User's guide for MT-CAN-LIN-BSI

MULTIPLEXING HS CAN, LS CAN, LIN

EXXOTEST®
EDUCATION

Document No. 00309362-v1

1. MULTIPLEXING

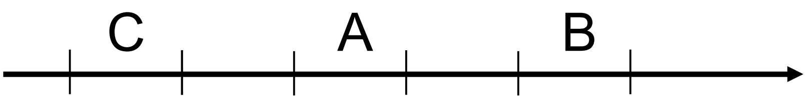
1.1. DEFINITION OF MULTIPLEXING

The combination of multiple signals (telegraphic, telephonic, radiotelephonic or electrical) so that they can be transmitted via a single shared medium (or channel).

<u>In automobile applications:</u> Multiplexing (sometimes called "muxing") lets manufacturers transfer many different signals or packets of information between the vehicle's various control units via just one or two wires.

The electrical circuit which carries the "multiplexed" information is known as a "bus" or "communication network". It lets the control units "dialog" with each other.

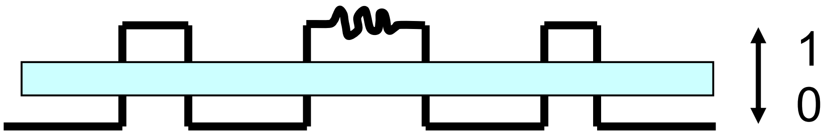
Time-division multiplexing:
(The option used in automobile applications)



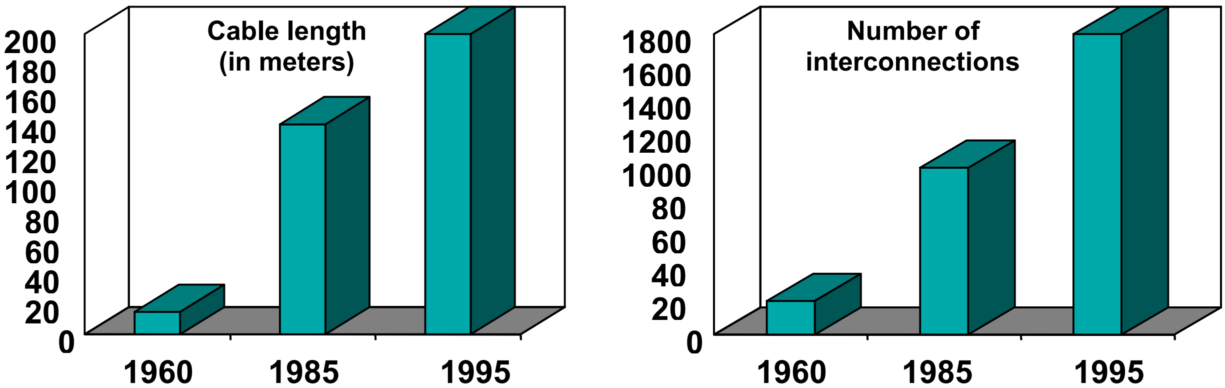
Frequency-division multiplexing:

Why is the data transmitted in digital form?

Digital signals offer a high level of protection against interference. A distorted digital signal may be restored using simple electronic techniques so long as it is possible to discriminate between the 0 and 1 levels.

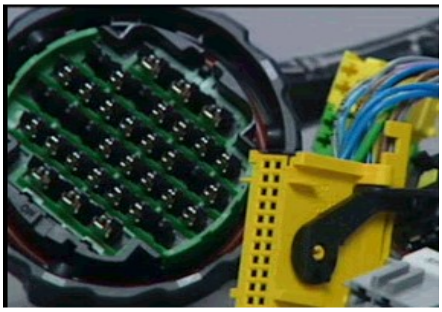


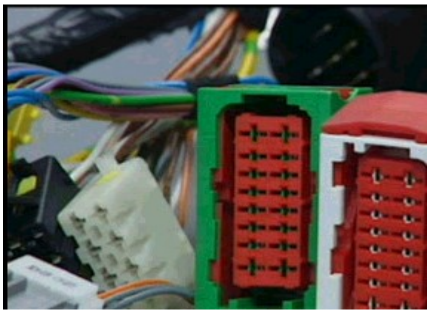
1.2. MANUFACTURERS' REQUIREMENTS



Indicators of increasing communication of data in vehicles

To respond to the ever-increasing utilization of electronic equipment and the growing number of links between the systems (sharing information, synchronization, etc.) manufacturers have had to find ways to simplify the wiring systems.





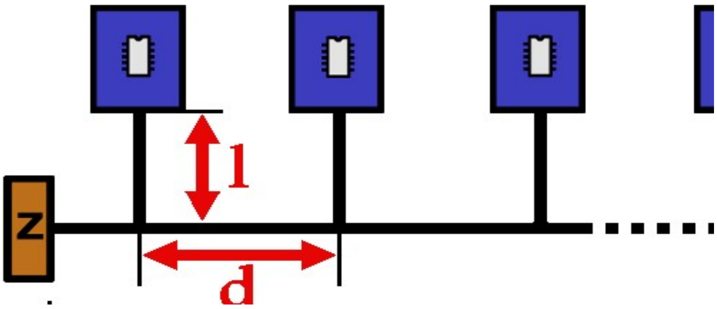
1.3. HS (HIGH SPEED) AND LS (LOW SPEED) CAN

1.3.1. Background

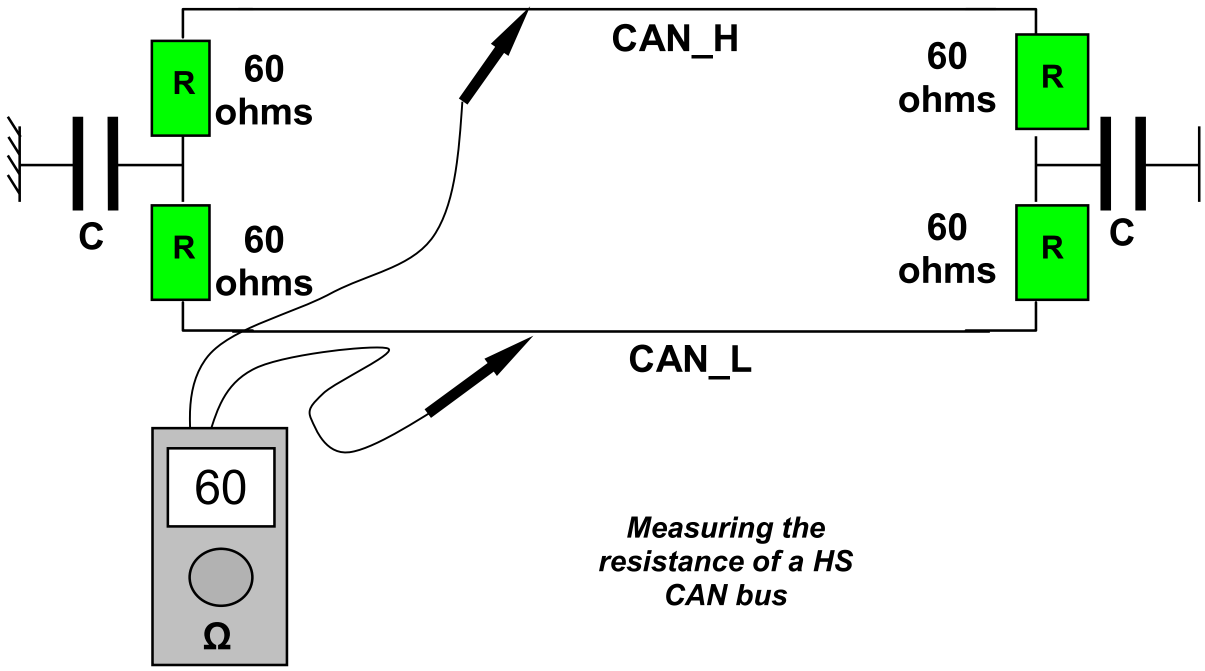
- **1980 ORIGINAL DEVELOPMENT WORK** (Robert BOSCH GmbH)
- **1987 FIRST CAN COMPONENTS** (Intel then Philips)
- **1991 Low-Speed CAN** is formally defined in standard ISO 15519-2
- **1992 MERCEDES** uses **CAN** in its S class cars
- **1993 High-Speed CAN** is formally defined in standard ISO 11898
- **1995** Amendment to standard ISO 11898 to cover the extended CAN

1.3.2. CAN topology

HS CAN: bus architecture limitations

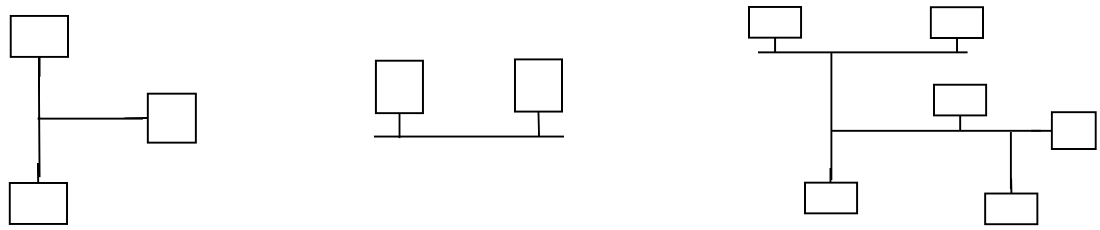


Note: The 120-ohm resistors (identified as Z) dampen the harmonics, prevent the creation of interference and protect the system from interference.



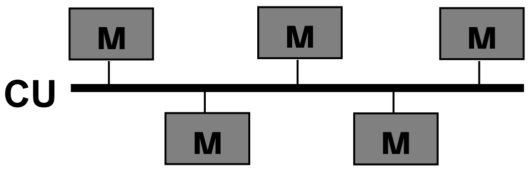
Measuring the resistance of a HS CAN bus

<u>LS CAN:</u> In Bus/Loop/Tree form…



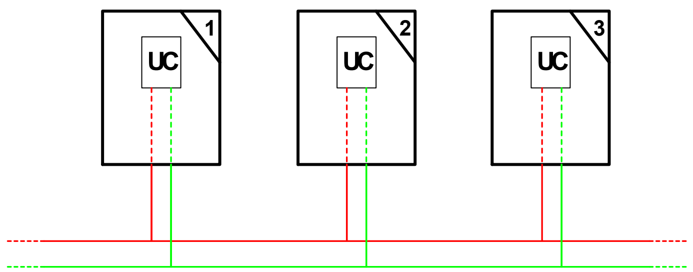
<u>Principles of HS and LS CAN:</u>

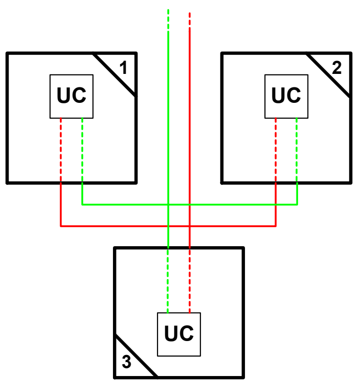
Multi-master



<u>Links between control units:</u>

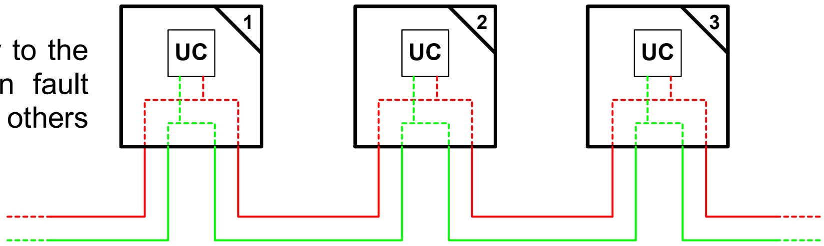
1. Free link: the control units are wired in parallel using permanent spliced connections

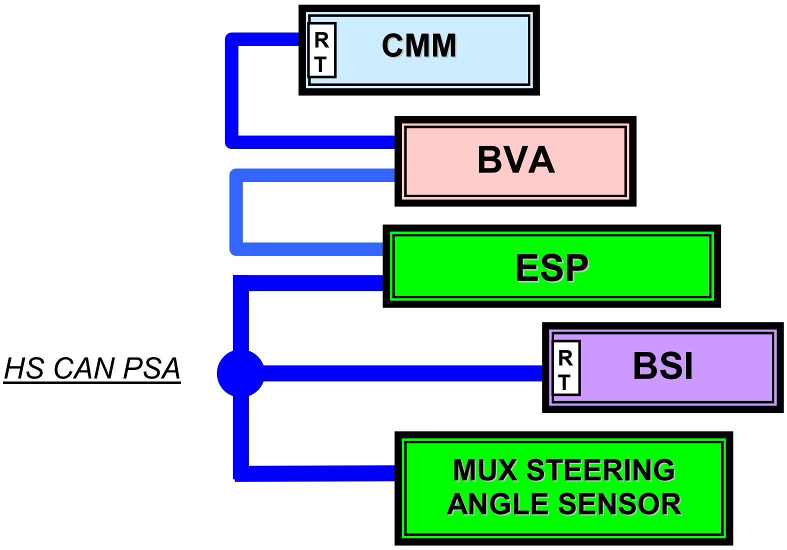




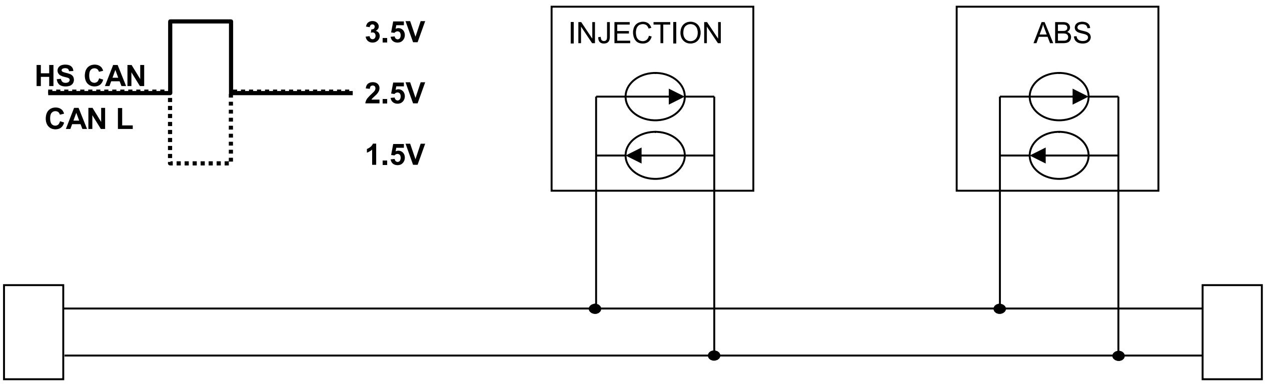
2. Parallel link:

Each control unit acts as a gateway to the other control units. If a connection fault occurs in one control unit, several others may also malfunction!





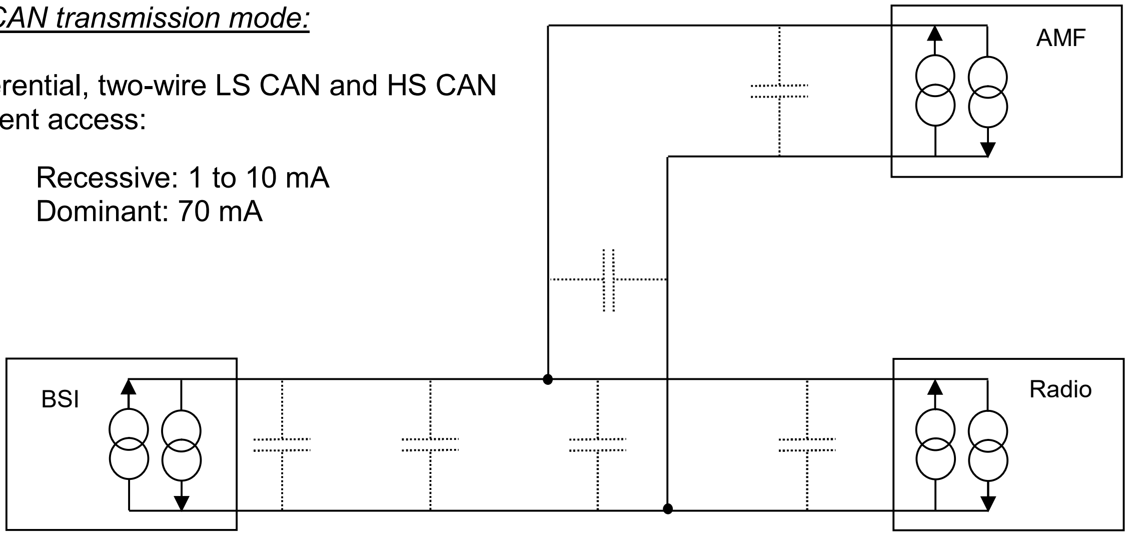
HS CAN transmission mode: Differential, two-wire HS CAN and LS CAN, voltage level control

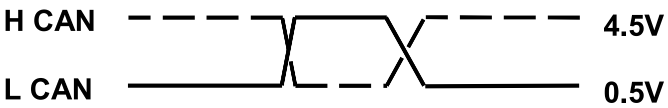


LS CAN transmission mode:

Differential, two-wire LS CAN and HS CAN
Current access:

Recessive: 1 to 10 mA
Dominant: 70 mA





Speeds:

Speed normalized up to 1 Mbit/s

HS CAN
Speeds commonly used: 250 kbit/s: PSA (CAN/VAN vehicles), RENAULT,
500 kbit/s: BMW, MERCEDES, PSA (full-CAN vehicles)

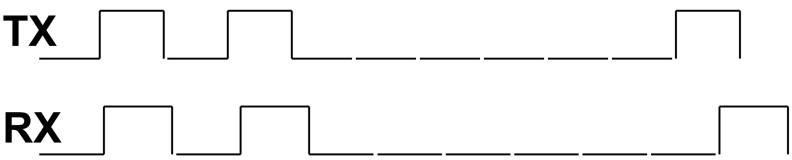
LS CAN
Speeds commonly used: 100 kbit/s: FIAT
125 kbit/s: MERCEDES and PSA (full-CAN vehicles)

Up to 10 items of equipment (approximately 100 normalized)

Serial transmission with auto resynchronization

In a vehicle, each element connected to the CAN bus has a line controller. This line controller has a quartz oscillator to generate the speed. However, depending on their location in the vehicle (passenger cell, exterior, near the engine, far from the engine, etc.) and on their tolerances, the quartz oscillators may drift and the clocks for all the line controllers therefore need to be resynchronized.

In a CAN data frame (or message) there is one resynchronization bit for every 5 identical bits. There are no resynchronization bits if they are not necessary.



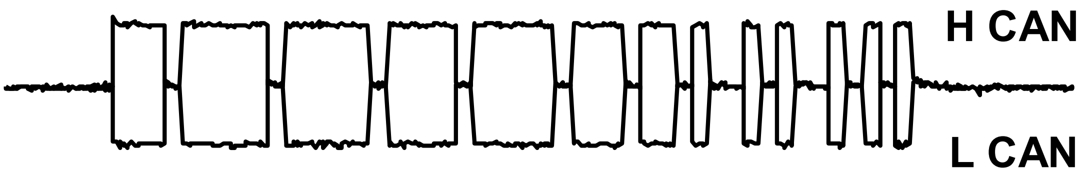
Example of drift

Structure of standard format CAN data frames on the bus (for automobile applications):

IFS	Start	Identifier	Com.	Data	CRC	ACK	EOF

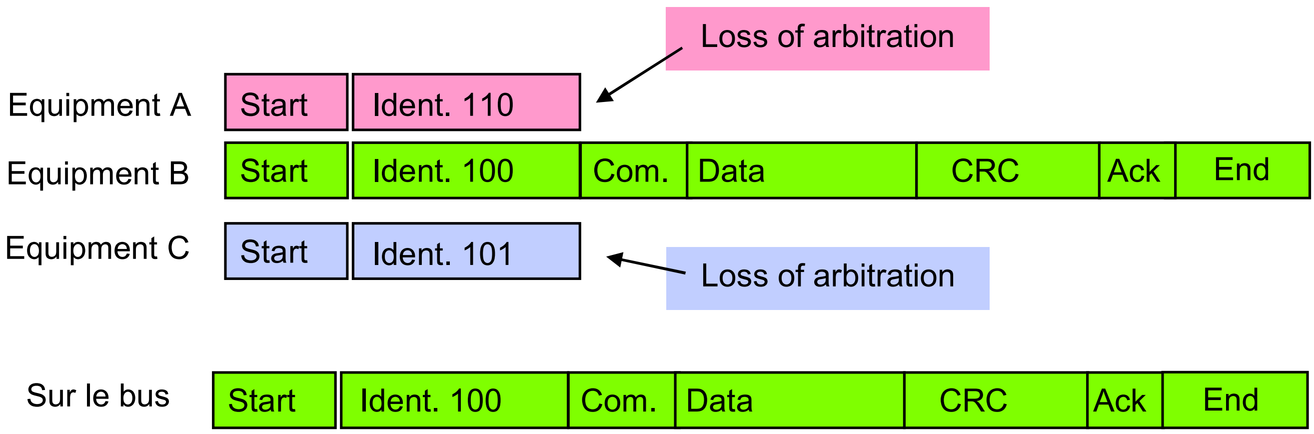
IFS (Inter Frame Space)	free frame, 3 bits as a minimum
Start or SOF	Start of frame (1 bit)
Identifier	Identification field for the frame (11 bits)
Com.	4-bit DLC (data length code) and 3-bit control field
Data	data transmitted by an item of equipment or read by an item of equipment, up to 8 bytes long (8 x 8 bits).
CRC (Cyclic Redundancy Check)	A 15-bit check field
ACK	2-bit acknowledgement field
End-Of-Frame (EOF)	symbol indicating the end of the frame (7 bits)

Data frame recorded with an oscilloscope on an HS CAN network



Arbitration and priority

The message with the highest priority "wins". Bitwise arbitration (logical levels: Recessive 1 / Dominant 0). A Dominant logical level always "wins" over a Recessive level.

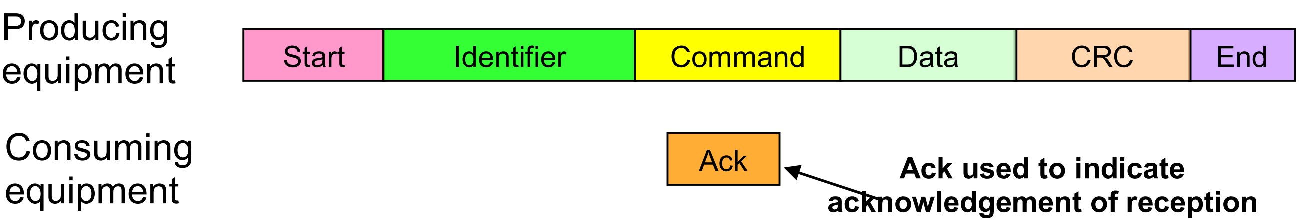


- The priority data frame wins the arbitration
- The non-priority frames are delayed

Question + answer in 2 data frames:

Master	Start	Identifier	Data	CRC	Ack	End	
Master	Start	Identifier	Command	Data	CRC	Ack	End

Acknowledgement:



The acknowledgement is generated by every element If a station receives a distorted message, it corrupts the frame to ensure that no other element shall take it into consideration. If the station disrupts the network too often, it may withdraw itself from the network.

Errors:

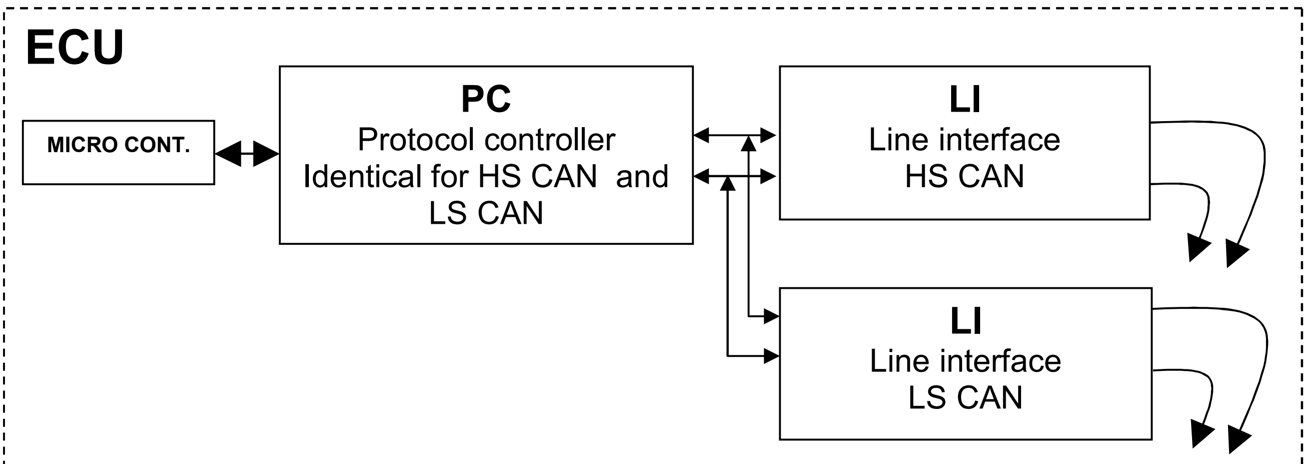
HS CAN: The bus carries no information whatsoever.

LS CAN: Detection of line faults: Short-circuit to ground or to the +power supply, short-circuit between H CAN and L CAN. Degraded mode for one wire.

For correct diagnostics to be performed, communication over the network is required.

Standby/wake-up:

LS CAN: The transition of the network to standby mode is controlled by the BSI. The stations provided with a permanent power supply (+Batt) may send a wake-up request frame. The BSI then restores the +CAN (+Temporary) and data communication resumes.



Block diagram of inner architecture of an electronic control unit on the CAN bus

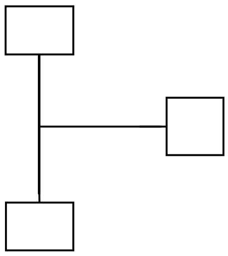
1.4. LIN (Local Interconnect Network)

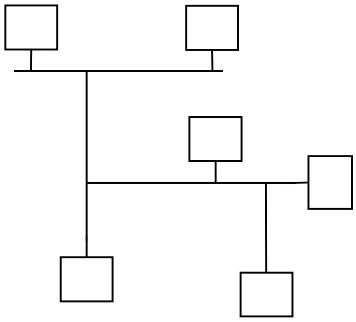
1.4.1. Background

Version 1.0	July 1999
Version 1.1	April 2000
Version 1.2	November 2000
The following manufacturers have contributed to the development of the LIN: AUDI, BMW, DAIMLER CHRYSLER, MOTOROLA, VOLVO, VOLKSWAGEN.	

1.4.2. LIN topology

In Bus/Loop/Tree form…

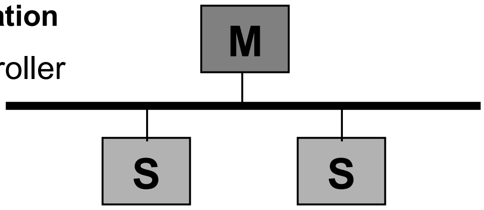




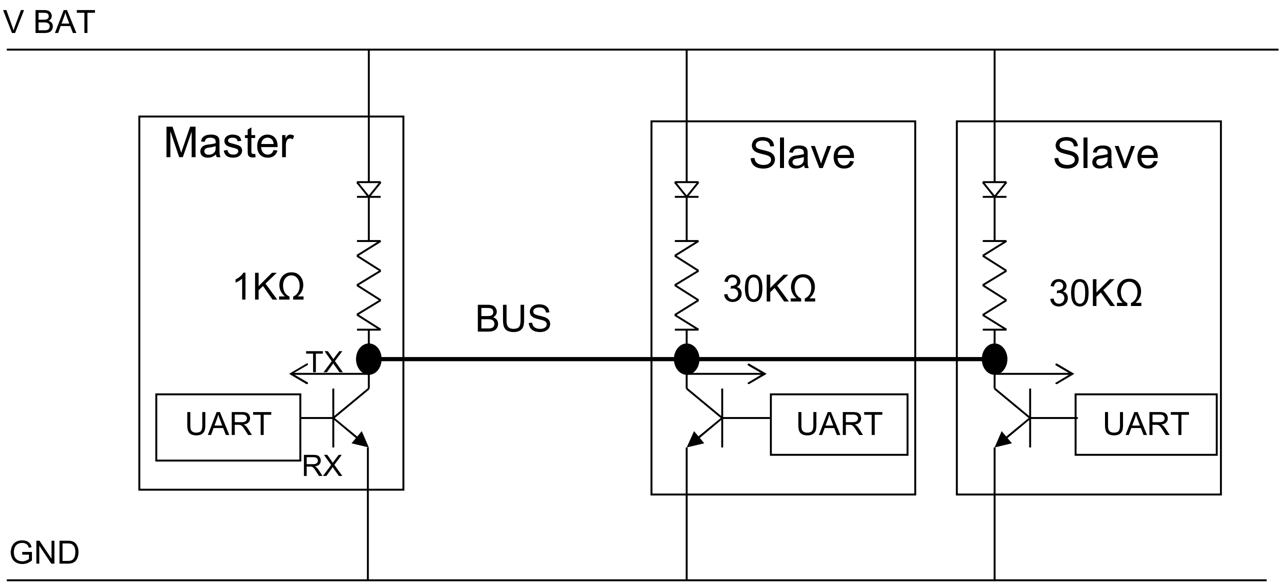
The LIN uses 1 master and 1 or more slaves (maximum of 32):

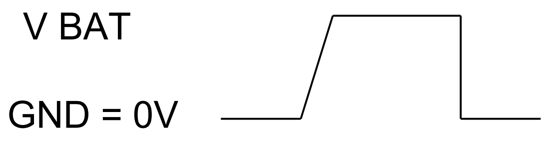
There is not, therefore, any need for arbitration

Microcontroller



<u>*Transmission modes: in series on a single wire*</u>

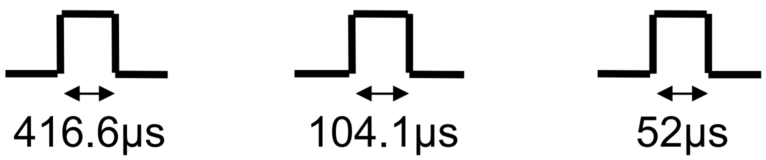




Recessive: 1 = V BAT
Dominant: 0 = ground

Speeds:

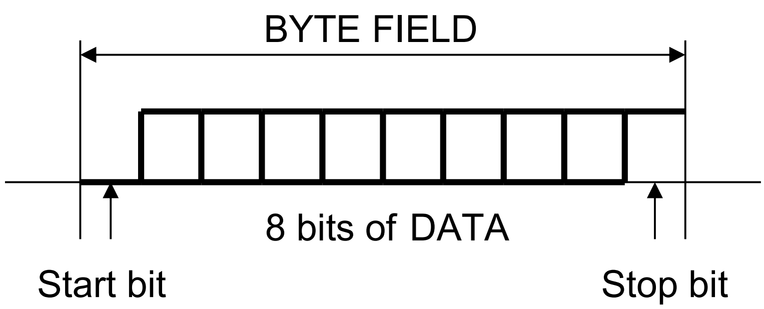
Slow	Medium	Fast
2400 bit/sec	9600 bit/sec	19200 bit/sec



Protocol, structure of the data frames on the bus

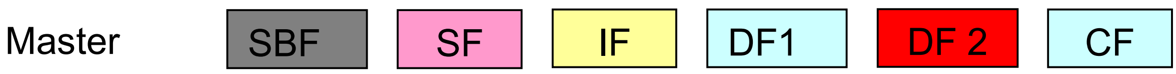
Byte fields (packets) of 10 bits run on the LIN.

Typical UART (RS232)
UART = universal asynchronous Rx/Tx



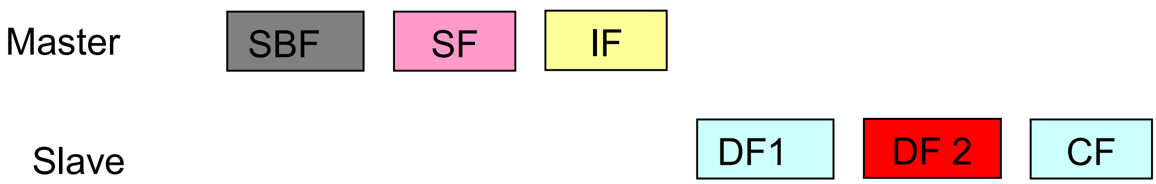
Writing frame:

Master-Slave control



Reading frame:

Request for data with reply in the frame



- Concept of 1 master, several slaves, no requirement for arbitration.
- The acknowledgement is not managed by the LIN protocol.
- A slave may not have a quartz oscillator (except for the most important slave).
- In a frame, there is one transmission of a bit (0 or 1) (Synch Field) to excite and synchronize the slave stations with or without a quartz oscillator.

For example: the coded chip in the ignition key does not have a quartz oscillator; it is thus the transponder which generates a magnetic field and retrieves the code from the key.

Faults:

- Grounded line
- Error checking
- Identifier check
- Slave does not reply
- SYNCH FIELD outside the tolerances
- Short-circuit

The main *advantage* offered by this network is that it is simple to implement and thus inexpensive to manufacture.

2. DIRECTIONAL HEADLAMPS

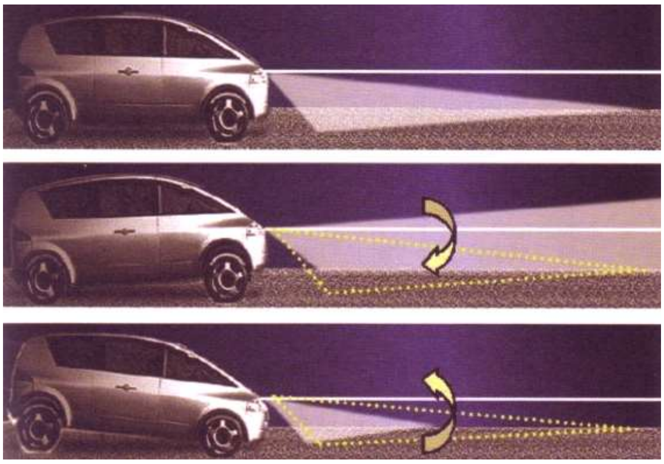
2.1. GENERAL

2.1.1. Purpose

The Directional headlamps function is also referred to with the terms AFS (Adaptative Front-lighting System) and Headlamps Dynamic Correction. This function illuminates the zone into which the driver intends to drive and respond to variables such as ride (or body) height) and the direction, tightness and speed of the turn. This headlamp control system must conform with the regulations covering headlamps fitted with high-intensity discharge (xenon) type headlamps. For this reason, they are fitted with an automatic elevation correction device.

2.1.2. Elevation correction

The elevation (i.e. variation in a vertical plane) correction function maintains a constant beam angle with regard to the plane of the road surface, regardless of variations in the vehicle's static pitch (loading) and dynamic pitch (braking, acceleration, uneven road surface).



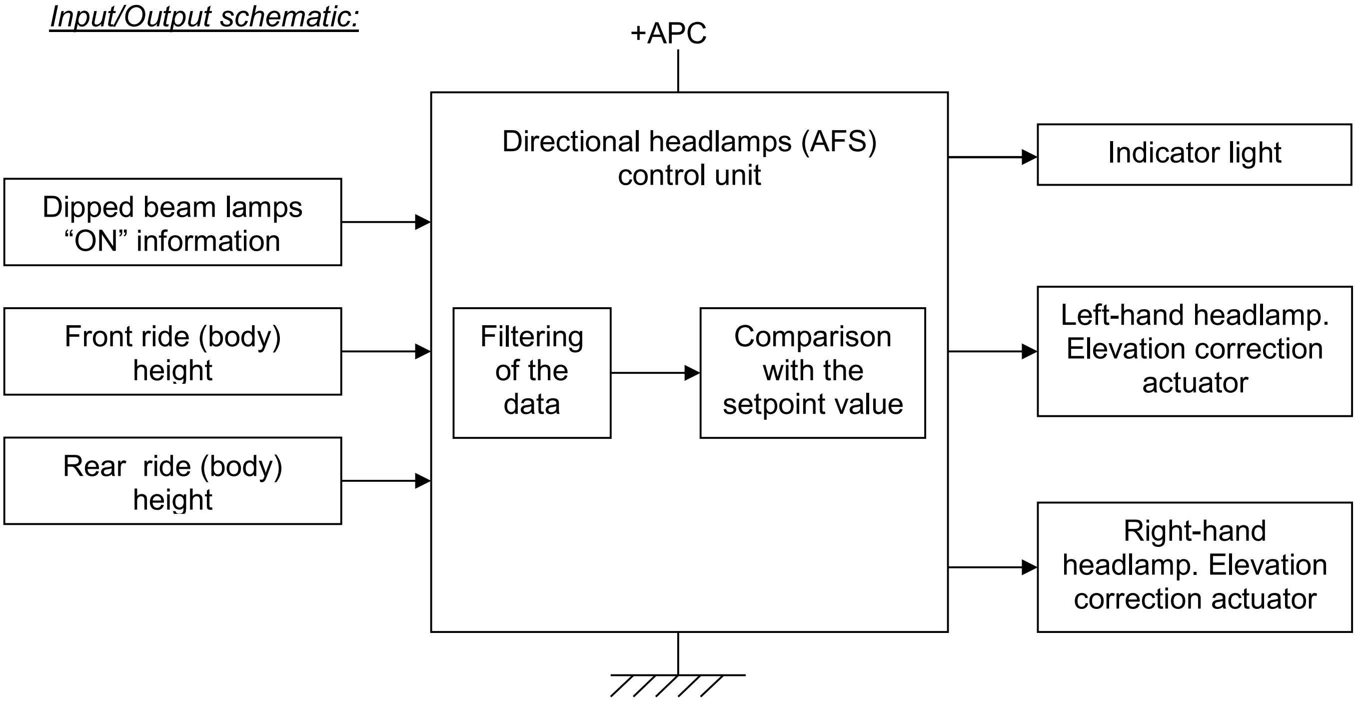
Beams correctly adjusted
→Setpoint value achieved

Beams too high
- Acceleration
- Loaded at rear

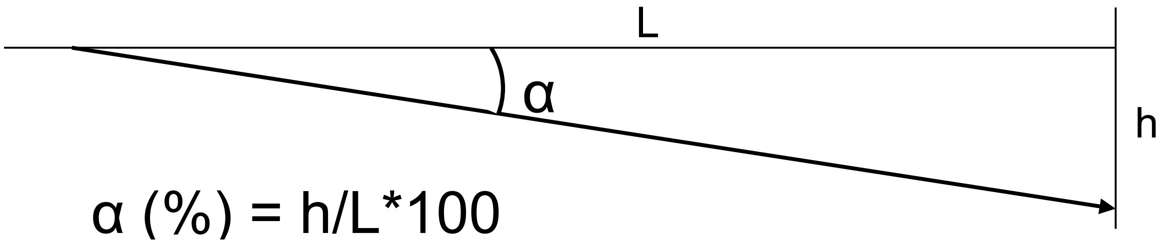
→Dip beam

Beam too low
→Raise beam

Input/Output schematic:



The angle of the light beam with respect to the horizontal is expressed as a %.

