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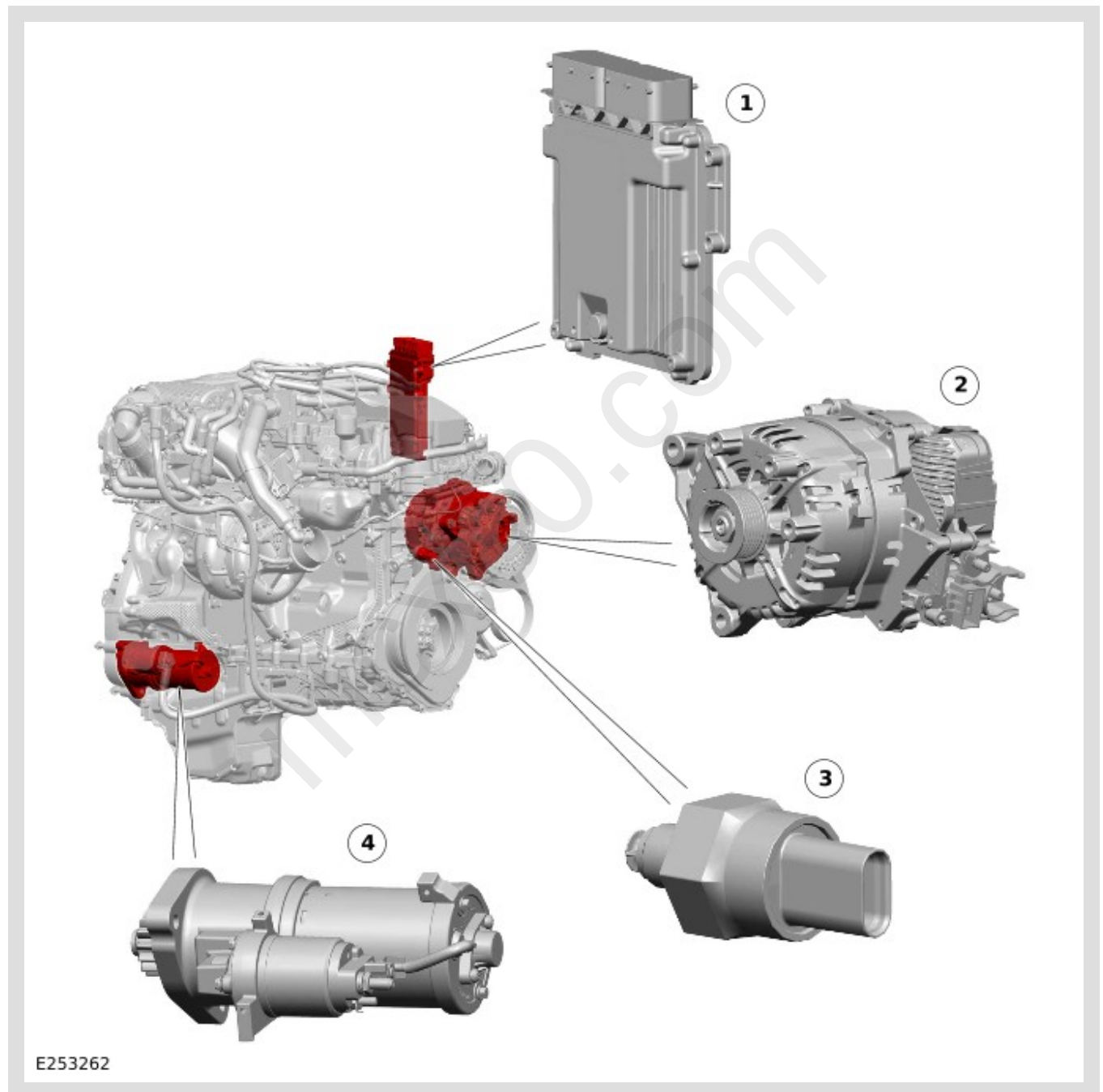
STARTING SYSTEM - INGENIUM I6 3.0L PETROL

[G2341945]

