Body and Equipment Mounting Manual
FORD **TOURNEO CUSTOM/TRANSIT CUSTOM** 2013

Date of Publication: 04/2017

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1.1 About This Manual

1.1.1 New for this Body and Equipment Mounting Manual (BEMM) Publication 04/2017

This BEMM has been updated since the last publication dated 03/2017. It is recommended to review this manual in full.

For an overview of the main differences please see below:

Refer to: 3.3 Accessory Drive (page 52).
When installing a new front end accessory drive - text revised.

Refer to: 4.4 Battery and Cables (page 93).
Warning: Where a battery guard is fitted - text revised.

ADR references updated in various sections

1.1.2 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.

1.1.3 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 he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or components.

1.1.4 Warnings, Cautions and Notes in This Manual

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 repair.

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

A warning, caution or note is placed at the beginning of a series of steps if 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).

1.1.5 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, Power train, Electrical and Body. 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 section of the book it may refer you to see additional sections for information, links have been provided, these links are in blue text.

This manual is also designed to be used as a printed document, where there are links page numbers in brackets have been added, which will help guide you to the start of the section which contains the relevant information.

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.

1.1.6 Supplemental Information

2D Engineering Drawings can be downloaded in DWG format via www.etis.ford.com/fordservice/. Select 'vehicle conversions' then 'BEMM Drawings' tab, this will then give you the option to navigate though a drop-down menu to specific drawings.

3D CAD data in IGES format can be requested by contacting the Vehicle Converter Advisory Service, vcas@ford.com

Signwriter's Guide, which have been produced for Transit Custom to assist companies applying labels to the sides of the vehicle, can be requested by contacting either the National Sales Representative or the Vehicle Advisory Service vcas@ford.com

1.2 Commercial and Legal Aspects

1.2.1 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.

1.2.2 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.

1.2.3 Whole Vehicle Type Approval

Fitment of Parts and Accessories

Whole Vehicle Type Approval (WVTA) 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. The aim is not to be impaired by the fitting of certain parts or equipment after vehicles have been placed on the market or have 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 regulations, 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 AU 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 Airbag 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: 1.5 Conversion Homologation (page 19).

1.2.4 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. Check with your local Ford National Sales Company representative.
- 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.

1.2.5 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.

1.2.6 Legal Obligations and Liabilities

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

1.2.7 General Product Safety Requirement

The Vehicle Converter shall ensure that any alteration it makes to a Ford vehicle or component does not reduce its compliance with local legislation.

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.

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.

NOTE: For further information please contact your local 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

Refer to: 1.3 Contact Information (page 11).

1.2.8 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, propeller 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.

1.2.9 Restraints System

WARNINGS:

Modifications to the restraints system are not allowed.

Airbag are explosive. For safe removal and storage during conversion follow the procedures in the Ford workshop manual or consult your local National Sales Company representative.

Do not alter, modify or relocate the airbag, sensor 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 200).

1.2.10 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 207).
Refer to: 5.1 Body (page 174).

1.2.11 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.

1.2.12 Road Safety

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

1.3 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 local National Sales Company Representative (NSC) or Local Ford Dealer in your Market.

If your Local National Sales Company Representative or Local Ford Dealer are unable to help you, please contact the Vehicle Converter Advisory Service at VCAS@ford.com.

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1.4.1 Special Vehicle Option (SVO) Order Codes

Order Code	Description
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
A736	2 High Performance AGM Batteries — 2x 80Ah capacity, 800CCA batteries
A526	Auxiliary Fuse Panel
A606	Beacon Preparation Pack — Switch and wiring front and rear (includes A526 and mini overhead console - 1DIN)*
A607	Utility Vehicle Switch Pack — Provides 3 switches for beacon and two power outputs (includes A526, A606 and mini overhead console 1 DIN)*
A608	High Specification Vehicle Interface Connector — Provides a range of hard-wire signals (includes A526)**

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.

Availability of options will vary on territories.

*Not to be ordered with tachograph, as uses the same 1 DIN console.

**Not available with A607

1.4.2 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 75).
Refer to: 4.15 Fuses and Relays (page 134).

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: 1.12 Package and Ergonomics (page 27).
	Refer to: 1.15 Towing (page 38).
	Refer to: 3.7 Fuel System (page 58).
	Refer to: 4.4 Battery and Cables (page 93).
	Refer to: 4.16 Special Conversions (page 137).
	Refer to: 5.8 Seats (page 195). Rear Seat Fixings Positions.
	Refer to: 5.12 Roof (page 204).

Refrigerated Vehicles	
Van Conversion	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 4.5 Climate Control System (page 111).
	Refer to: 4.15 Fuses and Relays (page 134).
	Refer to: 5.12 Roof (page 204). Roof Racks.
Compressor Installation	Refer to: 3.3 Accessory Drive (page 52).

Dry Freight	
Box Van	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.16 Special Conversions (page 137). Auto Wipe and Auto Light for Vehicles with large over-hangs
Pantechnicon	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.16 Special Conversions (page 137). Auto Wipe and Auto Light for Vehicles with large over-hangs
Money Carriers	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 5.12 Roof (page 204). Roof Ventilation.
	Refer to: 4.11 Exterior Lighting (page 128).
Refuse Collection	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 4.11 Exterior Lighting (page 128).

Emergency Services	
Ambulance (Front Line) / *Fire Brigade / *Armed Forces / *Police	Refer to: 3.2 Engine Cooling (page 50). Airflow Restrictions.
	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.12 Interior Lighting (page 129).
	Refer to: 4.15 Fuses and Relays (page 134).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 5.8 Seats (page 195).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).
	* Refer to: 4.16 Special Conversions (page 137). Auto Wipe and Auto Light for Vehicles with large over-hangs

Vocational Conversion	
Mobile Workshops	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 5.3 Racking Systems (page 182).
	Refer to: 5.12 Roof (page 204). Roof Racks.
	Refer to: 4.16 Special Conversions (page 137). Auto Wipe and Auto Light for Vehicles with large over-hangs
Mobile Shops / Offices	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 5.3 Racking Systems (page 182).
	Refer to: 5.12 Roof (page 204). Roof Racks.
	Refer to: 4.16 Special Conversions (page 137). Auto Wipe and Auto Light for Vehicles with large over-hangs
Glass Carrying	Refer to: 4.4 Battery and Cables (page 93).Generator and Alternator.
	Refer to: 5.1 Body (page 174). Racking System.
Racking Conversions	Refer to: 4.4 Battery and Cables (page 93).Generator and Alternator.
	Refer to: 5.3 Racking Systems (page 182).
Recovery Vehicles	Refer to: 4.4 Battery and Cables (page 93). Generator and Alternator.
	Refer to: 5.14 Frame and Body Mounting (page 207).
	Refer to: 4.16 Special Conversions (page 137). Auto Wipe and Auto Light for Vehicles with large over-hangs

Passenger Carrying	
Taxi	Refer to: Commercial and Legal Aspects (page ?). Restraints System.
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.12 Interior Lighting (page 129).
	Refer to: 5.8 Seats (page 195).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 198).
	Refer to: 5.12 Roof (page 204). Roof Ventilation.
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).
Mobility	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.12 Interior Lighting (page 129).
	Refer to: 5.8 Seats (page 195).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 198).
	Refer to: 5.12 Roof (page 204). Roof Ventilation.
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).
Coach Built	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 4.11 Exterior Lighting (page 128).
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	Refer to: 5.12 Roof (page 204). Roof Ventilation.
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).
Wheelchair Accessible	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 5.8 Seats (page 195).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 198).
	Refer to: 5.12 Roof (page 204). Roof Ventilation.
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.12 Interior Lighting (page 129).
	Refer to: 5.8 Seats (page 195).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).
Mini Bus	Refer to: 5.2 Hydraulic Lifting Equipment (page 179).
	Refer to: 4.11 Exterior Lighting (page 128).
	Refer to: 4.12 Interior Lighting (page 129).
	Refer to: 5.8 Seats (page 195).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 198).
	Refer to: 5.12 Roof (page 204). Roof Ventilation.
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 200).

1.5 Conversion Homologation

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.

NOTE: For further information please contact your local 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

For additional information on vehicle type approval

Refer to: 1.2 Commercial and Legal Aspects (page 8).

1.6 Electromagnetic Compatibility (EMC)

WARNINGS:

Your vehicle has been tested and certified to European legislation relating to electromagnetic compatibility (72/245/EEC, UN ECE Regulation 10 or applicable local legislation). It is your responsibility to make sure that any equipment fitted complies with applicable local legislation. Make sure any equipment is fitted by an authorized dealer.

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.

Do not mount any transceiver, microphones, speakers, or any other item in the deployment path of the airbag system.

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.

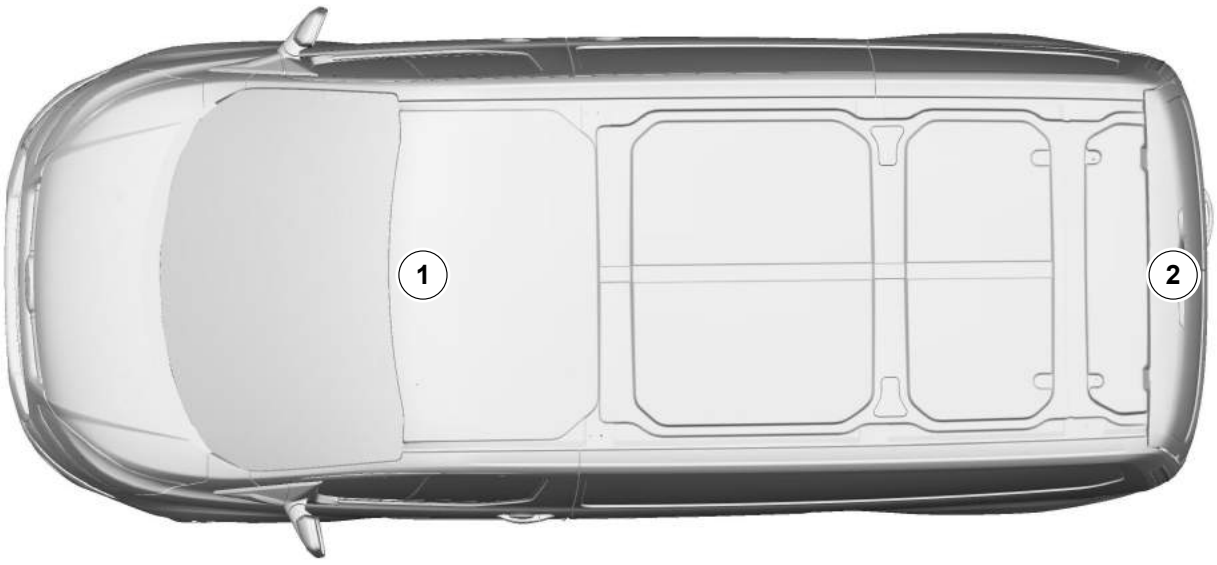
NOTE: Only fit one antenna in the positions shown to the roof of your vehicle.

NOTE: For EMC on Police conversions with rear view cameras please contact VCAS@ford.com

Frequency Overview

Frequency Band MHz	Maximum Output Power Watts (Peak RMS)	Antenna Position
1-30	50W	2
30-54	50W	1, 2
68-87.5	50W	1, 2
142-176	50W	1, 2
380-512	50W	1, 2
806-940	10W	1, 2
1200-1400	10W	1, 2
1710-1885	10W	1, 2
1885-2025	10W	1, 2

1.6.1 Permitted Antenna Location



E145333

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.

1.7 Vehicle Duty Cycle Guidelines

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.

NOTE: For further information contact your local 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

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.

1.7.1 Conversion Affect 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 Local Ford Dealer or 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).

1.7.2 Vehicle Ride and Handling Attributes

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

Due to the displacement of the center of gravity occurred by the conversion the ride and handling attributes may be different to the base vehicle.

NOTE: This vehicle should be evaluated for safe operation prior to sale.

1.8 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.

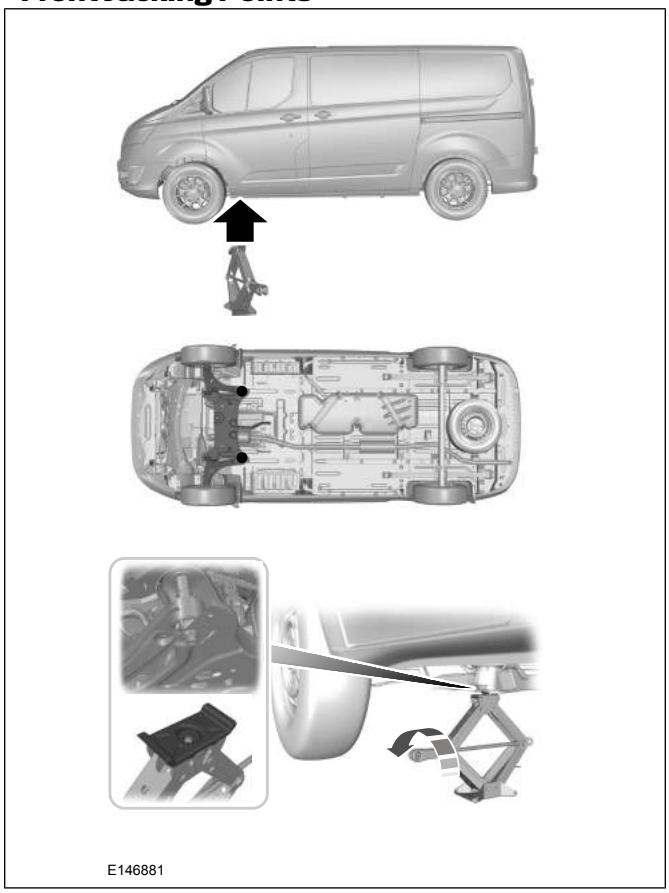
Make sure that access to the spare wheel is maintained when converting the vehicle or relocating the spare wheel.

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

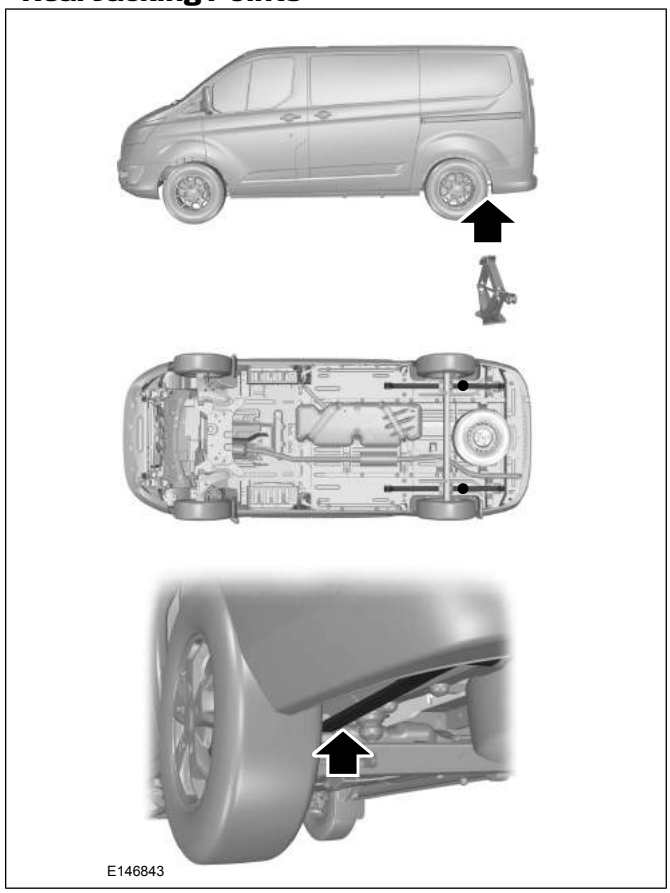
NOTE: Make sure that reinforcements are installed to maintain the integrity of the original body structure for/at jacking points.

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

Front Jacking Points



Rear Jacking Points



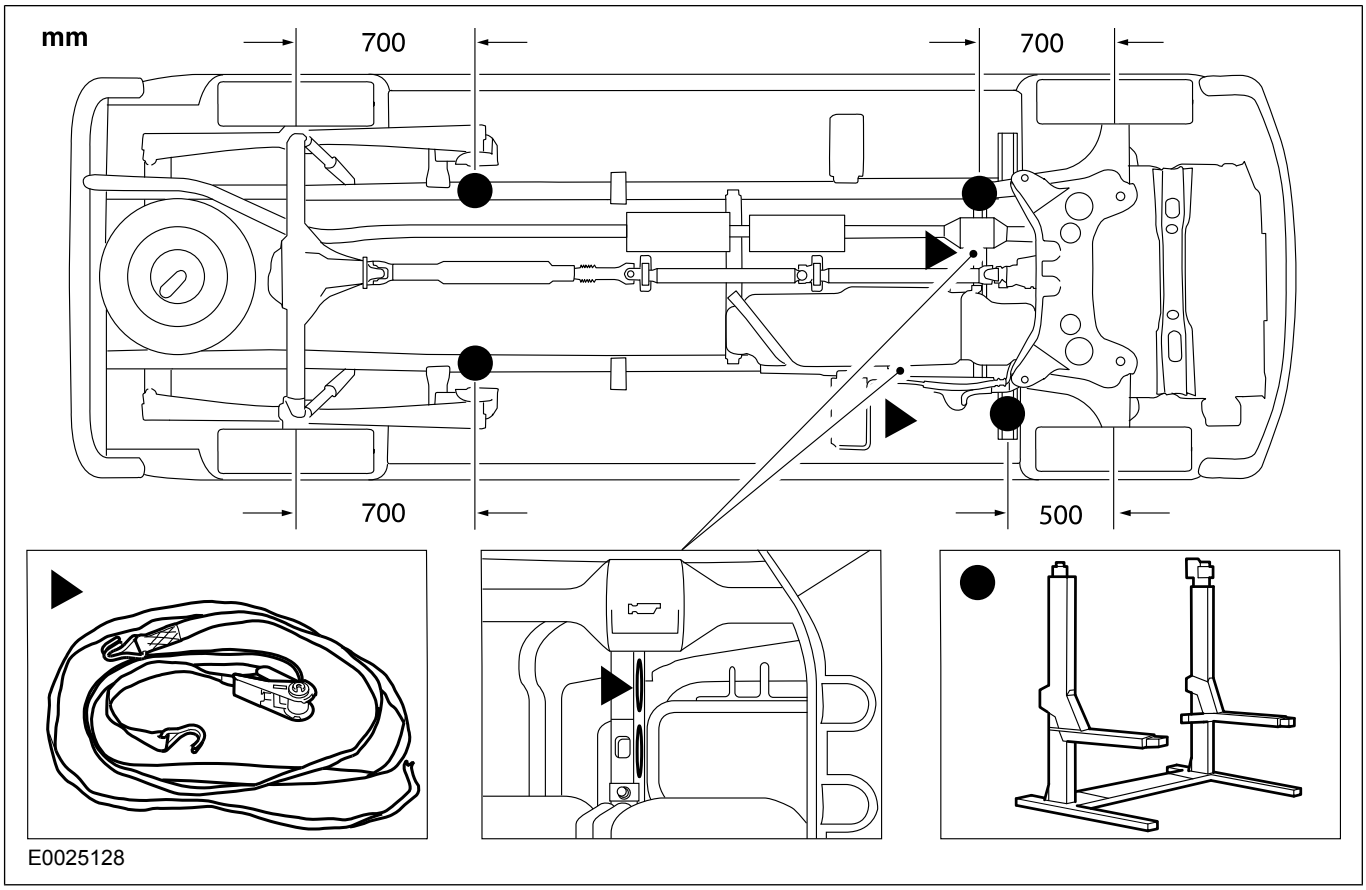
1.9 Lifting

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 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.**

Lifting Points



1.10 Noise, Vibration and Harshness (NVH)

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

CAUTION: The travel and function of pedals must not be restricted.

Changes to the powertrain, engine, transmission, exhaust, air intake system or tires may influence the exterior noise emission. 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.

1.11 Vehicle Transportation Aids and Vehicle Storage

CAUTIONS:

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 based 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.

Long term storage:

- Battery to 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) removed and stored in the luggage compartment.
- Engage first gear 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 in manufacture 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 93).

1.12.1 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.

1.12.2 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.

1.12.3 Driver Field of View

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

1.12.4 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: 4.11 Exterior Lighting (page 128).

1.12.5 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 local 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

1.12.6 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* or 2000/40 EC* or applicable local legislation.

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

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

*As amended periodically

1.12.7 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

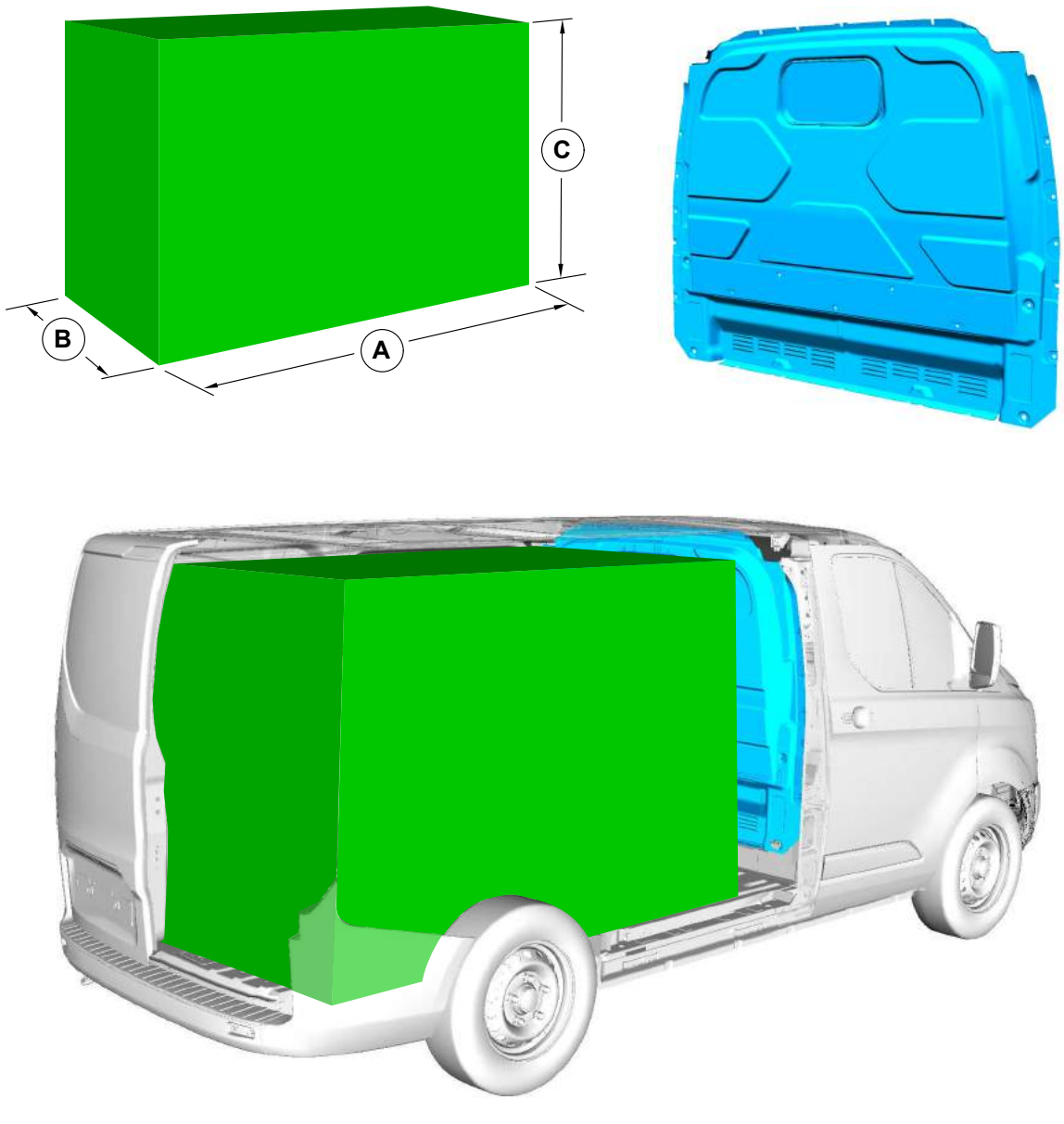
All dimensions are subject to manufacturing tolerances and refer to minimum specification models and do not include additional equipment.

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.

1.12.8 Recommended Main Load Area Dimensions

H1 Roof Height - Full Bulkhead - Fixed/Glazed



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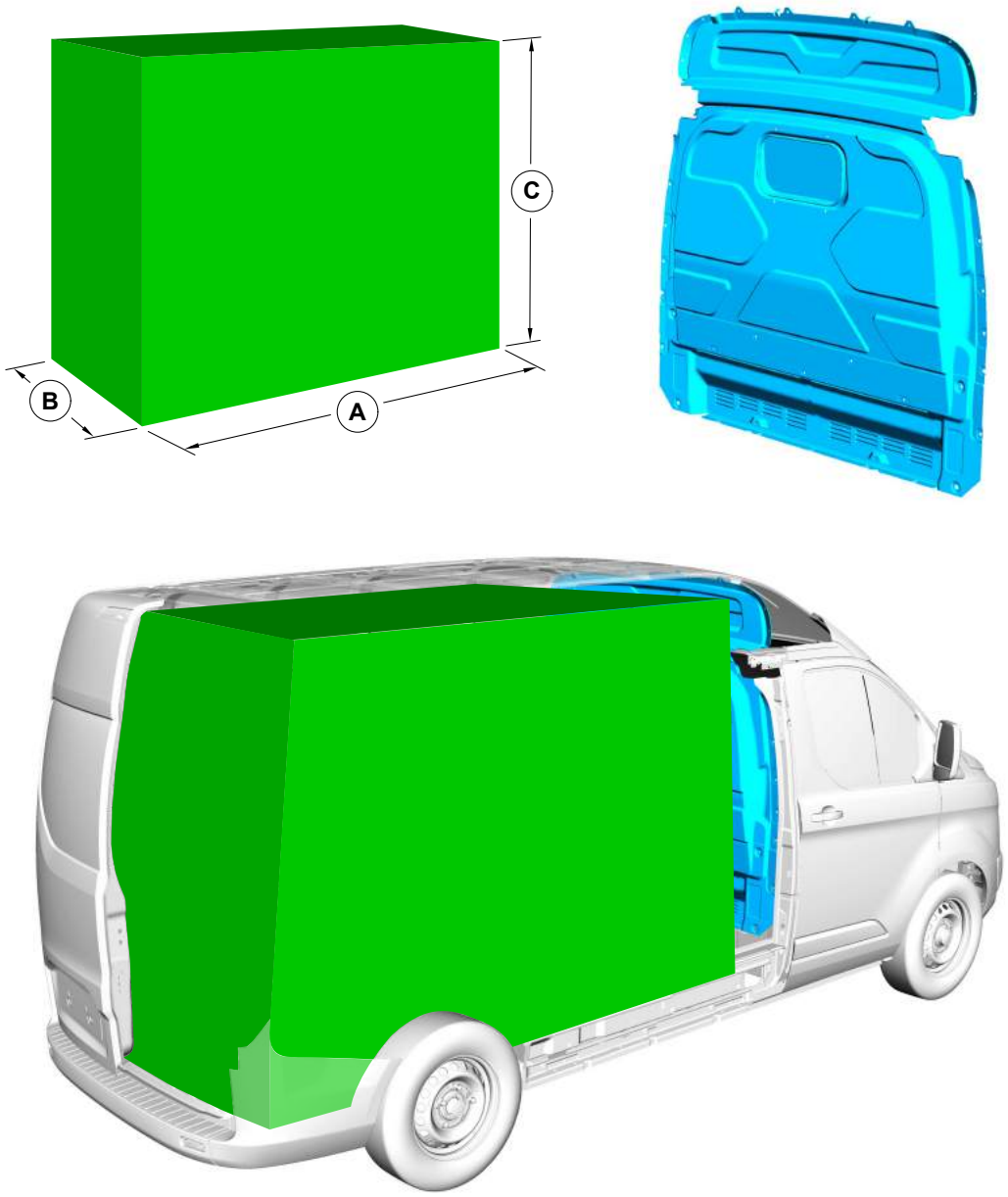
Vehicle	A (mm)	B (mm)	C (mm)
L1 - H1	2327	1260	1310
L2 - H1	2694	1260	1310

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



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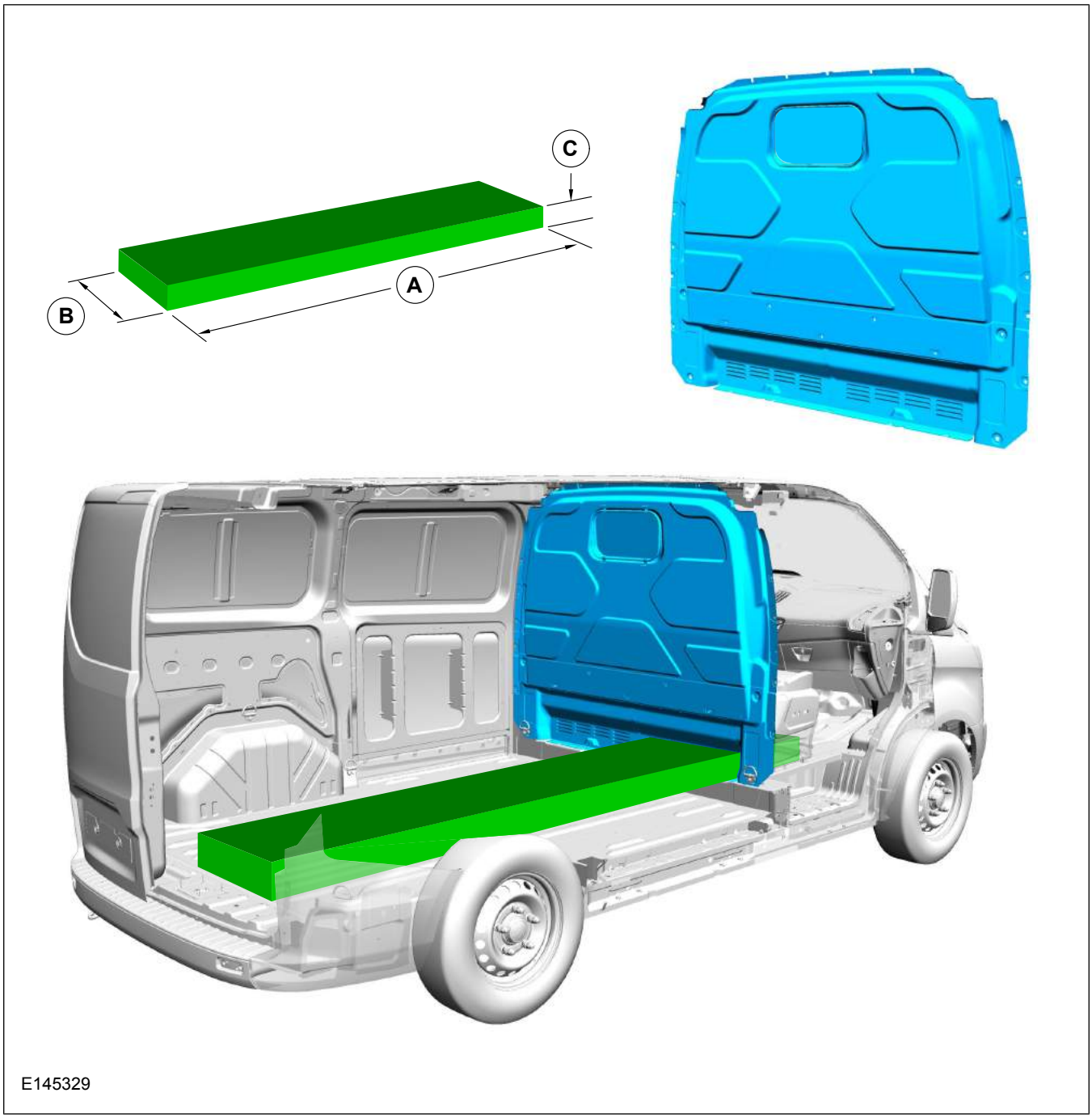
Vehicle	A (mm)	B (mm)	C (mm)
L1 - H2	2246	1140	1684
L2 - H2	2613	1140	1684

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)

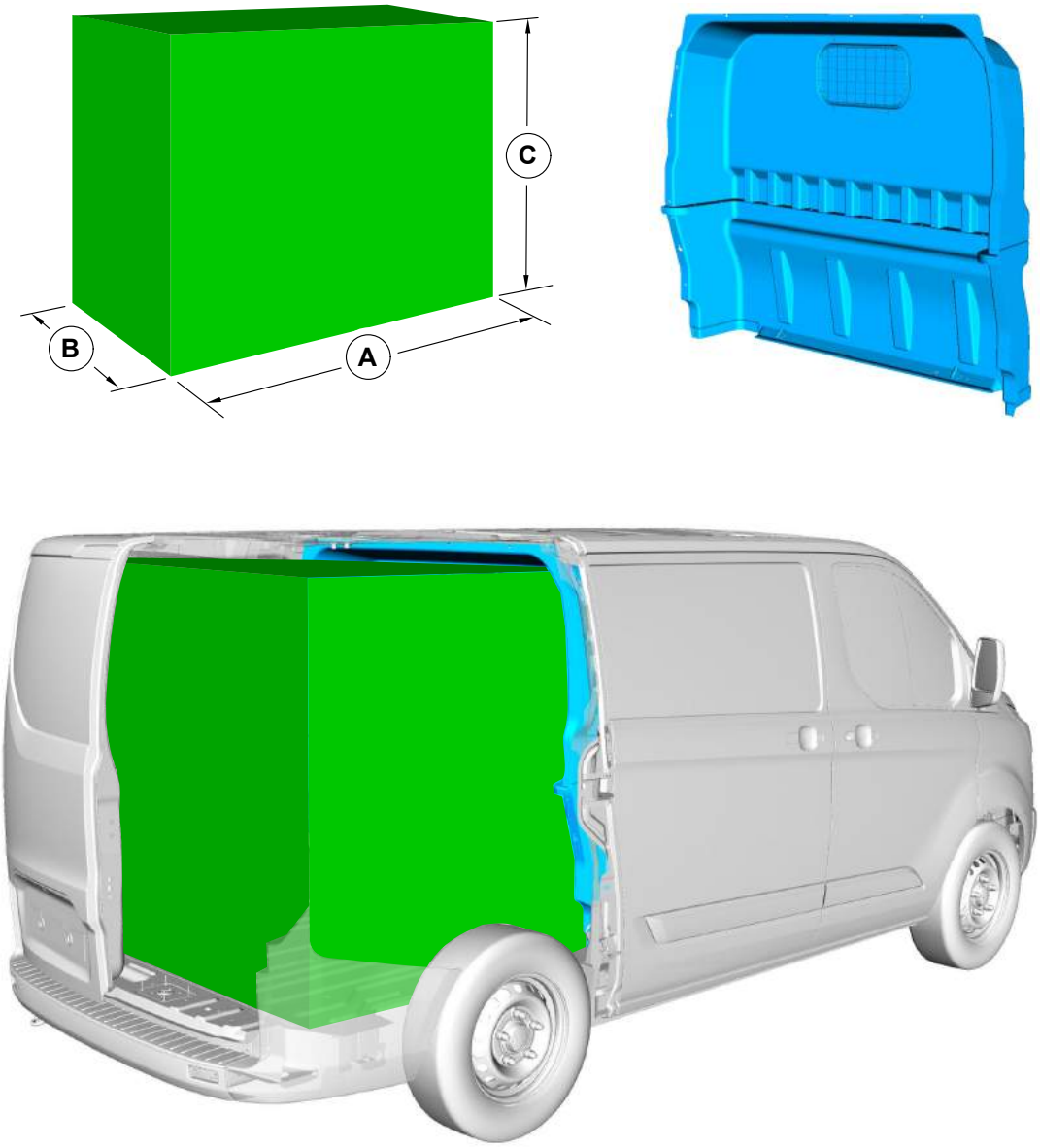


Vehicle	A (mm)	B (mm)	C (mm)
L1 - H1	3040	590	200
L2 - H1	3407	590	200

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



E145331

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

1.13 Hardware—Specifications

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.

1.14 Load Distribution

1.14.1 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 gross 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.

For further information please contact your local 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

1.14.2 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

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).

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

Vertical Position - Center of Gravity Height

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 the 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.

Except Sport Series Vehicles.

WARNINGS:

If the vertical center of gravity (CG_v) is equal to or less than 800mm 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 800mm, Ford Motor Company makes no representation as to conformity with ECE13-H, ANNEX 9 standard or ADR 35 or applicable local legislation.

1.14.3 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:

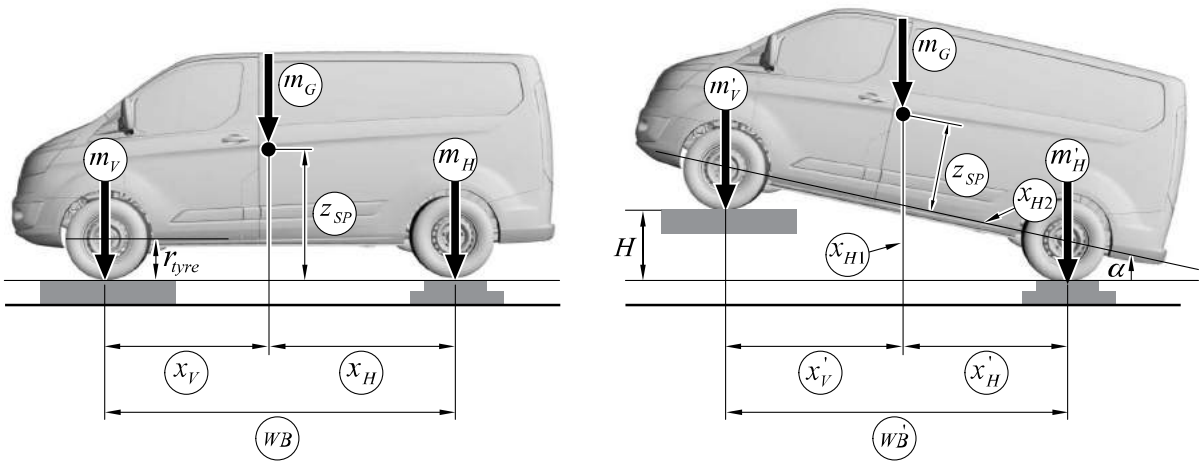
- Fix wheel travel, for example: solid shocks, or spring fixes.
- Increase tire pressure to maximum allowed value.
- It is important to remove all load, for example moving items, from the car or it should be properly fixed.
- Doors should be closed.

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

Calculation

In order to estimate the resulting Center of Gravity (CG_V) the axle load needs to be measured twice. First one 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:**

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

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

E146624

1.14.4 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}

1.14.5 Formulas

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

Taking the sum of moments equals zero law the distance Center of Gravity and wheel center can be calculated as:

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

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

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

Trigonometry leads to the projected wheelbase and analysis of the geometry as shown in the figure E145328 can be used to derive the auxiliary values below:

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

$$x_{H2} = \frac{x_H'}{\cos\alpha}$$

$$x_{H1} = x_H - x_{H2}$$

E146629

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

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

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

or

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

E146630

1.15 Towing

1.15.1 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. Contact your local Ford Dealer for details.

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

For further information on Towing a Trailer and Trailer Sway refer to Owner's Manual.

Refer to: 1.8 Jacking (page 23).

For further information on connecting the Tow bar,

Refer to: 4.1 Wiring Installation and Routing Guides (page 61).

1.15.2 Tow Bar Types

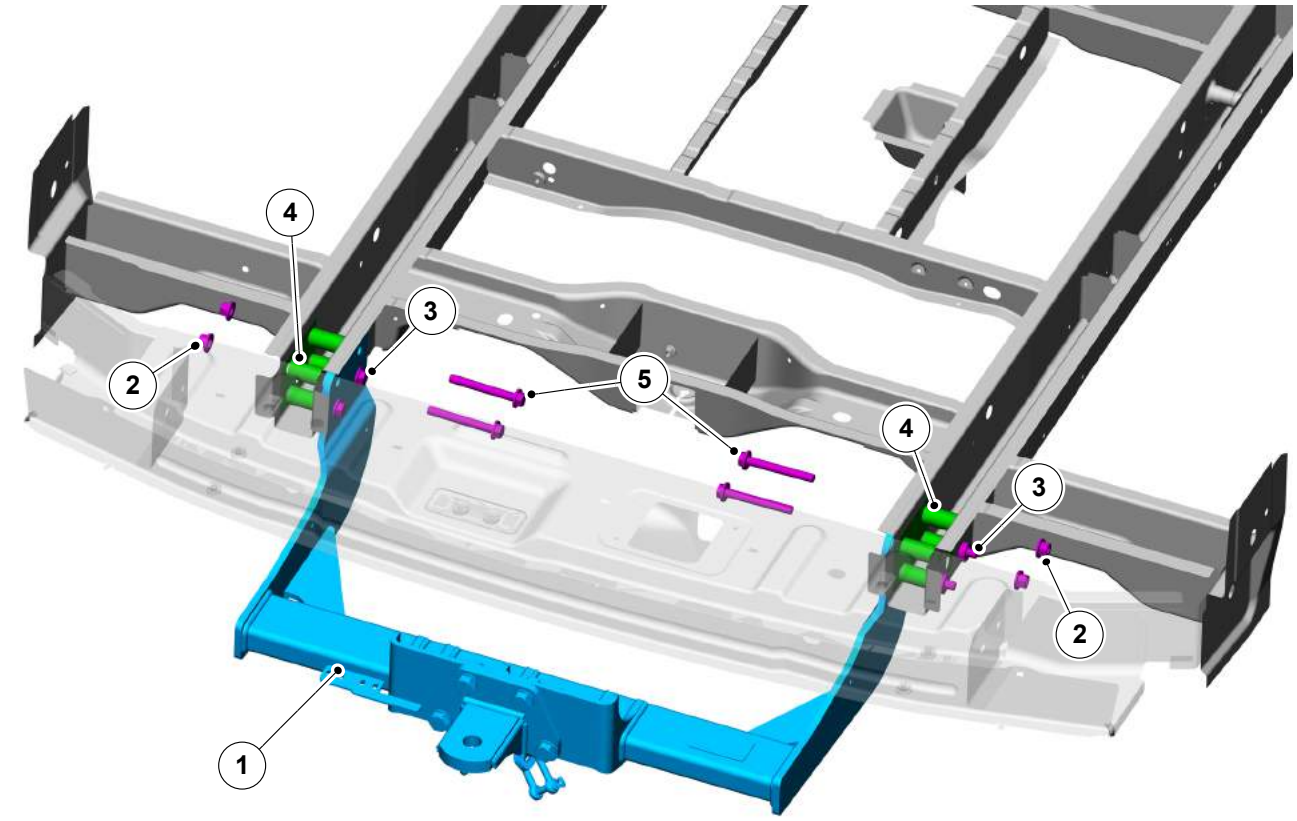
For tow bar devices fitted by the vehicle converter the following applies:

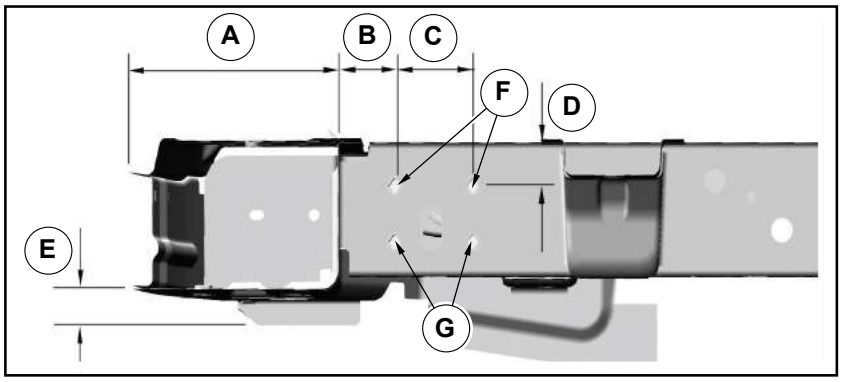
- Tow bar allowances must not exceed those of the standard vehicle.
- For attachment of the tow bar, under run bar and steps see figure 186508 - Tow Bar SWB Van 2.9 tonne (GVM) and LWB Van 3.3 tonne (GVM).
- Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation.
- The maximum allowable tow ball static load is 250kg for 290S SWB Van and 280kg for 330L LWB Van.
- 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 207).
  Mounting Points and Tubing.

For any further details and advice please consult your local National Sales Company representative, or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Advisory Service at VCAS@ford.com

Tow Bar SWB Van 2.9 Tonne and LWB Van 3.3 Tonne

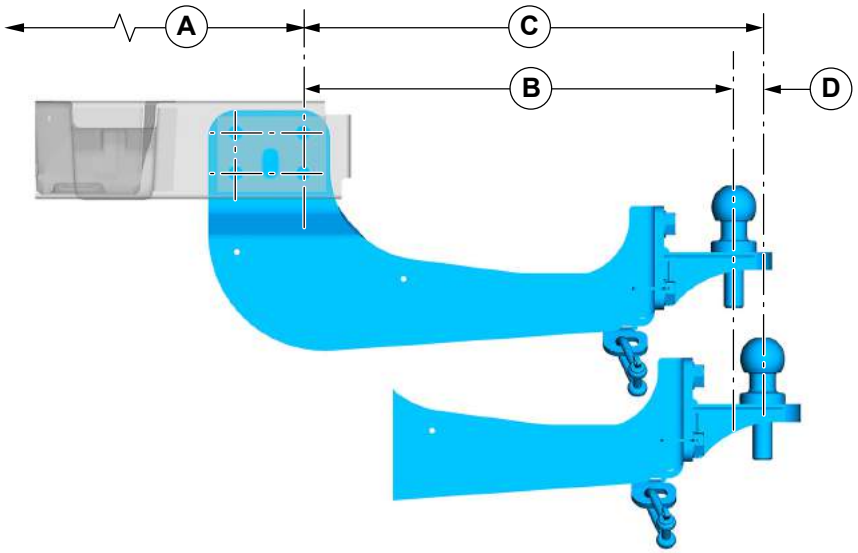




E186508

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*	SWB/LWB = 675mm
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.

* From center of rear axle.

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 detailed information 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 detailed information please contact the Vehicle Converter Advisory Service at VCAS@ford.com

2.3 Rear Suspension

2.3.1 Springs and Spring Mounting

WARNINGS:

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

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 can not be held responsible.

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 detailed information 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.

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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: 1.8 Jacking (page 23).

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

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.

CAUTION: Spoilers and wheel covers must not affect the brake cooling performance.

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 brake fluid reservoir.

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 local 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).

NOTE: For further information please contact your local 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

3.1 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 81).

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 (N1,N2/M1/M2) and weight. The final weight of a vehicle including the conversion, determines whether a vehicle needs a light-duty or heavy-duty emissions engine.

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.

For guidance purposes only, if the Reference Mass used for completed vehicle type approval is:

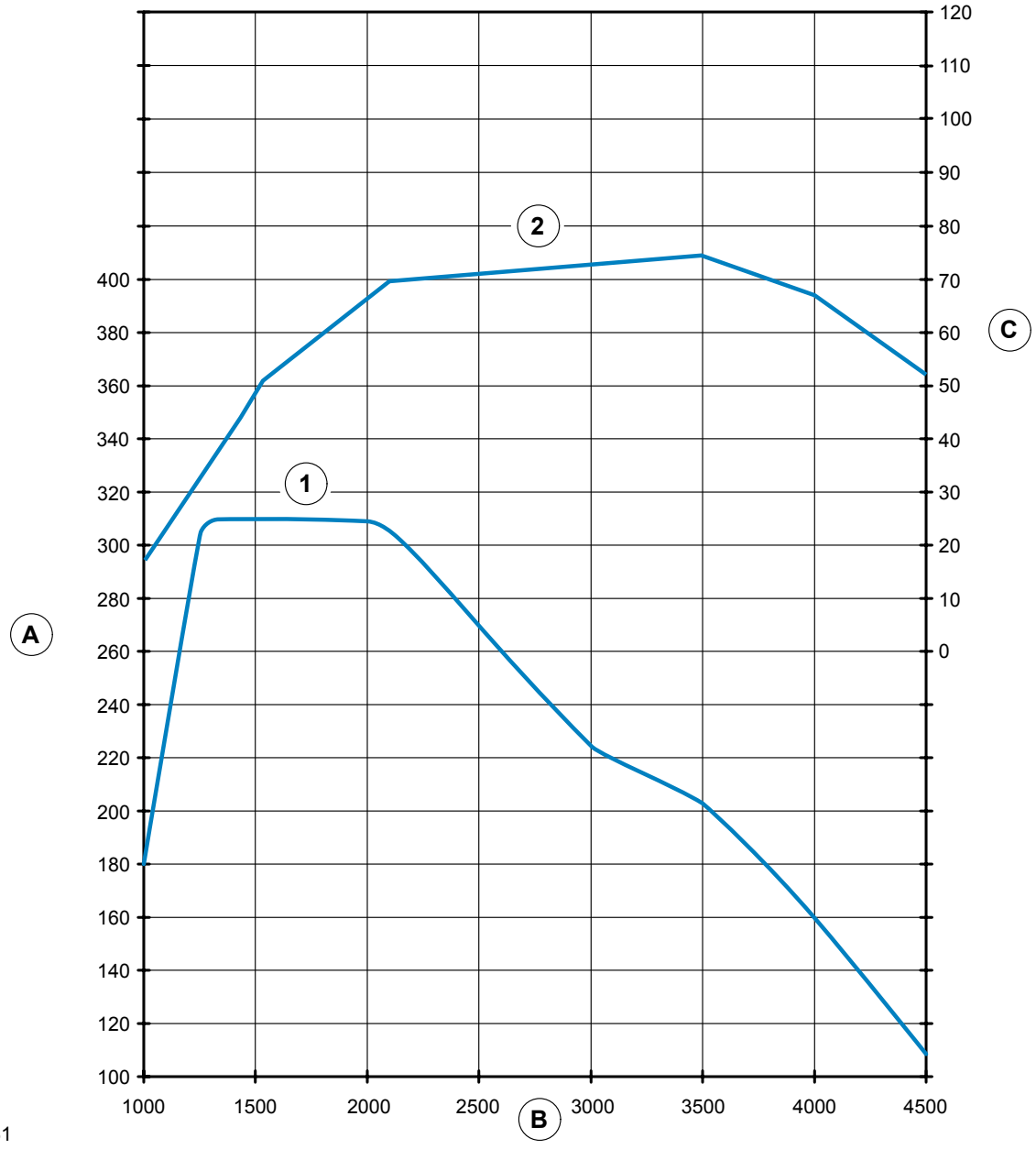
- Not exceeding 2,840kg, a light-duty engine may be specified.
- Greater than 2,840kg, a heavy-duty engine needs to be specified. Note: Heavy-duty engines are recommended for M2 Bus Conversions.

3.1.2 Engine Power Curves

Front Wheel Drive (FWD)

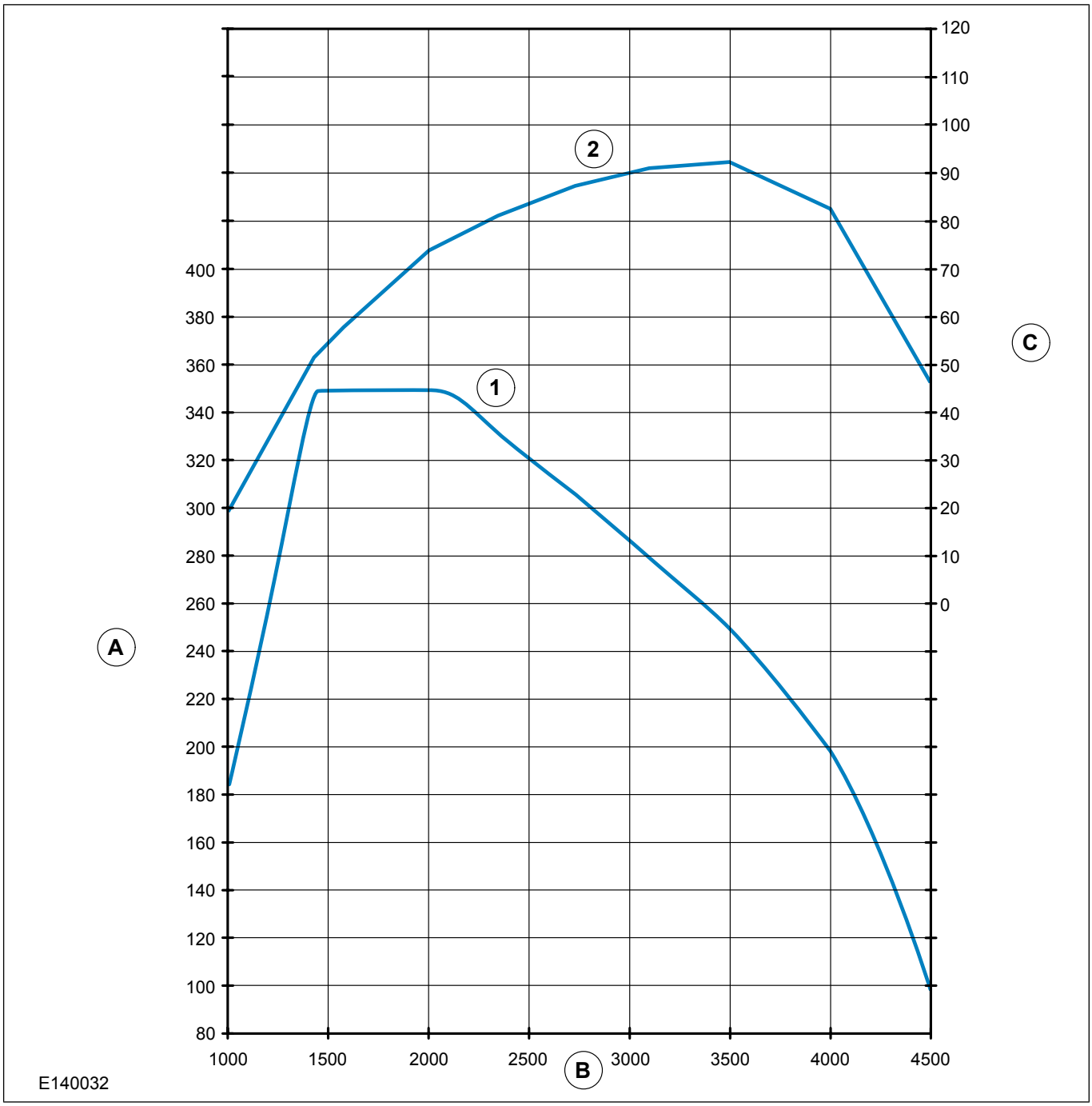
- Common Rail 2.2L TDCi 74kW (100PS) Diesel Engine.
- Common Rail 2.2L TDCi 92kW (125PS) Diesel Engine.
- Common Rail 2.2L TDCi 114kW (155PS) Diesel Engine.

