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BATTERY CHARGING - INGENIUM I6 3.0L PETROL, [+] MHEV

BELT INTEGRATED STARTER GENERATOR (G2431783)

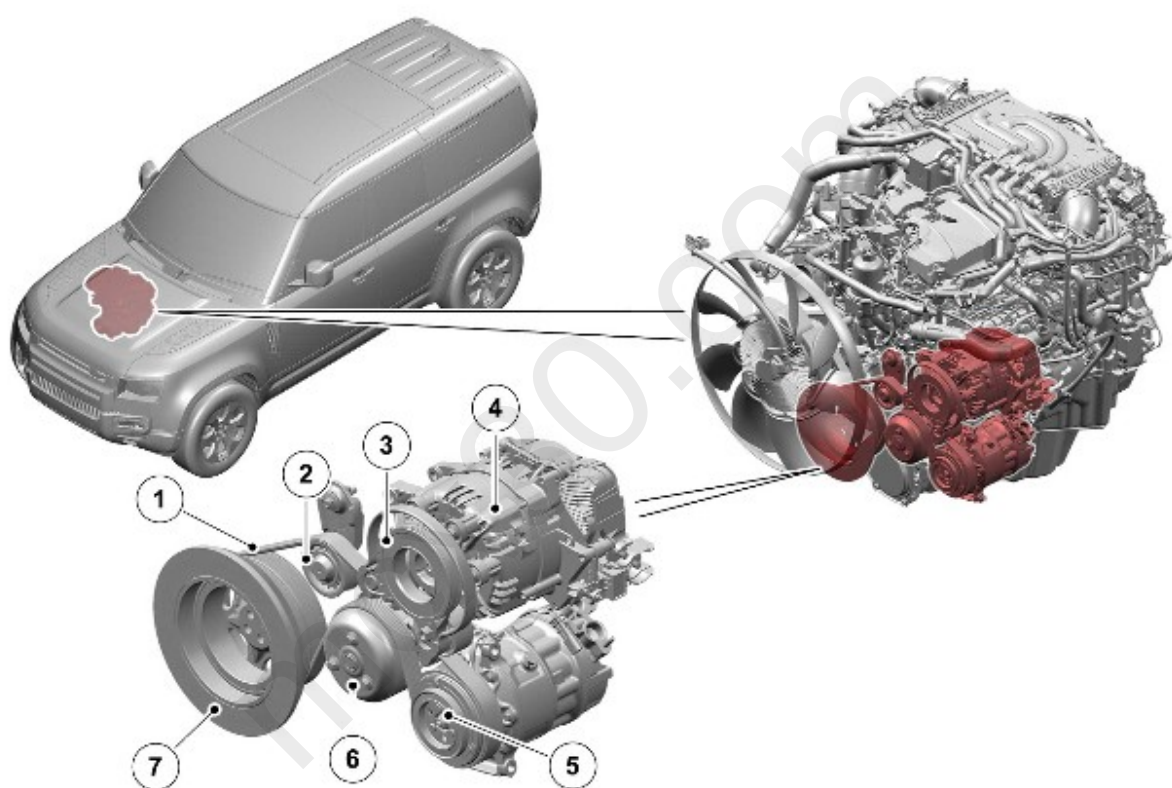
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COMPONENT LOCATION

COMPONENT LOCATION - 1 OF 1

 NOTE:

Vehicle with 5 doors is shown, vehicle with 3 doors is similar.



E247976

ITEM	DESCRIPTION
1	Belt Integrated Starter Generator (BISG) drive belt
2	Drive belt idler
3	BISG tensioner
4	BISG
5	Air Conditioning (A/C) compressor pulley
6	Coolant pump pulley

ITEM	DESCRIPTION
7	Crankshaft pulley

OVERVIEW

The BISG has the following functions:

- Charge the Mild Hybrid Electric Vehicle (MHEV) battery.
- Recover energy when the engine overruns.
- Provide power for engine assist, to help the engine power and improve fuel economy.

