152 - DOBLO' PANORAMA 1.6 Multijet INTRODUCTION - ENGINE STARTING

START&STOP SYSTEM

The Start&Stop device automatically stops the engine each time the vehicle is stationary and starts it again when the driver wants to move off.
In this way, the vehicle efficiency is increased, by reducing consumption, dangerous gas emissions and noise pollution.

The system activates each time the vehicle is started but can be excluded by pressing the dedicated button on the central tunnel at the side of the handbrake.

MAIN COMPONENTS

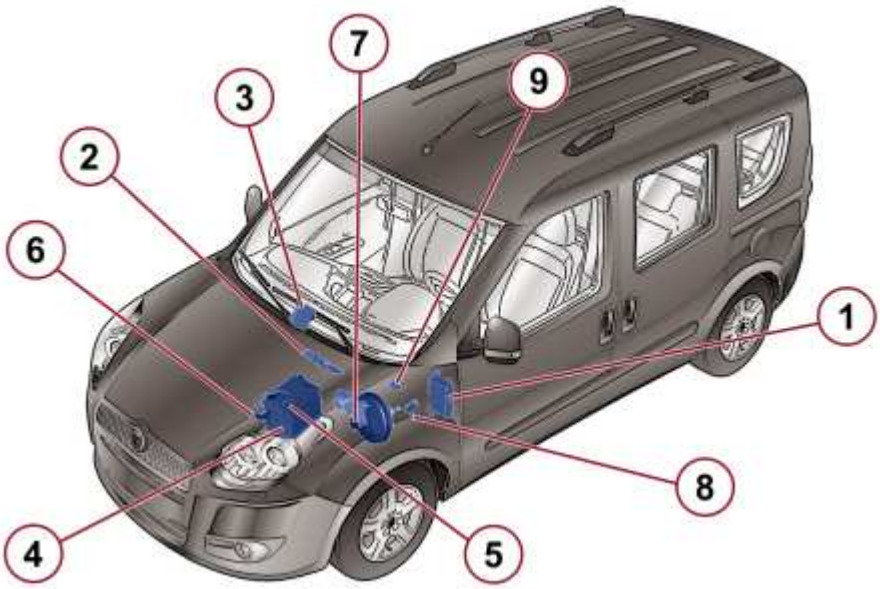
The Start&Stop device is essentially based on a starting system (battery and starter) which can restart the engine quickly and relatively quietly; it can withstand a number of start-ups much higher than traditional systems.
The system contains other hardware and software components (special sensors and control strategies) that manage the stopping and restarting operations without requiring the driver to change their driving style, ensuring the safety, driveability and energy balance of the vehicle with a minimum impact on climate comfort and the accessibility of the on-board services.
In safety conditions, the power unit is switched on and off by appropriate manoeuvres of the accelerator, brake and clutch pedals and the gear lever, which are provided with special sensors.
To guarantee driveability, starting responsiveness (when warm), reliability and safety a more powerful and robust starting system has been adopted.
To prevent voltage drop during the first start-up stages, with a consequent loss of "infotainment" service functionality (radio, etc.), a special voltage stabiliser is used to supply the loads sensitive to voltage drops.

The engine stopping and restarting activation and control strategies are managed by two control units:

- Engine Management Node (NCM);
- Body Computer Node (NBC).

The controls, signals and information necessary to activate the Start&Stop arrive at or come from these two elements, through direct connections or the CAN.
The Engine Management Node and Body Computer Node communicate constantly to establish whether, moment by moment, there are Start&Stop system "integrity" conditions, whether the

system is enabled or whether, on the other hand, it is temporarily or permanently disabled.
The Engine Management Node is the "master" control unit which controls the stopping and the restarting of the engine on the basis of the information acquired on the status of the vehicle and of the components relevant to the Start&Stop system.
The Body Computer acquires part of the information concerning the status of all the vehicle systems that interact with the Start&Stop system and are not directly monitored by the Engine Management Node. It communicates enablement or inhibition (temporary or permanent) to the NCM to switch off the engine or request that the power unit is restarted. In hazardous conditions that compromise safety it forces the NCM to "irreversibly" switch off the power unit; the engine can only then be restarted using the key.
The main system components are illustrated in the diagram.



1. Body computer node
2. Engine management node
3. Voltage stabiliser
4. Battery
5. Battery charge status sensor
6. Dummy negative battery terminal
7: Brake servo pressure sensor
8. Clutch pedal sensor (mechanical gearbox)
9. Neutral position sensor (manual gearbox)

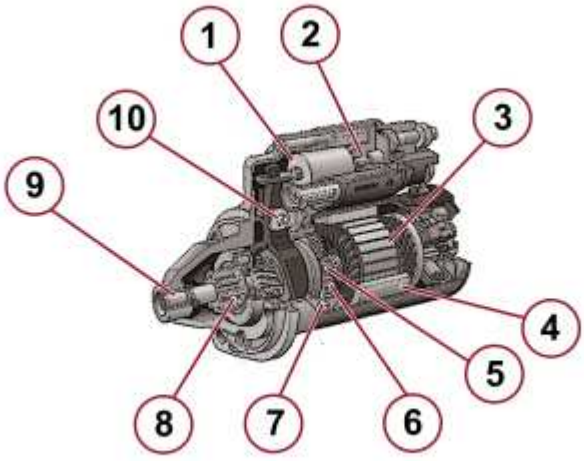
For the versions with robotised gearbox, the Robotised Gearbox Node control unit and the gear lever selector are functional to the Start&Stop system.

Starter

The starter used is more powerful and resistant thanks to the adoption of special improvements which guarantee:

- a vastly superior number of start-ups, by modifying the materials;
- noise reduction during starting, by modifying the materials and geometry;
- starting time reduction, by increasing the power of the starter.

The main starter components are illustrated in the picture.



1. Enamel-lined engagement relay switch
2. Reinforced springs
3. Larger electrical motor
4. Permanent magnets with increased flux and improved resistance to demagnetising
5. Gear reducer with lower reduction ratio
6. Gears with roller bearing
7. Gear reducer with rubber dampers
8. Pinion with a high number of teeth
9. End bush with roller bearing
10. Reinforced lever

Alternator

The alternator has also been increased, with a higher current supply capacity.

Battery

The battery of a car with Start&Stop system is subject to greater electrical stress due to the increased number of start-ups as well as the current supply when the vehicle is stopped (when the alternator is off).
To ensure high reliability the battery capacity has been increased and the "Heavy Duty" type suitable for increased electrical stress has been adopted.

Replacing a heavy duty battery with a regular battery may lead, in addition to reduced availability of the Start&Stop system, to the rapid wear of the battery, with a greatly reduced life.

Voltage stabiliser

The voltage stabiliser maintains a constant voltage for devices sensitive to voltage drops: in particular it is used to supply loads such as the "infotainment" services (radio, etc.) which can reset or switch off during starting.
The voltage stabiliser ensures that the supply voltage of the loads further on in the circuit, during automatic starting, is kept at limits where no power supply problems will occur.