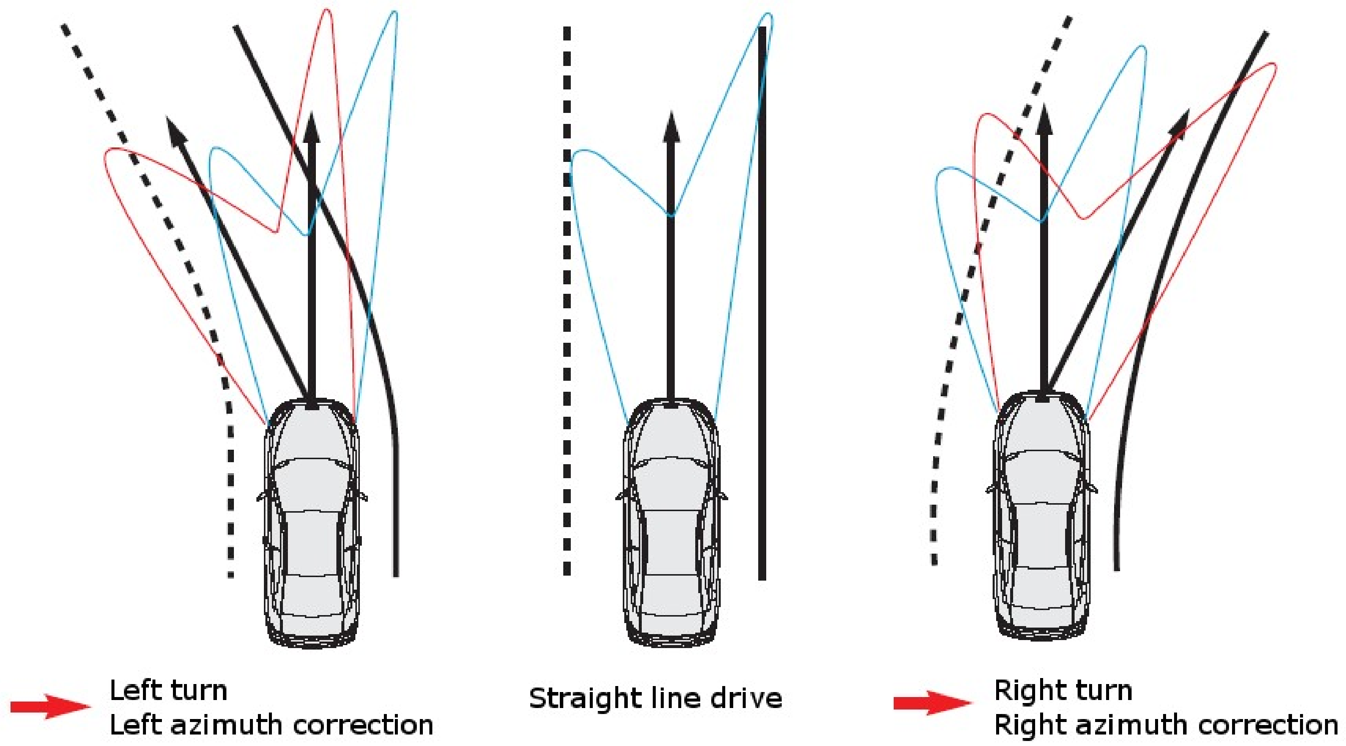


$$\alpha\ (\%) = h/L*100$$

The rated value is indicated on the headlamp.

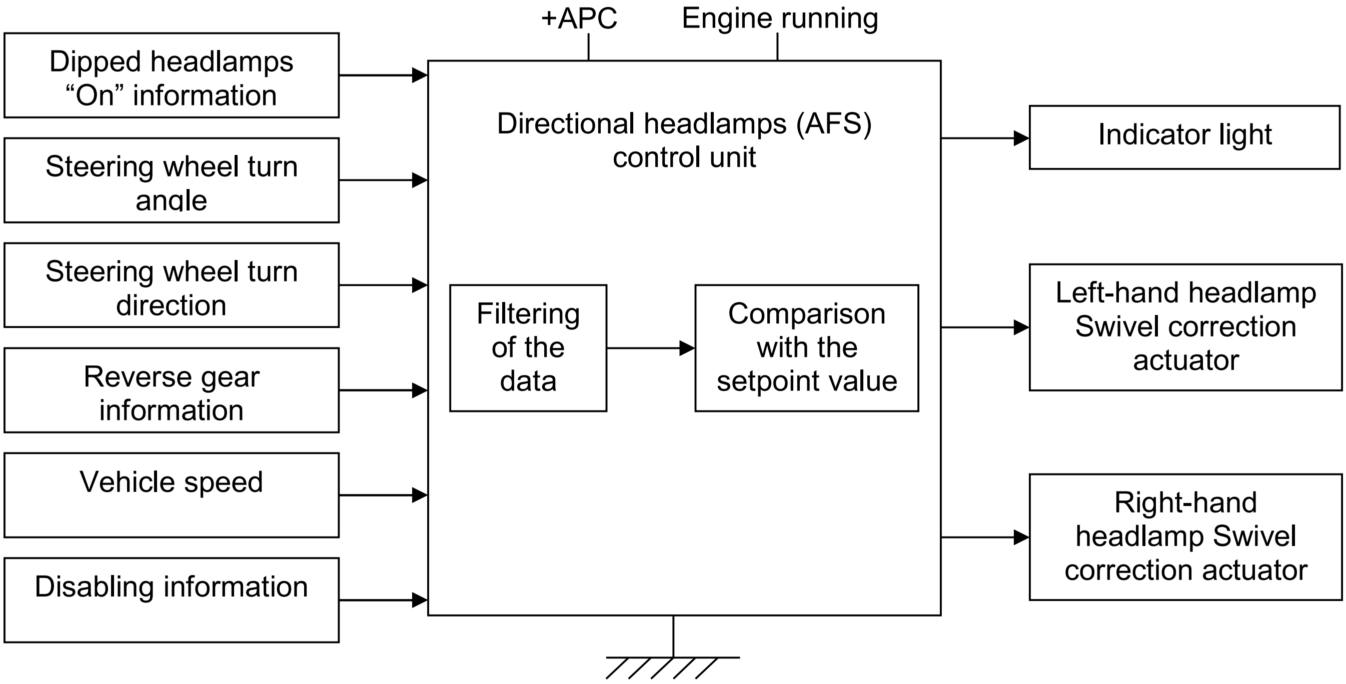
2.1.3. Swivel correction

Swivel (azimuth) correction adjusts the angle of the light beam in the horizontal plane with respect to the vehicle's longitudinal axis in response to the nature of the turn steered by the driver.



This system improves both the driving experience and road safety by letting the driver see the path which the vehicle will take rather than the zone directly in front of the vehicle.

Input/output schematic for swivel correction:



2.1.4. An overview of high-intensity discharge (HID) lights

A high-intensity discharge light has two electrodes and contains salts and a compressed gas (xenon).

An electric arc is struck between the electrodes by a very high voltage, of about 25 kV. Once the arc is made, it is maintained by an 85 V a.c. voltage. A ballast delivers a voltage of 1 kV to the light's terminals. The 1 kV is transformed up to 25 kV within the light itself.

The maximum current is approximately 40A at switch on (for a few milliseconds), then decreases over a period of 30 to 40 s down to a steady-state value of about 3 A. The arc stabilization period is approximately 2 seconds and the light takes about 30 to 40 seconds to reach its normal operating temperature.

A xenon headlamp consumes about 35 W of electrical power. The output is 90 lm/W, producing a total illumination of about 3150 lumens (compared with about 1500 lumens for a conventional H1 light). Ultraviolet light is generated in addition to the visible light. The bulb is thus coated with a film which reduces the propagation of UV light.

Consequently, compared with a conventional H1 light, a HID light generates twice as much illumination, and a light quality which is similar to sunlight. The service life for a bulb of this type is approximately 1500 hours.

Comparison:

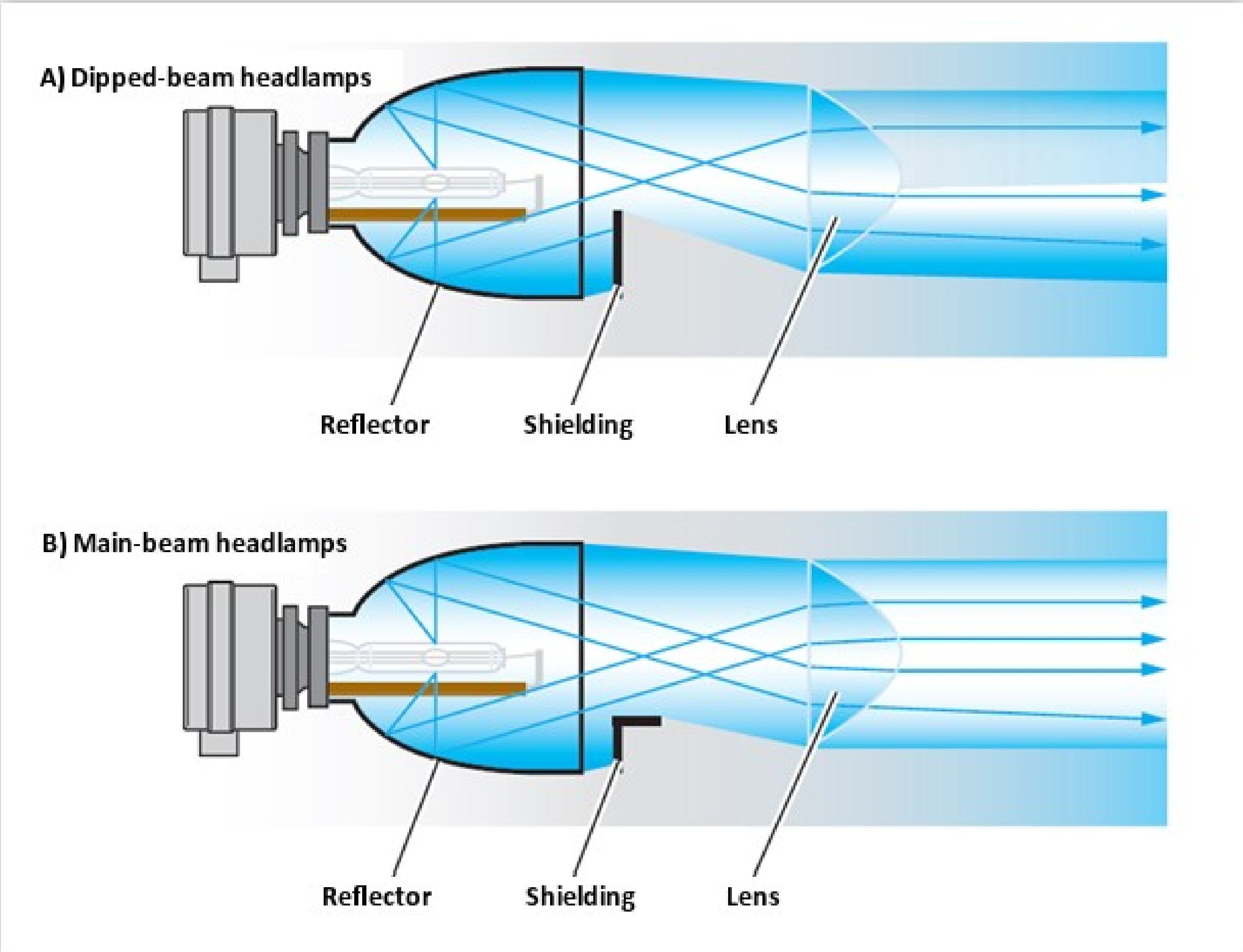
- At a distance of 210 m, a H1 light generates a light intensity of 0.4 lux, whereas a HID light generates 1 lux.
- At a distance of 60 m, the width of a beam from a H1 light is 36 m (i.e. the width within the beam where the light intensity is 0.4 lux or above) whereas the width of a HID light is 68 m.

Note: the quantity of light, or luminous flux is measured in LUMENS (lm) and the light intensity or illuminance is measured in lux (lx):

1 lux = 1 lumen / m²

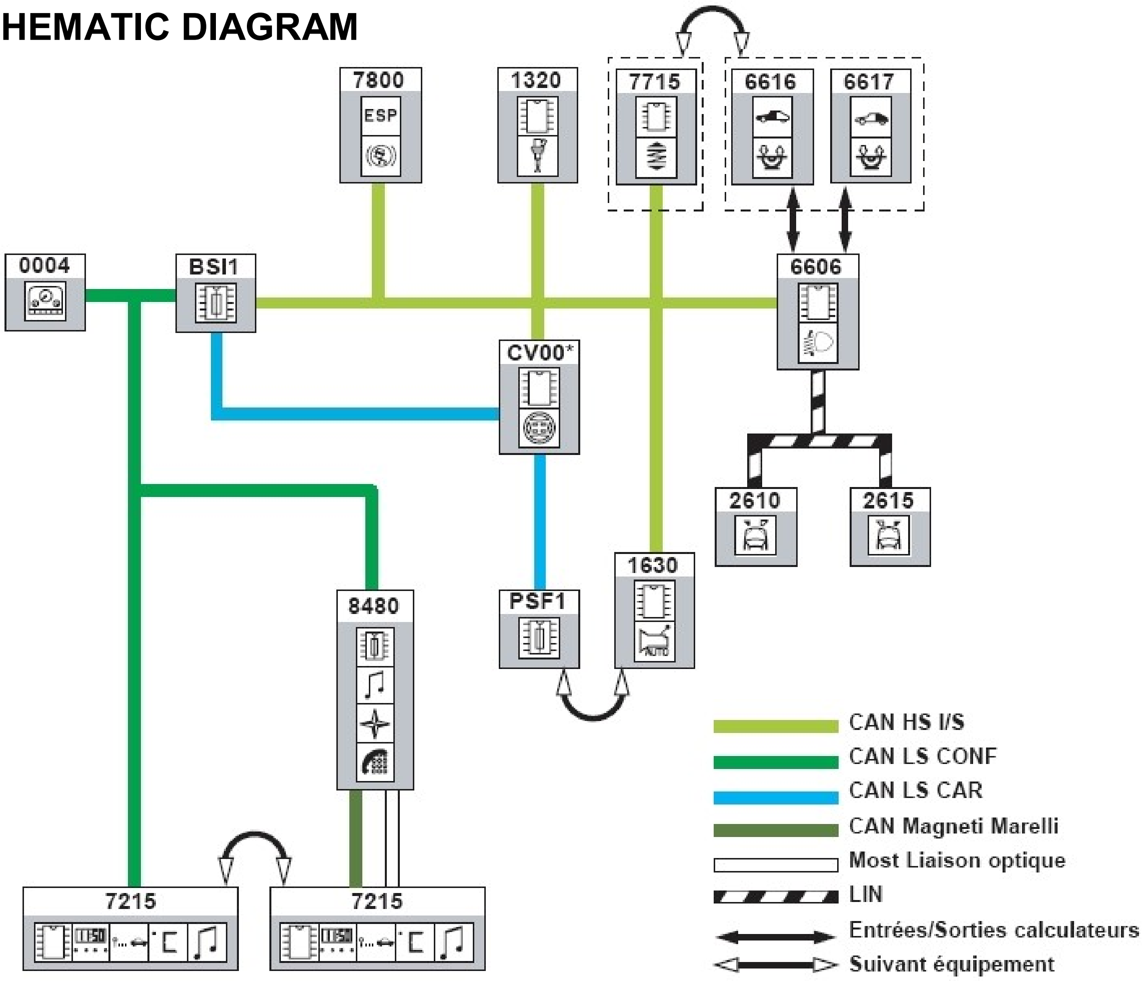
2.1.5. Shielding within headlamp assemblies in front of the HID light

The transition from dipped (low) beam to main beam is achieved using a plate which shields part of the HID light.

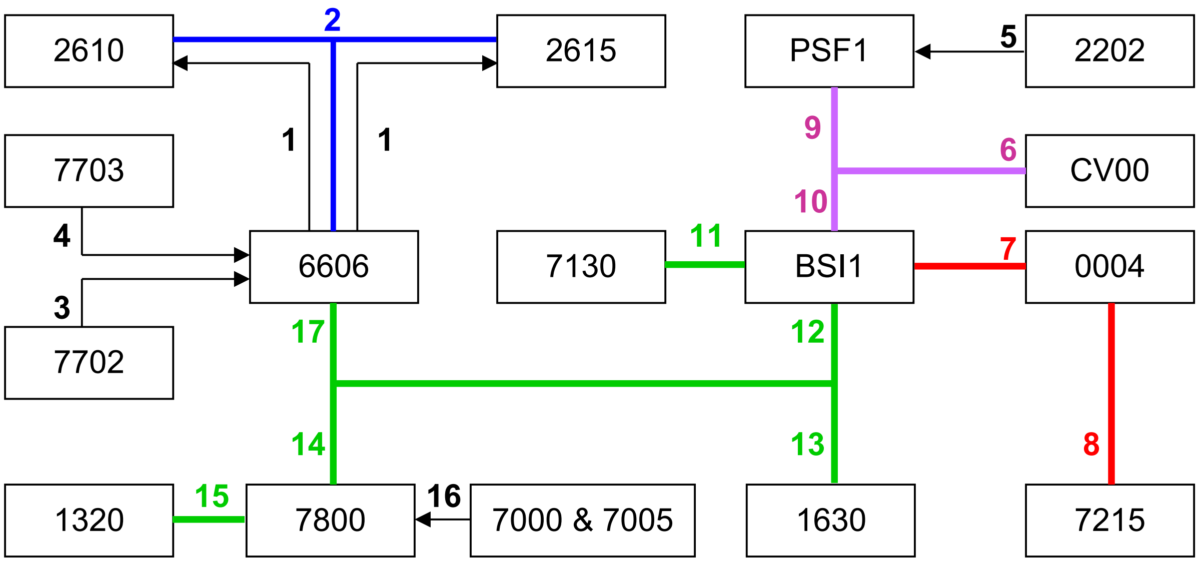


The shielding is actuated by an electromagnet. When the shielding is actuated (folded down), all the luminous flux is projected forwards (figure B).

2.2. SCHEMATIC DIAGRAM



Control units	
BSI1	Built-in Systems Interface
BSM	Engine bay fuse box
CV00	Steering wheel switching module
PSF1	Fuse box in engine compartment
0004	Instrument panel
1320	Ignition and injection control unit
1630	Automatic transmission control unit
2202	Reversing Switch (automatic transmission)
2610	Left-hand headlamp
2615	Right-hand headlamp
6606	Headlamps dynamic correction control unit
6616	Front ride (body) height sensor
6617	Rear ride (body) height sensor
7000 & 7005	Front left/right wheel speed sensor
7215	Multifunction display
7130	MUX steering angle sensor
7702	Body ride (height) sensor; front
7703	Body ride (height) sensor; rear
7715	Suspension control unit
7800	ESP control unit
8410	Audio unit
8480	Telematics transceiver



No.	Signal	Link
1	Elevation correction control	**Conv. wired**
2	Swivel correction control	**LIN**
3	Front ride (body) height information	**Conv. wired**
4	Rear ride (body) height information	**Conv. wired**
5	Reversing information (manual transmission)	**Conv. wired**
6	Status of road lighting controls	**CAN Body**
7	Indicator light control Swivel correction request	**CAN Comf**
8	Request enabling/disabling of swivel correction	**CAN Comf**
9	Reversing information (manual transmission)	**CAN Body**
10	Reversing information (man. transmission)/Status of lighting controls	**CAN Body**
11	Steering angle sensor information	**CAN I/S**
12	Steering angle sensor information/Reversing information (manual transmission) Status of road lighting controls/Indicator light control Request enabling/disabling of swivel correction	**CAN I/S**
13	Reversing information (automatic transmission)	**CAN I/S**
14	Engine running information/Vehicle speed	**CAN I/S**
15	Engine running information	**CAN I/S**
16	Rotational speed of front wheels information	**Conv. wired**
17	Steering angle sensor information/Reversing information Status of road lighting controls / Indicator light control / Swivel correction request / Engine running info / Vehicle speed	**CAN I/S**

CV00: Steering wheel switching module (COM2003)
Acquires the driver's input and passes it on to the BSI via the LS CAN CAR bus: switching on or off the dipped/main beam headlamps.

7130: MUX steering angle sensor
Acquires information about the angle and direction of rotation of the steering wheel and circulates it on the HS CAN I/S bus so that it can be used by the directional headlamps (AFS) control unit (6606).

PSF1: Fuse box in engine compartment (BSM)
Supplies power, controlled by BSI1, to the front lights (sidelamps, dual-function headlamps, indicator lights). Acquires reversing light information (2200, manual transmission) and then sends it to BSI1.

0004: Instrument panel
Indicates the status of the vehicle's lights.

1320: Ignition and injection control unit
Circulates "engine running" information on the HS CAN I/S bus which is used by the AFS control unit (6606).

1630: Automatic transmission (BVA) control unit
Circulates "reverse gear engaged" information on the HS CAN I/S bus which is used by the AFS control unit (6606).

2610/2615: Left-hand/right-hand directional headlamp (Power Module)
Communicates with the AFS control unit (6606) and performs elevation and swivel corrections.

6606: Headlamps dynamic correction control unit (AFS)
Manages the "directional headlamps" (AFS) function as well as elevation correction.
Acquires ride height information, either:

- via a conventionally-wired link, provided by two ride (body) height sensors (6616/6617), or
- via the HS CAN I/S bus, provided by the CSS control unit (suspension systems control).

Communicates via a LIN link with the "Power Modules" integrated into the headlamps.
These control the stepper motors used for swivel correction.

6616 / 6617: Front/rear ride (body) height sensor
On vehicles not fitted with a controlled suspension (7715) control unit, they measure the ride (body) height for the attention of the AFS unit (6606) which is transmitted via a conventionally-wired connection.

7215: Multifunction display (EMF)
Displays the menus used to activate or deactivate the "directional headlamps" function.
Displays faults.

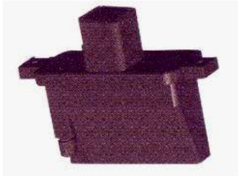
7715: Suspension systems control ECU (CSS)
Receives ride (body) height information, which it uses to control the suspension, then circulates this information on the HS CAN I/S bus for use by the AFS control unit.

7800: ESP control unit
Circulates "vehicle speed" information on the HS CAN I/S bus for use by the AFS control unit (6606).

8480: Telematics (radio/telephone/audio unit) transceiver
Acquires the driver's input and presents it on the multifunction display in accordance with the settings selected using the "Custom settings – Configuration" menu.

2.3. COMPOSITION OF THE SYSTEM

Control unit



The directional headlamps (AFS) control unit processes the various signals, some of which are produced by the MUX steering angle sensor and from the ride (body) height sensors, and sends control instructions to the power modules which perform the elevation and swivel corrections.

The ballast is an integral part the control unit and is mounted on the lower part of the headlamp; it consists of a box and an independent shielded cable harness fitted with a special connector on the bulb side.

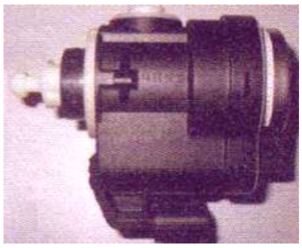
Power module

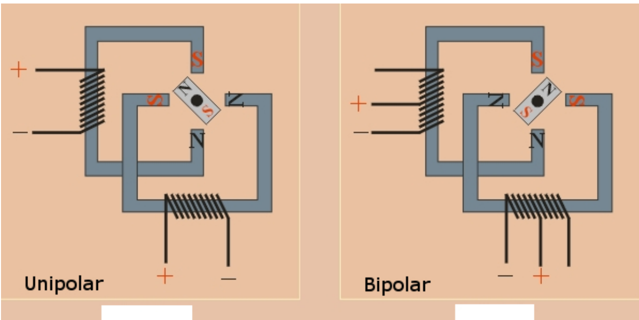
The power modules are mounted under the headlamps (2610/2615); they control the swivel correction stepper motors.

Elevation correction stepper motors

Stepper motors are increasingly popular in automotive applications. They are well suited to delivering stable speeds of rotation and to maintaining accurate positions. They are suited to being controlled by control units, and can thus offer high levels of precision.

Stepper motors convert electrical pulses received from the control unit into a rotating mechanical motion. Each command pulse produces a constant angle of rotation of the motor's rotor. This rotation is called a "step"; the motor thus always reacts in the same way to the command from the control unit. Because of this feature, it is possible to determine continuously the exact position of the motor and of the component which it actuates.





There are two types of stepper motor: unipolar and bipolar. In both types, a permanent-magnet rotor is driven by the magnetic fields generated by the stator windings. The key difference is in how the coils are connected and energized.

Bipolar
The direction of current flow through each coil is continuously changed (by polarity reversal on the same terminals).

Unipolar
The coils' positive terminal is common and does not change (the connection is made at the center of the coil). The motor is controlled exclusively by grounding.

The stepper motors are off-the-shelf parts (i.e. they are not intended to be disassembled or repaired). They are built into the headlamps and are controlled by their respective control unit. Their accuracy is < +/- 2 mm, the positional accuracy of the motor's output spindle is < +/- 0.07 mm.

Ride (body) height sensors

These sensors are connected directly to the directional headlamp (AFS) control unit. They are identical to those fitted to the C8. Telecoding is used to indicate which type of sensor is fitted. The sensors are off-the-shelf parts (i.e. they are not intended to be disassembled or repaired).

Capteur avant

Capteur arrière

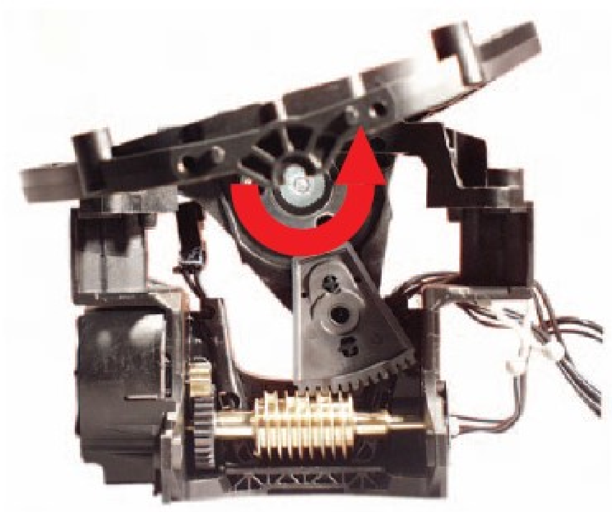
Angular deviation sensors are mounted on a vehicle body component and linked to the suspension arm on the anti-roll bar at the rear and front via a connecting rod system. They measure the vehicle’s pitch (i.e. the pivoting in a vertical plane passing through the vehicle’s longitudinal axis). Their measurement range is +/- 45 degrees.

These digital devices generate a PWM (Pulse Width Modulation) type output voltage, i.e. a square-wave signal with a frequency of 200 Hz with a variable cycle ratio. The cycle ratio is proportional to the angle of the link lever.

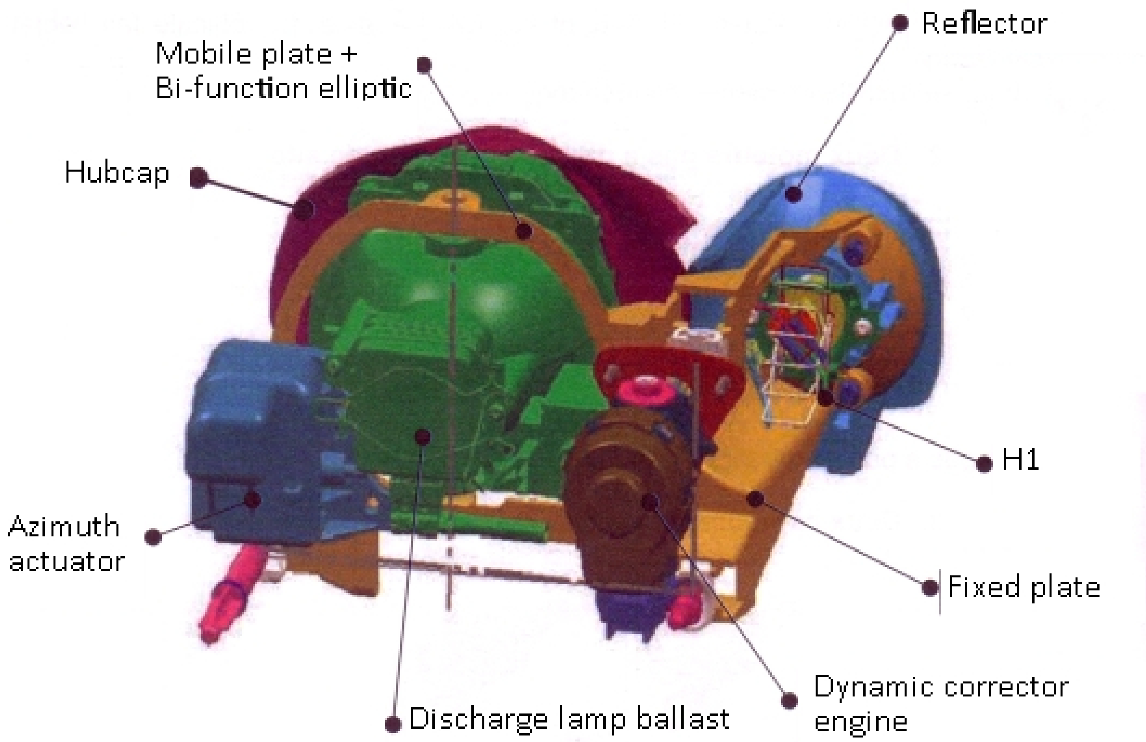
The sensor’s rated power supply voltage is equal to the battery voltage. It draws less than 15 mA.

Mobile mounting plates and swivel actuators

The mobile plates and swivel actuators cannot be ordered as spare parts. In the event of a malfunction, the entire headlamp must be replaced.



Rear view of a directional headlamp:



2.4. OPERATION

Initialization phase

Each time the ignition is set to “On”, the elevation correction motors and the swivel actuators run through an initialization procedure, even if the lights are switched off. The elevation is initialized by driving the motors to their lowered stop position followed by a return to their nominal position. The swivel is initialized by driving the actuators to their inside stop position followed by a return to their nominal position. These initialization operations on elevation and swivel occur simultaneously. If the engine is started before the initialization has completed, the initialization may pause and continue once the engine has started.

Elevation correction

The elevation correction function is active whenever the headlamps are switched on. The orientation (or pitch) of the vehicle’s body is determined based on the difference between the rear and front ride (body) height sensors. This information is filtered and then processed to determine the correction to be made to the inclination of the light beam. The filtering process eliminates any instabilities in the system.

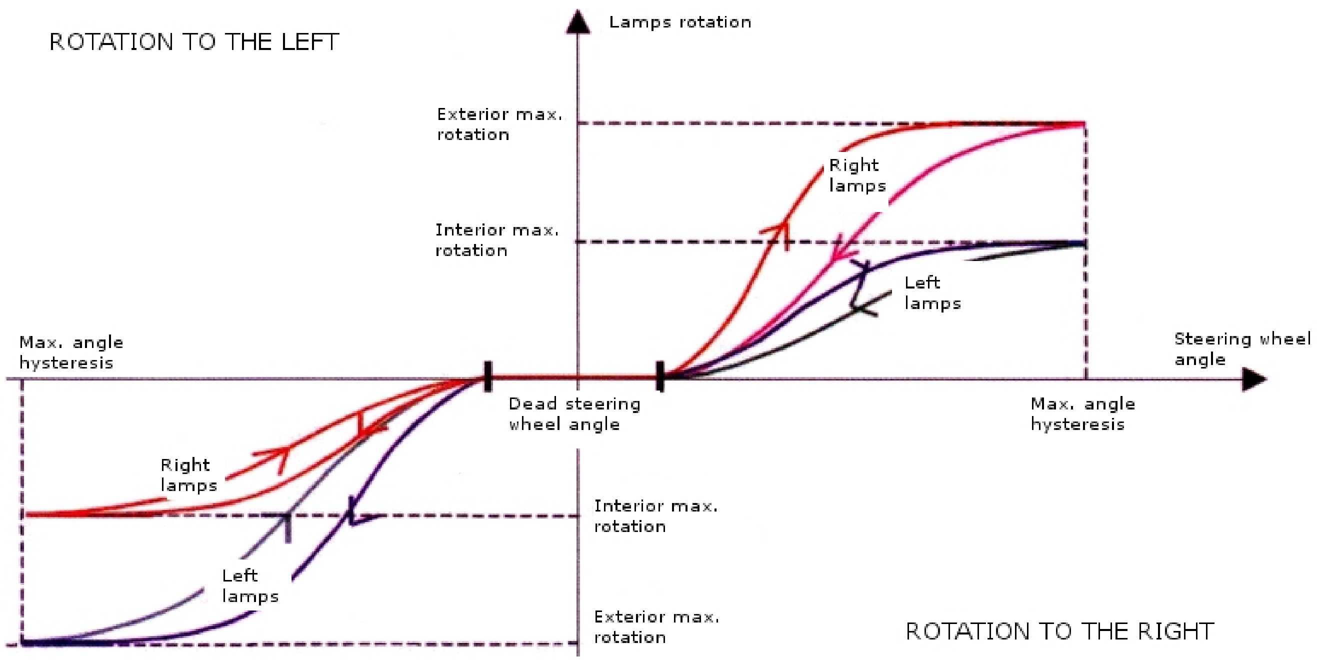
Swivel correction

The system operates if:

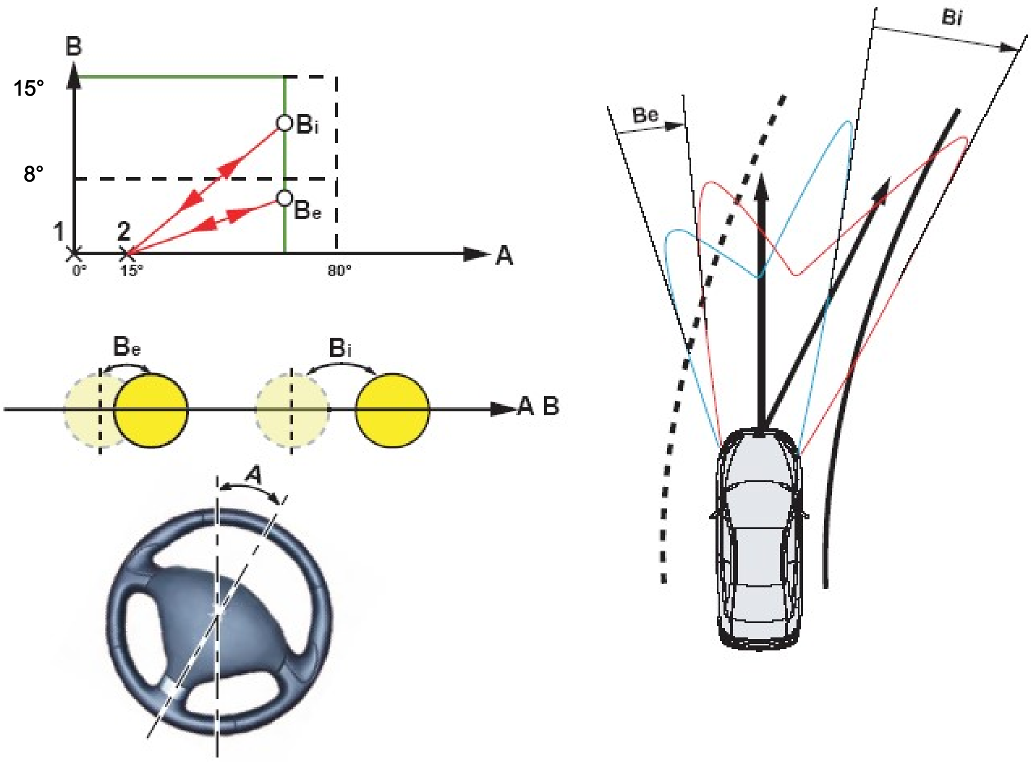
- The vehicle’s speed is not zero
- Reverse gear has not been selected
- The function has been enabled in the on-board computer
- The steering angle exceeds 15°

The swivel angles are calculated based on the steering angle and the direction of the turn. The first step is to filter the steering angle signal to take out any slight variations in steering angle. The swivel angle for the headlamp on the inside of the turn is calculated using an algorithm. The swivel angle for the headlamp on the outside of the turn is then determined as a proportion (approximately half) of that for the other headlamp. The range of headlamp deviation is from -8° (when swiveling towards the center line of the vehicle) to +15° (when swiveling away from this center line). The return to position algorithm is the same as the deviation from original position algorithm (except in reverse) so long as the steering angle is less than 80°. However, there is hysteresis in the return to position movement if the maximum steering angle exceeds 80°.

Swivel correction control algorithm:



Example 1: for a right-hand turn with a steering angle (i.e. a steering wheel rotation) of less than 80° the movements are as indicated below. The same applies to a left-hand turn.

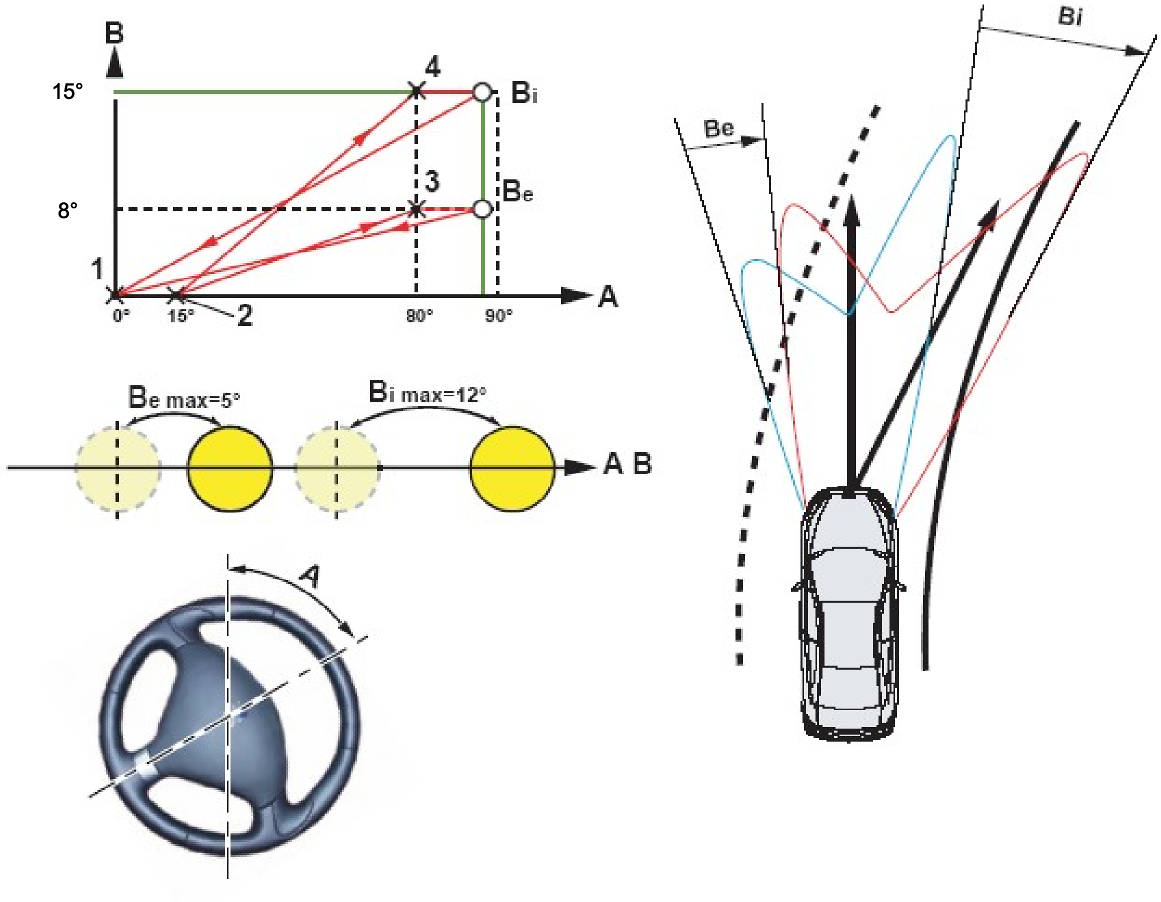


The headlamp swivel angle obtained varies as a function of vehicle speed.

