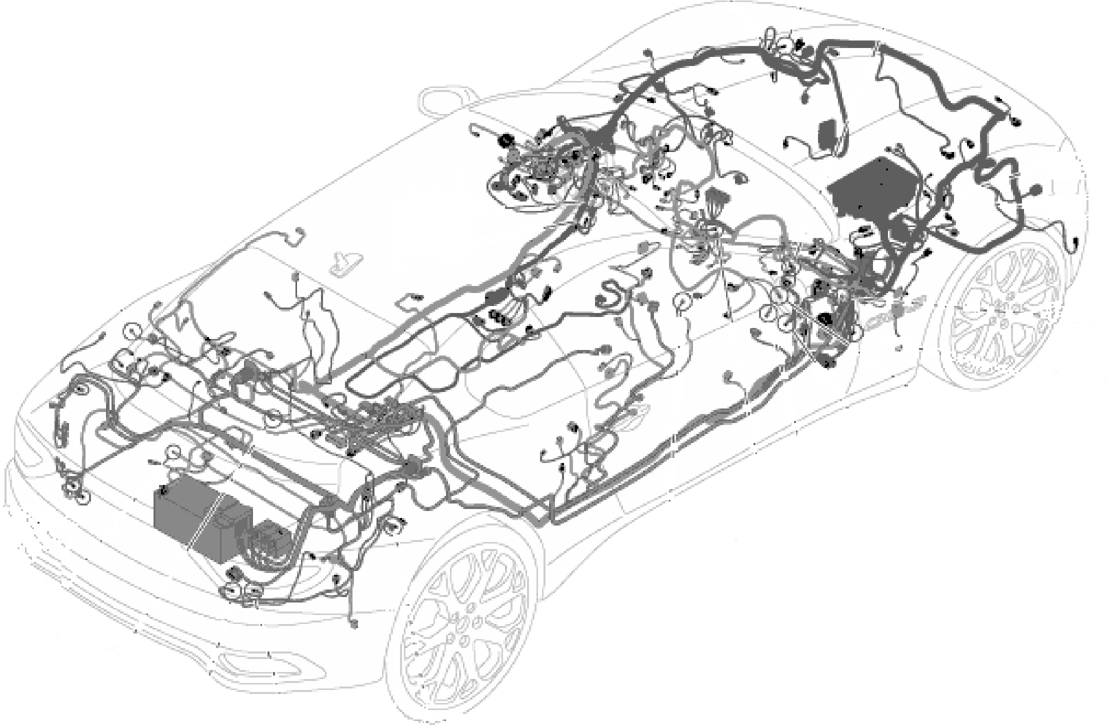
MASERATI
ACADEMY

Advanced Electronics 1

Engine and Power Train



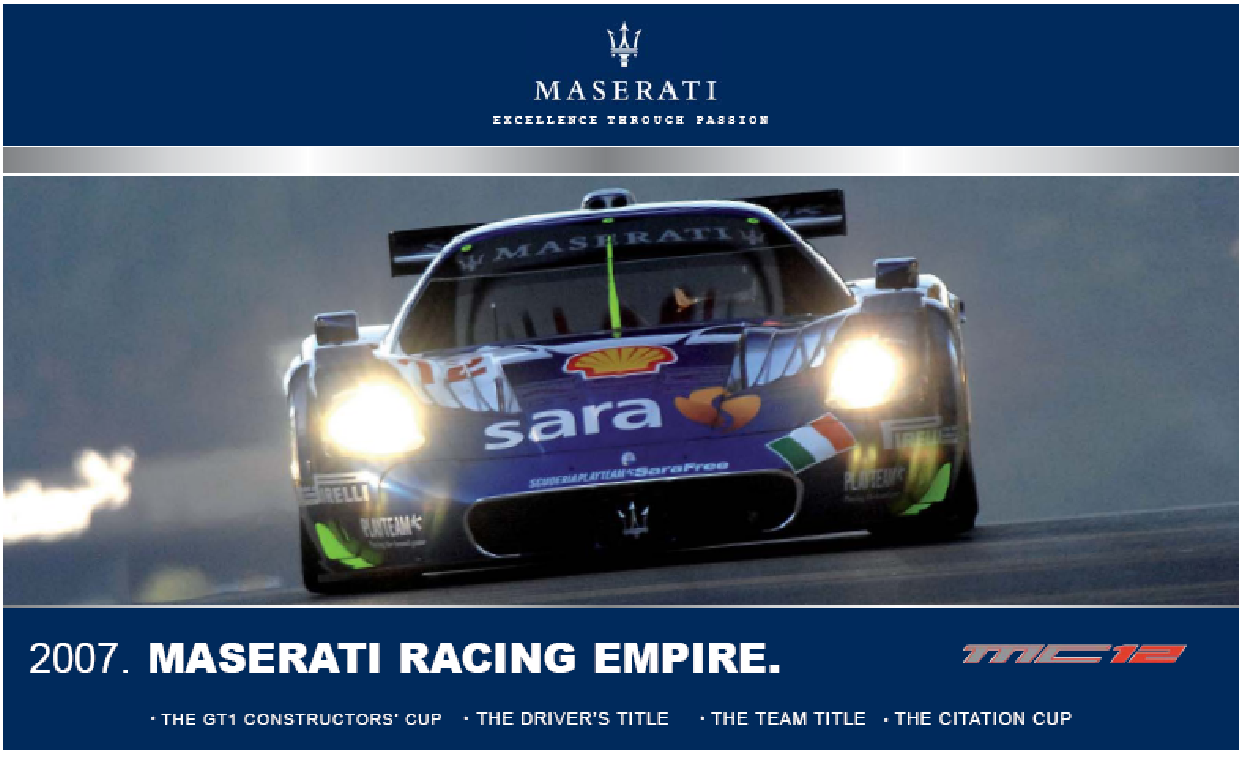
March 2008 Edition

Training Documentation for Maserati Service Network

Advanced Electronics part 1

Engine and Power Train

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



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 handling 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.

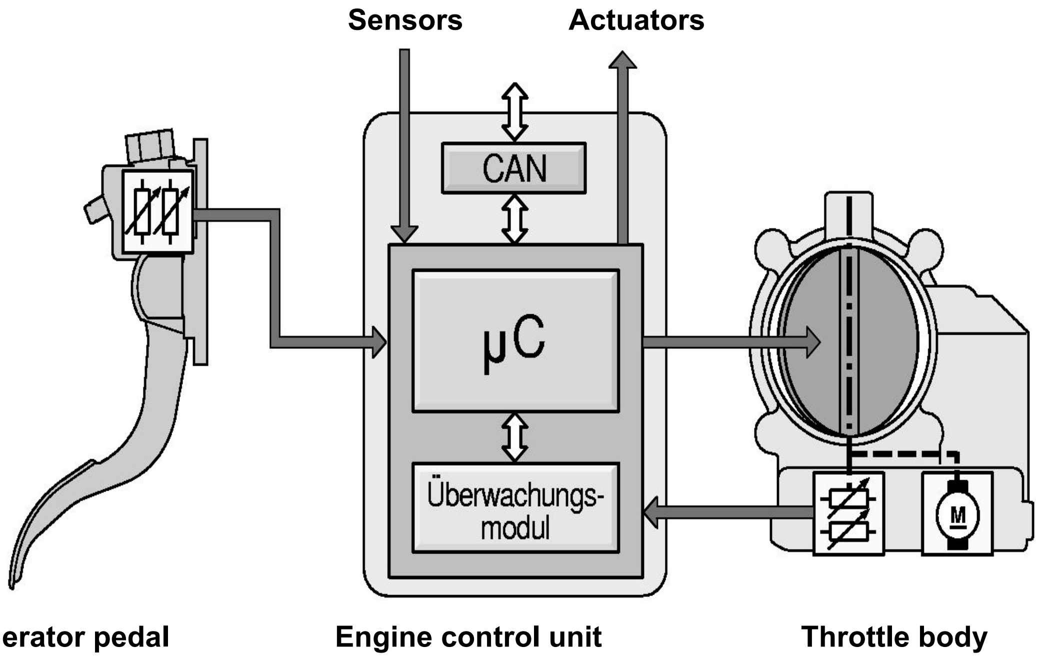
The engine control systems used on the most recent Maserati models are as follows:

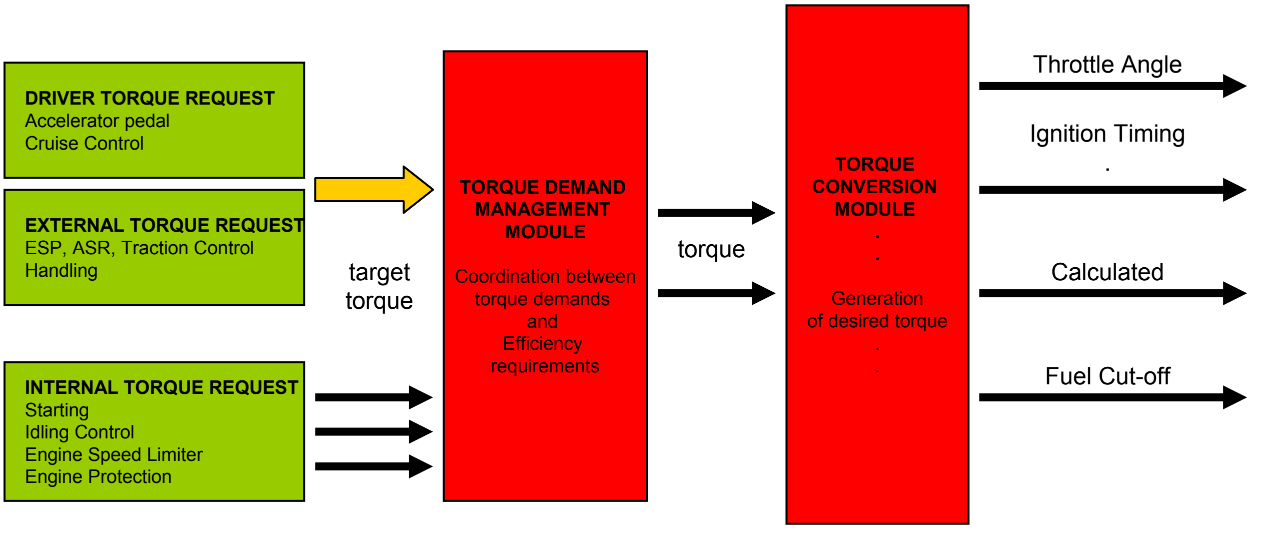
- 3200 GT (M338): Marelli IAW 4CM
- Coupé, Spyder, Gransport (M138): Bosch Motronic ME 7.1.1
- Trofeo (M138): Bosch Motronic ME 7.1.1
- Trofeo Light (M138): Italtecnica, dedicated to Motorsport
- Quattroporte (M139): Bosch Motronic ME 7.1.1
- GranTurismo (M145): Bosch Motronic ME 7.1.1
- MC12 road version (M144): 2 x Bosch Motronic ME 7.1.1
- MC12 race version: 2 x Bosch Motronic ME 7.1.1, (without air flow sensors)
- MC12 GT1: Marelli, dedicated to Motorsport

This manual describes exclusively the Bosch Motronic ME 7.1.1 system

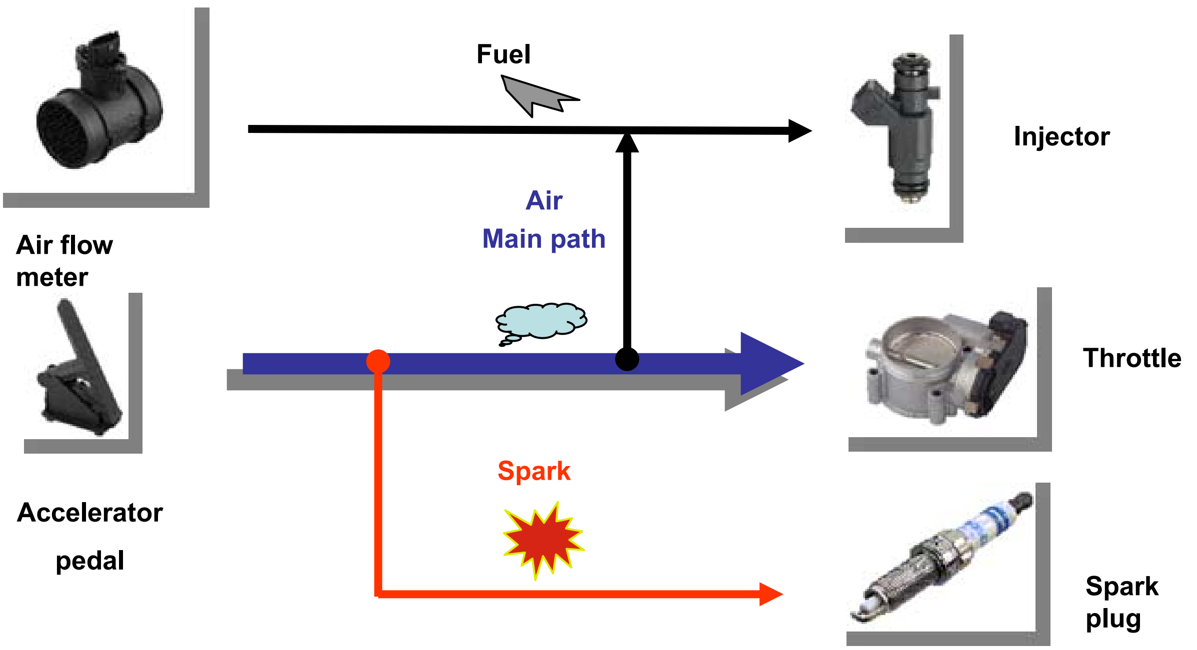
THE TORQUE BASED MODEL:

The main objective of the engine control system is that of delivering engine torque ("Torque based" model). This strategy is applicable 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 rpm value. This rpm target is subsequently transformed by the ECU into a torque target.

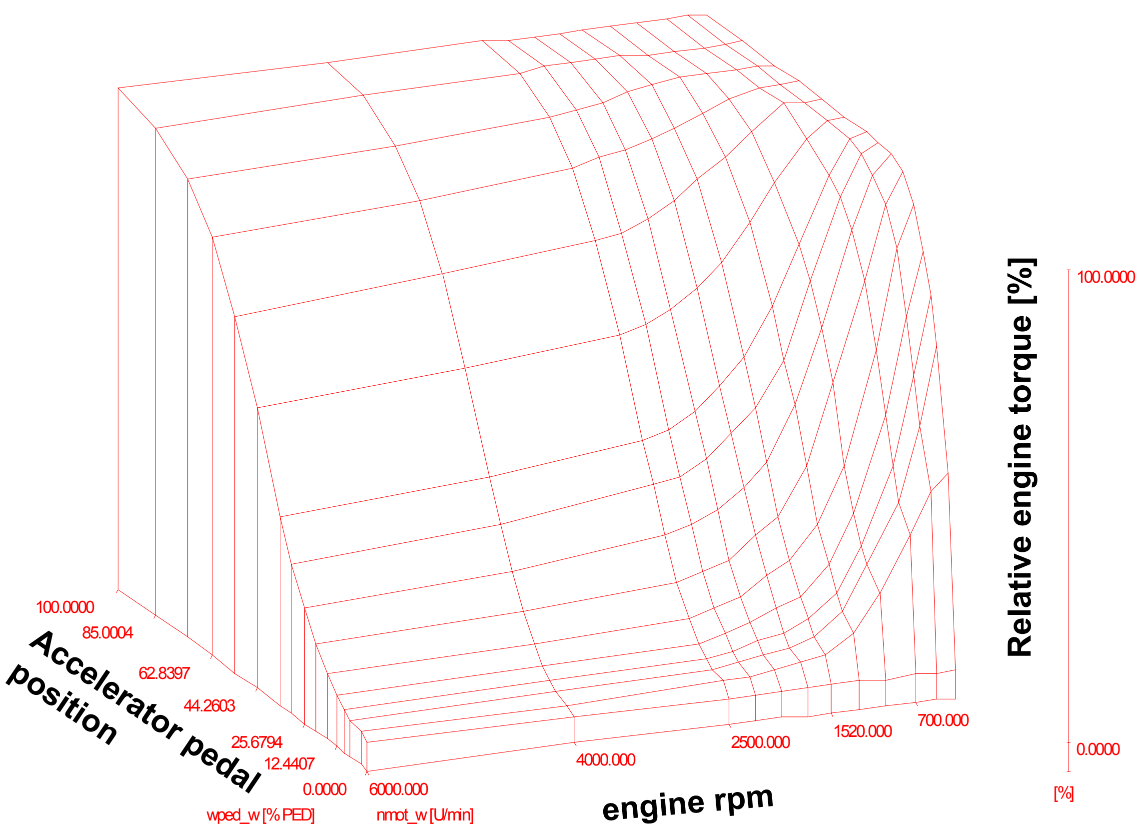




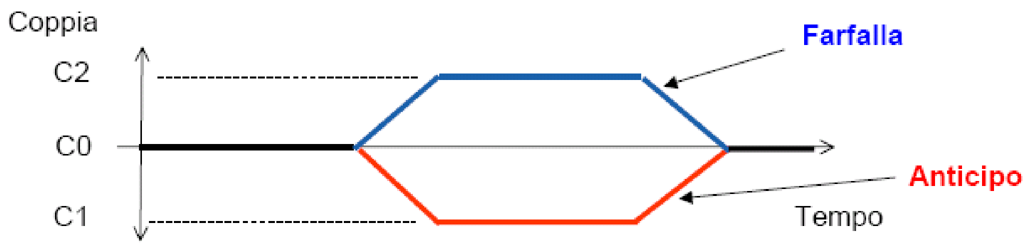
MOTRONIC PRIMARY FUNCTIONAL STRUCTURE:



TORQUE REQUEST: PEDAL MAP



TORQUE RESERVE STRATEGY:



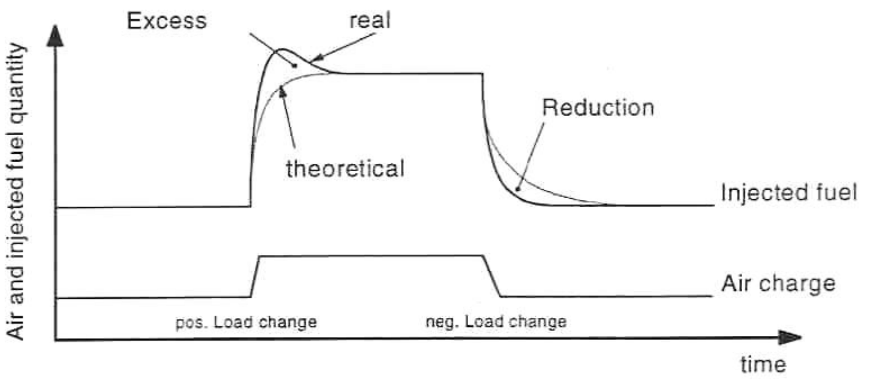
When the vehicle is cruising at minimum throttle sufficient torque must be delivered to overcome friction forces: C0

The same C0 can be delivered with less advance but more throttle: 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:

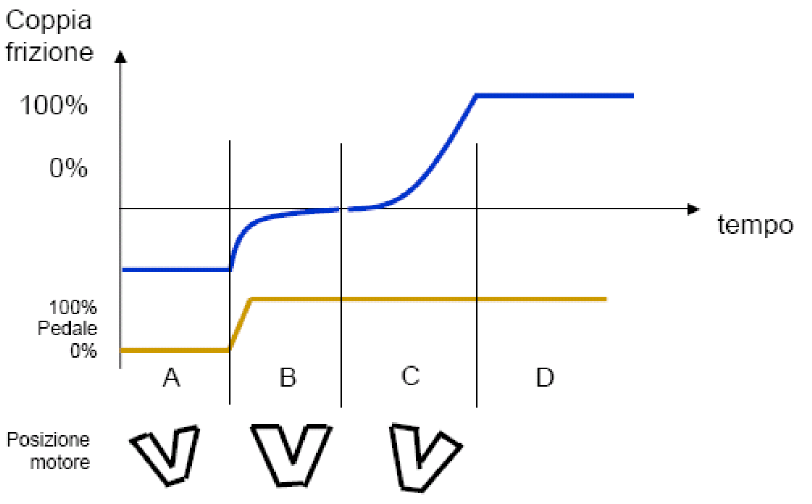
- fast C0-C1 torque delivery (even though of modest entity) for breakaway acceleration
- hot exhaust gas to heat the catalytic converter (the advance is retarded in C1)
- the negative aspect is that combustion is impaired (non-optimal spark advance)

TRANSITION STRATEGY:



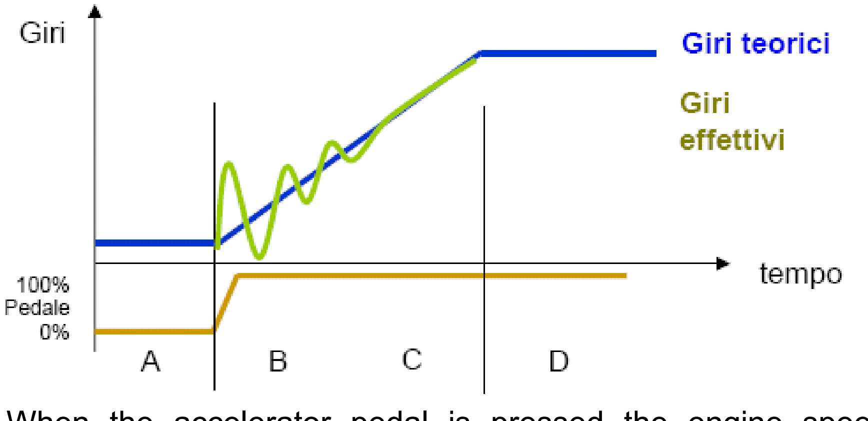
- The concept of a transient refers to the transition between two stable situations.
- There are two types of transients: acceleration and deceleration.
- In acceleration it must be taken into account that part of the fuel will be deposited on the walls as a fluid film. It is therefore necessary to inject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

DRIVEABILITY: TORQUE REVERSAL



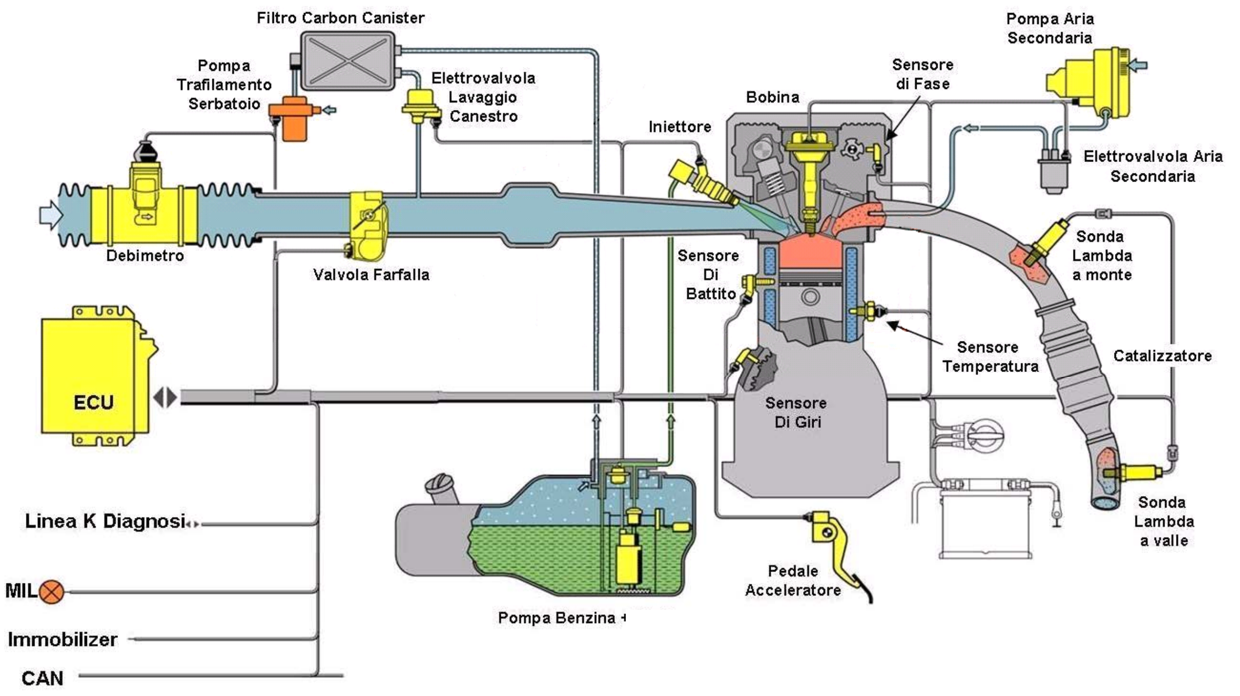
- In A the engine is being driven (drag torque): negative torque at clutch.
- In B the accelerator pedal is pressed: first filter to bring the engine to the neutral position.
- In C the transition of the engine from the neutral position to the torque delivery position is filtered.

DRIVEABILITY: "FLUTTER"



- 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.

MAIN SYSTEMS



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

1. Air
2. Fuel
3. Spark

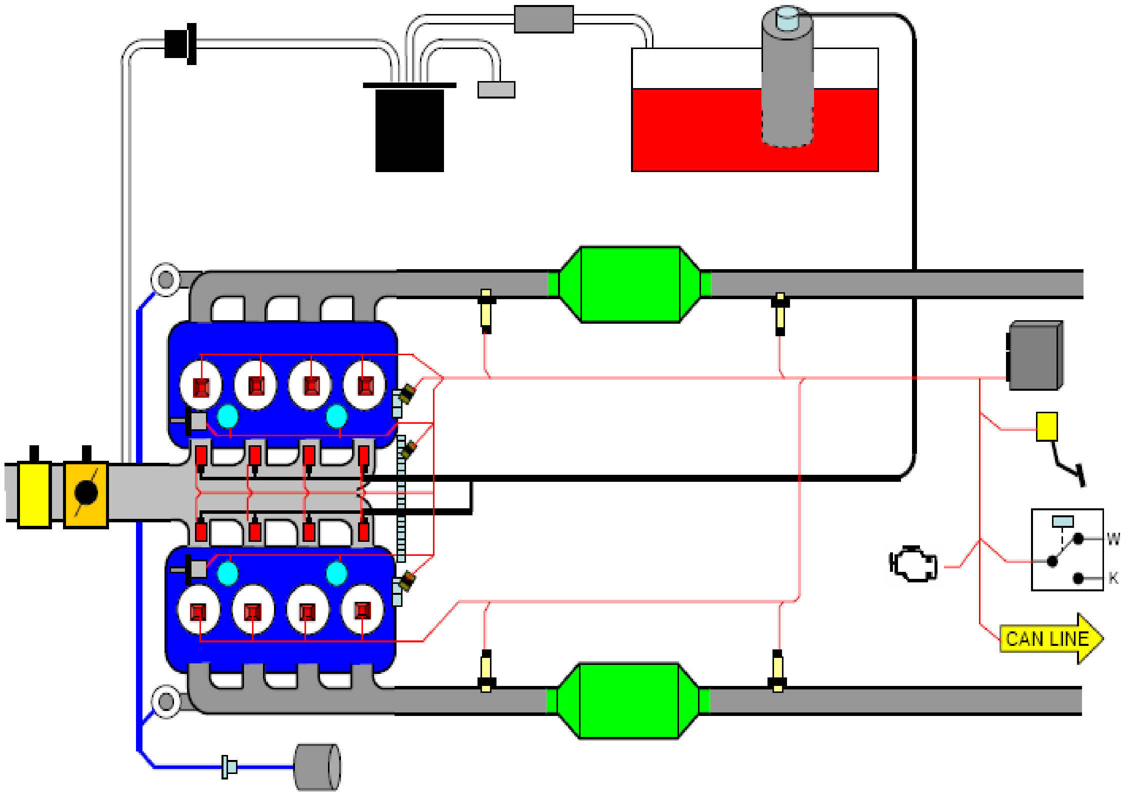
The main engine systems are as follows:

1. Aspiration system
2. Fuel system
3. Ignition system

In practical terms it is necessary to:

1. Scavenge burnt gas by means of the exhaust system.
2. Cool the engine by means of the coolant circuit.
3. Lubricate the engine with oil and the relative oil lubrication circuit.
4. …

MAIN SYSTEMS



Moreover, anti-pollution regulations prescribe that:

Fuel vapours that form in the fuel tank must be recycled to the fuel intake and the absence of leaks from the fuel tank must be guaranteed;

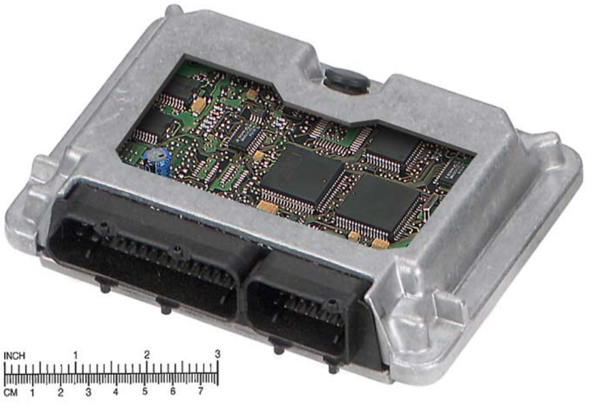
Oil vapours formed in the crankcase must be routed to the intake system;

Whenever necessary, use a "Secondary Air" system that delivers air into the exhaust system when it is still cold in order to complete the reaction of incombustibles and bring the catalytic converter to a condition of full efficiency faster;

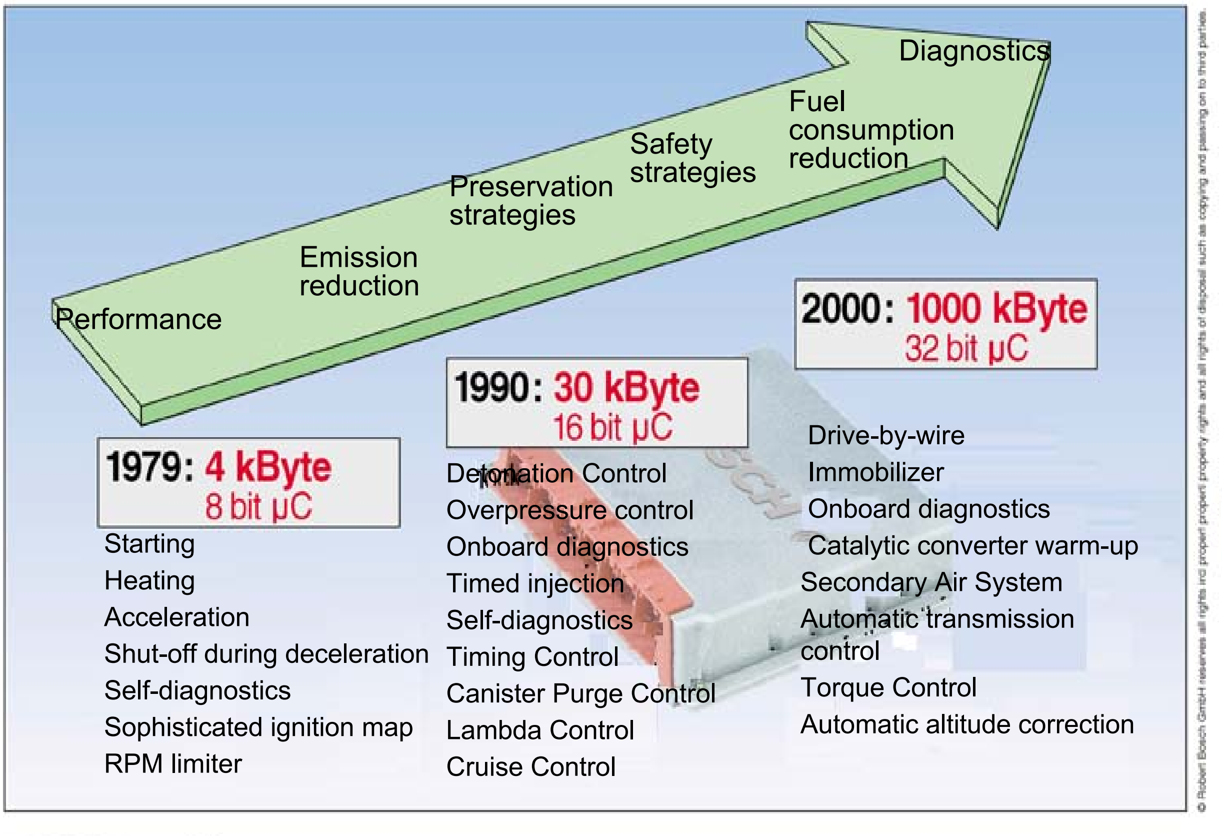
SYSTEM COMPONENTS

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

BOSCH MOTRONIC ENGINE CONTROL UNIT



The two main 32-bit microprocessors are located internally in the Motronic ME 7.1.1 control unit. Engine control system diagnostics functions 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

ENGINE CONTROL SYSTEM SOFTWARE VERSION

USA M139		MY 04/05			MY 06			
		da assembly 21925			da assembly 21926			
		M139	Risanamento 142	Aggiornamento	M139	Aggiornamento	ESP8.0 ass.24275	SPORT GT ass 24557
MOTRONIC - NCM	File SD2/SD3	INST5235	INST5235	INST5235	*	AGGIORNAMENTO DIRETTO da SD3		
	Nome SW	198428.002	198428.002	198428.002	219314.001	228926.001	222355.002	224756.001
DUOSELECT - NCR	File SD2/SD3	*	AGGIORNAMENTO DIRETTO da SD3		*	AGGIORNAMENTO DIRETTO da SD3		
	Nome SW	SOFAST III MDDD29U20	SOFAST III MDDD31U21	SOFAST III MDDD32U31	SOFAST III+ MDED31A60	SOFAST III+ MDED37A62	SOFAST III+ MDED4BA66	SOFAST III+ MDED4BC71
	Hardware	CFC301			CFC301			
	Nome SW di diagnosi	NCR nodo cambio robotizzato magneti marelli SOFAST 3	NCR nodo cambio robotizzato magneti marelli SOFAST 3	NCR nodo cambio robotizzato magneti marelli SOFAST 3	NCR nodo cambio robotizzato magneti marelli SOFAST 3+	NCR nodo cambio robotizzato magneti marelli SOFAST 3+	NCR nodo cambio robotizzato magneti marelli SOFAST 3 +	NCR nodo cambio robotizzato magneti marelli SOFAST 3 +

NOTE: * non disponibile sul portale

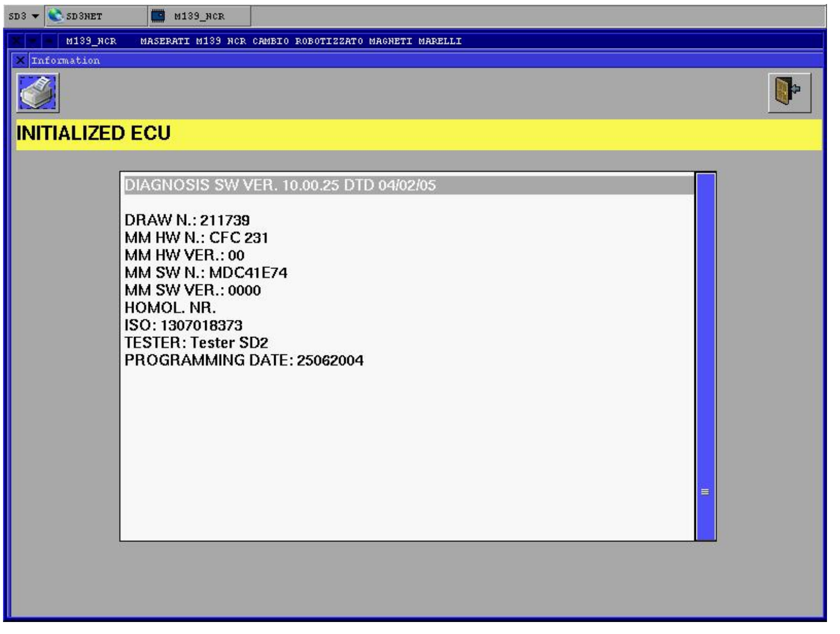
Example table, always check Modis for the latest release published!

Checking of the engine node software combined with the transmission software is of fundamental importance for correct diagnostics.

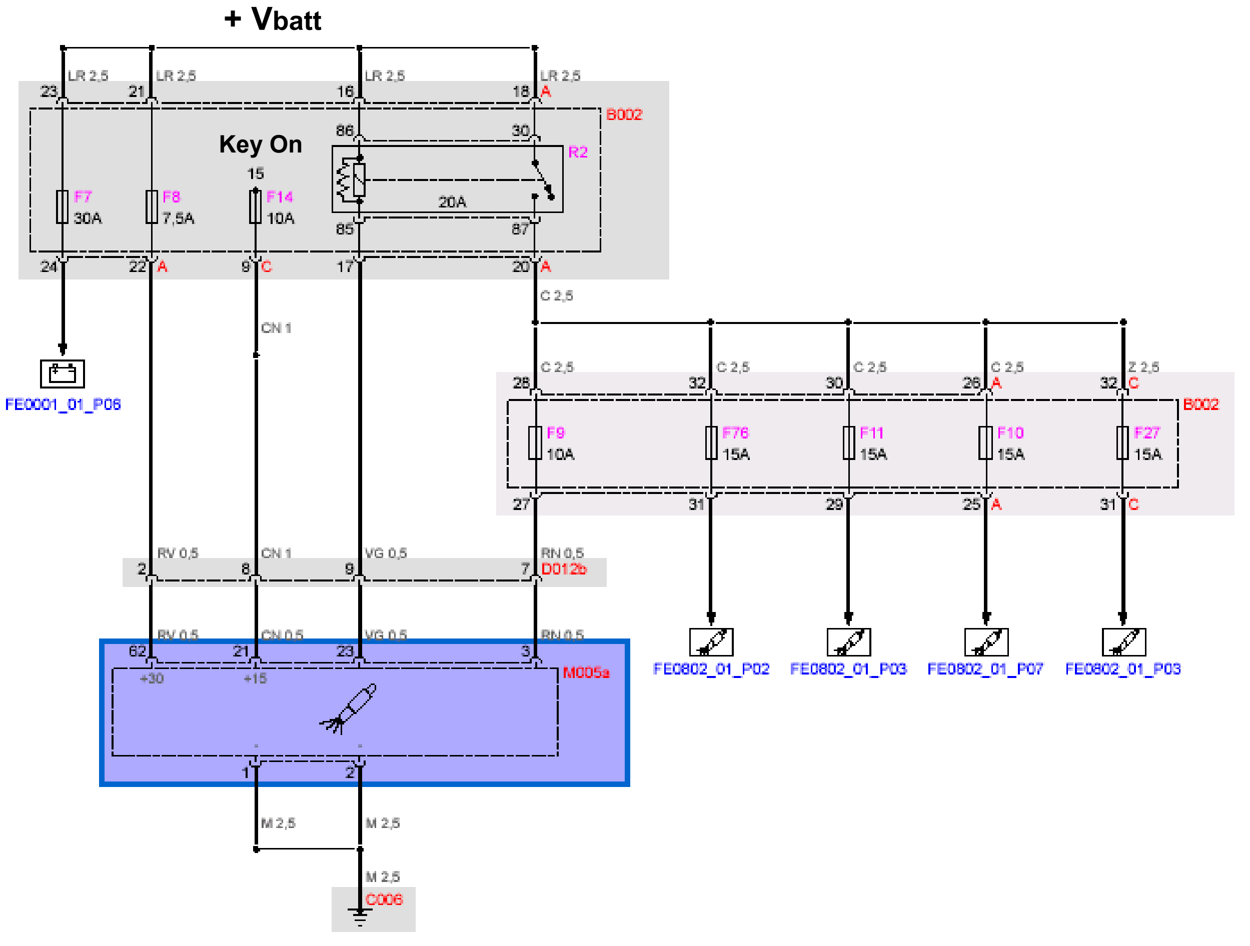
Before making any replacements or disassembling any parts of the car involving problems related to the engine or transmission control unit, it is mandatory to check the correspondence between the Engine SW and the Transmission SW, as shown in the table published on Modis, which is constantly updated by the Maserati Technical Assistance Service.

Also in the event of replacement of a control unit it is indispensable to subsequently check correct matching as per the table, in accordance with the assembly N°, Model, Year, and hardware version of the node concerned.

The Software is checked with SD3, interrogating the engine control node and the transmission control node and subsequently checking compatibility by means of the table and performing a remote download if necessary.



ENGINE CONTROL SYSTEM POWER SUPPLY



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) and for activation of certain subsystems that are active in Key OFF conditions (e.g.: DMTL system).

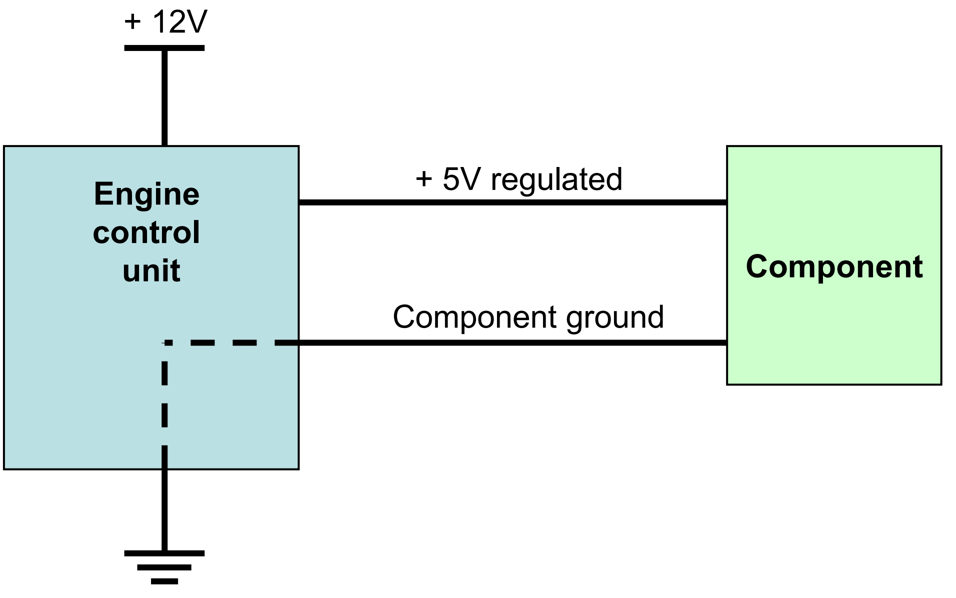
Influence of battery voltage:

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

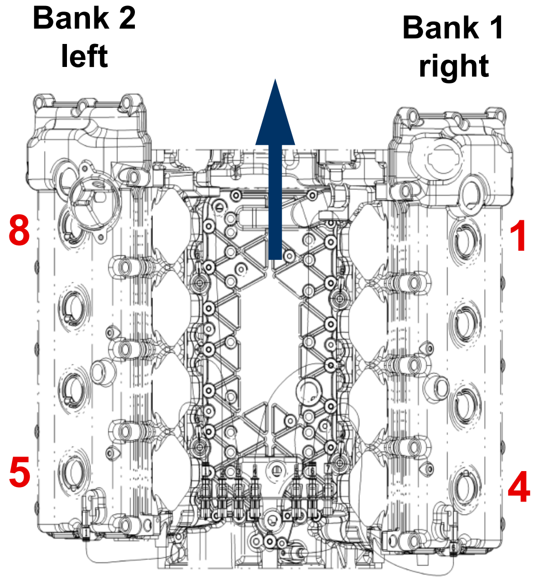


Various engine control system sensors use a regulated 5V power supply. This power supply is regulated with respect to a specific reference ground for the components in question. This solution is necessary for two reasons:

- **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!

BANKS NOMENCLATURE:

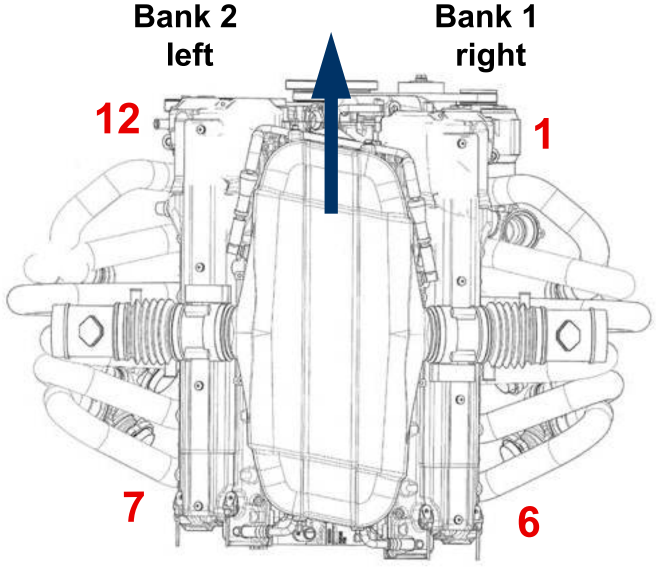


MC12: 2 x Bosch Motronic ME 7.1.1

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.

VARIOUS FUNCTIONS OF THE ENGINE CONTROL UNIT:

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

Fuel cut off:
In the event of collision, the Motronic ECU receives an "active low" signal from the inertia switch and consequently cuts off the fuel supply for safety reasons.

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

Fuel level:
The Body Computer informs the Motronic ECU 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 (manual transmission versions):
Utilised in the gear change strategy (diagnostics during gear changes).

Brake pedal switch:
torque modulation for engine braking.

Speed signal:
The speed signal (received on the CAN network) is required for monitoring of the Cruise Control function and for various self-learning/self-diagnostic functions of the ECU.

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

ASR / MSR:
The Motronic ECU 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).

"Sport" button:
The Motronic 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 ECU manages activation of the two fans (low and high speed) in accordance with the water temperature and activation of the aircon compressor.

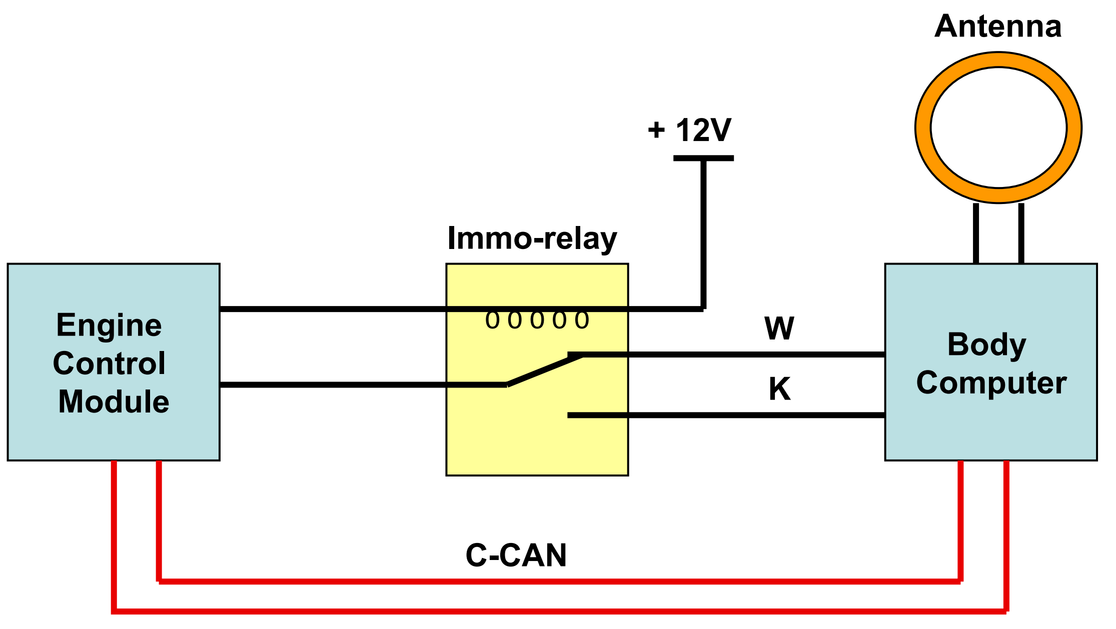
Cruise Control:
Cruise control related driver commands are connected directly to the Engine Control Unit. The Motronic ECU modulates engine torque in accordance with the requested road speed.

