

# FORD **Transit Custom/Tourneo Custom**

2020MY

## Supplemental Body and Equipment Mounting Manual Plug-In Hybrid Electric Vehicle (PHEV)



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## 1.1 About this Publication

This is a supplemental Body and Equipment Mounting Manual (BEMM) document to support the 2020MY Transit Custom Plug-In Hybrid Electric Vehicle (PHEV). This document only provides PHEV specific guidelines and recommendations and should be viewed in conjunction with the latest, live version, Transit Custom BEMM publication, which can be found on <https://azureford.sharepoint.com/sites/SVEBEMMPUBLIC>. It is the Vehicle Converter's responsibility to review both this document and the latest Transit Custom BEMM prior to starting any conversion.

**The numbering of the sections within this document directly relate to the existing sections in the live BEMM.**

For further information please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at [VCAS@ford.com](mailto:VCAS@ford.com)

## 1.2 About this Manual

### 1.2.1 Introduction


It must be emphasised that any change to the basic vehicle which does not meet the enclosed guideline standards may severely inhibit the ability of the vehicle to perform its function. Mechanical failures, structure failure, component unreliability or vehicle instability will lead to customer dissatisfaction. Appropriate design and application of body, equipment and or accessories is key to ensuring that customer satisfaction is not adversely affected.

## 1.3 Commercial and Legal Aspects

### 1.3.4 Legal and Vehicle Type Approval

Significant changes to the vehicle may affect its legal compliance. Strict adherence to the original design intent for brakes, weight distribution, lighting, occupant safety and - hazardous materials compliance in particular - is mandatory.

#### 1.3.13 High Voltage Vehicle Systems

 **WARNING: Any personnel working with or undertaking any modifications to the Transit PHEV vehicle must receive training for HV vehicle systems prior to starting any work.**


Working on a High Voltage Electrical Vehicles is only allowed after completion of the appropriate training(s):

**“Working on Electrical Vehicles”** includes driving the vehicle, performing mechanical works, performing electrical work and switching activities on these vehicles.

**“Electrical Vehicle”** includes all possible types such as HEV (Full Hybrids), PHEV (Plug-In Hybrid Electric Vehicle), BEV (Battery Electric Vehicle) or other versions.

**“Appropriate Training”** means that you as a person who followed the training, has sufficient knowledge about the risks and that you have knowledge about the required safety measures to perform the work in a safe way. The competencies granted by this training are still up-to-date and have not expired.

 **WARNING: Orange coloured cables are HV system (400V) parts and must not be modified nor rerouted.**

 **CAUTION: There are limitations when adding additional electrical devices. Any power take-off consumption needs to be controlled within the guidelines. Extra equipment and usage may have an impact to weight and vehicle driving range.**


## 1.6 Conversion Homologation

For any homologation information or information regarding type approval, please refer to the Transit Custom/Tourneo Custom Body & Equipment Mounting Manual

## 1.13 Vehicle Transportation and Vehicle Storage

 **CAUTION: The vehicle can only be towed to safety or to recovery vehicle for a limited distance (20m maximum) and at a limited speed (10Kph).**

## 1.16 Load Distribution

 **WARNING: If the vertical centre of gravity is equal or less than 870mm and no modifications have been made to components of the braking system, suspension, wheels and tires the converted vehicle complies with ECE13-H, ANNEX 9 standard.**

If the centre of gravity of the converted vehicle exceeds 820mm, Ford Motor Company makes no representation as to conformity with ECE13-H, ANNEX 9 standard.

This applies for the base vehicle fitted with 16" tyres.  
17" tyres are not permitted.

## 1.17 Towing

 **CAUTION: No tow bars are to be fitted**

The vehicle has no towing capability due to the risk of damaging the High Voltage motor during braking.

## 3.1 Engine

PHEVs are equipped with a 3 cylinder inline internal combustion gasoline engine coupled with a generator to supply electric power to the electric motors and the batteries.

## 3.2 Engine Cooling

 **CAUTION: Do not modify the PHEV cooling system.**

## 3.3 Accessory Drive

 **CAUTION: The Front End Accessory Drive (FEAD) of the internal combustion engine on the PHEV must not be modified.**

This vehicle has a DC/DC inverter/converter which replaces the alternator.

## 3.7 Exhaust System

 **CAUTION: Maintain existing routing and design of the exhaust system on the PHEV.**

## 3.8 Fuel System

 **WARNING: Do not modify the PHEV fuel system.**

 **CAUTION: Do not add an auxiliary fuel line on the PHEV fuel system.**



## 4.0 Electrical System

**WARNING:** Any component or part marked with the symbol below must not be drilled, damaged or modified in any way.

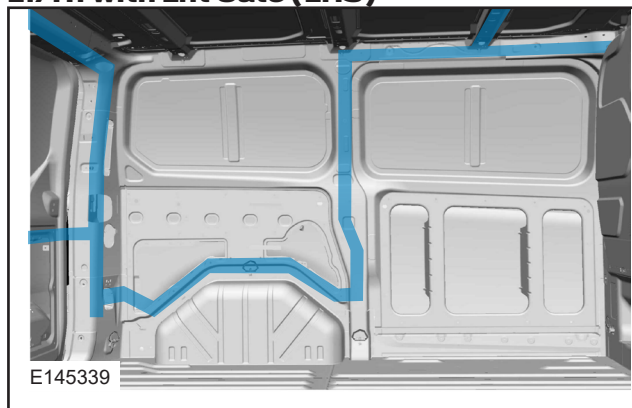


### 4.1 Wiring Installation and Routing Guides

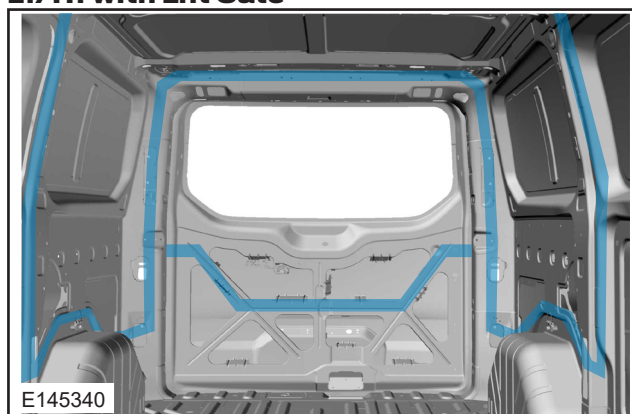
#### 4.1.12 Precautionary Drill Zones — Rear Cargo Area

**WARNING:** Take precaution for drilling or any other operation in the marked zones in order to prevent damages to any components.

