



Body and Equipment Mounting Manual

FORD **TOURNEO CUSTOM/TRANSIT CUSTOM** 2016.75

Date of Publication: 03/2019



The information contained in this publication was correct at the time of going to print. In the interest of development the right is reserved to change specifications, design or equipment at any time without notice and without incurring any obligations. This publication, or part thereof, may not be reproduced nor translated without our approval. Errors and omissions excepted.

© Ford Motor Company 2019

All rights reserved.

1 General Information

1.1 About this Publication.....	6
1.2 About this Manual.....	7
1.2.1 Introduction.....	7
1.2.2 How to Use This Manual.....	7
1.2.3 Important Safety Instructions.....	7
1.2.4 Supplemental Information.....	7
1.3 Commercial and Legal Aspects.....	8
1.3.1 Terminology.....	8
1.3.2 Warranty on Ford Vehicles.....	8
1.3.3 Whole Vehicle Type Approval (2007/46/EC) Regulations.....	8
1.3.4 Legal and Vehicle Type Approval.....	8
1.3.5 Alternative Type Approval.....	9
1.3.6 Legal Obligations and Liabilities.....	9
1.3.7 General Product Safety Requirement.....	9
1.3.8 Product Liability.....	9
1.3.9 Restraints System.....	10
1.3.10 Drilling and Welding.....	10
1.3.11 Minimum Requirements for Brake System.....	10
1.3.12 Road Safety.....	10
1.4 Contact Information.....	11
1.5 Conversion Type.....	13
1.5.1 Order Codes.....	13
1.5.2 Conversion Type - Reference Tables.....	13
1.6 Conversion Homologation.....	17
1.7 Electromagnetic Compatibility (EMC).....	18
1.7.1 Permitted Antenna Locations.....	18
1.8 Vehicle Duty Cycle Guidelines.....	19
1.8.1 Conversion Impact on Fuel Economy and Performance.....	19
1.8.2 Vehicle Ride and Handling Attributes.....	19
1.9 End of Life Vehicle (ELV) Directive.....	20
1.10 Jacking.....	21
1.11 Lifting.....	22
1.12 Noise, Vibration and Harshness (NVH).....	23
1.13 Vehicle Transportation Aids and Vehicle Storage.....	24
1.14 Package and Ergonomics.....	25
1.14.1 General Component Package Guidelines.....	25
1.14.2 Driver Reach Zones.....	25
1.14.3 Driver Field of View.....	25
1.14.4 Conversion Affects on Parking Aids.....	25
1.14.5 Aids for Vehicle Entry and Exit.....	25
1.14.6 Front, Rear and Side Under-run Protection.....	25
1.14.7 Vehicle Dimensions Key.....	26
1.14.8 Recommended Main Load Area Dimensions.....	26
1.15 Hardware.....	29
1.16 Load Distribution.....	30
1.16.1 Load Distribution.....	30
1.16.2 Center of Gravity Position.....	30
1.16.3 Center of Gravity Height Test Procedure.....	30
1.16.4 Center of Gravity Height Calculation.....	32

1.16.5 Formulas.....	32
1.17 Towing.....	34
1.17.1 Tow Bar Requirements.....	34
1.17.2 Tow Bar Types (for EU specification vehicles).....	34
1.17.3 Tow Bar Types (for AUS and NZL specification vehicles).....	36
1.17.4 Trailer Brakes.....	38

2 Chassis

2.1 Suspension System.....	39
2.2 Front Suspension.....	40
2.2.1 Springs and Spring Mounting.....	40
2.3 Rear Suspension.....	41
2.3.1 Springs and Spring Mounting.....	41
2.4 Wheels and Tires.....	42
2.4.1 Wheel Clearance.....	42
2.4.2 Tire Manufacturers.....	42
2.4.3 Tire Pressure Monitoring System (TPMS).....	42
2.4.4 Spare Wheel.....	42
2.4.5 Temporary Mobility Kit.....	42
2.4.6 Painting Road Wheels.....	42
2.5 Brake System.....	43
2.5.1 General.....	43
2.5.2 Kerb Mass Data.....	43
2.5.3 Brake Hoses General.....	43
2.5.4 Parking Brake.....	43
2.5.5 Hydraulic Brake—Front and Rear Brakes.....	43
2.5.6 Anti-Lock Control — Stability Assist.....	43

3 Powertrain

3.1 Engine.....	44
3.1.1 Engine Selection for Conversions.....	44
3.1.2 Engine.....	44
3.2 Engine Cooling.....	45
3.2.1 Auxiliary Heater Systems.....	45
3.2.2 Auxiliary Heater Installation.....	45
3.2.3 Air Flow Restrictions.....	45
3.3 Accessory Drive.....	46
3.3.1 Front End Accessory Drives — General Information.....	46
3.4 Automatic Transmission.....	48
3.5 Clutch.....	49
3.6 Manual Transmission.....	50
3.7 Exhaust System.....	51
3.7.1 Extensions and Optional Exhausts.....	51
3.7.2 Exhaust Pipes and Supports.....	51
3.7.3 Exhaust Heat Shields.....	51
3.7.4 Diesel Particulate Filter (DPF).....	51
3.7.5 Operator Commanded Regeneration (A660).....	52
3.7.6 Vehicle Exhaust Systems — Vans with Full Bulkheads.....	52
3.8 Fuel System.....	53

4 Electrical

- 4.1 Wiring Installation and Routing Guides.....56**
 - 4.1.1 Wiring Harness Information56
 - 4.1.2 General Wiring and Routing.....56
 - 4.1.3 Connector Pin Out Practices.....56
 - 4.1.4 Unused Connectors.....57
 - 4.1.5 Grounding.....57
 - 4.1.6 Prevention of Squeaks and Rattles.....57
 - 4.1.7 Water Leakage Prevention.....57
 - 4.1.8 Wiring Splicing Procedures.....57
 - 4.1.9 Wiring Specification.....58
 - 4.1.10 Electromagnetic Compatibility (EMC) Awareness.....59
 - 4.1.11 Wiring through Sheet Metal.....59
 - 4.1.12 Precautionary Drill Zones – Rear Cargo Area.....60
 - 4.1.13 Trailer Tow Electric (A055).....62
 - 4.1.14 Electrics for Tow Bar.....63
 - 4.1.15 Trailer Tow Connectivity (EU).....65
 - 4.1.16 Trailer Tow Connectivity (AUS and NZL).....66
- 4.2 Communications Network.....67**
 - 4.2.1 CAN-Bus System Description and Interface.....67
 - 4.2.2 Body Control Module (BCM).....69
- 4.3 Charging System.....72**
 - 4.3.1 General Information and Specific Warnings.....72
 - 4.3.2 System Operation and Component Description73
 - 4.3.3 Start-Stop Override and Configurable Charging.....74
 - 4.3.4 Power Management Settings.....75
 - 4.3.5 Electrical Conversions.....75
 - 4.3.6 Fitting Equipment Containing Electric Motors.....76
 - 4.3.7 Vehicle Electrical Capacity – Alternator.....77
 - 4.3.8 Charge Balance Guidelines.....77
 - 4.3.9 Circuit Diagrams.....77
- 4.4 Battery and Cables.....78**
 - 4.4.1 Power and Connectivity Usage Recommendations.....78
 - 4.4.2 High Current Supply and Ground Connections.....80
 - 4.4.3 Battery Information.....80
 - 4.4.4 Battery Rules.....84
 - 4.4.5 Battery Configurations (always in the drivers seat pedestal).....84
 - 4.4.6 Battery Configuration, Additional Loads, Start-Stop and Smart Regenerative Charging (SRC).....84
 - 4.4.7 Additional Loads and Charging Systems.....88
 - 4.4.8 The Ford Programmable Battery Guard (A540).....89
 - 4.4.9 The Ford Programmable Battery Guard System - Aftermarket Fitting.....100
 - 4.4.10 Battery Monitoring Sensor (BMS).....104
 - 4.4.11 Single and Twin Battery Systems.....105
 - 4.4.12 Power and Connectivity Usage Recommendations.....106
 - 4.4.13 Generator and Alternator.....108
- 4.5 Climate Control System.....112**

- 4.6 Instrument Panel Cluster (IPC).....113**
- 4.7 Horn.....114**
- 4.8 Electronic Engine Controls.....115**
 - 4.8.1 Start-Stop.....115
 - 4.8.2 Engine RPM (Revs per Minute) Speed Controller (A003).....117
 - 4.8.3 DPF and RPM Speed Control.....121
 - 4.8.4 Changing Vehicle Speed Maximum Setting.....122
- 4.9 Tachograph.....123**
 - 4.9.1 Legislation.....123
 - 4.9.2 Tachograph Harness Mounting.....123
 - 4.9.3 Fitting a Tachograph to vehicles built without Digital Tachograph Option.....124
 - 4.9.4 Vehicle Configuration Change.....125
 - 4.9.5 Calibration and Tachograph Fitting.....125
- 4.10 Information and Entertainment System.....126**
 - 4.10.1 Audio Head Unit (AHU) - Multimedia in Car Entertainment (ICE) Pack Summary.....126
 - 4.10.2 MyConnection Radio and MyConnection Radio with DAB.....128
 - 4.10.3 Mid-Radio and Mid-Radio with DAB.....128
 - 4.10.4 Additional Rear Speakers.....130
- 4.11 Cellular Phone.....132**
- 4.12 Exterior Lighting.....133**
 - 4.12.1 Reversing Lamps.....133
 - 4.12.2 Lamps – Front and Rear Fog.....133
 - 4.12.3 Lighting Loads.....133
 - 4.12.4 Lamps – Hazard / Direction Indication.....133
 - 4.12.5 Electrically Operated Door Mirrors.....133
 - 4.12.6 Additional External Lamps.....133
- 4.13 Interior Lighting.....134**
 - 4.13.1 Additional Internal Lamps134
 - 4.13.2 Additional Lighting for rear of vehicle interior.....134
- 4.14 Cruise Control.....135**
 - 4.14.1 Adaptive Cruise Control.....135
- 4.15 Lane Keeping System.....136**
- 4.16 Handles, Locks, Latches and Entry Systems.....137**
 - 4.16.1 Door Removal or Modification.....137
 - 4.16.2 Central Locking.....137
 - 4.16.3 Remote Keyless Entry/Tire Pressure Monitoring System Receiver (RKE/TPMS Receiver).....138
- 4.17 Fuses and Relays.....139**
 - 4.17.1 Fuses.....139
 - 4.17.2 Relays.....141
 - 4.17.3 Windscreen Wipers.....142
- 4.18 Special Conversions.....143**
 - 4.18.1 Special Vehicle Options (SVO) Harnesses and Aftermarket Kits.....143
 - 4.18.2 Additional Vehicle Signals/Features.....143
 - 4.18.3 Auto Wipe and Auto Lamp for vehicles with large overhangs.....146
- 4.19 Electrical Connectors and Connections.....147**
 - 4.19.1 Connectors.....147
 - 4.19.2 Customer Connection Points (CCP).....147
 - 4.19.3 Camper Central Connectors.....148

4.19.4	Vehicle Interface Connector.....	151	5.13.4	Painting Road Wheels.....	203
4.19.5	Auxiliary Fuse Panel (A526).....	153	5.13.5	Contact Corrosion.....	203
4.19.6	Beacon Preparation Pack (A606).....	159	5.14	Frame and Body Mounting.....	204
4.19.7	Utility Vehicle Switch Pack (A607) - Right Hand Drive shown.....	160	5.14.1	Mounting Points and Tubing.....	204
4.19.8	Auxiliary Switches.....	161	5.14.2	Frame Drilling and Tube Reinforcing.....	204
4.19.9	High Specification Vehicle Interface Connector (A608).....	162	5.14.3	Area for Fitting Additional Body Attachments to the Rear of the Bumper.....	205
4.19.10	Adding Connectors.....	172	5.14.4	Water Tank on Camper Vehicles.....	205
4.20	Grounding.....	173			
4.20.1	Ground Points.....	173			

5 Body and Paint

5.1	Body.....	177
5.1.1	Body Structures - General Information.....	177
5.1.2	Welding.....	177
5.1.3	Boron Steel Parts.....	179
5.1.4	Floor Precautionary Drill Zones - Fuel Tank.....	180
5.1.5	Front End Integrity for Cooling, Crash, Aerodynamics and Lighting.....	180
5.2	Hydraulic Lifting Equipment.....	181
5.2.1	Hydraulic Lifting Equipment for Van, Bus and Kombi.....	181
5.3	Racking Systems.....	184
5.3.1	Racking Systems.....	184
5.4	Loadspace.....	186
5.4.1	Load Compartment Tie Downs for Van, Bus and Kombi.....	186
5.5	Front End Body Panels.....	188
5.5.1	Partitions (Bulkhead) - Driver and Front Passenger(s) Protection on Van, Bus and Kombi.....	188
5.6	Body Closures.....	190
5.6.1	Security, Anti-Theft and Locking System	190
5.7	Interior Trim.....	193
5.7.1	Load Compartment Interior Lining.....	193
5.7.2	Plywood Lining/Cladding.....	193
5.8	Seats.....	194
5.8.1	Van.....	194
5.8.2	Windowed Van.....	194
5.8.3	Heated Seats.....	194
5.8.4	Rear Seat Fixing Positions.....	194
5.9	Glass, Frames and Mechanisms.....	197
5.9.1	Heated Windshield and Heated Rear Window.....	197
5.9.2	Rear and Side Windows.....	197
5.10	Airbag Supplemental Restraint System (SRS).....	198
5.10.1	Airbags.....	198
5.11	Seatbelt Systems.....	200
5.11.1	Seat Belts.....	200
5.11.2	Driver Belt Minder.....	200
5.12	Roof.....	201
5.12.1	Roof Ventilation.....	201
5.12.2	Roof Racks.....	201
5.13	Corrosion Prevention.....	203
5.13.1	General.....	203
5.13.2	Repairing Damaged Paint.....	203
5.13.3	Under Body Protection and Material.....	203

1.1 About this Publication

This Body and Equipment Mounting Manual (BEMM) is the latest publication for the 2016.75 Transit Custom. This BEMM is for 2.0L vehicles and comprises EU6 emissions powertrains, powertrain systems and further revised vehicle systems. It is recommended to review this manual in full. The BEMM is a live document which can be viewed on www.etis.ford.com/BEMM. It is the vehicle converters responsibility to review the online version for the most current information prior to starting any conversion.

This BEMM is for European and related markets source vehicles.

This BEMM has been updated since the last publication dated 09/2018 for consistency, alignment and layout. Also the following section have been updated:

Refer to: [4.4 Battery and Cables \(page 78\)](#).

Ford Programmable Battery Guard (FPBG) graphic amended to show LED location.

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

1.2 About this Manual

1.2.1 Introduction

This manual has been written in a format that is designed to meet the needs of Vehicle Converters. The objective is to use common formats with the workshop manual which is used by technicians worldwide.

This guide is published by Ford and provides general descriptions and advice for converting vehicles.

It must be emphasized 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.

The information contained within this publication takes the form of recommendations to be followed when vehicle modifications are undertaken. It must be remembered that certain modifications may invalidate legal approvals and application for re-certification may be necessary.

Ford cannot guarantee the operation of the vehicle if non-Ford -approved electrical systems are installed. Ford electrical systems are designed and tested to function under operational extremes and have been subjected to the equivalent of ten years of driving under such conditions.

Not all information in this manual applies to all territories. For availability of options and parts 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

1.2.2 How to Use This Manual

This manual covers vehicle conversion procedures.

The pages at the start of this manual list the content, by group. A group covers a specific portion of the vehicle. The manual is divided into five groups:

- General Information
- Chassis
- Powertrain
- Electrical
- Body and Paint

The number of the group is the first number of a section number. Each title listed in the contents links to the relevant section of the manual.

In some sections of the book it may refer you to see additional sections for information. The links have been provided in blue text. Page numbers have also been provided.

There is also an alphabetical index at the back of the manual. As with the contents pages you will be able to link to sections. To do this just click on the page number.

All left and right handed references to the vehicle are taken from a position sitting in the driver seat looking forward unless otherwise stated.

All references to ADR vehicle standards are only applicable to the Australian and New Zealand markets. Where no ADR is specified the EU standard is recommended.

1.2.3 Important Safety Instructions

Appropriate conversion procedures are essential for the safe, reliable operation of all vehicles as well as the personal safety of the individual carrying out the work.

This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Anyone who does not follow the instructions provide in this manual must first establish that they compromise neither their personal safety nor the vehicle integrity by their choice of methods, tools or components.

As you read through this manual, you will come across WARNINGS, CAUTIONS and NOTES.

If a warning, caution or note is placed at the beginning of a series of steps, it applies to multiple steps. If the warning, caution or note only applies to one step, it is placed at the beginning of the specific step (after the step number).



WARNING: Warnings are used to indicate that failure to follow a procedure correctly may result in personal injury.



CAUTION: Cautions are used to indicate that failure to follow a procedure correctly may result in damage to the vehicle or equipment being used.

NOTE: Notes are used to provide additional essential information required to carry out a complete and satisfactory conversion.

1.2.4 Supplemental Information

2D Engineering Drawings in DWG format can be downloaded from www.etis.ford.com/BEMM and 3D CAD data in STEP format can be requested by contacting the Vehicle Converter Advisory Service, VCAS@ford.com

1.3 Commercial and Legal Aspects

NOTE: 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

1.3.1 Terminology

NOTE: Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation.

Vehicle Converter refers to any re-seller altering the vehicle by converting the body and adding or modifying any equipment not originally specified and/or supplied by Ford.

Unique component or similar wording refers to non-Ford specified or after sale fitment not covered by Ford warranty.

1.3.2 Warranty on Ford Vehicles

Please contact The National Sales Company in the country where the vehicle will be registered for details of the terms of any applicable Ford warranty.

The Vehicle Converter should warrant its design, materials and construction for a period at least equal to any applicable Ford warranty.

The Vehicle Converter must ensure that any alteration made to a Ford vehicle or component does not reduce the safety, function, or durability of the vehicle or any component.

The Vehicle Converter shall be solely responsible for any damage resulting from any alteration made by the Vehicle Converter or any of its agents to a Ford Vehicle component.

The Vehicle Converter releases Ford from all claims by any third party for any cost or loss (including any consequential damages) arising from work performed by a Vehicle Converter unless Ford has given its prior written consent to such liability.

1.3.3 Whole Vehicle Type Approval (2007/46/EC) Regulations

Fitment of Parts and Accessories

The objective of the 2007/46/EC Whole Vehicle Type Approval (WVTA) legislation or applicable local legislation is to ensure that new vehicles, components and separate technical units put on the market provide a high level of safety and environmental protection. This will help to ensure that all vehicles are not damaged by the fitting or converting of certain parts or equipment, after they have been placed on the market or entered service.

Vehicle Converters are advised to check whether the fitment of parts require either Type Approval or Individual Vehicle Approval before the vehicle is registered.

- Type Approval requires a Conformity of Production (CoP) inspection to be carried out at the conversion location to demonstrate that all vehicles of the same type will conform to the type approved specification
- IVA requires inspection of an individual vehicle to establish compliance
- **Note:** Ford parts fitted in the plant are covered by the Certificate of Conformity (CoC)

Conversions from Commercial Vehicle N1 to Passenger Car M1

Vehicle Converters of Passenger Car M1 vehicles need to be aware of the latest Whole Vehicle Type Approval (2007/46/EC) regulations or applicable local legislation, especially when the base vehicle is a Commercial Vehicle N1. This affects vehicles which are homologated to meet Passenger Car M1 regulations.

Guidance to Vehicle Converters for M1 registered vehicles:

- The Vehicle Converter is responsible for checking the vehicle ordered can meet all the regulations for type approval
- Exemptions for certain regulations should be checked with latest regulation and Approval Authority
- Where possible, order a Passenger Car M1 base vehicle such as Kombi M1 and Tourneo Custom M1
- If specifying Air Conditioning, if the refrigerant needs meet the required EU Climate Guidelines for M1, then Transit Custom N1 entities are not suitable
- If Tire Pressure Monitoring System (TPMS) is required, specify this when ordering
- If Belt minder is required, specify Passenger air bag which includes the Belt minder function for the driver
- The 180 degree cargo door hinges on Transit Custom N1 entities have not been designed to meet the M1 requirements for Exterior Projections. If this is required, then the Transit Custom N1 entities are not suitable

For additional information

[Refer to: 1.6 Conversion Homologation \(page 17\).](#)

1.3.4 Legal and Vehicle Type Approval

- All components embodied on Ford vehicles are approved to the applicable legal requirements
- Ford vehicles have Type Approval for the intended marketing territories

⚠ WARNING: Exception - Incomplete vehicles require further approval when completed by the vehicle converter.

- The Transit range has Type Approval for many territories, although the full range of vehicles shown in this manual are not necessarily released in all territories.
- 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

1.3.5 Alternative Type Approval

If significant changes are made the vehicle converter must negotiate with the relevant authority. Any changes to the vehicle operating conditions must be advised to the customer.

1.3.6 Legal Obligations and Liabilities

The Vehicle Converter should consult with its legal advisor on any questions concerning its legal obligations and liabilities.

1.3.7 General Product Safety Requirement

The Vehicle Converter shall ensure that any vehicle it places in the market complies with the European General Product safety Directive 2001/95/EC (as amended periodically) or applicable local legislation. The Vehicle Converter shall also ensure that any alteration it makes to a Ford vehicle or component does not reduce its compliance with the European General Product Safety Directive.

The Vehicle Converter shall release Ford from all liability for damages resulting from:

- Failure to comply with these Body Equipment Mounting directives, in particular warnings
- Faulty design, production, installation, assembly or alteration not originally specified by Ford
- Failure to comply with the basic fit for purpose principles inherent in the original product

WARNINGS:

⚠ Do not exceed the gross vehicle mass, gross train mass, axle plates and trailer plate.

⚠ Do not change the tire size or load rating.

⚠ Do not modify the steering system.

⚠ Excessive heat can build up from the exhaust system, in particular from the catalytic converter and from the Diesel particulate filter (DPF). Ensure adequate heat shields are maintained. Maintain sufficient clearance to hot parts.

⚠ The travel and function of pedals must not be restricted.

⚠ Do not modify or remove heat protection shields.

⚠ Do not remove labels provided with the base vehicle. Ensure appropriate visibility.

⚠ Do not route any electrical cables with the Anti-lock Brakes System and Traction Control System cables because of extraneous signal risk. It is generally not recommended to hang electrical cables off existing harnesses or pipes.

⚠ Do not change original location or remove warning labels provided with the base vehicle in view to the driver. Ensure that labels remain in full view.

⚠ On Vehicles with ERA-GLONASS (Emergency Response to Accidents - Global Navigation Satellite System) maintain the functionality.

Refer to: 1.4 Contact Information (page 11).

1.3.8 Product Liability

The Vehicle Converter shall be liable for any product liability (whether for death, personal injury, or property damage) arising from any alteration to a Ford vehicle or component made by the Vehicle Converter or any of its agents. Ford shall not be liable for any such liability (except as provided by law).

The Vehicle Converter or equipment manufacturer is liable for the:

- Operational reliability and road-worthiness of the vehicle to its original intent
- Operational reliability and road-worthiness of any component or conversion, not listed in original Ford documentation
- Operational reliability and road-worthiness of the vehicle as a whole (for example the body changes and/or additional equipment must not have a negative effect on the driving, braking or steering characteristics of the vehicle)
- Subsequent damage resulting from the conversion or attachment and installation of unique components, including unique electrical or electronic systems
- Functional safety and freedom of movement of all moving parts (for example axles, springs, shafts, steering mechanisms, brake and transmission linkage, retarders)
- Functional safety and freedom of the tested and approved flexibility of the body and integral chassis structure.

1.3.9 Restraints System

WARNINGS:

-  **Modifications to the restraints system are not allowed.**
-  **Airbags are explosive. For safe removal and storage during conversion follow the procedures in the Ford workshop manual.**
-  **Do not alter, modify or relocate the airbag, sensors and modules of the restraints system or any of its components.**
-  **Attachments or modifications to the front end or 'B' Pillar of the vehicle may affect the airbag deployment timing and result in uncontrolled deployment.**

For additional information:

Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).

1.3.10 Drilling and Welding

-  **WARNING: Do not Drill or Weld Boron steel parts, see figure E146882 in the welding section of this manual.**

Drilling and welding of frames and body structure have to be conducted following the guidelines in Welding and Frame Drilling and Tube Reinforcing sections.

Refer to: 5.14 Frame and Body Mounting (page 204).
Refer to: 5.1 Body (page 177).

1.3.11 Minimum Requirements for Brake System

It is not recommended to modify the brake system. If a special conversion should require modifications:

- Maintain original settings
- Maintain brake certification load distribution

Changes to the Anti-lock Brake System (ABS), Traction Control System (TCS) and Electronic Stability Control ESC (also known as ESP) system are not permitted

1.3.12 Road Safety

The respective instructions should be strictly observed to maintain operational and road safety of the vehicle.

1.4 Contact Information

As a manufacturer, we want to provide you with the information you need for your vehicle conversion/modification. If the information you require is not in this manual or you have further questions, 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

Ford of Britain	
Contact:	CV Product Team
E-Mail:	cvquery@ford.com

Ford of Germany	
Contact:	Torsten Wagner
Phone:	+49-221-9017692
E-Mail:	twagner5@ford.com

Ford of France	
Contact:	Stephane Prolongeau
Phone:	+33-1-61016547
E-Mail:	sprolong@ford.com

Ford of Italy	
Contact:	Michele Montalto
Phone:	+39-06-51855332
E-Mail:	mmontalt@ford.com

Ford of Ireland	
Contact:	John O'Mahony
Phone:	+353-21-4329276
E-Mail:	jomahon6@ford

Ford of Spain	
Contact:	Javier Martin Sanchez
Phone:	+34-91-7145143
E-Mail:	jmart219@ford.com

Ford of Portugal	
Contact:	Luis Filipe Azinheiro
Phone:	+351-21-3122450
E-Mail:	lazinhei@ford.com

Ford of Belgium	
Contact:	Jean Vermeiren
Phone:	+32-3-8212120
E-Mail:	jvermeil@ford.com

Ford of Netherlands	
Contact:	Daan Koppert
Phone:	+31-20-504711
E-Mail:	dkoppert@ford.com

Ford of Austria	
Contact:	Gernot Payer
Phone:	+43-50-6581269
E-Mail:	gpayer@ford.com

Ford of Switzerland	
Contact:	Nicolas Pizzuto
Phone:	+41-43-2332252
E-Mail:	npizzuto@ford.com

Ford of Denmark	
Contact:	Bent Steen Jenson
Phone:	+45-43-480621
E-Mail:	bjense23@ford.com

Ford of Finland	
Contact:	Juuso Asp
Phone:	+358-9-35170134
E-Mail:	jasp4@ford.com

Ford of Norway	
Contact:	Roar Kvernhusengen
Phone:	+47-66-819743
E-Mail:	rkvernh2@ford.com

Ford of Sweden	
Contact:	Martin Tenggren
Phone:	+46 70 249 89 31
E-Mail:	mtenggr2@ford.com

Ford of Hungary	
Contact:	András Nagy
Phone:	+36-26-802-685
E-Mail:	anagy28@ford.com

Ford of Greece	
Contact:	John Amarantos
Phone:	+30-210-5709913
E-Mail:	jamaran1@ford.com

Ford of Poland

Contact:	Marcin Marczewski
Phone:	+48-22-608 6854
E-Mail:	mmarczew@ford.com

Ford of Czech Republic

Contact:	Radim Pacik
Phone:	+420-2-34650119
E-Mail:	pacik1@ford.com

Ford of Russia

Contact:	Evgeniy Gnusov
Phone:	+7-495-7459700 x2226
E-Mail:	egnusov@ford.com

Ford Central & Eastern Europe

Contact:	Balázs Págyi
Phone:	+36-26-802538
E-Mail:	bpagy@ford.com

Rest of the World (RoW)

Contact:	Duvall Hunter
Phone:	+44-1277-252073
E-Mail:	dhunte11@ford.com

Ford Otosan - Turkey

Contact:	Ford Otosan Call Center
Phone:	+90-216-4443673
E-Mail:	iletisim@ford.com.tr

Ford of Australia

Contact:	FoA Customer Team
Phone:	13 FORD or 13 36 73
E-Mail:	foacust1@ford.com
Fax:	03 8301 2582
Postal Address:	Ford Customer Relationship Centre Private Mail Bag 5 Campbellfield VIC 3061

Ford of New Zealand

Contact:	FoNZ Customer Team
Phone:	+64-9-2718500
E-Mail:	nzinfo@ford.com
Fax:	+64-9-2718573
Postal Address:	Private bag 76912 Manukau City NZ - 2241

1.5 Conversion Type

1.5.1 Order Codes

Availability of options will vary on territories.

It is necessary to take into account the anticipated usage of the modified vehicle in order to choose the appropriate specification of the base vehicle.

Order Code	Special Vehicle Option (SVO)
Body	
A304	Omit Passenger Seat — No pedestal, not available on Double Cab in Van
A532	Spare Wheel Access — With rear doors closed
Electrical	
A003	RPM Speed Control — 1300-3000rpm
A526	Auxiliary Fuse Panel
A606	Beacon Preparation Pack — Switch and wiring front and rear (includes A526 and mini overhead console - 1DIN) ⁽¹⁾
A607	Utility Vehicle Switch Pack — Provides 3 switches for beacon and two power outputs (includes A526, A606 and mini overhead console 1 DIN) ⁽¹⁾
A608	High Specification Vehicle Interface Connector — Provides a range of hard-wire signals (includes A526) ⁽²⁾
A055	Trailer Tow Electrics - Trailer tow electrics (connector and wiring) without tow bar.
A540	Ford Programmable Battery Guard - Patented 10-mode programmable battery guard system capable of protecting Ford third party battery.
A550	Converter-High Power Supply System - Meets heavy power-take-off requirements by equipping vehicles with two high performance deep cycle AGM Batteries, 240A Alternator, Engine RPM Speed Control and the Ford Programmable Battery Guard
Order Code	
Regular Production Order (RPO)	
HFQ	2 High Performance AGM Batteries

⁽¹⁾ = Not to be ordered with tachograph, as uses the same 1 DIN console.

⁽²⁾ = Not available with A607

1.5.2 Conversion Type - Reference Tables

NOTE: The following tables are for guidance only. Full reference to the Body and Equipment Mounting Manual (BEMM) should be made prior to starting any conversion.

NOTE: For any conversions requiring electrical power:

Refer to: [4.2 Communications Network \(page 67\)](#).
Refer to: [4.17 Fuses and Relays \(page 139\)](#).

The BEMM contains general and specific recommendations covering conversions to the new Transit range of vehicles. To assist users locate information by conversion type the following tables contain the relevant links within this Manual.

Camper Conversion	
Van Conversion / Multi-Purpose Vehicle Conversions	Refer to: 1.14 Package and Ergonomics (page 25) .
	Refer to: 1.17 Towing (page 34) .
	Refer to: 3.8 Fuel System (page 53) .
	Refer to: 4.4 Battery and Cables (page 78) .
	Refer to: 4.18 Special Conversions (page 143) .
	Refer to: 5.8 Seats (page 194) . Rear Seat Fixings Positions
	Refer to: 5.12 Roof (page 201) .

Refrigerated Vehicles	
Van Conversion	Refer to: 1.9 End of Life Vehicle (ELV) Directive (page 20).
	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.5 Climate Control System (page 112).
	Refer to: 4.17 Fuses and Relays (page 139).
	Refer to: 5.12 Roof (page 201). Roof Racks
Compressor Installation	Refer to: 3.3 Accessory Drive (page 46).

Dry Freight	
Box Van	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.18 Special Conversions (page 143). Auto Wipe and Auto Light for Vehicles with large over-hangs
Pantehnicon	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.18 Special Conversions (page 143). Auto Wipe and Auto Light for Vehicles with large over-hangs
Money Carriers	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.12 Roof (page 201). Roof Ventilation
	Refer to: 4.12 Exterior Lighting (page 133).
Refuse Collection	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 4.12 Exterior Lighting (page 133).

Emergency Services	
Ambulance (Front Line) / Fire Brigade / Armed Forces / Police	Refer to: 3.2 Engine Cooling (page 45). Airflow Restrictions
	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.13 Interior Lighting (page 134).
	Refer to: 4.17 Fuses and Relays (page 139).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 5.8 Seats (page 194).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).
	Refer to: 4.18 Special Conversions (page 143). Auto Wipe and Auto Light for Vehicles with large over-hangs

Vocational Conversion	
Mobile Workshops	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 5.3 Racking Systems (page 184).
	Refer to: 5.12 Roof (page 201). Roof Racks.
	Refer to: 4.18 Special Conversions (page 143). Auto Wipe and Auto Light for Vehicles with large over-hangs
Mobile Shops / Offices	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 5.3 Racking Systems (page 184).
	Refer to: 5.12 Roof (page 201). Roof Racks.
	Refer to: 4.18 Special Conversions (page 143). Auto Wipe and Auto Light for Vehicles with large over-hangs
Glass Carrying	Refer to: 4.4 Battery and Cables (page 78).Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.1 Body (page 177). Racking System
Racking Conversions	Refer to: 4.4 Battery and Cables (page 78).Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.3 Racking Systems (page 184).
Recovery Vehicles	Refer to: 4.4 Battery and Cables (page 78). Generator and Alternator
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 5.14 Frame and Body Mounting (page 204).
	Refer to: 4.18 Special Conversions (page 143). Auto Wipe and Auto Light for Vehicles with large over-hangs

Passenger Carrying	
Taxi	Refer to: 1.3 Commercial and Legal Aspects (page 8). Restraints System
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.13 Interior Lighting (page 134).
	Refer to: 5.8 Seats (page 194).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 197).
	Refer to: 5.12 Roof (page 201). Roof Ventilation
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).
Mobility	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.13 Interior Lighting (page 134).
	Refer to: 5.8 Seats (page 194).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 197).
	Refer to: 5.12 Roof (page 201). Roof Ventilation
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).
Coach Built	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 4.9 Tachograph (page 123).
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.13 Interior Lighting (page 134).
	Refer to: 5.8 Seats (page 194).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 197).
	Refer to: 5.12 Roof (page 201). Roof Ventilation
Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).	
Wheelchair Accessible	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 5.8 Seats (page 194).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 197).
	Refer to: 5.12 Roof (page 201). Roof Ventilation
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).
	Refer to: 4.13 Interior Lighting (page 134).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).
Mini Bus	Refer to: 5.2 Hydraulic Lifting Equipment (page 181).
	Refer to: 4.12 Exterior Lighting (page 133).
	Refer to: 4.13 Interior Lighting (page 134).
	Refer to: 5.8 Seats (page 194).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 197).
	Refer to: 5.12 Roof (page 201). Roof Ventilation
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 198).

1.6 Conversion Homologation

NOTE: 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

The Vehicle Converter must observe any statutory rules and regulations. When the conversion needs a new approval the following information must be quoted.

- All dimensional, weight and center of gravity data
- The fixing of the body to the donor vehicle
- Operating conditions

The responsible Technical Service may require additional information and/or testing.

For additional information on vehicle type approval

Refer to: [1.3 Commercial and Legal Aspects \(page 8\)](#).

1.7 Electromagnetic Compatibility (EMC)

WARNINGS:

⚠ Do not mount any transceiver, microphones, speakers, or any other item on or near the airbag cover, on the side of the seatbacks (of the front seats), or in front seat areas that may come into contact with a deploying airbag.

⚠ Do not fasten antenna cables to original vehicle wiring, fuel pipes and brake pipes.

⚠ Keep antenna and power cables at least 100mm from any electronic modules and airbags.

NOTE: Your vehicle has been tested and certified to electromagnetic compatibility legislation (UNECE Regulation 10 or applicable local legislation). Ensure that any additional equipment installed on your vehicle complies with applicable local legislation and other requirements.

NOTE: Radio Frequency (RF) transmitter equipment (for example: cellular telephones, amateur radio transmitters) may only be fitted to your vehicle if they comply with the parameters shown in the following 'Frequency Overview' table. There are no special provisions or conditions for installations or use.

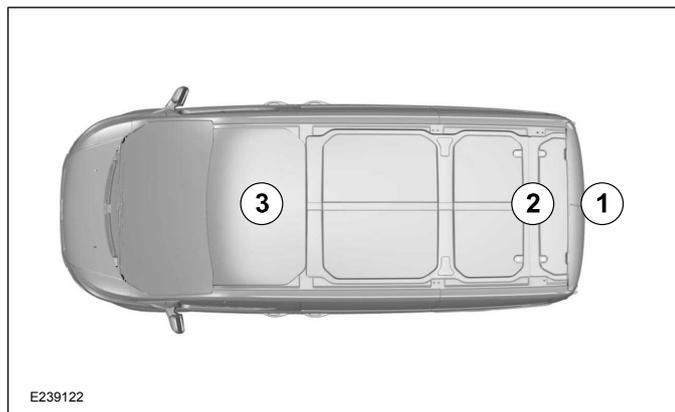
NOTE: Only fit one antenna in the positions shown to the roof of your vehicle.

NOTE: For EMC on Police conversions with rear view cameras 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

Frequency Overview

Frequency Band MHz	Maximum Output Power Watts (Peak RMS)	Antenna Position
1-30	50W	1
50-54	50W	2, 3
68-88	50W	2, 3
142-176	50W	2, 3
380-512	50W	2, 3
806-870	10W	2, 3

1.7.1 Permitted Antenna Locations



Item	Description
1	Rear Antenna location 1
2	Rear Antenna location 2
3	Front Antenna location 3

NOTE: After the installation of RF transmitters, check for disturbances from and to all electrical equipment in the vehicle, both in the standby and transmit modes.

Check all electrical equipment:

- With ignition **ON**

- With the engine running
- During a road test at various speeds

Check that electromagnetic fields generated inside the vehicle cabin by the transmitter installed do not exceed applicable human exposure requirements.

1.8 Vehicle Duty Cycle Guidelines

NOTE: For further information 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

It is necessary to take into account the customer usage profile and the anticipated vehicle duty cycles of the modified vehicle in order to choose the appropriate specification of the base vehicle.

It is necessary to select the appropriate drive, engine, gear ratio, gross vehicle mass, gross train mass, axle plates and payloads of the base vehicle to match the customer requirements.

Where possible make sure that the base vehicle is ordered with any necessary plant fit options.

A high numeric gear ratio is recommended for vehicles with customer requirements for:

- High payload
- Trailer tow
- Frequent stop-and-go cycles
- High altitude and gradients
- Terrain conditions such as found on building and construction sites

1.8.1 Conversion Impact on Fuel Economy and Performance

Any conversion may affect the fuel consumption and performance depending on the aerodynamics and the weight added by the conversion. The published information for fuel consumption for the incomplete base vehicles of category N1 are based on the European Regulation EC 715/2007 and 692/2008 (as last mentioned). The used reference mass includes a 'Default Added Mass' (DAM). For specific figures for fuel consumption and emissions of the base vehicle, 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. It is advisable to control the weight, but without deteriorating other vehicle attributes and functions (especially those related to safety and durability).

1.8.2 Vehicle Ride and Handling Attributes

 **CAUTION: Do not exceed the axle plate, gross vehicle mass, trailer plate and gross trailer mass limits.**

Conversions to the base vehicle that change the center of gravity may affect the ride and handling attributes.

NOTE: All vehicles should be evaluated for safe operation prior to sale.

1.9 End of Life Vehicle (ELV) Directive

NOTE: 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

The European End-of-Life Vehicle (ELV) directive requires that environmental and recycling aspects are integrated in the development process of new components and vehicles. This includes requirements with respect to:

- The overall recyclability (85%)/recoverability (95%) of vehicles
- Limited use of hazardous substances including the elimination of prohibited substances such as lead, hexavalent chromium, cadmium and mercury
- Publication of dismantling information
- Parts Marking according to the corresponding ISO Standards: ISO 1043-1, 1043-2 and 11469 for plastics and ISO 1629 for rubber materials
- Increasing use of recycled materials
- Producers meet all, or a significant part of, the costs to take back End-of-Life Vehicles

In addition to the requirements resulting from the End-of-Life directive other environmental targets should be taken into consideration such as:

- Minimizing costs and environmental burden along the product life-cycle
- Maximizing use of renewable materials e.g. natural fibers
- Minimizing the presence of substances impacting vehicle interior air quality/clean compartment or allergenic reactions. This refers to aspects like smell, fogging, toxicity and allergy coming from material in the interior
- Eliminate use of prohibited substances which are listed in the Global Automotive Declarable Substance List (GADSL) at <http://www.gadsl.org>

For continued legal compliance and environmental performance of all Ford products it is essential that any conversion of the vehicle is in compliance with the requirements listed above.

This is not a complete list of all legal requirements to be met by every converted vehicle.

1.10 Jacking

⚠ WARNING: Always position the vehicle on a hard level surface. If the vehicle must be jacked up on a soft surface use load spreading blocks under the jack. Always chock the wheel diagonally opposite the jacking point. Failure to follow these instructions may result in personal injury.

CAUTIONS:

⚠ It is important that only the correct jacking and support locations are used at all times. Other positions, you may damage the body, steering, suspension, engine, braking system or the fuel lines.

⚠ Make sure that access to the spare wheel is maintained when converting the vehicle or relocating the spare wheel.

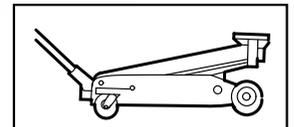
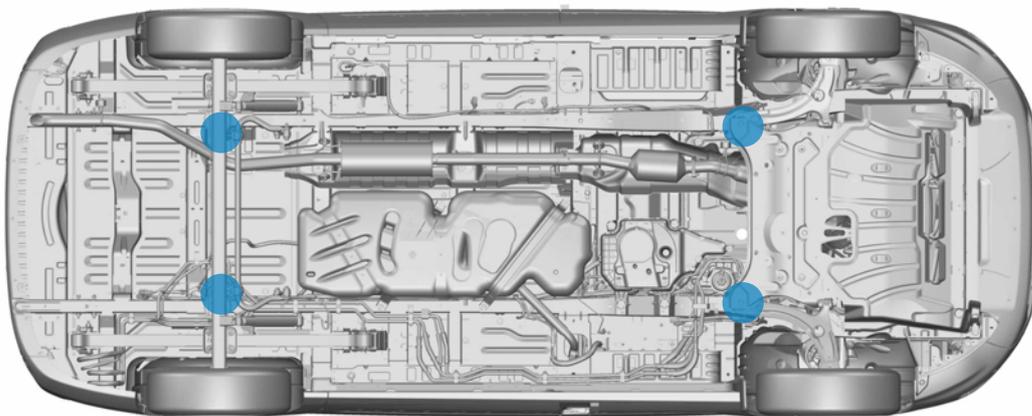
⚠ Ensure there is sufficient clearance when positioning the jacking equipment to prevent damage of any underfloor components.

NOTE: When using the vehicle jack, refer to the owner guide for correct operating instructions.

NOTE: Make sure that reinforcements are installed to maintain the integrity of the original body structure for/at jacking points.

NOTE: Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation.

Jacking Points



E289603

1.11 Lifting

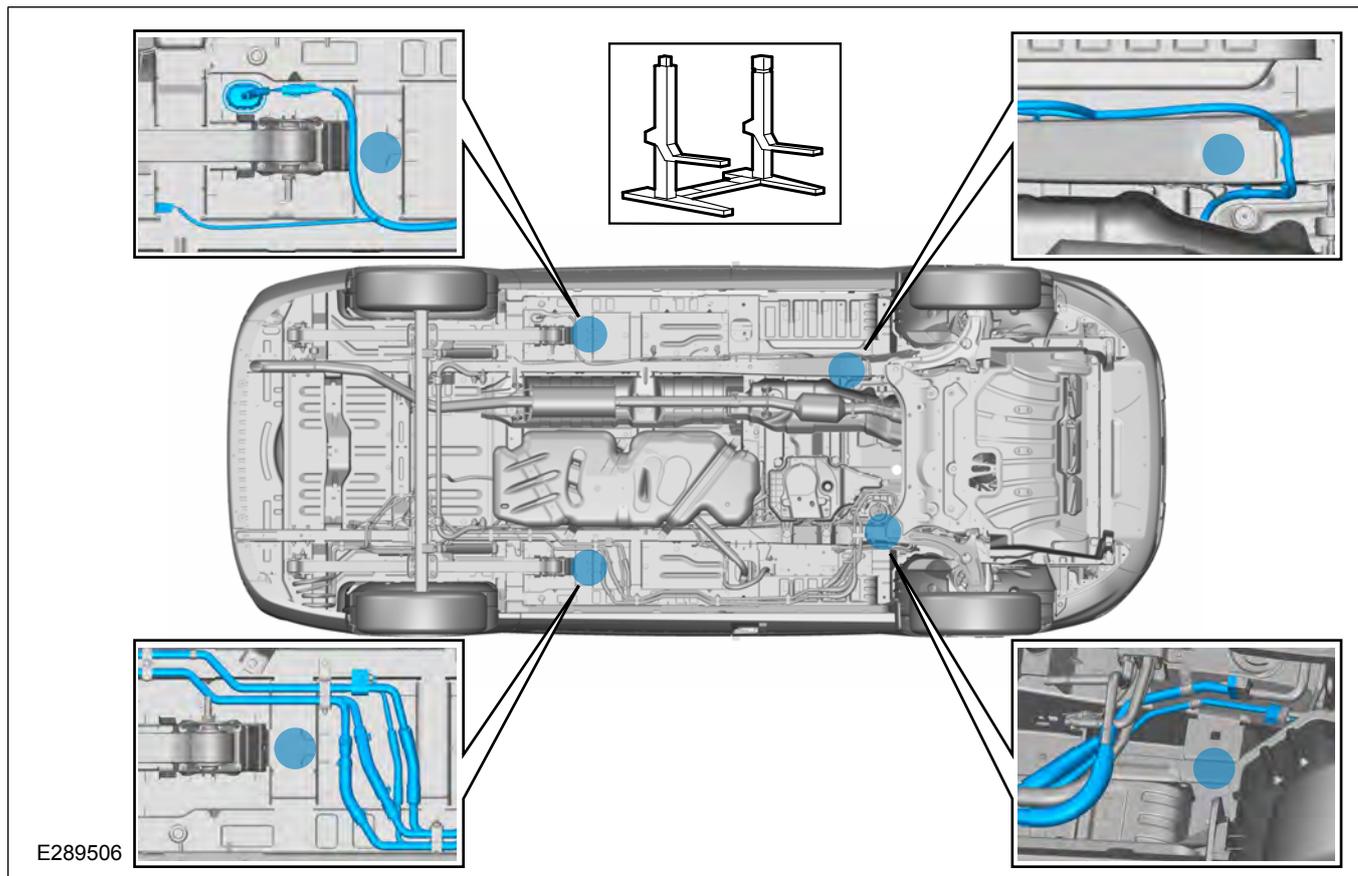
⚠ WARNING: When lifting the vehicle with a two post lift for the removal of the engine/transmission or rear axle, make sure the vehicle is secured to the lift using vehicle retention straps to prevent tilting. Failure to follow these instructions may result in personal injury.

CAUTIONS:

⚠ When lifting the vehicle with a two post lift, vehicle lift arm adapters must be used under the lifting points.

- ⚠** When lifting the vehicle with a two post lift, the maximum kerb weight must not be exceeded.
- ⚠** It is important that only the correct lifting and support locations are used at all times.
- ⚠** Ensure there is sufficient clearance when positioning the lifting equipment to prevent damage of any underfloor components.

Lifting Points



1.12 Noise, Vibration and Harshness (NVH)

 **WARNING: Make sure that the modified vehicle complies with all relevant legal requirements.**

Changes to the powertrain, engine, transmission, exhaust, air intake system or tires may influence the exterior noise emissions. Therefore the exterior noise level of the converted vehicle has to be verified.

The interior noise levels should not be deteriorated by the conversion. Reinforce panels and structures as appropriate to avoid vibrations. Consider the usage of sound deadening material on panels.

1.13 Vehicle Transportation Aids and Vehicle Storage

CAUTIONS:

-  **Make sure to disconnect the battery if the vehicle is to be stored for more than 7 days.**
-  **Make sure that the protective covers are not removed from an incomplete vehicle until the conversion is started.**
-  **Make sure that components removed during conversion are kept clean and dry.**
-  **Make sure that components removed during conversion are refitted to the same vehicle.**

In addition:

- The windscreen wipers should be lifted off the glass and set right up
- All air intakes should be closed
- Increase normal tire pressure by 0.5 bar
- The hand brake system should not be used
- Apply suitable wheel chock to prevent roll away

A significant risk during storage is deterioration of vehicle bodywork, therefore, appropriate storage procedures must be observed, including periodic inspection and maintenance.

Claims arising from deterioration caused by incorrect storage, maintenance or handling are not the responsibility of Ford.

Vehicle Converters must determine their own procedures and precautions, particularly where vehicles are stored in the open, as they are exposed to any number of airborne contaminants.

The following may be considered a sensible approach to storage:

Short term storage:

- Wherever possible, vehicles should be stored in an enclosed, dry, well-ventilated area. This area must be on firm, well drained ground which is free of long grass or weeds and where possible protected from direct sunlight
- Vehicles must not be parked near, under foliage or close to water as additional protection may be necessary for certain areas of the vehicle

Long term storage:

- The battery should be disconnected, but not removed from the vehicle
- The wiper blades should be removed and placed inside the vehicle. Make sure the wiper arms are suitably prevented from resting on the windscreen
- Wheel trims (where fitted) should be removed and stored in the luggage compartment
- Engage first gear (manual transmission) or place in park position "P" (automatic transmission) and release the parking brake completely. Chock the wheels first if the vehicle is not on level ground
- Set climate controls to the "open" position to provide ventilation, where possible

- Where protective film has been applied at manufacturing it must be left on the vehicle until prepared for delivery but must be removed after a maximum storage period of six months (film is date stamped to indicate required removal date)
- Make sure that all windows, doors, hood, lift gate, tailgate, luggage compartment lid, convertible top and roof opening panel are completely closed and the vehicle is locked

The Pre-Delivery Inspection (PDI) is the final opportunity to make sure a battery is fit for purpose prior the customer taking delivery of their new vehicle. The battery must be checked and appropriate action taken prior to the vehicle being handed over to the customer. Test results must be recorded on the PDI repair order.

Batteries: To make sure the battery is maintained correctly and to assist in preventing premature failure, it is necessary to check and recharge the battery monthly while a vehicle is not in use. Where a battery is left below its optimum charge level for any length of time, it may result in premature failure of the battery.

Action / Time in Storage	Monthly	Every 3 Months
Check vehicle is clean	X	-
Remove external contamination	X	-
Check battery condition — Recharge if necessary	X	-
Visually check tires	X	-
Check interior for condensation	-	X
Run engine for 5 minutes minimum with air conditioning switched on, where applicable	-	X

Refer to: [4.4 Battery and Cables \(page 78\)](#).

1.14 Package and Ergonomics

1.14.1 General Component Package Guidelines

 **WARNING: Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe or anti-roll bars, springs or shock absorbers including mounting brackets.**

The Vehicle Converter has to ensure that sufficient clearance is maintained under all drive conditions to moving components such as axles, fans, steering, brake system etc.

The Vehicle Converter is responsible for all installed components during the conversion. The durability has to be confirmed by appropriate test procedures.

1.14.2 Driver Reach Zones

Controls and/or equipment required to be used while driving should be located within easy reach of the driver so as not to impair driver control.

1.14.3 Driver Field of View

 **WARNING: Make sure that the modified vehicle complies with all relevant legal requirements.**

1.14.4 Conversion Affects on Parking Aids

 **WARNING: Ensure that monitors mounted in the cabin meet the interior package and safety requirements.**

On conversions requiring a rear camera, the reverse signal may be taken as described in the electrical section, described in reversing lamps.

Refer to: [4.12 Exterior Lighting \(page 133\)](#).

When modifying the vehicle, its dimensions or growing the vehicle, ensure that the correct function of parking aids is maintained. Please contact vcas@ford.com in case of any queries.

1.14.5 Aids for Vehicle Entry and Exit

Steps

WARNINGS:

 **Make sure that the modified vehicle complies with all relevant legal requirements.**

 **If this modification alters the homologated dimensions, a new approval may be necessary.**

 **CAUTION: Make sure that reinforcements are installed to maintain the integrity of the original body structure.**

Steps can be ordered as an option on the base vehicle. Please check for availability.

Where additional steps are installed the required ground clearance line is to be maintained.

The Vehicle Converter must make sure that a movable step is set in the stored position when the vehicle is running. The step surface must be non-slip.

Grab Handles

 **WARNING: Make sure that the location of the no-drill zones are checked before drilling.**

 **CAUTION: Make sure that reinforcements are installed to maintain the integrity of the original body structure.**

Grab handles can be ordered as an option on the base vehicle. Please check for availability.

NOTE: 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

1.14.6 Front, Rear and Side Under-run Protection

 **WARNING: Check local legislation for legal requirements.**

Front Under run Protection must be designed to directive ECE 93⁽¹⁾ or 2000/40 EC⁽¹⁾ or applicable local legislation.

Rear Under run Protection must be designed to directive ECE 58⁽¹⁾ or 70/221 EC⁽¹⁾ or applicable local legislation.

Side Under run Protection must be designed to directive ECE 73⁽¹⁾ or 89/297 EC⁽¹⁾ or applicable local legislation.

⁽¹⁾ = As amended periodically

1.14.7 Vehicle Dimensions Key

Dimension (mm)	L1	L2
Wheel Base Length	2933	3300
Overall Vehicle Height @ Base Kerb Weight		
H1	1972 - 2020	1967 - 2017
H2	2338 - 2389	2332 - 2381
Overall Vehicle Height @ GVM		
H1	1922 - 1953	1923 - 1954
H2	2280 - 2314	2284 - 2320

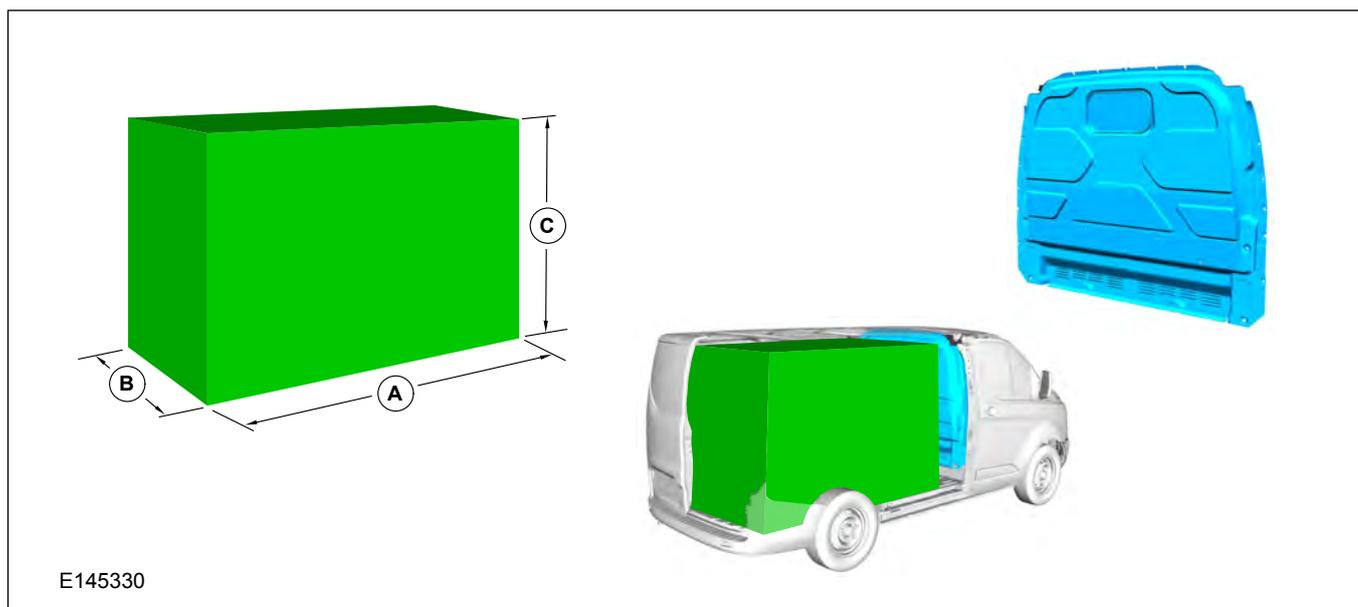
All dimensions are subject to manufacturing tolerances and refer to minimum specification models and do not include additional equipment.

Transit Custom is available in two wheelbases; short (L1) and long (L2) and two roof heights; low (H1) and high (H2).

Height dimensions show the range for the minimum to maximum weight range and are for guidance only.

1.14.8 Recommended Main Load Area Dimensions

H1 Roof Height - Full Bulkhead - Fixed/Glazed

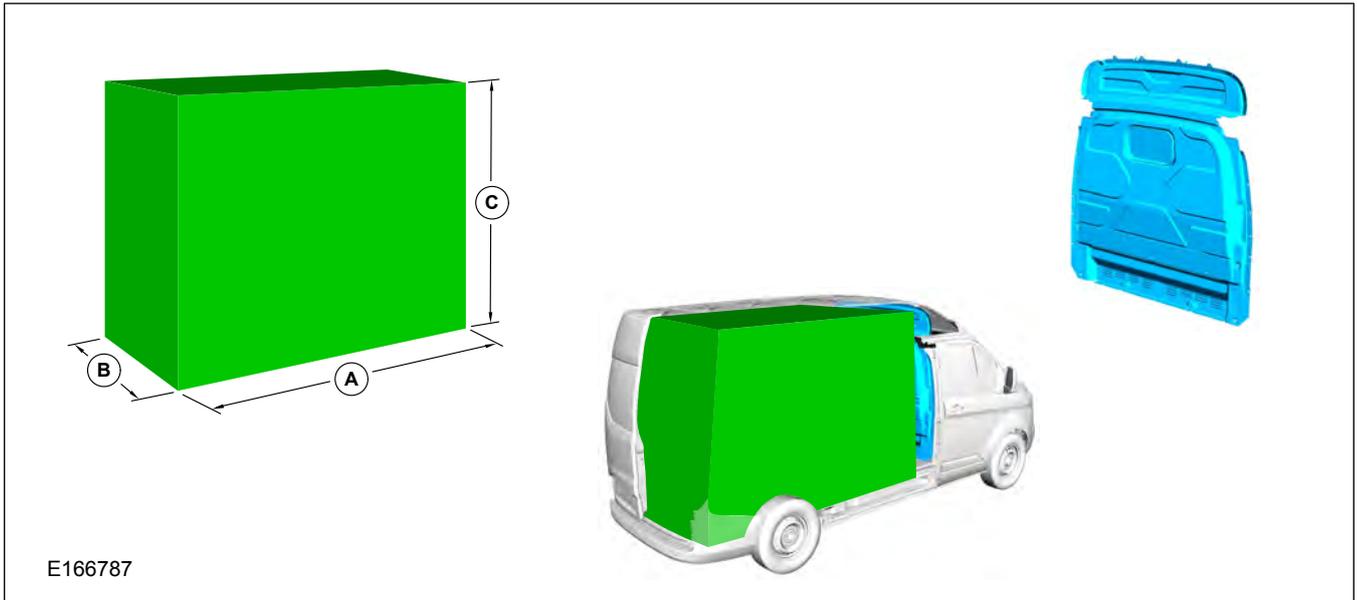


Vehicle	A (mm)	B (mm)	C (mm)
L1 - H1	2327	1260	1310
L2 - H1	2694	1260	1310

L1 = 2933mm wheel base, L2 = 3300mm wheel base

For vehicle heights see 'Vehicle Dimension Key' table in this section of this manual

H2 Roof Height - Full Bulkhead - Fixed/Glazed

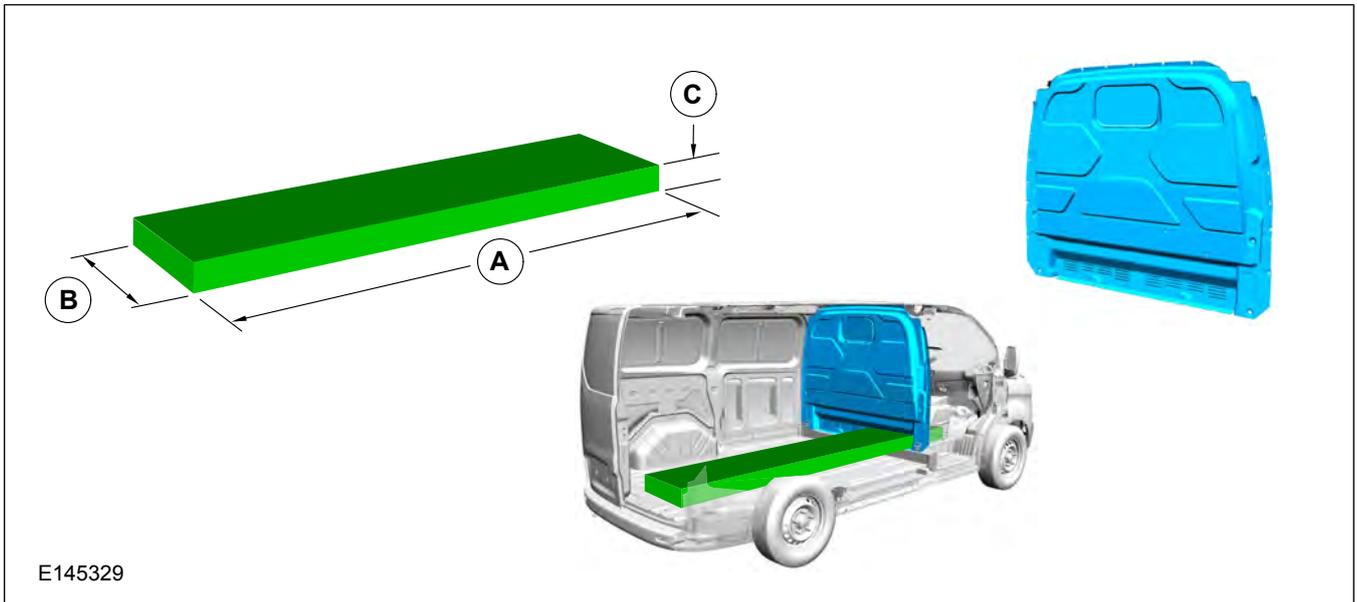


Vehicle	A (mm)	B (mm)	C (mm)
L1 - H2	2246	1140	1684
L2 - H2	2613	1140	1684

L1 = 2933mm wheel base, L2 = 3300mm wheel base

For vehicle heights see 'Vehicle Dimension Key' table in this section of this manual

Full Bulkhead with Load through Hatch (with Dual Passenger Seat)

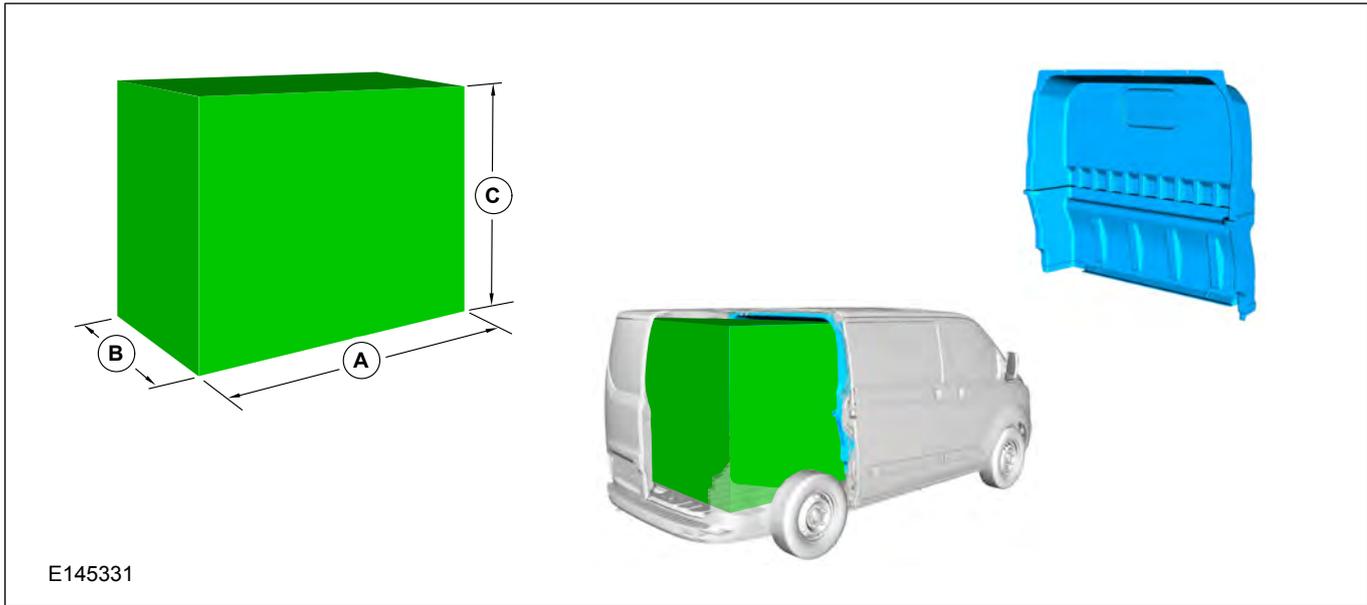


Vehicle	A (mm)	B (mm)	C (mm)
L1 - H1	3040	590	200
L2 - H1	3407	590	200

L1 = 2933mm wheel base, L2 = 3300mm wheel base

For vehicle heights see 'Vehicle Dimension Key' table in this section of this manual

Double Cab in Van Bulkhead



Vehicle	A (mm)	B (mm)	C (mm)
L1 - H1	1420	1260	1310
L2 - H1	1787	1260	1310

L1 = 2933mm wheel base, L2 = 3300mm wheel base

For vehicle heights see 'Vehicle Dimension Key' table in this section of this manual

1.15 Hardware

Material Specification, Strength and Torque

Standard Hardware and Tightening Torques (Nm) Bolts/Studs: ISO 898-1, Nuts: ISO 898-2						
	Grade 4.8		Grade 8.8		Grade 10.9	
Thread Size	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
M4	1.1	1.4	2.4	3.4		
M5	2.2	2.7	4.9	6.7		
M6	3.7	4.7	8.5	11.5	11.0	15.0
M8			20.0	28.0	25.0	35.0
M10			41.0	55.0	50.0	70.0
M12			68.0	92.0	95.0	125.0
M14			113	153	150	200
M16			170.0	230.0	230.0	310.0
M18			252.0	317.0	317.5	399.4
M20			345.0	430.0	434.7	541.8
M22			470.0	590.0	592.2	743.4
M24			600.0	750.0	756.0	945.0

This torque chart is a recommendation and the converter is responsible for the optimal torque for a specific joint.

1.16 Load Distribution

NOTE: 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

1.16.1 Load Distribution

CAUTIONS:

-  **Do not exceed the axle plated weights.**
-  **Do not exceed the gross vehicle weight.**
-  **The front axle load must, in all load cases, exceed 38% of the actual vehicle weight.**

NOTE: Overloading of the vehicle could result in unacceptable ground clearance.

NOTE: The center of mass of the payload should be located within the wheelbase of the vehicle.

NOTE: Avoid one-sided load distribution.

NOTE: Uneven load distribution could result in unacceptable handling and braking characteristics.

NOTE: Load distribution outside of the permitted range may result in unacceptable steering, handling and braking characteristics.

1.16.2 Center of Gravity Position

The position of the center of gravity is changed when masses are added or removed from the vehicle. This may influence the steering characteristics, handling behavior and the brake performance.

Lateral Position

 **WARNING: The difference right to left must not exceed 4% (absolute difference right to left/total weight in per cent).**

It is important to keep the Center of Gravity laterally within given limits.

Lateral Center of Gravity is determined by the vertical wheel forces difference right (front right mass added to rear right mass) to left (front left mass added to rear left mass).

Vertical Position - Center of Gravity Height

WARNINGS:

 **If the vertical center of gravity (CG_v) is equal to or less than 870mm and no modifications have been made to the components of the braking system, suspension, wheels and tires the converted vehicle complies with ECE13-H, ANNEX 9 standard or ADR 35 or applicable local legislation.**

 **If the Center of Gravity (CG_v) of the converted vehicle exceeds 870mm, Ford Motor Company makes no representation as to conformity with ECE13-H, ANNEX 9 standard or ADR 35 or applicable local legislation.**

 **When converted, Sport Series Vehicles are excluded from conformity with ECE13-H ANNEX 9 Standard or ADR 35 or applicable local legislation.**

The Center of Gravity Height of the vehicle is determined by the mass of the base delivered vehicle and the added and removed masses. In physics this relation is described by Steiner's theorem.

The Center of Gravity Height influences axle weights while braking. Center of Gravity height influences roll stability. Safety systems will work properly in the given boundaries.

1.16.3 Center of Gravity Height Test Procedure

Measurement

Vehicle shall be loaded according to test specifications specified in ECE13-H ANNEX 9 (Vehicle Mass) or ADR 35 or applicable local legislation.

In order to check the center of gravity height the following described method is proposed.

For this test four scales are required. The test is possible with two scales but this requires more preparation and it results in lower accuracy.

Initially the vehicle weights needs to be measured in a horizontal position. Afterwards the front is lifted and weights measured again. The higher it is lifted the more accurate the results will be. The height is restricted by different possible touch conditions, between vehicle parts and roof, ground and environment.

In order to improve measurements following preparations need to be done:

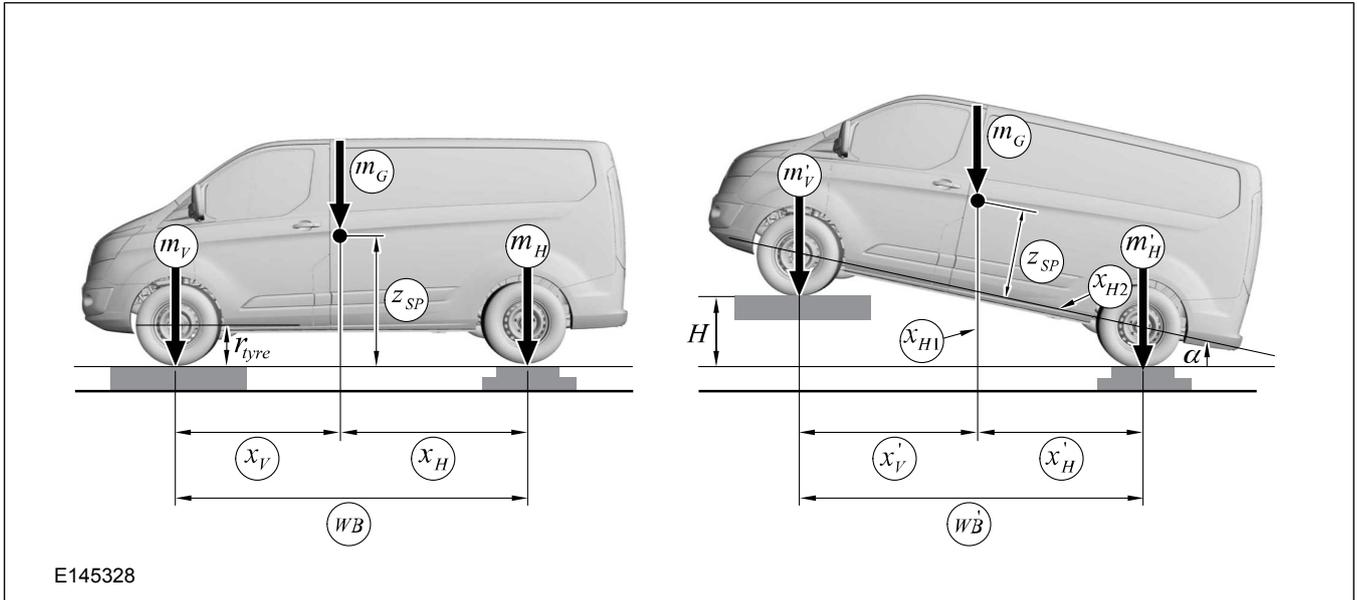
- Fix wheel travel, for example: solid shocks, or spring fixes.
- Increase tire pressure to maximum allowed value.
- It is important to remove all load, for example moving items, from the car or it should be properly fixed.
- Doors should be closed.

Before measuring the vehicle the engine must be switched off, after lifting it should be rolled freely in order to release tension in the tires and suspension.

Calculation

In order to estimate the resulting Center of Gravity (CG_v) the axle load needs to be measured twice. The first measurement is in the horizontal plane and the second measurement is after the front is lifted. To get a consistent result this test should be done 3 times independently with different heights.

To improve accuracy the test is done additionally the other way around, where the rear end is lifted.



E145328

Variables, to be measured, calculated or known			Measurement		
			1st	2nd	3rd
Wheelbase	WB	mm			
Front Axle Weight	m _v	kg			
Rear Axle Weight	m _H	kg			
Total Mass	m _G = m _v + m _H	kg			
INCLINED VEHICLE					
Front Axle Weight	m' _v	kg			
Rear Axle Weight	m' _H	kg			
Height (Lift)	H	mm			
Inclination Angle		deg			
Center of Gravity Height Z		mm			

Inclination Angle:

$$\alpha = \arcsin \left[\frac{H}{WB} \right]$$

E146623

Center of Gravity Height Z:

$$z_{SP} = \frac{m_H - m'_H}{m_G} \cdot WB^2 \cdot \cos \alpha$$

$$z = H_{CG} = z_{SP} + r_{tyre}$$

E146624

1.16.4 Center of Gravity Height Calculation

Given or measured parameter	
Wheelbase	WB
Front axle weight	m_v
Rear axle weight	m_H
Front height	H

Calculated and auxiliary parameter	
Center of Gravity (CoG) height	Z_{SP}
Total vehicle mass	m_G
Distance front axle to CoG (horizontal)	X_v
Distance rear axle to CoG (horizontal)	X_H
Wheelbase (projected in horizontal)	WB'
Front axle weight	m'_v
Rear axle weight	m'_H
Distance front axle to CoG (projected in horizontal direction)	X'_v
Distance rear axle to CoG (projected in horizontal direction)	X'_H
Inclination angle	arc sin
Front part of 'distance rear axle to CoG (horizontal)'	X_{H1}
Rear part of 'distance rear axle to CoG (horizontal)'	X_{H2}

1.16.5 Formulas

- Masses and lengths. Total vehicle mass is the sum of front and rear axle weight:
- $m_G = m_v + m_H$

The longitudinal distances between the Center of Gravity and the centres of wheels equal:

$$x_v = \frac{m_H}{m_G} WB$$

$$x_H = \frac{m_v}{m_G} WB$$

E146626

In inclined system the main variable is the inclination angle which is the quotient of the lifting height and the wheelbase:

$$\sin \alpha = \frac{H}{WB}$$

E146627

Similar to the equation for the horizontal system the distance projected in to the ground plane can be determined using the sum of moments around front and rear wheel center:

$$x'_V = \frac{m'_H}{m_G} WB'$$

$$x'_H = \frac{m'_V}{m_G} WB'$$

E146628

The following equations apply:

$$WB' = WB \cos \alpha$$

$$x_{H2} = \frac{x'_H}{\cos \alpha}$$

$$x_{H1} = x'_H - x_{H2}$$

E146629

Using the rule of proportion leads to the Center of Gravity height formula:

$$\frac{x_{H1}}{z_{SP}} = \frac{H}{WB'}$$

$$z_{SP} = \frac{m'_V - m'_V}{m_G \cdot H} \cdot WB^2 \cdot \cos \alpha, \quad \alpha = \arcsin \left[\frac{H}{WB} \right]$$

or

$$z_{SP} = \frac{m'_H - m'_H}{m_G \cdot H} \cdot WB^2 \cdot \cos \alpha, \quad \alpha = \arcsin \left[\frac{H}{WB} \right]$$

E146630

1.17 Towing

NOTE: 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

1.17.1 Tow Bar Requirements

When a tow bar device is required, the vehicle converter should use a Ford approved tow bar.

CAUTION: Rear cargo doors may not be compatible with all tow bars and couplers, check before fitting.

NOTE: Base vehicles ordered without a tow bar or underrun bar must order reinforcements and hardware.

NOTE: Not all vehicles are suitable or approved to have tow bars fitted. See an authorized dealer for further information.

NOTE: It is not recommended to retrofit a tow bar to vehicles equipped with rear air suspension.

For further information on Towing a Trailer and Trailer Sway Control (TSC) refer to the Owners Manual.

For Trailer Tow Electric Wiring Kit without a tow bar please refer to Trailer Tow Electric (A055) in Wiring Installation and Routing Guides section in this manual.

For additional information:

Refer to: 1.10 Jacking (page 21).

Refer to: 4.1 Wiring Installation and Routing Guides (page 56).

Electrics for Tow bar.

1.17.2 Tow Bar Types (for EU specification vehicles)

NOTE: When attaching a tow bar to the side rails the top two holes on either side are to be used with new bolts and nuts, plus the reuse of two bolts on the bottom holes each side which attach the Rear Crash Beam, as shown in figure E145327.