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COMPONENT LOCATION

COMPONENT LOCATION - 1 OF 2



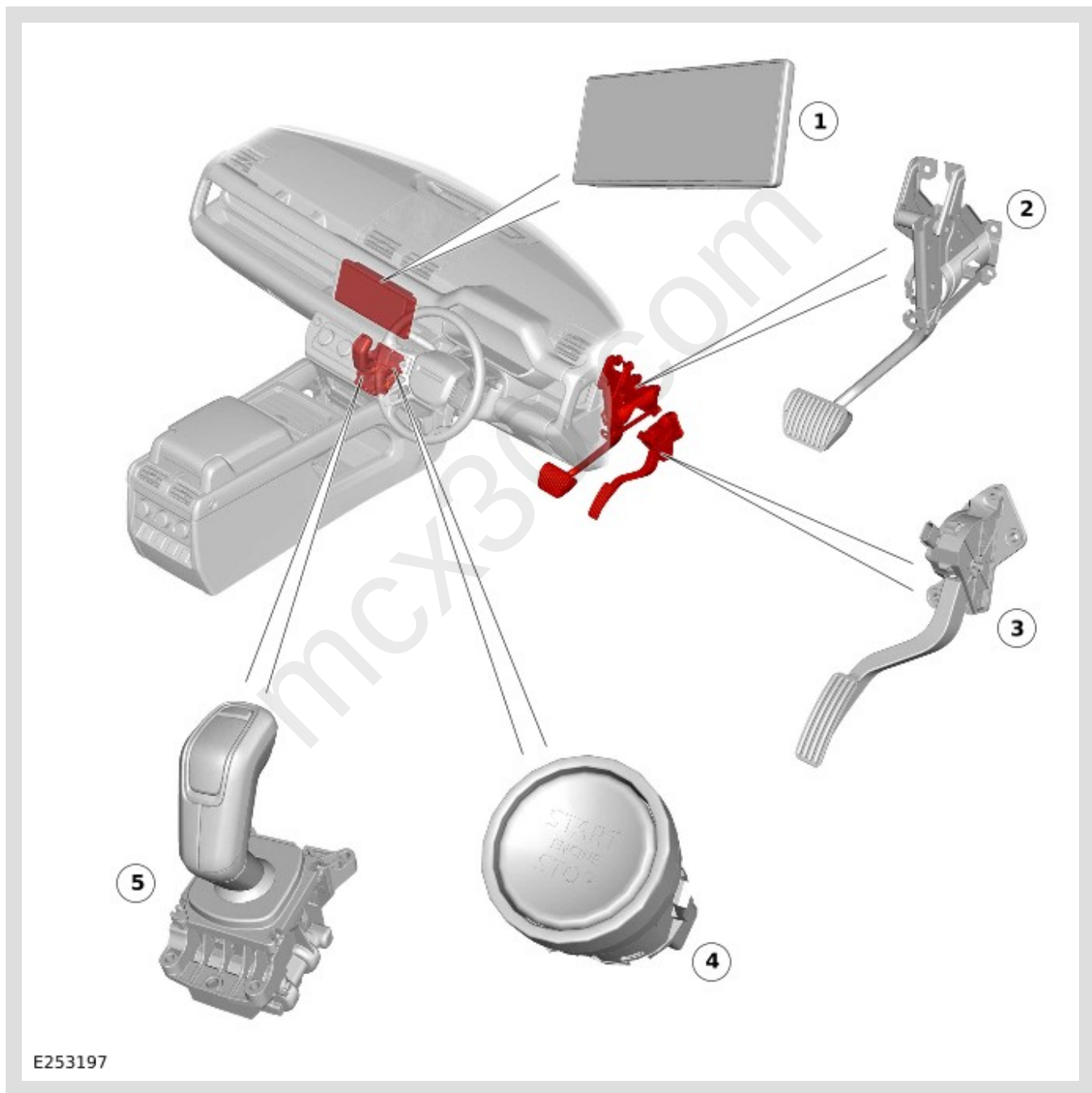
ITEM	DESCRIPTION
1	Powertrain Control Module (PCM)
2	Belt Integrated Starter Generator (BISG)

ITEM	DESCRIPTION
3	Crankshaft Position (CKP) sensor
4	Starter motor

COMPONENT LOCATION - 2 OF 2

NOTE:

Right Hand Drive (RHD) variant shown, Left Hand Drive (LHD) variant is similar.



ITEM	DESCRIPTION
1	Interactive Control Display Module (ICDM)

ITEM	DESCRIPTION
2	Brake pedal
3	Accelerator pedal
4	Ignition switch
5	Transmission Control Switch (TCS)

OVERVIEW

The Ingenium I6 2.0 petrol engines starting system consists of:

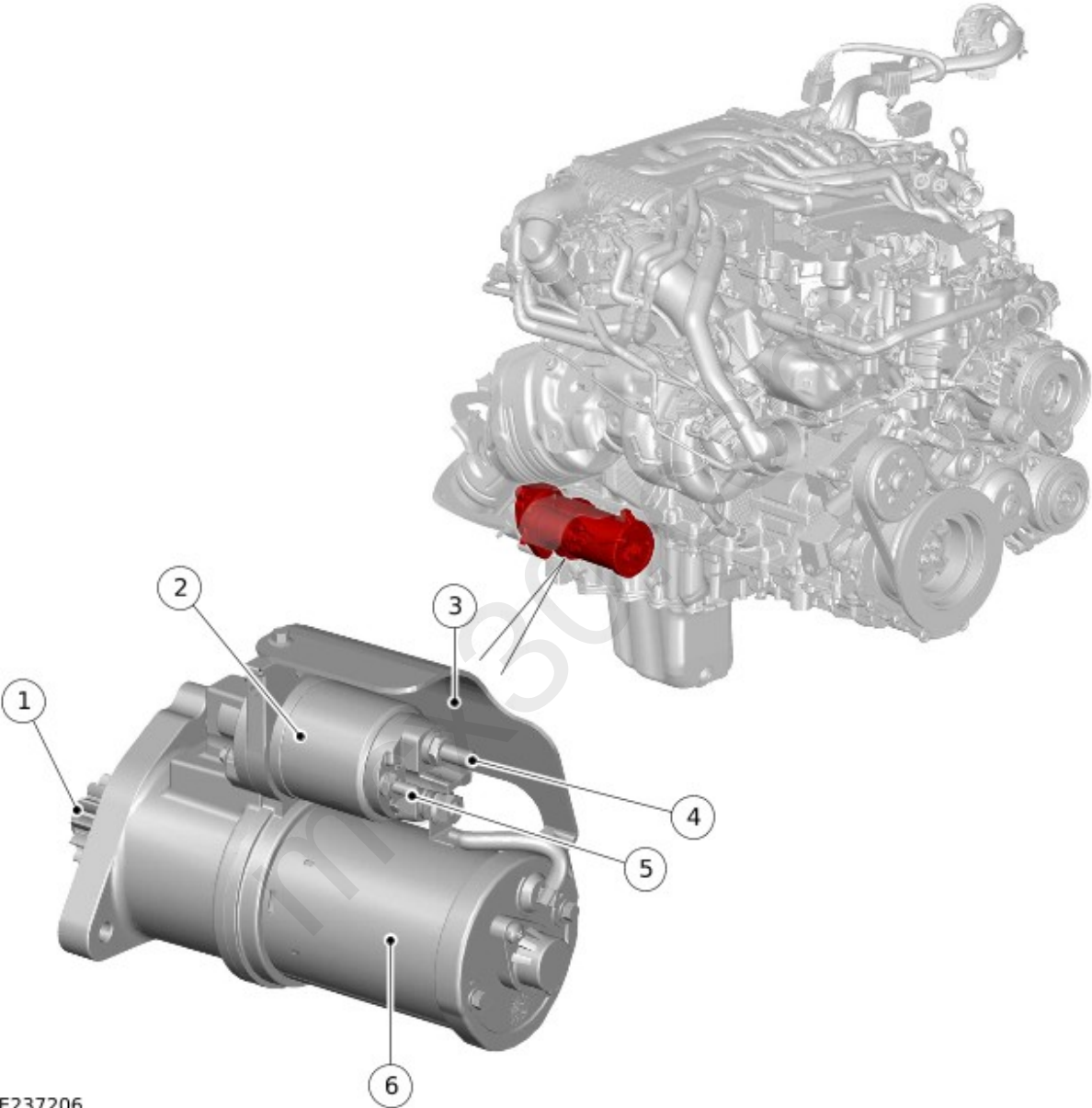
- A starter motor that engages with the ring gear on the crankshaft drive plate.
- A Belt Integrated Starter Generator (BISG) which engages the BISG drive belt to start the engine.

Operation of the starter motor and the BISG is controlled by the Powertrain Control Module (PCM). The starter motor is used for engine start when it is initiated by the driver with the ignition switch. Otherwise the PCM controls the BISG to start the engine.

The starting system incorporates an auto stop/start system. The PCM interacts with other vehicle systems to determine when auto stop/start intervention is required. The auto stop/start warning indicator provides a visual indication when the engine is stopped in a stop/start cycle. The auto stop/start system automatically stops and restarts the engine when appropriate conditions are met. This reduces the amount of time the engine is running at idle speed which improves economy and reduces engine emissions.

The auto stop/start system is automatically enabled each time the ignition is switched ON (Power Mode 6). The driver can disable the system using the auto stop/start switch.

STARTER MOTOR



E237206

ITEM	DESCRIPTION
1	Pinion gear
2	Starter motor solenoid
3	Heatshield
4	Starter motor electrical connection