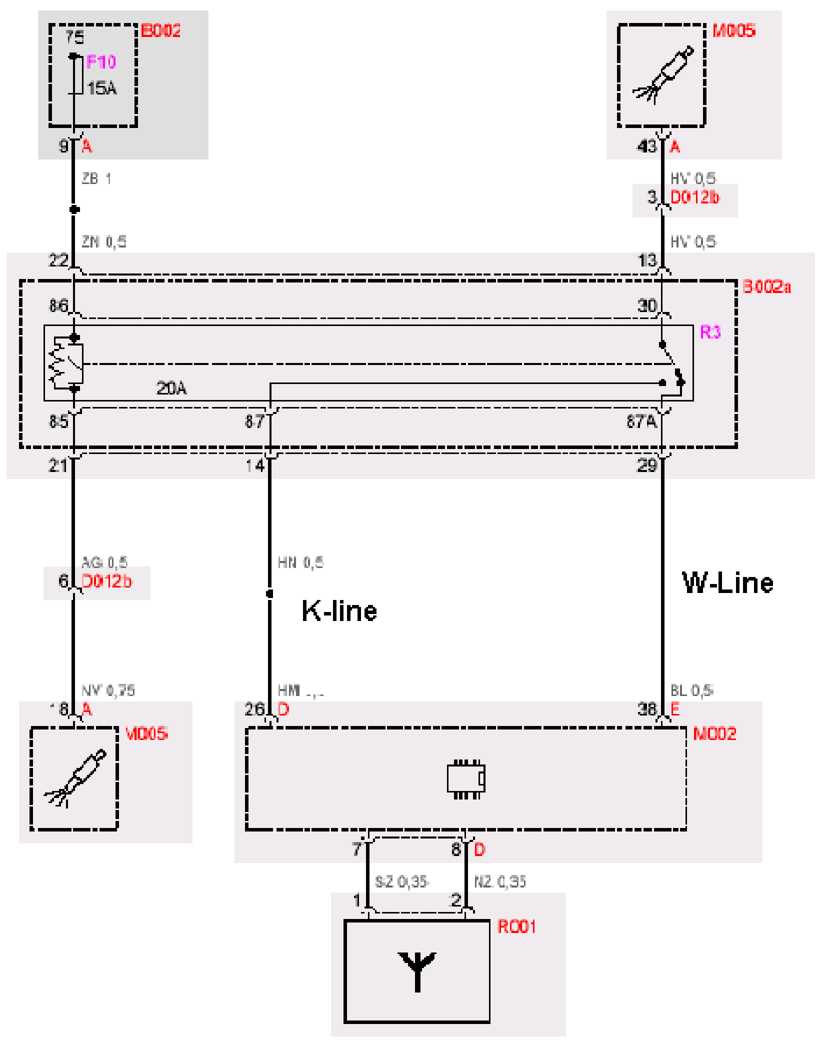
Torque reduction during gear changes (cars with Duoselect gearbox):
The Engine Control Unit and the Transmission Control Unit communicate on the CAN network for management of engine torque during gear changes.

Minimum oil level and pressure:
The Motronic ECU 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.

By-pass valve (Gransport and GranTurismo S):
The Motronic ECU regulates activation of the exhaust silencer by-pass valves on the basis of engine RPM, engine load, and selection of Sport mode.

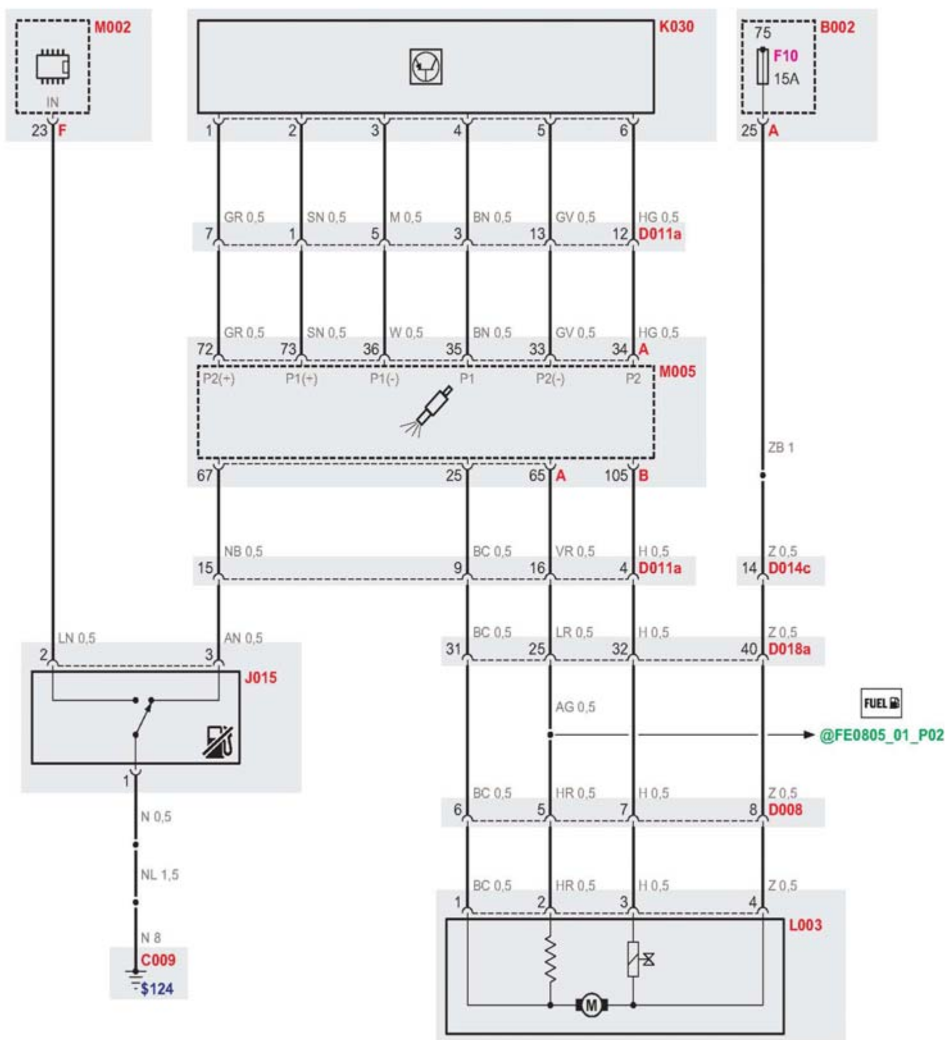
IMMOBILIZER





INERTIA SWITCH

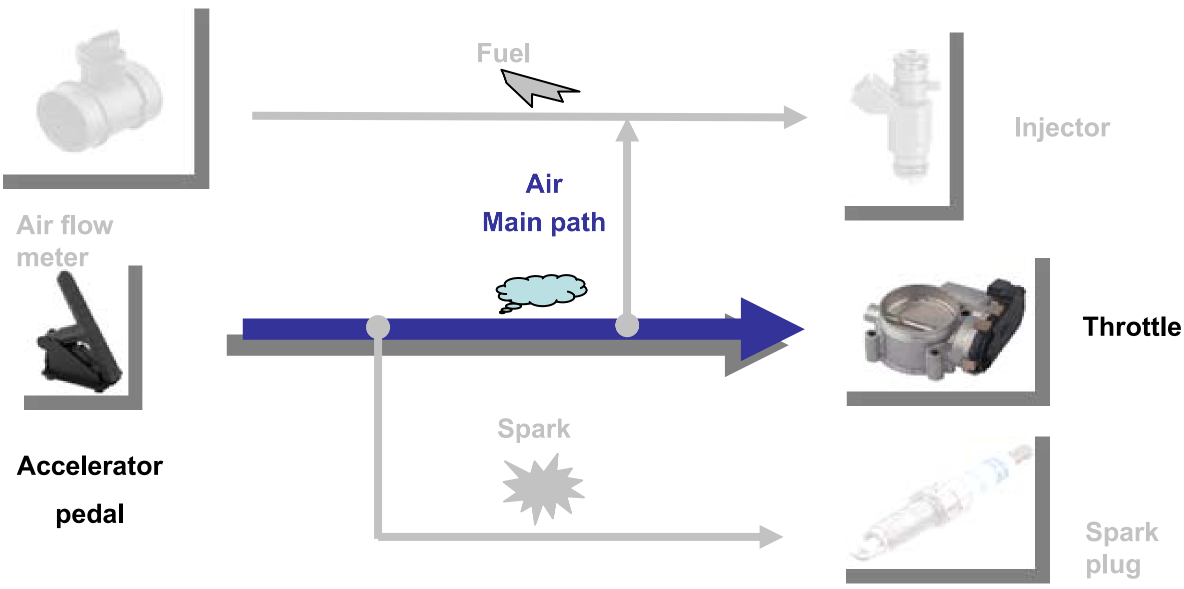
The operating logic of the inertia switch involves management of the NCM and NBC nodes common ground.
In the event of collision the switch cuts the ground connection (C009) with the NCM and "routes" the connection to the **NBC** in the **M145** and to the **NVB** in the **M139**. The power supply is disconnected from the fuel pump so that fuel delivery is suspended and, thanks to the intervention of the NBC (or NVB in the case of the Quattroporte), the doors are unlocked and the hazard warning lights are activated to facilitate the action of rescue crews (if required).



The status of the inertia switch can be checked by means of SD3 (parameters environment):
"Inertia switch status” (NVB and NCM)
"FIS input” (NBC)

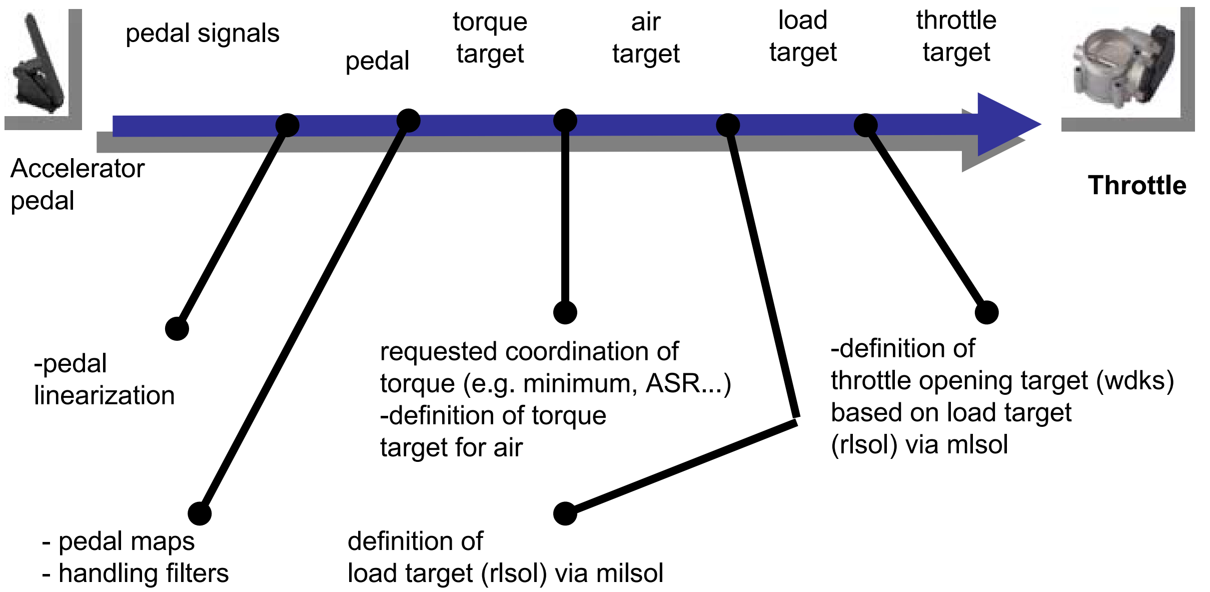
1st FUNDAMENTAL PARAMETER: AIR

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 torque and air flow.



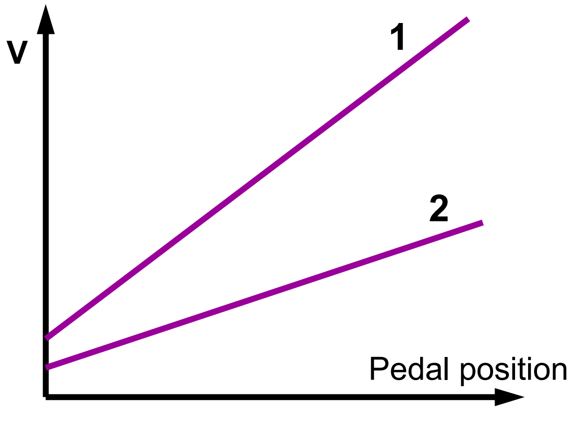
ACCELERATOR PEDAL MODULE

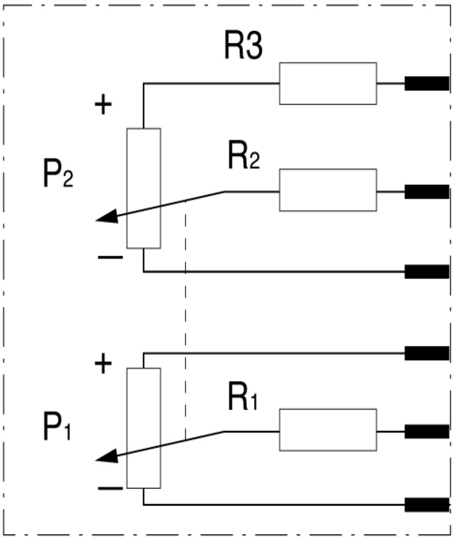
The accelerator pedal module is composed of two independent potentiometers with separate supplies to obtain a redundant signal for safety reasons. The signal value of one potentiometer is half that of the other.

Reference values

Potentiometer 1
- Rest position **= 0.65 ÷ 0.85 V**
- Max. position **= 3.7 ÷ 3.9 V**

Potentiometer 2
- Rest position **= 0.33 ÷ 0.42 V**
- Max. position **= 1.85 ÷ 1.95 V**

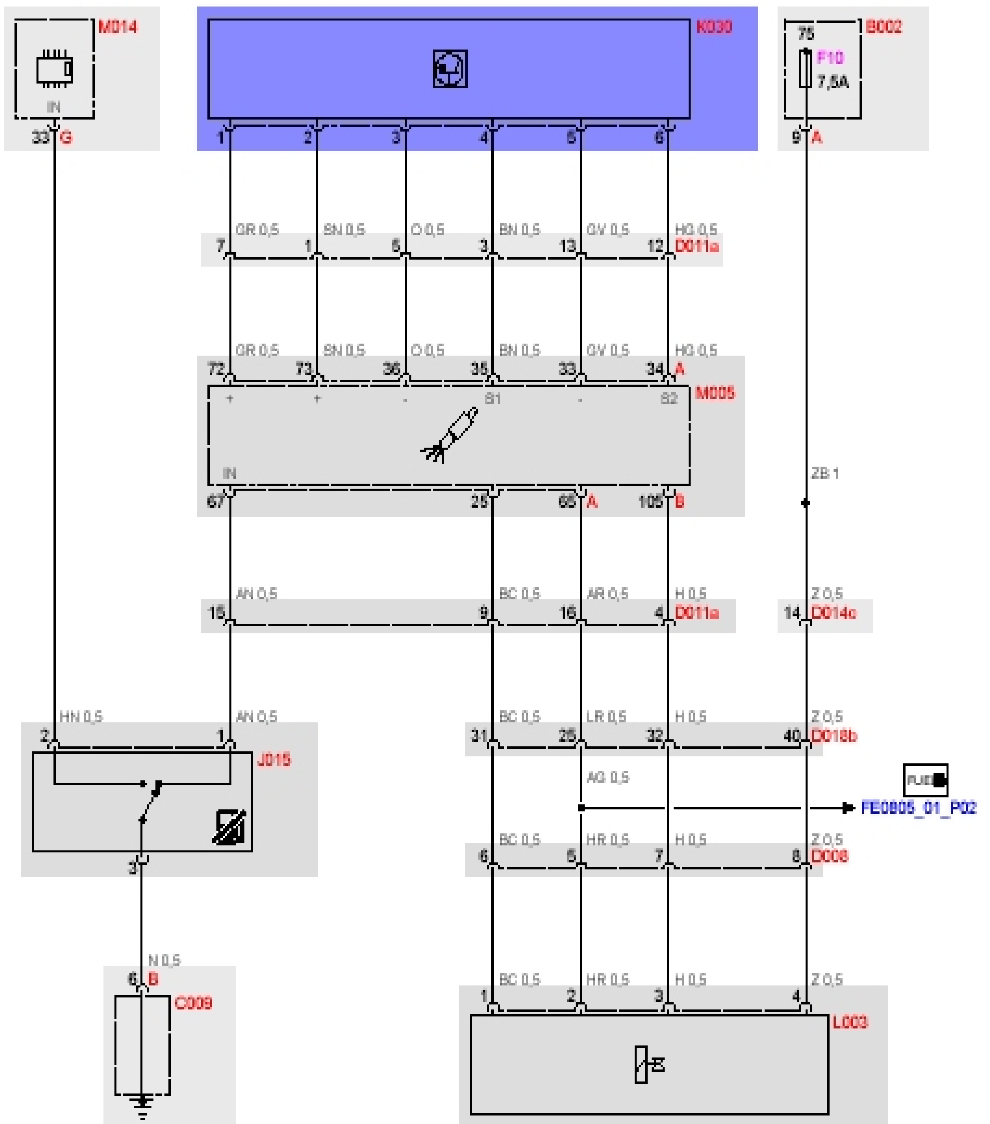


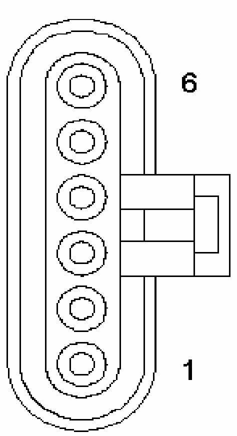


Potentiometer 1 = main
Potentiometer 2 = secondary

The recovery strategy in the event of a fault is different for the two potentiometers

Accelerator pedal circuit diagram:



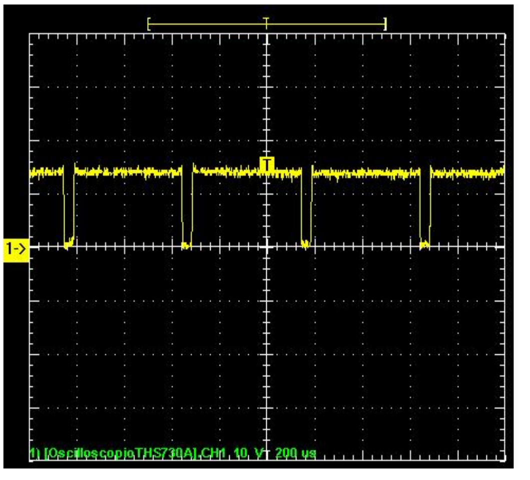


1. Stabiliser sensor 2 power supply
2. Stabiliser sensor 1 power supply
3. Accelerator pedal module ground reference, position 1
4. Accelerator pedal module, position 1
5. Accelerator pedal module reference ground, position 2
6. Accelerator pedal module, position 2

MOTOR-DRIVEN THROTTLE

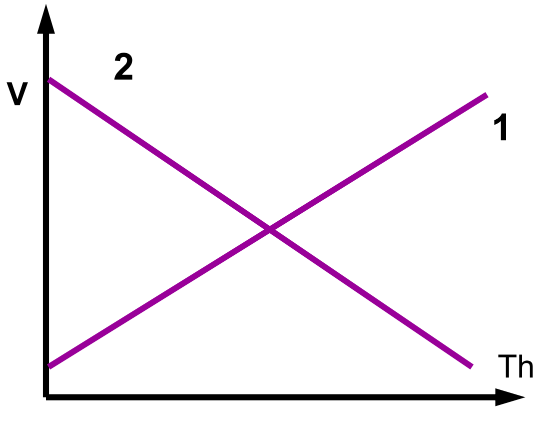
The throttle is driven by a PWM signal.

Throttle position control 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.



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 when power is reconnected.

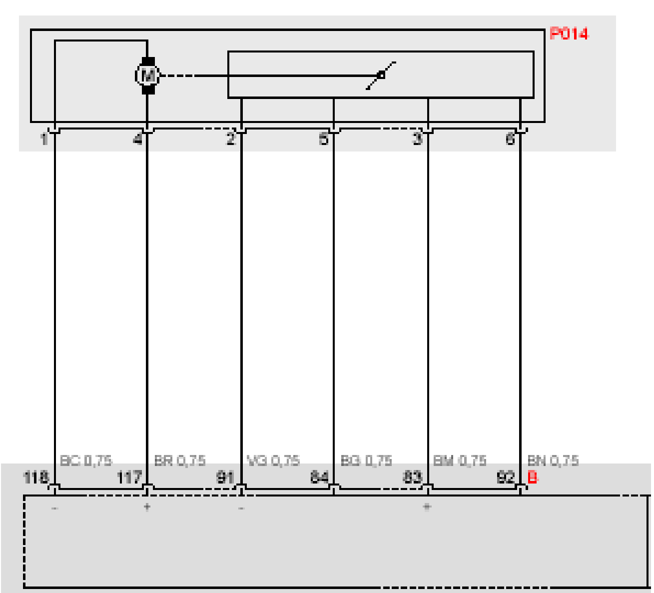
Procedure: Key ON (without starting) > wait at least 20 seconds > Key OFF

Tester SD3 can be used to check that the self-learning procedure has been executed correctly.

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.

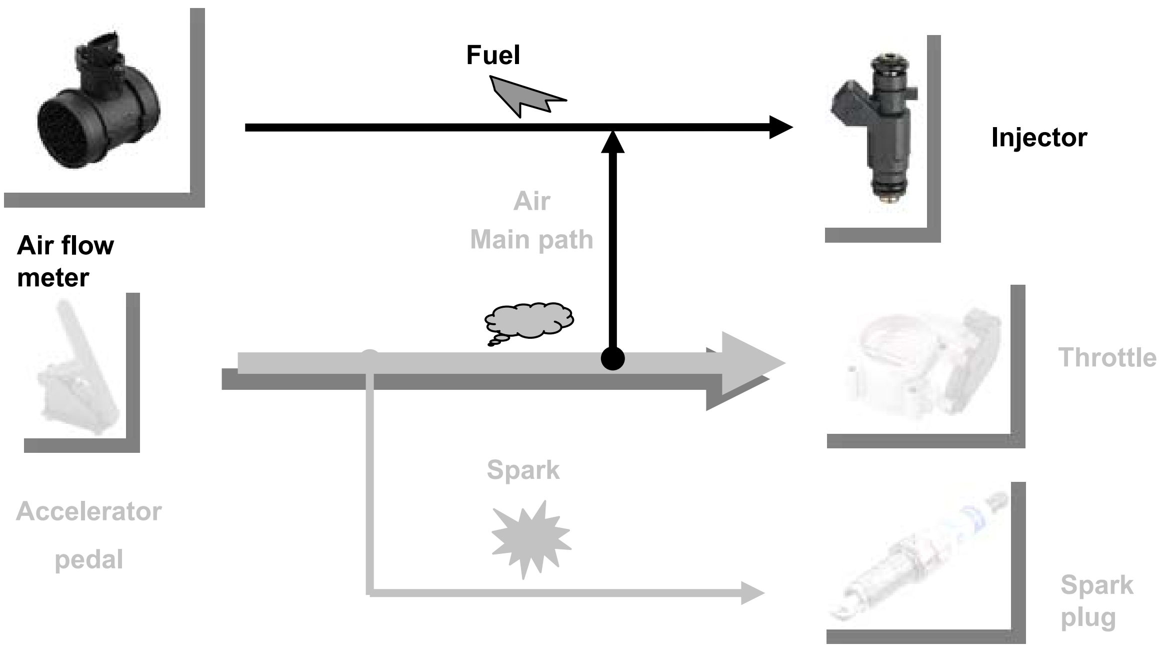
Motor-driven throttle circuit diagram:



1. Ground
2. Throttle ground position
3. Stabiliser sensor 1 power supply
4. Fuel supply
5. Throttle position 2
6. Throttle position 1

2nd FUNDAMENTAL PARAMETER: FUEL

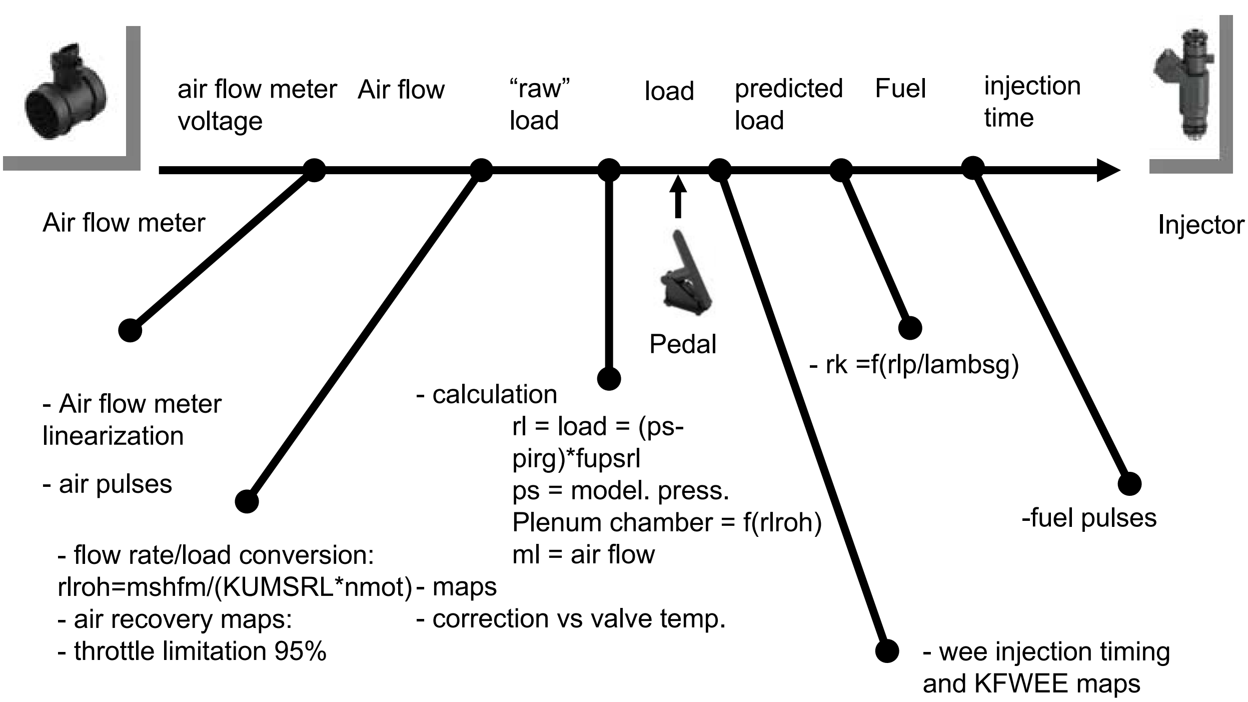
Fuel path:



Fuel calculation:

Having set a Lambda value (from the maps) and established the air flow, the quantity of fuel can be calculated

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



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

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

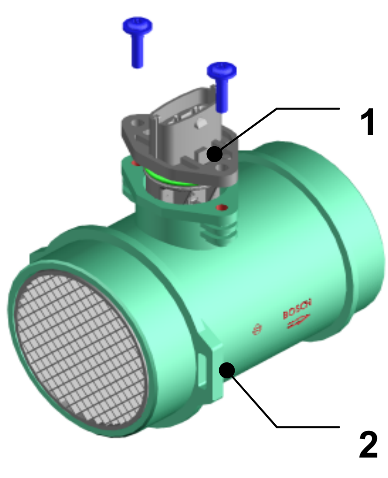
rka = self-learning at idle speed
fra = self-learning at partial opening
fr = short term correction
rkukg = transients correction
rkte = canister purge
KFBS = disparity between the two banks
lamns = oxygen sensor target during warm-up

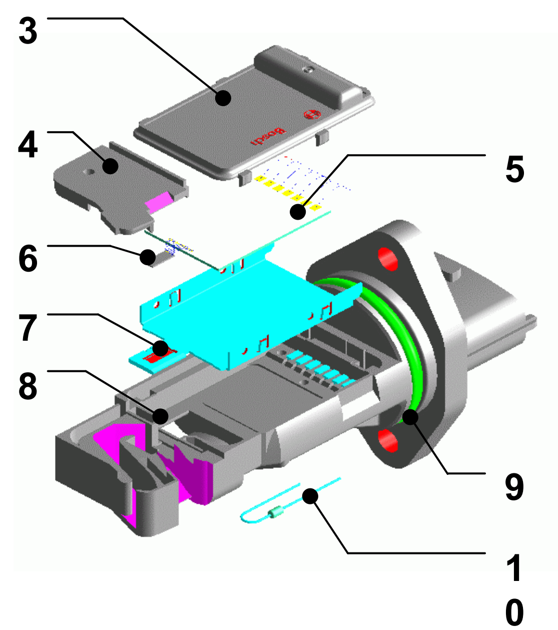
AIR FLOW METER

The air flow meter supplies the value relative to:

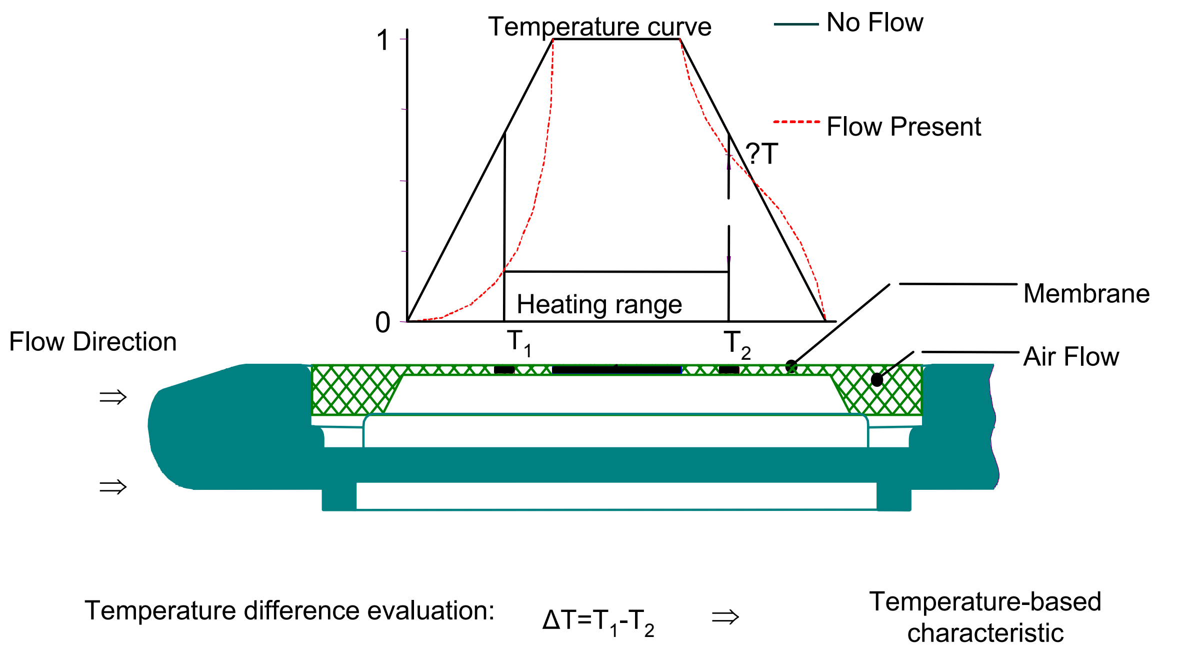
- **Mass of aspirated air**
- **Temperature of aspirated air.**

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.

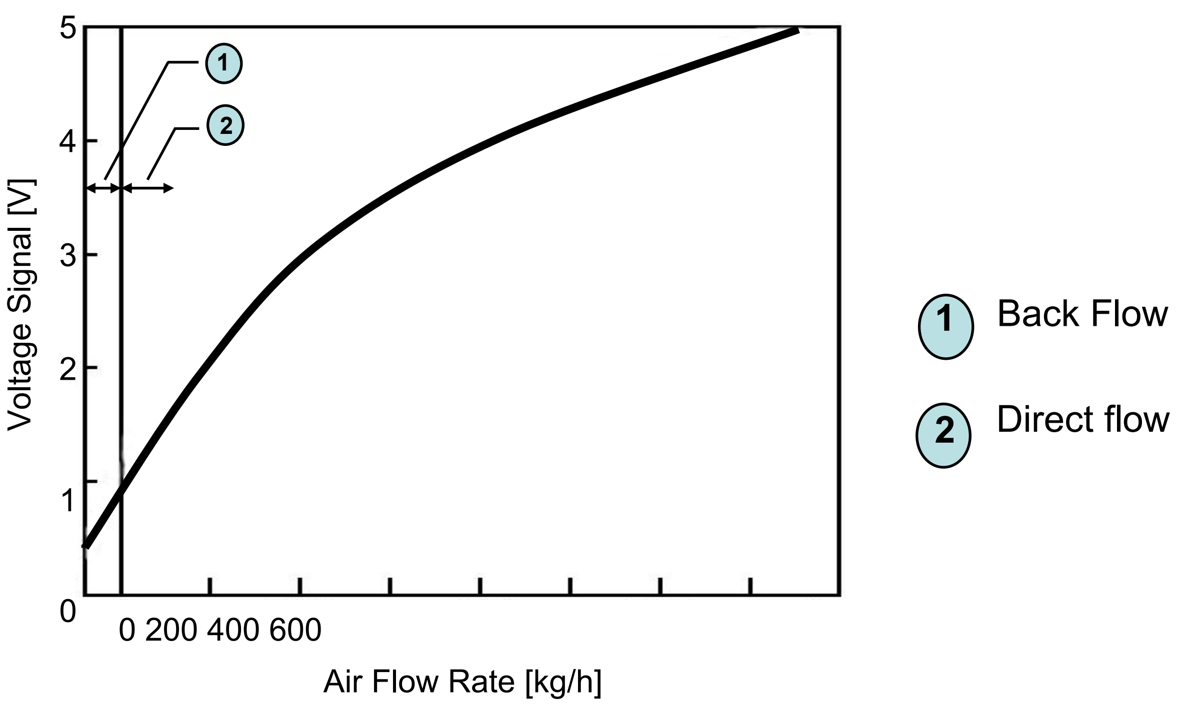




1 - Sensor
2 - Cylindrical Frame
3 - Casing
4 - Measuring channel cover
5 - Hybrid-SHF
6 - Sensor-CMF
7 - Carrying plate
8 - Plug-In Sensor Casing
9 - O-Ring
10 - Temperature sensor

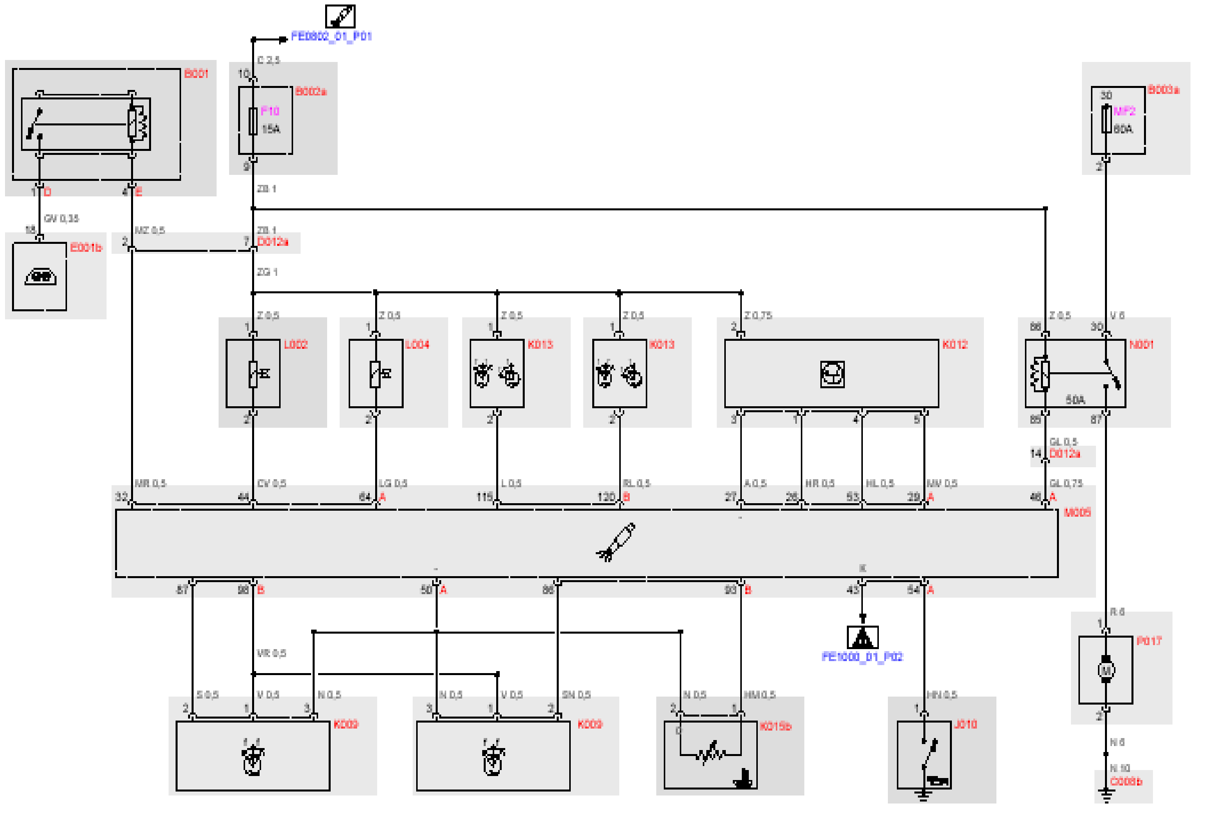


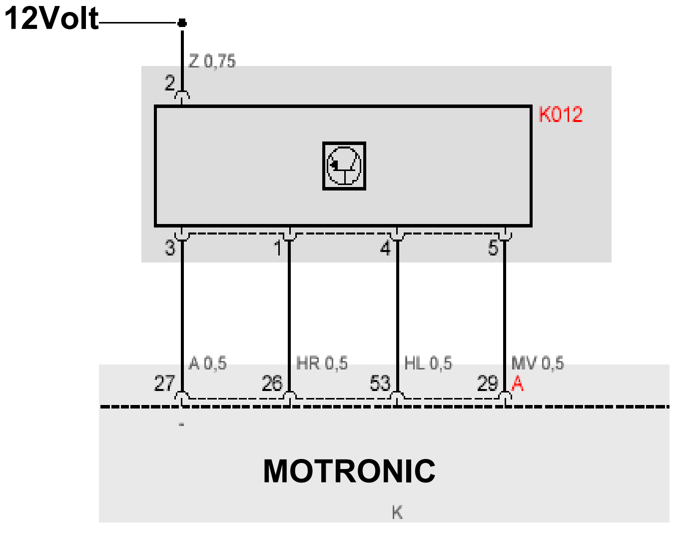
The sensor's platinum film is heated to a temperature of 130°C above ambient temperature. The air mass that strikes the film dissipates heat and tends to cool the film. The engine control node must heat the film to maintain a constant temperature of 130°C by means of a current control. The increase in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

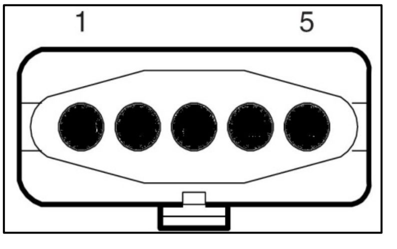


The area relative to the back flow is not measured by the ECU. The air flow meter requires an additional measurement tolerance range in order to accommodate this phenomenon.

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

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 ECU. The barometric pressure value is used for the following applications:

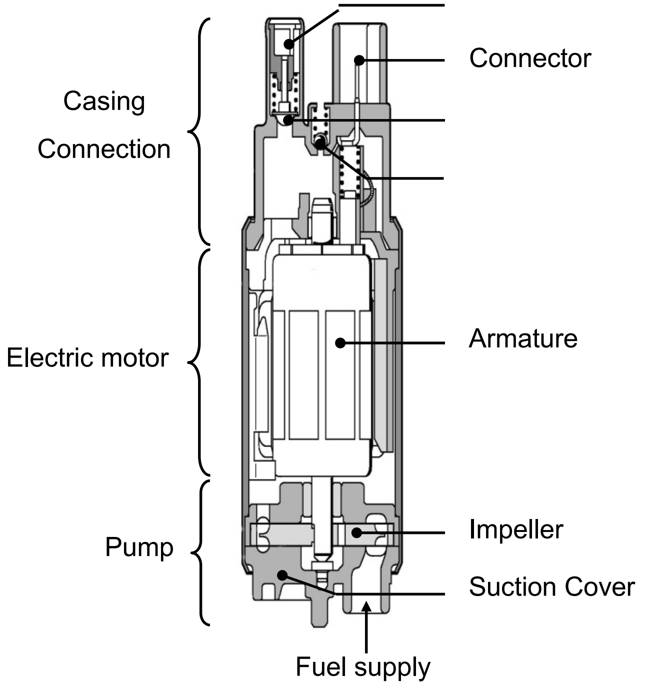
- Correction of mixture (injection quantity) in accordance with altitude.
- Correct operation of the DMTL system

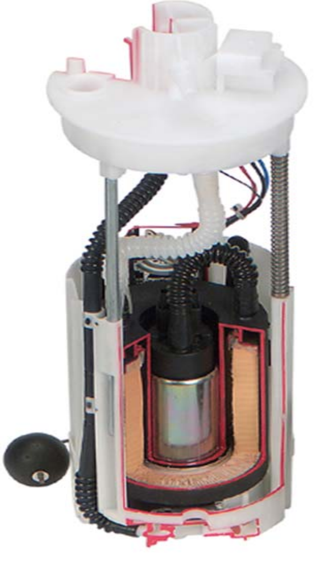
FUEL PUMP

The fuel systems utilised in Maserati cars are of the "Returnless" type

The fuel pump module is mainly composed of:

- Fuel filter
- Fuel pump with electric motor
- Pressure regulator: 3.5 bar
- Float with level sensor



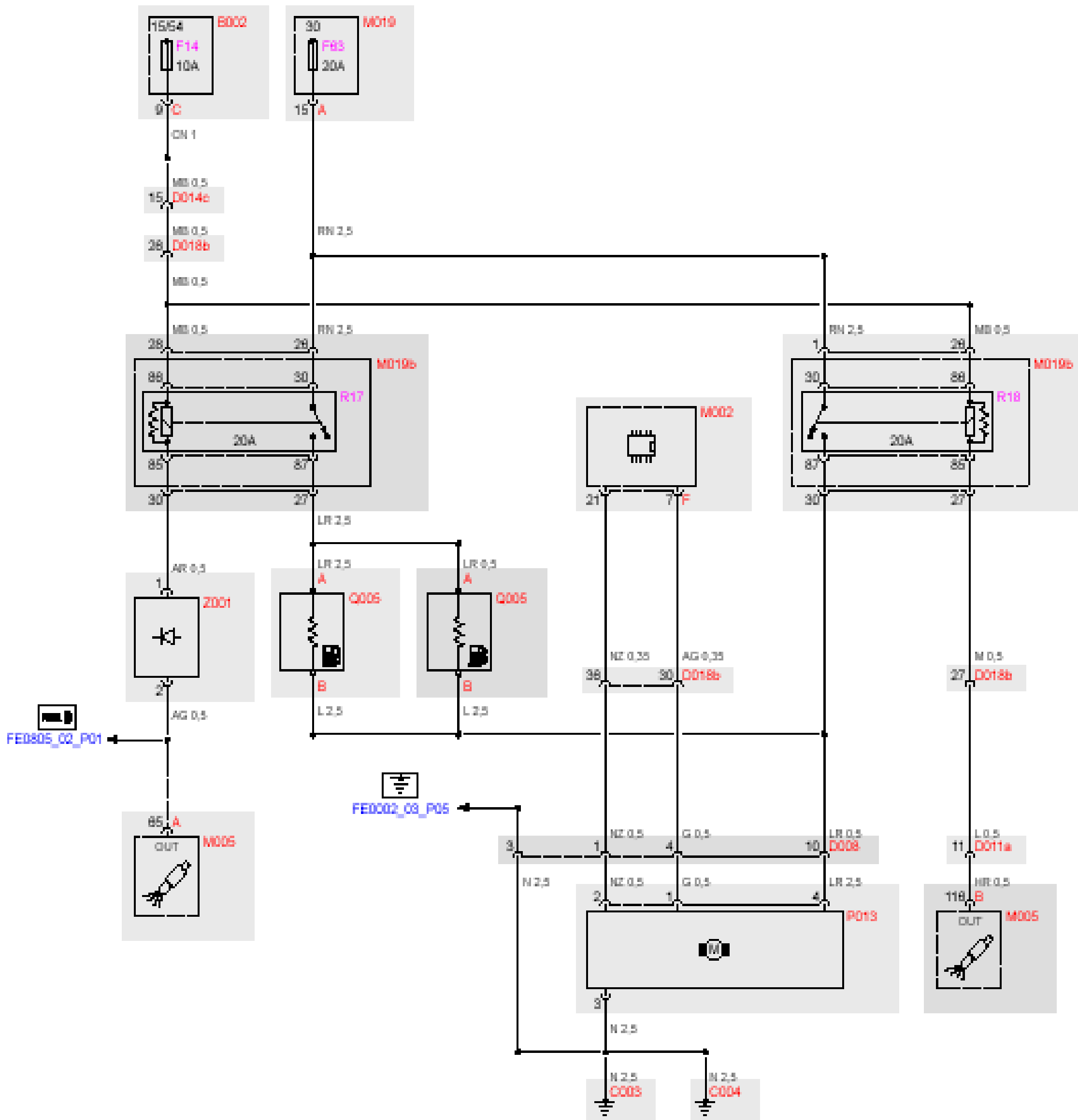


The two fuel pump relays are driven directly by the ECU. In contrast, the fuel level sensor is connected to the Body Computer. The ECU receives the information associated with the fuel level from the Body Computer via the C-CAN network.

When the fuel level is very low, the ECU changes the misfiring 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:



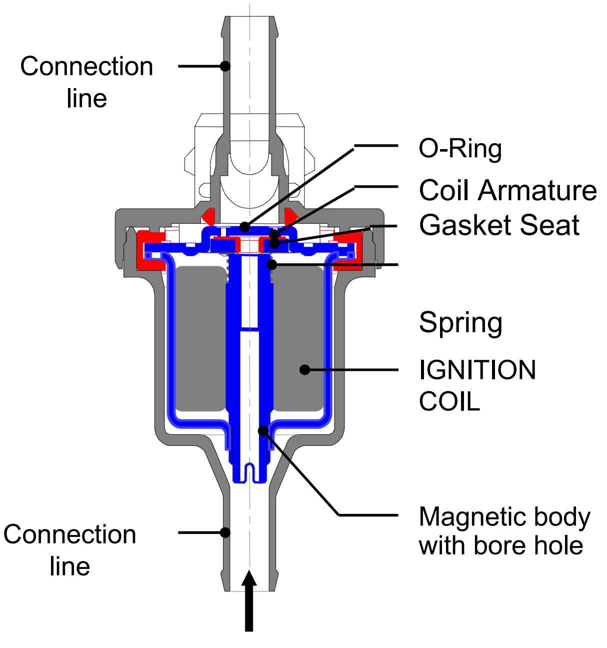
Pin 65 from the NCM has a dual function:

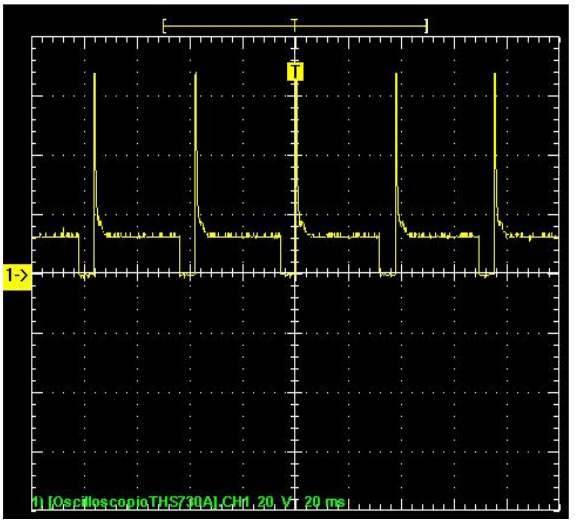
- Ground for relay R17 (Key ON)
- + 12V for TEST mode of the DMTL system (Key OFF)

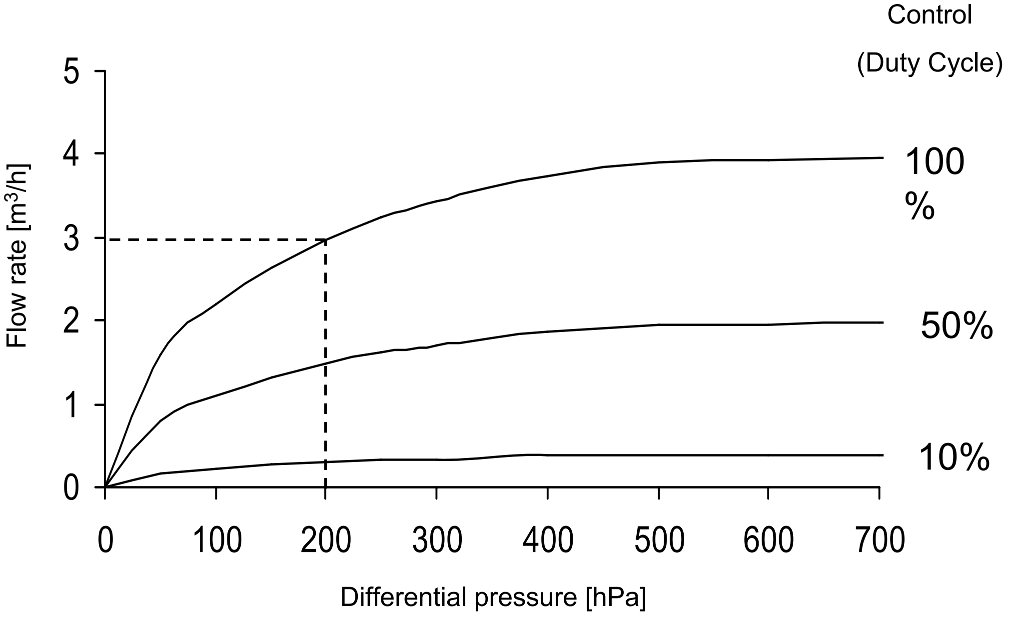
In order to reduce noise levels and avoid overheating of the fuel in the tank, the fuel pump runs at low speed (by means of R17 and two resistors) when fuel demand is low.
In hot start (water temp. > 120°C) and cold start conditions the fuel pump runs at high speed for a few seconds.