Examples:

- at 60 km/h the maximum headlamp swivel angle is obtained with a steering angle (A) of 60°.
- at 40 km/h the maximum headlamp swivel angle is obtained with a steering angle (A) of 70°.

Example 2: for a right-hand turn with a steering angle of more than 80° the movements are as indicated below (the same applies to a left-hand turn)



The headlamps have reached their maximum stop positions (-8; +15°) for a steering angle of more than 80°, the return is then controlled by a different algorithm (which creates hysteresis).

<u>Legend:</u>

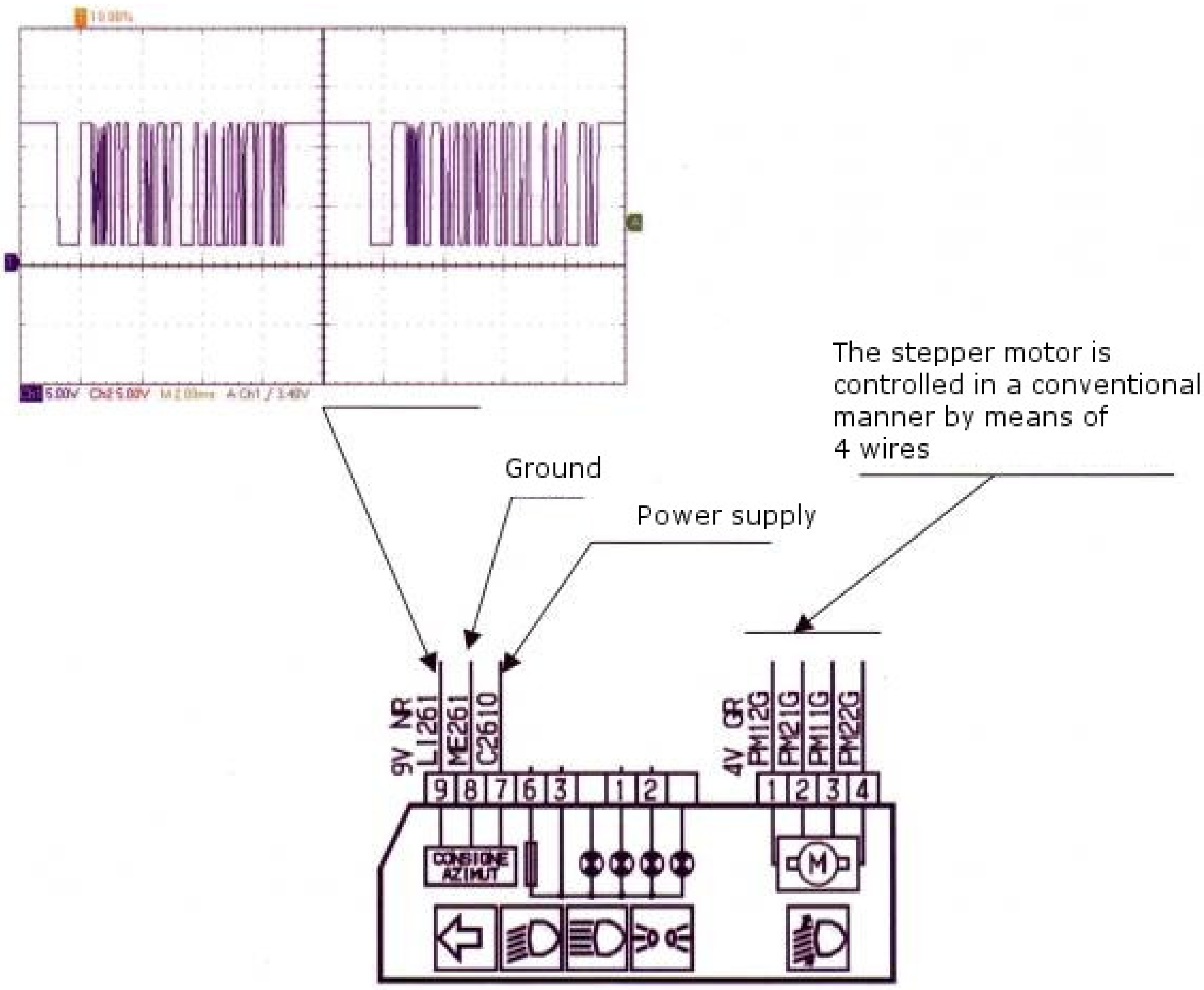
A	Steering angle
B	Directional headlamp angle
B_i	Swivel angle for headlamp on inside of turn
B_e	Swivel angle for headlamp on outside of turn
1-2	Inactive range for additional headlamps
3	Maximum swivel angle for headlamp on outside of turn
4	Maximum swivel angle for headlamp on inside of turn

The LIN (Local Interconnect Network)

The swivel actuators are controlled via a multiplexed LIN. Via this bus, the control unit sends the required position to the actuator and the actuator returns its status. There is no position feedback sensor fitted to the swivel actuators. The actual headlamp position is not known accurately, it is simply determined based on the commands received since completion of the initialization phase performed when switching the ignition key to “On”.

However, several microswitches located within the headlamps provide information about the zone within which they are located (left-hand position, nominal position, right-hand position).

The signal is defined by a data frame between 0V/1V and 12V.



Faults and degraded modes

If a component of the elevation or swivel system malfunctions, the fault light on the dashboard lights up and the multifunction display (EMF) displays a warning message. If the incident affects one headlamp only, elevation correction for the other headlamp shall continue. However, the swivel correction is systematically set to “malfunction” for both headlamps.

The headlamp affected by the fault is set to a degraded (default) position, if this is possible:

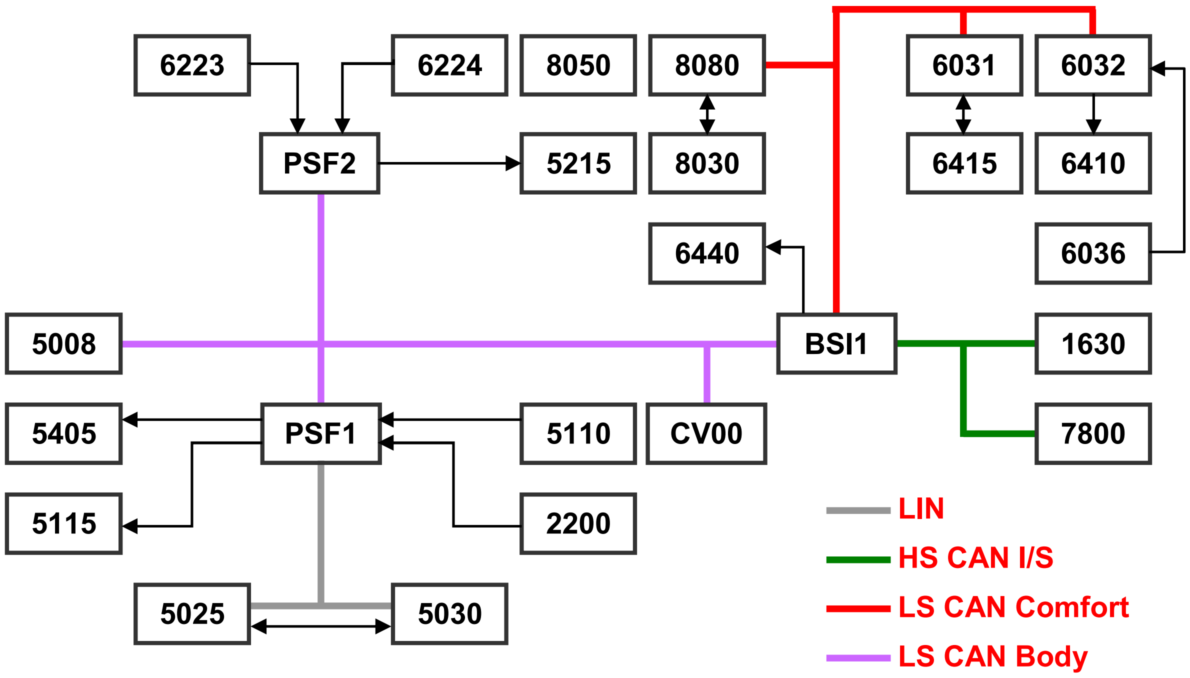
- For elevation correction, this position is a dipped beam position between the nominal position and the lowered position.
- For swivel correction, this position is the nominal position of the swivel system, i.e. straight ahead.

2.5. AUTOMATIC SWITCHING-ON/OFF OF LIGHTS

Presentation

When the system detects low ambient light levels or the presence of rain, the sidelamps and dipped headlamps are switched on automatically. No driver input on the lighting controls is required.

"VISIBILITY FUNCTION" BLOCK DIAGRAM



Ref.	Description	Ref.	Description
BSI1	Built-in Systems Interface	**6031**	FR RH sequential electric window unit + motor
CV00	Steering wheel switching module	**6032**	FR LH sequential electric window unit + motor
PSF1	Fuse box in engine compartment	**6036**	FR LH rear-view (wing) mirror/electric window control panel
PSF2	Fuse box in luggage compartment	**6223**	Window locking assembly
1630	Automatic transmission (BVA) control unit	**6224**	Shutter lock assembly
2200	Reverse light switch	**6410**	Driver's rear-view (wing) mirror
5008	Rain/light/tunnel sensor	**6415**	Passenger rear view (wing) mirror
5025	FR LH windscreen wiper motor	**6440**	Self-darkening interior rear-view mirror
5030	FR RH windscreen wiper motor	**7800**	Electronic stability program (ESP) control unit
5110	Screen wash fluid level sensor	**8030**	Passenger compartment air temperature sensor
5115	Front/rear screen wash pump	**8050**	Blower motor
5215	Rear screen wiper motor	**8080**	Air conditioning control unit
5405	Headlamp wash pump		

The light sensor, which incorporates the rain sensor, is located behind the interior rear-view mirror mounted on the windscreen. It consists of photodiodes. These diodes can detect any type of luminous flux:

- Ambient lighting (from the surroundings).
- Distant lighting (e.g. light at the end of a tunnel).
- Light at the front of the vehicle (e.g. the approach of a vehicle whose headlamps are on main beam).

Based on the light intensity detected by these photodiodes, the sensor's electronics determine whether or not the sidelamps and dipped beam headlamps should be switched on or off. This request is sent to the passenger cell's Built-in Interface System (BSI) by the LS CAN Body. The BSI then controls the switching on or off of the sidelamps and dipped beam headlamps.

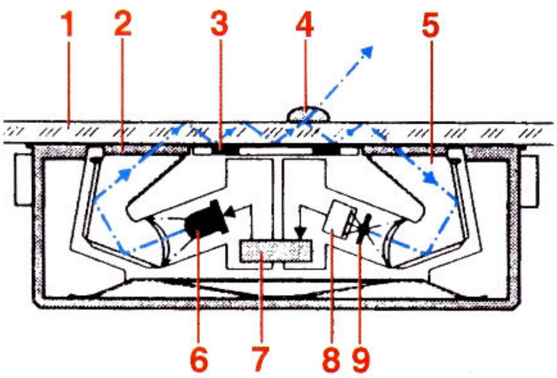
Another functionality of the automatic switch-on/off system is to keep the lights on for a brief period after switching off the engine. If the lights are switched on in automatic mode and the engine running information disappears, the lighting is maintained for a maximum of 60 s. This function, called "guide me home", is useful, for example, in an underground car park to light up the surroundings when the driver and passengers leave the vehicle.

The automatic switching-on/off of lights system is also linked to the windscreen wiping system. If the windscreen wipers have been operating for more than 10 seconds intermittently or at low wiping speed, or for more than two seconds at high speed, then the dipped headlamps are switched on.

If the windscreen wiping system has been inactive for 5 minutes then the BSI switches off the lights. Note that the headlamp wash function is only actuated when the lights are lit and when the driver activates the windscreen wash function. If a light is out-of-order, a pictogram on the instrument panel informs the driver of this fault. Finally, the automatic switching on/off of lights system can be deactivated by the driver if he or she prefers a more conventional mode of operation.

The Custom settings/Configuration menu, which can be accessed using the audio unit controls, can be used to set up the automatic system for switching on/off the lights and the "guide me home" lighting.

Operation of the light sensor



1. windscreen
2. optical coupling
3. heating
4. exterior light
5. light conductor
6. light-emitting diode
7. processing electronics
8. light sensitive diode
9. diaphragm

Simplified diagram of the light sensor

The operation of the light sensor involves the use of a dual, electrosensitive sensor. Two sensors are required because light level measurement by itself is not sufficient. The ambient luminous flux, i.e. that present in the vehicle's immediate environment, must be compared with the luminous flux in the driver's field of vision.

Although the sensors are of the same type, the light beam which reaches them is different. This is achieved through the use of an optical lens, which only allows light from the zone of interest to illuminate the sensor. As with rain detection, the signal is sent to the electronic unit which determines whether or not to switch on/off the lights.

3. AIR CONDITIONING

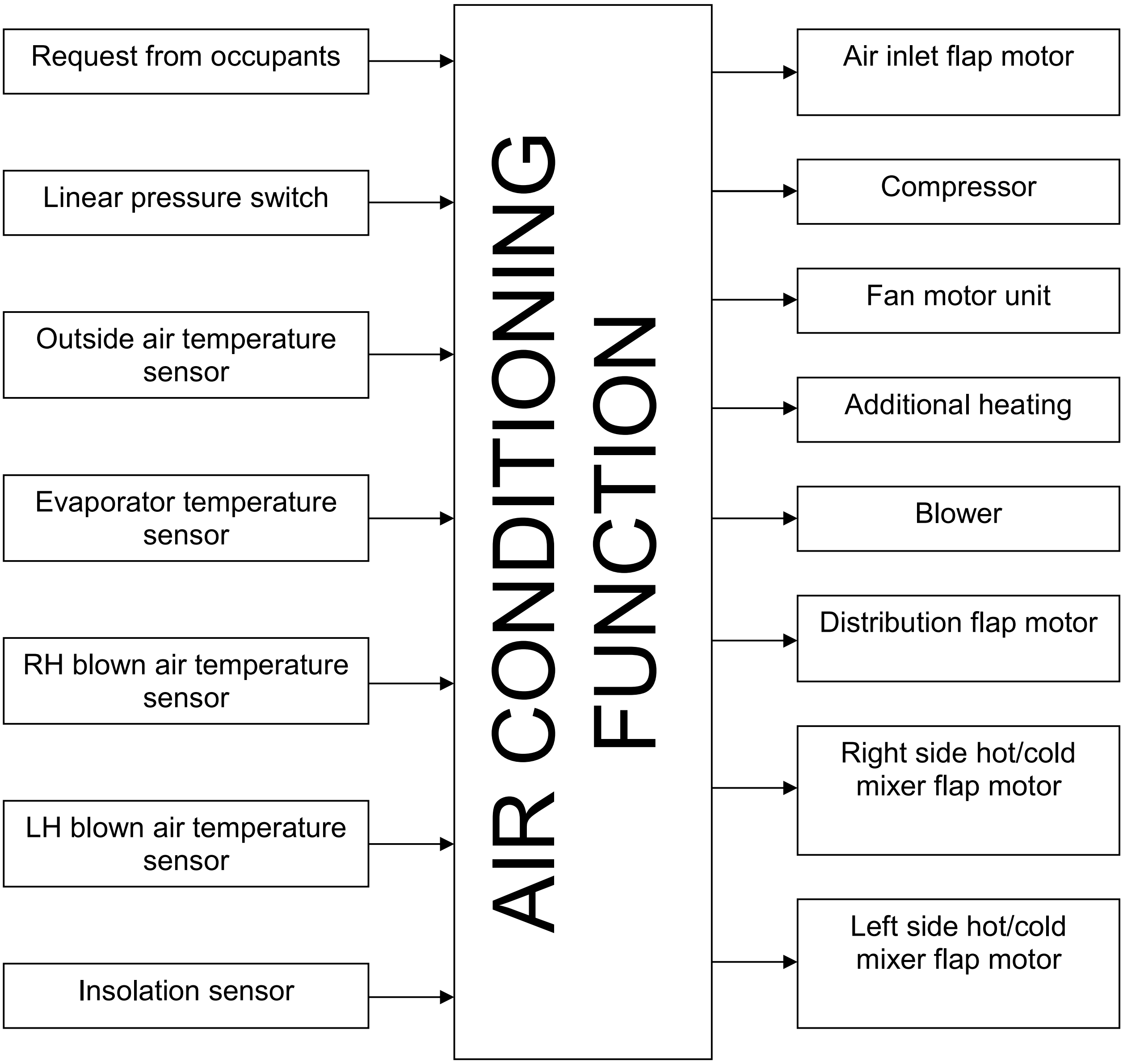
3.1. GENERAL

3.1.1. Role

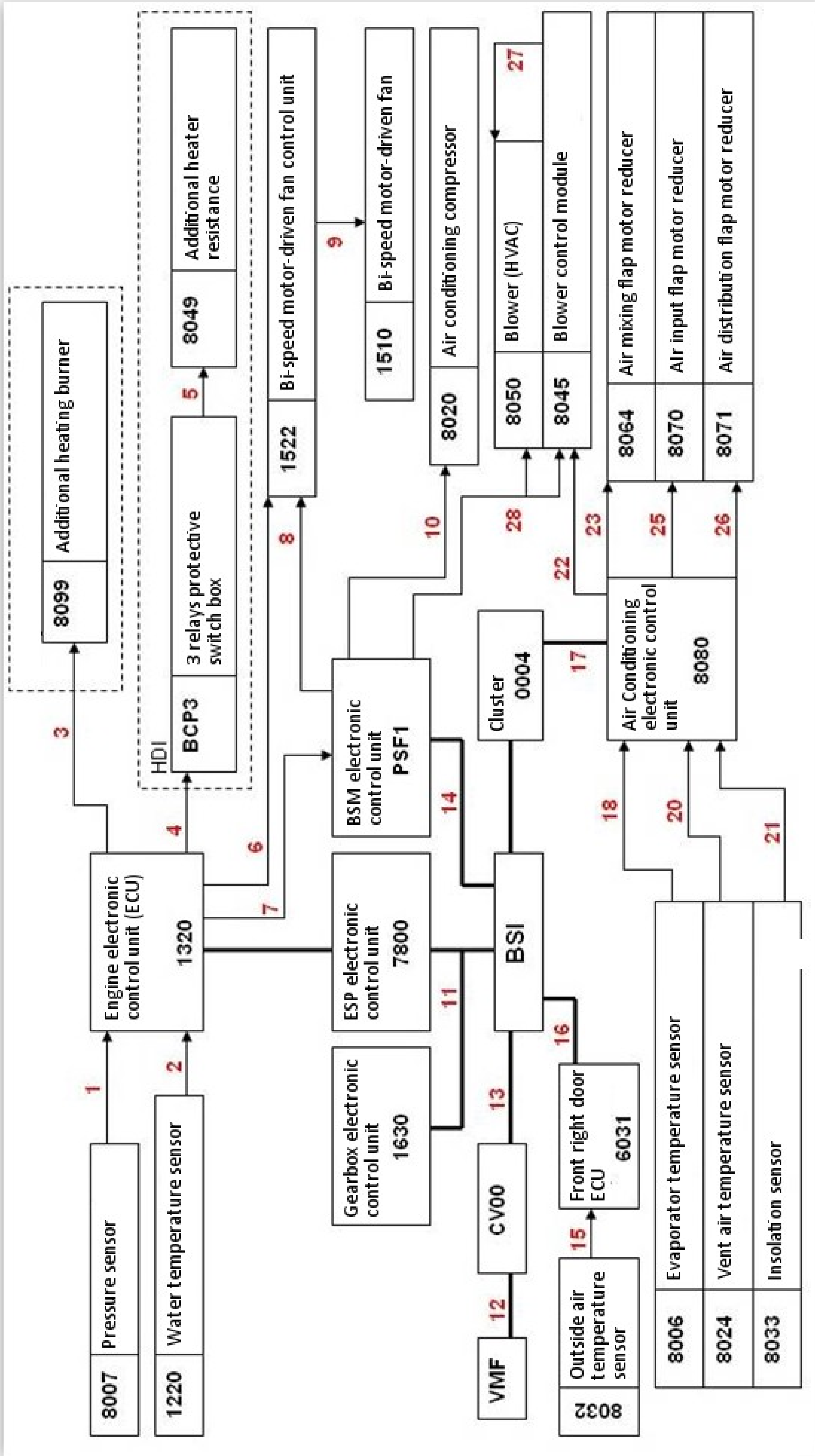
Air conditioning controls the temperature and humidity of the air in the passenger cell. This system is considered to be a contributor to road safety since the comfort provided helps the driver and passengers to be more attentive, thus preventing accidents. Moreover, air conditioning is more effective at demisting that a conventional heating system.

The system heats up the passenger cell in the winter and cools it in the summer.

3.1.2. Block diagram



3.2. PRESENTATION



Links		
Link No.	*Description of the signal*	*Signal type*
1	Coolant pressure information	Analog
2	Engine water t° information	Analog
3	Control of the additional heater	Binary
4	Control of the additional electrical heating	Binary
5	Power supply for additional heating	Binary
6	Control of the 1st and 2nd speed setting relays	Binary
7	Control of the power supply relays for the two-speed fan motor control unit	Binary
8	Power supply for the fan motor control unit	Binary
9	Control of the fan motors for the 1st and 2nd speed settings	Analog
10	Control of the coupling of the refrigeration compressor Control of the refrigeration compressor valve	Binary Square-wave
11	Status of the refrigeration compressor Request to increase engine idle speed Request to increase the fan motor speed to the transmitted setpoint Control of the additional heating / Engine water t° information Engine speed information / Coolant pressure information Relief by disconnecting the compressor instruction Status of the ventilation control transmitted to the motor fan unit Prohibition on changing the compressor status information/Vehicle speed	CAN
14	Refrigeration compressor fault/Refrigeration compressor valve fault/Compressor valve control Authorization for blower to operate / Control of the compressor	CAN BODY
15	Outside air temperature information	Analog
16	Outside air temperature information	CAN COMF
17	LH and RH blown air t° information / Evaporator t° information Operating instructions (OFF mode, AC/ON request, blower mode, blower setpoint value, front t° setpoint value, air distribution at the front, air inlet) RH/LH drive information / Blower control Air inlet control / Front right and front left mixer flap control Distribution flap motor control	CAN COMF
18	Evaporator t° information	Analog
20	RH and LH blown air T°	Analog
21	Insolation information	Analog
22	Blower module control	Binary
23	Front right and front left mixer flap motor control	Analog
25	Air inlet flap motor control	Analog
26	Distribution flap motor control	Analog
27	Blower speed adjustment	Square-wave
28	Power supply to blower and module	Binary

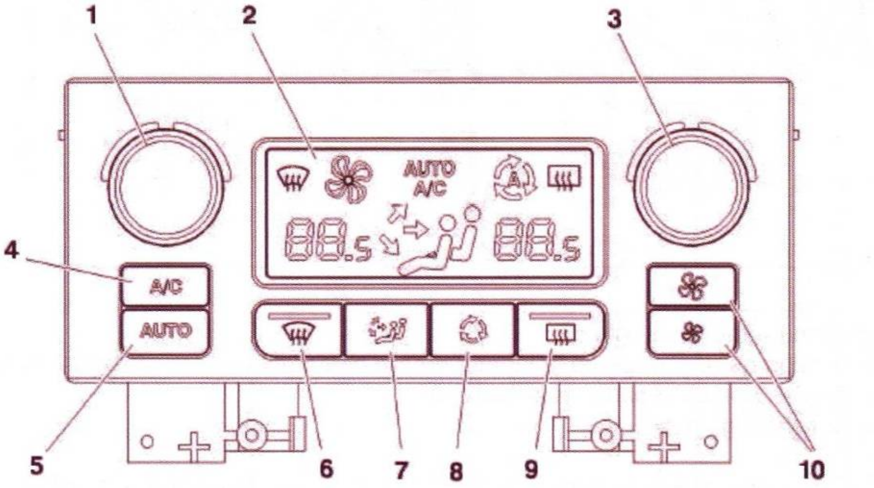
The air conditioning system operates automatically to reach the setpoint requested by the user. The automatic air conditioning system adjusts the following:

- The air flow rate
- The temperature of the blown air on the right and left-hand side (two sensors)
- The distribution of air within the passenger cell
- The recirculation of the air

The flow of air is generated by a d.c. motor (air blower). The temperatures requested for the RH and LH sides of the passenger cell are obtained by setting the position of RH and LH flaps which mix cold air with hot air. The position of each flap is controlled by a stepper motor:

- The air is heated by the circuit which cools the engine, with an additional heating unit provided for vehicles powered by HDi engines.
- The chilling of the air is provided by a conventional refrigeration system involving an evaporator.

The distribution, air inlet (recirculation) and the RH and LH mixing are controlled by flaps whose position is controlled by stepper motors, with the system as a whole managed by the air conditioning control unit.



1. Temperature setpoint selection knob, left-hand side
2. Backlit liquid crystal display
3. Temperature setpoint selection knob, right-hand side
4. A/C on/off button
5. Button used to activate automatic regulation
6. Windscreen demisting button
7. Distribution selection
8. Air recirculation button
9. De-icing of the heated rear window and rear-view (wing) mirrors
10. Blower speed selector

3.3. OPERATION

3.3.1. Activate compressor request

The user presses the A/C button to activate the A/C function. The air conditioning control panel sends the A/C request to the BSI via the CAN bus. The validation condition is generated by the air conditioning control unit, and considers the following conditions:

- Request from the user
- Power supply + engine running
- Blower status (blower not set to 0)

The safety features integrated into the BSI relate to the periods of time during which the refrigeration compressor is OFF. In terms of how the safety features process them, the periods of time during which the compressor is OFF are not cumulated. The cut-off time is 5 seconds for all cut-offs, only the cut-offs prompted by high-pressure and to allow de-icing last for 150 seconds.

3.3.2. Management of the refrigeration compressor

Compressor activation is managed in exactly the same way as for a basic chilling system and for two-zone, automatically-regulated chilling.

To stop the evaporator icing up, the BSI prohibits compressor activation under certain temperature conditions. This safety feature is managed by the BSI. If the temperature indicated by the evaporator sensor is less than 1 degree C for one minute, the compressor is switched off. The compressor is switched back on again if the temperature rises above 2 degrees C, and once a time delay of 1 minute has elapsed since the cut-off.

Once the compressor speed reaches 8100 rpm, the compressor is switched off. If the speed exceeds 7500 rpm for more than 10 seconds, the compressor is switched off. The pause before re-activation of the compressor after deactivation due to high speed depends on the coolant.

Coolant pressure (bar)	13.25	14	16	17.5	19	22	26.5	31
Compressor speed (rpm)	7500	7000	6000	5000	4000	3000	2000	1000

The linear pressure sensor measures the coolant pressure. The pressure information is acquired by the ignition and injection control unit via a conventionally-wired link and is then sent to the BSI via the HS CAN I/S bus.

If the coolant pressure drops below 2.8 bar the compressor switches off. The compressor switches back on when the coolant pressure rises above 3.3 bar. When the coolant pressure is greater than 27 bar, the compressor is switched off. The compressor switches back on when the coolant pressure drops below 20 bar.

When the outside temperature is less than 3.5 degrees C, the compressor is switched off. The compressor switches back on when the outside temperature rises to above 5 degrees C. The compressor is switched off under the following conditions:

- Compressor activation fault
- Fault with the compressor’s solenoid valve
- Faulty coolant pressure sensor
- Faulty blower
- Communication fault between the ignition and injection control unit and the built-in systems interface (BSI)
- Communication fault between the fuse box in the engine compartment (BSM) and the built-in systems interface (BSI)

A fault with the evaporator sensor does not result in the compressor being switched off, but does result in a fixed operating value being set for the compressor’s solenoid valve. This fixed value varies as a function of the outside air temperature:

Outside air temperature (°C)	-40	0	10	20	30	40	50	60
Compressor’s solenoid valve (%)	0	0	60	62.5	66	71	76	77.5

The externally-controlled compressor has a solenoid valve which is used to adjust the low pressure, thus making it possible to control the evaporator temperature to a value between 3°C and 13°C. The aim is to produce the quantity of chilling necessary for driver and passenger comfort and thus to save fuel.

NB: when the compressor is not activated, the compressor's solenoid valve is set to 0%.

The evaporator's temperature setpoint is set to a value between 3 and 13 °C, depending on outside conditions, the calculated passenger cell temperature and the temperatures requested by the occupants and displayed on the control panel. In "visibility" mode (i.e. to clear any windscreen misting), the evaporator's temperature setpoint is always set to 3 °C.

To prevent the compressor being switched off by the high-pressure safety feature when the pressure is greater than 23 bar:
The setpoint for the evaporator increases so as to reduce the value requested for the compressor's solenoid valve (as a %) and thus the cylinder capacity of the compressor. This setpoint ensures that the high pressure is not so high that it might compromise the reliability of the devices in the refrigeration circuit. Under certain conditions (e.g. in a workshop at 20 °C):

- To obtain an evaporator temperature of 3°C, the compressor's solenoid valve's setpoint is approximately 50% +/- 5%.
- To obtain an evaporator temperature of 10°C, the compressor's solenoid valve's setpoint is approximately 35% +/- 5%.

The ignition and injection control unit transmits the setpoints used to control the compressor's solenoid valve and for compressor activation to the BSI, packaged in the compressor relief instruction information.

This information may take one of 5 values:

- No request from the ignition and injection control unit
- Request to set the status of compressor activation and the value of the compressor's solenoid valve (e.g. when a gear shift is performed (automatic transmission or robotized manual gearbox))
- Request for the compressor's solenoid valve to be set at a position of 50%
- Request for the compressor's solenoid valve to be set at a position of 5%
- Request to switch off compressor activation

The ignition and injection control unit tells the BSI about the status of the fan motor unit (GMV).
The BSI supplies the ignition and injection control unit with information about the mechanical power consumption of the compressor.

3.3.3. Communication between the air conditioning control panel and the BSI

All the setpoints sent to the air conditioning system's actuators are processed in the BSI and sent to the air conditioning control panel via the CAN COMFORT bus.

If communication between the BSI and the air conditioning control panel is interrupted, the air conditioning control panel switches to degraded mode.

The air conditioning control panel then behaves as though in manual chilling mode. Each setpoint displayed corresponds to a fixed rate of mixing. The other actuators (distribution, blower, air inlet) are in manual mode. The compressor is then switched off.

4. OTHER COMPONENTS OF THE MODEL

4.1. STEERING WHEEL SWITCHING MODULE (COM2003)

The switching module mounted behind the steering wheel serves as an interface between the driver and the vehicle (Human-Machine Interface).

The steering wheel switching module receives input from the driver to control the following:

- Windscreen wiping/washing (front and rear wipers, windscreen washers)
- Road lights (dipped/main beam headlamps, foglamps, etc.)
- Transponder aerial (immobilizer)
- Horn
- Audio unit

It also accommodates the high-frequency receiver which is one part of the remote locking/unlocking function.

Network connections

The steering wheel switching module is connected to the CAN Body bus. It uses this bus to inform the BSI of driver inputs. The steering angle sensor is connected to the HS CAN inter-systems bus, which is electrically independent of the COM2003; however, it is not always possible to disassemble it.

Notable features

The steering wheel switching module does not have a degraded mode. It is supplied with power permanently (+ Batt) and may initiate a wake-up request (switching on lights, horn and flashing the vehicle's lights).

The reference used to identify the steering wheel switching module in the diagrams is always **CV00**.

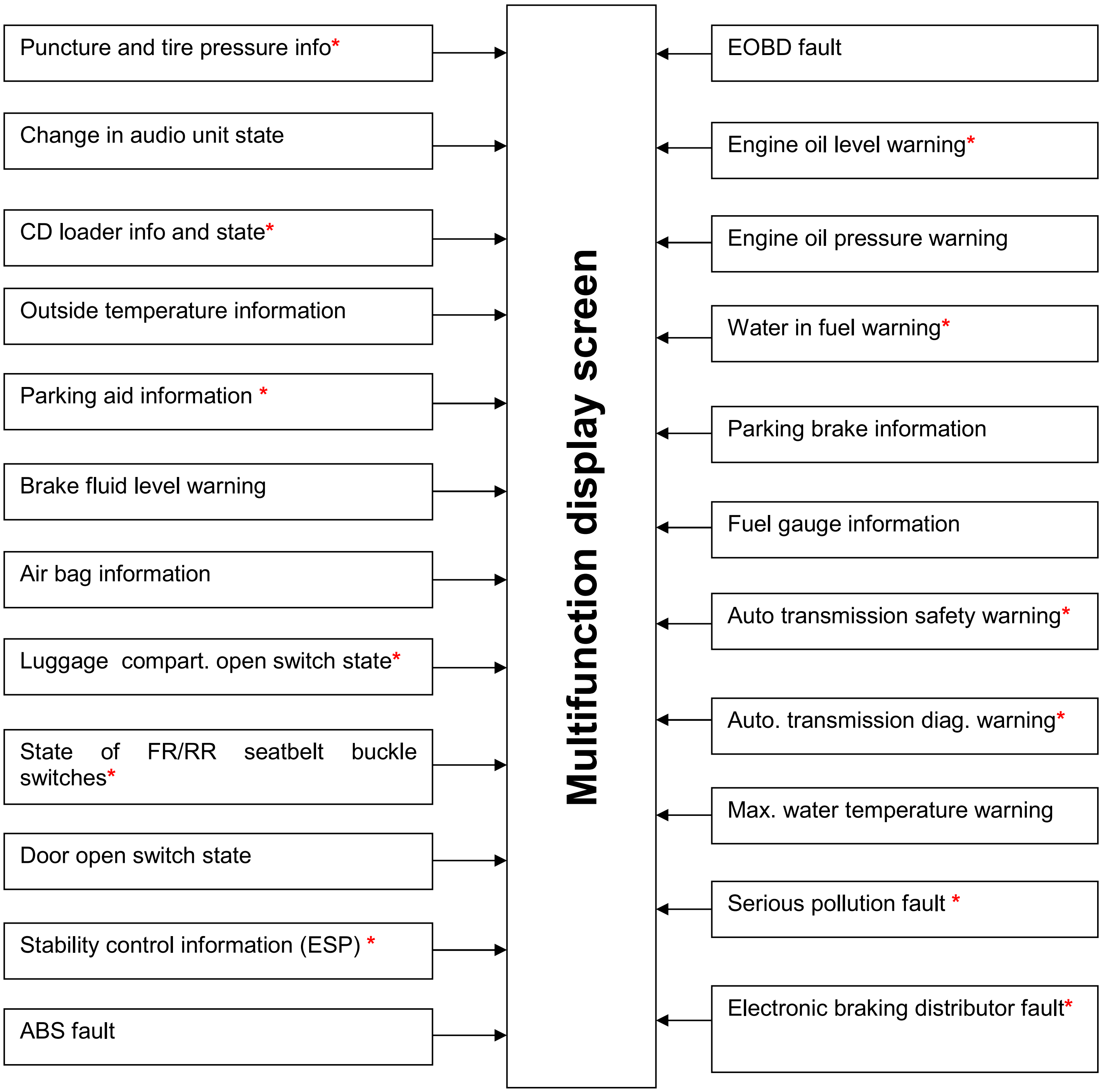
4.2. MULTIFUNCTION DISPLAY

4.2.1. Purpose

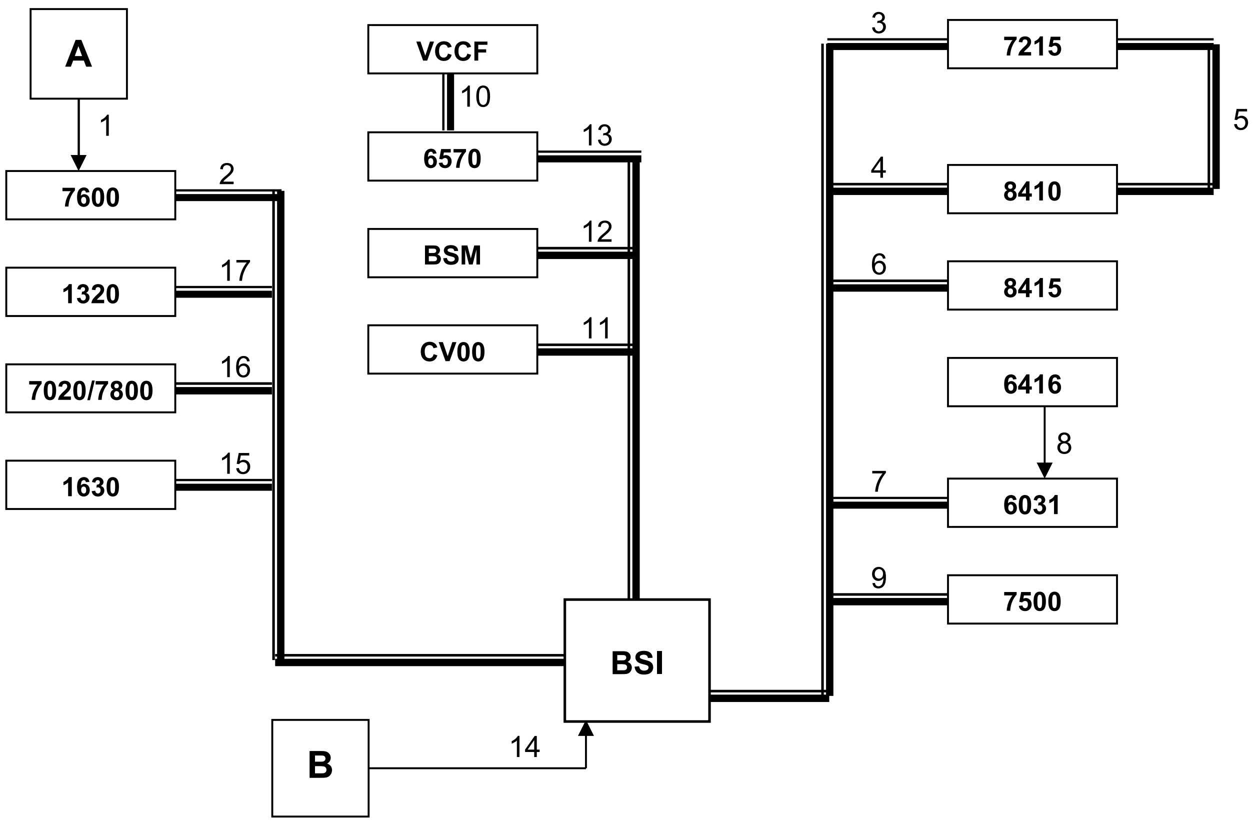
The multifunction display provides information for the driver. It is a control unit which utilizes the CAN Comfort bus. Its purpose is to:

- Provide the driver with information from sources external to the system (self-diagnostics, outside temperature),
- Provide the driver with information from sources internal to the system (self-diagnostics, on-board computer),
- Display states relating to audio unit, sat nav or cell phone.

