P-033

Police Modifier Bulletin

SVE BULLETIN

SPECIAL VEHICLE ENGINEERING – BODY BUILDERS ADVISORY SERVICE

E-Mail via website: www.fleet.ford.com/truckbbas (click "Contact Us")

Toll-free: (877) 840-4338

Date: 5 August, 2021

Mustang Mach-E Overview

Models Affected

2021MY Mustang Mach-E

Purpose

Provide overview of the electrical system for the 2021MY Mustang Mach-E also recommended power and ground points. Also, location illustrations of selected high voltage components.

Recommendation

The 220A DC-DC converter and extended-range battery pack standard on the Mustang Mach-E GT trim level can be used for applications that add aftermarket equipment such as lighting, radios, video, computers, video, spot lamps, surveillance, radar, etc.

The base vehicle (non-GT) does not have capacity for additional loads beyond vehicle standard equipment. This vehicle configuration should not be used for applications that add aftermarket equipment.

The Extended-Range High-Voltage Battery is recommended to maximize range and uptime.

Some electrical noise, inherent to all Electric Vehicle power controls may affect radios operating in lower frequency range.

Your vehicle consists of various high-voltage components and wiring. All of the high-voltage power flows through specific wiring assemblies labeled as such or covered with a solid orange convolute, or orange striped tape, or both. Do not come in contact with these components.

WARNING: This battery pack should only be serviced by an authorized electric vehicle technician. Improper handling can result in personal injury or death.

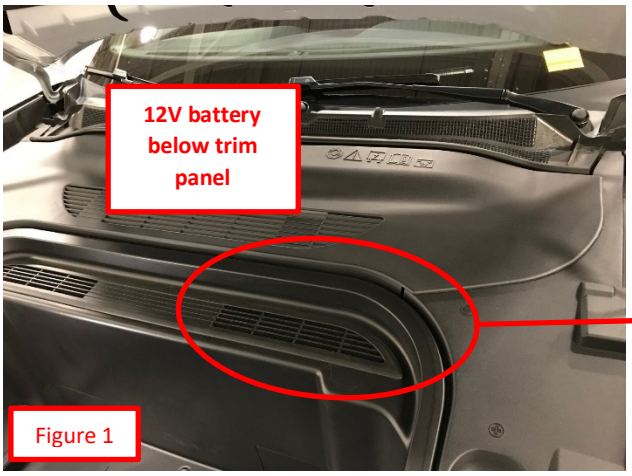
WARNING: Working in this area of the vehicle may result in serious personal injury or damage to a vehicle. Before working on this vehicle, the high voltage power must be disconnected.

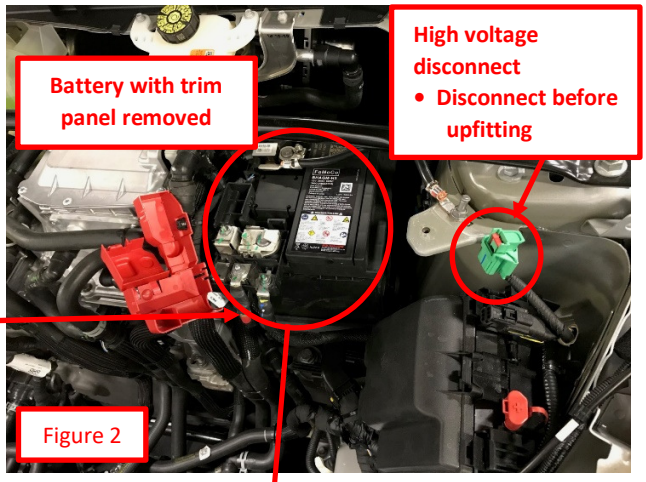
NOTE: This document is a selected high-level overview of the power supply system. Questions should be directed to the Body Builder Advisory Service. Ford Motor Company is not responsible for any modifications of the 2021 Mustang Mach-E.