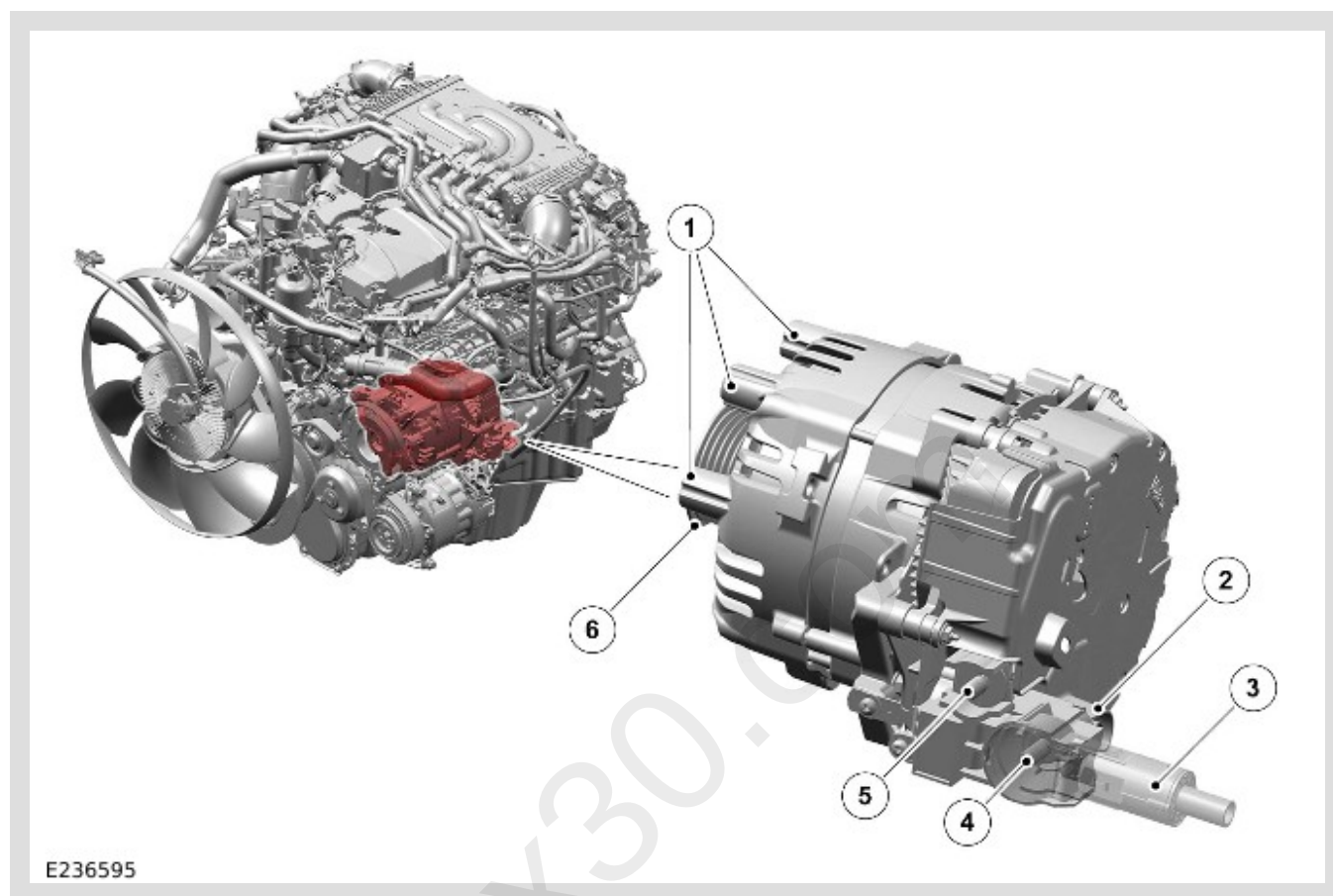
The operation of the BISG is controlled by the Powertrain Control Module (PCM).

The BISG is always used to restart the engine after each auto stop/start event, unless a fault is detected. When a fault is detected, the starter motor is used to restart the engine. No further auto stop/start events will be allowed over that drive cycle (until the ignition switch is pressed). The auto stop/start is inhibited below -5°C (23°F) and above 40°C (104°F).

For additional information, refer to: [Starting System](#) (303-06C Starting System - INGENIUM I6 3.0L Petrol, Description and Operation).

DESCRIPTION

BELT INTEGRATED STARTER GENERATOR



ITEM	DESCRIPTION
1	BISG drive belt tensioner mount (quantity 3)
2	Wiring harness connector
3	MHEV cable
4	BISG terminal (positive)
5	BISG terminal (negative)
6	BISG pulley

The BISG is located on the left of the engine towards the front. The BISG is connected to the engine crankshaft pulley by a BISG drive belt.

The BISG has 2 principles of operation:

- A generator to charge the MHEV battery.