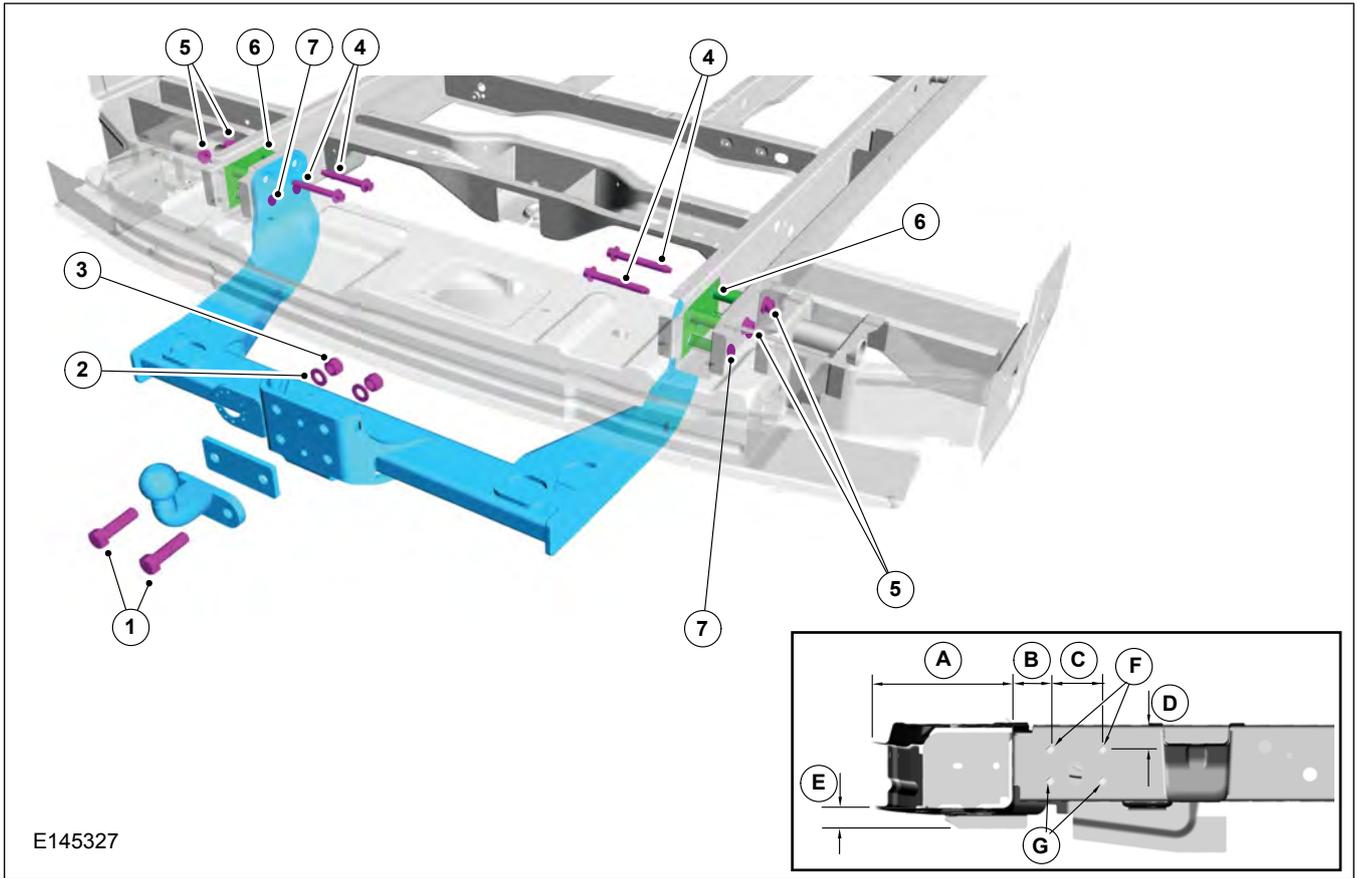
NOTE: When attaching the tow ball to the tow bar use the top two fixing holes.

For tow bar devices fitted by the vehicle converter the following applies:

- Tow bar allowances must not exceed those of the standard vehicle
- For attachment of the tow bar, under run bar and step see diagram E145327 - Tow Bar Van, Bus and Kombi 2.5 - 3.3 tonne
- Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation
- The maximum allowable tow ball static load is 112kg on a Van, Bus, Kombi
- Tow bar installations must meet the requirements of the EEC Directive 94/20 EC and /or ECE R55
- Whenever frame drilling is necessary use tube reinforcement, example shown as green in figure E145327

Refer to: 5.14 Frame and Body Mounting (page 204).
Mounting Points and Tubing

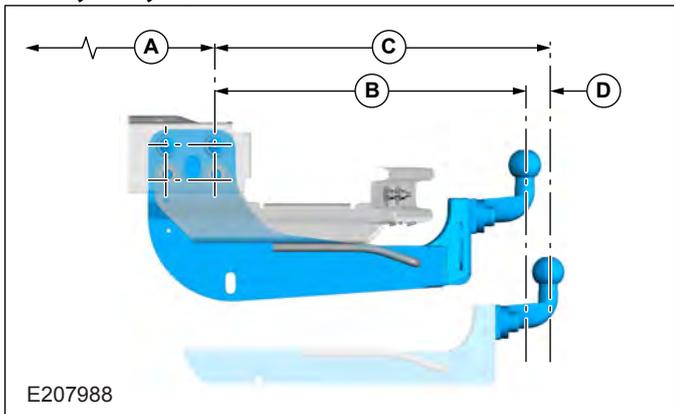
Tow Bar Van, Bus and Kombi, 2.5 - 3.3 tonne



E145327

ITEM	DESCRIPTION
1	M16 x 55 Screw - Torque 200nM ±30nM
2	M16 Washer
3	M16 Nut
4	M12 x 75 x 90 Hexagonal Flange Bolt in holes 'F' - Torque 103nM ±15nM
5	M12 Hexagonal Flange Nut
6	Reinforcement clamp plate
7	Reuse 2x bolts (each side) in holes 'G' - Torque 110nM ± 16.5nM
A	177mm
B	53mm
C	75mm
D	35mm
E	20mm

Trailer Sway Control (TSC) Tow Ball Zone - Van, Bus, Kombi



ITEM	Description
A	675mm (SWB/LWB) from center of rear axle
B	476mm
C	491mm
D	15mm

To ensure functionality of TSC, please make sure that the tow ball is within zone 'D' as shown in figure E207988.

1.17.3 Tow Bar Types (for AUS and NZL specification vehicles)

For tow bar devices fitted by the vehicle converter the following applies:

- Tow bar allowances must not exceed those of the standard vehicle
- For attachment of the tow bar, under run bar and steps see figure E186508 - Tow Bar SWB Van 2.9 tonne (GVM) and LWB Van 3.3 tonne (GVM)

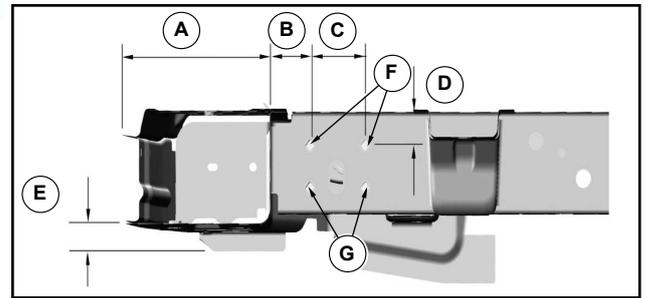
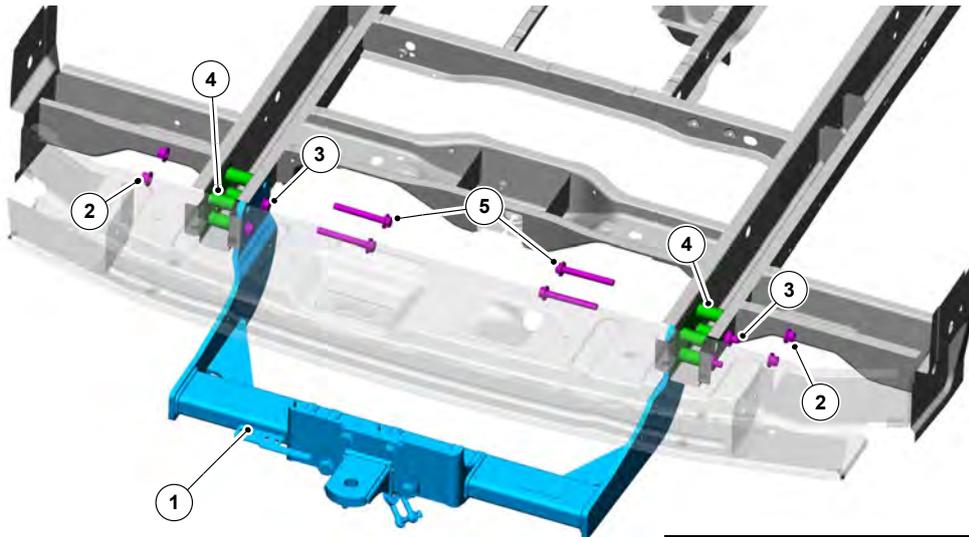
- Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation
- The maximum allowable tow ball static load is 180kg on 290S SWB (Automatic Transmission) Van - 1,800kg maximum towing
- The maximum allowable tow ball static load is 250kg on 290S SWB (Manual Transmission) Van - 2,500kg maximum towing
- The maximum allowable tow ball static load is 210kg on 340L LWB (Automatic Transmission) Van - 2,100kg maximum towing
- The maximum allowable tow ball static load is 280kg on 340L LWB (Manual Transmission) Van - 2,800kg maximum towing
- A minimum tow ball static load of 10% of towed weight is required for Australia and New Zealand
- Tow bar installations must meet the requirements of the Australian Design Regulations ADR 62
- Whenever frame drilling is necessary use tube reinforcement, example shown as green in figure E186508.

Refer to: 5.14 Frame and Body Mounting (page 204).

Mounting Points and Tubing

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

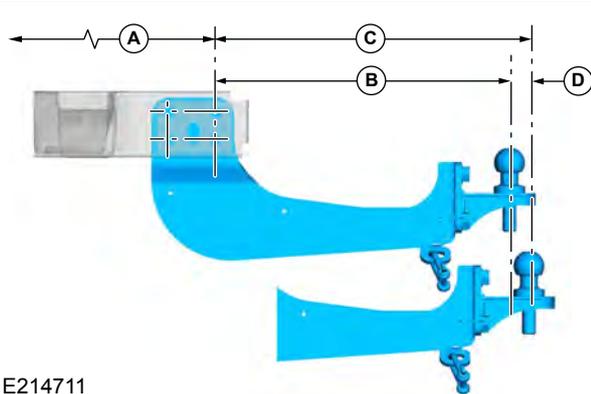
Tow Bar SWB Van 2.9 Tonne and LWB Van 3.3 Tonne



E186508

ITEM	DESCRIPTION
1	Tow bar frame assembly
2	2x fixing nuts each side
3	Reuse 2x bolts (each side) in holes 'G' - Torque 103±15Nm
4	Reinforcement clamp plate (each side)
5	2x fixing bolts each side in holes 'F' M12 x 75 x 90 - Torque 115±5Nm
A	177mm
B	53mm
C	75mm
D	35mm
E	20mm

Trailer Sway Control (TSC) Tow Ball Zone - SWB Van and LWB Van



E214711

ITEM	Description
A	675mm (SWB/LWB) from center of rear axle
B	477mm
C	492mm
D	15mm

To ensure functionality of TSC, please make sure that the tow ball is within zone 'D' as shown in figure E214711.

1.17.4 Trailer Brakes

 **WARNING: Failure to ensure compatibility of your brake controller may result in loss of vehicle control, which could result in serious injury or death.**

NOTE: The vehicle provides a pulsed brake signal of varying frequencies when an Assisted Emergency Braking (AEB) event occurs. This pulsed signal is not a direct current (DC) signal. The Ford-approved FLA Trailer Brake Controller (AMJAM-J2C405-BA) is compatible with these pulsed signals. If another aftermarket brake controller is installed, the vehicle owner or installer must ensure that it is compatible with all pulsed signals from the vehicle.

NOTE: Ford new vehicle warranty is provided for the Ford Licensed Accessory (FLA) Trailer Brake Controller (TBC) when it is fitted to the vehicle by an Authorised Ford dealer. Ford is not responsible for warranty and performance of other aftermarket brake controllers which are not approved by Ford.

If clarification is required on the specifications of the pulsed signals, please contact your Authorised Ford dealer.

2.1 Suspension System

WARNINGS:

 **Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe or anti-roll bars, springs or shock absorbers including mounting brackets.**

 **Interchangeability (between different Transit variants) of springs, shock absorbers and jounce bumpers is not permitted as the changes in vehicle dynamic performance can affect the ESP system.**

 **CAUTION: Modifications to the suspension system can cause a deterioration of the vehicle handling characteristics and durability.**

NOTE: 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

2.2 Front Suspension

2.2.1 Springs and Spring Mounting

WARNINGS:

 **Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe or anti-roll bars, springs or shock absorbers including mounting brackets.**

 **Interchangeability (between different Transit variants) of springs, shock absorbers and jounce bumpers is not permitted as the changes in vehicle dynamic performance can affect the ESP system.**

CAUTIONS:

 **When carrying out welding work the springs must be covered to protect them against weld splatter.**

 **Do not touch springs with welding electrodes or welding tongs.**

 **Make sure that components loosened or removed and reinstalled are properly reassembled and the torque set in accordance with manufactures requirements.**

NOTE: Do not modify the wheelbase or add any type of frame extension to vehicles fitted with Electronic Stability Control, ESC (also known as Electronic Stability Program, ESP).

NOTE: Do not damage the surface or corrosion protection of the spring during disassembly and installation.

NOTE: 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

2.3 Rear Suspension

2.3.1 Springs and Spring Mounting

 **WARNING: Interchangeability (between different Transit variants) of springs, shock absorbers and jounce bumpers is not permitted as the changes in vehicle dynamic performance can affect the ESP system.**

Rear Suspension Only

 **WARNING: On Steel Suspension only the rear leaf springs are pre-stressed in manufacture and should not be altered for rate or height in any way during vehicle conversion. Adding or removing leaves may result in failure or reduced function of the spring as well as other vehicle related issues for which Ford Motor Company cannot be held responsible.**

Rear Suspension and Rear Air Suspension

 **WARNING: Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, sub-frame, springs or shock absorbers including mounting brackets.**

CAUTIONS:

-  **When carrying out welding work the springs must be covered to protect them against weld splatter.**
-  **Do not touch springs with welding electrodes or welding tongs.**
-  **Make sure that components loosened or removed and reinstalled are properly reassembled and the torque set in accordance with manufactures requirements.**

NOTE: Do not modify the wheelbase or add any type of frame extension to vehicles fitted with Electronic Stability Control, ESC (also known as Electronic Stability Program, ESP).

NOTE: Do not damage the surface or corrosion protection of the spring during disassembly and installation.

NOTE: Do not add any additional axles.

NOTE: 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

2.4 Wheels and Tires

2.4.1 Wheel Clearance

The distance from the tire to the mudguard or wheel arch must be sufficient, even if snow or anti-skid chains are fitted and the suspension is fully compressed allowing for axle twist as well. Please consult the Vehicle Converter Advisory Service VCAS@ford.com for clearance requirements and data.

NOTE: Make sure that only approved wheels and /or permissible tire sizes are fitted.

NOTE: Ensure access to the wheel and wheel jack, and provide sufficient clearance in wheel arch to allow changing the wheels after conversion.

2.4.2 Tire Manufacturers

Replacement tires should be of the same make, size, tread pattern and load rating as the Original Equipment Manufacturer. Under these conditions the original tire label should be satisfactory, however if the specified tires and/or inflation pressures are changed then a new label should be affixed over the original label.

2.4.3 Tire Pressure Monitoring System (TPMS)

Ford TPMS is a direct system, using physical pressure sensors. TPMS is calibrated according to the tire pressure for the GVM of the vehicle. If the spare wheel is ordered on a base vehicle with TPMS, the tire will not be supplied with a TPMS sensor.

If you need to replace a road wheel and tire with the temporary spare wheel, the system will continue to identify a defect. This is to remind you to repair and refit the damaged road wheel and tire to your vehicle. To restore the correct operation of the system, you must have the repaired road wheel and tire assembly refitted to your vehicle.



2.4.4 Spare Wheel

When converting or relocating the spare wheel, access must be ensured.

2.4.5 Temporary Mobility Kit

Your vehicle may not have a spare tire. Therefore you will have a temporary mobility kit which will only repair one damaged tire. The kit is located in the left-hand side of the rear luggage compartment. For more information and usage of the tire repair kit please refer to the Owner's Manual. For information on vehicles with the spare wheel:

Refer to: 1.10 Jacking (page 21).

2.4.6 Painting Road Wheels

CAUTION: Do not paint wheel clamp surfaces in contact with brake drum or disc, hub and holes, or surfaces under wheel nuts. Any further treatment in these areas may affect the wheel clamp performance and the vehicle safety.

Mask the wheel when changing the color or repairing paint.

2.5 Brake System

NOTE: 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

2.5.1 General

The Brake System must be fully functional when the vehicle conversion is completed. The vehicle brake operating modes must be checked, including warning system and parking brakes.

Brakes are certified to 71/320EEC and ECE R13H requirements as amended or ADR 35 or applicable local legislation.

 **WARNING: Do not restrict the airflow and cooling to the brake system.**

CAUTIONS:

-  **Spoilers and wheel covers must not affect the brake cooling performance.**
-  **For converted vehicles fitted with AEBS (Advanced Emergency Breaking System), where vehicle mass or geometry is significantly altered, it is recommended that the radar vertical alignment and system functionality is checked by a Ford dealer. For further information, refer to the Workshop manual or Owner's manual.**

NOTE: Do not obstruct the view of the brake fluid reservoir level.

NOTE: The donor vehicle brake fluid reservoir is translucent so that it is possible to check the level of fluid without opening the reservoir which will reduce the risk of contamination. Do not move the brake fluid reservoir.

NOTE: Do not obstruct the radar.

NOTE: Do not paint the front grille of the vehicle as this may affect the functionality of the radar.

The brake fluid reservoir must remain accessible for servicing and for adding brake fluid.

2.5.2 Kerb Mass Data

NOTE: 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

2.5.3 Brake Hoses General

 **CAUTION: Make sure that the front and rear brake hoses are not twisted and are correctly located away from body and chassis components.**

Front and rear brake hoses must not rub, chafe or rest on body or chassis components. There must be clearance under all operating conditions, between full compression and extension and full lock to lock.

Brake lines must not be used to support or secure any other component.

2.5.4 Parking Brake

WARNINGS:

-  **Do not modify the brakes.**
-  **Do not splice into the parking brake cable.**
-  **CAUTION: Make sure that a new parking brake cable is fitted if modification to the wheel base impacts the existing parking brake cable.**

2.5.5 Hydraulic Brake—Front and Rear Brakes

WARNINGS:

-  **Do not modify the brakes.**
-  **Do not modify the disc in flow and out flow of cooling air.**

2.5.6 Anti-Lock Control — Stability Assist

 **WARNING: Do not modify any part of the braking system, including Anti Brake System (ABS), Traction Control System (TCS) and Electronic Stability Control (ESC), also known as Electronic Stability Program (ESP).**

3.1 Engine

CAUTION: Make sure to follow the equipment suppliers instructions for safety, warranty and sometimes legal compliance.

For electrical supply to auxiliary equipment.

Refer to: 4.3 Charging System (page 72).

The weight is based on the Reference Mass defined as the mass in running order, less a 75kg allowance for the driver, add a 100kg uniform mass.

NOTE: Light-duty emissions engines are available at Stage VI/ EU6 emissions level for Transit vehicle conversions not exceeding 2840kg.

3.1.1 Engine Selection for Conversions

The vehicle converter is responsible for specifying the correct emissions engine to the latest E.E.C/E.U. Regulations or applicable local legislation depending on the completed vehicle category and weight. The final weight of a vehicle including the conversion, determines whether a vehicle needs a light-duty or heavy-duty emissions engine.

3.1.2 Engine

Front Wheel Drive (FWD) Stage VI/ EU 6 emissions markets with DPF:

FWD Common Rail 2.0L TDCi 77kW (105PS) Diesel Engine

Item	description
Max Power kW/rpm	77kW (105PS) at 3500 1/rpm
Max Torque Nm/rpm	360Nm at 1375-2000 1/rpm

FWD Common Rail 2.0L TDCi 96kW (130PS) Diesel Engine

Item	description
Max Power kW/rpm	96kW (130PS) at 3500 1/rpm
Max Torque Nm/rpm	385Nm at 1500-2000 1/rpm

FWD Common Rail 2.0L TDCi 125kW (170PS) Diesel Engine

Item	description
Max Power kW/rpm	125kW (170PS) at 3500 1/rpm
Max Torque Nm/rpm	405Nm at 1750-2500 1/rpm

3.2 Engine Cooling

NOTE: 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

NOTE: The installation must be in line with the appropriate legal requirements.

3.2.1 Auxiliary Heater Systems

WARNINGS:

! **Ford coolant additives are necessary for the complete function of the system. Only use Ford approved or equivalent specification component, to withstand any detrimental effects on the materials.**

! **Do not mount components in front of the grille or in an area of air flow around the engine, which could affect the engine cooling.**

CAUTIONS:

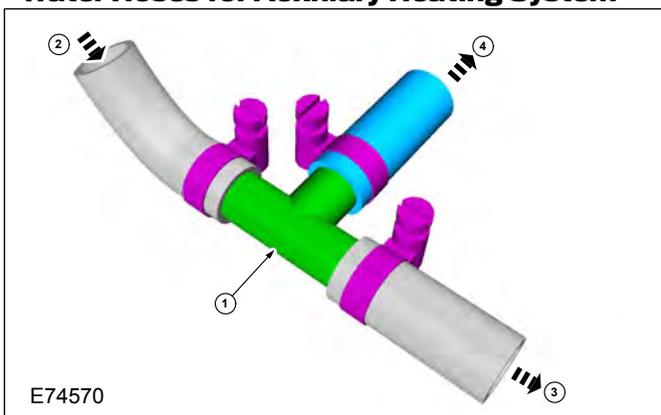
! **Only make connections into the heater hose between the front cab heater and water pump return inlet.**

! **Do not exceed the vehicle's original coolant volume (without auxiliary heater) by more than 10%.**

! **Maintain a coolant level between maximum and minimum line in cold condition after fill and de-aerating operations.**

! **Only use the manufacturer recommended (or equivalent specification) coolant additives/anti-freeze. Do not mix coolant types.**

Water Hoses for Auxiliary Heating System



Item	Description
1	Connector (aluminum or plastic)
2	Heater hose (maintain heater fluid)
3	Original flow
4	To ancillary equipment

- Coolant flow to cab heater must have priority over flow to auxiliary heater or hand wash facility.
- Coolant tube routing must be below the minimum line of the degas bottle.
- Use aluminum or plastic 'T' junction with swaged or beaded ends to prevent hose blow off. Reconnect original coolant tube as shown in view E74570 (in this section) with standard Ford water hose clip or suitable equivalent specification clip. Ensure interference fit between hose and 'T' joint.
- Tube routing must be secured to the body structure or suitable brackets avoiding electrical components or wires, hot or moving parts and brake or fuel system components.
- Hose must be heat sleeved with appropriate material if within 100mm of exhaust components (for example, manifold or exhaust gas recirculating).
- The vertical clearance between the critical cooling components (radiator, fan shroud and radiator brackets) and both the hood inner and outer (assembly) panels at design position shall not be less than 15mm.
- There must be a minimum clearance of 10mm between the engine assembly and flexible components (for example, hoses or wiring harnesses) affixed to front end sheet metal hardware, under a maximum engine torque roll condition.

3.2.2 Auxiliary Heater Installation

Ensure that the exhaust gas from any auxiliary heating system cannot be re-circulated into the vehicle. The exhaust gases must not pass into the engine intake system or the air intake for the passenger compartment ventilation. The heating system should be installed outside the passenger compartment. The location of the heating system should not be in close proximity to movable components. Any body reworks which damage the paint must be fully protected against corrosion.

Refer to: 5.13 Corrosion Prevention (page 203).

3.2.3 Air Flow Restrictions

! **WARNING: Do not mount components in front of the grille or in an area of air flow around the engine, which could affect the engine cooling performance.**

! **CAUTION: Over heating within the engine compartment can seriously compromise component robustness.**

NOTE: Please assume under hood environment is about 130°C when selecting appropriate materials.

3.3 Accessory Drive

NOTE: For further information on systems requiring a unique belt, 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

3.3.1 Front End Accessory Drives — General Information

When the correct belt is used, tensioning is and remains fully automatic for the life of the belt.

CAUTIONS:

-  **Only use the manufacturers recommended (or equivalent specification) components.**
-  **Make sure that the ancillary pulley diameter is less than the crankshaft pulley diameter.**
-  **Front End Accessory Drive shields must be maintained at all times. If shields are removed, for example when attaching an ancillary unit, they must be replaced so that it is protected appropriately.**

NOTE: No devices can be taken off the crank damper as this is a tuned device for system resonance.

NOTE: The shields are there to protect the Front End Accessory Drive system from STONE ingress and also protect people from rotating parts under Start-Stop function.

The Eigen frequency of the bracket with auxiliary unit should be above the maximum excitation frequency of the main excitation order of the individual engine at engine top speed. On 4-cylinder inline engines, this is the second engine order.

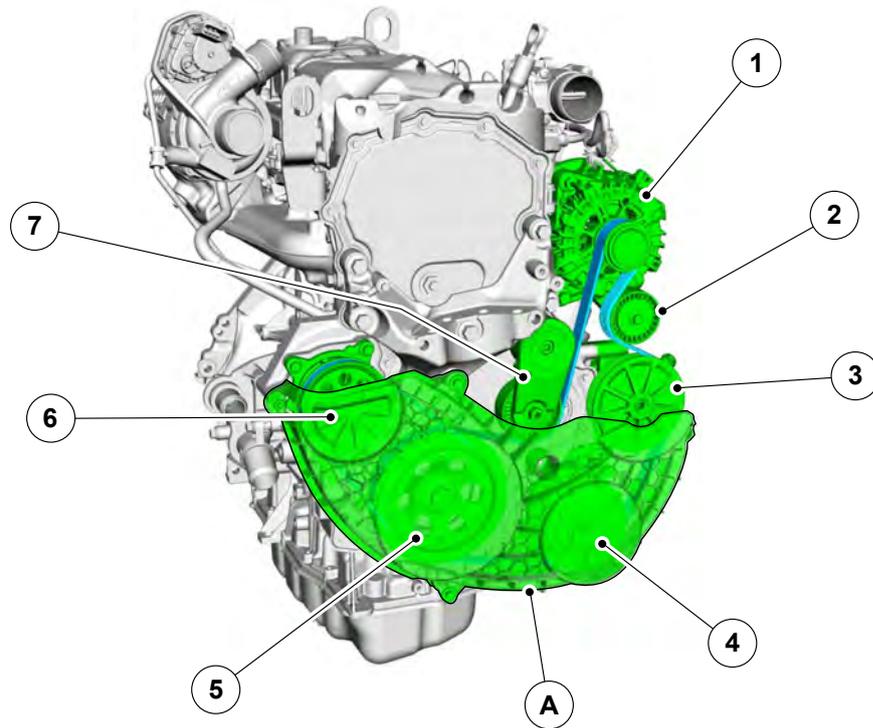
 **CAUTION: Do not fit an additional belt driven accessory within the existing belt drive when the vehicle is already equipped with an air conditioning compressor. If it is required to retain the air conditioning, then a further belt must be used to drive the additional accessory, driven from a third crankshaft pulley sheave.**

When engineering and installing a new front end accessory drive i.e. belt driven from the crankshaft pulley, the angular alignment of the belt to any pulleys must be within $\pm 0.5^\circ$.

When the vehicle is not equipped with an air conditioning compressor, an additional accessory can be added in its place, and the longer standard option air conditioning belt can replace the standard belt if pulley size and position are the same as the standard option compressor. Then maximum power/torque that is available in that case at any engine speed is 5kW or 21Nm based on the Ford released variable air conditioning compressor.

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

FWD 2.0L Diesel Engine - with Air Conditioning



E224688

Pulley, Belt Layout and Protective Shield on FWD 2.0L Diesel Engine - with Air Conditioning

Item	Description
1	Alternator
2	Idler
3	Pump
4	AC Compressor
5	Crankshaft Pulley
6	Water Pump
7	Tensioner
A	Front End Accessory Drive Shield

3.4 Automatic Transmission

The following automatic transmission is available for 2.0L TDCi Diesel Engine.



Tachographs cannot be fitted into 6F55 transmissions.



Do not change external electrical connectors.

WARNINGS:

 **Do not reroute external transmission gear shift cables.**

6F55 - 6 Speed Automatic FWD Transmission

Gears	Base Transmission Ratio	Overall Ratio - Final Drive 3.65
1st	4.484	16.367
2nd	2.872	10.483
3rd	1.842	6.723
4th	1.414	5.161
5th	1	3.650
6th	0.742	2.708
Reverse	2.882	10.519

3.5 Clutch

The manufacturer does not offer the option of a reinforced clutch system. The axle ratio available is dependent on the weight of the specified donor vehicle.

It is necessary to select the appropriate drive, engine, gear ratio, gross vehicle mass, gross train mass, axle plates and payloads of the base vehicle to match the customers order.

3.6 Manual Transmission

The following manual transmission is available for Diesel Engines.

NOTE: All VMT6 FWD transmissions are tachograph compatible.

 **WARNING: Do not reroute external transmission gear shift cables.**

VMT6 - 6 Speed Manual FWD Transmission

Gear	Base Transmission Ratio	Overall Transmission Ratio		
		4.19 Final Drive	3.94 Final Drive	4.43 Final Drive
1st	3.727	15.609	14.677	16.507
2nd	1.952	8.175	7.687	8.645
3rd	1.121	4.695	4.414	4.965
4th	0.780	3.267	3.072	3.455
5th	0.844	2.570	2.417	2.754
6th	0.683	2.080	1.956	2.229
Reverse	1.423	16.150	15.190	17.306

3.7 Exhaust System

NOTE: 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

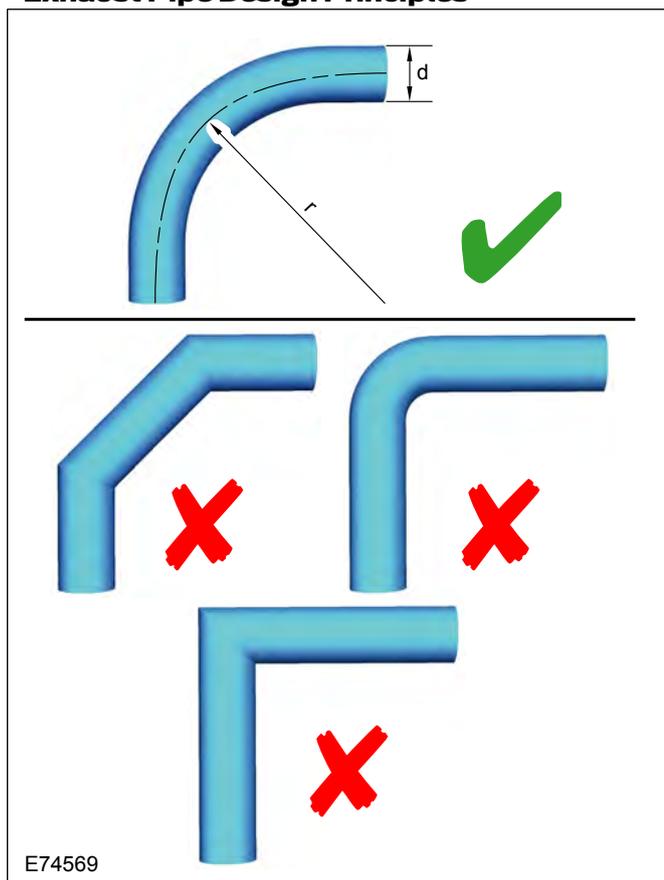
3.7.1 Extensions and Optional Exhausts

CAUTIONS:

- ❗ **Non-standard systems must be tested for engine back pressure and all legal compliance (noise and emissions).**
- ❗ **Make sure that for any pipes that require bending, the radius of the bend is minimum 2.5 x tube diameter.**
- ❗ **Make sure that sufficient clearance is maintained for all driving conditions to all hot and moving components.**

NOTE: Where possible all pipe connections should be designed so that the gas flows from smaller to larger diameter pipes.

Exhaust Pipe Design Principles



E74569

Item	Description
d	diameter
r	radius => 2.5d

3.7.2 Exhaust Pipes and Supports

CAUTIONS:

- ❗ **Maintain the original set-up and heat shields.**
- ❗ **Do not position any components closer than 150mm nominal (100mm minimum) clearance to the downpipe, the catalytic converter, the diesel particulate filter, the selective catalyst reduction and any part of the exhaust system.**

3.7.3 Exhaust Heat Shields

Exhaust Heat Shields

- Catalytic converters, in particular, operate at high temperatures
- Ensure existing shields are maintained
- Add further shields over exhaust system as necessary to avoid fire risk

Standard Exhaust Heat Shields

- ❗ **CAUTION: Standard heat shields are available from your local dealer and can easily be fitted. Additional heat shields may be required over the modified exhaust system, particularly in areas of close proximity to the floor.**

3.7.4 Diesel Particulate Filter (DPF)

The DPF forms part of the emissions reduction systems fitted to your vehicle. It filters harmful diesel particulates (soot) from the exhaust gas.

Regeneration

- ⚠ **WARNING: Do not park or idle your vehicle over dry leaves, dry grass or other combustible material. The DPF regeneration process creates very high exhaust gas temperatures. The exhaust will radiate a considerable amount of heat during and after DPF regeneration and after you have switched the engine off. This is a potential fire hazard.**

Unlike a normal filter which requires periodic replacement, the DPF has been designed to regenerate, or clean itself to maintain operating efficiency. The regeneration process takes place automatically. However, some driving conditions mean that you may need to support the regeneration process.

If you drive only short distances or your journeys contain frequent stopping and starting, occasional trips with the following conditions could assist the regeneration process:

- Drive your vehicle, preferably on a main road or motor way, for up to 20 minutes avoiding prolonged idling, but always observing speed limits and road conditions
- Do not switch off the ignition
- Use a lower gear than normal to maintain a higher engine speed during this journey, where appropriate

3.7.5 Operator Commanded Regeneration (A660)

With the vehicle stationary, the DPF is unable to start a regeneration event.

Where the anticipated usage profile of the vehicle is expected to include longer stationary durations, it is strongly recommended that the Operator Commanded Regeneration (OCR) is specified and ordered for the base vehicle.

OCR allows the driver/ operator to manually perform a DPF regeneration while the vehicle is stationary, after confirming that it is safe to do so.

Refer to: [4.8 Electronic Engine Controls \(page 115\)](#).
DPF and RPM Speed Control.

3.7.6 Vehicle Exhaust Systems – Vans with Full Bulkheads

Vehicle exhaust systems for vans with bulkheads are available in two lengths; a short length exhaust finishing approximately in the center of the vehicle, which is standard fit, and a long exhaust finishing at the rear of the vehicle. If you are undertaking any modification to the load compartment of the vehicle, especially in the lower half of the vehicle, ensure that the most suitable length of exhaust is used to avoid exhaust gas ingress into the vehicle.

3.8 Fuel System

WARNINGS:

 **Do not cut into the original fuel supply lines.**

 **Make sure that the modified vehicle complies with all relevant legal requirements.**

NOTE: Auxiliary Fuel line comes with Fuel Fired Heater as an orderable option. The Auxiliary Fuel line is available as a service item.

For vehicles without auxiliary fuel line that require a fuel supply for applications (for example: auxiliary heater or fuel fired hand wash facility) it is advisable to use the auxiliary fuel supply port on the top of the fuel sender unit located on the top of the fuel tank as shown in figure E224431.

NOTE: To fit the auxiliary fuel line, the fuel tank will need to be lowered, see following process:

To lower fuel tank:

- Drain tank.
- Disconnect fuel lines between fuel tank and urea tank
- Plug lines to prevent residual fuel from draining/spilling
- Remove filler pipe from tank
- Remove bolts securing the three tank straps
- Lower the fuel tank to gain access to the top, see Figure E224431 for fitting auxiliary fuel line

To refit fuel tank:

- Lift fuel tank ensuring not to trap fuel lines and electrical wires
- Refit straps, torque bolts to $47.5\text{Nm} \pm 7.2\text{Nm}$
- Refit filler pipe to tank spud securing hose clip torque to $3.7\text{Nm} \pm 0.6\text{Nm}$
- Remove plugs and reconnect fuel lines

CAUTIONS:

 **Make sure that sufficient clearance is maintained for all driving conditions to all hot and moving components.**

 **Make sure that when the port is cut that it is smooth with no sharp edges or burrs.**

NOTE: The tube and/or line must be routed independently and secured to the body structure or to suitable brackets.

NOTE: Ensure that a suitable fuel shut-off is fitted in any unique system.

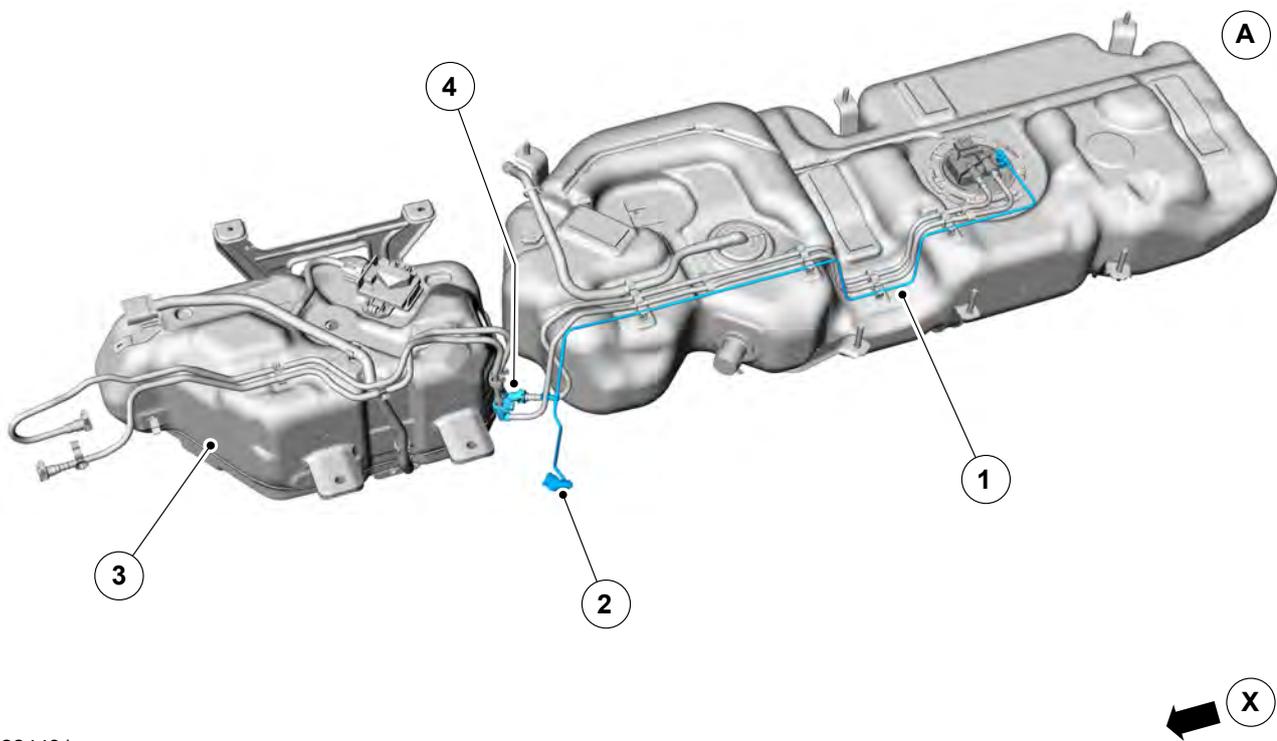
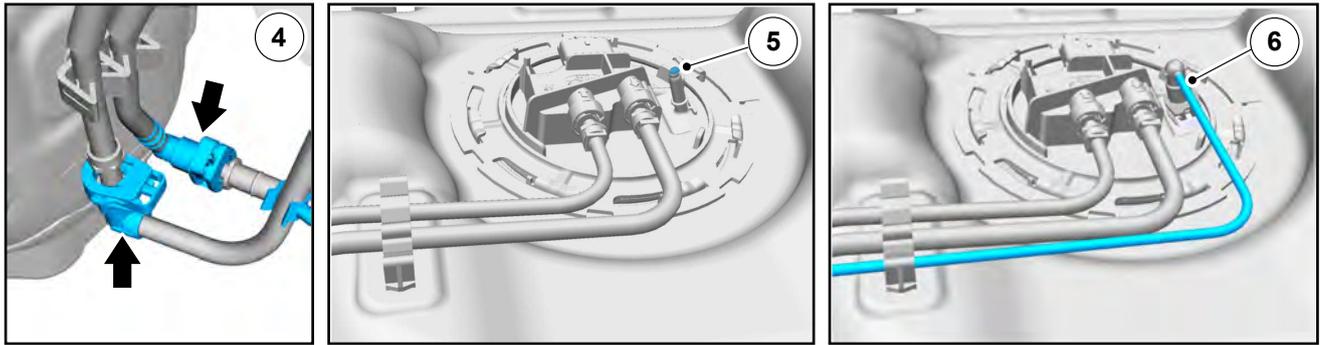
NOTE: Do not fasten anything to existing electrical components, wires or fuel lines.

For additional information

[Refer to: 5.1 Body \(page 177\).](#)

Floor Precautionary Drill Zones - Fuel Tank with UREA.

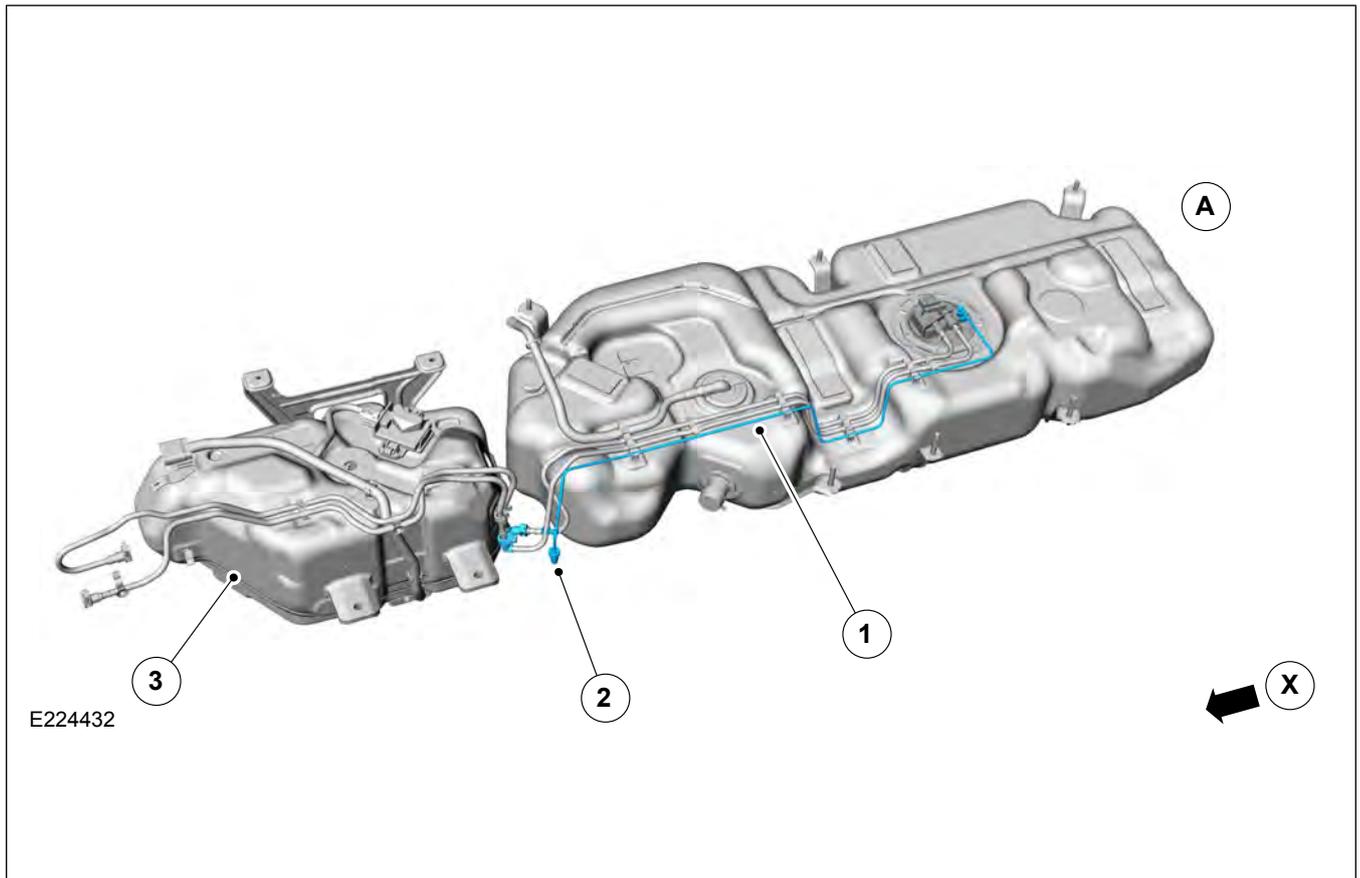
Auxiliary Fuel Line - For all vehicles except Campers



E224431

Item	Description
A	FWD 70L Fuel Tank - vehicles built from January 2017 onwards
1	Auxiliary fuel line, part number GK21-9N126-A*
2	Auxiliary fuel line has a female connector TI LOCC QC 7.89 fitted as standard. It is recommended to use a 7.89 male adapter mating part (manufacturer TI Automotive GmbH)
3	UREA Tank/AdBlue® Tank
4	Disconnect fuel lines between Fuel Tank and UREA Tank
5	Cut off top of port of diesel delivery module flange leaving 19.64 ± 0.12 mm and carefully insert heater tube, part number BK21-9T308-A*
6	Fix quick fit connector of fuel line to heater tube, part number GK21-9N126-A*
X	Drive Direction

Auxiliary Fuel Line - For Camper Vehicles



Item	Description
A	FWD 70L Fuel Tank - vehicles built from January 2017 onwards
1	Auxiliary Fuel Line, part number GK31-9N126-B*
2	Auxiliary Fuel Line has a male end adapter TI LOCC QC 7.89 fitted as standard with a female fuel spillage block connector. It is recommended to use a 7.89 female connector mating part (manufacturer TI Automotive GmbH), after female fuel spillage block connector is removed.
3	UREA Tank/AdBlue® Tank
4	Disconnect Fuel Lines between Fuel Tank and UREA Tank
X	Drive Direction

4.1 Wiring Installation and Routing Guides

4.1.1 Wiring Harness Information

⚠ WARNING: Incorrect design, for example: overloaded ground paths or insufficient mechanical protection to a third party wiring, could lead to a serious system or vehicle failure. It is recommended to follow the guidelines in the electrical sections of this BEMM.

NOTE: For additional information and recommendations on materials and equipment for interfacing to the Ford systems, power and grounds, 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

NOTE: Ford Motor Company has no control over the modification or installation process of the electrical content of auxiliary systems and therefore can take no responsibility for such installations.

The following provides an installation guide for any electrical modifications or additional systems being added to the vehicle. The aim is to maintain robust integration of auxiliary systems without compromising existing systems, in areas such as splicing techniques into existing wiring, module package location and EMC issues. It is also expected that the vehicle converter will test their installation and comply to all legal and homologation requirements.

4.1.2 General Wiring and Routing

Temperature requirements: Wiring systems in the vehicle interior are expected to function over the temperature ranges of -40°C to 85°C for exposure and -40°C to 75°C for function. For engine compartment and underbody, the minimum temperature is -40°C , while the maximum exposure and operational temperatures are 125°C for exposure and 105°C for operational.

Make sure that the insulation is compatible with any fluids it may encounter, for example: gasoline, oil, antifreeze, brake fluid, transmission fluid and power steering fluid.

If a connector will be located in a hostile environment or wet area use a sealed connector. 'Hostile environment' areas include the engine compartment, wheel wells, underbody and doors.

Do not route wires near weld points or weld flashes. A minimum of 15mm clearance to any sheet metal welds under static and dynamic conditions is required. However, it is best to avoid routing near weld points or weld flashes at all times.

In general, the distance between retention points for wiring not contained in a rigid shield should be less than 300mm.

A minimum 25mm clearance is recommended from all sharp edges and a minimum 35mm clearance of all moving parts of the parking brake assembly. If these clearances cannot be met, protect the wires with a convolute.

For conversions with walkthroughs, it is recommended to provide appropriate protection on the floor in the walkway.

Connecting blocks with screws or spring retention are not recommended due to the low frequency vibration that can occur in certain vehicles which could lead to terminals becoming loose.

A secondary clamp design is required on all eyelets to help avoid strain and breaking of a single conductor strand.

It is recommended to use a set ratchet crimp tool for the required crimp force.

Soldering is not permitted as the only method of retention. All connections must be crimped. Soldering should only be used as a supplementary retention method to the crimp, to reduce impedance.

If routing wiring through drilled metal all holes need to be protected by a grommet or protective edging to avoid chafing.

All wires, single or multiple, should have a secondary form of mechanical protection, for example: cotton, PVC tape, conduit or sleeving, depending on the routing environment within the vehicle.

It is recommended to use edge clips, fir tree clips or cable ties where required, to control all routing of all cables in non-weather zone areas of the vehicle. In weather zone areas of the vehicle do not use edge clips.

4.1.3 Connector Pin Out Practices

When designing a harness to component connection, it is best practice to put the female terminals in the harness side connection and the male terminals in the component side. When determining connector pin outs, make sure that power and ground circuits are not in close proximity, adjacent, to one another. A minimum separation of 5 mm between power and ground circuits is required.

⚠ WARNING: Do not use connectors which cut through the outer covering and into the core wire.

⚠ CAUTION: Only use Ford approved connectors

Cutting into vehicle wiring is not permitted because:

- The base vehicle specification is unsuitable for incremental loads except in conjunction with Special Vehicle Option Auxiliary Fuse Panel.
- Long term risk of a faulty connection developing.
- Potential fire risk from over-loading.

All connections into existing wiring must be permanently insulated. Exterior connections must be water-proof.

When designing electrical circuits, or making alterations, the following must be considered:

- Current rating of wiring, see table 'Current Rating of Wire Sizes' in this section.
- Any voltage drop in the circuit should not lower the terminal voltage at consumption point to below 95% of battery voltage.
- Do not cut into the original harness.
- Additional earth returns should be included to support new equipment.
- A supplementary circuit diagram and accompanying instructions should be added to the Owner's information or a separate manual supplied with the vehicle for each unique component.

NOTE: 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

Where wires are required to be extended, break in points and only Ford approved connectors should be used.

Ford approved jumper harnesses should be used.

4.1.4 Unused Connectors

The harnesses may have a number of unused connectors, which are dedicated to other features and options, for example heated seats, but are **not** always present depending on level of harness fitted. Ford **do not** recommend the use of these connectors for any other purpose than that intended by design.

4.1.5 Grounding

If a new grounding point is required, avoid weather zones, especially for high current grounds. Ground connections should be routed back close to the location of the +12V supply. This helps to reduce the electromagnetic field particularly generated by inrush current and improve electromagnetic compatibility.

Drill point screws are not to be used for any ground attachments:

- Do not ground to moving structures, for example: doors, deck lids, lift gates, as the ground return path through the hinges is not reliable.
- Do not exceed 2 eyelet or crimp terminals per stud connection. For high current applications [Refer to: 4.4 Battery and Cables \(page 78\)](#).
- Do not place electrical component attachments or ground nuts adjacent to vehicle fuel tanks or fuel lines.
- Each individual third party load must have a dedicated ground connected directly to the vehicle body ground or to the battery negative spare stud. See 'Additional Loads and Charging Systems' later in this section of the BEMM.
- Multiple grounds must not go to an interim splice to a main ground cable.
- If additional ground studs are required it is recommended to install a busbar with multiple studs fed directly from the battery ground post. See 'Additional Loads and Charging Systems'.

4.1.6 Prevention of Squeaks and Rattles

Wiring should be positively retained every 150 to 250mm. All connectors should be positively retained. Use tapes which do not squeak against metal or plastic.

4.1.7 Water Leakage Prevention

Make sure that drip loops are provided to prevent water leakage into the vehicle interior, passenger and cargo compartments, using wiring assemblies that pass from outside into the vehicle interior. The drip loop is a section of wiring that is deliberately formed and routed **BELOW** the point of entry into the vehicle, so that gravity assists in forming water droplets that escape from the lowest part of the wiring.

Wiring from door to passenger compartment, should be made such that the door entry point is below the passenger compartment entry point, which creates a type of drip loop.

4.1.8 Wiring Splicing Procedures

TYCO-RAYCHEM crimp splices



E131081

Ford Motor Company strongly advises against the use of wire splicing due to the variable and unpredictable nature of making robust, durable and reliable connections. However, if it is deemed that a wire splice is absolutely unavoidable, it must be made with **DuraSeal Heat-Shrinkable, Environmentally Sealed, Nylon-Insulated Crimp Splices** (manufactured by TYCO-RAYCHEM). For example the D406 series. As a further process to improve the splice integrity, the splice should be further sealed with a suitable heat shrink tubing. See Figure E131081.

4.1.9 Wiring Specification

ISO Conductor Size mm ² CSA	Conductor Resistance mOhm/m					
	Maximum			Minimum		
	Plain Copper	Tinned Plated Copper	Nickel Plated Copper	Plain Copper	Tinned Plated Copper	Nickel Plated Copper
0.13	136	140	142	-	-	-
0.22	84.8	86.5	87.9	-	-	-
0.35	54.4	55.5	56.8	-	-	-
0.5	37.1	38.2	38.6	-	-	-
0.75	24.7	25.4	25.7	22.7	23.3	23.6
1	18.5	19.1	19.3	17.0	17.6	17.7
1.5	12.7	13.0	13.2	11.7	11.9	12.1
2.0	9.42	9.69	9.82	8.66	8.91	9.03
2.5	7.60	7.82	7.92	6.99	7.19	7.28
3	6.15	6.36	6.41	5.66	5.85	5.89
4	4.71	4.85	4.91	4.33	4.46	4.52
5	3.94	4.02	4.11	3.62	3.70	3.78
6	3.14	3.23	3.27	2.89	2.97	3.01
8	2.38	2.52	2.60	2.19	2.32	2.39
10	1.82	1.85	1.90	1.68	1.70	1.75
12	1.52	1.60	1.66	1.40	1.47	1.53
16	1.16	1.18	1.21	1.07	1.09	1.12
20	0.955	0.999	1.03	0.870	0.919	0.948
25	0.743	0.757	0.774	0.688	0.701	0.716
30	0.647	0.684	0.706	0.595	0.629	0.650
35	0.527	0.538	0.549	0.489	0.500	0.510
40	0.473	0.500	0.516	0.435	0.460	0.475
50	0.368	0.375	0.383	0.343	0.350	0.357
60	0.315	0.333	0.344	0.290	0.306	0.316
70	0.259	0.264	0.270	0.243	0.248	0.254
95	0.196	0.200	0.204	0.185	0.189	0.193
120	0.153	0.159	0.159	0.146	0.149	0.152

When designing wire installations for additional equipment use the cable size recommended by the equipment manufacturer or select a suitable size from the 'Current Rating of Wire Sizes' table.

4.1.10 Electromagnetic Compatibility (EMC) Awareness

Electromagnetic Compatibility (EMC) Awareness

The installation and routing of Ford wiring have been fully-validated and have passed the requisite EMC tests. Ford Motor Company, however, are not responsible for the vehicle's EMC immunity when non-Ford-approved systems are installed.



WARNING: Do not route other wiring near/close to electrical cables with the Anti-Lock Brake System and Traction Control System cables because of extraneous signal risk. It is generally not recommended to hang it off existing looms or pipes.

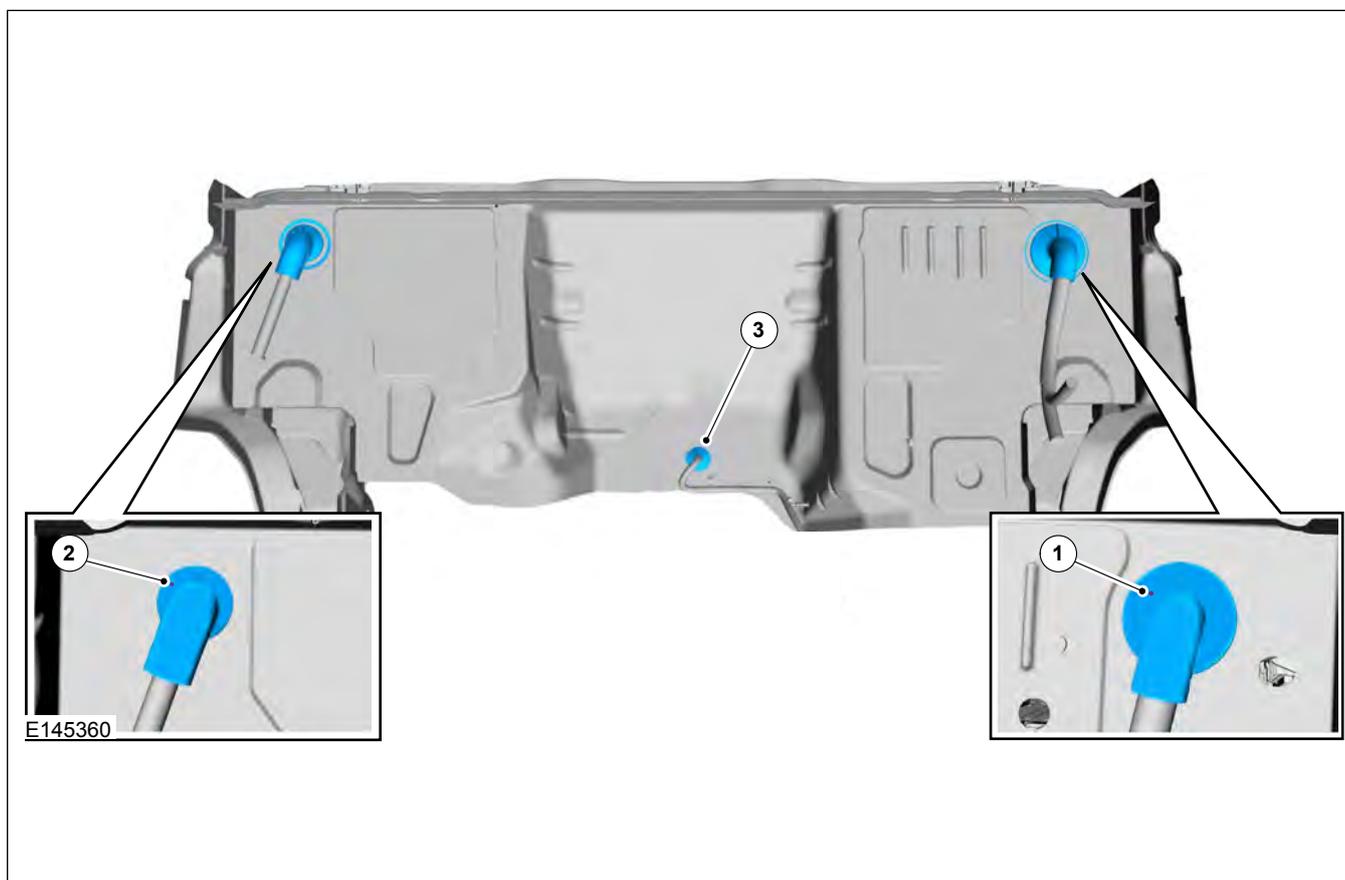
Wiring must be suitably fixed without any detrimental effect on other wiring.

Single or bunched looms must maintain the following clearances:

- 10mm from static components (unless clamped to it).
- 250mm from exhaust system.
- 30mm from rotating or moving components.

4.1.11 Wiring through Sheet Metal

Dash Panel (Left Hand Drive Shown)



Item	Description
1	Dash Grommet Left Hand Side
2	Dash Grommet Right Hand Side
3	Only available on vehicles without Tachograph



WARNING: Harnesses passing through sheet metal must be through protective grommets that also ensure a watertight seal. A windscreen type sealer should be used. Adhesive or tape is not acceptable.

NOTE: Holes must permit the appropriate connector to pass through.

NOTE: The maximum size of additional wire bundle diameter is 6mm

There are three locations in the dash panel which have been identified for additional holes to route wires through. See figure E145360 (view from dashpanel side) for locations. The number of suitable locations will depend on the vehicle specification.

The grommets in locations 1 and 2, shown in figure E145360, are molded directly to wire bundles in polyurethane foam material. It is not possible to feed extra wires through with the wire bundle. The grommets have an 'indent' molded into the surface face, engine bay side, which show the positions where an additional hole can be made using the following procedure:

- Check that the immediate surrounding area is free from obstructions and/or components to prevent damage to critical systems.
- Use a suitable tool, for example: a drill or spike bit.
- Insert the drill or spike bit, horizontal and parallel, through the indent of the grommet, making sure not to extend further than 25mm through the grommet surface, this will help eliminate any possible damage to items on the passenger side of the grommet.

Ford released hardware is available to support further installations to the vehicle. Only this hardware and released parts are to be used for this.

4.1.12 Precautionary Drill Zones — Rear Cargo Area

The areas marked in blue on figures E145339 - E145344 and E166796 - E166798 show the 'Precautionary Drill' zones for the rear cargo area where there is wire routing and is to be avoided, (for example: when installing cladding and racking). The same care should also be taken when using self-tapping screws. Not all derivatives are shown but the routing is the same for roof line and wheel base with regards to 'B', 'C' and 'D' pillars or roof bows and doors. Other non-electrical systems may also be present, for example: fuel tank under floor so it is important to check before drilling. For additional information refer to the following links.

CAUTION: Do not drill into the vehicle before checking the precautionary drill zones and electrical wire routing.

Refer to: [5.1 Body \(page 177\)](#).

Precautionary Drill Zones

Refer to: [5.4 Loadspace \(page 186\)](#).

Load Compartment Tie Downs

Refer to: [5.3 Racking Systems \(page 184\)](#).

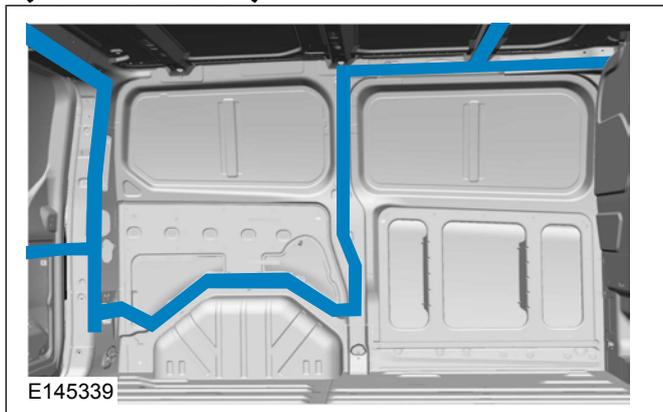
Refer to: [5.6 Body Closures \(page 190\)](#).

No Drill Zones

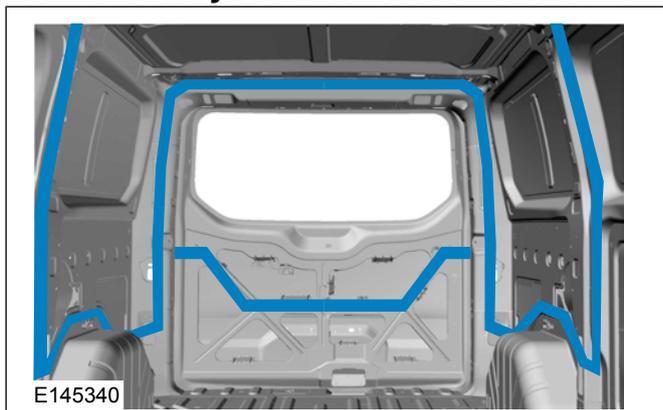
For Wheel Base and Roof Height dimensions

Refer to: [1.2 About this Manual \(page 7\)](#).

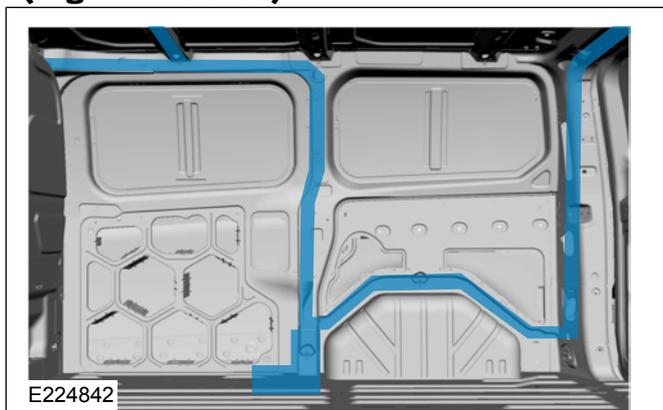
Precautionary Drill Zones L1/H1 with Lift Gate (Left Hand Side)



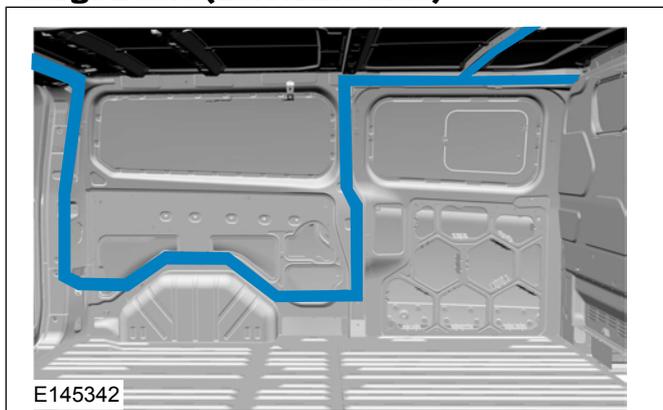
Precautionary Drill Zones L1/H1 with Lift Gate



Precautionary Drill Zones L1/H1 with Lift Gate (Right Hand Side)



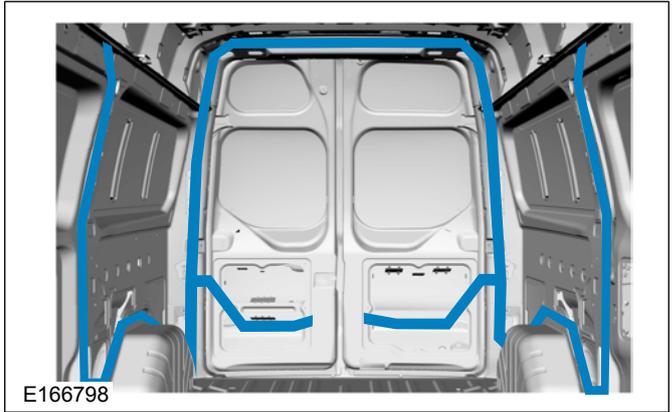
Precautionary Drill Zones L2/H1 with Rear Cargo Doors (Left Hand Side)



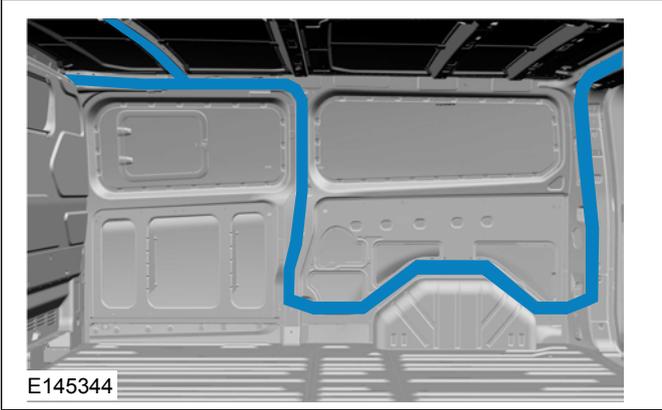
Precautionary Drill Zones L2/H1 with Rear Cargo Doors



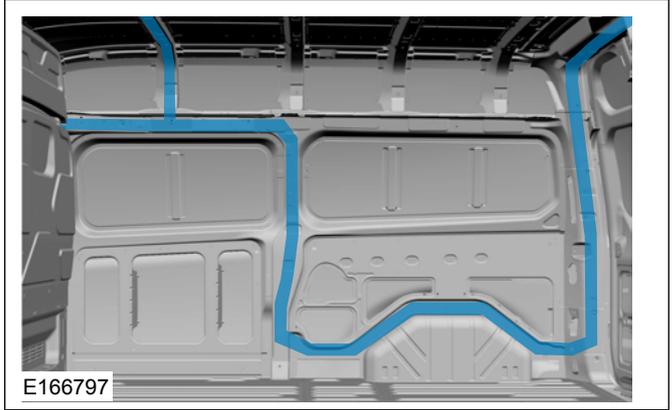
Precautionary Drill Zones L2/H2 — Rear Cargo Doors



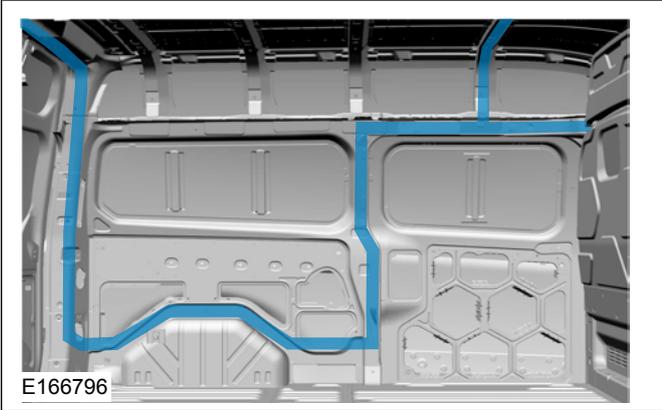
Precautionary Drill Zones L2/H1 with Rear Cargo Doors (Right Hand Side)



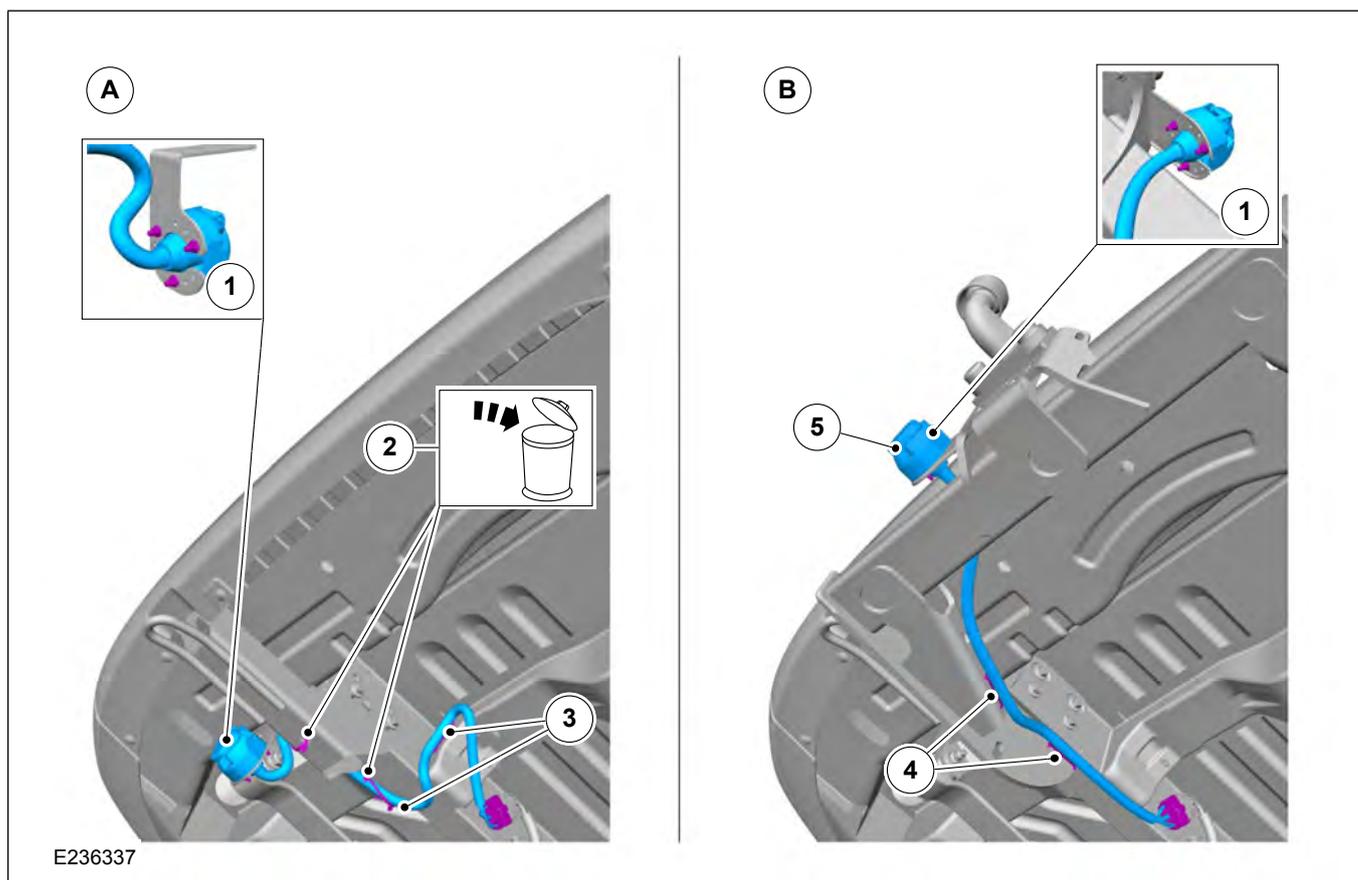
Precautionary Drill Zones L2 /H2 with Rear Cargo Doors (Right Hand Side)



Precautionary Drill Zones L2/H2 with Rear Cargo Doors (Left Hand Side)



4.1.13 Trailer Tow Electric (A055)



E236337

Item	Description
A	Trailer Tow Electric Wiring Kit without a Tow Bar
B	Rerouted Trailer Tow Electric Wiring Kit with a Tow Bar Retrofitted
1	3x Screw for 12V Socket
2	Cable Ties 2x
3	Wiring clips 2x
4	Recommended Wiring Clip Position 2x
5	Recommended 12V Socket Position

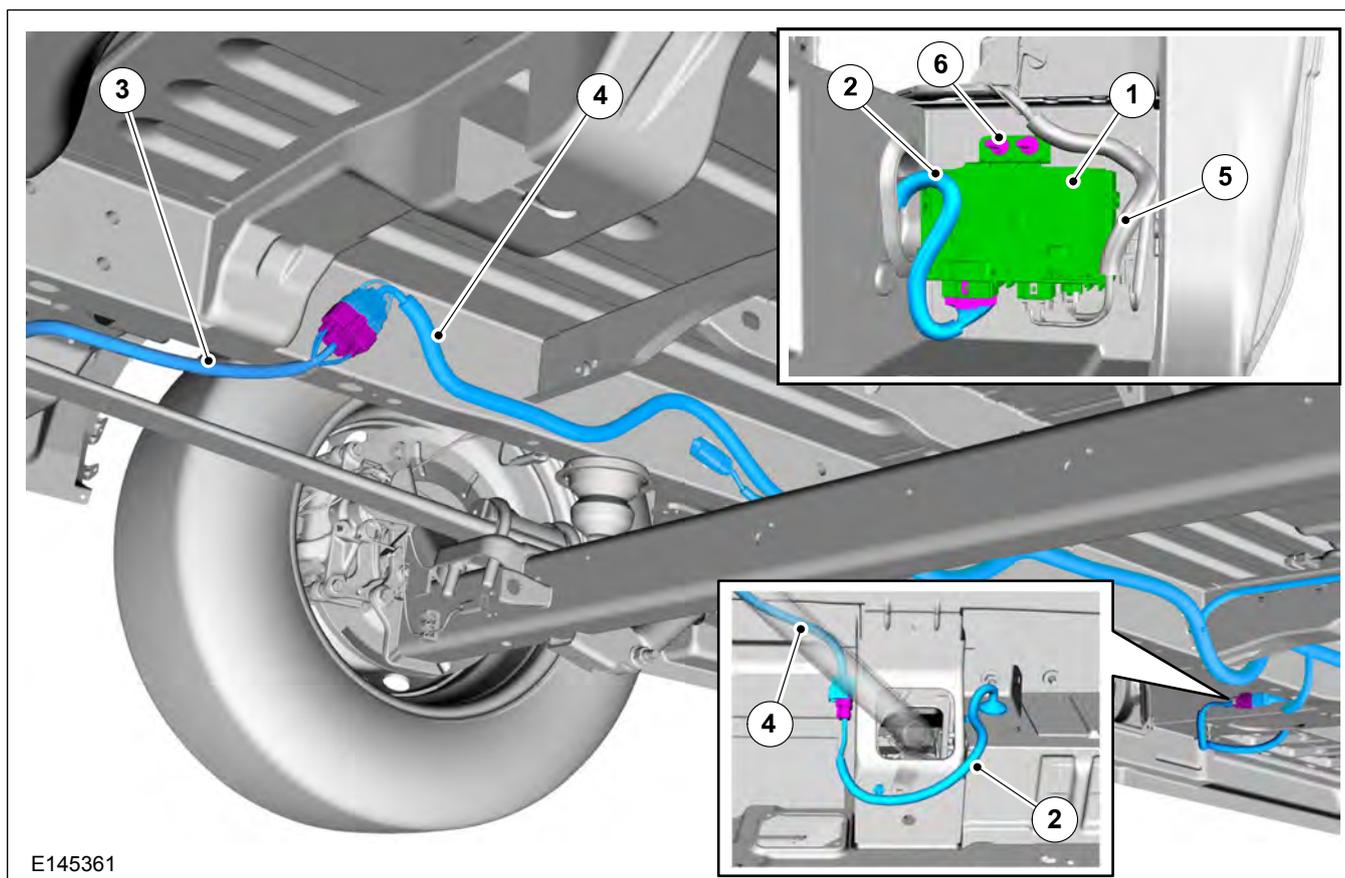
NOTE: Fix over length of the wiring on a secure area of the vehicle.

NOTE: The 12V socket bracket can stay in its original position when the socket is mounted in a different location.

Figure E236337 shows the routing for the Trailer Tow Electric Wiring Kit (A055) without a tow bar and the recommended wiring routing and wiring clip positions if a tow bar will be retrofitted.