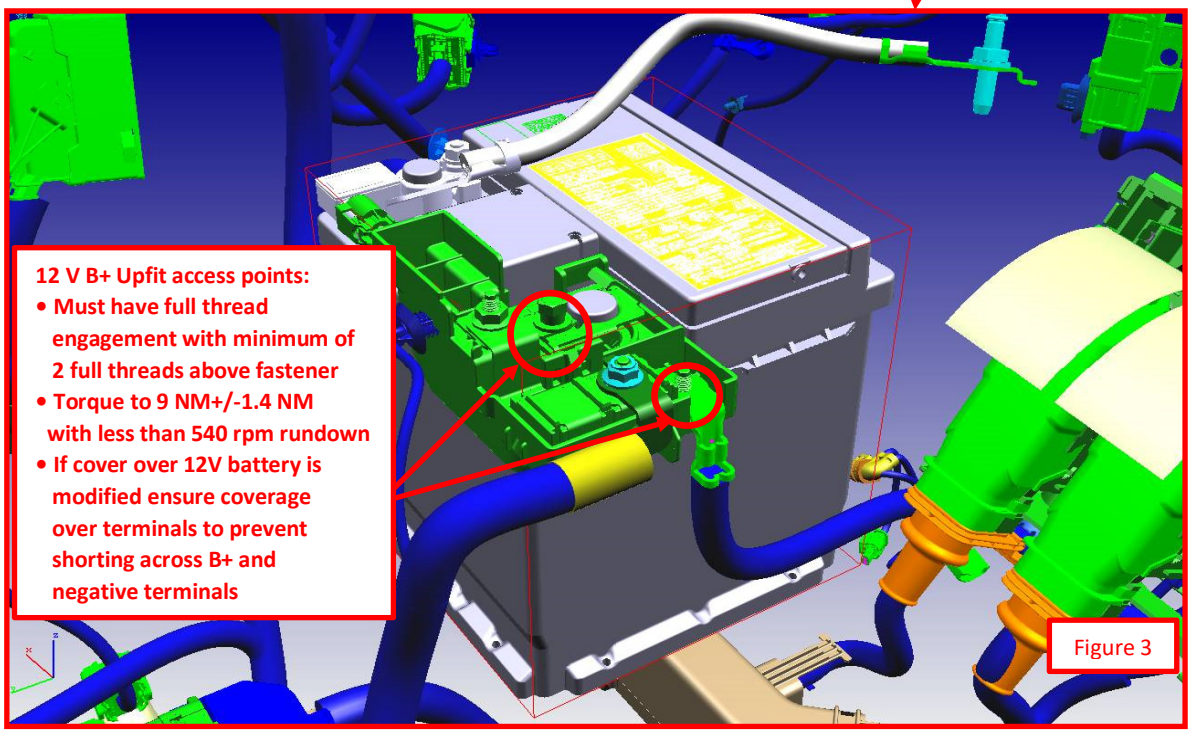
12V Power Access

The 12V battery under the hood in the front of the vehicle must be the access point for power used for addition of aftermarket equipment.

High voltage system must never be accessed or used for upfitting/providing power for anything outside of factory-installed modules. Ensure disconnect in Figure 2 is used before beginning upfit process.