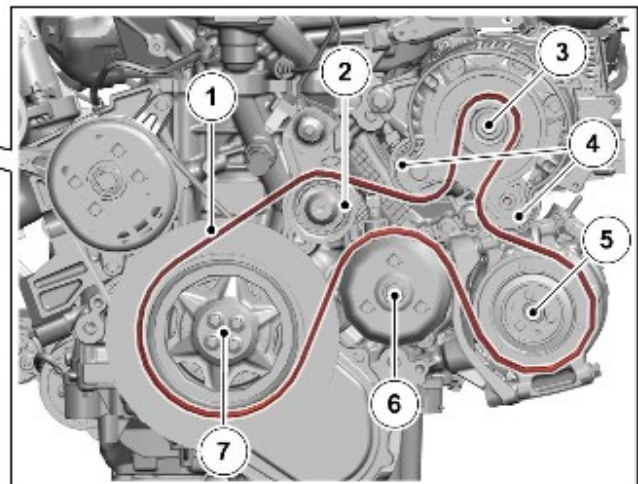
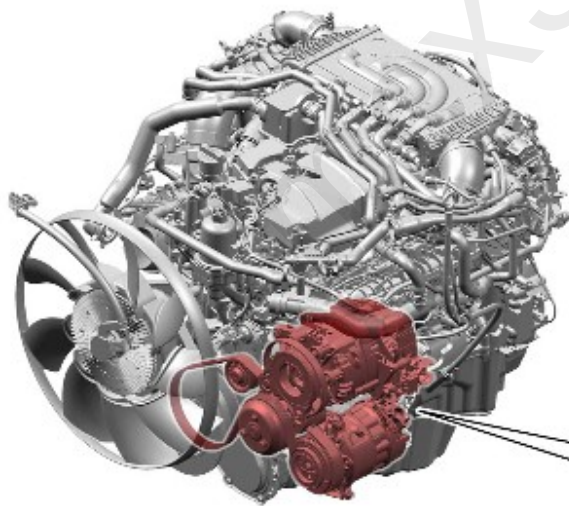
- To use engine rotation to generate electricity.
- To recover energy for the MHEV battery when the engine overruns.
- A motor for the following:
 - To start the engine in auto stop/start operation when the Ambient Air Temperature (AAT) is more than -5°C (23°F) and less than 40°C (104°F).
 - To provide engine assist and reduce fuel consumption.

The BISG is controlled by the PCM through the High Speed (HS) Controller Area Network (CAN) power mode zero systems bus.

The BISG has 3 electrical connections for the following:

- BISG terminal (positive).
- BISG terminal (negative).
- Wiring harness connector for the following connections:
 - HS CAN power mode zero system bus (quantity 2).
 - A power supply from the Engine Junction Box (EJB).
 - A ground connection.