4.1.14 Electrics for Tow Bar

Trailer Tow Module and Harnesses



E145361

Item	Description	Part Number
1	Trailer Tow Module	GK2T-19H378-A*
2	Trailer Tow Jumper (with Trailer Tow Module connector 'A' see figure E185972)	GK2T-13B576-A*
3	Trailer Tow Socket Jumper - Europe	BK2T-13B576-D*
	Trailer Tow Socket Jumper - Australia and New Zealand	AMBK3J-15A416-A*
4	Fuel Tank Harness	GK2T-14406-**
5	Main Harness (with Trailer Tow Module connectors 'B' and 'C' see figure E185972)	GK2T-14401-**

Tow bar electrical system may be ordered as a 13-pin DIN connector for Europe or 12-pin DIN connector for Australia and New Zealand, as part of the original vehicle build.

Where it is required to add trailer towing to an existing vehicle, and to ensure compliance with lighting regulations, the appropriate wiring accessory kit can be obtained from your Ford Dealer.

Fitment of non-Ford trailer tow wiring is not advisable due to Body Control Module control of lighting, and meeting legal lighting regulations. Contact your local Ford dealer for details of a harness that connects to the base vehicle harness.

NOTE: For Van tow bars it is necessary to connect into the rear lamp unit.

NOTE: If tow bar connectors are not used, appropriate fixing and cover must be applied for protection from water and contaminant ingress.

NOTE: The trailer detect circuit is part of the Ford Trailer Tow module, it can only be implemented on vehicles with power locking and perimeter or CAT 1 alarms.

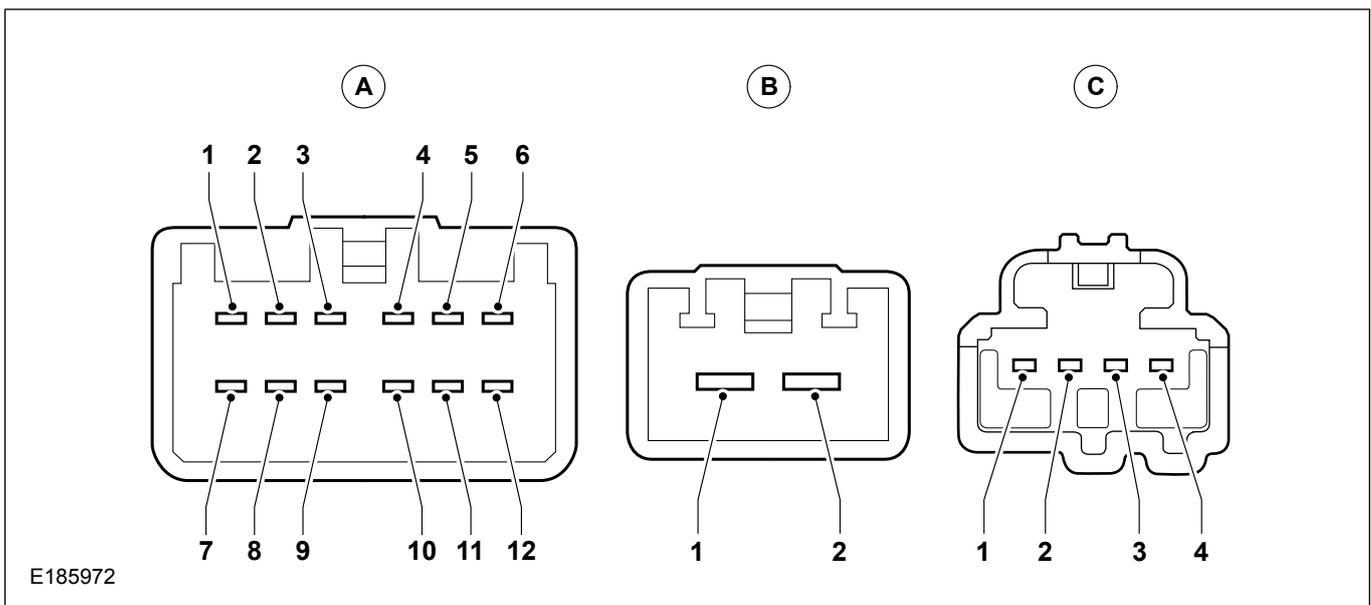
Each output driver could handle a current of 15A but it is not recommended to always run to this maximum. A higher current is interpreted as short circuit. If a short circuit is detected the related output will be switched off. The following table shows the recommended output maximums per circuit.

Trailer Tow Module Connectors (Figure E185972 and E145361)

Component Terminal Number	Feature	Current (A)		Voltage (V)	
		Min	Max	Min	Max
Connector A					
1	Left Turn Lamp	2.1	3.4	8	19.0
2	Right Turn Lamp	2.1	3.4	8	19.0
3	Position Lamp	5.3	8.6	8	19.0
4	Not used	-	-	-	-
5	Reverse Lamp	3.1	5.0	8	19.0
6	Battery Charge	13.0	15.0	8	16.0
7	Stop Lamp	3.1	11.0	8	19.0
8	Rear Fog Lamp	1.7	2.2	9.5	16.0
9	Not used	-	-	-	-
10	Not used	-	-	-	-
11	Not used	-	-	-	-
12	Not used	-	-	-	-
Connector B					
1	KL30	19.9	27.6	8	19
2	Battery Charge Feed KL30	12	12	8	16
Connector C					
1	Ground	0.5	0.5	8	19
2	MS CAN L	0.1	0.1	5	5
3	MS CAN H	0.1	0.1	5	5
4	Trailer Parameter Alarm	0.01	0.013	8	19

The electrical system on the vehicle is suitable for towing trailer with LED lights.

Trailer Tow Module Connectors



The TTM offers a battery charge output. This output is used for loading a trailer battery with a maximum parameter current of 10A. If the current exceeds 10A the output is switched off until the current drain goes below 10A. The voltage used to charge this battery is designed to maintain current charge up to 10A but not fully charge the battery or let it discharge. This voltage is approximately 13.5V. Full charge strategy should be performed separately.

The maximum total current is 30A of all circuits. If this is exceeded the battery charge output is switched off.

Summary:

- Max permanent current: 10A
- Switch on condition:
 - Power Mode > = Accessory_1
 - Total power consumption (all lamps + battery charge) < 30A
 - Permanent battery charge output current < = 10A
 - 9V < TTM power supply voltage < 16V
- Short circuit detection: 30A

If trailer tow system is to be added, the correct wiring and module needs to be ordered. The vehicle needs to have Central Car Configuration (CCC) programmed to the correct parameters:

CCC Parameter 20

- 0x1 without trailer tow
- 0x5 with trailer tow

NOTE: It is mandatory that a trailer is detected. Therefore at least one of the following lamps have to be connected in the **on mode** or in the **standby mode** (anti-theft mode): Stop right, Stop left, Position lamps or Direction indicator left.

If a trailer is detected the trailer detection hardware output (JP3-pin 5) is set low (open drain).

If a short circuit is detected or an overheating of the drivers occurs, the related output remains off until an ignition cycle is performed and the engine is restarted.

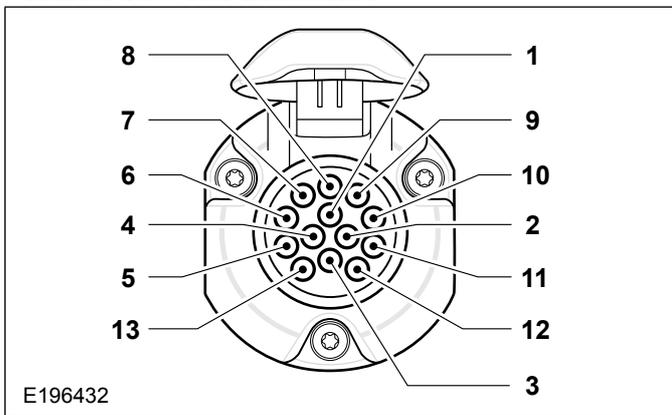
The trailer detection uses a strategy of having a 1K ohm resistor if the lights are not actually switched on to detect that the trailer has been connected. If a trailer light is already switched on the related current will be checked.

4.1.15 Trailer Tow Connectivity (EU)

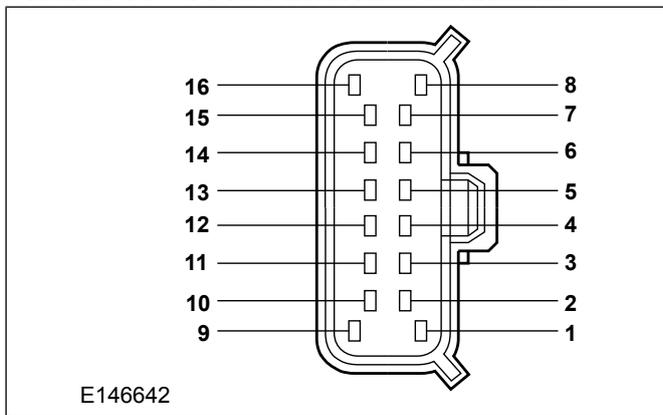
Trailer Tow Connectivity 13 Pin Socket

14406 Trailer Tow Connector		13 Pin Trailer Tow Connector	
Pin	Color	Pin	Description
3	Yellow	1	Left Turn Lamp
5	Gray/Orange	2	Fog
1	Black/Violet	3	Lamp Ground
6	Green	4	Right Turn Lamp
14	Brown	5	Right Position Lamp
12	Red	6	Stop Lamps
13	Brown	7	Left Position Lamp License Lamp
11	Gray/Brown	8	Reverse Lamp
9	Blue/Red	9	KL30 Power
10	Gray/Yellow	10	KL15 Ignition
8	Black/Violet	11	Ignition Ground KL15
Not Used	Not Used	12	Trailer Detect
16	Black/Violet	13	Power Ground

Trailer Tow 13 Pin Socket



Trailer Tow 14406 Interface Connector



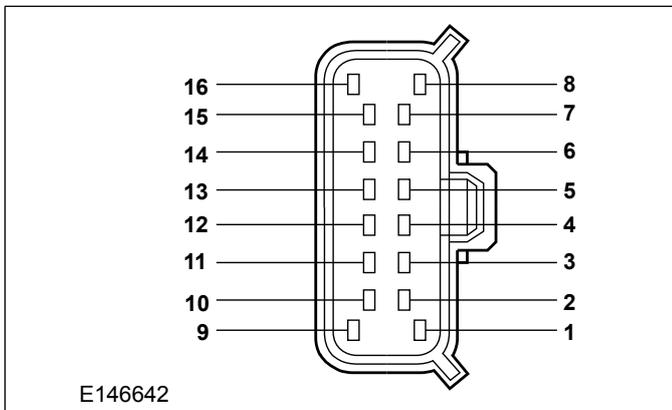
The Body Control Module does **not** support the incremental load of powering side marker lamps on a trailer, if these are required they should also be driven using separate relays.

4.1.16 Trailer Tow Connectivity (AUS and NZL)

Trailer Tow Connectivity 12 Pin Sockets

14406 Trailer Tow Connector		12 Pin Trailer Tow Connector - Australia and New Zealand	
Pin	Color	Pin	Description
3	Yellow	1	Left Turn Lamp
11	Black	2	Reverse
1	White	3	Lamp Ground
6	Green	4	Right Turn Lamp
Not Used	Blue	5	Electric Brakes
12	Red	6	Stop Lamps
13	Brown	7	Park Lamps
Not Used	Not Used	8	Not Used
9	Pink	9	KL30 Power
16	White	10	Ground
Not Used	Not Used	11	Not Used
Not Used	Not Used	12	Not Used

Trailer Tow 14406 Interface Connector



The Body Control Module does **not** support the incremental load of powering side marker lamps on a trailer, if these are required they should also be driven using separate relays.

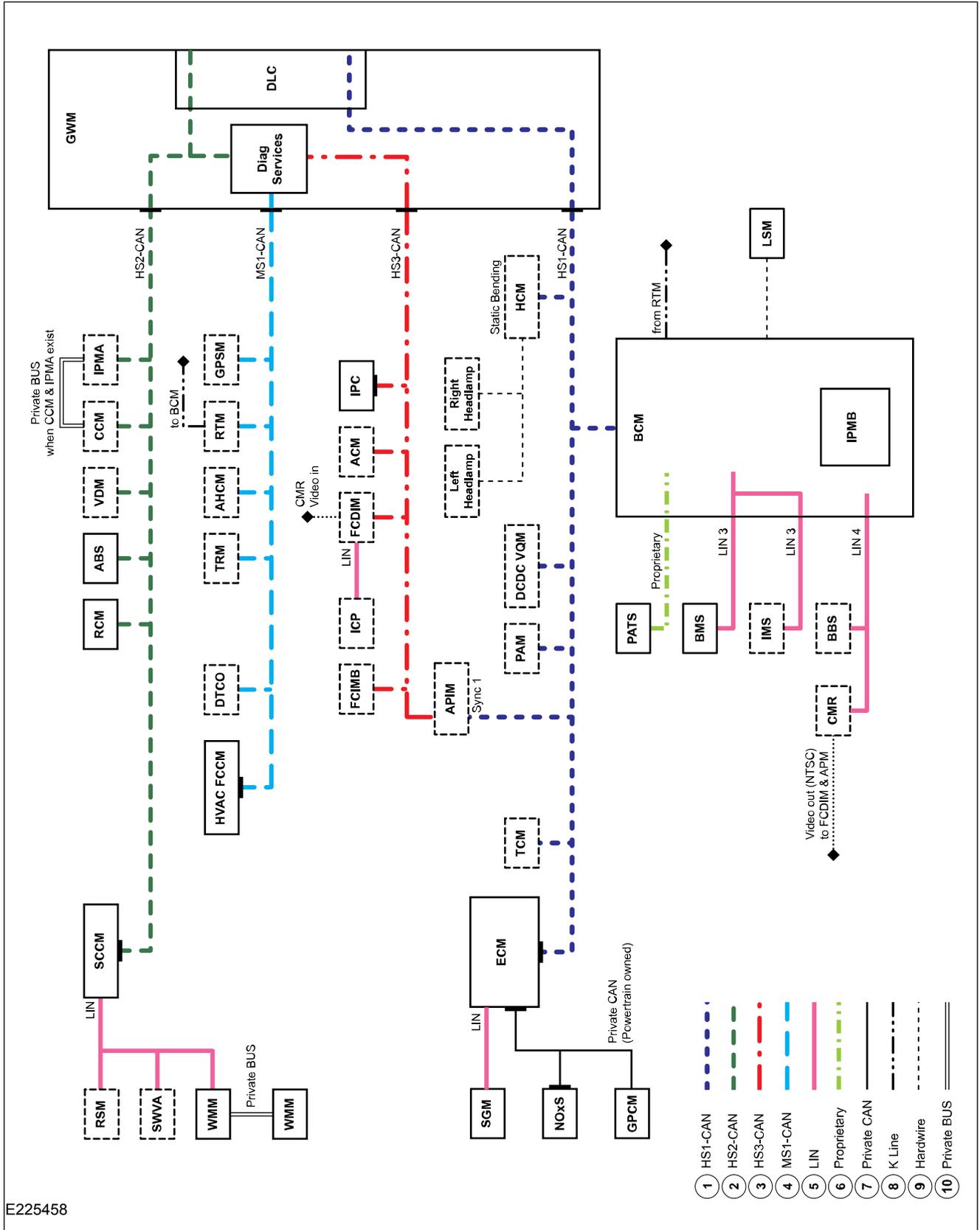
4.2 Communications Network

4.2.1 CAN-Bus System Description and Interface

⚠ WARNING: Do not tamper with, cut into or connect to any of the CAN-Bus interface wiring or connectors. The addition of unapproved CAN-Based modules could impact the safe operation of the vehicle.

CAN, Controller Area Network, uses propriety message sets to communicate between the devices shown, via Medium Speed (MS), High Speed (HS), Private and Public Buses. In addition there is localized application of Local Interconnect Network (LIN) and ISO 9141 K-line serial links.

CAN-Bus System



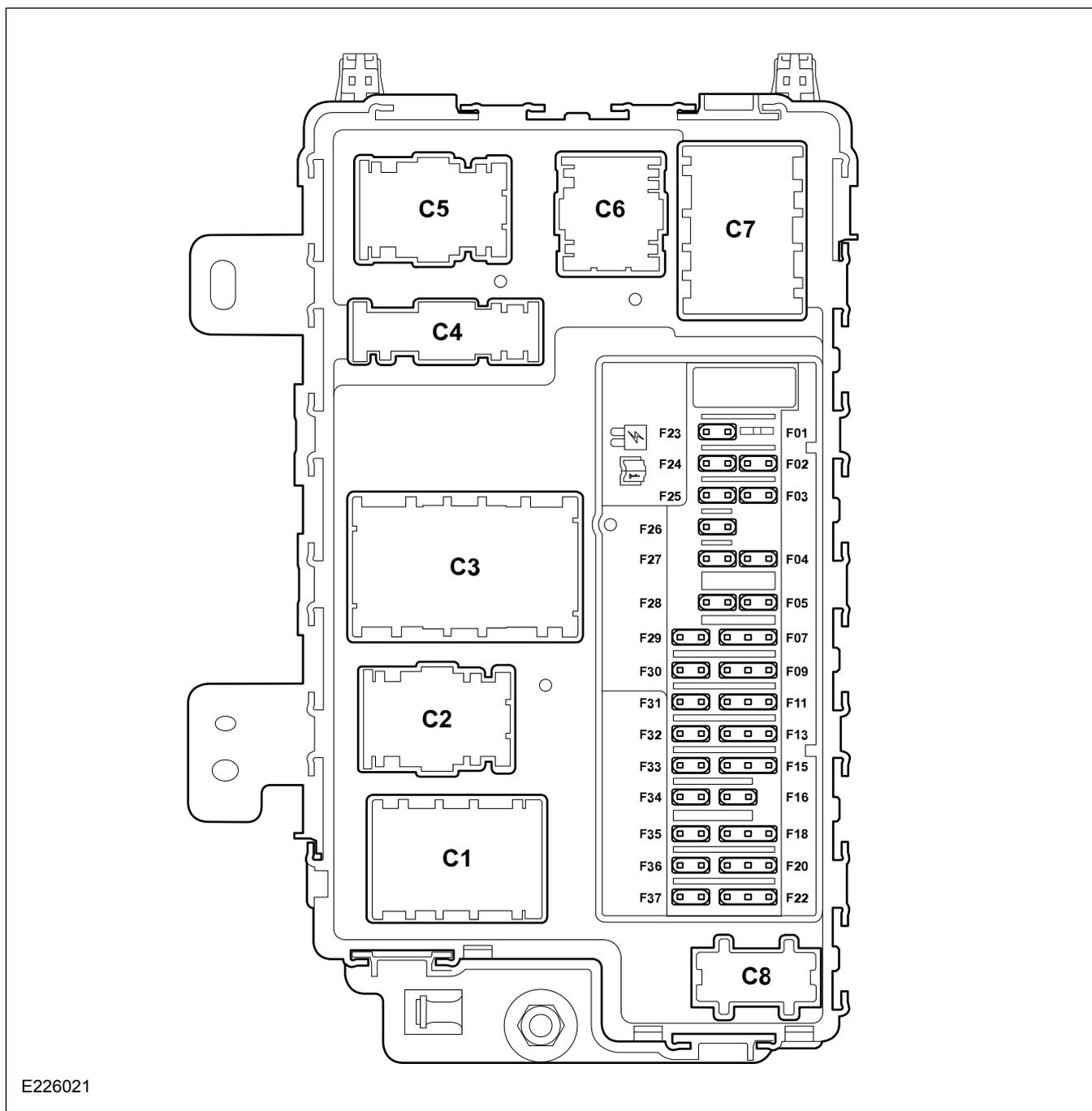
Communication Network System (Figure E225458 references)

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	HS1-CAN - High Speed 1 - CAN (500kb/s)	GPSM	Global Positioning System Monitor
2	HS2-CAN - High Speed 2 - CAN (500kb/s)	GWM	Gateway Module A (Smart Diag Link Connector)
3	HS3-CAN - High Speed 3 - CAN (500kb/s)	GPCM	Glow Plug Control Module
4	MS1-CAN -Medium Speed 1 - CAN (125kb/s)	HCM	Headlamp Control Module
5	Local Interconnect Connector (LIN)	HVAC-FCCM	HVAC Controls (was FCIM)
6	Proprietary	ICP	Integrated Control Panel
7	Private CAN	IMS	Interior Motion Sensor
8	K-Line	IPC	Instrument Panel Cluster
9	Hardwire	IPMA	Image processing Module A (Lane Departure System Camera)
10	Private BUS	IPMB	Image processing Module B (Part of BCM)
ABS	Anti-Lock Brake System Control Module	LSM	Light Switch Module
ACM	Audio Control Module - Radio Silver Box	NOxs	NOx Sensor
AHCM	Auxiliary Heater Control Module	PAM	Parking Aid Module
APIM G1	Sync Gen1	PATS	Passive Anti-Theft System
BBS	Battery Backed-up Sounder	RCM	Restraints Control Module
BCM	Body Control Module	RSM	Rain Sensing Module
BMS	Battery Monitoring Sensor	RTM	Radio Transceiver Module (RKE & TPMS Receiver)
CCM	Cruise Control Module (Adaptive)	SCCM	Steering Column Control Module (inc SAS)
CMR	Camera Module Rear	SGM	Alternator Regulator
DCDC-VQM	Voltage Quality Module	SWVA	Steering wheel Vibration Alert (IPMA Haptic Device)
DLC	Diagnostic Link Connector (Was OBD)	TCM	Transmission Control Module
DTCO	Tachograph	TRM	Trailer Module (Trailer Tow)
ECM	Engine Control Module	VDM	Vehicle Dynamics Module (Air Suspension)
FCIMB	Electronic Finisher Panel (Was EFP)	WMM	Wiper Motor Module (Master)
FCDIM	Front Control/Display Interface Module (MFD)	WMM	Wiper Motor Module (Slave)

kb/s - kilobits per second

4.2.2 Body Control Module (BCM)

BCM - as viewed in-car position



WARNINGS:

⚠ Unapproved and/or incorrect connection to any of the mating wiring can cause either the associated systems to shut down (overload protection), or permanent damage to the BCM itself.

⚠ Vehicle BCM configuration must NOT be modified once the vehicle has left a Ford production plant, except for any changes that may be carried out using dealership integrated diagnostic systems equipment.

The BCM is the prime control module in the vehicle's electrical architecture. It is responsible for management of most of the vehicle's lighting, locking and security systems.

BCM Output Information

Function	Component	Load Type	Max. Load	Overload Condition
Dipped Beam Left	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Dipped Beam Right	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Main Beam Left	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Main Beam Right	High Side Pulse Width Modulation	Bulb	55W	Output Shutdown
Daytime Running Light Left	High Side Pulse Width Modulation	Bulb	30W	Output Shutdown
Daytime Running Light Right	High Side Pulse Width Modulation	Bulb	30W	Output Shutdown
Position Lights Left Front	High Side Pulse Width Modulation	Bulb	10W	Output Shutdown
Position Lights Left Rear	High Side Pulse Width Modulation	Bulb	20W	Output Shutdown
Position Lights Right Front	High Side Pulse Width Modulation	Bulb	10W	Output Shutdown
Position Lights Right Rear	High Side Pulse Width Modulation	Bulb	20W	Output Shutdown
Front Fog Light Left	Relay Driver	Micro Relay	55W	Output Shutdown
Front Fog Light Right	Relay Driver	Micro Relay	55W	Output Shutdown
Turn Indicators Left Front	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Turn Indicators Left Rear	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Turn Indicators Right Front	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
Turn Indicators Right Rear	High Side Pulse Width Modulation	Bulb	27W	Output Shutdown
License Plate (& Marker Lights)	High Side Pulse Width Modulation	Bulb/LED	27W	Output Shutdown
Reverse Lights	High Side DC	Bulb + Micro Relay	42W + 250mA	Output Shutdown
Rear Fog Lights	High Side Pulse Width Modulation	Bulb	2 x 21W	Output Shutdown
Stop Light Left & Right	High Side Pulse Width Modulation	Bulb	2 x 21W	Output Shutdown
Center High Mounted Stop Light	High Side Pulse Width Modulation	Bulb	1 x 16W or LED string	Output Shutdown
Switch Illumination	High Side Pulse Width Modulation	LED	2A at 16V	Output Shutdown
Battery Saver Supply	High Side Driver	Bulb	105W	Output Shutdown
Front Cabin Lights Courtesy	High Side Pulse Width Modulation	Bulb	65W	Output Shutdown
Rear Cabin Lights Courtesy	High Side Pulse Width Modulation	Bulb + LED	65W	Output Shutdown
Vehicle Horn	High Side Relay Driver	Micro Relay	250mA	Output Shutdown
Alarm Siren	High Side Driver	Electro Mechanical Sounder	4A nominal, 8A for 10ms in-rush	Output Shutdown
Engine Run Status	High Side Relay Driver	Micro Relay	250mA	Output Shutdown
Lock/Double Lock Relays	Relay	Latch Motor	-	Fuse Blow ⁽¹⁾
Unlock Relays	Relay	Latch Motor	-	Fuse Blow ⁽¹⁾

Repeated overloading of circuits can result in output lock-out requiring dealer reset. Repeated dealer resets can result in permanent loss of a function.

⁽¹⁾ Increasing fuse rating above fitted may result in internal relay or PCB damage and render the BCM unusable.

BCM Fuse Overview

Fuse	Rating	Fuse Type	Function
F1	-	-	Not Used (Not Present)
F2	7.5A	Micro 2	Power Mirrors & Driver Window Switch
F3	20A	Micro 2	Locking - Unlock Driver & Passenger
F4	5A	Micro 2	Not Used (Spare)
F5	20A	Micro 2	Not Used (Spare)
F6	10A	Micro 3	Not Used (Spare)
F7	10A	Micro 3	Not Used (Spare)
F8	10A	Micro 3	Security Horn
F9	10A	Micro 3	Not Used (Spare)
F10	5A	Micro 3	Not Used (Spare)
F11	5A	Micro 3	Interior Motion Sensor & Rear AC
F12	7.5A	Micro 3	Climate Control & Hazard Switch
F13	7.5A	Micro 3	Steering Column, Cluster, OBDII Logic
F14	10A	Micro 3	Not Used (Spare)
F15	10A	Micro 2	OBDII Gateway Module
F16	15A	Micro 3	Locking - Unlock LH & RH Side Load Door
F17	5A	Micro 3	Battery Backed Sounder
F18	5A	Micro 3	Ignition Switch Supply
F19	7.5A	Micro 3	Passenger Airbag disable Indicator & Switch
F20	7.5A	Micro 3	Tachograph
F21	5A	Micro 3	PTC Heater
F22	5A	Micro 3	Not Used (Spare)
F23	10A	Micro 2	Delayed Accessory (Radio) & Power Inverter
F24	20A	Micro 2	Locking - Central Lock & Double Lock
F25	30A	Micro 2	Not Used (Spare)
F26	30A	Micro 2	Not Used (Spare)
F27	30A	Micro 2	Not Used (Spare)
F28	20A	Micro 2	Not Used (Spare)
F29	30A	Micro 2	Not Used (Spare)
F30	30A	Micro 2	Not Used (Spare)
F31	15A	Micro 2	Not Used (Spare)
F32	10A	Micro 2	GPS, Voice Control, Sync, Display, Adaptive Cruise Control, Remote Receiver
F33	20A	Micro 2	Radio Sync
F34	30A	Micro 2	Ignition Run/Start Relay Pre Fuse. (Parkaid, Heater Control, Lane Departure Warning Camera, Restraints, Central Control Panel, Passenger Airbag Off Indicator, Tachograph, PTC Heater, Steering Wheel Module)
F35	5A	Micro 2	Restraints
F36	15A	Micro 2	Park Aid, Lane Departure Warning Camera, Steering Wheel Module
F37	20A	Micro 2	Not Used (Spare)
F38	-	30A Circuit Breaker	Power Window Supply

4.3 Charging System

4.3.1 General Information and Specific Warnings

The Transit electrical system is a 12-Volt supply with a negative ground return. The factory fit alternator and battery equipment are designed for normal operations. The vehicle may have Standard Flooded, Enhanced Flooded or Absorbent Glass Mat (AGM) Batteries as factory fit. Higher capacity batteries are available as standard production options and special vehicle options offer AGM technology for heavy PTO and deep cycling applications. Before installing additional electrical equipment check that the battery capacity, technology type, harness load capability, and alternator output are suitable for the extra load.

Refer to: [4.4 Battery and Cables \(page 78\)](#).
'Power and Connectivity Usage Recommendations' table.

The battery capacity, technology and charge available from the alternator must be adequate to ensure engine cranking in unfavorable climatic conditions, even after fitment of additional electrical equipment.

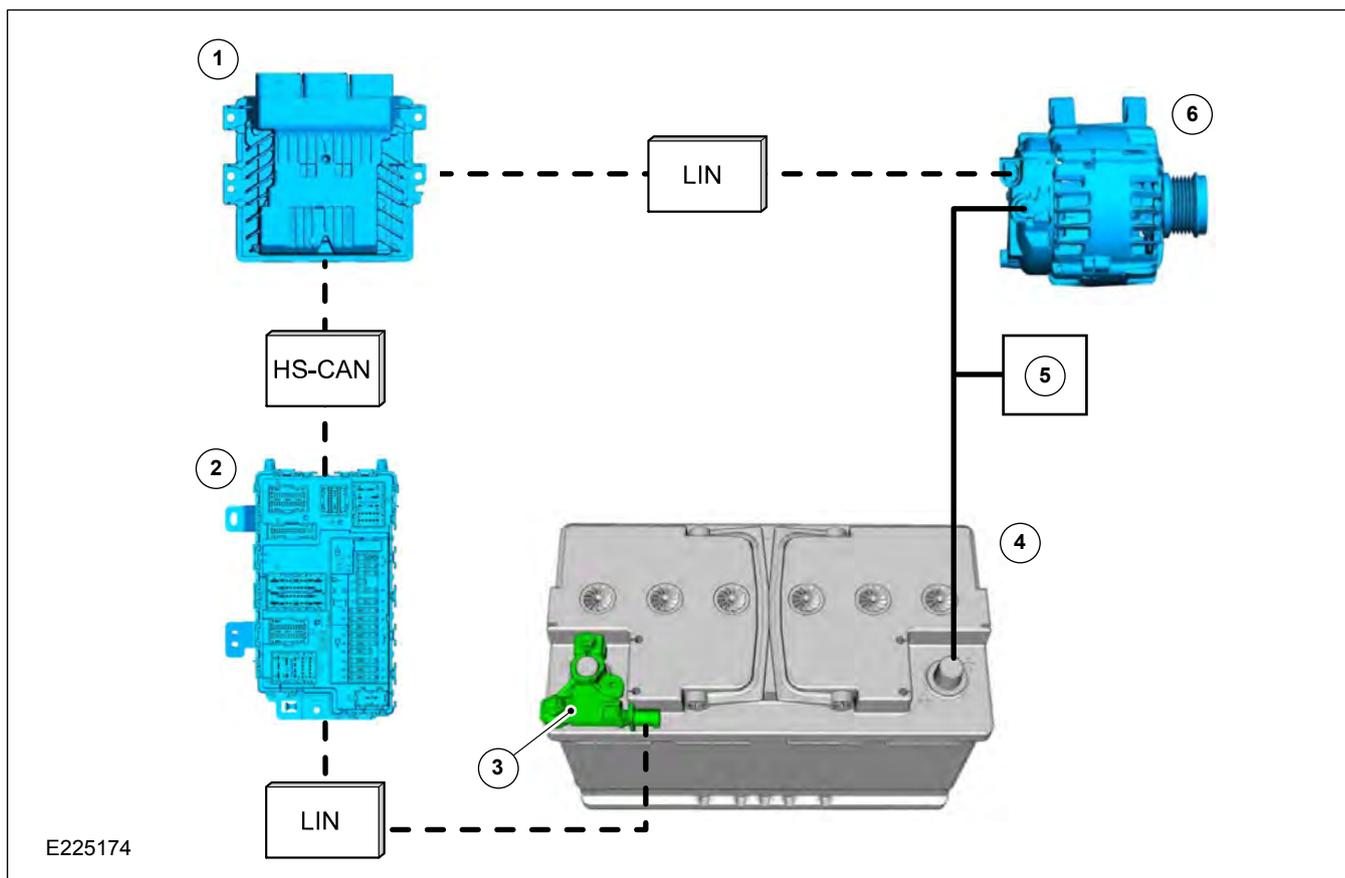
The Transit utilizes multiplexed vehicle electronics, it is recommended that the appropriate Ford proprietary accessory systems are used. Inappropriate or incorrect connection of additional equipment could cause misoperation, or damage to the vehicle, and so invalidate any warranty.

Additional connection points are provided specifically for customer use, and are located on the outside of the driver's seat pedestal. A 60Amp fused connection is provided as standard on Single Battery Vehicles. 3x 60Amp fused connections are provided for Twin Battery vehicles. A further connection is possible for higher current applications, see 'Battery and Cables' section for information.

Do not jump-start the vehicle directly from the battery. Use designated jump-start points. Refer to the Owner's Manual. The wiper motor bracket **must not be used as a ground** as it is isolated from the body.

4.3.2 System Operation and Component Description

System Diagram



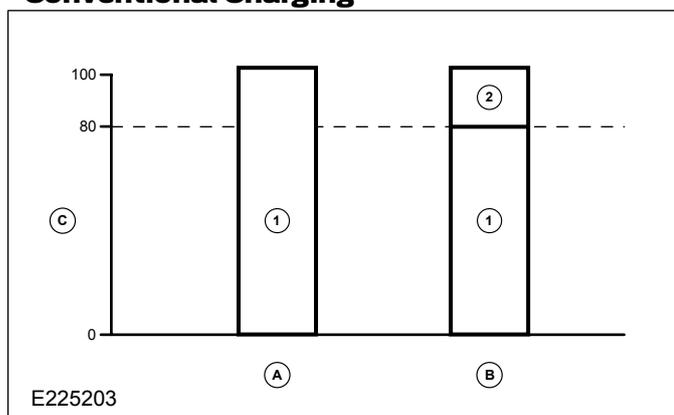
Item	Description
1	Power Control Module (PCM) or Engine Control Module (ECM)
2	Body Control Module (BCM)
3	Battery Monitoring Sensor (BMS) – Where fitted
4	Battery – Twin batteries are available as an upgrade or driven by specific features
5	Electrical consumers
6	Alternator

System Operation - Smart Regenerative Charging (SRC) Except Camper

Smart Regenerative Charging varies alternator output using information from the Battery Monitoring Sensor to reduce fuel consumption. Alternator output can be increased during deceleration to charge the battery without the use of additional fuel. Alternator output can also be decreased to reduce the load on the engine and therefore fuel used. During this condition the battery supports the electrical loads. This function can be turned off by the Start-Stop Switch or using the hardwire input as detailed later in this section of the manual.

By Comparison, Conventional Charging aims to charge the battery at a constant level which varies with battery temperature.

Smart Regenerative charging and Conventional Charging



Item	Description
A	Conventional Charging
B	Smart Regenerative Charging (SRC)
C	Battery Charge Level (%)
1	Minimum 13.5V
2	Minimum 12.2V

Summary of the Available Charging Modes

Charge Mode		Approximate Charging Voltages (Measured at Jump Start post)
SRC	Smart Regenerative Charging - normal charge mode.	Minimum 12.2 - Maximum 14.9
CC	Conventional Charging - applies a strong charging voltage until the battery is full and maintains alternator voltage above 13.5V unless battery temperature >40degC. The actual voltage at the battery will vary depending on the alternator load.	Minimum 13.5 - Maximum 14.9
SS	Start-Stop - there is a 5 second delay from when the CC/SS inhibitor is activated to when SS is inhibited.	Not Applicable

The voltages in the above table are approximate as the charging system is dynamic and can vary the voltage at any time.

For further information on Start-Stop

Refer to: [4.8 Electronic Engine Controls \(page 115\)](#).

2. Hardwire Input

The Hardwire Input can be accessed in three ways:

4.3.3 Start-Stop Override and Configurable Charging

There are two control methods to switch the power supply system to Conventional Charging. This may be required for converters requiring battery voltage that is being charged by the alternator in the range of 13.5 to 14.9 volts. Such applications include boost or supplemental battery charging, compensation for volt drop or high Ampere electrical loads whilst the engine is running. Both these methods also inhibit Start-Stop.

1. Start-Stop Switch - Manual Operation

The Start-Stop deactivation button also deactivates SRC when pressed (LED telltale is illuminated). When deactivated, and the vehicle is stationary, the engine will not shut down and the battery will be charged by the alternator with Conventional Charging.

- Pre-installed as part of a Camper Donor vehicle
- Pre-installed as part of the High Specification Vehicle Interface Connector (A608) and a link from the Hardwire Input to the chosen switch and ground point, but must not be a permanent ground. The grounding should only occur for a duration of the third party system needing a certain functionality and performance which can only be met by turning off the fuel save features of Smart Charging and Start-Stop. Grounding permanently might invalidate the emission and homologation of the vehicle and the vehicle could need to be re-homologated as part of the approval process by the converter. A mating 43 way connector with three meters of wiring (with all wires) is available as a kit (KTBK2V-14A411-D*) from your local Ford dealer. For information on High Specification Vehicle Interface Connector

Refer to: [4.19 Electrical Connectors and Connections \(page 147\)](#).

- As a kit to install to the standard 8 way Vehicle Interface Connector in the drivers seat pedestal, see 'Electrical Connectors and Connection' section.

Test Functionality: Start-Stop Inhibit - for vehicles with Start-Stop

1. Check Start-Stop functions as intended, refer to Owner's Manual for details.
2. While driving the vehicle, close the Hardware Input Switch, if safe to do so, and check that the Start-Stop no longer operates.
3. Open the Hardware Input switch and check Start-Stop functionality is restored.

Test Functionality: SRC Inhibit, Charging Mode Control

1. Ensure batteries have good charge. When charging, use the jump start point and engine bay ground point. Refer to the charging instructions in the Owner's Manual.
2. Measure voltage between jump start point and engine bay ground point with engine running and SRC inhibit switch open. Refer to the Roadside Emergencies section of the Owner's Manual.
3. With the engine running, close Hardwire Input Switch and measure voltage. The voltage should be in the ranges shown in the table 'Summary of the Available Charging Modes'.
4. Open the switch again and check voltage level returns to the original level measured in Step 2. SRC is active.

Note: There will be a delay between closing Hardwire Input Switch and change of voltage output. The voltage may depend on many factors including total electrical load, which loads are active, battery condition and others. The rate of charge between modes varies depending on which loads are active.

4.3.4 Power Management Settings

 **WARNING: The only method to return the vehicle to Transport mode is by using a Ford diagnostic service tool with the correct level of security clearance. The Ford dealer has the correct tools and level of security to do this if required.**

If the cluster displays 'Transport Mode' the vehicle may have reduced functionality. This mode is mainly to conserve battery life/warranty during pre-delivery.

To change mode, the brake pedal must be depressed five times, and the hazard warning switch operated twice (in any combination) within a 10 second period.

4.3.5 Electrical Conversions

 **WARNING: The fitting of voltage boosters or other devices to enhance alternator output are not allowed. The fitting of such devices will not only invalidate vehicle warranties, but could damage either or both, the alternator and Engine Management System/Power Control Module, and possibly affect vehicle legal compliance. Check local legislation.**

Operator requirements for additional and specialized electrical equipment varies. The vehicle converter/modifier must, therefore, consider the following points when designing the installation:

- Legality and regulatory conformity of the base vehicle
- Drive-ability and serviceability of the base vehicle
- The effect of regulations governing the proposed conversion including National Legislation in the country of sale
- The method of integrating the circuit into the base vehicle
- No additional circuits are to be run alongside the electrical circuits (shown in blue in figure E146305) associated with the Engine Management System (shown in green in figure E145305), due to the possible inductive or electrostatic coupling of electrical interference
- The base vehicle is equipped with either a single or twin battery system. It is important to also read relative information on Start-Stop and SRC.

Refer to: [4.4 Battery and Cables \(page 78\)](#).

- There is a Ford option that is recommended for third party take off. This will allow power at engine off and protect energy for cranking/starting and help maintain third party battery charge, see also Battery and Cables section

- When auxiliary electrical systems are added to the vehicle, it is recommended that the additional circuits are designed to be used with the Special Vehicle Option Auxiliary Fuse Panel to maintain the integrity of the electrical system.

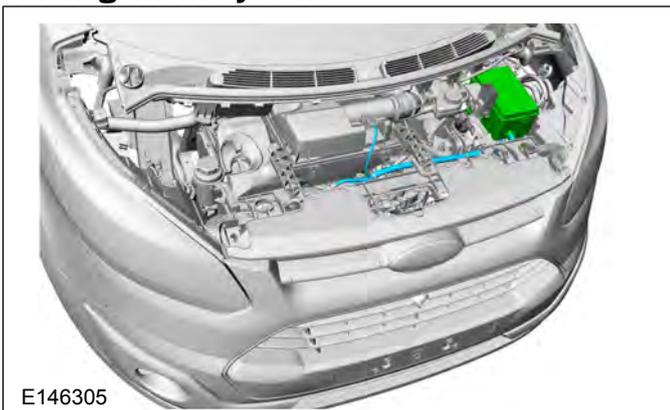
Refer to: 4.17 Fuses and Relays (page 139).

- The materials and installation must meet the quality standards described in this section
- Any additional equipment or components must be designed such that they have no adverse Electro Magnetic Compatibility - EMC effect on the vehicle
- The alternator and Engine Management System (EMS) — Also referred to as Powertrain Control Module (PCM) are interdependent
- The alternator is LIN controlled. It does not have a conventional D+ (engine start) signal line.

Refer to: 4.8 Electronic Engine Controls (page 115).

- Take special care with the routing of existing electrical harnesses within the vehicle to avoid damage when fitting additional equipment. Also see section concerning installation of equipment containing an electric motor

Electrical Circuits Associated with Management System



For additional third part ground and +12V power cable connections to the Ford system

Refer to: 4.4 Battery and Cables (page 78).

Camper vehicles: When fitting an additional battery, the auxiliary battery circuit. If high loads are to be supplied, exceeding the customer connection point supplies or high in general, especially at ignition off loads, an isolation switch disconnect relay should be fitted. This is to protect the vehicle start battery from a failed start. Suitable capacity in the wiring, fuses and alternator will be required. If unsure of which battery to interface with or what system requirements are needed, please contact your local dealer who can advise.

Refer to: 4.4 Battery and Cables (page 78).

NOTE: Before disconnecting the battery, check availability of radio key code.

NOTE: When auxiliary electrical systems are to be added to the vehicle it is mandatory that the additional circuit design includes the necessary fuses.

The Auxiliary Fuse Panel is recommended.

Refer to: 4.19 Electrical Connectors and Connections (page 147).

Safety

Increased use of comfort and safety electronics in modern motor vehicles also requires the greatest attention to be paid during body work. Over-voltages produced during welding and in alignment work during body shell rectification may cause electronic systems to be damaged. In particular, the safety instructions for performing welding / cutting work on vehicles with airbag systems must be adhered to. For additional information on welding

Refer to: 5.1 Body (page 177).

NOTE: After disconnecting the power supply and before performing further work, a wait time of up to 15 minutes must be maintained. Work on airbag systems may only be performed by persons who have a relevant certificate of competence.

Pay attention to the following points:

- Disconnect all the batteries, including ground and insulate the negative battery terminal(s)
- Disconnect the electrical connector at the airbag control module
- Disconnect the alternator multi-plug prior to using welding or cutting equipment
- If welding or cutting is to be performed directly near a control module, it must be removed before hand
- Never connect the negative cable of the welder near an airbag or a control module
- Connect the negative cable of the welder close to the location of the weld

4.3.6 Fitting Equipment Containing Electric Motors

⚠ WARNING: When electric motors are to be fitted, account must be taken of the potentially high in rush currents that a motor can draw.

⚠ CAUTION: The following must be observed:

- All motors must be driven via relays with contacts rated at least 3 times the maximum rated current of the motor
- All motor supply circuits must be individually fused with the proper fuse rating for the motor
- All power wiring must be rated for at least 3 times the rating of the motor and installed as far away as possible from any existing vehicle wiring
- All motors fitted should be fully suppressed to European or applicable local Legislation relating to Electromagnetic Compatibility to ensure electrical interference does not affect the vehicle systems
- Add EMC emissions statement to CE approval

4.3.7 Vehicle Electrical Capacity — Alternator

 **WARNING: Do not cut into the alternator wires. The alternator is LIN controlled. It does not have a conventional D+ (engine start) signal line.**

4.3.8 Charge Balance Guidelines

The base vehicle is fitted with a 150A alternator. It is recommended to conduct a charge balance calculation in case the conversion comprises a high number of electrical consumers or high electrical consumption is expected.

4.3.9 Circuit Diagrams

For circuit diagrams for Auxiliary Fuse Panel connections and standard Ford relays.

Refer to: [4.19 Electrical Connectors and Connections \(page 147\)](#).

Refer to: [4.17 Fuses and Relays \(page 139\)](#).

Full vehicle wiring and circuit diagrams are in the Ford Workshop Manual.

NOTE: 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

4.4 Battery and Cables

4.4.1 Power and Connectivity Usage Recommendations

WARNINGS:

 **It is important that the battery box lid, on vehicles fitted with H7 batteries or the battery cover and battery positive terminal cover, on vehicles fitted with an H8 battery, must be replaced after any conversions to the battery positive terminal. If the battery lid/cover is missing or damaged, a replacement part must be ordered and fitted. It is recommended to check fitment as part of a quality control process. See figure E278335 in the Battery Monitor Sensor (BMS) later in this section of the BEMM.**

 **Vehicles with Single or Twin batteries should always fit battery guards if engine off power is required. Ford recommend (A540).**

NOTE: Use AGM Batteries for deep cycle applications i.e. charge and discharge on a regular basis.

NOTE: When considering battery discharge, the converter needs to consider the current drawn when the added system is in operation, plus any continuous key off loads even when not in use. For example, an inverter fitted will consume power even with no load connected.

NOTE: Where possible, engine run operation of electrical equipment reduces battery discharge; both Vehicle Start and Auxiliary Batteries are utilized in conjunction with the charging system.

NOTE: User training and appropriate battery maintenance on a regular basis will assist in ensuring correct battery operation.

Engine State	Power Usage	Recommended Specification (order code in brackets)
Engine OFF Loads	LOW CONTINUOUS POWER TAKE OFF - Up to additional 5mA at Key OFF, for example: KL30 fed small current peripheral chargers.	Donor Vehicle Battery(s)
	MID CONTINUOUS POWER TAKE OFF - Between 5mA and 30mA at Key OFF, for example: Trackers (with sleep function, no GPS), Control Gear, KL30 fed medium current peripheral chargers.	Twin Batteries of same type (only standard on certain applications)
	HIGH CONTINUOUS POWER TAKE OFF - Between 30mA and 180mA at Key OFF, for example: Trackers with GPS, Control Gear, KL30 fed high current peripheral chargers OR vehicles with multiple/extended activations of interior lighting, cycle locks and rear door ajar events. DO NOT EXCEED 180mA.	2 High Performance Deep Cycle AGM batteries (HFQ)
	OCCASIONAL SHORT TERM HIGH POWER TAKE OFF - 40-240A at Key OFF, for example: Cranes, Tippers, Tail Lifts, 230V Inverters, Ambulances.	2 High Performance Deep Cycle AGM batteries (HFQ) + Ford Programmable Battery Guard -max 175A (A540). Additional batteries maybe required, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section.
Engine RUN Loads	LOW CONTINUOUS POWER TAKE OFF - Up to 30A, for example: Maintenance Van with water heater and additional lighting but no further systems.	Donor Vehicle Alternator
	HIGH CONTINUOUS POWER TAKE OFF - 30A - 240A, for example: Ambulance, High Load Maintenance Vehicle, Refrigeration. DO NOT ALLOW BATTERY DISCHARGE AND DO NOT ALLOW SYSTEM TO DROP BELOW 13V, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section.	Up rated 240A Extra Heavy Duty Alternator AND/OR RPM Speed Control (A003) to improve Alternator Output at idle if required. For further information see Battery Configuration, Additional Loads, Start-Stop and SRC in this section and Charging Systems to configure charge mode.
	Power Take Off applications which require elevated idle engine speeds, for example: Mobile Tire Filter Van, Welders Vehicle, Mechanical PTO from engine.	RPM Speed Control (A003)
	For application where the Customer Loads requirement exceed HIGH CONTINUOUS POWER TAKE OFF, for example: total Ford and Converter loads exceed the highest available Ford alternator rating	High Power Pack Option (A550) and Supplemental Batteries and Supplemental Energy Source pending charge balance calculation, see Battery and Cables section

NOTE: If with or without extra third party loads on the vehicle, requires door ajar at engine off for long durations and repetitive locking, it is recommended to specify the twin AGM battery upgrade. Failure to select this option may lead to immediate deactivation of the cargo lighting, power sockets, deep cycling of a standard battery technology and a failed start.

NOTE: The Ford Programmable Battery Guard (A540) can be stand alone or bought within the HIGH Power Converter Pack (A550). The system is an Intelligent PATENTED battery guard for Power Take Off requirements that has features including preserving enough energy to crank even with engine off power requirements, charge the entire battery system from a mains charger, charge third party batteries from engine run, preserve leisure batteries from too many crank cycles and helps maximize fuel save, reducing emissions, charging requirements by efficiently disconnecting third party loads that are not required. There are further features to warn from disconnect and override controls. Full details of the system can be found in this Battery and Cables section.

Connectivity Usage	Recommended Specification (order code in brackets)
Additional fused relay outputs. For example: Service Engineers Van.	Auxiliary Fuse Panel (A526) option includes 3 Customer Connection Points (3 x 60A Fuses).
Roof Beacons/Additional switches. For example: Highway Maintenance Vehicles.	Beacon Preparation Pack (A606)/Utility Vehicle Switch Pack (A607) ⁽¹⁾ Note: includes Auxiliary Fuse Panel (A526)
Conversions using various vehicle signals are required, such as indicators, stop lamp, door ajar, handbrake on. For example: Police Vehicles and Ambulances.	High Specification Vehicle Interface Connector (A608) ⁽¹⁾ Note: includes Auxiliary Fuse Panel (A526).

⁽¹⁾ Utility Vehicle Switch Pack (A607) and High Specification Interface Connector (A608) cannot be ordered together.

4.4.2 High Current Supply and Ground Connections

WARNINGS:

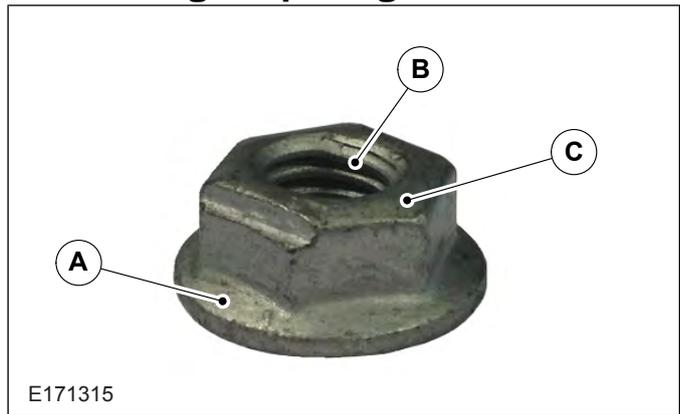
⚠ A self-locking crimp hexagonal nut MUST be used for high current terminal stud connections, for battery positive and negative or chassis ground. Do not use locking, split washers or nylon lock type nuts.

⚠ It is recommended to only use one eyelet per stud for high current applications. If more than one eyelet per stud is unavoidable, the highest current eyelet feed should be connected closest to the supply terminal. Do not exceed two eyelets or crimp terminals per stud connection.

For additional information

Refer to: [4.19 Electrical Connectors and Connections \(page 147\)](#).
Customer Connection Points.

Self-Locking Crimp Hexagonal Nut



Item	Description
A	Large flange for maximum surface area current flow and large clamp force area.
B	Crimp / locking feature is obtained by deformed female thread only
C	Finish must be a low resistance material which complies with the Restricted Substance Management Standards (RSMS).

4.4.3 Battery Information

WARNINGS:

⚠ For electrical power take-off that requires deep discharge and cycling from third party systems, High Performance Deep Cycle AGM batteries (HFQ) must be ordered on the base vehicle, for more information refer to 'Power and Connectivity Usage Recommendations' table later in the section. If option HFQ is not on the base vehicle they can be fitted by your local Ford Dealer. See table in Single and Twin Batteries Section.

⚠ Take necessary safety precautions when handling batteries, for example: protective clothing, eye and hand protection.

⚠ Ensure batteries are charged in a designated charging area that is correctly ventilated.

⚠ Vehicles with Start-Stop require an AGM battery. You must replace the battery with one of exactly the same specification and technology.

⚠ Make sure that the battery box is correctly sealed including any additional cables routing in and out of the box. After conversion, always check that the drain tubes have not been dislodged.

NOTE: If a converter intends to add systems or accessories that will add load at key off or engine run, then twin batteries should be specified in particular AGM battery type. There are also alternator upgrades and other options that are required for Power Take Off requirements. Refer to the table "Power and Connectivity Usage Recommendations" in this section of the BEMM for your vehicle. Heavy Power Take Off may inhibit Start-Stop but only for the duration of the third party load. This is normal functionality.

In order to protect the battery system from direct ground shorts or continuous high current loads, a 470A main fuse is fitted in the Pre Fuse Box under the driver's seat. Converter fit peripherals must not use this fuse as its sole purpose is protection of the starting and charging system.

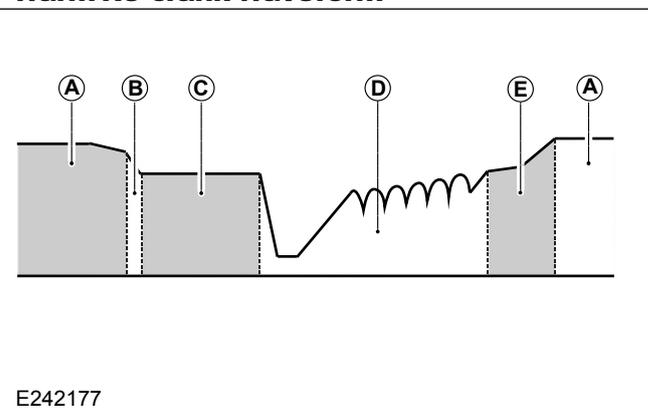
This fuse is not repairable — Use only a Ford replacement part.

Following battery disconnection, there is no need to reprogram the vehicle. It retains its 'normal' power management settings and configurations. However, the central locking latches may cycle if one of these was opened manually in the intervening period. With regard to the radio, all of the settings are retained.

There is no longer a need to re-program the electronic security code, as it is tied into the VIN of the factory fit Transit system. The clock initializes to 1200 and will need to be reset to correct time in accordance with the customer handbook procedure. After reconnecting, the Battery Monitoring Sensor (BMS) requires at least three hours quiescent period to re-calibrate to the correct battery state of charge, see also BMS information later in this section.

During a system warm re-crank the battery voltage will drop as low as 7V for 100ms. Followed by a period of voltage ripple providing an output to bring the voltage back to 12.3V. This can be up to 5 seconds. All third party fit modules must be robust to handle warm re-cranking waveform.

Warm Re-crank Waveform



E242177

Item	Description
A	Engine On
B	Fuel Cut Off
C	Engine Off (auto-stopped)
D	Engine Crank
E	Engine On (alternator ramping up)

For third party converter loads, required at engine off, it is recommended to install either the Ford Programmable Battery Guard (option A540) or a third party low voltage protection system. This is to protect the Ford Power supply from discharge and a failed engine start.

Where a Battery Guard or equipment with low voltage disconnect is fitted, the following applies:

- For standard single or twin flooded batteries, the open circuit voltage should not be set below 12V
- For AGM technology, single or twin configuration, the open circuit voltage should not be set below 11.8V
- If the system is under load, a voltage drop will occur. For example, at 20A continuous load, the approximate voltage drop is 0.3V. Therefore the Battery Guard on or below this load could be set to 11.7V for standard flooded or 11.5V for AGM technology
- If continuous battery cycling is required (power at engine off), then AGM is recommended. See also 'Power and Connectivity usage recommendations' tabs earlier in this section
- When setting the Battery Guard set point for a particular battery configuration, it is recommended to test that the vehicle will still start, factoring in low temperatures and an aged battery
- Equipment and the Battery Guard should also function and not disconnect above 15.3V as this is the normal voltage upper limit of the power supply. The guard is recommended to disconnect at around 16V as this is seen as the normal upper limit operating voltage. DCDC or voltage regulators may be required to protect sensitive third party equipment

- Third party equipment should not be damaged at 24V for upto 1 minute to protect for accidental connection of a second battery in series for jump start
- Low and high voltage transients will be experienced from cranking and load dump. Equipment is recommended to be robust against these voltages such as functionality preserved and no damage to the system

Any peripherals added to the power supply must be connected via the Customer Connection Points, from dedicated fuses such as the Auxiliary Fuse Panel (A526), the High Specification Interface Connector (A608) or the Ford Programmable Battery Guard (A540). For loads greater than 180A, see 'Third Party +12V Power Take Off for Loads Exceeding 180 Amps' in this section of the BEMM.

Where twin batteries are required on vehicles with a single battery installation, associated wiring and hardware should be fitted and aligned to Ford architecture. The extra battery must be of the same technology and performance rating as the existing battery. Alternatively both batteries can be upgraded to the High Performance Deep Cycle AGM batteries (HFQ).

If the battery type on a vehicle is changed to other compatible derivatives (see battery configuration table) it is required to reconfigure the vehicle to the new battery types from the dealer.

For special conversions requiring a third party battery, a further disconnect switch is recommended. This should be controlled via the engine run signal to a normally open relay. A schematic of this architecture can be found later in this section.

Refer to: [4.8 Electronic Engine Controls \(page 115\)](#). and

Refer to: [4.3 Charging System \(page 72\)](#).

Battery Voltage Requirements and Testing

As part of the Converter process and to maximize battery life and prevent premature failure of the Ford Batteries, the converter should protect and prevent battery discharge during any conversion or whilst the vehicle is in storage. This may include, leaving the vehicle in 'Transport' mode as long as possible, reducing the amount of crank cycling around the facility, door ajar events and duration. It is recommended to check voltage when receiving and before shipping. Recharge with an appropriate proprietary battery charger if the vehicle battery voltage is below 12.4V for standard and enhanced flooded or 12.3V for AGM. Measure connected to the vehicle at ignition off and no loads active including interior or exterior lights in OFF status.

All voltages are to be measured with an accuracy of: $\pm 5\%$ of values published using calibrated meters. Measure the voltage by using the Customer Connection Point (CCP) or the battery plus terminal for positive connection and battery ground or battery minus terminal for negative connection.

Surface Charge Dissipation

Prior to carrying out manual voltage checks, it is necessary to establish that the battery does not have any damage and the battery voltage is stable and free from surface charge which occurs after engine run.

To ensure surface charge is not present measure the battery voltage after the vehicle has been standing, with the ignition off and no loads active, for a prolonged period of 24 hours. If this is not possible an estimate can be made using the following method:

1. To dissipate whatever surface charge is present in the battery turn on the head lamps (main beam) for 5 seconds or turn on the parking lamps for 15 seconds if the head lamps will not turn on with the key in the off position.
2. Turn off the lights and allow the key off loads to reach their steady value. This typically takes 10 - 15 minutes.

Delayed Vehicles

Vehicles held at the vehicle converter premises and not in use for longer than 7 days, should have the battery's negative cable disconnected. Before shipping to the customer, the battery negative cable must be re-connected and the voltage re-checked. A complete recharge is required for battery voltage below 12.4V for standard and enhanced flooded or 12.3V for AGM or for no-crank vehicles by using an appropriate charger.

For additional information

Refer to: [1.13 Vehicle Transportation Aids and Vehicle Storage \(page 24\)](#).

Usage of Electrical Loads during Conversion

If electric loads are used during conversion, for example multiple crank cycles or door ajar, check the battery voltage more frequently than every 7 days and recharge the battery if necessary.

For additional information

Refer to: [1.13 Vehicle Transportation Aids and Vehicle Storage \(page 24\)](#).

Battery Charging Procedure

⚠ WARNING: Do not connect to any Ground or +12 volt potential points other than that specified in the Owner's Manual. There is a dedicated charge point under the hood. Failure to comply may lead to high current paths that may damage peripherals and ECU's especially in a jump start condition.

1. Cold batteries will not readily accept a charge. Therefore, batteries should be allowed to warm up to at least 5°C (41°F) before charging. This may require four to eight hours at room temperature depending on the initial temperature and battery size.
2. A battery which has been completely discharged may be slow to accept a charge initially, and in some cases may not accept a charge at the normal charger setting. When batteries are in this condition, charging can be started by use of the dead battery switch or boost charge on chargers that have this facility.

3. To determine whether a battery is accepting a charge, follow the manufacturers instructions for the charger, for use of the dead battery/boost charge mode.

Battery Cable Fixing Torque

The battery cables should be fixed to the terminal post with a torque of 8.0Nm ± 1.2Nm for battery +v/-v connection with/without BMS. For additional information see BMS later in this section.

Battery Options

Any additional or different batteries must be checked for correct functionality on a Start-Stop or Smart Regenerative Charging (SRC) vehicle.

Refer to: [4.8 Electronic Engine Controls \(page 115\)](#). Start-Stop and SRC

Refer to: [4.3 Charging System \(page 72\)](#).

NOTE: If wrong batteries or incorrect configuration, Start-Stop or SRC may not function correctly.

Battery Part Numbers and Usage

Battery Part Number	Type	Quantity	Size
Single Battery FWD (without Start-Stop) ⁽¹⁾			
GK2T-10655-D*	750 CCA (80Ah @20 hour rate) Standard Flooded Battery	1	H7
Single Battery FWD (without Start-Stop) ⁽²⁾			
GK2T-10655-E*	710 CCA (75Ah @20 hour rate) Enhanced Flooded Battery	1	H7
Single Battery FWD (with Start-Stop)			
DV6T-10655-B*	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	1	H7
Twin Battery (without Start-Stop) ⁽¹⁾			
GK2T-10655-D*	750 CCA (80Ah @20 hour rate) Standard Flooded Battery	2	H7
Twin Battery (without Start-Stop) ⁽²⁾			
GK2T-10655-E*	710 CCA (75Ah @20 hour rate) Enhanced Flooded Battery	2	H7
Twin Battery (with Start-Stop)			
DV6T-10655-B*	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	2	H7
High Performance Deep Cycle AGM Batteries (HFQ)			
DV6T-10655-B*	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	2	H7

⁽¹⁾ 2 year warranty territories, ⁽²⁾ 3 year warranty territories

4.4.4 Battery Rules

- Batteries in parallel must be of the same type and capacity and listed in the Ford battery table
- Third party batteries and loads are to be isolated from the standard Ford system at key off
- For external charging of batteries ensure that the maximum voltage of 15.2V is not exceeded. Normal proprietary charging equipment should operate below this voltage

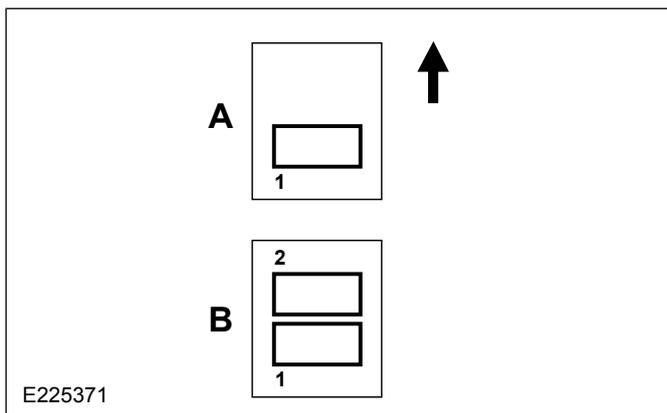
NOTE: Charge balance calculations are required when adding additional systems taking into account alternator size and battery capacity.

Important Factors for Battery Choice

- Battery specification capability in ampere hours for continuously loading until empty. For example an 80Ah fully charged battery can supply 4 Ampere over a 20 hour period at 20 degrees centigrade until it is fully discharged.
- The Cold Crank Ampere (CCA) rating is the maximum rating for cold start requirements.
- For deep cycling and micro cycling requirements (engine off loads) the deep cycle battery system (HFQ) is recommended.

Extra batteries added to the power supply should be connected as shown at the end of this section.

4.4.5 Battery Configurations (always in the drivers seat pedestal)



Item	Description
1	Main Battery
2	Auxiliary Battery
A	Single Battery System
B	Twin Battery System
Arrow	Front of vehicle direction

4.4.6 Battery Configuration, Additional Loads, Start-Stop and Smart Regenerative Charging (SRC)

Start-Stop and SRC will operate within specification only if a correct battery configuration is installed in the vehicle.

NOTE: The following battery configurations are NOT compatible with Start-Stop and SRC:

- Mixed battery types - for example: 1 x AGM and 1 x Flooded.
- Mixed sizes.
- Battery types other than those listed in the Battery Part Number and Usage table.
- Extra batteries than factory fit - for example: 3 or more, if not isolated from existing power supply at Key off.
- If twin Ford battery configured only fitting single Ford battery.
- If single Ford battery configured, fitting twin Ford battery.

Start-Stop and SRC system functionality cannot be guaranteed with these configurations. If such a battery configuration is required, it is recommended not to equip the vehicle with Start-Stop in the factory so the vehicle should be originally ordered without. It will not be possible to decommission the Start-Stop and SRC features due to Homologation, Vehicle Tax and Excise Requirements.

If the battery type on a vehicle with Start-Stop or SRC is changed to other compatible derivatives (see battery configuration table) it is required to reconfigure the vehicle to the new battery types from the dealer.

The feature content of the vehicle must still remain an Start-Stop or SRC vehicle to be in line with the Homologation, Vehicle Tax and Excise Requirements.

Convert Fit Additional Third Party Batteries

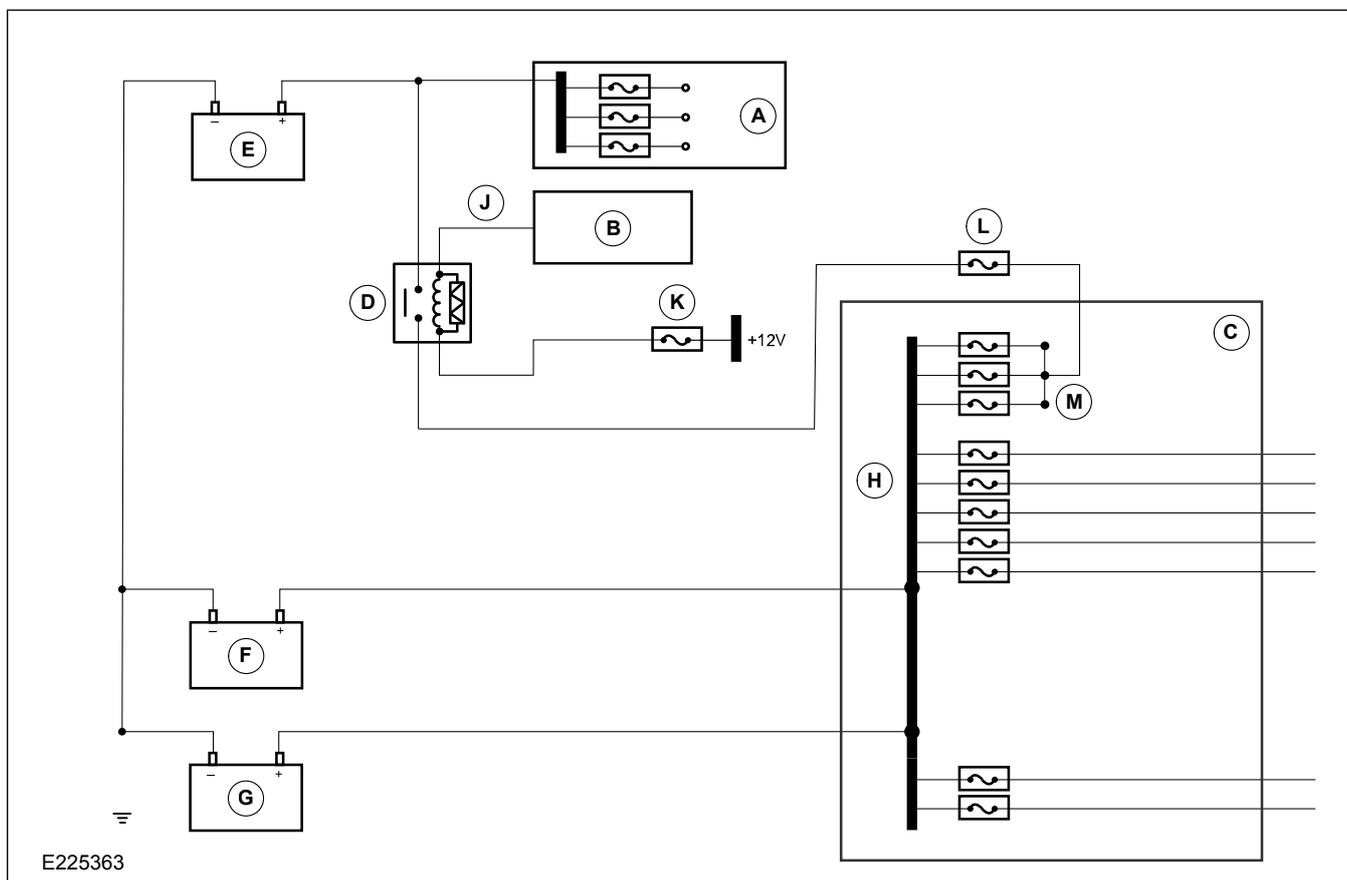
If additional batteries are added, a disconnect relay or main manual switch system is advised to isolate the converter fit battery from the Ford fit batteries. It is recommended to only connect the third party battery to Ford fit batteries and alternator at engine Run. The third party battery should be connected to the auxiliary battery side of the system via the customer connection points or the Ford Programmable Battery Guard (A540) for the +12V supply. If the third party battery and added system requirements exceed 180A of current, connection to the battery positive 6mm stud is permissible, as detailed in the 'Third Party +12V Power Take Off for Loads Exceeding 180A' section of this manual. This ensures the vehicle start battery is untouched. If supplemental chargers are added for the third party converter fit battery, direct connection of such chargers to this battery is required. Connection to the auxiliary battery also reduces the number of crank micro cycling that a third party battery will be exposed to on a Start-Stop variant. This is because the starter motor in an auto start condition, only uses energy from the vehicle start battery, the rest of the power supply is isolated until the engine is running. Gel batteries in particular are vulnerable to multiple starter cycles, see next figure E225363 for an example of converter fit third party battery installation to existing Ford power supply architecture.

The Charge can also be applied to the Ford fit batteries, all relays/switches connected, but only for an emergency charge.

When changing from an incompatible battery configuration to a compatible system, Start-Stop and SRC functionality will take some time (ignition off overnight and multiple ignition run cycles) to re-establish full functionality.

Refer to: 4.3 Charging System (page 72).
System Operation

Convert Fit Third Party Battery Installation to Existing Ford Power Supply Architecture (Example Only)



ITEM	DESCRIPTION
A	Converter Fit — Loads
B	Body Control Module — Provides Engine State
C	Pre Fuse Box — Drivers Seat Pedestal
D	Converter Fit — Normally open Third Party Battery Control Relay
E	Converter Fit — Third Party Battery
F	Ford Fit — Auxiliary Battery
G	Ford Fit — Vehicle Start Battery
H	Ford Fit — Loads (from Auxiliary Battery)
J	Switched Ground Engine Run Signal (250mA)
K	Converter Fit — +12V Fused KL30 Supply
L	Converter Fit Power Supply Fuse
M	Customer Connection Points - 60A standard, 180A with any SVO Fuse Box option (including A526)

Converter fit power supply fuse may not be required if custom connection points are the correct value.

See also similar solution which offers a relay and power off from the Ford Battery system as well as third party battery protection with the Ford Programmable Battery Guard later in this section.

Third Party +12V Power Take Off for Loads Exceeding 180 Amps

WARNING: It is important that the battery box lid, on vehicles fitted with H7 batteries or the battery cover and battery positive terminal cover, on vehicles fitted with an H8 battery, must be replaced after any conversions to the battery positive terminal. If the battery lid/cover is missing or damaged, a replacement part must be ordered and fitted. It is recommended to check fitment as part of a quality control process. See figure E278335 in the Battery Monitor Sensor (BMS) later in this section of the BEMM.

Third party +12V power take off connectivity should be made to the Customer Connection Points (CCP) where possible. In the event of greater than 180A current power requirements but less than 250A peak loading (maximum fuse value third party installed), connecting to the rear battery +12V clamp, 6mm stud, is permitted.

The following fusing principles must apply:

- If for a long duration (greater than one hour continuous), the fuse must be no higher rating than the alternator fitted to the vehicle. For example: vehicles fitted with a 150A alternator, a maximum 150A fuse can be fitted, vehicles fitted with a 210A alternator, a maximum 210A fuse can be fitted. Conversion example: 2 kW Inverter installation.
- For short term loads such as one minute peak loads, a 250A fused cable can be installed. Conversion examples: Crane, Tipper, Tail-Lift.

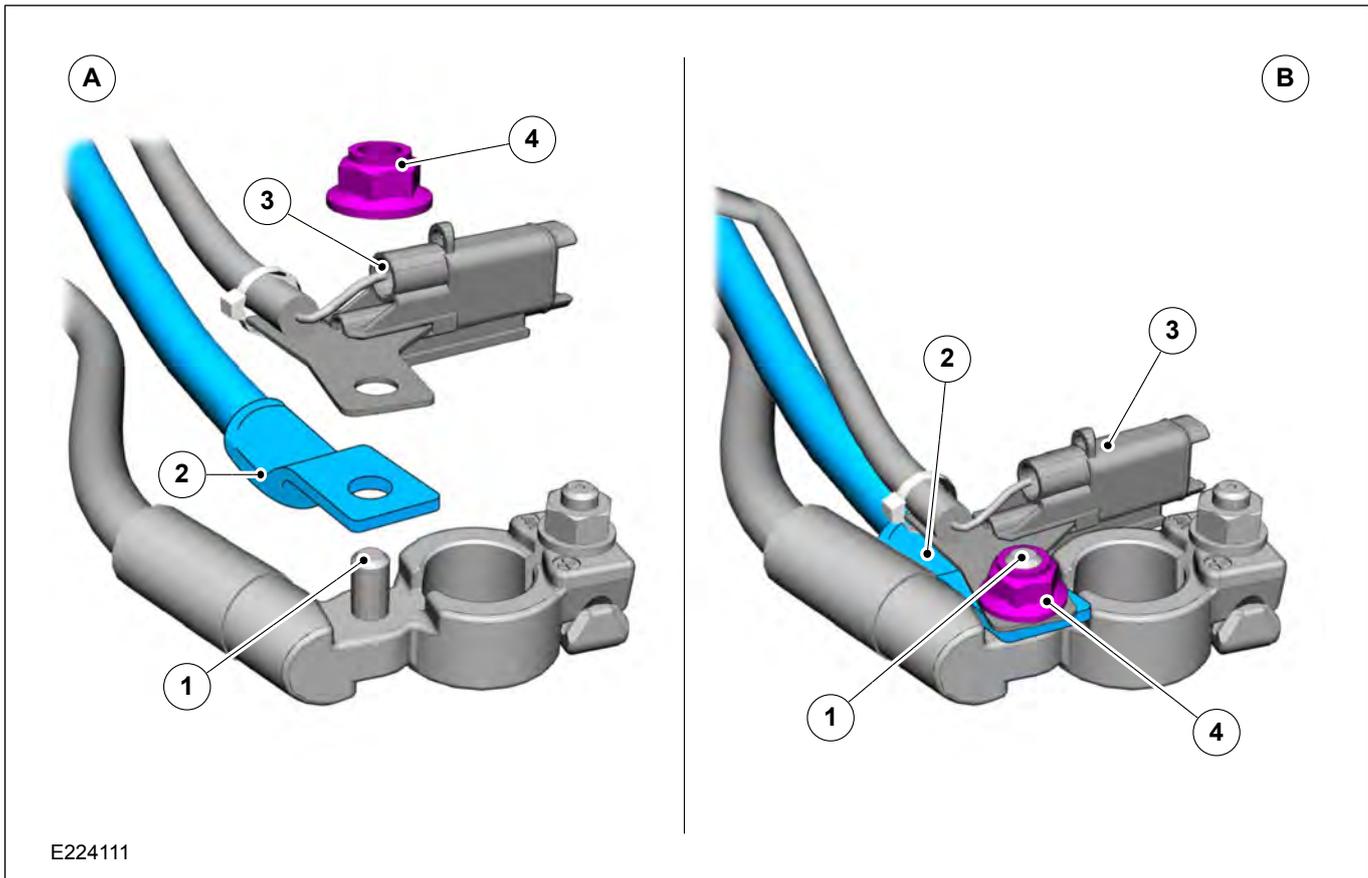
This is only allowed if testing by the converter confirms that there are no issues (documentation must be held to confirm the tests) and the following criteria is met:

- No movement before full tightening of the nut (no risk of rotation). The third party eyelet must be a tight fit within the battery clamp slot and have a maximum Cross Sectional Area (CSA) for current flow.
- The cable CSA must be oversized, Refer to: [4.1 Wiring Installation and Routing Guides \(page 56\)](#). Wiring Specifications table. For example: 245A has 70mm CSA cable.
- The third party positive conductor is mounted directly to the battery clamp with the supply for Battery Monitoring Sensor (BMS) last, see figure E224111.
- No deformation to the Ford BMS can occur. The conductor terminal/eyelet may need to be inverted, see item 4 in figure E224111.
- Only one termination (third party conductor) can be added to the 6mm stud in addition to the BMS.
- The Ford 6mm self-locking nut is to be re-used and torque to 8Nm \pm 1.2Nm. Separate locking washers are prohibited.
- A Mega inline fuse must be fitted as close to the 6mm stud as possible. Not to exceed 250A for short duration applications such as on Tipper, Cranes or Tail Lifts.
- For long duration continuous power applications such as High Power Inverter, the Mega fuse must not exceed the rating of the alternator fitted to the vehicle. The alternator saturation voltage must be above 13.0V when testing full load. AGM battery twin system (HFQ) must be fitted to the derivative. See 'Single and Twin Battery System' and 'Power and Connectivity Usage Recommendation' table in this section of the BEMM.

