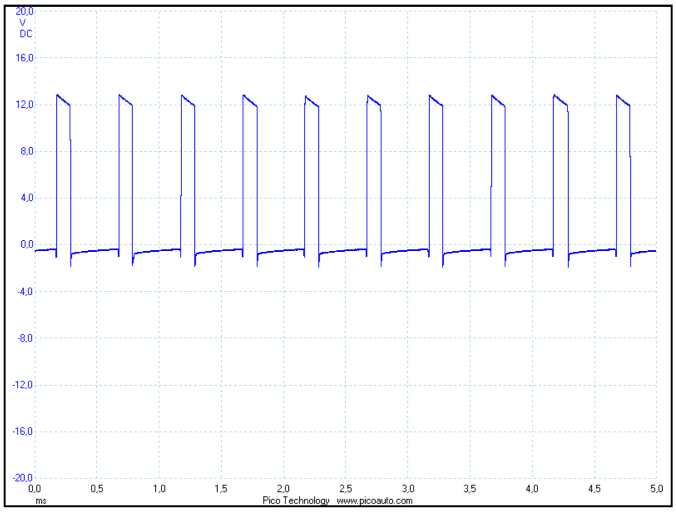


1. Stabilised power supply sensor 2
2. Stabilised power supply sensor 1
3. Reference ground, sensor 1
4. Position signal, sensor 1
5. Reference ground, sensor 2
6. Position signal, sensor2

Motor driven throttle

The throttle valve is driven by a PWM signal from the NCM.

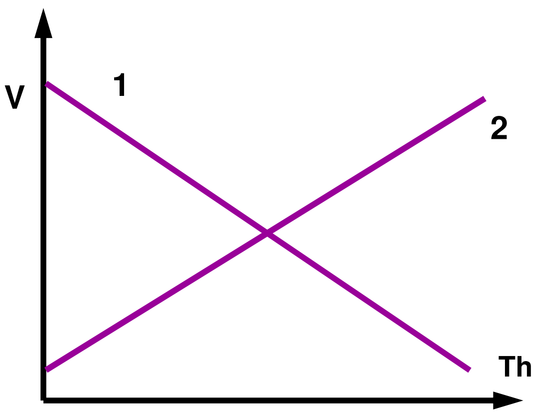
The throttle position information is provided by two complementary potentiometers. Idle speed is maintained by adjusting the position of the throttle directly. In the event of a fault a recovery position is guaranteed to arrive at an engine speed that is slightly higher than idling.



Throttle DC-motor signal scope view

Technical data:

- Actuation: The throttle is actuated in a 0-12 V duty-cycle (PWM)
- Reading voltage: 0-5V
- Max. current: 9.5A
- Time to reach 90% of target opening: <100 ms
- Throttle opening with engine idling: 2-3%
- Throttle opening in recovery conditions: 8% (mechanical zero = 1600 rpm)



1 = position sensor 1
2 = position sensor 2

Whenever the engine is started the throttle resets to the idle speed position; for this reason the accelerator pedal should never be pressed during engine starting.

Self-learning of the motor-driven throttle

For proper operation of the throttle a self-learning procedure must be executed. Throttle self-learning concerns 3 parameters:

- Throttle totally closed position
- Unpowered closed position.
- Checking the return springs and maximum opening

The self-learning values (stored in the ECU) are lost when power is disconnected from the ECU (battery disconnection or unplugging of ECU connector). Following a power disconnection the self-learning procedure must be performed after power is reconnected.

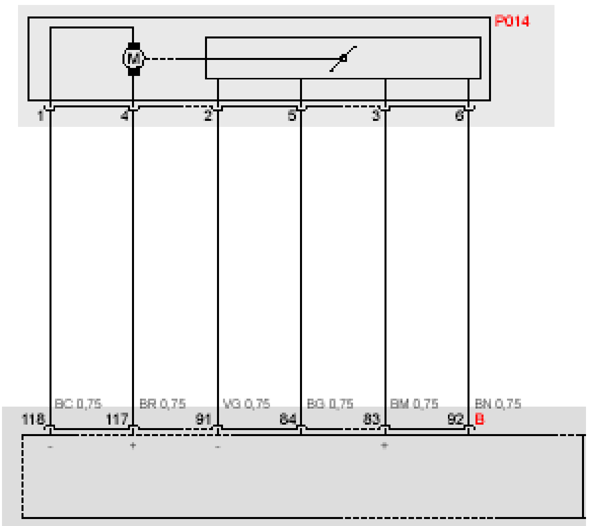
Procedure: Key ON (without starting) > wait at least 20 seconds > Key OFF

Tester Maserati Diagnosi can be used to check that the self-learning procedure has been executed correctly. The vehicle speed must be 0 to enable self learning.

Throttle self learning counter = 11:	self learning to perform or in execution
Throttle self learning counter = 0:	self learning completed
Throttle self learning counter = 1-10:	self learning not completed

This latter condition may denote a problem with the motor-driven throttle or that the correct conditions for self learning have not been fulfilled.

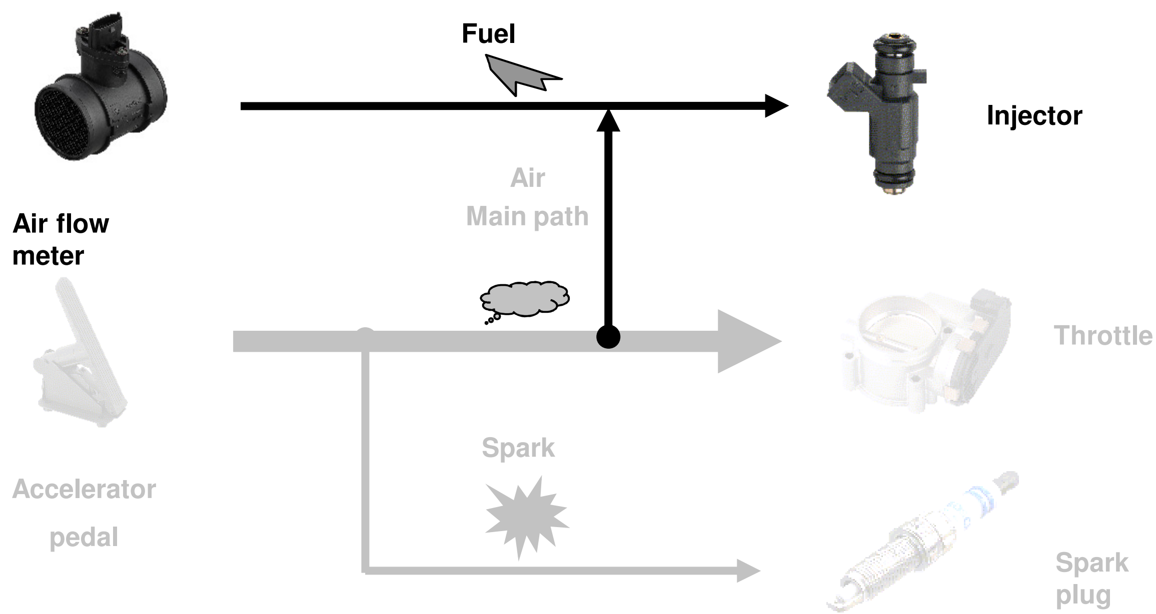
Motor-driven throttle circuit diagram:



1. Ground for DC-motor
2. Ground for position sensors
3. Stabilised sensor voltage 1 (5V)
4. Power supply DC-motor
5. Throttle position 2
6. Throttle position 1

2nd Fundamental Parameter of engine control: FUEL

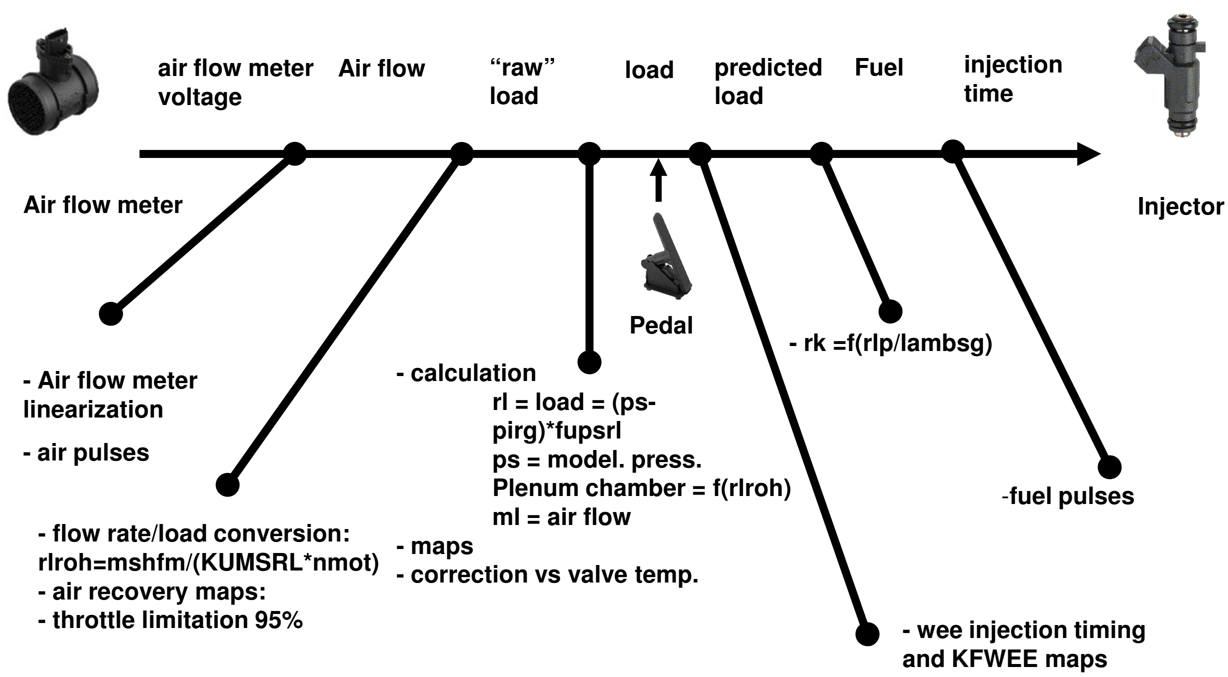
Fuel path:



Fuel calculation:

Having set a Lambda target value and established the air flow, the quantity of fuel can be calculated based on the fuel maps

$$\textbf{Fuel} = \frac{\textbf{Air}}{\lambda}$$



$$\mathbf{rk} = \left[\frac{(fgru*fst*fns*fwl*fwe*lamns*\mathbf{rlp}*(1 \pm KFBS)+rka)*fr}{\mathbf{lamsbg}} + rkukg \right] *fra-rkte$$

rk = quantity of fuel to inject
rlp = predicted air load
lamsbg = target Lambda value
fst = correction during starting
fns= post-starting correction
fwl = correction during warm-up
fwe = return from cut-off

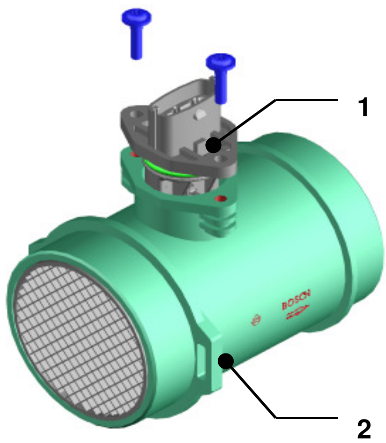
rka = self-learning at idle speed
fra = self-learning at partial opening
fr = short term correction
rkukg = transients correction
rkte = canister purge
KFBS = disparity between the two banks
lamns = oxygen sensor target during warm-up

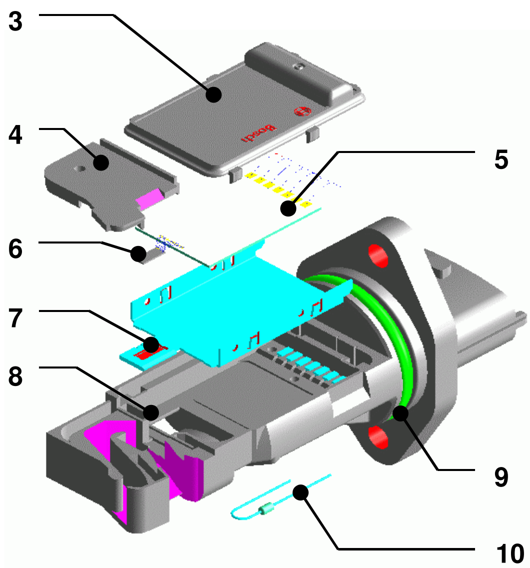
Air flow meter (Bosch HFM5)

The air flow meter supplies the value relative to:

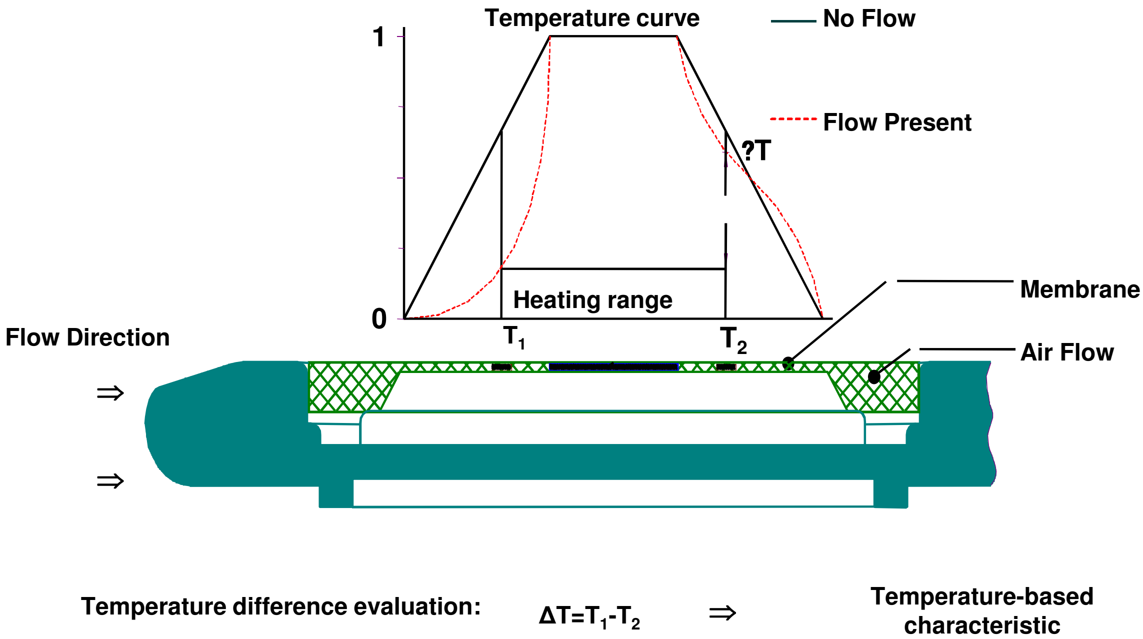
- **Mass flow quantity of aspirated air**
- **Temperature of aspirated air.**

The sensor is supplied by a current value designed to maintain it as a reference temperature. When it is subjected to an air flow it tends to cool and the ECU must increase the current required to maintain the reference temperature. A variable NTC resistance indicates the aspirated air temperature value.

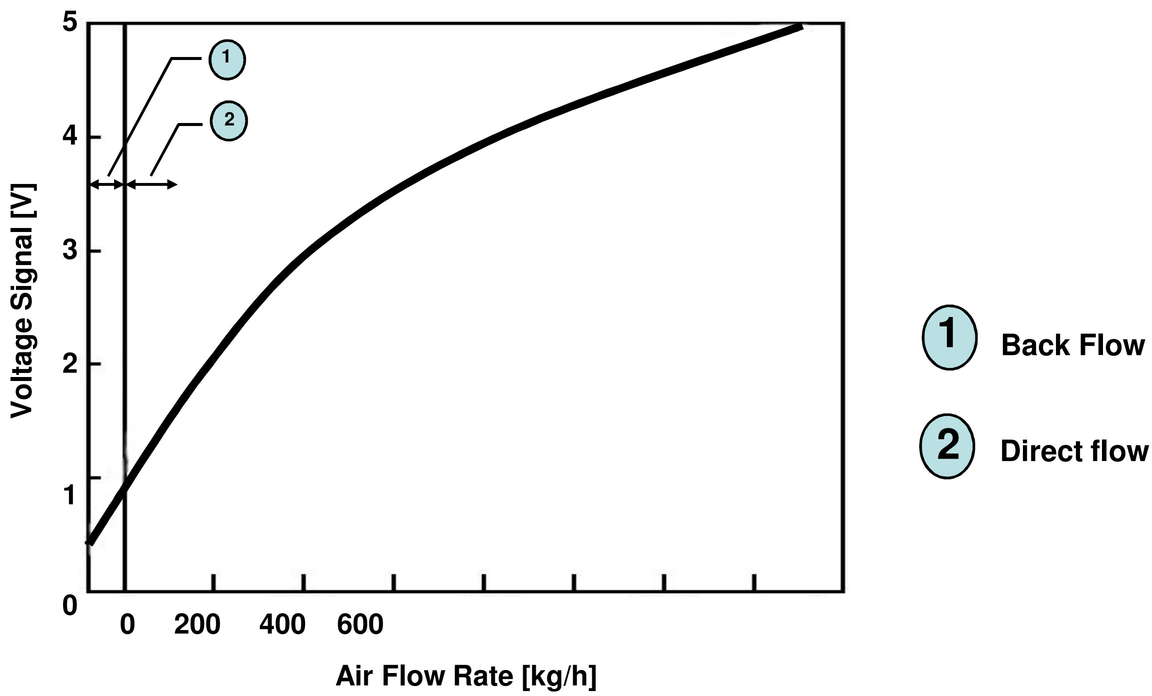




1 - Sensor
2 - Cylindrical Frame
3 - Casing
4 - Measuring channel cover
5 - Hybrid-SHF
6 - Sensor-CMF
7 - Carrying plate
8 - Plug-In Sensor Casing
9 - O-Ring
10 - Temperature sensor

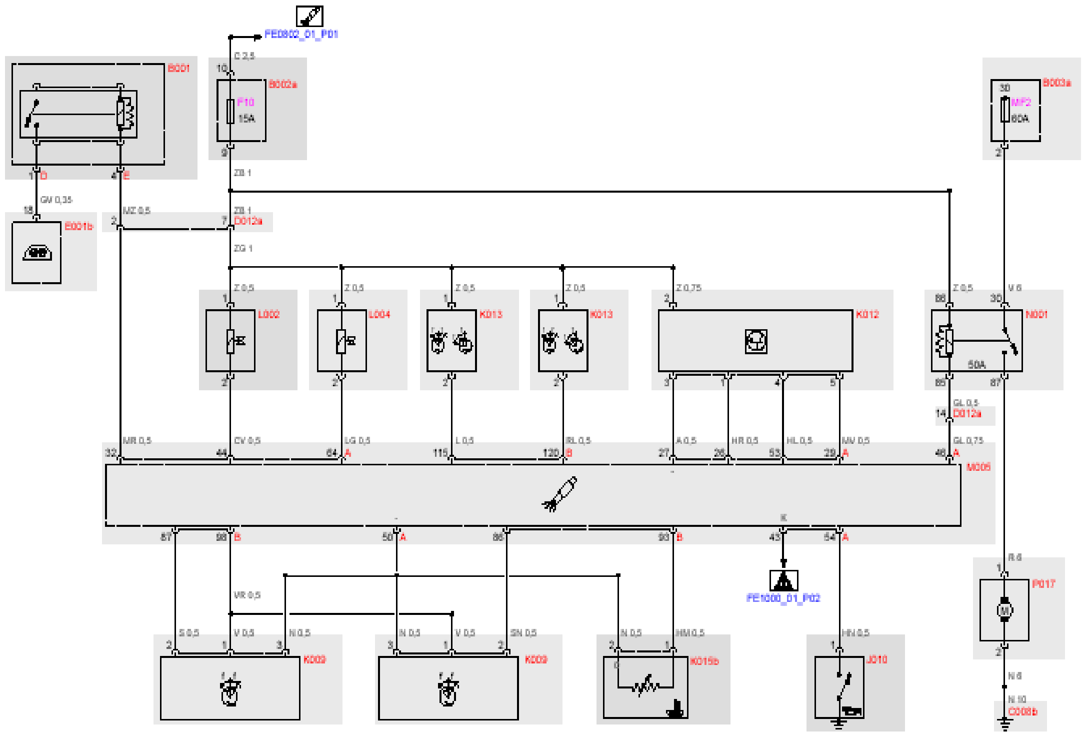


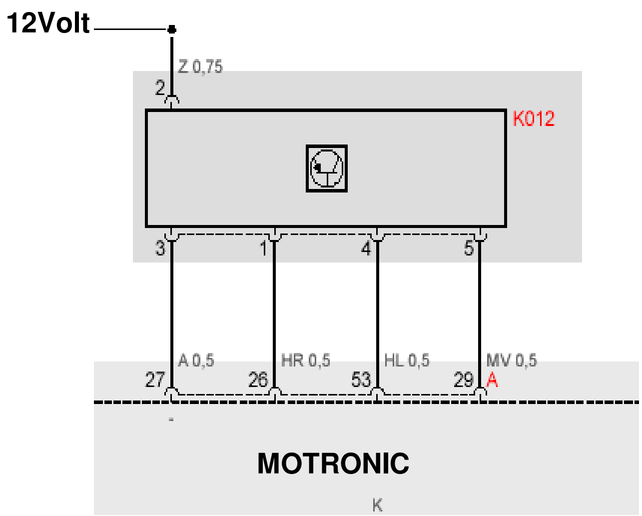
The sensor's platinum film is heated to a temperature of 130°C above ambient temperature. The air mass that strikes the film dissipates heat and tends to cool the film. The engine control node must heat the film to maintain a constant temperature of 130°C by means of a current control. The increase in current required to heat the film makes it possible to calculate the air mass flowing through the channel.

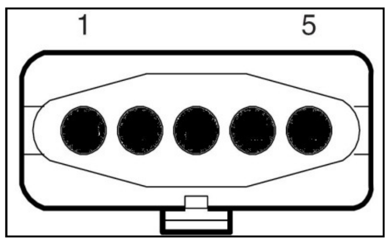


The area relative to the back flow is not measured by the ECU. The air flow meter requires an additional measurement tolerance range in order to accommodate this phenomenon.

Air flow meter electrical diagram:



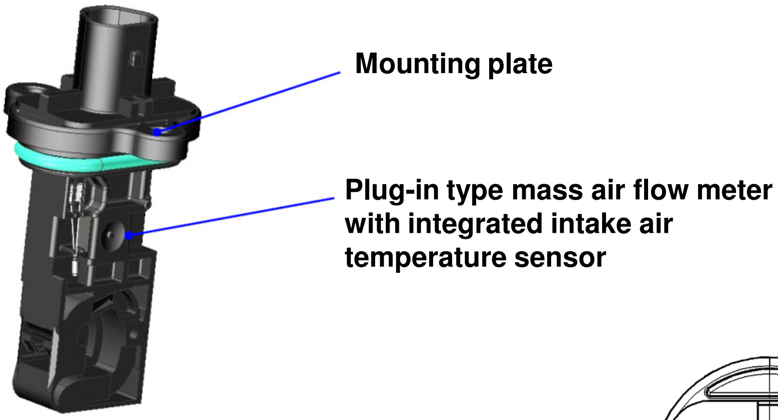




Pin	Denominazione	Tipo Segnale
1	Temperatura	Segnale Analogico
2	Tensione Alimentazione	12V
3	Massa	GND
4	Tensione Riferimento	5V
5	Portata	Segnale analogico

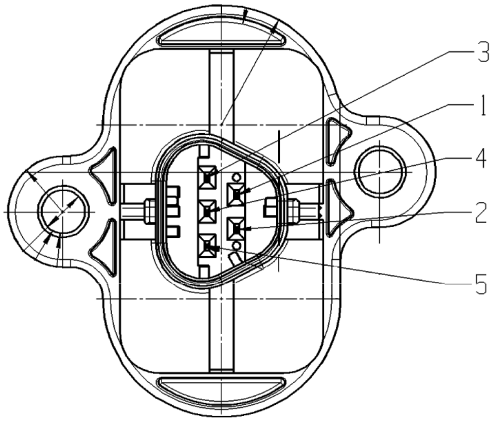
Bosch HFM7 air flow meter

On Maserati models equipped with the larger 4.7L engine (F136Y), a new plug-in type air flow meter is used: the Bosch HFM7. The HFM7 air flow meter can be easily identified from the HFM5 type meter due to the new connector design.



Pin-out HFM7 air flow meter:

1. Ground
2. 5V reference voltage
3. 12V power supply
4. Intake air temperature analogue signal
5. Mass air flow analogue signal



Except from the new sensor design, the air flow meter used on F136Y engines is characterised by the absence of an air flow strainer. The task of an air flow strainer is to ensure a regular and laminar air flow inside the sensor duct. At the same time the strainer also forms an obstruction to the incoming air flow.
By eliminating the strainer, a power advantage of 7-8 hp is obtained thanks to a more free air flow.
The absence of the strainer will cause turbulences in the sensor duct which translates into an unreliable mass air flow signal. For this reason the mass air flow is no longer the main parameter to calculate the injection quantity, but will only be used to apply corrections on the fuel quantity. Instead, throttle position and engine speed are used as main parameters. This modification implicates a specific calibration of the engine control software.

The causes of an air flow meter malfunction may be:

- Scored or dented plate
- Air flow meter wet or fouled with oil
- Foreign matter in the duct

CAUTION!

Never clean the air flow meter with degreasing agents!
This operation can damage the meter .

Barometric pressure sensor

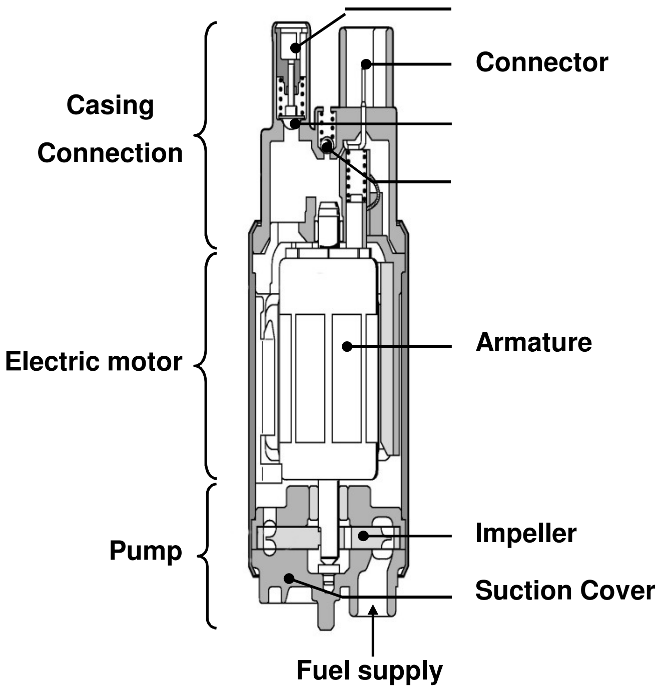
The barometric pressure sensor is integrated in the Motronic ME 7.1.1 and ME 9.1.1 ECU. The barometric pressure value is used for the following applications:

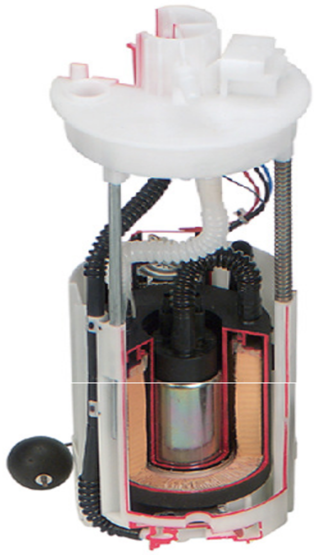
- Correction of mixture (injection quantity) in accordance with altitude.
- Correct operation of the DMTL system.

Fuel pump

The fuel systems utilised in Maserati cars are of the "Returnless" type.
The fuel pump module is composed of:

- Fuel filter
- Electric fuel pump
- Pressure regulator: 3.5 bar
- Float with level sender
- Active filling reservoir (0,45L) with jet pump



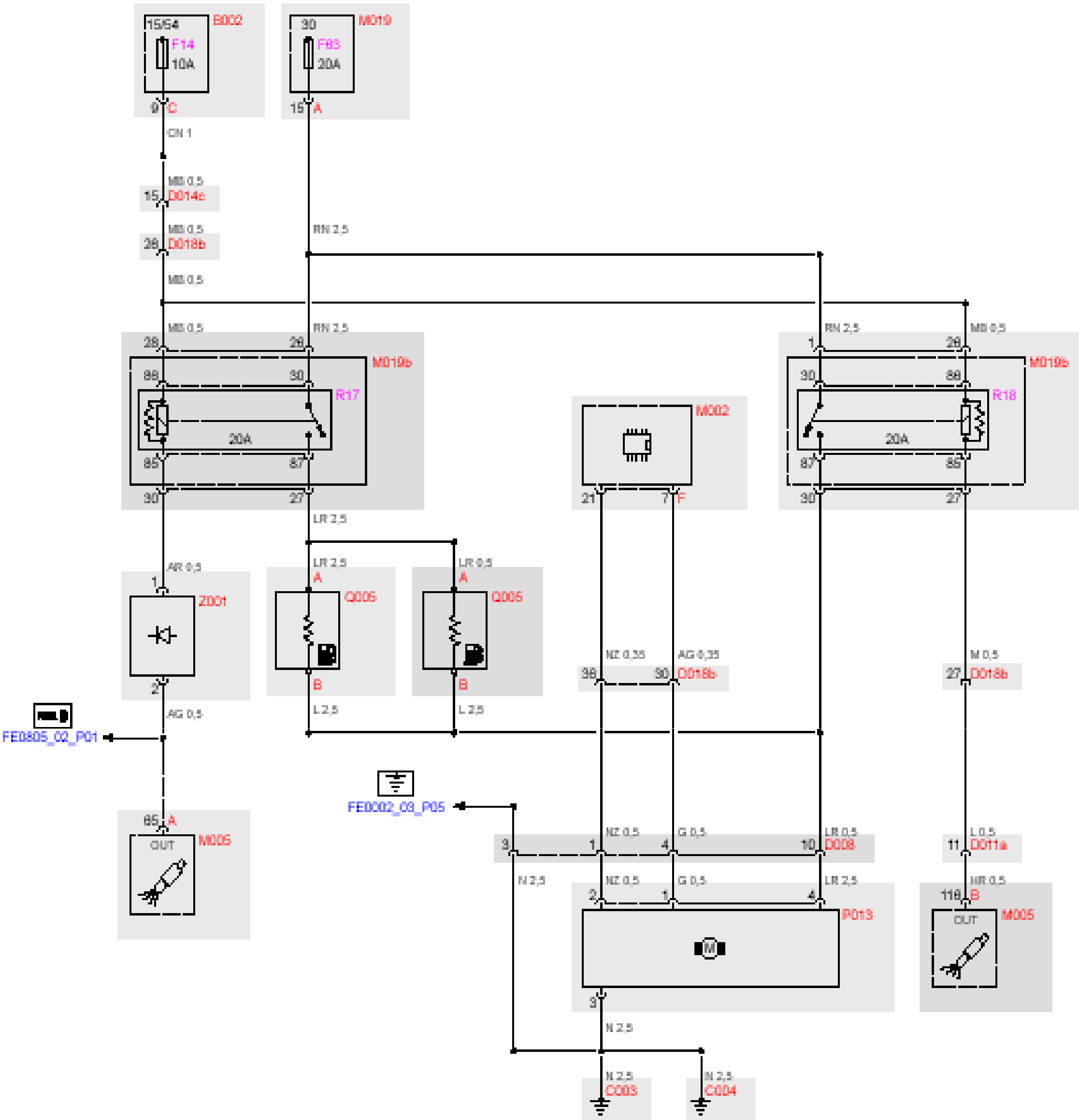


The two fuel pump relays are driven directly by the NCM. In contrast, the fuel level sensor is connected to the Body Computer. The NCM receives the information associated with the fuel level from the Body Computer via the C-CAN network.

When the fuel level is very low, the NCM disables the misfire detection strategy. This means that a fuel shortage is not interpreted as a misfire. This strategy avoids storage of unjustified misfiring errors.
The fuel level is also important in order to enable or disable several diagnostic functions.

All cars from MY06 onward have a single fuel pump.

Fuel pump control circuit electrical diagram:



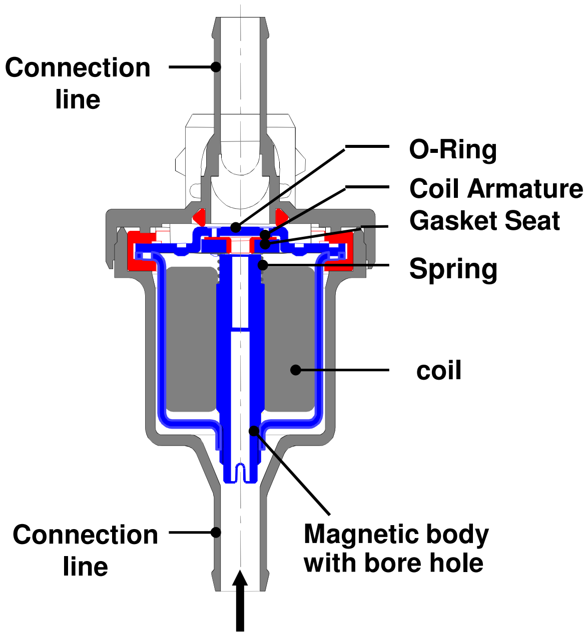
Pin 65 from the NCM has a dual function:

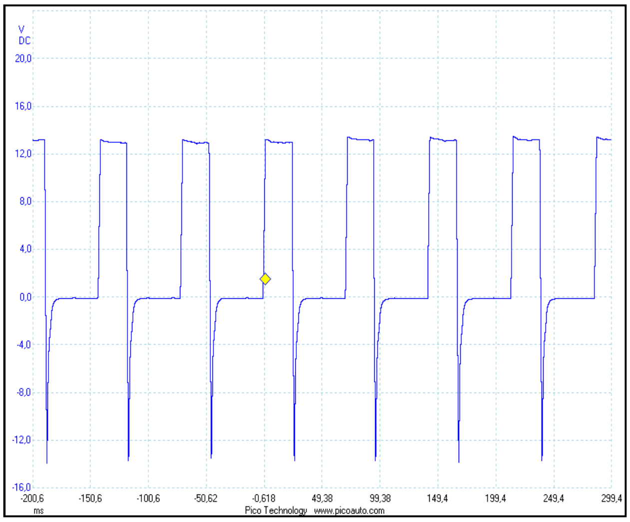
- Ground for relay R17 (Key ON)
- + 12V for TEST mode of the DMTL system (Key OFF)

In order to reduce noise levels and avoid overheating of the fuel in the tank, the fuel pump runs at low speed (by means of R17 and two resistors) when fuel demand is low.
In hot start (water temp. > 120℃) and cold start conditions the fuel pump runs at high speed for a few seconds.

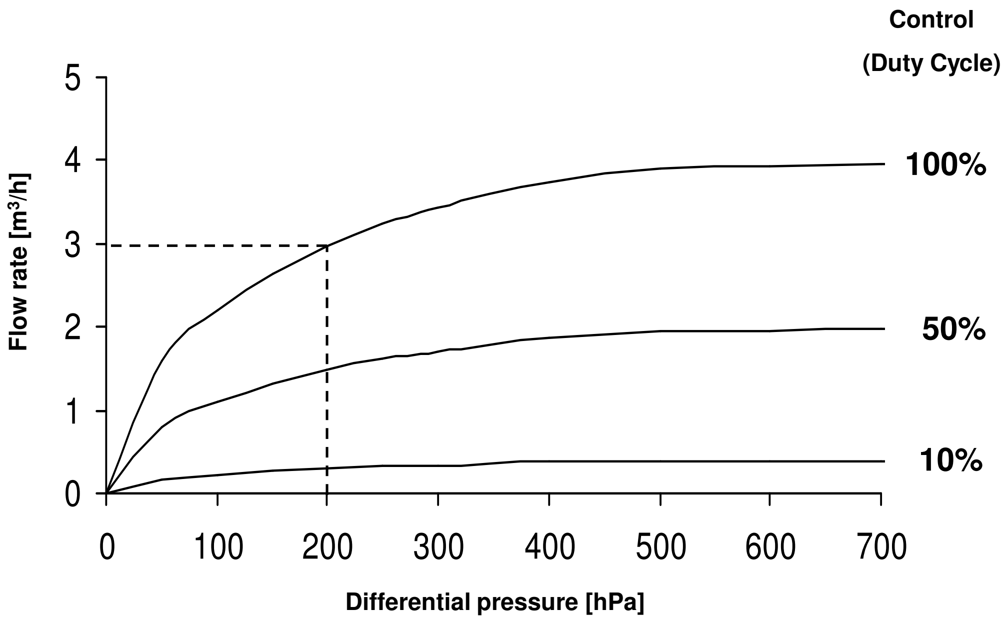
Canister purge valve

The canister purge valve is controlled in Duty-cycle (PWM). The use of this valve makes it possible to recuperate fuel vapours from the tank system by routing them to the intake air system. The engine control module activates the purge valve periodically and determines the necessary opening of the valve based on the engine running conditions and the fuel level in the fuel tank.





Canister purge valve activation signal scope view

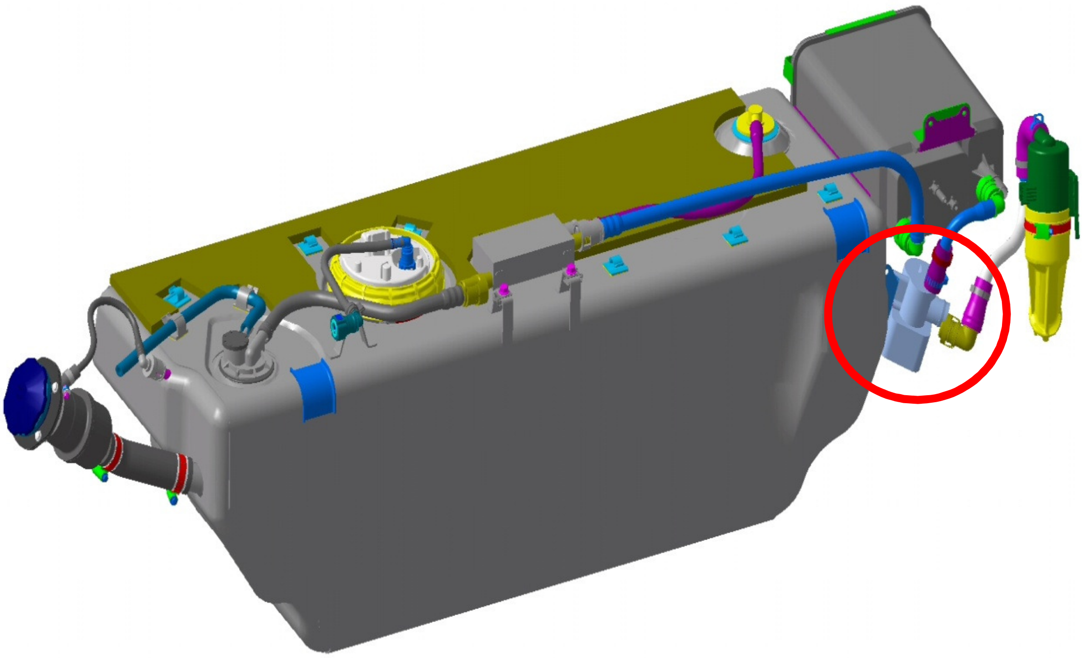


DMTL system

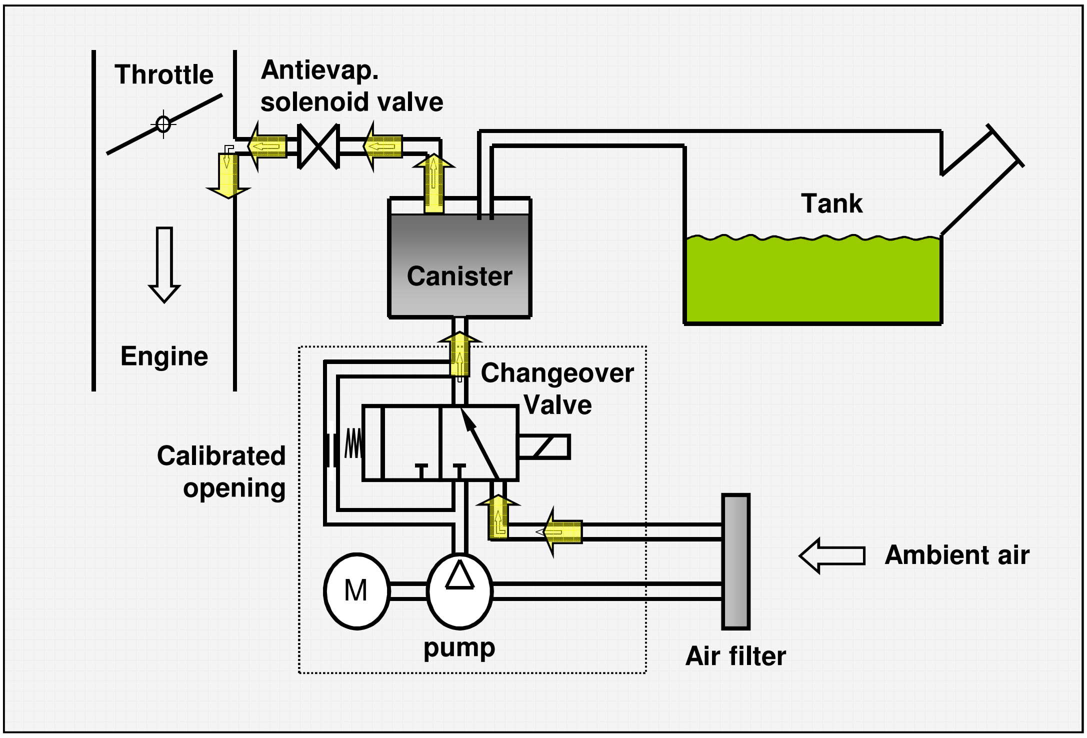
The Diagnostic Module for Tank Leakage (DMTL) is employed on cars for the US market and Europe EURO 5 specification vehicles. Its task is to verify fuel vapour circuit seal and alarm the driver when a leakage is detected.
For diagnostic purposes, the reference used by DMTL is the current required to drive a small motor driven pump that forces air through a 0.5 mm hole. Subsequently it pressurises the tank and, if it detects a hole, the required current will be lower than the reference current of the 0.5 mm hole.
In contrast, during canister purge mode, the DMTL controls the inlet of ambient air which then flows through the canister toward the intake air system.

For canister bleeding the anti-evaporation valve is opened and the engine vacuum aspirates fresh air through the filter and the canister.

When the system is in standby condition the fuel tank breathes through the canister, the changeover valve and the air filter.

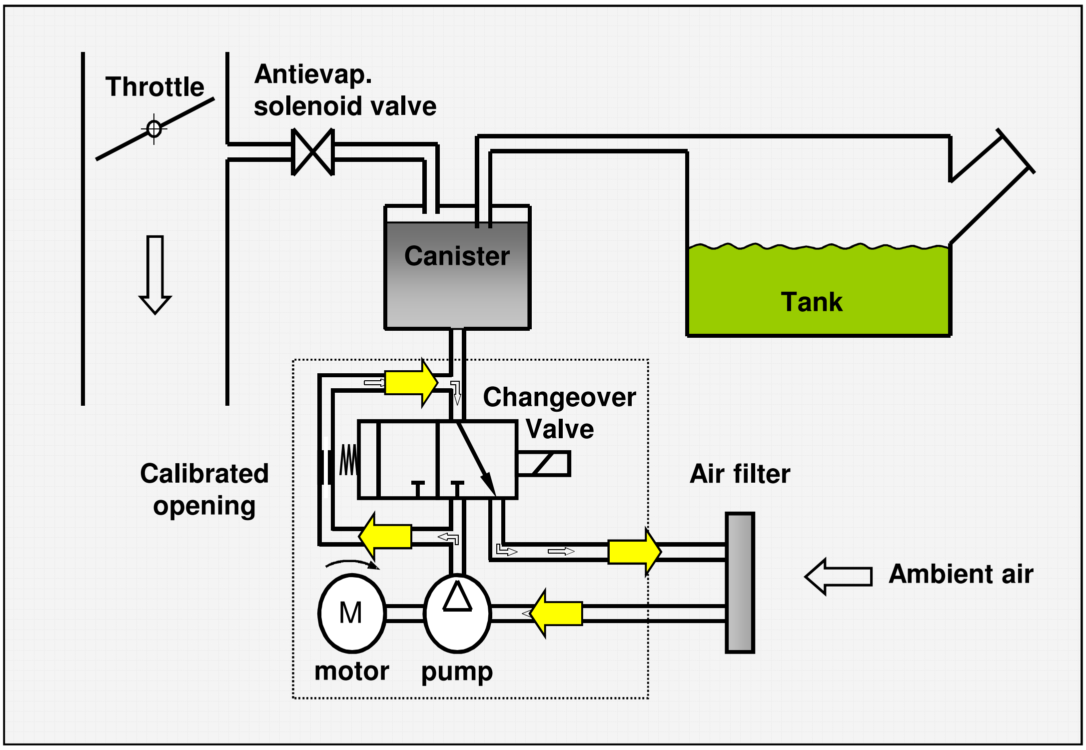


DMTL bleeding phase:



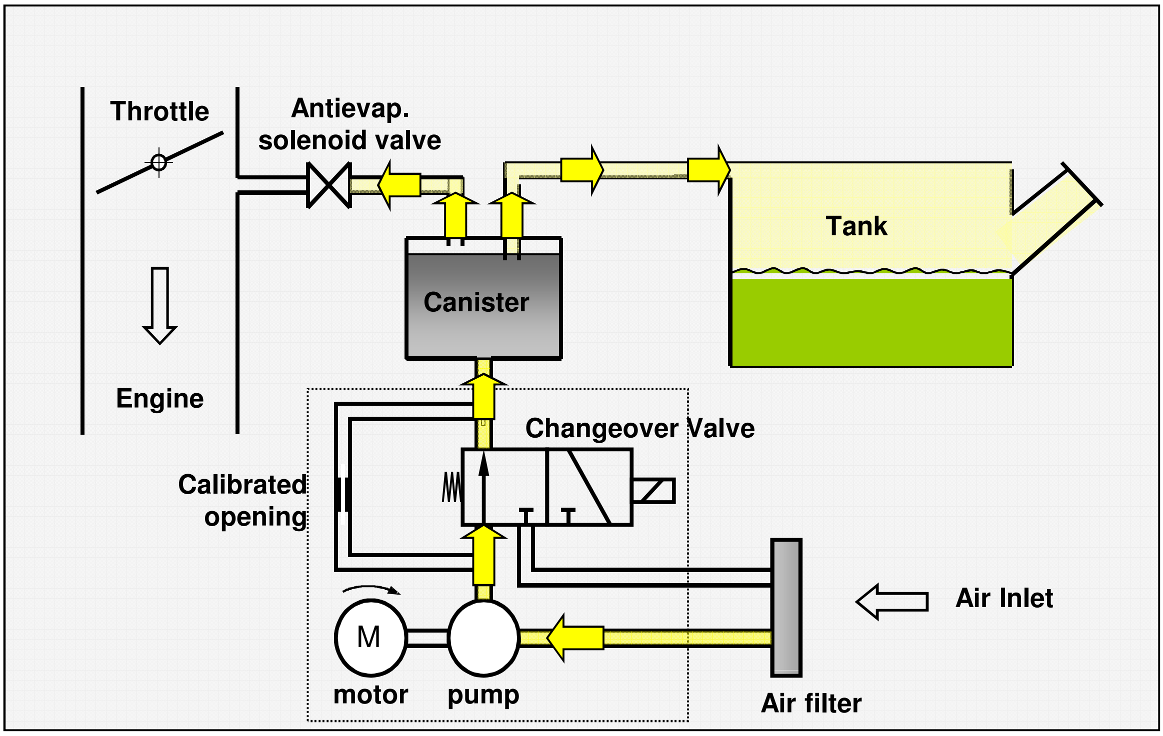
DMTL calibration phase:

The motor drives the pump and the air flows through an 0.5 mm calibrated hole, during which procedure the constant current absorbed by the motor, which is strictly dependent on the size of the hole, is recorded.



DMTL test phase:

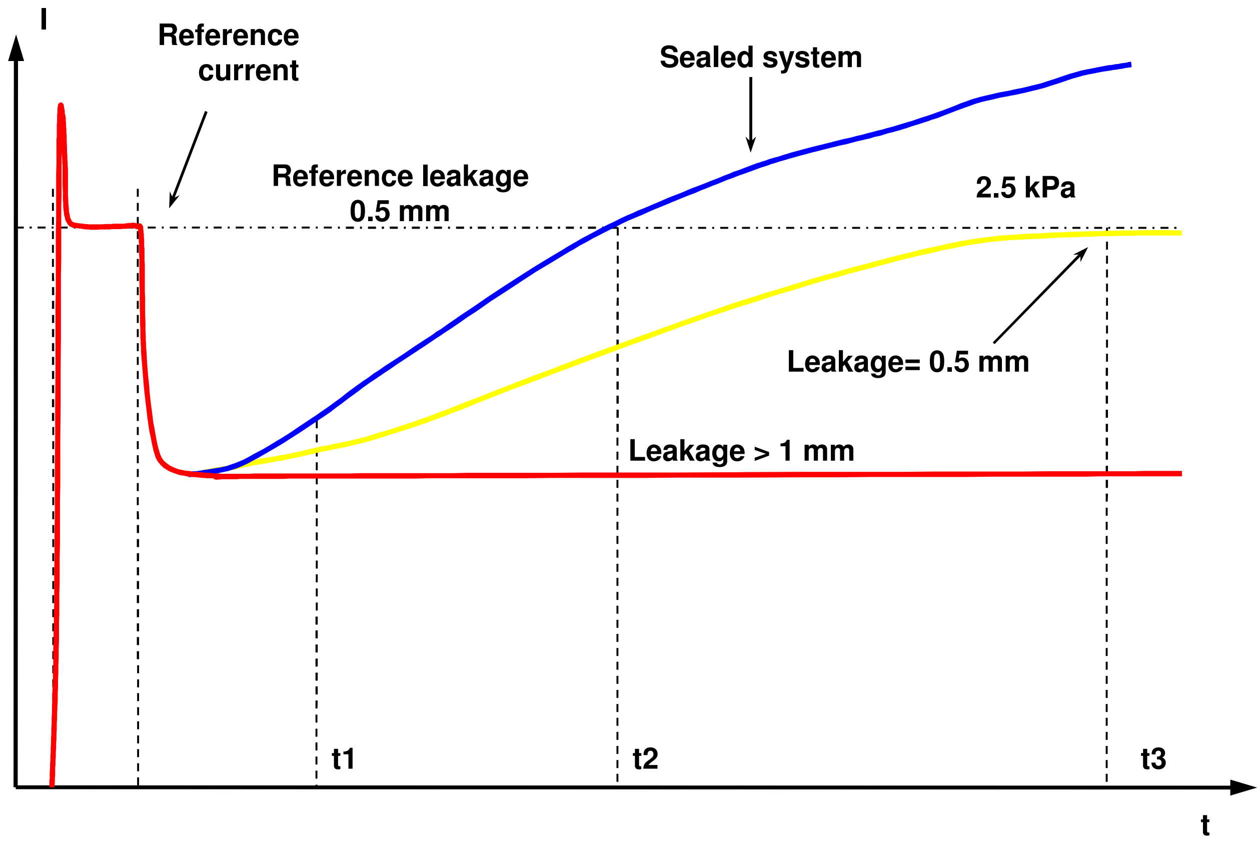
The changeover valve is open and the anti-evaporation valve is closed. The canister/tank air circuit is set and held under pressure by the pump. The absorbed current is measured and compared to the reference current value.



- engine rpm = 0
- altitude < 2800m
- engine temperature (off) > 3.8 °C
- ambient temperature 3.8° < T < 35,3 °C
- fuel level from 15% to 85%
- vehicle speed = 0 Km/h
- battery voltage 10.95 < Vb < 14.5
- Correct operation of the altitude, engine temperature, vehicle speed, air pump, and anti-evaporation valve sensors.
- Driving cycle of at least 600 seconds, then
- Engine off for at least 5 hours, then
- Driving cycle of at least 800 seconds
- Test launched several seconds after KEY OFF

The test can also be launched manually by means of the short trip (cycle environment in Maserati Diagnosi)

Pump motor current absorption



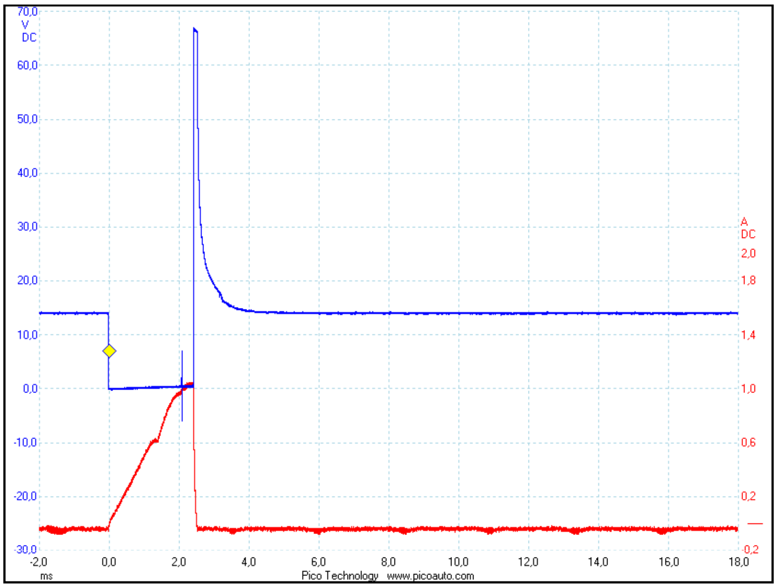
The first part of the curve is relative to the calibration phase: the system performs calibration using the reference current. This is the absorbed current of the pump corresponding to a leak through a calibrated 0.5 mm hole.

The second section of the curve is relative to the test phase:

- When the system is sealed the pump current increases proportionally with pressure in the system (blue curve).
- When the system has a leak corresponding to an 0.5 mm hole (critical leakage) the current reaches the maximum value at critical point t3 (yellow curve).
- When the system has a major leak (more than 1 mm) the current never reaches the reference value (red curve).
- The test terminates in a couple of minutes, depending on various factors such as the fuel level in the tank.
- When a leak has been detected the ECU saves a DTC (P0455, P0456) and illuminates the MIL warning light

Fuel injectors

The fuel injector is composed of a needle that is forced against the seat to prevent the inlet of fuel in aspiration. The needle is integral with a magnet. Next to the magnet there is a solenoid which, when energised, interacts with the magnet thereby forcing it upward and with the magnet also the needle.
The injector opening time is proportional to the quantity of fuel supplied in aspiration.



