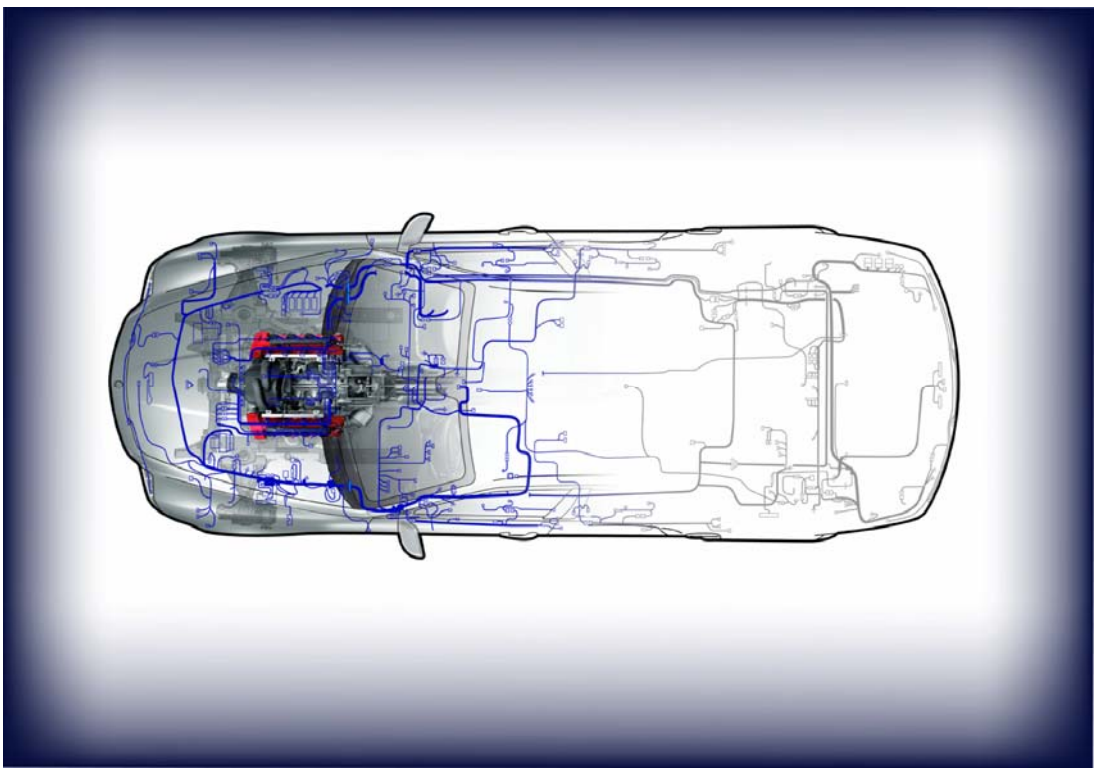
MASERATI
ACADEMY

Advanced Electronics 2

Chassis and Body



September 2009 Edition

Training Documentation for Maserati Service Network

Advanced Electronics part 2

Chassis and Body

Preface

This document, “Advanced Electronics 2”, comes as a natural sequel to the Advanced Electronics 1 course. Where the first part of the Advanced Electronics courses was focused on the power train – more specifically engine control and gearbox control, this second part will go into more detail on a number of body and chassis related functions.

After an introduction to the Florence electronic vehicle architecture and CAN technology, the following nodes will be treated: NBC, NFR, NPB, NCS, NTP, NFA and CSG.

The goal of this document is to give a detailed description of the vehicle systems listed above as used in Maserati vehicles from 2003 onward. Different aspects will be covered, such as operating principles, electrical system characteristics and diagnostics. This together with the accompanying practical exercises of the training course, aim to provide the Maserati service technician with the necessary knowledge and the right confidence to carry out repairs and service operations on these systems.



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The Florence Electronic Vehicle Architecture

Introduction

The “Florence” architecture (Fiat Luxury car ORiented Network Control Electronics) is an electronic architecture which integrates the different ECU’s (indicated as “nodes”) present in the vehicle to a complete and integral communication system. Its main goal is optimizing the management of the different electrical and electronic functions present in the vehicle.

Florence has been developed by the Fiat group specifically for the application in luxury cars. The first vehicle from the Fiat group to use the Florence system was the Lancia Thesis (model 841) in 2001. The First Maserati to apply Florence was the Quattroporte model of 2003. Maserati uses Florence for all its vehicles since.

The Florence system uses a number of communication lines which link the different nodes to each other. The task of “network manager” is performed by the body computer (NBC) which is the heart of the Florence system.

Florence uses a strategy of “optimal topological approach”. This means that every ECU is located in the barycentre of the functions it controls. By this way the wiring length has been significantly reduced.

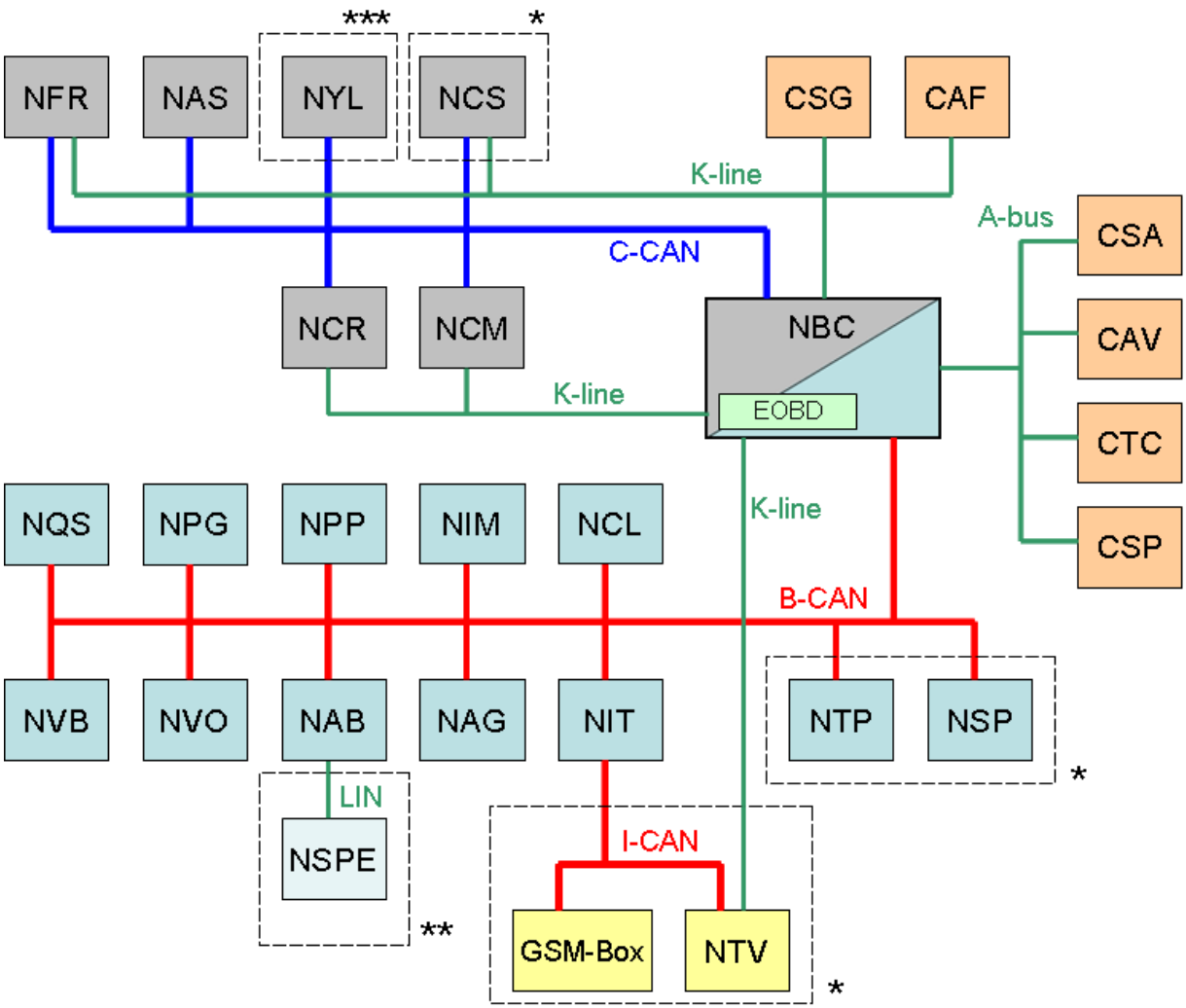


Maserati introduced Florence in 2003 on the M139 model

Advantages of Florence:

- Data which is “owned” by a certain node is also available to the other vehicle nodes
- High speed communication between nodes, adapted to the needs of each vehicle subsystem
- Reduction of wiring length
- Reduction of the number of hardware components
- Elimination of data redundancy
- Extended diagnostic functions
- Extension capacity for new (future) applications
- Optimized energy management of vehicle’s various electrical functions

Florence diagram: Quattroporte Duoselect



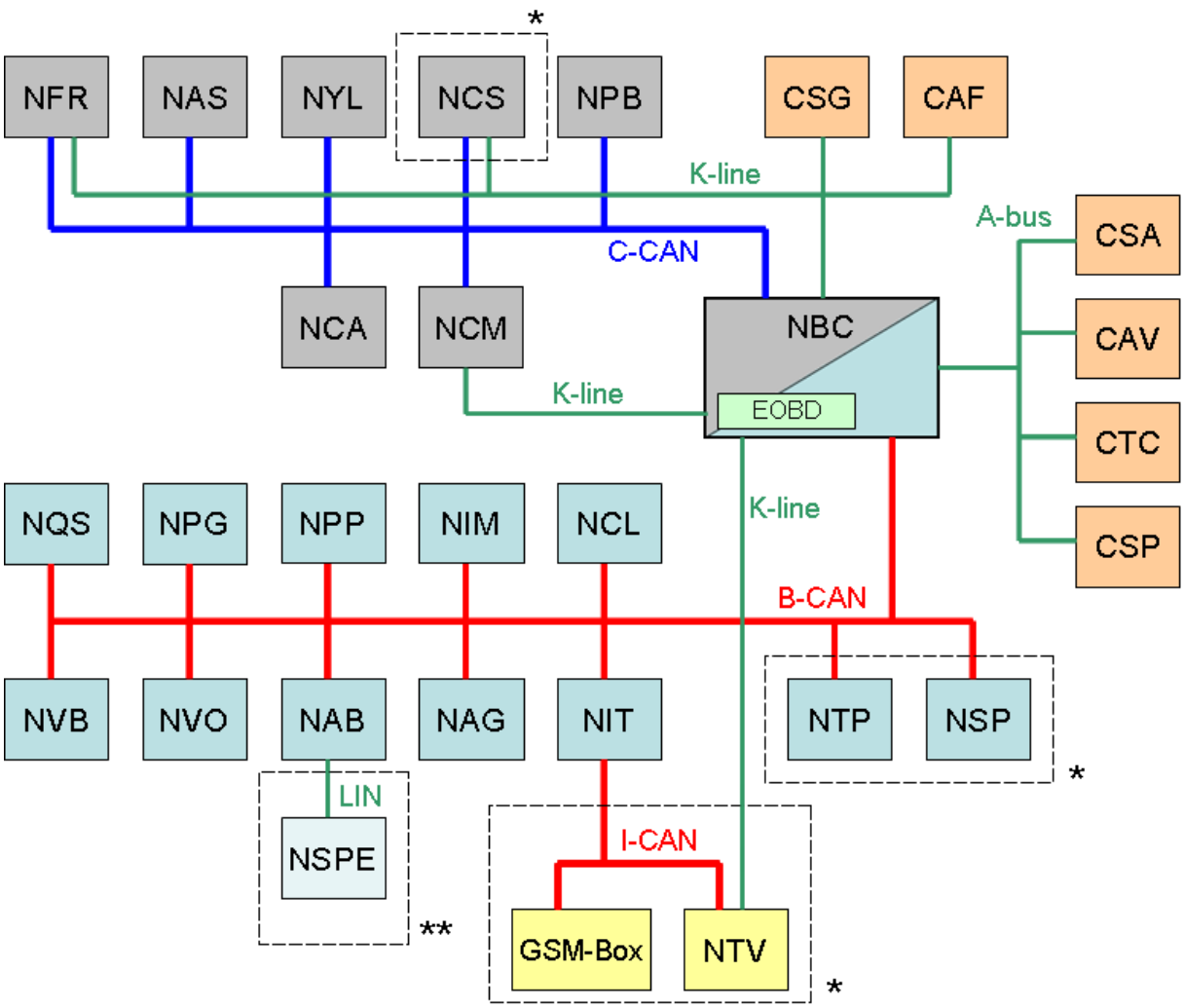
Notes:

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

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

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

Florence diagram: Quattroporte Automatic

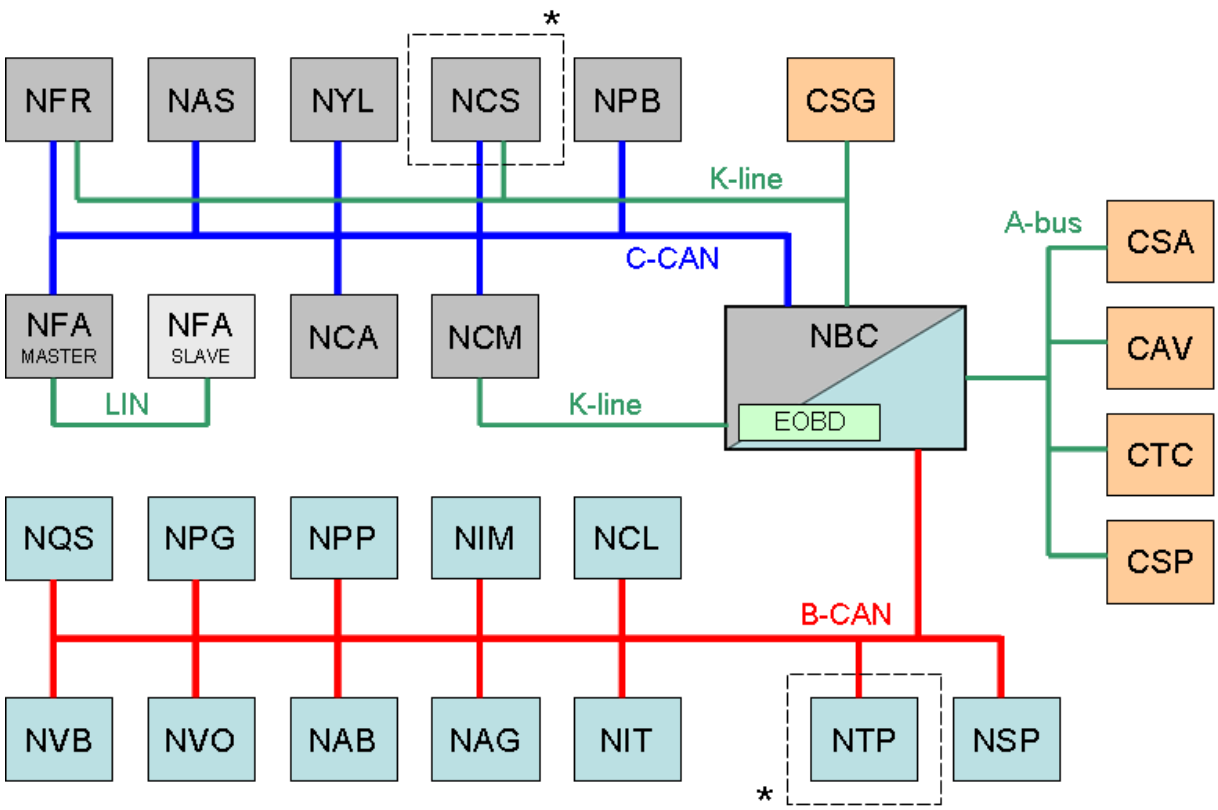


Notes:

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

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

Florence diagram: Quattroporte restyling (MY09 onward) 4.2L & 4.7L

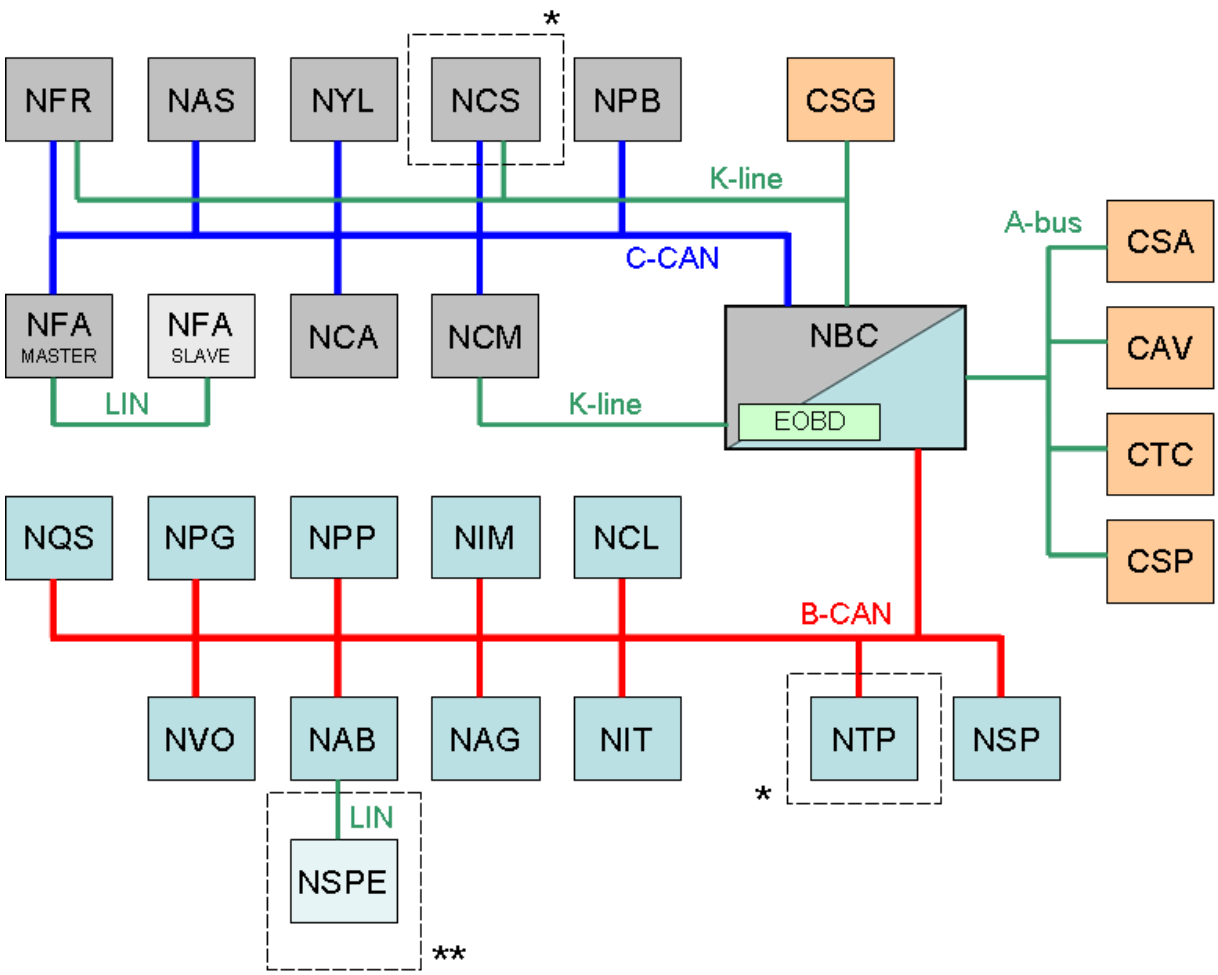


Notes:

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

The K-line for NCM is only present on vehicles using the Motronic ME7 system.

Florence diagram: GranTurismo Automatic 4.2L & 4.7L



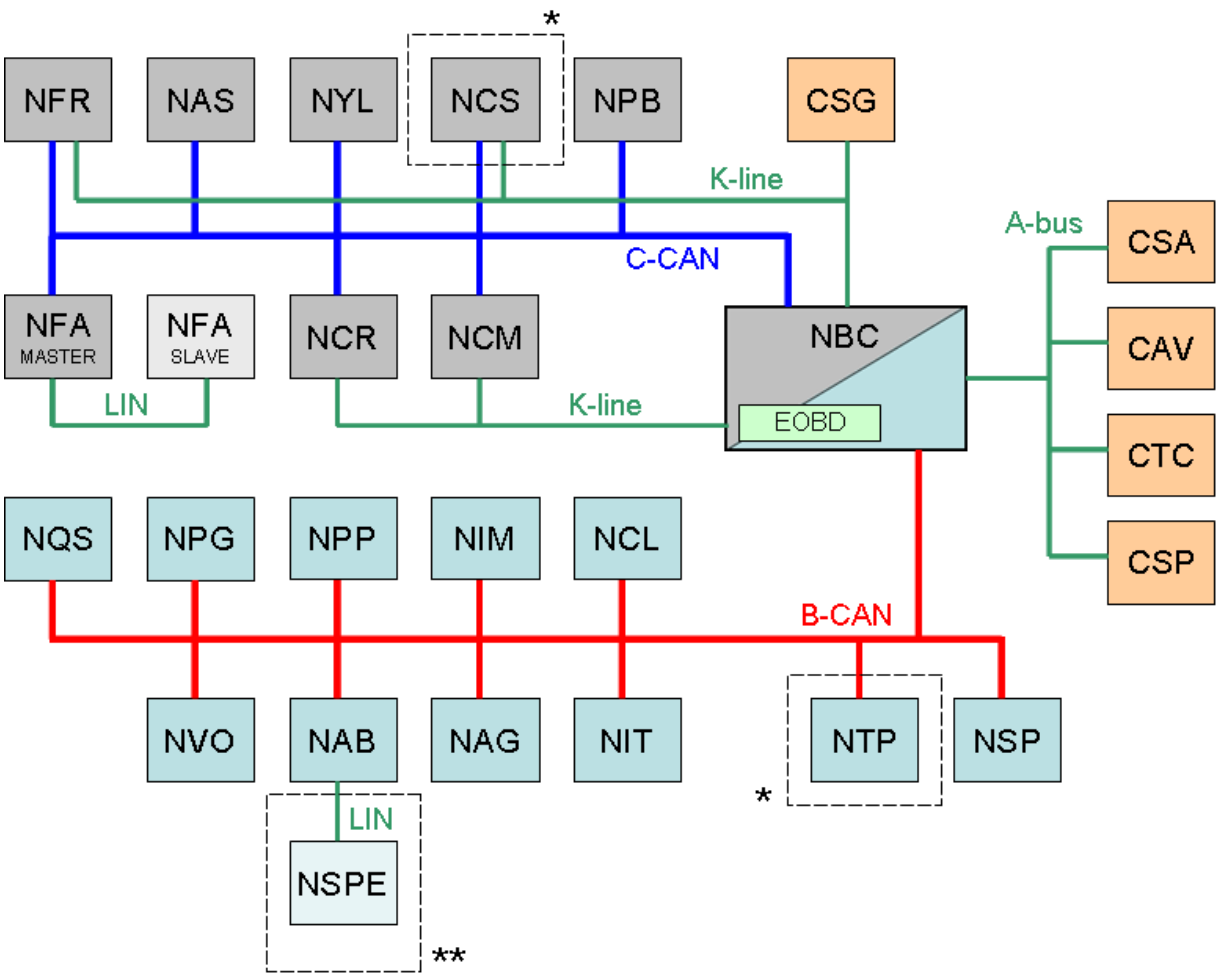
Notes:

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

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

The K-line for NCM is only present on vehicles using the Motronic ME7 system.

Florence diagram: GranTurismo S with robotized transmission

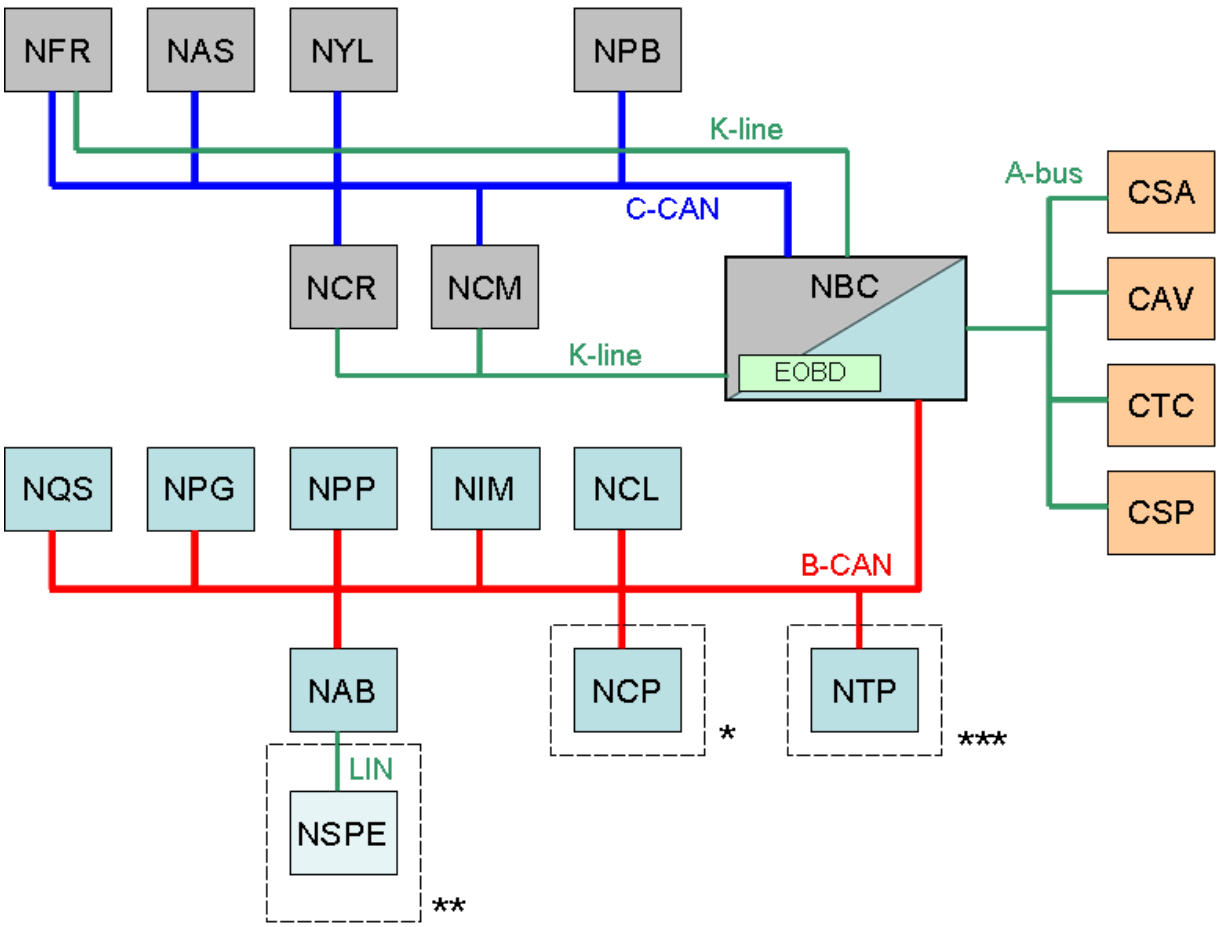


Notes:

(*) Non standard item.

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

Florence diagram: Alfa Romeo 8C Competizione & 8C Spider



Notes:

(*) 8C Spider only.

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

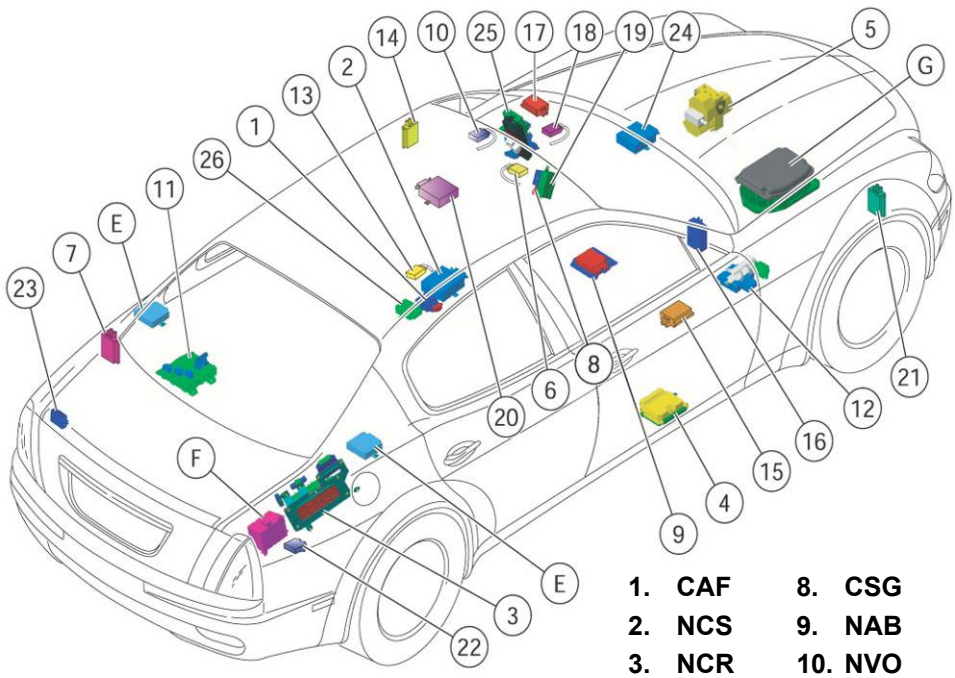
(***) USA specification vehicles only.

Different ECU's and nodes used in Maserati vehicles

CAF	Centralina Assetto Fari	Head lights level control system ECU
CAV	Centralina Alarme Volumetrico	Volumetric alarm system ECU
CSA	Centralina Sirena Antifurto	Anti theft siren ECU
CSG	Centralina Servo Guida	Power steering ECU
CSP	Centralina Sensore Pioggia /crepuscolare	Rain and twilight sensor ECU
CTC	Centrallina Tergi Cristallo	Windscreen wiper ECU
DSP	Amplificatore Hifi	Hifi amplifier
NAB	Nodo Air Bag	Airbag system node
NAG	Nodo Assetto Guida	Driving position set up node
NAS	Nodo sensore Angolo Sterzata	Steering wheel angle sensor node
NBC	Nodo Body Computer	Body computer node
NCA	Nodo Cambio Automatico	Automatic gearbox node
NCL	Nodo Climatizzazione	HVAC system node
NCM	Nodo Controllo Motore	Engine control system node
NCP	Nodo Capote	Soft top node
NCR	Nodo Cambio Robotizzato	Robotized gearbox node
NCS	Nodo Controllo Sospensioni	Suspension control system node
NFA	Nodo Fari Adattativi	Adaptive head light system node
NFR	Nodo impianto Frenante	Braking system node
NIM	Nodo Imperiale	Inside roof node
NIT	Nodo Infotainment	Infotainment system node
NPB	Nodo Parking Brake	Electric parking brake node
NPG	Nodo Porta Guidatore	Drivers door node
NPP	Nodo Porta Passaggero	Passengers door node
NQS	Nodo Quadro Strumenti	Instrument cluster node
NSP	Nodo Sensori Parcheggio	Parking sensors node
NSPE	Nodo Sensori Peso (AWS)	Advanced weight sensing system node
NTP	Nodo Tyre Pressure	Tyre pressure monitoring system node
NTV	Nodo TV	TV node
NVB	Nodo Vanno Baule	Luggage compartment node
NVO	Nodo Volante	Steering wheel node
NYL	Nodo Yaw Lateral	Yaw rate and lateral acceleration sensor node

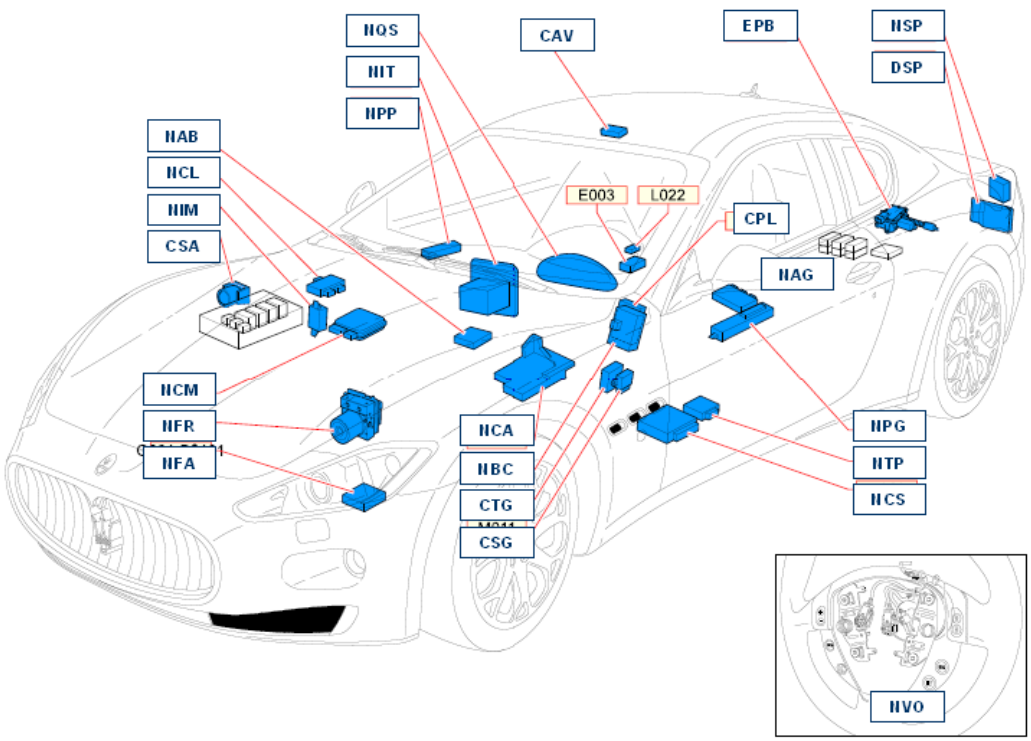
Position of ECU's and nodes

Example: Quattroporte Duoselect



1. CAF	8. CSG	15. NPP	22. NTV
2. NCS	9. NAB	16. NIM	23. DSP
3. NCR	10. NVO	17. NQS	24. NIT
4. NCM	11. NVB	18. CSP	25. NBC
5. NFR	12. NCL	19. CTC	26. NTP
6. NAS	13. NAG	20. CAV	
7. NSP	14. NPG	21. CSA	

Example: GranTurismo Automatic

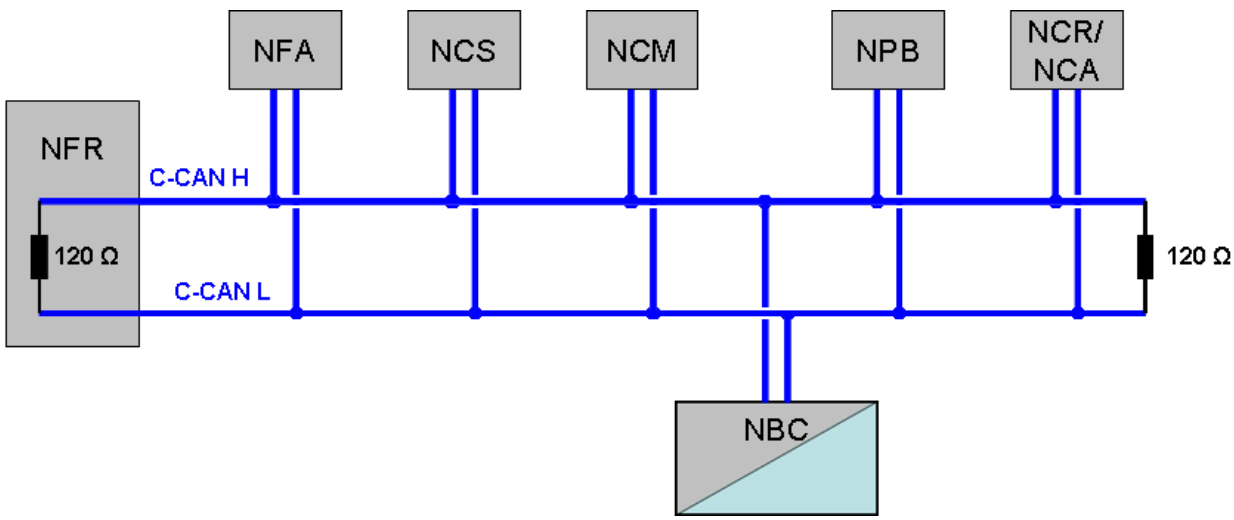


C-CAN (high speed CAN)

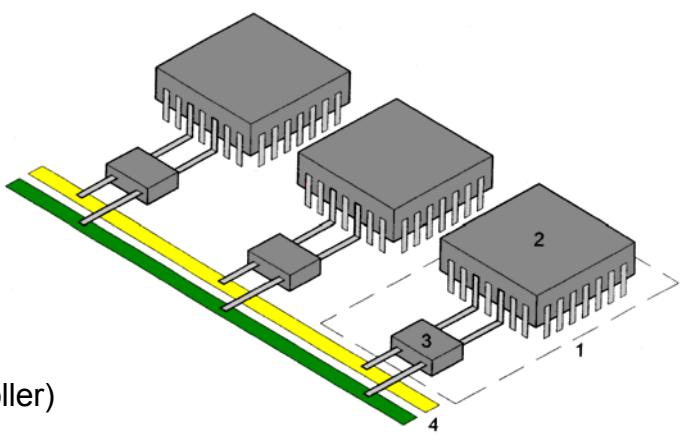
The C-CAN is used for information exchange between an number of nodes involved with primary vehicle functions (power train control and chassis control systems). It uses the Class C CAN 2.0A protocol which is standardised in ISO11898.

CAN (Controller Area Network) has become an industry standard for vehicle data exchange during the last two decades, and is today used by a wide segment of car manufacturers and automotive suppliers.

C-CAN is mainly intended for the data transfer between nodes, while for diagnostics of most C-CAN nodes the K-line is used. Some nodes use C-CAN also for diagnostics (NCA, NFA, NPB, NCM Motronic ME9)



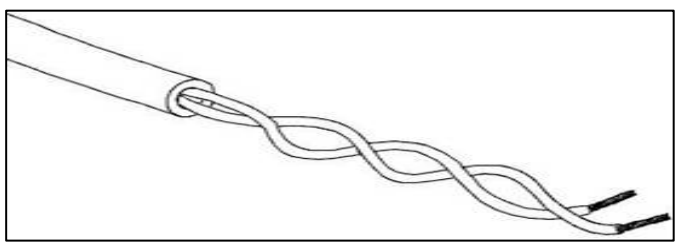
Every node contains a CAN controller which encodes information from the ECU to a standard CAN data frame and puts it on the bus. The CAN controller also reads the data available on the bus and decodes it to make it understandable for the ECU.



1. ECU called “NODE”
2. Microprocessor
3. Communication interface (CAN controller)
4. CAN bus (two wires)

C-CAN characteristics:

- Hi speed CAN of Class C (ISO 11898)
- Bi-directional, serial communication bus
- Multi-master principle
- Made of two wires, C-CAN Low and C-CAN High
- Wiring colours: white (C-CAN High) and green (C-CAN Low)
- Both wires are twisted in a pair
- Two end of line resistors of 120 Ohms each
- Voltage level of C-CAN Low: 2,5V (idling), 1,5V (with data activity)
- Voltage level of C-CAN High: 2,5V (idling), 3,5V (with data activity)
- Data speed: 500 Kbits/second
- Data put on the bus by a node is not addressed. Every other node can decide to receive or to ignore the data present on the bus.
- Nodes can be added / removed without affecting the bus operation
- Both lines drop to 0 volts when the vehicle goes into sleep mode.



Both wires of the C-CAN line are twisted in a pair to minimise electro-magnetic disturbance

Location of C-CAN end of line resistors in the vehicle

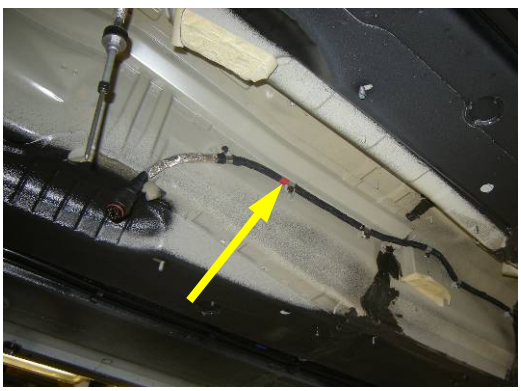
The front end of line resistor is integrated inside the NFR for all vehicles.



The rear end of line resistor for vehicles with robotized transmission is located in the luggage area, near the NCR.



Vehicles with automatic transmission do not have the end of line resistor in the luggage area.



The rear end of line resistor for vehicles with automatic transmission is integrated inside the wiring harness, near to the NCA connector (marked with red tape)



The integrity of the C-CAN line can be easily checked by means of a multi meter:

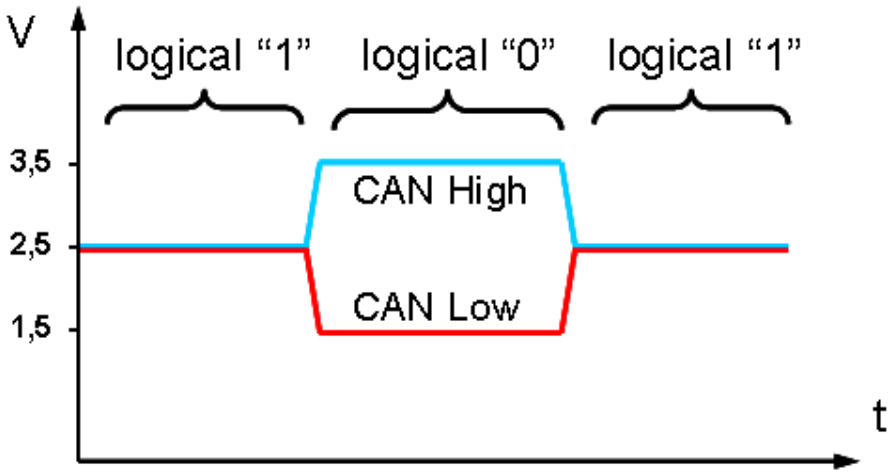
- Resistance between CAN H and CAN L: 60 Ohms ±10%
- Resistance between CAN H and ground: > 500 Ohms
- Resistance between CAN L and Ground: > 500 Ohms

Measured resistance close to 0 Ohms indicate a short circuit in the line.

CAUTION

Always disconnect the vehicle's battery before measuring resistance on a CAN line!

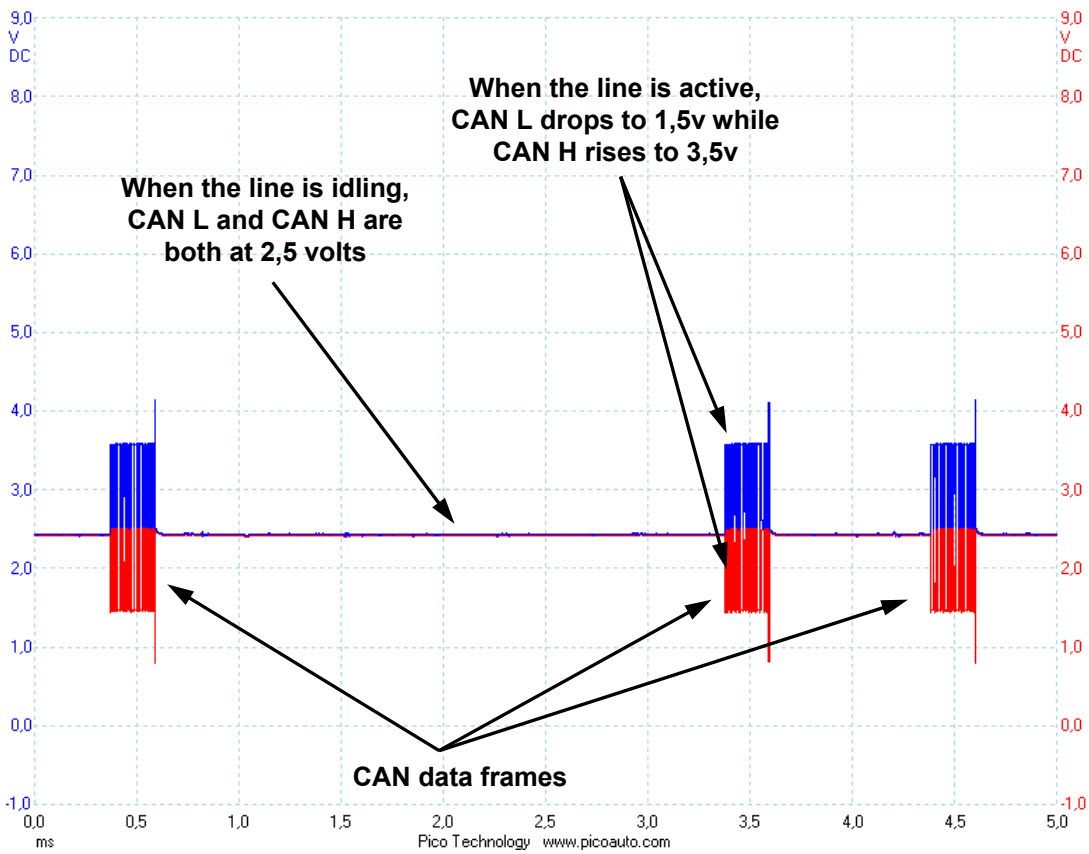
C-CAN voltage level



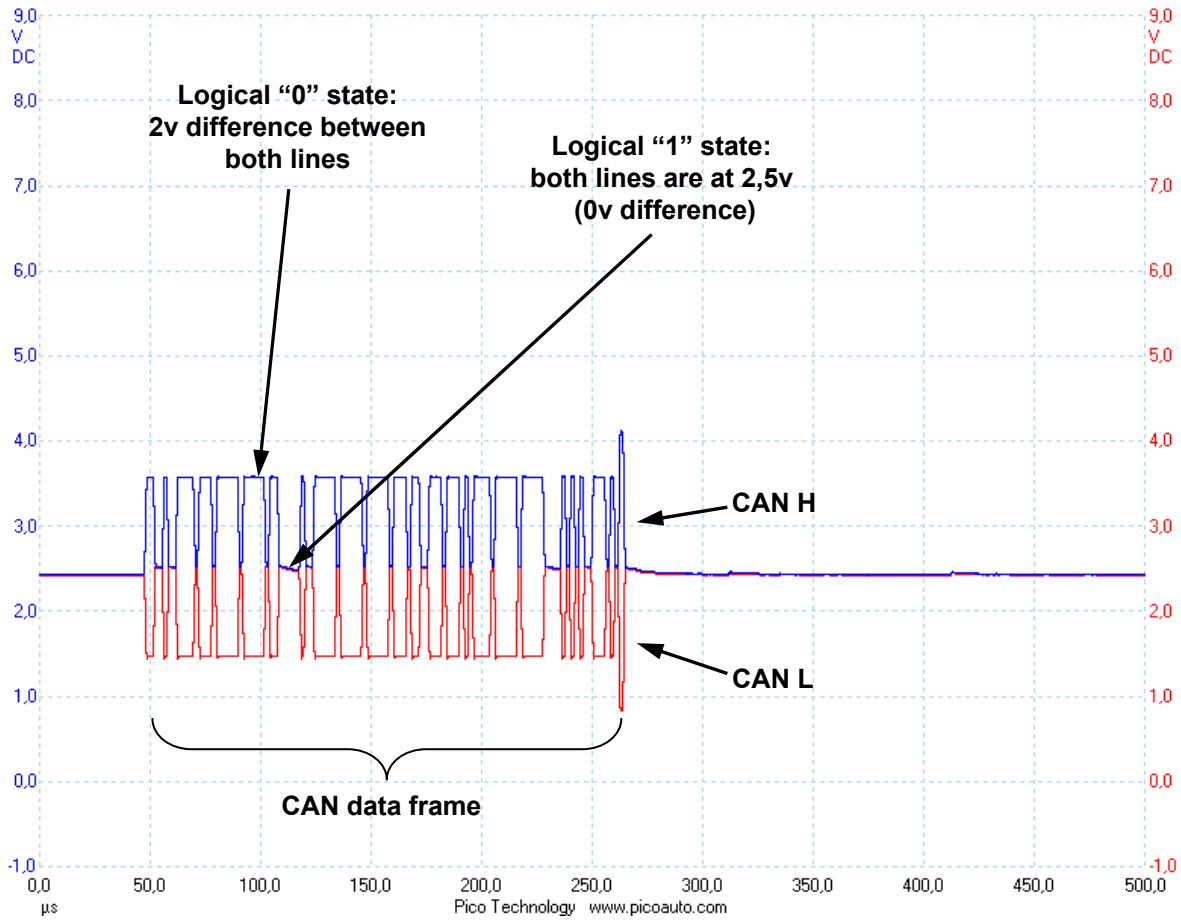
C-CAN works with two logical states:

Both wires are at 2,5 volt:	the line is idling ►	logical “1”
CAN L = 1,5v and CAN H = 3,5v:	the line is active ►	logical “0”

C-CAN scope view



Let's take a closer look at a CAN data frame:



A data frame is composed of a sequence of bits, which can have the logical "0" or the logical "1" state.

In case of a logical "1" (line is idling), there is no voltage difference between both CAN lines. A logical "1" state of the line is recessive.

In case of a logical "0" (line is active), there is a 2 volts difference between CAN H and CAN L. A logical "0" state is dominant.

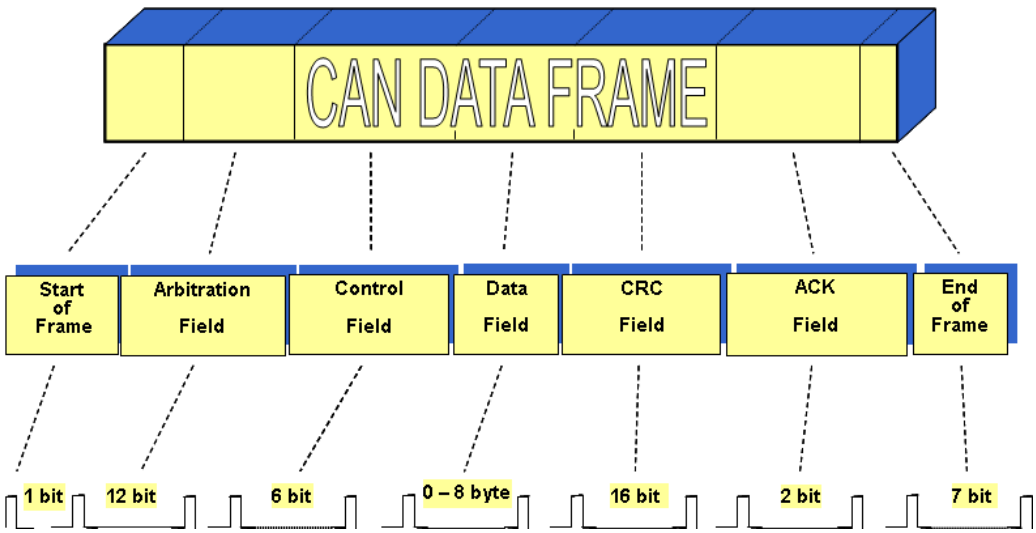
Logical "0" has priority over logical "1"!

This means that a logical "1" state can be overwritten by a logical "0". The bus is in the logical "1" state only when every node connected to the bus puts a "1" on the line.

As soon as at least one node puts a logical "0" on the line, the bus changes its state into logical "0".

Note: all signals displayed in the scope views on these and following pages are measured with respect to the chassis ground, unless mentioned otherwise.
A low pass filter of 1MHz was used to clean the signals from noise.

Structure of a CAN data frame:



A data frame is made of different fields, which are defined in the CAN protocol:

Start of Frame (1 bit)
This is a single dominant bit (logical “0”) which indicates the start of the transmission of a data frame. This bit can be sent whenever the bus is in a recessive state (idling). All the nodes synchronise on this beginning of a the data frame put on the bus by the node which started the transmission.

Arbitration field (11 + 1 bits)
This field contains an 11 bit identifier followed by an RTR bit (Remote Transmission Request). The identifier is used to determine the priority of the data carried in the data frame. Every sending node will assess during the data transmission whether it has still priority. If more than one nodes are sending data frames at the same time, and a sending node detects the transmission of a higher priority, it interrupts its own data transmission and becomes a receiver.

A logical “0” bit is dominant and has priority over a logical “1” bit, which is recessive.
In case more nodes access the bus at the same time, the node which sends the first recessive bit looses priority in favour of the nodes which send a dominant bit.

The RTR bit is a dominant bit in case the data frame contains data. The RTR bit is a recessive bit when the data frame is a so called “remote frame”. A remote frame is an empty frame sent by a node to request data from another node. The receiving node will fill the frame with the requested data and put it back on the bus.

Control field (6 bits)
This field contains 4 DLC bits (Data Length Code) which give information on the length (= the number of bytes) of the data contained by the data frame. By this way the receiving nodes can check whether they have received all data.
These 4 bits are followed by 1 IDE-bit (Identifier Extension bit), dominant in the standard format, and 1 reserved bit (dominant).

Data field (maximum 64 bits)
This field contains the actual data which a node wants to share with the other nodes. The data field can vary in length, from 0 to maximum 8 bytes. A byte is a sequence of 8 bits. The length of the data field is described in the DLC field. A data frame with an empty data field can for example be used for synchronisation purposes.

CRC field (16 bits)
The CRC field (Cyclic Redundancy Check) contains a code based on the content of the data field. Every receiving node decrypts this code and checks if it matches with the received data. By this way transmission errors (disturbance) can de detected. The CRC field is made of 15 bits, followed by one recessive closing bit.

Acknowledge field (2 bits)
This field contains a confirmation signal from all the nodes which have received the data correctly. The sender puts two recessive bits in this field. The first bit will be turned into a dominant bit by every node who received and understood the data correctly. In case a node did not receive the data correctly, it will alert the sending node by turning the second bit into a dominant bit.

End of frame (7 bits)
A sequence of 7 recessive bits is marking the end of the data frame. This field gives the nodes the necessary processing time to be ready to receive a new frame, and offers a last possibility to alarm errors in receiving the data.

5 possible CAN faults

1. **Data frame transmission error:** A node did not succeed to put a data frame correctly on the CAN line. A cause can be an internal problem with the CAN controller of the node or a problem external to the node, such as a sudden fluctuation on the power supply voltage of the node.

2. **Bus occupied or disturbed:** The bus can be disturbed by an external factor (noise) or by a node itself. Example: a faulty node stays in “writing mode” and by this way inhibits other nodes from using the line. Such a fault can be identified by disconnecting the nodes from the bus one by one.

3. **Data signals too low:** A node puts a data frame on the bus, but the voltage levels are not sufficient for the other nodes to read the data. As in problem one, the cause can be a faulty node or insufficient power supply of the node, creating in this way a bus error.

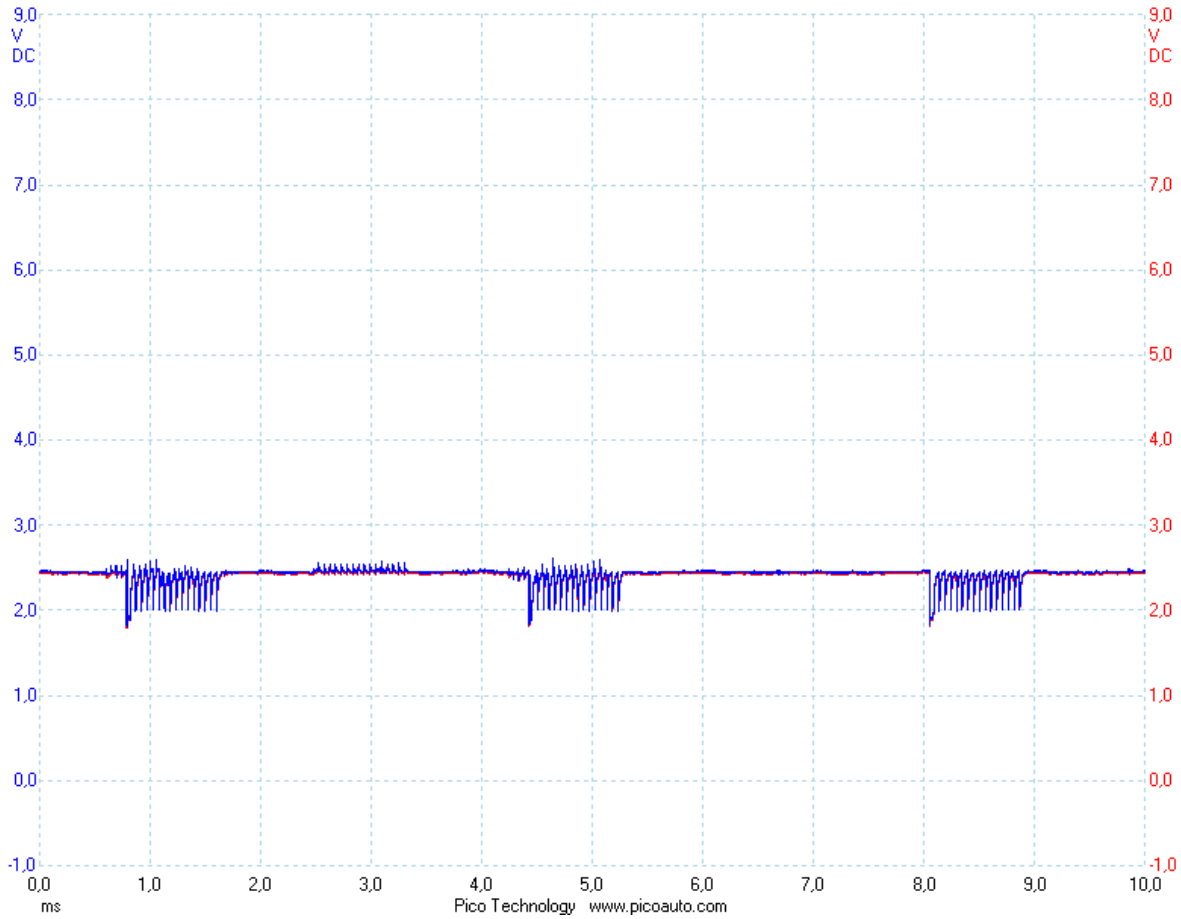
4. **Wrong or missing reference voltage:** The correct idling voltage of 2,5 volts (for C-CAN) on one or on both bus lines is not present. A typical cause of such a problem is a short circuit or open circuit in the line. These type of faults can be identified with old-school trouble shooting using a multi meter.

5. **Wrong programming:** The message put on the bus is correct on the physical level but contains wrong content, creating by this way a bus error. A fault of this type can be resolved only by replacing or reprogramming (when possible) the node.



Bus problems of category 1 to 4 can be identified by the correct use of a digital oscilloscope!