- A higher ampere alternator must be fitted if long duration (greater than one hour) high loads are required. See 'Single and Twin Battery System' and 'Power and Connectivity Usage Recommendation' table in this section of the BEMM.
- The SRC override feature must be used for Engine Run applications.
[Refer to: 4.3 Charging System \(page 72\).](#) Start-Stop Override and Configurable Charging.
- Efficient isolation of third party equipment, when not required, to minimize battery discharge/deep cycling.
- Testing for end customer usage, including duty cycle, at a range of temperatures and drive cycles, worst case.
- Testing of vehicle converters system must confirm no heating of Ford or third party cables or any junctions utilized.
- Testing of vehicle converters +12V conductor must demonstrate no loosening possible to Ford battery cable clamp.
- No detriment to Ford systems from Volt drop/Inrush current by third party system (functionality or Warnings).
- If Engine Off can still operate the third party system then testing also required in this vehicle state.
- A Charge Balance must also be performed to confirm system has correct battery and alternator ratings.
- If idle loading can saturate the alternator (fully load and go below 13.0V) then Engine RPM speed control system must be utilized to increase alternator output at idle.
- The return ground cable is recommended, routed in parallel to +12V supply for EMC compliance.
- When in Engine Run, unrequited systems should be turned off to help the alternator supply the main load of the third party system. This information should be passed onto the end user by the vehicle converter.
- The BEMM is adhered too in all relevant areas. This document allows connectivity to Ford battery clamp if the above criteria is met.

For further information please contact VCAS@ford.com

Third Party +12V Power Take Off Assembly



E224111

Item	Description
A	Assembly sequence
B	As installed
1	+12V Battery Clamp 6mm Stud
2	Third Party Eyelet and Cable - Must be a tight fit to the battery clamp
3	BMS Fuse
4	Self Locking Crimp Hexagonal Nut - Re-use and torque to 8.0Nm \pm 1.2Nm

4.4.7 Additional Loads and Charging Systems

NOTE: Auxiliary customer electrical loads must only be made via the Customer Connection Points provided, the Auxiliary Fuse Panel or the High Specification Vehicle Interface Connector. For loads greater than 180A see 'Third Party +12V Power Take Off for loads exceeding 180A' section in this BEMM. For further information or advice contact your local Ford Dealer or National Sales Company representative.

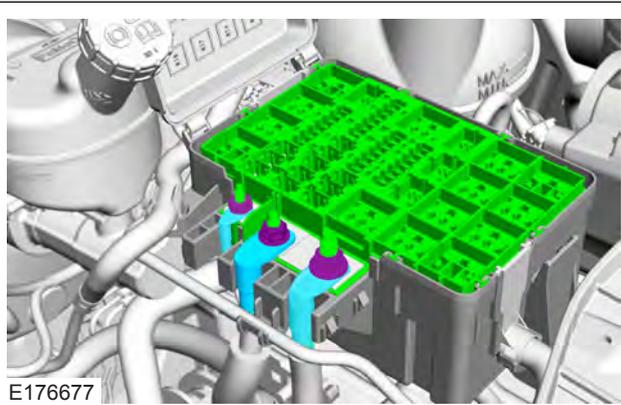
NOTE: Do not make any additional connections to the Engine Junction Box (EJB) terminals, as over-torqueing could cause damage to the EJB. Any electrical loads should be taken from the customer connection point. For applications that require a permanent installation to gain power for jump start requirements for example recovery vehicle conversion, contact your National Sales Company representative.

For additional information on number of available Customer Connection Points

Refer to: [4.19 Electrical Connectors and Connections \(page 147\)](#).

All loads that exceed 100mA continuous key off load must be fitted with an isolation switch or disconnected relay. In general all loads should have some form of isolation. A supplemental battery may be required to power systems, for example: GPS vehicle tracking systems, that pull high key off loads continuously. This is to protect from discharging batteries at ignition off and interfering with the BMS correlation of battery state of charge. This supply should also have a dedicated protection fuse of the correct value. High loads should also be grounded directly to the vehicle body and not the negative battery terminal. Connecting to the negative battery terminal will bypass the BMS and affect the correct assessment of the battery state of charge. Refer to BMS section in this manual.

EJB Terminal Studs



If separate charging systems are added, the ground side of the charger must also be connected to the body. An auxiliary ground stud eyelet, see figure E226134, can be ordered, part numbers DU5T-14436-G* for single battery or jumper cable GK2V-14301-F* for twin battery systems. This will be standard when pre ordered with Special Vehicle Options, A526, A606, A607, A608, and A652 also Regular Production Order HFQ. For additional information on order codes

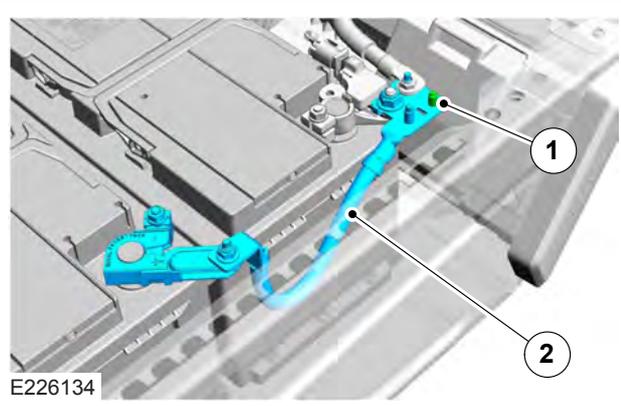
Refer to: 1.5 Conversion Type (page 13).

NOTE: If there is an isolation relay, check settings to ensure batteries are connected to the charging circuit.

For additional information on number of available Customer Connection Points

Refer to: 4.19 Electrical Connectors and Connections (page 147).

Auxiliary Ground Stud Eyelet (Twin Battery System shown)



Item	Description
1	6mm Auxiliary Ground Stud for Converter Equipment - Torque 8Nm ±0.8Nm
2	Battery Ground Jumper Cable part number GK2V-14301-F* for Twin Battery System

4.4.8 The Ford Programmable Battery Guard (A540)

WARNINGS:

⚠ The Ford Programmable Battery Guard (FPBG) is not designed for long duration engine run power for loads greater than 70A. The system is mainly designed for engine off short duration heavy loads, or long duration low loads with the protection by isolation to allow enough energy to still crank the engine. The guard can still provide engine run power to provide high current short duration, charge systems such as third party batteries and systems such as inverters but only for amperage versus time durations as described further in this section.

⚠ If the vehicle does not come with the 240A alternator, or greater current for a long duration is required at engine run, than the rating of the fitted vehicle alternator, then extra dedicated third party alternator and cabling must be added. This is to avoid saturation of the Ford alternator and thermal issues on the system including the Ford wiring and related systems. The table described in Power and Connectivity Usage Recommendations also applies when to upgrade alternators and batteries.

NOTE: FPBG new nodes (11-20) are not available until October 2017, for availability 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

FPBG is not available with relocated handbrake or Ford 230V Inverter.

System Overview

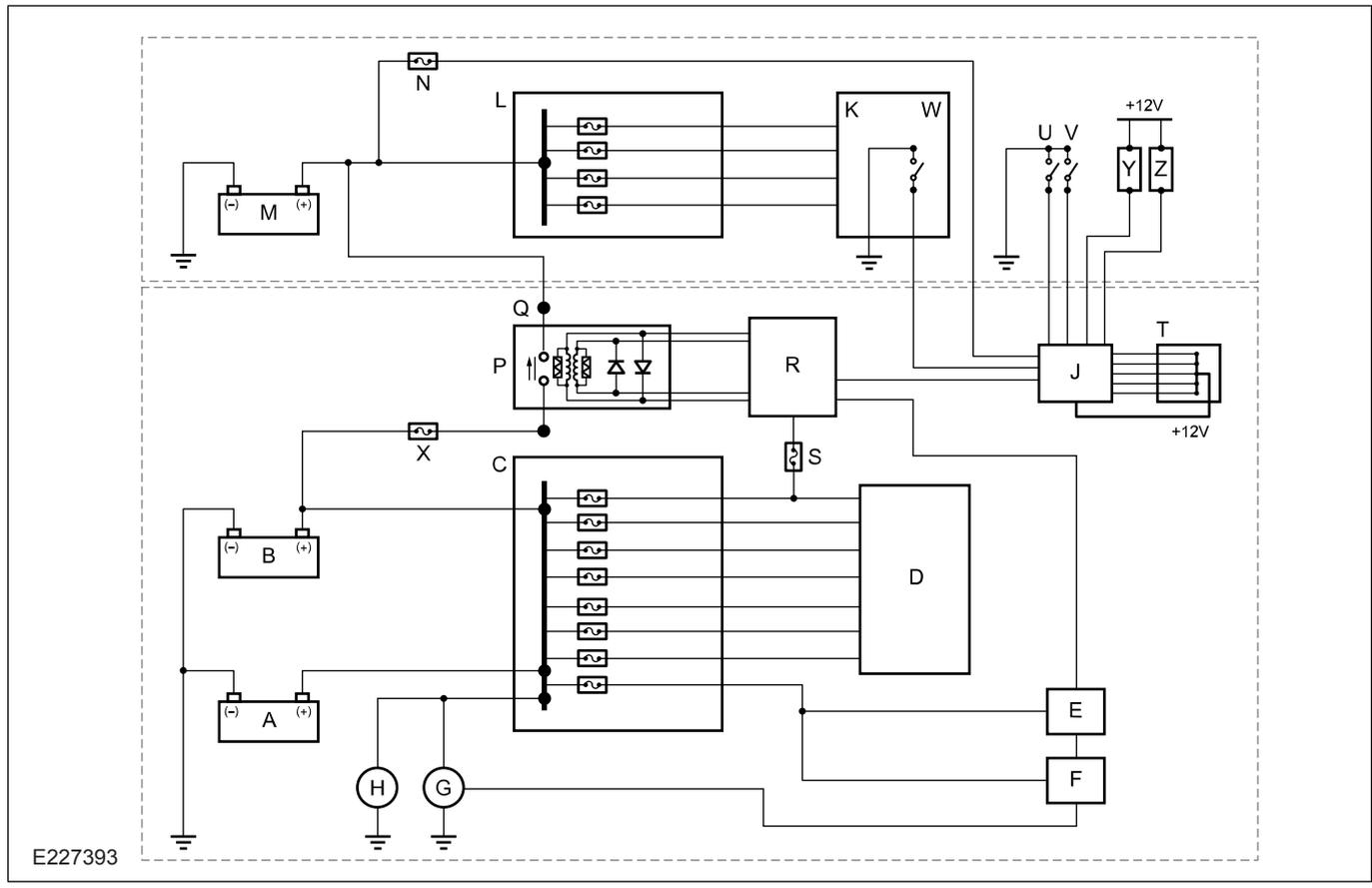
The Ford Programmable Battery Guard (FPBG) is a production or service fit system which provides 175A fused 12V power for customer use at any engine or ignition state. The system can be down-rated depending on the Mega fuse range available, changed by the Converter.

Main System Benefits Include:

- Intelligent control of power that isolates the 175A power to third party systems protect vehicle`s crank capability. Fuse values can be lowered if required
- Third party batteries can be connected and monitored including charging where required
- Easy setup operation modes(1 to 20) depending on the battery configuration on the vehicle and time duration power requirements at engine off
- Protects Ford battery State of Charge (SOC) by isolating the power relay when a low voltage is detected or a specific time point is reached

- Efficiently controls the Ford SRC and Start-Stop Inhibit to receive maximum charging to the third party batteries whilst protecting Ford battery SOC
- Provides warning signals prior to timed or required power shut down
- Immediate relay close function to receive emergency power, after auto disconnect, for a limited period of time
- Immediate relay close function to override mode timers for extended engine off usage on low current devices
- Immediate relay open function to isolate third party system when isolation is needed
- Controls voltage range to smaller band width between 14.0V and 14.9V, in high load mode at engine run – less variation than seen with SRC which can range from 12.2V to 15.2V
- Load Active Pin provides longer Engine Off usage duration for currents above 20A while still protecting the crank capability
- Will provide a charge to all batteries when detecting a mains charger applied to one of the batteries, at engine off
- Will protect third party batteries, particularly leisure type GEL batteries from crank cycles and only use energy if required
- Provides a warning that a mains charger is still connected to the vehicle if the system sees an ignition state change to start the engine
- Reduce fuel usage and emissions from less charging time due to mains charging and efficient isolation of third party system
- Improves third party battery warranty as system will now monitor the state of charge of the third party battery and protects from the majority of engine crank cycles
- Helps maintain the standard Ford SRC system
- Will provide continuous power at engine off if mains charger applied by manual switch demand

Overview of System



Item	Description	Item	Description
A	Ford Battery - Standard	N	Third Party Battery Voltage Sense Line Fuse
B	Ford Battery - Standard/Optional	P	Power Relay ⁽¹⁾
C	Ford Power Distribution	Q	Power Relay Terminal - Third Party Power Connection
D	Ford Vehicle Load	R	Module ⁽¹⁾
E	Body control module (BCM)	S	Ford Battery Voltage Sense Line Fuse ⁽¹⁾
F	Power Control Module (PCM)	T	Mode Wires ⁽¹⁾
G	Alternator	U	Immediate Relay close
H	Starter Motor	V	Immediate Relay Open
J	FPBG Interface Connector ⁽¹⁾	W	Third Party SRC Inhibit / Load Active
K	Third Party Loads	X	Mega Fuse ⁽¹⁾
L	Third Party Power Distribution	Y	Status Indicator
M	Third Party Battery	Z	Power Isolation Warning

⁽¹⁾ Ford Programmable Battery Guard (FPBG). See figures E227390, E227391, E227392, E227394, E252619 and E257003

Modes and Set Up

NOTE: Where a third party battery is fitted, and directly coupled to a third party device, it is recommended that a deep cycle type battery be installed such as AGM (Absorbent glass matt) or GEL technology. Due to the resilience of AGM technology, these batteries will work in any mode. The timer duration will be met providing the system voltage stays above the cut off threshold. However, if the voltage value is below the set point within the timer value, isolation will occur at 60 seconds after the minimum voltage is reached.

NOTE: The modes in the following table are a guide. It is not recommended to go below 12V with a single standard flooded battery. If an incorrect battery or mode is selected the timer duration may never be achieved and extra fuel (engine run time) be required.

Battery Quantity, Type and Timer Modes

Mode	Ford Battery	Minimum Voltage (V)	Key Off Time (Minutes)
1	Single Standard Flooded, No Third Party Battery	12.2	30
2	Single Standard Flooded, With Third Party Battery	12.2	60
3	Twin Standard Flooded, No Third Party Battery	12.0	45
4	Twin Standard Flooded, With Third Party Battery	12.0	90
5	Single AGM, No Third Party Battery	12.0	60
6	Single AGM, With Third Party Battery	12.0	120
7	Twin AGM, No Third Party Battery	11.8	90
8	Twin AGM, With Third Party Battery	11.8	180
9	Nordic Market Twin AGM Batteries, No Third Party Battery	11.8	60
10	Nordic Market Twin AGM Batteries, With Third Party Battery	11.8	90

Set Up

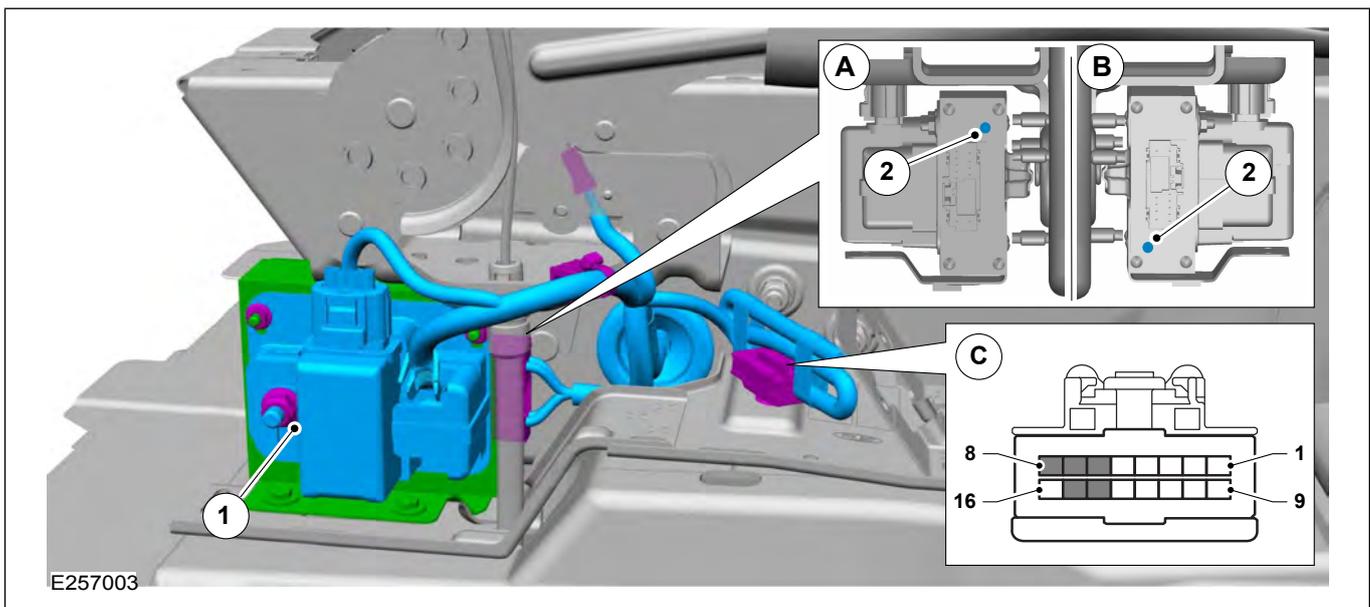
1. Locate FPBG Interface Connector, under the parking brake console, see figure E257003.
2. Find the System Mode Pins 15,14,8,7,6,in the FPBG Interface Connector, see figure E257003.

3. Refer to the Battery Quantity, Type and Timer Mode table and configure the required mode. Cut and isolate pins where shown as OFF in the Mode Configuration Pin table. For example: If Mode 8 is required, cut wire and isolate to pin 15,14,8 and 6.

Mode Configuration Pins

Mode	Pin 15	Pin 14	Pin 8	Pin 7	Pin 6
	Black Wire	Red Wire	Blue Wire	Green Wire	Gray Wire
1	ON	OFF	OFF	OFF	OFF
2	OFF	ON	OFF	OFF	OFF
3	ON	ON	OFF	OFF	OFF
4	OFF	OFF	ON	OFF	OFF
5	ON	OFF	ON	OFF	OFF
6	OFF	ON	ON	OFF	OFF
7	ON	ON	ON	OFF	OFF
8	OFF	OFF	OFF	ON	OFF
9	ON	OFF	OFF	ON	OFF
10	OFF	ON	OFF	ON	OFF

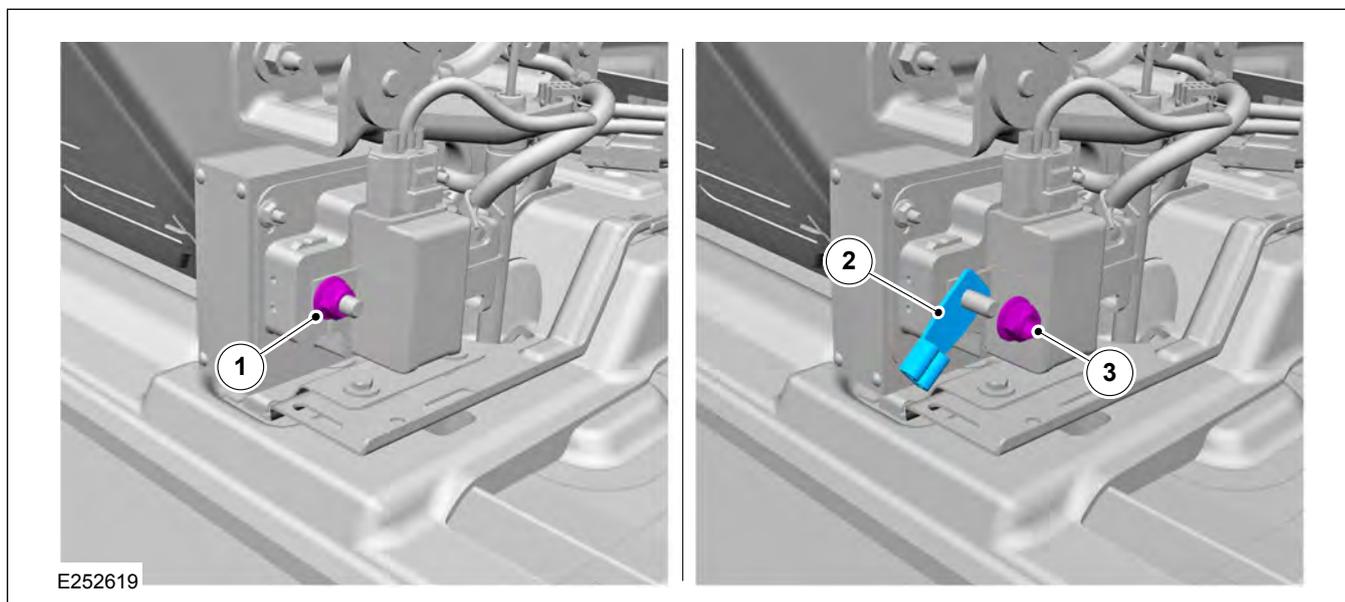
FPBG Interface Location



Item	Description
A	FPBG Interface Connector - LHD
B	FPBG Interface Connector - RHD
C	Power Relay Terminal (B)- Third Party Power Connection (+12V)
1	FPBG Interface Connector
2	LED

FPBG Interface Connector Pin layout

Pin	Description	Wire Color
1	Close Relay Request Input - SW GND	Yellow/Gray
2	Open Relay Request Input - SW GND	Blue/Red
3	Empty	-
4	B+ Converter Battery Sense Line	Black/Gray
5	Empty	-
6	Mode Configuration Pin 6	Gray
7	Mode Configuration Pin 7	Green
8	Mode Configuration Pin 8	Blue
9	SRC Inhibit Converter Request Input - SW GND / Load Active Input	Blue/Gray
10	Empty	-
11	Power Isolation Warning	Black/Yellow
12	Status Indicator / Diagnostics	Gray/Orange
13	Empty	-
14	Mode Configuration Pin 14	Red
15	Mode Configuration Pin 15	Black
16	Ignition KL15 +12V	Gray/Yellow

Power Connection**FPBG Power Relay Terminal - Third Party Power Connection (+12V)**

1. Remove M8 Nut
2. Place Third Party Power Cable Eyelet onto M8 Stud
3. Secure M8 Nut to Torque 12Nm \pm 1.8

Function

Low Voltage Cut off – Engine off: The system will disconnect power when voltage is sensed below the mode threshold value (11.74V or 12.2V). The system will only disconnect if the low voltage is below threshold for 60 seconds continuously. The system will keep the relay contacts open until a key cycle occurs or a voltage increase is detected (for example: an external charger applied) above the low set point threshold.

External Charger – Engine off: The system will close the relay contacts if a voltage over 13.1V is detected in the system (an external charger is added to the Ford or third party battery) for 8 hours to provide a charge to all batteries in the system. Manual override can be done by keeping Immediate Relay Close Pin grounded during the period when continuous power is required. A third party fit latched switch type would achieve this functionality. When a low voltage condition is detected on Ford battery system in modes 2,4,6,8,10, relay will not be opened if third party battery system has voltage higher than defined threshold.

Low Voltage Cut off – Engine on: The system will close the relay contacts when an engine run is detected and the voltages prior to crank event was higher than the threshold value. An SRC Inhibit request is sent, 5 seconds before closing the relay contacts if the converter battery voltage is detected lower than the threshold value. This allows time for the alternator to ramp up to full charge voltage. Isolation of the relay, will occur immediately when the ignition signal is detected, if a mains charger is connected to the system prior to the crank event. A warning will also be given via the Status Indicator circuits. It is up to the converter as to decide whether third party visual or audible warning devices are fitted to the signal.

Load Active Input - Engine off: Load Active Input allows longer Engine Off usage at currents above 20A by reducing the cut off voltage threshold of the Modes. When the Load Active Input is turned on the cut off threshold is set 0.3V lower than the actual Mode threshold. This feature has a dual function, it is also used as SRC Inhibit at Engine Run, therefore, when the engine is running, the function of the Load Active will end and SRC will start. At Engine Off, when the input is applied whilst load is active, a new threshold will be set and relay will stay connected until the new threshold is reached. For Example: Mode 7 has 11.8V Mode threshold value. If the Load Active Input is activated at Engine Off, the new threshold will be 11.5V. The user can continue using battery power until voltage goes below 11.5V. This is the closed circuit voltage under loads above 20A, therefore when the cut-off happens, open circuit voltage will be observed to recover. The lower calibration is required to compensate for load versus actual battery state of charge. To reduce the risk of early Power disconnect, the load feature must be utilized for peripheral continuous loading above 20A. Repeat usage of this function without charging the batteries will lead to shorter usage duration and may lead to a failed crank.

Smart Regenerative Charging and Start Stop Inhibit: The system has an SRC Inhibit input and can be utilized by third party systems in conjunction when third party heavy loads are active, such as a Power Inverter, Crane or Tipper. This feature is to maintain a stable voltage at a conventional charge state of between 14.0 to 14.9V. The system will also inhibit SRC and start stop if it measures the third party battery at a low state of charge and requires to be charged. The SRC Inhibit will happen with the following circumstances;

a) When the relay is open and a converter load input is received, The system will give SRC Inhibit output immediately, 5 seconds later close relay contacts.

b) If converter battery low voltage is detected after an engine off event (below set point voltage reached >60 seconds), the system will send SRC Inhibit signal immediately at engine run for a defined period of engine run duration. The system will re-assess the battery voltages on the next engine run if the first engine run duration is less than the defined period.

The assessment will be made in correlation with voltage and SOC relation. The following table refers to estimated charge times. When system is sharing alternator charge on all batteries, the target value is 80% SOC but some may be higher.

SRC Inhibit Timer Chart

Mode	Ford Battery Configuration	SRC Inhibit Timer (Hours)	Min. Voltage (V)
Mode 2	80Ah	2.0	12.2
Mode 4	2 x 80Ah	3.7	12.0
Mode 6	80Ah AGM	2.8	12.0
Mode 8	2 x 80AH AGM	4.4	11.8
Mode 10	2 x 95Ah AGM	4.4	11.8

If the third party battery voltage is above 12.6V, The system will not perform an SRC Inhibit assessment with no inhibit output.

Power Isolation Warning: The system provides a Power Isolation Warning at the dedicated output. This is a switched ground output and requires a third party audio or visual device to be fitted, such as an LED lamp or buzzer installed and is activated prior to main supply disconnect.

The value of this output is a low side driver rated at 1000mA. This is to provide early warning that the supply is imminent for disconnect and gives a chance to restart the engine, add a mains charger or finish their power usage task.

Power Isolation Warning output will be given when voltage is sensed to be under the voltage threshold value for 30 seconds.

This assessment is required to ensure there is no instant voltage drop in the system because of an initial start of high power equipment or cranking.

The Power Isolation Warning output will be continuous until the 60 seconds completed under threshold and relay is already open circuit. This allows the operator to understand why they have lost power. In extreme power take off events, but with a good state of charge of battery, there may be events when the warning is triggered but disconnection does not occur, if the load is removed within the trigger period due to the battery recovering voltage above the cut off threshold. This is normal operation and further loads could be applied before an engine start and charge is required.

Power Isolation Warning output will also be given when key off timer is in the last 30 seconds.

Status Indicator: The system provides a Status Indicator output which is the indication of the system status on certain functions. The value of this output is a low side driver rated at 1000mA. This is a switched ground output to be used by third party audible or visual device, such as an LED lamp or buzzer.

Status Indicator output will be given when an Immediate Relay Contact Close switch (third party switch) is detected to be on. The output will be continuous as long as the Immediate Relay Close is active.

Status Indicator output will also be given when Ignition is detected if the voltage is higher than external charger voltage threshold 13.1V. This is to give the warning that external charger is still on before the crank and user should check the cable connections. The warning will be given as a pulse signal 500ms ON 500ms OFF. Output will be stopped after 30 seconds regardless of the engine state.

Status Indicator also gives output with a dot-space matrix pre-defined set of functions when related conditions occur. The set of conditions are shown in Diagnostic section.

Immediate Relay Contact Close Feature: If immediate Relay Contact Close signal is activated via a momentary pulse, it will immediately close relay contacts. This overrides all other functions of operation at engine off for 2 minute duration except the Immediate Relay Contact Open. After 2 minutes, the system will go back to normal operation monitoring providing the signal is inactive. If a switch cycle is detected, another 2 minute power is provided.

If immediate Relay Contact Close signal is activated continuously via a latched switch, it overrides the key off timer providing the batteries in the system are above the low voltage threshold. The relay contacts will stay closed until the batteries go below the low voltage threshold. This may be used to extend engine off power duration, however, it is not recommended to use the feature permanently. There will be a disconnect if ignition position 2 is selected, for example during a crank event. See Cold Crank Aid in this section of the manual. For system specific questions if uninterrupted power is required, 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

Immediate Relay Contact Open: If OPEN relay signal is activated, it will immediately open relay contacts and override all other functions until next key ignition cycle and the switch is deactivated. When a new key cycle is detected (Ignition Position 0 then 2), the module will go back to normal operation. If the signal is still activated regardless of ignition state, the relay contacts remain open. This system should not be used as an emergency stop. A separate emergency stop for safety critical systems must be included in the third party system.

Engine Run Alternator Protection: When voltage is detected below low voltage threshold for 5 seconds continuous during an Engine Run, FPBG will activate SRC Inhibit output until next engine off state is achieved. This is to protect the alternator under engine run if there is not enough capacity under the SRC voltage to support immediate high power loads. After activation of the SRC Inhibit output the system will assess the voltages for 15 seconds. When the voltage is detected higher than 12.8V the system will keep the relay contacts close. When voltage is detected below 12.8V the system will open the relay contacts for 4 minutes. When 4 minutes open-contact timer ends the system will check the voltages for 10 seconds and close contact if voltage is detected higher than 12.8V.

Over-Voltage Protection: When a voltage above 15.5V is detected the system will send open contact signal if the voltage is below 15.8V. The module then stops sending outputs until voltage recovers below this voltage upper limit.

When voltage is detected above 15.8V the system will still understand voltages up to 17.4V but will not send any outputs. Diagnostic LED will light continuously RED-RED-ORANGE sequence in Over-Voltage when it is higher than 15.8V.

Sleep Mode: The system will be active when it sees ignition position 2 signal from position zero or key out. When ignition position 2 is deactivated, the key-off operation timer starts where it will monitor voltages and continue normal operation for a timed period set, depending on which MODES from 1-10 are set. The module will go to Sleep mode after 10 minutes from the timer duration period or low voltage cut off point. To wake up the module, the following conditions need to occur, either: Ignition state change back to position 2, Battery Voltage increase or Immediate Relay Contact Close.

Cold Crank Aid and Third Party Battery Starter Motor Protect: The system will keep the relay contacts open after ignition position 2 is detected until it receives the engine run signal unless crank does not initiate within a 30 second period. When engine run signal is received within the first 30 seconds, the system will close the relay contacts immediately if converter battery is above the low voltage threshold set point. If the third party battery is below the threshold voltage set point, the system will activate SRC inhibit after engine run and close the contacts 5 seconds later. If the system detects a second ignition position 2 cycle without engine run within the first 30 seconds, it will immediately close the contacts for 30 seconds. This is to provide supplemental crank energy from the third party battery whilst not always exposing the third party battery to the starter motor in-rush current. Also the feature is designed to avoid third party systems competing for energy with the starter motor and so maximize energy for crank on the first attempt. For continuous key cycles, the relay will remain open for each 60 seconds period. Function will reset after 60 seconds and can be used again.

Diagnostics

The system will provide diagnostic messages via an LED indicator on the modules enclosure. Certain conditions will be transmitted to the Status Indicator pins to show the normal operation state or fault during operation. This will help identify a failure mode coded by a mark space ratio output, see the System Diagnostic - Operation table.

The system will expect 12V on the 5 MODE pins with various combinations. When a change happens in the MODE bridge pins, the system will detect the change and give necessary response via an LED. The system will check the mode pins every ignition cycle or when a hardwire voltage reset is detected. Checking which mode can therefore be done at every ignition cycle. The system transmits an LED color message when a bridging change is detected on the MODE pins, see System diagnostic – Mode Setup.

If the system detects more than one failure mode, the failures are transmitted to an LED one after the other. When one of the fault condition is cleared (corrected), the next detected failure mode would be transmitted until all faults are cleared. The system will give an LED light colors and flash rates as shown in the System Diagnostic

FPBG Diagnostic - Operation

Function/Signal	Status	LED Color Sequence	Status Indicator Output (Signal Pattern)
12V Ford Battery (Battery Sense & Power)	OK	G	
	Low Voltage	OO	
12V Converter (Battery Sense)	OK	G	
	Low Voltage	OOO	
	Open Circuit	RRR	OOO
Engine Run Alternator Protection	OK	G	
	Low Voltage Cut-Off	RRRR	OOOO
Power Isolation Warning	Not Triggered	G	
	Triggered	OOOOO	
External Charger - Engine Off	Not Detected	G	
	> 13.5V Detected	O-O	
	IGN2 Detected	R-R	O
Over Voltage Protection (>15.8V)	OK	G	
	Over Voltage	RRO	O-OO
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	OO-OO
Immediate Relay Contact Close	Not Triggered	G	
	Triggered (Close Switch)	OOO-O	O Continuous
Ignition Position 2 (Engine Run)	OK	G	
	Open Circuit	RRR-RR	OOO-OO
FPBG Internal Failure	No Failure	G	
	Soft Voltage Reset (Ignition Cycle)	RRR-R	OOO-O

G = Green, O = Orange, R = Red, - = Space

FPBG Mode Setup LED Sequence

Mode Condition	Status	LED Color Sequence	Number or Repeat Sequence
Pin Check - Ever Ignition Cycle & Hardware Voltage Reset	Change Detected	G O R	2
Setup Change Issue	Not OK Combination	O R	3
Setup Successful	OK Combination	G O	3
1 Selected	OK	G	1
2 Selected	OK	G G	1
3 Selected	OK	G G G	1
4 Selected	OK	G G G G	1
5 Selected	OK	G G G G G	1
6 Selected	OK	G G G G G G	1
7 Selected	OK	G G G G G G G	1
8 Selected	OK	G G G G G G G G	1
9 Selected	OK	G G G G G G G G G	1
10 Selected	OK	G G G G G G G G G G	1
11 Selected	OK	O G	1
12 Selected	OK	O G G	1
13 Selected	OK	O G G G	1
14 Selected	OK	O G G G G	1
15 Selected	OK	O G G G G G	1
16 Selected	OK	O G G G G G G	1
17 Selected	OK	O G G G G G G G	1
18 Selected	OK	O G G G G G G G G	1
19 Selected	OK	O G G G G G G G G G	1
20 Selected	OK	O G G G G G G G G G G	1

G = Green, O = Orange, R = Red

Further Information:

- Normal functionality at ignition ON or OFF may lead to a clicking sound of the relay opening and closing as part of its strategy. 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. Further power take off must come from the Ford Customer Connection points as shown in the section Electrical Connectors and Connections
- If the fuse needs to be down-rated, a Mega fuse size can only be used. The fuse value must not exceed 175A
- Emergency isolation for safety applications must not be used by the isolation feature. If control is lost, to the main relay, it remains in the same state as is a latched type relay
- It is recommended that a latched switch on the relay close circuit always be installed. There are certain scenarios related to mains chargers and engine off quiescent voltage that may be above 13.1V, that the relay contacts would need to be closed manually, to deliver power to the third party systems when required

- If the timer value is never or rarely achieved, the following factors maybe the reason:
 - Wrong battery and alternator specification (too small ratings) for the third party load
 - System degradation has occurred, such as failing batteries (always check battery condition, if this keeps occurring contact your local Ford dealer for a battery health check), other systems are fitted draining the batteries (such as trackers or other third party loads, connected to the CCPs)
 - Incorrect installation such as battery sense lines not installed
 - Wrong mode configuration set to required timer value
 - Main mega fuse is open circuit
 - Cold temperatures will lower battery voltage and ability to hold or receive charge
 - Drive cycle versus engine off application is not providing enough time to charge up the batteries
 - Alternator performance issues, saturated or failed
 - Peripherals left always plugged into 12V Power Cigar sockets (which are no longer on 30 minute battery saver but deactivate at 60% Battery SOC)
- When cutting the linked wires to set the mode, it is recommended to insulate each cut wire
- The system at full load must not let the alternator drop below 13.0V. This is an indication that the alternator and system is saturated and cannot meet the demand for power
- For static conditions, in workhorse mode for the third party main load, the operator may need to be instructed to manually load shed Convenience Ford systems to maximize available energy from the alternator. Further systems may also help performance such as the Engine RPM option A003. This system elevates engine idle which will increase current output of the alternator
- The Ford Programmable Battery Guard System can also be bought as part of the Converter High Power Pack grouping dealer option A550. This pack includes the Engine RPM control, the AGM batteries and a 240A up rated alternator.
- 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. For instance, the charger has adequate current limiting to avoid overload
- The output warning features may occur during a normal drive cycle. Therefore audible or visual peripherals, connected to the outputs should be located where not deemed a distraction to the driver. I.e. a buzzer only on the cherry picker external platform and a small LED warning lamp in the CAB area
- The system cannot be ordered as factory fit option or retrofitted with the Ford 150 Watt inverter as it utilizes the same package space. However, this system can power a 2,000 watt third party fit inverter as long as the 175A rating is not exceeded
- The relay may cycle between 8 hour periods, closing the relay when connected to a mains charger at key off load, depending on battery voltage during long engine off periods. This is normal functionality and designed to ensure adequate charge is given to all batteries
- For the 175A ground point, the converter is to supply their own ground location or utilize the auxiliary ground as shown in battery and cables or ground points section
- Before performing a Mode change or initial setup, the converter is to un-power the system to avoid risk of contact between Mode Pins (+12V) and the vehicle body. The Mode pins have to be cut according the Mode Table to setup correct Mode for vehicle battery configuration. This could be achieved either by disconnecting the system feed connector, or removing all battery B- terminals completely. Note that removing the system cable from the battery is not enough to disconnect the power from the module. On the Mode Pins setup, none of the cut mode wires should be grounded as damage to the module could occur
- For high current applications above 70A and at engine Run, vehicle load shedding must be applied and battery cables and alternator temperatures must be monitored. For these applications the 240A high power alternator must also be fitted
- If continuous heavy load usage is required the following values and duration must comply to the following:
 - 70A to 90A, a maximum of 10 minutes is allowed
 - 91A to 120A a maximum of 4 minutes is allowed
 - 121A to 175A a maximum of 1 minute is allowed
- It is recommended to disconnect loads for at least 10 minutes for the cool down after the defined duration is achieved. Different system conditions may lead to longer waiting period, for example: wiring cross sectional area, cable length and impedance in the system. It is recommended that the converter tests the finished system to define cool down period in between the usages. Contact VCAS@ford.com for system specific questions
- If the vehicle does not come with the 240A alternator, or longer duration is required at these amperage values above, then a dedicated alternator and power cabling must be applied to avoid saturation to the Ford alternator and any thermal issues on vehicle wiring and related systems

- 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.
- For heavy current applications at engine run, Third Party SRC Inhibit (FPBG Interface Connector Pin 9) must be utilized.
- General system re-setting function is performed via Ignition cycle. If functionality does not restore, check Status Indicator output message or Diagnostic LED on the module. If further help is required, 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
- The SRC Inhibit Timers Chart should not be used as a reference. SOC depends on temperature, battery health, alternator size etc. The information in the BEMM for SOC Timers are theoretical values and should only be used for guidance. The actual timer duration of SRC Inhibit may vary and depend on battery SOC assessment

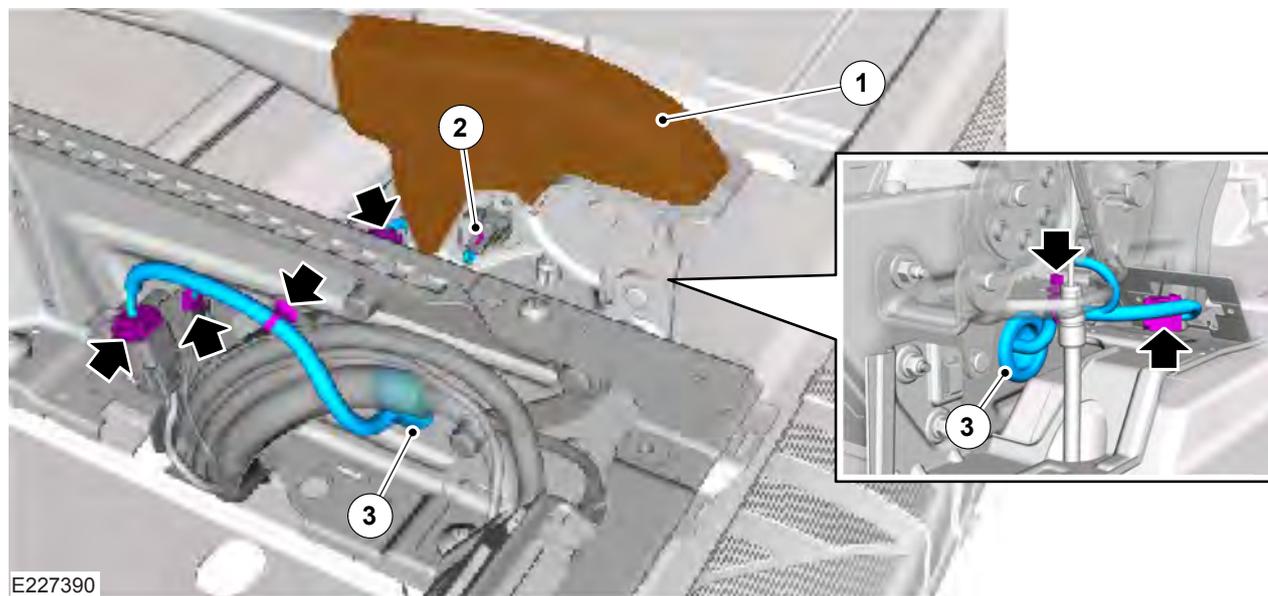
- The engine off "Load Active Input" should not be used on loads less than 20A. This is due to the load drop below this value being close to actual SOC of the battery where this is below energy required to crank
- The timers of the battery guard has certain tolerances depending on the assessment factors in the system. There will be slight time variations in reaction time differences for the inputs and outputs as the system does not require calibrated chronometer accuracy

4.4.9 The Ford Programmable Battery Guard System - Aftermarket Fitting

NOTE: If the vehicle is fitted with 150W Inverter this will need to be removed to enable retrofit of the Ford Programmable Battery Guard System. A new Hand Brake Console will be required for less 150W Inverter.

NOTE: It is necessary to remove the upper seat, disconnect the battery/batteries power and take out the battery/batteries (and box if one) prior to fitting the Ford Programmable Battery Guard System. For further information contact your local Ford dealer.

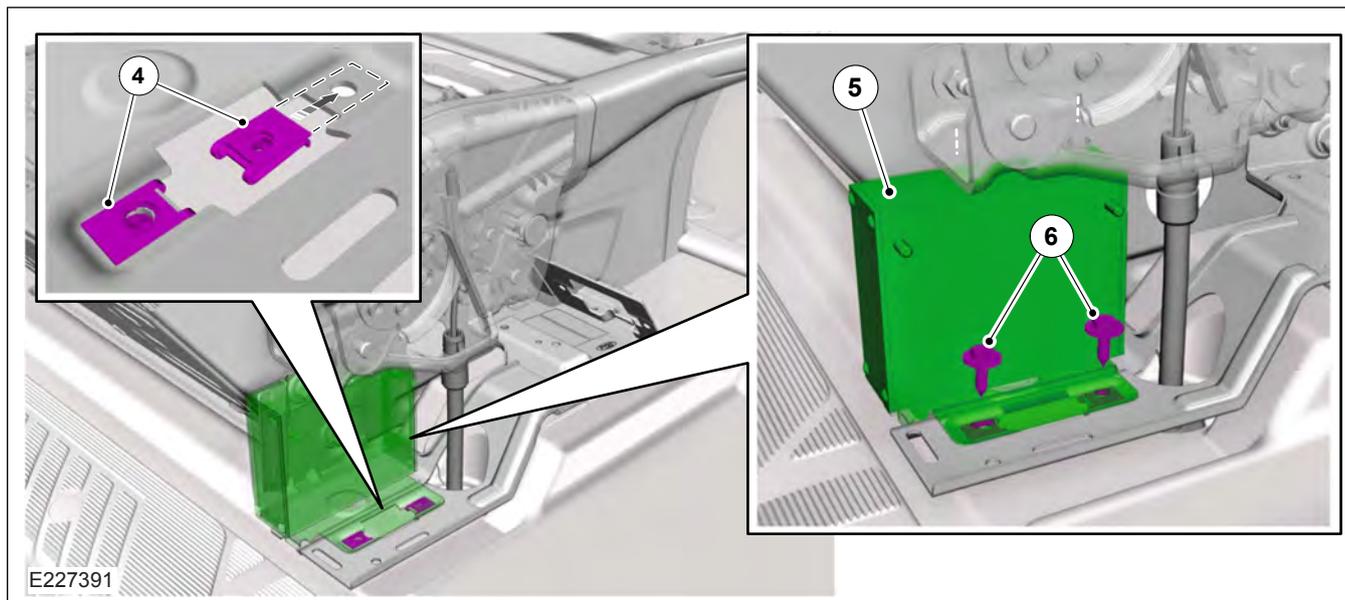
Removal of Handbrake Harness



1. Remove Handbrake Console
2. Disconnect the Handbrake Lever Connector

3. Remove Grommet, disconnect Connectors, Firtree Clips, Tiewraps. Dispose of Harness.

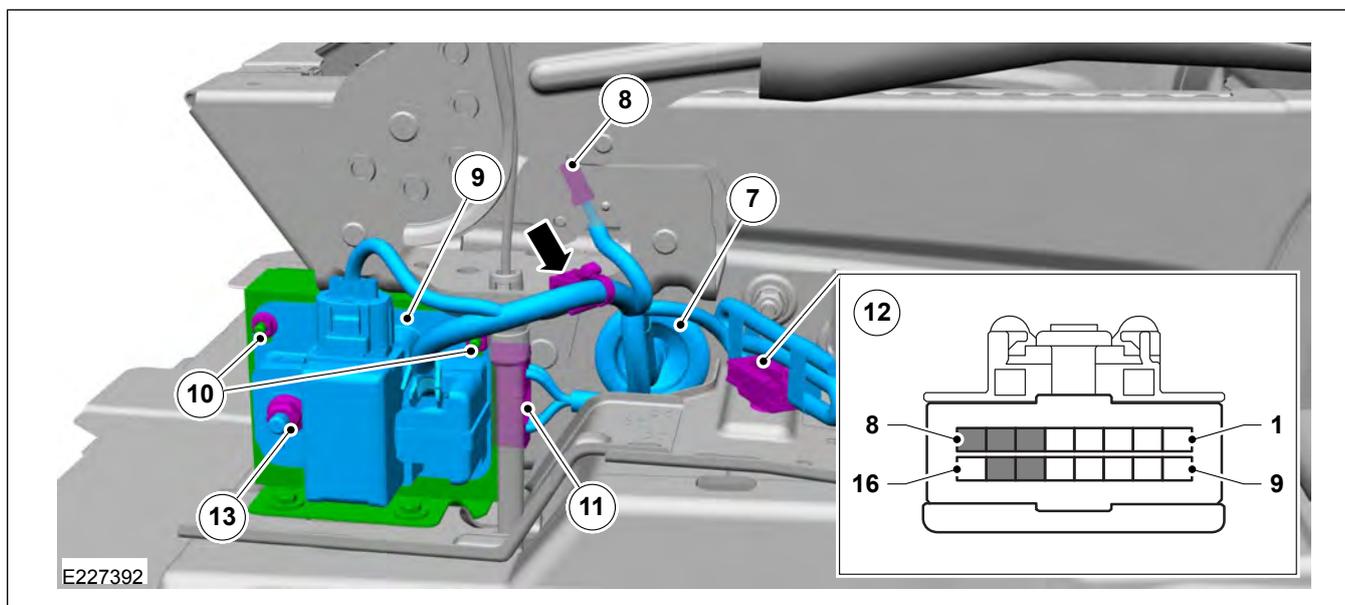
Ford Programmable Battery Guard Module



4. Fit 2x U Nuts
5. Fit Module GK2V-10B727-A*LHD/B*RHD.

6. Secure Module with 2x screws - torque 3.2Nm \pm 0.5Nm

New Harness Routing - Outside Pedestal

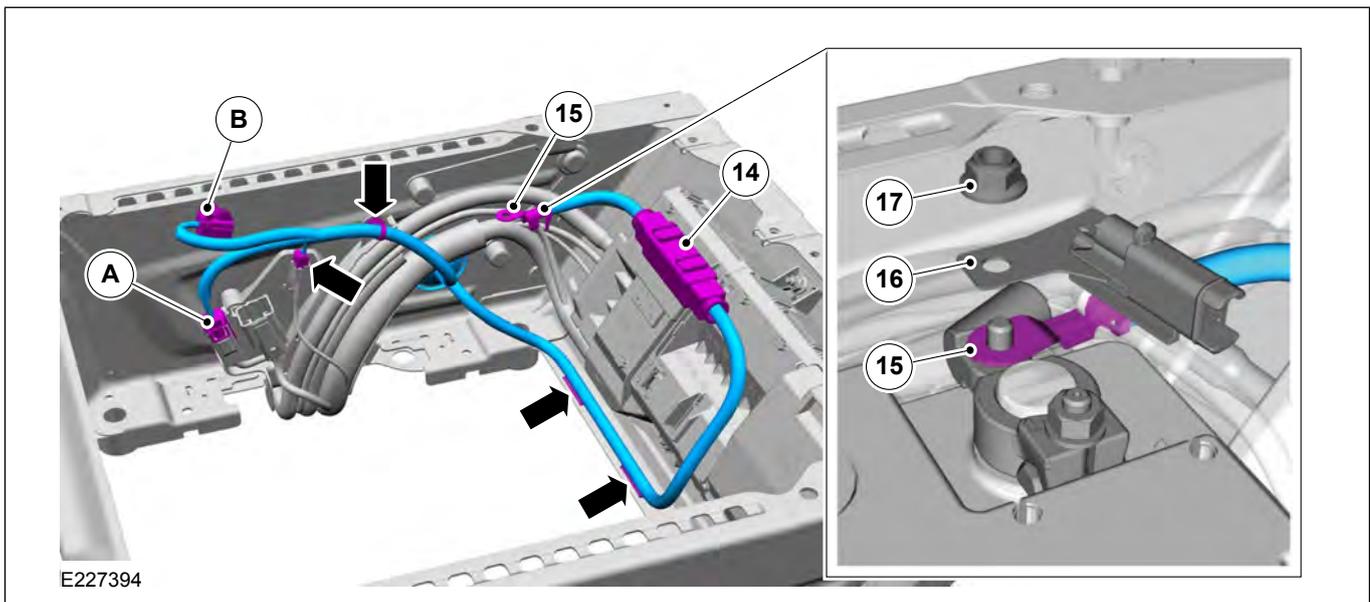


7. Route Harness GK2V-15K857-E*LHD/F*RHD through the drivers seat pedestal, making sure the grommet is seated/sealed properly making sure the harness does not obstruct or interfere with the handbrake cable and assemble edge clip to handbrake bracket.
8. Fit Handbrake Connector
9. Fit Relay Holder

10. Secure Relay Holder with 2x M5 Nuts - Torque 3.2Nm \pm 0.5Nm
11. Fit Module Connector
12. FPBG Interface Connector - Mating Connector face view showing Mode Configuration Pins 15,14,8,7 and 6
13. FPBG Power Connection - Relay Terminal Nut - Torque 12Nm \pm 1.8. See also figure E252619.

FPBG Interface Connector - see item 12 in figure E227392

Pin	Description	Wire Color
1	Close Relay Request Input - SW GND	Yellow/Gray
2	Open Relay Request Input - SW GND	Blue/Red
3	Not Used	-
4	B+ Converter Battery Sense Line	Black/Gray
5	Not Used	-
6	Mode Configuration Pin 6	Gray
7	Mode Configuration Pin 7	Green
8	Mode Configuration Pin 8	Blue
9	SRC Inhibit Converter Request Input - SW GND / Load Active Input	Blue/Gray
10	Not Used	-
11	Power Isolation Warning	Black/Yellow
12	Status Indicator / Diagnostics	Gray/Orange
13	Not Used	-
14	Mode Configuration Pin 14	Red
15	Mode Configuration Pin 15	Black
16	Ignition KL15 +12V	Gray/Yellow

New Harness Routing - Inside Drivers Seat Pedestal

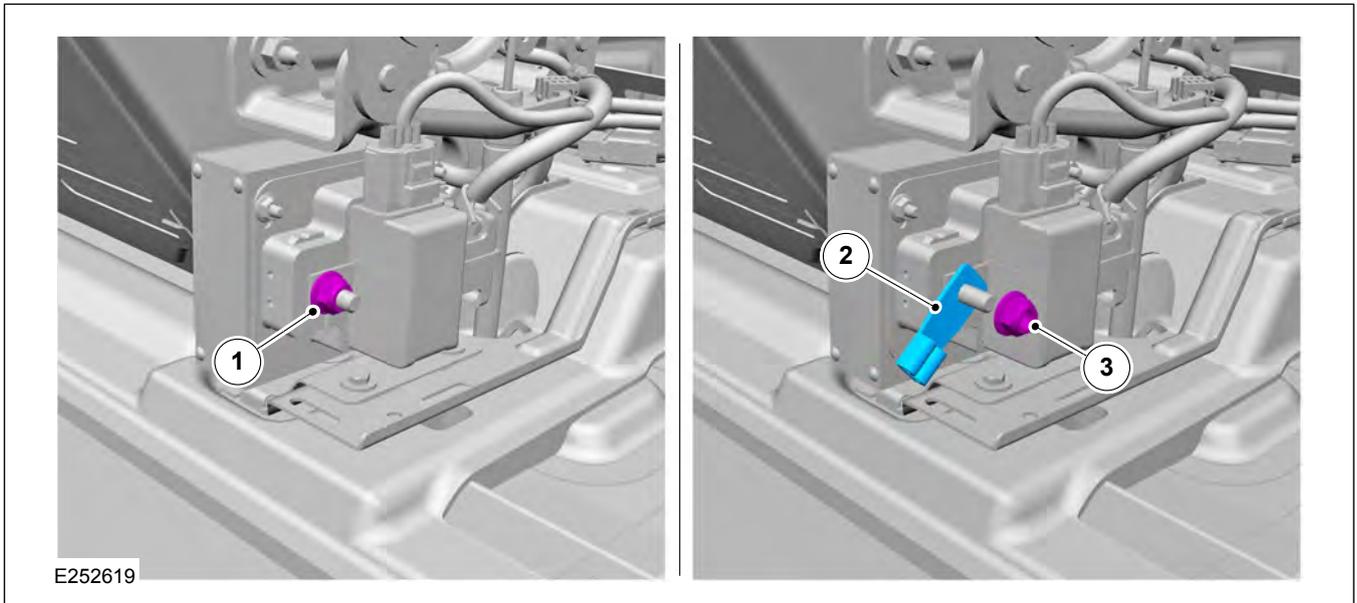
- E227394
14. 175A Mega Fuse - Route and connect harness as shown in E227394
 15. Battery Positive Eyelet⁽¹⁾
 16. Battery Monitoring Sensor
 17. M6 Nut - Torque 8.0Nm ±1.2Nm

NOTE: Vehicles without Auxiliary Fuse Panel need to use connector 'A' location, Vehicles with Auxiliary Fuse Panel need to use connector 'B' location'.

⁽¹⁾ = After routing the FPBG System, refit the battery/batteries into the pedestal and reconnect as shown in E227394.

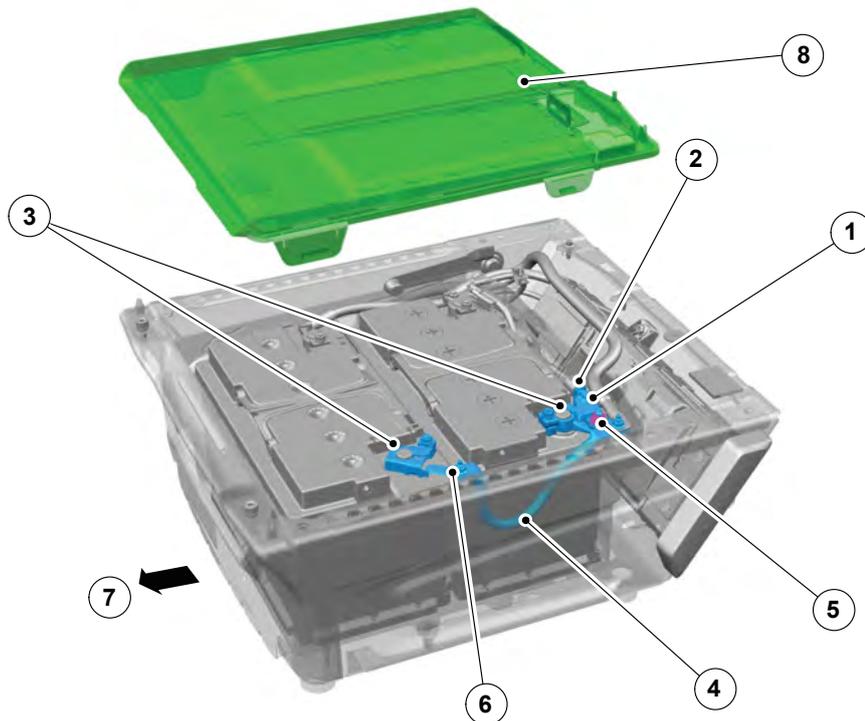
Use correct torque when re installing the upper seat.

FPBG Power Relay Terminal - Third Party Power Connection (+12V)



1. Remove M8 Nut
2. Place Third Party Power Cable Eyelet onto M8 Stud
3. Secure M8 Nut to Torque $12\text{Nm} \pm 1.8$

4.4.10 Battery Monitoring Sensor (BMS)



E283928

Item	Description
1	Battery Monitoring Sensor (BMS) GK2T-10C652-A*
2	Plug-in connection — Local Interconnect Network (LIN) and Battery Positive +12V (B+) Feed
3	Connection to Negative Terminal of Main Battery Post — See 'Battery Cable Fixing Torque'
4	Jumper Cable (GK2T-14301-A*) only with twin batteries
5	1x M8 nuts. Do not loosen or remove
6	1x M6 nut. Do not loosen or remove
7	Front of vehicle direction
8	Battery Box Lid
9	Battery Positive Terminal Cover
10	Battery Cover

WARNING: It is important that the battery box lid/covers are replaced after any conversions to the battery positive terminal. If the battery lid/cover is missing or damaged, a replacement part must be ordered and fitted. It is recommended to check fitment as part of a quality control process. See figure E283928.

CAUTION: Do not permanently remove jumper cable (GK2T-14301-A*) from BMS.

The BMS continuously monitors the condition of the main battery (or twin batteries). To do this, it is bolted directly to the negative terminal of the battery. It is recommended that this is not removed. However, if removal is required, please refer to the ETIS workshop manual, local Ford dealer or customer services.

The BMS re-calibrates itself at regular intervals. This occurs during a rest period at key off, when the battery closed-circuit current is less than 100mA. The rest period must last for at least three hours. If the system cannot carry out a re-calibration then it is unable to establish the correct state of charge of the battery. In this case, the Start-Stop system may be deactivated.

It is recommended that the total Ampere consumption, in sleep mode, does not exceed 100mA. This is because BMS will not be able to accurately correlate the battery state of charge. Note there is approximately 20mA of key off load from existing Ford fit systems so the additional maximum is 80mA of converter fit system. Any third party installations should ideally be activated via Ignition or engine RUN. However, a sleep mode of 100mA is still high and will lead to deep discharge. Regardless of battery system, long periods of discharge may necessitate long periods of recharge. See 'Power and Connectivity Usage Recommendation' table at the end of this section.

After converter system is installed, it is recommended to measure total key off load to battery with a clamp on ammeter calibrated and sensitive to mili ampere's (mA). Perform this test after 10 minutes of key off with all doors shut so that the vehicle remains in sleep mode.

NOTE: If the key off load only drops to the expected lower value after 30 minutes, it is probably because a feature is still active, controlled by the battery saver timer. This could be because any door is ajar, interior lamp is switched on. Peripherals plugged into the power sockets will continue to drain power until the battery reaches a low level of charge.

4.4.11 Single and Twin Battery Systems

Wiring of Batteries in Parallel for High Current Applications

If higher current is required an additional battery can be added as shown in the proposed interface schematic. In this case the engine run signal is used to control relay "D", see figure E225363, third party topology diagram to allow the third party battery to be charged when the engine is running. Also see figure E227393, Overview of System for Ford Programmable Battery Guard system.

Generic items when converting from Single to Twin Batteries

Part Number	Description	Quantity
GK2T-14301-A*	BMS Jumper Cable - less auxiliary ground stud	1
GK2V-14301-F*	BMS Jumper Cable - with auxiliary ground stud	1
BK2T-14300-A*	Left Hand Drive positive cable	1 ⁽¹⁾
BK2T-14300-D*	Right Hand Drive positive cable	1 ⁽¹⁾

⁽¹⁾ only one battery pending on drive.

Single to Twin Battery Conversion

Any additional or different batteries must be checked for correct functionality on a Start-Stop or SRC vehicle, please refer to Battery Configuration, Additional Loads, Start-Stop and Smart Regenerative Charging (SRC) and also:

Refer to: [4.3 Charging System \(page 72\)](#).

Refer to: [4.8 Electronic Engine Controls \(page 115\)](#).

If a requirement exists, it may be viable to order vehicles installed with a single battery, a battery disconnect relay, and a kit of harnesses to be fitted by the installer. See following table for battery cables and components.

NOTE: A vehicle ordered with a single battery cannot be converted into a Start-Stop derivative.

Battery Cables and Components

A vehicle ordered with a single battery can be converted to twin standard batteries or to High Performance Deep Cycle AGM batteries. When converting to the standard option it is necessary to order an additional single battery to the same specification as the original fit. Alternatively when converting to the High Performance Deep Cycle AGM batteries it is necessary to replace the original battery with two AGM batteries of the same type. The battery part numbers for each option is shown later in this section.

Replacing with Twin Basic System – Same as Single Fitted

Part Number	Description	Quantity
GK2T-10655-D*	Lead Acid 80Ah Standard Flooded Battery - 2 year warranty territories	1
GK2T-10655-E*	Lead Acid 80Ah Enhanced Flooded Battery - 3 year warranty territories	1

Replacing with High Performance Deep Cycle AGM System

Part Number	Description	Quantity
DV6T-10655-B*	High Performance Deep Cycle 80Ah AGM Battery	2

4.4.12 Power and Connectivity Usage Recommendations

Engine State	Power Usage	Recommended Specification (order code in brackets)
Engine OFF Loads	LOW CONTINUOUS POWER TAKE OFF - Up to additional 5mA at Key OFF, for example: KL30 fed small current peripheral chargers.	Donor Vehicle Battery(s)
	MID CONTINUOUS POWER TAKE OFF - Between 5mA and 30mA at Key OFF, for example: Trackers (with sleep function, no GPS), Control Gear, KL30 fed medium current peripheral chargers.	Twin Batteries of same type (only standard on certain applications)
	HIGH CONTINUOUS POWER TAKE OFF - Between 30mA and 180mA at Key OFF, for example: Trackers with GPS, Control Gear, KL30 fed high current peripheral chargers DO NOT EXCEED 180mA.	2 High Performance Deep Cycle AGM batteries (HFQ)
	OCCASIONAL SHORT TERM HIGH POWER TAKE OFF - 40-240A at Key OFF, for example: Cranes, Tippers, Tail Lifts, 230V Inverters, Ambulances.	2 High Performance Deep Cycle AGM batteries (HFQ) + Ford Programmable Battery Guard -max 175A (A540). Additional batteries maybe required, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section.
Engine RUN Loads	LOW CONTINUOUS POWER TAKE OFF - Up to 30A, for example: Maintenance Van with water heater and additional lighting but no further systems.	Donor Vehicle Alternator
	HIGH CONTINUOUS POWER TAKE OFF - 30A - 240A, for example: Ambulance, High Load Maintenance Vehicle, Refrigeration. DO NOT ALLOW BATTERY DISCHARGE AND DO NOT ALLOW SYSTEM TO DROP BELOW 13V, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section.	Up rated 240A Extra Heavy Duty Alternator AND/OR RPM Speed Control (A003) to improve Alternator Output at idle if required. For further information see Battery Configuration, Additional Loads, Start-Stop and SRC in this section and Charging Systems to configure charge mode.
	Power Take Off applications which require elevated idle engine speeds, for example: Mobile Tire Filter Van, Welders Vehicle, Mechanical PTO from engine.	RPM Speed Control (A003)
	For application where the Customer Loads requirement exceed HIGH CONTINUOUS POWER TAKE OFF, for example: total Ford and Converter loads exceed the highest available Ford alternator rating	High Power Pack Option (A550) and Supplemental Batteries and Supplemental Energy Source pending charge balance calculation, see Battery and Cables section

NOTE: The Ford Programmable Battery Guard (A540) can be stand alone or bought within the HIGH Power Converter Pack (A550). The system is an Intelligent PATENTED battery guard for Power Take Off requirements that has features including preserving enough energy to crank even with engine off power requirements, charge the entire battery system from a mains charger, charge third party batteries from engine run, preserve leisure batteries from too many crank cycles and helps maximize fuel save, reducing emissions, charging requirements by efficiently disconnecting third party loads that are not required. There are further features to warn from disconnect and override controls. Full details of the system can be found in this Battery and Cables section.

Connectivity Usage	Recommended Specification (order code in brackets)
Additional fused relay outputs. For example: Service Engineers Van.	Auxiliary Fuse Panel (A526) option includes 3 Customer Connection Points (3 x 60A Fuses).
Roof Beacons/Additional switches. For example: Highway Maintenance Vehicles.	Beacon Preparation Pack (A606)/Utility Vehicle Switch Pack (A607) ⁽¹⁾ Note: includes Auxiliary Fuse Panel (A526)
Conversions using various vehicle signals are required, such as indicators, stop lamp, door ajar, handbrake on. For example: Police Vehicles and Ambulances.	High Specification Vehicle Interface Connector (A608) ⁽¹⁾ Note: includes Auxiliary Fuse Panel (A526).

⁽¹⁾ Utility Vehicle Switch Pack (A607) and High Specification Interface Connector (A608) cannot be ordered together.

⚠ WARNING: If the lifetime vehicle usage regarding frequency cycles of discharge, total current drain or real time battery state of charge, cannot be defined, as mentioned below, then the Conversion must default to AGM battery technology.

Standard Flooded Lead Acid Batteries can be utilized, though prior to choosing Standard Flooded over High Performance AGM batteries, the following parameters should be considered.

Taking account of standard vehicle operation over a 3 year period, the following Ah capacity cycling is available:

- Standard Flooded Battery = 30 times the battery Ah capacity
- AGM = 600 times the battery Ah capacity

For example: For an 80Ah Standard Flooded Battery, 30 x 80Ah = 2400Ah of battery turnover is available for the converter to use during the battery life (3 years)

The following are examples (in an engine off condition, using this battery size) of equivalent loading:

- 8 Amp draw for 1 hour and 300 times during battery life
- 20 Amp draw for 10 minutes and 720 times during battery life

- 60 Amp draw for 1 minute and 2400 times during battery life
- 160 Amp for 1 minute and 900 times during battery life

When calculating the available capacity it is also recommended the battery state of charge does not fall below 50% at any time.

⚠ WARNING: Vehicles with Single or Twin batteries should always fit battery guards if engine off power is required. Ford recommend (A540).

NOTE: Use AGM Batteries for deep cycle applications i.e. charge and discharge on a regular basis.

NOTE: • When considering battery discharge, the converter needs to consider the current drawn when the added system is in operation, plus any continuous key off loads even when not in use. For example, an inverter fitted will consume power even with no load connected.

NOTE: • Where possible, engine run operation of electrical equipment reduces battery discharge; both Vehicle Start and Auxiliary Batteries are utilized in conjunction with the charging system.

NOTE: • User training and appropriate battery maintenance on a regular basis will assist in ensuring correct battery operation.

4.4.13 Generator and Alternator

Torque Curve of Alternator

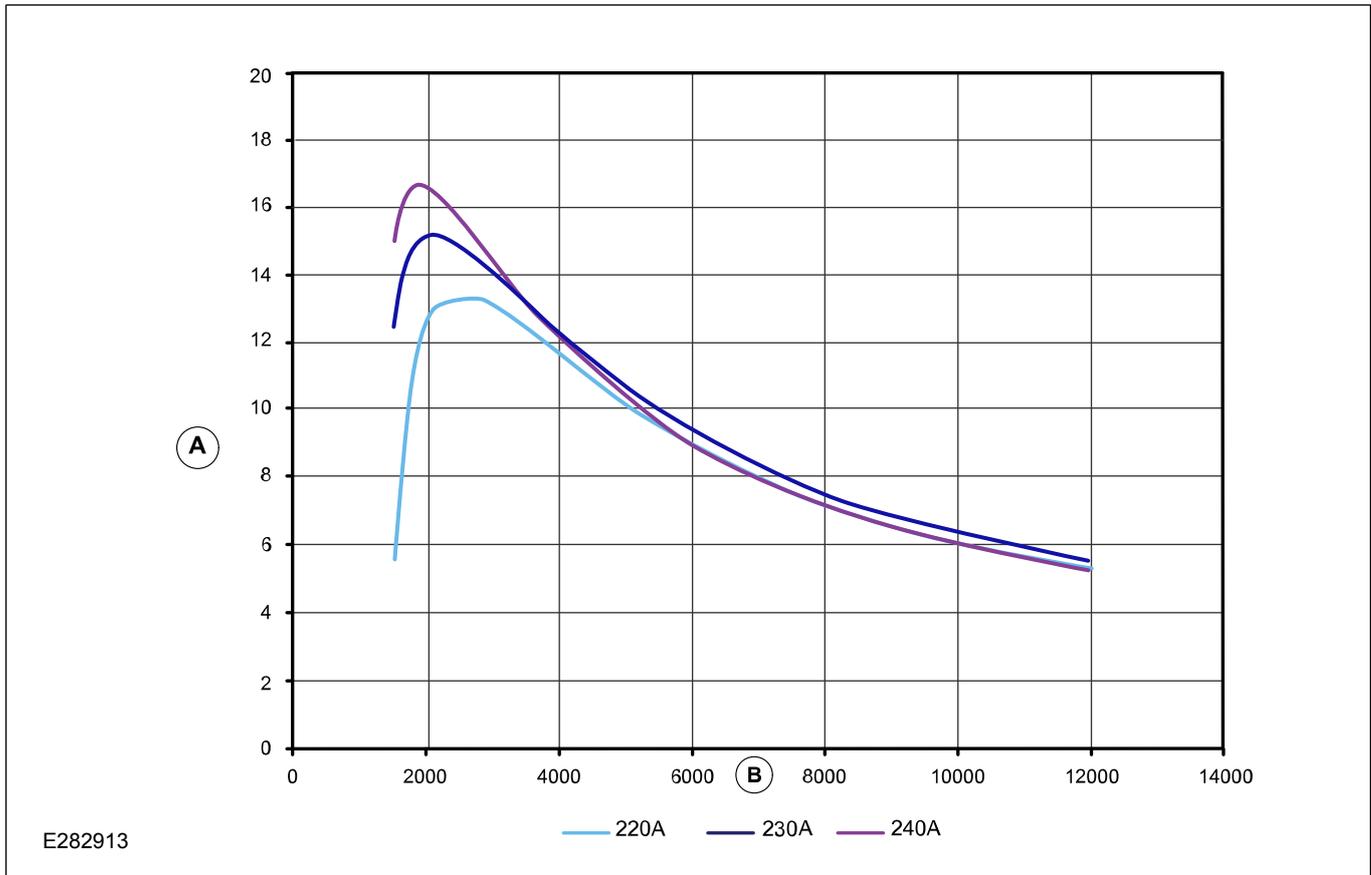
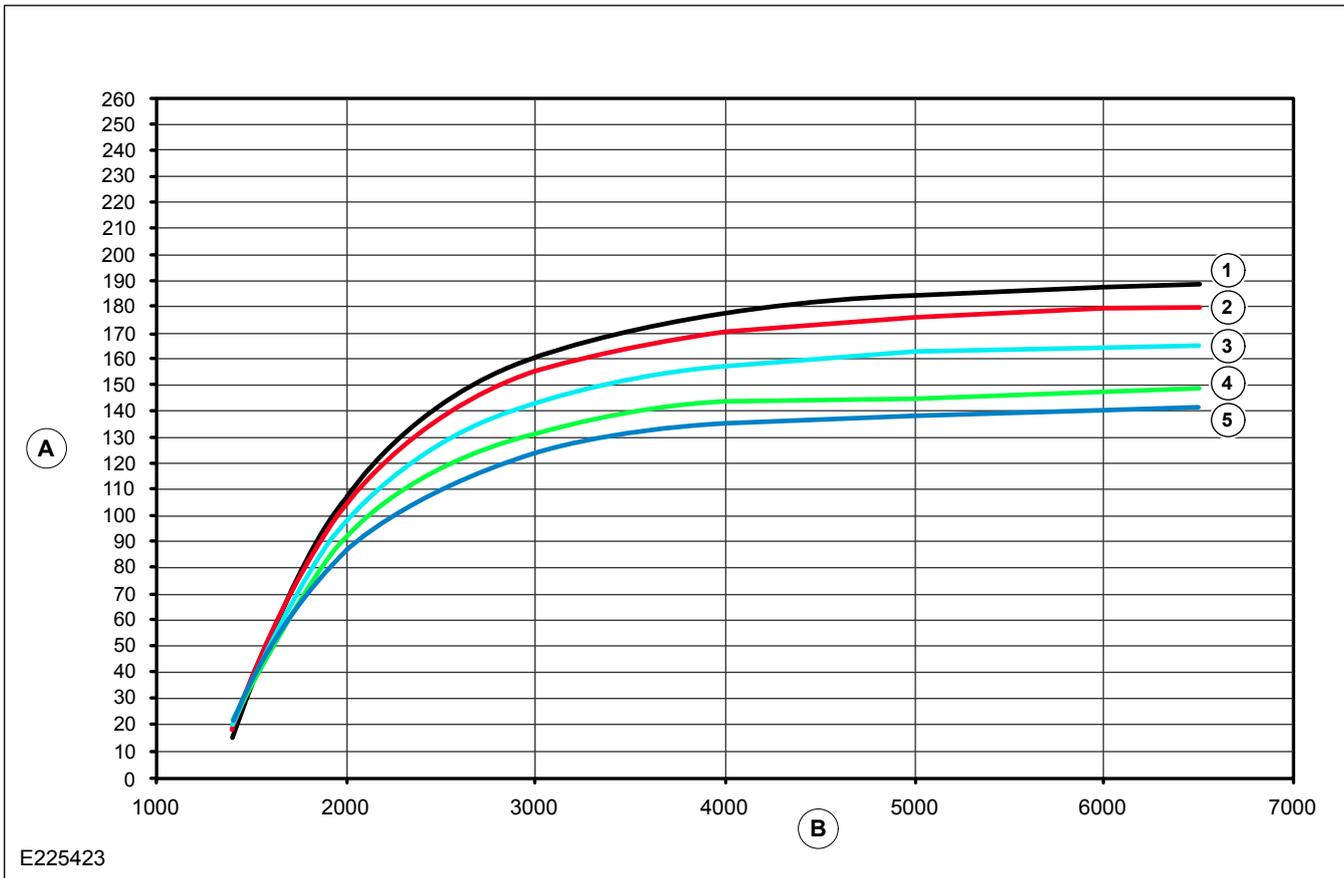


Diagram E282913 shows the torque in Nm which is required to drive the alternator. The vertical axis (A) shows the torque (Nm) and the horizontal axis (B) shows the alternators revolutions per minute (1/min).

NOTE: For equivalent engine revs per minute (RPM), the alternators revolutions, axis (B) should be divided by the following factor: 2.79 for 2.0L diesel.

NOTE: These alternator curves do not show spare output capacity as this would be dependent on original vehicle features and options.

Output Performance of Alternator - 165A



E225423

Item	Description
1	Temperature 0°C — Voltage 14.1V
2	Temperature 27°C — Voltage 13.8V
3	Temperature 60°C — Voltage 13.5V
4	Temperature 93°C — Voltage 13.1V
5	Temperature 115°C — Voltage 12.9V

Diagram E225423 shows the alternator output performance at five different temperatures. In accordance to Ford specification at five different temperatures. The vertical axis (A) shows output current (Amps) and the horizontal axis (B) shows Alternator speed in revolutions per minute (1/min).