The voltage stabilization function is not, on the other hand, guaranteed during starting using the key.
The Body Computer Node receives a signal from the voltage stabiliser which provides information relating to a possible fault in the component. A possible malfunction in the voltage stabilizer may lead to the radioreceiver cutting out or being reset during a restarting stage.
The voltage stabiliser is fitted under the dashboard, on the passenger side, to the side of the glove compartment:

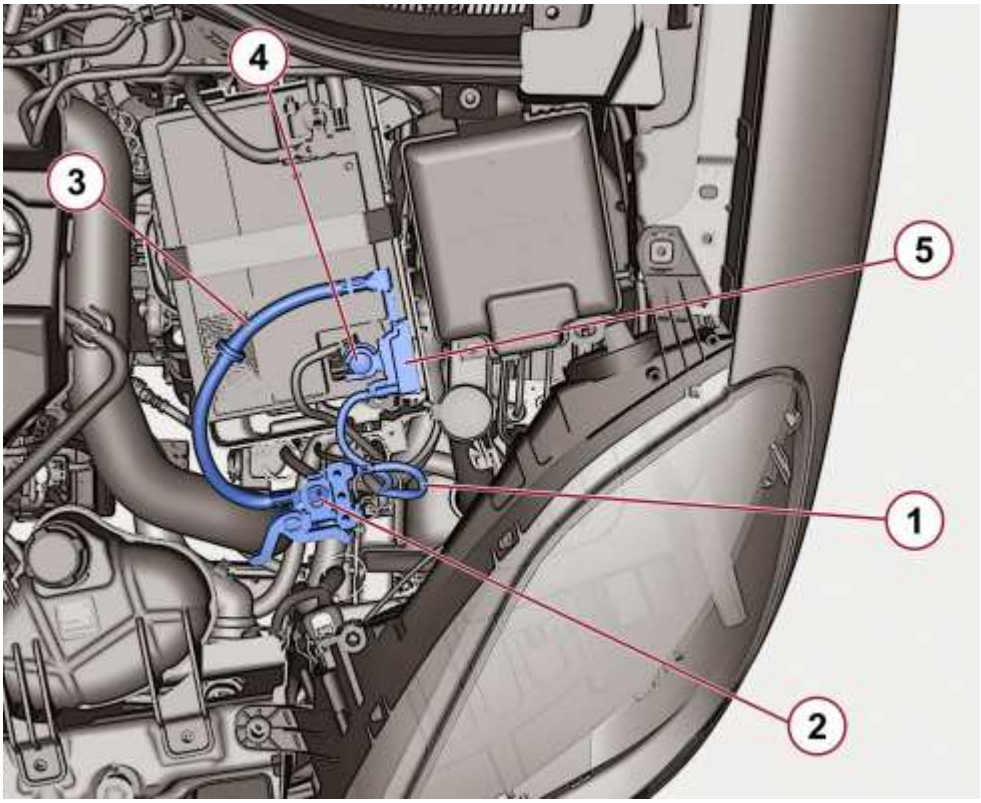
VOLTAGE STABILISER PIN-OUT

PIN	FUNCTION
1	+30 power supply (OUT)
3	Signal for voltage stabiliser diagnosis
4	Power supply +50 from relay switch 2 for starting management T20 (87)
6	Power Supply INT from Body Computer Node
8	Power Supply +30 (IN) from Body Computer Node
9	Setup for power supply +30 (OUT)
16	Chassis earth

Battery status sensor

In addition to modifications to the battery, in order to integrate it with the Start&Stop strategies, a battery status sensor has been introduced (IBS - Intelligent Battery Sensor) that monitors the battery status and notifies the vehicle (in particular the Body Computer Node) to allow the optimum management of the battery within the framework of the Start&Stop strategies.
The sensor is fitted on the battery negative pole.
For Euro 5 versions, the actual negative pole is connected directly to the earth distribution terminal board (called “dummy pole”): the latter is slightly moved and must be considered as a real earth reference.
For Euro 5 Plus and Euro 6 versions, on the other hand, the actual negative pole is replaced by a quick-release terminal (“RADSOK”-type) that connects directly to the power earths of the system (engine/gearbox and body).

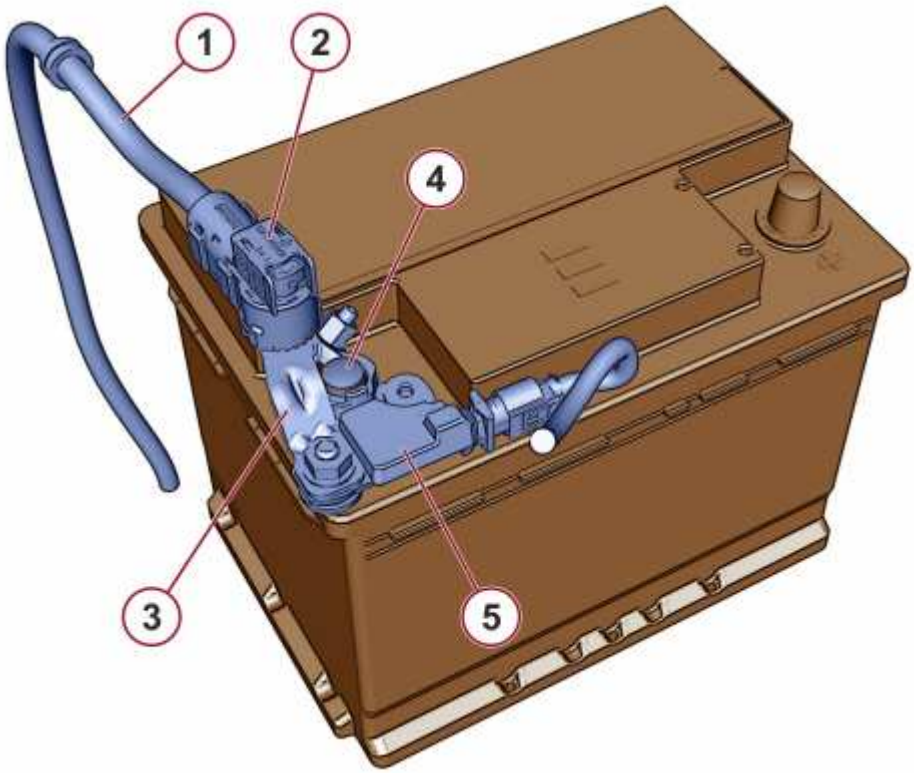
Euro 5 versions



1. Earth lead
2. Battery "dummy pole"
3. Connection between "dummy pole" and battery status sensor
4. Negative battery pole
5. Battery status sensor

Thanks to the "dummy pole" solution there is no connection on the negative battery pole. In this way all current consumption is detected by the IBS sensor: otherwise the battery status could not be evaluated correctly.
The IBS is connected to a line protected by a dedicated fuse in the junction unit, generally with a capacity of 5 A.

Euro 5 Plus/Euro 6 versions



1. Earth lead
2. Quick-release negative terminal (“Radsok” connector)
3. Connection between terminal and battery status sensor
4. Negative battery pole
5. Battery status sensor

Thanks to this solution there can be no connections on the negative pole of the battery, that can compromise operation of the sensor and of the entire system.

Sensor operation

The IBS takes certain measures, using its internal sensors:

- Battery voltage (V);
- Battery current (A);
- Battery temperature (°C).