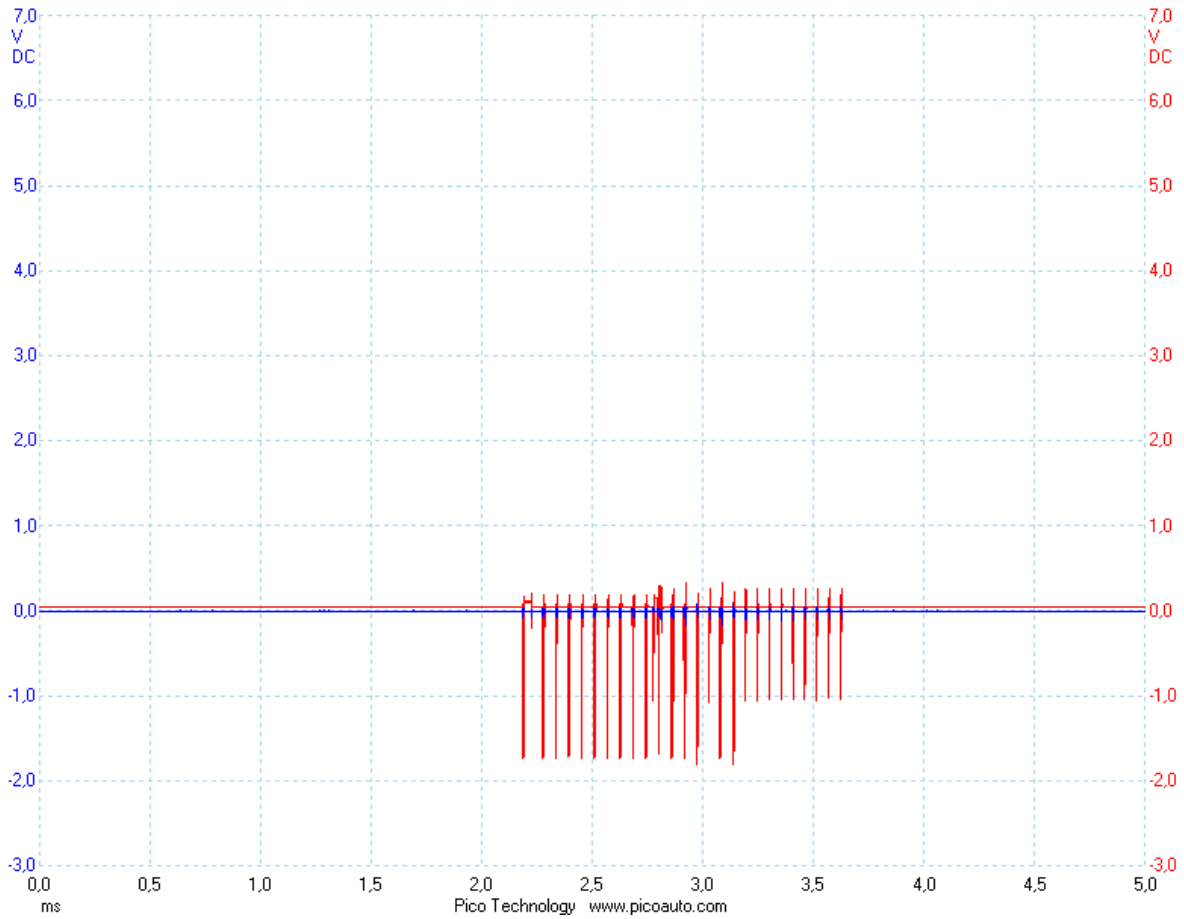
Examples of bus errors: short circuit between CAN L and CAN H



In case of a short circuit between both CAN lines, the bus is off. As we can see on the scope view, CAN L and CAN H maintain their 2,5v base level, but attempts by nodes to put a data frame on the bus results in electrical noise.
C-CAN looses complete functionality in this case.

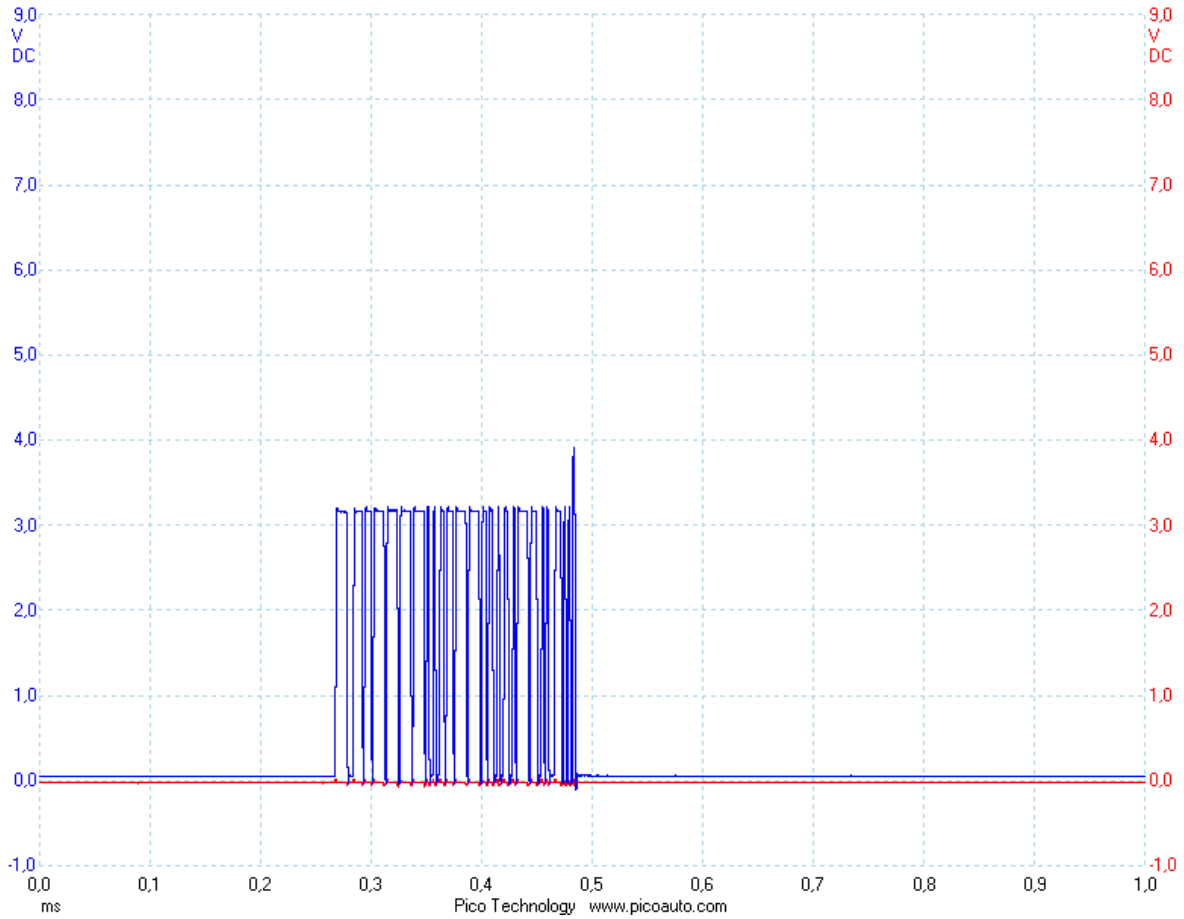
Blue trace: CAN L
Red trace: CAN H

Examples of bus errors: CAN H in short circuit to ground



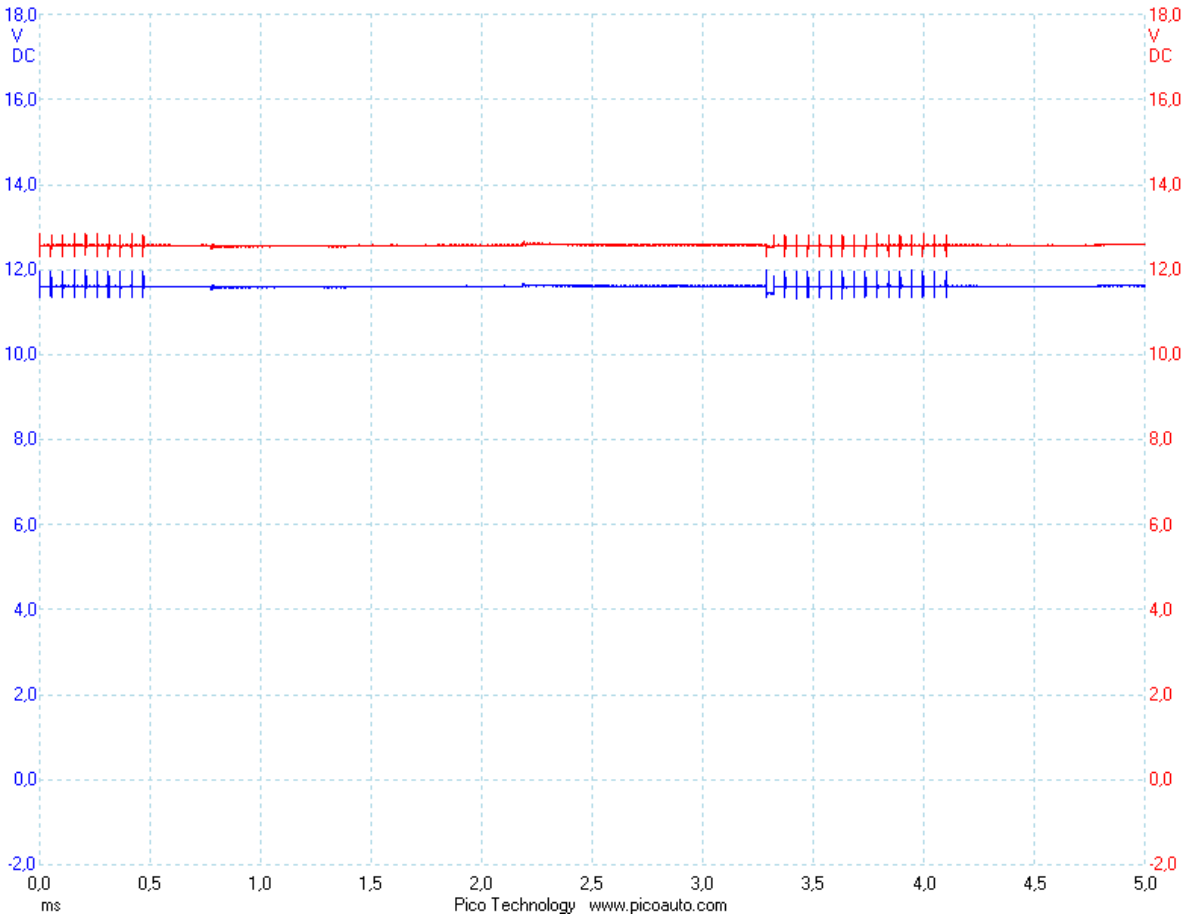
In the above scope view CAN H is in short circuit to the ground, bringing the voltage level of both lines to 0 volts. Data frames put on the bus by nodes are heavily disturbed.
C-CAN looses complete functionality in this case.

Examples of bus errors: CAN L in short circuit to ground



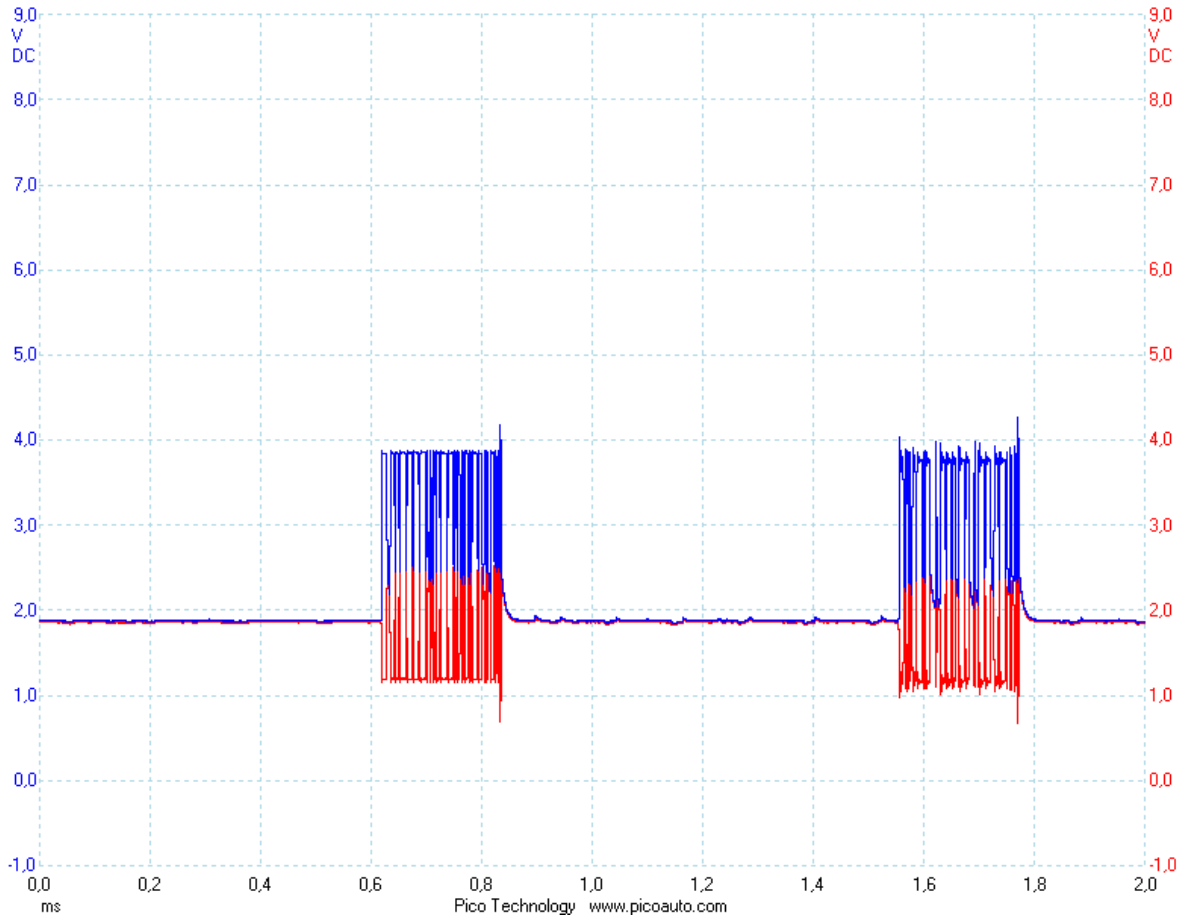
In case of a short circuit to ground of CAN L, the base level of both lines drops to 0 volts. When a node puts a data frame on the bus, CAN H manages to maintain it's normal level, while CAN L is off. The bus is in recovery mode and communication between nodes is still possible over a single wire only (CAN H).
Protection against electromagnetic disturbance is heavily reduced in this situation.
In such a case, various nodes will store DTC error codes.

Examples of bus errors: one of both CAN lines in short circuit with 12v power supply



In case of a short circuit between one of the lines and the power supply (CAN L in the above example), the level of both lines is pulled up to around 12v. Attempts to put data frames on the bus result in noise only.
The bus is off and no data exchange is possible (complete loss of functionality).

Examples of bus errors: one of both end of line resistors is disconnected



In the above example, an open circuit in the line caused the exclusion of one of both 120 Ohms terminal resistors. This fault affects the voltage level on the line (voltage drop to beneath 2v).
We can also see from the scope view that data frames on the bus manage to maintain their regular format. Data communication over the C-CAN line in this case is still possible in a reduced mode (recovery). Protection against noise and disturbance will however be reduced.

Conclusions

C-CAN has a limited recovery operating mode. In certain cases of physical faults in the bus, data exchange is still possible but with reduced functionality. Various nodes will store bus errors (DTCs) in such a case. In other cases of physical bus faults, C-CAN will loose its complete functionality. Also in this case the nodes will store error codes.

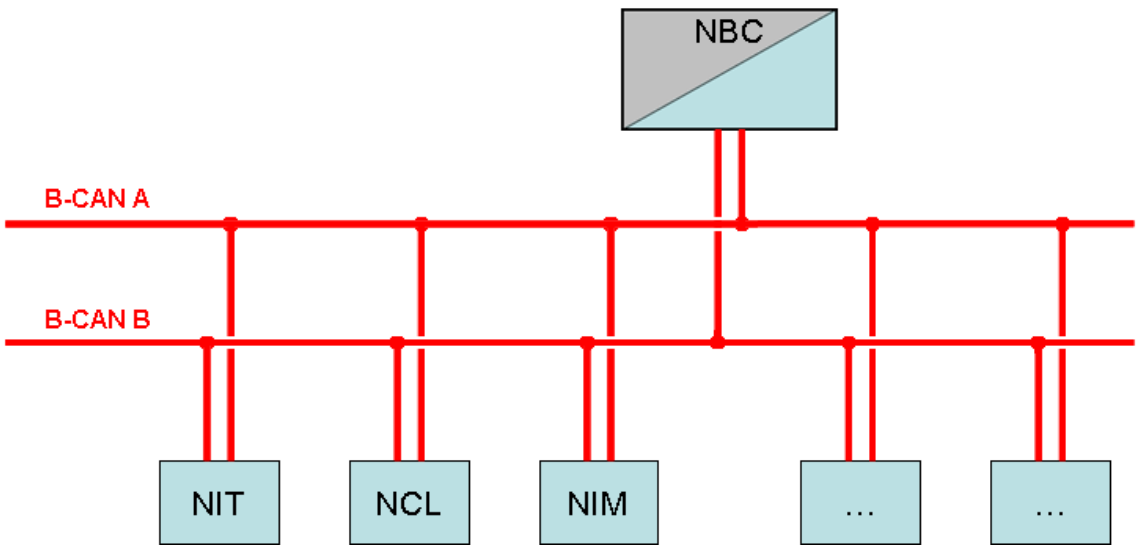
In the event of a complete loss of C-CAN communication, every node has a recovery strategy, depending on the specific node, which permits the node to offer a reduced functionality.

B-CAN (low speed CAN)

The B-CAN network (low speed CAN of Class B) groups a number of body and comfort related nodes. B-CAN is used for both data transfer between nodes and for diagnostic purposes. Unlike C-CAN, B-CAN uses no end of line resistors. By this way the number of nodes can be extended without affecting the bus operation.

This is particularly useful for body and comfort functions where the number of present nodes can vary depending on the vehicle specification.

Please note that B-CAN, when compared to C-CAN, has different operating voltages, wiring and components.



B-CAN characteristics:

- Low speed CAN of Class B (ISO 11898)
- Bi-directional, serial communication bus
- Multi-master principle
- Made of two wires, B-CAN A and B-CAN B
- Wiring colours: black-pink (B-CAN B) and white-pink (B-CAN A)
- B-CAN has no end of line resistors!
- Voltage level of CAN A: 5v (idling) and 1v (with bus activity)
- Voltage level of CAN B: 0,1v (idling), 4v (with bus activity)
- CAN A will go to 12v while CAN B will drop to 0v during sleep mode
- Can be active also in key-off conditions
- Data speed: 50 Kbits/second
- Data put on the bus by a node is not addressed. Every other node can decide to receive or to ignore the data present on the bus.
- Nodes can be added / removed without affecting the bus operation



Checking the B-CAN line with a multi meter:

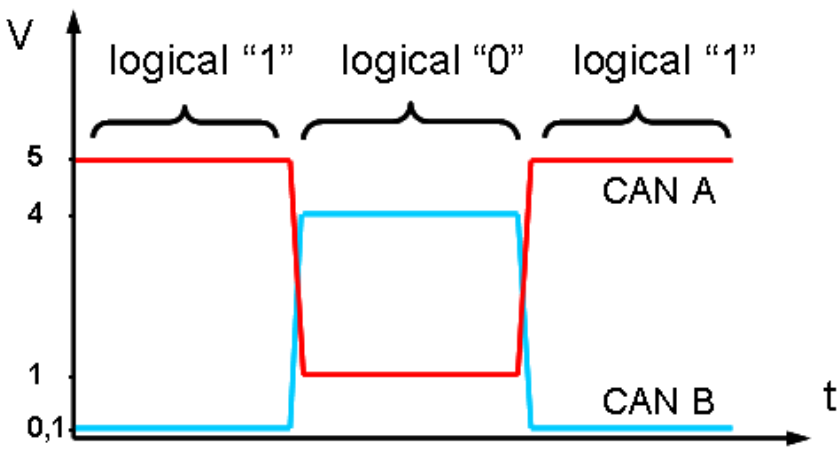
- Resistance between CAN A and CAN B: > 1,2 KΩ
- Resistance between CAN A and ground: open circuit
- Resistance between CAN B and Ground: open circuit

Measured resistance close to 0 Ohms indicate a short circuit in the line.

CAUTION

Always disconnect the vehicle's battery before measuring resistance on a CAN line!

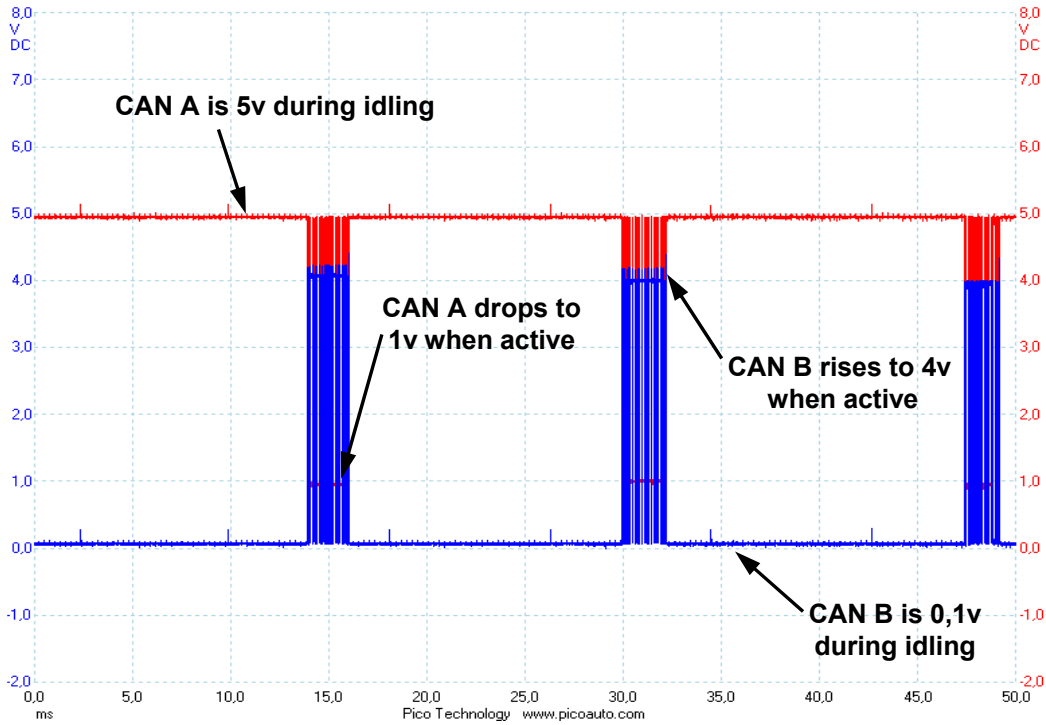
Voltage levels on B-CAN



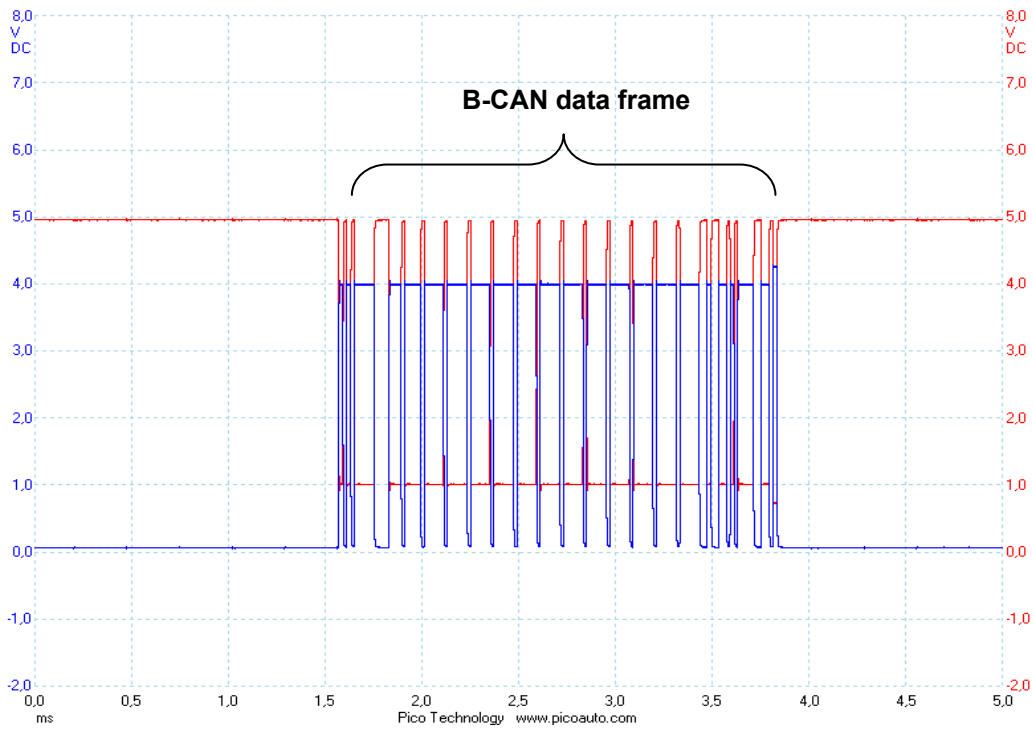
Note that he voltage levels on B-CAN are different than those on C-CAN!

Two logical states of B-CAN:		
CAN A = 5v and CAN B is 0,1v :	the line is idling ►	logical "1"
CAN A = 1v and CAN B = 4v :	the line is active ►	logical "0"

B-CAN scope view

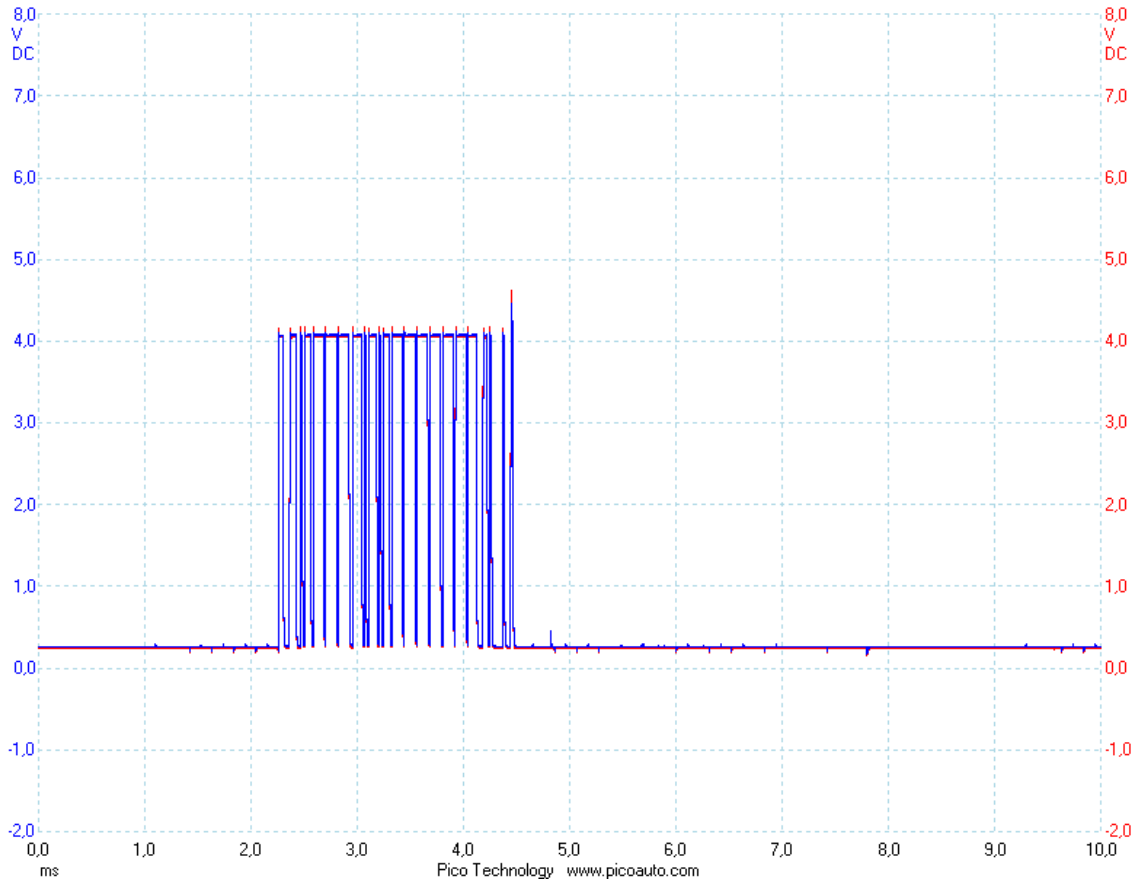


Close-up of a B-CAN data frame



A B-CAN data frame is structured in the same way as a C-CAN data frame. It uses the same principle of two logical states (“1” and “0“). Just like in C-CAN, the logical state “0” has priority over the logical state “1”. Arbitration and bus access is managed in the same manner as with C-CAN.

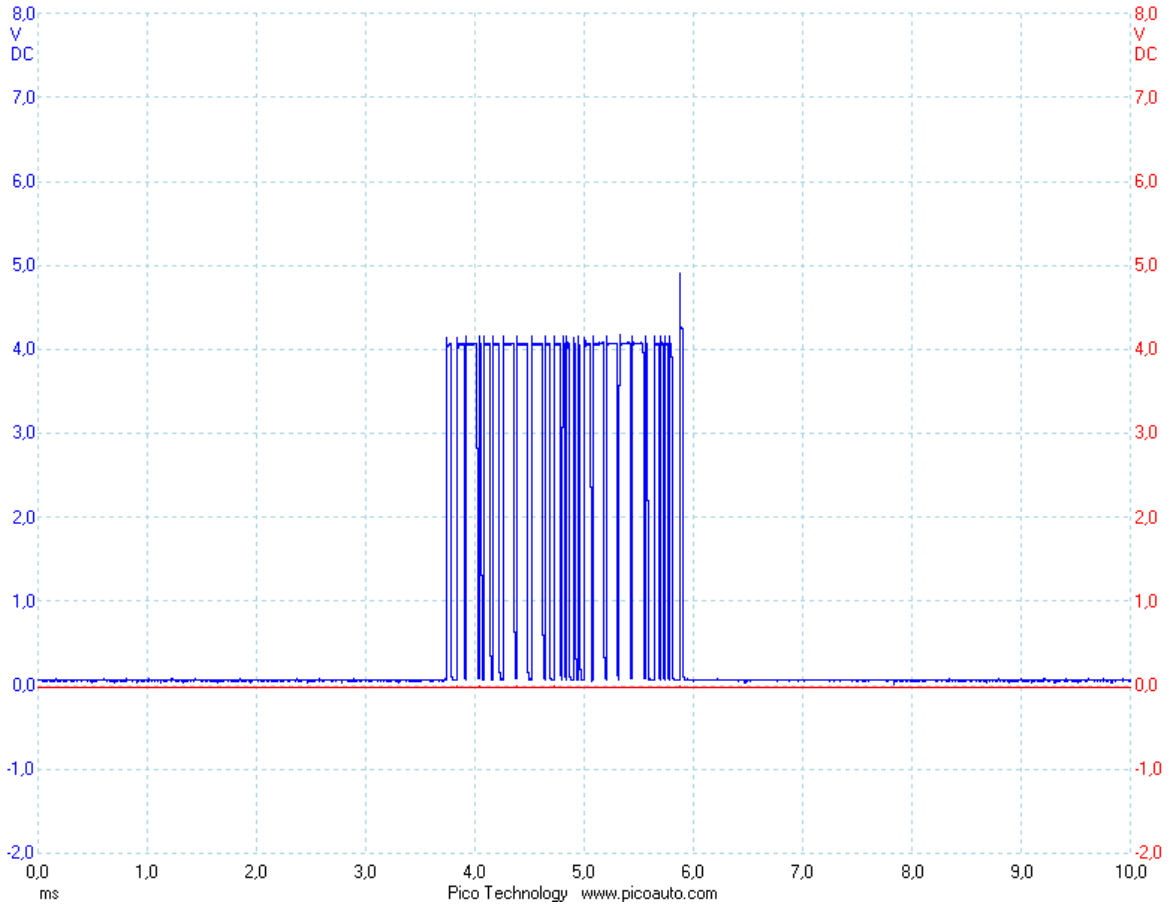
Examples of bus errors: short circuit between CAN A and CAN B



In case of a short circuit between both lines, CAN B maintains its normal voltage level while CAN A is drawn to the same level as CAN B. Communication between nodes is still possible in recovery node.

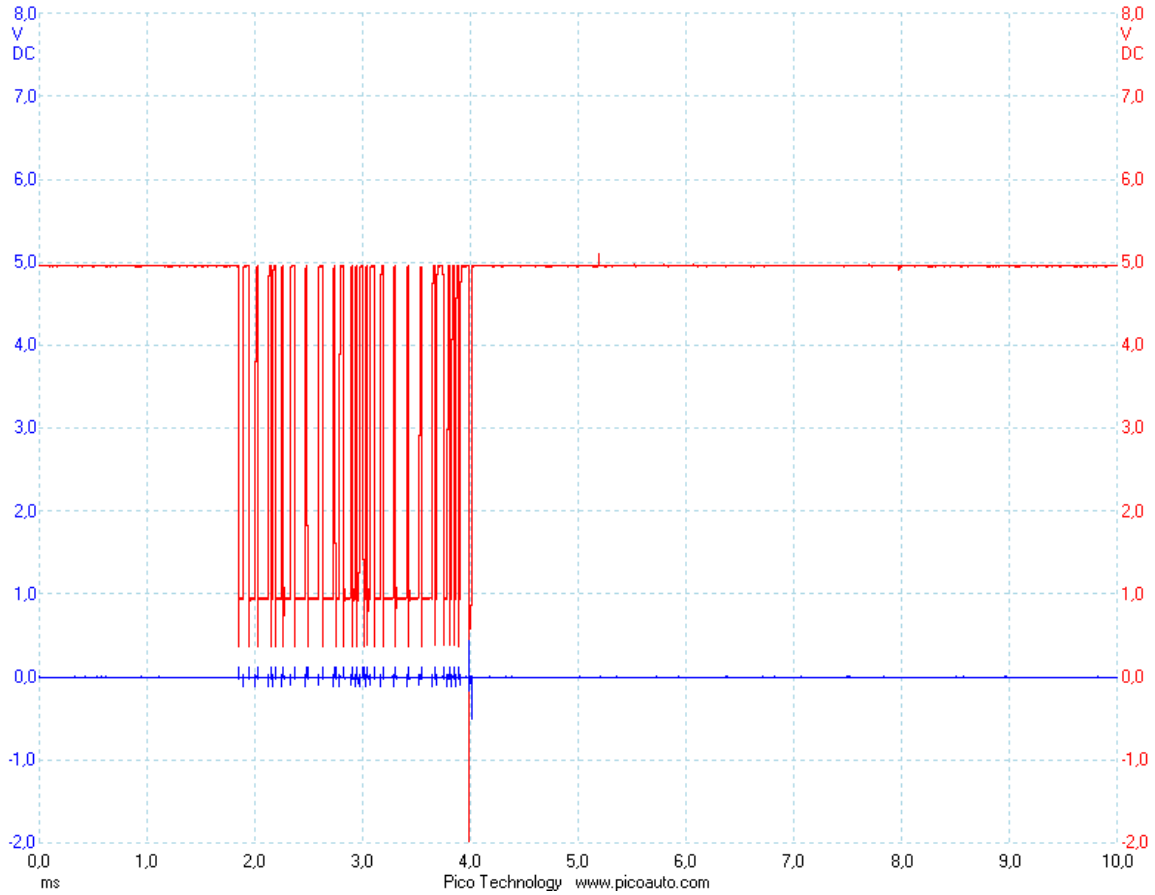
Red trace: CAN A
Blue trace: CAN B

Examples of bus errors: CAN A in short circuit to ground



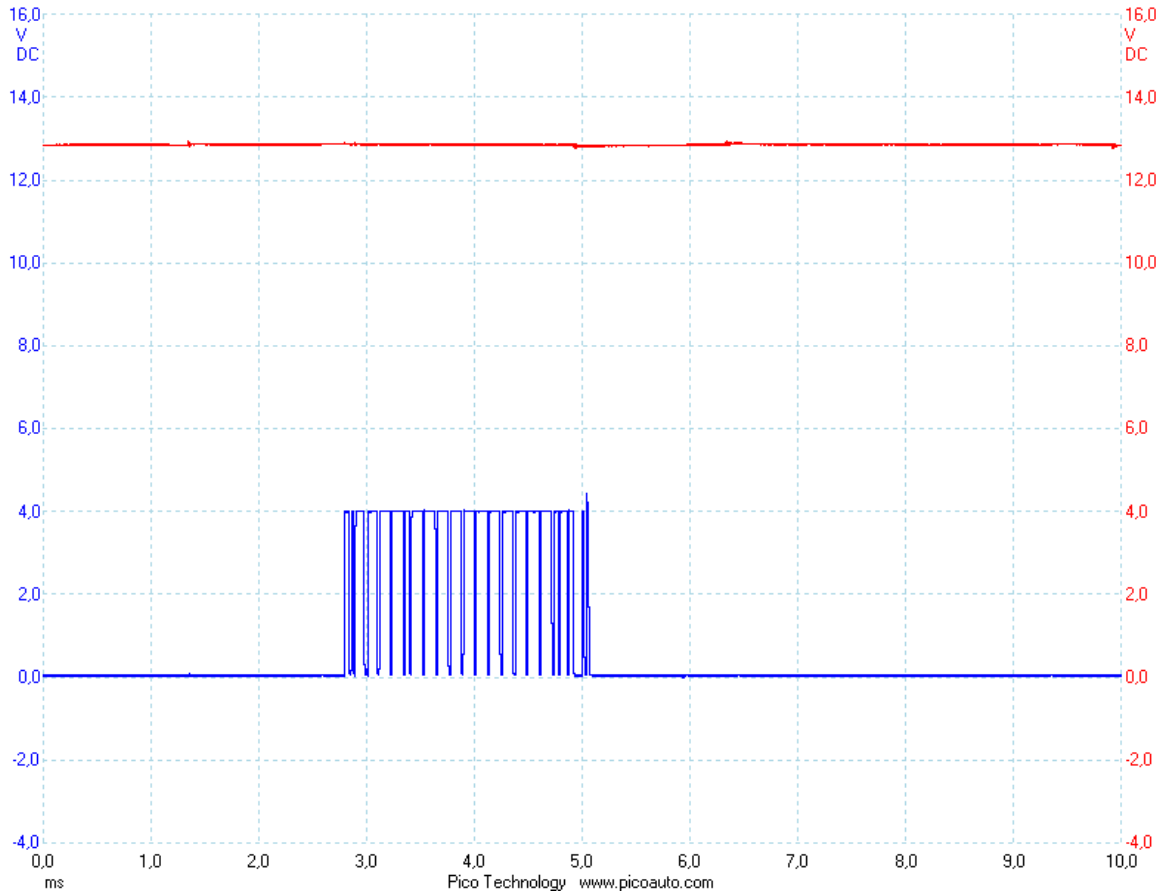
When CAN A is shorted to ground, its voltage level drops to zero. We can see that the voltage level of CAN B is however not affected. Communication between nodes is still possible over a single wire (recovery mode).
B-CAN remains operational over the CAN B line only.

Examples of bus errors: CAN B in short circuit to ground



We see a similar result when CAN B is shorted to ground. While CAN B is stays at 0 volt, CAN A maintains its normal voltage level. Communication over the bus is also in this case still possible.
B-CAN is able to exchange data in recovery over the CAN A line only.

Examples of bus errors: one of both B-CAN lines in short circuit with 12v power supply



In case of a short circuit between one of the lines and the power supply (CAN A in the above example), we can see that while the voltage level of the shorted wire is pulled up to Vbatt, the voltage level of the other line is not affected.
Communication in recovery mode is still possible over the non-shorted line.

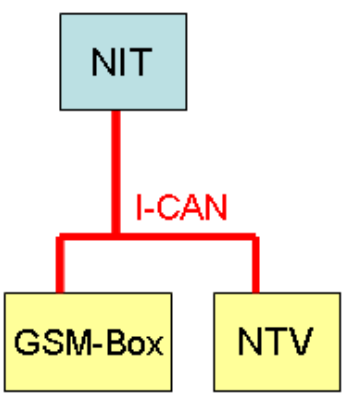
B-CAN recovery strategies

• CAN A = out of order:	communication takes place over CAN B
• CAN B = out of order:	communication takes place over CAN A
• CAN A and CAN B = out of order:	no more communication is possible

Conclusion:
Data exchange over B-CAN is possible as long as one of both lines is still intact. Also in case of a short circuit between both lines, data exchange is still possible.
In these cases B-CAN operates in a “single wire” recovery mode.
Data communication can still take place, but protection against electro-magnetic noise and other disturbance is strongly reduced.

I-CAN (Quattroporte up to MY08 only)

Dedicated CAN line of Class B (low speed) for multimedia devices. This dedicated bus is only present in case the vehicle is equipped with the optional mobile phone and/or the optional rear TV set. I-CAN uses the same operating principle and physical level as B-CAN.





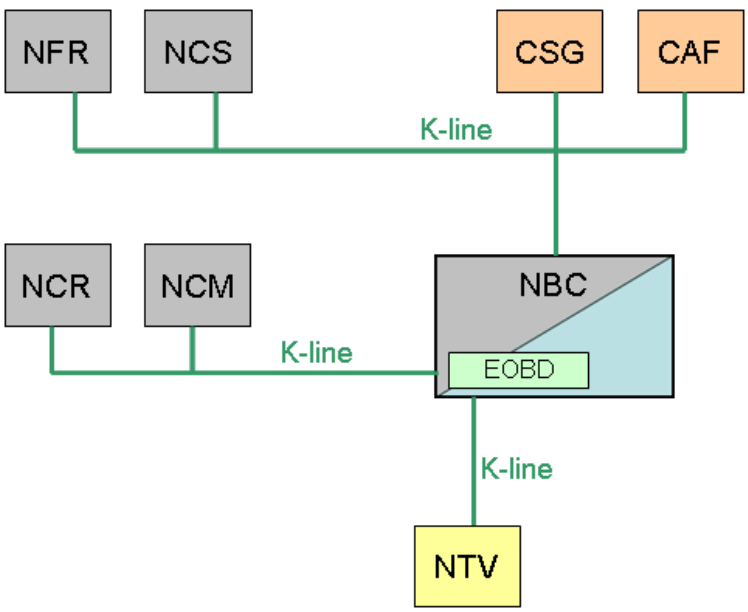
Note:
For Quattroporte vehicles from MY09 onward (restyling), a mobile phone unit (GSM-box) and TV receiver (NTV) are still available on request, but these items are integrated inside the NIT unit, they are no longer separate components. The TV receiver is in this case only available in combination with NIT from Bose (not available with NIT Marelli). Diagnoses of the TV receiver can be done through the NIT.

K-Line

The K-line is a serial line dedicated for the communication between various ECU's and the diagnostic tester unit. Data exchange over the K-line can be bi-directional. For example: reading out data from the ECU such as error codes and parameters, and sending data to the ECU during software programming. The protocol used by the K-line is standardised as ISO 9141.

More than one K-line is present in the vehicle. We can identify the following K-lines:

- K-line for NCM and NCR
- K-line for NFR, NCS, CSG and CAF
- K-line for NTV (Quattroporte up to MY08 only)

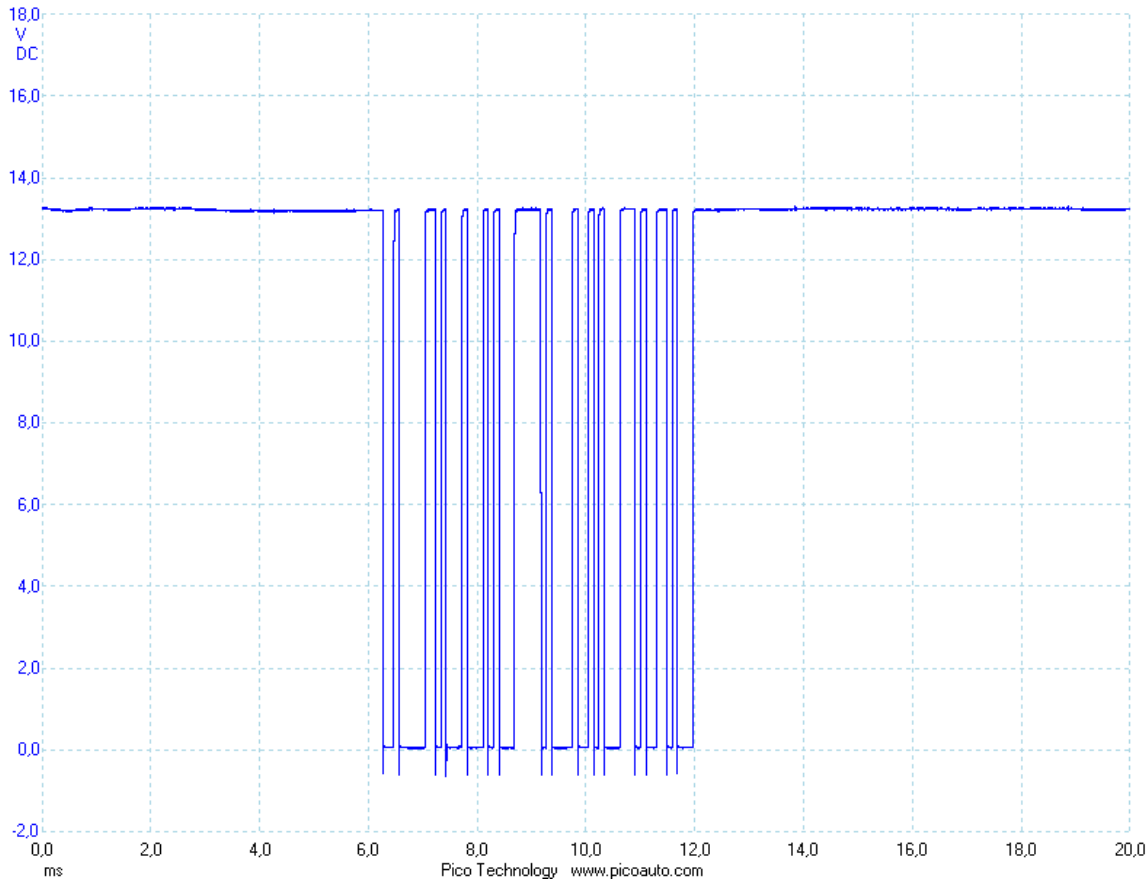


K-Line characteristics:

- Single wire, bi-directional communication line
- Used for diagnostic purposes
- Data speed of 10,4 Kbaud
- Line is +12V (Vbatt) during idling (= logical 1)
- Line is grounded (0V) when active (= logical 0)
- Message length is limited to 12 bytes
- "Terminal to terminal" communication. The number of connected nodes can nevertheless be more than two thanks to a well defined priority.
- Similar to the RS232 protocol as used in computer technology

Note: K-line for NCM is only used for Motronic ME7 systems. Motronic ME9 uses C-CAN for diagnostic data transfer.

K-line scope view



With the ignition key switched on, the voltage level on the K-line is equal to Vbatt. During data transmission with the diagnostic tester, the voltage drops to the ground level. This can be seen in the scope view above.

W-Line

The W-line is a recovery line for the immobilizer system between NBC and NCM and is used in vehicles which are fitted with the Motronic ME7 engine control system. It uses the same physical level as the K-line (ISO 9141).

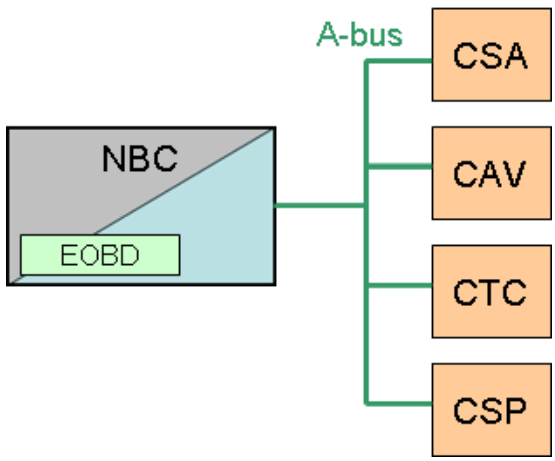
Note: the W-line is not indicated on the Florence diagrams on the previous pages. See the “Advanced Electronics 1” manual for more details.

A-bus

The A-bus (or CAN of Class A) has a goal the data transfer between a number of auxiliary ECU's.

The nodes on the A-bus are the following:

- Body Computer
- Volumetric alarm ECU (with integrated inclination sensor)
- Anti-theft siren
- Rain and twilight sensor
- Windscreen wipers ECU



A-bus characteristics:

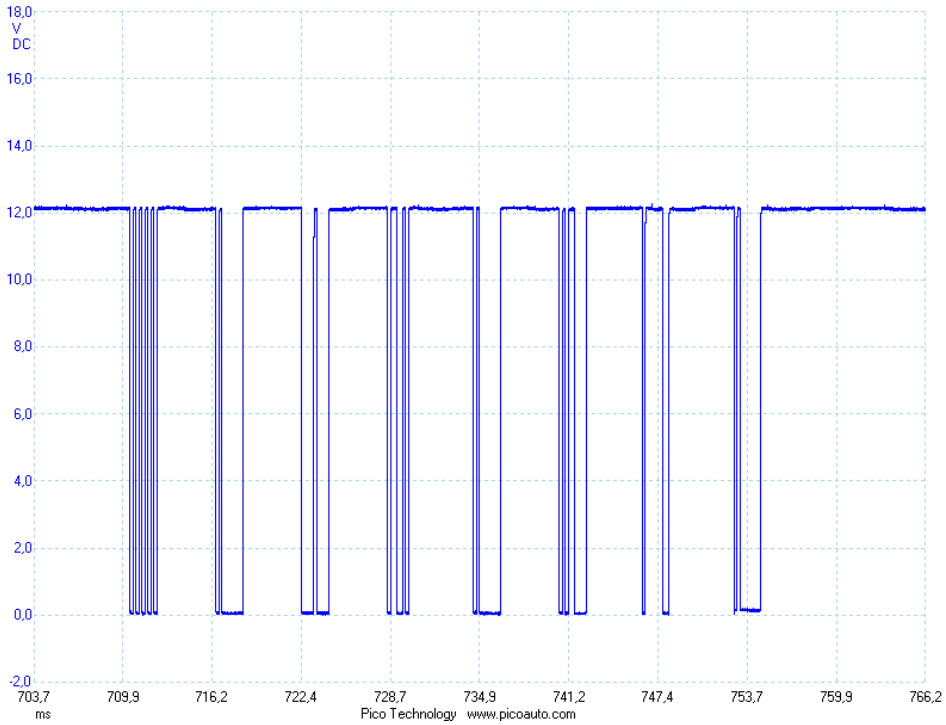
- Single wire, bi-directional communication line (Class A)
- Uses a data protocol similar to the K-line (ISO 9141)
- Multi-master bus system: every node can send and receive data. This is managed through a priority strategy of time based bus access.
- Data on the bus is always addressed to a certain node
- Repetitive communication: data on the bus is continuously repeated in time, as long as a command is valid
- Data speed of 4800 baud
- Line is +12V (Vbatt) during idling (= logical "1")
- Line is grounded (0V) when active (= logical "0")

Diagnostics of the A-bus ECU's

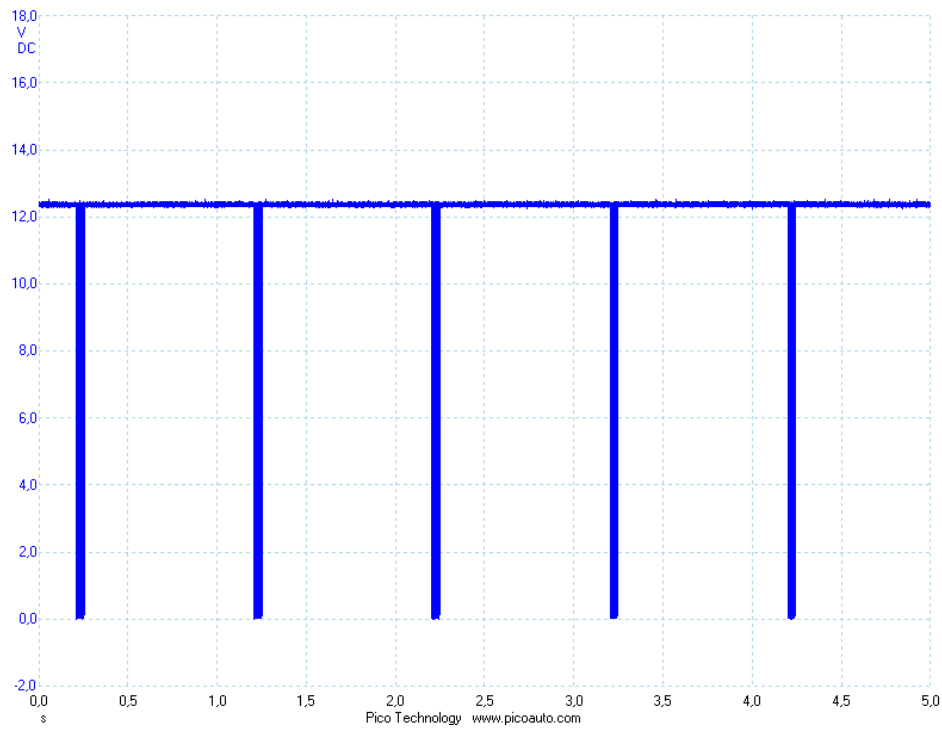
The different ECU's connected to the A-bus (CSA, CAV, CSP, CTC) are capable of performing an auto diagnosis on request of the body computer (NBC). They will send the result of the performed auto diagnosis to the NBC. The diagnostic information of these ECU's can be subsequently read out by the diagnostic tester through the NBC.

A-bus scope view

Data transmission on the A-bus. Similar to the K-line, the basic voltage level is equal to Vbatt, and pulled to ground during the transmission of data.

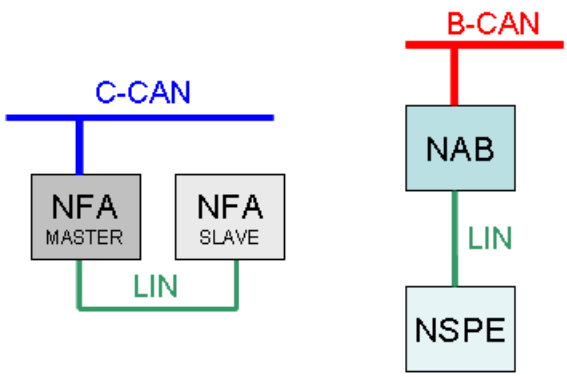


On the below scope view can be seen that data frames on the A-bus are repeated once every second.



LIN (Local Interface Network)

LIN is a local serial communication line with a dedicated function and is used for specific applications. It uses a protocol similar to the K-line (ISO 9141).



A LIN line is used in the following cases:

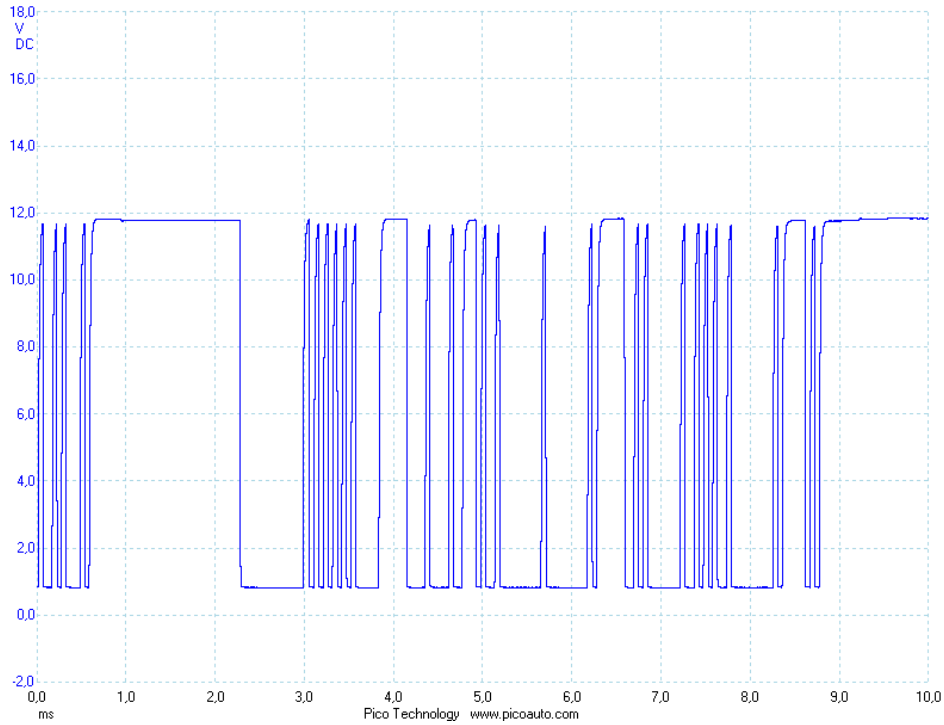
- Communication between both NFA nodes for the auto adaptive headlight system (GranTurismo and Quattroporte restyling).
- Communication between the NAB and NSPE nodes for the advanced weight sensing system (only for certain market specifications).
- Communication between NCL and the front and rear HVAC control panels (not used for diagnostics).
- Communication between NTP and the wheel antennas on vehicles fitted with TPMS.

LIN characteristics:

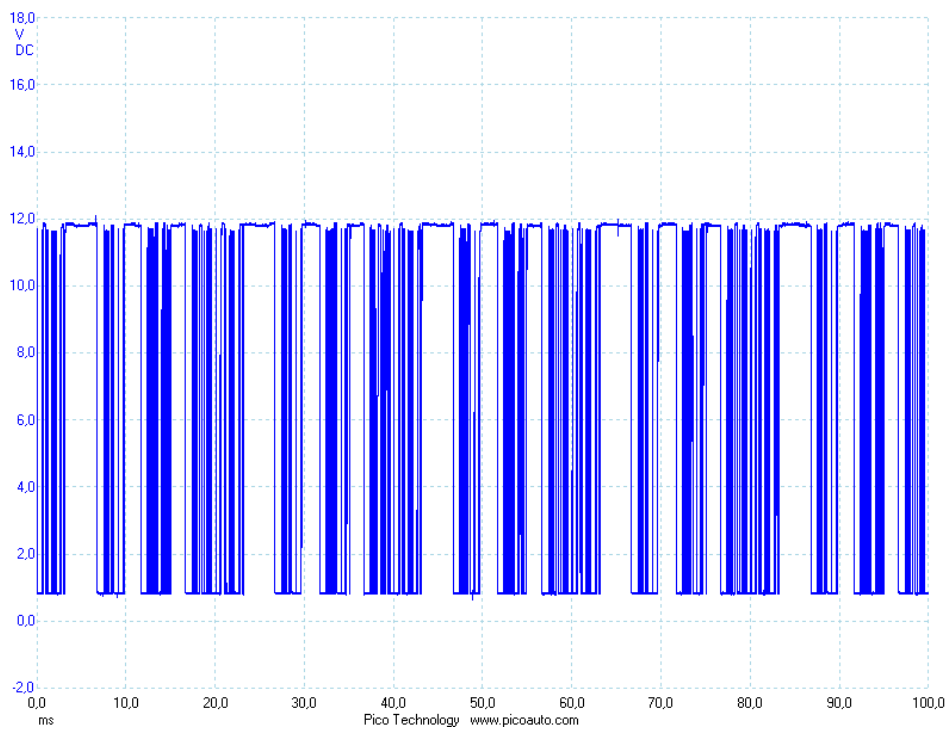
- Single wire serial bus, bi-directional
- Terminal to terminal communication
- Master-slave principle
- Protocol similar to A-bus and K-line
- Data speed = 20 Kbit/s
- Repetitive communication: data on the bus is continuously repeated in time, as long as a command is valid
- Line is +12V (Vbatt) during idling (= logical 1)
- Line is grounded (0V) when active (= logical 0)
- Active in key-on conditions

LIN scope view

A LIN line maintains the Vbatt level when idling. Data is put on the line by drawing the voltage level towards ground, creating by this way a sequence of digital bits.



On the below scope view, the repetitive character of the data communication on a LIN line can be clearly seen.



CAN Class A communication lines

Single wire serial communication lines as used in our vehicles (K-line, W-line, A-bus and LIN) fall under the category which can be indicated as "CAN class A".
Even if there are a number of differences between the various types of lines, such as operating speed and bus strategy, their operating principles are very similar.

