FORD **Transit Custom/Tourneo Custom**

2019.75

Body and Equipment Mounting Manual

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1.1 About this Publication

This Body and Equipment Mounting Manual (BEMM) is the second publication for the 2019.75 Transit Custom/Tourneo Custom. It is recommended to review this manualin full. The BEMM is a live document which can be viewed on www.etis.ford.com/BEMM. It is thevehicle converter's responsibility to review the online version for the most current information prior to starting any conversion.

This BEMM is for European and related markets sourced vehicles.

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

1.2 About this Manual

1.2.1 Introduction

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

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

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

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

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

Not all information in this manual applies to all territories. For availability of options and parts, please contact your National Sales Company representative or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

1.2.2 How to Use This Manual

This manual covers vehicle conversion procedures.

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

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

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

In some sections of the book it may refer you to see additional sections for information. The links have been provided in blue text. Page numbers have also been provided. There is also an alphabetical index at the back of the manual. As with the contents pages, you will be able to link to sections. To do this just click on the page number.

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

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

1.2.3 Important Safety Instructions

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

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

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

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

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

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

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

1.2.4 Supplemental Information

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

1.3 Commercial and Legal Aspects

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

1.3.1 Terminology

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

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

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

1.3.2 Warranty on Ford Vehicles

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

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

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

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

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

1.3.3 Worldwide Harmonised Light-Duty Vehicle Test Procedures (WLTP)

The WLTP is replacing the NEDC (New European Driving Cycle) test procedure that has been in force since 1992.

WLTP takes into account individual optional equipment for weight, aerodynamics and rolling resistance, which have an impact on the fuel consumption and exhaust emissions. For incomplete and complete conversions, WLTP will now take into account the completed option equipment. Vehicle Converters now have a new responsibility to recalculate the CO2 and fuel consumption for any completed vehicle by either using a tool provided by the OEM or contacting the OEM to obtain new values.

To determine the new values in line with WLTP, registered customers will now be able to access Ford's multi stage WLTP calculation tool via ETIS. For further information and registration please contact 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). It is also advisable for you to contact your local type approval authority for any questions related to the application of WLTP to multi stage conversions under regulation 2007/46 and single vehicle approvals.

For some incomplete and complete vehicles, speed limiters have been fitted to ensure robust emissions compliance with WLTP and on-road emissions requirements. Where speed limiters have been fitted to ensure emissions compliance they should not be removed or delimited. For further information, please contact VCAS@ford.com

For additional information:

- Refer to: 1.8 Vehicle Duty Cycle Guidelines (page 22).
- Refer to: 1.14 Package and Ergonomics (page28).
- Please go to http://www.etis.ford.com/BEMM and register/login
- Contact VCAS@ford.com

1.3.4 Emissions Performance & In-Service Compliance

The emissions regulation 715/2007, as amended by 2018/1832, now includes new requirements for completed vehicles with regards to emissions performance and in service compliance. Ford has developed an emissions envelope that the Vehicle Converter must stay within.

For further information please contact VCAS@ford.com. It is advisable for you to contact your local type approval authority for any questions related to the application of WLTP to multi stage conversions under regulation 2007/46 and single vehicle approvals.

1.3.5 Whole Vehicle Type Approval Regulations - EU Markets only

WARNING: For non-European Union territories, please refer to local legislation.

Fitment of Parts and Accessories

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

Vehicle Converters are advised to check whether the fitment of parts require either type approval or Individual Vehicle Approval (IVA) 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.

Conversions from Commercial Vehicle N1 to Passenger Car M1

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

Guidance to Vehicle Converters for M1 registered vehicles:

- The Vehicle Converter is responsible for checking the vehicle ordered can meet all the regulations for type approval
- Exemptions for certain regulations should be checked with latest regulation and approval authority
- Where possible, order a Passenger Car M1 base vehicle such as Kombi M1 or Tourneo Custom M1
- If specifying Air Conditioning, check that the base commercial vehicle refrigerant meets the latest completed vehicle regulations. If the refrigerant needs meet the required EU Climate Guidelines for M1, then Transit Custom N1 entities are not suitable.
- If Tyre 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
- Refer to: 5.6 Body Closures (page 194). For information on sliding door gap reduction on M1 vehicles
- The 180 degree cargo door hinges on Transit Custom N1 entities have not been designed to meet the M1 requirements for Exterior Projections. If this is required, then the Transit Custom N1 entities are not suitable

For additional information
Refer to: 1.6 Conversion Homologation (page 20).

1.3.6 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 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

1.3.7 Alternative Type Approval

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

1.3.8 Legal Obligations and Liabilities

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

1.3.9 General Product Safety Requirement

WARNINGS:

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

Do not change the tyre size or load rating.

Do not modify the steering system.

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

The travel and function of pedals must not be restricted.

Do not modify or remove heat protection shields.

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

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

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

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

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

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

Refer to: 1.4 Contact Information (page 12).

1.3.10 Product Liability

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

The Vehicle Converter or equipment manufacturer is liable for the:

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

1.3.11 Restraints System

WARNINGS:

Modifications to the restraints system are not allowed.

Airbags are explosive. For safe removal and storage during conversion follow the procedures in the Ford workshop manual.

Do not alter, modify or relocate the airbags, sensors and modules of the restraints system or any of its components.

Attachments or modifications to the front end or 'B' Pillar of the vehicle may affect the airbag deployment timing and result in uncontrolled deployment.

For additional information:
Refer to: 5.11 Airbag Supplemental Restraint System (SRS) (page 201).

1.3.12 Drilling and Welding

WARNING: Do not Drill or Weld Boron steel parts, see figure E167660 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: 5.15 Frame and Body Mounting (page 207).

1.3.13 Minimum Requirements for Brake System

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

- Maintain original settings
- Maintain brake certification load distribution

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

1.3.14 Road Safety

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

1.4 Contact Information

As a manufacturer, we want to provide you with the information you need for your vehicle conversion/ modification. If the information you require is not in this manual or you have further questions, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

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

Ford of Germany	
Contact:	Torsten Wagner
Phone:	+49-221-9017692
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Ford of France	
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Ford of Ireland	
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E-Mail:	jomahon6@ford.com

Ford of Spain	
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E-Mail:	jmart219@ford.com

Ford of Portugal	
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Ford of Belgium	
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E-Mail:	jvermei1@ford.com

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

Ford of Austria	
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Ford of Switzerland	
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Ford of Denmark	
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E-Mail:	rkvernh2@ford.com

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Ford of Greece	
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Ford of Poland	
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Ford of Czech Republic	
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Ford of Russia	
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E-Mail:	egnusov@ford.com

Ford Central & Eastern Europe	
Contact:	Balázs Págyi
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Rest of the World (RoW)	
Contact:	Duvall Hunter
Phone:	+44-1277-252073
E-Mail:	dhunte11@ford.com

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

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

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

1.5 Conversion Type

1.5.1 Order Codes

The following tables show overviews of the available options which will assist in your conversion. 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.

Please ensure that the base vehicle is ordered with all required options by your Ford dealer. Availability of options vary by territory. For availability please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

Chassis

Order Code	Special Vehicle Option (SVO)	Description
A092	Low Series Police Brakes	Special brake pack for police vehicle conversions.

Powertrain

Order Code	Special Vehicle Option (SVO)	Description
A660	DPF Manual Regeneration	Diesel Particulate Filter (DPF) regeneration manually commanded by the operator.

Electrical

Order Code	Special Vehicle Option (SVO)	Description
A003	RPM Speed Control	Enables the ability to run the engine of the vehicle at elevated RPM speed.
A055	Trailer Tow Electrics Kit	Provides trailer tow electrics (connector and wiring) without tow bar. Not available with air suspension.
A095	Configurable Front Parking Aid	Front only parking sensors (to allow fitment of aftermarket rear steps).
A100	Tachograph - Digital	New Smart tachograph system including Dedicated Short Range Communication (DSRC) sensor.
A526	Auxiliary Fuse Panel	Provides access to fused power connections and various signals and control circuits.
A540	Ford Programmable Battery Guard (FPBG)	Patented multi-mode FPBG system capable of protecting Ford and third party batteries.
A550	High Power Supply Pack	Meets heavy electrical power take-up requirements (including options: HFQ, HFP, A003, A540).
A606	Beacon Preparation Pack	Provides wiring for front and rear beacons and switch located in 1-DIN mini overhead console (includes option: A526/not available with tachograph)
A608	High Specification Vehicle Interface Connector	Provides a range of hard-wired signals and control circuits (includes option: A526 / not available with A626).
A652	Roof Mounted Turn Signal Pack A	Additional turn signal lamps at rear of the roof above the rear doors. (Austria and Germany only)
A626	Utility Vehicle Switch Pack	Provides wiring and 3 switches for beacon and 2 power outputs located in 1-DIN mini overhead console (includes options: A526, A606 / not available with tachograph).

Body

Order Code	Special Vehicle Option (SVO)	Description
A304	Seat Pack SVO 11	Delivers vehicle without passenger seat and pedestal, less fire extinguisher, with black seat belt (not available on Double Cab in Van).
A305	Seat Pack SVO 3	This seat pack provides a single front passenger seat option with orange seat belt.
A306	Seat Pack SVO 4	This seat pack provides a dual front passenger seat option with orange seat belt.
A307	Seat Pack SVO 5	This seat pack provides a less front passenger seat option with orange seat belt (includes less fire extinguisher).
A312	Seat Pack SVO 12	This seat pack provides a less front passenger seat option on a trend (level 4) Van with black seat belt.
A532	Tyre Carrier Drop Door Closed	Provides spare wheel access from the outer side of the vehicle without need to open the rear doors.

Additional

Order Code	Special Vehicle Option (SVO)	Description
A6	Service Van pack	Floor covering, Side Lining and Tie Down for a wide variety of delivery uses
A7	Van pack 1	Base vehicle for Service Line conversion. For further information please contact your National Sales Company representatives, or local Ford dealer.
AV	Parcel Delivery Van pack	Base vehicle for Service Line conversion. For further information please contact your National Sales Company representatives, or local Ford dealer. Italy only.
C9	Camper Van pack	Base vehicle for camper van conversion. For further information please contact your National Sales Company representatives, or local Ford dealer.
E4	Multi-Purpose Vehicle 6 Seat Office	Base vehicle for Business Edition conversion. For further information please contact your National Sales Company representatives, or local Ford dealer.
E5	Multi-Purpose Vehicle Camper	Base vehicle for Euroline conversion. For further information please contact your National Sales Company representatives, or local Ford dealer.
EX	Taxi pack Version 1	2nd row seats deletion on titanium bus for taxi conversion purposes. Britain and Ireland only.
EZ	Bodybuilder Prep pack	A kombi/kombi-van donor vehicle including less rear seats headliner, trim (except in the front row doors) and flooring removed behind the 'B' pillar.
FV	Refrigeration Unit Prep pack	Refrigerated donor vehicle containing refrigeration main harness and single AGM battery for Van, Chassis Cabs and Skeletal Chassis.
RG	Refrigeration pack for LWB Van	Refrigerated donor for LWB van (RHD only).

Order Code	Regular Production Order (RPO)	Description
HFQ	2 High Performance AGM Batteries	High Performance deep cycle batteries for electrical Power Take Off (PTO) that requires deep discharge and cycling from third party systems at engine-off condition.
HFP	Heavy Duty Alternator	240A Alternator for high continuous PTO at engine-run condition.

1.5.2 Conversion Type - Reference Tables

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.

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: 4.3 Communications Network (page 75).
Refer to: 4.22 Fuses and Relays (page 151).

Chassis Cab Conversion	
Van Conversion/ Multi-Purpose Vehicle Conversions	Refer to: 1.14 Package and Ergonomics (page 28)
	Refer to: 1.17 Towing (page 38)
	Refer to: 3.8 Fuel System (page 58)
	Refer to: 4.6 Battery Systems (page 91)
	Refer to: 4.7 Battery Protection (page 105)
	Refer to: 4.23 Special Conversions (page 154)
	Refer to: 5.8 Seats (page 198). Rear Seat Fixings Positions
	Refer to: 5.12 Roof (page 204). Roof Racks

Dry Freight	
Box Van	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.23 Special Conversions (page 154). Auto Wipe and Auto Light for Vehicles with Large Overhang
Pantechnicon	Refer to: 1.16 Load Distribution (page 34)
	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.23 Special Conversions (page 154). Auto Wipe and Auto Light for Vehicles with Large Overhang
Money Carriers	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.12 Roof (page 204).
	Refer to: 4.15 Exterior Lighting (page 141).
Refuse Collection	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 4.16 Interior Lighting (page 142).

Emergency Services	
Ambulance (Front Line)/Fire Brigade/ Armed Forces / Police	Refer to: 3.2 Engine Cooling (page 48). Airflow Restrictions
	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.16 Interior Lighting (page 142).
	Refer to: 4.18 Cruise Control (page 146).
	Refer to: 4.22 Fuses and Relays (page 151).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 5.8 Seats (page 198).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 201).
	Refer to: 4.23 Special Conversions (page 154). Auto Wipe and Auto Light for Vehicles with Large Overhang

Vocational Conversion	
Mobile Workshops	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 5.3 Racking Systems (page 189).
	Refer to: 5.12 Roof (page 204). Roof Racks
	Refer to: 4.23 Special Conversions (page 154). Auto Wipe and Auto Light for Vehicles with Large Overhang
Mobile Shops / Offices	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 5.3 Racking Systems (page 189).
	Refer to: 5.12 Roof (page 204). Roof Racks
	Refer to: 4.23 Special Conversions (page 154). Auto Wipe and Auto Light for Vehicles with Large Overhang
Glass Carrying	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.1 Body (page 183). Racking System.
Racking Conversions	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.3 Racking Systems (page 189).
Recovery Vehicles	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 5.14 Frame and Body Mounting (page 207).
	Refer to: 4.23 Special Conversions (page 154). Auto Wipe and Auto Light for Vehicles with Large Overhang

Passenger Carrying	
Taxi	Refer to: 1.3 Commercial and Legal Aspects (page 9). Restraints System
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.16 Interior Lighting (page 142).
	Refer to: 5.8 Seats (page 198).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 200).
	Refer to: 5.12 Roof (page 204).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 201).
Mobility	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.16 Interior Lighting (page 142).
	Refer to: 5.8 Seats (page 198).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 200).
	Refer to: 5.12 Roof (page 204).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 201).
Coach Built	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 4.12 Tachograph (page 128).
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.16 Interior Lighting (page 142).
	Refer to: 5.8 Seats (page 198).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 200).
	Refer to: 5.12 Roof (page 204).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 201).
Wheelchair Accessible	Refer to: 5.1 Body (page 183) Racking System, Welding & Precautionary Drill Zones
	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 5.8 Seats (page 198).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 200).
	Refer to: 5.12 Roof (page 204).
	Refer to: 4.16 Interior Lighting (page 142).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 201).
Mini Bus	Refer to: 5.2 Hydraulic Lifting Equipment (page 186).
	Refer to: 4.15 Exterior Lighting (page 141).
	Refer to: 4.16 Interior Lighting (page 142).
	Refer to: 5.8 Seats (page 198).
	Refer to: 5.9 Glass, Frames and Mechanisms (page 200).
	Refer to: 5.12 Roof (page 204).
	Refer to: 5.10 Airbag Supplemental Restraint System (SRS) (page 201).

Refrigerated Vehicles	
Van Conversion	Refer to: 1.9 End of Life Vehicle (ELV) Directive (page 23).
	Refer to: 4.4 Charging System (page 80). Generator and Alternator
	Refer to: 4.8 Climate Control System (page 117).
	Refer to: 4.22 Fuses and Relays (page 151).
	Refer to: 5.12 Roof (page 204). Roof Racks
Compressor Installation	Refer to: 3.3 Accessory Drive (page 49).

1.6 Conversion Homologation

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

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

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

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

For additional information on vehicle type approval Refer to: 1.3 Commercial and Legal Aspects (page 9)

1.7 Electromagnetic Compatibility (EMC)

WARNINGS:

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

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

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

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

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

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

NOTE: For EMC on Police conversions with rear view cameras please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

Frequency Overview

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

1.7.1 Permitted Antenna Locations

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

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

Check all electrical equipment:

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

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

1.8 Vehicle Duty Cycle Guidelines

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

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

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

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

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

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

1.8.1 Vehicle Ride and Handling Attributes

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

NOTE: All vehicles should be evaluated for safe operation prior to sale. Conversions to the base vehicle that change the centre of gravity may affect the ride and handling attributes.

1.9 End of Life Vehicle (ELV) Directive

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

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

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

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

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

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

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

1.10 Jacking

WARNINGS:

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.

You must use the specific jacking points.

CAUTIONS:

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

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

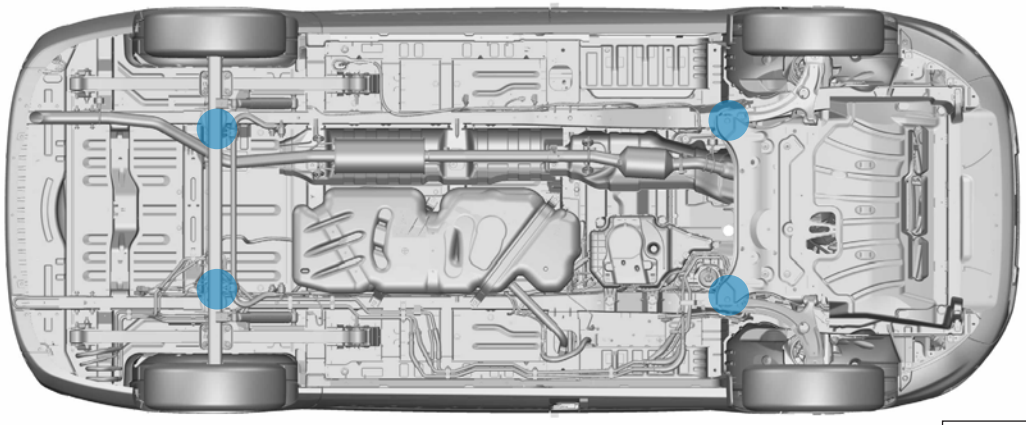
Ensure there is sufficient clearance when positioning the jacking equipment to prevent damage of any underfloor components.

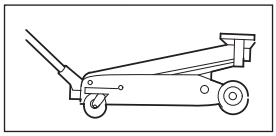
NOTE: When using the vehicle jack, refer to the owner guide for correct operating instructions.

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

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

Jacking Points





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1.11 Lifting

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

CAUTIONS:

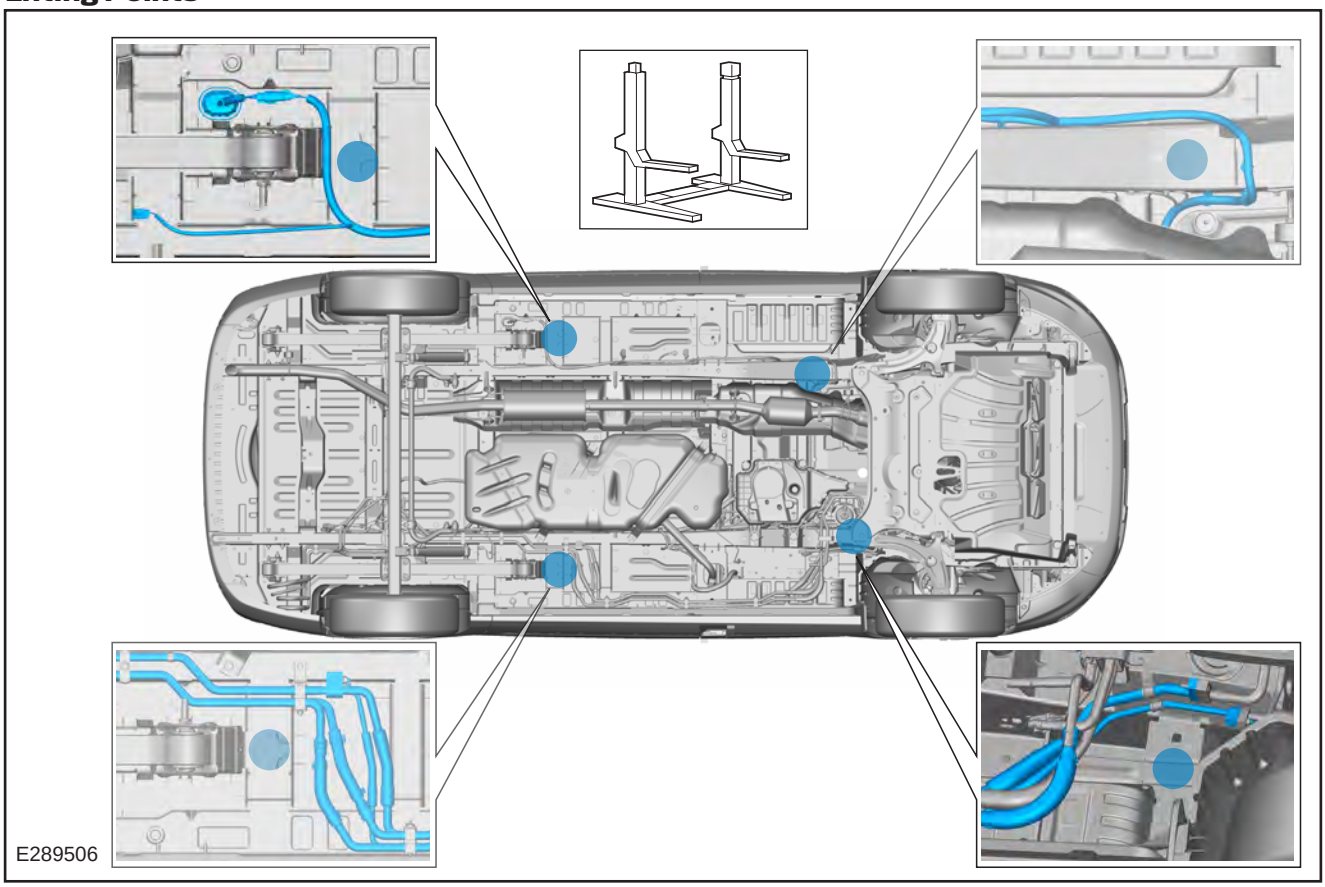
When lifting the vehicle with two post lift, vehicle lift arm adapters must be used under the lifting points.

When lifting the vehicle with a two post lift, the maximum kerb weight must not be exceeded.

It is important that only the correct lifting and support locations are used at all times.

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

Lifting Points



1.12 Noise, Vibration and Harshness (NVH)

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

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

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

1.13 Vehicle Transportation Aids and Vehicle Storage

CAUTIONS:

Make sure to disconnect the battery if the vehicle is to be stored for more than 7 days.

Make sure that the protective covers are not removed from an incomplete vehicle until the conversion is started.

Make sure that components removed during conversion are kept clean and dry.

Make sure that components removed during conversion are refitted to the same vehicle.

In addition:

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

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

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

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

The following may be considered a sensible approach to storage:

Short term storage:

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

Long term storage:

- The battery should be disconnected, but not removed from the vehicle
- The wiper blades should be removed and placed inside the vehicle. Make sure the wiper arms are suitably prevented from resting on the windscreen
- Wheel trims (where fitted) should be removed and stored in the luggage compartment
- Engage first gear (manual transmission) or place in park position 'P' (automatic transmission) and release the parking brake completely. Chock the wheels first if the vehicle is not on level ground
- Set climate controls to the 'open' position to provide ventilation, where possible
- Where protective film has been applied at manufacturing it must be left on the vehicle until prepared for delivery but must be removed after a maximum storage period of six months (film is date stamped to indicate required removal date)
- Make sure that all windows, doors, bonnet, 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.

MHEV Batteries: When storing for a period greater than 6 months, the vehicle should be started periodically. The vehicle should be stored in an environment with low humidity, free from corrosive gas within a temperature range of 20 to 35°C. A temperature of 40°C or higher will accelerate the deterioration of the battery performance. The 48V battery should be stored in an environment with between 45-85% humidity.

Refer to: 4.5 Mild Hybrid Charging System (page 87).

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 tyres	X	-
Check interior for condensation	-	X
Run engine for 5 minutes minimum with air conditioning switched on, where applicable	-	X

1.14 Package and Ergonomics

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

1.14.1 General Component Package Guidelines

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

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

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

1.14.2 Driver Reach Zones

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

1.14.3 Driver Field of View

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

1.14.4 Conversion Effects 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 detailed in the electrical section, described in reversing lamps.

Refer to: 4.15 Exterior Lighting (page 141).

1.14.5 Aids for Vehicle Entry and Exit

Steps

WARNINGS:

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

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

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

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

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

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

Grab Handles

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

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

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

1.14.6 Front, Rear and Side Under-Run Protection

WARNING: Check local legislation for legal requirements.

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

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

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

(1) As amended periodically

1.14.7 Worldwide Harmonised Light-Duty Vehicle Test Procedures (WLTP) Calculation Inputs

The following attributes are required as part of the WLTP calculation for completed vehicles

Mass of the Completed Vehicle

All modifications and changes that effect the actual mass of the vehicle must be taken into account. The definition of actual mass is described under the provisions of regulation 2017/1151 Annex XXI. The actual mass of the completed vehicle needs to be provided for the front and rear axle. This weight split will be important where the completed vehicle has mixed tyres between the front and rear.

Frontal Surface Area

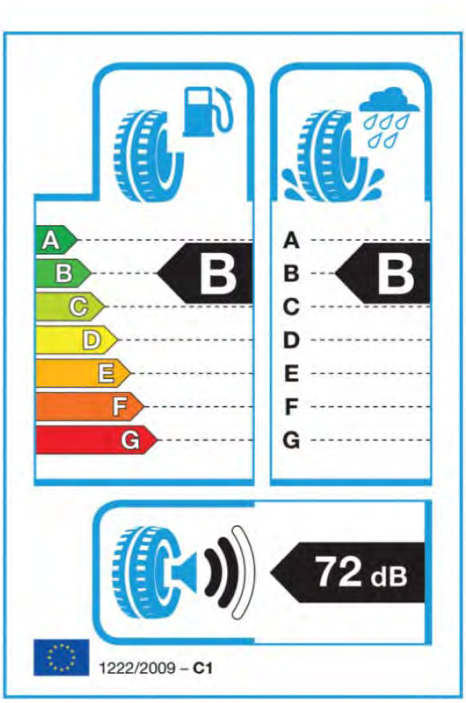
All modifications and changes that affect the frontal surface area of the completed vehicle must be taken into account. For further information please see information later in this section.

Tyre Rolling Resistance

Any changes in tyres fitted to the completed vehicle must be taken into account. The efficiency class and tyre class is needed to determine the correct calculation. This can be found on the tyre label as per the example below.

Exceeding Attribute Limits

As a requirement of the Vehicle Converter to use the base vehicle approval, the Vehicle Converter must stay within the defined limits of the BEMM and the Emissions Type Approval applicable to the vehicle. It is the responsibility of the Vehicle Converter to ensure they stay within these defined limits to remain compliant with the emissions performance. If the Vehicle Converter wishes to exceed the limits they must seek clarification with the relevant technical service or type approval authority. In this case, the base approval may become invalid and the Vehicle Converter may need to re-certify the vehicle against the exceeded limits.



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1.14.8 Vehicle Dimensions Key

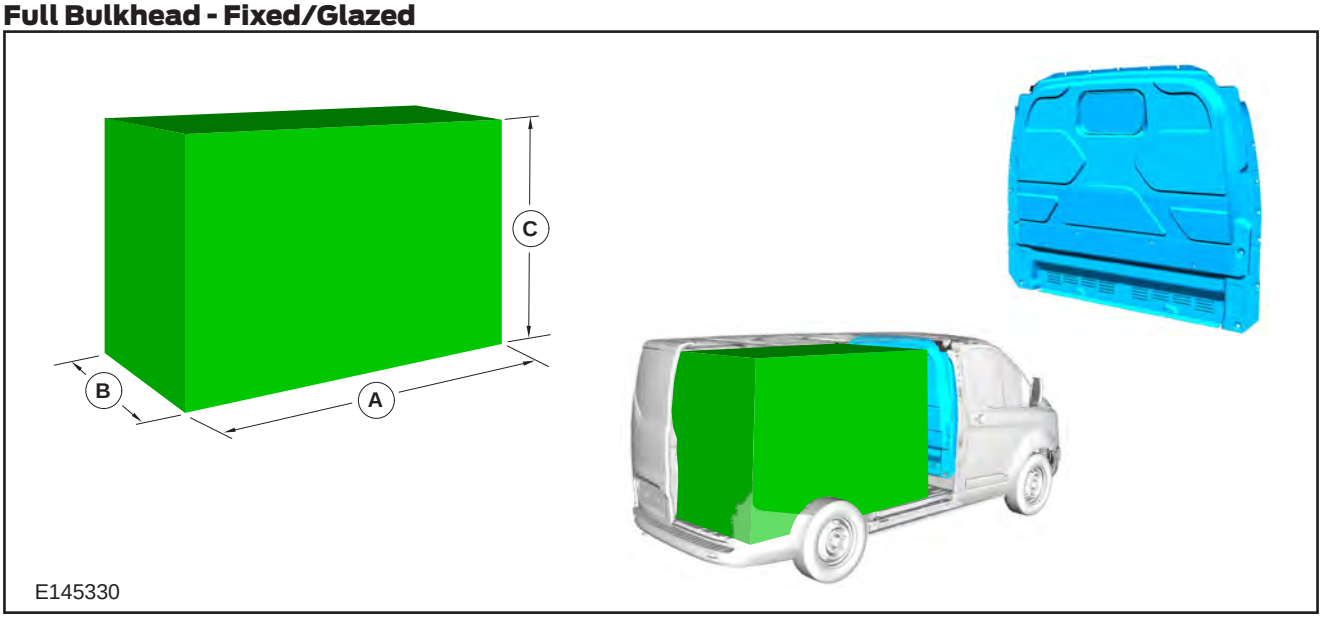
Dimension (mm)	L1	L2
Wheelbase Length	2933	3300
Overall Vehicle Height @ Base Kerb Weight		
H1	1972 - 2020	1967 - 2017
H2	2338 - 2389	2332 - 2381
Overall Vehicle Height @ GVM		
H1	1922 - 1953	1923 - 1954
H2	2280 - 2314	2284 - 2320