Output Performance of Alternator - 220A

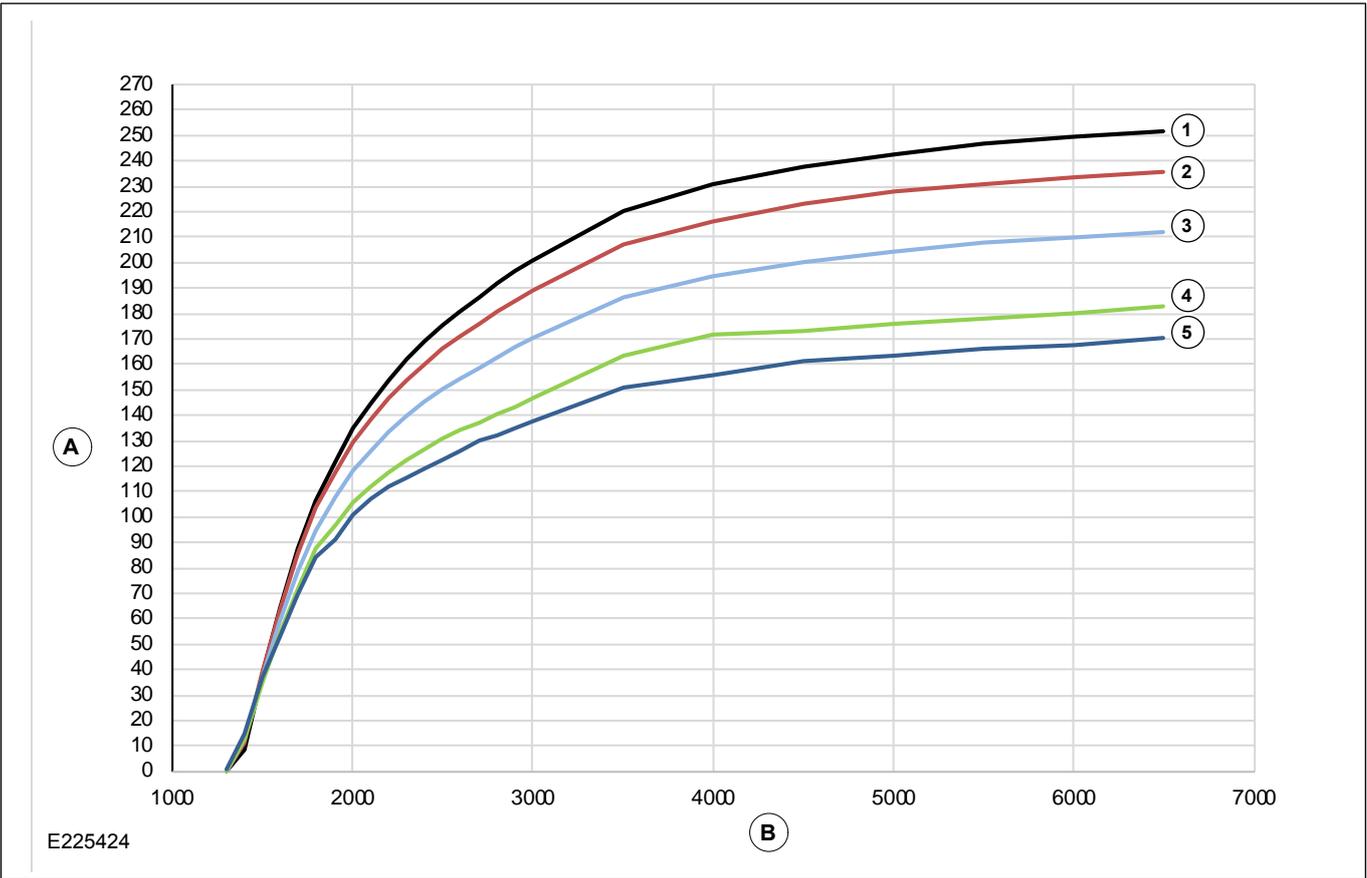


Diagram E225424 shows the alternator output performance at five different temperatures. In accordance to Ford specification at five different temperatures. The vertical axis (A) shows output current (Amps) and the horizontal axis (B) shows Alternator speed in revolutions per minute (1/min).

Output Performance of Alternator - 240A

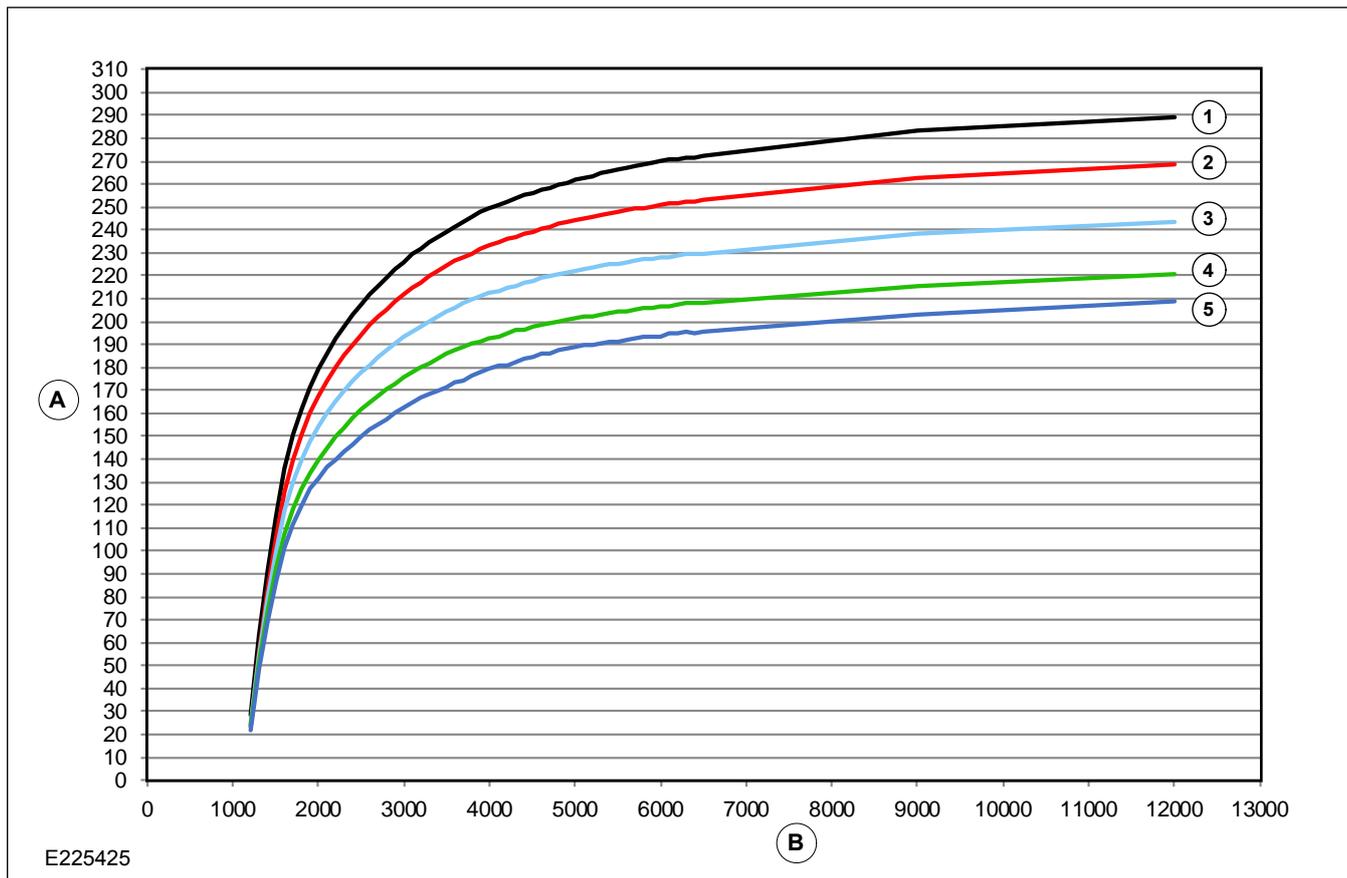


Diagram E225425 shows the alternator output performance at five different temperatures. In accordance to Ford specification at five different temperatures. The vertical axis (A) shows output current (Amps) and the horizontal axis (B) shows Alternator speed in revolutions per minute (1/min).

4.5 Climate Control System

⚠ WARNING: Do not use propylene glycol based coolant.

- Never secure hoses or tubes to the transmission fill or dip stick or to any fuel system or brake component.
- Do not route heater or refrigerant lines near or directly over any exhaust system component, including the exhaust manifolds.

- Avoid routing of hoses in the wheelhouse or stone kick-up arch. If routing is required in these areas, shield against stone pecking as appropriate.
- Do not route hoses near sharp edges. Utilize guards to protect against cutting or chafing.

Climate Control System Pin-Outs

Pin	Description
J1-1	Temp Door C
J1-2	Temp Door A
J1-3	Mode Door D
J1-4	Mode Door B
J1-5	KL31 - Ground
J1-6	ECO Switch Input
J1-7	DC Motor Recirc 1
J1-8	DC Motor Recirc 2
J1-9	EVAP Temp Sensor Input
J1-10	Not Used (connected to ground on Printed Circuit Board Assembly)
J1-11	Heated Front Screen - Button Input
J1-12	Heated Front Screen - Indicator LED Output
J1-13	Not Used (connected to ground on Printed Circuit Board Assembly)
J1-14	Mode and Temp Door Power Supply
J1-15	Heated Front Screen - Relay Output
J1-16	Heated Rear Window - Relay Output
J1-17	Mode Door A
J1-18	Mode Door C
J1-19	Temp Door D
J1-20	Temp Door B
J1-21	Supplier Diagnostic Line
J1-22	ECO Mode Indicator LED Output
J1-23	CAN Bus High
J1-24	CAN Bus Low
J1-25	Ground For Evap Temp - Sensor
J1-26	Not Used (connected to ground on PCBA)
J1 - 27	Heated Rear Window - Button Input
J1 - 28	Heated Rear Window - Indicator LED Output
J1 - 29	Smart Regenerative Charging Input
J1 - 30	Pulse width Modulation Signal for PTC Heater Control
J1 - 31	Blower Fan Relay Output
J1 - 32	Battery Power Supply (+12V)

4.6 Instrument Panel Cluster (IPC)

⚠ WARNING: Do not tamper with, cut into or connect to any of the CAN-Bus interface wiring or connectors.

Most of the functions are managed over the CAN-Bus interface.

Instrument Cluster

Connector Pin (C1)	Description	Wire Color	
1	Fuel Sender	Yellow/Violet	-
2	Low Washer Fluid	Violet	-
3	Positive Power supply	Gray/Red	-
4	High Speed CAN Low	White/Green	Twisted
5	High Sped CAN High	Green/Blue	
6	-	-	-
7	Fuel Sender Return	Green/Blue	-
8	-	-	-
9	Not in Park	Green	-
10	-	-	-
11	-	-	-
12	Negative Power Supply - Ground	Black/Violet	-

4.7 Horn

Any other aftermarket horn (for example an air horn) will need to be driven by a separate relay energized by the horn circuit.

4.8 Electronic Engine Controls

CAUTION: Do not make any additional connections to the electrical circuits associated with the engine management system.

NOTE: It is not necessary to disconnect or remove engine management modules.

4.8.1 Start-Stop

WARNINGS:

⚠ The engine may restart automatically if required by the system. It will only automatically restart when the clutch pedal is pressed. If no pedal is pressed, the Start-Stop indicator will flash and a message will be shown in the display.

⚠ Switch the ignition off before opening the hood or carrying out any maintenance.

⚠ Always switch the ignition off before leaving your vehicle, as the system may have shut down the engine but the ignition will still be live.

⚠ The system may not function if you leave additional loads connected with the ignition off.

It is very important not to make any modifications to the shielding around exposed moving parts on the engine, for example the drive belt.

General Information

Start-Stop is designed to improve fuel economy and reduce CO₂ emissions by automatically stopping the vehicle's combustion engine during idle phases when it is not required for motive power, and restarting it when required.

Start-Stop Logic

Automatic engine stops and restarts are controlled by the Start-Stop logic within the Electronic Control Module (ECM). This is connected to a number of vehicle and powertrain signals, sensors and switches and decides when to shut down and when to restart the engine, based on the particular Start-Stop strategy employed. Stop-in-Neutral is a Start-Stop strategy applicable to manual transmissions which stops the engine, subject to inhibitors, whenever the vehicle is stationary AND neutral is selected AND the clutch has been fully released. The engine is restarted on clutch pedal press in neutral.

Inhibitors

Sometimes the engine may not shut down or will request auto restart due to one or more system inhibitors being active. The engine will shut down only when all inhibitors are cleared, which maybe some time after the transmission is shifted to neutral and the clutch pedal is released.

Typical examples of inhibitors are:

- If the ambient temperature is below the lower limit or above the higher limit for Start-Stop
- Engine coolant temperature not warmed up (value dependent on ambient temp)
- Heated front screen is on
- Insufficient battery charge to sustain a stop event or too high a current drain or battery is cold or battery failure
- Driver's door has been opened and vehicle has not been driven over 5 kph since
- Engine management reason, for example: during a DPF regeneration event
- The ABS warning lamp is on or the vehicle is on a steep gradient
- High electrical load where total vehicle current A drain exceeds 50 Ampere
- Ford Engine RPM (Revs per Minute) Speed Controller System is active
- Un-recognized battery fitted or BMS damaged or removed
- Start-Stop or ECO button is pressed (LED illuminated)
- Accelerator pedal or clutch pedal is not released
- Greater than 100mA continuous load at ignition off. The BMS will be unable to correctly assess battery state of charge
- Vehicle in Factory or Transport mode

Stall Recovery/Start Abortion Recovery

Stall recovery is an additional feature available with Start-Stop, and is active even if Start-Stop itself has been deselected or is inhibited. Under stall recovery, an automatic engine restart is invoked if the clutch pedal is fully depressed immediately following a vehicle stall, thus enabling the driver to quickly recover from a stall condition without needing to cycle the ignition key/start-button. Stall recovery is only available for 5 seconds following a stall.

Start-Stop De-selection (Start-Stop button with LED illuminated)

The Start-Stop function may be deselected by the driver by means of the Start-Stop button on the dash panel. An integral amber LED in the button illuminates to indicate that the function is disabled. After ignition OFF and ON, Start-Stop will be re-enabled. Pressing the button again (LED not illuminated) will make auto Start-Stop active.

Vehicle Modification Considerations

There are two main considerations: impacts to Start-Stop behavior as a result of vehicle modifications and impacts from the Start-Stop system.

Impacts to Start-Stop Behavior

Inhibitor occurrence may be increased by vehicle modifications. For example the 12V energy management system on the vehicle is designed to allow the engine to shutdown only if the current drain is less than 60A. High current loads may lead to this threshold being exceeded. In addition engine stops will be inhibited if the battery state of charge is below 68%, which may occur if added electrical loads are active during key-off periods. When installing extra peripherals, be aware of the continuous / quiescent current drain of such equipment, even when in Off or Standby mode. Any module should not draw more than 5 mA (milliamps) in electrical load when off. If current draw is high at key-off, a different battery system should be considered instead of the standard fit battery system. The AGM 2 x 80Ah twin system which has been engineered to work with Start-Stop, should be considered if electrical loads will be high at Engine Run and Off but total key off load including Ford systems must not exceed 90mA. Please contact your local Ford dealer to enquire about this option.

NOTE: Regardless of the battery configuration, key-off load in excess of 100mA for 7 days or more will cause Start-Stop to inhibit.

For additional information

Refer to: [4.4 Battery and Cables \(page 78\)](#).
Battery Monitoring Sensor.

Start-Stop uses a small DC-DC converter (Voltage Quality Module) to isolate sensitive electrical modules from the effects of the voltage transient caused by the starter motor in-rush current when the engine restarts.

Start-Stop is only designed to operate with the specified Battery type for the system. Fitting additional batteries or the incorrect type will cause incorrect state of charge assessment leading to Start-Stop becoming permanently inhibited and therefore the fuel saving features lost. This is the same as for Smart Regenerative Charging (SRC).

Refer to: [4.3 Charging System \(page 72\)](#).
SRC.

The driver's door switch is used to help identify if the driver has left the vehicle and prevent engine shutdowns. If any modifications are made to the door or switch then this functionality may be affected. If the driver's door is not used then ensure this switch is permanently closed (input grounded).

The system uses signals from switches/sensors on the clutch, brake and accelerator pedals along with and the transmission shift mechanism. To avoid compromising the safety of the system, no electrical connection should be made to any of these signals.

Impacts from Start-Stop System

Start-Stop is designed to shut down the engine when it would otherwise be idling. Some modifications may rely upon a running engine to operate. Ford's RPM speed controller will automatically inhibit Start-Stop from shutting down the engine when the vehicle is stationary. Aftermarket systems do not have this facility so the driver may need to use the Start-Stop button to disable Start-Stop when such devices are being used. The starter relay should never be bypassed or driven directly.

With the Ford-fit RPM controller, please be aware that the throttle pedal functionality is different. For instance, if RPM is active, pressing the throttle pedal will stall the engine. If an RPM controller is required – it is recommended to use the Ford engineered system as this is developed with the Start-Stop System. An aftermarket fit system may still have the engine switch off when not expected.

The Special Vehicle Option feature Engine Run signal, which is a switched ground signal, on a Start-Stop vehicle is only active when the vehicle's engine is actually running (for example: not active during an auto-stop). Any equipment connected to the Engine Run signal will therefore experience more cycles than on a conventional vehicle. Such equipment must ensure that it can handle a lifetime of 300,000 cycles. A quiet or silent type relay may also be required as these increased cycles may be audible to occupants during Start-Stop Events. Alternatively, consider packaging the control system away from the occupants.

All converter fit loads should be connected to either customer connection points. Converter fit loads must not be connected to the vehicle start battery, on a twin battery system.

4.8.2 Engine RPM (Revs per Minute) Speed Controller (A003)

System Overview

This feature enables the engine in the vehicle to be run at elevated RPM speeds. The power from the engine can then be used to drive ancillary equipment. The ancillary equipment may be powered via a Front End Accessory Drive (FEAD) layout (in a similar fashion to the air conditioning compressor).

The maximum power that is available for front end accessory drive applications at any engine speed is 6kW (in lieu of the 26Nm air conditioning compressor). For additional information please contact the Vehicle Converters Advisory Service, VCAS@ford.com

The converter should consider any increased engine cooling requirements due to the conversion and running the vehicles engine under load for extended periods while the vehicle is stationary.

3 Modes of Operation

There are 3 principle modes in which this feature can operate, they are:

1. **3 Speed Mode** this provides the end user a choice of up to 3 preset RPM values of 1100, 1600 and 2030rpm to select from. The end user cannot easily override these values so there is minimal risk of damage to ancillary equipment due to it being run at speeds it was not designed for. Very limited vehicle speed is allowable while in this mode (up to 2.5mph approx)
2. **Variable Speed Mode** this provides the end user with RPM speed ramp up and down buttons. The end user is free to select RPM values between 1300-3000rpm in 25rpm steps. A single press results in a 25 rpm jump. If a ramp button is held depressed by the end user then the rate of change is 250rpm/sec. Very limited vehicle speed is allowable while in this mode (up to 2.5mph approx).
3. **Idle Up Speed** this mode allows the engines normal idle to be increased (in 25 rpm steps) in the range 900-1200rpm. There is not a vehicle speed restriction in this mode as the intended use is to raise the engine idle to reduce the likelihood of engine stall when

ancillary equipment is being run from the engine during normal drive operations. For example: Refrigerator units used to keep the cargo bay cool.

System Availability

This feature is built into the latest Powertrain Control Module (PCM) software on all diesel engine variants.

By default the feature is not enabled unless the vehicle is specifically ordered with the feature from the factory.

Vehicles which have not been ordered with this feature, may have the feature enabled at a dealer via the Integrated Diagnostic System (IDS) on vehicles built before 2016.75MY or the Ford Diagnostic Repair System (FDRS) on vehicles built after 2016.75MY. There is a dealer charge for this service.

Vehicles fitted with Start-Stop technology may be converted to RPM speed control, however, the customer should turn Start-Stop off prior to starting RPM speed control. For more information refer to 'Impacts from Start-Stop System' in this section.

How to control this feature

A loop of wire (green/white) is provided in the main electrical harness to permit control of the RPM Speed Control software. Cutting this loop will provide two wires to connect a control box to the PCM. The loop wire is always on the left hand side of the vehicle.

The control box needs to switch resistors into the circuit across the two green/white wires which formed the loop prior to being cut. This sort of circuit is known as a resistance ladder, see figure E88295. The PCM software monitors the green/white wire circuit and when certain resistance's are detected they are interpreted as various inputs which control the feature. The switch box can be located where it is ideally required for the vehicle conversion in question, rather than having to be mounted on the Instrument Panel (IP). If the converter chooses to locate the switch box in a location which is subject to an adverse environment then the converter should design the switch box to withstand with these conditions.

Green/White Loop Location (RHD shown) - Vehicles built before November 2016

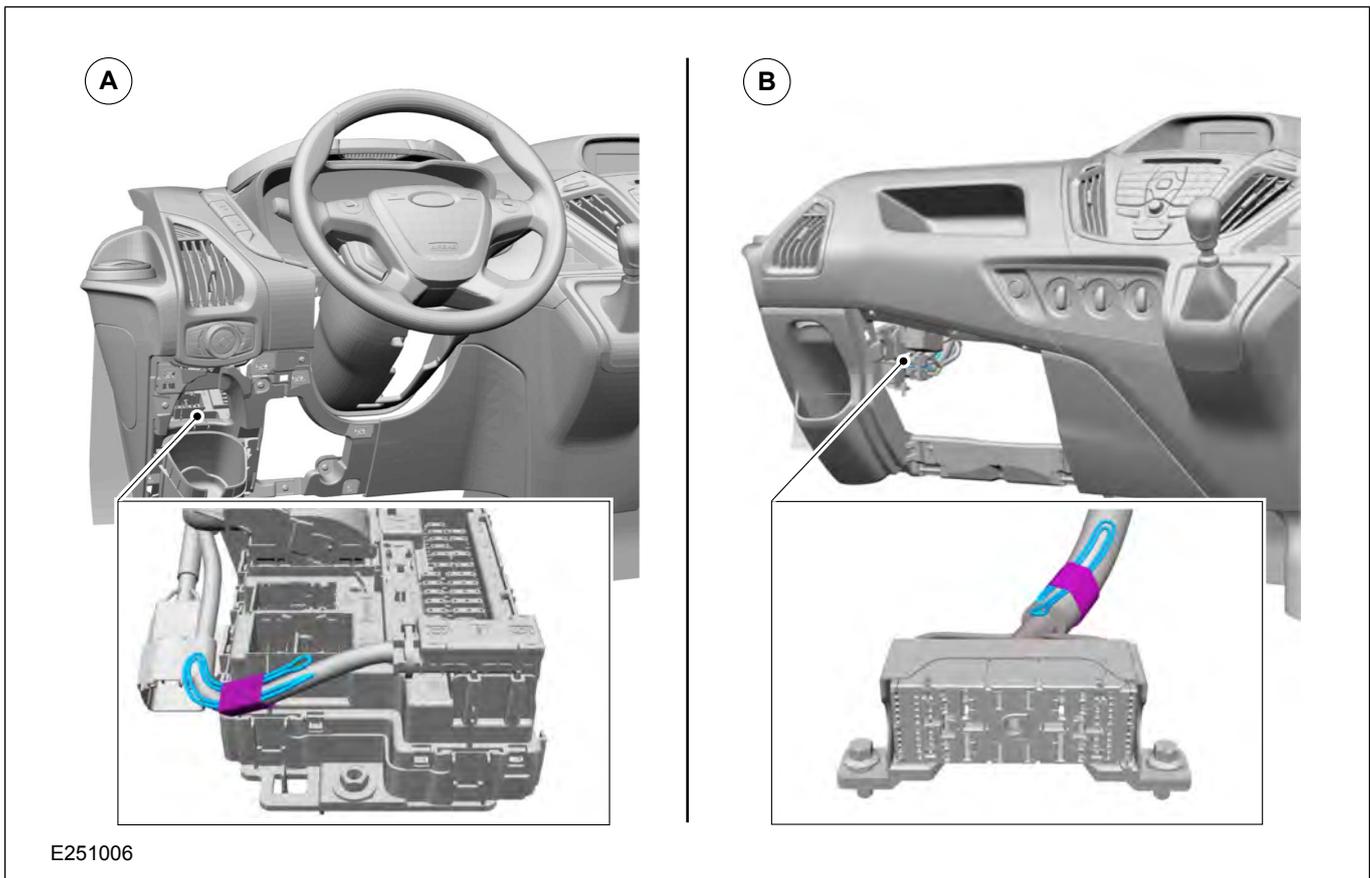


E146658

The harness is loosely taped in this location, so that the green/white loop (1) can be easy to extract.

The harness and loop is always on the left hand side of the vehicle. See figure E146658.

Green and White Loop Location - Vehicles built after November 2016



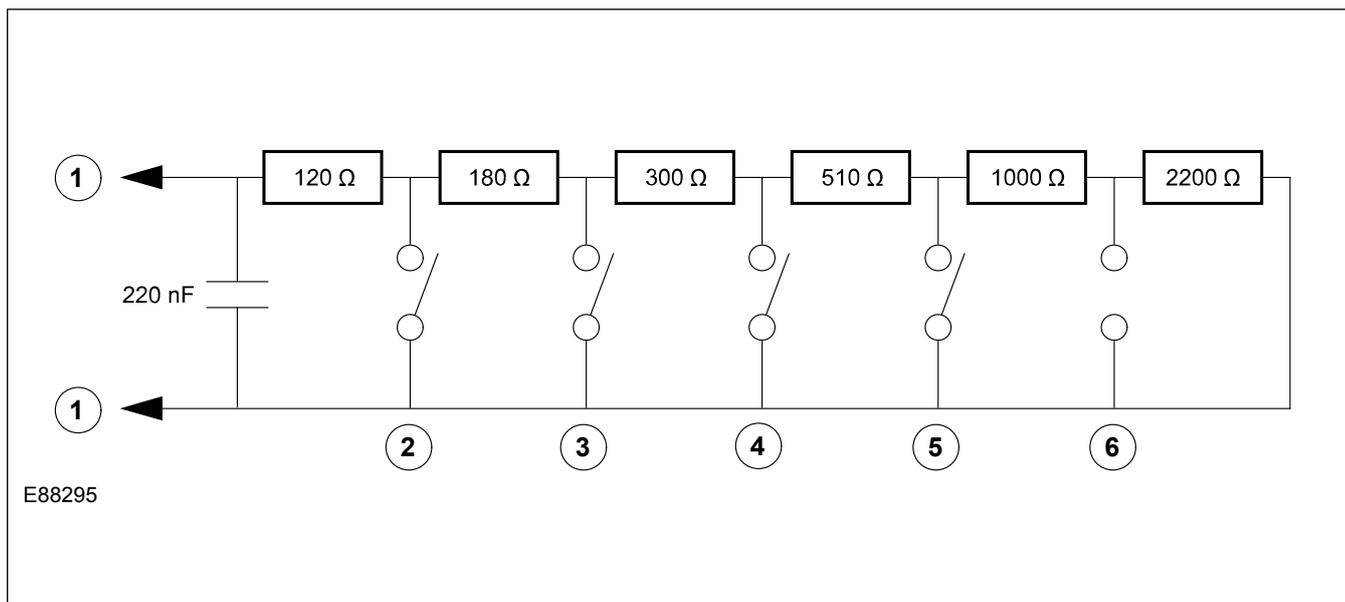
E251006

On left hand drive vehicles the loop is taped to the harness feeding the fuse/relay box, located behind the lower instrument Panel trim to the left of the steering wheel, this can be accessed through the bottle holder, see (A) in figure E251006. Refer to Workshop Manual for removal of trim.

On right hand drive vehicles (B) the loop is taped to the harness which feeds the 64 way main instrument panel connector, located behind the lower instrument panel trim, which can be accessed through the glove box, see figure E251006. Refer to Workshop Manual for removal of trim.

Resistance Ladder

Resistance Ladder Circuit



Item	Description
1	To Green/White Wire
2	Stop Engine
3	RPM 1 on/off or Variable Control 'Idle'
4	RPM 2 on/off or Variable Control 'Negative (-)'
5	RPM 3 on/off or Variable Control 'Positive (+)'
6	RPM Control Armed or Increased Idle on/off

The resistance ladder circuit acts as a potential divider. The PCM has an internal reference voltage of 5 volts. Current passes through an internal 320 ohm resistor (not shown above) prior to passing through the resistance ladder. There is also a (second) 220 nF capacitor internally within the PCM between the 320 ohm resistor and ground (not shown above) and this is to reduce Electromagnetic Compatibility (EMC) effects.

With all the switches open there is a total resistance in the green/white loop of approx 4310 ohms and this corresponds to normal driving operation (the condition prior to the loop being cut).

To ensure robust operation, it is recommended for all switches that a switch de-bounce specification is chosen as close to zero ms (mili seconds) as possible.

Starting from the right of the diagram, when the key switch is closed only 2110 ohms is in the circuit and the PCM software recognizes this as the RPM mode being armed and ready for operation (Key switch closed = off, open = on. **Note:** this is the reverse situation of vehicles with 2.2L engine). A key switch is recommended in this position for a couple of reasons:

- If the control box is located externally on the vehicle, the requirement for a key avoids any passers by being able to put the vehicle into RPM Speed Control mode by simply pressing a button.
- Using a key switch where the key can be removed in either the on or off condition could be used as an aid to anti-theft. If the operator uses a key to put the vehicle into RPM Speed control mode and then removes the key, then the vehicle cannot quickly and easily be taken out of RPM speed control mode. If a foot pedal is pressed while in either the 3 speed or variable speed modes, the vehicles engine will stall and therefore the vehicle cannot easily be driven away and stolen. A software update is available from November 2016 which will prevent the engine from starting after a stall event until the RPM speed control box is turned off. Check with your local Ford dealer or NSC for latest software update.

When in 3 speed mode pressing any of the middle 3 switches (with the feature armed) results in the engine RPM jumping to the corresponding RPM value held in memory (defaults of 1100, 1600 or 2030rpm) for the 3 switch positions. A second consecutive press of the same button returns to normal idle.

When in variable speed mode the same 3 buttons act as ramp up, ramp down and return to idle selections respectively.

The software in the PCM responds to the change of state, so it is recommended that these 3 middle switches be non-latching push button micro switches. When going from idle to an elevated RPM the execution of the command will occur as the button is released. When going to idle the execution of the command occurs as the button is pressed.

The final button (the one on the left in figure E88295) acts as a vehicle engine stop. It is recommended that this be a red and oversize non-latching micro switch button. The execution of this command will occur as the button is pressed.

All wiring connecting the PCM to the resistance ladder control box should be shielded and twisted (33 twists/m) to reduce EMC effects.

All resistors should have a tolerance of +/- 5% or better.

Switch contact, connectors and loom (loom between the green/white wires and the control box) total resistance must be no greater than 5 ohm max.

The PCM to resistor ladder control switch box loom should not come within 100mm of any other harness, especially any carrying heavy loads.

Designs which do not require all the button switches must still have the complete resistor network with the switches positioned correctly within the network.

A suitable two way quality connector should be used to connect the control box to the two green/white wires.

How to change the default settings

NOTE: It is not possible via either method below, to change the step value of 25 rpm per press or the 250 rpm per sec for a held down button, in the variable rpm speed.

By default, when the feature is first enabled (either via factory order, via dealer IDS or FDRS tools), it will be set to the 3 speed mode of operation with preset RPM values of 1100, 1600 and 2030rpm for the 3 speeds.

There are two methods by which these defaults can be modified:

1. Via the IDS or FDRS at a Ford dealer (there may be a charge for this).

Via the IDS or FDRS the mode of operation can freely be changed between any of the 3 principle modes of operation, the feature can even be turned off (disabled). The 3 default RPM speeds can also be modified within the allowable range for the mode of operation as detailed in this section.

Via IDS the RPM Speed Controller menu is under the tool box tab, then Powertrain, then Service Functions, then PCM. Via FDRS, once you have logged into FordEtis & performed a "vehicle lookup" for your vehicle, the RPM Speed Control menu is under "Vehicle Software" - "PCM" - "Configuration" - "Engine Speed (RPM) Control Configuration". The FDRS on screen menus will guide the dealer through the options & setup.

2. Via an inbuilt vehicle 'learn mode'.

Via the vehicle 'learn mode', it is possible to switch from the default 3 speed mode to variable speed mode, however it is not possible to switch back using this method.

How to enter vehicle 'Learn mode'

1. Make sure that the RPM Speed controller switch box is connected but turned off.
2. Start the engine (vehicle out of gear and no foot pedals being pressed, handbrake on).
3. Wait a couple of seconds for the instrument panel start up diagnostic lamps to extinguish.
4. Press and release the clutch pedal.
5. Press and release the brake pedal.
6. Repeat steps 4 and 5 a further four times (clutch & brake pressed a total of five times sequentially each).

NOTE: Steps 4 to 6 have to be started within 10 seconds of the engine start.

The vehicle should now be in 'learn mode'.

On successful entry into 'learn mode' the engine RPM will momentarily rise up to 1000rpm and drop back to normal idle, which can be seen by monitoring the rev counter needle in the IP while performing step 6 above.

How to select between modes

NOTE: If the engine stalls out at the initial brake pedal input then the vehicle was not in, or has dropped out of learn mode and you will have to restart the learn procedure.

1. Enter learn mode (see directions above).
2. Arm the RPM speed controller (turn the key switch to ON).

If the vehicle is already in 3 speed mode (the initial default):

3. Press and release the brake pedal five times.

The vehicle should now be in variable speed mode. The new settings can be saved and learn mode exited (see below).

or

4. Press and release the brake pedal once.

The vehicle should now be in 3 speed mode. The new settings can be saved and learn mode exited (see below).

Using this method it is easy to change between these two modes of operation for the RPM speed controller.

How to change the 3 pre-set default RPM values in the 3 speed mode

NOTE: If the engine RPM responds to the initial RPM button press, then the vehicle has not entered 'learn mode' correctly and you will have to restart the procedure. If the engine stalls out at the brake or accelerator pedal inputs then the vehicle was not in, or has dropped out of 'learn mode' and you will have to restart the procedure.

1. Enter 'learn mode' (see directions above).
2. Arm the RPM speed controller (turn the key switch to 'on').
3. Press and release the brake pedal once.
4. Press and release the RPM button that requires re-programming.
5. Use the accelerator pedal to rev the engine to the new desired RPM speed and hold at this speed (only speeds between 1200 to 3000 rpm can be selected in 3 speed mode).
6. Press and release the same RPM button to reset the stored RPM speed to the current engines RPM.
7. Release the accelerator pedal.
8. Repeat steps 4 to 7 for the remaining RPM buttons.

The 3 RPM speeds should now be re-programmed to the new RPM speeds. The new settings can be saved and 'learn mode' exited (see below).

How to save new settings and exit from 'Learn mode'

NOTE: The engine stalling indicates that the settings should have been saved and the vehicle has exited from 'learn mode'. Learn mode however is very specific that the exact steps are taken in the correct order and within certain time limits otherwise the learn procedure fails and it may take several attempts to get this order and timing correct and a successful modification from the default settings.

1. From within the 'learn mode' and with the RPM Speed Control switch box 'armed', fully press & release the clutch pedal at least five times in quick succession. The engine may stall out on the last depress which is normal, however if the engine does not stall out after at least 5 clutch pedal depresses, then you can key off after the sequence of rapid clutch depresses.
2. Restart the engine and test the new settings, repeat above procedures if necessary.

Reasons why RPM speed Control operation may stop or fail

The RPM Speed control software monitors vehicle information during operation in RPM speed control mode and will drop out of RPM speed control and/or stall the engine should any adverse signals be detected. For example:

- If the engine temperature becomes too hot then RPM speed control will stop in order to protect the engine.
- If the engine oil lamp illuminates then RPM speed control will stop in order to protect the engine.
- If the low fuel level lamp illuminates then RPM speed control will stop so that the vehicle can be driven to a refueling point.
- If the vehicle speed exceeds approx 2.5 mph while in 3 speed or variable speed modes, then RPM speed control may stop. RPM speed control should normally be operated with the hand brake on, but some uses may require a low level of vehicle 'creep' during RPM speed control operation.
- The software monitors for 'stuck on' buttons on the control switch box, this may result in RPM speed control being halted. A button that is held down for too long may be registered by the software as a 'stuck' button.
- The software monitors the foot pedals, if depressed these may stall the engine if in 3 speed mode or variable speed mode (does not apply to idle up speed).
- If the control switch box circuitry significantly exceeds 2110 ohms or there is a short circuit then RPM speed control will not be possible.
- If a PTO conversion has been attempted on a vehicle with a non anti braking system (ABS) then RPM speed control will fail due to vehicle speed being registered via a transmission speed sensor and / or the need to press the clutch in order to put the vehicle in gear while in RPM speed control mode.

4.8.3 DPF and RPM Speed Control

The Diesel Particulate Filter (DPF) captures soot in the exhaust fumes to improve vehicle exhaust emissions. The condition of the DPF is monitored by the vehicles electronic systems. Under normal driving conditions a regeneration feature is triggered to clean the filter. If the DPF becomes full, a red engine warning lamp illuminates on the instrument cluster and the vehicle will need to be taken into the local Ford dealer to have the DPF specially purged.

Vehicles fitted with DPF, running under RPM Speed Control with the engine running under load at elevated idle, may produce soot build up over time. With the vehicle stationary, the DPF is unable to start a regeneration event. It is therefore recommended that vehicle converters advise operators to break up any long periods under RPM Speed Control operation with some normal driving to permit the DPF to regenerate. Rapid cycling of the engine RPM, while in the RPM Speed Control mode, should be restricted where possible, as RPM transients increase soot generation rate. Where the anticipated use for RPM Speed Control is expected to be for longer durations, it is strongly recommended that the Operator Commanded Regeneration (OCR) option is also specified in conjunction with RPM Speed Control (check with your local Ford dealer for availability of option). OCR allows the driver/operator to manually perform a DPF regeneration while the vehicle is stationary, after confirming that it is safe to do so.

 **WARNING: Do not park or idle your vehicle over dry leaves, dry grass or other combustible material. The DPF regeneration process creates very high exhaust gas temperatures. The exhaust will radiate a considerable amount of heat during and after DPF regeneration and after you have switched the engine off. This is a potential fire hazard.**

For additional information on DPF

Refer to: [3.7 Exhaust System \(page 51\)](#).

4.8.4 Changing Vehicle Speed Maximum Setting

The Vehicle Speed Maximum Setting can be changed via the IDS menu under the following tabs: Toolbox, Powertrain, Service, Functions, PCM. The IDS on screen menus will guide the dealer through the options and setup.

4.9 Tachograph

NOTE: Siemens VDO are now known as Continental VDO, part of Continental Automotive Group.

It is recommended that any vehicle that requires a tachograph is sent to an authorized Continental VDO Tachograph Service Center for system installation and calibration.

Ford Motor Company is not responsible for calibration of any tachograph unit.

Details of all recommended service centers can be found on VDO web sites. These sites also contain details of current regulations and tachograph operation.

4.9.1 Legislation

WARNING: All tachographs require the same wiring connections as this is controlled by tachograph legislation.

NOTE: Digital Tachograph (DTCO) is the legal requirement for Europe.

Pin Assignment

For detailed information about pin assignments please contact Continental Automotive Group directly, 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

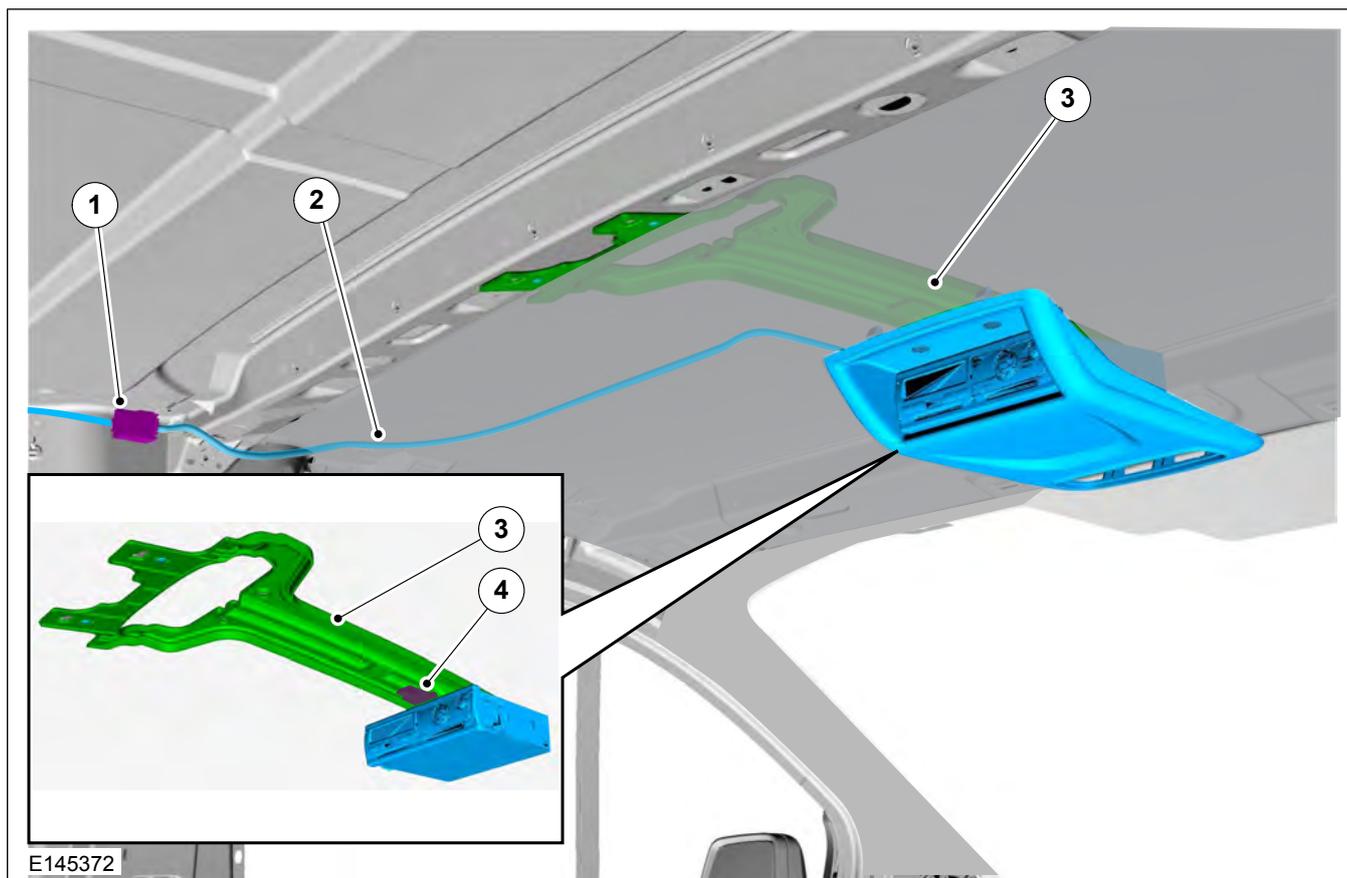
Wiring

The tachograph wiring consists of two parts:

- Speed Sensor Harness, see figure E145371 for harness routing.
- Tachograph Harness, see figure E145372 for mounting and harness routing.

4.9.2 Tachograph Harness Mounting

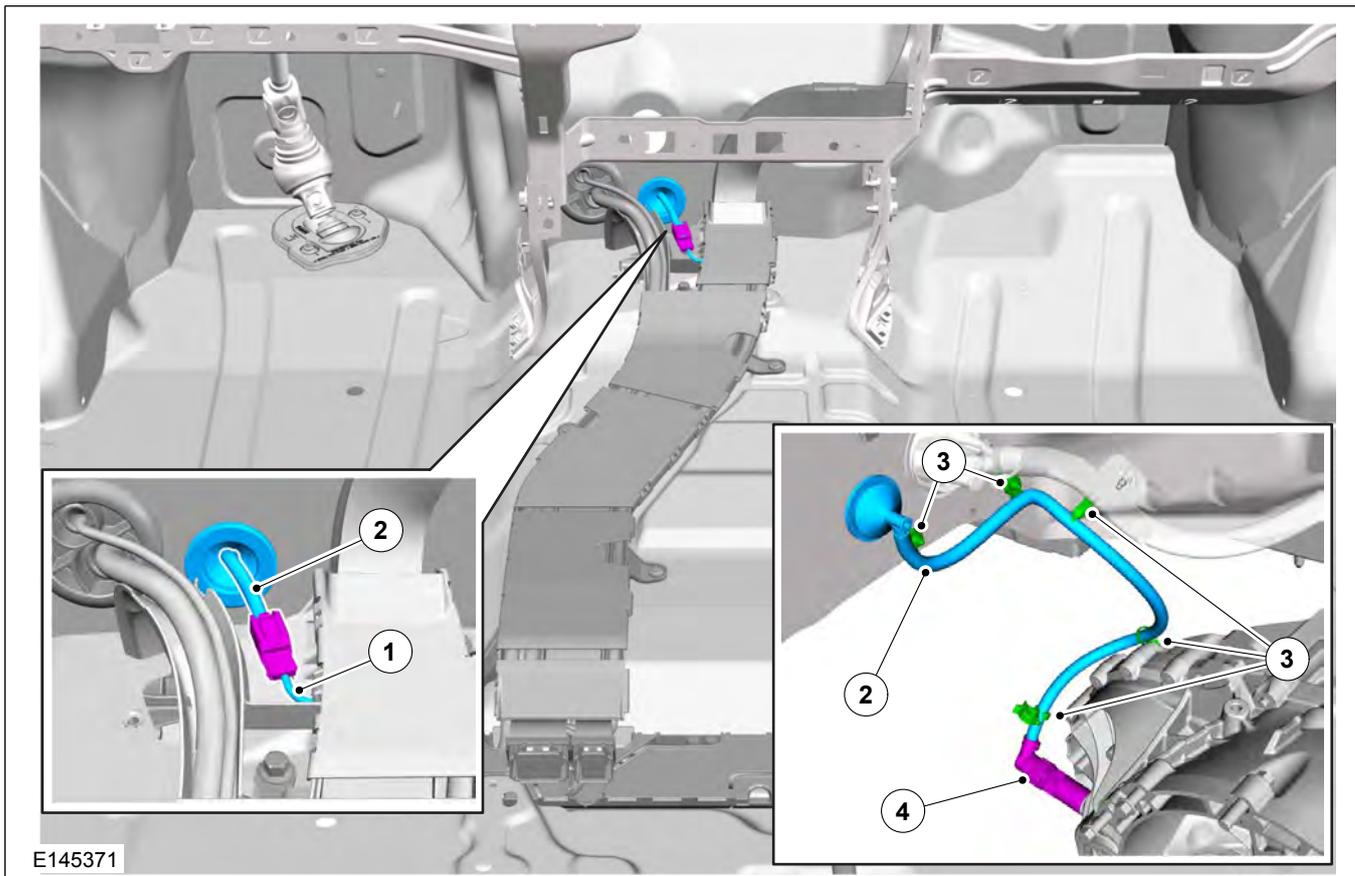
Tachograph Mounting - H1 shown



Item	Description
1	In-line connector to main harness
2	Tachograph Harness
3	Bracket Roof Console
4	Bracket Console Mounting Tachograph

Standard Ford installation in the overhead console using DIN radio bracket (headliner omitted for sake of clarity).

Tachograph Speed Sensor Harness Routing



E145371

Item	Description
1	Main Harness
2	Tachograph Speed Sensor Harness
3	Clips
4	Sensor into Transmission

4.9.3 Fitting a Tachograph to vehicles built without Digital Tachograph Option

NOTE: It is not always possible to retrofit a tachograph. If a tachograph is required, it is recommended that this is ordered on the base vehicle. For further information, please contact vcas@ford.com

NOTE: The base vehicle ordered must have an overhead console and the correct level of trim (head liner) to support fitting a Tachograph.

NOTE: The Tachograph units are not supplied by Ford service and are only available by the Continental/VDO Calibration Center. Formerly known as Siemens/VDO.

Parts required to support aftermarket fitting of a Digital Tachograph

Prefix	Base	Suffix	Name
Mounting Parts			
BK21	V519K22	A*	Bracket Roof Console
BK21	V045B34	A*	Bracket Console Mounting Tachograph
4C1T	18923	A*	Bracket Radio Receiver
Fixings			
-	W525107	S437	Rivet 4x required
-	W712703	S900	Clip
-	W502660	S437	Screw
Tachograph Units			
BK2T	17A266	A*	Digital
Speed Sensor			
BK2T	17K321	A*	VMT6
Wiring Harness			
GK2T	14K141	B*	Speed Sensor Harness
GK2T	14K141	C*	Tachograph Harness

Fitting the Speed Sensor – See figure E145371

1. Locate the sensor housing
2. Remove the protective cap
3. Fit the speed sensor
4. Fit the supporting wiring harness

For further information on fitting instructions of a Tachograph unit please contact the Vehicle Converts Advisory Service at VCAS@ford.com

4.9.4 Vehicle Configuration Change

For the cluster to obtain the vehicle speed from the Tachograph the central car configuration parameter 118 needs to be changed to 0x03 – this will be done at the Dealer.

Fitting the Tachograph Unit – See figure E145372

NOTE: The Tachograph head unit will be fitted by the Continental Calibration Center.

118 Tachograph			
Less Tachograph	HDKAA	0x01	Block 17 byte 7 - Parameter 118
Digital Tachograph	HDKAD	0x03	Block 17 byte 7 - Parameter 118

4.9.5 Calibration and Tachograph Fitting

The Continental Calibration Center will order the Tachograph and fit the unit to the vehicle. EU Legal legislation requires that before the vehicle can be used on the road, the DTCO Tachograph must be calibrated. The Digital Tachograph activation **must** be completed by an authorized VDO workshop. The Ford Dealer will organize the Tachograph Calibration.

NOTE: The Tachograph and the Cluster have independent speed signal sources, thus a difference in distance reading between the two parts may occur.

4.10 Information and Entertainment System

4.10.1 Audio Head Unit (AHU) - Multimedia in Car Entertainment (ICE) Pack Summary

The Multimedia System you have, as a standard fit, will depend on the market region, body style and model of the vehicle.

NOTE: Depending on the vehicle upgrade you are planning it is important to order the right level parts that include new Instrument Panel Harness, Instrument Panel Bezel and Hood.

NOTE: Pre Equipment Pack (less speakers) does not have wiring between the roof-mounted AM/FM/DAB antenna and the co-axial cable that connects to the AHU. If planning to retrofit an AHU you will need to order the Pre Equipment Pack.

AHU/Multimedia ICE Packs

AHU/ICE Pack	Description
0	Pre Equipment Pack (less speakers) - no audio
1	Pre Equipment Pack - no audio
2	MyConnection Radio
3	MyConnection Radio with DAB
6	Low Radio Less SYNC Gen 1
7	Low Radio Less SYNC Gen 1 with DAB
8	Mid Radio with SYNC Gen 1
9	Mid Radio with DAB/SYNC Gen 1
11	Low Navigation (NAV) SYNC Gen 1
40	Low Navigation (NAV) SYNC Gen 1 with RVC

AHU/Multimedia ICE Pack Content

Description	0	1	2	3	6	7	8	9	11	40
Less ICE	X	X	-	-	-	-	-	-	-	-
MyConnection Radio AHU/AM/FM + USB + Blue tooth	-	-	X	-	-	-	-	-	-	-
MyConnection Radio AHU/AM/FM + DAB + USB + Blue tooth	-	-	-	X	-	-	-	-	-	-
ICE - Low Audio (LOC)	-	-	-	-	X	-	X	-	-	-
ICE - Low Audio (LOC) with DAB	-	-	-	-	-	X	-	X	X	X
ICE-Low Audio (LOC) 6 Channel	-	-	-	-	O	-	O	-	-	-
ICE-Low Audio (LOC) with DAB + 6 Channel	-	-	-	-	-	O	-	O	O	O
Less Multi-Function Display (MFD)	X	X	X	X	-	-	-	-	-	-
Mid MFD - 4" TFT	-	-	-	-	X	X	X	X	-	-
Low NAV MFD - 5" TFT with NAV	-	-	-	-	-	-	-	-	X	X
Less Integrated Control Panel (ICP)	X	X	X	X	-	-	-	-	-	-
ICP Mid - Extended Less SYNC	-	-	-	-	X	X	-	-	-	-
ICP Mid - Extended	-	-	-	-	-	-	X	X	-	-
ICP NAV - Extended WITH NAV	-	-	-	-	-	-	-	-	X	X
Less Speakers	X	-	-	-	-	-	-	-	-	-
4 Front Speakers (2 woofer/2 Tweeters) + 2 Rear Speakers ⁽¹⁾	-	-	-	-	X	X	X	X	X	X
10 Speakers (Tourneo Only)	-	-	-	-	O	O	O	O	O	O
Single AM/FM Antenna	X	X	X	-	X	-	X	-	-	-
Single AM/FM DAB Antenna	-	-	-	X	-	X	-	X	X	X
Less GPS Antenna	X	X	X	X	X	X	X	X	-	-
GPS Antenna	-	-	-	-	-	-	-	-	X	X
Less GPSM	X	X	X	X	-	-	-	-	X	-
GPSM	-	-	-	-	X	X	X	X	-	X
Less NAV Data	X	X	X	X	X	X	X	X	-	-
NAV Map Data	-	-	-	-	-	-	-	-	X	X
Less Radio Controls	X	X	-	-	-	-	-	-	-	-
Radio Controls on Steering Wheel	-	-	X	X	X	X	X	X	X	X
Less SYNC	X	X	X	X	X	X	-	-	-	-
SYNC GEN 1	-	-	-	-	-	-	X	X	X	X
Less Microphone	X	X	-	-	X	X	-	-	-	-
Microphone	-	-	X	X	-	-	X	X	X	X
Less Auxiliary Heater	-	X	-	-	-	-	-	-	-	-
Aux Input Jack (AIJ)	-	-	X	X	X	X	X	X	X	X
Accessory Media Hub 1 x USB	-	-	-	-	-	-	X	X	X	X
RVC	-	-	-	-	O	O	O	O	O	X

⁽¹⁾ Rear Speakers are dependent on body style.

X = Included / O = Optional

4.10.2 MyConnection Radio and MyConnection Radio with DAB

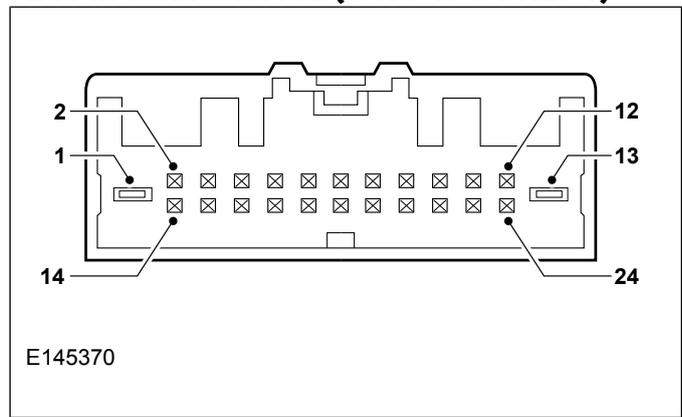
Audio Head Units (AHU) are connected to the instrument panel wiring via a single 24 pin connector, see figure E145370 and table.

NOTE: There is a black co-axial cable for the roof-mounted AM/FM/DAB antenna that goes to the side of the AHU.

NOTE: MyConnection Radio variants do not accept Multi-Function Display (MFD) or Integrated Control Panel (ICP)

NOTE: Power for radio - **do not** switch the permanent battery feed (KL 15) and ignition feed (KL 30) on the radio connection. The ignition feed 15 is only used to 'wake up' the radio.

24 Pin Connector ICE (8475-1 / 544127-1)



E145370

24 Pin Connector ICE

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	13	Audio Ground	Input
2	Switched B+ Power	Output	14	Illumination + (PWM VIH)	Input/Output
3	Ignition SW Crank Position	Input	15	Illumination -	Input/Output
4	Run/Accessory	Input	16	Audio Shield (AIJ)	Output
5	Starter Motor Control Sense	Input	17	AIJ Left +	Input
6	Aux IN Jack (AIJ) Common	Input	18	AIJ Right +	Input
7 ⁽¹⁾	Microphone +	Input	19 ⁽¹⁾	Microphone -	Input
8	Steering Wheel Control +	Input	20	Steering Wheel Control -	Input
9	Left Rear Speaker -	Output	21	Left Rear Speaker+	Output
10	Left Front Speaker -	Output	22	Left Front Speaker +	Output
11	Right Front Speaker -	Output	23	Right Front Speaker +	Output
12	Right Rear Speaker -	Output	24	Right Rear Speaker +	Output

⁽¹⁾ Pins 7 and 19 are for external microphone. Check availability with your Local Ford Dealer.

4.10.3 Mid-Radio and Mid-Radio with DAB

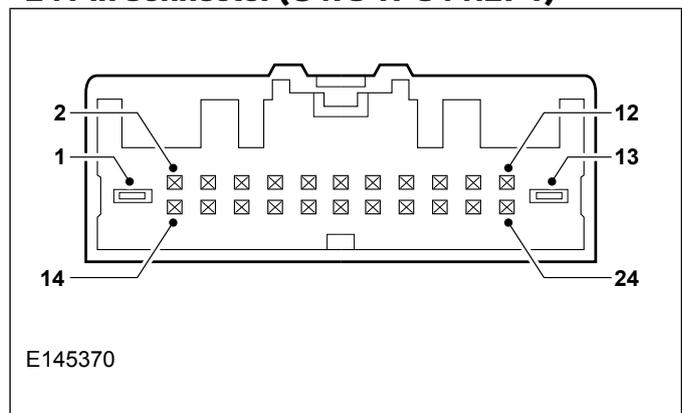
NOTE: AHU/ICE Pack 4,5 and 11 are connected to the instrument panel wiring via a 24 and 26 way connector, see figures E145370 and E146212.

NOTE: There is a black co-axial cable that connects the roof-mounted AM/FM/DAB antenna to the back of the AHU. If the vehicle has a navigation display, the black co-axial cable goes into the back of the navigation display and a second co-axial cable connects the navigation display to the AHU. There is also a thin black co-axial cable for the global positioning system antenna that goes to the navigation display.

NOTE: All vehicles, except those ordered with a Pre Equipment Pack or Pre Equipment Pack (less speakers) and all MyConnection Radios, have 3 variants of a Multi-Function Display (MFD) and Integrated Control Panel (ICP).

NOTE: Power for radio - **do not** switch the permanent battery feed (KL 15) and ignition feed (KL 30) on the radio connection. The ignition feed 15 is only used to 'wake up' the radio.

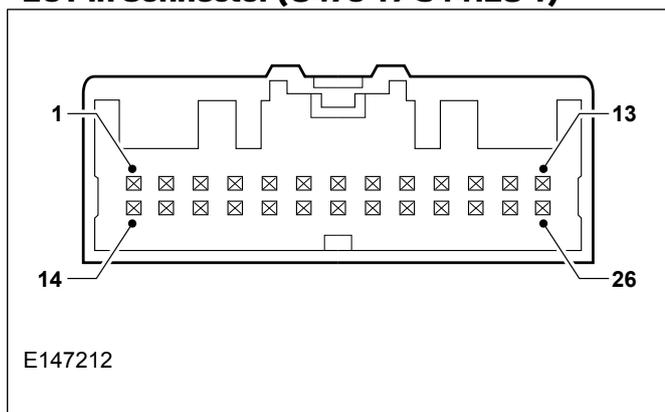
24 Pin Connector (8475-1 / 544127-1)



E145370

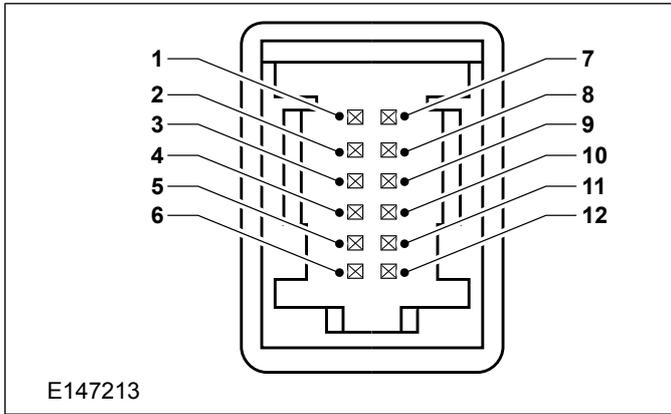
24 Pin Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	13	Ground	Input
2	Switched B+ Power	Output	14	CAN - High	Input/ Output
3	Not used	-	15	CAN - Low	Input/ Output
4	Navigation Audio In +	Input	16	Audio Shield for AIJ	Output
5	Navigation Audio In -	Input	17	AIJ Left +	Input
6	Auxiliary Input Jack (AIJ) - common	Input	18	AIJ Right +	Input
7	Not used	-	19	Audio Shield for Aux 2	Output
8	Not used	-	20	Not used	-
9	Left Rear Speaker -	Output	21	Left Rear Speaker+	Output
10	Left Front Speaker -	Output	22	Left Front Speaker +	Output
11	Right Front Speaker -	Output	23	Right Front Speaker +	Output
12	Right Rear Speaker -	Output	24	Right Rear Speaker +	Output

26 Pin Connector (8476-1 / 544128-1)**26 Pin Connector**

Pin	Description	Type	Pin	Description	Type
1	Not used	-	14	Not used	-
2	Not used	-	15	Not used	-
3	Not used	-	16	Audio Shield Aux 1	Output
4	Auxiliary Out 1 +	Output	17	Auxiliary Out 1 -	Output
5	Not used	-	18	AE_CD 1	Input/Output
6	Not used	-	19	Not used	-
7	Not used	-	20	Not used	-
8	Alert In +		21	Alert In -	Input
9	Not used	-	22	Not used	-
10	Not used	-	23	Not used	-
11	Not used	-	24	Not used	-
12	Stereo In 1 Left +	Input	25	Stereo In 1 Left -	Input
13	Stereo In 1 Right +	Input	26	Stereo In 1 Right -	Input

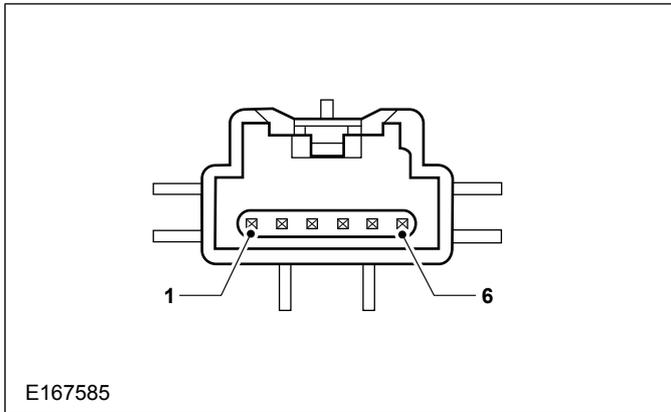
Multi-Function Display (MFD) 12 Pin Connector



12 Pin MFD Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	7	Stalk Switch	-
2	MS Body CAN +	Input/Output	8	MFD – LIN Bus	Input/Output
3	MS Body CAN -	Input/Output	9	Ground	Input/Output
4	CAN – High	Input/Output	10	Stalk Switch Return/Alarm Sense	-
5	CAN – Low	Input/Output	11	Ground	Input/Output
6	Audio Out +	Output	12	Audio Out -	Output

Integrated Control Panel (ICP) 6 Pin Connector



Item	Description
1	Battery +
2	PADI Voltage Ignition
3	PADI ON
4	PADI OFF
5	LIN
6	Ground

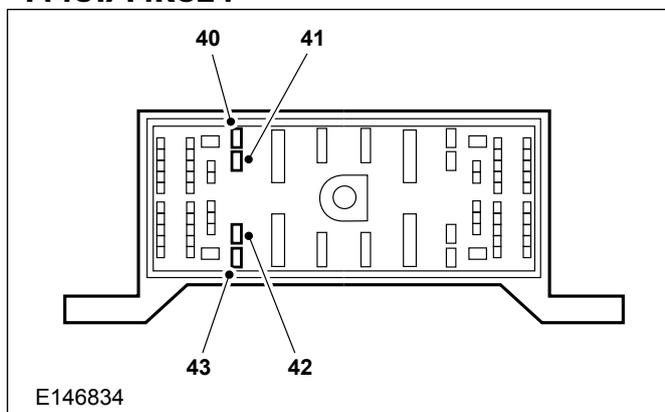
4.10.4 Additional Rear Speakers

Rear speaker wiring is always present in the instrument panel harness 14K024, but not necessarily in the harnesses 14401 and 14405/14A005 that then take the signals to the rear speaker locations.

When the rear speakers are not present at the body harness 14401/IP harness 14K024 in-line connector on low series variants the rear speakers may be spliced into the Audio Jumper Harness at the rear of the Audio Head Unit, see next table for details.

Rear Speakers - Spliced into the Audio Jumper Harness

Pin	Speaker	Wire Color
24	Right Rear +	Brown/White
12	Right Rear -	Brown/Blue
21	Left Rear +	White/Green
9	Left Rear -	Brown/Yellow

**Rear Speakers - In-line connector
14401/14K024**

Item	Description
Pin 40	Rear Speaker Left + (White/Green)
Pin 41	Rear Speaker Left - (Brown/Yellow)
Pin 42	Rear Speaker Right - (Brown/Blue)
Pin 43	Rear Speaker Right + (Brown/White)

4.11 Cellular Phone

 **WARNING: Installation of any non-Ford-approved system is not recommended and operation with associated systems cannot be guaranteed. Any resultant damage will not be covered under warranty.**

Ford offer hands-free and wireless technology (Bluetooth) phone systems (including voice recognition) as factory-fit options, these will also be available as aftermarket accessory kits from your Ford dealership.

These use the Ford MS CAN multimedia bus to operate in conjunction with the Ford audio and navigation systems.

4.12 Exterior Lighting

WARNINGS:

 **Make sure that the modified vehicle complies with all relevant legal requirements.**

 **Do not tamper with the base system (controlled by Body Control Module and multiplex architecture) and any feeds taken from the associated wiring or controller.**

4.12.1 Reversing Lamps

Reversing lamps are activated by the Body Control Module (BCM) which is controlled by the BCM high side driver. Accessories that add additional load, such as back up sounders, connected to the reverse lamp circuit, should be connected by a relay. Connecting such loads directly to the reverse lamp circuit could damage the BCM.

4.12.3 Lighting Loads

BCM Outputs	Controlling Device	Max. Load	Vehicle
License Plate and Marker Lamp Supply ⁽¹⁾	High Side Driver	27W	2 x 5W ⁽²⁾
Position/Parking Lamp Front - each side	High Side Driver	10W	5W
Position/Parking Lamp Rear each side	High Side Driver	20W	5W
Direction Indicator Front - each side	High Side Driver	27W ⁽³⁾	21W + 5W
Direction Indicator Rear - each side	High Side Driver	27W ⁽³⁾	21W
Daytime Running Lamps - each side	High Side Driver	30W	15W

⁽¹⁾License Plate and Marker Lamps not to exceed 27W. LED Markers are recommended where available.

⁽²⁾+14W if side, Roof or End Marker Lamps are already fitted.

⁽³⁾Turn Indicator Supply, smaller load will cause double flashing (bulb outage detection).

The BCM exterior lighting outputs have shutdown protection in the event of an overload condition. If the overload condition is not addressed, the output will be shutdown permanently to protect the driver hardware. A dealer visit and/or BCM replacement may be required if overload condition is not removed.

4.12.4 Lamps – Hazard / Direction Indication

The standard system configuration each side:

- 1 x Front Indicator 21W and 1 x Side Repeater 5W (shared single output) - max load 27W.
- 1 x Rear Indicator 21W (single output) - max load 27W.

4.12.5 Electrically Operated Door Mirrors

NOTE: These options are not suitable for aftermarket or converter fit.

The load on the reversing lamps should not exceed a total of 3A (42W).

4.12.2 Lamps – Front and Rear Fog

National Regulations regarding inter-connection with other Front and Rear Fog Lamps must be checked before designing the wiring circuit. The maximum permissible load with the standard system is:

- Front Fog Lamps - 2 x 55W (High Side Driver Controlled).
- Rear Fog Lamps - 2 x 21W (High Side Driver Controlled).

For additional information on Trailer Tow and Rear Fog Lighting,

Refer to: [4.18 Special Conversions \(page 143\)](#).

4.12.6 Additional External Lamps

All power for additional exterior lamps must be taken through the Auxiliary Fuse Panel with a suitable switch and/or relay as required.

Refer to: [4.17 Fuses and Relays \(page 139\)](#).

Refer to: [4.19 Electrical Connectors and Connections \(page 147\)](#).

4.13 Interior Lighting

4.13.1 Additional Internal Lamps

Electrical supply for additional cabin interior lighting may be obtained by directly accessing the connector inside the dome lamp in the cabin.

Electrical supply for additional load space interior lighting may be obtained by directly accessing the connector inside the load space lamps in the load space area.

CAUTION: The maximum total internal lamp load must not exceed 7A (105W).

For additional information on BCM

Refer to: [4.2 Communications Network \(page 67\)](#).

The battery saver system provides power for the interior lighting for a limited time.

Power supply for the interior lights.

The BCM provides power to the interior lights by three outputs, two for courtesy and one for demand:

- Cabin light courtesy function - BCM pin C3-13 with maximum load of 5A
- Cargo light courtesy function - BCM pin C3-26 with maximum load of 5A
- Combined cabin and cargo light demand function - BCM pin C3-14 with maximum load of 7A

Each interior light circuit is grounded locally to the lamp. The lamps fitted to the cabin or cargo circuit depends on the vehicle type. To determine the lamps on the rear or cargo circuit:

- Set any lights with a switch to courtesy
- Close all the doors and allow the lights to switch off
- Open the door or lift gate at the rear of the vehicle
- Any interior lights that switch on are in the rear cargo or rear zone

If fluorescent lighting is required it must not be connected to the existing interior cabin or cargo lighting as it is not compatible with the pulse width modulated (PWM) lighting circuit and may cause premature failure of the fluorescent lighting. If florescent lighting is required, it should be connected to the Auxiliary Fuse Panel.

If enhanced bright lamps are required for the cargo area of a van, it is recommended to fit the Ford Enhanced Load Space Lighting. Option A080 and LED lamp part numbers: low roof vehicles 2x BK2V-13776-A* for the front and 2x BK2V-13773-A*W for the rear. For high roof vehicles 4x BK2V-13773-B*W for the front and rear total. Jumper wires may also be required for updates. This is variant dependent part numbers GK2T-14334-A* or C*. These are controlled from the side load or rear door being ajar or manual demand from the dome lamp in the front cabin. For further information on required parts and configurations to order contact your local Ford dealer.

4.13.2 Additional Lighting for rear of vehicle interior

Where higher wattage installations are required, these should be taken through the Auxiliary Fuse Panel with a suitable switch and/or relay as required. For additional information

Refer to: [4.19 Electrical Connectors and Connections \(page 147\)](#).

4.14 Cruise Control

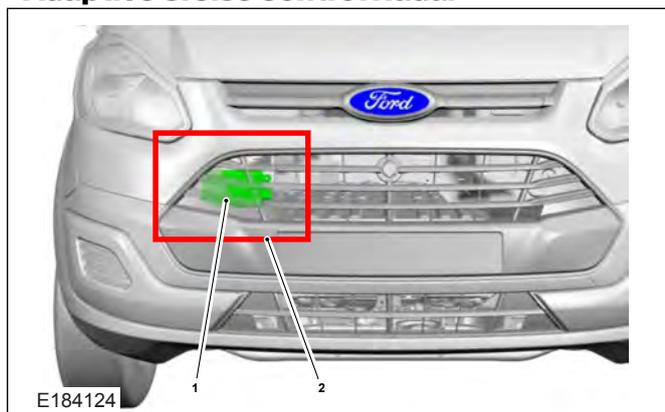
4.14.1 Adaptive Cruise Control

! **CAUTION:** For converted vehicles fitted with adaptive cruise control, where vehicle mass or geometry is significantly altered it is recommended that the radar vertical alignment and system functionality is checked by a Ford dealer. For further information refer to Workshop Manual or Owner's Manual.

NOTE: Do not obstruct the cruise control radar, see clearance zone 2 in Figure E184124

NOTE: Do not paint the front grill of the vehicle as this may affect the functionality of the cruise control radar.

Adaptive Cruise Control Radar

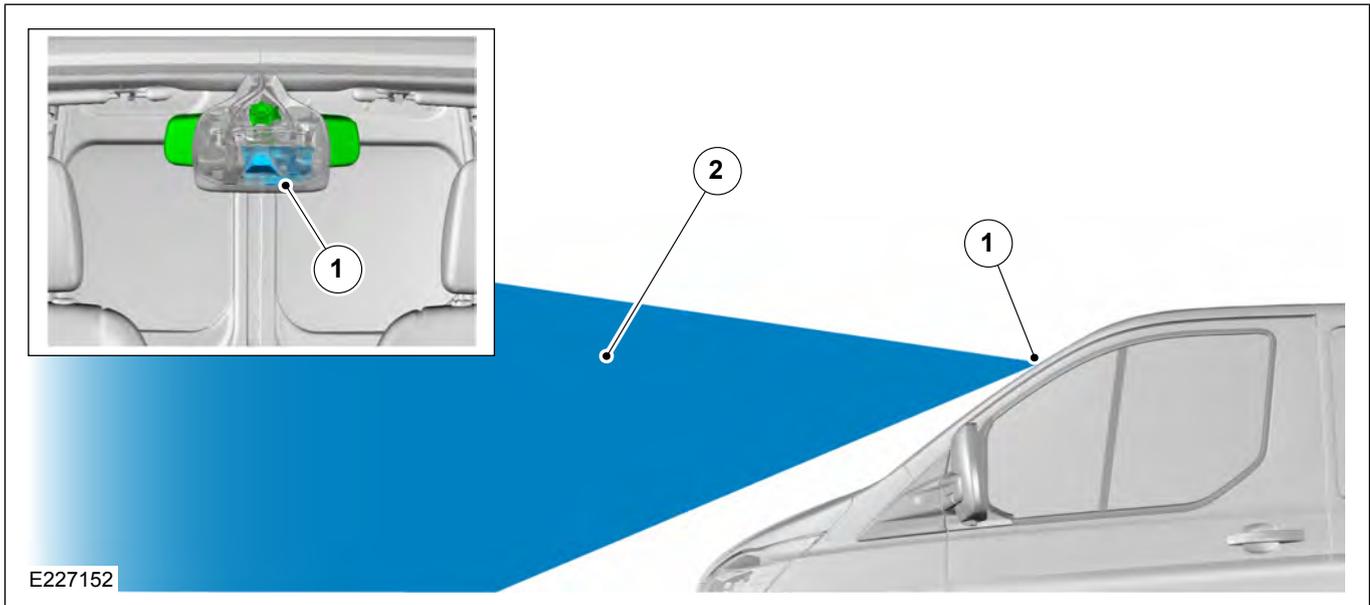


Item	Description
1	Adaptive Cruise Control Radar
2	Adaptive Cruise Control Radar clearance zone

4.15 Lane Keeping System

NOTE: The lane keep alert feature will not function if any conversion or installation is in the field of view from the lane keeping system camera.

NOTE: For converted vehicles fitted with lane keeping system, where vehicle mass or geometry is significantly altered, a new calibration for the camera sensor needs to be made.



Item	Description
1	Lane keeping system camera located behind the interior rear view mirror trim
2	View cone from camera, horizontal direction and downwards to the hood edge of the vehicle

For additional information for vehicles with large overhangs

Refer to: [4.18 Special Conversions \(page 143\)](#).

4.16 Handles, Locks, Latches and Entry Systems

4.16.1 Door Removal or Modification

CAUTION: If an additional third party control system is incorporated into the Ford Locking/Unlocking System the Crash Event Mid Speed Can Signal must be utilized to override the third party control system to trigger a crash unlock feature within the locking system in case of a relevant event.

For derivatives requiring no doors, to ensure door ajar warnings do not appear on the instrument cluster and the interior lamp does not stay on, for any doors that are not fitted the Body Control Module (BCM) must be connected in the following way:

- C5-33 Front Left -ground
- C5-21 Front Right - ground
- C5-34 Ajar lift gate switch - not connected
- C5-46 Ajar left side cargo switch - not connected
- C5-19 Ajar left side cargo switch - not connected

4.16.2 Central Locking

Locking is controlled by the BCM. There is current sensing on certain locking circuit pins as part of the security system – if these are tampered with, locking cannot be guaranteed.

BCM	14A631 in-line Drive Side	14A631 in-line Passenger Side	Function
C3-35	A16	A16	Central Lock
C3-27	A17	-	Drivers Door Unlock
C3-32	B17	B17	Double Lock
C3-05	-	A17	Passenger Door Unlock

BCM	19L540	Function
C3-24	1	Unlock RH Sliding Rear Door
C3-33	1	Unlock LH Sliding Rear Door

Junction Box	18C394	Function
R11-3	6	Unlock Lift Gate/Cargo

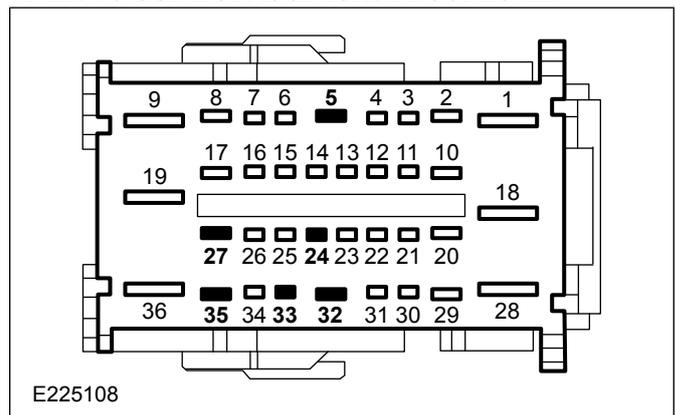
Locking Configurations The following list details specific locking scenarios that have been noted by customers:

1. Raid locking or drive away locking for taxi and parcel van usage – this is a configurable parameter in the BCM (Ford Dealerships can set this). There is also the option to configure via the instrument cluster once the configurable parameter has been set.
2. Slam locking – this is a configurable parameter in BCM (dealerships can only switch off this feature, but not switch on).
3. NI lock reconfiguration into no deadlocks – this can be reconfigured to be central-locking only by a Ford Dealer (via Dealership hotline).
4. Auto unlock - There is an option to configure central unlock where the drivers door, when opened, will automatically unlock all doors except any doors controlled by the third button on the key fob.