FWD Common Rail 2.2L TDCi 74kW (100PS) Diesel Engine



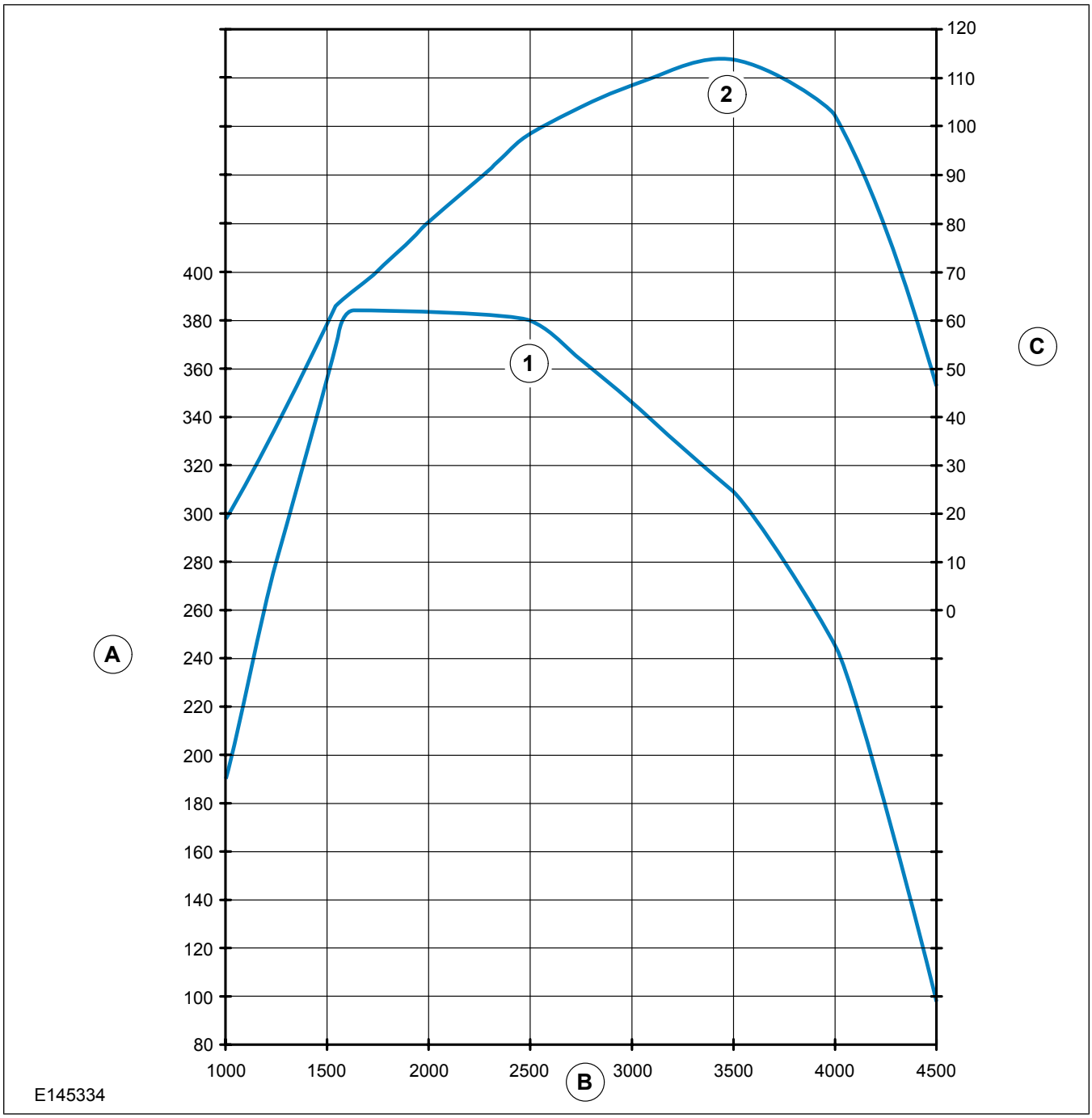
Item	Description
1	Torque Curve Nm — Max Torque = 310Nm at 1300-2100 1/min
2	Power Curve kW — Max Power = 74kW (100PS) at 3500 1/min
A	Nm
B	1/min
C	kW

FWD Common Rail 2.2L TDCi 92kW (125PS) Diesel Engine



Item	Description
1	Torque Curve Nm — Max Torque = 350Nm at 1450-2000 1/min
2	Power Curve kW — Max Power = 92kW (125PS) at 3500 1/min
A	Nm
B	1/min
C	kW

FWD Common Rail 2.2L TDCi 114kW (155PS) Diesel Engine



Item	Description
1	Torque Curve Nm — Max Torque = 385Nm at 1600-2300 1/min
2	Power Curve kW — Max Power = 114kW (155PS) at 3500 1/min
A	Nm
B	1/min
C	kW

3.2 Engine Cooling

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%.

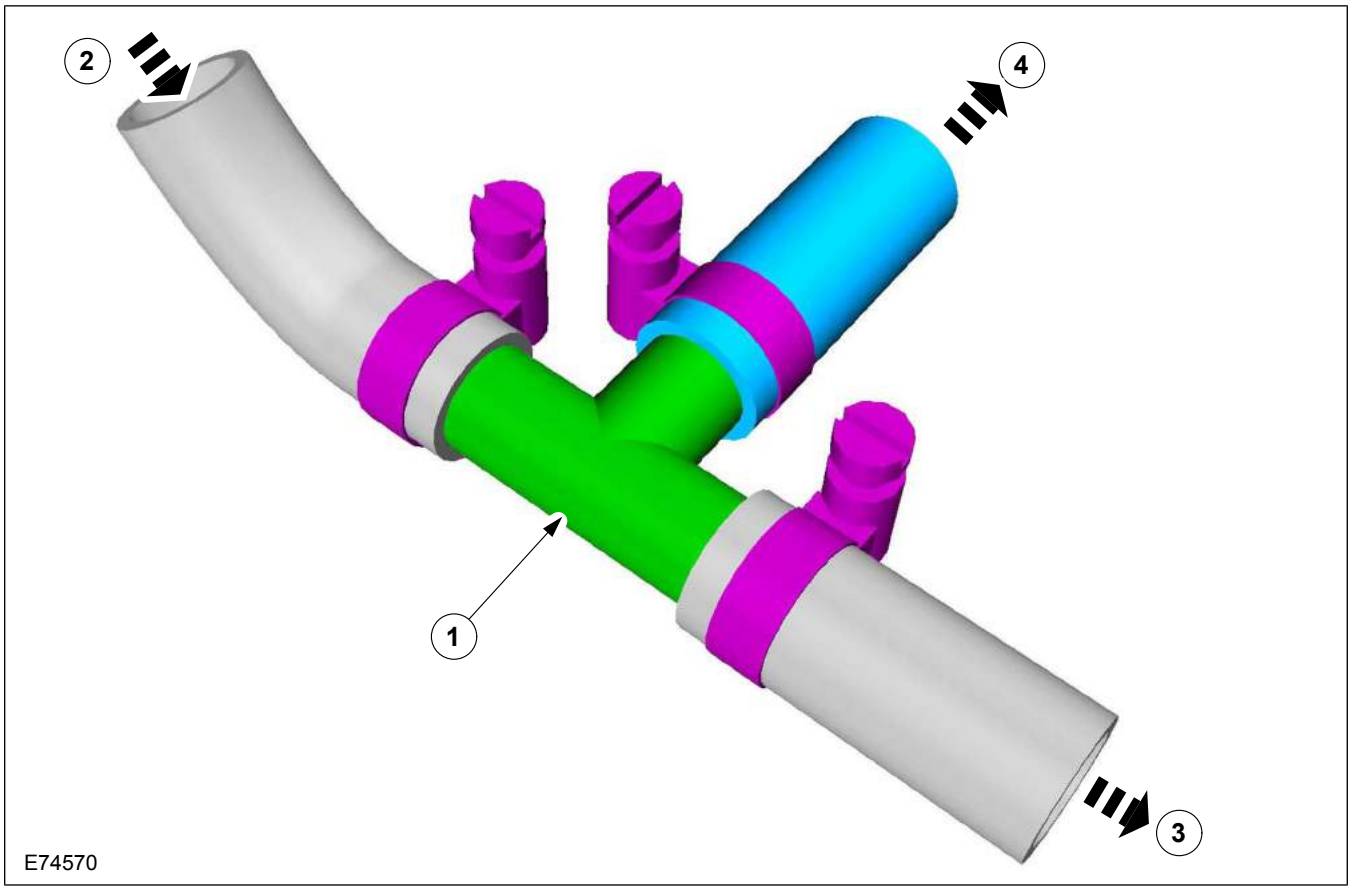
Maintain a coolant level between maximum and minimum line in cold condition after fill and de-aerating operations.

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

- 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 shall 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.

NOTE: For further information please contact your local 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

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

3.2.2 Auxiliary Heater Installation

Ensure that the exhaust gas from any auxiliary heating system can not 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 206).

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

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 130ºC when selecting appropriate materials

NOTE: For further information please contact your local 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 Accessory Drive

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.

NOTE: For further information on systems requiring a unique belt please contact your local 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 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 ±0.5º.

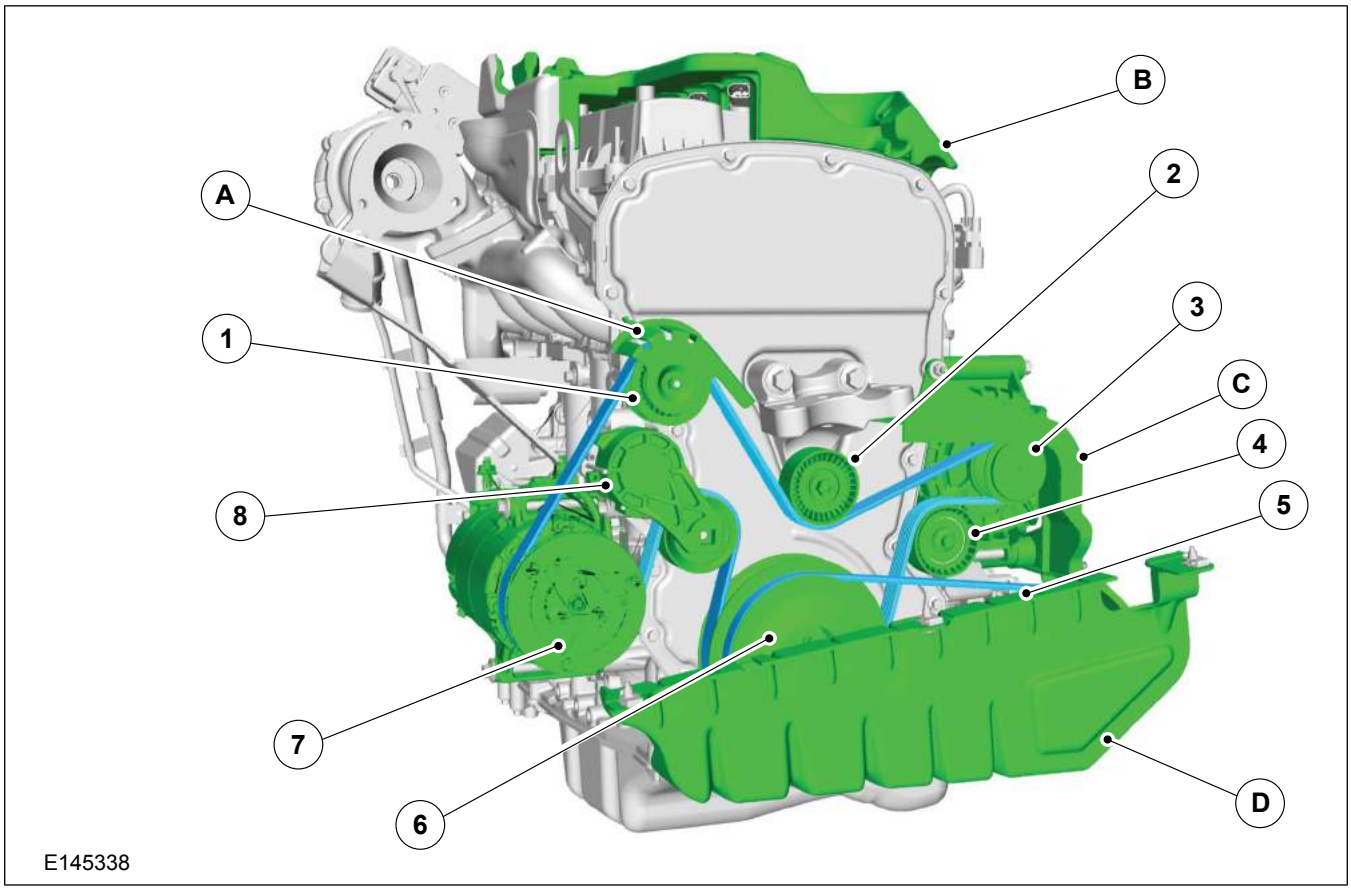
When the vehicle is not equipped with an air conditioning compressor, an additional accessory can be added in its place, and the longer standard option air conditioning belt can replace the standard belt if pulley size and position are the same as the standard option compressor. Then maximum power/torque that is available in that case at any engine speed is 10kW or 21.6Nm based on the Ford released variable air conditioning compressor.

For additional information please contact the Vehicle Converters Advisory Service, VCAS@ford.com

Abbreviations

- FWD = Front Wheel Drive

FWD 2.2L Diesel Engine - with Air Conditioning



Pulley, Belt Layout, Engine Top Cover and Protective Shields on FWD 2.2L Diesel Engine - With Air Conditioning

Item	Description
1	Idler
2	Idler
3	Alternator
4	Idler - Not with 150A Alternator
5	Power Steering Pump
6	Crankshaft Pulley
7	Compressor
8	Auto Tensioner
A	Front End Accessory Drive Shield - only Start-Stop
B	Engine Top Cover
C	Front End Accessory Drive Shield
D	Front End Accessory Drive Shield

3.4 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.

3.5 Manual Transmission

The following manual transmission is available for Diesel Engines.

Front Wheel Drive (FWD) vehicle

— VMT6 Transmission

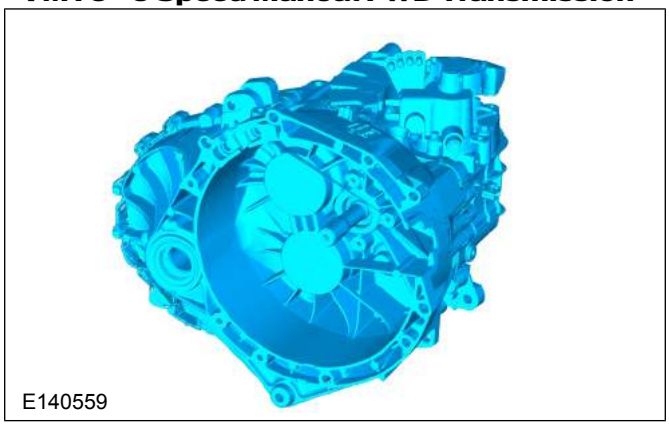
WARNING: Do not reroute external transmission gear shift cables.

NOTE: All VMT6 FWD transmissions are tachograph compatible.

VMT6 - 6 Speed Manual FWD Transmission

Gear	Base Transmission Ratio	Overall Transmission and Differential Drive Ratio		
		Vehicles less than or equal to 3000kg GVM		Vehicles greater than 3000kg GVM
		Standard	Eco	Standard
1st	3.727	15.608	14.676	17.571
2nd	1.864	7.804	7.338	8.786
3rd	1.121	4.695	4.415	5.286
4th	0.780	3.268	3.073	3.679
5th	0.844	2.570	2.416	2.784
6th	0.683	2.080	1.956	2.254
Reverse	1.423	16.154	15.189	17.504

VMT6 - 6 Speed Manual FWD Transmission



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3.6 Exhaust System

3.6.1 Extensions and Optional Exhausts

CAUTIONS:

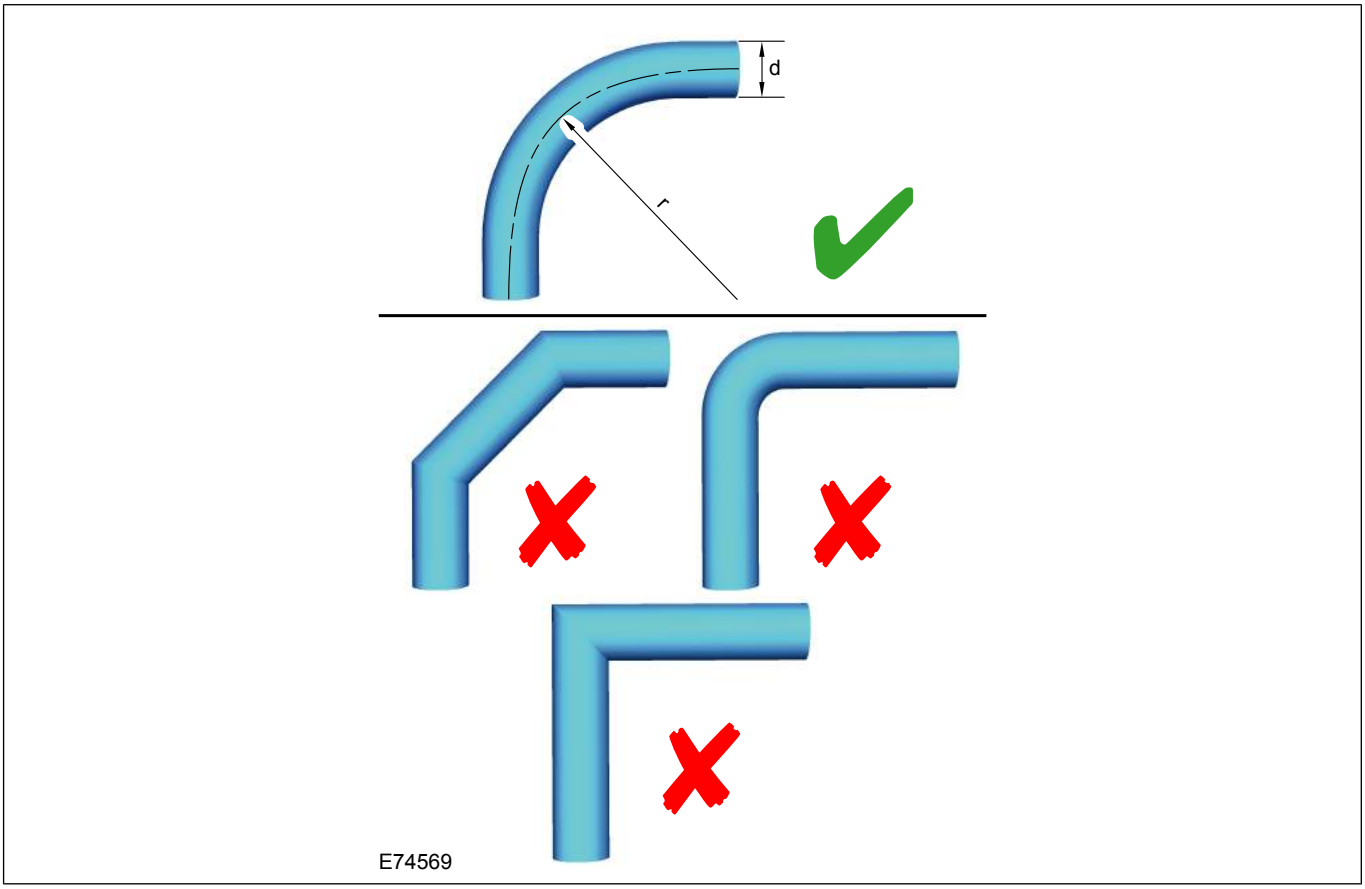
Non-standard systems must be tested for engine back pressure and all legal compliance (noise and emissions).

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



Item	Description
d	diameter
r	radius = 2.5d

3.6.2 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 and any part of the exhaust system.

3.6.3 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.

NOTE: For further information please contact your local 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

3.6.4 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.

3.6.5 Vehicle Exhaust Systems — Vans with 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.

3.7 Fuel System

WARNINGS:

Do not remove or relocate fuel cooler, where fitted, when modifying vehicle.

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 E145336.

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

To lower fuel tank:

- Drain tank.
- Remove filler pipe from tank.
- Remove bolts securing the three tank straps.
- Lower the fuel tank to gain access to the top, see Figure E145336 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 47.5Nm +/- 7.2Nm.
- Refit filler pipe to tank spud securing hose clip torque to 3.7Nm +/- 0.6Nm.

CAUTIONS:

Ensure modifications to vehicle do not obstruct airflow to fuel cooler, where fitted.

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.

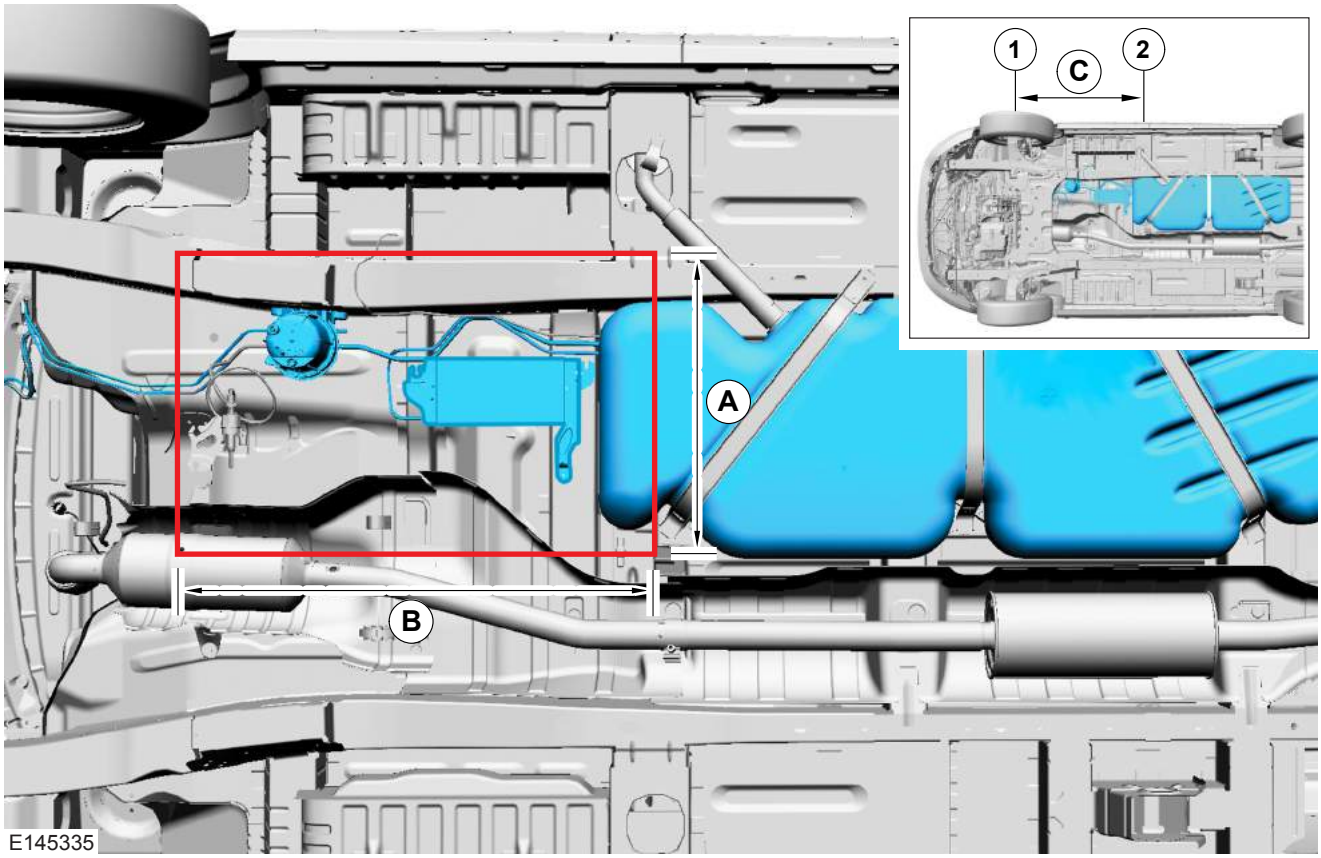
NOTE: The tube and/or line must be routed independently and secured to the body structure or to suitable brackets.

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.

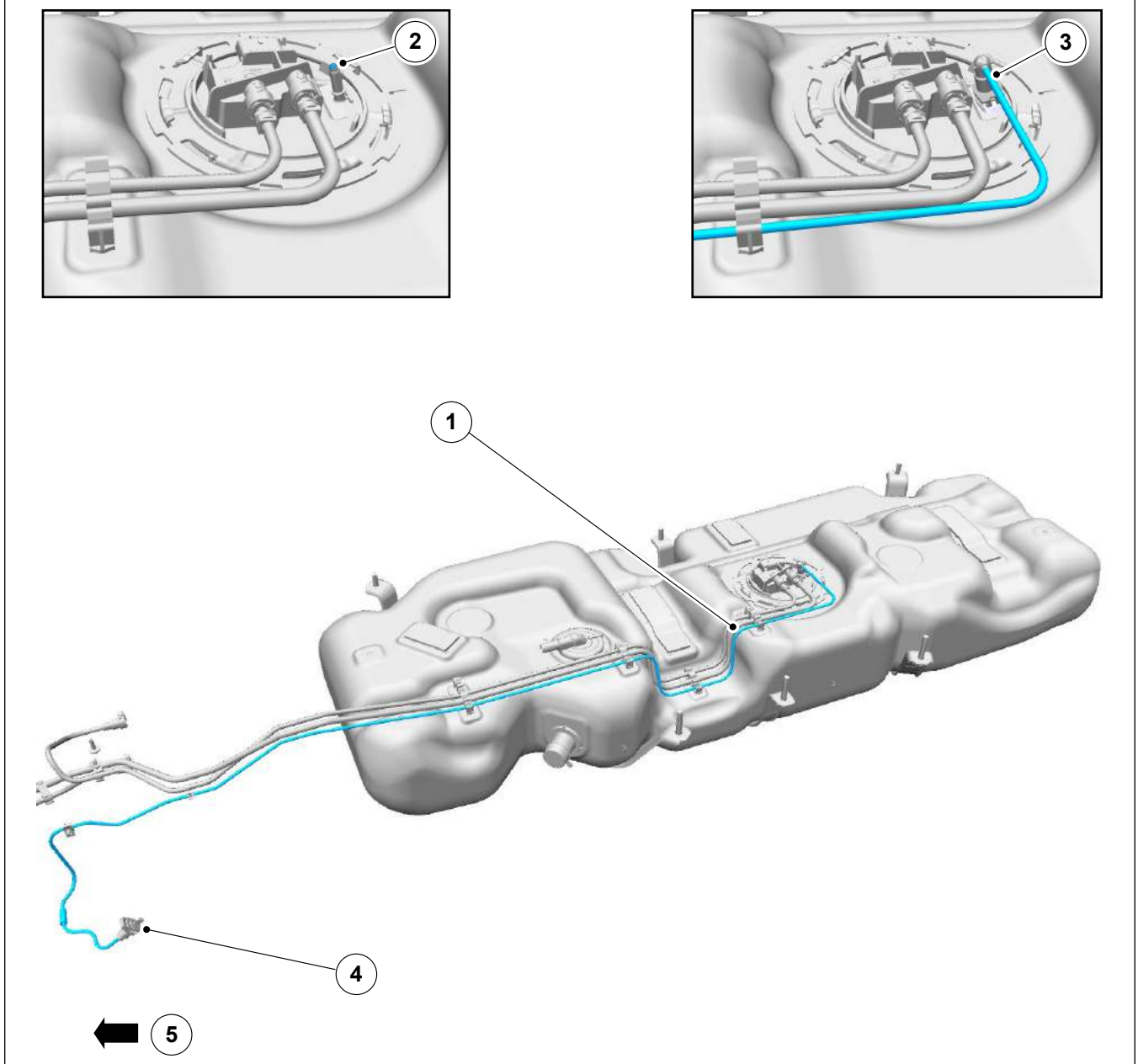
NOTE: To ensure the correct functionality of the fuel cooler, where fitted, sufficient clearances are required around the fuel cooler for air flow, see figure E145335.

Fuel Cooler Clearance Zone for Air Flow



1 = Center Line Front Wheel Axle, 2 = Center Line B Pillar, A = 580mm, B = 1000mm, C = 1207mm

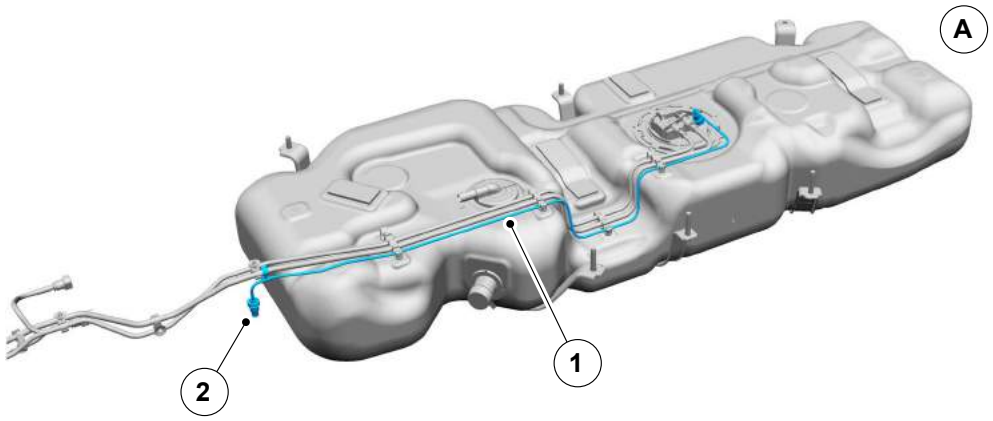
Auxiliary Fuel Line - For all vehicles except Campers



E145336

Item	Description
1	Auxiliary fuel line, part number BK21-9N126-A_
2	Cut off top of port of diesel delivery module flange leaving 19.64 +/- 0.12mm and carefully insert heater tube, part number BK21-9T308-A_
3	Fix quick fit connector of fuel line to heater tube, part number BK21-9N126-A_
4	Auxillary 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). For further information please contact VCAS@ford.com
5	Drive Direction

Auxiliary Fuel Line - For Camper Vehicles



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Item	Description
A	FWD Fuel Tank
1	Auxiliary fuel line, part number BK31-9N126-B
2	Auxillary 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). For further information please contact VCAS@ford.com
3	Drive Direction

4.1 Wiring Installation and Routing Guides

4.1.1 Wiring Harness Information

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 – 40ºC to 85 ºC for exposure and – 40ºC to 75ºC for function. For engine compartment and underbody, the minimum temperature is - 40ºC, while the maximum exposure and operational temperatures are +125ºC for exposure and 105ºC 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 can not 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.

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 local National Sales Company representative, or local Ford Dealer.

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 93).
- Do not place electrical component attachments or ground nuts adjacent to vehicle fuel tanks or fuel lines.

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

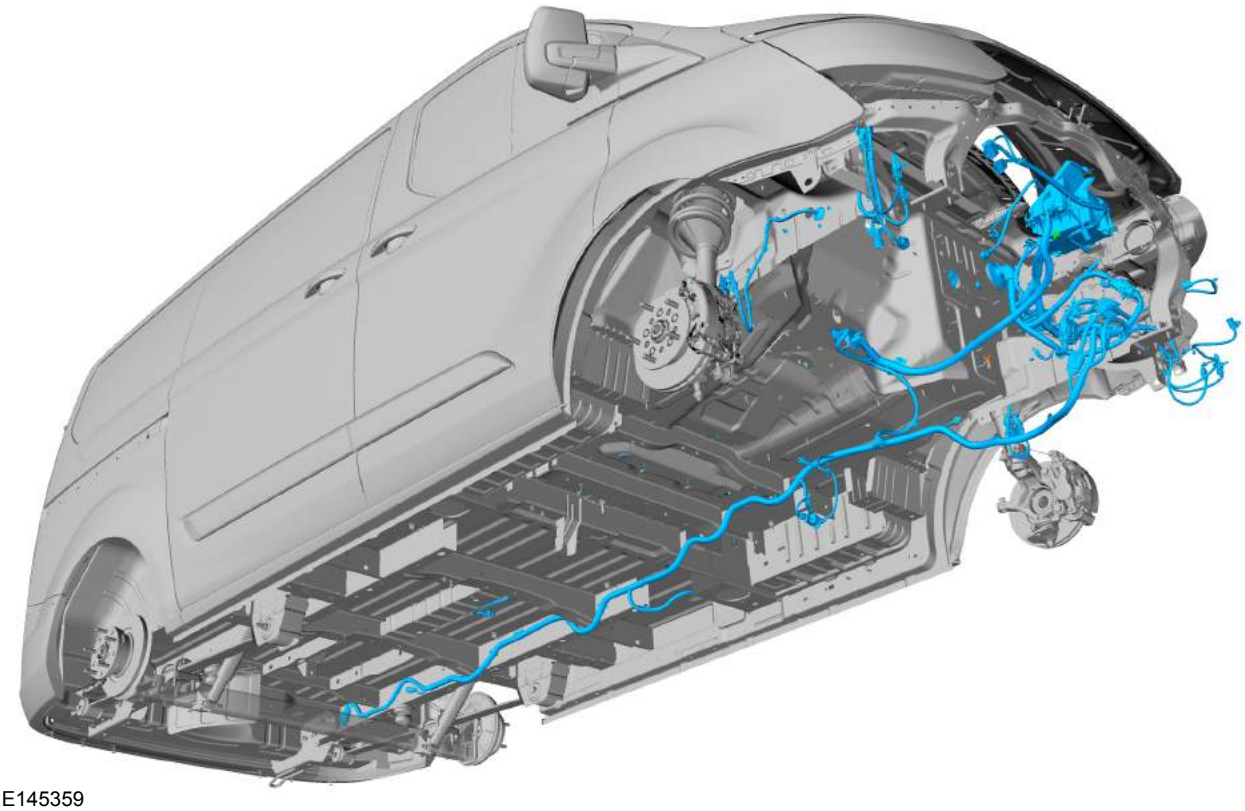
Current Rating of Wire Sizes

		Maximum Continuous current (A)	
Cross Sectional Area	**mW/m@20°C**	**30°C**	**50°C**
0.35	54.4	7	4.9
0.5	37.1	11	7.7
0.75	24.7	14	9.8
1	18.5	19	13.5
1.5	12.7	24	17.0
2.5	7.6	32	22.7
4	4.71	42	29.8
6	3.14	54	38.3
10	1.82	73	51.8
16	1.16	98	69.6
25	0.743	129	91.6
35	0.527	158	112
50	0.368	198	140
70	0.259	245	174
95	0.196	292	207
120	0.153	344	244

NOTE: The maximum continuous current (A) values for 30°c and 50°c is a value below the maximum fuse rating allowed for the cable. This is because the fuse/cable system values at these temperatures are the continuous usage where as the maximum fuse also needs to protect for high current short term loadings such as electric motors.

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



E145359

Electromagnetic Compatibility (EMC) Awareness

The installation and routing of Ford wiring, (example of wiring shown in figure E145359), 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.

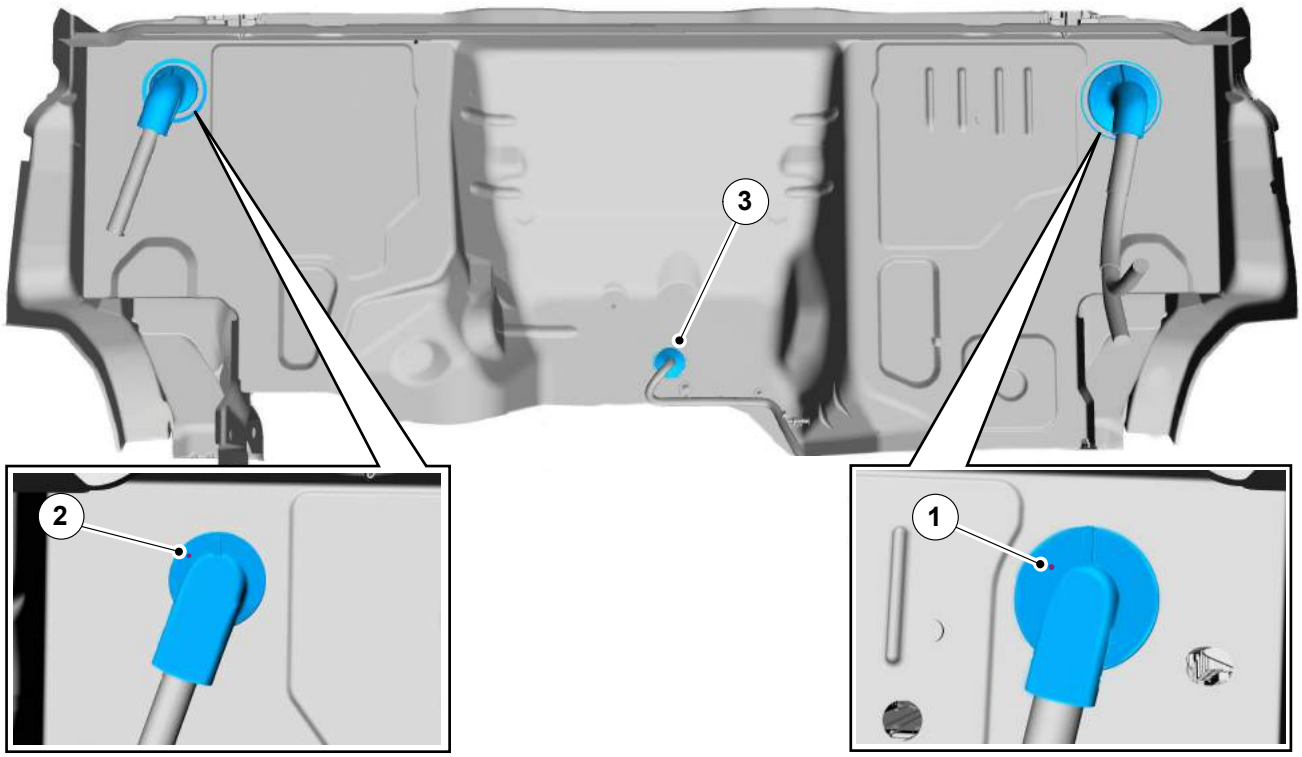
Wiring must be suitably fixed without any detrimental effect on other wiring.

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)



E145360

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 engine bay) 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 moulded 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' moulded 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 No Drill Zones — Rear Cargo Area

The areas marked in blue on figures E145339 - E145344 and E166796 - E166798 show the 'NO 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.

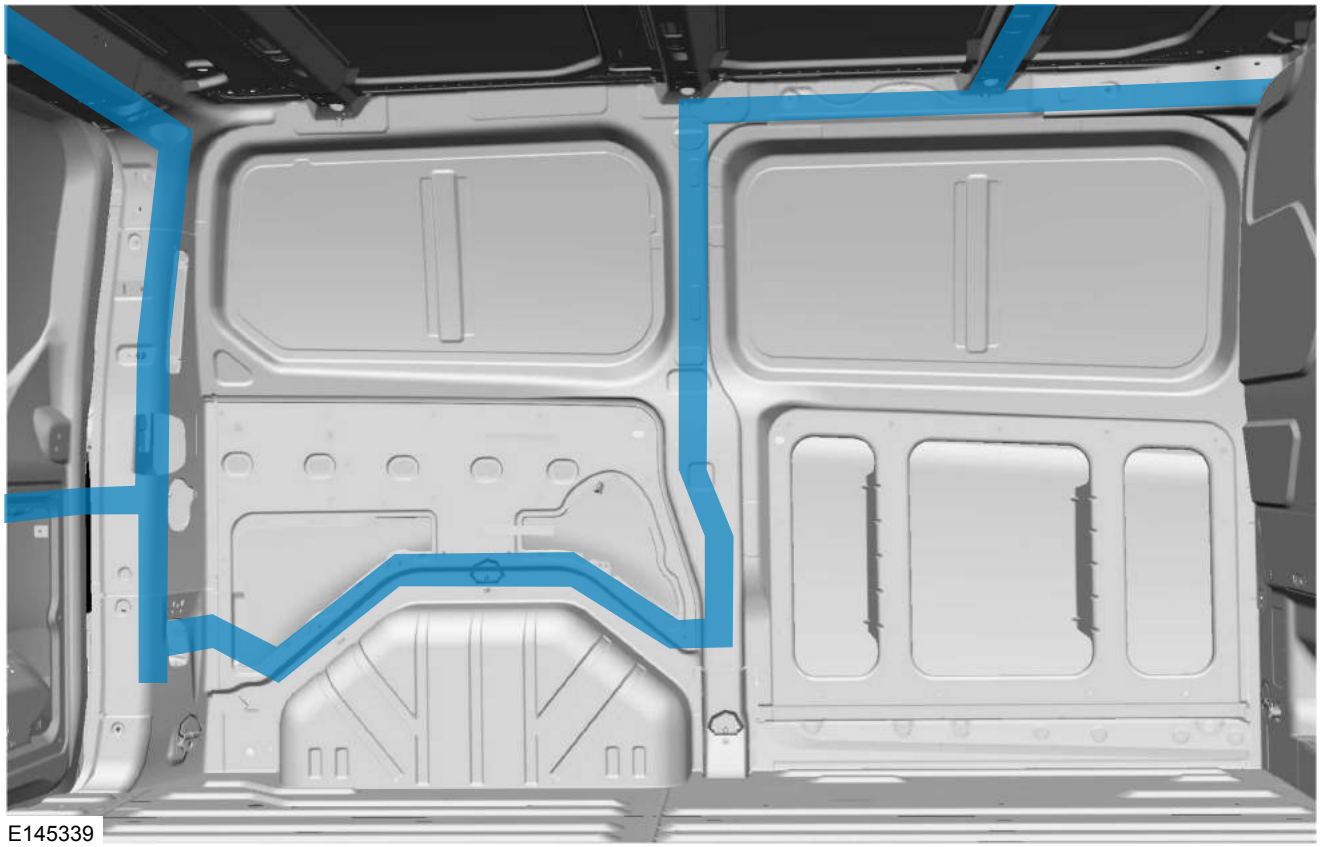
CAUTION: Do not drill into the vehicle before checking 'No Drill' zones and electrical wire routing.

Refer to: 5.1 Body (page 174).
No Drill Zones -Under the Floor Tank
Refer to: 5.4 (page 186).
Load Compartment Tie Downs
Refer to: 5.3 Racking Systems (page 182).
Refer to: 5.6 Body Closures (page 190).
No Drill Zones - Closures

For Wheel Base and Roof Height dimensions

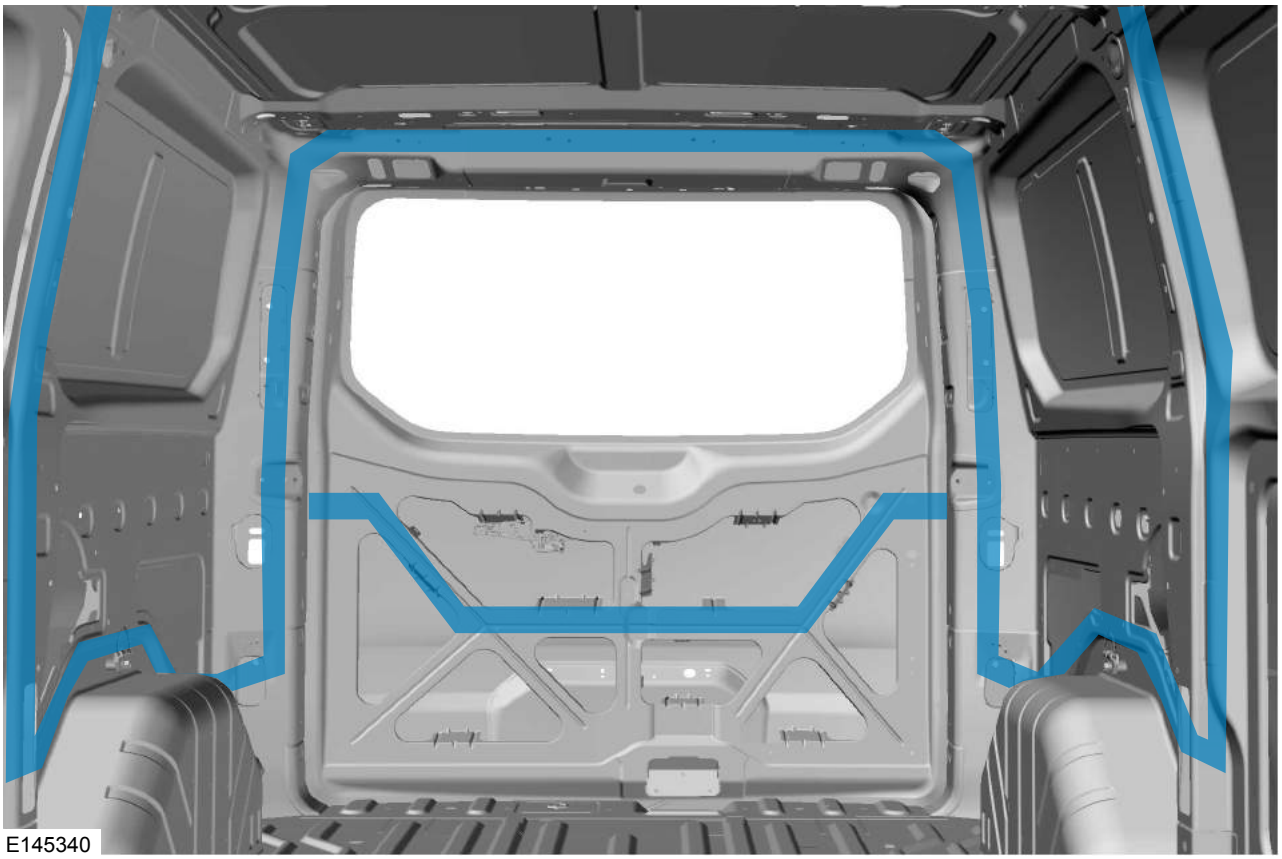
Refer to: 1.1 About This Manual (page 6).

No Drill Zones L1/H1 with Lift Gate (Right Hand Side)

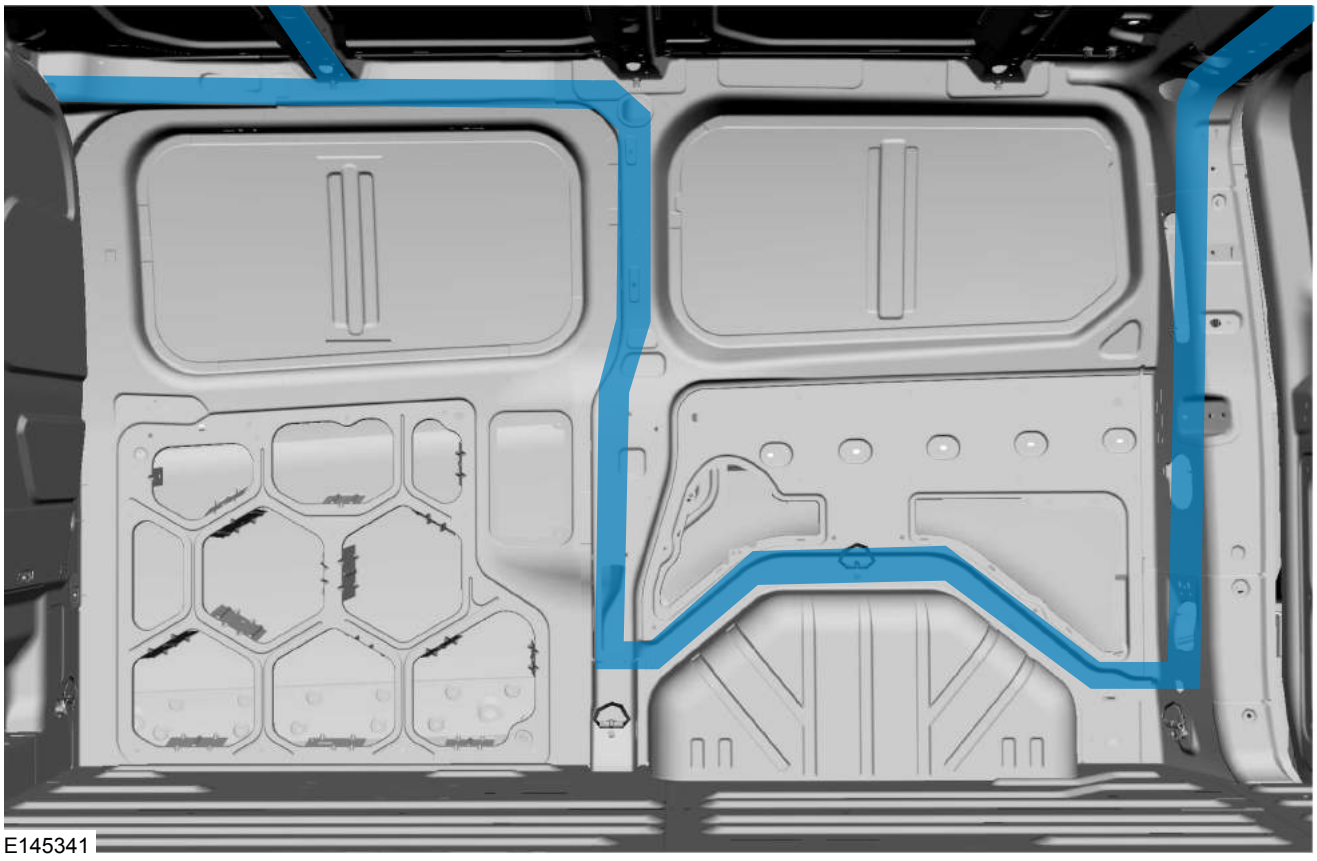


E145339

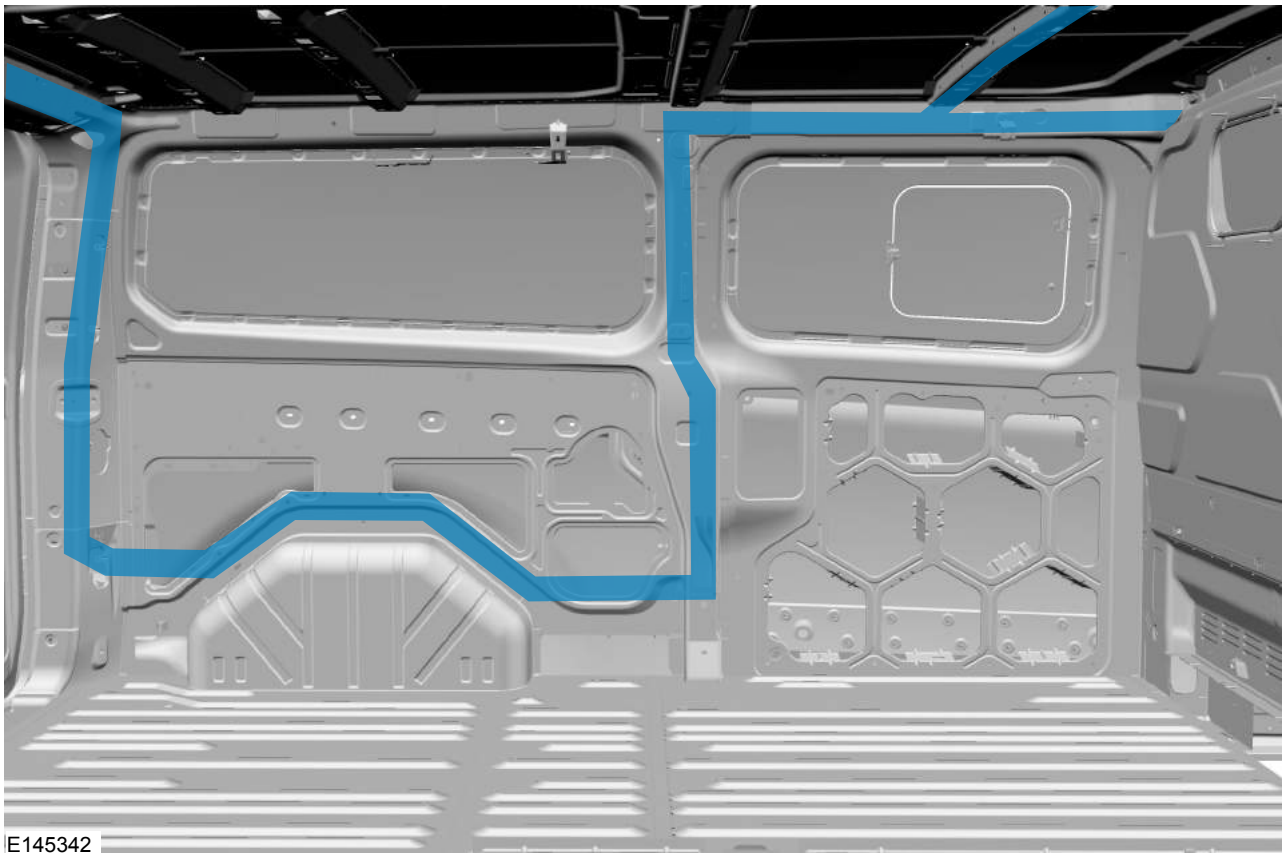
No Drill Zones L1/H1 with Lift Gate


E145340

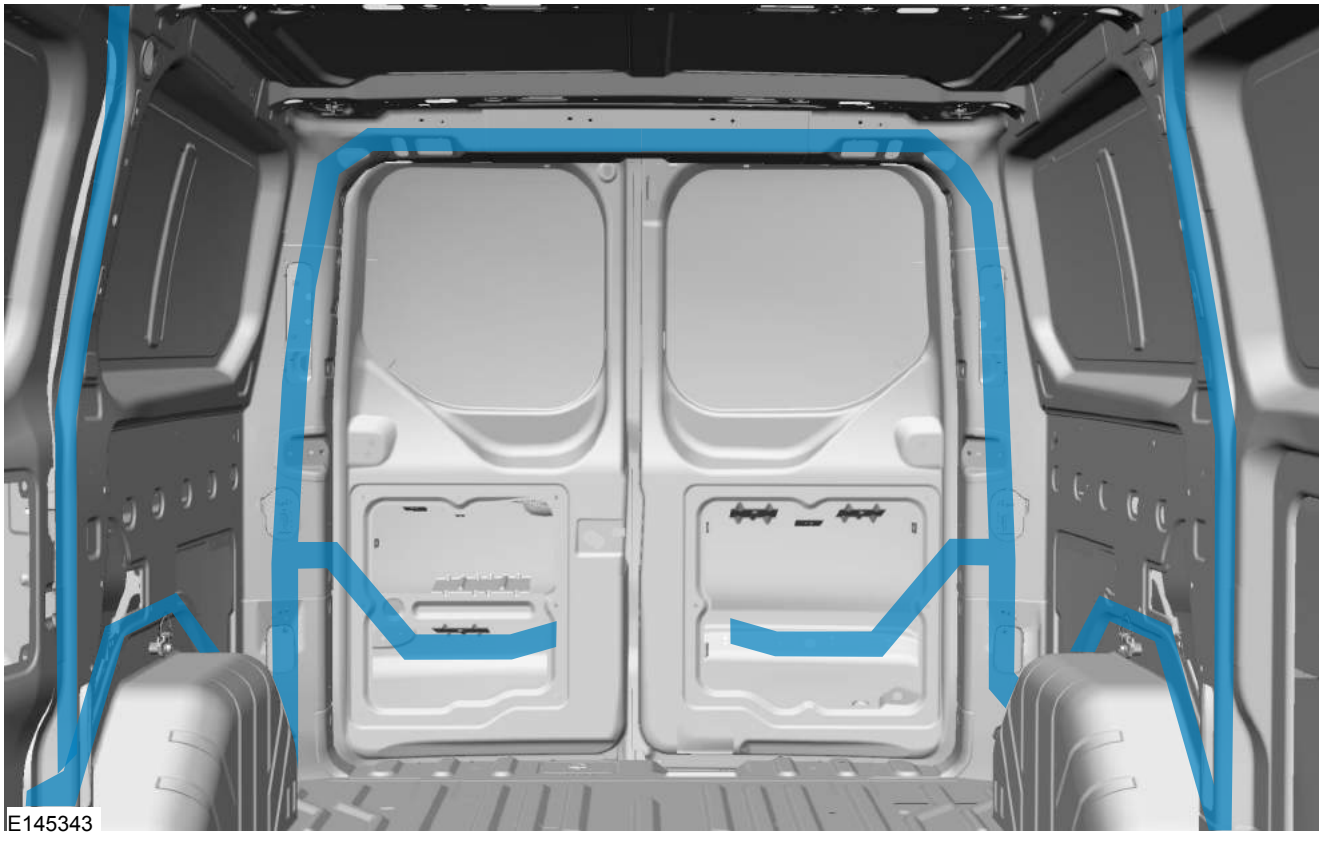
No Drill Zones L1/H1 with Lift Gate (Left Hand Side)


E145341

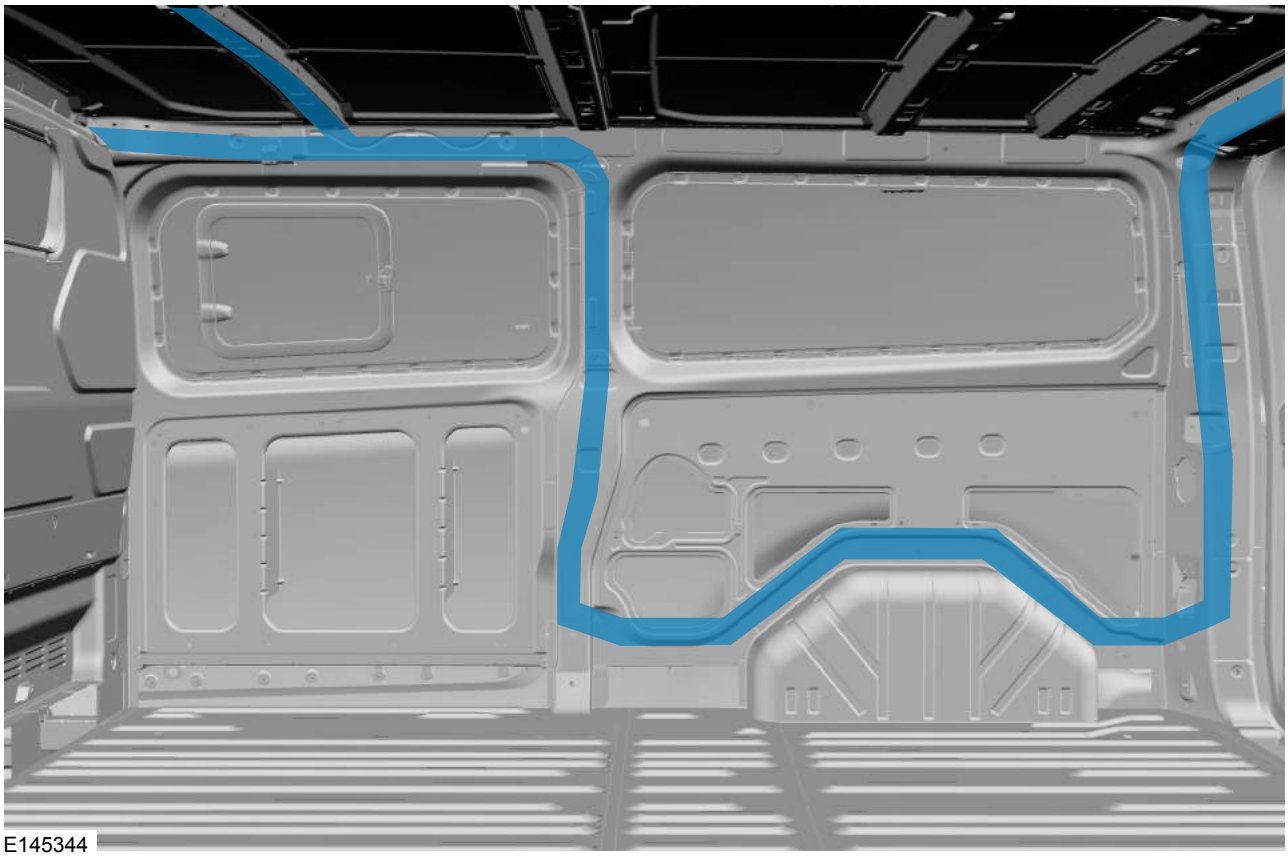
No Drill Zones L2/H1 with Rear Cargo Doors (Right Hand Side)



