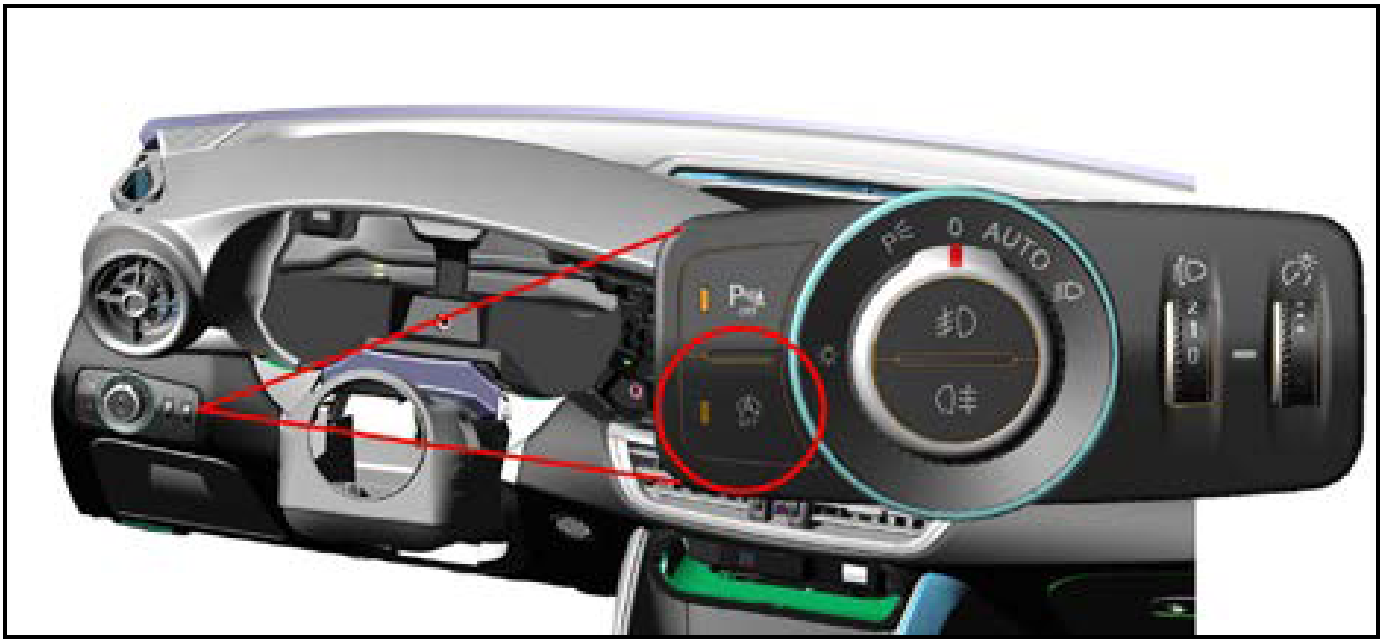
# ENGINE STOP START




The Engine Stop Start (ESS) system automatically stops the engine whenever the vehicle is stopped and restarts it when the driver wants to start driving again. This improves vehicle efficiency by reducing fuel consumption, the emission of harmful gases, and noise pollution.

The ESS system can be turned on and off by actuating a switch located on the headlamp control panel located on the left side of the dashboard.

The ESS system consists of the following components:

- Brake pedal switch
- Intelligent Battery Sensor (IBS)
- Hood ajar switch
- Manual On/Off switch

**ESS System Operation**

The ESS system is designed to shut off the engine under safe conditions to help save fuel. The engine will shut off and a green letter A with a partially open circle will illuminate in the Instrument Panel Cluster (IPC).

The ESS system will enter Autostop when:

- Vehicle speed is less than 3 km/h (2 mph)
- The brake pedal pressed

The system will Autostart when the brake pedal is released.

**Engine Failure to Stop Conditions**

When the ESS system is active, the engine may not stop in some conditions for reasons of comfort, emission control and safety. These conditions include:

- Engine temperature is still cold
- Battery is not sufficiently charged
- Windshield wipers are being used at maximum speed
- Driver’s door is not shut
- Driver’s seat belt is not fastened

- Vehicle is in the reverse gear(e.g. parking maneuver)
- When Automatic Temperature Control (ATC) is equipped, a desirable level of comfort has not been reached
- Barometric pressure (over threshold)

A message will appear on the instrument panel display in these cases.