The IBS internally processes these values and calculates the parameters which express the battery status:

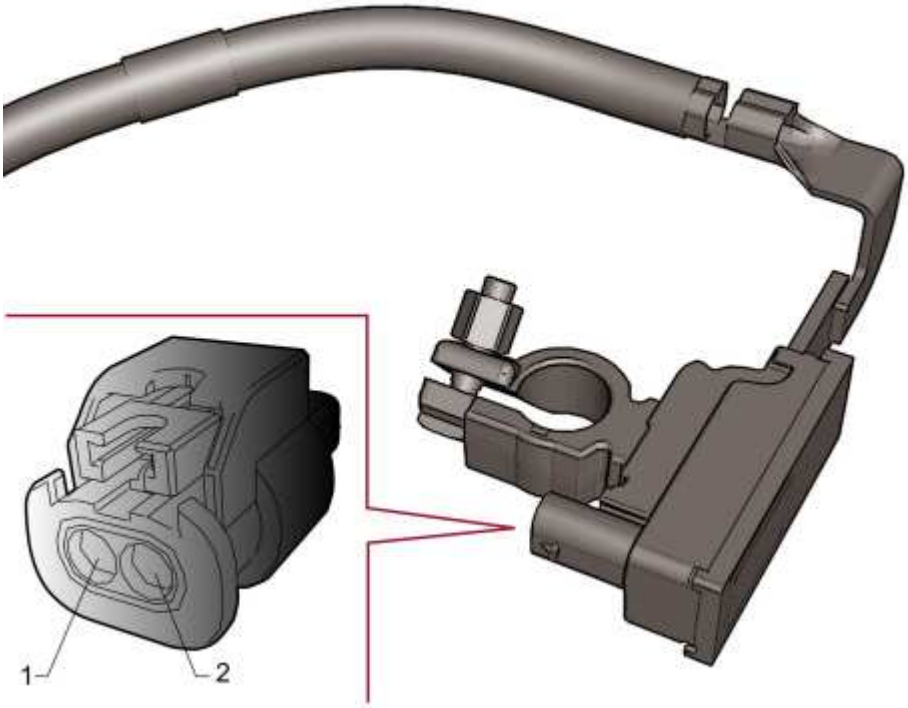
- SOC = State Of Charge: percentage of the battery's residual charge as compared to its nominal capacity. In practice, it indicates the battery charge.
- SOH = State Of Health: indicates the battery's ageing. It indicates the actual battery capacity, as a %, in relation to the rated capacity. The reading is due to the fact that, during operation, the battery is subject to irreversible processes that reduce its capacity to be recharged and supply energy (ageing of the battery).
- SOF = State Of Function: minimum voltage peak that can be reached during the next engine start-up, in volts.

These three parameters identify the start-up capacity of the battery:

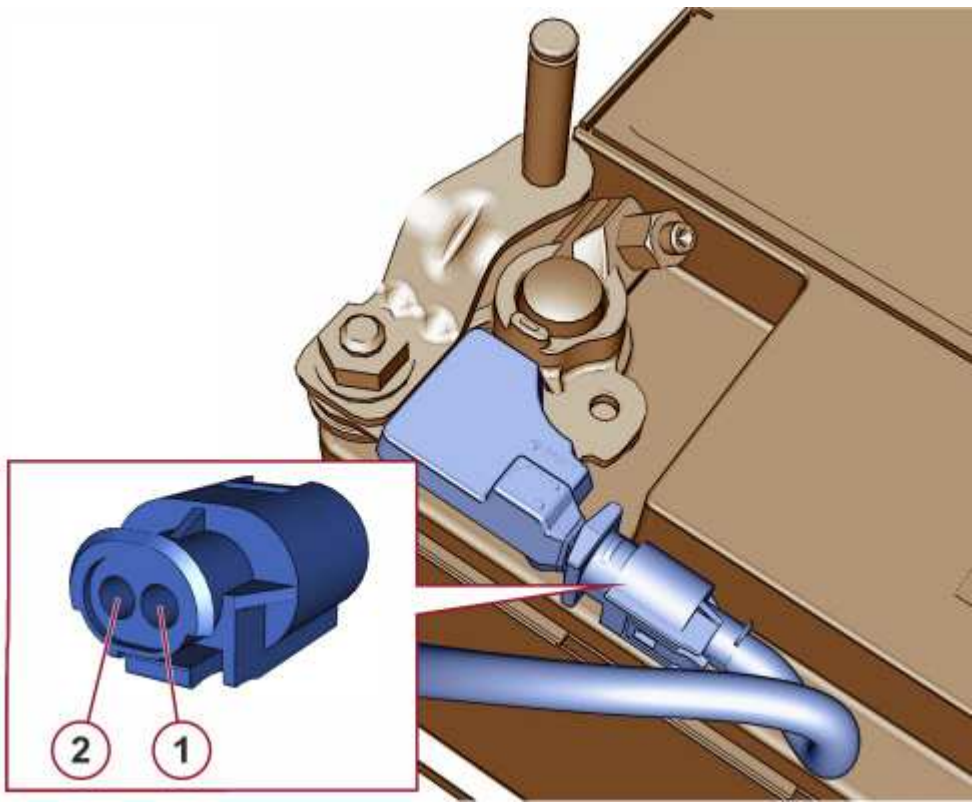
- in the event of a low SOC or SOH the battery might not be able to restart the engine;
- in the case of a low SOF the battery voltage during starting may be too low for the correct operation of the vehicle's electronic control units.

The following figures show the IBS sensor connector, which is also connected to the car's electric network nodes with a LIN communication line.