No recovery for Class A: one characteristic of a Class A line is that there is no recovery strategy available. Due to the fact that the line is made of a single wire, a short circuit or open circuit results in an immediate dropping out of the line.



CAUTION

Always be extremely cautious not to generate short circuits while performing measurements or repairs on a Class A communication line. Since these lines are idling high (12v), a short circuit to ground in the line could cause fatal damage to the ECU's connected to it!

Current consumption of various ECU's and nodes in sleep mode

CAF	Head lights level control system ECU	0 mA
CAV	Volumetric alarm system ECU	1 mA - 8 mA (in surveillance mode)
CSA	Anti theft siren ECU	1 mA
CSG	Power steering ECU	0 mA
CSP	Rain and twilight sensor ECU	0 mA
CTC	Windscreen wiper ECU	0 mA
DSP	Hifi amplifier	0,5 mA
NAB	Airbag system node	0 mA
NAG	Driving position set up node	< 1 mA
NAS	Steering wheel angle sensor node	0 mA
NBC	Body computer node	< 12 mA
NCA	Automatic gearbox node	0 mA
NCL	HVAC system node	1,3 mA
NCM	Engine control system node	< 1 mA
NCP	Soft top node	
NCR	Robotized gearbox node	0,5 mA
NCS	Suspension control system node	0 mA
NFA	Adaptive head light system node	0 mA
NFR	Braking system node	0 mA
NIM	Inside roof node	0,22 mA
NIT	Infotainment system node	
NPB	Electric parking brake node	0 mA
NPG	Drivers door node	1 mA
NPP	Passengers door node	1 mA
NQS	Instrument cluster node	< 3 mA
NSP	Parking sensors node	0 mA
NSPE	Advanced weight sensing system node	
NTP	Tyre pressure monitoring system node	0,3 mA - 4 mA
NTV	TV node	
NVO	Steering wheel node	0 mA
NYL	Yaw rate and lateral acceleration sensor node	0 mA
GSM BOX	Mobile phone unit	< 6 mA
CBA	battery junction box	1 mA

Total sleep current per vehicle:

- GranTurismo: Min 25 mA / Max 35 mA (depending on the specification)
- Quattroporte: Min 27 mA / Max 38 mA (depending on the specification)

Body computer (NBC)

Magneti Marelli

BODY COMPUTER NODE

- The Body Computer Node (NBC) is an electronic component connected to the serial networks of the vehicle and controls the basic functions of the Mini F.L.ORE.N.C.E. architecture. (internal/external lights, immobilizer, diagnostics, heated rear window, door locking, alarm system, fuel level) and hosts the gateway between the B-CAN and the C-CAN network.
- The NBC also performs interconnection functions between the front and rear dashboard wiring and is connected to the dashboard ECU (CPL) by means of a connector on the front.
- On the front there is also a fixed EOBD connector used to perform diagnosis of the Engine Control Node via the K line and of the nodes connected to it as well as the unconnected systems (e.g. airbags) via the B-CAN line. The connected nodes can be programmed/characterised on the assembly line.

General functions of the Body Computer Node

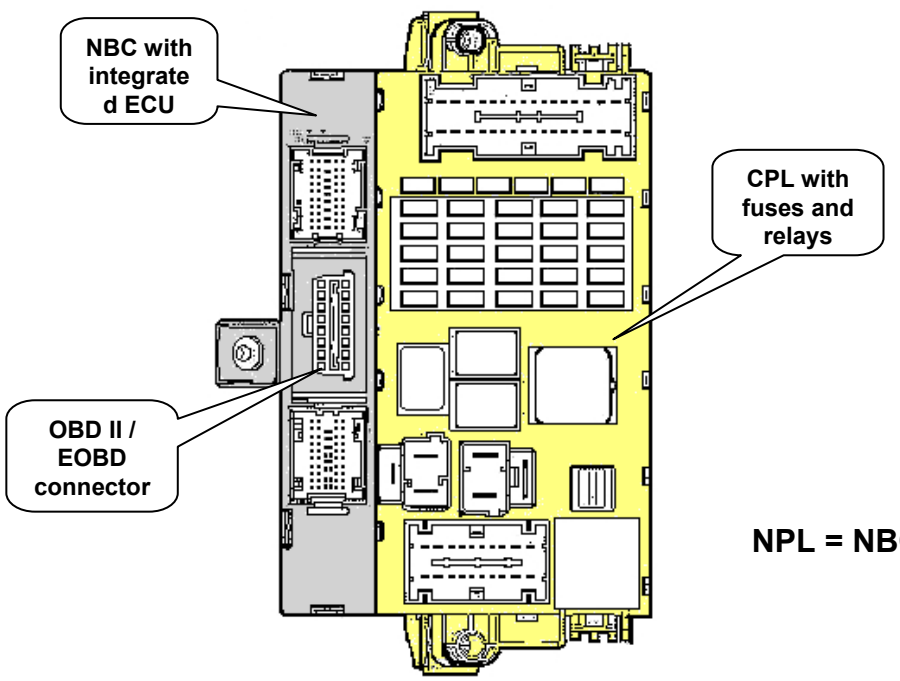
To summarise, the NBC performs the following functions:

1. It receives and transmits information on the B-CAN network (e.g. diagnosis, warning lights, commands, data)
2. It receives and transmits information on the C-CAN network
3. It hosts the gateway for communication between the C-CAN and the B–CAN network
4. It is connected to the front and rear dashboard wiring
5. It allows interfacing for diagnosis (EOBD)
6. It controls the low fuel consumption mode (Logistic Mode)
7. It is connected to the CPL to draw power/signals and drive relays.

In detail, we have the following functions:

- Dome light control with timed deactivation and dimming
- On/off output control on the relays: headlight washer pump, high beams, fog lights, low beams, rear window and devices
- On-off control of the RH/LH direction indicators or hazard lights
- On/off output control directly on the loads and light check function: front and rear position lights (RH and LH); front, rear and side direction indicators (RH and LH); number plate lights (RH and LH); stop lights (RH and LH); rear fog lights (RH and LH)
- On/off output control directly on the loads: hazard button LED, etc.)
- Acquisition and repetition of the vehicle speed signal
- Driver control for ideogram lighting
- Driver control for SBMT (load deactivation with key turned to OFF)
- Serial recovery line control (W) towards the engine ECU (immobilizer) for vehicles equipped with Bosch ME7 NCM

- Serial line control (A-BUS) towards rain/twilight sensor, steering column switch, motion sensing alarm ECU and tyre pressure ECU.
- Master of the entire system: control of its slave nodes and monitoring by other master nodes, protocol error monitoring and control, timing control.
- Diagnosis of the entire system: diagnosis information gathering, diagnosis control via Maserati Diagnosis.
- On/off signal acquisition: low beams, high beams, luggage compartment lock opening, heated rear window, luggage compartment lock, parking brake, hazard lights, RH and LH rear fog lights, fog light relay, LH direction indicators, RH direction indicators, parking lights, position lights, steering column switch, headlight washer, FIS, luggage compartment button, lid button, front brake pad wear, brake fluid level, reverse gear engaged.
- Analogue signal acquisition: fuel level, voltage alternator, battery voltage.
- Fuse status detection: stop lights, central dome light, RH and LH spot lights stop lights; door lock sensor signal acquisition.
- Provision for various new electrical functions.



NPL = NBC + CPL

The Body Computer is located underneath the dashboard at driver's side, close to the A-pillar. It forms a single unit with the dashboard junction box (CPL or Centralina Plancia). The dashboard junction box or CPL is an electromechanical unit which contains fuses and relays, and is connected to the front, rear and dashboard wiring harness.
The Body computer or NBC carries an internal ECU which represents the "brains" of the vehicle. Together with the CPL, the Body Computer forms a single set which is indicated as the Dashboard Node or NPL (Nodo Plancia)

SYSTEM EVOLUTION

The Dashboard Node went into production with the “L0“ version (Lancia Thesis origin) as from the Quattroporte to then go to version “L3“ (Fiat Croma origin) with the Quattroporte MY07, and the later vehicles M145 and 8C are all equipped with the “L3“ version.

The main difference between the two versions is the different position of the diagnosis lines.

Pin	M139	M139EV07	M145
1	N.C.	B-CAN H	B-CAN H
2	N.C.	N.C.	N.C.
3	N.C.	N.C.	N.C.
4	GND	GND	GND
5	GND	GND	GND
6	B-CAN H	C CAN-H	C CAN-H
7	K-line (NCM, NCR)	K-line (NCM (ME7), NCR)	K-line (NCM (ME7), NCR)
8	N.C.	N.C.	N.C.
9	K-line (CSG, CAF)	B-CAN L	B-CAN L
10	N.C.	N.C.	N.C.
11	N.C.	N.C.	N.C.
12	K-line (NFR, NCS)	K-line (NFR, NCS, CSG, CAF)	K-line (NFR, NCS, CSG)
13	K-line (NTV)	K- line (NTV)	not used
14	B-CAN L	C CAN-L	C CAN-L
15	N.C.	L - not used	L - not used
16	VBATT +30	VBATT +30	VBATT +30

AREAS WHERE THE NBC IS INVOLVED

Remote control learning procedure.

The Body Computer Node controls storage and recognition of the remote controls and sends the vehicle unlocking command.
When the procedure is started all the data used to program the remote controls is deleted from RAM. The data of the new remote controls is stored in the cleared RAM.
If no errors occur during the procedure and if the number of remote controls is between 1 and 8, the NBC compares the data in RAM with the data residing in EEPROM.
The remote controls present in EEPROM and not in RAM are deleted.
The remote controls present in RAM are stored in EEPROM for a maximum of 8 keys.

The errors that may corrupt the procedure are:

1. Remote control button not pressed or frames corrupted - repeat learning
2. Remote control already learned continue the procedure with another key
3. Battery charge low → replace the battery and repeat the procedure.

Alarm system

The Body Computer Node controls storage and recognition of the transponders and the remote controls and enables the electronic consent to start the engine and deactivate the alarm system. In the 8C, vehicle, also the mechanical command to start the engine is controlled via a button by driving a relay whose contact is connected in series to the start button.

Light check

This function allows always actively checking the light system of the entire vehicle, in particular for:

- Position and number plate lights
- Direction indicators
- Stop lights
- Rear fog lights

For each circuit, the following are checked:

- Open circuit or no light
- Short-circuit to ground (light short-circuited or wiring short-circuited to ground)
- Short-circuit to Vbatt (wiring short-circuited to Vbatt)

If any one of the above events occur, the Body Computer sends the failure status via the CAN network. The dedicated “light failure” warning light on the instrument panel comes on and at the same time the information is shown on the display.
In addition, for the stop lights the continuity of the protection fuse of the brake pedal switch is checked. When the position lights are on and one of the rear position lights fails, the stop light on the side where the failure has occurred comes on at reduced power so as to simulate the brightness of the position lights.
The system also detects any failure of the twilight sensor, if necessary turning on the generic failure warning light and at the same time showing the information on the display.
If the direction indicators fail, the light failure warning light on the instrumental panel comes on and the blinking frequency of the visual indication and the acoustic signal are increased; the blinking frequency of the external direction indicators and the LED on the Hazard button remain unchanged.

FIAT CODE SYSTEM

For the immobilizer function, the vehicles are equipped with an electronic system called FIAT CODE. FIAT CODE allows engine starting via the NCM only after receiving a previously stored secret code.
The second-generation CODE system is integrated in the Body Computer Node (NBC).
FIAT CODE consists of 5 essential elements (in addition to the Body Computer that acts as control unit):

- C-CAN line for communication with the NBC and the NCM
- Bidirectional serial line for recovery (W-line)
- Two electronic keys containing a transponder with a secret code
- An antenna that reads the code contained in the key transponders
- The NCM.

Operation

FIAT CODE allows launching engine control by the NCM via coded communication between the NBC and the NCM in the phase prior to starting.
After turning the key to ON, the NCM sends a code request to the NBC which responds only if it recognises the transponder stored.
If the secret code contained in the response is valid, the NCM continues with the usual engine control activity allowing the engine to be started.
The NCM can store the secret code only by means of a specific automatic programming procedure described further on.
FIAT CODE functionality is guaranteed also in the event of malfunctioning of other functions of the NBC.
Once FIAT CODE has recognised an enabled transponder, it also controls disarming of any alarm system.

FIAT CODE interaction with the electronic key

Each key contains a transponder with the IDENTIFIER CODE and the SECRET CODE.
As soon as the key is inserted, the transponder is energised and sends the identifier to the NBC via the antenna, which, recognising it as one of the enabled ones, continues with the recognition strategy of the cryptographic transponder.
If the identifier is not recognised, the procedure is aborted and the engine cannot be started.
Recognition of the cryptographic transponder occurs by means of a challenge-response algorithm with exchange of the encrypted code. The code recognition time is not more than 160 ms per attempt. The NTR in any case attempts to acquire the transponder for up to 1 second.

Communication between the engine control node and FIAT CODE

Communication between the NBC and the NCM is activated on C-CAN network in normal operating conditions. Each information exchange between the NBC and the NCM is guided by the NCM (the NBC never interrogates the NCM but only responds after it has made a request).
From KEY ON, the flow of code exchange operations between the NBC and the NCM depends on the status (virgin or stored) the engine ECU is in.
If the NCM is virgin, the procedure requires a fix code request from the NBC. In this way, the NCM learns the secret code and stores it. This procedure is called CODE RECORDING (the TEG must always be present in the TEG reader).
If the NCM is stored, the procedure requires two secret code exchanges between the NCM and the NBC.

Code recording

The CODE RECORDING procedure consists of storing the fix code in the engine ECU. Only after storing the identifiers, the secret code and the fix code, is the NBC ready to satisfy the code transmission request from the still virgin NCM.
After power on, the engine ECU initialises its software and, if it is virgin, requests the fix code.
If the NBC is not virgin, it responds by sending the fix code, but only after having recognised an authorised TEG. If there is an unauthorised transponder (key unknown) or no transponder is inserted, the NBC does not respond.
If FIAT CODE is virgin and there is no transponder in the TEG reader, the NBC will not respond to the fix code request from the NCM.

Code verify

This is the standard procedure repeated for the lifetime of the vehicle each time the user inserts the key in the ignition block and turns it to ON (KEY ON). This procedure enables engine starting if the transponder is enabled.
The code verify procedure continues also when the user sets the TEG to START position (CRANKING).
When the key is inserted in the ignition block, the NBC recognises whether the transponder is one of the enabled ones (up to 8 transponders available). If it is recognised, engine starting is enabled.
Simultaneously with KEY ON, the NCM sends a start authorisation request to the NBC. In response to this request, the NBC sends a response encrypted with Minikrypt to the engine ECU only if the transponder has been recognised as enabled.

If the NBC receives further verify requests, it must reread the transponder in the antenna before responding to the NCM only if signs of possible manipulation are visible (see below).
If the transponder recognition result is negative (transponder incorrect, no transponder readable, etc.), the NBC will send the code (incorrect transponder or no transponder) to the engine ECU and the “vehicle protection system failure” warning light on the instrument panel will come on.
If FIAT CODE is virgin and the NCM sends a fix code request, FIAT CODE, after recognising a transponder, responds by refusing authorisation to start.

C-CAN or W-line operating procedures

Communication between the NBC and the NCM occurs on the C-CAN line by default. If there is a C-CAN network failure, the recovery strategy is as follows:

- The NCM goes into recovery on the W serial line, requesting the code from the NBC; if the result is positive, starting is enabled.

- If there are problems on the W-line as well, after some retransmission attempts, the NCM goes into recovery by means of the diagnostic tester.

The recovery strategy is mainly controlled by the NCM which acts as master in the communication. The NBC, acting as slave, must always be ready to respond to the code requests coming from both the C-CAN network and the W serial line.

Communication on C-CAN network

Communication between the Body Computer and the NCM occurs by means of the following two CAN messages:

- IMMO CODE REQUEST
- IMMO CODE RESPONSE
- The IMMO CODE REQUEST is sent by the NCM and received by the NBC.
- The IMMO CODE RESPONSE is sent by the NBC and received by the NCM.

Communication on W-line

If because of a C-CAN network malfunction the system goes into the recovery condition, the code exchange between the NCM and the NBC must be on the W-serial line.
This code exchange occurs only for the CODE VERIFY procedure; a CODE RECORDING procedure can therefore not be run on the W-line.
The data exchange on the serial line occurs in the same way as on the C-CAN network. The NCM ECU is the master of the communication, while the NBC ECU responds to the requests received from the NCM.
The two messages IMMO CODE REQUEST and IMMO CODE RESPONSE transit on the serial line.

W-LINE ELECTRICAL CONNECTION CHECK (ONLY WITH BOSCH ME7 NCM)

As the dialogue on W-line occurs only in the case of recovery, an error condition would not be recognised if not at the time the line is used and hence the end customer would be unable to move the vehicle.
A checking strategy of the W-serial line has therefore been introduced for its diagnosis.
Approximately 1 second after KEY ON, a code is sent to the NBC on the W-line.
If the NBC does not repeat it correctly, a fault is signalled to the instrument panel for activation (with triple blinking) of the “passenger compartment protection system failure” warning light.

Protection codes

The FIAT CODE function is performed by exchanging secret codes between the various subsystems of which it is made up (transponder, antenna, NBC, NCM).

UNIVERSAL CODE: this is the code that the not yet programmed NBC sends to the NCM when it has recognised the presence of a transponder in the TEG. The “vehicle protection” warning light will come on with a frequency of 1.6 Hz and a 50% duty cycle. The blinking warning light means that the system is properly connected and functioning, but the vehicle is not protected by a code.

IMMO CODE: This is the basic code from which the secret code and the fix code are obtained. An automatically generated IMMO CODE is associated with each vehicle. All the other secret codes used by the FIAT CODE function are generated from the IMMO CODE.

SECRET CODE: This is the code residing in the transponder. It is stored in the transponders contained in the TEG when the transponders are programmed and in the NBC when the keys are programmed at the end of the line.

FIX CODE: It is stored in the NBC when it is programmed at the end of the line.
ELECTRONIC CODE (PIN): It is obtained from the fix code and is printed on the CODE CARD that is handed to the owner of the vehicle; it is a 5-digit decimal code (0 may not be used). It is used for protected access to the NBC memory in order to reprogram or program new keys.

IDENTIFIER: It resides in the transponder and is different for each transponder. It is stored in FIAT CODE during the programming procedure. The NBC controls an enabled identifier table and a disabled identifier table.

FIAT CODE function in the NBC

FIAT CODE is a function of the NBC.

The main functions of FIAT CODE are:
- Deactivate the alarm system after recognition of an enabled transponder (NBC)
- Energise the antenna to read the transponder in the key
- Receive the cryptographic code emitted by the transponder
- Store the secret NBC code
- Control a list of maximum 8 enabled NBC identifiers
- Control a list of permanently disabled NBC identifiers
- Control the C-CAN line to the engine ECU (NBC)
- Control activation of the warning light on the instrument panel by communicating with the NQS
- Perform NBC diagnosis.

Antenna

The antenna is energised by the NBC.
Because the antenna needs to be as close as possible to the transponder (for electromagnetic immunity, the small size and the limited range of the transponder), it is positioned on the front of the ignition block.

Transponder (in the key)

Each key contains a cryptographic transponder.

Operation

When the +15V signal arrives, the transponder is energised by the antenna and responds by emitting the secret code in a variable and encrypted mode.
If the code is recognised as valid, the NBC sends a coded signal to the engine ECU on its request allowing engine starting.
Up to 8 key transponders can be stored in the NBC.

Specifications

The transponder contained in the key has in its memory the coded information necessary for encrypted communication with the NBC.
The identifier differs from transponder to transponder in order to ensure, also when duplicate keys are requested, that there are no transponders with the same identifier.

POSITION LIGHTS / NUMBER PLATE LIGHTS

The position lights are activated when the end knob of the left-hand lever of the steering column switch is turned by one click.
Activation of the position lights is controlled by the Body Computer.

The position light control function is activated with the enable signals transmitted when the key is inserted in the ignition device and turned to ON (INT from the steering lock ECU) and with the command signals from the steering column switch, thus powering the four position lights.

As well as the position lights the number plate lights and numerous other internal lights are activated to illuminate the passenger compartment, the instrument panel and the controls (these lines are illustrated in the wiring diagrams of the components to which they refer).

The light activation and/or deactivation information is sent via CAN network, so that also the “position lights” warning light on the instrument panel is turned on/off. The instrument panel also activates night-time illumination of the screen-printed symbols.
The position lights can automatically be activated via the twilight sensor (integrated in the electro-chromatic rear-view mirror) if the AUTO function is set with the end knob of the left-hand lever of the steering column switch.

The twilight sensor is an infrared device that detects the variations in outside light intensity in relation to the light sensitivity set: the greater the sensitivity the lesser the intensity of outside light necessary to activate the position lights.

Activating the twilight sensor, a message is displayed on the instrument panel indicating the level of sensitivity set (1 to 3; default 2). This intensity can be adjusted by means of the MODE buttons on the left-hand external light control panel.

The “parking lights” function allows turning on the position lights and the number plate lights with the key in the ignition device turned to STOP. The logic is activated by pressing the PARK button on left-hand control panel. When the button is pressed, a “Roger beep” is sounded.

Turning the left-hand lever of the steering column switch (like for activating the direction indicators) you can choose to turn on the position lights on both sides of the vehicle and the number plate lights (lever in central position) or only those on one side (lever down to select the left-hand side, lever up to select the right-hand side).
The next time the key in the ignition device is turned to ON, the “parking lights” function is deactivated and reset.
The follow-me-home function allows keeping the position lights and the low beams on after turning the key in the ignition device to OFF or after removing it (STOP position) for a time equal to or a multiple of 30 seconds.

The function is activated by acting on the high-beam flash lever within 2 minutes from turning off the engine. Each time the lever is operated the light holding time increments by 30 seconds with a maximum time of 210 seconds. The instrument panel in its turn increments the time value by 30 seconds for the follow-me-home indication. The relative function page is displayed for 20 seconds from the last pulse of the steering column switch unless the function is deactivated with a reset command during display.
If the high-beam flash lever is held for more than 2 seconds, the function is deactivated (the lights are turned off and the remaining time on the counter and valid commands are reset). The function is also deactivated when turning the key in the ignition device to ON.

Proper functioning of the lights is checked by the position light and number plate light check function. The light check is performed on the vehicle branch involved (right-hand and left-hand side). For each of the two circuits the following are checked:

- Open circuit or no light
- Short-circuit to ground (light short-circuited or wiring short-circuited to ground);
- Short-circuit to Vbatt (wiring short-circuited to Vbatt);
- Replacement of the 5W with a 21W lamp.

If any one of the above events occur, the Body Computer sends the failure status via the CAN network. The “external lights failure” warning light on the instrument panel comes on and at the same time the information is shown on the display.
For driving safety, when the position lights are on and one of the two rear position lights fails, the stop light on the side where the failure has occurred comes on at reduced power (5W) so as to simulate the brightness of the position lights.
The system also detects any twilight sensor faults. If a fault is detected, the “generic failure” warning light on the instrument panel comes on and at the same time the information is shown on the display.

POSITION LIGHTS / NUMBER PLATE LIGHTS

Depending on the position of the end knob of the left-hand lever, the steering column switch sends two earth signals to the Body Computer:

- Position light and low-beam activation in manual mode
- Position light and low-beam activation in AUTO mode (automatic activation by the twilight sensor).

The two signals are of course incompatible with each other. Should both signals be present, the lights will always be off.
The Body Computer controls activation of the position lights.
The position lights are activated in AUTO mode by the twilight sensor integrated in the electrochromic rear-view mirror unit (signal via the A-BUS serial line).
The twilight sensor is powered by the INT line protected by the fuse of the switching ECU under the dashboard.
The position and number plate lights are activated by means of the “parking lights” button (PARK) on the left-hand control panel, which sends an earth signal.
The follow-me-home function is activated by means of the “high-beam flash” earth signal sent by the steering column switch to the Body Computer.
The Body Computer connects to the instrument panel via the CAN line to control the “position lights on” warning light and, in case of a circuit or light failure, the “external lights failure” warning light or, in case of a twilight sensor failure, the “generic failure” warning light, as well as all the messages on the display.

FUEL LEVEL SIGNALLING

The fuel level sensor signal is type analogue. It measures the resistive value of the sensor in the tank through two connections (signal and earth reference that arrive from the ECU).
The sensor resistance is approx. 300 ohm. With the aid of the microprocessor the interface reads a number corresponding to a resistance value. The NBC must also read the information coming from the B-CAN network, such as Key Status.
The NBC processes this value internally according to the logic described below based on the filling curve and tank capacity data stored in the NBC. The signal is then transformed into a percentage tank value and transmitted to the NQS on the B-CAN network. The measurement resolution is approximately 1 ohm.
The interface circuit must be protected against short-circuit to the power supplies.

Indication damping

With reference to the FuelLevel signal transmitted on B-CAN, the reserve fuel indication and signalling must be dampened with a time constant of 240 sec. + 10%. This value represents the time in which the pointer shifts from 0 to 63% of the actual level. The warning light follows the pointer and the hysteresis is on the litres.
The FuelLevelRawValue transmitted on C-CAN represents the unfiltered value of the fuel level.

Startup Status

The startup status is determined from KEY ON.
At KEY ON the NBC must send the fuel level value with a filter of 2 seconds and discretization of 250 msec on B-CAN, while the instantaneous unfiltered value will be sent on C-CAN.
The NBC must receive from the CILC the information relating to the tank characteristics/capacity as follows:

Type (Maserati single-pump):

Percentuale	100%	100% (4/4)	88%	75% (3/4)	62%	50% (1/2)	38%	25% (1/4)	**15% riserva**	0%
Quantità carburante [l]	93	86	82	70	58	46.5	35	23	14	0
Resistenza [Ω]	60	60	89.2	116.3	148.3	190.6	226.1	253.2	286.8	345

The NBC must recognise a “valid” signal in the following ohmic range: 0 – 450 ohm.
The fuel level reading at KEY ON must always be guaranteed even in extreme operating conditions, as defined in the Fiat specifications 9.90110. If the drive voltage is not stable, the frequency of the fuel level signal acquisition must be such as to allow correct indication on the NQS.

Fuel reserve warning light activation control logic

Activation/deactivation of the fuel reserve warning light on the NQS is controlled by the NBC by means of a specific signal on the B-CAN network.
At KEY ON, the status of the fuel reserve warning light must be congruent with the fuel level in the tank (no timing).
In normal operating conditions, in order to ensure coherence between activation of the fuel reserve warning light and the corresponding actual volume of fuel in the tank, and also to ensure that the warning light does not run into “blinking” phenomena, the NBC controls activation of the warning light on the NQS with a hysteresis on the time and on the litres i.e. the warning light is turned on with a 5-second delay with tank filling equal to 15% for a single-pump tank.
The warning light is turned off with a 20-second delay with tank filling of 19% for a single-pump tank.

Status of Shutdown

The shutdown status is determined from KEY OFF.
At KEY OFF the NBC will transmit the equivalent of 0% fuel level on the network.

SIGNAL D + ALTERNATOR

General characteristics

The NBC acquires the D+ signal from the alternator and transmits the alternator status signal on B-CAN and C-CAN.
The NQS receives the alternator recharge signal and controls the relative indication.

Insufficient battery voltage signalling

The NBC acquires the battery voltage in the range 6-18V by means of an analogue circuit able to guarantee a tolerance of ±5%.
The measurement made is filtered to eliminate any electrical disturbances, sampling it with a minimum period of 50ms and with a time constant of 1s.

Load deactivation control logic

At KEY ON no load deactivation strategy is implemented.
At KEY OFF the following load deactivation strategy is implemented:
• The moment the key is turned to OFF a 15-minute timer is set and when it runs out the loads are deactivated.
• The same 15-minute timer is set when any door is opened or when the door unlocking signal is received from the remote control.
• If another door is opened or a door unlocking signal is received within this time of 15 minutes, the running time is reset and the timer restarts the 15-minute countdown.
• When the time has run out, if one of the above described events occurs, timing will restart.

AUTOMATIC HEADLIGHT ADJUSTMENT CORRECTOR

Version with CAF
The NBC repeats the vehicle speed signal for the CAF, which controls it together with the data coming from the front and rear axle sensors and the low-beam activation signal from the CPL.

Version with NFA
The NBC transmits the direction indicator and reverse gear status on C-CAN, while the speedometer signal is taken directly from the C-CAN line.
The NFA returns the command for control of NFA failure signalling to the NBC via C-CAN, the NBC transfers the command to B-CAN for the NQS through the gateway functions.

In relation to the NFAM or CFD inputs, it directly controls the motor for adjustment of the front LH headlight and indirectly the front RH headlight, thanks to the NFAS ECU controlled by the CPS or the NFAM ECU via a serial line.
Headlight adjustment is enabled only when the low beams are on.
In the event of a failure, the CPS positions the headlights in such a way as to prevent blinding vehicles coming from the opposite direction.
The NQS will display the fault only if the NFAFailSts signal assumes the value Critical Error (for more information relating to the display, refer to the finalised NQS specifications).
In the event of a system failure, a message will be shown on the display with the specific ISO symbol blinking for 10 sec.
At the end of the time indicated, both the message and the symbol will disappear from the display. They will reappear (if the fault persists) at the next KEY ON with the same display cycle. For more details refer to the finalised headlight specifications.

ENGINE COOLANT TEMPERATURE AND OVERHEATING WARNING LIGHT

The NBC performs the gateway functions for the engine coolant temperature signal and the overheating indication.
The data is published on C-CAN by the NCM which acquires it from the sensor and is made available on B-CAN for the NCL and the NQS.
The NQS uses two pieces of information, one for the temperature indications and the other for controlling the overheating indications.

ENGINE RPM SIGNALLING

The NBC performs the gateway functions for the engine RPM signal.
The data is published on C-CAN by the NCM which acquires it from the sensor and is made available on B-CAN for the NCL, NQS and NTP.

MINIMUM ENGINE OIL PRESSURE SIGNALLING

The NBC performs the gateway functions for the minimum engine oil pressure signal.

NCM functions

The NCM acquires the signal from the engine oil pressure sensors, checks for abnormal conditions (minimum engine oil pressure and/or engine oil pressure sensor fault) and transmits the respective signals to the NQS.

NQS functions

The NQS acquires and controls the following:
- Minimum engine oil pressure from B-CAN
- Engine oil pressure sensor failure from B-CAN
- “Engine RPM” signal from the B-CAN network.

In relation to the *“OilPressureSts”* and *“OilPressureFailSts” CAN signals received* it controls the signals according to the logic in the table below.

Segnali CAN		Indicazione “Minima pressione olio motore”	Indicazione “Avaria sensore pressione olio motore”
“OilPressureSts”	*“OilPressureFailSts”*		
0	0	OFF	OFF
0	1	OFF	ON
1	0	ON	OFF
1	1	OFF	ON

Regarding signalling of the minimum oil pressure, the NQS uses the engine RPM data (*"EngineSpeed" signal* associated with the respective *"EngineSpeedValidData"* validation signal) to inhibit display of the relative message when the engine has not been started even though permitting the "minimum engine oil pressure" warning light to come on. If the NQS receives the signal "EngineSpeedValidData=NOT Valid" it will never display the minimum oil pressure message (see "NQS reference documents").

SPEEDOMETER SIGNAL

Vehicle speed signal control logic NFR:
The NFR calculates the actual vehicle speed value starting from the values received from the driving wheel sensors (of which the NFR calculates the mean) and from the actual wheel circumference value received from the NBC.
The wheel circumference value transmitted by the NBC is stored by the NFR in a non-volatile memory. This data is updated with that received in case of discordance.
The NFR in any case transmits the actual vehicle speed value even if one, two or three sensors fail.

Sensore ruota anteriore sx (Asx)	Sensore ruota anteriore dx (Adx)	Sensore ruota posteriore sx (Psx)	Sensore ruota posteriore dx (Pdx)	Valore velocità reale VehicleSpeed	Avaria valore velocità reale VehicleSpeedFailSts
-	-	OK	OK	f(Psx, Pdx)/2	0
OK	-	KO	OK	f(Pdx, Asx)/2	0
-	OK	OK	KO	f(Psx, Adx)/2	0
OK	OK	KO	KO	f(Asx, Adx)/2	0
KO	OK	KO	OK	f(Pdx, Adx)/2	0
OK	KO	OK	KO	f(Psx, Asx)/2	0

In cases where three sensors fail, the speed signal is constructed using the fourth sensor (these cases also include the roller test bench conditions with one of the rear sensors faulty).
If all four sensors fail, the fault is signalled by means of a specific signal.
The initial value of the wheel circumference stored in the NFR is 2000mm. This parameter will be overwritten if the NFR receives a value different from zero in the EOL message.

NBC:
The NBC periodically sends to the NFR the actual circumference value of the wheels used in the specific outfitting by means of the “RearWheelCircumference” and “ FrontWheelCircumference” signal.
By means of EOL programming (Maserati end of line), the NBC acquires the actual wheel circumference. In the absence of this data, the NBC must send the preset circumference value equal to 1440 mm (00 HEX).
The VSO signal is a frequency-modulated square wave with a 50% duty cycle.
The NFR supplies 14 pulses every actual wheel revolution. The actual wheel circumference value is periodically transmitted by the NBC by means of the “RearWheelCircumference” and “FrontWheelCircumference” signal.

By means of EOL programming (Maserati end of line), the NBC acquires the actual wheel circumference. In the absence of this data, the NBC must send the preset circumference value (00 HEX).

The values assumed by the VSO signal if the vehicle is stationary or the VSO faulty are:
- Vehicle standstill: Hardware VSO Signal is low
- VSO faulty: Hardware VSO Signal is high

INSTANTANEOUS CONSUMPTION SIGNAL
The NBC performs the gateway functions for the instantaneous consumption signals and the valid instantaneous consumption data that comes from the NCM and goes to the NQS.

ODOMETER SIGNAL

Function description
The odometer is used to display the total and trip mileage.

Strategies controlled by the NFR

The NFR transmits on C-CAN the pulses counted by the non-driving wheel sensors using two signals (LHRPulseCounter and RHRPulseCounter). The LHRPulseCounter and RHRPulseCounter are incremented only when the vehicle speed exceeds 0.1m/s.
The NFR signals failure of the individual non-driving wheel sensor through a special bit (LHRPulseCounterFailSts or RHRPulseCounterFailSts).
If only one non-driving wheel revolution sensor fails, the NFR transmits only the value acquired by the sensor that has not failed.
If both non-driving wheel revolution sensors fail, the NFR replicates the value of only one sensor of the driving wheel on that corresponding to the non-driving wheel disabling the relative FailSts bit.
If the non-driving wheel revolution sensor fails, the relative counter (transmitted by the CAN signal) is not incremented.
The NFR resets the counters (LHRPulseCounter,RHRPulseCounter) at each KEY ON.
In brief, the conditions are as follows:

Sensore ruota motrice sx (Psx)	Sensore ruota motrice dx (Pdx)	Sensore ruota non motrice sx (Asx)	Sensore ruota non motrice dx (Adx)	LHRPulse Counter	RHRPulse Counter	LHRPulse CounterFailSts	RHRPulse CounterFailSts
OK	OK	OK	OK	il contatore viene incrementato	il contatore viene incrementato	0	0
OK	OK	KO	OK	il contatore non viene incrementato	il contatore viene incrementato	1	0
OK	OK	OK	KO	il contatore viene incrementato	il contatore non viene incrementato	0	1
OK	OK	KO	KO	viene replicato il valore di Psx	il contatore non viene incrementato	0	1

If at least 3 wheel revolution sensors fail, no counter is incremented and both the failure bits are set to 1.

Strategies controlled by the NBC

The NBC receives via C-CAN the cumulative counters of the pulses acquired by the NFR through the toothed wheel sensors of the non-driving wheels.
Starting from the values received, the NBC calculates the relative distance (odometer signal) the vehicle has travelled and transmits it on B-CAN and C-CAN network using the signal with a resolution of [1 bit = 9.8m].
If one of the non-driving wheel sensors fails, the NBC calculates the odometer signal starting from the available one.
In the event that a fault is signalled for both non-driving wheel sensors, the NBC does not update the TravelDistance counter (condition where at least three sensors have failed).
Each time the NBC is subjected to a power-up procedure triggered by a reset or by return to sleep mode, and at each KEY ON, it resets the counter (but takes into account the travel distance in the previous cycle which did not determine a counter increment).
The maximum permissible error at battery disconnection is 9.8 m. The NBC replicates the LHRPulseCounter and RHRPulseCounter signals and the relative failure bits on the B-CAN network.

CRUISE CONTROL WARNING LIGHT CONTROL

The NCM acquires the Cruise Control commands and transmits the command signal to activate the Cruise Control indication via C-CAN.
The NBC performs the gateway functions for the command signal to activate the Cruise Control indication. The NQS acquires the signal from B-CAN and controls activation of the Cruise Control indication.

POSITION LIGHTS WITH INDICATION

The NBC acquires the position light command from the “external lights“ function (KEY ON).
It acquires the position light command from the “parking lights”, “follow-me-home” and “follow-me-car” functions (KEY OFF)
It activates the position lights (front LH, front RH, rear LH, rear RH) and side markers where present.
It controls position light failure and transmits the failure on B-CAN.
It transmits the position light status on B-CAN network.

The NQS acquires the position light status from the B-CAN network and controls the indication. It acquires the position light failure status from the B-CAN network and controls the indication.

“Position lights” indication
The command transmitted by the NBC to turn the position light indication on or off is coded in two signals (*LHParkTailLightSts and RHParkTailLightSts)*. The indication is turned on/off according to the logic in the table below:

LHParkTailLightSts	*RHParkTailLightSts*	Indicazione luci posizione
0	0	Non attiva
0	1	Non attiva
1	0	Non attiva
1	1	Attiva

PARKING LIGHTS

The NBC acquires the parking light command

1. It acquires the direction indicator commands (LH and RH) from the steering column switch
2. It activates the position lights
3. It activates the number plate lights
4. It transmits on B-CAN network the parking light status for turning on the warning light and requests acoustic signalling for activation of the “parking lights”.

Operating logic (KEY OFF)

This function allows turning on the position lights, the number plate lights and the side markers with the key turned to OFF to signal the presence of the vehicle when it is parked.

The logic is activated exclusively at KEY OFF by positioning the external light switch on Parking. With the direction indicator lever of the steering column switch you can select whether to turn on all the position lights (lever in central position - activation of *LDirectionSwitchIn* and *RDirectionSwitchIn*) or only those on one side of the vehicle (selection of the side by positioning the lever – activation of only one signal, either *LDirectionSwitchIn* or *RDirectionSwitchIn*).

COMANDI			RICHIESTE DI ATTUAZIONE			
Comando stazionamento (*ParkLight Cmd*)	Leva direzioni del devioguida		Luci di posizione lato sinistro (*LposLight ParkCmd*)	Luci di posizione lato destro (*RPosLight ParkCmd*)	Luci targa (*PlateLight ParkCmd*)	Side Marker
	LDirection SwitchIn	*RDirection SwitchIn*				
0	~	~	0	0	0	0
1	Non attivo	Attivo	0	1	0	0
1	Attivo	Non attivo	1	0	0	0
1	Non attivo	Non attivo	1	1	1	1

For the US market, this function is not active.

COMANDI			RICHIESTE DI ATTUAZIONE			
Comando stazionamento (*ParkLight Cmd*)	Leva direzioni del devioguida		Luci di posizione lato sinistro (*LposLight ParkCmd*)	Luci di posizione lato destro (*RPosLight ParkCmd*)	Luci targa (*PlateLight ParkCmd*)	Side Marker
	LDirection SwitchIn	*RDirection SwitchIn*				
0	~	~	0	0	0	0
1	~	~	1	1	1	1

Follow-me-home active: The left-hand and/or right-hand “parking lights” and “follow-me-home” logics (both at KEY OFF) are independent. Activating both generates activation of all the relative outputs. At the end of one of the two logic operations, the conditions requested by the still active logic are maintained.

Key-ON conditions: At KEY ON the “parking lights” function is deactivated and the position lights, number plate lights and side markers will therefore be turned off.

“Parking lights” indication
This warning light is turned on if the lights on one or both sides of the vehicle are on.
The command transmitted by the NBC to turn on the “position lights” indication is coded by the two signals *“LHParkTailLightSts”* and *“RHParkTailLightSts”*.
The indication is turned on/off by the NQS according to the logic in the table below:

LHParkTailLightSts	RHParkTailLightSts	Indicazione “Luci stazionamento”
0	0	Non attiva
0	1	Attiva
1	0	Attiva
1	1	Attiva

ECE48/01 REAR FOG LIGHT CONTROL WITH WARNING LIGHT

The rear fog lights are turned on by pressing the rear fog light button (activation of *RearFogLightSwitchIn*), only if the low beams or the fog lights are already on.
At least one of the two low-beam or fog light enable commands (OR logic) must therefore be present to turn on the rear fog lights.
The rear fog lights are turned off if the same button used to turn them on is pressed again or if the two enable commands are no longer active (the low beams and fog lights are off).
In the second case, the rear fog light command is also reset.
If the rear fog lights were turned off because there was no enable command, turning on the low beams or fog lights (enable restore) will not turn the rear fog lights on again. To turn them on, the command must be given with the button each time.

Comando retronebbia (*RearFogLight SwitchIn*)	**Comando Anabbaglianti (*LowBeamCmd*)**	**Comando fendinebbia (*FrontFogLight Cmd*)**	**LUCI RETRONEBBIA**
Non attivo	~	~	Spente
Attivo	0	0	Spente
Attivo	0	1	Accese
Attivo	1	0	Accese
Attivo	1	1	Accese

Key-OFF conditions:
When the rear fog lights are on (KEY ON), switching to KEY OFF will turn them off and also reset the rear fog light command, in the sense that at the next KEY ON the rear fog lights will stay off. To turn on the rear fog lights the button must be pressed each time.

Rear fog lights check
This function also checks the rear fog lights and transmits the relative status on CAN network. If a fault occurs, the NBC separately controls diagnosis of the two lights. Any failure status is stored by the NBC for subsequent diagnosis.

Driver	*Attuazione*	*Potenza MAX NBC*	*Potenza lampada*	**Sintomi diagnosticabili**
Driver HS potenza	Luci retronebbia Dx	21 w 100%	21W	CC-Vbatt o CA o Mancanza di una lampada da 21w / CC-GND
Driver HS potenza	Luci retronebbia Sx	21 w 100%	21W	CC-Vbatt o CA o Mancanza di una lampada da 21w / CC-GND

FOLLOW ME CAR

At KEY OFF, when the NBC receives a double door unlocking command, it activates the low-beam and position light relay for 30 seconds.
The low beams and position lights are turned off before the 30 seconds have elapsed when at least one of the following conditions occur:

- Key on
- Lock from remote control

The follow-me-home function has priority over the follow-me-car function.
If the follow-me-car function is activated when the follow-me-home function is active, it is ignored. If the follow-me-home function is activated when the follow-me-car function is active, follow-me-car timing is reset and follow-me-home is activated.

FOG LIGHT RELAY CONTROL WITH WARNING LIGHT

The fog lights are turned on by pressing the fog light button only if the position lights are already on.

Comando fendinebbia (*FrontFogLight SwitchIn*)	**Comando luci di Posizione (*PosLightCmd*)**	**LUCI FENDINEBBIA (*FrontFogLightOut*)**
Non attivo	~	Spente
Attivo	0	Spente
Attivo	1	Accese

The position lights enable command must therefore be present to turn on the fog lights. The fog lights are turned off if the same button used to turn them on is pressed again or if the enable command is no longer active (the position lights are off).
If the fog lights were turned off because there was no enable command (*PosLightCmd* = '0'), turning the position lights on again (enable restore) will also turn the fog lights on again.

Key-OFF conditions: When the fog lights are on (KEY ON) switching to KEY OFF will turn them off. At the next KEY ON the fog lights will turn on again.

LOW-BEAM RELAY CONTROL

Operating logic (KEY ON)
The NBC drives low-beam activation (relay activation) when receiving the low-beam command from the external light control.
If at KEY ON the command from the steering column switch is already active, the low beams must immediately be turned on.
When the command is no longer active or at KEY OFF the lights must be turned off.

Follow me home (KEY OFF)
The low beams can be turned on also at KEY OFF (only within a certain time) by the follow-me-home function.

Follow me car (KEY OFF)
The low beams can be turned on also at KEY OFF by the follow-me-car function without any display on the NQS.

No check is performed on the low beams.

POSITION LIGHT AND LOW BEAM ACTIVATION BY THE TWILIGHT SENSOR

At KEY ON, the twilight sensor every second communicates the information acquired on the outside light conditions to the NBC via the A-BUS serial network, regardless of whether it has been enabled by the user.

When the twilight sensor is enabled (light selector in 'Auto' position), the NBC informs the NQS on B-CAN network.

Having selected the level of sensitivity, the NQS sends this information to the NBC on the B-CAN network, which acts as gateway and returns this information to the twilight sensor on the twilight sensor.

The sensor sensitivity can also be varied after enabling the sensor by selecting the corresponding option in the NIT.

The NBC uses the message sent by the twilight sensor to control activation /deactivation of the external lights (position lights and low beams).

The message is sent periodically (every second) and per event each time the sensor sensitivity is varied.

Twilight sensor failure control

If one of the following faults occur:

1. Sensor failure signalling
2. No message on A-BUS serial network (detection time = 3s)

the NBC implements the following recovery strategies:

1. Light selector in 'Auto' position: the NBC sends the failure signal to the NQS and turns on the lights.

2. Light selector not in 'Auto' position: the NBC sends the failure signal to the NQS but does not turn on the lights (no recovery action).

Active function diagnosis

During a diagnosis session, the NBC may be requested to perform a diagnostic check of the twilight sensor. The NBC sends the message to the sensor via A-BUS network and communicates the result to the diagnostic tester. If during this operation the NBC is unable to communicate with the sensor, the response to the diagnostic tester may be:

- Serial line disturbed: the NBC has received 3 NACKs sent to the sensor.
- The module does not respond: the NBC has not received any result for the message sent to the sensor.
- The module does not perform the diagnosis: the NBC has received the result for the message sent to the sensor, but does not receive the response message within the set time.

KEY INSERTED SIGNALLING

The buzzer logic is controlled by the NBC.
At KEY OFF, when the front driver-side door is opened, the NBC activates the transponder to detect the key in the switch. If the key is detected, the NBC sends the command to activate the buzzer to the network and, consequently, the NQS activates its buzzer.
The buzzer will turn off if one of the following conditions occurs:

- The driver-side door is closed
- The key is removed
- Key on

If the door is open and the key is removed, the buzzer must turn off, and when the key is next inserted the buzzer will not be reactivated (solution currently used for the Ferrari/Maserati vehicles)

HIGH-BEAM RELAY CONTROL WITH WARNING LIGHT

The NBC turns on the high beams (relay activation) when it receives the "high beams on fixed" or "high-beam flash" command. The lights remain on for as long as one of the commands remains active.
The "high beams on fixed" and "high-beam flash" commands cannot be activated at the same time because of the actuator configuration.
During cranking, if the function is already active, the high beams are turned off, but the signal on B-CAN network remains ON.

FOLLOW ME HOME

Operating logic

This function allows timed activation of the position lights and low beams immediately after turning off the engine (KEY OFF) as follows:
after the transition from KEY ON to KEY OFF, the NBC keeps the output functions active for a time of 3 minutes ± 1sec, thus allowing execution of some functions also after KEY OFF.
If during these 3 minutes the NBC detects opening of one of the doors, it keeps the output functions active for a further 30 seconds ± 1sec.

Function activation

The function can be activated with the timing as indicated in F003 by means of the high-beam flash command from the steering column switch (follow-me-home activation).
When this command is received:
- The NBC activates the position lights and low beams for 30 seconds (countdown by a counter in the NBC).
- The NQS, reading the high level of the bit *"HighBeamSts"* (high-beam flash command) on the CAN network, activates the follow-me-home indication displaying the light activation time in seconds. This indication will remain active for 20 seconds.

For the output behaviour of the follow-me-home indication, see "NQS reference documents".

Activation time increment

When the function is active (position lights and low beams on), at each high-beam flash command:
- The NBC increments the NBC counter by a further 30 seconds for the light holding time for a maximum total time of 210 seconds. The command to increment the light holding time is recognised as valid by the NBC if less than 7 commands have been given from the last activation of the follow-me-home function and if the function is still active.
- The NQS, for every command valid for the NBC, activates the follow-me-home indication with the light activation time incremented by 30 seconds. This indication will remain active for 20 seconds.

Function deactivation (abort)

If holding the high-beam flash command for more than 2 seconds:
- The NBC turns off the position lights and low beams, resets the NBC counter for the light holding time and resets the counter of the 7 valid commands.
- The NQS turns off the follow-me-home indication and resets the relative light holding time.

The abort command does not necessarily need to be given within the time defined by KEY OFF, nor does one of the 7 commands need to be valid to increment the light holding time; for it to be valid it is sufficient that the follow-me-home function is active.
After the follow-me-home function has been aborted, it can be reactivated with the high-beam flash lever within the time defined as described in the operating logic.

Function end
When the light holding time has elapsed according to the counter in the NBC, the follow-me-home function is deactivated, therefore:
- The NBC turns off the position lights and low beams.
- The NQS resets the light holding time of the follow-me-home indication.
This indication is already off given that its light holding time (20 seconds) is less than the minimum light holding time (30 seconds).
Unless otherwise specified, all the times described above are understood with a tolerance of 5%.
Note that this function is strictly enabled at KEY OFF (described in the operating logic). At KEY ON the “high-beam flash” command produces only the high-beam flash (and the corresponding indication coming on).

Parking lights on: The right-hand and/or left-hand “parking lights” and “follow-me-home” logics are independent. Activation of both generates activation of all the relative outputs, and KEY ON.

Key-ON: La commutazione da Key-OFF a Key-ON con follow-me-home attivo comporta la sua disattivazione (come per l’abort), quindi vengono spente le luci e l’indicazione su NQS.

Luci e indicazione	ACCENSIONE	SPEGNIMENTO
Luci di posizione	All’attivazione del follow-me-home. [se è attiva la logica “luci di stazionamento” le corrispondenti luci sono già accese]	Allo scadere del tempo del contatore mantenimento luci accese (contatore NBC) o all’abort del follow-me-home. [se è attiva la logica “luci di stazionamento” le corrispondenti luci rimangono accese]
Luci anabbaglianti	All’attivazione del follow-me-home.	Allo scadere del tempo del contatore mantenimento luci accese (contatore NBC) o all’abort del follow-me-home.
Indicazione ‘follow-me-home’	All’attivazione del follow-me-home e ad ogni comando lampo luci ‘valido’ (bit “HighBeamSts” a ‘1’).	Dopo 20 secondi dalla sua accensione o all’abort del follow-me-home (bit “LowBeamSts” a ‘0’).

BLINKER WITH ALARM

The blinker function with alarm controls blinking of the direction indicators to signal an attempted theft. The function includes the blinker drive strategies in relation to the destination market.

Law obligations

The operating modes for the various countries are characterised mainly by the definition of the signalling action (for alarm and arming/disarming).
In any event, activation of the direction indicators must be in compliance with the European Directive 95/56/EC.

Operating modes

The operating mode parameters are defined in the table “operating modes” (which must periodically be checked and kept up to date by the suppliers).
In particular, signalling to the outside is as follows:
· BLINKER ENABLE IN ALARM:
indicates enabling of light signalling by means of blinkers during an alarm.
· BLINKER BLINKING IN ALARM:
indicates the duration of light signalling by means of blinkers in an alarm cycle.
· PAUSE BETWEEN ALARM CYCLES:
indicates the time interval that must elapse between one alarm cycle and the next.
· BLINKER FREQUENCY IN ALARM:
indicates the blinking frequency of light signalling by means of blinkers.
· TOTAL NUMBER OF ALARM CYCLES:
indicates the total maximum signalling cycles triggerable up to the next disarming
· NUMBER OF ALARM CYCLES FOR DOORS/ENGINE COMPARTMENT LID/LUGGAGE COMPARTMENT LID/KEY ON:
indicates the number of signalling cycles to be triggered in case of activation for perimeter surveillance, understood as the number of alarms to be triggered for each of the inputs indicated
· NUMBER OF ALARM CYCLES FOR MOTION/ANTI-LIFTING SENSORS:
indicates the number of signalling cycles to be triggered in case of activation of the external modules, understood
as the number of alarms to be triggered for each of the inputs indicated
· NUMBER OF ALARM CYCLES FOR CABLE CUTTING:
indicates the number of signalling cycles triggered by the siren in case a cable is cut.
· NUMBER OF EXTRA BLINKER CYCLES:
indicates the number of blinker cycles activated once the maximum number of alarm cycles has been reached.

Activation/deactivation of blinker in alarm

An alarm state is characterised by activation of optical/acoustic signalling consisting of activation of the siren and the direction indicators.
When the AlarmStartWarning information is received (also containing the cause that triggered the alarm), the NBC starts light signalling by activating a sequence of blinker alarm cycles, understood as blinking of the direction indicators for a time equal to BLINKER BLINKING IN ALARM alternated by a pause equal to PAUSE BETWEEN ALARM CYCLES.
The number of alarm cycles to be activated is determined in relation to the cause of the alarm and the operating mode identified for the destination market (AlarmMode).
The NBC interrupts signalling when it receives the AlarmDisarm information or at the end of the relative cycles.

Blinker cycle control

The NBC controls the type, number and duration of the alarm cycles in relation to the operating mode.
For example, if the operating mode includes 3 alarm cycles with a duration of 26s alternated by a pause of 6s, the NBC will behave as follows:

1. Blinker activation
2. After 26s blinker deactivation
3. 6-second pause
4. Repeat of steps 1, 2 and 3 until all the required cycles have been run.

The blinker cycles must be synchronous with the acoustic alarm cycles of the siren.

End-of-line programming (EOL)

Programming for the destination market is done only for the “alarm system” function: the information, represented by AlarmMode, is propagated to the submultiples of the alarm system in order to configure its behaviour.

Below is a list of the various operating modes:

MODE 1 DEFAULT MODE (EEC)
MODE 2 (Great Britain)
MODE 3 (Belgium)
MODE 4 (Holland)
MODE 5 (World/USA/JPN)
MODE 6 (temp)

Operating mode table (for the blinker function)

FUNZIONE	1	2	3	4	5	6	7
PAESE	CEE	G.B.	BELGIO	OLANDA	WORLD/ USA/JPN	Temp	RANGE
BLINKER IN INSERIMENTO/DISINSERIMENTO	SI	SI	SI	SI	SI	X	N/A
BLINKER IN AUTOINSERZIONE	SI	SI	SI	SI	SI	X	N/A
ABILITAZIONE BLINKER IN ALLARME	SI	SI	SI	SI	SI	X	N/A
LAMPEGGIO BLINKER IN ALLARME (S)	26	26	26	26	26	X	255S
PAUSA TRA CICLI ALLARME (S)	6	6	4	6	6	X	31S
FREQUENZA BLINKER IN ALLARME (HZ); D.C. 50%	2	2	2	2	2	X	20HZ
NUMERO CICLI ALLARME TOTALI	10	24	12	12	10	X	255
NUMERO CICLI ALLARME PORTE/COFANO/BAULE/KEY ON	3	8	3	3	3	X	31
NUMERO CICLI ALLARME VOLUMETRICI E ANTINCLINAZIONE	3	8	3	3	3	X	31
NUMERO CICLI ALLARME DA TAGLIO CAVI	3	12	3	3	3	X	31
NUMERO CICLI SUPPLEMENTARI BLINKER	8	8	0	2	8	X	31

The default operating mode is EEC (1) and it is customised in EOL.
This value can also be modified by downloading a new proxy file dedicated to the change of market. This operation must be performed with the diagnostic tester in order to customise the vehicle at the dealer.

DIRECTION INDICATORS/HAZARD LIGHTS WITH INDICATION

The hazard light command may be one of the following:
1. Dedicated button (acquired by the NBC)
2. Alarm system logic command (see F050)
3. From FIS signal (see F005)

The function will behave differently depending on the command.

In case 1 the logic is as follows:
1. The NBC directly acquires the hazard light command (Hazard button)
2. The NBC acquires the command and directly drives the hazard lights and the LED on the button
3. The NBC requests blinking of the direction indicators from the NQS

In case 2, the commands are directly acquired by the NBC which directly activates only the hazard lights without requesting blinking of the warning lights on the instrument panel and the LED on the hazard light button.

In case 3, the command sent after FIS activation is acquired by the NBC which activates the hazard lights, the indication on the NQS and the LED on the button. This way, case, the hazard lights cannot be deactivated with the button.

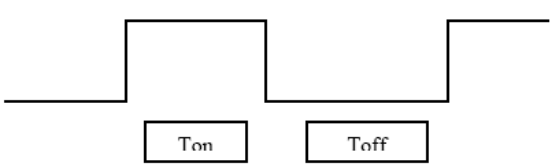
In cases 1 and 3, there is also acoustic signalling (see direction indicators/hazard lights acoustic signalling).

In cases 1 and 3, the hazard light activation signals coming from the hazard light command and/or from the FIS are controlled by the NBC in OR logic between the two activations. Therefore, the hazard lights will continue to be active until one of two signalling operations is requested.

The activation times of the hazard lights (front LH and RH, rear LH and RH and side LH and RH), the two warning lights on the instrument panel (direction indicator warning lights) and acoustic signalling must always be synchronised.

Direction indicators/hazard lights blinking characteristics

When the command is activated (LH, RH, hazard) the lights on the left-hand and right-hand side of the vehicle or all the lights simultaneously have to come on the first time within 1 second, i.e. in normal operating conditions they must start blinking as follows:



Frequency = 90 cycles/minute ± 15 cycles/minute
Ton = 45 %
Toff = 55 %

Operating logic - “Direction indicators” function

When receiving the command from the left-hand or right-hand lever of the steering column switch with a debounce time of 50 ms ± 10% (only at KEY ON), the NBC individually drives the direction indicators on the side of the vehicle selected according to the following logic:
a) Command time > 500 msec. **Direction change**
b) Command time =<500 msec. **Lane-change hold**.

Light check function

The light check is performed on the vehicle branch involved. The diagnoses listed in the paragraph “Function diagnosis” are performed on each branch.
When detecting a light failure, the NBC activates (logic state high) the CAN failure signals corresponding to the side involved:

“RHFTurnLightFailSts” + *“RHRTurnLightFailSts”* **RH SIDE**
“LHRTurnLightFailSts” + *“LHFTurnLightFailSt”* **LH SIDE**

If the NBC signals a fault condition (B-CAN signals of the **RH side** or the **LH side** active), the NQS turns on (only at KEY ON) the “direction indicators failure” indication.

Direction indicators recovery (KEY ON)

If a fault is found on one of the front or rear direction indicators on the side of the vehicle selected for the "direction indicators" or "hazard lights" function, at the same time the failure indication is turned on the nominal blinking frequency of the corresponding visual indication is increased ('LH direction indicators' or 'RH direction indicators’ for the "direction indicators" function, both for the "hazard lights" function). The blinking frequency of the external lights and the LED on the Hazard button however remains unchanged.

Operating status

The direction indicators, the relative warning light and the acoustic signalling must continue their activity synchronous with the frequency described above.
The activation times of the direction indicators on the side of the vehicle selected (front, rear and side), the relative warning light on the instrument panel and acoustic signalling must always be synchronised.

Status of Shutdown

The shutdown state is determined by deactivating the direction indicators (central position of the left-hand lever of the steering column switch) or by KEY OFF.
The function is disabled. If the direction indicators are deactivated, the lights must turn off within 1 second from the command.

Diagnosis of function

The diagnosis on all the light outputs will be activated by the Body Computer only if the command signal is present.