Injector voltage and current scope view

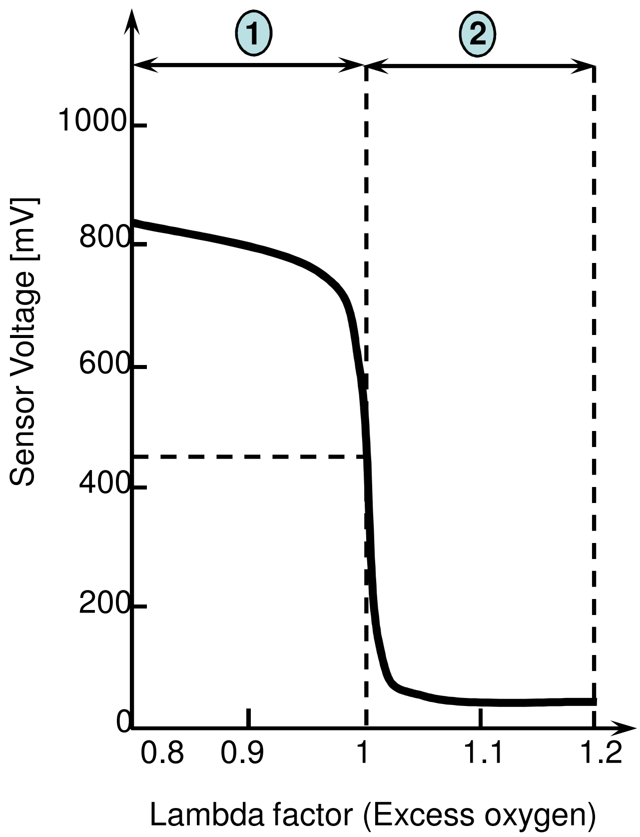
A change in the current that creates the magnetic field results in voltage that tends to oppose the current change. This is the reason for the counter-voltage peak that can be measured on an oscilloscope. The injector is active when the pin from the engine control unit is grounded. Motronic calculates the appropriate injection time individually for each cylinder bank.

Technical data:

- flow rate: 239.7 g/min
- internal leakage: 2 mm^3/min
- voltage: 12 V
- injection time: 2-4 ms with engine idling
- injector resistance EV6: 14,5 Ohm (20℃)
- injector resistance EV14: 12 Ohm (20℃)

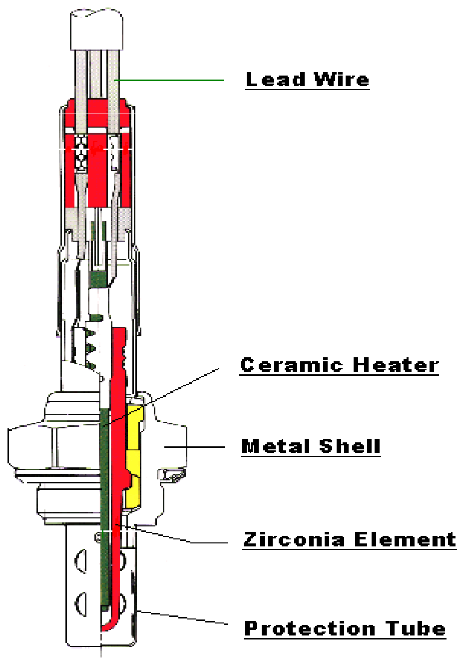
Two level oxygen sensor (Bosch LSF)

The oxygen sensor measures the A/F ratio in burnt exhaust gas with respect to a stoichiometric composition. In practical terms, the sensor measures the difference in the concentration of oxygen in the exhaust gas and in ambient air.
Once the sensor has been heated by its internal heating circuit, the oxygen on the external electrode is broken down into ionic form by the catalytic film of the electrode. A similar process occurs on the internal electrode with ambient air. The concentration difference generates a voltage signal in mV. These sensors are capable of defining only whether the mixture is rich or lean, without providing any quantitative information. The sensors are therefore also known as on-off or LSF sensors.



1 "Rich" mixture

2 "Lean" mixture



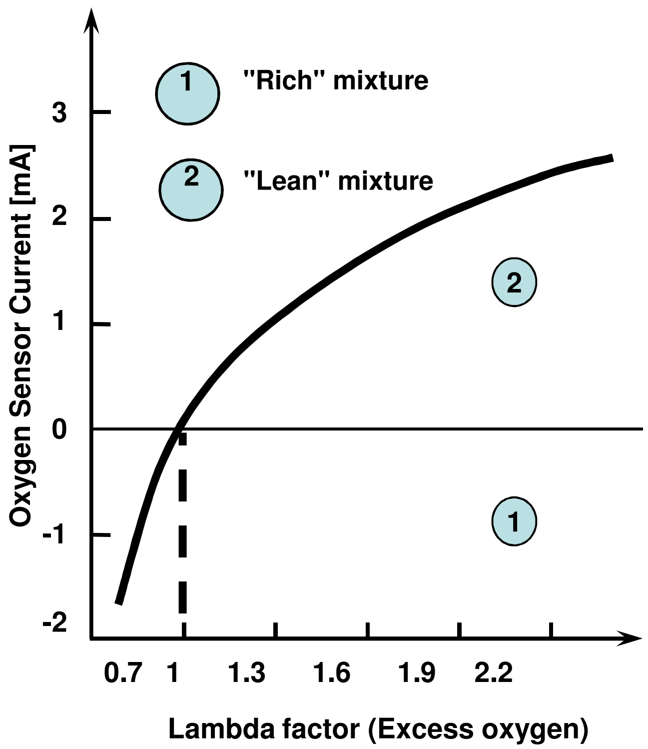
Technical data:

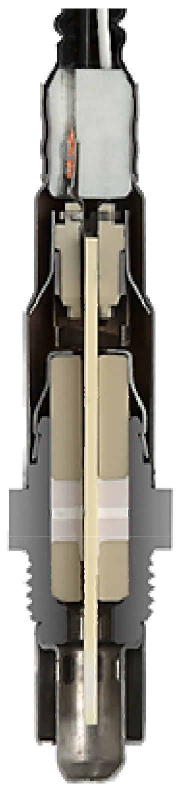
- Power supply: 12 V
- heater power: 7 W
- heating current: 2.1 A
- heating control: PWM 0-12 V
- exit: 0-900 mV

Closed loop check conditions: feedback on the rear oxygen sensors can be checked with a road test, by means of acquisition with Maserati Diagnosi.

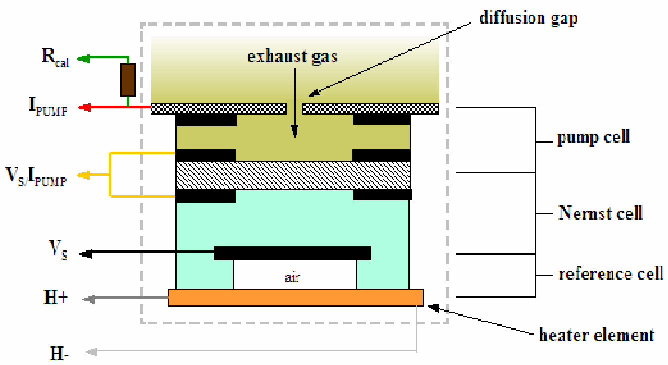
Wide band oxygen sensor (Bosch LSU)

The pumping or measuring cell is maintained with a stoichiometric A/F ratio. In the presence of excess oxygen in the exhaust gas, positive pumping current makes it possible to remove said excess oxygen. The opposite situation occurs with rich mixtures.
The pumping current therefore indicates the stoichiometric ratio and the concentration difference generates a current.





LSU type broad band oxygen sensors always function in CLOSED LOOP mode except during the "light off" period and for very short intervals during transients.



Technical data:

- power supply 12 V
- heater power: 10W
- operating temperature: 750 °C
- heater control: 0-12 V in PWM

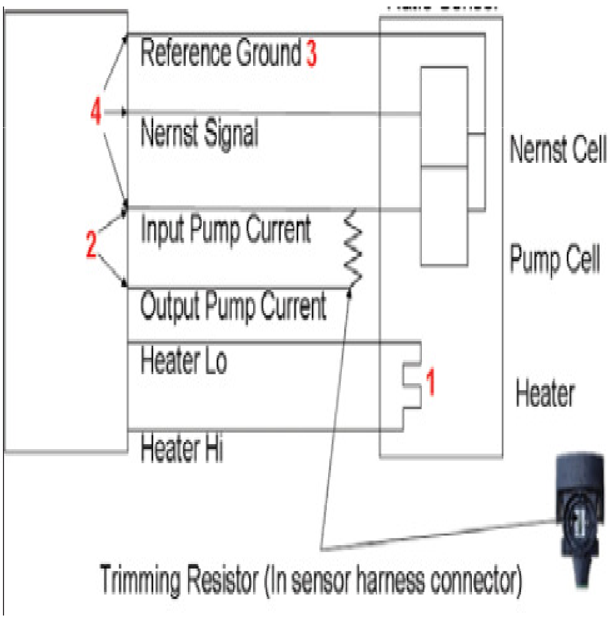
Heater efficiency check:
Disconnect the sensor and use a multitester on the impedance scale to measure the resistance between pins 3 and 4. The measured value should be 3.2 Ohm.

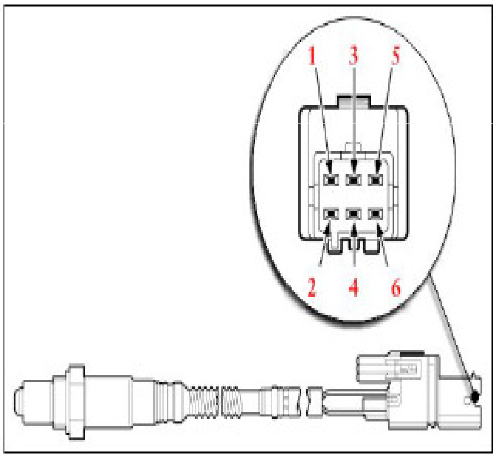
Trimming resistor check:
Disconnect the sensor and using a multitester set to the impedance scale measure the resistance between pins 2 and 6. The measured value should be 300 Ohm.

Pumping current check:
The pumping current is converted by the ECU into voltage, which can be analysed using an oscilloscope. This voltage signal varies continuously between +300mV and -300mV.

On Maserati Diagnosi the converted voltage measured is 1.5V and can be checked in the OBD parameters

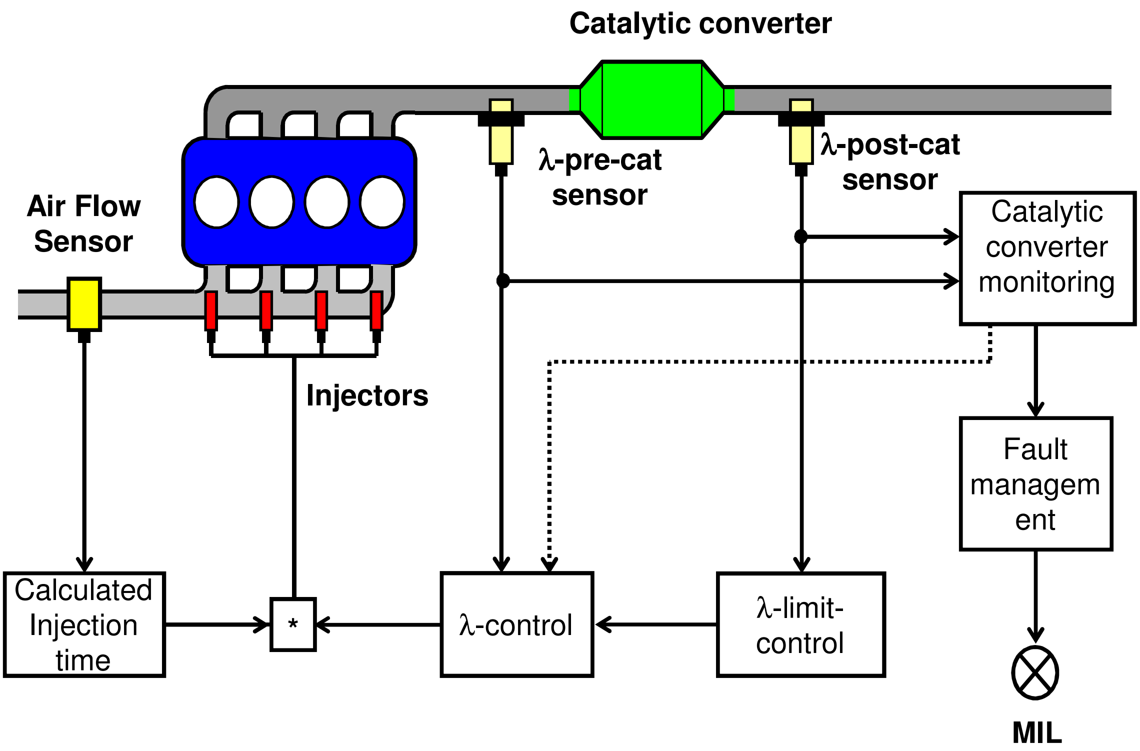
Closed loop check conditions: it is possible to check feedback on the front oxygen sensors with engine T° of 90°C at idle speed





PIN	Description
1	Sensor voltage (+)
2	Pump Output signal
3	Heater (+ batt.)
4	Heater (-)
5	Sensor voltage (-)
6	Pump input signal

Catalytic converters monitoring



Pre-cat oxygen sensor = LSU
Post-cat oxygen sensor = LSF

Lambda > 1 :	**Mixture = lean**
Lambda = 1:	**Mixture = correct**
Lambda < 1 :	**Mixture = rich**

In accordance with regulations, the engine must always* run with Lambda = 1 (correct mixture)

(*): except during a brief interval after cold starting and during short-term transients.

To obtain and maintain a correct F/A mixture the Lambda monitoring system must function in "Closed Loop" mode (with feedback). The "open loop / closed loop" state can be checked with the Maserati Diagnosi tester.

Pre-cat lambda value monitoring

The Lambda value for the two banks upstream from the catalytic converters is monitored by means of LSU type sensors (broad band oxygen sensors). These sensors make it possible to measure the Lambda value in real time and with high precision.
The measured Lambda value is subsequently compared by the ECU with the value calculated in accordance with a model (target Lambda value) and any changes are compensated by means of the "Fuel Trim" strategy (Closed Loop operation)

Fuel trim:

- The expression Fuel Trim is used in various regulations to indicate the correction of the quantity of fuel based on information supplied by the oxygen sensors.
- The ECU compares the real Lambda value measured by the pre-cat sensor with the target Lambda value.
- To maintain the correct stoichiometric air/fuel ratio the ECU calculates a correction of the injection quantity in real time.
- This real time correction is designated "Short Term Fuel Trim".
- The "Short Term Fuel Trim" is expressed as a percentage correction of the fuel quantity.
- When the mixture is too lean or too rich, the ECU continues to make corrections until the limit is reached (in both directions).
- The ECU transfers the Short Term Fuel Trim value continuously and progressively to the "Long Term Fuel Trim" (= integral correction). The Motronic subsequently corrects the carburetion map and adapts it by "moving it".
- A "Long Term" correction corresponds to a 1% correction of the map (positive or negative) and is saved in the ECU.
- When the Long term Fuel Trim reaches a certain limit (usually a 10% variation, although this depends on the standard), an error code is stored and the engine check warning light illuminates.
- This condition indicates the presence of a problem in the air or fuel system (malfunction of air flow meter, injectors, oxygen sensors, exhaust, EVAP system...).
- The Long Term Fuel Trim is specific for engine idling and for low/high engine load conditions.
- The Fuel Trim is specific for both cylinder banks and can be verified with the Maserati Diagnosi tester.

The Maserati Diagnosi displays various Fuel Trim self-learning values (parameter environment, self learning parameters):

- **“Additive correction of the idle mixture adaptation”:** this information regards the additive fuel adaptation applied by the Motronic for idling conditions. The range of the self-learning correction lies between -10,20% and +10,20%. “0” means there is no correction. For example: a value equal to +1% means that the Motronic applies a positive correction. With the basic fuel map the engine is running to lean; consequently the Motronic increases the amount of injected fuel with 1 %. The normal range for the idle fuel correction is between -2,5% to +2,5%. A value outside this range indicates a possible problem with the air/fuel circuit.
- **“Fuel self-learning at low/high engine load”:** these are multiplicative values for low/high engine load conditions (“1.000” means there is no correction). The range for this self learning value lies between 0,703 and 1,296. A value higher than 1 means that the engine is running to lean with the basic mapping; a value lower than 1 means that the engine is running to rich with the basic mapping. The Motronic multiplies the amount of injected fuel with the indicated value in order to maintain the target lambda value.
- **“Actual self-learning”:** indicates which of the various self-learned fuel maps is actually used in function of the actual engine running conditions.

- The fuel trim self-learning process will be deactivated in case any DTCs regarding the engine control system are present inside the ECU. The self-learning will pick up again once the problem is solved and the error code is not present anymore or cleared.
- The various self-learning values will be reset when the DTC memory of the engine ECU is cleared or when the battery is disconnected.
- The self-learning is interrupted while the canister purge solenoid valve is activated.
- **Fuel Trim is very usefull diagnostic information which will get lost when the ECU memory is cleared!**

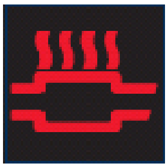
Post-cat lambda value monitoring

The Lambda value down-stream of the catalytic converters is monitored by LSF type oxygen sensors (two-level sensors). These Oxygen sensors are less precise than LSU type sensors, and they are utilised primarily for diagnostic purposes.
The Lambda value down-stream from the catalytic converters is used to:

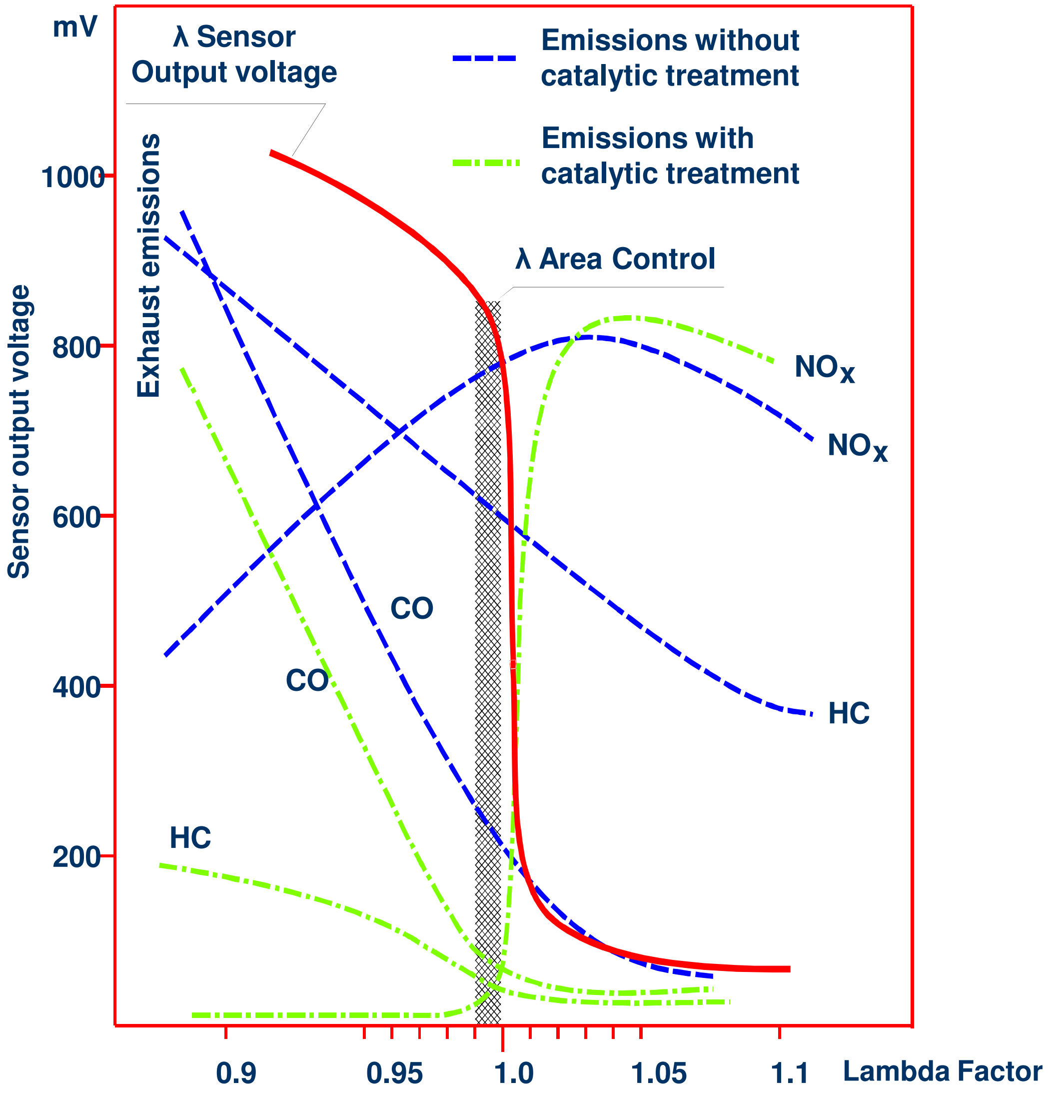
- Check proper operation of the catalytic converters: In the event of detection of low efficiency of the catalytic converters, the Motronic ECU stores a DTC and illuminates the MIL warning light.
- Check proper operation of the Oxygen sensors up-stream of the catalytic converters (plausibility check).
- Provide a minor contribution to the Fuel Trim.

Slow Down strategy

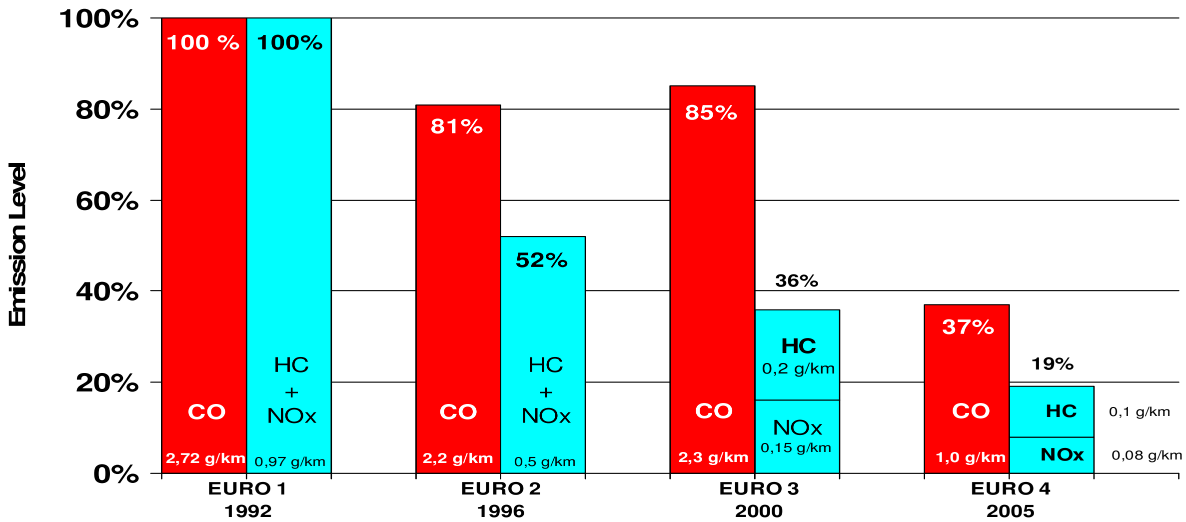
- The catalytic converters may be damaged if the temperature rises excessively.
- A mathematical model integrated in the ECU makes it possible to calculated the temperature of the catalytic converters in real time.
- The parameters utilised for the calculation are as follows: engine coolant temperature, ambient temperature, engine load, ignition advance and Lambda value.
- The calculated temperature allows the ECU to protect the system from serious problems by implementing suitable strategies.
- When the calculated temperature reaches 980°C the Slow Down warning light flashes on the dashboard to alert the driver to the presence of a critical situation.
- When the calculated temperature reaches 1040°C the Slow Down warning light remains steadily illuminated and the ECU switches off the engine. Higher catalytic converter temperatures would damage the converters and may result in a fire outbreak.



Influence of the Lambda value on exhaust emissions (pre- and post-cat):



Evolution of the EURO emission regulations:



Emissions verification:

The verification of exhaust emissions is performed in the following conditions:

- Engine idling, steady state
- Warm Engine
- Lambda control inactive (open loop)

Values (example: Quattroporte 4.2L):

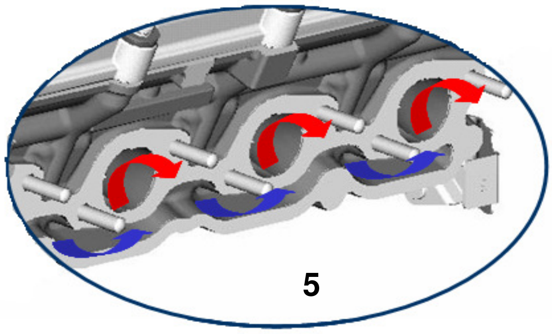
- HC: 40 - 300 ppm
- CO: 0.25...1.00 %
- O2: 0...1.5 %
- CO2: there is no reference value, CO2 is proportional to the quantity of fuel consumed. CO2 falls when combustion is incomplete

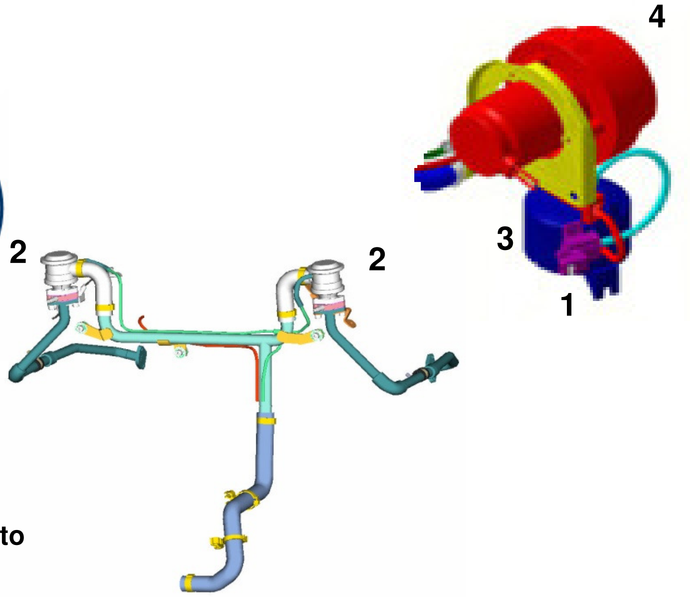
In the event of misfiring caused by failure to ignite the mixture, the HC value increases significantly (e.g. around 2000 ppm when one cylinder fails to fire).

Idle speed carburation parameters (example: Quattroporte 4.2L):

- engine speed (nmot): 660..740'
- load (rl): 15..35%
- throttle (wdkba): 2..4%
- RH and LH bank injection time (ti_b1/b2): 2..4 ms
- air flow read by air flow meter (ml): 20..35 kg/hr
- LH and RH mechanical timing (wnwkwas/2): 106..124°CS
- accelerator pedal (wped): 0..100%
- throttle self-learning (lrnstep): 0 or 11
- lambda control feedback (fr): 0.92..1.08
- advance (zwout): -10°..+10°CS
- engine temperature (tmot): 90..100°C
- initial LH and RH mechanical timing self-learning (dwnwrp0e/2)
- fuel adaptive self learning at idling LH and RH (rkat/2): -2.5..+2.5
- aspirated air temperature (tans): 20..60°C
- front LH and RH oxygen sensor (lamsoni/2): 0.98..1.02
- rear LH and RH oxygen sensor (lamsonh/2): 0.95..1.05
- mechanical phase self-learning OK LH and RH (B_phad/2): true/true

Secondary air system





1. Solenoid Valve
2. Pneumatic valves
3. Vacuum tank
4. Secondary air pump
5. System for secondary air injection into cylinder heads (wet sump engine)

In order to reduce emission levels in accordance with the prescriptions set down in the various regulations, the catalytic converters must reach their operating temperature very rapidly following a cold start.

One way of speeding up heating of the catalytic converters is to retard the ignition advance when the engine is cold; another method is to install a secondary air injection system.

During the "light off" period (brief interval after cold starting during which the catalytic converter is inoperative) the engine runs in "Open Loop" mode with a rich mixture (Lambda $\cong$ 0.75). Combustion is incomplete in the cylinder and the exhaust gas contains a high concentration of HC and CO.

By injecting air in the vicinity of the exhaust valve a chemical reaction occurs in the duct between the HC, CO (both of which are present in excess) and the O_2 present in the injected air. In this manner the unburnt fuel is subsequently burnt in the exhaust system.

The heat generated by this process causes rapid heating of the catalytic converters; Moreover, emissions are significantly reduced thanks to this "completion" of the combustion process.

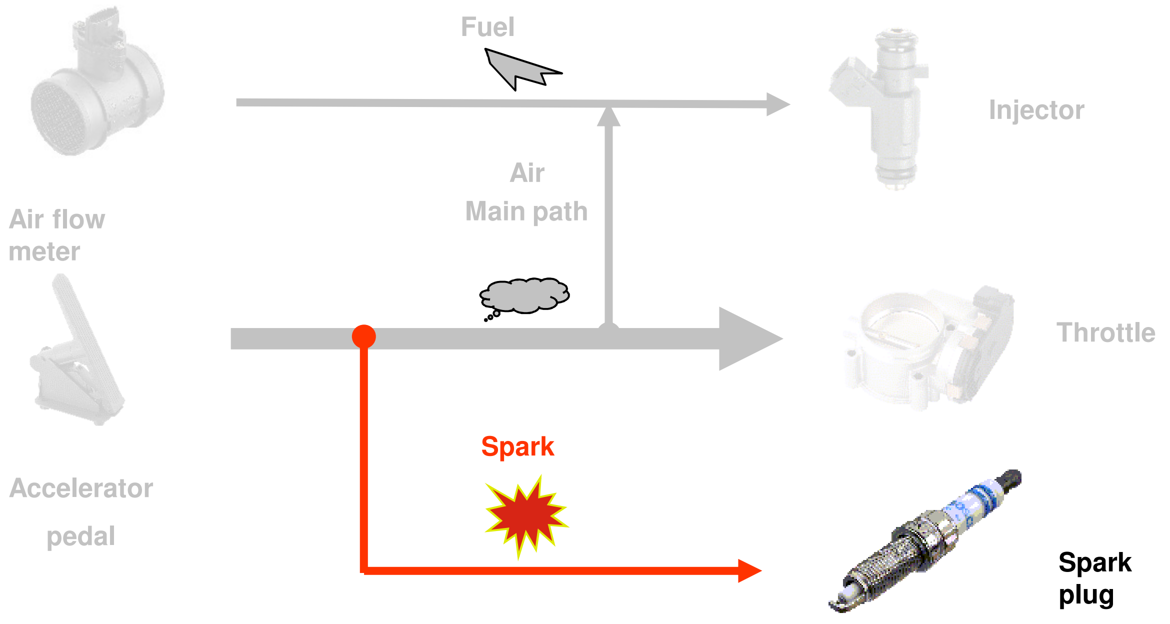
The secondary air system is composed of an electric pump controlled by a relay, two pneumatic valves that close the line when the system is inoperative, and a solenoid valve that controls the pneumatic valves by means of the vacuum provided by a connection with the plenum chamber.

The secondary air system is activated by the ECU after a cold start and only when engine temperature is in the range -7 to + 40°C. In these conditions the engine runs in "Open Loop" conditions.

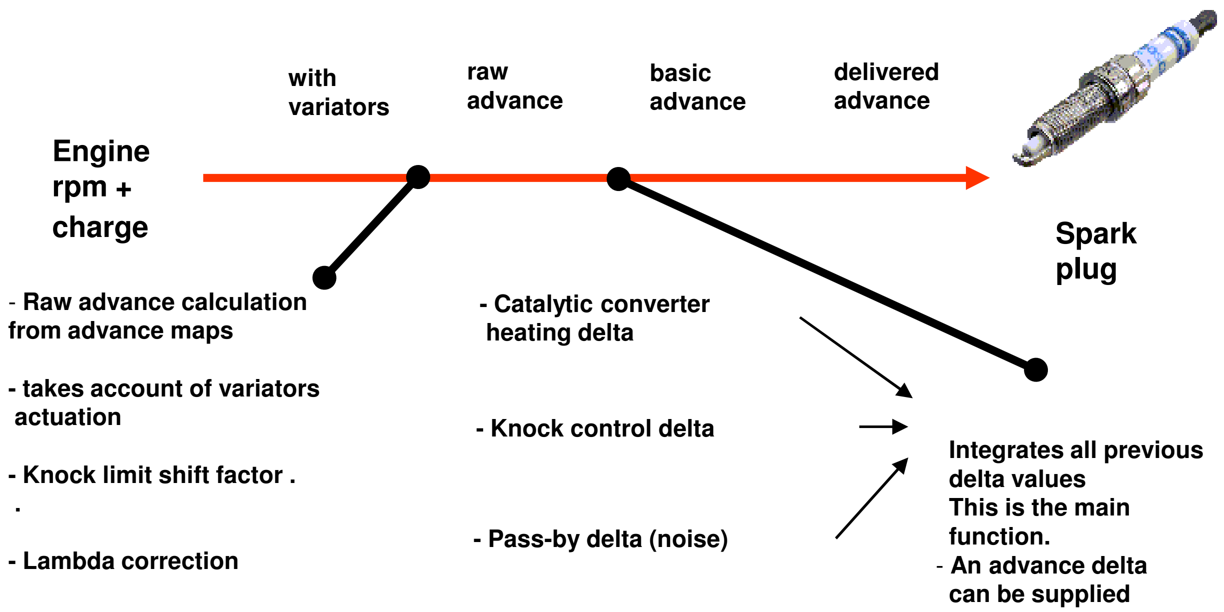
During this phase the Oxygen sensors signal is utilised to calculate the temperature of the catalytic converters, utilising a mathematical calculation model.

3rd Fundamental Parameter of engine control: Spark advance

Spark path:



Spark advance calculation:



Three running conditions can be identified, each of which characterised by an advance path:

- **Starting:** specific maps are provided
- **With map advance:** the advance is as specified in the map
- **With advance that differs from map**

Reasons for advance other than that specified in the map:

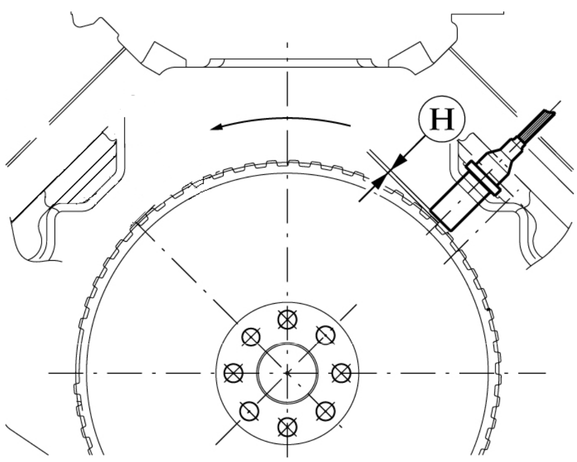
- Torque reserve
- Catalytic converter warm-up
- Anti-flutter strategy
- Comfort and driveability strategies
- Engine protection strategies (knock control)

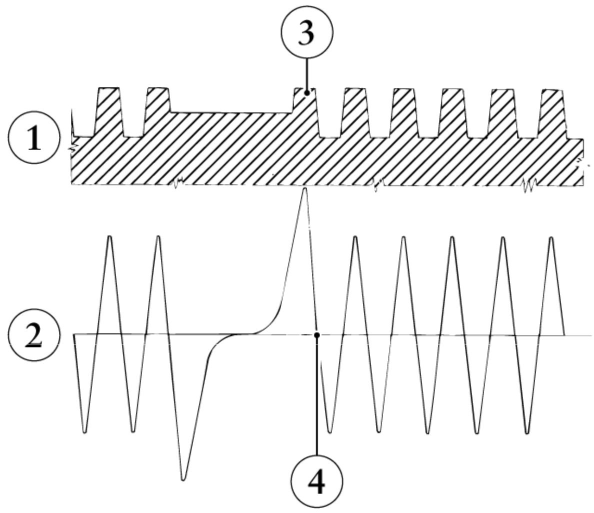
Engine speed (RPM) sensor

The RPM sensor is a variable reluctance transducer (also known as a pick-up or inductive sensor) located in proximity of the tone wheel which is an integral part of the engine flywheel. The tone wheel has 58 (60-2) teeth.

Electrical characteristics:
Resistance = 1134 ÷ 1386Ω (20℃).

The prescribed gap between the tip of the sensor and the tone wheel to obtain correct readings is between 0.5 and 1.5 mm. The output voltage varies with the rotation speed.





1) Projection of the tone wheel section

2) Waveform read by the sensor

3) First tooth after space

4) Signal status change

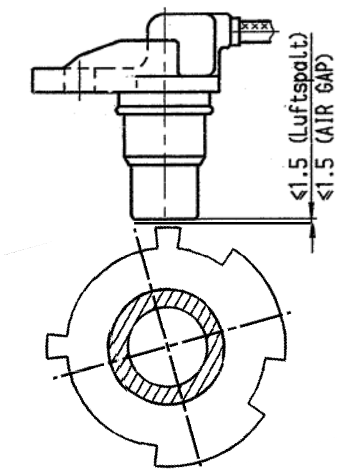
The engine RPM signal must always be rising in correspondence with the tone wheel toothspace! (a falling signal means the sensor polarity is inverted)

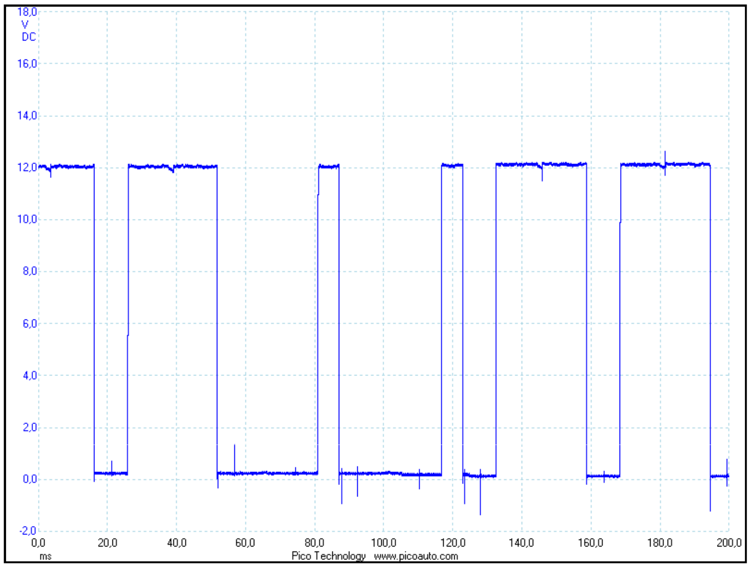
The RPM sensor is a passive transducer (no signal output when the tone wheel is stationary); this means that the position of the crankshaft cannot be identified when the engine is stopped.

It is extremely important to ensure the sensor is correctly fixed in order to obtain efficient engine operation. Movements, vibrations,... etc. of the RPM sensor can create engine problems, even though the RPM signal seems to be OK when the engine is idling.

Engine timing sensor

The timing sensor is a Hall-effect transducer fitted in correspondence with a tone wheel with four cams on the camshaft.
In normal conditions the timing sensor output signal is 5V, but when the magnetic cam is aligned with the sensor the signal drops to 0 volts, thereby informing the NCM of the position of the camshaft (the NCM reads the downward flanks of the timing signal)
The timing sensor is an active transducer. This means that the position of the camshaft is recognised even when the engine is stopped. The timing signal is utilised to recognise the position of the engine and for the VVT-system.



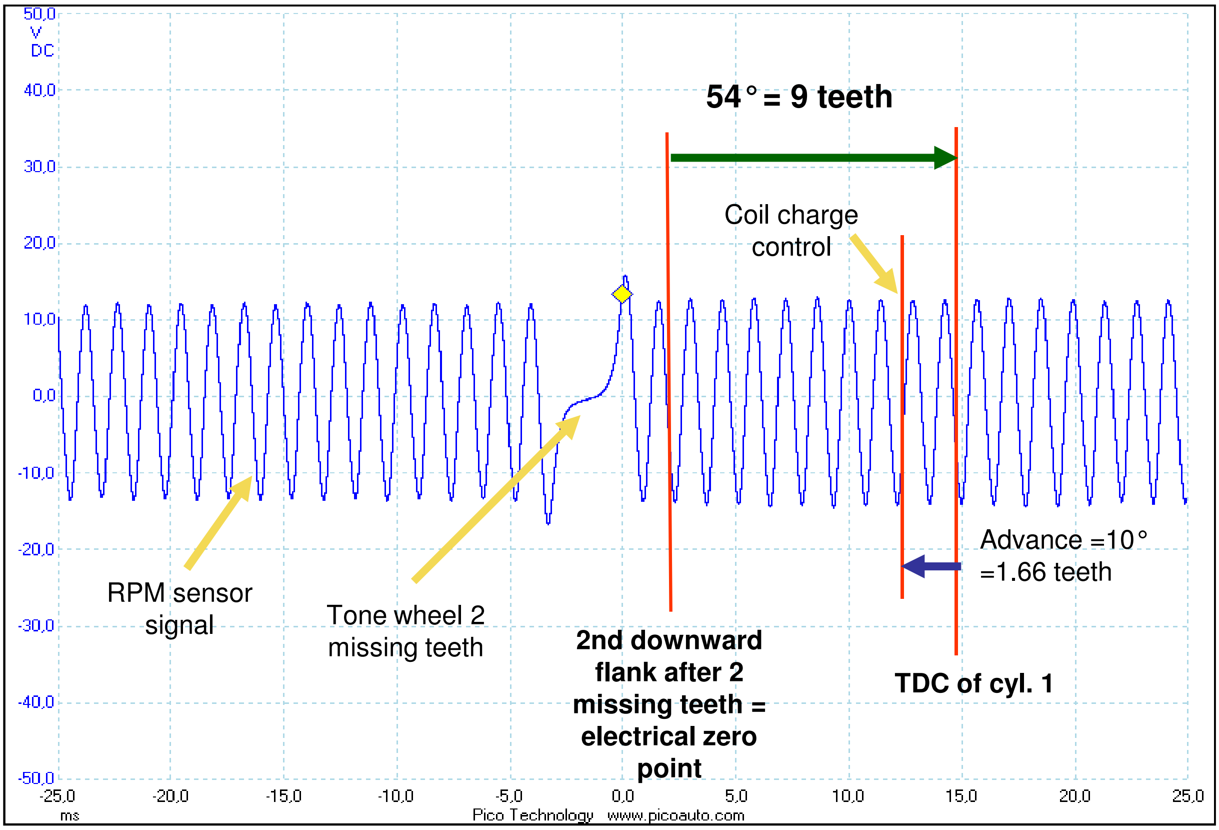


Timing sensor signal scope view

The electrical timing signal is composed of four high parts (2 x 140° + 2 x 40°) and four low parts (2 x 40° + 2 x 140°), the timing signal is electrically symmetrical.

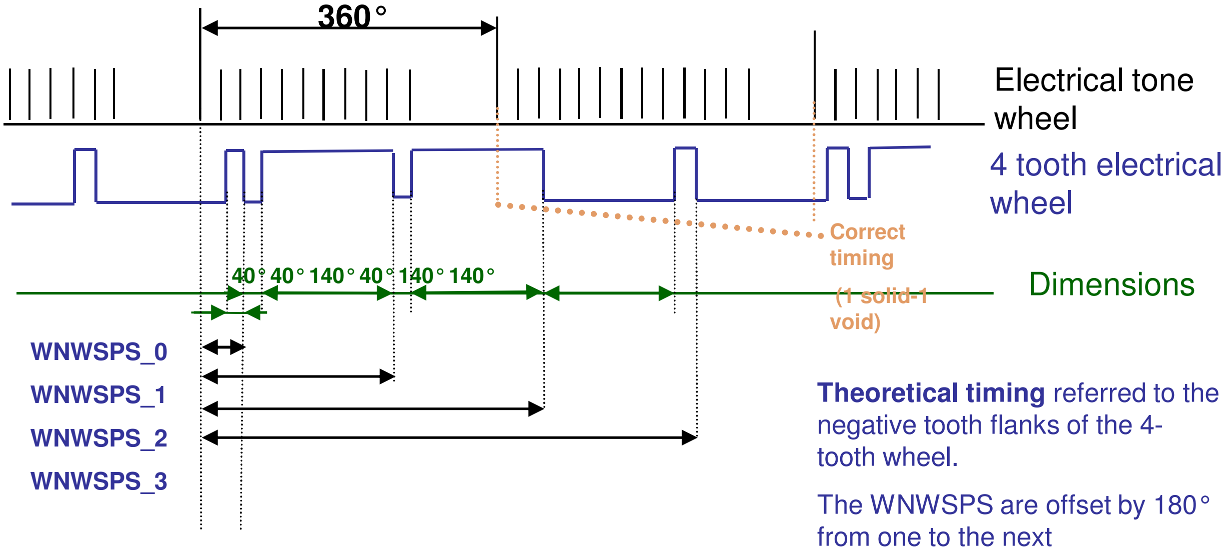
Error	Description	Criterion	MIL (EURO)	MIL (USA)
P1323	Alignment between timing signal and RPM signal	Timing signal excessively advanced	After 3 Driving-cycles	After 2 Driving-cycles
P1339	Alignment between timing signal and RPM signal (B2)	Timing signal excessively advanced	After 3 Driving-cycles	After 2 Driving-cycles
P1324	Alignment between timing signal and RPM signal	Timing signal excessively retarded	After 3 Driving-cycles	After 2 Driving-cycles
P1340	Alignment between timing signal and RPM signal (B2)	Timing signal excessively retarded	After 3 Driving-cycles	After 2 Driving-cycles

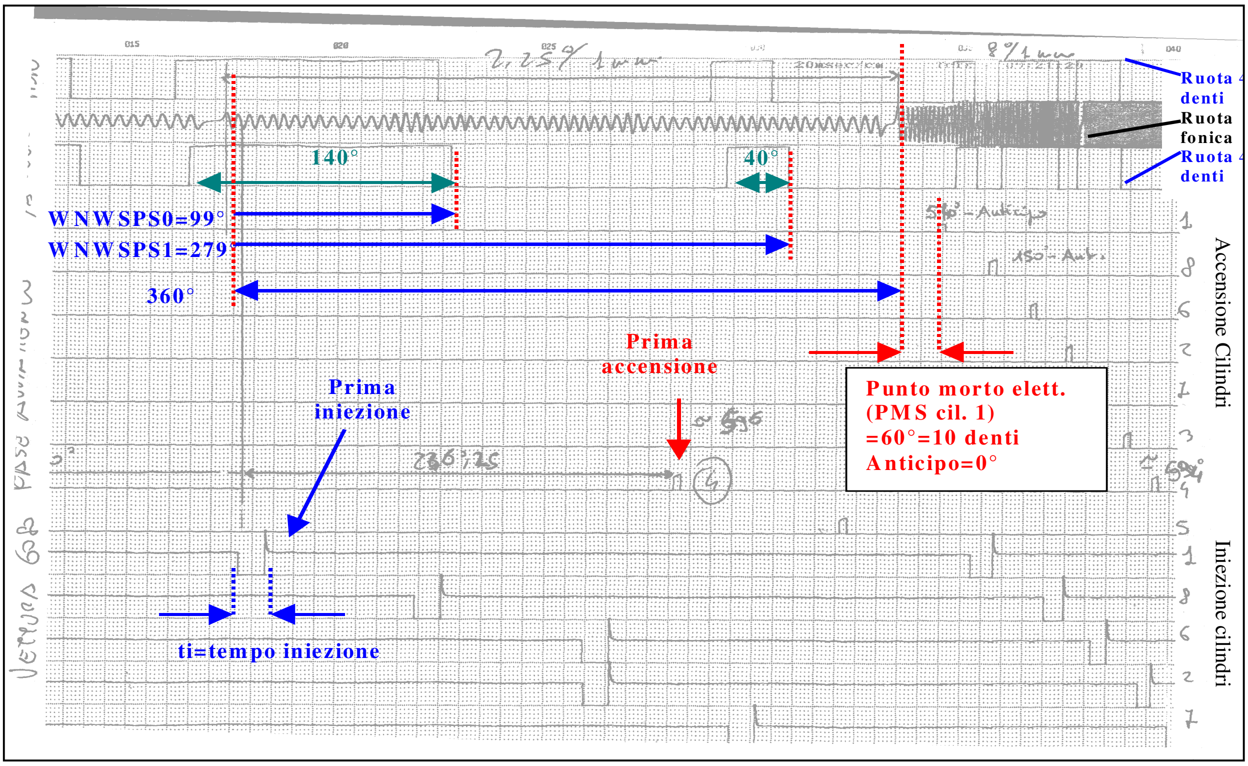
Electrical engine timing



- The tone wheel on the crankshaft has 58 teeth (60 teeth minus two missing teeth)
- The zero point for the NCM is constituted by the zero-crossing of the second descending signal flank after the gap measured by the engine RPM signal. The NCM detects an interval between teeth that lasts more than twice the time of the previous and subsequent intervals.
- The mechanical top dead centre of the first cylinder is exactly 9 teeth (54 degrees) after the electrical zero point of the RPM signal.
- In order to recognise the position of the engine, the NCM checks the timing signal at the time of the zero point identified by the RPM signal.
- It is essential, in order to read the engine position, that when the zero point of the RPM signal corresponds with a high signal of the camshaft, the next zero point corresponds to a low signal (see diagram on next page).
- Recognition of the engine position is indispensable for operation of the sequential ignition and injection system.
- The NCM performs a check of the alignment between the RPM signal and the timing signal. The applicable regulations allow a tolerated maximum "shift" of 10° in both directions. When the engine exceeds this tolerance, the Motronic saves a DTC and illuminates the MIL warning light.

Electrical engine timing





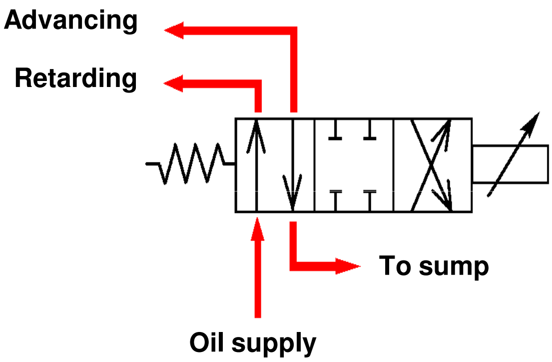
The correct electrical engine timing can be checked by using the Maserati Diagnosi tester (parameter environment). The values indicated in the lower table are the angles between the engine electrical zero point and each trailing edge of the timing signal (4 per camshaft revolution).
Note: the indicated values are with non-activated timing variators (engine idling).

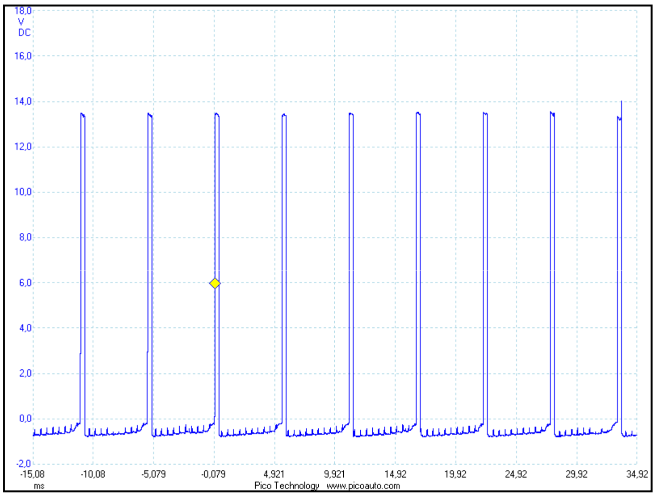
F136 R /S	**F136 UC / UD**	**F136UE**	**F136 YC /YE /YK**	**F136 YG /YH /YI**
101	115	125	110	131
281	295	305	290	311
461	475	485	470	491
641	655	665	650	671

Engine code	**Vehicle type**	**Motronic**	**Timing var.**
F136R	Coupé, Spyder, GranSport all versions	ME7	50° (H.P.)
F136S	Quattroporte Duoselect	ME7	50° (H.P.)
F136UC	Quattroporte 4.2L Auto MY07/08/09	ME7	50° (L.P.)
F136UD	GranTurismo 4.2L Auto MY07/08/09	ME7	50° (L.P.)
F136UE	Quattroporte & GranTurismo 4.2L Auto from MY10	ME9	50° (L.P.)
F136YC	Alfa 8C & 8C Spider	ME7	50° (L.P.)
F136YE	GranTurismo S 4.7L MC-shift	ME7	50° (L.P.)
F136YG	Quattroporte S 4,7L Auto	ME9	60° (L.P.)
F136YH	GranTurismo S 4,7L Auto & Quattroporte Sport GT S 4,7L Auto	ME9	60° (L.P.)
F136YI	GranCabrio 4,7L Auto	ME9	60° (L.P.)
F136YK	GranTurismo MC Stradale	ME7	50° (L.P.)

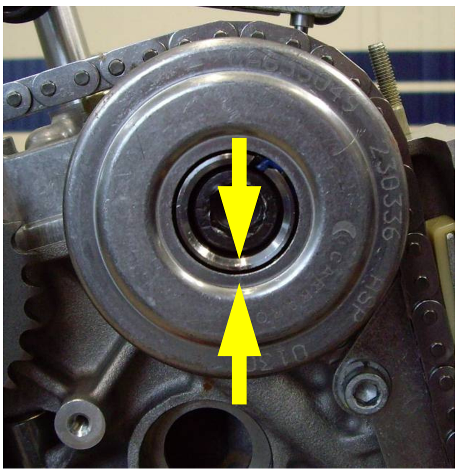
Variable valve timing system

On all Maserati engines of the F136 family, a Variable Valve Timing (VVT) system is applied on both intake camshafts. The high pressure VVT-system of the dry sump engines was replaced by a low pressure system when the wet sump engine variant was introduced in 2007.
Each VVT-actuator is regulated by a solenoid valve that controls oil delivery to the advance chambers and to the retard chambers. The solenoid valves are controlled directly by the Engine Control Node (NCM) by means of a PWM signal (pulse width modulation) and on the basis of programmed mapping (which depends on the engine load and RPM). The NCM constantly monitors the actual position of the VVT-actuators by comparing the signals from the crankshaft position sensor and the camshaft position sensors. When the oil control solenoid valve is in its rest position, oil delivery is connected to the retard line and the advance side of the circuit is connected to the drain towards the oil sump.





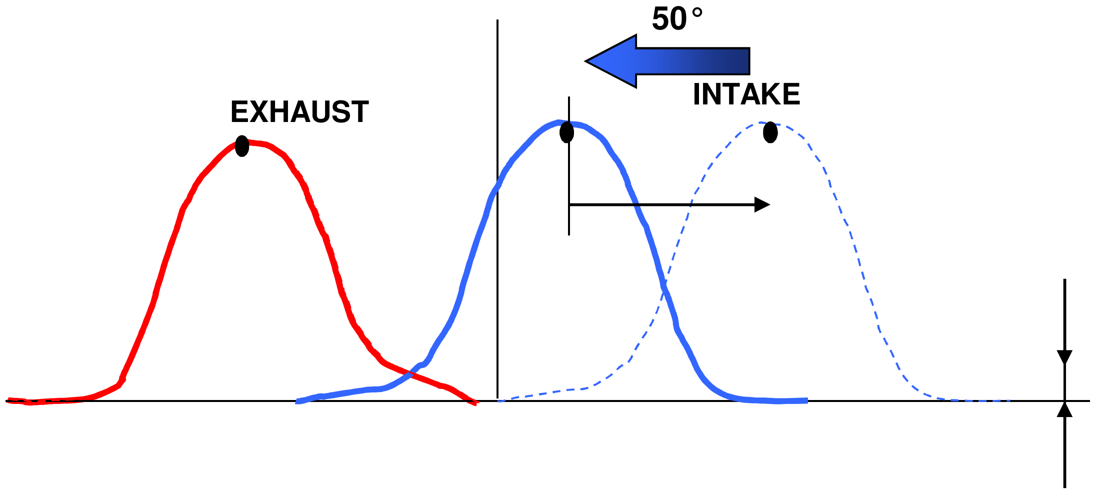
VVT solenoid valve activation signal (during idle) scope view



Note: when removing/installing the VVT-actuator, always make sure the actuator is locked in its rest position. This can be verified by means of reference marks on the actuator housing (see picture). Engine timing procedure can only be performed correctly when the VVT-actuators are in their rest position.