Euro 5 versions



Euro 5 Plus/Euro 6 versions

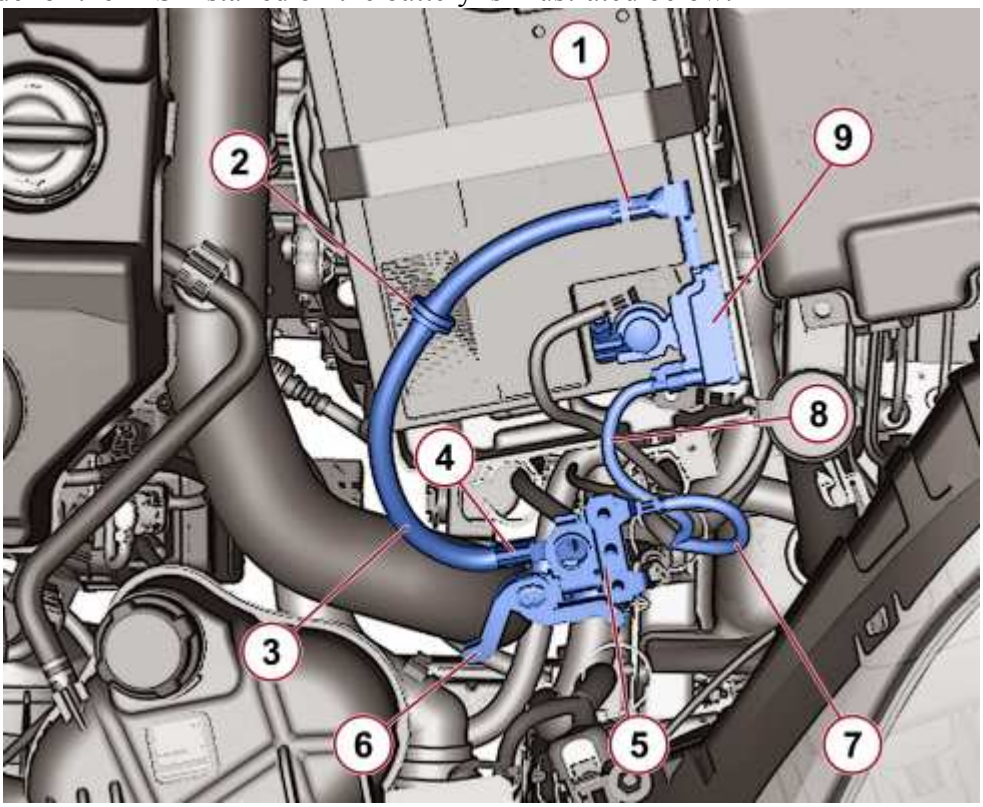


IBS SENSOR PIN-OUT

PIN	FUNCTION
1	LIN serial communication line
2	Power supply +30 from F87 engine compartment junction unit

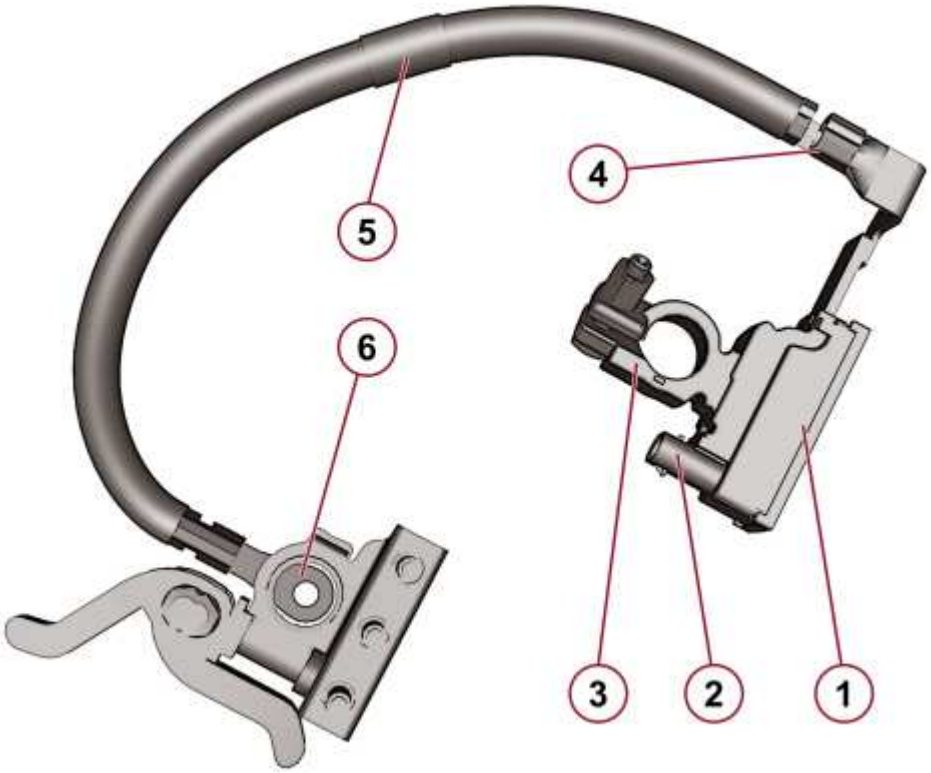
Installation (euro 5 versions)

The 3D model of the IBS installed on the battery is illustrated below.



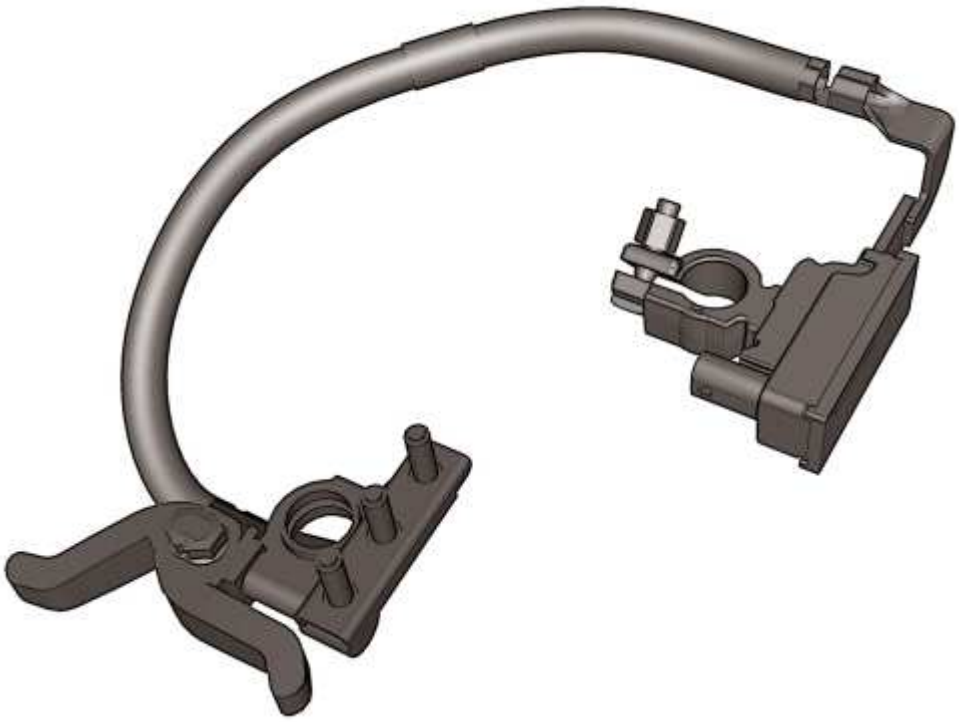
1. Terminal
2. Vibration damper rubber mounting (if fitted)
3. IBS earth lead
4. Terminal with eyelet
5. Distribution terminal
6. Quick release terminal
7. Earth lead
8. Communication and power supply lead
9. IBS (Intelligent Battery Sensor)

The IBS assembly is illustrated below.