ITEM	DESCRIPTION
5	Solenoid electrical connection
6	Starter motor

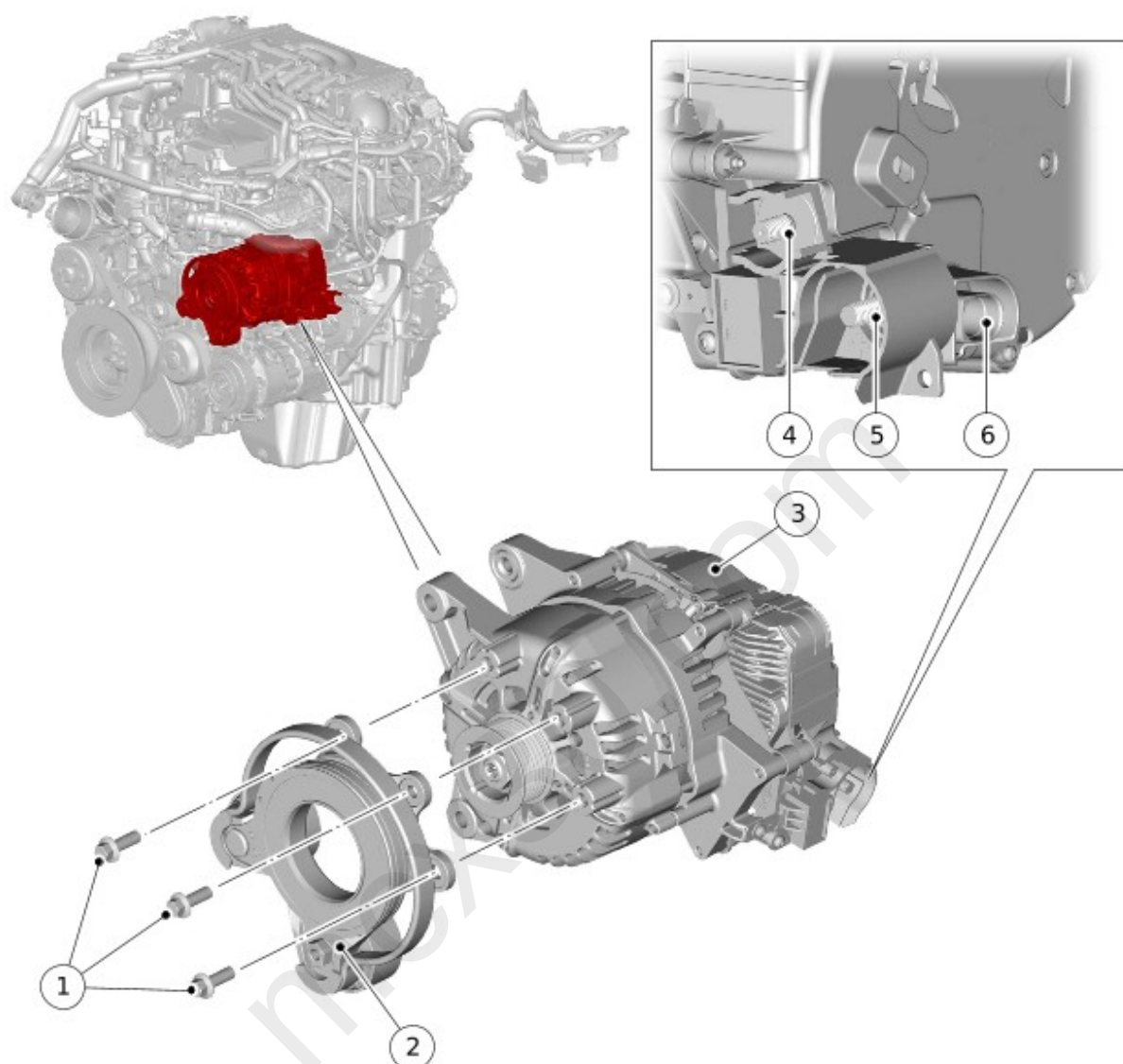
The starter motor is attached to the cylinder block, at the joint between the transmission and the engine. The pinion gear of the starter motor protrudes through an aperture in the transmission housing, adjacent to the ring gear on the drive plate.

The starter motor has the motor located directly behind the pinion gear. The motor is geared directly to the pinion gear and is a pre-engaged type comprising a series wound motor and an overrunning clutch.

The starter motor has a permanent power supply through a fuse, located in the Battery Junction Box (BJB). The starter solenoid is connected to a power feed from the starter relay in the Engine Junction Box (EJB). The starter relay is controlled by the Powertrain Control Module (PCM). When the motor solenoid is energized, it closes a high-current contact within the solenoid. The high-current contact supplies the starter motor with power from the startup battery.

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BELT INTEGRATED STARTER GENERATOR