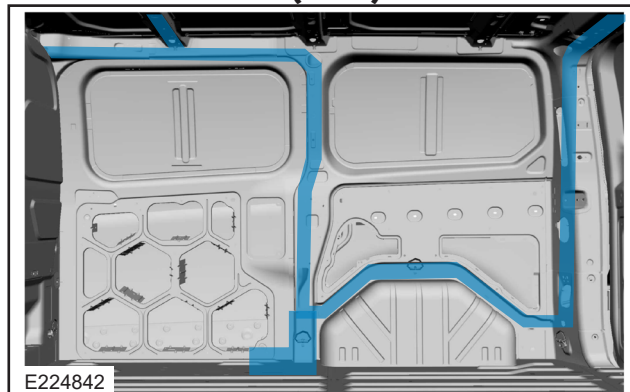
##### L1/H1 with Lift Gate (LHS)



##### L1/H1 with Lift Gate



##### L1/H1 with Lift Gate (RHS)



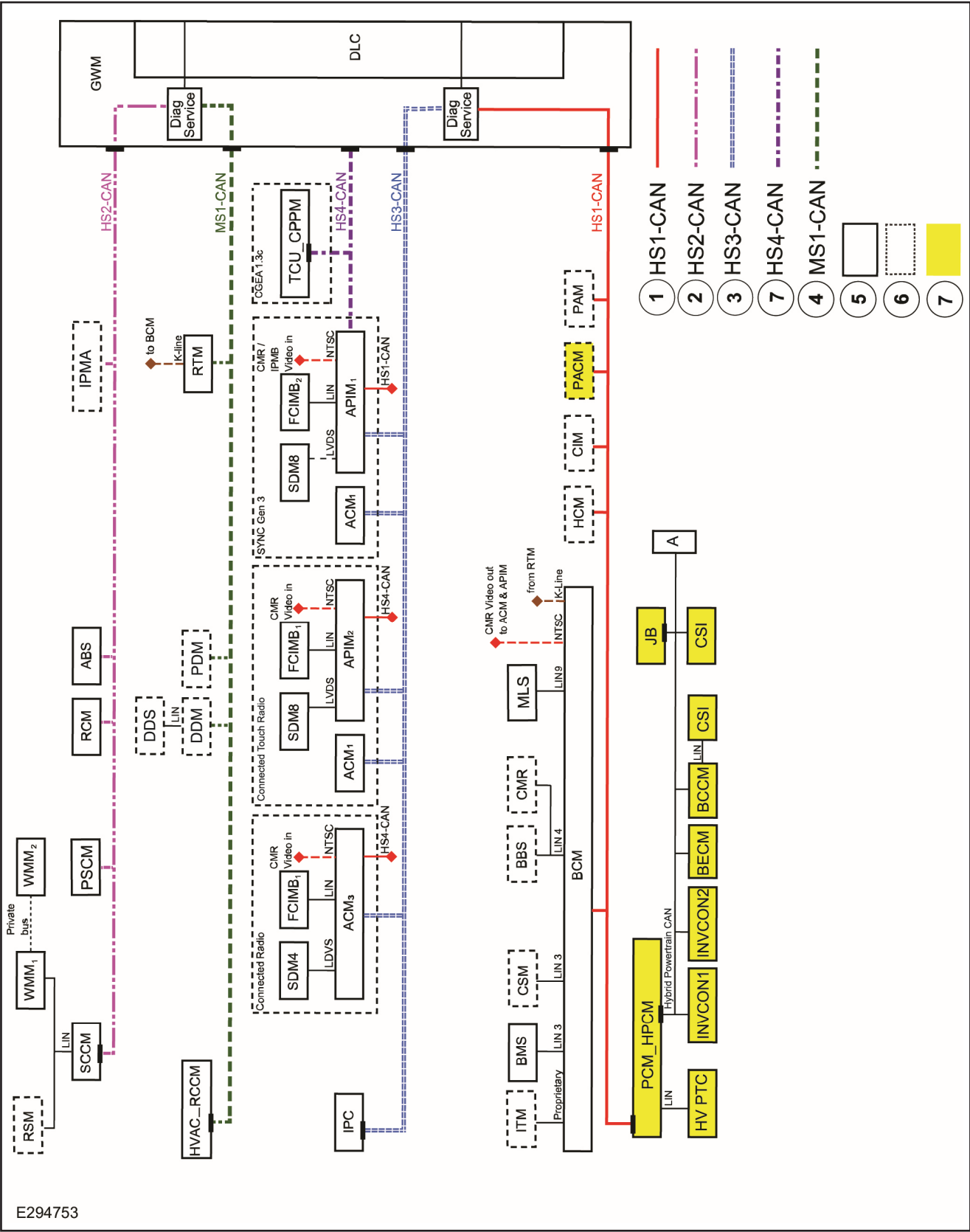
See also the following sections in the Transit Custom BEMM:

- Section 5.3 Racking Systems
- Section 5.4 Loadspace (Cargo Securing)
- Section 5.6 Body Closures (No Drill Zones)