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

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

1.14.9 Recommended Main Load Area Dimensions

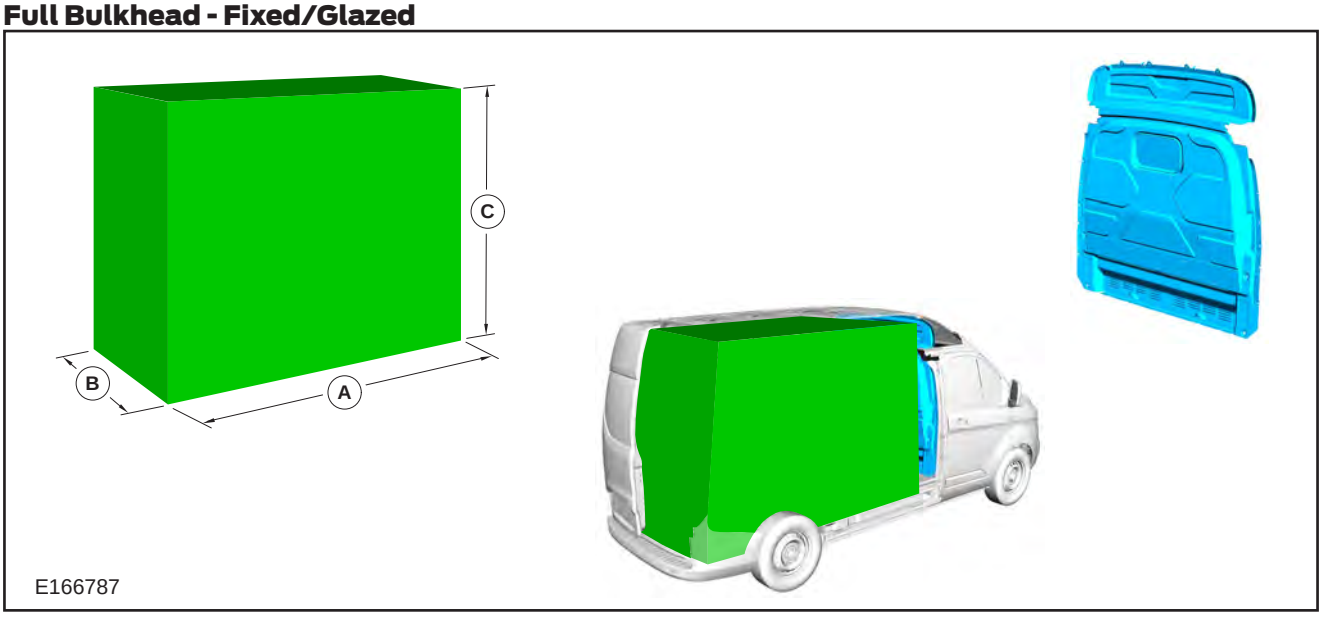
Full Bulkhead - Fixed/Glazed



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

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

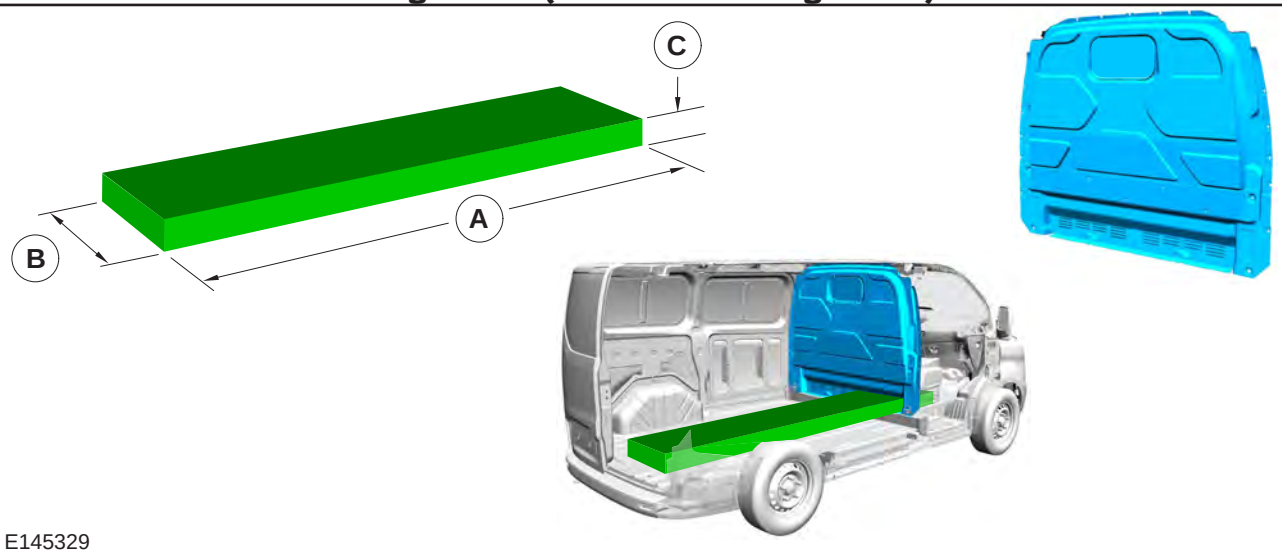
Full Bulkhead - Fixed/Glazed



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

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

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



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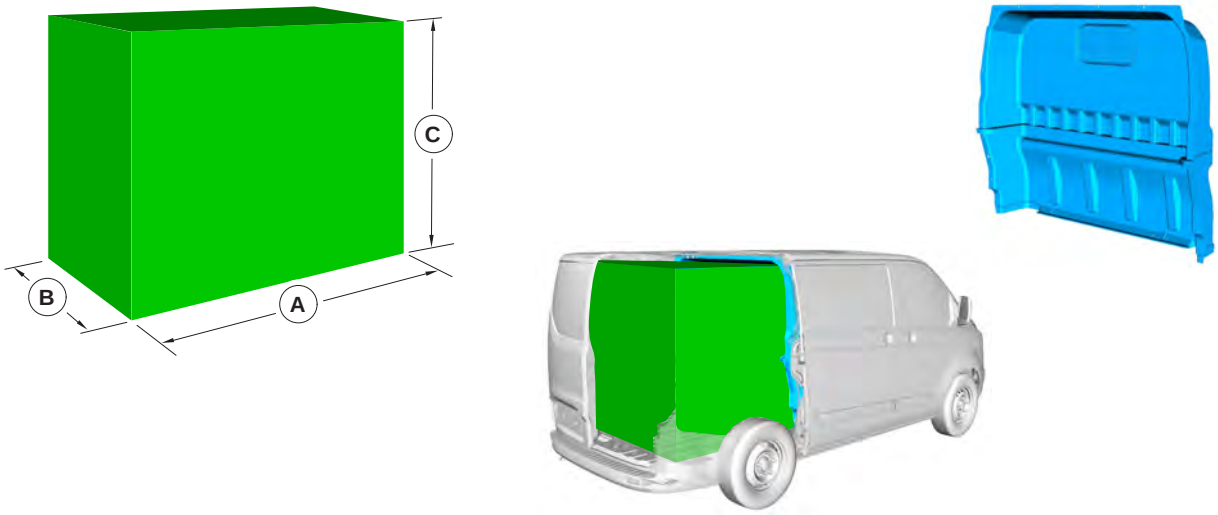
Vehicle	A (mm)	B (mm)	C (mm)
L1 - H1	3040	590	200
L2 - H1	3407	590	200

Not available with MHEV

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

Double Cab in Van Bulkhead



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

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

1.14.10 Vehicles with Roof Mounted Units

Vehicle with Roof Mounted Units Frontal Area Calculation

NOTE: The WLTP calculator can be accessed at www.etis.ford.com/BEMM. You will need to register or login to use it.

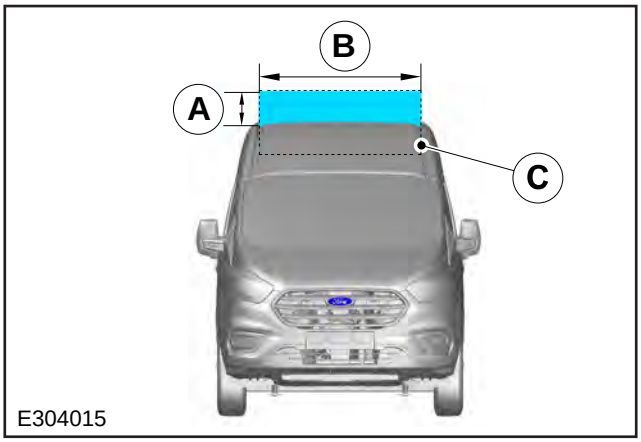
NOTE: SRW FWD is covered.

NOTE: All standard/optional equipment have already been taken into account, i.e. base vehicle frontal area including mirrors.

Roof mounted units may be integrated below the roof. For the height measurement (A), only measure the part of the unit that protrudes above the roof line.

The Vehicle Converter only needs to calculate the frontal area of the mounted unit (AxB) in m^2. The total frontal area calculation (AxB) of any roof mounted unit must not exceed $0.7m^2$ for medium roof vehicles and $0.2m^2$ for high roof vehicles. This additional frontal area needs to be added to the base vehicle frontal area which is on ETIS in the WLTP calculator.

Frontal Area Calculation



Item	Description
A	Roof Mounted Unit Height
B	Roof Mounted Unit Width
C	Integrated Roof Mounted Unit

1.15 Hardware

Material Specification, Strength and Torque

Use Ford-specified torques on Ford interfaces or, where not provided, use Standard Hardware and Tightening Torques (Nm) Bolts/Studs: ISO 898-1, Nuts: ISO 898-2

Standard Hardware and Tightening Torques (Nm) Bolts/Studs: ISO 898-1, Nuts: ISO 898-2				
	Grade 8.8		Grade 10.9	
Thread Size	Minimum	Maximum	Minimum	Maximum
M5	5.2	7.2	5.9	8.1
M6	8.9	12.1	10.2	13.8
M8	21.2	28.8	25.5	34.5
M10	40	54	53	72
M12	68	92	93	126
M14	113	153	148	201
M16	170	230	233	316

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

1.16 Load Distribution

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

1.16.1 Load Distribution

CAUTIONS:

Do not exceed the axle plated weights.

Do not exceed the gross vehicle weight.

In front wheel drive (FWD) vehicles, the front axle load must, in all load cases, exceed 38% of the actual vehicle weight.

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

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

NOTE: Avoid one-sided load distribution.

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

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

1.16.2 Centre of Gravity Position

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

Lateral Position

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

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

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

Vertical Position - Centre of Gravity Height

The Centre 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 Centre of Gravity Height influences axle weights while braking. Centre of Gravity height influences roll stability. Safety systems will work properly within the centre of gravity boundaries specified in the following warnings:

WARNINGS:

The table opposite shows maximum vertical centre of gravity (CG_v) heights by vehicle type. If the CG_v is equal to or less than the values stated and no modifications have been made to the components of the braking system, suspension and/or wheels and tyres, the converted vehicle complies with ECE 13-H, ANNEX 9 standard or ADR 35 or applicable local legislation.

If the CG_v of the converted vehicle is above the values stated, Ford Motor Company makes no representation as to conformity with ECE 13-H, ANNEX 9 standard or ADR 35 or applicable local legislation.

1.16.3 Centre 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 centre 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 tyre 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 tyre and suspension.

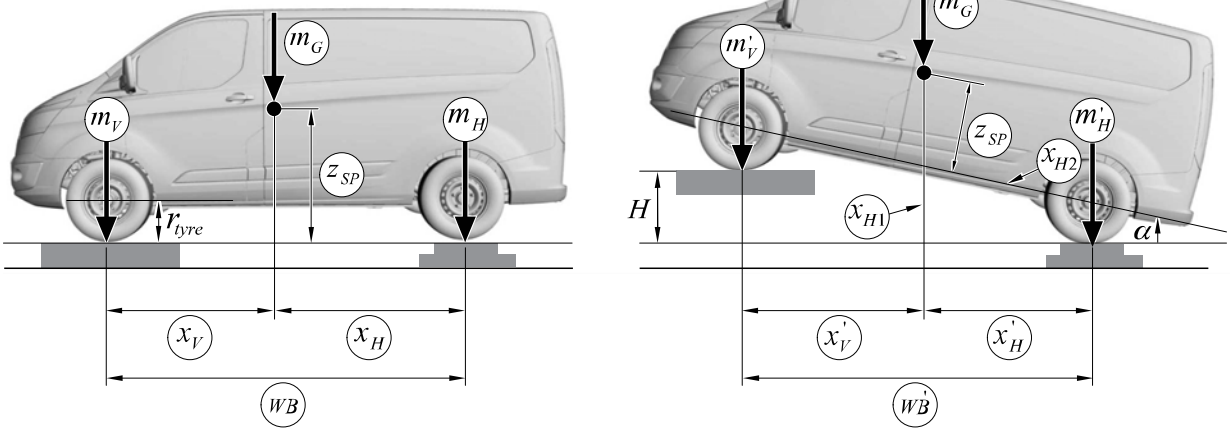
Calculation

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

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

Maximum Vertical Centre of Gravity (CG_v) Height

Vehicle	Wheelbase	Maximum Vertical Centre of Gravity (CG_v) Height
All Transit Customs except Sports Series	All	870mm
Sports Series Only	All	750mm



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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			
Centre of Gravity Height Z		mm			

Inclination Angle:

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

E146623

Centre of Gravity Height Z:

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

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

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1.16.4 Centre 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	
Centre of Gravity (CoG) height	Z_{SP}
Total vehicle mass	m_G
Distance front axle to CoG (horizontal)	X_V
Distance rear axle to CoG (horizontal)	X_H
Wheelbase (projected in horizontal)	WB'
Front axle weight	m'_V
Rear axle weight	m'_H
Distance front axle to CoG (projected in horizontal direction)	X'_V
Distance rear axle to CoG (projected in horizontal direction)	X'_H
Inclination angle	arc sin
Front part of 'distance rear axle to CoG (horizontal)'	X_{H1}
Rear part of 'distance rear axle to CoG (horizontal)'	X_{H2}

1.16.5 Formulas

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

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

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

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

E146626

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

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

E146627

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

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

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

E146628

The following equations apply:

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

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

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

E146629

Using the rule of proportion leads to the Centre 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

1.17 Towing

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

1.17.1 Tow Bar Requirements

When a tow bar device is required, the Vehicle Converter should use a Ford approved tow bar.

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

NOTE: For base vehicles ordered without a tow bar or underrun, bar reinforcements and hardware need to be ordered and fitted. Contact your local Ford dealer for details.

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

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

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

An electric Prep Pack (A055) can be ordered with the base vehicle and is fitted in the plant. A055 does not contain any tow bar, reinforcements or tow bar hardware.

For additional information in this manual:

Refer to: 1.11 Lifting (page 25).

Refer to: 4.2 Wiring Installation and Routing Guides (page 63). Electrics for Tow bar.

1.17.2 Tow Bar Types (for EU specification vehicles)

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

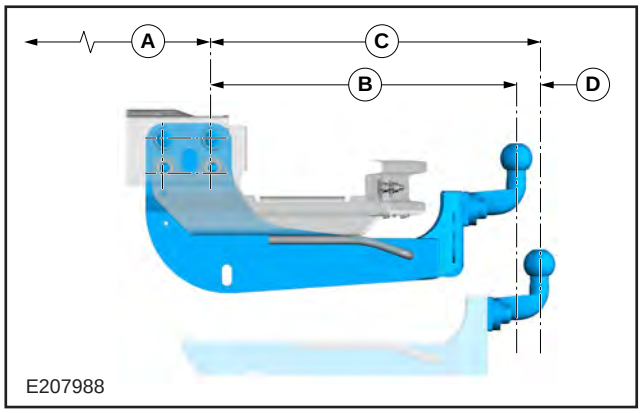
NOTE: When attaching the tow ball to the tow bar use the top two fixing holes.

For tow bar devices fitted by the Vehicle Converter the following applies:

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

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

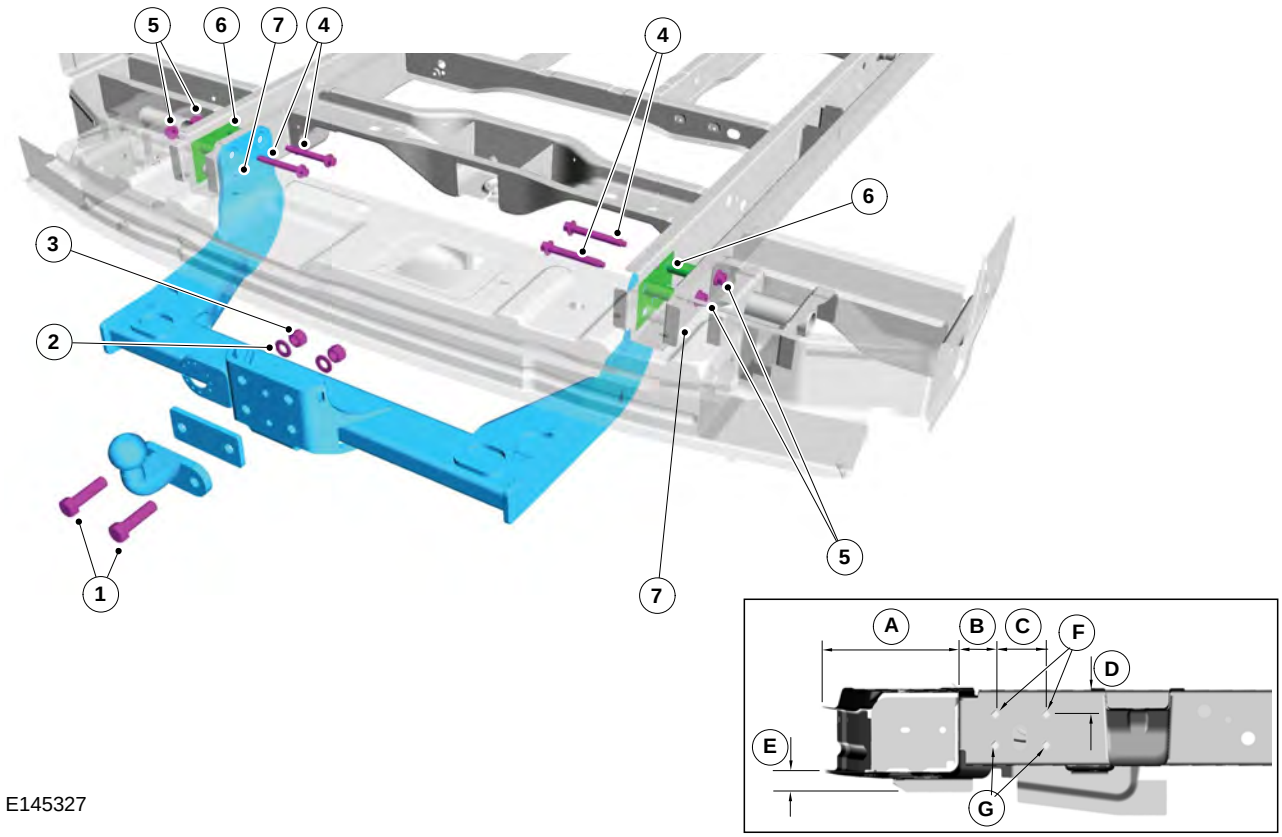
Trailer Sway Control (TSC) Tow Ball Zone - Van, Bus, Kombi



Item	Description
A	675mm (SWB/LWB) from centre of rear axle
B	476mm
C	490mm
D	15mm

WARNING: To ensure functionality of Trailer Sway Control (TSC), please make sure that the tow ball is within zone 'D' as shown in figure E207988.

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



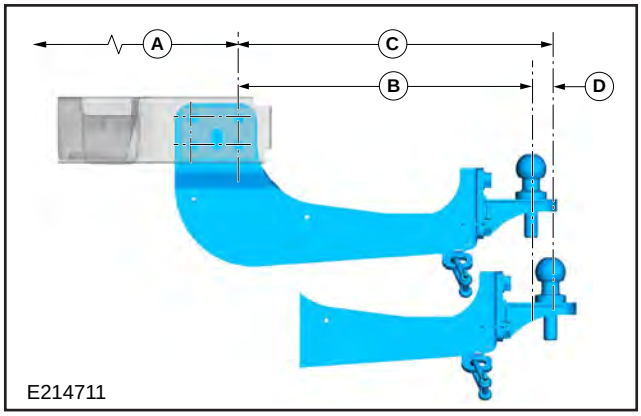
Item	Description
1	M16 x 55 Screw - Torque 200nM ±30nM
2	M16 Washer
3	M16 Nut
4	M12 x 75 x 90 Hexagonal Flange Bolt in holes 'F' - Torque 103nM ±15nM
5	M12 Hexagonal Flange Nut
6	Reinforcement clamp plate
7	Reuse 2x bolts (each side) in holes 'G' - Torque 110nM ± 16.5nM
A	177mm
B	53mm
C	75mm
D	35mm
E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

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

For tow bar devices fitted by the Vehicle Converter the following applies:

- Tow bar allowances must not exceed those of the standard vehicle.
- For attachment of the tow bar, under run bar and steps see figure E186508 - Tow Bar SWB Van 2.9 tonne (GVM) and LWB Van 3.3 tonne (GVM).
- Any modifications to the vehicle must be noted in the owner's handbook or new descriptive literature included with the owner's documentation
- The maximum allowable tow ball static load is 280kg on 340L LWB (Manual Transmission) Van - 2800kg maximum towing
- The maximum allowable tow ball static load is 250kg on 340S SWB Van (6MT) - 2500kg maximum towing
- The maximum allowable tow ball static load is 200kg on 340S SWB Van (6AT) - 2000kg maximum towing
- The maximum allowable tow ball static load is 280kg on 340L LWB Van (6MT) - 2800kg maximum towing
- The maximum allowable tow ball static load is 200kg on 340L LWB Van (6AT) - 2000kg maximum towing
- The maximum allowable tow ball static load is 180kg on 320S Sport SWB Van (6AT) - 1800kg maximum towing
- The maximum allowable tow ball static load is 180kg on 320L Sport LWB DCIV (6AT) -1800kg maximum towing
- A minimum tow ball static load of 10% of towed weight is required for Australia and New Zealand
- Tow bar installations must meet the requirements of the Australian Design Regulations ADR 62
- Whenever frame drilling is necessary use tube reinforcement, example shown in green in figure E186508

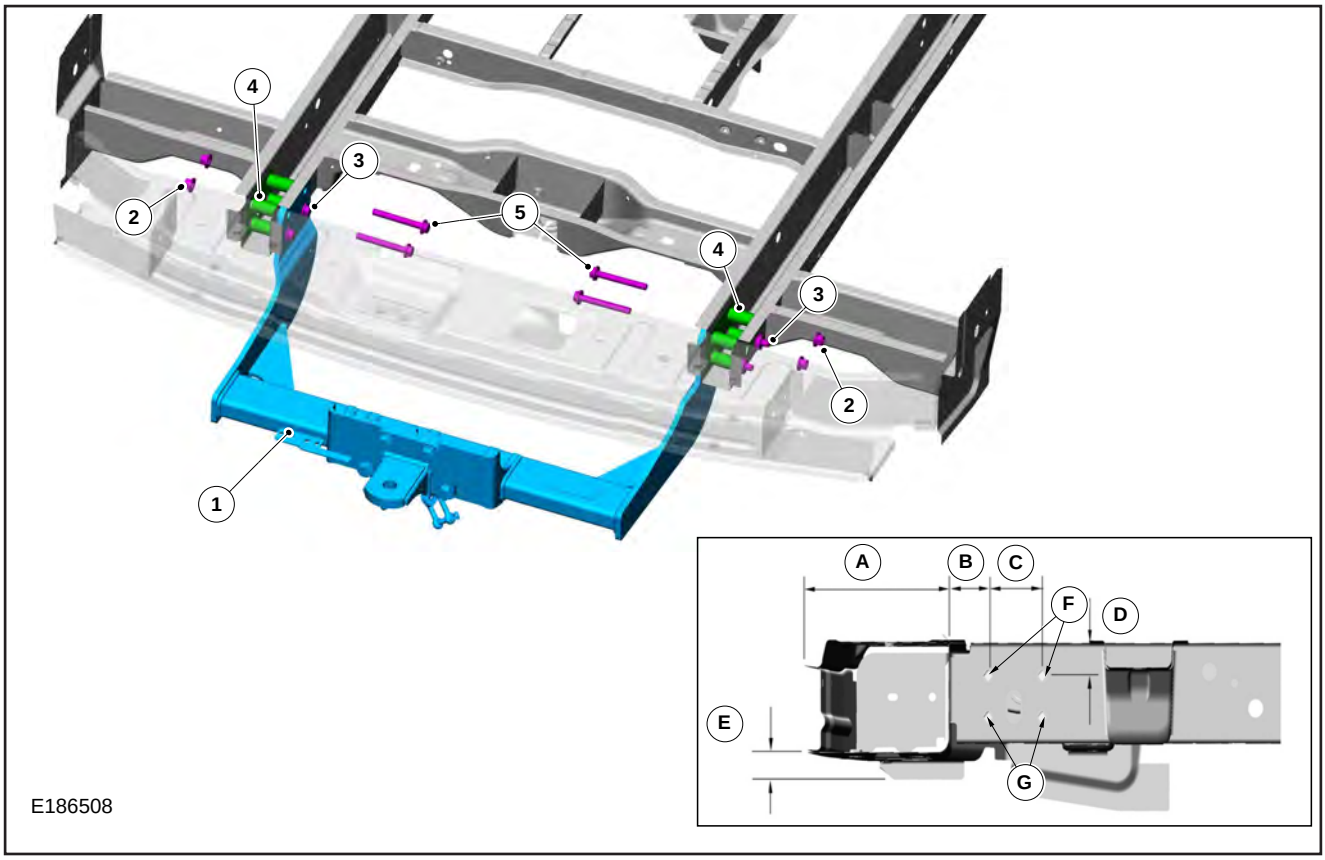
Refer to: 5.14 Frame and Body Mounting (page 207).
Mounting Points and Tubing



Item	Description
A	675mm (SWB/LWB) from centreof rear axle
B	477mm
C	492mm
D	15mm

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

Tow Bar SWB Van 2.9 Tonne and LWB Van 3.3 Tonne



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

1.17.4 Trailer Brakes

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

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

NOTE: Ford new vehicle warranty is provided for the Ford Licensed Accessory (FLA) Trailer Brake Controller (TBC) when it is fitted to the vehicle by an Authorized Ford dealer. Ford is not responsible for warranty and performance of other aftermarket brake controllers which are not approved by Ford. If clarification is required on the specifications of the pulsed signals, please contact your Authorized Ford dealer.

2.1 Suspension System

WARNINGS:

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

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

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

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

2.2 Front Suspension

2.2.1 Springs and Spring Mounting

WARNINGS:

Do not modify, drill, cut or weld any suspension components, specifically the steering gear system, subframe, lower control arm 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 spatter.

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 manufacturer's requirements.

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

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

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

2.3 Rear Suspension

2.3.1 Springs and Spring Mounting

WARNINGS:

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.

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

Rear Suspension and Rear Air Suspension

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

CAUTIONS:

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

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 manufacturer's requirements.

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

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

NOTE: Do not add any additional axles.

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

2.4 Wheels and Tyres

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

2.4.1 Wheel Clearance

The distance from the tyre 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.

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

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

2.4.2 Tyre Manufacturers

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

2.4.3 Tyre Pressure Monitoring System (TPMS)

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

If you need to replace a road wheel and tyre 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 tyre to your vehicle. To restore the correct operation of the system, you must have the repaired road wheel and tyre assembly refitted to the vehicle.

NOTE: If fitting new tyres, you must ensure that the TPMS sensors are fitted correctly as outlined in the service literature.


E167541

2.4.4 Spare Wheel

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

2.4.5 Temporary Mobility Kit

If your vehicle does not have a spare tyre, it will have a temporary mobility kit which will only repair one damage tyre. Both compressor and sealant bottle are located in the front right hand step.

For more information and usage of the tyre repair kit please refer to the Owner's Manual.

For information on vehicles with the spare wheel:
Refer to: 1.10 Jacking (page 24)

2.4.6 Painting Road Wheels

CAUTION: Do not paint wheel clamp surfaces in contact with other wheels, 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 colour or repairing paint.

2.6 Brake System

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

2.6.1 General

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

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

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

CAUTIONS:

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

For converted vehicles fitted with AEBS (Advanced Emergency Braking System), where vehicle mass or geometry is significantly altered, it is recommended that the radar vertical alignment and system functionality is checked by a Ford dealer. For further information, refer to the Workshop manual or Owner's manual.

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

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

NOTE: Do not obstruct the radar.

NOTE: Do not paint the front grille of the vehicle as this may affect the functionality of the radar. The brake fluid reservoir must remain accessible for servicing and for adding brake fluid.

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

2.6.2 Kerb Mass Data

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

2.6.3 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.

2.6.4 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 wheelbase impacts the existing parking brake cable.

2.6.5 Hydraulic Brake - Front and Rear Brakes

WARNINGS:

Do not modify the brakes.

Do not modify the disc inflow and outflow of cooling air.

2.6.6 Anti-Lock Control — Stability Assist

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

3.1 Engine

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

For electrical supply to auxiliary equipment.
Refer to: 4.4 Charging System (page 80).

3.1.1 Engine Selection for Conversions

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

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

NOTE: Light duty emissions engines are available at Stage 6 EU emissions level for Transit vehicle conversions not exceeding 2840kg,

3.1.2 Engine Types

Front Wheel Drive (FWD) 2.0L engines Stage 6 EU emissions with DPF:

TDCi	Max Power kW/RPM	Max Torque Nm/RPM
FWD		
77kW (105PS)	77kW (105PS) at 3500 1/RPM	310Nm at 1500-2250 1/RPM
96kW (130PS)	96kW (130PS) at 3500 1/RPM	360Nm at 1500-2500 1/RPM
125kW (170PS)	125kW (170PS) at 3500 1/RPM	390Nm at 1750-2750 1/RPM
136kW (185PS)	136kW (185PS) at 3500 1/RPM	415Nm at 1750-2750 1/RPM

3.2 Engine Cooling

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

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

3.2.1 Auxiliary Heater Systems

WARNINGS:

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

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

CAUTIONS:

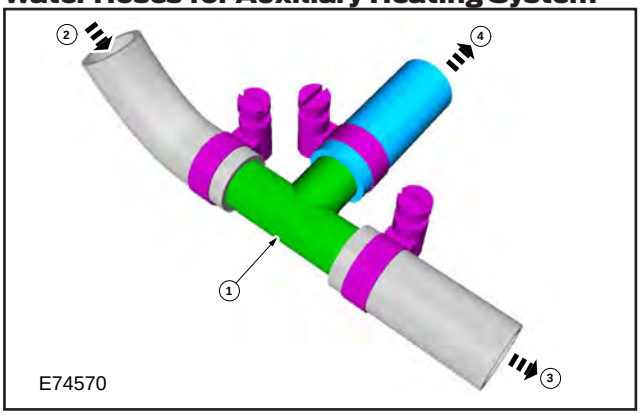
Only make connections into the heater hose between the front cab heater and water pump return inlet.

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

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

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

Water Hoses for Auxiliary Heating System



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

- Coolant flow to cab heater must have priority over flow to auxiliary heater or hand wash facility
- Coolant tube routing must be below the minimum line of the degas bottle
- Use aluminium 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 bonnet inner and outer (assembly) panels at design position shall not be less than 15mm
- There must be a minimum clearance of 10mm between the engine assembly and flexible components (for example, hoses or wiring harnesses) affixed to front end sheet metal hardware, under a maximum engine torque roll condition

3.2.2 Auxiliary Heater Installation

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

Refer to: 5.13 Corrosion Prevention (page 206).

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: Overheating within the engine compartment can seriously compromise component robustness.

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

3.3 Accessory Drive

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

3.3.1 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 manufacturer's recommended (or equivalent specification) components.

Make sure that the ancillary pulley diameter is less than the crankshaft pulley diameter.

The MHEV FEAD must not be modified or any accessory drive added.

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.

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.

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

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

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

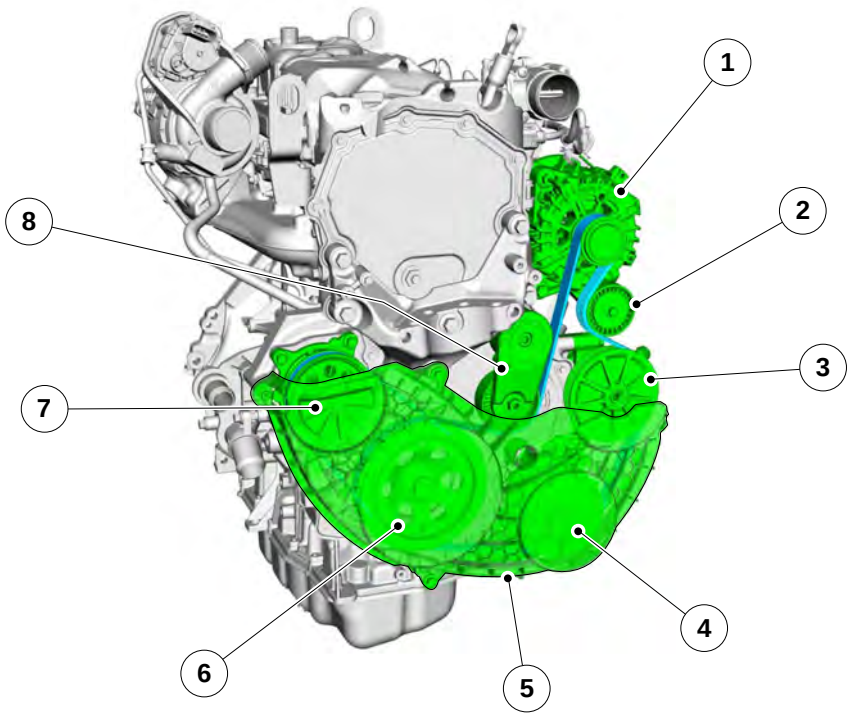
When engineering and installing a new front end accessory drive i.e. belt driven from the crankshaft pulley, the angular alignment of the belt to any pulleys must be within ±0.5º.

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 5kW or 21Nm based on the Ford released variable air conditioning compressor.

FWD TDCi

Figure	Engine
E224688	GEN1 TDCI with HPAS
E289251	GEN1 with EPAS / Upgrade with EPAS. Start-Stop Shields as standard. Optional AC.
E289252	GEN1 with EPAS and MHEV / Upgrade with EPAS and MHEV. Start-Stop Shields as standard. Optional AC.