No Drill Zones L2/H1 with Rear Cargo Doors

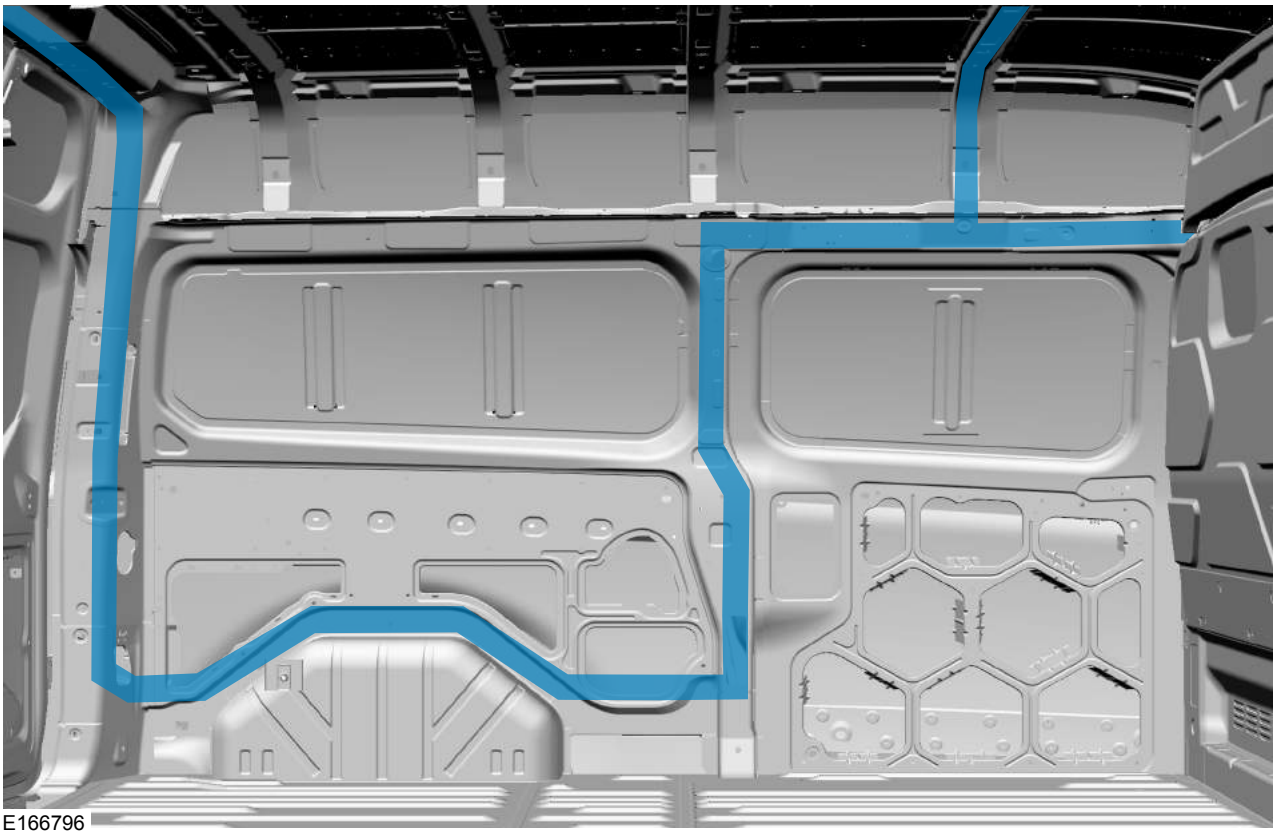


No Drill Zones L2/H1 with Rear Cargo Doors (Left Hand Side)



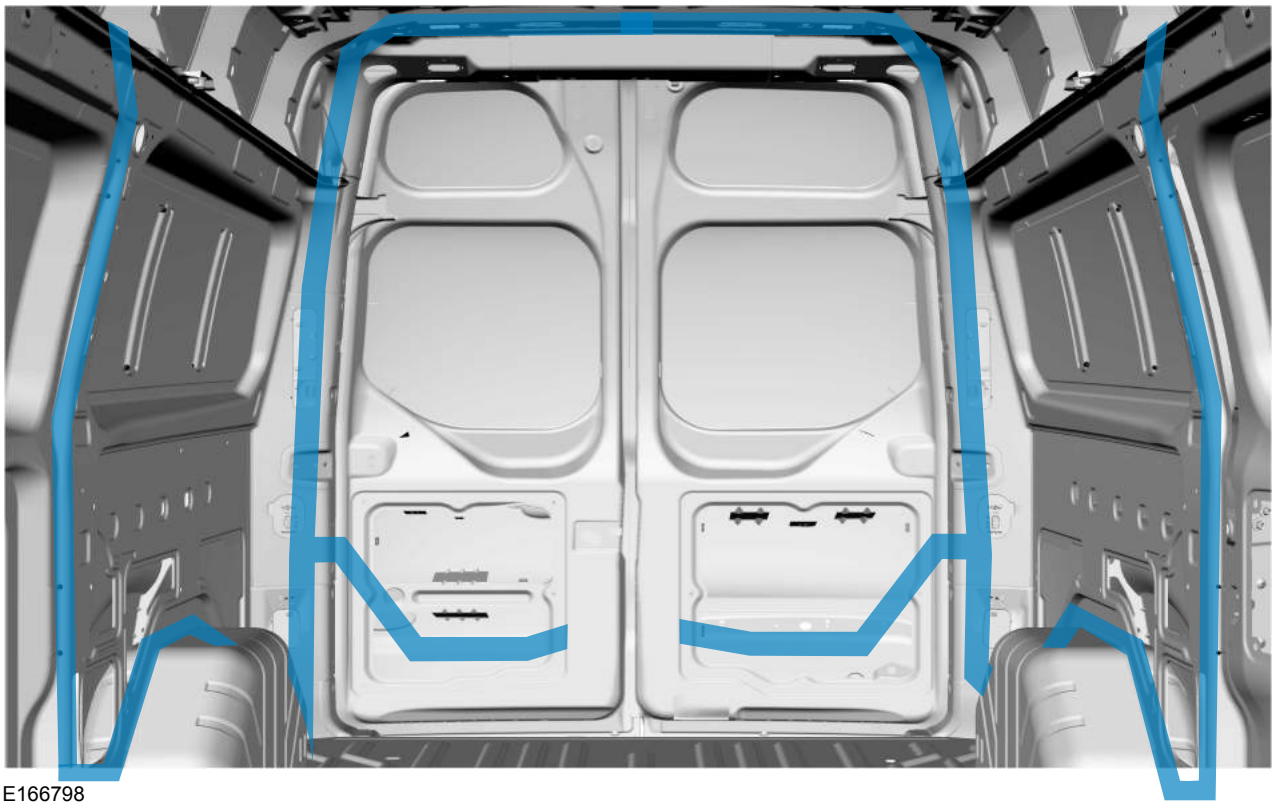
E145344

No Drill Zones L2/H2 with Rear Cargo Doors (Right Hand Side)



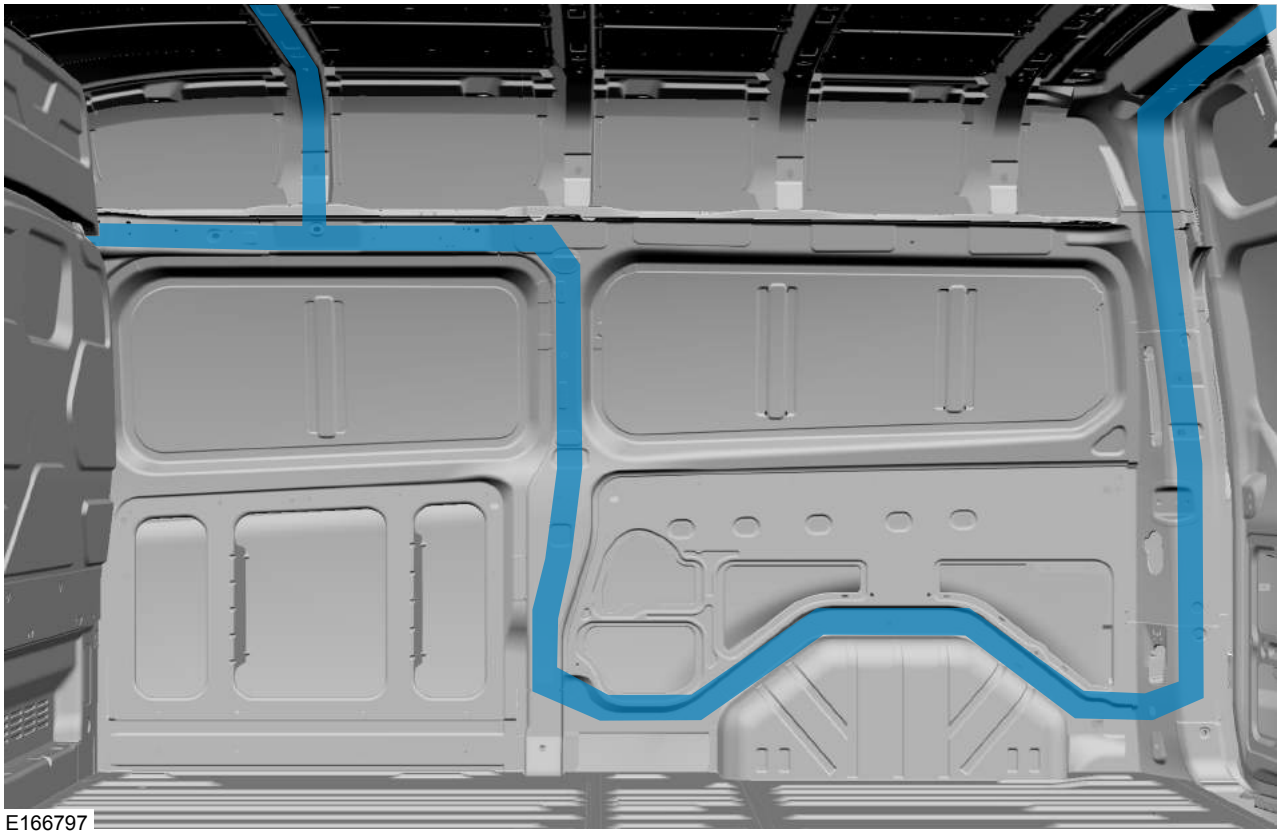
E166796

No Drill Zones L2/H2 — Rear Cargo Doors



E166798

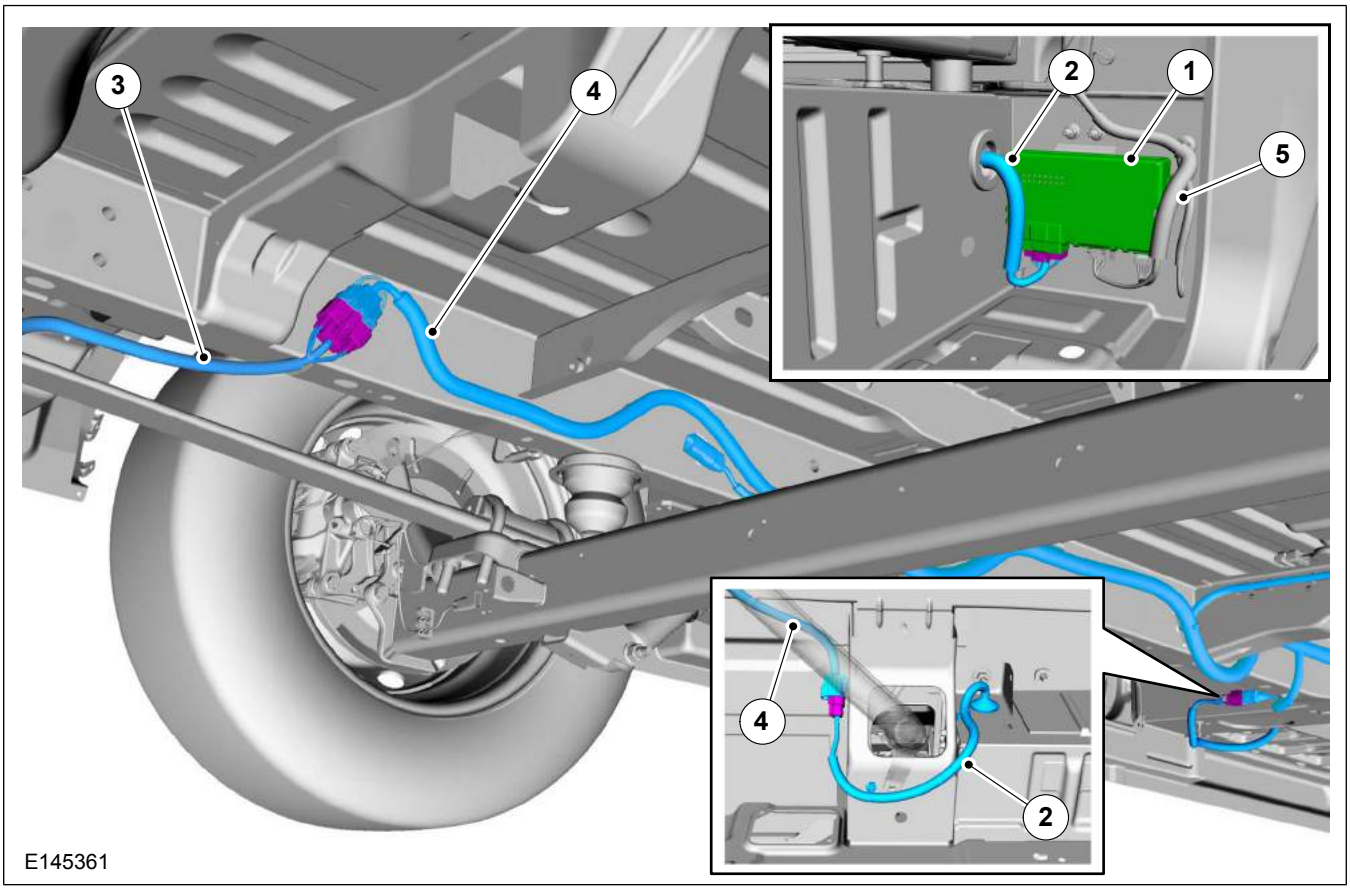
No Drill Zones L2 /H2 with Rear Cargo Doors (Left Hand Side)



E166797

4.1.13 Electrics for Tow Bar

Trailer Tow Module and Harnesses



Item	Description	Part Number
1	Trailer Tow Module	BK2T-19H378-A_
2	Trailer Tow Jumper (with Trailer Tow Module connector 'A' see figure E151247)	BK2T-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	BK2T-14406-**
5	Main Harness (with Trailer Tow Module connectors 'B' and 'C' see figure E151247)	BK2T-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.

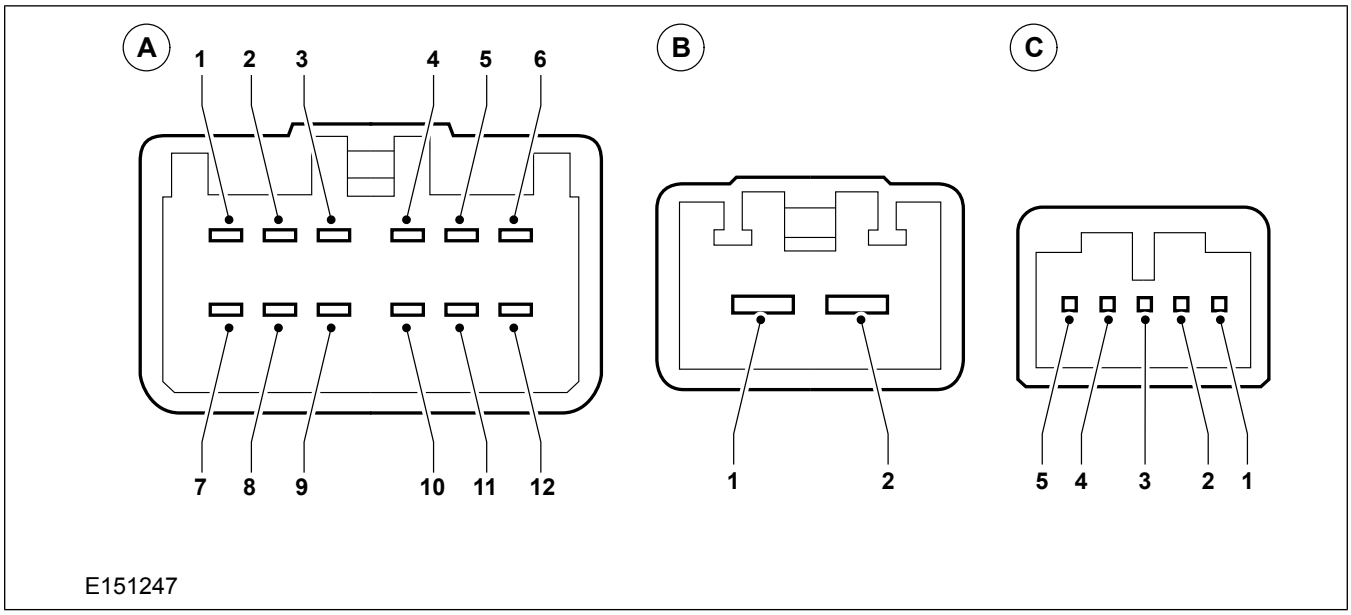
The Trailer Tow Module (TTM) can support pure LED trailer lamps as long as each circuit exceeds 500mA, below this and the system will not detect a trailer has been connected and shuts down all outputs (sleep mode). It is recommended to target a 550mA mimimum load to allow for system tolerances. This would need to be obtained with a supplemental load resistor, if the LED lighting circuits are below this threshold.

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 E151247 and E145361)

	Feature	Current (A)		Voltage (V)	
Component Terminal Number	**Circuit Number**	**Min**	**Max**	**Min**	**Max**
Connector A					
1	Right Direction Indicator	0.5	3	6	-
2	Battery Charge Out	-	10	9	16
3	Stop Left	0.5	4	6	-
4	Not used	-	-	-	-
5	Not used	-	-	-	-
6	Reverse Lamp	0.5	4	6	-
7	Stop Right	0.5	4	6	-
8	Fog Lamp	0.5	2	6	-
9	Not used	-	-	-	-
10	Left Direction Indicator	0.5	3	6	-
11	Not usedPin	-	-	-	-
12	Position Lamp	0.5	7	6	-
Connector B					
1	Not used	-	-	-	-
2	Term 30 (Ubat)	-	30	6	16
Connector C					
1	CAN H	-	0.1	6	-
2	CAN L	-	0.1	6	-
3	Brake Line In (Vehicle -)	-	0.1	6	-
4	Ground	-	1	6	-
5	Trailer Detect Output	-	0.1	-	16

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 **stand by 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.

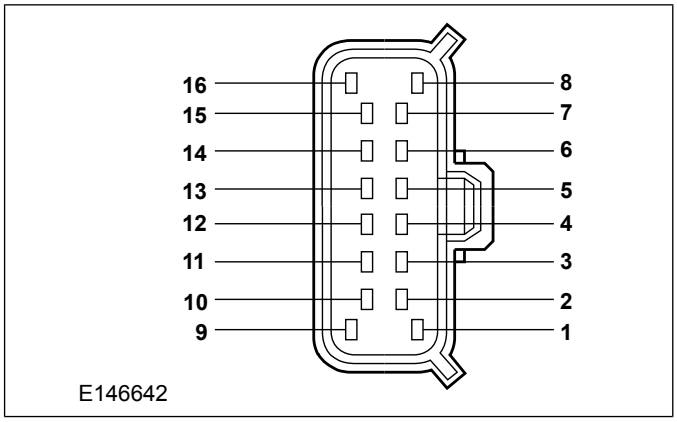
The trailer detection uses a strategy of having a 1K ohm resistor if the lights are not actually switched on to detect that the trailer has been connected. If a trailer light is already switched on the related current will be checked.

4.1.14 Trailer Tow Connectivity

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.

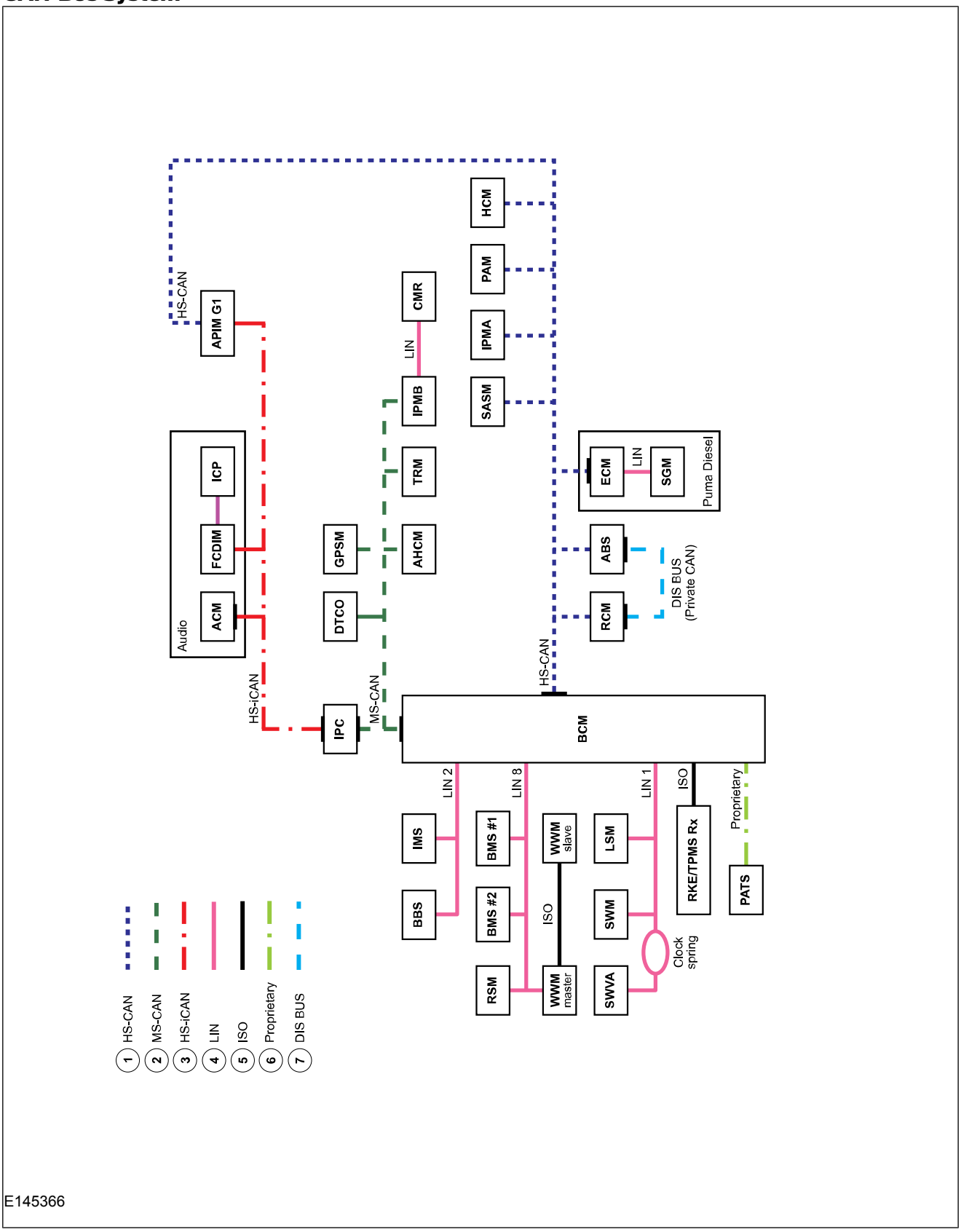
4.2 Communications Network

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



E145366

Communication Network System (Figure E145366 references)

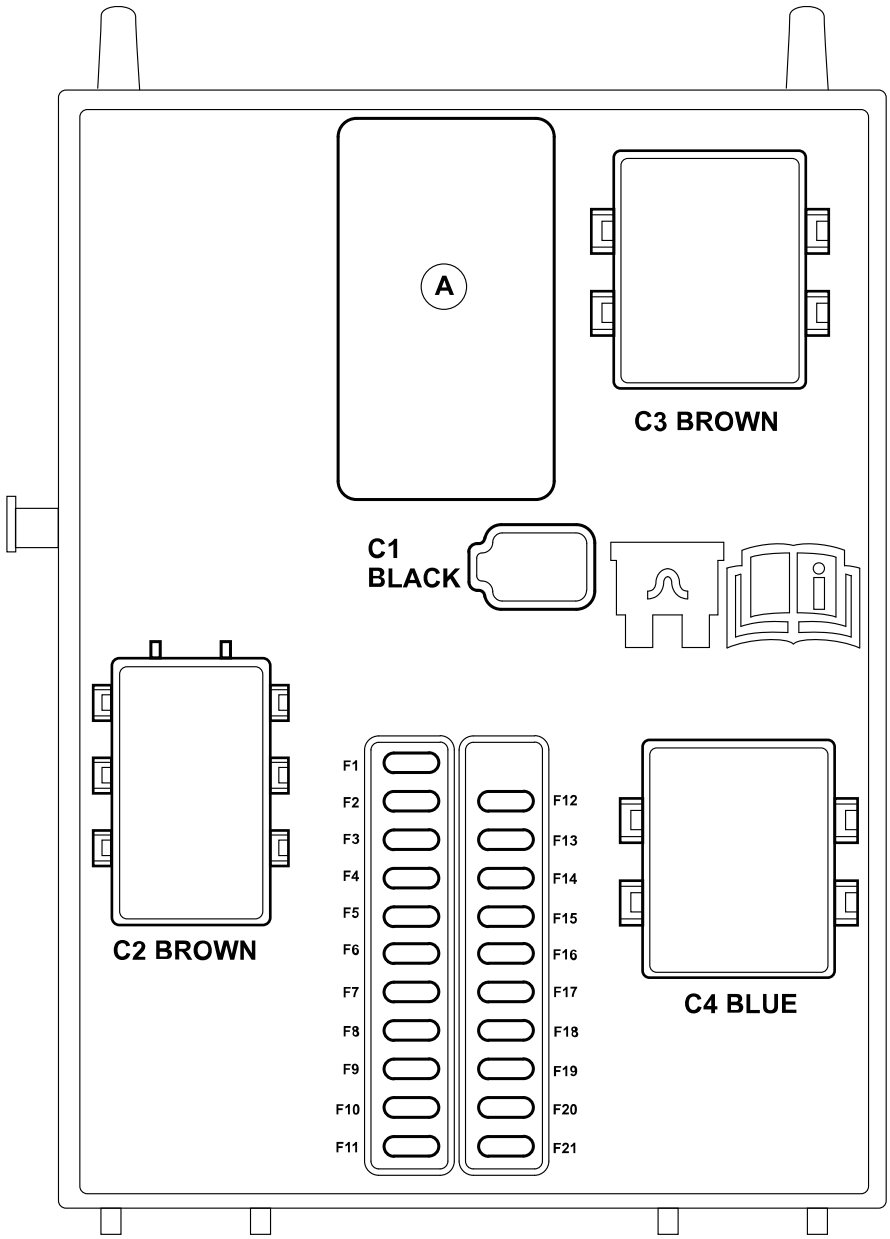
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	High Speed CAN -500kb/s	BCM	Body Control Module
2	Medium Speed CAN -125kb/s	BBS	Battery Backed-up Sounder
3	High Speed iCAN - 500kb/s	IMS	Interior Motion Sensor
4	Local Interconnect Connector (LIN)	BMS#1	Battery Monitoring Sensor (Start Battery)
5	International Standards Organization (ISO)	BMS#2	Battery Monitoring Sensor (Auxiliary Battery)
6	Proprietary	RSM	Rain Sensing Module
7	DIS BUS (Private CAN)	WWM master	Windscreen Wiper Motor (driver side wiper)
ACM	Audio Control Module - Radio/CD	WWM slave	Windscreen Wiper Motor (passenger side wiper)
FCDIM	Front Control/Display Interface Module (MFD 2,3,5)*	SWVA	IPMA Steering Wheel Haptic Device (Lane Departure Warning)
ICP	Integrated Control Panel	SWM	Steering Wheel Module
APIM G1	Sync Gen1	LSM	Light Switch Module
IPC	Instrument Panel Cluster	RKE/ TPMS Rx	Remote Keyless Entry/Tire Pressure Monitoring System Receiver
DTCO	Tachograph	PATS	Passive Anti-Theft System
GPSM	Global Positioning System Monitor	SASM	Steering Angle Sensor Module
AHCM	Auxiliary Heater Control Module	IPMA	Image processing Module A (Lane Departure Camera)
TRM	Trailer Module (Trailer Tow)	PAM	Parking Aid Module
IPMB	Image processing Module B (Rear View Camera System)	HCM	Headlamp Control Module
CMR	Camera Module Rear	RCM	Restraints Control Module
ECM	Engine Control Module	ABS	Anti-Lock Brake System Control Module
SGM	Starter/Generator Control Module (Alternator)		

*Either low, medium or navigation

kb/s - Kilo bytes per second

4.2.2 Body Control Module (BCM)

BCM - as viewed in-car position



E145367

Item	Description
A	Label 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 Functionality

Functionality	
Low Series - BK2T-14B476-A*	
Dipped Beam	Dual Battery Relay Control
Main Beam	High Speed and Medium Speed CAN Gateway
Position Lamps	Engine Run Signal
Licence Plate	Fuel Pump Control
Brake Lamps	Front Wash Wipe
Rear Fog Lamps	Climate Control Fan Relay Control
Daytime Running Lamps	Switch Back light Illumination (dimming with headlamp switch fitted)
Direction Indicators and Hazard Lamps	Vehicle Horn
Courtesy Lamps	Base Remote Locking
Battery Saver Timer	Brake Pad Wear Indication
Tire Pressure Monitoring System	-
Mid Series - BK2T-14B476-B* (incremental over Low)	
Perimeter Alarm	Power Fold mirrors
Auto Wipe	Rear Screen Wash Wipe
Auto Lamp	Auxiliary Heater (PTC)
Heated Front Screen	Front Fog Lamps
Heated Rear Screen	Configurable Locking (set at time of order)
Heated Mirrors	Park Aid Module Power Supply
Washer Fluid Level Sensor	-
High Series - BK2T-14B476-C* (incremental over Mid)	
Category 1 Alarm (CAT1) includes:	
Interior Motion Sensor (IMS)	
Battery Backed Sounder with Inclination Sensor (BBS)	

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	High Side Driver	Bulb	2x55W	Blown Fuse — if bigger fuse fitted, relay and/or Printed Circuit Board damage
Day Time Running Lamps (if enabled)	High Side Pulse Width Modulation	Bulb	30W	Output Shutdown
Position Lamps Left	High Side Pulse Width Modulation	Bulb	23W	Output Shutdown
Positions Lamps Right	High Side Pulse Width Modulation	Bulb	23W	Output Shutdown
Front Fog Lamps	Internal Relay	Bulb	2x55W	Blown Fuse — if bigger fuse fitted, relay and/or Printed Circuit Board damage
Turn Indicators Left	High Side Driver	Bulb	63W	Output Shutdown
Turn Indicators Right	High Side Driver	Bulb	63W	Output Shutdown
License Plate Lamps	High Side Pulse Width Modulation	Bulb	46W	Output Shutdown
Reverse Lamps	High Side Driver	Bulb	42W	Output Shutdown
Rear Fog Lamp	High Side Pulse Width Modulation	Bulb	42W	Output Shutdown
Stop Lamp Left	High Side Pulse Width Modulation	Bulb	21W	Output Shutdown
Stop Lamp Right	High Side Pulse Width Modulation	Bulb	21W	Output Shutdown
Center High Mount Stop Lamp	High Side Pulse Width Modulation	Bulb	32W	Output Shutdown
Switch Illumination	High Side Pulse Width Modulation	Bulb	3A@13.5V	Output Shutdown
Battery Saver Supply	High Side Driver	Bulb	105W	Output Shutdown
Front Cabin Lamps	Low Side Pulse Width Modulation	Bulb	75W	Output Shutdown
Rear Cargo Lamps	Low Side Pulse Width Modulation	Bulb	90W	Output Shutdown
Alarm Siren	High Side Driver	Electro Mechanical Horn	4A normal, 8A 10msec in-rush	Output Shutdown
Twin Battery Disconnect Relay	Low Side Driver	Relay	3.5A/50msec	Output Shutdown
Engine Run Status Relay	Low side Relay Driver	Relay	250mA	Output Shutdown
Power Fold Mirrors Unfold	High Side Driver	Mirror Motor	8A	Blown Fuse — if bigger fuse fitted, relay and/or Printed Circuit Board damage
Power Fold Mirrors Fold	High Side Driver	Mirror Motor	8A	Blown Fuse — if bigger fuse fitted, relay and/or Printed Circuit Board damage
Lock/Double Lock	High Side Driver	Latch Motor	15A (fuse limited)	Blown Fuse — if bigger fuse fitted, relay and/or Printed Circuit Board damage
Unlock Relay	High Side Driver	Latch Motor	5A	Blown Fuse — if bigger fuse fitted, relay and/or Printed Circuit Board damage

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

BCM Fuse Overview

Fuse	Series	Rating	Function
F1	Low/Mid/High	15A	Central/Configuration Locking 2
F2	Low/Mid/High	15A	Central/Configuration Locking 1
F3	Low/Mid/High	15A	Ignition Switch Supply
F4	Mid/High	5A	Parking Aid Module Source
F5	Mid/High	5A	Rain Sensor Supply
F6	Low/Mid/High	15A	Water Pump Supply
F7	Mid/High	7.5A	Mirror Supply
F8	Mid/High	15A	Fog Lamps Front Supply
F9	Low/Mid/High	10A	Main Beam Right Supply
F10	Low/Mid/High	10A	Main Beam Left Supply
F11	Low/Mid/High	25A	Exterior Lamp Right / position Lamp Left
F12	Mid/High	20A	BBS Supply, Security Horn
F13	Low/Mid/High	15A	On Board Diagnostic II Supply, Battery Saver Supply
F14	Low/Mid/High	25A	Turn Indicator Supply, Daytime Running Lamps, Fog lamp Rear Supply
F15	Low/Mid/High	25A	Exterior Lamp Left / position Lamp Right / Central High Mounted Stop Lamp
F16	Low/Mid/High	20A	Radio/CD Navigation Supply
F17	Low/Mid/High	7.5A	Hybrid Electronic Cluster Supply
F18	Low/Mid/High	10A	Light Switch Module, Steering Wheel Module Supply, Stop Lamp Switch Supply
F19	Low/Mid/High	5A	Instrument Control Panel, Multi Function Display Supply
F20	Low/Mid/High	5A	Ignition Passive Anti-Theft Supply
F21	Low/Mid/High	3A	Radio, Hybrid Electronic Cluster, Navigation KL75 Supply

4.3.1 General Information and Specific Warnings

The Transit electrical system is a 12-Volt supply with a negative ground return. The alternator and battery equipment used as standard are designed for normal operations with the type of engine fitted. 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.

The battery capacity, technology and charge available from the alternator must be adequate to ensure engine cranking in unfavorable climatic conditions.

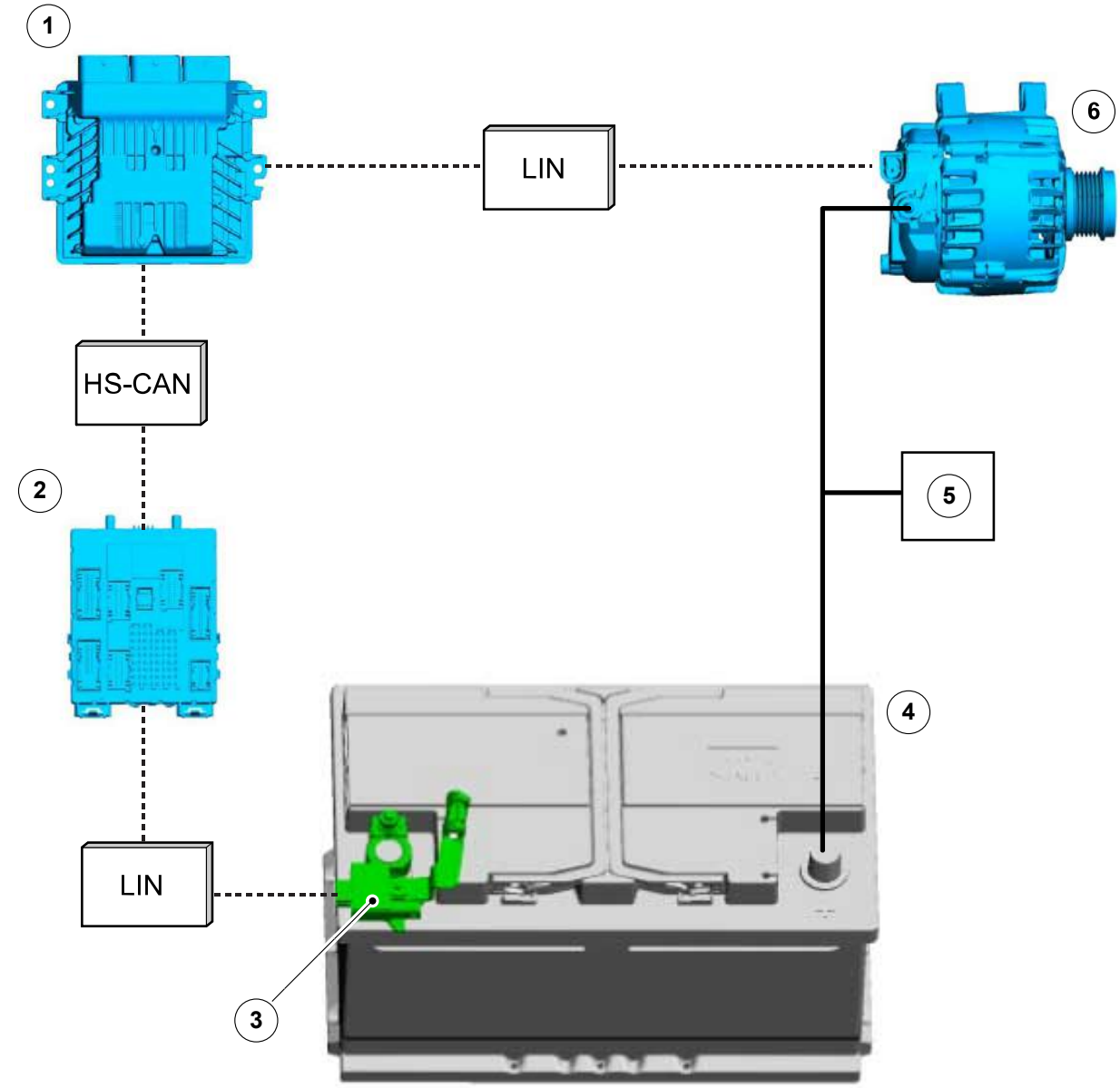
The Transit utilizes multiplexed vehicle electronics, it is recommended that the appropriate Ford proprietary accessory systems are used. Inappropriate or incorrect connection of additional equipment could cause mis operation, or damage to the vehicle, and so invalidate any warranty.

Additional connection points are provided specifically for customer use, and are located on the outside of the driver's seat pedestal. A 60 Amp fused connection is provided as standard.

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 — For Start-Stop application there will be two batteries
5	Electrical consumers
6	Alternator

System Operation - Smart Regenerative Charging (SRC) Except Camper

The largest element of the SRC strategy is stored in the Body Control Module (BCM). It receives all of the important information relating to the battery condition sent by the Battery Monitoring Sensor (BMS) via the Local Interconnect Network (LIN) data bus.

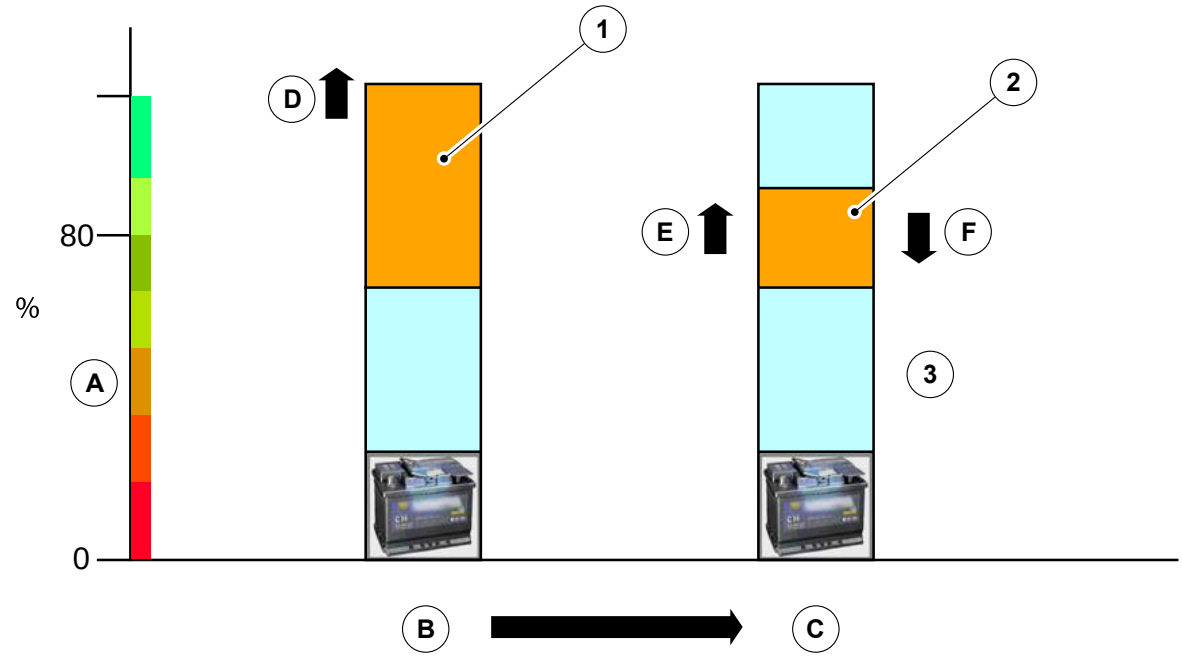
Using the information received, the BCM then sends the set value needed for the alternator charging voltage via the HS CAN (Controller Area Network) data bus to the PCM/ECM. This then adjusts the value received if necessary and passes it on the alternator via the LIN. The charging voltage is adjusted depending on various parameters, such as the current level of engine efficiency. The smallest possible set value for the alternator voltage (V) is 12.2V, while the maximum charging voltage may be anywhere between 14.5V and 14.9V. However, when the battery is in a refresh phase, the voltage could occasionally reach up to 15.2V. These refresh phases are required as the battery charge status is 80% over long periods of time.

Refer to: 4.4 Battery and Cables (page 93).

Comparison of SRC and Conventional Charging

The following figure E140419 demonstrates the difference between SRC and conventional battery charging. Conventional charging aims to charge the battery to the highest possible levels. During this process the battery temperature is monitored (inferred temperature) and the battery must not be overcharged. By comparison SRC uses the information from the battery monitoring sensor (voltage, current and direct temperature) to maintain, more accurately, the battery at a calibrated state of charge. This means that the battery has a certain amount of extra charging capacity at all times. If the BCM detects that the charge status is above the calibrated value the alternator charging voltage is reduced, in order to discharge the battery. If the opposite occurs and too low a value is detected, the charging value is increased in order to return the battery to the calibrated value.

Smart Regenerative charging and Conventional Charging



E140419

Item	Description
A	State of Charge — SOC
B	Conventional Charging
C	Regenerative Charging
D	Charging continuously
E	Charging during deceleration
F	Discharge during normal driving
1	High SOC control target
2	Partial SOC control
3	Charging continuously

4.3.3 Start-Stop Override and Configurable Charging

There are two control methods to switch the power supply system to Conventional Charging. This maybe required for converters requiring battery voltage that is being charged by the alternator in the range of 14.0 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.

1. ECO Switch - Manual Operation

The ECO functions are OFF when the ECO switch is pressed and the LED is ON (Conventional Charging). It can be reactivated if the ECO switch is pressed again or the ignition key is set to Accessory or OFF (Normal Charging) see Summary of the Available Charging Modes table.

Summary of the Available Charging Modes

Charge Mode		Approximate Charging Voltages (Measured at Jump Start post)
SRC	Smart Regenerative Charging - normal charge mode.	Minimum 12.8 - Maximum 14.9
CC	Conventional Charging - applies a strong charging voltage until the battery is full and maintains alternator voltage above 14V unless battery temperature >40degC. The actual voltage at the battery will vary depending on the alternator load.	Minimum 14.0 - 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 114).

2. Hardwire Input

NOTE: Only available on Body Control Modules (BCM) with software version BK2T-14C184-AG or later. Not available before September 2013.

This is a pin in the BCM that the customer can connect to and switch between open circuit and ground to change between Normal Charging and Conventional Charging modes.

The Hardwire Input can be accessed in three ways:

- 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: 4.17 Electrical Connectors and Connections (page 142).
- As a kit to install the additional pin in the BCM connector pin C3-38. The kit KTBK2V-14A411-E_ is available from your local Ford dealer.

Installation of Converter Pin to BCM Connector C3

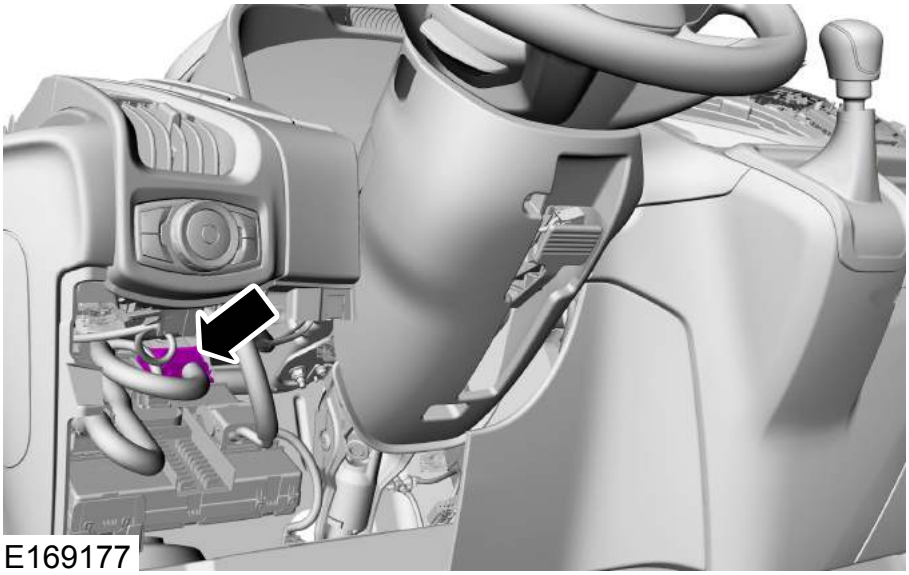
Jumper Kit KTBK2V-14A11-E_

E169178

Item	Description
Jumper Kit	KTBK2V-14A11-E_ contains spare connector, 3 meter fly lead with pre-crimped terminal and cable tie.

To access the BCM refer to the Workshop Manual Removal and Installation instructions.

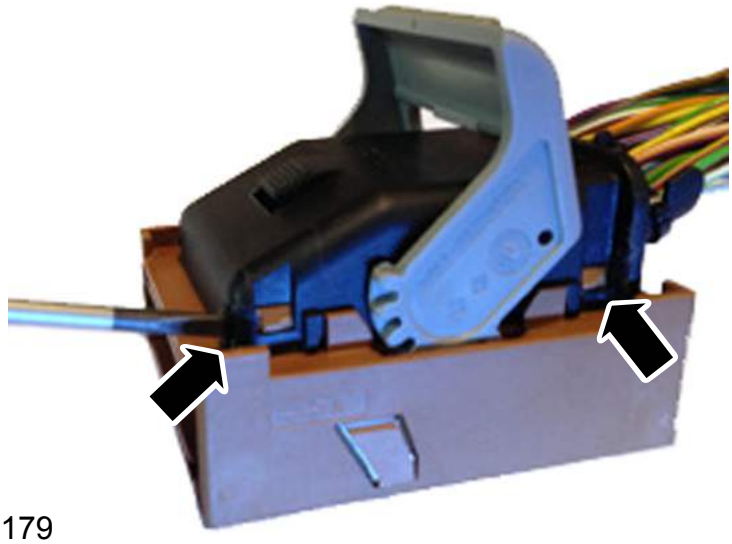
BCM C3 Connector Location



E169177

1. Disconnect the C3 connector from the BCM by pulling back the grey lever mechanism.

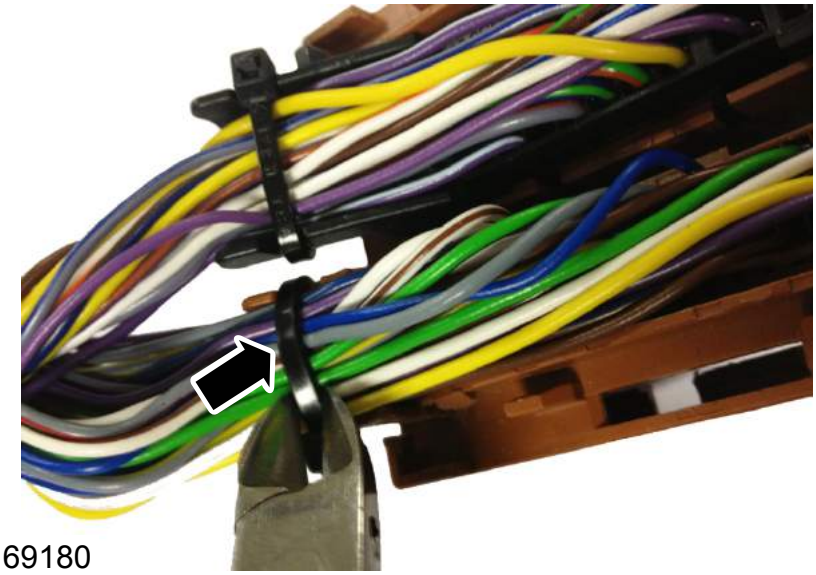
C3 Connector



E169179

2. Remove the black connector cover - 2x clips each side.

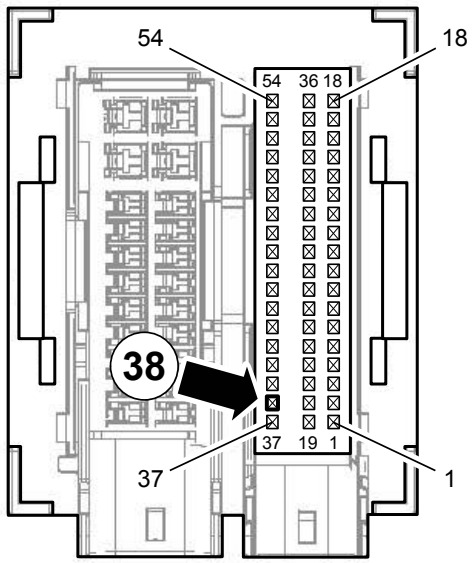
Cut Cable Tie



E169180

3. Cut cable tie on brown cable guide side of connector.

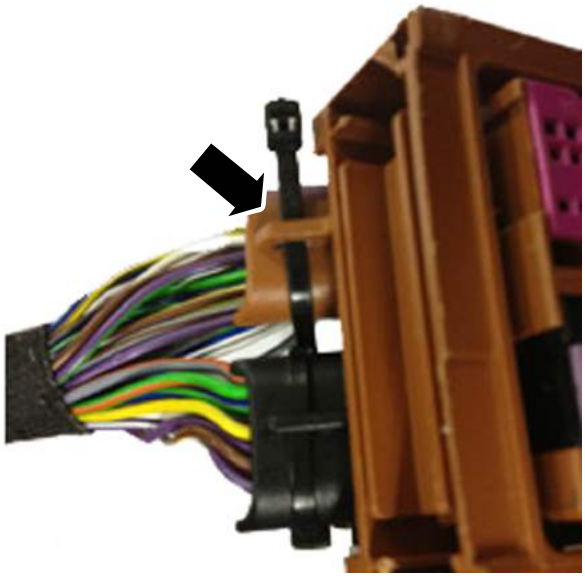
Insert Converter Pin



E169181

4. Insert converter pin into connector pin 38. The pin will only fit one way. Once inserted, gently pull back the terminal to ensure that it is latched in position.

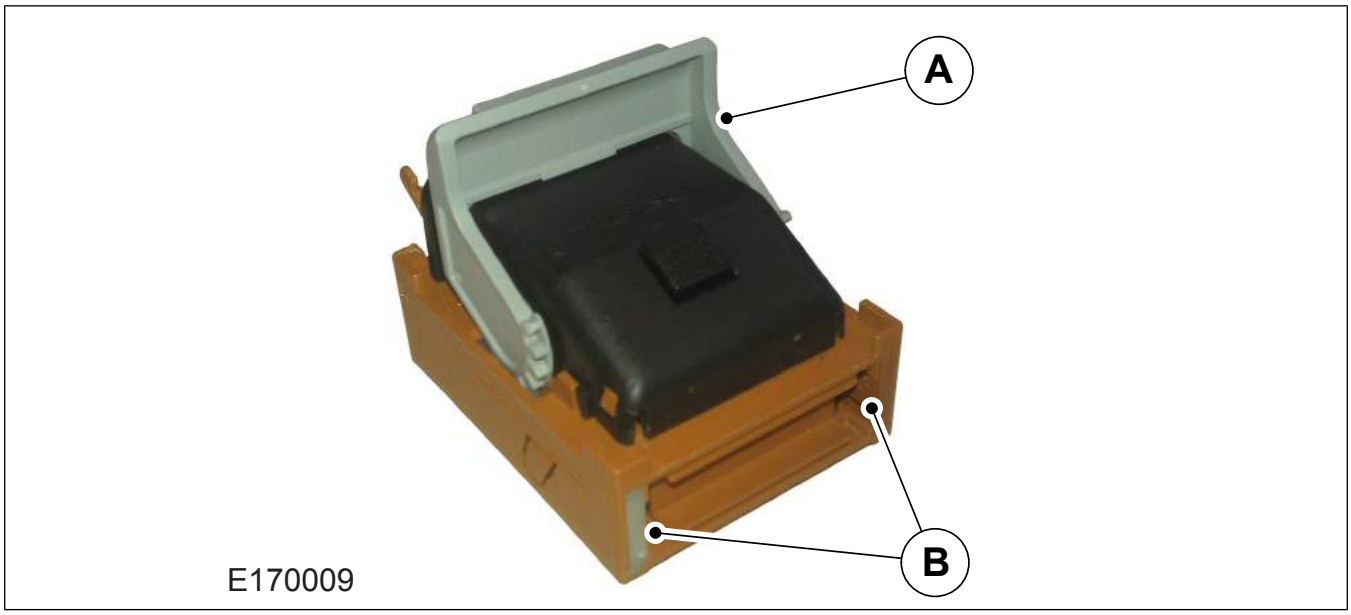
Wire Routing



E169182

5. Route the wire through the harness retainer with the rest of the loom and fix in place with a cable tie.

Reassemble Connector



6. When reassembling the connector into the BCM the latch (A) must be in the fully open position and the sliders (B) on both sides must be level with the front of the connector, see figure E170009.

7. To reconnect the connector to the BCM push the grey lever to engage the connector and click into position.

8. Route the harness to required switch mounting point,

Refer to: 4.2 Communications Network (page 75). BCM section. Reinstall trim using reverse of the removal procedure. Verify BCM function by operating the vehicle horn.

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.

There are four power management settings available; Factory, Transport, Normal and Crash. Factory and Transport modes are only active with the engine not running (for example: ignition off or with ignition on and engine not running); with engine running, the vehicle operates with full functionality. When in Transport mode, the interior lights, clocks, and power locking and alarms (where fitted) do **not** work.

It is possible to switch from Transport mode to Normal mode without the use of any ancillary equipment, but not vice versa. To change mode, the brake pedal must be depressed five times, and the hazard warning switch operated twice (in any combination) within 10 seconds.