4.2 Communications Network

4.2.1 CAN-Bus System Description and Interface

CAN-Bus System





**Communication Network System (Figure E294753 references)**

Item	Description
1	HS1-CAN - High Speed 1 - CAN <sup>(1)</sup>
2	HS2-CAN - High Speed 2 - CAN <sup>(1)</sup>
3	HS3-CAN - High Speed 3 - CAN <sup>(1)</sup>
4	MS1-CAN -Medium Speed 1 - CAN <sup>(2)</sup>
5	Standard ECU
6	Optional ECU
7	Standard PHEV ECU
A	Diag Connector (For Prototypes only)
ABS	Anti-Lock Brake System Control Module
ACCM	Adaptive Cruise Control Module
ACM <sub>1</sub>	Audio Control Module
ACM <sub>2</sub>	Audio Control Module
ACM <sub>3</sub>	Audio Control Module
APIM	Auxiliary Protocol Interface Module
BBS	Battery Backed-up Sounder
BCCM	Battery Charge Control Module
BCM	Body Control Module
BECM	Battery Energy Control Module
BMS	Battery Monitoring Sensor
CIM	CAN Interface Module
CMR	Camera Module Rear
CSI	Charge Status
CSM	Combined Sensor Module
DDS	Driver Door Switch Pack
DDM	Driver Door Module
FCIMB <sub>1</sub>	Electronic Finisher Panel (10 Button)

Item	Description
FCIMB <sub>2</sub>	Electronic Finisher Panel (5 Button)
GWM	Gateway Module (CGEA 1.3)
HCM	Headlamp Control Module
HVAC -RCCM	HVAC Controls (Remote Climate Control Module)
HV PTC	High Voltage Positive Temperature Coefficient Heater
INCON1	Generator
INCON2	Motor
IPC	Instrument Panel Cluster
IPMA	Image processing Module A (Lane Departure System Camera)
ITM	Integrated Key Transmitter (PATS)
JB	Junction Box
MLS	Main Light Switch
PACM	Pedestrian Alert Control Module
PAM	Parking Aid Module
PCM_HPCM	Hybrid Powertrain Control Module
PDM	Passenger Door Module
PSCM	Power Steering Control Module
RCM	Restraints Control Module
RSM	Rain Sensing Module
RTM	Radio Transceiver Module (RKE & TPMS Receiver)
SCCM	Steering Column Control Module (incl absolute SAS)
SDM4	Slim Display Monitor 4"
SDM8	Slim Display Monitor 8"
TCU_CPPM	Transmission Control Module
WMM <sub>1</sub>	Wiper Motor Module (Master)
WMM <sub>2</sub>	Wiper Motor Module (Slave)

<sup>(1)</sup>500kb/s (kilobits per second)<sup>(2)</sup>125kb/s (kilobits per second)

## 4.3 Charging System

### 4.3.1 General Information and Specific Warnings



**WARNING:** It is not permitted to keep the DC/DC active by leaving the keys in the ignition to position 2 (for Third Party systems) or incorporating a RUNLOCK system.

**NOTE:** The DC/DC 12V power supply is activated at Ignition ON and deactivated at Ignition OFF, unless the vehicle has been delivered with Ford Programmable Battery Guard (FPBG) GEN2. When activated, the voltage supplied is at “conventional charging” mode and based on the battery temperature. For details on conventional charging mode, please refer to the owner’s manual.

### 4.4.8 PHEV EPOWER PACK LV/FPBG GEN3 BEMM

#### WARNINGS:



**Maximum Fused Current on PHEV Epower Pack LV / FPBG Gen3 is 250A. Continuous current capability depends on Third Party System and Conversion. Contact VCAS if further information is required.**