4.2.2. Block diagrams



*** Not represented on the model.**



COMPONENTS	
A*	Tires underinflation module mounted in each wheel (transmitter)
B	Fuel gauge/Brake switch/Parking brake Seatbelt buckle switch input * Door open switch input/Luggage compartment open switch input*
BSI	Built-in Systems Interface
BSM	Fuse box in engine compartment
CV00	Steering wheel switching module
VCCF	Fixed steering wheel hub control
1320	Ignition and injection control unit
1630*	Automatic transmission control unit
6031	FR LH sequential electric window unit + motor
6416	RH rear-view (wing) mirror
6570	Airbags and pretensioner unit
7215	Multifunction display
7500*	Parking aid control unit
7600*	Tires underinflation detection control unit
7020 / 7800	ABS control unit/ESP control unit
8410	Audio unit
8415*	CD loader

*** Not represented on the model.**

LINKS		
Link No.	**Signal**	**Type of signal**
1*	Tire pressure information	High frequency
2*	Puncture and tire pressure information	CAN I/S
3	Transmission of information to be displayed on the multifunction display	CAN Comfort
4	Change of audio system state	CAN Comfort
5	Transmission of information to be displayed on the multifunction display	CAN Comfort
6*	Control, states and information regarding the CD loader	CAN Comfort
7	Outside temperature information	CAN Comfort
8	Outside temperature sensor information	Analog
9*	Parking aid fault	CAN Comfort
10*	Audio system control on fixed hub	LIN
11	Audio unit control	CAN Body
12	Engine coolant level warning/Oil level warning Oil pressure warning/Water in diesel warning	CAN Body
13	Air bag information	CAN Body
14	Fuel gauge information	Analog
	Parking brake information/Status of front/rear safety belt buckle switches* State of open luggage compartment switch* State of open door switch	Binary
15*	Automatic transmission safety/diagnostics warning	CAN I/S
16	Stability control (ESP) fault / ABS fault Brake fluid level warning Electronic braking distributor fault	CAN I/S
17	Engine on-board diagnostics (EOBD) control unit fault Max. coolant temperature warning Serious pollution fault	CAN I/S

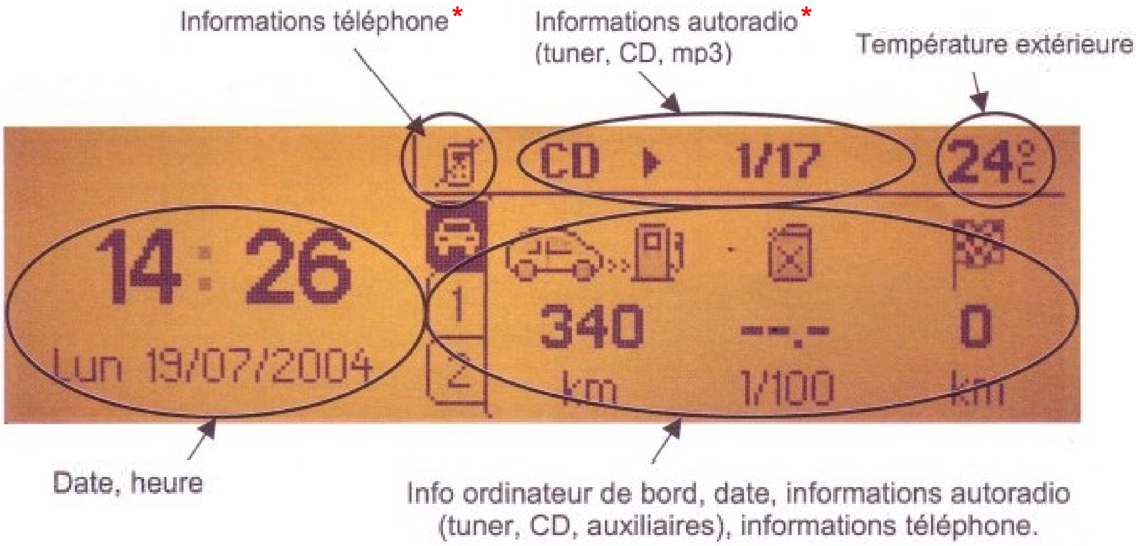
*** Not represented on the model.**

There are 4 types of multifunction display: type A+, type C-, type Ct (RT3 monochrome navigation), or type Dt (RT3 color navigation). The multifunction display lets the user configure the units of temperature (°C/°F), the units of fuel consumption, the units of pressure (bar/psi), time format (12/24 hour), language, date and time, etc.

4.2.3. SCREEN C-

The MT-CAN-LIN-BSI model provides a C- type multifunction display.

Home screen



Warning messages:

Main menu:

Sub-menu:

4.2.4. Channel assignation

CHANNEL	ALL VERSIONS	FUNCTION
1	+ battery	Power supply to multifunction display (EMF)
2	Ground	Power supply to multifunction display (EMF)
7	LS CAN (COMFORT)	Network communication line
9	HS CAN (COMFORT)	Network communication line

Multifunction display fault codes:

TITLE OF THE FAULT	C- DISPLAY
Outside T° information fault	X
Remote control information fault with the multifunction display control unit	X
Fault resulting in no communication with the BSI	X
CAN bus fault	X
Silent control unit fault on the CAN bus	X
Fault resulting in no communication with audio unit control unit	X
Fault resulting in no communication with parking aid control unit	X
Absence of permanent + power supply for the display	X

4.3. INSTRUMENT PANEL

4.3.1. Purpose

Information is presented to the driver in a number of ways, all involving the CAN COMFORT bus:

- The instrument panel,
- The multifunction display,
- The buzzer integrated into the steering wheel switching module.

Information for the attention of the driver may be displayed by more than one device simultaneously. This information is managed based on its priority and on the type of presentation medium. For example, the lit “Stop” indicator light is linked to a description of the warning on the multifunction display and to a noise emitted by the buzzer on the steering wheel switching module. The instrument panel dialogs with the other control units on the CAN COMFORT bus and runs its own self-diagnostic functions.

4.4. SCHEMATIC DIAGRAM

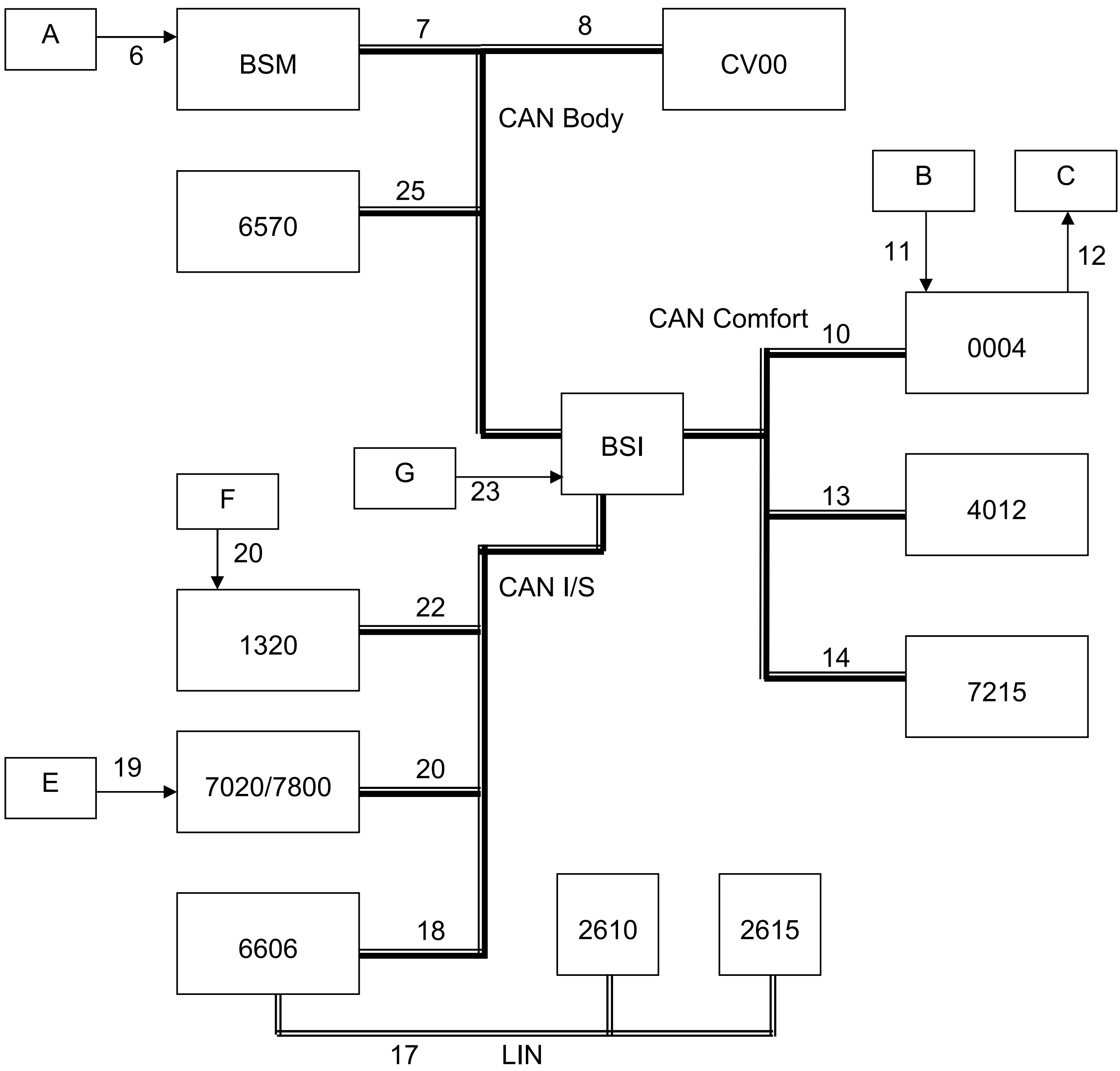
COMPONENTS	
A	Presence of water in diesel sensor* / Engine oil pressure switch Engine oil level sensor* / Engine coolant temperature sensor Battery voltage / Alternator voltage
B*	Switch input for activation/deactivation of electronic stability control program (ESP) Switch input for activation/deactivation of parking aid (AAS) Switch input for activation/deactivation of lane departure warning system (AFIL) / Switch input for heated rear window / Switch input for air conditioning
C	Hazard lights switch diode / Heated rear window diode* Stability control (ESP) switch diode* Parking aid switch diode (AAS)* Lane departure warning system (AFIL) switch diode*
D*	Rear exterior left proximity sensor Rear interior left proximity sensor Rear exterior right proximity sensor Rear interior right proximity sensor Front exterior left proximity sensor Front interior left proximity sensor Front exterior right proximity sensor Front interior right proximity sensor
E	Wheel speed sensor / Brake fluid level switch
F	Engine speed sensor / Water in diesel sensor*
G	Switch input for activation/deactivation of snow mode (automatic transmission)* Switch input for activation/deactivation of sport mode (automatic transmission)* Fuel gauge/Parking brake switch Seatbelt buckle switch input* Battery voltage value information / Open luggage compartment switch input * Open door switch input / Child safety activation input* Hazard warning lights switch input

*** Not represented on the model.**

INSTRUMENT PANEL

Activation/deactivation of ESP switch	INSTRUMENT PANEL	Hazard warning lights switch diode
Activation/deactivation of AAS switch*		AAS switch diode*
Activation/deactivation of AFIL switch*		AFIL switch diode*
Heated rear windscreen switch*		Heated rear windscreen switch diode*
Activation/deactivation of air conditioning switch*		ESP switch diode*
Hazard warning lights switch		
Brake fluid level switch		Parking brake switch
Diesel preheating		Seatbelt buckle switch
Engine oil level and temperature sensor		Fuel gauge
Engine coolant temperature sensor		Open door switch
Front and rear proximity sensors		Open luggage compartment switch
Child safety activated		State of additional headlamps
Wheel speed sensor		Sidelamps on information
Presence of water in diesel information		Press on brake to start (RMG)
Passenger air bag disabled		Battery voltage value information
Cruise control and speed limiter request		Engine oil pressure switch
Request black panel screen display		Display setting (km or miles)

* **Not represented on the model.**



COMPONENTS			
BSI	Built-in Systems Interface	**2615**	Right-hand headlamp
BSM	Fuse box in engine compartment	**6570**	Airbags and pretensioner unit
CV00	Steering wheel switching module	**6606**	Headlamps dynamic correction control unit (AFS)
0004	Instrument panel	**7215**	Multifunction display
1320	Ignition and injection control unit	**7020 / 7800**	ABS control unit / ESP control unit
2610	Left-hand headlamp		

LINKS		
Link N°	***Signal***	***Type of signal***
6	Engine oil level information / Engine oil pressure information / Engine coolant level information / Min. windscreen wash level information	Analog
	Presence of water in windscreen wash reservoir information	Binary
7	Engine oil level information / Engine oil pressure information / Engine coolant level information / Min. windscreen wash level information / Presence of water in windscreen wash reservoir information	CAN BODY
8	Sidelamps on information	CAN BODY
9	Request "Black panel" screen display	LIN
10	Request lighting up of indicator lights on instrument panel / Display of instrumentation	CAN COMF.
11	State of the activation/deactivation switch for the parking aid (AAS) State of the lane departure warning system (AFIL) switch State of the activation/deactivation switch for the air conditioning State of the activation/deactivation switch for the heated rear window	Binary
12	Lighting up of the hazard warning lights switch's diode Lighting up of the parking aid switch's diode (AAS) Lighting up of the lane departure warning system (AFIL) switch's diode / Lighting up of the heated rear window switch's diode	Binary
13	Lighting up of the snow mode diode (auto. transmission) / Lighting up of the sports mode diode (automatic transmission) / Lighting up of the gear selected	CAN Comfort
14	Display setting for km or miles	CAN Comfort
15	Front/rear proximity sensor information	CAN Comfort
16	Front/rear proximity sensor information	Binary
17	State of directional headlamps information	LIN
18	State of directional headlamps information	CAN I/S
19	Wheel speed sensor information	Freq.-based
	Insufficient brake fluid information	Binary
20	Request to deactivate ESP / Insufficient brake fluid info./Wheel speed info	CAN I/S
21	Presence of water in diesel information	Binary
	Engine speed information	Freq.-based
	Engine coolant temperature information	Analog
22	Pre-heating / Presence of water in diesel information Engine speed information / Engine coolant temperature information	CAN I/S
23	Fuel gauge information / Battery voltage value information	Analog
	Parking brake information / State of hazard warning lights switch State of open luggage compartment switch / State of snow mode switch (automatic transmission) State of sports mode switch (automatic transmission) / State of front and rear seatbelt buckle switches / State of the open door switch	Binary
24	State of the passenger airbag neutralization switch	Binary
25	State of the passenger airbag neutralization switch	CAN Body

5. USING THE MT-CAN-LIN-BSI

5.1. INSTRUCTION MANUAL

Installing and starting up MT-CAN-LIN-BSI

With the ignition key in the “Off” position, connect the model to the 230 V mains supply (check that the circuit breaker under the work surface has not tripped).
Close the battery disconnect switch, then use the ignition key as you would on a vehicle (“On”, then “Start”…).

Environment

The MT-CAN-LIN-BSI model must be used in a dry place away from dust, steam and combustion fumes.
The model requires approximately 400 to 500 lux of lighting. It may be placed in a practical exercise room. Its operating noise level does not exceed 70 decibels.

Calibrating and maintaining model MT-CAN-LIN-BSI

Calibrating: factory setting.
Maintenance frequency: none.
Cleaning: use a clean and soft cloth and a window-cleaning product.
If you have to change the battery, replace it with an equivalent battery in terms of size, power, etc. Dispose of the old battery by recycling it in compliance with the requirements applicable in your region.

Number of work stations and position of user

The MT-CAN-LIN-BSI model is considered to be a single work station.
The user of this learning model shall remain seated in front of the work surface throughout the practice exercise.

Lockout/Tagout procedure

Turn the ignition key to the 0 position (“Off”).
Set the battery disconnect switch to its open position.
Remove the 230 V connection.
Check that there is no current by turning the ignition switch to “Start” – if nothing happens, then there is no current.
Remove the ignition key and place it in a lockable cabinet.
Store model MT-CAN-LIN-BSI in a secure room while out of use.

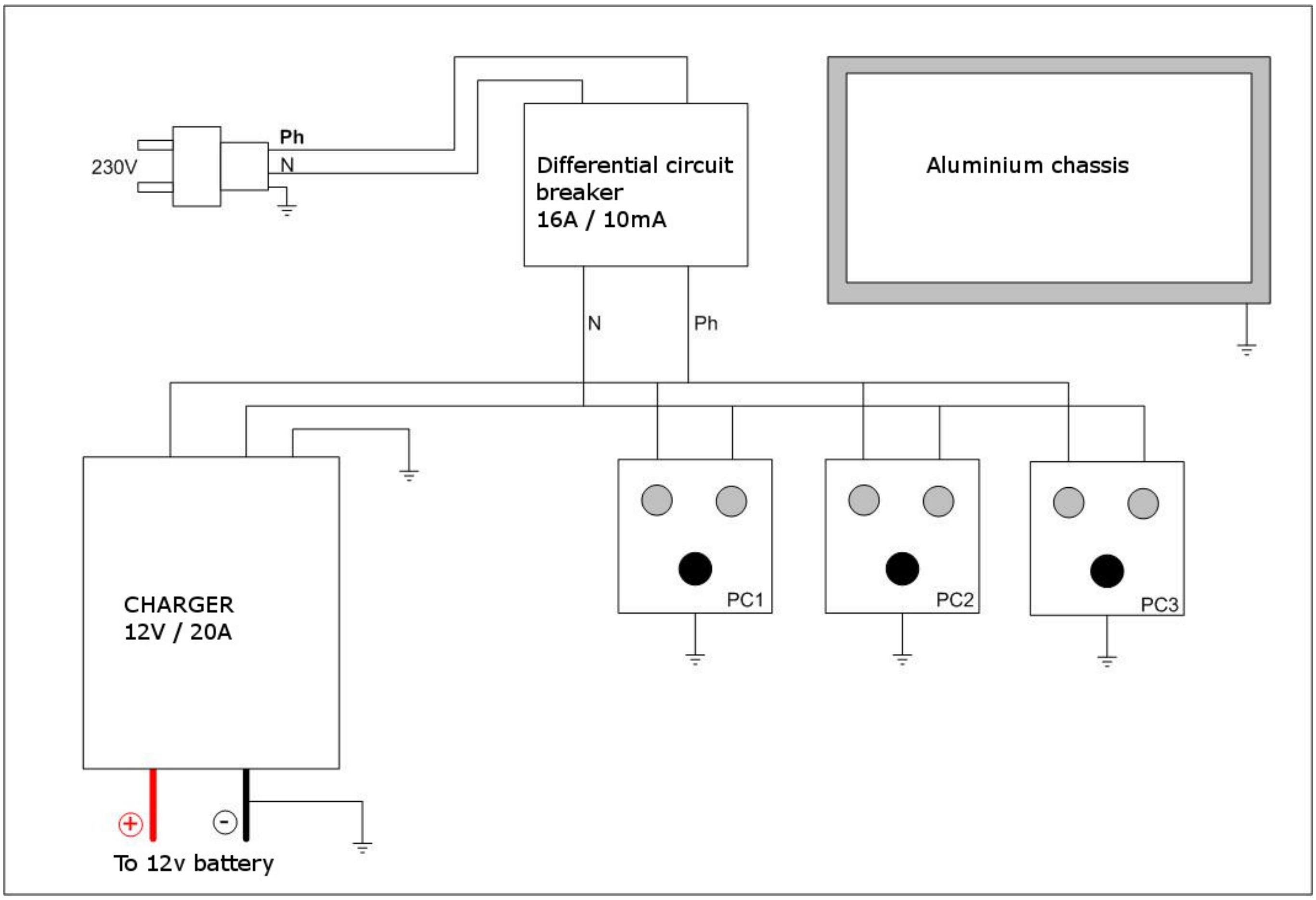
Residual risk

The MT-CAN-LIN-BSI model should only be accessed (after disassembly) by certified and authorized persons.

Transporting model MT-CAN-LIN-BSI

The model must be switched off and disconnected before transport.
Ensure that nothing is left on the shelves.
At least two people are required when transporting the model.
Caution: the casters cannot negotiate anything higher than very low steps.

Diagram of the entire 230 V installation



5.2. DESCRIPTION OF THE MODEL

The model represents a latest generation vehicle, and features the “Full CAN” elements of the Citroën C4 (C5Restyled) and of the Peugeot 307.

This model is equipped with the manufacturer’s communication buses:

High Speed CAN, Low Speed CAN and LIN.

This model ships with **MUXTRACE software and a USB-MUX-4C2L unit for viewing, analyzing and transmitting data frames on the system’s buses.**

The hardware provided is:

- Air conditioning control screen
- Multifunction display
- Control panel for the electric windows and for the driver’s rear-view (wing) mirror
- Control panel for the passenger’s electric window
- 1 High Speed CAN bus, 2 Low Speed CAN buses and one LIN bus,
- EOBD diagnostic connector
- Radio/CD player with two loudspeakers,
- Two electric folding rear-view (wing) mirrors,
- Two front door locks,
- Front right and front left electric window control units/motors,
- Instrument panel, warning buttons and central locking,
- COM2003 with key-operated ignition,
- Front and rear ride (body) height sensors for headlamp elevation correction,
- BSI and PSF1 units,
- Front and rear road light clusters,
- Directional headlamps (AFS) control unit,
- 12 V battery mounted in the base of the aluminum frame.

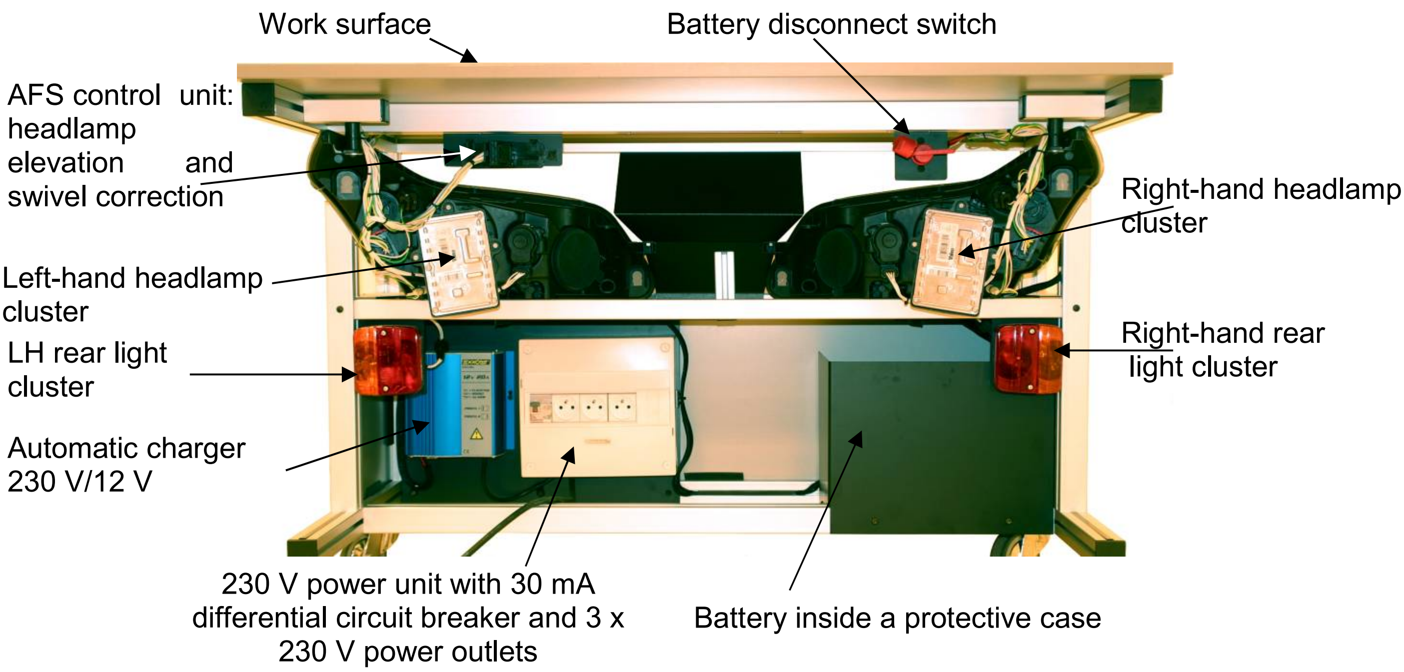
Elements assembled by EXXOTEST:

- An aluminum frame on casters with:
  - a 12 V charger connected to the battery supplied (protected by a 50-A fuse)
  - a 230 V outlet socket, protected by a 10 mA differential circuit breaker,
  - A 5-metre cable for connection to a 230 V mains supply
- A control panel used to:
  - Control the brake (stop) lights, handbrake, fuel gauge level and to display the de-icing action of the heated rear window,
  - Control the gas pedal (accelerator) and engine coolant temperature
  - Activate the airbag
  - Simulate worn brake pads and to control the handbrake and gear selection,
  - Control an oil pressure fault and display the vehicle’s speed,
  - Control the light level and rain sensors,
  - Display the front windscreen wiper speeds.
- A breakout box panel with protective fuses and terminal connectors for the inputs/outputs to/from the various units (BSI, PSF1…) served by multiplexed buses.

The components operate under conditions which replicate those on the vehicle.

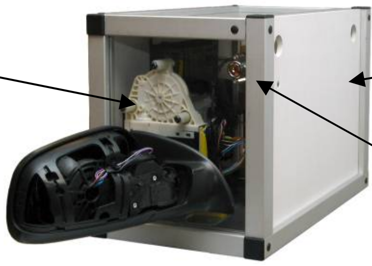
View of the model

Lower part

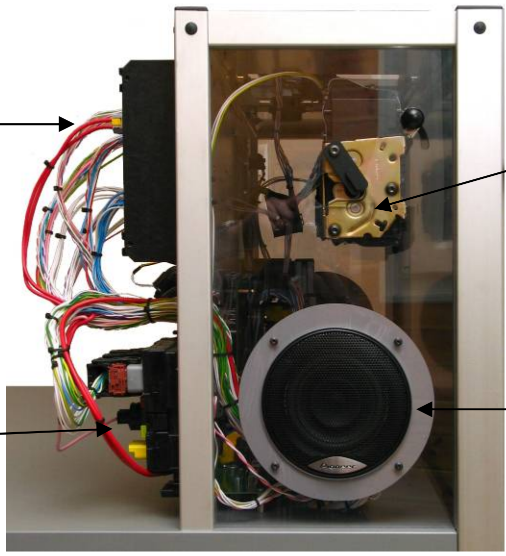


Upper part

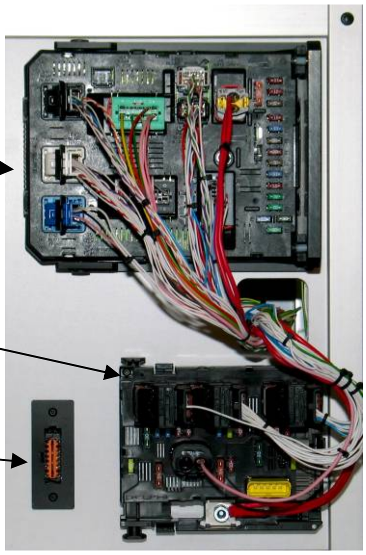
View of ¾ of the upper part



Side view (left-hand side) of middle part



Side view (right-hand side) of middle part

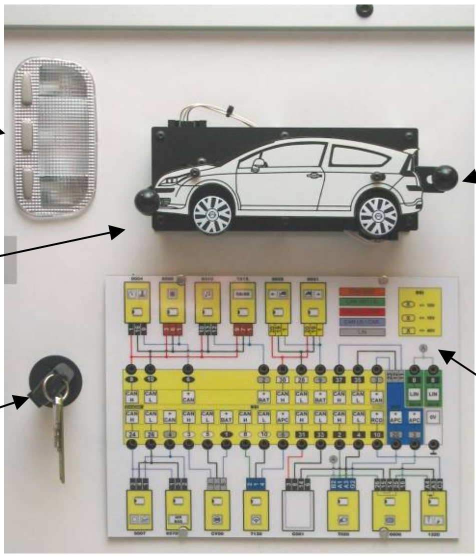


BSI1 Built-in Systems Interface

PSF1 Fuse box in engine compartment

16-channel diagnostics connector

Middle part, central area



Courtesy light

Rear ride (body) height sensor (for xenon lights corrector)

Front ride (body) height sensor (for xenon light corrector

Breakout box for measuring and generating faults with schematic of multiplexed part of the system (details on following page)

Ignition with key

Middle part, left-hand side

Instrument panel of Peugeot 307

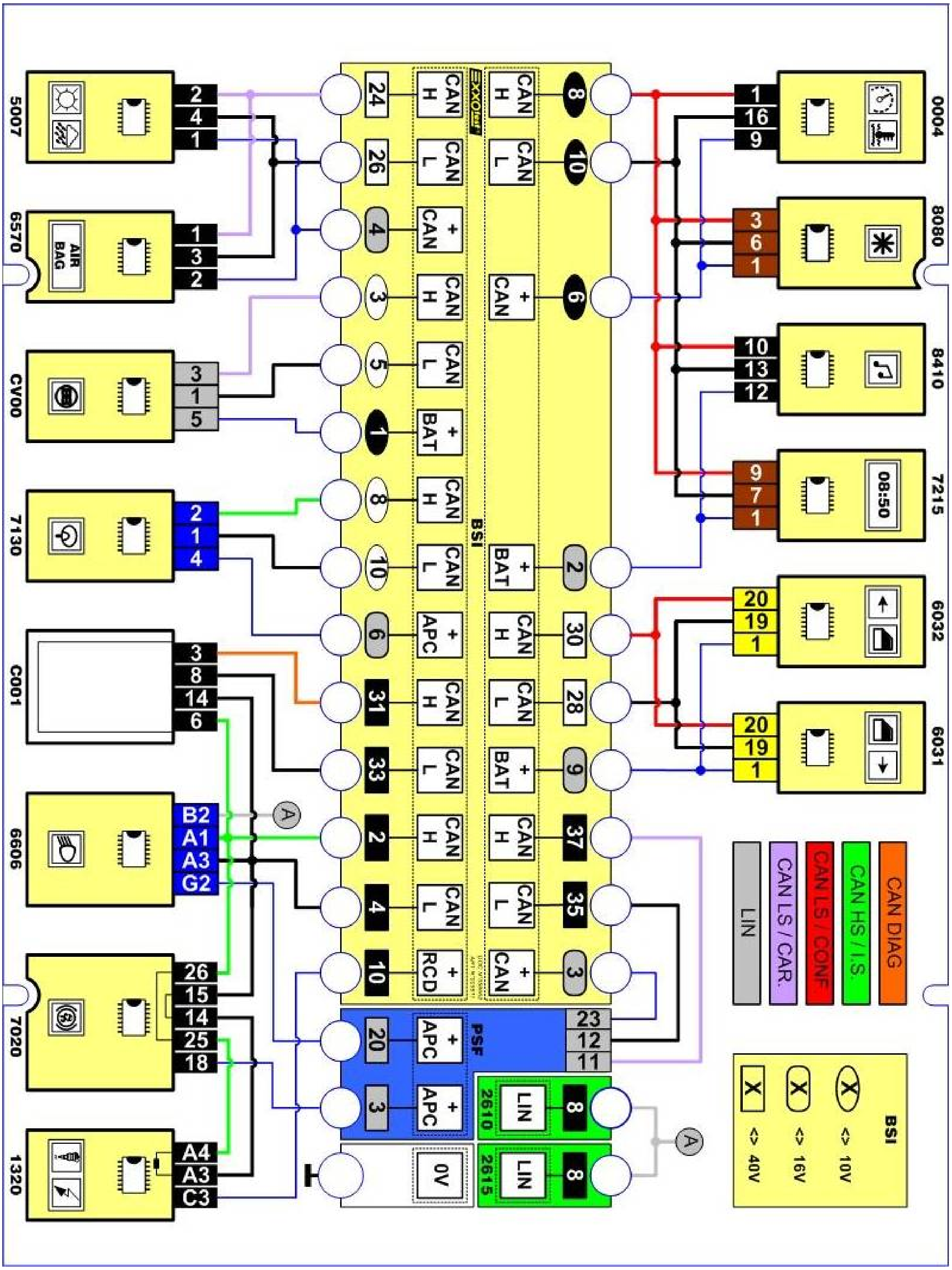
Com2003 switching module (road lighting, wiper controls, cell phone,…)

Steering wheel (swivel function) with horn

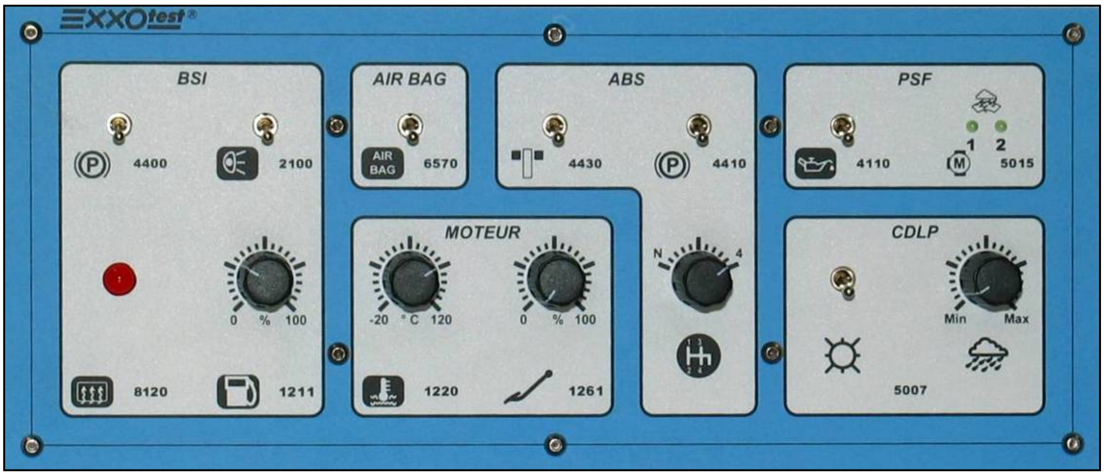
Control panel for generating inputs and for adjusting variables.