Driver	*Attuazione*	*Potenza MAX NBC*	Potenza Lampada	Sintomi diagnosticabili
Driver HS di potenza (AV05- - LN18-AZ50)	Luci di direzione ramo sx	47 W 50%	21 W A (Incandescenza) + 12 W P (Led) + 5 W L (Incandescenza)	CC-Vbatt o CA o Mancanza di una lampada da 21w 12 W / CC-GND
Driver HS di potenza (AZ31-LN06-AZ51)	Luci di direzione ramo dx	47 W 50%	21 W A (Incandescenza) + 12 W P (Led) + 5 W L (Incandescenza)	CC-Vbatt o CA o Mancanza di una lampada da 21w e 12 W / CC-GND

Failure of one of the lights of the branch is signalled by increasing the nominal blinking frequency of the warning lights on the NQS and acoustic feedback (buzzer) of at least 90% and at maximum 110%.
The blinking frequency of the external lights remains unchanged.
It is understood that the fault condition to be displayed is distinct by branch; the blinking frequency is doubled only if the branch activated has a fault.

RH/LH STOP LIGHTS

The CAN signal BrakeSwitchSts is sent by the NBC when the brake pedal is depressed or on request of the NFR.
To activate the stop lights after receiving a stop light command, the NBC executes an OR operation of the two STOP (N.O.) signal inputs.
This function also checks the stop lights and transmits the relative status on CAN network. If a failure occurs, the NBC controls both the fail signals.

Logic description

Startup status
When the brake pedal is depressed or on request of the NFR, the two stop lights must start activating within 10 ms.
Steady State
The stop lights must remain on for as long as the brake pedal is depressed or the request from the NFR persists.
Status of Shutdown
The stop lights must be turned off within 40ms from when the brake pedal is released or the request from the NFR terminates.

Diagnosis of function

Driver	*Attuazione*	*Potenza MAX NBC*	*Potenza Lampada*	Sintomi diagnosticabili
Driver HS potenza	Luci Stop SX	21w	5 W (led)	CC-Vbatt o CA o Mancanza di una lampada/ CC-GND
Driver HS potenza	Luci Stop DX	21 w	5 W (led)	CC-Vbatt o CA o Mancanza di una lampada / CC-GND

REVERSE LIGHTS AND REVERSE SIGNAL

For versions with a manual gearbox and an F1 gearbox, the reverse lights relay is driven directly by the reverse gear engagement command (manual or electronically-controlled gearbox). For versions with an automatic gearbox the reverse lights relay is driven by the NBC.

Description of output behaviour: Reverse lights for versions with F1 gearbox

StartUp:
When reverse gear is engaged, the reverse gear relay is directly activated.
In parallel, the NBC acquires the reverse gear engaged state from the reverse light output and transmits it to the CAN network (for other functions).

SteadyState:
If reverse gear remains engaged, the reverse lights remain on and the NBC transmits the reverse gear engaged status to the CAN network.

ShutDown:
When reverse gear is disengaged, the reverse lights must turn off. The NBC transmits the reverse gear disengaged status to the CAN network.

MINIMUM OIL LEVEL INDICATION

NCM Functionality

At key-on, NCM, acquire immediately the minimum oil level signal from sensor. When contact to ground is closed means oil level is sufficient, otherwise when contact is open the level is insufficient.

After proper signal processing, the NCM transmits via Can the “OilLevelSts” signal to the Dashboard according to the following logic:

OIL LEVEL	OIL LEVEL SWITCH	OILLEVELSTS
Low	Open	ACTIVE
Normal	Closed to ground	NOT ACTIVE

To avoid incorrect warnings the evaluation of the oil level signal must be evaluated only after the Key-ON.

NCM receives from CAN network (NYL) the signals related lateral and longitudinal acceleration(LongAcceleration, LatAcceleration).

By these messages the NCM calculate the lateral and longitudinal slopes of the vehicle. If the values of slopes led between the threshold of hysteresis curves, the oil level measurement will start.

The strategy outputs a valid measure in case oil is not circulate in engine, so the measurement has to be performed before cranking phase (KeySts = CRANK ON). Following each key-off/key-on transition a new measurement has to be performed.

Microprocessor has to manage also timer function (unit is minute). At first battery connection timer will be reset. Timer is set to value “T_OilLevCountdown” after measurement or when, during measurement, the signal KeySts assumes values CRANK ON.During key-on period, timer decreases of one unit every minute until a minimum value (T_OilLevCountdown_min). At next key-off timer decrease to zero.

At key-on, if following condition is true:

1) Switch of oil level is open
2) Timer = 0
3) Vehicle is parked on plane (long. Slope < P_Long_max & lateral slope < P_Lat_max)
4) KeySts = ON (status befor CRANK ON)

If one of above described condition is False, excepting following notes, no visualization are performed by IC.

Remarks:

At each battery connection the variable linked to time (see condition 2) has no effect on measurement.

In case of oil level low already present, at next key-on, if conditions 1, 3, 4 are True, the previous visualization of oil level low is shown.

In case of oil level low already present, at next key-on, if condition 3 is False, the previous visualization of oil level low is shown.

Remarks:
At each battery connection the variable linked to time (see condition 2) has no effect on measurement.
In case of oil level low already present, at next key-on, if conditions 1, 3, 4 are True, the previous visualization of oil level low is shown.
In case of oil level low already present, at next key-on, if condition 3 is False, the previous visualization of oil level low is shown.

Smudginess filter

The algorithm has to not consider bad measurement caused by temporary mass of oil in proximity of sensor, generated by mechanic movement of internal engine. The smudge may endure several minute from engine stop. At key-on, in case following conditions are True:
1) Switch of oil sensor is closed
2) Timer > 0
3) Vehicle is parked on plane
4) KeySts = ON (status befor CRANK ON)
a comparison with previous measurement is performed; if before key-off the Oil level low condition was stored and:

A) if one of following condition is True:
- engine coolant temperature measured at the end of measurement is bigger (or equal) than parameter “TempSmudgeFilter” and time elapsed is bigger than “T_WarmOilSmudgeFilter” from last key-off
- engine coolant temperature measured at the end of measurement is smaller than “TempSmudgeFilter” and time elapsed is bigger than “T_ColdOilSmudgeFilter” from last key-off any visualization are performed on display.

B) If any condition described at item “A”, is satisfied, the level corresponding to last right measurement of oil level low is shown and stored.
Otherwise at key-on, with above mentioned condition, if before key-off there was no stored “oil level low”
condition, no message on display are shown.
At the end Of measurement timer is reset however after time equal to “T_OilLevCountdown” starting decrease as shown above.
Smudginess filter is enabled with tester. As default must be not enable.

NQS Functionality

The dashboard receives the signal “OilLevelSts” and its plausibility check. When this signal indicates that the oil level is under minimum conditions, the dashboard shall provide to indicate this information lighting a telltale and writing a message on the display. The dashboard shall also provide to check the light during Key on for a determined period.

LIGHTING + LIGHTS

The NBC acquires the position light status signal.
It acquires the external light signal from the twilight sensor.
It activates lighting for the cigarette lighter, power socket and ashtray.
It transmits the external light status on the B-CAN network.

The NBC powers lighting of the screen-printed symbols/icons of the power socket, ashtray and cigarette light if the position lights are on and the sensor detects a night-time condition.
This enabled condition is transmitted on the CAN network also for other functions. The status of this signal is determined according to the following table:

DOME LIGHT AND FRONT AND REAR SPOT LIGHT CONTROL

The NBC controls the front dome light and the rear RH/LH dome lights.

Dome light control description

When any one of the front or rear doors are opened:
- the front dome light comes on
- the rear dome lights come on
-a 3-minute (±10%) timer is activated, which is reactivated each time a door is opened.

When all the doors are closed:
At KEY OFF:
- a 10-second (±10%) timer is activated
At KEY ON:
- the dome lights are immediately turned off
When the key is removed while the device relay 2 is active:
- the front dome light comes on
- the rear dome lights come on
- a 10-second (±10%) timer is activated.

Door locking (with the remote control, the pawl on the driver and passenger door, autoclose from PE):
- the front dome light goes off.
- the rear dome lights go off.

Door unlocking (with the remote control, PE handle, the pawl on the driver and passenger door)
- the front dome light comes on
- the rear dome lights come on
- a 10-second (±10%) timer is activated.

Front dome light activation from control on front dome light panel
The button on the front dome light panel acts only locally on the relative dome light, in particular:
- If the dome light is off, it is turned on
- If the dome light is on, it is turned off (also when FIS is active).

This has priority over all the events that may modify the on/off status of the dome lights. In other words, if the dome light is on, acting on the local button, it will be turned off, and if it was off, it will be turned on unless the key is removed or the door is unlocked with the remote control or pawl. In this case, the dome lights remain on for 10s even if they are turned off with the local control.

• If in the condition where the front dome light was turned on with the local control and an event occurs that causes the dome light that is still off to come on, when the time related to the event that has occurred has elapsed, the dome light must not turn off.

• If in the condition where the front dome light was turned off with the local control and the dome lights are on, a subsequent event that occurs before the dome light that is still on is turned off, must not cause the dome light that is off to come on (for example, if a door is opened, the dome lights are turned on and a 3-minute timer is set. If during this time, a dome light is turned off with the local control, it will remain off also if subsequent events that should turn on the dome light occur within the 3 minutes).
The timing with activation from the button is 15 minutes ±10% with the key in OFF position, while there is no timing when the key is in ON position.
t3=15m (if KEY OFF) if the button on the front dome light panel is pressed.

Rear dome light activation with the control on the rear dome light panels
The rear dome lights are driven by a switch and by the NBC according to the diagram shown in Fig. 2. The switch, if set to ON, disconnects the light from the NBC; therefore, the NBC will not have a load.

Spotlight activation
The front spotlights (RH/LH) are activated only with the local control and are timed at 15 minutes ±10% if activated with the key turned to OFF, while they are not timed if activated with the key turned to ON.
There is no dimming with spotlight activation/deactivation.

Command from FIS activation
When the FIS activates, the dome lights are turned on for 15 minutes ±10%.
If the FIS is rearmed, the dome lights must be off.

KEY ON event
When this event occurs, the status of the doors is checked, and if they are all closed, the dome lights are turned off checking that:
- the dome lights have not been turned on with the local control
- the dome lights have not been turned on by FIS.

An independently controlled timer is associated with each of the above mentioned events:
• td = 2s: dome light dimming time
• t1 = 3m: timing for dome light activation for door open
• t2 = 10s: timing for dome light activation for closing of all the doors
• t3 = 15m: timing for front dome light activation with local control at KEY OFF
• t5 = 15m: timing for rear dome light activation with local control at KEY OFF
• T4 = 15m: timing for dome light activation by FIS.
• T6 = 10s: timing for dome light activation for key removal (RF) or KEY OFF (PE) or door unlocking
• t7 = 15m: timing for spotlight activation at KEY OFF

The NBC does not run any check on the SBMT status for dome light activation. Therefore, even if an event requires dome light activation by the NBC and the time defined by SBMT has run out, the NBC will in any case attempt dome light activation (as if it were a +30) even though, failing the power supply, this dome light will not turn on. In all the cases described above, turning on and off must occur:

- simultaneously if it involves more than one dome light/spotlight
- progressively (dimmer) with a time of 2 seconds (±10%); the light flow must be activated linearly. The dimming time of 2 seconds (±10%) is always added to the times described above, both when turning on and turning off.

During turn-on and turn-off with dimmer any event that requires turning on/off, generates inversion of the dimmer. In all the cases described above, except those where the dome lights are turned on with the controls on the dome light panel, the last command takes priority.

LUGGAGE COMPARTMENT MOTION SENSING ALARM WITH DEACTIVATABLE ULTRASOUND SENSORS

The CAV integrates the motion sensors and controls the software functions. Sensor activation/deactivation is controlled by the A-BUS serial line.
The CAV also acquires the button that controls disabling of the module and drives the LED integrated in the button which signals when the control is activated.
The functions of the motion sensors are described in the component specifications “Ultrasound motion sensors”.

Logic description (normal and recovery conditions)

Law obligations

The alarm system must be homologated according to Directive 95/56/EC and in compliance with the requirements of the European insurance companies and their associated technical centres ((e.g.:.: Germany: Allianz, ...; Great Britain: Thatcham, ...; France: S..R.A., ... etc.). The following is the state of the art of the relative information in FIAT Auto’s possession. The suppliers are responsible for carefully keeping this rapidly changing information up to date. This information, if contrary to what is defined in these specifications, must immediately be communicated to FIAT Auto.

Motion sensor module activation

When the alarm system is activated (receipt of the information VPSAlarmStartArming), the NBC sends a request for diagnostic testing of the module by sending the DIAUS command on the A-BUS line.
In response to the DIAUS command, the module sends the EDIAUS command (with timing described in the “A-BUS serial line” specifications) which describes the component status.
The procedure ends generating the VPSAlarmUSSts information which informs the alarm system whether or not the motion sensor module is functioning.
If the module is declared as not functioning, it is excluded from the system until the next arming.
N.B: If the response to the DIAUS command does not arrive in the times indicated, the respective module is declared not functioning.
If the diagnosis produces a positive result on functioning of the sensor module, the NBC sends the IUS command to the motion sensor module requesting arming; the sensors go into a surveillance state.

Motion sensor module disable

In the rest state with the alarm system deactivated, the motion sensing alarm can be manually disabled.
Disabling the motion sensing alarm results in the motion sensors not being armed, which disables the emission of ultrasounds.

Disabling with dedicated button

When the EXCLUS message is received on A-BUS, the NBC considers the motion sensors disabled for the next alarm activation/deactivation cycle.
This means that when the message is received, the modules are disabled and the diagnosis and activation actions will therefore not be executed when the alarm system is activated (VPSAlarmStartArming).
The “sensors disabled” condition remains until the next alarm deactivation command (VPSAlarmDisarm): from this moment on the sensors are once again active.
If other EXCLUS commands are received, disabling in any case remains active until the next deactivation of the alarm.

Surveillance

During surveillance when the alarm system is active, the motion sensors protect the passenger compartment checking if there are any moving bodies.
If an intrusion attempt is detected, the motion sensor module sends the ALRUS command to the NBC.
When the command is received from the A-BUS line, the information VPSAlarmUSDetected is sent to the alarm system for signalling of the attempted theft.

Luggage compartment opening

During surveillance, unlocking and opening of the luggage compartment may be requested. The F087 sends the VPSAlarmInputInhibit request to activate temporary disarming of the sensor using the DUS command.
The motion sensor module is reactivated with the IUS command when the VPSAlarmInputEnable information is received and the system returns to the normal surveillance state.
The operations are not executed if the sensor is not functioning.
The module is of course also reactivated after a new subsequent closing of the luggage compartment (VPSAlarmStartArming).

Motion sensor module disable for low battery voltage.

If the battery voltage remains below 8.5V ± 5% for more than 30 minutes, the motion sensor module is deactivated to safeguard the battery life and the possibility of subsequent engine starting.

Anti-intrusion strategy on A-BUS line

If during surveillance the NBC reads a DUS command on the serial line, it interprets this condition as an intrusion attempt in order to disable the motion sensing alarm.
It therefore sends the information to the alarm system for signalling activation.

Disarming

When the information is received, the NBC deactivates the motion sensor module by means of the DUS command on A-BUS line.

Diagnosis of function

The moment the alarm system is disarmed, the status of the motion sensor module is requested by means of the DIAUS command to which the module responds:
- ultrasound module not functioning
- it does not respond (communication with the module not possible – serial line interrupted).
The information received must be sent back to the alarm system by means of the VPSAlarmUSSts information.

Active diagnosis

During a diagnosis session, the NBC may be requested to perform a diagnostic check on the ultrasound module. The NBC therefore sends the DIAUS command and communicates the EDIAUS result to the diagnostic tester.
If during this operation the NBC is unable to communicate with the module, the response to the diagnostic tester will be:
· Serial line disturbed (in the case where 3 NACKs have been received in response to the DIAUS command).
· Module not responding (in the case where an EDIAUS response has not been received).

FUEL TANK DOOR OPENING CONTROL

At KEY OFF, pressing the fuel tank door button causes the fuel tank door to open.
The activation time of the fuel tank door command is 400 ms.
The NBC acquires the signal requesting opening of the fuel tank door, checks the key status, drives the opening relay, acquires the status of the switch on the fuel tank door and transmits the door status on B-CAN.

ALARM SYSTEM

The NBC acts as alarm system coordinator. The sequence of operations to be performed on the system modules is hence described in this function, while the activities related to the individual subsystems are described in the relative functions.
In addition, the alarm system must be homologated in accordance with Directive 95/56/EC and in compliance with the requirements of the European insurance companies and their associated technical centres (e.g. (e.g.:.: Germany: Allianz, ...; Great Britain: Thatcham, ...; France: S..R.A., ... etc.). The following is the state of the art of the relative information in FIAT Auto's possession. The suppliers are responsible for carefully keeping this rapidly changing information up to date. This information, if contrary to what is defined in these specifications, must immediately be communicated to FIAT Auto.

General description

The alarm system detects and signals intrusion attempts and theft of the vehicle.
It is composed of the following components:

· Stand-alone siren
· Sensors (door switches, anti-lift, motion ...)

The alarm system keeps the vehicle perimeter, vehicle movement and lifting (if the motion and anti-lifting sensors are present), power cable cutting and the ignition key block under surveillance. If it detects an intrusion or theft attempt, it generates optical alarms (blinking of the direction indicators) and acoustic alarms (sounding of the siren) in compliance with Directive 95/56/EC and the regulations in force in the destination country.

Arming of the alarm system is indicated by the direction indicators coming on permanently with a simultaneous beep of the siren.
At this point, a deterrence warning light/LED will start blinking intermittently to indicate the surveillance status.
When the system is armed the motion sensing alarm and/or the anti-lifting alarm can be disabled.
Disarming of the alarm system is indicated by a double-blink of the direction indicators with a simultaneous double-beep of the siren. The alarm system is also disarmed when inserting an enabled key, which the immobilizer and/or the Passive Entry system recognises.

System states

System operation is coordinated by the NBC which sends/receives commands to/from external modules via the A-BUS serial line. The list and the description of the commands are given in the “Technical specifications of the A-BUS serial line”.
The alarm system may be in eight different states:

• DEACTIVATED;
• REST;
• ARMED;
• SURVEILLANCE;
• ALARM ;
• DISARMING;
• PROGRAMMING;
• DIAGNOSIS

Each of these states is described in the following paragraphs.

Deactivated

The alarm system goes into deactivated state each time an enabled key/CID (VPSCIDFoundCntrl) is recognised by the immobilizer (VPSTxpIDCntrl) or by the Passive Entry system.
This operation de facto disarms the alarm. In the deactivated state the alarm system does not respond to the commands of the receiver or the Passive Entry system.
The alarm system goes from deactivated to rest state when the key is turned to OFF

Rest

The rest state is the basic state the alarm system is in.
From this state the alarm system can go into:
· diagnosis: when a diagnosis session is activated by means of the diagnostic tester connected to the NBC
· surveillance: when wishing to protect the vehicle by sending an arming command and going through the arming phase
· deactivation: when an enabled key is recognised by the immobilizer/Passive Entry system.
In rest condition, the NBC continues to acquire the +15 signal state to inhibit the system from going to the surveillance and especially to the alarm state. This information distinguishes the two basic modes of the rest state: vehicle in use (+15 signal present) or vehicle abandoned (+15 signal absent), which preludes the surveillance state.

Motion and anti-lift sensor disable

In rest condition the motion and anti-lifting sensors can be deactivated at KEY ON or at KEY OFF as long as NBC is in RUN. When the messages are received after the alarm has been armed, the sensors are not activated after the alarm has been armed, the sensor is not activated.

Armed

The arming operation allows the alarm system to go from the rest to the surveillance state.
This operation is always inhibited when the +15 signal is present.
The alarm system is armed the moment the doors are locked (VPSAlarmONCntrl), which may occur by pressing the remote control transmitter button or by means of the Passive Entry system, and is signalled by activation of the direction indicators (controlled in the same way as the remote control system) with simultaneous sounding of a beep. Both the signalling operations are activated/deactivated for each operating mode (parameters “BLINKERS ON/OFF and “BEEP ON/OFF”).
When the command is received, the NBC activates the alarm system arming procedure within 100 ms as described below:

1.Arming in progress signalling:
- Sending of VPSAlarmMode information to identify the operating mode.
- Sending of VPSAlarmStartArming information to activate diagnosis of the alarm system modules.
The VPSAlarmStartArming information also gives the go ahead for optical/acoustic signalling the moment the system is armed.

2. System Diagnosis:
Plausibility check on the door switches (2 or 4) and luggage and engine compartment switches (perimeter alarm). If it is detected that one of the doors or lids is not closed, that door or lid is excluded from the surveillance.

3. Sensor status check:
-the information is received maximum 3 seconds after the system has been armed. If the siren is not OK, “siren already on” or “siren does not respond”, the system actuates two blinks of the blinkers by means of the information (0.5 ON, 0.5 OFF)
- The information is received from the motion sensor module maximum 4 seconds after the system has been armed.
-the information is received from the anti-lifting sensor maximum 4 seconds after the system has been armed.

4 - Diagnosis information display:
Arming problems are signalled by:
- Sounding of a warning beep 4 seconds after the door locking/alarm arming command.
- Signalling of the type of problem by means of the deterrence warning light:
a) Blinking at 8 Hz for 2.5s if the motion sensors are faulty
b) Warning light on permanently for 10 seconds if one or more of the following causes for the fault are found:
Siren failure
Anti-lifting sensor failure
If both faults occur simultaneously, signalling as in a) above is given priority.

5 – Module arming:
After receiving the results in response to the diagnosis, the functioning modules (excluding the siren) are enabled.

6 - Siren arming:
If the siren functions properly, heart-beat control on the serial line is activated.

7– Arming terminated – end of procedure:
The alarm system declares the arming phase concluded by means of the VPSAlarmArm information.
Finally, the deterrence warning light is driven by the door locking system.

Interruption for disarming request
If during the arming phase a door unlock command is received (corresponding to alarm system disable) (VPSAlarmOFFCntrl), the procedure is interrupted and the system goes to the disarming phase.
If optical or acoustic signalling is in progress, it must be interrupted to give the go ahead for signalling of disarming.

If the results on the module state do not arrive in the times indicated, the respective module is declared not functioning. If a non-functioning module is detected, an alarm system failure will be signalled by means of the VPSAlarmFailCntrl message.

Self-arming – valid for the Belgian market

The self-arming operation allows the alarm system automatic and timed change from the rest to the surveillance state.
There are two self-arming modes.

1 - From KEY OFF:
· KEY OFF is detected
· The self-arming counter start counting
· The counter reaches the value “SELF-ARMING TIME” set in EEPROM
· The NBC checks if a valid transponder/CID is present
· If a valid transponder is present and/or the flag “ALARM SELF-ARMING WITH TRANSPONDER/CID RECOGNISED AND ENABLED” = 1 ⇒ self-arming is executed regardless of the door status
· If a valid transponder/CID is not present ⇒ self-arming is executed regardless of the door status.
2 – PASSIVE mode (from last door status):
KEY OFF is detected. The first self-arming counter starts counting (fixed time = 2 minutes).
If an open ⇒ close transition is detected within 2 minutes on the driver’s door or on the last lid (second flag in EEPROM), a second counter starts counting (value “SELF-ARMING TIME (check enabled by “SELF-ARMING FROM DRIVER’S DOOR CLOSING” = 1 and “SELF-ARMING FROM LAST LID CLOSING” =1).
If a close ⇒ open transition is detected on any of the doors or lids, the second counter is reset within the countdown time and counting restarts from the value set in the TABLE.

The second counter reaches the value “SELF-ARMING TIME”
· the NBC checks if an enabled transponder is present
· if an enabled transponder is present and “ALARM SELF-ARMING WITH TRANSPONDER RECOGNISED AND ENABLED” = 1 ⇒ self-arming is executed
· If a valid transponder is not present ⇒ self-arming is executed
· If upon expiry of the self-arming time (2 minutes) no door status transitions have occurred, the system exits without arming the alarm. The counter is reset at the next KEY OFF.

NOTE: For both the modes described, during the self-arming cycle the system must continuously.

Perimeter surveillance

The NBC checks the state of the six inputs coming from the four doors and the two lids. If one of these changes its state for more than 500ms, the NBC recognises an intrusion attempt.

External module disable for low battery voltage

If the battery voltage remains below 8.5V ± 5% for more than 30 minutes (value programmable in EEPROM), the NBC disarms the external modules (motion sensors, anti-lifting sensor, external input modules) to safeguard the battery life and the possibility of subsequent engine starting.

Protection against false alarms due to an NBC reset

During the surveillance phase, an external disturbance or an intrusion or theft attempt may cause the NBC to reset and re-initialise its functions.
In this case, the NBC must check whether the alarm was armed before the reset so that the external modules can be re-armed, except those disabled at the last arming.
In case of a reset, no optical/acoustic signalling to the outside must occur.

Alarm activation

During the surveillance phase, the alarm may be triggered not only by the perimeter protection but also by the external modules (ultrasound, anti-lifting,...) or by the siren (for cable cutting).
When information type VPSAlarm…Detected is received, the NBC immediately goes into the alarm state, triggering the cycles for the type of alarm received.

Luggage compartment opening/closing control

The luggage compartment opening command (from the remote control or the Passive Entry system) is accepted in the following states: Deactivated, Rest, Surveillance and Alarm.
During the armed and disarmed states, any request is ignored.
If the system is in surveillance or alarm state, when it receives the luggage compartment opening command, it disables the external motion sensing/anti-lifting modules (message to disarm the alarm system input modules), disables the luggage compartment input from the perimeter alarm (the door and engine compartment lid inputs remain active) and activates blinker signalling.
Disabling of the perimeter alarm is intrinsic in the NBC which simply does not take any switching of the luggage compartment switch into account.
If within 2 seconds from command recognition (from the remote control) the luggage compartment switch does not change its state (from luggage compartment closed to open), the system rearms the motion sensing, anti-lifting and perimeter alarms.
In particular, if the alarm is armed, the blinkers are activated only if the input is under surveillance (luggage compartment switch functioning at previous arming) and the alarm system is active.
Optical signalling must indicate that a door or lid has been unlocked from the remote control/Passive Entry system and it must be repeated at every unlocking command.
The 2-second timing to detect a switch state change ensures that the vehicle is also protected against intrusion through the luggage compartment. If the luggage compartment has been left open and a luggage compartment opening command is received, when the 2 seconds have elapsed, not having detected any changes in the state of the switch, the system rearms the motion sensing/anti-lifting alarm.
Optical signalling must indicate that a door or lid has been opened from the remote control/Passive Entry system.
The modules are rearmed when the information is received.

NOTE: Luggage compartment opening and subsequent closing must also be signalled when there is an active hazard; in this case, signalling will start at the end of the ON/OFF cycle of the hazard lights followed by a pause.

Alarm

If one of the surveillance sensors identifies an abnormal condition (attempted or actual intrusion, tampering with and/or theft of the vehicle), the alarm system goes into the alarm state. An alarm state is characterised by activation of optical/acoustic signalling consisting of activation of the siren and the direction indicators.

Signalling
Signalling consists of a succession of alarm cycles, understood as the phase in which optical/acoustic signalling to the outside is active.
Signalling is activated by sending information to the various submodules of the alarm system. This information also contains the cause that triggered the alarm so that each module can generate signalling coherent with the operating modes in the various countries.

Storage of the alarm cause
For diagnostic purposes, track must be kept of the causes of the alarms detected by the NBC.
The NBC must therefore store the last 10 causes of an alarm in a table, associating with each cause the state the alarm system was in when it was armed.

The following alarm causes can be stored (alarm from...):
- Driver-side door
- Passenger-side door
- Rear left-hand door
- Rear right-hand door
- Ultrasound sensor
- Anti-lifting sensor (if present)
- Cable-cut siren
- Luggage compartment lid
- Engine compartment lid
- +15
- +30 for cable cutting
- Intrusion on the siren with incorrect DSIR command
- Intrusion on the external modules
- Incorrect heart-beat

For each alarm cause the state of the system must be stored describing the cause that triggered the alarm:
- Driver-side door open
- Passenger-side door open
- Rear left-hand door open
- Rear right-hand door open
- Engine compartment lid open
- Luggage compartment open
- Alarm system armed by means of self-arming
- Alarm system armed by owner (by means of remote control, Passive Entry system,…)
- Ultrasound sensor defective
- Anti-lifting sensor defective (if present)
- Siren defective
- Serial line not working

From the alarm state the system goes into the following states:

1. rest: with a disarming command or at KEY ON when the immobilizer or the Passive Entry system recognises an enabled key.
2. surveillance: when the alarm cycles triggered have been run.

Disarming

The alarm system can be disarmed when it is in the surveillance or the alarm state.
It is disarmed by means of the remote control, which sends a command to the NBC to disarm the alarm system the moment the doors are unlocked.
When the information is received the alarm system modules are disarmed and the optical/acoustic signalling relative to the disarming phase is activated.
This information must be sent within 100ms from receipt of the disarming command: the command is accepted also when the +15 signal is present.
Upon disarming, the NBC interrupts the perimeter alarm and, where applicable, all the countermeasures in progress.
The alarm system can also be disarmed passively by:
- Inserting an enabled key in the ignition switch and turning it to position +15.
When the alarm system detects the +15 signal, it checks for the presence of an enabled key and, if the response is affirmative, disarms the alarm.

- The presence of a valid CID in the passenger compartment the moment the +15 signal is given.
If the user gets into the vehicle when the alarm system is active, the moment the +15 signal is given, the system checks for the presence of a valid CID in the passenger compartment and, if the response is affirmative, disarms the alarm system.
This operation is, for example, necessary when the CID has discharged and the driver-side door is opened by means of the mechanical key pawl thus activating the alarm system. Positioning the CID in Garage position, the alarm can be deactivated.
After disarming and at first KEY ON, the ECU signals any motion, anti-lifting, perimeter, +15 and +30 alarms that have occurred, sending the intrusion and theft attempt messages to the instrument panel.

LUGGAGE COMPARTMENT AND DOOR OPENING SIGNALLING

The NBC acquires the negative signals from normally open switches for door and luggage compartment opening and transmits the door/luggage compartment status on the B-CAN network.
It sends the signals to the alarm system for perimeter surveillance.
The NQS acquires the door status from B-CAN and displays the status.

DOORS, LUGGAGE COMPARTMENT AND FUEL TANK DOOR LOCKING /UNLOCKING CONTROL

Introduction to the locking/unlocking control strategy

The function controls driving of the door locking/unlocking motors in relation to the locking/unlocking requests coming from the door pawls, the remote control, the internal vehicle buttons and from other functions in the vehicle (e.g. Passive Entry).
In general, the door/luggage compartment locking/unlocking control strategy is performed by the NBC. The NBC also activates the luggage compartment locks while the NPP and NPG nodes activate the door lock motors according to the commands transmitted by the NBC.
In the following the functions performed by the various nodes (NBC, NPG, NPP, NQS) are described first and then the "door locking strategy" as a whole is defined.

NBC functions

Door control

Door unlocking:
From the setup menu it can be selected whether to unlock all the doors or only the driver-side door.
Based on this selection, the NBC transmits on B-CAN the unlocking command for only the driver-side door or for all the doors.
Based on the unlocking command transmitted, the NBC updates the "locked"/"unlocked" status of the individual doors and then transmits it on the B-CAN network.
In addition, if the NBC receives the door unlocking signal from:
the NPG: it must take the setup into account
the NPP: both doors must be unlocked
This ensures that unlocking of the driver's door with the key pawl or the internal handles has the correct effect on the other locks.

Door locking:
Having received the door locking command (internal status to the NBC), door locking is controlled by the NBC and is always actuated on both doors using the CAN signal sent to the NPG and the NPP.
Based on the locking command transmitted, the NBC updates the "locked"/"unlocked" status of the individual doors and then transmits it on the B-CAN network.

Actions from the control panel

If a door is open when the door locking button is pressed, door locking is inhibited.
When the unlocking buttons on the control panel are pressed when the doors are locked from the outside, nothing happens. The buttons are therefore disabled until the doors are unlocked from the outside or in case of KEY ON.

Unlocking command inhibition when the doors are open
Once any door locking command has been received, the NBC checks the open/closed state (F091) of the doors, and if one door is found open, no activation command is sent to the door/luggage compartment nodes.

Mechanical lock alignment
Having detected the transition from door closed to open, the NBC checks the congruence between the logic state of the door (locked/unlocked) and the physical state of the door (open/closed), and if the result is negative (incoherent locked/open condition) it activates a 500 ms timer and after timeout sends a central door unlocking command on the network and updates the logic state of the doors.

Vehicle locking/unlocking signalling
In order to ensure proper functioning of the system, it must be signalled whether the vehicle has been locked/unlocked.
To this end, the NBC transmits the information on the B-CAN network.

Luggage compartment lock control
The luggage compartment lock is controlled directly by the NBC, which checks the state in relation to the information.
The function therefore receives the requests and calculates the luggage compartment state (locked/unlocked). However, it does not activate any lock drive as the locked/unlocked state is simply a logic state to which no mechanical movement corresponds (in fact, there is no locking/unlocking motor but only a release motor).

Luggage compartment locking/unlocking
The NBC receives the state to be actuated. Consequently, the NBC actuates the luggage compartment state (logic state).
Based on the locking/unlocking command transmitted, the NBC updates the “locked”/”unlocked” state of the luggage compartment and then transmits it on the B-CAN network.

Step lights on mirror
The moment the doors are unlocked with the remote control,
the signals that allow the door nodes to turn on the step lights on the mirrors are sent on the B-CAN network. The moment the doors are locked, the signals are updated to allow the door nodes to turn off the step lights on the mirrors.

Locking/unlocking actuation by the commands sent by the NBC on the B-CAN network
The NPG receives the commands from the B-CAN network and, consequently, drives the lock to the locked or unlocked state.

Locking/unlocking actuation from the motor bars
The vehicle can be locked/unlocked manually by means of the mechanical key or the internal handle.
In this case, the door node acquires the changed state of the motor bar and, consequently, actuates the door unlocking motor to execute the manoeuvre.
In addition, the changed state of the motor bar is transmitted to the NBC on the B-CAN network.
The NBC in its turn, depending on the setting on the NIT, transmits on the B-CAN network the commands to request the NPP to lock/unlock the other doors.

NPP FUNCTIONS

Locking/unlocking actuation by the commands sent by the NBC on the B-CAN network
The NPP receives the commands from the B-CAN network and drives the lock to the locked or unlocked state.

Locking/unlocking actuation from the motor bars
The vehicle can be locked/unlocked manually by means of the mechanical key or the internal handle. In this case, the door node acquires the changed state of the motor bar and, consequently, actuates the door unlocking motor to execute the manoeuvre. In addition, the changed state of the motor bar is transmitted to the NBC on the B-CAN network. The NBC in its turn transmits on the B-CAN network the command to request the NPG to lock/unlock the other doors.

DOOR LOCKING STRATEGY

This paragraph describes the overall strategy of the door locking sub-system, integrating the functions of the individual nodes described in the paragraphs above.
The central door locking strategy is as follows:
1. An input event (be it a request from the remote control, the key pawl, the internal handle or any button in the passenger compartment) is received by the NBC which updates the locked/unlocked state of the individual doors and communicates it to the system by transmitting it on the B-CAN network.
2. The changed state generates a locking/unlocking command which is transmitted on the B-CAN network to all the nodes that need to actuate it.
3. The NPG and NPP nodes receive the command and, consequently, act on the lock motor to actuate it. **No** feedback is given to the NBC at the end of the operation.
Based on the above, the NBC is simply a collector of commands that update the system to the “desired” state, that is, the state into which the vehicle must go. If for reasons of faults on the locks this state cannot be reached, no information is given to the NBC, **which as a result does not update**
the state, but maintains the “desired” state.
Therefore, the “repulsion” concept of the conventional door locking systems is no longer implemented. In fact, the new concept is **“command actuation where possible”**.

The absence of signalling is however acceptable, since:
• The door locking function does not signal any fault states of the lock. In any event, these fault states are due to real HW malfunctions of the lock, which are identified by the customer when acting on the door (which does not open) or by means of optical feedback on the safety knobs (possibly replaced, as in the Florence architecture, by the electronic safety knob which requires the presence of the motor bar to detect the state of the lock).
• The signalling function in any case signals to the customer that the vehicle is not properly closed using the door-open switches for this purpose. In fact, when the door is open, the lock is in any case locked (closing the door it is locked) but the customer must always be warned that the door is not properly closed.
The motor bars are no longer used to get feedback of successful locking/unlocking but simply as pawl or internal handle “motion detector”. In fact, the lock motor bar must be used to identify that a key has been inserted in the pawl and that it has been turned.
In this case, the changed state of the motor bar acts as command for the door locking system. The node (NPG or NPP) that detects it transmits the locking or unlocking signals on the B-CAN network.
The NBC acquires these signals, calculates the new state of the door locking system and transmits it on the B-CAN network to implement the door locking system strategy.
The opening signal has an effect on all the doors or only on the driver’s door depending on the selection made by the user. From the NPP the pawl always causes central opening.

Unlocking command inhibition when the doors are open
Once a door locking command has been received, the NBC checks the open/closed state of the doors, and if a door is found open, no actuation command is sent to the door/luggage compartment nodes. This is to prevent accidentally leaving the keys in the vehicle.

Simultaneous command inhibition:
When the NBC receives the locking and unlocking CAN signals, it uses the internal state to disable the functions for 0.5 sec thus eliminating any overlaps with the commands from the outside.

Unlocking from “external” events (FIS)
The signal from the FIS sensor causes unlocking of the luggage compartment irrespective of the selections made.
The state of the FIS sensor is acquired directly by the NBC. Therefore, the NBC drives door unlocking. The NBC replicates the lock release command a second time 1 second after the earlier command has been sent.
When the FIS has been activated, it must in any case be possible to lock the door from the outside (with the key or the remote control).

LUGGAGE COMPARTMENT LOCKING/UNLOCKING CONTROL STRATEGY

The luggage compartment locking/unlocking strategy is as follows:
1. The NBC receives the command either from the remote control or directly from the button or the FIS sensor and calculates the new locked/unlocked state of the luggage compartment.
2. The NBC drives the lock to the desired state. In the case of an electric lock (composed of a release motor and not a locking/unlocking motor and a switch on the luggage compartment handle (for the command)), the state is purely logic and corresponds to enabling (unlocked) or disabling (locked) functioning of the luggage compartment handle.

Luggage compartment unlocking

Luggage compartment unlocking can be driven as follows:
• Interlocked with the door locking system: the luggage compartment state follows that of the door locks. The logic also depends on whether or not unlocking of all the doors or only the driver's door is enabled, as described below:
• Independent driver-side door unlocking = luggage compartment unlocking is disabled
• Central unlocking of all the doors = luggage compartment unlocking is enabled.
• Independent: the luggage compartment is locked when the doors are locked, while it can only be unlocked independent of door unlocking (in other words, when the doors are unlocked, the luggage compartment remains locked). The luggage compartment can be unlocked with a specific command (button or FIS or remote control or …..).
The "independent luggage compartment" option can be set through the setup menu.

Relay activation times

The activation relays of the door locking and fuel tank door motors are fitted on the NBC, NPG and NPP.
The activation time for the door relay (locking/unlocking) must be 400 ms ±10%. The maximum activation time for the luggage compartment opening relay must be 700 msec. The various nodes drive the following electric motors:
- Fuel tank door (NBC)
- Luggage compartment lid (NBC)
- Front door locking/unlocking (NPG, NPP)

Inhibition for high number of manoeuvres

If 10-11 individual locking/unlocking operations are performed within 25 seconds from the first locking/unlocking operation, the NBC inhibits the door locking/unlocking commands and the relative signalling for 30s.

Motor activation check

The NBC, NPG and NPP must be able to check the locking/unlocking operation in progress, measuring the activation polarity at the ends of the electric motor parallel.
Therefore, at each operation, it is checked that the connection to the motor involved changes from negative to positive for the activation time and then returns to the GND potential.
If one of the two connections remains connected to Vbatt (relay with contacts stuck), the microprocessor must activate the other relay to bring the connections to the same potential and deactivate the current in the motors.
Unfortunately, the coil of the activated relay continues consuming, which may discharge the battery.
In this case, with a regular frequency (e.g. once every 5 seconds) the polarity must be checked and the relay deactivated if the circuit returns to normal conditions.

NORMAL/SPORT DRIVING MODE SELECTION AND WARNING LIGHT CONTROL
NBC functions, SPORT button control

At KEY ON and after terminating SPORT reactivation control, the NBC repeats the state of the SPORT button on the C-CAN network.
At KEY OFF the “SportModeButtonSts” signal must always be “not active”.
“SportModeSts” storage control.
At KEY ON and after terminating SPORT reactivation control, upon occurrence of the KEY OFF event, the NBC maintains in memory the last SPORT signal transmitted by the NFR during KEY ON.
In the absence of the NFR, the value stored will be “not inserted” (default).
SPORT reactivation control.
Starting condition: KEY ON and SPORT stored = “not inserted”.
At KEY ON if SPORT stored is equal to “not inserted”, the NBC immediately terminates reactivation control.
It enables button control and storage of the new SPORT setting.
Starting condition: KEY ON and SPORT stored = “inserted”.
At KEY ON if “SportModeSts” stored is equal to “inserted”, the NBC activates a timer t1=450ms (±10%).
At T1 timeout, the NBC goes into standby to receive a SPORT signal transmitted by the NFR and activates a timer T2=10sec (±10%).
If the NFR does not transmit messages, at T2 timeout the NBC terminates reactivation control.
If SPORT = “inserted”, the NBC immediately terminates reactivation control.
If SPORT = “not inserted”, the NBC sends the signal SPORT = “Active”.
“SportModeButtonSts” will be set to “not active” either at T2 timeout or if the SPORT signal is set to “inserted” by the NFR (SPORT reactivation terminated).
For the entire time that reactivation control is active, the SPORT button will not be controlled and the NBC will not store the state of the “SportModeSts” signal.

NFR functions

The NFR acquires from the network the information that the SPORT button has been pressed through the SPORT signal and changes the state (from Sport to Normal or vice versa) if no ABS, ASR, MSR or VDC operation is running (if an ABS, ASR, MSR or VDC operation is running when the SPORT button is pressed, the state will be changed if at the end of the operation of the above mentioned systems, the button is still pressed). In addition, for versions with electronically-controlled gearbox, when ICE mode is active, the NFR must inhibit the change to SPORT.
For versions with electronically-controlled gearbox, if the ICE function is activated, the NFR must change the setting to NORMAL if SPORT was previously active.

AUTOMATIC CLOSING OF DOORS, LUGGAGE COMPARTMENT, FUEL TANK DOOR AT OVER 20 km/h OR WHEN PARKED (activatable by the customer).

NBC – Logic description

If the function was previously enabled by the user, 'automatic locking' of the doors is requested in the following conditions:
1. When the speed exceeds the threshold (20 km/h), the NBC requests locking of the doors.
2. When the vehicle is locked and any one of the doors is opened and then closed (mechanically unlocked) at a speed over the threshold (20 km/h) the NBC requests locking of the doors.

The condition to re-enable the function is: door opening and closing sequence.
NOTE: If the function was previously enabled by the user and the doors are unlocked at a speed over the threshold (20 km/h), no door locking operation will be executed.

AUTOMATIC/ELECTRONICALLY-CONTROLLED GEARBOX SIGNALLING

The NBC performs the gateway service for the signal coming from the NCR/NCA on C-CAN and passes it to B-CAN for the NQS which acquires the command and activates signalling.

SIGNALLING OF AUTOMATIC GEARBOX OIL OVERHEATING

The NBC performs the gateway service for the signal coming from the NCA on C-CAN and passes it to B-CAN for the NQS which acquires the command and activates signalling.

DOOR UNLOCKING FROM INERTIA SWITCH (FIS)

The NBC acquires the FIS state and actuates unlocking of all the doors; this function is valid in the presence of K-ON or an active timing command.

LUGGAGE COMPARTMENT UNLOCKING/OPENING

The internal button is used to unlock and open the luggage compartment.
Pressing the luggage compartment opening button when the doors have been locked from the outside will have no effect. The button is hence disabled until the doors are unlocked from the outside (command from the remote control, key pawl, FIS) or at KEY ON with a recognised transponder in the case of a programmed Body Computer or a valid transponder in the case of a virgin Body Computer.
If the luggage compartment button is enabled, the luggage compartment can be opened both at KEY ON and KEY OFF and the door locked/unlocked state is not taken into account.
Pressing the button requests luggage compartment unlocking and opening.
At KEY ON the luggage compartment can only be opened if the speed is <2km/h.
The luggage compartment is opened from the outside with the remote control or the external handle. If the luggage compartment is already open, pressing the button must not generate any action.

NBC functions

The NBC acquires the luggage compartment release button and controls the luggage compartment according to the following logic:
when the luggage compartment button is pressed if the button is enabled, the luggage compartment is unlocked and released at the same time.

In any case, if the vehicle speed is greater than or equal to 2 km/h, the commands from the button are not accepted.

SIGNALLING OF LID OPENING

The NBC acquires the negative signal from the lid-open switch, signals the lid-open state to the alarm function, transmits the state to the NQS on B-CAN and to the NCR on C-CAN.

DEFROST TIMING CONTROL

Commands for defrost activation

Mirror, heated rear window and nozzle defrosting is activated by:
command 1: Unstable type heated rear window control connected to the NCL and sent as command to the NBC via the CAN network
command 2: Remote command coming from the defrost function MaxDefrost.

The mirror, heated rear window, windscreen and windscreen washer nozzle defrost command coming from the MaxDefrost function acts with the same logic as the specific command for the heating and air conditioning system.

ABS, Stability and Traction Control Systems (NFR)

Bosch

INTRODUCTION

The brake node (NFR) is the ECU that controls all the vehicle functions related to braking, cornering stability and traction control. The different dynamics are controlled by five different systems, all integrated in the BRAKE NODE.

ABS (Anti-lock Braking System): prevents the wheels from locking during braking

ASR (Anti-Slip Regulation): prevents the wheels from slipping during acceleration.

EBD (Electronic brake force distribution): distributes the brake force between the front and the rear axle.

MSR (Motor Schleppmoment Regelung): electronically controls the engine braking torque during downshifting.

MSP (ESP), (Maserati Stability Program): controls each individual wheel to ensure vehicle stability on bends.

The brake node is composed of an electronic unit, connected to the hydraulic component and to the front wiring. The braking system controls the information via the following communication networks:

1. C-CAN line (data transfer)
2. K LINE (diagnosis)
3. VSO SIGNAL
4. WAVE-UP SIGNAL

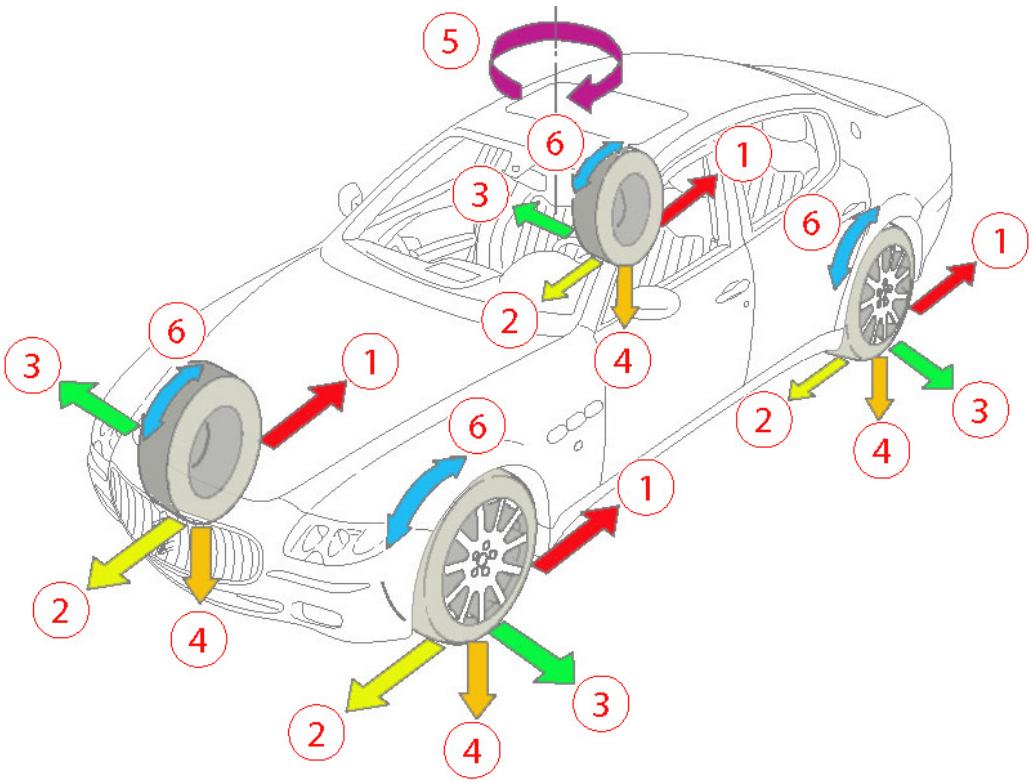
The ECU controls and processes the functions related to the following peripherals:

- Yaw sensor *****
- Wheel speed sensors
- MSP* and ASR* deactivation button
- Brake pedal switch
- It acquires the steering angle signal from the steering angle node (NAS) *****
- Wheel Speed Sensors
- Brake oil level switch
- Pad wear sensors
- Brake oil pressure sensor integrated in the ABS ECU
- Connection to EPB Node
- ABS system failure warning light
- ASR system failure warning light
- MSP (ESP) system failure warning light

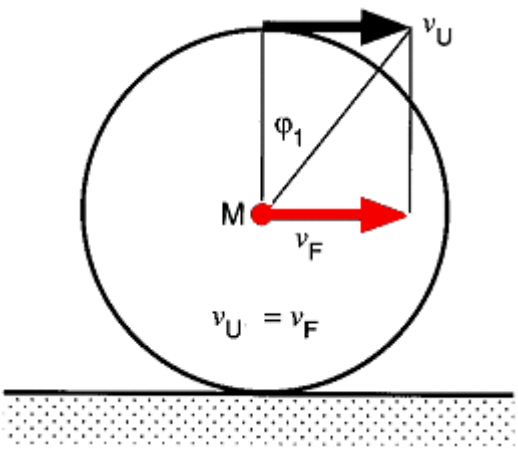
***** Only on vehicles equipped with Bosch ESP 5.7 and Bosch ESP 8.0 control unit

As the control unit versions have been differentiated according to the vehicle, this appendix will deal with the Bosch ESP 8.0 system.

DIRECTION OF THE MAIN FORCES

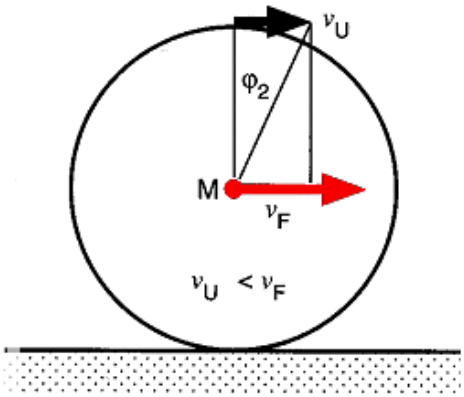


1. Directional longitudinal forces on the vehicle axis
2. Directional longitudinal forces on the vehicle axis
3. Lateral forces
4. Vertical forces
5. Rotational forces
6. Forces originating from the torque at the wheels



Rolling phase: Wheel unbraked

During wheel rolling and in the absence of traction or braking forces, the peripheral wheel speed $\mathbf{V_U}$ coincides with the vehicle speed $\mathbf{V_F}$ in the centre of the wheel

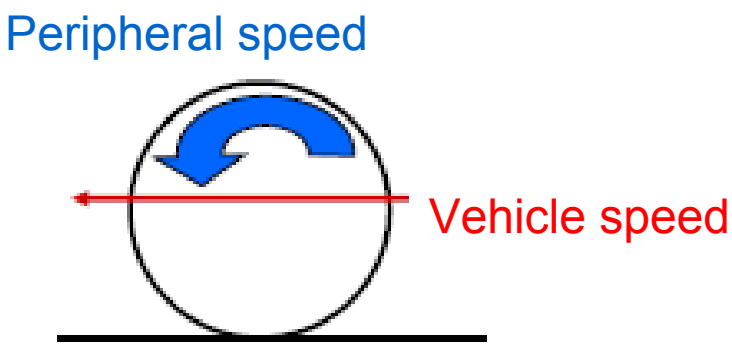


Rolling phase: Wheel braked

During wheel rolling and in the presence of braking forces, the peripheral wheel speed $\mathbf{V_U}$ is lower than the vehicle speed $\mathbf{V_F}$ in the centre of the wheel.

The difference in peripheral speed between the wheel and the vehicle is known as “slipping” and expresses the percentage deviation between the vehicle speed and the peripheral wheel speed in relation to the vehicle speed.

$$\text{Slipping in \%} = \frac{Vf - Vu}{Vf} \times 100$$

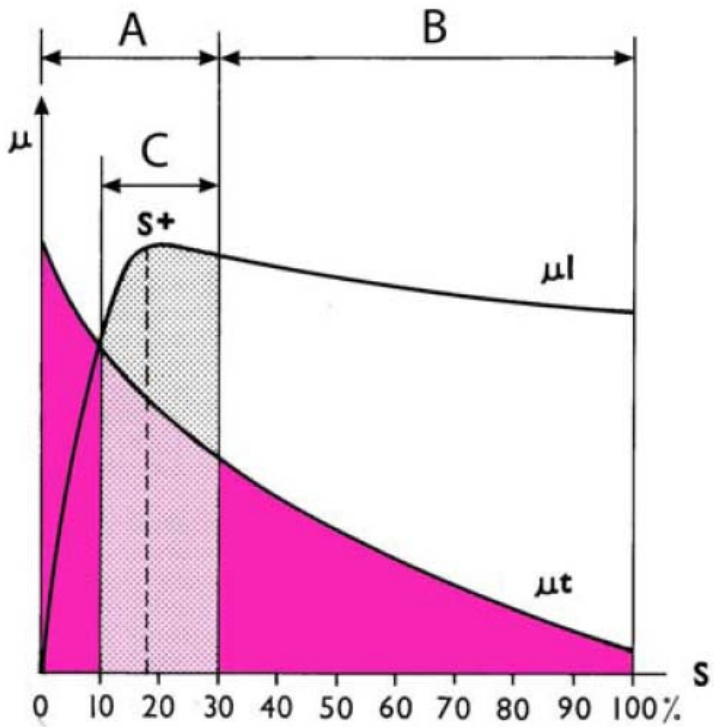


Slipping is due to a tangential force generated as a result of traction on the the tyre peripheral area, which makes contact with the ground and balances the braking torque applied to the wheel during braking. In these conditions, there is a relative difference between the wheel rotation speed and the vehicle forward movement speed. During normal driving, there is a certain percentage of slipping (in the order of 5%) due to tyre deformability. BY applying a braking torque, slipping increases up to the point of maximum tyre grip which causes the wheel to lock.

Traction coefficient

The traction coefficient is the ratio between the load P, acting on the wheel, and the tangential force T, generated when the wheel makes contact with the ground. This parameter indicates the ability of the wheel to “get a grip on” the road without slipping.
CONDITIONS: The traction coefficient does NOT depend on the vehicle characteristics nor on its speed, but on the type of tyre, its condition and the ground conditions, and reaches the maximum value in the absence of slipping.

The traction coefficient is the parameter for the transmissible braking force. It reaches its maximum value at 20% slipping.



The ABS system activates in a slipping range between 15 and 30%, between stability range A and instability range B.

EVOLUTION OF THE BOSCH CONTROL SYSTEM ON MASERATI CARS

As of the 1995 Maserati Ghibli, Maserati vehicles are equipped with ABS version 5.3, which is not equipped with stability, yaw and traction control systems. Development of a dedicated CAN network has allowed the Maserati 3200 GT to be equipped with the evolution of version 5.3, integrated with the electronic traction control and brake force distribution systems and, of course, the braking system.

Vehicle	**Braking system version**
Quattroporte V8 Evoluzione	Bosch ABS 5.3
Quattroporte V6 Evoluzione	Bosch ABS 5.3
Ghibli ABS	Bosch ABS 5.3
3200 GT*	Bosch ABS 5.3
MC12	Bosch ABS 5.3
4200 Coupè/Spider/Gransport	Bosch A.B.S /E.S.P 5.7
Quattroporte	Bosch A.B.S /E.S.P. 5.7 Bosch A.B.S /E.S.P. 8.0
Granturismo	Bosch A.B.S /E.S.P. 8.0
Alfa Romeo 8C	Bosch A.B.S /E.S.P. 8.0

(*) 3200 GT The first Maserati to integrate ASR and EBD electronic control in the ABS ECU. The same HW version for the Maserati MC12.

ABS 5.3 VERSIONS

With the Maserati 3200 GT, the braking control system has made a great generational leap, even though the Bosch hardware version is the same of the three earlier models. Connected to the engine control system via CAN line, it is capable of modifying delivery of the driving torque in relation to the different wheel speeds. Brake force distribution (EBD) is now electronic and related to the vehicle speed.

ABS/ESP 5.7 VERSIONS

The first version where ABS control is integrated in the Bosch ESP system. The ECU controls not only braking and traction, but also cornering stability (ESP, known in Maserati as MSP) by means of the information received from the acceleration sensor on the centre console in the passenger compartment. Introduction of the Hill Holder function allows the driver to use the vehicle brake for fractions of a second during uphill starting, so that the brake pedal can be released without the vehicle rolling back, even if standing on a slope.

ABS/ESP 8.0 VERSION

From assembly number 24275, a new generation of the integrated ABS/stability control system has been used, to replace the current Bosch ABS 5.7 system. The Bosch ABS 8.0 system integrates the following functions: ABS, EBD, ASR, MSR, ESP and Hill Holder. The various operating strategies of the system have remained unchanged. The only difference from the customer's point of view is improved comfort during ABS/EBD intervention, thanks to a more refined system operation.

On vehicles equipped with the Bosch ESP8 brake control unit, electronic brake force distribution is a function of deceleration measured in proximity of the vehicle barycentre by the sensor on the centre console.

Modifications with respect to Bosch ABS 5.7 system:

- Basic functions have remained identical
- Reduced weight by 25%: from 3 kg to 2,2 kg
- Reduced dimensions by 30%: from 2,5 l to 1,6 l
- Possibility to upload software updates.
- Improved noise behaviour on account of new inlet valves and pump motor speed control.
- Control of system pressure in ASR or ESP operation by PWM control of the electro-valve and failsafe monitoring.
- Submersible HU due to tight accumulator design and sealed motor.
- Improved performance of integrated ECU.

ABS/ESP 8.0 updates

- Upgraded rear brakes: 330 x 28 ventilated discs and 4 piston calipers (from MY07 onwards)
- Introduction of an electric parking brake (EPB) for the Quattroporte Automatic.
- Introduction of a pre-release function of the EPB system for the Quattroporte Automatic MY08 (from Assembly 34071) and standard on the Maserati GranTurismo (all versions).
- New revolutionary dual-cast ventilated front brake discs with increased diameter (360mm), equipped with and six piston calipers for the Quattroporte Sport GTS.

ECU POSITION IN THE VEHICLE

The ABS ECU/brake control node is positioned in the engine compartment, below the air filter area towards the front left-hand wheel. To access it, you can follow the same instructions as for all the Maserati vehicles, except the MC12 where it is positioned in the front compartment of the vehicle, in the front right-hand wheel area. The ECU is positioned in the same place in the vehicle, be it a left-hand or a right-hand drive.