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Recommended Ground Points

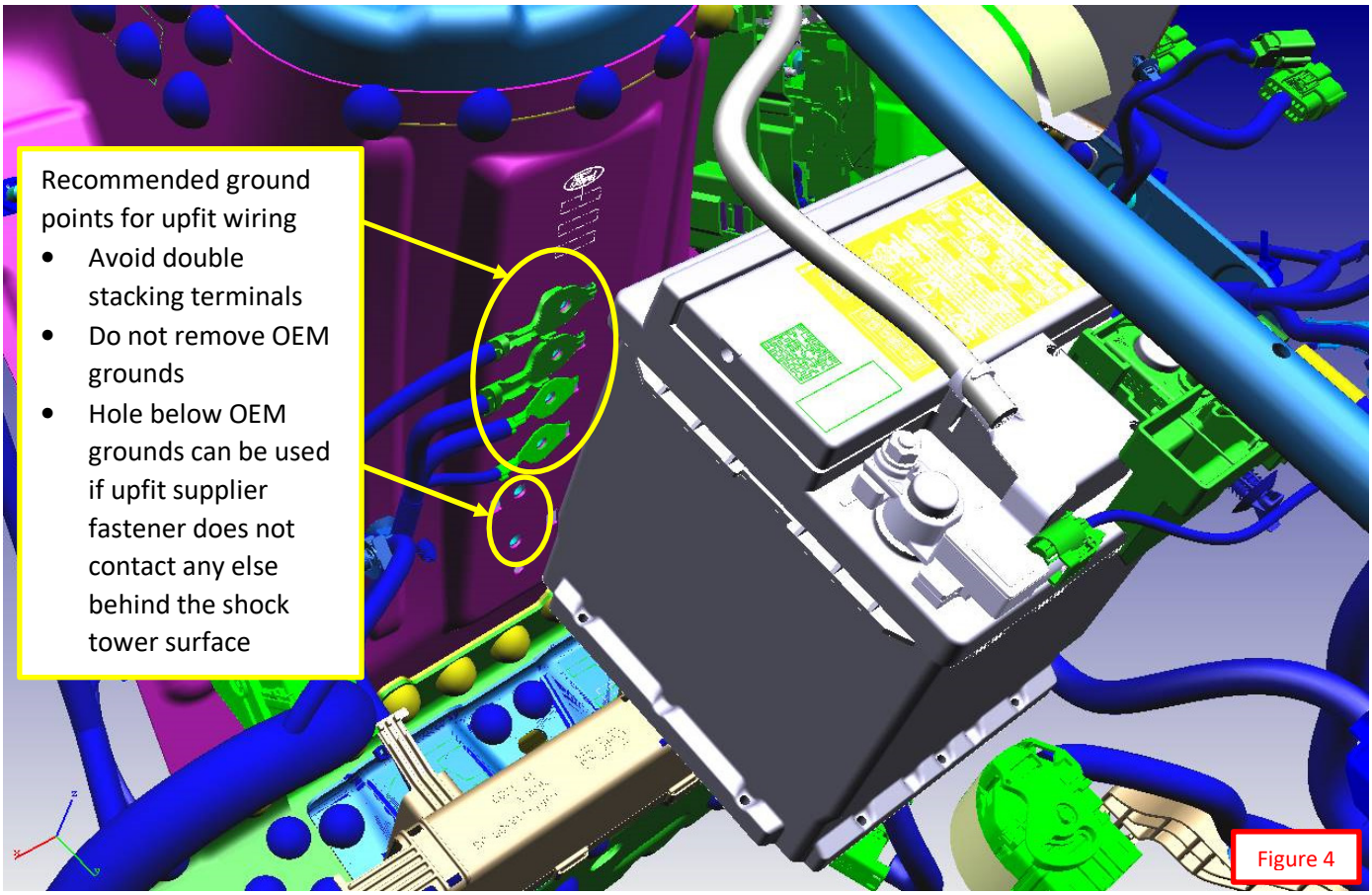

Figure 4

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While ignition status is off, DC-DC is normally off and 12V battery supports the 12V loads.

While ignition is off, if 12V battery reaches 40% state of charge, then vehicle waits 48 hours , before the DC-DC transfers 300 Watt-hours of energy to recharge the 12V battery. The HV power comes from either HV battery or wall power while on plug. If the 12V battery state of charge reaches 30%, then this HV to LV energy transfer happens immediately with no delay.