CANISTER PURGE VALVE

The canister purge valve is controlled in Duty-cycle (PWM). The use of this valve makes it possible to eliminate fuel vapours from the tank system by routing them to the aspiration 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.





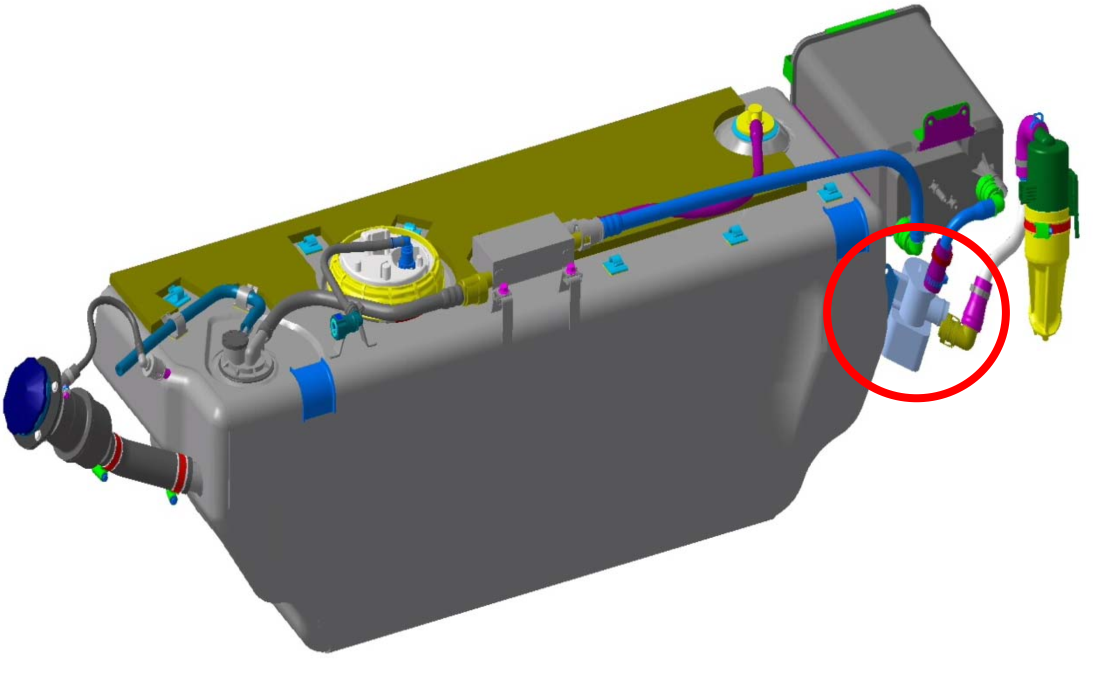


TANK LEAKAGE DIAGNOSTIC PUMP

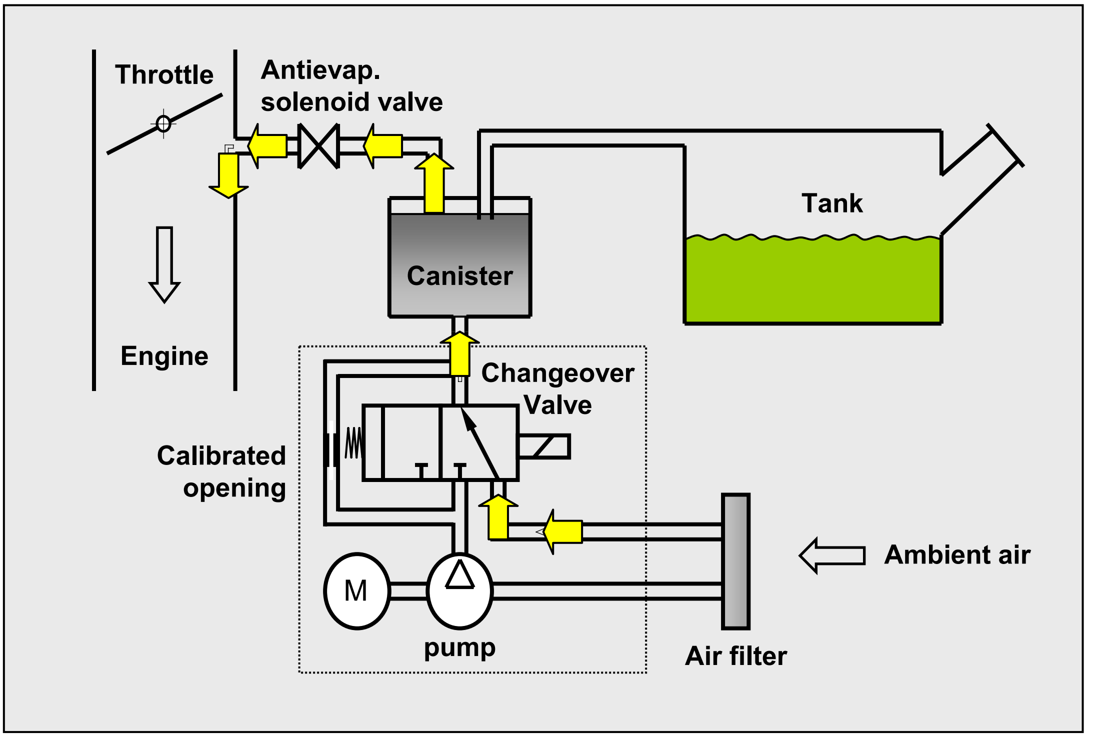
The Diagnostic Module Tank Leakage (DMTL) is employed on cars for the US market for tank seal diagnostics and for canister purging. For diagnostic purposes, the reference used by DMTL is the current required to drive a motor that forces air through a 0.5 mm hole. Subsequently it pressurises the tank and, if it detects a hole, the required current will be higher 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 aspiration 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.

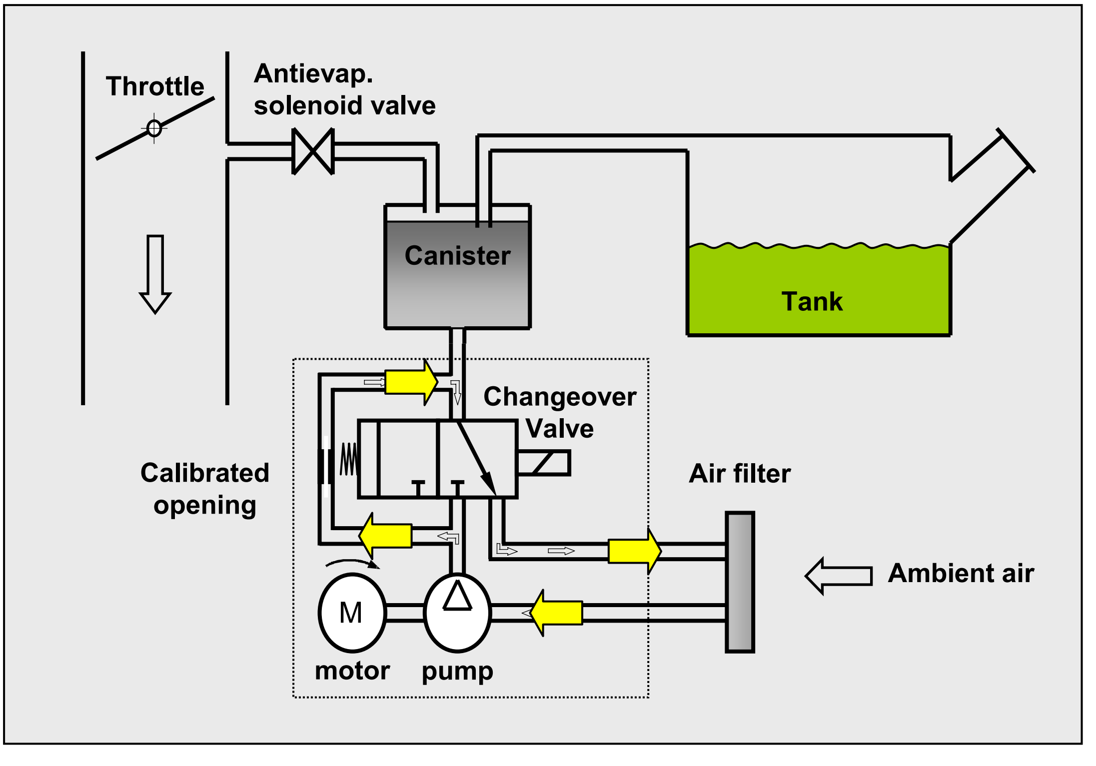


Bleeding procedure:



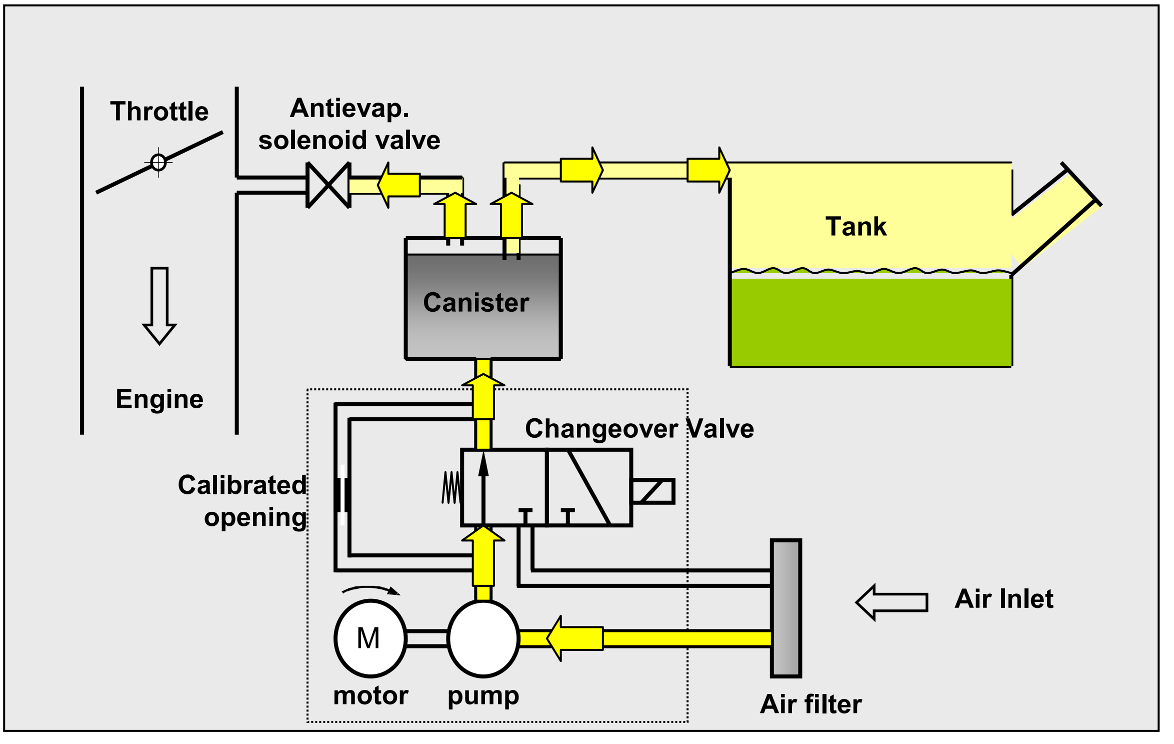
Calibration procedure:

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.



Test procedure:

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.

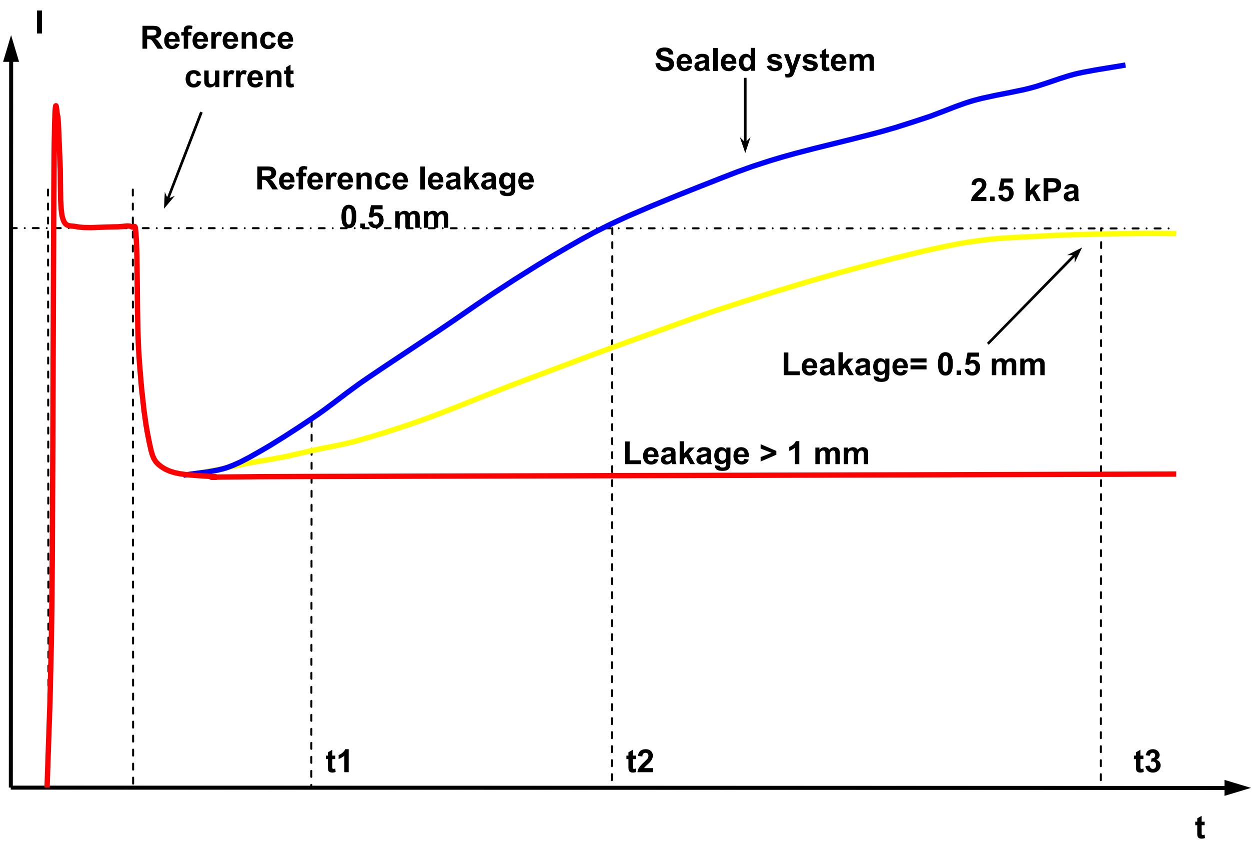


•	engine rpm	= 0
•	altitude	< 2800m
•	engine temperature (off)	> 3.8 °C
•	ambient temperature 3.8 °	< T < 35,.3 °C
•	fuel level	from 15% to 85%
•	vehicle speed	= 0 Km/h
•	battery voltage	10.95 < Vb < 14.5

- 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 SD3)

Pump motor current absorption



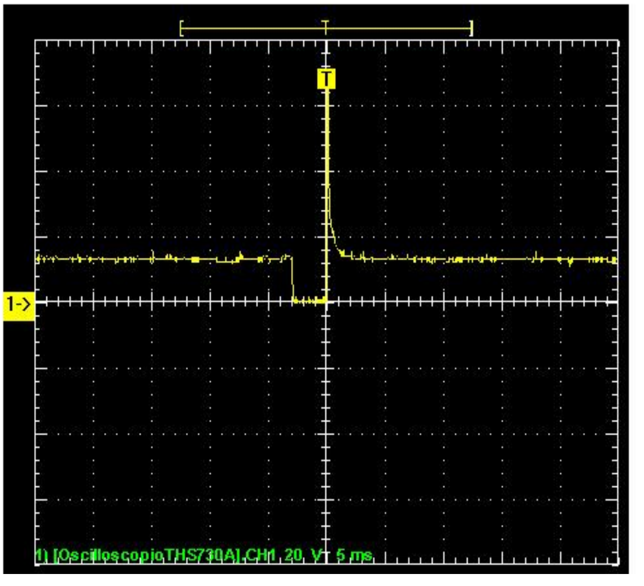
The first part of the curve is relative to the calibration phase: the system performs calibration using the reference current. This is the absorbed current of the pump corresponding to a leak through a calibrated 0.5 mm hole.

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

INJECTOR

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.



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.

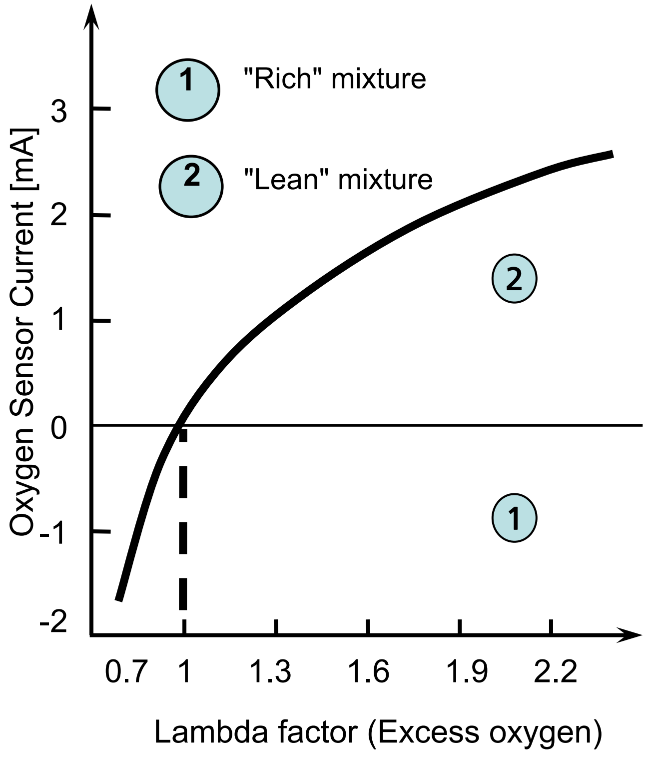
The injector is active when the pin from the ECU is connected to ground.

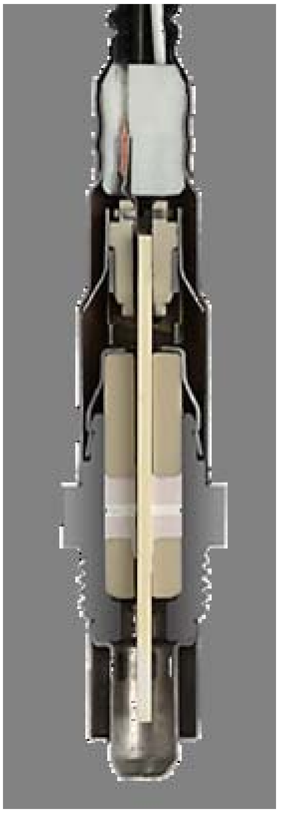
Technical data:

- 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: +-12 Ohm (20°C)

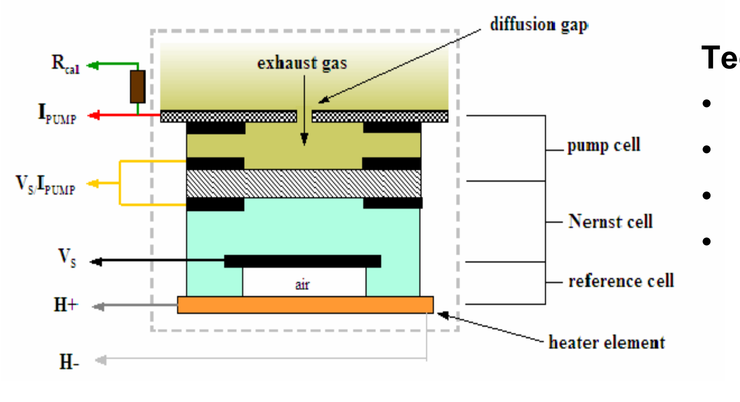
BROAD BAND OXYGEN SENSOR (Bosch LSU)

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

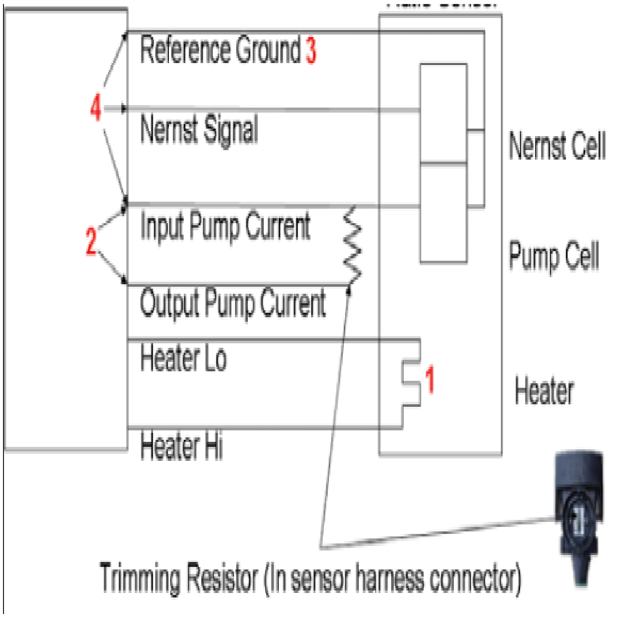
Heater efficiency check:
Disconnect the sensor and use a multitester on the impedance scale to measure the resistance between pins 3 and 4. The measured value should be 3.2 Ohm.

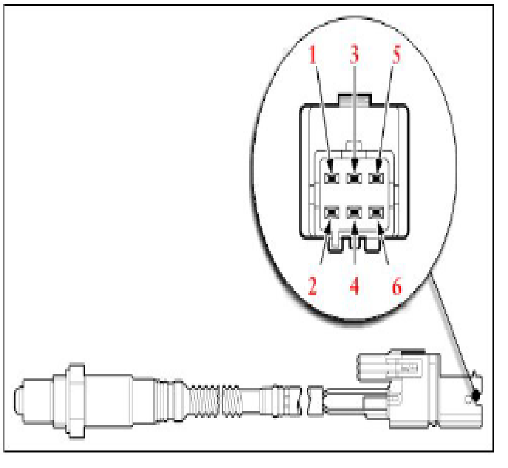
Trimming resistor check:
Disconnect the sensor and using a multitester set to the impedance scale measure the resistance between pins 2 and 6. The measured value should be 300 Ohm.

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 SD3 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

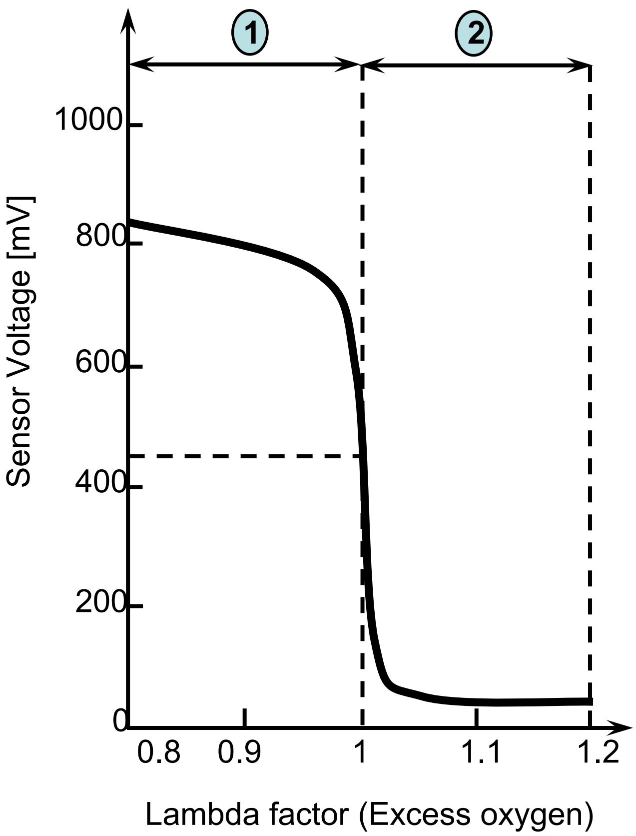




PIN	Description
1	Sensor voltage (+)
2	Pump Output signal
3	Heater (+ batt.)
4	Heater (-)
5	Sensor voltage (-)
6	Pump input signal

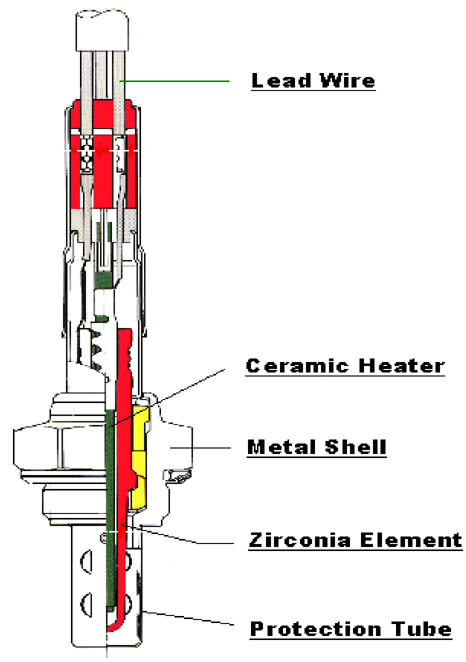
TWO-LEVEL OXYGEN SENSOR (Bosch LSF)

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

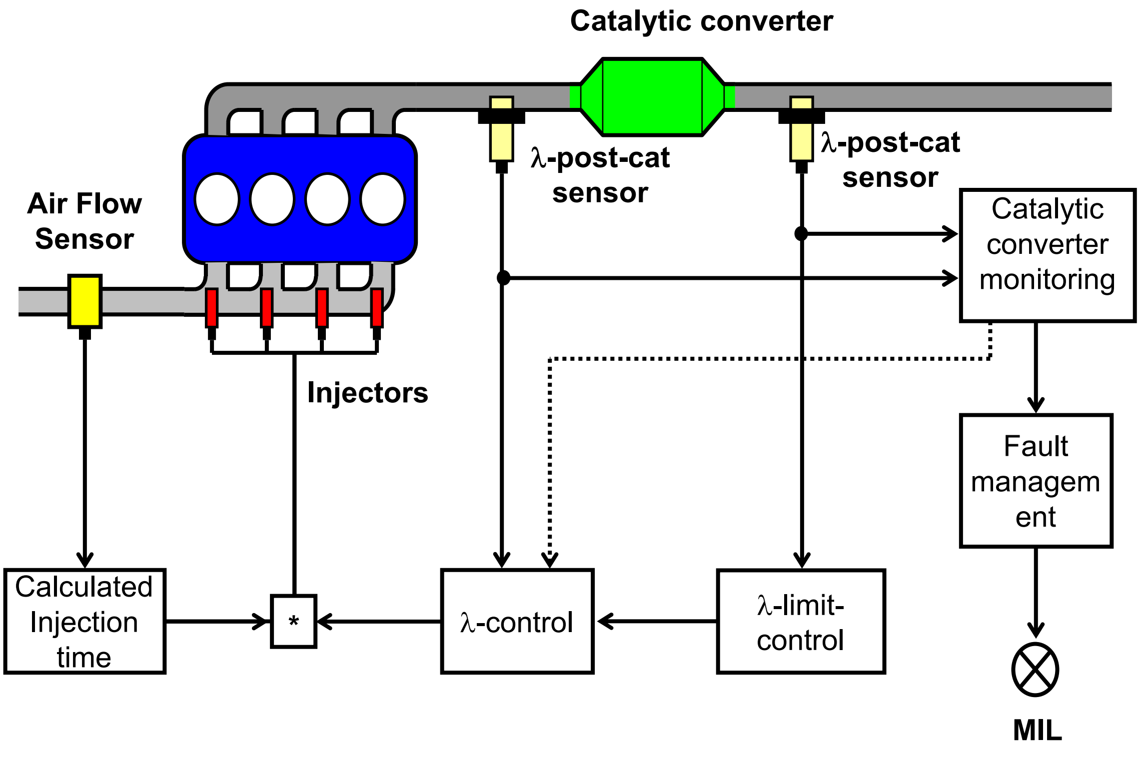


Technical data:

- 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 SD3.

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 by means of tester SD3.

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 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 SD3 tester.

The SD3 displays various Fuel Trim self-learning values (parameter environment):

- **“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 stored inside the ECU. The self-learning will pick up again once the problem is solved and the error cleared.
- The various self-learning values will be reset when the DTC memory of the engine ECU is cleared.
- 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!**

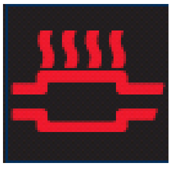
POST-CAT LAMBDA VALUE MONITORING

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:

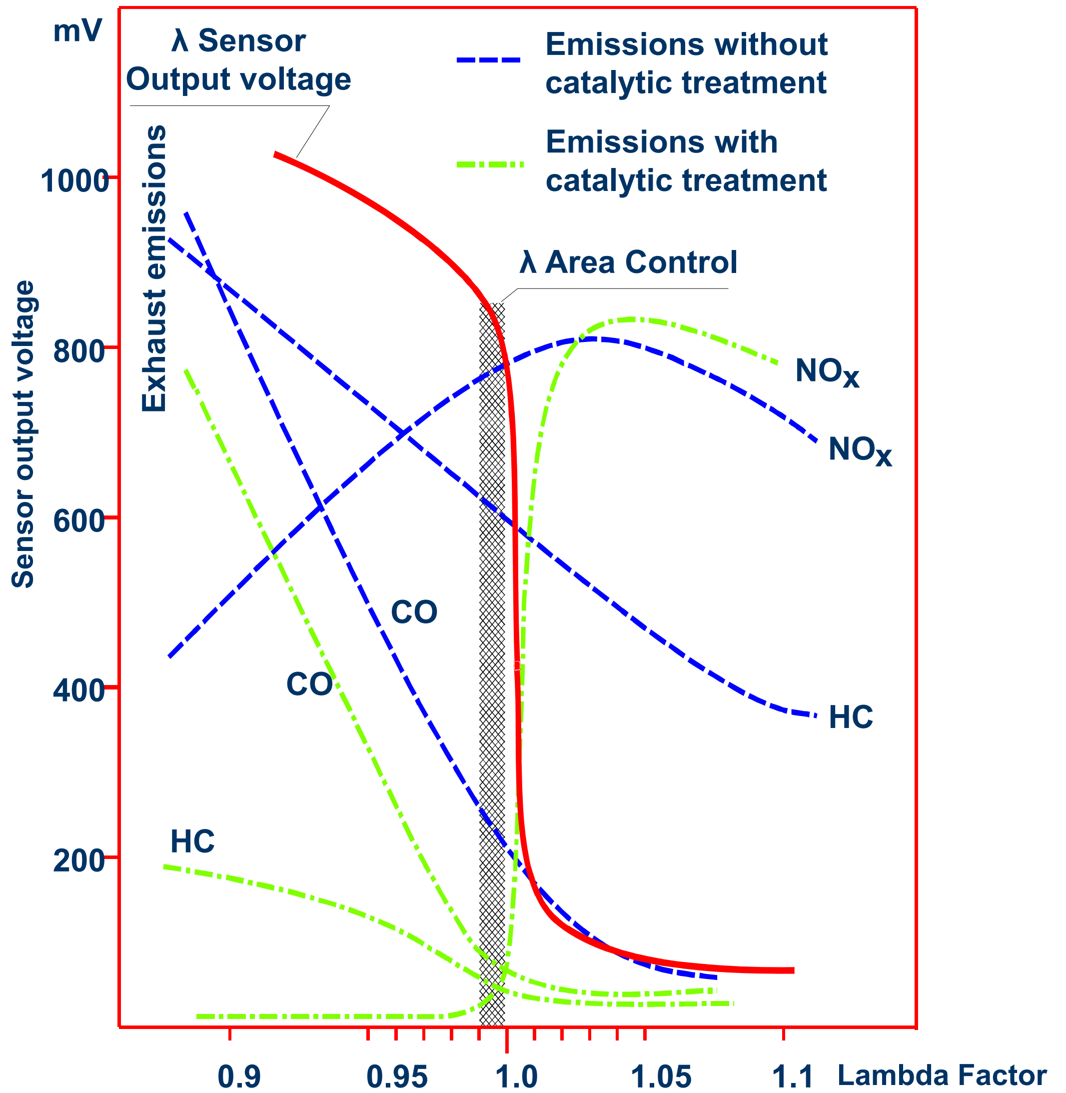
- Check proper operation of the catalytic converters: In the event of detection of low efficiency of the catalytic converters, the Motronic ECU stores a DTC and illuminates the MIL warning light.
- Check proper operation of the Oxygen sensors up-stream of the catalytic converters (plausibility check).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

SLOW DOWN STRATEGY

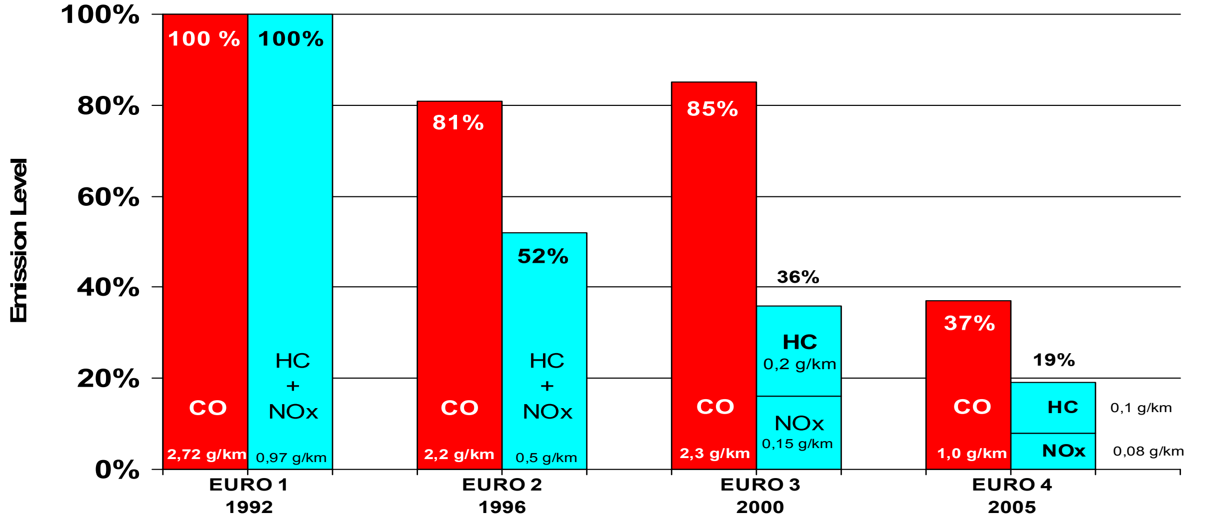
- The catalytic converters may be damaged if the temperature rises excessively.
- A mathematical model integrated in the ECU makes it possible to calculated the temperature of the catalytic converters in real time.
- The parameters utilised for the calculation are as follows: engine coolant temperature, 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 EURO regulations:



EMISSIONS CONTROL (M139):

The control of emissions in applications is performed in the following conditions:

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

Values:

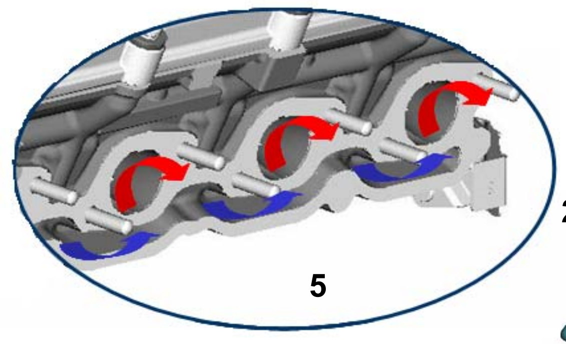
- HC: 40 - 300 ppm
- CO: 0.25...1.00 %
- O2: 0...1.5 %
- CO2: there is no reference value, CO2 is proportional to the quantity of fuel consumed. CO2 falls when combustion is incomplete

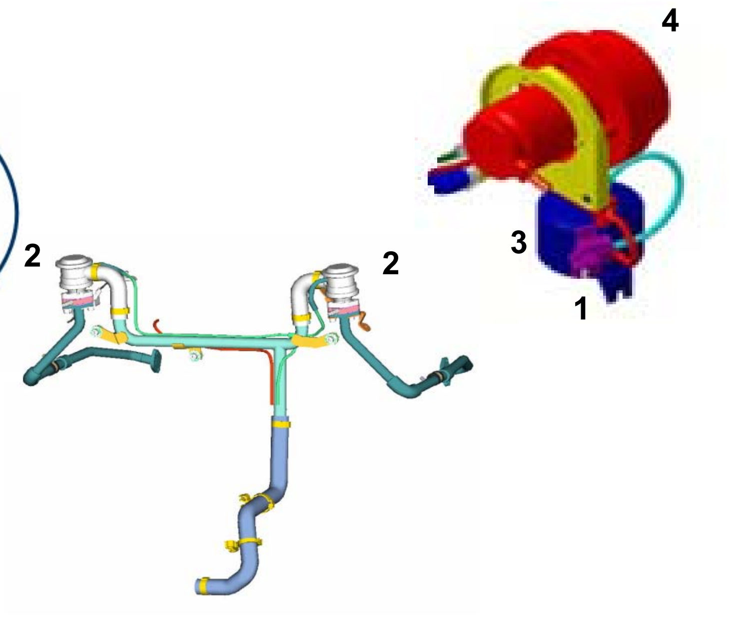
In the event of misfiring caused by failure to ignite the mixture, the HC value increases significantly (e.g. around 2000 ppm when one cylinder fails to fire).

Idle speed carburetion parameters:

- 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 at minimum self learning 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.

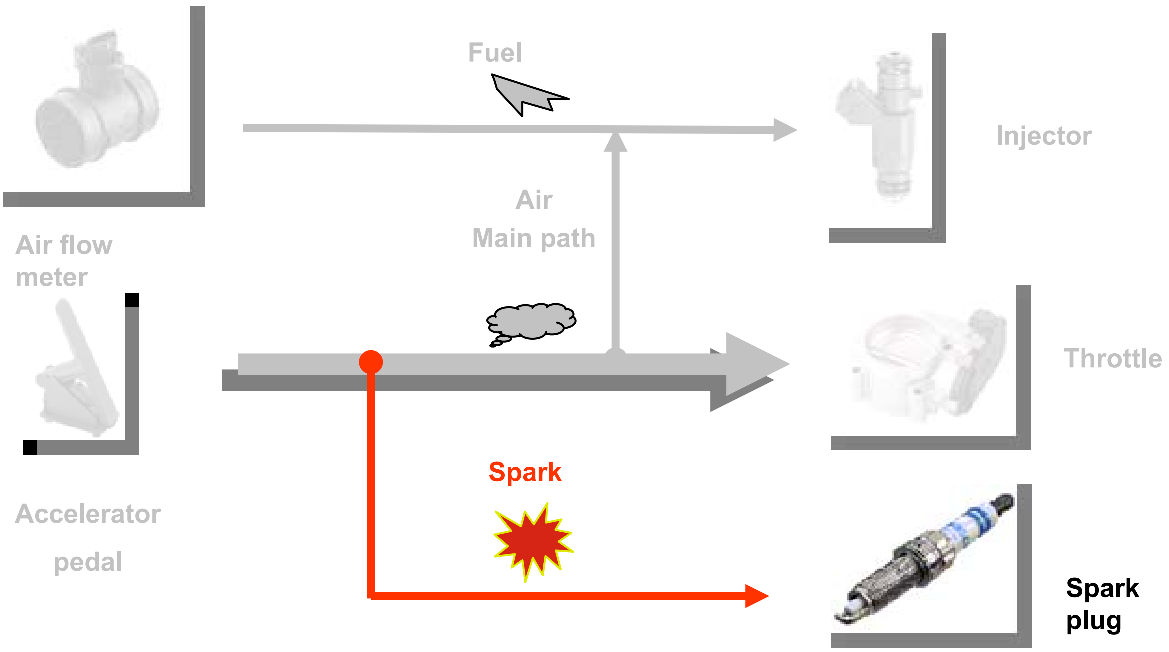
The secondary air system is composed of an electric pump controlled by a relay, two pneumatic valves that close the line when the system is inoperative, and a solenoid valve that controls the pneumatic valves by means of the vacuum provided by a connection with the plenum chamber.

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.

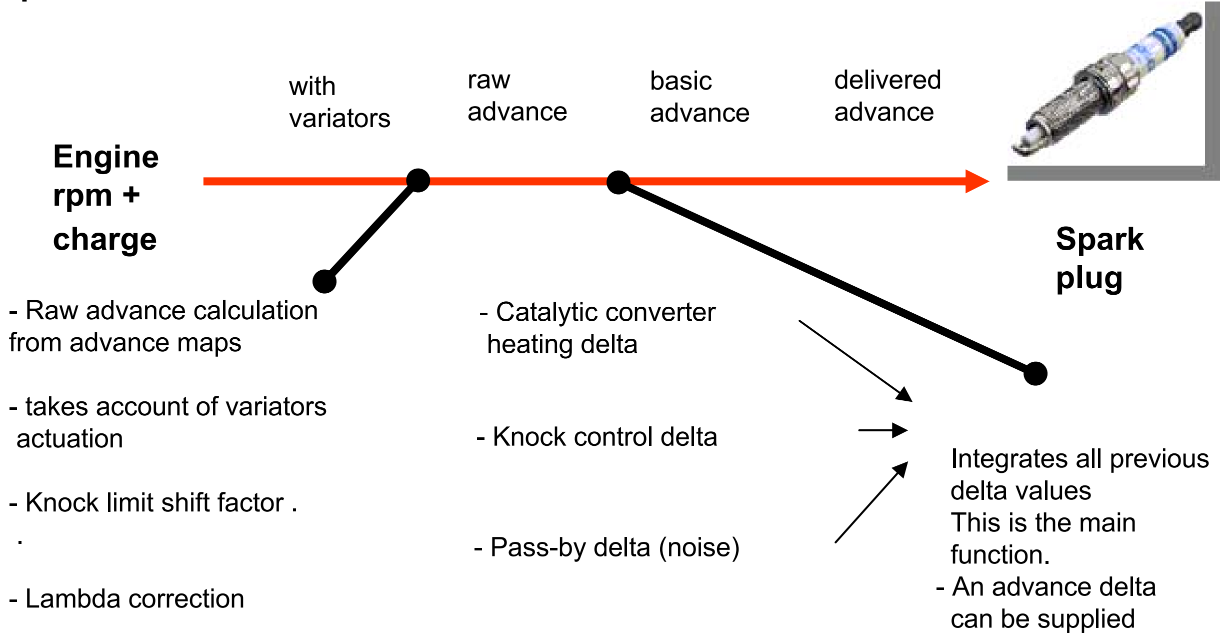
During this phase the Oxygen sensors signal is utilised to calculate the temperature of the catalytic converters, utilising a mathematical calculation model.

3rd FUNDAMENTAL PARAMETER: 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:

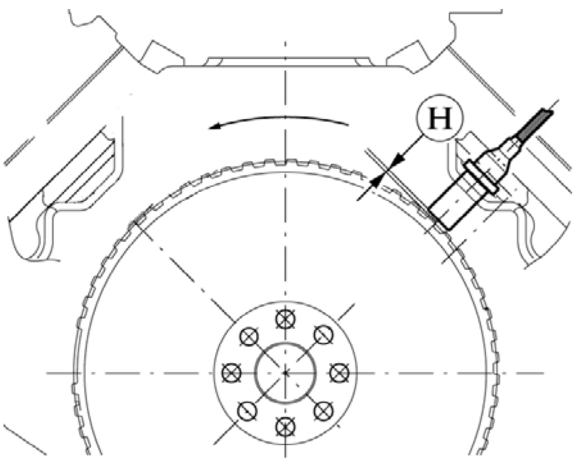
- Torque reserve
- Catalytic converter warm-up
- Anti-flutter strategies
- Comfort - handling strategies
- Engine protection strategies

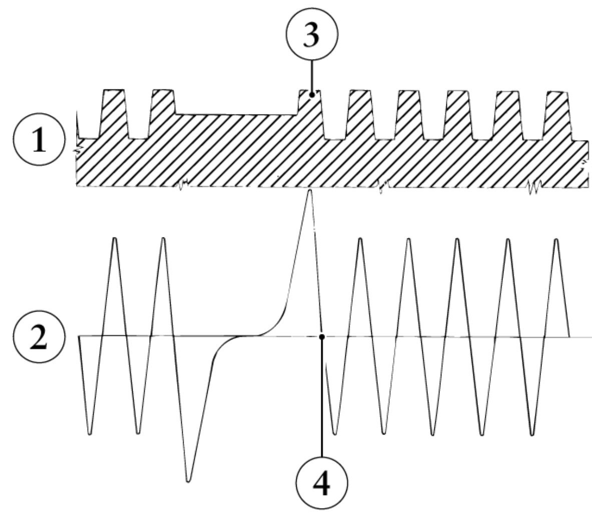
RPM SENSOR

The RPM sensor is a variable reluctance transducer (also known as a pick-up or inductive sensor) located in proximity of the tone wheel keyed to the crankshaft.
The tone wheel has 58 (60-2) teeth.

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

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**

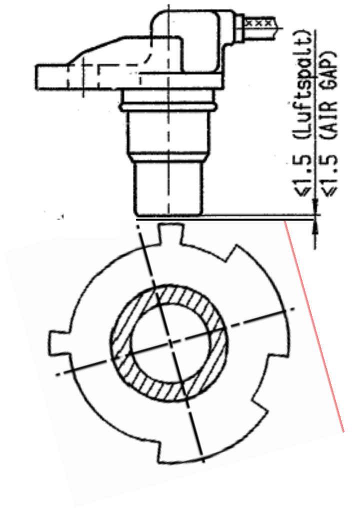
The engine RPM signal must always increase in correspondence with the tone wheel toothspace! (if the signal decreases at this point this means the sensor polarity is inverted)

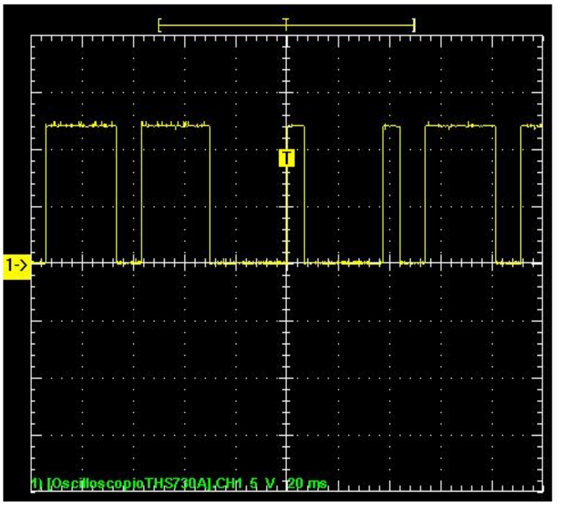
The RPM sensor is a passive transducer (no signal output when the tone wheel is stationary); this means that the position of the crankshaft cannot be identified when the engine is stopped.

