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2020.0 DEFENDER (LE), 414-01B

BATTERY, MOUNTING AND CABLES – VEHICLES WITH: MHEV

# MHEV BATTERY AND CABLES (G2342548)

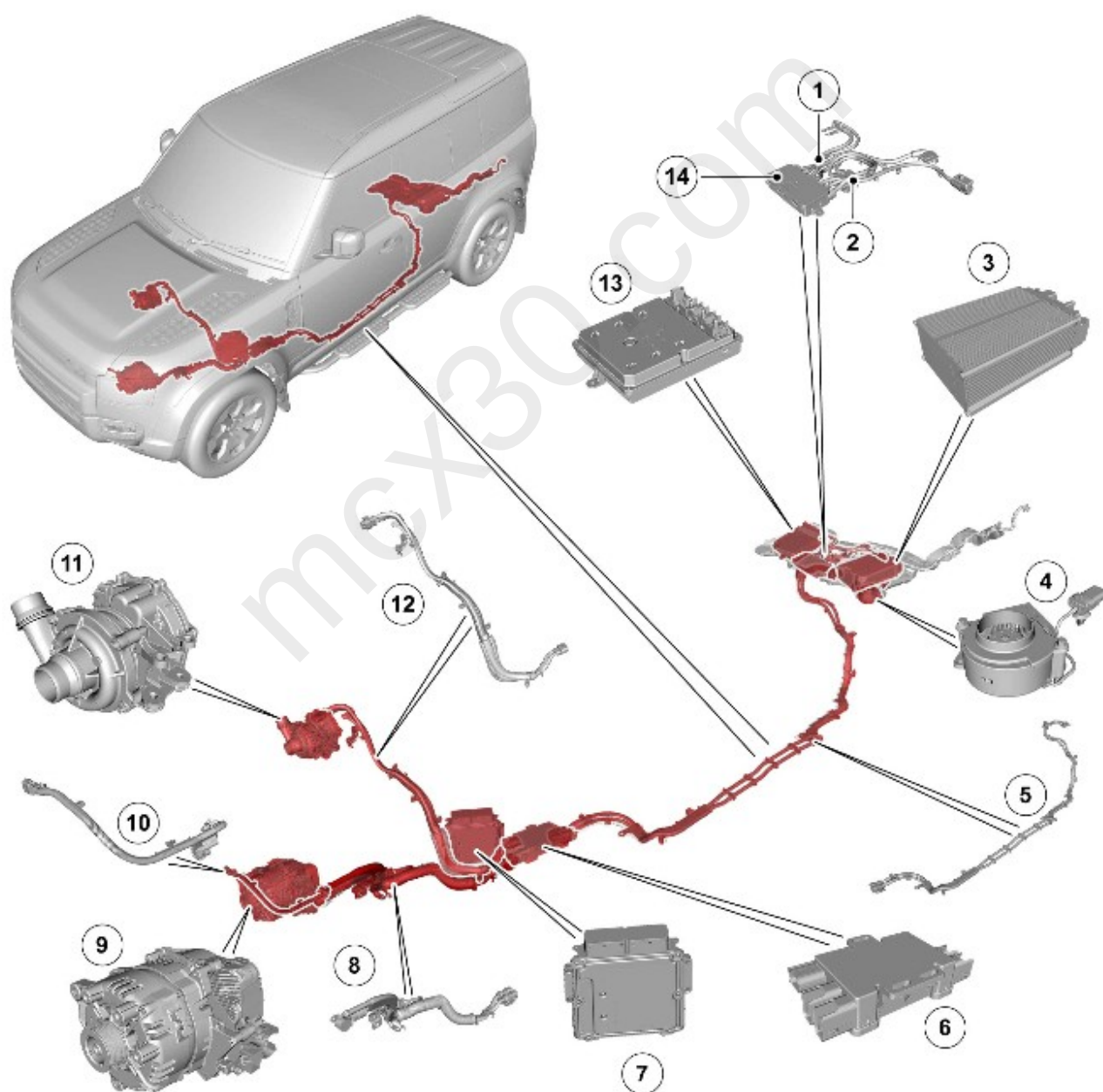
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## COMPONENT LOCATION

## COMPONENT LOCATION - 1 OF 1

 NOTE:

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



E249923

| ITEM | DESCRIPTION                                                                                                               |
|------|---------------------------------------------------------------------------------------------------------------------------|
| 1    | Mild Hybrid Electric Vehicle (MHEV) cables - Rear MHEV junction box to Direct Current to Direct Current converter (DC/DC) |
| 2    | MHEV cables - Rear MHEV junction box to MHEV battery                                                                      |
| 3    | MHEV battery                                                                                                              |
| 4    | MHEV battery electric cooling fan                                                                                         |
| 5    | MHEV cables - Front MHEV junction box to rear MHEV junction box                                                           |
| 6    | MHEV junction box - Front                                                                                                 |
| 7    | Powertrain Control Module (PCM)                                                                                           |
| 8    | MHEV cables - Front MHEV junction box to Belt Integrated Starter Generator (BISG)                                         |
| 9    | BISG                                                                                                                      |
| 10   | MHEV cables - BISG                                                                                                        |
| 11   | Electric supercharger                                                                                                     |
| 12   | MHEV cables - Front MHEV junction box to electric supercharger                                                            |
| 13   | DC/DC                                                                                                                     |
| 14   | MHEV junction box - Rear                                                                                                  |

## OVERVIEW

The MHEV battery has 5 primary functions:

- Provide all the electrical power for the 12V systems through the 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).
  - For additional information, refer to: [Startup Battery and Cables - INGENIUM I6 3.0L Petrol](#) (414-01B Battery, Mounting and Cables - Vehicles With: MHEV, Description and Operation).
- Store the electrical energy from the BISG. The BISG generates electrical energy from recovered energy when the engine overruns and from engine torque.
  - For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
- Provide the power for the BISG when it provides torque for the engine assist.
  - For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
- Provide power to the BISG for engine start when auto stop/start is in operation.
  - For additional information, refer to: [Starting System](#) (303-06C Starting System - INGENIUM I6 3.0L Petrol, Description and Operation).

- Provide the power for the electric supercharger.
  - For additional information, refer to: [Supercharger Cooling](#) (303-03D Supercharger Cooling - INGENIUM I6 3.0 L Petrol, Description and Operation).

The MHEV cables distribute the electrical energy to the MHEV battery system components.