Belt Integrated Starter Generator Drive Belt



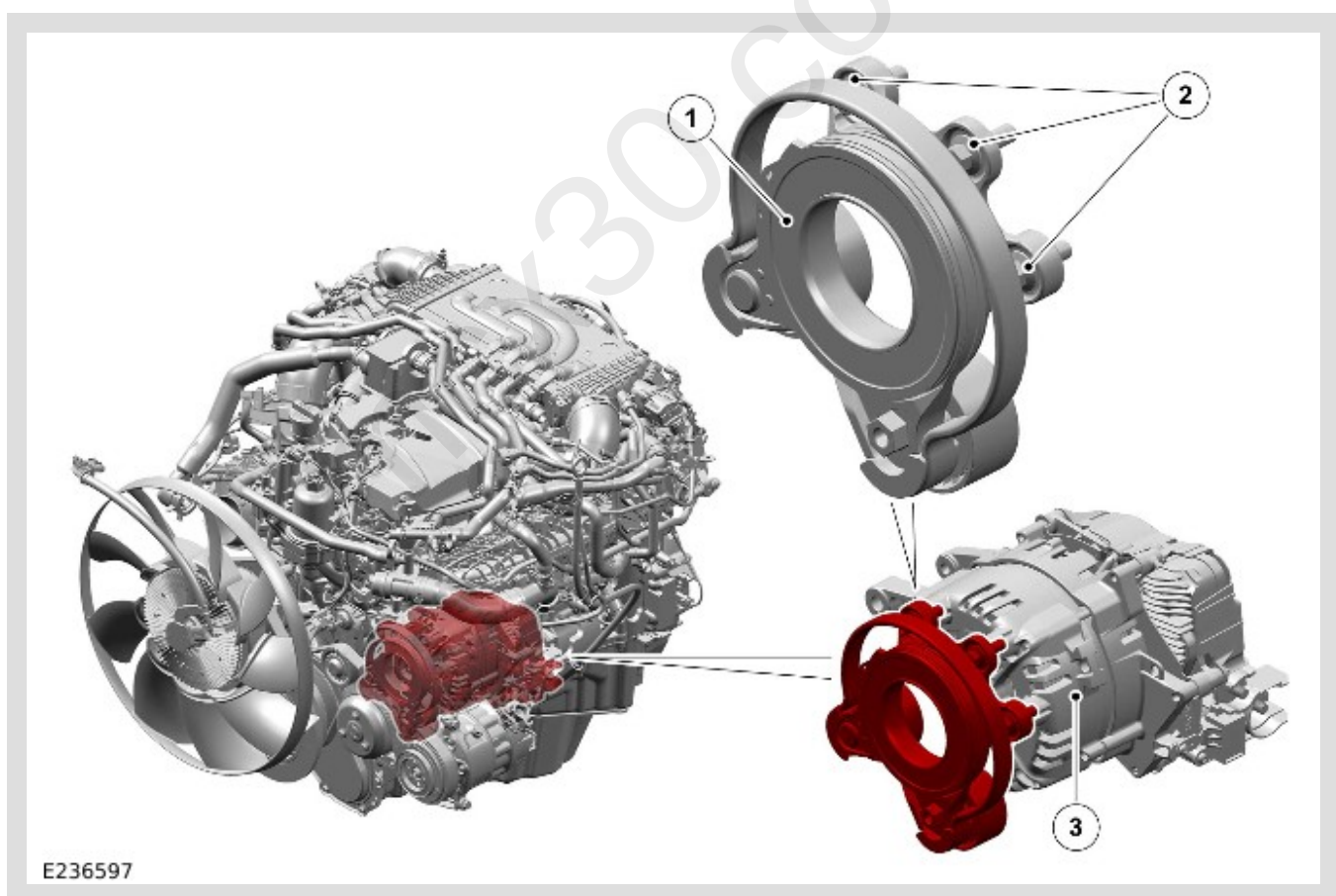
ITEM	DESCRIPTION
1	BISG drive belt
2	Idler pulley
3	BISG pulley
4	BISG drive belt tensioner
5	A/C compressor pulley
6	Coolant pump pulley
7	Crankshaft pulley

BISG DRIVE BELT TENSIONER



WARNING:

The BISG belt tensioner moves during operation of the BISG.