**Automatic Restarting Conditions**

For reasons of comfort, emission control and safety, the engine can restart automatically without any intervention by the driver under certain conditions, including:

- Battery is not sufficiently charged
- Vehicle is moving (e.g. on roads with a gradient)
- Engine stopped by ESS for longer than approximately three minutes.
- Barometric pressure (below threshold)

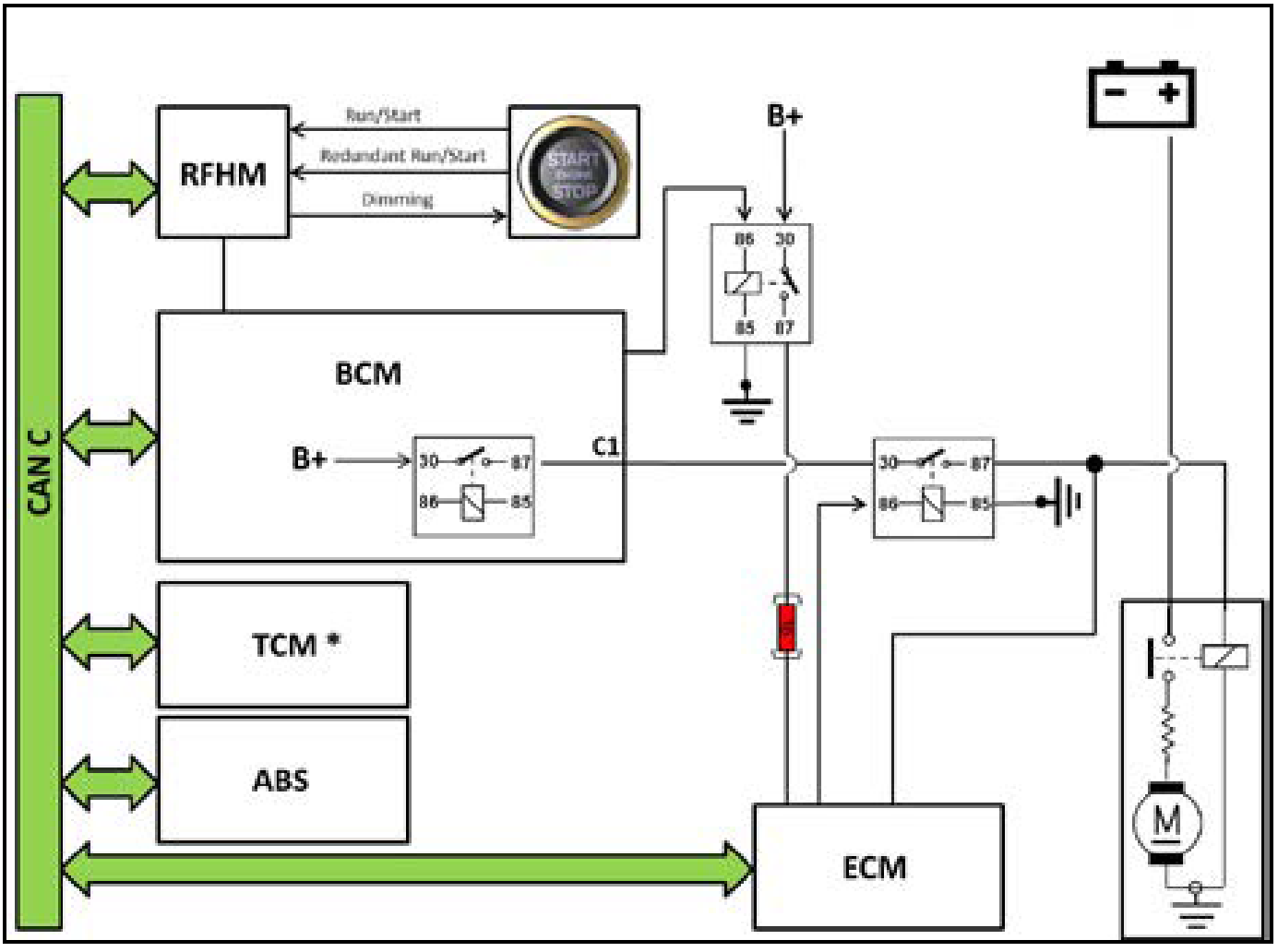
With a gear engaged, the ESS starting event is only permitted by releasing the brake pedal. This operation is requested through a message on the IPC.