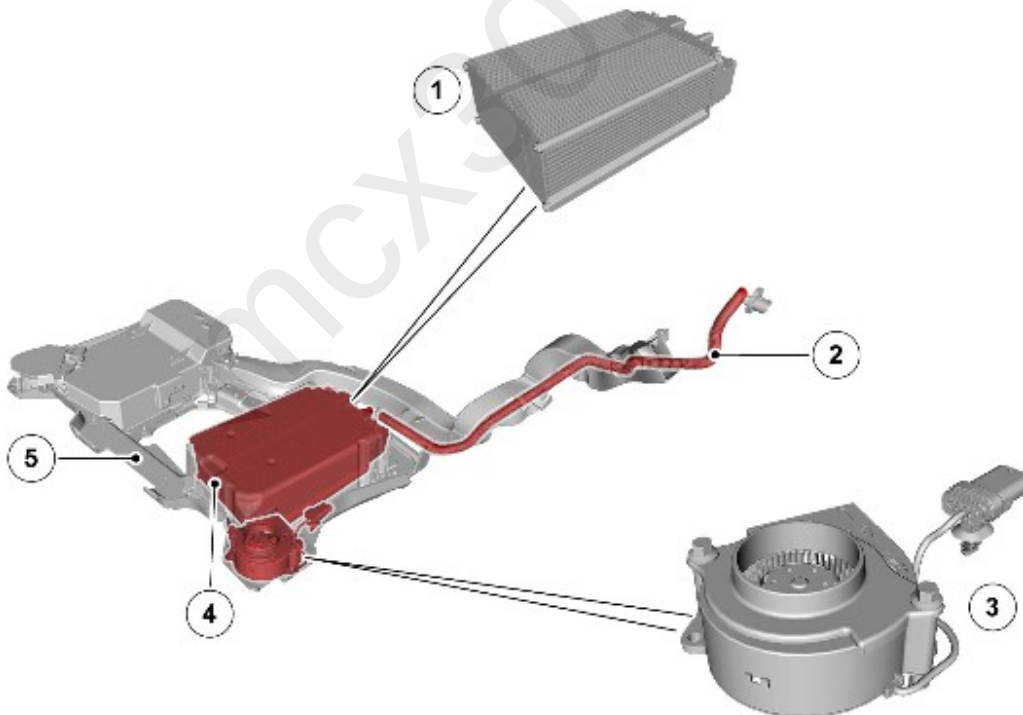
DESCRIPTION

MHEV BATTERY HOUSING

**ⓘ CAUTION:**

Make sure that the air inlet behind the second row seats is not obstructed. A reduction in the cooling airflow can cause overheating in the following components:

- The MHEV battery
- The DC/DC.



E249924

| ITEM | DESCRIPTION                |
|------|----------------------------|
| 1    | MHEV battery               |
| 2    | MHEV battery breather pipe |

| ITEM | DESCRIPTION                       |
|------|-----------------------------------|
| 3    | MHEV battery electric cooling fan |
| 4    | MHEV battery housing              |
| 5    | Cradle                            |

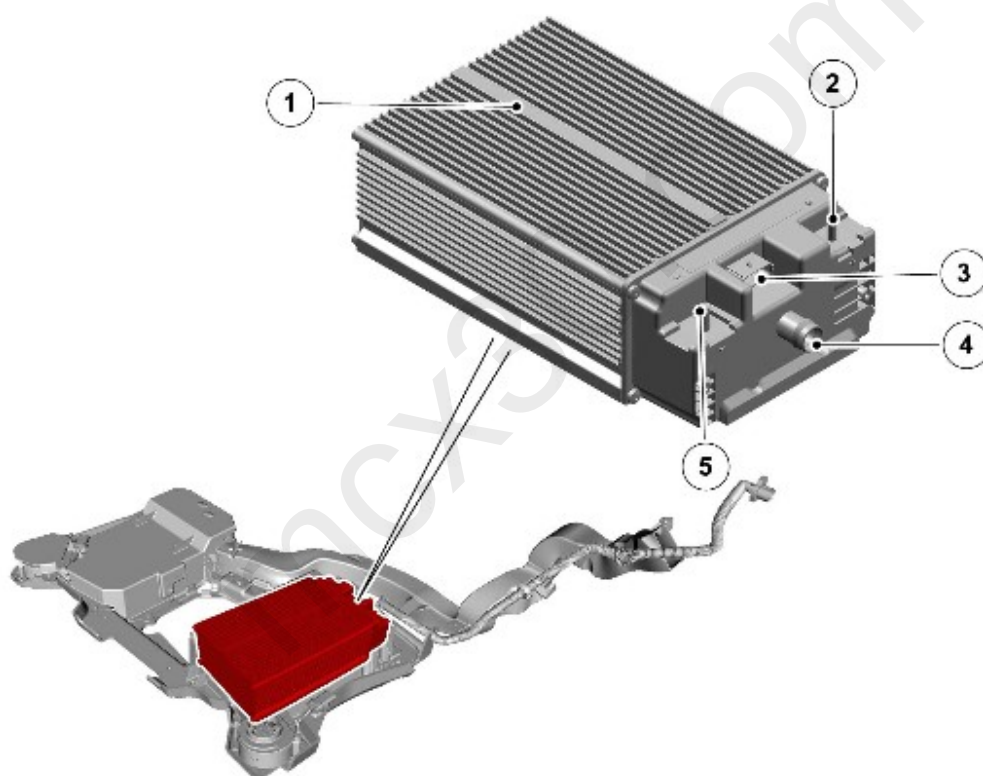
The battery housing is a metal cowl which surrounds the MHEV battery. The MHEV battery cooling fan blows air into the housing. The air is directed over the surface of the MHEV battery and absorbs heat from the battery surface. The air is expelled at the rear of the housing.

#### MHEV BATTERY



#### NOTE:

The MHEV battery is connected to ground through the MHEV junction box (rear).



E249925

| ITEM | DESCRIPTION                           |
|------|---------------------------------------|
| 1    | MHEV battery                          |
| 2    | MHEV cable terminal (positive)        |
| 3    | Wiring harness connector              |
| 4    | MHEV battery breather pipe connection |

| ITEM | DESCRIPTION                    |
|------|--------------------------------|
| 5    | MHEV cable terminal (negative) |

The MHEV battery is located in the loadspace under the floor, adjacent to the DC/DC. The MHEV battery is installed in the MHEV battery housing with bolts.

The MHEV battery is a sealed unit and cannot be opened. The MHEV battery contains the following:

- MHEV battery module with 14 cells.
- The Battery Energy Control Module (BECM).

The cells in the MHEV battery module are the Lithium-ion type.

The BECM controls the electrical current flowing into and out of the MHEV battery.