The timing of the intake camshafts can be modified continuously between maximum retarded and maximum advanced position. The VVT-actuator has an operating range of 25 degrees, corresponding to 50 crankshaft degrees.

- **VVT-actuator in rest position (retarded):**
  intake valves open at **15° atdc** (corresponding to 0,6mm valve lift)
- **VVT-actuator fully operated (advanced):**
  intake valves open at **35° btdc** (corresponding to 0,6mm valve lift)



Engine idling: intake timing is retarded. Late opening of the intake valves minimizes valve overlap. This guarantees stable combustion and smooth idling.

Low and middle revs, medium to high load: intake timing is advanced. Early opening of the intake valves creates high valve overlap. Exhaust gasses are partially re-burned which lowers combustion temperature and reduces emissions of NOx. Early closing of the intake valves at low revs improves volumetric efficiency.

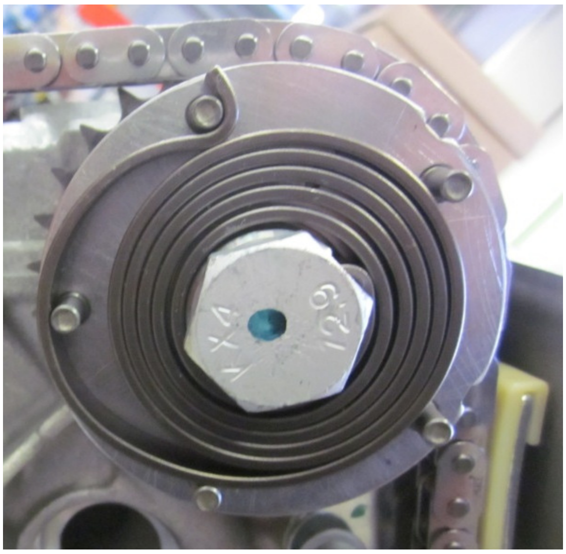
High revs, full load: intake timing is retarded. Late closing of the intake valves improves volumetric efficiency as a result of the high inertia of the incoming air.

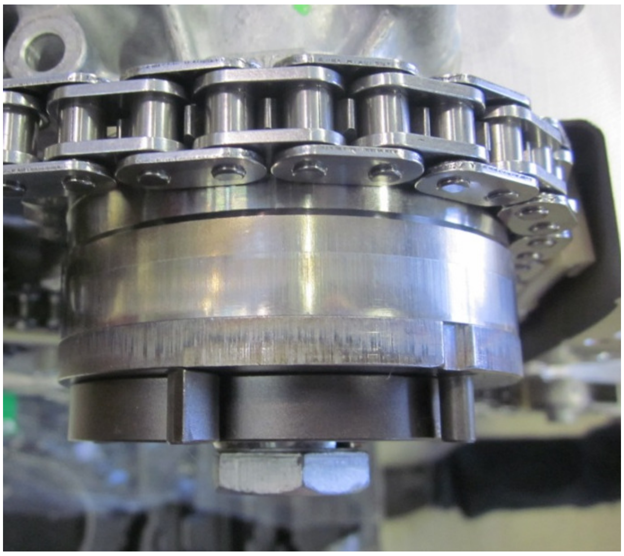
Note: when switching off the engine, the solenoid valve is brought back to the retarded position, this to make sure the VVT-actuator returns to its rest position, against the force of the internal spring.

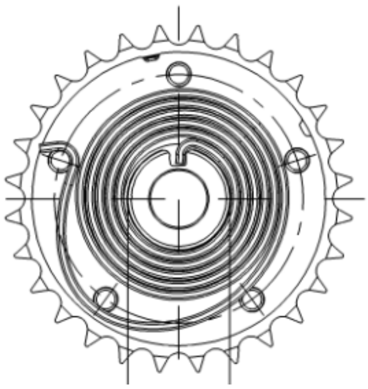
4.7L engines combined with automatic transmission (F136YG /YH /YI) use a timing variator with an angular stroke extended to 60 degrees. The basic intake timing on these engines is retarded with 10° (25° atdc instead of 15° atdc). The operating principle remains unchanged with respect to the 50° VVT-actuators.

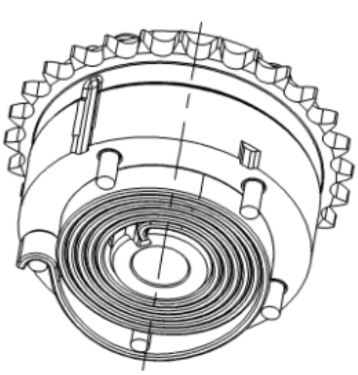
New "INA" type VVT-actuators (from engine number 150070)

All Maserati engines from engine number 150070 onwards (production starting from September 2010) use a new type of VVT-actuator manufactured by INA.
These new type of actuators can easily be recognised by the assisting spring which is fitted externally. The operating principle as well as the timing values of the different engines remain unaltered.







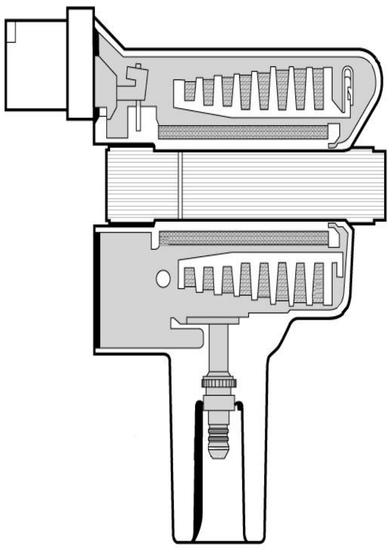


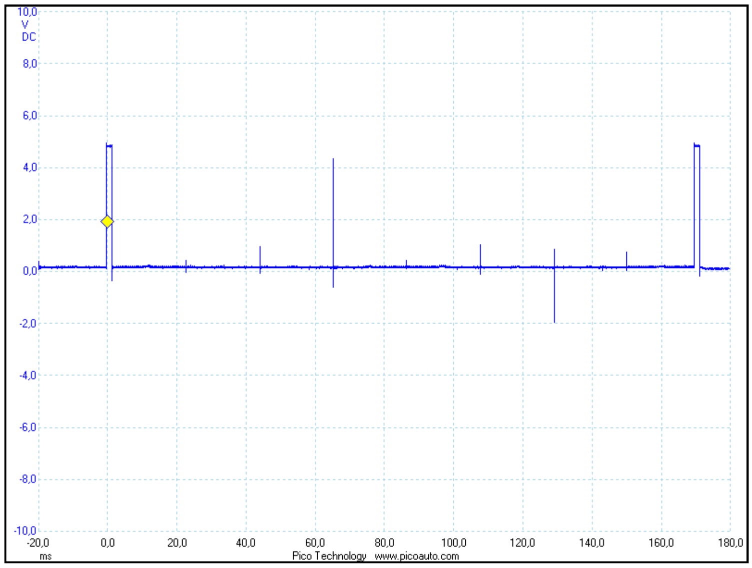
The tightening procedure of the fixing bolt of the INA type actuator is as follows:

1. **Lubricate the thread of the bolt with engine oil.**
2. **Tighten with 50Nm torque followed by an angle of 70°.**

Ignition coil

The ignition coil is of the magnetic closed circuit type. The windings are housed in a plastic casing immersed in epoxy resin and positioned one on top of the other around a central ferrous core.





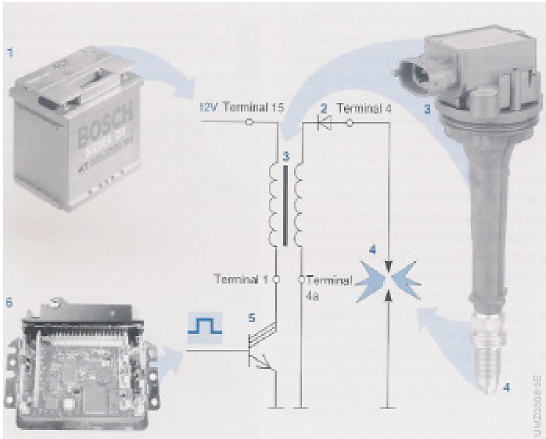
Ignition coil activation signal scope view

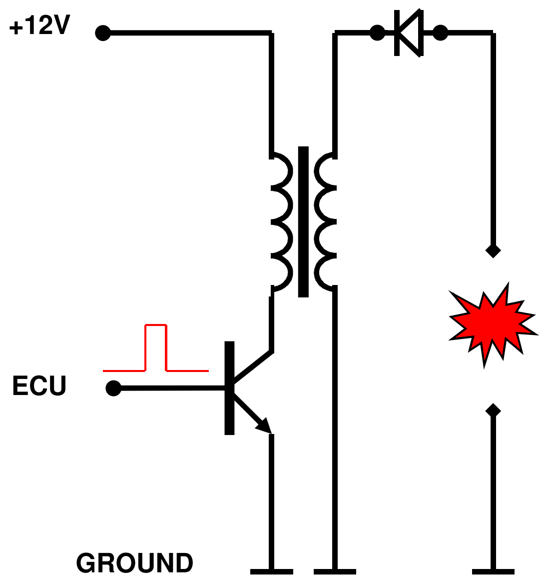
The Motronic activates the power stage (thanks to a series of transistors) on the coil for the necessary charge time to bring the primary winding current to its maximum value. The energy stored in the coil is proportional to the charge time.
At the time of ignition (which corresponds to the required advance) the power stage interrupts the flow of current on the primary winding. At this point the significant change in the magnetic field generates a voltage on the secondary winding. When this voltage is applied to the spark plug it results in the generation of a spark.

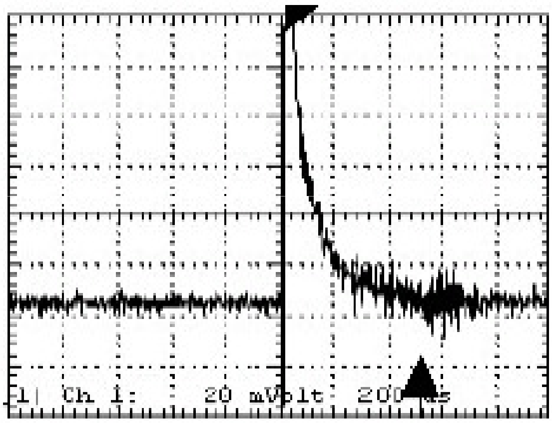
Technical data:

- Power supply: 12V
- Primary winding current: 7 A
- Charge control: 5V
- Dwell time: 2.8 ms
- Secondary winding voltage: 30 kV
- Energy: 33-37 Mj
- Primary winding resistance: 0,73 Ohm (internally)
- Secondary winding resistance: 9,6 kOhm (internally)

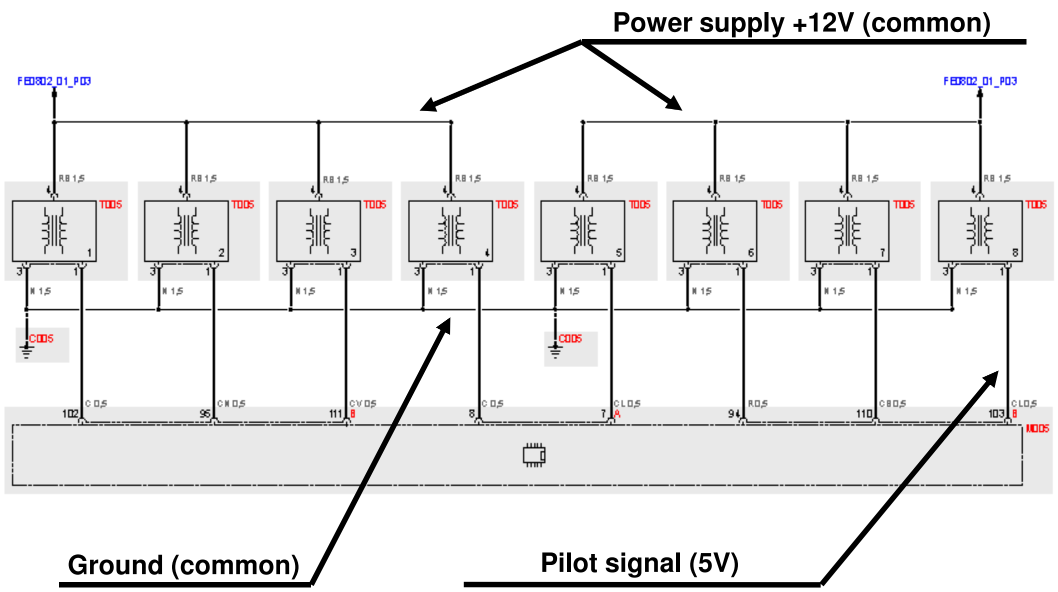
The ignition coil is made up of two coupled windings. The generation of a voltage peak in the primary winding, trigged by the ECU, generates an overvoltage peak and the transit of current on the secondary winding (which is discharged through the spark plug).







Spark plug Voltage



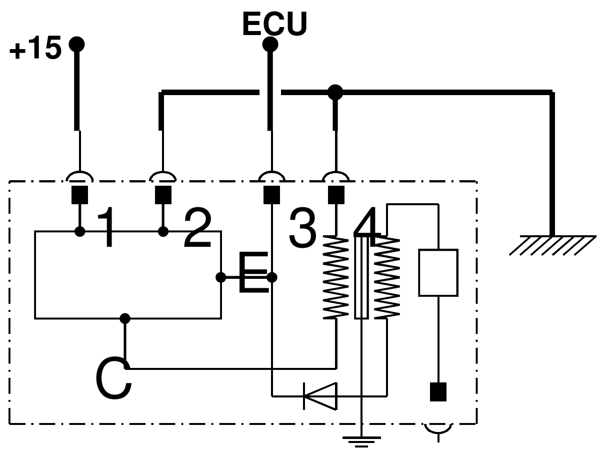
"Eldor" ignition coils

Application of the new Eldor type coil was introduced:

- From assembly 24275 for the Quattroporte
- All GranTurismo cars

Benefits of the Eldor coil:

- Simplification of fixing on the cylinder head covers.
- Provision to accommodate future developments for knock and misfiring diagnostics.
- More stable combustion at high revs.

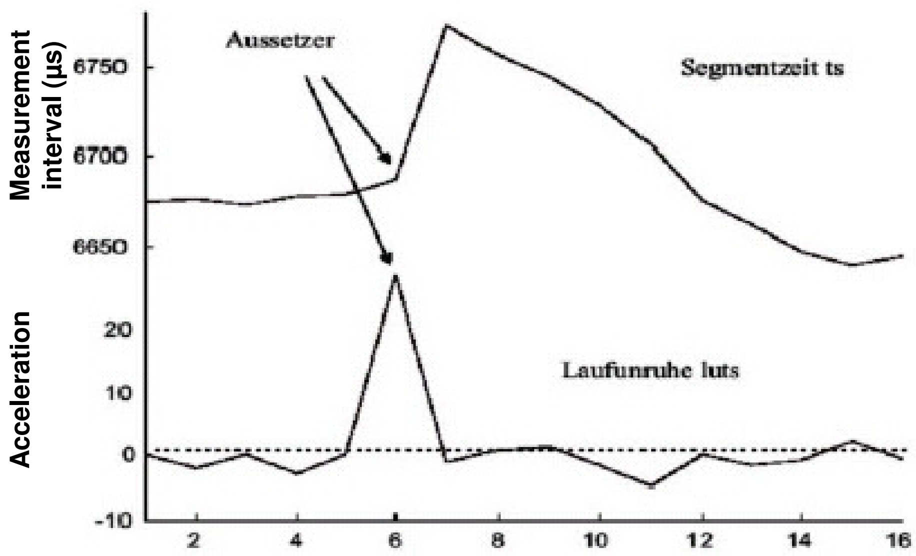


Pin 3 = 5V control signal from ECU

The Eldor coil requires a specific spark plug. This results also in a modification of the cylinder head for all engines equipped with Eldor coils. Always check the correct match when replacing spark plugs.

Misfiring

- In compliance with OBD-II / EOBD standards it is obligatory to detect the absence of combustion.
- For this reason a monitoring strategy has been developed that allows the ECU to detect and identify misfires.
- A misfire causes fluctuations of the crankshaft rotation speed that are read by the RPM sensor.
- For misfiring control, changes in crankshaft rotation speed are monitored when the engine is running smoothly.
- Aware of the position of each piston - by means of the timing sensor - it is possible to connect a low peak in rotation speed to a given cylinder.
- A misfire error code is saved in the memory when a critical number of misfires are detected in a given time interval.
- DTC P0300 indicates unspecified or multiple misfires.
- DTC P0301-P0308 indicates misfires by cylinder from 1 to 8.
- The misfiring control strategy is active only when the NCM has completed its self-learning procedure.
- A specific strategy prevents fuel starvation from being interpreted as misfiring.



Exhaust gas monitoring upstream from catalytic converter:

Misfiring causes:
- Reduction of CO_2
- Radical increase in HC
- Increase in CO
- Temperature reduction

Misfiring can seriously damage the catalytic converters!

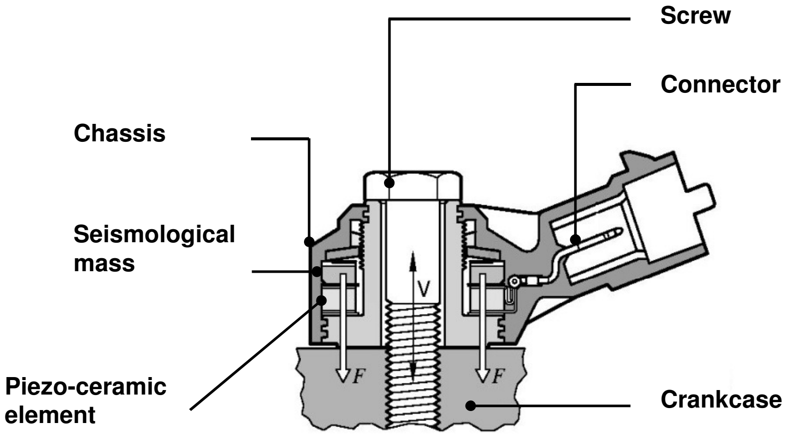
Knock control

Knocking, or detonation, is caused by an uncontrolled, fast combustion as the result of the auto-ignition of non-burning fuel in a certain part of the combustion chamber. This combustion is charactarised by significant local pressure gradients causing the typical "knocking" phenomena. Knock can cause severe mechanical engine damage.

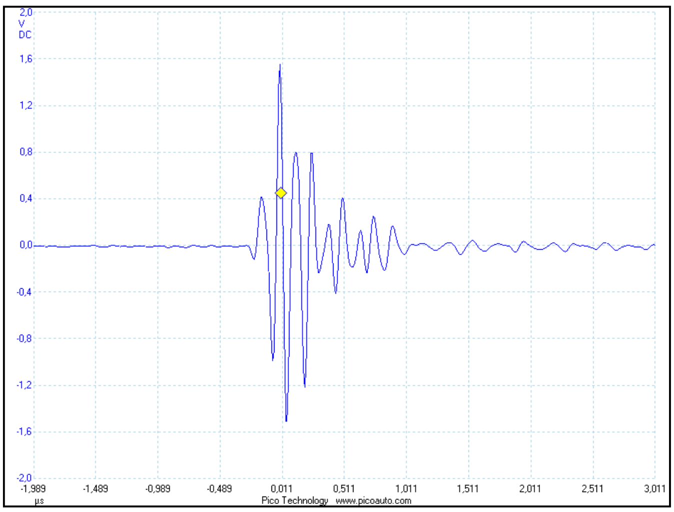
This problem can be solved by retarded the ignition timing, i.e. reducing the spark advance.

The Motronic control unit (NCM) detects detonation in individual cylinders thanks to 4 piezoelectric sensors that generate an electrical current in function of the pressure gradients in the cylinder. The signal is subsequently analysed, filtered, integrated and converted.

Subsequently the advance on the cylinder subject to knocking is retarded and then returned gradually.



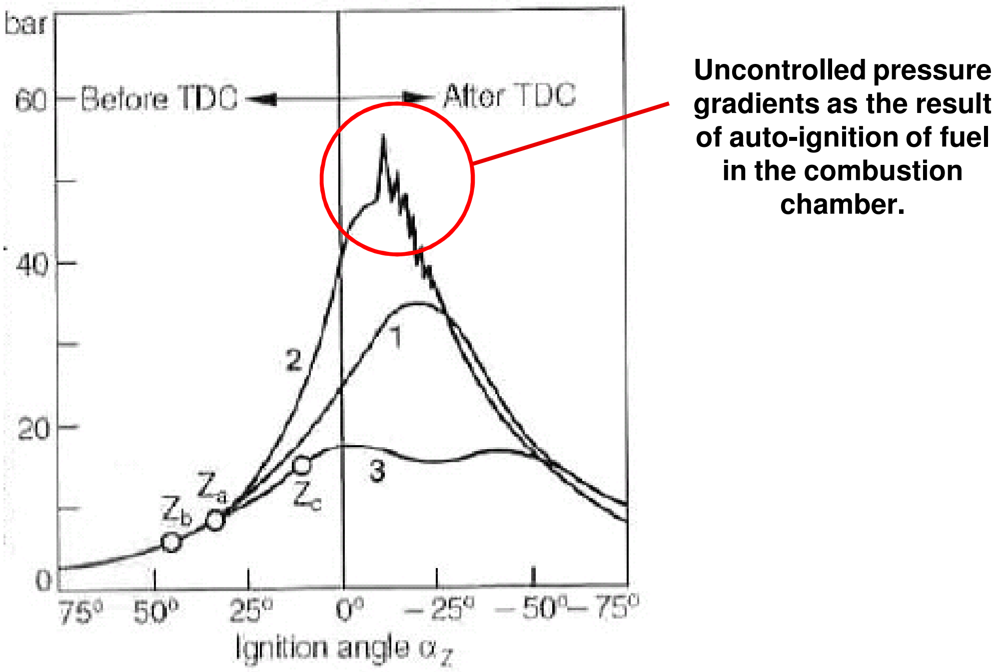
V = Vibration
F = Compression forces



Knock sensor signal scope view

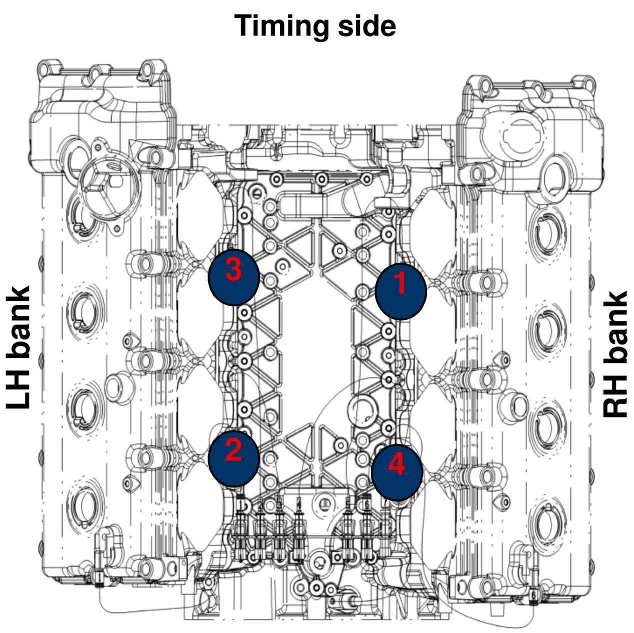
Note: The NCM enables the electronic knock control strategy when the engine temperature reaches 40℃ and the engine load is more than 30%.

Curves showing effective pressure in the combustion chamber in relation to the ignition angle:



Za: correct advance (curve 1)
Zb: excess advance can cause knocking in the cylinder (curve 2)
Zc: insufficient advance greatly reduces cylinder compression (curve 3)

Layout of sensors on crankcase:



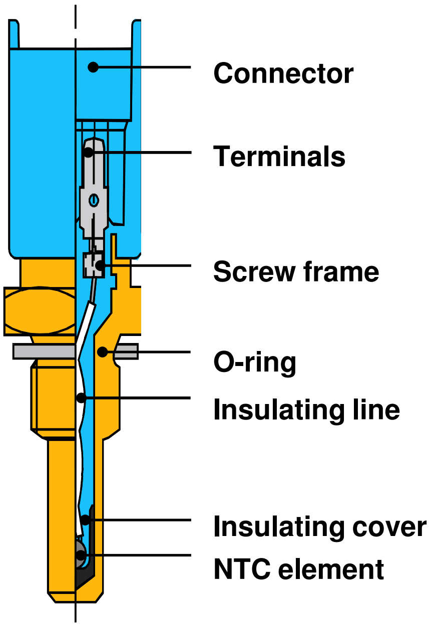
Sensors positioning

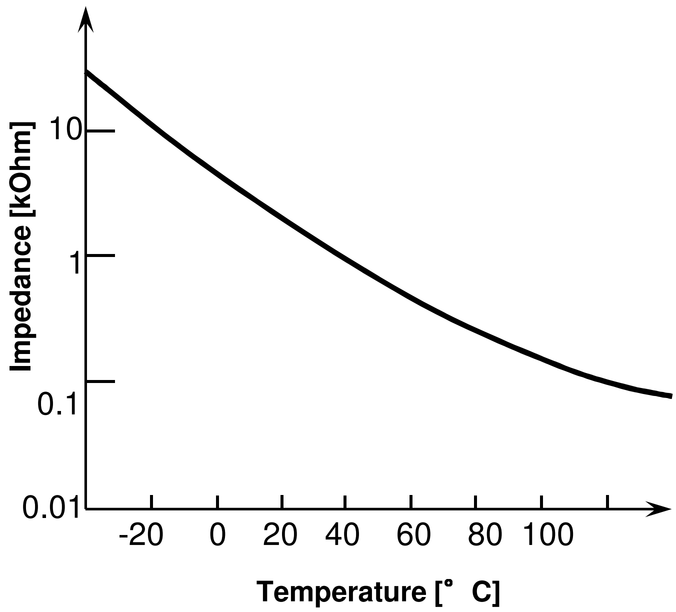
1 Cylinders 1 - 2
2 Cylinders 5 - 6
3 Cylinders 7 - 8
4 Cylinders 3 - 4

For correct operation of the knocking sensors it is important that assembly be performed in compliance with the correct tightening procedure.

Coolant temperature sensor

Negative Temperature Coefficient (NTC) type temperature sensors form part of a voltage division circuit integrated in the NCM and connected to a 5V power supply. The sensor voltage varies in proportion with impedance and provides temperature information to the NCM. A strategy integrated in the NCM filters linearity errors between the temperature and the impedance.



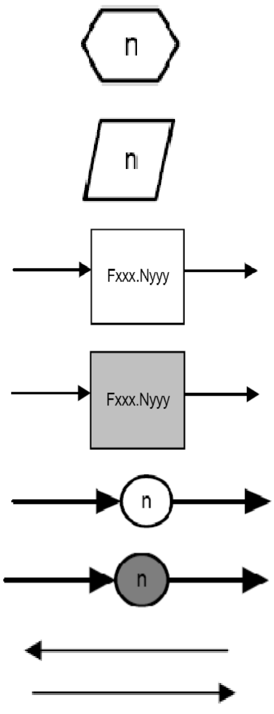


Impedance at 20 °C: 2.5 kOhm
Impedance at 100 °C: 0.186 kOhm

Maserati engines use two engine coolant temperature sensors: upstream from the thermostatic valve and on the radiator. This layout allows the NCM to control proper operation of the thermostatic valve and carry out a plausibility check of the temperature sensors (at KEY ON with cold engine the temperature measured by the two sensors must be identical).

DTC P0128 indicates a problem of plausibility between the two sensors.

Communication flow of parameters involved in engine control.



Input/output with sensor/actuator included

Input/output with sensor/actuator not included

B-CAN node

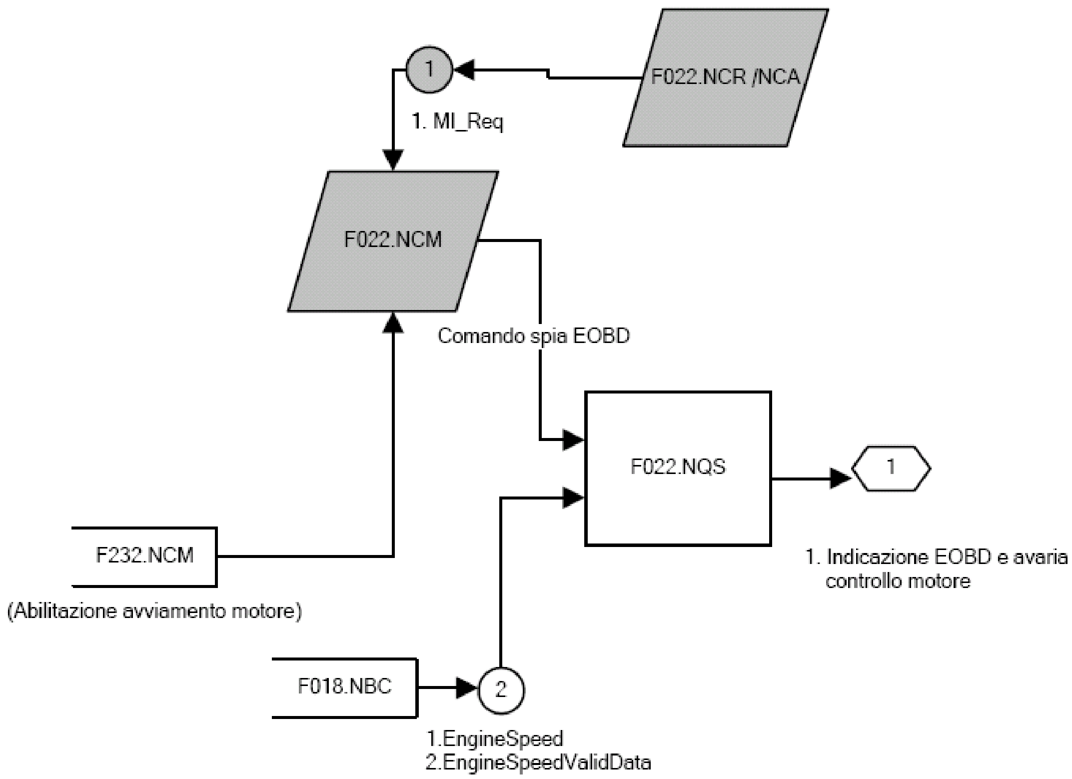
C-CAN node

B-CAN signal (n = number of data units)

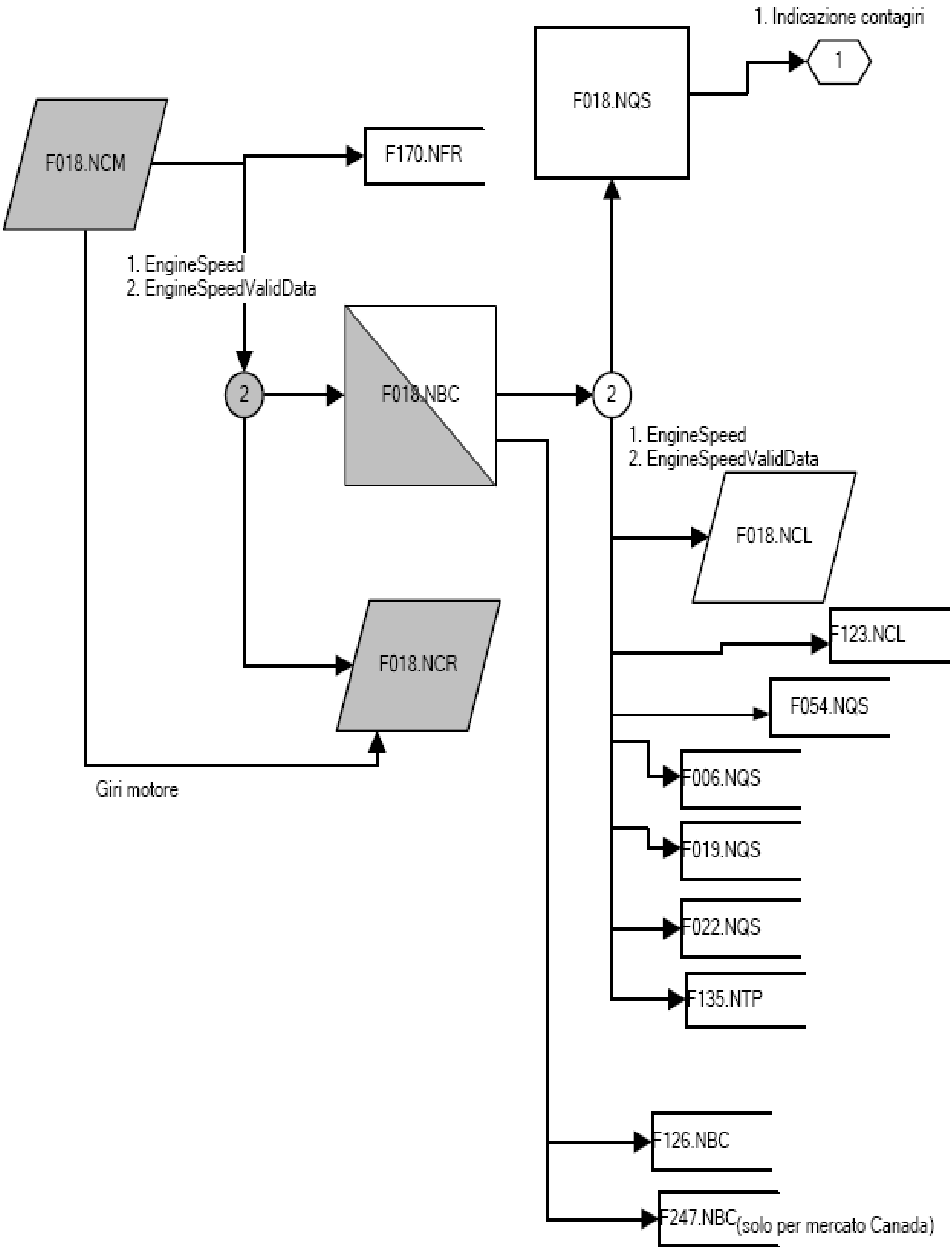
C-CAN signal (n = number of data units)

Non-CAN signal (hard wire)

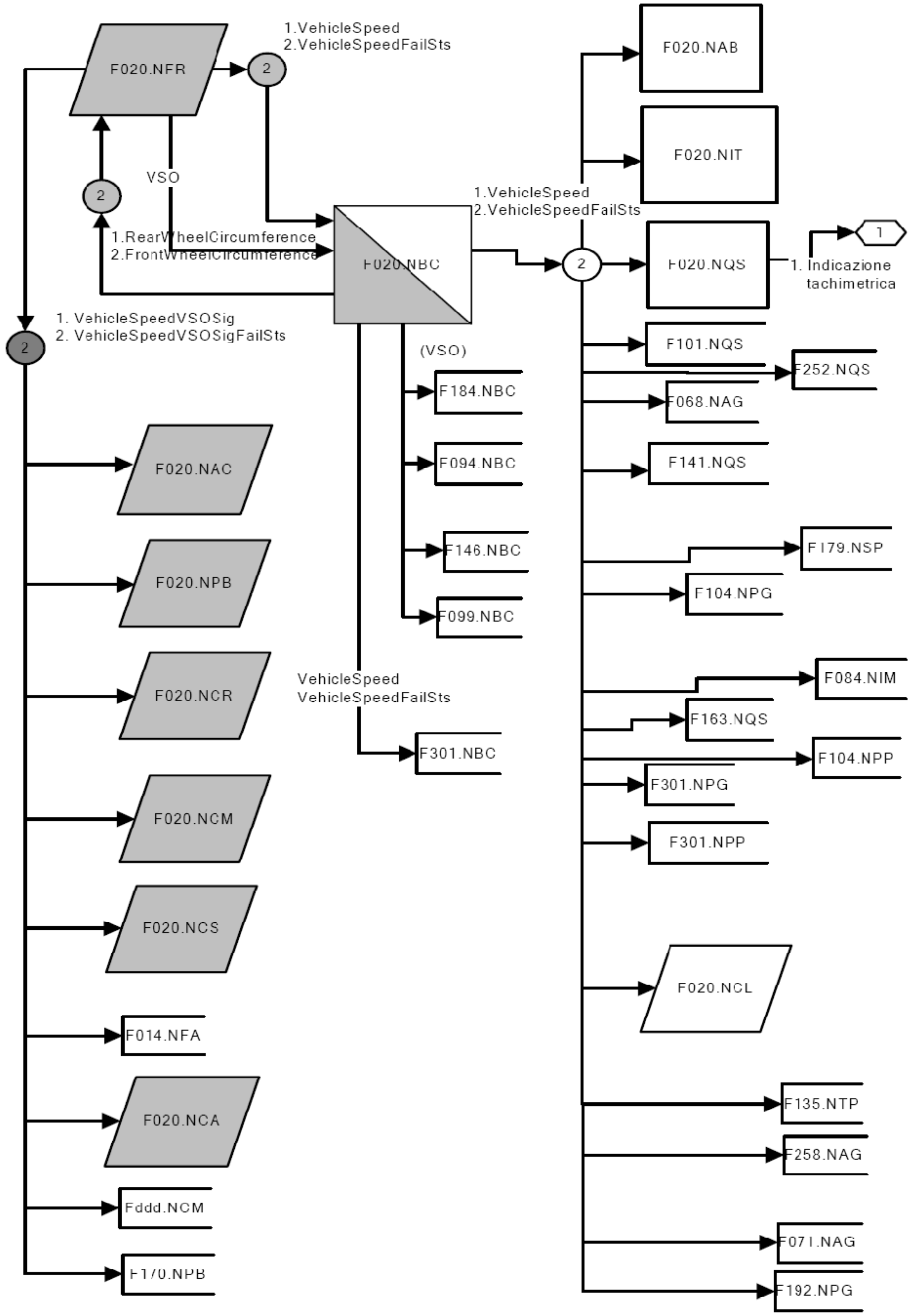
Engine warning light (MIL) activation signal:



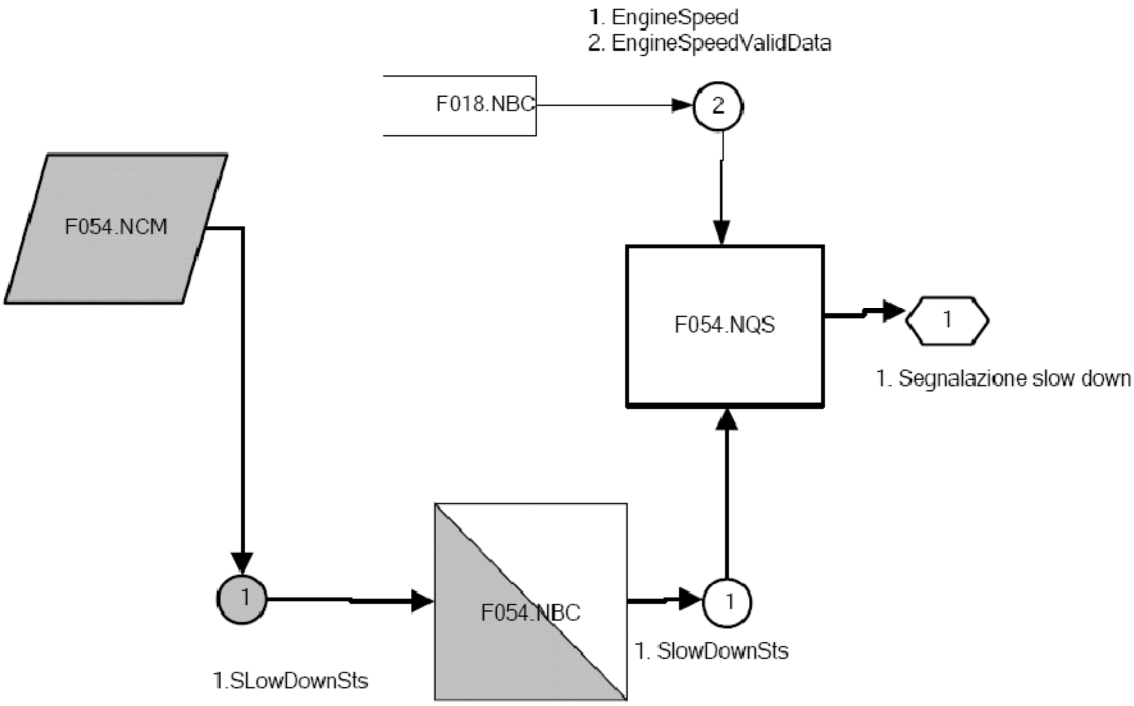
Engine rpm signal:



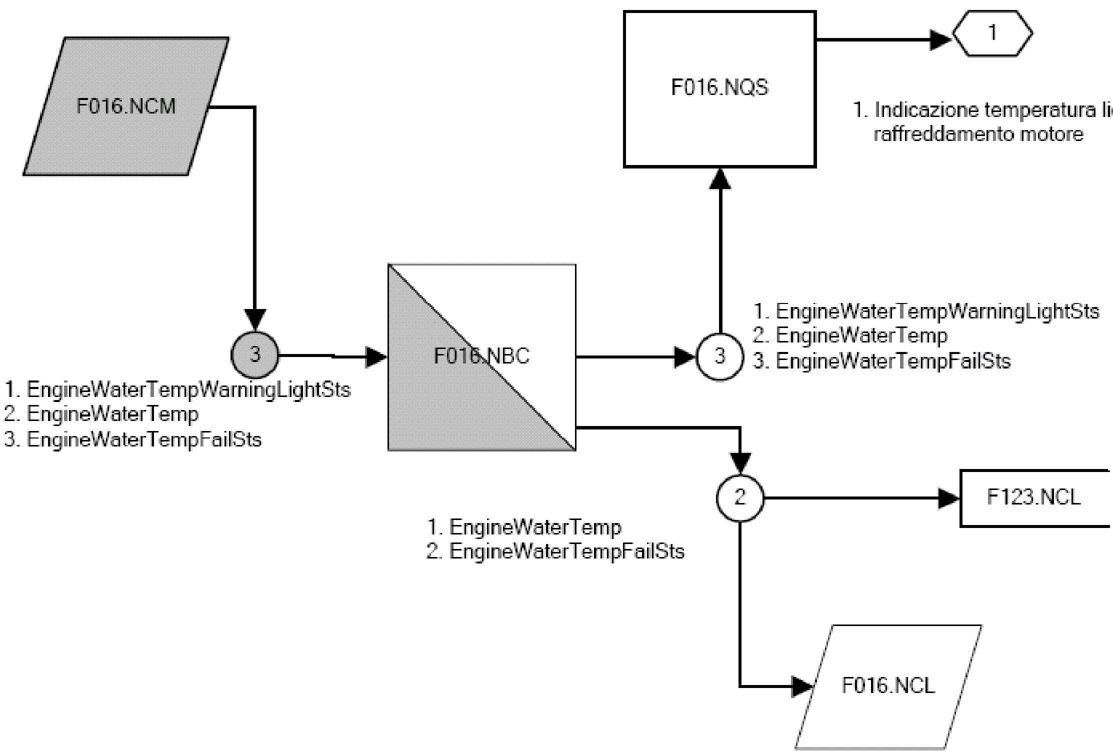
Vehicle speed signal:



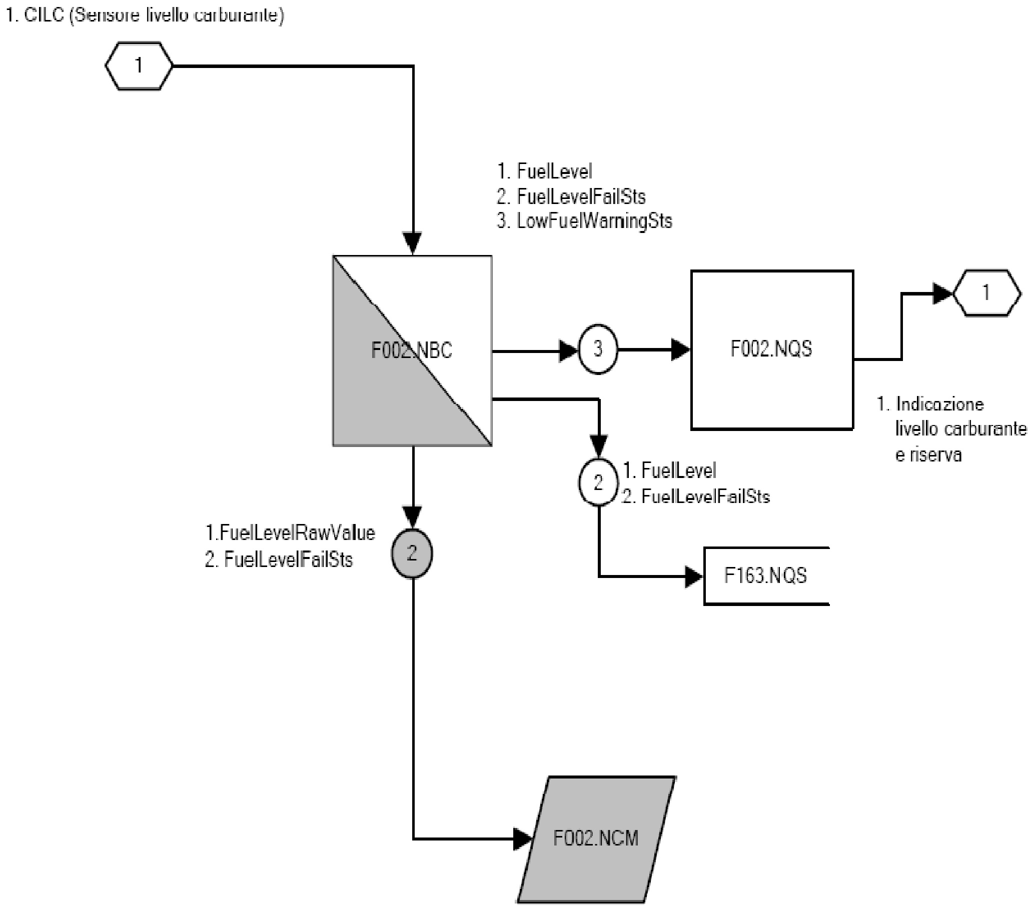
"Slow Down" warning light activation signal:



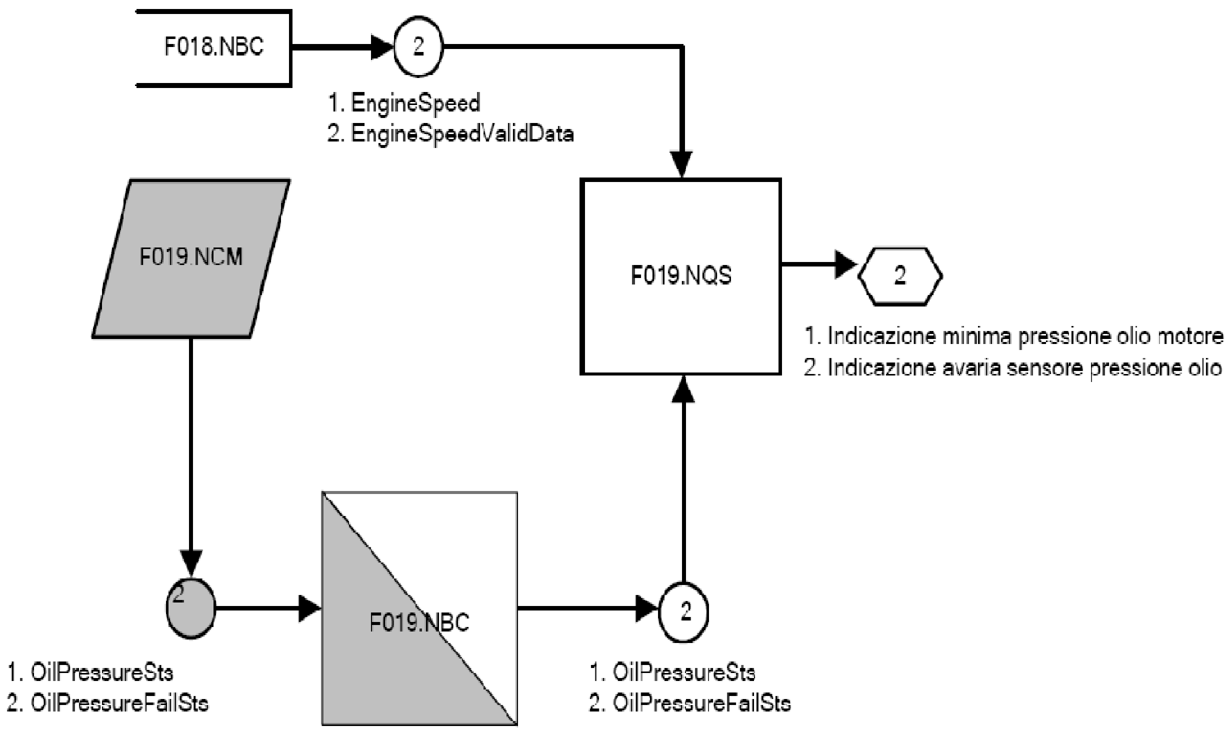
Engine coolant temperature signal:



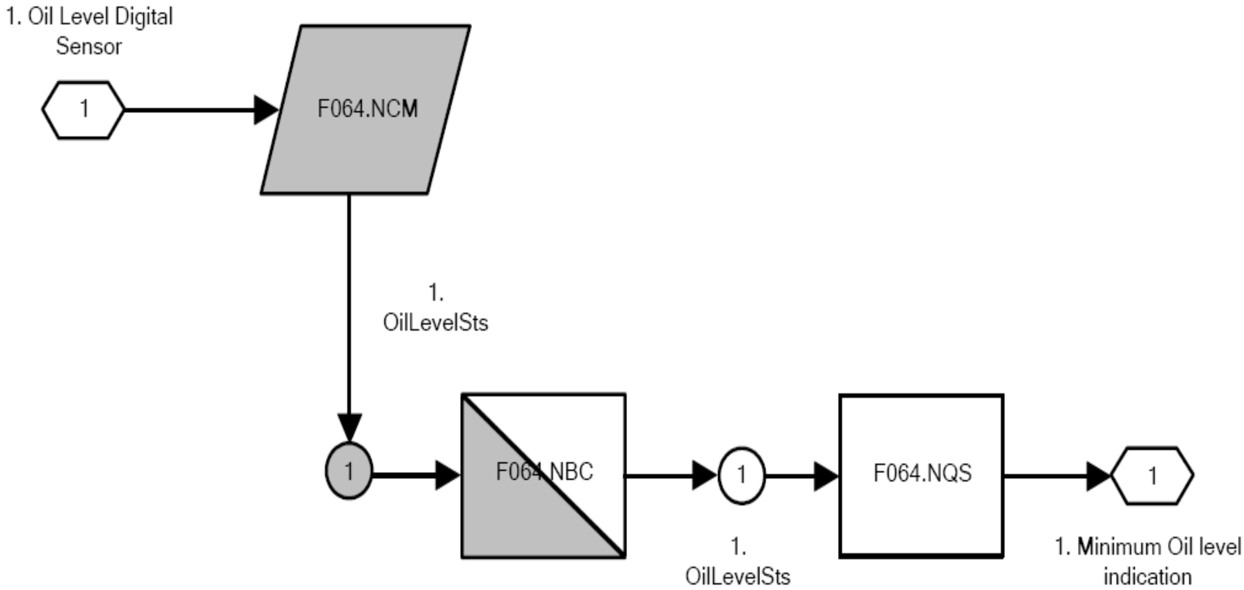
Fuel level signal:



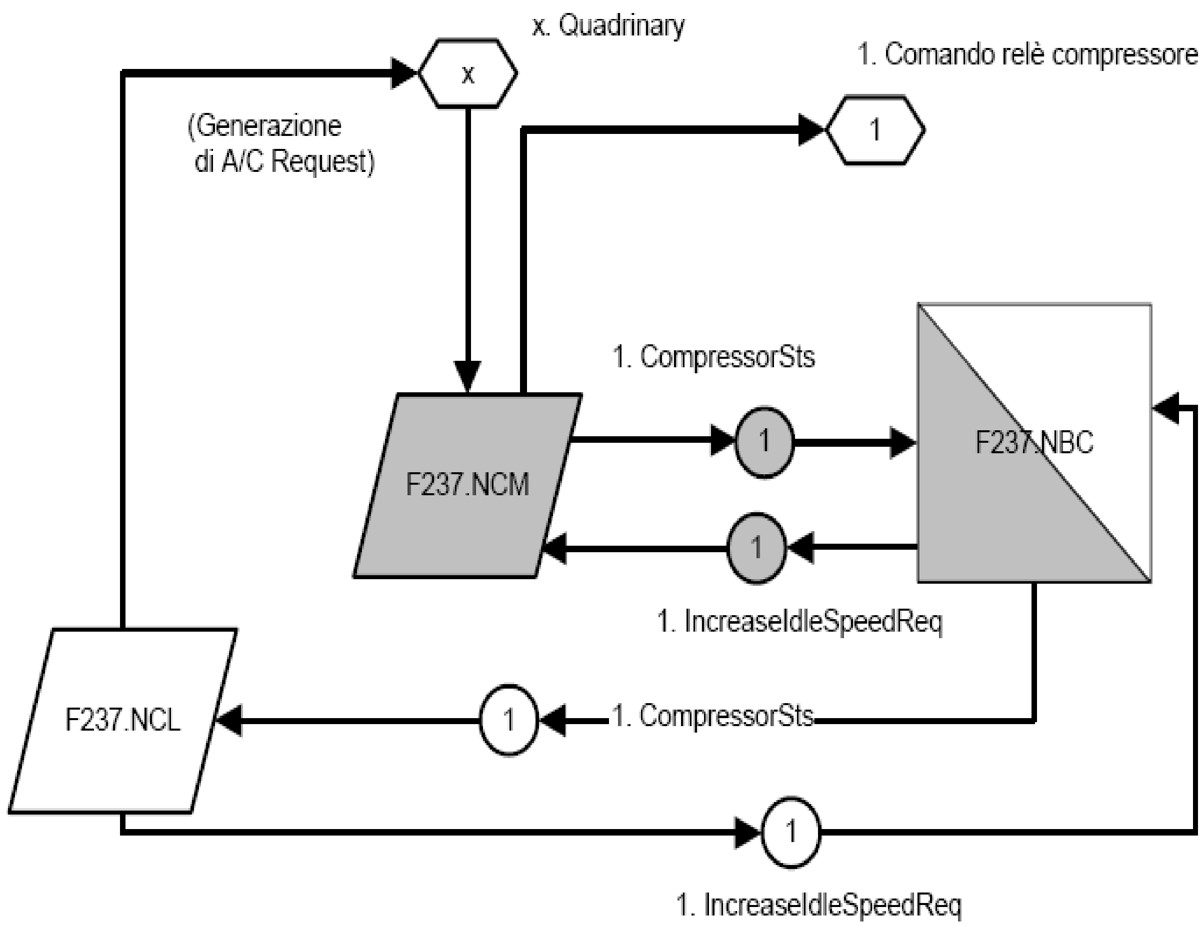
Engine oil minimum pressure signal:



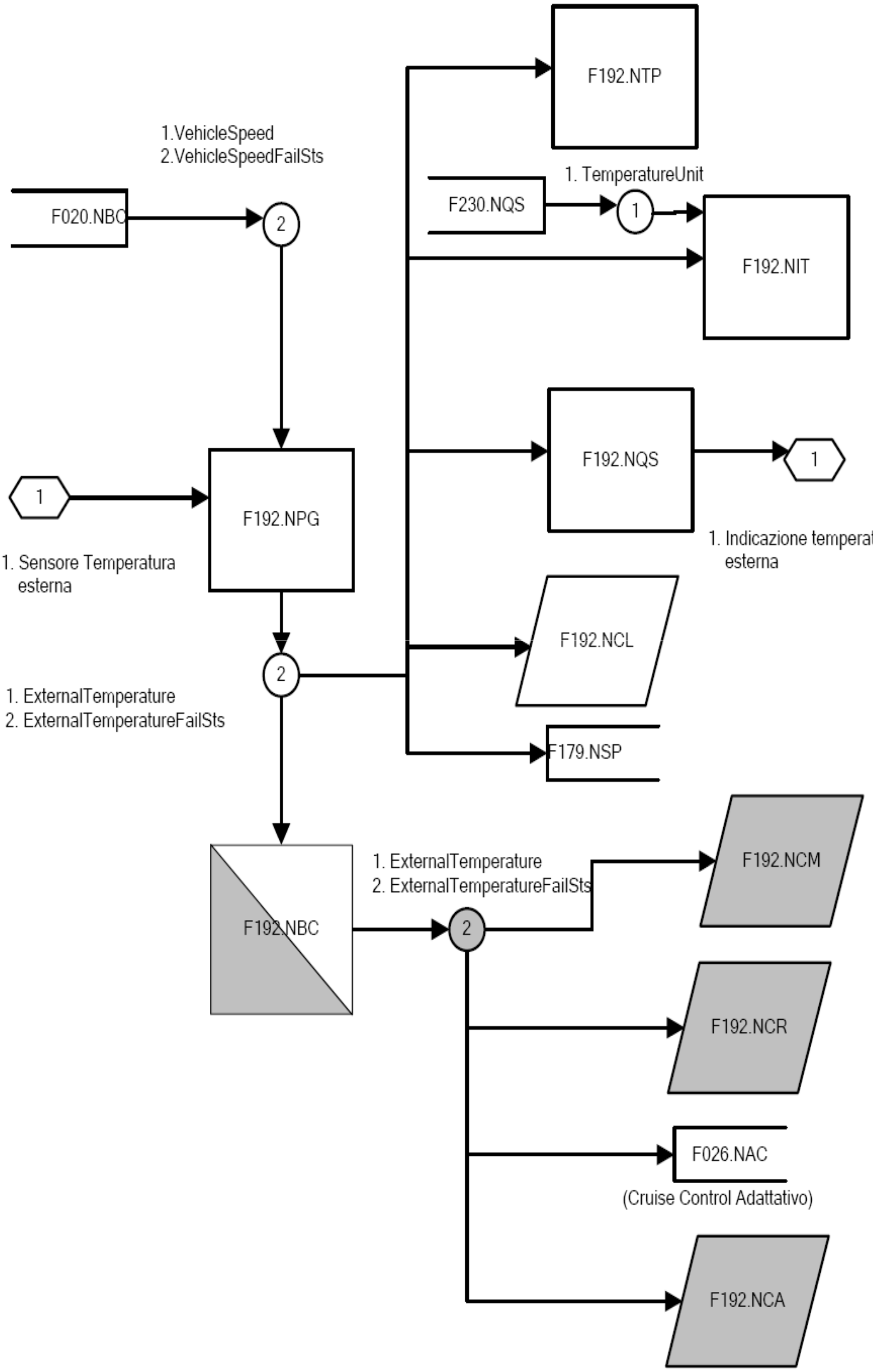
Engine oil minimum level signal:



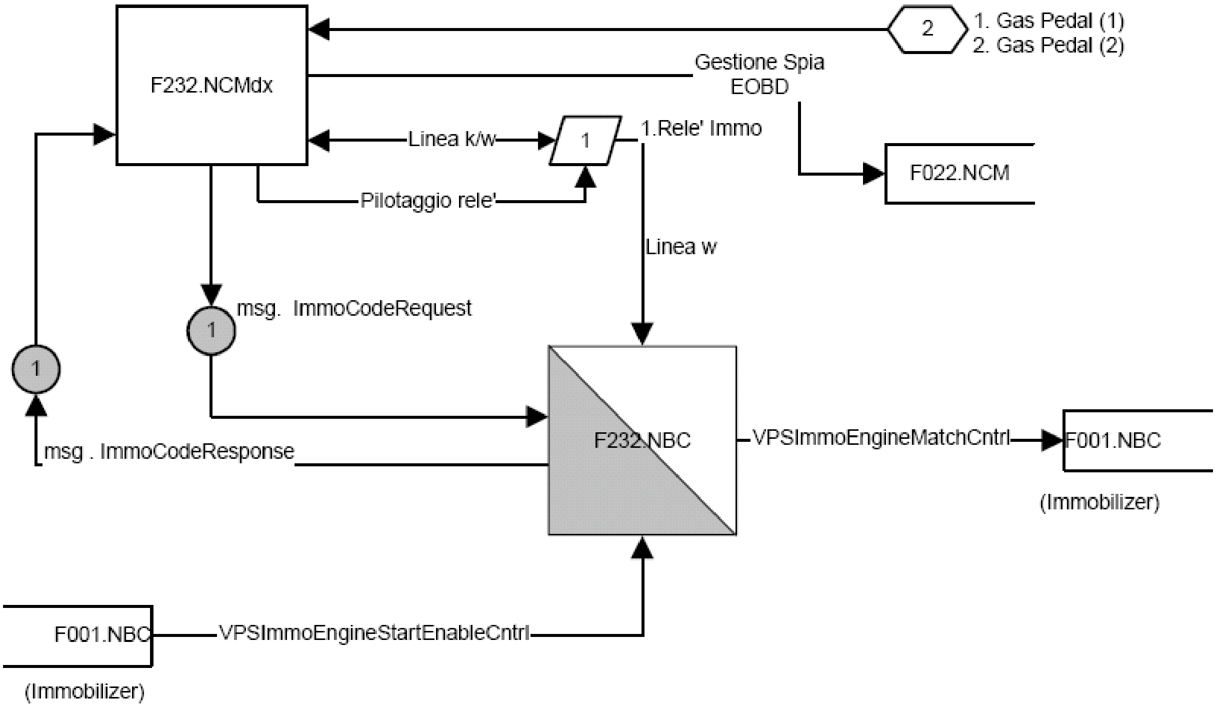
A/C compressor activation signal:



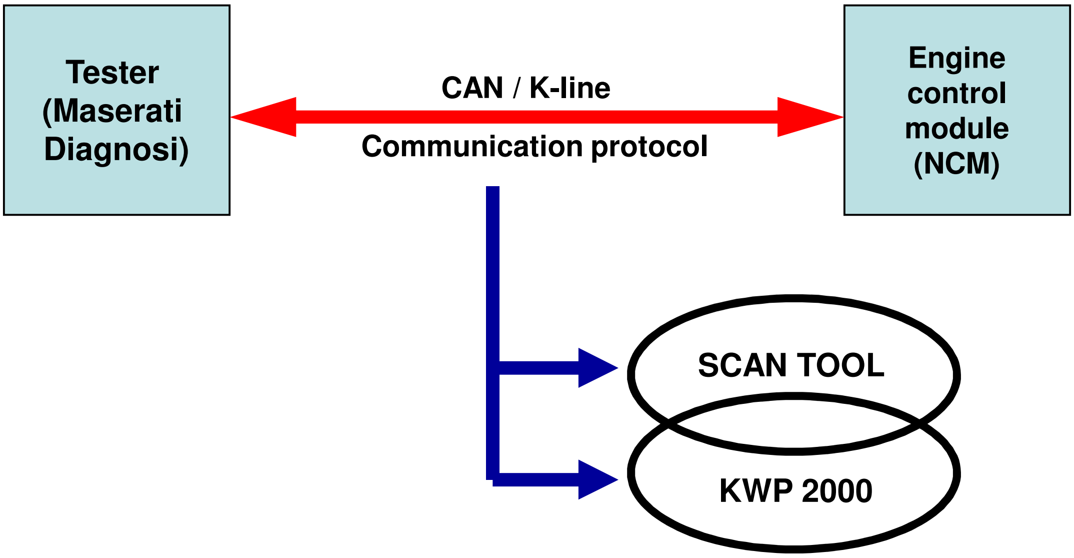
Ambient temperature signal:



Immobilizer signal:



Engine diagnostics



SCAN TOOL:
Scan Tool is the communication protocol between the tester and the ECU that describes and controls diagnostics of systems or subsystems relative to exhaust emissions. Scan Tool was a spin-off from CARB (California Air Resources Board) and EPA (Environmental Protection Agency), two US environmental protection agencies.
Subsequently Scan Tool was standardised and defined by SAE (Society of Automotive Engineers) and in an equivalent manner also by ISO (International Organisation for Standardization). The relative standards are:
SAE J1979, SAE 2012 and ISO 15031-1/4/6.
These standards were implemented in order to standardise diagnostics in accordance with the US OBD-II (On Board Diagnostics II) standard and the European derivative version EOBD (European On Board Diagnostics). As from 2008 the regulations will be updated with the issue of the new ISO 15765-4 standard.

KWP 2000:
For diagnostics of vehicle systems that are not necessarily associated with emissions, the automotive sector has developed a common standard: Keyword Protocol 2000. KWP 2000 is strongly anchored to the Scan Tool philosophy and the two standards are partially overlapping.
KWP 2000 is not compulsory but automakers are strongly encouraged to work in compliance with this standard as far as possible.

Diagnostic Trouble Codes (DTC)

An error indicates a malfunction of a system, subsystem or component and is detected and saved by means of the diagnostic function.
The driver is alerted to the error by illumination of the MIL warning light only when the malfunction of the subsystem or component may result in worsening of pollutant emissions. Specifically, the warning light is illuminated after 2 (OBD-II) or 3 (EOBD) times in which the error is detected.
There are two types of error code: ISO / SEA controlled codes and manufacturer controlled codes:

ISO / SAE controlled codes:
These error codes are those in relation to which the automotive industry has established uniformity, so they are identical for all automakers. Standardisation was imposed by ISO / SAE and specified in the various standards. OBD-II / EOBD standards use ISO / SAE controlled codes for diagnostics of emission-related systems.

Specific manufacture controlled codes:
The standard provides a sequence of codes that are placed at the disposal of individual manufacturers. This means that the manufacturer is free to assign the meaning it chooses to these codes. This may be necessary because of the differences between the systems or implementations of each individual automaker. Manufacturers are anyway encouraged to follow the same subdivisions as for the ISO / SAE controlled codes.

Error codes (standard acronym: DTC) are divided into four groups:

PXXXX (Powertrain):	Errors relative to the engine and powertrain
BXXXX (Body):	Errors related to the vehicle body
CXXXX (Chassis):	Errors related to the vehicle chassis
UXXXX (Undefined):	Errors related to the communication network

Each group contains ISO / SAE controlled codes and codes freely assignable by the manufacturer.

Note: with regard to the technical terminology utilised to describe each error code (DTC), manufacturers are obliged to adhere to terminology in compliance with standard SAE J1930.

When diagnostics is completed a flag is set, and in the event of an error also the error flag is set. Diagnostics can be:

- **continuous** (e.g. misfiring, fuel self-learning)
- **discrete** (e.g. thermostat diagnostics). performed once per driving cycle.

Diagnostic Trouble Code Classes:

DTCs are divided into various classes. The class indicates: whether the error illuminates the MIL warning light, after how long the error is acknowledged or not acknowledged, whether the error must be saved in the memory, the validation and de-validation time of the MIL warning light, whether the error calls for storage of Freeze Frame Data,...

DTC status

The DTC status can be "Pending" or "confirmed":

- **Pending:** a pending DTC is defined as the DTC stored after the initial detection of the problem (e.g. after a single driving cycle), prior to illumination of the MIL warning light and in compliance with the various standards.
- **Confirmed:** defined as the DTC stored when OBD-II / EOBD has confirmed the existence of the problem. The MIL warning light illuminates in compliance with the various standards.

Deleting a confirmed DTC:
The OBD-II system can auto-delete a DTC if the indicated fault has not been detected during at least 40 warm-up cycles.

Diagnostic Readiness Status:
In compliance with SAE J1979, the OBD-II system indicates a "Complete" or "Incomplete" status for diagnostics of each component or subsystem that is monitored and after the errors memory has been cleared for the last time.
All constantly monitored components or systems must always indicate "complete".
All components or systems that are not monitored continuously (discrete diagnostics) must immediately indicate "complete" when the diagnostic of the component or system in question has been fully executed and no faults have been detected.

Freeze Frame Data

- When an error (DTC) connected to emissions is saved in the memory, the OBD-II / EOBD system provides also a "Freeze Frame Data".
- Freeze Frame Data provides information concerning the conditions relative to the moment in which the DTC was detected.
- The saved parameters are as follows: DTC, engine RPM, air flow rate, engine load, Fuel Trim, engine coolant temperature, pressure in the plenum chamber, loop status (open/closed), vehicle speed.
- This is valuable information for diagnostic purposes that is lost as soon as the DTC is deleted!

What does a Diagnostic Trouble Code mean?

A DTC tells us something about the condition of an electrical signal monitored by a control unit. Clearly the OBD-II / EOBD system is only able to detect electrical problems rather than mechanical problems. In many cases however also mechanical problems can be detected inasmuch as they exert an influence on certain electrical parameters.
Example: OBD-II / EOBD is not capable of detecting a jammed throttle because there is no DTC for "jammed throttle". However this mechanical problem causes a related electrical problem: the throttle position sensor signal will no longer correspond with the ECU control signal for the motor-driven throttle. The saved DTC indicates: throttle position sensor - signal not plausible.
At this point the diagnostic engineer can conclude that the problem with the sensor may be caused by a jammed throttle.

There are 4 error code categories:

Minimum:
If the measured or calculated value is below a minimum threshold, for example a sensor signal is below 0.5V (one possible cause may be a ground fault), or the value of a self-learning procedure that arrives at the minimum value.

Maximum:
The measured or calculated value is above a maximum threshold; this may be an electrical problem (short circuit to power supply) although not necessarily; it may also be a counter value that exceeds a critical threshold level. Example: The DTC that indicates a misfire in a given cylinder is not saved after the first misfire, but only when a certain number of misfires are detected in a given time period.

Signal:
The signal is absent continuously or intermittently: one cause could be an open circuit or bad contact on the connector.

Plausibility:
The ECU measures a signal that is in its normal band, but the value does not correspond to the expected value (according to information received from another sensor or according to a mathematical model). The ECU reads a value and checks it. The ECU concludes that in the given conditions the measured value cannot be correct. Example: the air flow meter signal does not correspond with expectations on the basis of the opening of the throttle and the engine RPM. The cause may be that the air flow meter is contaminated.

For diagnostics of a component or subsystem, only one code of these four categories can be saved at a time.

Various DTC subgroups:

P0XXX: SAE / ISO controlled

P00XX:	Fuel and air measurement and auxiliary emissions control
P01XX:	Fuel and air measurement
P02XX:	Fuel and air measurement
P03XX:	Ignition or misfire system
P04XX:	Auxiliary emissions control
P05XX:	Vehicle road speed, idle speed and various inputs control
P06XX:	ECU and various inputs
P07XX:	Transmission
P08XX:	Transmission
P09XX:	Transmission
P0AXX:	Hybrid propulsion
P0BXX:	ISO / SAE reserved
P0CXX:	ISO / SAE reserved
P0DXX:	ISO / SAE reserved
P0EXX:	ISO / SAE reserved
P0FXX:	ISO / SAE reserved

P1XXX: Manufacturer controlled

P10XX:	Fuel and air measurement and auxiliary emissions control
P11XX:	Fuel and air measurement
P12XX:	Fuel and air measurement
P13XX:	Ignition or misfire system
P14XX:	Auxiliary emissions control
P15XX:	Vehicle road speed, idle speed and various inputs control
P16XX:	ECU and various inputs
P17XX:	Transmission
P18XX:	Transmission
P19XX:	Transmission

P2XXX: SAE / ISO controlled

P20XX:	Fuel and air measurement and auxiliary emissions control
P21XX:	Fuel and air measurement and auxiliary emissions control
P22XX:	Fuel and air measurement and auxiliary emissions control
P23XX:	Ignition or misfire system
P24XX:	Auxiliary emissions control
P25XX:	Various inputs
P26XX:	ECU and various inputs
P27XX:	Transmission
P28XX:	ISO / SAE reserved
P2AXX:	Fuel and air measurement and auxiliary emissions control

P3XXX: Manufacturer controlled and ISO / SAE reserved

P30XX:	Fuel and air measurement and auxiliary emissions control
P31XX:	Fuel and air measurement and auxiliary emissions control
P32XX:	Fuel and air measurement and auxiliary emissions control
P33XX:	Ignition system or misfire
P34XX:	Deactivation of cylinders
P35XX:	ISO / SAE reserved
P36XX:	ISO / SAE reserved

Various DTC subgroups (contd.):

P37XX:	ISO / SAE reserved
P38XX:	ISO / SAE reserved
P39XX:	ISO / SAE reserved

B0XXX: ISO / SAE controlled
B1XXX: Manufacturer controlled
B2XXX: Manufacturer controlled
B3XXX: Reserved

C0XXX: ISO / SAE controlled
C1XXX: Manufacturer controlled
C2XXX: Manufacturer controlled
C3XXX: Reserved

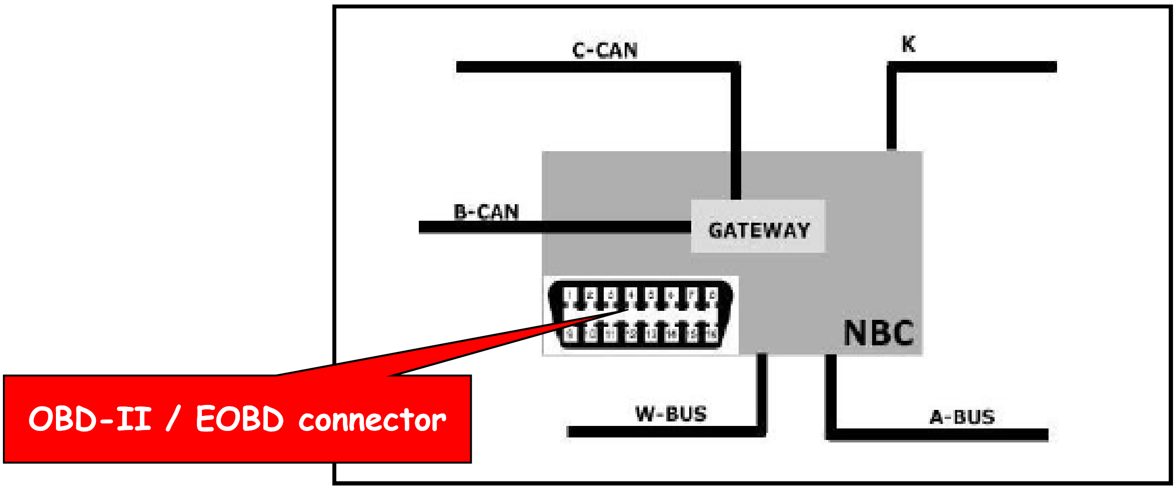
U0XXX: ISO / SAE controlled

U00XX:	Electrical network
U01XX:	Communication network
U02XX:	Communication network
U03XX:	Software network
U04XX:	Data network

U1XXX: Manufacturer controlled
U2XXX: Manufacturer controlled
U3XXX: Reserved

OBD-II / EOBD diagnostic link connector

The 16-pin diagnostic connector is standardised in accordance with OBD-II / EOBD standards (for Europe: from EURO 3 onward). The first Maserati with the 16-pin OBD-II / EOBD connector was the 3200GT of 1998. For vehicles with Florence electronic architecture (M139 and M145), the ODB-II / EOBD connector is located on the Body Computer. The diagnostic connector is the interface between the tester (Maserati Diagnosi) and the various communication networks.



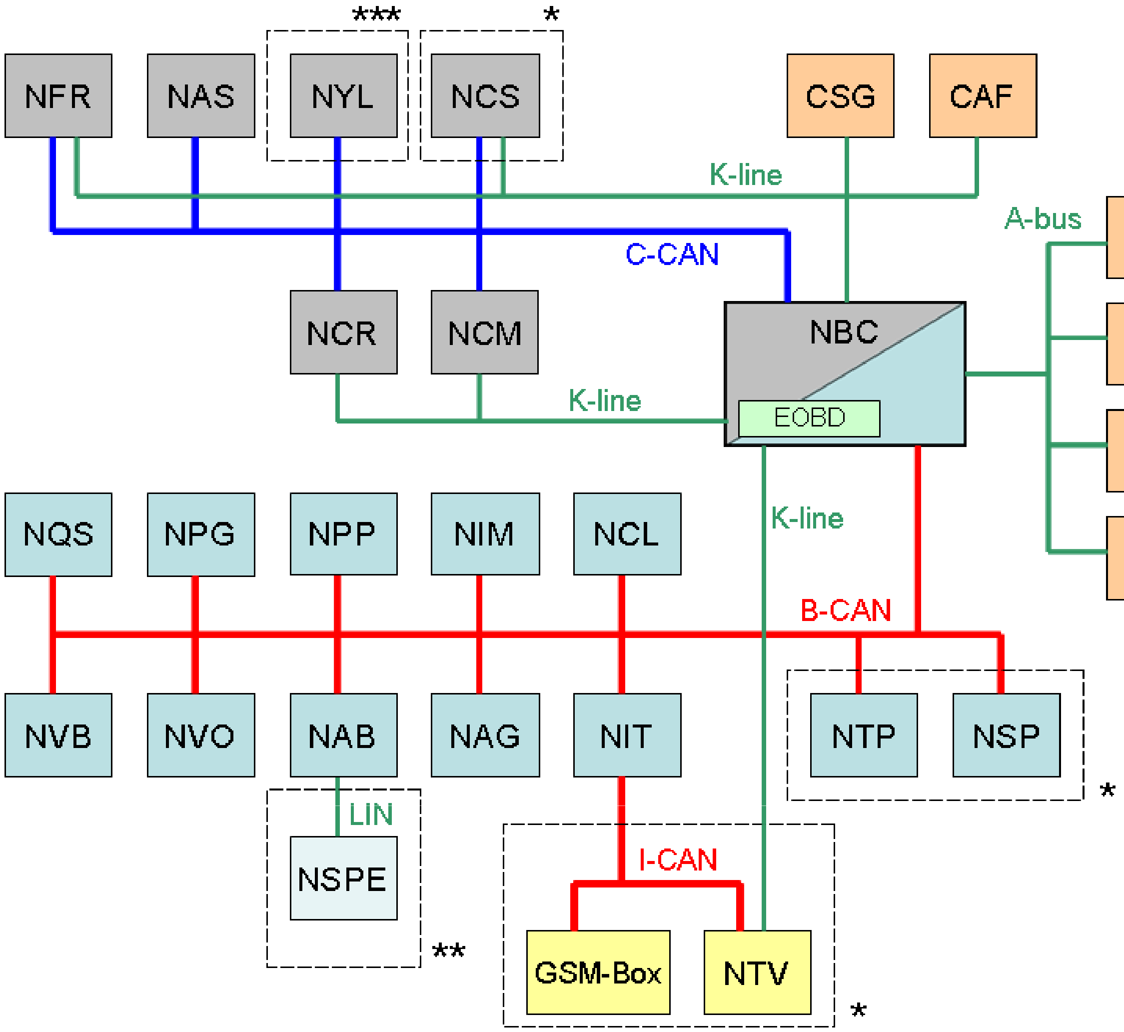
Quattroporte from MY07 and GranTurismo OBD-II / EOBD connector pinout

In compliance with ISO / SAE standards, for all cars from MY08 onward, Scan Tool must be available on the CAN line. For the Quattroporte from MY07 and for the Maserati GranTurismo, a new pinout assignment for the OBD-II / EOBD connector has been introduced (modified body computer). For diagnosing these vehicles with the SD3 tester, it is necessary to use the "Switch Matrix" diagnostic cable.

Pin	M139	M139 MY07	M145
1	N.C.	B-CAN H	B-CAN H
2	N.C.	N.C.	N.C.
3	N.C.	N.C.	N.C.
4	GND	GND	GND
5	GND	GND	GND
6	B-CAN H	C CAN-H	C CAN-H
7	K-line (NCM, NCR)	K-line (NCM (ME7), NCR)	K-line (NCM (ME7), NCR)
8	N.C.	N.C.	N.C.
9	K-line (CSG, CAF)	B-CAN L	B-CAN L
10	N.C.	N.C.	N.C.
11	N.C.	N.C.	N.C.
12	K-line (NFR, NCS)	K-line (NFR, NCS, CSG, CAF)	K-line (NFR, NCS, CSG)
13	K-line (NTV)	K- line (NTV)	not used
14	B-CAN L	C CAN-L	C CAN-L
15	N.C.	L - not used	L - not used
16	VBATT +30	VBATT +30	VBATT +30

All diagnostics for cars with Florence electronic architecture are performed with the SD3 tester or with Maserati Diagnosi!

Florence architecture (example: Quattroporte Duoselect):



The following serial communication lines can be identified:

- C-CAN (High speed CAN): initially only for data transfer between nodes and later also for diagnostics.
- B-CAN (Low speed CAN): data transfer between nodes and diagnostics.
- K-line (serial line ISO 9141): dedicated to diagnostics.
- A-bus (serial line ISO 9141): serial line for data excghange between ECU's (no diagnostics).
- LIN (serial line ISO 9141): dedicated line for data exchange and diagnostics.

Notes:

(*) Non standard item / depending on the version.

(**) Only for vehicles fitted with the Advanced Weight Sensing System (AWS), USA specification vehicles only.

(***) Only for vehicles fitted with Bosch ABS/ESP 8.0 (Assembly 24275 onward).

Diagnostic strategy

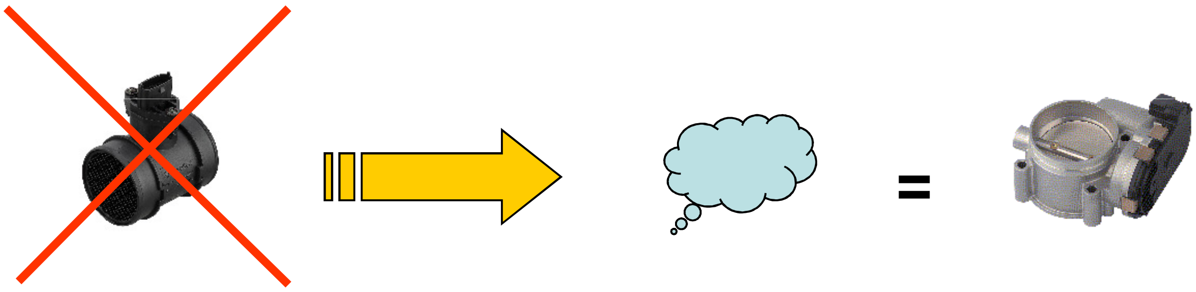
Safety
3 components of the engine control system are of fundamental importance for road safety:

- **Accelerator pedal**
- **Air flow meter**
- **Motor-driven throttle**

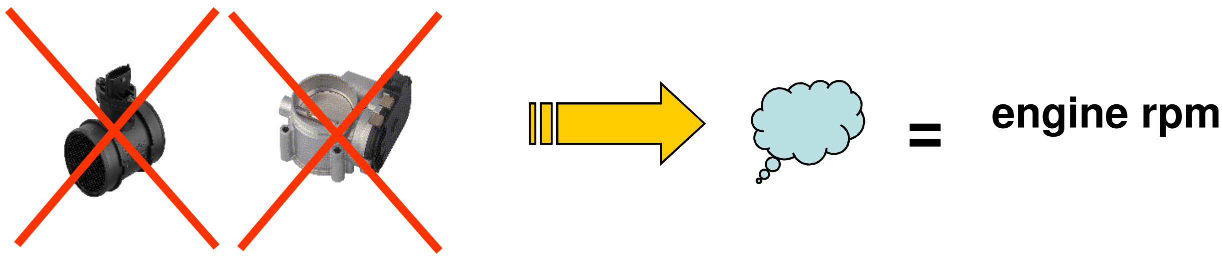
For this reason diagnostics of these three components is covered in greater detail!

Recovery management in the event of a breakdown of critical components:

In the case of an air flow meter malfunction the air flow is estimated in accordance with the throttle opening angle (from maps)



In the event of a malfunction of both air flow meter and throttle, the air flow is established by a map exclusively in relation to engine RPM



Toubleshoot charts

Starting problems, throttle self-learning not executed

Problem	***Component***	***Solution***
Speed different from 0 but vehicle stationary	ABS/ASR	Update/renew ABS/ASR control unit
Discharged	Battery	Check battery
Coolant temperature sensor fault	Coolant temperature	Check/renew sensor
Coolant temperature above 100°	Coolant temperature	Cool down engine
Coolant temperature below 5°	Coolant temperature	Warm up the engine
Air temperature below 5°	Air flow meter	Take car to warm environment
Air flow meter fault	Air flow meter	Check/renew air flow meter
Accelerator pedal pressed	Accelerator pedal	Release the accelerator pedal
Faulty accelerator pedal	Accelerator pedal	Check/renew Accelerator pedal
CAN problem	CAN network	Check/Repair CAN network

Starting problems: starter motor fails to turn

Problem	***Component***	***Solution***
Immo not deactivated with key	*Immobilizer*	*Press key*
Uncoded key	*Immobilizer*	*Encode key*
ECU with incorrect immo code	Immobilizer	Renew ECU CCM/IMMO/NBC
Discharge/Spikes	Battery	Check battery
Transmission F1 prevents engine starting	Transmission Control Unit F1	Check clutch position sensor Check start relay Check clutch solenoid valve Disengage gear Check Transmission Control Unit F1
Burnt out fuses	Fuses	Check fuses/check system
Bad ground contact	Chassis ground	Check/test ground connections
Satellite anti-theft system active	Satellite anti-theft system	Check satellite anti-theft system

Starting problems: Engine fails to start

Problem	***Component***	***Solution***
Inertia switch has tripped	Inertia Switch	Reset inertia switch
Exhaust temperature too high	Catalytic converters	Allow car to cool
Low voltage on main relay	Main relay	Check wiring or main relay
Starter motor running without cranking engine	Starter motor	Check starter motor clutch for jamming or fouling Check electromagnets

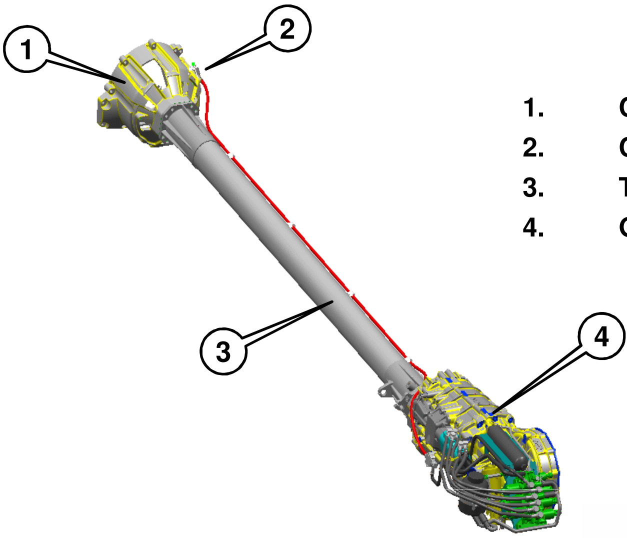
Problem	***Component***	***Solution***
Engine too rich	Air cleaner clogged	Renew air filter
Engine too lean	Leakage	Check sealing efficiency of intake duct
Incorrect air flow	Air flow meter	Check/Renew Air Flow Meter
Fuel temperature too high/Vapours in fuel rails	Vapour lock	Cool down engine
Insufficient fuel	Fuel supply	Degreaser on injectors in aspiration phase during cranking Check fuel pump

Robotized Gearbox Control System

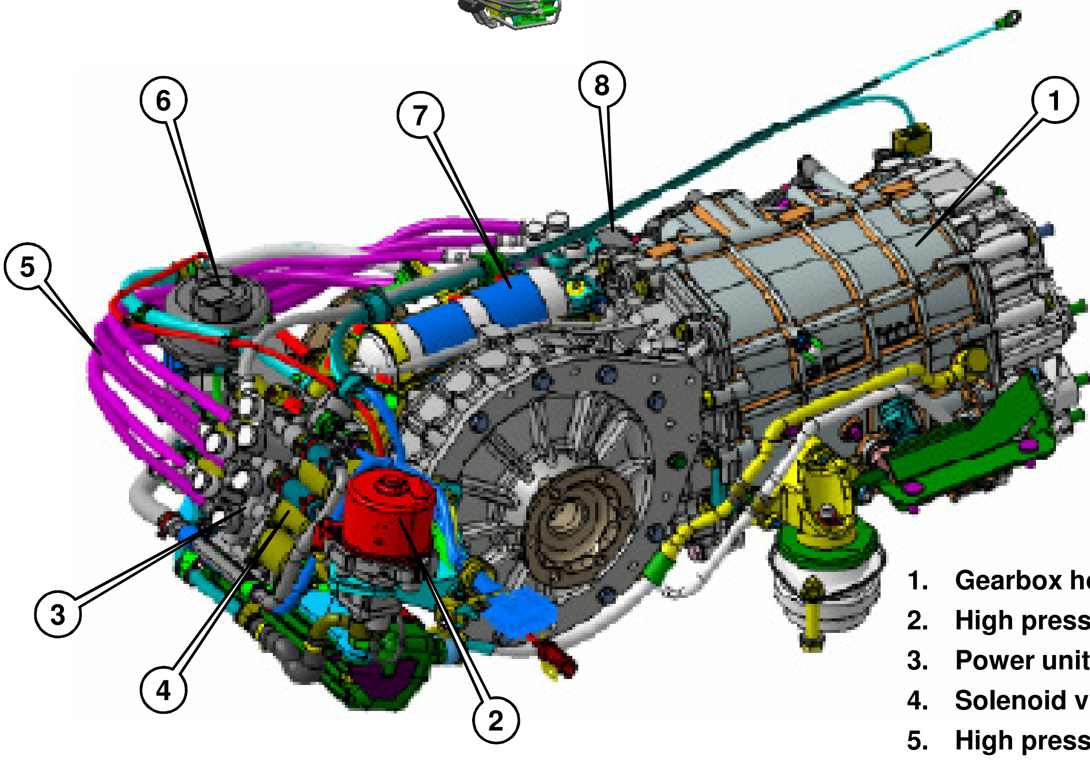
Magneti Marelli

Robotized gearbox system overview

The robotized gearbox control system is composed of an electro-hydraulic servo system which manages the gearshift and clutch operation.
A specific ECU (NCR) controls the complete system by using a strategy which is based on driver inputs and various vehicle parameters. Therefore the NCR interacts with other vehicle systems (NCM, NFR,…) and uses a driver interface (gearshift paddles and control buttons). A specific characteristic of the system is that it can be integrated on a mechanical transmission without requiring any specific modifications.



1. Clutch housing
2. Clutch pressure sensor (from Sofast 3)
3. Torque reaction tube with transmission shaft
4. Gearbox assembly with limited slip differential



1. Gearbox housing
2. High pressure pump
3. Power unit
4. Solenoid valves
5. High pressure pipes
6. Fluid reservoir
7. Pressure accumulator
8. Hydraulic gearshift actuator

Driver interface

The driver interface is composed of the following parts:

- Gearshift paddles fitted on the steering column: Up (right) and Down (left).
- Driving direction selector on the central console for selection of 1° or reverse gear.
- Driving mode selection buttons (Auto/Manual, Normal/Sport, Ice, Race).
- Display screen for visualisation of the selected gear and driving mode.

Quattroporte Duoselect

Gearshift paddles

T-lever for selection of 1° or Reverse gear

Gear and driving mode visualisation on central display

GranTurismo S and GranTurismo MC Stradale

Longer gearshift paddles permit easy shifting during cornering

Push buttons replace the T-lever for driving direction selection

Driving mode selection buttons on the central console: Auto/Manual, Normal/Sport, ICE, Race (MC Stradale only)

Evolution of the transmission control systems

The robotized gearbox control system went through a number of significant modifications that have also involved the introduction and modification of specific components. Various software and hardware evolutions have been applied during the years with the aim to improve driving comfort, reduce gearshift times, reduce clutch wear and simplify service operations.

- **PRE-SOFAST** and **SOFAST** transmission control system (CFC201): this is the first generation of transmission control system as introduced in 2001 on the M138 model. The name SOFAST (soft + fast) was introduced little later when a new control software was applied with the aim to enhance operating comfort. Management of gearchanges is not influenced by information concerning vehicle dynamics.

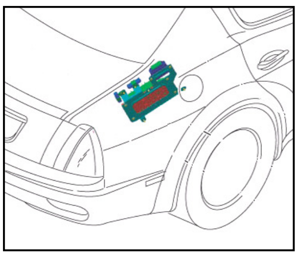
- **SOFAST II** transmission control system (CFC231): a new control unit with new software was introduced to optimise gearchange comfort and reduce noise levels. An improved operating management of the clutch was obtained by the introduction of the Kisspoint self-learning procedure. Management of gearchanges is not influenced by information concerning vehicle dynamics.

- **SOFAST III** transmission control system (CFC301): the introduction of Sofast III involves a new control unit and the introduction of a longitudinal acceleration sensor and a clutch pressure sensor. The longitudinal acceleration information allows a gearchange and clutch management influenced by the vehicle dynamics. The clutch pressure information allows the ECU to calibrate the clutch diaphragm spring characteristic. These modifications resulted in a much improved cluch management.

- **SOFAST III+** transmission control system (CFC301): identical to SOFAST III but with modified clutch and new operating software for further improved cluch management.

- **SOFAST IV with Superfast shift** transmission control system (CFC301): new operating software and various hardware modifications are applied. The introduction of the Superfast shift gearshift operating strategy reduces gearshift times to 100 ms.

- **SOFAST IV with Superfast shift 2** transmission control system (CFC301): new operating software and various hardware modifications are applied. The introduction of the Superfast shift 2 gearshift operating strategy further reduces gearshift times to 60 ms.



The robotized gearbox control node (NCR) is located in the boot space at right hand side (image: Quattroporte Duoselect)

MASERATI M138 Cambiocorsa

HW CFC 201 (SOFAST) up to assembly 12203

HW CFC 231 (SOFAST II) from assembly 12204

MASERATI M139 Duoselect, EUROPE version

HW CFC 231 (SOFAST II) up to assembly 18821

HW CFC 301 (SOFAST III) from assembly 18822

HW CFC 301 (SOFAST III+) from assembly 21925

MASERATI M139 Duoselect, US version

HW CFC 301 (SOFAST III) up to assembly 21925

HW CFC 301 (SOFAST III+) from assembly 21926

MASERATI M145 GranTurismo S (MC-Shift)

HW CFC 301 (SOFAST IV with Superfast shift)

MASERATI M145 GranTurismo MC Stradale (MC-Race)

HW CFC 301 (SOFAST IV with Superfast shift 2)

MASERATI M144

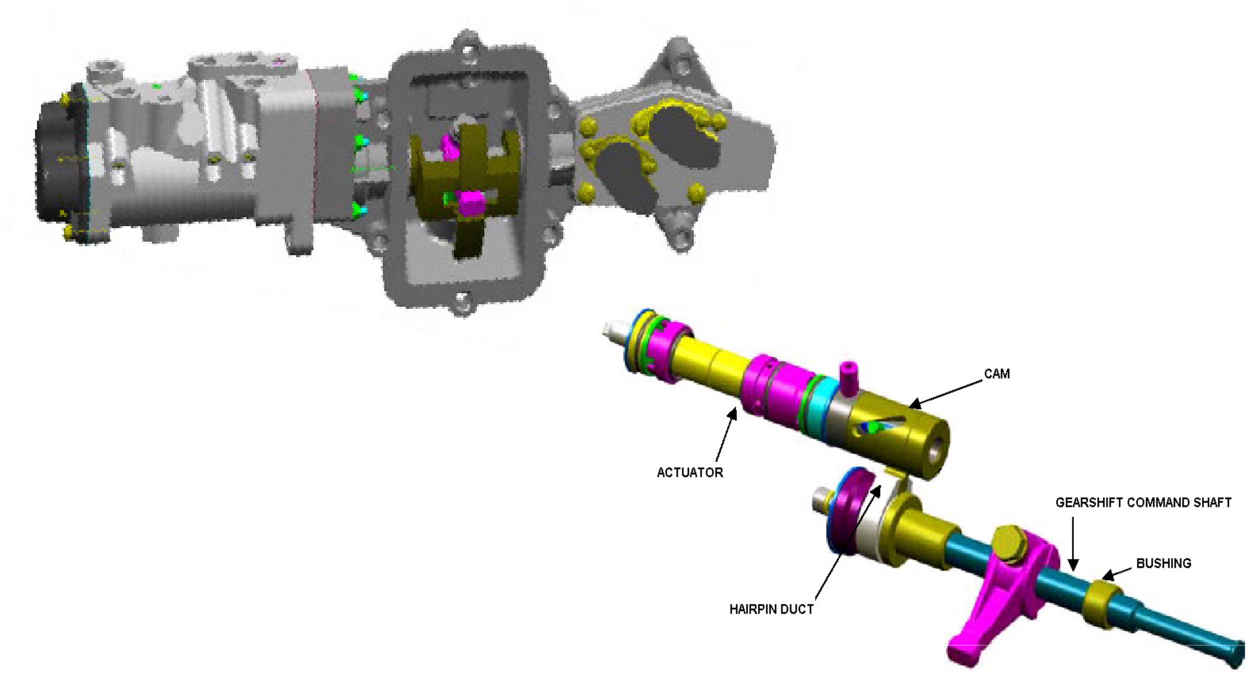
HW CFC 201 (SOFAST)

ALFA ROMEO 8C Competizione (Q-Select)

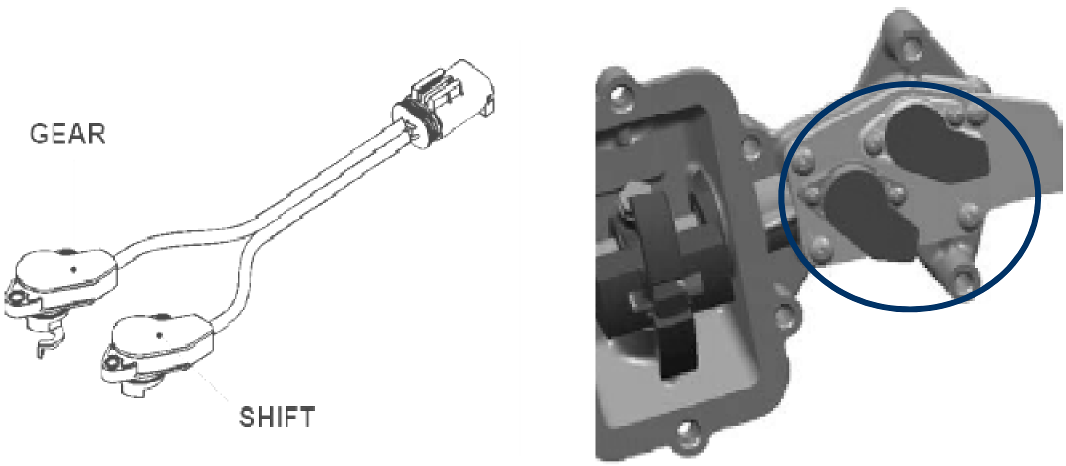
HW CFC 301 (SOFAST III+)

Component description

Hydraulic actuator
The function of this subsystem is that of directly activating the gearshift forks in order to drive the gear engagement and selection movements.



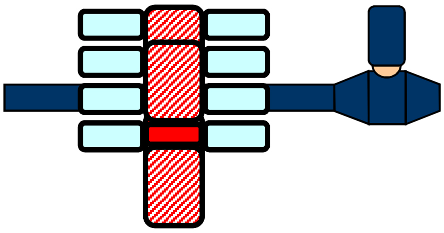
The hydraulic actuator is equipped with two sensors designed to monitor the actual position of the gear engagement finger. One sensor monitors the selection stroke while the other checks the gear engagement stroke. Both sensors are of the contactless type (Hall effect). The integrated electronic circuit in the sensor converts the output signal of the Hall ceramic element into an 0-5V DC signal. A failure of the sensors will enable a safety strategy that prevents engine starting.



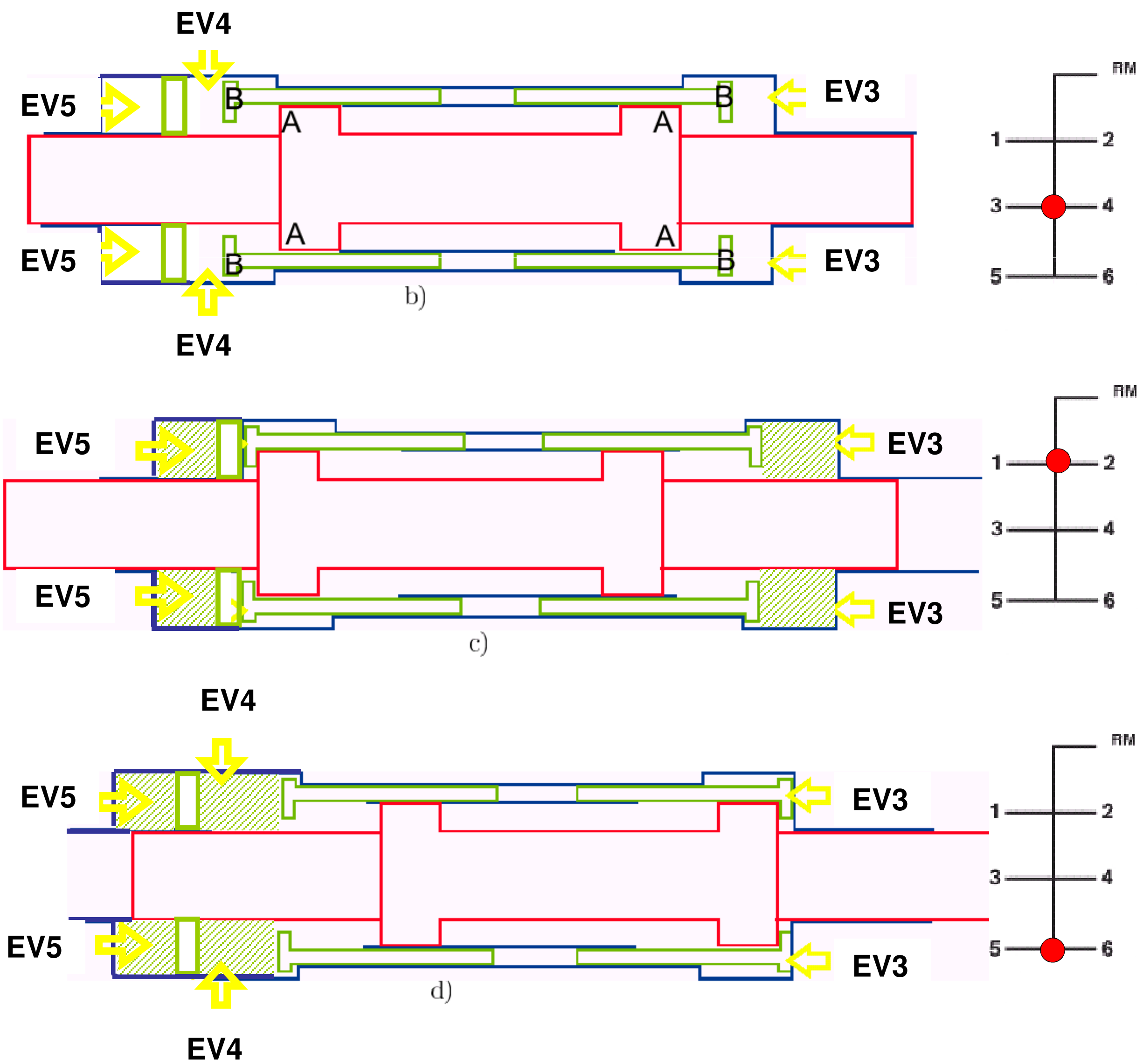
Actuator unit position detection Hall effect type contactless sensors

Selection

The hydraulic actuator converts the hydraulic pressure supplied by the gear selection solenoid valves (EV3, EV4, EV5) into a rotary movement of the gearshift command shaft. The gearshift command shaft has 4 possible positions separated by 15° angles.

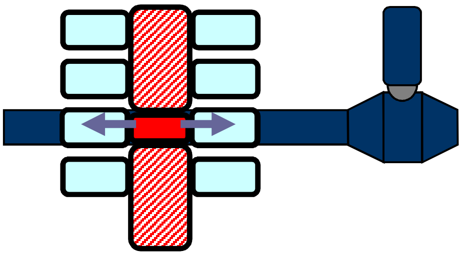


Gear	EV3	EV4	EV5
1 - 2	ON	OFF	ON
3 - 4	ON	ON	ON
5 - 6	OFF	ON	ON
REV	ON	OFF	OFF

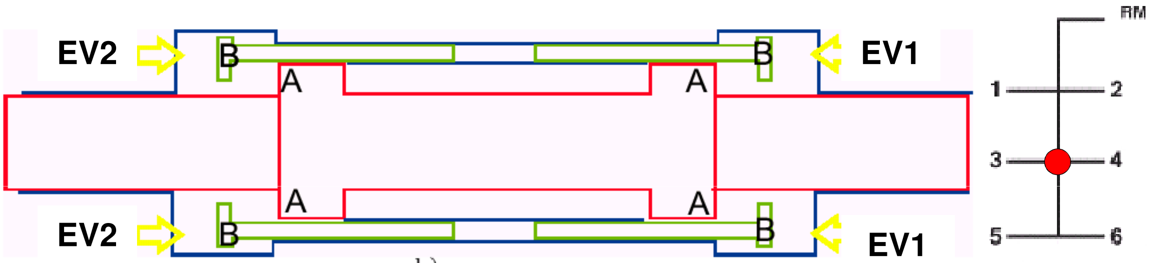


Engagement

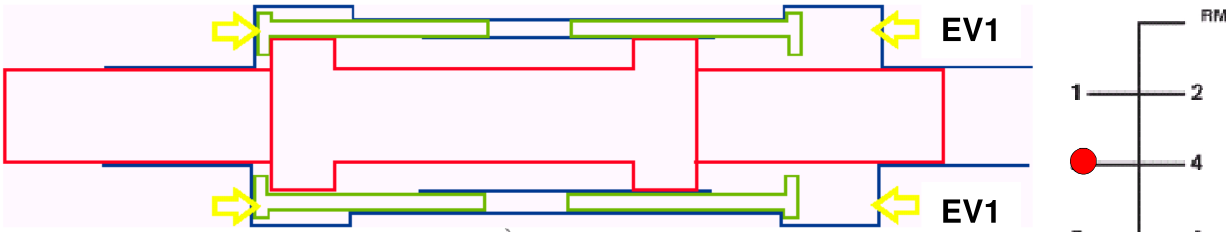
The hydraulic actuator converts the hydraulic pressure deriving from both the gear engagement solenoid valves (**EV1** for odd number gears and **EV2** for even number gears) into travel of the gearhift finger to three possible positions: Even number gears and reverse gear / Neutral / Odd number gears.



Gear	EV1	EV2
2- 4- 6- R	OFF	ON
Neutral	ON	ON
1- 3- 5	ON	OFF



b)



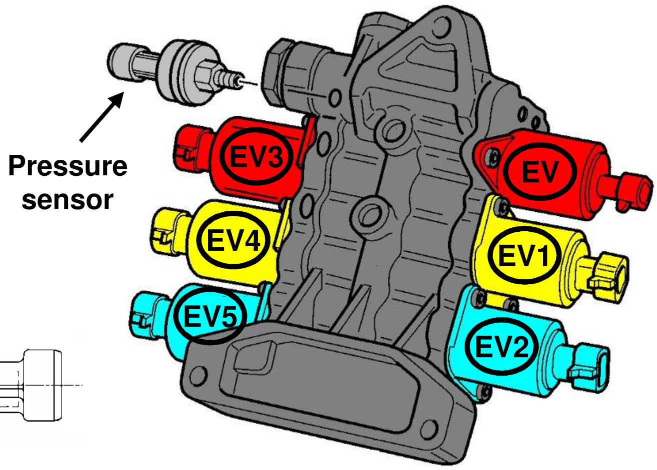
c)

d)

Power Unit

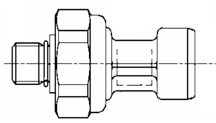
The Power Unit is heart of the system. The function of this subsystem is that of managing the actuation of the hydraulic actuator and the clutch release bearing. Therefore it provides hydraulic energy by using various solenoid valves. The power unit contains the following components:

- 6 solenoid valves
- Pressure sensor
- Check valve
- Pressure relief valve
- Bypass screw



Pressure sensor:

Working range: 0 - 80 bar
Power supply: 5V DC.
Output signal: 0.5 - 4.5 V DC.



Solenoid valves:

EV: Clutch solenoid valve (PFV)
EV 1-2: Gear engagement solenoid valves (PPV)
EV 3-4-5: Gear selection solenoid valves (PFV)

Check valve

The check valve is located downstream from the electric pump inside the Power Unit and serves to prevent the oil from flowing backwards. The presence of the check valve makes it possible to maintain hydraulic pressure in the Power Unit when the electric pump is not running so that operating pressure is immediately available when the ignition switched to ON.

1. **Pressure relief valve**
2. **Bypass screw**

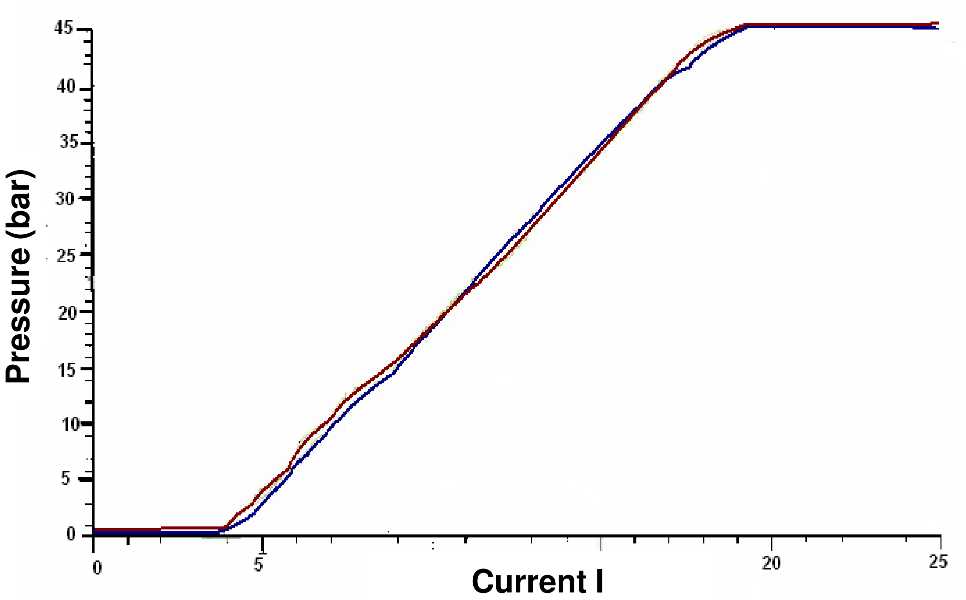
Pressure relief valve

The pressure relief valve prevents damage to F1 system components potentially resulting from excess oil pressure in the event of anomalous operation of the oil pump. The pressure relief valve opens at approximately 90 bar and dumps the oil to the low pressure side of the circuit.