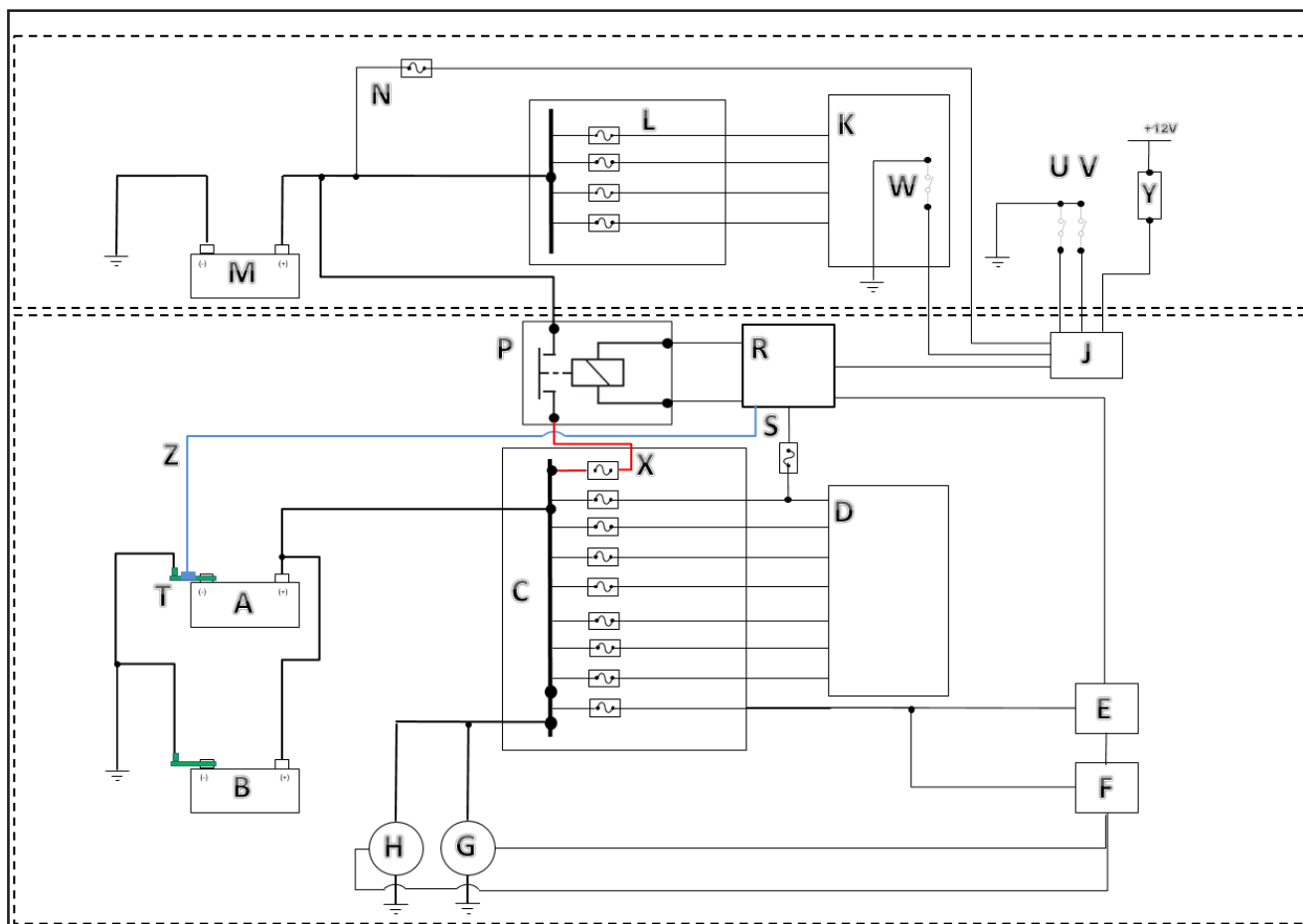


**The Epower Pack LV / FPBG Gen3 may isolate the Third Party system at Drive Ready or Key Off. If sensitive equipment is installed on the Third Party system, the upfitter/converter needs to ensure protection is in place for power disconnect.**

### System Overview

The Epower Pack LV / FPBG Gen3 is the intelligent power management system that provides Drive Ready and Key Off power for Third Party Electrical Systems. The System Topology is shown in the following illustration.