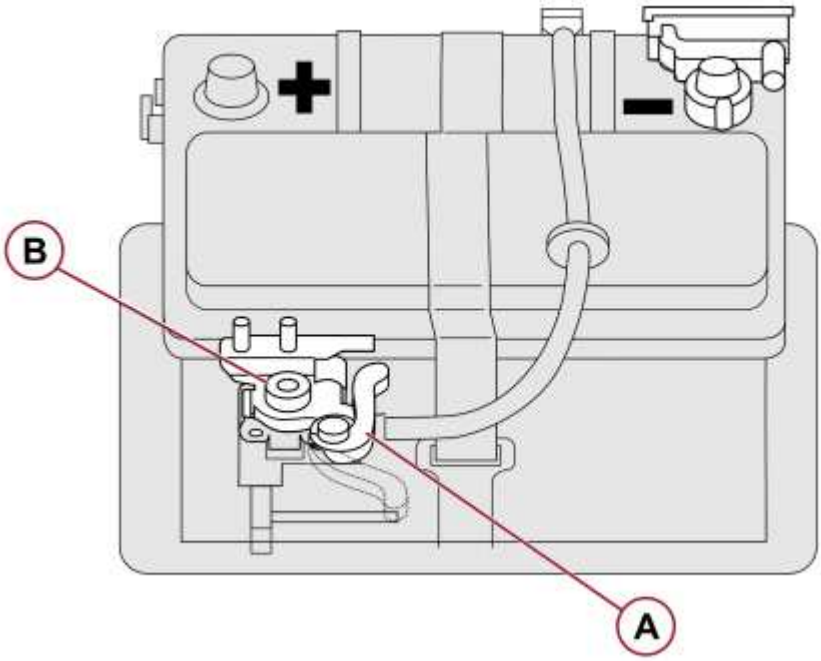
1. Sensor
2. LIN connector and power supply (+)
3. Connection at the battery pole (-)
4. Terminal
5. Damper rubber mounting
6. Terminal with eyelet

A 3D model of the IBS assembly, connected to the negative dummy pole is illustrated below.



Negative pole disconnection (euro 5 versions)

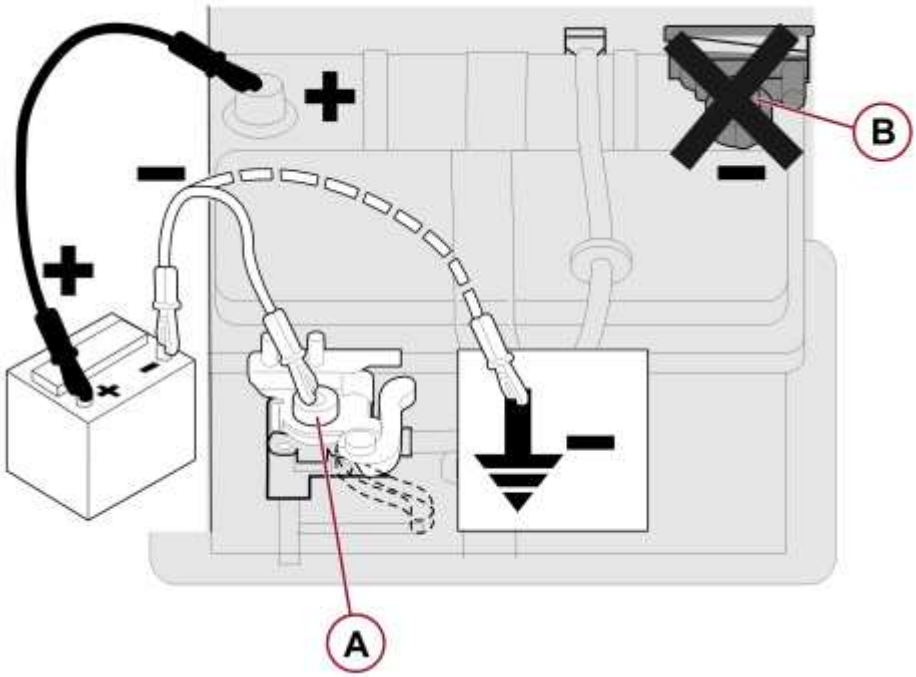
To disconnect the negative pole, adjust the quick release terminal A disconnecting it from the negative dummy pole B.



A. Quick release terminal
B. Negative dummy pole

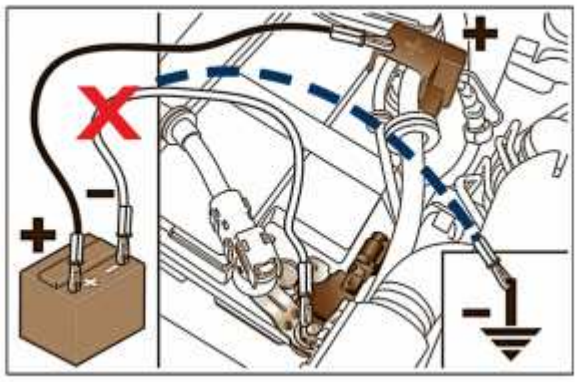
Jump starting (euro 5 versions)

In case of jump starting, never connect the negative cable (-) of the auxiliary battery to the negative pole **B** of the car battery, but rather to either the dummy pole **A** or to an earth point.



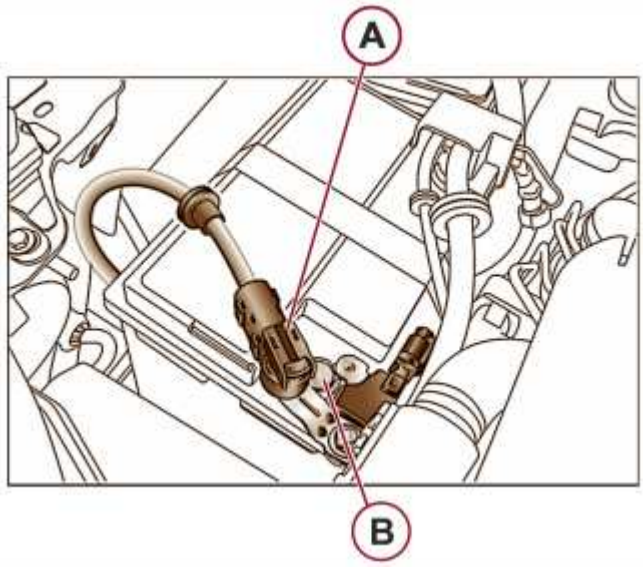
Jump starting (euro 5 plus/euro 6 versions)

In case of jump starting, never connect the negative lead (-) of the auxiliary battery to the negative pole of the car battery, but rather to an earth point on the engine or gearbox.



Battery recharging (euro 5 plus/euro 6 versions)

To charge the battery, proceed as follows:
- disconnect the terminal **A** (pressing the red button) from the IBS sensor monitoring the battery conditions, on the negative pole of the same battery;
- connect the positive cable of the device to the positive pole of the battery and the negative cable to the **B** pole;
- turn on the battery charger. After the recharge, turn the charger off before disconnecting it from the battery;
- after disconnecting the battery charger, reconnect the quick-release negative terminal **A**;



Ibs sensor recalibration

When the IBS receives a power supply for the first time or receives a power supply after a break in supply, it enters a so-called "recalibration" stage in which the IBS must recognise the type of battery, its specifications and its status.
During this stage the tolerances for the status variables (SOC, SOF, SOH) are higher than in normal operating conditions.
The IBS exits from the recalibration stage when the SOC and SOF evaluations are within the tolerances: this occurs after a rest stage (engine off) of at least 4 hours followed by a start-up.

Vacuum sensor on brake servo

The Engine Management Node acquires information about the brake servo circuit vacuum by means of a vacuum sensor, switch on/off type.

Neutral sensor (manual gearbox)

The Engine Management Node acquires information on the engagement of neutral from a dedicated sensor fitted on the gearbox.

Clutch sensor (manual gearbox)

The Engine Management Node receives, from the rotary sensor associated with the clutch pedal, a value which can be:

- HIGH (pedal not pressed),
- MIDDLE (pedal partly pressed),
- LOW (pedal pressed).