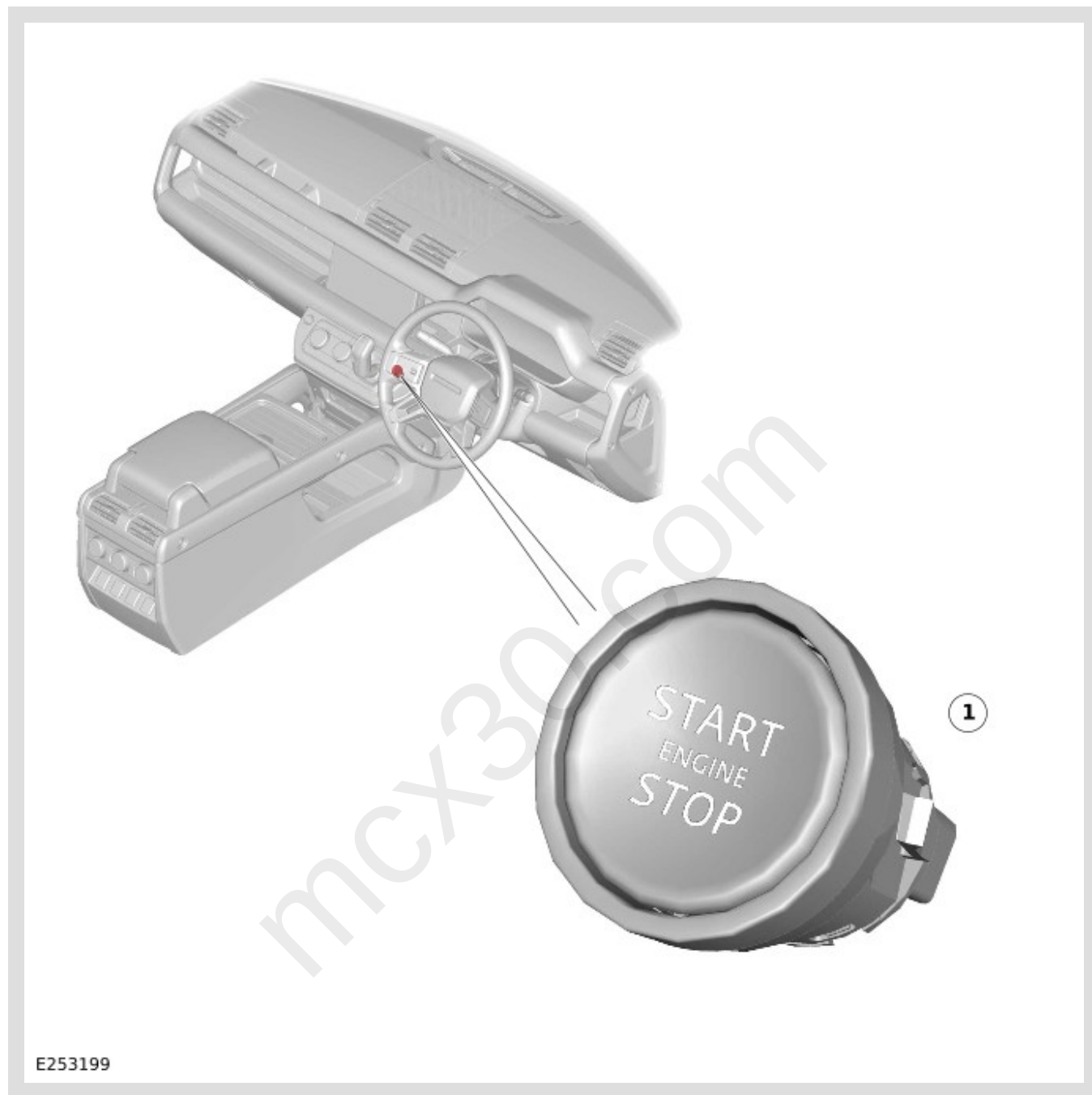


E237204

ITEM	DESCRIPTION
1	Bolt
2	Belt Integrated Starter Generator (BISG) drive belt tensioner
3	Belt Integrated Starter Generator (BISG)
4	Negative connection
5	Positive connection
6	Engine wiring harness connection

The Belt Integrated Starter Generator (BISG) is part of the accessory drive system and used as a starter motor. The BISG is used to provide a virtually silent engine restart.