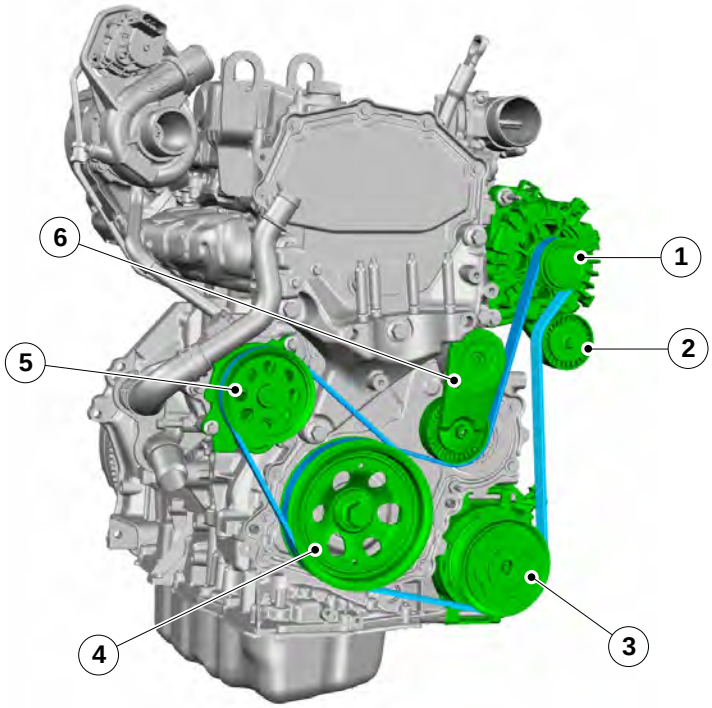
GEN1 TDCI with HPAS



E224688

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

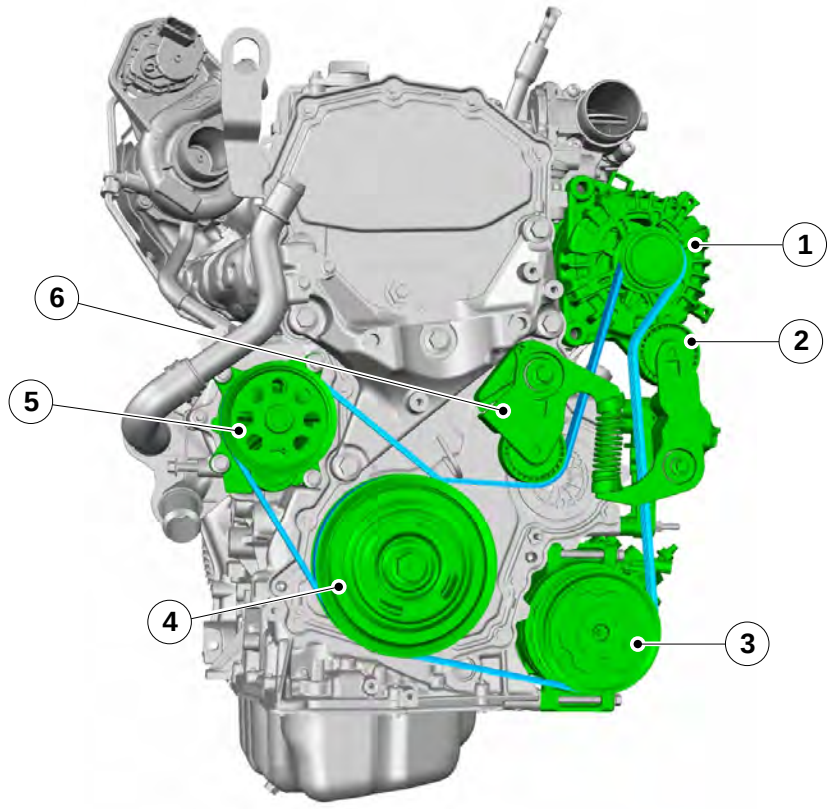
GEN1 with EPAS / Upgrade with EPAS. Start-Stop Shields as standard. Optional AC.



E289251

Item	Description
1	Alternator
2	Idler
3	AC Compressor
4	Crankshaft Pulley
5	Water Pump
6	Tensioner

GEN1 with EPAS and MHEV / Upgrade with EPAS and MHEV. Start-Stop Shields as standard. Optional AC.



E289252

Item	Description
1	Generator
2	Idler
3	AC Compressor
4	Crankshaft Pulley
5	Water Pump
6	Tensioner

3.4 Automatic Transmission

WARNINGS:

Do not reroute external transmission gear shift cables.

Tachographs cannot be fitted into 6F55 transmissions.

Do not change external electrical connectors.

6F55 - 6 Speed Automatic FWD Transmission

Gears	Base Transmission Ratio	Overall Ratio - Final Drive 3.39
1st	4.484	15.201
2nd	2.872	9.736
3rd	1.842	6.244
4th	1.414	4.793
5th	1	3.390
6th	0.742	2.515
Reverse	2.882	9.770

3.5 Clutch

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

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

3.6 Manual 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 Ratio		
		4.19 Final Drive	4.43 Final Drive	4.93 Final Drive
1st	3.727	15.609	16.507	18.370
2nd	1.952	8.175	8.645	9.620
3rd	1.121	4.695	4.965	5.530
4th	0.780	3.267	3.455	3.850
5th	0.844	2.570	2.754	2.910
6th	0.683	2.080	2.229	2.360
Reverse	1.423	16.150	17.306	18.30

3.7 Exhaust System

NOTE: For further information please contact your National Sales Company representative or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

3.7.1 Extensions and Optional Exhausts

CAUTIONS:

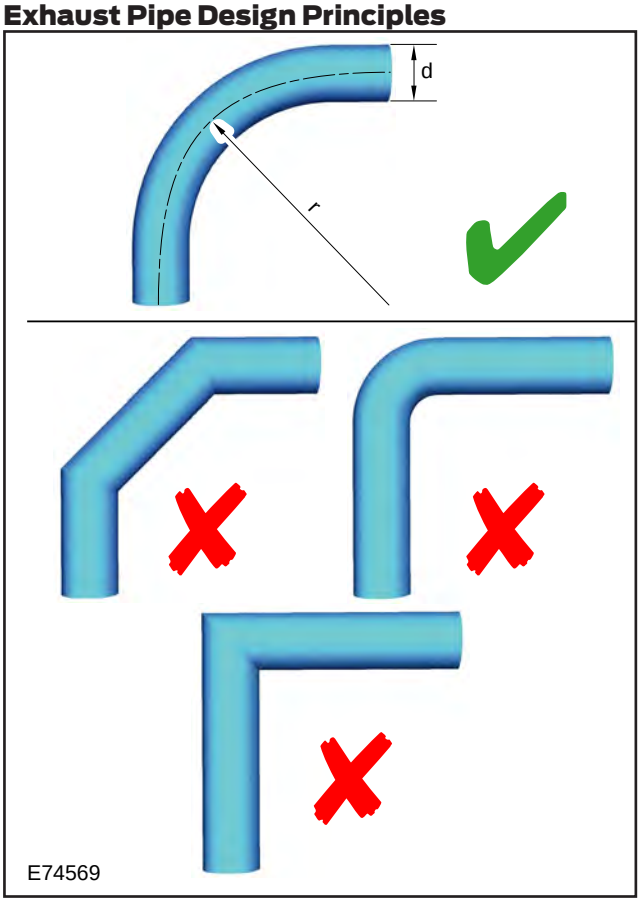
Non-standard systems must be tested for engine back pressure and all legal compliance (noise and emissions).

Make sure that for any pipes that require bending, the radius of the bend is minimum 2.5 x tube diameter.

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

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

Exhaust Pipe Design Principles



Item	Description
d	diameter
r	radius => 2.5d

3.7.2 Exhaust Pipes and Supports

CAUTIONS:

Maintain the original set-up and heat shields.

Do not position any components closer than 150mm nominal (100mm minimum) clearance to the downpipe, the catalytic converter, the diesel particulate filter, the selective catalyst reduction and any part of the exhaust system.

3.7.3 Exhaust Heat Shields

Exhaust Heat Shields

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

Standard Exhaust Heat Shields

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

3.7.4 Diesel Particulate Filter (DPF)

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

Regeneration

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

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

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

- Drive your vehicle, preferably on a main road or motor way, for up to 20 minutes avoiding prolonged idling, but always observing speed limits

and road conditions
- Do not switch off the ignition
- Use a lower gear than normal to maintain a higher engine speed during this journey, where appropriate

3.7.5 Operator Commanded Regeneration (A660)

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

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

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

Refer to: 4.11 Electronic Engine Controls (page 121).
DPF and RPM Speed Control

3.7.6 Vehicle Exhaust Systems — Vans with Full Bulkheads

Vehicle exhaust systems for vans with bulkheads are available in two lengths; a short length exhaust finishing approximately in the centre 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 ensure that the most suitable length of exhaust is used to avoid exhaust gas ingress into the vehicle.

3.8 Fuel System

WARNINGS:

Do not cut into the original fuel supply lines.

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

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

NOTE: The fuel heater line comes with a fuel fired heater as an orderable option. The fuel heater line is available as a service item.

For vehicles without the 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 E295569.

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

To lower fuel tank:

- Drain tank
- Disconnect fuel lines between fuel tank and urea tank
- Plug lines to prevent residual fuel from draining/ spilling
- Remove filler pipe from tank
- Remove bolts securing the three tank straps
- Lower the fuel tank to gain access to the top, see Figure E295569 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
- Remove plugs and reconnect fuel lines

CAUTIONS:

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

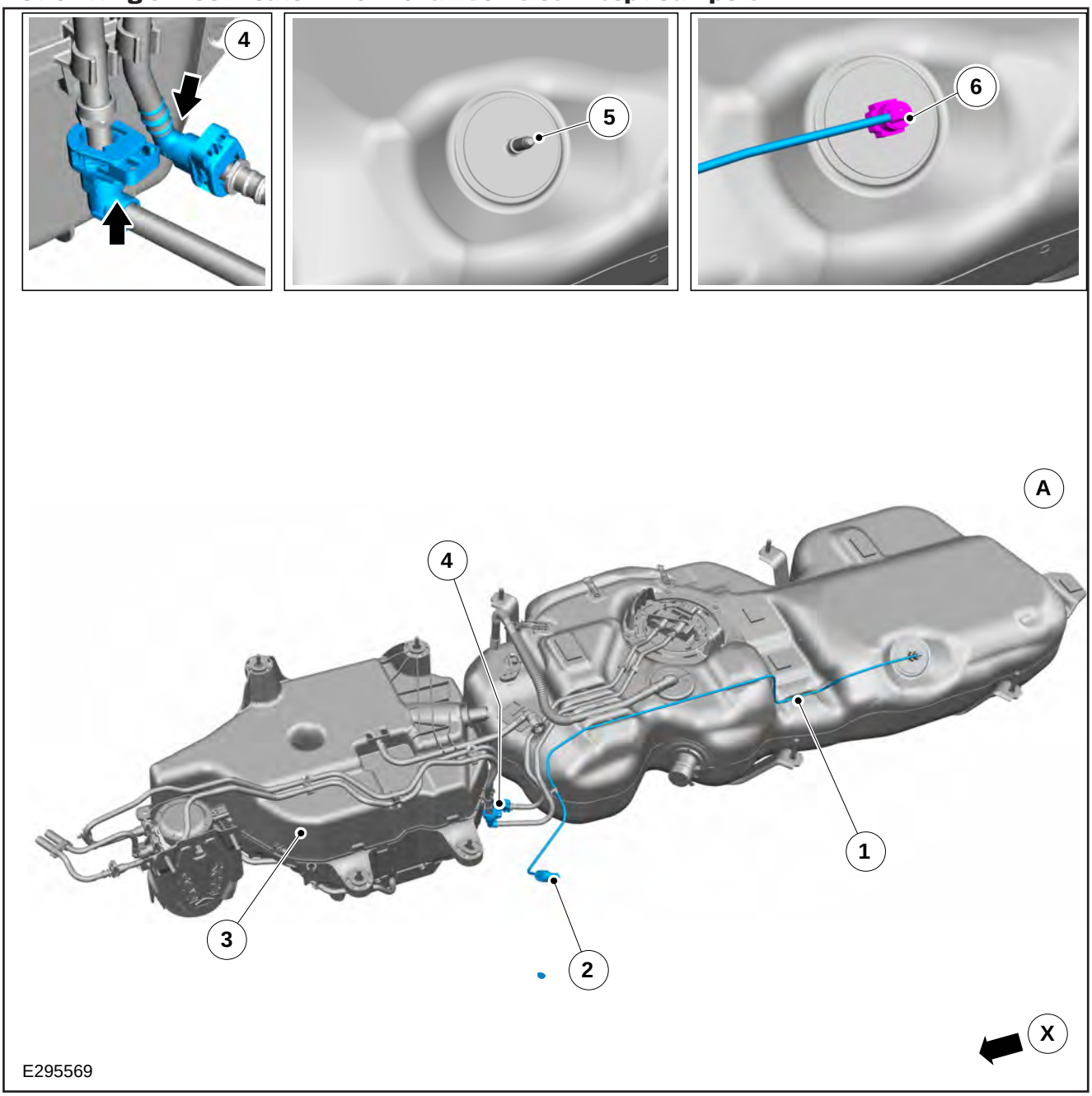
Make sure that when the port is cut that it is smooth with no sharp edges or burrs.

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

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

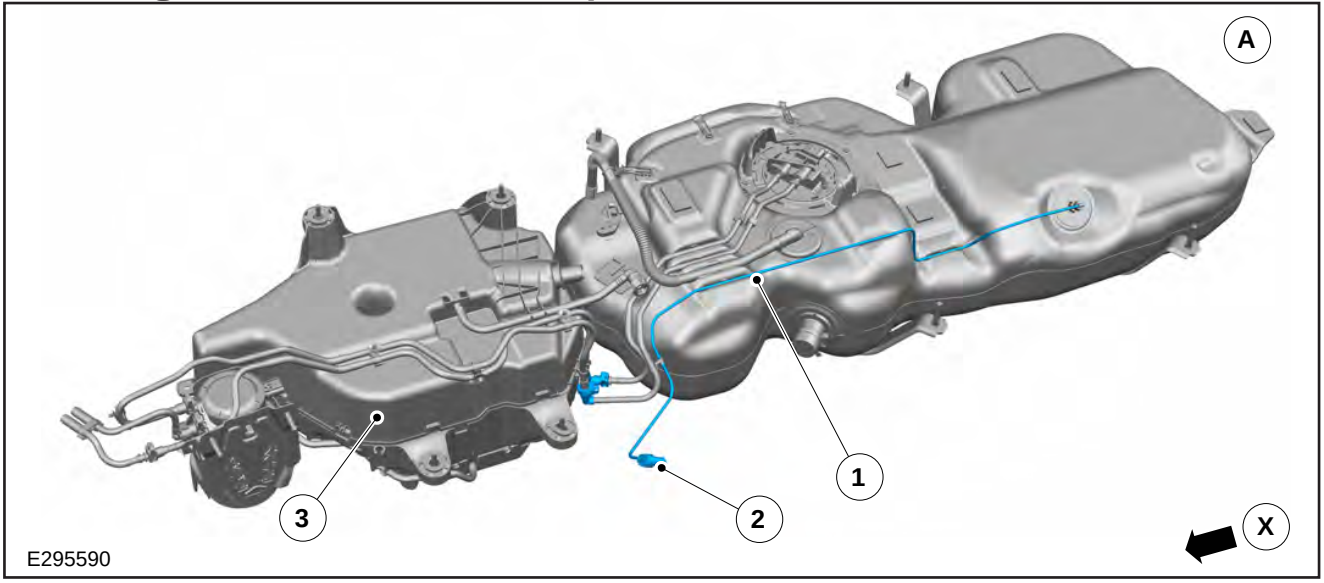
NOTE: Do not fasten anything to existing electrical components, wires or fuel lines.
For additional information
Refer to: 5.1 Body (page 183). Floor 'Precautionary Drill Zones' Fuel Tank with Urea.

Retrofitting of Fuel Heater Line - For all Vehicles Except Campers



Item	Description
A	FWD 70L Fuel Tank
1	Fuel Heater line, part number KK21-9N126-A*
2	Fuel Heater line has a female connector TI LOCC QC 7.89 fitted as standard. It is recommended to use a 7.89 male adapter mating part (manufacturer TI Automotive GmbH).
3	UREA Tank/AdBlue® Tank
4	Disconnect fuel lines between Fuel Tank and UREA Tank
5	Cut off top of port of diesel delivery module flange leaving 19.64 ± 0.12mm and carefully insert heater tube, part number BK21-9T308-A*
6	Fix quick fit connector of fuel line to heater tube, part number GK21-9N126-A*
X	Drive Direction

Retrofitting of Fuel Heater Line - For Camper Vehicles



Item	Description
A	FWD 70L Fuel Tank
1	Heater Fuel Line, part number KK31-9N126-B*. Fitted in Plant
2	Heater Fuel Line has a male end adapter TI LOCC QC 7.89mm diameter fitted as standard, with a female blind quick connector. After the female blind quick connector is removed, it is recommended to use a female 8mm (5/16") quick connector that meets SAE J2044 standard (August 2009 or later), where the seal diameter = 7.89mm.
3	Urea Tank/AdBlue® Tank
X	Drive Direction

4.1 Electrical System Overview

WARNINGS:

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

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.

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.

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

4.1.1 Electrical Architecture Changes

Fusing Strategy

The Power Distribution Box (PDB) replaces the previous Electrical Junction Box (EJB).

Several signal wires and fuses may have changed the location which may have an effect on the conversion design.

Refer to: 4.3 Communications Network (page 75). on new BCM output signals.

Ford Programmable Battery Guard GEN2 (A540)

Vehicles will be equipped with a new generation of Ford Programmable Battery Guard (FPBG), if ordered with this option or retrofitted.

The new generation 2 differs from the previous generation 1:

- There is increased power output to 200A
- There is an easier selection of modes, with only ignition cycles
- Extra sensing capability looking at battery temperature, ageing and current flow
- Thermal protection is added to the Electrical Distribution System (EDS) to support high current usages
- The new electrical architecture is supported with the load-shedding input signal compliance
- Features integrated FPBG control to Aux Fuse panel (engine off) where fitted
- Features built in Mode 1 Engine RPM control when buying option A003

The FPBG GEN2 differs from the previous version in its setup and provides a range of additional features based on the new electrical architecture.

Refer to: 4.7 Battery Protection (page 105). For further information on the FPBG.

Electric Power Assisted Steering (EPAS)

The Electric Power Assisted Steering (EPAS) replaces the Hydraulic Power Assisted Steering (HPAS). AWD, however, still takes HPAS.

Load-Shedding and Standard Battery Guard

Vehicles using EPAS are equipped with a load-shedding system. This is designed to protect the base vehicle system voltage. The load-shedding system will be standard for all vehicles and may affect the design of your conversion.

At engine run, if the supply voltage is near to 11V, the supplies to the CCP2, FPBG, Auxiliary Fuse Panel and signal to certain connectors will be disconnected. At engine off, disconnection occurs after a certain time or SOC value to protect the battery so the vehicle can restart (crank).

Refer to: 4.7 Battery Protection (page 105). for load-shedding

Vehicle Interface Connector

The Vehicle Interface Connector has been updated from an 8-way to a 10-way connector.

SVO Auxiliary Fuse Panel (A526, A606 and A626)

The Auxiliary Fuse Panel is now located behind the glove box. It now offers more circuits, more power, battery guard and Third Party High Power Mode.

High Specification Interface Connector [A608]

Increased features and functions (RunLock, load-shedding, battery guard, locking third party latches and lower cost mating kit).

GNSS/4G Antenna

The introduction of the Global Navigation Satellite System (GNSS)/4G antenna.

Automatic Engine Idle Shut down (AEIS)

AEIS, which is a safety feature, may be available on certain vehicles. Check with your dealer. If the AEIS is operating incorrectly (i.e. engine shuts down when still required) it may be inhibited by Third Party High Power Mode.

Refer to: 4.24 Electrical Connectors and Connections (page 158).

Customer Connection Point (CCP)

Vehicles are equipped with a different power supply strategy. The previous 3 x Customer Connection Point (CCP) with 3x 60A fuses is replaced with a 1x 60A 'CCP1' power at all times stud and a 1x 175A 'CCP2' controlled stud.

Refer to: 4.24 Electrical Connectors and Connections (page 158).

Third Party High Power Mode for SRC and Start-Stop Inhibit

The SRC and Start-Stop inhibit functions have been included in the Third Party High Power Mode feature. This also provides AEIS inhibit, and at engine off, inhibit of the SBG timeout.

Refer to: 4.6 Battery Systems (page 91).

Mild Hybrid Electric Vehicle (MHEV) 48V Systems

MHEV vehicles are provided with a 48V charging system. This replaces the alternator. The 12V supply is from a DC/DC converter in the 48V battery pack.

Electrical conversions are restricted on MHEV variants.

Refer to: 4.5 Mild Hybrid Charging System (page 87).

4.2 Wiring Installation and Routing Guides

4.2.1 Wiring Harness Information

NOTE: For additional information and recommendations on materials and equipment for interfacing to the Ford systems, power and grounds, please contact your National Sales Company representative or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

The following provides an installation guide for conversions affecting electrical components and/or electrical systems. The aim is to maintain robust integration of auxiliary systems without compromising existing systems, by control of splicing techniques, module package location, electromagnetic compatibility (EMC) etc. The Vehicle Converter must test their installation and ensure the design and function complies with all legal and homologation requirements.

4.2.2 General Wiring and Routing

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

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

If a connector is to be located in a wet area, use a sealed connector. Wet areas include: the Engine Compartment, Wheel Wells, Underbody and Doors.

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

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

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

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

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

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

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

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

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

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

It is recommended to use edge clips, where required, to control routing of all cables in weather zone areas of the vehicle. For non-weather zone areas of the vehicle do not use edge clips.

4.2.3 Connector Pin Out Practices

When designing a harness to connect a component, 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 recommended 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 overloading

All connections into existing wiring must be permanently insulated. Exterior connections must be waterproof.

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

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.

4.2.4 Unused Connectors

Harnesses may have a number of unused connectors, depending on which features have been ordered on the donor vehicle, e.g. heated seats. Ford **do not** recommend the use of these connectors for any other purpose than that intended by design.

4.2.5 Grounding

If a new grounding point is required, avoid placing it in a wet area, 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
- Do not place electrical component attachments or ground nuts adjacent to vehicle fuel tanks or fuel lines
- Each individual third party load must have a dedicated ground connected directly to the vehicle body ground or to the battery negative spare stud - see 'Additional Loads and Charging Systems' later in this section of the BEMM
- Multiple grounds must not go to an interim splice to a main ground cable
- If additional ground studs are required it is recommended to install a busbar with multiple studs fed directly from the battery ground post. See 'Additional Loads and Charging Systems'

4.2.6 Prevention of Squeaks and Rattles

Wiring should be positively retained/ supported every 150 to 250mm, with a maximum distance not to exceed 300mm. All connectors should be positively retained. Use tapes which do not squeak against metal or plastic.

4.2.7 Water Leakage Prevention

Make sure the harness design includes drip-loops to prevent water seepage into the vehicle interior when wiring passes from the outside to the inside of the vehicle. The drip-loop is a section of wiring deliberately formed to route below the point of entry into the vehicle. Water droplets on the harness will migrate under gravity to the lowest part of the harness.

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.

4.2.8 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 the joint created. However, if it is decided that a wire splice is unavoidable, it must be made using **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.

4.2.9 Wiring Specification

ISO Conductor Size mm² CSA	Conductor Resistance mOhm/m					
	Maximum			Minimum		
	Plain Copper	Tinned Plated Copper	Nickel Plated Copper	Plain Copper	Tinned Plated Copper	Nickel Plated Copper
0.13	136	140	142	-	-	-
0.22	84.8	86.5	87.9	-	-	-
0.35	54.4	55.5	56.8	-	-	-
0.5	37.1	38.2	38.6	-	-	-
0.75	24.7	25.4	25.7	22.7	23.3	23.6
1	18.5	19.1	19.3	17.0	17.6	17.7
1.5	12.7	13.0	13.2	11.7	11.9	12.1
2.0	9.42	9.69	9.82	8.66	8.91	9.03
2.5	7.60	7.82	7.92	6.99	7.19	7.28
3	6.15	6.36	6.41	5.66	5.85	5.89
4	4.71	4.85	4.91	4.33	4.46	4.52
5	3.94	4.02	4.11	3.62	3.70	3.78
6	3.14	3.23	3.27	2.89	2.97	3.01
8	2.38	2.52	2.60	2.19	2.32	2.39
10	1.82	1.85	1.90	1.68	1.70	1.75
12	1.52	1.60	1.66	1.40	1.47	1.53
16	1.16	1.18	1.21	1.07	1.09	1.12
20	0.955	0.999	1.03	0.870	0.919	0.948
25	0.743	0.757	0.774	0.688	0.701	0.716
30	0.647	0.684	0.706	0.595	0.629	0.650
35	0.527	0.538	0.549	0.489	0.500	0.510
40	0.473	0.500	0.516	0.435	0.460	0.475
50	0.368	0.375	0.383	0.343	0.350	0.357
60	0.315	0.333	0.344	0.290	0.306	0.316
70	0.259	0.264	0.270	0.243	0.248	0.254
95	0.196	0.200	0.204	0.185	0.189	0.193
120	0.153	0.159	0.159	0.146	0.149	0.152

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

4.2.10 Electromagnetic Compatibility (EMC) Awareness

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 extra wiring off existing looms or pipes.

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

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

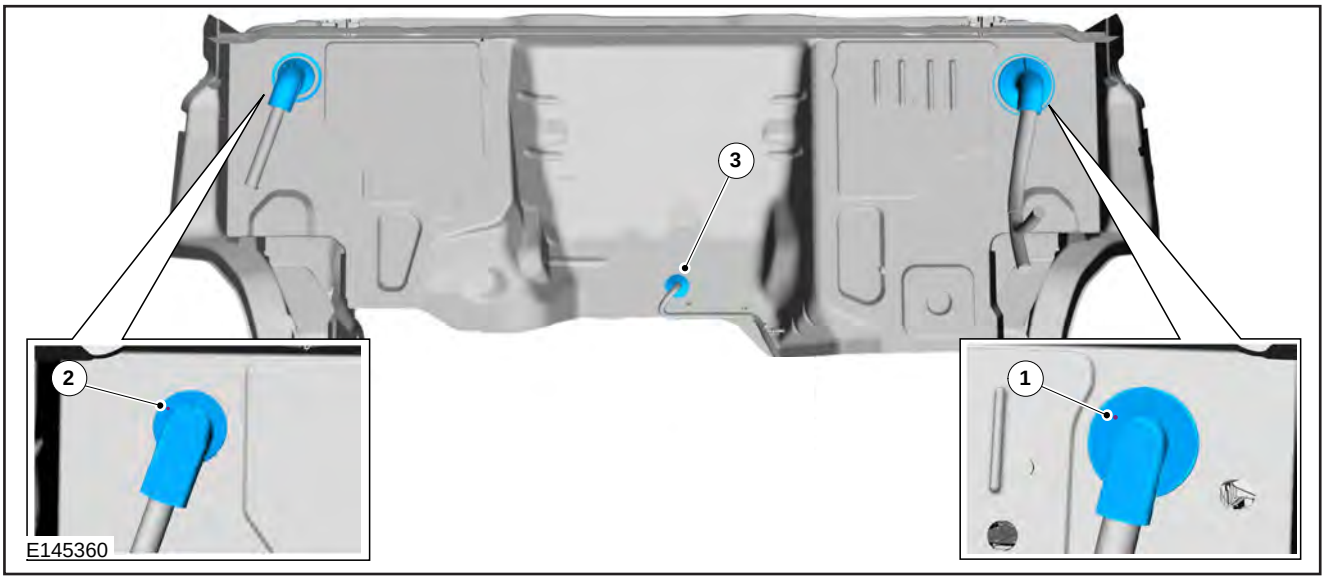
Single or bunched looms must maintain the following clearances:

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

Refer to: 1.7 Electromagnetic Compatibility (EMC) (page 21).

4.2.11 Wiring through Sheet Metal

Front Wheel Drive Dash Panel (Left Hand Drive Shown)



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

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

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

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

There are three locations in the dash panel which have been identified for additional holes to route wires through. See figure E145360 (view from 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.

4.2.12 Precautionary Drill Zones — Rear Cargo Area

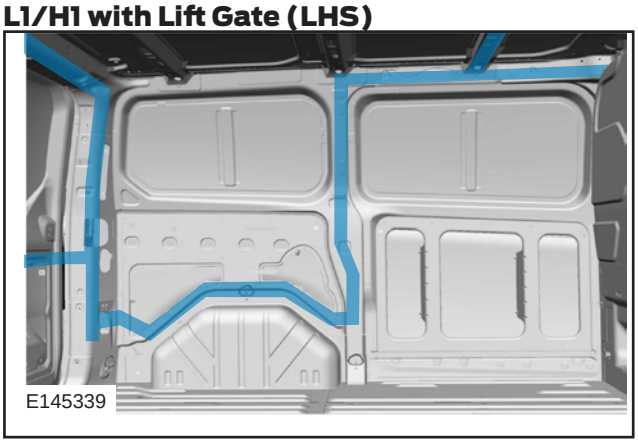
CAUTION: Do not drill into the vehicle before checking the precautionary drill zones and electrical wire routing.

The areas marked in blue on figures E145339-E145344 and E166796-E166798 show the Precautionary Drill Zones for the rear cargo area where there is wire routing and is to be avoided, (for example: when installing cladding and racking). The same care should also be taken when using self-tapping screws. Not all derivatives are shown but the routing is the same for roof line and wheelbase 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.