OPERATION

The system operates every time the car is started.
Engine stopping mode (versions with manual gearbox)

With car almost at a standstill (speed lower than 3 km/h for more than 0.5 seconds and accelerator pedal released), the engine stops if the following manoeuvres are made:

- gearbox in neutral,
- clutch pedal released.

Engine stopping mode (versions with robotised gearbox)
The engine cuts out if the vehicle stops and the brake pedal is depressed.
This condition can be maintained even if the brake pedal is not depressed, if the gear lever is in position N (Neutral).
Engine stopping is signalled, on both versions, by the dedicated warning light on the instrument panel display.

The engine can only be stopped automatically after a speed of about 10 km/h is reached, to prevent the engine from being repeatedly stopped when driving at walking pace.

Engine restarting mode (versions with manual gearbox)
The engine is automatically restarted when the clutch is depressed.
When the gearbox is not in neutral (caused by the forced engagement of a gear whilst the engine is stopped), the clutch should be fully depressed, whilst if the gearbox is in neutral restarting takes place with the clutch not yet fully depressed in order to facilitate quick starting.
In practice driving behaviour does not change: once the driver has decided to set off, he will press the clutch to re-engage gear: at this point the engine will already have been restarted and the vehicle is ready to set off again.

Engine restarting mode (versions with robotised gearbox)
The engine is restarted automatically when the gear lever is moved from the N position to any other driving position.
In the same way the engine is restarted, if the brake pedal is pressed and then released and the gear lever is moved to the UP (+), DOWN (-) or reverse (R) position.

For vehicles with robotised gearbox, in the event of automatic engine stopping with the vehicle on a slope, the engine must be restarted by moving the gear lever towards (+) or (-) without releasing the brake pedal.

For vehicles with robotised gearbox and Hill Holder function (versions with ESP), in the event of automatic engine stopping with the vehicle on a slope, the engine must be restarted by moving the gear lever towards (+) or (-) without releasing the brake pedal, so that the Hill Holder function, active only with the engine running, becomes available.

Manual activation and deactivation

The device can be activated/deactivated through the button located on the central tunnel to the side of the handbrake.
When the system is deactivated, the button LED switches on.
The versions provided with instrument panel equipped with multifunction display provide additional indications and messages concerning the system's activation/deactivation.

1. Start&Stop function deactivation/activation button
2. Start&Stop deactivation warning light

DISPLAY IN INSTRUMENT PANEL

The instrument panel display shows additional information (messages) concerning the system's deactivation or activation, according to the logic described below:
The S&S icon only switches on when the engine switches off after one of the S&S strategies is actuated. When the engine is key-started or the S&S is disabled due to a fault or a safety condition and the engine is off, the dedicated icon remains off.
If one of the expected fault conditions occurs, the "S&S system fault" warning light and the "general failure" warning light switch on in the MODAL instrument panel or only the "general failure" warning light switches on with a dedicated message on the display in the COMFORT panel.
The messages on the display inform the driver about the different situations concerning the Start&Stop system operation.

The possible messages are:

- "Start&Stop disabled" or "Start&Stop enabled", displayed when the corresponding button is pressed. The display is temporary and occurs with the engine switched on or off.
- "Start&Stop not available" is displayed in the event of temporary unavailability or permanent fault. The display is temporary and can occur with engine switched on or off.
- "Press clutch pedal" is displayed when, with the engine off and the gear engaged, the engine must be restarted. The display is temporary and occurs only with the engine off.

BUZZER

When the Start&Stop switches off the engine, if the driver:

- unfastens his/her seat belt;
- opens the driver's door or the passenger door,

the text message on the display, indicating that the Start&Stop is not available, is accompanied by an acoustic signal.
For safety reasons, in this situation the engine can only be restarted using the ignition key.

CONTROL LOGIC

Engine stopping failure conditions

With the Start&Stop device activated, the engine cannot be automatically stopped for a series of conditions due to the operation of the engine and the vehicle linked to safety and comfort conditions and reduction of emissions.
The Engine Management Node control unit controls the engine directly and therefore is delegated to managing stopping and restarting and therefore decides when and whether to stop the engine automatically; the Body Computer Node communicates with the engine control unit and can request that the engine is not switched off in certain conditions.

Below is a list of all the conditions in which the engine is not stopped:

- engine still cold (the signal from the engine coolant temperature sensor is outside of a range of values between 40°C and 100°C);
- battery not sufficiently charged (charge state lower than 75%) or battery charge sensor malfunction;
- low braking system vacuum (the Engine Management Node control unit prevents the engine from being stopped if the vacuum sensor indicates that the pressure in the braking system is too low);
- particulate filter regeneration in progress (diesel engines with DPF only);
- voltage stabiliser malfunction;
- heated rear screen activated (assuming the driver wishes to demist the windows, it is advisable for the engine to remain running to have hot air and/or air conditioning available);
- windscreen wiper operating at maximum speed for more than 4 seconds (in this condition it is assumed that the weather conditions are adverse and so it is preferable to have maximum driving comfort);
- driver's door not shut;
- driver's seat belt not fastened;
- reverse gear engaged (in this way the driveability during parking manoeuvres is not compromised);
- with automatic climate control system on, if an adequate level of thermal comfort has not been reached (difference between the climate control temperature set by the customer and the temperature inside the passenger compartment greater than 4°C) or MAX-DEF function activation;
- alternator malfunction (in the event of malfunction stopping the engine is not allowed);
- bonnet open (on versions with bonnet switch, the engine cannot be automatically stopped if the bonnet is open);
- during the first period of use, to initialise the system;
- particularly cold outside temperature, if the corresponding indication is provided.

The engine also does not stop when a malfunction of some sensors or systems is detected:

- accelerator pedal;
- brake pedal;

- brake servo vacuum sensor;
- water temperature sensor in the engine;
- wheel speed sensors;
- switch on clutch pedal (manual gearbox);
- engine rpm sensor;
- camshaft sensor;
- reversing engagement switch;
- engine or Engine Management Node control unit;
- robotised gearbox or Robotised Gearbox Node control unit.

In the above cases there is an information message in the multifunction display and, where provided, the warning light will flash on the instrument panel.

Automatic restart conditions

When the vehicle is at standstill, under certain circumstances the engine may restart automatically without any intervention by the driver due to comfort, emission control and safety reasons.
The conditions that lead to the automatic restarting of the engine can be detected and managed by the Body Computer Node or the engine control unit, but automatic restarting is always controlled and managed by the Engine Management Node control unit.
If the gearbox is not in neutral, a message on the instrument panel display requests the driver to press the clutch pedal to allow safe engine restarting.