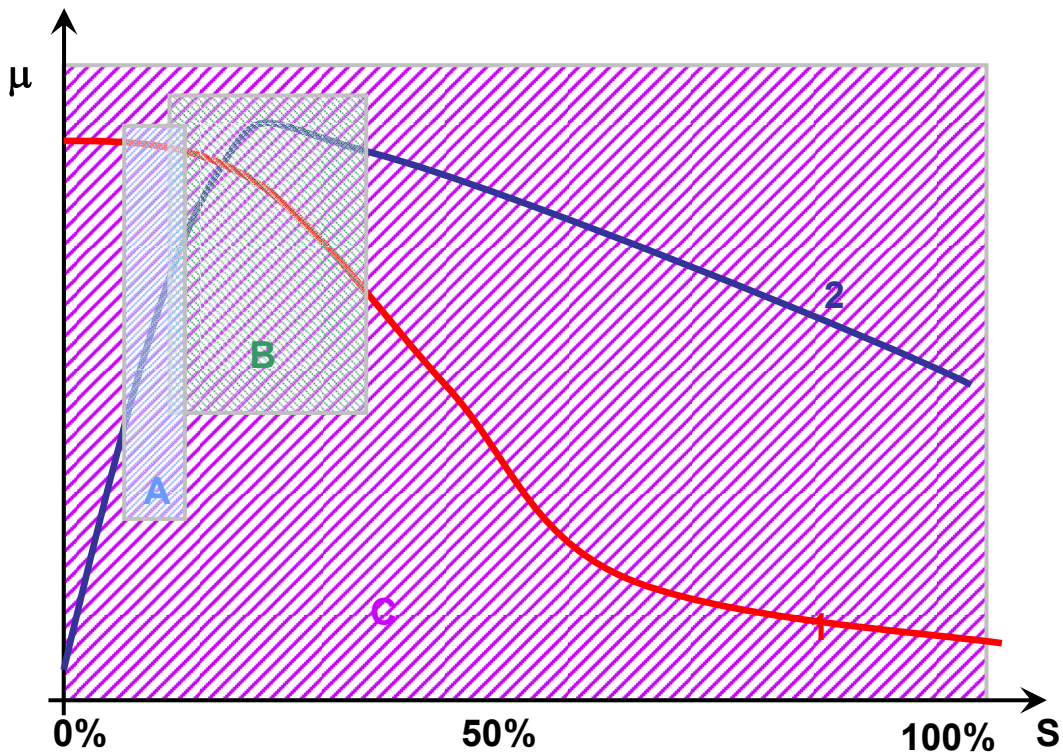
Image of ECU position in the vehicle for Maserati Coupè, Spyder, GranSport, Quattroporte, GranTurismo and Alfa Romeo 8C.

DESCRIPTION OF BOSCH ESP 8.0 CONTROL UNIT FUNCTIONS

The brake node is composed of an electronic unit, connected to the hydraulic system and to the front wiring.

The Bosch ESP 8.0 system integrates all the anti-skid, braking control and brake force distribution functions, optimising vehicle dynamic control by means of specific sensors:

- Steering angle sensor
- Yaw, lateral acceleration (Y), longitudinal acceleration (X) and slope sensor positioned in proximity of the vehicle barycentre.



μ – Wheel grip
S – Wheel slipping
A – EBD operating range
B – ABS operating range
C - ESP operating range
1 – Curve of lateral forces (Y)
2 – Curve of longitudinal forces (X)

As can be seen from the grip/slip diagram, the ESP system covers a larger range than a conventional ABS/EBD system.

The ESP system continually detects when the wheels lose grip both in longitudinal and transverse direction, in all driving conditions from braking to acceleration, in order to ensure the vehicle's stability and direction.
The ESP is controlled by the ABS ECU integrated in a specific electro-hydraulic control unit which allows the braking system to operate independently of the driver’s action.

The ECU processes the following signals:

- Steering angle and steering wheel rotation
- Lateral acceleration and yaw
- Engine operating conditions
- Wheel revolutions
- Hydraulic braking system pressure

From the values obtained, the ECU uses special algorithms implemented in its software to calculate the measurement values for dynamic vehicle control:

- Longitudinal and transverse slipping between the wheels and the road surface
- Axle drift.

Through these values, the system interprets the vehicle's effective dynamics, identifying all the critical conditions due to environmental factors (e.g. road with poor grip) or any errors made by the user (e.g. in panic situations) and subsequently acts on the brakes and the driving torque to bring the vehicle back to good driving conditions.
The system interfaces with:

- NCM for driving torque adjustment via the C-CAN line
- Instrument panel via CAN line for warning light control
- There is a dedicated line for system diagnostics (K line).

The system works in combination with a power unit with a specific brake master cylinder. In addition, the lines between the brake master cylinder and the ABS ECU have a Titaflex fitting, since the line diameter is larger than the normal pipes of vehicles not equipped with ESP system. This is to prevent negative effects on ESP operation at low brake oil temperatures.
As mentioned above, the ESP system controls vehicle slipping in both longitudinal and transverse direction, and hence its lateral stability.
The lateral stability of a vehicle is given by the reaction of the tyres to the lateral forces due to the increase in centrifugal force.
The action of the lateral forces determines a variation in the wheel drift angle and therefore a variation in the axle drift (drift angle = angular difference between the desired trajectory and the actual trajectory).

However, the lateral forces do not act in the same way on all four wheels, since they are not in the same load conditions: actually, the wheels have different loads, depending on the current situation. These situations are:

- Acceleration (reduced load on the front and increased load on the rear axle)
- Braking (increased load on the front and reduced load on the rear axle)
- Right/left cornering (increased load on the outside and reduced load on the inside wheels)
- Cornering in acceleration/deceleration (combination of the above mentioned cases).

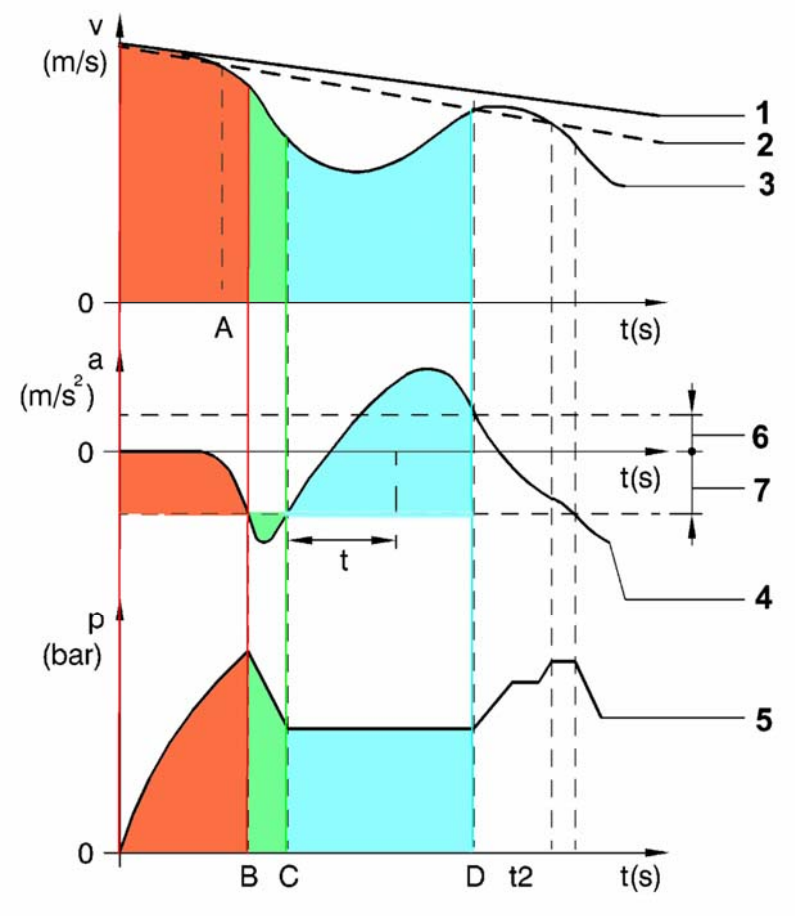
It is evident that if the lateral forces acting on the individual wheels vary, there will also be a variation in the resulting forces acting on the vehicle axles. This ensures that the prevailing lateral forces acting on the front axle with respect to the rear and vice versa cause a rotation (moment) on the vertical axis of the vehicle (yaw axis).
The yaw moment affects the vehicle behaviour creating understeering or oversteering.

As we may understand from the above, the control unit is capable of:

- Detecting the driver's actions by means of: the position of the steering wheel, to check by how many degrees (wide or narrow radius bends) and how fast (sudden or smooth rotation) the steering wheel is being turned; the position of the throttle and the brake pressure, to check whether the driver is accelerating or braking, in other words, how the driver negotiates the bend or deviates from the rectilinear trajectory.
- Detecting the actual behaviour of the vehicle given by the environmental variables (e.g. slippery road) and the vehicle’s reaction to incorrect manoeuvres by the driver etc., in order to identify the yaw moment and lateral slipping of the axles by means of the sensors on the four wheels and the yaw/lateral and longitudinal acceleration sensor.

These two operations are necessary to compare the mathematical model mapped in the control unit with the actual behaviour of the vehicle, in order to identify the vehicle status (understeering or oversteering) and decide what action to take on the brakes and the engine.

SYSTEM OPERATION



1. **Actual vehicle speed**
2. **Reference vehicle speed**
3. **Peripheral wheel speed**
4. **Wheel acceleration/deceleration**
5. **Braking circuit pressure**
6. **Permissible acceleration band**
7. **Permissible deceleration band**

SPEED SIGNALS: The signals sent to the control unit by the wheel revolution sensors are translated into digital signals by the input amplifier. The frequency of these signals provides the control unit with corresponding speed (3) and acceleration/deceleration values of the (4) individual wheels.

VEHICLE SPEED: By combining the individual peripheral wheel speeds a reference speed (2) is calculated, which, being continually updated, indicates the actual vehicle speed (1).

ACCELERATION/DECELERATION THRESHOLDS: The electronic control unit also stores the deceleration/acceleration thresholds (6) and (7) that the individual wheels may never exceed. Therefore, by systematically, continuously and very quickly comparing the wheel deceleration/acceleration values with those of the band stored, tyre rolling during braking is kept under control.

OPERATING CONDITIONS

Sudden rectilinear trajectory variations

In the event of sudden trajectory variations, (e.g. overtaking, slalom), the control unit identifies possible oversteering and understeering conditions and corrects the vehicle trajectory acting as mentioned above.

Sudden rectilinear trajectory variation (driving on different surfaces)

The control unit is capable of detecting trajectory deviations and the drift prevalence of the axles and corrects the trajectory with appropriate actions on the brakes and engine.

Panic braking deceleration

When the pressure gradient exceeds a minimum threshold following sudden brake application, the system multiplies the braking pressure applied by the driver on the wheels, thus obtaining the maximum possible deceleration.

Operation - operating times in good road grip conditions (asphalt)

The engine ECU reduces the torque by varying the ignition advances 6/100 of a second after exceeding the skidding threshold. The torque is further reduced by decreasing the throttle opening (by the engine ECU with motor-driven throttle body) after 15/100 of a second.
The hydraulic system operates (braking force on the driving wheels) after 2/10 of a second.
The engine ECU reduces the torque by reducing the fuel supply after 6/100 of a second.
The hydraulic system operates (braking force on the driving wheels) after 2/10 of a second.

Operation in poor grip conditions

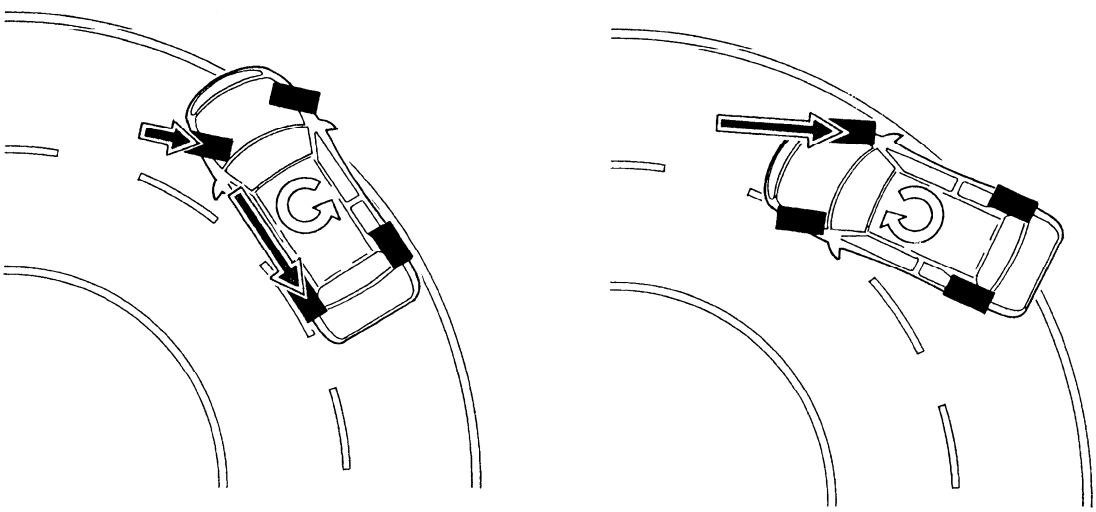
The system is capable of detecting this condition by comparing the driving wheel acceleration with the torque transmitted by the engine (engine load from the engine ECU).
The system behaves like when both driving wheels skid in good road grip conditions (asphalt) and the operating thresholds are brought to the lower limit.

Understeering conditions in a curve

When the control unit detects an understeering condition (drift prevalence on the front axle) it corrects the vehicle behaviour by braking the inside wheels during cornering, in order to create a counter moment such as to steer the vehicle towards the centre of the curve and, if necessary, reducing the driving torque.

Oversteering conditions in a curve

When the control unit detects an oversteering condition (drift prevalence on the rear axle) it corrects the vehicle behaviour by braking the front outside wheels during cornering in order to create an opposite yaw moment and, if necessary, increasing it by increasing the driving torque. The system operates before reaching excessive oversteering and understeering values, so as to limit countersteering manoeuvres that may be difficult to control.



Operation – operating times

The engine ECU reduces the torque by varying the ignition advances 6/100 of a second after exceeding the threshold.
Torque is further reduced by decreasing the throttle opening (by the engine ECU). By acting on the hydraulic system, a braking action is exercised on the skidding wheel, thus ensuring that the differential has the resistive force required on the side with poor grip (TC). This resistive force allows the differential to transmit an equal torque with good grip. The engine ECU reduces the torque by decreasing the fuel supply after 6/100 of a second.
By acting on the hydraulic system, a braking action is exercised on the skidding wheel, thus ensuring that the differential has the resistive force required on the side with poor grip (TC). This resistive force allows the differential to transmit an equal torque with good grip.

STRATEGY SELECTION MODES

NORMAL

This mode provides maximum grip and the risks related to the most diverse driving conditions are reduced. This offers the driver an invisible "safety guard", for any driving style. If losing grip or in the event of skidding, the system operates in a targeted way braking one or more wheels, thus allowing the driver to fully control the vehicle. The operation is accurately performed without involving the driver. In this way, the vehicle will continue to move in the desired direction without taking into account the action on the accelerator pedal or the input transmitted to the braking system by the driver, whatever the road conditions.

SPORT

This is the second option provided by the management system. When this mode is set, the system will continue to provide the driver with an electronic protection system that is capable of correcting possible critical situations, but at the same time it will offer more demanding drivers enhanced driving freedom. For example, the vehicle is allowed to slide sideways until reaching an angle of six degrees so as to offer the driver a sufficient handling margin to express his vehicle control skills. This mode also offers the driver the opportunity to explore the limits of the vehicle in full safety.

MSP OFF mode

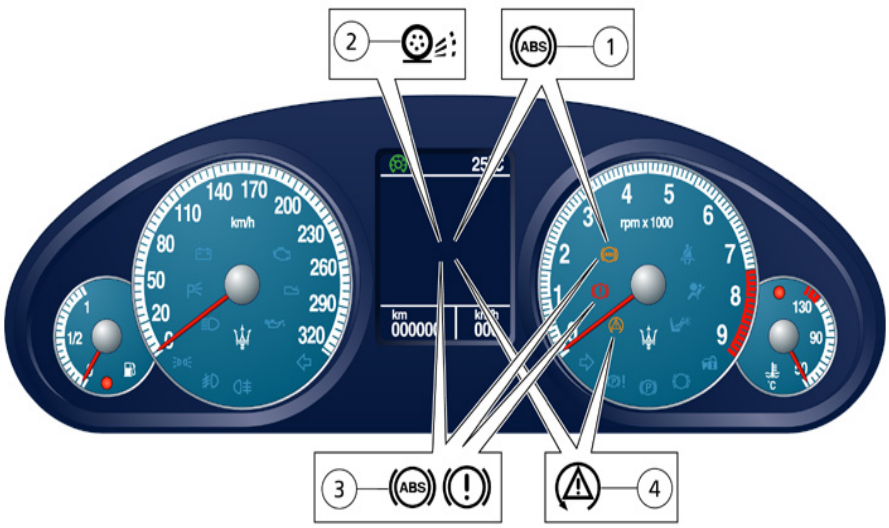
If the vehicle is driven under "extreme" conditions, the ESP, ASR and MSR systems can be fully deactivated by the driver. The vehicle will perform without any safety system and the driver will have to rely only on the vehicle and his driving skills for particularly exciting driving. Even if the control system is deactivated, ABS and EBD will remain active to prevent wheels from locking. MSP OFF is also the applicable driving mode in case snow chains are installed.

Low-grip mode (ICE)

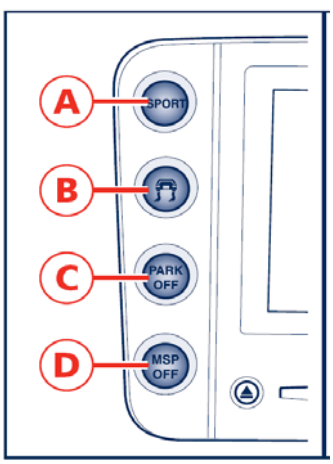
This mode can be used on particularly slippery road surfaces (e.g. in the case of snow or ice) and can be activated/deactivated by pressing the relative button on the NIT. The word ICE will illuminate on the instrument panel display. In “Low-grip" mode the system uses 2nd instead of 1st gear. This means that starting from a stationary position with the engine running - both in automatic and manual mode - the vehicle will start in 2nd gear.

When sequential manual mode is selected with 2nd gear engaged, a downshift request will be ignored. While driving, the system automatically switches to the higher gear if the engine reaches the pre-established speed (3000 RPM). “Low-grip" mode has priority over SPORT mode and assists the MSP system.
If “ICE” mode is activated when “SPORT” mode is active, during the transition stage it may happen that both the “ICE” and the “SPORT” messages are present on the CAN line. In this case, the system will give priority to the “ICE” message, immediately showing it on the display.

INDICATIONS ON THE INSTRUMENT PANEL AND PUSHBUTTON PANEL



1. ABS system failure warning light and fault message on display
2. ASR system failure warning light and fault message on display
4. MSP system failure warning light and fault message on display

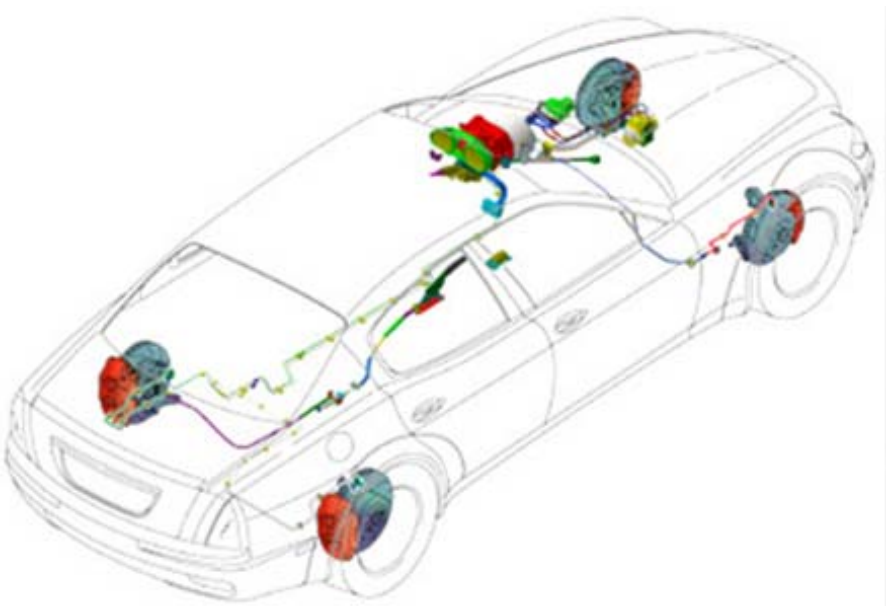


A. SPORT BUTTON
B. ICE BUTTON
C. PARK OFF BUTTON (only for vehicles with EPB)
D. MSP OFF BUTTON

COMPONENT DESCRIPTION

HYDRAULIC PART:

- Hydraulic brake circuit, X-separated (steel flexible brake lines on Sport GT)
- 15/16” master brake cylinder with 18+18 mm stroke



- Vacuum brake assistance Ø 8 + 9”, control ratio of 13.5
- Ventilated front discs, 330 x 32 mm (cross-drilled on Sport GT)
- Front brake calipers with 4 pistons
- Ventilated rear discs, 316 x 28 mm (cross-drilled on Sport GT)
- Rear brake calipers with 2 pistons
- Drum parking brake integrated in the rear brake discs (activation with EPB from the Quattroporte Automatic and all the GranTurismo models).

ELECTRO-HYDRAULIC PART:

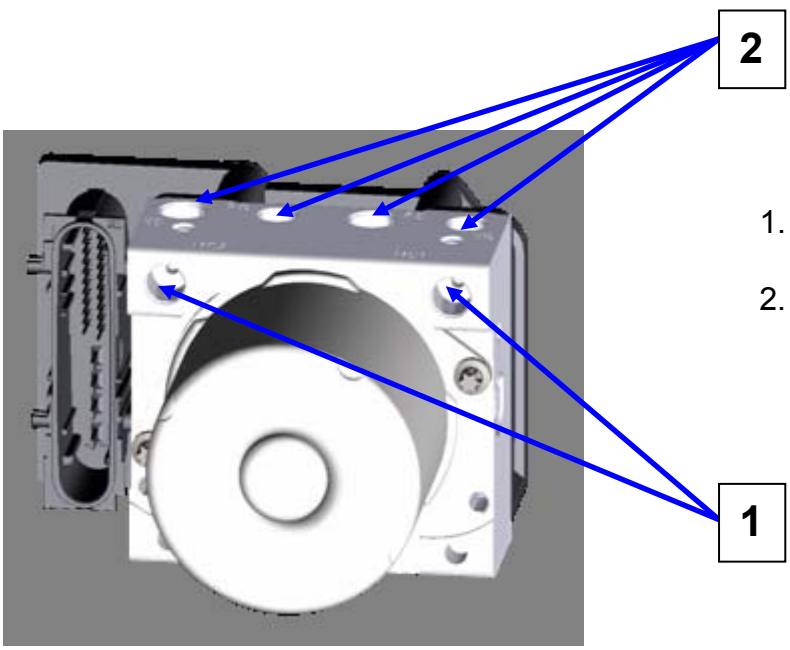
- Control unit and electrohydraulic unit assembly
- Twelve two-way solenoid valves (N.O. and N.C.)
- A double circuit scavenge electric pump
- Two low pressure accumulators
- Two high pressure accumulators
- Pressure sensor
- Four pressure dampers
- Wheel revolution sensors

ELECTRONIC COMPONENTS INVOLVED IN SYSTEM CONTROL
ESP 8.0

- Steering angle sensor
- Yaw rate and acceleration sensor
- Engine Control Node

ELECTRO-HYDRAULIC ECU

The only element that characterises an electronic control system of a braking system is the electro-hydraulic unit.
This device contains: the electronic control unit, the solenoid valves that control the braking circuit pressures and all the actuators essential for system functioning.



1. Oil inlet from the brake master cylinder
2. Oil outlet to the four brake actuators

CHARACTERISTICS: In addition to the construction differences of the various car manufacturers, the only really important characteristic that groups these electro-hydraulic units into two classes is as follows:
unit with 8 solenoid valves
unit with 12 solenoid valves

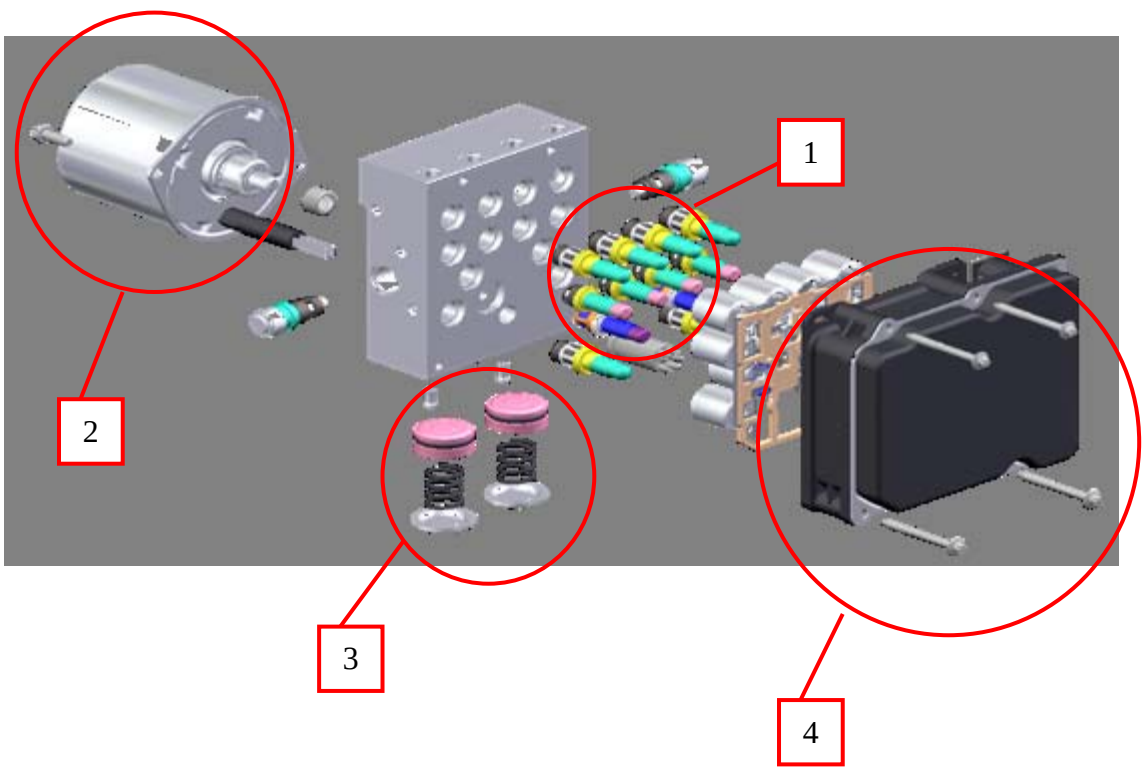
CONNECTIONS: The electro-hydraulic control unit is connected to the brake master cylinder and to the brake caliper cylinders by means of the braking system lines, and it is integrated in the electronic control unit.

FUNCTION: The function of the electronic control unit is to:

- Acquire the data sent by the wheel revolution sensors
- Store the control parameters defined during vehicle testing
- Process the data acquired to control the braking process
- Detect component failures by means of self-diagnosis
- Store the failures found
- Implement the diagnostic strategies when necessary
- Dialogue with the engine ECU.

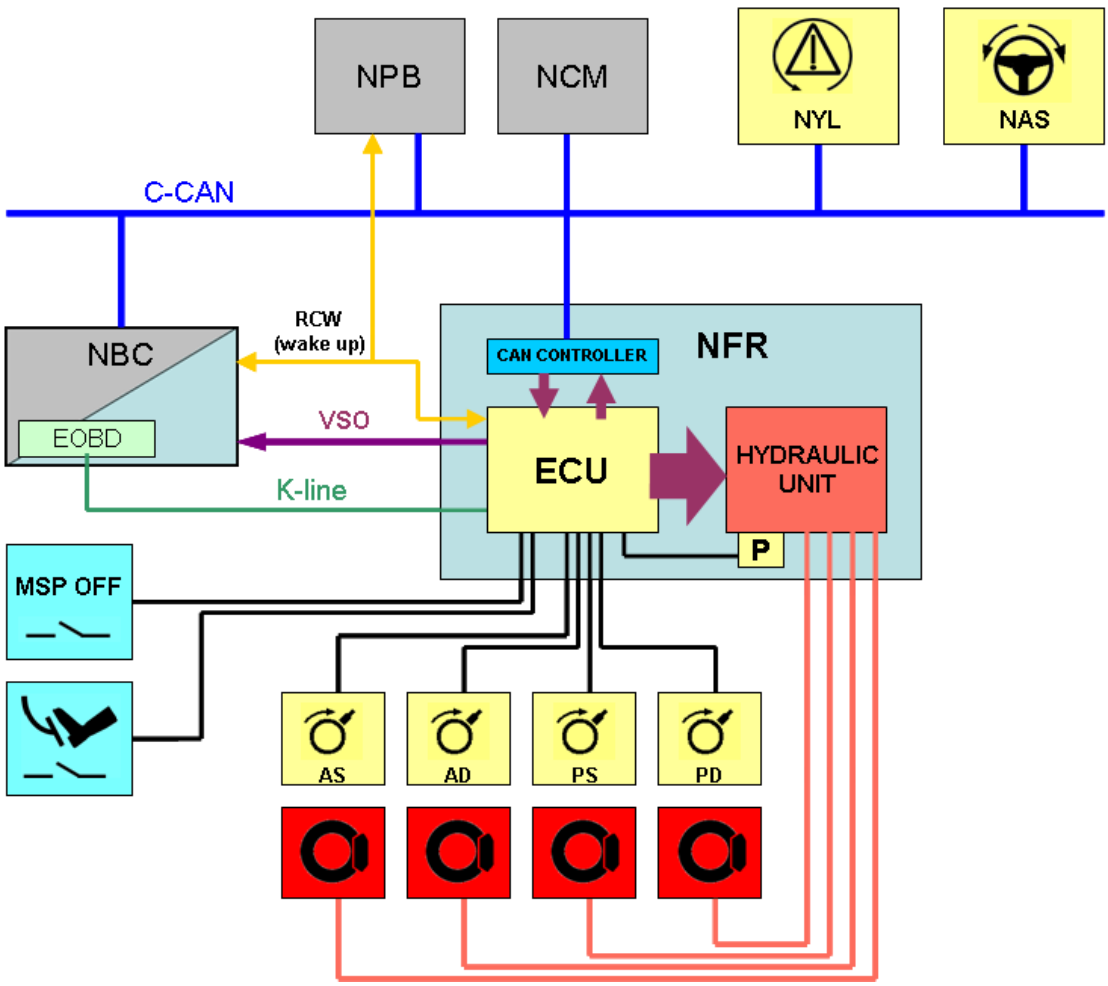
Vary the brake fluid pressure in the brake caliper cylinders upon receiving the signals from the different sensors.

COMPOSITION: The electro-hydraulic control unit is composed of two-way solenoid valves (two for each hydraulic circuit), a dual-circuit motor-driven pump driven by the electronic control unit and four accumulators (two for each circuit branch). In particular, the scavenge pump allows recovery of the brake fluid during the pressure reduction phases, delivering back the oil discharged upstream of the solenoid valves for the subsequent pressure increase phases.



1. Solenoid valves
2. Motor - pump
3. Accumulators
4. Electronic control unit

FUNCTIONAL DIAGRAM



The NFR controls information through the following communication ways:

C-CAN line (data transfer and reading)

K LINE (dedicated line for system diagnosis)

RCW (Wake Up) (this is a signal sent by the Body Computer to NFR and NPB; it is bidirectional between NPB and NBC). Its purpose is to send a signal following a wake-up event of the Florence network. For example, selecting the NPB lever on the centre console in the passenger compartment or turning the key to on, it allows the NBC to wake up all the other ECUs. The Wake Up signal has a duration of 1 sec, in the case of a signal from 0 to 12 Volt. The time required by the NFR to switch to sleep mode varies from 5min to15min, depending on the slope detected by the yaw/acceleration sensor.

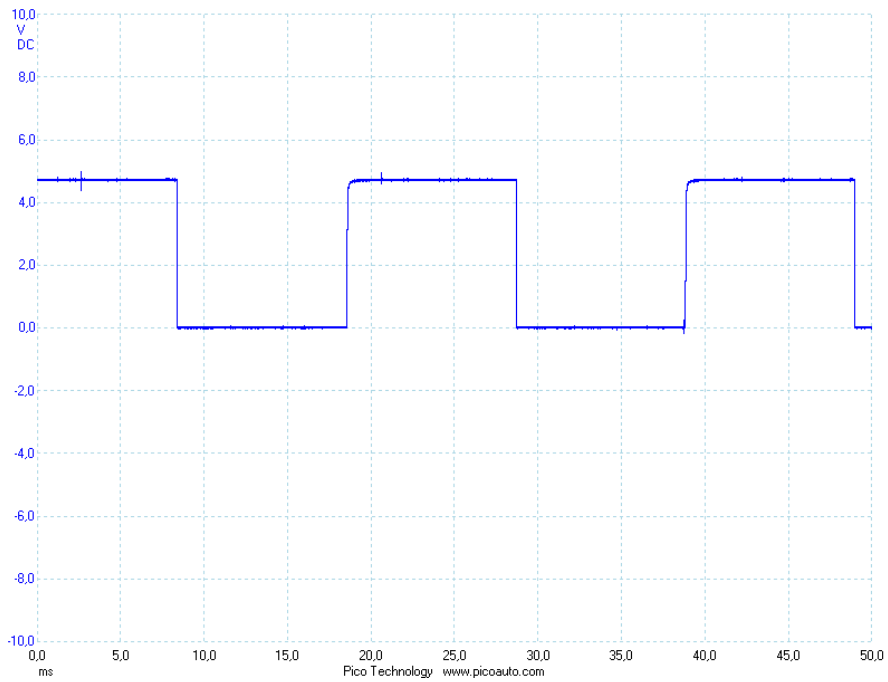
If during this time period the ECU detects a vehicle movement, it will apply a greater traction force on the EPB engagement cables. Following a wake-up signal. The brake Node acquires the signal from the wheel RPM sensors for 6 seconds.

NOTE: Activation of the brake switch will not cause any wake-up in the network.

VSO (Vehicle Speed Odometer) is the “raw” speed value sent to the NBC to be then sorted in the control units which need this signal but do not communicate on the CAN network (CSG and CAF).

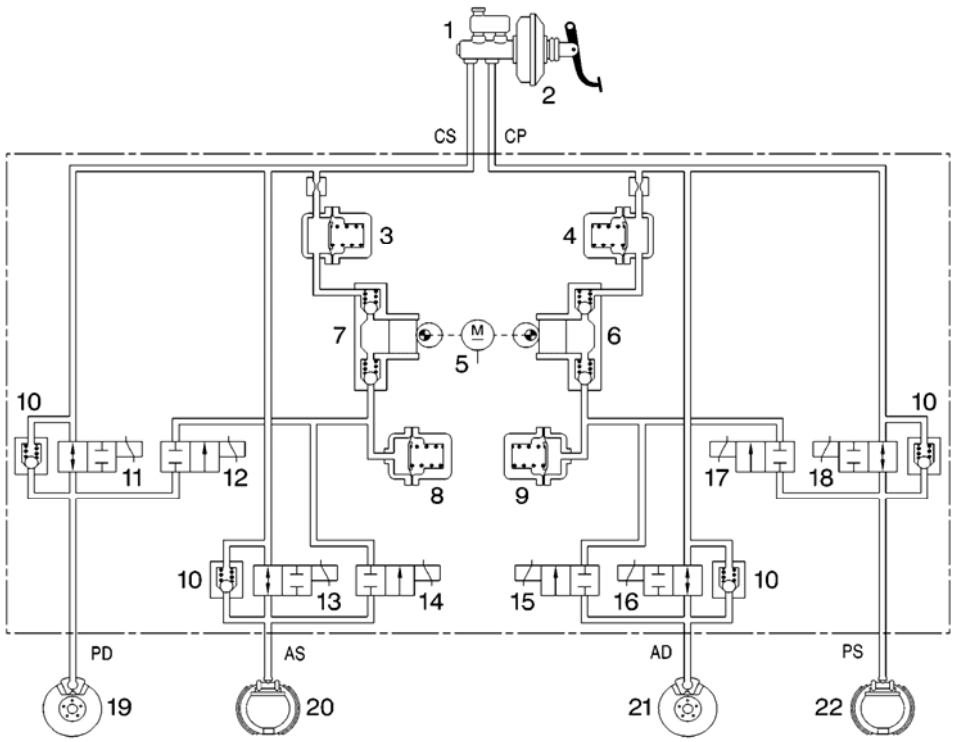
The VSO signal is a frequency-modulated square wave with a 50% duty cycle.
The NFR supplies 14 pulses every actual wheel revolution. The actual wheel circumference value is periodically transmitted by the NBC. The signal may be measured with the rear wheels moving.

Picoscope settings: Time scale: 5ms/div. Voltage scale: ± 20V



SPEED SIGNAL: This signal does not have a dedicated line (contrary to the VSO signal), but is sent by the Brake Node directly to all the nodes that need this information on the C-CAN network. The speed signal emitted by the NFR is a reprocessed and not a raw signal, calculated based on the information stored in the proxy file (wheel type and diameter) in the NBC and sent to the NFR.
For the nodes in the B-CAN network, the speed signal information reaches the Body Computer Node to be subsequently sent to the B-CAN network by the NBC.

HYDRAULIC DIAGRAM

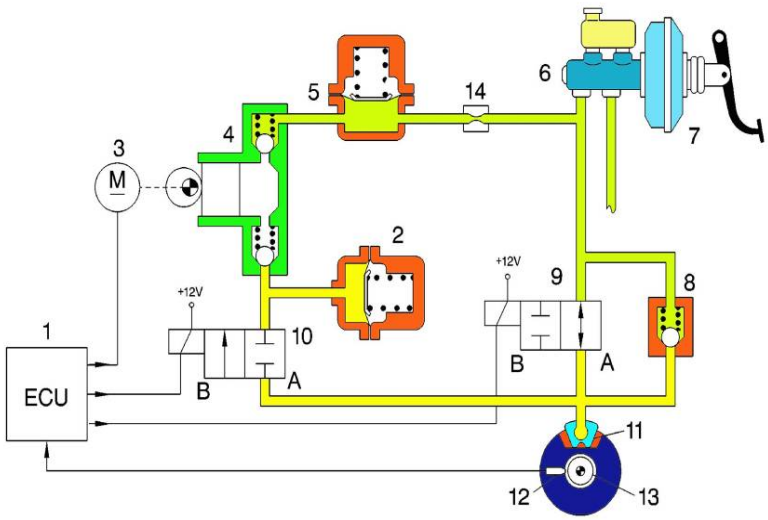


1. Brake master cylinder	12. Rear right-hand outlet solenoid valve
2. Brake servo	13. Front left-hand inlet solenoid valve
3. High-pressure accumulator	14. Front left-hand outlet solenoid valve
4. High-pressure accumulator	15. Front right-hand outlet solenoid valve
5. Scavenge pump drive motor	16. Front right-hand inlet solenoid valve
6. Scavenge pump	17. Rear left-hand inlet solenoid valve
7. Scavenge pump	18. Rear left-hand outlet solenoid valve
8. Low-pressure accumulator	19. Rear right-hand brake drum
9. Low-pressure accumulator	20. Front left-hand brake caliper
10. Fast pressure reducing valve	21. Front right-hand brake caliper
11. Rear right-hand inlet solenoid valve	22. Rear left-hand brake drum

CAUTION!

When replacing the brake pads, it is important to slowly move back the brake caliper pistons to prevent damaging the mechanical fast pressure relief valve (10).

ELECTRO-HYDRAULIC ECU OPERATION: STANDBY PHASE



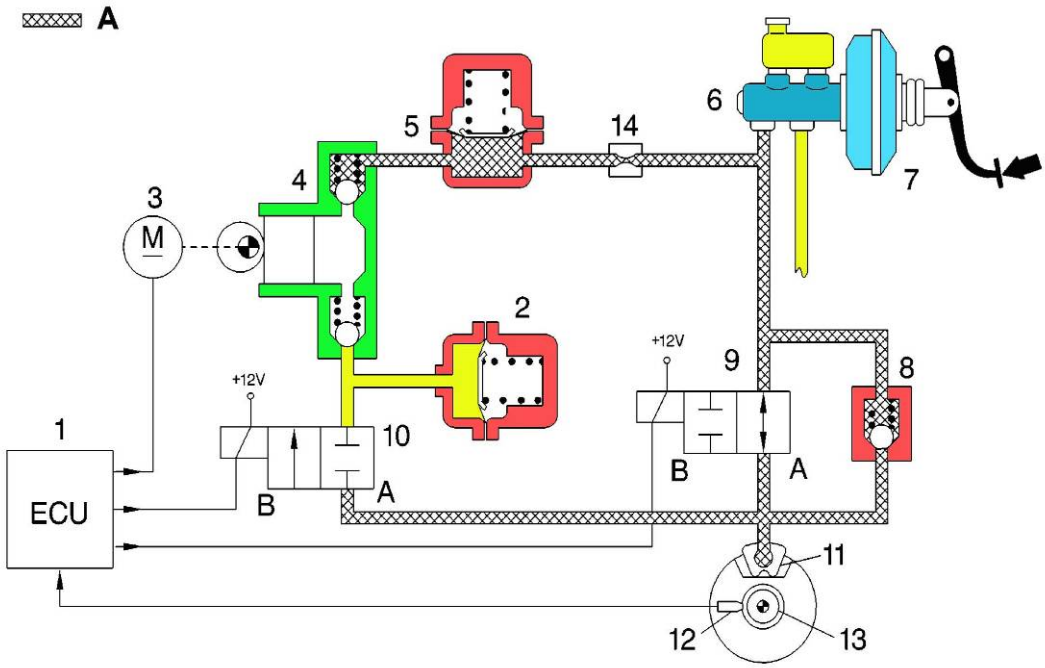
1. **Electronic control unit**
2. **Low-pressure accumulator (reservoir)**
3. **Scavenge pump drive motor**
4. **Scavenge pump**
5. **High-pressure accumulator (damping chamber)**
6. **Brake master cylinder**
7. **Brake servo**
8. **Fast pressure reducing valve**
9. **Inlet solenoid valve**
10. **Outlet solenoid valve**
11. **Brake caliper**
12. **Active wheel revolution sensor**
13. **Multipolar ring**
14. **Narrowing**

SOLENOID VALVES: In standby conditions, the inlet solenoid valve for each channel is open, i.e. it allows the fluid to flow to the brake caliper. On the other hand, the outlet solenoid valve is closed and does not allow fluid discharge to the low-pressure accumulator. In these conditions, the electrohydraulic control unit is completely open to passage of oil from the brake master cylinder. In the event of an ABS system failure, the electrohydraulic control unit remains in standby conditions, allowing the driver to brake in the conventional manner.

ACCUMULATORS: The purpose of the accumulators is to provisionally store the brake fluid during the pressure reduction phase.

SCAVENGE PUMP: The purpose of the scavenge pump during the pressure reduction phase is to recover the brake fluid flowing from the caliper and send it through the high-pressure accumulator to the brake master cylinder. The scavenge pump is of the dual-circuit free-piston type and is driven by an electric motor. The pistons are directly connected to the crankshaft by means of a cam that rests on the pistons and which permits only the pushing but not the pulling stroke of the piston.

PRESSURE INCREASE PHASE



A. System branch with increasing pressure

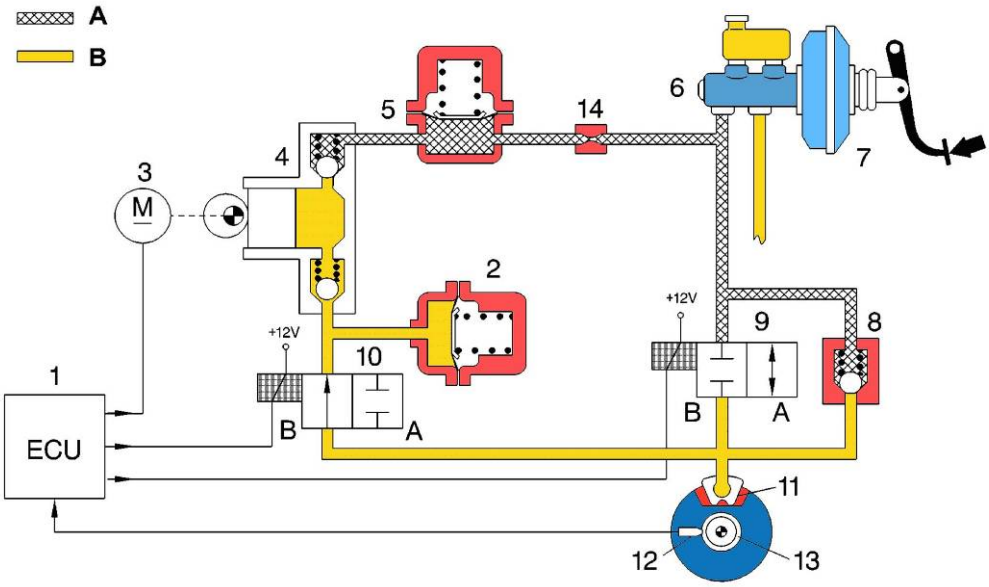
SOLENOID VALVES: When the driver depresses the brake pedal, the pressure generated by the brake master cylinder reaches the brakes without undergoing any variations, since the solenoid valves are not electrically powered by the ECU and remain in standby condition.

ACCUMULATORS: The high-pressure accumulator is adjusted to the caliper control pressure, while the low-pressure accumulator is not powered.

SCAVENGE PUMP: The brake control pressure does not reach the scavenge pump, which remains inactive.

WHEELS: During the pressure increase phase, controlled by the driver acting on the brake pedal, the wheels slow down until a deceleration value below the threshold stored in the ECU is detected.

PRESSURE REDUCTION PHASE



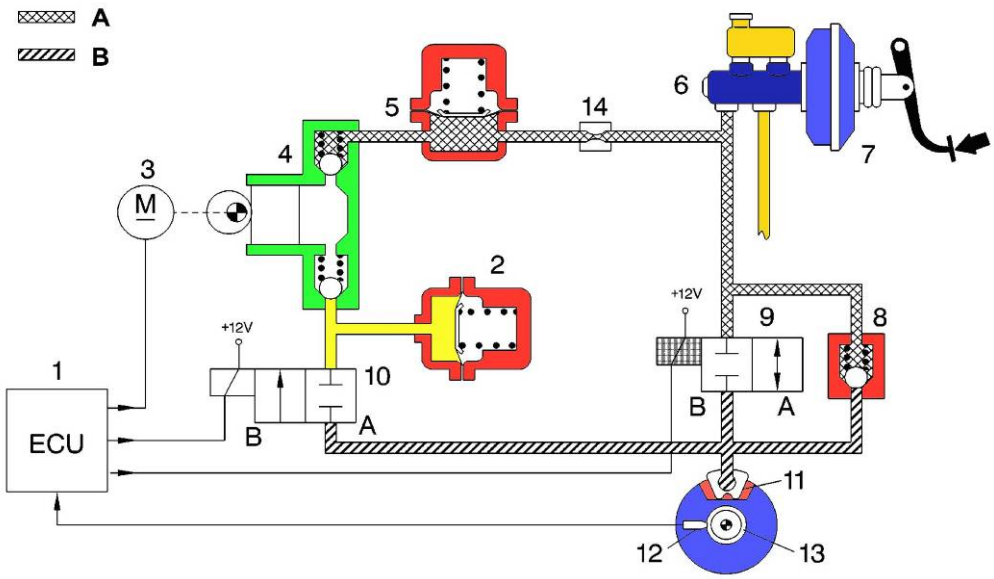
A: System branch with increasing pressure
B: System branch with decreasing pressure

SOLENOID VALVES: The ECU detects that the wheels tend to lock and activates the electro-hydraulic unit to limit wheel deceleration within the permitted values. The inlet solenoid valve is powered to interrupt the connection between the brake master cylinder and the brake caliper. The same occurs for the outlet solenoid valve with the purpose however of allowing the flow of a certain amount of oil to the low-pressure accumulator and the scavenge pump, in order to reduce the brake caliper pressure.

ACCUMULATORS: The purpose of the low-pressure accumulator in the circuit is to store a part of the brake fluid removed from the calipers, thus stabilising the brake caliper pressure as well. The oil flowing from the scavenge pump sweeps across the high-pressure accumulator, whose purpose is to damp (with the aid of the narrowing) the pressure waves generated by the scavenge pump.

SCAVENGE PUMP: The control unit powers the scavenge pump motor in order to extract a certain amount of brake fluid which is returned to the brake master cylinder's main circuit. It is in this phase that the pressure waves are generated and, although dampened by the high-pressure accumulator and the narrowing, they are nevertheless perceived by the driver as slight vibrations on the brake pedal.

PRESSURE MAINTENANCE PHASE



A: System branch with increasing pressure
B: System branch with decreasing pressure

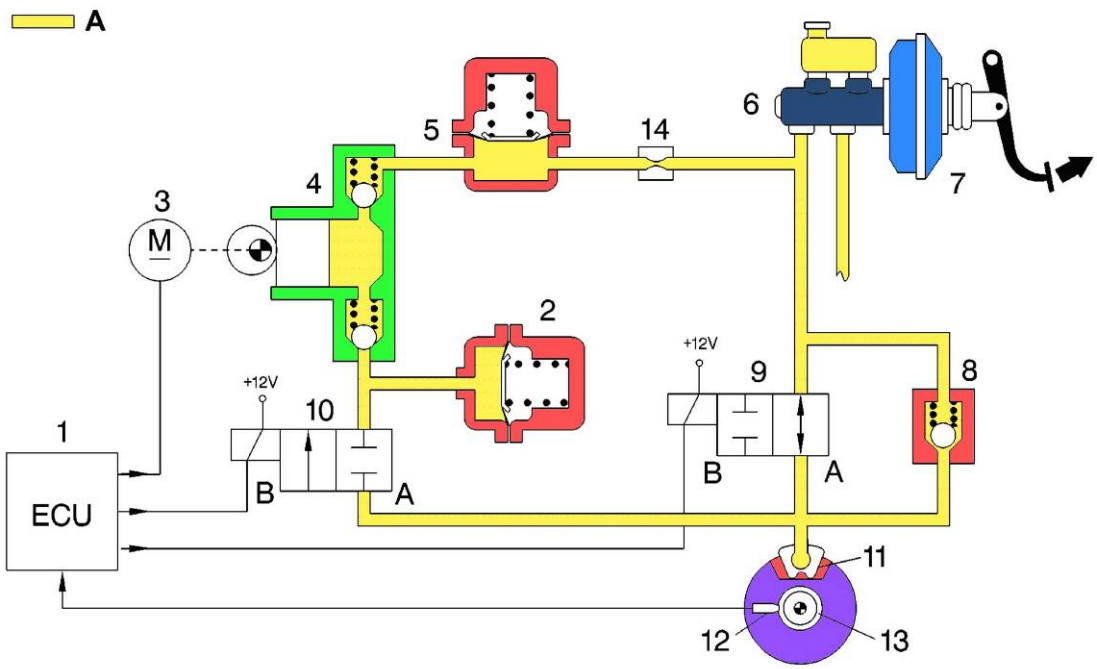
SOLENOID VALVES: In this phase, the ECU powers only the inlet solenoid valve, which closes the connection between the brake master cylinder and the relative caliper. The outlet solenoid valve is not powered, thus closing the line to the scavenge pump. In this way, any connection between the brake master cylinder and the caliper is interrupted so that the pressure value reached previously (either in the pressure increase or the reduction phase) is kept constant.

ACCUMULATORS: The high-pressure accumulator is adjusted to the brake master cylinder pressure, controlled by the driver with the pedal, while the low-pressure accumulator is not involved in this phase.

SCAVENGE PUMP: The brake control pressure does not reach the scavenge pump, which remains inactive.

WHEELS: In this phase, despite the braking force which performs a continuous deceleration action, the wheel may vary its speed in relation to the road grip, until the active wheel RPM sensor detects a speed variation outside tolerance with respect to the reference speed.

BRAKE PEDAL RELEASE



A: System branch with decreasing pressure

SOLENOID VALVES: Having detected that the brake pedal has been released, the ECU sets the two solenoid valves to standby mode.

ACCUMULATORS: The pressure in the entire system is reduced so that also the two accumulators can discharge.

SCAVENGE PUMP: The scavenge pump remains inactive.

WHEELS: The wheels are no longer subject to the braking force applied by the brake calipers.

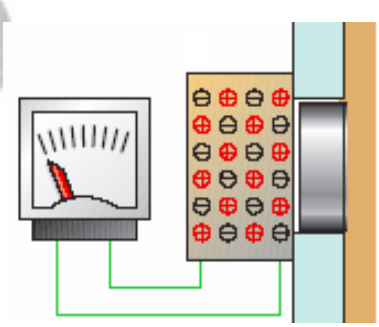
FAST PRESSURE REDUCING VALVE: To allow fast pressure reduction on the brake caliper when the pedal is released, the system is equipped with a check valve positioned parallel to the inlet solenoid valve. When the pedal is released, the pressure upstream of the solenoid valve is reduced and the pressure in the downstream branch is therefore higher. Given the small flow passage through the inlet solenoid valve, which would determine slower pressure reduction, the check valve starts operating allowing greater passage and hence much shorter emptying times.

PRESSURE SENSOR

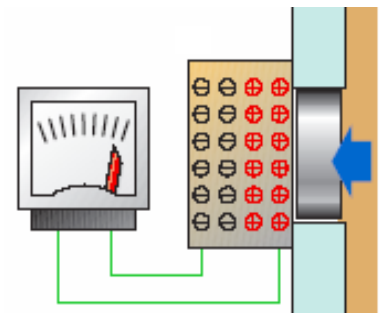
The introduction of the ESP has created the need to control the pressure. The ECU incorporates a sensor consisting of a piezo-resistive membrane that translates the flexure caused by the oil pressure into voltage.



Bosch 8.0



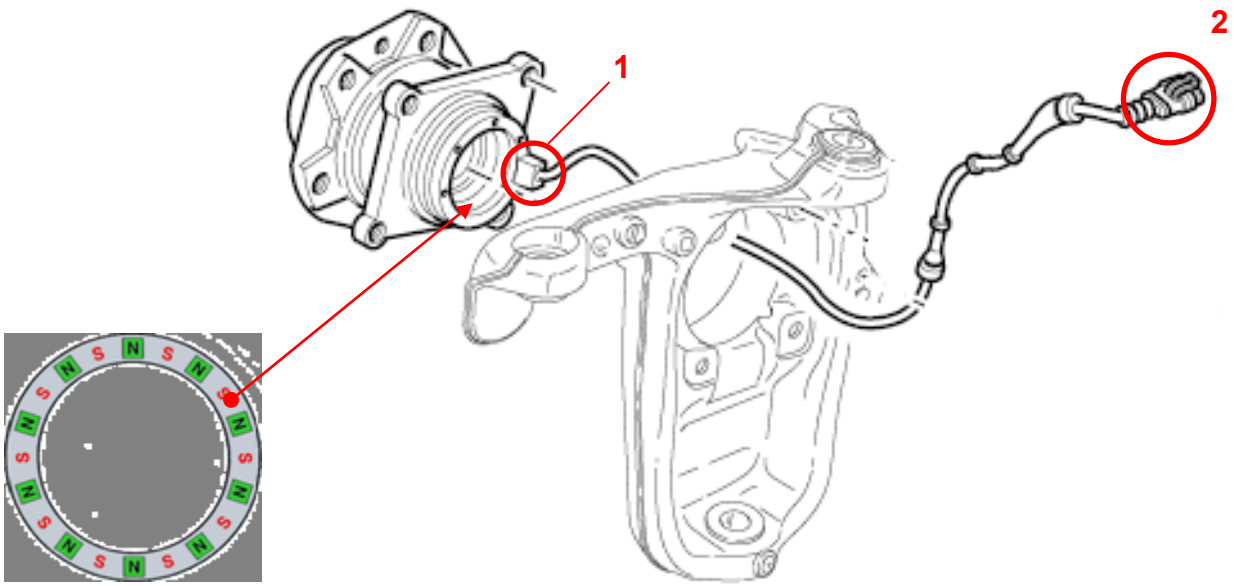
PRESSURE IN THE CIRCUIT



NO PRESSURE IN THE CIRCUIT

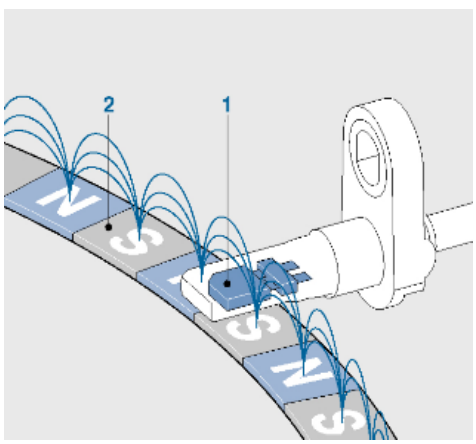
WHEEL REVOLUTION SENSORS

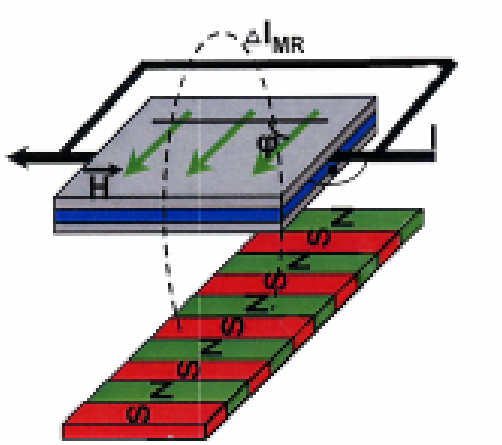
The wheel revolution sensors are the active type (powered) and are fitted in the relative wheel bearings.



1. Sensor
2. Connector
3. Multipolar disc

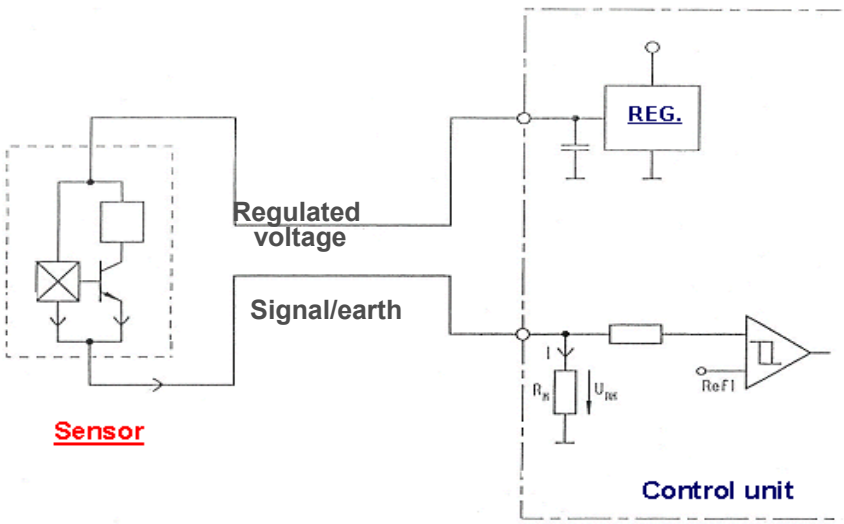
Each of the four sensors interfaces with the relative multipolar magnetic encoder, which is a disc divided into alternating positive and negative magnetic sections, integrated in the bearing. When the disc sections pass in front of the active sensor, they create a magnetic flow variation. The sensor utilises the Hall/Gauss effect and is composed of a silica plate with two connection terminals. During wheel rotation, increased resistance is generated between the sensor and the magnetic track integrated in the bearing, and the relative voltage drop can be read on an oscilloscope.





SENSOR POWER SUPPLY:
The sensor is powered directly by the ECU. The sensor power supply leading directly from the ECU is connected on one pin and the signal leading to the ECU on the other pin. The signal is actually made up of two wave forms:

1. Fixed-frequency square wave (1.3 – 1.4 Hz) coming from the ECU
2. Signal coming from the variable frequency sensor



These two signals can only distinctly be displayed (for the same sensor). At Key On, the signal coming from the control unit can be read on an oscilloscope. As soon as the relative wheel rotates, the signal received from the sensor superimposes on the square wave of the ECU, which can therefore not be displayed.