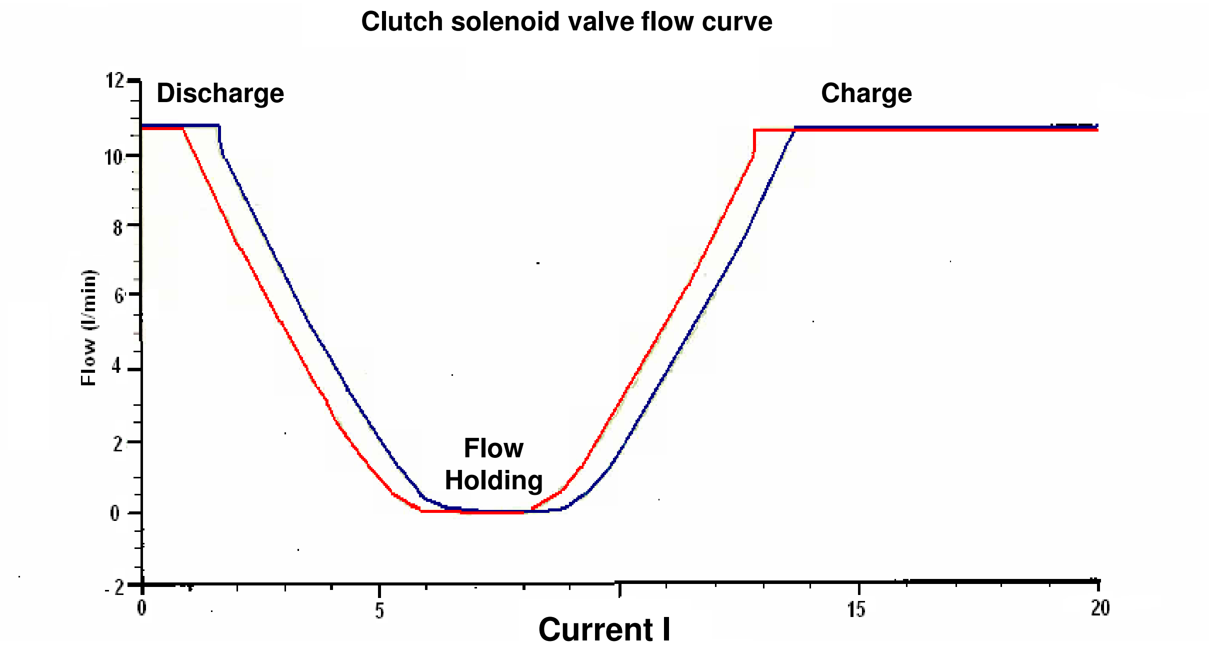
Bypass screw

The bypass screw makes it possible to connect the high pressure circuit to the low pressure circuit to relieve system hydraulic pressure. This operation is required, for example, when renewing hydraulic system components.

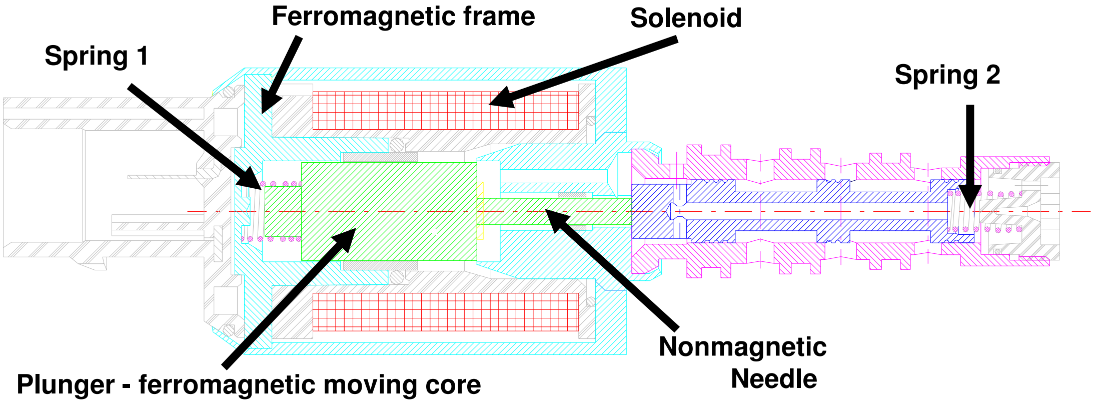
Proportional Pressure Valve (PPV):
The two gear engagement solenoid valves (EV1, EV2) responsible for meshing and disengaging the gears, are of the proportional pressure type (PPV). The solenoid valves are controlled by a PWM signal and they modulate hydraulic pressure in accordance with the input current

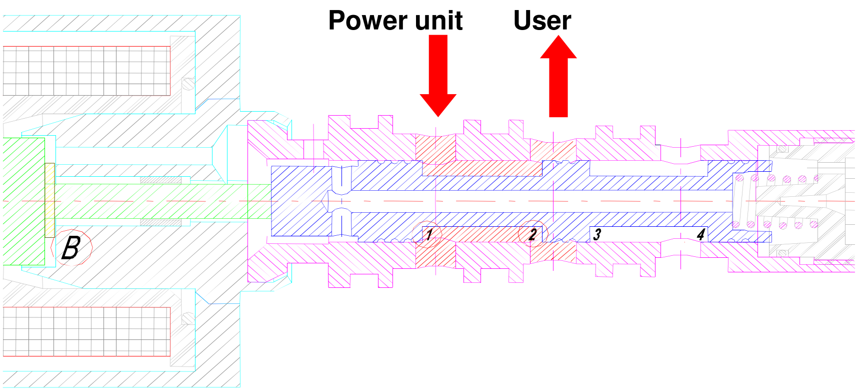


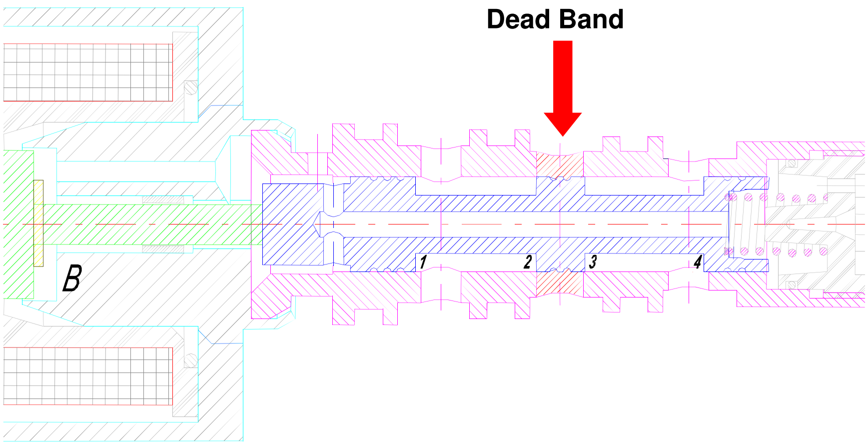
Proportional Flow Valve (PFV):
The 3 gear selection solenoid valves (EV3, EV4, EV5) and the clutch solenoid valve (EV) are of the proportional flow type (PFV). The clutch solenoid valve is controlled by a PWM signal and modulates hydraulic pressure in accordance with the input current. The three selection solenoid valves are used as On/Off type valves.

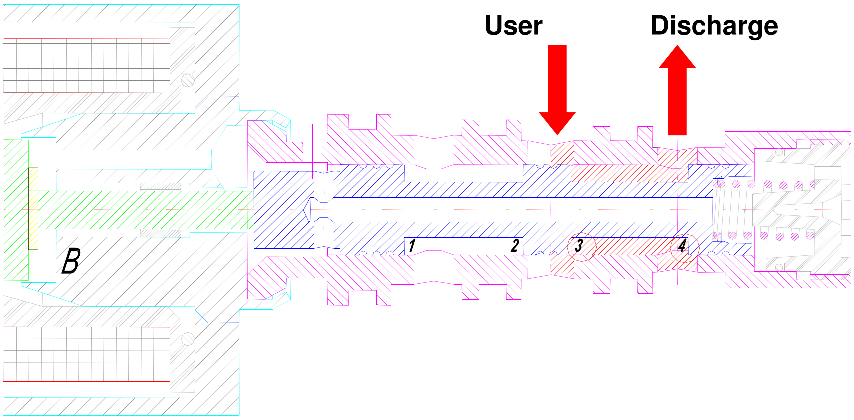


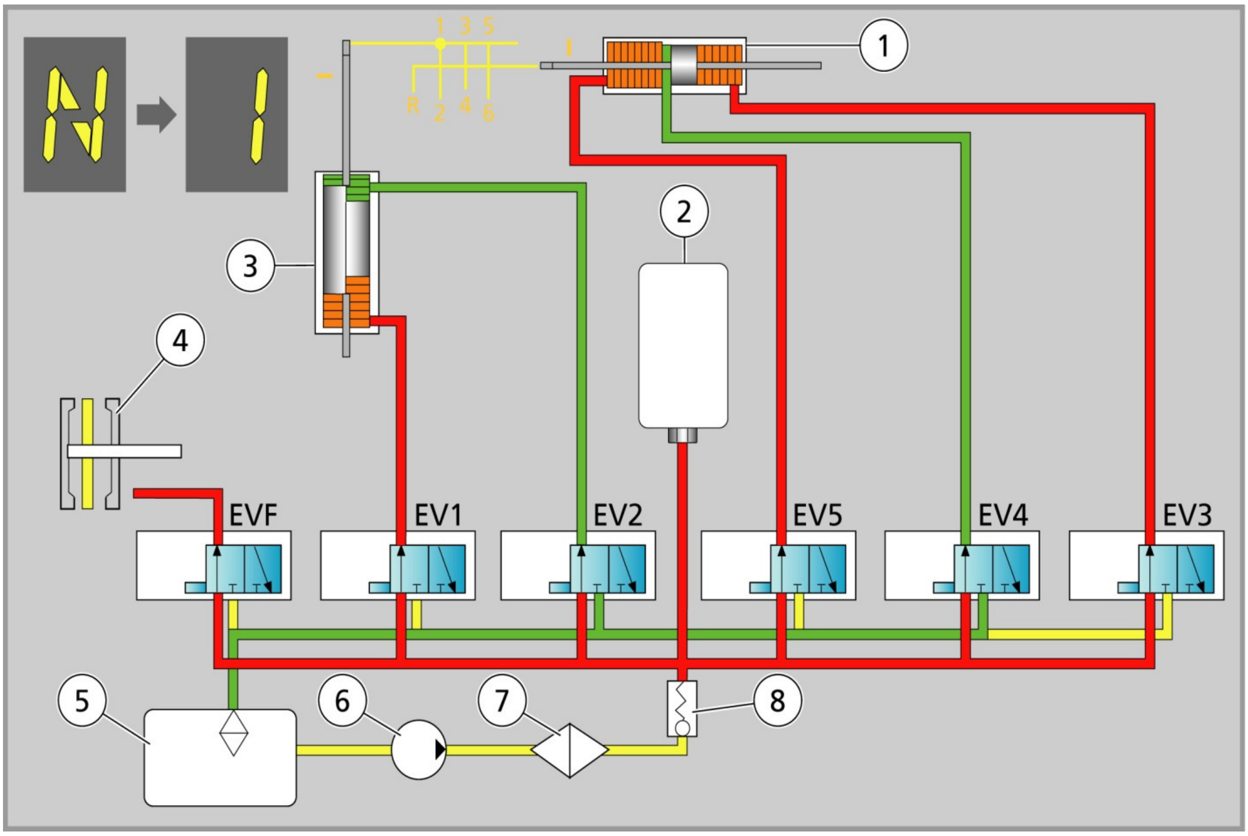
The activation characteristic varies among different solenoid valve types.









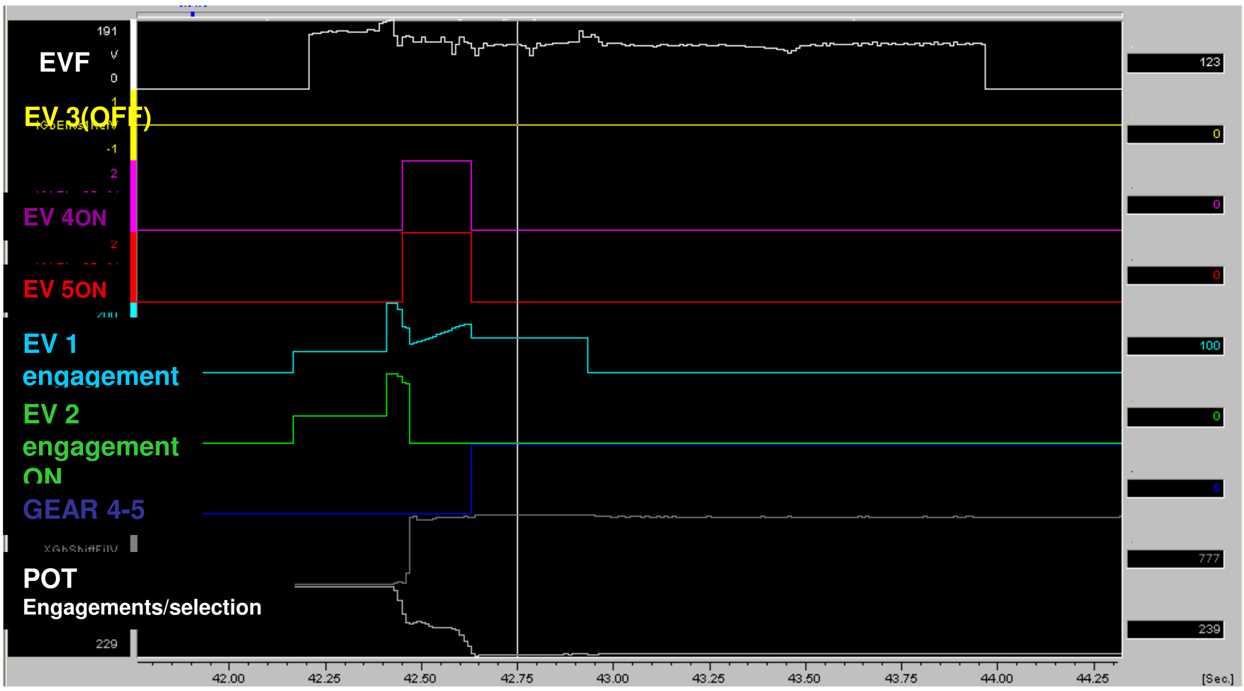


1. Selection actuator
2. Hydraulic accumulator
3. Engagement actuator
4. Clutch
5. Oil reservoir
6. Electric pump
7. Filter
8. Check valve

Pressure

Return

Neutral

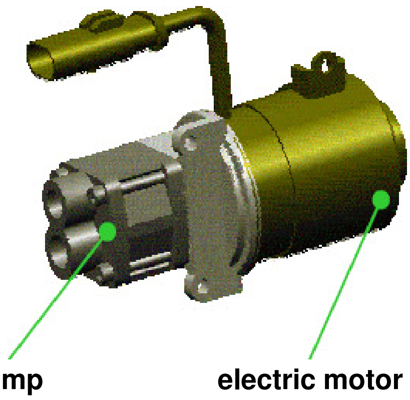


Electric pump

The electric pump brings the oil from the hydraulic reservoir to the operational pressure for the power unit.

The pump is driven by an electric DC motor and is managed by an ON/OFF control strategy (the pump does not run continuously). The pump is activated when hydraulic pressure drops below 40 bar and is switched off when the pressure reaches 50 bar.

When the driver's side door is opened and the ignition key is not inserted, the transmission control module (NCR) runs the pump briefly to build up hydraulic pressure before starting the engine.



In case of replacement of the electric pump, the pump must be replaced together with its activation relay!

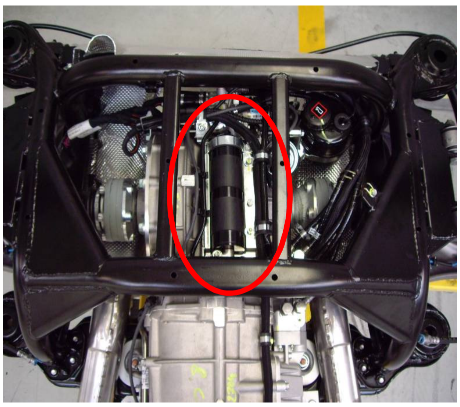
Sofast 4:

For the Sofast 4 system (GranTurismo S and GranTurismo MC Stradale) with Superfast shift shiftshiftshift strategy, a higher operating pressure is obtained when the Superfast shift shiftshiftshift mode is active (range 50 - 70 bar). Therefore, a new, more powerful electric pump is used. Further, an air conveyor is installed to provide fresh air to the pump for heat removal.

The temperature of the electric pump motor is monitored by the NCR by means of a mathematical model. In base of certain temperature thresholds, specific recovery strategies can be activated to prevent overheating of the pump.

Pressure accumulator

The system is equipped with a piston type pressure accumulator located on top of the gearbox. The function of this device is to accumulate hydraulic pressure during the electric pump running time and deliver high pressure oil to the power unit when the pump is stopped.



Solenoid valves internal leakage

Leakage past the spool of the control valve, which is estimated by the NCR and can be read out by the diagnostic system, constitutes a valuable diagnostic aid in the event of an electrohydraulic system fault. The value shown is periodically acquired by the NCR in a self-learning procedure.

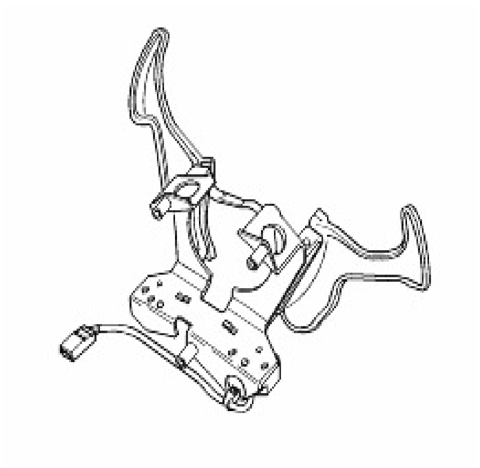
Solenoid valve internal leakage in excess of 30 cc/min, combined with problems of engagement and/or selection, offers an excellent point of reference to understand the nature of the problem. In this case the solenoid valve must be renewed.
In the case of hydraulic problems use the following procedure in order to isolate the offending component:

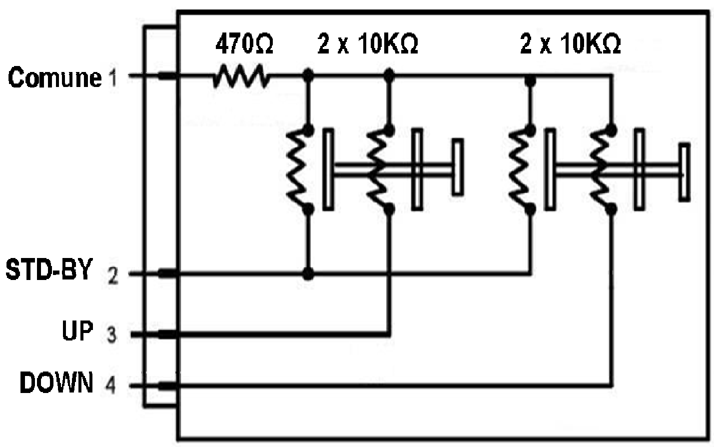
Key ON, Engine Off: the interval time between two pump activations must be no less than 2 minutes. This makes it possible to check the solenoid valves - accumulator - electric pump assy.

Key On, Engine running: the interval time between two pump activations must be no less than 60 seconds. This makes it possible to check the clutch solenoid valve and, by acquiring the pump restart times, the condition of the accumulator.

The conditions of the electric pump can be assessed by acquisition of its activation time: an activation ramp with an increasingly gradual slope and activation time in excess of 5 seconds are clear symptoms of deterioration of the pump.

Up / down paddles
Selection of gear engagement by means of steering wheel paddles

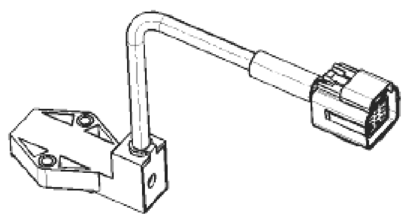


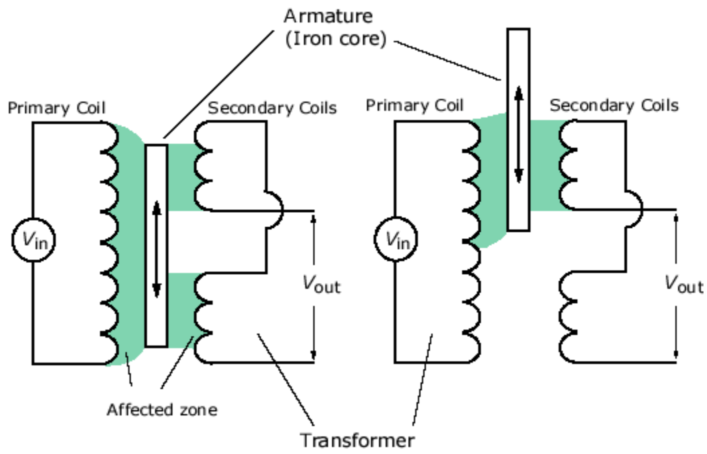


The NCR checks the activation status of the paddles by means of voltage values generated by activation of the gearshift paddles.

Clutch position sensor

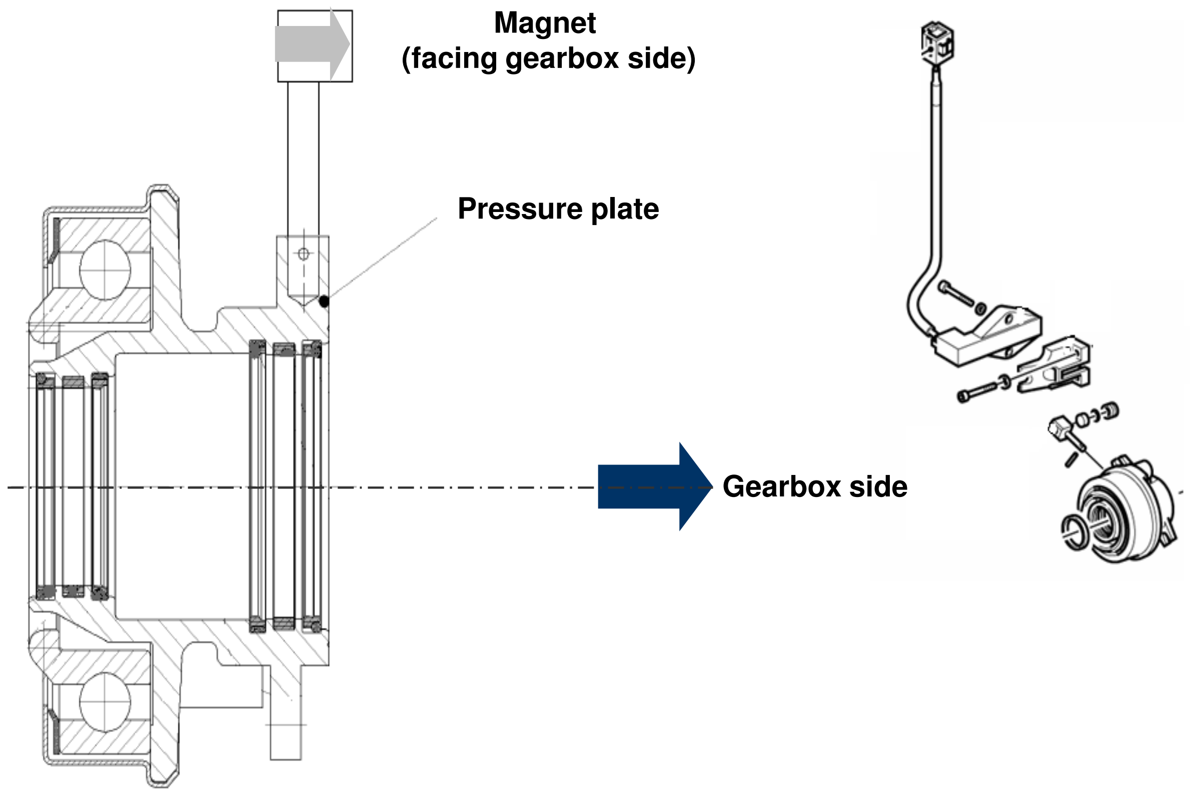
A contactless type sensor is used to measure in real time the position of the clutch release bearing. This sensor uses LVDT (Linear Variable Differential Transformer) technology. The movement of a magnet, fitted on the release bearing, will affect the voltage induced in the coils integrated in the sensor element.
Note: failure of the clutch position sensor may lead non-starting of the engine.



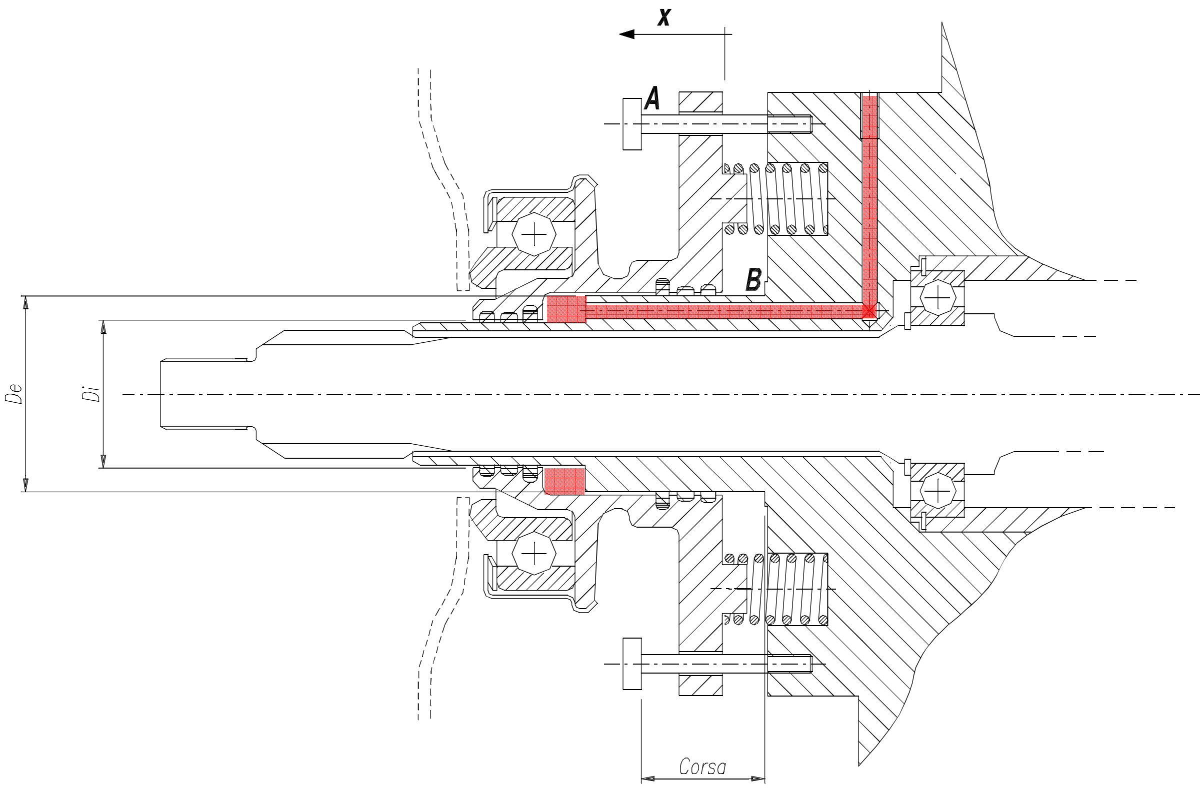


Clutch Actuator

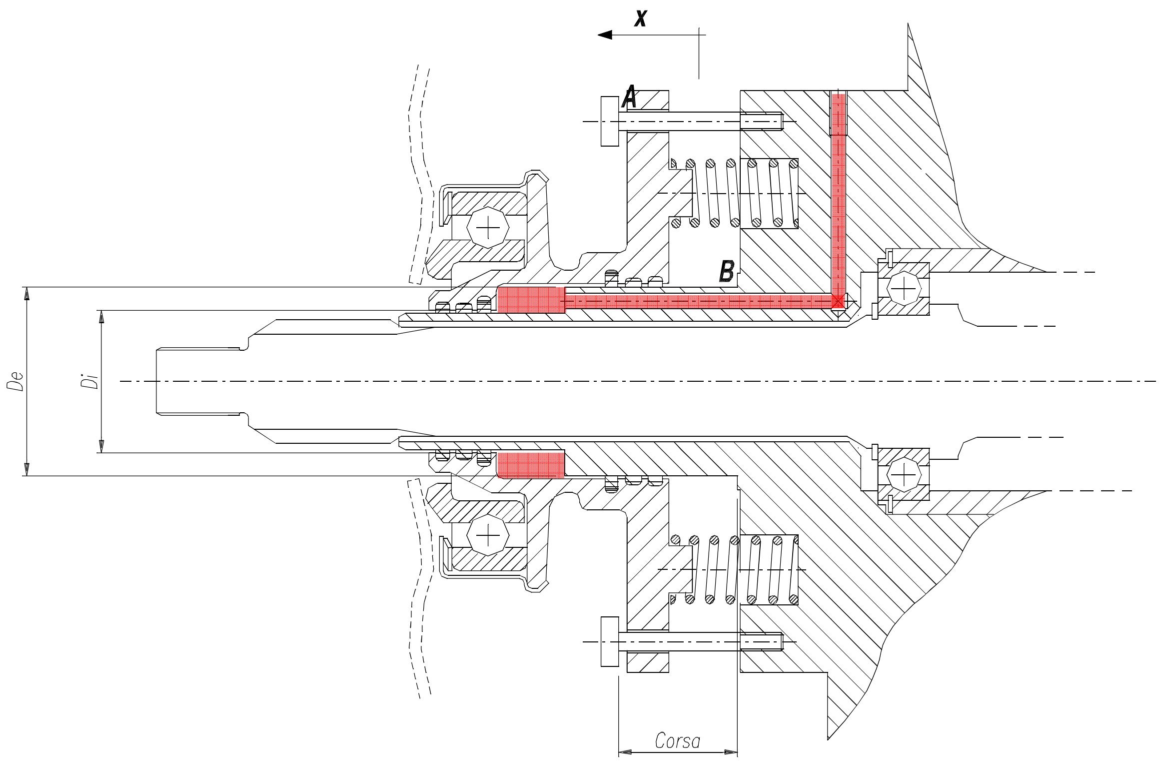
The clutch actuator is responsible for activating the clutch thrust bearing; the actuator is composed of a hydraulically operated circular ring. Attention must be payed to the correct direction of installation of the position sensor magnet with reference to the clutch thrust bearing position.



Clutch pressure plate in rest position:

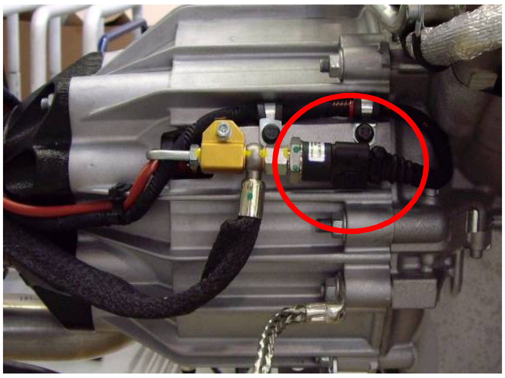


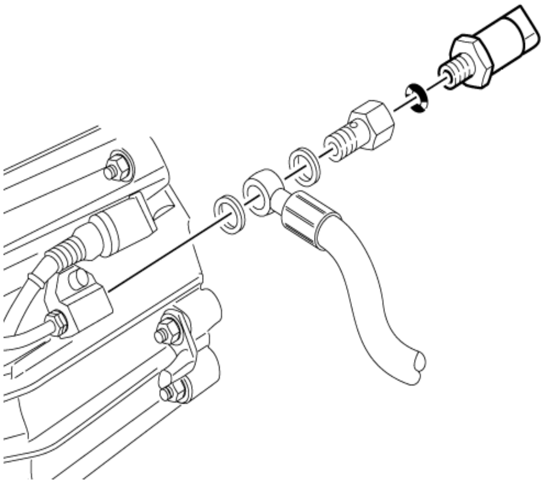
Clutch pressure plate in working position:



Hydraulic pressure sensor on clutch housing (Sofast III onward)

An analogue pressure sensor measures the hydraulic pressure in the clutch actuator, which is in direct relation to the application force of the diaphragm spring. By this way the exact clutch characteristic can be identified. This component is installed starting from sofast III.



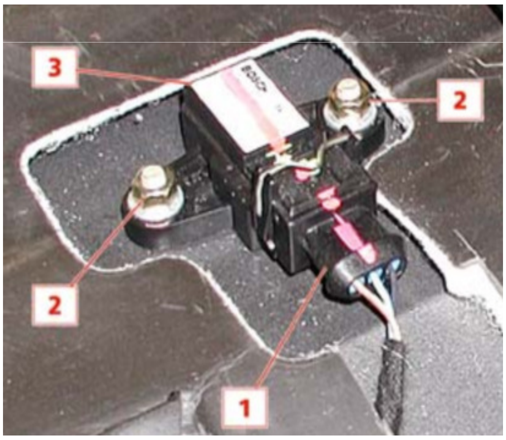


Measuring range:	0 - 80 bar
Response voltage:	0.5 - 4.5V

Longitudinal acceleration sensor (Sofast III)

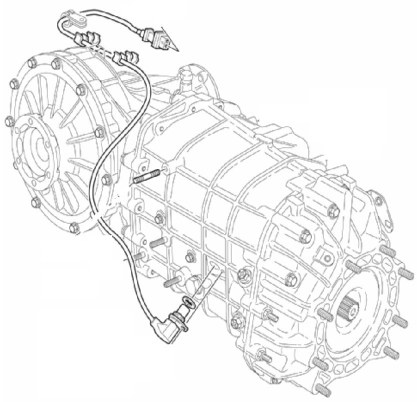
A longitudinal acceleration sensor was introduced on the Sofast III system to allow to calculate the road gradient (flat surface, uphill, downhill). This information is used by the NCR to adapt the clutch activation during driving away and the gearshift strategy in automatic driving mode in base of the road gradient.

Starting from assembly **24275**, the sensor has been dropped and longitudinal acceleration ionformation is received from the ABS / ESP system (NFR) over the C-CAN line.



Gearbox input shaft speed sensor

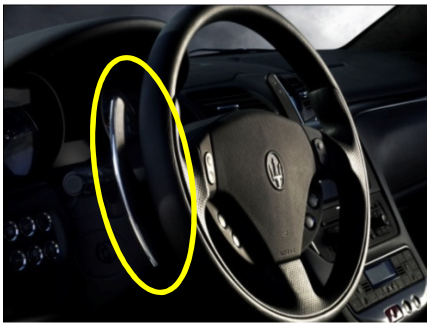
The rotation speed of the gearbox primary shaft is monitored by a magnetic induction type speed sensor located on the right-hand side of the gearbox.



Specific components for Sofast 4 with Superfast shift:

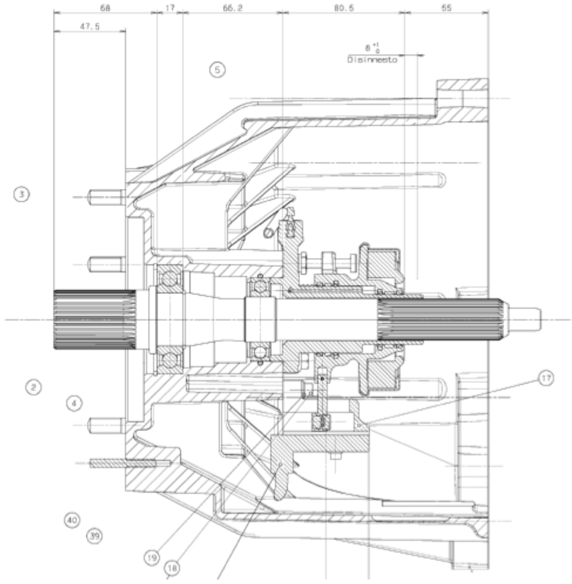
For the GranTurismo S model (Sofast 4 with Superfast shift gearshift strategy), the following hardware modifications have been made:

- Reinforced gearbox housing (new differential lid)
- Reinforced, three-pad gearshift forks made of a new material
- New clutch “Ribbed finger” (PIS value still 4,2mm – 327 bit)
- New clutch housing with double support bearing
- New electric pump with increased capacity and air conveyor
- Clutch position sensor with improved thermal isolation for wiring
- New hydraulic circuit oil: Shell Donax TX (0,5L)
- High pressure leads without restrictors: on previous generations, restrictors were fitted in the high pressure leads to reduce operating noise. For Sofast 4 they have been removed to allow the increase of gearshift times.
- Direct connection between NCR (pin 80 CFC301) and NCM (pin 81 Motronic ME7.1.1) for engine cut-off in Superfast shift mode: When Superfast shift mode is active, the fuel cut-off command during gearshift to the engine control system is not given over the C-CAN line but by a direct connection by an “active low” signal. This allows a faster command and improved synchronisation between gearbox control and engine control during gearshift phase.
  Note: in case of failure of the line (interruption, short circuit) a specific error code will be stored (DTC P1761) and the Superfast shift mode will be disabled.
- Activation of reverse lights via CAN: pin 41 of the CFC301 unit is no longer used to operate the reverse lights relay. Instead, it operates the LED behind the Reverse button on the control panel located on the central console.
- Improved driver interface with longer gearshift paddles at the steering wheel and a new control panel to select the driving direction (1st gear or Reverse).



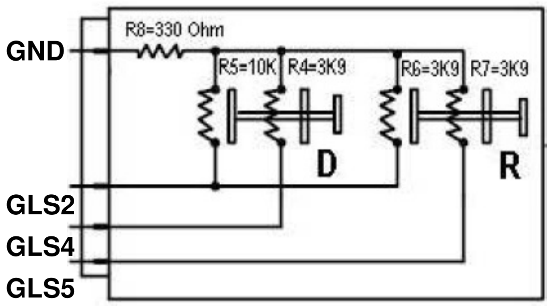
The various modifications result in a modified pin-out for the CFC301 ECU with respect to Sofast III and Sofast III+

Redesigned clutch housing
The clutch housing has been redesigned and contains now a clutch support shaft with double support bearing. This solution reduces bearing noise and wear.



Redisigned clutch
This new cluch, indicated as “Ribbed Finger”, has a newly designed diaphragm spring and new friction material in order to reduce noise and wear.
The main characteristics of the clutch have remained unchanged: dry twin-plate, 215 mm disc with hydraulic control. The PIS value has remained unchanged at 4,2 mm (327 bit).

New driving direction selector
The new controls to select the driving direction (“1” and “R” buttons) operate in a similar way as the gearshift paddles. That is they are no longer interrupters like on previous generation systems. Instead, The NCR checks the activation status of the buttons by means of voltage values generated by activation of the buttons.



Voltage output table:

1	R	GSL2 (pin74)	GSL4 (pin75)	GSL5 (pin61)
0	0	1 (2,94 V)	1 (4,04 V)	1 (4,04 V)
0	1	1 (4,32 V)	0 (1,7 V)	0 (1,7 V)
1	0	0 (1,7 V)	0 (1,7 V)	1 (4,32 V)
1	1	0 (2,19 V)	0 (2,19 V)	0 (2,19 V)

Voltage values up to 2,19V are regarded as “0” (rest position). Higher voltage values are considered “1” (active).

Specific components for Sofast 4 with Superfast shift 2 (CV2):

The gearbox system used on the GranTurismo MC Stradale model (Sofast 4 with Superfast shift 2 gearshift strategy) is an evolution of the Sofast 4 with Superfast shift system as used on the GranTurismo S model. The only hardware modification regards the hydraulic actuator with the gearshift finger.

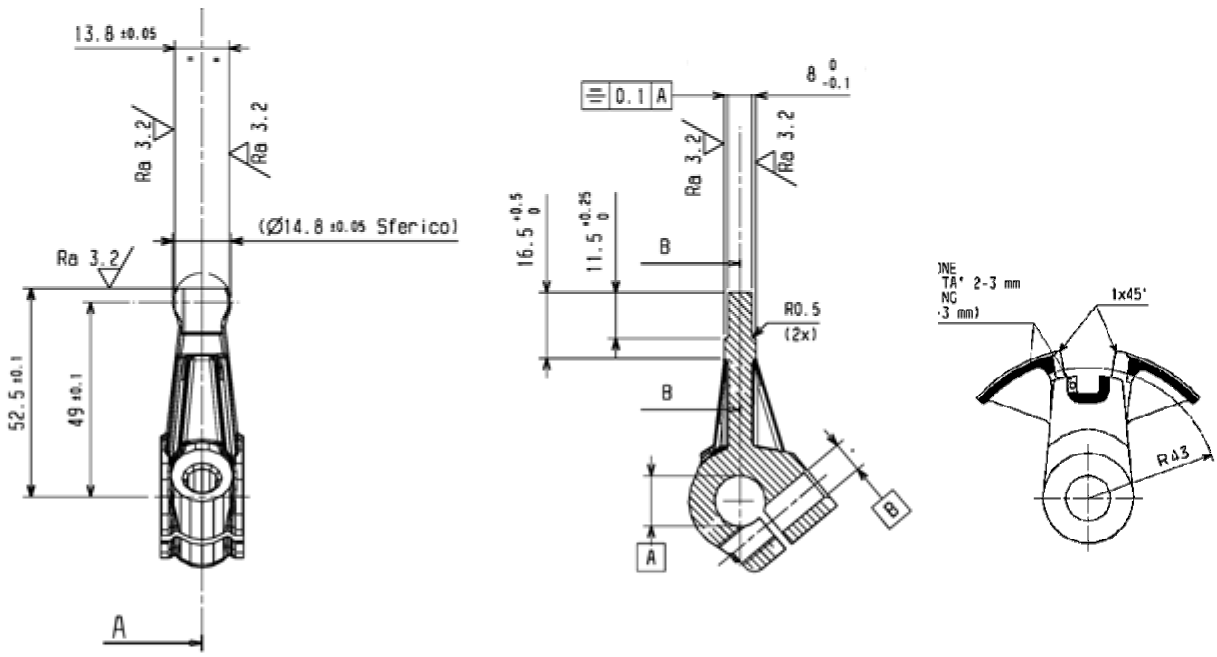
Redesigned hydraulic actuator to reduce shifting times

In order to further reduce the needed time for a gearshift operation it was necessary to develop a system that does not require a centering in the neutral position during the gearshifting.

This system involves removing the engagement actuator tappets and increasing the lever/fork clearance, consequently increasing the actuator stroke by 2mm. Simplification of the system, thanks to the elimination of the centering tappets and relative seals, use of a piston shaft with only one seal, reduced machining work on the engagement shaft due to the elimination of the sealing seats.

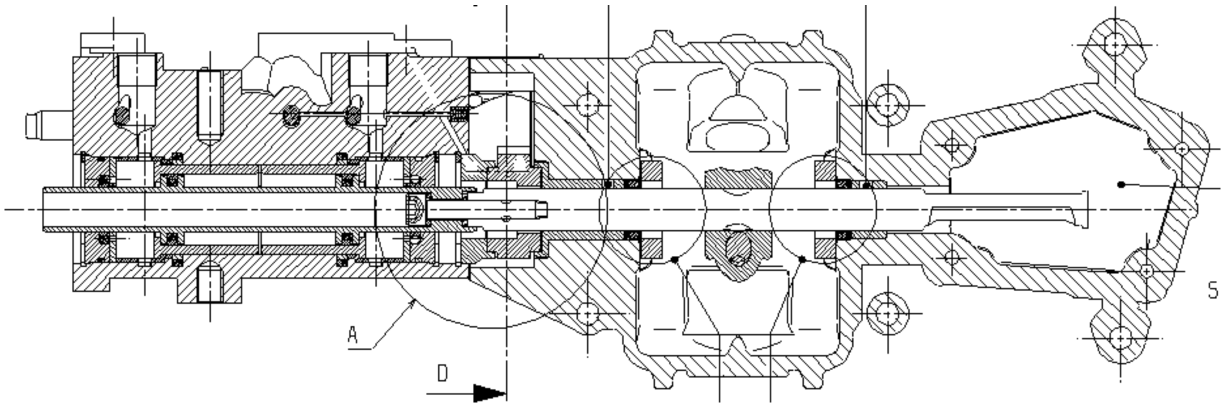
The interface components have been redefined:

- Gearshift finger
- Latch and relative drive bushings

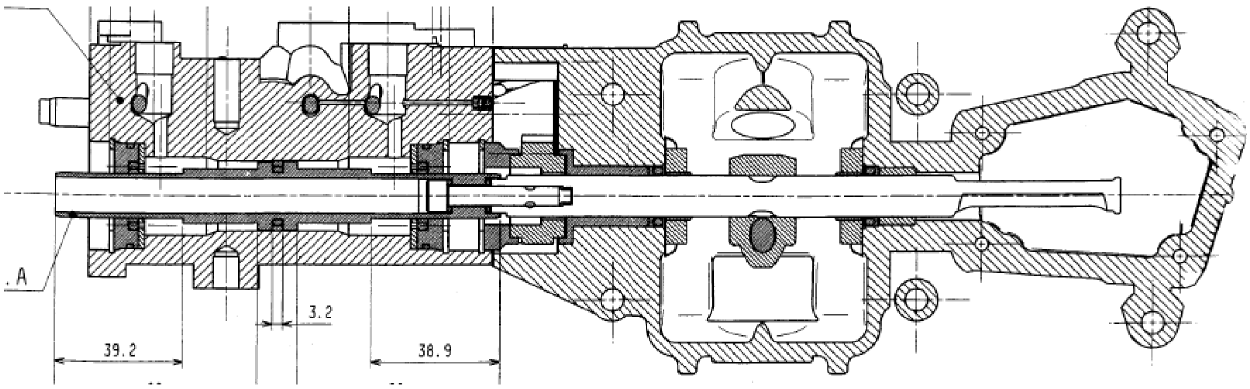


The following internal components of the hydraulic actuator have been modified:

- Engagement piston sleeve
- Engagement shaft
- Selection movement lobe

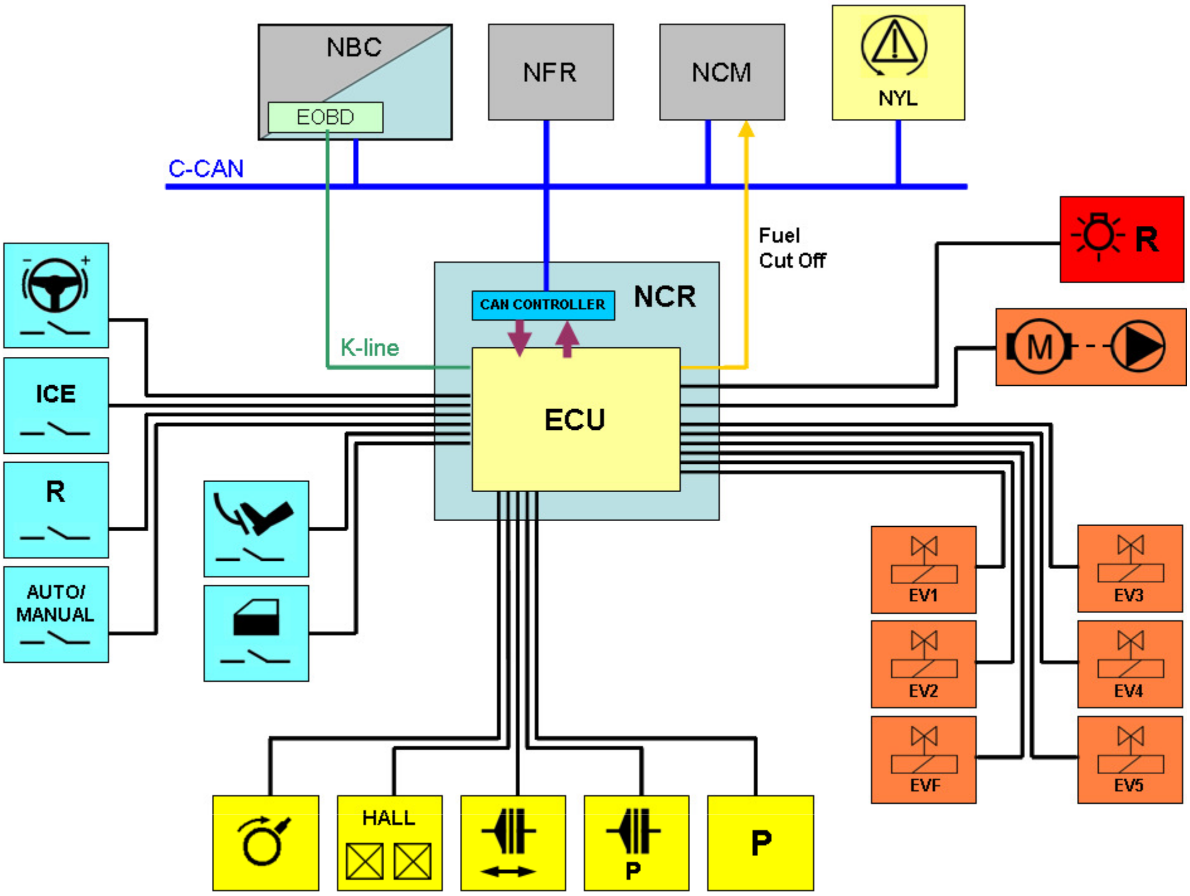


Quattroporte Duoselect, GranTurismo S



GranTurismo MC Stradale

Functional diagram NCR (example: Sofast 4)



The transmission control module (NCR) uses the following input signals for operation of the gearbox and clutch:

Analogue input signals:

- Shift up selector
- Shift down selector
- "Ice" switch signal
- "Auto/Manual" switch signal
- "Reverse" selector signal
- Brake pedal switch
- Driver's door switch

Sensor input signals:

- Primary shaft speed sensor
- Selection and engagement actuator position sensors (Hall)
- Clutch actuator position sensor
- Clutch pressure sensor (Sofast III onward)
- Oil pressure sensor on power unit

Received information via CAN:

Key On status, vehicle speed signal, engine rpm signal, engine torque signal, “Sport” switch activation status, hood open status, longitudinal acceleration signal (from VIN 24275), lateral acceleration signal (Sofast 4 only),

Gearbox operating strategies

System activation
By turning the ignition key to ON, the system will be activated and all the display segments on the information display will be activated, during which time a self-test of the system is performed. The gearbox malfunction indicator will go out after a few seconds if no anomalies were detected. The inserted gear will remain indicated on the display.

Key ON, engine OFF
When the engine is not running, only Neutral, 1st gear and Reverse gear can be selected. Driver requests to select other gears are ignored.
Note: if continuous gear changes are performed while the engine is not running, a protection strategy will be enabled which will disable further gear changes for a determined period depending on various parameters. This strategy is to prevent overheating of the electric pump and battery discharge. The rejection to perform further gear changes will be announced by the buzzer.

Engine starting
The engine can be started with the gearbox in neutral or in gear, always with the brake pedal depressed. The system opens the clutch, brings the gearbox in the neutral position and enables the engine control module (NCM) to activate the starter engine.

Engine running
Once the engine is running, the system behaves in the following way:

- When a gear is selected, the brake pedal is not depressed and the driver's door is opened, the gearbox will immediately return to neutral.
- When a gear is selected, the doors are closed and the brake pedal is not depressed, the gear will remain engaged. If no further actions are taken, the system will return to neutral after a 1 minute delay.
- When a gear is selected and the brake pedal is depressed, the gear will remain engaged for 10 minutes, after which the system will return to neutral if no further actions are taken.
- The gearbox will always return to neutral if the bonnet is opened.

Driving away

For driving away, the clutch has to close progressively. The engaging speed of the clutch depends on the engine speed and accelerator pedal depression speed.

Note: at cold temperatures, the clutch will be engaged at a higher engine speed.

Note (2): when taking off is continued or repeated excessively, there is a high risk of clutch overheating. The transmission control module (NCR) will detect the raise of the clutch temperature and activate the buzzer signal to warn the driver.

Upshifting

- Upshifts can be carried out by pulling the “Up” lever without lifting the accelerator pedal.
- Only one gearchange at a time can be performed. Wait until the gearchange operation is completed before demanding a next one.

Downshifting

- Downshifts can be carried out by pulling the “Down” lever.
- Only one gearchange at a time can be performed. Wait until the gearchange operation is completed before demanding a next one.

Different gearbox operating modes

	Manuale	Automatica
Normale	x	x
Sport	x	x
Ice	x	

The gearbox can be used in either “Manual” and “Automatic” mode, for manual or fully automatic operation. The “Sport” button enables the driver to opt between “Normal” or “Sport” operating modes. Normal mode aims to achieve the best balance between comfort, performance and fuel economy, while Sport mode adapts the gearshift strategy to maximise driving pleasure and vehicle performance.
The “Ice” button activates a specific gearshift strategy to offer maximum safety and handling on ice or low-grip road conditions.

Note: when both “Sport” and “Ice” modes are selected, Ice (low grip) mode has priority and the Sport mode will be cancelled.

Normal-Manual operating mode

In this mode the gears are selected by the driver using the gearshift paddles behind the steering wheel. The selected gear (R,N,1,2,3,4,5,6) will be indicated on the information display.
In Manual mode certain functions are still controlled automatically:

- When the vehicle is slowing down and the engine speed decreases to around 1200 RPM, the system engages automatically a lower gear to avoid under-revving of the engine.
- When the engine speed is reaching its maximum RPM with the accelerator pedal depressed (around 7200 RPM), a higher gear will be selected automatically.

Normal-Automatic operating mode
In this operating mode the gearshifts are performed completely automatically according to a gearshift map which is programmed in the transmission control module (NCR). The gearshift strategy is designed to offer the best compromise between driving comfort, fuel economy and vehicle performance.
In this mode, the actual gear is indicated on the information display together with the "AUTO" indicator.
Note: when driving in Automatic mode, gear changes can still be requested manually by using the gearshift paddles. By doing so, the gearbox will temporary return to Manual mode, during which time the "AUTO" indicator on the information display will flash for 5 seconds. After this the system returns to Automatic mode.

Sport operating mode
In Sport operating mode, the accent shifts towards driving pleasure and vehicle performance. This function can be selected in both Manual and Automatic driving mode and the "SPORT" indicator will be activated on the information display. Gearchanges are performed more quickly and more aggressively with respect to Normal mode. The shifting speed will also increase proportionally with throttle angle and engine speed.
When downshifts are performed at an engine speed superior to 5000 RPM, double-clutching is performed automatically to raise the engine speed before engaging a lower gear.

Note: in Manual-Sport mode, no automatic upshifts are performed when the engine speed reaches the maximum RPM and the accelerator pedal is depressed. The engine will remain at speed limiter revs if no manual upshifts are performed.

Note (2): in Manual-Sport mode, the automatic downshift function remains active to prevent under-revving.
Note (3): when Ice (low grip) mode is activated, the Sport and MSP OFF modes will be cancelled to give priority to driving safety.

Ice (low grip) operating mode

By pushing the "Ice" button, a specific gearshift strategy for low adherence conditions (rain, snow, ice,…) will be enabled and the "ICE" indication will be activated on the information display. The Ice function can be used in both Manual and Automatic driving mode and will cancel the Sport mode if it was activated. The Ice gearshift strategy operates as follows:

Downshift requests which cause an engine speed higher then 2800 RPM are ignored.