The engine is forced to restart automatically, without any action by the driver, under particular conditions, such as:

- reduced braking system vacuum (if the vacuum sensor provides a very low value, indicating that there may be a deterioration in the braking capacity). This prevents undesired movement of the car with the engine off on a gradient due to possible brake servo failure.
- car in motion: if the car speed exceeds 5 km/h. This avoids dangerous situations due to failure of the engine brake on gradients.
- vehicle stopped for too long (the engine is restarted if it has been stopped by the Start&Stop system for more than 160 seconds, provided that the gear lever is still in neutral).
- reverse engaged (this measure is adopted in order not to compromise driveability during parking manoeuvres);
- cold engine; the engine control unit forces the automatic restarting of the engine if the engine coolant temperature sensor signal is less than about 30°C, because in this case the reduction in consumption and emissions derived from the Start&Stop system is not guaranteed;
- catalytic converter temperature below 0°C;
- handbrake applied with the car moving: if the handbrake is applied whilst the vehicle is moving with the engine stopped at a speed higher than 3 km/h. This is a further safety measure to prevent dangerous situations due to engine brake failure on a gradient;
- particulate filter regeneration in progress (diesel engines with DPF only);
- battery not sufficiently charged (state of charge lower than 70%);
- battery charge status sensor fault (IBS);
- especially cold outside temperature;
- with automatic climate control system, if the difference between the climate control temperature set by the customer and the temperature inside the passenger compartment is greater than 7°C, or MAX-DEF function is activated.
- windscreen wiper operating at maximum speed for more than 4 seconds.

With a gear engaged, the engine can be automatically restarted only by fully depressing the clutch pedal. The driver is asked to perform this operation through a message in the multifunction display and by the warning light on the instrument panel flashing.
If the clutch is not pressed, when approx. three minutes have elapsed since the engine was stopped, the engine can only be restarted using the key.

In cases of undesired engine stops, due for example to the clutch pedal being released abruptly with a gear engaged, if the Start&Stop system is activated, the engine can be restarted by fully depressing the clutch pedal or by placing the gear lever in neutral.

Safety functions

In some cases, after the engine has been automatically stopped through the intervention of the Start&Stop, it is possible that the automatic restarting requested by the driver is not carried out. Under these circumstances, restarting is only possible through manual intervention by the driver using the key.
This function is managed by the Engine Management Node and the Body Computer Node control units.

The conditions that prevent automatic restarting for safety reasons are:

- the driver unfastens his/her seat belt and opens the driver's door or the passenger door. The driver is notified of this condition both by a buzzer and through an information message in the display and by the warning light on the instrument panel flashing.
- many unsuccessful automatic start-up attempts, if the maximum number (5) of failed engine automatic start-up attempts is exceeded, this threshold is set to avoid damaging the starter by too many successive attempts;
- the driver has been prompted to perform an action but did not perform it in time (175 second timeout from when the engine stops); for example if an automatic engine restart attempt is unsuccessful as a result of a failure to press the clutch or because the gearbox is not in neutral and the driver is then requested to allow automatic restarting by pressing the clutch or engaging neutral, the engine can only be restarted using the ignition key after 175 seconds have elapsed from the engine stopping;
- if the engine bonnet is open.

Automatic restarting is also prevented when a malfunction of some sensors or systems is detected:

- accelerator pedal;
- brake pedal;
- brake servo vacuum sensor;
- water temperature sensor in the engine;
- vehicle speed;
- clutch pedal switch (manual gearbox);
- neutral sensor;
- engine rpm sensor;
- camshaft sensor;
- reversing engagement switch;
- engine or Engine Management Node control unit;
- robotised gearbox or Robotised Gearbox Node control unit.

"energy saving" function

If, after the engine has been automatically restarted, the driver does not take any action for a period of about three minutes, the Start&Stop system will definitively stop the engine to avoid fuel consumption. The engine can only be started using the key in such cases.

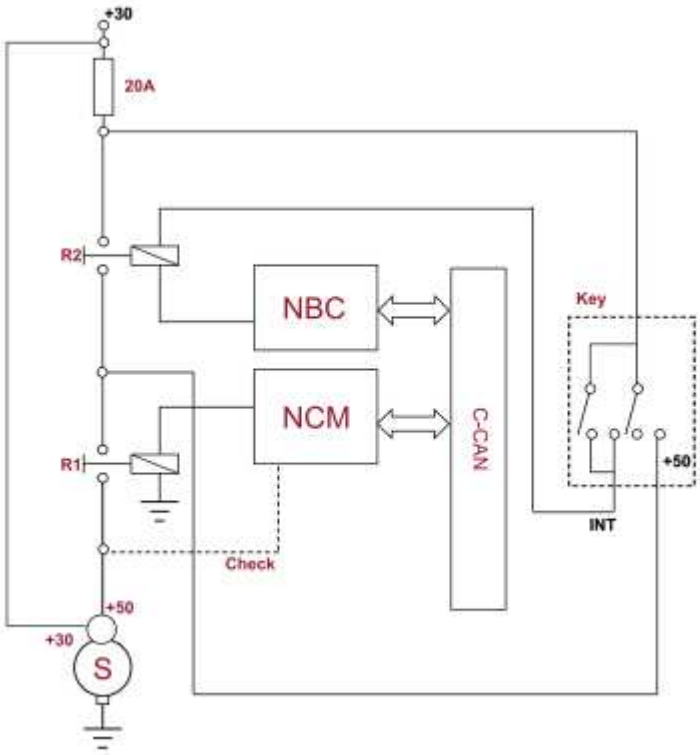
In any case, it is possible to keep the engine running by deactivating the Start&Stop system.

Irregular operation

In the case of malfunctions the Start&Stop system is disabled.
The driver is informed of the fault by the switching on of the "S&S system fault" warning light and the "general failure" warning light on the MODAL instrument panel or only of the "general failure" warning light with a dedicated message on the display in the COMFORT panel.

STARTING SYSTEM WIRING DIAGRAM

The vehicle starting scheme manages both the start ups performed by the user (using the key) and automatic engine restarting as part of the Start&Stop function.
The following figure shows the simplified wiring diagram for the starting system.



S - Starter with control (+50) and power (+30) connections
20A - Starting control circuit protective fuse
NCM - Engine Management Node control unit
NBC - Body Computer Node
R1 - Relay switch controlled by NCM control unit
R2 - Relay switch controlled by NBC control unit
Key - Ignition switch
C-CAN - Communication line
Check - Voltage measurement line

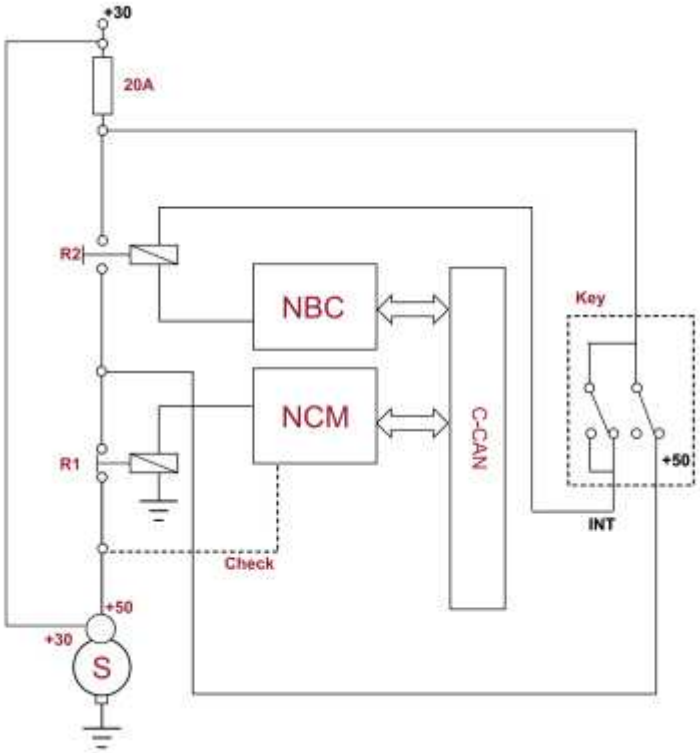
There are two types of starting:

- Key start-up: is directly controlled by the driver through the ignition key;
- Automatic start-up: is managed by the Start&Stop function in order to restart the engine after the vehicle has been stopped.