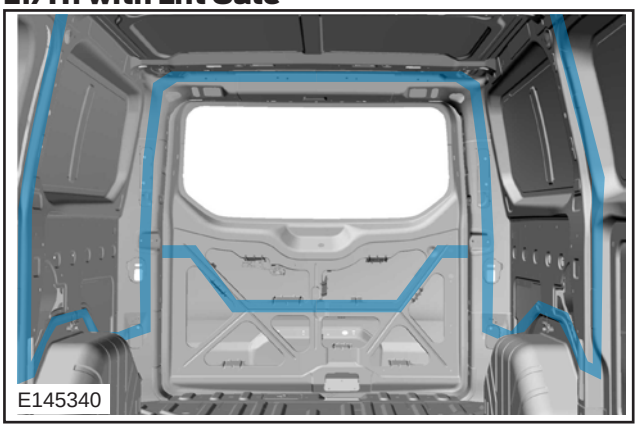
Refer to: 5.1 Body (page 183). Precautionary Drill

Zones
Refer to: 5.3 Racking Systems (page 189).
Refer to: 5.6 Body Closures (page 194). No Drill Zones, Load Compartment Tie Downs

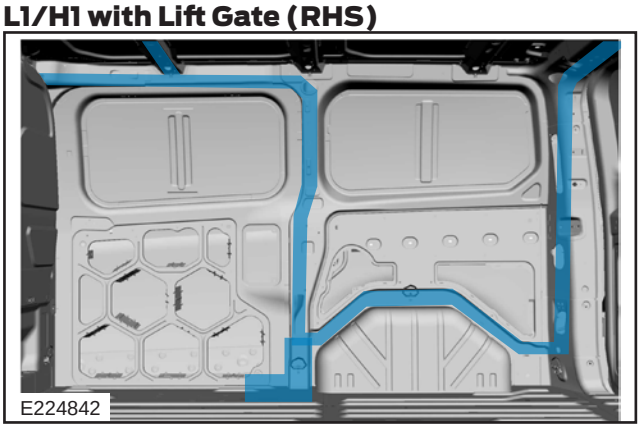
L1/H1 with Lift Gate (LHS)



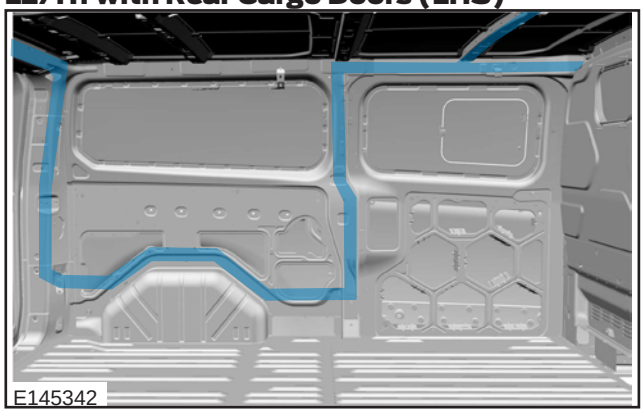
L1/H1 with Lift Gate



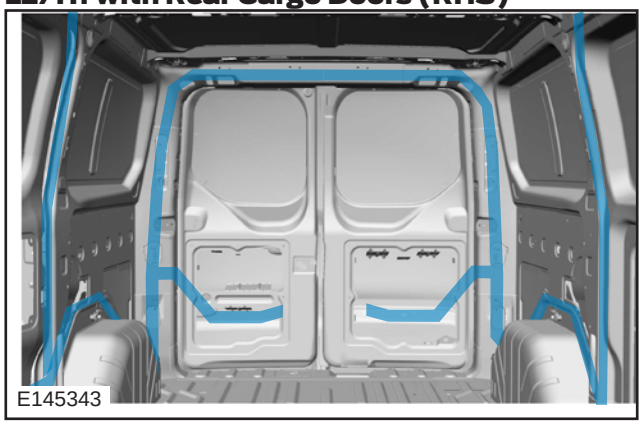
L1/H1 with Lift Gate (RHS)



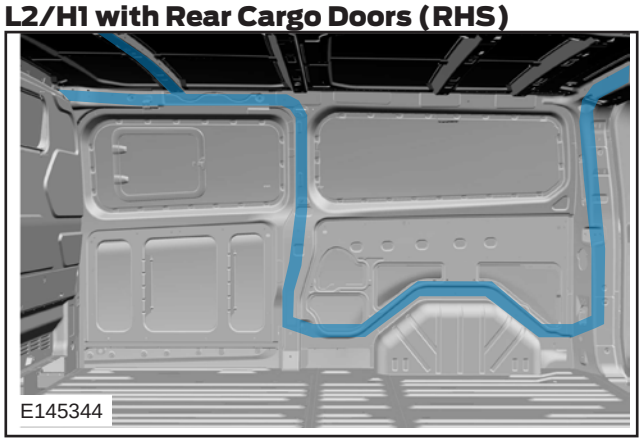
L2/H1 with Rear Cargo Doors (LHS)



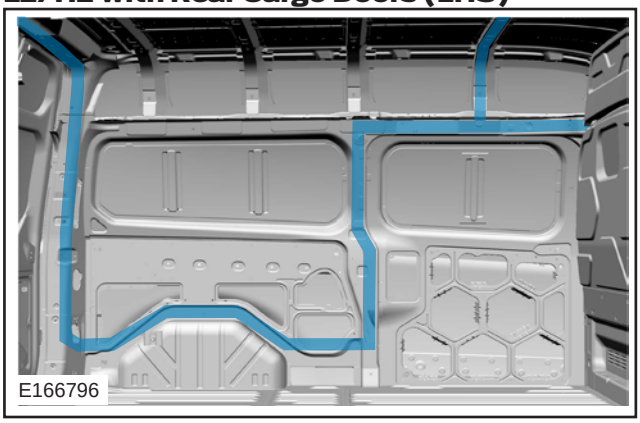
L2/H1 with Rear Cargo Doors (RHS)



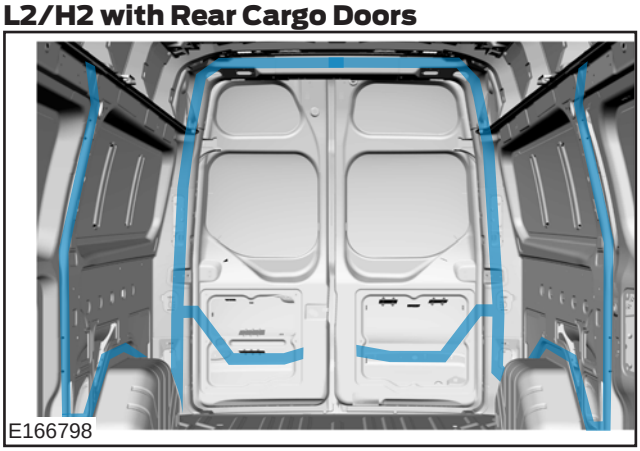
L2/H1 with Rear Cargo Doors (RHS)



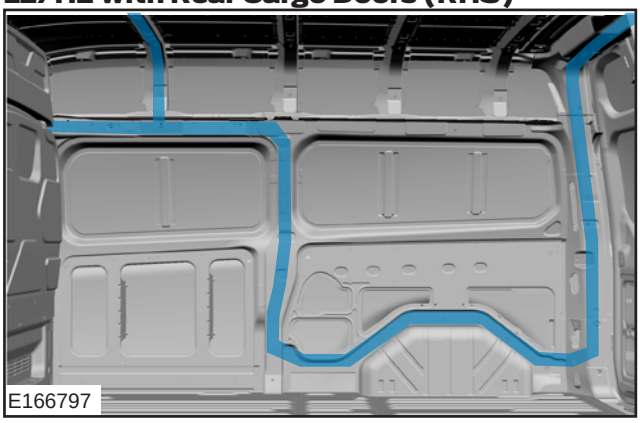
L2/H2 with Rear Cargo Doors (LHS)



L2/H2 with Rear Cargo Doors



L2/H2 with Rear Cargo Doors (RHS)

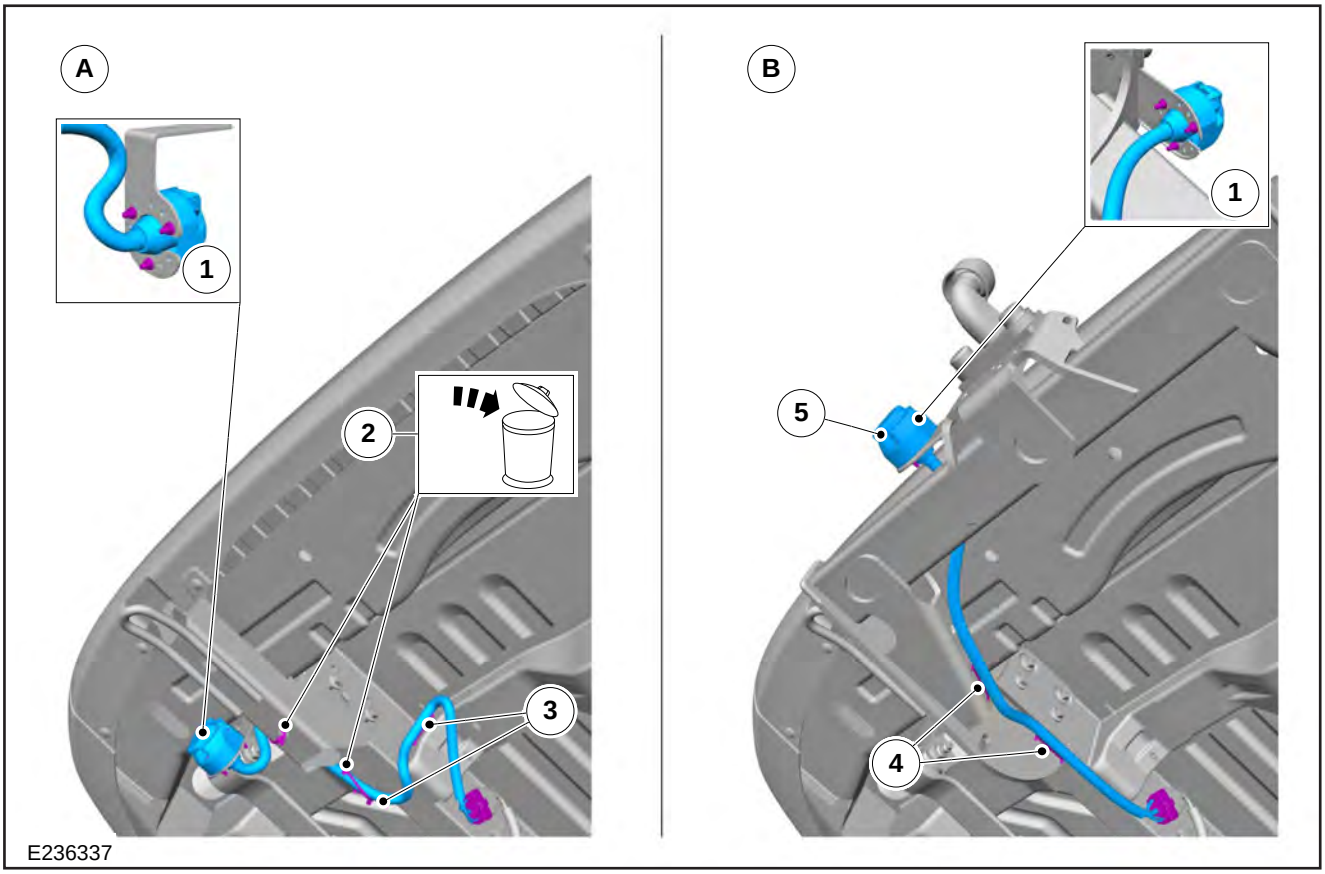


4.2.13 Trailer Tow Electrics (A055)

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

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

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



E236337

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

4.2.14 Electrics for Tow Bar

NOTE: The Ford trailer tow system is integrated with the Ford park aid system. When a trailer is connected, the system communicates on CAN only, to deactivate reverse park aid feature, there is no hardwired interface. It is not possible to turn off reverse park aid with an aftermarket trailer tow system.

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

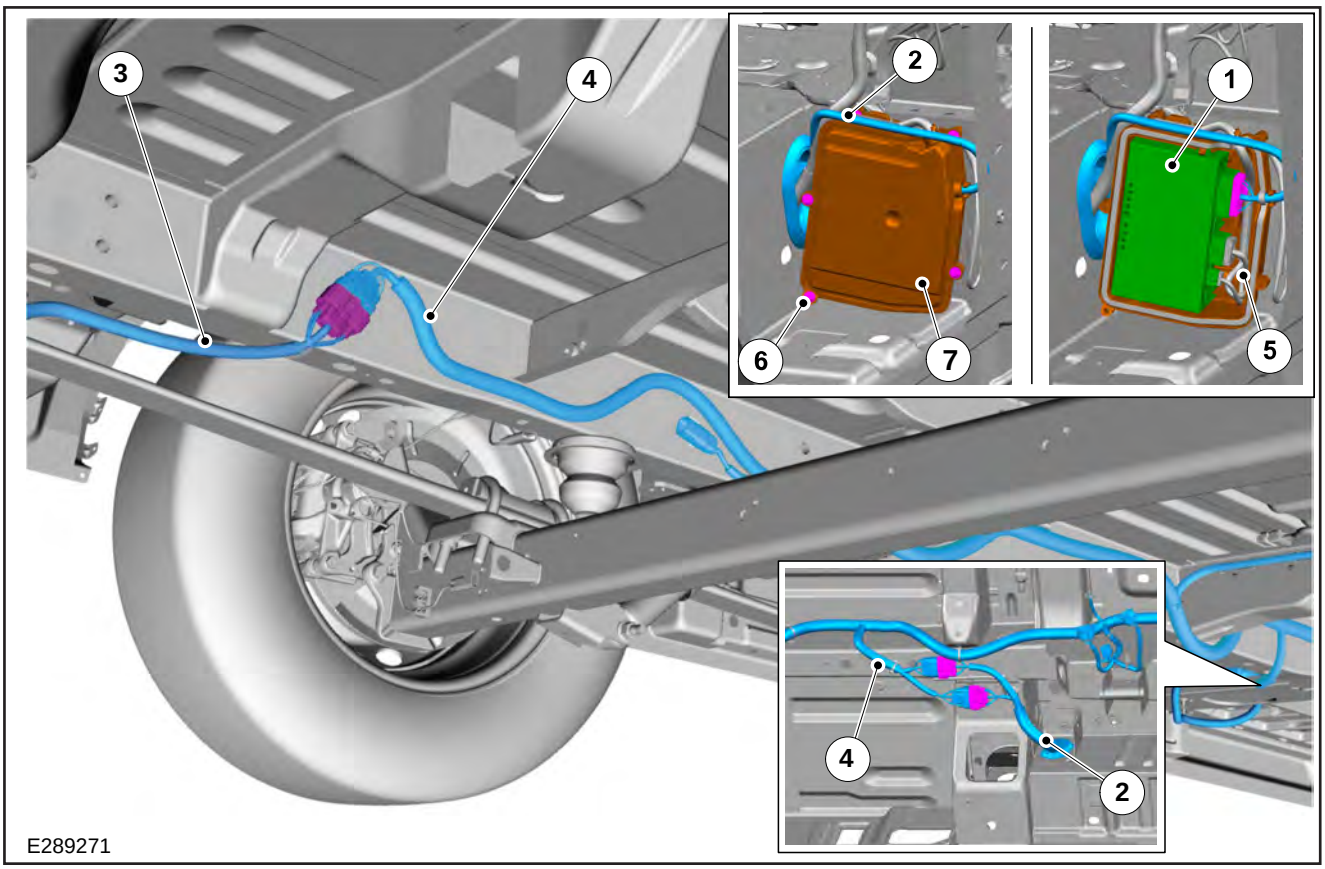
NOTE: If tow bar connectors are not used, appropriate fixing and cover must be applied for protection from water and contaminant ingress.

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.

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.

Trailer Tow Module and Harnesses



Item	Description	Part Number
1	Trailer Tow Module	DG9T-19H517-AJ
2	Trailer Tow Jumper (with Trailer Tow Module connector 'A' see figure E185972)	KK2T-14D469-A*
3	Trailer Tow Socket Jumper - Europe	BK2T-13B576-D*
	Trailer Tow Socket Jumper - Australia and New Zealand	AMBK3J-15A416-A*
4	Underbody Harness	KK2T-14406-**
5	Main Harness (with Trailer Tow Module connectors 'B' and 'C' see figure E185972)	KK2T-14401-**
6	Screws (x5)	W720357
7	Trailer Tow Module Box	LK4T-14D054-A*

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.

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 (page 72) shows the recommended output maximums per circuit.

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

4.2.15 Trailer Tow Connectivity

If trailer tow system is to be added, the correct wiring and module needs to be ordered. For the correct vehicle configuration, please contact your National Sales Company representative or local Ford dealer. If they are unable to help you then contact the Vehicle Converter Advisory Service at VCAS@ford.com

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

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

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

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

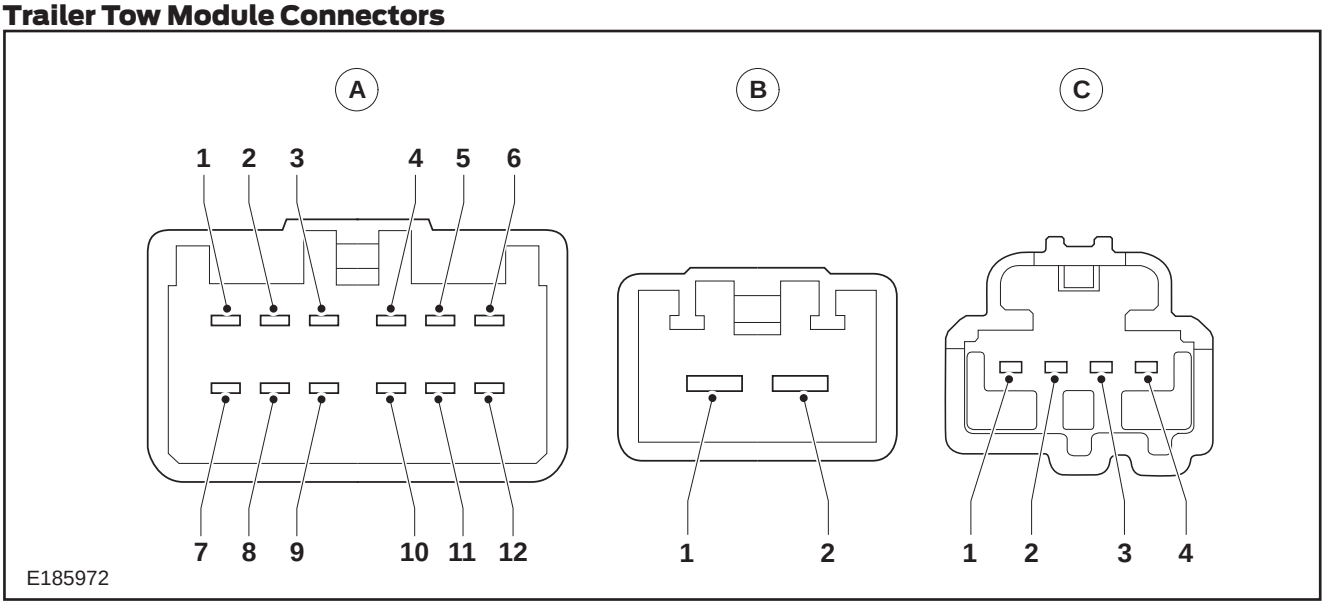
The Trailer Tow Module **does not** support the incremental load of powering side marker lamps on a trailer, if these are required they should also be driven using separate relays.

Trailer Tow Module Connectors (Figure E185972)

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

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

Trailer Tow Module Connectors



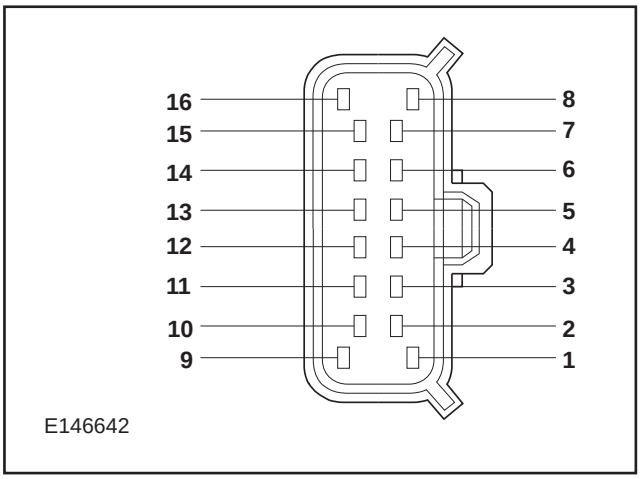
4.2.16 Trailer Tow Connectivity (EU)

Trailer Tow Connectivity 13 Pin Socket

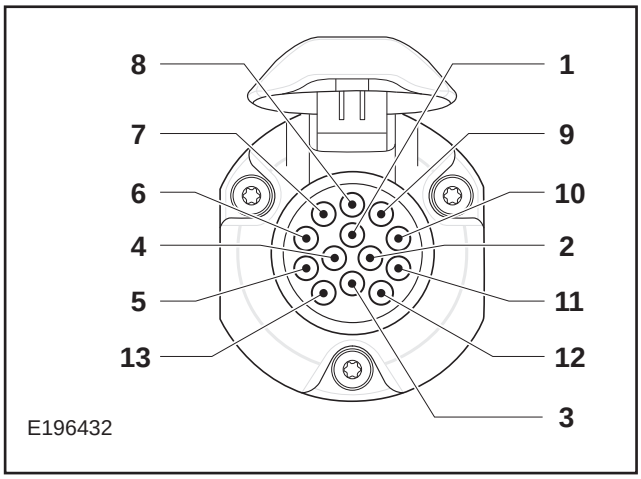
14406 Trailer Tow Connector		13 Pin Trailer Tow Connector	
Pin	**Colour**	**Pin**	**Description**
3	Yellow	1	Left Turn Lamp
5	Grey/Orange	2	Fog
1	Black	3	Lamp Ground
6	Green	4	Right Turn Lamp
13	Brown	5	Right Position Lamp
12	Red	6	Stop Lamps
14	Brown	7	Left Position Lamp License Lamp
11	Grey/Brown	8	Reversing Lamp
9	Violet/Red	9	KL30 Power
10	Grey/Yellow	10	KL15 Ignition
8	Black	11	Ignition Ground KL15
16	Black	13	Power Ground

Any pins not listed in the table above are not to be used.

Trailer Tow 14406 Interface Connector



Trailer Tow 13 Pin Socket

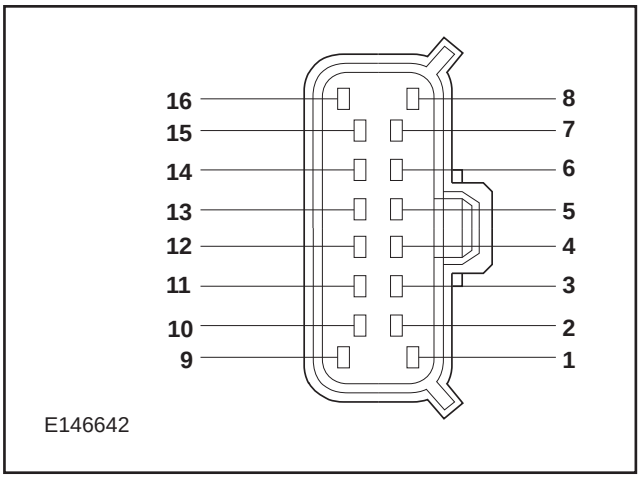


4.2.17 Trailer Tow Connectivity (AUS and NZL)

Trailer Tow Connectivity 12 Pin Socket

14406 Trailer Tow Connector		12 Pin Trailer Tow Connector - Australia and New Zealand	
Pin	**Colour**	**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



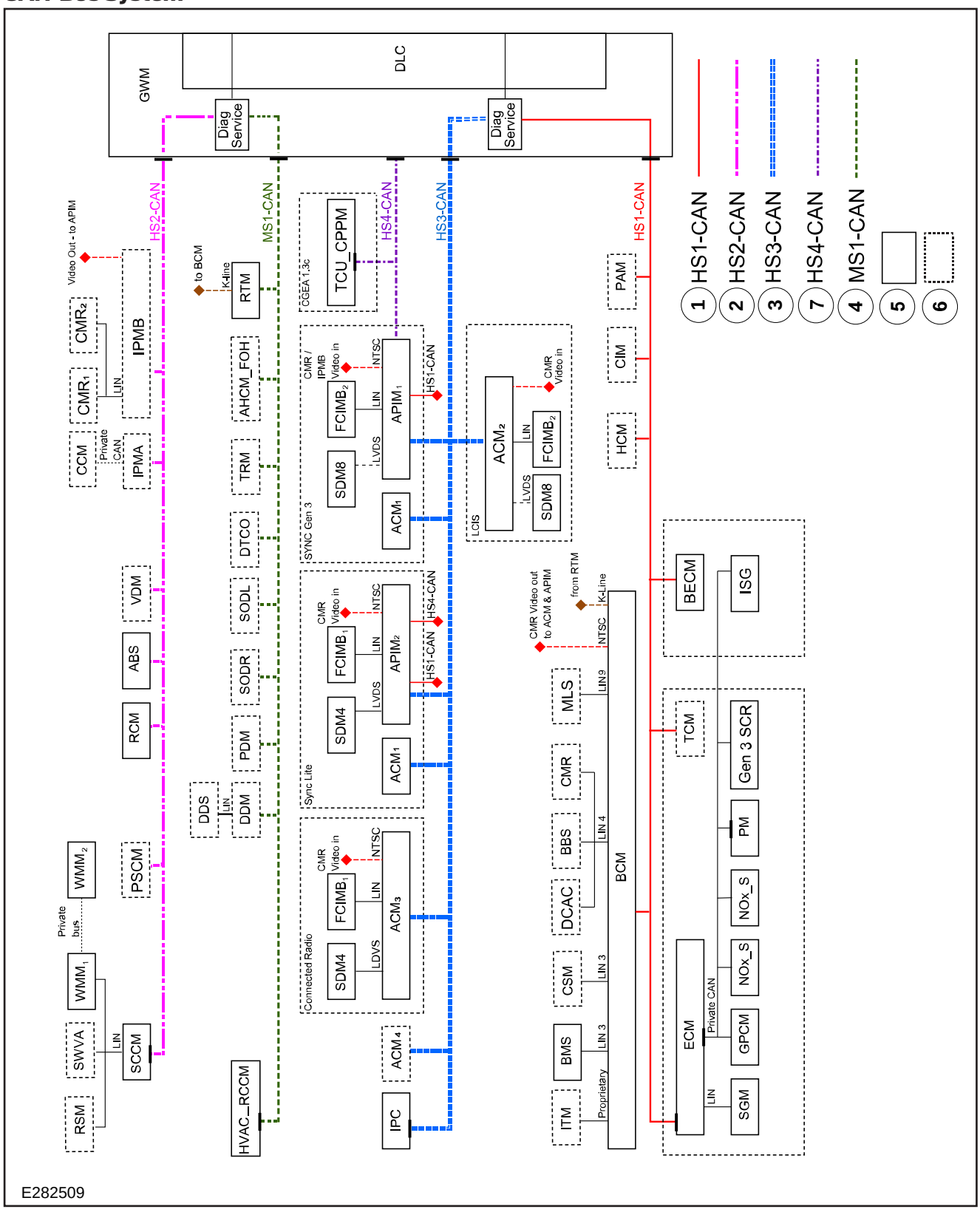
4.3 Communications Network

4.3.1 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 localised application of Local Interconnect Network (LIN) and ISO 9141 K-line serial links.

CAN-Bus System



E282509

Communication Network System (Figure E282509 references)

Item	Description
1	HS1-CAN - High Speed 1 - CAN(1)
2	HS2-CAN - High Speed 2 - CAN(1)
3	HS3-CAN - High Speed 3 - CAN(1)
4	MS1-CAN -Medium Speed 1 - CAN(2)
5	Standard ECU
6	Optional ECU
7	HS4-CAN - High Speed 4 - CAN(1)
ABS	Anti-Lock Brake System Control Module
ACM_1	Audio Control Module (SYNC Radio)
ACM_2	Audio Control Module (LCIS Radio)
ACM_3	Audio Control Module ('Connected' Radio)
ACM_4	Audio Control Module (1 DIN Radio)
AHCM_ FOH	Auxiliary Heater Control Module _ Fuel Operated Heater
$APIM_1$	Auxiliary Protocol Interface Module (Gen 3 Sync)
$APIM_2$	Auxiliary Protocol Interface Module (Gen 3 Sync Lite)
BBS	Battery Backed-up Sounder
BCM	Body Control Module
BECM	Battery Energy Control Module (Micro- Hybrid Controller)
BMS	Battery Monitoring Sensor
CCM	Cruise Control Module (Adaptive Cruise)
CIM	Converter Interface Module
CMR_1	Camera Module (Rear)
CMR_2	Camera Module (Front)
CSM	Combined Sensor Module (Interior motion detect & Tilt Sensor)
DCAC	Direct Current to Alternate Current Inverter

Item	Description
DCDC-VQM	Voltage Quality Module (Direct Current - Direct Current)
DDS	Driver Door Switch Pack
DDM	Driver Door Module
DLC	Diagnostic Link Connector
DTCO	Digital Tachograph
ECM	Engine Control Module
ECU	Electronic Control Unit
$FCIMB_1$	Front Control Interface Module (10 Button)
$FCIMB_2$	Front Control Interface Module (5 Button)
GWM	Gateway Module (CGEA 1.3c)
GPCM	Glow Plug Control Module
HCM	Headlamp Control Module
HVAC -RCC M	HVAC Controls (Remote Climate Control Module)
IPC	Instrument Panel Cluster
IPMA	Image processing Module A (Lane Depar- ture System Camera)
IPMB	Image processing Module B (Front & Rear Camera)
ISG	Integrated Starter Generator
ITM	Integrated Key Transmitter (PATS)
MLS	Master Light Switch
NOx_S	NOx Sensor
PAM	Parking Aid Module
PDM	Passenger Door Module
PM	Particulate Matter Sensor
PSCM	Power Steering Control Module
RCM	Restraints Control Module

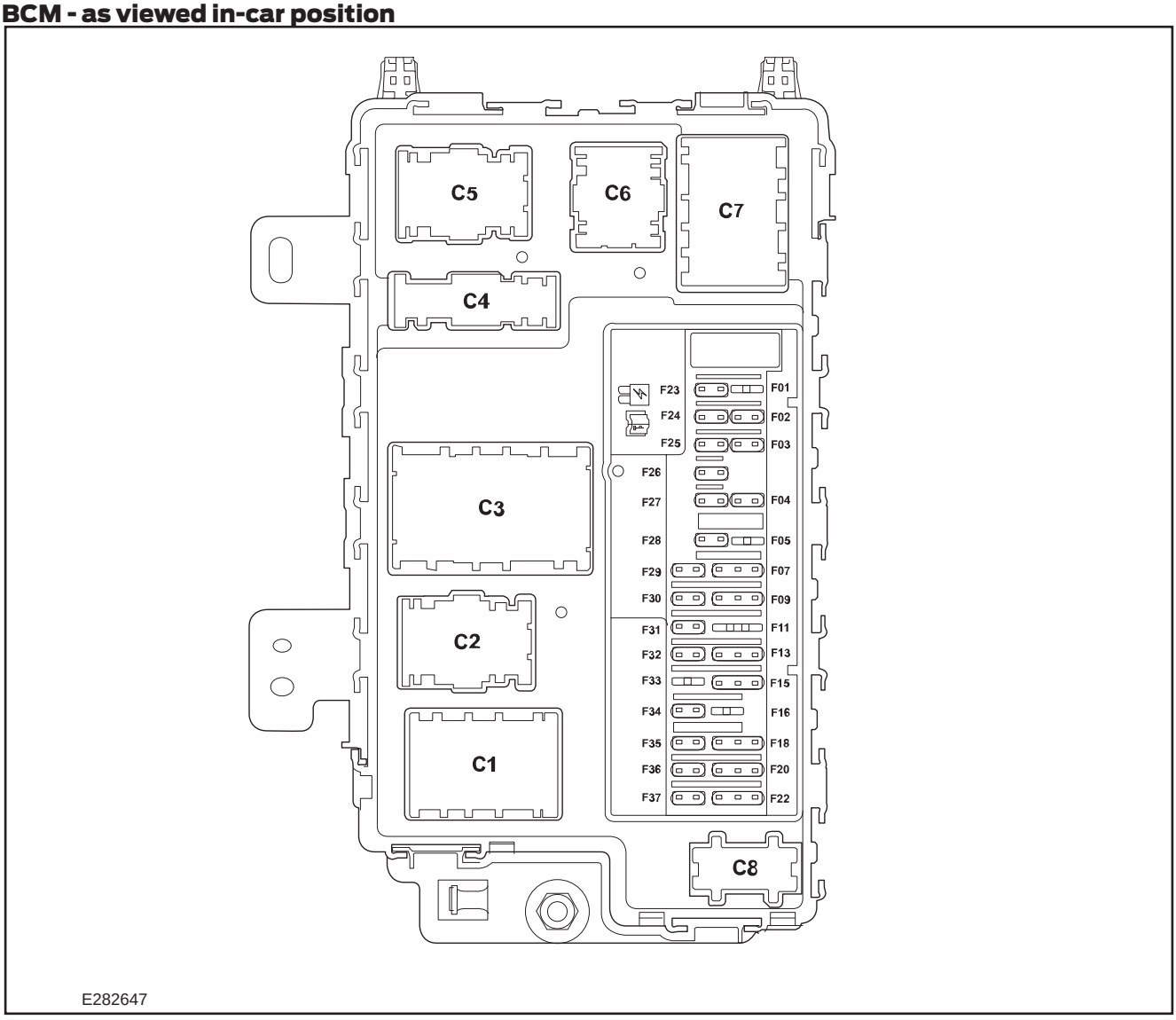
Item	Description
RSM	Rain Sensing Module
RTM	Radio Transceiver Module (RKE & TPMS Receiver)
SAS	Steering Angle Sensor
SCCM	Steering Column Control Module (incl absolute SAS)
SCR	Selective Catalytic Reduction (Gen 3 UREA Sensor)
SDM4	Slim Display Monitor 4" (for non-SYNC Display)
SDM8	Slim Display Monitor 8" (for SYNC Display)
SGM	Starter Generator Control Module (Alternator Control)
SODL	Side Obstacle Detection Control Module Left

Item	Description
SODR	Side Obstacle Detection Control Module Right
SWVA	Steering Wheel Vibration Alert (IPMA Haptic Device)
TCM	Transmission Control Module
TCU_ CPPM	Cell Phone Passport Module (MODEM for CGEA1.3c)
TRM	Trailer Module (Trailer Tow)
VDM	Vehicle Dynamics Module (Air Suspension)
WMM_1	Wiper Motor Module (Master)
WMM_2	Wiper Motor Module (Slave)

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

4.3.2 Body Control Module (BCM)

BCM - as viewed in-car position



E282647

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 Fuse Overview

Fuse	Rating	Fuse Type	Function
F2	10	Micro 2	Power inverter
F3	7.5	Micro 2	Power window switch and power exterior mirrors
F4	20	Micro 2	Not Used (Spare)
F6	10	Micro 3	Anti-theft alarm horn
F7	10	Micro 3	Not Used (Spare)
F8	5	Micro 3	Not Used (Spare)
F9	5	Micro 3	Interior sensor and rear air conditioning
F12	7.5	Micro 3	Climate control
F13	7.5	Micro 3	Steering column, instrument cluster and data link connector
F14	15	Micro 3	Battery energy control module - MHEV
F15	15	Micro 3	SYNC 3 module
F17	7.5	Micro 3	Tachograph
F18	7.5	Micro 3	Passenger airbag disable indicator and switch
F19	5	Micro 3	Battery backed sounder
F20	5	Micro 3	Ignition switch
F21	5	Micro 3	PTC heater control
F22	5	Micro 3	Pedestrian alert control module
F23	30	Micro 2	Passenger door module
F24	30	Micro 2	Not Used (Spare)
F25	20	Micro 2	Not Used (Spare)
F26	30	Micro 2	Driver door module
F27	30	Micro 2	Not Used (Spare)
F28	30	Micro 2	Not Used (Spare)
F29	15	Micro 2	Not Used (Spare)
F30	5	Micro 2	Not Used (Spare)
F31	10	Micro 2	Data link connector and remote key receiver
F32	20	Micro 2	Radio and telematics module
F34	30	Micro 2	Ignition run/start relay pre fuse (park aid, heater control, LDW camera, restraints, central control panel, passenger airbag off indicator, tachograph, heater control, PTC heater, steering wheel module)
F35	5	Micro 2	Not Used (Spare)
F36	15	Micro 2	Park aid, lane departure warning camera, steering wheel module
F37	20	Micro 2	Not Used (Spare)
F38	30	Circuit Breaker	Power window supply

Any pins not listed in the table above are not to be used.