Note:

- This system was designed to recharge 12V battery while the vehicle was left parked for many days either on or off plug or occasional drain from customer usage. The 12V battery will wear out if this energy transfer is completed daily due to aftermarket loads draining the 12V battery down to 40% or lower.
- Vehicle has 35 Amp-hour AGM 12V Battery

Power Flow Overview for Illustration Purposes ONLY

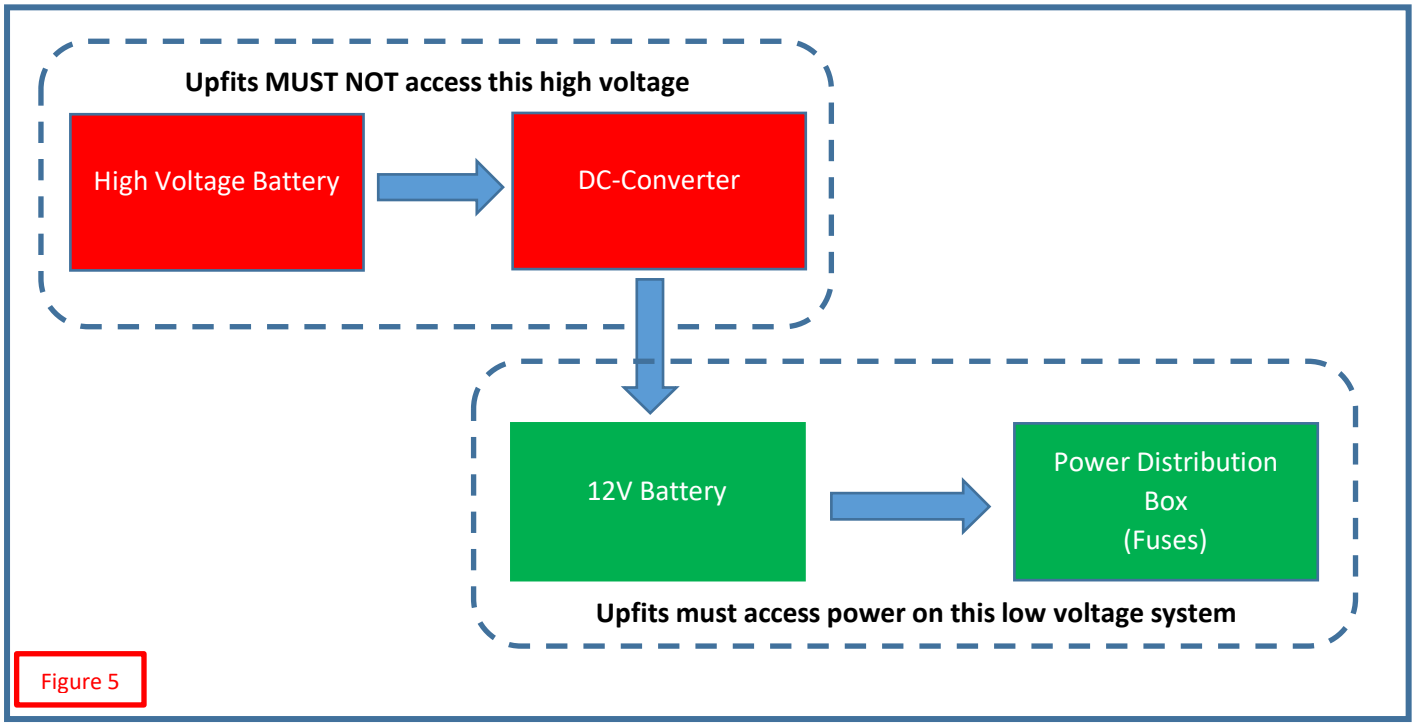

Figure 5

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HV to LV Energy Transfer

The HV to LV Energy system is providing energy transfer from the HV battery to the low voltage battery to prevent non-start condition when vehicle has been keyed-off for extended time. This is to avoid non-start conditions of empty LV battery and the system is only available to electrified plug-in vehicle only. The feature document is to provide high level requirements to develop functional requirements and implementation.