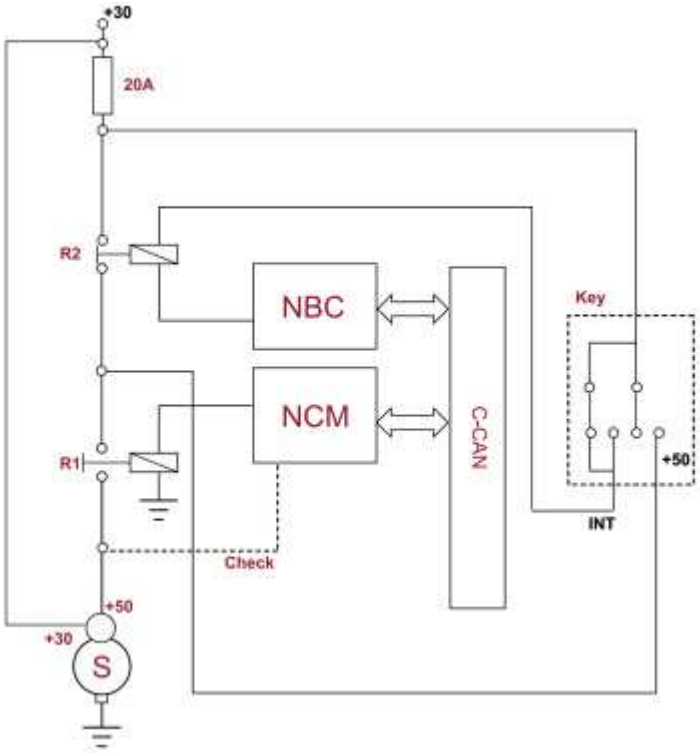
The procedure is different depending on the type of starting.

Key starting

Key starting is controlled by the user by placing the key in the AVV position: under these circumstances starting is managed by the NBC and NCM control units according to the following procedure:
1. With the key in STOP position, the starting relay switches are not supplied and therefore open.
2. When the key is placed in MAR position both relay switches are opened by the respective control units.
3. When the key is turned to AVV position, the NCM control unit closes the relay switch R1 and controls the starter supply.



4. When the key is released, it returns to the MAR position, the NCM control unit opens the relay switch R1 and performs diagnosis on both relay switches.
Depending on the outcome of the diagnosis, the following conditions may occur:
4a. Both relay switches operate normally: the Body Computer closes R2 and Start&Stop functionality is enabled;



4b. relay switch R1 is "stuck": R2 is kept open and the Start&Stop disabled;
4c. relay switch R2 is "stuck": R1 is kept open and the Start&Stop disabled.
The relay switch status during manual starting stages is given in the table below.

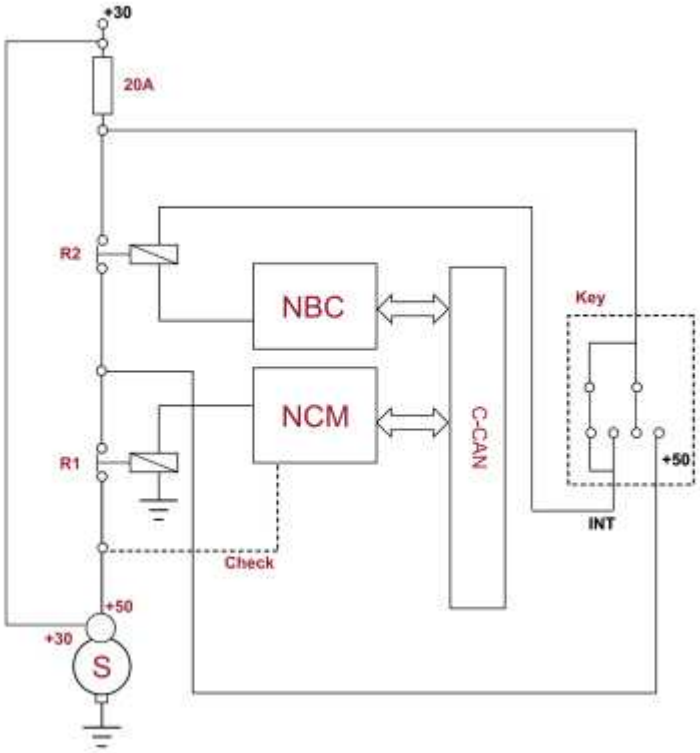
Step	Description	Key position	Status of relay switch R1	Status of relay switch R2
1	Key in engine stop position	STOP	Open	Open
2	Key in INT position	MAR	Open	Open
3	Key in engine start position	START	Closed	Open
4a	Key release after starting	MAR	Open	Closed
4b	Key release when starting has taken place, relay R1 stuck	MAR	Closed	Open
4c	Key release when starting has taken	MAR	Open	Open

	place, relay R2 stuck			

For versions with robotised gearbox, during the initial starting stage using the key, the enablement for turning the starter is given by the robotised gearbox control unit.
The control unit provides the vehicle starting enablement via the C-CAN only if the following conditions are met: gear lever in position N (Neutral) and brake pedal pressed.
For subsequent engine stopping and restarting, the robotised gearbox control unit is incorporated in the Start&Stop system providing information, via the C-CAN, shared with the main components (Body Computer Node and Engine Management Node).

Automatic starting

When, as a result of the action of the user or for operating requirements, the Start&Stop strategy determines that automatic starting must take place, the engine is started according to the following procedure without the user having to use the ignition switch:
1. The Start&Stop strategy determines that the engine must be restarted automatically.
2. Relay switch R1 is closed by the NCM control unit: relay switch R2 had already been closed at the end of the key starting procedure, so the starter power supply is operated, as shown in the following picture.



3. Once the engine is started, the NCM control unit controls the opening of R1 then performs its diagnosis.
Depending on the outcome of the diagnosis, the following conditions may occur:
3a. Relay switch R1 is diagnosed as being open, as controlled: Start&Stop functionality is enabled;
3b. Relay switch R1 is diagnosed as being closed (stuck), relay switch R2 is open and Start&Stop functionality is disabled.
The relay switch status during automatic starting stages is given in the table below.

Step	Description	Key position	Status of relay switch R1	Status of relay switch R2
1	Vehicle stationary	STOP	Open	Closed
2	Engine starting stage	MAR	Closed	Closed
3a	Starting has taken place correctly	START	Open	Closed
3b	Starting occurred, but R1 stuck: R2 is opened	MAR	Closed	Open