## System Topology

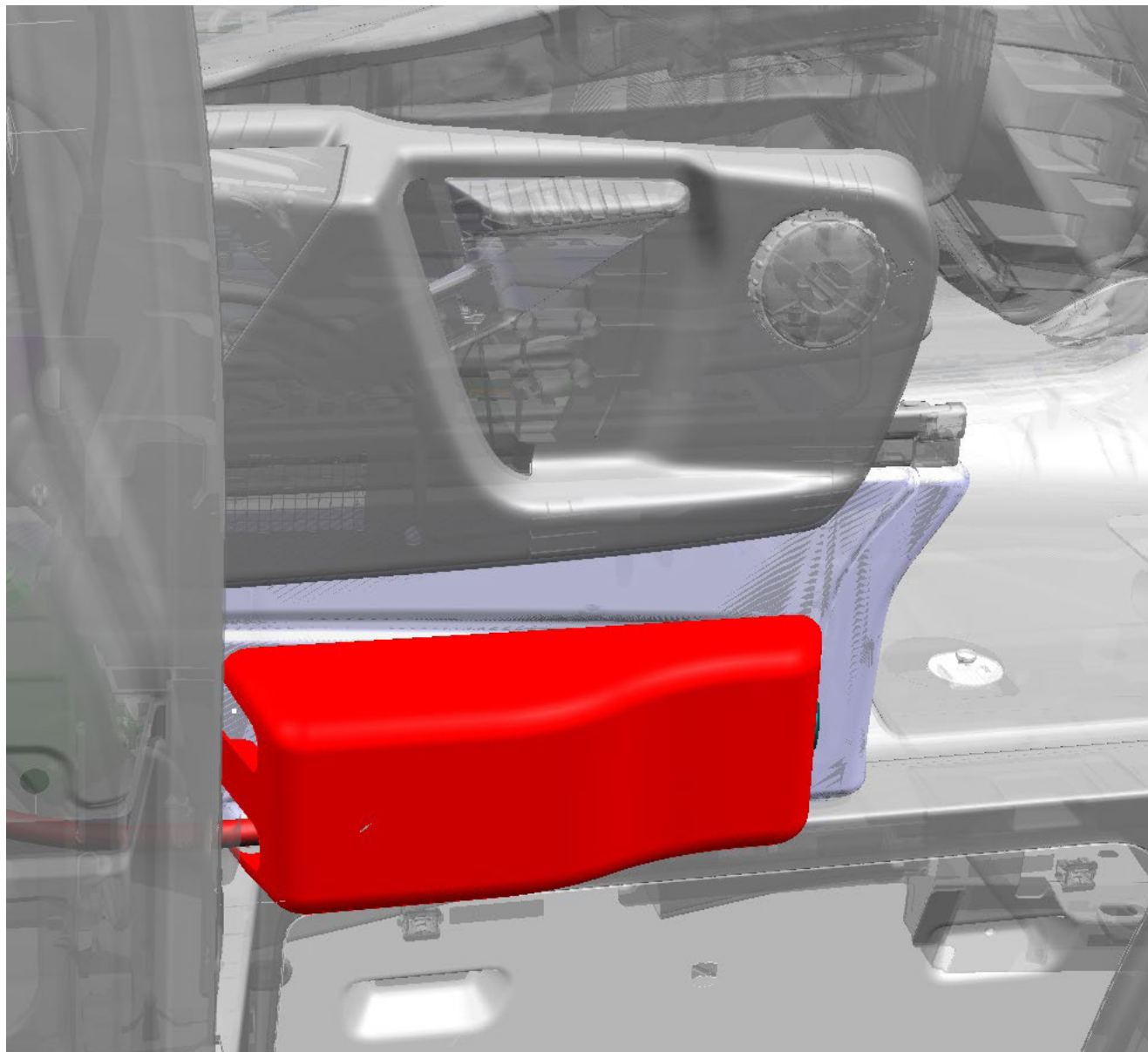


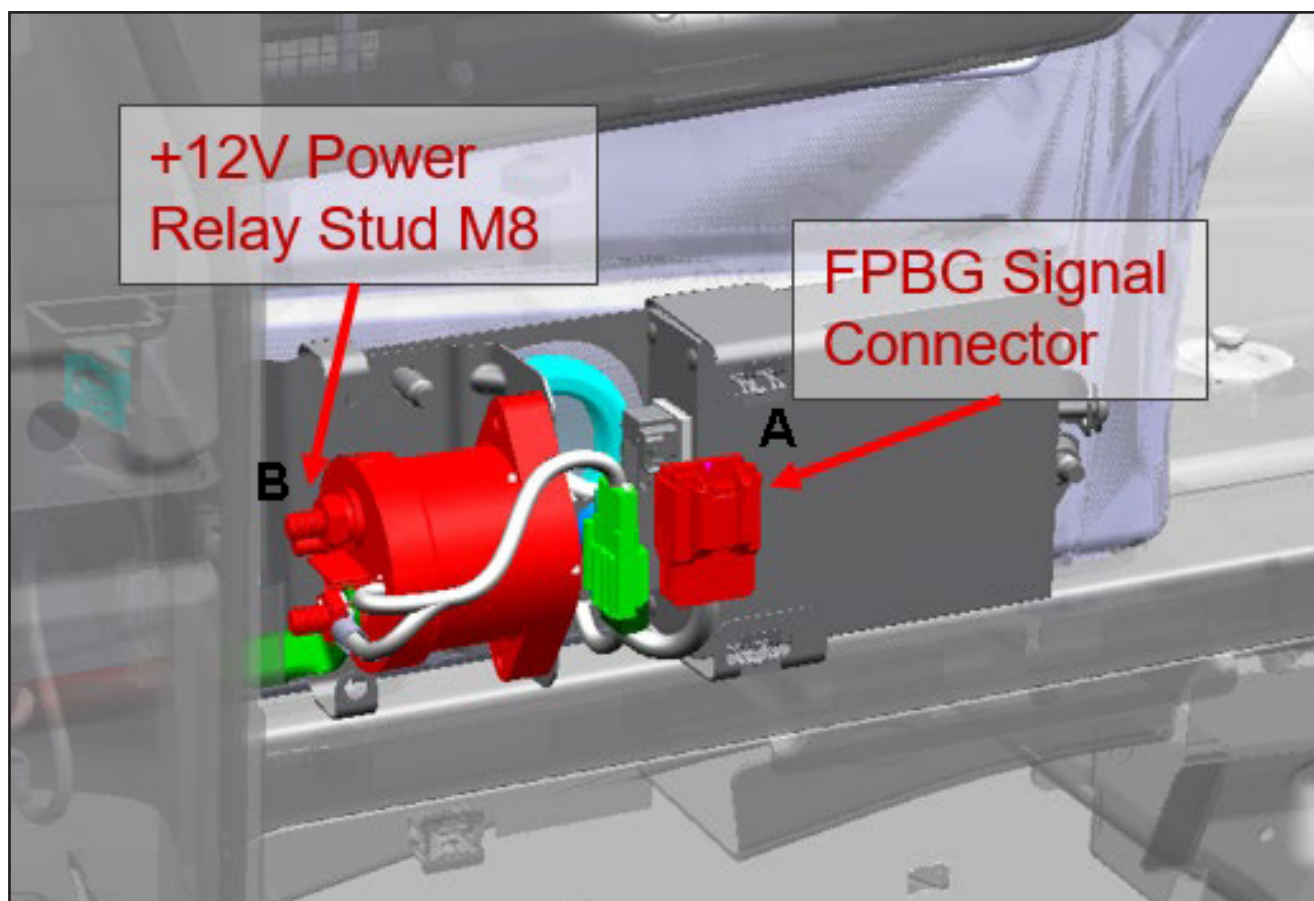
Item	Description	Item	Description
A	Vehicle Battery 1	M	Third Party Battery
B	Vehicle Battery 2	N	Third Party Battery Sense Fuse
C	Vehicle Power Distribution	P	FPBG Power Relay
D	Vehicle Loads	R	FPBG Module
E	Body Control Module	S	FPBG Module Fuse
F	Vehicle Control Module	U	Immediate Close Relay
G	DCDC Converter 1	V	Immediate Open Relay
H	DCDC Converter 2	W	Third Party Full Power Mode
J	Interface Connector	X	Mega Fuse
K	Third Party Loads	Y	Power Isolation Warning/Status Indicator
L	Third Party Power Distribution	Z	Battery Guard/BMS LIN Connection

## Third Party System Connections

Third party systems must be connected to Epower Pack LV / FPBG Gen3 as per below instructions.

The Epower Pack LV / FPBG Gen3 connections are located under the driver seat outboard pedestal cover. They are accessible when the cover (illustrated below) is removed.





Item	Description
A	FPBG Interface Connector
B	Power Relay Terminal (B)- Third Party Power Connection (+12V)

## Power Connections

The Battery Guard Power Relay secondary terminal has M8 Stud and Nut for Third Party Power connection.

1. The M8 Nut needs to be removed
2. The Third Party Power Cable Eyelet need to be seated onto the stud
3. The M8 Nut needs to be tightened to 12Nm+/-1.8

### Signal Connections

The Battery Guard Interface Connector has below signals available to use in Third Party Electrical System.

The connections must be done only to the wires behind the connector. The rest of the vehicle wiring must not be cut or tampered with.