The MHEV battery has the following connections:

- The MHEV cable terminal (positive).
- The MHEV cable terminal (negative).
- A wiring harness connector for the BECM.
- A MHEV battery breather pipe connection allows for pressure equalization between the inside of the MHEV battery and the outside atmosphere. A MHEV battery breather pipe also allows gases to be vented outside the passenger compartment.

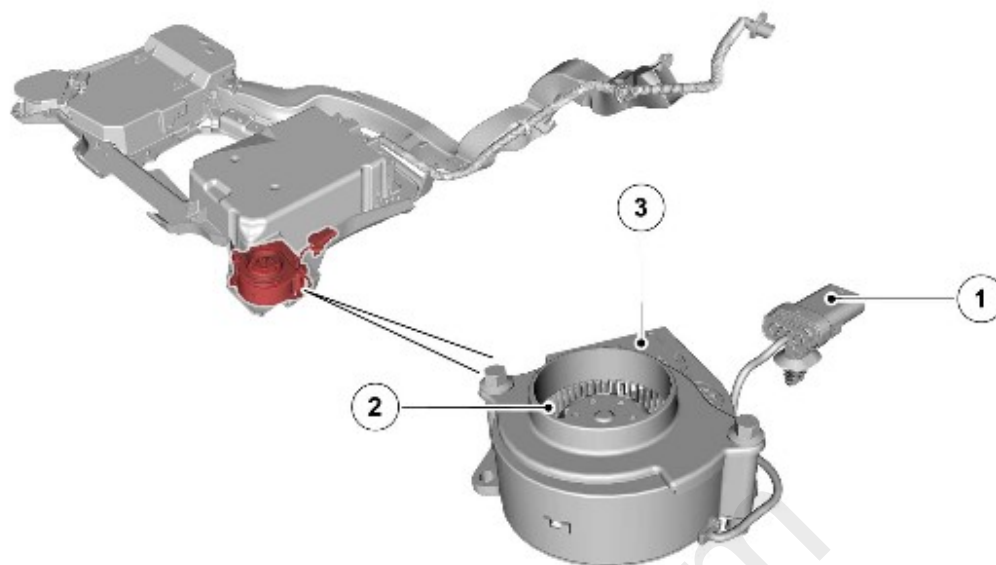
The MHEV battery is cooled by an air flow produced the MHEV battery electric cooling fan. The MHEV battery electric cooling fan is powered by a 12V Direct Current (DC) motor which is controlled by a Pulse Width Modulation (PWM) signal from the BECM.

#### MHEV BATTERY ELECTRIC COOLING FAN

##### CAUTION:

Make sure that the air inlet behind the second row seats is not obstructed. A reduction in the cooling airflow can cause overheating in the following components:

- The MHEV battery
- The DC/DC.



E249926

| ITEM | DESCRIPTION              |
|------|--------------------------|
| 1    | Wiring harness connector |
| 2    | Cooling air inlet        |
| 3    | Cooling air outlet       |

The MHEV battery electric cooling fan is adjacent to the MHEV battery housing. The MHEV battery electric cooling fan housing is attached to the cradle with 2 bolts.

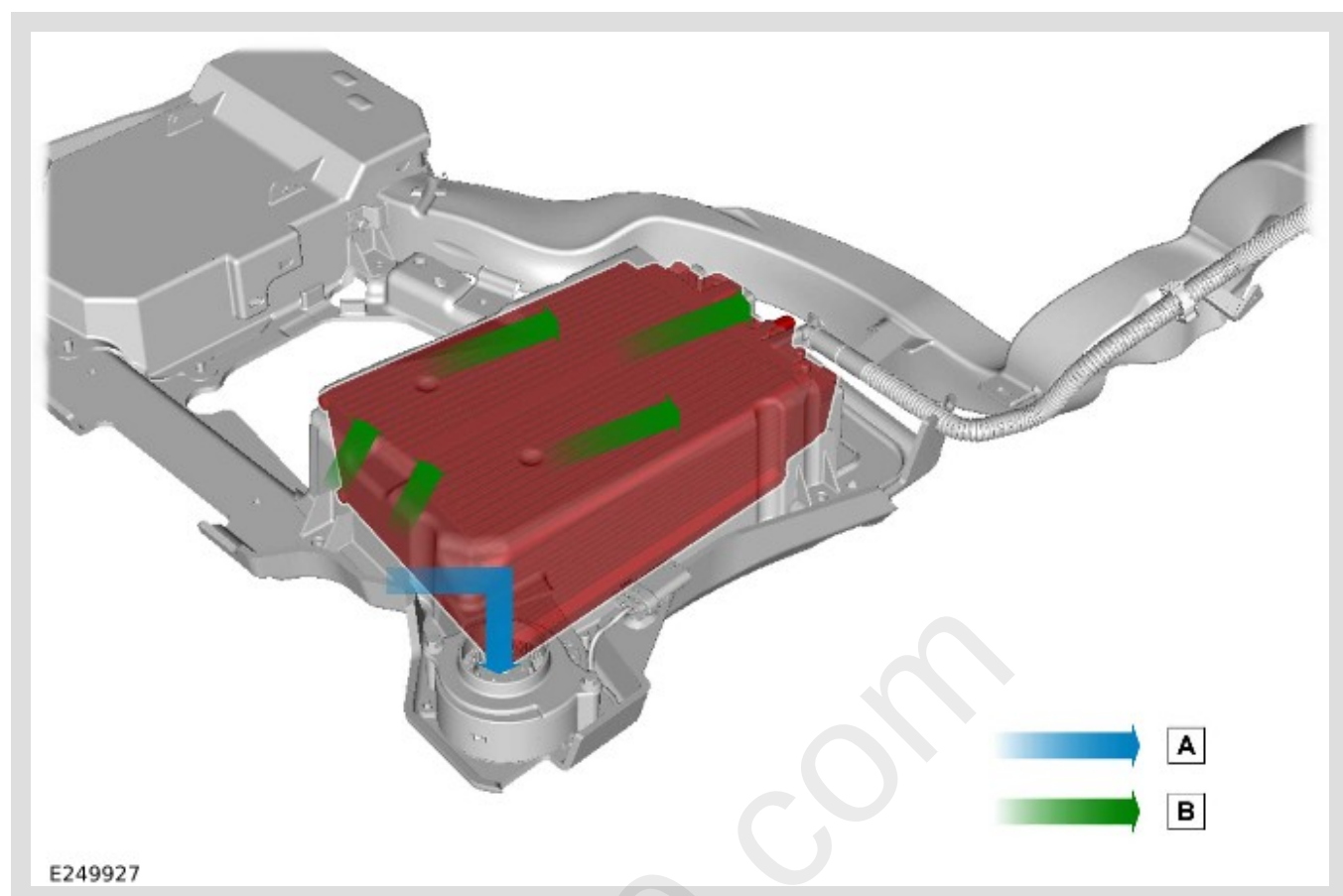
The cooling fan outlet connects with the MHEV battery housing. Cool air is directed into the housing where it passes over the outside of the MHEV battery in order to absorb heat.