Hazard warning

Vehicle locking button


5007
6570
CV00
7130
C001
6606
7020
1320
0004
8080
8410
7215
6032
6031
BSI
PSF
AIR BAG
08:50
CAN DIAG
CAN HS / I.S.
CAN LS / CONF
CAN LS / CAR.
LIN
<> 10V
<> 16V
<> 40V
0V

Detail of the front face of the control panel for generating inputs and for adjusting variables



BSI: Built-in systems interface

4400: Parking (hand)brake

2100: Stop lamp switch

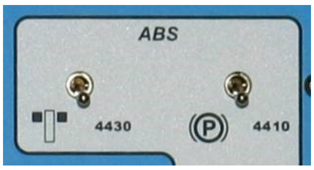
8120: LED display of de-icing of rear window

1211: variation in fuel level (considered after the BSI switches to standby)

6570: Airbag activation (engine switches off; to restart remove the ignition key and then repeat the starting procedure)

1220: variation in coolant temperature

1261: variation in the position of the gas pedal



4430: activate brake pad wear

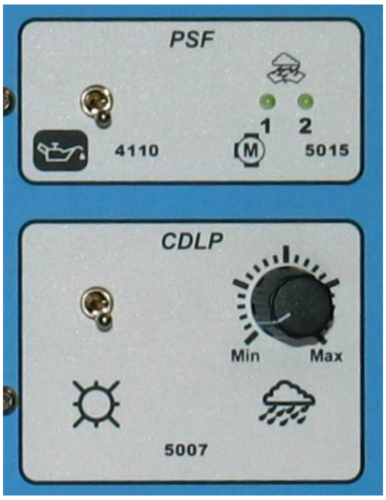
4410: activate min brake fluid level

Gear selection

PSF (fuse box in engine comp.):

4110: engine oil pressure switch

5015: display of wiper speeds 1 and 2



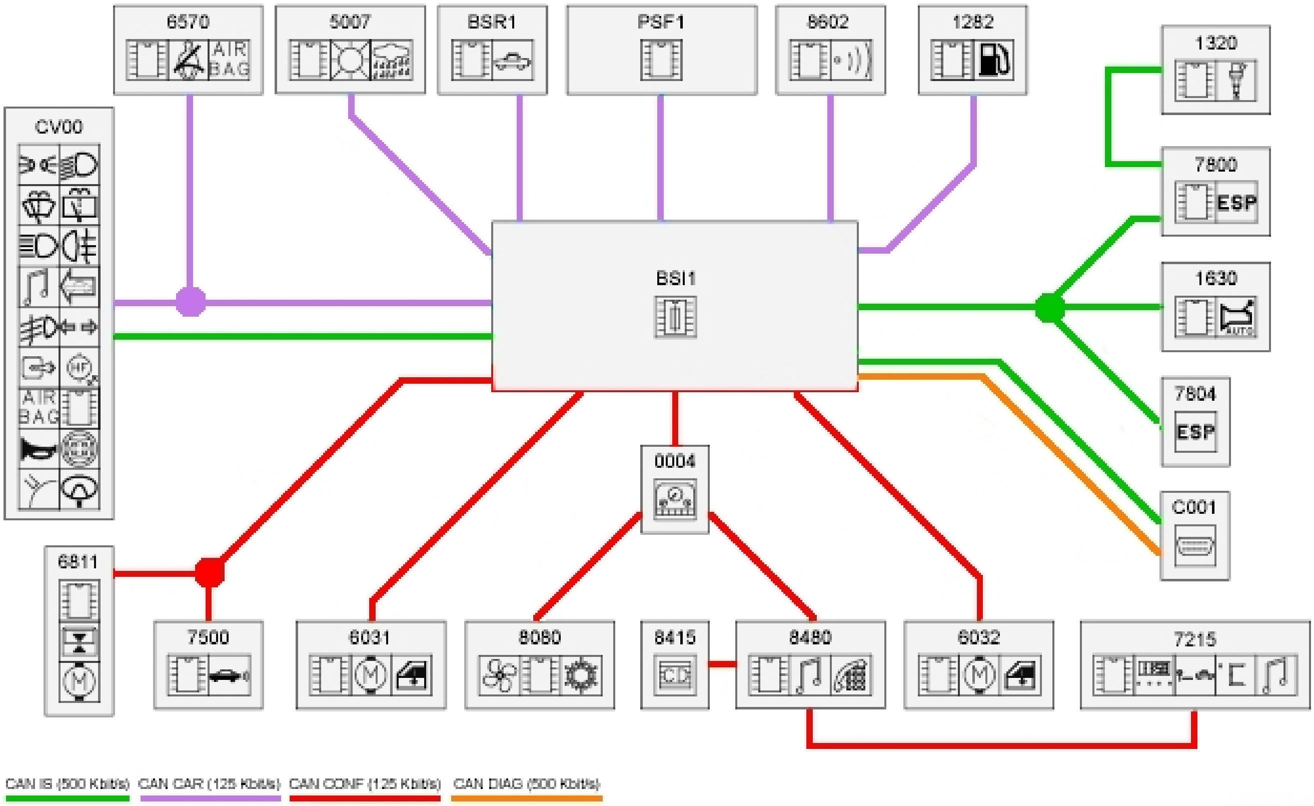
CDLP (Light and rain control unit):

Presence of light (day/night) switch,

Variation in rainfall potentiometer

6. WIRING DIAGRAMS

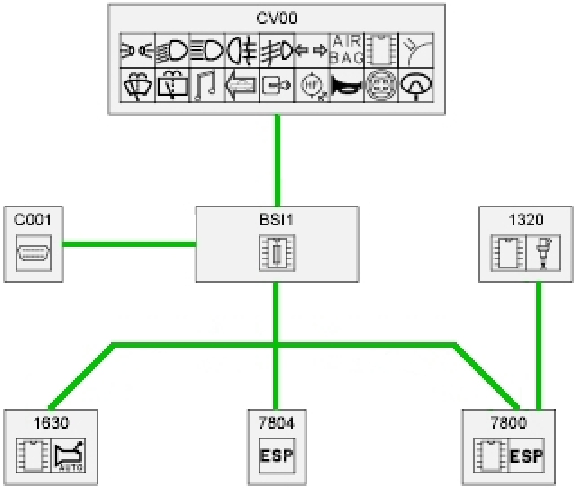
General block diagram of the vehicle's networks

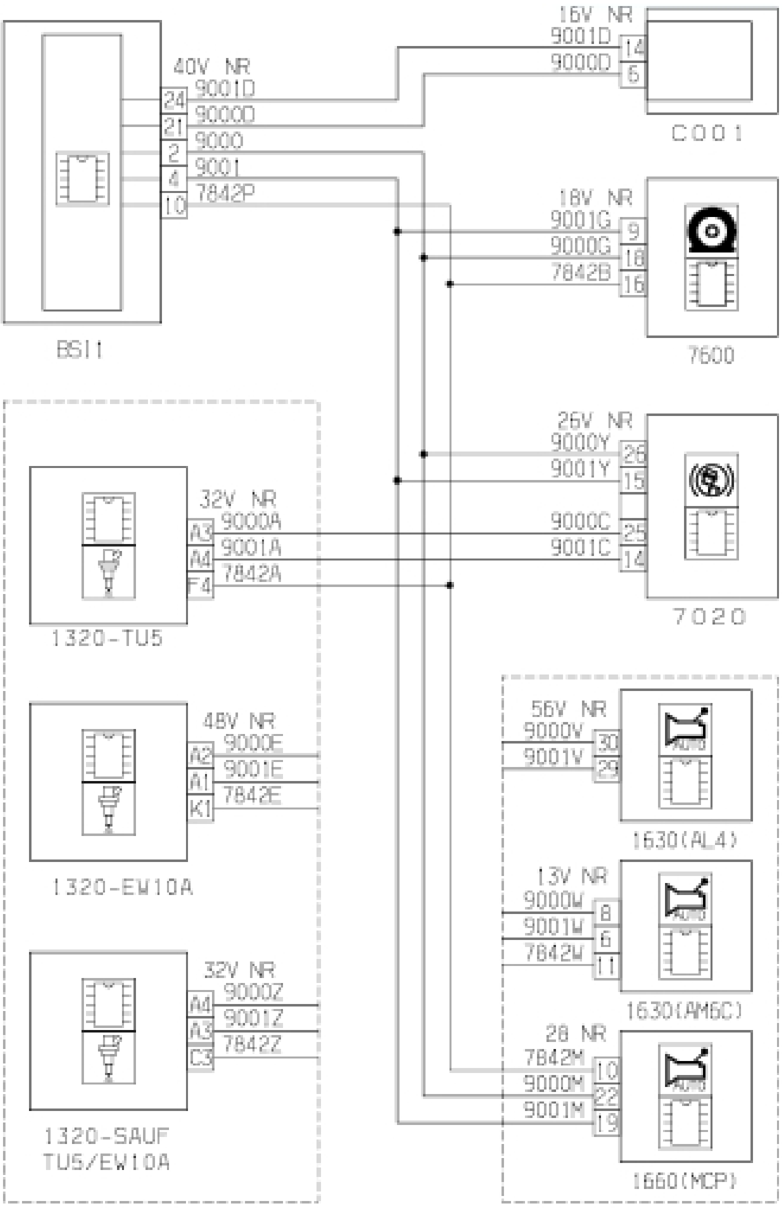


Manf. code	Name of component
0004	Instrument panel
1282	Additive control unit
1320	Ignition and injection control unit
1630	Automatic transmission control unit
5007	Rain and light sensor
6031	FR RH sequential electric window unit + motor
6032	FR LH sequential electric window unit + motor
6570	Airbags and pretensioner unit
7215	Multifunction display
7500	Parking aid control unit
7800	Electronic stability program (ESP) control unit
7804	ESP accelerometer gyrometer
7811	Sunroof control unit
8080	Air conditioning control unit
8415	CD loader
8480	Telematics transceiver
8602	Movement detection unit (anti-theft alarm)
BSI1	Built-in Systems Interface
BSR1	Tow control unit
C001	Diagnostic connector
CV00	Steering wheel switching module (COM2000)
PSF1	Fuse box in engine compartment

Diagram for the CAN INTER/SYSTEM part (500 kbit/s)

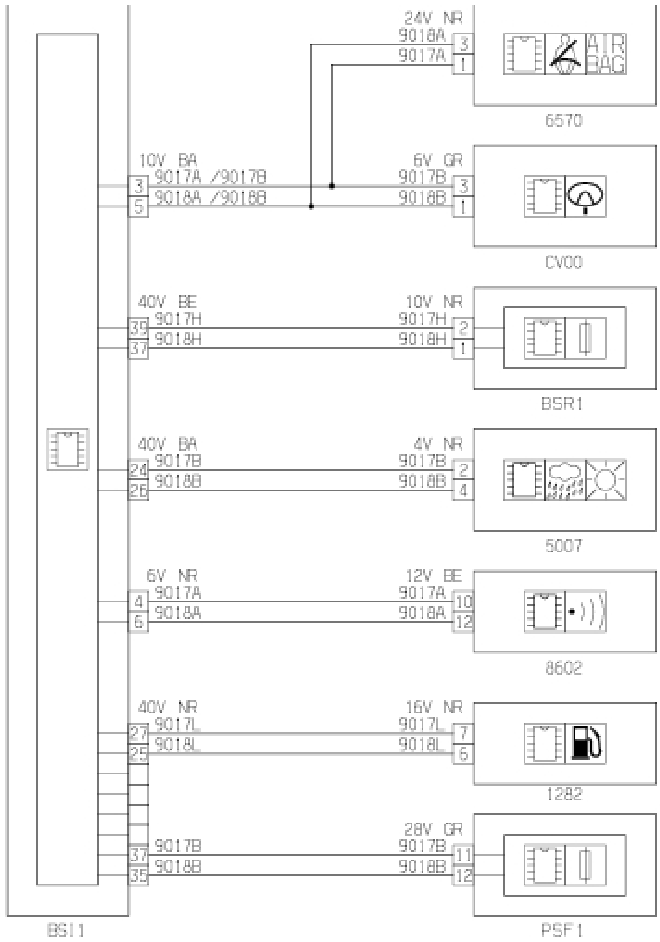
Manf. code	Name of component
BSI1	Built-in Systems Interface
CV00	For MUX steering angle sensor (7130) only
1320	Ignition and injection control unit
7800	Electronic stability program (ESP) control unit
1630	Automatic transmission control unit
7600	Tires underinflation detection control unit
7804	ESP accelerometer gyrometer
C001	Diagnostic connector





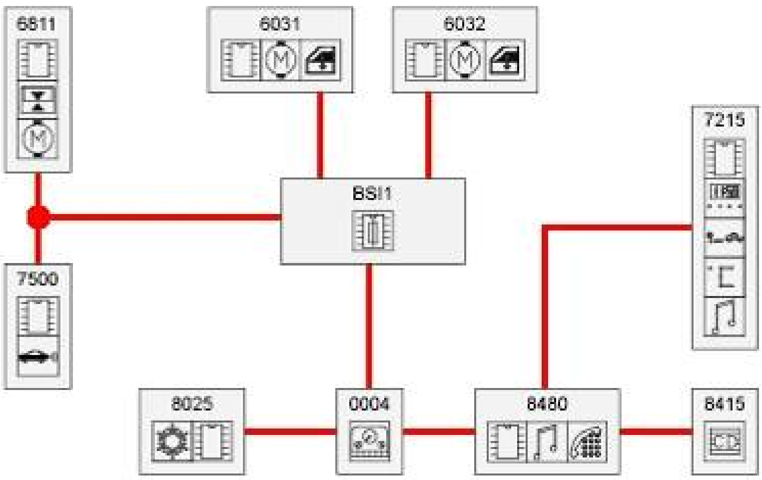
<ins>Diagram for the CAN Body part (125 kbit/s)</ins>

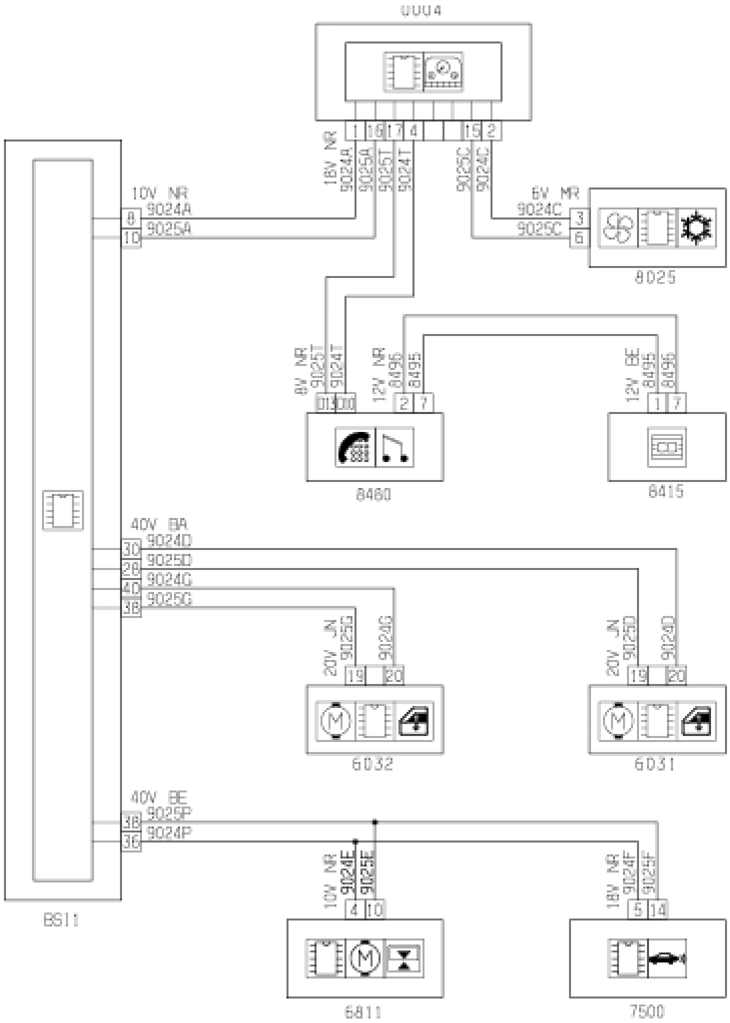
Manf. code	Name of component
5007	Rain and light sensor
BSR1	Tow control unit
PSF1	Fuse box in engine compartment
8602	Movement detection unit (anti-theft alarm)
BSI1	Built-in Systems Interface
1282	Additive control unit



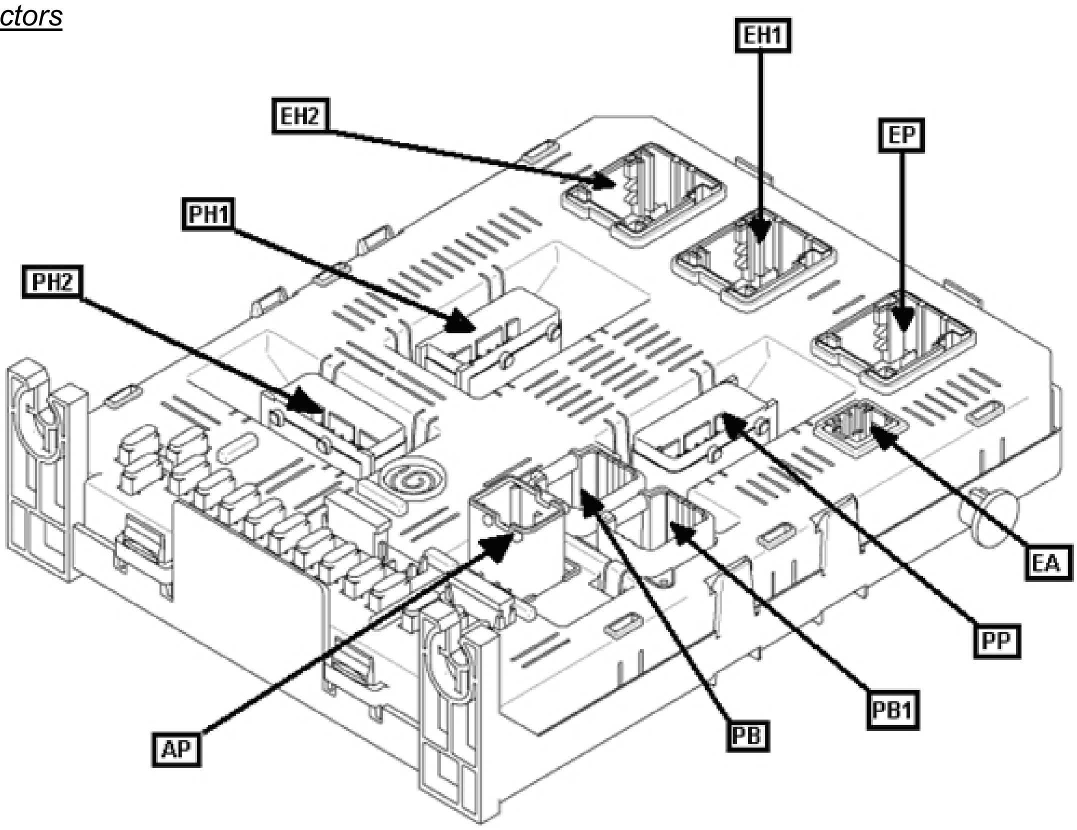
<ins>Diagram for the CAN Comfort part (125 kbit/s)</ins>

Manf. code	Name of component
BSI1	Built-in Systems Interface
7215	Multifunction display
6032	FR LH sequential electric window unit + motor
8480	Telematics transceiver
8415	CD loader
6031	FR RH sequential electric window unit + motor
7500	Parking aid control unit
7811	Sunroof control unit
8080	Air conditioning control unit
0004	Instrument panel





BSI connectors



EP (Prince engine) range: 40-channel black connector:

Connector pin	Assignation
Pin 2	High wire for the HS CAN inter/systems (under the hood)
Pin 4	Low wire for the HS CAN inter/systems (under the hood)
Pin 5	Output: Power supply + engine running
Pin 10	Output: Remote controlled wake-up information (RCD)
Pin 12	Input: fuel cap sensor information
Pin 13	Output: fuel cap sensor ground
Pin 14	Output: fuel gauge ground
Pin 15	Input: fuel gauge information
Pin 16	Input: A/C evaporator sensor information
Pin 17	Output: A/C evaporator sensor ground
Pin 21	High wire for the HS CAN inter/systems (under the hood)
Pin 24	Low wire for the HS CAN inter/systems (under the hood)
Pin 25	Low wire for the LS CAN (body)
Pin 27	High wire for the LS CAN (body)
Pin 31	High wire for the LS CAN diagnostic (body and comfort) connected to the diagnostic connector
Pin 32	Output: + start information (+ DEM)
Pin 33	Low wire for the LS CAN diagnostic (body and comfort) connected to the diagnostic connector
Pin 35	Low wire for the LS CAN (body)
Pin 36	Input: Clutch switch information
Pin 37	High wire for the LS CAN (body)
Pin 38	Input: sport mode control (automatic transmission)
Pin 39	Input: snow mode control (automatic transmission)

EH1 engine: 40-channel white connector:

Connector pin	Assignation
Pin 1	Input: fixed stop for the rear windscreen wiper motor
Pin 2	Input: not assigned / Ground for the hydraulic pump unit relay (307 CC)
Pin 4	Input: open door switch (CPO) on driver's side and state of the vehicle's openable features
Pin 5	Input: open door switch (CPO) on passenger's side and state of the vehicle's openable features
Pin 8	Output: common for the outside temperature sensor
Pin 9	Output: control for lowering rear right-hand electric window / control of the hydraulic pump unit relay (307 CC)
Pin 10	Output: control for raising rear right-hand electric window / not assigned (307 CC)
Pin 11	Output: control for front courtesy light
Pin 12	Output: power supply for rear electric window switches (Authorization to operate).
Pin 13	Input: open luggage compartment information
Pin 14	Output: rear right-hand stop (brake) light
Pin 15	Output: rear left-hand stop (brake) light
Pin 16	Output: control of additional stop (brake) lights
Pin 18	Input: outside temperature information
Pin 19	Output: control for lowering the rear left-hand electric window
Pin 20	Output: control for raising the rear left-hand electric window
Pin 21	Low wire for the LS CAN (body)
Pin 22	Output: Power supply + engine running
Pin 23	High wire for the LS CAN (body)
Pin 24	High wire for the LS CAN (body)
Pin 25	Input: control of front courtesy light information

EH1 engine, continued: 40-channel white connector:

Connector pin	Assignation
Pin 26	Low wire for the LS CAN (body)
Pin 27	Input: status (locked/unlocked) of the driver’s side door lock information
Pin 28	Low wire for the LS CAN (comfort)
Pin 29	Input: state (locked/unlocked) of the driver’s side door lock information
Pin 30	High wire for the LS CAN (comfort)
Pin 31	Input: State of the rear right-hand door child lock
Pin 32	Output: control for courtesy light
Pin 33	Input: rear right-hand door open (CPO) switch
Pin 34	Input: rear left-hand door open (CPO) switch
Pin 35	Input: parking brake switch information
Pin 36	Input: State of the rear right-hand door child lock
Pin 37	Input: fastened front left-hand safety belt information
Pin 38	Low wire for the LS CAN (comfort)
Pin 39	Input: fastened front right-hand safety belt information
Pin 40	High wire for the LS CAN (comfort)

EH2 engine: 40-channel blue connector:

Connector pin	Assignation
Pin 7	Input: control for opening retractable sunroof information (307 CC)
Pin 8	Input: control for closing retractable sunroof information (307 CC)
Pin 9	Input: state of rear window lock
Pin 10	Input: control to open luggage compartment (switch)
Pin 11	Input: control to open luggage compartment or rear window
Pin 12	Output: control for rear right-hand sidelamps
Pin 13	Output: control for rear left-hand sidelamps
Pin 14	Output: control for front door threshold lights
Pin 16	Output: control for luggage compartment light
Pin 18	Output: control for registration plate light
Pin 20	Output: + accessories (+ ACC)
Pin 25	Input: fastened rear right-hand safety belt information
Pin 26	Input: fastened rear left-hand safety belt information
Pin 27	Input: fastened rear central seat safety belt information
Pin 34	Output: control for opening rear window
Pin 35	Output: control for opening luggage compartment
Pin 36	High wire for the LS CAN (comfort)
Pin 37	Low wire for the LS CAN (body)
Pin 38	Low wire for the LS CAN (comfort)
Pin 39	High wire for the LS CAN (body)

PH1 engine: 16-channel black connector:

Connector pin	Assignation
Pin 1	Output: control for the heated rear window
Pin 2	Output: control of double-locking of rear-doors / child locks
Pin 3	Output: + CAN
Pin 4	Output: control of rear right-hand foglamp
Pin 5	Output: control of rear wiper motor
Pin 6	Output: Rear right-hand reversing light
Pin 7	Output: Reverse gear information

PH1 engine, continued: 16-channel black connector:

Connector pin	Assignation
Pin 8	Output: + Battery / (+ APC if the BSI shunt is not in place)
Pin 9	Output: control for the heated rear window
Pin 10	Output: + accessories (+ ACC)
Pin 11	Output: lighting of the switches
Pin 12	Output: control of rear left-hand foglamp
Pin 13	Output: control of rear right-hand indicator
Pin 14	Output: control of rear left-hand indicator
Pin 15	Output: control of rear left-hand reversing light
Pin 16	Output: + Battery (+ BATT)

PP engine: 16-channel green connector:

Connector pin	Assignation
Pin 1	Input: + after switching ignition to “On” (+ APC input)
Pin 2	Output: + after switching ignition to “On” (+APC)
Pin 3	Output: + CAN
Pin 4	Input: Control of stop (brake) lights
Pin 6	Output: electronic ground
Pin 7	Output: lighting of the registration plate
Pin 8	Output: body ground
Pin 9	Output: + after switching ignition to “On” (+APC)
Pin 10	Output: + Battery
Pin 11	Output: + accessories (+ ACC)
Pin 12	Output: + Battery / (+ APC if the BSI shunt is not in place)
Pin 14	Output: lighting of the switches
Pin 16	Output: + CAN

PH2 engine: 16-channel grey connector:

Connector pin	Assignation
Pin 1	Output: + accessories (+ ACC)
Pin 2	Output: + Battery / (+ APC if the BSI shunt is not in place)
Pin 3	Output: + CAN
Pin 4	Output: + CAN
Pin 5	Output: + after switching ignition to “On” (+APC)
Pin 6	Output: + after switching ignition to “On” (+APC)
Pin 8	Output: power supply to rear electric windows (control panel)
Pin 9	Output: power supply to front electric windows
Pin 10	Output: power supply to sunroof
Pin 11	Output: + CAN
Pin 12	Output: lighting of the switches
Pin 13	Output: control of deadlocking
Pin 14	Output: control of selective unlocking of the driver’s door
Pin 15	Output: common for locking/unlocking/deadlocking of the locks
Pin 16	Output: control of deadlocking of front doors

PB engine: 10-channel black connector:

Connector pin	Assignation
Pin 1	Output: + Battery / (+ APC if the BSI shunt is not in place)
Pin 2	Input: hazard warning lights switch
Pin 3	Input: door locking request from inside passenger cell
Pin 4	Output: + accessories (+ ACC)
Pin 5	Output: + Battery (+ BATT)
Pin 6	Output: + CAN
Pin 7	Output: lighting of the switches
Pin 8	High wire for the LS CAN (comfort)
Pin 9	Output: system status / control of anti-theft alarm indicator light
Pin 10	Low wire for the LS CAN (comfort)

PB1 engine: 10-channel white connector:

Connector pin	Assignation
Pin 1	Output: + after switching ignition to “On” (+APC)
Pin 2	Output: + after switching ignition to “On” (+APC)
Pin 3	High wire for the LS CAN (body)
Pin 4	Input: + after switching ignition to “On” (+APC)
Pin 5	Low wire for the LS CAN (body)
Pin 6	Input: request to control starter
Pin 7	Output: starter ground
Pin 8	High wire for the HS CAN inter/systems (under the hood)
Pin 9	Output: starter indicator light
Pin 10	Low wire for the HS CAN inter/systems (under the hood)

AP: 2-channel grey connector:

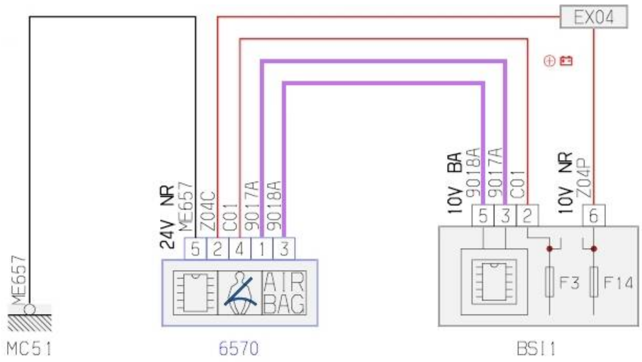
Connector pin	Assignation
Pin 1	Input: + Battery (from the fuse box in the engine compartment)
Pin 2	Input: + Battery (from the fuse box in the engine compartment)

EA engine: 6-channel black connector:

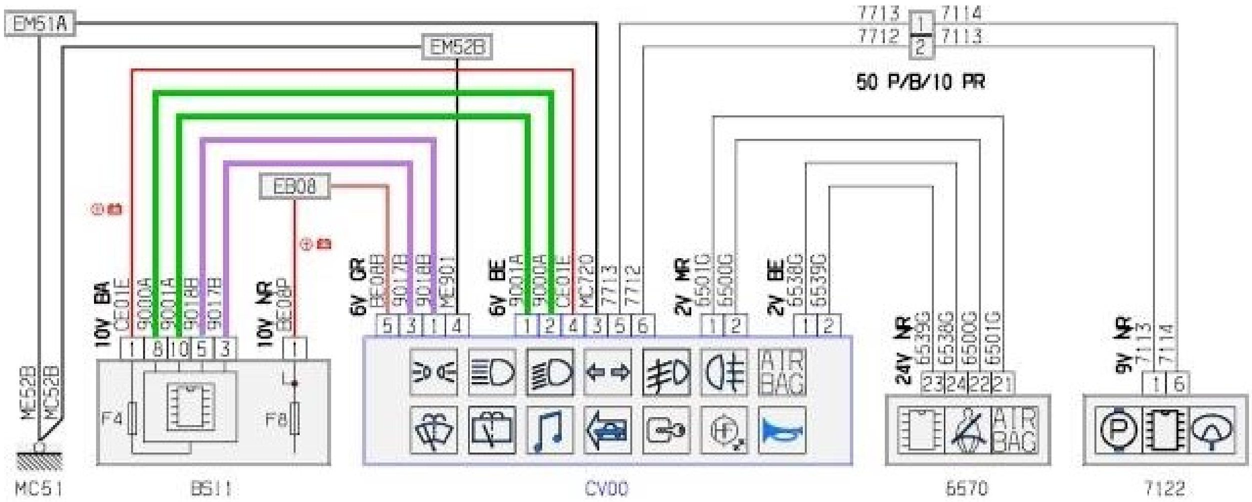
Connector pin	Assignation
Pin 1	Output: + Battery / (+ APC if the BSI shunt is not in place)
Pin 2	Output: anti-theft alarm ground
Pin 3	Output: lighting of the switches
Pin 4	High wire for the LS CAN (body)
Pin 5	Output: + CAN
Pin 6	Low wire for the LS CAN (body)

<u>Circuit diagram showing the elements of the system:</u>

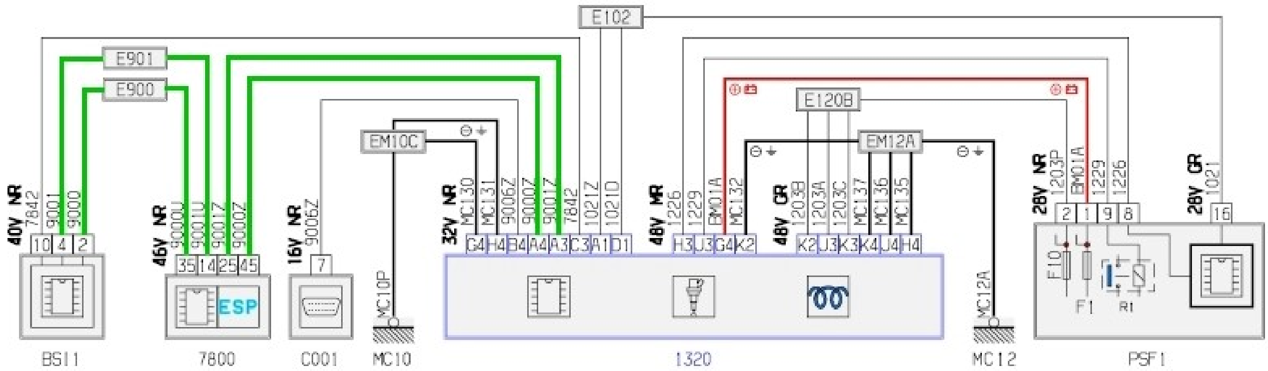
BSI with airbag control unit:



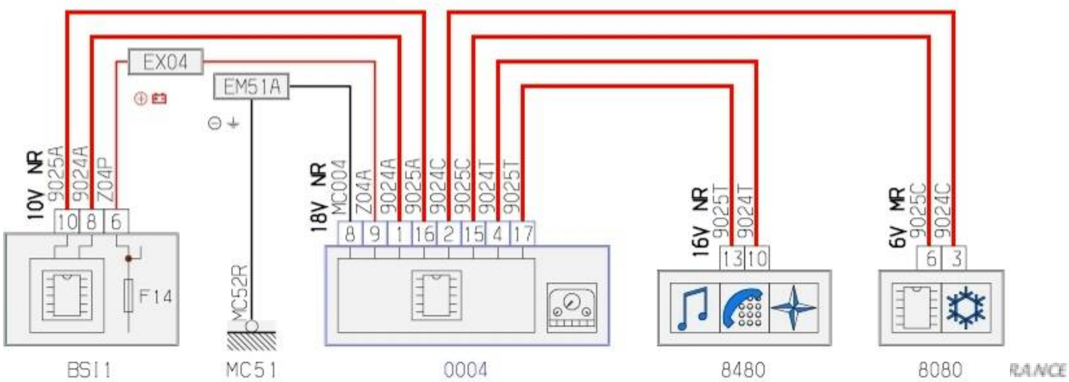
BSI and COM2000 with airbag controls from the steering wheel and steering angle speed information for power-assisted steering :



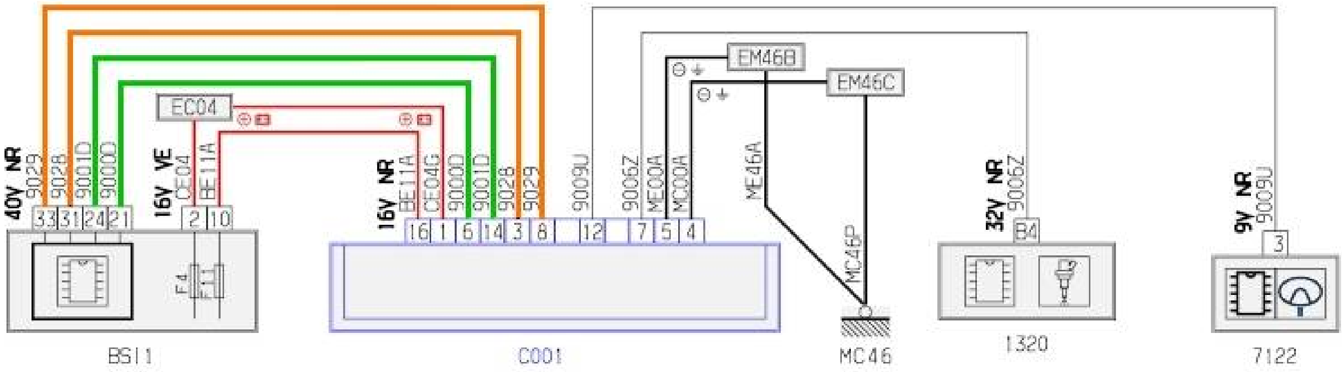
BSI with the ignition and injection control unit (1320), PSF1, ESP and the diagnostic connector:



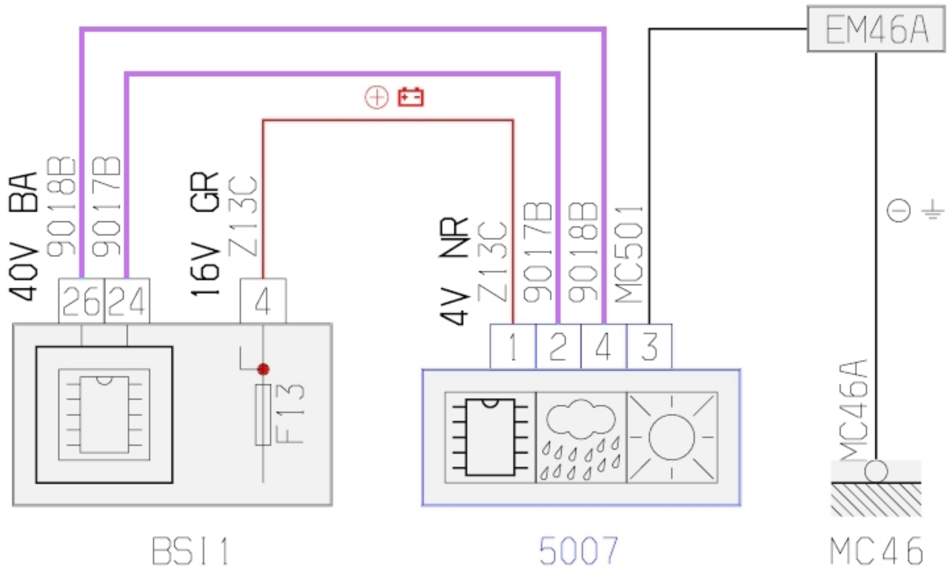
BSI with the instrument panel (0004), the telematics transceiver (8480) and the air conditioning control unit (8080):



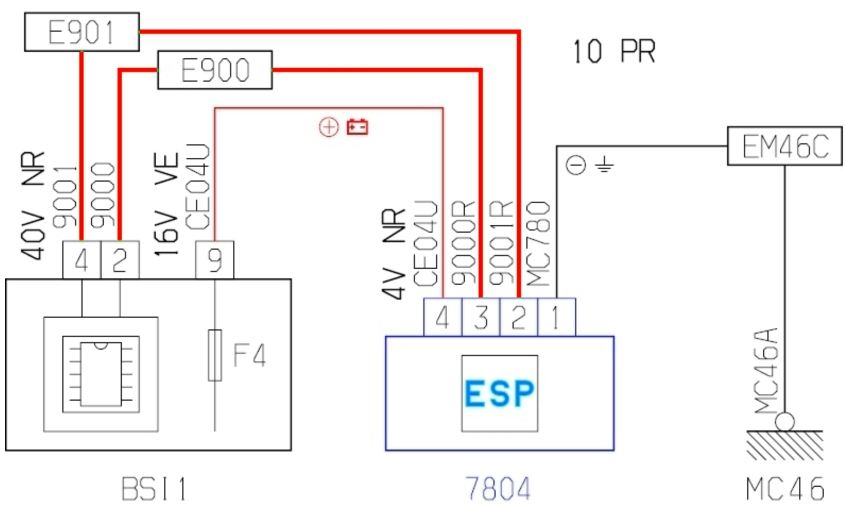
BSI with the diagnostic connector and the K links for ignition & injection and ESP control units:



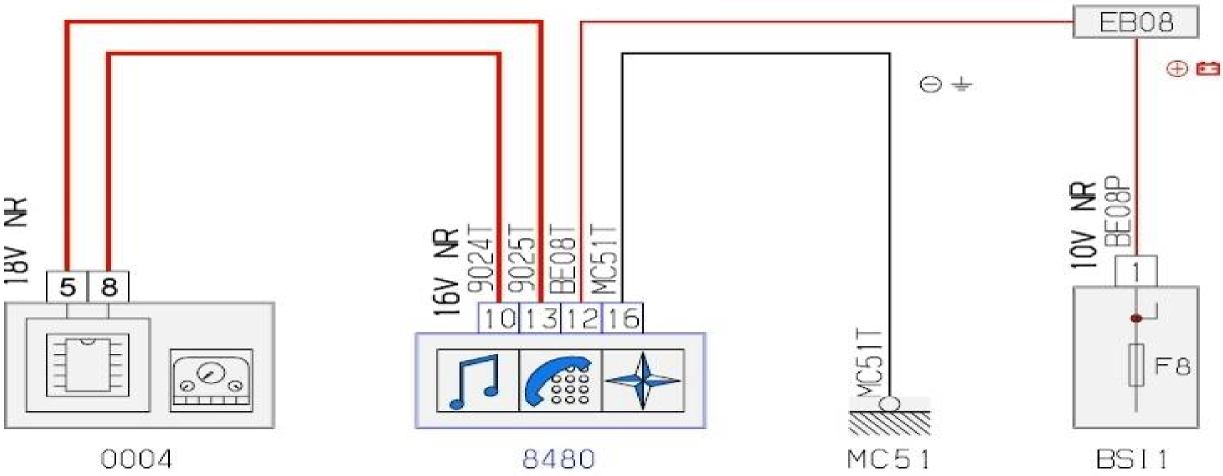
BSI with the rain and light sensor (5007):