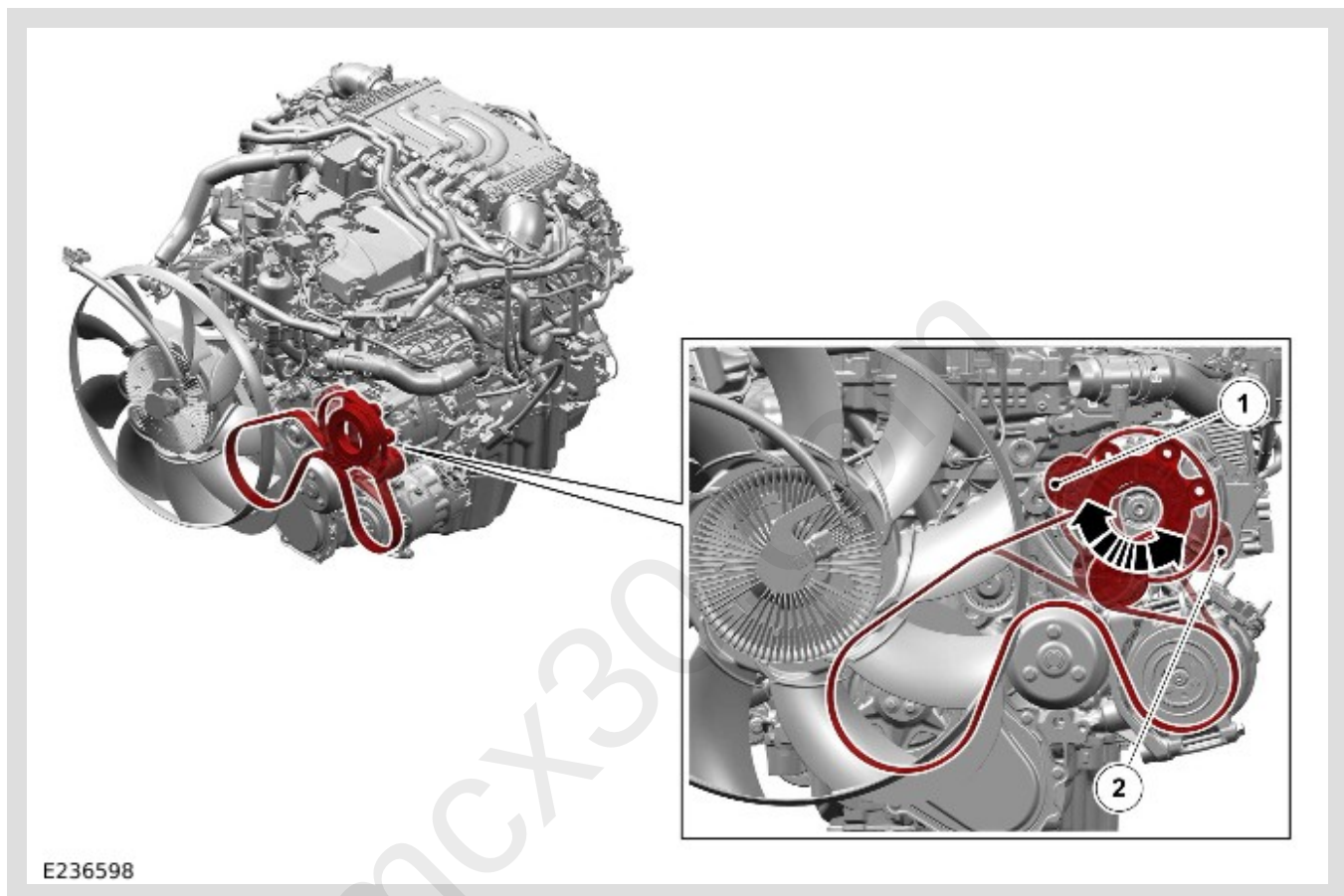


ITEM	DESCRIPTION
1	BISG drive belt tensioner
2	Mounting bolt (quantity 3)

ITEM	DESCRIPTION
3	BISG

The BISG has a BISG drive belt tensioner located on the pulley side of the BISG. The BISG drive belt tensioner is mounted by 3 bolts onto the BISG.

The BISG drive belt tensioner moves when the BISG changes its operation modes.



ITEM	DESCRIPTION
1	BISG drive belt tensioner position 1
2	BISG drive belt tensioner position 2

OPERATION

The BISG operates as a motor and a generator dependant on operation requests. The BISG is controlled by the PCM through the HS CAN power mode zero systems bus. The BISG also sends data to the PCM and other modules on the HS CAN power mode zero systems bus.

CHARGING

The MHEV system consists of the following:

- BISG
- MHEV battery
 - For additional information, refer to: MHEV Battery and Cables (414-01 Battery, Mounting and Cables - Vehicles With: Non-Electric Vehicles, Description and Operation).
- Direct Current to Direct Current converter (DC/DC)
 - For additional information, refer to: [Direct Current to Direct Current Converter](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
- Electric supercharger.
 - For additional information, refer to: [Intake Air Distribution and Filtering](#) (303-12C Intake Air Distribution and Filtering - INGENIUM I6 3.0L Petrol, Description and Operation).

In the Power Mode 7 (engine running), the BISG outputs or consumes current when operating as a generator or as a start motor respectively. The electrical power output from the BISG provides power for the following:

- Charging the MHEV battery.
- A 48V Direct Current (DC) voltage for the DC/DC for use by the vehicle 12V DC systems and to charge the startup battery.
 - For additional information, refer to: [Direct Current to Direct Current Converter](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
- A 48V DC power supply for the electric motor for the supercharger compressor.
 - For additional information, refer to: [Intake Air Distribution and Filtering](#) (303-12C Intake Air Distribution and Filtering - INGENIUM I6 3.0L Petrol, Description and Operation).

When in the Power Mode 7 (engine running), the BISG produces an Alternating Current (AC), which is converted to a DC internally. The BISG output voltage is internally regulated to 48V DC.

During engine starting, the charge warning indicator lamp illuminates in the Instrument Panel Cluster (IPC) in Power Mode 6 (ignition ON) and below. The warning indicator lamp is extinguished in the Power Mode 7 (engine running) when the Body Control Module (BCM)/ Gateway Control Module (GWM) receives a signal.

ENERGY RECOVERY WHEN THE ENGINE OVERRUNS

The BISG recovers energy when the engine overruns to generate electric energy. This electric energy is stored in the MHEV battery for used by the DC/DC and the BISG when required.