MHEV= Mild Hybrid Electric Vehicle; PTC= Positive Temperature Coefficient

BCM Output Information

Function	Component	Load Type	Max. Load	Overload Condition
Dipped Beam Left	High Side PWM or DC for HID Relay	Bulb/HID (via Relay)	55W	Output Shutdown (1)
Dipped Beam Right	High Side PWM or DC for HID Relay	Bulb/HID (via Relay)	55W	Output Shutdown (1)
Main Beam Left	High Side PWM or DC for HID Main Beam Shutter	Bulb/ HID Shutter	55W	Output Shutdown
Main Beam Right	High Side PWM or DC for HID Main Beam Shutter	Bulb/ HID Shutter	55W	Output Shutdown
Daytime Running Light Left	High Side PWM (configurable for Smart LED DRL/ Position Light)	Bulb/Smart LED	30W	Output Shutdown
Daytime Running Light Right	High Side PWM (configur- able for Smart LED DRL/ Position Light)	Bulb/Smart LED	30W	Output Shutdown
Position Light Left Front	High Side PWM	Bulb	10W	Output Shutdown
Position Light Left Rear	High Side PWM	Bulb	6W	Output Shutdown
Position Light Right Front	High Side PWM	Bulb	10W	Output Shutdown
Position Light Right Rear	High Side PWM	Bulb	6W	Output Shutdown
Front Fog Light Left	High Side PWM	Bulb	35W	Output Shutdown
Front Fog Light Right	High Side PWM	Bulb	35W	Output Shutdown
Turn Indicators Left Front	High Side PWM	Bulb	27W	Output Shutdown
Turn Indicators Left Rear	High Side PWM	Bulb	27W	Output Shutdown
Turn Indicators Right Front	High Side PWM	Bulb	27W	Output Shutdown
Turn Indicators Right Rear	High Side PWM	Bulb	27W	Output Shutdown
Number Plate (& Marker Lights)	High Side PWM	Bulb/LED	25W	Output Shutdown
Reversing Lights	High Side DC	Bulb + Micro Relay	42W + 250mA	Output Shutdown
Rear Fog Lights	High Side PWM	Bulb	2 x 21W	Output Shutdown
Stop Light Left	High Side PWM	Bulb	2 x 21W	Output Shutdown
Stop Light Right	High Side PWM	Bulb	2 x 21W	Output Shutdown
Centre High Mounted Stop Light	High Side PWM	LED	1 x 16W or LED string	Output Shutdown
Switch Illumination	High Side PWM	LED	1.5A at 16V	Output Shutdown
Battery Saver Supply	High Side Driver	Bulb	75W	Output Shutdown
Front Cabin Lights Courtesy	High Side PWM	Bulb or LED	65W	Output Shutdown
Rear Cabin Lights Courtesy	High Side PWM	Bulb or LED	65W	Output Shutdown
Vehicle Horn	High Side Relay Driver	Micro Relay	250mA	Output Shutdown
Alarm Siren	High Side Driver	Electro Mechan- ical Sounder	4A nominal, 8A for 10ms in-rush	Output Shutdown
Engine Run Status	High Side Relay Driver	Micro Relay	250mA	Output Shutdown
Lock/Double Lock Outputs	Bi-directional Driver	Latch Motor (x 5 max)	6A per latch, 110ms Pulsed	Output Shutdown
Unlock Outputs	Bi-directional Driver	Latch Motor (x 5 max)	6A per latch, 110ms Pulsed	Output Shutdown

PWM = Pulse Width Modulation / DRL = Daytime Running Lights / HID = High Intensity Discharge

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

(1) BCM does NOT support HID directly Driven. HID MUST use relays.

4.4 Charging System

WARNING: Do not cut into the alternator wires.

NOTE: Alternator systems use Smart Regenerative Charging (SRC), please refer to this section. MHEV systems use Smart Charging (SC)

NOTE: The alternator is LIN controlled. It does not have a conventional D+ (engine start) signal line.

NOTE: For further information please contact your National Sales Company representative or Local Ford Dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

4.4.1 General Information

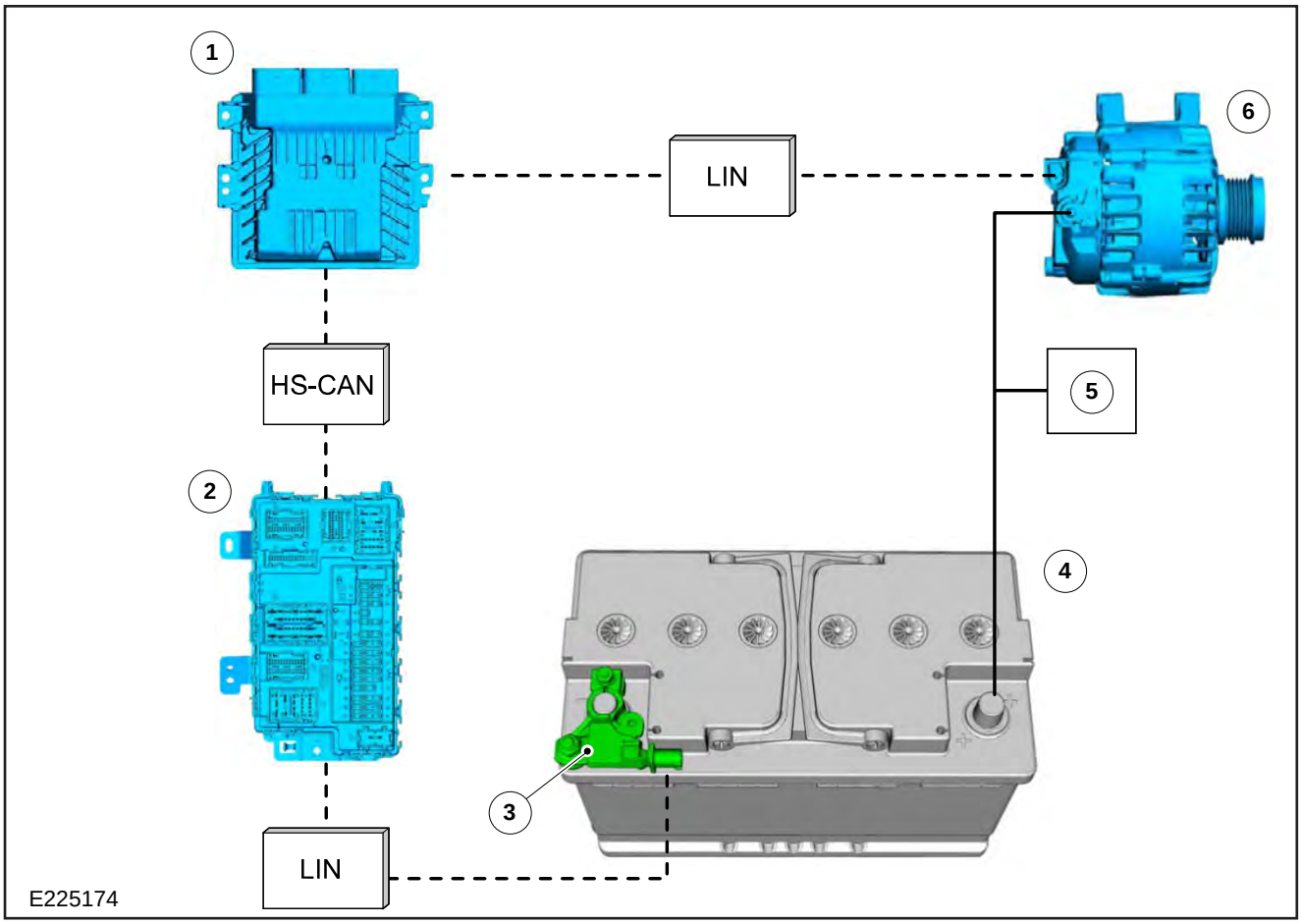
The battery capacity, technology and charge available from the alternator must be adequate to ensure engine cranking in unfavourable climatic conditions, even after fitment of additional electrical equipment.

Additional connection points are provided specifically for customer use, and are located on the outside of the driver's seat pedestal. A 60A fused connection is provided as standard on single battery vehicles. An additional 175A switched connection is provided for twin battery vehicles. Other options are possible for higher current applications,

Refer to: 4.6 Battery Systems (page 91).

4.4.2 Alternator-Based System Layout

System Diagram



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

Summary of the Available Charging Modes

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

The voltages in the above table are approximate as the charging system is dynamic and can vary the voltage at any time. There is also a refresh mode that is activated periodically if the vehicle stands for more than 30 days. This may take the voltage to 15.2V.

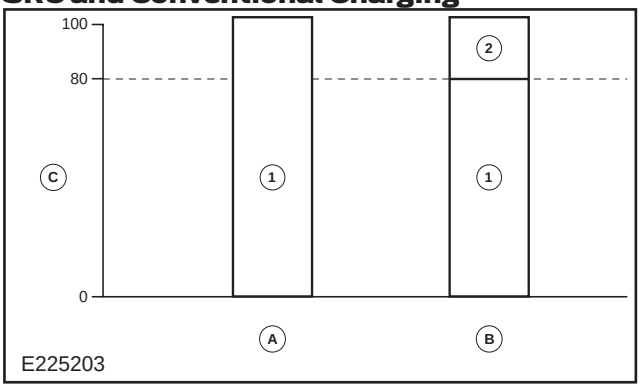
For further information on Start-Stop
Refer to: 4.11 Electronic Engine Controls (page 121).

4.4.3 Smart Regenerative Charging (SRC)

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

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

SRC and Conventional Charging



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

4.4.4 SRC Override

SRC can be interrupted temporarily in the following ways:

- By the Start-Stop button if the vehicle is stationary.
- By Third Party High Power mode

Refer to: 4.11 Electronic Engine Controls (page 121).

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

4.4.5 Third Party High Power Mode

WARNINGS:

The Third Party High Power mode can inhibit engine shutdown (AEIS) which is a safety procedure designed to protect against carbon monoxide (CO) poisoning. Do not operate the feature on a vehicle in a confined space. Do not install the feature on a vehicle that may be left running in a confined space. Do not allow carbon monoxide to accumulate.

The Third Party High Power mode is a single method that has various effects. Do not allow the Third Party High Power mode to be active in incorrect conditions, as this may lead to unintended consequences. When implementing automated control of Third Party High Power mode, be sure to consider the full range of effects.

The Third Party High Power mode feature must not be grounded permanently. This will invalidate the emission and homologation of the vehicle. Permanently disabling the vehicle's fuel save features will require rehomologation as part of the approval process by the converter.

When fitting automated systems to control Third Party High Power mode, be sure to

record details within the owner's vehicle information. Advise subsequent owners of modifications relating to application of Third Party High Power mode. Subsequent owners of equipped vehicles are to be informed of applications of Third Party High Power mode.

CAUTION: Third Party High Power mode is only to be used where required for third party equipment functionality. When equipment is off and in a normal drive cycle. All fuel and emission save features must be active.

NOTE: When a vehicle is decommissioned for resale, the Third Party High Power mode inhibit needs to be removed from the vehicle.

Introduction

Third Party High Power mode has only one input that can affect the following features:

- SRC inhibit
- Start-Stop inhibit
- AEIS inhibit (feature restricted in some markets)
- At engine off, inhibit of the timer of the Standard Battery Guard (SBG)

Examples of when to not switch to third party mode include in a normal drive cycle when no extra loads are active. Solutions should only be used for heavy electrical loads, or mechanical power from the Front End Accessory Drive (FEAD), mainly when stationary.

The Third Party High Power mode is subject to configuration and may be subject to restriction.

SRC Inhibit (Conventional Charging)

When SRC is inhibited, such as by Third Party High Power mode, then the system is using Conventional Charging.

This may be required for converters requiring voltage in the range of 13.5V to 14.9V. Such applications include boost or supplemental battery charging, compensation for voltage drop or high ampere electrical loads whilst the engine is running.

For additional information Refer to: 4.7 Battery Protection (page 105). Load-shedding.

Start-Stop Inhibit

This may be required where the charging system is required to provide voltage or high electrical power while driving, for example refrigeration or emergency service conversions.

AEIS Inhibit

This may be required to keep the engine running when the vehicle is used for power generation, mechanical or electrical, in a stationary application. Normal AEIS functionality is where the engine will automatically shutdown after 30 minutes if no driver input is detected.

Timer of Standard Battery Guard at Engine Off

This may be required to prevent the SBG operating too soon, when the engine is off.

Refer to: 4.7 Battery Protection (page 105). Load shedding.

Installation/Access

The Third Party High Power mode is activated by the grounding of a particular electrical circuit to a 'non permanent' switching strategy.

The Third Party High Power mode can be accessed at various vehicle connectors:

- As a kit to install the standard 10-way Vehicle Interface Connector in the driver's seat pedestal.
  - Interface Connector pin 3 available on all Non Camper variants.
- Pre-installed as part of a Camper Donor vehicle (C9)
  - 15-way camper connector pin 14
- Pre-installed as part of the High Specification Vehicle Interface Connector (A608).
  - A mating 43 way connector with three metres 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, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com
- High Specification Interface Connector (A608) pin 23
- Feature included in the Ford Programmable Battery Guard (A540) – where load active or third party sensing will trigger a ground required to turn off the fuel save features. Examples are:
  - To avoid low voltage tripping of high powered inverters
  - Charging extra batteries
  - RunLock
  - Voltage drop compensation
  - Voltage Stabilisation
  - FEAD third party ancillaries requiring the engine to run continuously

For further information
Refer to: 4.7 Battery Protection (page 105).
Refer to: 4.24 Electrical Connectors and Connections (page 158).

4.4.6 Test Functionality

NOTE: There will be a delay between setting the Third Party High Power mode and the effect occurring (up to a 5 seconds delay).

NOTE: If the 12V SOC is already too low, the circuit will open before the timer to protect the engine start.

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 input circuit open. Refer to the Roadside Emergencies section of the Owner's Manual
3. With the engine running, set to ground the circuit for Third Party High Power mode and measure battery voltage. The voltage should be in the ranges shown in the table 'Summary of the Available Charging Modes'. 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. Open the switch again and check voltage level returns to the original level measured in Step 2. SRC is active

Test Functionality: AEIS Inhibit, Idle Shutdown Control (where fitted)

1. Check that AEIS is fitted and operational
2. Set Third Party High Power mode
3. Check that the engine continues to run whilst the inhibit is set
4. Check that normal AEIS behaviour resumes when the inhibit is not set, for example the engine shuts down after 30 minutes

Test Functionality: Inhibit of Timer for Engine Off Load-Shedding

1. Establish the preset timer of a the SBG circuit e.g.
   - CCP2
   - Other switched ground circuits fed from the feature
2. Set Third Party High Power mode
3. Check that the circuit remains on after the timer period

Refer to: 4.7 Battery Protection (page 105).

4.4.7 Charge Balance Guidelines

The base vehicle, less EPAS, may be fitted with a 220A alternator. When fitting medium to high third party electrical loads, including extra batteries, a charge balance test should be performed. This includes all relevant Ford and third party loads active at the same time where the battery voltage should not go below 13V. This will ensure that the alternator is not damaged, extra batteries are charged and correct system functionality is maintained. SRC override is recommended to ensure the alternator is in full power mode. Increased performance can be achieved by elevating the idle, utilising the engine RPM control option (A003).

4.4.8 Circuit Diagrams

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

Refer to: 4.24 Electrical Connectors and Connections (page 158).
Refer to: 4.22 Fuses and Relays (page 151).

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

4.4.9 Alternator Characteristics

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

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

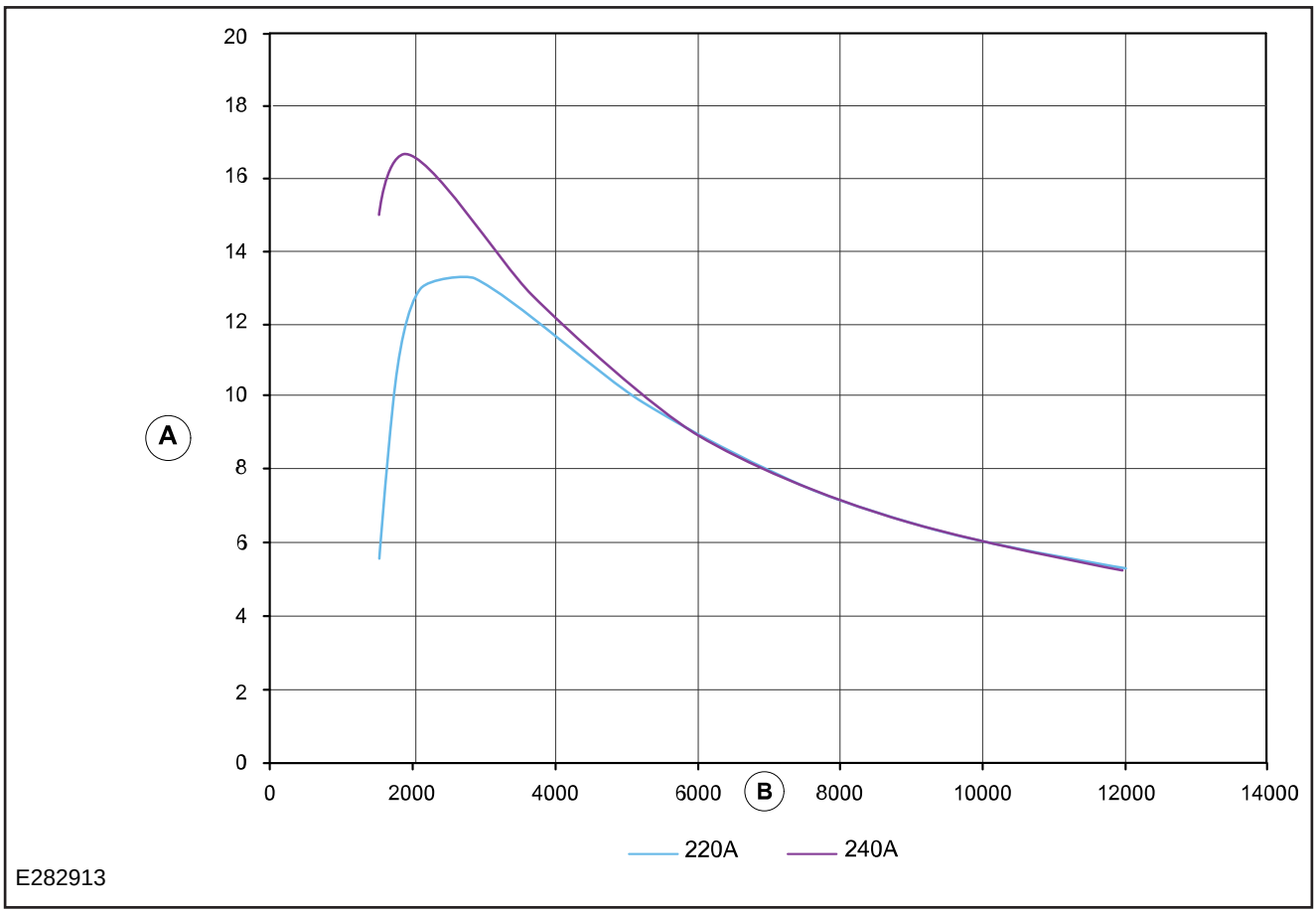
NOTE: If the engine is running for long periods, assume the hotter temperatures apply.

The alternator performance curves show the Engine RPM speed control option (A003) and the factory set engine RPM values for mode 1. This data can be used for calculating charge balance values for the finished third party system and is also the set points utilised by the Ford Programmable Battery Guard (A540) which will auto range or return to base idle depending on third party power requirements.

Refer to: 4.7 Battery Protection (page 105).

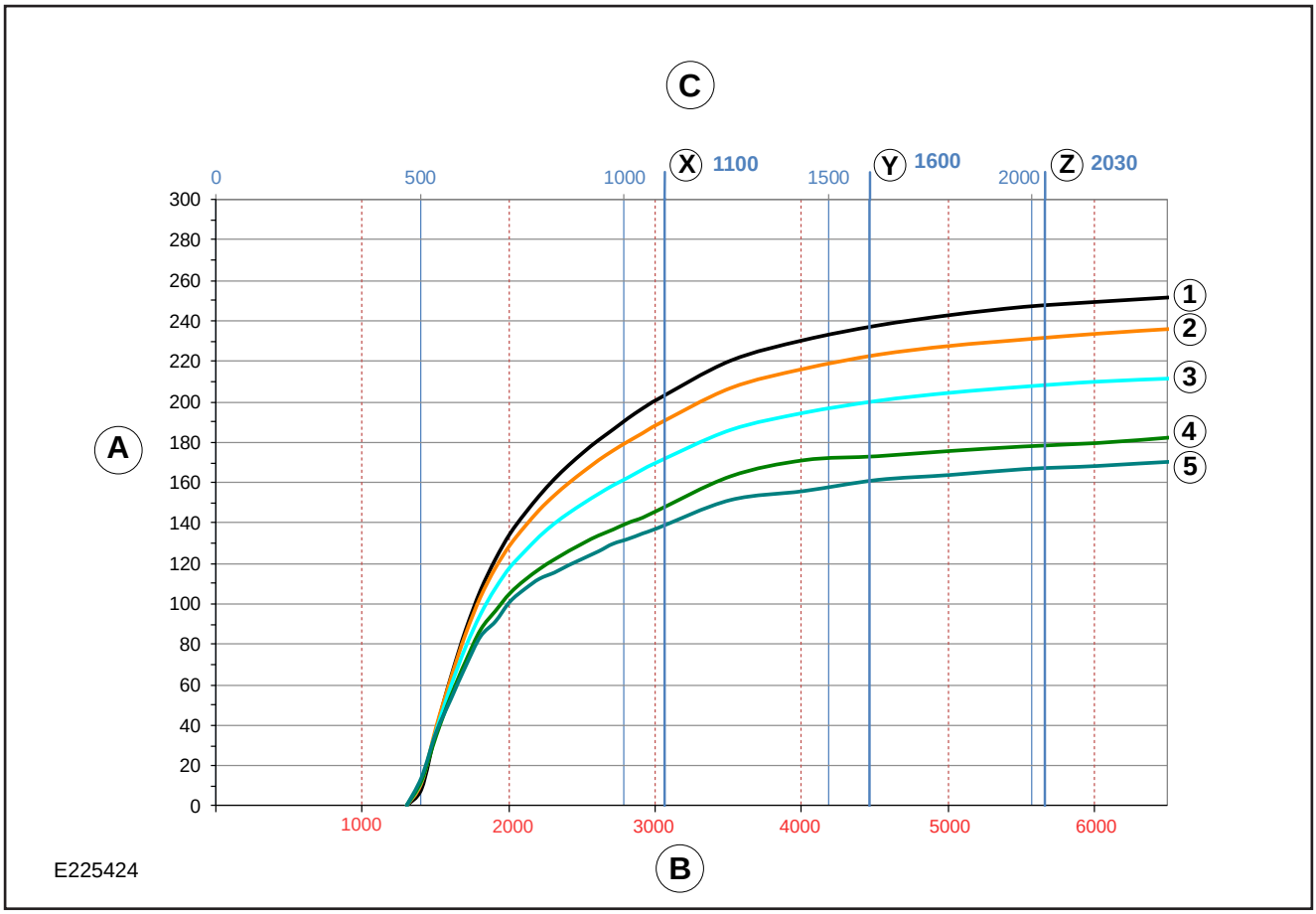
Allow for the Ford system to require approximately 20A to run the engine. Any further Ford systems active such as blowers and lights, will further reduce available Ampere for third party systems. It is also recommended to utilise the SRC override feature (Third Party High Power mode) to maximise alternator output. An overloaded alternator will exhibit voltage lowering below 12.8V and could lead to damage, so must be avoided.

Torque Curve of Alternators



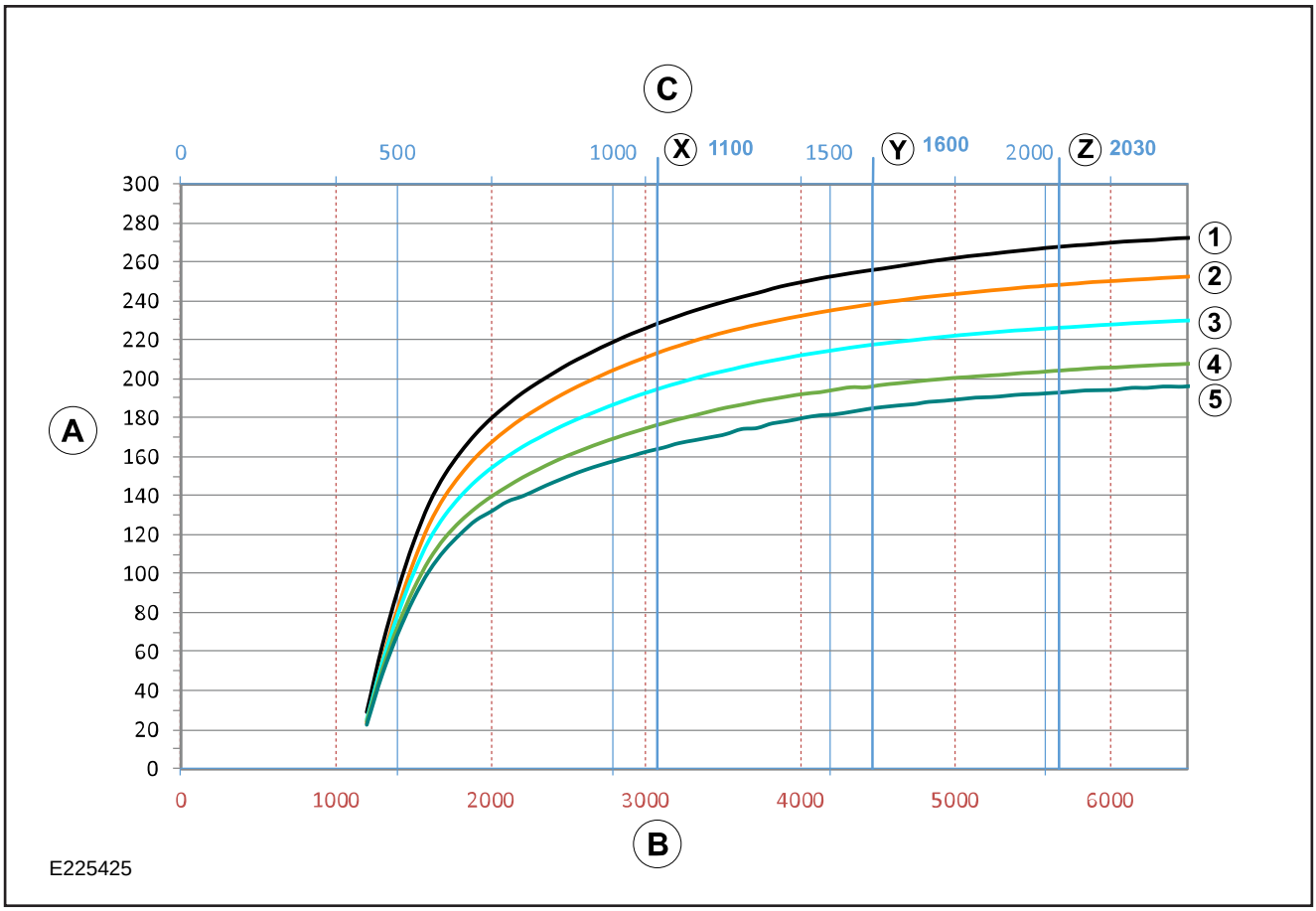
Item	Description
A	Torque (Nm)
B	Revolutions Per Minute (RPM)

Output Performance of Alternator - 220A



Item	Description
A	Output current (Amps)
B	Alternator speed (RPM)
C	Engine speed (RPM)
X	RPM 1 Default
Y	RPM 2 Default
Z	RPM 3 Default
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

ToOutput Performance of Alternator - 240A



Item	Description
A	Output Current (Amps)
B	Alternator Speed (RPM)
C	Engine Speed (RPM)
X	RPM 1 Default
Y	RPM 2 Default
Z	RPM 3 Default
1	Temperature 0°C — Voltage 14.1V
2	Temperature 23°C — Voltage 13.9V
3	Temperature 60°C — Voltage 13.5V
4	Temperature 93°C — Voltage 13.1V
5	Temperature 116°C — Voltage 12.9V

4.5 Mild Hybrid Charging System

WARNINGS:

The MHEV system cannot be used for vehicle conversions.

Do not remove, open, repair or modify the 48V battery pack. The MHEV system is a 48V system separate from the main 12V electrical system. The 48V battery is located in the passenger seat pedestal.

CAUTION: MHEV vehicles have a Belt Integrated Starter Generator (BISG) instead of an alternator. Do not remove, open, repair or modify the BISG.

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

4.5.1 General Information

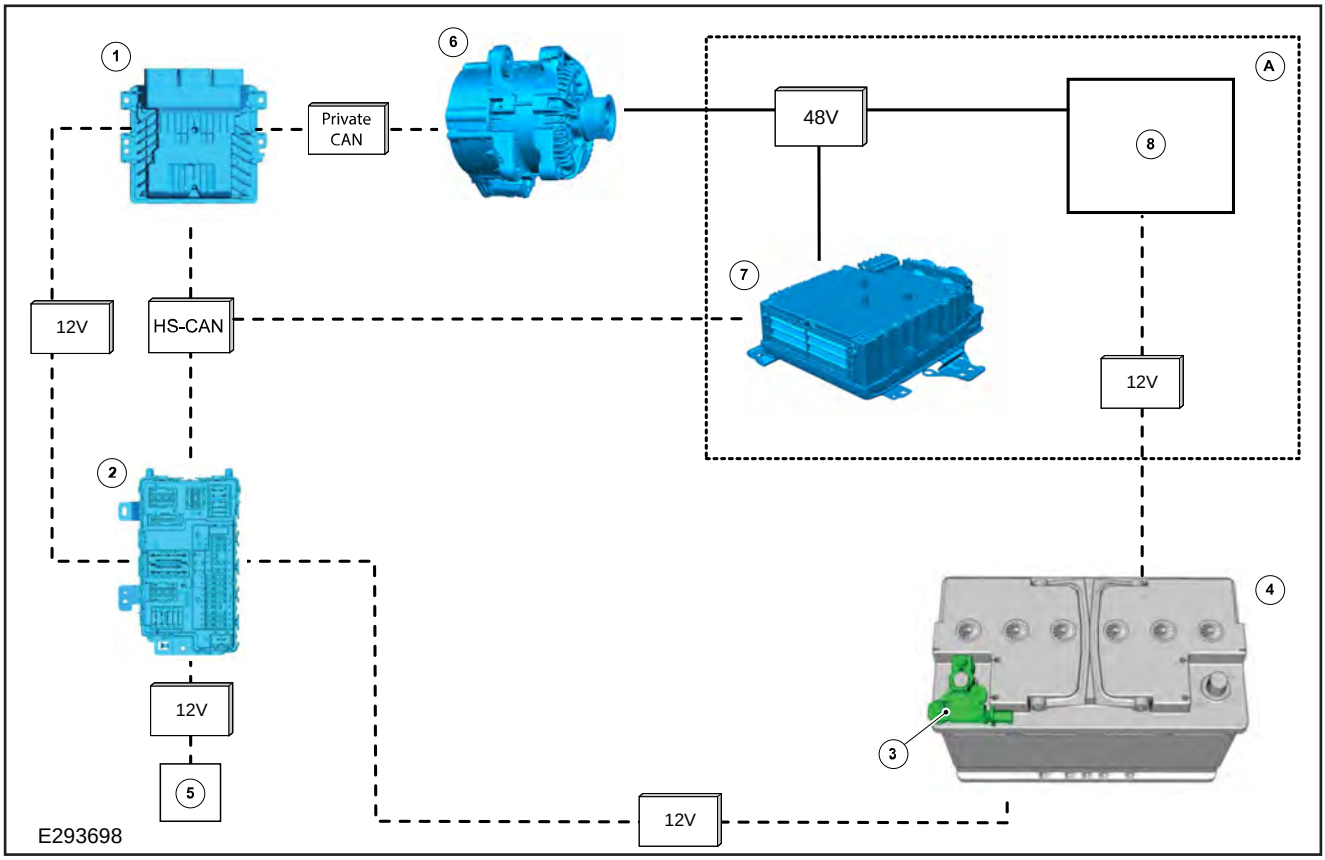
The BISG serves as the generator. The BISG can also act as a motor to restart the engine during Start-Stop operation, and to give torque assistance. The BISG is connected to the Battery Energy Control Module (BECM) by a special 48V circuit.