Note: in Manual-Ice mode, the automatic upshift strategy is identical to that used in Manual-Normal mode. Automatic upshifts are performed when the engine reaches its maximum speed of around 7200 RPM.

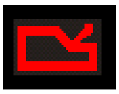
System safety

The gear disengages:

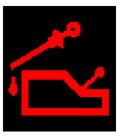
- Immediately when the engine compartment is open;
- After 2 seconds when the door is open and the brake pedal is released;
- After 1 minute when the door is closed and the brake pedal is released;
- After 10 minutes when the door is closed and the brake pedal is depressed;

Indicator lights

The instrument cluster is fitted with following transmission-related warning lights:



The gearbox warning light is "ON" under self-test conditions and whenever an anomaly has been detected. The activation signal is sent over the CAN line.



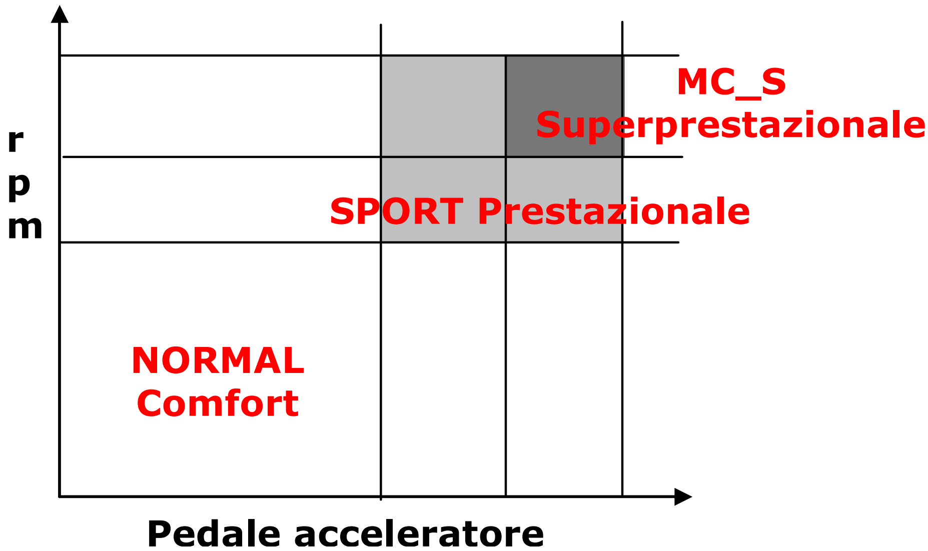
The oil level warning light relating to the reservoir of the hydraulic circuit is not controlled by the NCR but by the imperial module (NIM). Activation passes through the CAN line.

Gearbox operating strategies SOFAST 4 with Superfast shift

Robotized gearbox of the GranTurismo S model (Sofast 4 with Superfast shift) has two main operating modes: MANUAL and AUTO.
Both modes can be overlapped with the SPORT function, which makes gear changes quicker. In particular, in MANUAL+SPORT mode the Maserati GranTurismo S activates the innovative MC-Superfast shift gearshift function.

The Maserati GranTurismo S Robotized gearbox system has a total of six operating modes:

- **Manual Normal**
- **Manual Sport**
- **Manual Sport with MC-Superfast shift**
- **Auto Normal**
- **Auto Sport**
- **Ice**



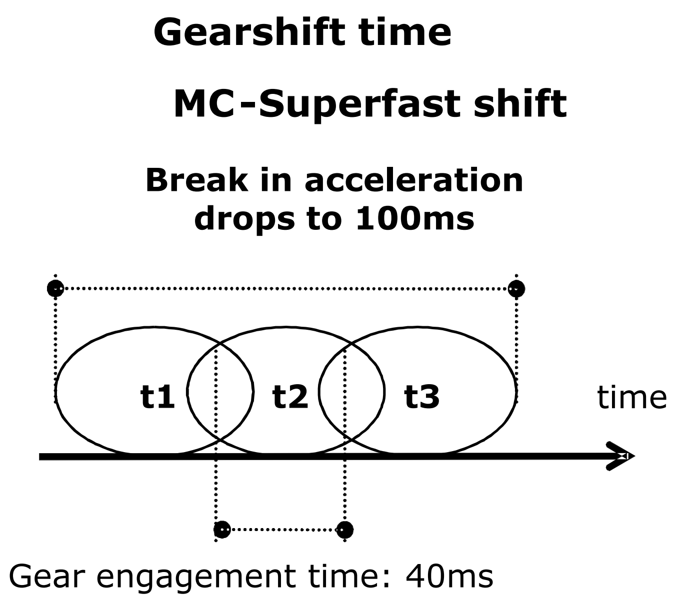
Manual-Normal mode:
In MANUAL NORMAL mode the choice of gear lies solely with the driver. To ensure greater driving enjoyment the system holds the gear when the limiter is reached; the control unit merely checks that the gear requested matches engine speed, so as to avoid taking it beyond the limiter when shifting down, or below the minimum speed when shifting up.
With engine speed above 4,000 rpm and the accelerator depressed through more than 80% of its travel, the fuel cut-off strategy is activated on each gear change: during the gearshift this function shortens the time taken to discharge torque and limits engine speed reduction, enabling quicker gearshifts.

Manual-Sport mode:

In MANUAL mode, pressing the SPORT button causes the transmission control system to adopt a more performance-oriented gearshift strategy, with much shorter times to change between one ratio and another. When moving down to lower gears, each shift is accompanied by a more pronounced double de-clutching effect.

MC-Superfast shift:

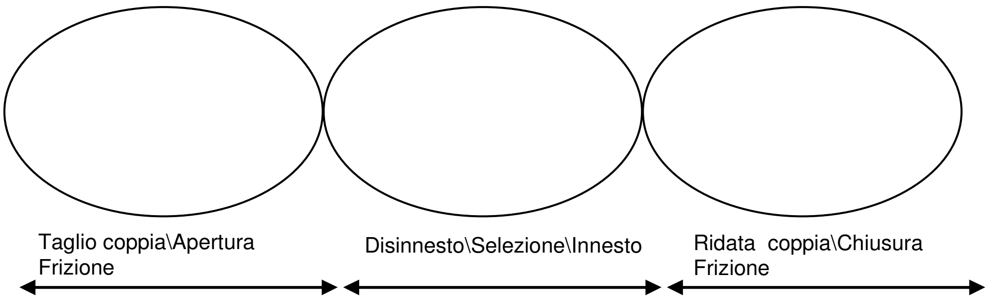
The MC-Superfast shift gearshift function is the most recent innovation of the electro-actuated Robotized gearbox system: this mode exploits the elastic energy of the transmission parts and delivers top performance in terms of gearshift times. This means that the shift time (calculated as the break in acceleration) drops to 100 ms, ensuring maximum sports characteristics and exhilarating driving.



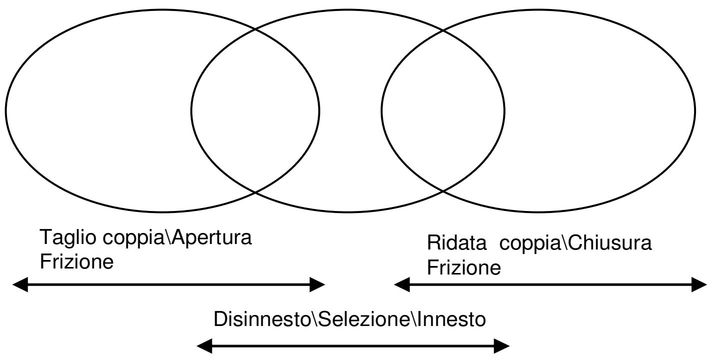
The Robotized gearbox management software enables gear engagement/ disengagement to take place in parallel with the opening/closing of the clutch. In this way the gearshift time, which is calculated according to the acceleration gap (and not just the time it takes to engage the gear) is reduced by activating the various operations at overlapping times:

1. Torque interruption and clutch disengagement (t1)
2. Gear disengagement, selection and engagement (t2)
3. Clutch engagement and torque recovery (t3)

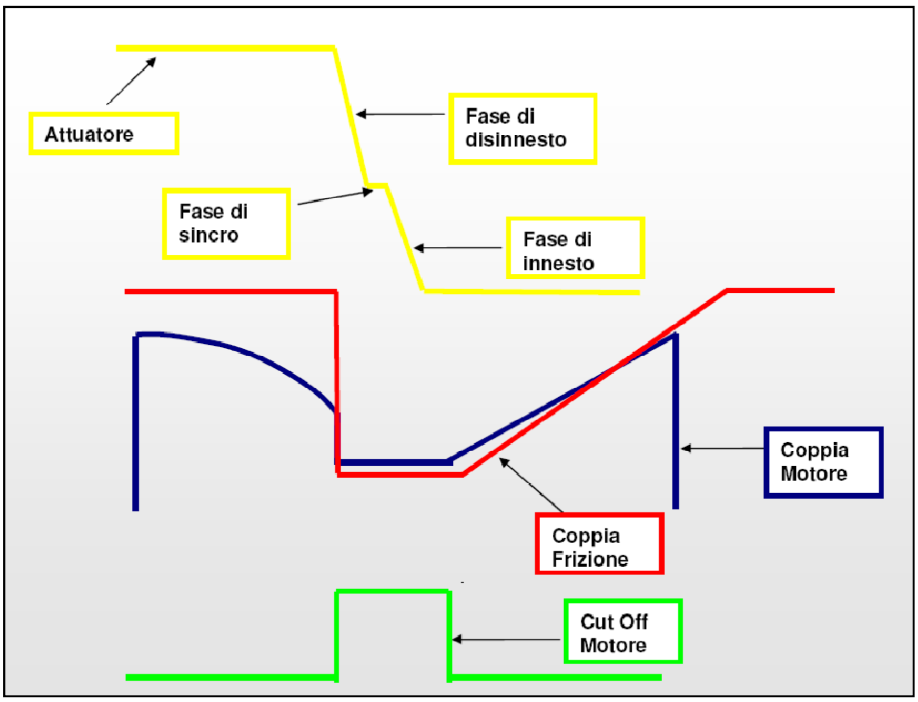
Cambiata Sport



Cambiata MC-SuperFast



Synchronisation of different gearshift-related actions:

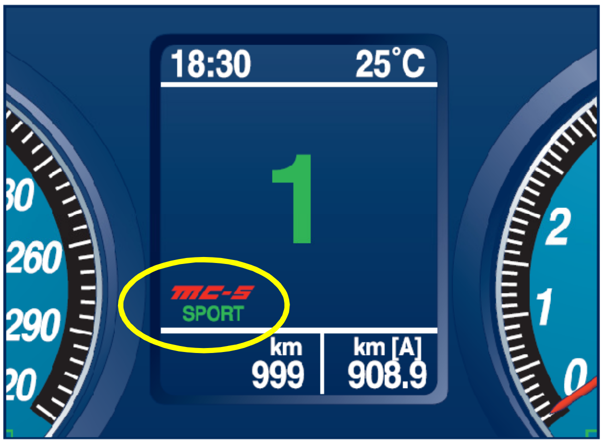


Superfast shift is available only when shifting up and in Sport mode. With regard to gearbox hardware, in order to support Superfast shift the hydraulic pump has been oversized to be able to deliver the increased pressure of the system, which under extreme conditions is twice as high compared to conventional use. A direct wire connection has been installed between the transmission control unit and the engine control unit, to increase the communication speed with respect to the conventional CAN communication line.

When is MC-Superfast shift available?

Superfast shift is only available in MANUAL SPORT mode.

With the vehicle in a steady state with hydraulic circuit oil and engine coolant at operating temperature and the clutch at normal operating temperature, in Manual Sport mode the letters **MC-S** light up on the dashboard display.



Moreover, the following conditions must are present:

- Engine speed > 5500 rpm
- Accelerator pedal fully depressed (>80%)
- Lateral acceleration <0.9g
- ASR inactive
- No wheel slip present

If one or more of the conditions above are not met, a normal gearshift occurs instead of a Superfast shift.

Note: there is no Superfast shift for downshifting

Auto-Normal mode:

In Auto mode the gear change is managed completely automatically by the transmission electronic control system. The control unit determines engine speed and moment of the shift as well as its speed, based on parameters such as vehicle speed, engine speed and the driver's request for torque and power. In AUTO mode a gear can also be requested manually through the paddles behind the steering wheel (gear suggestion).

The system recognises the type of driver by means of functions that assess the driver's style of driving through lateral and longitudinal acceleration and accelerator pedal movement. If a sportier driving style is recognised, the "UP" shifts are moved to a higher number of engine revs. The control system also recognises the type of road, adapting gear changes when the road climbs or falls, on a bend, in town and on motorways.

AUTO NORMAL mode is the mode most designed for comfort: changing to a higher gear is required as soon as possible in order to obtain the lowest level of vibrations and acoustic return from the engine. Shifting is managed in such a way as to ensure that gear changes are ultra-smooth. This mode also ensures lower fuel consumption when combined with a normal and non-aggressive driving style.

This does not mean, however, having to give up on the car's sporty nature: during sports driving, with frequent opening of the throttle, gearshift speeds approach those of the AUTO SPORT mode.

In AUTO mode, the engaged gear will be indicated on the info display on the instrument cluster.

Auto-Sport mode:

AUTO SPORT mode is activated with the transmission in auto mode and by pressing the SPORT button located on the centre dashboard: gear changing is still managed automatically by the transmission control unit, but by varying the speed of the operations to open up and reduce torque, disengage, select and engage gear, close the clutch and restore engine torque. The result is a faster gear change and a more sporty driving feel.

Compared to AUTO NORMAL mode, shifting up takes place at higher engine speeds, whereas moving down a gear is accompanied by a more pronounced double de-clutching effect.

Ice mode:

This mode can be used on particularly slippery road surfaces (snow, ice), or more generally in low-grip conditions. It is activated through the ICE button located on the centre tunnel. When switched on, the system avoids having to run the engine at more than 3,000 rpm.
ICE mode takes priority over SPORT and MSP OFF modes: this means that when the driver requests the ICE mode, Sport mode is deactivated automatically (if it was on) and the stability control (MSP) restored (if previously deactivated).

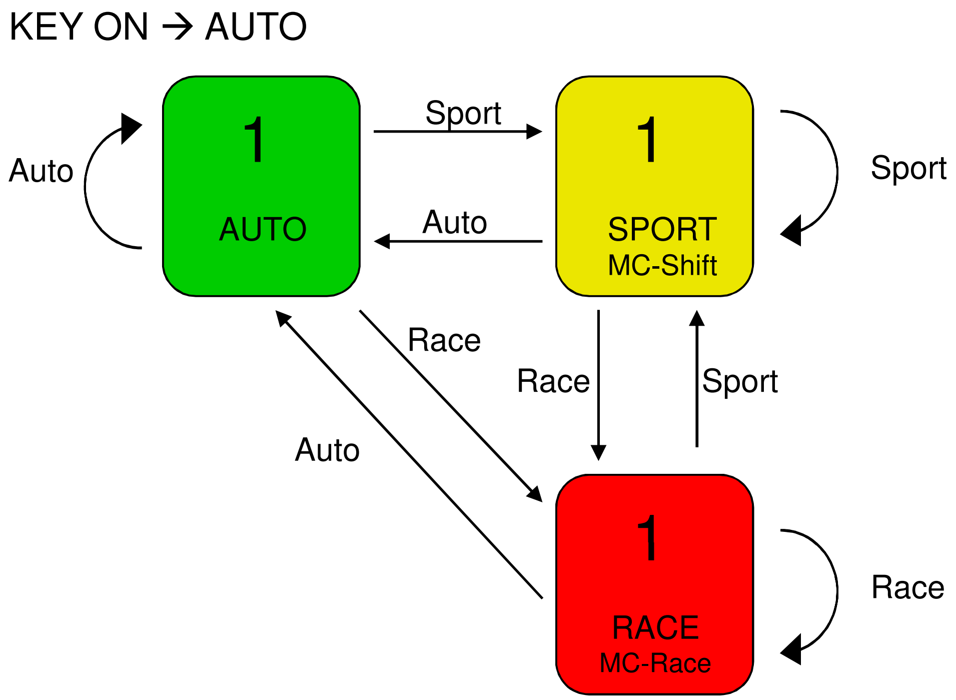
Automatic mode with Easy-exit:

The default configuration of the gearbox is Automatic mode. If requested, the Auto mode can be switched off (and Manual mode activated) by pushing the “Auto” button on the centre console.
If the engine is switched of with the gearbox in Manual mode, at the next engine start the system will activate the “Automatic with Easy-exit” configuration. This configuration will last for two minutes during which the “Auto” indication on the info display will flash.
If during this period while the car is driving a gear is selected manually, the gearbox will exit the Auto mode en go to Manual mode. If during this time no gearchange request is made, the gearbox will go to Auto mode.

Note: for what concerns the “Sport” and “Ice” modes, at engine restart the robotized gearbox configuration is the same as when the engine was switched off.

Gearbox operating strategies SOFAST 4 with Superfast shift 2 (CV2)

The robotized gearbox of the GranTurismo MC Stradale model is operated through the gearshift paddles on the steering wheel and through the buttons on the centre console for 1st gear and reverse gear engagement and for activation of the AUTO, SPORT and RACE driving modes.



Selection of the three different driving modes: Auto, Sport and Race

Selecting one of these three modes, the gearbox software strategy implements an adjustment of the gear engaged, shifting one or two gears down depending on the mode selected.

This should give the driver the feeling that the vehicle responds quickly and promptly to his precise request for high performance driving.

The gear engaged is adjusted in relation to the transition of state controlled with the buttons as indicated on the next page.

Driving mode selection:

Auto → Sport, if the conditions are satisfied: One gear down

Sport → Race, if the conditions are satisfied: One gear down

Auto → Race, if the conditions are satisfied: Two gears down or one gear down

Race → Sport, if the conditions are satisfied: One gear up

Sport → Auto, if the conditions are satisfied: One gear up

Race → Auto, if the conditions are satisfied: Two gears up or one gear up

Driving mode	Auto	Sport	Race
Gearshift times	240 ms	100 ms	60 ms
Automatic gearshifting	Yes	No	No
Manual gearshifting	Yes	Yes	Yes

Auto Mode

The gearbox strategy requires that the vehicle always be started in automatic mode. In this operating mode, the gearshifts are completely automatic based on a gearshift map programmed in the Robotized Gearbox Node (NCR). The gearshift strategy has been defined to get the best compromise between driving comfort, contained consumptions and vehicle performance.

In this mode, the gear engaged is shown on the display together with the indication "AUTO".

Note: When driving in automatic mode, gearshifting can still be manually controlled using the paddles on the steering wheel. When the driver uses the manual controls, the gearbox temporarily goes back to Manual mode; during this interval, the indication "AUTO" on the display flashes for about 5 seconds, after which the system goes back to Automatic mode.

"Auto easy-exit mode" strategy

Every time the engine is started, the gearbox system is set to AUTO mode. If the engine is turned off with either SPORT or RACE mode set, the next time the engine is started, the "Auto easy-exit mode" strategy activates AUTO mode.

This condition is indicated by the word "AUTO" flashing on the display. This strategy allows the driver to go back to SPORT mode simply by first shifting gears manually (using the UP and DOWN paddles).

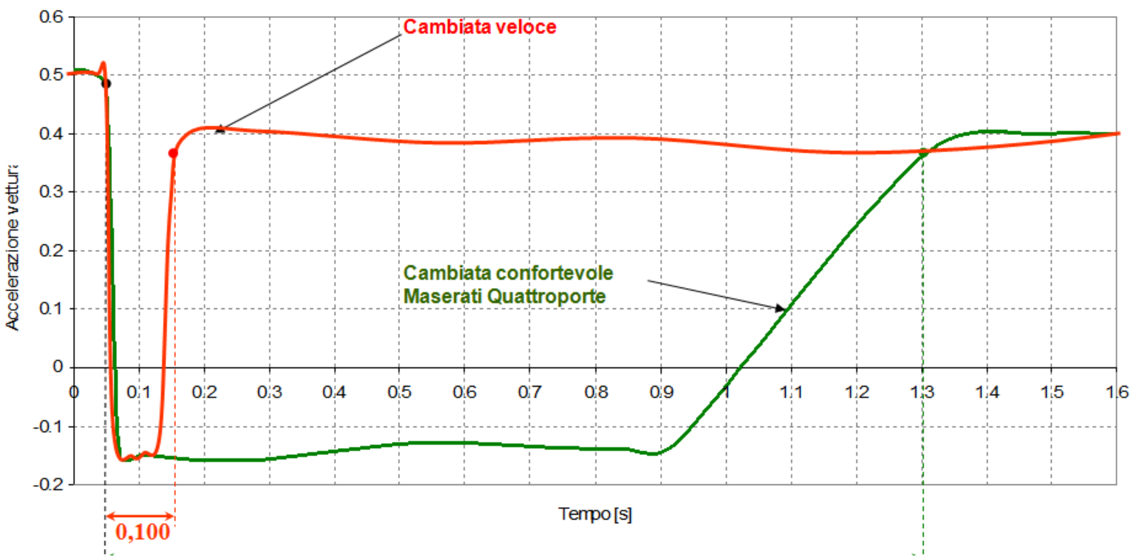
If the driver does not shift gears after two minutes of driving, the system automatically activates AUTO mode.

SPORT mode

In SPORT mode, the gearbox control system follows a gearshift control strategy more focused on performance, with much shorter changing times between one gear and the next in relation to RPM and the accelerator pedal position.
In SPORT mode, the exhaust pneumatic valves are open. In addition to giving the engine a fuller and deeper sound, the lower counter pressure allows the engine to increase its RPM more rapidly and enhance its maximum power.
Downshifting is accompanied by a more accentuated double-clutch effect.
Upon exceeding 4000 RPM and with the accelerator pedal 80% depressed, the fuel cut-off strategy is activated (engine turned off and fuel supply cut off) during gearshifting: this reduces the torque discharge time and the drop in engine RPM, resulting in faster gearshifting.

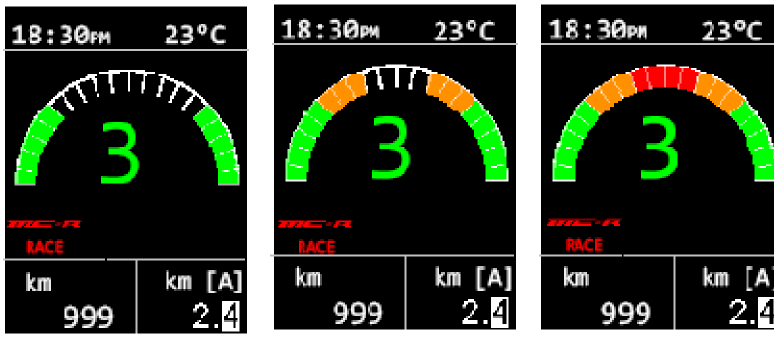
RACE mode

Gearshifting in RACE mode is the most recent innovation of the electronically-controlled gearbox system. This mode exploits the elastic energy of the transmission devices and results in very fast gearshift times and absolutely outstanding performance. The result is a gearshift time which drops to 60 ms (measured as acceleration dip), a value that ensures the best sports handling and unrivalled driving emotions.



Sequential downshifting strategy

Sequential downshifting can be obtained by setting one of the two manual modes, SPORT or RACE, and holding the DOWN lever pulled and the brake pedal depressed. The number of downshifts and the downshift speed depend on the braking duration and intensity.



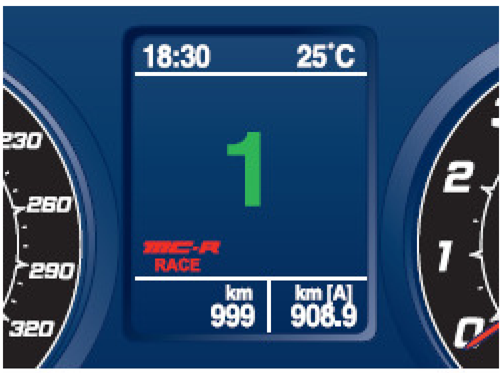
In RACE mode, the GranTurismo MC Stradale can change gear in just 60 milliseconds (0.06 seconds) thanks to computerised control and gear selection optimisation. The MC-Race gearshift is available only if specific conditions are met: a temperature suitable for all the vehicle systems has been reached and the accelerator pedal is at least 65% depressed. When these conditions occur, MC-Race fast gearshift is activated, which is indicated on the display with the red “MC-R” pictogram.

RACE gearshift in 60ms. When?

Race gearshift is available in RACE mode only.

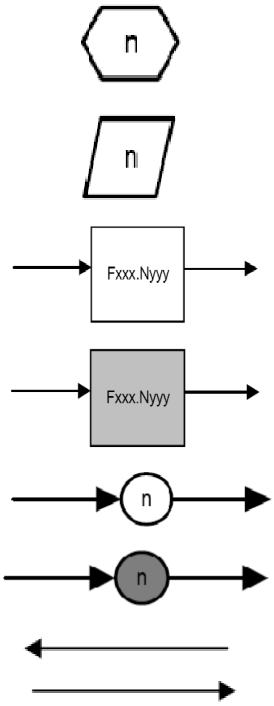
When the system hydraulic fluid and the engine coolant have reached the operating temperature and RACE driving mode has been selected, the letters MC-R illuminate on the display. This means that the following conditions have occurred:

- Engine speed > 5000 RPM
- Accelerator pedal depressed >65%
- Lateral acceleration <0.9g
- ASR not in operation
- No wheel spin



Activation of this strategy is communicated to the driver via the “MC-R” icon, which at first flashes on the display and then remains permanently illuminated.

Communication flow of parameters involved in gearbox control.



Input/output with sensor/actuator included

Input/output with sensor/actuator not included

B-CAN node

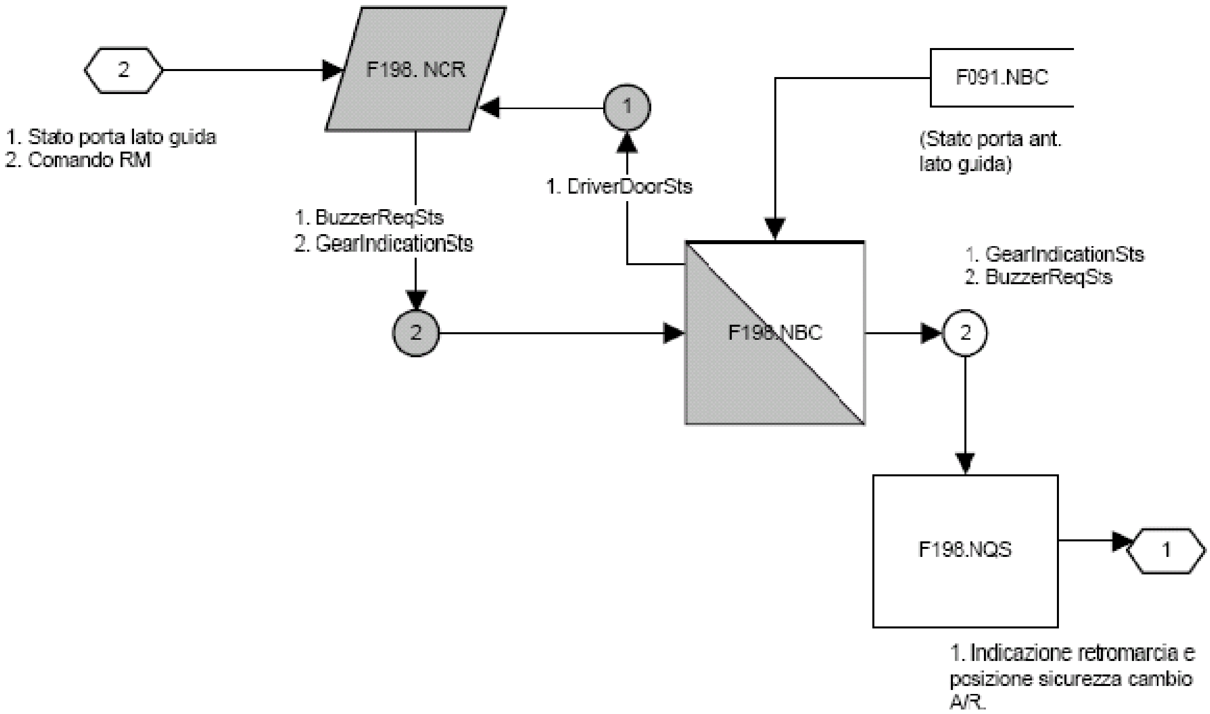
C-CAN node

B-CAN signal (n = number of data units)

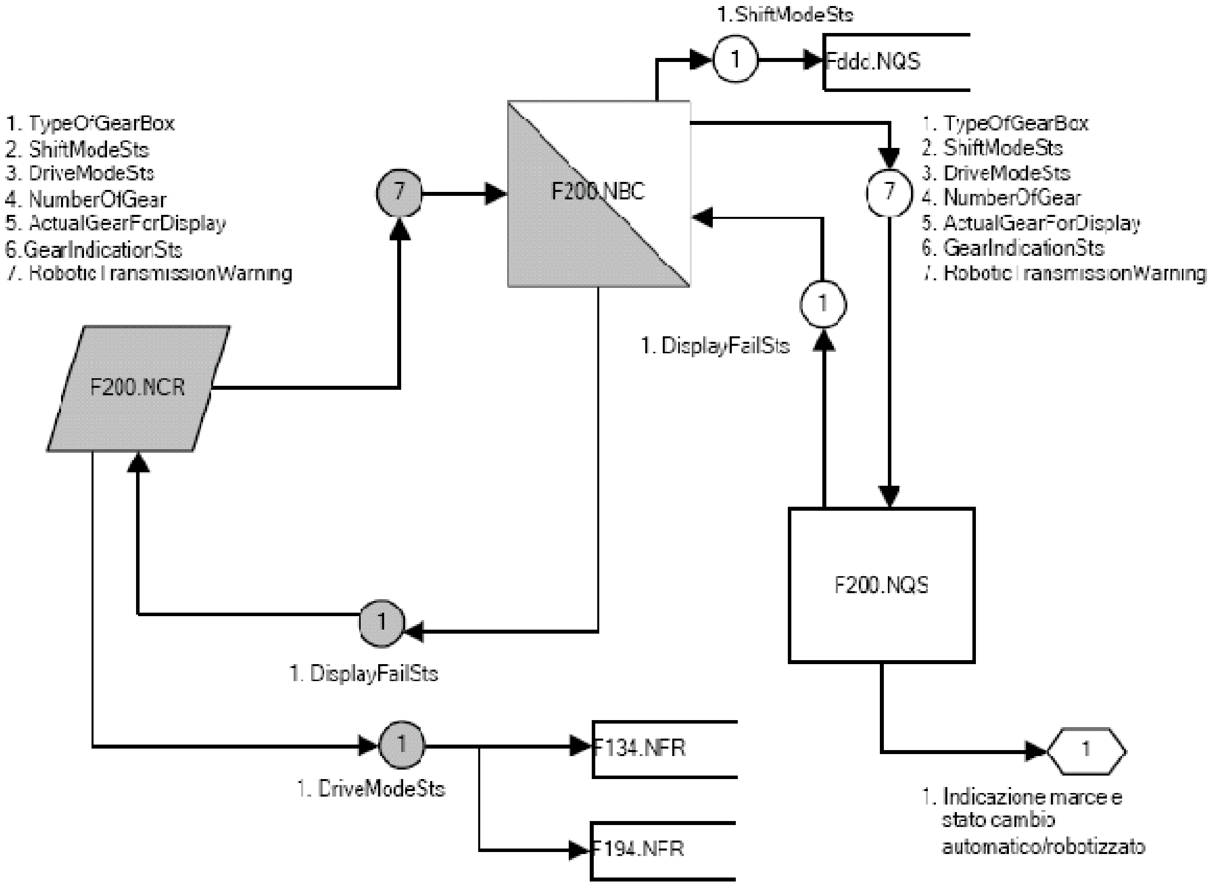
C-CAN signal (n = number of data units)

Non-CAN signal (hard wire)

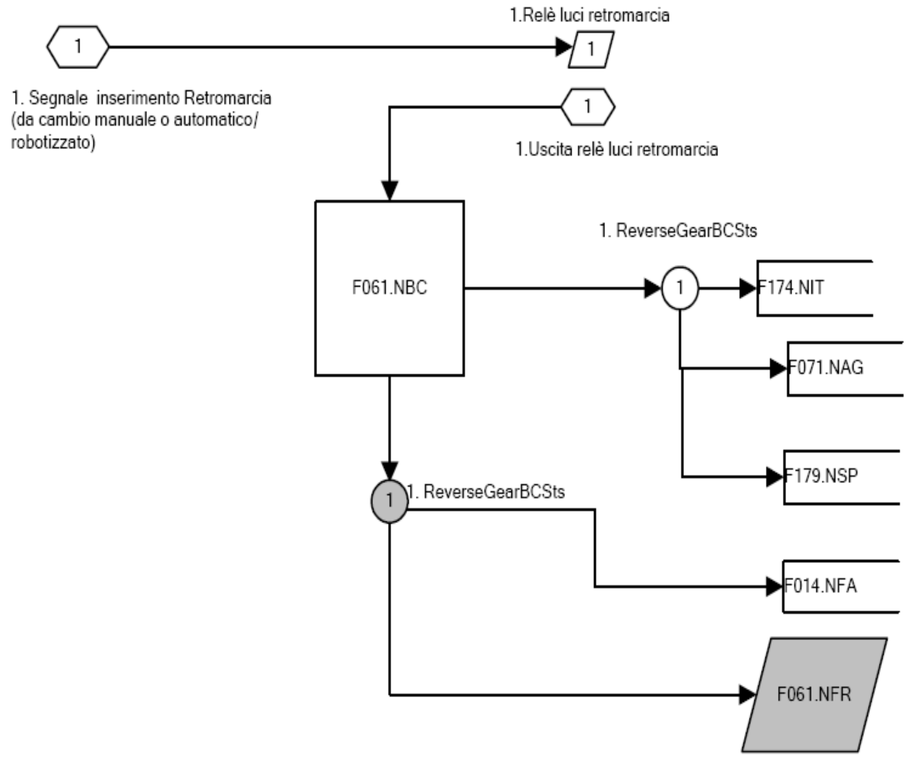
Buzzer activation:



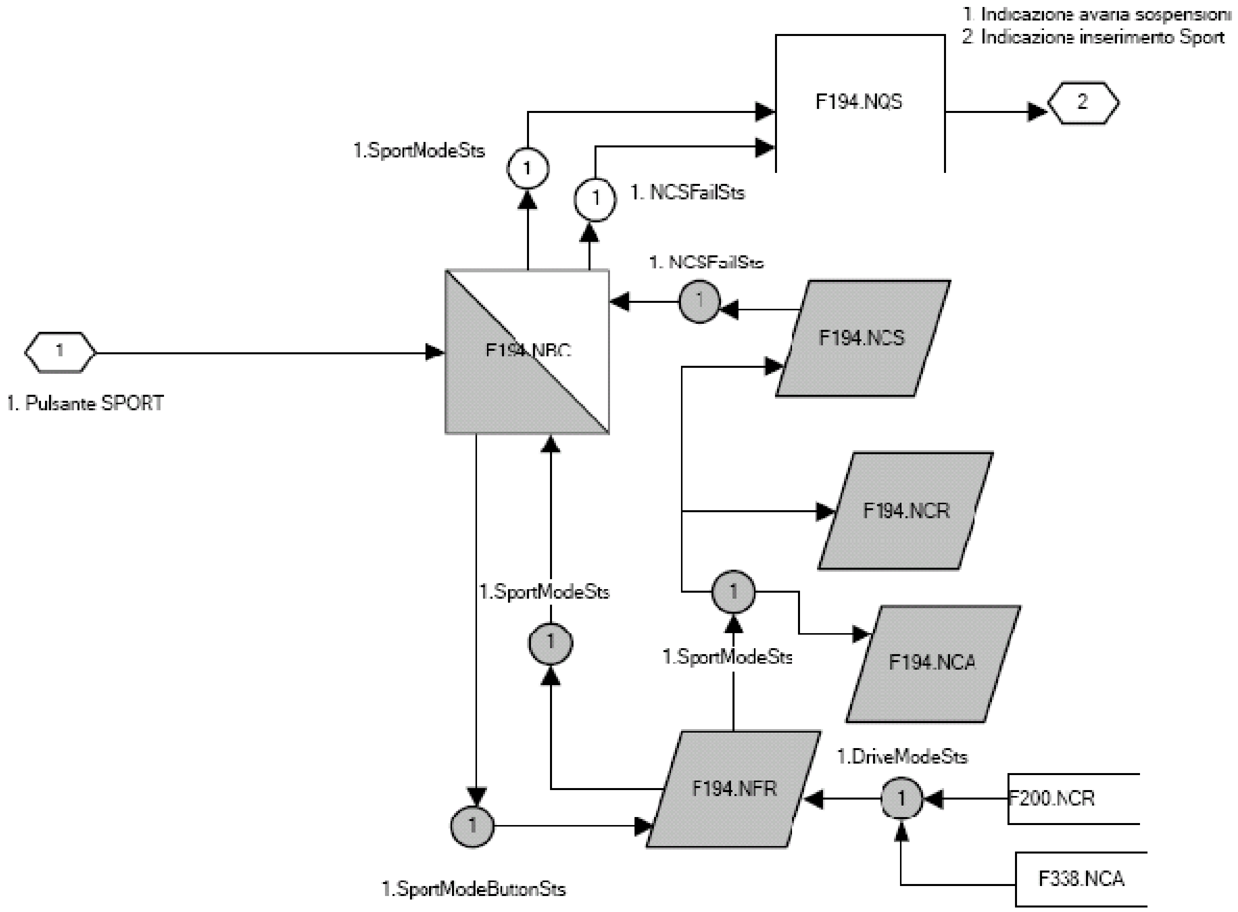
Status ef engaged gear signal:



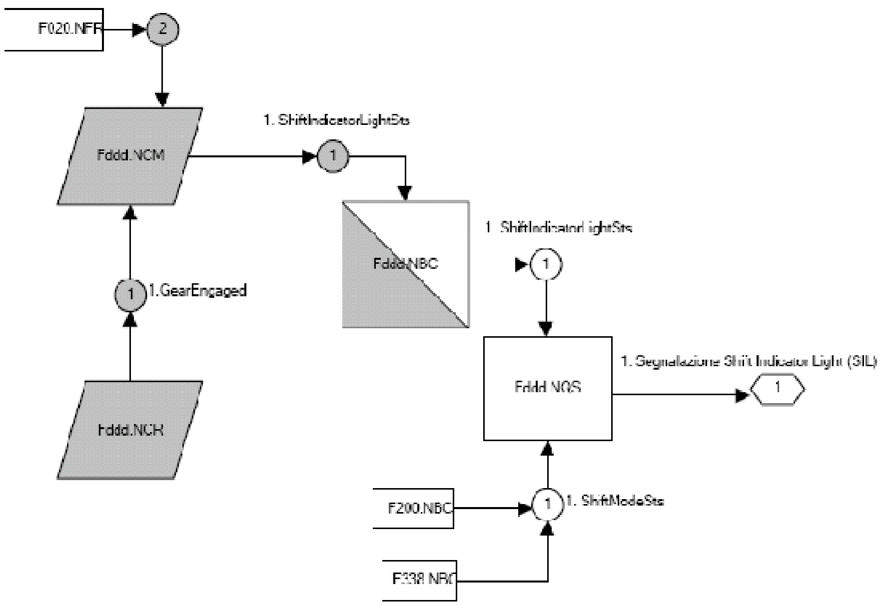
Reverse gear signal:



Sport mode activation:



Shift indicator signal:



Clutch operation management

Clutch operation management, and all strategies related thereto, is based on control of the clutch position calculated in real time.
The clutch control strategies are based on absolute references:

- clutch position
- transmissible torque

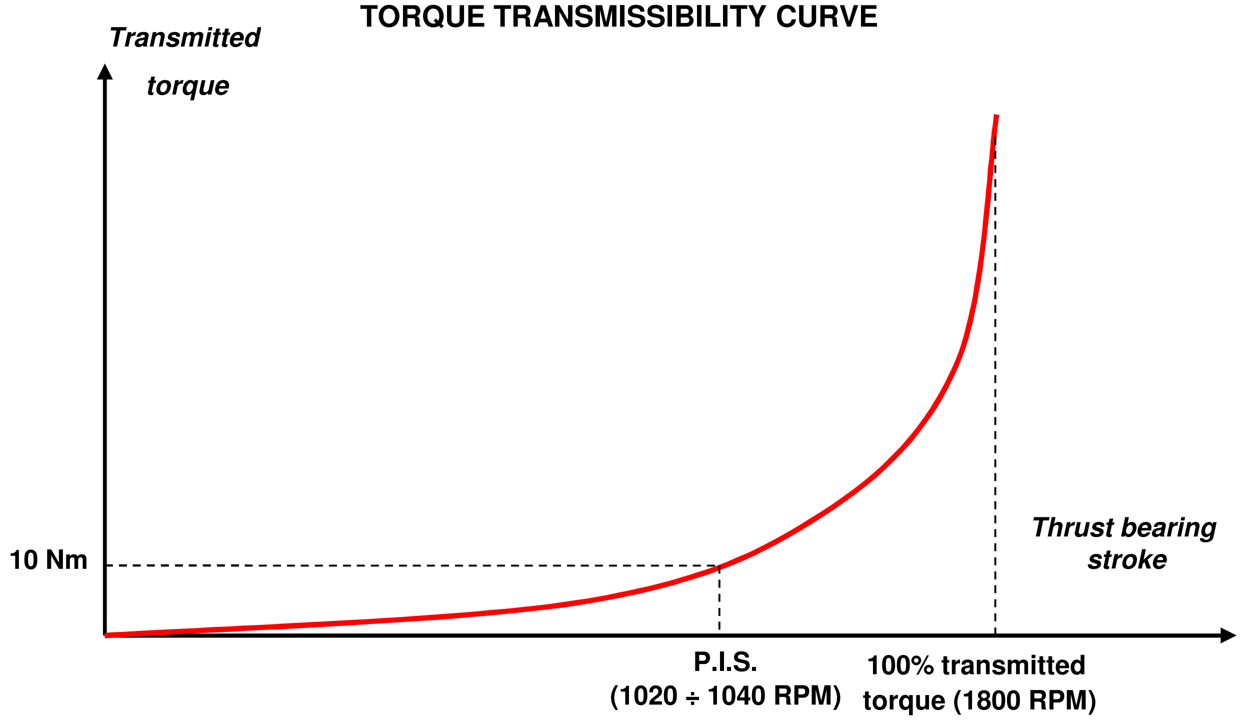
Calculation and control of the torque transmissibility curve depends on two positions:

1. KISS POINT (PIS position)
2. CLOSED CLUTCH POSITION

Kiss Point

The kiss point – also referred to as the PIS (Punto Incipiente Slittamento or slip beginning point) – is a parameter that defines the nominal value of the clutch engagement point in the gearbox control module (NCR). The kiss point is the actual thrust bearing position at the moment of clutch engaging, expressed in millimetres and in relation to the closed clutch position. The kiss point depends on various factors such as the clutch disc surface condition and clutch temperature. It does not depend on clutch wear

TORQUE TRANSMISSIBILITY CURVE



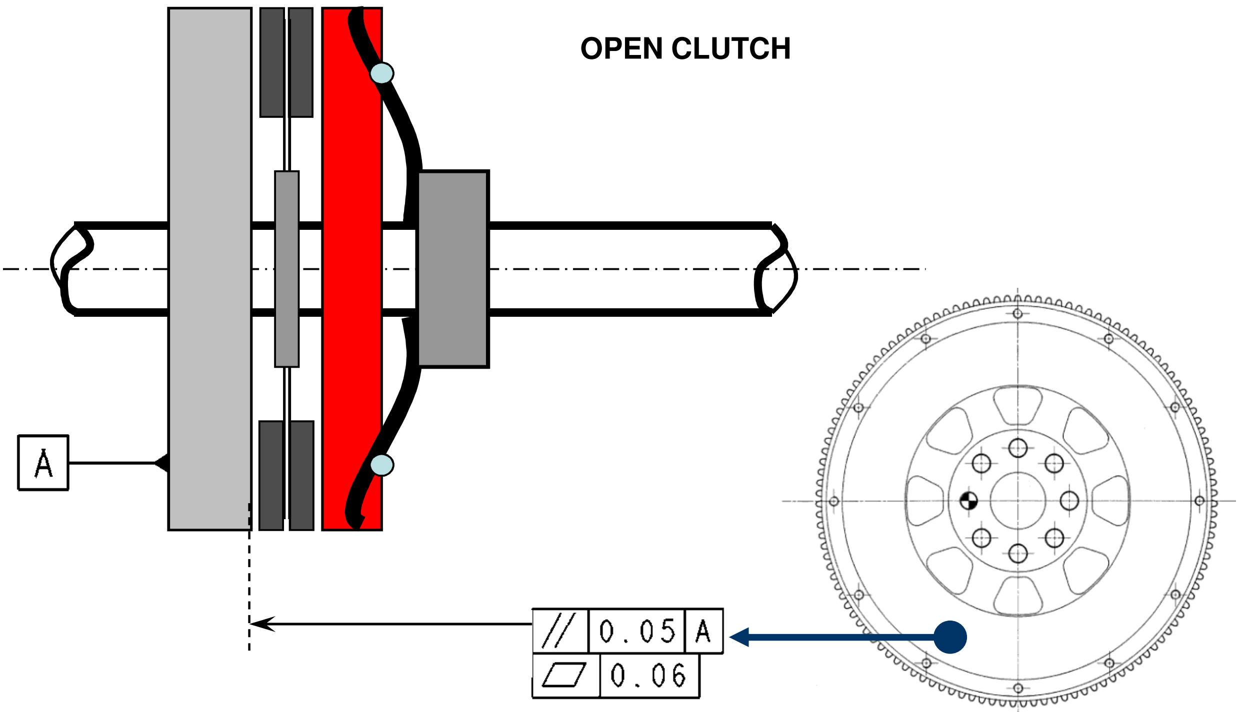
The kiss point is reached at between 1020 - 1040 RPM. The clutch “closes” and therefore full torque transmission is attained at 1800 RPM. When driving at below 1800 RPM and especially when travelling uphill, the temperature of the clutch disc tends to rise due to the clutch not being fully closed causing clutch slip. This results in disc wear and drastically reduces the lifespan of the clutch.

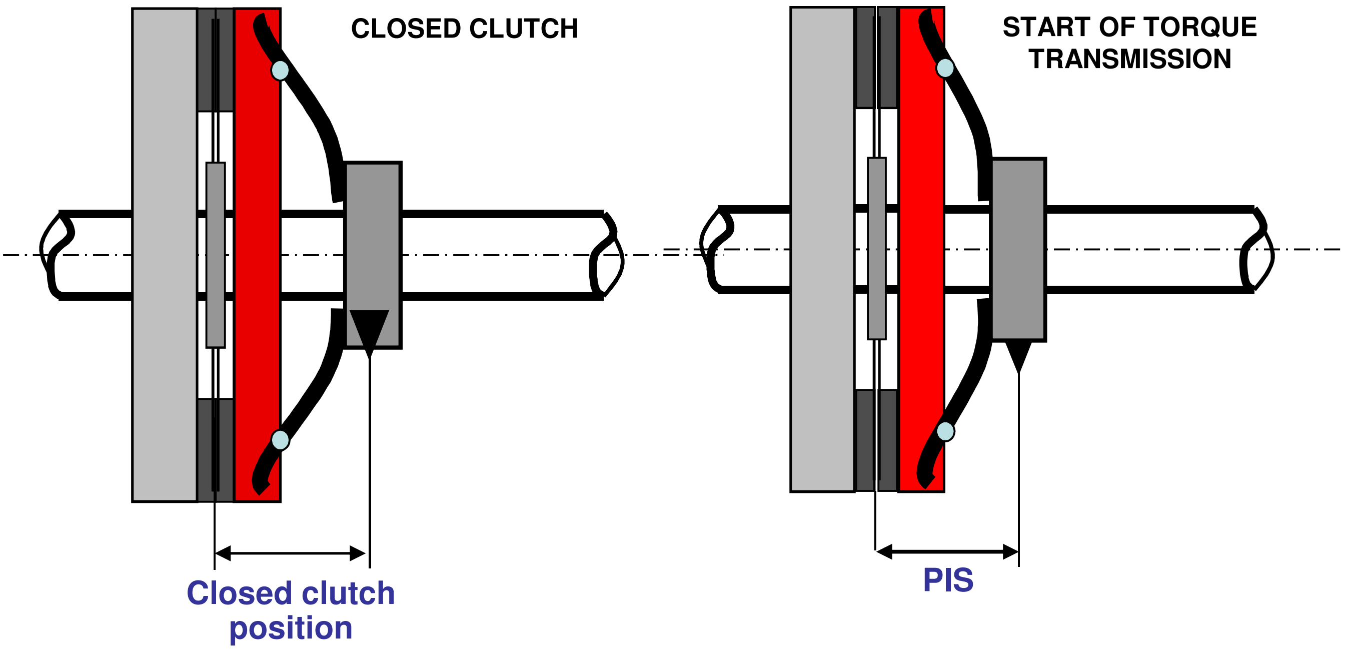
The kiss point can be set into the NCR module by means of a calibration procedure with the Maserati Diagnosi diagnostic tester. This procedure should be carried out after replacement of the clutch or the transmission control module. Since the temperature is an important factor for the determination of the kiss point, the calibration procedure should only be carried out at the correct clutch operating temperature. Correct calibration of the actual kiss point is crucial for correct clutch performance.

Kisspoint basic values				
Model	**System**	**Min**	**Standard**	**Max**
M138 Coupé, Spyder, Gransport	Pre-Sofast	4,8 mm	5,1 mm	5,4 mm
	Sofast 1	4,8 mm	5,1 mm	5,4 mm
	Sofast 2	4,8 mm	5,1 mm	5,4 mm
M139 Quattroporte Duoselect	Sofast 2	4,8 mm	5,1 mm	5,4 mm
	Sofast 3	3,9 mm	4,2 mm	4,4 mm
	Sofast 3 +	3,9 mm	4,2 mm	4,4 mm
M145 GranTurismo S	Sofast 4 Superfast shift	3,9 mm	4,2 mm	4,4 mm
M145 GranTurismo MC Stradale	Sofast 4 Superfast shift 2	3,9 mm	4,2 mm	4,4 mm
Alfa Romeo 8C & 8C Spider	Sofast 3 +	3,9 mm	4,2 mm	4,4 mm

Closed clutch position:

This is a value in mm which defines the thrust bearing position when the clutch is fully closed. This value depends on the clutch wear and is auto-calibrated after each gearshift.

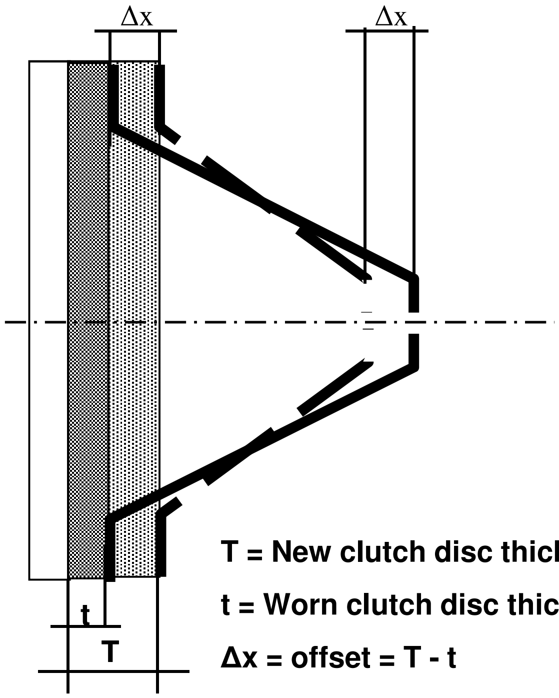




PIS value = CC position – PIS position

Calculation of clutch wear percentage:

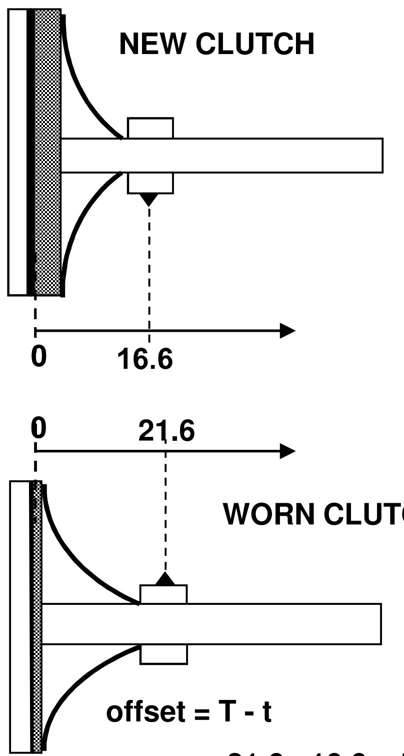
$$\frac{\text{Autocalibrated closed clutch value – NEW closed clutch value}}{\text{Clutch thickness (5.6 mm)}} \text{ X 100 = } \text{% Wear on clutch}$$



T = New clutch disc thickness

t = Worn clutch disc thickness

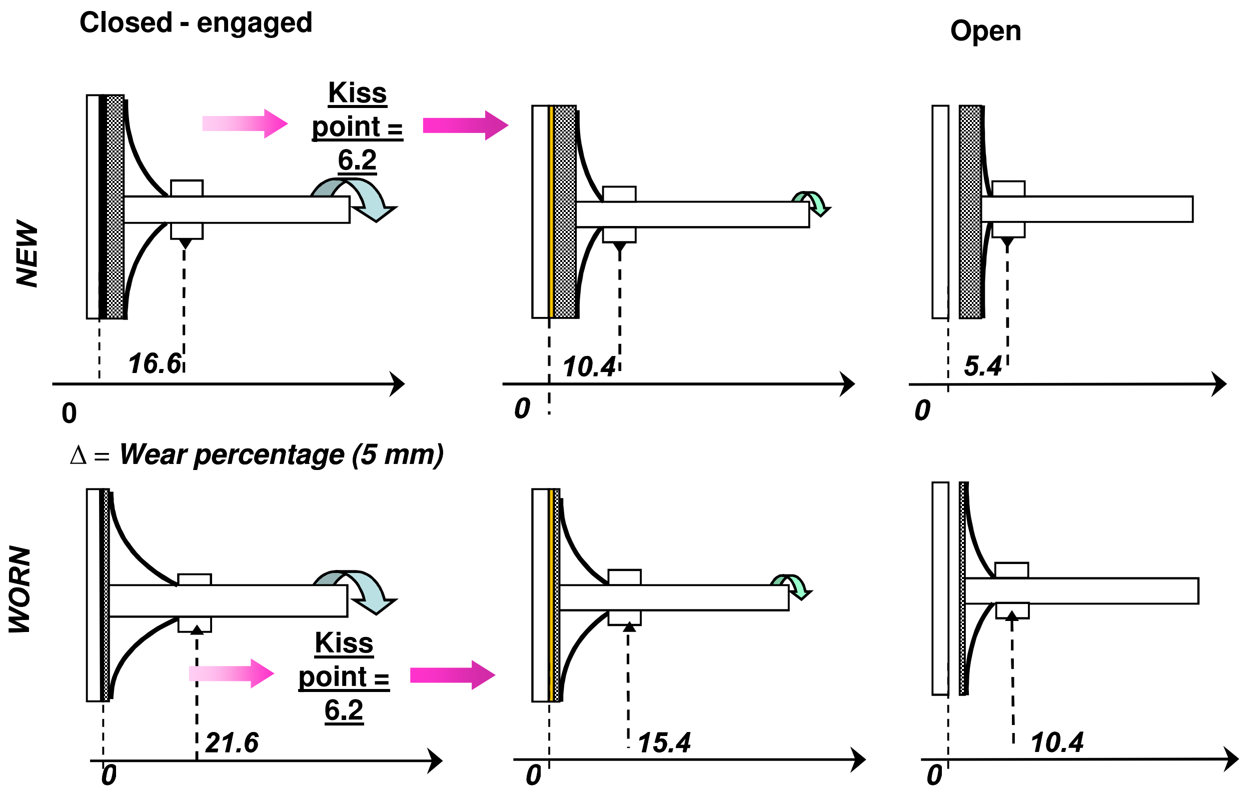
Δx = offset = T - t



offset = T - t

= 21.6 - 16.6 = 5 mm

Example of clutch position values in new and in worn condition

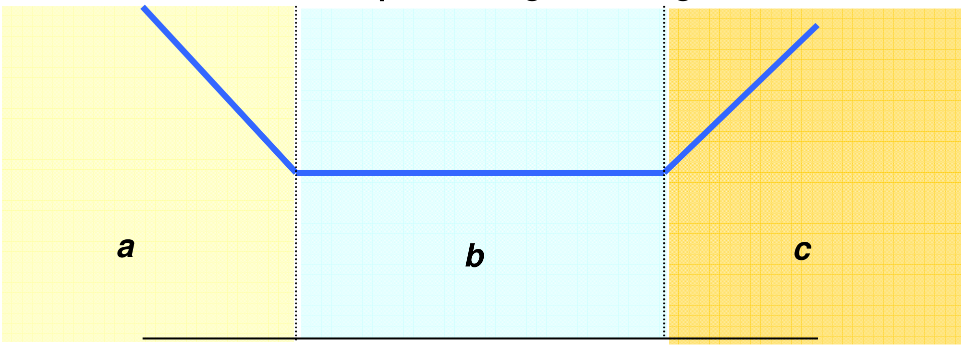


The clutch wear percentage does not affect the Kisspoint value!