Conditions where High Voltage (HV) to Low Voltage (LV) Energy Transfer is not supported

When the gear selection is not park (e.g. reverse, neutral, drive, sport etc.) the HV to LV Energy Transfer Feature shall deactivate and/or stop the energy transfer process.

When the ignition status is not key-off (e.g. key-on, remote on etc.) the HV to LV Energy Transfer Feature shall deactivate and/or stop the energy transfer process and reset lock out period.

When OTA update is in the process with a software update (non-interruptible state), the HV to LV Energy Transfer Feature shall proceed after the Over the Air (OTA) software update is complete.

When HV to LV Energy Transfer Feature is in the process of an energy transfer, the OTA update shall stop the energy transfer and proceed with the OTA software update.

When an internal error and/or fault is detected (e.g. HV to LV DTC etc.) the HV to LV Energy Transfer Feature shall immediately deactivate and/or stop the energy transfer process.

The HV to LV Energy Transfer Feature shall be enabled to provide energy transfer when vehicle is in “customer mode” or “transport mode”. The feature shall be disabled in all other lifecycle modes.

The customer shall be notified in the vehicle and/or mobile app of the HV to LV Energy Transfer Status if the HV to LV Energy Transfer Feature occurred because of battery consumption conditions (battery EOL, high KOL, park lamps active, hazard lamps active).

- The 12V battery needs to power modules and close the HV battery contactors upon key-on.
- If the 12V battery is depleted (very low SOC), it will not be capable of performing this function. With no ability to close the HV battery contactors, the vehicle will not start. This is true even when the HV battery is fully charged.

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ENTRY CONDITIONS FOR HIGH VOLAGE TO LOW VOLTAGE ENERGY TRANSFER

Normal Entry Conditions:

- The following are entry conditions that must be met to initiate an Energy Transfer Request:
  - Ignition = Off
  - Parked Gear
  - No Error or Faults Detected in HV to LV Energy Transfer System (e.g. DTCs etc.)
  - No OTA software update in process
  - HV Battery SOC and Power Limits > 15% HV SOC
  - LV Battery Temp > -15°C
  - *** LV Battery SOC <= 40%
  - *** Minimum Lock Out Period – 48 hours
    - Since ignition off, and last energy transfer

*** Indicate special conditions where can be over written

ENTRY CONDITIONS FOR HIGH VOLAGE TO LOW VOLTAGE ENERGY TRANSFER (continued)

Special Conditions:

- 1.) If Customer On-Demand Request is detected (e.g. OTA On-Demand)
  - Then request will be honored with any LV Battery SOC.
  - [Overrides LV Battery SOC <= 40% condition.]
    - But other conditions must apply before sending energy transfer request
    - OTA (Over The Air) On-Demand Request provides option for LV battery energy top off before OTA software update
- 2.) If LV Battery SOC =< 40% and detection of any of the following special error conditions:
  - Battery End of Life (EOL)
  - High Key Off Load (KOL)
  - Park Lamps Active / Hazard Lamps Active
  - Then will initiate energy transfer request.
  - [Overrides 48 hour delay limit]
    - But other conditions must apply before sending energy transfer request.
    - Special error conditions and customer on-demand noted above are excluded from 48 hour lock out period.
- 3.) If LV Battery SOC =< 30%; extreme threshold - will initiate transfer request
  - [Overrides 48 hour delay limit]

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12V Battery Charging System

The 12V batter is charged by the DC-DC converter control module. The Battery Management System (BMS) continuously monitors the battery state of charge condition and provides the BCM with this information. The BCM communicates this information to the PCM over the HS-CAN1. The PCM communicates the battery desire setpoint to the DC-DC converter control module which supplies the necessary charge voltage to the 12V battery.