The MHEV battery electric cooling fan has a short fly lead with a 4-pin wiring harness connector. The 4-pin connector only uses 3 pins of the wiring harness connector for the following electrical connections:

- Power supply from the Passenger Junction Box (PJB).
- A PWM signal from the BECM in the MHEV battery.
- A ground connection.

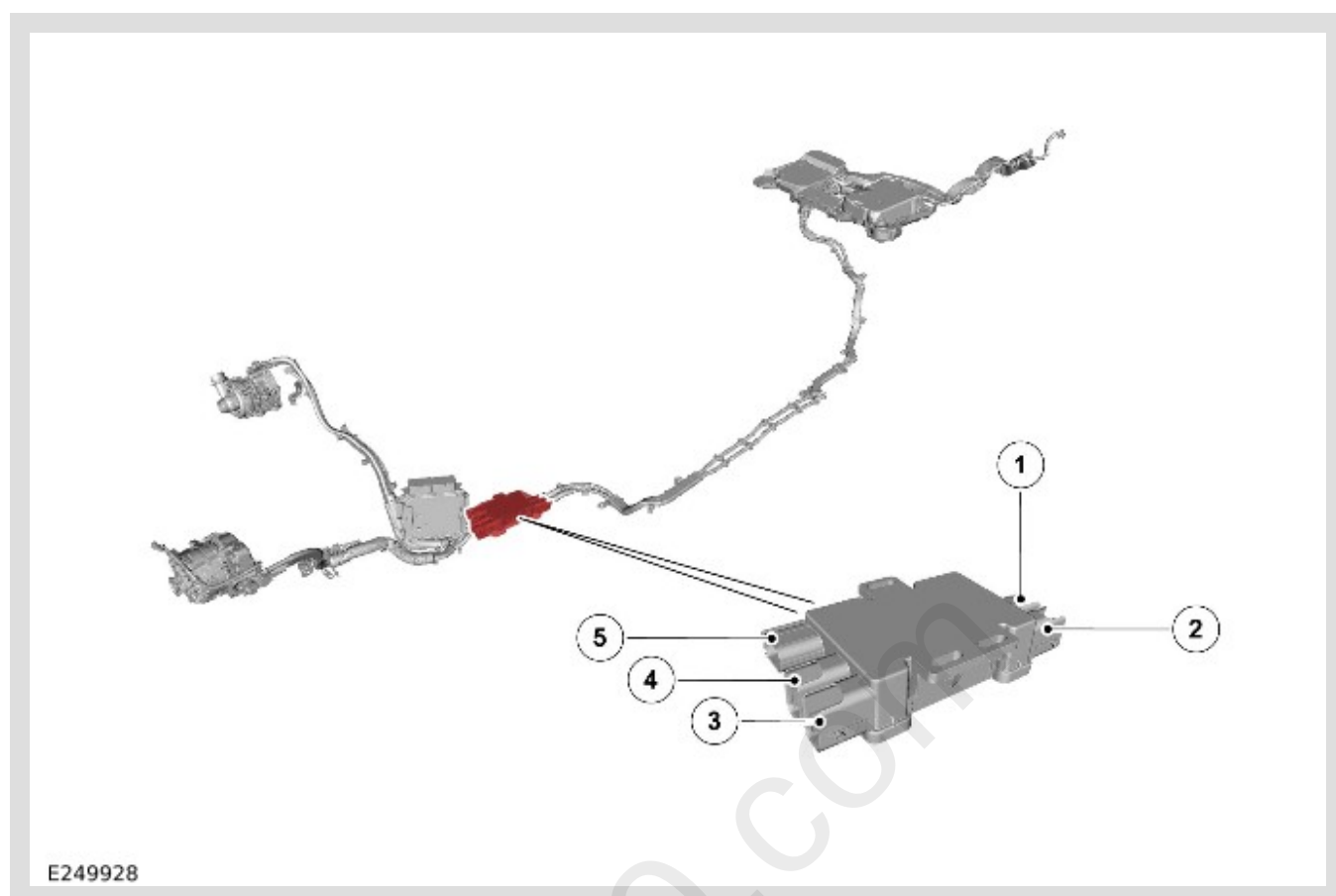
The BECM in the MHEV battery sends a PWM signal to the MHEV battery electric cooling fan. The BECM controls the speed of the MHEV battery electric cooling fan. The MHEV battery electric cooling fan then regulates its speed depending on the duty cycle of the PWM signal.

## COOLING AIR FLOW



| ITEM | DESCRIPTION        |
|------|--------------------|
| A    | Cooling air inlet  |
| B    | Cooling air outlet |

## MHEV JUNCTION BOX – FRONT



| ITEM | DESCRIPTION                                      |
|------|--------------------------------------------------|
| 1    | MHEV cable - To rear MHEV junction box connector |
| 2    | MHEV cable - To rear MHEV junction box connector |
| 3    | MHEV cable - To BISG                             |
| 4    | MHEV cable - To BISG                             |
| 5    | MHEV cable - To electric supercharger            |

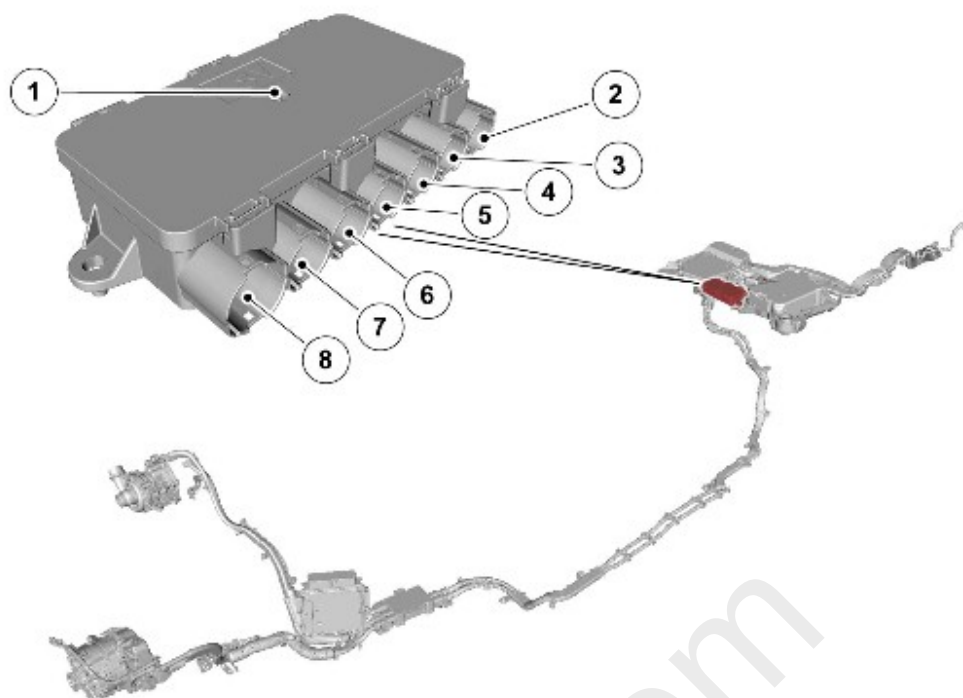
The front MHEV junction box is located under the floorpan on the left. The front MHEV junction box is attached to the floorpan with 3 bolts.