**Safety Functions**

If the driver's seat belt is released and the driver's or passenger's door is opened while the engine is in Autostop mode, Autostart is deactivated and the engine can be restarted by pressing the Keyless GO Start/Stop button.

**Fault Operation**

The ESS system is disabled in case of a malfunction. The driver is informed by a warning indicator illuminating for general failure and, where provided, by the information message and by the icon of system failure on the IPC.



**Control Modules Involved in the Operation of the ESS System**

The ESS System Module Diagram shows the block chart of the components involved in first starting and operation of the ESS system.

The initial starting is managed directly by the driver by pressing the Keyless Entry GO Start/Stop button.

When the start request and authentications are complete and processed by the Radio Frequency Hub Module (RFHM), Body Control Module (BCM), Powertrain Control Module (PCM) (Primary and Secondary) and the Electronic Steering Lock (ESL) module, relay T39 in the BCM and starter relay R6 managed by PCM will be managed to allow current to reach the starter motor and perform the first start operation.

Once the engine has started, the BCM holds its relay closed while the starter relay managed by the PCM will be open.

The PCM will manage closing of the starter relay whenever the engine is started by the ESS system.

**NOTE:** If the starter motor remains powered after restarting the engine, the BCM will open its own relay to cut off current. The ESS system will be disabled.

**IBS with Negative Pole**

The IBS is a Local Interconnect Network (LIN) bus module that communicates with the BCM . The IBS is used for monitoring the battery to make sure the ESS system can operate correctly. This information, in conjunction with other coming information from other vehicle devices/modules, is used to activate or deactivate the ESS system.

The general principle is that the engine should not be stopped automatically if the battery capacity is not sufficient to restart it. If during an Autostop cycle, if the battery conditions are questionable when a restart is needed, the system will restart instead of waiting for other system inputs.

The ESS system is also disabled if a possible IBS fault does not allow the actual battery status to be properly

determined. In this situation, an internal error signal is generated in the BCM.

The ESS system function is primarily managed by the PCM which decides whether to enable or disable the system.

**IBS – Operation**

The IBS performs the following measurements:

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

The BCM processes these values and calculates the following parameters which express the status of the battery:

- State Of Charge (SOC): The SOC indicates residual battery charge percentage compared to its rated capacity. This is the amount of charge in the battery .
- State Of Health (SOH): The SOH indicates the real battery capacity percentage compared to its rated capacity .
    - As the battery ages over time, its ability to be fully recharged and to supply energy is reduced.
- State Of Function (SOF): The SOF indicates the minimum voltage peak which can be reached during cranking (V) .

These parameters identify the start-up capacity of the battery . The battery may no longer be able to restart the engine if the SOC or SOH is compromised.

In case of insufficient SOF, the battery voltage during cranking may reach such low values that the standard operating conditions of the vehicles electrical systems are no longer guaranteed to properly perform.

**IBS Calibration**

The IBS enters the calibration mode when it is connected to the battery for the first time or is reconnected after a service operation.

During calibration, the SOC, SOH and SOF) are calculated less accurately and with broader tolerances for a given period of time during which the IBS must recognize the battery type it is connected to, its voltage and its efficiency status.

Whenever the IBS is removed or disconnected from the battery, the calibration process begins to relearn the current battery conditions and parameters.

**NOTE:** This process can take up to 24-48 hours to complete . During this time, the ESS system is disabled .

| | Sensor Reconnected to the Battery | Initial Start | First Period of Inactivity > 4 hours -200mA < battery current < +50mA and engine cranking |
|---|---|---|---|
| Calibration | | | Standard Operation |
| SOC | Out of range | Out of range | Tolerance OK |
| SOF | Out of range | Tolerance OK | Tolerance OK |
| SOH | Out of range | Out of range | Tolerance OK |

When the connection to the battery is restored, all parameters are out of range because the system has not yet determined the battery status .

On initial engine start, the IBS calibrates the SOF, immediately considering the minimum voltage already. The other parameters have not yet been taken into account.

After at least four hours of inactivity and at least one starting cycle, the SOC and SOH parameters are considered if the battery current remains constant:

- -200mA < battery current < +50mA

If the IBS does not recognize the values of the above mentioned parameters, the system will appropriately limit the engine stopping and starting cycles (ESS) to ensure that the battery recharges correctly .