The recovered energy improves the fuel economy of the vehicle by 2 methods:

- Reducing the power generated by the BISG using engine power to supply the DC/DC.
- Assisting the engine by using the recovered energy to power the BISG to reduce the fuel used by the engine for a given torque requirement.

The PCM uses data from various modules to determine the amount of energy that can be recovered from the engine overruns. The PCM uses sensors data and others from these:

- Accelerator Pedal Position (APP) sensor
- Engine speed
- Vehicle speed
- MHEV battery state of charge
- Transmission gear.

When driving a MHEV, the driver may notice increased engine braking when the engine overruns, this is normal operation.

ENGINE STARTING – AUTO STOP/START



NOTE:

The conventional starter motor always does the first crank, regardless of the ambient temperature.

The PCM controls the operation of the conventional starter motor and the BISG. The BISG does all engine restarts when the AAT is greater than -5°C (23°F) and less than 40°C (104°F).

For further information on the conventional starter system:

For additional information, refer to: [Starting System](#) (303-06C Starting System - INGENIUM I6 3.0L Petrol, Description and Operation).

The PCM controls the starting function of the BISG through messages on the HS CAN power mode zero systems bus. The EJB provides the 12V voltage to the BISG. The MHEV battery provides the power for the BISG to crank the engine in an auto stop/start engine restart.

If a valid smart key is detected in the vehicle and the ignition switch is pressed, the PCM initiates the starting system operation.

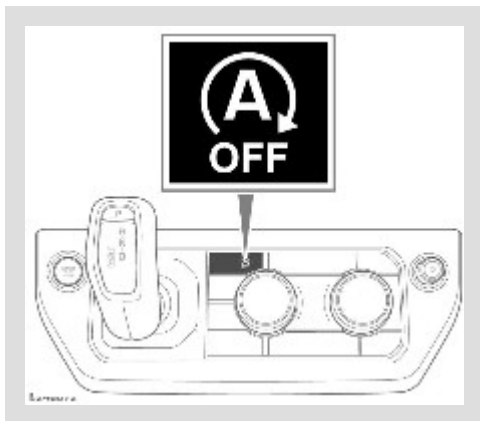
For additional information, refer to: [Anti-Theft - Passive](#) (419-01B Anti-Theft - Passive, Description and Operation).

Auto stop/start Soft Key



NOTE:

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



Software within the PCM controls the operation of the auto stop/start system. In addition to its own dedicated components, the auto stop/start system encompasses many other vehicle systems. Complex technology interconnects these systems.

The PCM monitors these systems:

- Brake hydraulic system pressure
- Transmission Control Switch (TCS) position
- Vehicle speed
- Brake vacuum
- Heating, ventilation, and air conditioning (HVAC) control module
- The state of vital vehicle systems
- Environmental conditions.

For additional information, refer to: [Starting System](#) (303-06C Starting System - INGENIUM I6 3.0L Petrol, Description and Operation).

Fault Condition

The BISG receives a cranking signal from the PCM through the HS CAN power mode zero systems bus.

If the BISG:

- Reports an error to the PCM.
- The PCM cannot communicate with the BISG.

The conventional starter motor cranks the engine.

The fault produces a Diagnostic Trouble Code(s) (DTC). The DTC and related data are read using the Jaguar Land Rover (JLR) approved diagnostic equipment.

Trailer Towing

The auto stop/start system automatically disables when trailer lamps are detected by the Towbar Control Module (TBM).

For additional information, refer to: [Towbar](#) (502-03 Towbar, Description and Operation).

ENGINE ASSIST

In certain conditions the BISG is used to assist the engine which is not visible to the driver.

The use of the BISG assists in increasing the fuel efficiency, by replacement of a proportion of the engine power with power from the BISG. The BISG uses the recovered energy when the engine overruns that is stored in the MHEV battery.