12V Battery Management System

NOTICE: When any vehicle module is being programmed, connect an external battery charger to make sure the module programming is complete without interruption due to the load shedding feature becoming active. The external battery charger must maintain a system voltage above 13 volts. This may require a charger setting higher than the lowest charge setting. The external battery charger negative connection must be made to an engine or vehicle chassis ground and not the negative battery terminal.. If the connection is to the negative battery terminal, load shedding may begin and module programming may be corrupted. After charging has begun, start the engine to clear any load shed states and then turn the engine off the proceed with programming.

Charging and Jumping

Do not charge or jump start the vehicle by connecting to the battery negative terminal. Refer to the Owners Guide for more information.

If the vehicle has been jump started, test the battery condition.

If the 12V vehicle battery has been charged by connecting to the battery negative terminal, do not reset the Battery Monitoring System.

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Component Description

Battery Monitoring Sensor

The Battery Monitoring Sensor continuously monitors the conditionand state of charge of the 12V battery and provides the BCM with this informatino. The Battery Monitoring Sensor also estimates losses in the battery capacity over time. The Battery Monitoring Sensor should only be reset when the batter is replaced. It is urgently recommended that the replacement battery has the exact same specification as the origina battery. If it does not, the accuracy of the Battery Monitoring Sensor outputs will be compromised.

The Battery Monitoring is clamped directly to the negative terminal of the battery and grounds to the vehicle at the chassis ground connection point through the negative battery cable and eyelet. It is part of the negative battery cable and cannot be serviced separately.

External customer loads must only be connectred to the vehicle at the customer battery connection point. If an eternal customer load is connected at the negative battery post, the Battery Monitoring Sensor accuracy cannot be guaranteed. It is recommended that the Battery Monitoring Sensor pole clamp is not removed unless a battery replacment is required. Shoud the battery need to be isolated, this should be done by disconnecting the ground eyelet at the chassis ground.

Body Control Module (BCM)

The BCM monitors the Battery Monitoring Sensor and provides the PCM with battery state of charge information.

Powertrain Control Module (PCM)

The PCM provides desired voltage set point to the DC-DC converter control module.

Direct Current-Direct Current (DC-DC) Converter Control Module

The DC-DC converter control module is responsible for maintaining and charging the 12V battery. It is enabled when the high voltage battery contactors have closed, providing high-voltage power to the DC-DC converter control.

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High Voltage Battery Location

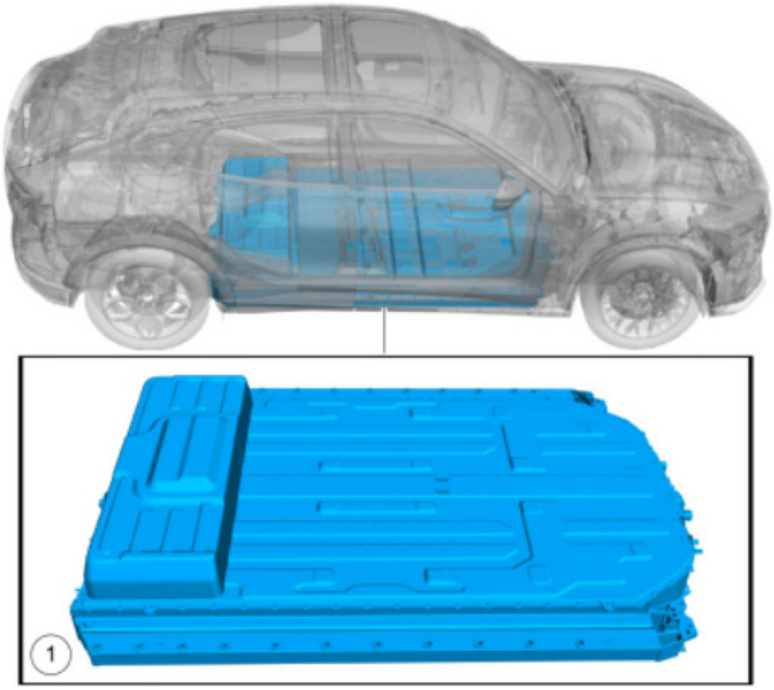

Figure 6

E342153

Item	Description
1	High voltage battery (extended range high voltage battery pack shown, standard range high voltage battery pack similar)

Do not attach or mount aftermarket equipment to trim and/or cover panls these or other high voltage components and/or wiring to prevent contact with high voltage and restrict access to them.