**Use of Information Supplied by the IBS**

**Engine on**

In engine running conditions, the BCM uses the information received from the IBS to activate or deactivate a possible automatic stop according to the battery starting capacity estimated by the IBS .

The battery starting capacity is usually evaluated through the battery status, expressed as SOC, SOF, SOH and temperature. When the IBS is being calibrated, some status variables are not reliable and therefore only the SOF and the battery temperature are taken into account.

The request to enable/disable an automatic stop by the BCM is translated into a signal generated by the BCM itself and sent, via the Controller Area Network (CAN)-C data bus network to the PCM .

The strategy used by the BCM to manage the information from the IBS and the ESS system is shown below .

When the ESS system is enabled by the BCM, the PCM is then enabled to automatically stop the engine if the driving conditions (actions on the brake and accelerator pedals) are satisfied as the other conditions controlled by the PCM .

When the ESS system is disabled by the BCM, the PCM is not enabled to automatically stop the engine if the driving conditions (actions on the brake and accelerator pedals) are satisfied as the other conditions controlled by the PCM .

**Autostop Mode**

When the ESS system has been automatically switched off, a request can be produced by a device or module which then requires automatic restarting of the engine .

The BCM collects the information from the vehicle and, if necessary, requests the PCM to automatically restart the engine (the PCM checks first whether safe automatic restarting conditions are satisfied).

The decision to request or not request an automatic restart by the BCM is translated into a signal generated by the BCM and sent over the CAN-C data bus network to the PCM .

This strategy is used by the BCM to manage the information from the IBS when determining whether or not a ESS request will be processed.

**Engine conditions that disable Autostop**

When the ESS system is activated, there are specific conditions that will prevent the ESS system event to occur. The following conditions leading to an ESS system operation preventiont can be detected and managed by the BCM or the PCM:

- Cold engine: Autostop is prevented if the Engine Coolant Temperature (ECT) sensor is outside of a range of 40°C (104°F) and 100°C (212°F). In this case, the fuel efficiency and emission reduction deriving from

use of the ESS system is not guaranteed .

- Reverse gear is engaged: the PCM will not allow the automatic stopping of the engine if reverse gear is engaged . This measure has been adopted in order not to adversely affect performance during parking maneuvers.
- A malfunction or fault detected in at least one of the following components will also disable the ESS system:

    - Accelerator Pedal Position Sensor (APPS)
    - Brake pedal position sensor
    - Automatic Braking System (ABS) Hydraulic Control Unit (HCU)
    - ECT sensor
    - Wheel Speed Sensors (WSS)
    - Engine crank sensor
    - Engine camshaft sensor
    - Reverse switch
    - PCM (Malfunction Indicator Lamp/MIL on)

The BCM will signal prevent the engine automatic stopping by sending a CAN-C data bus network message if one or more conditions managed by the BCM occur:

- Battery not being sufficiently charged

    - IBS calibrating
    - SOF of the battery is below 8 .3 V
    - Battery temperature is below -23°C (-9°F)
- If the IBS is not calibrating, Autostop will be prevented if one of the following conditions occurs:

    - SOC is below 75%
    - SOH is below 60%
    - SOF is below 8 .2 V
    - Battery temperature is below -23°C (9°F)
- IBS fault: The automatic engine stop event is prevented if an IBS malfunction occurs.
- Driver's door not shut: Autostop is prevented if the driver's door is open .
- Driver's seat belt not fastened: Autostop is prevented if the driver's seat belt is not fastened .
- Outside temperature sensor: Autostop is prevented if:

    - Outside temperature is lower than -16 °C (3°F)
    - Outside temperature is higher than 82 °C (180°F)

    **NOTE:** The temperature limits that have been set on the outside temperature sensor are "extreme" and therefore must always be considered .
- ATC: Autostop is prevented if the difference between the climate control temperature set by the customer and the temperature inside the passenger compartment is greater than ± 4°C (39°F)

    **NOTE:** If the vehicle is equipped with manual air conditioning, the engine can always be Autostopped .
- Generator fault: Autostop is prevented in the case of generator malfunctions.
- Hood open: Autostop is prevented if the hood is open.
- Logistic Mode status active: Autostop is prevented if the Logistic Mode status is active.
- BCM relay fault: Autostop is prevented if there is a starting circuit relay issue. The relay is operated by the BCM.
- Steering position: Autostop is prevented if the Steering Angle Sensor (SAS) is out of calibrated range.
- Fuel level: if the fuel level is below a certain threshold, Autostop is disabled

**Automatic Restarting (Autostart)**

When the ESS system is operating, due to comfort, emission control and safety reasons, the engine can restart automatically without any intervention by the driver.