DIAGNOSTICS

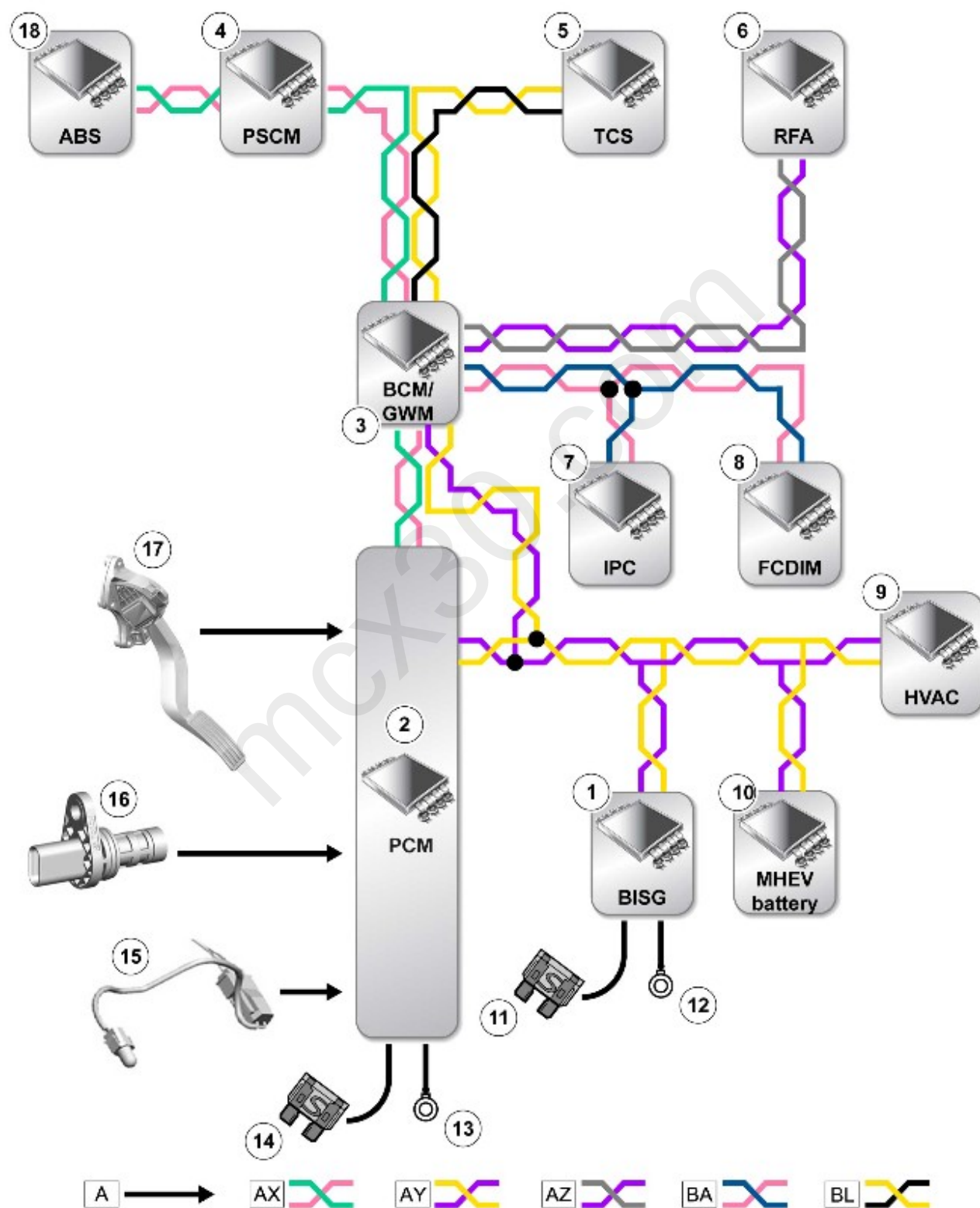
The PCM records any DTCs and related data. The DTCs and related data are read using the JLR approved diagnostic equipment.

The JLR approved diagnostic equipment enables certain components to be activated and also read live data.