Do not drill, tap and/or run fasteners through flooring above the high voltage battery in Figure 6.

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Front Electric Drive

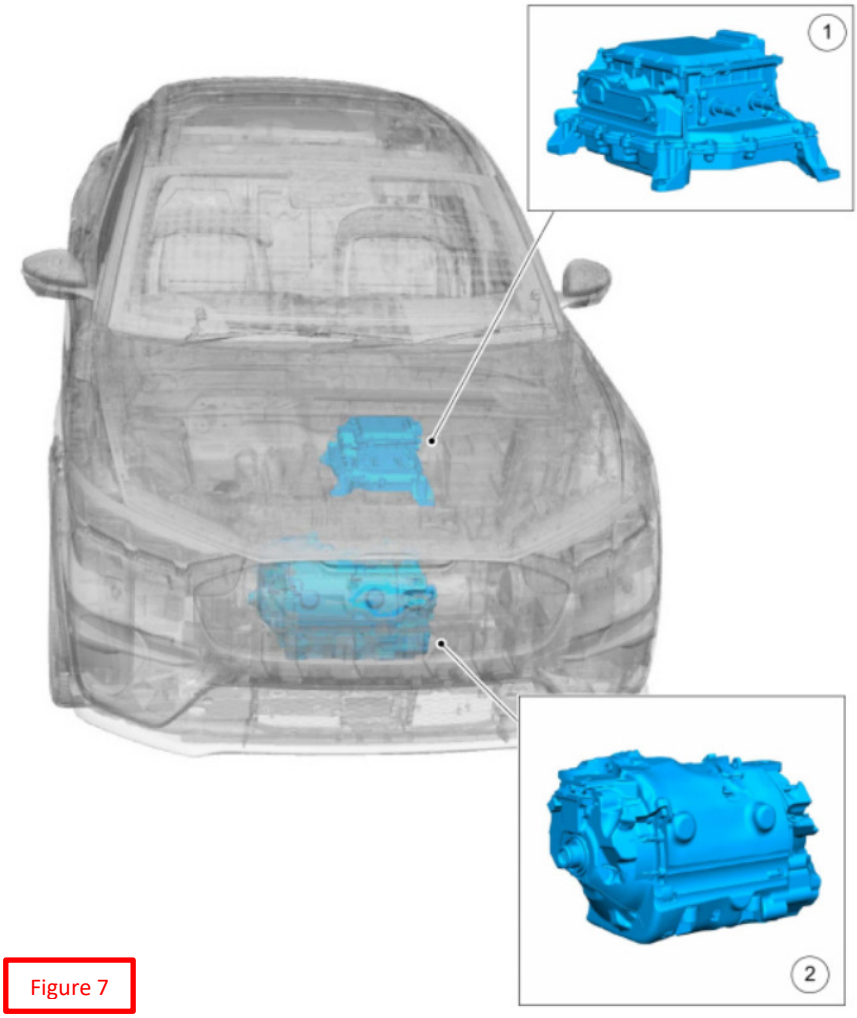

Figure 7

Item	Description
1	Secondary Inverter System Controller (S-ISC) SOBDMB
2	Front Electric Drive Assembly

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Rear Electric Drive Assembly