If a vehicle is received from the dealer where modules do not seem to be functioning correctly, please contact the dealer as the vehicle may still be in Transport Mode. Transport Mode is mainly used to conserve battery life/warranty. The normal process is for the pre delivery phase to change the vehicle from Transport Mode to Normal Mode.

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:

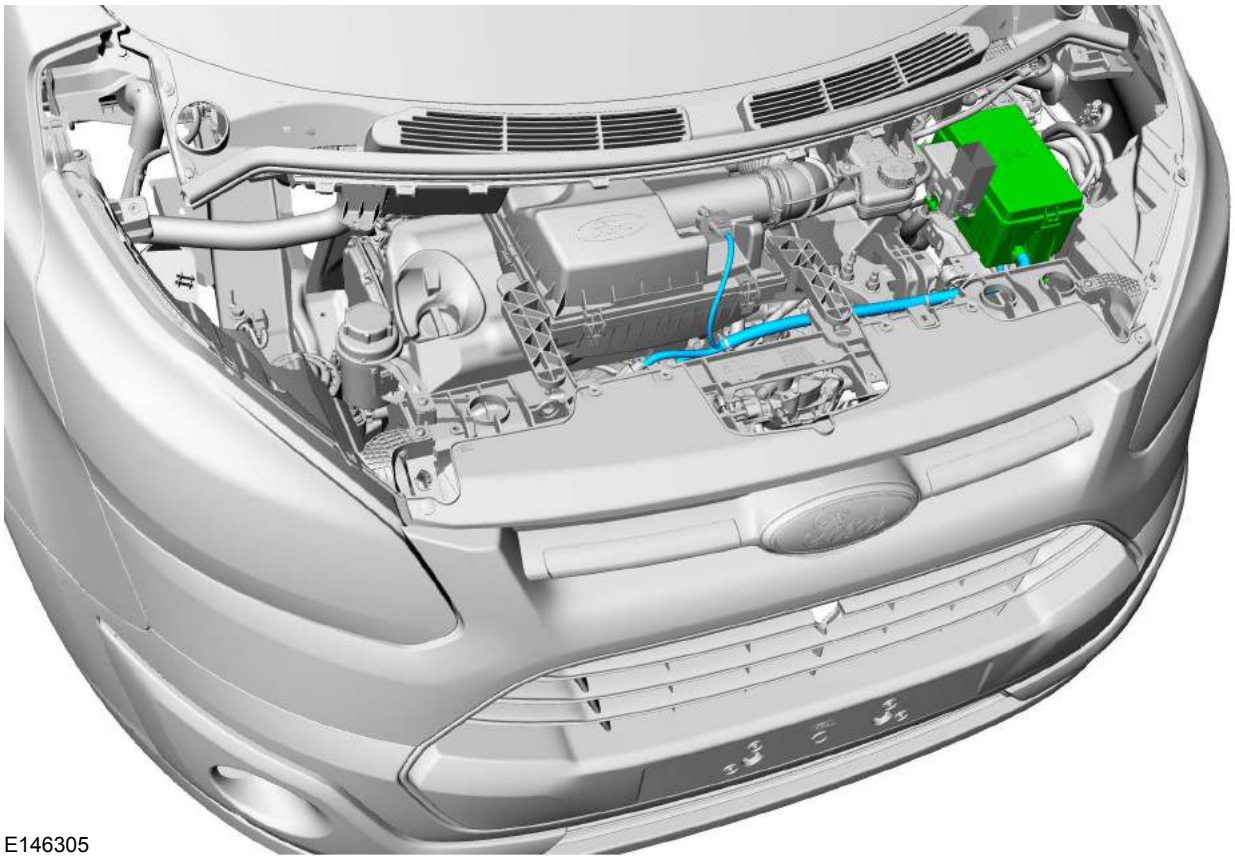
- Legality and regulatory conformity of the base vehicle.
- Drive-ability and serviceability of the base vehicle.
- The effect of regulations governing the proposed conversion including National Legislation in the country of sale.
- The method of integrating the circuit into the base vehicle.
- No additional 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 (with battery disconnect switch). Additional batteries can be fitted in conjunction with a battery disconnect switch (cut-off relay), described in the section 'Battery and Cables'. It is important to also read relative information on Start-Stop and SRC.

  Refer to: 4.4 Battery and Cables (page 93).
- 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: 4.15 Fuses and Relays (page 134).
- 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 114).
- 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 gound and +12V power cable connections to the Ford system

Refer to: 4.4 Battery and Cables (page 93).

Camper vehicles: When fitting an additional battery, this must be connected to 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 93).

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: 4.17 Electrical Connectors and Connections (page 142).

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.

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 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: 4.17 Electrical Connectors and Connections (page 142).
Refer to: 4.15 Fuses and Relays (page 134).

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

NOTE: For further information please contact your local 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

4.4.1 High Current Supply and Ground Connections

WARNINGS:

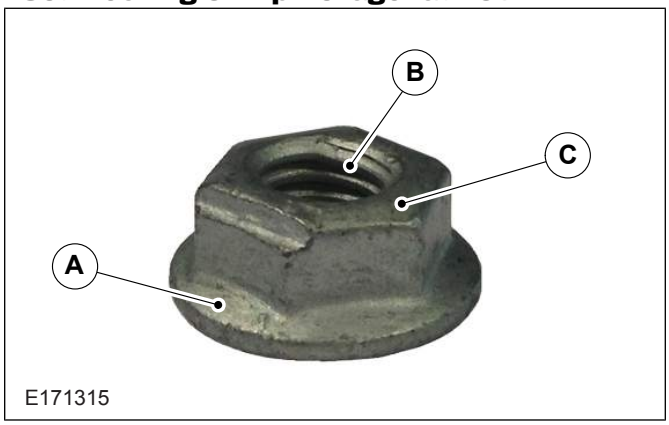
A self locking crimp hexagonal nut MUST be used for high current terminal stud connections, for battery positive and negative or chassis ground. Do not use locking, split washers or nylon lock type nuts.

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: 4.17 Electrical Connectors and Connections (page 142).
Customer Connection Points.

Self Locking Crimp Hexagonal Nut



E171315

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).

4.4.2 Battery Information

WARNINGS:

For electrical power take-off that requires deep discharge and cycling from third party systems, High Performance Deep Cycle AGM batteries (A736) must be ordered on the base vehicle, for more information refer to 'Power and Connectivity Usage Recommendations' table later in the section. If option A736 is not on the base vehicle they can be fitted by your local Ford Dealer. See table in Single and Twin Batteries Section.

If serviceable batteries are fitted, it is essential that regular checks are made to determine that the electrolyte (acid) levels are correctly maintained. There is a level indicator in each cell.

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 enhanced battery. You must replace the battery with one of exactly the same specification and technology or upgrade to a High Performance Deep Cycle AGM battery if adding a deep cycle system.

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.

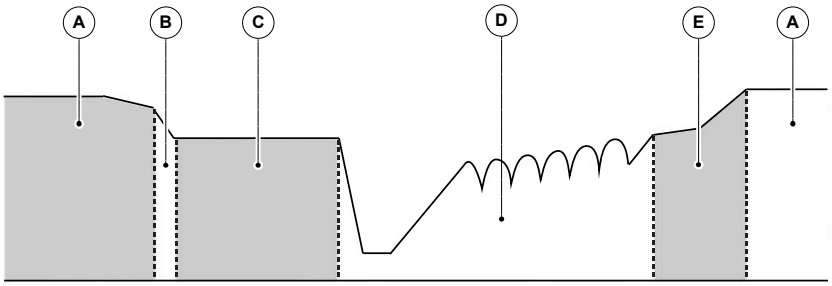
Following battery disconnection, there is no need to reprogram the vehicle. It retains its 'normal' power management settings and configurations. However, the central locking latches may cycle if one of these was opened manually in the intervening period. With regard to the radio, all of the settings 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 12:00 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.

The Ford SureStart® system (battery disconnect relay) prevents inadvertent discharge of the starter battery to ensure the vehicle will crank. The vehicle start battery is only connected to the rest of the systems when the engine is running. During a warm engine auto stop, the vehicle start battery is isolated until auto restart is performed.

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)

After market battery management systems are not required unless for converter fit equipment or third party battery low voltage protection.

WARNING: Where a battery guard is fitted, the supply from a non-deep cycle twin standard flooded battery system (2x80Ah) should not be set below 12V at open circuit voltage. If a battery guard is monitoring a supply from a deep cycle twin AGM battery system (2x80Ah), it is recommend not being below 11.8V at open circuit voltage. If the supply has different configuration, it is recommended to test the Low Voltage Threshold to ensure crank capability. There will be volt drop if the system is under load. It is recommended to test the volt drop under the load and compensate for the volt drop to avoid early disconnect. For example: loads above 20A will cause approximately 0.3V drop in the twin AGM battery system. If the system is under load above 20A, Low Voltage Threshold can be set to 11.5V. If a battery guard is required because equipment can be active at engine off, then it is recommended to fit deep cycle batteries as standard. See also 'Power and Connectivity Usage Recommendations' table later in this section. A battery guard high voltage set point should also not be below 15.3V as this is the normal operation voltage of an SRC system, when in refresh mode. For full peripheral robustness, it is recommended that equipment can handle up to 24V to allow for accidental jump start by extra 12V supply in series and not parallel.

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) or the High Specification Interface Connector (A608). 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, the battery disconnect relay (SureStart® relay), 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 (A736).

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. Central car configuration can be updated at a dealership.

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 114).
and
Refer to: 4.3 Charging System (page 81).

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: ± 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.

For EU5 vehicles starter and auxiliary battery need to be checked separately. Use the jump start connection points in the engine compartment to check the starter battery and use the CCP and battery minus terminal to check the auxiliary battery.

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 convertor 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: 1.11 Vehicle Transportation Aids and Vehicle Storage (page 26).

Usage of Electrical Loads During Conversion

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

For additional information

Refer to: 1.11 Vehicle Transportation Aids and Vehicle Storage (page 26).

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 5ºC (41ºF) 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 114).
Start-Stop and SRC
Refer to: 4.3 Charging System (page 81).

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 (without Start-Stop) Battery Configuration A			
6C16-10655-C_*	700 CCA (80Ah @20 hour rate) Standard Flooded Battery	1	T7
Twin Battery (without Start-Stop) Battery Configuration B			
6C16-10655-C_ *	700 CCA (80Ah @ 20 hour rate) Standard Flooded Battery	2	T7
Twin Battery (with Start-Stop)* ** Battery Configuration C			
CC1T-10655-B_ **	700 CCA (75Ah @ 20 hour rate) Enhanced Flooded Battery	2	T7
DK2T-10655-A_ ^	700 CCA (75Ah @ 20 hour rate) Enhanced Flooded Battery	2	T7
High Performance Deep Cycle AGM Batteries* ** Battery Configuration D			
DV6T-10655-B	800 CCA (80Ah @ 20 hour rate) Absorbent Glass Mat Battery	2	H7

* Can be replaced by 8G9N-10655-P_ in service.

** Can be replaced by BV6N-10655-B_ in service.

*** Compatible with SRC and Start-Stop vehicles only, pending availability in markets.

See Battery Configurations

^ Turkey Markets Only.

4.4.3 Battery Rules

- Batteries in parallel must be of the same type and capacity when using the SureStart ® system 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.

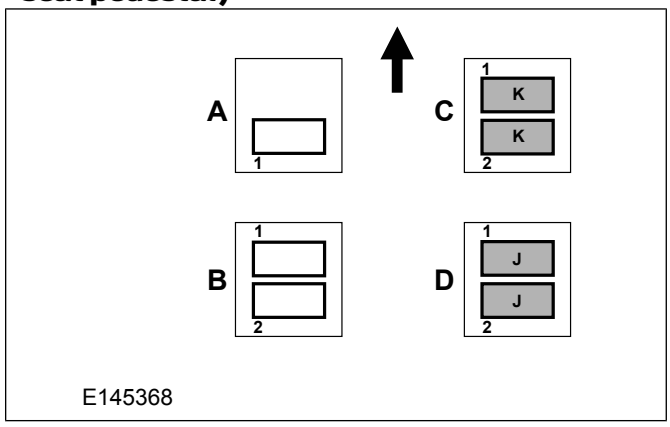
Important Factors for Battery Choice

- 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 (A736) is recommended.

Always observe circuit set-up outlined in diagram E74522 - Battery Disconnect Relay (Split Charge Relay) Circuit, later in this section. Extra batteries added to the power supply should be connected as shown at the end of this section.

4.4.4 Battery Configurations

Battery Configurations (always in the drivers seat pedestal)



Battery Configuration

Item	Description
1	Vehicle Start Battery
2	Auxiliary Battery
A	Single standard battery system — Without Start-Stop
B	Twin standard battery system — Standard Duty — Without Start-Stop
C	Improved flooded standard order battery — Start-Stop (K)
D	Twin special vehicle option battery system — With and without Start-Stop (J)
Arrow = Front of vehicle direction	

4.4.5 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 - for example: 1 x 60Ah, 1 x 80Ah.
- 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. Central car configuration can be updated at a dealership.

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.

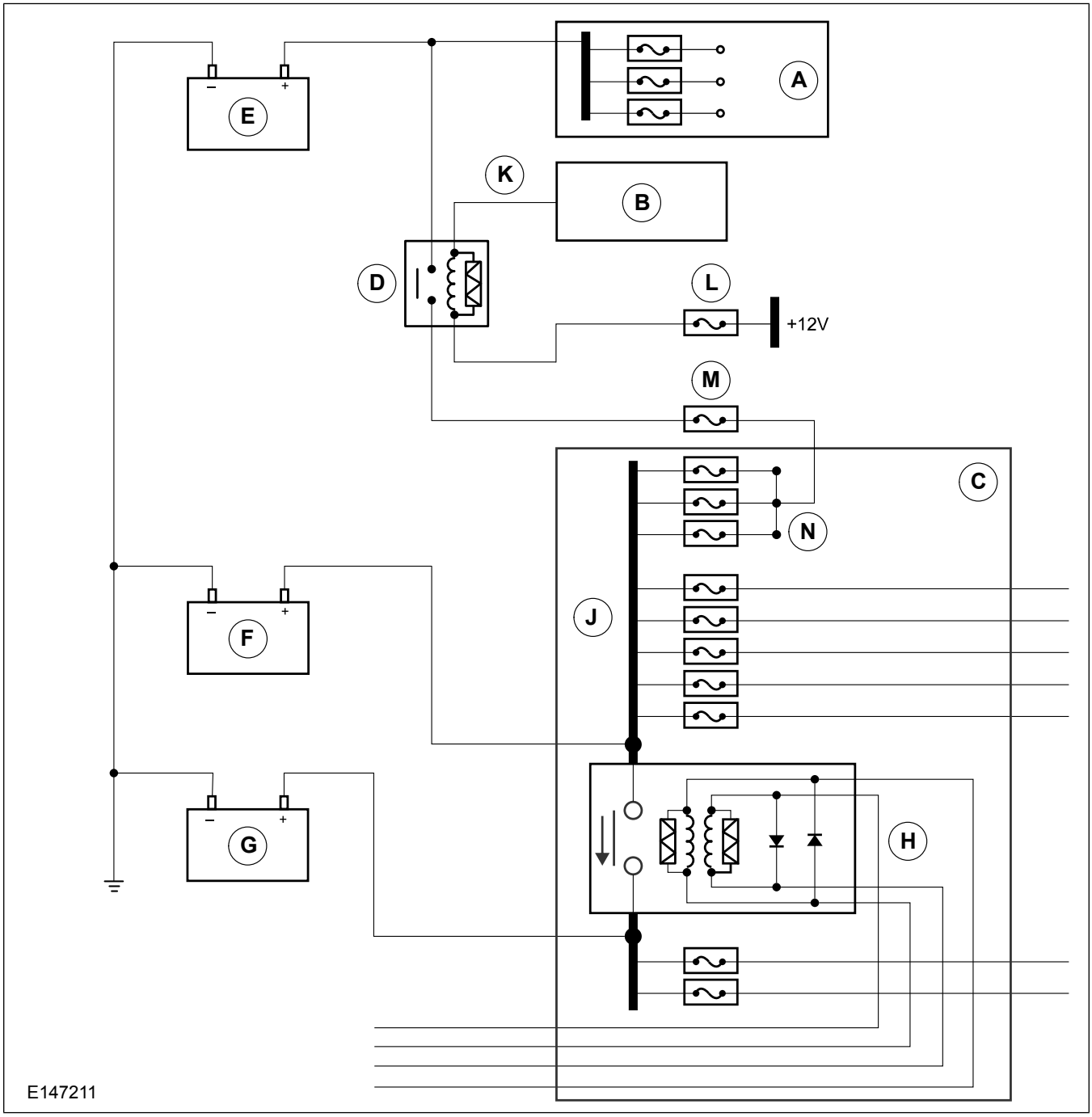
Convert Fit Additional Third Party Batteries

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 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 permissable, 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 E147211 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 81).
System Operation



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 —SureStart® Battery Relay
J	Ford Fit — Loads (from Auxiliary Battery)
K	Switched Ground Engine Run Signal (200mA)
L	Converter Fit — +12V Fused KL30 Supply
M	Converter Fit Power Supply Fuse

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

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:

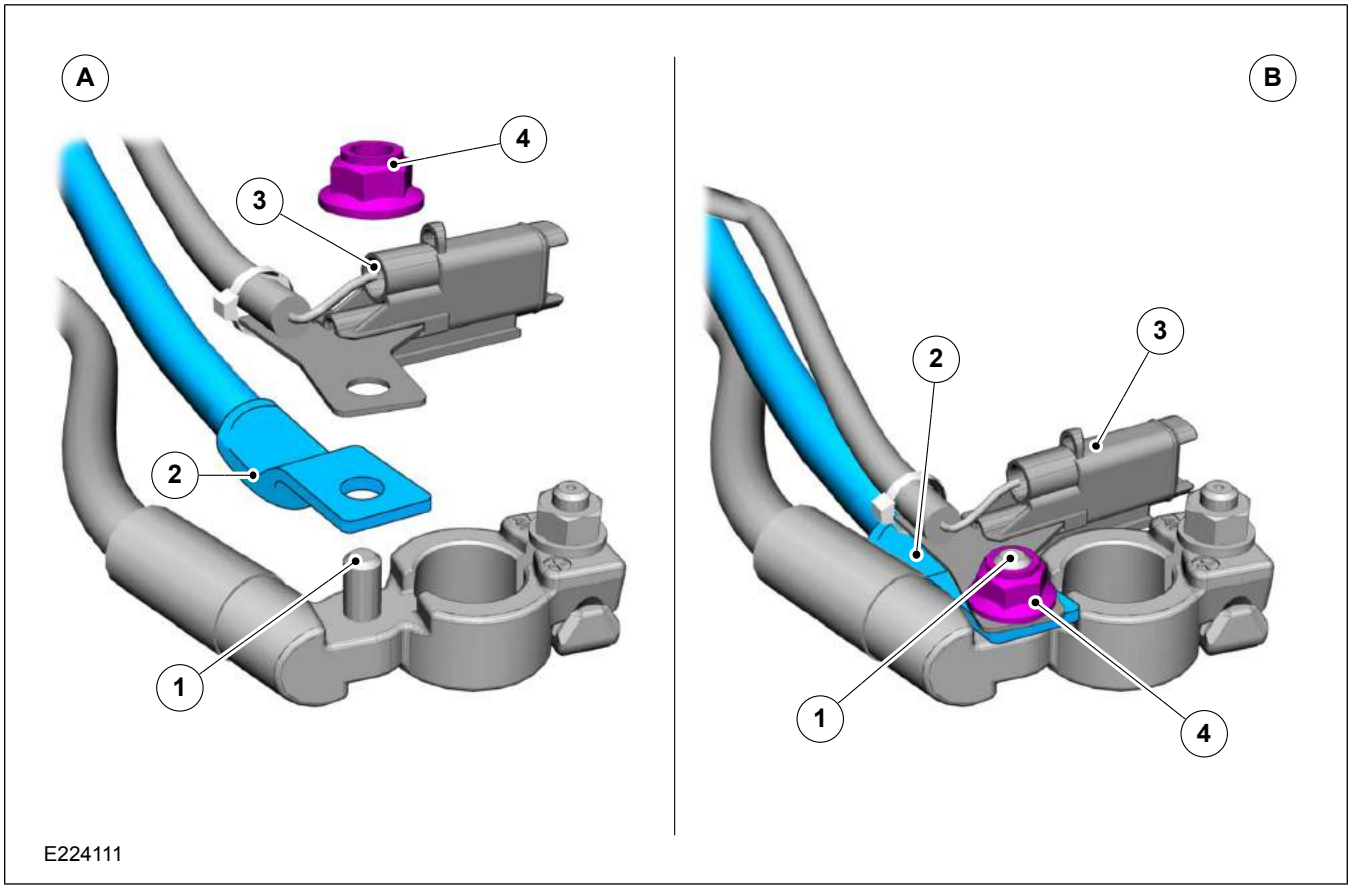
- No movement before full tightening of the nut (no risk of rotation). The third party eyelet must be a tight fit within the battery clamp slot and have a maximum Cross Sectional Area (CSA) for current flow.
- The cable CSA must be oversized,

  Refer to: 4.1 Wiring Installation and Routing Guides (page 61).
  Wiring Specifications table. For example: 245A has 70mm CSA cable.
- The third party conductor is mounted directly to the battery clamp with the 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 9Nm ±10%. 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 Tippers, 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 (A736) 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 amphere 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 81).
  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, unrequired 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



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 ± 1.2Nm

4.4.6 Additional Loads and Charging Systems

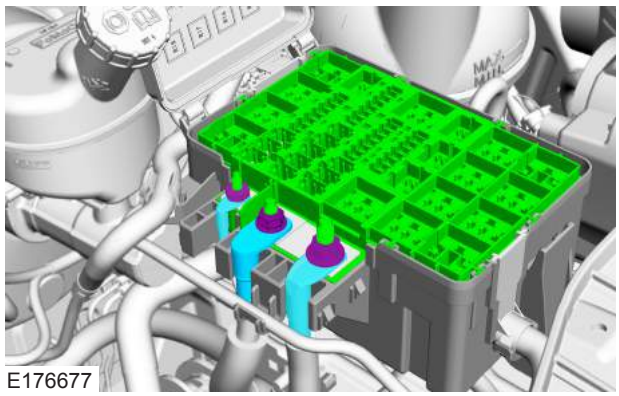
NOTE: Auxiliary customer electrical loads must only be made via the Customer Connection Points provided, the Auxiliary Fuse Panel or the High Specification Vehicle Interface Connector. For loads greater than 180A see 'Third Party +12V Power Take Off for Loads Exceeding 180A' section in this BEMM. Contact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

NOTE: Do not make any additional connections to the Engine Junction Box (EJB) terminals, as over-torquing 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: 4.17 Electrical Connectors and Connections (page 142).

EJB Terminal Studs



All loads that exceed 80mA 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.

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 E176720, can be ordered, part numbers DU5T-14436-G_ for single battery or BK2V-14301-F_ for twin battery systems. From October 2014 this will be standard when pre ordered with Special Vehicle Options, A526, A606, A607,A608, A736 and A652. For additional information on order codes

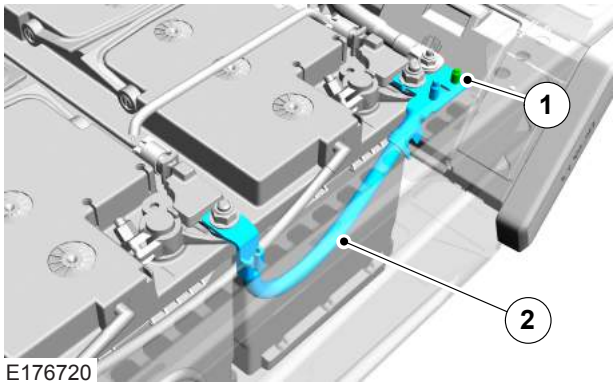
Refer to: 1.4 Conversion Type (page 15).

Each battery must also have a separate charger as the batteries are isolated at Ignition off and two minutes after Key-on if the engine is not running.

For additional information

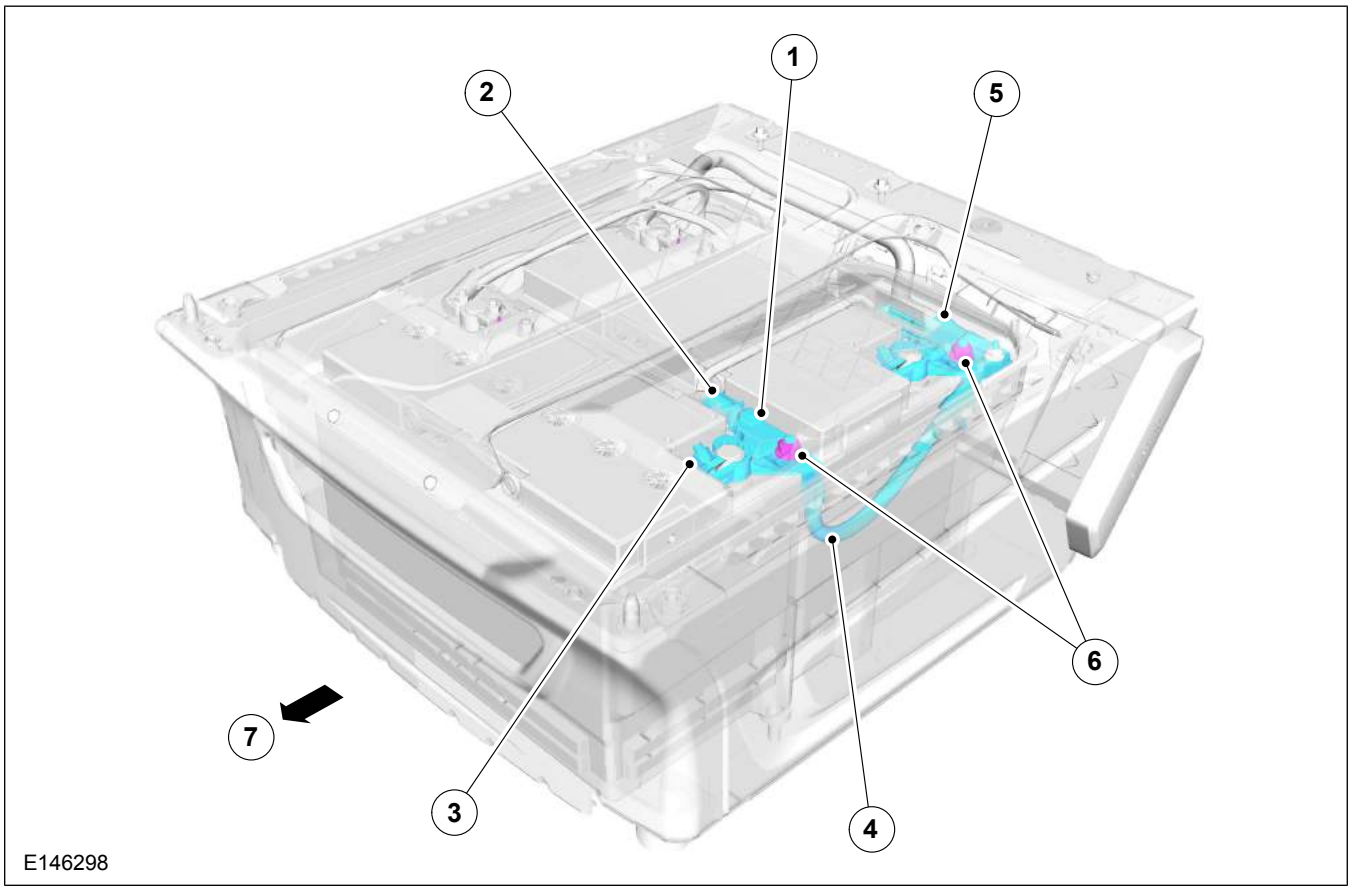
Refer to: 4.17 Electrical Connectors and Connections (page 142).
Customer Connection Points.

Auxiliary Ground Stud Eyelet



Item	Description
1	6mm Auxiliary Ground Stud for Converter Equipment - Torque 8Nm +/- 0.8Nm
2	Battery Ground Jumper Cable part number BK2V-14301-F_

4.4.7 Battery Monitoring Sensor (BMS)



E146298

Item	Description
1	Battery Monitoring Sensor (BMS) AV1T-10C652-A_. Used with Start Battery on twin battery systems.
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 (BK2T-14301-A_) only with twin batteries.
5	Second BMS (CC1T-10652-A_). Used with Auxiliary Battery on twin battery systems. Used with Start Battery on single battery systems.
6	2x M8 nuts. Do not loosen or remove.
7	Front of vehicle direction

CAUTION: Do not permanently remove jumper cable (BK2T-14301-A_) from BMS.

The BMS continuously monitors the condition of the main battery (or twin batteries on a Start-Stop vehicle). 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, from the auxiliary battery, 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. The High Performance Deep Cycle AGM batteries option should be pulled if greater than 5mA in sleep mode of additionally fitted systems. Regardless of battery system, it will still be required to frequently charge when at long periods of engine off.

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 milli ampere's (mA). Perform this test after 10 minutes of key off with all doors shut so that the vehicle remains in sleep mode.

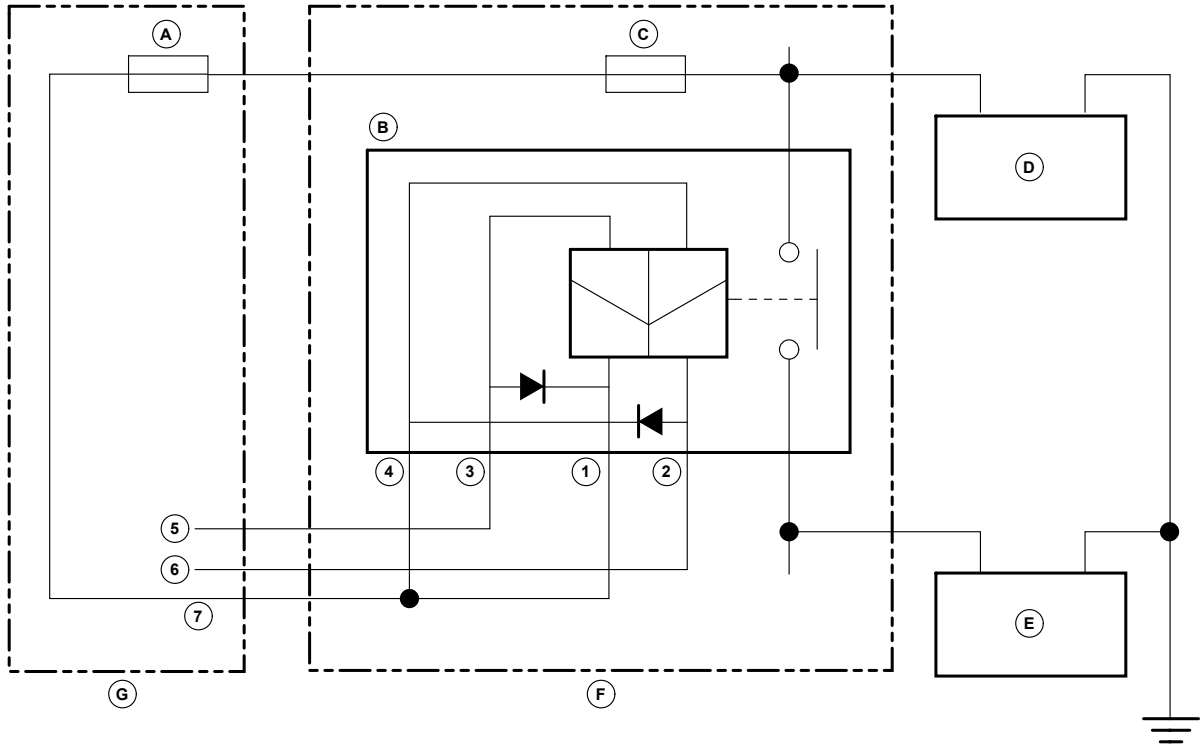
NOTE: If the key off load only drops to the expected lower value after 30 minutes, its probably because a feature is still active, controlled by the battery saver timer. This could be because any door is ajar, interior lamp is switched on or a peripheral is plugged into one of the power sockets.

If the BMS system has been changed, removed or retro fitted the following DTC's (Diagnostic Trouble Codes) can be set in relation to the BMS

- 0xD007 - 87: Lost Communications BMS 1.
- 0xD00F - 87: Lost Communications BMS 2.
- 0x91DB - 49: BMS Hardware fault 1.
- 0x93AE - 49: BMS Hardware fault 2.

4.4.8 Single and Twin Battery Systems

Battery Disconnect Relay (Split Charge Relay)



E74522

Battery Disconnect Relay(Split Charge Relay)			
A	Ignition Switch Supply, Fuse KL30 — Fuse F3 (BCM)	1	Relay Pin 1 — Supply +12V (KL30)
B	Battery Disconnect Relay	2	Relay Pin 2 — Ground Switched (to close relay)
C	Ignition Switch Supply, Fuse KL30, Fuse F2 (PFB)	3	Relay Pin 3 — Ground Switched (to open relay)
D	Vehicle Start Battery	4	Relay Pin 4 — Supply +12V (KL30)
E	Auxiliary Battery	5	BCM Output — Pin C3-13
F	Pre Fuse Box	6	BCM Output — Pin C3-30
G	Body Control Module (BCM)	7	BCM Output — Pin C4-65

Battery Disconnect Relay (Split Charge Relay)

Where a vehicle is equipped with a single battery, the system can be updated to a twin system. This requires updating to a split charge relay, instead of the shorting bar. This ensures that auxiliary circuits are isolated from the vehicle start battery at key off, ensuring the engine can be cranked.

The battery disconnect relay is controlled from the BCM using a pulsed change of state strategy (coil not continuously energized) and is always factory fit for twin systems. Reconfiguration of the BCM software by the Ford dealership is required to support this feature. It will also be required to update the system to include a second BMS and wiring, also requiring dealership battery type reconfiguration. An update list of parts is shown at the end of this section.

Refer to: 4.3 Charging System (page 81).
SRC
Refer to: 4.8 Electronic Engine Controls (page 114).
Start-Stop.

Wiring of Batteries in Parallel for High Current Applications

For vehicles equipped with a twin battery system, wiring of the two batteries in parallel without a battery disconnect relay is not recommended. If higher current is required a third party 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 E147211, to allow the third party battery to be charged when the engine is running.

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 81).
Refer to: 4.8 Electronic Engine Controls (page 114).

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.

The shorting bar needs to be removed and the SureStart® relay added in its place. Dealer support is also required to update the central car configuration for twin and specification of the new batteries.

Number of batteries are in parameter 40

- value 0 x 01 is single
- value 0 x 04 is twin

Battery values are in parameter 210

- value 0 x 0B = T7 75Ah standard Start-Stop Only
- value 0 x 03 = T7 80Ah standard SRC only
- value 0 x 13 = H7 80Ah High Performance Deep Cycle AGM for SRC or Start-Stop

The start battery is to be packaged at the front of the drivers seat pedestal, the auxiliary is to be packaged at the rear. NOTE: when attaching the two BMS's to the 14301 cable, care is needed to avoid damage to the BMS sensor with the M8 nut being torque. Contact the National Company Sales representative for these torques and schematics for layout and package.

Generic items when converting from Single to Twin Batteries

Part Number	Description	Quantity
BK2T-10B728-A_	SureStart® Relay	1
BK2T-14301-A_	BMS Jumper Cable	1
BK2T-14300-A_	Left Hand Drive positive cable to pre fuse box	1*
BK2T-14300-D_	Right Hand Drive positive cable to pre fuse box	1*
CC1T-10C652-A_	BMS for Auxiliary Battery (also used for Single Battery System)	1
AV1T-10C652-A_B_	BMS for Vehicle Start Battery	1
W520102 -S442	M8 Nut for fixing BMS to 14301 (1 each BMS)	2

*only one battery pending on drive.

Replacing with Twin Basic System – Same as Single Fitted

Part Number	Description	Quantity
6C16-10655-C_	Lead Acid 80Ah Standard Battery	1

Replacing with High Performance AGM System

Part Number	Description	Quantity
CC1V-10655-A_	High Performance Deep Cycle 80Ah AGM Battery	2
BK2V-10A721-A_	Bracket Battery Clamp	1
YC1T-10A818-B_	Dual Drain Tube	1
BK2V-14277-A_	Battery Positive Isolation Covers	2
BK2V-V13002-A_	Foam Mat	1

4.4.9 Power and Connectivity Usage Recommendations

Power Usage	Recommended Specification (order code in brackets)
Occasional electrical loads less than 30A at engine run, and less than 5mA at key off. For example: Courier Van or Hotel Transfer Bus where occupants use interior lamps and power points for charging laptops, phones or portable navigation systems.	Standard Power Supply with the vehicle, single or twin batteries, with standard 150A Alternator is acceptable.
Frequent electrical loads less than 30A at engine run, and less than 5mA at key-off. For example: Service Engineer's Van with additional lighting and beacons.	Twin Batteries (NLX), with standard 150 Ampere Alternator.
Electrical loads greater than 30A at engine run, or, greater than 5mA at key-off over a long duration. For example: Maintenance Van with power tools, water heater, and additional lighting.	2 High Performance Deep Cycle AGM batteries (A736), with standard 150 Ampere Alternator. Note: if loads used over a long duration with the engine running, then recommend the 210 Ampere Alternator option (HFL).
High electrical loads for short duration (100 - 250A requirements). For example: Ambulances with rear lift gate, medical equipment, communications, beacons	2 High Performance Deep Cycle AGM batteries (A736), with 210 Ampere Alternator option (HFL) Note: for loads greater than 190A, supplemental batteries may be required.
Power Take Off applications which require elevated idle engine speeds. For example: Mobile Tire Fitter Van.	RPM Speed Control (A003).
Connectivity Usage	**Recommended Specification (order code in brackets)**
Additional fused relay outputs. For example: Service Engineers Van.	Auxiliary Fuse Panel (A526) option
Roof Beacons/Additional switches. For example: Highway Maintenance Vehicles.	Beacon Preparation Pack (A606)/Utility Vehicle Switch Pack (A607)* 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)* Note: includes Auxiliary Fuse Panel (A526).

*Utility Vehicle Switch Pack (A607) and High Specification Interface Connector (A608) can not 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:

- 8Amp draw for 1 hour and 300 times during battery life
- 20Amp draw for 10 minutes and 720 times during battery life
- 60Amp draw for 1 minute and 2400 times during battery life
- 160Amp 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.

NOTE: With Twin Battery systems, only the Auxiliary Battery should be considered in Ignition Off applications.

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.

4.4.10 Generator and Alternator

Torque Curve of Alternator - 150A

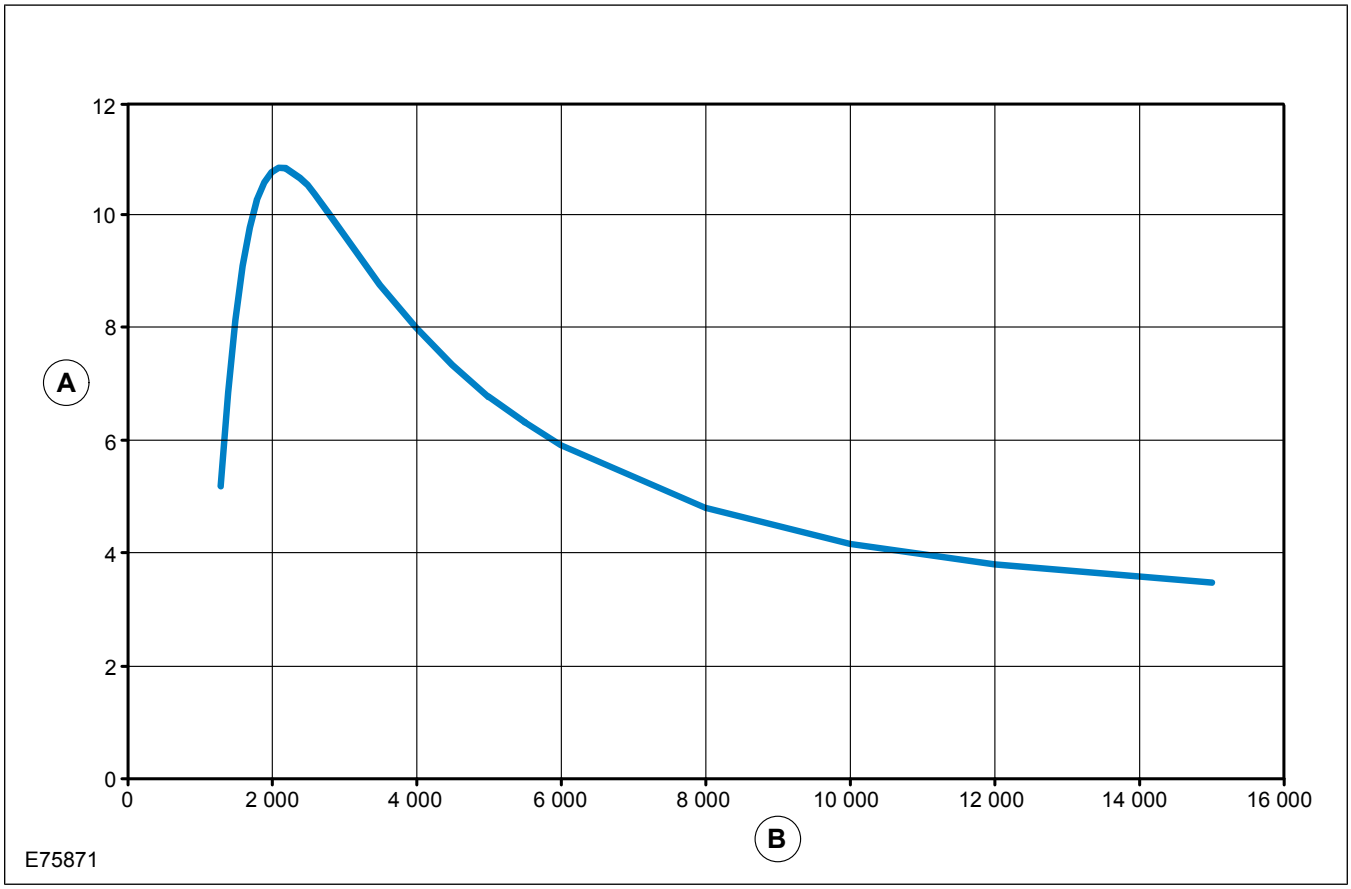
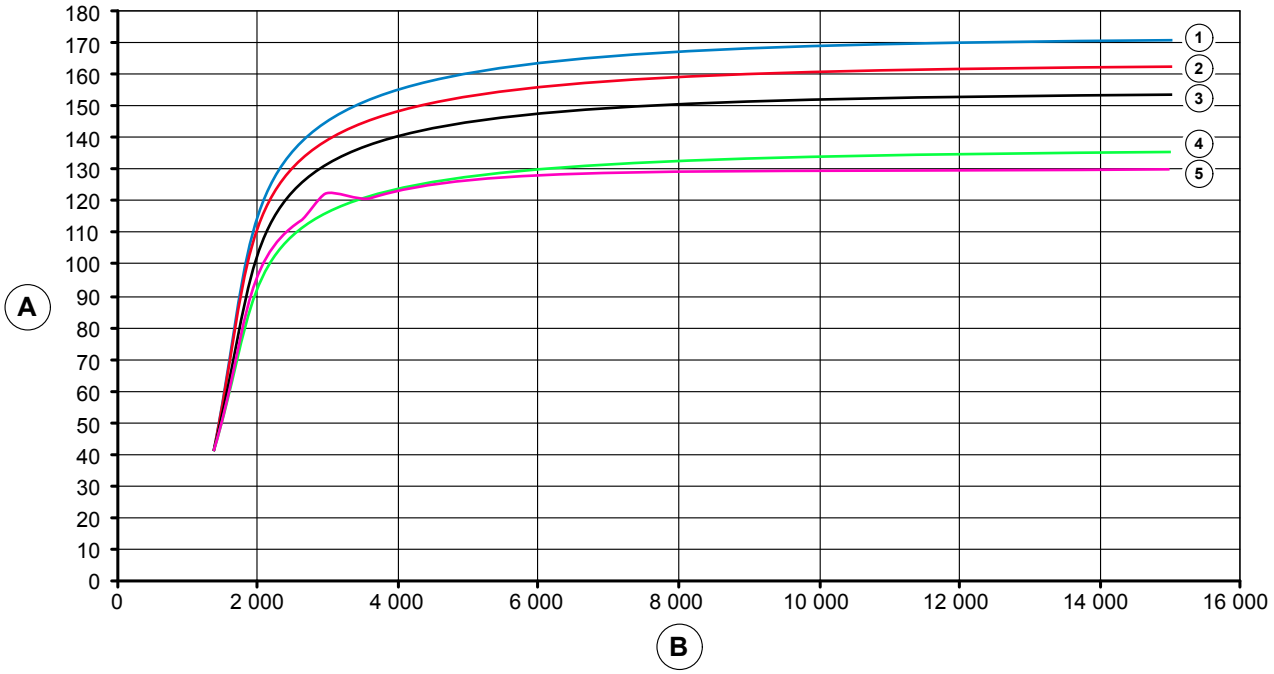


Diagram E75871 shows the torque in Nm which is required to drive the alternator. The vertical axis (A) shows the torque (Nm) and the horizontal axis (B) shows the alternators revolutions per minute (1/min).

NOTE: For equivalent engine revs per minute (RPM), the alternators revolutions, axis (B) should be divided by the following factor: 2.66 for 2.2L diesel.

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

Output Performance of Alternator - 150A



E75873

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

Diagram E75873 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).

Torque Curve of Alternator - 210A

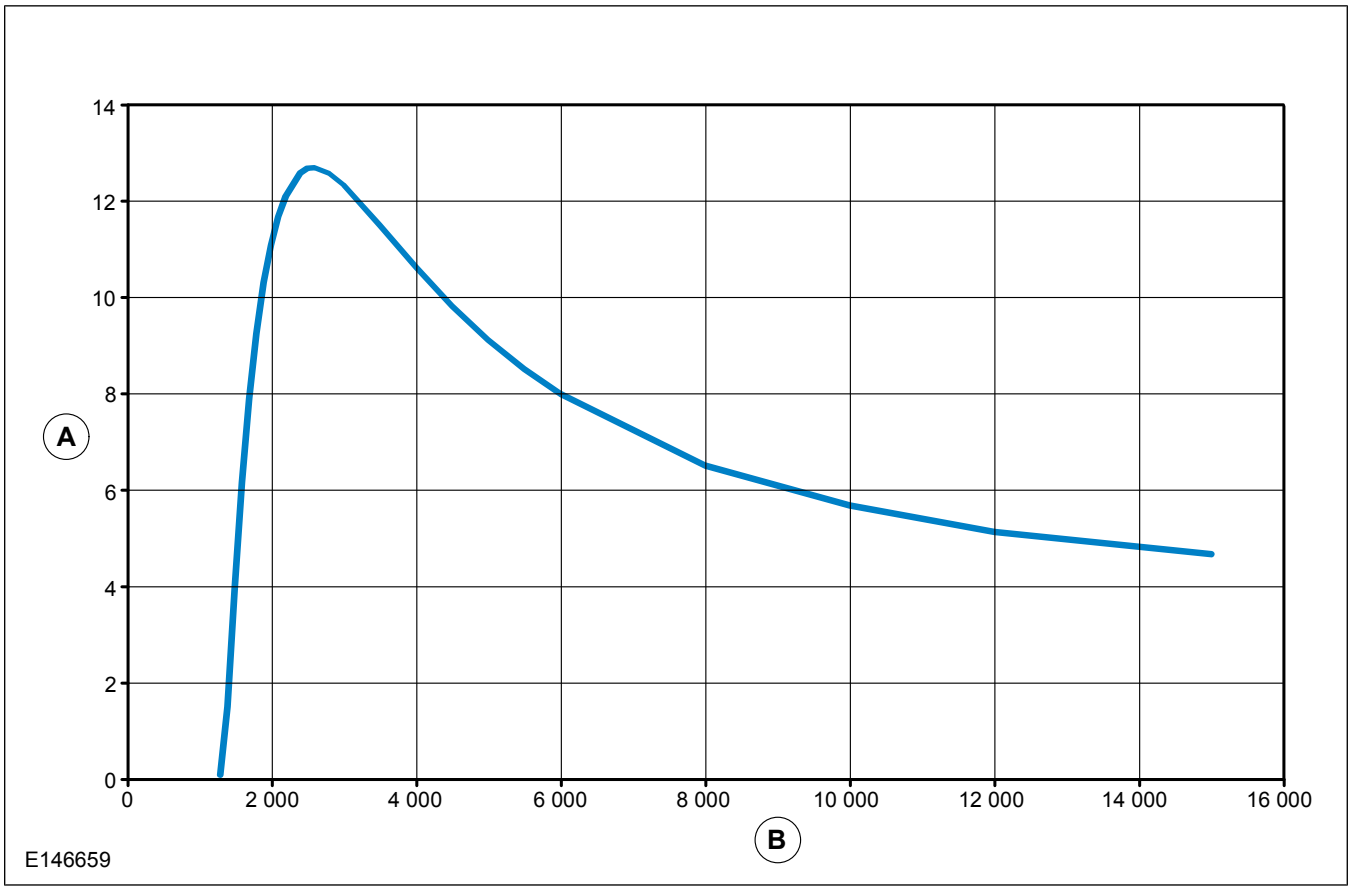
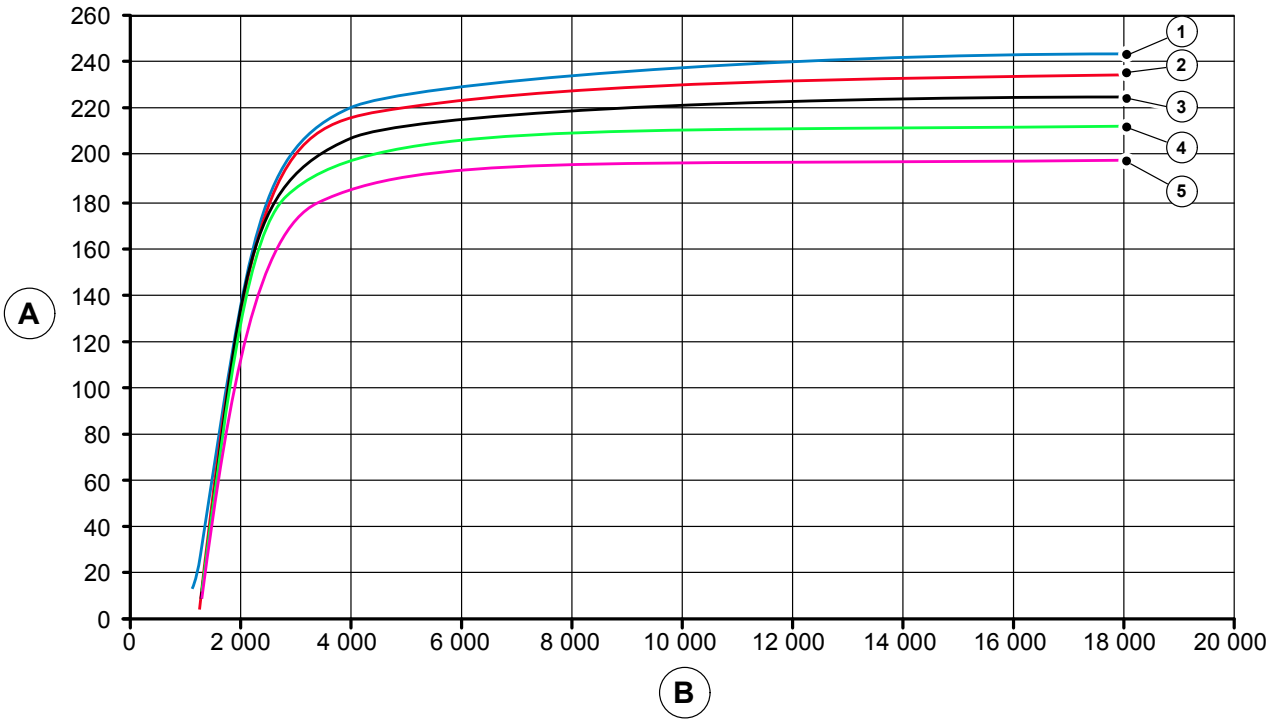


Diagram E146659 shows the torque in Nm which is required to drive the alternator. The vertical axis (A) shows the torque (Nm) and the horizontal axis (B) shows the alternators revolutions per minute (1/min).

Output Performance of Alternator - 210A



E146660

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 E146660 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).

NOTE: Vehicles fitted with SRC and Start-Stop will switch off the alternator if the batteries are at a high state of charge when at engine idle. Requirements for full alternator charge voltage for functions such as; charging a third party battery, jump starting, inferred engine run status and high voltage to counteract volt drop in systems, will need to switch on the alternator. This can be done by turning on the hazard switch in conditions where it is convenient and legal to do so. Contact your local Ford Dealer or National Sales Company representative.

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	KL58 - Backlight Illumination Power Supply
J1-2	Temp Door Power
J1-3	Air Disribution Door Power
J1-4	KL31 - Ground
J1-5	AC Request (only BK2T-19980-**)
J1-6	PTC - Auxilary Heater Request (only BK2T19980-E* and BK2T-18518549-B*)
J1-7	Air Distribution Door A
J1-8	Air Distribution Door B
J1-9	Air Distribution Door C
J1-10	Air Distribution Door D
J1-11	Spare - Ground
J1-12	Spare - Ground
J1-13	Spare - Ground
J1-14	KL30 - Battery Voltage
J1-15	KL15 - Switch Battery Voltage
J1-16	Reserved for Supplier Diagnostic
J1-17	KL31 - Ground
J1-18	REC Out 1 - DC Motor Power/Ground Toggle
J1-19	REC Out 2 - DC Motor Power/Ground Toggle
J1-20	Temp Door A
J1-21	Temp Door B
J1-22	Temp Door C
J1-23	Temp Door D
J1-24	Spare - Ground
J1-25	Spare - Ground
J1-26	Spare - Ground
J2-1	Blower Stage 1
J2-2	Blower Stage 2
J2-3	Blower Stage 3
J2-4	Blower Stage 4
J2-5	Blower Ground

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	MS CAN -	Violet/Orange	Twisted
2	MS CAN +	Grey/Orange	
3	Power	Red	-
4	MS CAN Low	Violet/Grey	Twisted
5	MS CAN High	Blue/Grey	
6	Cluster Signal Ground	White/Brown	-
7	Cluster Signal	Yellow	-
8	Cluster Set	Green/Violet	-
9	Automatic Transmission	-	-
10	Ground	Black/Violet	-
11	Tachograph	Grey/Blue	-
12	Crank Detect	White/Green	-

4.7 Horn

A dual horn may be fitted to the vehicle in place of the single horn.

Any other aftermarket horn (for example an air horn) will need to be driven by a separate relay energised 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 one of the pedals 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 CO_2 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 ECM (engine control module), known as the Start-Stop scheduler. 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 restart, due to one or more system inhibitors being active. The engine will shutdown only once 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 and above the higher limit for Start-Stop.
- Engine coolant temperature not warmed up (value dependent on ambient temp).
- Heated screens are 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 batteries fitted or BMS damaged or removed.
- ECO button is pressed (LED illuminated).
- Accelerator pedal or clutch pedal is not released.
- Greater than 100mA continuos load on each battery 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 (ECO button with LED illuminated)

The Start-Stop function may be deselected by the driver by means of the "ECO" 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. This switch also overrides the 110kph speed limiter. Pressing the ECO button (LED illuminated) will inhibit the auto Start-Stop feature and allow the vehicle to drive to maximum speed or a higher speed limit value if also fitted. Pressing the button again (LED not illuminated) will make auto Start-Stop active and vehicle will be limited to 110KPH. These are part of the fuel saving features.

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 50A. High current loads (attached to the secondary battery) 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 load 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 93).
Battery Monitoring Sensor.

The Start-Stop system on Transit employs a modified version of Ford's patented SureStart® twin battery system to isolate the vehicle electrical system from the effects of the voltage transients from increase starter motor warm crank cycles. This means, when the engine is restarted, the auxiliary battery is connected with a delay timer to isolate the load connected to it from the volt drop. Therefore extra electrical loads should always connect to the auxiliary battery to reduce the equipment's exposure to these transient voltage drops (Customer connection points).

Start-Stop is only designed to operate with two batteries that are calibrated by 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 a Smart Regenerative Charging (SRC) vehicle.

Refer to: 4.3 Charging System (page 81).
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 ECO 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 or to the auxiliary battery. 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, except EU6 2.2L Heavy Duty engines.