1. Remove the Battery Guard Interface Connector.
2. Untape the spiral and spot tapes around the wires behind the connector.
3. Locate the blunt cut signal wires with heat shrink in the end.
4. Cut the heat shrink, strip the insulation.
5. Use U-shape crimp and heat shrink when making the connection to the Third Party wiring. Do not solder the crimp.

### FPBG Interface Connector Pin layout

Pin	Description	Wire Colour
1	Open Relay Request Input - SW GND	Black
2	Close Relay Request Input - SW GND	Yellow
3	Vehicle Switch Illumination	Brown
4	B+ Converter Battery Sense Line	Brown/Yellow
5	Unused	Green/White
6	Unused	Green/White
7	Empty	-
8	Empty	-
9	Third Party Full Power Mode - SW GND	Green
10	Empty	-
11	Power Isolation Warning/Status Indicator	Yellow
12	Relay Status	Black/White
13	Vehicle Speed	Violet/Orange
14	Engine Run	Grey
15	Auto RPM Control Activation Input - SW GND	Black
16	Ignition KL15 +12V	Blue/Red

### Functionality

- **State of Charge Protection** The Epower Pack LV/FPBG Gen3 isolates Power Relay when the vehicle batteries lose charge under certain State of Charge percentage. That will ensure vehicle preserve drive ready capability. In order to avoid issues on vehicle electric drive, it is recommended to charge batteries via mains charger or a HV charge, after a State of Charge disconnect.
- **Wire Temperature Monitoring** The Epower Pack LV/FPBG Gen3 isolates Power Relay when power cable temperature rises above certain temperatures to avoid thermal issues on the cables. It is recommended to leave the system at rest for at least 10minutes if a Wire Temperature Disconnect happens.
- **Drive Ready Voltage Protection** The Epower Pack LV/FPBG Gen3 isolates Power Relay if voltage level drops below certain threshold at drive ready to protect the low voltage vehicle electrical system. The system will re-connect automatically after 4 minutes if the system voltage recovers.
- **Mains Charger Support** The Epower Pack LV/FPBG Gen3 will automatically detect connection of a mains charger on 12VBatteries to share the charge across all batteries in the system, including the Third Party Battery. The Battery Guard will still detect and react if the mains charger is applied onto the Third Party Battery.
- **Third Party Battery Charge** The Epower Pack LV/FPBG Gen3 monitors the Third Party Battery Voltage at engine off and activates a Conventional Charge State if the Third Party Battery needs charging.
- **Load Shedding** The Epower Pack LV/FPBG Gen3 accepts Body Control Module as Master on the Load Shed Signal at engine run. When the Body Control Module requests Third Party Loads to be disconnected, the Battery Guard will immediately disconnect until the BCM disconnect command disappears. The Battery Guard is the Master for disconnecting the Third Party Loads at engine off.
- **SVO Fuse Box Control** The Epower Pack LV/FPBG Gen3 controls the SVO fuse box at engine run and engine off. The main Power Relay Status will be replicated onto the SVO Fuse Box control output signal. Therefore, if main power relay is connected, SVO Fuse Box will also be connected. Otherwise, they will be both disconnected.
- **Drive Ready Signal** The Epower Pack LV/FPBG Gen3 provides a 1000mA low side driver Drive Ready output for Third Party Systems. The signal can be used to indicate the Drive Ready Status to the Third Party equipment.
- **Full Power Mode** The Epower Pack LV/FPBG



**Epower Pack LV/FPBG Gen3 Power Isolation/Status Indicator Signal Coding**

Function/Signal Name	Status	LED Colour Sequence	Power Isolation/Status Indicator (Signal Pattern)
		'G' = Green 'O' = Orange 'R' = Red '-' = Space	
12V Ford Battery (Battery Sense & Power)	OK	G	
	Low Voltage	OO	
12V Converter Battery (Battery Sense)	OK	G	
	Low Voltage	OOO	
	Open Circuit	RRR	•••
Engine Run Alternator Protection	OK	G	
	Low Voltage Cut Off	RRRR	••••
Power Isolation Warning	Not Triggered	G	
	Triggered	OOOOO	• (Continuous 30 sec)
External Charger (Engine Off)	Not Detected	G	
	> 13.1V Detected	O-O	
	IGN2 Detected	R-R	•
Over Voltage Protection (>15.8V)	OK	G	
	Over Voltage	RRO	•-••
SRC Inhibit Output	Not Triggered	G	
	Triggered	OO-O	
Converter Load SRC Inhibit Input	Not Triggered	G	
	Triggered	O-OOO	
Immediate Relay Contact Open	Not Triggered	G	
	Triggered	OO-OO	••-••
Immediate Relay Contact Close	Not Triggered	G	
	Triggered (Close Switch)	OOO-O	• (Continuous)
Ignition Position 2 (Engine Run)	OK	G	
	Open Circuit	RRR-RR	•••-••
Load Shed Signal	OK	G	
	Open Circuit	RRR-RRR	•••-•••
ECRM Internal Failure	No Failure	G	
	Soft Voltage Reset (Ignition Cycle)	RRR-R	•••-•

**System Check** The system status can be checked via the LED on the module near the connector, if Green is pulsed, the system is ok. If other status codes received, observe for the code and refer to code table above.

Gen3 sends a Full Power Mode Request signal to the vehicle in order to activate the 2nd DCDC Converter in the system which increases power availability to maximum. There is a Ground input available on the Interface Connector for the user to connect the input to the Ground when full power is needed by the Third Party Device. The feature controls voltage into a narrow bandwidth 14.0 to 14.9V where SRC varies between 12.2 to 15.2V. The feature must be used for heavy current applications at Drive Ready and Ignition On to avoid volt drop issues.