The front MHEV junction box has 2 MHEV cable connections from the following:

- BISG
- Electric supercharger.

The main cable runs from the BISG to the rear MHEV junction box are connected by non fused bus bars. The connection to the electric supercharger incorporates a non serviceable 100A fuse.

## MHEV JUNCTION BOX – REAR



E249931

| ITEM | DESCRIPTION                                      |
|------|--------------------------------------------------|
| 1    | MHEV junction box - Rear                         |
| 2    | MHEV cable - To MHEV battery - Positive          |
| 3    | MHEV cable - To DC/DC                            |
| 4    | MHEV cable - To DC/DC                            |
| 5    | MHEV cable - Ground                              |
| 6    | MHEV cable - To MHEV battery - Negative          |
| 7    | MHEV cable - To rear MHEV junction box connector |
| 8    | MHEV cable - To rear MHEV junction box connector |

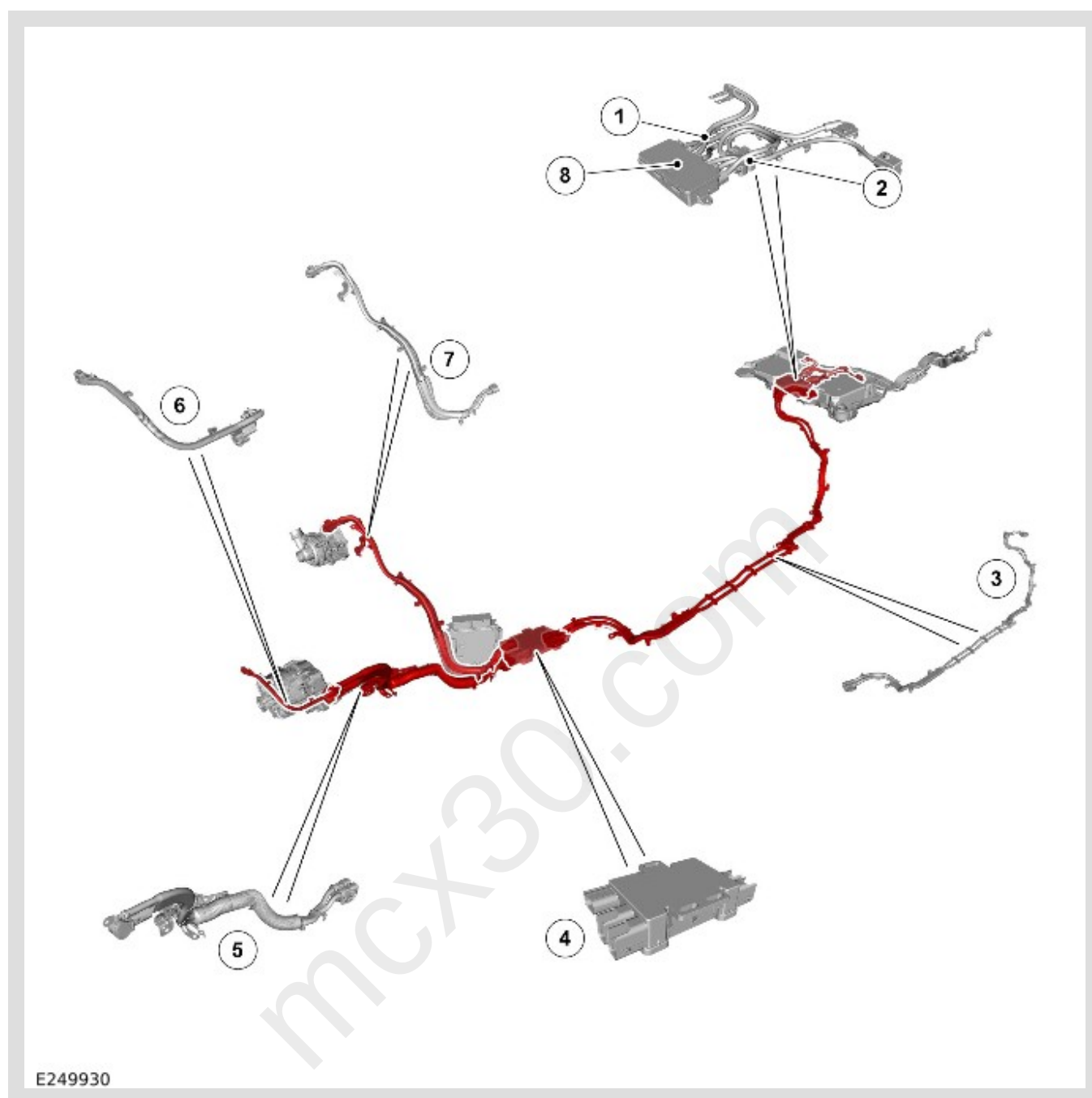
The rear MHEV junction box is located in the cradle between the DC/DC housing and the MHEV battery housing. The rear MHEV junction box is secured to the cradle by 2 bolts.

There is a connection from the MHEV battery 48V negative terminal to the DC/DC, body ground and the front MHEV junction box. The rear MHEV junction box has a 100A fuse on the 48V positive terminal to the DC/DC.

The rear MHEV junction box has a 200A fuse on the 48V positive terminal to the MHEV battery.

The 48V negative cables to the DC/DC, BISG, and electric supercharger provide a high current return circuit.