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 IDS diagnostics system. 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

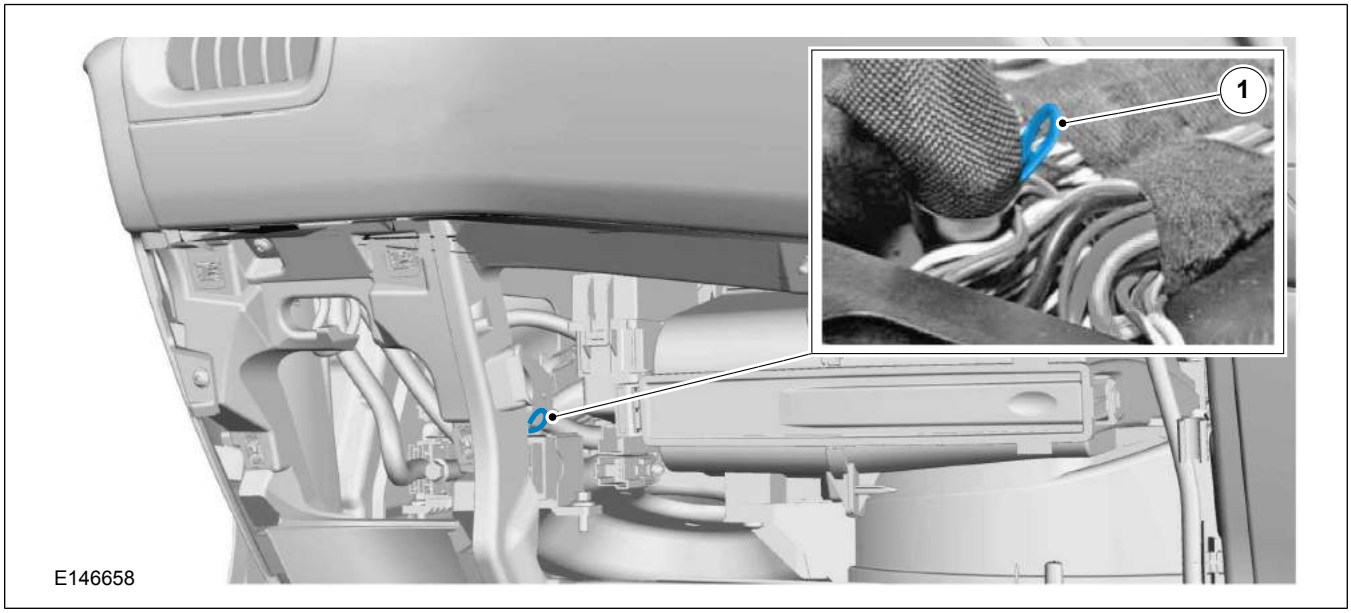
Refer to: 4.8 Electronic Engine Controls (page 114). Impacts from Start-Stop System.

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 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.

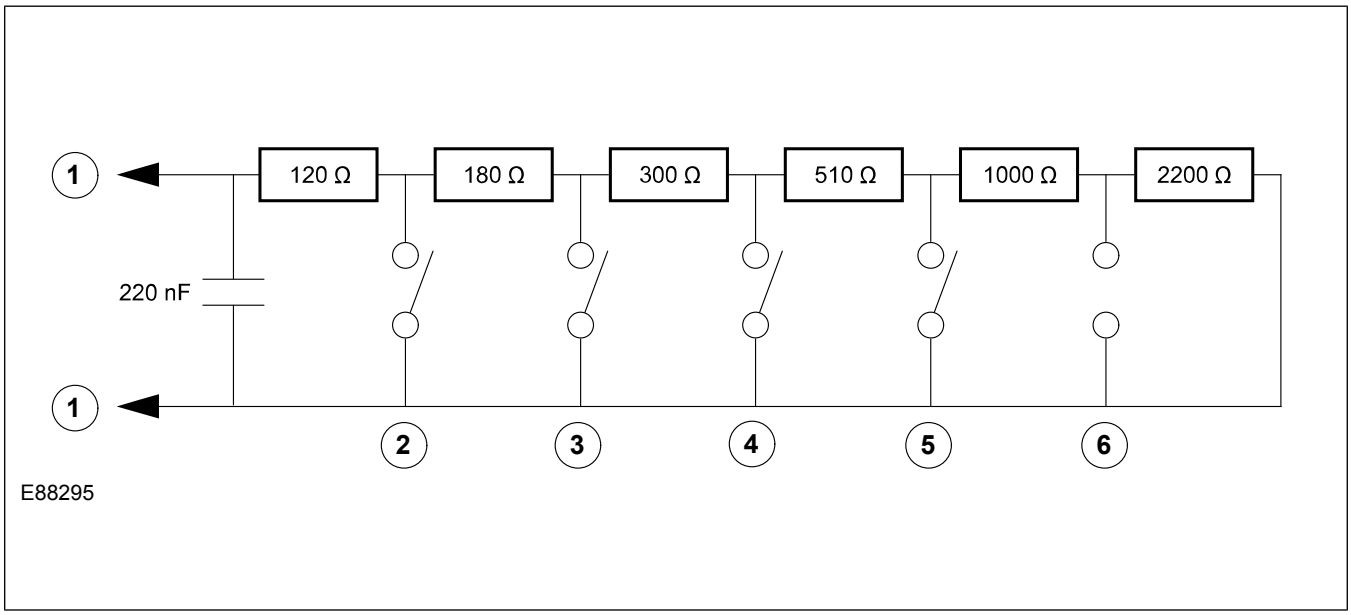
Green/White Loop — Right Hand Drive Shown



The harness is loosely taped in this location, so the green/white loop should be easy to extract. Figure E146658 shows the location of the green and white loop.

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 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 (milli 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 = on, open = off). 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 can not easily be driven away and stolen.

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 an emergency 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 resister 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 or via dealer IDS 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 diagnostics system at a Ford dealer (there may be a charge for this).

Via the IDS system the mode of operation can freely be changed between any of the 3 principle modes of operation, the feature can even be turn 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. The IDS on screen menus will guide the dealer through the options and 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'.

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. When operating RPM Speed Control, it is recommended that the idle speed is limited to 1600rpm to avoid soot build up over long periods.

For additional information on DPF

Refer to: 3.6 Exhaust System (page 56).

4.8.4 Changing Vehicle Speed Maximum Setting

The Vehicle Speed Maximum Setting can be changed via the Integrated Diagnostic System (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 Information and Entertainment System - General Information—Specifications

4.9.1 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
*	Pre Equipment Pack (less speakers) - no audio
**	Pre Equipment Pack - no audio
2	MyConnection Radio
3	MyConnection Radio with DAB
4	Mid Radio with SYNC Gen 1
5	Mid Radio with DAB / SYNC Gen 1
11	Low Navigation (NAV) SYNC Gen 1

AHU/Multimedia ICE Pack Content

Description	*	**	2	3	4	5	11
Less ICE	X	X	-	-	-	-	-
MyConnection Radio AHU/AM/FM + USB + Bluetooth	-	-	X	-	-	-	-
MyConnection Radio AHU/AM/FM DAB + USB + Bluetooth	-	-	-	X	-	-	-
ICE - Low Audio (LOC)	-	-	-	-	X	-	-
ICE - Low Audio (LOC) with DAB	-	-	-	-	-	X	X
Less Multi Function Display (MFD)	X	X	X	X	-	-	-
Mid MFD - 3.5" Dot Matrix	-	-	-	-	X	X	-
Low NAV MFD - 5" TFT with NAV	-	-	-	-	-	-	X
Less Integrated Control Panel (ICP)	X	X	X	X	-	-	-
ICP Mid - Extended	-	-	-	-	X	X	-
ICP NAV - Extended with NAV	-	-	-	-	-	-	X
Less Speakers	X	-	-	-	-	-	-
2 Front Speakers + 2 Rear Speakers*	-	X	X	X	-	-	-
4 Front Speakers (2 woofer/2 Tweeters) + 2 Rear Speakers*	-	-	-	-	X	X	X
Single AM/FM Antenna	X	X	X	-	X	-	-
Single AM/FM/DAB Antenna	-	-	-	X	-	X	X
Less GPS Antenna	X	X	X	X	X	X	-
GPS Antenna	-	-	-	-	-	-	X
Less GPSM	X	X	X	X	-	-	-
GPSM	-	-	-	-	X	X	X
Less NAV Data	X	X	X	X	X	X	-
NAV Map Data	-	-	-	-	-	-	X
Less Radio Controls	X	X	-	-	-	-	-
Radio Controls on Steering Wheel	-	-	X	X	X	X	X
MFD Controls on Steering Wheel	-	-	-	-	X	X	X
Less SYNC	X	X	X	X	-	-	-
SYNC GEN 1	-	-	-	-	X	X	X
Less Microphone	X	X	-	-	-	-	-
Microphone	-	-	X	X	X	X	X
Less Auxiliary Heater	-	X	-	-	-	-	-
Aux Input Jack (AIJ)	-	-	X	X	X	X	X
Accessory Media Hub 1 x USB	-	-	-	-	X	X	X

* Rear Speakers are dependent on body style.

4.9.2 MyConnection Radio and MyConnection Radio with DAB

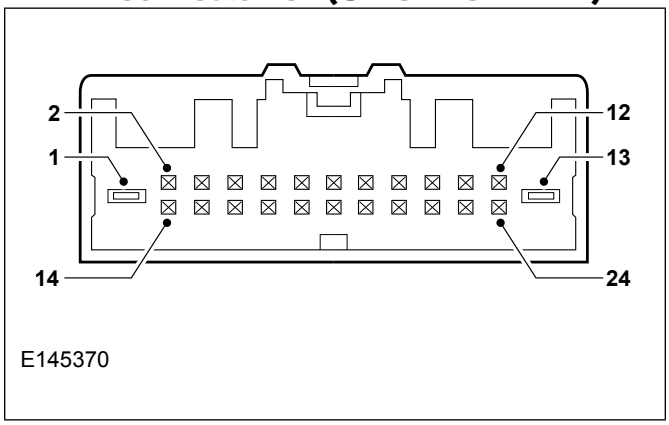
Audio Head Units (AHU) are connected to the instrument panel wiring via a single 24 pin connector, see figure E145370 and table.

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)



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*	Microphone +	Input	19*	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

* Pins 7 and 19 are for external microphone. Check availability with your Local Ford Dealer.

4.9.3 Mid-Radio and Mid-Radio with DAB

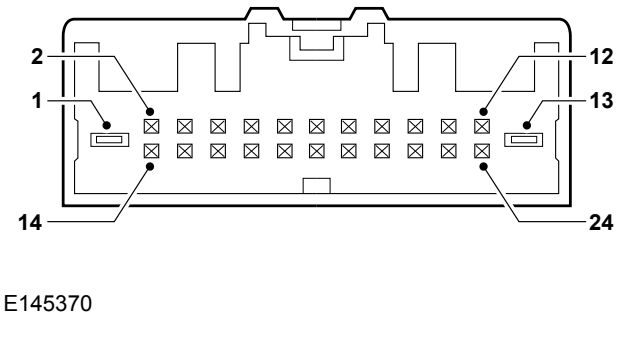
NOTE: AHU/ICE Pack 4,5 and 11 are connected to the instrument panel wiring via a 24 and 26 way connector, see figures E145370 and E146212.

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.

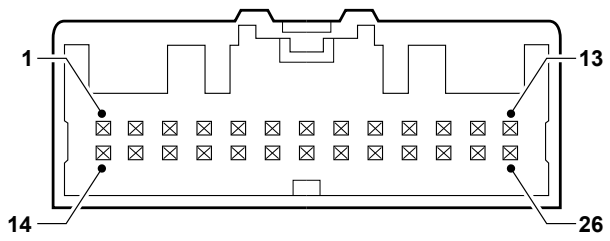
24 Pin Connector (8475-1 / 544127-1)



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 Aux2	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)

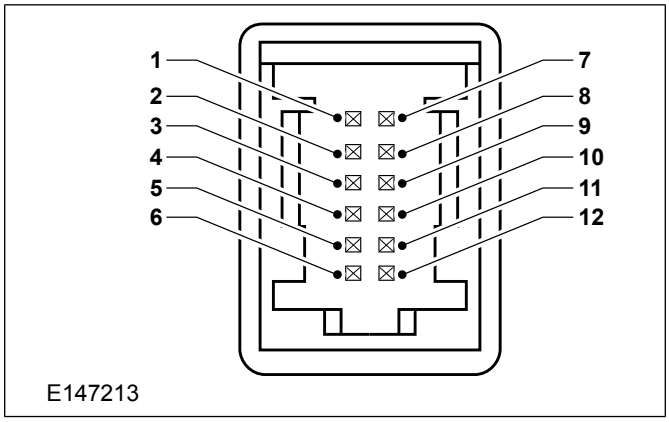


E147212

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

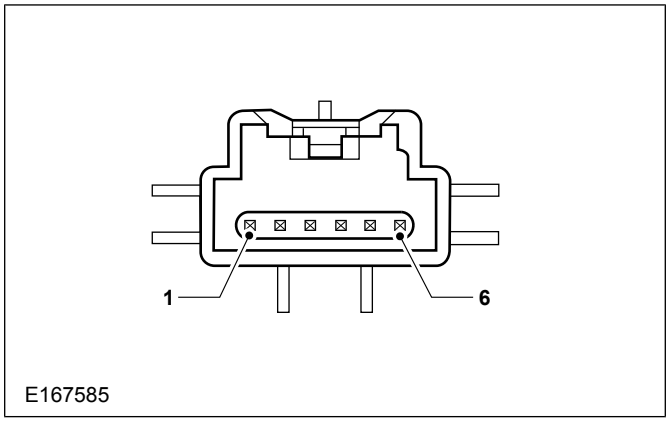
Multi Function Display (MFD) 12 Pin Connector



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

4.9.4 Additional Rear Speakers

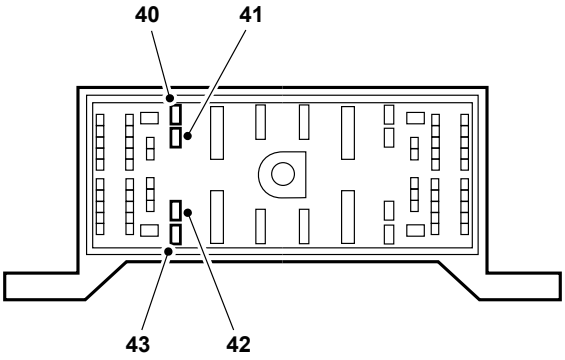
Rear speaker wiring is always present in the instrument panel harness 14K024, but not necessarily in the harnesses 14401 and 14405/14A005 that then take the signals to the rear speaker locations.

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



E146834

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)

4.10 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.

4.11 Exterior Lighting

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

4.11.1 Reversing Lamps

Reversing lamps are activated by the reversing switch on the transmission and sensed by the Body Control Module (BCM) which is controlled by the BCM high side driver.

4.11.2 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: 4.15 Fuses and Relays (page 134).
Refer to: 4.17 Electrical Connectors and Connections (page 142).

The load on the reversing lamps should not exceed a total of 3A (42W).

Lighting Loads

BCM Outputs	Controlling Device	Max. Load	Vehicle
Licence Plate and Marker Lamp Supply **	High Side Driver	46W	2x5W
Position/Parking Lamp Left (Front and Rear)	High Side Driver	23W	2x5W
Position/Parking Lamp Right (Front and Rear)	High Side Driver	23W	2x5W
Direction Indication Front Left*	High Side Driver	63W	21W + 5W
Direction Indication Rear Left*			21W
Direction Indication Front Right*	High Side Driver	63W	21W + 5W
Direction Indication Rear Right*			21W
Daytime Running Lamp Left /Right	High Side Driver	30W	2x15W

*Turn Indicator Supply, smaller load will cause double flashing (bulb outage detection).

**Licence Plate and Marker Lamps not to exceed 46W. LED Markers are recommended where available.

Lighting Fuses		
F8	15A	Front Fog Lamp
F9	10A	High Beam - Right Hand Side
F10	10A	High Beam - Left Hand Side
F11	25A	Exterior Lamp - Right Hand Side, Side Lamp - Left Hand Side
F14	25A	Turn Signal Indicator, Rear Fog Lamp, Day Time Running Lamps
F15	25A	Exterior Lamp - Left Hand Side, Side Lamp - Right Hand Side, Central High Mounted Brake Lamp

4.11.3 Lamps – Hazard / Direction Indication

The maximum permissible load with the standard system is:

- 1 x 21W — front indicator, 1 x 21W rear indicator + 1x 5W side repeaters (Left hand side).
- 1 x 21W — front indicator, 1 x 21W rear indicator + 1x 5W side repeaters (Right hand side)

* 63W per side maximum load.

4.11.4 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 (relay controlled).
- Rear fog lamps - 2 x 21W (high side driver controlled).

For trailer tow, rear fog lighting, relating to that system.

Refer to: 4.16 Special Conversions (page 137).

4.11.5 Electrically Operated Door Mirrors

WARNING: 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.

NOTE: These options are not suitable for aftermarket or converter fit.

4.12.1 Additional Internal Lamps

Additional cabin interior lighting may be obtained by directly accessing the connector inside the dome lamp in the cabin.

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 11A (150W).

Power for the Interior Lamps - Cabin and cargo areas come from the battery save system, Body Control Module (BCM) pin C2-9. The courtesy lamps for each area (front and rear) are controlled by seperate pins on the BCM:

- Front (cabin) lamps, pin C2-2
- Rear (cargo) lamps, pin C2-1

For additional information on BCM

Refer to: 4.2 Communications Network (page 75).

The battery saver system provides power for the interior lighting for a limited time.

Maximum loads for all interior lamps (vanity, map, courtesy) 150 total. Courtesy lamps have maximum loads of:

Van

- Front cabin lamps - 75W max.
- Rear load space lamps - 75W max.
- Combined total including vanity and map lamps not to exceed 150W max.

Kombi

- Front cabin lamps, including 2nd row seat lamp and entrance lamps - 75W max.
- Rear load space lamps - 75W max.
- Combined total including vanity and map lamps not to exceed 150W max.

Bus

- Front cabin lamps including entrance and luggage lamps - 75W max.
- Rear over seat lamps - 75W max.
- Combined total including vanity and map lamps not to exceed 150W max.

Each of these pins on the BCM can take a load of 75W. Lamps that are controlled by the battery save circuit will extinguish 30 to 180 minutes after ignition off (dependent on vehicle configuration).

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 2x front BK2V-13776-A* and 2x rear BK2V-13773-A*, jumper wires may also be required for updates. This is variant dependant part numbers BK2T-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. The default setting is 30 minutes from the battery saver system but this can be changed up to 180 minutes. For further information on required parts and configurations to order contact your Local Ford Dealer.

4.12.2 Additional 'Theater 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: 4.17 Electrical Connectors and Connections (page 142).

4.13 Cruise Control

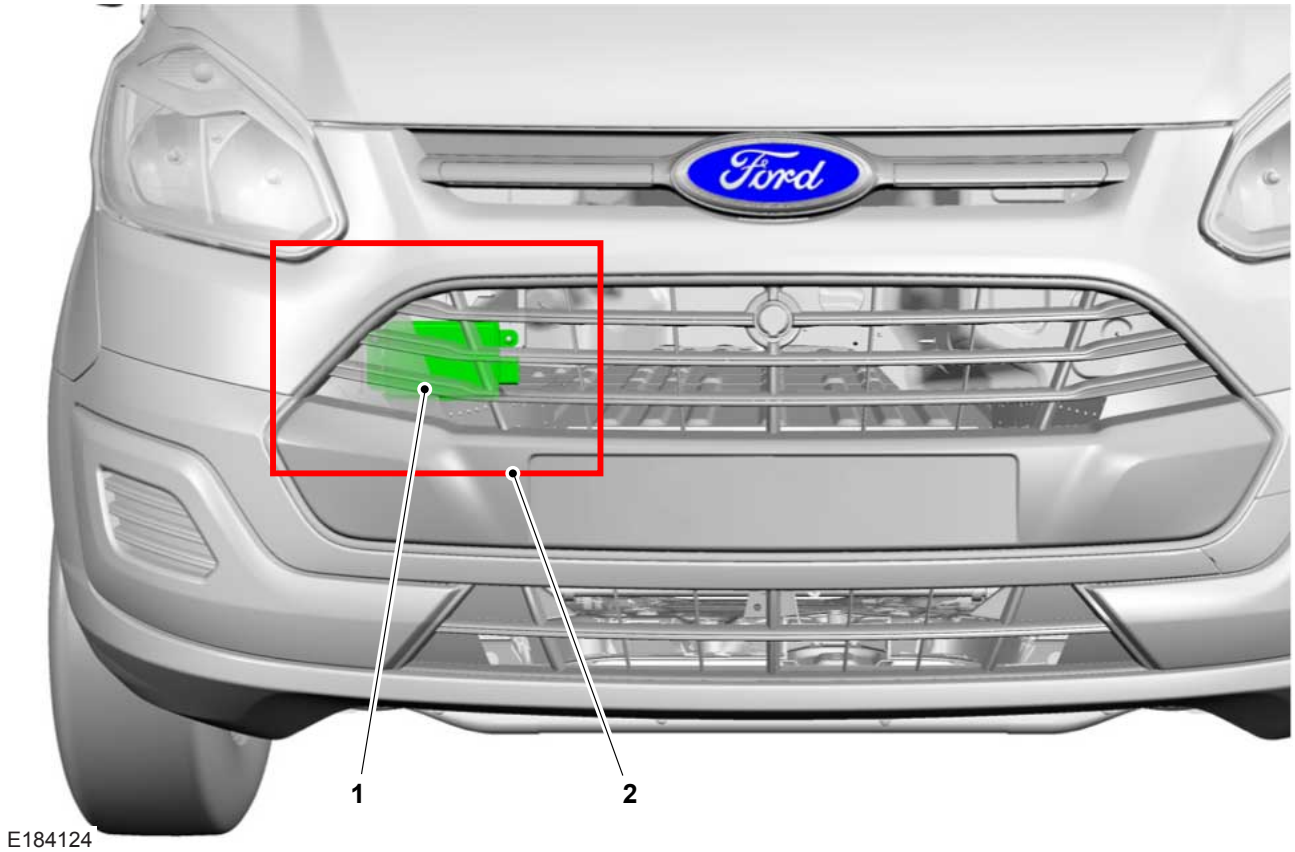
4.13.1 Adaptive Cruise Control

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

4.14.1 Door Removal or Modification

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:

- C3-44 Front Left -ground
- C3-34 Front Right - ground
- C3-50 Ajar lift gate switch - not connected
- C3-35 Ajar left side cargo switch - not connected
- C3-51 Ajar left side cargo switch - not connected

4.14.2 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
C2-18	8	8	Lock Left
C2-27	8	8	Lock Right
C2-39	17	-	Driver Door unlock
C2-40	5	5	Deadlock Left
C2-41	-	-	Lift gate release
C2-42	5	5	Deadlock Right
C2-44	-	-	Rear Cargo Door unlock
C2-45	-	17	Passenger Door unlock

Locking Configurations The following list details specific locking scenarios that have been noted by customers:

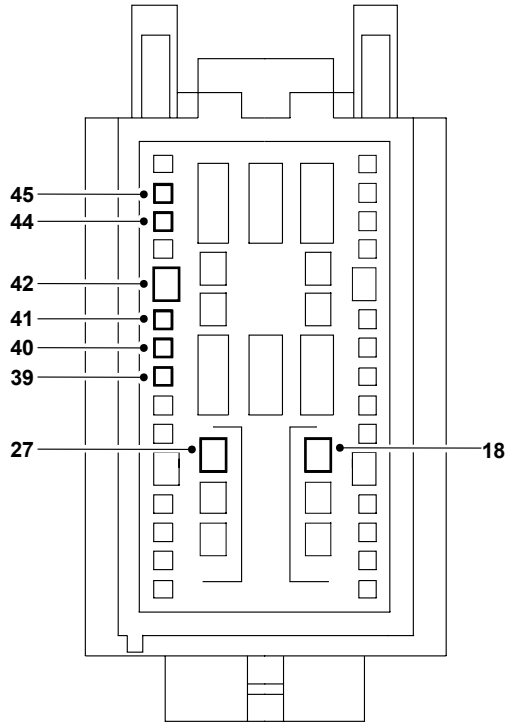
1. Raid locking or drive away locking for taxi and parcel van usage – this is a configurable parameter in the BCM (Ford Dealerships can set this). There is also the option to configure via the instrument cluster once the configurable parameter has been set.
2. Slam locking – this is a configurable parameter in BCM (dealerships can only switch off this feature, but not switch on).
3. N1 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

The following parameter (automatic locking by speed) is configured as follows:

- IDS parameter 32 - Change 0x02 [on] to 0x01 [off].

Pins to Control Additional Door Locks



E145374

Item	Description
Pin 18	Left Lock Supply
Pin 27	Right Lock Supply
Pin 39	Driver Door Unlock Supply
Pin 40	Dead Lock Left Door Supply
Pin 41	Lift Gate Latch Release
Pin 42	Dead Lock Right Door Supply
Pin 44	Rear Cargo Door
Pin 45	Passenger Door Unlock Supply

4.14.3 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.

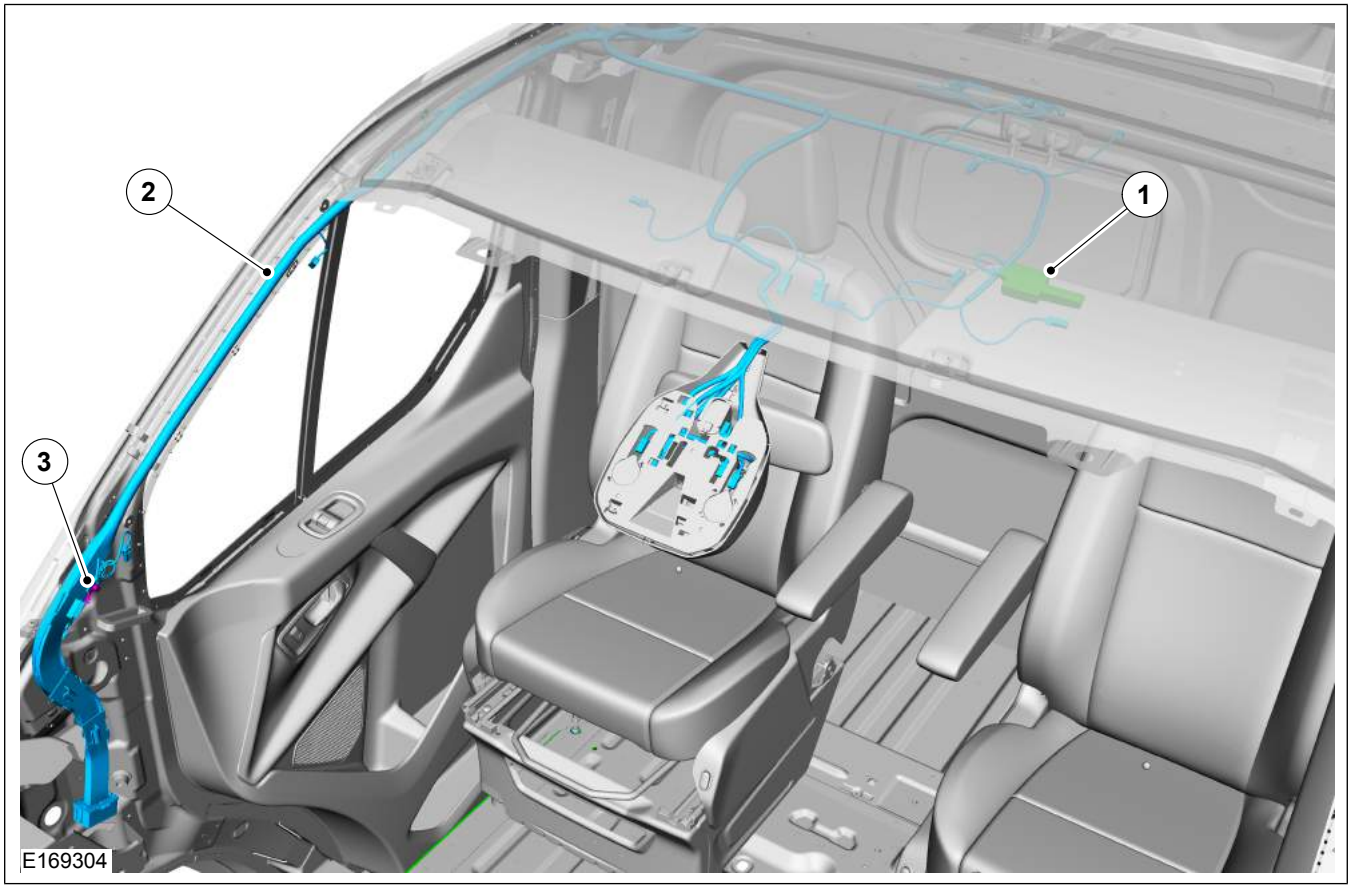
NOTE: It is recommended that the RKE/TPMS has a dedicated ground wire and ground stud, do not splice with other modules.

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: 4.18 Grounding (page 171).
E145385.

For additional information

Refer to: 2.4 Wheels and Tires (page 44).



Item	Description
1	RKE/TPMS Receiver
2	Harness 14A005
3	Ground point location

4.15 Fuses and Relays

4.15.1 Fuses

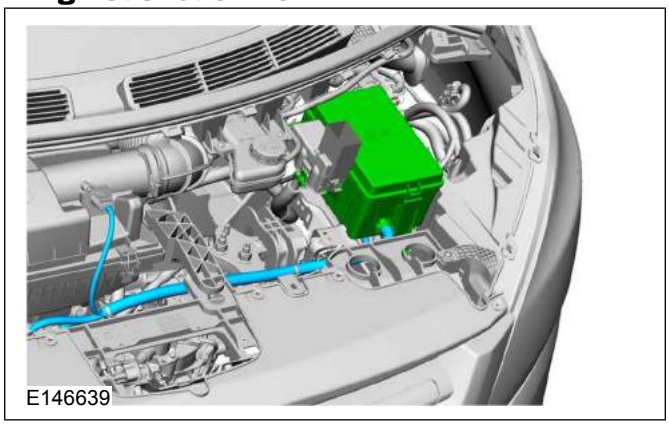
WARNING: No increase in existing vehicle standard fuse capacity is allowed under any circumstances. There are no spare fuses in the Engine Junction Box (EJB), Standard Relay Box (SRB) or Body Control Module (BCM). The vehicle converter/modifier must provide additional fuses as required. Please refer to below chart.

NOTE: Only use Ford fuses as shown in below table. Other fuses may interfere with the validated fusing strategy.

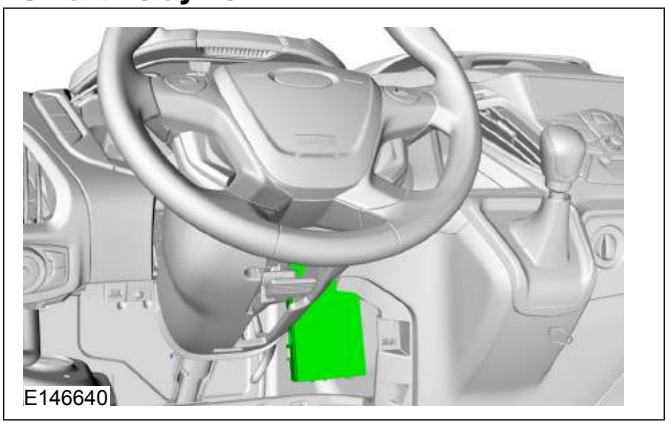
Ford Fuses

Part Number	Ampere Rating	Color
Mini Fuse		
1L3T-14A094-A_	2A	Grey
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
Maxi Fuse		
6EST-14A094-A_	20A	Yellow
6EST-14A094-B_	30A	Green
6EST-14A094-C_	40A	Orange, Amber
6EST-14A094-D_	50A	Red
6EST-14A094-E_	60A	Blue
J-Case Fuse		
6EST-14A094-A_	20A	Blue
6EST-14A094-B_	30A	Pink
7T4T-14A094-D_	40A	Green
6EST-14A094-C_	40A	Green
7T4T-14A094-E_	50A	Red
6EST-14A094-D_	50A	Red
7T4T-14A094-F_	60A	Yellow
6EST-14A094-E_	60A	Yellow

Engine Junction Box



Smart Relay Box



4.15.2 Relays

Ford Relays

Part Number	Ampere Rating	Color
Mini Relay		
5M5T-14B192-E_	70A	Grey
5M5T-14B192-C_	40A	Black
5M5T-14B192-D_	40A	Black
Micro Relay		
5M5T-14B192-A_	20A	Black
6X4T-14B192-A_*	20A	Grey

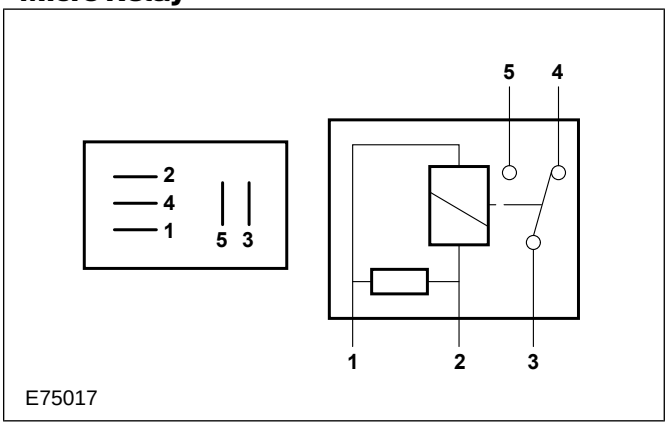
*Silent/Low Noise Relay

NOTE: Only use Ford Relays shown in table.

Ford standard relays have a nominal coil current of 300mA (max) at 25ºC. Relays with higher loads should not be used.

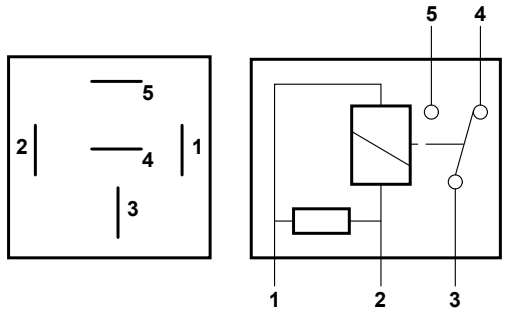
For maximum switching currents please refer to Relay Figures E75017—E75021.

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)	

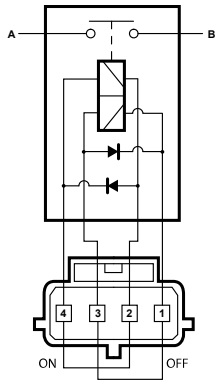
Mini Relay



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)	

Battery Disconnect Relay



E75021

Battery Disconnect Relay Parameters	
Normally continuous rated current (B-A)	260 Amps @ 25ºC
Nominal excitation coil current	3.3 Amps @ 25ºC for 60ms
High Power Bi-stable relay — Part number: BK2T-10B728-A_	

4.15.3 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 198).

4.16.1 Special Vehicle Options (SVO) Harnesses and Aftermarket Kits

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: 4.15 Fuses and Relays (page 134).
Refer to: 4.18 Grounding (page 171).

In addition to the Auxiliary Fuse Panel already mentioned, a number of other kits are available to meet customer needs see next table.

Part Number	Special Vehicle Option Harnesses and Aftermarket Kits
BK2V-14517-A*	Auxiliary Fuse Panel Harness LHD
BK2V-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)
KTBK2V-14A411-C*	Vehicle Interface Connector
KTBK2V-14A411-D*	High Specification Vehicle Interface Connector Jumper Harness
KTBK2V-14A411-E*	BCM C3 Connector Jumper (for Start-Stop Override and Configurable Charging)
KTBK2V-14A411-F*	Utility Pack Connector Jumper Harness
KTBK2V-14A411-G*	Beacon Connector Jumper Harness
BK2V-10A933-A*	Beacon Preperation Pack (Rear Beacon Harness)
BK2V-14A303-A*	Beacon Preperation Pack (Front Switch Harness)
BK2V-14A303-F*	Utility Vehicle Switch Pack (Front Switch Harness)
BK2V-14659-A*	Utility Vehicle Switch Pack (Rear Harness)
BK2T-13B576-A*	Trailer Tow Jumper
BK2T-13B576-D*	Trailer Tow Socket Jumper
BK2T-19H378-A*	Trailer Tow Module

4.16.2 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:

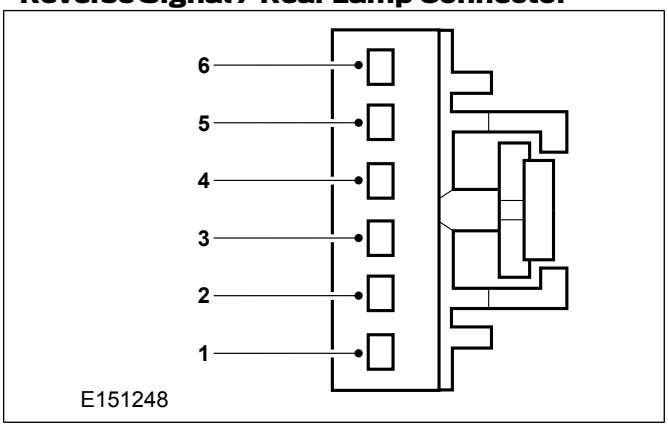
Refer to: 4.2 Communications Network (page 75).
Body Control Module (BCM) Output Information table.

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.

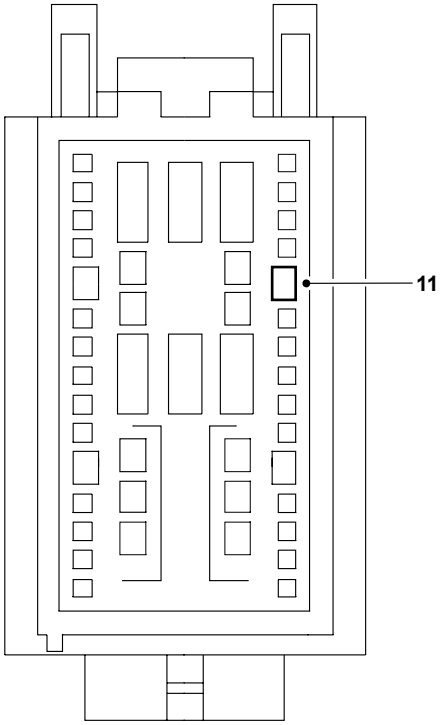
Reverse Signal / Rear Lamp Connector



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	Grey/Orange	Green/Orange
2	4	Position/Park Lamp	0.5	Violet/Green	White/Orange
3	5	Brake Lamp	0.5	White/Green	Grey/Violet
6	1	Ground	1.5	Black/Grey	Black/Green
4	3	Fog Lamp	0.5	Brown/Green	White/Blue

Reverse Signal in BCM C2 Connector



E151619

Item	Description
Pin 11	Reverse Signal

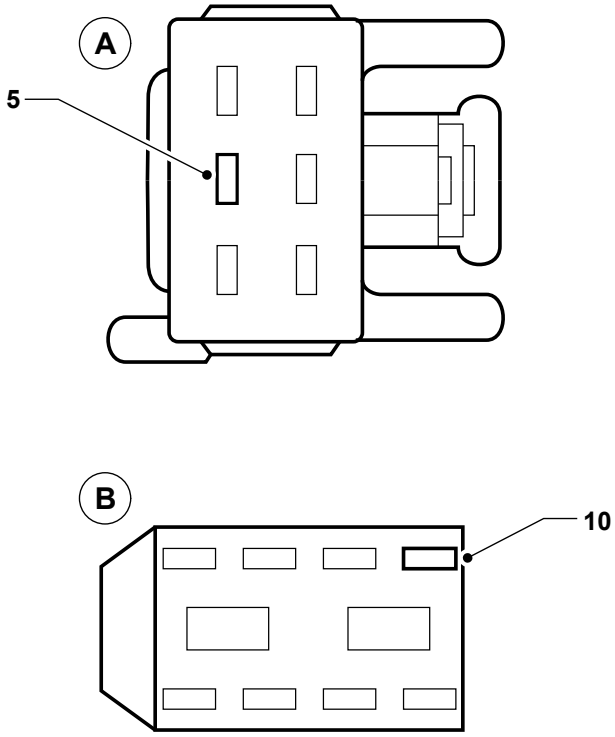
In addition, the reverse signal is also available directly from the BCM (max. 300mA), but there is no free pin available. **The only way to access this signal at this location would be via a splice into the existing wire.**

Refer to: 4.1 Wiring Installation and Routing Guides (page 61).

Splicing procedures and Refer to: 4.2 Communications Network (page 75). BCM, figure E145367(connector C2) and the following Figure E151619 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 Connectors



E151249

Item	Description
A	Left Connector Pin 5 on 14405 Harness - Yellow/Grey
B	Right Connector Pin 10 on 14A005 Harness - Yellow/Grey

A signal for a third brake/stop lamp is also available on the tail lamp connector.

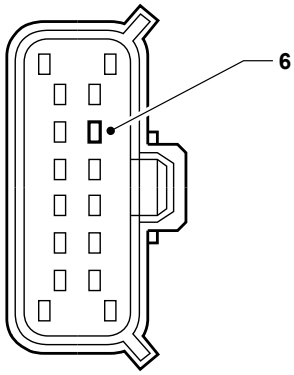
In order to avoid electrical issues due to leakage, and to ensure connector compatibility, a mating connector with seals/plugs and pre-crimped wire and terminal should be used.

For connectivity, see following 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 BK2T-13B576-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 61).

Trailer Tow Connector

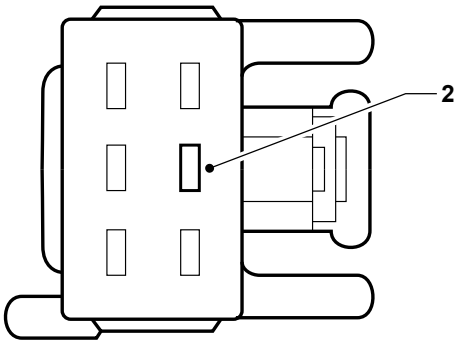


E151250

Item	Description
Pin 6	Stop Light Feed

Additional Position Lamps at the Rear of the Vehicle

Lighting Connector



E151251

Item	Description
Pin 2	Position Lamps

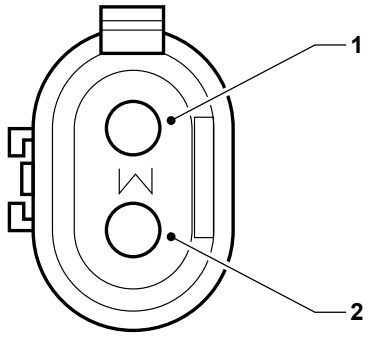
The feed for position lamps can be taken from the lighting connector, at the rear of the vehicle on 13B472 harness, pin 2, see figure E151251 or direct from the licence plate feed connector, see figure E151252, which is located in the door. The dealer will need to reconfigure this output for the maximum rating 46W total.

NOTE: Lighting connector shown in E151251 will require a local ground.

For Lighting Loads

Refer to: 4.11 Exterior Lighting (page 128).

Licence Plate Connector



E151252

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.

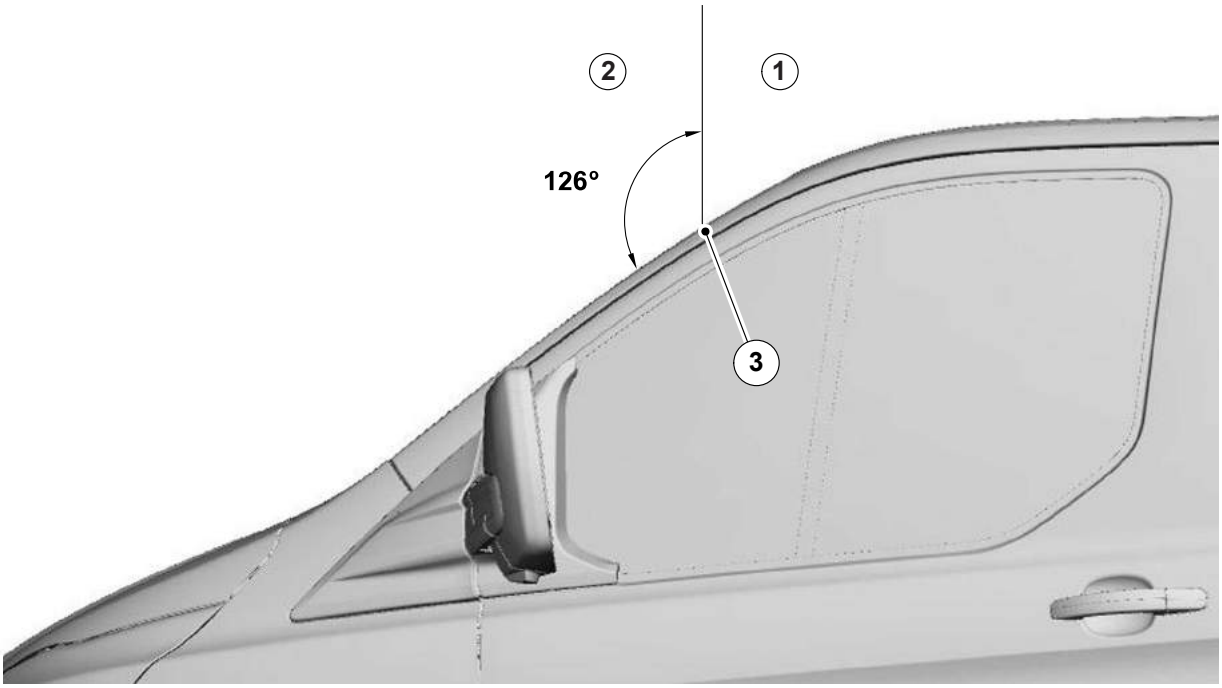
Fog Lamp Connector

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).

4.16.3 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).

4.17 Electrical Connectors and Connections

4.17.1 Connectors

Cutting into the Original Wiring System

WARNINGS:

Under no circumstances should the CAN Bus be tampered with. This may lead to failure of safety critical components such as Anti-Lock Brake System.

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.

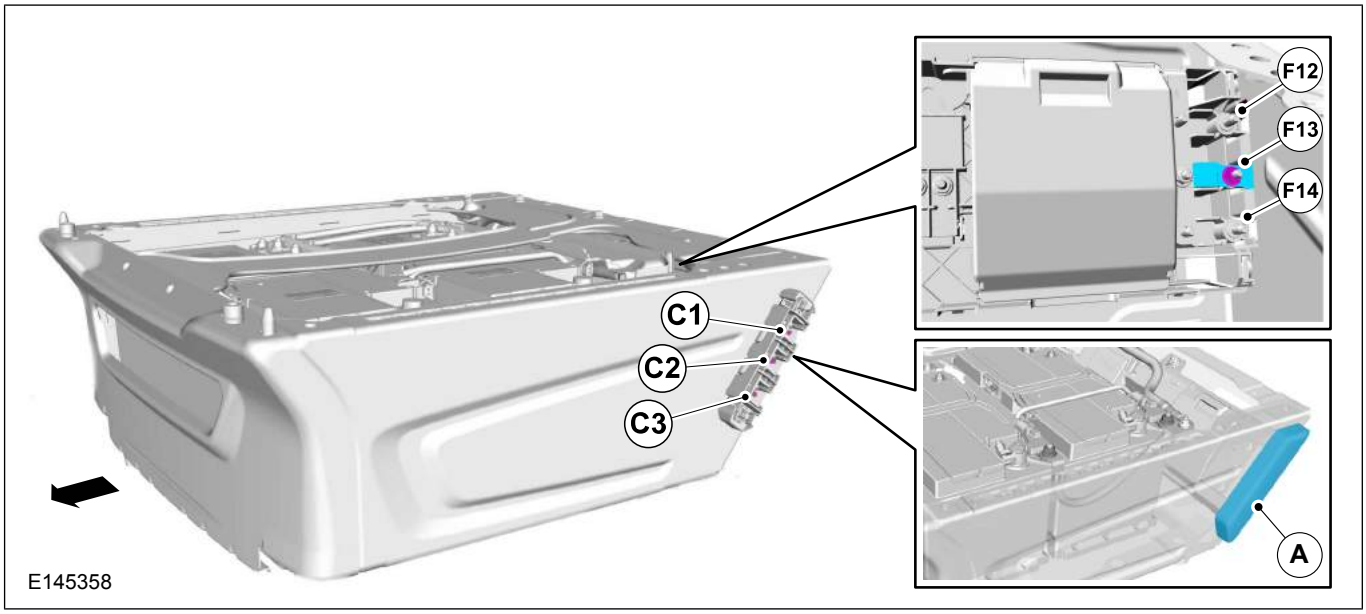
All connections into existing wiring must be permanently insulated. Exterior connections must be water-proof and with a drip loop.

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: Wiring Installation and Routing Guides (page ?).

NOTE: Ford approved jumper harnesses should be used.

4.17.2 Customer Connection Points (CCP)



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: Battery and Cables (page ?).

4.17.3 Camper Central Connectors

WARNING: If multiple systems are to use this supply, the total system load must not exceed the 60A short term loading.

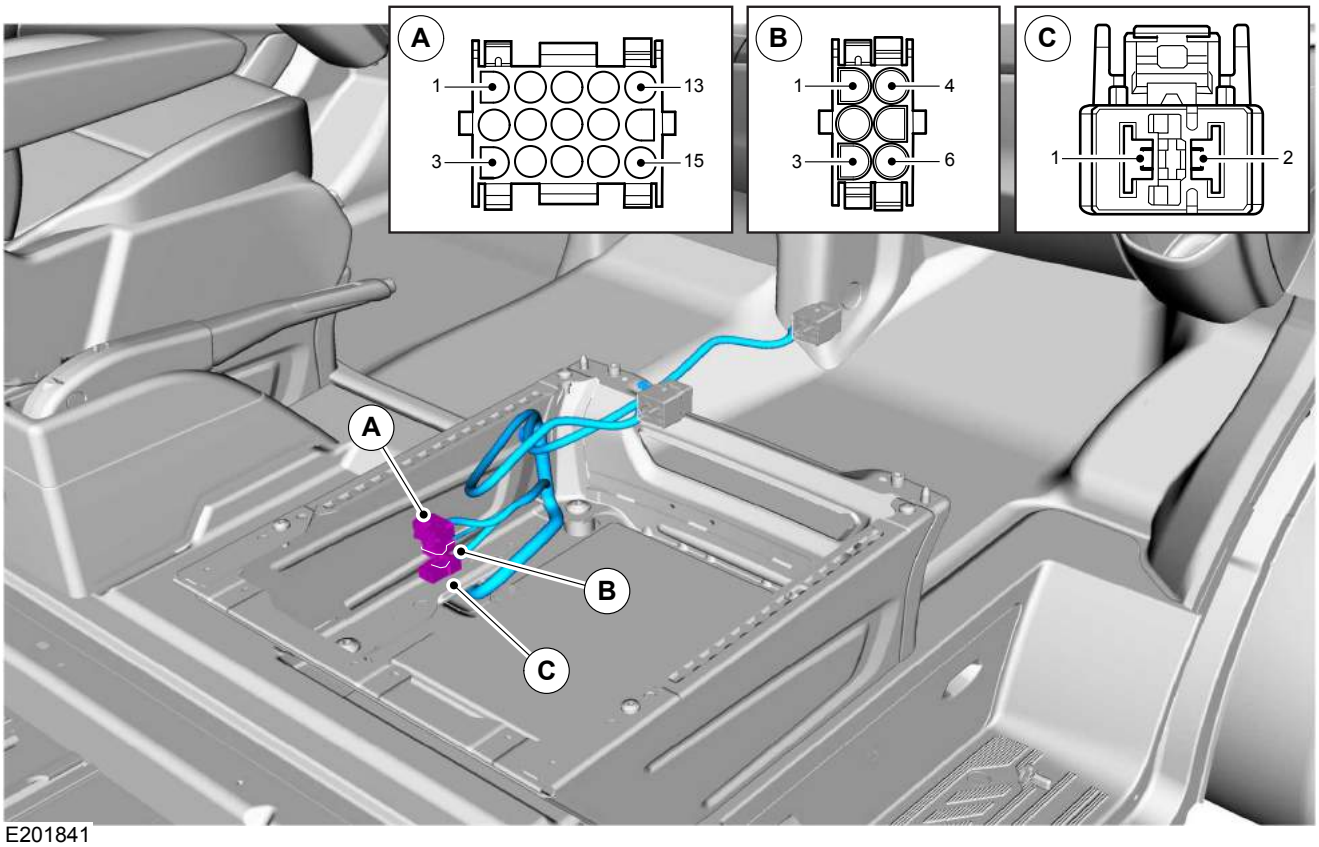
Camper conversions are fitted with a dedicated main wiring loom BK2V-14401-J*/K* including 3 customer connection points, as well as a dedicated instrument panel wiring loom BK2V-14K024-A*/D*. There is no customer interface, instead, three connectors are located within the passenger seat pedestal to support 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: Electrical Connectors and Connections (page ?).

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

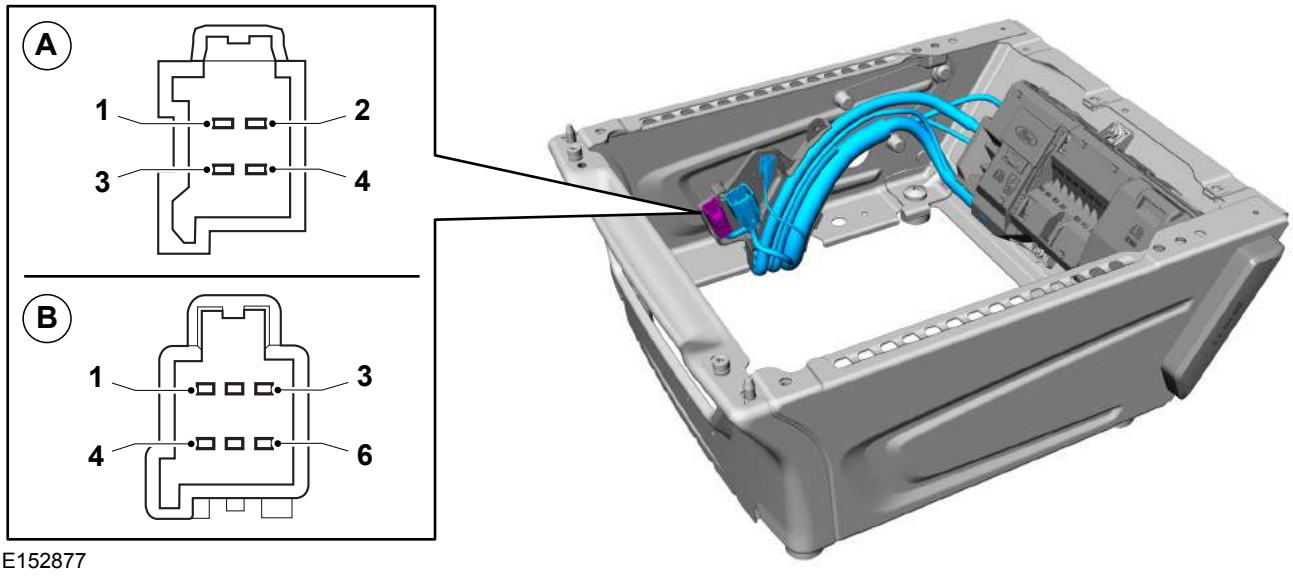
Pin	Function	Wire CSA	Color	Comments
Connector C2-1 (Figure E169183 - Item A)				
1	Stop lamp (CHMSL)	1.5	Yellow/Grey	21W max
2	Engine Run	0.5	Brown/Yellow	300mA,**Ground** switching
3	Vehicle Speed Output	0.5	Violet/Orange	138Hz@100KPH, 50% duty cycle
4	Lock^	1.5	Grey/Yellow	Ford lock set (+ve pulse)
5	Unlock^	1.5	Violet/Grey	Ford lock set (+ve pulse)
6	Rear Door Ajar	0.5	Brown/Violet	300mA max
7	Interior light feed^^	0.75	Violet/Green	300mA max
8	Interior light ground	0.75	Yellow/Grey	300mA max
9	Not used			
10	Not used			
11	Not used			
12	Air Conditioning request	0.75	Violet	300mA (nominal)
13	Ignition (KL15)	1.5	Blue/Grey	10A/F21 (SRB)
14	SRC/Start-Stop Inhibitor	0.5	Violet/Grey	Ground=SRC/Start-Stop disabled
15	Reverse signal	0.75	Green/Brown	300mA max
Connector C2-2 (Figure E169183 - Item B)				
1	Not used			
2	Rear Speaker Left +	0.75	White/Green	Twisted pair
3	Rear Speaker Left -	0.75	Brown/Yellow	
4	Rear Speaker Right +	0.75	Brown/White	twisted pair
5	Rear Speaker Right -	0.75	Brown/Blue	
6	Instrument Panel Illumination	0.5	Yellow/Grey	300mA (nominal)
Connector C2-3 (Figure E169183 - Item C)				
1 (A)	B+ (KL30)	6.0	Brown/Red	60A Fed from Pre Fuse Box
2 (B)	B-	6.0	Black/Grey	Ground

^ The lock and unlock signals are intended to operate with Ford lock sets, or components with equivalent function and operational characteristics: – Central Locking: 1.0s pulse; followed by 0.25s pulse for Double Locking, – Unlocking: 0.25s pulse followed immediately by 1.0s pulse.

^^ Battery saver default time is 30 minutes (alternative configurations: 180 minutes).