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.

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 is lost, thereby informing the ECU of the position of the camshaft (the ECU 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.

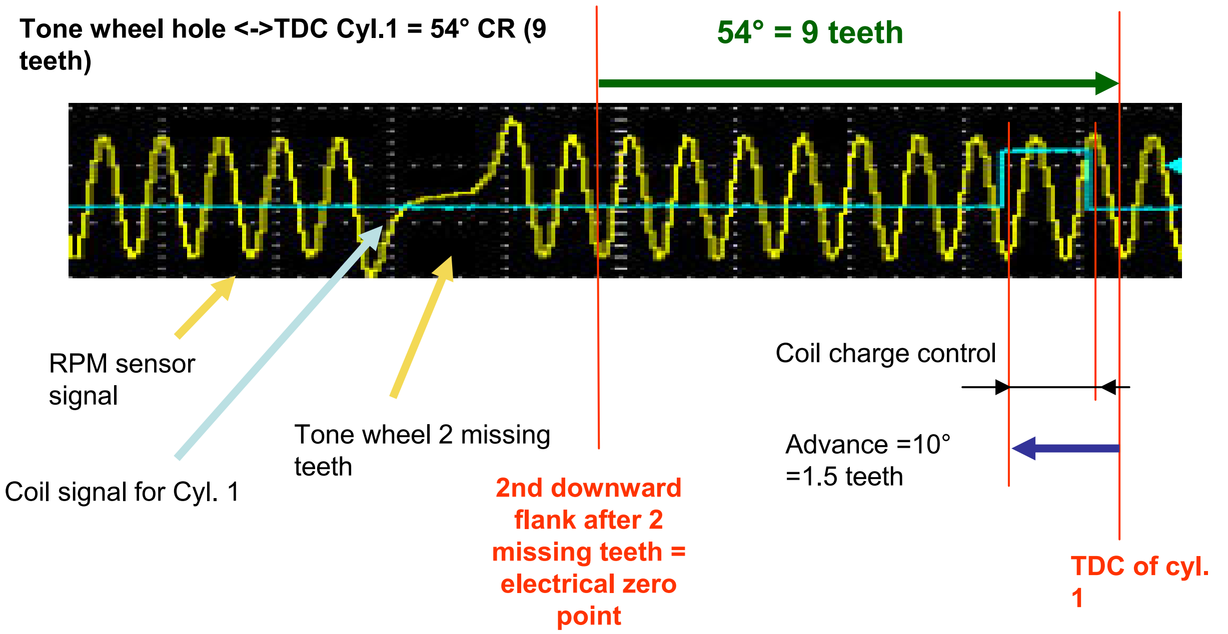




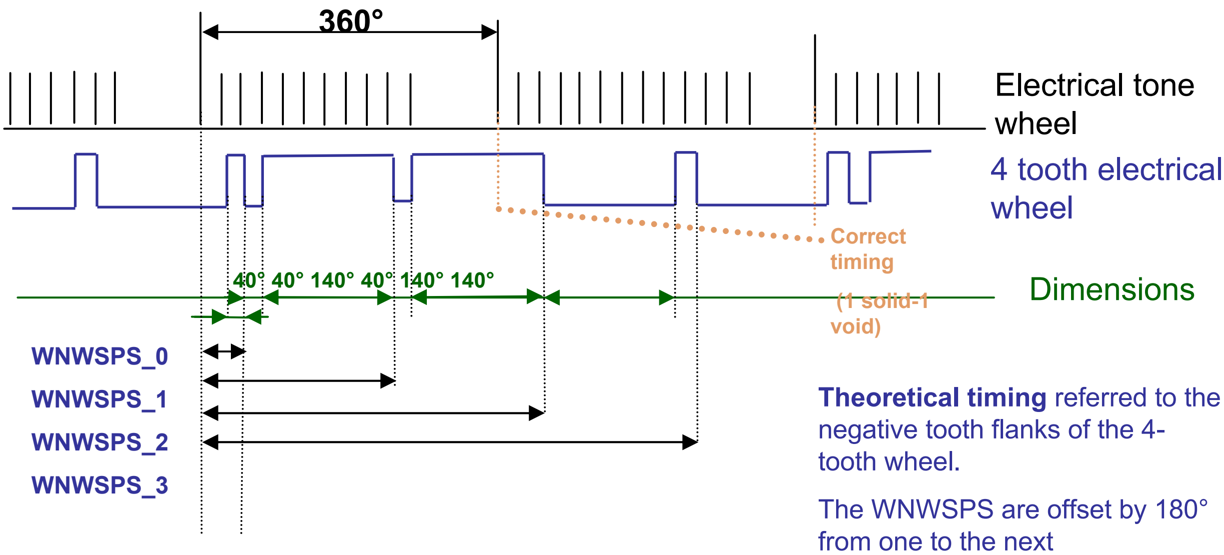
The electrical timing signal is composed of four high parts (2 x 140° + 2 x 40°) and four low parts (2 x 40° + 2 x 140°), the timing signal is electrically symmetrical!

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

ENGINE ELECTRICAL TIMING

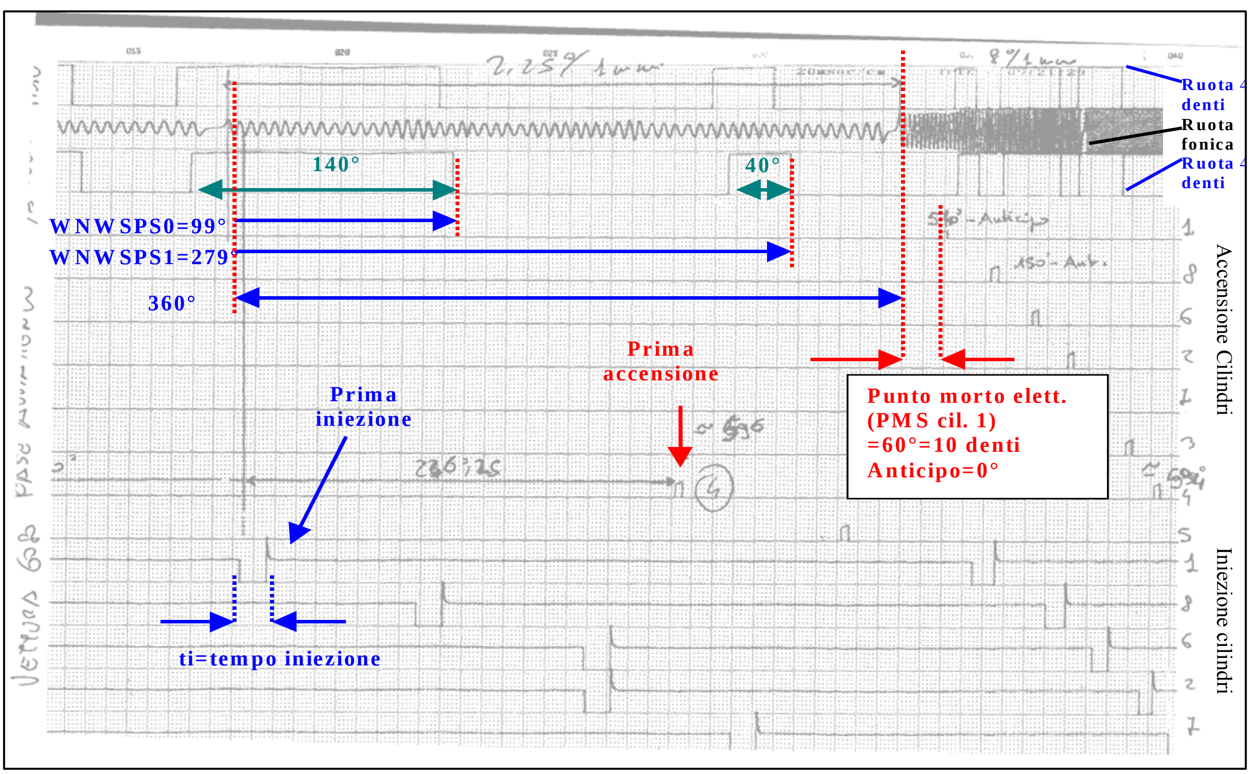


- The tone wheel on the crankshaft has 58 teeth (60 teeth minus two missing teeth)
- The zero point for the ECU is constituted by the second descending tooth flank after the space measured by the engine RPM signal. The ECU detects an interval between teeth that lasts more than twice the time of the previous 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 ECU 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 ECU 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.



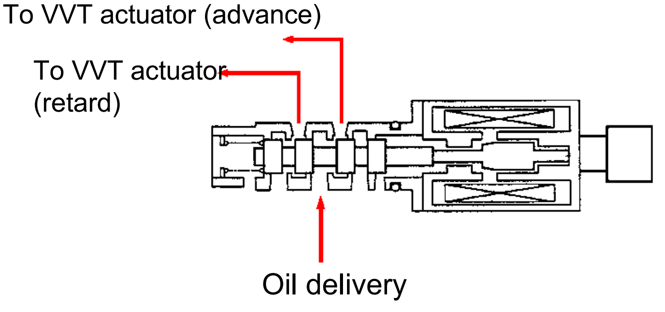
Theoretical timing referred to the negative tooth flanks of the 4-tooth wheel.

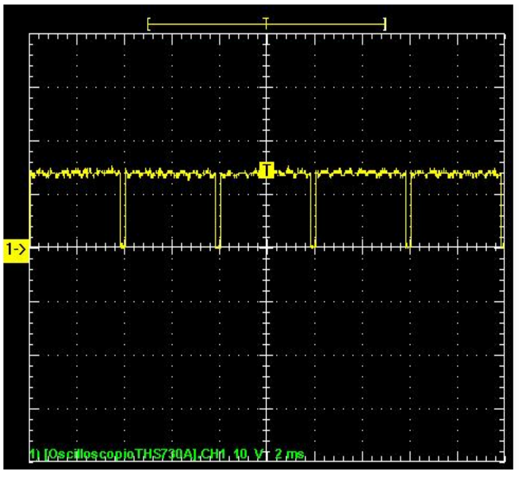
The WNWSPS are offset by 180° from one to the next



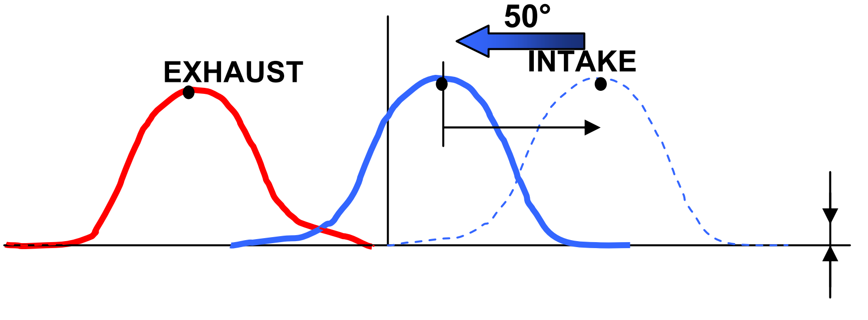
TIMING VARIATOR SOLENOID VALVE

Each Variable Valve Timing (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 engine control module 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 sump.



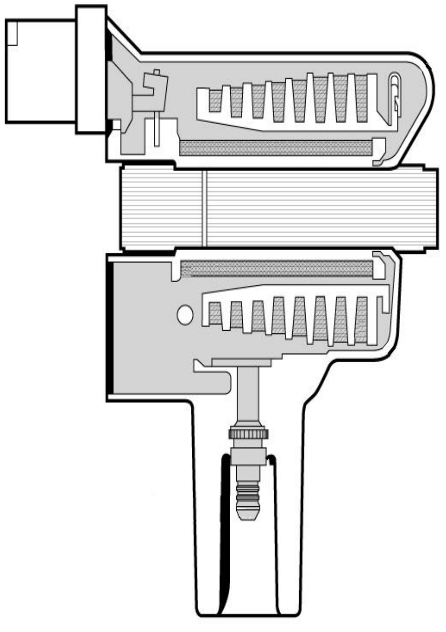


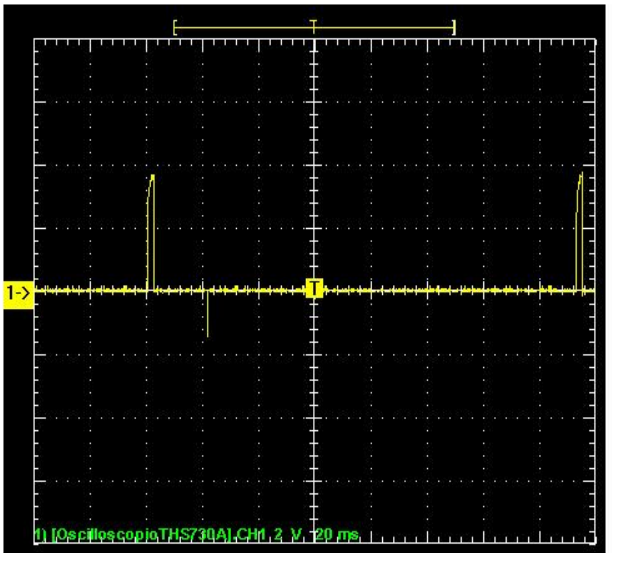
TIMING VARIATOR ACTIVATION



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.



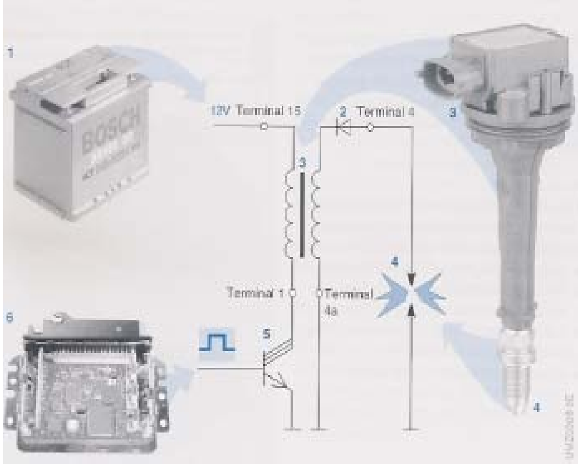


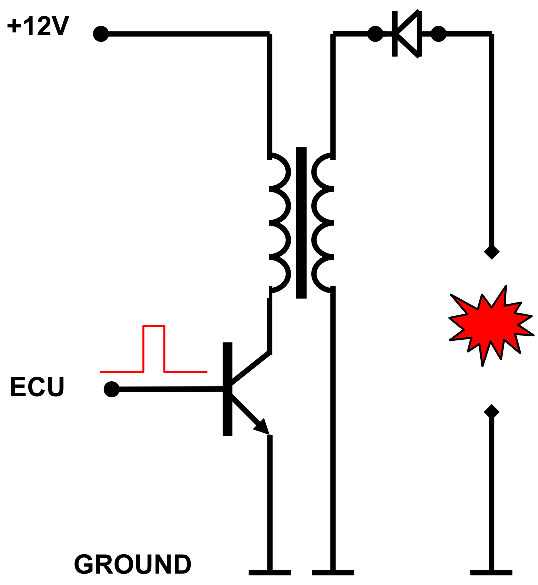
The Motronic activates the power stage (thanks to a series of transistors) on the coil for the necessary charge time to bring the primary winding current to its maximum value. The energy stored in the coil is proportional to the charge time.
At the time of ignition (which corresponds to the required 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.

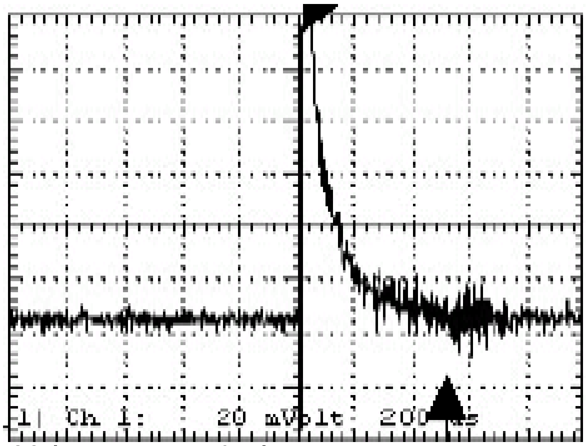
Technical data:

- 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)

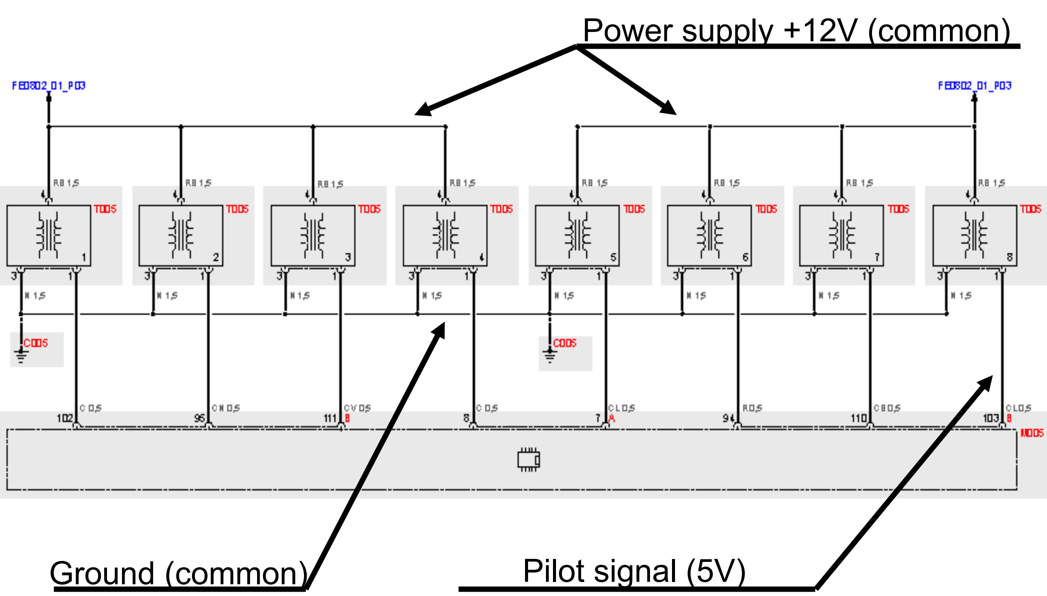
The ignition coil is made up of two coupled windings. The generation of a voltage peak in the primary winding, trigged by the ECU, generates an overvoltage peak and the transit of current on the secondary winding (which is discharged through the spark plug).







Voltage on spark plugs



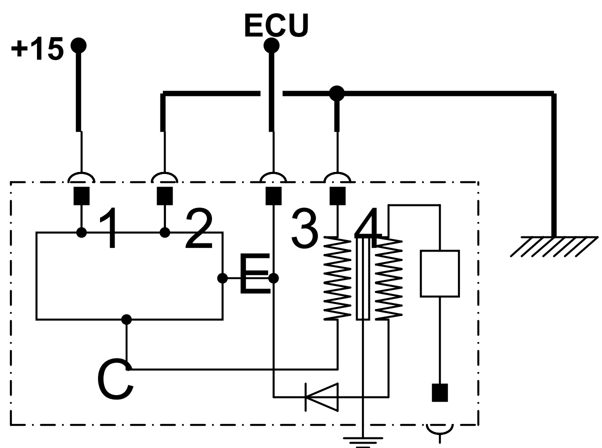
ELDOR COIL

Application of Eldor coils on the vehicle:

- 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.

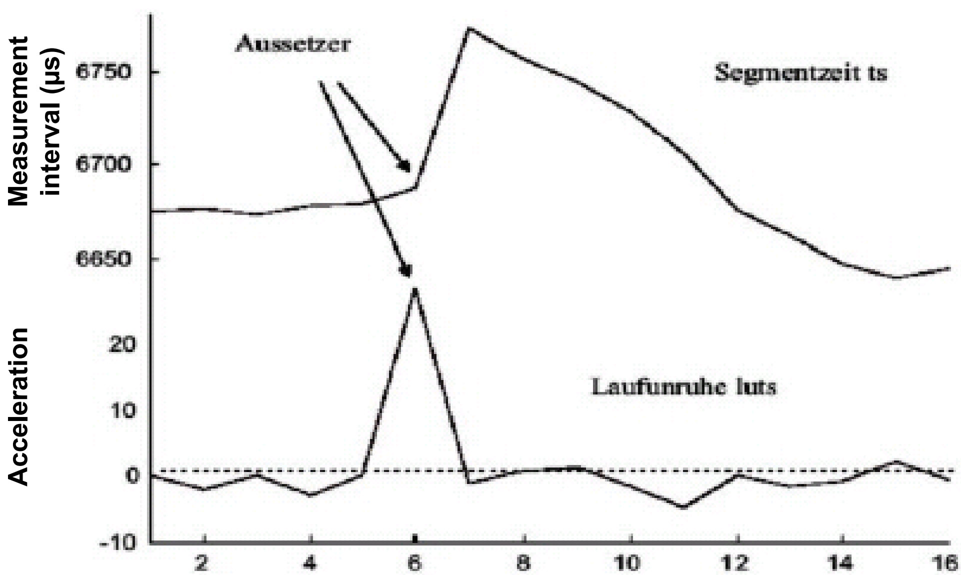


Pin 3 = 5V control signal from ECU

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 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:

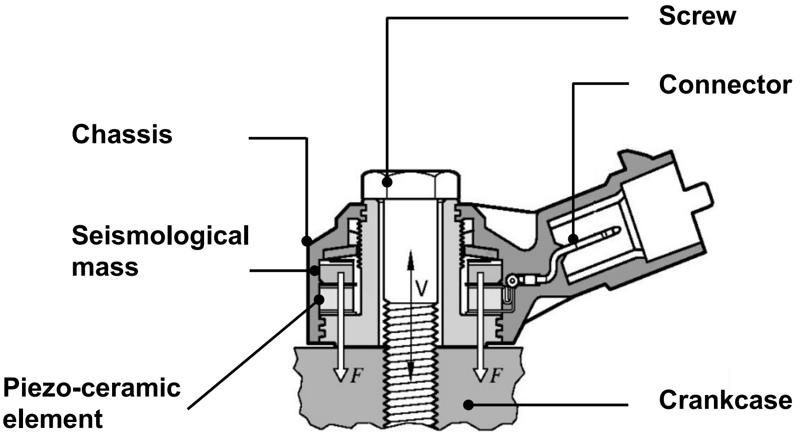
Misfiring causes:

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

Misfiring can seriously damage the catalytic converters!

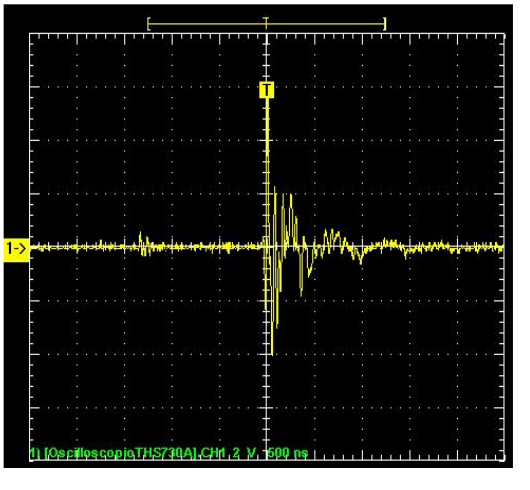
KNOCKING SENSOR

Knocking is caused by detonation, uncontrolled, fast combustion with significant pressure gradients, including local gradients caused by detonating rather than explosive combustion of the mixture due to self-ignition phenomena.
This problem can be solved with retarded ignition, i.e. by "removing the spark advance".
The Motronic control unit detects detonation in individual cylinders thanks to piezoelectric sensors that generate an alternating current. The signal is subsequently analysed, filtered, integrated and converted.
Subsequently the advance on the cylinder subject to knocking is retarded and then returned gradually.

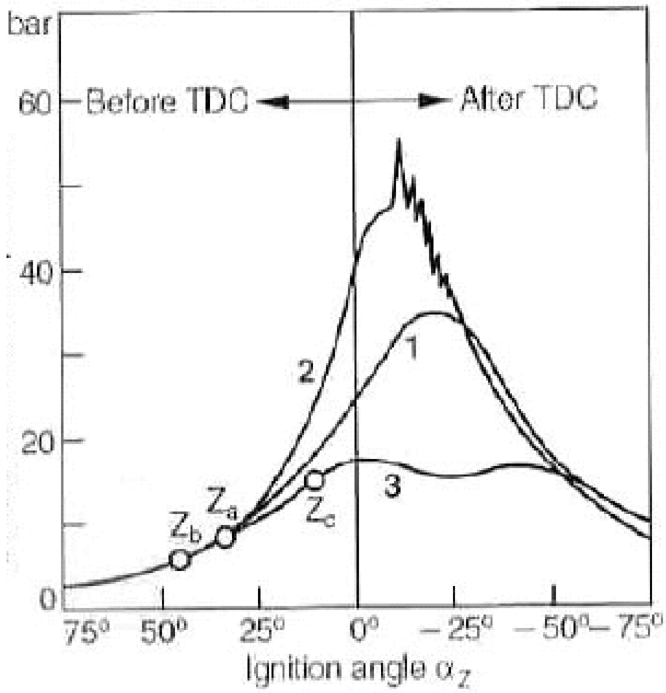


V = Vibration
F = Compression forces

The ECU activates the electronic knocking control strategy when the engine temperature reaches 40°C and the engine load is more than 30%.

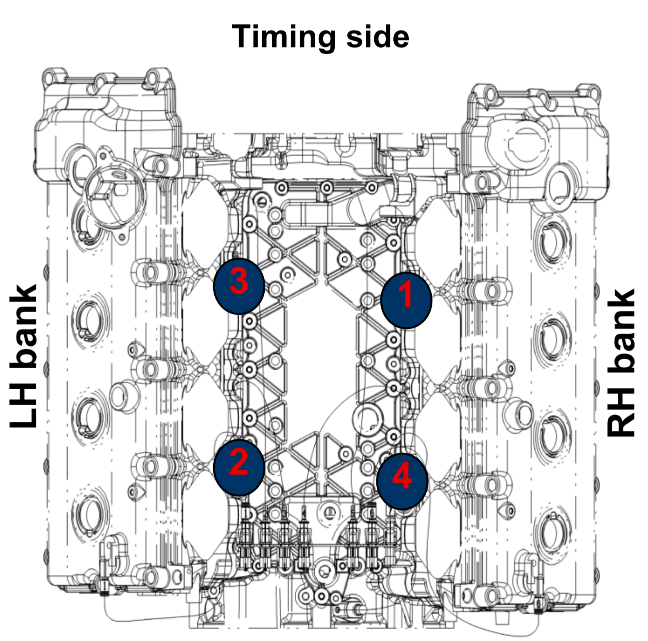


Curves showing effective pressure in the combustion chamber in relation to the ignition angle:



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:



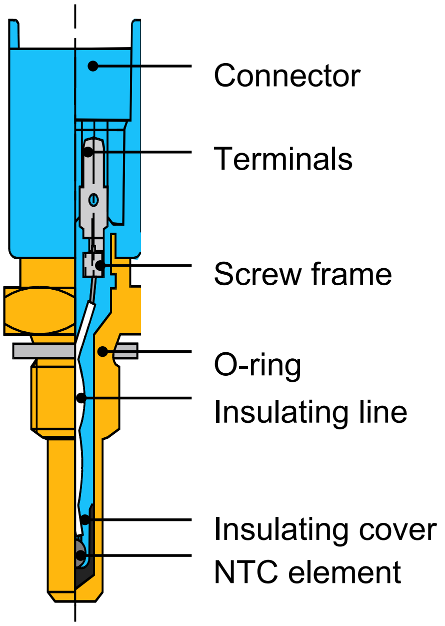
Sensors positioning

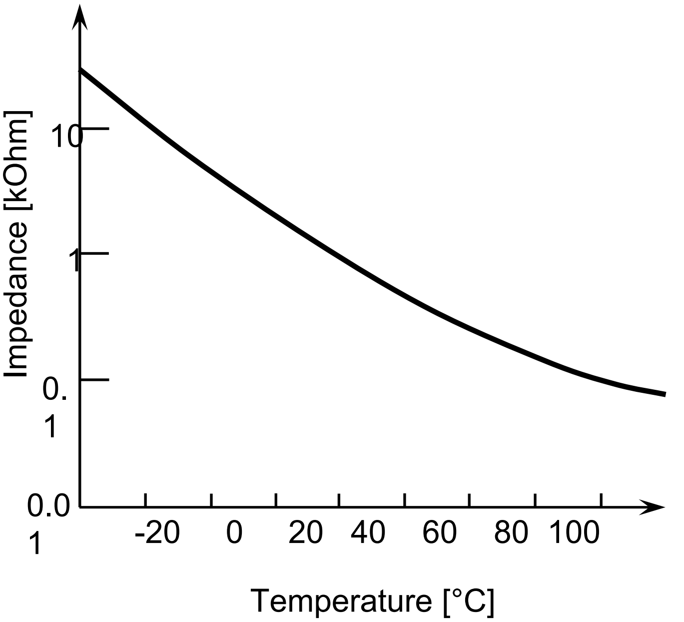
1. Cylinders 1 - 2
2. Cylinders 5 - 6
3. Cylinders 7 - 8
4. Cylinders 3 - 4

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

TEMPERATURE SENSOR

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



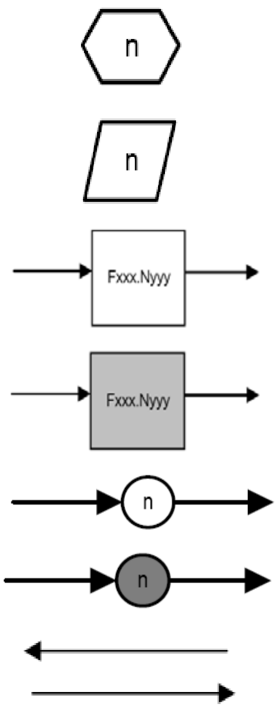


Impedance at 20 °C: 2.5 kOhm
Impedance at 100°C: 0.186 kOhm

Maserati engines use two coolant temperature sensors: upstream from the thermostatic expansion valve and on the cooler. This layout allows the ECU 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 RELATIVE TO THE ENGINE CONTROL SYSTEM



Input/output with sensor/actuator included

Input/output with sensor/actuator not included

B-CAN node n = number of signals

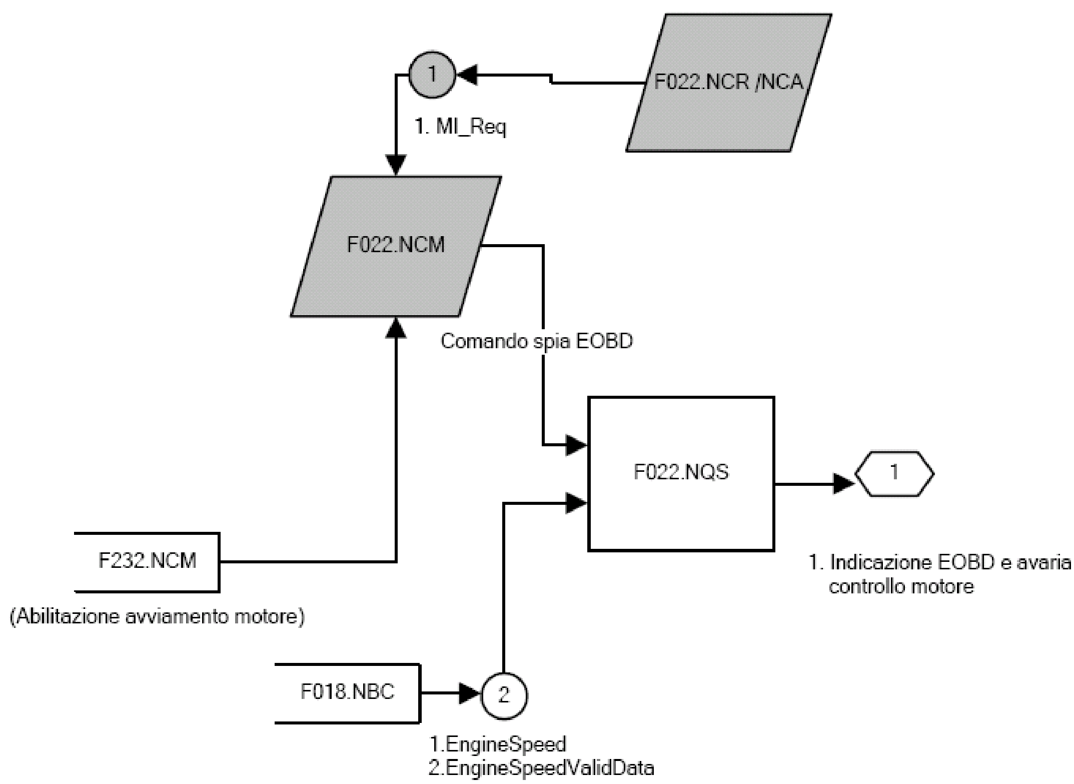
C-CAN node

B-CAN signal

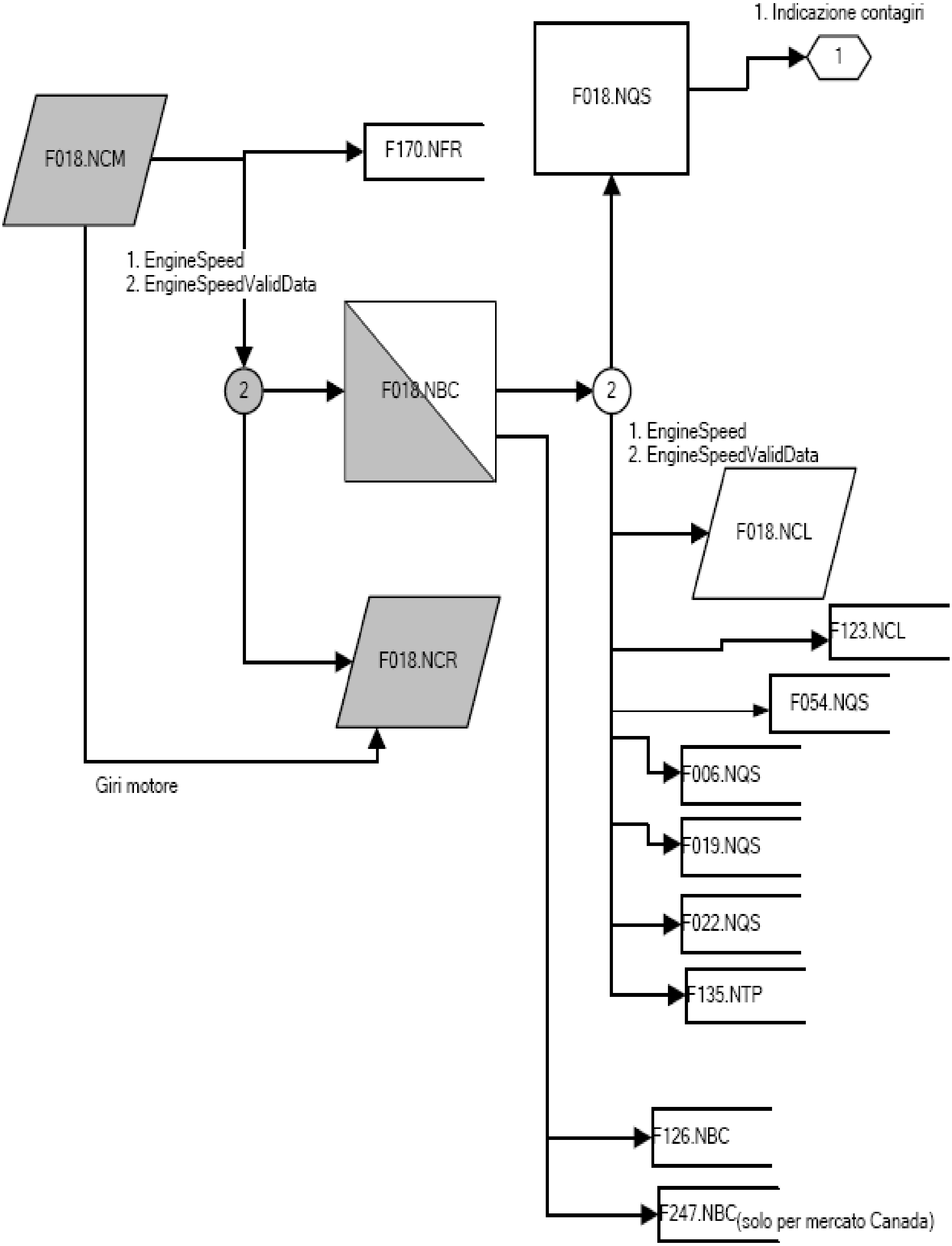
C-CAN signal

Non-CAN signal

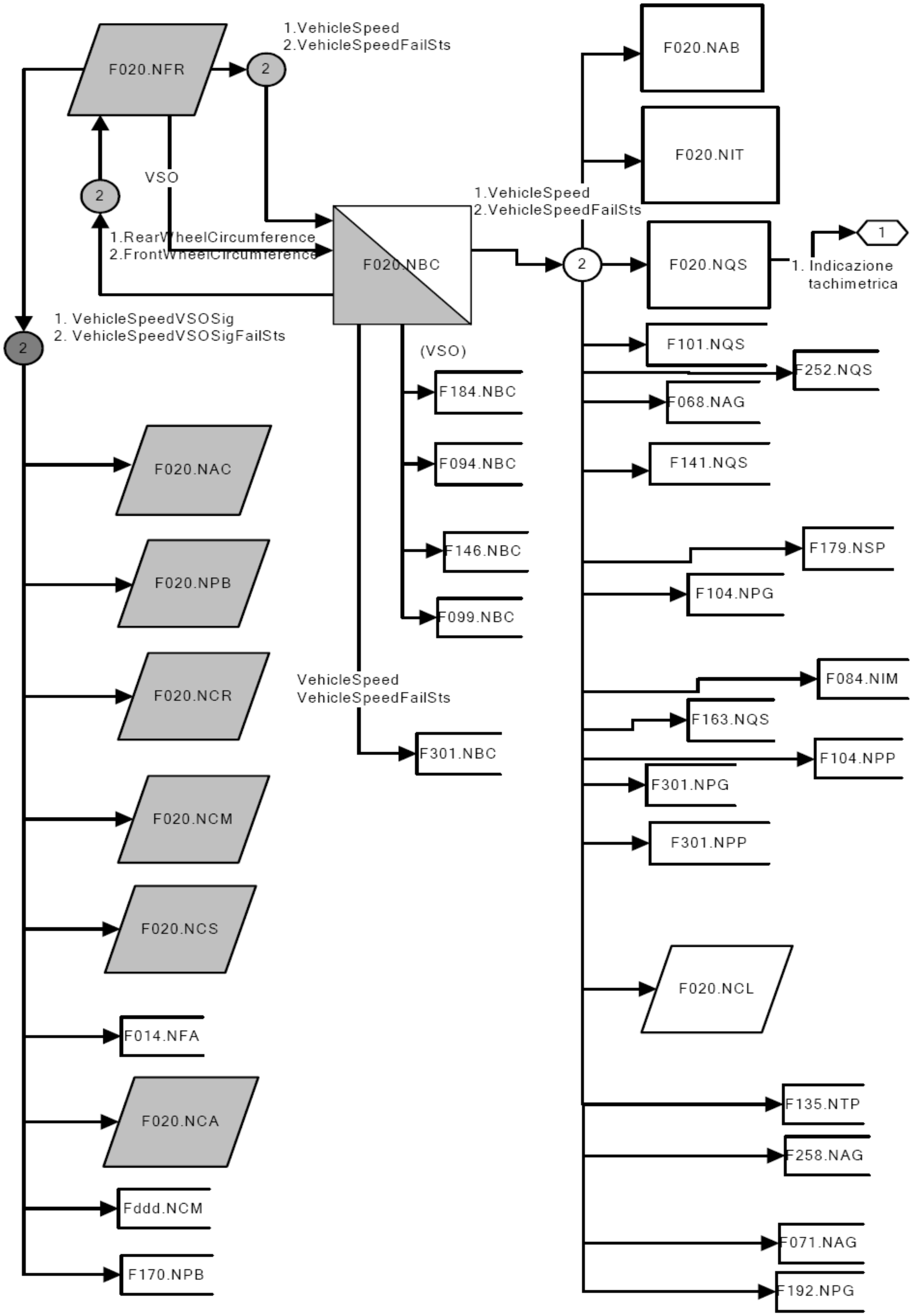
Engine warning light (MIL) activation signal:



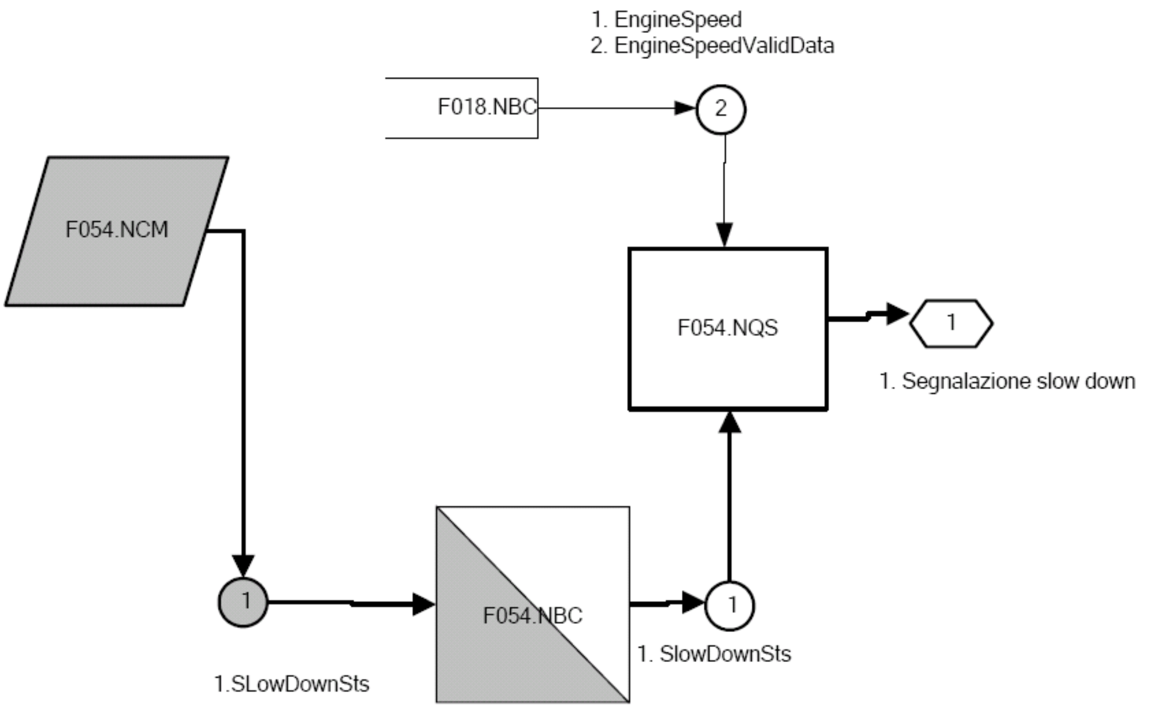
Engine rpm signal:



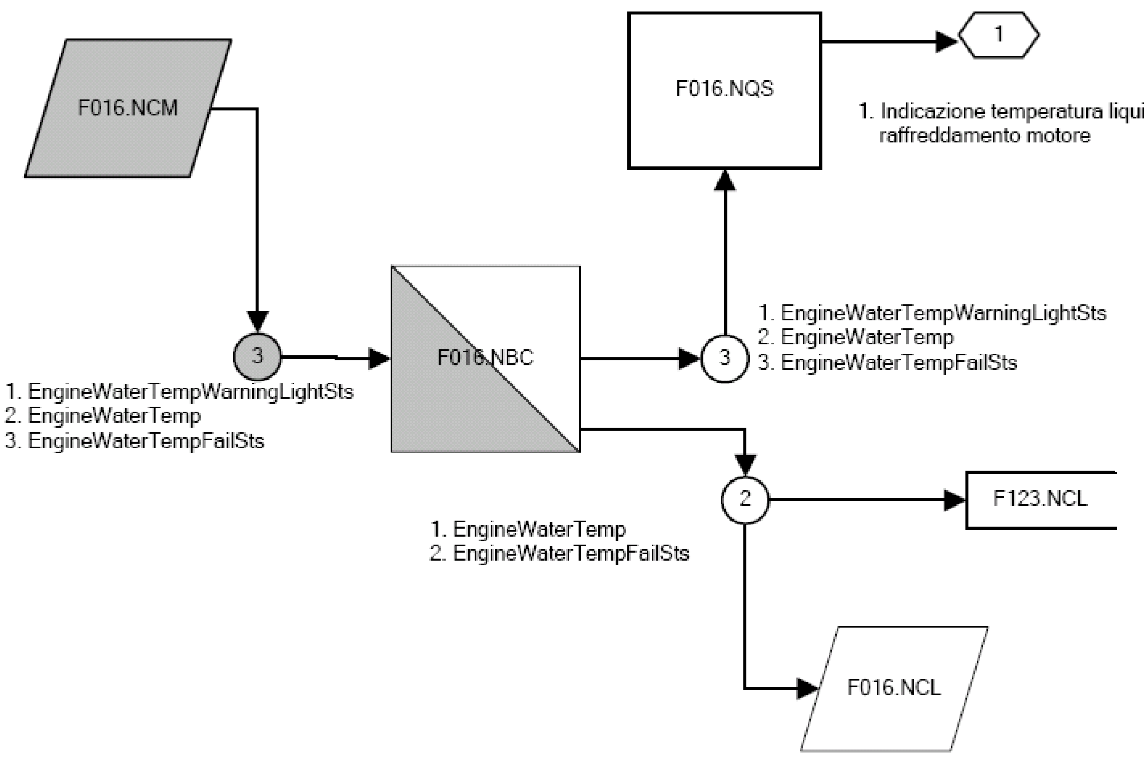
Vehicle speed signal:



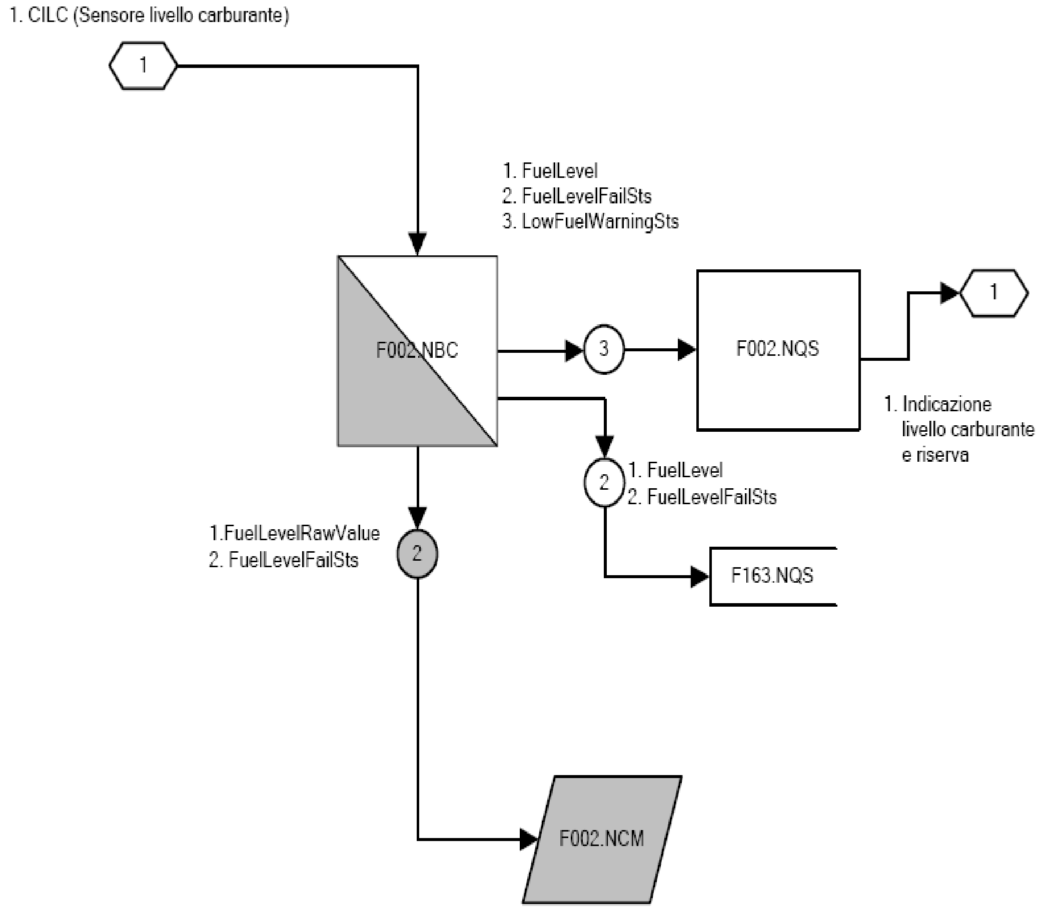
"Slow Down" warning light activation signal:



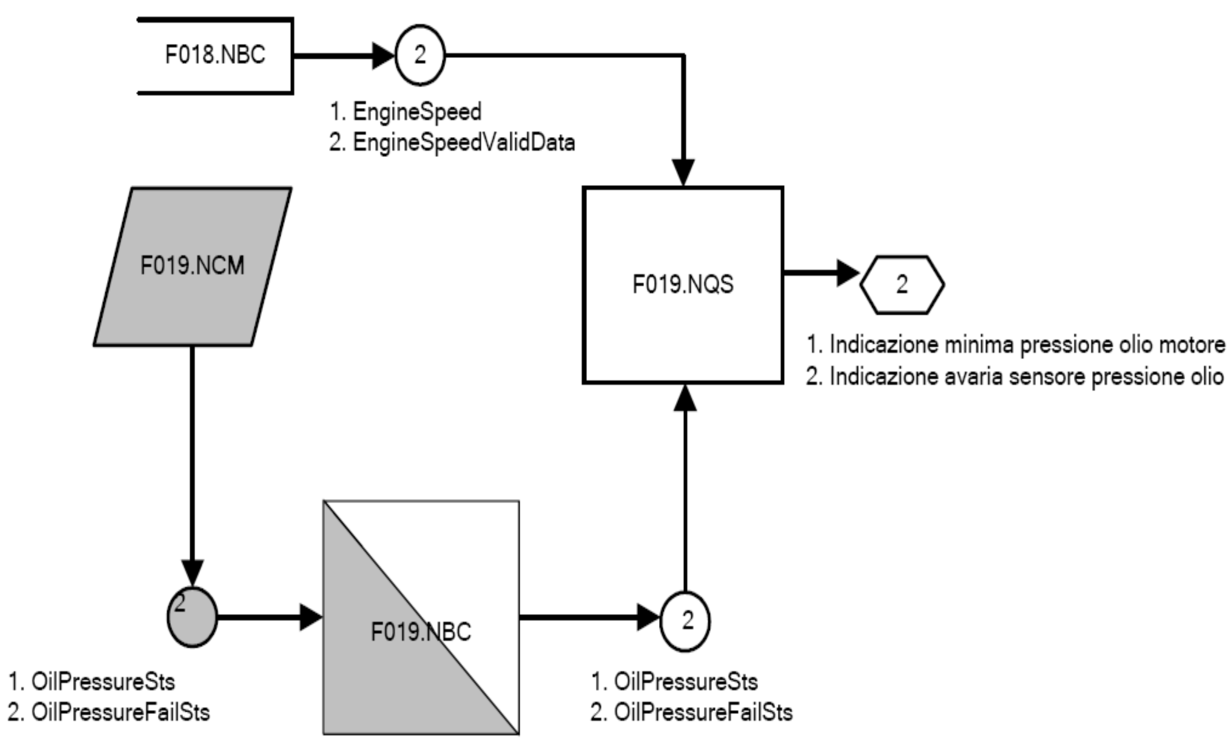
Engine coolant temperature signal:



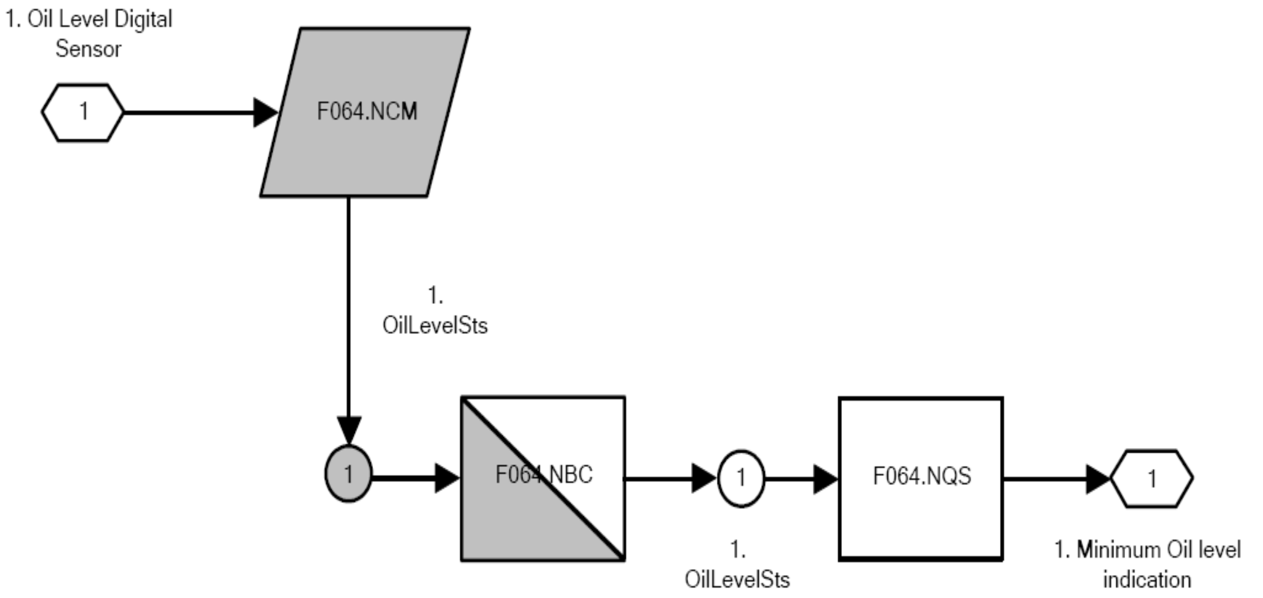
Fuel level signal:



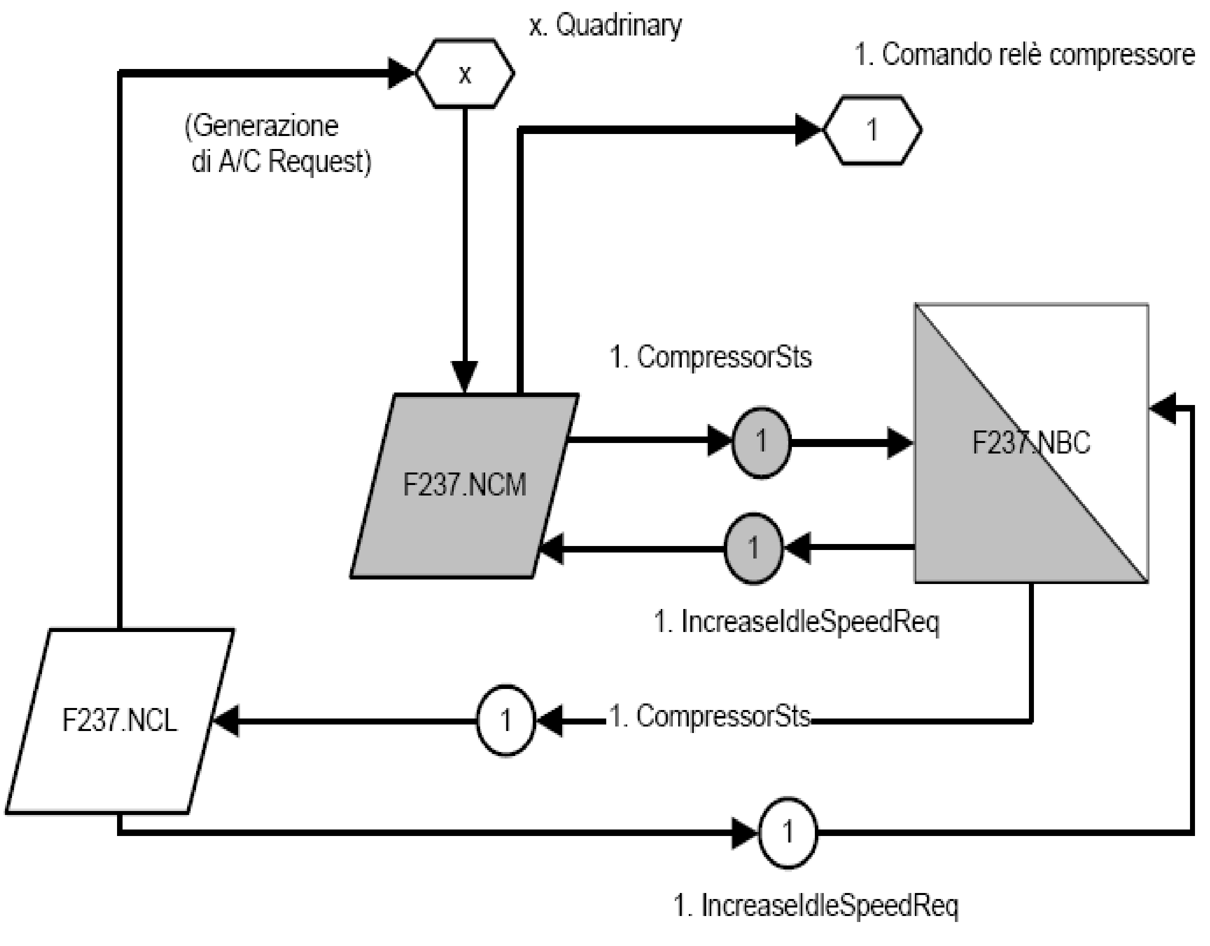
Engine oil minimum pressure signal:



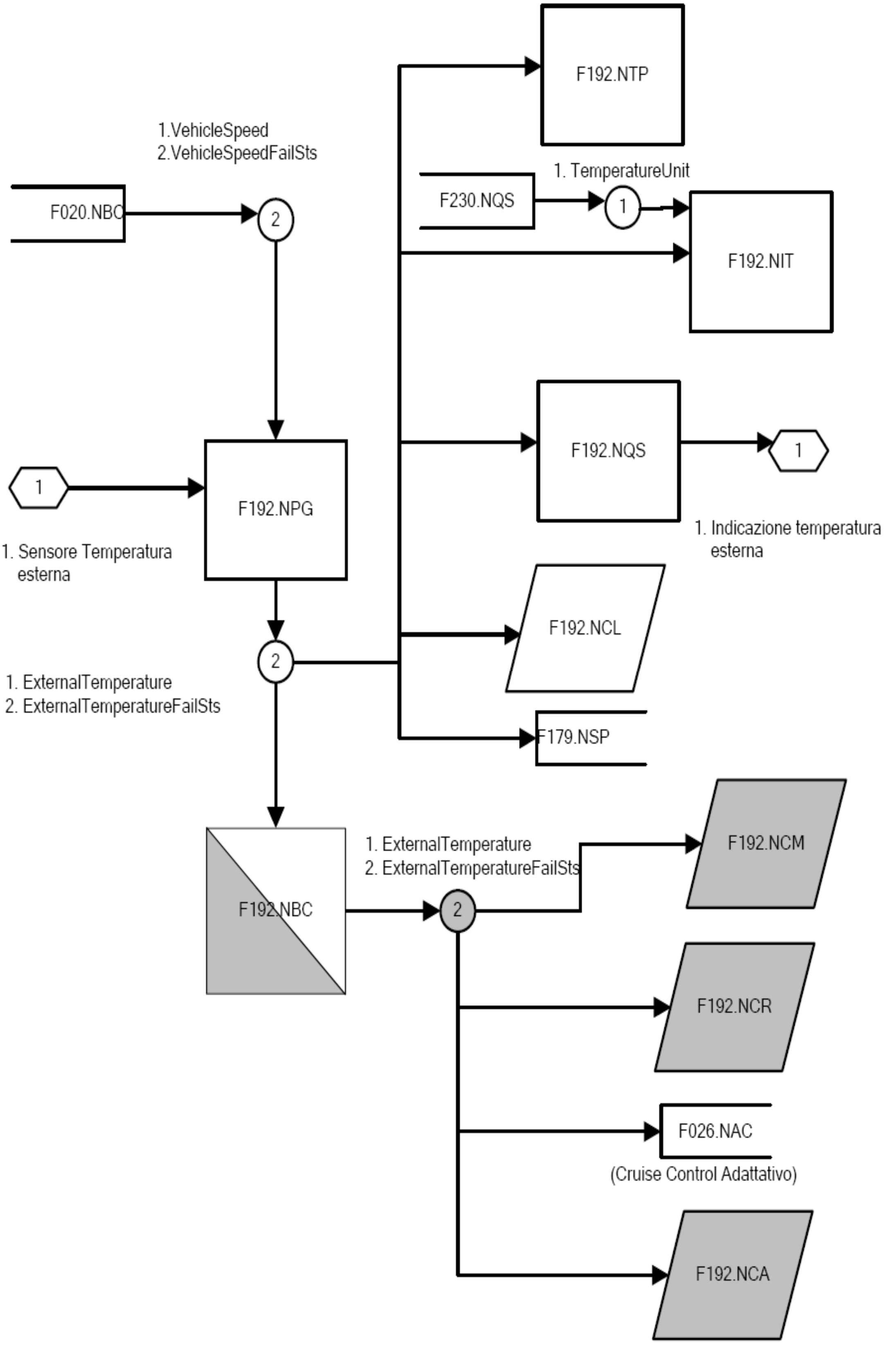
Engine oil minimum level signal:



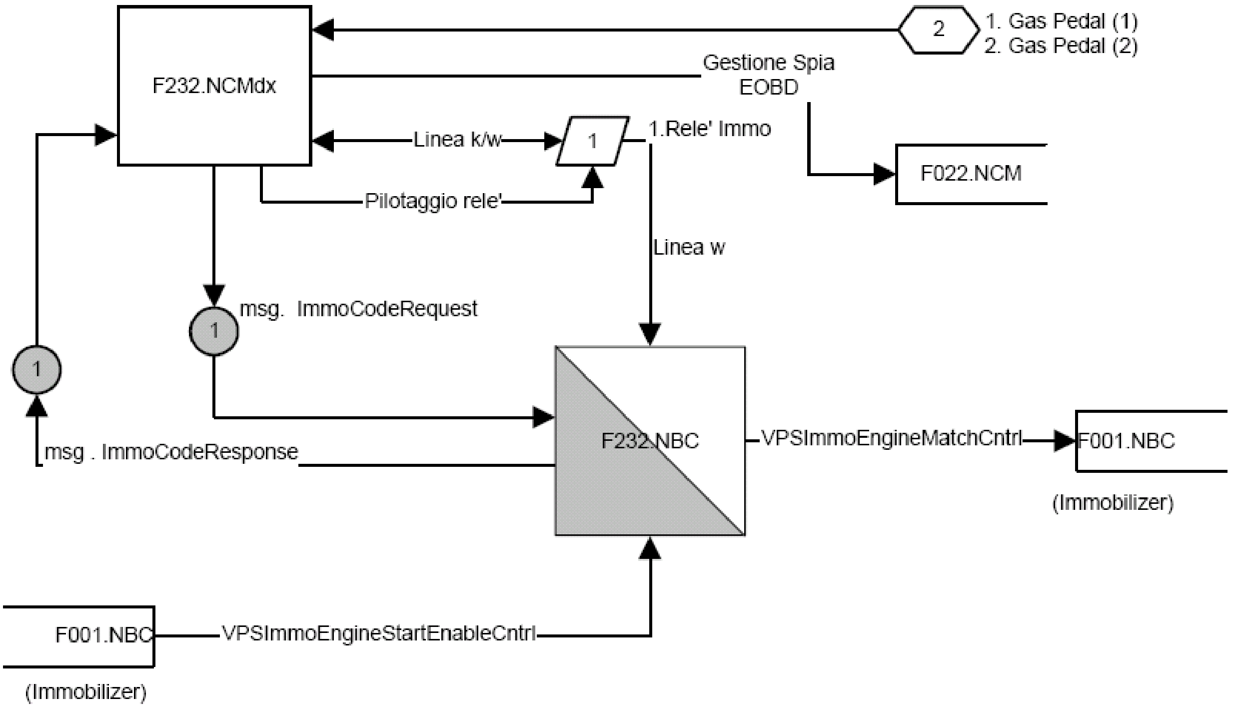
A/C compressor activation signal:



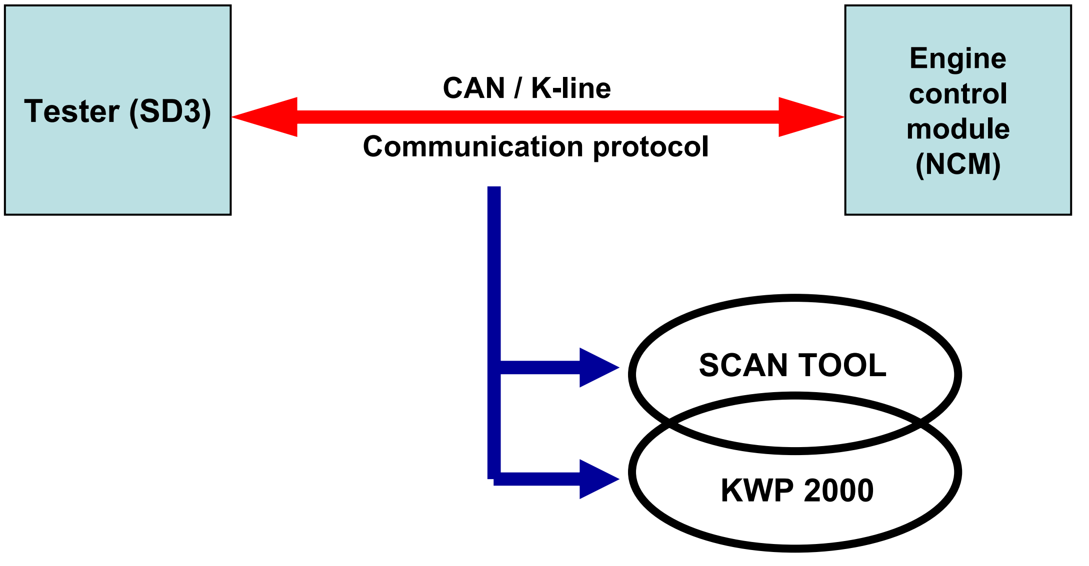
Ambient temperature signal:



Immobilizer signal:



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.

DIAGNOSTICS

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

DIAGNOSTICS
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.

DIAGNOSTICS

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!

DIAGNOSTICS

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.

DIAGNOSTICS

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

DIAGNOSTICS

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

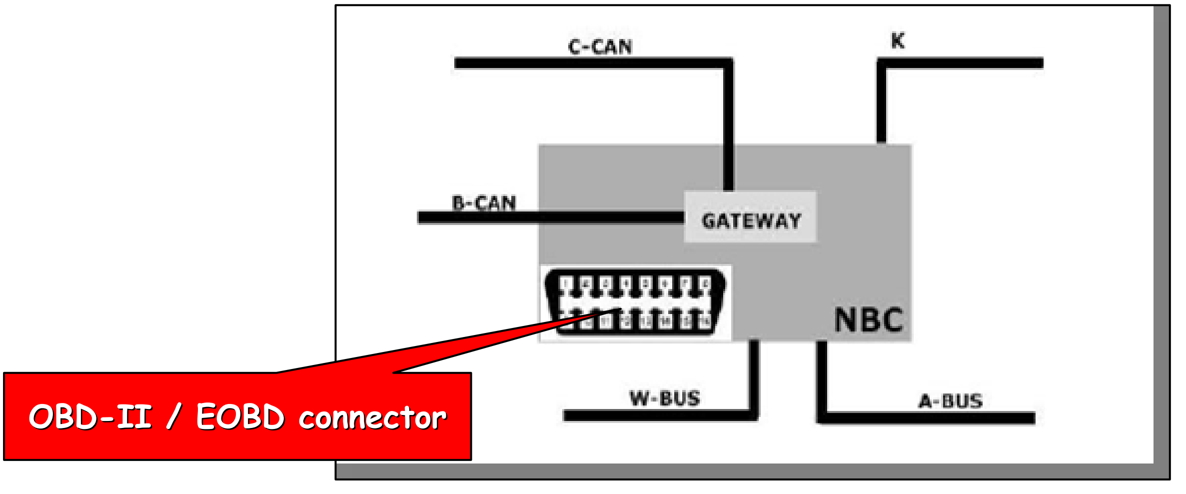
U00XX:	Electrical network
U01XX:	Communication network
U02XX:	Communication network
U03XX:	Software network
U04XX:	Data network

U1XXX: Manufacturer controlled
U2XXX: Manufacturer controlled
U3XXX: Reserved

DIAGNOSTICS

OBD-II / EOBD 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 (SD3) and the various communication networks.



Quattroporte OBD-II / EOBD connector pinout:

			Connettore 16 v. 150 per collegamento diagnosi 1/01534/87-91343/42 (EOBD)	
E04KK	1	150	B-CAN_L privata per sensore di peso (collegamento con AV16)	X
E04KK	2	150	C-CAN H (solo per sviluppo)	-
E04KK	3	150	B-CAN_H privata per sensore di peso (collegamento con PD12)	X
E04KK	4	150	Massa di potenza per apparecchiatura di diagnosi (collegamento con PF9)	X
E04KK	5	150	Massa di segnale per apparecchiatura di diagnosi (collegamento con PF8)	X
E04KK	6	150	B-CAN B per diagnosi	X
E04KK	7	150	Linea K per diagnosi NCM/ NCR (collegamento con AV20)	X
E04KK	8	150	Non disponibile	-
E04KK	9	150	Linea K per zona plancia – CSG, CAF (collegamento con PD11)	X
E04KK	10	150	C-CAN L (solo per sviluppo)	-
E04KK	11	150	Non disponibile	-
E04KK	12	150	Linea K per zona anteriore, NFR, NCS (collegamento con AZ35)	X
E04KK	13	150	Linea K per NTV (collegamento con LN18)	X
E04KK	14	150	B-CAN A per diagnosi	X
E04KK	15	150	Non disponibile	-
E04KK	16	150	+30 presa diagnosi EOBD da F-39 (collegamento con CY17)	X

DIAGNOSTICS

Quattroporte MY07 Automatic and Gran Turismo OBD-II / EOBD connector pinout

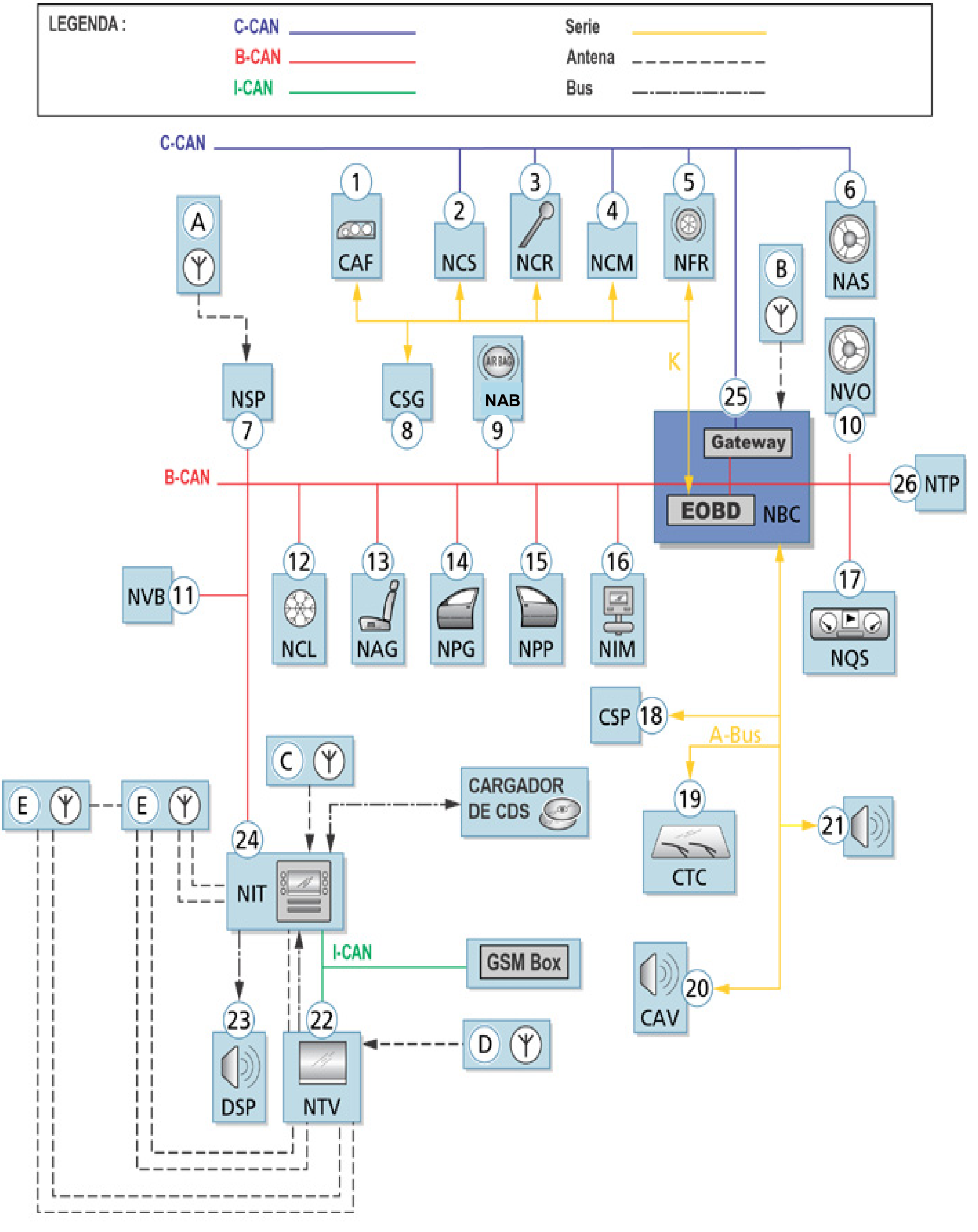
In compliance with ISO / SAE standards, for all cars from MY08 onward, Scan Tool must be available on the CAN line. For the Quattroporte from MY07 and Automatic, and for the Gran Turismo Maserati, a new pinout assignment for the OBD-II / EOBD connector has been introduced. This makes it necessary to use a new "Switch Matrix" diagnostic cable.

PIN	Funzione	M139 GQ	M139 FQ	Collegamenti interni
	Connettore 16 v. 150 per collegamento diagnosi 1/01534/87-91343/42 (EOBD)			
1	B-C.A.N. High (oppure B) a bassa velocità per diagnosi	X	X	AZ36-KK01-PF06-PD24-CY05
2	Reserved (Bus + SAE J1850)	-	-	
3	Reserved	-	-	KK03-PD12
4	Massa di potenza per apparecchiatura di diagnosi	X	X	AZ30-KK04-KK05-PF08-PF09-PD10-PG36-PD19-LN03-AZ27
5	Massa di segnale per apparecchiatura di diagnosi	X	X	AZ30-KK04-KK05-PF08-PF09-PD10-PG36-PD19-LN03-AZ27
6	C-CAN High per diagnosi	X	X	KK06-AZ45-AZ49
7	Linea K per diagnosi NCM/ NCR (collegamento con AV26)	X	X	AV26-KK07
8	Reserved	N.C.	N.C.	
9	B-C.A.N. Low (oppure A) a bassa velocità per diagnosi	X	X	KK09-AZ35-PF05-CY07-PD25
10	Reserved (Bus – SAE J1850)	-	-	AZ44-AZ48-KK10
11	Reserved	N.C.	N.C.	
12	Linea K per zona anteriore, NAC, NFR, NCS, CSG, CAF (collegamento con AZ47)	X	X	AZ47-KK12
13	Linea K per NTV (collegamento con LN24)	X	X	KK13-LN24
14	C-CAN Low per diagnosi	X	X	KK14-AZ44-AZ48
15	Linea L per diagnosi NOT USED	N.C.	N.C.	
16	+30 presa diagnosi EOBD da F-39 (collegamento con CY17)	X	X	CY17-PD26-KK16-LP51-AV17-AZ46

All diagnostics for cars with Florence architecture are performed with the SD3 tester!

DIAGNOSTICS

Florence architecture (example: Quattroporte):



DIAGNOSTICS

Safety

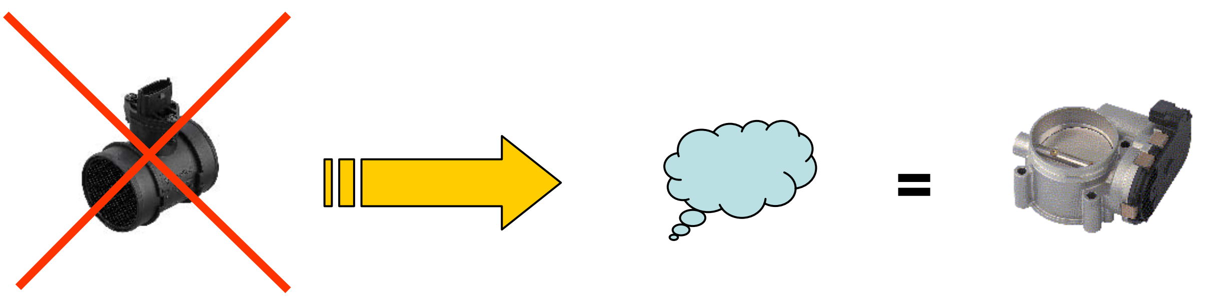
3 components of the engine control system are of fundamental importance for road safety:

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

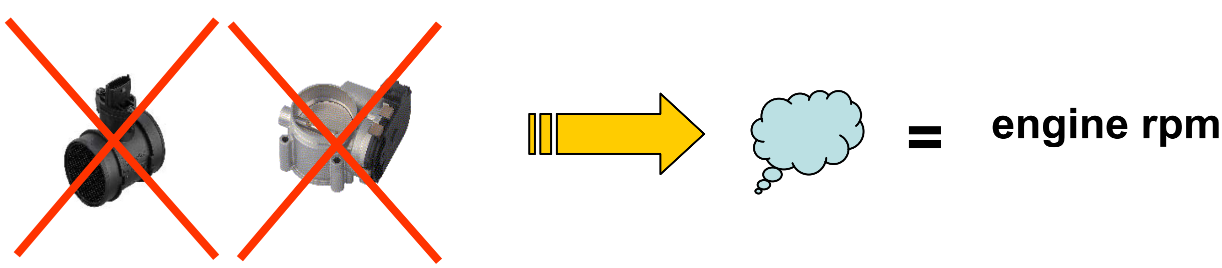
For this reason diagnostics of these three components is covered in greater detail!

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



DIAGNOSTICS

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

DIAGNOSTICS

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

DIAGNOSTICS

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

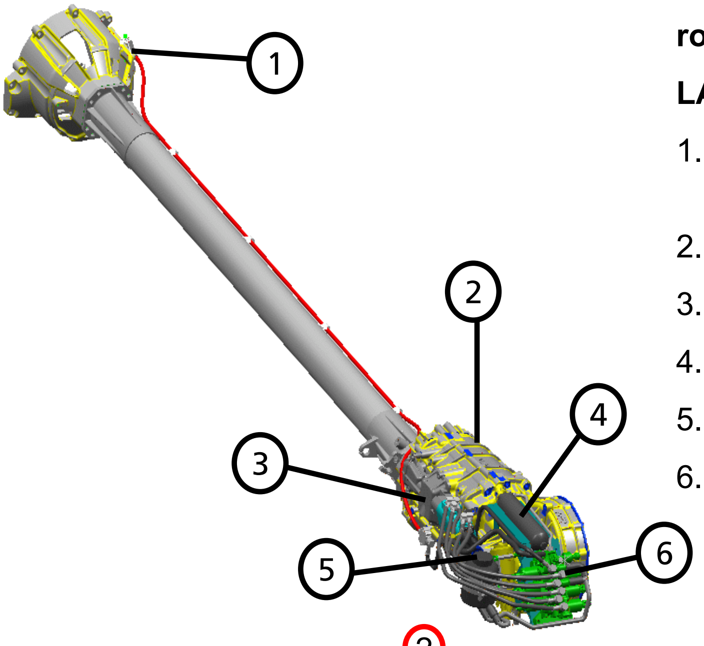
Problem	***Component***	***Solution***
Engine too rich	Air cleaner clogged	Renew air filter
Engine too lean	Leakage	Check sealing efficiency of intake duct
Incorrect air flow	Air flow meter	Check/Renew Air Flow Meter
Fuel temperature too high/Vapours in fuel rails	Vapour lock	Cool down engine
Insufficient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

Robotized Gearbox Control System

Marelli

ROBOTIZED GEARBOX CONTROL SYSTEM

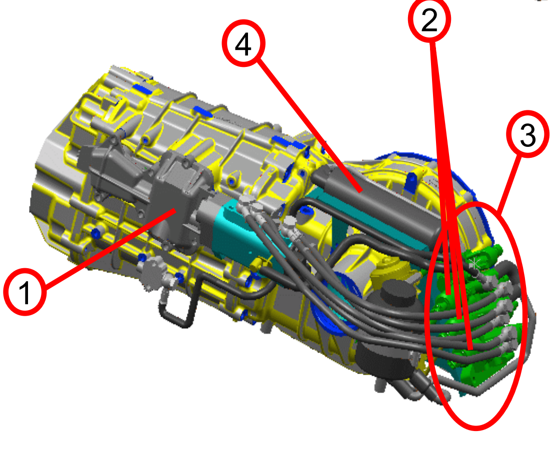
The specific feature of the system is that it can be integrated on a mechanical transmission without requiring any special modifications.
The gearbox is operated by a servo system controlled by steering wheel paddle levers.



robotized gearbox

LAYOUT

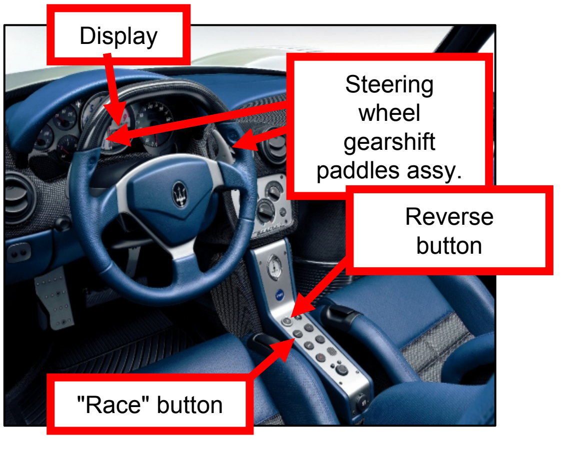
1. Clutch Position Sensor on Clutch Housing (Sofast III)
2. Gearbox Unit
3. Hydraulic actuator
4. Accumulator
5. Reservoir
6. Power Unit Assy



robotized gearbox

LAYOUT

1. Hydraulic actuator
2. Solenoid valves
3. Power unit
4. Accumulator



DRIVER CONTROLS

- Display
- Steering wheel gearshift paddles
- Reverse gear selection
- Auto/manual mode selection

EVOLUTION OF TRANSMISSION CONTROL SYSTEMS

The robotized gearbox node has evolved through three different specifications that have also involved the introduction and modification of other components of the car. Evolution of the SW for the robotized gearbox led to the implementation of components designed to improve the gearshift comfort, reduce clutch wear, and reduce maintenance requirements following replacement and adjustment of the clutch (kiss point).

The **SOFAST** type of transmission control operates without an acceleration sensor. Management of gear changes is not influenced by information concerning vehicle dynamics.

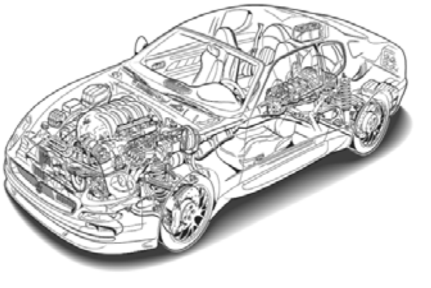
The **SOFAST II** transmission control system underwent an initial evolution to optimise gear change comfort during engagement phases and reduce noise levels. Management of gear changes is not influenced by information concerning vehicle dynamics.

The **SOFAST III** transmission control system involves an evolution of the software and control of vehicle dynamics with the integration of a dedicated acceleration sensor initially which was subsequently incorporated in the MSP system. By means of a pressure sensor on the clutch housing it is possible to acquire the characteristic of the diaphragm spring that acts on the clutch disc.

The **SOFAST III+** transmission control system. Identical to SOFAST III but with modified clutch.

The following list shows variants subdivided by model.

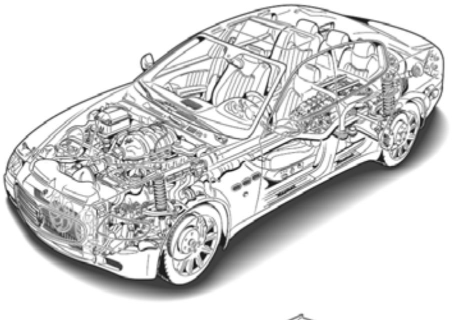
MASERATI M138



SW CFC 201 (SOFAST) up to assembly 12203

SW CFC 231 (SOFAST II) from assembly 12204

MASERATI M139 EUROPE version



SW CFC 231 (SOFAST II) up to assembly 18821

SW CFC 301(SOFAST III) from assembly 18822

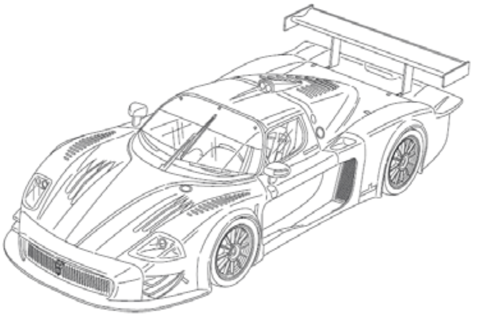
SW CFC 301(SOFAST III+) from assembly 21925

MASERATI M139 US version

SW CFC 301 (SOFAST III) up to assembly 21925

SW CFC 301 (SOFAST III+) from assembly 21926

MASERATI M144

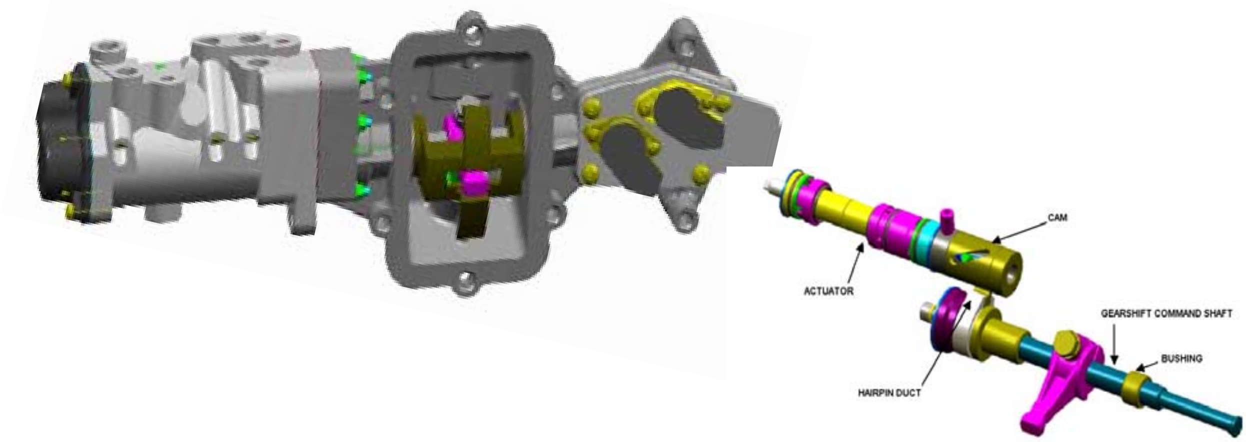


SW CFC 201(SOFAST)

COMPONENT DESCRIPTION

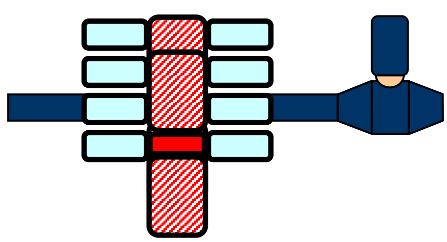
Hydraulic actuator

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

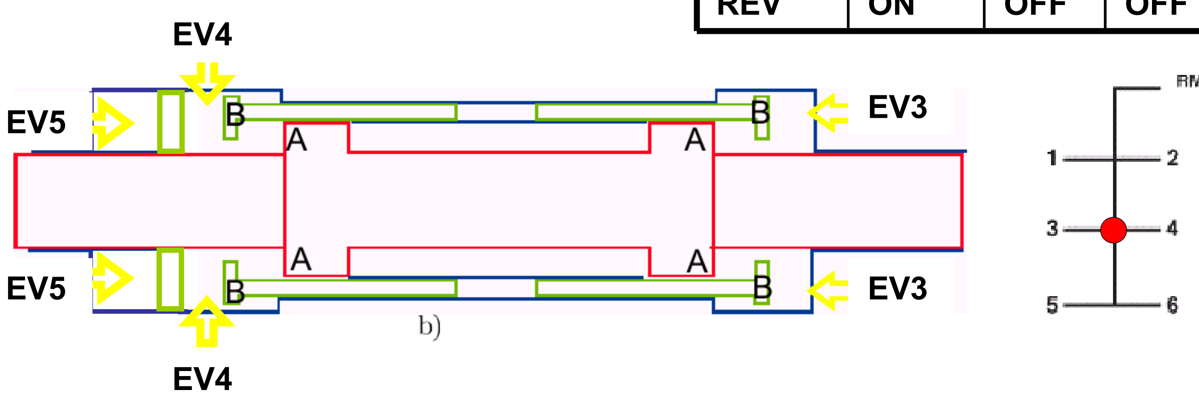


SELECTION

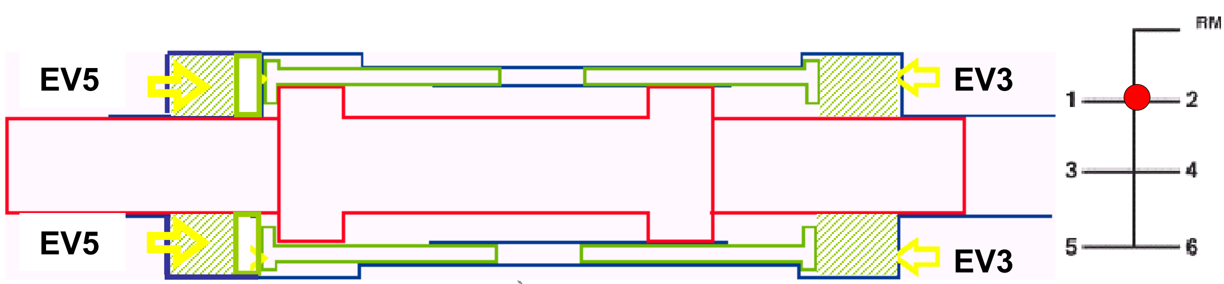
The hydraulic actuator converts the hydraulic pressure supplied by the gear selection solenoid valves (EV3, EV4, EV5) into a rotary movement of the gearshift command shaft. The gearshift command shaft has 4 possible positions separated by 15° angles.



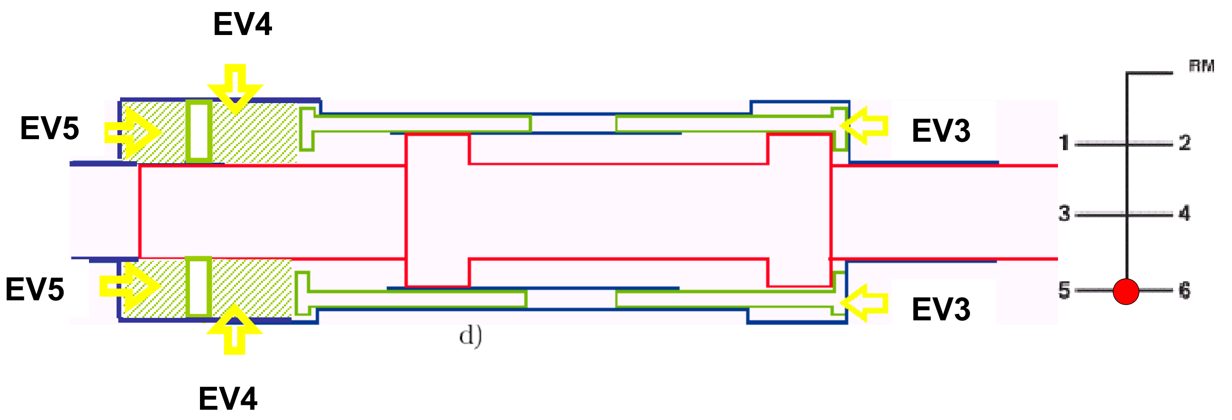
Gear	EV3	EV4	EV5
1 - 2	ON	OFF	ON
3 - 4	ON	ON	ON
5 - 6	OFF	ON	ON
REV	ON	OFF	OFF



b)



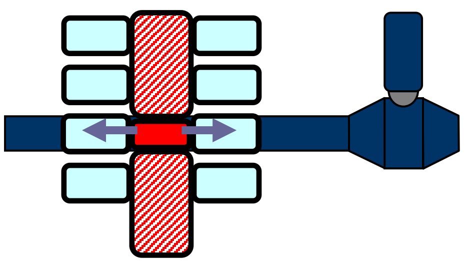
c)



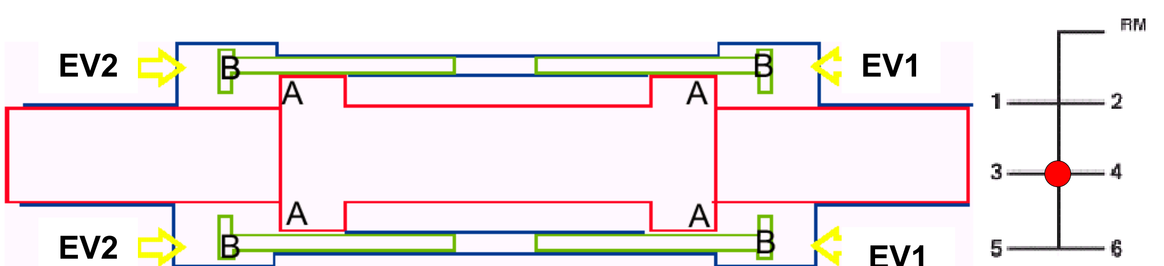
d)

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 gearbox control shaft 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



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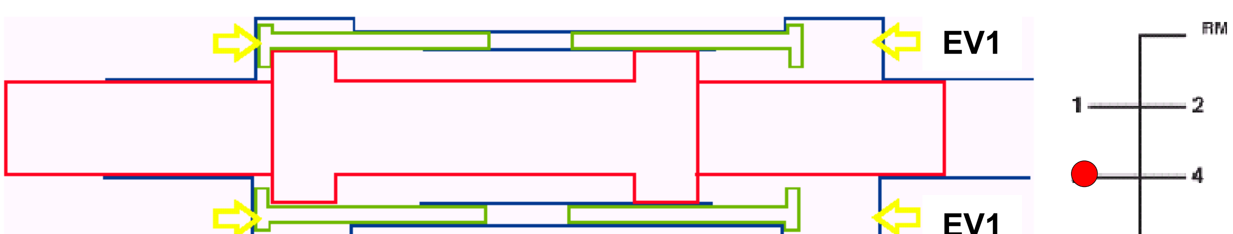

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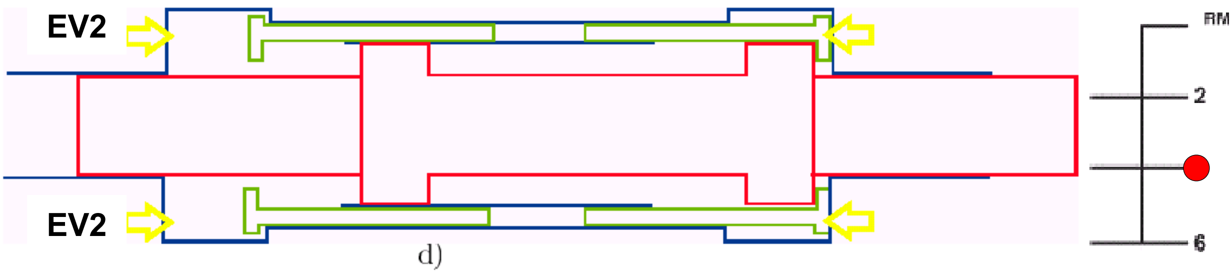
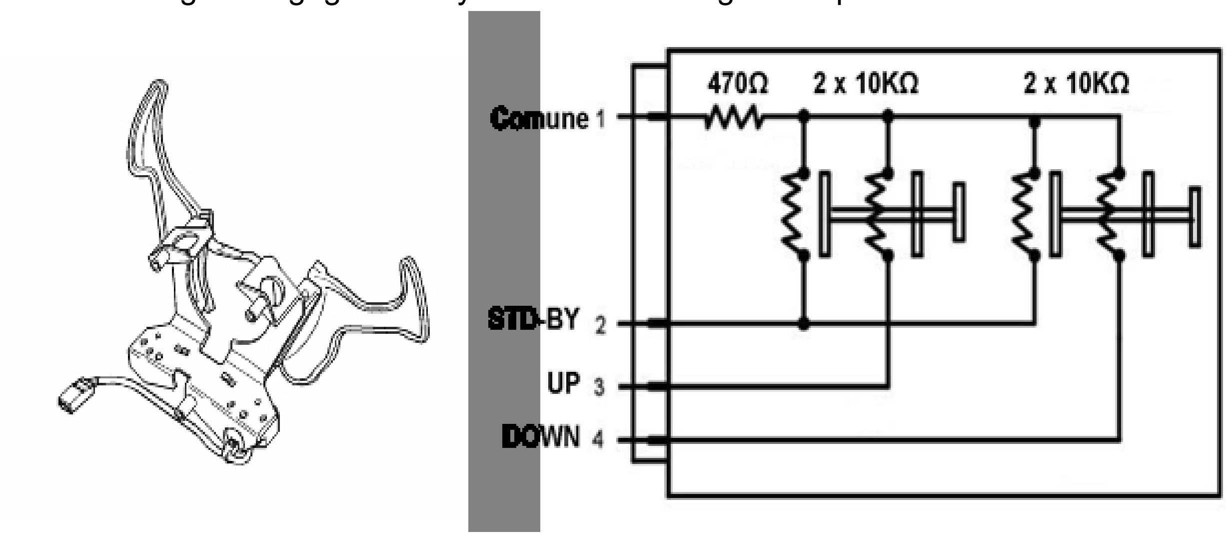


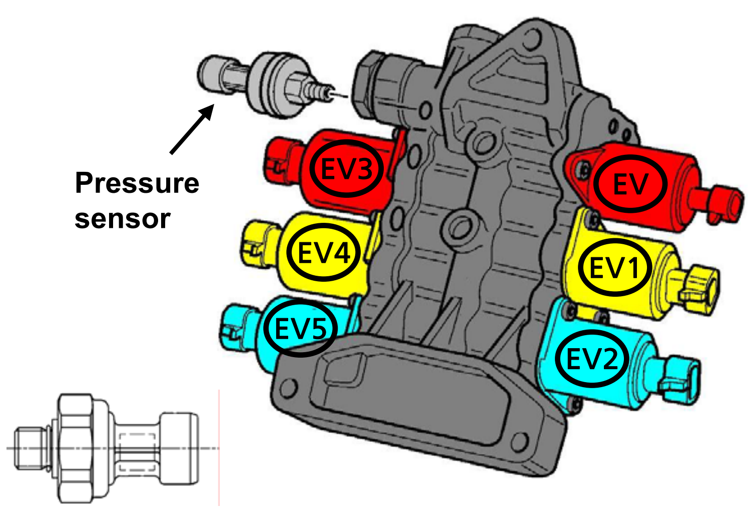
Up / down paddles
Selection of gear engagement by means of steering wheel paddles



The NCR checks the activation status of the paddles by means of voltage values measured via the control switches.