IGNITION SWITCH



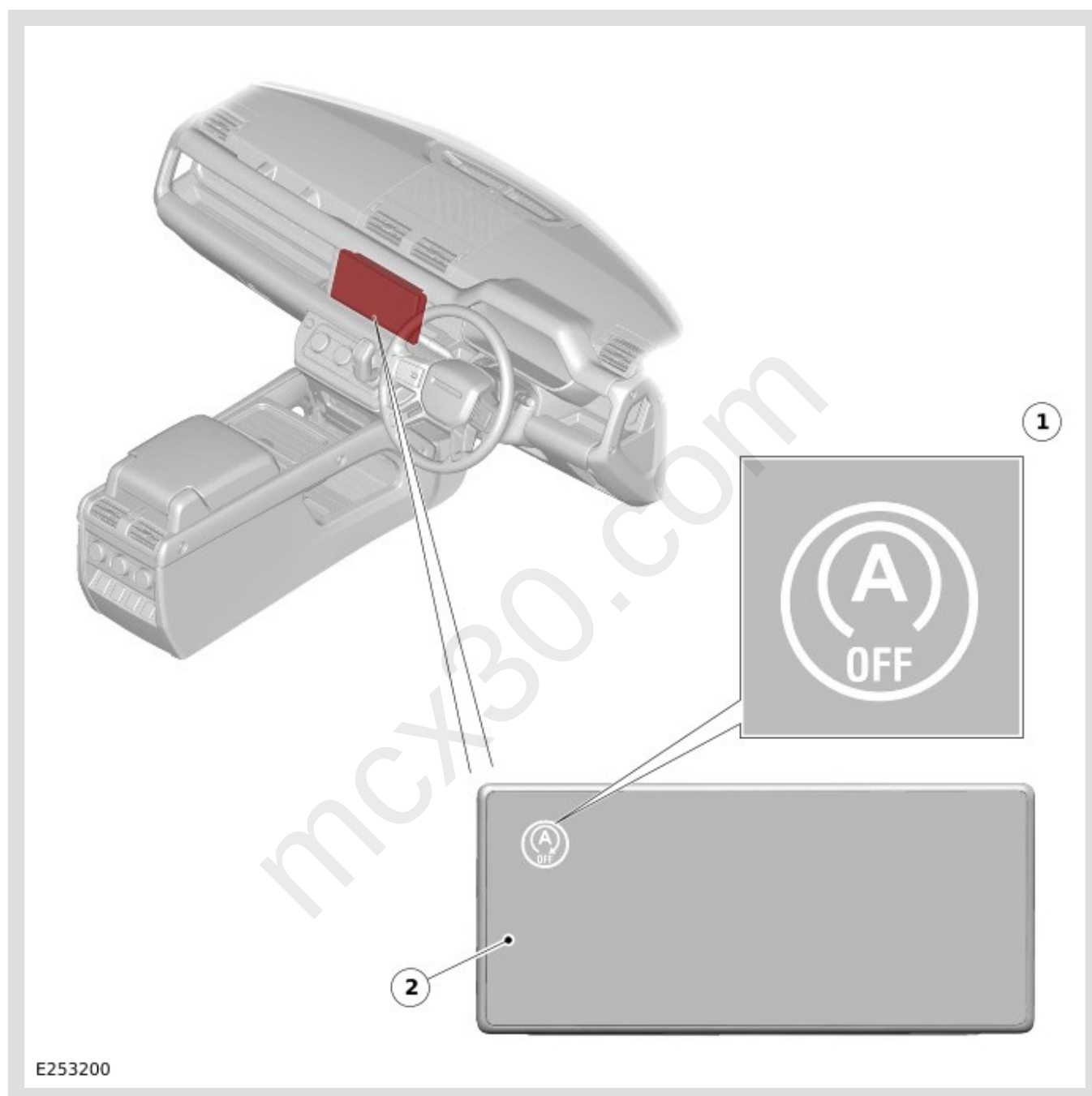
ITEM	DESCRIPTION
1	Ignition switch

The ignition switch is located in the instrument panel. The ignition switch is hardwired to the Body Control Module /Gateway Module (BCM/GWM). When the ignition switch is operated, the 2 signal wires from the BCM/GWM are return to the BCM/GWM through 1 wire, then connects to ground.

AUTO STOP/START SOFT KEY

NOTE:

Some variation in the illustrations may occur, but the essential information is always correct.



ITEM	DESCRIPTION
1	Auto stop/start soft key
2	Interactive Control Display Module (ICDM)

On vehicles with InControl Touch Pro Duo infotainment system, the Interactive Control Display Module (ICDM) is installed to the instrument panel. The auto stop/start soft key can be accessed from the 'Vehicle' menu on the ICDM.

When the driver enables or disables the auto stop/start system, the request is transmitted from the ICDM to the Body Control Module/Gateway Module (BCM/GWM). The request message is transmitted through the High Speed (HS) Controller Area Network (CAN) Human Machine Interface (HMI) systems bus.

AUTO STOP/START WARNING INDICATOR

The auto stop/start warning indicator is located in the Instrument Cluster (IC). The auto stop/start warning indicator is controlled by the Powertrain Control Module (PCM). To illuminate the auto stop/start warning indicator, the PCM sends signals to the Body Control Module/Gateway Module (BCM/GWM) through the FlexRay bus. The BCM/GWM transmits the message to the IC through the High Speed (HS) Controller Area Network (CAN) Human Machine Interface (HMI) systems bus.

OPERATION

AUTO STOP/START SYSTEM

If the Remote Function Actuator (RFA) detects a valid smart key, the driver can start the engine. When the ignition switch is operated, the Body Control Module/Gateway Module (BCM/GWM) transmits a hardwired crank request. The crank request is transmitted to the Powertrain Control Module (PCM).

When the PCM receives the crank request signal, the PCM energizes the starter relay to start the engine. When the motor solenoid is energized, it closes a high-current contact within the solenoid. The high-current contact supplies the starter motor with power from the startup battery through the Battery Junction Box (BJB).

When the auto stop/start system is active and the ambient temperature is above -5°C (23°F), the PCM uses the Belt Integrated Starter Generator (BISG) to crank the engine. When the PCM receives an engine restart request, the PCM sends a crank command to the BISG. The crank command to the BISG is sent through the High Speed (HS) Controller Area Network (CAN) power mode zero bus. The BISG starts the engine by turning the crankshaft through the BISG drive belt.

For additional information, refer to: [Belt Integrated Starter Generator](#) (414-02C Generator and Regulator - INGENIUM I6 3.0L Petrol, Description and Operation).



NOTE:

If the Belt Integrated Starter Generator (BISG) reports an error to the Powertrain Control Module (PCM) or the PCM cannot communicate with the BISG, the starter motor is used to start the engine.

The auto stop/start system is controlled by the PCM and the BCM/GWM through the FlexRay bus. Signals from other system components and modules are used to determine the correct conditions for system operation. The auto stop/start system detects when it is appropriate to stop and start the engine.

The auto stop/start system automatically stops the engine in appropriate conditions, resulting in zero exhaust emissions and saving fuel when the vehicle is stationary. When the driver is ready to move off, the engine instantly restarts. Sophisticated controls make sure that the auto stop/start system does not compromise the needs of either the driver or the vehicle.

By default the stop/start system is enabled at the start of each ignition cycle. The auto stop/start system can be enabled/disabled using the auto stop/start soft key.

Software within the PCM controls the operation of the stop/start system.

In addition to its own dedicated components the auto stop/start system encompasses many other vehicle systems such as:

- Road speed.
- The state of vital vehicle systems.
- Environmental conditions.
- Transmission Control Switch (TCS) position.

If all necessary conditions are satisfied, the stop/start system automatically stops the engine if:

- The vehicle stops from a speed higher than 17 km/h (10.5 mph).
- Sufficient pressure is applied to the brake pedal to make sure that the vehicle is stationary.
- The transmission is in DRIVE or SPORT.
- PARK or NEUTRAL is selected on the TCS.