Cluch position control

Real-time clutch open/close control by means of the position sensor, is calculated using the PIS value and the closed clutch position. During gearshifts, the NCR transmission control module becomes MASTER, while the NCM becomes SLAVE and sets a target torque value. Once the target torque value is reached, the NCM module reverts to the MASTER condition.

The three phases of gearshifting



a = Torque Reduction

The target torque is decided by the TCU (master)

b = RPM Control

The target torque is managed by the TCU (master) (120 ms)

c = Torque Transmission

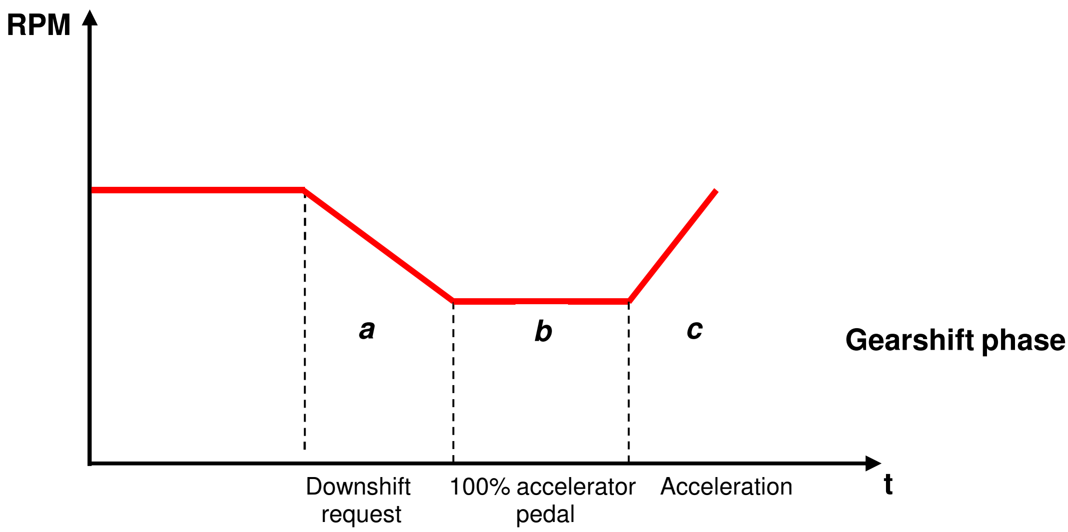
The TCU is now slave and MOTRONIC decides on the target torque value

Flow control by means of I_0 current management. Phase **b** control involves management of the EVF that controls the hydraulic flow, in function of in the controlling current. All Maserati electro-actuated control systems up to sofast II use this type of parameter, which must be calibrated in the event of malfunction or maintenance on the Power Unit.

Calibration is carried out as follows:

- Engine running with the gearbox in neutral for approx. 5 min.
- Engine running with the gearbox in 1st gear and foot on the brake for approx. 5 min.

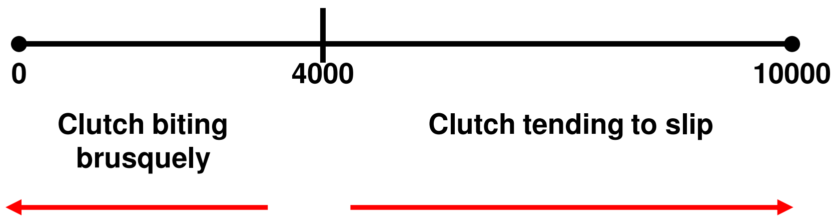
SOFAST III onward systems execute this procedure using the “DEIS” function.



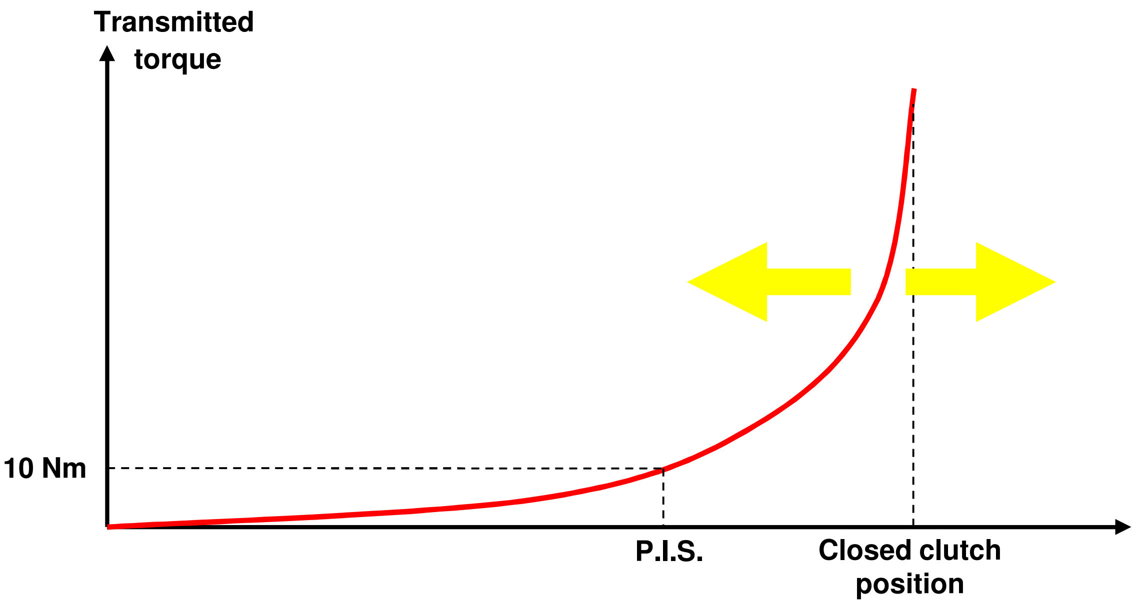
Clutch Wear Index (Sofast II onward)

The clutch wear index (also referred to as “clutch wear degree” or “clutch degradation index”) is a self-learned parameter which is used by the NCR to adjust the clutch management in function of the degradation of the torque transmissibility capacity of the clutch.

The clutch wear index can be found in the Maserati Diagnosi parameter menu and provides usefull information about degradation of the transmissibility of the clutch. The wear index is self-learnt by the NCR each time the clutch is in the closing phase.

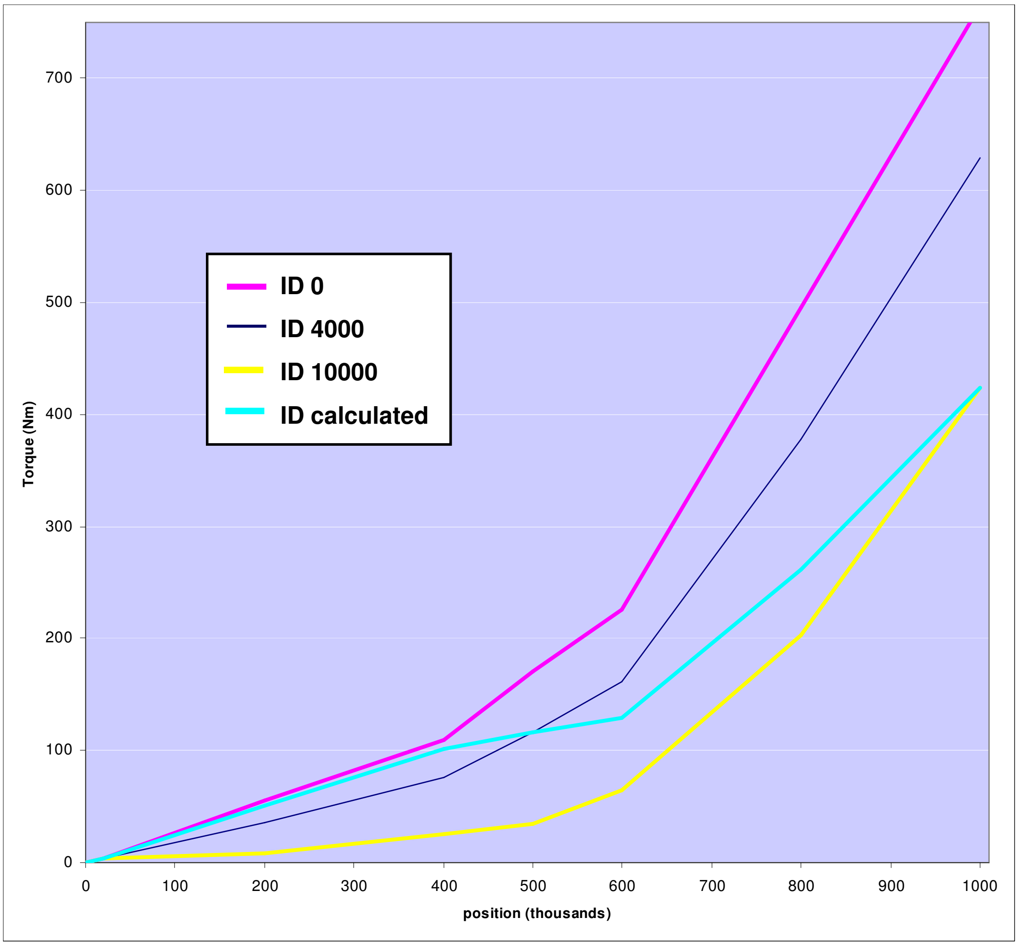


The clutch wear index is a value between 0 (100% torque transfer) and 10000 (no torque transfer, constant slipping of the clutch). The default value is 4000. A clutch that is operating correctly will have a wear index of around 3000/4000. If the clutch has not been replaced and the wear index is high, after performing the resetting and subsequent Kiss point procedures, the value of the parameter should fall.



On Sofast II and Sofast III systems, the clutch wear index is used by the NCR to “move up” the torque transmissibility curve which is used as a reference for clutch control. A clutch wear index of higher than 4000, will move the curve to the right, a lower to the left.

For Sofast III+, the calculation of the clutch wear index has been refined. The clutch wear index is no longer one single value, but 5 different points which together will define a new torque transmissibility curve.

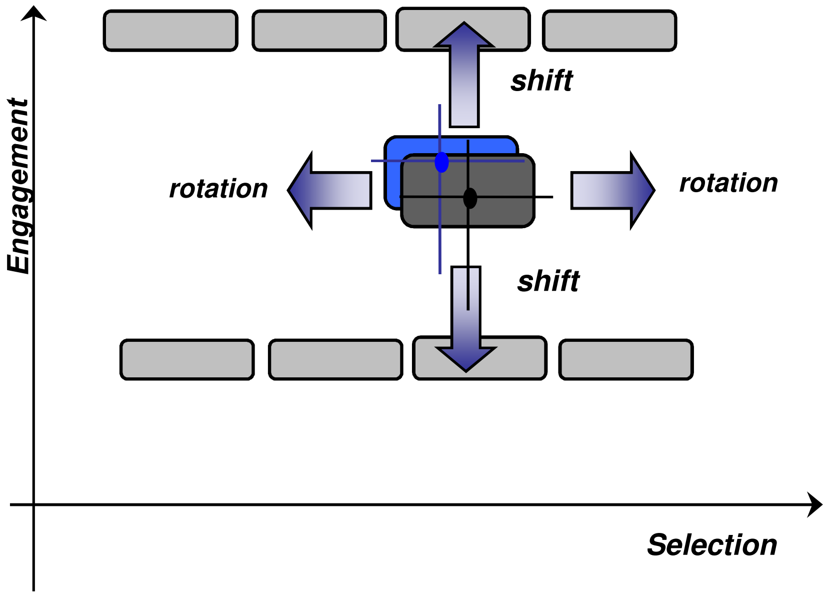


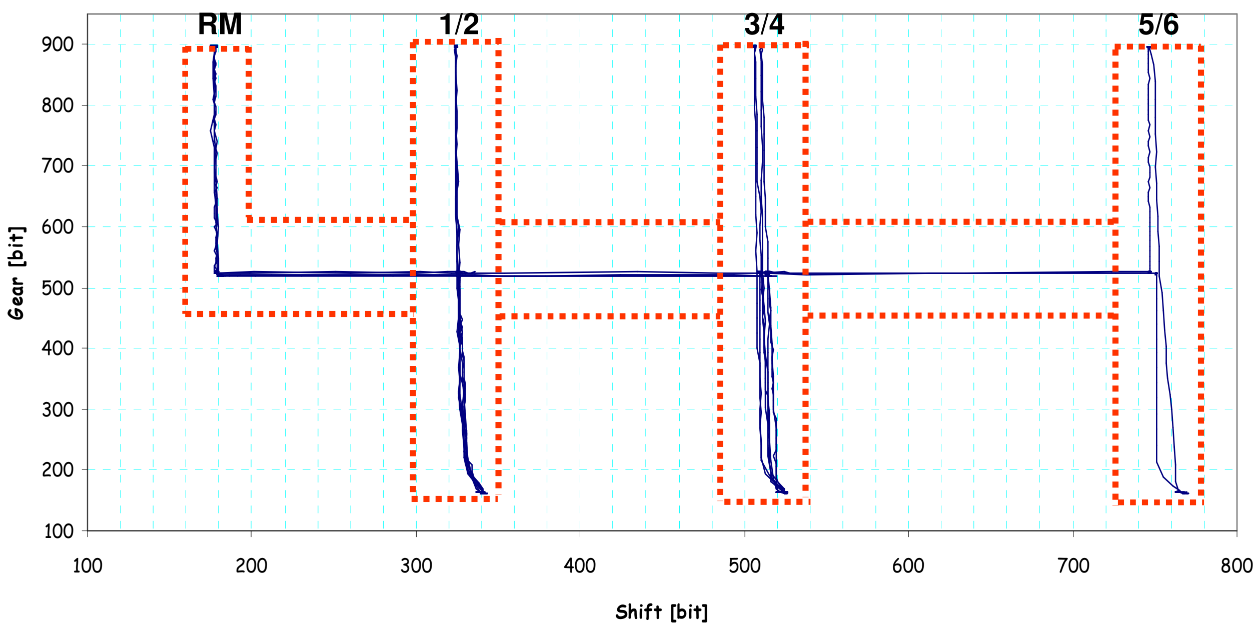
Note: the clutch wear index must be reset (= bring back to the default value of 4000) after replacement of the clutch and before performing the Kisspoint procedure.

Note (2): from Sofast III+ onward, the clutch wear index is no longer present in the parameter environment of the Maserati Diagnosi tester unit. The reset command (in the Active diagnoses menu) is still present and will reset all 5 values.

Gear engagement strategy

The gear engagement and selection values are self-learnt and stored in the NCR by means of two position sensors which must be within strictly defined ranges. By means of this procedure, the NCR builds a grid and checks 2 engagement and 2 selection thresholds (MIN and MAX). The calculation grid spreadsheet can be used to check the correct centring and movement of the actuator. It is advisable to execute a calculation grid when the vehicle is new and after each maintenance operation on the gearbox, and to keep documentation archived for future reference.





Robotized gearbox system failure

Degraded functionality (recovery)

When the system detects validated faults of its components, the normal operation strategies are reconfigured and the system switches to operation in degraded mode (recovery).
The reconfiguration causes limited/degraded functionality depending on the fault. In the case of failure, the NCR reconstructs the signal using a virtual sensor model, with the following inhibitions imposed on the system:

- The engine is started holding the foot on the brake and takes longer than the normal starting procedure.
- LIMP-HOME mode activation: an upshift can only be requested up to second gear, neutral and reverse.
- Gearshifting is slower than normal.
- The display flashes.
- If the engine cut out due to the failure, engine ignition is disabled.
- Clutch closing in neutral is disabled.
- Self-learning: not OK
- Bleeding: not OK

The following safety measures are implemented:

momentary suspension of the gearshift in progress if any of the following are detected:

1. incorrect gear selection
2. clutch not sufficiently open
3. gear input over-revving
4. immediate engine stop command (via CAN line) in situations when gear is engaged and during pickup or pickup delay, in the event that a hydraulic failure of the clutch subsystem is detected which causes the clutch to rapidly close again.

implementation of system safety measures in the event of failure of the main ECU microprocessor:

1. maintenance of existing drive status until the vehicle is about to stop
2. open clutch command when the vehicle is about to stop

Pressure Sensor Recovery:

The pump is independently pressure controlled: during a gearshift, the pump is activated; the “pump off” time depends on whether the clutch is in standby or activated (for example during pick-up); in the first case, the time is longer than in the second case.

Neutral may automatically be engaged if the fault occurs when the vehicle is stationary, with the engine running and a gear engaged. All gears are accepted.

- Self-learning: not OK
- Bleeding: not OK

Engagement / Selection Sensor Recovery:

Reconstruction of the signal through a virtual sensor model.

The engine is started holding the foot on the brake and takes slightly longer than normal.

- LIMP-HOME mode activation: An upshift can only be requested up to second gear, neutral and reverse.
- Gearshifting is slower than normal.
- The display flashes.
- Engine starting is disabled.
- Clutch closing in neutral is disabled.
- Self-learning: not OK
- Bleeding: not OK

Clutch Position Sensor Recovery:

- No gearshifts can be requested, except neutral from stationary, nor can the engine be started.
- Emergency clutch opening and engine stop request.
- A few seconds after the engine stop request, neutral is automatically engaged to allow towing the vehicle.
- Clutch closing in neutral is disabled.
- Self-learning: not OK
- Bleeding: not OK

Clutch Recovery:

Clutch closed during engagement:

- Emergency neutral request.
- All gearshifts are disabled until neutral is engaged and then re-enabled.

Hydraulic failure:

- Engine stop
- Open-loop neutral
- Gearshifting disabled

Clutch overrunning:

- Emergency neutral request.
- All gearshifts are disabled until neutral is engaged and then re-enabled.

Engine RPM Signal Recovery:

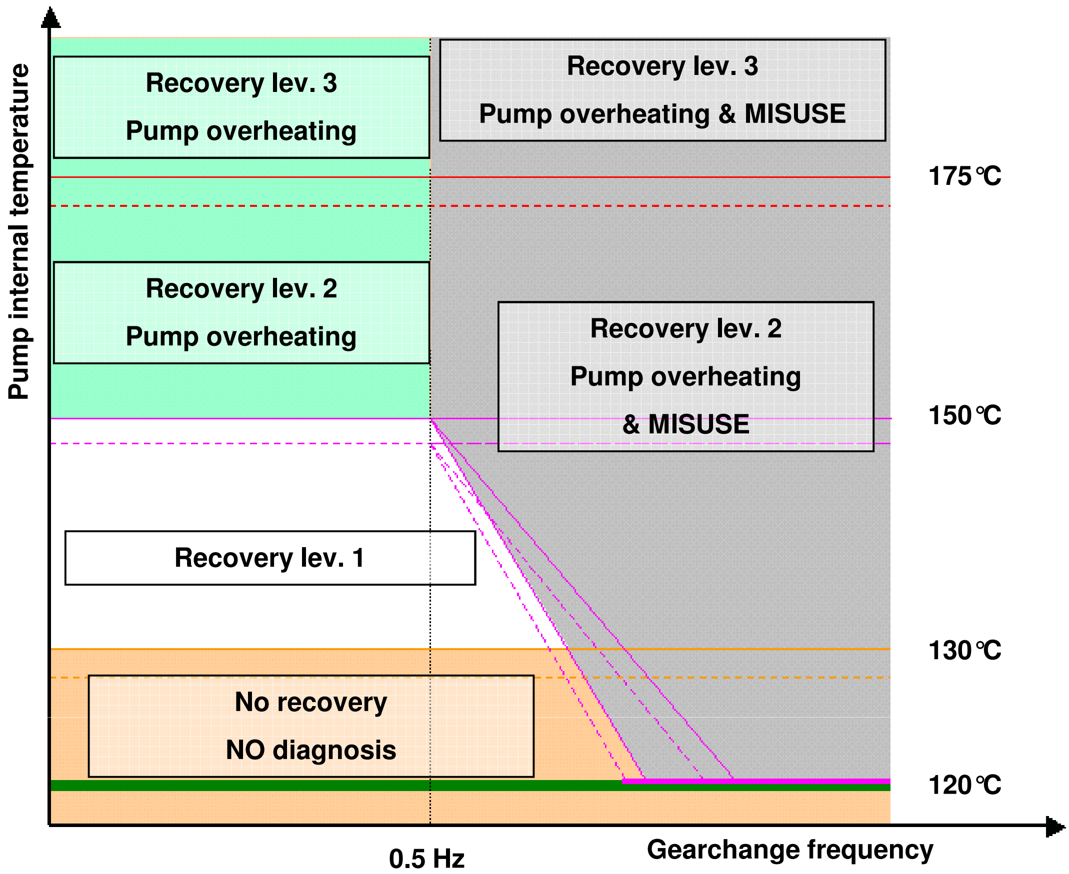
- The CAN value is used as recovery signal. If this signal is not available (for example, following a CAN line fault), engine RPM is set starting from the clutch RPM if the latter is closed, otherwise in relation to the accelerator pedal.
- In the event of a simultaneous fault in the engine RPM from CAN and in the primary gearbox RPM, emergency neutral is requested to then get ready for the pickup stage.
- Engine starting with gear engaged is disabled only in the case of a simultaneous fault in the engine RPM from CAN and in the primary gearbox RPM.

Lever Cluster Recovery:

- AUTO mode is automatically activated and all gearshift requests are disabled.
- The engine can be started by holding the brake pedal depressed; when the engine has started, the system automatically engages first gear and indicates engagement with the buzzer.
- If there is a lever fault when low-grip mode is active, the gears will not be automatically engaged and upshifting will occur from low-grip mode while downshifting will occur automatically as a result of under-revving.
- **REVERSE GEAR LEVER:** Once the fault has been validated, the lever requests are correctly accepted and reverse gear can no longer be engaged.

Electric pump overheating recovery strategy:

On the Sofast 4 system with Superfast shift shiftshiftShift, a specific recovery model is applied in base of the estimated pump temperature and the gearshift frequency.



Recovery level 1:

- Reduction of pump switch-off pressure threshold
- Reduction in dither amplitude of proportional solenoid valves
- Clutch autocalibration disabled
- Reduction in time taken to engage neutral and close clutch due to absence of commands pending breakaway acceleration (calibrated out-of-range)

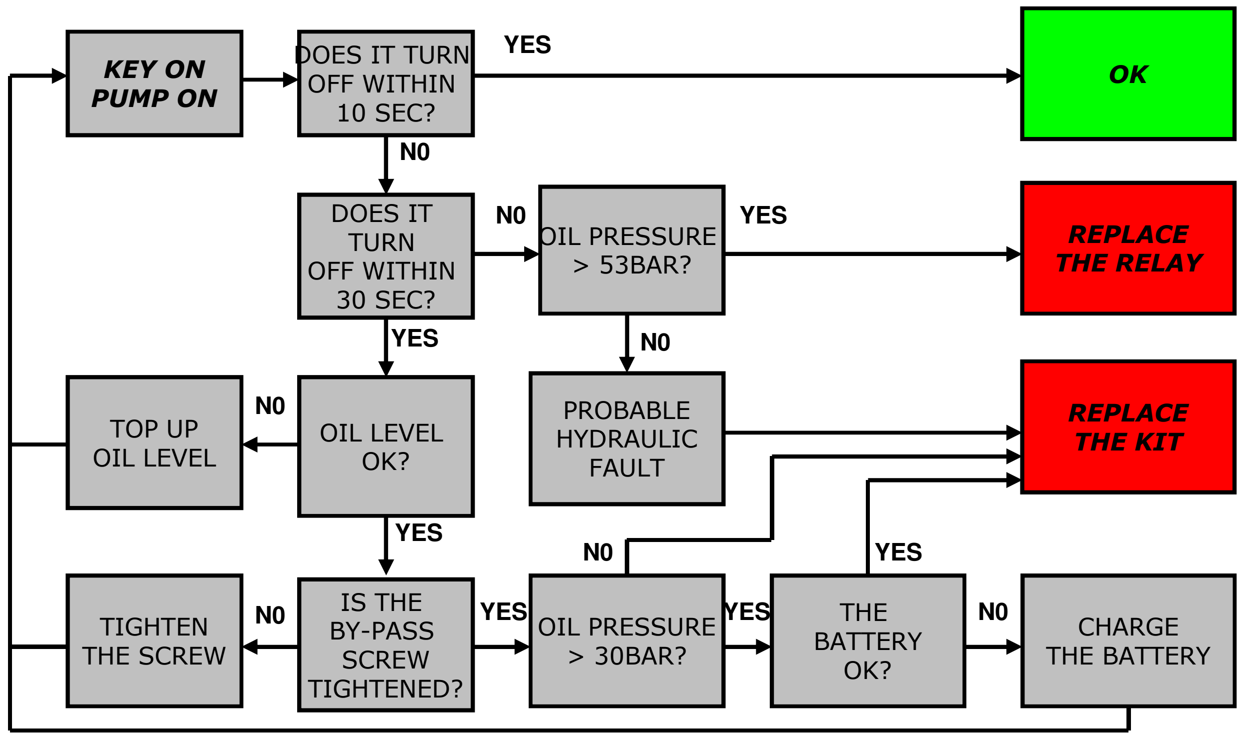
Recovery level 2:

- Recovery of level 1
- Gearshift limitations: in manual mode the overspeed and underspeed thresholds are modified to reduce the number of shifts; in automatic mode, dedicated gearchange maps are used to reduce the number of shifts
- Disable of Superfast shift shiftshiftShift mode

Recovery level 3:

- Recovery of level 1 and level 2
- Pump switched off so that its temperature returns to within normal operating limits.

Diagnosis flowchart for pump operation



Gearshifting problems

Gear jumping, difficult engagement, return to neutral while driving and/or stationary.

STEP	***OPERATION***	***RESULT OK***	***PROBLEMS FOUND***	***OPERATION***
0	Check the oil level (Procedure 2)	Continue with Step 1	Level different from MAX	Procedure 3
1	Check the oil pressure (Procedure 4)	Continue with Step 2	Incorrect pressure	Procedure 5
2	Check for ECU and wiring errors (Procedure 1)	Continue with Step 3	ECU errors	Procedure 1
			Wiring faults	Repair wiring
3	Check auto-calibration of the gearbox (Procedure 6)	End of diagnosis	Auto-calibration error (if never done or if unsuccessful), Gear engagement problems	Procedure 6

Failed engine starting

The engine does not start even though the battery is charged.

STEP	OPERATION	RESULT OK	PROBLEMS FOUND	OPERATION
0	Brake pedal switch check (Procedure 7)	Continue with Step 1	Irregular operation	Repair or replace the faulty component
1	Check for ECU and wiring errors (Procedure 1)	Continue with Step 2	ECU errors	Procedure 1
			Wiring faults	Repair wiring
			Ignition not possible (Step 5 Procedure 1)	Continue with Step 2
2	Check the oil level (Procedure 2)	End of diagnosis	Level different from MAX	Procedure 3
			Malfunction persists	Continue with diagnosis (C)

Impossible to engage gears

STEP	*OPERATION*	*RESULT OK*	*PROBLEMS FOUND*	*OPERATION*
0	Check the oil level (Procedure 2)	Continue with Step 1	Level different from MAX	Procedure 3
1	Check the oil pressure (Procedure 4)	Continue with Step 2	Incorrect pressure	Procedure 5
2	Check the steering wheel paddles and reverse gear lever (Procedures 8 and 9)	Continue with Step 3	Irregular operation	Repair or replace the faulty components
3	Check for ECU and wiring errors (Procedure 1)	Continue with Step 4	ECU errors	Procedure 1
			Wiring faults	Repair wiring
4	Check auto-calibration of the gearbox areas (Procedure 6)	End of diagnosis	Auto-calibration error (if never done or if unsuccessful) Gear engagement problems	Procedure 6

Frequent and persistent flashing of “F” (Fault) on the instrument display (certain older vehicles only)

STEP	*OPERATION*	*RESULT OK*	*PROBLEMS FOUND*	*OPERATION*
0	Check the oil level (Procedure 2)	Continue with Step 1	Level different from MAX	Procedure 3
1	Check the oil pressure (Procedure 4)	Continue with Step 2	Incorrect pressure	Procedure 5
2	Check for ECU and wiring errors (Procedure 1)	Continue with Step 3	ECU errors	Procedure 1
			Wiring faults	Repair wiring
3	Check auto-calibration of the gearbox areas (Procedure 6)	End of diagnosis	Auto-calibration error (if never done or if unsuccessful) Gear engagement problems	Procedure 6

Engine stalling

The engine turns off spontaneously when the vehicle is stationary.

STEP	*OPERATION*	*RESULT OK*	*PROBLEMS FOUND*	*OPERATION*
0	Check the oil level (Procedure 2)	Continue with Step 1	Level different from MAX	Procedure 3
1	Check the oil pressure (Procedure 4)	Continue with Step 2	Incorrect pressure	Procedure 5
2	Check for ECU and wiring errors (Procedure 1)	Continue with Step 3	ECU errors	Procedure 1
			Wiring faults	Repair wiring
3	Check the engine control ECU	End of diagnosis	Engine control ECU faults	Repair/replace the ECU or the components
			Improper engine deactivation requests from gearbox ECU	Check the clutch wear

Gear engagement only possible with 1ST - 2ND gears (limp-home mode)

Impossible to engage a gear higher than 2nd (with failure warning light on or off).

STEP	*OPERATION*	*RESULT OK*	*PROBLEMS FOUND*	*OPERATION*
0	Check for ECU and wiring errors (Procedure 1)	Continue with Step 1	ECU errors	Procedure 1
			Wiring faults	Repair wiring
1	Check the oil level (Procedure 2)	Continue with Step 2	Level different from MAX	Procedure 3
2	Check the oil pressure (Procedure 4)	End of diagnosis	Incorrect pressure	Procedure 5

Bad clutch behaviour

During pickup the vehicle jerks and sometimes switches off

STEP	***OPERATION***	***RESULT OK***	***PROBLEMS FOUND***	***OPERATION***
0	Check for ECU and wiring errors (Procedure 1)	Continue with Step 1	ECU errors	Procedure 1
			Wiring faults	Repair wiring
			Hydraulic unit prewiring faults	Replace the hydraulic unit
			Gearbox ECU malfunction	Replace the gearbox ECU
1	Check clutch oscillations during pickup	Continue with Step 2	Pickup problem due to clutch oscillations	Bleeding
2	Proceed with testing as indicated in the diagnosis table and in steps 0, 1, 2, 4, 5			

Procedure 1: check the NCR for stored errors

MALFUNCTION	PROBABLE CAUSES
Vehicle speed error	❑ ABS ❑ ABS wiring ❑ CAN line
Accelerator pedal error	❑ Engine control ECU wiring ❑ CAN line ❑ Engine ECU
Brake pedal switch error	❑ Switch / gearbox ECU wiring ❑ Switch / engine control ECU wiring ❑ CAN line ❑ Engine ECU
Engine RPM error	❑ Engine control ECU wiring ❑ CAN line ❑ Engine ECU
Simultaneous presence of at least errors 2, 3 and 4	❑ CAN line

Procedure 2: check the hydraulic fluid level

STEP	*OPERATION*
1	Wait for the pump to turn off.
2	Turn the key to ON.
3	Shift gears a few times with the engine off until the pump activates.
4	Wait for the pump to turn off.
5	Check the oil level in the hydraulic fluid reservoir. If the level is below MAX, top up to MAX level; if above MAX, drain out until it is at MAX level.

Note: If procedure 3 needs to be performed (oil leak check), note down the amount of oil required for topping-up.

Procedure 3: check for oil leaks

STEP	*OPERATION*
1	Perform procedure 2
2	Visually inspect: pipes, pump, tank, hydraulic unit, engagement/selection actuators.
3	Replace/repair the parts involved, top up the oil.

Procedure 4: check the hydraulic circuit pressure

STEP	*OPERATION*
1	Turn the key to ON.
2	Connect the tester.
3	When the pump is off, the pressure must be between 40 and 55 bar at ambient temperature.

Note: the pump is activated when the driver-side door is opened and automatically turns off after a maximum of 10 seconds. Always wait for the pump to turn off before reading the pressure value.

Procedure 5: high pressure pump functional test

STEP	***OPERATION***
1	Turn the key to ON, connect the tester and wait for the pump to go off.
2	Perform procedure 2
3	Using the tester, check that the battery voltage is higher than 11V and, if it is lower, check the battery charge.
4	Check with the tester that the pump relay is OFF.
5	Shift gears until the pump is activated (pump relay ON).
6	Stop requesting any gearshifts and check how long the pump remains active by reading the PUMP RELAY parameter and listening to the pump.
7	If the activation time is between 4 and 6 seconds at ambient temperature (15 - 20°) and the battery voltage is higher than 11V, the pump is working properly.
8	If the tests are successful, check the oil pressure (Procedure 4)
9	If the tests fail: ❑ Time less than 4 seconds: check that the accumulator is in proper working condition ❑ Time more than 6 seconds: check the pump, bleeding screw tightness, check valve, oil leaks from the F1 kit

Procedure 6: perform the self learning of the gearchange grid

STEP	***OPERATION***
1	Turn the key to ON and connect the diagnostic tester.
2	Print out the gearshift structure values stored in the gearbox ECU.
3	Auto-calibrate the gearchange grid.
4	Turn the key to OFF, wait 15 seconds and then turn the key to ON.
5	Print out the gearshift structure values stored in the gearbox ECU.
6	Check the differences between the old and the new gearshift structure.
7	Engage all the gears and check their engagement on the gear display.
8	Road test the vehicle performing the following manoeuvres: ❑ Ignition ❑ Pickup in 1st, 2nd and reverse gear ❑ Engage all the gears, upshifting and downshifting at different engine RPM

Procedure 7: brake pedal switch check

STEP	***OPERATION***
1	Turn the key to ON and connect the tester.
2	Check the BRAKE PEDAL STATUS parameter.
3	Depress the brake pedal and check if the parameter status changes.
4	If the parameter status does not change, check the brake pedal switch, its fastening, the wiring and functionality of the CAN line.

Procedure 8: check the gearshift paddles and the reverse gear command

STEP	*OPERATION*
1	Turn the key to ON and connect the tester.
2	Check the LEVER STATUS parameter.
3	Make all the possible gear selections with the steering wheel paddles and with the reverse gear lever, checking that the parameter status is correct according to the following scheme: ❑ UPshift paddle ❑ DOWNshift paddle ❑ UP and DOWN paddles simultaneously ❑ Reverse gear lever ❑ All the levers/paddles released
4	Check that there are no paddle-related errors in the error environment. In the event of errors, delete them. If not deleting any errors, go to step 5.
5	Check the wiring and the paddle cluster on the steering wheel, and the reverse gear lever.

Procedure 9: check the Auto/Manual button

STEP	*OPERATION*
1	Turn the key to ON and connect the tester.
2	Check the AUTO BUTTON STATUS parameter.
3	Press and release the AUTO button and check that the parameter changes.
4	Start the engine and check that when the button is pressed, the word AUTO appears on the display.
5	If the parameter status does not change and/or the word AUTO does not appear, check the button and the button wiring.

Faults that enable the limp home mode (recovery)

	Failure
1	ENGAGEMENT POTENTIOMETER
2	SELECTION POTENTIOMETER
3	ENGINE RPM
4	CLUTCH RPM
5	VEHICLE SPEED
6	RELAY CRANKING
7	BRAKE PEDAL
8	CAN MESSAGE TRANSMISSION
9	CAN MESSAGE RECEPTION
10	ENGAGEMENT AND SELECTION POTENTIOMETER SWITCH
11	SENSOR COMMON GROUND DETACHMENT

Service operations and procedures

Depending on the type of operation performed on robotized gearbox system components managed by the NCR module, it is necessary to perform the following operations, which are divided into the relative areas of intervention.

Self calibration of the DEIS parameters (Sofast III onward):

The DEIS parameter calibration function is a self-learning function which relates to a number of clutch operation parameters, e.g. self-learning of the clutch solenoid valve and clutch diaphragm spring.
By means of the DEIS self-learning procedure, the transmission control module (NCR) uses a specific algorithm to calculate the spring characteristic of the clutch diaphragm.
This function can be activated by the Maserati Diagnosi diagnostic tester and should be carried out after replacement of clutch-related components or the transmission control module (NCR).
To activate the function, connect the Maserati Diagnosi tester and select the single ECU menu to enter the transmission control node (NCR). Then select the active diagnostics menu where the DEIS self-learning function can be found.
The procedure has a duration of between 3 minutes 30 seconds and 9 minutes. In case the procedure has not been completed entirely, it is been considered as failed and has to be repeated.
After the procedure has been concluded positively, turn off the ignition key and wait for 25 seconds. This time is needed for the module to memorize the different parameters.
If the procedure has a negative result, try to find the cause by checking the correct operating of the clutch.
Also check if the hydraulic circuit has been correctly bled. Repeat the procedure.

The aim of the DEIS procedure is to obtain a fine-tuned control of 2 parameters:

1. **<u>Clutch position</u>**
2. **<u>Clutch solenoid valve pressure</u>**

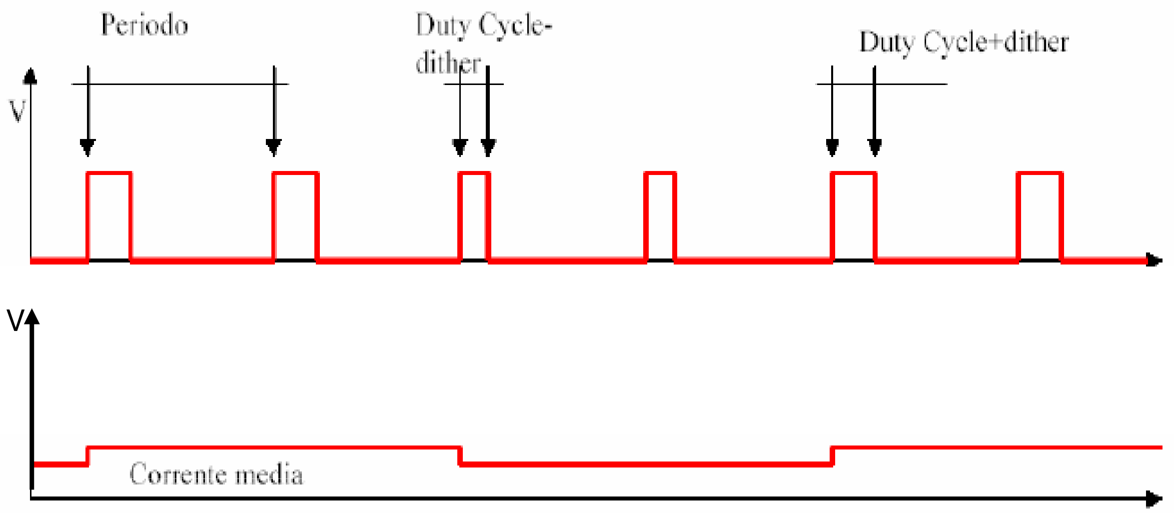
The procedure comprises the following steps:

1. autocalibration of closed centre current for the clutch solenoid valve I0
2. autocalibration of optimal Dither current
3. autocalibaration of the dead band of the clutch solenoid valve
4. autocalibration of the current/capacity of the clutch valve
5. autocalibration of the clutch Belleville spring

(*)DEIS: Dipartimento di Elettronica, Informatica e Sistematica (Department of Electronics, Computer Sciences and Systems), University of Bologna, which has collaborated with Maserati on the development of the procedure carrying its name.

Autocalibration of optimum Dither current:

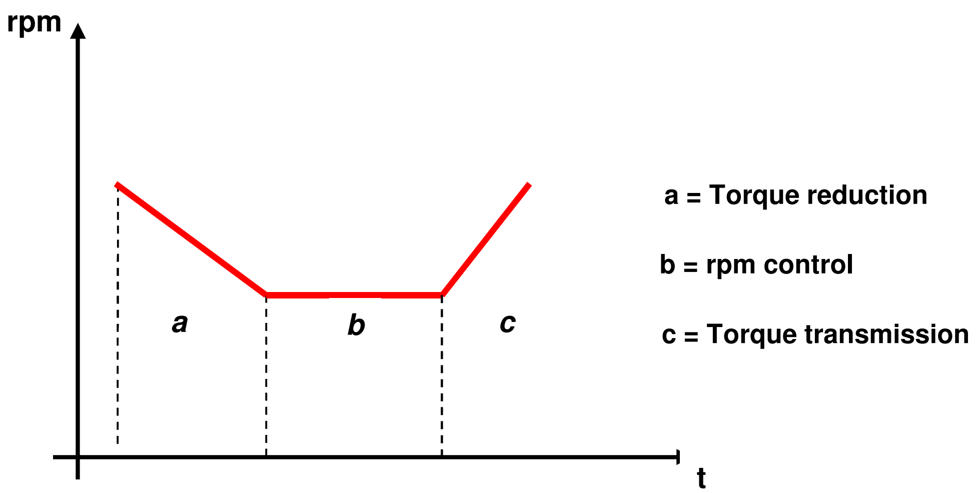
The dither current is a signal superimposed on the DUTY CYCLE of the PWM signal, which controls the clutch solenoid valve. By means of an appropriate frequency, it is possible to keep the spool of the clutch solenoid valve in a state of slight oscillation, thus eliminating the delay in response. This makes it possible to avoid sticking of the spool. By generating a continuous variation in the current delivered to the solenoid, it is possible to keep a light film of oil around the walls of the spool, thus reducing breakaway friction. This is why the solenoid valve is is kept constantly powered with an alternating current (max 1200mA).



* Autocalibration present in DEIS procedure

Autocalibration of closed center current for the clutch solenoid valve I0:

The current I0 is the current absorbed by the solenoid valve when the clutch is stationary, awaiting re-engagement. The management of the I0 current controls the capacity of the solenoid valve in phase **b** by managing the clutch solenoid valve that coordinates **capacity**, controlled in current.

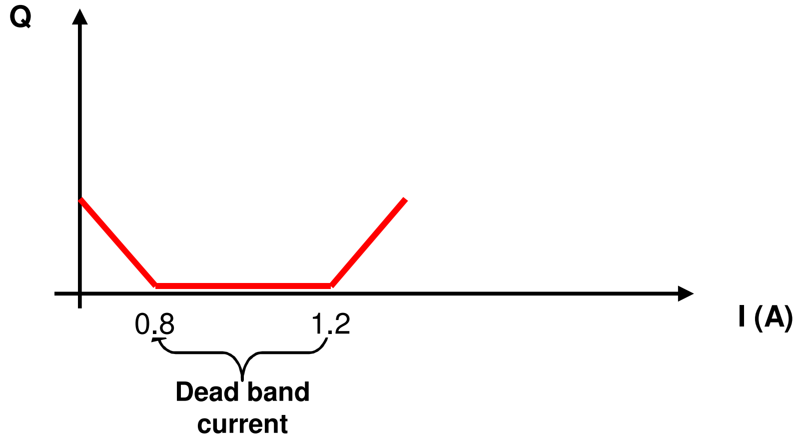


* Autocalibration present in DEIS procedure

The center band current self-learns by means of DEIS self-learning, but later also with the car stationary, the engine running and the clutch open (Neutral or 1st engaged). This current value is the current value at which the clutch stays open; for lower values it closes and for higher values it opens

Autocalibration of the dead band of the clutch solenoid valve:

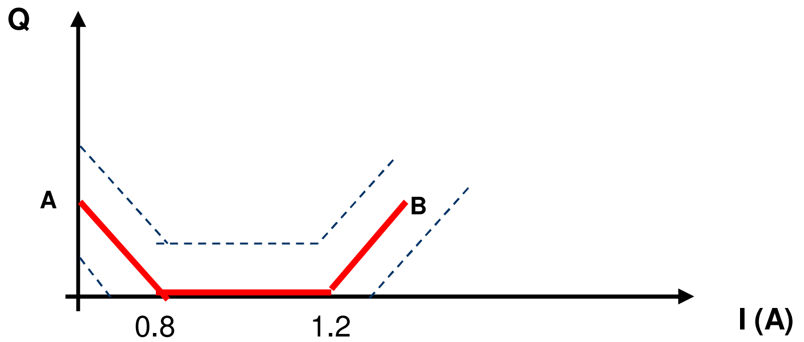
This is the current which sets the spool of the clutch solenoid valve to the closed position at all times. Autocalibration is used to verify the capacity of the solenoid valve to block the movement of the clutch. In the event of incorrect procedure, bleed the system and replace the clutch solenoid valve.



* Autocalibration present in DEIS procedure

Autocalibration of the current/capacity of the clutch solenoid valve:

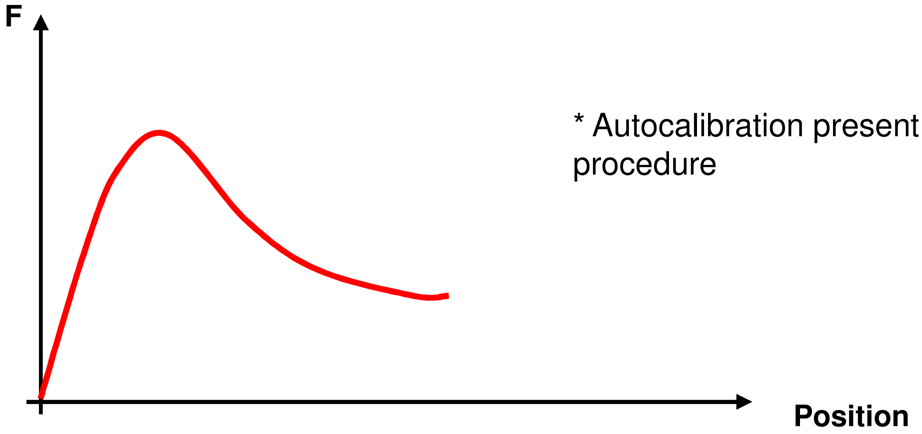
The phases of solenoid valve discharge (A) and charge (B) are reconstructed by the control unit. The points described on a quoted Capacity/Current plan are reconstructed by the control unit to check that they fall within a defined range of acceptability.



* Autocalibration present in DEIS procedure

Autocalibration of the clutch diaphragm spring:

Through the clutch pressure sensor and the clutch position sensor, the relationship between the application force and the position of the diaphragm spring is reconstructed.



* Autocalibration present in DEIS procedure

The control unit checks 15 different positions, which have to fall within a range of tolerance. If the pressure required to move the diaphragm spring is greater than 40 bar, the procedure is interrupted and an error code is displayed. In this case, the car does not start. It is necessary to bleed the system before replacing components.

Reset of the Clutch Wear Index (Sofast II onward):

The clutch wear index provides information about degradation of the torque transmissibility of the clutch. The clutch wear index is a self-learned parameter which will influence the management of the clutch and which is specific for each clutch. Therefore the clutch wear index must be reset after replacement of the clutch and before carrying out the Kiss Point procedure.
The reset command for the clutch wear index can be found in the Active diagnosis menu of the Maserati Diagnosi tester.

Note: with recent diagnostic software, the clutch wear index reset is integrated in the Kisspoint procedure.

Cluch configuration:

The “clutch configuration”, which is a command in the “Active diagnostic” menu of Maserati Diagnosi, is used to store the actual “closed clutch position”, as measured by the clutch position sensor in real time, as the “closed clutch position of new clutch”. Therefore, this operation must only be performed after the installing of a new clutch. The clutch configuration is crucial for the correct calculation of the clutch wear %.
Note: it is advised to perform the clutch configuration after a brief bedding in of the new clutch.
Note (2): with recent diagnostic software, the clutch configuration is integrated in the Kisspoint procedure.

Kisspoint adjustment procedure (Pre-Sofast and Sofast):

For cars fitted with transmission control systems prior to Sofast II (Pre-Sofast and Sofast) the Kisspoint value must be entered manualy with the diagnostic tester.

The Kiss point base value depends on the vehicle type and the system generation. After entering the base value, the value can be adjusted after an assessment of the clutch in order to obtain an optimal clutch behaviour.

Kiss Point self learning procedure (Sofast II onward):

On vehicles fitted with Sofast II or later, the ideal Kiss point can be found by means of a self-learning procedure which is activated by the diagnostic tester.
Before starting the kiss point procedure, it is first necessary to **bed in the clutch:**

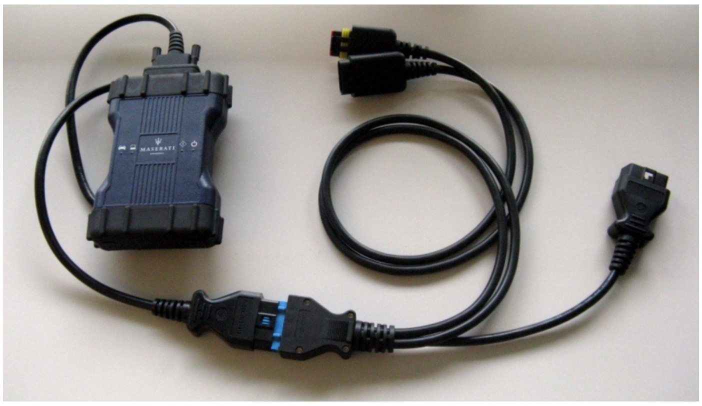
- For the first few miles, follow the guidelines below in order to allow the clutch to bed in sufficiently:
- avoid using sport mode
- change gear at a maximum of 4000 rpm and a maximum of 50% pedal
- avoid releasing the clutch sharply
- avoid prolonged use of the clutch (traffic jams, maneuvers)
- make frequent gear changes while driving

Keep the engine idling for 5 minutes to calibrate the solenoid valves while hot. With the vehicle in motion, engage 1-2-1 in sequence, and keep the engine idling in first and the brake pedal pressed for 1 minute. Repeat the sequence three times to allow correct estimation of clutch solenoid valve internal leakage.

Important note:
A correct clutch temperature is crucial for the successfull performing of the Kisspoint procedure. A clutch temperature outside the acceptable range will result in the procedure being interrupted.

Proceed as follows to perform the Kisspoint procedure:

- Switch the ignition key to Off
- For recent vehicles (M139 Duoselect MY07, M145): connect the VCI to the vehicle's OBD connector.
- For older vehicles (M138, M139 Duoselect up to MY06): connect the VCI by using the 4-way adapter cable (part number 900027832). The adapter cable must be connected to the OBD connector and to the vehicle's C-CAN interconnector.



VCI with 4-way adapter cable for older vehicles

- Switch the ignition On and establish connection between the vehicle and the Maserati Diagnosi tester unit.
- Select the NCR in the ECU selection menu.
- Perform the "Clutch Dergadation Index Reset" in the "Active Diagnosis" menu.

Attention!

- If the car has been parked for more than 30 minutes after the bedding-in phase, make 10 consecutive breakaways up to an engine speed of 1500 rpm.
- If the car has been parked for less than 30 minutes after the bedding-in phase, make 5 consecutive breakaways up to an engine speed of 1500 rpm.

- Select the "Kiss Point" procedure in the "Specific Functions" menu
- Perform the subsequent steps by following precisely the guided indications on the screen.

The system will display a warning message for the operator, reminding him what conditions the car must meet in order for the calibration procedure to be executed correctly.

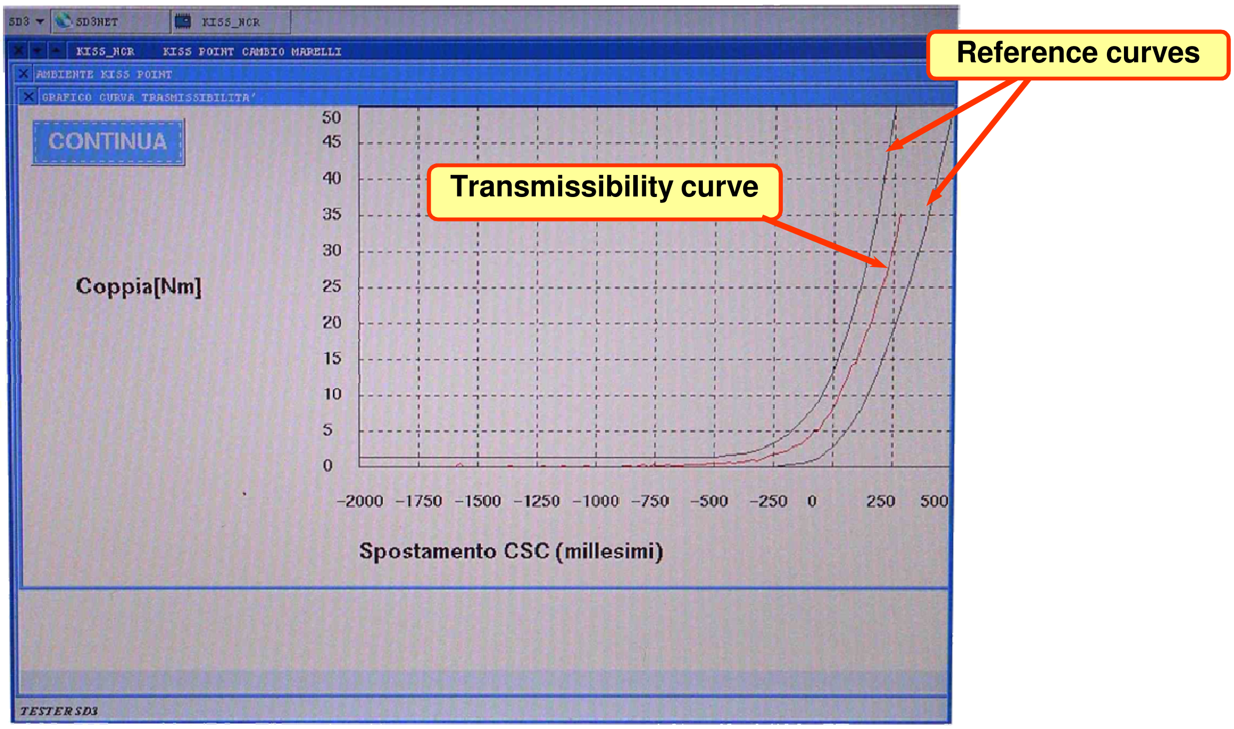
If the car meets the necessary conditions to proceed, press "ENTER“ and start with the procedure.