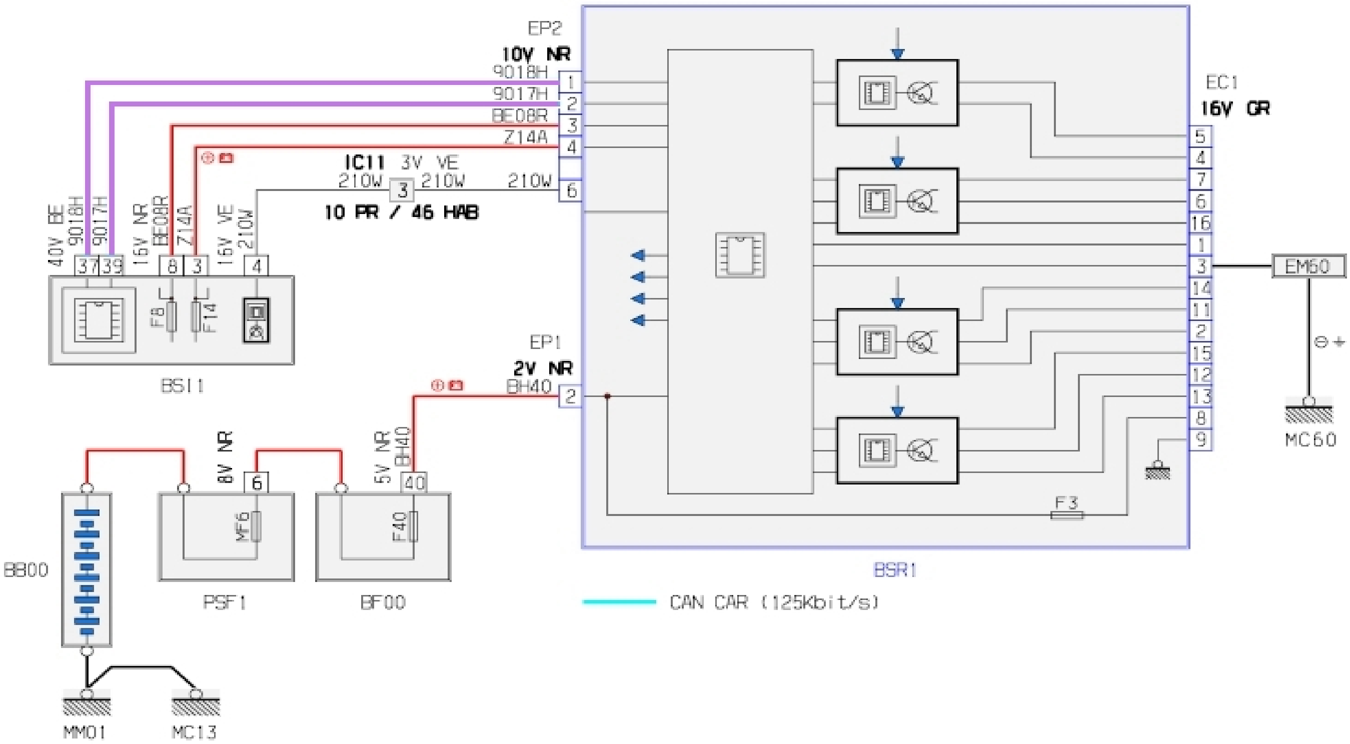
BSI with the ESP accelerometer gyrometer control unit (7804):



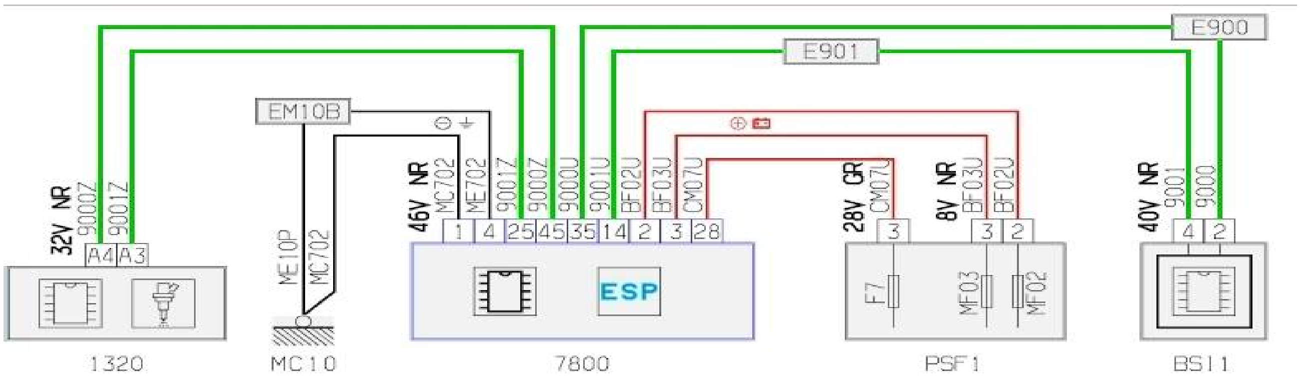
Instrument panel (0004) with the telematics transceiver (8480)



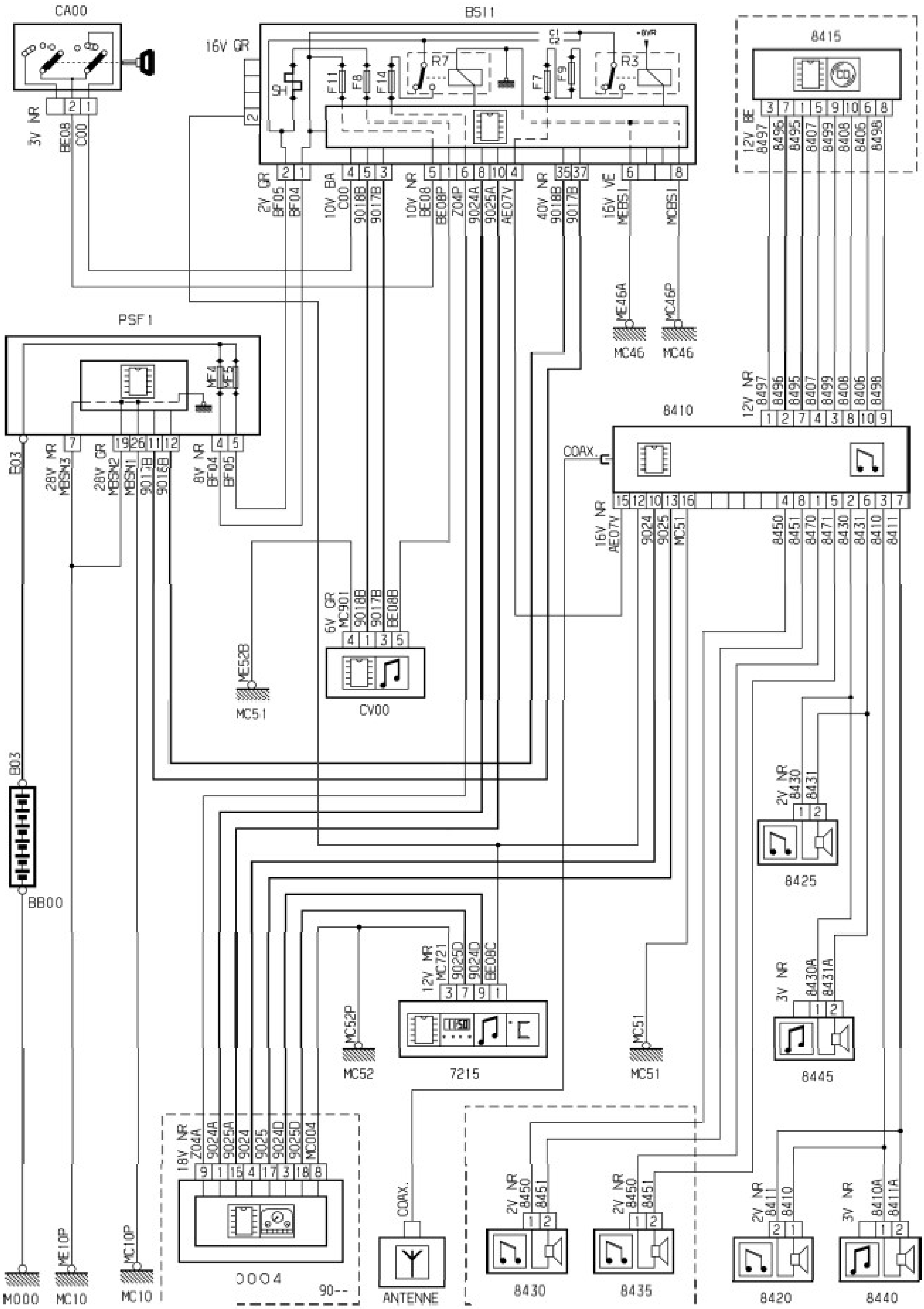
The model is not equipped with the power supplies and communication buses for the BSR1.



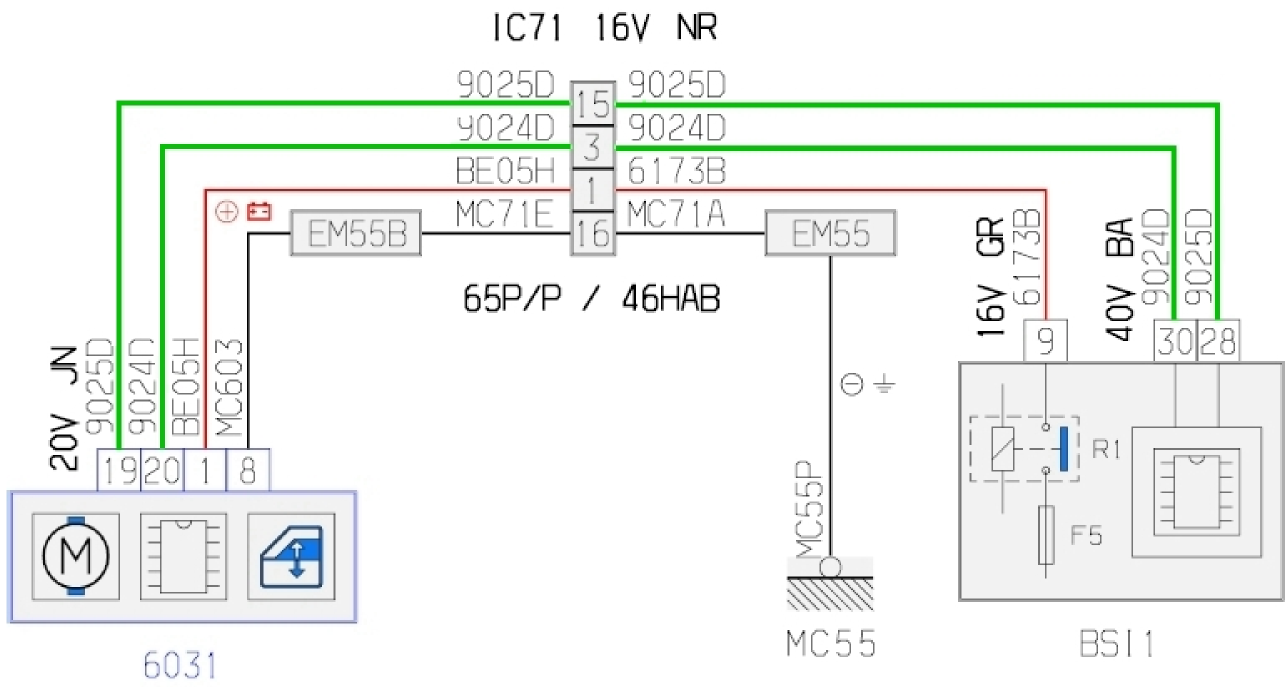
BSI1, PSF1 with the ESP and ignition & injection control units:



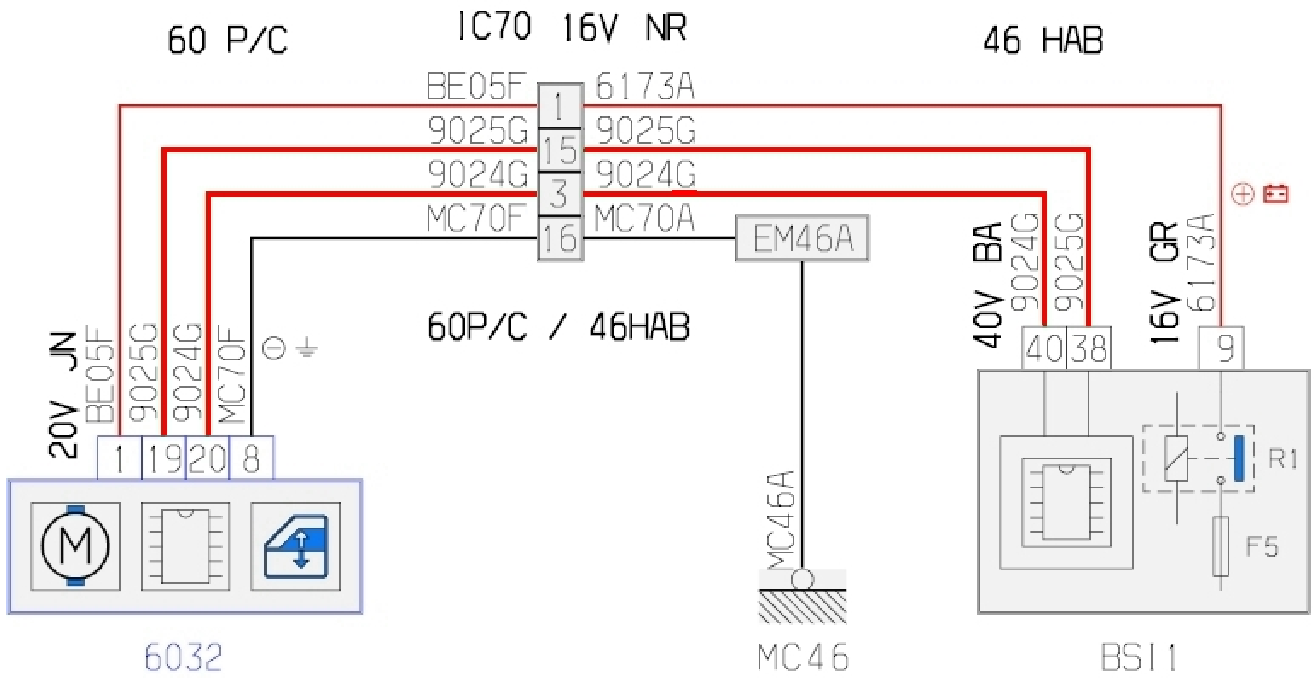
Telematics transceiver (8480) with the multifunction display (7215):



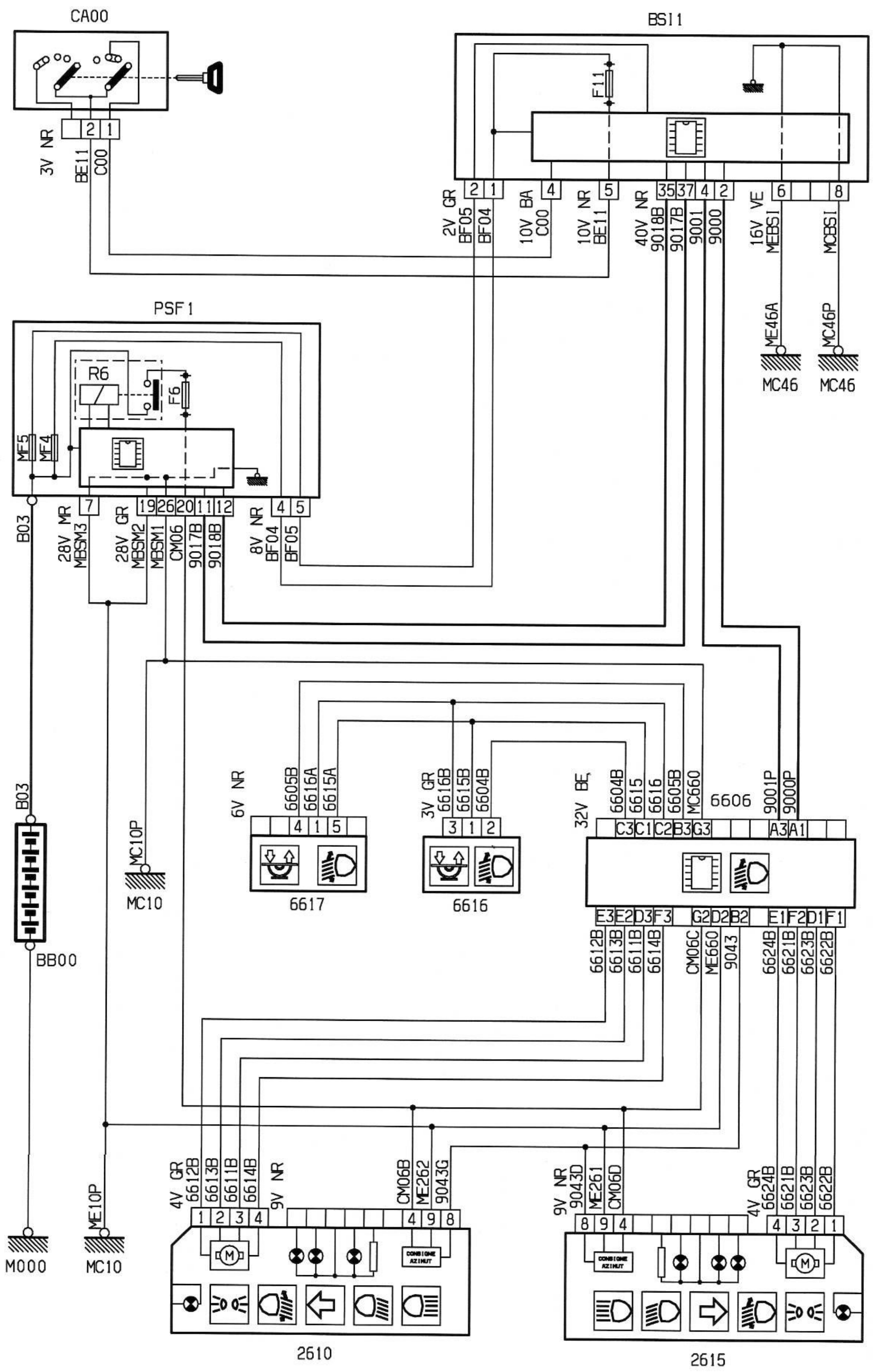
BSI with the driver's door module (6031 - sequential electric window unit + motor):

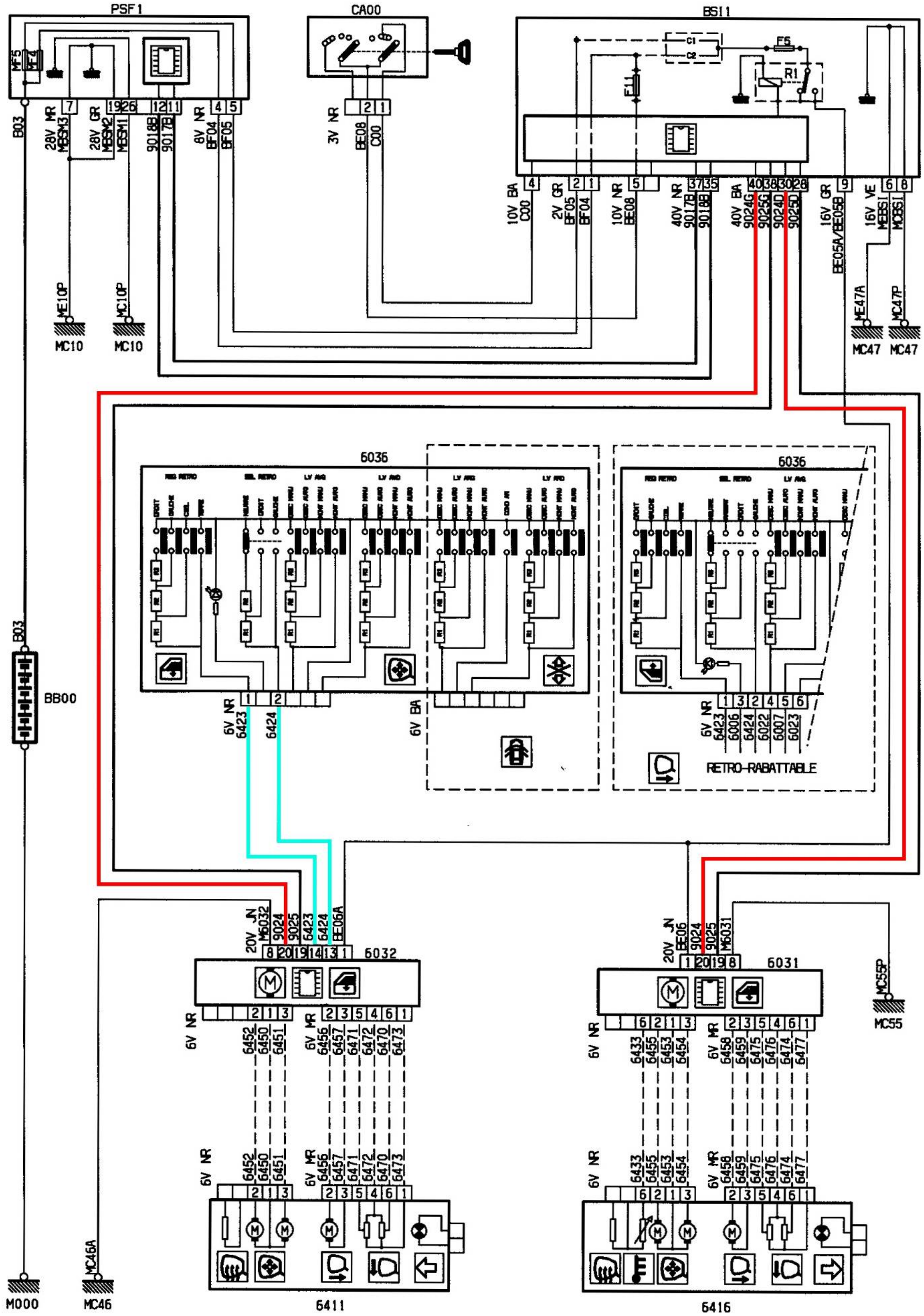


BSI with the passenger's door module (6032 - sequential electric window unit + motor):



Control diagram for the xenon lights:

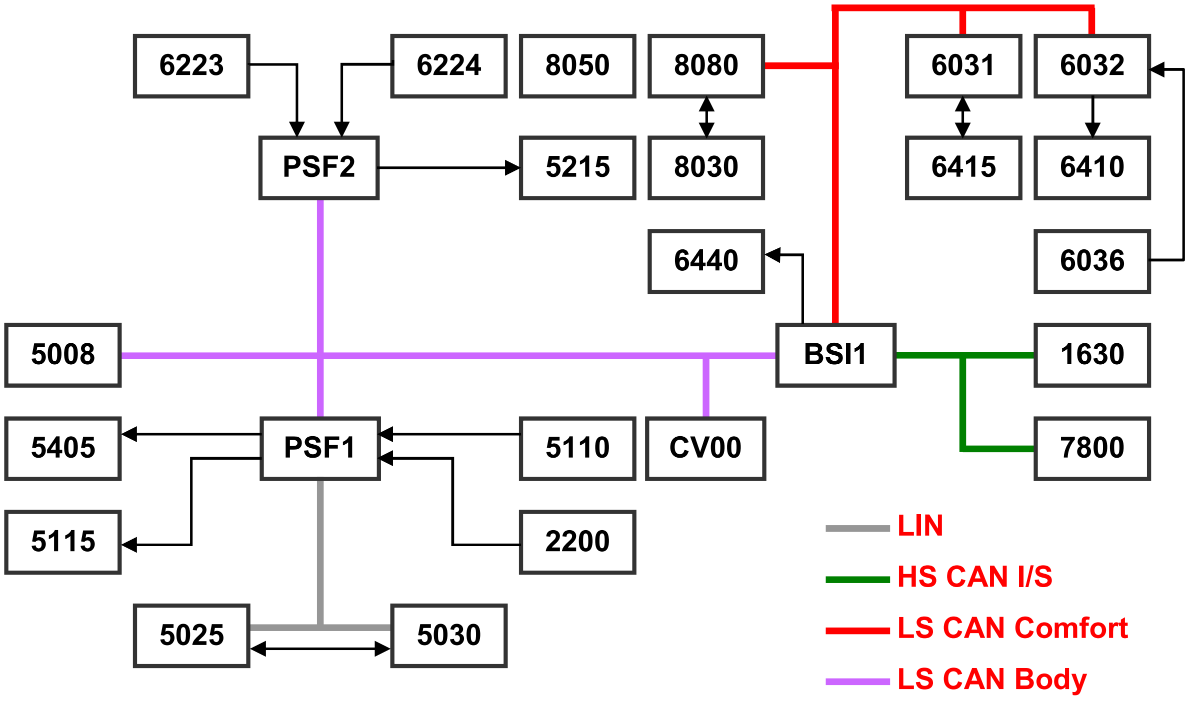



PSF1
CA00
BSI1
F5
R1
F11
MC10
MC47
BB00
B03
6036
RETRO-RABATTABLE
6032
6031
6411
6416
M000
MC46
MC55
9024
9025
6423
6424
BE06A
M6032
M6031
9024G
9025G
9024D
9025D

7. PRACTICAL EXERCISES

7.1. CONTROL OF REAR VIEW MIRRORS

DIAGRAM SHOWING THE MULTIPLEXED BUSES

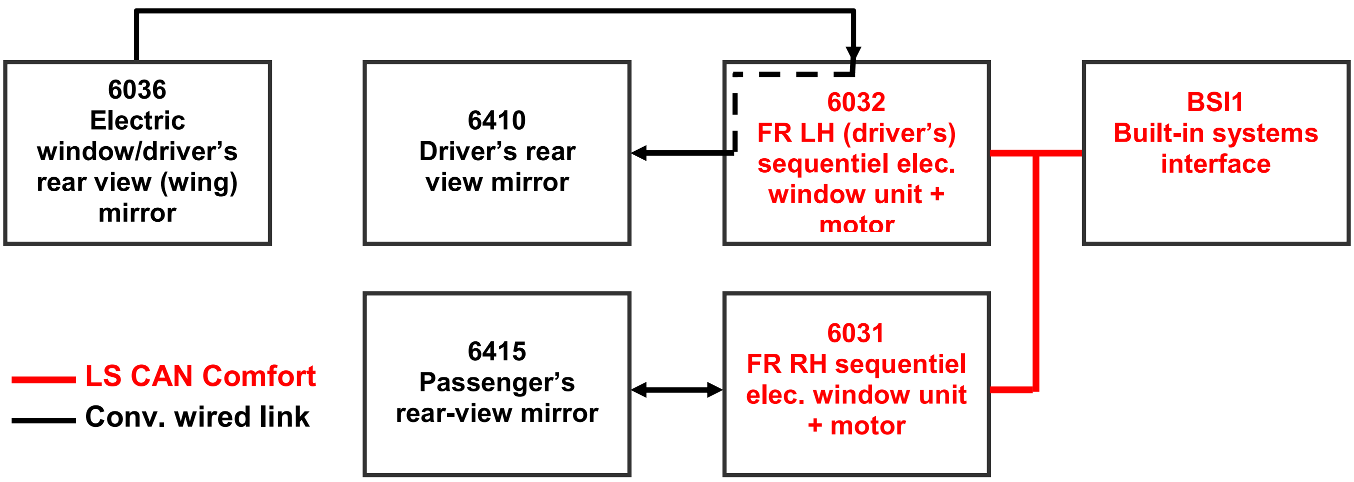


1) By referring to the block diagram and the table underneath in section **2.5.** page 28:

   a) Which component receives the controls for adjusting the rear view mirrors? Which bus carries these control instructions?

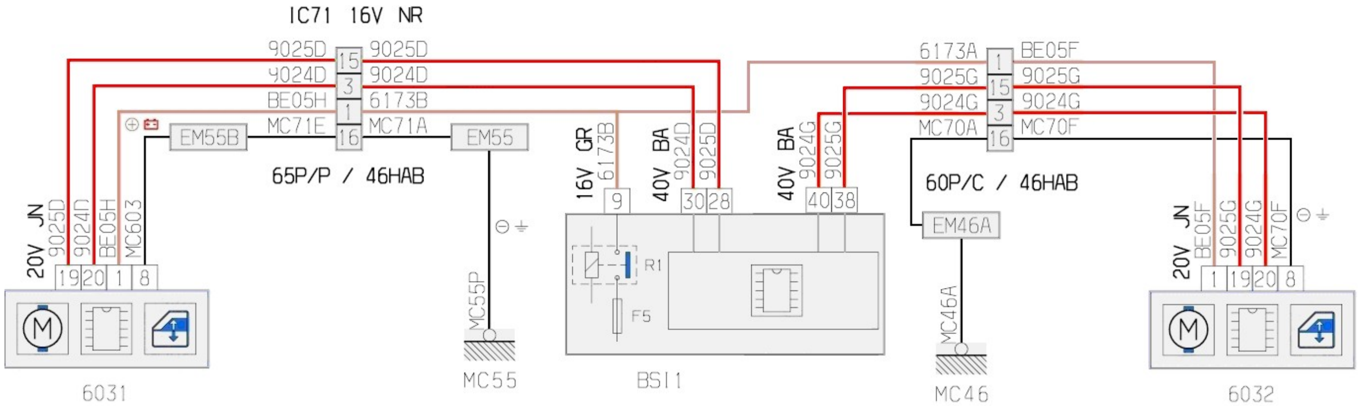
The rear view mirror control instructions are received by the driver's door module (6032 – FR LH sequential electric window unit + motor). They are carried on the CAN COMFORT bus.

   b) Identify this bus and indicate its architecture schematically.



2) By referring to the wiring diagram below for the door modules (sequential electric window units + motor), complete the table below

DOOR MODULE DIAGRAM



Wire number	Assignation
9024D	*LS CAN COMFORT HIGH*
9025D	*LS CAN COMFORT LOW*
BE05F	*Power supply to passenger's control panel*
BE05H	*Power supply to driver's control panel*
MC603	*Ground for driver's door panel*
MC70F	*Ground for passenger's panel*

3) At what speed are signals carried on this bus?

The speed for this bus is 125 kbits/s

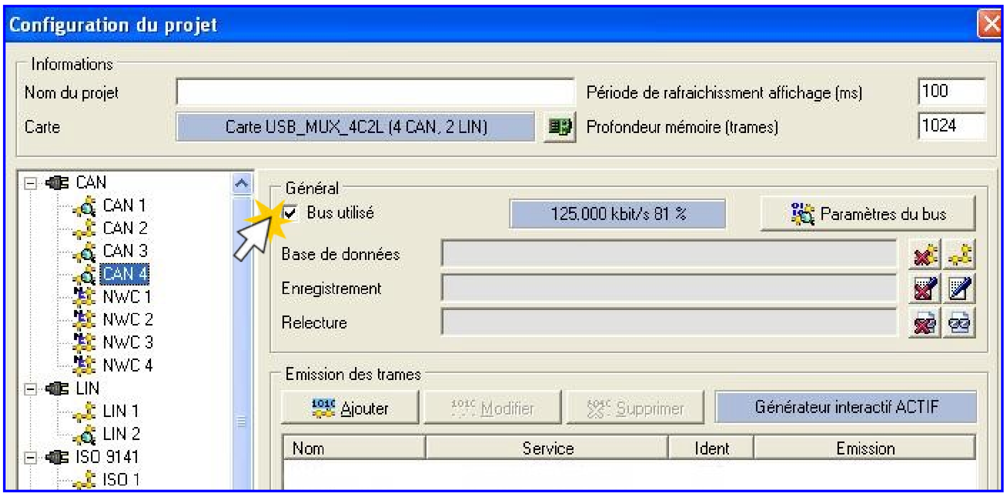
4) Using the Muxtrace® software, record the data frames present on the LS CAN COMFORT bus (refer to the tutorial below and the user manual for the software).

MUXTRACE TUTORIAL

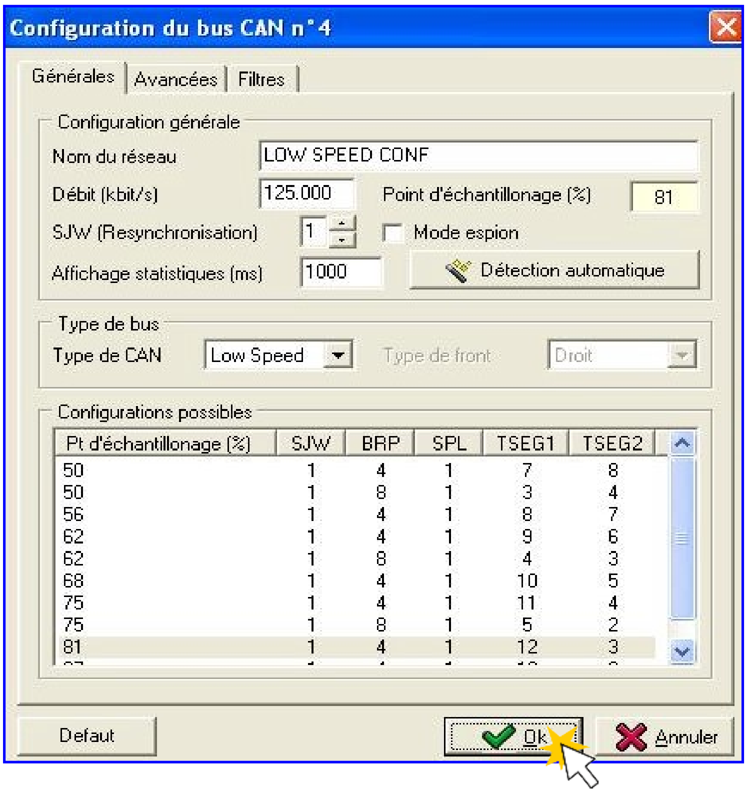
When it starts up, Muxtrace® checks the cards or USB units present or connected to the computer:

- Click "OK", then on "New document"…

- In the “Project setup” window, assign a name to the project and then select BUS No.4 and tick the “Activate bus” box:

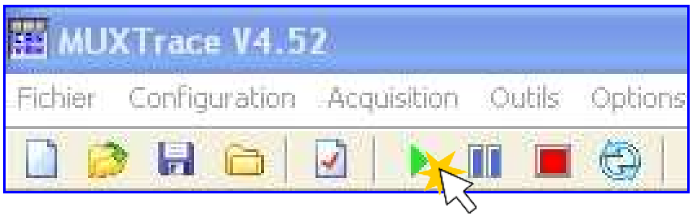


- Click on “Bus setup”:



- Name the bus
- Deactivate spy mode
- Enter the correct speed
- Click OK to confirm this window, then confirm the setup for the project …

➢ Muxtrace® then displays the window for the CAN COMFORT bus which has just been set up:



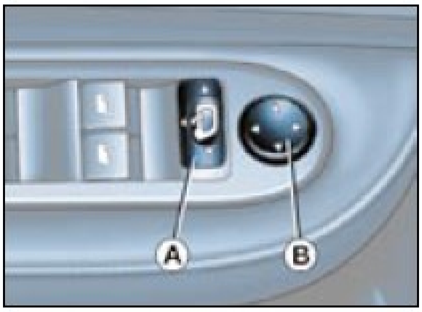
- Connect the USB unit to the model (CAN COMFORT)
- Start the data acquisition by clicking on the green arrow.

➢ The data currently carried on the CAN COMFORT bus is displayed on the screen:

Heure	Ident	Lg	Données	Période	Svc
00:01:06.2603	1E0	5	52 00 A2 00 00	508.3	DA
00:01:06.3620	165	4	C0 A0 10 00	99.4	DA
00:01:06.3404	24C	5	04 00 00 00 00	100.0	DA
00:01:06.2636	2A5	8	00 00 00 00 00 00 00 00	510.6	DA
00:01:06.2642	325	3	00 00 00	510.6	DA
00:01:06.2650	365	5	FF FF FF 00 00	510.6	DA
00:01:06.2658	3A5	6	FF FF FF FF 7F 00	510.6	DA
00:01:06.3466	036	8	0E 00 00 28 21 00 00 A0	99.0	DA
00:01:06.3115	355	2	02 00	100.0	DA
00:01:06.3211	2D5	1	02	100.1	DA
00:01:06.3563	1BE	8	B4 00 06 1F 80 00 00 00	100.7	DA
00:01:06.3613	115	4	01 00 00 00	99.3	DA
00:01:06.3817	131	5	81 00 00 00 00	101.6	DA
00:01:06.3715	1A8	8	00 00 00 00 00 0F E7 D8	200.1	DA
00:01:06.1854	227	4	00 00 00 00	500.1	DA
00:01:06.2108	2B6	8	FE FE FE FE FE FE FE FE	1000.1	DA
00:01:06.2206	128	8	01 20 00 00 C0 80 A0 01	200.0	DA
00:01:06.1920	50C	8	09 00 00 00 00 00 00 00	999.4	DA
00:01:06.2123	315	5	FF FF 00 80 00	999.4	DA
00:01:06.2613	12D	8	01 21 30 00 00 64 98 00	500.6	DA
00:01:06.2714	168	8	00 00 00 00 00 04 00 00	200.0	DA
00:01:05.8832	3E5	6	00 00 00 00 00 00	508.6	DA
00:01:06.2856	161	7	00 00 FF 36 00 00 FF	500.1	DA
00:01:06.3108	221	7	80 FF FF FF FF FF FF	1000.2	DA
00:01:06.3606	26D	4	00 00 00 00	500.3	DA
00:01:06.3856	3A7	8	24 A0 00 08 CB 01 6D 05	500.0	DA
00:01:06.0050	1A5	1	E2	508.0	DA
00:01:05.4105	3B6	6	FE FE FE FE FE FE	1000.1	DA
00:01:05.4358	120	8	BC 00 00 00 00 00 00 00	1000.3	DA
00:01:05.4414	50B	8	09 00 00 00 00 00 00 00	1000.2	DA
00:01:05.4555	512	8	AF 00 D1 00 00 00 00 00	1000.1	DA
00:01:05.4618	255	5	FF FF 00 FD 00	1000.1	DA
00:01:06.0875	1E5	7	3F 3F 3F 3F 3F 00 02	509.5	DA
00:01:05.9833	1ED	1	10	500.0	DA
00:01:05.4843	525	8	0D 00 00 00 00 B4 00 00	1000.1	DA
00:01:05.9855	361	6	09 14 11 80 10 00	499.5	DA
00:01:06.0301	2A0	1	00	500.1	DA
00:01:05.5338	3F6	7	06 1F 80 00 00 C0 00	1000.1	DA
00:01:06.0607	0F6	8	8E 88 8D 71 BF 80 80 20	500.1	DA
00:01:06.0046	1D0	7	22 00 00 56 00 0B 0A	519.4	DA
00:01:06.0636	15B	8	01 01 B1 40 00 D0 00 10	500.0	DA
00:01:06.0643	0DF	3	10 00 40	500.0	DA
00:01:06.1780	225	5	20 00 10 04 06	508.7	DA

5) Operate the rear-view mirrors on the right-hand and left-hand sides, and watch carefully the list of data frames. What is the number of the identifier for the frame which corresponds to the left-hand and right-hand rear view mirrors?

The frame with the identifier 115 controls the rear view mirrors



Rétroviseurs extérieurs à commande électrique

- Placez la commande **A** à droite ou à gauche pour sélectionner le rétroviseur correspondant.
- Déplacez la commande **B** dans les quatre directions pour effectuer le réglage.
- Replacez la commande **A** en position centrale.

En stationnement, les rétroviseurs sont rabattables, électriquement en tirant la commande **A** vers l'arrière ou automatiquement lors du verrouillage du véhicule à la télécommande.

Le déploiement des rétroviseurs s'effectue en mettant le contact sur le 2ème cran ou sur la position marche.

6) How did you find out this information?

When the controls are actuated, the first byte of data in frame 115 changes.

7) What is the size of the data in this frame?

The data is sent on four bytes

8) Is the data in decimal, hexadecimal or binary form?

The data displayed by Muxtrace® is in hexadecimal form.

9) What does the first byte of data correspond to?

The first byte corresponds to the control of the left-hand and right-hand rear view mirrors.