Do not connect anything to the BISG wiring. The low voltage power supply for the vehicle's electrical system comes from the low voltage (12V) output of the DC/DC converter which is part of the BECM.

The voltage of the wiring between the BISG and the BECM is 48V. The 12V system is supplied from a 3kW DC/DC converter within the BECM, not directly from the generator.

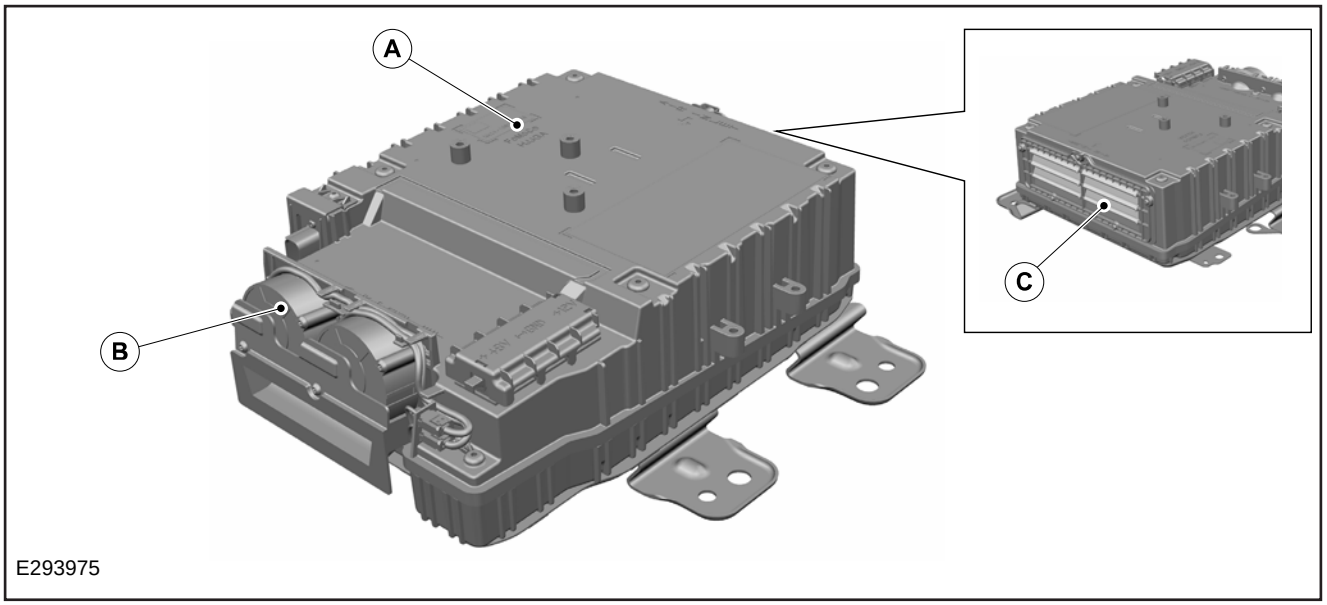
4.5.2 MHEV 48V System Operation and Component Description

System Diagram



Item	Description	Item	Description
1	Power Control Module (PCM) or Engine Control Module (ECM)	6	48V Generator
2	Body Control Module (BCM)	7	48V Battery
3	Battery Monitoring Sensor (BMS)	8	DC/DC Converter
4	Battery	A	BECM (located in the passenger seat pedestal)
5	Electrical Consumers		

MHEV 48V Battery - Driver Seat Pedestal



Item	Description
A	Cover
B	Dual Fan Air Outlet
C	Air inlet Louvre

4.5.3 48V Battery Pack

WARNINGS:

The 48V Battery must not be removed, opened, repaired or modified in any way during the conversion process.

Do not perform any vehicle modifications that fully or partially block the air inlet or outlet of battery.

Do not electronically or mechanically connect any third party accessories to the 48V battery.

NOTE: Any service or replacement of the 48V battery must be performed by an authorised Ford dealer.

Only persons with appropriate training should be allowed to handle MHEV batteries.

When storing for a period greater than 6 months, the vehicle should be started periodically. The vehicle should be stored in an environment with low humidity, free from corrosive gas within a temperature range of 20 to 35ºC. A temperature of 40ºC or higher will accelerate the deterioration of the battery performance. The 48V battery should be stored in an environment with between 45-85% humidity.

4.5.4 System Operation - Smart Charging (SC)

12V battery charging is controlled by the DC/DC converter within the 48V battery, instead of the alternator.

The output voltage and power of the 48V battery are dependent upon the vehicle electrical loads, 12V battery State of Charge (SOC), 12V battery temperature, 48V battery SOC and BISG output. The 48V Battery output voltage is effectively independent of engine speed and Start-Stop status during normal operation.

The output voltage at of the DC/DC converter varies between 12.50V and 15.25V.

If the 12V battery is below about 83% SOC, the DC/DC output voltage will be in the region of 13.5V to 15.25V. Once the 12V battery reaches above 83% SOC, the DC/DC output voltage will drop to about 12.50V to 13.5V.

4.5.5 Smart Charging Override

MHEV smart charging is not influenced by the Start-Stop inhibit button, unlike alternator based charging.

4.5.6 Third Party High Power Mode

WARNINGS:

The Third Party High Power mode can inhibit engine shutdown (AEIS) which is safety procedure designed to protect against carbon monoxide (CO) poisoning. CO can accumulate to dangerous levels from engines running in confined spaces and can cause harm or death. Do not operate the feature on a vehicle in a confined space. Do not install the feature on a vehicle that may be left running in a confined space. Do not allow carbon monoxide to accumulate.

The Third Party High Power mode is a single method that has various effects. Do not allow the Third Party High Power mode to be active at incorrect conditions as this may lead to unintended consequences. When implementing automated control of Third Party High Power mode, be sure to consider the full range of effects.

The Third Party High Power mode feature must not be grounded permanently. This will invalidate the emission and homologation of the vehicle. Permanently disabling the vehicle's fuel save features will require rehomologation as part of the approval process by the Vehicle Converter.

When fitting automated systems to control Third Party High Power mode, be sure to record details within the owner's vehicle information. Advise subsequent owners of modifications relating to application of Third Party High Power mode. Subsequent owners of equipped vehicles are to be informed of applications of Third Party High Power mode.

CAUTION: Third Party High Power mode is only to be used where required for third party equipment functionality. When equipment is off and in a normal drive cycle. All fuel and emission save features must be active.

Introduction

Third Party High Power mode has only one input that can affect all the following features. It can be configured by dealer to have a selective effect. Ford may restrict feature availability, in certain markets.

- SC inhibit – sets Conventional Charging
- Start-Stop inhibit
- Automatic Engine Idle Shutdown (AEIS) inhibit
- At engine off, inhibit of the timeout of the standard battery guard (SBG)

Examples of when to not switch to Third Party High Power mode include in a normal drive cycle when no extra loads are active. Solutions should only be for heavy electrical loads, or mechanical power from the Front End Accessory Drive (FEAD), mainly when stationary.

The Third Party High Power mode is subject to configuration and may be subject to restriction.

SC Inhibit - Conventional Charging

This may be required for Vehicle Converters requiring voltage in the range of 13.5V to 14.9V. Such applications include boost or supplemental battery charging, compensation for voltage drop or high ampere electrical loads whilst the engine is running.

Start-Stop Inhibit

This may be required where the charging system is required to provide voltage or high electrical power while driving.

AEIS Inhibit

This may be required to keep the engine running when the vehicle is used for power generation, mechanical or electrical, in a stationary application. Normal AEIS functionality is where the engine will automatically shutdown after 30 minutes if no driver input is detected.

Timer of Standard Battery Guard at Engine Off

This may be required to prevent the SBG operating too soon, in case the engine is off.

Refer to: 4.7 Battery Protection (page 105).

Installation/Access

The Third Party High Power mode is activated by the grounding of a particular electrical circuit to a 'non permanent' switching strategy.

The Third Party High Power mode can be accessed at various vehicle connectors:

- As a kit to install the standard 10-way Vehicle Interface Connector in the driver's seat pedestal.
  - Interface Connector pin 3 – available on all Non Camper variants.
- Pre-installed as part of a Camper Donor vehicle (C9)
  - 15-way camper connector pin 14
- Pre-installed as part of the High Specification Vehicle Interface Connector (A608).
  - A mating 43 way connector with three metres 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, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com
  - High Specification Interface Connector (A608) pin 23
- Feature included in the Ford Programmable Battery Guard (A540) – where load active or third party sensing will trigger a ground required to turn off the fuel save features. Examples are:
  - To avoid low voltage tripping of high powered inverters
  - Charging extra batteries
  - RunLock
  - Voltage drop compensation
  - Voltage Stabilisation
  - FEAD third party ancillaries requiring the engine to run continuously

Refer to: 4.7 Battery Protection (page 105).
Refer to: 4.24 Electrical Connectors and Connections (page 158).

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

NOTE: There will be a delay between setting the Third Party High Power mode and the effect occurring (up to a 5 seconds delay).

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: SC Inhibit, Charging Mode Control

NOTE: There will be a delay between setting the Third Party High Power mode and the effect occurring (up to a 5 seconds delay).

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 SC inhibit input circuit open. Refer to the Roadside Emergencies section of the Owner's Manual
3. With the engine running, set to ground the circuit for Third Party High Power mode and measure battery voltage. The voltage should be in the ranges shown in the table 'Summary of the Available Charging Modes'. 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. Remove the ground and check voltage level returns to the original level measured in Step 2. SC is active

Test Functionality: AEIS Inhibit, Idle Shutdown Control (where fitted)

NOTE: There will be a delay between setting the Third Party High Power mode and the effect occurring (up to a 5 seconds delay).

1. Check that AEIS is fitted and operational
2. Set Third Party High Power mode
3. Check that the engine continues to run whilst the inhibit is set beyond 30 minutes
4. Check that normal AEIS behavior resumes when the inhibit is not set, for example the engine shuts down after 30 minutes

Test Functionality: Inhibit of Timer for Engine Off Load-Shedding

NOTE: There will be a delay between setting the Third Party High Power mode and the effect occurring (up to a 5 seconds delay).

NOTE: If the 12V SOC is already too low, the circuit will open before the timer to protect the engine start.

1. Establish the preset timer of a the SBG circuit e.g.
   - CCP2
   - Other switched ground circuits fed from the feature
2. Set Third Party High Power mode
3. Check that the circuit remains on after the timer period

Refer to: 4.7 Battery Protection (page 105).

4.5.7 Vehicle Electrical Capacity

The MHEV vehicle does not have a conventional alternator. The 12V system is supplied by a DC/DC converter, integrated into the BECM under the front passenger seat, which replaces the function of the alternator.

4.5.8 Charge Balance Guidelines

The maximum DC/DC converter output is 3kW/223A. This is a 'constant power' device so the 12V supply current may vary with voltage. The output current may be further limited under certain conditions.

When fitting medium to high third party electrical loads, including extra batteries, a charge balance test should be performed. This includes all relevant Ford and third party loads active at the same time where the battery voltage should not go below 13V. This will ensure that the system is not overloaded, extra batteries are charged and correct system functionality is maintained. SC override is recommended to ensure the DC/DC is in full power mode. Increased performance can be achieved by elevating the idle, utilising the engine RPM control option (A003).

4.5.9 Circuit Diagrams

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

Refer to: 4.24 Electrical Connectors and Connections (page 158).
Refer to: 4.22 Fuses and Relays (page 151).

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

4.6 Battery Systems

WARNING: For electrical Power Take Off (PTO) that requires deep discharge and cycling from third party systems, High Performance Deep Cycle AGM batteries (HFQ or A739) must be ordered on the base vehicle. For more information refer to 'Power and Connectivity Usage Recommendations' table later in the section. If option HFQ or A739 is not on the base vehicle they can be fitted by your local Ford Dealer. See table in Single and Twin Batteries Section.

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

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

NOTE: Auxiliary customer electrical loads exceeding 60A must be regulated by the Standard Battery Guard (SBG) and load-shedding system. For loads greater than 175A see 'Third Party +12V PTO for loads exceeding 175A' section in this BEMM.

NOTE: Do not make any additional connections to the Power Distribution Box (PDB) terminals, as over-torqueing could cause damage to the PDB. Any electrical loads should be taken from the CCP.

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

4.6.1 Power and Connectivity Usage Recommendations

WARNING: If a third party battery guard is fitted, it must be connected to the load-shedding signal so that EPAS is protected in the event of an overload at engine run.

NOTE: Use Absorbent Glass Mat (AGM) batteries for deep cycle applications, i.e. charge and discharge on a regular basis.

NOTE: When considering battery discharge, the Vehicle 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 utilised in conjunction with the charging system.

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

The section is to serve to assist with fitting the appropriately sized charging system.

Connectivity Usage	Recommended Specification (order code in brackets)
Additional fused relay outputs. For example: Service Engineers Van.	Auxiliary Fuse Panel (A526) option include CCP2.
Roof Beacons/Additional switches. For example: Highway Maintenance Vehicles.	Beacon Preparation Pack (A606)/Utility Vehicle Switch Pack (A626)[1] Note: includes Auxiliary Fuse Panel (A526)
Conversions using various vehicle signals are required, such as indicators, stop lamp, door ajar, handbrake on. For example: Police Vehicles and Ambulances.	High Specification Vehicle Interface Connector (A608)[1] Note: includes Auxiliary Fuse Panel (A526).

[1]Utility Vehicle Switch Pack (A626) and High Specification Interface Connector (A608) cannot be ordered together

Engine State	Power Usage	Recommended Specification (order code in brackets)
Engine Off Loads	**LOW CONTINUOUS PTO:** Up to additional 5mA at Key Off, for example: KL30 fed small current peripheral chargers.	Donor Vehicle Battery(s)
	MID CONTINUOUS PTO: Between 5mA and 30mA at Key Off, for example: Trackers (with sleep function, no GPS), Control Gear, KL30 fed medium current peripheral chargers.	Twin Batteries of same type (only standard on certain applications)
	HIGH CONTINUOUS PTO: Between 30mA and 175A at Key Off, for example: Trackers with GPS, Control Gear, KL30 fed high current peripheral chargers OR vehicles with multiple/ extended activations of interior lighting, cycle locks and rear door ajar events. DO NOT EXCEED 175A.	Limited Engine Run/Charge Cycles, 2 High Performance H7 Deep Cycle Absorbent Glass Mat (AGM) batteries (HFQ). Frequent Engine Run/Charge Cycles, single High Performance H8 Deep Cycle AGM battery (A739) Where possible connect to loads to the standard battery guard, FPBG or Third Party Battery Guard. Refer to: 4.7 Battery Protection (page 105) for load-shedding.
	OCCASIONAL SHORT TERM HIGH PTO: Between 40A and 240A at Key Off, for example: Cranes, Tippers, Tail Lifts, 230V Inverters, Ambulances.	2 High Performance Deep Cycle AGM batteries (HFQ) + Ford Programmable Battery Guard (FPBG) -max 200A (A540). Additional batteries may be required, for further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section. Refer to: 4.7 Battery Protection (page 105), for Load-Shedding.
Engine Run Loads	**LOW CONTINUOUS PTO:** Up to 30A, for example: Maintenance Van with water heater and additional lighting but no further systems.	Donor Vehicle Alternator
	HIGH CONTINUOUS PTO: up to 240A, for example: Ambulance, High Load Maintenance Vehicle, Refrigeration. DO NOT ALLOW BATTERY DISCHARGE AND DO NOT ALLOW SYSTEM TO DROP BELOW 13V. For further information see Battery Configuration, Additional Loads, Start-Stop and SRC, in this section. Any loads greater than 60A must be connected to a controlled load-shedding connection.	Use RPM Speed Control (A003) to enhance 12V charging if required. For voltage support consider using Third Party High Power Mode. Any loads greater than 60A must be connected to a controlled load-shedding connection.
	PTO: Applications which require elevated idle engine speeds, for example: Mobile Tyre Fitter Van, Welder's Vehicle and Mechanical PTO from engine.	RPM Speed Control (A003). This does not assist MHEV 12V charging.
	For applications where the Vehicle Converter Load requirement exceeds HIGH CONTINUOUS PTO, for example: total Ford and Vehicle Converter loads exceed the highest available Ford alternator rating.	High Power Pack option (A550) and supplemental batteries and supplemental energy source pending charge balance calculation.

4.6.2 High Current Supply and Ground Connections

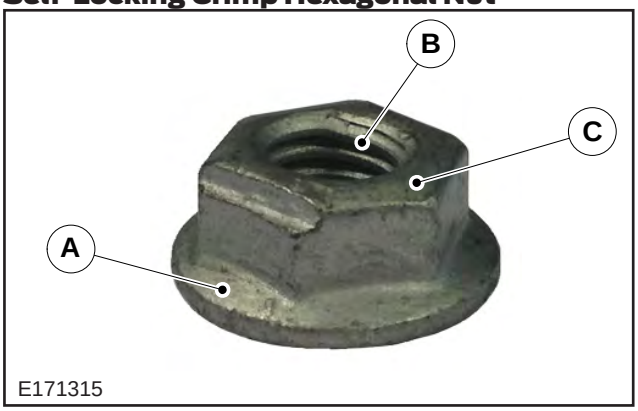
WARNINGS:

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

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

For additional information
Refer to: 4.24 Electrical Connectors and Connections (page 158). 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).

4.6.3 Guidelines When Converting Vehicles

Responsibilities and Considerations

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 warranty, 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 specialised electrical equipment vary. The Vehicle Converter must therefore consider the following points when designing the installation:

- Maintain legality and regulatory conformity of the base vehicle
- Driveability 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
- The materials and installation must meet the quality standards described in this section

Normal Operating Voltage

The Transit electrical system is charged either by an alternator or by an MHEV system. The vehicle electronics run on a 12V supply with a negative ground return. The factory fit equipment are designed for normal operations to be fully operational in the range 9-14V.

The MHEV system uses 48V charging with a common ground, with a 48V battery and a 48V/12V DC/DC converter. The 48V Battery Pack is not suitable for any conversion work.

Voltage Check and Charging Procedure

WARNING: Do not connect to any ground or +12V potential points other than that specified in the Owner's Manual. There is a dedicated charge point under the bonnet. Failure to comply may lead to high current paths that may damage peripherals and electronic modules especially in a Jump Start condition.

All voltages are to be measured with an accuracy of ±5% of values published using calibrated meters. Measure the voltage by using the CCP1 or the battery plus terminal for positive connection and battery ground or battery minus terminal for negative connection.

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 manufacturer's instructions for the charger, for use of the discharged battery/ boost charge mode.

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.

Sensitivity and Voltage Tolerance

The Transit utilises 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.

Stored and Delayed Vehicles

Vehicles held at the Vehicle Converter premises and/or 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 reconnected and the voltage rechecked. A complete recharge is required for battery voltage below 12.4V for standard and enhanced flooded or 12.3V for AGM or for no-crank vehicles by using an appropriate charger.

For additional information
Refer to: 1.13 Vehicle Transportation Aids and Vehicle Storage (page 27).

Transport Mode

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

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

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

The SBG, CCP2 and third party load-shedding system is 'always off' during Transport mode. FPBG is inhibited during engine run.

Power Disconnection

WARNING: Disconnection is required for welding work and work with airbags. Disconnect all the batteries, including ground and insulate the negative battery terminal(s).

NOTE: After disconnecting the power supply and before performing further work, a wait time of 15 minutes must be maintained to ensure safety systems are fully deactivated.

Following battery disconnection, there is no need to reprogramme 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 reprogramme the electronic security code, as it is tied into the VIN of the factory fit Transit system. The clock initialises to 1200 and will need to be reset to the correct time in accordance with the customer handbook procedure.

Ground Connections

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

High electrical 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.

Refer to: 4.7 Battery Protection (page 105).

If separate charging systems are added, the ground side of the charger must also be connected to the body. An auxiliary ground stud eyelet, can be ordered, part numbers KU5T-14436-B** for single battery and standard with A739 option or jumper cable KK2V-14301-K* for twin battery systems.

Refer to: 4.24 Electrical Connectors and Connections (page 158).

This will be standard when pre-ordered with Special Vehicle Options, A526, A606, A607, A608, and A652 also Regular Production Order HFQ.

For additional information on order codes
Refer to: 1.5 Conversion Type (page 14).

Battery Cable Fixing Torque

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

Battery Safety

WARNINGS:

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

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

Vehicles with Start-Stop* require an AGM battery. You must replace the battery with one of exactly the same specification and technology. *Optional in some markets

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.

When a battery guard is fitted, the supply from a non-deep cycle twin standard flooded battery should not be below 12.0V measured at the battery terminals at open circuit voltage. If a battery guard is monitoring a supply from a deep cycle twin AGM battery, it is recommended not being below 11.8V measured at the battery terminals at open circuit voltage.

Battery Type and Capacity

NOTE: If a Vehicle 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 PTO requirements. Refer to the table 'Power and Connectivity Usage Recommendations' in this section of the BEMM for your vehicle. Heavy PTO may inhibit Start-Stop but only for the duration of the third party load. This is normal functionality.

The base vehicle is equipped with either a single or twin battery system. It is important to also read related information on Start-Stop and charging systems.

The vehicle may have Standard Flooded, Enhanced Flooded or AGM batteries as factory fit. Higher capacity batteries are available as standard production options and special vehicle options offer AGM technology for heavy PTO and deep cycling applications. Before installing additional electrical equipment check that the battery capacity, technology type, harness load capability and charging system output are suitable for the extra load.

Refer to: 4.6 Battery Systems (page 91). Power and Connectivity Usage Recommendations table.

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

Battery Box

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

Battery Drain Prevention

As part of the Vehicle Converter process and to maximise battery life and prevent premature failure of the Ford batteries, 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.

Battery Rest Period

After reconnecting, the BMS requires at least 4 hours quiescent period to recalibrate to the correct battery state of charge, see also BMS information later in this section.

Usage of Electrical Loads During Conversion

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

For additional information
Refer to: 1.13 Vehicle Transportation Aids and Vehicle Storage (page 27).

Engine Off Loads

All loads that exceed 100mA continuous key off load require 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.

Refer to: 4.7 Battery Protection (page 105).

Jump Start

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.

Customer Connection Points (CCP) and Other PTO Locations

Any peripherals added to the power supply must be either connected in one of the following ways via the CCPs, or from dedicated fuses such as: the Auxiliary Fuse Panel (A526), the High Specification Interface Connector (A608), the Ford Programmable Battery Guard (A540) or CCP 60A. For loads greater than 175A (CCPs) or 200A (FPBG), up to 240A can be connected from the battery cable.

Refer to: 4.7 Battery Protection (page 105).

Auxiliary Electrical Systems

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.

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

Refer to: 4.22 Fuses and Relays (page 151).

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.

Third Party High Power Mode

Third Party High Power mode is a Ford function that is available to assist with third party electrical and mechanical PTO. This will allow power for longer at engine off and help sustain a higher voltage during engine run. This mode includes SRC Inhibit, Start-Stop Inhibit, AEIS inhibit, and engine off load-shedding timer over-ride.

Cable Routing

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.

Fitting Equipment Containing Inductive Loads

WARNING: When inductive loads, such as electric motors, are to be fitted consideration of inrush current is needed.

CAUTION: The following must be observed:

- All inductive loads must be driven via relays with contacts rated at least 3 times the maximum rated current of the motor
- All inductive loads 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 inductive loads fitted should be fully suppressed to European or applicable local Legislation relating to EMC to ensure electrical interference does not affect the vehicle systems
- Add EMC emissions statement to CE approval

Airbags

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

Pay attention to the following points:

- Disconnect all the batteries, including ground and insulate the negative battery terminal(s)
- Disconnect the electrical connector at the airbag control module

Welding and Cutting

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

For additional information on welding
Refer to: 5.1 Body (page 183).

Pay attention to the following points:

- 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 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

4.6.4 Battery Options

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

Any additional or different batteries must be checked for correct functionality on a Start-Stop or SRC vehicles.

Refer to: 4.11 Electronic Engine Controls (page 121).
Start-Stop and SRC
Refer to: 4.4 Charging System (page 80).

Battery Part Numbers and Usage

Battery Part Number	Type	Quantity	Size
Single Battery (without Start-Stop) (1)			
GK2T-10655-D*	750CCA (80Ah @20 hour rate) Standard Flooded Battery	1	H7
Single Battery (without Start-Stop) (2)			
GK2T-10655-E*	710CCA (75Ah @ 20 hour rate) Enhanced Flooded Battery	1	H7
Single Battery (with Start-Stop)			
GK2T-10655-FA	800CCA (80Ah @ 20 hour rate) AGM Battery	1	H7
Twin Battery (without Start-Stop) (1)			
GK2T-10655-D*	750CCA (80Ah @ 20 hour rate) Standard Flooded Battery	2	H7
Twin Battery (without Start-Stop) (2)			
GK2T-10655-E*	710CCA (75Ah @ 20 hour rate) Enhanced Flooded Battery	2	H7
Twin Battery (with Start-Stop)			
DV6T-10655-B*	800CCA (80Ah @ 20 hour rate) AGM Battery	2	H7
High Performance Deep Cycle AGM Batteries (HFQ)			
DV6T-10655-B*	800CCA (80Ah @ 20 hour rate) AGM Battery	2	H7
High Performance Deep Cycle AGM Batteries (OW5)			
8C1V-10655-AA	850CCA (95Ah @ 20 hour rate) AGM Battery	1	H8

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

4.6.5 Battery Rules

NOTE: When modifying the battery pack it is recommended to also update the vehicle configuration.

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

- Batteries in parallel must be of the same type and capacity and listed in the Ford battery table
- Third party batteries and loads are to be isolated from the standard Ford system at key off or by a Ford or third party battery guard system
- 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

Where twin batteries are required on vehicles with a single battery installation, associated wiring and hardware should be fitted and aligned to Ford architecture. The extra battery must be of the same technology and performance rating as the existing battery. Alternatively, single or twin battery systems can be upgraded to the High Performance Deep Cycle AGM batteries: twin (HFQ) or single (A739) system.

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

For special conversions requiring a third party battery, a further disconnect strategy is required. 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: 4.4 Charging System (page 80).

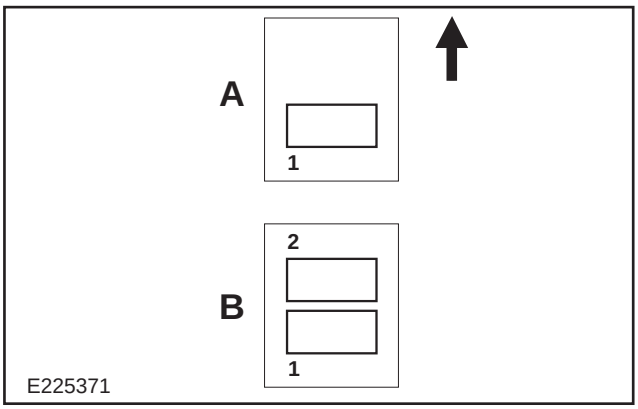
The load a battery could add to the vehicle when requiring a charge, may exceed 60A. If third party loads are also connected, a relay or contactor, controlled by the load-shedding signal, must be used to isolate.

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 4A over a 20 hour period at 20°C 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 is recommended. For high power (twin system) requirements at engine off use H7 (HFQ) or for low power (single system) at engine off use H8 (A739)

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

4.6.6 Battery Configurations



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

Additional Loads, Start-Stop and SRC

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

Start-Stop and SRC will operate within specification only if a correct battery configuration is installed in the vehicle. Start-Stop and SRC system functionality cannot be guaranteed with the following configurations.

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

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 at your local Ford dealer.

The feature content of the vehicle must still remain a Start-Stop or SRC vehicle to be in line with the homologation, vehicle tax and excise requirements.

4.6.7 Converter Fit Additional Third Party Batteries

WARNING: For any third party power connections needing greater than 60A when CCP2 is not used, all connections must be controlled via either the load-shedding or FPBG signal. There must not be any exceptions to this conversion strategy as the signal is to protect the Ford power supply from overload and voltage drop that can affect critical systems such as the FPBG. It is not recommended to use the 60A CCP1, Camper, High Specification Interface Connector feed to supply a third party battery.

NOTE: It is the Vehicle Converter's responsibility to ensure the power supply on the vehicle is adequate to supply both Ford and third party systems, especially if they can be active at the same time. System voltage at engine run must not fall below 13.0V whilst the vehicle is in motion and if Third Party High Power mode is active.

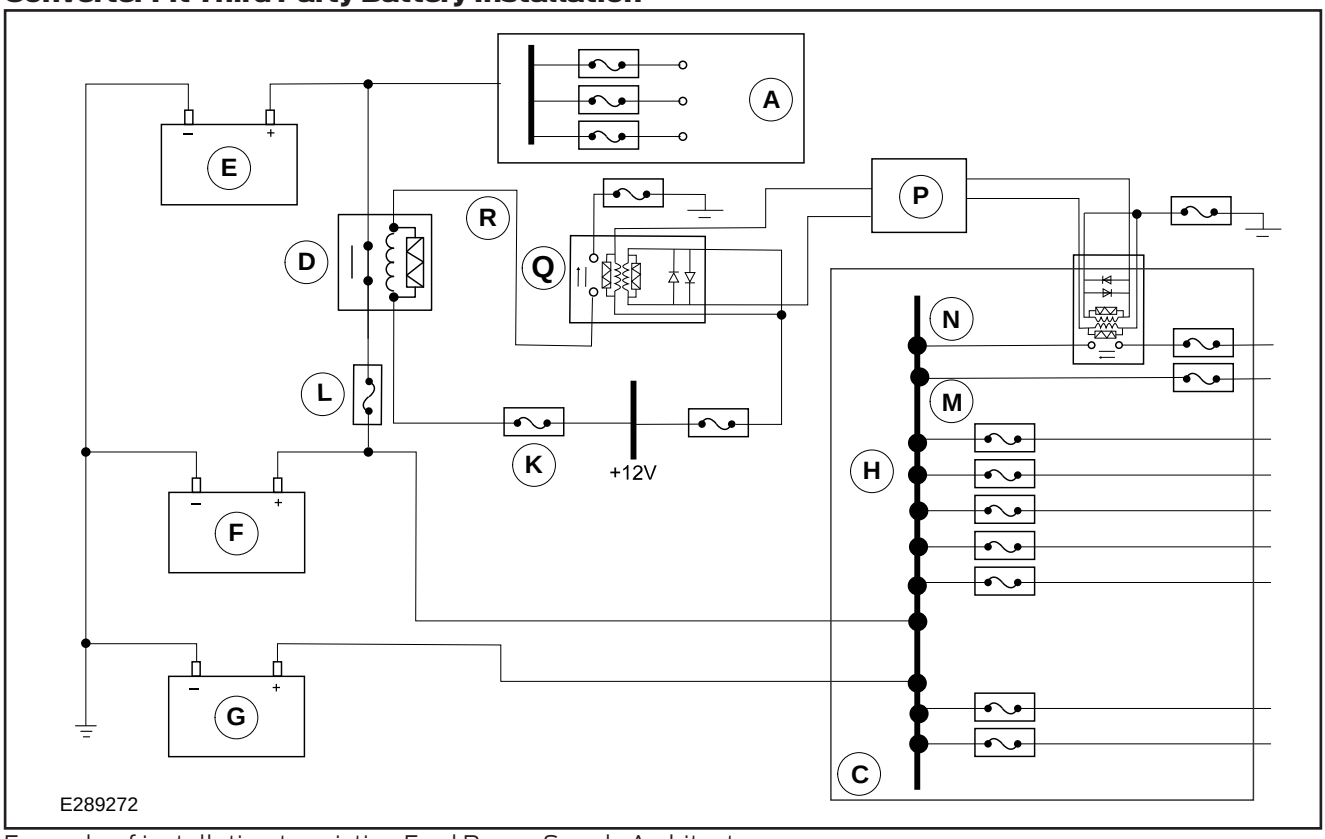
The assumption is that greater than 60A would be required for camper vehicles and any other conversions requiring an additional battery. Therefore, isolation should be provided by either the 175A Customer Connection Point (CCP2), the Ford Programmable Battery Guard 200A or a third party

relay or contactor controlled by the load-shedding signal. In all systems, there is engine off power protection, providing enough remaining energy for a future engine start. Suitable capacity in the wiring, fuses and energy sources must be calculated. The extra battery, when discharged, becomes a load that can be up to 100A, so adds to the energy requirement from the charging sources, along with the third party loads.

Refer to: 4.7 Battery Protection (page 105).