Note: There are no additional ground wires in either C2-1 or C2-2 auxiliary devices and systems; local grounds should be used.

4.17.4 Vehicle Interface Connector



E152877

The Vehicle Interface Connector is on every vehicle except Camper Vans and Business Bus derivatives and provides a direct interface to signals. See figure E152877 for location and the following table for signals.

NOTE: There are two versions of Vehicle Interface Connector depending on the build date of the vehicle, connector A or connector B.

Vehicle Interface Connector Signals

4 Way - Connector A		6 Way - Connector B	
1	Vehicle Speed	1	Vehicle Speed
2	Switch Illumination only, not for relay as pulse width modulated (PWM)	2	Switch Illumination only, not for relay as pulse width modulated (PWM)
3	Engine Run - Ground	3	Engine Run - Ground
4	Ignition	4	Ignition
-	-	5	_
-	-	6	-

WARNINGS:

Signals 1 to 3 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 4 is 10A and not to be exceeded in any situation.

Unused wires in the service kit must have cable ends insulated to avoid shorting on any ground points.

A service kit can be ordered from your local Ford Dealer, the kit contains the mating connector to access these signals, and 3 meters of wiring. Check with your local Ford Dealer which Vehicle Interface Connector you have on your vehicle before ordering the kit.

Connector A or B	Mating Connector	Kit
4 Way - Connector A	4S7T-14489-VD*	KTBK2V-14A411-CB*
6 Way - Connector B	4S7T-14A459-VGA	KTBK2V-14A411-C*

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 1 - 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.

Switch Illumination

Pin 2 - Switch Illumination signal is only to be used for sensing or to control a relay. It is a PWM singnal only for low current illumination 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 3 - 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.

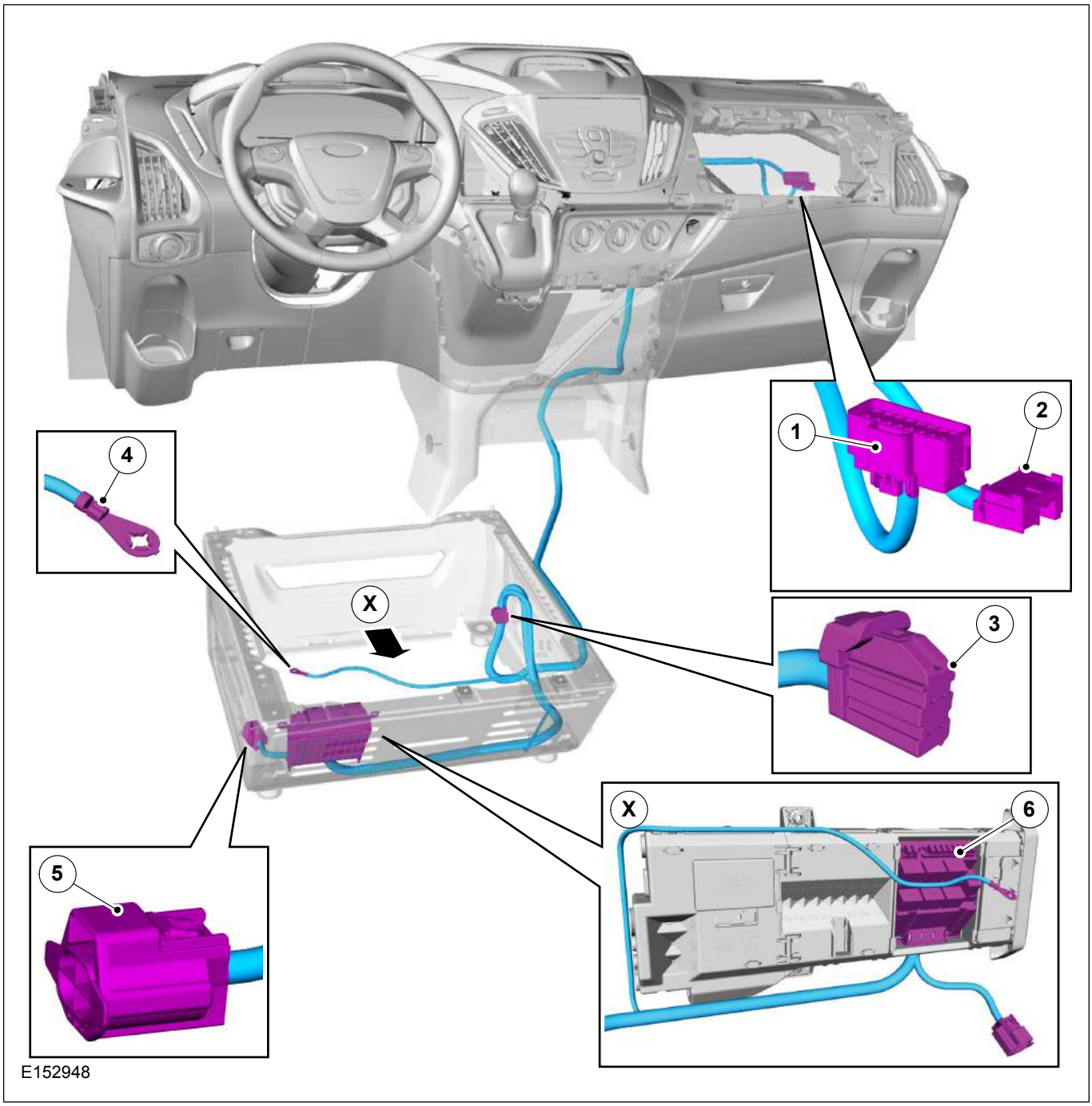
Ignition

Pin 4 - 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.

4.17.5 Auxiliary Fuse Panel (A526)

The Auxiliary Fuse Panel is recommended for vehicle converters where access to fused power connections are required (for example, additional lighting), see figures E152948 and E152949. A dedicated wiring harness (BK2V-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 E152877, 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.

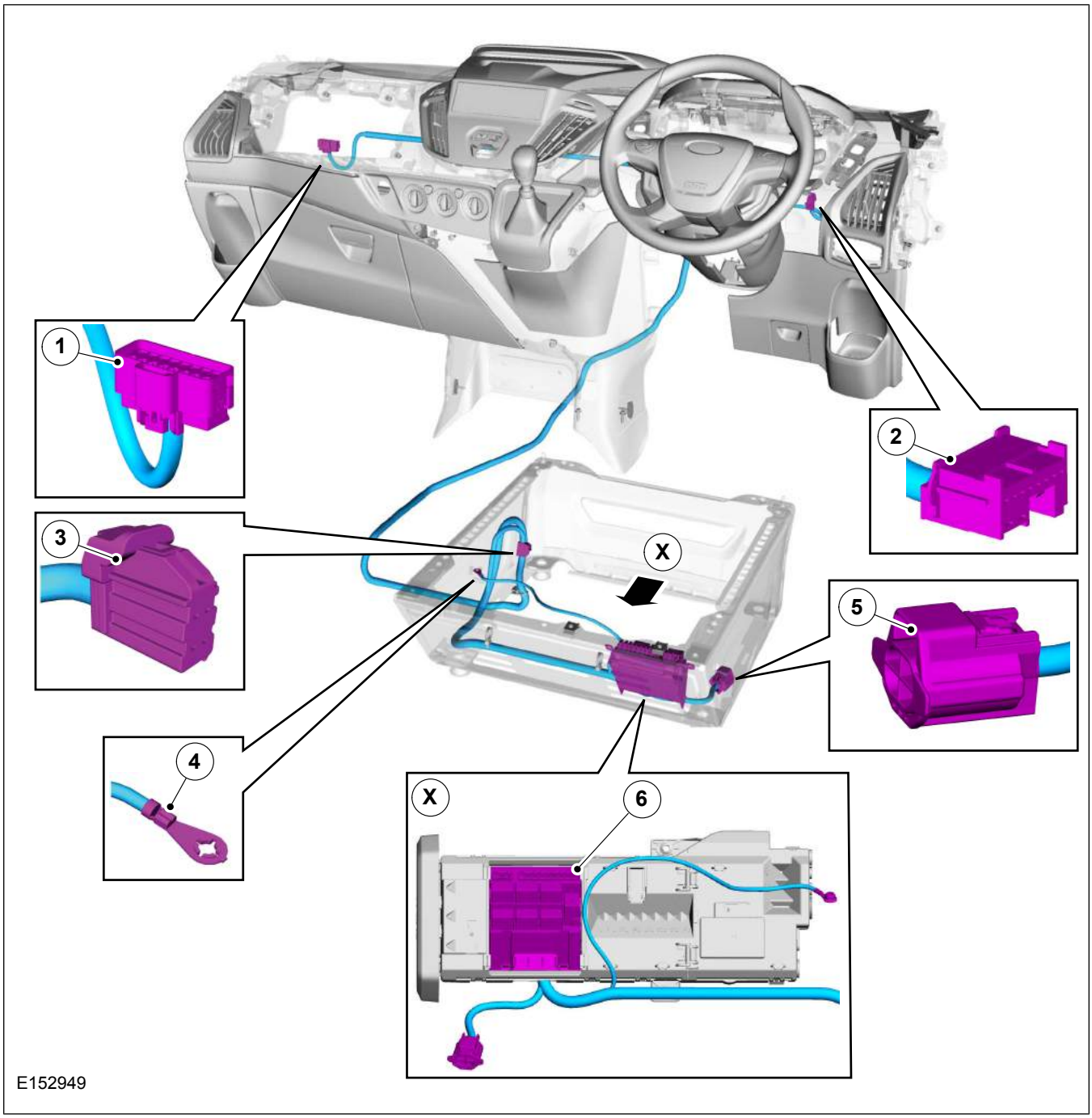
Auxiliary Fuse Panel (A526) - Left Hand Drive



E152948

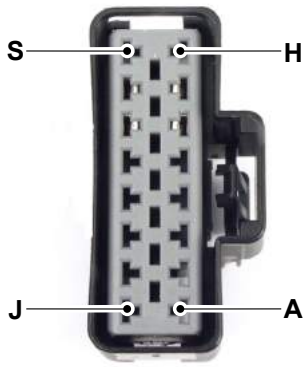
Item	Description
1	C1 Connector
2	C2 Switch Connector
3	Vehicle Interface Connector
4	Ground
5	C3 — 2 Way Radio Connector
6	Auxiliary Fuse Panel within the Pre-Fuse Box (lid not shown)

Auxiliary Fuse Panel (A526)- Right Hand Drive



Item	Description
1	C1 Connector
2	C2 Switch Connector
3	Vehicle Interface Connector
4	Ground
5	C3 — 2 Way Radio Connector
6	Auxiliary Fuse Panel within the Pre-Fuse Box (lid not shown)

C1 Connector

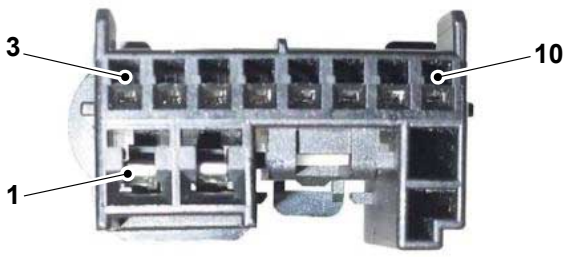


E102527

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 E152948 and E152949. 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 (KTBK2V-14A411-A*) can be ordered from your local Ford dealer, this kit contains the mating connector, and 3 meters of wiring.

C2 Switch Connector



E152952

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 Connector — KTBK2V-14A411-B*

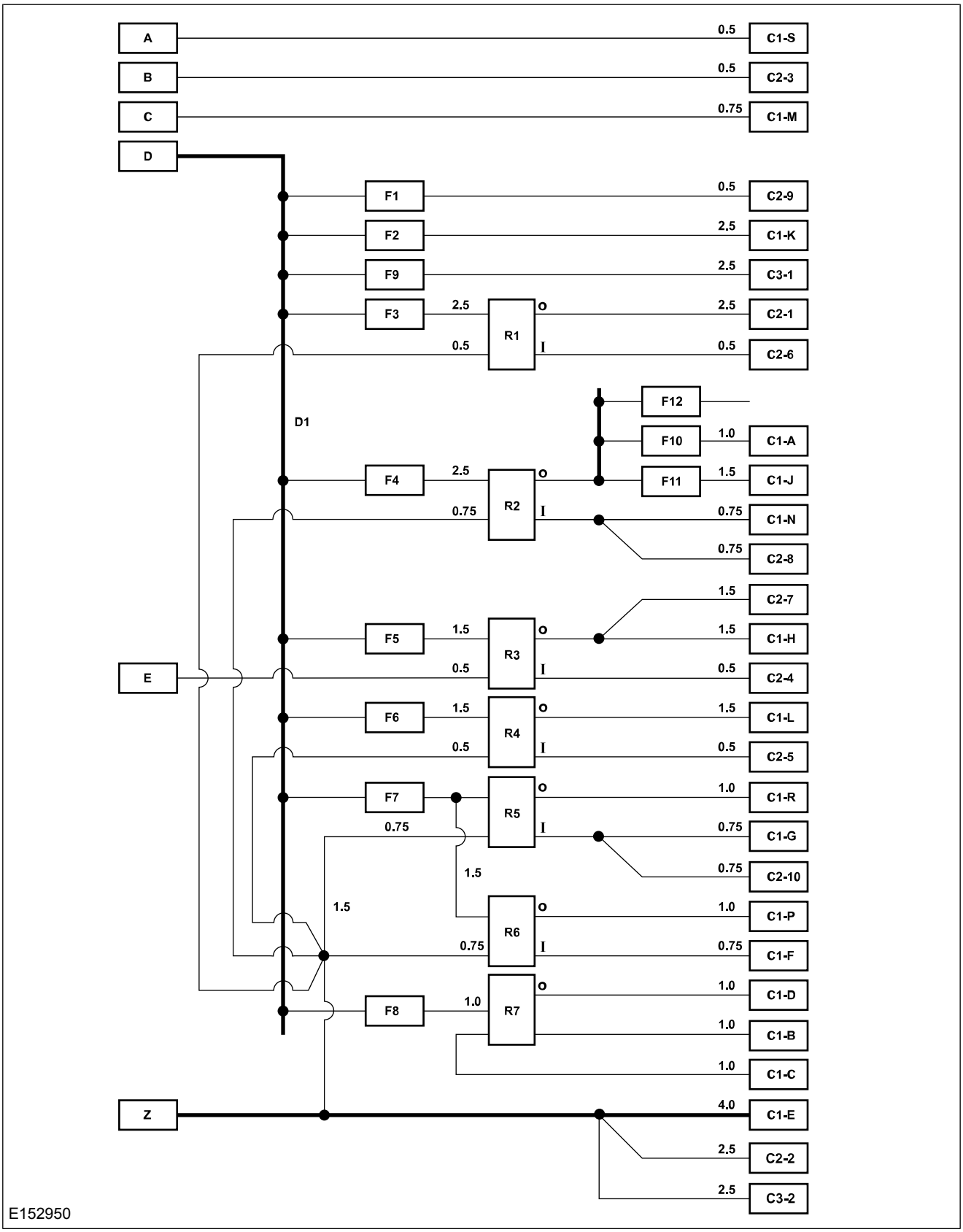
C3 - 2 Way Radio Connector

E152951

Item	Description
1	KL30 20A
2	Ground

C3 Mating Connector - 6S6T-14A459-HK*

Auxiliary Fuse Panel Circuit Diagram

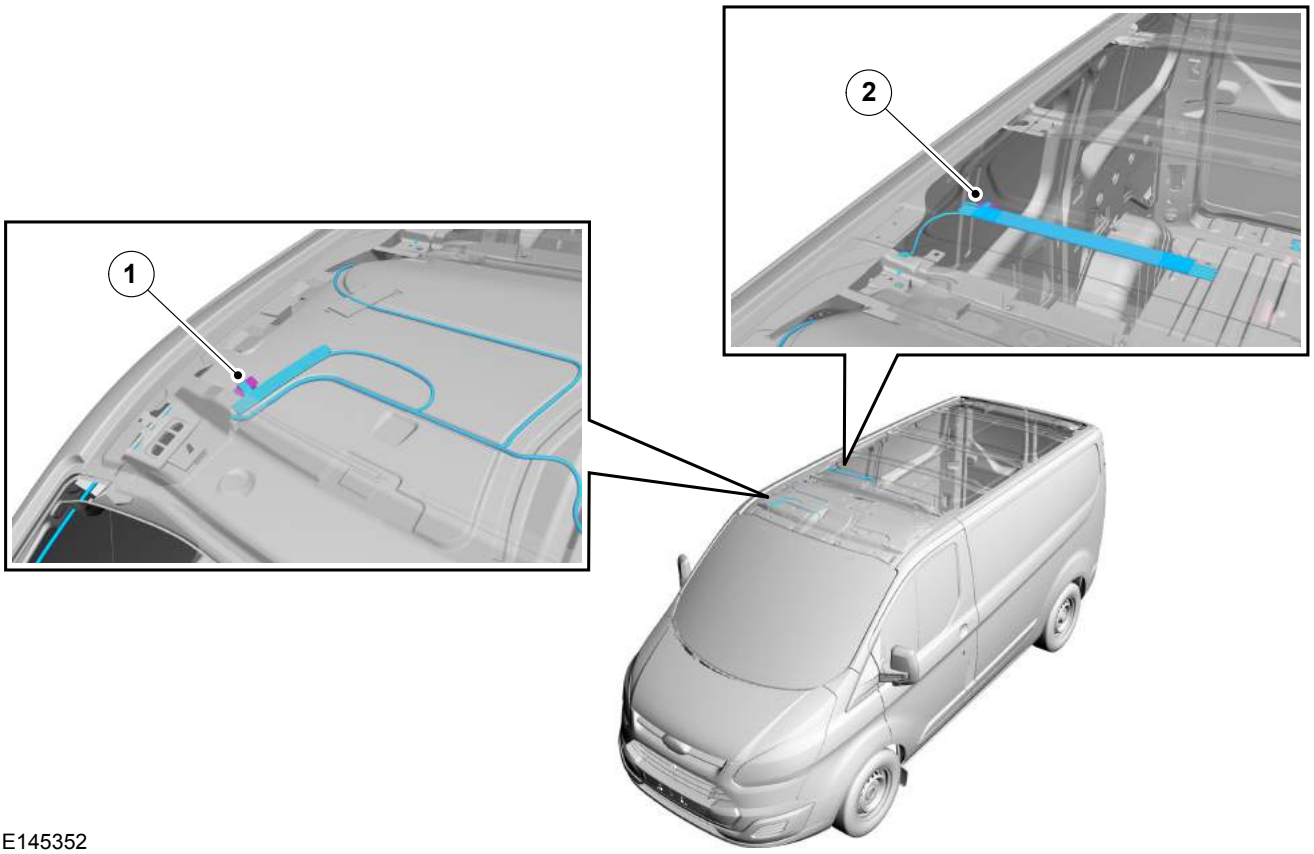


Item	Description	Item	Description
A	Vehicle Speed	C1-B	R7 Coil OUT
B	Switch Illumination	C1-C	R7 Coil IN
C	Ignition Switch	C1-D	R7 Output
D	KL30	C1-E	Ground
E	Engine Run Signal - Ground	C1-F	R6 Coil IN
D1	Busbar	C1-G	R5 Coil IN A
Z	B-	C1-H	R3 Output 1
F1	3A Fuse	C1-J	R2 Output 2
F2	20A Fuse	C1-K	KL30
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 (Beaconˆ)	C2-5	R4 Coil IN
R2	20A Relay (Ignitionˆ)	C2-6	R1 Coil IN
R3	20A Relay (Aux 2/Water Heaterˆ)	C2-7	R3 Output 2
R4	20A Relay	C2-8	R2 Coil IN B
R5	20A Relay (LHS Indicator/Aux 1ˆ)	C2-9	KL30
R6	20A Relay (RHS Indicatorˆ)	C2-10	R5 Coil IN B
R7	20A relay	C3-1	KL30
C1- A	R2 Output 1	C3-2	Ground

ˆWhen specified on Ford options

4.17.6 Beacon Preparation Pack (A606)

A606 - Vehicles built before February 2016



E145352

Item	Description
1	Front beacon harness on BK2V-14A303-**
2	Rear beacon harness on BK2V-14A303-**

Figure E145352 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 E152953 and E152954 for Switches and see figures E152948 and E152949 for Auxiliary Fuse Panel, shown in this section.

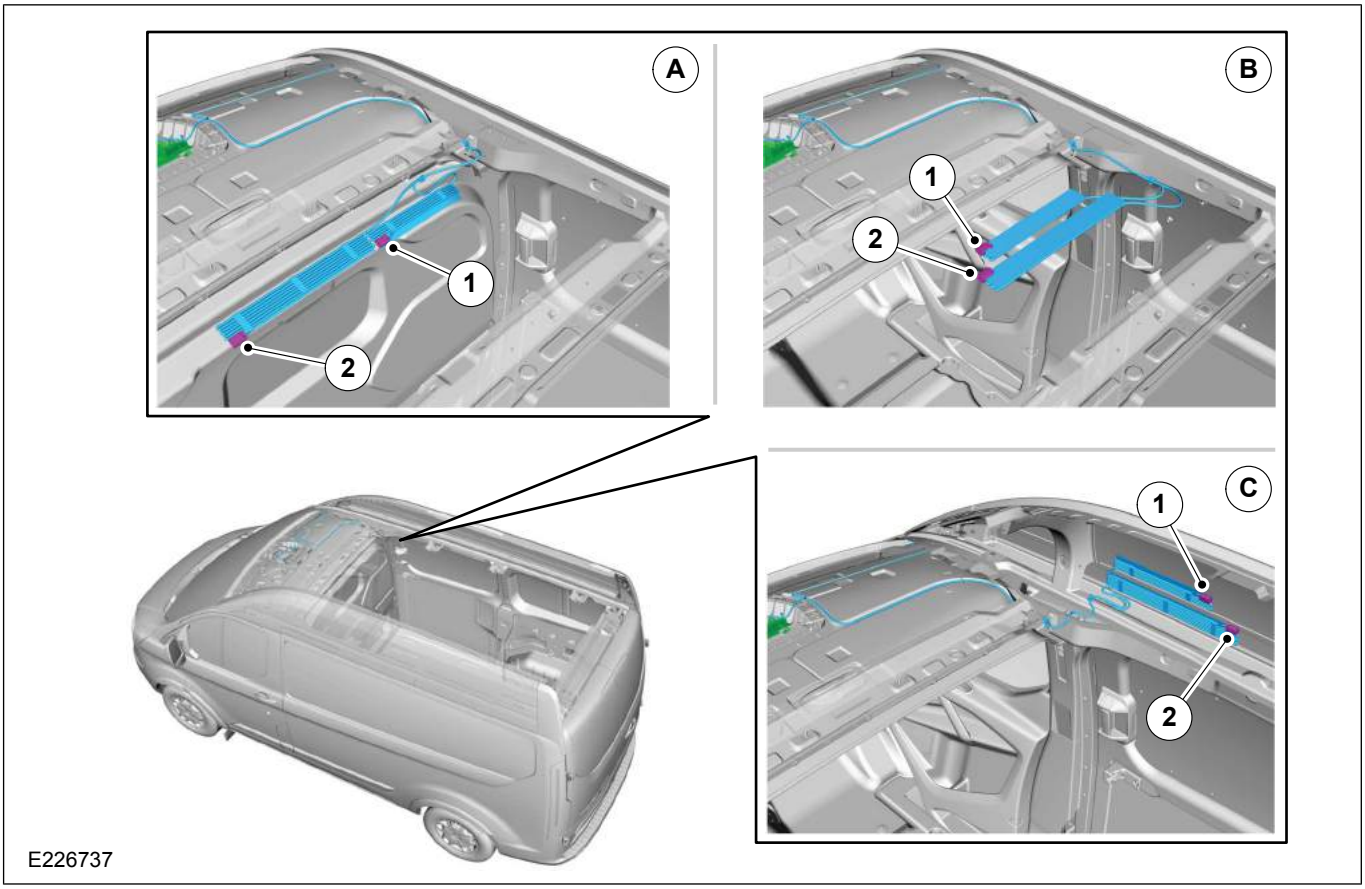
The beacon wiring circuit is fused at 20A. Any increase in this current demand should be met with the use of an external relay.

Contact your National Sales Company representative or Local Ford Dealer for availability and options.

E118455

Item	Description
1	Ground
2	Beacon Supply

A606 - Vehicles built after February 2016



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 E152948 and E152949 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.

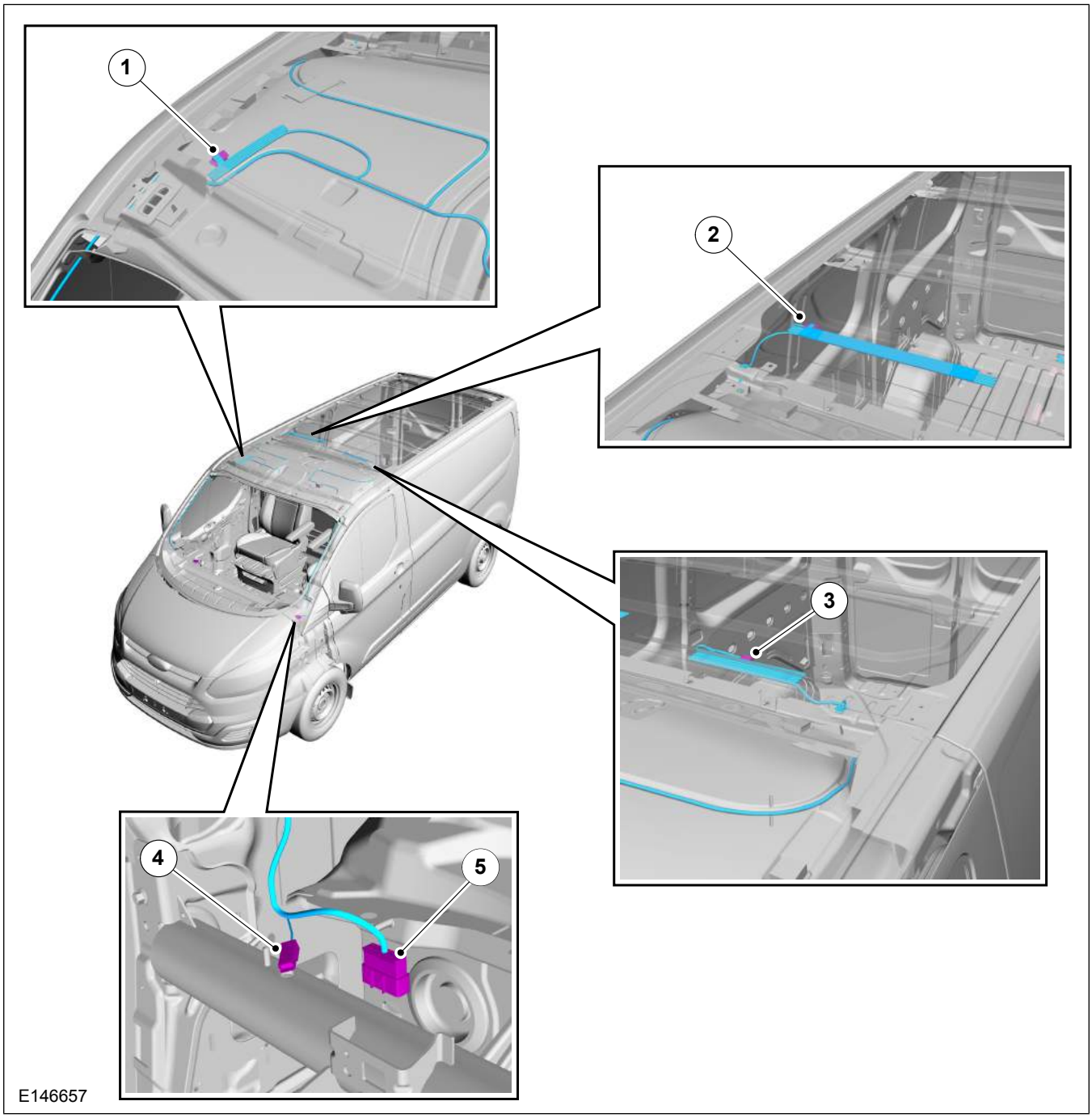
Contact your National Sales Company representative or Local Ford Dealer for availability and options.

E118455

Item	Description
1	Ground
2	Beacon Supply

4.17.7 Utility Vehicle Switch Pack (A607)

A607 - Vehicles built before February 2016 - Right hand drive shown

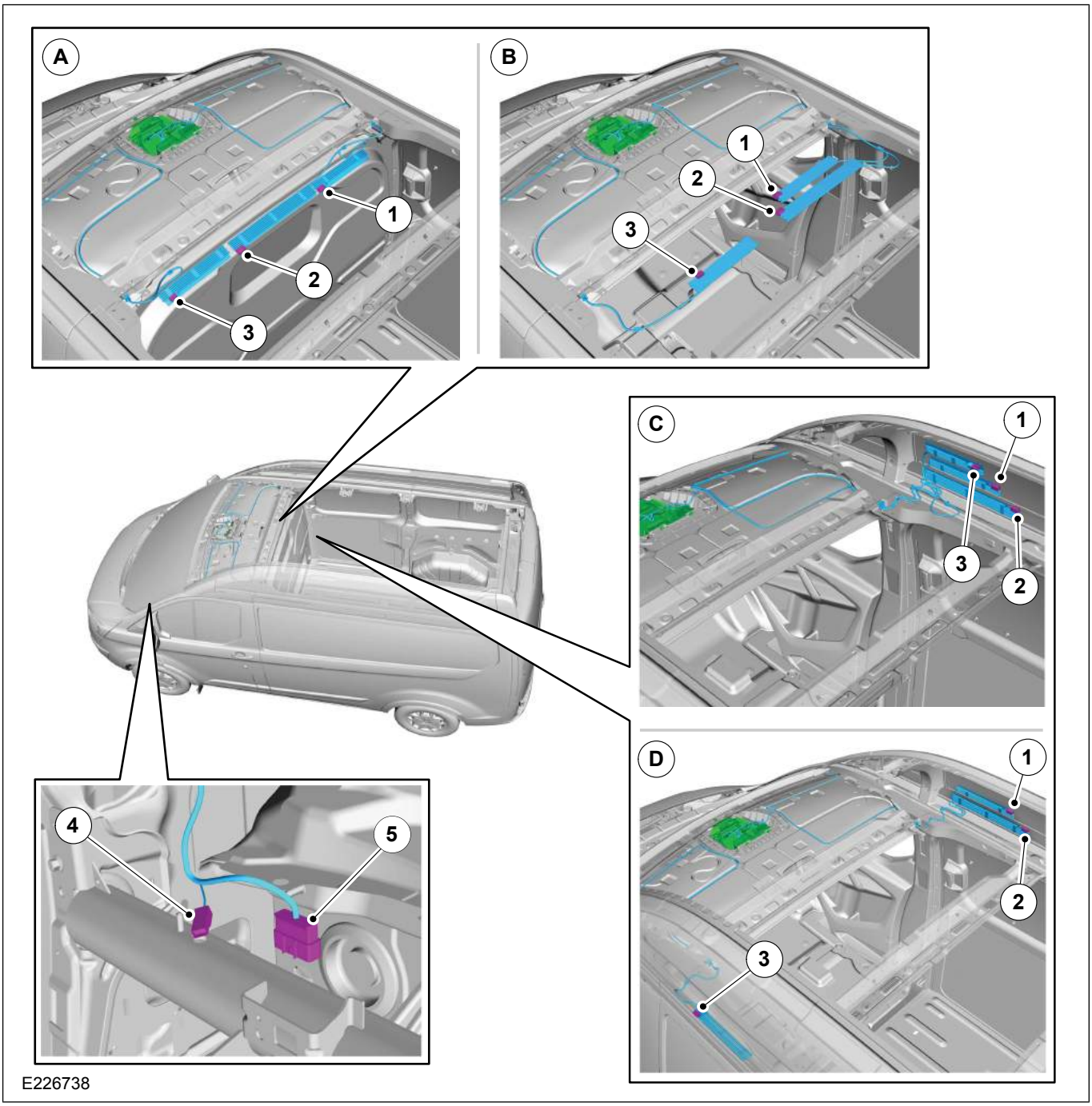


Item	Description
1	Front Beacon Connector
2	Rear Beacon Connector
3	Aux 2 Connector (Limited availability, check local National Sales Company representative)
4	Aux 1 Connector
5	Mating C1 Connector

The Utility Vehicle Switch Pack has Beacon Preparation Pack and an additional harness BK2V-14659-B*. 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-**.

Harness BK2V-14659-B* is always on the passenger side of the vehicle and connects to the C1 connector of the switch harness BK2V-14A303-**, see E152948 and E152949 for C1 connector location and also figures E152953 and E152954 for Switches.

A607 - Vehicles built after February 2016 - Right Hand Drive shown



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*
D	High Roof LHD vehicles (without bulkhead)	4	Aux 1 Connector
-	-	5	Mating C1 Connector

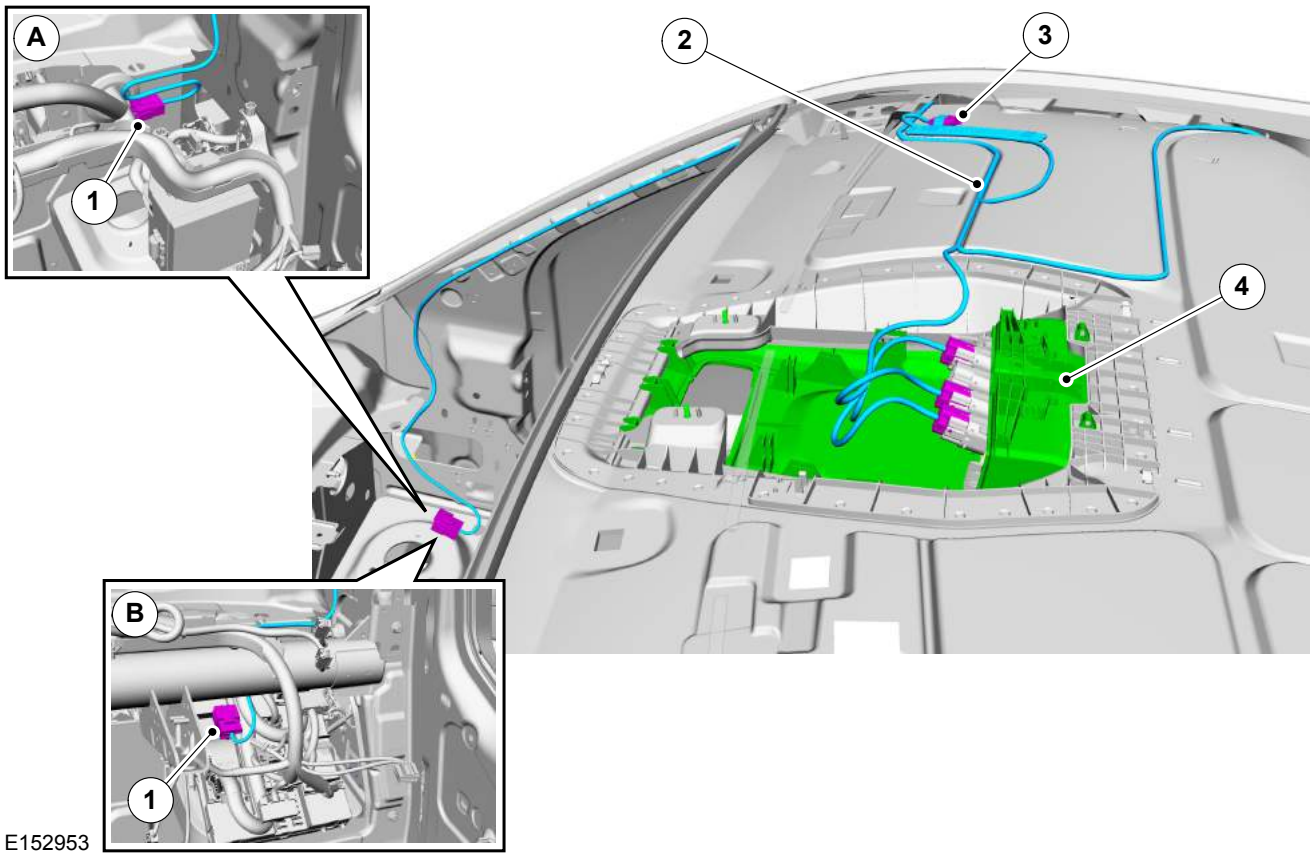
* Limited Availability, check with local National Sales Company Representative.

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 E152948 and E152949 for C1 connector location and also figures E226739 and E152954 for Switches.

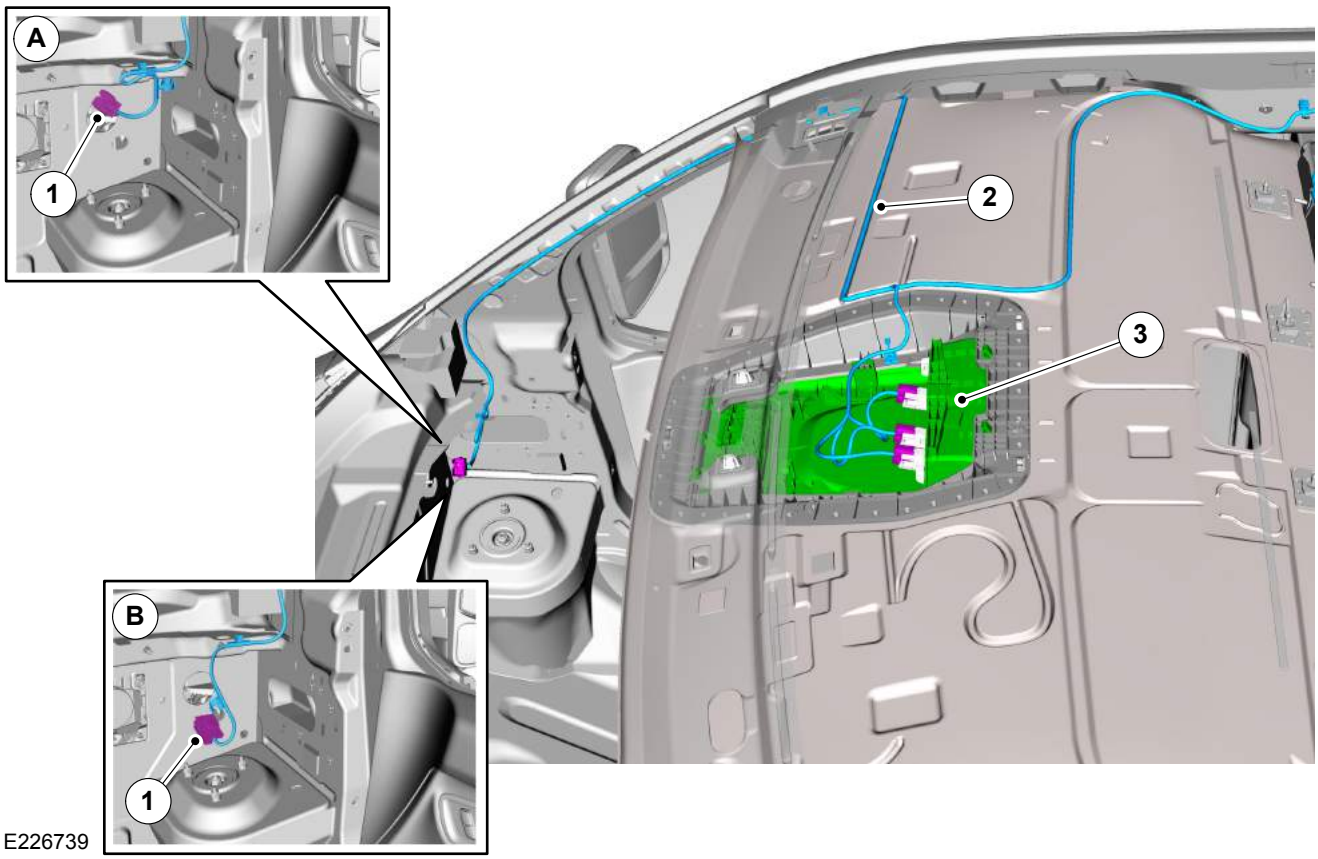
4.17.8 Auxiliary Switches

Vehicles built before February 2016



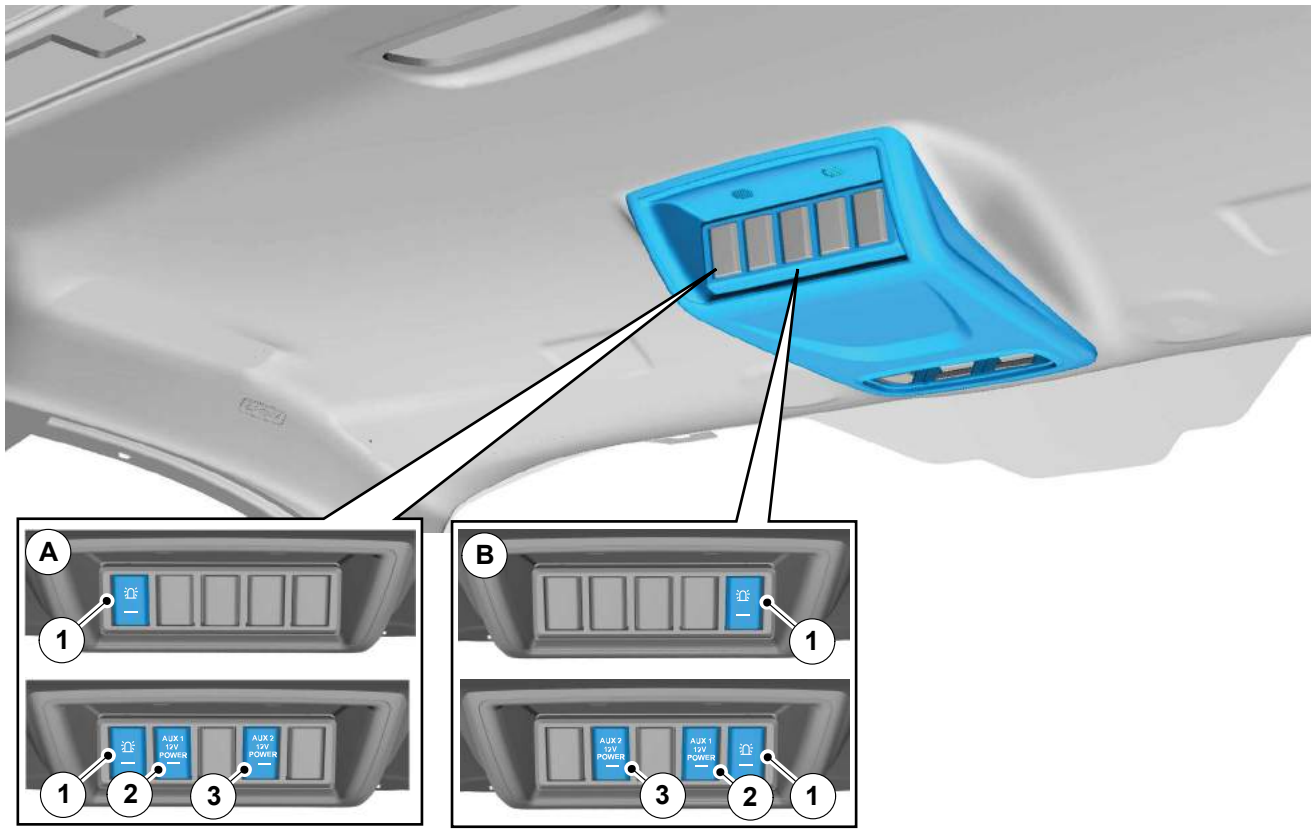
Item	Description
A	Left Hand Drive location
B	Right Hand Drive location
1	C2 Connector
2	BK2V-14A303_** Harness (see E152954 and switch table)
3	Front Beacon Connector
4	Over Head Console - Containing Switches

Vehicles built after February 2016



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

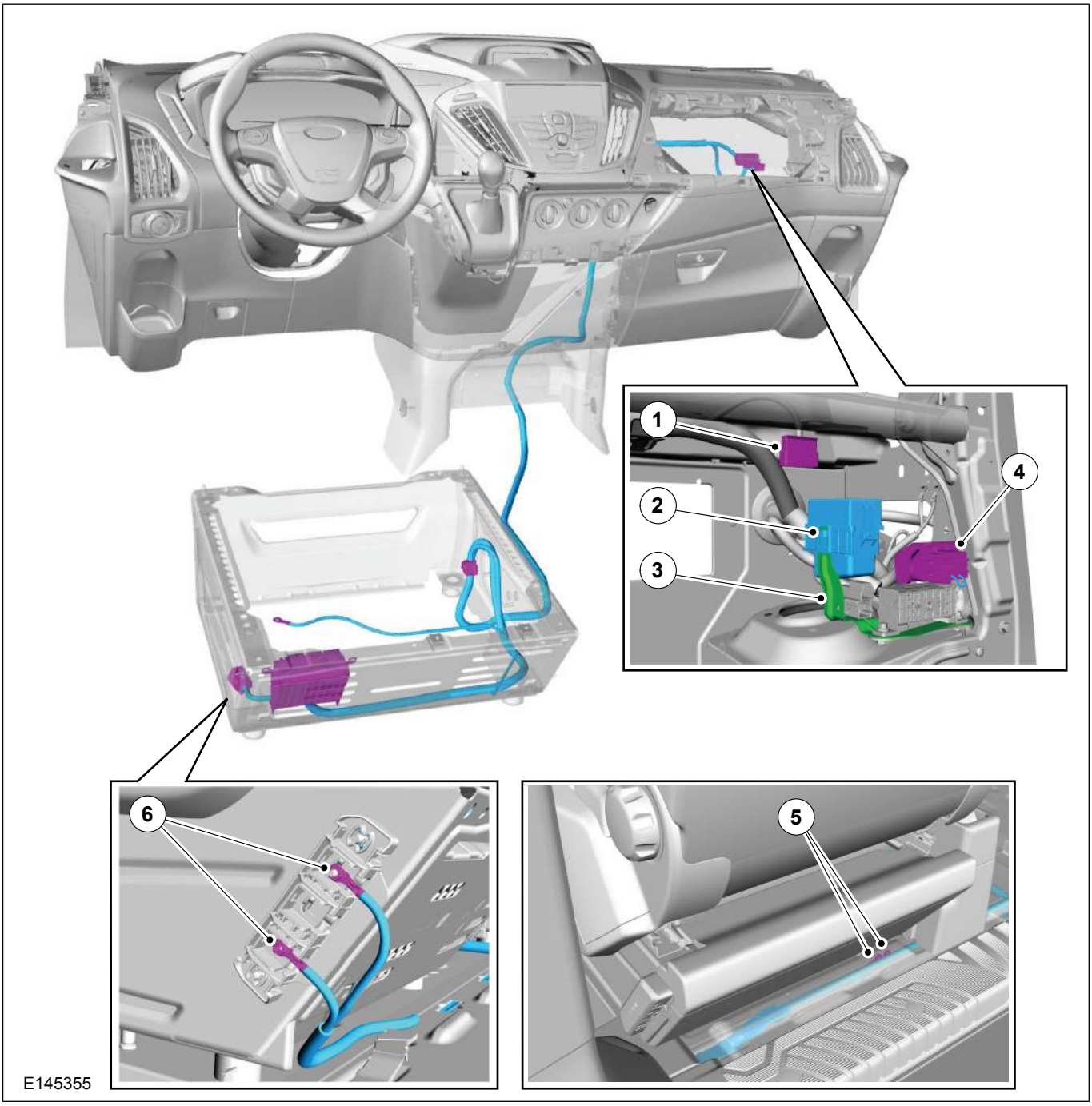
Harness	Beacon	Aux 1 (12V)	Aux 2 (12V)
BK2V-14A303-A*	BK2V-13D768-A*	-	-
BK2V-14A303-F*	BK2V-13D768-A*	BK2V-13D734-A*	BK2V-13D734-B*

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 (A736). 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.

4.17.9 High Specification Vehicle Interface Connector (A608)



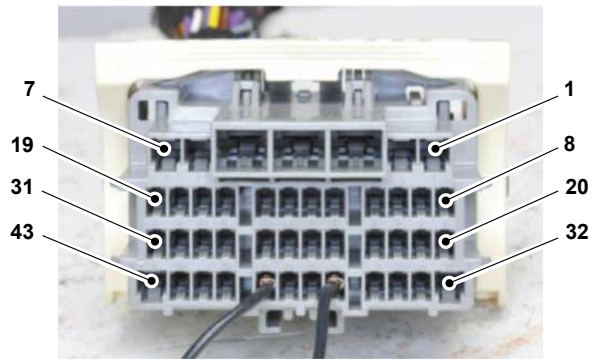
Item	Description
1	C1 Connector
2	Fuse Box — For High Specification Vehicle Interface Connector
3	Fuse Box Bracket
4	High Specification Vehicle Interface Connector
5	The connections are taped back to the harness under the carpet, behind the Drivers Seat Pedestal
6	60A fuse Connections on Drivers Seat Pedestal

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 can not 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 BK2V-14401-A*/D* and BK2V-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.



E145357

High Specification Vehicle Interface Connector

Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
1	2.00	KL58	Licence 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	0.50	AC Active	AC Active = Ground (<50 ohms)	-	-	NA
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	Output from BCM	-	-	300mA
36	0.50	KL50	Bridged with 39 - Open Circuit will inhibit Crank ^	-	-	300mA
37	0.50	Handbrake Signal	Handbrake Activated = Ground (<50 ohms)	-	-	NA
38	0.50	Engine Run	Engine Running = Ground(<50 ohms)	-	-	NA
39	0.50	No Start Function	Bridged with 36 - Open Circuit will inhibit Crank ^	-	-	NA
40	1.00	Key In^^	12V	-	-	-

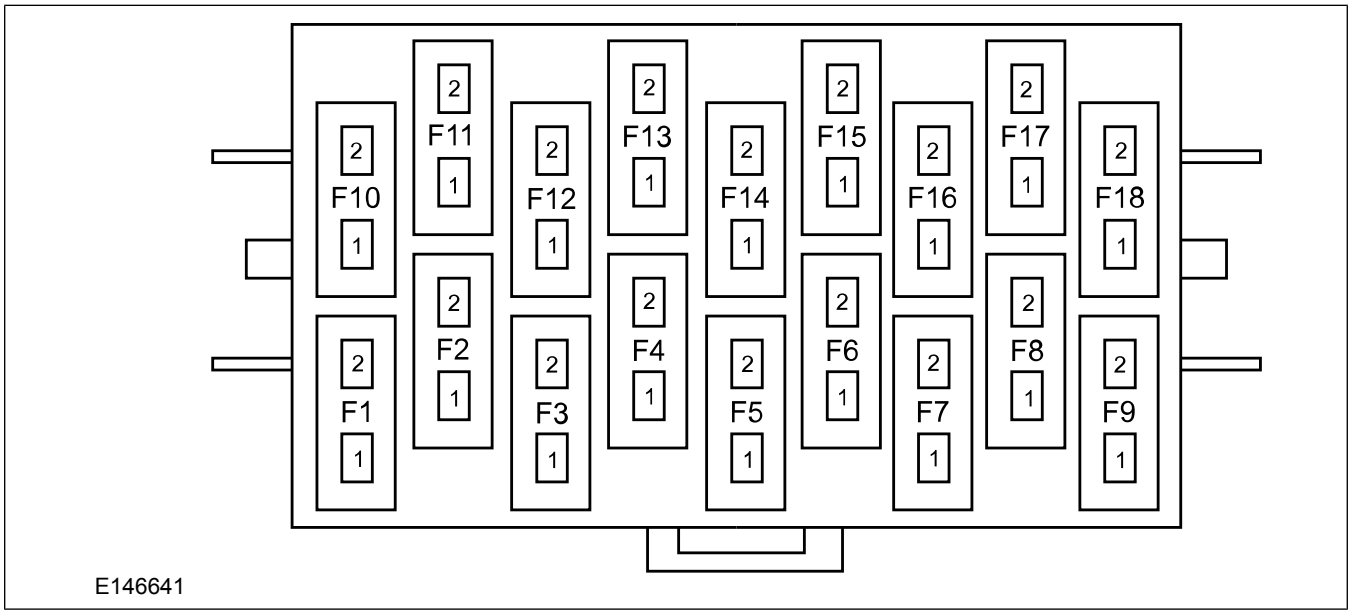
Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
41	0.50	Driver Door Ajar	Door Closed = Ground (<50 ohms)	-	-	NA
42	0.50	Lock	Lock Request = Ground 500mS.	-	-	NA
43	0.50	Unlock	Unlock Request = Ground 500mS.	-	-	NA

ˆ Bridged via circuit on mating connector to enable crank/start. If mating connector is removed, vehicle will not start

ˆˆ 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.

KL Terminology	
KL15	Ignition - Position 2
KL30	B+ (Always +12V)
KL31	Chassis or Body Ground
KL50	Crank/Start Position 3
KL58	Side Marker and Licence 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 could insecurely 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.

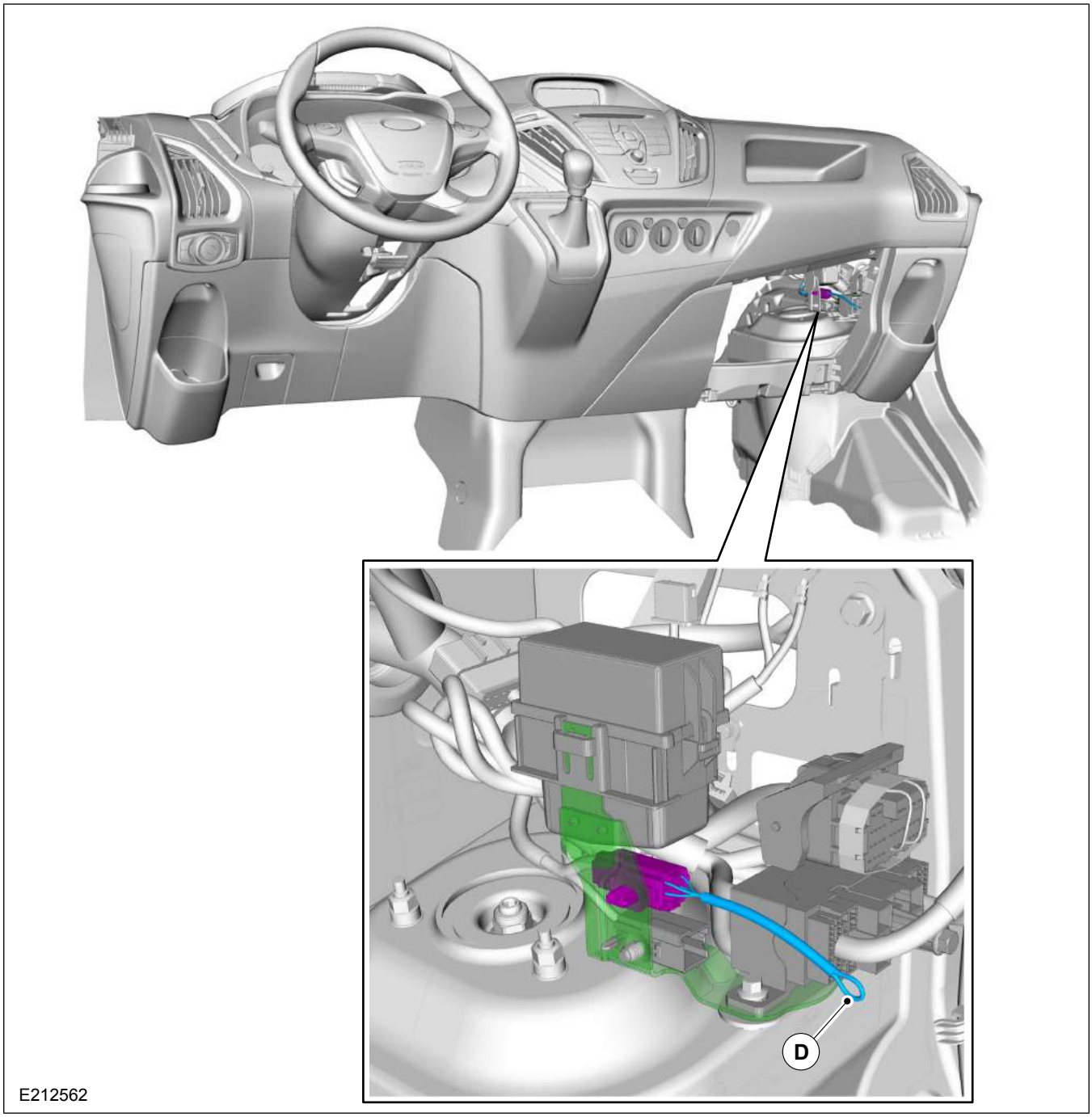
The High Specification Interface Connector option A608 has a 125Kb/s MS CAN interface EDS connection point that can have third party CAN wires spliced into. This is designed to provide Ford CAN Bus interfacing for third party fit module telematics and logic controller systems. For further information on splicing

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

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 Grey/Orange wire. CAN High is the Violet/Orange wire.