These conditions which cause automatic engine restarting can be detected and managed by the BCM or the PCM .

**Conditions Monitored by the PCM**

- Vehicle moving: an automatic engine restart is forced if the vehicle speed is over than given threshold of about 5 km/h (3 mph). This condition avoids dangerous situations due to a failure of the brake on gradients.
- Engine stopping by the ESS system for longer than 160 seconds.
- Reverse engaged: the PCM will automatically restart the engine if the driver engages reverse gear during an Autostop event . This measure has been adopted in order not to adversely affect performance during parking maneuvers.
- Cold engine: the PCM forces automatic engine restarting if the signal from the ECT sensor is below 30°C (86°F).
- The BCM requested automatic engine restarting without any action by the driver and transmitted this information to the PCM by means of a specific message on CAN-C data bus network.
- Catalytic converter temperature below a given threshold.
- The parking brake is applied while the vehicle is in motion with the engine stopped at a speed higher than 3 km/h (2 mph). This is a safety measure to avoid dangerous situations due to a failure of the parking brake on gradients.

**Conditions monitored by the BCM**

- Battery not sufficiently charged
- If the IBS is being calibrated, the engine is automatically restarted without any action by the driver if one of the following conditions occurs:
    - SOF is below 7 .6 V .
    - Battery temperature is below -23°C .
- If the IBS is not being calibrated, the engine is automatically restarted if one of the following conditions occurs:
    - (SOC is below 70% .
    - SOH is below 60% .
    - SOF is below 7 .3 V .
    - Battery temperature is below -23°C .
- IBS fault: The engine is automatically restarted without any action by the driver if an IBS malfunction is confirmed.
- Outside temperature sensor: the engine is automatically restarted without any action on behalf of the driver if:
    - The outside temperature is lower than -16 °C (3 °F).
    - The outside temperature is higher than 82 °C (180 °F).

    **NOTE:** The temperature limits set on the outside temperature sensor are “extreme” and therefore are always respected .
- ATC: The engine is automatically restarted without any action by the driver if the difference between the climate control temperature set by the customer and the temperature in the passenger compartment is greater than ± 7°C (45 °F) .

**NOTE:** If the vehicle is equipped with manual air conditioning, the engine stays off .

**Disabling Autostart (Safety Function)**

In some cases, after the engine has been automatically stopped, it is possible that the automatic restarting request by the driver is not honored .

In these circumstances, restarting is only possibly by manually pressing the Keyless GO Start/Stop button. The management of this function is transferred to the PCM and the BCM

**Conditions Monitored by the PCM**

- Too many unsuccessful attempts at automatic starting:
    - The maximum cranking attempts threshold of 5 attempts has been exceeded . This threshold is set to prevent damage to the starter by too many starting attempts close together .
- The BCM requested to prevent the engine automatic restart.
- A malfunction or fault detected in at least one of the following components will also disable the ESS system:
    - Accelerator Pedal Position Sensor (APPS)
    - Brake pedal position sensor
    - Automatic Braking System (ABS) Hydraulic Control Unit (HCU)
    - ECT sensor
    - Wheel Speed Sensors (WSS)
    - Engine crank sensor
    - Engine camshaft sensor
    - Reverse switch
    - PCM (Malfunction Indicator Lamp/MIL on)
- The driver has been requested to perform an action but did not perform it in time:

**NOTE:** The engine stopped by the ESS system can be restarted by releasing the brake pedal . If no action is performed to restart the engine for approximately three minutes after the engine was stopped, it will restart automatically . If the engine starts and the driver does not perform any action for 10 minutes (climate control operation, gear engagement and starting) the engine will stop automatically. At this point, restart is only possible by pressing the ignition button.

**Conditions Monitored by the BCM**

- Hood open: Autostart is prevented if the hood is open .
- Driver’s or passenger door not shut and driver’s seat belt not fastened:
    - Automatic engine restarting is prevented if the driver’s door or the passenger door is open and, at the same time, the driver’s seat belt is not fastened .
- BCM relay fault: Automatic engine restarting is prevented in case of a relay T39 issue. The relay controlled by the BCM .