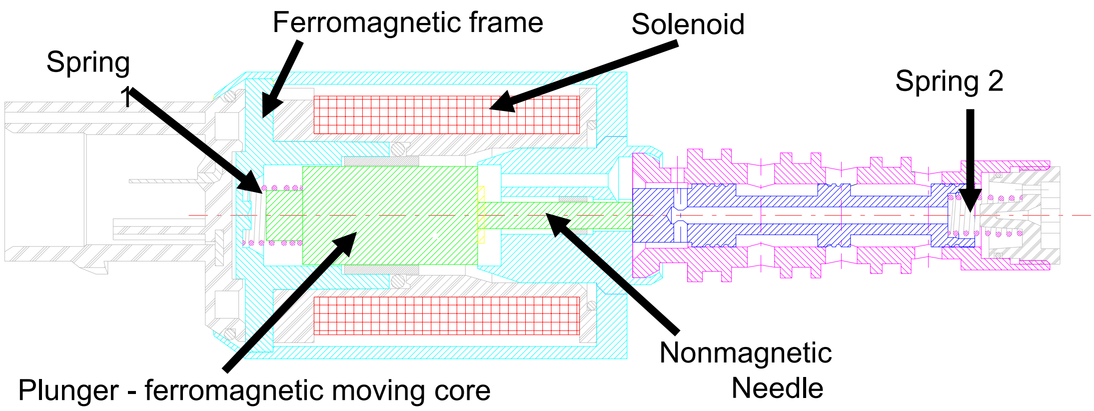
Hydraulic power unit supply system
The function of this subsystem is that of providing the necessary fluid power for actuation in a pressure range of between 40 and 50 bar. The power unit is made up of the following components:

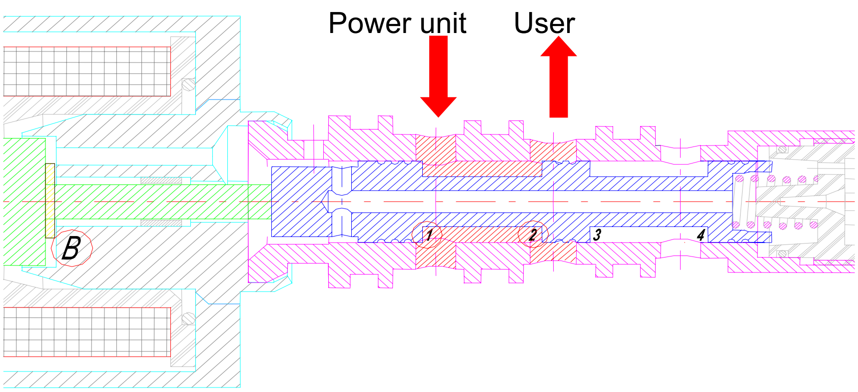
- 6 solenoid valves
- Pressure sensor
- Check valve
- Pressure relief valve
- Bypass screw

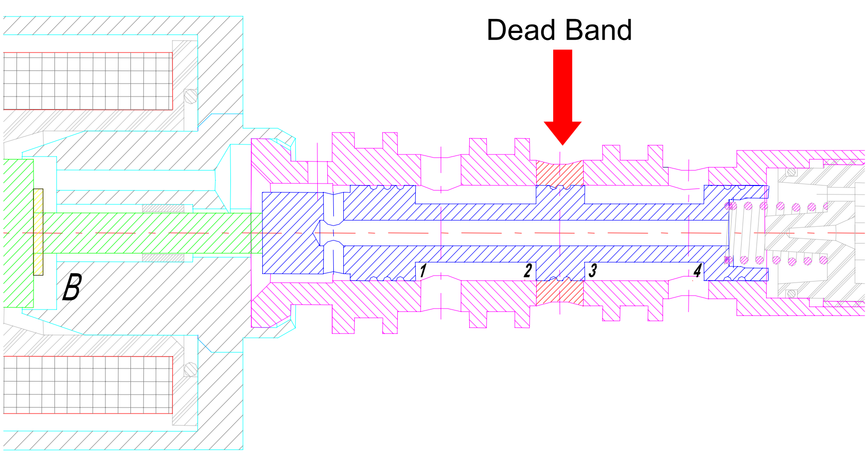


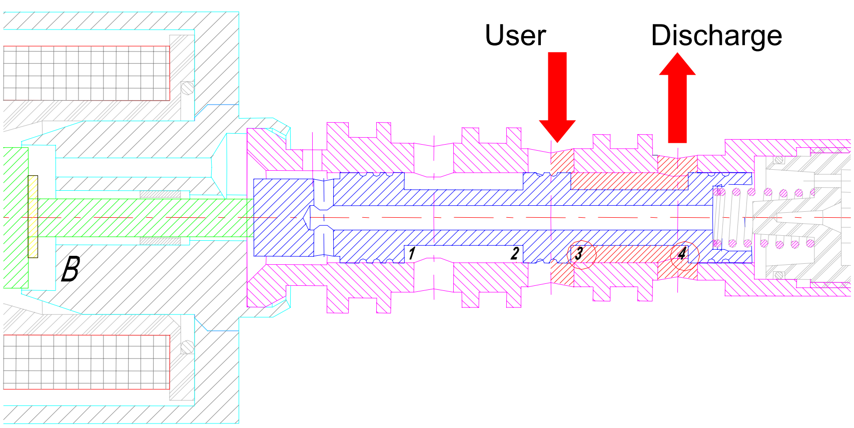
Pressure sensor:
Working range: 0 - 80 bar
Power supply: 5V DC.
Output signal: 0.5 - 4.5 V DC.

The activation characteristic varies among different solenoid valve types.







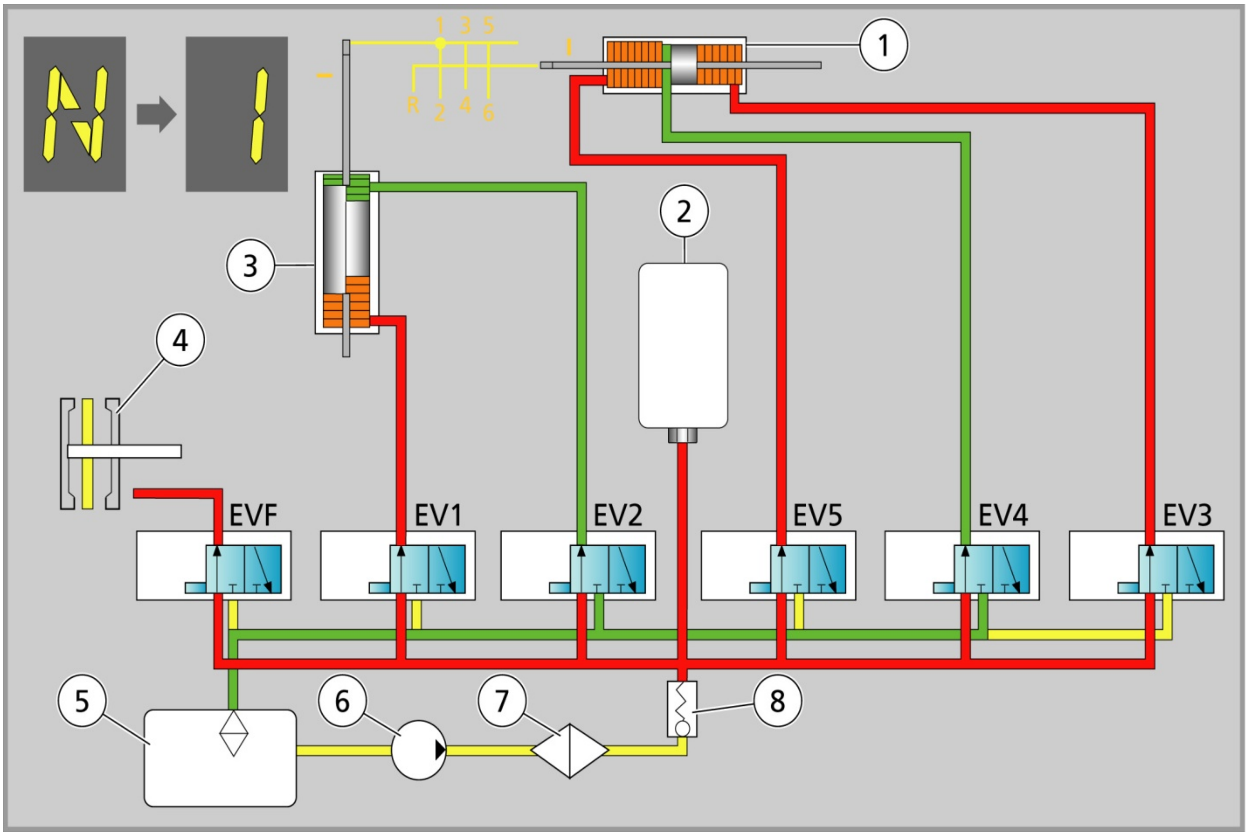


Solenoid valves:

EV: Clutch solenoid valve

EV 1-2: Gear engagement solenoid valves

EV 3-4-5: Gear selection solenoid valves



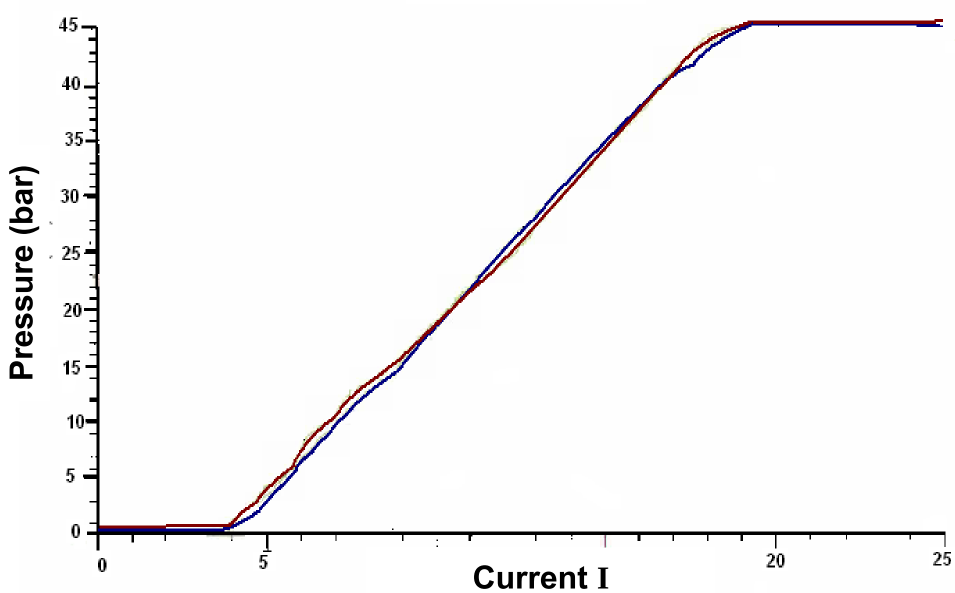
1. **Selection actuator**
2. **Hydraulic accumulator**
3. **Engagement actuator**
4. **Clutch**
5. **Oil reservoir**
6. **Electric pump**
7. **Filter**
8. **Check valve**

Pressure

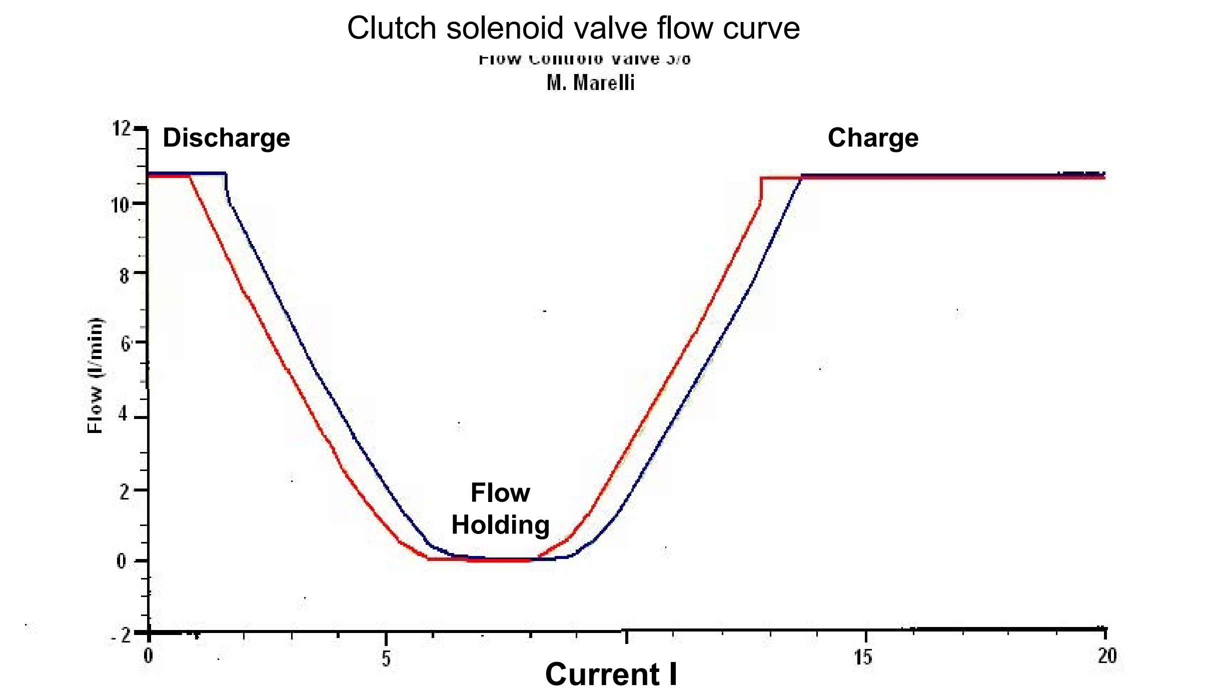
Return

Neutral

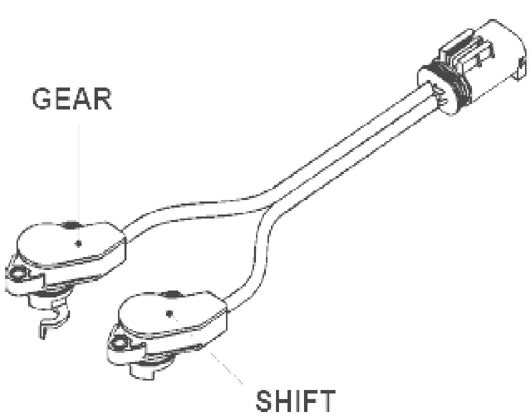
The two gear engagement solenoid valves **(EV1, EV2)** responsible for meshing and disengaging the gears, are of the **proportional pressure type (PPV).** The solenoid valves are controlled by a PWM signal and they modulate hydraulic pressure in accordance with the input current

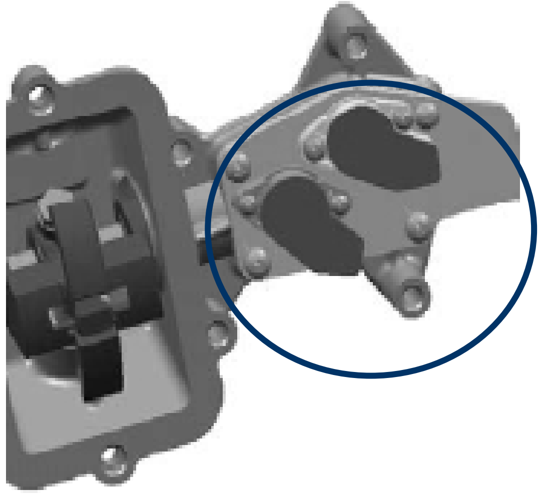


The 3 gear selection solenoid valves **(EV3, EV4, EV5)** are of the **ON/OFF** type and the clutch solenoid valve **(EV)** is of the **proportional flow type (PFV)**. The solenoid valves are controlled by a PWM signal and they modulate hydraulic pressure in accordance with the input current.

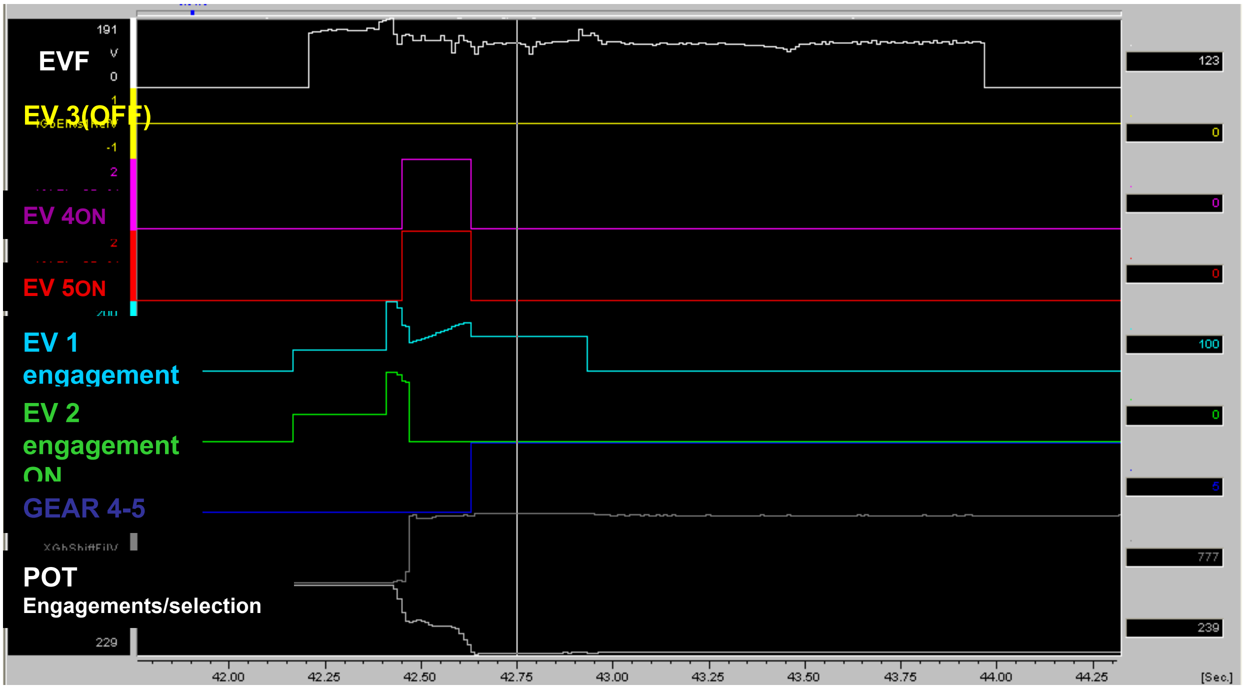


Informed of the two signals, the TCU recognises the position of the gearshift paddles: gear engaged, neutral, fault. The hydraulic actuator is equipped with two sensors designed to monitor the position of the gear engagement finger. One sensor monitors the selection stroke while the other checks the gear engagement stroke. Both sensors are of the contactless type and their operation is similar to that of the clutch position sensor. The integrated electronic circuit in the sensor converts the transformer output signal into an 0-5V DC signal.





Actuator unit position detection Hall effect type contactless sensors



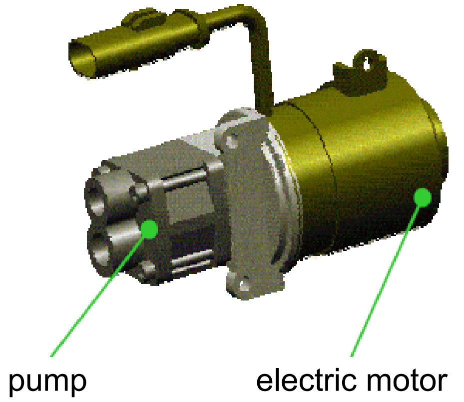
Electric pump

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

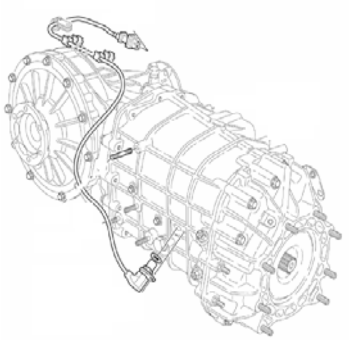
The pump is driven by an electric DC motor and is equipped with ON/OFF control strategy (the pump does not run continuously).

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.

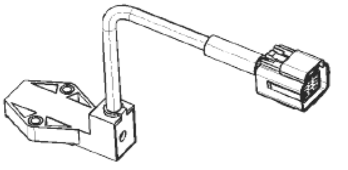


Gearbox input RPM sensor



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.

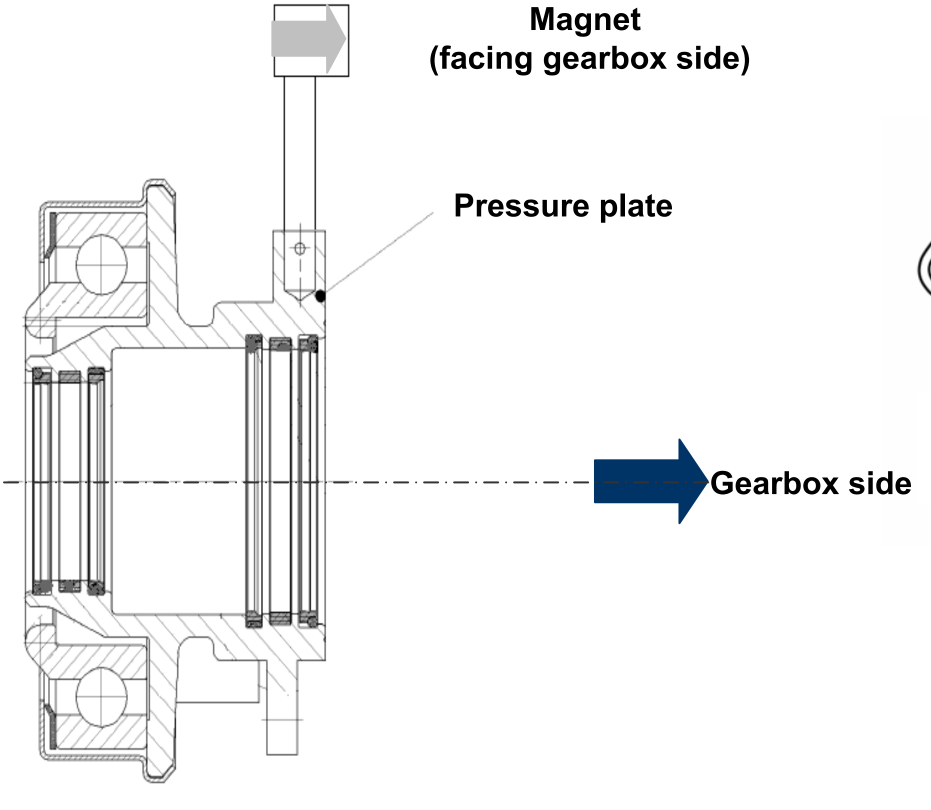
Clutch position sensor

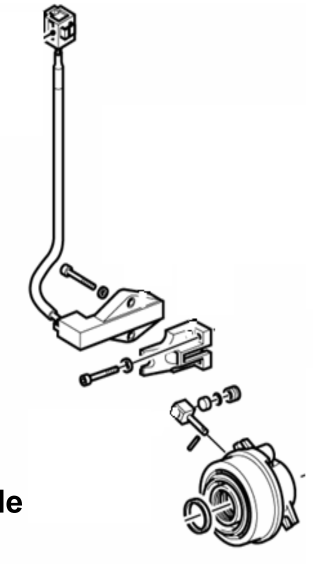


Electromagnetic sensor to detect the position of the clutch actuator, mounted in the clutch housing

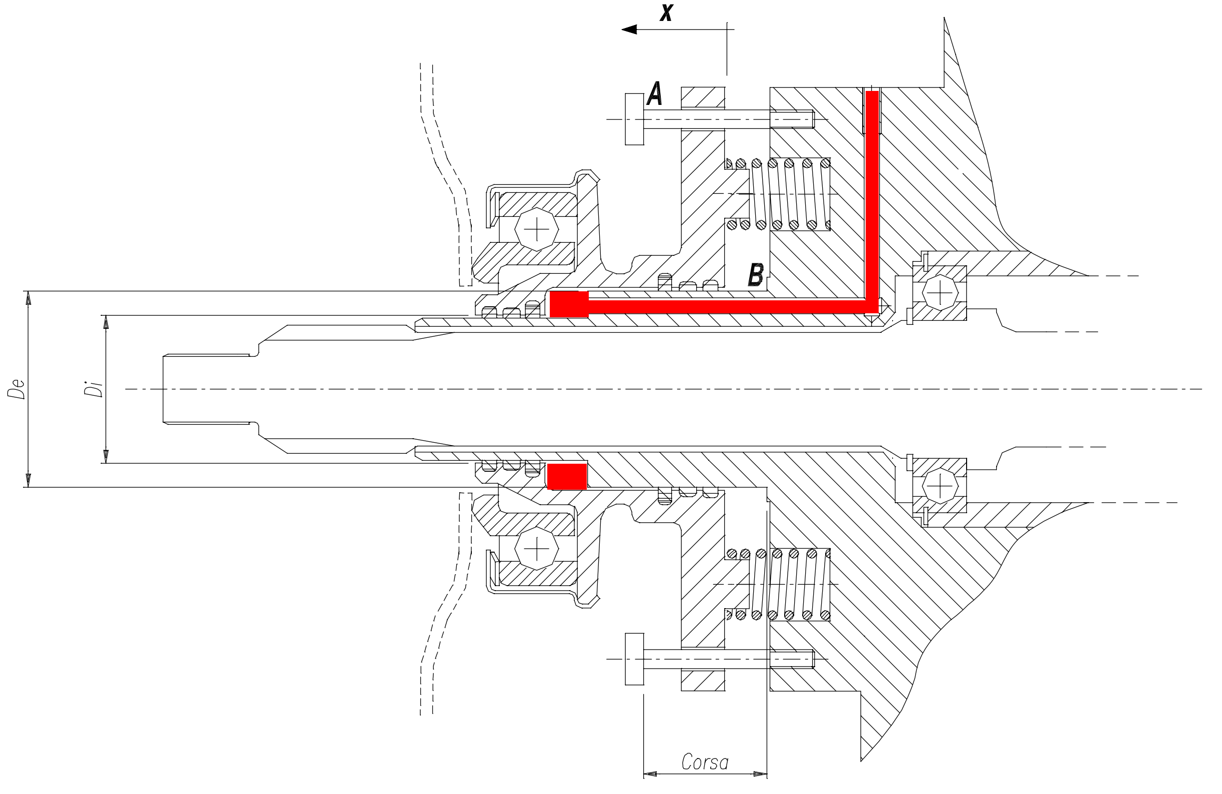
Clutch Actuator

The clutch actuator is responsible for activating the clutch thrust bearing; the actuator is composed of a hydraulically operated circular ring. Pay attention to the correct direction of installation of the magnet with reference to the clutch thrust bearing position.

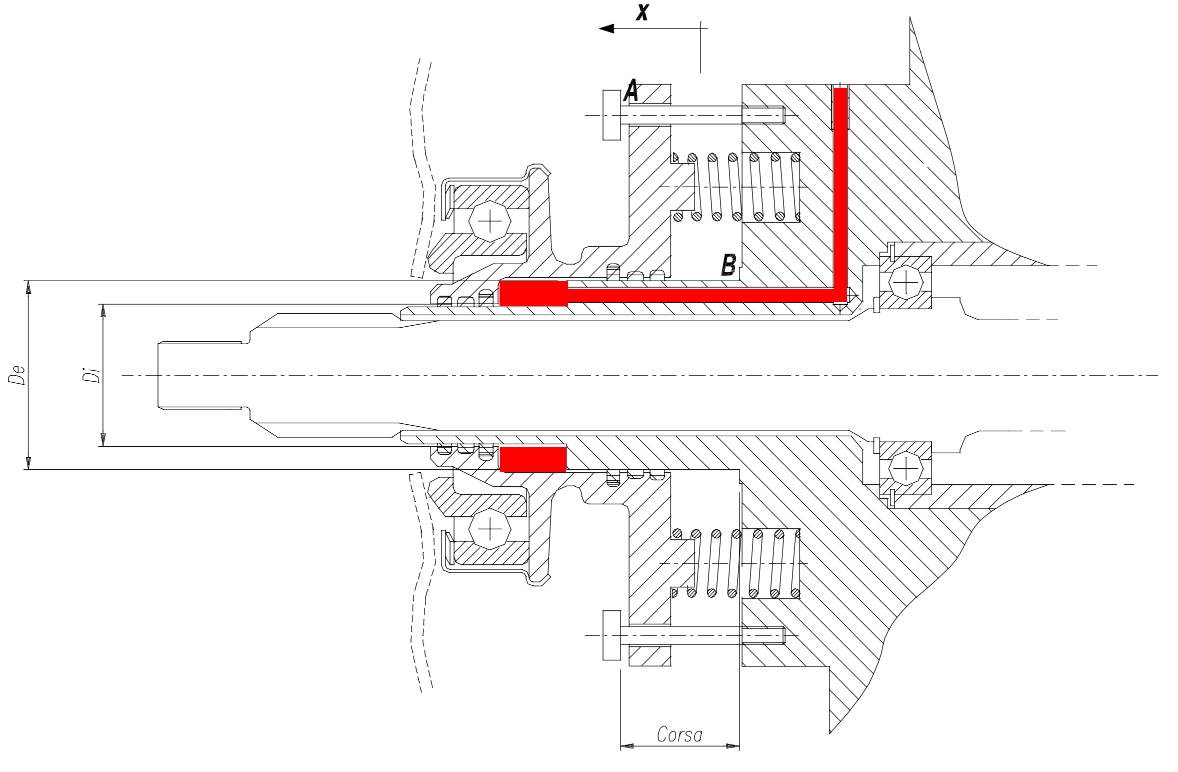




Clutch pressure plate in rest position



Clutch pressure plate in working position



Solenoid valves internal leakage

Leakage past the spool of the control valve, as detected 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: the electric pump should not run before 2 minutes have elapsed. This makes it possible to check the solenoid valves - accumulator - electric pump assy.

Engine RUN: the electric pump should not run before 60 seconds have elapsed. 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 must be assessed by acquisition of the diagnostic system: an activation ramp with an increasingly gradual slope and activation time in excess of 5 seconds are clear symptoms of deterioration of the pump.

Check valve
The check valve is located downstream from the electric pump inside the hydraulic 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 is set to ON.

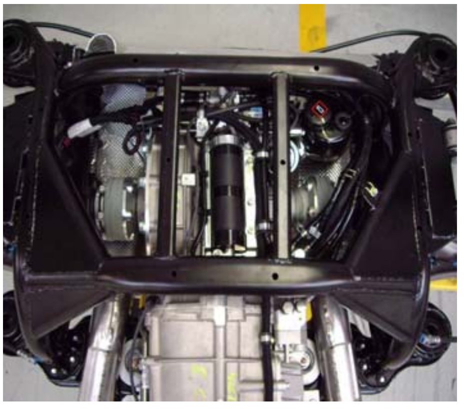
1. **Pressure relief valve**
2. **Bypass screw**

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.

Pressure accumulator

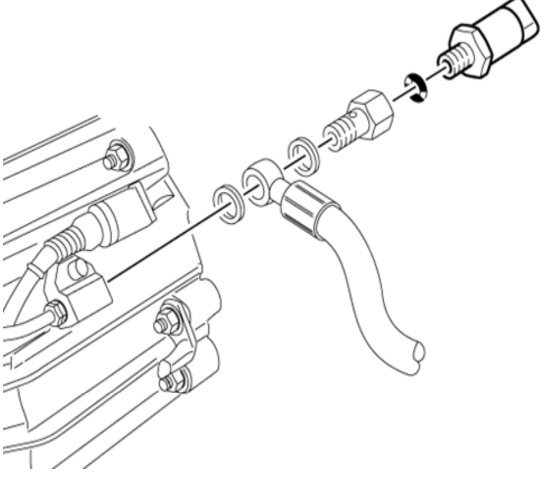
The F1 system is equipped with a piston type pressure accumulator located on top of the gearbox. The function of this device is to accumulate hydraulic pressure during the electric pump running time and deliver high pressure oil to the power unit when the pump is stopped.

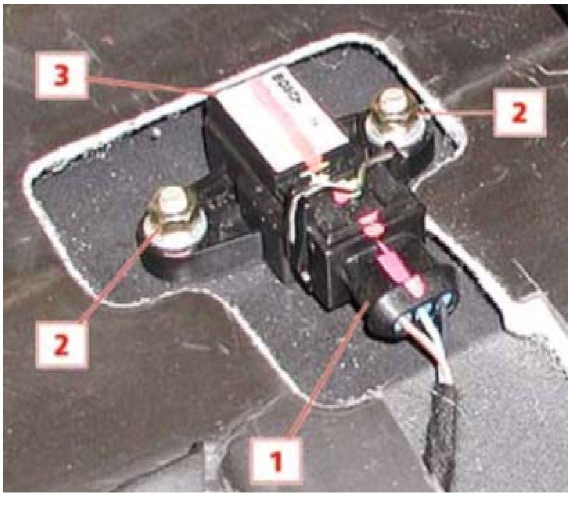


From the **SOFAST III** control unit software onward also the following specific components have been installed on the car:

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

Hydraulic pressure detection analogue sensor

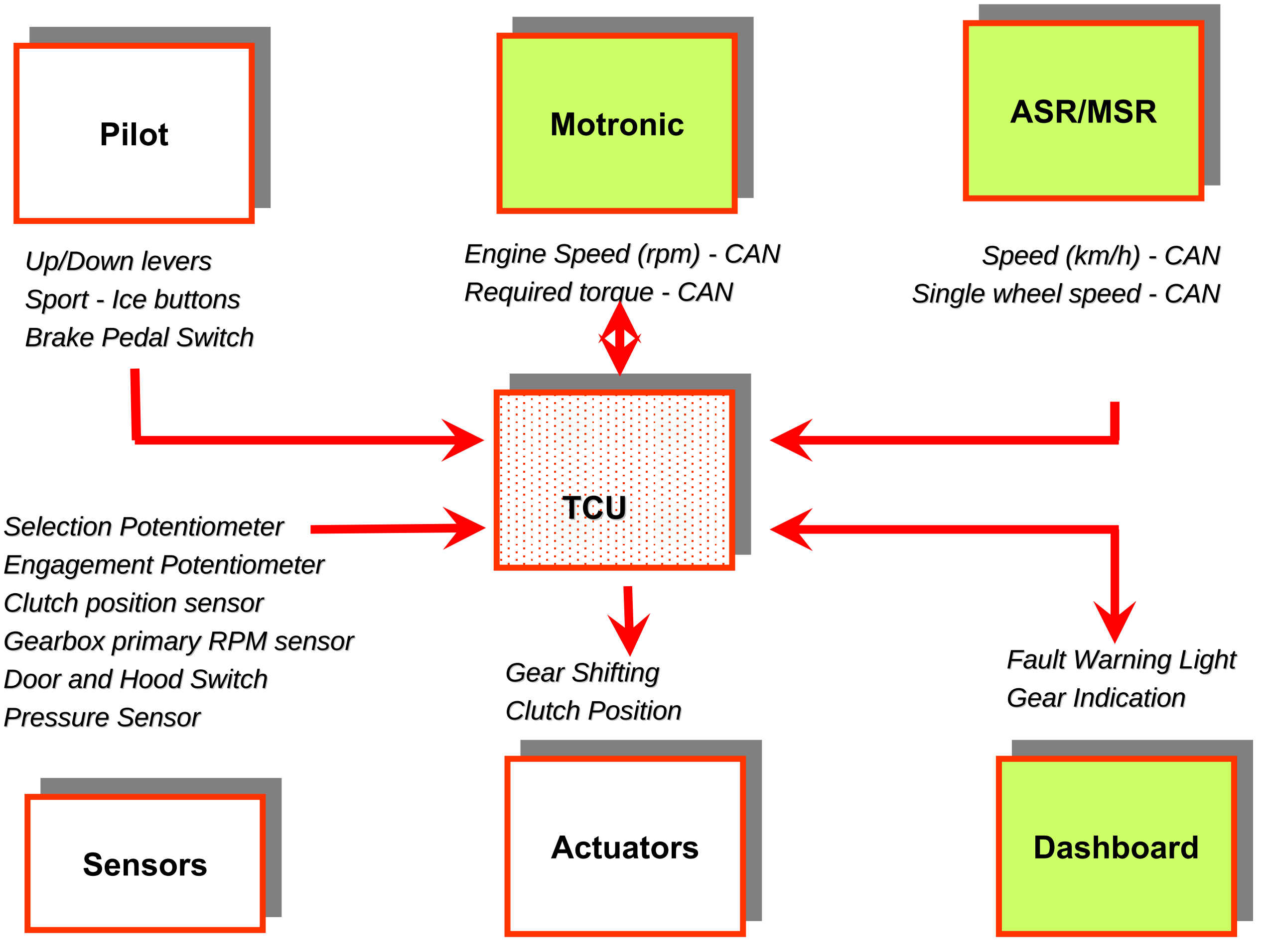




Longitudinal acceleration sensor

Specific component of the servo assisted transmission with SOFAST III type control. Component present on cars with SOFAST III software up to assembly **24274**, subsequent to asembly **24275** the relative functions were integrated within the MSP system yaw sensor.

OPERATING PRINCIPLE CHART

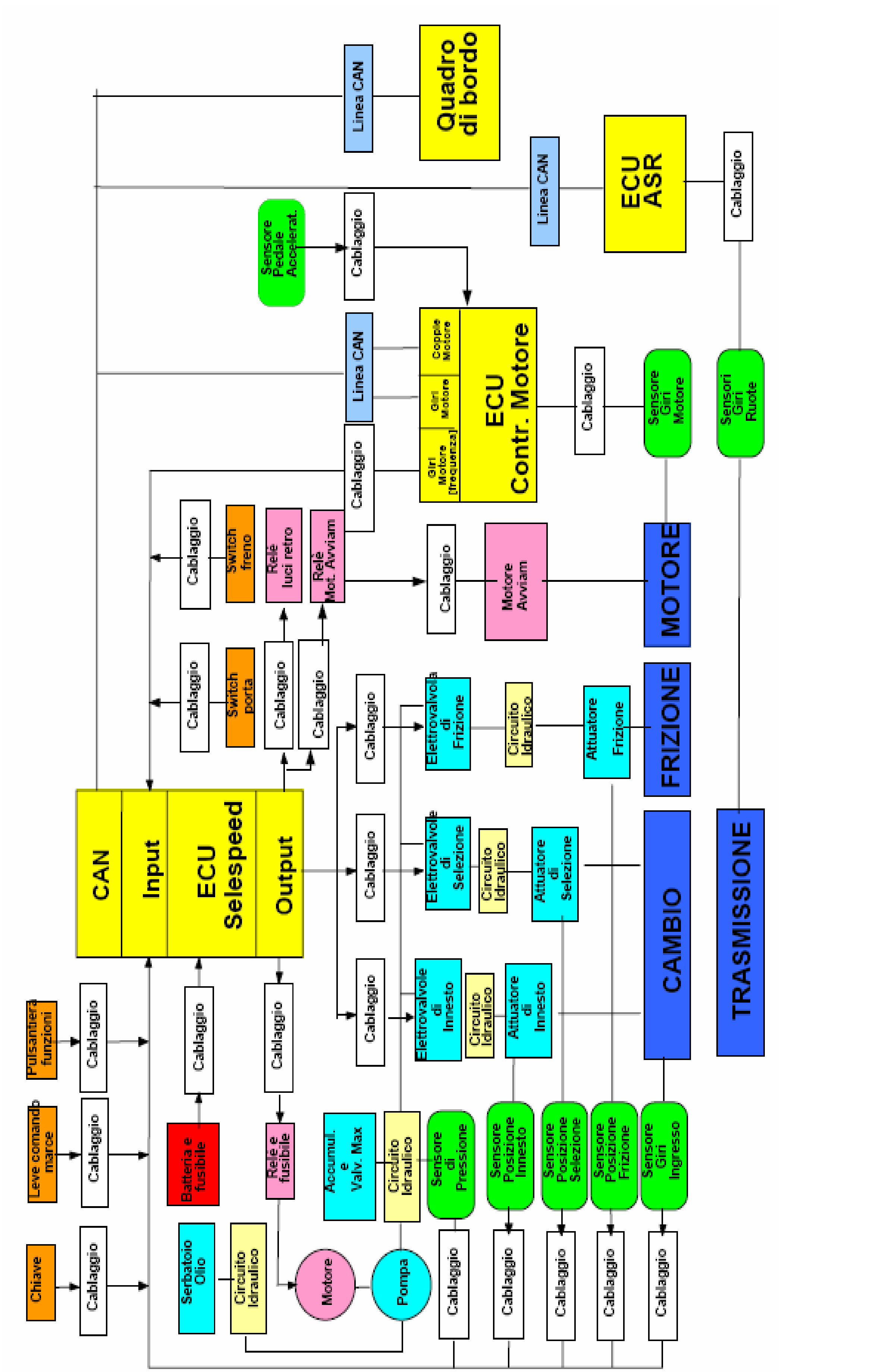


Input signals
The transmission control module (NCR) uses the following input signals for operation of the gearbox and clutch:

Analogue input signals:
- Shift up selector
- Shift down selector
- Vehicle speed signal
- "Ice" switch signal (low grip)
- "Auto" switch signal
- "Reverse" switch signal
- Brake pedal switch
- Driver's door switch
- "KEY ON" signal

Input signals from different sensors:
- Shift actuator position sensor
- Selection actuator position sensor
- Clutch actuator position sensor
- Clutch pressure sensor
- Primary shaft speed sensor
- Oil pressure sensor power unit

CAN input signals:
- Engine speed signal
- Engine torque signal
- "Sport" activation signal (from NFR)
- Hood switch signal
- Brake pedal switch signal


Quadro di bordo
Linea CAN
Linea CAN
ECU ASR
Cablaggio
Sensore Pedale Accelerat.
Cablaggio
Linea CAN
Coppie Motore
Giri Motore
Giri Motore (frequenza)
ECU Contr. Motore
Cablaggio
Sensore Giri Motore
Sensori Giri Ruote
Cablaggio
Cablaggio
Switch freno
Relè luci retro
Relè Mot. Avviam
Cablaggio
Motore Avviam
MOTORE
Cablaggio
Switch porta
Cablaggio
Cablaggio
Cablaggio
Elettrovalvola di Frizione
Circuito Idraulico
Attuatore Frizione
FRIZIONE
CAN
Input
ECU Selespeed
Output
Cablaggio
Elettrovalvole di Selezione
Circuito Idraulico
Attuatore di Selezione
CAMBIO
TRASMISSIONE
Cablaggio
Elettrovalvole di Innesto
Circuito Idraulico
Attuatore di Innesto
Pulsantiera funzioni
Cablaggio
Cablaggio
Cablaggio
Leve comando marce
Cablaggio
Batteria e fusibile
Relè e fusibile
Accumul. e Valv. Max
Circuito Idraulico
Sensore di Pressione
Sensore Posizione Innesto
Sensore Posizione Selezione
Sensore Posizione Frizione
Sensore Giri Ingresso
Chiave
Cablaggio
Serbatoio Olio
Circuito Idraulico
Motore
Pompa
Cablaggio
Cablaggio
Cablaggio
Cablaggio
Cablaggio

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.

GEARBOX OPERATING STRATEGIES

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

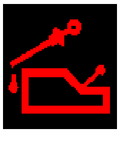
The gear disengages:

- 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:

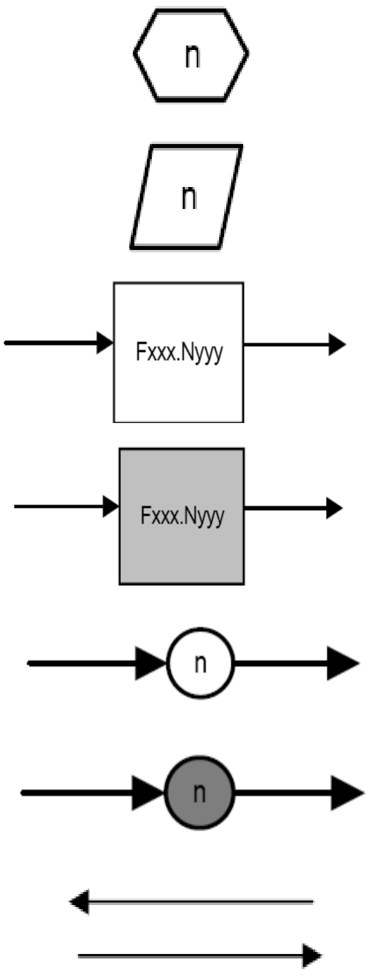
The gearbox warning light is "ON" under self-test conditions and whenever an anomaly has been detected. The activation signal is sent over the CAN line.