If additional batteries are added, these should be connected via a disconnect mechanism such as CCP2, FPBG, or another battery guard controlled by the load-shedding signal. If the third party battery and added system requirements exceed 175A (CCP2) or 200A (FPBG) of current, connection to the battery positive 6mm stud is permissible only when integrated with the load-shedding signal. Refer to the 'third Party +12V PTO for Loads Exceeding 175A' in this section. For example of converter fit third party battery installation to existing Ford power supply architecture see figure E289272 in this section.

Converter Fit Third Party Battery Installation



Example of installation to existing Ford Power Supply Architecture

Item	Description
A	Converter Fit — Loads
C	Pre Fuse Box — Driver's Seat Pedestal
D	Converter Fit — Normally open latched third party Battery Control Relay
E	Converter Fit — third party Battery
F	Ford Fit — Auxiliary Battery(1)
G	Ford Fit — Vehicle Start Battery
H	Ford Fit — Loads (from Auxiliary Battery)
K	Converter Fit — +12V Fused KL30 Supply
L	Converter Fit Power Supply Fuse (For loads between 175-240A)
M	CCP1 - 60A standard
N	CCP2 - 175A relay and Mega fuse (with any SVO Fuse Box option (including A526)/Twin Batteries)
P	BCM
Q	Ford fit SBG and load-shedding control relay
R	Ford fit signal/grid, 10A switched ground, controlled by SBG and load-shedding control relay

(1) Must be ordered as an extra option

Converter fit power supply fuse may not be required if CCPs are the correct value.

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

If supplemental chargers are to be used, they must be connected directly to the third party battery.

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/SC (MHEV) functionality will take some time (ignition off overnight and multiple ignition run cycles) to re-establish full functionality.

Refer to: 4.4 Charging System (page 80). System Operation

Third Party +12V PTO for Loads Exceeding 175A

WARNINGS:

DO NOT connect the same load to both CCP1 and CCP2. The system is not designed to work together as the fuses have different values.

It is important that the battery box lid/ cover are replaced after any conversions to the battery positive terminal. See figure E278335 in the BMS later in this section of the BEMM. If the battery lid/cover is missing or damaged, a replacement part must be ordered and fitted. It is recommended to check fitment as part of a quality control process after a conversion.

Third party +12V PTO connectivity should be made to the CCP or FPBG where possible. In the event a current requirement greater than 175A but less than 250A peak loading (maximum fuse value third party installed), connecting to the rear battery +12V clamp 6mm stud is permitted in conjunction with a disconnect relay controlled by the load-shedding signal. A twin battery system is recommended for this application.

Refer to: 4.7 Battery Protection (page 105).

The following fusing principles must apply:

- For a long duration (greater than one hour continuous), the fuse must be no higher rating than the alternator fitted to the vehicle
- 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 Vehicle 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

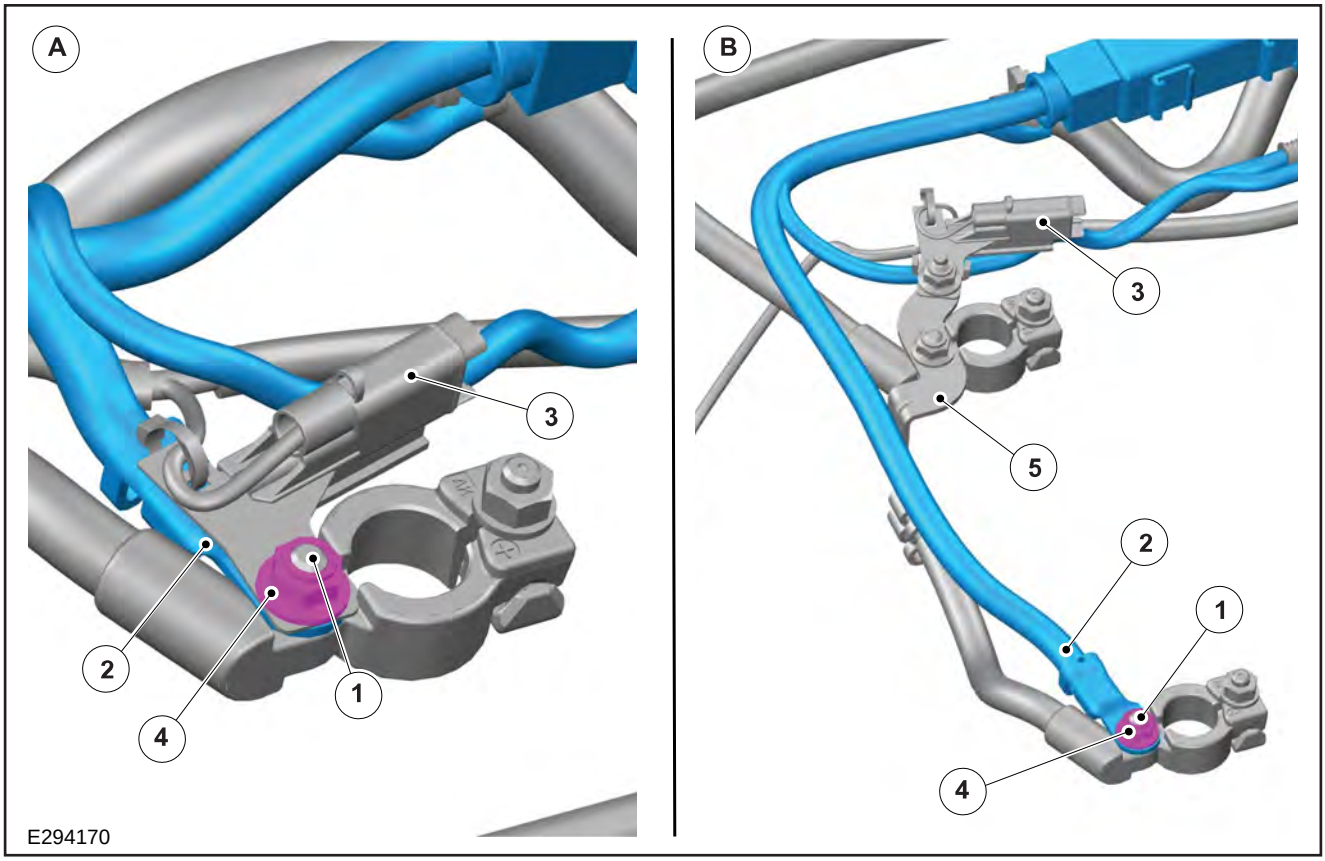
Refer to: 4.2 Wiring Installation and Routing Guides (page 63). Wiring Specifications table. For example: 245A has 70mm² CSA cable

- The third party positive conductor is mounted directly to the battery clamp with the supply for the BMS last, see figure E278335
- No deformation to the Ford BMS can occur. The conductor terminal/eyelet may need to be inverted, see item 4 in figure E278335
- 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 torqued to 8Nm ± 1.2Nm. Separate locking washers are prohibited
- A Mega inline fuse must be fitted as close to the 6mm stud as possible. Not to exceed 250A for short duration applications such as on 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 (HFQ) must be fitted to the derivative. See 'Single and Twin Battery System' and 'Power and Connectivity Usage Recommendation' table in this section of the BEMM
- A higher ampere alternator must be fitted if long duration (greater than one hour) high loads are required. See 'Single and Twin Battery System' and 'Power and Connectivity Usage Recommendation' table in this section of the BEMM
- The Third Party High Power mode feature must be used for Engine Run applications.

Refer to: 4.4 Charging System (page 80). Start-Stop Override and Configurable Charging

- Efficient isolation of third party equipment, when not required, to minimise battery discharge/deep cycling. The load-shedding signal control offers this
- Testing for end customer usage, including duty cycle, at a range of temperatures and drive cycles, worst case
- Testing of the Vehicle Converter's system must confirm no heating of Ford or third party cables or any junctions utilised, unless thermal protection is incorporated
- Testing of Vehicle Converter's +12V conductor must demonstrate no loosening possible to Ford battery cable clamp
- No detriment to Ford systems from voltage 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

Third Party +12V PTO Assembly



Item	Description
A	Single Battery Assembly
B	Twin Battery Assembly
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
5	Twin Battery positive link cable with 6mm stud - KK2V-14300-M*

speed control system must be utilised 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, systems that are not required 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 to in all relevant areas. This document allows connectivity to Ford battery clamp if the above criteria is met

4.6.8 Battery Monitoring Sensor (BMS)

WARNING: It is important that the battery box lid/covers are replaced after any conversions to the battery positive terminal. See figure E278335. If the battery box lid/cover is missing or damaged, a replacement part must be ordered and fitted. It is recommended to check fitment as part of a quality control process.

CAUTION: Do not permanently remove jumper cable from the BMS.

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

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

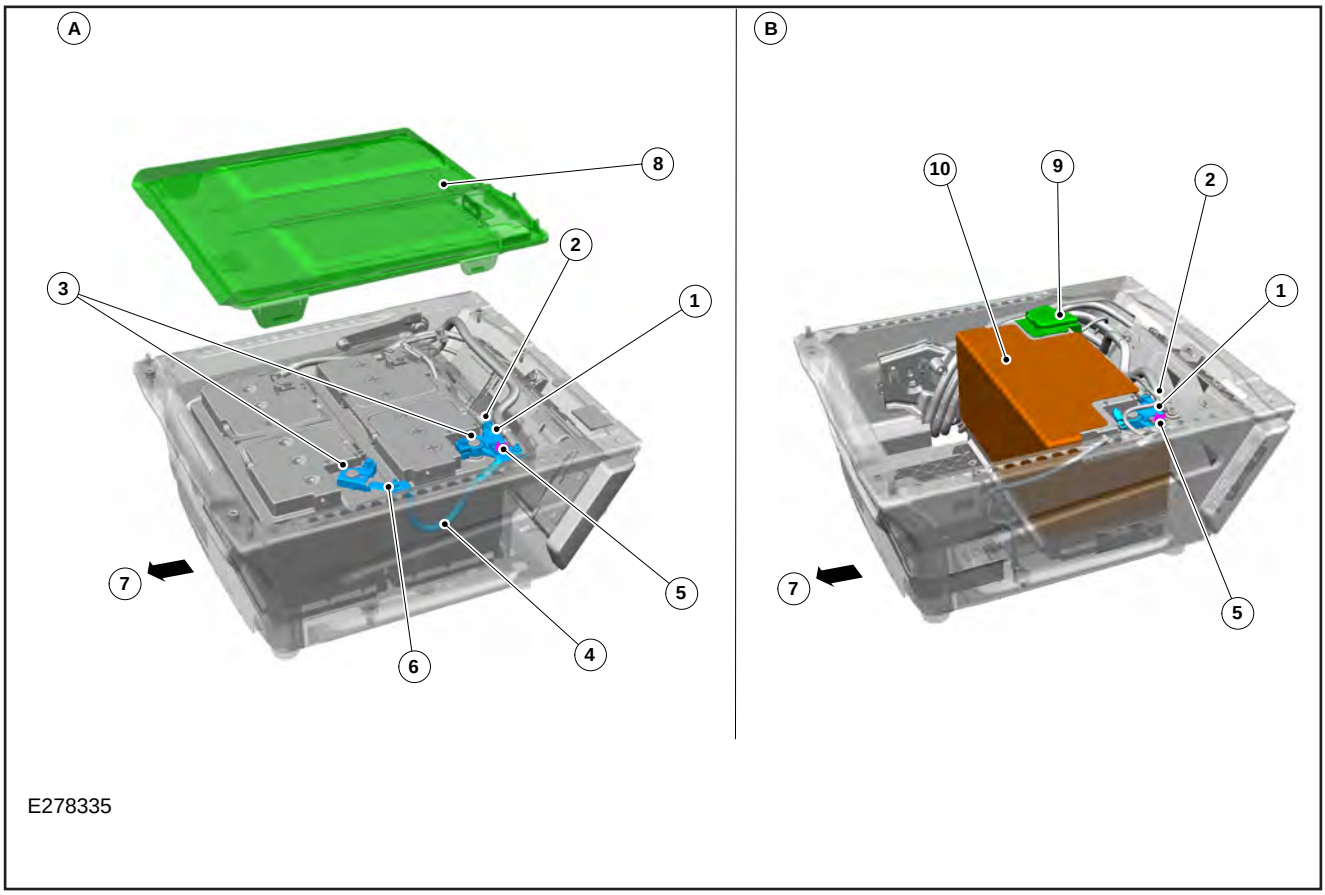
closed-circuit current is less than 100mA. The rest period must last for at least 4 hours. If the system cannot carry out a re-calibration then it is unable to establish the correct state of charge of the battery. In this case, the Start-Stop system may be deactivated.

It is recommended that the total Ampere consumption, in sleep mode, does not exceed 100mA. This is because BMS will not be able to accurately correlate the battery state of charge. Note there is approximately 15mA of key off load from existing Ford fit systems so the additional maximum is 85mA of converter fit system. Any third party installations should ideally be activated via ignition or engine run.

However, a sleep mode of 100mA is still high and will lead to deep discharge. Regardless of battery system, long periods of discharge may necessitate long periods of recharge. See 'Power and Connectivity Usage Recommendation' table at the end of this section.

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

Battery Box Lid/Covers



E278335

Item	Description
A	Vehicles with H7 Batteries
B	Vehicles with a single H8 Battery
1	Battery Monitoring Sensor (BMS) GK2T-10C652-A*
2	Plug-in connection — Local Interconnect Network (LIN) and Battery Positive +12V (B+) Feed
3	Connection to Negative Terminal of Main Battery Post — See 'Battery Cable Fixing Torque'
4	Jumper Cable (KK2T-14300-LA) only with twin batteries
5	1x M8 nuts. Do not loosen or remove
6	1x M6 nut. Do not loosen or remove
7	Front of vehicle direction
8	Battery Box Lid
9	Battery Positive Terminal Cover
10	Battery Cover

4.6.9 Single and Twin Battery Systems

Wiring of Batteries in Parallel for High Current Applications

Review whether an upgrade to a single High Performance H8 deep cycle AGM Battery (A739) would be sufficient or alternatively if a higher current is required, an additional battery can be added as shown in the proposed interface schematic. In this case the load-shedding signal is used to control relay 'D', see figure E289272 'Converter Fit Third Party Battery Installation' diagram to allow the third party battery to be charged when the engine is running.

Also refer to: 4.7 Battery Protection (page 105). figure E286668, Battery Guard System Overview'.

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: 4.4 Charging System (page 80). and
Refer to: 4.11 Electronic Engine Controls (page 121).

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.

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 are shown later in this section.

When changing the battery capacity or technology, the vehicle configuration must be updated after the new batteries have been installed. The vehicle needs to be connected to the Dealer Service Tool to reprogram the new batteries. Contact your National Sales Company representative or local Ford dealer with your vehicle VIN. If they are unable to help you then please contact the Vehicle Converters Advisory Service at vcas@ford.com. Failure to set the correct battery configuration may lead to incorrect SRC/SC and Start Stop functionality.

4.6.10 Additional Loads and Charging Systems

NOTE: Do not make any additional connections to the Power Distribution Box (PDB) terminals, as over-torqueing could cause damage to the PDB.
For applications that require a permanent installation to gain power for jump start requirements for example recovery vehicle conversion, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

Generic items when converting from Single System to single H8 AGM

Part Number	Description	Quantity
KU5T-14436-BU*	Auxiliary ground stud	1
BK3V-10A721-C*	Battery clamp	1
JK2V-10A818-AA	Breather tube	1
JK3V-10N669-AA	Battery tray	1
KK2V-14277-A*	Battery positive insulation covers	1
KK2V-14277-B*	Battery negative insulation covers	1
BK21-63226-A* / 63227-A*	Driver's pedestal	1
JK2V-10A687-A	Battery cover	1

Generic items when converting from Single to Twin Batteries

Part Number	Description	Quantity
GK2T-14301-A*	BMS jumper cable - less auxiliary ground stud	1
KK2V-14301-K*	BMS jumper cable - with auxiliary ground stud	1
KK2T-14300-L*	Battery link positive cable	1(1)
KK2T-14300-M*	Positive link cable with auxiliary positive stud	1

(1) only one battery pending on drive.

Replacing with Twin Basic System – Same as Single Fitted

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

Replacing with High Performance Deep Cycle AGM System

Part Number	Description	Quantity
DV6T-10655-B*	High Performance Deep Cycle 80Ah AGM Battery	2
8C1V-10655-AA	High Performance deep Cycle 95Ah AGM Battery	1

4.7 Battery Protection

NOTE: If a third party battery guard is fitted, it must be connected to the load-shedding signal so that EPAS is protected in the event of an overload at engine run.

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

4.7.1 Interior Lights and 12V Sockets

12V sockets and interior lighting are both controlled by timers and SOC control. Both reset at vehicle wake for example, door opening. These will switch off earlier if battery is low.

- 12V sockets - 30 minutes from key off
- Interior lighting - 10 minutes from key off (there are some options where the interior lighting has been extended to 30 minutes)

4.7.2 Standard Battery Guard (SBG) and Load-Shedding

WARNINGS:

When connecting a third party load, these installation instructions must be followed to avoid low system voltage during normal driving operation.

The load-shedding system must not be disabled or interfered with.

Vehicles with Single or Twin batteries should always fit battery guards if engine off power is required. The Ford Programmable Battery Guard (FPBG) A540 is recommended.

If a third party battery guard is fitted, it must be connected to the load-shedding signal so that EPAS is protected in the event of an overload at engine run.

NOTE: It is recommended to maintain the vehicle battery to a good level of charge to avoid load-shedding events.

Load-shedding is a system protection feature to stop excessive voltage drops at engine on. At engine off this system helps stop excessive battery drain which could lead to a failed start. To protect the system from sudden voltage drops it will on rare occasions of extreme conditions be necessary to disconnect high-current third party electrical loads. All third party electrical loads totalling over 60A must be connected under one or other method of load-shedding control. Charge balance system testing is expected of the third party system with any Ford system loads, to ensure that the voltage does not go lower than 13.0V at engine run. If 11.0V is measured, this is the cut off point for load-shedding but here there would be serious problems with the system design of supply and demand.

At engine-off, it helps prevent excessive battery discharge with a SBG.

To avoid the risk of there being load-shedding during engine run in a **stationary** electrical Power Take Off (PTO) requirement, two systems are recommended to be utilised:

1. **Third Party High Power Mode override feature**
   This will help maintain the highest voltage by forcing the charging system into conventional charge mode.
2. **Engine RPM speed control feature**
   This can help increase current output of the charging system by increasing the engine idle. Charge balance system testing is expected of the third party system with any Ford system loads, to ensure that the voltage does not go lower than 13.0V at engine run. If 11.0V is measured, this is the cut off point for load-shedding but here there would be serious problems with the system design of supply and demand.

4.7.3 Power Connections

This section explains where to connect third party electrical power connections, based on the power that will be drawn.

Ground connections are not controlled

Refer to: 4.25 Grounding (page 182).

Connections without SBG and Load-Shedding

NOTE: Suitable for up to 60A total.

A total limit of 60A applies to all non-sheddable third party electrical loads added to the vehicle, across all locations including the following:

- Customer Connection Point 1 (CCP1)
- Camper connection (C Connector)
- The Auxiliary Fuse Panel (A526)
- High Specification Interface Connector (A608)

Refer to: 4.24 Electrical Connectors and Connections (page 158).

All higher current third party loads are to be regulated using Ford controlled load-shedding.

Optionally, third party loads below 60A can also be connected to the load-shedding control system to make use of the protection from battery drain that this may provide.

It is required to connect loads with over 100mA continuous drain to the load-shedding system.

Connections using SBG and Load Shedding

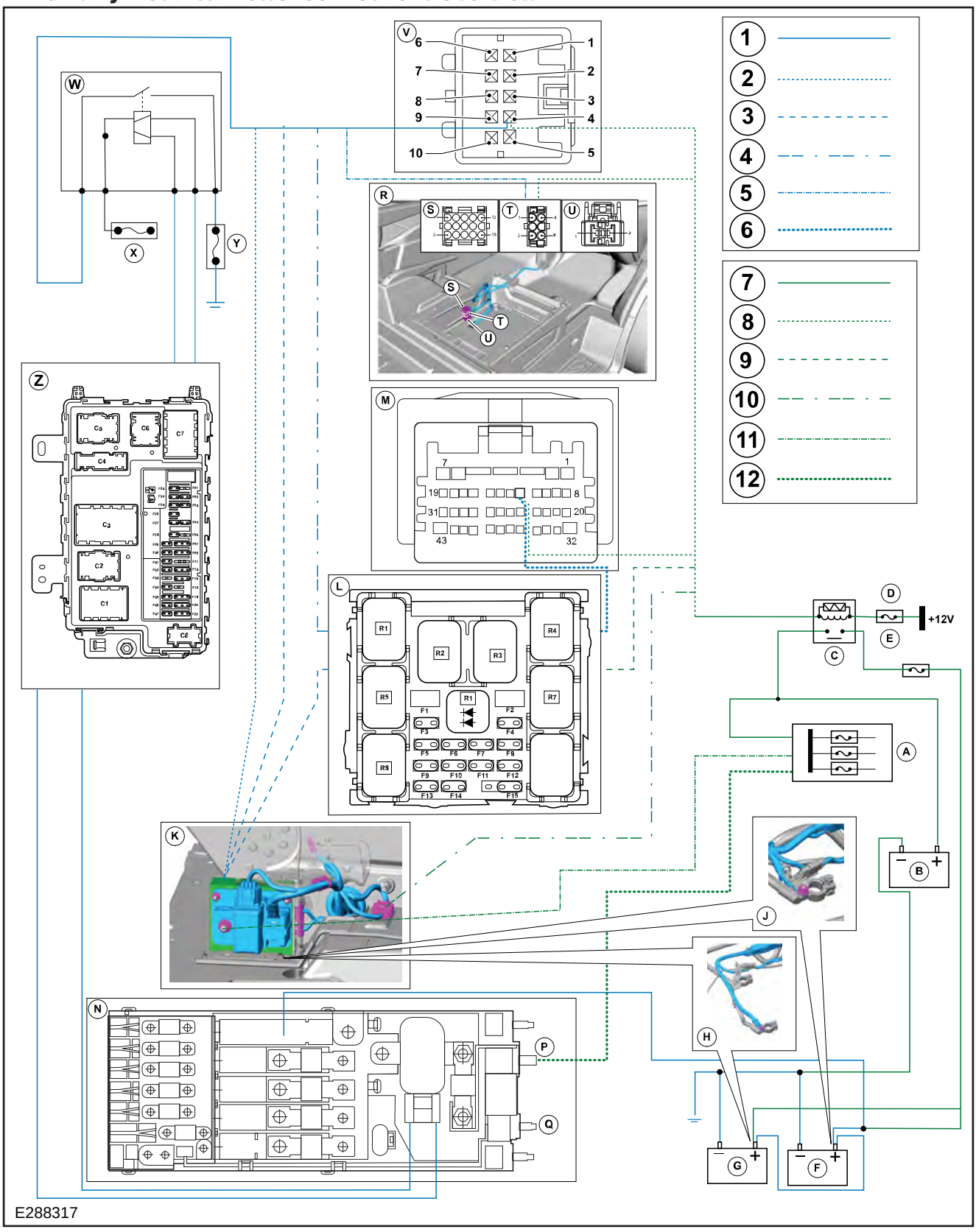
This provides some protection of the battery for parked vehicles, and some protection of system voltages when the vehicle is running.

Regulation by load-shedding is required where total added electrical load is over 60A. Regulation by load-shedding is also optional for connections totalling less than 60A.

Load-shedding for third party systems is to be installed using one of the following 3 methods:

1. **Using the provided third party isolation signal directly.**
   - This is a switched ground system
   - The control wire can supply relay coil currents

Third Party Electrical Power Connections Overview



up to 10A total, for connected third party control relays

- The control signal is routed to the following locations
  - 10-way standard interface connector in the driver's seat pedestal (pin 4)
  - High Specification Interface Connector [A608] [pin 12]
  - The Auxiliary Fuse Panel, cloned, 10-way standard interface connector (A526) (pin4)
  - FPBG (A540) (pin 12)
- Camper 6-way (pin 1)
- The control signal is to be used with a third party relay when Customer Connection Point 2 (CCP2), see below, or FPBG cannot be utilised. This control is also recommended when connecting leisure batteries.

2. Using Customer Connection Point 2

CCP2 is a high current load-shedding connection point to provide robust power availability whilst maintaining vehicle operation

- Loads up to 175A may use CCP2
- CCP2 is provided in any of the below options:
  - Twin battery/heavy-duty battery pack
  - Any High Specification Interface Connector packs [A608]
  - Aux Fuse Panel [A526]
  - Refrigeration [FV]
  - Camper Donor vehicles

3. Using FPBG

Loads up to 200A can utilise the FPGB.

Refer to: 4.7 Battery Protection (page 105).

Third Party Electrical Power Connections Overview - Key

Item	Description	Item	Description
1	Ford Wiring (FW)	G	Front pedestal battery (twin)
2	FW - FPBG less Auxiliary Fuse Panel	H	Twin battery connection
3	FW - FPBG and Auxiliary Fuse Panel	J	Single battery connection
4	FW - Auxiliary Fuse Panel less FPBG	K	FPBG (A540 or A550)
5	FW - with Camper connector (no Vehicle Interface Connector)	L	Auxiliary Fuse Panel (A526)
6	FW - With High Specification Interface Connector	M	High Specification Interface Connector (A608) - Pin 12
7	Third Party Wiring (TPW)	N	High current fuse box^
8	Option connection (Vehicle Interface Connector, High Specification Interface Connector, Camper Connector, Auxiliary Fuse Panel or FPBG) to connect to Third Party control relay	P	CCP2 (175A)
9	TPW - Auxiliary Fuse Panel less FPBG	Q	CCP1 (60A)
10	TPW - FPBG less Auxiliary Fuse Panel **OR** FPBG and Auxiliary Fuse Panel	R	Camper C2 (Y) connector - Pin 1
11	TPW - FPBG (200A)	S	C2-1 - 15 way connector
12	TPW - CCP2 (175A) less FPBG	T	C2-2 - 6 way connector
A	Third Party loads	U	C2-3 - KL30 connector 60A fed from high current fuse box and ground
B	Third Party battery (if fitted)	V	Vehicle Interface Connector - Pin 4
C	Third Party battery control relay (normally open)	W	Slave load-shedding relay (10-20A) - FU5T-14B192-A*
D	Third Party +12 fused KL30 supply	X	2A fused +12V
E	Third Party power supply fuse	Y	10A fused ground
F	Rear pedestal battery (single or twin)	Z	Body Control Module (BCM)

^CCP2 (175A) standard for FPGB and some single SVO Options.

4.7.4 SBG and Load Shedding Functionality

WARNINGS:

Changing configurations may invalidate the vehicle warranty.

Using Third Party High Power mode may invalidate the vehicle warranty.

Ensure the Third Party High Power mode feature does not inadvertently remain active when the battery is being charged by the vehicle.

Use of the Third Party High Power mode feature to override the connection timeout will allow more energy to be discharged from the vehicle battery. Excessive energies cycled through the battery may invalidate battery warranty.

When designing automation of the Third Party High Power mode avoid unintended consequences. If activated when the engine is running, use of Third Party High Power mode can also prevent AEIS, where applicable. Use of Third Party High Power mode can disable this safety feature and leave the engine running. Engines that run in confined spaces cause CO accumulation which can lead to CO poisoning and death. CO can seep into adjacent confined spaces. The AEIS inhibit can be configured off at a Ford dealer.

Standard Battery Guard - Vehicle -Off

Standard Battery Guard (SBG) operates when the vehicle is off. The purpose of the SBG is to protect the vehicle battery from being drained.

It disconnects the controlled third party circuits when the battery is low or after timeout has occurred. Timeout is up to 30 minutes for single-battery vehicles and up to 75mins for vehicles with twin AGM batteries. Twin AGM batteries have a lower SOC threshold and can offer for longer duration.

Refer to: 4.7 Battery Protection (page 105).

Normally the SBG is configured to reconnect at vehicle unlock. The circuits are then connected before the key-crank.

Camper vehicles do not reconnect at unlock. Instead reconnection is delayed to about 3s after ignition-on to allow the vehicle to be cranked first. This is intended for vehicles with Gel batteries. With this configuration, the third party load-shedding circuits are disconnected as soon as both the key is out and the driver door is opened. Other non-Camper vehicles can be configured the same, by a Ford dealer.

The Third Party High Power Mode inhibits the timer so the SBG monitors for low SOC only. The user must ensure the Third Party High Power Mode is not used during normal drive cycles except where required for third-party equipment.

Refer to: 4.4 Charging System (page 80).

The SBG does not offer warning if an external charger is connected to the vehicle. It will not automatically connect all batteries if an external charger is applied. Please see FPBG for these features.

If extra functionality is required, or up to 200A, consider using the FPBG (A540).

Load Shedding - Vehicle -On

In rare situations of very high electrical demand, it is necessary that the system can act to prevent the voltage from becoming too low. Essential loads, including some 3rd-party loads, will never be shed. Loads totalling over 60A must be connected to the Load-Shedding function.

The ability to do Vehicle-On load-shedding is required in order to be able to prevent too low voltage during driving.

Short Term Disconnection - Contributing Factors

- Extreme environmental conditions
- High system electrical load at or already exceeding power supply capacity – including third party loads
- During short term high transient loads, such as inrush currents

If the system voltage drops very low, disconnection of the controlled third party loads may occur. This will be for a minimum of 4 seconds.

If load-shedding occurred, third party equipment may be reset and may re-initialise.

For Battery configuration

Refer to: 4.6 Battery Systems (page 91).

Driver Notification

Driver Notification Instrument Cluster Notification is provided to alert the driver that third party connections have been reset, and that this may indicate an overload condition has occurred.

A customer information message is displayed briefly on the Instrument Panel Cluster (IPC). The message is “Electrical Power Saver Active Features Turned Off”.

Where the warning occurs frequently, it is recommended to review the Power Supply requirements, and additional generating equipment may be required.

No message is given when power is restored. If CCP2 or FPBG is fitted an audible click may be heard from the driver’s seat area.

Longer Term Disconnection

If the 12V SOC is very low when load-shedding occurred, the load-shedding will remain active until the 12V SOC has been raised significantly. This will take longer in cold conditions or with old batteries. This condition inhibits activation of Auto-Park-Assist.

After a Flat Battery

An indication of continuous flat batteries is that the SBG has not been utilised.

If the battery is low, there is increased probability of load-shedding occurring.

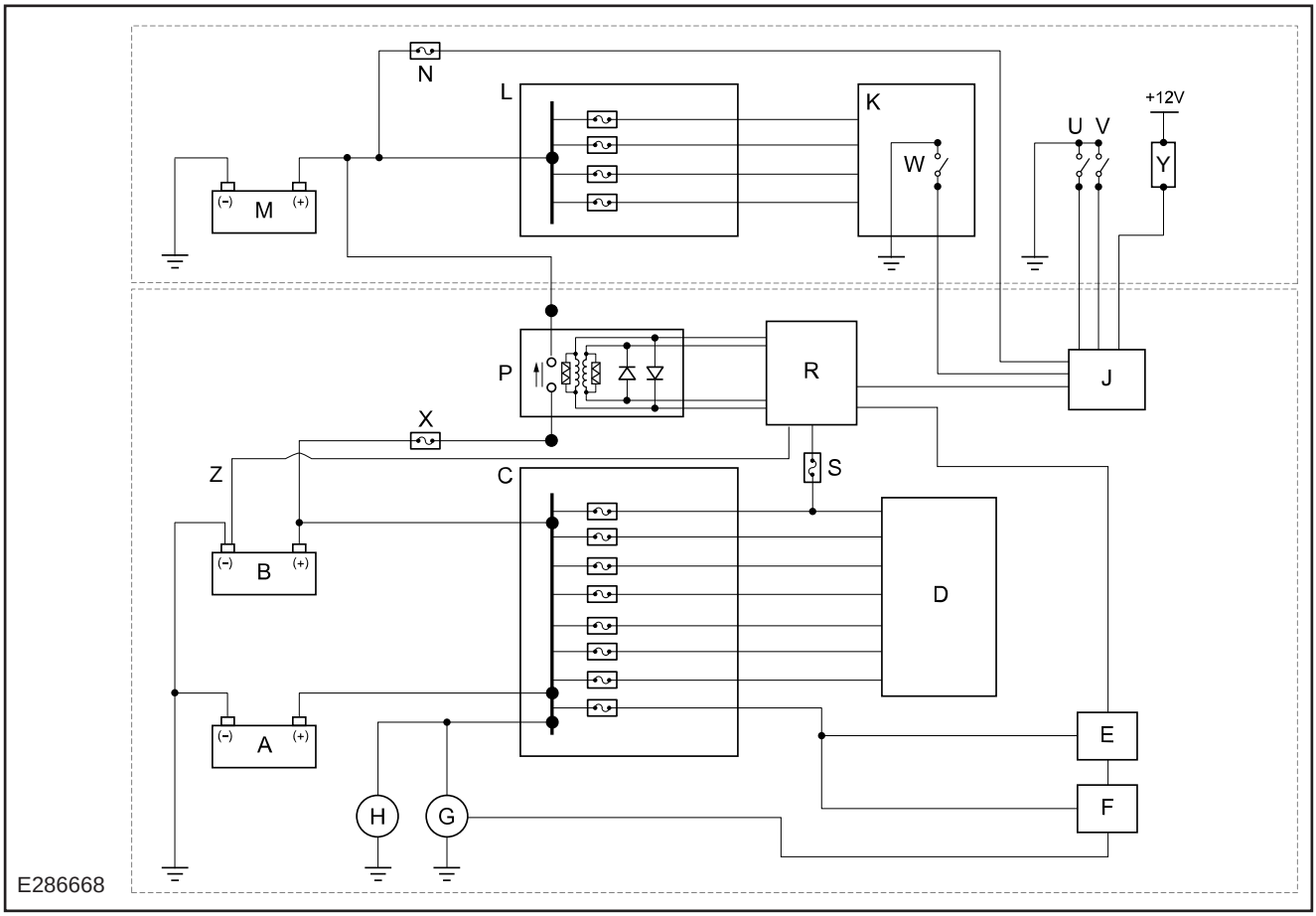
4.7.5 Ford Programmable Battery Guard GEN2 (A540)

WARNINGS:

The maximum fused current on the Ford Programmable Battery Guard (FPBG) is 200A. Continuous current capability depends on the third party system and conversion.