Drive-Away Locking Disable

For parameter settings, 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 .

Pins to Control Additional Door Locks



Item	Description
C3-05	Passenger Door Unlock
C3-27	Diver Door Unlock
C3-24	Unlock RH Sliding Rear Door
C3-35	Central Lock
C3-33	Unlock LH Sliding Rear Door
C3-32	Double Lock

4.16.3 Remote Keyless Entry/Tire Pressure Monitoring System Receiver (RKE/TPMS Receiver)

WARNING: For best performance the RKE/TPMS receiver must be a minimum distance of 25mm from any metal objects and 100mm from high switch loads.

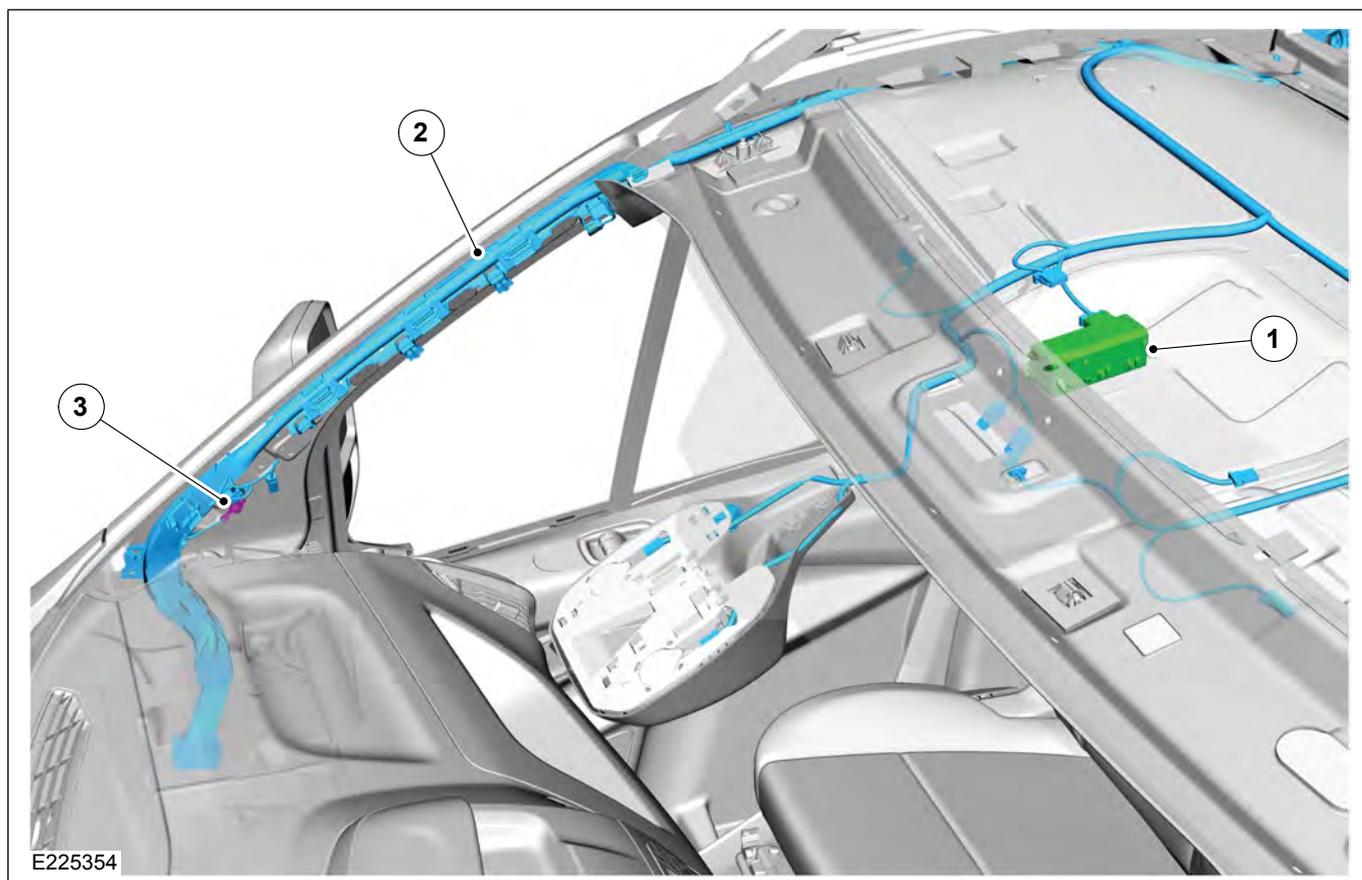
NOTE: It is recommended that the RKE/TPMS has a dedicated ground wire and ground stud, do not splice with other modules.

The RKE/TPMS Receiver is fed via a connection to the 14A005 Harness and then earthed at the ground point located on the A-Pillar. For Ground point location

Refer to: 4.20 Grounding (page 173).

For additional information

Refer to: 2.4 Wheels and Tires (page 42).



Item	Description
1	RKE/TPMS Receiver
2	Harness 14A005
3	Ground point location

4.17 Fuses and Relays

4.17.1 Fuses

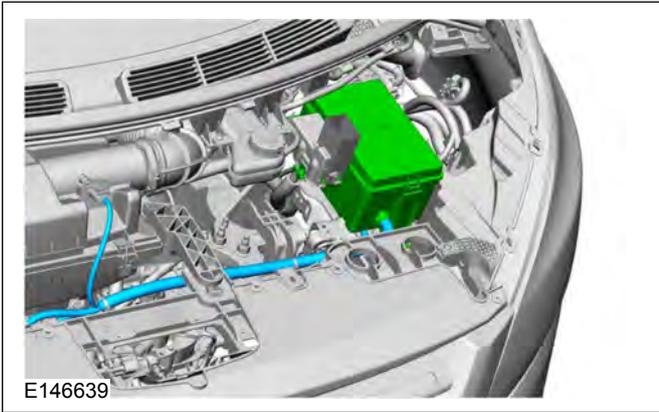
 **WARNING: No increase in existing vehicle standard fuse capacity is allowed under any circumstances. There are no spare fuses in the Engine Junction Box (EJB), Standard Relay Box (SRB) or Body Control Module (BCM). The vehicle converter/modifier must provide additional fuses as required. Please refer to below chart.**

NOTE: Only use Ford fuses as shown in below table. Other fuses may interfere with the validated fusing strategy.

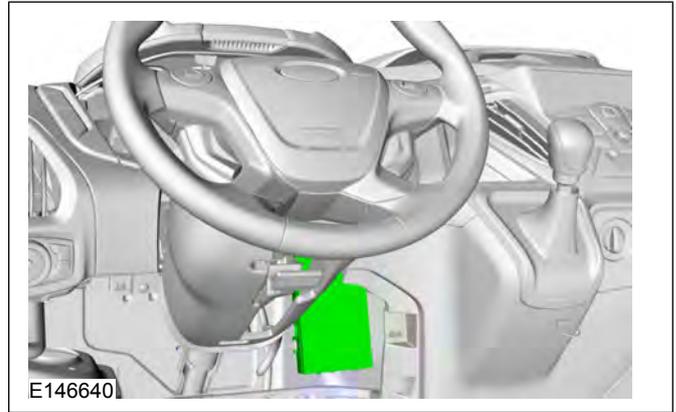
Ford Fuses

Part Number	Ampere Rating	Color
Mini Fuse		
1L3T-14A094-A*	2A	Gray
1L3T-14A094-B*	3A	Violet
1L3T-14A094-C*	4A	Pink
1L3T-14A094-D*	5A	Tan
1L3T-14A094-E*	7.5A	Brown
1L3T-14A094-F*	10A	Red
1L3T-14A094-G*	15A	Blue
1L3T-14A094-H*	20A	Yellow
1L3T-14A094-J*	25A	Clear
1L3T-14A094-K*	30A	Green
Micro Fuse		
DG9T-14A094-F*	5A	Tan
DG9T-14A094-G*	7.5A	Brown
DG9T-14A094-H*	10A	Red
DG9T-14A094-J*	15A	Blue
DG9T-14A094-K*	20A	Yellow
DG9T-14A094-L*	25A	White
DG9T-14A094-M*	30A	Green
M-Case Fuse		
DG9T-14A094-A*	15A	Gray
DG9T-14A094-B*	20A	Light Blue
DG9T-14A094-C*	25A	White
DG9T-14A094-D*	30A	Pink
DG9T-14A094-E*	40A	Green
J-Case Fuse		
F8SB-14A094-A*	20A	Blue
6E5T-14A094-A*	20A	Blue
2L5T-14A094-A*	25A	Natural
F8SB-14A094-B*	30A	Pink
6E5T-14A094-B*	30A	Pink
7T4T-14A094-D*	40A	Green
F8SB-14A094-C*	40A	Green
6EST-14A094-C*	40A	Green
7T4T-14A094-E*	50A	Red
F8SB-14A094-D*	50A	Red
6E5T-14A094-D*	50A	Red
7T47-14A094-F*	60A	Yellow
XS21-14A094-A*	60A	Yellow

Engine Junction Box



Smart Relay Box



4.17.2 Relays

Ford Relays

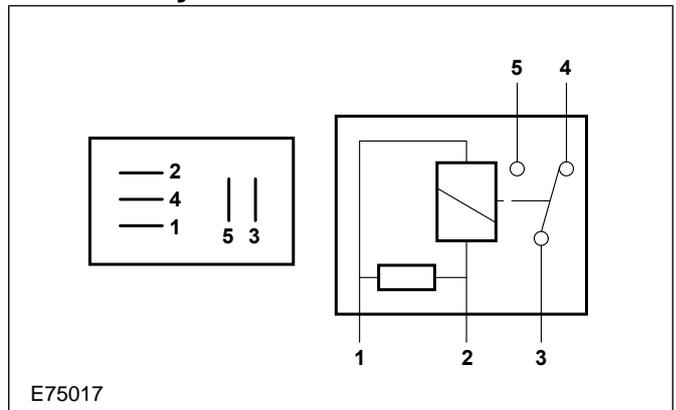
Part number	Ampere Rating	Color
5M5T-14B192-A*	20	Black
5M5T-14B192-C*	40	Black
5M5T-14B192-D*	40	Black
5M5T-14B192-E*	70	Gray
8T2T-14B192-C*	20	Black
8T2T-14B192-A*	40	Black
8T2T-14B192-B*	40	Black
FU5T-14B192-A*	40	Blue

NOTE: Only use Ford Relays shown in table.

Ford standard relays have a nominal coil current of 300mA (max) at 25°C. Relays with higher loads should not be used.

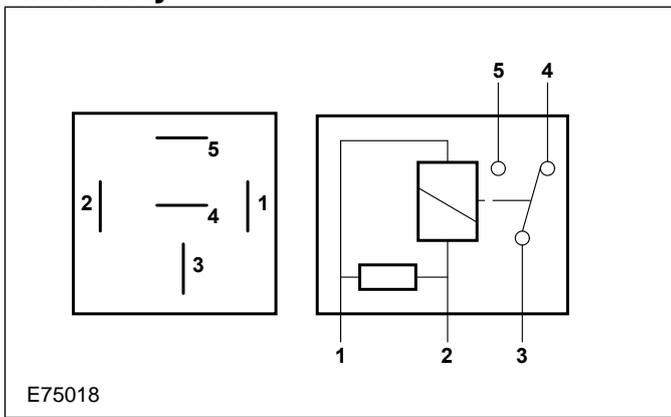
For maximum switching currents please refer to Relay Figure E75017.

Micro Relay



Micro Relay Parameters	
Open contacts	20 Amps
Closed contacts	16 Amps
Nominal coil current	300 mA (max)
Medium current changeover relay - Part number: 6G9T-14B192-B*	
Medium current normally open relay - Part number: 6G9T-14B192-A* (pin 4 not present)	

Mini Relay



E75018

Mini Relay Parameters

Normally open contacts	40 Amps
Normally closed contacts	20 Amps
Nominal coil current	300 mA (max)
Medium current changeover relay — Part number: 6G9T-14B192-D*	
Medium current normally open relay — Part number: 6G9T-14B192-C* (pin 4 not present)	

4.17.3 Windscreen Wipers

The base wiper system should not be tampered with (controlled by BCM and multiplex architecture with LIN technology).

NOTE: Power to wiper motors is limited by the size of the wiring and associated relays. If any alternative wiper installation is made, it must have a specification equivalent to Ford components.

Refer to: [5.9 Glass, Frames and Mechanisms \(page 197\)](#).

4.18 Special Conversions

4.18.1 Special Vehicle Options (SVO) Harnesses and Aftermarket Kits

In addition to the Auxiliary Fuse Panel already mentioned, a number of other kits are available to meet customer needs see next table.

⚠ WARNING: Only Ford release wiring should be used to support added vehicle functionality. If the implementation of wiring other than this is required, Ford guidelines must be followed. Please also

Refer to: 4.17 Fuses and Relays (page 139).

Refer to: 4.20 Grounding (page 173).

Part Number	Special Vehicle Option Harnesses and Aftermarket Kits
GK2V-14517-A*	Auxiliary Fuse Panel Harness LHD
GK2V-14517-B*	Auxiliary Fuse Panel Harness RHD
KTBK2V-14A411-A*	C1 Connector Jumper Harness (for Auxiliary Fuse Panel)
KTBK2V-14A411-B*	C2 Switch Connector Jumper Harness (for Auxiliary Fuse Panel)
KTGK2V-14A411-C*	Vehicle Interface Connector
KTBK2V-14A411-D*	High Specification Vehicle Interface Connector Jumper Harness
KTBK2V-14A411-F*	Utility Pack Connector Jumper Harness
KTBK2V-14A411-G*	Beacon Connector Jumper Harness
BK2V-14A303-A*	Beacon Preparation Pack (Front Switch Harness)
BK2V-14A303-F*	Utility Vehicle Switch Pack (Front Switch Harness)
BK2V-14659-B*	Utility Vehicle Switch Pack (Rear Harness LHD)
BK2V-14659-C*	Utility Vehicle Switch Pack (Rear Harness RHD)
GK2T-13B576-A*	Trailer Tow Jumper
BK2T-13B576-D*	Trailer Tow Socket Jumper
GK2T-19H378-A*	Trailer Tow Module

4.18.2 Additional Vehicle Signals/Features

⚠ WARNING: When interfacing with specific lighting high side driver outputs, additional supplemental signal access, relays and peripherals fitted, must be compatible with a Pulse Width Modulation (PWM) frequency of 200Hz.

For list of lighting circuits that are PWM supplied:

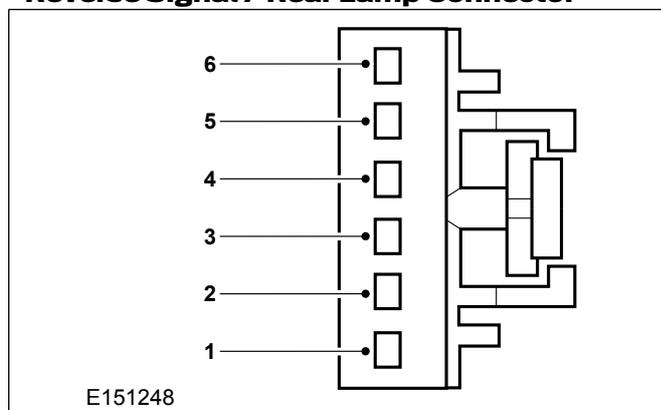
Refer to: 4.2 Communications Network (page 67).
Body Control Module (BCM) Output Information table.

Reverse Signal

A reverse signal is available on the tail lamp connector. In order to avoid electrical issues due to leakage, and to ensure connector compatibility, a mating connector with seals/plugs and pre-crimped wire and terminal should be used.

NOTE: It is not recommended that reverse signal is used to drive auxiliary equipment directly – a relay (max 300mA) should be used. The existing reverse lamp load is close to the threshold and is hard-wired through the BCM for current sensing and other feedback systems.

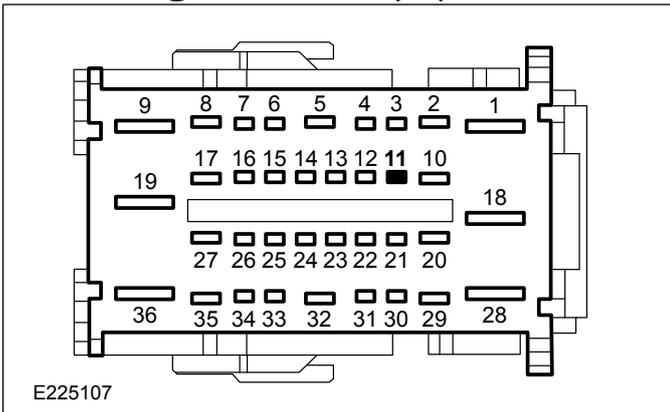
Reverse Signal / Rear Lamp Connector



Reverse Signal / Rear Lamp Connector - Van, Bus and Kombi

Pin		Function	Wire CSA	Color	
Left	Right			Left	Right
5	2	Reverse Lamp	0.75	Green/Brown	Green/Brown
1	6	Direction Indicator	0.75	Gray/Orange	Green/Orange
2	4	Position/Park Lamp	0.5	Violet/Green	White/Orange
3	5	Brake Lamp	0.5	Gray/Violet	Gray/Violet
6	1	Ground	1.5	Black/White	Black/Green
4	3	Fog Lamp	0.5	White/Blue	White/Blue

Reverse Signal in BCM C3 (J3) Connector



Item	Description
Pin 11	Reverse Signal

In addition, the reverse signal is also available directly from the BCM (max. 300mA), but there is no free pin available. **The only way to access this signal at this location would be via a splice into the existing wire.**

Refer to: [4.1 Wiring Installation and Routing Guides \(page 56\)](#).

Splicing procedures and

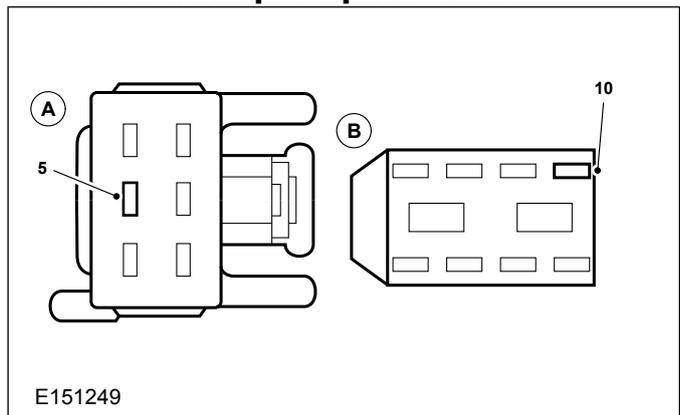
Refer to: [4.2 Communications Network \(page 67\)](#).

BCM, figure E145367 connector C3 (J3) and figure E225107 pin 11.

Pin 11 can be accessed from either male or female connector between harnesses 14401 to 14A005 or 14401 to 14405 (Green/Brown wire).

Third Brake/Stop Lamp

Third Brake/Stop Lamp Connectors



Item	Description
A	Left Connector Pin 5 on 14405 Harness - Yellow/Gray
B	Right Connector Pin 10 on 14A005 Harness - Yellow/Gray

A signal for a third brake/stop lamp is also available on the tail lamp connector.

In order to avoid electrical issues due to leakage, and to ensure connector compatibility, a mating connector with seals/plugs and pre-crimped wire and terminal should be used.

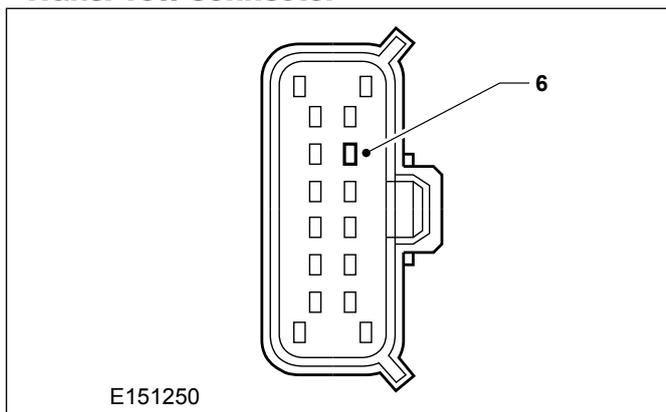
For connectivity, see Figure E151249 and the details given in the section for reverse signal. The third brake lamp feed can be accessed from the body side connector of 14405 harness (left, pin 5) or 14A005 harness (right, pin 10) which connects to the door harness 13B472. These connectors are located at the rear of the vehicle near the interface of the rear door or lift gate wiring. This circuit can only have a relay added (maximum 300mA) to control additional lighting. Check with your local Ford dealer or National Company Sales representative for conversion compatibility.

The use of the trailer tow connector is not recommended. In situations where it is necessary, please see the following figure E151250. This connector can be found at the 14406 interface with the 13B576 harness. Pin 6 is the stop light feed. The trailer tow module GK2T-19H378-A* will

need to be fitted to get the system active. For full trailer tow kit, BK2T-13B576-D* is also required. For additional information on electrics for tow bars:

Refer to: 4.1 Wiring Installation and Routing Guides (page 56).

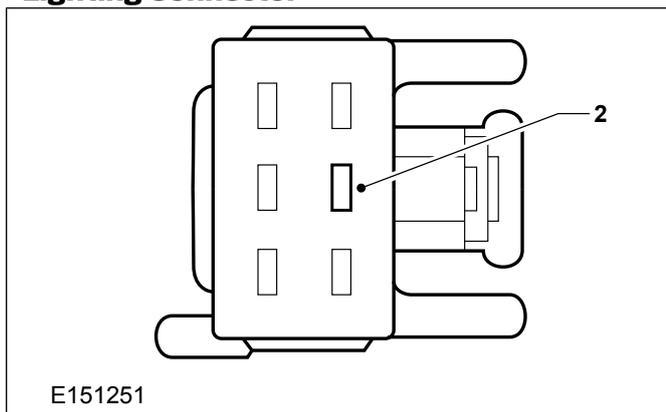
Trailer Tow Connector



Item	Description
Pin 6	Stop Light Feed

Additional Position Lamps at the Rear of the Vehicle

Lighting Connector



Item	Description
Pin 2	Position Lamps

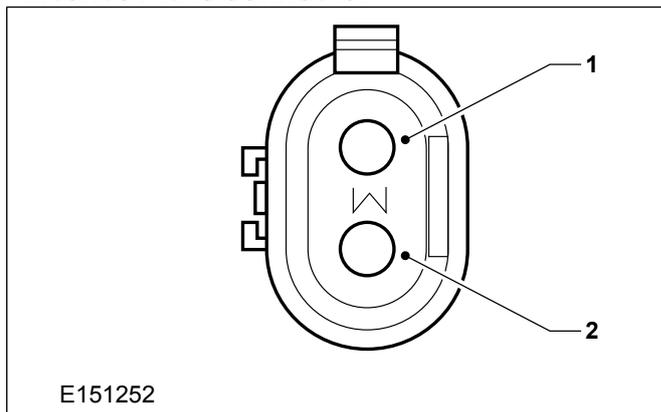
The feed for position lamps can be taken from the lighting connector, at the rear of the vehicle on 13B472 harness, pin 2, see figure E151251 or direct from the license plate feed connector, see figure E151252, which is located in the door. The dealer will need to reconfigure this output for the maximum rating 46W total.

NOTE: Lighting connector shown in E151251 will require a local ground.

For Lighting Loads

Refer to: 4.12 Exterior Lighting (page 133).

License Plate Connector



Item	Description
1	12V Feed
2	Ground

The position and parking functions operate independently.

When the position lamps are extinguished, the side marker and end-outline markers turn off simultaneously, in line with Inter Regs No 48, which states the following:

The electrical connections must be such that the front and rear position lamps, the end-outline marker lamps (if they exist), the side-marker lamps (if they exist) and the rear registration plate lamp can only be switched on and off simultaneously. This condition does not apply when using front and rear position lamps, as well as side-marker lamps when combined or reciprocally incorporated with said lamps, as parking lamps and when side-marker lamps are permitted to flash.

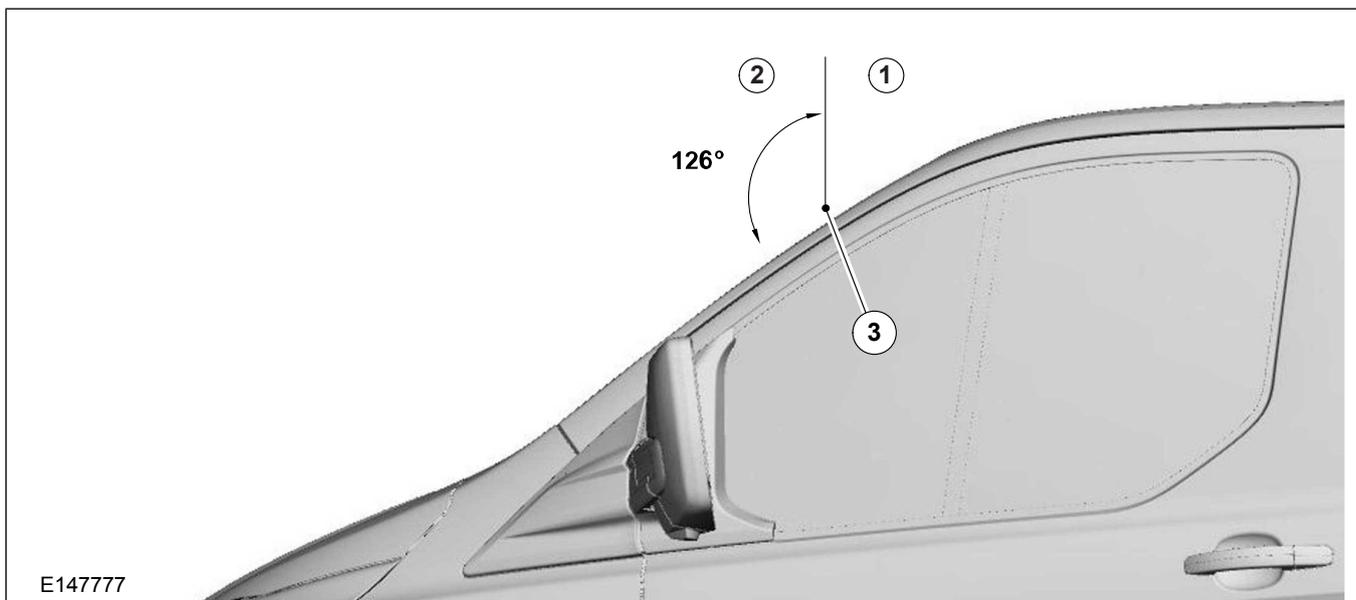
Fog Lamp Connector

Connectors are already part of the wiring if the vehicle is medium or high specification, (for example with electrical side mirrors). The main lamp switch will need to be changed for one that includes this feature. (There are switches with and without front fog lamp function).

Connecting to Lighting Information

Additional turn indicators must be powered through relays (max 300mA), driven by existing turn lamps. The maximum load that the BCM can drive is 3 x 21W per side (front, rear).

4.18.3 Auto Wipe and Auto Lamp for vehicles with large overhangs



Item	Description
1	Conversion or Installation rearward (zone 1) where Auto Lamp and Wipe feature will function correctly.
2	Conversion or Installation forward (zone 2) where Auto Lamp and Wipe feature will NOT function correctly — The feature is not to be specified with the donor or configured OFF by the Ford dealer.
3	Auto sensor location.

NOTE: The Auto Wipe, Auto Lamp feature should not be ordered for vehicles that are to be built where the installation covers any part shown forward of the vehicle see figure E147777. This will affect the auto sensors ability to detect light or moisture to the defined calibration and it will not function correctly.

In the event that a donor vehicle has been supplied with these features, the dealer can configure the vehicle to manual lamp and wipe with the following settings.

- Set Central Car Configuration parameter 24 – With Rain sensor to 01: (Without Rain Sensor)
- Parameter 88 for Auto Lamp should be set to 01: (Without Auto Lamps)

It is also recommended that the Auto Lamp main switch is changed for a non-auto switch. If not changed when selecting auto position (A), the dipped beam will remain on (due to a not valid condition) and the system will run in fail safe mode. Dipped beam will be operated at Ignition on and with Engine RUN. If the wiper is selected with the lamp switch in (A) the wiper will work as if intermittent mode has been selected. A Ford Dealer can help advise which switch should be ordered and fitted, starting with part number BM5T-13A024-** (depending on the specification of the vehicle).

4.19 Electrical Connectors and Connections

4.19.1 Connectors

Cutting into the Original Wiring System

WARNINGS:

⚠ The CAN Bus should not be tampered with as this may lead to failure of safety critical components such as Anti-Lock Brake System, unless the High Specification Vehicle Interface Connector (option A608) is ordered and the procedure followed, see later in this section for more details.

⚠ Do not use connectors which cut through the outer covering and into the core wire.

⚠ CAUTION: Only use Ford approved connectors.

It is not recommended to cut into vehicle wiring because:

- The base vehicle specification is unsuitable for incremental loads except in conjunction with Auxiliary Fuse Panel or the High Specification Vehicle Interface Connector.
- Long term risk of a faulty connection developing.
- Potential fire risk from over-loading.

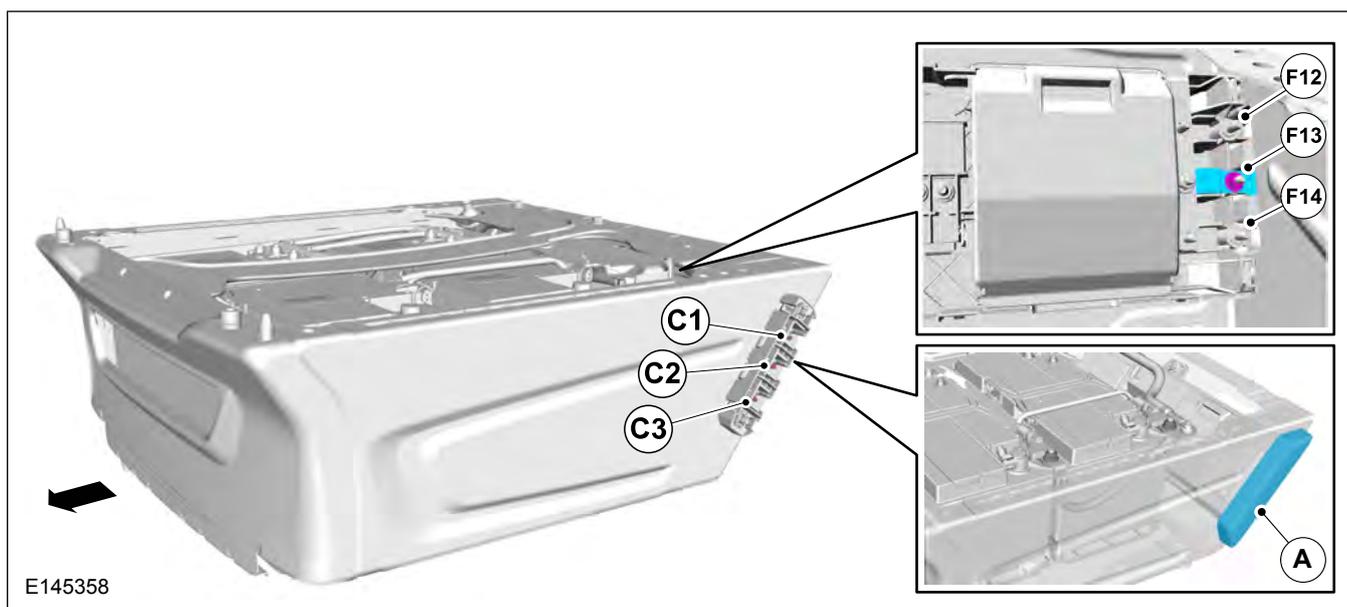
All connections into existing wiring must be permanently insulated. Exterior connections must be water-proof and with a drip loop.

Where wires are required to be extended, break in points should only be at existing connector points. If splicing into existing wiring is unavoidable, see wiring splicing procedures in this manual.

Refer to: [4.1 Wiring Installation and Routing Guides \(page 56\)](#).

NOTE: Ford approved jumper harnesses should be used.

4.19.2 Customer Connection Points (CCP)



E145358

Battery/Batteries	F12	F13	F14	C1	C2	C3
Single Battery - Without Aux Fuse Panel	Spare	60A Fuse	Spare	Spare	CCP	Spare
Single Battery - With Aux Fuse Panel	60A Fuse	60A Fuse	60A Fuse	CCP	CCP	CCP
Twin Battery - Without Aux Fuse Panel	60A Fuse	60A Fuse	60A Fuse	CCP	CCP	CCP
Twin Battery - With Aux Fuse Panel	60A Fuse	60A Fuse	60A Fuse	CCP	CCP	CCP
A	Customer Connection Point Cover					

⚠ WARNING: Only use the Ford approved kit for adding fuses to the CCPs.

⚠ CAUTION: When connecting to the CCP, it is recommended to disconnect the battery ground so as to avoid a short circuit. The fixing torque (M5) is 3.5–4.5 Nm.

NOTE: When fitting additional power wiring feeds the protective cover will need to be revised to allow routing for the extra wires. The cover is pre marked with the relevant areas so that they can be easily removed.

NOTE: There is a maximum of three CCPs, each capable of supplying a max current of 60 A (Ampere). These points are always located on the driver's seat pedestal and are protected by a cover.

NOTE: Vehicles with Single Battery without Aux Fuse Panel will only have one CCP fitted, the remaining two can be used after fitting the CCP kit KTBK2T-14B475-A*.

NOTE: Camper Vehicles will have three CCP, one of them is used for the Camper Central Connector which means only 2 CCP are available to use.

Contact your local Ford dealer or National Sales Company representative for details of the kit.

E145358 shows the left hand drive situation. On a right hand drive vehicle the pre fuse box is rotated 180 degrees. Therefore C1/F12 will be at the bottom and C3/F14 at the top connections.

For High Current Supply and Ground Connections

Refer to: [4.4 Battery and Cables \(page 78\)](#).

4.19.3 Camper Central Connectors

⚠ WARNING: If multiple systems are to use this supply, the total system load must not exceed the 60A short term loading.

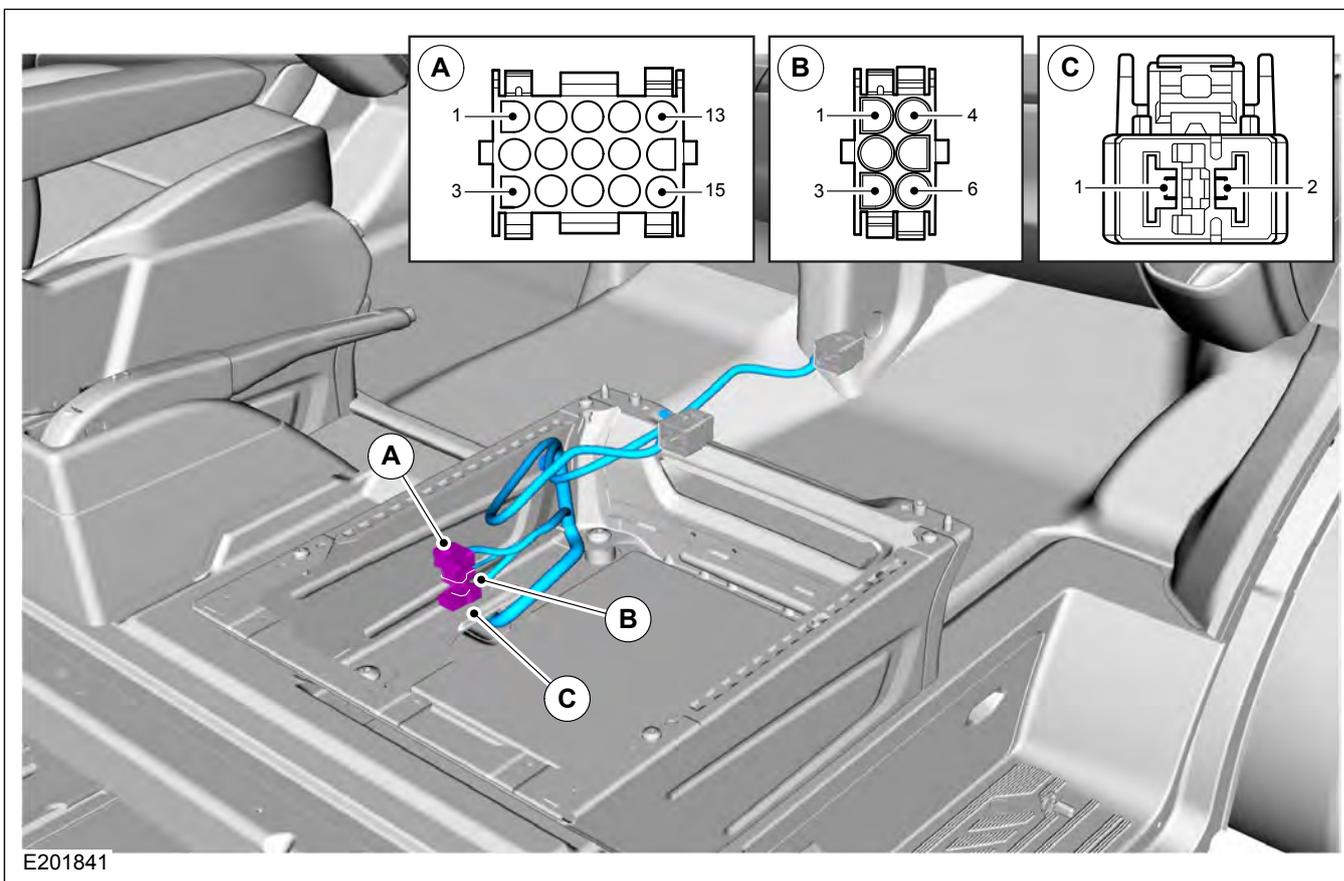
Camper conversions are fitted with a dedicated main wiring loom GK2V-14401-J*/K*/M*. There is no customer interface, instead, three connectors are located within the passenger seat pedestal to support camper installations. The connector to power up the 2-way connector underneath the passenger pedestal is securely taped back to the main wire branch running behind the front seats and would need to be connected by the converter during the installation. See customer connection points in this section for further information. The converter is responsible for good protection of the exposed wire to the customer connection point, protecting the wire against chafing.

For a Camper Van on a Kombi derivative rear speaker wiring and Camper speaker connectivity is provided at 2.5mm CSA. It is recommended to only connect one 4 ohm speaker to each channel either from the Camper interface connector or the body wiring. If twin speakers per channel are required then each value must be 8 ohm.

For additional information

Refer to: [4.1 Wiring Installation and Routing Guides \(page 56\)](#).

Wiring Specification table for characteristics on continuous loads versus temperature.



E201841

Item	Description
A	C2-1 - 15 way connector (face view)
B	C2-2 - 6 way connector (face view)
C	C2-3 - KL30 connector (face view) 60A Fed from Pre Fuse Box + Ground

Tyco and Ford part numbers that are used for vehicle connectors, and suggested mating connectors.

Vehicle Connectors			Mating Connectors	
Connector	Tyco Connector	Tyco Terminal	Tyco Connector	Tyco Terminal
15 way (C2-1)	0-926647-1	926882-1 (socket)	1-480710-0	926883-1 (pin)
6 way (C2-2)	0-480705-0	926882-1 (socket)	1-480704-0	926883-1 (pin)
Connector	MTA Connector	MTA Terminal	MTA Connector	MTA Terminal
2 way (C2-3)	44.40300	11.07660	44.40400	17.07685

Pin	Function	Wire CSA	Color	Comments
Connector C2-1 (Figure E169183 - Item A)				
1	Stop lamp (CHMSL)	0.5	Yellow/Gray	16W max
2	Engine Run	0.5	Brown/Yellow	300mA, Ground switching
3	Vehicle Speed Output	0.75	Violet/Orange	138Hz@100KPH, 50% duty cycle
4	Interior Lock Switch Input ⁽¹⁾	0.5	Gray/Yellow	Lock switch momentary signal to ground
5	Interior Unlock Switch Input ⁽¹⁾	0.5	Violet/Gray	Unlock switch momentary signal to ground
6	Rear Door Ajar	0.5	Brown/Violet	Local switch to ground (Circuit Closed = Door Closed)
7	Interior light feed ⁽²⁾	0.5	Green/Gray	300mA max
8	Auto Trans Output - PARK	0.5	Gray/Brown	160mA Ground switched (100 Ohm min external resistance. Logic sense only - NOT suitable for standard relays)
9	Lock Motor Output ⁽¹⁾	1.0	Gray/Brown	15A Total (3A per latch) - Total load for locking al vehicle latches
10	Unlock Motor Output ⁽¹⁾	1.0	Violet/Gray RHD	15A Total (3A per latch) - Total load for locking al vehicle latches
			White/Orange LHD	
11	Courtesy Light Dimming High Side Rear	0.75	White/Blue	PWM +12V 5A max including all existing rear interior lights
12	Auto Trans Output - NEUTRAL	0.5	Green/White	160mA Ground switched (100 Ohm min external resistance. Logic sense only - NOT suitable for standard relays)
13	Ignition (KL15)	0.75	Gray/Yellow	10A/F21 (SRB)
14	SRC/Start-Stop Inhibitor	0.5	Violet/Gray	Grounded = SRC/Start-Stop disabled
15	Reverse signal	0.75	Green/Brown	+12V 300mA max
Connector C2-2 (Figure E169183 - Item B)				
1	Not used			
2	Rear Speaker Left +	1.5	White/Green	Twisted pair
3	Rear Speaker Left -	1.5	Brown/Yellow	
4	Rear Speaker Right +	1.5	Brown/White	twisted pair
5	Rear Speaker Right -	1.5	Brown/Blue	
6	Instrument Panel Illumination	0.5	Brown	PWM +12V 300mA (nominal)
Connector C2-3 (Figure E169183 - Item C)				
1 (A)	B+ (KL30)	6.0	Yellow	60A Fed from Pre Fuse Box
2 (B)	B-	6.0	Black/Gray	Ground

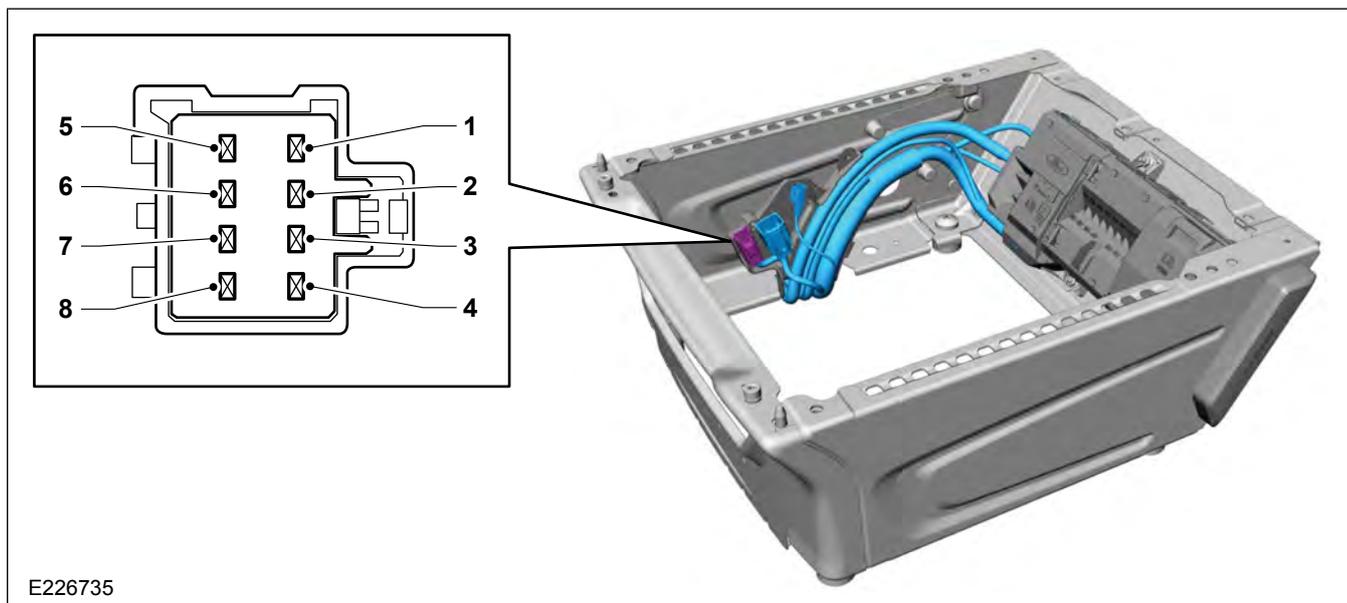
⁽¹⁾ = The lock and unlock signals are intended to operate with Ford lock sets, or components with equivalent function and operational characteristics: – Central Locking and unlocking are a 120ms high side pulse. There is no double locking available via this connector.

⁽²⁾ = Interior light feed is a high side output used for demand lighting. It is battery saver timed to switch off after 20 minutes. Do not use this high demand load which will re-energize every time the door is opened.

⁽³⁾ = Pulse Width Modulation (PWM) output optimized for LED switch back lighting & dimmable when vehicle has I.P. dimmer fitted. Do not fit relays to this output.

Note: There are no additional ground wires in either C2-1 or C2-2 auxiliary devices and systems; local grounds should be used.

4.19.4 Vehicle Interface Connector



E226735

The Vehicle Interface Connector provides a direct interface to signals. See figure E226735 for location and the following table for signals.

8 Way Vehicle Interface Connector Signals	
1	Ground
2	Engine Run
3	SRC Inhibit (Start Stop disabled)
4	Not used
5	Vehicle Speed
6	Ignition
7	IP Switch Illumination
8	Ford Programmable Battery Guard

WARNINGS:

⚠ Signals 3, 5 and 7 on the Vehicle Interface Connector are for sensing purposes only and not to be loaded by high current consumers. The max current rating for signal 6 is 10A and not to be exceeded in any situation, this includes the total of the Ford System and Third Party System requirements.

⚠ Unused wires in the service kit must have cable ends insulated to avoid shorting on any ground points.

A service kit (KTGK2V-14A411-C*) can be ordered from your local Ford Dealer, the kit contains the mating connector (4S7T-14489-VH*) to access these signals, and 3m of wiring.

When the Auxiliary Fuse Panel is fitted to the vehicle, the Interface Connector is occupied by the attached wiring harness. In this case these signals and some additional features are available through the C1 connector. For more details refer to Auxiliary Fuse Panel section.

Vehicle Speed

Square Wave Characteristics

Specifications	
Max High Signal	Battery Voltage
Min High Signal	3.67 Volts
Max Low Signal	1.1 Volts
Min Low Signal	- 1.1 Volts
Max Ground Offset	± 1.0 Volts
Rise Time	10µ sec <= tr <= 250µ sec
Fall Time	10µ sec <= tf <= 250µ sec
Duty Cycle	50% ± 10%
Pulse Rate	2.2 Hz/MPH (1.3808 Hz/KPH)

⚠ WARNING: Do not interface with the CAN (Controller Area Network) for vehicle speed.

Pin 5 - Vehicle Speed signal is a direct current coupled square wave that varies in frequency in proportion to vehicle speed. This provides a square wave-form (50% duty cycle) signal, where a frequency of 138Hz equates to 100km/h.

Ignition

Pin 6 - Ignition signal is protected by a 10A fuse. It is +12V active at ignition positions: Accessory (1) and Run (2). It is not active at Ignition OFF (0) or Crank (3). Whilst it can drive equipment directly it is recommended to use this feed to control a converter fitted relay, especially for high current applications.

Switch Illumination

Pin 7 - Switch Illumination signal is only to be used for sensing or to control a relay. It is a PWM signal only for low current illumination 300mA max, that can be dimmed and not to drive a relay.

Engine Run

⚠ WARNING: Do not cut into the alternator wires or use the alternator as a source to obtain a 'D+ Signal'.

Pin 2 - Engine Run signal will only support a sense line or relay control.

This engine run signal is ground switching (max current sink 250mA), it provides no positive output (open circuit) and is only active when the engine is running regardless of vehicle variant, for example Start-Stop or SRC.

The signal will not be present when:

- Key states - OFF (0), Accessory (1), Run but Engine OFF (2), Crank (3).
- Key in Run position, where Start-Stop vehicle has auto stopped the engine.
- Engine running but load is greater than 250mA (driving two or more relays in error).

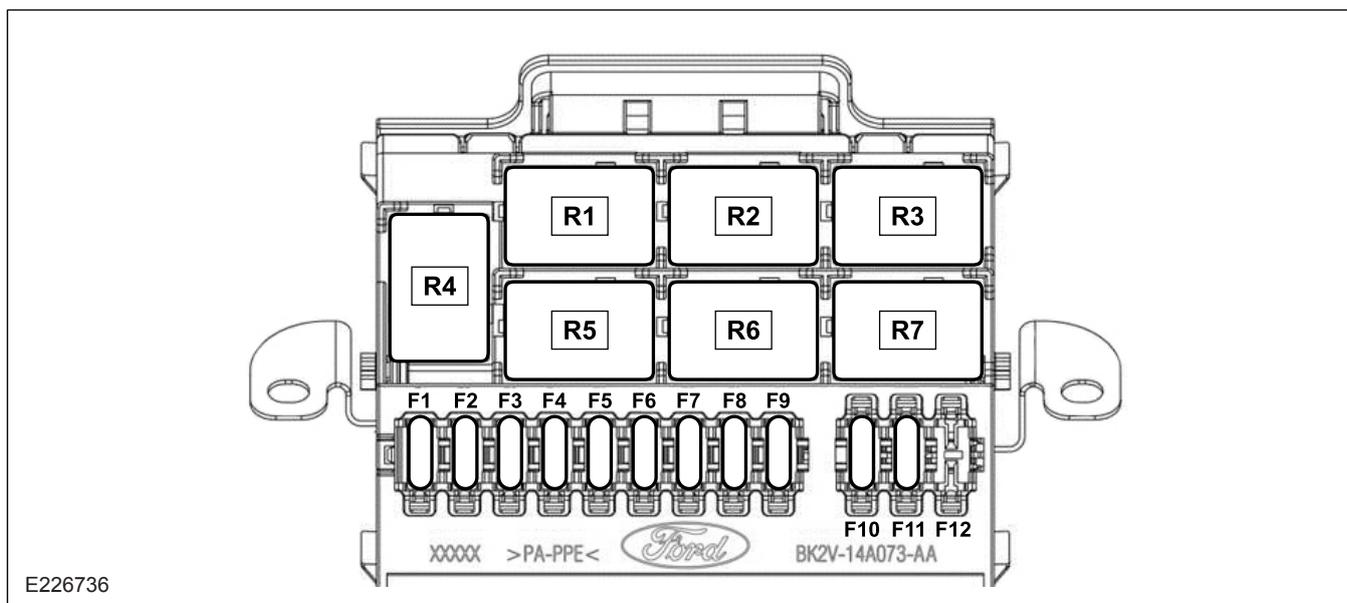
Due to Start-Stop vehicles, the signal may switch up to 300,000 times. Provision is required for control relays switched by this signal to meet this durability cycle.

The fitment of the Auxiliary Fuse Panel will provide a power +12V side for the relay (although connection to the engine run pin is still required). This allows up to 15A output on the C1 connector with the manual demand switch Aux 2, see SVO Auxiliary Fuse Panel circuit diagram later in this section

If a positive (+12V) engine run signal is required, it can be done by using the switched ground to control an ignition fed relay, to give this output.

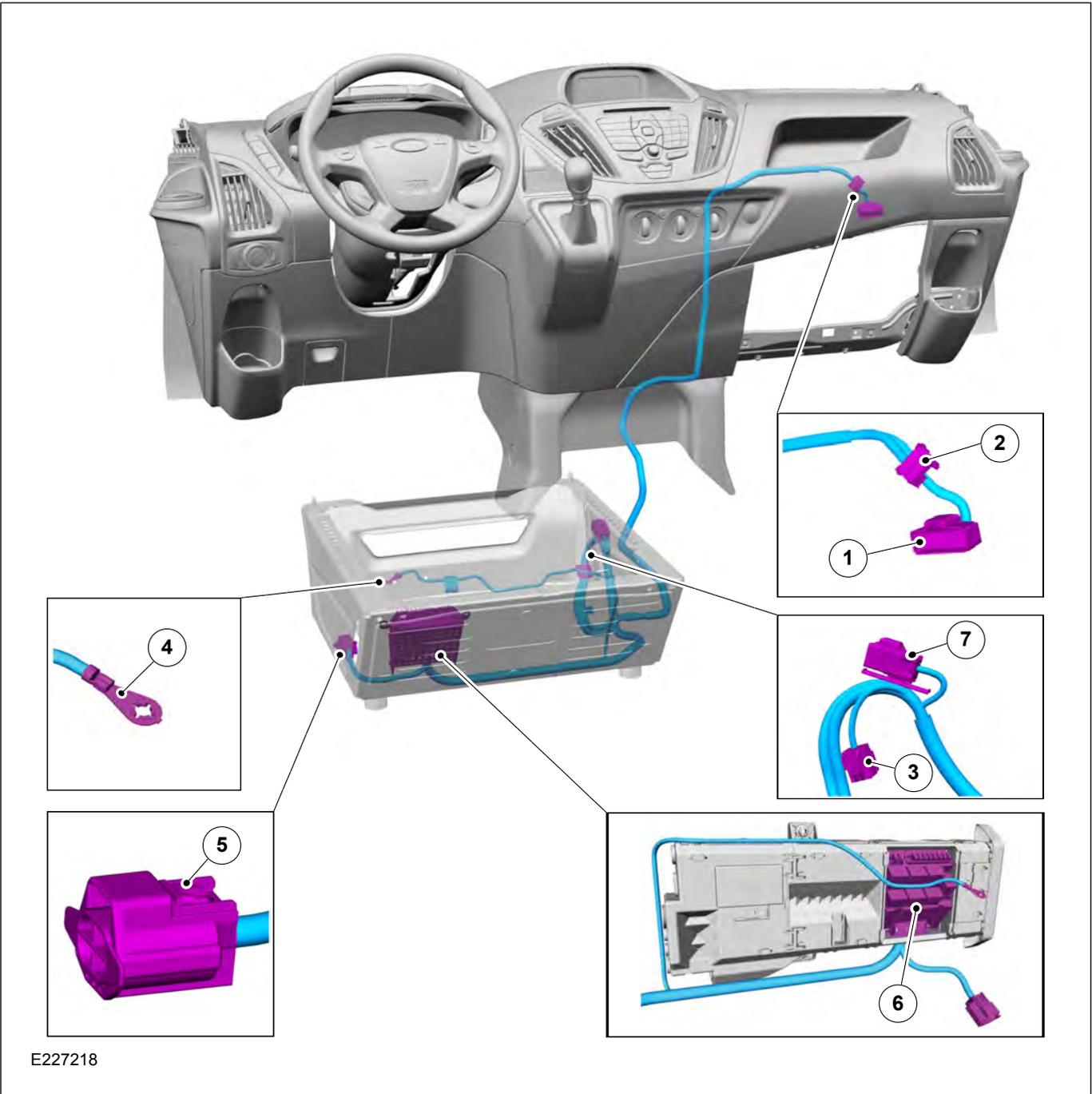
4.19.5 Auxiliary Fuse Panel (A526)

Auxiliary Fuse Panel and Relays



The Auxiliary Fuse Panel is recommended for vehicle converters where access to fused power connections are required (for example, additional lighting), see figures E227218 and E227219. A dedicated wiring harness (GK2V-14517-A*/B*) is used to implement the Auxiliary Fuse Panel to the vehicle. This fuse panel is located within the drivers seat pedestal as part of the Pre Fuse Box (PFB). The Auxiliary Fuse Panel uses the Vehicle Interface, shown in figure E226735, and provides an advanced customer access point (C1) connector as well as a (C2) interface connector to further switch installations and a power and ground supply.

Auxiliary Fuse Panel (A526) - Left Hand Drive (LHD)

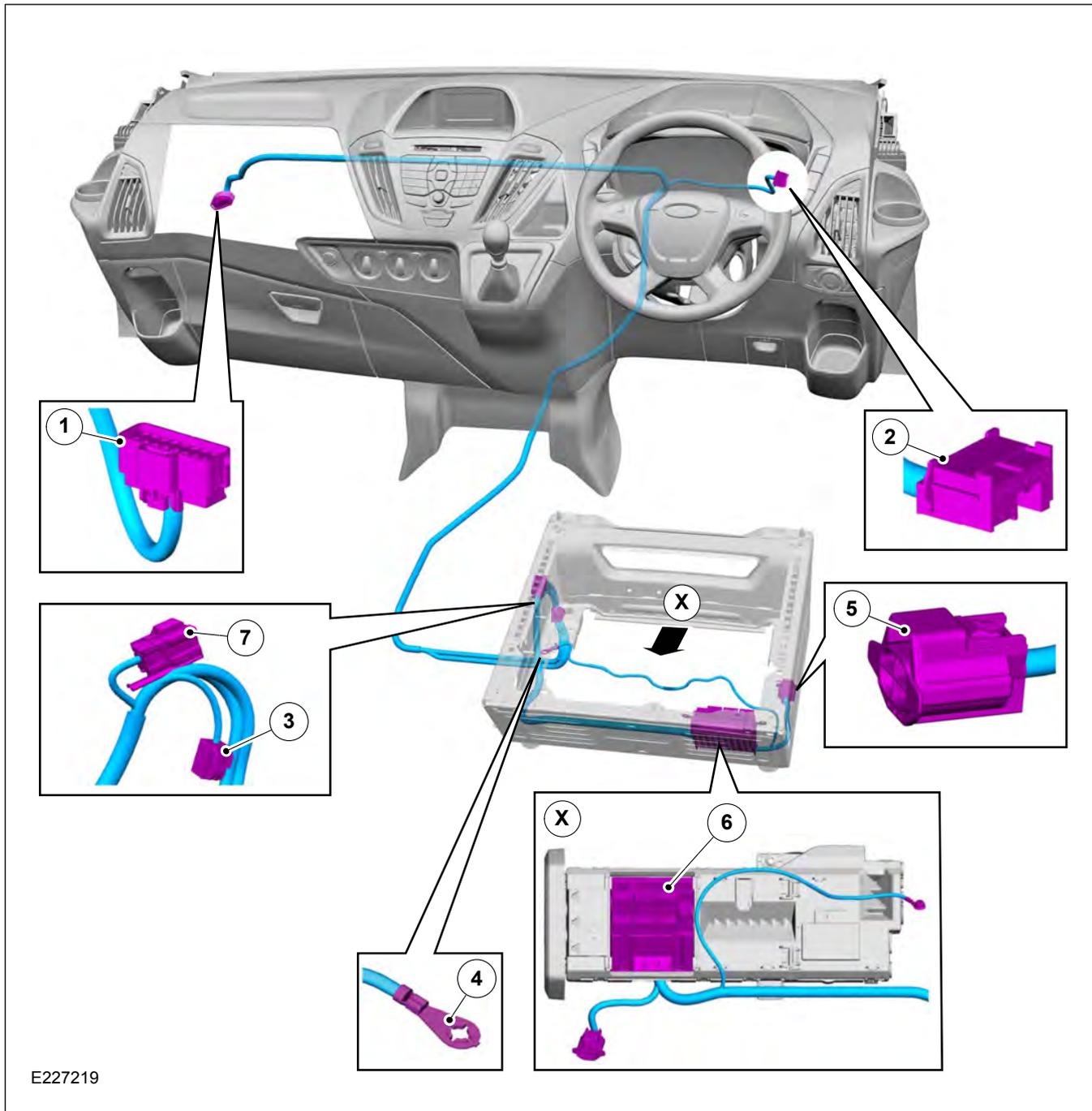


E227218

Item	Description
1	C1 Connector
2	C2 Switch Connector
3	Vehicle Interface Connector 1
4	Ground
5	C3 – 2 Way Radio Connector
6	Auxiliary Fuse Panel within the Pre-Fuse Box (lid not shown)
7	Vehicle Interface Connector 2^

^ Only suitable to be used with Ford Programmable Battery Guard (A540). No other connections to be made via this connector.

Auxiliary Fuse Panel (A526)- Right Hand Drive (RHD)

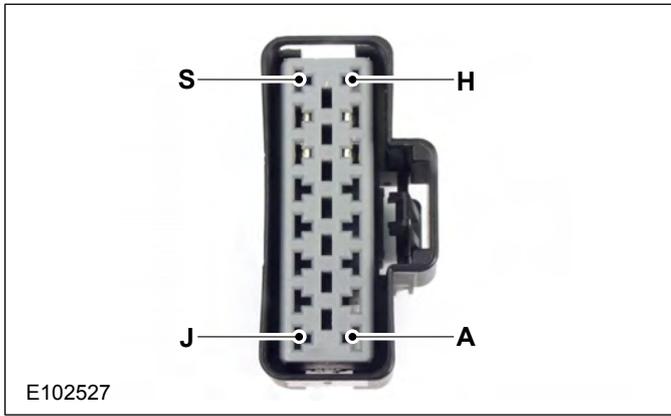


E227219

Item	Description
1	C1 Connector
2	C2 Switch Connector
3	Vehicle Interface Connector 1
4	Ground
5	C3 – 2 Way Radio Connector
6	Auxiliary Fuse Panel within the Pre-Fuse Box (lid not shown)
7	Vehicle Interface Connector 2^

^ Only suitable to be used with Ford Programmable Battery Guard (A540). No other connections to be made via this connector.

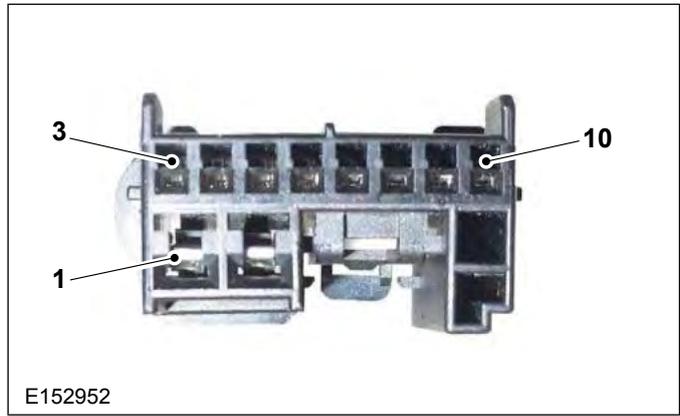
C1 Connector



Item	Description
A	Relay 2 Output (5A)
B	Relay 7 Coil OUT
C	Relay 7 Coil IN
D	Relay 7 Output (10A)
E	Ground
F	Relay 6 Coil IN
G	Relay 5 Coil IN A
H	Relay 3 Output 1 (15A - F5 Fuse Shared)
J	Relay 2 Output 2 (15A)
K	KL30 20A
L	Relay 4 Output (15A)
M	KL15 Ignition Switch
N	Relay 2 Coil IN A
P	Relay 6 Output (15A - F7 Fuse Shared)
R	Relay 5 Output (15A - F7 Fuse Shared)
S	Vehicle Speed Signal

The C1 connector is a major interface to the vehicle, providing various signals and control circuits. It is wired to the Auxiliary Fuse Panel, see figures E227218 and E227219. The mating connector for the C1 is DELPHI 15326956. The fuse ratings, relays and circuits are shown in figure E152950 and table. A service kit (KTGK2V-14A411-A*) can be ordered from your local Ford dealer, this kit contains the mating connector, and 3m of wiring.

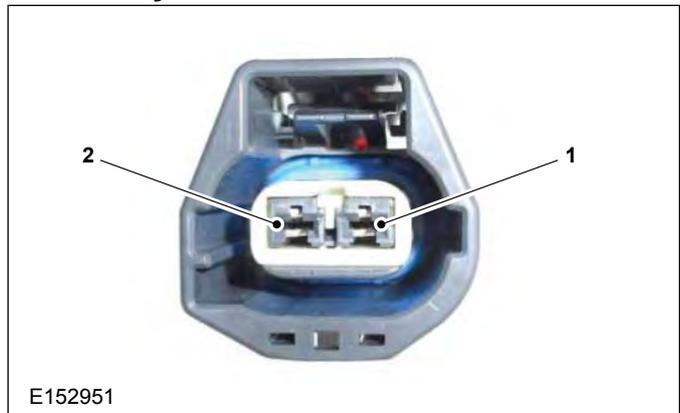
C2 Switch Connector



Item	Description
1	Relay 1 Output (20A)
2	Ground
3	Switch Illumination Supply
4	Relay 3 Coil IN
5	Relay 4 Coil IN
6	Relay 1 Coil IN
7	Relay 3 Output 2 (F5 Fuse Shared)
8	Relay 2 Coil IN B
9	KL30 (3A)
10	Relay 5 Coil IN B

C2 Mating Kit — KTBK2V-14A411-B*

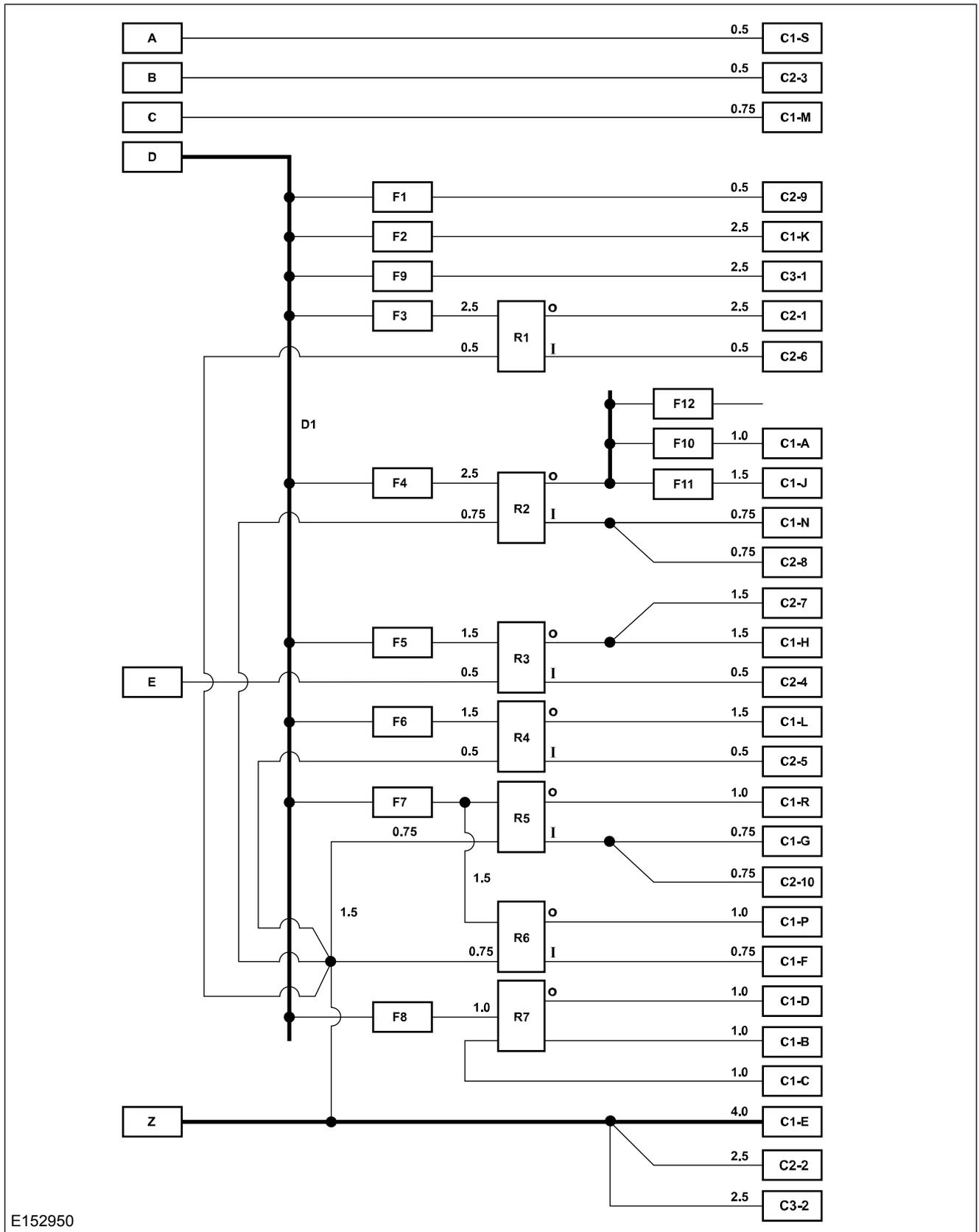
C3 - 2 Way Radio Connector



Item	Description
1	KL30 20A
2	Ground

C3 Mating Kit - KTBK2V-14A411-H*

Auxiliary Fuse Panel Circuit Diagram

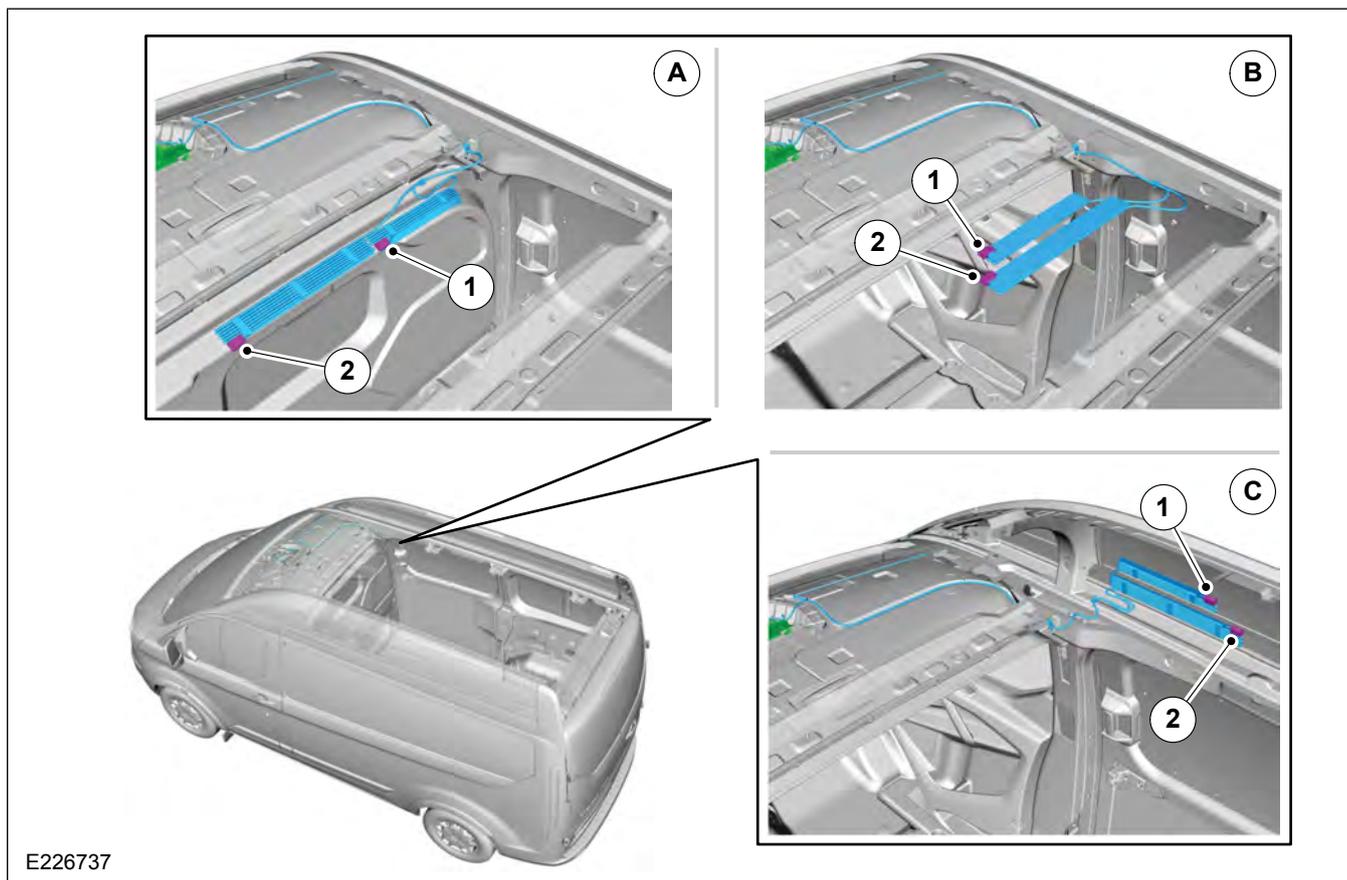


E152950

Item	Description	Item	Description
A	Vehicle Speed	C1-B	R7 Coil OUT
B	Switch Illumination	C1-C	R7 Coil IN
C	Ignition Switch	C1-D	R7 Output
D	KL30	C1-E	Ground
E	Engine Run Signal - Ground	C1-F	R6 Coil IN
D1	Busbar	C1-G	R5 Coil IN A
Z	B-	C1-H	R3 Output 1
F1	3A Fuse	C1-J	R2 Output 2
F2	20A Fuse	C1-K	KL30
F3	20A Fuse	C1-L	R4 Output
F4	20A Fuse	C1-M	Ignition Signal / KL15
F5	15A Fuse	C1-N	R2 Coil IN A
F6	15A Fuse	C1-P	R6 Output
F7	15A Fuse	C1-R	R5 Output
F8	10A Fuse	C1-S	Vehicle Speed
F9	20A Fuse	C2-1	R1 Output
F10	5A Fuse	C2-2	Ground
F11	15A Fuse	C2-3	Switch Illumination
F12	Not Used	C2-4	R3 Coil IN
R1	20A Relay (Beacon ⁽¹⁾)	C2-5	R4 Coil IN
R2	20A Relay (Ignition ⁽¹⁾)	C2-6	R1 Coil IN
R3	20A Relay (Aux 2/Water Heater ⁽¹⁾)	C2-7	R3 Output 2
R4	20A Relay	C2-8	R2 Coil IN B
R5	20A Relay (LHS Indicator/Aux 1 ⁽¹⁾)	C2-9	KL30
R6	20A Relay (RHS Indicator ⁽¹⁾)	C2-10	R5 Coil IN B
R7	20A relay	C3-1	KL30
C1- A	R2 Output 1	C3-2	Ground

⁽¹⁾= When specified on Ford options

4.19.6 Beacon Preparation Pack (A606)



E226737

Item	Description
A	Vehicles with a bulkhead
B	Low Roof vehicles (without bulkhead)
C	High Roof vehicles (without bulkhead)
1	Front Beacon harness on BK2V-14A303-**
2	Rear Beacon harness on BK2V-14A303-**

Figure E226737 shows the routing for front and rear beacon wiring installations and location of connectors for the beacons which should be viewed in conjunction with the fitment of the beacon switch, BK2V-13D768-A*, see figures E226739 and E152954 for Switches and see figures E227218 and E227219 for Auxiliary Fuse Panel, shown in this section.

The beacon wiring circuit is fused at 20A. Any increase in this current demand should be met with the use of an external relay.

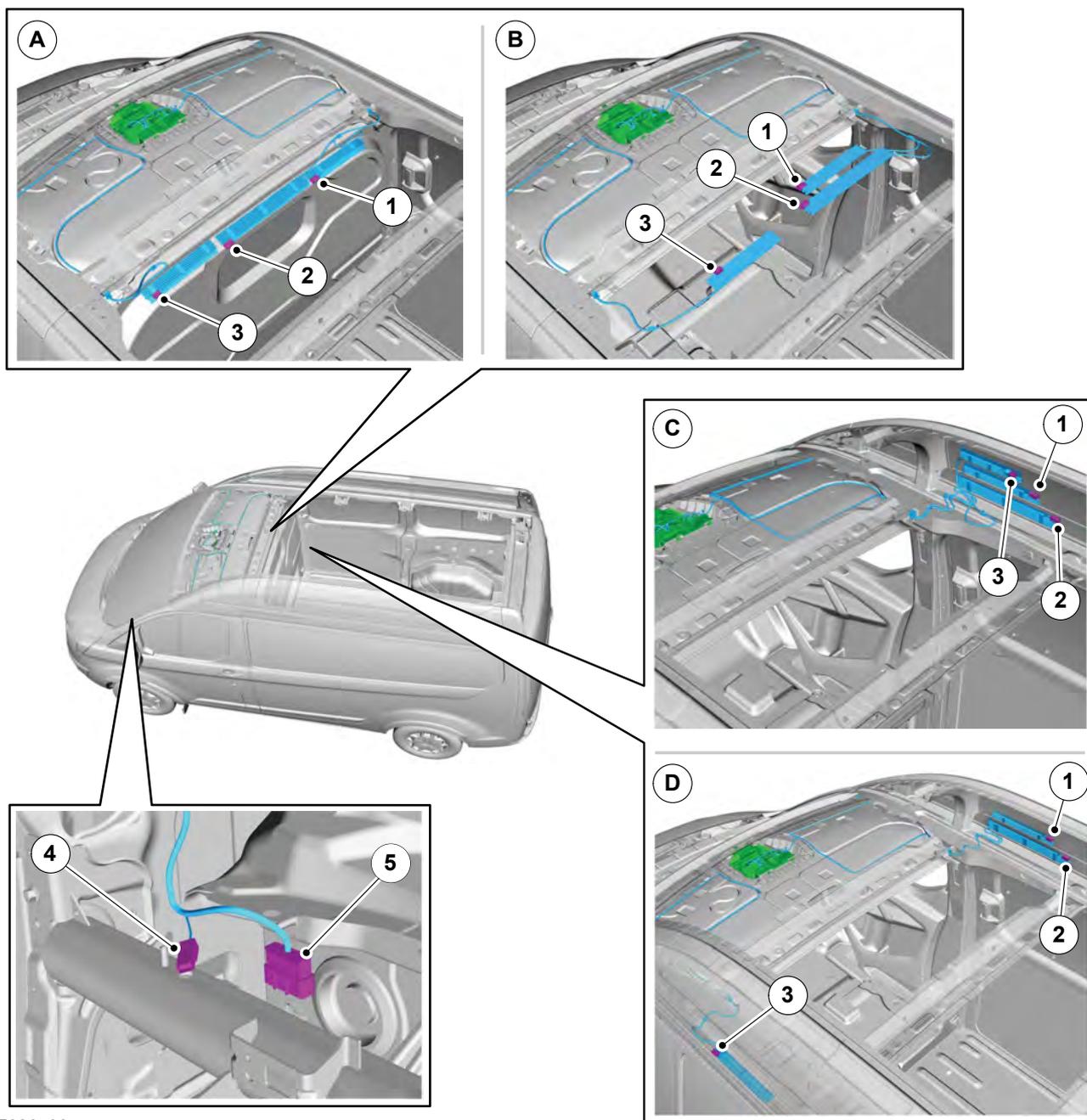
Contact your National Sales Company representative or Local Ford Dealer for availability and options.