- **Immediate Relay Open** the Epower Pack LV/FPBG Gen3 will open contacts immediately if the Immediate Relay Open input is connected to the Ground. It is not recommended to use the feature as a safety switch. The feature will only work if the module and connections are properly made. For protection, it is recommended to use a separate safety switch.
- **Immediate Relay Close** The Epower Pack LV/FPBG Gen3 will close relay contacts immediately providing the Immediate Relay Close input is connected to the Ground, and Immediate Relay Open input is inactive.
- **Power Isolation/Status Indicator** The Epower Pack LV/FPBG Gen3 gives 1000mA low side driver output to indicate the status of the system. The signals are coded to identify the status. Below is the table for the functions and warnings on the output. There is also an LED on the module to indicate the status with colour coded pulses.
- **Mode Selection With Ignition Cycle** Epower Pack LV/FPBG Gen3 detects the vehicle battery technology automatically. The battery quantity is set to single battery by default. If the vehicle has twin batteries, user must perform 5 Ignition Cycles (Igniton 2 – Ignition 0) to set the system into Twin Battery Mode. Relay will click 2 times to indicate correct mode setup for twin battery. If the system is updated to single battery. The mode can be changed to single battery with performing 5 Ignition Cycles again. The relay will click one time to indicate correct setup to single battery mode. Contact [VCAS@ford.com](mailto:VCAS@ford.com) for system specific questions

### Additional Information

- The Epower Pack LV / FPBG Gen3 is fused at 250A, however, if required, Mega Fuse can be down-rated by the upfitter/converter. Contact VCAS for further information.
- The normal operation may lead to click sound when opening and closing power relay contacts. The end operator may need to be advised of this condition.
- The main +12V feed supply is taken from the main Ford battery cable. It is not permitted to touch this interface. If further power take off is required, it must come from the Ford Customer Connection

points as shown in the section Electrical Connectors and Connections.

- If continuous heavy load usage is required, the following values and duration will be observed. The system will disconnect automatically to protect the wiring:
  - up to 175A = continuous
  - over 175 = Contact VCAS
- The system will automatically disconnect loads for approximately 10 minutes for the cool down after allowed maximum wire temperature is achieved. Different system conditions may lead to longer waiting period and shorter usage durations, for example: wiring cross sectional area, cable length and impedance in the system. It is recommended that the converter tests the finished system to calculate the usage duration and cool down period. Contact [VCAS@ford.com](mailto:VCAS@ford.com) for system specific questions.
- The 250A Mega Fuse on the Epower Pack LV / FPBG Gen3 has slow blow characteristics which allow short term higher currents. Example: 337A=Min120/Max1800seconds. Contact [VCAS@ford.com](mailto:VCAS@ford.com) for system specific questions.
- Mains chargers must be of the multi stage type (include trickle charge) and be checked for performance before installation as the system will connect all batteries to the charger.
- Before performing power and signal connections, converter must un-power the system to avoid risk of contact +12V and the vehicle body.
- Under heavy load applications, total system impedance should be calculated to design for volt-drop conditions. Power supply cable should be added as short as possible and to the correct cross-sectional area as described in Wiring Specification Table.

## 4.16 Cruise Control

**NOTE:** The Adaptive Cruise Control Module is present but not active.

## 4.21 Special Conversions



**WARNING: There are restrictions on the 12V power take-off. If your conversion requirements deviate from the advice given in this document please contact [VCAS@ford.com](mailto:VCAS@ford.com)**

## 4.22 Electrical Connectors and Connections

### 4.22.2 Customer Connection Points (CCP)

Before removing the CCP cover, move the driver's seat pedestal forward to provide sufficient access, avoiding the need to remove any body trim.

The Third Party system must only be active whilst the handbrake is active and must be battery guard protected to a voltage no lower than 11.8V. Please refer to section 4.4 in the 2018.5 Transit Custom BEMM for load drop compensation where in summary, a threshold can be set to 11.5V if there is a 20A or greater load, compensating for voltage drop.

## 4.23 Grounding

Where a second eyelet is added to an existing Ground, the added Third Party eyelet should be placed on top of the Ford eyelet already present, so that the Ford eyelet is always in direct contact with the Body. Where two eyelets are already present, do not add a third. All equipment casing should be interconnected and grounded onto the vehicle body structure with ground strap, with a conductor. The individual application details can be asked to VCAS.