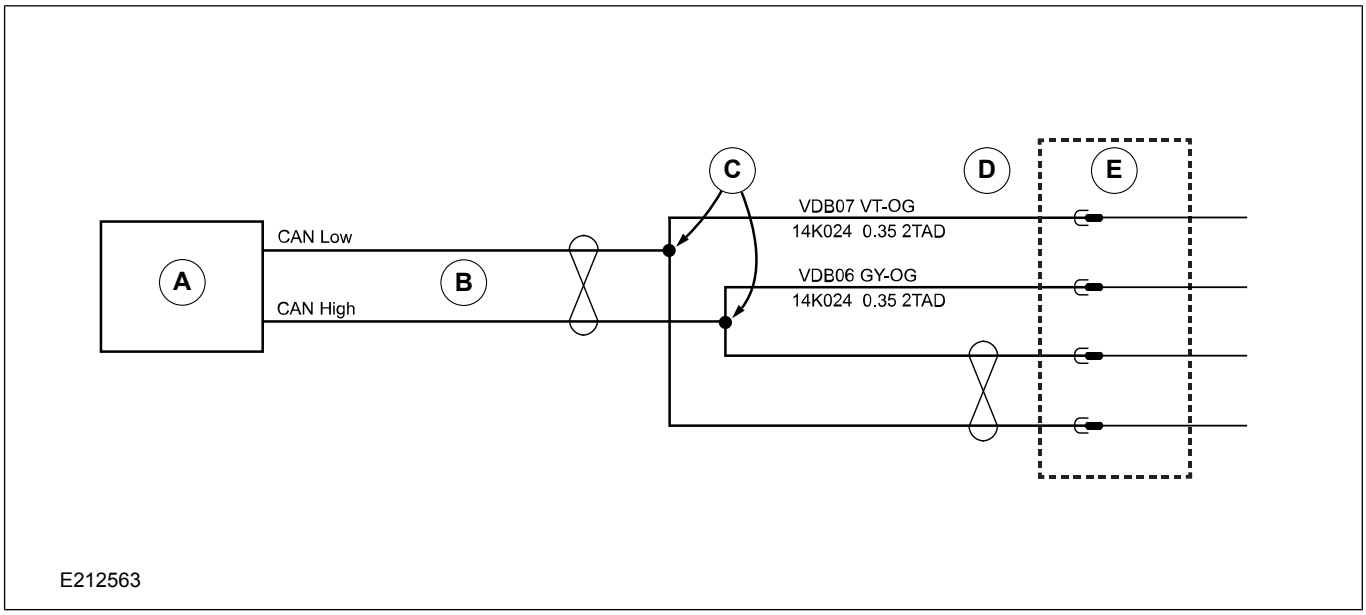
CAN Bus Interface Loop Wire Location



E212562

Item	Description
D	Splice into mid point of loop

Third Party Fit CAN Read Module



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 (Grey/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.

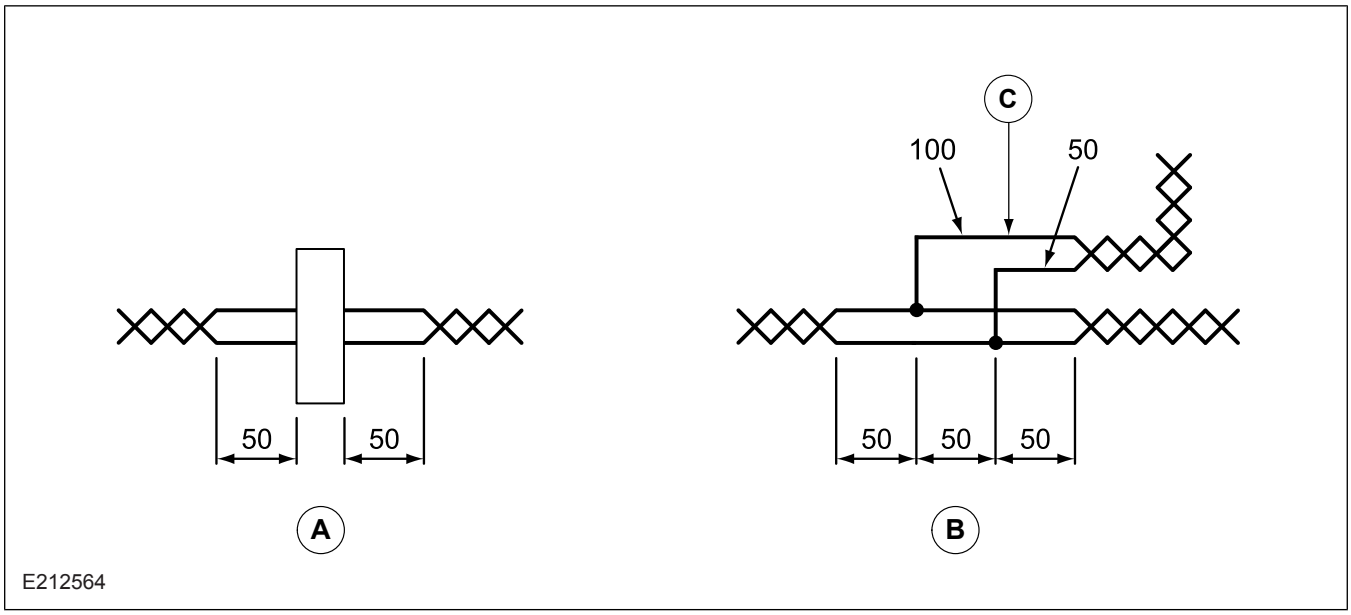
Physical Interface of spliced in EDS Requirements

Parameter	Minimum	Nominal	Maximum	Units
Impedance	108	120	132	Ohm
Resistance	-	-	175	milli Ohm/meter
Signal Speed	-	-	5.5	nano Second/ meter
Twisting	3^	-	-	Twisted/50mm
Phase Shift	-	-	3.4	nano Second
Differential Mode Offset	-	-	0.5	Volts

^ The Twisted circuits shall have a minimum twist rate of 3 twists (4 wire crossovers) per 50 mm. One "twist" or "turn" = 180 deg. Rotation. Twisting shall be maintained to within 50mm of any in-line or component connector.

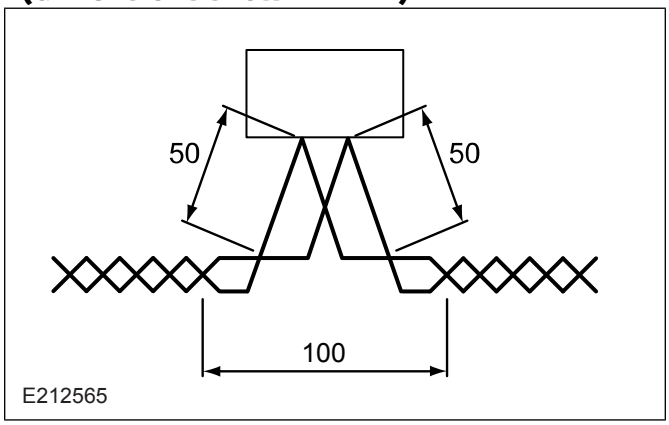
The twisted pair that forms the CAN Bus shall be twisted throughout the total run of the vehicle except for a maximum of 50mm from connectors or harness splices. At splices an additional 50mm of untwisted wire is allowed between the CAN H and CAN L contact points

Twisted Circuits - all values are maximum limits (dimensions shown in mm)



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)



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

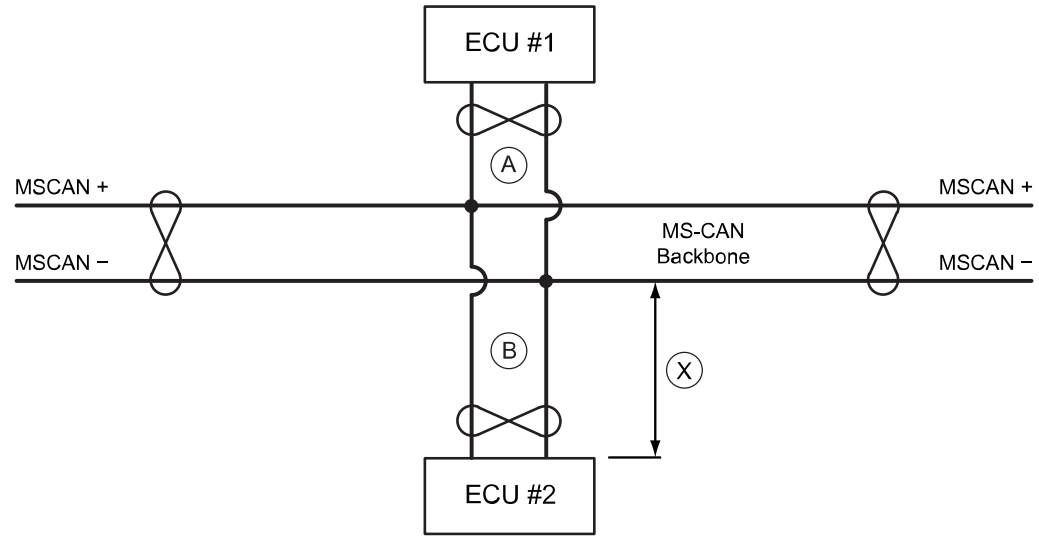
Network Speed	Between terminating ECU's	SAE J1962 Connector to 'Furthest' Terminating ECU^
125 kbps	50m	45m
500 kbps	33.5m	28.5m

^ 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



Item	Description
A	Stub 1
B	Stub 2
X	Stub - Final length between 0.3m and 2m

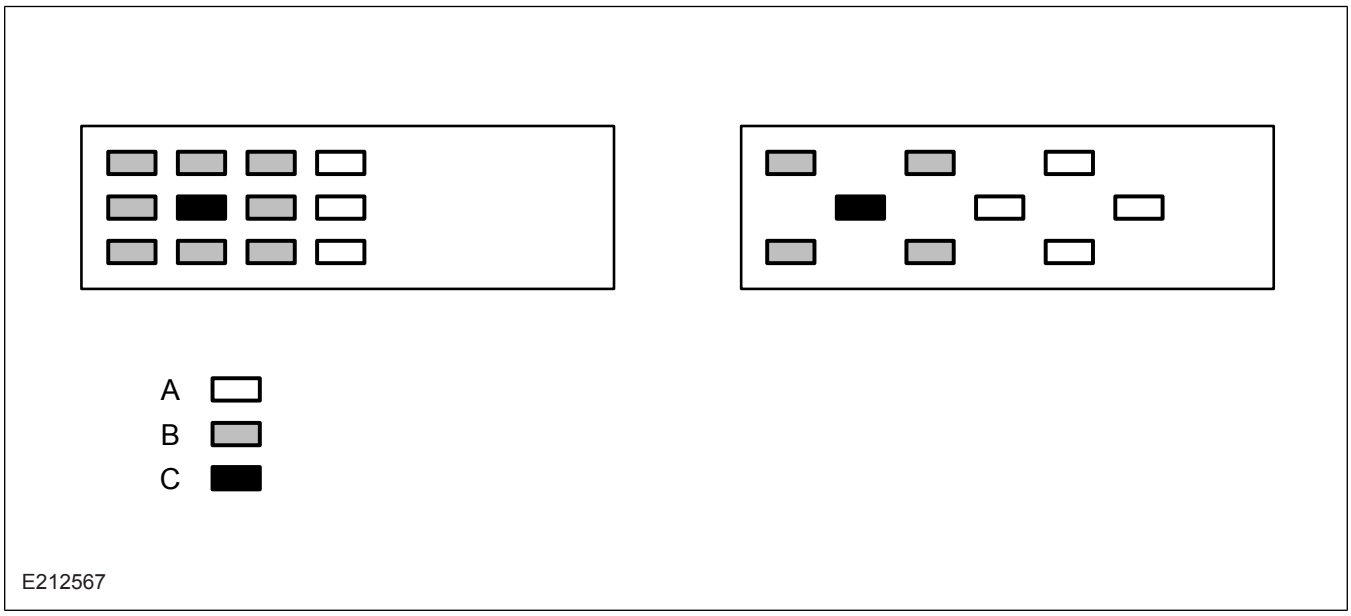
Stub Splices: The general rule is that there shall be at least 50mm of twisted wire between any series of the following connections: splice – splice, connector - splice, connector - connector, Splices include wire to wire splices and splice blocks.

Two stubs may be connected to the same stub connection point at the CAN backbone only on a 125 kbit/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 kbps, 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.



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

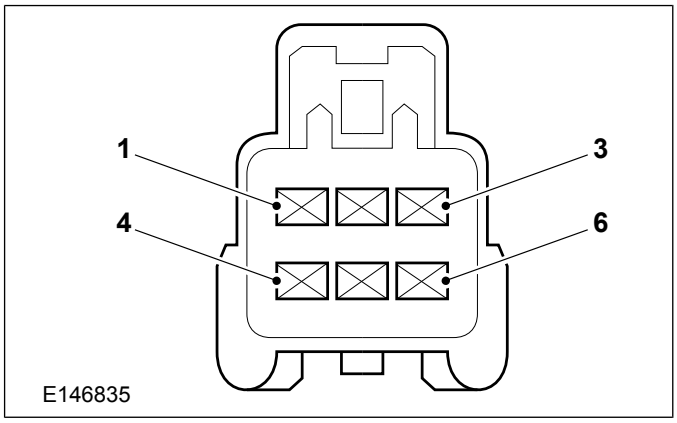
All guard tracks shall be at least 0.5mm wide and grounded at least every 10mm.

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.

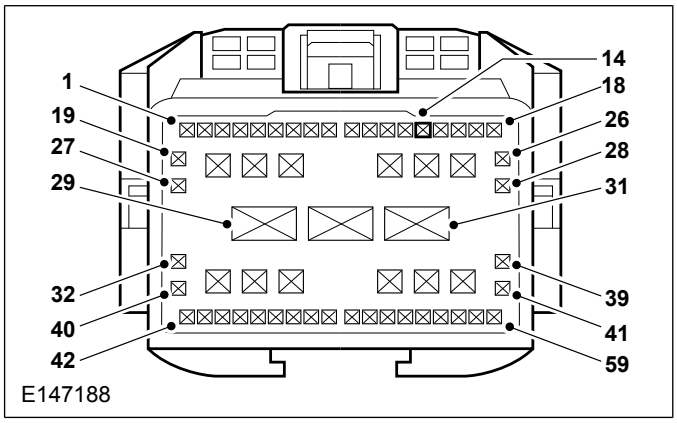
4.17.10 Adding Connectors

Additional 'Theater 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: The Position and Marker Lamps of the vehicle are collectively powered via F15 in the Body Control Module at a rating of 25A. A nominal current rating of 20A (full load including all potentially fitted additional lamps) must not be exceeded.

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: 4.9 (page 121).

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 saver system, where the supply will switch off at 30 minutes. Battery saver can be ordered or reconfigured to a longer duration of 180 minutes.

4.18.1 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 E145379 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.

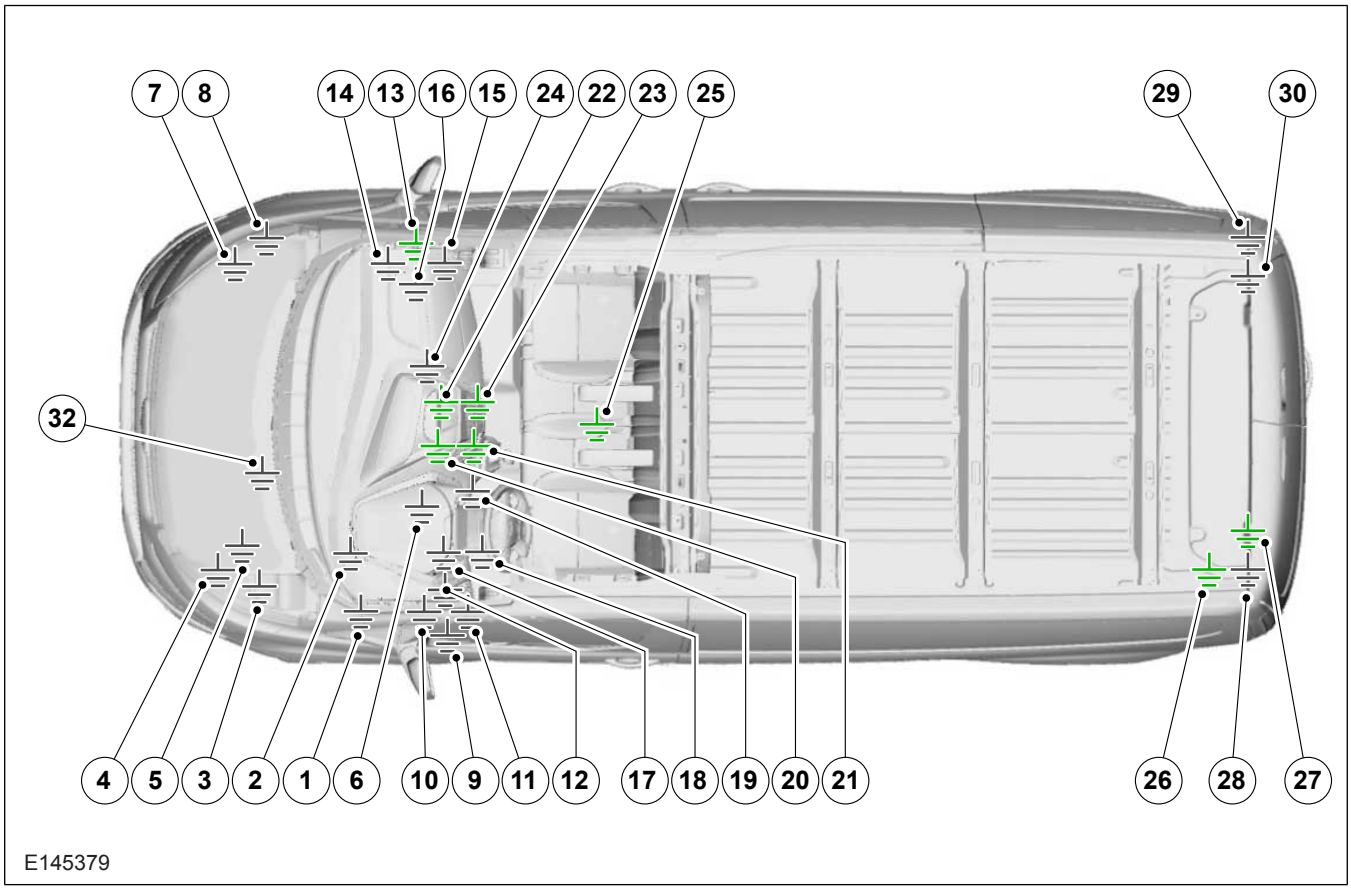
NOTE: The Ground Point (GP) numbers are only for reference to show the location of the GP.

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

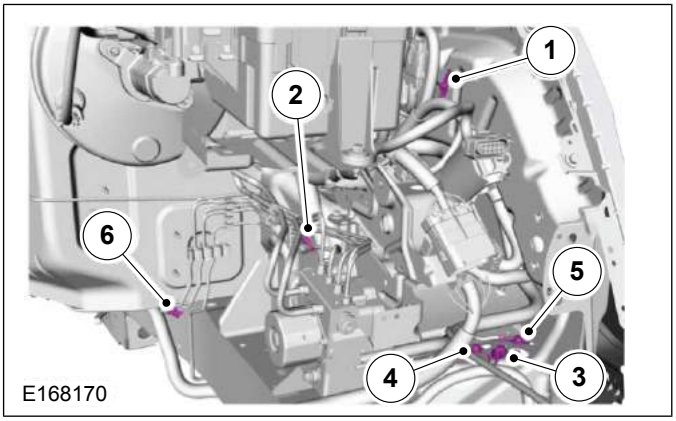
Refer to: 4.4 Battery and Cables (page 93).

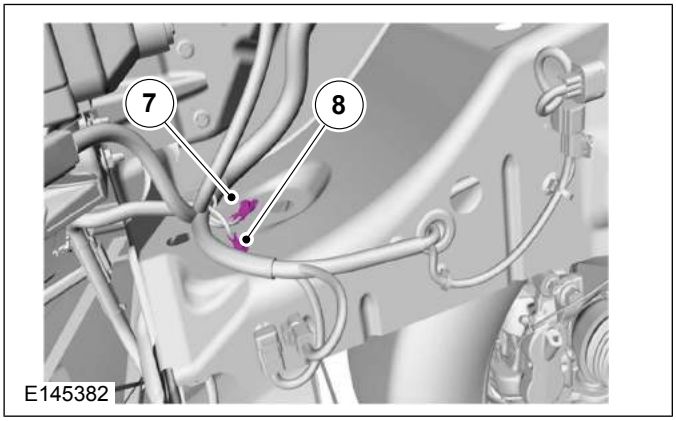
If a new grounding point is required, avoid weather zones, especially for high current grounds. Ground connections should be routed back close to the location of the +12V supply. This helps to reduce the electromagnetic field particularly generated by inrush current and improve electromagnetic compatibility.

Van, Bus, Kombi Ground Points



E145379





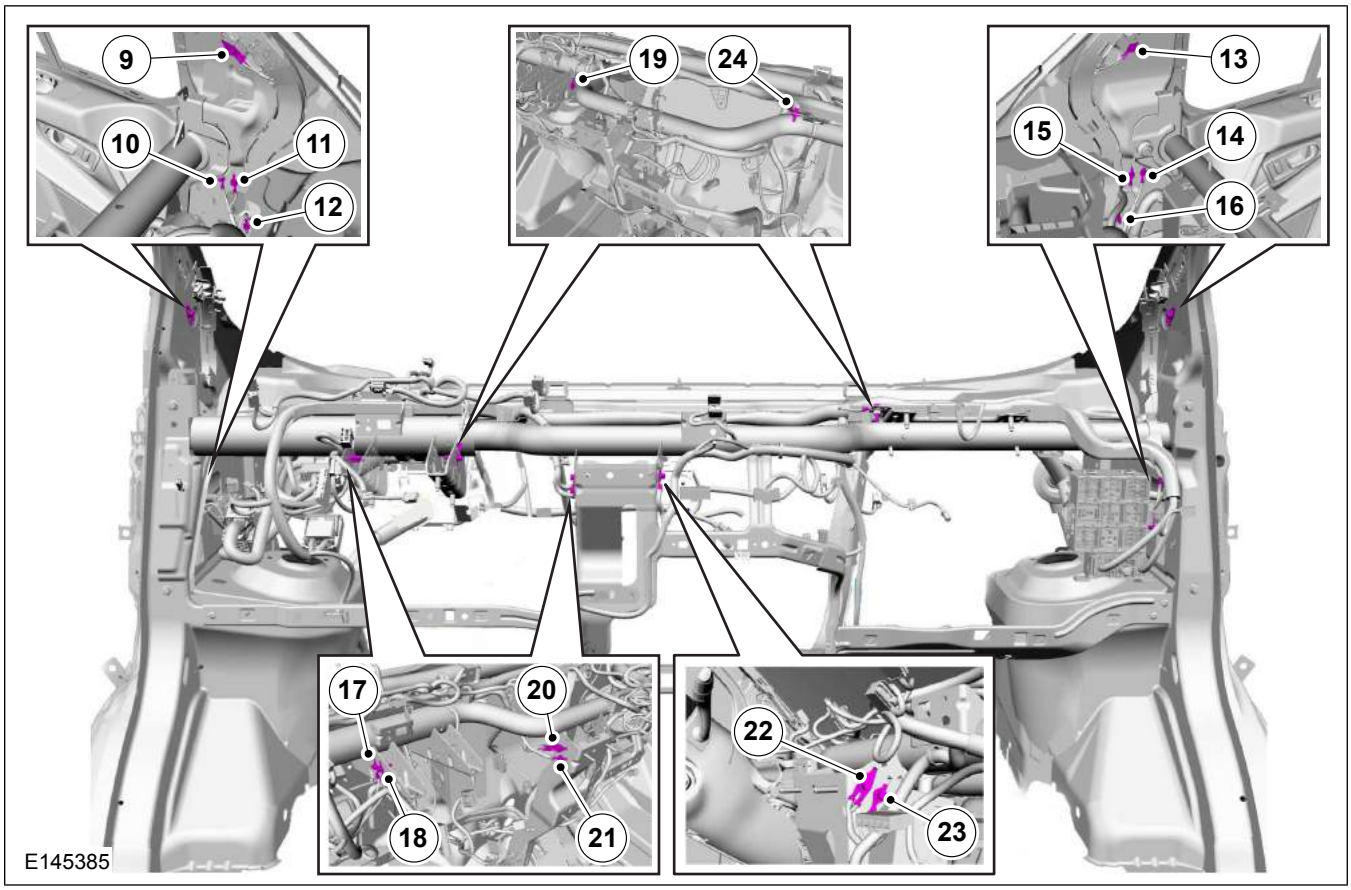
Ground Point	Location	Type	Harness
GP1	Engine Bay LHS	Misc Power Electric	14401
GP2	Engine Bay LHS	Misc Power Electric	14401
GP3	Engine Bay LHS Front	EXH EMS Control	9K499
GP4	Engine Bay LHS Front	EXH EMS Control	9K499
GP5	Engine Bay LHS Front	EXH EMS Control	9K499
GP6	Engine Bay LHS	Fuel Tank Sender	14406
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*	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*	Cross Car Beam LHS	Misc Power Electric	14K024
GP21*	Cross Car Beam LHS	Misc Power Electric	-
GP22*	Cross Car Beam LHS	Misc Power Electric	14K024
GP23*	Cross Car Beam RHS	Misc Power Electric	14K024
GP24*	Cross Car Beam RHS	Misc Power Electric	14K024
GP25*	Floor Pan	Misc Power Electric	14401
GP26*	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

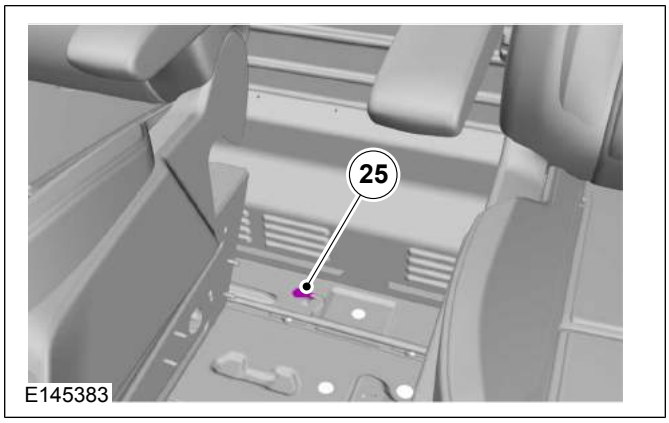
* Recommended Ground Points that can be used.

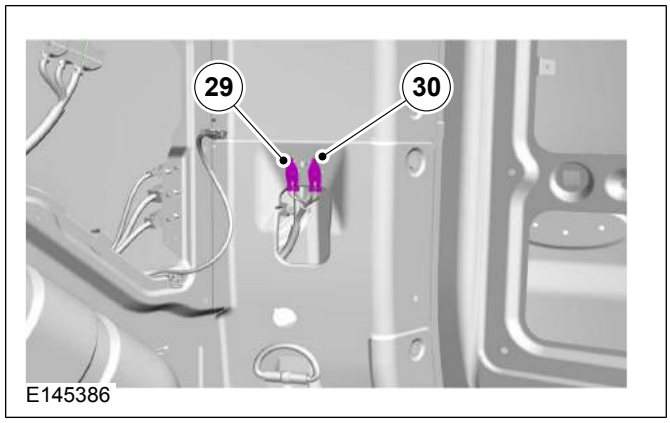
Ford Part Number W505255-S450M, M6 Screw type fixing - Torque 12Nm +/- 1.8

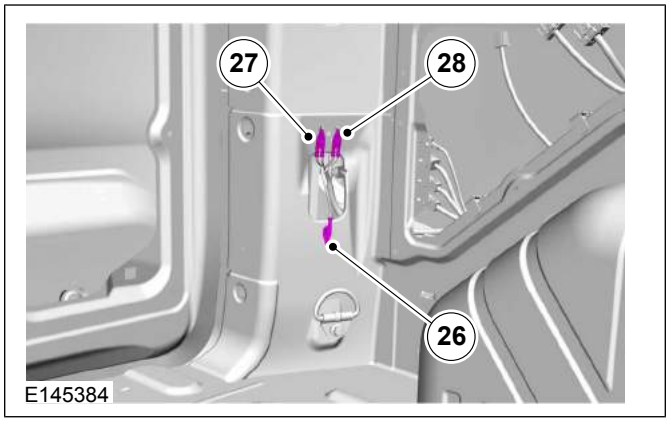
Abbreviations used in table:

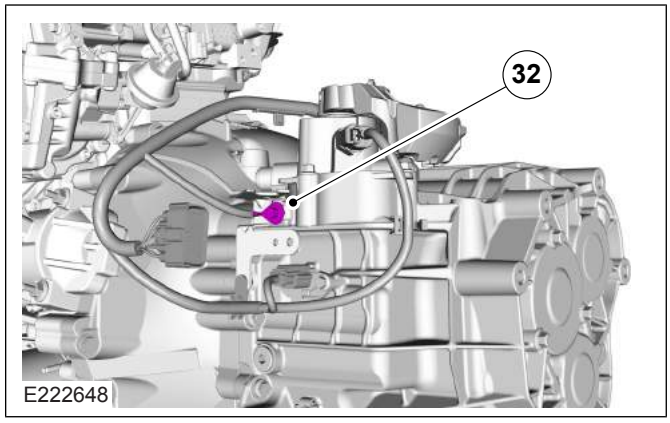
- LHS - Left Hand Side
- RHS - Right Hand Side
- Misc - Miscellaneous
- EXH EMS - Exhaust Emissions
- FWD - Front Wheel Drive











5.1 Body

5.1.1 Body Structures - General Information

When carrying out vehicle conversions/modifications 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 206).

- 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 207).

For Load Compartment Tie Downs (Load Lashing Points)

Refer to: 5.4 (page 186).

WARNINGS:

Do not drill Boron steel parts, see figure E146882 in this section.

Before drilling the floor, check the No Drill Zones, see Figure E145378 in this section.

For additional No Drill Zones

Refer to: 4.1 Wiring Installation and Routing Guides (page 61).
Refer to: 5.6 Body Closures (page 190).

5.1.2 Welding

WARNING: Do not weld Boron steel parts, see figure E146882 in this section.

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.

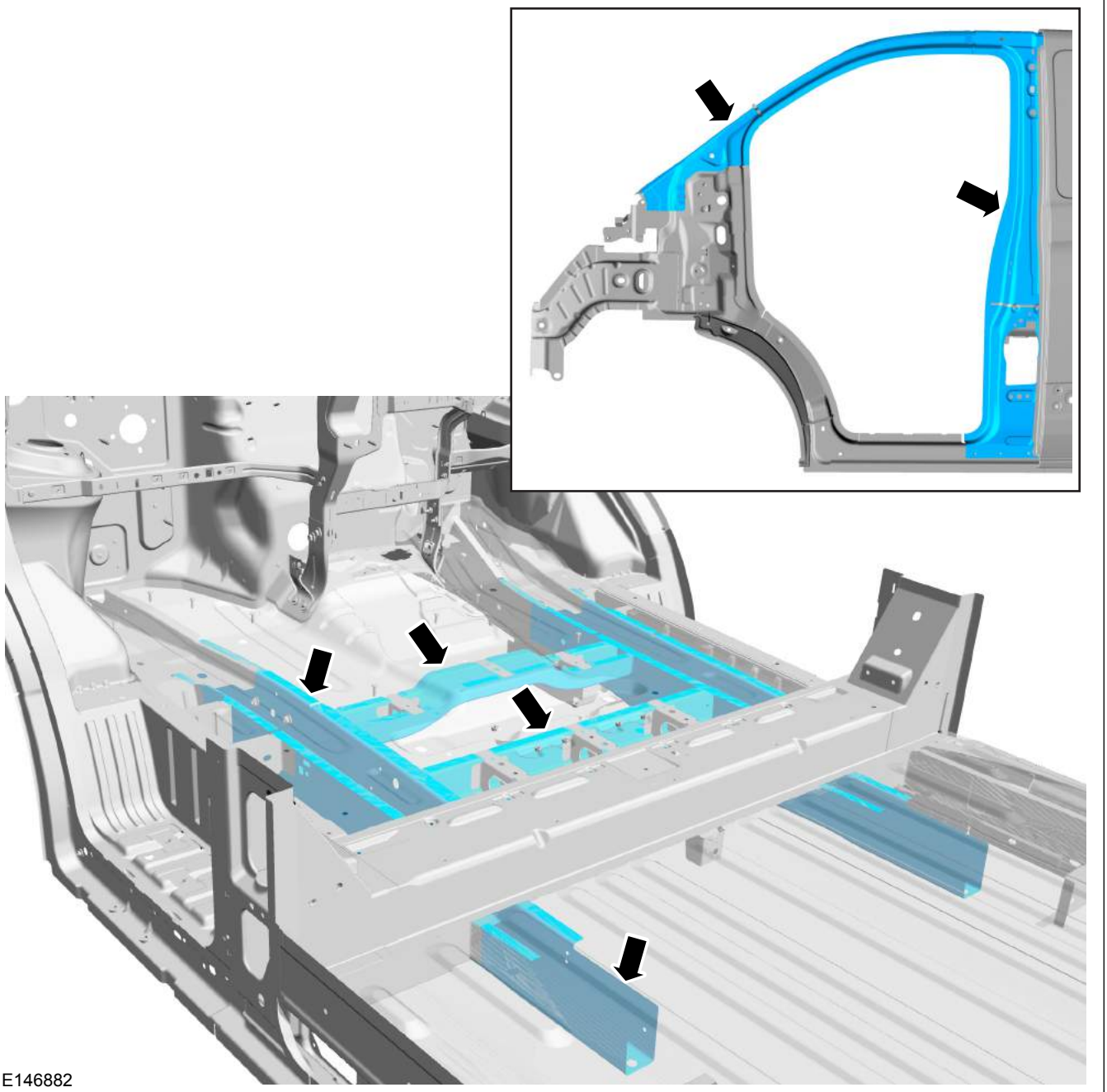
NOTE: Only apply a small amount of panel cleaner to the cleaning cloth when cleaning the area. Make sure that no cleaner reaches the connecting flange, so that the welding primer is not washed away again.

Priming after welding

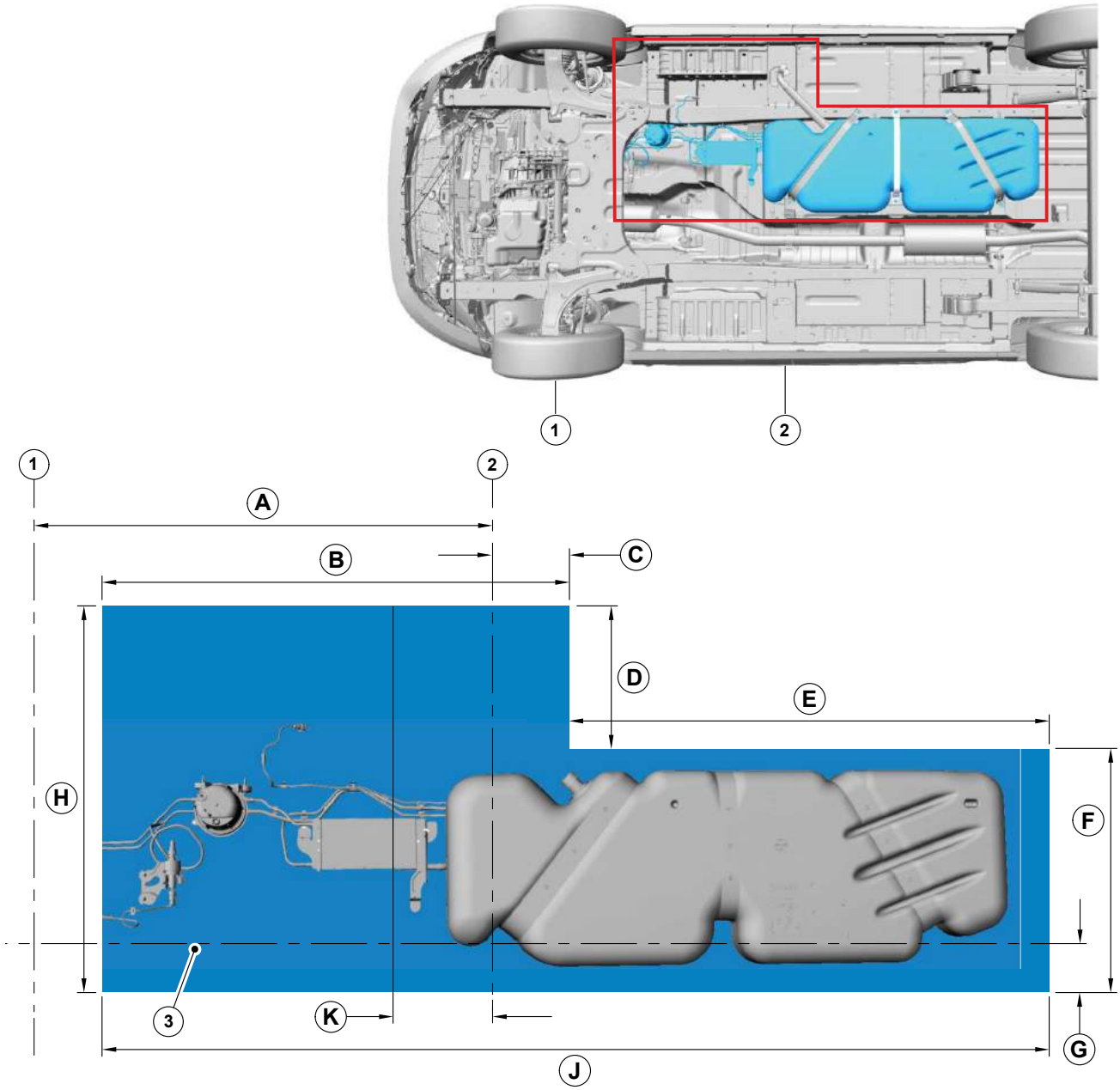
Primer is applied to the welded flanges after cleaning. A check must also be made that the production corrosion protection is present in the area of the flanges. Any damage must also be re-primed.

5.1.3 Boron Steel Parts

Boron Steel Parts - No Drill or Weld Zones



5.1.4 Floor 'No Drill Zones' under the Floor Fuel Tank



E145378

Floor 'No Drill Zones' Dimensions (mm)					
1	Center line Front Wheel Axle	D	394	K	350
2	Center of 'B'-Pillar	E	1282	Note: Vehicles with fuel cooler use dimension 'J', vehicles without fuel cooler use dimensions C + E + K	
3	Center line of vehicle	F	680		
A	1207	G	164		
B	1182	H	1074		
C	250	J	2464		

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. If uncertain please consult the Vehicle Converter Advisory Service VCAS@ford.com

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 swivelling device is fitted on the front seats.
- Any additional material or structure is attached to the B-pillar inner and/or outer area.

5.2.1 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 adequete reinforcements from below.

For additional information:

Refer to: 5.14 Frame and Body Mounting (page 207).

The vehicle converter is responsible for:

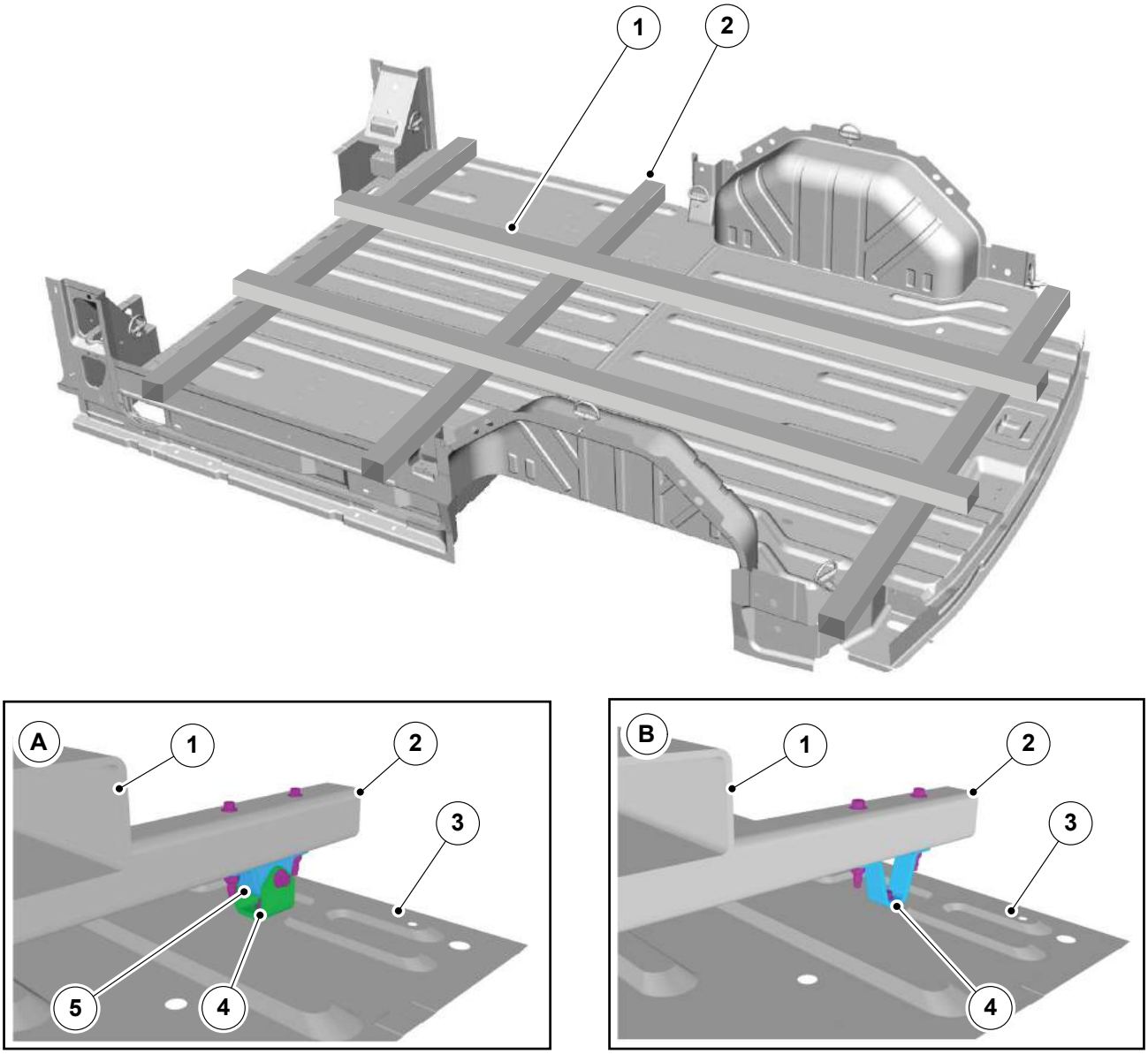
- Fitting decals, advising on the safe use of the equipment.
- Route electrical and hydraulics separately and away from original Ford equipment.
- Use suitable clip to fix on vehicle body and sub frame.
- Offer master switch in the cab to isolate the whole system.

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 +/-12mm movement at a rate of 100kg per 1.0mm 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.

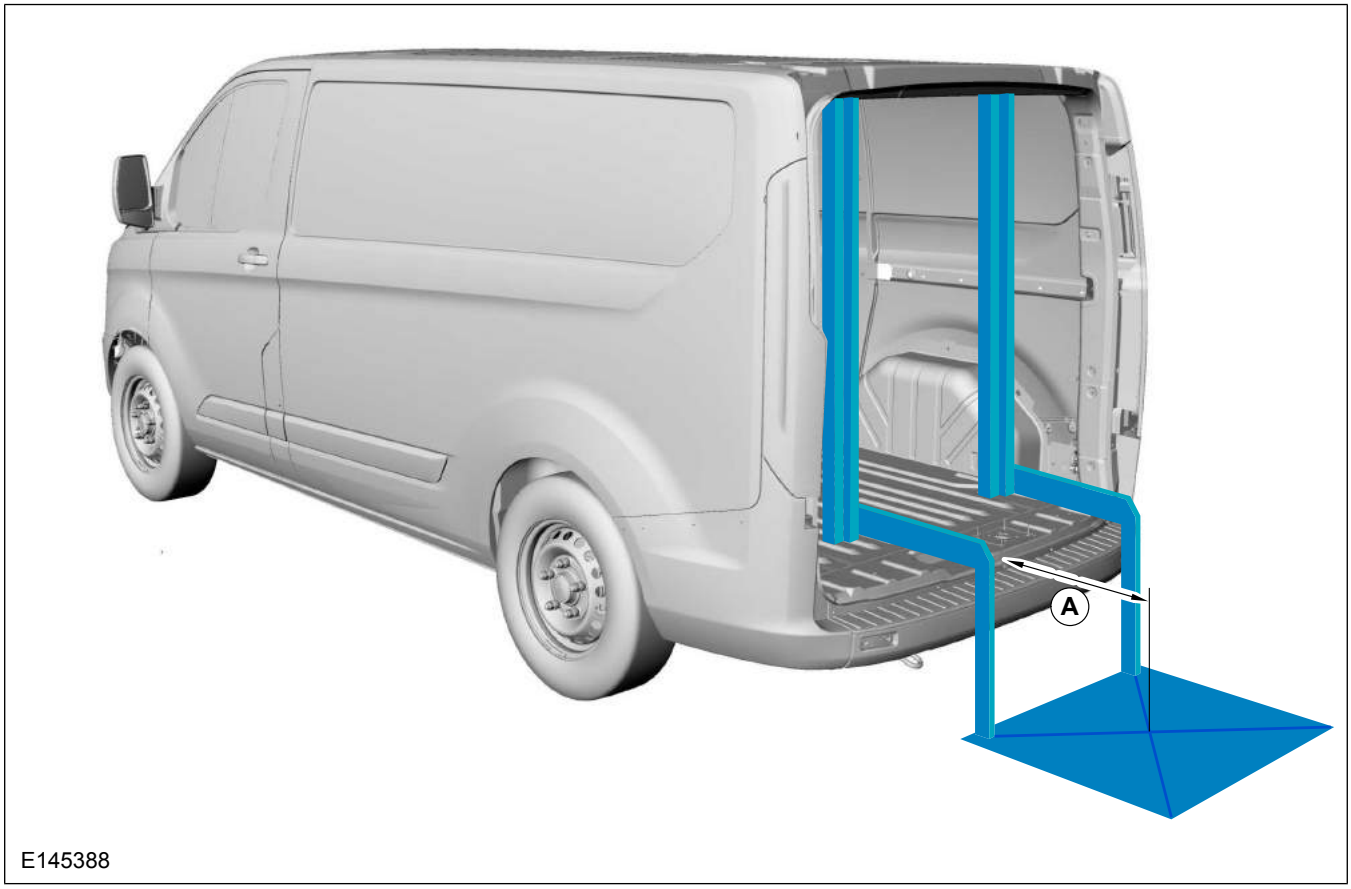
Rigid or Torsion Stiff Sub-frame for Van, Bus and Kombi



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. If uncertain please consult your local national sales representative or the Vehicle Converter Advisory Service VCAS@ford.com

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.

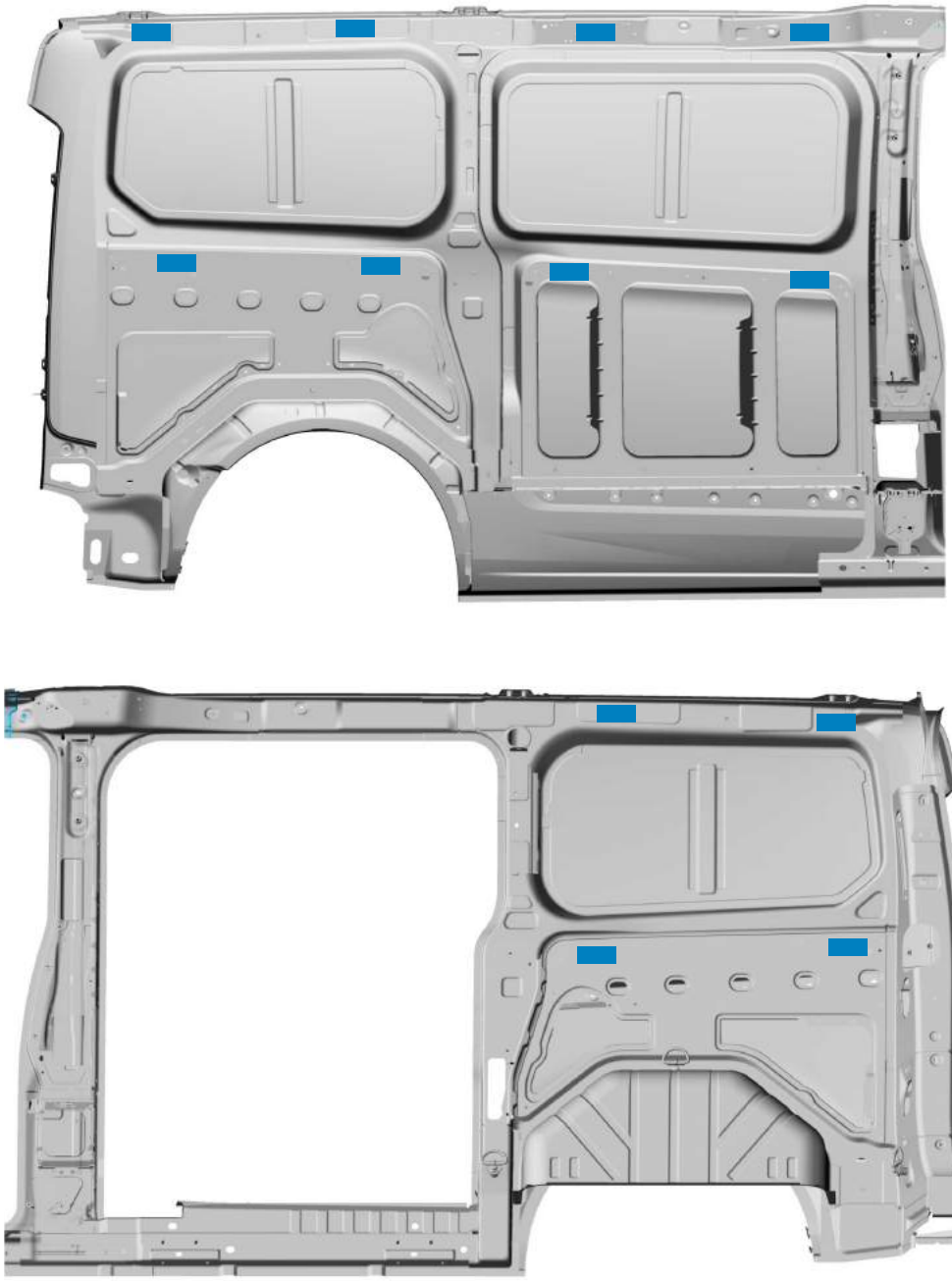
For additional information

Refer to: 5.13 Corrosion Prevention (page 206).

For additional information on Precautionary/No Drill Zones

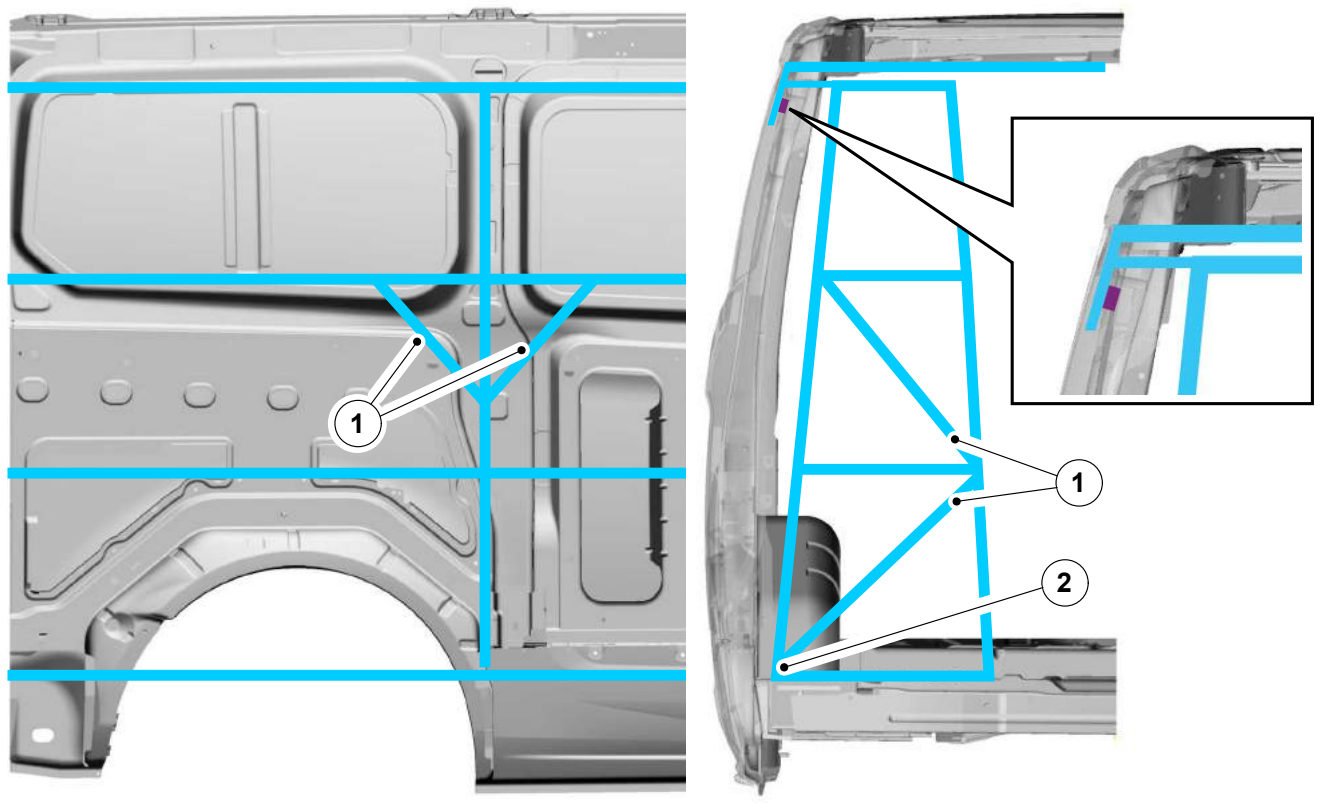
Refer to: Wiring Installation and Routing Guides (page ?).
Refer to: Body (page ?).
Refer to: 5.6 Body Closures (page 190).