## MHEV CABLES



| ITEM | DESCRIPTION                                                         |
|------|---------------------------------------------------------------------|
| 1    | MHEV cables - Rear MHEV junction box to the DC/DC                   |
| 2    | MHEV cables - Rear MHEV junction box to the MHEV battery            |
| 3    | MHEV cables - Rear MHEV junction box to the front MHEV junction box |
| 4    | MHEV junction box - Front                                           |
| 5    | MHEV cables - Front MHEV junction box to the BISG                   |
| 6    | MHEV cables - BISG                                                  |
| 7    | MHEV cables - Front MHEV junction box to the Electric supercharger  |

| ITEM | DESCRIPTION              |
|------|--------------------------|
| 8    | MHEV junction box - Rear |

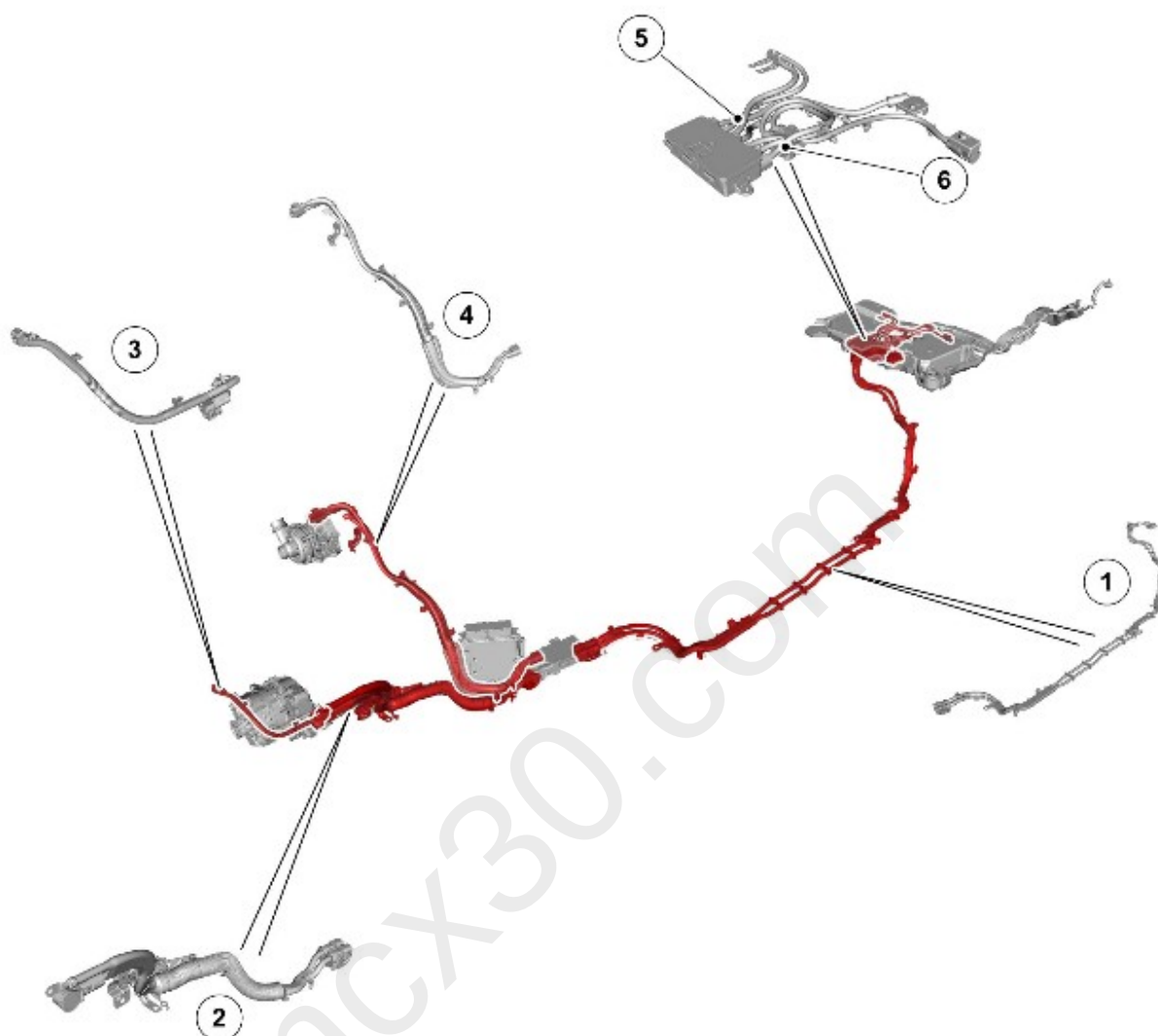
The MHEV cables have a pale blue outer covering. The MHEV cables connect the following components:

- MHEV battery
- MHEV junction box - Front
- MHEV junction box - Rear
- DC/DC
- BISG
- Electric supercharger.

The MHEV cables distribute the MHEV battery voltage of approximately 48V to the MHEV battery components.

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## MHEV CABLES ELECTROMAGNETIC COMPATIBILITY INSULATION



E249929

| ITEM | DESCRIPTION                                                           |
|------|-----------------------------------------------------------------------|
| 1    | MHEV cable - Front MHEV junction box to the rear MHEV junction box    |
| 2    | MHEV cable - Front MHEV junction box to the BISG                      |
| 3    | MHEV cable - BISG                                                     |
| 4    | MHEV cable - Front MHEV junction box to the electric supercharger     |
| 5    | MHEV cable - Rear MHEV junction box to the MHEV battery and the DC/DC |
| 6    | MHEV cable - Rear MHEV junction box to the MHEV battery               |

There are 5 sections of the MHEV cables that have Electromagnetic Compatibility (EMC) screening on them as following:

- The front MHEV junction box to the rear MHEV junction box
- The front MHEV junction box to the BISG
- The MHEV cables - BISG
- The front MHEV junction box to the electric supercharger
- The rear MHEV junction box to the MHEV battery and the DC/DC.

Each section of EMC screening on the MHEV cables has an electrical wiring connector to provide a ground connection. The EMC screening ground connections are installed to the body with bolts.

## OPERATION

The MHEV battery is controlled by the PCM through the integrated BECM which is incorporated into the MHEV battery. The PCM communicates with the BECM through the High Speed (HS) Controller Area Network (CAN) power mode zero systems bus. The BECM transmits the MHEV battery State of Charge to the PCM.

When there is a fault with the MHEV battery system the PCM sends a message to the Instrument Panel Cluster (IPC) to do the following:

- Display the red battery warning indicator in the IPC.
- Display any related warning messages in the IPC message center.

### BATTERY ENERGY CONTROL MODULE

The BECM monitors the following to make sure that the MHEV battery operates within normal operational limits:

- MHEV battery module internal temperature
- MHEV battery module voltage.