## 5.1 Body

### 5.1.4 Floor Precautionary Drill Zones - Fuel Tank and Batteries

**WARNINGS:**

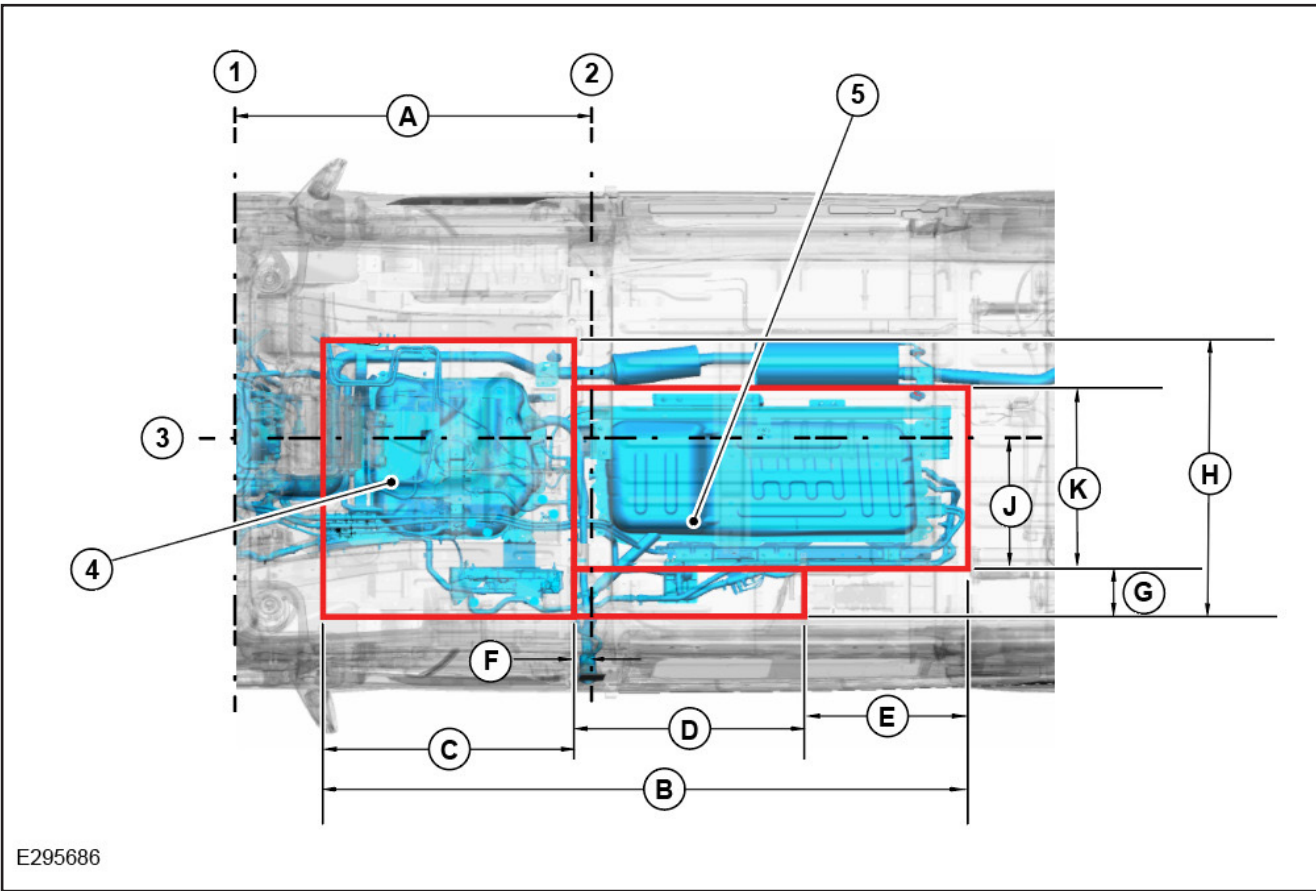
**⚠ Take precaution for drilling or any other operation in the red marked zones in order to prevent damages to the components placed underneath the floor, in particular the fuel tank, the fuel system components, the battery and high voltage system components.**

**⚠ Do not exceed the total gross vehicle mass, which must include kerb weight, driver, all passengers and any additional loads to the vehicle.**

It is advised to weigh the vehicle after the Third Party equipment is added (simulating tools, equipment mass, and distribution) and adjust for the known weight of operators if the information can be obtained from the particular Fleet.

It is recommended to bias the weight of any installed equipment including weight of customer-laden equipment in e.g. racking systems towards to rear axle rather than front axle in order to not overload the front axle.

### Floor Precautionary Drill Zones - Fuel Tank and Batteries



Item	Description	Item	Description
1	Centre Line Front Wheel Axle	D	835mm
2	Centre of 'B' Pillar	E	615mm
3	Centre Line of Vehicle	F	85mm
4	Fuel Tank	G	175mm
5	Li-Io (400V) Battery	H	1070mm
A	1230mm	J	475mm
B	2400mm	K	655mm
C	950mm		

## 6.0 Appendix

### 6.1 Failure Mitigation

**NOTE:** You can determine that the Hybrid system is active by opening the driver's door. If active, then a cluster pop-up message indicates 'Vehicle is On'.

#### Retry Strategy #1

1. Key off
2. Open driver's door
3. Close driver's door
4. Wait ~10 sec
5. Retry

#### Retry Strategy #2

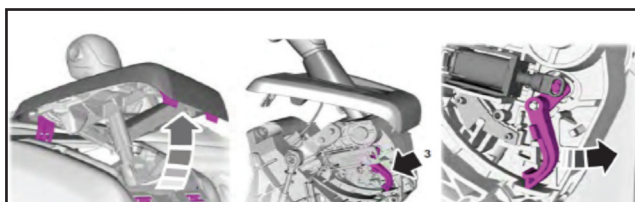
1. Key off
2. Open driver's door
3. Close driver's door
4. Wait for CAN busses to sleep Cluster dims completely
5. Retry

### 6.2 Brake- Shift Interlock

Your vehicle has a brake-shift interlock feature. This prevents you from shifting the gearshift lever from the park (P) position, unless the brake pedal is pressed.

In the event of an electrical malfunction, or if the vehicle battery has run out of charge, use the following procedure to shift the gearshift lever from the park (P) position.

1. Apply the parking brake and switch the ignition off.
2. Use a suitable tool, for example a screwdriver, to carefully remove the housing cover.
3. Locate the white lever, situated on the left hand side of the gearshift lever.
4. Move the white lever toward the rear of your vehicle.
5. Shift the gearshift lever out of park (P) and into neutral (N).
6. Replace the gearshift lever housing cover, apply the brake pedal, switch the ignition on and release the parking brake.



## Glossary

BEMM	Body & Equipment Mounting Manual
SDB	Signal Database
EPAS	Electric Power Assisted Steering
SoC	State of Charge
EV	Electric Vehicle
REx	Range Extender
FEAD	Front End Accessory Drive
TCS	Traction Control System
FPBG	Ford Programmable Battery Guard
VCAS	Vehicle Converter Advisory Service
IPC	Instrument Panel Cluster
WLTP	Worldwide Harmonised Light Vehicle Test Procedure
PHEV	Plug-In Hybrid Electric Vehicle
VCM	Vehicle Communication Module