Recommended Fixing Locations



E146883

Design Proposal for non Ford Production Option Racking System (Left Hand Side Shown)

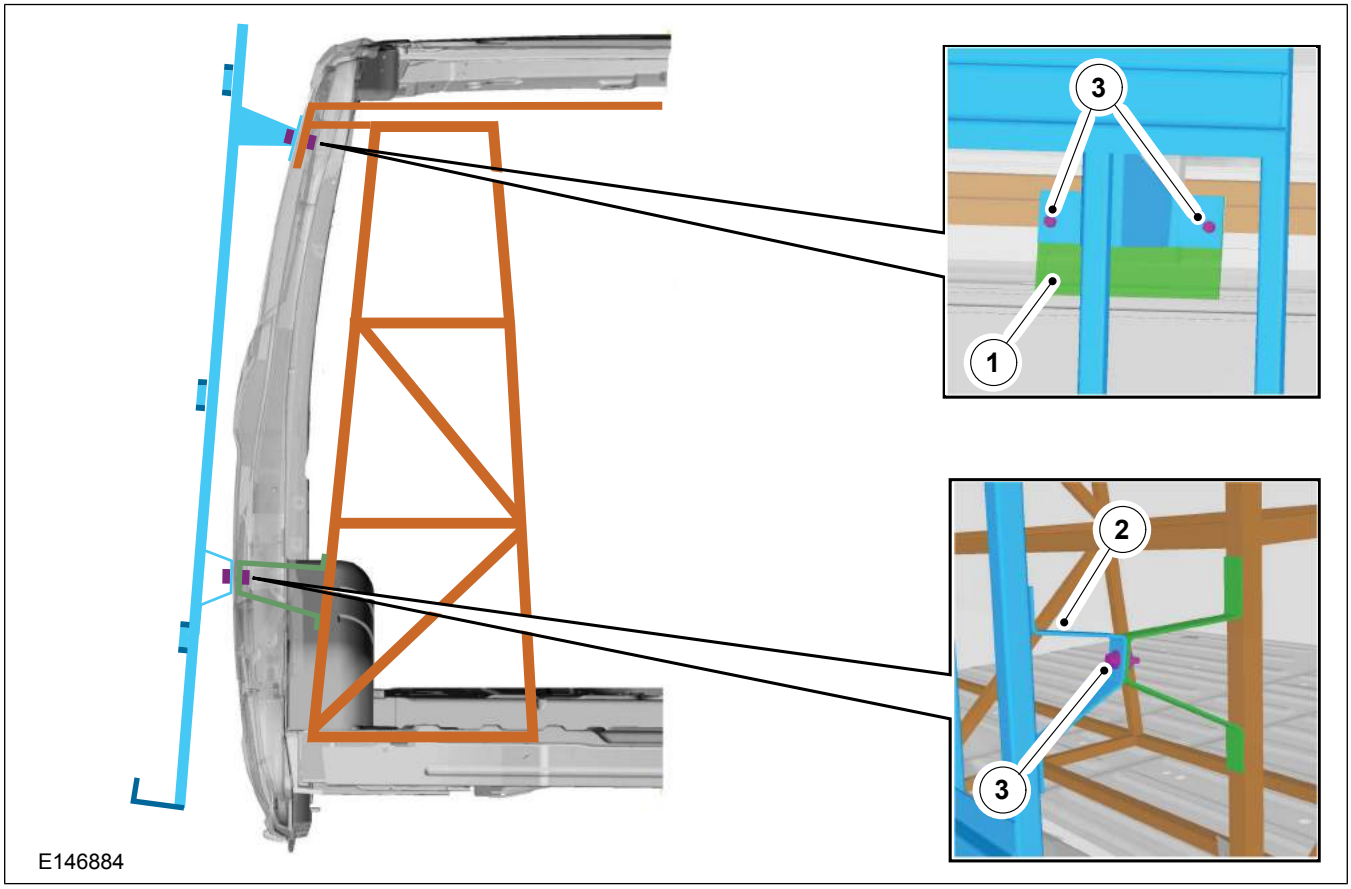


E146885

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)

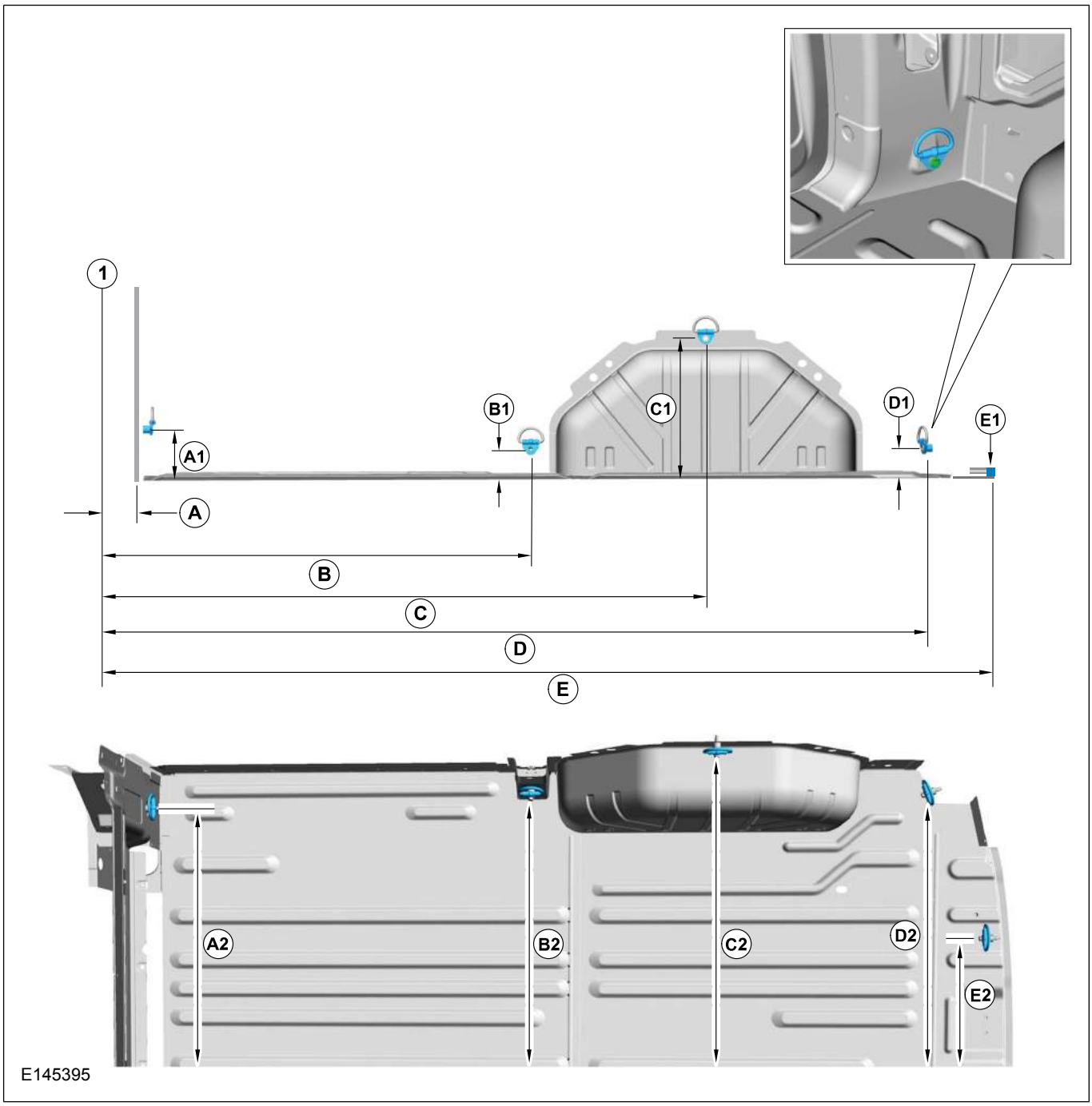
For designing glass carrying rack on body side outer, construct internal rack and bolt through the body side to the internal rack, see figure E146885.

5.4 Body System - General Information—Specifications

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 182).



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.

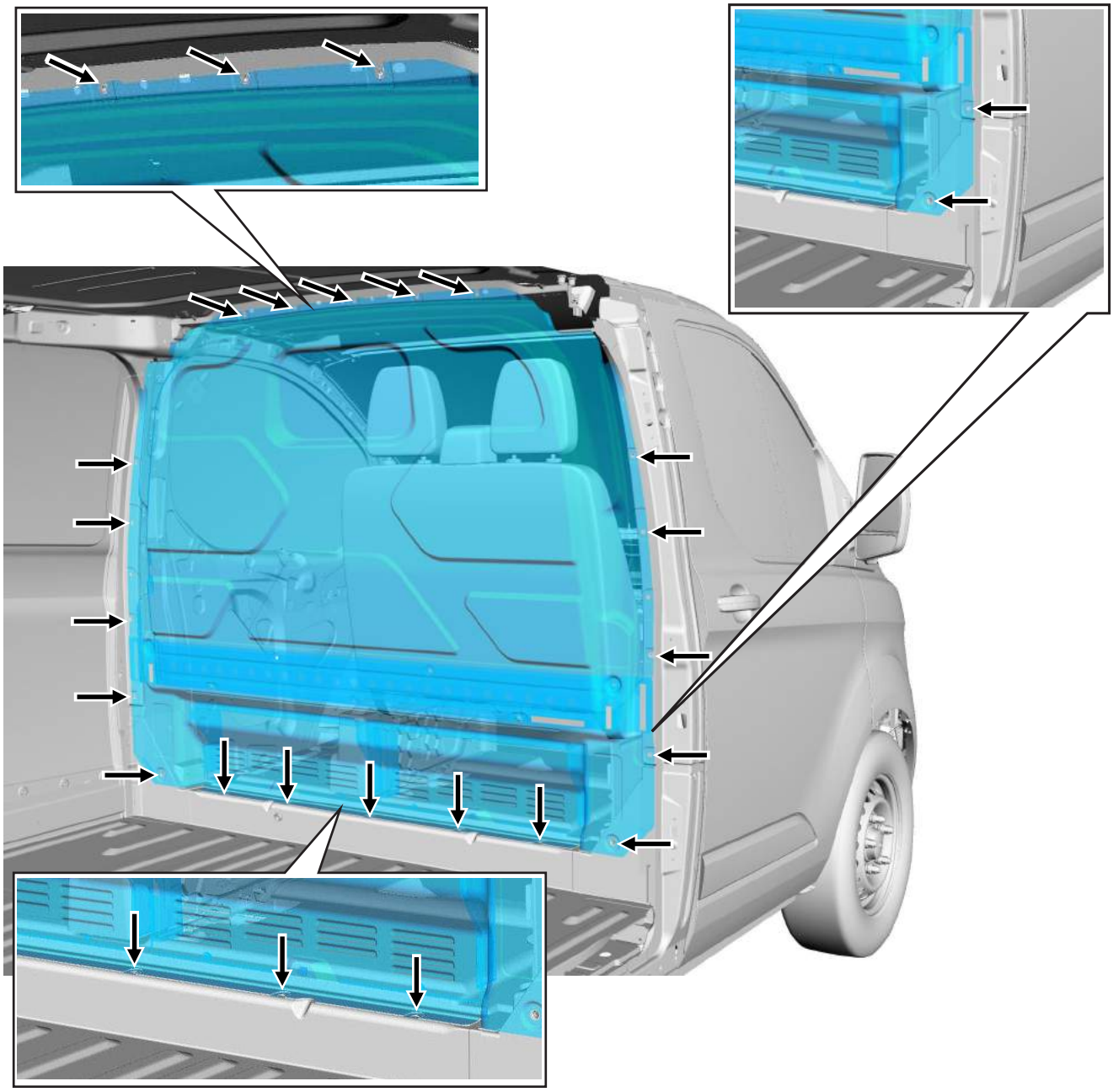
It is the vehicle converter's responsibility to ensure local current legislation, governing bulkheads and protective window grilles, is met. It is also the converter's responsibility to ensure legal load constraint requirements if using a non Ford standard bulkhead.

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 passengers's seat adjustment travel.

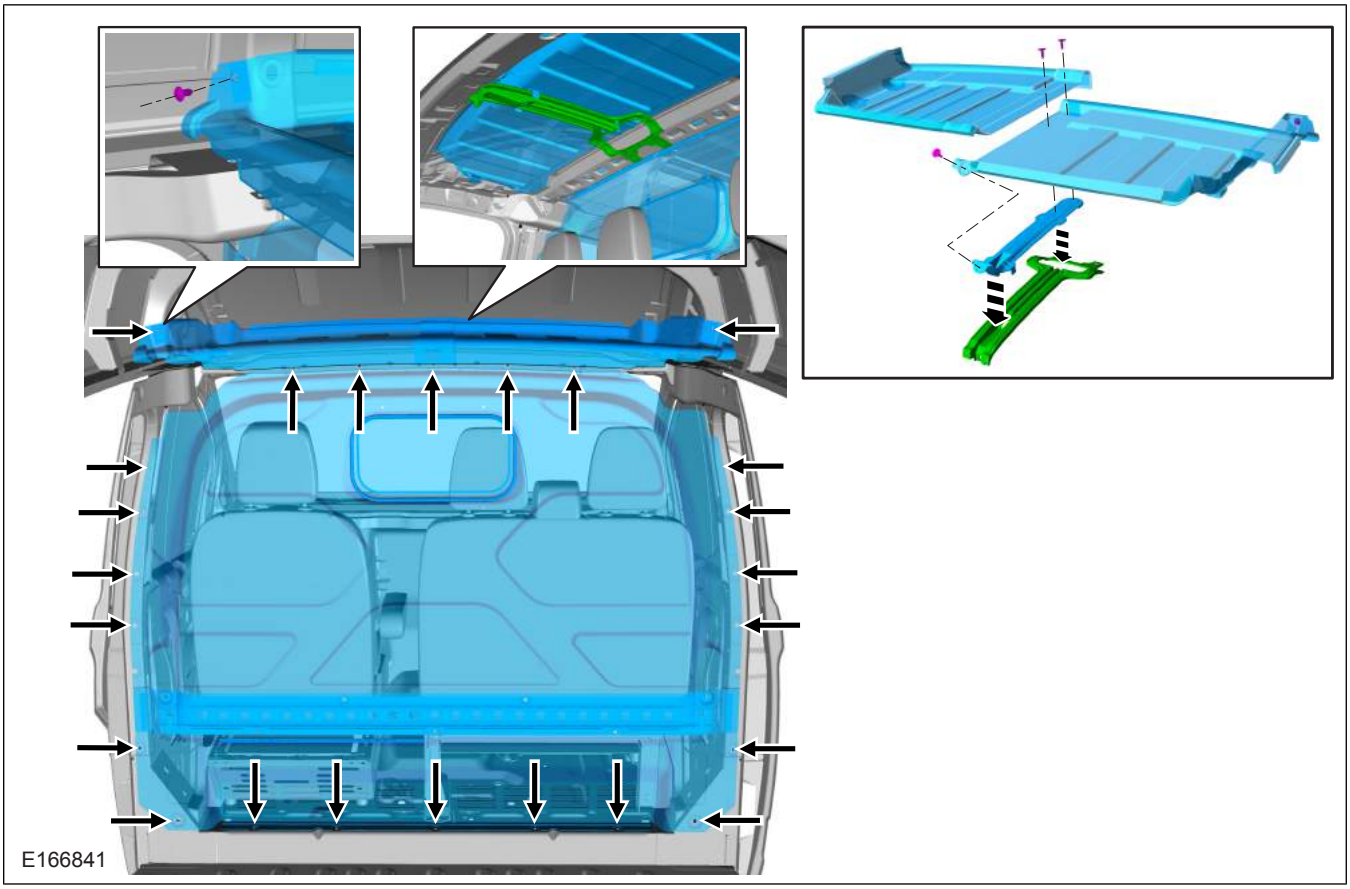
The following figures E145399 and E166841 show the standard bulkhead fixing locations on B-pillar. These are hexagonal holes for M6 thin sheet rivet type nuts. The standard range of Ford bulkheads can be retro-fitted at these points. Standard Ford Bulkheads are fitted with tamper-proof bolts.

H1 Roof Height - Bulkhead Fixing Locations

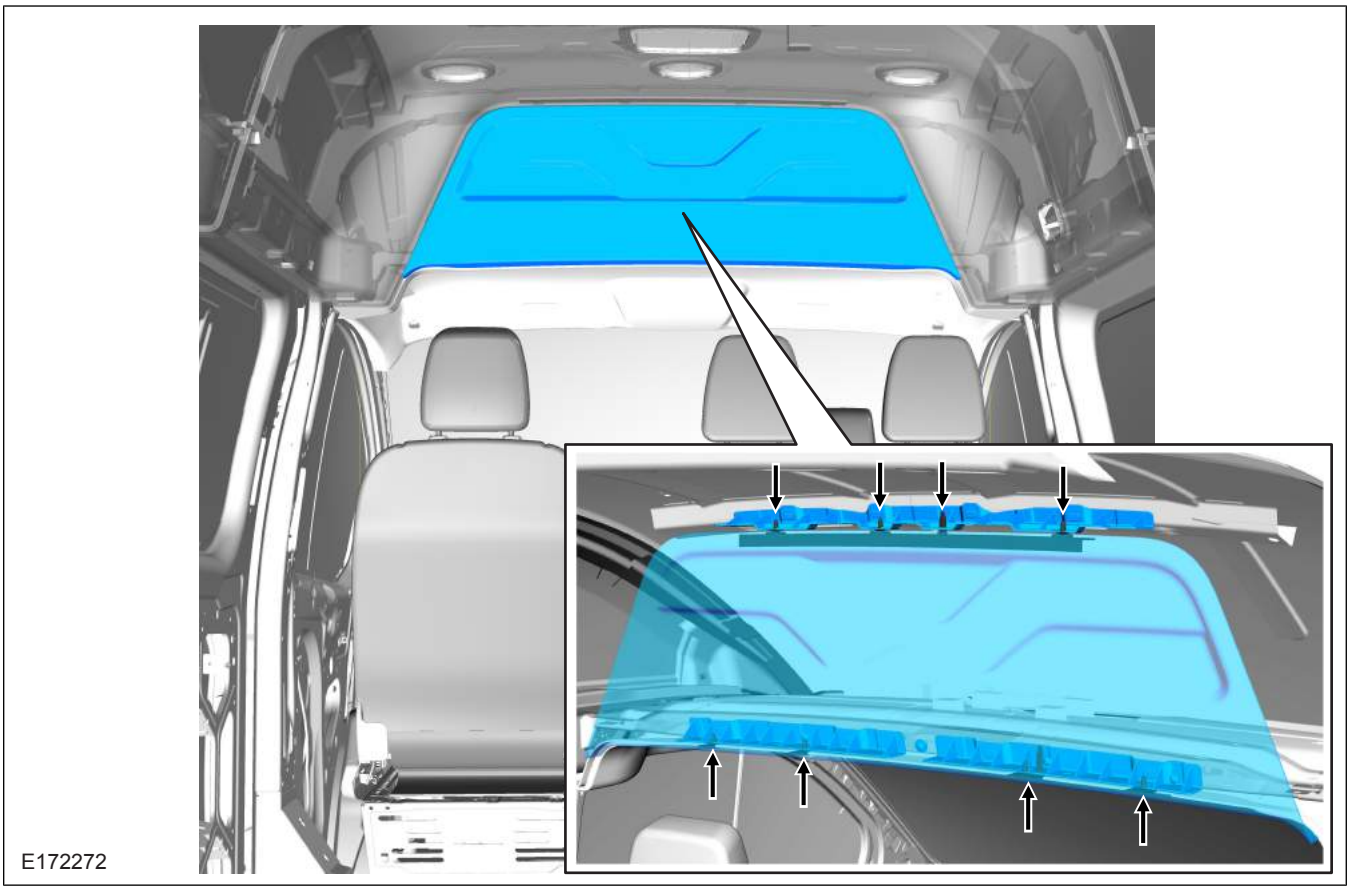


E145399

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.

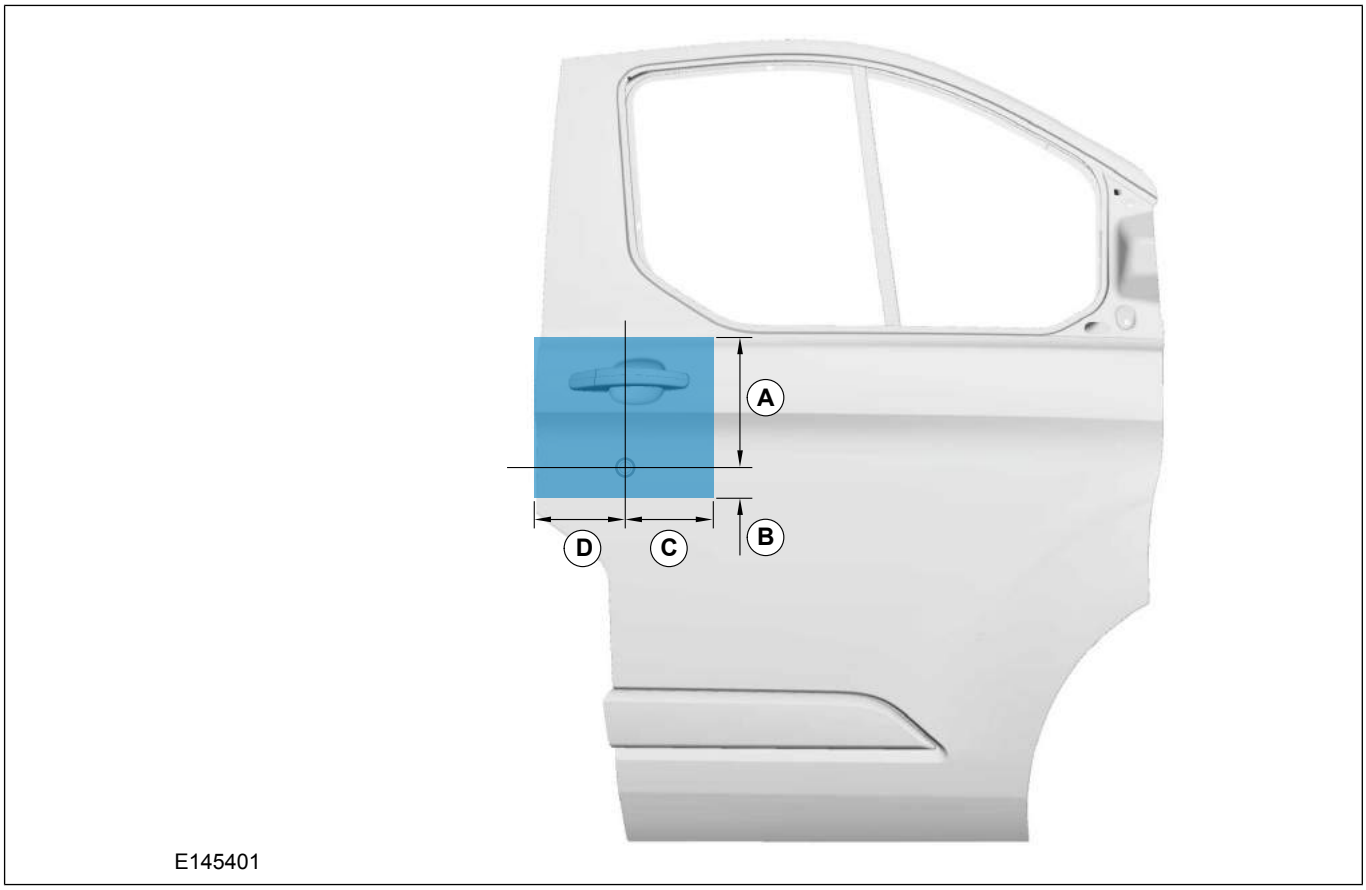
To avoid locking system security complications, it is recommended to discuss with the local Ford dealer prior to modifications taking place.

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

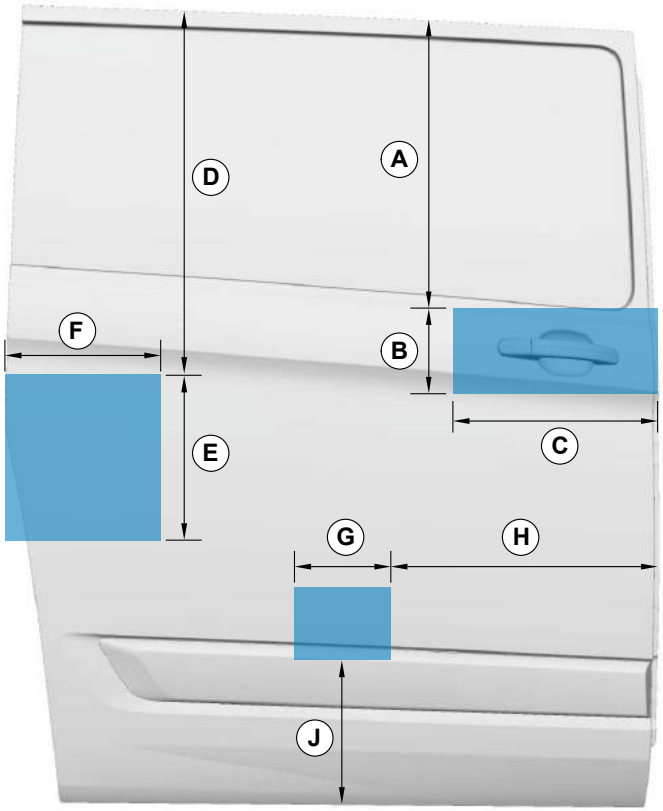
No Drill Zone - Lift-Gate

E145402

No Drill Zone - Lift-Gate

Item	Description
A	480mm
B	430mm
C	305mm

No Drill Zone - Side Sliding Doors

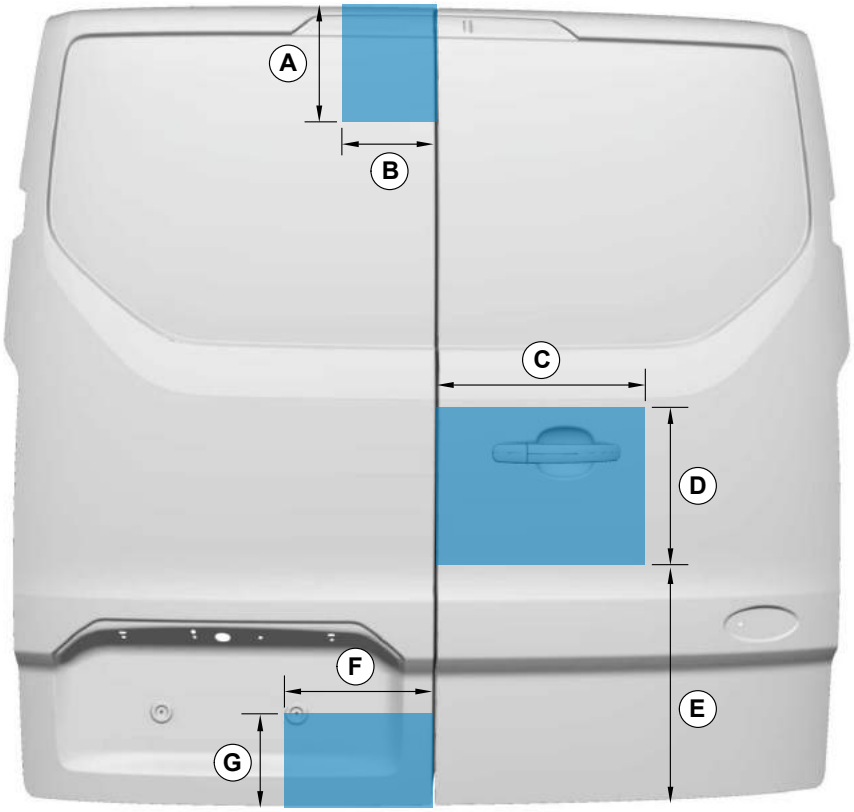


E145403

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



E145404

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

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.

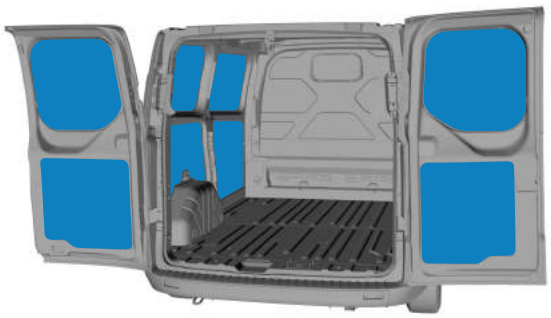
WARNINGS:

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



E145400

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 61).
Refer to: 5.6 Body Closures (page 190).
Refer to: 5.1 Body (page 174).

- 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.
- 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.

For any further details and advice please consult your local National Sales Company representative or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converters Advisory Service at VCAS@ford.com

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: 3.6 Exhaust System (page 56).
Vehicle Exhaust Systems - Vans with Bulkheads.

5.8.3 Heated Seats

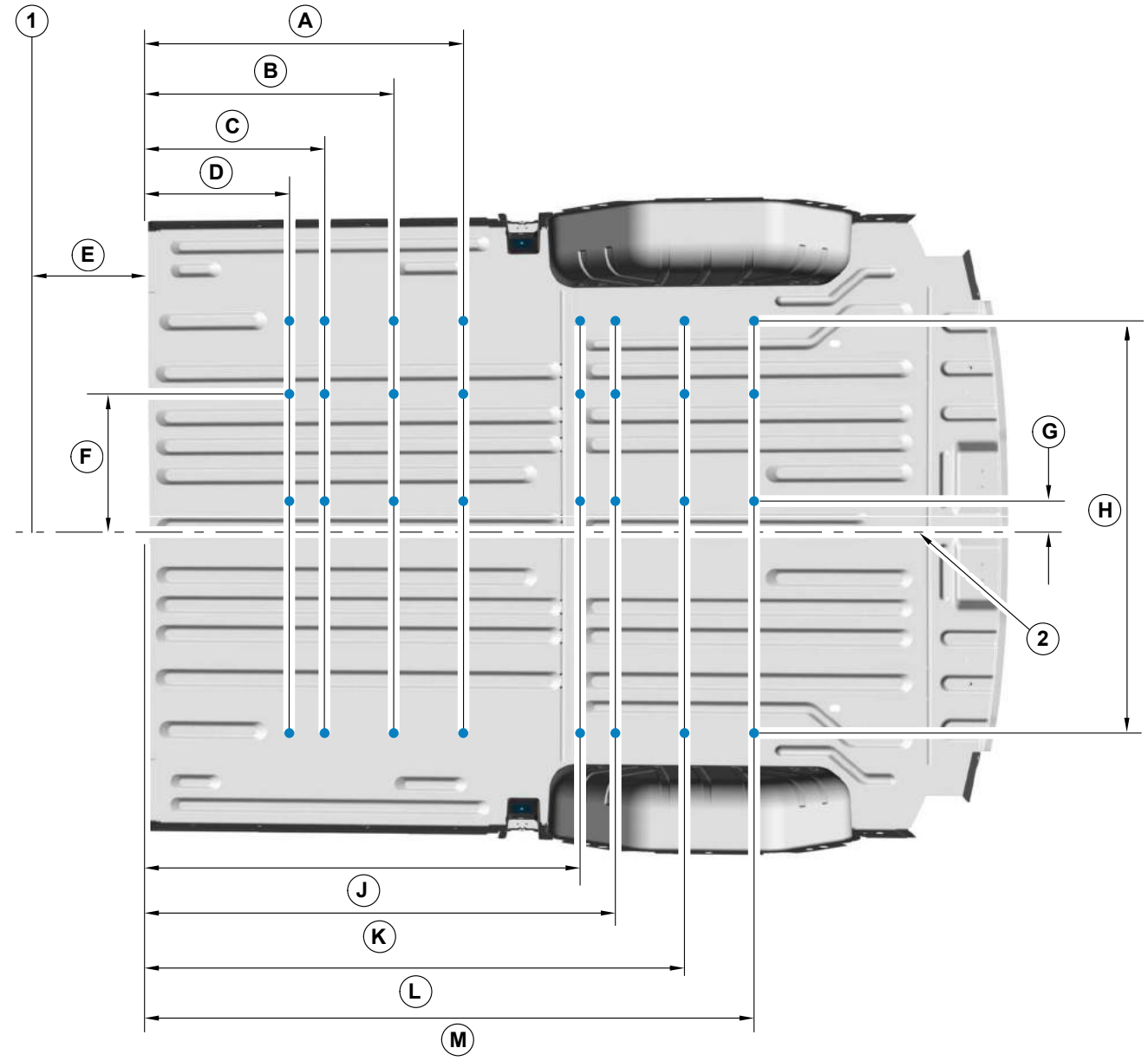
WARNING: The electrical feed for the original heated Ford seat must not be used for other purposes, e.g. other electrical consumers.

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)

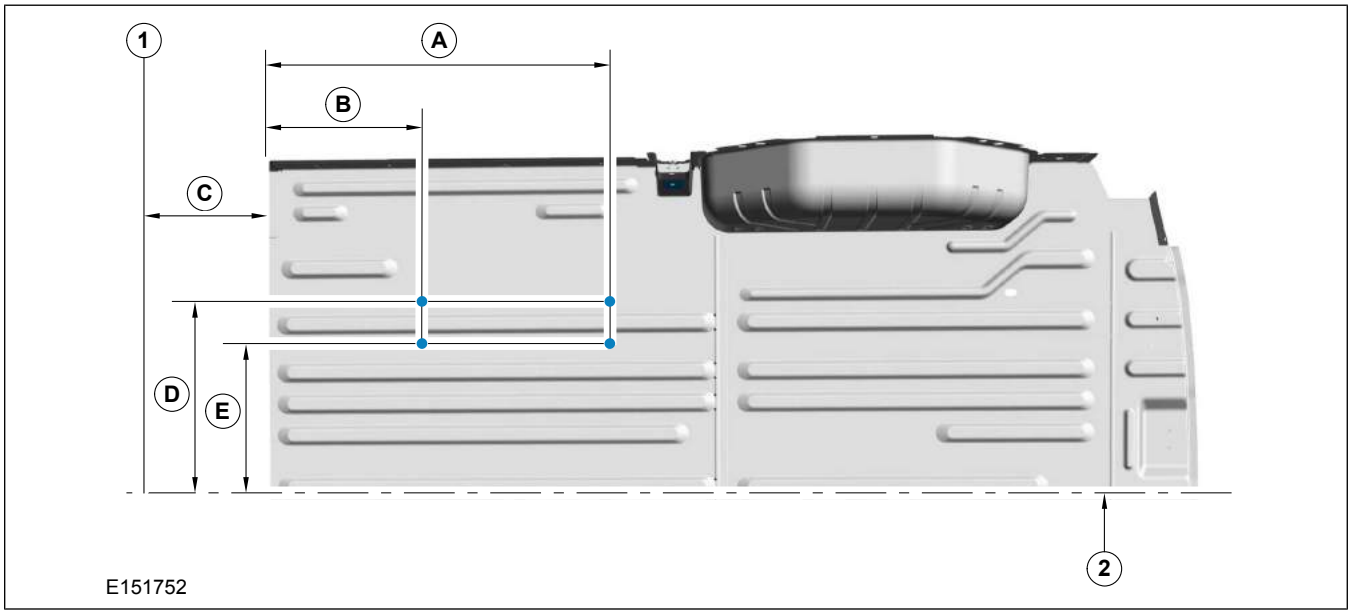


Kombi Van - Rear Seat Seat Fixing Positions

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

Righ Hand Side symmetrically opposite

5.9 Glass, Frames and Mechanisms

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.

NOTE: For further information please contact your local 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

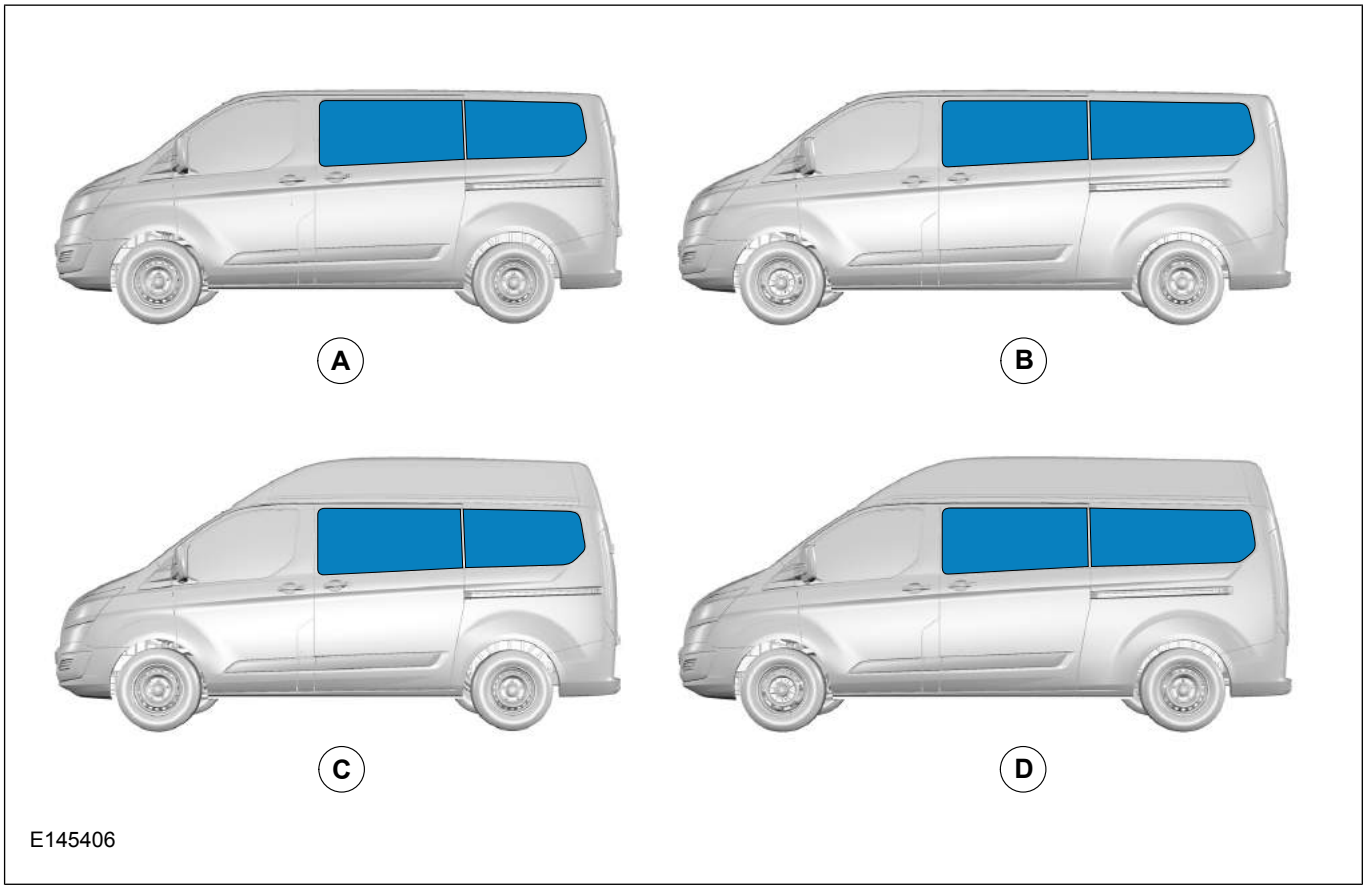
5.9.2 Rear Windows

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.

WARNING: For rear seat installation

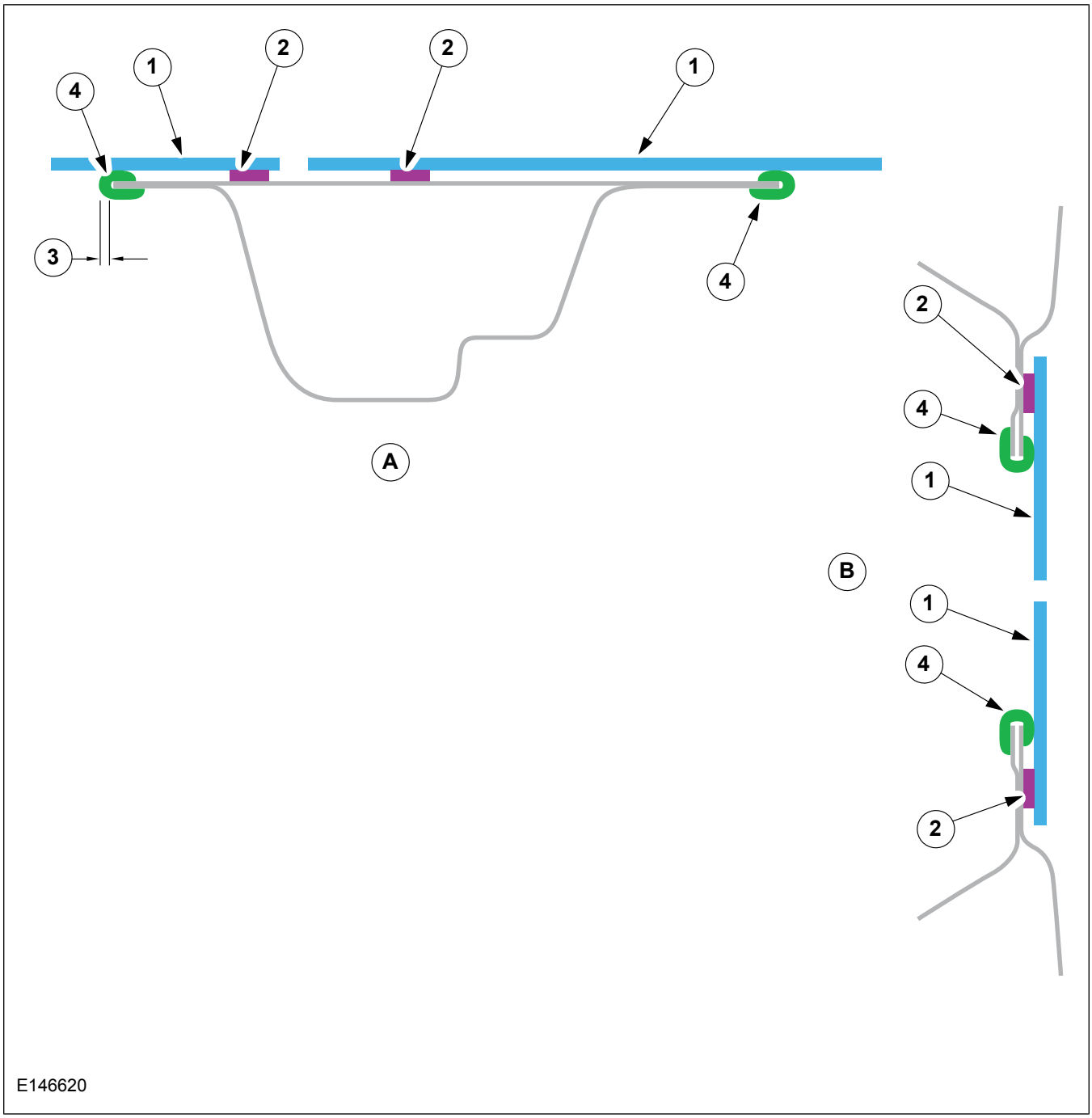
Refer to: 5.8 Seats (page 195).



For wheel base and overall vehicle height key dimensions

Refer to: 1.1 About This Manual (page 6).

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 within 0 and 1.5mm of inner body panel flange edge all around
4	Window trim strip

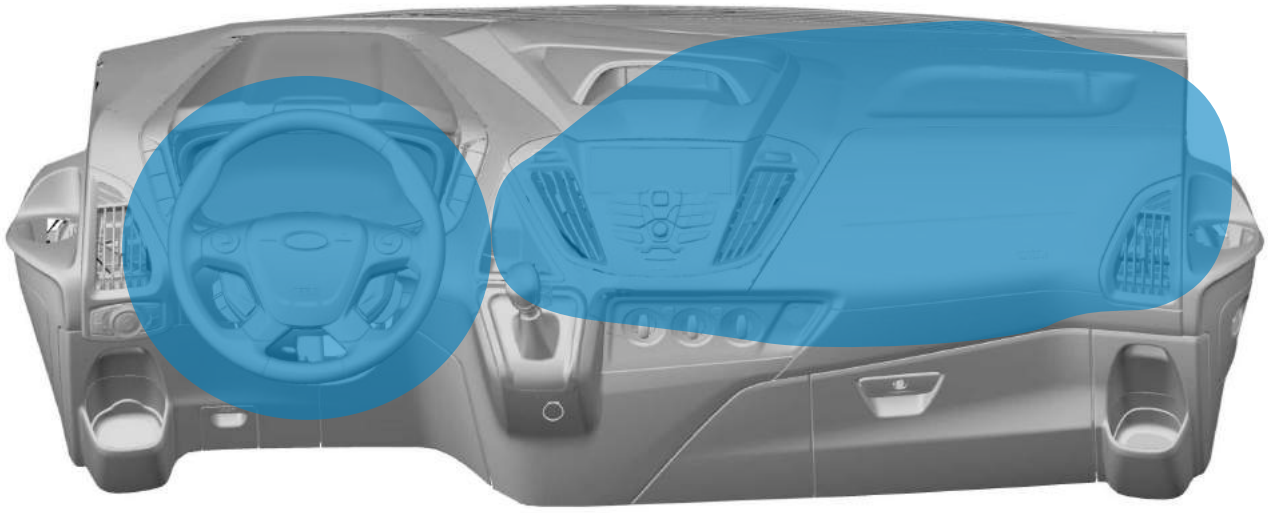
5.10 Airbag Supplemental Restraint System (SRS)

5.10.1 Airbags

NOTE: Front passenger airbag includes belt minder function.

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.



E145410

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.

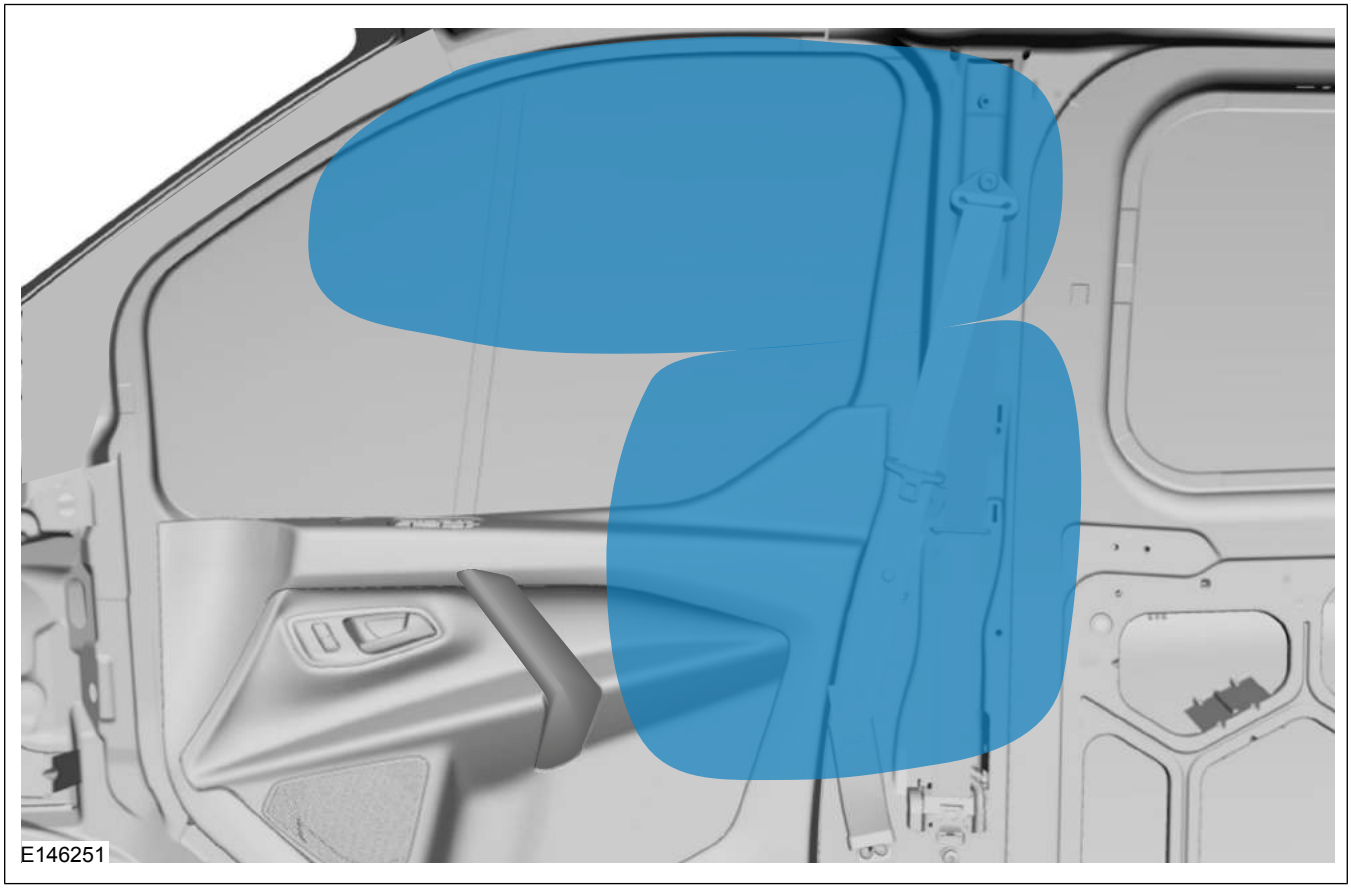
NOTE: It is recommended to specify a base vehicle without airbags if planning modifications in this area.

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 swivelling front seats. Do not specify a base vehicle with side airbags if planning to retrofit a swivelling 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.


E146251

Restraints Control Module (RCM)

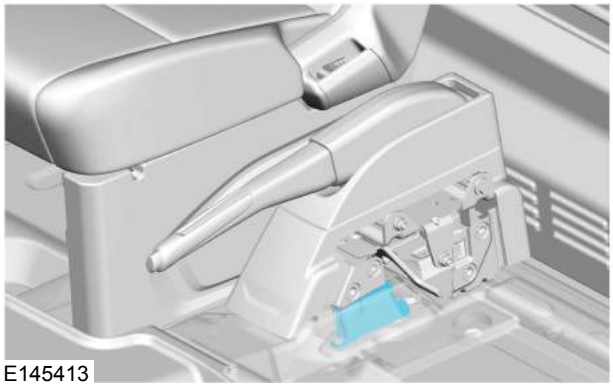
The RCM is located between the front seats , underneath the parking brake console, see figure E145413.

WARNINGS:

Modifications or reinforcements in the area of the RCM may affect the side airbag deployment timing and result in uncontrolled side airbag deployment.

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.

Restraints Control Module (RCM)


E145413

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:

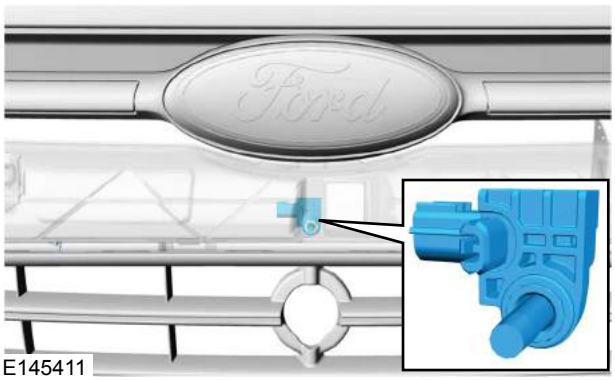
Modifications or reinforcements in the area of the sensors may affect the side airbags deployment timing and result in uncontrolled side airbag deployment.

Drilling or grinding operations in these area are only permitted when battery cables are disconnected.

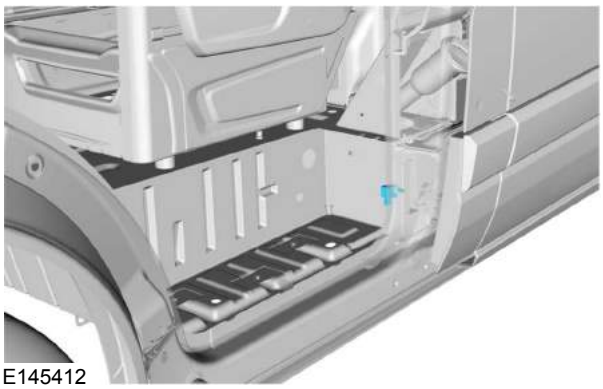
If the battery is disconnected

Refer to: 4.4 Battery and Cables (page 93).
Battery and Monitoring Sensor section for reconnecting battery.

Front Sensor



Side Sensor



5.11 Seatbelt Systems

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. Please consult your local National Sales Company representative for further information.

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

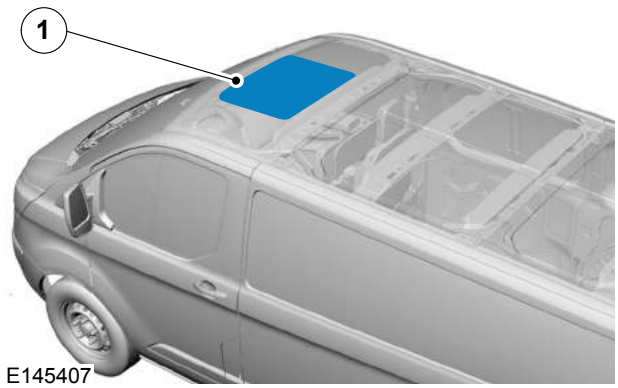
Driver belt minder is a legal requirement for an M1 vehicle. A switch is provided in the driver's buckle to sense the seat belt wearing status of the driver. If an M1 vehicle is modified, this function must be retained.

Belt minder is included with the front passenger airbag.

5.12 Roof

5.12.1 Roof Ventilation

Sun Roof Retrofit Option



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.

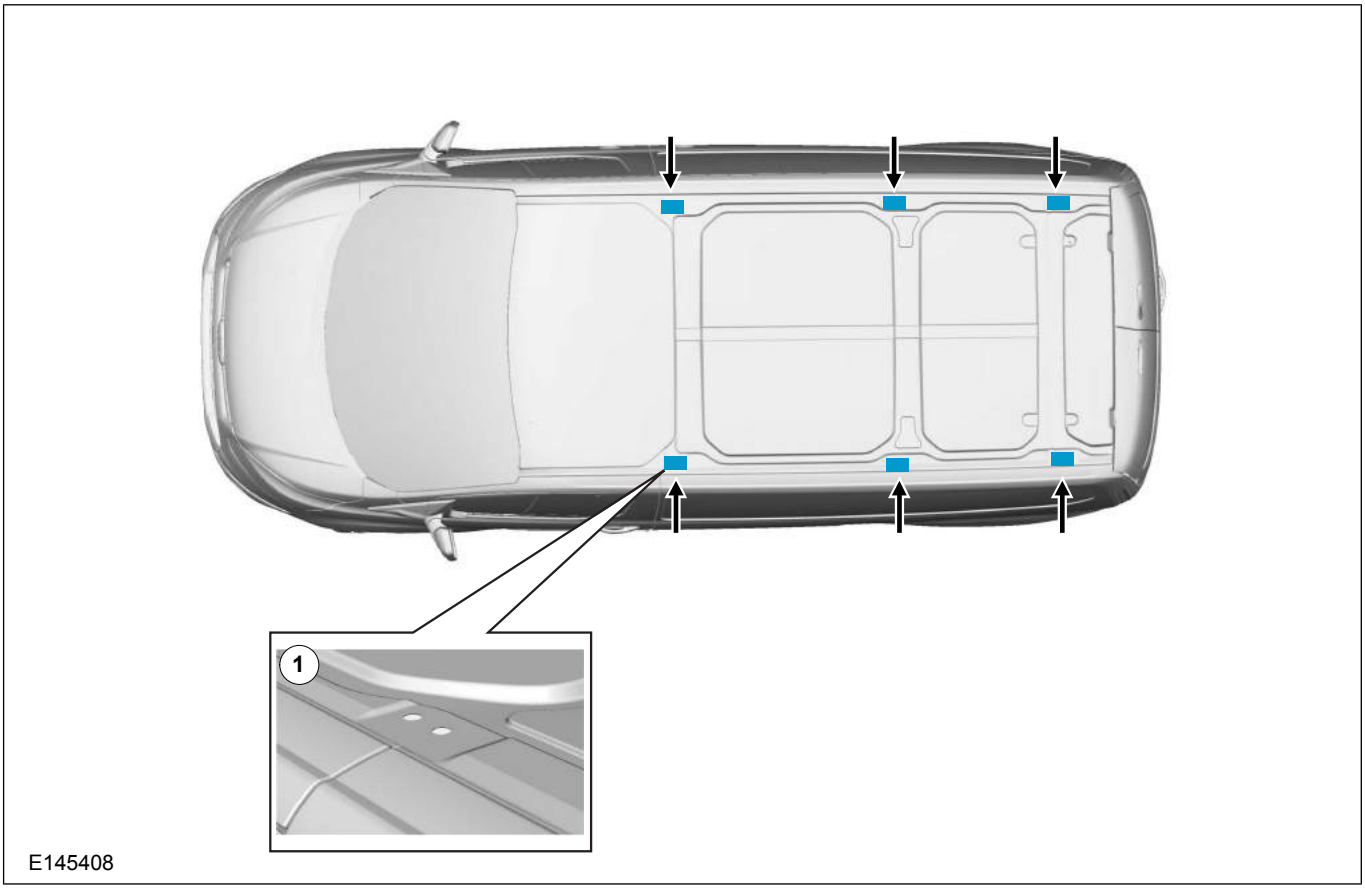
In case a roof bow is cut or removed, it must be replaced by an appropriate structure providing the equivalent structural integrity and functionality as the original structure. Any legal requirements must be maintained.

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



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

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 174).

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. For specifications consult the Vehicle Converter Advisory Service VCAS@ford.com

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. For specifications of corrosion protection materials, please consult your local National Sales Company representative or the Vehicle Converter Advisory Service VCAS@ford.com

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.

Use appropriate isolation materials. Where possible, choose materials with low level of electrochemical potential difference.

5.14 Frame and Body Mounting

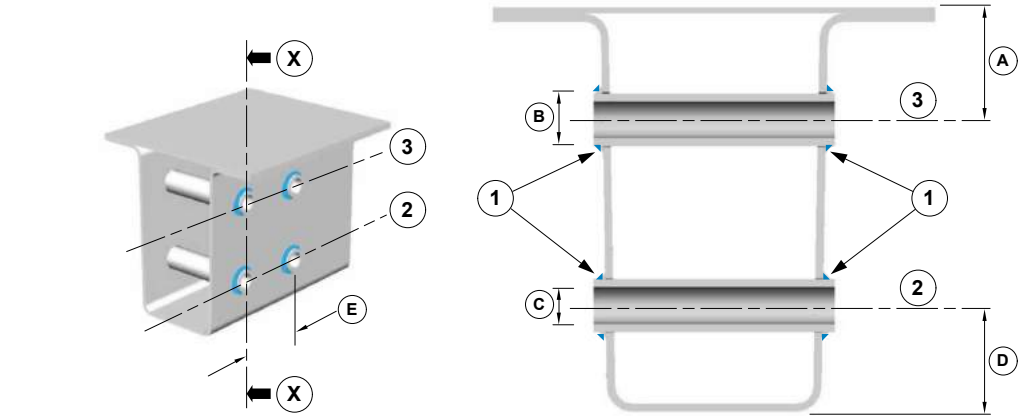
5.14.1 Mounting Points and Tubing

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 206).

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 206).
- 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 206).

Drilling and welding of frames and body structure have to be conducted following the guidelines. Please consult the Vehicle Converter Advisory Service VCAS@ford.com for details.

Refer to: 5.1 Body (page 174).
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.

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