The next screen tells the operator to keep the accelerator pedal pressed for the full duration of data acquisition.

The system will automatically run 10 clutch open/close cycles, with the gearbox in neutral, during which the Maserati Diagnosi will acquire the necessary data for calculating the kiss point correctly.

Wait for the "end of data acquisition procedure" message to appear on the display and for the instrument panel node to give an audible alert signal.

The Maserati Diagnosi display will show the "TRANSMISSIBILITY" graph, i.e. the torque value as a function of clutch position (red) and the two reference curves (black), which indicate the tolerance range within which the torque ransmissibility curve must be positioned.



The system will automatically check that the torque transmissibility curve falls within the two tolerance curves.
Depending on the result of processing, there can be two different outcomes:

- The data are correct, and the system will thus continue with the next phases of data acquisition.
- The data are incorrect, the procedure is canceled and an error message is displayed, showing how to correct the error.

At the end of each sequence of data acquisition and processing, the following parameters will be displayed:

- Number of breakways
- Kiss point value (bit,mm)
- Value of dispersal of points (bit)

If completed correctly, the procedure will be repeated twice more.
On completion of the three phases, the average kiss point value will be calculated, and this value can be saved in the NCR (if confirmed by the operator).

At the end of the procedure, the system will ask the operator if a new clutch has been fitted to the vehicle:

- No: no further action is taken, the procedure is completed
- Yes: the "Clutch Degradation Index Reset" and the "Clutch Configuration" are automatically performed. The procedure is completed.

Self learning of the acceleration sensor offset (Sofast III onward):

After replacement or disconnection/reconnection of the acceleration sensor or replacement of the transmission control module (NCR), it is necessary to run the accelerometer autocalibration procedure.
Therefore the vehicle must be positionned on a level surface, with the tyres at their correct pressure and with correct wheel alignment.
The procedure can be found in the "Active diagnosis" menu of the Maserati Diagnosi tester.
This procedure should take about 30 seconds, with a checking time of 40 seconds. Once this time is up, if the procedure has not finished, it has failed.
If the procedure has been completed successfully, and no further adjustments are necessary, turn the ignition key to "**OFF**" and wait for at least 25 seconds. Minimum time for allowing the control unit to save the parameters read.

Note: for vehicles without dedicated longitudinal acceleration sensor (assembly 24275 onward), the longitudinal acceleration data is received from the NFR (Bosch ESP 8.0) by the CAN line. Also in this case the sensor self-learning procedure must be performed in the same way, as the CAN received data is a raw value.

Self learning of the gearchange grid:

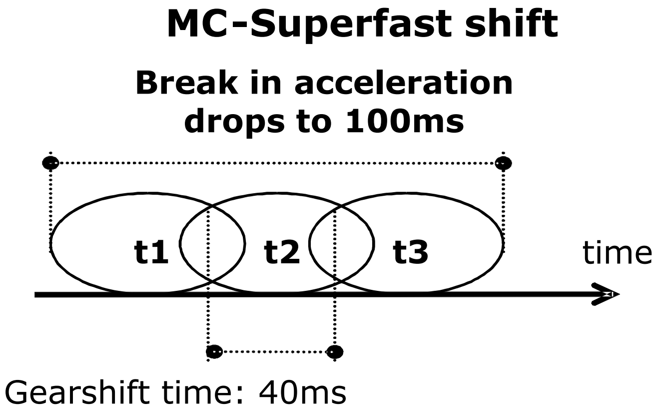
The Self-learning of the gearchange grid (simply indicated by “self learning”) is activated by means of an instruction from the tester with the car stationary and the ignition switched to On. This operation teaches the ECU the areas of engagement and selection for the gearbox with which it is associated. On completion of the procedure, the system automatically checks whether learning has taken place correctly. Make sure that the battery is charged, the handbrake is released and the car is moving slightly (by pushing) in the event that self-learning is blocked due to sticking when engaging gears.

Note: In case the self learning does not end successfully, check if the hydraulic actuator bleeding has been correctly performed.

Note (2): Self learning values are stored inside the NCR at the successive “Key Off”.

Self learning of the Superfast shift (Sofast 4 with Superfast shift & Superfast shift 2):

Where the self learning of the gearshift grid has for purpose to calibrate the travel of the gear selection and gear engagement movement, the Superfast shift self learning has been created to optimize the synchronization of the various gearshift related actions.

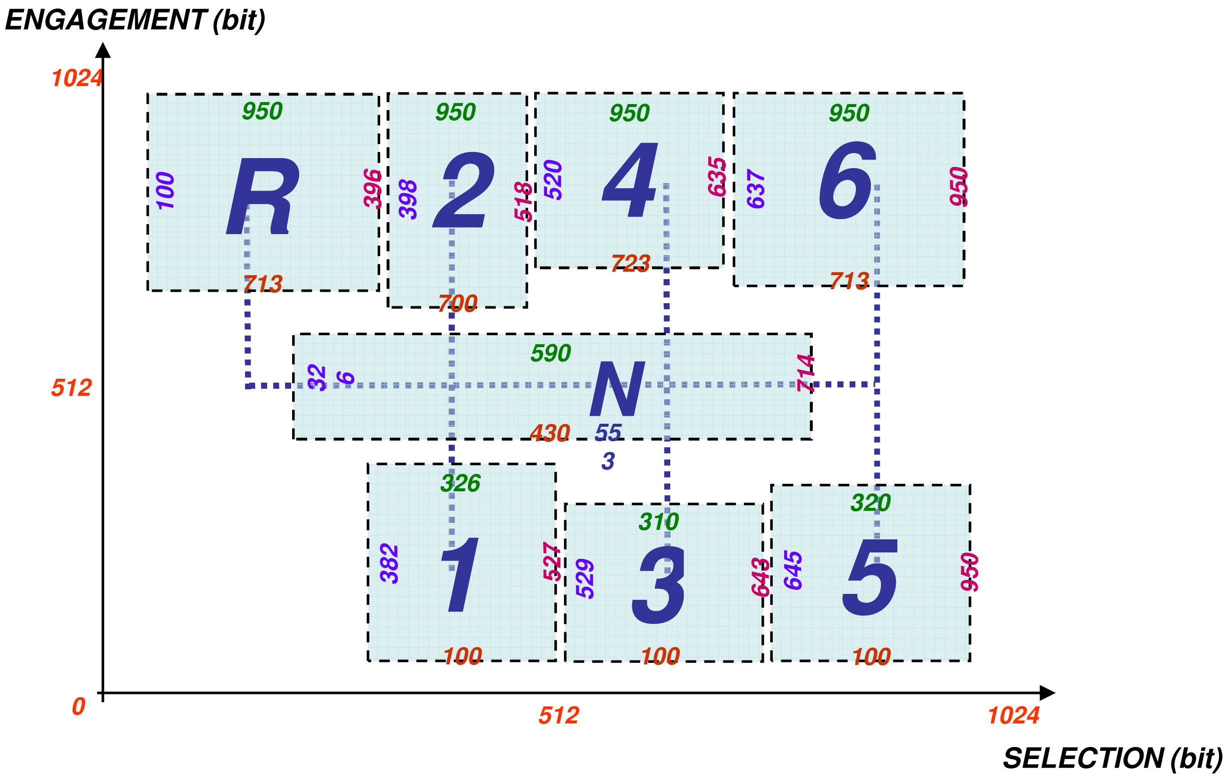


To obtain the shortest possible total gearshift time, it is of upmost importance that the different phases of a complete gearchange operation (power cut-off and clutch opening, gear disengagement, gear selection, gear engagement, clutch closing and power restore) are perfectly synchronised. During the Superfast shift self-learning procedure, the NCR will calibrate the duration of the solenoid valve activation and the actual gearshift for every gear.
This procedure can be activated with the diagnostic tester and needs to follow after completion of the self-learning of the gearchange grid.

Note: in case the Superfast shift self learning procedure has not been performed, a specific DTC will be stored by the NCR (P1768) and the Superfast shift gearshift mode will be disabled.

Calculation of the gearchange grid (*):

The gearchange grid, as recorded by the NCR by means of the selection and engagement position sensors, is presented in a field of 1024 x 1024 bits.
The grid is made up by the secure engagement thresholds (min / max) and secure selection thresholds (min / max) for all gears + neutral. These thresholds are calibrated during the self-learning of the gearchange grid.



The threshold values listed can be found in the parameter environment in Maserati Diagnosi. All these values subsequently simply transferred to a spreadsheet to illustrate what they represent on the vehicle.
The thresholds will define the field of each gear + neutral.
Subsequently, the actual finger position (engagement + selection) for each gear + neutral must be entered in the spreadsheet. Therefore each gear mus be selected after which the actual position can be read out with Maserati Diagnosi (parameter environment).

Once the engagement and selection values have been transcribed by means of the spreadsheet, we can generate the gearbox grid to check for correct centering of the actuator. This operation is useful if gear engagement problems persist after the self-learning process has been completed correctly. To check that the finger is properly centered and nowhere near “limit conditions”, we check the gear engagement grid.

(*) note: this is not an official procedure from the Maserati Service Department, but it can be usefull to locate the problem in certain cases. A custom-made Excell spreadsheet is required.

Engagement:

MINIMUM SECURE ENGAGEMENT THRESHOLD - NEUTRAL	**430**
MINIMUM SECURE ENGAGEMENT THRESHOLD - FIRST	**100**
MINIMUM SECURE ENGAGEMENT THRESHOLD - SECOND	**700**
MINIMUM SECURE ENGAGEMENT THRESHOLD - THIRD	**100**
MINIMUM SECURE ENGAGEMENT THRESHOLD - FOURTH	**723**
MINIMUM SECURE ENGAGEMENT THRESHOLD - FIFTH	**100**
MINIMUM SECURE ENGAGEMENT THRESHOLD - SIXTH	**713**
MINIMUM SECURE ENGAGEMENT THRESHOLD - REVERSE	**713**

MAXIMUM SECURE ENGAGEMENT THRESHOLD - NEUTRAL	**590**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - FIRST	**326**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - SECOND	**950**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - THIRD	**310**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - FOURTH	**950**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - FIFTH	**320**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - SIXTH	**950**
MAXIMUM SECURE ENGAGEMENT THRESHOLD - REVERSE	**950**

These values are purely guideline and cannot be used for comparison purposes during diagnosis

The SECURE ENGAGEMENT thresholds indicate the MINIMUM/MAXIMUM value of the engagement stroke expressed in bits, below which diagnosis is activated, with the result that secure engagement of the gear is not recognized (gear indicator flashing further to retry).

Selection:

MINIMUM SELECTION THRESHOLD - NEUTRAL	**326**
MINIMUM SELECTION THRESHOLD - FIRST	**382**
MINIMUM SELECTION THRESHOLD - SECOND	**398**
MINIMUM SELECTION THRESHOLD - THIRD	**529**
MINIMUM SELECTION THRESHOLD - FOURTH	**520**
MINIMUM SELECTION THRESHOLD - FIFTH	**645**
MINIMUM SELECTION THRESHOLD - SIXTH	**637**
MINIMUM SELECTION THRESHOLD - REVERSE	**100**

These values are purely guideline and cannot be used for comparison purposes during diagnosis

MAXIMUM SELECTION THRESHOLD - NEUTRAL	**714**
MAXIMUM SELECTION THRESHOLD - FIRST	**527**
MAXIMUM SELECTION THRESHOLD - SECOND	**518**
MAXIMUM SELECTION THRESHOLD - THIRD	**643**
MAXIMUM SELECTION THRESHOLD - FOURTH	**635**
MAXIMUM SELECTION THRESHOLD - FIFTH	**950**
MAXIMUM SELECTION THRESHOLD - SIXTH	**950**
MAXIMUM SELECTION THRESHOLD - REVERSE	**396**

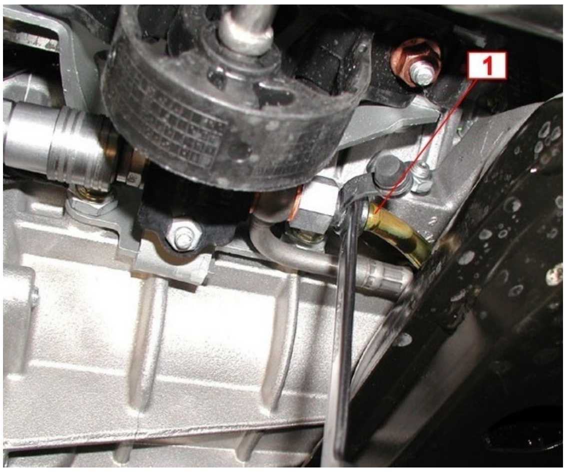
Outside of these thresholds, diagnosis of the recognition of the selected position is activated (gear indicator flashing further to retry).

The selection thresholds defined by the MIN/MAX values (expressed in bits) in the following gearshift ranges:

1st – 2nd
2nd – 3rd
3rd – 4th
4th – 5th
5th – 6th
REVERSE

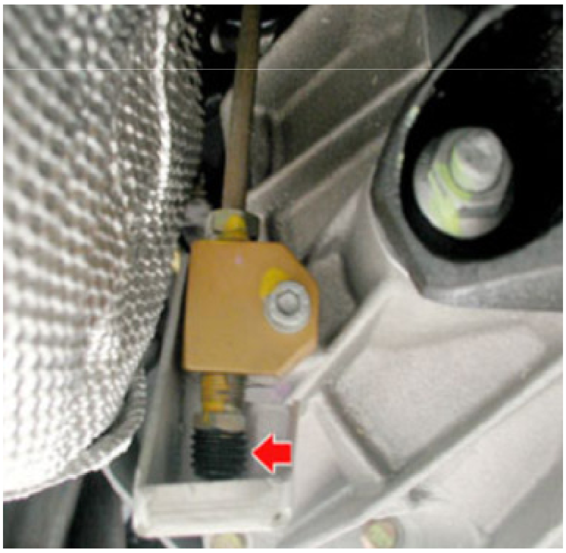
Cluch actuator bleeding:

The procedure becomes necessary if air bubbles need to be eliminated or following disassembly of a component of the hydraulic clutch circuit. Bleeding is done by using the bleed screw on the clutch housing.



The procedure involves bleeding the system first through the bleed screw located next to the connection block with the clutch housing and subsequently through its counterpart on the side (up to assembly 14804) or underneath the clutch housing.

The clutch bleed valve is located on the clutch housing. There are two different versions:



up to assembly 14803

Assembly 14804 onward

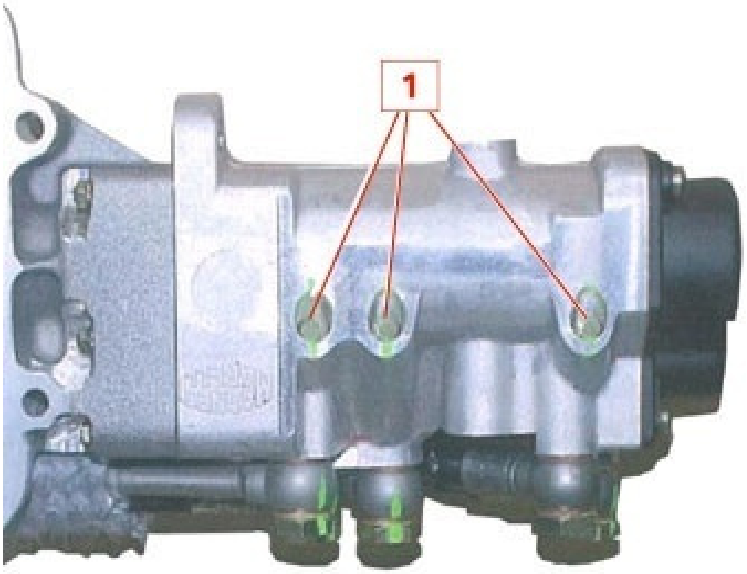
With the Maserati Diagnosi, start the clutch bleeding procedure while adding oil continuously into the electro-actuated gearbox oil reservoir, in such a way that there can be no infiltration of air.
The bleeding procedure ends when the oil coming out of the bleed screw no longer contains any air.
Use the Maserati Diagnosi to run the gearbox through a sequence of gear changes to check that the pump is working correctly.
At the end of the cycle, check the level of the oil in the reservoir. Top up if necessary.

Hydraulic actuator bleeding:

To access the actuator bleed screws, it is necessary to remove the actuator, while leaving it connected to the electrical and hydraulic system.
Remove the actuator and support it correctly so as to ensure safe working conditions.

Important:
During bleeding, support the actuator in such a way that the sensor cables are not too taut and the hoses are not bent to excessively tight angles. Keep your hands away from the actuator while bleeding is in progress.

- Connect the Maserati Diagnosi diagnosis tester to the diagnosis socket.
- From the main menu, go to “**Active diagnosis**".
- Check and top up the oil in the reservoir if necessary.
- Loosen the three actuator bleed screws **(1)** by two complete turns.



On completion of the procedure, execute self-learning of the engagement and selection thresholds by choosing the “self-learning" function from the “Active diagnosis" menu.

Service operations for vehicles using a system prior to Sofast 2:

Maserati M138

HW CFC 201 (SOFAST) up to assembly 12203

Maserati M144

HW CFC 201(SOFAST)

Action	**Required servicing operation for PRE - SOFAST II**
Clutch replacement *	Clutch bleeding procedure (clutch balancing for M138) Kiss point adjustment
Gearbox replacement	Self-learning
Hydraulic actuator replacement	Hydraulic actuator bleeding Self-learning
Replacement of solenoid valves EV1-2-3-4-5	Gearbox actuator bleeding Self-learning
Replacement of clutch solenoid valve EVF	Clutch actuator bleeding
Pump replacement	Hydraulic actuator bleeding
NCR replacement	Remote loading of software Reading of closed clutch value from new on the replaced NCR and setting the value on the new NCR Self-learning Kiss point adjustment

* Clutch replacement for **pre-SOFAST** cars: in this case the CLOSED CLUTCH VALUE FROM NEW is fundamental. Before saving/confirming, it is imperative to allow the clutch to bed in briefly by running in the disc.

Service operations for vehicles using Sofast 2:

Maserati M138

HW CFC 231 (SOFAST II) from assembly 12204

Maserati M139 Europe version

HW CFC 231 (SOFAST II) up to assembly 18821

Action	Required servicing operation for SOFAST II
Clutch replacement	Clutch bleeding procedure Kiss Point (includes resetting the clutch degradation index and configuring the clutch)
Gearbox replacement	Self-learning Check gear change grid
Hydraulic actuator replacement	Hydraulic actuator bleeding Self-learning
Replacement of solenoid valves EV1-2-3-4-5	Gearbox actuator bleeding Self-learning
Replacement of clutch solenoid valve EVF	Clutch actuator bleeding Kiss Point (includes resetting the clutch degradation index and configuring the clutch)
Pump replacement	Hydraulic actuator bleeding
NCR replacement	Remote loading of software Reading of closed clutch value from new on the replaced NCR and setting the value on the new NCR Self-learning Kiss point

Service operations for vehicles using Sofast 3 and Sofast 3+:

Maserati M139 Europe version

HW CFC 301(SOFAST III) from assembly 18822

HW CFC 301(SOFAST III+) from assembly 21925

Maserati M139 US version

HW CFC 301 (SOFAST III) up to assembly 21925

HW CFC 301 (SOFAST III+) from assembly 21926

Alfa Romeo 8C Competizione and 8C Spider all vehicles

Action	Required servicing operation for SOFAST III and SOFAST III+
Clutch replacement	Clutch bleeding procedure Calibration of DEIS parameters Kiss Point (includes resetting the clutch degradation index and configuring the clutch)
Gearbox replacement	Self-learning
Hydraulic actuator replacement	Hydraulic actuator bleeding Self-learning
Replacement of solenoid valves EV1-2-3-4-5	Gearbox actuator bleeding Self-learning
Replacement of clutch solenoid valve EVF	Clutch actuator bleeding Calibration of DEIS parameters Kiss Point (includes resetting the clutch degradation index and configuring the clutch)
Pump replacement	Hydraulic actuator bleeding
NCR replacement	Remote loading of software Calibration of DEIS parameters Self-learning Reading of closed clutch value from new on the replaced NCR and setting the value on the new NCR Autocalibration of acceleration sensor offset Kiss point
Acceleration sensor replacement or ABS unit replacement	Autocalibration of acceleration sensor offset

Service operations for vehicles using Sofast 4:

Maserati M145 GranTurismo S and GranTurismo MC Stradale all vehicles

HW CFC 301 (hardware ECU is identical to SOFAST III)

Action	Required servicing operation for SOFAST IV
Clutch replacement	Clutch bleeding procedure Calibration of DEIS parameters Kiss point (includes resetting the clutch degradation index and configuring the clutch)
Gearbox replacement	Self-learning Superfast shift self-learning
Hydraulic actuator replacement	Hydraulic actuator bleeding Self-learning Superfast shift self-learning
Replacement of solenoid valves EV1-2-3-4-5	Gearbox actuator bleeding Self-learning Superfast shift self-learning
Replacement of clutch solenoid valve EVF	Clutch actuator bleeding Calibration of DEIS parameters Kiss Point (includes resetting the clutch degradation index and configuring the clutch)
Pump replacement	Hydraulic actuator bleeding
NCR replacement	Remote loading of software Calibration of DEIS parameters Self-learning Superfast shift self-learning Reading of closed clutch value from new on the replaced NCR and setting of this value on the new NCR Autocalibration of acceleration sensor offset Kiss point
Acceleration sensor replacement or ABS unit replacement	Autocalibration of acceleration sensor offset

Note: In any event, it is advisable to perform the self-learning procedures (DEIS; Self-Learning, Superfast shift, acceleration sensor offset during each servicing operation.

Automatic Gearbox Control System

Bosch-ZF

ZF 6HP 26 Automatic gearbox

The Automatic gearbox control system is of “Mechatronik” type, i.e. the hydraulic control unit is combined with the electronic control unit in a single unit inside the gearbox.
The control unit allows dynamic gear selection and a sequential (manual) program of gear selection.

The mechanical transmission components are made up of planetary gears.

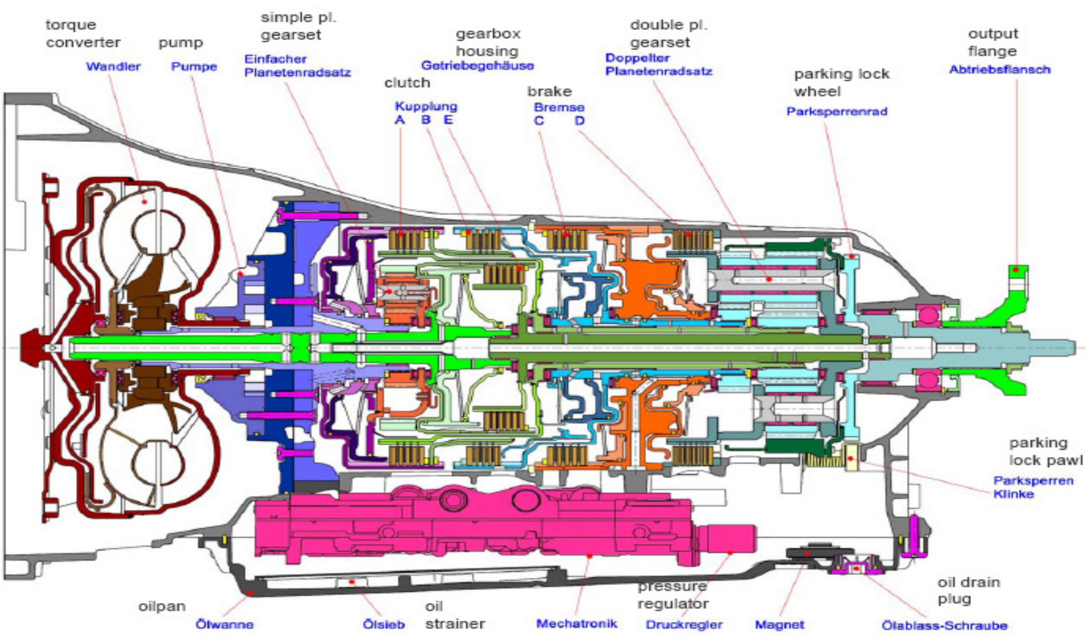
The parts are controlled by an electro-hydraulic system, in which the hydraulic and electronic control units are integrated into a single control unit (Mechatronik), mounted on the gearbox. Engine power reaches the transmission by means of a hydrodynamic torque converter with built-in Lock-up (WK) clutch.

The 6 forward gears and reverse are provided by a double planetary gear (Ravigneaux) and a single planetary gear mounted at the front. The integrated operating modes of the planetary gears are patented (Lepelletier).

Gear disengagement management logic

With the engine idling, the car stationary and the gear lever in “D”, the torque converter transmits a given level of torque, which moves the car forward slightly if the brake pedal is not pressed. With the pedal pressed, the converter is obliged to dissipate power by slowing down the rotation of the engine, which must be compensated by increasing the idling torque (opening the throttle body further), until the correct idling speed is restored. This leads to an increase in fuel consumption and greater force on the pedal (for example, to keep the car stationary when stopping at traffic lights or due to road signs), which impacts negatively on driving comfort and practicality.

Disengagement therefore occurs if a gear is engaged with the car stationary, on the basis of various parameters monitored by the gearbox node.



As well as the torque converter with lock-up clutch (WK) as an engagement element, there are three rotating multi-plate clutches A, B and E and two fixed multi-disc brakes C and D.

The engagement elements are used for gear changes under load without interrupting the flow of power.

The clutches A, B and E transmit the power of the engine to the planetary gears. The brakes C and D oppose the movement of other components of the transmission in order to obtain the required resistance.

Adaptive gearshift strategy

By increasing and synchronizing the control of the transmission with other systems in the car, such as the engine, braking system, drive wheels and steering,
a series of signals are provided, which describe the driving conditions in real time.
In response to the application of longitudinal or lateral acceleration, the control unit actuates additional functions of the electronic transmission control system, by acquiring signals such as engine torque and speed, oil temperature, the position and movement of the accelerator and the speed (rpm) of each wheel.
On the basis of this information, the transmission control system is able to recognize whether the car is cornering, the driver is braking or the driver wants to accelerate.
Using these signals, it is possible to draw conclusions about the effective load of the car and the topography of the stretch of road (uphill or downhill gradient), which can then be applied to the transmission function.
This system is generally known as automatic transmission with adaptive transmission control.
It is capable of recognizing the intentions of the driver, recording his style of driving and adapting the gear selection accordingly. No manual intervention is therefore necessary.

Lateral acceleration: When acceleration values are recognized, even after long periods of regular driving, the type of driver will be increased continually until maximum level is reached in about 10 seconds. The resulting level for the driver and the time taken to reach this level depend on the level of lateral acceleration.

Longitudinal acceleration: The assessment of longitudinal acceleration is used chiefly to reduce the counter relating to the type of driver in consistent driving situations, in the event that no other information is present (breakaway or lateral acceleration). During braking, the counter for the type of driver is locked out.

Calculating the road gradient:

The road gradient is calculated by comparing the actual acceleration of the car with the acceleration expected of the car when driving on a completely flat road. Expected acceleration is calculated on the basis of the weight of the car and the torque being delivered to the transmission. The ASIS system distinguishes 5 different categories of road gradient, each of which is associated with a gearchange map. The five situations correspond to: downhill, flat and three different uphill gradients.

In AUTO NORMAL and AUTO SPORT modes, recognition of driving style and calculation of road gradient take place simultaneously. Since road gradient and driving style category are calculated independently, the ASIS system has 20 gearchange maps. 10 for AUTO NORMAL and 10 for AUTO SPORT. Due to the interpolation between the different categories, the current gearchange map generally represents the interpolation of 4 gearchange maps (2 for driving style and 2 for road gradient). The appropriate gearchange points are therefore always calculated.

Downhill strategies

When DRIVE is selected and the accelerator pedal not pressed, the gearchange system recognizes that the car is travelling downhill and prevents the gearbox from changing UP. Pressing the accelerator pedal restores the possibility of changing up, but this will be delayed for a few seconds.
If the driver presses the brake pedal, the gearbox can change DOWN to provide a higher degree of engine braking.
Basically, during downhill driving, the gearbox acts in such a way as to avoid upward gear changes, does not generally change when the accelerator pedal is not pressed, and delays engagement of the gear for a few seconds once the accelerator pedal is pressed. When braking, furthermore, it selects the lowest gear to provide more engine braking.
The purpose of this management strategy is to make downhill driving safer.

Cornering strategies

The gear management system recognizes when the car is cornering by means of lateral acceleration and steering angle. When DRIVE is selected and the car is cornering, the system prevents both changing UP and changing DOWN for the full duration of the maneuver. In specific conditions involving cornering very tightly on an uphill bend, the system changes down.
Gear changes are enabled again once the car has come out of the bend after a distance that varies depending on the speed of travel.

Hotmode strategy

If the temperature of the transmission oil, coolant or both rises too high, the gearbox system reduces maximum engine speed to 4000 rpm. For this reason, changing up will take place at this limit.
The only situation excluded from this strategy is downhill driving, so that pedal braking is always combined with engine braking.

Solenoid valve activation logic

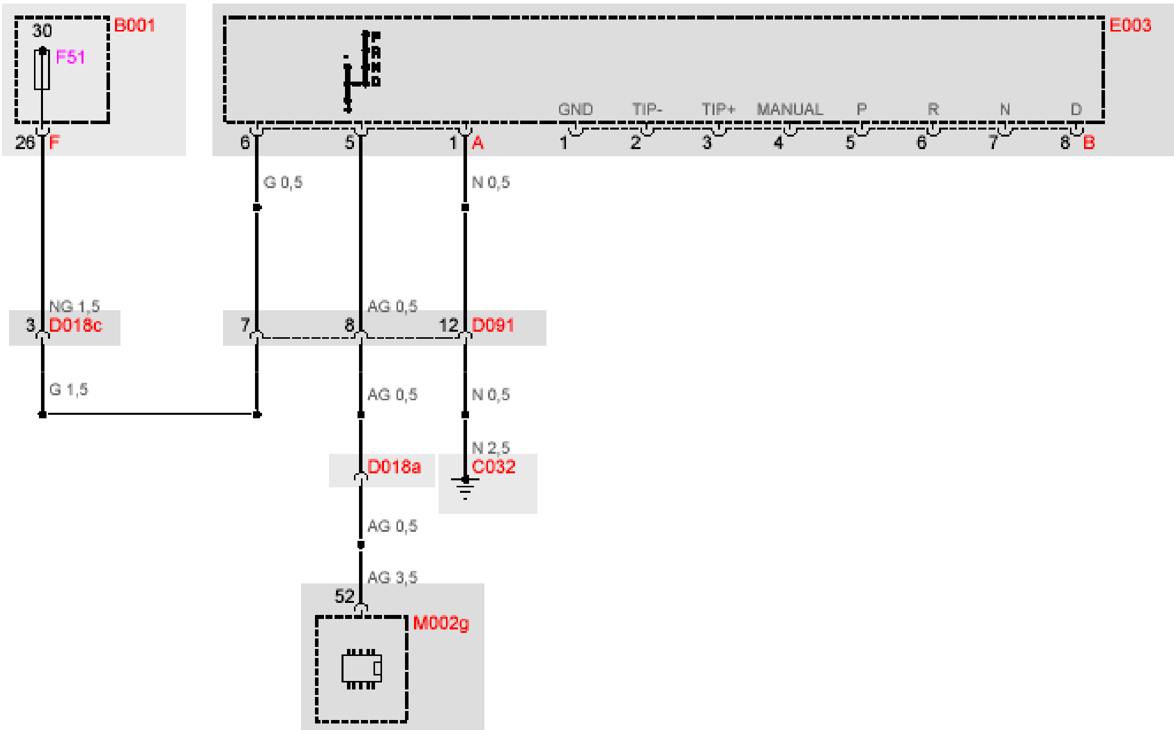
6HP26														
Pos/marcia	Logica elettrovalvola								Logica frizione					
	Elettrovalvola		Pressione - valvola di controllo pressione elettronica						Frizione				Freno	
	1		1	2	3	4	5	6	A	B	E	WK	C	D
Parking						x	x							•
retromarcia				x		x	x			•				•
folle						x	x							•
1a marcia			x			x	x	x	•			•		•
2a marcia			x		x		x	x	•			•	•	
3a marcia			x	x			x	x	•	•		•		
4a marcia	x		x			x	x	x	•		•	•		
5a marcia	x			x		x	x	x		•	•	•		
6a marcia	x				x	x	x	x			•	•	•	
	Valvola di sezione 1		Frizione A	Frizione B	Freno C	Freno D Frizione E	Pressione principae	Controllo frizione sulla logica marce	Porta planetario, ingranaggio planetario semplice	Ingranaggio centrale 1, ingranaggio planetario doppio	Porta setallite ingranaggio planetario doppio	Controllo frizione su convertitore	Ingranaggio centrale 1, ingranaggio planetario doppio	Porta setallite ingranaggio planetario doppio

Gear	Clutch			Brake		Final Drive Ratio
	A	B	E	C	D	
1	*				*	4.171
2	*			*		2.34
3	*	*				1.521
4	*		*			1.143
5		*	*			0.867
6			*	*		0.691
R		*			*	-3.403

Selector lever

The lever can be positioned in the following sectors shown by the gearbox panel on the transmission tunnel:

P (park)
R (reverse)
N (neutral)
D (drive)
+ / **-** (Manual)

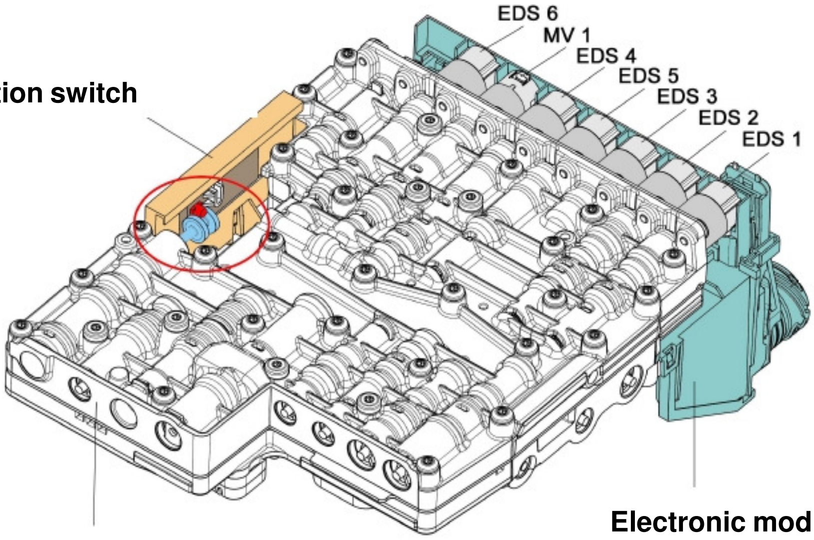


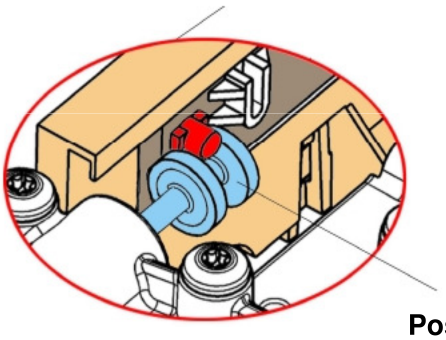
Gearshift information passes through the gearbox panel to the mechatronik. The engine can be started only if the gear lever is in position P or N.

WARNING: after starting the engine, do not press the accelerator pedal before or while moving the gear lever. It is particularly important to observe this precaution when the engine is cold.

Automatic transmission control node - NCA (Mechatronik)

When refitting the Mechatronik, it is imperative to take extreme care to fit the gear position selector correctly.





Via the C-CAN line, the NCA receives the following information:

- Wheel speed from NFR via CAN
- Brake pedal from NFR via CAN
- Accelerator pedal from NCM via CAN

If replacing the NCA, it is necessary to perform the cycle procedure envisaged in the active diagnoses of the diagnosis system

CAUTION!

When working on the Mechatronik, always take the appropriate safety precautions to avoid static electric discharges in particular.
The term ESD stands for ElectroStatic Discharge. If electrically charged but not correctly earthed, the human body is transformed into an electrostatic "cloud" and could cause damage to electrical components.

It is therefore vital to wear conductive footwear and suitable outer clothing. To prevent possible damage from electrostatic discharge, always take appropriate precautions in the following cases:

- when receiving goods
- in the area for checking goods received in the workshops, and when entering the replacement parts warehouse even for short periods
- in the dispatch/delivery area
- in the transport or maritime shipment area
- when handling, fitting or removing the Mechatronik

Keep the packaging material and the ESD protective film so that you can use them when returning the parts removed from the transmission. Be sure to use a suitable support or fitting equipment to position and center the components of the Mechatronik during installation operations.

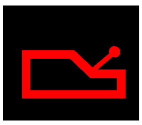
System failure

Automatic gearbox failure information reaches the instrument by means of a signal from the C-CAN line;

Gearbox oil level low

The red pictogram shows that the gearbox oil level is too low. If the warning light comes on, stop the car.

Automatic Gearbox Failure



According to the various message combinations (see below), the pictogram indicates:
- gearbox failure;
- gearbox oil temperature too high.

Gearbox failure
This message, highlighted in red, indicates an anomaly in the gearbox system, so if you are driving, the control unit managing the device imposes an emergency program. You are advised, in any event, to stop the car in these circumstances and switch off the engine for at least a minute. When re-starting, the auto-diagnosis system could exclude the anomaly, which will be recorded by the control unit anyway.
In failure conditions, it is still possible to move the gear lever to R, N, P and D. In the last of these, the gearbox will engage only a few gears, according to the anomaly found.

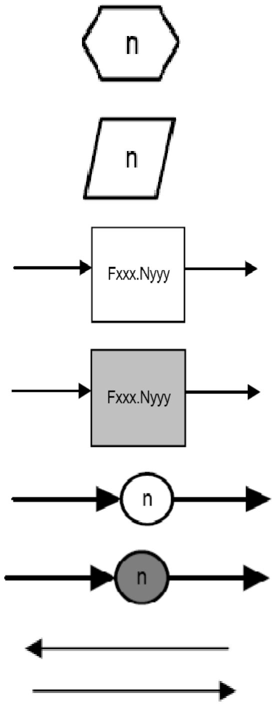
Gearbox oil overheating protection strategy

- **126°C:** gearbox recovery due to reaching of the first critical temperature threshold: the gearbox maximises the flow of oil to the exchanger to optimize heat exchange and the warning lamp comes on.
- **136°C**: The engine software reduces torque and limits engine speed to 4000rpm; the Mechatronik imposes the use of high gears. The warning lamp remains ON.
- **140°C:** The power supply is interrupted; the gearbox engages 5th and 3rd thanks to the “normally open” solenoid valves of the Mechatronik. The warning lamp remains ON.

Checking the lock up clutch

- **Converter open**: The tester shows 0.048 A as the current of the proportional valve and a difference of 640 rpm between turbine and pump.
- **Converter under adjustment**: The tester shows 0.376 A as the current of the proportional valve and a difference of 60 rpm between turbine and pump.
- **Converter closed**: The tester shows 0.712 A as the current of the proportional valve and a difference of 0 rpm between turbine and pump. If a difference between turbine rpm and pump rpm is displayed, particularly during closure of the converter, this is a sure sign of a problem with the converter.

Communication flow of parameters involved in automatic gearbox control.



Input/output with sensor/actuator included

Input/output with sensor/actuator not included

B-CAN node

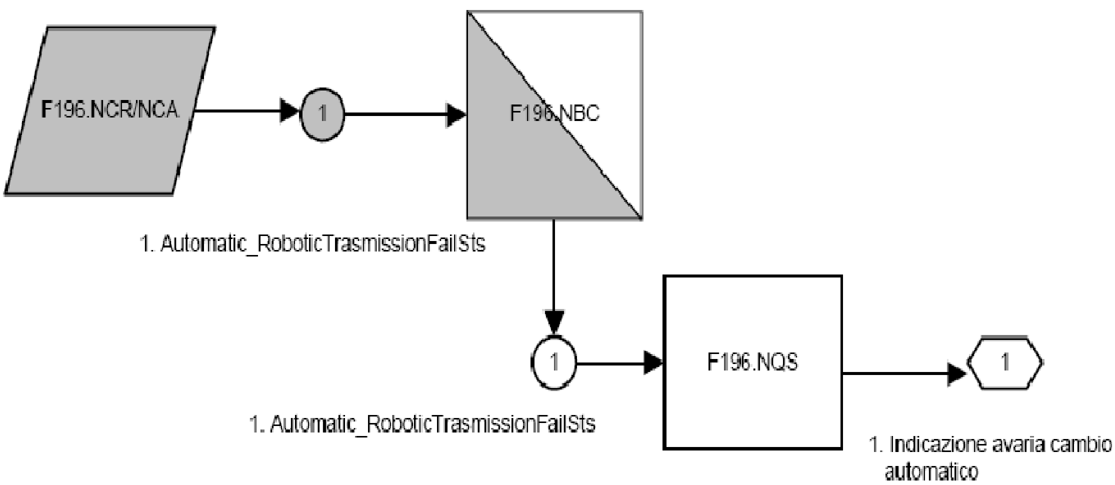
C-CAN node

B-CAN signal (n = number of data units)

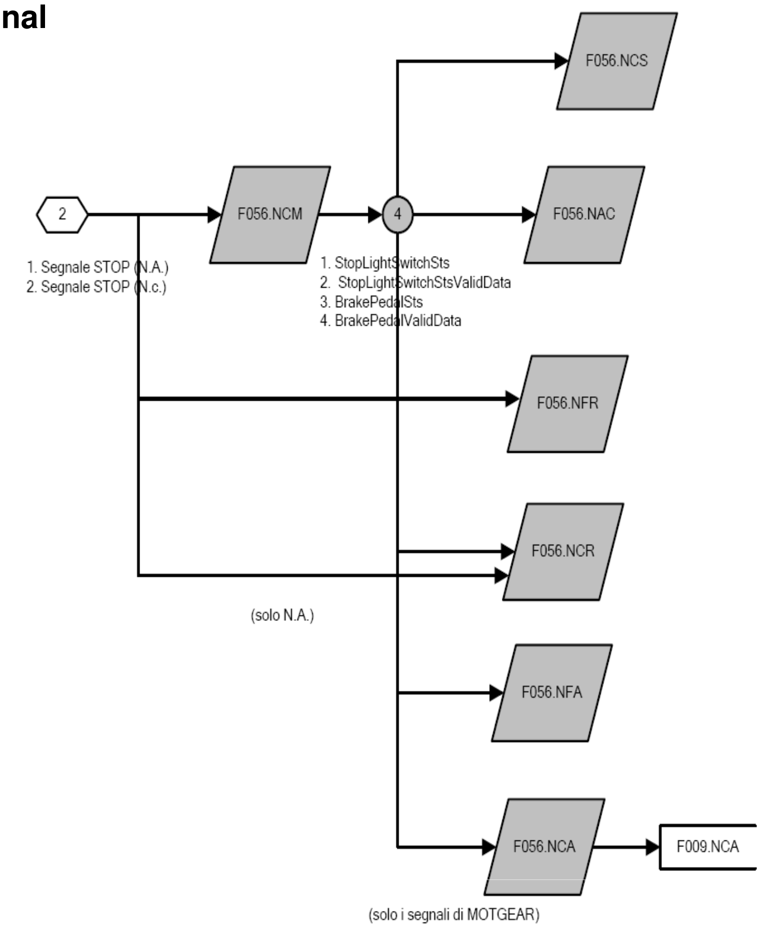
C-CAN signal (n = number of data units)

Non-CAN signal (hard wire)

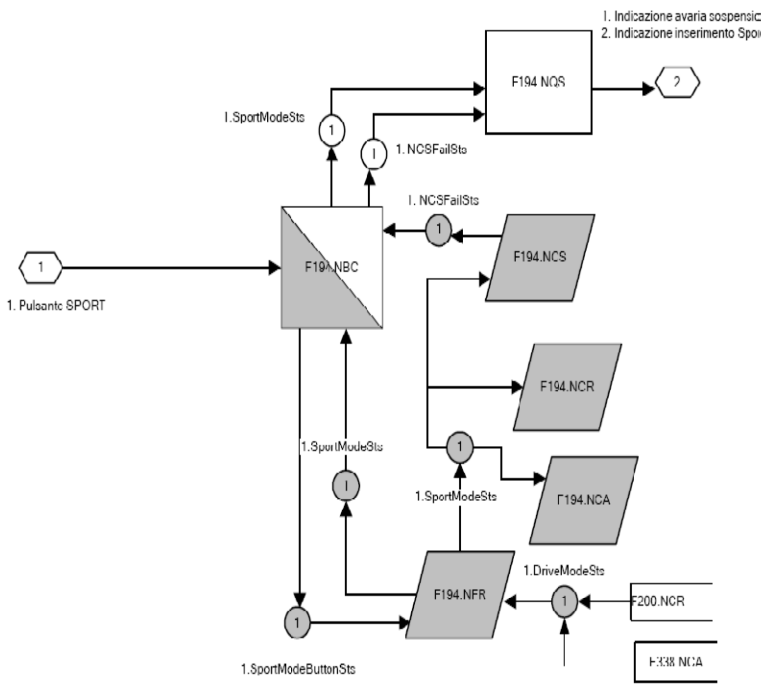
Gearbox failure signal



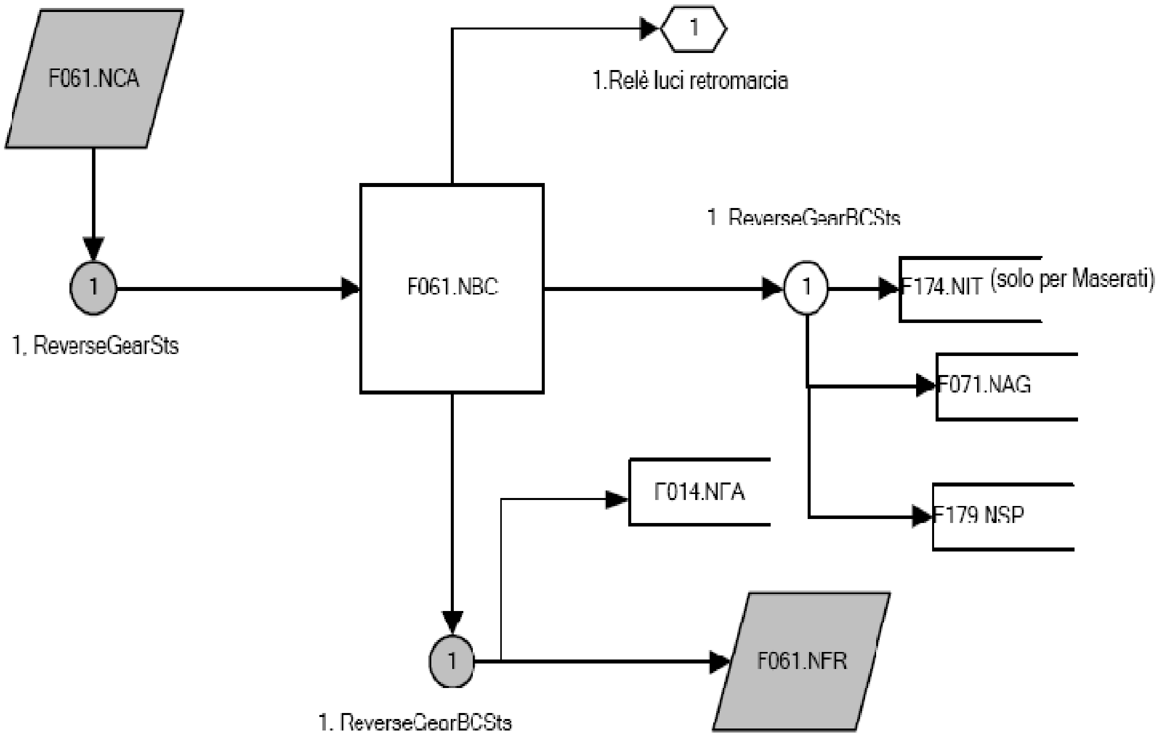
Stop signal



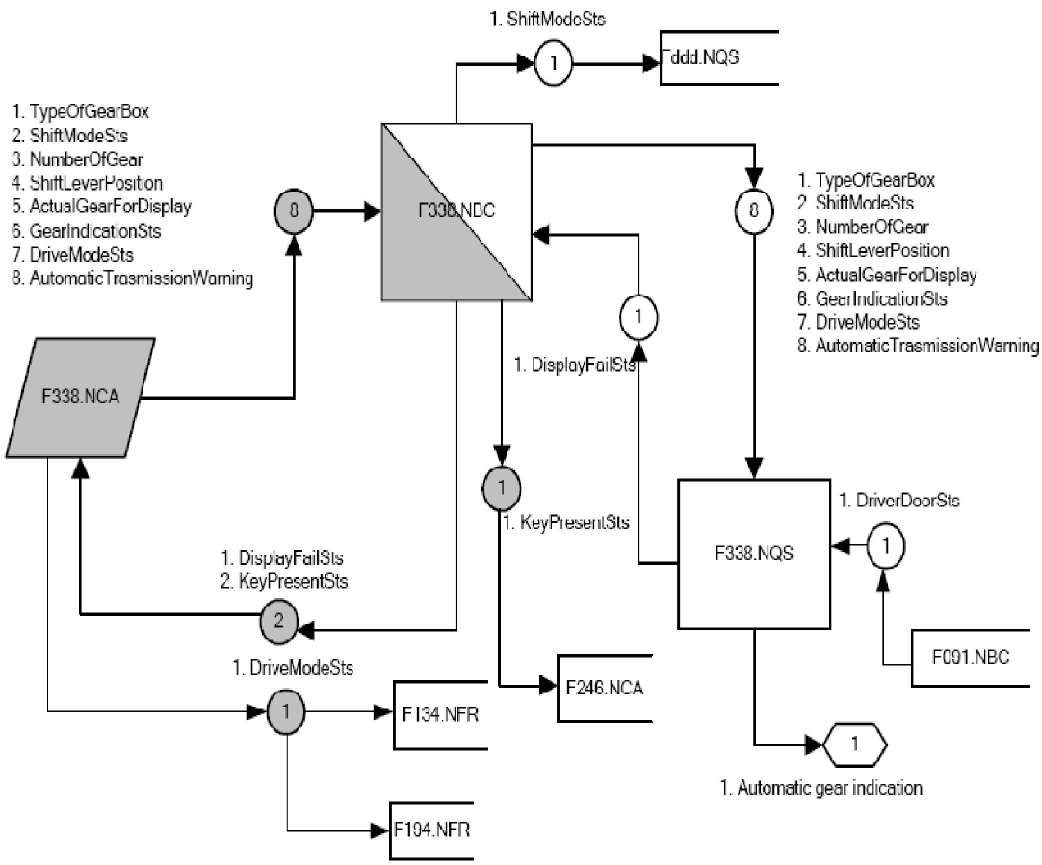
Sport mode signal



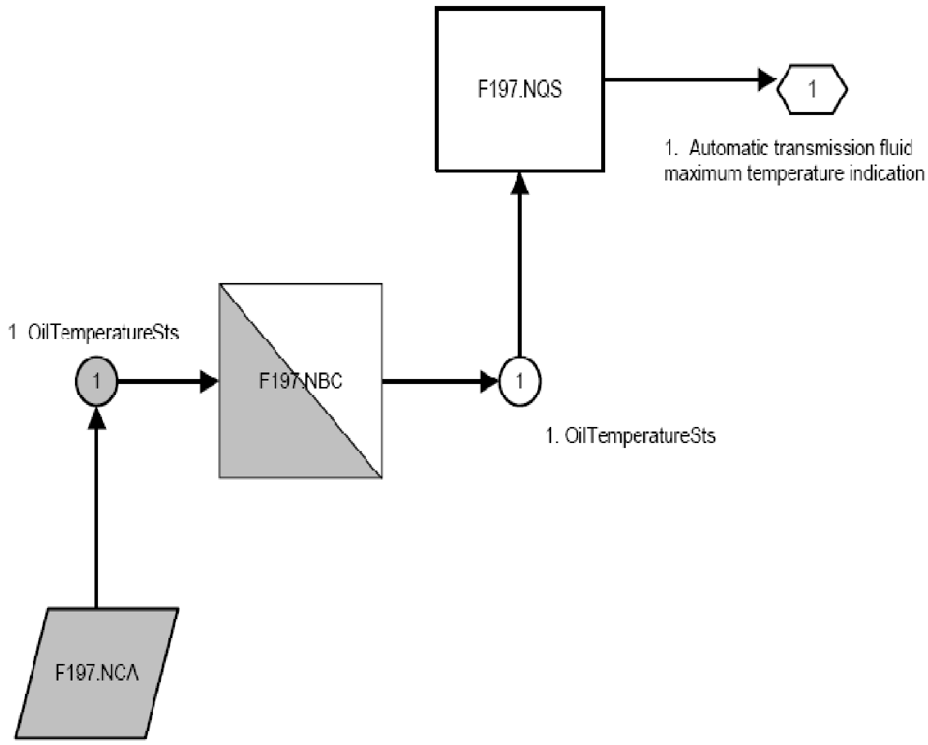
Reverse signal



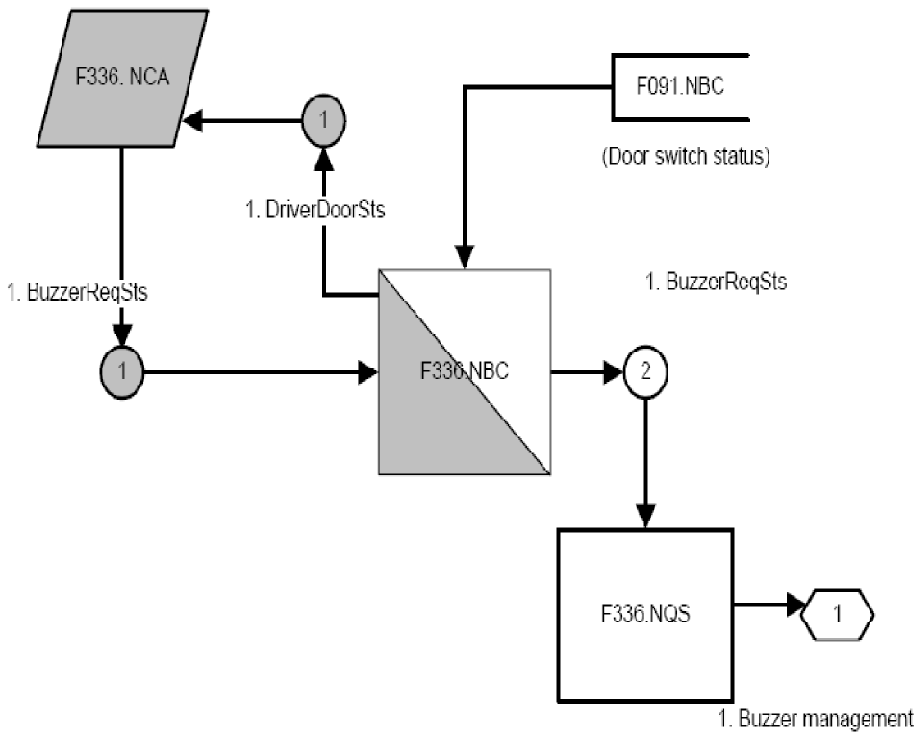
Automatic gearbox status and engaged gear signal



Gearbox oil temperature signal



Buzzer activation signal



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