10) Observe the first byte in data frame 115 and complete the table below:

ACTION PERFORMED	FIRST BYTE
Mirror stationary	*01*
Control: LH rear view mirror, movement towards left	*44*
Control: LH rear view mirror, movement towards right	*84*
Control: LH rear view mirror, movement upwards	*24*
Control: LH rear view mirror, movement downwards	*14*
Control: RH rear view mirror, movement towards left	*42*
Control: RH rear view mirror, movement towards right	*82*
Control: RH rear view mirror, movement upwards	*22*
Control: RH rear view mirror, movement downwards	*12*
Control: folding in of rear view mirrors	*08*

11) What can you conclude about the nature of this byte in terms of its control of the rear view mirrors?

The first nibble (1st hexadecimal digit) determines the direction of movement of the mirror, and the second nibble identifies which rear view mirror is being controlled: passenger's or driver's.

12) Complete the hexadecimal/binary conversion table below for the first nibble (direction of movement):

Control	Nibble (hexadecimal digit)	Nibble (binary)
Folding in	*0*	*0000*
Downwards	*1*	*0001*
Upwards	*2*	*0010*
Towards left	*4*	*0100*
Towards right	*8*	*1000*

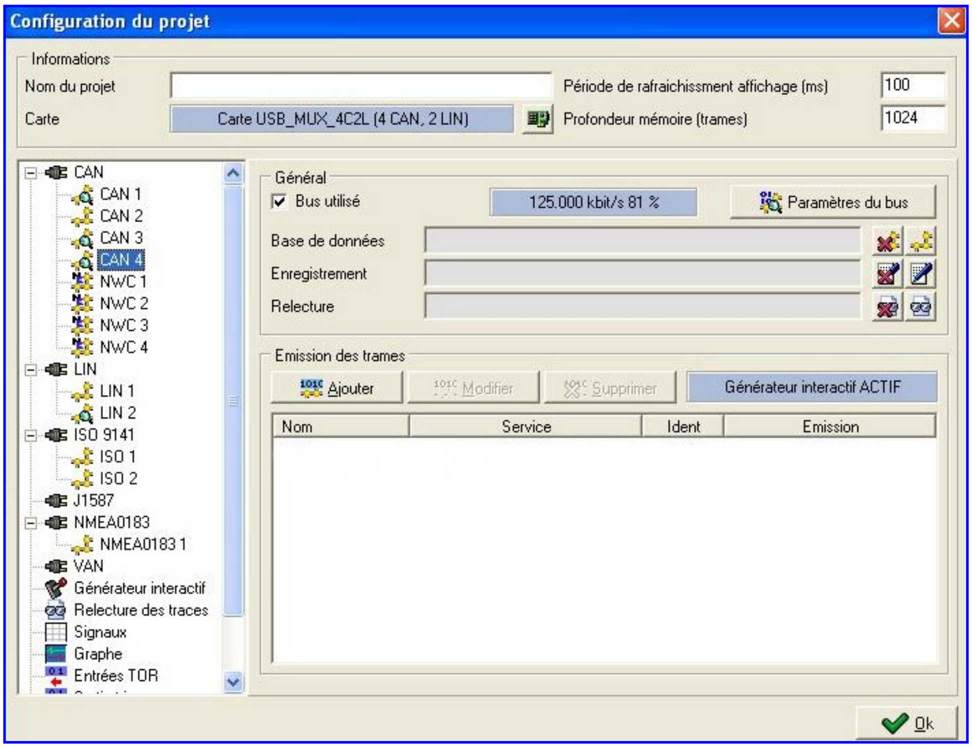
Reminder Conversion table

Decimal	Hexadecimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

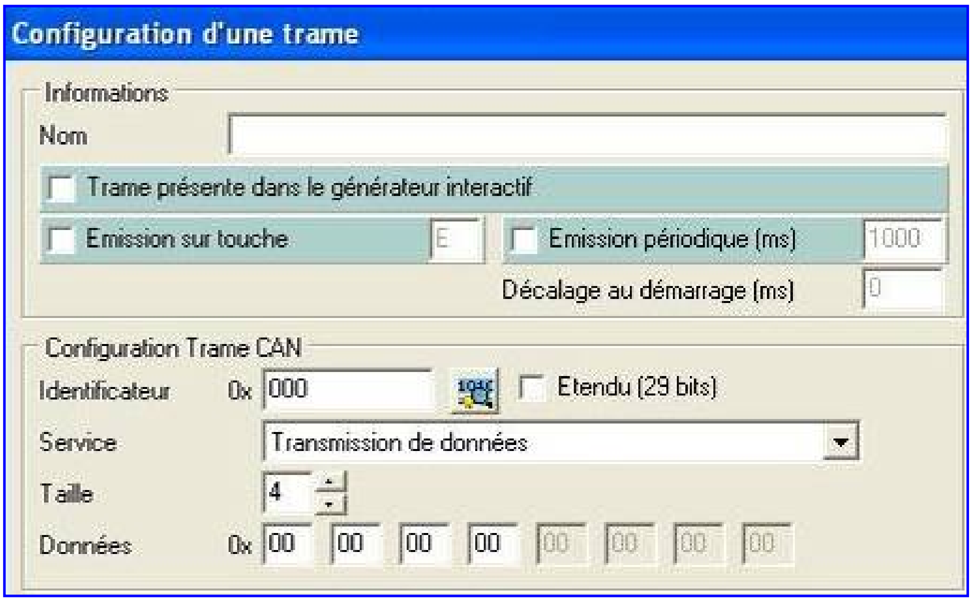
13) What do you notice about the control nibble when considered in binary form?

It is the position in the nibble of the bit whose state is **1** *which determines the direction of movement of the rear view mirror.*

➢ Using Muxtrace® to send data:

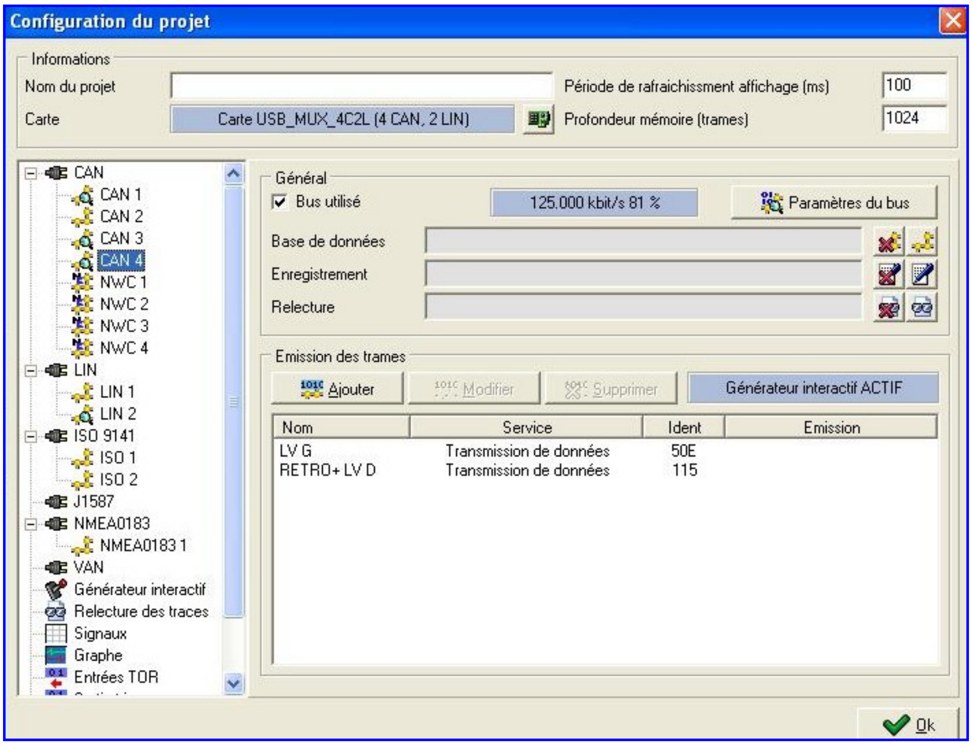


- Halt the data acquisition and open “Project setup”
- Click on “Add” (with spy mode deactivated)



- Assign a name to the function (e.g.: control front RH rear view mirror: upwards)
- Select “Transmit at keypress of:” and enter the key to be pressed
- Indicate the identifier and the number of data bytes in the frame
- Enter the data bytes and confirm

The frames which are ready to be sent are listed in the bottom right of the window:



Create a frame for each of the controls recorded in the table *(as part of the answer to Question 12)*, so as to check that these values produce the expected effect.

Using this function, you can link each control frame to a specific key on your keyboard; this means that you control the rear view mirrors, electric windows, etc. from your computer.

***CAUTION!* AVOID SENDING FRAMES AS PERIODIC (OR REPEATED) TRANSMISSIONS, OR IF YOU DO THEN SWITCH OFF THE ACQUISITION WHEN THE ACTUATOR HAS REACHED ITS END-OF-TRAVEL STOP, SO AS NOT TO DAMAGE THE MECHANISMS.**

14) Control the front LH rear view mirror (by transmitting a frame with a keypress)

This has no effect since control panel 6036 (FR LH rear view mirror/electric window) is conventionally wired up to the FR RH sequential electric window unit + motor (6031). Control panel 6036 directly controls the LH rear view mirror via a conventionally wired link, refer to the diagram on page 67

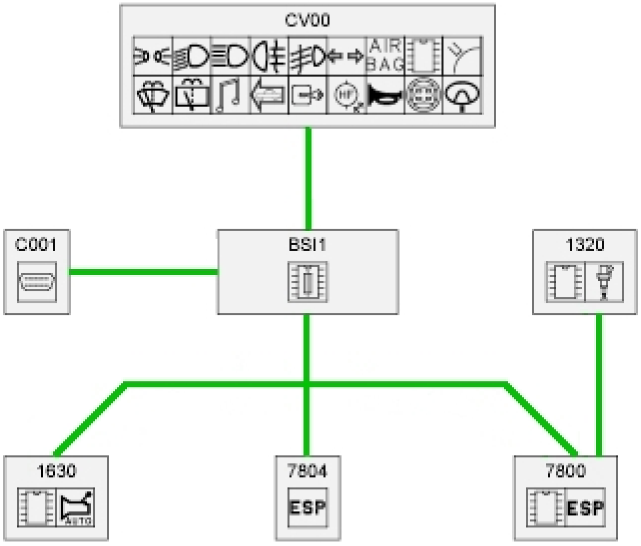
15) Control the front RH rear view mirror (by transmitting a frame with a keypress)

a) RV mirror upwards
b) RV mirror towards the left.
c) RV mirror downwards.
d) RV mirror towards the right.

16) Control the folding in of the rear view mirrors (by transmitting a frame with a keypress)

THE EFFECTS OF CONTROLLING THE REAR VIEW MIRRORS IN THIS WAY ARE ONLY VISIBLE BY PRESSING RAPIDLY AND REPEATEDLY ON THE DESIGNATED KEY; OTHERWISE IT IS THE ORIGINAL FRAME WHICH TAKES PRECEDENCE OVER YOURS.

7.2. ANALYSIS OF HIGH-SPEED CAN INTER/SYSTEMS DATA FRAMES



Display using Muxtrace® the data frames carried on the CAN I/S bus at 500 kbit/s.

Part 1:

1) On the CAN bus, look at the data frame with the number 208 as its identifier, then vary the engine speed. What happens?

   When the engine speed is increased, the first byte increases in value, and vice-versa.

2) Set the engine speeds shown on the instrument panel to the values indicated in the table below and complete the table below:

Engine speed (rpm)	1st byte / Frame 208	Conversion to binary	Conversion to decimal
0	*00*	*0000 0000*	*0*
1000	*1F*	*0001 1111*	*31*
2000	*3F*	*0011 1111*	*63*
3000	*5F*	*0101 1111*	*95*
4000	*7F*	*0111 1111*	*127*
5000	*9F*	*1001 1111*	*159*

3) Can you identify a logic sequence for this variation in engine speed:

Change in engine speed	Difference in decimal form
From 0 to 1000 rpm	*+31*
From 1000 to 2000 rpm	*+32*
From 2000 to 3000 rpm	*+32*
From 3000 to 4000 rpm	*+32*
From 4000 to 5000 rpm	*+32*

***CAUTION:** The speed that you read off the instrument panel may not be accurate due to human error.*

The mean of the decimal values for the 5 measurements is 31.8 per 1000 rpm step.

Let us assume a maximum engine speed = 6000 rpm.

Using these figures the maximum on the frame should be = 31.8 x 6 = $190.8_{(10)}$ or $BE_{(16)}$.

The range as a decimal for 1 byte is from 0 to 256, however, the maximum for this speed counter is $C0_{(16)}$, i.e. $192_{(10)}$. Accordingly let us set as a new maximum: 6000 rpm = 192:

192 / 6 = 32, shall be our new 'increment'.

The table below is a modified version of the table above with this new “increment”:

Change in engine speed	Value as a decimal	Value as a hexadecimal
1000 rpm	32	20
2000 rpm	64	40
3000 rpm	96	60
4000 rpm	128	80
5000 rpm	160	A0
6000 rpm	192	C0

4) Check if this new “increment” appears to be consistent by sending frames with these values (refer to the previous practical exercise for details about frame transmission).

- On the model, there is an accuracy of approximately: 1000 / 32 = 31.25 rotations.
- On the vehicle:

Two bytes are used to determine the speed, giving a range from 00 00 to FF FE. (FF FF is not used, it may be used to indicate an invalid value or as a default value)

In decimal form, the range is therefore from 0 to 65534. Since the maximum displayed speed is 8000 rpm, the accuracy is 8000 / 65534 = 0.122 rpm. Let us assume a rounded-off accuracy of: 0.125 rpm.

The maximum becomes: 65534 x 0.125 = 8191.75 rpm on the display.

On the vehicle, you can run the decoding test using this factor:

- For example, a value of 2A 36 in hexa = 10806 in decimal 10806 x 0.125 = 1350.75 rpm.
- To display 3000 rpm, the calculation gives: 3000 / 0.125 = 24000 as a decimal which gives 5D C0 as a hexa value.

You can use MUXTRACE® to transmit these values.

Part 2:

5) What are the identifiers of the frames which change when the vehicle’s speed changes?

When the vehicle’s speed is varied, the data frames with identifiers 44D and 38D vary.

6) Observe frame 44D and complete the table below:

Vehicle speed (km/h)	1st data byte in the frame (hexadecimal)	Conversion to binary	Conversion to decimal
0	00	0000 0000	0
10	04	0000 0100	4
20	08	0000 1000	8
30	0B	0000 1011	11
40	10	0001 0000	16
50	14	0001 0100	20
60	18	0001 0111	23
70	1B	0001 1011	27
80	1F	0001 1111	31
90	22	0010 0010	34

7) Can you identify a logic sequence for the variation in vehicle speed?

Variation in speed	Value as a decimal
0 to 10	+4
10 to 20	+4
20 to 30	+4
30 to 40	+5
40 to 50	+3
50 to 60	+4
60 to 70	+4
70 to 80	+4
80 to 90	+3

CAUTION: *The speed that you read off the instrument panel may not be accurate due to human error.*

Let us take ***4*** as the new “increment”, and revise the table accordingly:

Vehicle speed (km/h)	Value as a decimal
10	4
20	8
30	12
40	16
50	20
60	24
70	28
80	32
90	36

8) Check if this new “increment” appears to be consistent by sending frames with these values.

- On the model, there is an accuracy of approximately: 10 / 4 = 2.5 km/h.

- On the vehicle:

Two bytes are used to determine the speed, giving a range from 00 00 to FF FE (since FF FF is not used, it may be used to indicate an invalid value or as a default value).

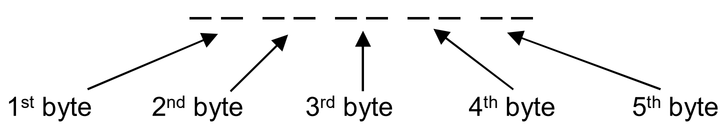
In decimal form, the range is therefore from 0 to 65534. Since the maximum displayed speed is 210 rpm, the accuracy is 210 / 65534 = 0.0032 km/h.

On the vehicle, you can run the decoding test using this factor:

- For example, a value of CD FF$_{(16)}$ in hexa = 10806$_{(10)}$ x 0.0032 = 34.58 km/h
- To display 200 km/h, the calculation gives 200 / 0.0032 = 62500 $_{(10)}$ or F4 24$_{(16)}$

You can use MUXTRACE® to transmit these values.

Part 3: Composition of frame 38D.



9) What does the first byte in this frame correspond to?

The first byte corresponds to the speed of the vehicle.

10) Vary the speed of the vehicle – what happens to the 5th byte?

The 5th byte does not vary, and remains at the AF value

11) Using MUXTRACE®, send a frame corresponding to a speed of 90 km/h (24$_{(16)}$) and change the 5th byte by setting it to 00$_{(16)}$, What happens?

The model's hazard warning lights come on.

12) What do you deduce from this?

That the 5th byte corresponds to the longitudinal acceleration of the vehicle.

13) Using MUXTRACE®, send a number of frames with a view to determining the speed at which the hazard warning lights switch on when the vehicle decelerates sharply. Record this speed in hexadecimal form, then calculate, using the answers to question 7), the vehicle speed which correspond to this hexadecimal value. What speed have you determined?

The hazard warning lights switch on from a speed of 10$_{(16)}$ which corresponds to a vehicle speed of 10 x 4 = 40 km/h

14) Using MUXTRACE®, send a number of frames with a view to determining the deceleration at which the hazard warning lights switch on, and record this deceleration in hexadecimal form. What value have you determined?

The hazard warning lights switch on when the deceleration reaches 57$_{(16)}$

15) Why do you think that the last byte, which corresponds to the vehicle's acceleration, is not 00 when there is no acceleration?

Because, when braking, there is no acceleration but there is deceleration. So that the control unit does not have to process a negative value an "offset" value is applied to the entire range of accelerations/decelerations.

16) Can the value of the deceleration (in m/s^2) at which the hazards warning lights switch on be determined by calculation? Explain your answer.

This value cannot be determined by calculation since we only have one point of reference, i.e. AF = 0 m/s^2 (offset value)

17) Knowing that the maximum acceleration which the vehicle can achieve is 6.32 m/s^2, which corresponds to a hexadecimal value of FE: Complete the following table, determine the coefficient and calculate the value of deceleration (in m/s^2) at which the hazard warning lights switch on.

Value in m/s²	Value in hexadecimal form	Value in decimal form
6.32 (maxi)	FE	254
0.00	AF	175
- 6.32	60	96
- 7.04 (mini)	57	87

Calculation of the coefficient: (254 – 175) / 6.32 = 12.5

Calculation of the deceleration: (87 – 175) / 6.32 = - 7.04 m/s^2

18) Consider frame 44D on the bus, then vary the vehicle's speed. What happens?

Bytes 1, 3, 5 and 7 vary; the values of bytes 1, 3 and 5 are all the same as one another, and are different from byte 7.

Vehicle speed (km/h)	Bytes 1, 3 and 5 (hexadecimal)	Byte 7 (hexadecimal)	Bytes 1, 3 and 5 (decimal)	Byte 7 (decimal)
10	04	08	4	8
20	08	10	8	16
30	0B	18	11	24
40	10	20	16	32
50	13	27	19	40
60	17	2F	23	47
70	1B	38	27	56
80	1F	40	31	64
90	22	47	34	72

19) What do you notice?

The value of byte 7 is more than twice that of the value of the other bytes.

20) Byte 7 corresponds to the average rotational speed of the wheels in rpm. Determine the ∅ of the wheels by calculation, knowing that you have to multiply the decimal value by a coefficient of 10 to obtain the rpm of the wheel.

at 90 km/h, the decimal value of byte 7 is 72:

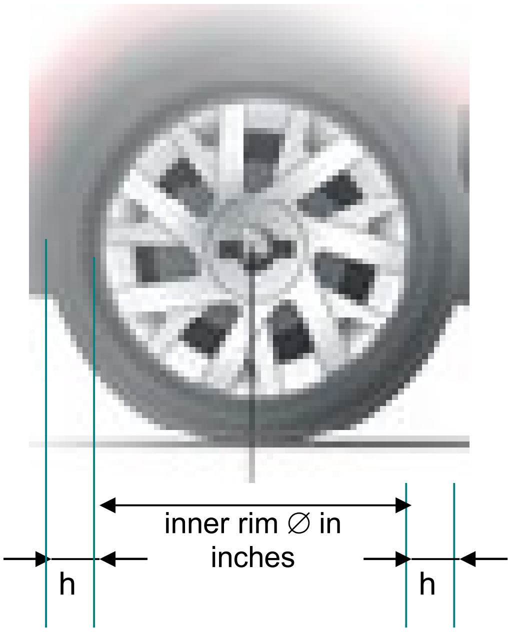
- 72 x 10 = 720 rpm
- 90 km/h => 90/3.6 => 25 m/s
- 720 / 60 = 12 rps
- 25 / 12 = 2.083 m/rotation
- 1 rotation = $2\pi R$
- R = 2.083 / 2π = 0.33 m

∅ = 0.33 x 2 = **0.66 m**

21) If the vehicle has wheels with an inner rim of 16 inches, what is the sidewall height (h) of the tires?

<u>Reminder</u> 1 inch <=> 2.54 cm

The aspect ratio is the height of the sidewall expressed as a % of the tread width
e.g. for a tire marked as 145 / 70 x 13, the sidewall height is 70% of 145 or: h = 70/100 x 145 = 101.5 mm



16 x 2.54 = 40.64 cm

66 – 40.64 = 25.36

25.36 / 2 = 12.68 cm (the value of h)

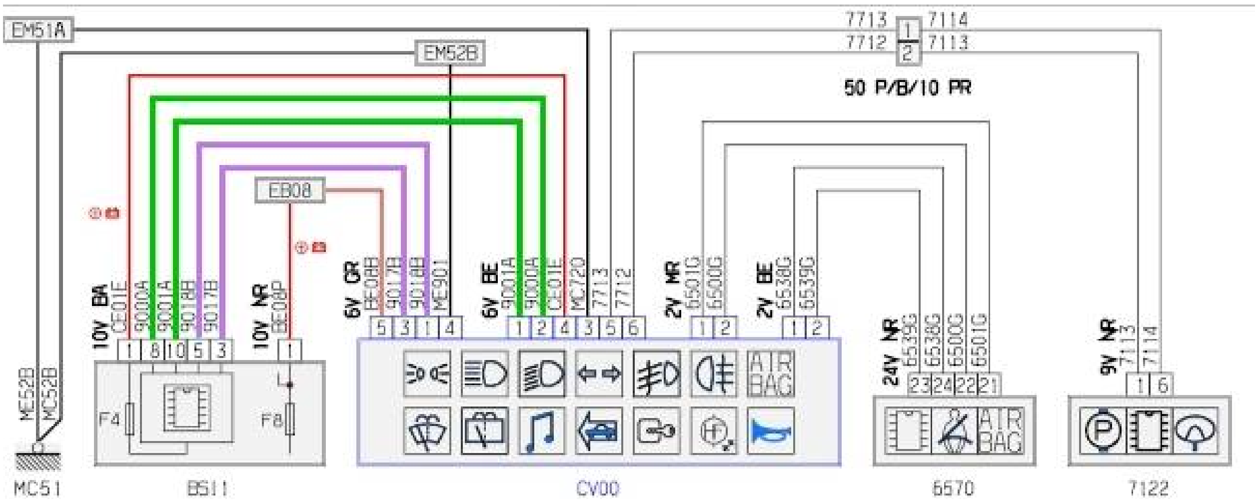
A tire with an aspect ratio of 65 and a tread width of 195 would have this sidewall height (65/100 x 195 = 12.675

⇨ ***195 / 65 x16***

7.3. ANALYSIS OF THE COM 2003 SYSTEM

1) What does the COM 2003 do?

The COM 2003 module manages all windscreen wiping, road lighting and signaling functions. This module receives the high frequency code from the remote control (unlocking/locking the doors and luggage compartment) and sends, via the transponder aerial, the code which disables the immobilization of the ignition and injection control unit. It also hosts the control features for the audio unit and for cruise control/speed limiting.



2) On which multiplexed bus does the COM 2003 manage the road lighting, signaling and windscreen wiping functions?

The COM 2003 manages the road lighting, signaling and windscreen wiping functions on the LS CAN Body bus.

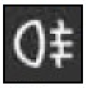
3) Connect the MUXTRACE® software to the LS CAN Body bus. Operate the functions on the COM 2003, and watch the data frames carefully. What are the identifier numbers for the frames which relate to the road lighting, signaling and windscreen wiping controls, and how can the frames be detected?

*The frame with the identifier number **094** contains these controls. It can be identified since the values changes when the switches are actuated.*

4) What is the size of this frame and what numeral system (e.g. binary, decimal, etc.) is used to represent it. ?

This frame has 7 bytes and is written in hexadecimal form.

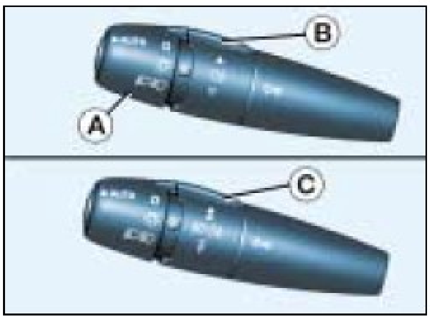
Vehicles fitted with a rear fog lamp (ring B)



Rear fog lamp

This only operates with the dipped/main beam headlamps.

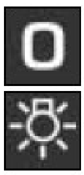
Note: when the lights are switched off automatically, the rear fog lamp and the dipped headlamps will remain on (turn the ring backwards to switch off the rear fog lamp. The dipped headlamps and side lights will then be switched off).



THE LIGHTS STALK

Front and rear lights

Selection is by turning ring A.



Lights off

Side lights

Dipped/main beam headlamps

5) Record the data in frame **094** when each lighting control (using the light stalk) is actuated, and complete the table below:

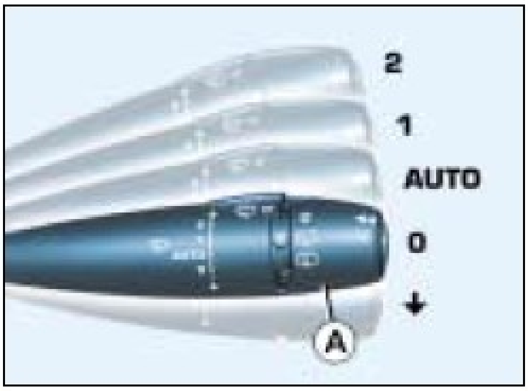
Function controlled	Frame data recorded (hexadecimal)
No actuation	*20 00 00 00 00 00 00*
Sidelamps	*40 00 00 00 00 00 00*
Dipped headlamps	*80 00 00 00 00 00 00*
Main beam headlamps	*98 00 00 00 00 00 00* *Then 80 00 00 00 00 00 00*
Flash of the headlamps (from no actuation setting)	*28 00 00 00 00 00 00* *Then 20 00 00 00 00 00 00*
Activation of foglamps	*84 00 00 00 00 00 00* *Then 80 00 00 00 00 00 00*
Switching off of foglamps	*82 00 00 00 00 00 00* *Then 80 00 00 00 00 00 00*
Activation of automatic lights (from no actuation setting)	*21 00 00 00 00 00 00*

6) What did you notice about the effect of actuating the various light stalk controls on this frame? Can you work out from this the number of bits needed for it to operate?

The light stalk controls only have an effect on the first byte in the frame. The number of bits needed for the coding is thus 8 bits.

7) By referring to the table above, complete the table below:

Function controlled	1st byte in the frame recorded (binary)
No actuation	*0010 0000*
Sidelamps	*0100 0000*
Dipped headlamps	*1000 0000*
Main beam headlamps	*1001 1000*
Flash of the headlamps	*0010 1000*
Activation of the foglamps	*1000 0100*
Switching off of the foglamps	*1000 0010*
Activation of automatic lights	*0010 0001*



Front windscreen wiper with automatic wipe

2 Fast wipe (heavy rain).
1 Normal wipe (moderate rain).
AUTO Automatic wipe.
0 Off.
↓ Single wipe (press downwards).

In the AUTO position, the wiping speed is in proportion to the intensity of the rainfall.

8) Actuate the windscreen wiping controls (using the wiper stalk) and observe the frame – what happens?

The data in the 2nd byte changes.

9) Record frame **094** when each wiper control (using the wiper stalk) is actuated, and complete the table below:

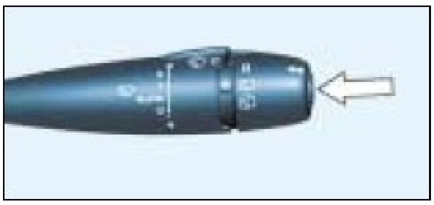
Function controlled	Data in frame 094 (hexadecimal)
No actuation	*00 00 00 00 00 00 00*
Intermittent wipe	*00 10 00 00 00 00 00*
Automatic wipe	*00 20 00 00 00 00 00*
Normal wipe	*00 40 00 00 00 00 00*
Fast wipe	*00 80 00 00 00 00 00*
Windscreen washing	*00 08 00 00 00 00 00*
Navigation through trip computer	*00 01 00 00 00 00 00*

10) What did you notice about the effect of actuating the various wiper stalk controls on this frame? Can you work out from this the number of bits needed for it to operate?

The wiper stalk controls only have an effect on the 2nd byte in the frame. 8 bits are needed.

11) Activate the windscreen washing functions and push the Trip Computer button on the end of the wiper stalk when the stalk is in the "no actuation" position and then in another position. What do you notice? Why is this?

TRIP COMPUTER



Each time the button on the end of the wiper stalk is pressed, the following sequence of data is displayed:

– the remaining range
– the distance travelled
– the average consumption
– the current consumption
– the average speed

The 1st nibble corresponds to the following four positions: no activation, intermittent wipe, automatic wipe, normal/fast speed wipe and the second nibble corresponds to the following positions: windscreen wash and trip computer push button – this is used to navigate through the trip computer and to control the windscreen washing irrespective of the wiper stalk position.

12) By referring to the table above, complete the table below. If there is more than one option, indicate this with an "x"

Function controlled	Data in frame 094, byte No.2 (binary)
No actuation	*0000 0000*
Intermittent wipe	*0001 0000*
Automatic wiping	*0010 0000*
Normal wipe	*0100 0000*
Fast wipe	*1000 0000*
Windscreen washing	*xxxx 1000*
Navigation through trip computer	*xxxx 0001*

13) What do you notice about the results.

All the wiping controls actuated using the wiper stalk are controlled by 1 bit in the first nibble, and the windscreen washing and trip computer controls are controlled by the first and fourth bits of the second nibble.

14) Actuate the left and right direction indicators and the horn. What happens?

The direction indicators result in changes to the 3rd byte and the horn changes the 5th byte.

15) Record the data in frame **094** when each direction indicator and the horn are actuated:

Function controlled	Data in frame 094 (hexadecimal)
No actuation	00 00 00 00 00 00 00
Right-turn indicator	00 00 40 00 00 00 00
Left-turn indicator	00 00 80 00 00 00 00
Horn	00 00 00 00 80 00 00

16) What is the effect on this frame of actuating the various indicator stalk controls? Can you work out from this the number of bits needed for it to operate?

The indicator stalk only has an effect on the 3rd byte of the frame. The number of bits needed is 1 bit. The horn only has an effect on the 5th byte and also only requires 1 bit.

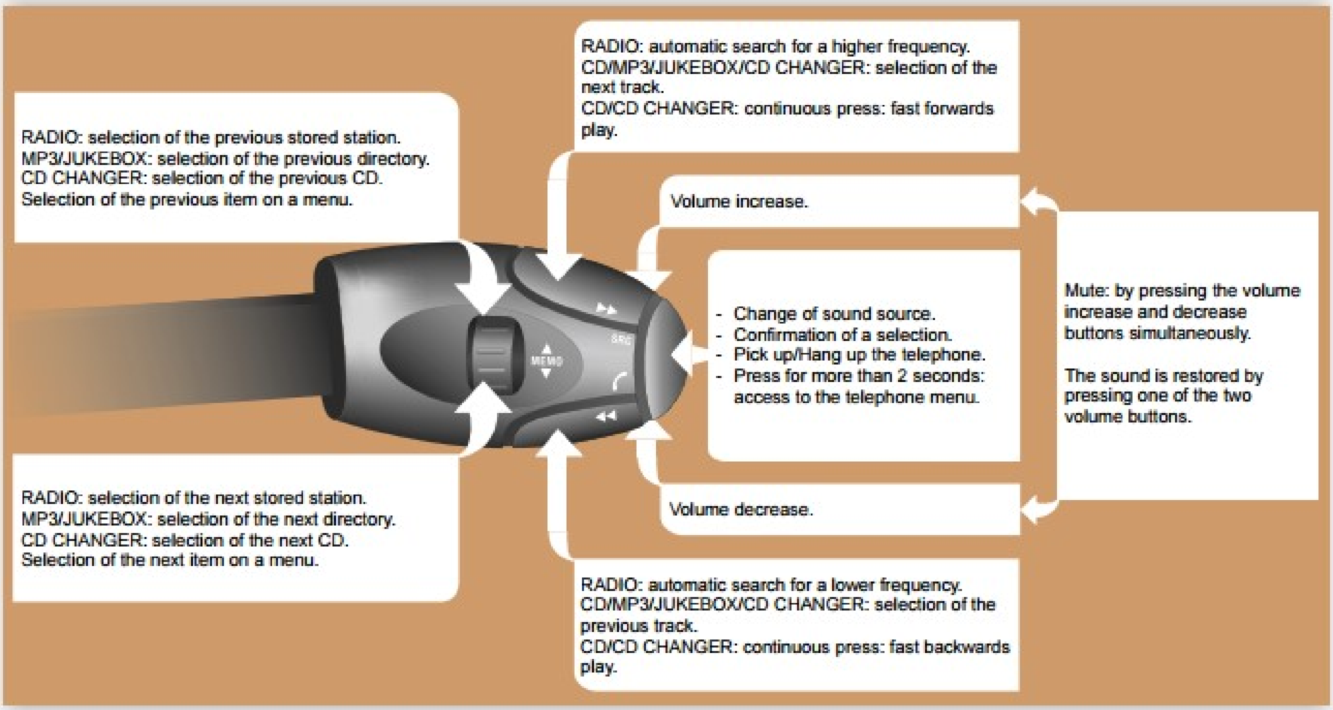
17) By referring to the table above, complete the table below:

Function controlled	Data in frame 094, byte No.3 (binary)
No actuation	0000 0000
Right-turn indicator	0100 0000
Left-turn indicator	1000 0000
Horn (5th byte)	1000 0000 (5th byte)

18) While still connected to the Low Speed CAN bus, determine the identifier for the audio control frame.

The identifier for the audio control frame is ***21F***

19) Record the data in frame 21F when each audio control is actuated, and complete the table below:



Function controlled	Data in frame 21F (hexadecimal)
Push SRC (source)	*02 00 00*
Push vol +	*08 00 00*
Push vol -	*04 00 00*
Push station ++	*80 00 00*
Push station --	*40 00 00*
Stored station thumbwheel	*00 00 00 ⇔ 00 00 FF*

20) How many bits are used to code the stored station thumbwheel and how many stations could theoretically be stored?

*The stored radio stations are coded on the 3rd byte of frame **21F**: 1 byte ⇔ 8 bit.*
FF$_{(hexa)}$ ⇔ 255$_{(decimal)}$ plus zero; 256 stations can thus be coded (2^8=256)

21) Use Muxtrace® to send data:

Send a frame corresponding to each of the controls recorded in the table above to check that these values produce the expected effect.

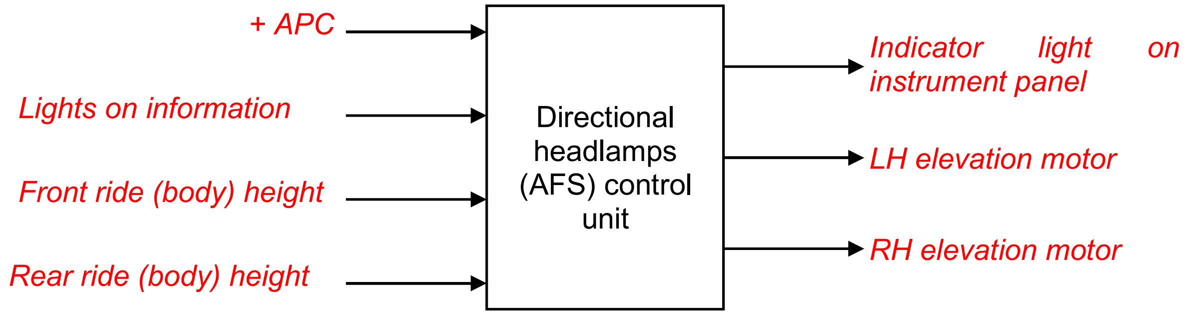
Using MUXTRACE®, assign control frames to a key on your keyboard for the following functions so that you can control these functions from your keyboard: sidelamps, dipped headlamps, flash of the lights, main beam headlamps, foglamps, automatic wiping, normal and fast wipe, audio unit controls, etc.

7.4. DIRECTIONAL HEADLAMPS

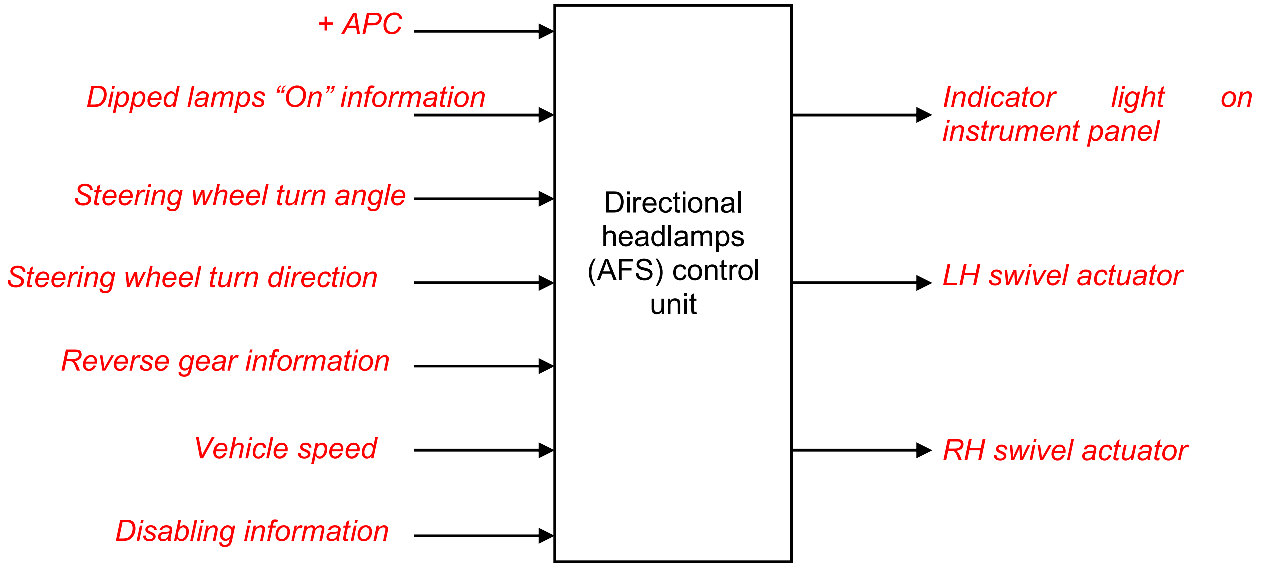
1) What are the two types of correction performed by the “directional headlamps” (or AFS) function?