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.

COMMUNICATION STRATEGIES

Nomenclature for connection flow.



Input/output with sensor/actuator included

Input/output with sensor/actuator not included

B-CAN node

C-CAN node

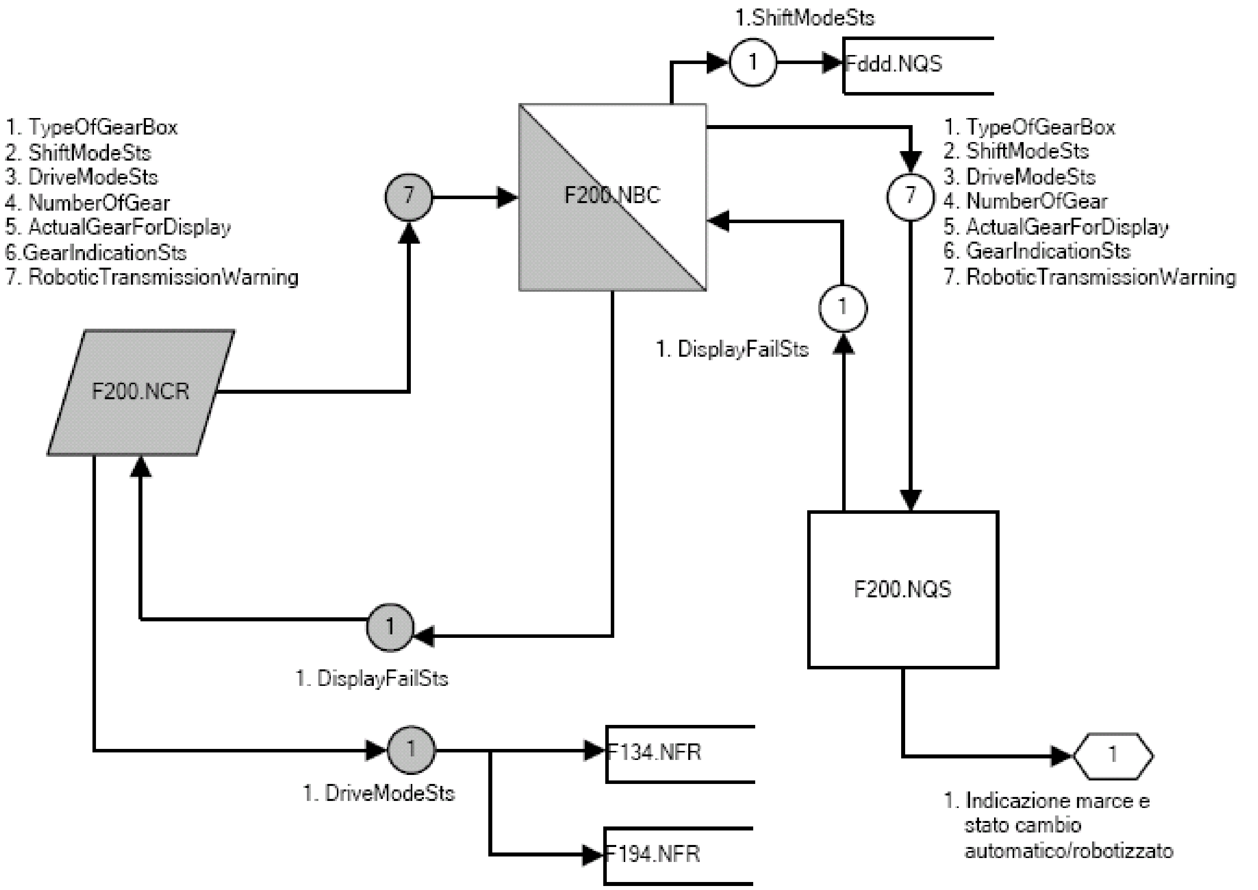
B-CAN signal

C-CAN signal

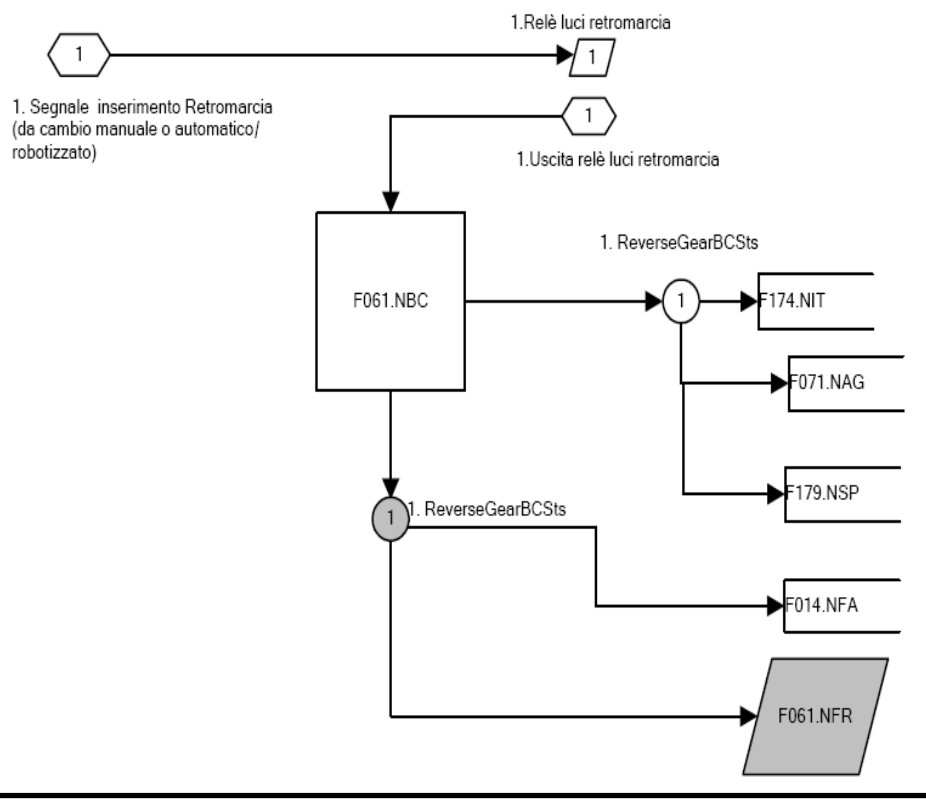
Non-CAN signal

n = number of signals

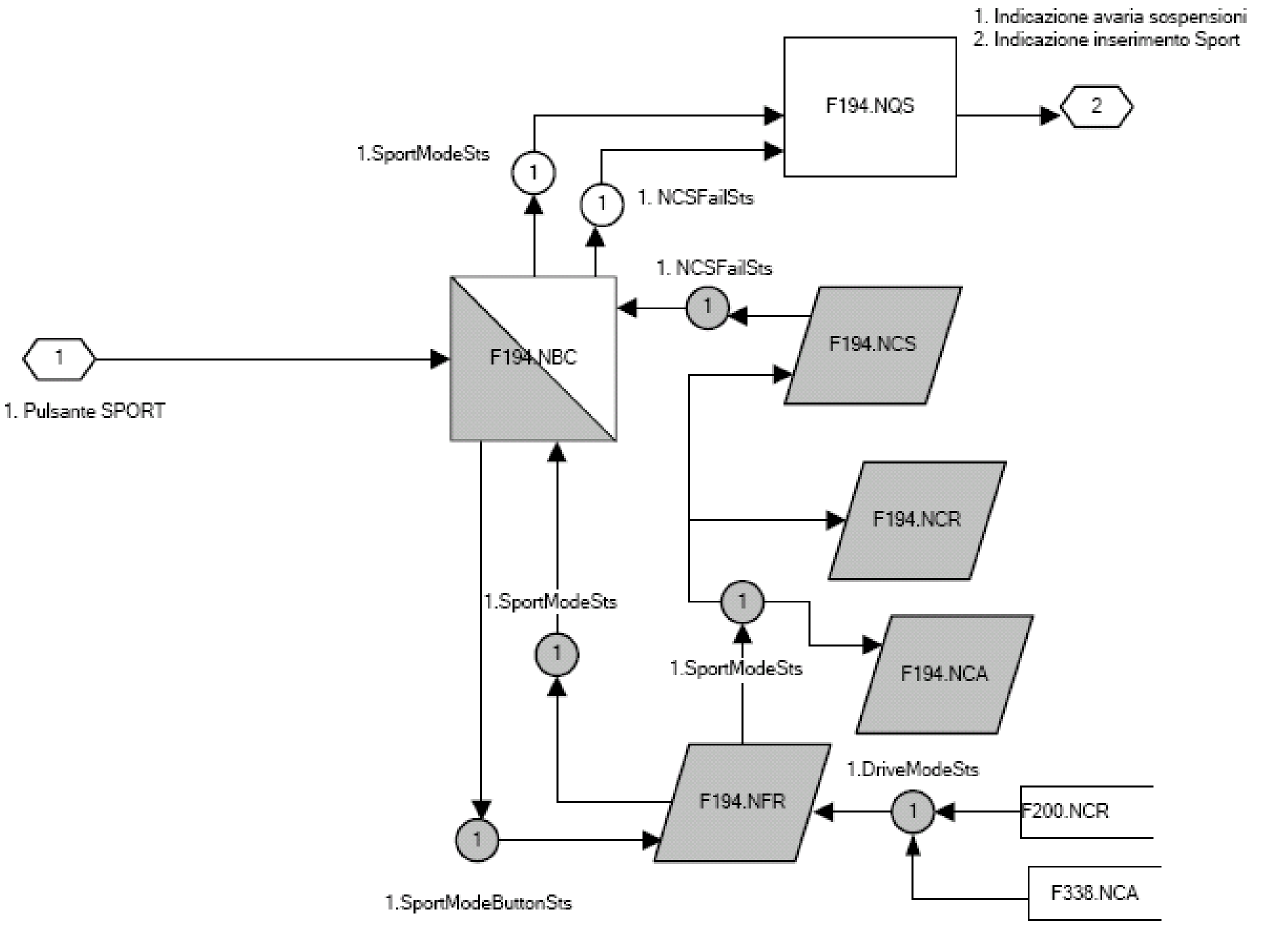
STATUS OF ENGAGED GEAR SELECTION SIGNAL



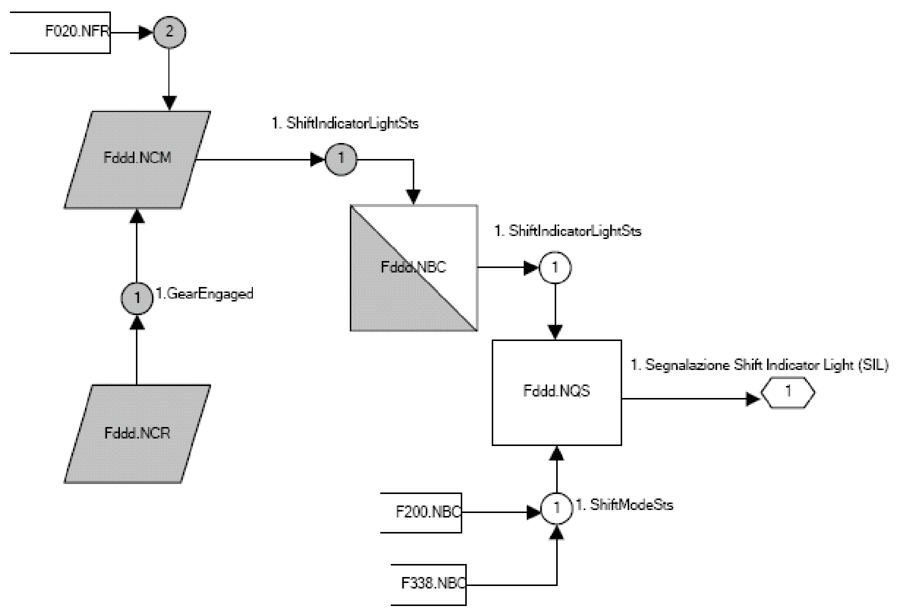
REVERSE SIGNAL



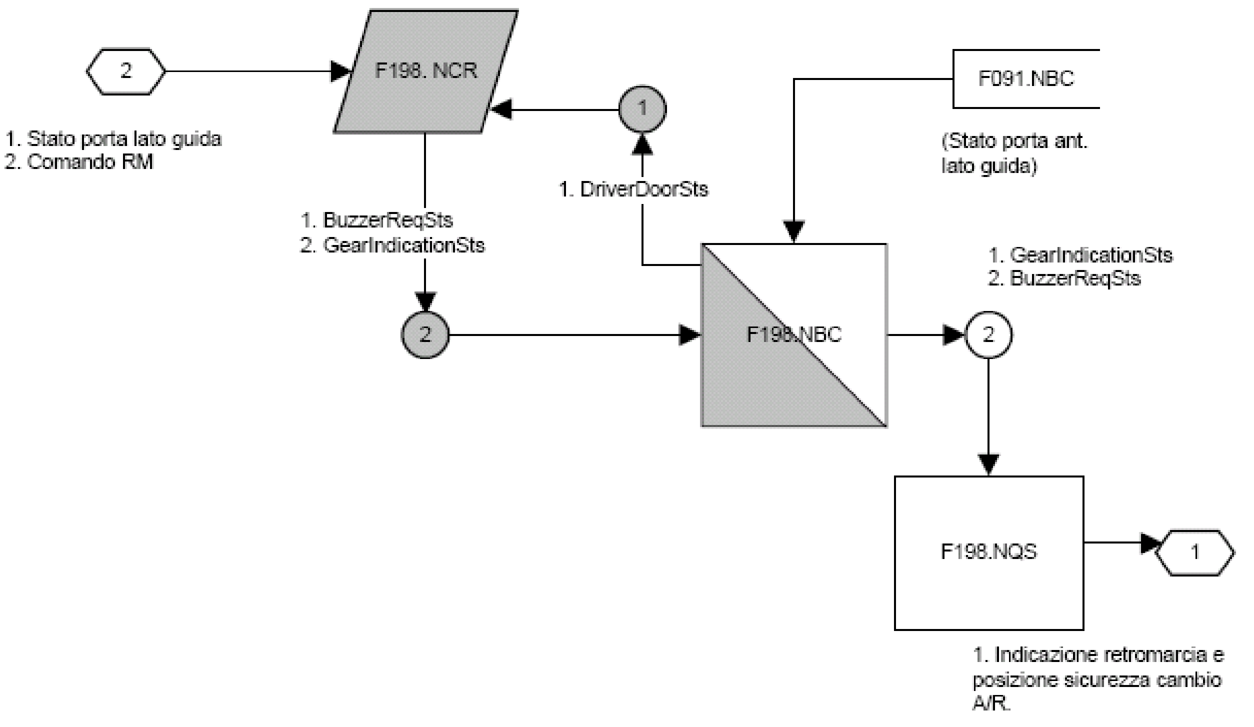
SPORT MODE



SHIFT INDICATOR LIGHT SIGNAL



BUZZER


2
1. Stato porta lato guida
2. Comando RM
F198. NCR
1
1. DriverDoorSts
1. BuzzerReqSts
2. GearIndicationSts
2
F091.NBC
(Stato porta ant.
lato guida)
F198.NBC
1. GearIndicationSts
2. BuzzerReqSts
2
F198.NQS
1
1. Indicazione retromarcia e
posizione sicurezza cambio
A/R.

CLUTCH OPERATION MANAGEMENT

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

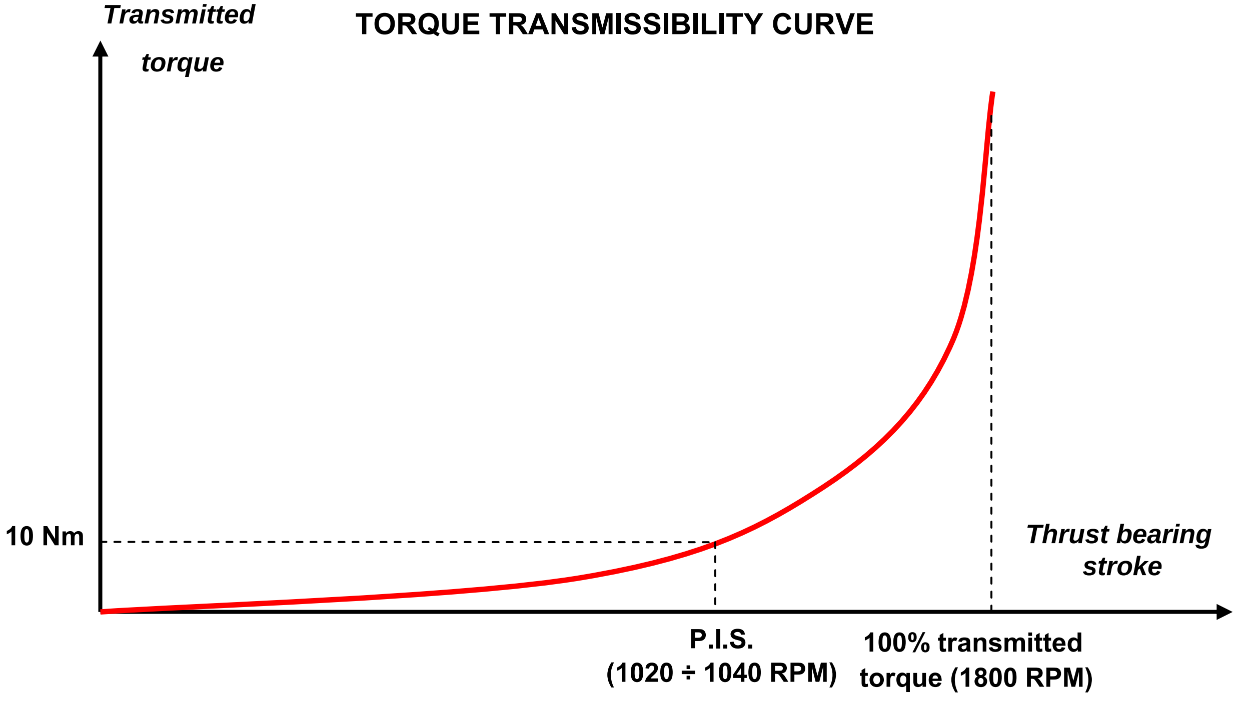
The clutch control strategies are based on absolute references:

- 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

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

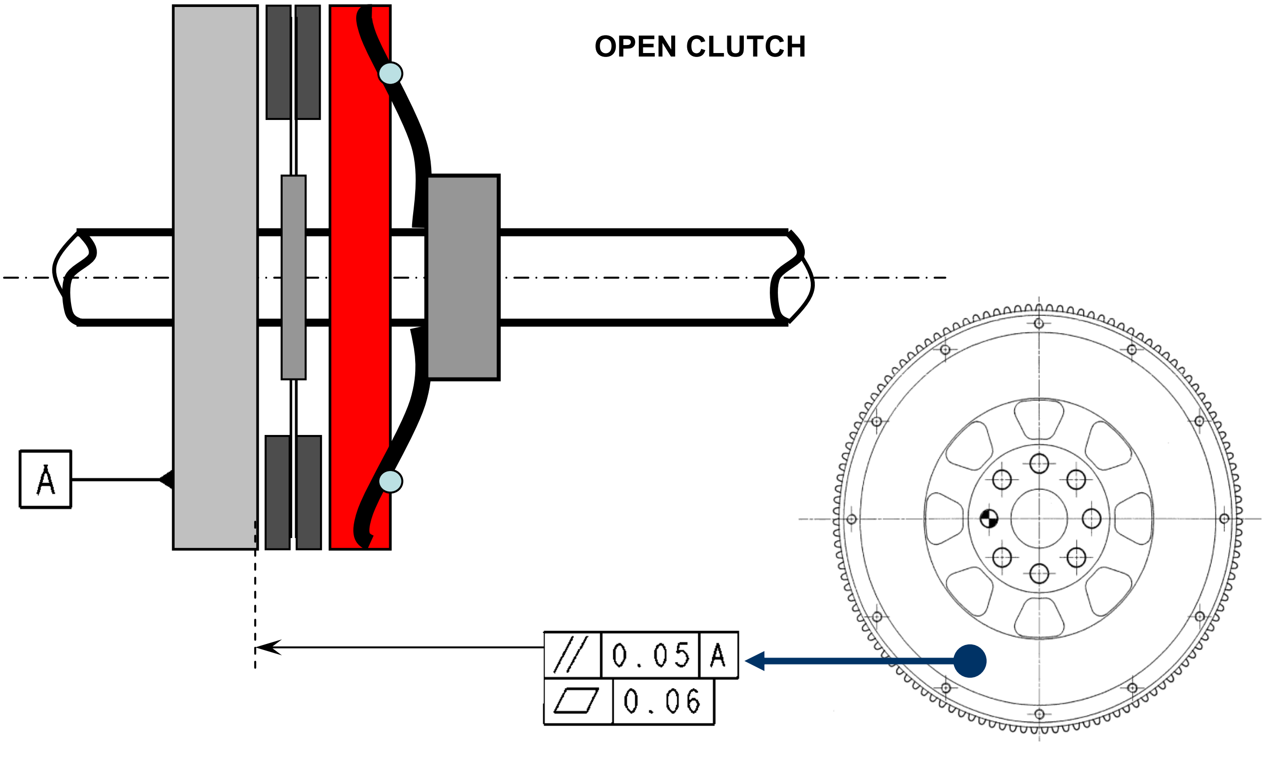


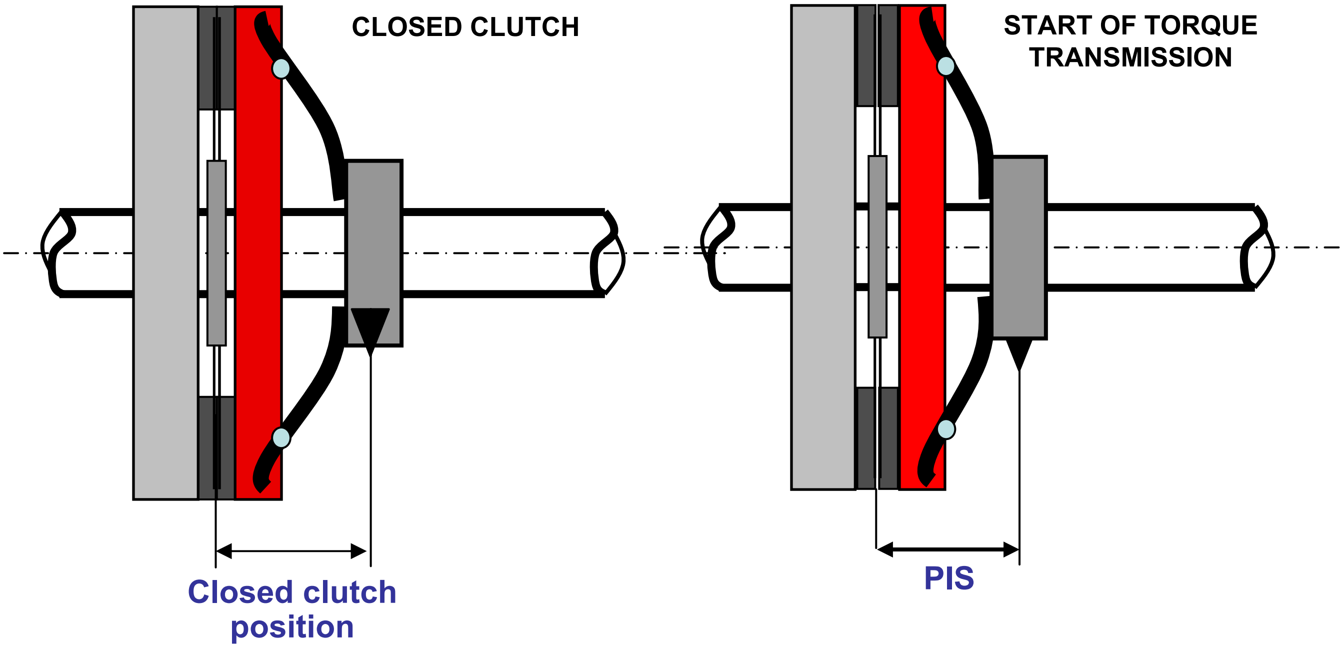
The kiss point is reached at between 1020 - 1040 RPM. The clutch "closes" and therefore full torque transmission is attained at 1800 RPM. When driving at below 1800 RPM and especially when travelling uphill, the temperature of the clutch disc tends to fall due to the clutch not being fully closed. This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

The kiss point can be set into the NCR module by means of a calibration procedure with the SD3 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.

MODELLO	PRODUZIONE	SoFast	TCU	MIN	BASE	MAX
Spyder / Coupè	MY02	NO (Ante SoFast)	CFC201	4,8	5,1	5,4
	MY03	SoFast 1	CFC201	4,8	5,1	5,4
	MY04	SoFast 1	CFC201	4,8	5,1	5,4
	MY05	SoFast 2	CFC231	4,8	5,1	5,4
	MY06	SoFast 2	CFC231	4,8	5,1	5,4
Quattroporte Duoselect	MY05 EU	SoFast 2	CFC231	4,8	5,1	5,4
	MY05 US	SoFast 3	CFC301	3,9	4,2	4,4
	MU05 EU	SoFast 3	CFC301	3,9	4,2	4,4
	MY06	SoFast 3 +	CFC301	3,9	4,2	4,4

The 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 calibrated after each gearshift.

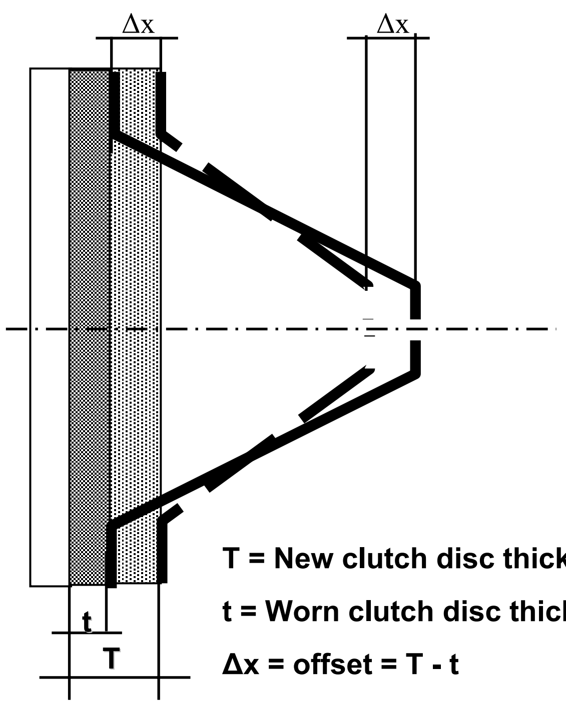




PIS value = CC position – PIS position

Calculation of wear:

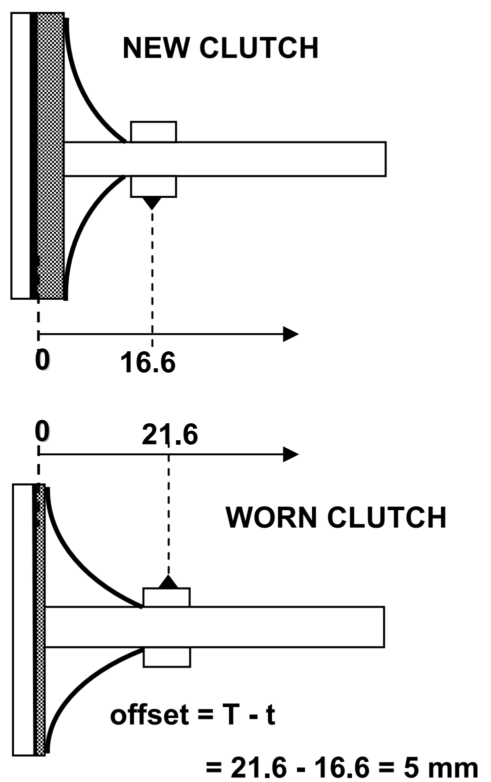
$$\frac{\text{Autocalibrated closed clutch value} - \text{NEW closed clutch value}}{\text{Clutch thickness (5.6 mm)}} \times 100 = \text{\% Wear on clutch}$$



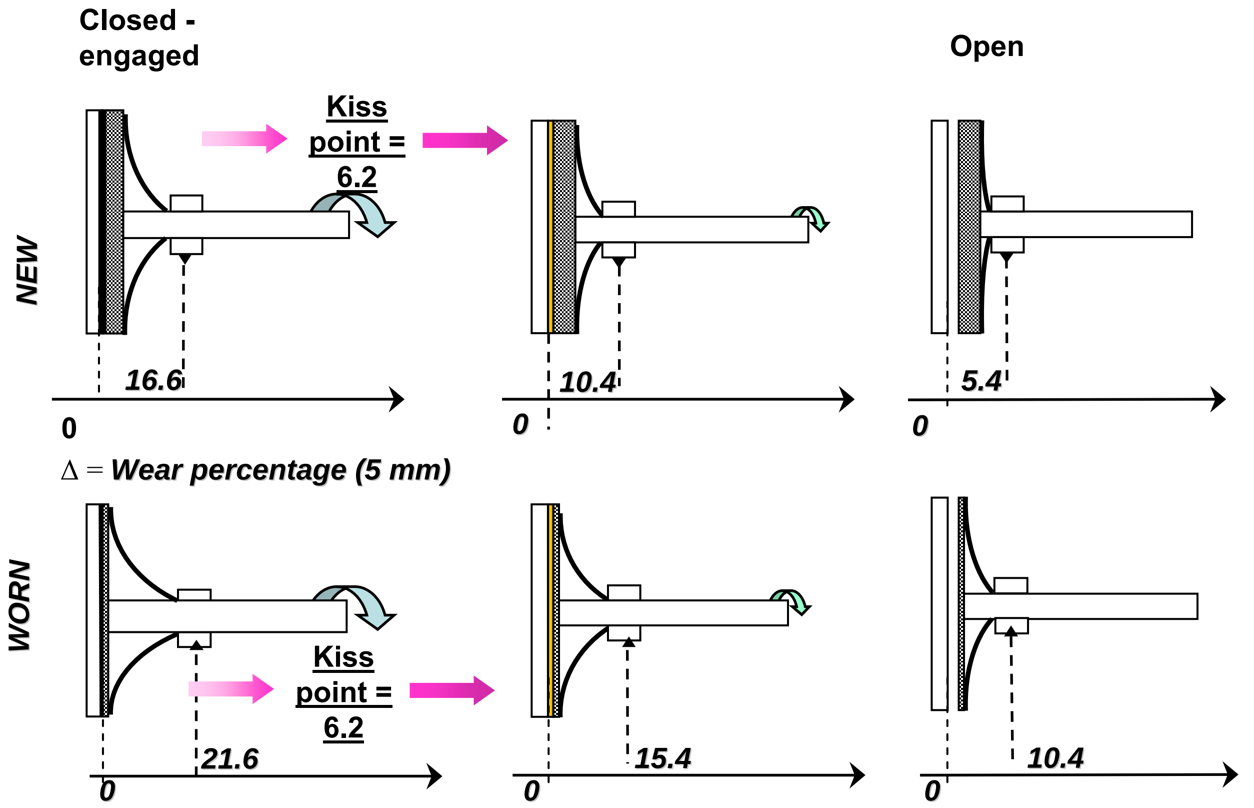
T = New clutch disc thickness

t = Worn clutch disc thickness

Δx = offset = T - t



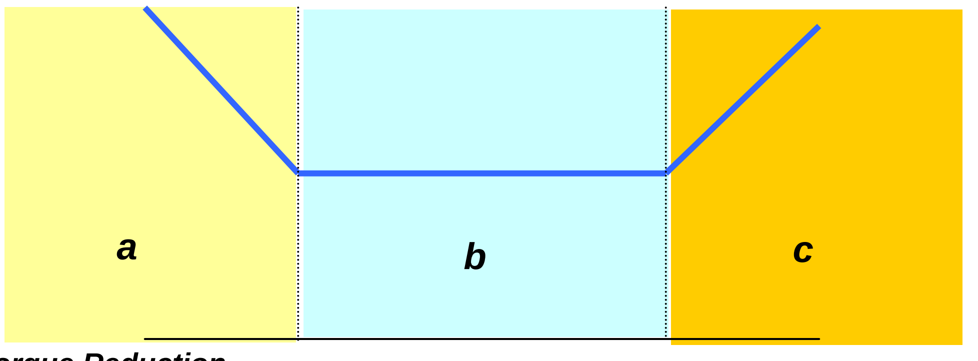
The kiss point does not depend on clutch wear


Closed - engaged
Open
NEW
Kiss point = 6.2
16.6
10.4
5.4
0
0
0
Δ = Wear percentage (5 mm)
WORN
Kiss point = 6.2
21.6
15.4
10.4
0
0
0

CLUTCH 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 gear engagement phases



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

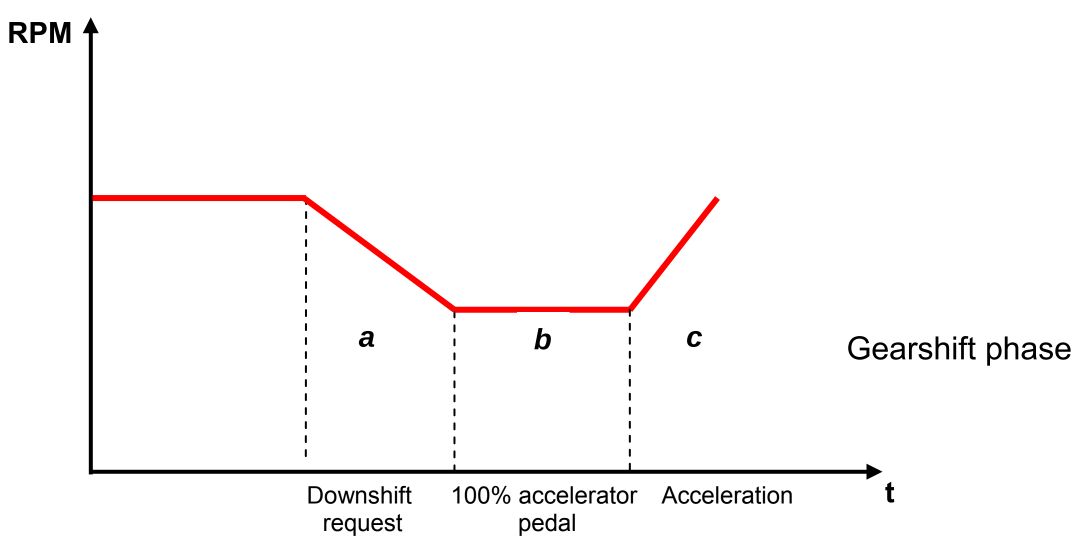
The TCU is now slave and MOTRONIC decides on the target torque value

Flow control by means of I_0 **CURRENT** management. Phase **b** control involves management of the EVF parameter which that coordinates capacity, controlled in current. All Maserati electro-actuated control systems use this type of parameter, which must be calibrated in the event of malfunction or maintenance on the Power Unit. (excluding SOFAST III)

Calibration is carried out as follows:

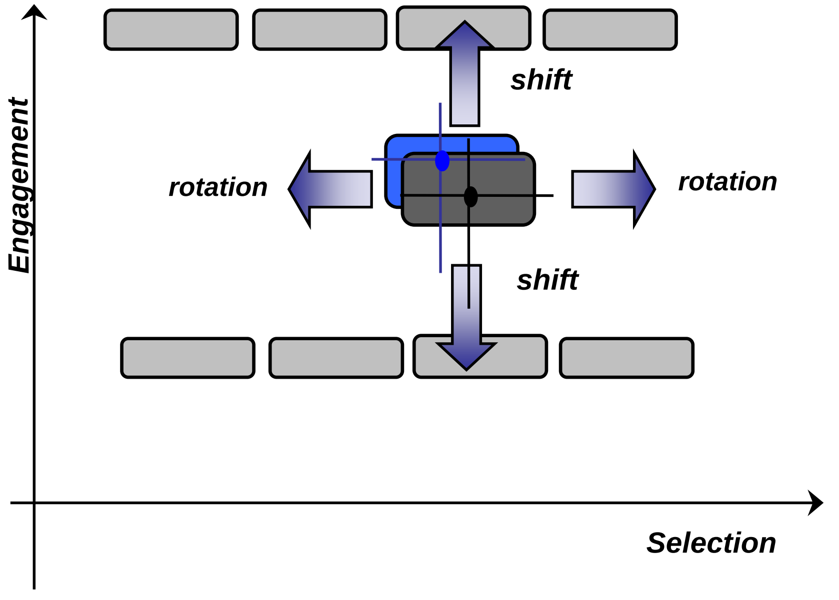
- Engine running with the gearbox in neutral for approx. 5 min.
- Engine running with the gearbox in 1^{st} gear and foot on the brake for approx. 5 min.

The SOFAST III system executes this procedure using the “DEIS” function.



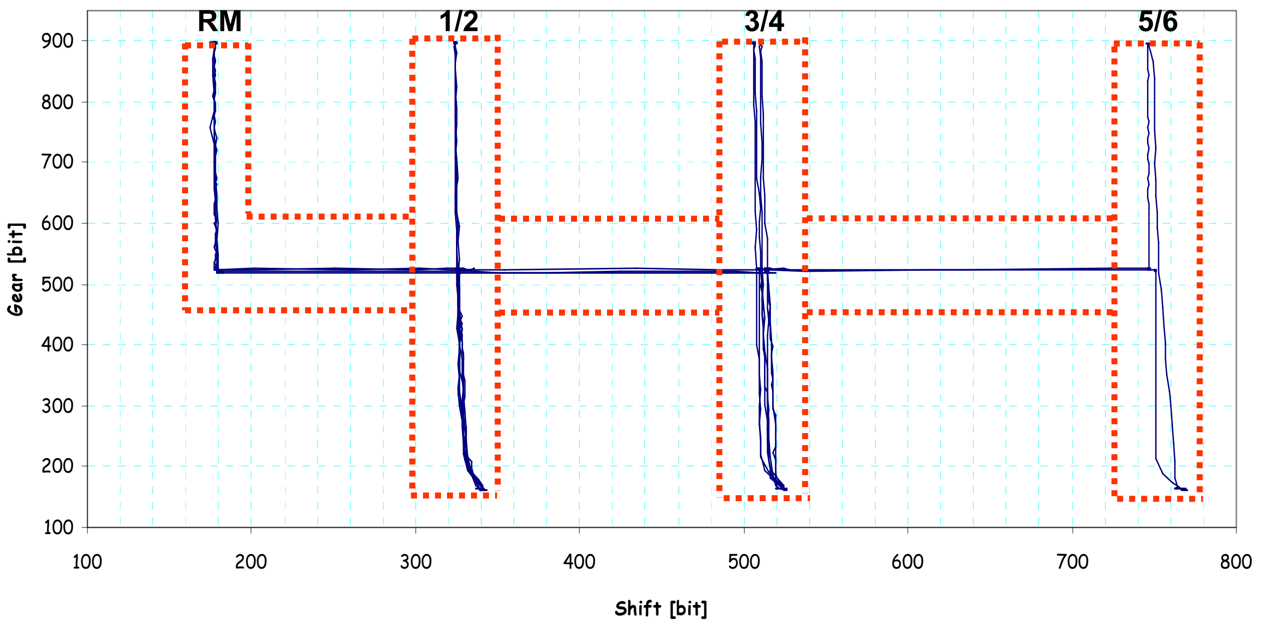
GEAR ENGAGEMENT STRATEGY

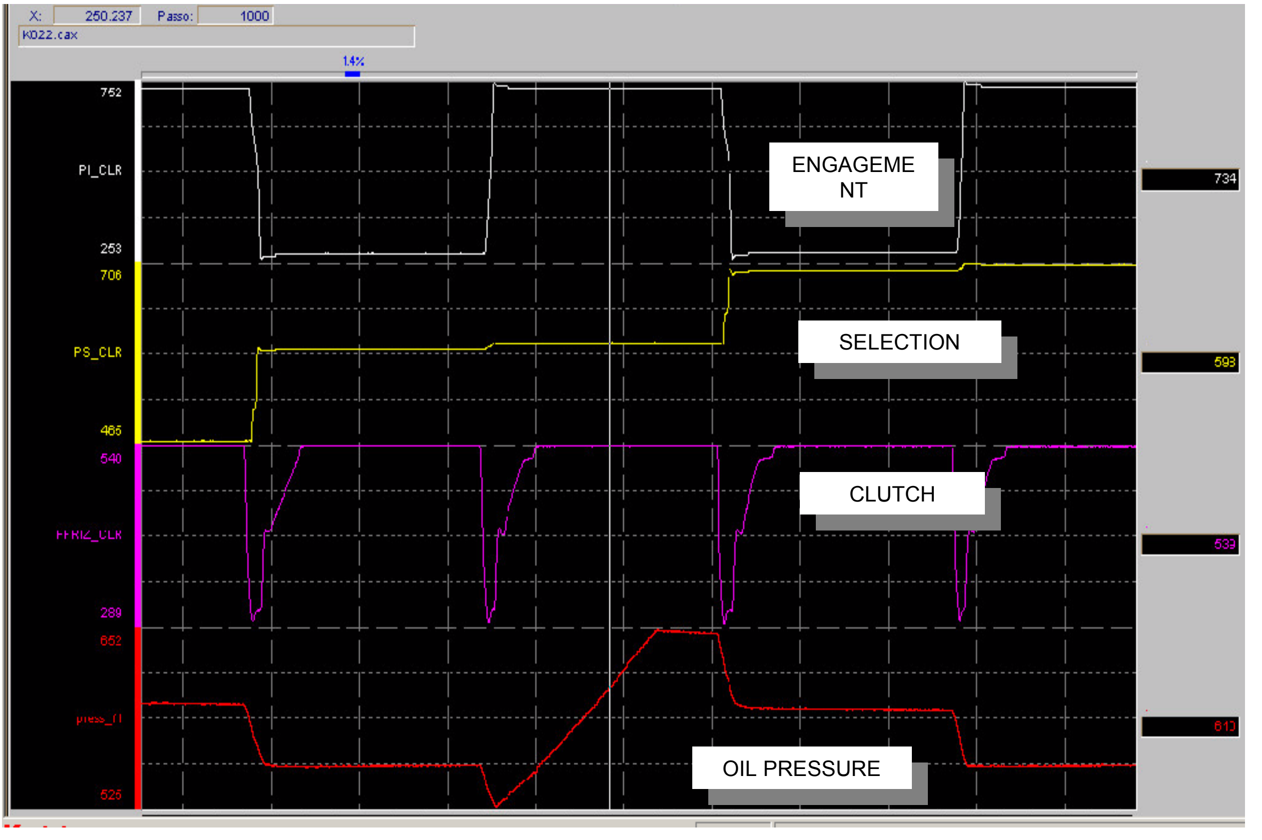
The gear engagement and selection values are self-learnt and stored in the NCR by means of potentiometers which must be within strictly defined ranges. By means of this procedure, the NCR builds a grid and checks 2 engagement and 2 selection thresholds. The calculation grid can be used to check the correct 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.



Actuator centring delta of the "finger":

Min 0º - nom +/- 1.5º - max +/- 3.0º
(0 bit - +/- 15 bits - +/- 30 bits)
(10 bit = 1°)





F1 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

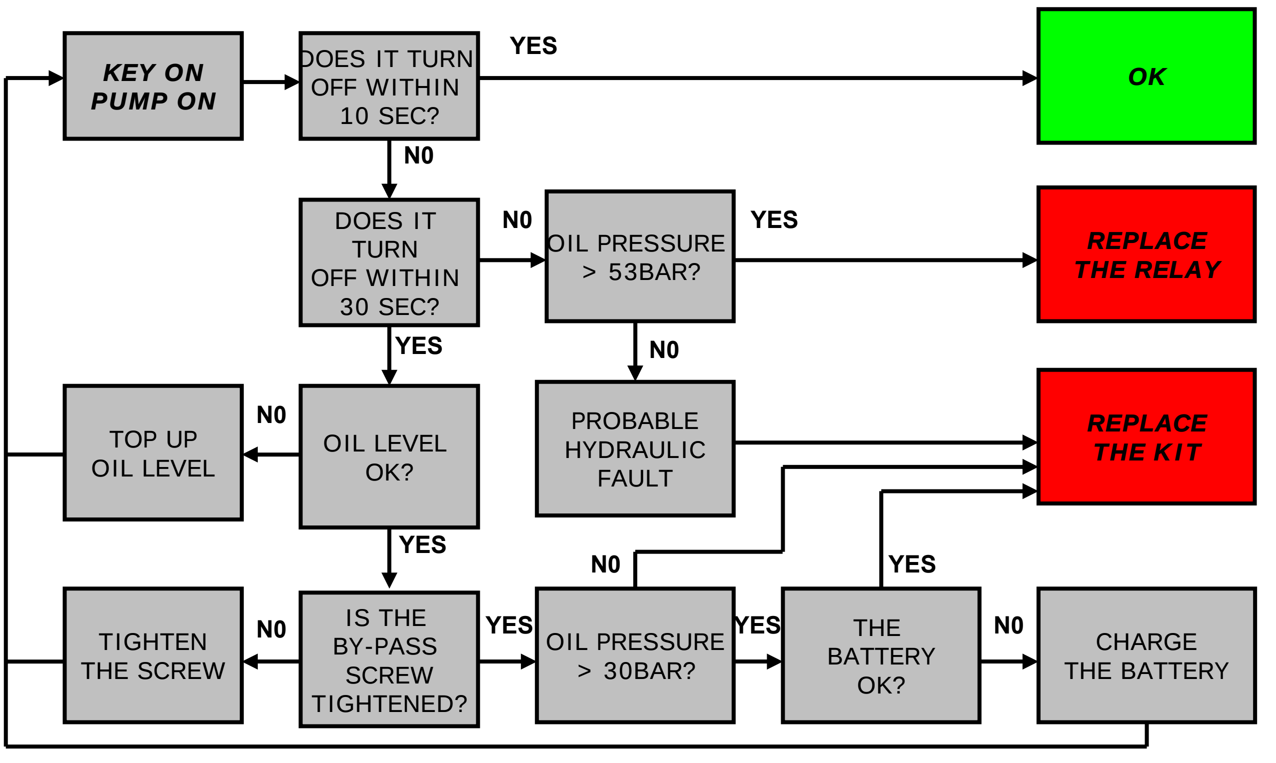
- The CAN value is used as recovery signal. If this signal is not available (for example, following a CAN line fault), engine RPM is set starting from the clutch RPM if the latter is closed, otherwise in relation to the accelerator pedal.
- In the event of a simultaneous fault in the engine RPM from 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.

DIAGNOSIS TREE

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 starter motor does not turn 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

Impossible to engage any gear

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” ON THE GEAR DISPLAY

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

CLUTCH BURSTS DURING PICKUP

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 FOR NCR 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 OIL 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 unit. 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 OIL 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: 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: CHECK AUTOCALIBRATION OF THE GEARBOX AREAS

STEP	***OPERATION***
1	Turn the key to ON and connect the tester.
2	Print out the gearshift structure values stored in the gearbox ECU.
3	Auto-calibrate the gearbox areas.
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 STEERING WHEEL PADDLES AND THE REVERSE GEAR LEVER

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 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.