The BECM has the following wiring harness connections:

- Power supply from the Rear Junction Box (BCMB).
- HS CAN power mode zero systems bus (quantity 2).
- Power Mode 6 (ignition ON) signal from the Body Control Module/Gateway Module (BCM/GWM).
- PWM signal to the MHEV battery electric cooling fan.

The BECM communicates with the PCM through the HS CAN power mode zero systems bus. The PCM controls the BISG to charge the MHEV battery when electrical energy is required.

For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).

The BECM also controls the power available from the MHEV battery for the following:

- BISG for auto stop/start engine starts and engine assist to increase fuel economy.
  - For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
- 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: [Supercharger Cooling](#) (303-03D Supercharger Cooling - INGENIUM I6 3.0 L Petrol, Description and Operation).

The BECM contains a relay. The relay isolates the MHEV battery from the MHEV battery system, without having to remove any MHEV cables.

The BECM controls the MHEV battery electric cooling fan with a PWM signal. The duty cycle of the PWM is used to request the required cooling from the MHEV battery electric cooling fan.

#### MHEV BATTERY CHARGING

The MHEV battery is charged by the BISG with energy from the following sources:

- Recovered energy when the engine overruns.
  - This uses energy derived from deceleration when the accelerator is released. The crankshaft is being driven by the transmission as the vehicle slows down. The BISG recovers the energy that would otherwise be lost and fully charges the MHEV battery.
- Engine torque
  - On extended motorway journeys there may be limited opportunities to recover energy during deceleration. In these circumstances energy is taken from the engine when the vehicle is cruising to maintain a minimal battery State of Charge.

The PCM monitors the MHEV battery State of Charge. The PCM determines when is the most efficient time to charge the MHEV battery. The PCM only charges the MHEV battery to a specific State of Charge with engine torque. The MHEV battery can be charged to the maximum State of Charge with the recovered energy when the engine overruns. The recovered energy can then be used by the BISG to provide engine assist when required.

#### MHEV BATTERY STORED ENERGY USAGE

The electrical energy produced by the BISG is stored in the MHEV battery and is used by the following:

- The BISG for the engine auto stop/start operation.
  - For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
- The BISG to provide engine assist when requested by the PCM, to reduce fuel consumption and exhaust emissions.

- The DC/DC to supply the 12V systems and to charge the startup battery. The DC/DC is controlled by the BCM /GWM.
  - For additional information, refer to: [Direct Current to Direct Current Converter](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).
  - For additional information, refer to: [Startup Battery and Cables - INGENIUM I6 3.0L Petrol](#) (414-01B Battery, Mounting and Cables - Vehicles With: MHEV, Description and Operation).
- The electric supercharger to supply air to the turbocharger. The electric supercharger is controlled by the PCM.
  - For additional information, refer to: [Supercharger Cooling](#) (303-03D Supercharger Cooling - INGENIUM I6 3.0 L Petrol, Description and Operation).

When the MHEV battery State of Charge is less than a specific limit, the auto stop/start is disabled. The auto stop/start disabled warning indicator is also shown in the IPC.

For additional information, refer to: [Belt Integrated Starter Generator](#) (414-03 Battery Charging - INGENIUM I6 3.0L Petrol, [+] MHEV, Description and Operation).

If the internal temperature of the MHEV battery is outside specific limits, the BECM will restrict the amount of energy which is available.

#### MHEV BATTERY COOLING

##### CAUTION:

Make sure that the air inlet behind the second row seats is not obstructed. A reduction in the cooling airflow can cause overheating in the following components:

- The MHEV battery
- The DC/DC.

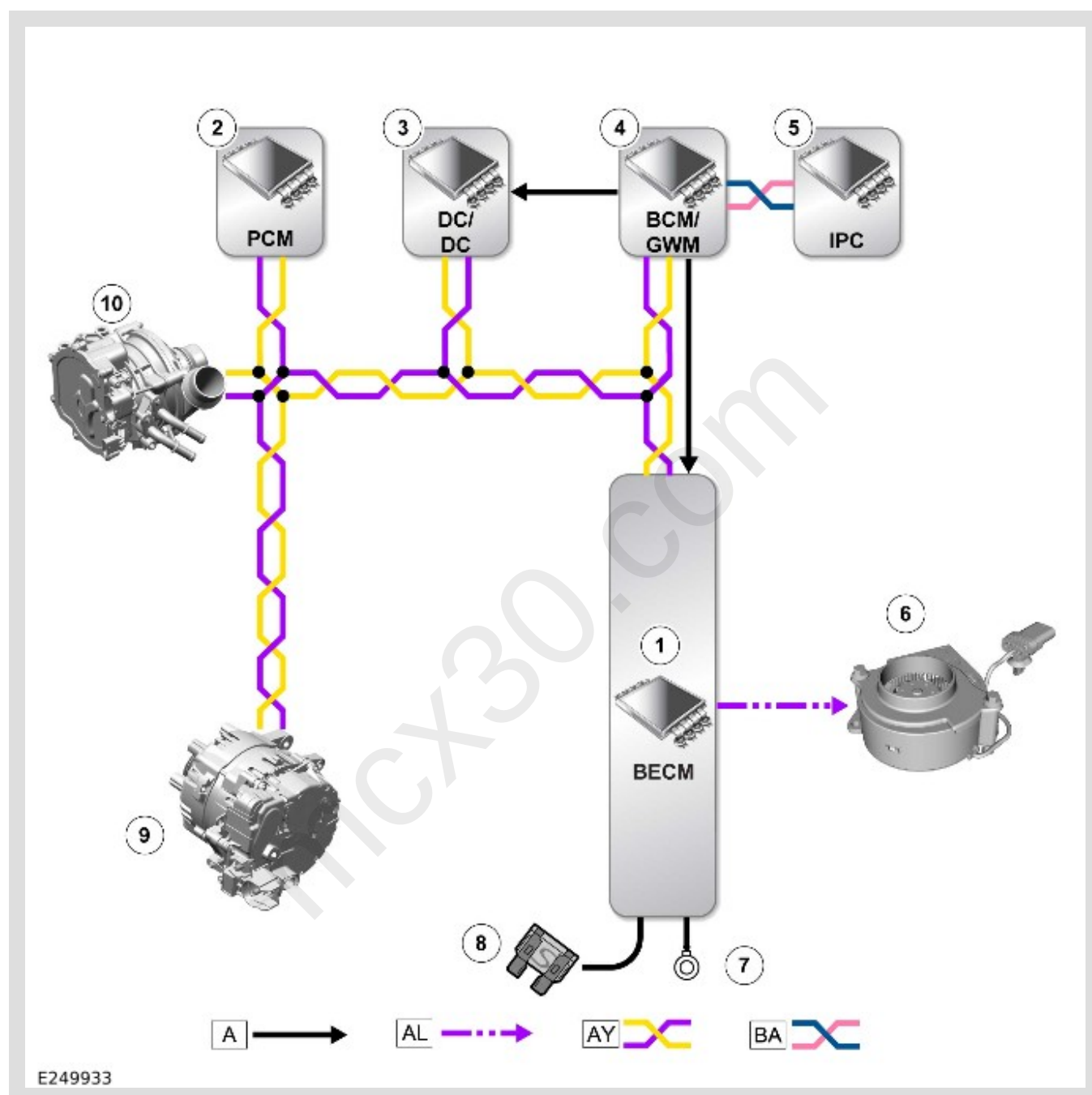
The MHEV battery is air cooled to regulate the internal MHEV battery module temperature. The BECM controls the MHEV battery internal temperature by the operation of the MHEV battery electric cooling fan. The BECM monitors the internal temperature of the MHEV battery. If the BECM determines that cooling is required it sends a PWM signal to operate the MHEV battery cooling fan at an applicable speed.