When the engine stops, the auto stop/start indicator illuminates in the Instrument Cluster (IC) to tell the driver. Other warnings normally associated with an engine stoppage will not illuminate during the engine stop within an auto stop/start cycle. For example, the charge warning indicator and low oil pressure indicators are suppressed.

To restart the engine, the driver must release the brake pedal or press the accelerator pedal. Depending on ambient temperature, the PCM then operates the starter motor or the BISG to start the engine.

If system conditions are not approved by the PCM the auto stop/start system will not behave as expected.

For example:

- System inhibit - The engine continues running even though the vehicle is stationary with the brake pedal pressed and the TCS in DRIVE or SPORT. Another condition is when the vehicle is stationary and the TCS is in PARK or NEUTRAL.
- System override - The engine has been stopped by the auto stop/start system but conditions have since changed, this activates an early automatic engine restart.

These interventions make sure that the auto stop/start system does not impact on:

- Vehicle and occupant safety.
- Driver requirements.
- Occupant comfort.

- Vehicle on road and off road capabilities.

The main control logic for auto stop/start operation resides in the PCM. However the BCM/GWM has software to communicate engine stoppage inhibits to the PCM. In some instances the driver is notified of the reason for the intervention.

Stop Inhibitors

The following conditions prevent the auto stop/start system from stopping the engine.

Driver initiated stop inhibitors:

- Driver disables the auto stop/start system.
- Brake pedal not fully pressed.
- Accelerator pedal pressed.
- Hood is open.
- Driver door is open.
- Driver seatbelt is not fastened.
- Climate control system operated above the calibrated threshold.
- Windshield demist is operating.

Vehicle system initiated stop inhibitors:

- Startup battery cold cranking capability below threshold.
- Startup battery state of charge is low.
- Catalytic converter outside either pre or post calibration range.
- Engine coolant temperature below threshold.
- Engine oil temperature below threshold.

Environmental initiated stop inhibitors:

- Ambient air temperature above 40°C (104°F).
- Ambient air temperature below -5°C (23°F).

Start Initiators

When the engine stops within an auto stop/start cycle the following conditions initiate an early restart within the same auto stop/start cycle.

Driver initiated start initiators:

- Driver disables the auto stop/start system.
- The accelerator pedal is pressed.
- REVERSE gear is selected on the TCS.
- Vehicle speed is above the calibrated threshold 3 km/h (2 mph). A restart only occurs if the transmission is in NEUTRAL and the driver is present. For example, the driver seatbelt remains fastened and the driver door remains latched.
- A higher climate control blower speed is selected.
- Windshield demist is activated.

Vehicle system initiated start initiators:

- Windshield demist activates.
- The passenger compartment temperature decreases below, or increases above the selected thresholds.

Environmental initiated start initiators:

- Ambient air temperature rises above 40°C (104°F).
- Ambient air temperature falls below -5°C (23°F).

The maximum engine stop duration is 270 seconds, the vehicle will restart after this duration.

Start Inhibitors

When the engine stops within a stop/start cycle, certain conditions prevent an automatic restart.

Driver initiated start inhibitors:

- The hood is opened.
- The driver seatbelt is disengaged. This is an automatic start inhibitor, therefore the engine can be restarted by the brake pedal being released or the accelerator pedal being operated.
- The driver door is unlatched. This is an automatic start inhibitor, therefore the engine can only be restarted by the brake pedal being released or the accelerator pedal being operated.

Vehicle system inhibitor:

- There is a system fault.

AUTO STOP/START STRATEGY

Engine restart without Belt Integrated Starter Generator (BISG) or starter motor intervention:

This is when an auto stop sequence begins, but before the engine stops fully and it is necessary to start the engine again. For example, the traffic lights go to green. The Powertrain Control Module (PCM) detects engine restart parameters from a driver action or system request. The PCM activates the fuel injection and ignition systems to allow

the engine to continue to operate. This is available at a variable engine speed threshold which depends on engine type.

Engine restart with BISG or starter motor intervention:

If the PCM cannot restart the engine without intervention, the PCM uses the BISG or the starter motor to control engine restart. If an engine restart is initiated, the PCM activates the BISG at the earliest opportunity to rotate the engine. The PCM activates the BISG through the High Speed (HS) Controller Area Network (CAN) power mode zero bus. Then on the first available compression, the PCM operates the fuel injection and ignition systems to restart the engine in less than 0.36 second.

AUTO STOP/START WARNING INDICATOR

Auto Stop/Start Warning Indicator - System Active



The auto stop/start warning indicator illuminates green when the engine stops during a stop/start cycle, then extinguishes when the engine restarts.