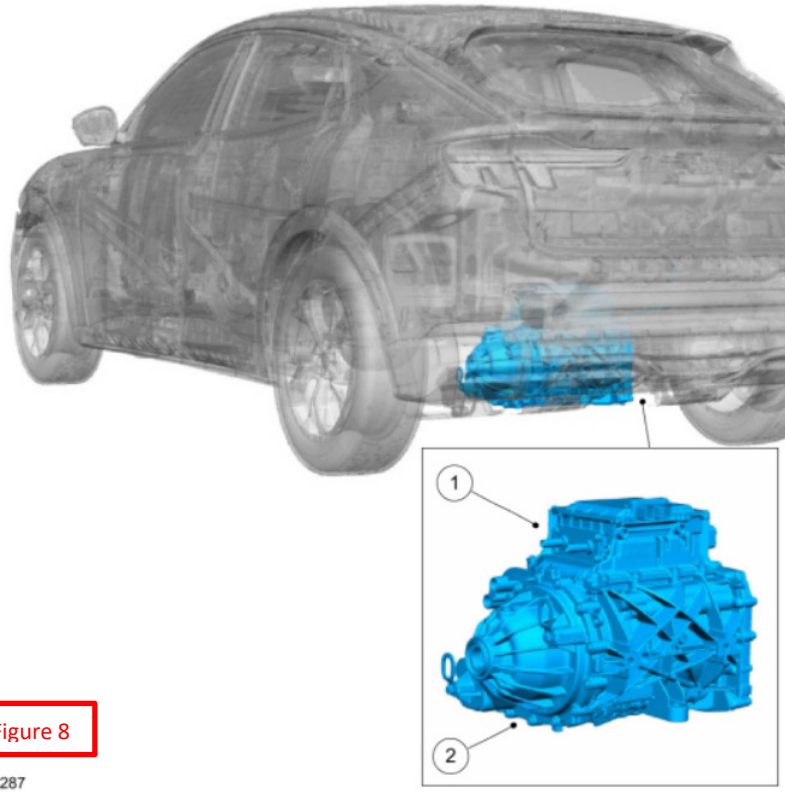

Figure 8

E333287

Item	Description
1	Inverter System Controller SOBDMC
2	Rear Electric Drive Assembly

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High Voltage Battery Charging System

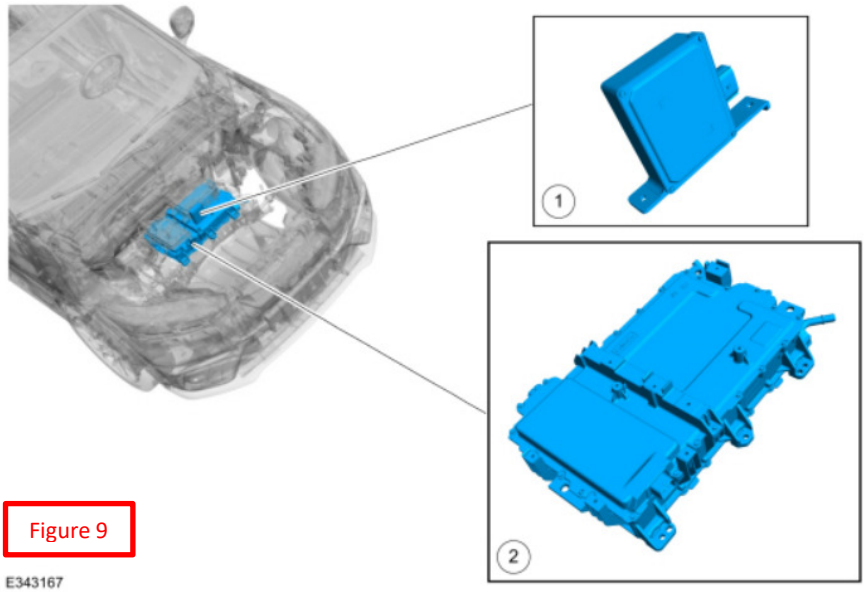

Figure 9

E343167

Item	Description
1	Off Board Charger Controller
2	Inverter System Controller

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