Elevation correction and swivel correction.

2) What information does the AFS (Adaptive Front-lighting System) control unit need to correct the elevation (i.e. the pivoting in a vertical plane)? Complete the block diagram below to show the control unit’s inputs/outputs.



3) What information does the AFS control unit need to correct the swivel (i.e. the pivoting in a horizontal plane)? Complete the block diagram below to show the control unit’s inputs/outputs.



4) Complete the level A-0 functional analysis for the directional headlamps function by placing the text labels below in the correct location:

- Control unit information, CAN bus

- Luminous flux before correction

- Electrical ω

- Luminous flux after correction

- Front and rear ride (body) height

- Disabling of the function

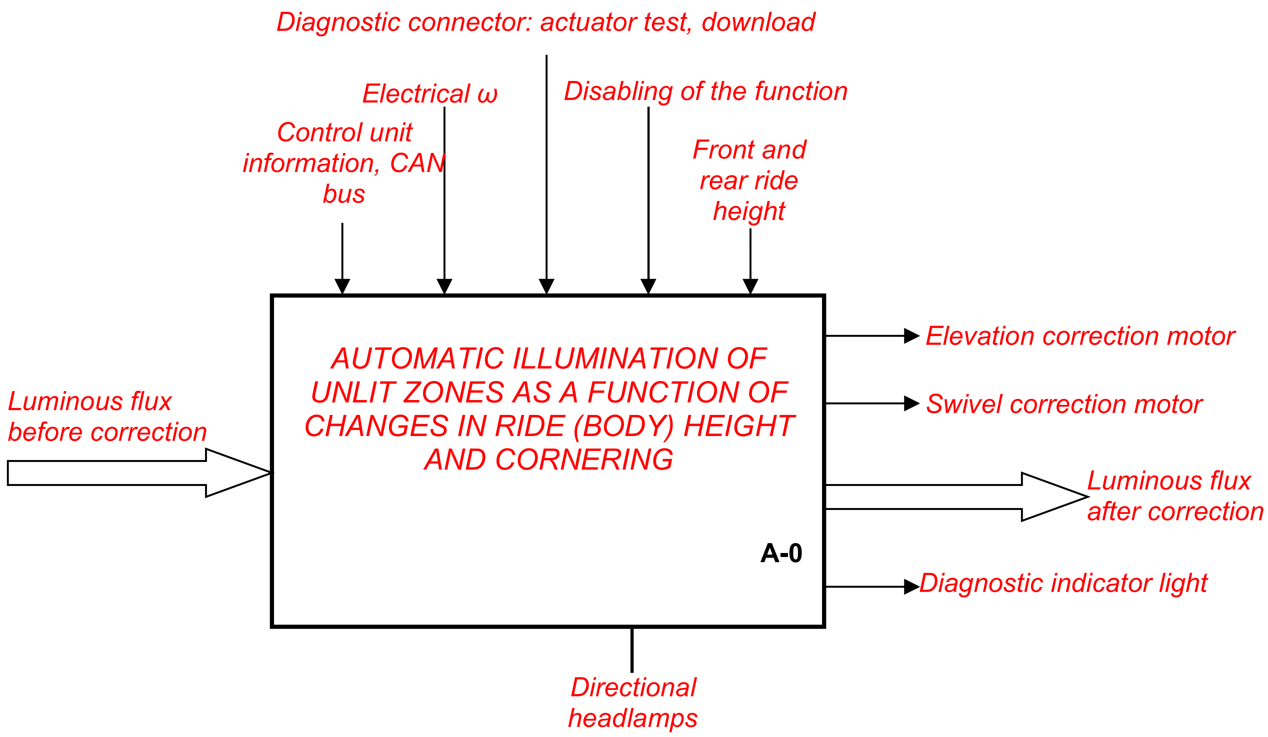
- Directional headlamps

- Elevation correction motor

- Swivel correction motor

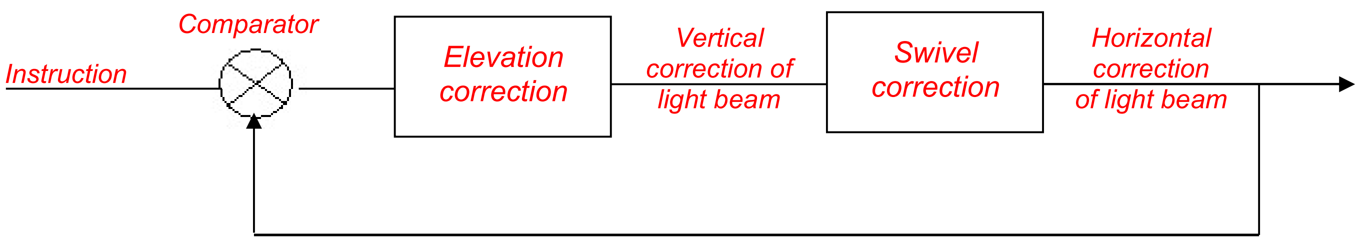
- Diagnostics indicator light

- Diagnostic connector: actuator test, download



5) Complete the servo (or feedback) loop for the directional headlamps using the text labels below:

- Instruction
- Comparator
- Elevation correction
- Swivel correction
- Vertical correction of light beam
- Horizontal correction of the light beam



6) Are the items of information received by the AFS control unit filtered? If they are, for what reasons?

The information received by the AFS control unit is filtered to prevent movement in response to small variations in steering angle; this avoids system instability.

7) What types of lights are fitted to directional headlamps? What are their component parts?

High-intensity discharge lights: they have two electrodes and contain salts and a compressed gas (xenon).

8) Explain the principle of operation for this type of light.

An electric arc is struck between the two electrodes by a very high voltage, of about 25 kV. Once the arc has been made, it is maintained by an 85 V a.c. voltage.

9) What are the benefits of this type of light?

A low electrical power consumption of 35 W for a luminous flux of 3150 lumens, compared with 1500 lumens for an H1 light.

10) Does this device use more than one light to transition from dipped beam to main beam lights? If it does not, how is this transition achieved?

No, the same light provides both dipped beam and main beam. A shielding device, controlled by an electromagnet, blanks off or not a portion of the light beam.

11) Does the AFS control unit directly control the elevation correction stepper motors; if not, how are they controlled?

No, the AFS control unit controls "power modules" which in turn control the elevation and swivel correction stepper motors.

12) What type of link is used (conventionally wired, multiplexed…) between the AFS control unit and the "power modules"? What is this link called, and what is its speed?

The AFS control unit ⇔ Power module link is multiplexed. It is a LIN and operates at a speed of 19.2 kbit/s.

13) Using the inputs and outputs listed below, and by referring to the wiring diagrams (section 6), recreate schematically the electrical architecture for the directional headlamps.

Input data:

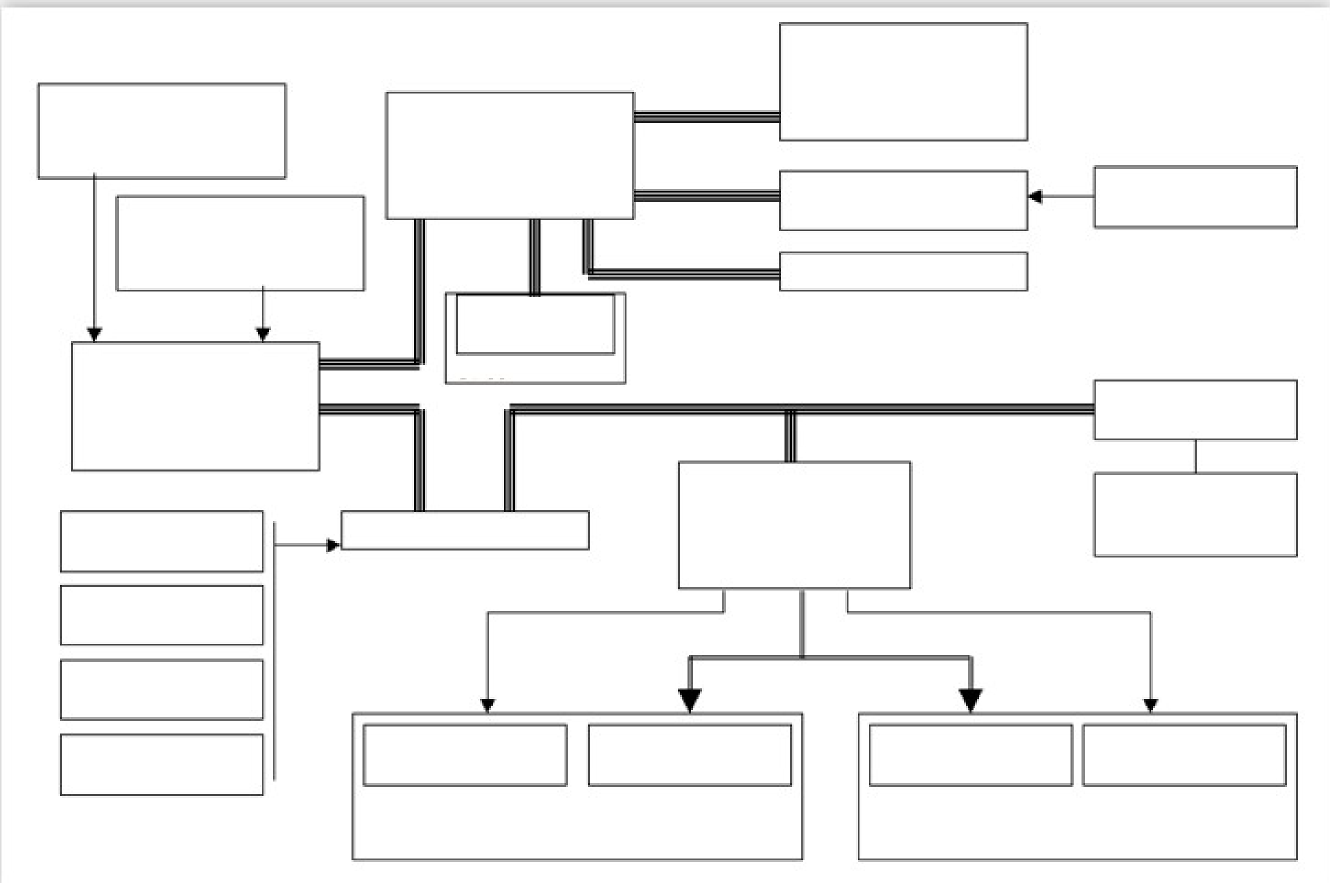
- Front ride (body) height,
- Rear ride (body) height,
- Switching lights on/off,
- Vehicle speed,
- Steering angle,
- Steering direction,
- Reverse gear

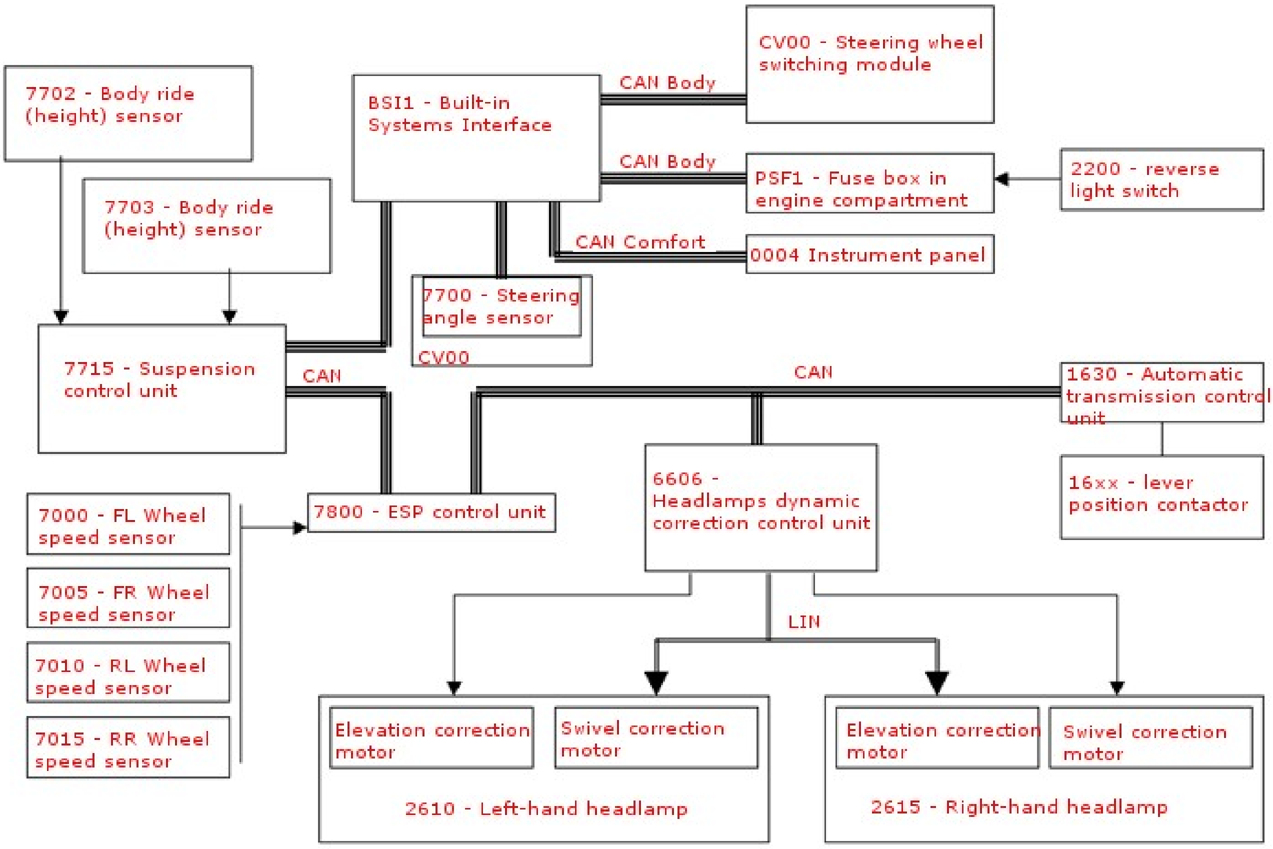
Indicate:

- conv. wired links,
- multiplexed links CAN I/S, CAN COMF,
- CAN BODY or LIN

Controls:

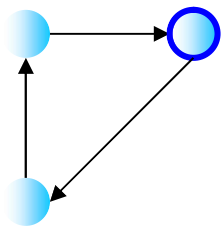
- Indicator light on instrument panel,
- Dynamic elevation correction actuator,
- Swivel actuator




7702 - Body ride (height) sensor
7703 - Body ride (height) sensor
BSI1 - Built-in Systems Interface
CAN Body
CV00 - Steering wheel switching module
CAN Body
PSF1 - Fuse box in engine compartment
2200 - reverse light switch
CAN Comfort
0004 Instrument panel
7700 - Steering angle sensor
CV00
7715 - Suspension control unit
CAN
CAN
1630 - Automatic transmission control unit
16xx - lever position contactor
7000 - FL Wheel speed sensor
7800 - ESP control unit
6606 - Headlamps dynamic correction control unit
7005 - FR Wheel speed sensor
LIN
7010 - RL Wheel speed sensor
7015 - RR Wheel speed sensor
Elevation correction motor
Swivel correction motor
2610 - Left-hand headlamp
Elevation correction motor
Swivel correction motor
2615 - Right-hand headlamp

14) On the model, turn the ignition to "On" and observe the directional headlamps – what movements do they make?

Initialization movements



15) Turn the ignition key to "Off" and then switch it back to "On" straight away. Do the lights repeat the initialization? If they do, what can you conclude from this?

Yes they do. Initialization is necessary when + APC is lost.

16) Place a white board in front of the right-hand headlamp:

- With the steering wheel at the 0° position, make a mark on the board to identify the position of the light beam.
- Make the beam swivel to its farthest left position and mark this position on the white board.
- Make the beam turn to its farthest right position and mark this position on the white board.
- Compare these extreme positions with respect to the central point. What do you notice?

For the right-hand beam, the farthest right position angle is double that of the farthest left position angle.

17) Set the steering wheel to its 30° position and mark the position of the beam on the white board. Set the steering wheel to its 60° position and make another mark to identify the position of the beam on the white board. Reset the steering wheel to its 30° position; the beam returns to its previous position. What do you notice?

The way in which the beam returns is the same, but in reverse, to its outgoing motion.

18) Set the steering wheel to its 90° position and mark the position of the beam on the white board. Return the steering wheel to its 60° position and make another mark to identify the position of the beam on the board; it is different from that marked previously. Set the steering wheel at its 30° position and mark the position of the beam on the board; it is different from that marked previously. What conclusion do you make from this?

In this case, the way in which the beam returns is different from its outgoing motion. The beam returns more quickly to its central position if the steering wheel has exceeded an angle of 80° - this is due to the hysteresis built into the system.

19) On the wiring diagram for the directional headlamps, find the control wires for the swivel actuators on the directional headlamps connector, and complete the tables below.

Type of connector	
Number of channels	*9*
Color	*Black*

Identification of the terminals and wires	
Terminal 4	*CM06D*
Terminal 8	*9043D*
Terminal 9	*ME261*

20) Using the REFLET software or a dual-trace oscilloscope (CL 500), record the signals which pass between:

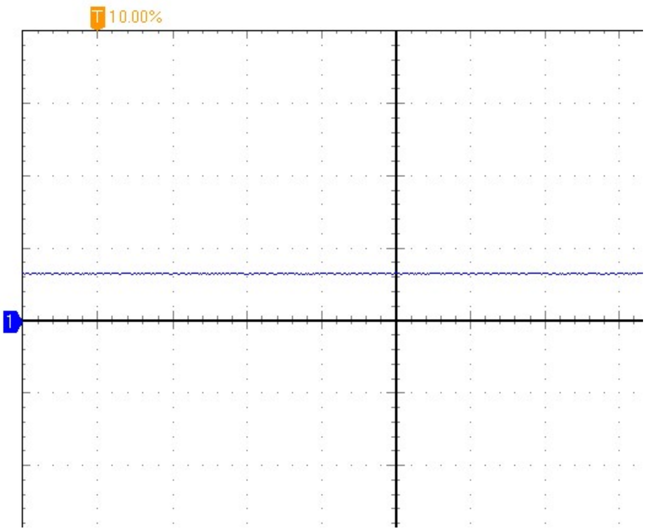
- Terminal 9 and a ground (channel 1)
- Terminal 4 and a ground (channel 2)

Interpret the results for different states:

- *Ignition switch turned to "Off", modules on standby*
- *With ignition switch turned to "Off", wake up the CAN bus (e.g. by opening a door)*
- *Ignition switch turned to "On"*
- *Model ready to operate the directional headlamps*

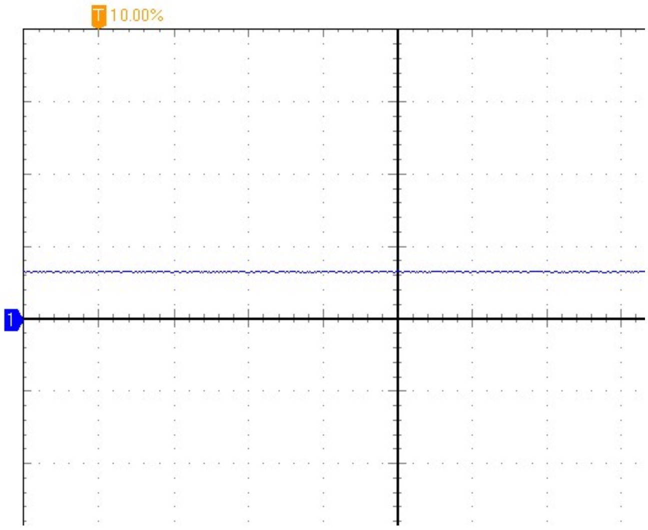
Ignition switch turned to Off, modules on standby:

There is no communication on the LIN bus, no +12 V.



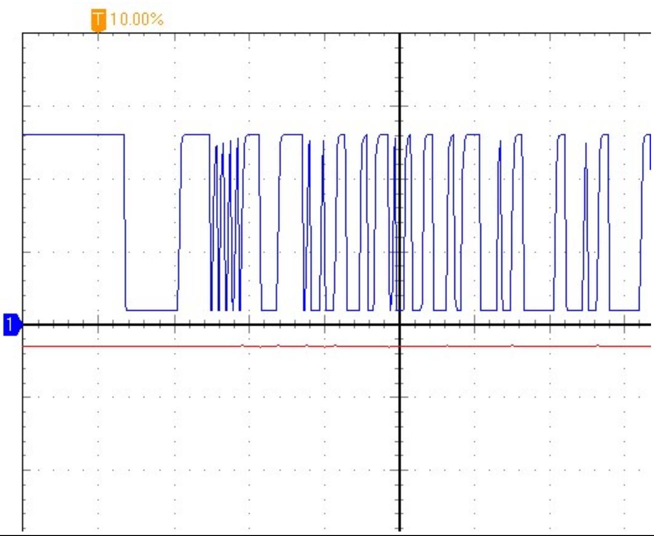
With the ignition switch turned to Off, wake up the CAN bus: (e.g. by opening a door)

Waking up the CAN bus does not have any effect on the LIN, nor on the 12 V for swivel correction.



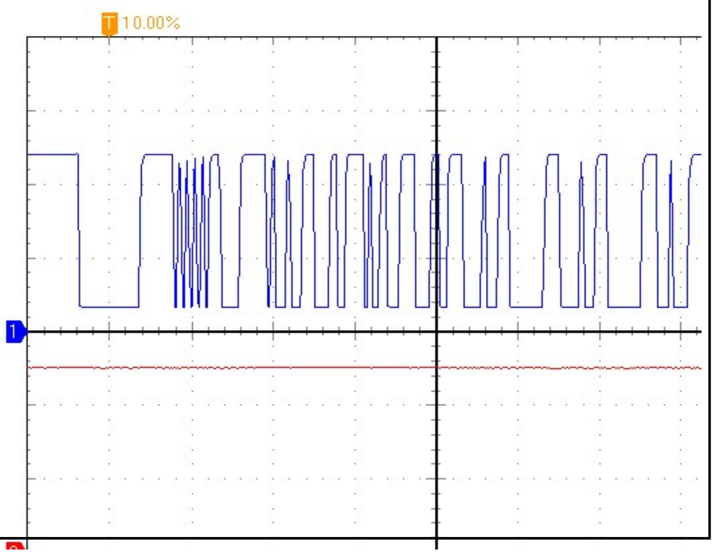
Ignition switch turned to "On":

There is clear evidence of communication on the LIN bus and of a power supply to the swivel corrector.



Model ready to operate the directional headlamps:

There is communication on the LIN bus and a power supply to the swivel corrector.



21) By referring to the wiring diagram on page 66, find the terminals for the ride (body) height sensors on the AFS control unit and complete the tables below.

Identification of the terminals and wires	
Terminal C3	*6604B*
Terminal C1	*6615*
Terminal C2	*6616*
Terminal B3	*6605B*

Type of connector	
Number of channels	*32*
Color	*Blue*

22) Using the EXXOtest® BM211 measurement terminal unit, break-out the wiring harness from the AFS control unit and measure the voltages at terminals C3, C1, C2 and B3 when you vary the ride (body) height sensors. What signals are recorded?

Terminal C1 = +5V power supply for the sensors
Terminal C2 = Ground for the sensors
Terminal B3 = Output signal for the front ride (body) height sensor.
Terminal C3 = Output signal for the rear ride (body) height sensor.

23) Connect a voltmeter across terminal B3 and ground and rotate the front sensor. Complete the table below with the min and max voltages measured for the sensor for the beam positions indicated.

	Beam in high position	Beam in dipped position
Maximum voltage	*-*	*3.43 V*
Minimum voltage	*0.49 V*	*-*

24) Connect a voltmeter across terminal C3 and ground and rotate the rear sensor. Complete the table below with the min and max voltages measured for the sensor for the beam positions indicated.

	Beam in high position	Beam in dipped position
Maximum voltage	*4.05 V*	*-*
Minimum voltage	*-*	*0.46 V*

25) Set the beam at an intermediate position, approximately at the midway point through its travel. This position may be obtained with different combinations of front and rear sensor position. Set the beam in this position for two such combinations and record the sensor voltages each time. Calculate the difference in voltage and compare the results.

	Front sensor voltage	Rear sensor voltage	Difference
Combination 1			
Combination 2			

What can you conclude from this?

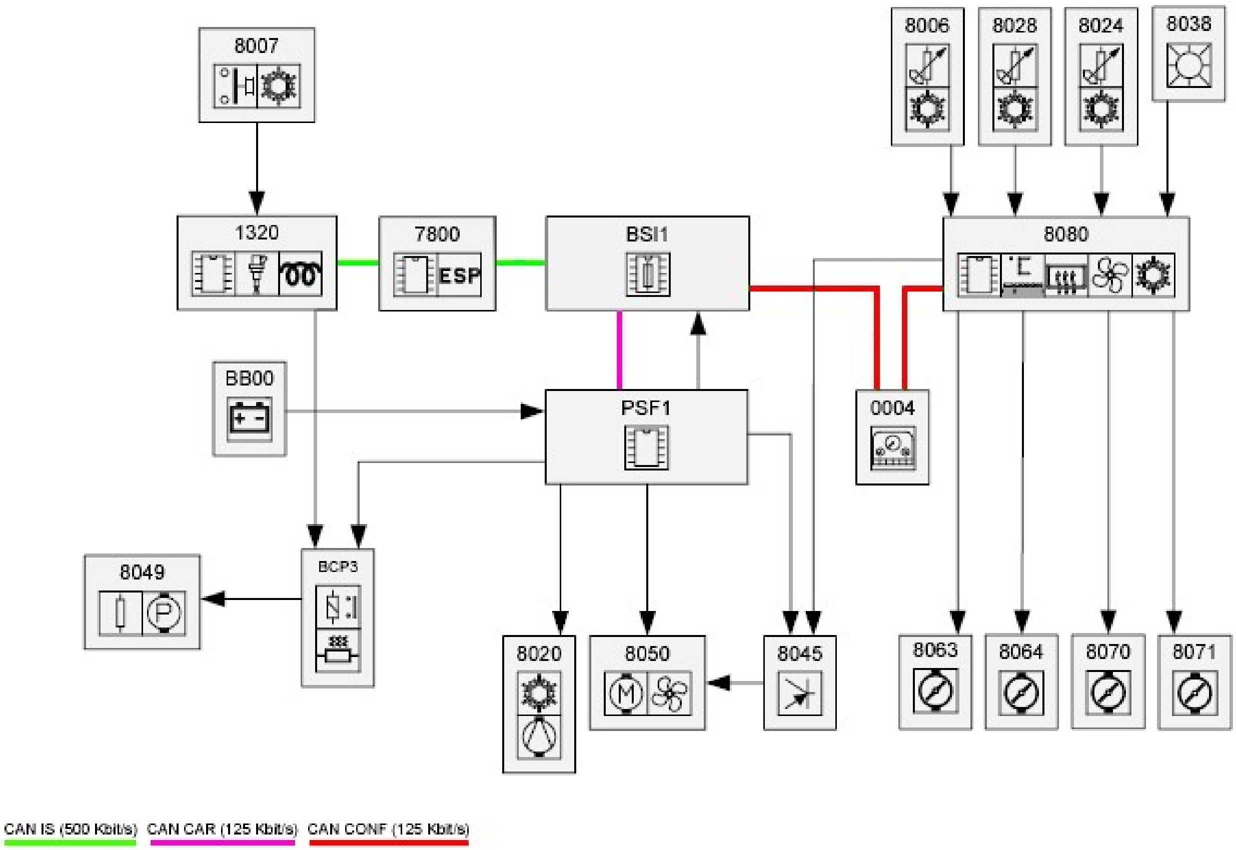
The beam position determined by the control unit is calculated based on the difference in the voltage generated by the rear sensor signal and that generated by the front sensor.

26) Using the model and the manufacturer's documentation, complete the table below.

- Return to Refuge (or default) position => **RR**
- Normal Functioning => **NF**
- No movement, blocked => **B**

Anomaly	Elev. correction		Swivel correction	
	To left	To right	To left	To right
Faulty signal from front ride (body) height sensor	*RR*	*RR*	*RR*	*RR*
Faulty signal from rear ride (body) height sensor	*RR*	*RR*	*RR*	*RR*
Inconsistency in front ride (body) height sensor	*RR*	*RR*	*RR*	*RR*
Inconsistency in rear ride (body) height sensor	*RR*	*RR*	*RR*	*RR*
Loss or drift in steering angle information	*NF*	*NF*	*RR*	*RR*
Faulty RH elevation correction motor	*NF*	*RR*	*RR*	*RR*
Faulty LH swivel correction motor	*NF*	*RR*	*RR*	*B*
Faulty voltage in directional headlamps control unit	*RR*	*RR*	*RR*	*RR*
Faulty directional headlamps control unit	*RR*	*RR*	*RR*	*RR*
LIN bus fault with RH headlamp	*NF*	*RR*	*RR*	*B*
Silent directional headlamps control unit	*RR*	*RR*	*RR*	*RR*
CAN fault, no communication	*RR*	*RR*	*RR*	*RR*
No communication with another control unit/values received are erroneous	*NF*	*NF*	*RR*	*RR*
No communication with the suspension control unit/values received are erroneous	*RR*	*RR*	*RR*	*RR*

7.5. AIR CONDITIONING



1) By referring to the manufacturer's documentation and the block diagram above. Complete the table below:

Code	Name of component	Code	Name of component
BB00	Battery	*8028*	RH passenger compartment temperature sensor
BCP3	*3 relay protection switching unit*	8038	*Light sensor*
BSI1	Built-in Systems Interface	8045	Blower control module
PSF1	*Fuse box in engine compartment*	*8049*	Additional A/C blower resistor module
0004	*Instrument panel*	8050	*Blower motor*
1320	*Ignition and injection control unit*	*8063*	Right side mixer flap motor
7800	*ESP control unit*	8064	*Left side mixer flap motor*
8006	*A/C evaporator temperature sensor*	*8070*	Air inlet flap motor
8007	A/C pressure switch	*8071*	Distribution flap motor
8020	A/C compressor	*8080*	Air conditioning control unit
8024	LH passenger compartment temperature sensor		

2) Complete the block diagram below with the text labels relating to the A/C control unit's inputs/outputs.

- Request from occupants
- Linear pressure switch
- Outside air temperature sensor
- Evaporator temperature sensor
- RH blown air temperature sensor
- LH blown air temperature sensor
- LH mixer flap motor
- Light sensor

- Air inlet flap motor
- Fan motor
- Additionnal heating
- Blower
- Distribution flap motor
- RH mixer flap motor
- LH mixer flap motor
- Compressor

INPUTS		OUTPUTS
Request from occupants		*Compressor*
Linear pressure switch		*Fan motor*
Outside air temperature sensor		*Additional heating*
RH blown air temperature sensor	**Air conditioning control unit**	*Blower*
LH blown air temperature sensor		*Distribution flap motor*
Evaporator temperature sensor		*RH mixer flap motor*
Light sensor		*LH mixer flap motor*
		Air inlet flap motor

3) Based on the manufacturer's documentation and the block diagram, complete the table below by putting a cross in the box corresponding to the network which transmits the information.

INFORMATION	CAN I/S	CAN BODY	CAN COMF
Status of the A/C compressor	*X*		
Incoming air request			*X*
Blower operation authorization		*X*	
Control of the compressor		*X*	
A/C On/Off control			*X*
Motor speed information	*X*		
Evaporator T° information			*X*
Coolant pressure information	*X*		
Vehicle speed information	*X*		
Outside air temperature information			*X*
LH and RH blown air T° information			*X*
Distribution flap motor control			*X*
A/C compressor fault		*X*	
Power relief instruction by disconnecting the compressor	*X*		

1

Using the MUXTRACE®, software, record the frames present on the CAN I/S, CAN BODY and CAN COMF buses.

4) Control the A/C and observe the frames on the CAN COMF bus; what are the identifiers of the frames which relate to air conditioning?

*Identifiers **1D0** and **12D** relate to air conditioning.*

5) How many bytes are used to code these frames?

Frame 1D0 is coded on 7 bytes and frame 12D is coded on 8 bytes.

6) Vary the setpoint temperature on the driver's side (knob 1) and observe these frames. What do you notice?

Byte 6 of frame 1D0 changes when the button is actuated and byte 4 of frame 12D changes after a slight paused when the button is actuated.

7) Set the driver's setpoint temperature to the minimum position (LO) and observe the frames. What do you notice?

Byte 6 of frame 1D0 and byte 4 of frame 12D both change to the hexadecimal value 00.

8) Now set the passenger's setpoint temperature to the max position (HI) and observe the frames. What do you notice?

Byte 6 of frame 1D0 changes to the hexadecimal value 16 and byte 4 of frame 12D changes to the hexadecimal value 64.

9) Convert 64 into decimal.

$64_{(16)}$

$0110_{(2)}$ $0100_{(2)}$

$\boxed{64+32+4 = 100_{(10)}}$

10) What do you think this value relates to?

It relates to the percentage opening of the mixer flap on the driver's side.

11) Repeat the above for the passenger setpoint temperature (knob 2). What do you find?

The results are identical; the driver and passenger temperatures are managed in the same way.

12) Set the distribution flap (button 6) in different positions and complete the table.

Distribution flap	Byte 4, frame 1D0	Decimal value	Byte 2, frame 12D	Decimal value
Footwell	*26*	*38*	*33*	*51*
Footwell/pass. cell	*56*	*86*	*22*	*34*
Passenger cell	*36*	*54*	*01*	*01*
Demisting	*46*	*70*	*64*	*100*
Demisting/footwell	*66*	*102*	*43*	*67*

13) Control the air blower (button 7) and complete the table.

Blower speed	Byte 3, frame 1D0	Decimal value	Byte 1, frame 12D	Decimal value
0	*0F*		*00*	*00*
1	*00*		*01*	*01*
2	*01*		*0A*	*10*
3	*02*		*19*	*25*
4	*03*		*28*	*40*
5	*04*		*37*	*55*
6	*05*		*46*	*70*
7	*06*		*55*	*85*
8	*07*		*64*	*100*

8. CE DECLARATION OF CONFORMITY

By this declaration of conformity under the terms of Electromagnetic Compatibility Directive 2004/108/EC:

ANNECY ELECTRONIQUE S.A.S.
Parc Altaïs – 1, rue Callisto
F74650 CHAVANOD

Declares that the following product:

Make	Reference	Product name
EXXOTEST	**MT-CAN-LIN-BSI**	**BENCHTOP LEARNING MODEL: HS CAN, LS CAN and LIN multiplexing buses**

I - has been manufactured in accordance with the requirements of the following European directives:

- Low Voltage Directive 2006/95/EC of 12 December 2006
- Machinery Directive 98/37/EC of 22 June 1998
- Electromagnetic Compatibility Directive 2004/108/EC of 15 December 2004

and complies with the requirements of standard:

- EN 61326-1:1997 + A1:1998 + A2:2001
  Electrical equipment for measurement, control and laboratory use. EMC requirements.

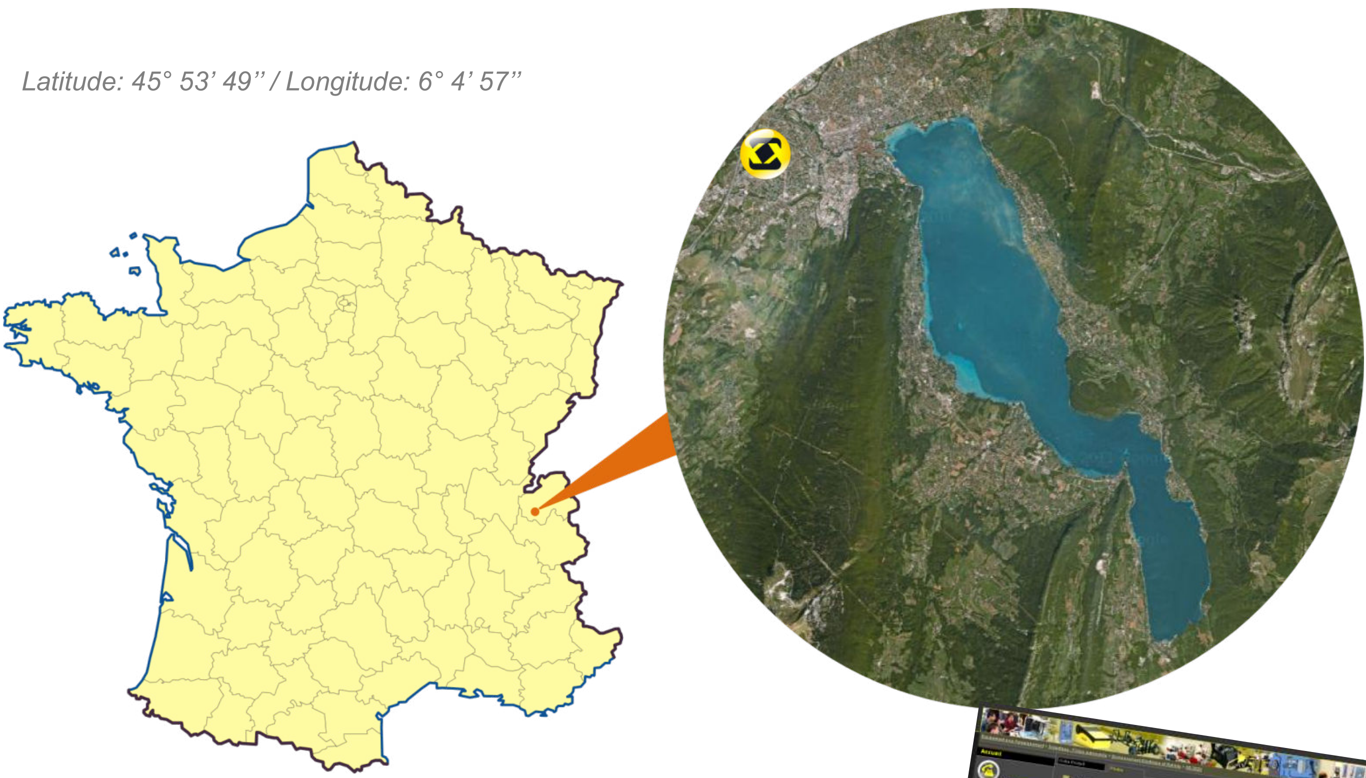
II – has been manufactured in compliance with the requirements of European directives relating to the design of Electrical & Electronic Equipment (EEE) and the management of Waste Electrical & Electronic Equipment (WEEE) in the EU. :

- Directive 2002/96/EC of 27 January 2003 on waste electrical and electronic equipment
- Directive 2002/95/EC of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Signed in Saint-Jorioz on 24 July 2007

Stéphane Sorlin, Chairman

Latitude: 45° 53' 49'' / Longitude: 6° 4' 57''



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