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CONTROL DIAGRAM

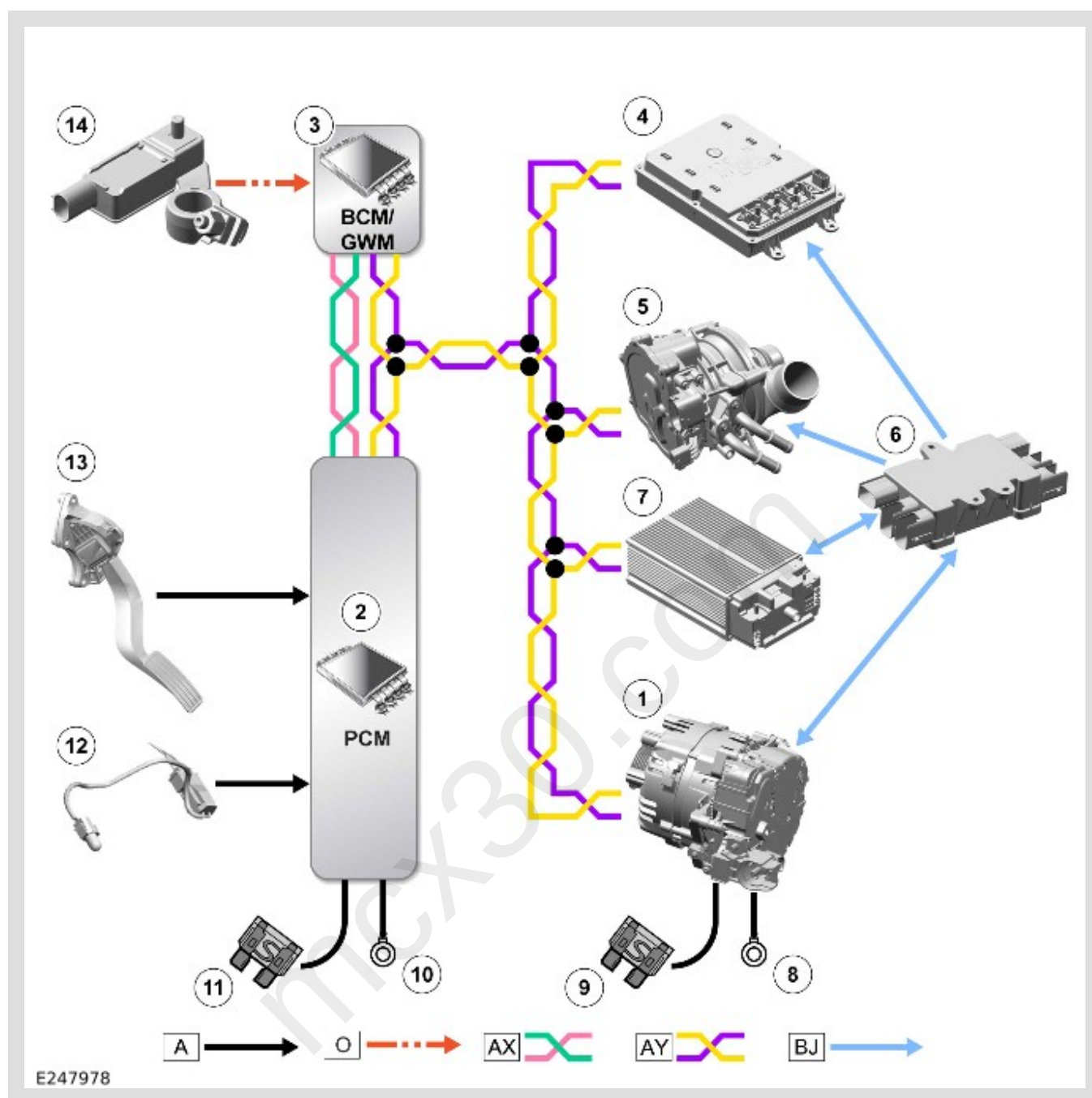
CONTROL DIAGRAM - 1 OF 2 - STARTING SYSTEM



A = HARDWIRED: AX = FLEXRAY: AY = HS CAN POWER MODE ZERO SYSTEM BUS: AZ = HS CAN BODY SYSTEM BUS:
BA = HS CAN HUMAN MACHINE INTERFACE (HMI) SYSTEM BUS: BL = HS CAN UNDERBODY (UN) SYSTEM BUS.

ITEM	DESCRIPTION
1	BISG
2	PCM
3	BCM/ GWM
4	Power Steering Control Module (PSCM)
5	TCS
6	Remote Function Actuator (RFA)
7	IPC
8	Touch Screen (FCDIM)
9	HVAC control module
10	MHEV battery
11	Power supply
12	Ground
13	Ground
14	Power supply
15	AAT sensor
16	Crankshaft Position Sensor (CKP)
17	APP sensor
18	Anti-Lock Brake System Control Module (ABS)

CONTROL DIAGRAM – 2 OF 2 – CHARGING SYSTEM



A = HARDWIRED; O = LOCAL INTERCONNECT NETWORK (LIN); AX = FLEXRAY; AY = HS CAN POWER MODE ZERO SYSTEM BUS; BJ = MHEV BATTERY CABLES.

ITEM	DESCRIPTION
1	BISG
2	PCM
3	BCM/ GWM
4	DC/DC
5	Supercharger Control Module (TSCM)

ITEM	DESCRIPTION
6	MHEV battery junction box
7	MHEV battery
8	Ground
9	Power supply
10	Ground
11	Power supply
12	AAT sensor - In the left door mirror
13	APP sensor
14	Battery Monitoring System (BMS) control module

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