E118455

Item	Description
1	Ground
2	Beacon Supply

4.19.7 Utility Vehicle Switch Pack (A607) - Right Hand Drive shown



E226738

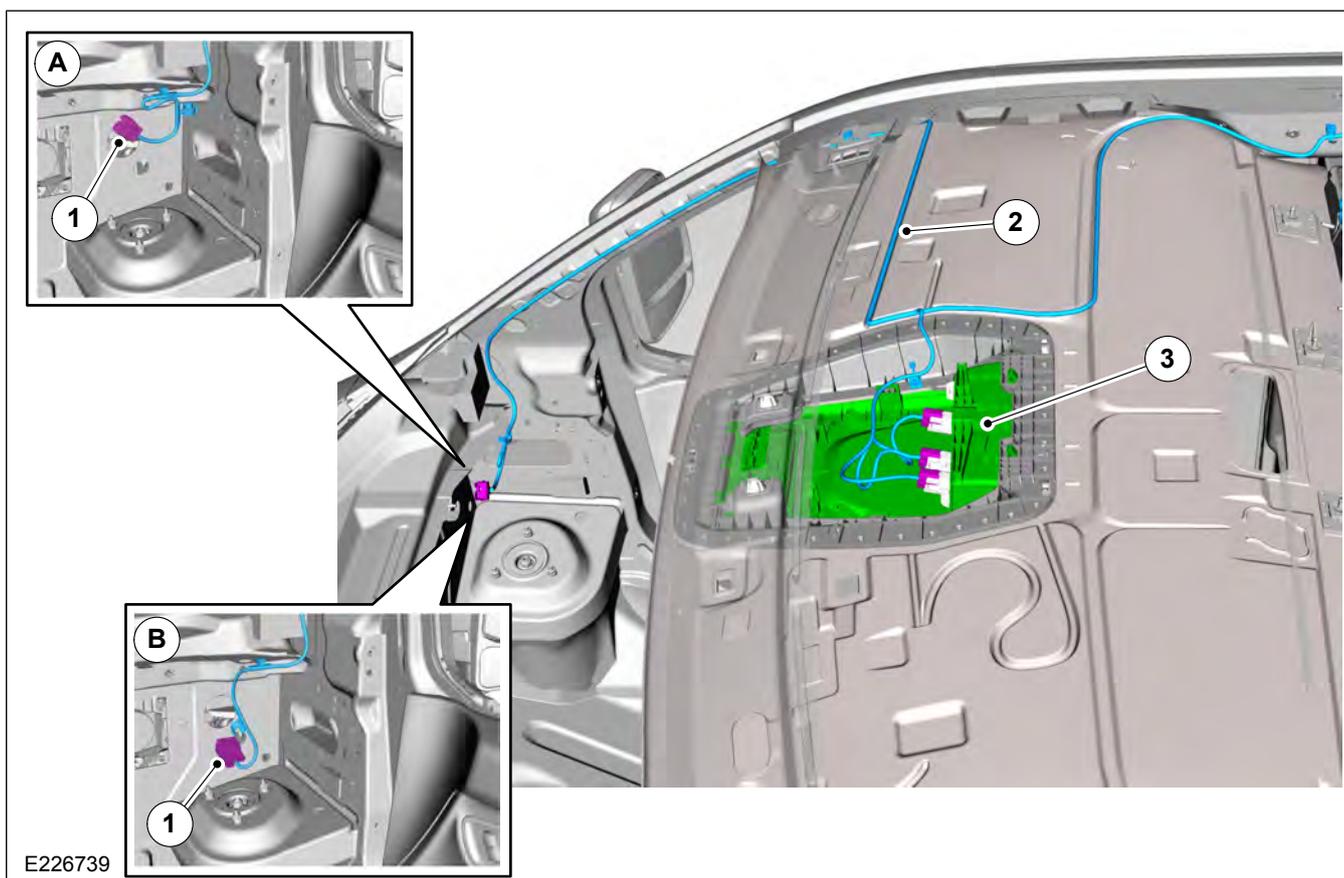
Item	Description	Item	Description
A	Vehicles with Bulkheads	1	Front Beacon Connector
B	Low Roof vehicles (without bulkhead)	2	Rear Beacon Connector
C	High Roof RHD vehicles (without bulkhead)	3	Aux 2 Connector ⁽¹⁾
D	High Roof LHD vehicles (without bulkhead)	4	Aux 1 Connector
-	-	5	Mating C1 Connector

⁽¹⁾= Limited Availability, 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

The Utility Vehicle Switch Pack has Beacon Preparation Pack and an additional harness BK2V-14659-**:

The beacon wiring is always on the right hand side of the vehicle and connects into the C2 connector of the switch harness BK2V-14A303-A* and harness BK2V-14659-** is always on the passenger side of the vehicle and connects to the C1 connector of the switch harness BK2V-14A303-A*; see E227218 and E227219 for C1 connector location and also figures E226739 and E152954 for Switches.

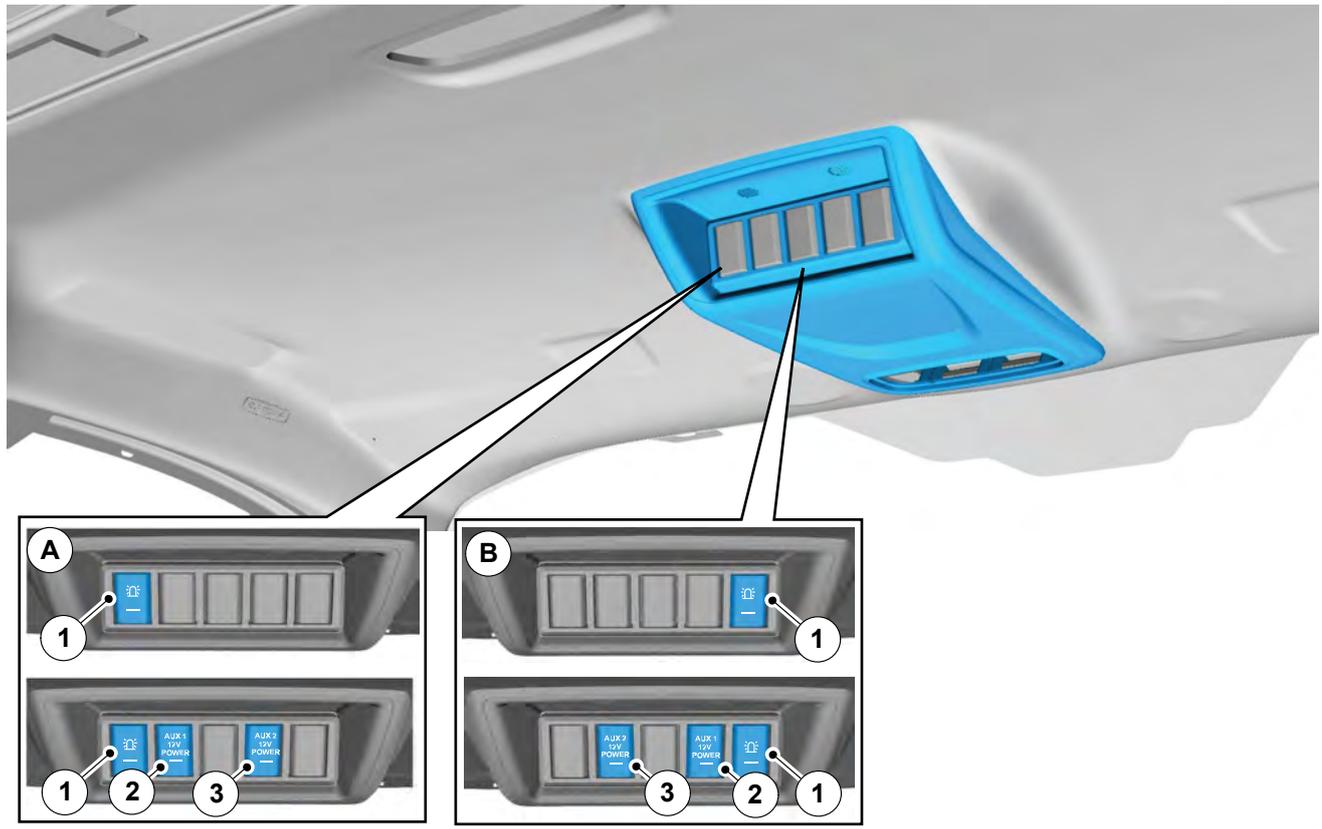
4.19.8 Auxiliary Switches



E226739

Item	Description
A	LHD location
B	RHD location
1	C2 Connector
2	BK2V-14A303-F* Harness, see figures E152954 and Switch table
3	Over Head Console - Containing Switches

Switch Locations



E152954

Item	Description
A	Left Hand Drive Switch options
B	Right Hand Drive Switch options
1	Beacon
2	Aux 1 — Part of Utility Vehicle Switch Pack (A607)
3	Aux 2 — Part of Utility Vehicle Switch Pack (A607)

Switches and Harness Part Numbers

Harness	Beacon	Aux 1 (12V)	Aux 2 (12V)
BK2V-14A303-A*	BK2V-13D768-A*	-	-
BK2V-14A303-F*	BK2V-13D768-A*	BK2V-13D734-A*	BK2V-13D734-B*

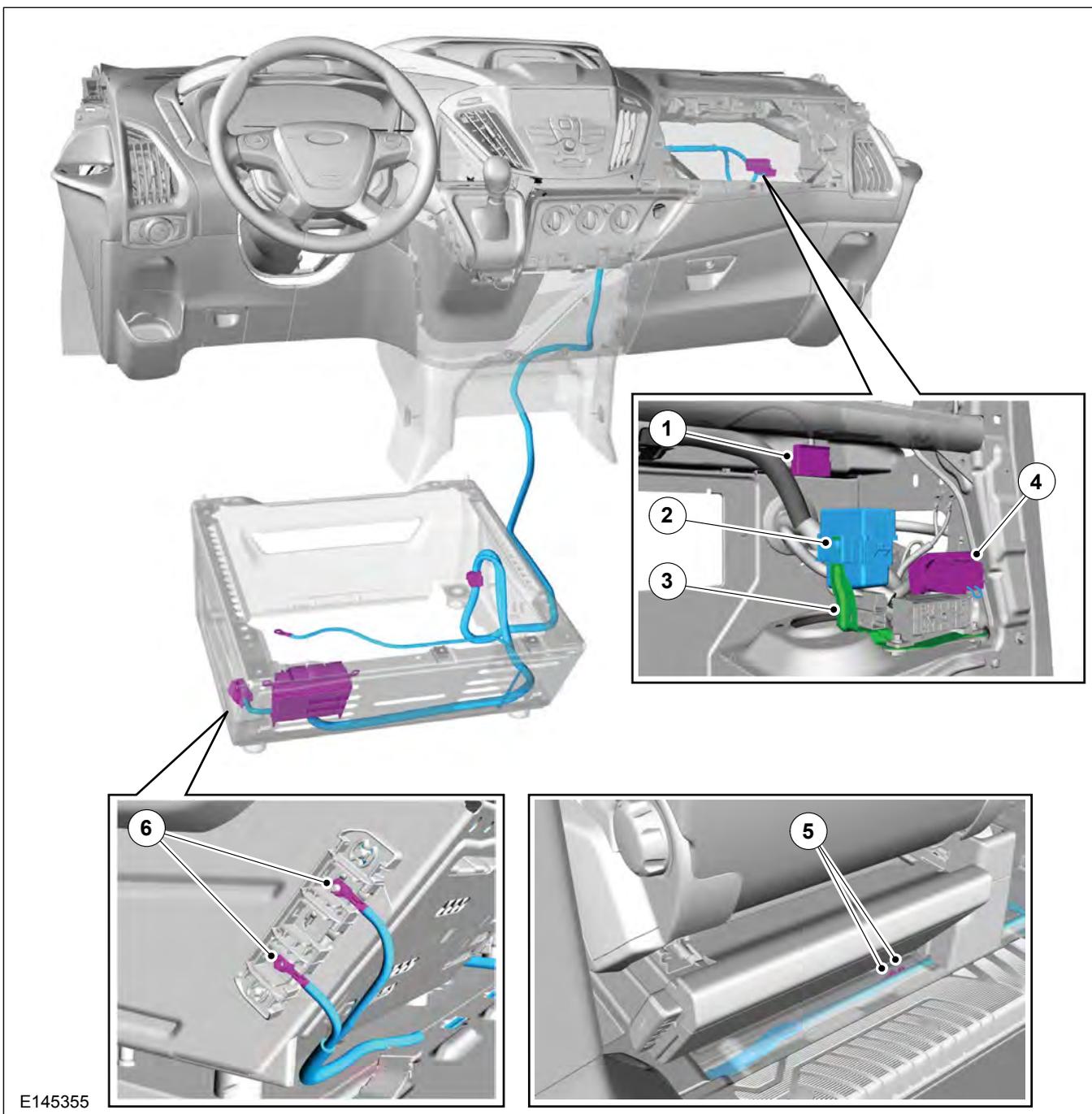
There are a combination of switch packs available to order for specific conversions. The 'Beacon Preparation Pack' or 'Utility Vehicle Switch Pack' are high current latched switches that control relays in the Auxiliary Fuse Panel. When the switches are pressed (light on) the switches provide a +12V/20A output.

NOTE: The Aux 2 switch must have the engine running before it will give an output. The output will be switched off during an engine auto-off (Start-Stop vehicle). The other switches (Beacons and Aux 1) are fed directly from the battery. It is important to switch these off when not required, as the battery charge level will be depleted.

If heavy loads are required, controlled via these switches (especially at engine off) it is recommended to install the High Performance Deep Cycle AGM Battery option (HFQ). The switches are illuminated red when the lights are: side, dipped, full beam or auto lights on. They switch +12V and can switch up to 8A directly.

4.19.9 High Specification Vehicle Interface Connector (A608)

NOTE: For access to individual CAN bus read signals, please contact the Vehicle Converter Advisory Service at VCAS@ford.com



E145355

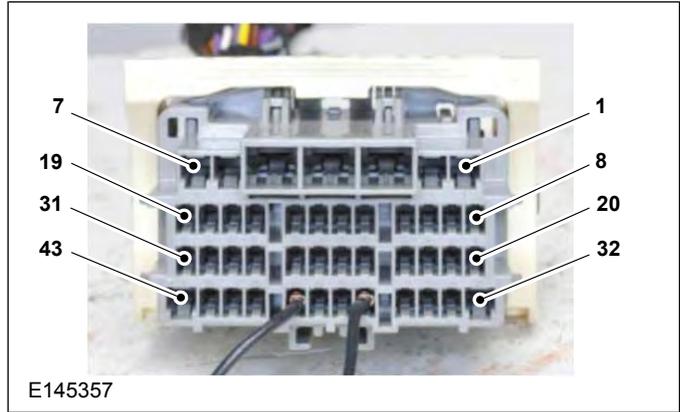
Item	Description
1	C1 Connector
2	Fuse Box – For High Specification Vehicle Interface Connector
3	Fuse Box Bracket
4	High Specification Vehicle Interface Connector
5	The connections are taped back to the harness under the carpet, behind the Drivers Seat Pedestal
6	60A fuse Connections on Drivers Seat Pedestal - Final Installation by Converter

The standard system includes the Auxiliary Fuse Panel and a supplementary Fuse Box, it is powered by two fuses from the Customer Connection Points at the driver's seat pedestal (item 6 in figure E145355), therefore on these high-specification vehicles there will only be one remaining customer connection point available for customer to use. See also Fuse Rating table.

The High Specification Vehicle Interface Connector (43 way connector), see E145357, is an order only option (A608) for production fit and cannot be updated after the vehicle is built. The connector is located behind the glove box as shown in E145355. It provides access to multiple signals, power and ground. These signals include those required for Police /Emergency Service conversions. The part numbers of the dedicated harnesses are GK2V-14401-A*/D* and GK2V-14K024-A*/D*.

A standard mating connector, with only a link wire between cavity 36 and 39, is provide (no other wires). A mating 43 way connector with 3m of wiring (with all wires) is available as a kit (KTBK2V-14A411-D*) from your local Ford dealer.

WARNING: This link wire provides a 'no start function'. If the connection becomes 'Open Circuit' by removing the mating connector or link wire the vehicle will not Crank/Start.



High Specification Vehicle Interface Connector

Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
1	2.00	KL58	License Plate Supply	-	-	-
2	2.50	KL31-20A max.	Ground	17	20A	16A
3	2.50	KL31-20A max.	Ground	13	20A	16A
4	2.50	KL31-20A max.	Ground	14	20A	16A
5	2.50	KL31-20A max.	Ground	15	20A	16A
6	2.50	KL31-20A max.	Ground	16	20A	16A
7	1.00	KL30	Battery Supply	1	10A	8A
8	0.50	KL30	Battery Supply	2	5A	4A
9	1.00	KL30	Battery Supply	3	15A	12A
10	1.00	KL30	Battery Supply	4	15A	12A
11	1.00	KL30	Battery Supply	5	10A	8A
12	1.00	KL30	Battery Supply	6	7.5A	6A
13	1.00	KL30	Battery Supply	7	10A	8A
14	0.75	KL30	Battery Supply	8	7.5A	6A
15	1.00	KL15	Ignition	9	5A	4A
16	0.75	KL15	Ignition	10	5A	4A
17	0.75	KL15	Ignition	11	10A	8A
18	1.00	KL15	Ignition	12	5A	4A
19	0.5	Rear Door Ajar Switch	Ground = Door Open	-	-	-
20	0.75	IP+Switch Illumination	Pulse Width Modulation Signal from BCM	-	-	300mA
21	-	-	Not Used	-	-	-
22	0.75	Stop Lamp Signal	<= 13V DC, > Pulse Width Modulation Signal from BCM	-	-	3A
23	0.50	SRC/Start-Stop Inhibit	Ground = SRC/Start-Stop deactivated.	-	-	-
24	0.50	LHS Sliding Door Ajar	Door Open = Ground (<50 ohms)	-	-	NA
25	0.50	Passenger Door Ajar	Door Closed = Ground (<50 ohms)	-	-	NA
26	0.50	Parking Lamps	Pulse Width Modulation Signal from BCM	-	-	300mA
27	0.50	RHS Sliding Door Ajar	Door Open = Ground (<50 ohms)	-	-	NA
28	1.00	Turn Indicator LHS	Fuse and Relay located in Aux Fuse Panel in seat pedestal	-	-	12A
29	1.00	Turn Indicator RHS		-	-	
30	0.50	Horn Signal	Relay Output from Smart Relay Box 1	-	-	300mA
31	0.75	Vehicle Speed	To be used as input to Electronic Control Units only	-	-	NA
32	0.75	Reverse Signal	Pulse Width Modulation Signal from BCM	-	-	300mA
33	0.75	High Beam	Output from BCM	-	-	300mA
34	0.75	Low Beam	Output from BCM	-	-	300mA
35	0.75	Fog Lamps (Front)	Output from BCM	-	-	300mA
36	0.50	KL50	Bridged with 39 - Open Circuit will inhibit Crank ⁽¹⁾	-	-	300mA
37	0.50	Handbrake Signal	Handbrake Activated = Ground (<50 ohms)	-	-	NA
38	0.50	Engine Run	Engine Running ⁽³⁾	-	-	NA
39	0.50	No Start Function	Bridged with 36 - Open Circuit will inhibit Crank ⁽¹⁾	-	-	NA
40	1.00	Key In ⁽²⁾	12V	-	-	-

Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
41	0.50	Driver Door Ajar	Door Closed = Ground (<50 ohms)	-	-	NA
42	0.50	Lock	Lock Request = Ground 500mS.	-	-	NA
43	0.50	Unlock	Unlock Request = Ground 500mS.	-	-	NA

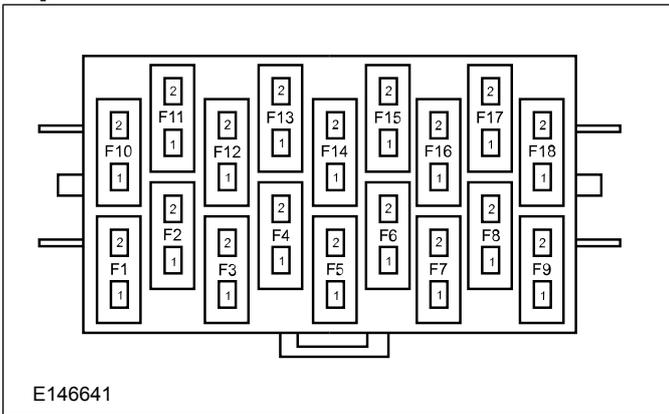
⁽¹⁾= Bridged via circuit on mating connector to enable crank/start. If mating connector is removed, vehicle will not start

⁽²⁾= Ignition Switch 3M5T-11572-A* is required for Key In Signal. To replace the Ignition Switch refer to the Workshop Manual Removal and Installation for Steering Wheel and Column Electrical Components - Ignition Switch.

⁽³⁾= Attached system impedance must be between 6K and 10K if a true 12V to Ground value is needed. To use as an input signal a 10K pull up resistor is needed.

KL Terminology	
KL15	Ignition - Position 2
KL30	B+ (Always +12V)
KL31	Chassis or Body Ground
KL50	Crank/Start Position 3
KL58	Side Marker and License Plate Lighting
KL75	Accessory - Position 1

Supplementary Fuse Box - for High Specification Interface Connector



Fuse Ratings

Fuse	Type	Rating (A)	Color	Function	Part Number
F1	Mini	10	Red	Battery KL30	1L3T-14A094-F*
F2	Mini	5	Tan	Battery KL30	1L3T-14A094-D*
F3	Mini	15	Blue	Battery KL30 STD	1L3T-14A094-G*
F4	Mini	15	Blue	Battery KL30 STD	1L3T-14A094-G*
F5	Mini	10	Red	Battery KL30 STD	1L3T-14A094-F*
F6	Mini	7.5	Brown	Battery KL30	1L3T-14A094-E*
F7	Mini	10	Red	Battery KL30	1L3T-14A094-F*
F8	Mini	7.5	Brown	Battery KL30	1L3T-14A094-E*
F9	Mini	5	Tan	Ignition KL15	1L3T-14A094-D*
F10	Mini	5	Tan	Ignition STD	1L3T-14A094-D*
F11	Mini	10	Red	Ignition KL15	1L3T-14A094-F*
F12	Mini	5	Tan	Ignition KL15	1L3T-14A094-D*
F13	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F14	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F15	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F16	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F17	Mini	20	Yellow	Fused Ground	1L3T-14A094-H*
F18	-	-	-	Spare	-

WARNINGS:

 **The fuse ratings and nominal ratings within the table should be followed strictly. Any deviation will interfere with the validated fusing strategy and wiring architecture. Some inputs are provided via electronic modules and any overloading could cause serious vehicle malfunction and may conflict with legal requirements.**

 **No increase in existing vehicle standard fuse capacity is allowed under any circumstances.**

On high-spec vehicles the C1 connector is not available as a customer interface and only the 43 way connector should be used. The connector to add wiring for switches and beacons is still available.

125kb/s MS CAN Access Interface

 **WARNING: It is not allowed to transmit DATA on any of the CAN lines. The system provided to splice into the 125kb/s MS CAN Bus is for modules that will read only. If messages are transmitted from a third party fit module, vehicle functionality can be compromised and lead to serious failure. It is vital that any CAN stubs added must comply to the twisted rate, length, correct parity, with routing away from any high EMP devices.**

NOTE: Please contact your National Sales Representative or your local Ford Dealer for availability.

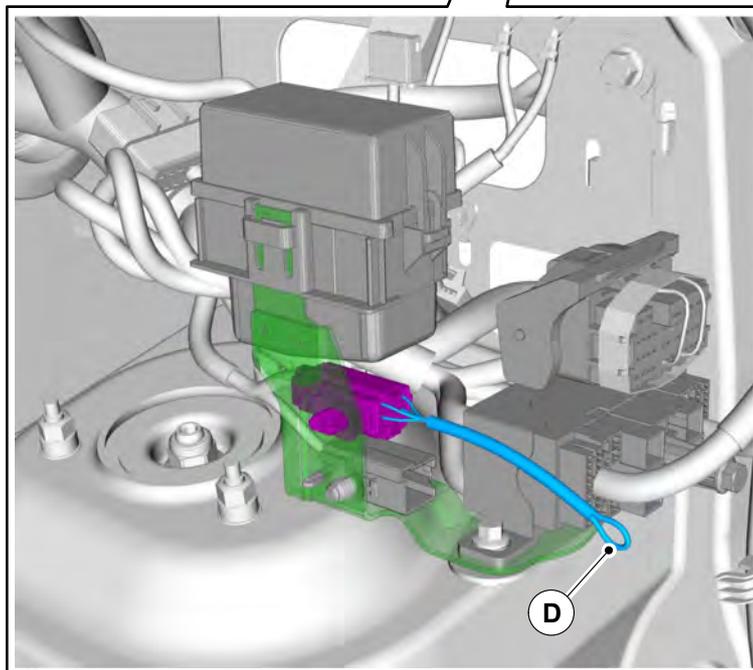
The High Specification Interface Connector option A608 has a 125Kb/s MS CAN interface EDS connection point that can have third party CAN wires spliced into. This is designed to provide Ford CAN Bus interfacing for third party fit module telematics and logic controller systems. For further information on splicing

Refer to: [4.1 Wiring Installation and Routing Guides \(page 56\)](#).

Modules to be installed are only allowed to be read ONLY of the Ford system CAN Bus data and must be CE marked. After installation, functional testing of Ford systems connected to the same CAN Bus is expected. These include Trailer Tow, Rear Camera, Tachograph, Body Control Systems, Fuel Fired Heater and Cluster Systems. The system should also receive a health check DTC read to ensure no failures are present after the installation and ignition cycle has been performed. The converter is also responsible for legal compliance to EU EMC requirements of the finished system and ensure no adverse impact has been generated to the existing Ford systems. Please refer to Section 1 of the BEMM for responsibility and EMC compliance.

The CAN Interface loop wire, see figure E212562, is located near the 43 WAY interface connector, behind the glove box and outboard to the wheel arch. The half way loop point can be spliced into with third party twisted pairs of at least 3 twists per 50mm and a minimum of 0.3m to a maximum of 2m stub length to module. CAN Low is the Gray/Orange wire. CAN High is the Violet/Orange wire.

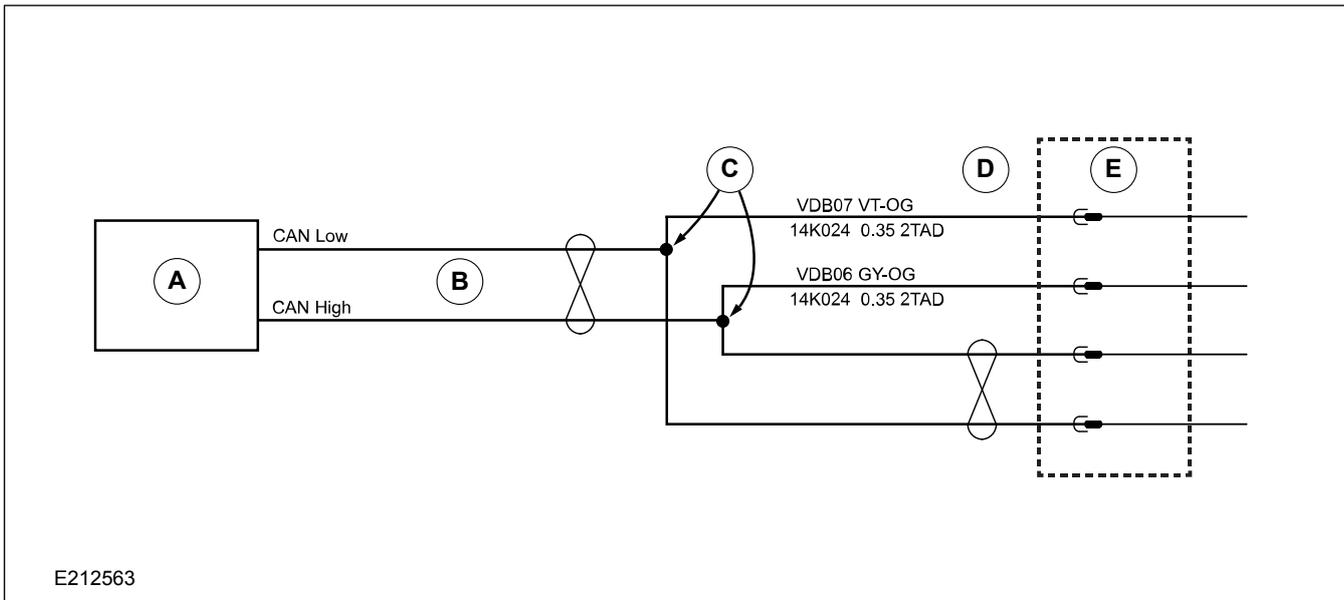
CAN Bus Interface Loop Wire Location



E212562

Item	Description
D	Splice into midpoint of loop

Third Party Fit CAN Read Module



E212563

Item	Description
A	Converter Fit Read Module
B	Converter Fit Stub Wiring
C	Spliced Interface Connection
D	Ford CAN Loop Wire - CAN Low (Violet/Orange wire), CAN High (Gray/Orange wire)
E	C22-AB

Can bus network stubs must comply with the following standards:

- Originate at the CAN bus backbone
 - Have a final length of between 0.3m and 2m, see dimension 'X' in figure E212566
 - Have at least 3 twists per 50mm of wire
 - Follow the splice guidelines, shown later in this section
- Stub length added must exceed 0.3m but be less than 2m, at least 3 twists per 50mm of wire and not be less than 50mm of untwisted wire to the added module or splice.

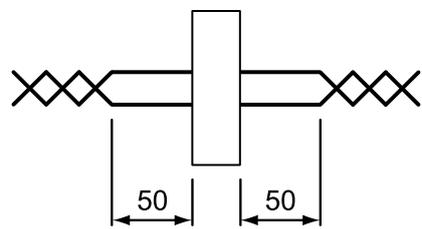
Physical Interface of spliced in EDS Requirements

Parameter	Minimum	Nominal	Maximum	Units
Impedance	108	120	132	Ohm
Resistance	-	-	175	mili Ohm/meter
Signal Speed	-	-	5.5	nano Second/meter
Twisting	3 ⁽¹⁾	-	-	Twisted/50mm
Phase Shift	-	-	3.4	nano Second
Differential Mode Offset	-	-	0.5	Volts

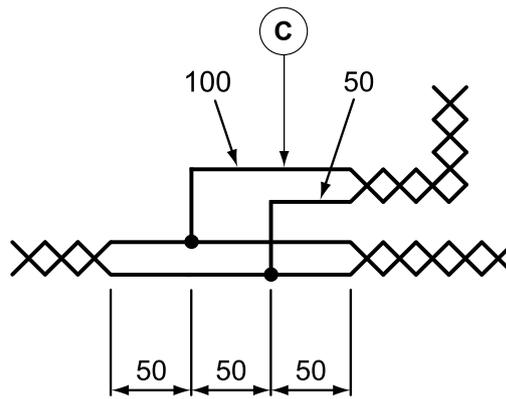
⁽¹⁾ = The Twisted circuits shall have a minimum twist rate of 3 twists (4 wire crossovers) per 50mm. One "twist" or "turn" = 180 deg. Rotation. Twisting shall be maintained to within 50mm of any in-line or component connector.

The twisted pair that forms the CAN Bus shall be twisted throughout the total run of the vehicle except for a maximum of 50mm from connectors or harness splices. At splices an additional 50mm of untwisted wire is allowed between the CAN H and CAN L contact points

Twisted Circuits - all values are maximum limits (dimensions shown in mm)



(A)

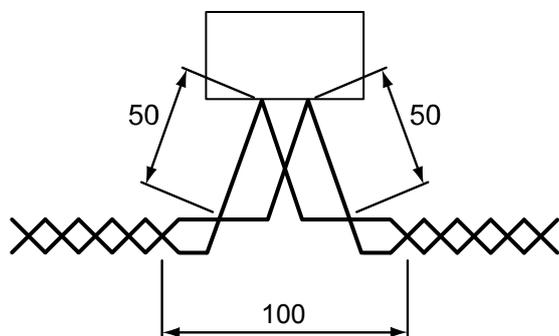


(B)

E212564

Item	Description
A	Connector
B	Splice
C	Typically taped to backbone

Maximum CAN Bus Length Series Chain Method - all values are maximum limits (dimensions shown in mm)



E212565

It is allowed to connect modules to the backbone using a series chain method instead of a stub. If the series chain method is selected, the untwisted wire on each side of the double crimp in the connector cannot exceed 50mm. See figure E212565

The two terminating ECU's shall be placed the 'furthest' distance apart on the CAN Bus. The maximum wiring length for each type of network is defined in the following table

Maximum CAN Network Lengths

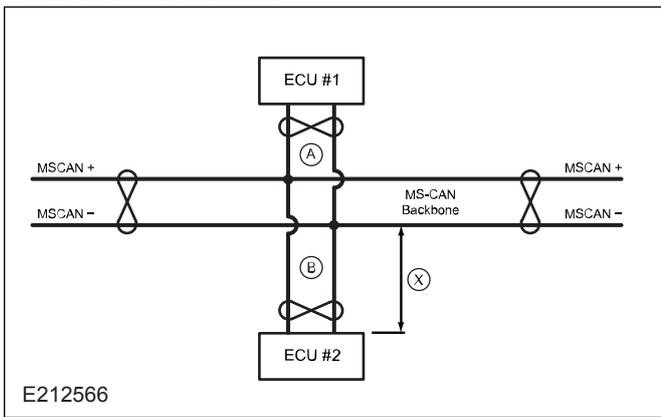
Network Speed	Between terminating ECU's	SAE J1962 Connector to 'Furthest' Terminating ECU ⁽¹⁾
125 kbps	50m	45m
500 kbps	33.5m	28.5m

⁽¹⁾= This allows for an off-board tester cable of up to 5m.

NOTE: Exceeding the permitted CAN network lengths will result in data transfer issues and could cause serious vehicle error.

Cable Stub Length: Must be a final length of between 0.3m and 2m, see dimension 'X' in figure E212566. It is acceptable for any stub, except the terminating ECU stubs, to be open circuit and unterminated, i.e. harness variants are not required to support option fit ECU's.

Cable Stub Circuit



E212566

Item	Description
A	Stub 1
B	Stub 2
X	Stub - Final length between 0.3m and 2m

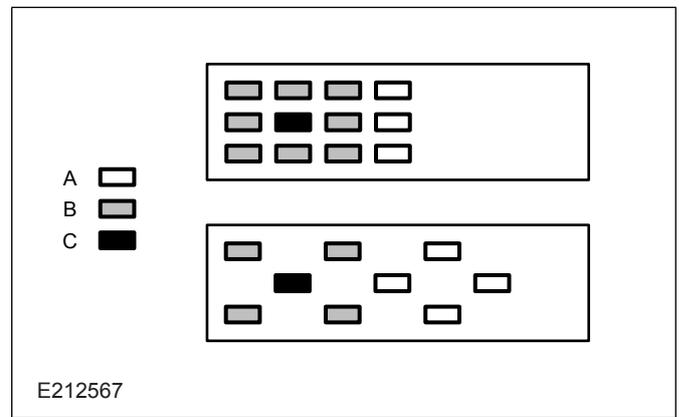
Stub Splices: The general rule is that there shall be at least 50mm of twisted wire between any series of the following connections: splice – splice, connector - splice, connector - connector, Splices include wire to wire splices and splice blocks.

Two stubs may be connected to the same stub connection point at the CAN backbone only on a 125 kb/s (MSCAN) bus. In this case the stubs must differ in length by at least 10%. Example: If one stub is 1m long the second can be less than 0.9m or between 1.1m and 2m.

Stub Topologies: Stubs connected to stubs are not allowed. If multiple nodes need to be connected to a single stub then the nodes must be series chained. This can be accomplished by double crimping if only two pins (CAN H & CAN L) are available or making the CAN Bus connection through the module if four pins are available (2 x CAN H & 2 x CAN L).

The maximum number of ECU's on network transmission speed 125 kb/s, including the off-board tester, is 32.

The two wires forming each pair of CAN H and CAN L connections shall be routed via physically adjacent pins as shown in the figure E212567.



E212567

Item	Description
A	Non Adjacent Pins
B	Adjacent Pins
C	CAN H or CAN L

Each Bus pair may be routed via separate connectors.

Details of the pin allocation for each node shall be defined in the relevant module specification

The voltage supply used by the network interface must not be directly connected to any external part. That means that the regulated power used by the CAN-circuitry on the printed circuit board shall be used only inside the cover of the ECU. Note: this does not apply to the Vbat connection required for full-sleep functionality in transceivers powered by Vbat.

The CAN network shall be fully functional, as a minimum, over the operating range 9V to 16V, as measured at the modules battery pin. Outside this operating range, it is recommended that modules continue to communicate. However, it is not acceptable for modules to send corrupt messages/error frames/illegal symbols, or disrupt the transmissions of other modules.

NOTE: Module feature requirements may require a larger operating range

Modules shall not drive the CAN bus dominant during module reset.

Common mode EMC chokes shall not be used in terminating nodes. Additionally chokes may only be used in non-terminating ECU's with the agreement of the relevant FMC design authority, for each vehicle program to which the ECU shall be fitted.

Suppliers may Electrostatic Component Discharge components as long as pass tests:

- Conducted Immunity
 - CI 280 Electrostatic Discharge
 - CI 270-C Immunity to Voltage Overstress (24V), applied to CAN H and CAN L

Additionally, the capacitance of the component, measured at 2.5V reverse bias, shall be <30pF

The zener stacks may be removed for modules on CAN links that do not connect to the diagnostic connector as long as it is shown that the unpowered ESD test can be passed without these parts (Powered ESD testing on the CAN pins is not required for modules that do not connect to the diagnostic connector). The circuit board pads for these parts must be present for all designs.

All grounding of the CAN transceiver and capacitors shall be made to ECU signal ground.

All transceiver voltage reference pins shall be left open circuit.

Capacitors shall be monolithic ceramic capacitors or equivalent.

A ground plane is required under the transceiver chip on the component layer of the PCB.

Transceiver shall be located as close to edge connector as possible. Other IC's are not permitted between edge connector and the transceiver

CAN H / CAN L circuits between edge connector and transceiver shall be as short as possible and routed side-by-side. Guard tracks are required for all CAN H / CAN L, TXD and RXD circuits on the same PCB layer. Guard tracks should not be placed between CAN H and CAN L

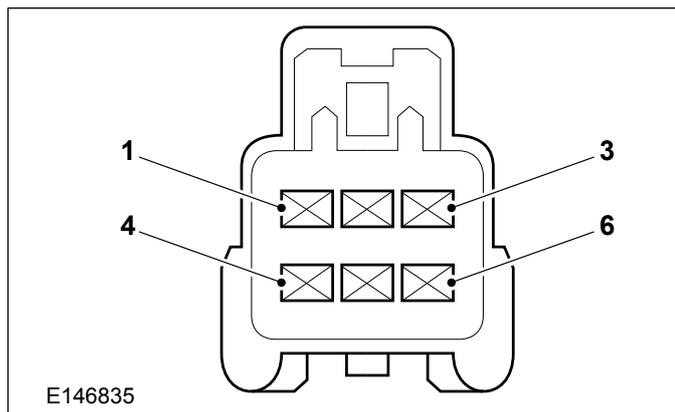
All guard tracks shall be at least 0.5mm wide and grounded at least every 10mm.

The decoupling capacitor shall be placed as close as possible to the transceiver.

Transceivers that are battery powered are required to have a Flexisafe capacitor.

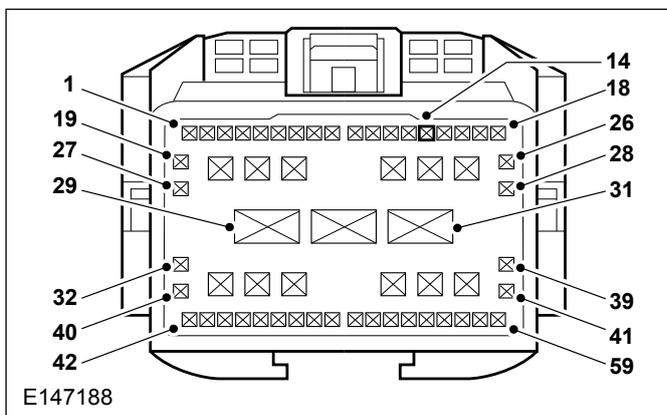
4.19.10 Adding Connectors

Additional Lighting for rear of vehicle interior



Item	Description
Pin 1	Supply through Battery Saver
Pin 5	Ground - Dimming

Marker Lamps



Item	Description
Pin 14	Side Marker Supply - Yellow /Violet

WARNING: Maximum load on pin 14 is 2.5A including existing license plate bulbs. Do not exceed 2.5A on this circuit. Recommended only LED side markers be added.

Additional Rear Speakers

NOTE: The connectors on the Instrument Panel harness (14K024) and the main harness (14401) are reversed between Left Hand Drive (LHD) and Right Hand Drive (RHD) vehicles, hence different sets of terminals/wires are required to cover all the markets.

For information on rear speakers:

Refer to: 4.10 Information and Entertainment System (page 126).

Unused Connectors

The harnesses may have a number of unused connectors – these are dedicated to other features and options, e.g. heated seats, but are **not** always present depending on level of harness fitted. Ford **do not** recommend the use of these connectors for any other purpose than that intended by design.

Power Outlet / Cigar Lighter

Both features adopt a 20A fusing strategy. With a single battery system, continued loading of these features will lead to battery drain, and risk vehicle starting. If continuous power is required, a second battery option should be installed and the customer connection points, where fitted, utilized. At engine OFF, all three power outlets are connected to the battery state of charge. The power will be deactivated at 60% state of charge. If peripherals require charging for long durations at engine OFF, it is recommended that the high capacity, high powered AGM option (HFQ) is selected. This will provide a longer time until the 60% state of charge is reached.

4.20 Grounding

4.20.1 Ground Points

⚠ WARNING: It is recommended to only use one eyelet per stud for high current applications. If more than one eyelet per stud is unavoidable, the highest current eyelet feed should be connected closest to the supply terminal. Do not exceed two eyelets or crimp terminals per stud connection. See figure E227461 and the following table for recommended ground points that can be used.

CAUTIONS:

- ⚠ Only use the ground points indicated. Using alternative points may affect the vehicle integrity.**
- ⚠ Make sure that all ground points are tightened to the correct torque.**

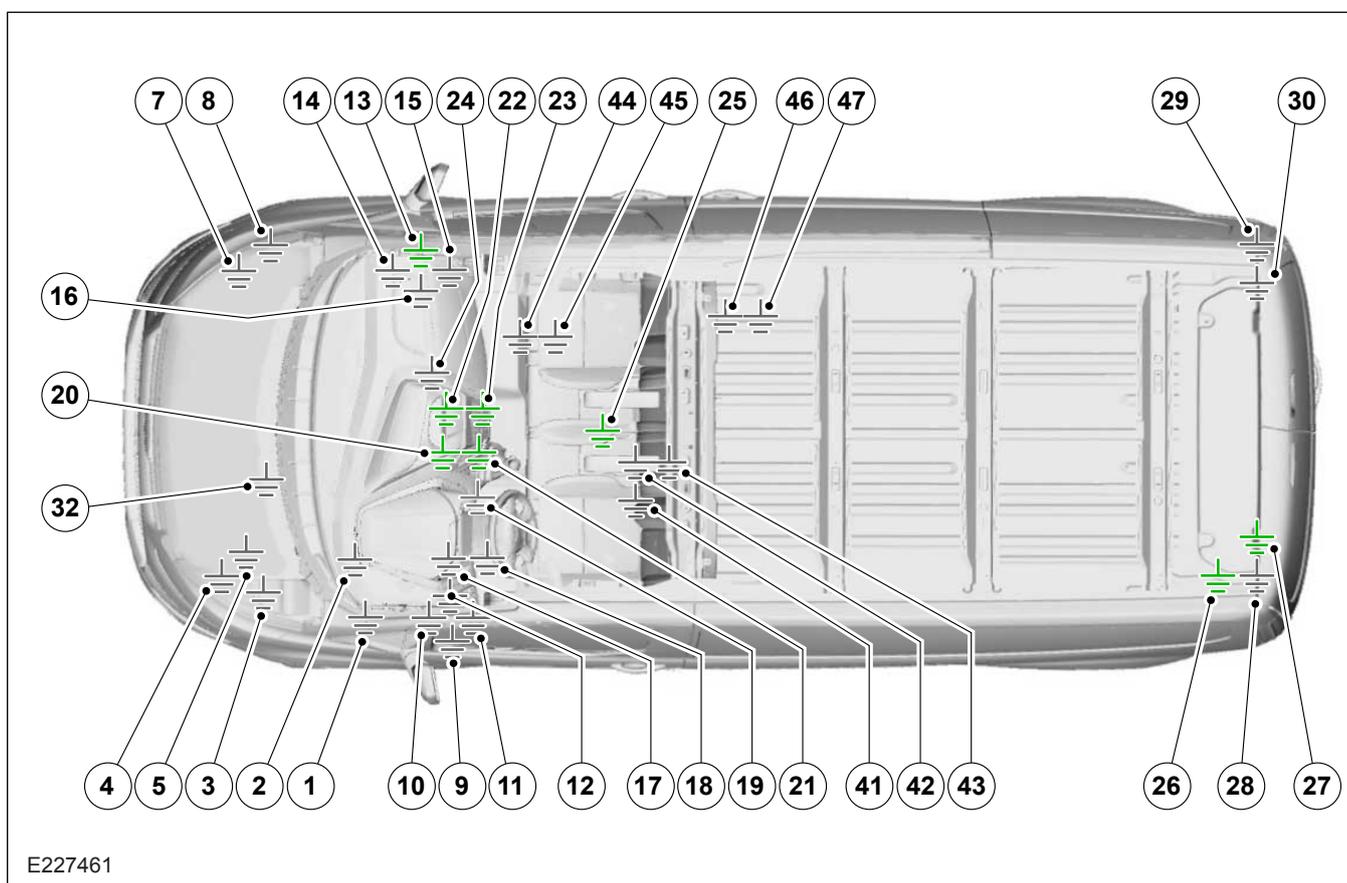
NOTE: The Ground Point (GP) numbers are only for reference to show the location of the GP.

Ground wires should be brought back to the Ford ground points provided, please refer to the following figures. For very high current users, it is recommended that the ground connection is made directly to the ground point close to the battery ground point. For High Current Supply and Ground Connections

Refer to: 4.4 Battery and Cables (page 78).

If a new grounding point is required, avoid weather zones, especially for high current grounds. Ground connections should be routed back close to the location of the +12V supply. This helps to reduce the electromagnetic field particularly generated by inrush current and improve electromagnetic compatibility.

Van, Bus, Kombi Ground Points

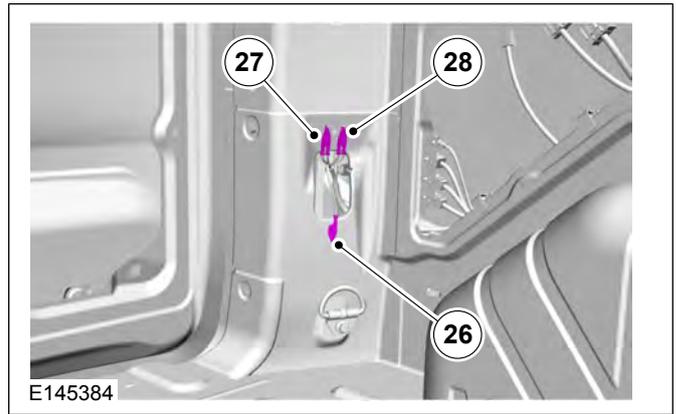
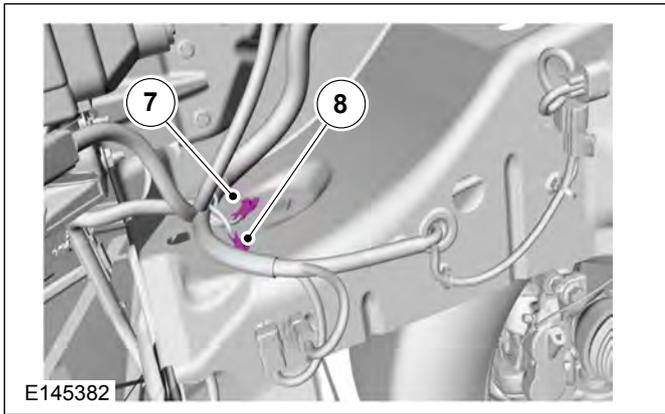
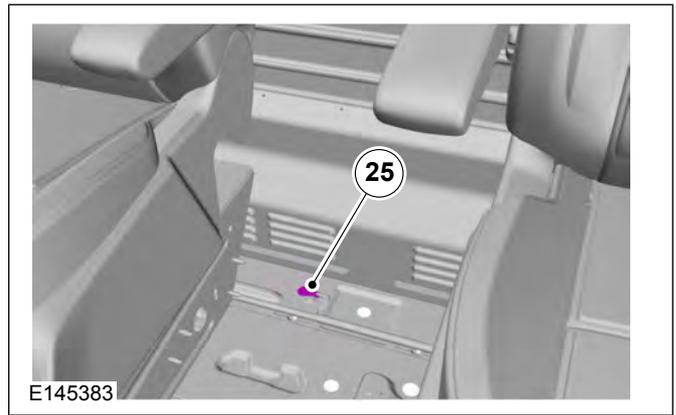
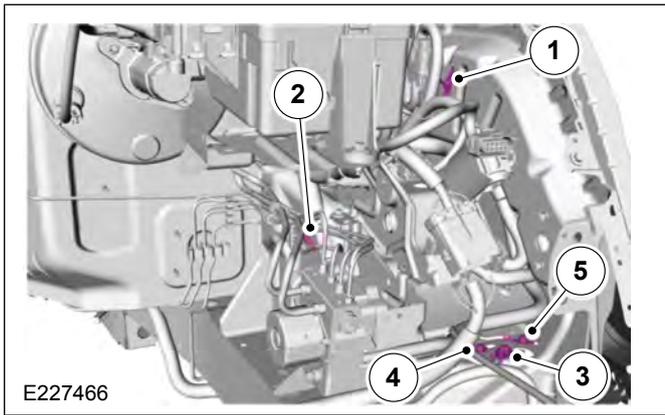
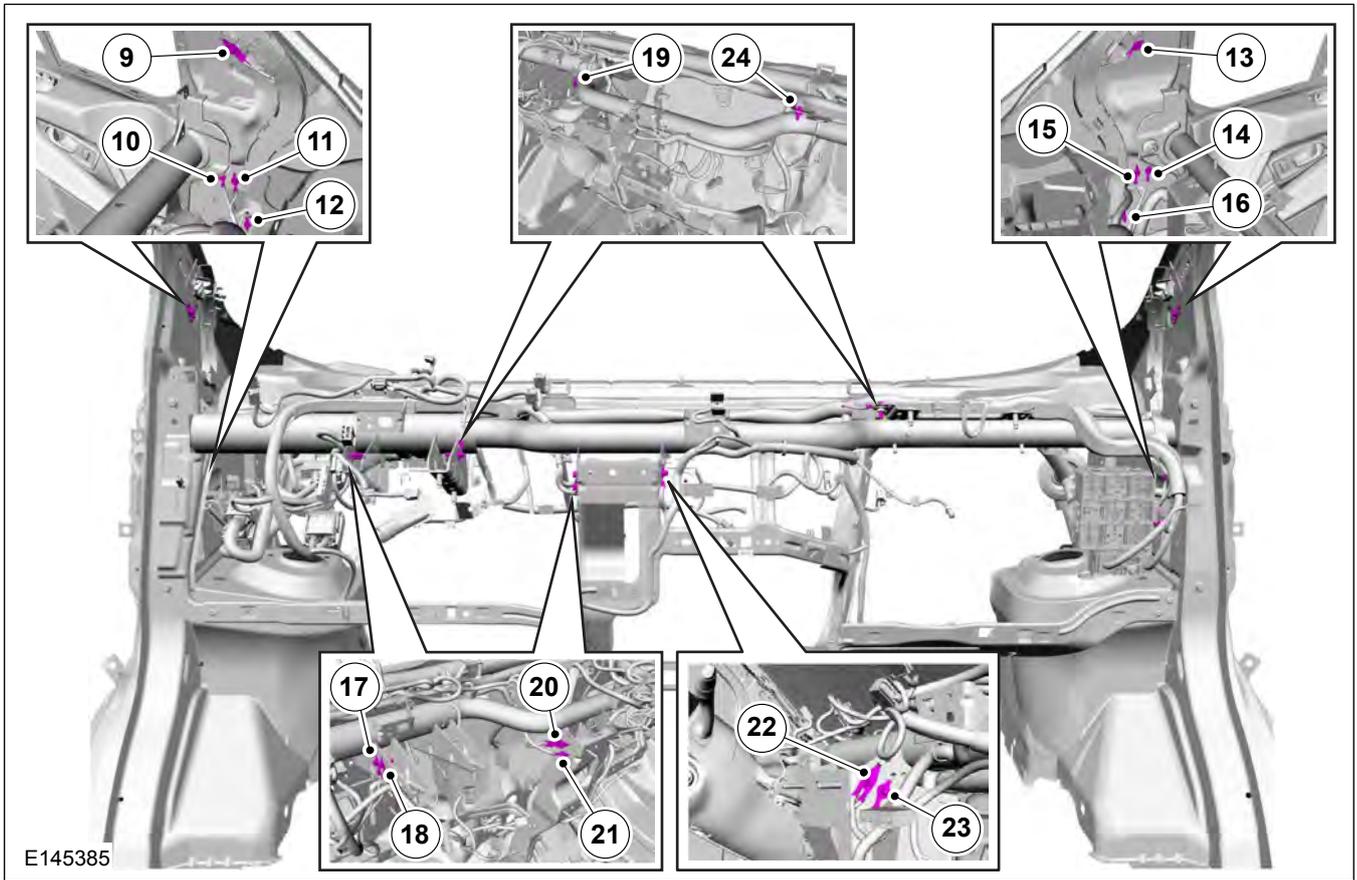


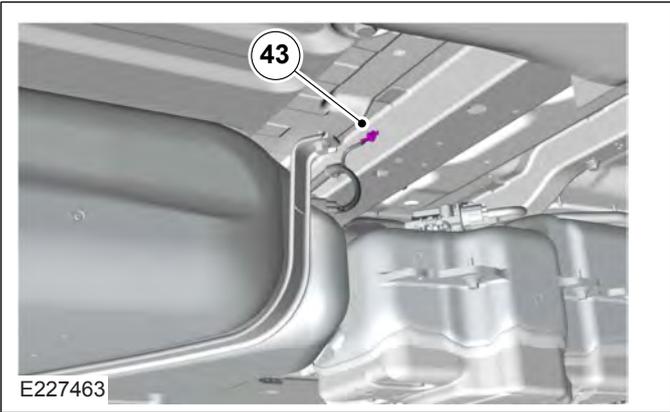
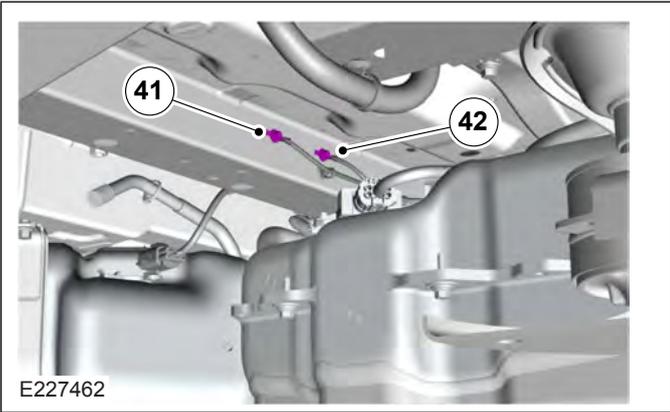
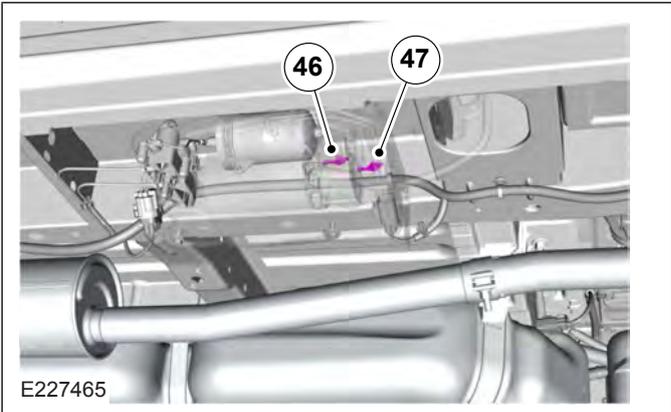
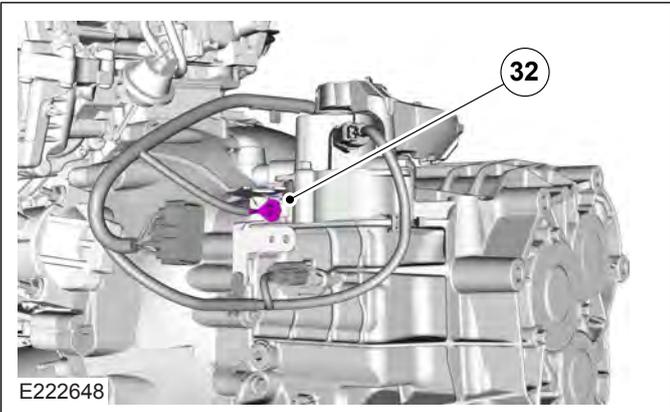
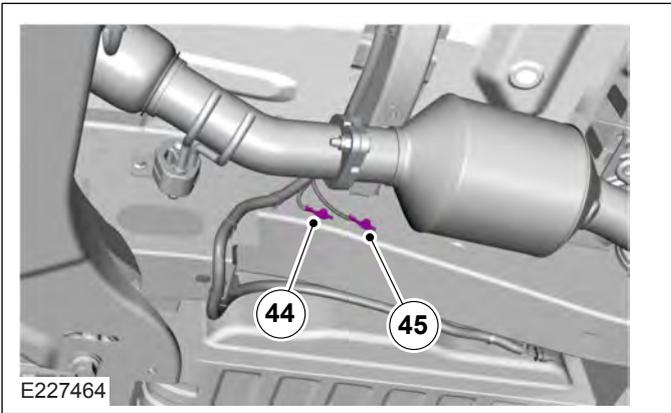
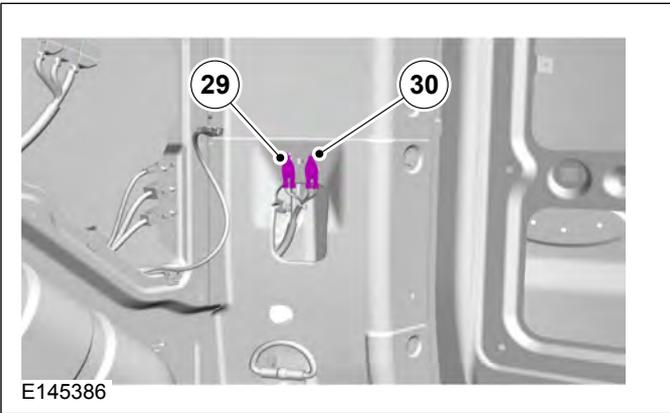
Ground Point	Location	Type	Harness
GP1	Engine Bay LHS	Misc Power Electric	14401
GP2	Engine Bay LHS	Misc Power Electric	14401
GP3	Engine Bay LHS Front	EXH EMS Control	9K499
GP4	Engine Bay LHS Front	EXH EMS Control	9K499
GP5	Engine Bay LHS Front	EXH EMS Control	9K499
GP7	Engine Bay RHS Front	Misc Power Electric	14401
GP8	Engine Bay RHS Front	Misc Power Electric	14401
GP9	A Pillar LHS Upper	Rear Lamp	14405
GP10	A Pillar LHS Lower	Misc Power Electric	14401
GP11	A Pillar LHS Lower	Misc Power Electric	14401
GP12	A Pillar LHS Lower	General Power Ground	14401
GP13 ⁽¹⁾	A Pillar RHS Upper	Rear Lamp	14A005
GP14	A Pillar RHS Lower	Misc Power Electric	14401
GP15	A Pillar RHS Lower	Misc Power Electric	14401
GP16	A Pillar RHS Lower	General Power Ground	14401
GP17	Cross Car Beam LHS	Misc Power Electric	14K024
GP18	Cross Car Beam LHS	Misc Power Electric	14K024
GP19	Cross Car Beam LHS	Misc Power Electric	14K024
GP20 ⁽¹⁾	Cross Car Beam LHS	Misc Power Electric	14K024
GP21 ⁽¹⁾	Cross Car Beam LHS	Misc Power Electric	-
GP22 ⁽¹⁾	Cross Car Beam LHS	Misc Power Electric	14K024
GP23 ⁽¹⁾	Cross Car Beam RHS	Misc Power Electric	14K024
GP24 ⁽¹⁾	Cross Car Beam RHS	Misc Power Electric	14K024
GP25 ⁽¹⁾	Floor Pan	Misc Power Electric	14401
GP26 ⁽¹⁾	D Pillar LHS Lower	Misc Power Electric	14405
GP27	D Pillar LHS Lower	Misc Power Electric	14405
GP28	D Pillar LHS Lower	Misc Power Electric	14405
GP29	D Pillar RHS Lower	Misc Power Electric	14A005
GP30	D Pillar RHS Lower	Misc Power Electric	14A005
GP32	Transmission FWD	Diesel Vaporizer Pump	14D502
GP41	Frame Middle Left	Trailer Tow	14406
GP42	Frame Middle Left	Fuel Fired Heater & Filter Heater	14406
GP43	Frame Middle Left	PEM (Fuel Pump Control Module)	14406
GP44	Frame Middle Right	NOx Sensor	14406
GP45	Frame Middle Right	NOx Sensor	14406
GP46	Frame Rear Right	Rear Air Suspension	14406
GP47	Frame Rear Right	Rear Air Suspension	14406

⁽¹⁾ = Recommended Ground Points that can be used.

Misc = Miscellaneous, EXH EMS = Exhaust Emissions

Ford Part Number W505255-S450M, M6 Screw type fixing - Torque 12Nm ±1.8





5.1 Body

NOTE: 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

5.1.1 Body Structures - General Information

When carrying out vehicle conversions the following points should be considered:

- Make sure that the vehicle structural integrity is maintained
- Do not drill into closed frame body members
- Make sure that the design for the body alterations or additional structure disperse the load evenly

 **CAUTION: Uneven load distribution could result in unacceptable handling and braking characteristics.**

- Re-paint metal edges after cutting or drilling. All metal edges must comply with exterior and interior protection legislation
- All fixings through the floor, sides or roof must be sealed

Ensure proper sealing against ingress of water, salt, dust, after cutting or drilling the body. Use Ford approved sealing and finishing material, and underbody corrosion protection.

Refer to: [5.13 Corrosion Prevention \(page 203\)](#).

- Make sure that fixings in the 'B' pillar area do not encroach on the seat belts or seat belt reels

For unique floor fixings, see (Frame Drilling and Tube Reinforcing).

Refer to: [5.14 Frame and Body Mounting \(page 204\)](#).

For Load Compartment Tie Downs (Load Lashing Points)

Refer to: [5.4 Loadspace \(page 186\)](#).

WARNINGS:

 **Before drilling see figure E146882 for Boron Steel parts, in this section of the manual.**

 **Before drilling the floor, check the Precautionary Drill Zones, see Figure E224822 in this section.**

For additional Precautionary/No Drill Zones

Refer to: [4.1 Wiring Installation and Routing Guides \(page 56\)](#).

Refer to: [5.6 Body Closures \(page 190\)](#).

5.1.2 Welding

 **WARNING: Before welding see figure E146882 for Boron Steel parts, in this section of the manual.**

Before welding work is performed on a vehicle body, all safety measures for the protection of people, modules and electrical components must be observed.

Electronic Components

Increased use of comfort and safety electronics in modern motor vehicles also requires the greatest attention to be paid during body work. Over voltages produced during welding and in alignment work during body shell rectification may cause electronic systems to be damaged. In particular, the safety instructions for performing welding work on vehicles with airbag systems must be adhered to.

NOTE: After disconnecting the power supply and before performing further work, a wait time of up to 15 minutes must be maintained, depending on the vehicle. Work on airbag systems may only be performed by personnel who have a relevant certificate of competence.

Pay attention to the following points:

- Disconnect the battery negative clamp and cover the battery terminal
- Disconnect the electrical connector at the airbag control module
- If welding is to be performed directly near a control module, it must be removed beforehand
- Never connect the negative cable of the welder near an airbag or a control module
- Connect the negative cable of the welder close to the location of the weld

Before Welding

Interior surfaces of new bodywork components which will no longer be accessible after installation must be painted beforehand. The welding flanges are treated with a special welding primer. The joint areas are not always accessible from inside later. Therefore, prepare these areas so that no soot is produced by burning paint during welding.

NOTE: In order to ensure that the corrosion protection produced in production is not destroyed, the working area must be kept as small as possible.

NOTE: Do not touch cleaned bare metal any more with the bare hands. The dampness of your hands will corrode the metal.

Procedure:

- Remove the primer or paint/zinc layer in the welding area using a tress wire brush to prevent the formation of soot from the paint
- Thoroughly clean the welding area with a metal cleaning agent and rub dry
- Coat the welding flange with welding primer on all sides and allow to dry

NOTE: The welding primer must only be applied thinly to the spot welding area, to minimize spattering when welding.

The following points must be noted when welding:

- Zinc starts to melt at about 420°C
- The zinc vaporizes at a temperature of about 900°C
- The amount of heating determines the damage to the zinc coating, and therefore to the corrosion protection
- Resistance spot welding is particularly suitable for welding zinc-coated panels, because no widespread warming occurs
- With electrolytically zinc-plated panels there is no need for any special preparation because the zinc coating does not need to be removed

After Welding

During work, body panels are often heated at very high temperatures, which results in the destruction of the corrosion protection.

Working of the affected areas is therefore vital:

- Grind the welded seams flat and clean thoroughly with silicone remover. Dry with a lint-free cloth
- If the join area is accessible from the inside, the transition area to the paint must be abraded for all types of join so that good adhesion of the primer is achieved later
- If the join area is not accessible from the inside, the cleaning and sanding work is not done. For this reason, ensure that there is as little contamination as possible in the area of the repair. This allows the cavity wax applied later to penetrate the join area without hindrance

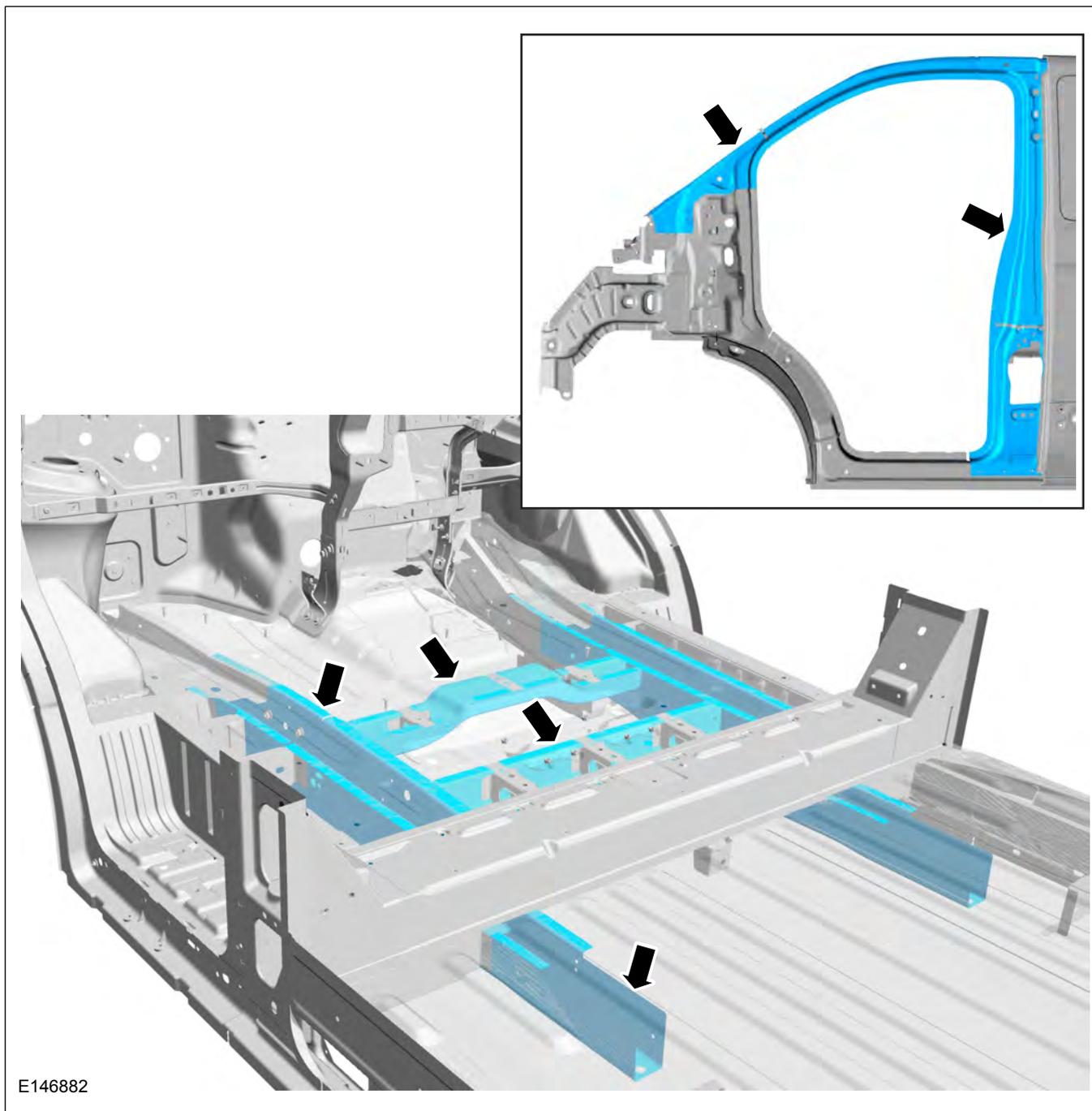
NOTE: Only apply a small amount of panel cleaner to the cleaning cloth when cleaning the area. Make sure that no cleaner reaches the connecting flange, so that the welding primer is not washed away again.

Priming after welding

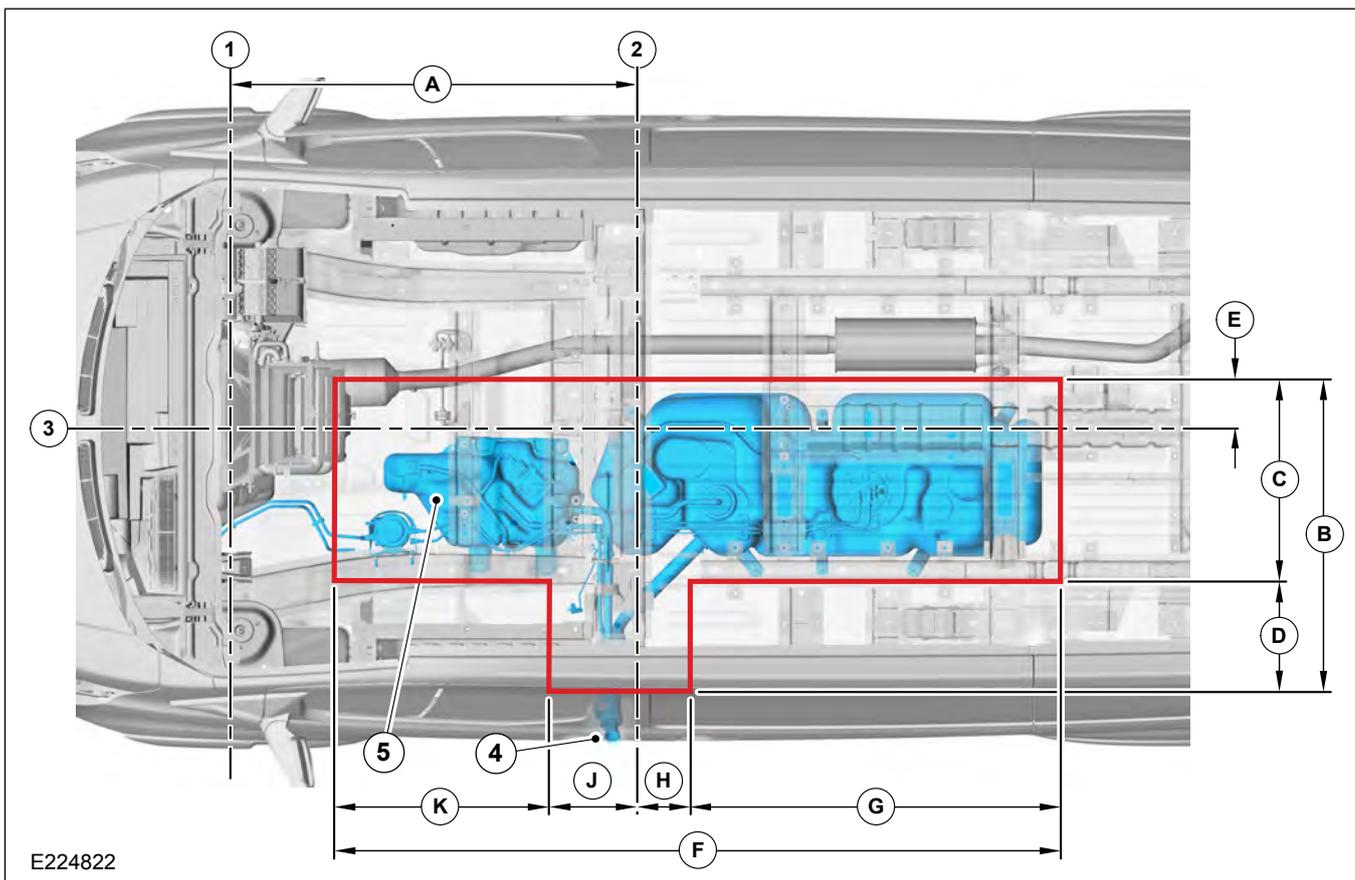
Primer is applied to the welded flanges after cleaning. A check must also be made that the production corrosion protection is present in the area of the flanges. Any damage must also be re-primed.

5.1.3 Boron Steel Parts

Boron Steel Parts - Precautionary Drill or Weld Zones



5.1.4 Floor Precautionary Drill Zones - Fuel Tank



E224822

Floor Precautionary Drill Zone Dimensions (mm)

1	Center line Front Wheel Axle
2	Center of 'B' Pillar
3	Center line of vehicle
4	Fuel Filler - Driver's side 'B' Pillar
5	UREA Tank
A	1235
B	990
C	660
D	330
E	150
F	2300
G	1140
H	260
J	230
k	670

5.1.5 Front End Integrity for Cooling, Crash, Aerodynamics and Lighting

Cooling Continuous air flow through the front end and engine compartment is not to be hindered by adding any additional equipment.

Lighting Do not alter the lighting system.

Crash Do not cut, drill or weld any parts that are load path relevant in case of crash. Do not add material in the crash zone. This could affect the crash sensor calibration.

The side airbag system is not permitted if:

- A swiveling device is fitted on the front seats
- Any additional material or structure is attached to the 'B' pillar inner and/or outer area

5.2 Hydraulic Lifting Equipment

NOTE: 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

5.2.1 Hydraulic Lifting Equipment for Van, Bus and Kombi

General Information

WARNINGS:



Do not cut away any structural member.



Equipped vehicles must be designed to be stable under “worst case” operating conditions with support legs extended, if fitted.



Do not lift vehicle off the ground.

CAUTIONS:



Safety devices must ensure the legs are deployed when operating the lifting equipment.



Safety devices must ensure the legs are stowed and locked away prior to engaging vehicle drive.

NOTE: There are no tie down locations in the floor. It is the converters responsibility to fix with adequate reinforcements from below.

For additional information:

Refer to: [5.14 Frame and Body Mounting \(page 204\)](#).