This type of sensor is capable of detecting the vehicle driving direction. The direction in which the square wave emitted by the NFR develops (from right to left or vice versa) informs the ECU whether the vehicle is moving forward or backward.

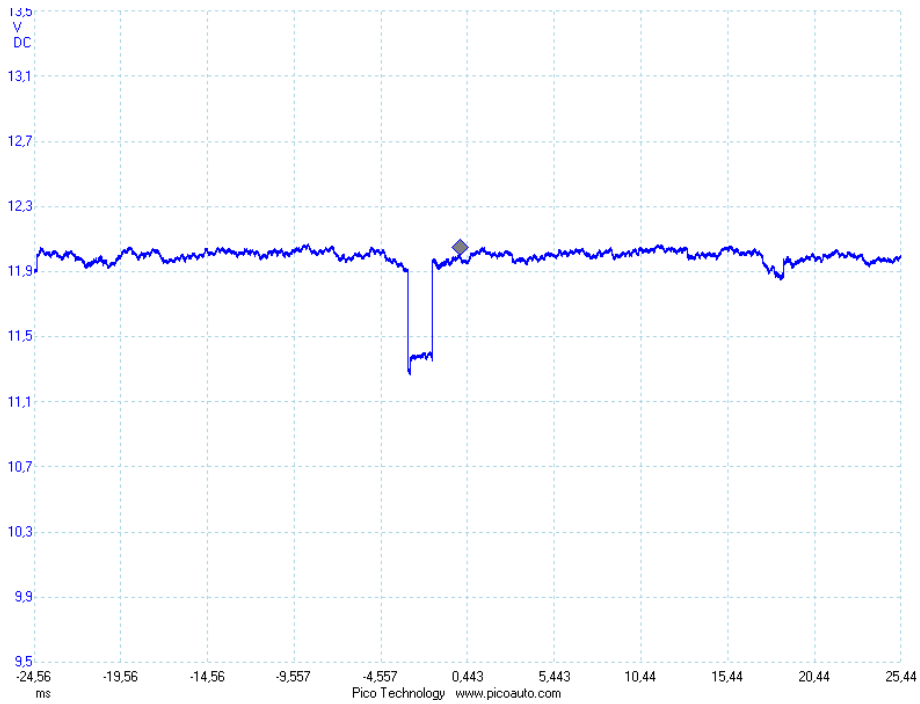
The technical advantages offered by use of this type of sensor, known as an “active sensor”, are:

1. Reduced sensitivity to electromagnetic interferences.
2. Reduced sensitivity to the distance between the sensor and the magnetic disc.
3. Signal useable directly by the control unit
4. The voltage does not vary as the speed varies, making the signal readable also at every low speeds.

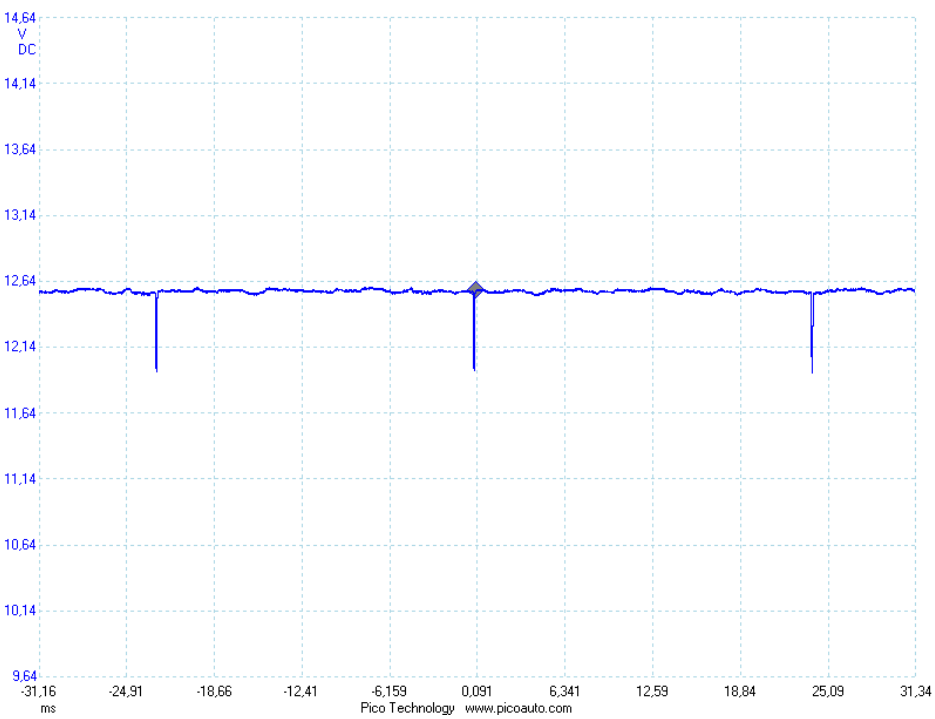
NOTE: The images subsequently acquired with the oscilloscope have been verified by directly measuring the 2 pins of a wheel RPM sensor on the NFR ECU.

Signal from NFR to wheel sensor: Vbatt nominal voltage with square wave voltage drop of 0.5-0.6 Volt.

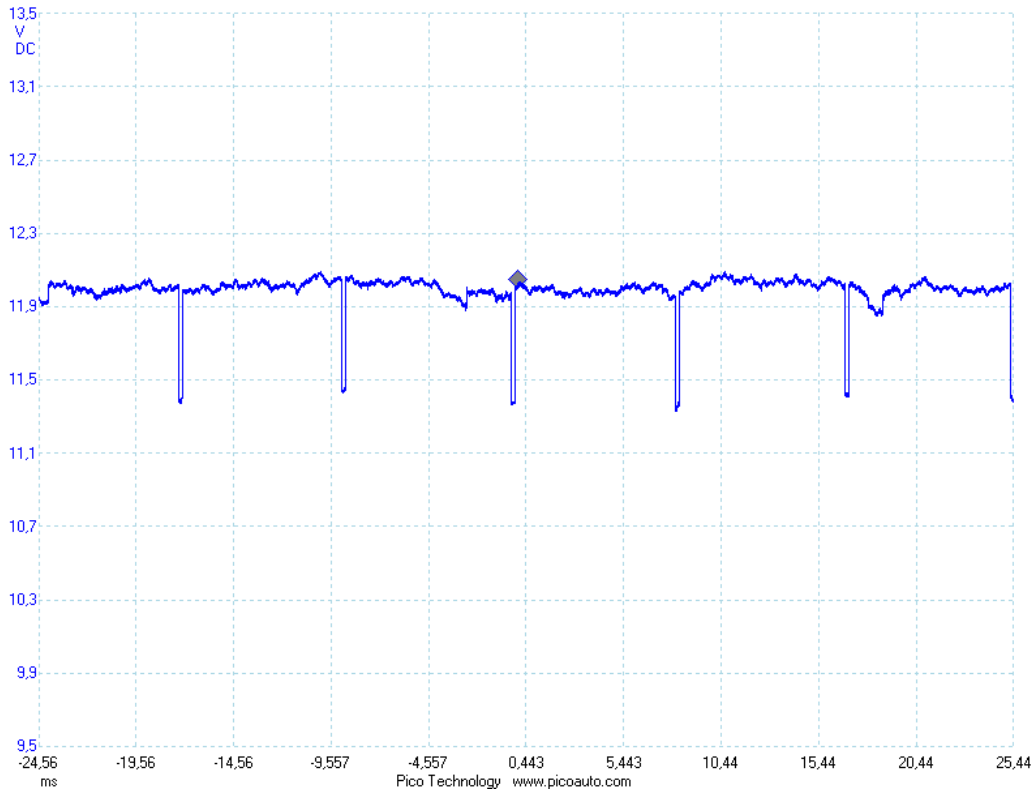
Picoscope settings: Time scale 2ms/div Voltage scale ± 20V



Signal from wheel revolution sensor: Vbatt nominal voltage with square wave voltage drop of 0.5-0.6 Volt. The frequency varies as the speed increases.



Sensor signal: increasing the speed the frequency varies.



The NFR calculates the actual vehicle speed value starting from the values received from the driving wheel sensors (of which the NFR calculates the mean) and from the actual wheel circumference value received from the NBC.
The wheel circumference value transmitted by the NBC is stored by the NFR in a non-volatile memory. This data is updated with that received in case of discordance.

ACQUISITION MODE:

1. Acquisition of the wheel speed signal by the sensors on the driving wheels.
2. Acquisition from the C-CAN network of the actual circumference value of the specific wheels fitted.
3. Calculation and transmission to the C-CAN network of the actual and average vehicle speed.
4. Discrete transmission (no CAN network) of the actual vehicle speed signal (VSO) to the NBC.

The NFR always transmits the actual vehicle speed value, even if one or two of the driving wheel sensors fail, according to the following table:

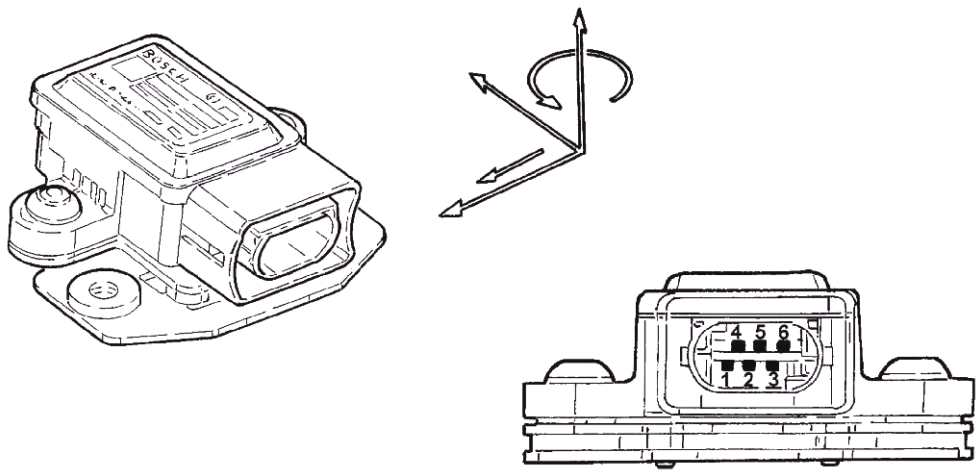
Wheel sensor front LH (FLH)	**Wheel sensor front RH (FRH)**	**Wheel sensor rear LH (RLH)**	**Wheel sensor rear RH (RRH)**	**Actual speed value**
-	-	OK	OK	F(RLH, RRH)/2
OK	-	Not OK	OK	F(RRH, FLH)/2
-	OK	OK	Not OK	F(RLH, FRH)/2
OK	OK	Not OK	Not OK	F(RLH, FRH)/2
Condition on roller test bench (no pulse)	Condition on roller test bench (no pulse)	OK	Not OK	F(RLH)
Condition on roller test bench (no pulse)	Condition on roller test bench (no pulse)	Not OK	OK	F(RRH)



IF A WHEEL RPM SENSOR FAILS, THE BRAKING SYSTEM WILL BE MANAGED IN RECOVERY MODE.

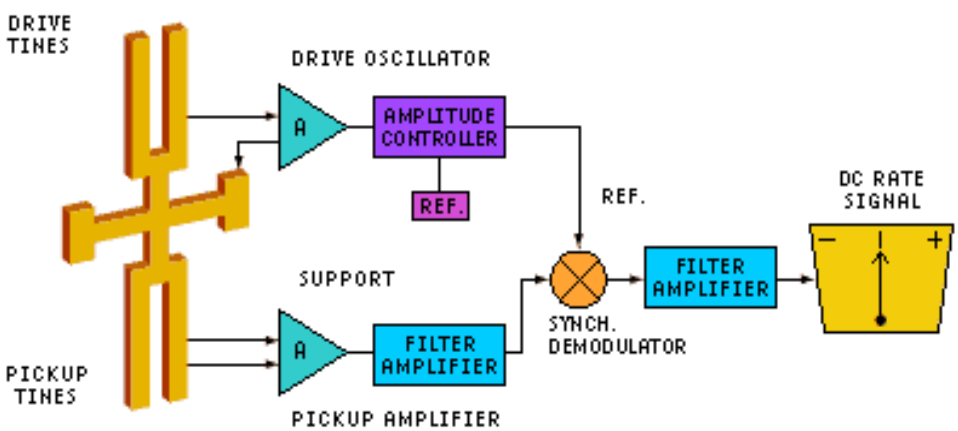
ACCELERATION/YAW SENSOR (NYL)

The yaw, lateral and longitudinal acceleration sensor is integrated in the NYL NODE. Its purpose is to detect the rotations on the vertical axis of the vehicle (yaw) and the lateral and longitudinal thrusts.



OPERATION: The sensor is powered by the ABS ECU and supplies, by means of the piezoelectric elements, a voltage proportional to the lateral thrust and a voltage proportional to the rotation speed around the vertical axis.

The sensor is composed of a "diapason" with four elements. It exploits the Coriolis effect to return a voltage that is generated by the difference in potential between the upper and the lower end of the diapason. The voltage varies when the sensor is involved in a proportional rotation.



INSTALLATION: The sensor must always be positioned in proximity of the vehicle barycentre and connected to the respective fitting.





WIRING
The sensor is directly connected to the ABS ECU for both power supply and measuring signals. The 4 sensor pins have the following functions:

- Earth in common with the steering angle sensor
- Direct power supply from the NFR and in common with the steering angle sensor
- C-CAN H line
- C-CAN L line

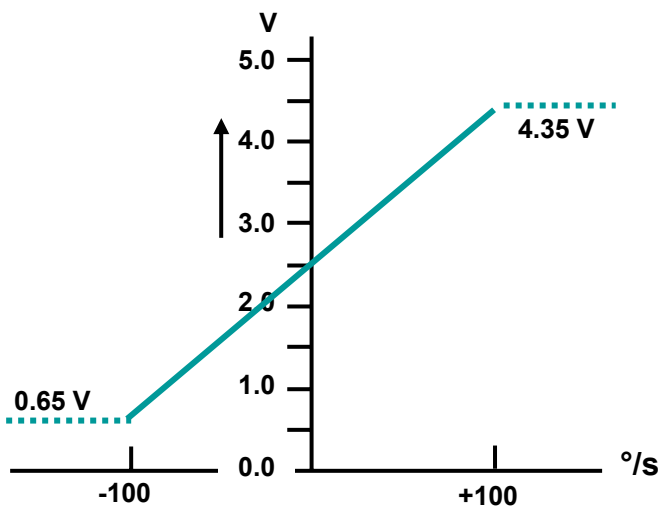
ELECTRICAL CHARACTERISTICS

- Power supply voltage: 8.2V (min) – 12V (nominal) – 16V (max)
- Operating temperature: -40°C (min) – +85°C (max)
- Yaw sensor range: □ 100 °/s
- Yaw sensor resolution ± 0.3 °/s
- Lateral acceleration sensor range ± 1.8 g

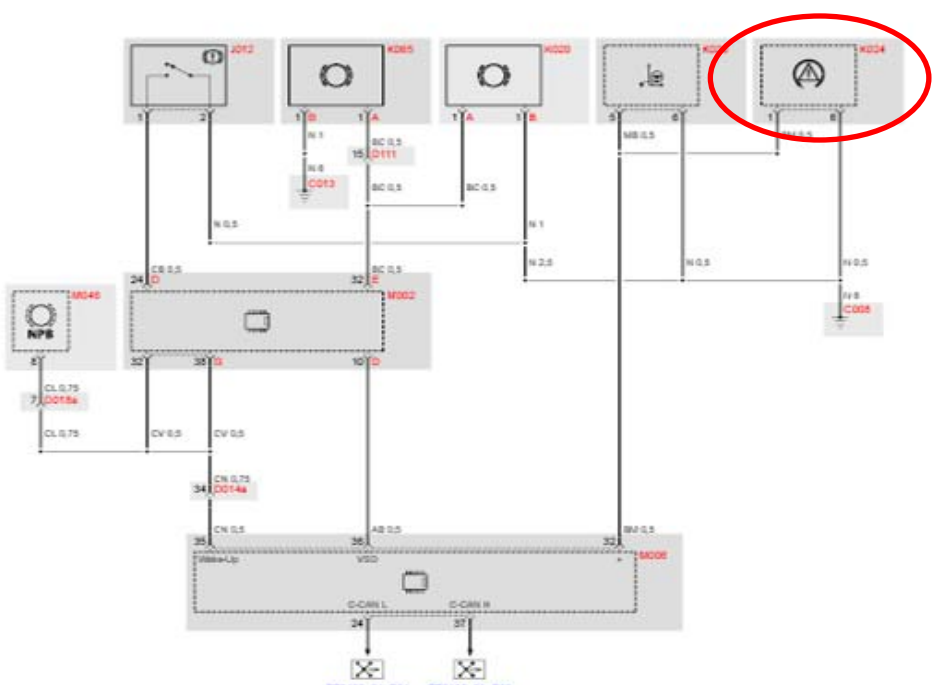
OUTPUT SIGNAL: The yaw sensor provides an output signal, which is translated into CAN protocol deriving from the voltage and proportional to the rotation speed around the vertical axis of the vehicle and to the lateral force to which the vehicle is subjected.

In standby position, i.e. with the vehicle driving in a straight line or during cornering at a constant radius, the reference voltage is 2.5V.
During a violent rotation of the vehicle, for example, when it turns 90° with respect to the driving direction in one second, there may a voltage of 4V or 1V depending on the rotation direction.

For all the cases of intermediate rotation speed, refer to the graph below.

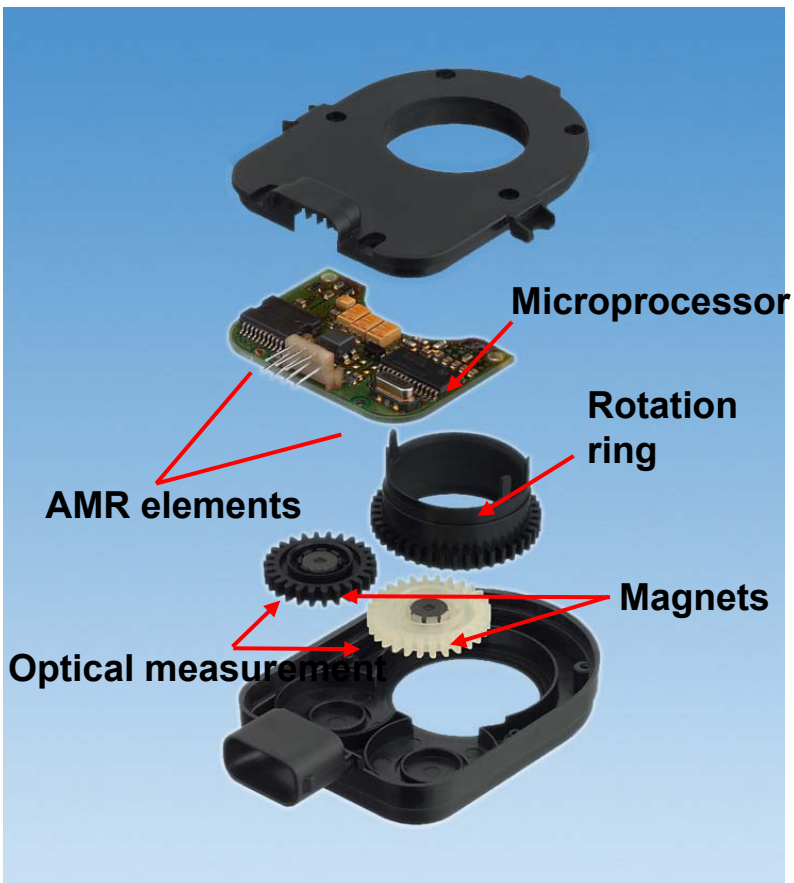


The signal shown in the graph above is converted and sent to the NFR on the C-CAN line.



STEERING ANGLE SENSOR

The purpose of the steering angle sensor is to detect the angular degrees and the rotation speed of the steering wheel and to make these values available on the CAN network. The sensor is mechanical and splined on the steering column. As well as interacting with the NFR and the NYL, it sends information to the NFA via the C-CAN line.



OPERATION

The sensor is composed of 6 LEDS for photoelectric barrier measurement and 2 microcontrollers that form a single component with a signal measuring ring.
The LEDS are evenly spaced out in a photoelectric barrier channel across which there are 15 diaphragms of different length.

Thanks to its internal electronics, the sensor is capable of measuring:

1. The angular position of the steering column
2. The rotation speed of the steering column

The operating range is 1560° (i.e. more than 4 complete revolutions from left to right) with a resolution of 0.1°.

1- Main ring

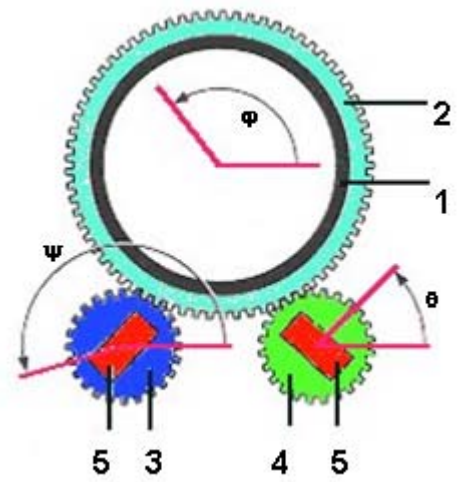
2 –Driving gear

3- Incremental gear 1

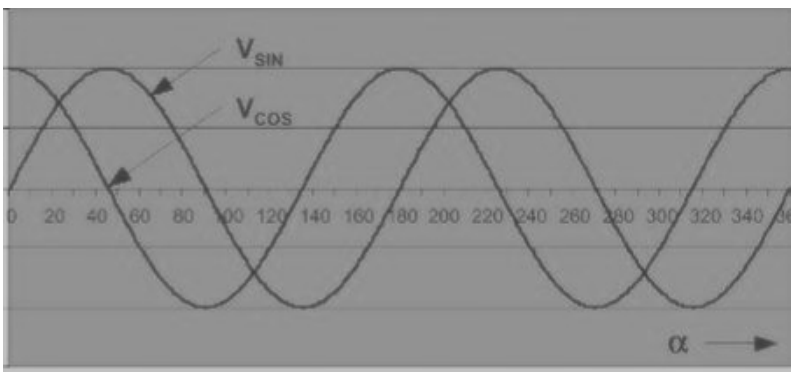
4- Incremental gear 2

5 – Magneto resistive sensors

ψ , θ, φ Rotation angle

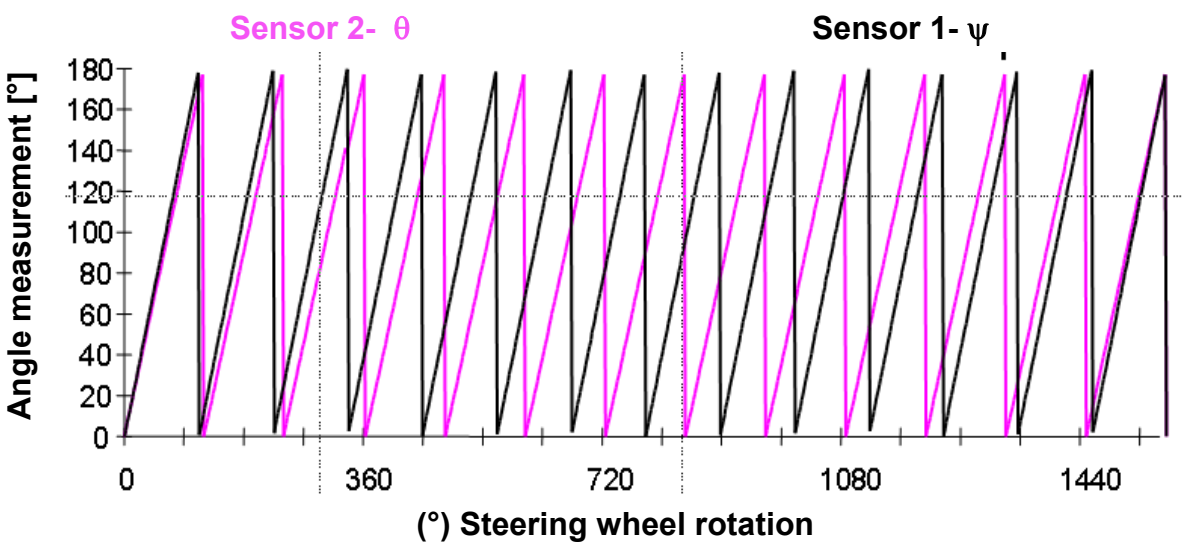


The two gears that allow incremental reading have a different number of teeth. For this reason, the signal generated by the two magneto resistive sensors is out of phase.



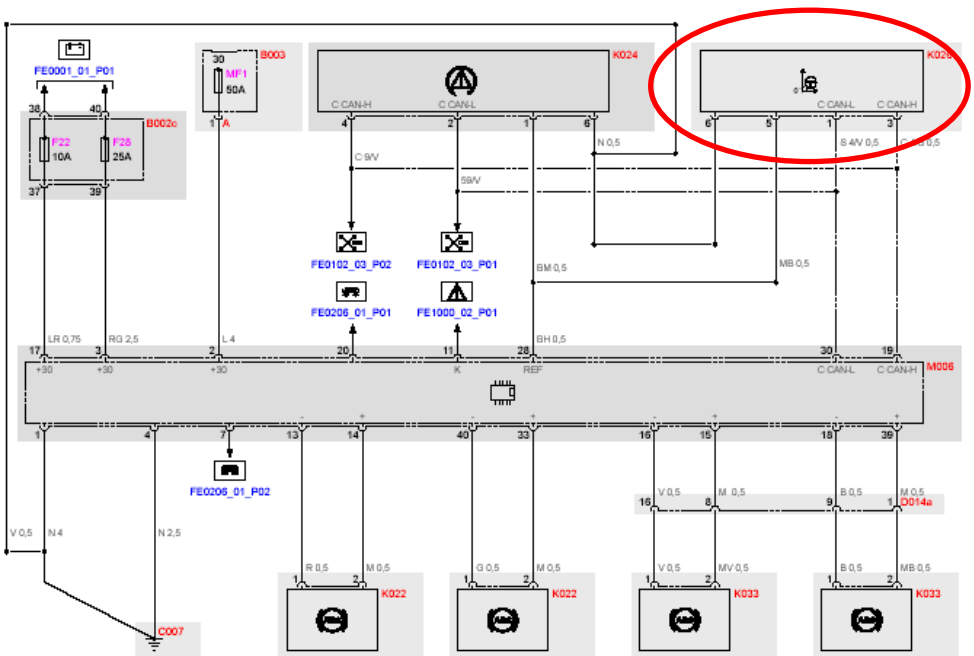
Output signals generated by gears 1 and 2

The sine-wave signals generated reach the microprocessor in the steering angle sensor which calculates the rotation angle:

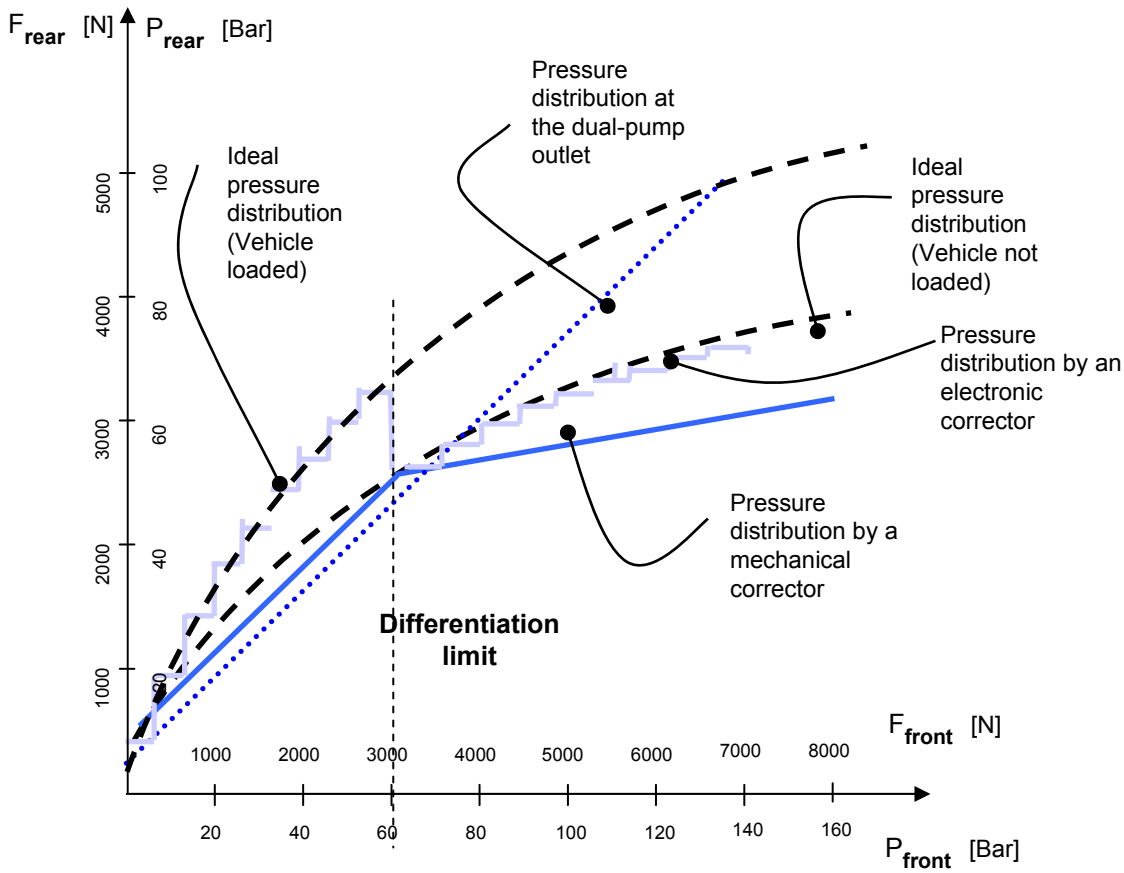


WIRING: The sensor has a 4-pin connector, two pins dedicated to power supply and two pins to C-CAN network connection:

- Earth, in common with the yaw sensor
- Direct power supply from the NFR and in common with the yaw sensor
- C-CAN H line
- C-CAN L line

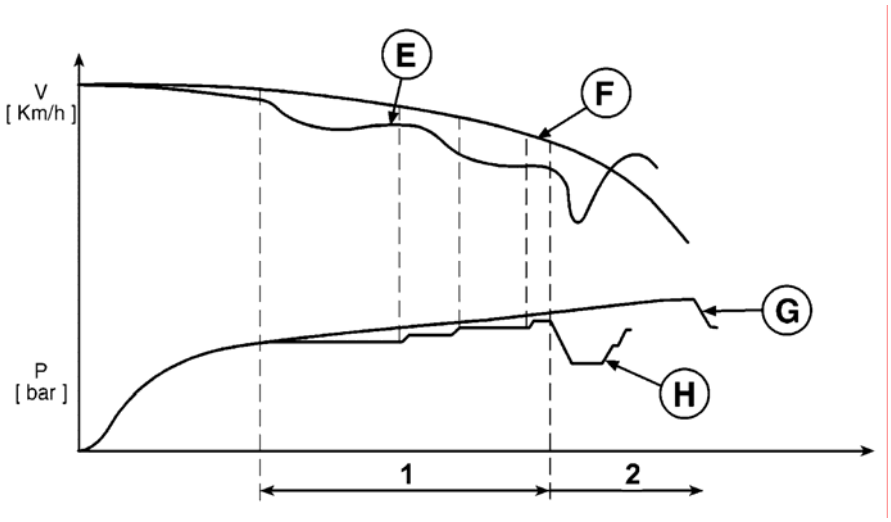


EBD FUNCTION



During braking, the inertial force applied at the barycentre produces a load transfer that tends to increase the load on the front wheels and reduce that on rear wheels. Should a braking moment proportional to the static load be applied to all four wheels, the rear tyres would be the first to reach the grip limit, thus jeopardizing the vehicle directional stability (oversteering). To prevent this, the systems not equipped with ABS have been fitted with a valve, the brake force regulator, capable of limiting the braking pressure on the rear wheels.
Today, this adjustment can be achieved directly by means of the hydraulic modulator of the ABS system, known as EBD (Electronic Brake Force Distributor).
The EBD copies the ideal braking distribution curve more faithfully than using a mechanical brake force regulator. Starting from the speed signals of the four wheels, it calculates the average wheel speed on the front and rear axles and, by comparing the decelerations on the two axles, modulates the rear axle pressure.

EBD OPERATION



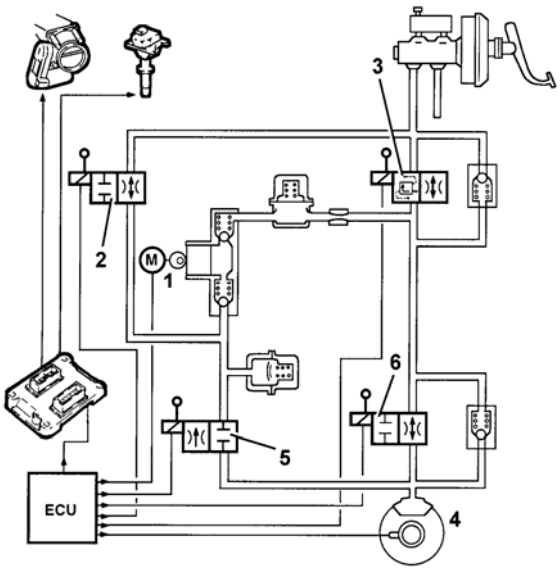
1: EBD control
2: ABS control
E: rear wheel speed
F: front wheel speed
G: front wheel pressure
H: rear wheel pressure

INTEGRATION WITH THE ABS SYSTEM: As already mentioned, the ABS system's EBD is capable of adapting itself to the ideal pressure curve, always using the grip available in all braking conditions. The integration of the EBD function in the normal operating logic of the ABS system allows the two strategies to be applied simultaneously. Therefore, the system normally operates so as to maintain “slipping” of the rear tyres within values very close to the ideal ones, however, allowing the ABS strategy to actiuvate whenever a wheel tends to lock.

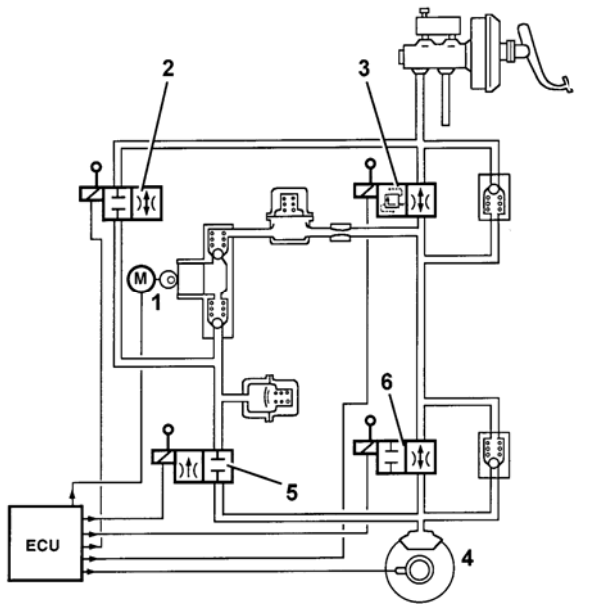
EBD CONTROL The graph shown above illustrates this type of strategy. While the front wheels are decelerating and their speed variation remains within the set limits (the ABS system is in the pressure increase phase for the front wheels and therefore inactive), the braking pressure on the rear calipers is modulated upward by the rear ABS branch, the purpose of which is to implement the EBD function. Also note that in phase 1 the pressure on the rear calipers is always below that of the front calipers, as indicated by the ideal distribution curve.

ABS CONTROL: As the rear wheels tend to decelerate excessively with respect to the reference conditions, the system operates as ABS also for the rear wheels, following the pressure increase, pressure reduction and pressure maintenance phases (phase 2 in the graph).

ASR HYDRAULIC OPERATION



STANDBY CONDITIONS



OPERATING CONDITIONS

1.Scavenge pump
2.intake solenoid valve
3.control solenoid valve

1.brake calipers
2.outlet solenoid valve
3.inlet solenoid valve

SOLENOID VALVES: The ABS electro-hydraulic unit, in the version equipped with ASR, has four additional solenoid valves (two for each driving wheel); therefore, for the rear wheels the hydraulic diagram reflects that of the ABS, while for the front wheels there are two extra solenoid valves (per wheel). When the normally closed intake solenoid valve is activated, the scavenge pump receives the quantity of extra fluid necessary to increase the pressure on the brake caliper and to brake the wheel. When the normally open control solenoid valve is activated, it maintains the modulated pressure generated by the scavenge pump in the brake master cylinder/caliper circuit, as this is necessary for ASR operation.

STANDBY CONDITIONS: If the two above mentioned solenoid valves are not activated, the system will operate in normal ABS system mode.

OPERATING CONDITIONS:

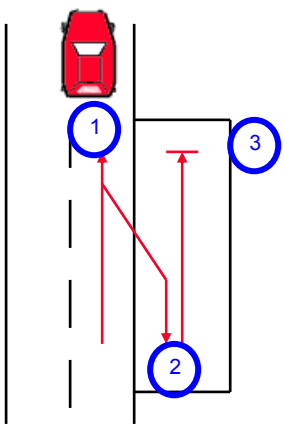
When ASR operation is requested, the two solenoid valves are electrically powered, allowing the brake fluid to flow from the scavenge pump (which is activated in this phase) to the brake caliper. Finally, the brake fluid pressure that acts on the caliper is modulated by the inlet and outlet solenoid valves.

The system operates with the signals coming from the active sensors, from the stop light switch and from the ASR activation/deactivation button.

It continuously compares the speed of the wheels on the same side of the vehicle (Front RH with Rear RH and Front LH with Rear LH) and when it detects a difference in speed of more than 2-6 km/h (operating threshold) between the two wheels on the same side, it operates with ASR logic.

HILL HOLDER

The Hill Holder system is integrated in the ABS/ESP and allows the driver to start off when standing on uphill roads, without the vehicle involuntarily rolling back.
The Hill Holder purpose is to assist the driver during uphill starting. The Hill Holder system is actually capable of automatically providing sufficient braking torque to hold the vehicle stationary until the clutch is fully released and engine torque is sufficient to start the vehicle comfortably.
To detect the vehicle inclination, the same yaw/lateral acceleration sensor as for the ESP system is used, which also measures the vehicle inclination.





Uphill parking

OPERATING MODE

- The Hill Holder function is automatically activated when the brake pedal is depressed in conjunction with the following events:
- the vehicle speed is equal to zero, the slope is greater than 2% and the brake pedal is depressed.
- The moment the brake pedal is released, subject to all the other conditions, the Hill Holder system keeps the braking system pressurised for about 2 seconds, to allow the driver to move his foot from the brake pedal to the accelerator pedal without the vehicle rolling back and without having to use the parking brake.
- After depressing the accelerator pedal, the Hill Holder system holds the vehicle in place for a further 2 seconds or until there is sufficient engine torque to start the vehicle.

OPERATING LOGIC

- The time indicated (2+2 seconds) is a maximum time which the control unit varies (reducing it) if the succession of actions (braking/acceleration/sufficient torque) by the driver is faster.
- Vice versa, should the driver not depress the accelerator pedal within the first 2 seconds after releasing the brake pedal, or the necessary torque should not be reached within the 2 additional seconds, the Hill Holder system will reduce the hydraulic circuit pressure using a strategy of -1 bar every 0.02 seconds so as not to have a sudden release.
- In low-grip conditions the Hill Holder is deactivated. This is because if stopping on an icy hill and the Hill Holder keeps the wheels locked, the vehicle would slide back (this is an extreme condition).
- In the event of such extreme conditions, a slip test is implemented when ABS/ASR have activated or when a wheel locks just before the Hill Holder is activated.
- During the test, the ECU defines (by means of the ABS parameters) which wheel is the most stable and then releases the braking pressure on that wheel, holding the other three braked.
- If the speed sensor of the unbraked wheel indicates a speed other than zero, it means that the vehicle is moving even though the other wheels are locked. This indicates a low-grip condition and the Hill Holder system is therefore deactivated and the pressure in the entire brake circuit released.
- Vice versa if the unbraked wheel does not move, it means that the condition is stable and, consequently, the Hill Holder continues operating.
- The slip test lasts about 150 ms.

SIGNALS AND SENSORS REQUIRED:

- Reverse gear engaged
- Clutch status
- Accelerator pedal status
- Brake pedal status
- Engine torque value
- Engine RPM
- Longitudinal or inclination sensor
- Brake pressure sensor (incorporated in the ABS ECU)

Additional functions

Hydraulic brake assist (HBA)

Functions

- Increases the braking pressure when the brake pedal is depressed fast but with insufficient force
- Reduces the braking distances

Input signals

- Master cylinder pressure sensor
- Wheel speed sensors
- Stop light switch

Output signals

- Increase in braking pressure

Hydraulic Rear Wheel Boost (HRB)

Functions

- Increases the rear braking pressure during front ABS activation
- Reduces the stopping distance

Input signals

- Master cylinder pressure
- Wheel speed sensors
- Stop light switch

Output signals

- Increase in braking pressure on the rear wheels

Roll-over mitigation (ROM)

Functions

- Reduces the risk of vehicle roll-over
- Stabilizes the vehicle with braking torque action on the front outside corner

Input signals

- Wheel RPM sensor
- Steering angle sensor
- Engine torque sensor
- Yaw sensor

Output signals

- Engine torque reduction (optional)

SPECIFIC PROCEDURES

- Brake circuit bleeding procedure
- Steering angle sensor calibration
- Acceleration sensor calibration

Brake circuit bleeding procedure

For proper bleeding of the brake hydraulic circuit, it is essential that the procedure be performed based on the diagnostic tester procedure. For proper execution of this procedure, strictly follow the instructions given in the workshop manual.
The bleeding procedure must be performed every time components of the brake hydraulic circuit are removed or loosened.

Steering angle sensor calibration

This procedure must be performed with the diagnostic tester after replacing the steering angle sensor (NAS) or the electro-hydraulic node (NFR).

Acceleration sensor calibration

This procedure must be performed with the diagnostic tester after replacing or removing the combined yaw/acceleration sensor or the electro-hydraulic node (NFR). For proper execution of the procedure, the vehicle must be parked on an even surface.

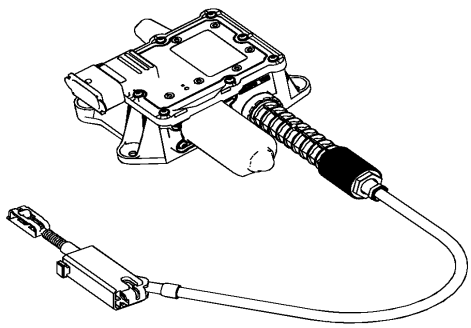
Electric Parking Brake (NPB)

Bosch / Siemens

Introduction

The Electric Parking Brake or EPB is an electro-mechanical device which prevents the vehicle from moving in stationary situations. It replaces and extends the functionality of the traditional mechanical lever-controlled parking brake (hand brake).

The EPB operates completely automatically - this means automatic engagement and disengagement during parking the vehicle or when driving off - or can be operated manually by the driver by means of a small lever on the central console.



Applied vehicles

- All Quattroporte vehicles with automatic transmission
- All GranTurismo vehicles
- All Alfa 8C Competizione and 8C Spider vehicles

System history

The EPB was first introduced on the Quattroporte Automatic model when it was launched in January 2007. On the Granturismo model, launched during the month of March of the same year, the EPB featured the new Pre-release function.

This modification was also applied on the Quattroporte Automatic for MY08 (Assembly 34071 onward).

All Alfa 8C vehicles are fitted with the same EPB unit including the Pre-release function.



The EPB was introduced on the Quattroporte Automatic in January 2007.

Location in the vehicle

The EPB unit is for both Quattroporte and GranTurismo models located in the trunk compartment. It can be accessed by removing the trunk floor lid. On Alfa 8C vehicles the EPB is located in the area underneath the storage space behind the front seats, on the left hand side.



Quattroporte



GranTurismo



Alfa 8C

Node electrical characteristics

- Operating voltage range for full functionality: 9-16v
- Operating voltage range for degraded functionality: 8-9v
- Nominal operating voltage (regulated at node input): 14v

Note: no motor activation is possible under 9v or above 16v.

- Current consumption in sleep mode: < 350 µA
- Current consumption in stand by mode : < 350 mA

Data communication

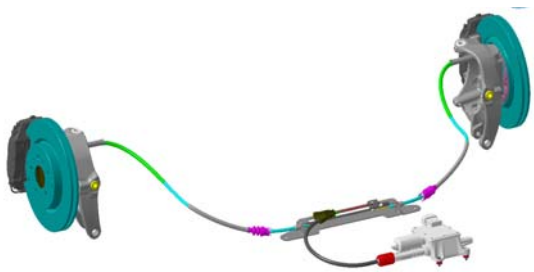
The EPB node or NPB is connected to the C-CAN line which it uses for data transfer with other vehicle systems and for communication with the diagnostic tester.

System description

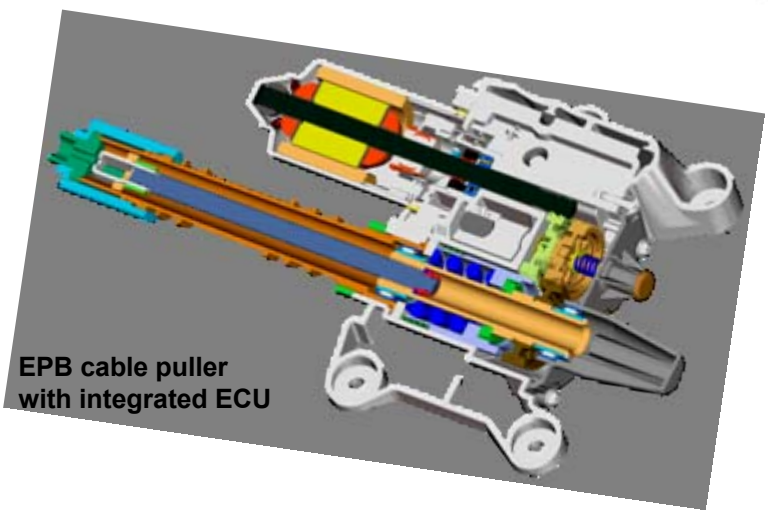
System overview

The system is made of the following components:

- EPB unit (cable puller with integrated ECU)
- 180 mm drum parking brakes, integrated in the rear brake discs (Drum In Hat)
- Brake cables and divider
- EPB activation lever
- Park Off switch
- Emergency release tool, provided with the car
- Parking brake warning light



Parking brakes and cables



EPB cable puller with integrated ECU



Emergency release tool



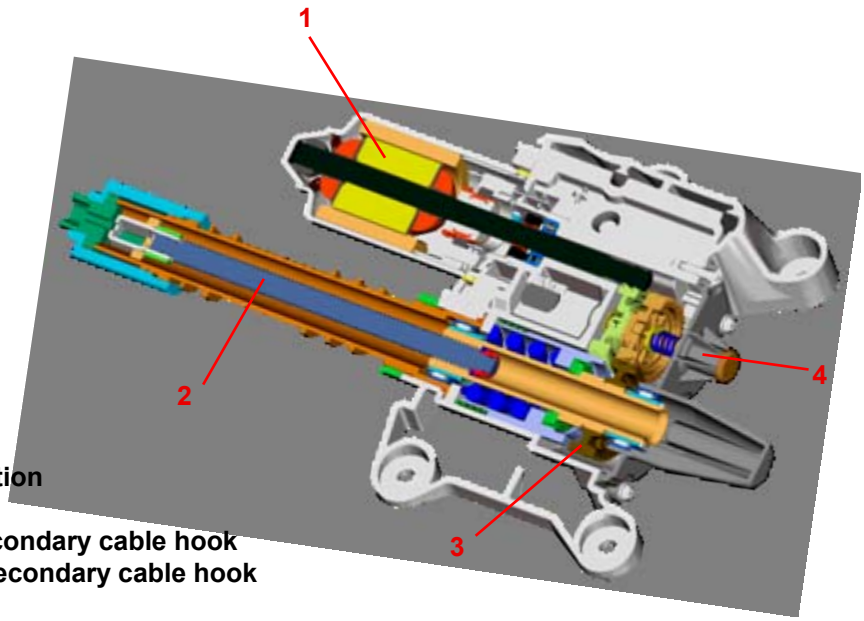
EPB activation lever



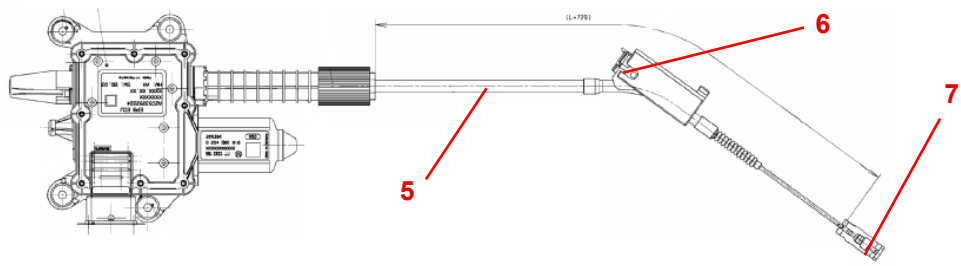


Park Off button

Mechanical system characteristics



1) **DC motor**
2) **Spindle**
3) **Spur gear wheels**
4) **Emergency operation**
5) **Primary cable**
6) **Left hand side secondary cable hook**
7) **Right hand side secondary cable hook**

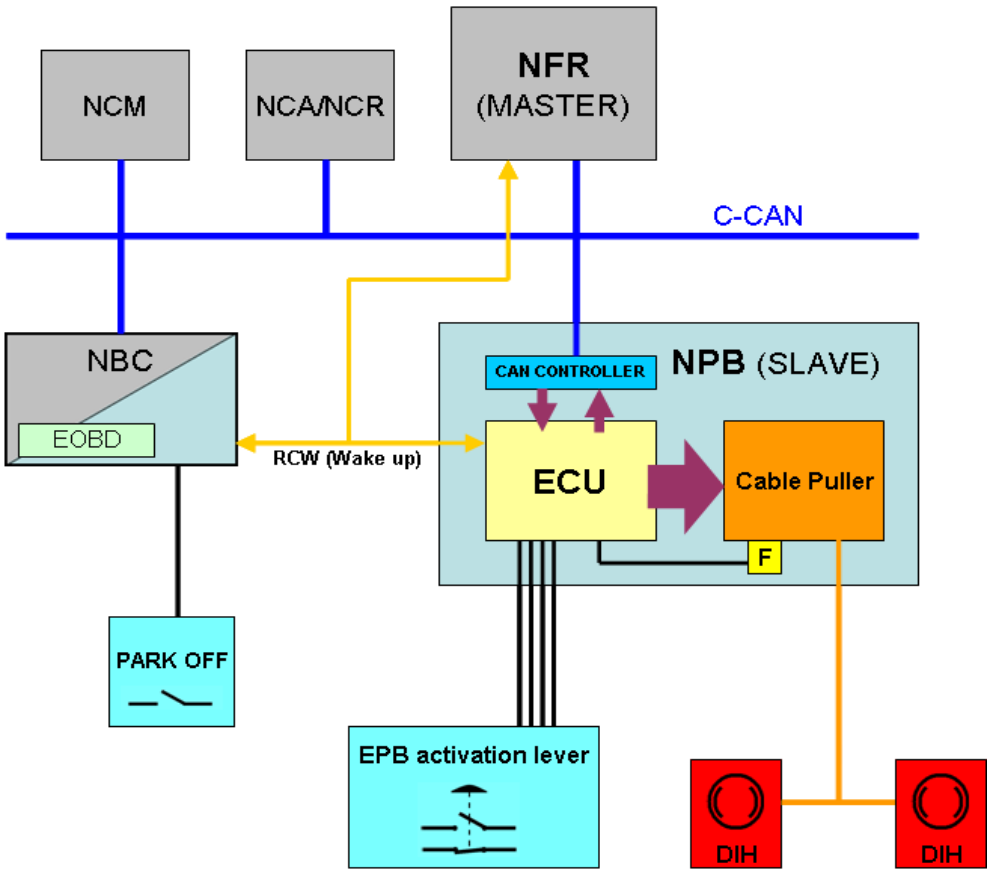


Mechanical characteristics:

- Nominal apply force: 1500 N
- Maximum apply force: 1650 N
- Overall stroke: 122 mm
- Working stroke: 48 mm
- Apply time: max 1,3 s
- Release time: max 1,1 s
- Temperature range: - 40° to 85°C

The system has been designed for 100.000 activations

Functional diagram



Description

The NPB module is an electro-mechanic actuator with the ECU integrated into a single component. The cable puller is made of a DC motor attached to a spindle mechanism. A hall effect sensor is integrated to measure the pulling force applied on the primary cable.

The primary cable is linked to the left hand side and right hand side secondary cable by means of a divider. The actual parking brakes are of the “drum in hat” type (DIH) and operate exactly in the same manner as on vehicles fitted with a traditional, manual parking brake.

The EPB activation lever on the central console contains a double switch (one with normally open contacts and the other one normally closed). It is directly wired to the NPB unit by four wires.

A hardwire wake up line (RCW = Remote Control Wakeup) links the NPB with the body computer and the NFR.

All data exchange with other vehicle systems takes place over the C-CAN line. Example: vehicle speed (from NFR), inserted gear (from NCA/NCR), driver’s door open signal (from NFR).

The “PARK OFF” switch, located on the centre console, is linked to the body computer. This is a normal open switch which gives an active low signal to the NBC when pushed. The NBC sends this information over C-CAN to the NPB.

Master /slave strategy

A master/ slave strategy is adopted for the NPB and the NFR. The NFR has the position of master while the NPB is in the position of slave.

This means that it is the NFR that determines when and with how much application force the parking brake is engaged and disengaged.

During normal use of the vehicle, the NFR will send a parking brake engagement /disengagement request to the NPB depending on the conditions (driving speed, inserted gear, throttle angle, door open /close signal, etc.)

In case the driver wants to engage or disengage the parking brake by pulling the EPB activation lever, the NPB will send this driver request to the NFR. Depending on the conditions, the NFR will evaluate this request and give or refuse authorization to the NPB to operate the parking brake.

Wake up mechanism

Since both the service brake and the parking brake are important safety features, a direct line (RCW line) between these systems and the network manager (NBC) permits the wake up of the various vehicle systems at the occurrence of certain events.

The NBC, NFR and NPB are all interconnected by the bi-directional RCW line. The NPB can use this line to wake up the NFR and the NBC. The NBC can use this line to wake up the NPB and the NFR. The NFR can only receive a wake up signal but can not wake up the other nodes. A 12 volt pulsation with a duration of 1 second is used as wake up command.

Examples of wake up:

- When the driver's door is opened (with the vehicle in sleep mode), The NBC will wake up the NFR and the NPB to allow them to for check for possible vehicle movement and monitor the parking brake efficiency.
- When the EPB lever is pulled (with the vehicle in sleep mode), the NPB will wake up the NBC and the NFR. The NFR will evaluate this driver's request and, depending on the conditions, give authorization to the NPB for parking brake engagement.

Sleep mode

Sleep mode is initialized by the key off command combined with a timer function, depending on the angle of the slope on which the car is parked. Before falling to sleep mode, NFR and NPB will monitor the parking brake efficiency. If a wheel movement is detected, the NFR will ask the NPB to increase the applied cable force, in order to prevent the vehicle from moving. The strategy is as follows:

- Vehicle is parked on a level surface: sleep mode begins after 6,5 minutes
- Vehicle is parked on a slope: sleep mode begins after 16 minutes

After falling to sleep mode, there is no further monitoring of the parking brake efficiency. The RCW line is low.

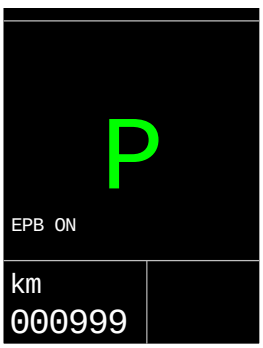
EPB operating strategies

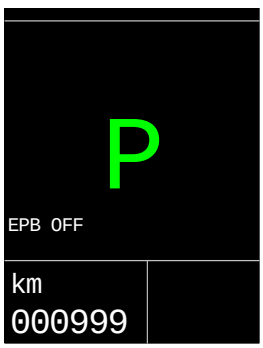
Assisted parking brake

The parking brake can be engaged and disengaged when the vehicle is stationary by pulling the EPB activation lever on the centre console. The brake pedal must be pressed. The EPB can be applied also in Key Off conditions. To disengage the EPB, the key must be on.

Automatic parking brake

Automatic parking brake engagement when the vehicle is stationary and the key is turned OFF (default condition); this function can be disabled by the EPB OFF switch on the central console before turning the key to OFF.
The PARK OFF switch positioned on the central console must be pressed before switching off the engine to prevent automatic activation of the EPB. The message PARK OFF is displayed on the instrument panel. The system is disabled only for next key-off action, and when the engine is next started the default status is reset.





When the electric parking brake is engaged, the specific warning light comes on. The EPB activation status is repeated on the instrument panel in the display area (EPB ON or EPB OFF).

When the EPB is engaged, the parking brake warning light is on. During the moments of engagement and disengagement, the warning light will flash.



Parking brake warning light (EU, Japan specifications)



Parking brake warning light (US specifications)

Drive away

This is an automatic parking brake disengagement function during driving off. The accelerator pedal angle must exceed 3% and the transmission must be not in neutral.
This function is always active.

Pre-release (GranTurismo and Quattroporte starting from MY08)

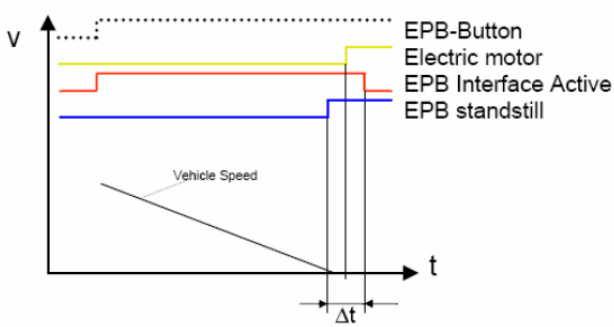
The Pre-release function will disengage the parking brake in case the brake pedal is depressed and a gear is engaged (with engine running).
This function eliminates the acoustic discomfort caused by the disengaging parking brake during driving away (Drive away function).

Dynamic brake

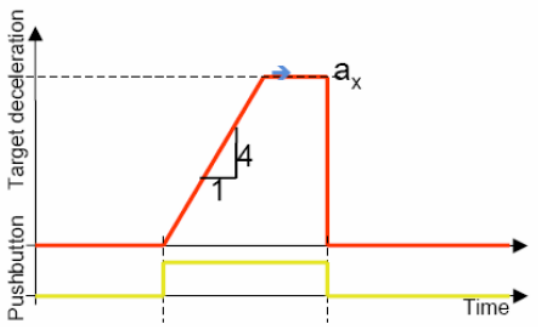
Dynamic braking is an emergency function which permits to slow down the vehicle to standstill by pulling the EPB lever.
This function is managed by the NFR through the application of the hydraulic brakes until the vehicle is stationary. After this, the EPB will engage the parking brake and the NFR will release the brake callipers.

Notes:

- Dynamic brake is active as long as the EPB lever is pulled. The function interrupts when the lever is released.
- During dynamic braking, the vehicle deceleration (brake force) increases gradually until a target deceleration is obtained.
- During dynamic braking, all vehicle safety and stability functions of the NFR are operational as during normal braking.
- Dynamic brake is a safety function, not a comfort function.