#### DIAGNOSTICS

The PCM records any Diagnostic Trouble Code(s) (DTC) and related data. Read the DTCs and related data with the Jaguar Land Rover (JLR) approved diagnostic equipment.

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

## CONTROL DIAGRAM - 1 OF 2



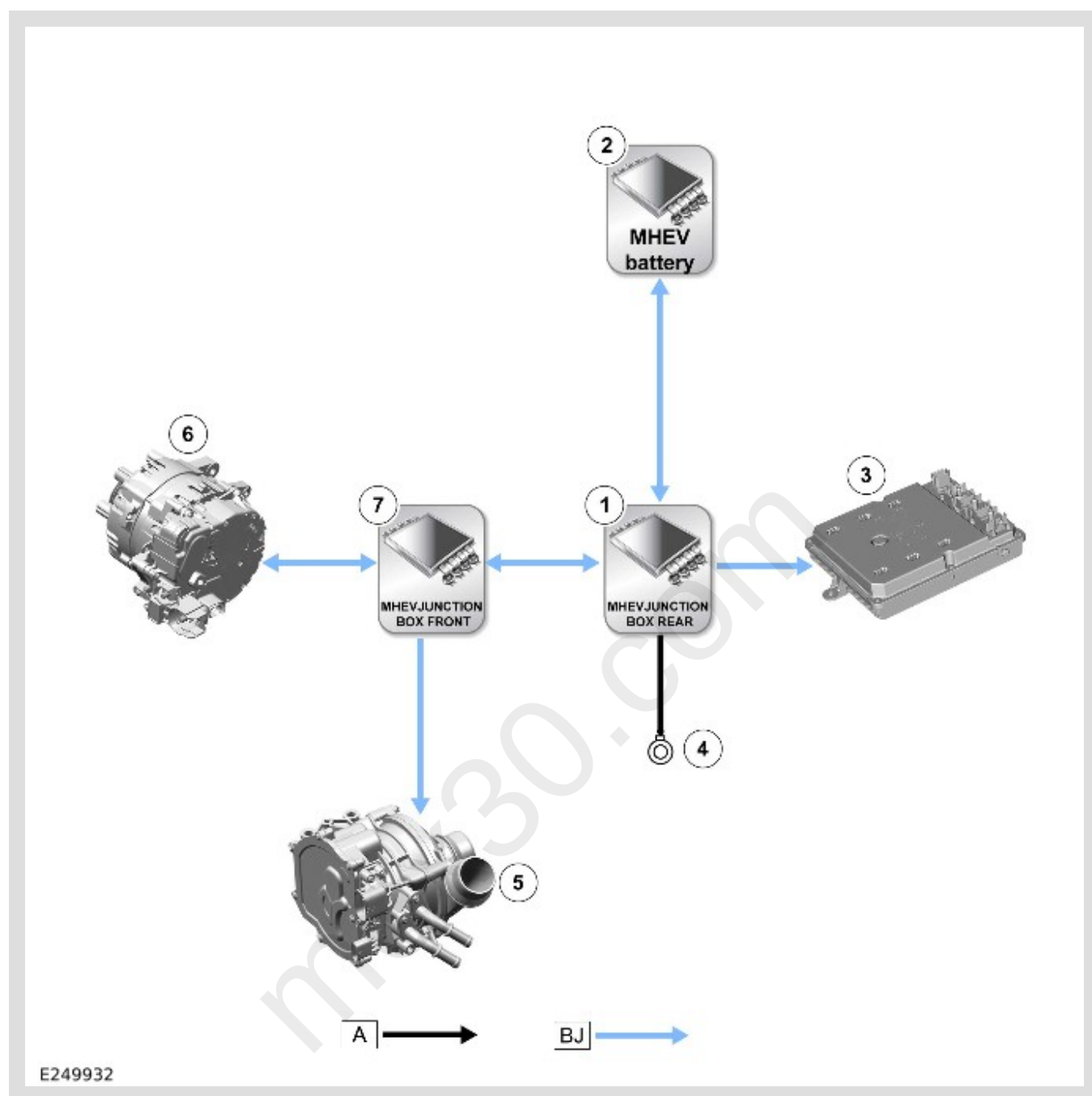
A = HARDWIRED: AL = PWM: AY = HS CAN POWER MODE ZERO SYSTEMS BUS: BA = HS CAN HUMAN MACHINE INTERFACE (HMI) SYSTEMS BUS.

| ITEM | DESCRIPTION                           |
|------|---------------------------------------|
| 1    | BECM - Integrated in the MHEV battery |
| 2    | PCM                                   |

| ITEM | DESCRIPTION                       |
|------|-----------------------------------|
| 3    | DC/DC                             |
| 4    | BCM/GWM                           |
| 5    | IPC                               |
| 6    | MHEV battery electric cooling fan |
| 7    | Ground                            |
| 8    | Power supply                      |
| 9    | BISG                              |
| 10   | Electric supercharger             |

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# CONTROL DIAGRAM – 2 OF 2 – MHEV CABLES



A = HARDWIRED: BJ = MHEV CABLES.

| ITEM | DESCRIPTION              |
|------|--------------------------|
| 1    | MHEV junction box - Rear |
| 2    | MHEV battery             |
| 3    | DC/DC                    |
| 4    | Ground                   |
| 5    | Electric supercharger    |

| ITEM | DESCRIPTION               |
|------|---------------------------|
| 6    | BISG                      |
| 7    | MHEV junction box - Front |

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