The vehicle converter is responsible for:

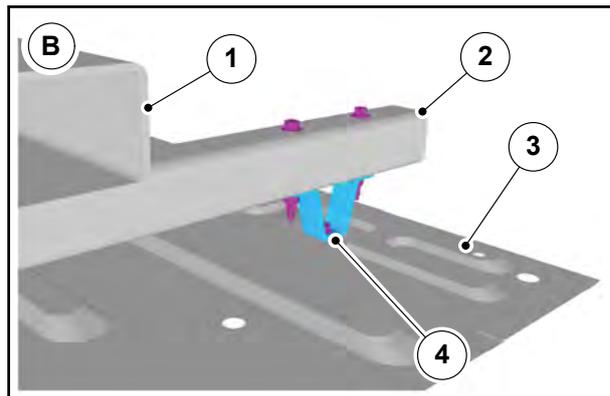
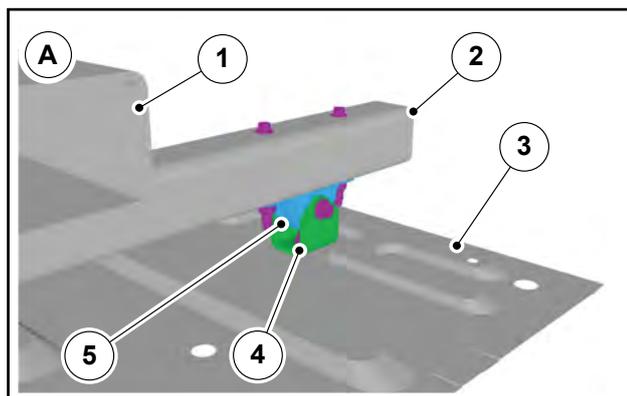
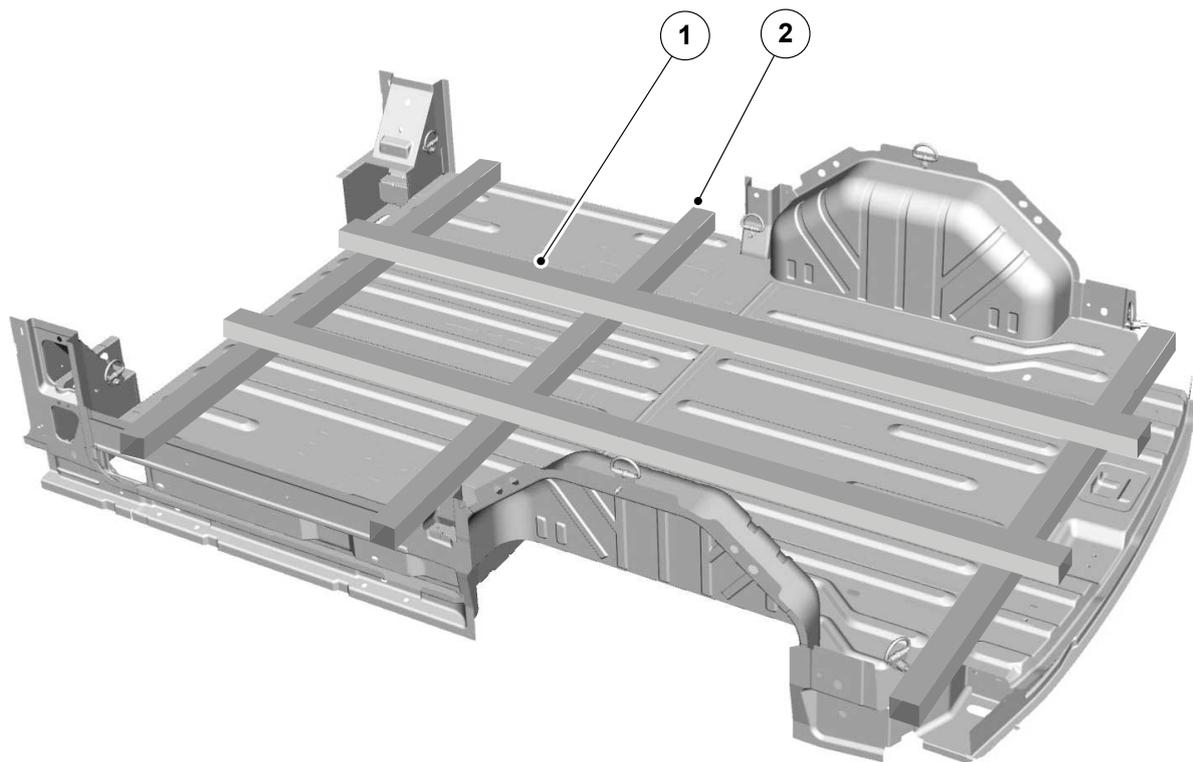
- Fitting decals, advising on the safe use of the equipment
- Route electrical and hydraulics separately and away from original Ford equipment
- Use suitable clip to fix on vehicle body and sub frame
- Offer master switch in the cab to isolate the whole system

It is recommended to design sub-frames in way that there is no adverse strain on the vehicle structure. Use compliant and fixed mounts to attach to the vehicle body. For design principle refer to E145387

For Van, Bus and Kombi:

- It is recommended to fix every mount with M8 bolt grade 8.8 minimum
- Any other floor contact should be padded to prevent local stress and to allow function of compliant mounts
- Very stiff sub-frames should not be rigidly mounted to the floor, please refer to Figure E145387 for an example of a compliant mount. Compliant bushes should allow up to ± 12 mm deflection with only the rear pair of load compartment tie down mounting brackets being fixed
- Support legs, if required, must be fitted directly to the sub-frame
- Support legs must be designed to prevent any adverse strain on the vehicle structure when operating the equipment
- It is recommended to lift the subframe from the floor as shown in figure E145387

Rigid or Torsion Stiff Sub-frame for Van, Bus and Kombi



E145387

Item	Description
A	Compliant Mount
B	Fixed Mount
1	Sub-frame longitudinal
2	Sub-frame outriggers
3	Floor of vehicle
4	Fix to floor using adequate reinforcements
5	Captive compliant bush

Hydraulic tail lift



E145388

Item	Description
A	1000mm

It is recommended to fix lift framework on bottom and on top side by using reinforcing plates and through bolts. It is also recommended to design and/or locate the reinforcing plates in a way that load can be routed into adjacent reinforced body structure. If mounted at rear door symmetrical to the vehicle center line load capacity is up to 700kg at 1000mm from floor edge to center of load.

If mounted asymmetrical to the vehicle center line or if mounted at side load door load capacity is up to 500kg at 1000mm from floor edge to center of load. For pillar lifts with adjustable reach swing jib fixed only to one rear door pillar load capacity is reduced to 100kg at maximum 1000mm reach.

For load conditions as described above additional stabilizing equipment is not necessary. Hydraulic under-slung tail lifts are not recommended for Transit Van, bus and Kombi.

Greater off-sets and/or loads require additional stabilizing equipment such as outriggers or ground jacks. It is recommended not to increase vehicle body stress over limit as given by load factors above.

It is the Vehicle converters responsibility to fit a decal to the converted vehicle stating that the equipment must not be used without outriggers/ground jacks in operating position. It is also the vehicle converters responsibility to guarantee safe functioning of the equipment.

5.3 Racking Systems

5.3.1 Racking Systems

For attaching a racking system it is recommended to use the marked areas shown in figure E146883.

- Frames should be rigid, self-supporting and bolted through the floor, use reinforcements on the underfloor
- It is not recommended to drill through the floor in combination with plastic load floor liners
- For alternatively fixing through the floor to the side members please refer also to Figure E148689 Frame Drilling and Tube Reinforcing
- Ensure proper sealing against ingress of water, salt, dust, after cutting or drilling the body. Use Ford approved sealing and finishing material, and underbody corrosion protection
- To minimize stress in body side upper area additional cross brace roof bows are to be used
- If linings are planned for the inside of the load area. All racking through bolts must be designed to be accessible through the lining to the body structure with spreader plate
- No load bearing fixing to the lining only
- For increased crash performance the racking system should be designed with diagonal reinforcements
- Vehicle should be equipped with Ford standard option bulkhead to give best protection to driver and front passengers
- Preferably, there should be a rack each side to balance the vehicle load

For additional information

Refer to: 5.13 Corrosion Prevention (page 203).

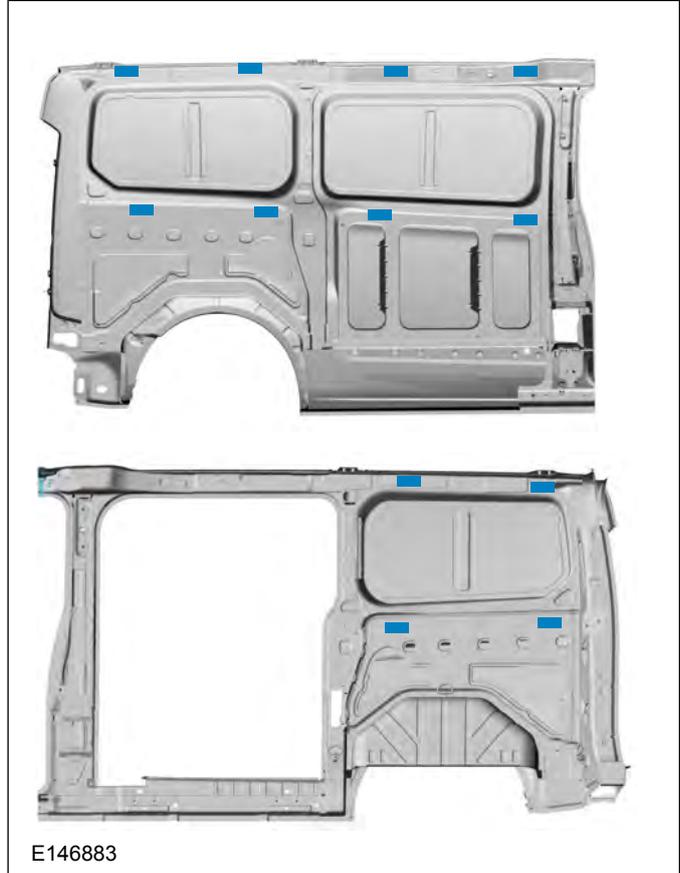
For additional information on Precautionary/No Drill Zones

Refer to: 4.1 Wiring Installation and Routing Guides (page 56).

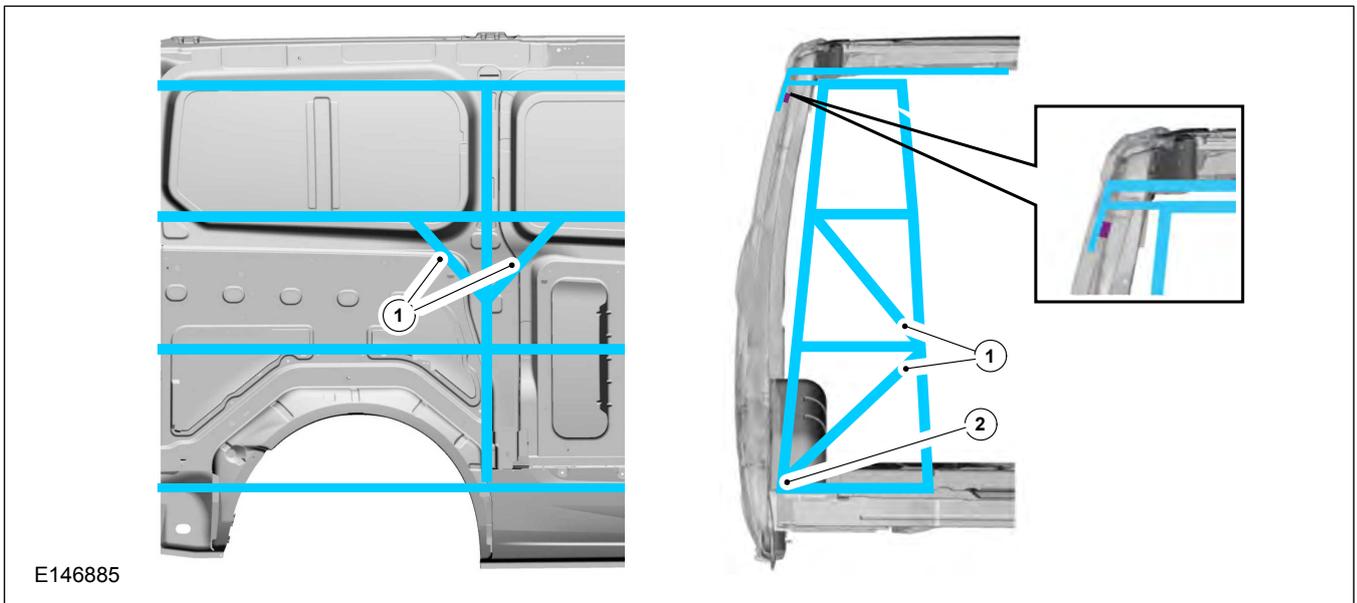
Refer to: 5.1 Body (page 177).

Refer to: 5.6 Body Closures (page 190).

Recommended Fixing Locations



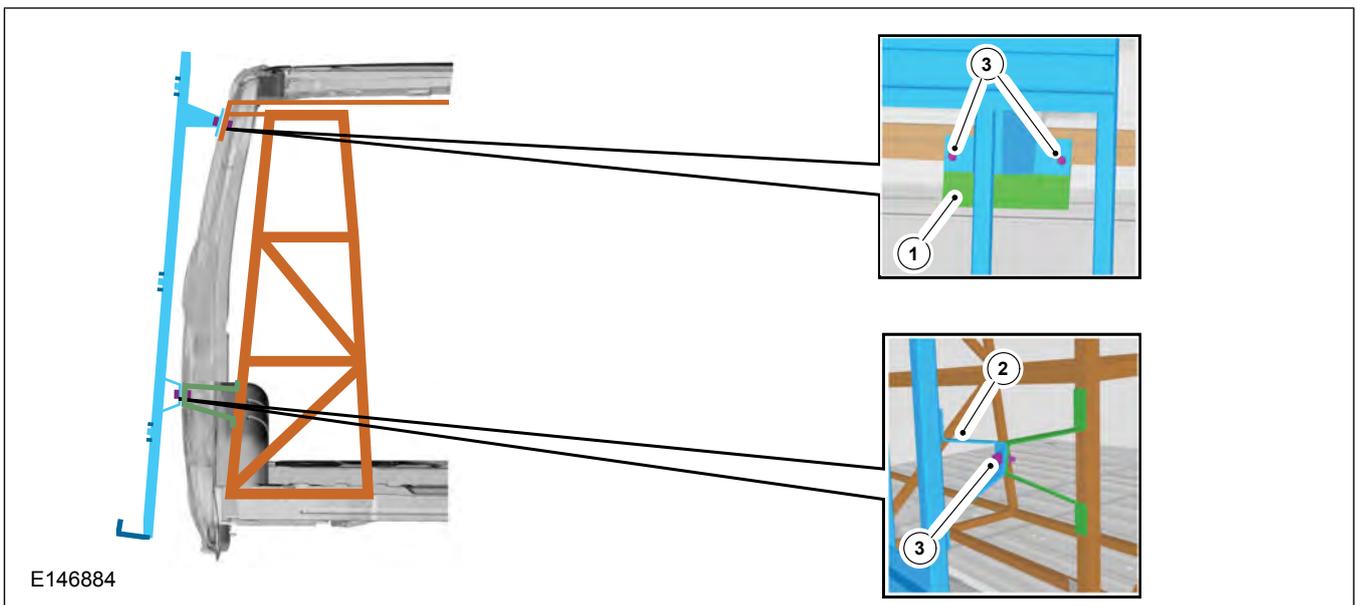
Design Proposal for non Ford Production Option Racking System (LHS Shown)



Racking - Floor Fixings to Load Compartment Tie Downs

Item	Description
1	Rigid Self-Supporting Racking Frame Work
2	Fixing to floor

Glass Racking on Outside of Van



Glass Racking on Outside of Van - Through Fixed to Internal Racking (Recommended Minimum)

Item	Description
1	Top Load Bearing Attachments (2x)
2	Lower Load Bearing Attachments, through body side to internal racking (2x)
3	New Through Bolts (2 bolts per top attachment and 1 bolt per lower attachment)

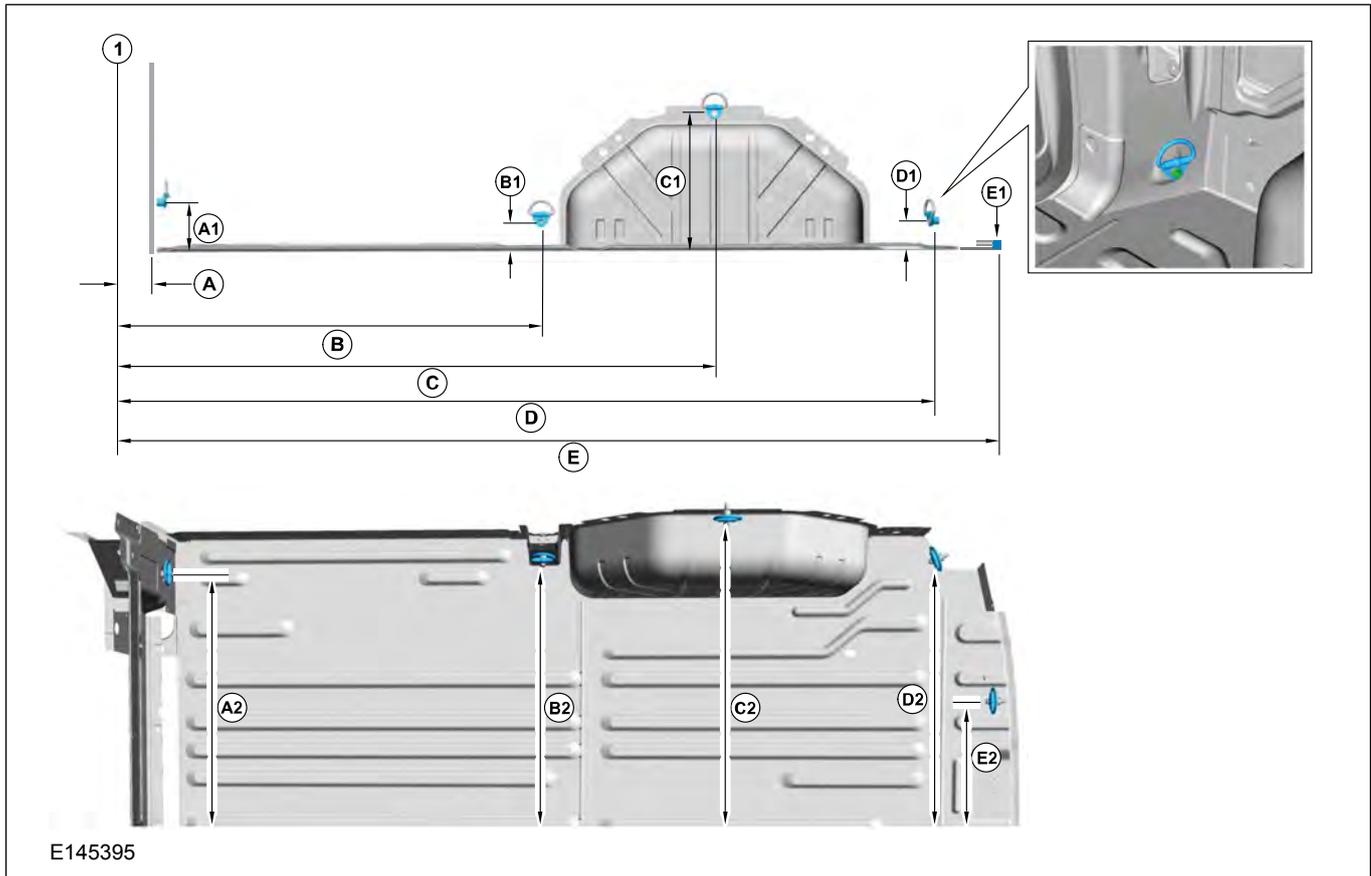
For designing glass carrying rack on body side outer, construct internal rack and bolt through the body side to the internal rack, see figure E146885.

5.4 Loadspace

5.4.1 Load Compartment Tie Downs for Van, Bus and Kombi

All vehicles are fitted with load compartment tie downs, these are all 'D' rings as shown in E145395. Not all vehicles will have all locations shown, it will depend on the base vehicle. For additional fixing locations.

Refer to: 5.3 Racking Systems (page 184).



Dimensions for Load Tie Downs

Dimension (mm)	L1	L2
Dimension from 'B' Pillar (1)		
A	78	
B	1177	
C	1716	2083
D	2374	2611
E	2515	2882
Vertical from floor		
A1	137	
B1	61	
C1	395	
D1	75	
E1	2	
From center line of vehicle		
A2	733	
B2	817	
C2	882	
D2	791	
E2	450	

L1 = 2933mm Wheel Base, L2 = 3300mm Wheel Base

5.5 Front End Body Panels

5.5.1 Partitions (Bulkhead) - Driver and Front Passenger(s) Protection on Van, Bus and Kombi

CAUTION: Bulkheads serve an important function and are legally required in some territories.

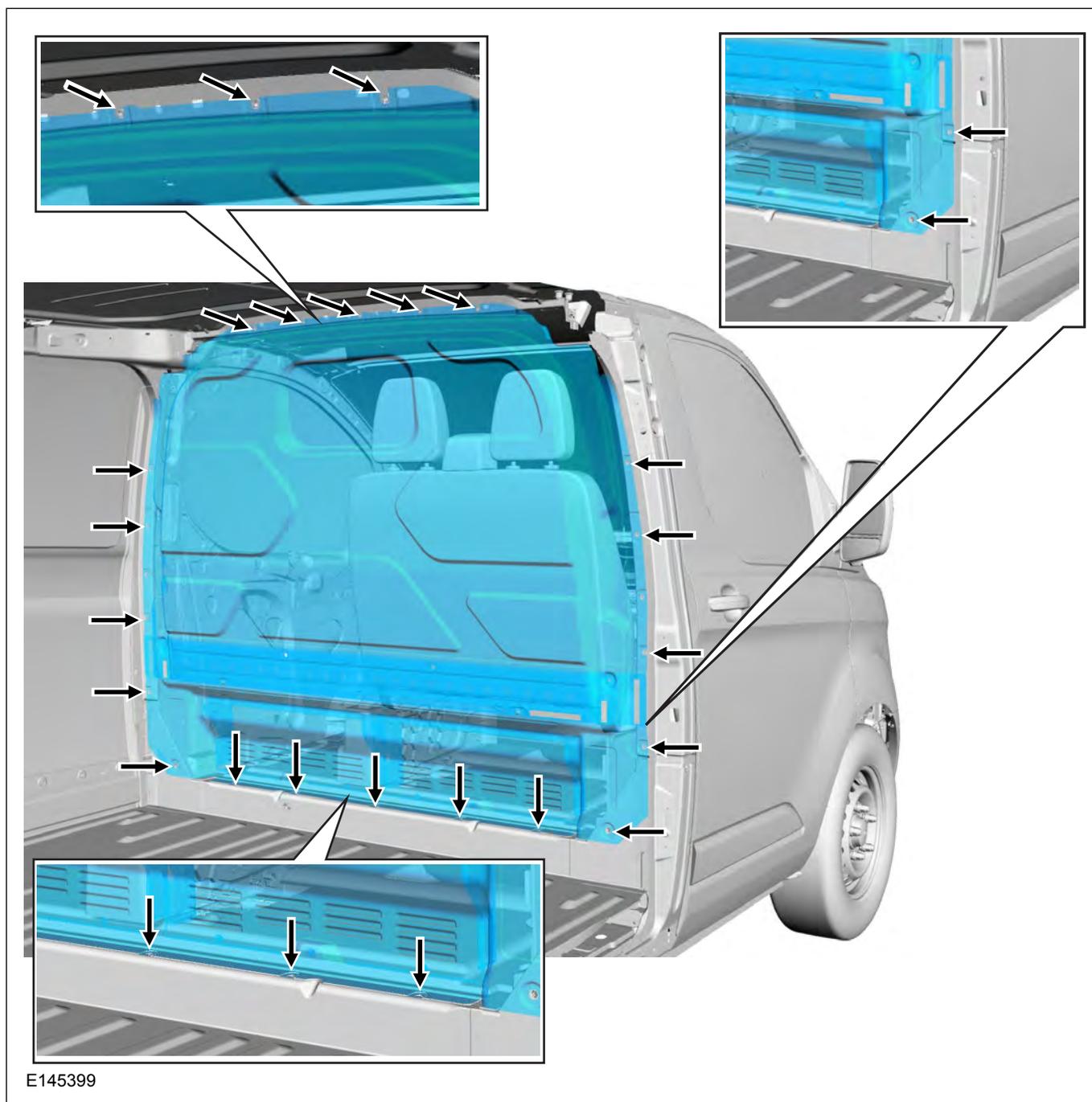
It is the vehicle converter's responsibility to ensure local current legislation, governing bulkheads and protective window grilles, is met. It is also the converter's responsibility to ensure legal load constraint requirements if using a non Ford standard bulkhead.

Standard Ford bulkheads do have a clearance between bulkhead and body structure to allow natural body flexing and an air circulation from the cab to the rear load space for ventilation control.

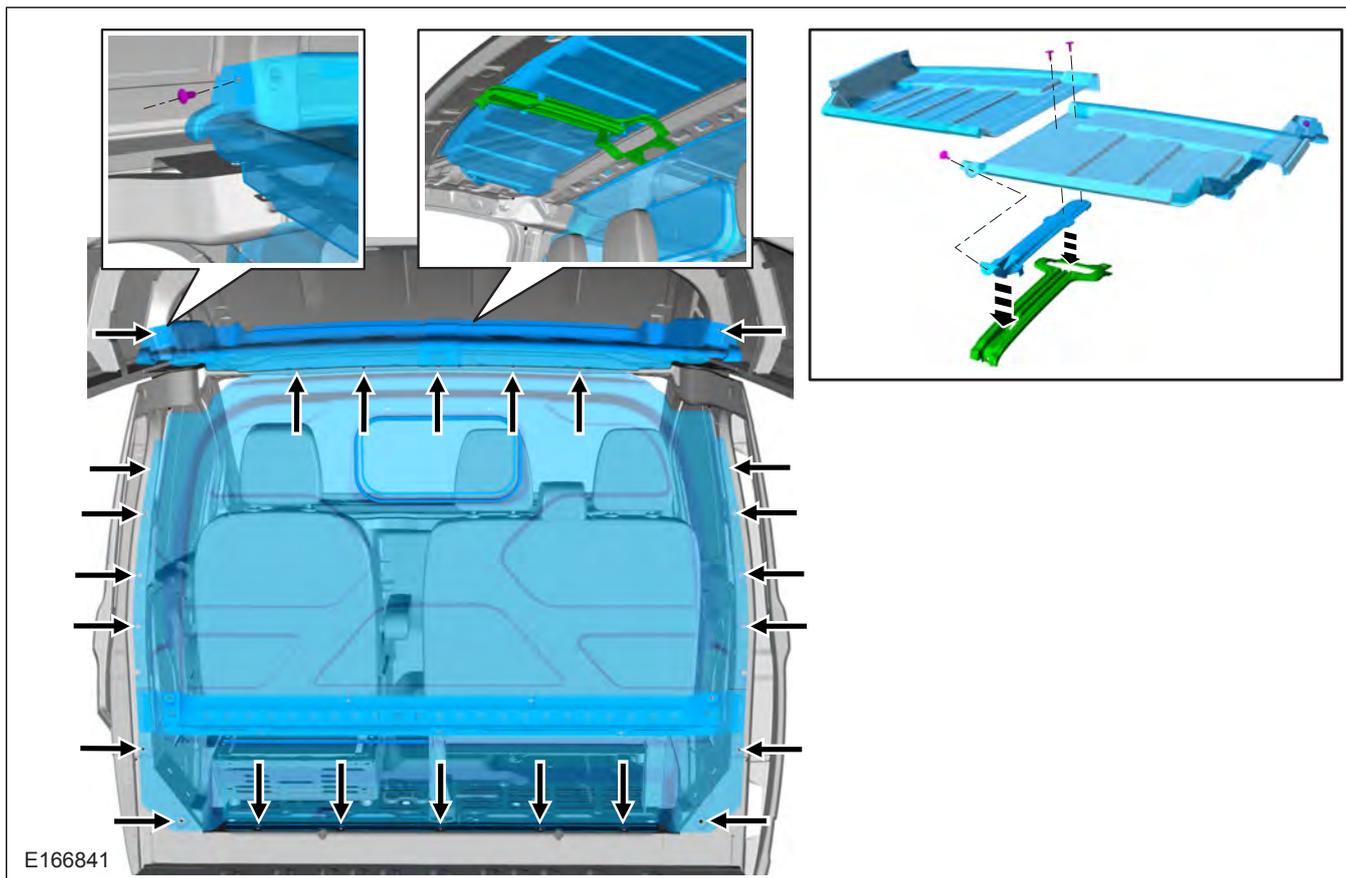
Air circulation and body flexing must be also given consideration when engineering an alternative bulkhead. It is not recommended to restrict driver's or passenger's seat adjustment travel.

The following figures E145399 and E166841 show the standard bulkhead fixing locations on B-pillar. These are hexagonal holes for M6 thin sheet rivet type nuts. The standard range of Ford bulkheads can be retro-fitted at these points. Standard Ford Bulkheads are fitted with tamper-proof bolts.

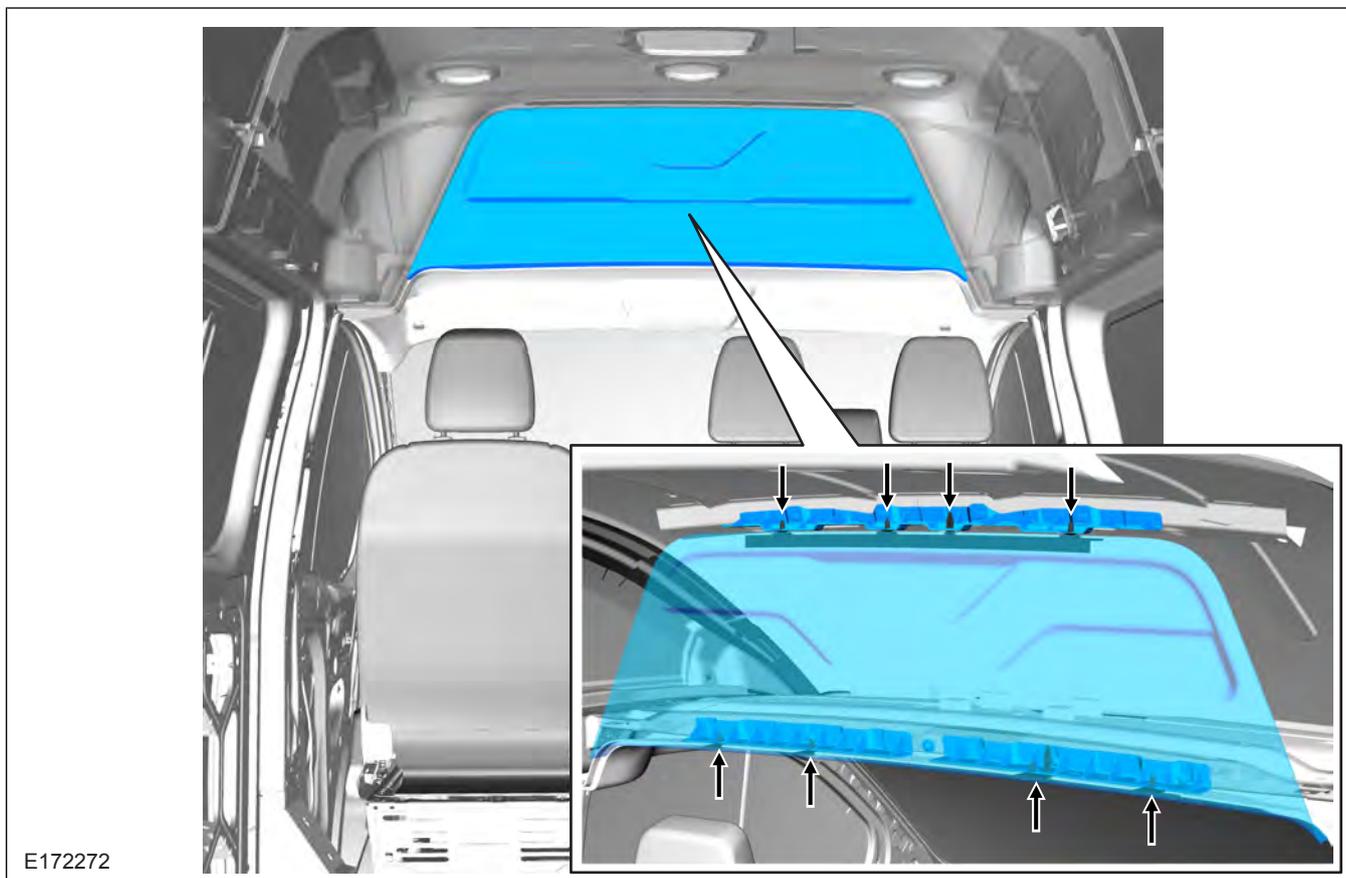
H1 Roof Height - Bulkhead Fixing Locations



H2 Roof Height - Bulkhead and Parcel Shelf Fixing locations



H2 Roof Height - Kombi Close Out Panel



5.6 Body Closures

5.6.1 Security, Anti-Theft and Locking System

NOTE: It is not recommended to alter the locking system or damage the security shielding around the lock and latch.

However, in case a modification is required for the conversions, please consult the Vehicle Converter Advisory Service VCAS@ford.com.

To avoid locking system security complications, it is recommended to discuss with the local Ford dealer prior to modifications taking place.

When removing and reapplying door seals take care to fit correctly, using the same seals as this is critical to door closing efforts. Any modification to the sealing flanges or surfaces will require consultation with your local Ford dealer or Vehicle Converter Advisory Service (VCAS@ford.com). This may also include air extraction/venting adjustments to assist door close efforts if significant changes to closures are required.

The Body Control Module is designed to work specifically with the Ford Transit lock and latch mechanisms and therefore drives latches to lock and unlock for specific time periods. Additional power locking functionality should be based around the use of additional Ford Transit latch mechanisms. Additional latches can be driven via relays connected in parallel with existing latches.

The following figures outline the areas in which it is not advisable to drill.

No Drill Zone - Driver and Passenger Doors



No Drill Zone - Driver and Passenger Doors

Item	Description
A	300mm
B	55mm
C	150mm
D	190mm

No Drill Zone - Lift-Gate

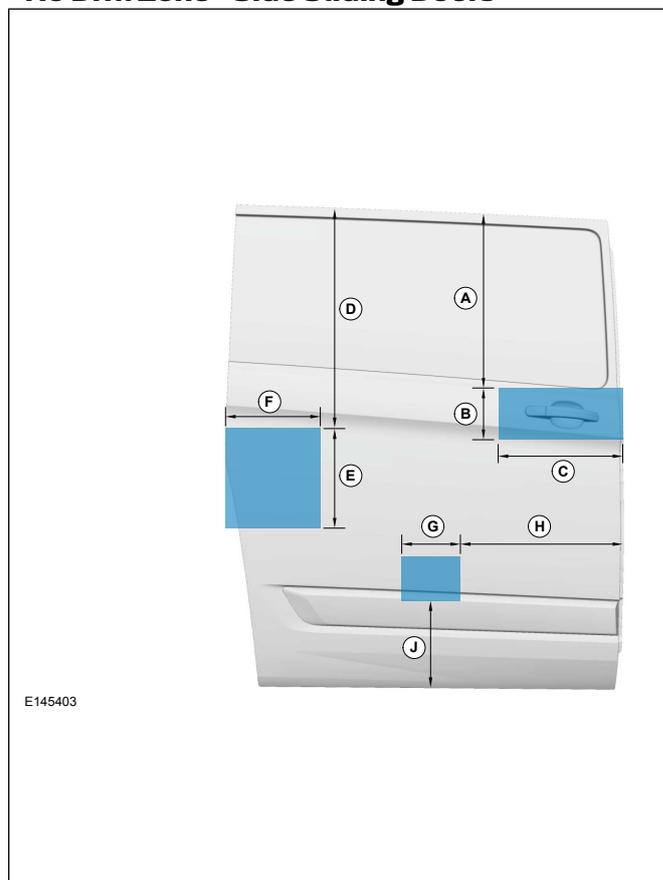


E145402

No Drill Zone - Lift-Gate

Item	Description
A	480mm
B	430mm
C	305mm

No Drill Zone - Side Sliding Doors

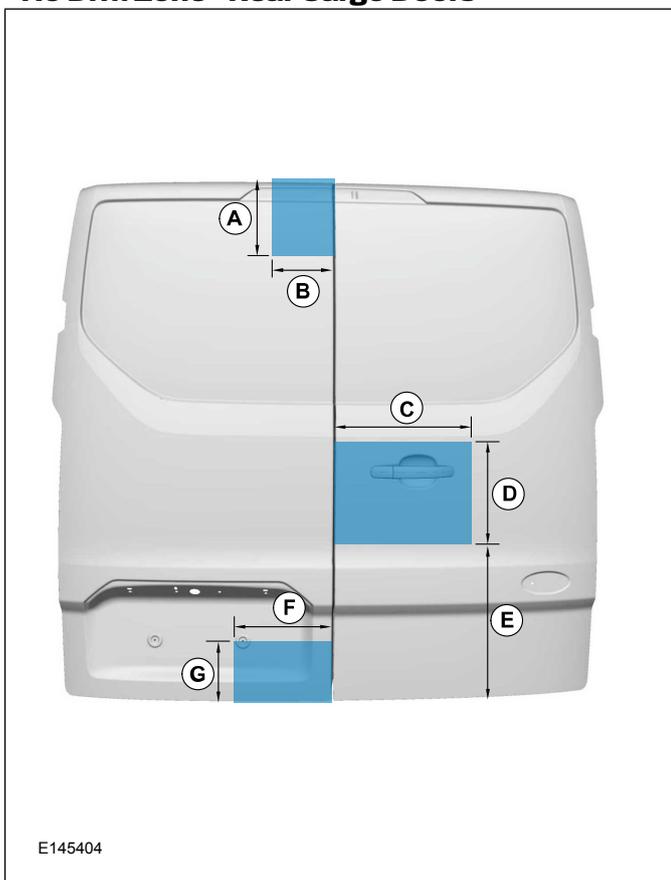


E145403

No Drill Zone - Sliding Doors

Item	Description
A	620mm
B	165mm
C	360mm
D	740mm
E	290mm
F	250mm
G	215mm
H	500mm
J	300mm

No Drill Zone - Rear Cargo Doors



No Drill Zone - Rear Cargo Doors

Item	Description
A	250mm
B	115mm
C	385mm
D	250mm
E	480mm
F	260mm
G	175mm

5.7 Interior Trim

NOTE: 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

- Plywood should be water resistant (WBP, water and boil proof)
- It is recommended to use 9mm thickness for floors and 6mm thickness for side and door lining

5.7.1 Load Compartment Interior Lining

Do not damage the lock, hinge, latch or check arm system (electrical cables, release system) when applying interior lining.

Be careful not to damage the weather shield (water shield covering inner door access hole) when removing or applying interior door trim.

WARNINGS:

! **Plan fixing points for other fitments such as racking to ensure through bolting can be achieved. Fixing to the lining material may be inadequate for normal safe operation of the vehicle.**

! **Varnish or paint wooden interior cargo area panels if exposed to high humidity conditions.**

The additional weight of the linings on doors may require additional reinforcements to the door and pillar at the hinge and check mechanism.

5.7.2 Plywood Lining/Cladding



! **CAUTION: Do not drill into the vehicle before checking the Precautionary/No Drill Zones and electrical wire routing.**

Refer to: 4.1 Wiring Installation and Routing Guides (page 56).

Refer to: 5.6 Body Closures (page 190).

Refer to: 5.1 Body (page 177).

- Panels should be precision cut by machine, not by hand jigsaw, to reduce rough edges and splinters
- Panels should be pre drilled
- Do not drill through floor panels, use existing load lashing points when securing the panels
- It is recommended that when fitting a plywood floor that it is joint free
- Use aluminum floor trims

5.8 Seats

NOTE: When reassembling the seat and the seat belt use specified bolts and ensure to apply the specified torque. For torque specifications contact your local Ford dealer or the Vehicle Converter Advisory Service at VCAS@ford.com

5.8.1 Van

 **CAUTION: Do not install seats in the rear cargo area of a van.**

5.8.2 Windowed Van

The body and floor of a windowed van are not equipped with the appropriate reinforcements required for Original Equipment Manufacturers (OEM) rear seats and seat belt systems. Do not install original rear seats or rear seat belts.

For installation of non OEM rear seats, the rear seats and seat belt systems need to comply with the relevant legal requirements and ECE directives or ADR 3,4,5 or applicable local legislation.

Refer to: [3.7 Exhaust System \(page 51\)](#).
Vehicle Exhaust Systems - Vans with Bulkheads.

5.8.3 Heated Seats

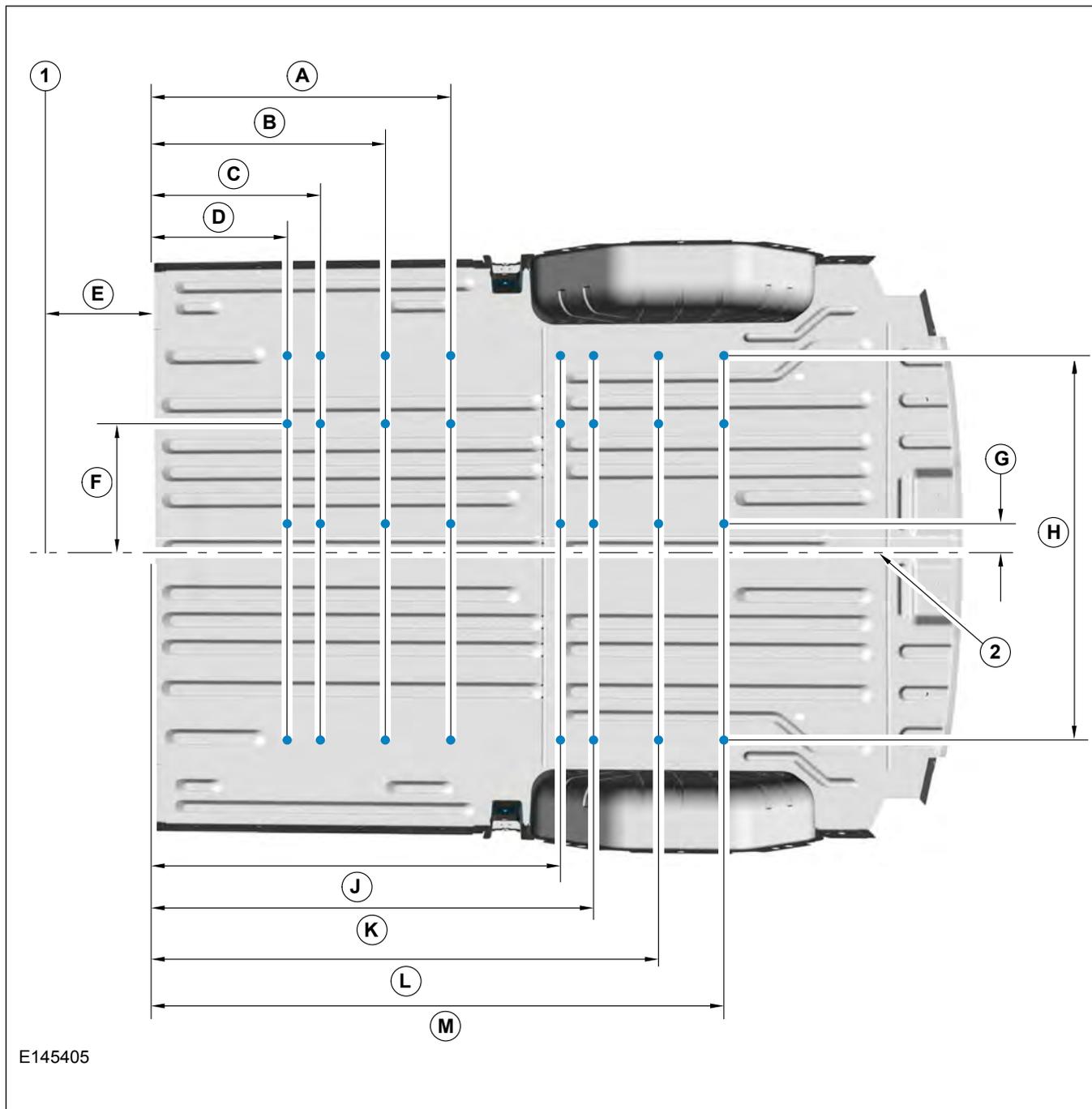
 **WARNING: The electrical feed for the original heated Ford seat must not be used for other purposes, e.g. other electrical consumers.**

It is not advisable to retrofit heated seats due to potential airbag operation or malfunction (incorrect configuration).

5.8.4 Rear Seat Fixing Positions

The following figure shows the second and third row seat fixing positions in the floor. These positions are independent of the wheelbase.

Kombi Van - Rear Seat Fixing Positions (Left Hand Drive Shown)



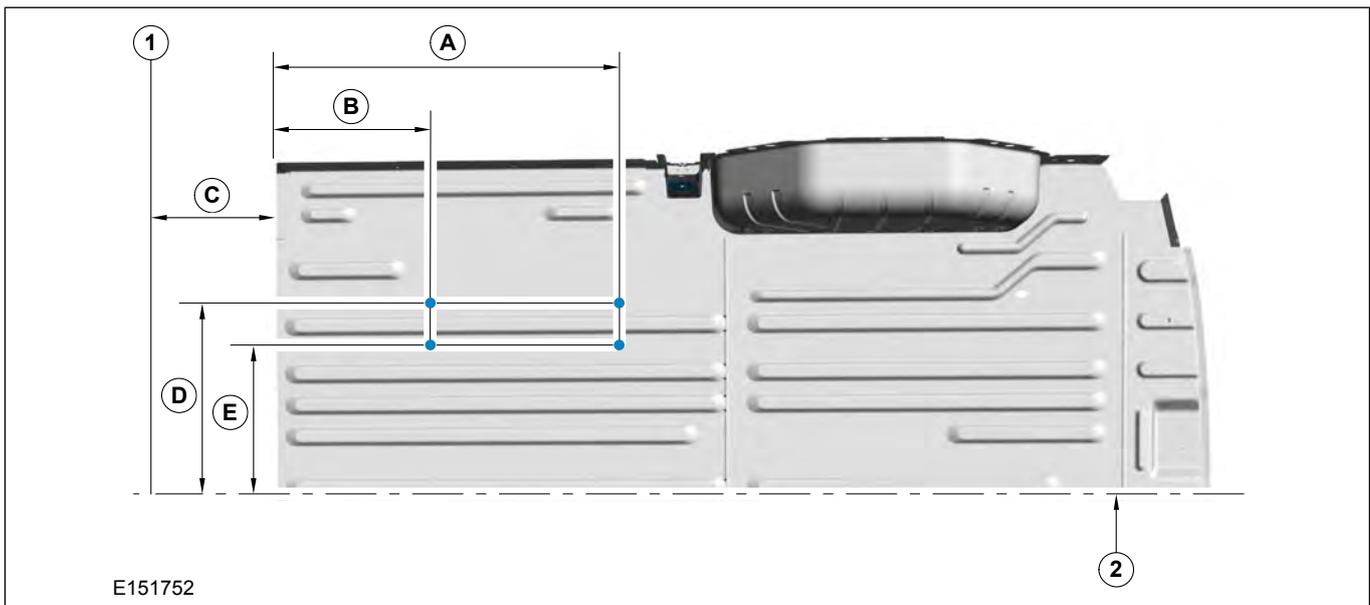
E145405

Kombi Van - Rear Seat Fixing Positions

Item	Second Row	Third Row
1	Front Axle	
2	Center line of vehicle	
A	937	-
B	758	-
C	538	-
D	433	-
E	1302	1302
F	378	378
G	90	90
H	1232	1232
J		1291
K	-	1395
L	-	1658
M	-	1794

Right Hand Drive symmetrically opposite about center line of vehicle.

Double Cab in Van (DCIV) - Rear Seat Fixing Locations (Left Hand Side Shown)



DCIV - Rear Seat Fixing Locations

Item	Triple Seat - Second Row
1	Front Axle
2	Center line of vehicle
A	937
B	280
C	1302
D	520.5
E	377.5

Right Hand Side symmetrically opposite

5.9 Glass, Frames and Mechanisms

NOTE: 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

5.9.1 Heated Windshield and Heated Rear Window

WARNING: The base system should not be tampered with (controlled by body control module and multiplex architecture) and no feeds taken from the associated wiring or controller.

These options are not suitable for aftermarket or Vehicle Converter fit.

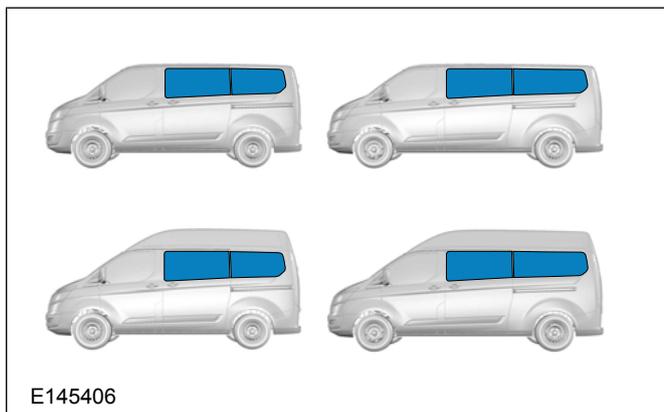
5.9.2 Rear and Side Windows

For windows, it is recommended to specify the base vehicle as a Kombi or Bus body - however, when converting a van, the following should be adhered to:

- Cut the outer panel of the body side and door to within 1mm of the inner panel flange
- Do not cut across panel joints or pillars
- Use approved glass for installation according to legal requirements
- After cutting the outer panel, join the inner panel and the outer panel robustly together.

WARNING: For rear seat installation

Refer to: 5.8 Seats (page 194).

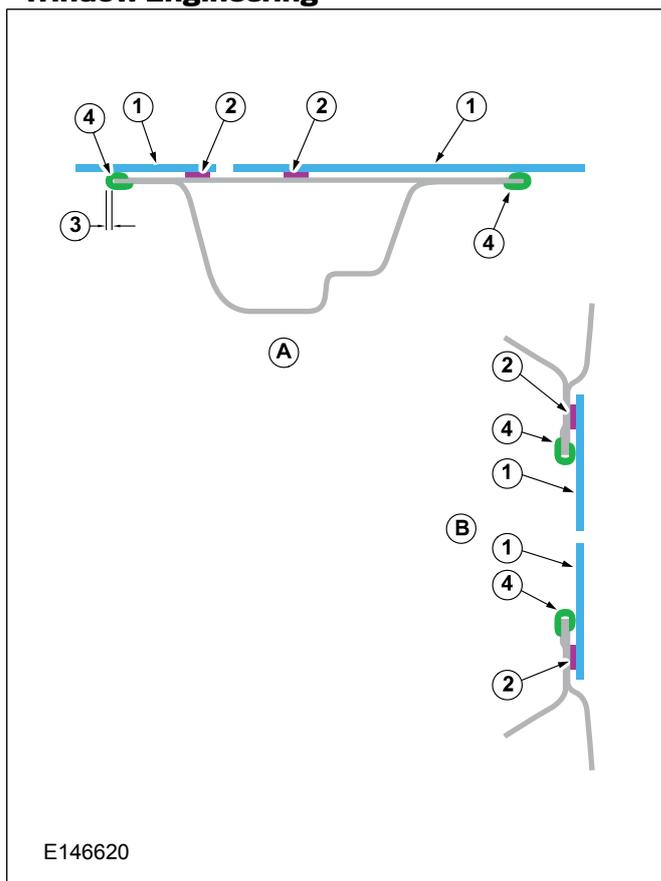


E145406

For wheel base and overall vehicle height key dimensions

Refer to: 1.14 Package and Ergonomics (page 25).

Section through Typical Van Body Side for Window Engineering



E146620

Item	Description
A	Horizontal section through 'C' pillar
B	Vertical section through side window (Non side Load Door)
1	Glass
2	Adhesive
3	Cut outer panel flange flush with inner panel flange edge all round within 0 and 1.5mm
4	Window trim strip

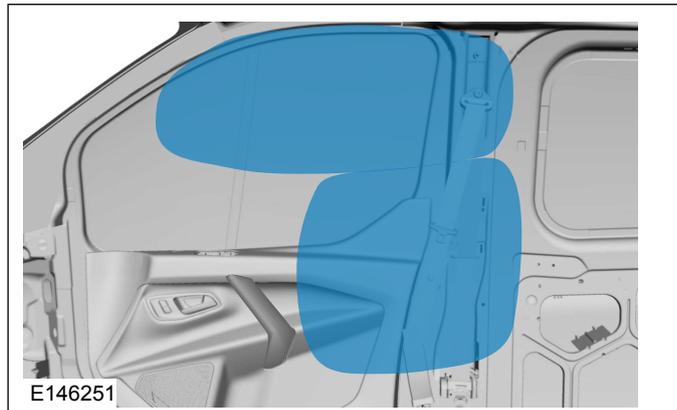
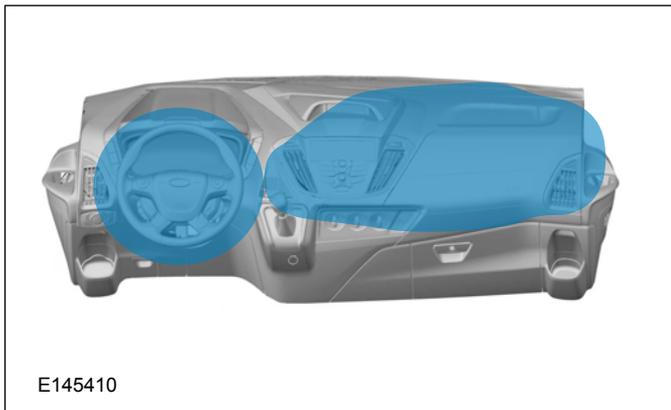
5.10 Airbag Supplemental Restraint System (SRS)

5.10.1 Airbags

Front Airbag Deployment Zones

WARNING: Do not place accessories in the deployment zone of the driver and passenger airbags as they may impair airbag deployment.

NOTE: Front passenger airbag includes belt minder function.



Restraints Control Module (RCM)

The RCM is located between the front seats, underneath the parking brake console, see figure E145413.

WARNINGS:

WARNING: Modifications or reinforcements in the area of the RCM may affect the side airbag deployment timing and result in uncontrolled side airbag deployment.

WARNING: The RCM device is protected by the parking brake and console to prevent damage from occupants when stepping past the seat to access the rear of the vehicle. The parking brake and console should be maintained in their fitted position to ensure protection for the RCM.

Side and Curtain Airbag Deployment Zones

WARNING: Do not place accessories in the deployment zone of the side and curtain airbags as they may impair airbag deployment.

NOTE: It is recommended to specify a base vehicle without airbags if planning modifications in this area.

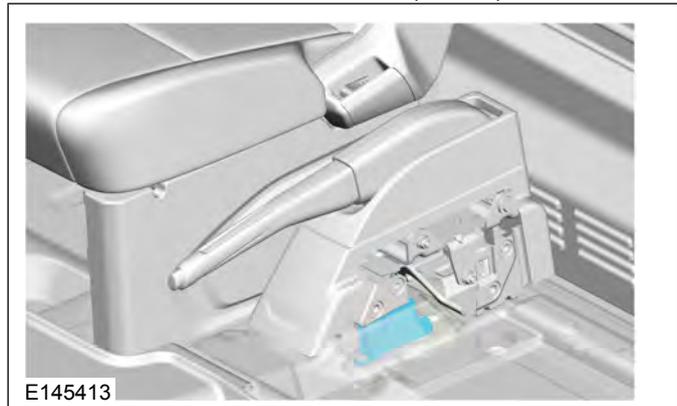
NOTE: All M1 Buses are specified with side and curtain airbags as standard fitment.

Side Airbags (Seat Mounted): The side airbags on this vehicle have not been validated for use with swiveling front seats. Do not specify a base vehicle with side airbags if planning to retrofit a swiveling device on the front seats and/or an armrest on the outer side of the front seats; this may affect the function and/or deployment of the side airbags. Ensure any seat covers installed are designed to be used with side airbag equipped seats.

Curtain Airbags: Extensive modifications to the roof and headlining may impair deployment of the curtain airbags. If roof or headlining is to be modified or replaced, do not specify curtain airbags on the base vehicle.

If access to the roof is required, to install roof mounted exterior accessories for example, ensure the unmodified headlining is refitted using the existing mounting points.

Restraints Control Module (RCM)



Front and Side Sensors

The airbag sensor for the front airbags is located behind the front grille, see figure E145411.

The sensors for the side airbags are located at the bottom of the B-pillars, see figure E145412.

WARNINGS:

WARNING: Modifications or reinforcements in the area of the sensors may affect the side airbags deployment timing and result in uncontrolled side airbag deployment.

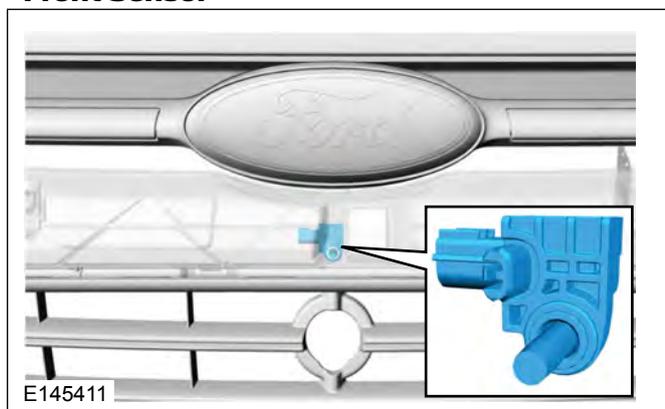
 **Drilling or grinding operations in these area are only permitted when battery cables are disconnected.**

If the battery is disconnected

Refer to: [4.4 Battery and Cables \(page 78\)](#).

Battery and Monitoring Sensor section for reconnecting battery.

Front Sensor



Side Sensor



5.11 Seatbelt Systems

NOTE: 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.

5.11.1 Seat Belts

 **WARNING: Follow removal and installation procedures for the seat belt system to ensure correct function of the restraints system.**

The removal and reinstallation of the seat belt, buckle or any component of the seat belt system should be avoided. However if removal and re-installation of the system is required during the conversion, follow the removal and installation guidelines of the seat belt system as described in the workshop manual.

When removing the seat belt system, a seat belt webbing forked retainer should be applied to the webbing 200mm below the webbing button stop. This prevents a situation where all the webbing runs back into the retractor and the retractor becomes locked.

When reinstalling, fit the retractor to the body first and gently pull the webbing out of the retractor to allow fitment of the D loop. Then remove the forked retainer. If the retractor is locked, allow a small amount of webbing to reel back into the retractor to allow the webbing lock to release. Do not attempt to release the retractor by pulling on the webbing with significant force or by manually interfering with the locking mechanism.

5.11.2 Driver Belt Minder

Driver belt minder is a legal requirement for an M1 vehicle. A switch is provided in the driver's buckle to sense the seat belt wearing status of the driver. If an M1 vehicle is modified, this function must be retained.

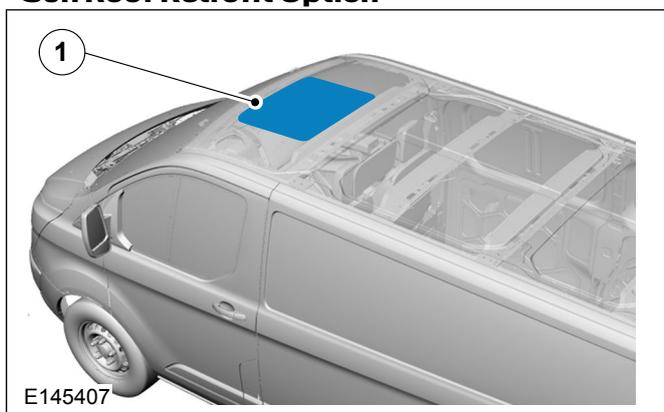
Belt minder is included with the front passenger airbag.

5.12 Roof

5.12.1 Roof Ventilation

⚠ WARNING: Avoid all antenna positions when retrofitting a sunroof or any roof mounted units.

Sun Roof Retrofit Option



E145407

Item	Description
1	Local form in Roof Panel (Low Roof Only)

General - It is not recommended for apertures to cut through roof bows, see figure E145407. Ventilators must prevent direct entry of water and dust. A shut-off system should be available to prevent fume ingress. Interior and exterior projection legal requirements must be maintained.

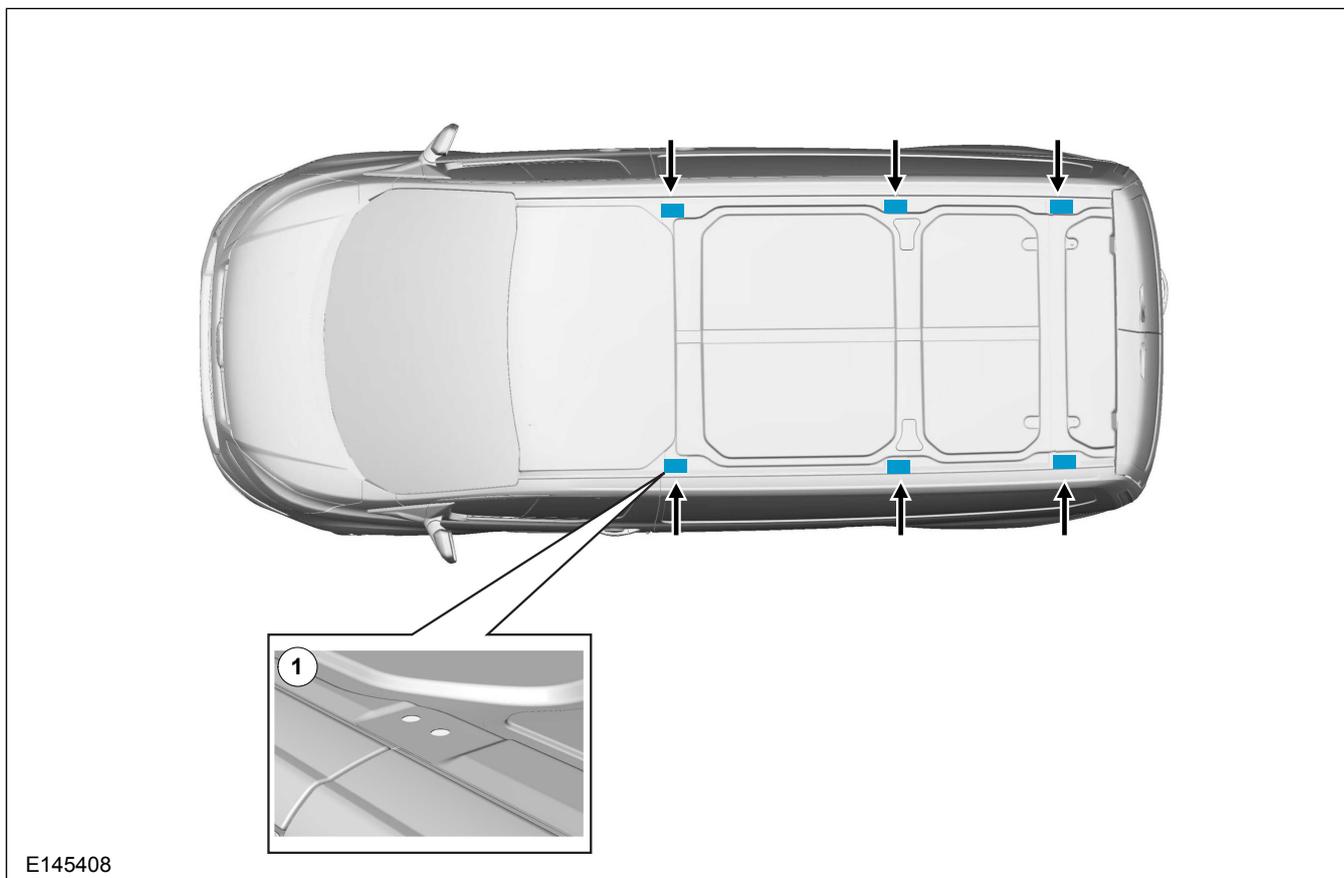
In case a roof bow is cut or removed, it must be replaced by an appropriate structure providing the equivalent structural integrity and functionality as the original structure. Any legal requirements must be maintained.

Ventilation Units - The roof panel can support up to 1kg on an unsupported area of roof. Loads, up to a maximum of 25kg must be distributed over 2 - roof bows.

Air Conditioning Units - Units weighing more than 25kg must be internally supported on cross brace members distributing the load out to the roof rails.

5.12.2 Roof Racks

H1 Roof Height



E145408

Item	Description
1	Roof Rack Supports, 3 attachments each side. Positions depend on wheel base.

 **WARNING: When installing a roof rack or any other accessory the fixing points need to be sealed for preventing water ingress into the interior of the vehicle.**

NOTE: Refer to the Owner's Manual for maximum roof load, including roof rack.

NOTE: Read and follow the manufacturer's instructions when fitting a roof rack.

NOTE: Maximum roof rack length for H1 roof height vehicles should consider liftgate in fully opened position.

NOTE: Vehicles with H2 roof height do not have reinforcement bolts in the roof. It is recommended to use Roof Rack Mounting Kit AMBK21-V46002-AC, which contains the fitting instructions.

Roof racks may be fitted to all van, bus and kombi variants as illustrated in figure E145408, providing the following is satisfied:

- The carried load does not exceed the recommended weight stated in the Owner's Manual
- The load is evenly distributed (converter to ensure Owner's information book identifies this limitation)
- The load of a single attachment under worst case loading, must not exceed 75kg
- The roof rack should be fixed to the roof using one or two M8 bolt/s per attachment as shown in figure E145408
- It is recommended that the rack leading edge should not be located forward of the rear edge of the driver's door, or "B" pillar

5.13 Corrosion Prevention

NOTE: 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.

Use appropriate isolation materials. Where possible, choose materials with low level of electrochemical potential difference.

5.13.1 General

Avoid drilling into closed frame body members to avoid the risk of corrosion from swarf.

If drilling is required, however:

- Re-paint metal edges and protect against corrosion after cutting or drilling operations
- Endeavor to remove all swarf from inside the side member and treat to prevent corrosion
- Apply corrosion protection inside and outside of the chassis frame

For Welding:

Refer to: [5.1 Body \(page 177\)](#).

5.13.2 Repairing Damaged Paint

After cutting or reworking any sheet metal on the vehicle the damaged paint must be repaired.

Ensure all materials are compatible with the relevant Ford specifications and maintain the original performance where possible.

5.13.3 Under Body Protection and Material

 **WARNING: Do not over-coat or contaminate surfaces of components such as brakes or catalytic converters.**

Ensure all materials are compatible with the relevant Ford specifications and maintain the original performance where possible.

Some proprietary products affect the original coatings.

5.13.4 Painting Road Wheels

 **WARNING: Do not paint wheel clamp surfaces in contact with other wheels, brake drum or disc, hub and holes or surface under wheel nuts. Any further treatment in these areas may affect the wheel clamp performance and the vehicle safety. Mask the wheel when changing the color or repairing paint.**

5.13.5 Contact Corrosion

When using different materials with a different electrochemical potential, ensure that materials are isolated from each other to prevent contact corrosion caused by a potential difference.

5.14 Frame and Body Mounting

NOTE: 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

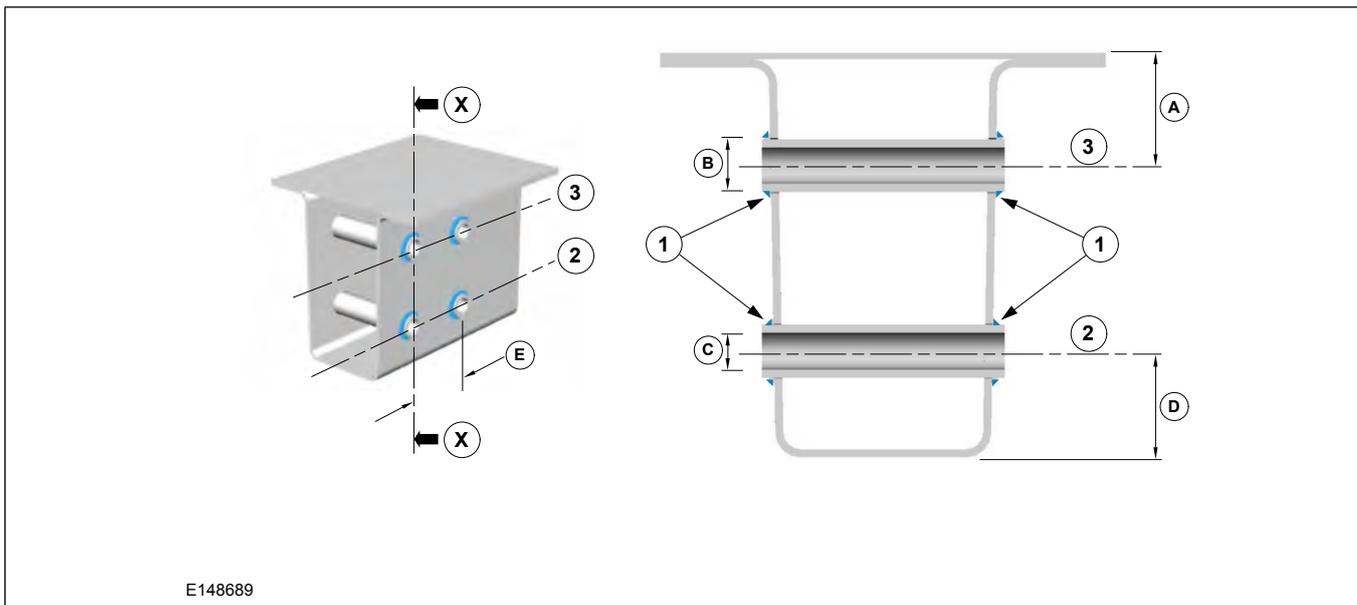
5.14.1 Mounting Points and Tubing

Holes on frame are a result of the production process. They are not designed for fixing additional equipment. If additional fixings to the chassis frame are required please follow the recommendation given in figure E148689. This does not apply to areas of load applications such as spring fixings or damper fixings.

NOTE: After drilling, deburr and countersink all holes and remove chips from the frame. Follow corrosion prevention.

Refer to: [5.13 Corrosion Prevention \(page 203\)](#).

Frame Drilling and Tube Reinforcing



E148689

Item	Description	Item	Description
1	Full Penetration, Full diameter weld each side	B	Diameter 16.5mm maximum
2	Center line of holes/tubing	C	Diameter 11mm
3	Center line of holes/tubing	D	30mm to 35mm
A	30mm to 35mm	E	50mm minimum

5.14.2 Frame Drilling and Tube Reinforcing

The chassis frame may be drilled and reinforcing spacer tubes may be welded in place, providing the following is applied:

- Adhere to all details shown in figure E148689
- Drill and weld only side walls of the chassis frame
- Locate and drill holes accurately, using a drill guide to ensure holes are square to frame vertical center line (allow for side member draft angle)
- Drill undersize and ream out to size

- Endeavor to remove all swarf from inside side member, and treat to prevent corrosion
- Fully weld each end of the tube and grind flat and square, in groups if applicable. Be aware of side member draft angle
- Apply corrosion protection inside and outside of the chassis frame.

Refer to: [5.13 Corrosion Prevention \(page 203\)](#).

- Holes should be in groups of two, either vertically spaced at 30 to 35mm from chassis frame top and/or bottom surface, or horizontally at 50mm minimum pitch, 30 to 35mm from top and/or bottom chassis frame surface, please refer to figure E148689
- Always use M10 bolts with grade 8.8 minimum

- Do not position tubes at the medium chassis frame height, this may create “oil canning” of the deep section side walls
- A diameter of 16.5mm is the maximum allowable hole size in the chassis frame side wall, irrespective of the usage

Avoid drilling into closed frame body members to avoid the risk of corrosion from swarf.

Refer to: [5.13 Corrosion Prevention \(page 203\)](#).

Drilling and welding of frames and body structure have to be conducted following the guidelines.

Refer to: [5.1 Body \(page 177\)](#).

Welding.

5.14.3 Area for Fitting Additional Body Attachments to the Rear of the Bumper

NOTE: With the vehicle on level ground and with all measurements taken rear ward of the bumper bar edge. The area designated for the fitting of attachment is defined as 220mm horizontally by 95mm vertical downward to the road surface, with a max width of 1390mm about vehicle center line.

It is not the manufactures recommendation to fit additional body attachments (tow bars, steps, bicycle racks and carriers) outside of the designated area.

5.14.4 Water Tank on Camper Vehicles

NOTE: It is recommended that a decal or label is fitted adjacent to the filler aperture identifying the correct fluid to be used, for example: 'Water only' for water tanks.

A	
About this Manual.....	7
About this Publication.....	6
Accessory Drive.....	46
Adaptive Cruise Control.....	135
Adding Connectors.....	172
Additional External Lamps.....	133
Additional Internal Lamps.....	134
Additional Lighting for rear of vehicle interior.....	134
Additional Loads and Charging Systems.....	88
Additional Rear Speakers.....	130
Additional Vehicle Signals/Features.....	143
Aids for Vehicle Entry and Exit.....	25
Airbags.....	198
Airbag Supplemental Restraint System (SRS).....	198
Air Flow Restrictions.....	45
Alternative Type Approval.....	9
Anti-Lock Control — Stability Assist.....	43
Area for Fitting Additional Body Attachments to the Rear of the Bumper.....	205
Audio Head Unit (AHU) - Multimedia in Car Entertainment (ICE) Pack Summary.....	126
Automatic Transmission.....	48
Auto Wipe and Auto Lamp for vehicles with large overhangs.....	146
Auxiliary Fuse Panel (A526).....	153
Auxiliary Heater Installation.....	45
Auxiliary Heater Systems.....	45
Auxiliary Switches.....	161
B	
Battery and Cables.....	78
Battery Configuration, Additional Loads, Start-Stop and Smart Regenerative Charging (SRC).....	84
Battery Configurations (always in the drivers seat pedestal).....	84
Battery Information.....	80
Battery Monitoring Sensor (BMS).....	104
Battery Rules.....	84
Beacon Preparation Pack (A606).....	159
Body.....	177
Body Closures.....	190
Body Control Module (BCM).....	69
Body Structures - General Information.....	177
Boron Steel Parts.....	179
Brake Hoses General.....	43
Brake System.....	43
C	
Calibration and Tachograph Fitting.....	125
Camper Central Connectors.....	148
CAN-Bus System Description and Interface.....	67
Cellular Phone.....	132
Center of Gravity Height Calculation.....	32
Center of Gravity Height Test Procedure.....	30
Center of Gravity Position.....	30
Central Locking.....	137
Changing Vehicle Speed Maximum Setting.....	122
Charge Balance Guidelines.....	77
Charging System.....	72
Circuit Diagrams.....	77
Climate Control System.....	112
Clutch.....	49
Commercial and Legal Aspects.....	8
Communications Network.....	67
Connector Pin Out Practices.....	56
Connectors.....	147
Contact Corrosion.....	203
Contact Information.....	11
Conversion Affects on Parking Aids.....	25
Conversion Homologation.....	17
Conversion Impact on Fuel Economy and Performance.....	19
Conversion Type.....	13
Conversion Type - Reference Tables.....	13
Corrosion Prevention.....	203
Cruise Control.....	135
Customer Connection Points (CCP).....	147
D	
Diesel Particulate Filter (DPF).....	51
Door Removal or Modification.....	137
DPF and RPM Speed Control.....	121
Drilling and Welding.....	10
Driver Belt Minder.....	200
Driver Field of View.....	25
Driver Reach Zones.....	25
E	
Electrical Connectors and Connections.....	147
Electrical Conversions.....	75
Electrically Operated Door Mirrors.....	133
Electrics for Tow Bar.....	63
Electromagnetic Compatibility (EMC) Awareness.....	59
Electromagnetic Compatibility (EMC).....	18
Electronic Engine Controls.....	115
End of Life Vehicle (ELV) Directive.....	20
Engine Cooling.....	45
Engine.....	44
Engine RPM (Revs per Minute) Speed Controller (A003).....	117
Engine Selection for Conversions.....	44
Exhaust Heat Shields.....	51
Exhaust Pipes and Supports.....	51
Exhaust System.....	51
Extensions and Optional Exhausts.....	51
Exterior Lighting.....	133
F	
Fitting a Tachograph to vehicles built without Digital Tachograph Option.....	124
Fitting Equipment Containing Electric Motors.....	76
Floor Precautionary Drill Zones - Fuel Tank.....	180
Formulas.....	32
Frame and Body Mounting.....	204
Frame Drilling and Tube Reinforcing.....	204
Front, Rear and Side Under-run Protection.....	25
Front End Accessory Drives — General Information.....	46
Front End Body Panels.....	188
Front End Integrity for Cooling, Crash, Aerodynamics and Lighting.....	180
Front Suspension.....	40
Fuel System.....	53
Fuses and Relays.....	139
Fuses.....	139

System Operation and Component Description.....73

T

Tachograph Harness Mounting.....123
 Tachograph.....123
 Temporary Mobility Kit.....42
 Terminology.....8
 The Ford Programmable Battery Guard (A540).....89
 The Ford Programmable Battery Guard System - Aftermarket Fitting.....100
 Tire Manufacturers.....42
 Tire Pressure Monitoring System (TPMS).....42
 Tow Bar Requirements.....34
 Tow Bar Types (for AUS and NZL specification vehicles).....36
 Tow Bar Types (for EU specification vehicles).....34
 Towing.....34
 Trailer Brakes.....38
 Trailer Tow Connectivity (AUS and NZL).....66
 Trailer Tow Connectivity (EU).....65
 Trailer Tow Electric (A055).....62

U

Under Body Protection and Material.....203
 Unused Connectors.....57
 Utility Vehicle Switch Pack (A607) - Right Hand Drive shown.....160

V

Van.....194
 Vehicle Configuration Change.....125
 Vehicle Dimensions Key.....26
 Vehicle Duty Cycle Guidelines.....19
 Vehicle Electrical Capacity – Alternator.....77
 Vehicle Exhaust Systems – Vans with Full Bulkheads.....52
 Vehicle Interface Connector.....151
 Vehicle Ride and Handling Attributes.....19
 Vehicle Transportation Aids and Vehicle Storage.....24

W

Warranty on Ford Vehicles.....8
 Water Leakage Prevention.....57
 Water Tank on Camper Vehicles.....205
 Welding.....177
 Wheel Clearance.....42
 Wheels and Tires.....42
 Whole Vehicle Type Approval (2007/46/EC) Regulations.....8
 Windowed Van.....194
 Windscreen Wipers.....142
 Wiring Harness Information.....56
 Wiring Installation and Routing Guides.....56
 Wiring Specification.....58
 Wiring Splicing Procedures.....57
 Wiring through Sheet Metal.....59