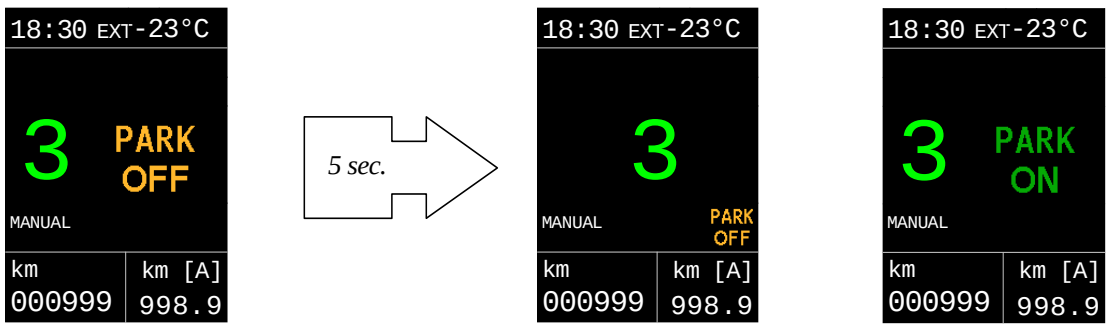
Δt = up to 2 seconds



Target deceleration = between 0,35g and 0,8g

Park ON/OFF conditions

The parking brake is always active by default (PARK ON) and this state is not displayed on the instrument panel.
When pressing the PARK OFF switch with key on, the PARK OFF message is displayed on the multifunctional display for 5 seconds.
Subsequently, if the PARK OFF switch is pressed again, the PARK OFF message disappears and is replaced with the message PARK ON, which is displayed for 5 seconds and then disappears.



When turning the key from ON to OFF, the EPB activation status is displayed on the instrument panel, regardless of whether PARK ON or PARK OFF has been set. If the engine is turned off when the PARK OFF function is active, the EPB function can be reactivated by commanding the EPB activation switch. The new strategy suggested will be shown on the display as EPB ON.

Specific service related procedures

EPB emergency release procedure

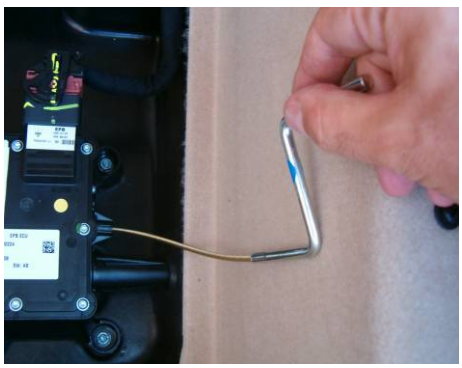
If the EPB has jammed (complete system failure, dead battery,…) the system can be mechanically released using a specific tool. This tool can be found in the emergency tool kit, delivered with the vehicle.

To release the EPB, insert the tool in the designated hole (after removing the covering tap) and turn clockwise until the parking brake cables are fully released. This procedure must be carried out in key off conditions.

Note: after having performed the emergency release, the EPB calibration procedure must be carried out with the diagnostic tester.







when performing the emergency release procedure, a specific DTC will be stored in the EPB unit, indicating the mechanical release of the EPB. If afterwards the vehicle is driven, another DTC will be stored indicating the non-calibrated status of the EPB actuator.
In this case the EPB has to be mechanically released again, followed by the calibration procedure with SD3. Afterwards the DTCs have to be deleted.

Actuator calibration

Calibration is an operation whereby the nominal operating position of the ECU is set. In brief, the ECU pulls the cables until the nominal tension is attained, determining the zero position in the actuator stroke. This procedure calibrates the cable force – which is measured by means of an integrated Hall-effect force sensor – in relation to the cable course.

This operation is absolutely essential after having removed or replaced components of the EPB system or after performing the emergency release procedure.

This procedure can be activated in the active diagnosis menu of the diagnostic tester.

Control cable release
If replacing one or more components of the EPB system (control cables, brake pads and/or discs, etc.) the cable tension must be slackened until fully releasing the cables: this will allow to remove the different parts. This function can be activated in the active diagnosis menu of the diagnostic tester.

EPB function for cable running-in function (Cable Bedding)
If one or both the secondary system cables are replaced, a running-in procedure must be performed using the diagnostic tester. This procedure, which repeatedly tensions the cables in 5 different steps, allows the system to reach maximum operating efficiency, preventing residual elastic effects during the operating phases.
This function can be activated in the active diagnosis menu of the diagnostic tester.

Garage Braking
After the rear brakes discs/drums or pads have been replaced, it is necessary to perform a running in procedure by activating the “garage braking”. This function is enabled by the diagnostic tester in the active diagnoses menu.

Preconditions for garage braking mode:
- Vehicle stationary (driving speed < 3 km/h)
- Key ON
- EPB released

Garage braking cycle:
- Driving speed = 35 km/h
- EPB applies parking brake load and holds for 4 seconds
- EPB releases load and waits 10 seconds (cable released)
- This cycle is repeated three more times

During the cycle, the EPB lever must be pulled

The cycle will be aborted in the following cases:
- The EPB lever is released
- The driving speed exceeds 45 km/h
- The key is switched off
- The time limit (30 min) is exceeded
- The service brake is applied or ABS / MSR / ASR / MSP operates
- The procedure is interrupted by the diagnostic tester
- An error occurs

Diagnostics / recovery strategies

EPB system failure
The EPB failure information is sent to the instrument cluster via a CAN signal. In these conditions, the EPB failure warning light comes on (for all markets except the USA where the BRAKE warning light is used) and at the same time a “Parking brake failure” message is shown on the display. This specific message is accompanied by an acoustic warning.
A failure of the ABS/MSP system, can lead to the EPB operation being disabled,



EPB failure light



EPB failure light (US specifications)

Vehicle speed signal failure recovery
In case the NPB does not receive any vehicle speed information (as a result of an internal failure of the ABS/MSP system), the automatic operating of the parking brake will be disabled. The parking brake will remain in its current position. In such a case the parking brake can be manually engaged /disengaged by pulling the EPB lever at the condition that the transmission is in neutral.

Note: in particular conditions where the battery voltage is low, the electric parking brake system may temporarily be deactivated (degraded functionality). Therefore, typically upon starting the engine, when the battery voltage is reduced, the message PARK OFF may be temporarily displayed, indicating that automatic operation is momentarily disabled.

Note: in the event of a complete loss of CAN communication with the NPB, the NPB will loose functionality and the parking brake will stay in its current position.



As a result of the Master-Slave strategy between NFR and NPB, an error inside the NFR can impede normal operation of the NPB. Always check the NFR for stored error codes in case of a non-correct operation of the EPB, even in case the NPB itself has no stored errors.

Suspension Control System (NCS)

ZF - Sachs

INTRODUCTION

The Suspension Control Node (NCS) is the ECU that controls the controlled suspension damping system. Developed by ZF-Sachs, the CDC (Continuous Damping Control) system is "semi-active" type, where damping is controlled by continuously varying the damping value without the need for additional energy supply. The aim of this type of system is to dampen the stress transmitted to the chassis through the wheels, in order to enhance vehicle comfort and attenuate rolling and pitching during dynamic driving.

The suspension control node is composed of:

1. Four shock absorbers equipped with a proportional solenoid valve
2. Electronic control unit
3. Two acceleration sensors positioned on the front lower levers
4. Three acceleration sensors fitted on the car body.

The system processes the information sent by the sensors fitted on the car body and on the levers, appropriately damping the extension and compression of each individual shock absorber.

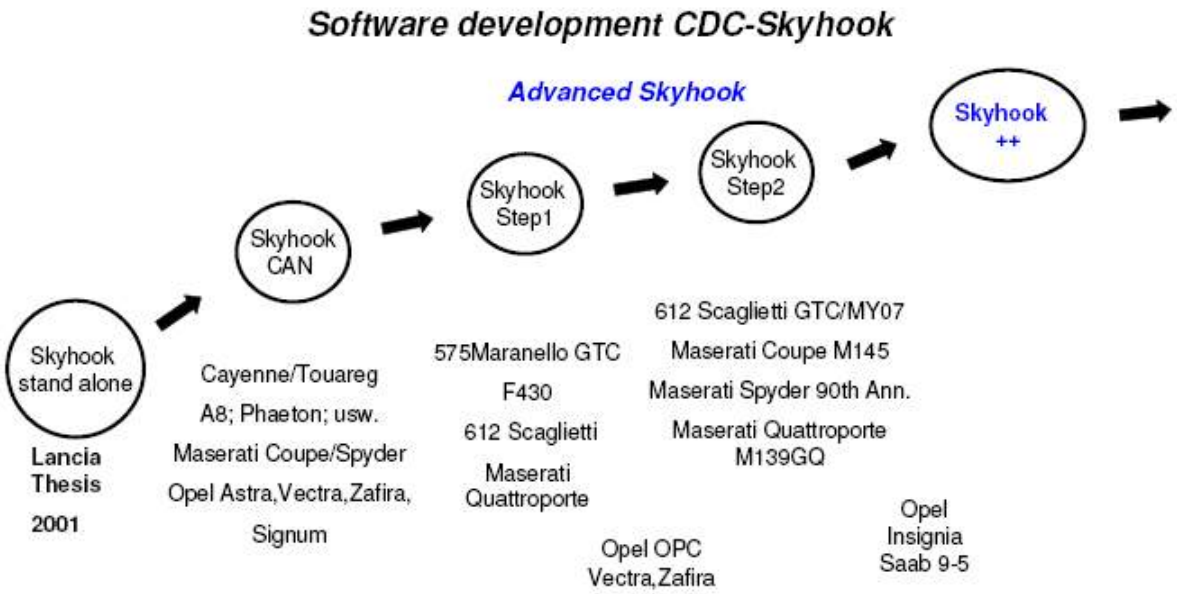
The ECU interfaces by the following communication lines:

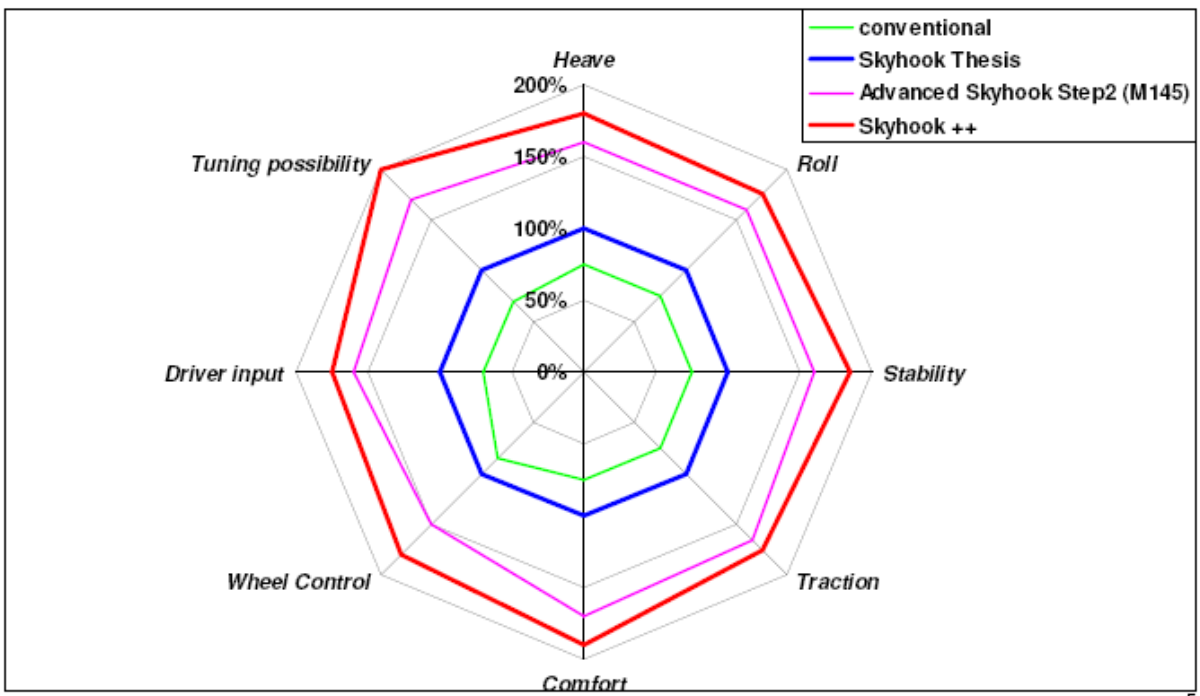
1. C-CAN LINE (data transfer with other ECU's)
2. K LINE (diagnostics)

The ECU controls and processes the functions related to the following peripherals:

1. Acceleration sensor on the front right-hand of the chassis
2. Acceleration sensor on the front left-hand of the chassis
3. Acceleration sensor on the rear chassis
4. Acceleration sensor on the front right-hand suspension lever
5. Acceleration sensor on the front left-hand suspension lever
6. Brake pedal depressed signal
7. Braking system hydraulic circuit pressure signal via C-CAN
8. Lateral acceleration sensor signal (longitudinal and yaw)
9. Signal coming from the NCR via C-CAN to signal gearshifting
10. Throttle valve opening signal from the NCM
11. Vehicle speed signal
12. SPORT button on dashboard
13. Steering angle sensor

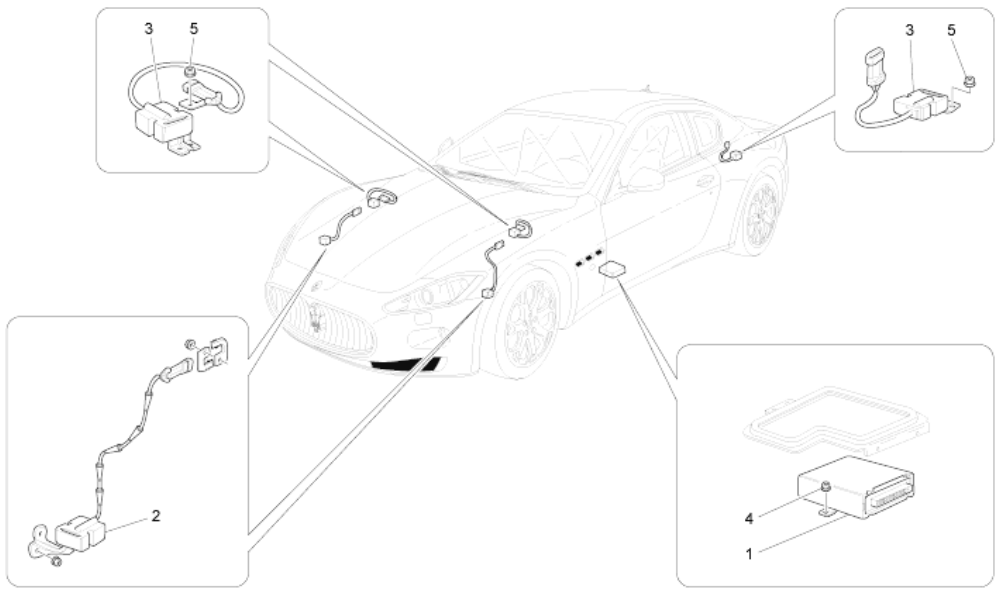
EVOLUTION OF THE MASERATI SUSPENSION CONTROL SYSTEM



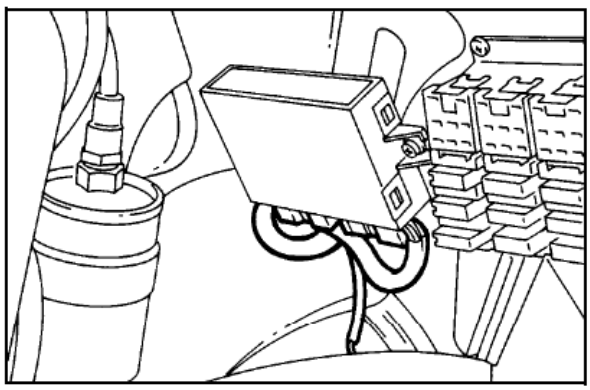


ECU POSITION IN THE VEHICLE

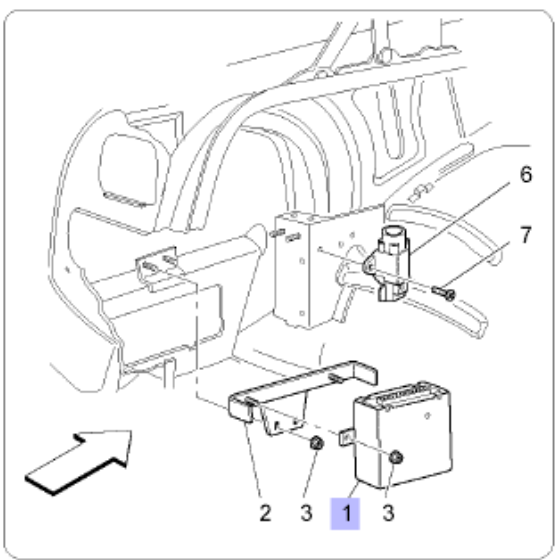
For the Quattroporte and GT, the NCS ECU can be accessed from the footwell area in front of the LH seat (driver's side for left-hand drive). The control unit housing is covered with a small cover. For the Maserati M138 Coupè and Spider, the suspension control unit can be accessed from the luggage compartment through the cover positioned on the left-hand side. In the Maserati 3200 GT, it is in the same position as in the M138. The ECU is positioned in the same place in the vehicle, be it a left-hand or a right-hand drive.



Maserati GranTurismo (idem for the Maserati Quattroporte)



Maserati 3200 GT

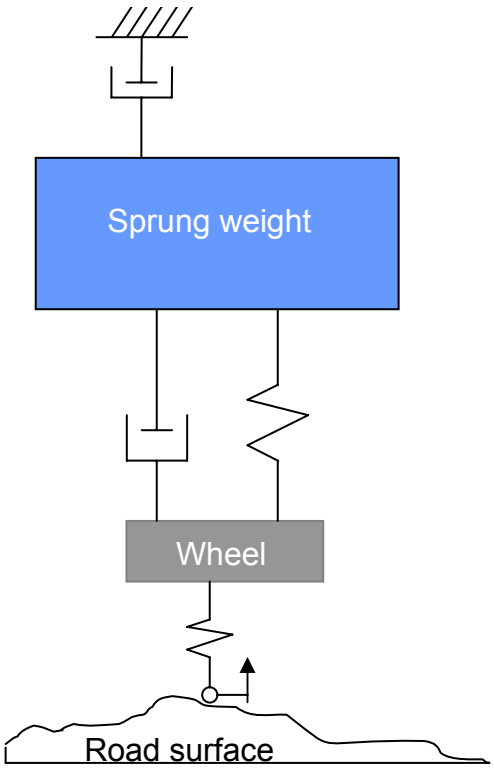


Maserati Coupè, Spider and GranSport

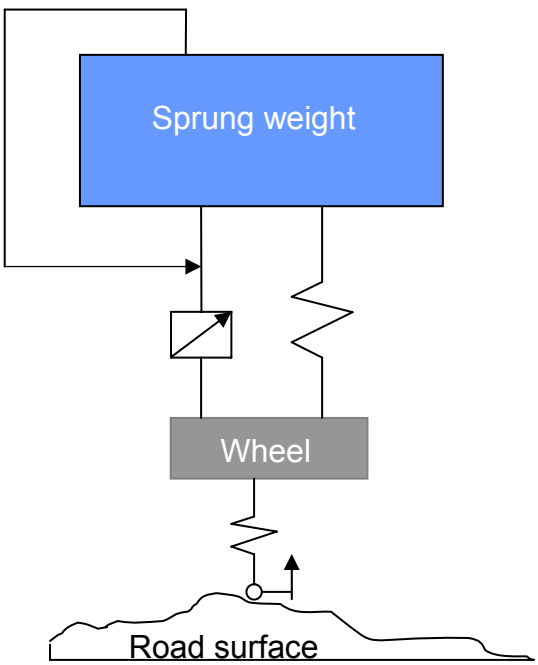
DESCRIPTION OF THE SACHS CONTROL UNIT FUNCTIONS

The control logic simulates the presence of a Skyhook damper pegging the sprung weight to a fictitious inertia reference, distinguished from the road surface as shown in the diagram below.

Theoretical Skyhook model



Real Skyhook model

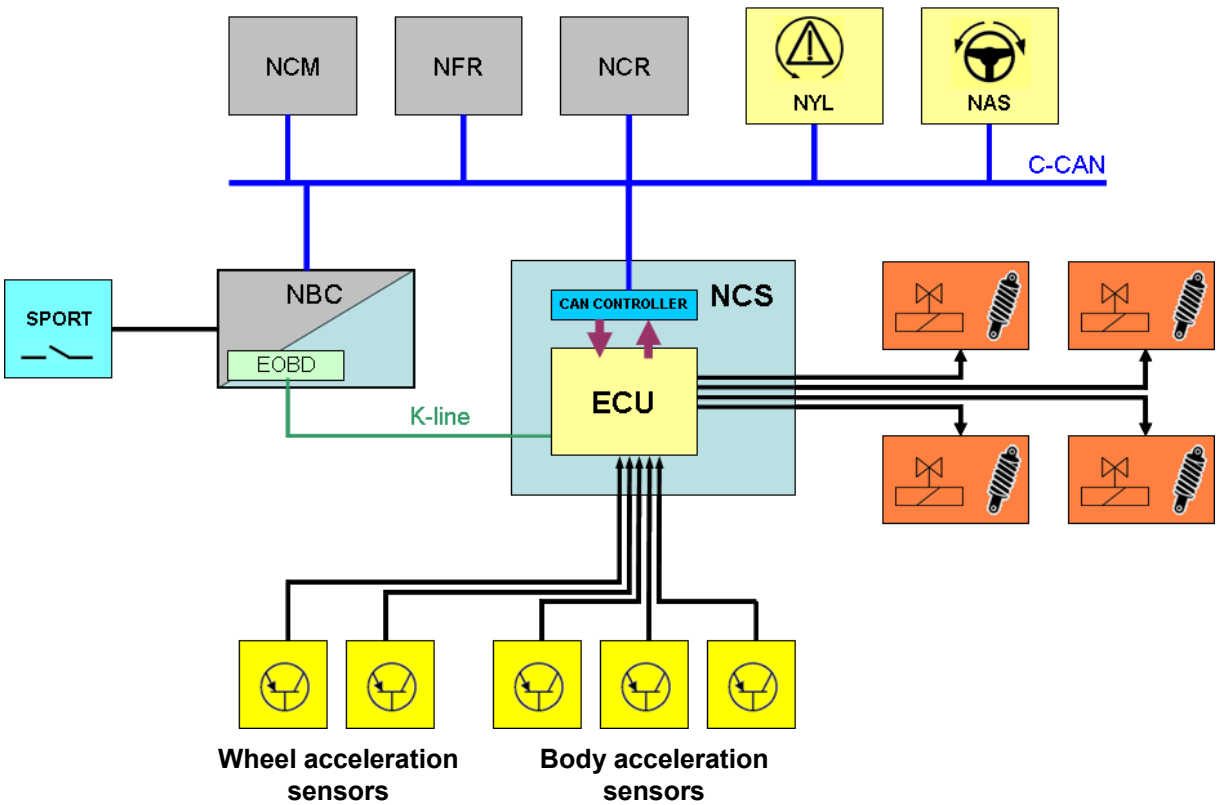


Actually, the fictitious damper is simulated in the vehicle by introducing a closed-loop control on shock absorber damping, with the advantage that body motions are dramatically reduced and as a result comfort is enhanced.

The system exploits the motion of unsprung weights on the road surface to develop forces that act in counter-phase to the body motion, with consequent reduction in rolling and pitching as well as vertical swivelling. The forces are developed by continuously varying the shock absorber damping value in relation to the relative body motions and unsprung weights.

The system operates:
by increasing damping (FIRM CONDITION) when the motion direction of the unsprung weight is counter to the body motion.
by reducing damping (SOFT CONDITION) when the suspension movement is timed with the body motion, thus preventing an undesired disturbance to the stabilised vehicle motion.

FUNCTIONAL DIAGRAM



The system is composed of the following:

- 1 ECU on CAN line

  It contains the interpretation algorithms of the system sensors and the CAN line signals.

  It powers the solenoid valves with the activation current.

- 4 aluminium twin-pipe shock absorbers with solenoid valve:

  In a time of 50ms the solenoid valves continuously adjust the shock absorber response (viscoelastic force) to the conditions interpreted by the ECU

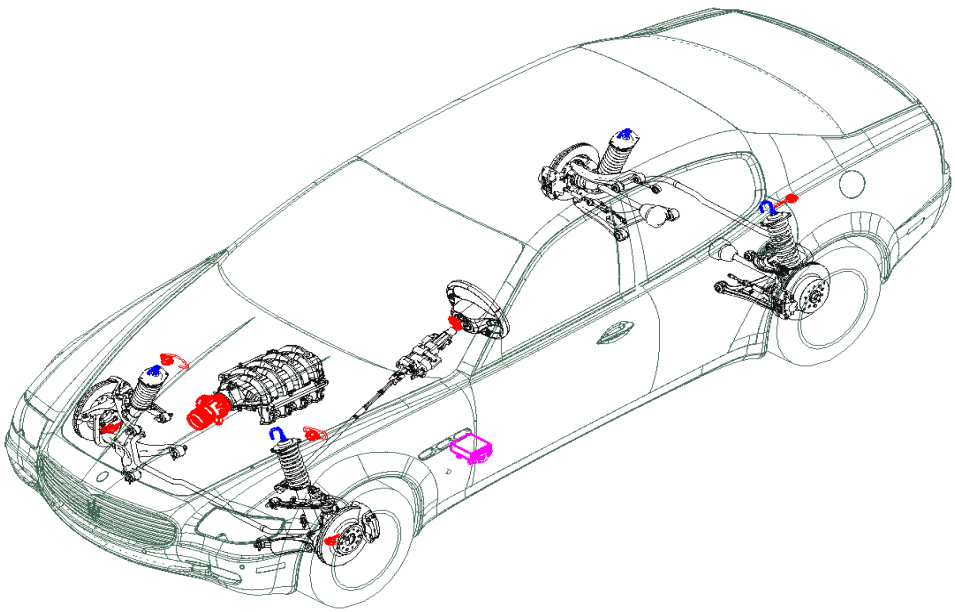
- 2 vertical accelerometers on the front hubs (wheel acceleration sensors)

  They read the accelerations of the front unsprung weights in relation to the road surface. The rear accelerations are calculated from these signals delayed by a vehicle pitch/speed time.

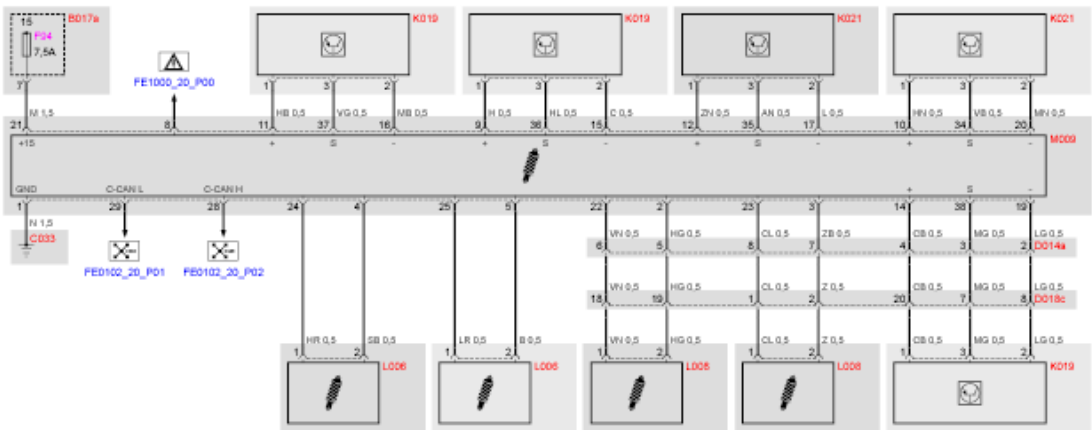
- 3 vertical accelerometers on the chassis (body acceleration sensors)

  They read the accelerations of 3 body corners (2 front domes, 1 rear dome), considering the chassis as infinitely rigid, and obtain the body movements according to the 3 axes (roll, pitch, rebound).

The outputs of the incoming information to the CDC ECU are the four control currents of the shock absorber solenoid valves.



WIRING DIAGRAM



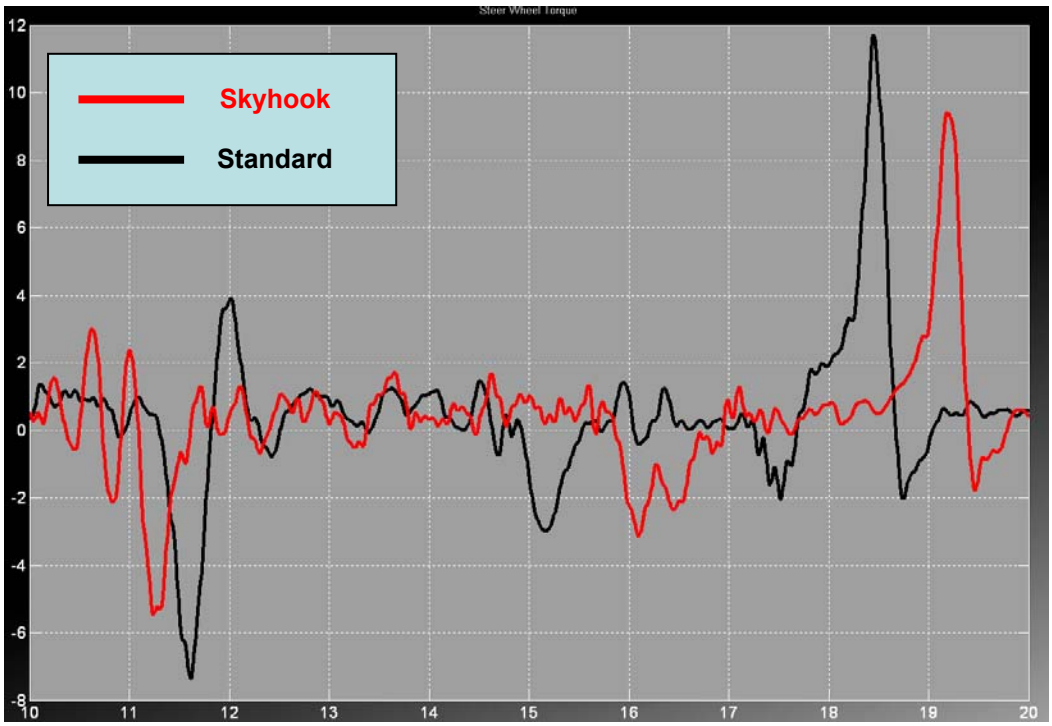
Unlike the traditional shock absorbers, which unambiguously define the force/speed ratio and consequently the characteristic damping of the various vehicle requirements (hardness, comfort, impact, filtering, chassis motion), this system is capable of continuously choosing the optimal damping value based on:

1. Information received from dedicated sensors (accelerometers on hubs and domes).
2. Information received via C-CAN line (vehicle speed, yaw, lateral acceleration, brake pedal signal, brake circuit pressure, all coming from the NFR, and the gearshift signal from the NCR).
3. The strategy and priority defined by the software logic (active safety, lateral, longitudinal, roll and pitch dynamics).
4. Software fine-tuning in relation to road uneven surfaces.
5. Driving mode control (NORMAL/SPORT, command generated by the button on the dashboard and sent by the NBC to the NFR and subsequently to the NCS via C-CAN line).

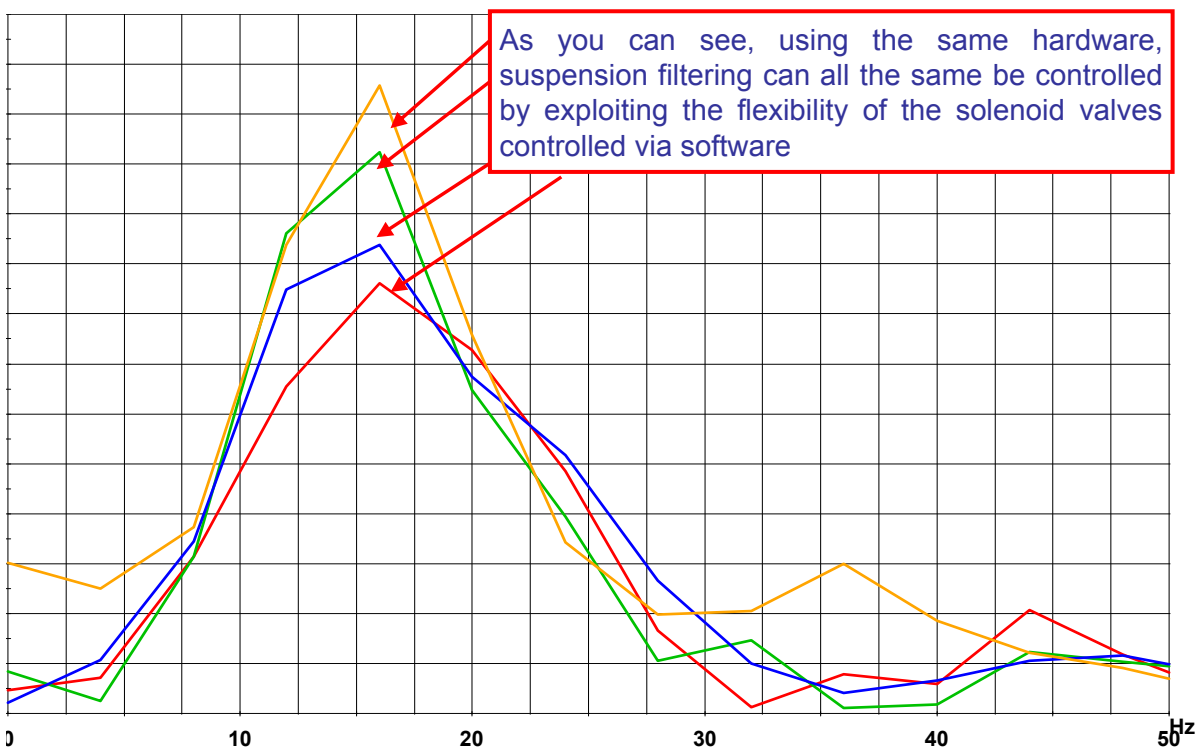
The main aims of the suspension control system are the following:

1. Attain the best compromise between handling and comfort in any dynamic condition.
2. Characterise and differentiate the vehicle dynamics on different levels, via software, using the same hardware.
3. Affect longitudinal dynamics (pitch and traction), lateral dynamics (roll speed and angle with derived effect on yaw and wheel alignment) and vertical dynamics (filtering, impact, sprung and unsprung weight motion damping).
4. Integrate the vehicle dynamics control systems.

Braking test: comparison between the standard dynamic condition and that filtered by the dynamic control



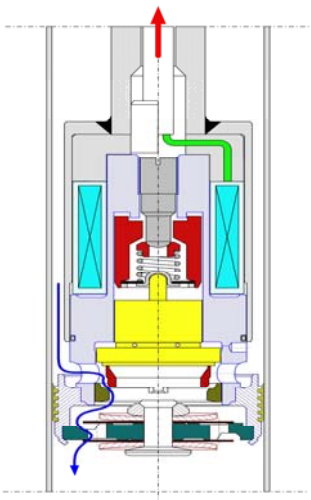
Impact test: obstacle on the four wheels with vertical acceleration

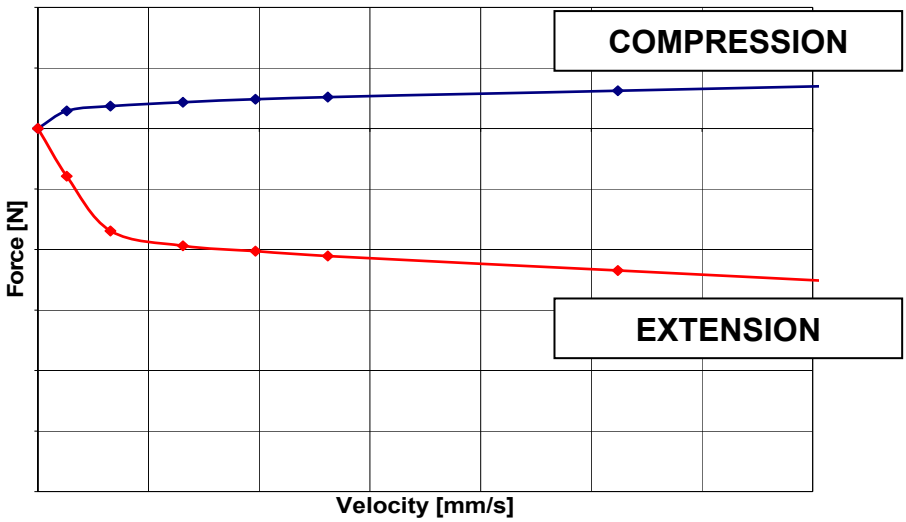


COMPONENT DESCRIPTION

SHOCK ABSORBERS

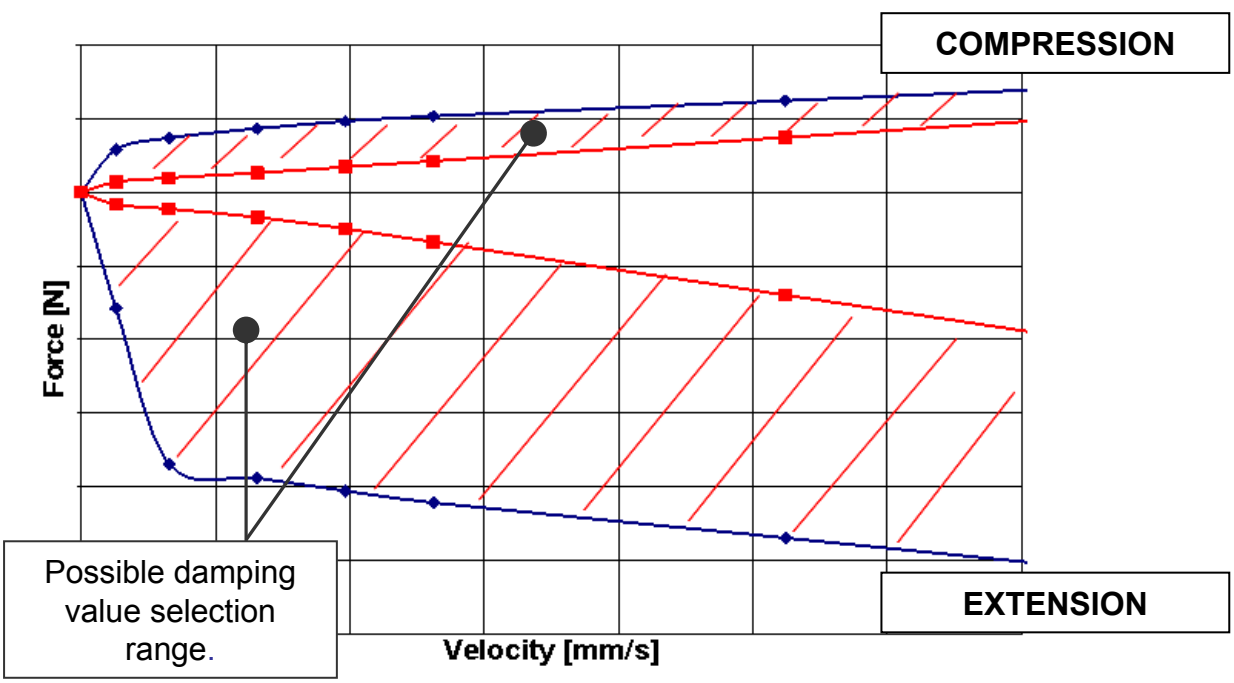
In “conventional” shock absorbers, the force/speed ratio is defined by finding the best compromise at every shock absorber stem speed, to ensure damping of the wheel and body movement and at the same time letting the wheel follow the road profile.





Two extreme force/speed ratios are defined in the dynamic control system:

1 0A current, which corresponds to a system fail state
2 1.8A current, which corresponds to the minimum obtainable damping





The behaviour of the shock absorbers must be tested both through active diagnosis with the diagnostic tester and in road test conditions after a complete vehicle driving cycle with the engine warm.

Fine-tuning of the system basically requires two curves:

Definition of the maximum damping curve: 0A

The aim is to try and achieve the best handling on a smooth road (body movement) in a bend and in longitudinal acceleration.
Check that comfort remains above the discomfort and safety limits (vibrations, noise)

Definition of the minimum damping curve: 1.8A

The aim is to try and achieve the best comfort on special roads and surfaces
Check that handling remains above the safety limits.

NORMAL mode:

1. The aim is to try and achieve balancing that gives priority to comfort over handling
2. Define the change in operations in relation to the vehicle speed
3. Define the operations (soft limiter) for the safety strategies:
   limit the current in lateral and longitudinal dynamics
   limit the current during ABS operations and gearshifting
4. Define the operations (firm limiter) for the comfort modes:
   limit stiffening on excessively bumpy roads

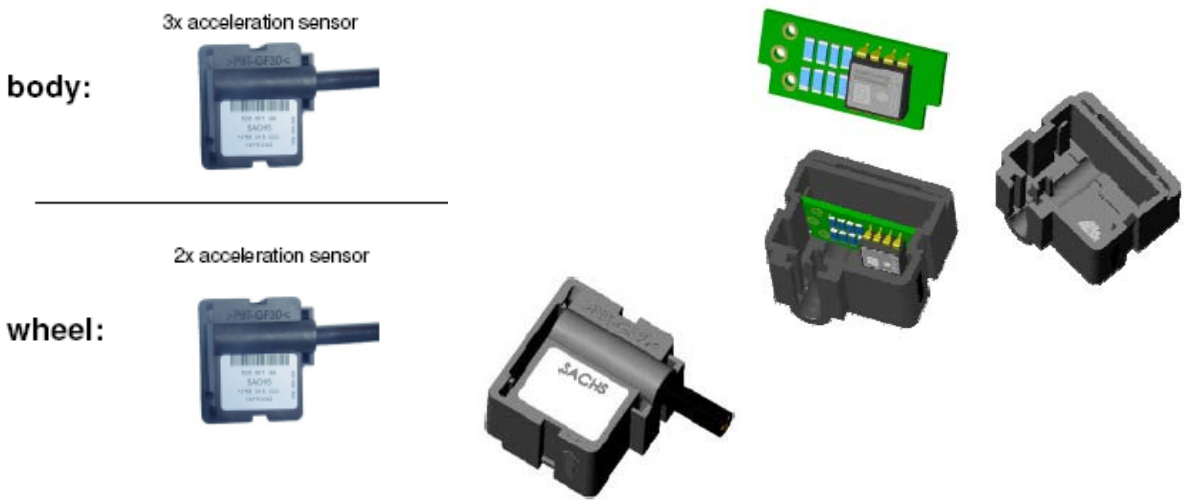
SPORT mode:

1. The aim is to try and achieve balancing that gives priority to handling over comfort
2. Repeat the steps defined in NORMAL mode but calibrated for sports-style driving

COMPONENT DESCRIPTION

WHEEL AND BODY VERTICAL ACCELERATION SENSORS

The wheel and body acceleration sensors are components that translate into an electrical signal (Volt) the physical acceleration input measured in proximity of the two front wheel hubs and the three car body domes (two front and one rear).



Sensor type

The acceleration sensors are capacitive sensors. The wheel and body sensors are similar and differ only in their sensing range, since the accelerations recorded by the wheel sensors are higher than those measured by the body sensors, as can be seen in the tables below.

Body sensor

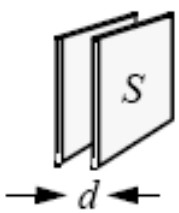
Feature	Range	Unit	Remarks
Sensor type	acceleration	g	capacitive measurement
Temperature range	-40 to +120 (140)	°C	140°C short term (15min.)
Supply voltage	5 ± 0.25	V	
Over voltage	16	V	DC, +23°C
Reverse polarity	-13	V	+23°C, 60 s
Supply current	< 5	mA	without load
Measuring range	-1.33 to +1.33	g	earth gravity compensated
Offset voltage	2.5	V	at 0 g
Sensitivity	1.5	V/g	
Resolution	± 1.5	mg	
Water protection		IP6K9K	DIN 40050

Wheel sensor

Feature	Range	Unit	Remarks
Sensor type	acceleration	g	capacitive measurement
Temperature range	-40 to +120 (140)	°C	140°C short term (15min.)
Supply voltage	5 ± 0.25	V	
Over voltage	16	V	DC, +23°C
Reverse polarity	-13	V	+23°C, 60 s
Supply current	< 5	mA	without load
Measuring range	-13.3 to +13.3	g	earth gravity compensated
Offset voltage	2.5	V	at 0 g
Sensitivity	0.15	V/g	
Resolution	± 15	mg	
Water protection		IP6K9K	DIN 40050

Sensor operating principle

As operating principle to measure mass shifting, the capacitive sensor uses the variation in electrical capacitance of a condenser, which varies as the distance between its armatures changes.
In these sensors, the mass (made of conductive material) constitutes one armature, while the other is made on the fixed structure of the device in the immediate proximity of the mass. The mass is suspended on a relatively rigid elastic element (typically a membrane). A dedicated circuit measures the capacitance of the condenser thus constructed and generates an electrical signal which is proportional to the mass position.

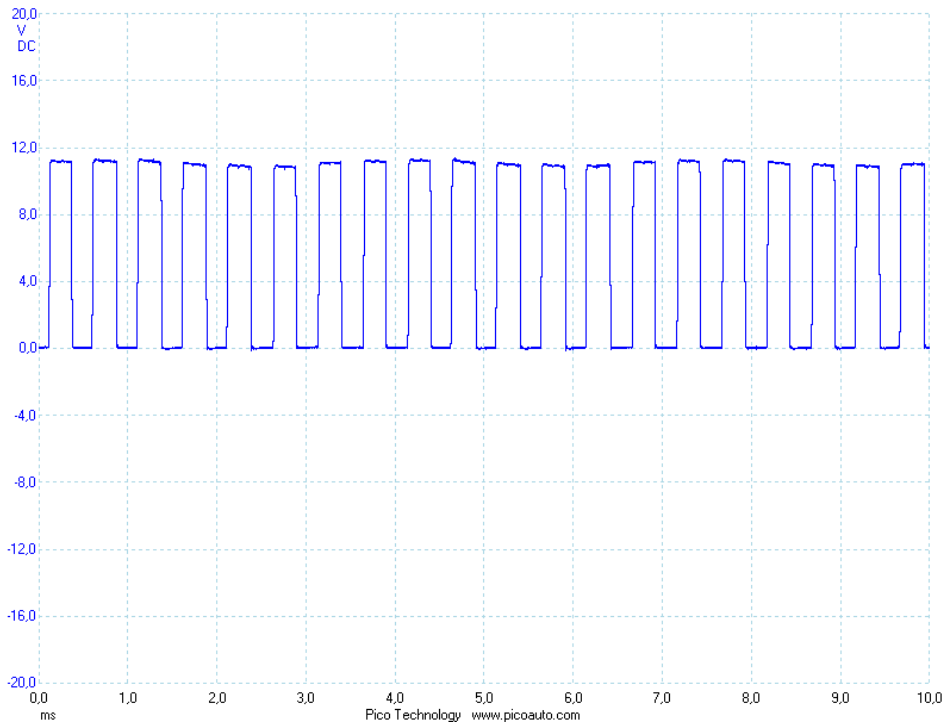


The sensors are driven by the suspension control node by means of a 0- 5 V power signal. The sensors provide the suspension control node with a voltage signal (0-5 V) which is proportional to the acceleration measured.
The suspension control node drives the solenoid valves in the shock absorbers with a PWM current signal:

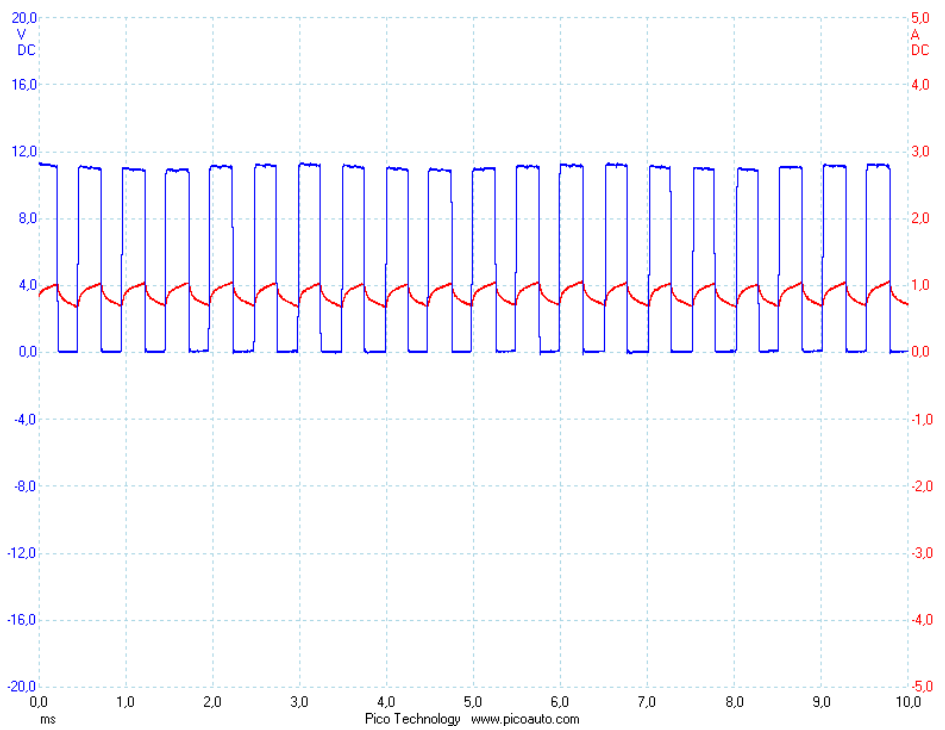
Frequency: 2kHz
Max current: 1.8 A
Max peak current: 3.0 A

Signal acquisition

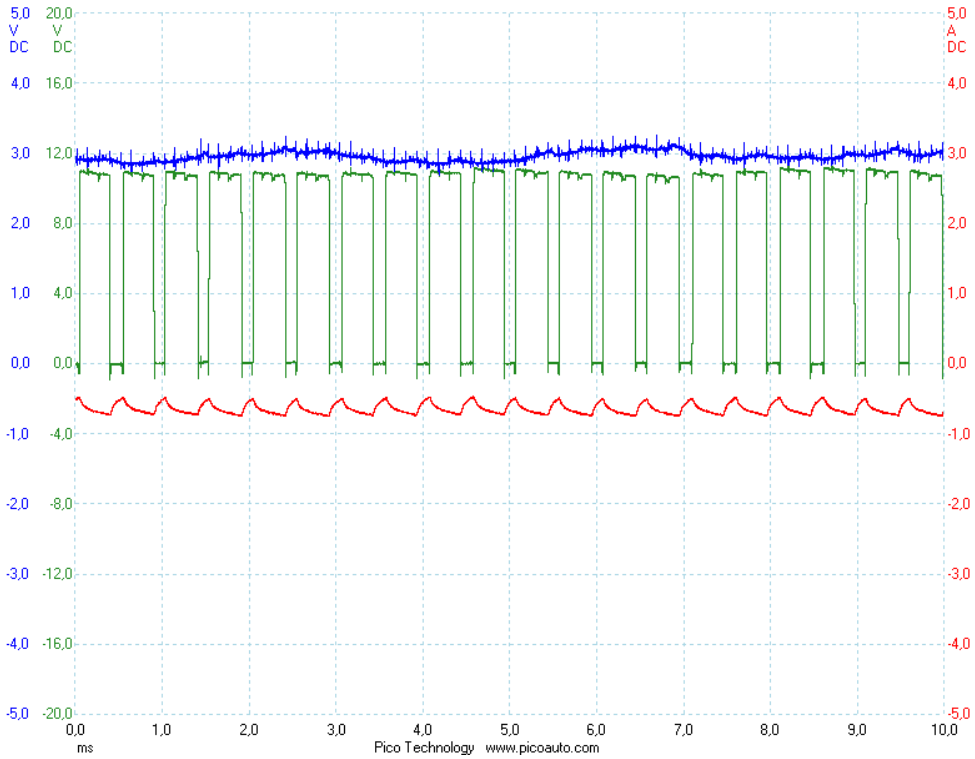
PWM signal from the NCS to the shock absorber for control of the proportional solenoid valve. Vehicle stationary



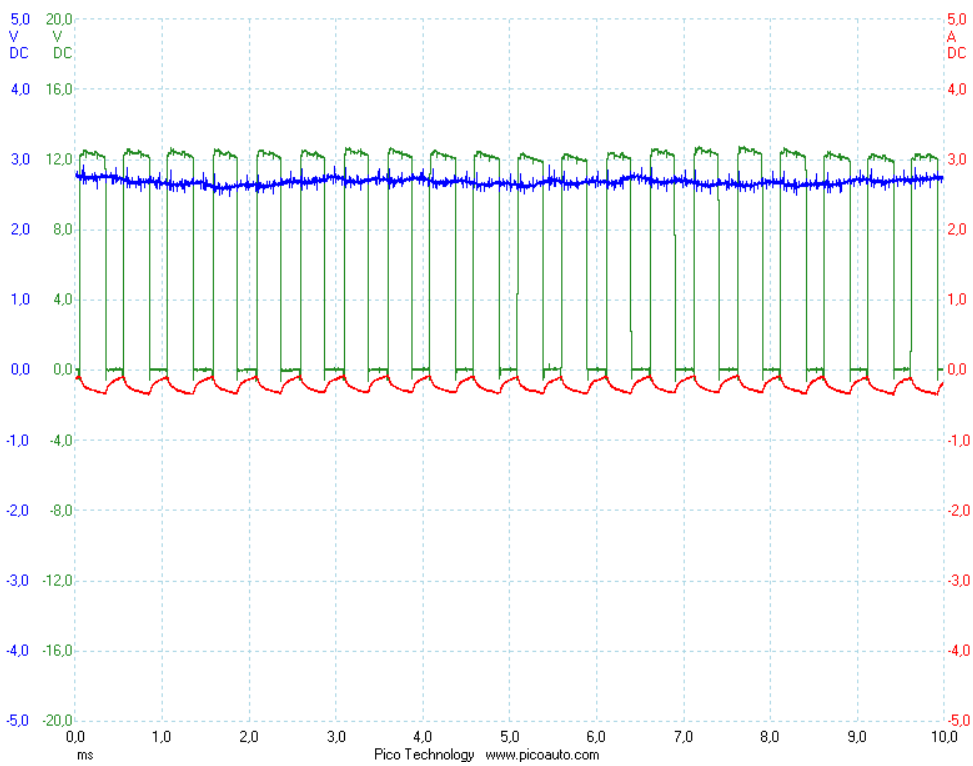
PWM signal and measurement by means of an absorbed current measuring clamp, to control the proportional solenoid valve. Vehicle stationary



PWM signal and measurement by means of an absorbed current measuring clamp, to control the proportional solenoid valve and the acceleration sensor voltage on the dome



Braking phase



Operating principle

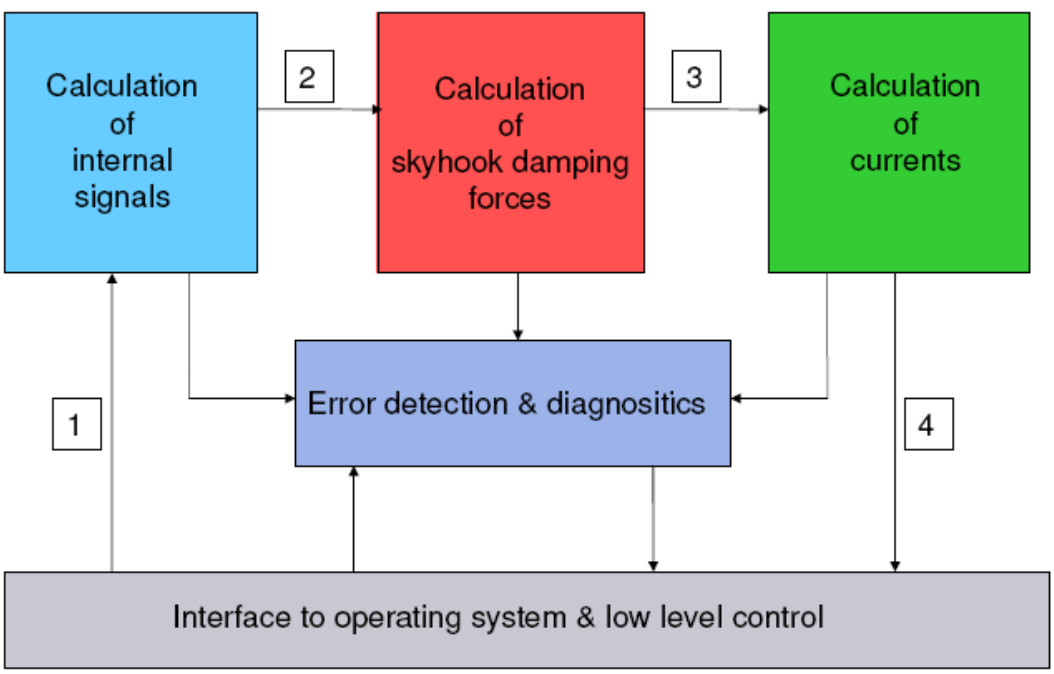
1) The sensors communicate the data measured to the control unit.
2) The signals communicated by the ECU sensors are used by the control system to define the speed and position of the wheels and the car body through a mathematical process.

   The result of the wheel signal calculation represents the main information related to the road profile and is also used to predict rear wheel movement.

   The result of the car body signal calculation is chiefly translated into the typical pitch, roll and swivel motions.
3) The comparison between all the signals processed (wheels and car body) exactly defines the active dynamics for each individual shock absorber and hence the dynamic condition of the vehicle in general.

   Based on the comfort and handling targets of the ECU and related to the setting chosen (NORMAL or SPORT), the system is capable of defining the correct damping levels required.
4) The system translates the damping levels identified into control currents and sends them directly to the actuators in the hydraulic valves of the shock absorbers.

The entire process is continuously monitored through diagnostic cycles, for detection of any malfunctions.



NOTE: The ECU integrates the signals coming from the specific sensors of the Skyhook system with the signals coming from other sensors controlled by various electronic control units (NFR, NBC and NCM)

Indications for installation

The wheel and body acceleration sensors are fitted on the two front wheel hubs and on the three domes of the car body (two front and one rear).

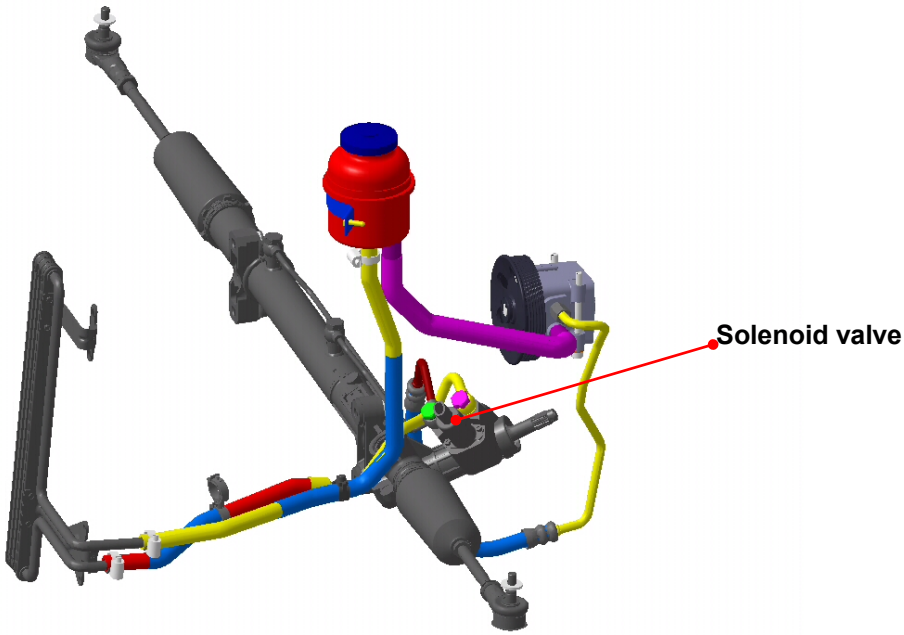


Take great care during installation in the vehicle, since the capacitive sensors do not function properly if fitted in an incorrect position and will generate a system failure (message on the display with relative icon).
In addition, the Skyhook system performance will be reduced.
For this reason, an arrow on the sensor body indicates the fitting direction. Correct sensor positioning is with the arrow pointing up.