PROCEDURE 10: FAULTS THAT CAUSE LIMP-HOME MODE TO BE ACTIVATED

STEP	***OPERATION***
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 ON THE ROBOTIZED GEARBOX SYSTEM

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 DEIS PARAMETERS

The DEIS parameter calibration function is a self-learning function which relates to a number of clutch operation functions, 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 SD3 diagnostic tester and should be carried out after replacement of the clutch or the transmission control module (NCR).
To activate the function, connect the SD3 tester and select the single ECU menu to enter the transmission control module (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 enable the fine-tuned control of 2 parameters:

<u>Clutch position</u>
<u>Clutch solenoid valve pressure</u>

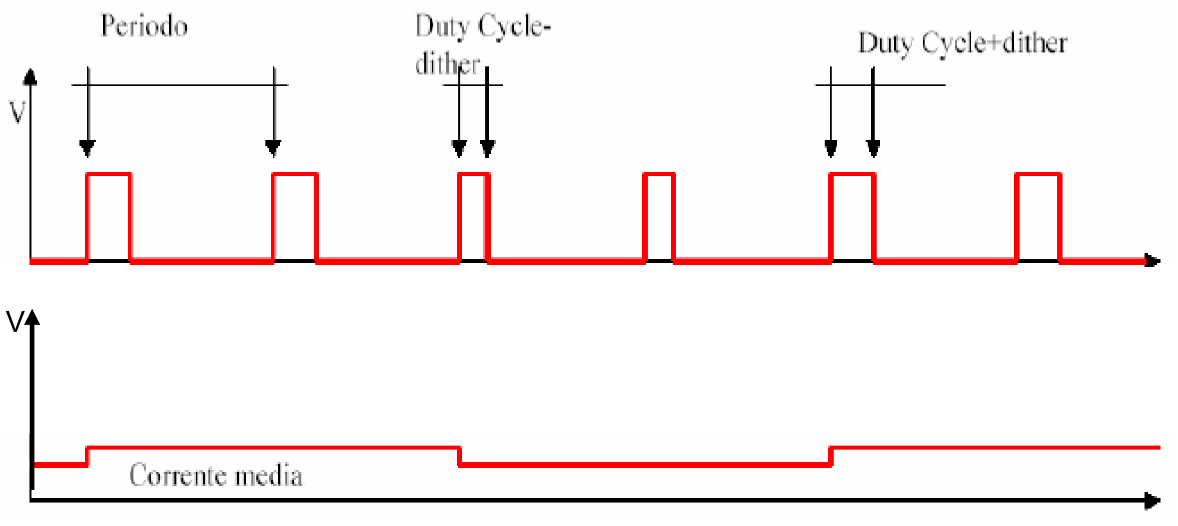
The procedure comprises the following steps:

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: Department of Electronics, Computer Sciences and Systems, University of Bologna, which has developed the DEIS procedure in conjunction with Maserati.

Autocalibration of optimum Dither current

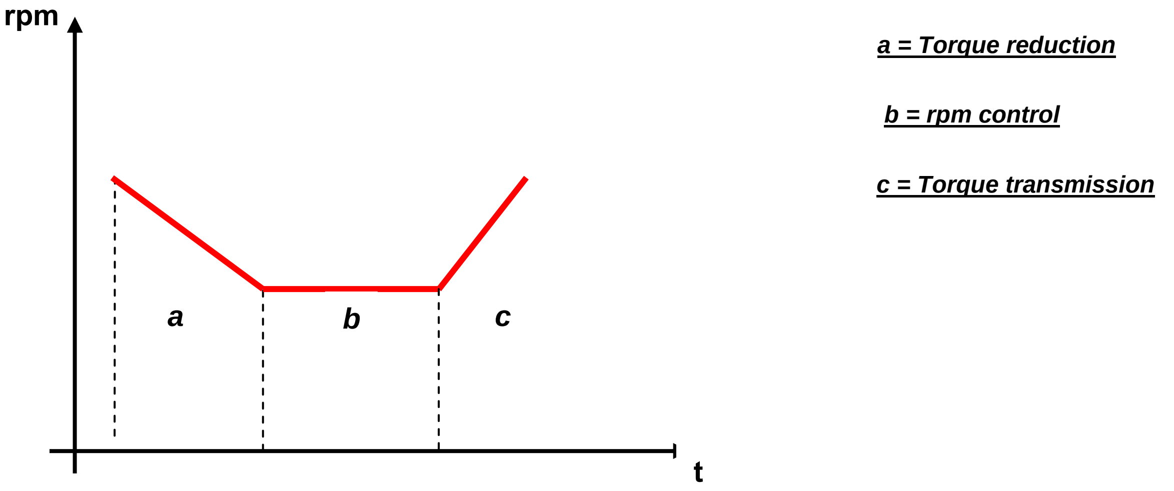
The dither current is a signal superimposed on the DUTY CYCLE of the PWM signal, which controls the clutch solenoid valve. By means of an appropriate frequency, it is possible to keep the spool of the clutch solenoid valve in a state of slight oscillation, thus eliminating the delay in response. This 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 IO 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.

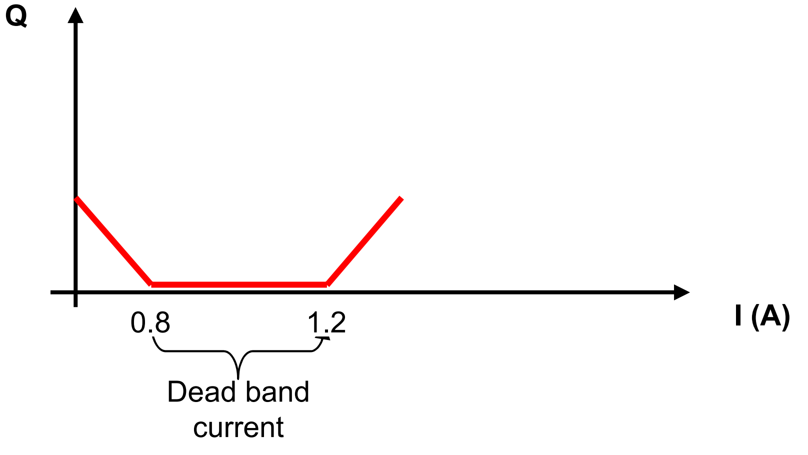


* Autocalibration present in DEIS procedure

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

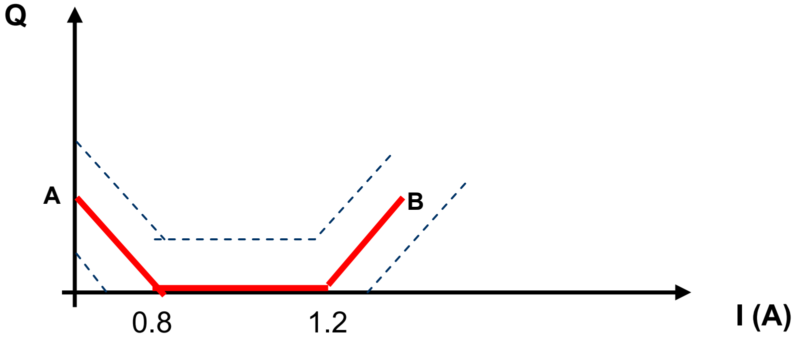
This is the current which sets the spool of the clutch solenoid valve to the closed position at all times. Autocalibration is used to verify the capacity of the solenoid valve to block the movement of the clutch. In the event of incorrect procedure, bleed the system and replace the clutch solenoid valve.



* Autocalibration present in DEIS procedure

Autocalibration of the current/capacity of the clutch valve

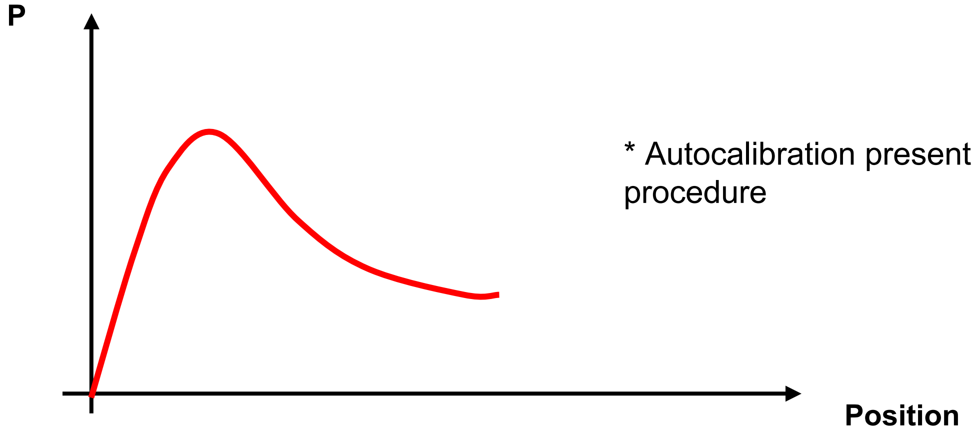
The phases of solenoid valve discharge (A) and charge (B) are reconstructed by the control unit. The points described on a quoted Capacity/Current plan are reconstructed by the control unit to check that they fall within a defined range of acceptability.



* Autocalibration present in DEIS procedure

Autocalibration of the clutch Belleville spring

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

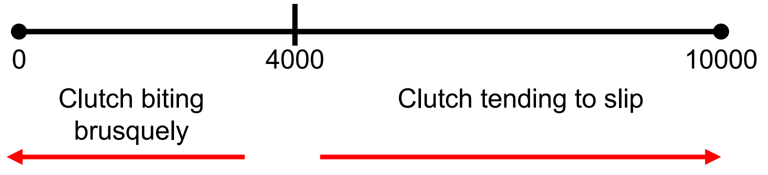


* Autocalibration present in DEIS procedure

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 CLUTCH WEAR INDEX

Provides information about degradation of the transmissibility of the clutch. The clutch wear index must be reset before carrying out the Kiss Point procedure. The wear index is self-learnt by the NCR each time the clutch is in the breakaway phase.



A clutch that is operating correctly will have a degradation index of around 3000/4000. If the clutch has not been replaced and the degradation index is high, after performing the resetting and subsequent Kiss point procedures, the value of the parameter should fall.

SELF-LEARNING

Self-learning is activated by means of an instruction from the tester with the car stationary and the key inserted. 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.

KISS POINT ADJUSTMENT PROCEDURE

On cars built with **Sofast II** systems, the kiss point must be adjusted by means of the KISS POINT procedure. For other cars, the procedure is performed manually by entering values as per the table on the basis of Model Year.

KISS POINT ADJUSTMENT PROCEDURE

Note: **operations to be performed only for versions equipped with SOFAST 2 gearbox**

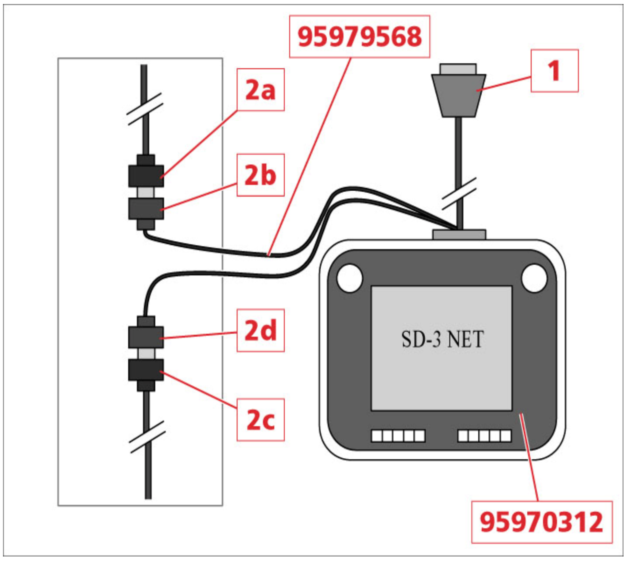
Before adjusting the kiss point, it is first necessary to **bed in the clutch:**

- 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.

- Adjust the KISS POINT.
- Stop the engine, make certain that the ignition switch is in the OFF position

Connect SD3 (**95970312**) to the EOBD diagnosis connector **(1).**
Connect the C-Can connector **(2a)** to the SD3 cable (**95979568**)
Connect the C-Can connector **(2c)** with the SD3 cable (**95979568**) **(2d).**

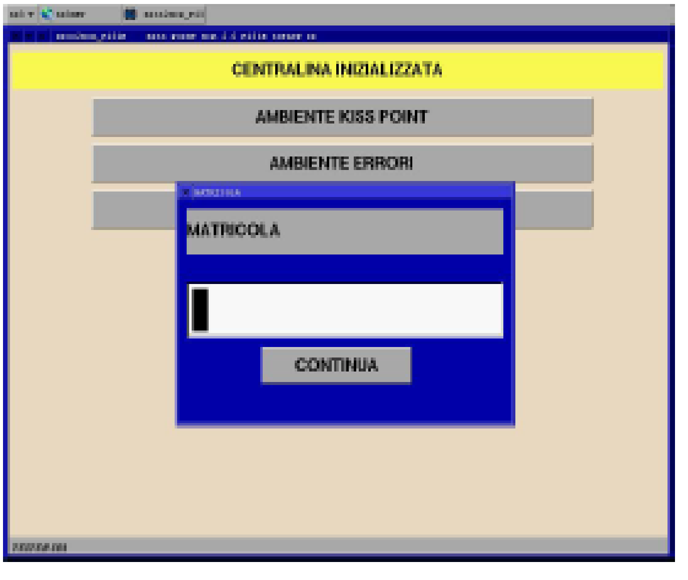


First reset the **CLUTCH DEGRADATION INDEX** in the NCR parameters environment.

<u>ATTENTION!</u>
Before adjusting the gear engage/select actuator, make the following checks:

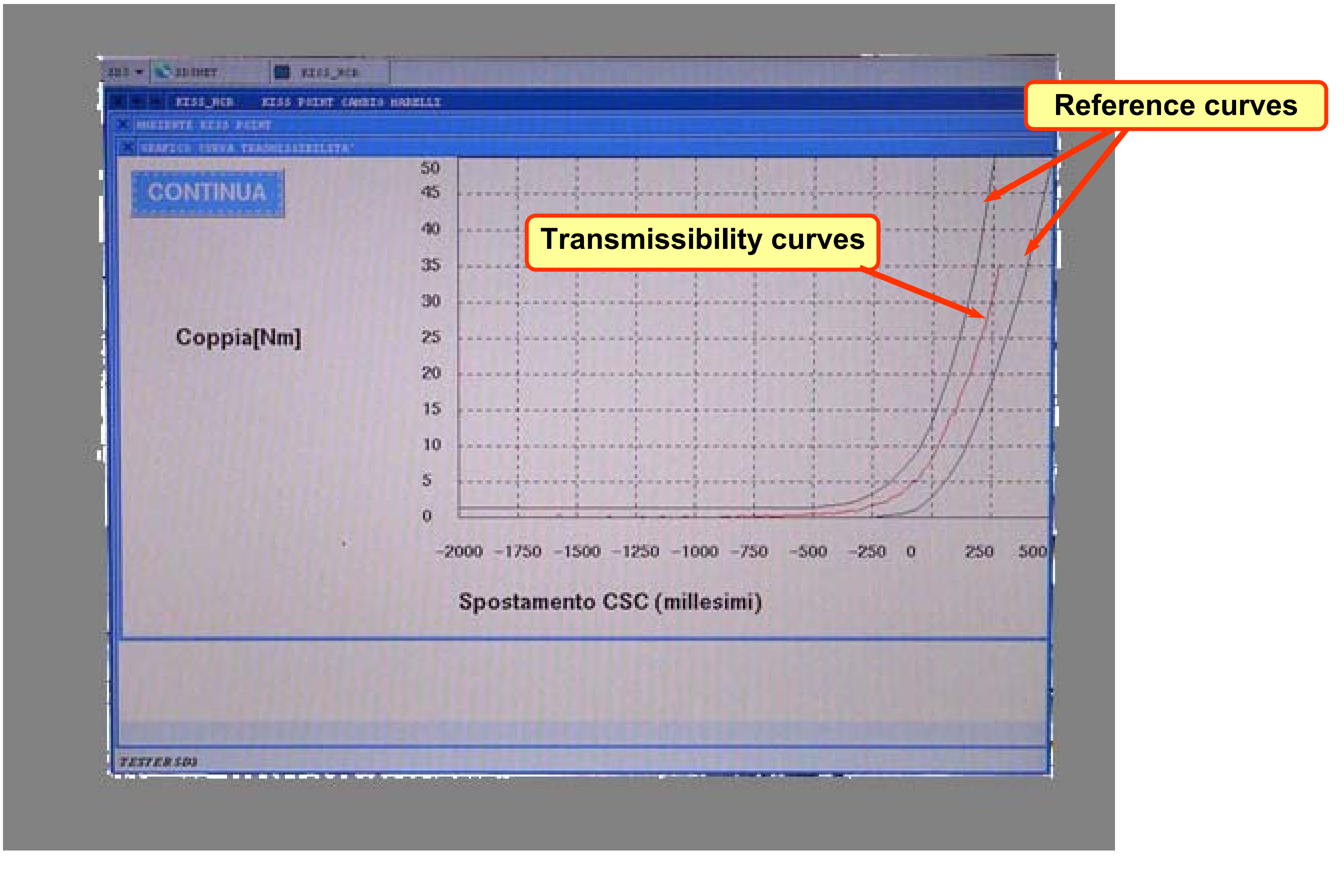
- **If the car has been parked for more than 8 hours, drive it for 15 minutes in Free Drive, changing gear repeatedly.**
- **If the car has been parked for more than 30 minutes after the bedding-in phase, make 10 consecutive breakaways up to an engine speed of 1500 rpm.**
- **If the car has been parked for less than 30 minutes after the bedding-in phase, make 5 consecutive breakaways up to an engine speed of 1500 rpm.**

Switch on the SD3 and select the **KISS-POINT NCR** application from the list of diagnosis programs. Select the **KISS POINT ENVIRONMENT** function from the M138 software list.
The subsequent phases are guided by the chosen diagnosis system.
Enter the serial number of the car.



Use the TAB key to select "**CONTINUOUS**", then press "**ENTER**" to confirm. 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".
Put the gearbox in neutral, turn the ignition switch to the OFF position, wait for about 15 seconds, then start the engine and select "ENTER" on SD3.
Select “**START 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 SD3 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 SD3 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 transmissibility curve must be positioned.



The system will automatically check that the 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 will be saved to the gearbox control unit.
The SD3 display will show the message "**KISS POINT SAVED CORRECTLY**".

GEARBOX GRID

The grid used by the NCR uses the threshold values that can be determined through SD3.
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).

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**
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**

The values listed are the network parameters found in SD3. All these values simply constitute an example subsequently transferred to a spreadsheet to illustrate what they represent on the vehicle. The first of these are those which define the current position of the gearbox actuator and are located in the first group of parameters.
These values were printed with the gearbox in neutral. Below is an example created with these specific values inserted in it.

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

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

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

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

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**

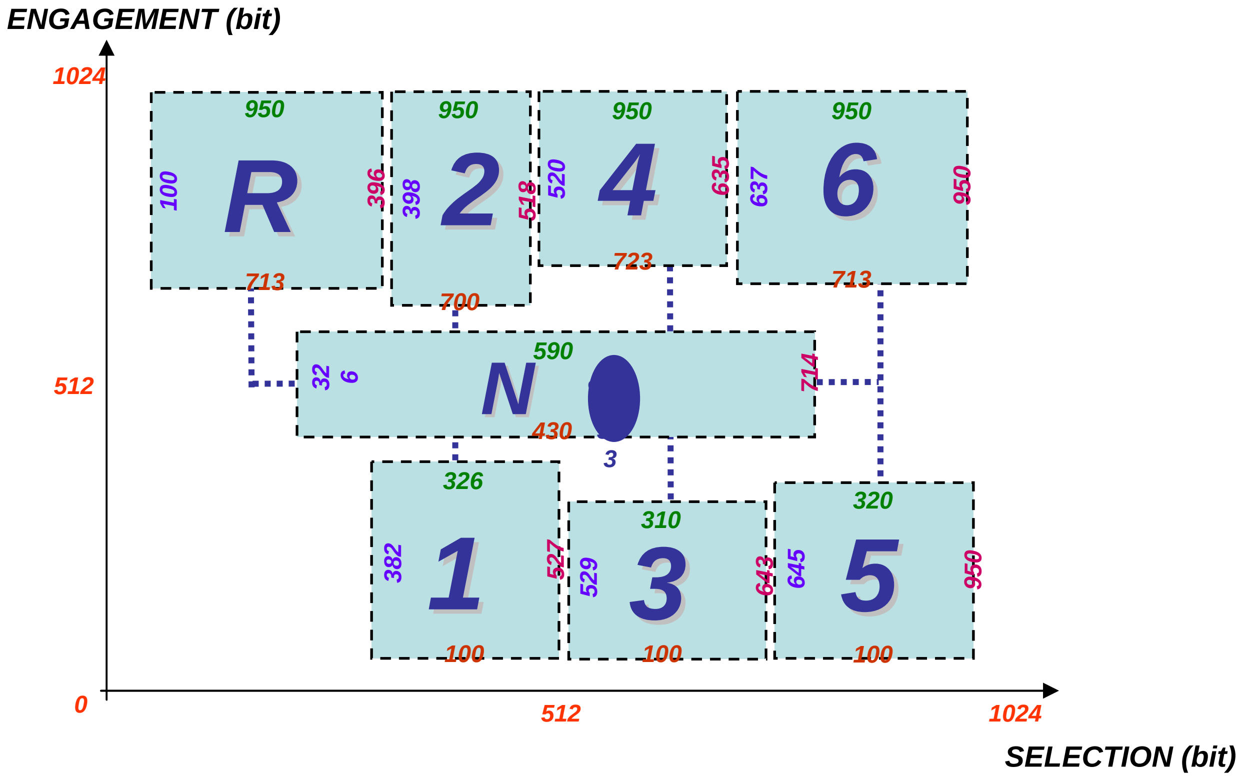
These values are purely guideline and cannot be used for comparison purposes during diagnosis

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**

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**

GEAR ENGAGEMENT GRID

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.



SELF LEARNING OF ACCELERATION SENSOR OFFSET

After replacement or disconnection/reconnection of the accelerometer or replacement of the transmission control module (NCR), it is necessary to run the accelerometer autocalibration procedure.
It is imperative to position the car on a flat surface.
This procedure should last 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.

CLUTCH ACTUATOR BLEEDING

The procedure becomes necessary if air bubbles need to be eliminated or following disassembly of a component of the hydraulic clutch circuit. Operate 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 bleed valve is located on the clutch housing. There are two different versions:

up to assembly 14804

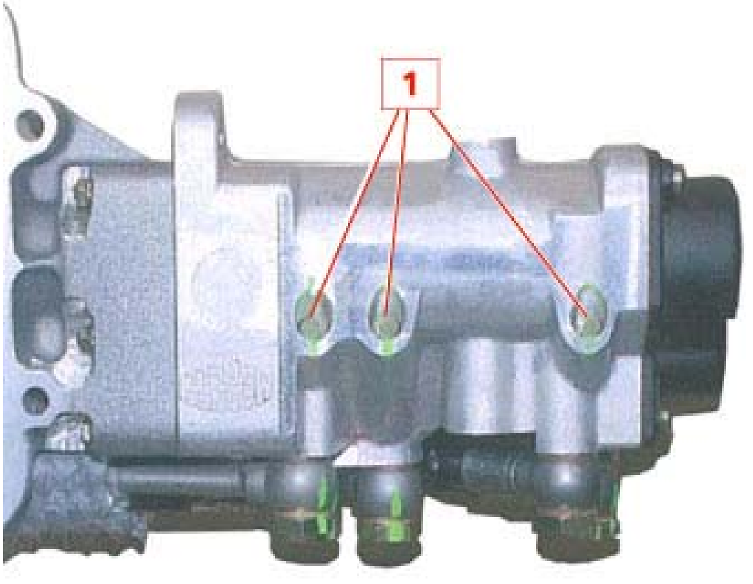
after 14804

With the SD3, start the clutch bleeding procedure by introducing 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 has any air in it.
Use the SD3 to run the gearbox through a sequence of gear changes so that you can check that the pump is working correctly.
At the end of the cycle, check the level of the oil in the Power Unit.

GEARBOX ACTUATOR BLEEDING
To access the actuator bleed screws, 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 SD3 diagnosis tester to the diagnosis socket.
- From the main menu, go to "**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 "**GEARBOX SELF-LEARNING**" function from the "**DIAGNOSIS**" menu.

SERVICING OPERATIONS FOR CARS EQUIPPED WITH A GEARBOX MANAGEMENT SYSTEM PRIOR TO SOFAST II

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.

SERVICING OPERATIONS FOR CARS EQUIPPED WITH SOFAST II GEARBOX MANAGEMENT SYSTEM

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

SERVICING OPERATIONS FOR CARS EQUIPPED WITH SOFAST III AND SOFAST III+ GEARBOX MANAGEMENT SYSTEMS

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

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

Automatic Gearbox Control System

Bosch-ZF

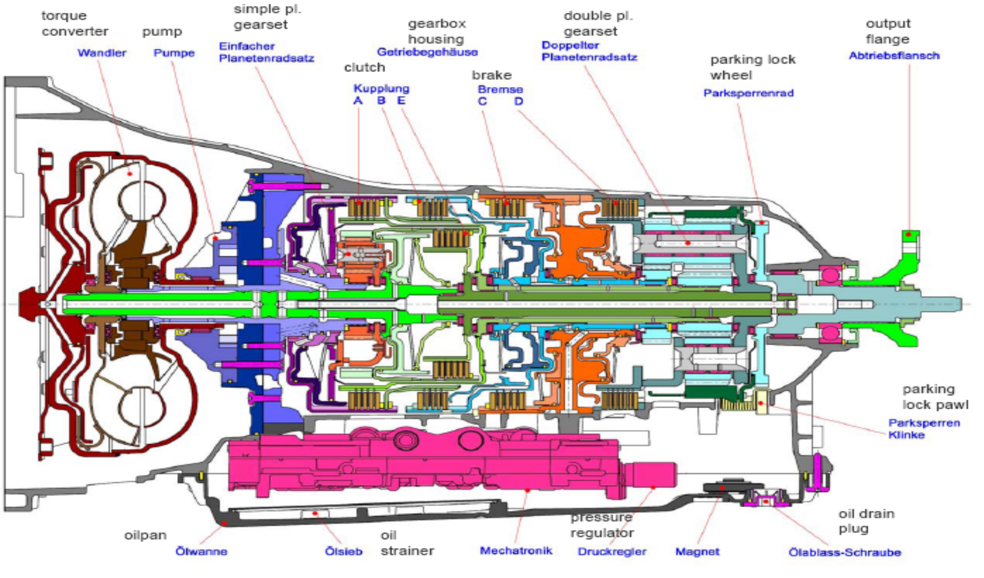
ZF 6HP 26 AUTOMATIC GEARBOX

The electronic transmission management 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 (Tiptronic) 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 gear change 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 MANAGEMENT LOGIC

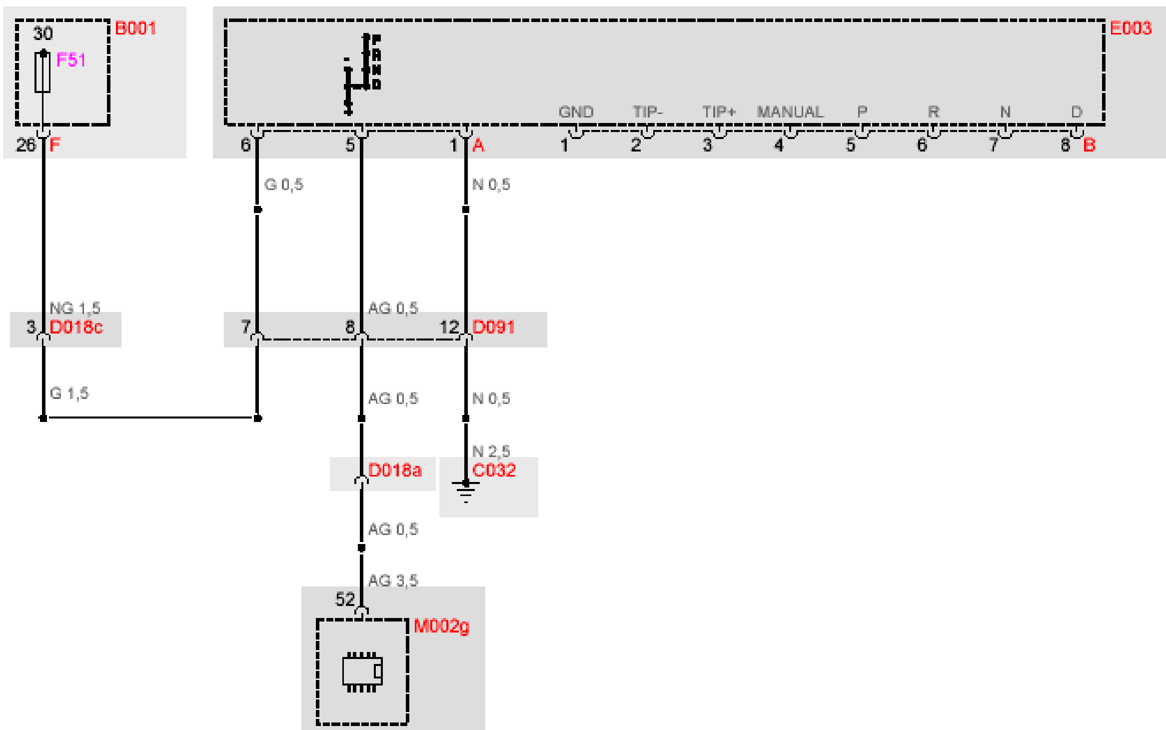
6HP26														
Pos/marcia	Logica elettrovalvola								Logica frizione					
	Elettrovalvola		Pressione - valvola di controllo pressione elettronica						Frizione				Freno	
	1		1	2	3	4	5	6	A	B	E	WK	C	D
Parking						x	x							•
retromarcia				x		x	x			•				•
folle						x	x							•
1a marcia			x			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

GEAR CHANGE MANAGEMENT

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)

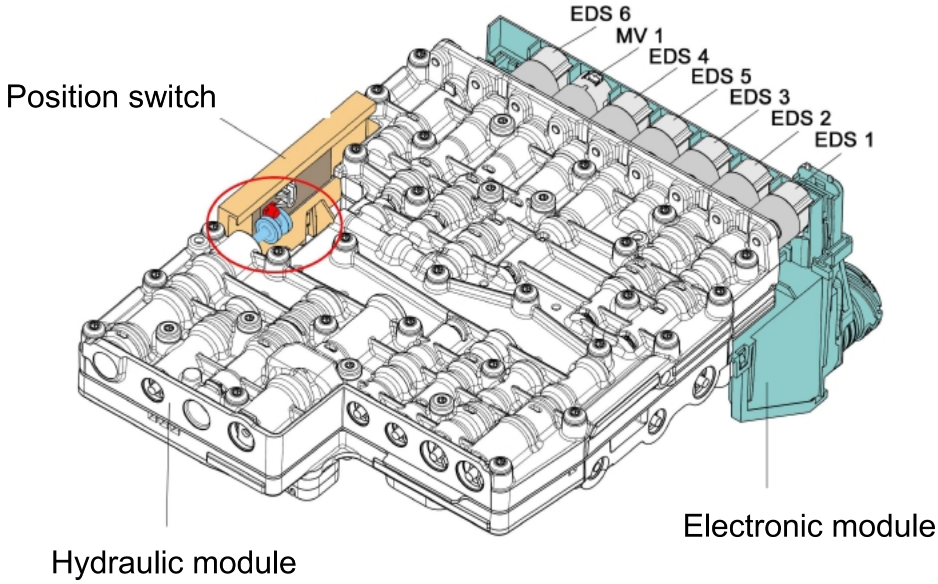


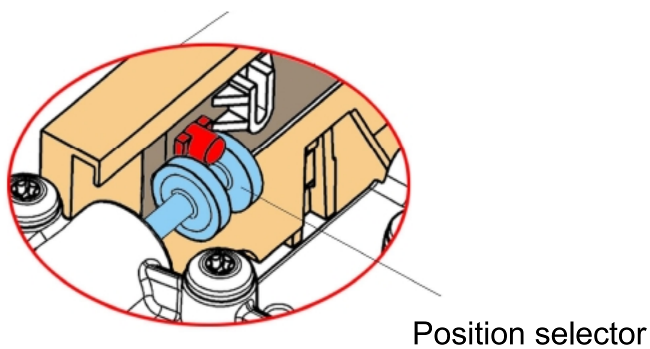
Gear change information passes through the gearbox panel to the mechatronik. The engine can be started only if the gear lever is in position P or N.

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.

TRANSMISSION CONTROL MODULE (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.

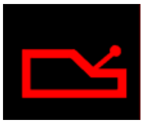
SYSTEM FAILURE

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 temperature too high
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.

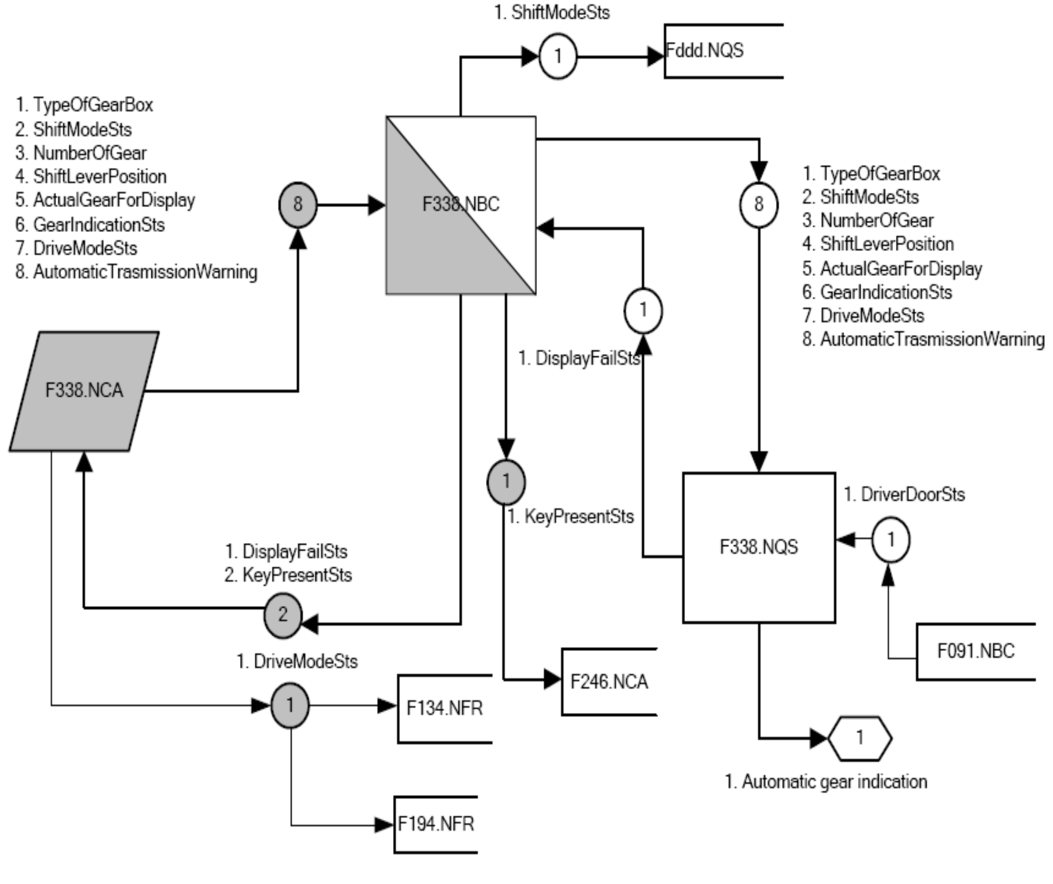
CHECKING THE LOCK-UP CLUTCH

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.*

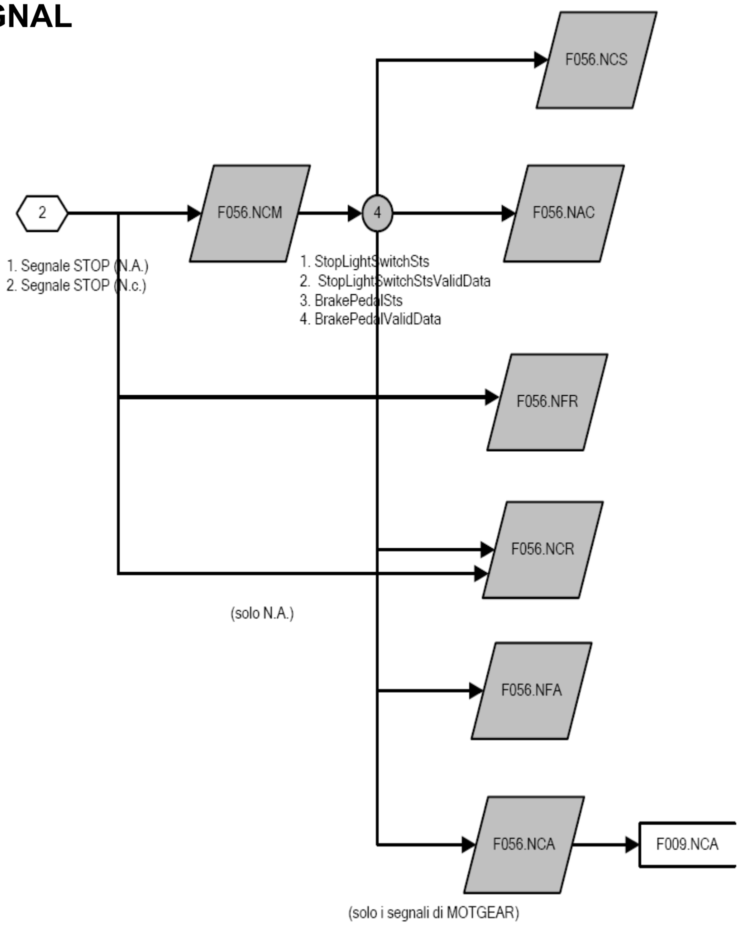
Converter under adjustment*: The tester shows 0.376 A as the current of the proportional valve and a difference of 60 rpm between turbine and pump.*

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.*

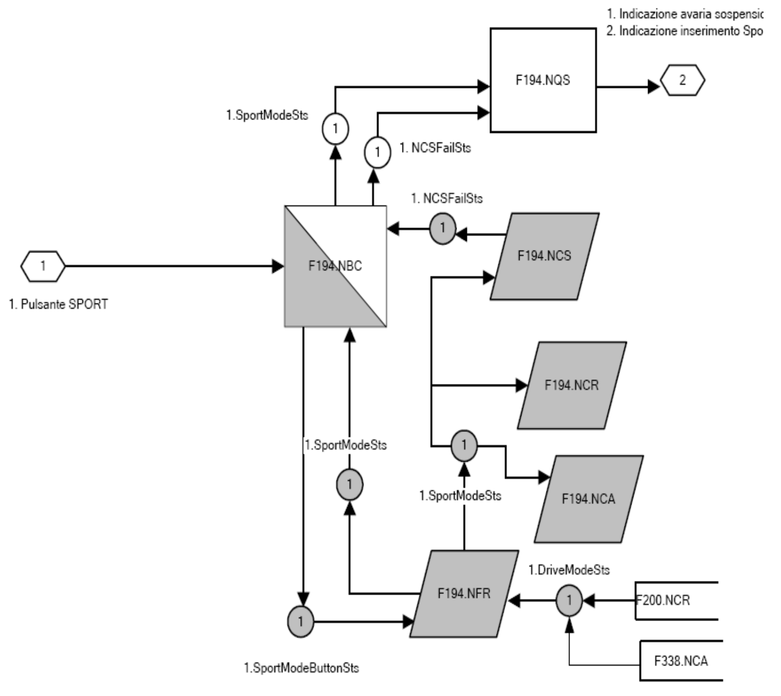
AUTOMATIC GEARBOX STATUS AND GEAR ENGAGED INDICATOR



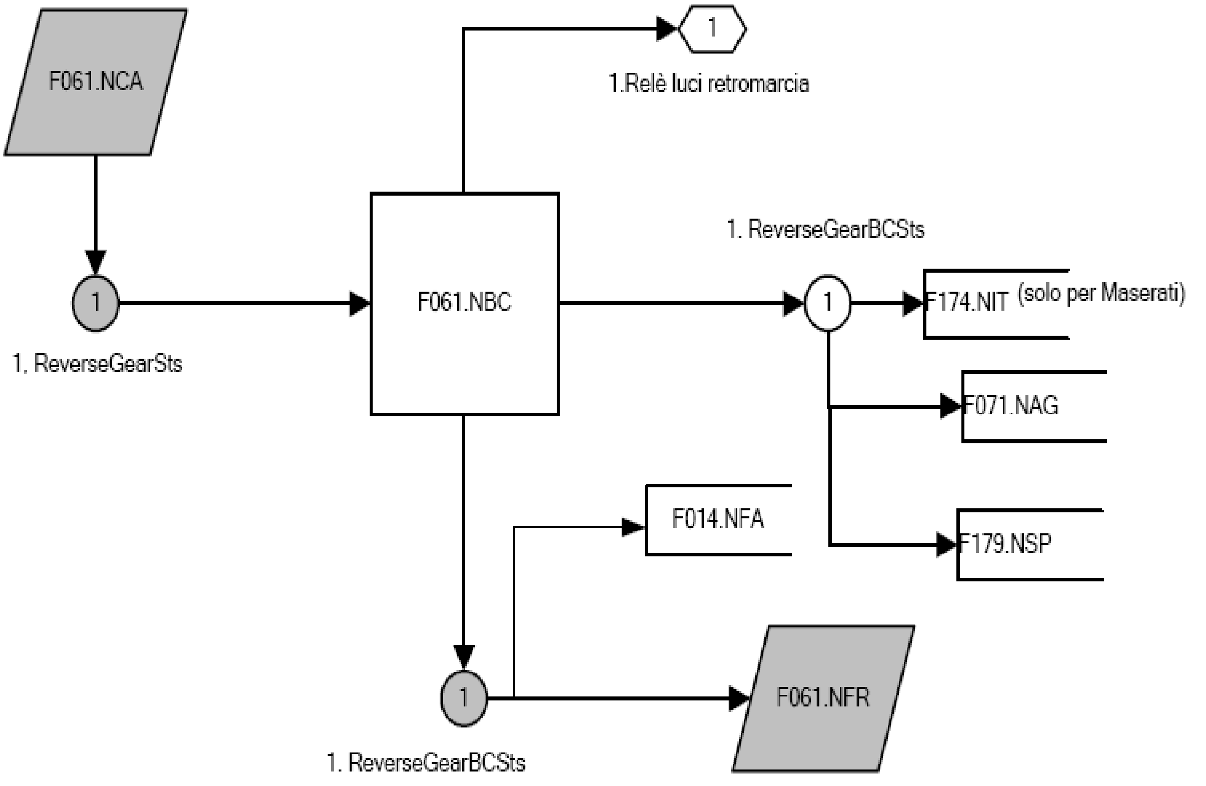
STOP SIGNAL



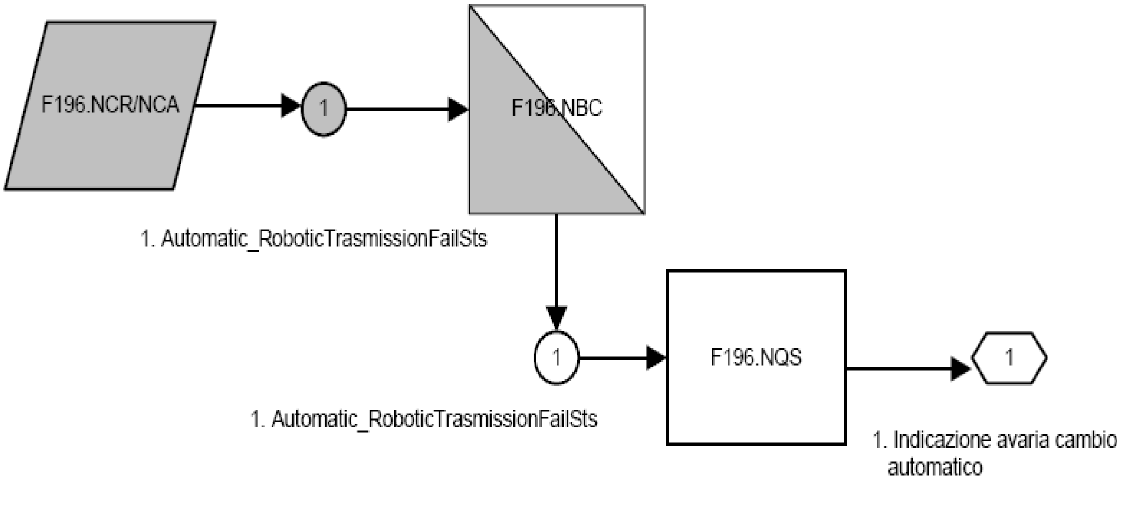
SPORT MODE SIGNAL



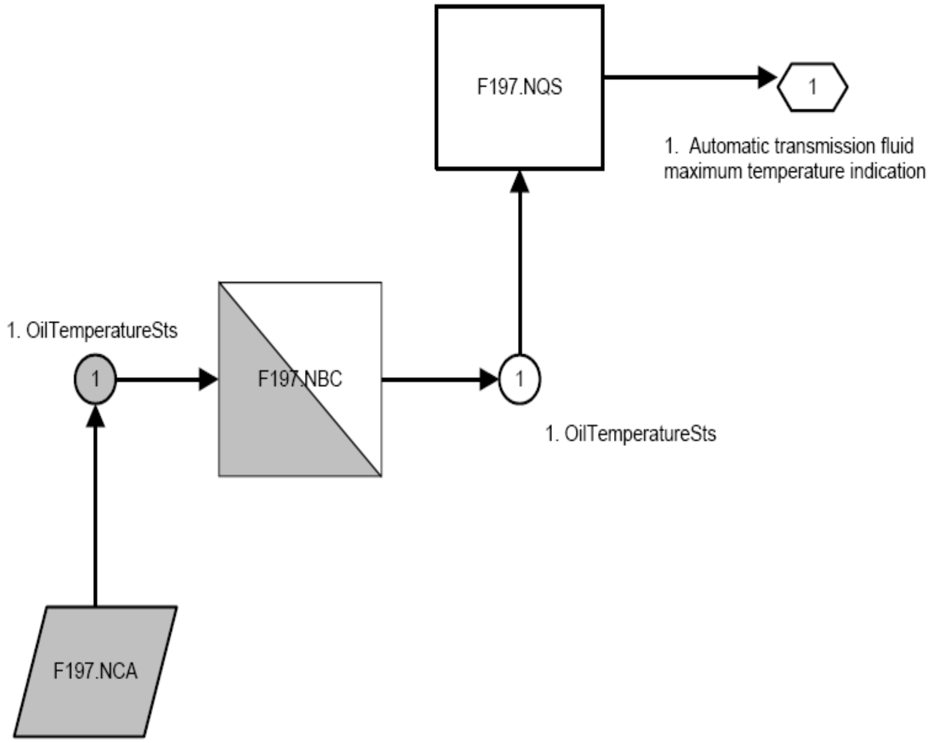
REVERSE SIGNAL



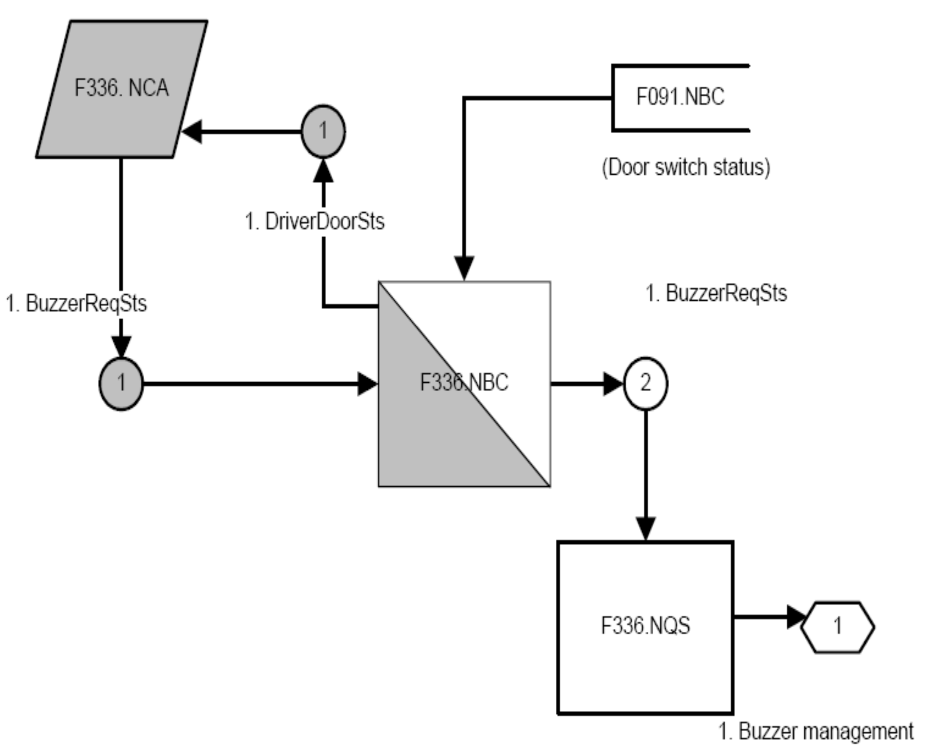
GEARBOX ANOMALY SIGNAL



GEARBOX OIL TEMPERATURE SIGNAL



BUZZER ACTIVATION SIGNAL



Maserati Academy – March 2008