Auto Stop/Start Warning Indicator - System Disabled

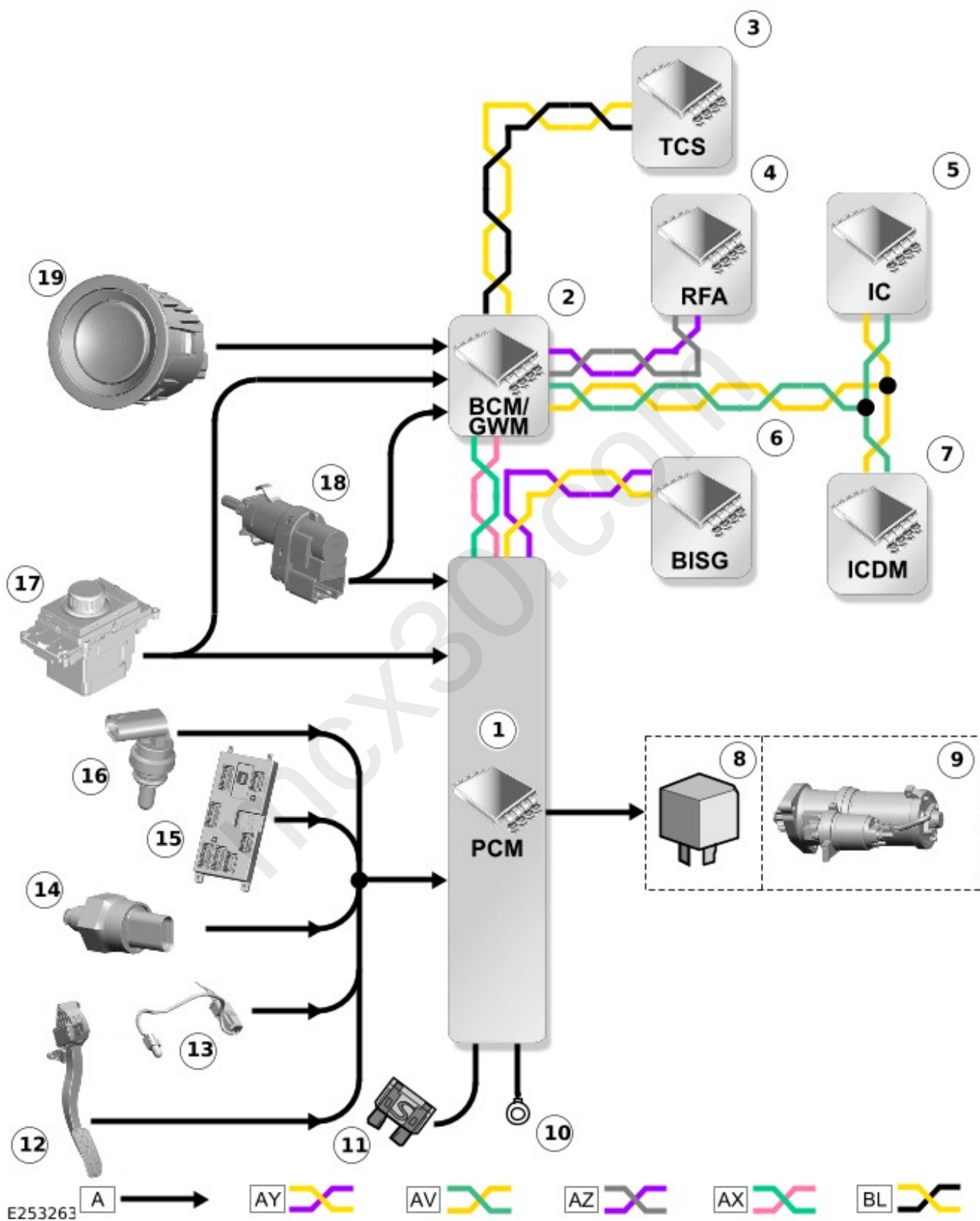


The auto stop/start warning indicator illuminates white when the auto stop/start system is disabled.

The auto stop/start warning indicator is controlled by the Powertrain Control Module (PCM). To illuminate the auto stop /start warning indicator, the PCM sends a signal to the Body Control Module/Gateway Module (BCM/GWM) through the FlexRay bus. The BCM/GWM transmits the message to the Instrument Cluster (IC) through the High Speed (HS) Controller Area Network (CAN) Human Machine Interface (HMI) systems bus.

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CONTROL DIAGRAM



A = HARDWIRED: AY = HIGH SPEED (HS) CONTROLLER AREA NETWORK (CAN) POWER MODE ZERO BUS: AV = HS CAN COMFORT SYSTEMS BUS: AZ = HS CAN BODY SYSTEMS BUS: AX = FLEXRAY: BL = HS CAN UNDER BODY (UB) SYSTEMS BUS.

ITEM	DESCRIPTION
1	Powertrain Control Module (PCM)
2	Body Control Module/Gateway Module (BCM/GWM)
3	Transmission Control Switch (TCS)
4	Remote Function Actuator (RFA)
5	Instrument Cluster (IC)
6	Belt Integrated Starter Generator (BISG)
7	Interactive Control Display Module (ICDM)
8	Starter relay
9	Starter motor
10	Ground
11	Power supply
12	Accelerator Pedal Position (APP) sensor
13	Ambient Air Temperature (AAT) sensor
14	Crankshaft Position (CKP) sensor
15	Crank signal - BCM/GWM
16	Engine Coolant Temperature (ECT) sensor
17	PARK/NEUTRAL signal - TCS
18	Brake pedal switch
19	Ignition switch