Power Steering Control System (CSG)

TRW

Introduction



The Quattroporte and GranTurismo models are equipped with a speed-sensitive hydraulic power steering system.
The aim of this system is to make the steering comfortably light during manoeuvring and at low driving speeds, while providing appropriate road feel at higher driving speeds.
The flow of the hydraulic fluid which is providing power assistance to the steering rack is regulated by a solenoid valve. An ECU is controlling the solenoid valve depending on the driving speed.

Applied vehicles

- M139 all vehicles
- M145 all vehicles

System history

From its introduction in 2003 till today the system did not undergo significant modifications.

Node electrical characteristics

Current consumption in sleep mode: 0 mA

Location in the vehicle

The CSG ECU is for all vehicles fitted underneath the dashboard at driver's side (both for LHD and for RHD vehicles), close to the A-pillar.



The CSG unit is located close to the A-pillar, behind the driver's foot rest (for LHD vehicles).



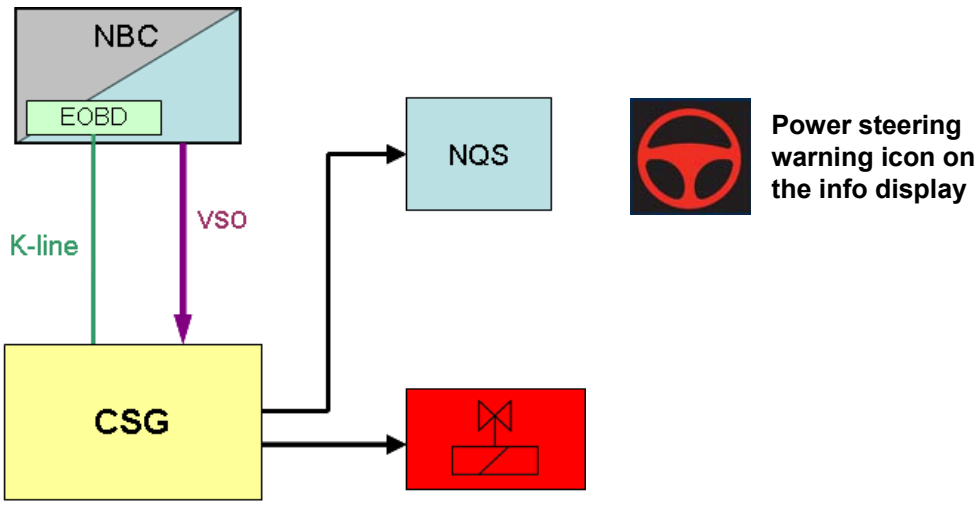
The power steering solenoid valve is fitted on the steering rack.

Data communication

The CSG is not connected to a CAN network. It receives necessary information via hardwire connections. CSG uses the K-line for diagnostics.

System description

Functional diagram



The CSG-unit (Centralina Servo Guida or power steering ECU) receives a +15 switched 12v power supply and is consequently only operational under Key On conditions.

The CSG controls a solenoid valve fitted on the steering rack by means of a variable current signal (0-800 mA). The solenoid valve is connected to the CSG by two wires (+ and -).

The CSG operates the solenoid valve in relation to the driving speed, therefore it receives the VSO signal (Vehicle Speed Odometer) from the body computer.

The CSG also controls the power steering warning light on the instrument cluster (NQS). In the event of a system failure, the CSG will activate the warning light by means of an active low signal.

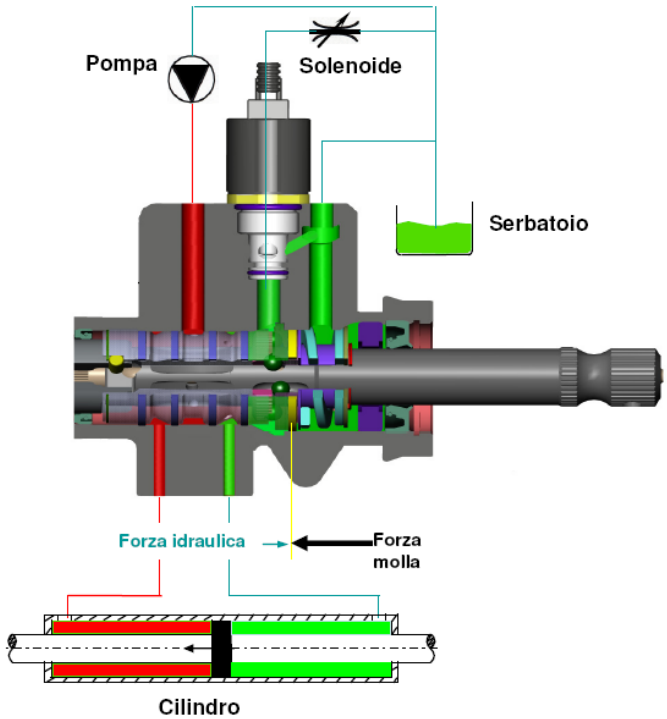
The CSG is connected to the K-line for diagnostic purposes.

System operation

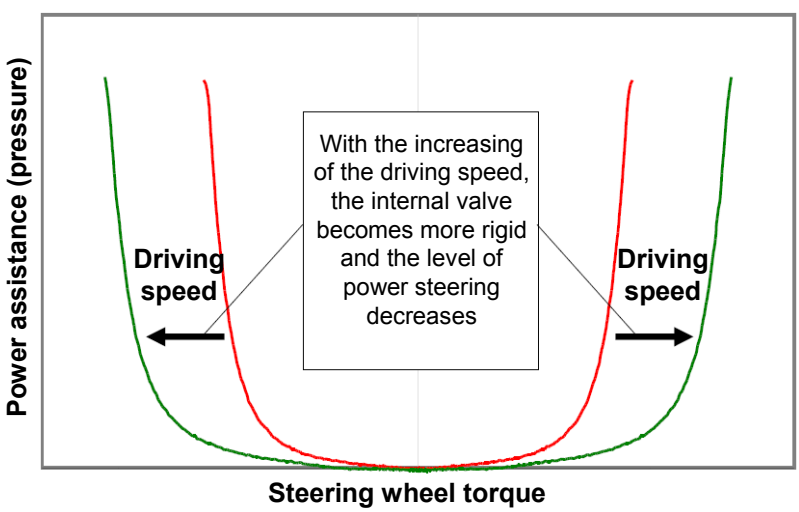
At low and parking speeds, the solenoid valve is provided maximum current. This will allow more hydraulic flow and make the steering feel lighter.

When the driving speed increases, the current is reduced to the solenoid valve. The amount of power assistance will be limited and this will increase the road feel.

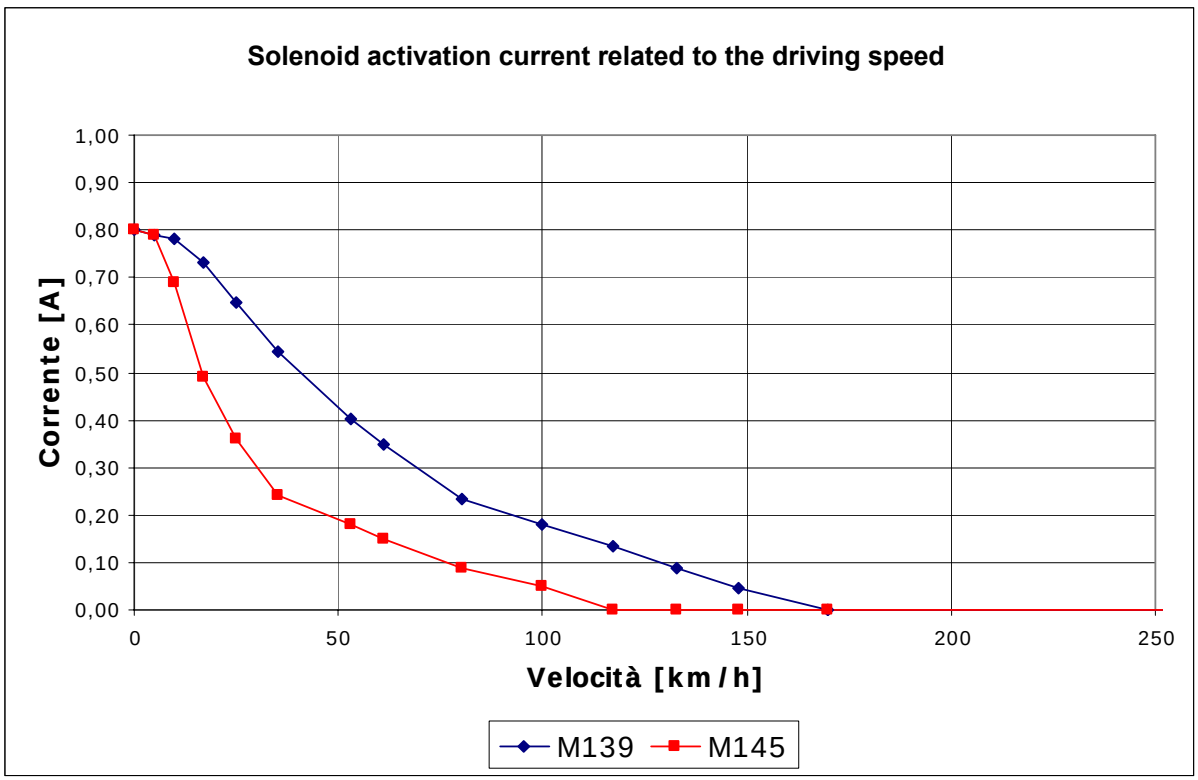
Solenoid valve fully activated (I = 800 mA):	**power assistance is maximal**
Solenoid valve in rest position (I = 0 mA):	**power assistance is minimal**



When the solenoid valve is maximally activated, it closes the oil opening and the pressure underneath the spring increases. The hydraulic force against the spring increases and the internal valve becomes less rigid. The amount of power assistance is at highest.
When the electrical current of the solenoid valve is reduced, the oil opening expands. The rigidity of the internal valve increases and the amount of power assistance decreases.
With the solenoid valve in rest position (no current), the oil opening is fully open and the counter-pressure is low. The rigidity of the internal valve is maximal and the amount of power assistance is minimal.



Related to the driving speed, the Quattroporte and the GranTurismo models have each a specific power steering characteristic (activation current in relation to vehicle speed signal).



Specific service related procedures

There are no specific service or maintenance actions required for the electronic power steering control.
Checking the hydraulic fluid level in the reservoir should be done at each service interval and replacing of the hydraulic fluid is necessary every two years. See the scheduled maintenance tables for each vehicle type and the workshop manual for more details.

Diagnostics/ recovery strategies

DTC list:

C1017	Solenoid valve short to ground Solenoid valve short to power supply Solenoid short or open circuit
C1012	Vehicle acceleration or deceleration excess
C1014	Warning light open or short circuit
C1011	Battery voltage under 10v
C1001	ECU failure

All this error codes will result in the warning light coming on.
When an error is first detected, an event counter is set at 64 and shall be decreased with one after every occurrence of the next cycle without anomaly:

Key On > driving speed exceeds 10kmh > Key Off

The error code will be cleared when the counter arrives at 0.



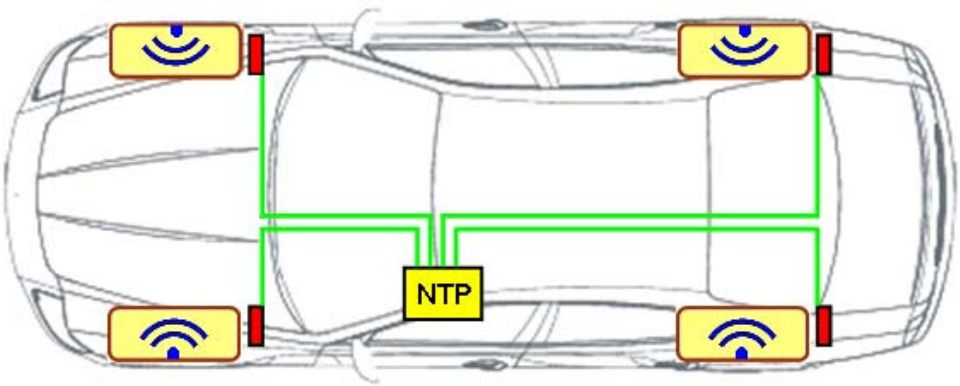
In case of a system failure, a heavier feel in the steering wheel can be experienced at low speeds.

Tyre Pressure Control System (NTP)

Beru

Introduction

Faults and defects with the tires are among the most common causes of breakdowns and accidents: Inadequate air pressure leads to increased flexing work and premature tire wear. In turn, at high speeds this can lead to tires no longer being able to withstand the loads and bursting.
Therefore Maserati in collaboration with automotive supplier Beru has developed a Tyre Pressure Monitoring System (TPMS) for its vehicles. This system measures in real time the air pressure of the four tyres and has the task of alarming the driver in the event of a pressure loss.



Applied vehicles

- M139 as optional (standard feature on certain versions and for certain market specifications)
- M145 as optional (standard feature on certain versions and for certain market specifications)
- Alfa 8C standard feature for USA specification vehicles, not available for other market specifications.

Note that in the USA, all newly licensed vehicles from 2007 onward must be fitted with a system that alarms the driver in case a tyre has a pressure loss of 25% below the target pressure.

System history

From its introduction in 2003 till today, the system did not undergo significant modifications.

Location in the vehicle

The NTP ECU is for all vehicles (Quattroporte, GranTurismo and Alfa 8C) fitted in the floor area, at left hand side for LHD vehicles and at right hand side for RHD vehicles. It can be accessed by removing the floor cover in front of the drivers seat.



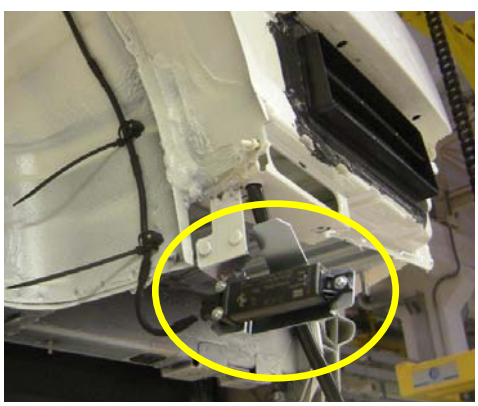
NTP on Quattroporte (example: LHD)



NTP on GranTurismo (example: LHD)



Front TPMS antenna location



Rear TPMS antenna location

Data communication

The NTP is connected to the B-can line for data exchange with other nodes and for diagnostic communication.
The NTP uses also dedicated LIN-lines to receive data from the wheel antennas.

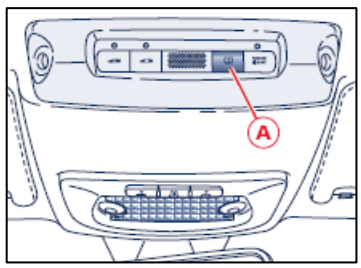
System description

The TPMS is made of the following components:

- NTP central ECU
- 4 wheel electronic units, integrated in the wheel valves
- 4 digital antennas
- TPMS calibration button
- TPMS warning light



NTP ECU



TPMS calibration button, located on the roof console



TPMS warning light on the instrument cluster

Digital antenna

The digital antenna contains a 433MHz RF (315MHz for Japanese market) receiver to capture the data sent by the wheel electronic unit. It demodulates and decodes the received signal. An integrated LIN interface puts the data on a LIN line which connects the antenna with the NTP ECU.

The Antenna has a waterproof housing and is fitted in the wheel arch area.



Digital antenna, located in the wheel arch area

Pin out:

1. Ground (from NTP)
2. 12v power supply (from NTP)
3. LIN line

Wheel electronic units

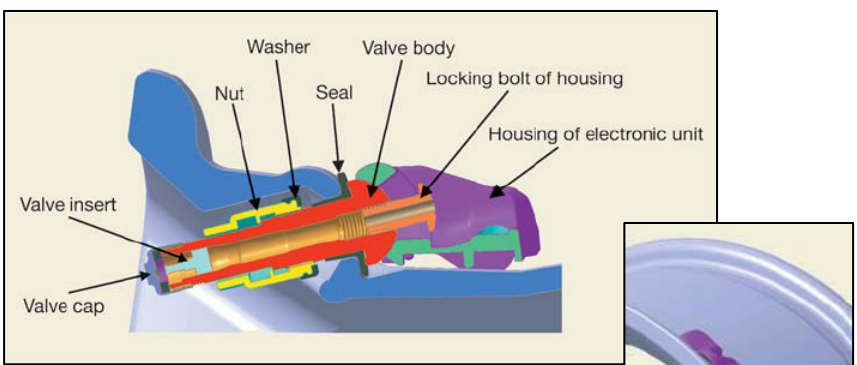
The wheel electronic unit (wheel sensor) is made of the following components:

- Pressure sensor
- Temperature sensor
- Integrated processor
- 433 MHz RF transmitter with antenna
- Integrated lithium battery
- Housing

Note: vehicles for the Japanese market use 315 MHz transmitters.



Wheel electronic unit, integrated in the wheel valve

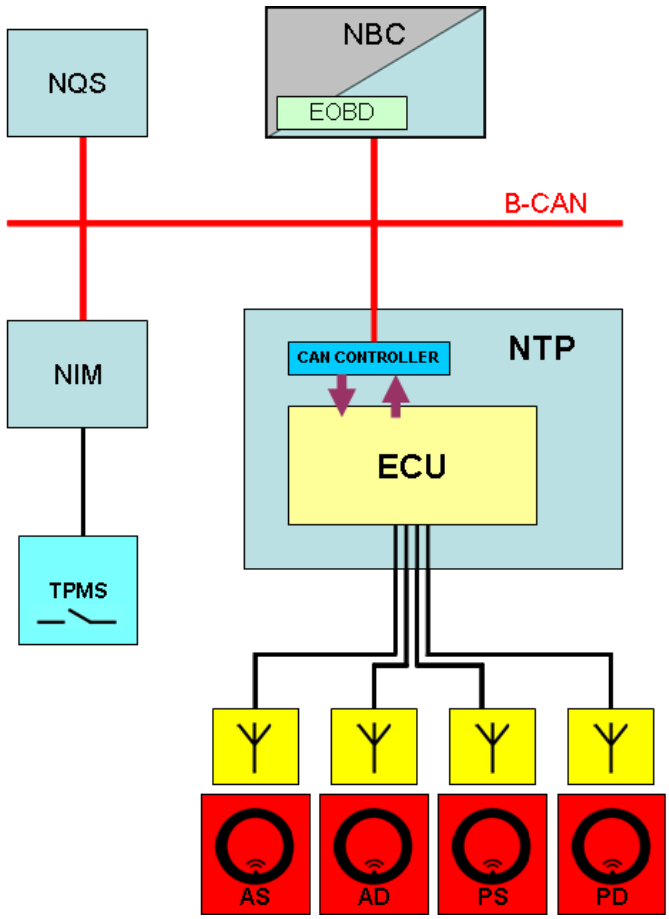


Section view of the wheel valve with wheel electronic unit

The wheel electronic unit is integrated in the wheel valve. It has an internal lithium battery that allows a service life up to 10 years. An integrated acceleration trigger detects the wheel movement and will activate the system.
The electronic unit transmits data regarding the pressure and the temperature together with an identification code at certain intervals, depending on the wheel movement and measured variations in the pressure.
This component is designed to operate under extreme conditions regarding temperature and g-force (up to 2000g). It is protected against the penetration of moisture and chemical substances such as tyre residue and the products used to ease the fitting of tyres.

In case the internal battery is dead, the wheel electronic unit must be replaced with a new one. The condition of charge of the battery can be checked in the parameter menu of the diagnostic tester.

Functional diagram



Description

The NTP receives a +30 battery voltage for power supply, and is informed about the Key On status by a B-CAN message from the NBC.

The NTP acquires information regarding the air pressure and the temperature of each of the four tyres from the four wheel antennas, located in the wheel arch area of each wheel. The antennas read this information from the wheel electronic unit by radio frequency (RF) waves.

Each wheel electronic unit, integrated in the wheel valves, has its own ID code which is sent together with the temperature and pressure information. This means that each tyre is monitored separately. The NTP receives the following further information over the B-CAN line:

- Engine speed (from NBC)
- Vehicle speed (from NBC)
- External temperature (from NPG)

The NTP uses a specific algorithm to calculate the standard pressure based on the measured pressure, the wheel temperature , the external temperature and the driving speed.

System operation

When the NTP wakes up, it starts receiving data from the antennas about the wheel sensors. When the system receives datagrams from the wheel sensors, it looks at the pressure of each tyre, and if it is below the required level, it will alert the driver. If a soft warning occurs (a small loss of pressure), it will alert the driver to this on the next ignition cycle. If a hard warning occurs (a large loss of pressure), it will alert the driver immediately.

The TPMS will alert the driver if the following conditions occur:

- A tyre pressure drops 300mbar below the calibrated (target) pressure, at a rate not greater than 200mbar/min. This is a soft warning.
- A tyre pressure drops at a rate greater than 200mbar/min. This is a hard warning.
- A tyre pressure drops to 75% or less than the calibrated (target) pressure.

If any of these conditions occur, the system will alert the driver by solidly illuminating the TPMS warning light.

For a soft warning to be activated, 10 successive datagrams from the wheel sensor must be received with the pressure below the soft warning limit. A soft warning will only be indicated to the driver at the next ignition on cycle.

For a hard warning to be activated, 2 successive datagrams from the wheel sensor must be received with the pressure below the hard warning limit. A hard warning will be indicated to the driver immediately.

Data transmission to the instrument cluster

The NTP sends periodically information regarding the tyre pressure to the NQS over the B-CAN line. Based on the received data, the NQS can display the following messages on the info display:

- System temporarily inactive
- System not programmed (calibration required)
- System failure
- System inactive (if disabled by the diagnostic tester)
- Low pressure or tyre puncture left front tyre
- Low pressure or tyre puncture right front tyre
- Low pressure or tyre puncture left rear tyre
- Low pressure or tyre puncture right rear tyre
- Low pressure or tyre puncture in unidentified tyre

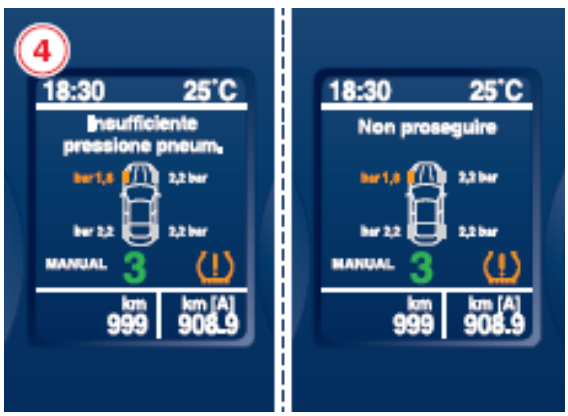
The temporarily inactive state of the system could be the result of radio frequent interference, in case external RF sources are located in the proximity of the vehicle.

At request of the driver by pushing the MODE button, the NQS will display the exact pressure values for the four tyres.





The tyre pressure values can be displayed for 10 seconds by pushing the MODE button



Calibration management

The TPMS calibration button is located on the central roof console and is wired to the NIM node.

If the button is pressed for a time t of: 4s < t < 10s, the NIM will send a calibration request message to the NTP via B-CAN.

If the button is pressed for a time of more than 10 seconds, the NIM will store an error code.

When the NTP receives a calibration request from the NIM, this request will be accepted if the conditions are met (Key On and engine Off). The NTP will send the accepted calibration status to the NQS, The NQS will display the “Calibration activated” message on the central info display.

The calibration will start when the driving speed exceeds 7 km/h. This procedure can take up to 20 minutes in total. The procedure will interrupt when the driving speed drops under 3 km/h.

The calibration request from the NIM will be rejected by the NTP when the necessary conditions are not met.



TPMS calibration could be disturbed if it is carried out in a region where a lot of RF radiation is present. Try to perform the procedure on an open road and outside the urban centre in case calibration difficulties are experienced.

Specific service related procedures

TPMS calibration
The tyre pressure calibration will be completed in a few minutes of driving time (see instructions below). The systems learns the different tyre pressures set in the vehicle and checks whether a wheel has been changed. During the calibration the system remains active, but will only alert the driver if a pressure deviation from the target pressure of 0,4 bar or more has been detected.
During the calibration, the system will store the measured pressure as the target pressure. It is therefore extremely important that the tyre pressure is set at the correct value before performing the calibration.

TPMS calibration instructions:

- Set the tyres at their correct pressure (in cold condition)
- Key On, engine Off
- Press the TPMS calibration button between 4 and 10 seconds
- The message “Calibration Activated” will appear on the information display
- Start the engine and drive the car. The calibration will start when the driving speed exceeds 7 Km/h.

This procedure can take up to 20 minutes and will be interrupted when the driving speed drops under 3 Km/h.

The calibration procedure is always necessary if…

- …the tyre pressure has been changed
- …new wheel sensors have been mounted
- …the wheel position has been changed
- …the spare wheel has been used
- …wheels with wheel electronic units have been transported in the vehicle
- …the NTP ECU has been replaced

Changing tyres
Special care should be taken when removing and fitting the tyre on the rim to prevent damage to the valve and the sensor.
When re-fitting the valve cap to the valve, it is highly recommended that a small amount of grease is applied on the thread of the valve. This is to prevent the cap from sticking and causing problems or damage during removal in the future.
After a tyre change, the tyres must be inflated to the correct pressure and the calibration procedure must be performed.

Changing wheels, changing wheel positions or replacing a wheel electronic unit.

In such a case the calibration procedure must be carried out. During calibration, the system will automatically detect and identify the new wheel sensors, or the new wheel sensor position and adapt to the new situation.

Diagnostics/ recovery strategies

If the NTP detects a fault with the system (eg. antenna has been unplugged or wheel sensors have been removed from the wheels), it will alert the driver to the fact there is a TPMS fault by flashing the TPMS warning lamp and subsequently solidly illuminating it.

Adaptive Headlight System (NFA)

Automotive Lighting

Introduction

The NFA (Nodo Fari Adattivi) have the task to control and optimize the aiming of the headlights, which is adapted to the static vehicle conditions (load and chassis settings) and to the dynamic vehicle conditions (driving speed, cornering and road conditions). They also control the igniters of the gas discharge lights (bi-Xenon).

The system uses two separate ECU's, one for each headlight, who interact by a master-slave relationship. The left hand side NFA fulfils the role of Master, while the one at right hand side has a Slave position.

Note: the job of both NFA is limited to the aiming of the headlight beaming and the management of the discharge lamps. The activation of the headlights (and the different individual lights integrated in the front headlight units) is managed by the body computer (NBC) and the CPL, using input signals from the light switches and the twilight sensor.

Modelli applicati

- Quattroporte (M139 from Restyling MY2009)
- GranTurismo (M145 all versions)



Quattroporte Restyling



GranTurismo

System history

From its introduction in 2007 till today, the system did not undergo significant modifications.

Node electrical characteristics

Current consumption in sleep mode: 0 mA

Data communication

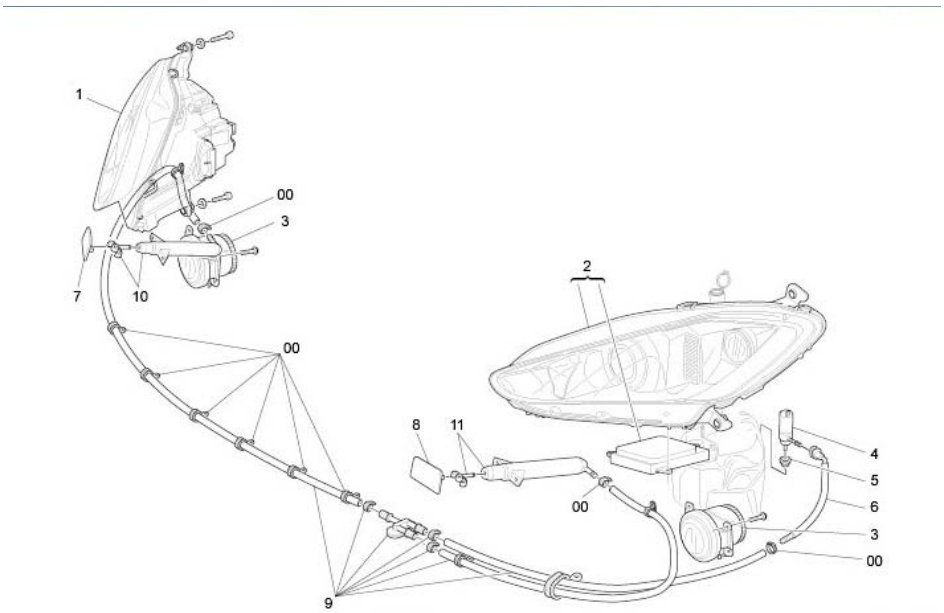
The NFA on the left hand side (Master) is connected to the C-can line for data exchange with other nodes and for diagnostic communication.

The NFA on the right hand side (Slave) is connected to the left hand side NFA by a bi-directional LIN line. This line is used to send and receive commands, and also for diagnostic purposes.

Location in the vehicle

Both NFA units are attached underneath the front headlight units (for both GranTurismo and Quattroporte restyling models). They can be accessed by removing the front inner wheel fenders.

The front and rear ride height sensors are fitted onto the left hand side suspension levers.

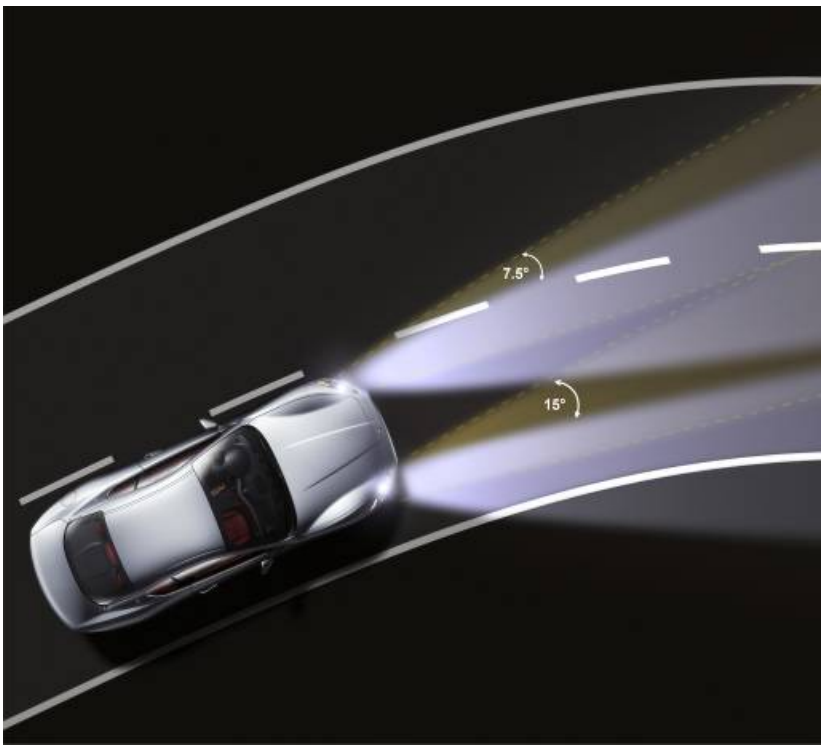


Both NFA ECU's are an integral part of the headlight unit and it is not possible to replace them separately.

System Description

The AFS – Advanced Front lighting System (Adaptive Headlights) consists of a set of bi-xenon lights and controls the headlight swivelling movements in horizontal direction, based on the information received through the steering angle, and the vertical movements through a front axle sensor and a rear axle sensor. The headlights' movement is managed by an ECU (NFA) located in the lower part of the headlight, which defines the movements of two step motors controlling the horizontal swivelling lights (Dynamic Bending Lights - DBL) and the vertical swivelling lights (AVAC - Automatic Vehicle Aim Control).

The vehicle is equipped with two headlights, each fitted with its own ECU. The Master ECU is always positioned on the left-hand side headlight of the vehicle (driver side) and houses two connectors, a 14-pin connector and a 6-pin connector. The Slave node is always located on the right-hand side of the vehicle (passenger side) and houses only a 14-pin connector.



External lights



1. Side markers
2. Direction indicator
3. Position light
4. Bi-xenon headlight: low-beam + high-beam
5. Additional high-beam (*Flash to Pass*)
6. Front headlight cleaning system
7. Fog light

A number of head light functions are not managed by the NFA but by other vehicle systems, for example:

Lights managed by the twilight sensor (AUTO mode)

the external lights are activated automatically by the twilight sensor. From the NIT user menu, you can set the twilight sensor's sensing range (3 levels).

Follow me home

This control enables the position lights and low beams to switch on automatically for a timed period, immediately after the vehicle is turned off (Key-OFF).

Activation: After turning the key to OFF, you must operate the control for flashing the headlights, found on the steering column stalk. The instrument panel activates the 'follow-me-home' signal and displays the time (in seconds) during which the lights will remain on. (Signal active for 20 sec.)

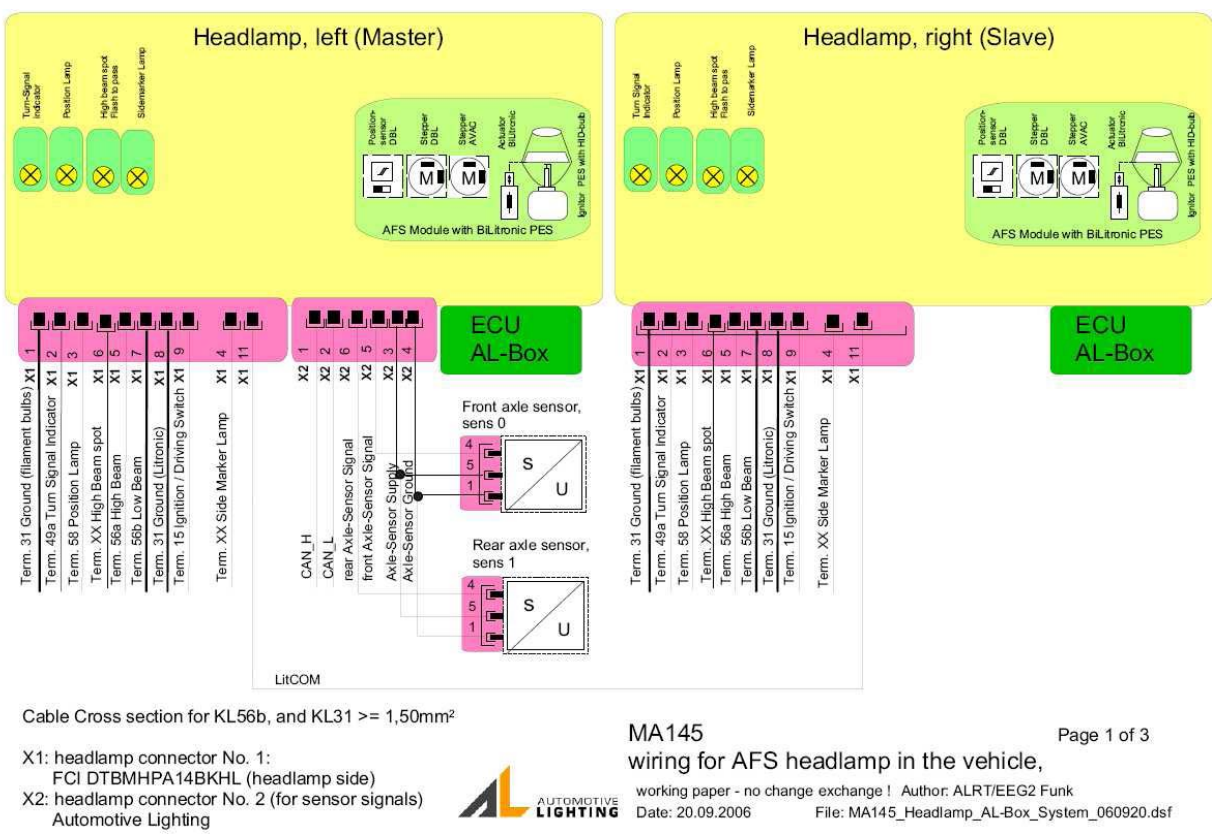
Activation time increase: When this function is active, every time you flash the headlights, the time the lights remain on is extended for a further 30 seconds (max. 210 sec.)

Deactivation: keep the control for flashing the headlights active for over 2 seconds. Then turn the ignition key from OFF to ON.

System Components

The overall system comprises the optical, electronic and mechatronic components of an AFS headlamp.

- Left hand side and right hand side NFA units (AI box ECU's)
- PES (Poly Ellipsoid System)-AFS module in the left and right-hand headlight unit with the following parts:
  - BiLitronic – PES (Poly Ellipsoid System)
  - Ignitor
  - Stepper motor for AVAC
  - Stepper motor for Dynamic Bending Light
  - Gas Discharge Lamp (GDL)
  - Sensor for detection of the swivel position of the moving BiLitronic – PES (Poly Ellipsoid System)- for dynamic bending light
- LitCOM, bidirectional communication line (LIN) between the NFA's, Master & Slave.
- Sensors to determine the vehicle tilt, linked to the suspension levers.

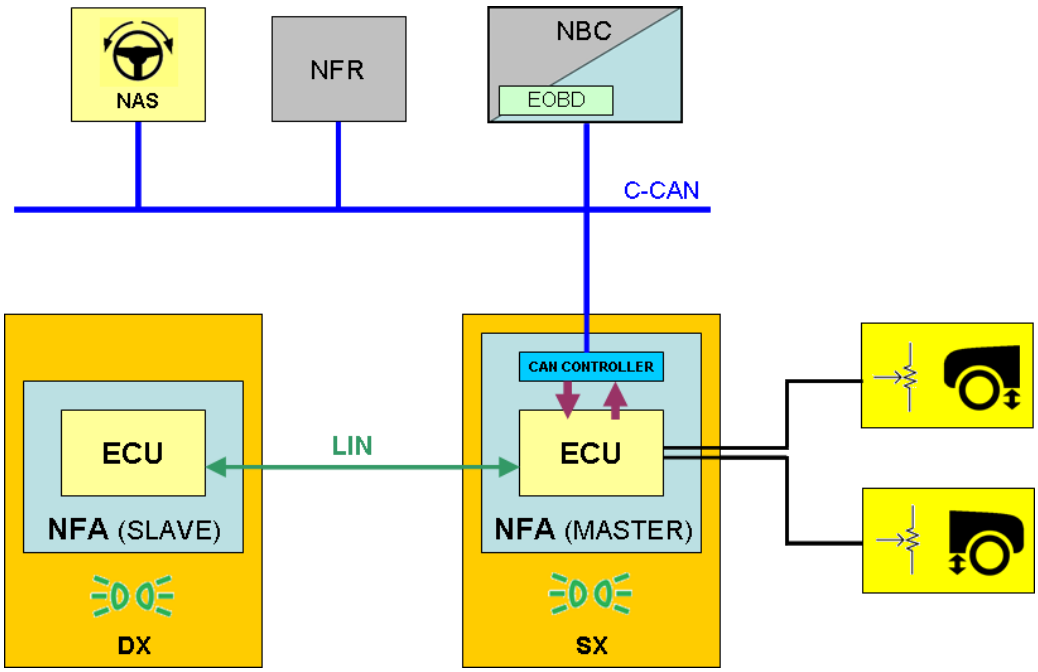


Cable Cross section for KL56b, and KL31 >= 1,50mm²

X1: headlamp connector No. 1:
FCI DTBMHPA14BKHL (headlamp side)
X2: headlamp connector No. 2 (for sensor signals)
Automotive Lighting

MA145 Page 1 of 3
wiring for AFS headlamp in the vehicle,
working paper - no change exchange ! Author: ALRT/EEG2 Funk
Date: 20.09.2006 File: MA145_Headlamp_AL-Box_System_060920.dsf

Functional diagram



Description:

The Master NFA, integrated in the left hand side headlight unit, forms the heart of the complete system. It receives a number of data from other vehicle systems over the C-CAN line (eg. Ignition key status, vehicle speed signal, steering wheel angle signal, reverse gear inserted status, brake pedal switch status).

Further, it powers the front and rear potentiometers which are connected to the suspension levers and provide information about the front and rear ride height of the vehicle. This information is used by the NFA calculate the tilt angle of the vehicle and control the beaming of the headlights in the vertical direction accordingly.

The Master NFA contains vehicle configuration data (LHD /RHD, vehicle dynamic characteristics) which is programmed during the headlight Proxi procedure.

Other than managing the left hand side headlight, the Master NFA also commands the Slave NFA, integrated in the right hand side headlight, through a dedicated LIN communication line.

Note that both NFA ECU's are technically identical and that they only differ from each other in the fact that they are programmed differently. The Master NFA contains specific software and configuration data to manage both headlight units, while the Slave NFA is programmed to execute commands from the Master.

The LIN line (indicated as LitCom) between both NFA is bi-directional.

This permits the Slave NFA to perform its own auto diagnoses and communicate the results to the Master. In the event of a failure in the system, a DTC will be stored and can be read out by the diagnostic tester in each NFA individually.

Diagnostic information is exchanged with the diagnostic tester unit over the C-CAN line, as the NFA do not use a K-line.

In the event of a functional failure, the Master NFA will send an activation request signal for the warning light to the NBC over the C-CAN line. The NBC at his turn will forward this request to the instrument cluster (NQS) over the B-CAN line.

The NFA receive a switched 12v power supply. This means that they are only operational in Key On conditions.

Electrical connection:

The vehicle is equipped with two ECUs, one per headlight. The left-hand one is the Master and has two connectors, a 14-pin and a 6-pin one, and the right-hand one is the Slave, which has one 14-pin connector only.



The 14-pin connector has the same pinout both on the Master and on the Slave.

Activation of the Gas Discharge Lamp (Xenon)

The gas contained in the Gas Discharge Lamp (GDL) has to be pre-ionized by a high electrical field strength (voltage) between the two electrodes positioned opposite each other inside the GDL. This takes place by applying an ignition voltage between the two electrodes.

The required ignition voltage is generated by interaction between the ECU and the ignitor. If the ignition process is successful, the resistance between the terminals of the GDL becomes smaller, i.e. the voltage applied at the GDL assumes a smaller value, where upon the control unit recognizes that ignition has successfully taken place and controls the start-up operation. If the control unit does not recognize a successful ignition, ignition voltage continues to be generated for a further 500 ms maximum.

During start-up operation, the GDL is operated with a defined excess power so that light generation approximates, within the required limits, the light output in static burning operation in line with a specified characteristic.

During the Lighting operation the GDL is operated in continuous mode using square-wave voltage, in order to prevent separation of the gases in the combustion chamber and uneven stress on the two electrodes, so maintaining a suitable light arc for the headlamp.

Step motor contol

The light beams are moved by means of two step motors (one for vertical swivelling and the other for horizontal swivelling) integrated in each headlight cluster.

As relatively operating actuating drive systems without position feedback, the step motors require a referencing routine when they begin their function, whereby the motors are traversed far enough in the non-dazzling direction that a mechanical stop inside the motor is reached. In this position, the internal step counter in the ECU is initialized. Furthermore, referencing at the slope of the position sensor (sensor referencing, AFS) is performed during system start. The stepper-motors are traversed towards the position where the slope of the position-sensor is expected. The referencing takes place at the sensor slope. Potentially occurred positioning errors during horizontal swivel movement are gradually corrected upon recognition of the sensor slope If the error exceeds a certain threshold an error (DTC) is set on the NFA.

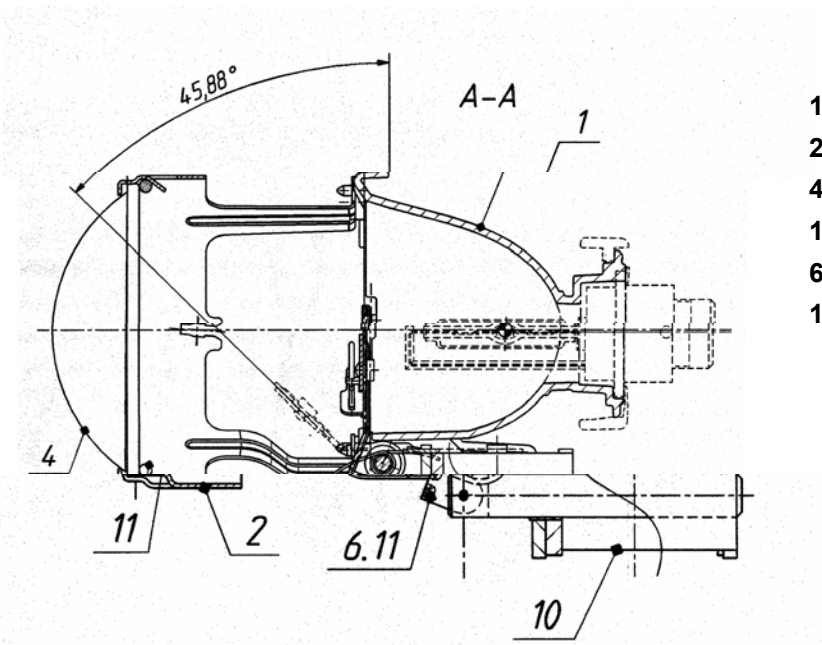
Sensor for the detection of the swivel position (AFS-Module)

A position feedback of the current module alignment is necessary for the "Dynamic bending light“ function. For the position sensor used for this purpose, it is possible to detect the previously set photometric basic setting position while in the operating mode. The position sensor operates according to the Hall principle, whereby the magnetic flux acting on the Hall element, which is varied by a sensor plate which either approaches or travels past to one side, is transformed into a signal proportional to the voltage. Post-processing of the signal in the sensor generates a digital output signal (2-point characteristic line with hysteresis). The sensor slope is positioned towards the outside in the swivel range, allowing the system to recognize and correct a position error when swiveling from the outside to the optical central position. This means that the system is optimized for swiveling in the outer range, as in case of a position error this is where greater dazzle can occur.

Control of the high beam shutter

In BiPES modules, switchover between low beam and high beam is achieved by adjustment of a shutter. The shutter is adjusted by a pull-type electromagnet with one winding. The magnet must exert a force greater than the return spring force (+ possible friction forces).

In order to achieve optimum adjustment of the shutter from the low beam to the high beam position in terms of adjustment time, impact speed and reliability, the control magnet is actuated with a PWM sequence. The PWM sequence varies depending on voltage ranges. Switchover from the high beam to the low beam position takes place by removing the control voltage. The return movement is brought about by moment acting on the rotary thrust spring arranged on the rotary axis which is transmitted directly to the shutter and so simultaneously to the armature.

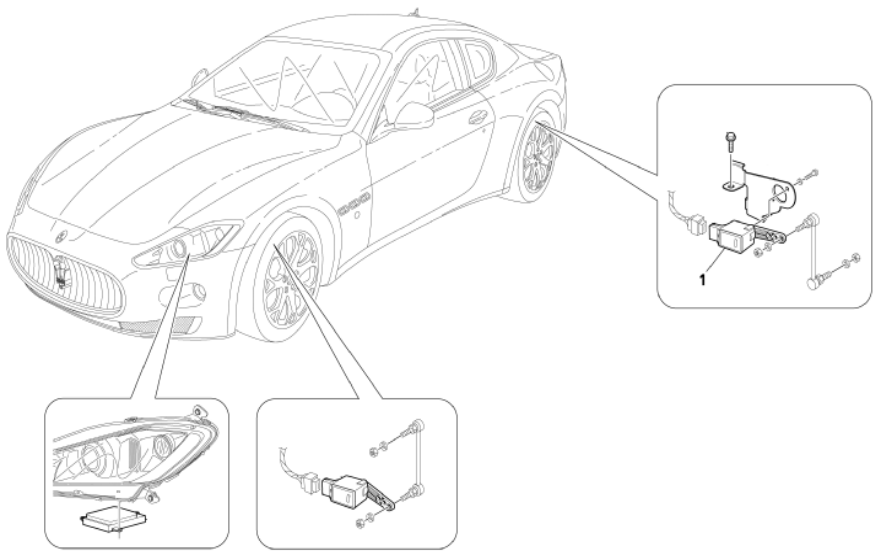


1 Die-cast aluminium reflector
2 Lens holder
4 Glass lens
11 Mounting ring
6.11 Shutter
10 Control magnet

Front and rear axle sensor

Potentiometers for front and rear vehicle axle movement acquisition. They transmit the adaptive headlight ECU the information required for vertical lamp swivelling.

The vehicle is equipped, in the positions indicated, with the following:



The sensors are potentiometers powered with 5 Volt. The axial sensor connector is a 6-way male - female pin described in the following figure:



Pin Out:

1. GND
2. n.c.
3. n.c.
4. Signal (from 0,2 to 4,7 Volt)
5. Power supply: 5V
6. n.c.

Bi-Xenon high beam (Bi-Litronic)

With the aid of the Bi-Litronic function, it is possible to use xenon light not only for the low beam but also the high beam. In terms of projection technology, the shutter, which is located in the path of the beam, is moved between the two end positions by means of a control magnet. This then engages the high beam.

Actuation of the internal high beam switch terminal activates the function by means of the power supply / signal input for the control magnets. If no low beam terminal has yet been switched on, the xenon light generation (Litronic) must be activated.

An integrated spring mechanism ensures that the low beam status of the shutter is effectively restored (also in case of a fault).

Automatic vehicle aim control

Dynamic AVAC corrects the illumination distance of the vehicle headlamps automatically in such a way that, when the low beam is switched on, both

a) vehicle loads and

b) pitching movements of the vehicle due to driving dynamics are unable to bring about dazzling of the oncoming traffic and at the same time sufficient depth of vision is ensured for the driver.

Therefore the influence of vehicle body tilt on the illumination distance is compensated relative to an idealized road surface.

The NFA:

- Calculate the vehicle body pitching angle (e.g. from the axle positions)
- Correct the reflector angle depending on the pitching angle
- Evaluates vehicle speed for operating mode switchover

Operating modes

When travelling at a constant rate, the system operates in the "static mode" with high damping and minimal adjustment speed of the headlamps. During accelerated travel the "dynamic mode" is activated, in which the response time of the system is substantially reduced.

Restrictions:

- Only the body angle relative to the axles, not to the idealized road surface can be measured.
- The progressive camber of the road surface cannot be taken into consideration.
- Compensation for wavy road surfaces is not possible for system-related reasons.
- Pot holes can influence the movement of the headlamps.

The service life of the powered mechanical components (actuator, reflector) is optimized:

The number of adjustment processes must be adapted to the service life of the actuators by correcting only slowly while driving under constant conditions (static mode) and activating fast correction only during stronger acceleration and braking processes (dynamic mode).

The functional performance depends on the supply voltage (system monitoring).

Note: evaluation of the vehicle level signals and correction of the headlamp position take place also when the vehicle is stationary.

Dynamic bending light

The dynamic bending light is achieved by horizontal swiveling of the low beam. This swivel action depends on various parameters relating to the driving dynamics of the vehicle and provides improved illumination particularly during driving on country roads in comparison to conventional lighting.

A smooth rotary swivel action is achieved as the result of a speed-dependent algorithm in the various travel environments. Depending on the speed, the correct headlamp swivel angle is set for the current bend. Using this procedure, the required behavior can be achieved for the various driving situations.

Vehicle standstill does not constitute a special operating mode, but instead the reduction of speed to zero causes the headlamp swivel angle to move continuously towards the centre (zero position).

The algorithm can be calibrated separately for right and left-hand bends.

Special cases (reduction of the system adjustments)

In the zero position of the system, a range is defined in which minor adjustments to the steering angle do not yet cause the headlamp to swivel. This range is known as the "dynamic dead centre". In the case of active steering movements, the dynamic dead centre is faded out. This mode is intended to reduce the number of swivel movements performed by the system in cases where straight forward driving is detected. The second effect is that the natural see-sawing movements which a vehicle performs during straight forward travel do not bring about disturbing adjustments of the light beam. The bending light function is designed to achieve improved illumination during night-time driving. In contrast, when using the function "Automatic Vehicle Aim Control", the low beam also has to be corrected during the day, as it is possible for oncoming traffic to be dazzled.

Swivel mode

The preferred behavior for adjustment between the bending light modules is for the headlamp on the outside of the bend to follow the headlamp on the inside of the bend with half the swivel angle. This mode is known as "α - α /2 swivel".

Other aspects of the adjustment behavior can be set using parameters. The following possibilities exist:

- "Parallel swivel action“: both headlamps are prescribed the same swivel angle
- "Unilateral swivel action“: only the headlamp on the inside of the curve is adjusted. The outside headlamp remains in the central position

The maximum applicable swivel angles are:

- Headlamp on the inside of the bend: 15°
- Headlamp on the outside of the bend: 7.5°

Restrictions

- The bending light function is deactivated when the additional conditions (CAN signals) are not complied with.
- Current statutory regulations governing bending lights stipulate that adjustment in the horizontal direction may only take place when the radius of the bend is < 500 m.
- The function may only be active during forward travel of the vehicle.
- The functional scope depends upon the supply voltage (system monitoring).

Operating strategy:

- The system is activated at a speed of 5 km/h.
- From 90 km/h to 120 km/h the swivel angle is reduced.
- Over 120 km/h and in reverse, the swivel function is deactivated for safety reasons.

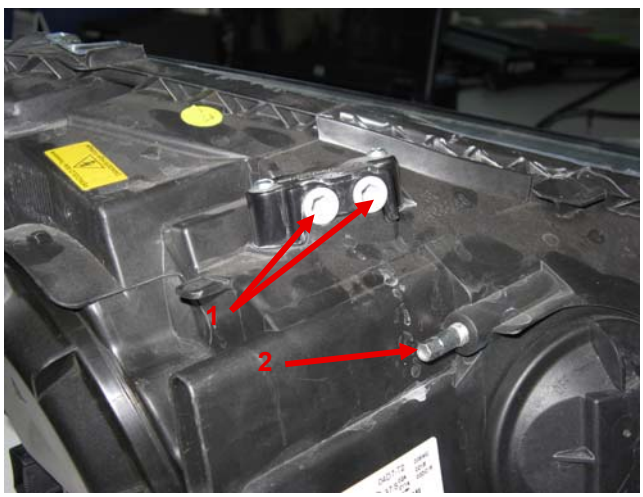
Specific service related procedures

The different service procedures related to the headlights are the following. In case a headlight unit / NFA is replaced, the different steps must be performed in the order as indicated below.

1. Mechanical headlight adjustment
2. Proxi headlight procedure
3. Calibration procedure of the zero position of the axle sensors

Initial mechanical adjustment

For proper system operation, the light beam must be fitted and mechanically adjusted by means of the adjusters indicated by the arrows in the figure.



1. **Vertical adjustment**
2. **Side adjustment**

Vehicle conditions for mechanical adjustment:

1. Vehicle unloaded
2. Vehicle parked on an even ground
3. Tyre pressure at the prescribed values

Initial electronic calibration (Proxi headlight procedure)

The vehicle may have different spare parts, identified by different part numbers, according to the market: the headlight hardware changes, but the ECU remains the same, as it comes with the same functional hardware. The system requires a special parameter calibration, which distinguishes each individual vehicle. The Maserati servers therefore provide the history of the parameter configurations for each vehicle.

If you need to replace the headlight (and therefore the ECU) you must download the configuration for the vehicle through the "Proxi headlight" procedure.

To perform this operation at today's date, you must:

1. Connect to MODIS CS
2. Download the specific file
3. Connect to the vehicle via SD3 and program the ECU using SD3 net

This function is being implemented with the new Maserati Diagnosi tool: with this system you will only have to connect to the vehicle when the MDT tester is connected to the Internet, then from the "special functions" environment of the NFA node you must launch the "Proxi headlight" procedure.

The guided procedure will automatically identify the vehicle and its programming.



After performing the above procedures, it is essential to check proper functioning of the step motors and of the sensors through active diagnostic cycles. We recommend that you perform the NFA node cycle through Maserati Diagnosi in order to test proper system functioning.

Calibration procedure of the zero position of the axle sensors

When replacing the Master NFA and /or one or both axle sensors, a calibration procedure must be carried out afterwards. This procedure can be found in the active diagnoses menu of the diagnostic tester.

The required vehicle conditions are the following:

1. Vehicle in unloaded condition
2. The vehicle must be level
3. Tyres at the prescribed pressure

Notes:

- This procedure is also included in the cycle procedure of the NFA. It is recommended to perform a cycle procedure after every service intervention on the headlight system. The cycle procedure allows to perform a complete functionality check of the system.
- After disconnecting or replacing the battery, it is not necessary to carry out any specific operation; when the key is next turned to on and with the headlights on, the node performs a self-learning process as calibration.



In the event of a collision involving the left-hand headlight, the signal connector for the C-CAN line may be damaged. A problem in the CAN line connector can interfere with proper vehicle starting or create other problems. Therefore, if the vehicle cannot be used after a collision and the headlight is damaged, detach the CAN line connector and check engine starting.

Diagnostics/ recovery strategies

The NFA system manages diagnostics of the internal components and of the signals received from the sensors and the C-CAN line. In practice, the system controls activation of the bi-xenon lights by checking the voltage status received. Activation lasts approximately 15 minutes, after which the system reaches its standard operating temperature and the optimal voltage for operation. The NFA diagnostics handles this situation by monitoring the internal sensors and the light powering lines (inside the headlight).

If these parameters do not meet the thresholds set by the software, the system will record some internal errors. The signals received by the node from the outside are only those coming from the axle sensors (power supply, ground, signal) and the C-CAN line messages.

In the event of a malfunction, the system will issue a DTC error code. Depending on the type of malfunction, a warning light activation request will be sent to the NQS and the related recovery. Not all the DTCs will activate the warning light on the instrument panel.

Since the ECU and the headlight are not severally available, the diagnostic check procedures may be summarised in 4 main categories:

1. Internal problem: this involves replacing the headlight
2. Lamp service life expired: this involves replacing the lamp
3. Connection/external sensor problem: this involves checking the signals and wiring, therefore the external component.
4. No C-CAN line message: the line and the nodes connected to the NFA functions must be inspected

The technical documentation, in the Diagnosis Help section, provides a detailed description of the causes for each DTC, of the system behaviour following a malfunction and of the components to be inspected for troubleshooting.

Below you will find an example for each of the error types described above and the logical flow to identify the defect and correct the malfunction.



IMPORTANT: the NBC manages diagnostics of the light functioning and of the relative warning light activation in the event of a blown light bulb or disconnected wire. For proper system diagnostics, it is important to check all the errors in the vehicle and not only analyse an individual node.

Safety precautions for dealing with gas discharge lamps

- Always switch off the light before opening the headlamp to change a bulb.
- The gas discharge lamp may only be operated when mounted in the reflector.
- Only ever exchange bulbs using gloves and protective goggles. Never touch the glass bulb of the gas discharge lamp.
- The control unit housing must not be opened. Penetration of the control unit by objects is prohibited.
- Take care of live hazardous voltage levels at the output of the Litronic control unit (PIN 1-4)! (During the ignition process approximately up to 28kV. During operation, lamp burning voltage levels reach approximately 68 to 130 Volt)
- The control unit housing must be connected during operation to earth potential if the control unit is not properly mounted in the headlamp / the vehicle (personal safety in case of a malfunction).
- Operation of the control unit and the ignition is only admissible in conjunction with a lamp.
- Operation of the gas discharge lamp is only admissible in the headlamp / in a suitable protective fixture (touch guard due to extreme heat of the lamp, absorption of UV radiation, avoidance of dazzle, explosion protection).

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