The Battery Guard may isolate the Third Party system at engine run or engine off. If sensitive equipment is installed on the Third Party system, the Vehicle Converter needs to ensure protection is in place for power disconnect.

System Overview



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

The system cannot be ordered with Ford 150W Power Inverter.

NOTE: Vehicles should always use a battery guard if engine off power is required. A540 is recommended.

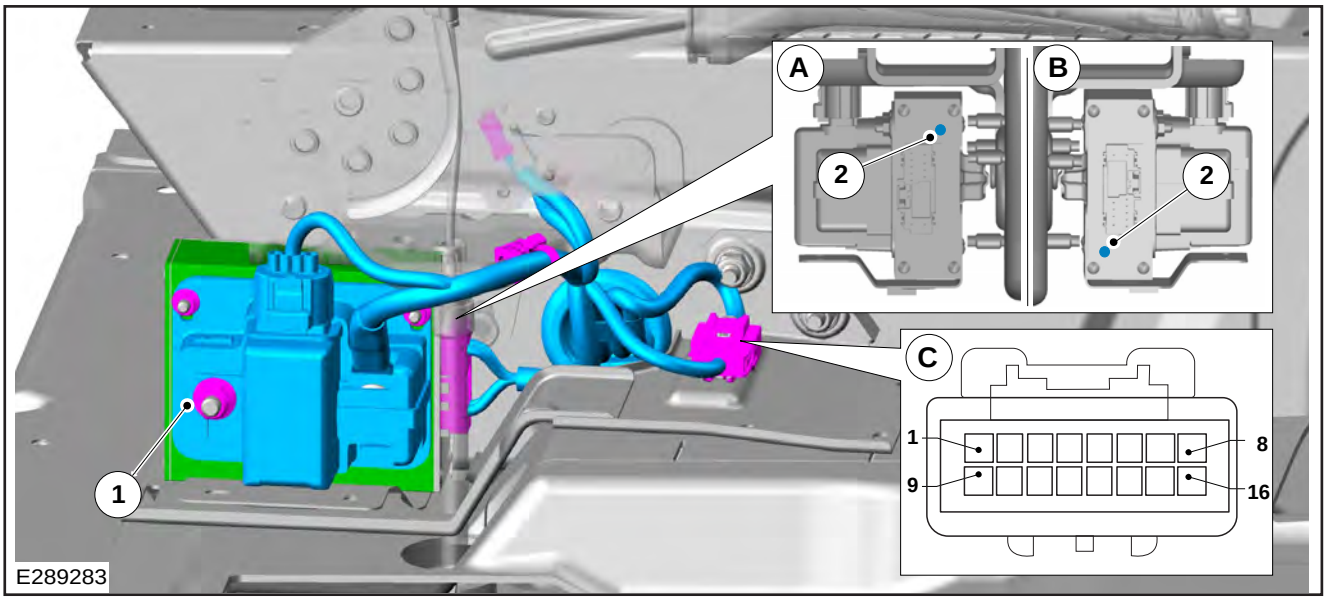
NOTE: For further information please contact your National Sales Company representative or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

FPBG System Overview

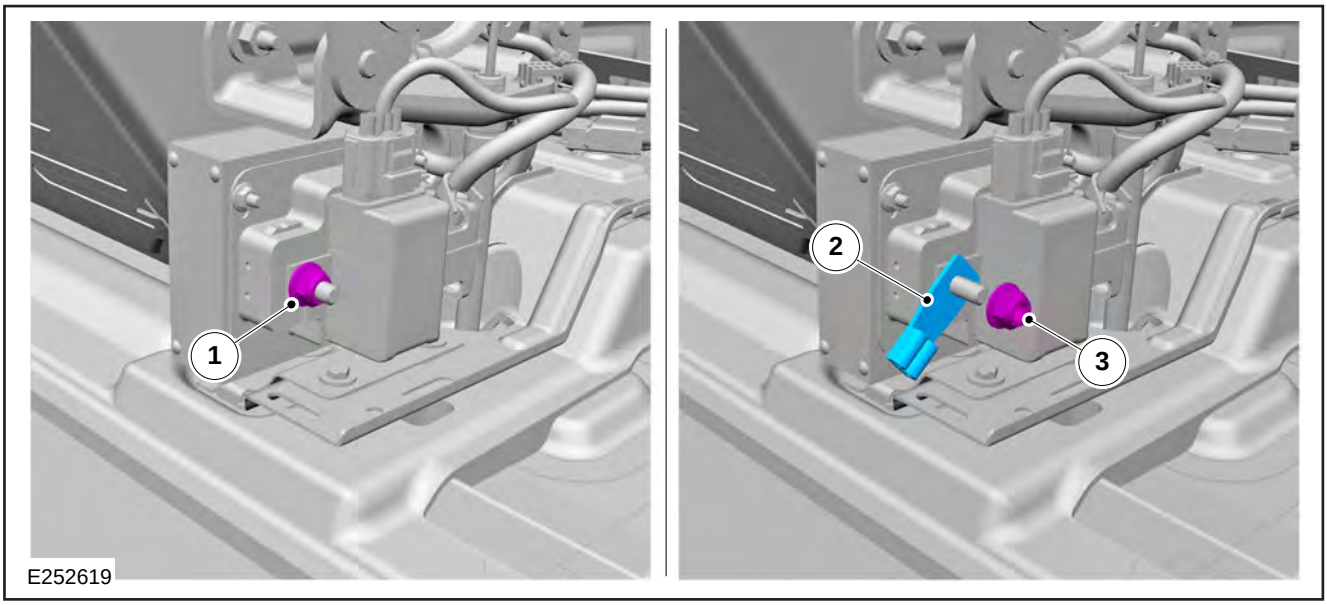
The Battery Guard is the intelligent power management system that provides engine run and engine off power for Third Party electrical systems, see figure E286668 System Overview.

Third Party System Connections

Third party systems must be connected to the FPBG as per below instructions. The FPBG connections are located under the handbrake lever. They are accessible when the handbrake shroud top and bottom are removed.



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



Power Connections

The FPBG Power Relay secondary terminal has a M8 stud and nut for Third Party Power connection.

1. Remove the M8 nut
2. The Third Party power cable eyelet needs to be seated onto the stud
3. The M8 Nut needs to be tightened to 12Nm ±1.8Nm

Signal Connections

The FPBG Interface Connector has the signals in the next table available to use in third party electrical system.

FPBG Interface Connector Pin layout - See E289285

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

Any pins not listed in the table above are not to be used.

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

1. Remove the FPBG Interface Connector
2. Undo the spiral and spot tapes around the wires behind the connector. Locate the blunt cut signal wires with heat shrink on the end
3. Cut the heat shrink, strip the insulation
4. Use a U-shape crimp and heat shrink when making the connection to the third party wiring. Do not solder the crimp

Functionality

- **State of Charge Protection:** The FPBG isolates the power relay when the vehicle batteries lose charge under certain State of Charge (SoC) percentage. That will ensure vehicle preserves cranking capability. In order to avoid issues on cranking, it is recommended to charge batteries via mains charger or engine run, after a SoC disconnect.
- **Wire Temperature Monitoring:** The FPBG isolates the power relay when power cable temperatures rise above a certain temperature to avoid thermal issues on the cables. It is recommended to leave the system at rest for at least 10 minutes if a wire temperature disconnect happens.
- **Alternator Protection:** The FPBG isolates the power relay if the voltage level drops below a certain threshold at engine run to protect the alternator. The system will reconnect automatically after 4 minutes if the system voltage recovers.
- **Mains Charger Support:** The FPBG will automatically detect connection of a mains charger to share the charge across all batteries in the system including the third party battery. The FPBG will still detect and react if the mains charger is applied onto the third party battery.
- **Third Party Battery Charge:** The FPBG monitors the third party battery voltage at engine off and activates a Conventional Charge state if the third party battery needs charging.
- **Load-shedding:** The FPBG accepts the BCM as master on the load-shedding signal at engine run. When the BCM requests third party loads to be disconnected, the FPBG will immediately disconnect until the BCM disconnect command disappears. The FPBG is the master for disconnecting the third party loads at engine off
- **SVO Fuse Box Control:** The FPBG controls the SVO fuse box at engine run (except BCM signal as master for EPAS load-shedding) and engine off. The main power relay status will be replicated onto the SVO Fuse Box control output signal. Therefore, if the main power relay is connected, the SVO Fuse Box will also be connected. Otherwise, they will both be disconnected.
- **Engine Run Signal:** The FPBG provides a 1000mA low side driver engine run output for third party systems. The signal can be used to indicate the engine run status to the third party equipment.
- **Third Party High Power Mode - SRC/Start-Stop/AEIS Inhibit/SBG Timeout Inhibit:** The FPBG sends a third party high power mode signal to the vehicle in order to inhibit the functions temporarily.

There is a ground input available on the Interface Connector for the user to inhibit those features by connecting the input to the ground when needed by the third party device. The feature controls voltage into a narrow bandwidth of 13.5V to 15.25V where SRC varies between 12.2V to 15.2V. The Third Party High Power mode feature must not be used permanently. The FPBG also sends temporary inhibit signal to charge third party battery when needed. The feature must be used for heavy current applications at engine run to avoid voltage drop issues.

- **Immediate Relay Open:** The FPBG will open contacts immediately if the immediate relay open input is connected to the ground. It is not recommended to use the feature as a safety switch. The feature will only work if the module and connections are properly made. For protection, it is recommended to use a separate safety switch.
- **Immediate Relay Close:** The FPBG will close relay contacts immediately providing the Immediate relay close input is connected to the ground, and immediate relay open input is inactive.
- **Power Isolation/Status Indicator:** The FPBG gives 1000mA low side driver output to indicate the status of the system. The signals are coded to identify the status. Below is the table for the functions and warnings on the output. There is also an LED on the module to indicate the status with colour coded pulses.

FPBG Diagnostic - Operation

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

Green (G), Orange (O), Red (R) and Space (-)

- **Mode Selection with Ignition Cycle:** The FPBG detects the vehicle battery technology automatically. The battery quantity is set to single battery by default. If the vehicle has twin batteries, the user must perform 5 ignition cycles (Ignition 2 – Ignition 0) to set the system into twin battery mode. The relay will click 2 times to indicate the correct mode setup for twin batteries. If the system is updated to a single battery, the mode can be changed to single battery with performing 5 ignition cycles again. The relay will click one time to indicate correct setup to single battery mode.
- **AUTO RPM CONTROL:** The FBPG changes engine RPM automatically to increase alternator efficiency for higher power outputs. This is required when high current electrical demand causes voltage drop in the system and engine idle speed is not enough for the alternator to provide the required voltage. The feature is provided with blunt cut wires on the FPBG Customer Interface Connector. The Vehicle Converter needs to complete the system as per the below instructions:
- There are two RPM control pins (RPM Control 1 and 2 - Pin 5 and 6) that needs to be connected to the RPM loop wire from the vehicle. In order to ensure correct pin connection, the voltages need to be checked between the pins after connection. The voltage needs to be 4.34V when the feature is not activated and 4.65V when feature is activated. If the voltage is 1.84V the connection needs to be reversed.
- There is one RPM activation pin (Pin 15) that needs to be switched to ground to activate and open circuit to deactivate the feature. Switched ground connection needs to be completed by the Vehicle Converter.
- When the system is activated and RPM control pins are connected to the RPM Loop wire, the system will automatically increase RPM one step in after 1 minute if voltage stays below 14.0V. The pre-set RPM values are 1100-1600-2030. If the RPM is elevated and voltage stays above 14.5V for 1 minute, the system will step down RPM until idle is reached.

4.7.6 Retrofitting a FPBG

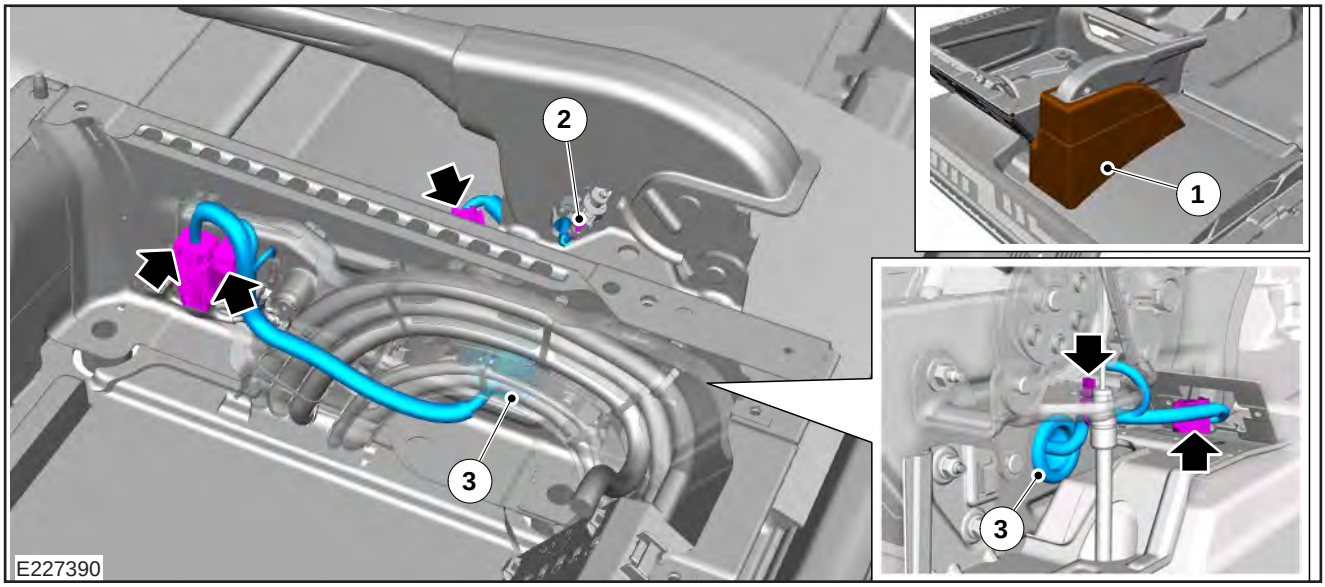
WARNING: The system cannot be ordered with either a Ford 150W or 400W Power Inverter.

Vehicle Preparation

- The FPBG is compatible with the 10-way connector
- The handbrake shroud top and bottom needs to be removed
- The handbrake jumper wiring needs to be removed. Please refer to figure E227390

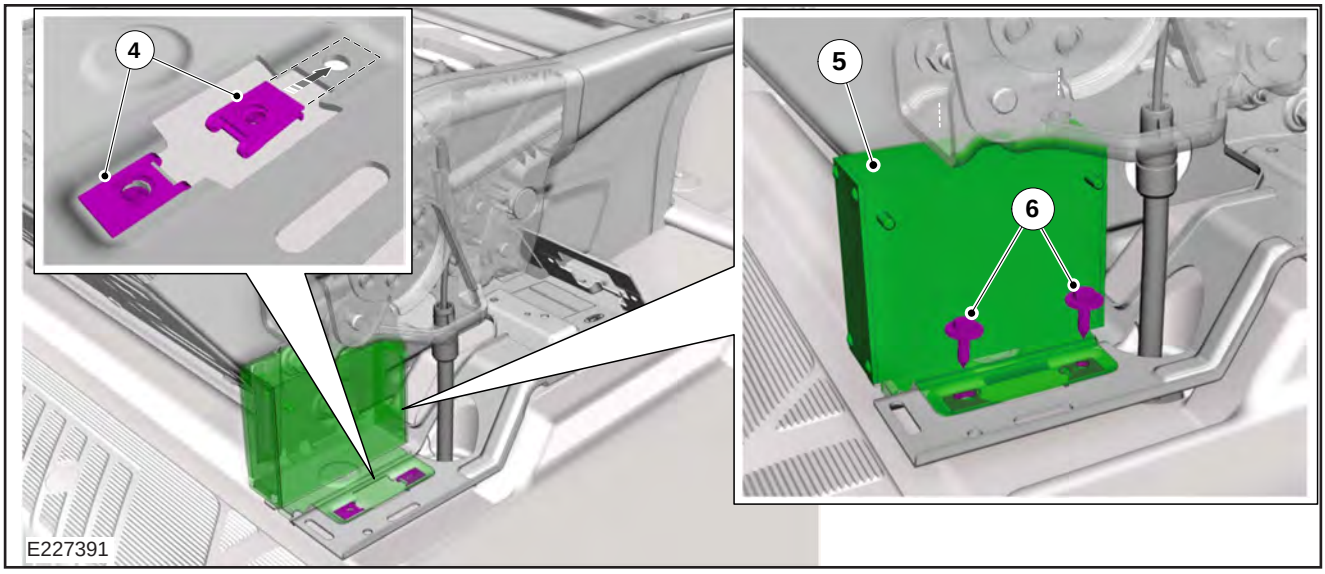
System Check

The system status can be checked via the LED on the module near the connector, if Green is pulsed, the system is OK. If any other status codes are received, refer to the POWER ISOLATION/STATUS INDICATOR table in this section for the code you observe.



Item	Description
1	Remove Handbrake Console
2	Disconnect the handbrake lever connector
3	Remove grommet, disconnect connectors, fir tree clips and tie wraps. Dispose of Harness.

Module Fitment

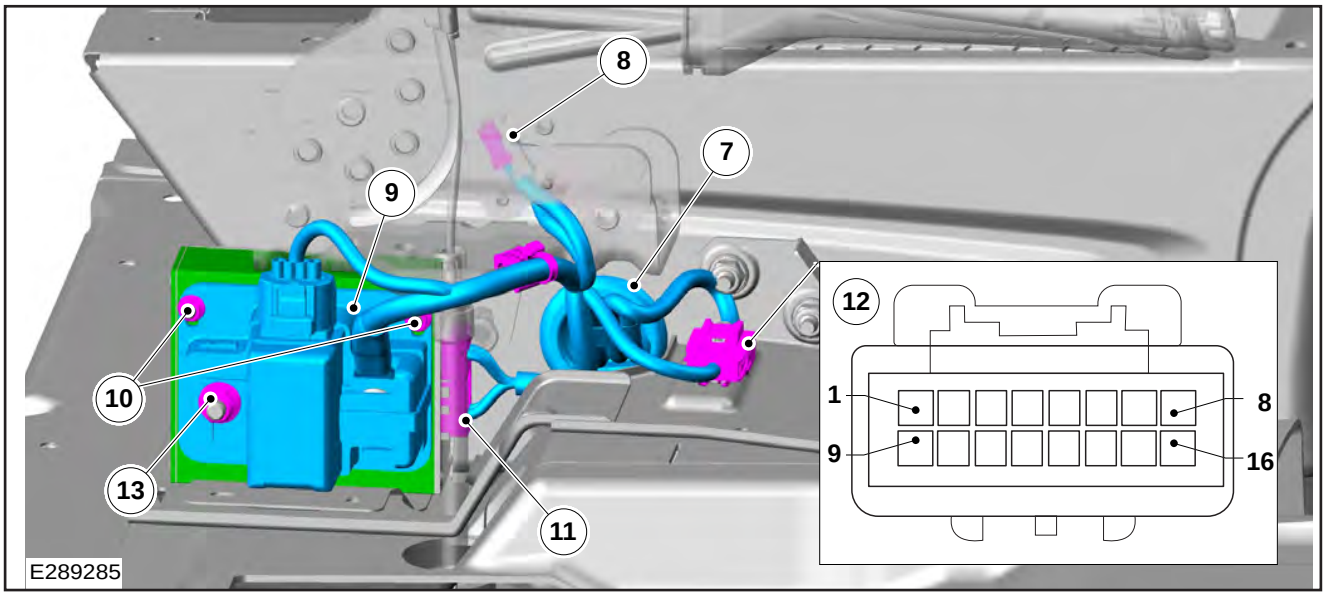


Item	Description
4	Fit 2 x U nuts
5	Fit Module (part number)
6	Secure Module with 2 x screws - torque 3.2Nm ± 0.5Nm

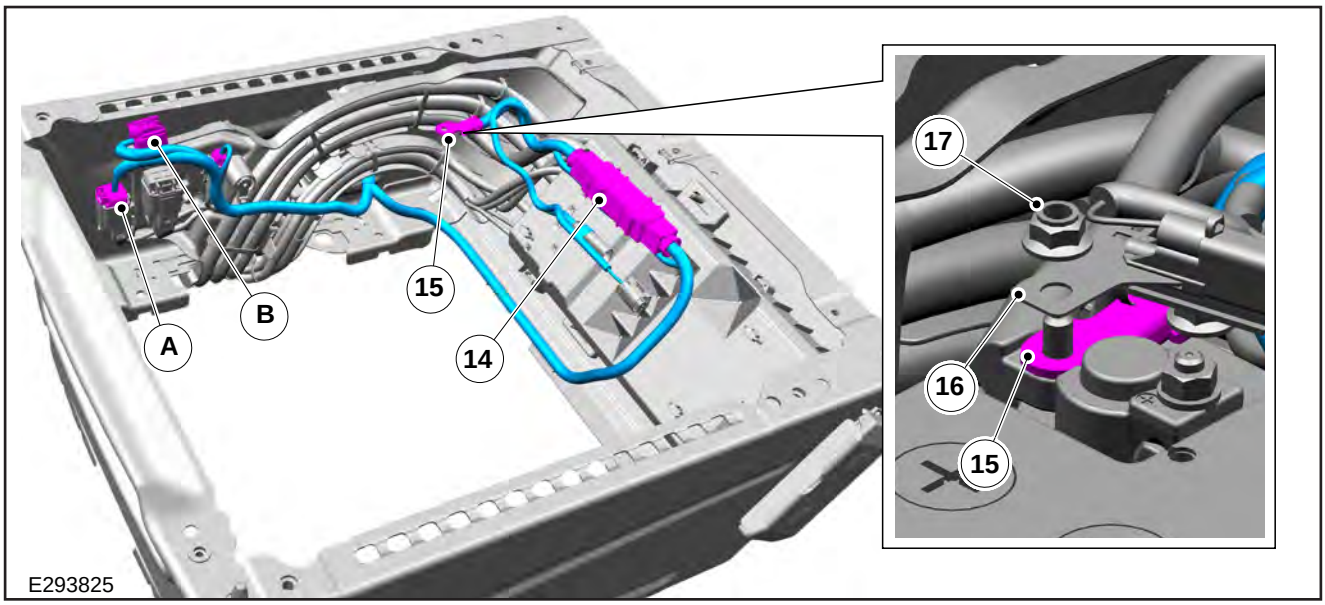
Module needs to be fitted with 2 x U-Nuts and 2 x Screws

Harness Fitment

Harness needs to be fitted onto the module and routed inside the pedestal.

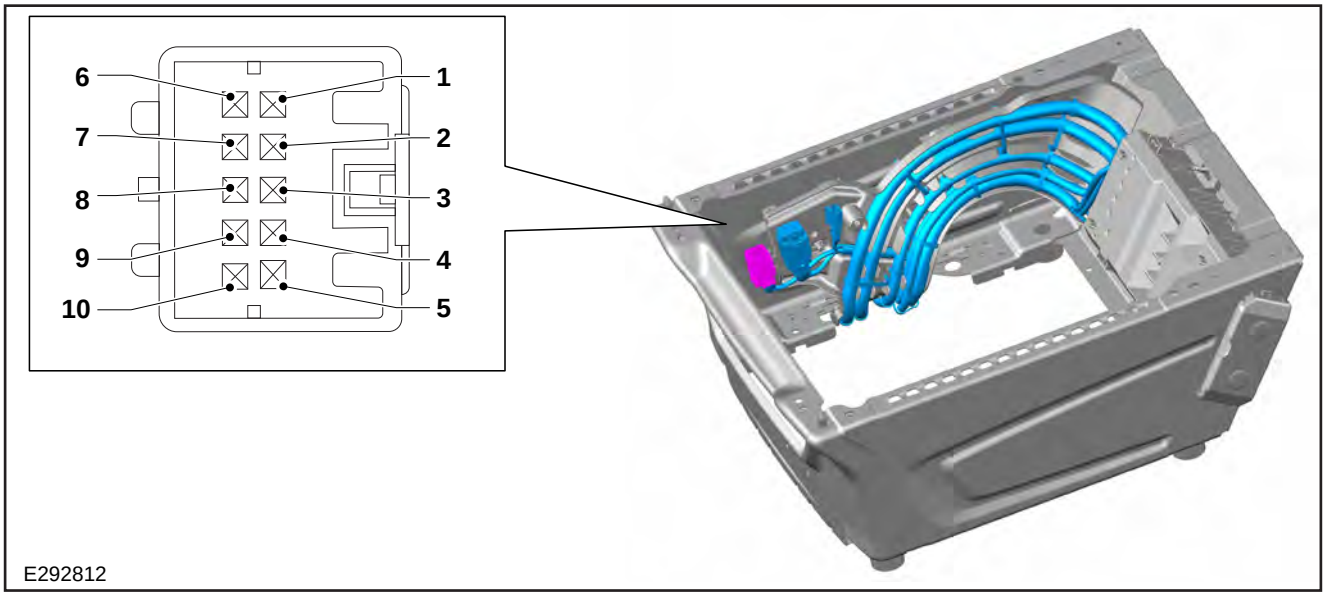


Item	Description
7	Route Harness GK2V-15K857-** through the driver's seat pedestal, making sure the grommet is seated/sealed properly making sure the harness does not obstruct or interfere with the handbrake cable and assemble edge clip to handbrake bracket.
8	Fit Handbrake Connector
9	Fit Relay Holder
10	Secure Relay Holder with 2 x M5 Nuts - Torque 3.2Nm ± 0.5Nm
11	Fit Module Connector
12	FPBG Interface Connector - Mating Connector face view
13	FPBG Power Connection - Relay Terminal Nut - Torque 12Nm ± 1.8. See also figure E252619



Item	Description
A	Connection without SVE Fuse box
B	Connection with SVE Fuse box
14	200A Mega Fuse - Route and connect harness as shown in E289285
15	Battery Positive Eyelet
16	Battery Monitoring Sensor
17	M6 Nut - Torque 8.0Nm ± 1.2Nm

Vehicle Interface Connector



FPBG - Additional Information

- The FPBG GEN2 is fused at 200A. If required, the Mega Fuse can be down-rated by the Vehicle Converter.
- Normal operation may lead to a click sound when opening and closing power relay contacts. The end operator may need to be advised of this condition
- The main +12V feed supply is taken from the main Ford battery cable. It is not permitted to touch this interface. If further PTO is required, it must come from the CCPs

Refer to: 4.24 Electrical Connectors and Connections (page 158).

- If continuous heavy load usage is required, the following values and duration will be observed. The system will disconnect automatically to protect the wiring:
  - Up to 120A = Continuous
  - 121A to 140A = 20 to 26 minutes
  - 141A to 160A = 14 to 20 minutes
  - 161A to 175A = 8 to 14 minutes
  - 176A to 200A = 6 to 12 minutes

- The system will automatically disconnect loads for approximately 10 minutes for the cool down after allowed maximum wire temperature is achieved. Different system conditions may lead to a longer waiting period and shorter usage durations, for example: wiring cross sectional area, cable length and impedance in the system. It is recommended that the Vehicle Converter tests the finished system to calculate the usage duration and cool down period.
- The 200A Mega fuse on the FPBG has slow blow characteristics which allow short term higher currents. Example: 270A = Min 30/Max 1800 seconds. Contact vcas@ford.com for system specific questions.
- The FPBG System can also be ordered as part of the Converter High Power Pack (A550)
- Mains chargers must be of the multi-stage type (including trickle charge) and be checked for performance before installation as the system will connect all batteries to the charger
- Before performing power and signal connections, the Vehicle Converter must unpower the system to avoid risk of contact +12V and the vehicle body
- Under heavy load applications, total system impedance should be calculated to design for voltage drop conditions. The power supply cable should be added as short as possible and to the correct cross-sectional area

Refer to: 4.1 Electrical System Overview (page 61). For the Wiring Specification table

4.8 Climate Control System

WARNING: Do not use propylene glycol based coolant.

NOTE: The Transit Custom Climate Control system utilises shared components from other vehicles, which may have higher feature levels and systems. Therefore, in addition to pins that are not used generally, there are others that are not available and could impede function or cause damage if connected for external use.

- 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. Utilise guards to protect against cutting or chafing

4.8.1 Front Climate Control System

J1 Climate Control System Pin-Outs

Pin	Description
1	Ground
2	Voltage reference return
3	Voltage reference
4	Third Party High Power mode (For Vehicle Converter use)
5	A/C request (For Vehicle Converter use)
7	Rear Defrost output
8	Left Temp door feed 'A'
9	Left Temp door feed 'B'
10	Left Temp door feedback
11	Front Blower relay output
14	Eco/Selectable Drive Mode Input
17	MS1-CAN Bus High
18	MS1-CAN Bus Low
19	Evaporator Temp Sensor input
20	Mode Door #1 feed 'A'
21	Mode Door #1 feed 'B'
22	Mode Door #1 feedback
23	Front Blower Controller PWM Command output
24	Recirc Door feed 'A'
25	Recirc Door feed 'B'
26	Battery Power Supply (+12V)

Any pins not listed in the table above are not to be used.
PTC= Positive Temperature Coefficient, NTC= Negative Temperature Coefficient

J2 Climate Control System Pin-Outs

Pin	Description
1	Voltage Battery left Heated Seat Element supply
2	Voltage Battery right Heated Seat Element supply
6	PTC PWM output
12	Heated Windscreen right Relay Driver
15	Right Heated Seat NTC Sense
16	Left Heated Seat Element output
17	Right Heated Seat Element output
23	Start-Stop Disable Button input
24	Start-Stop Indication output
28	Heated Windscreen left Relay Driver
30	Left Heated Seat NTC Sense

Any pins not listed in the table above are not to be used.
PTC= Positive Temperature Coefficient, NTC= Negative Temperature Coefficient

4.8.2 Rear Climate Control System

J2 Climate Control System Pin-Outs

Pin	Description
1	PWM Signal Blower
2	Temp Door 3
3	Temp Door 1
4	Mode Door 3(1)
5	Mode Door 1(1)
8	Ground
9	Mode Door Power Supply (KL30)(1)
10	Ignition Signal (KL15)
11	Battery Power Supply (+12V)
14	PWM Signal Blower(2)
15	Temp Door 4
16	Temp Door 2
17	Mode Door 4(1)
18	Mode Door 2(1)
23	Temp Door Power Supply (KL30)
24	Backlighting Illumination (KL58)

Any pins not listed in the table above are not to be used.
(1) FWD Only
(2) RWD Only
PTC= Positive Temperature Coefficient, NTC= Negative Temperature Coefficient

4.9 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 Colour	
2	Fuel Level Sensor Return	Green/Blue	-
3	Ground	Black/Violet	-
4	Switch - Transmission Park Detect	Green	-
8	12V Power	Grey/Red	-
10	Fuel Level Sensor	Yellow/Violet	-
11	Switch - Low Level Washer Fluid	Grey	-
12	CAN Bus High Speed -High	Green/Blue	Twisted pair
13	CAN Bus High Speed -Low	White/Green	

Any pins not listed in the table above are not to be used.

4.10 Horn

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

4.11 Electronic Engine Controls

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

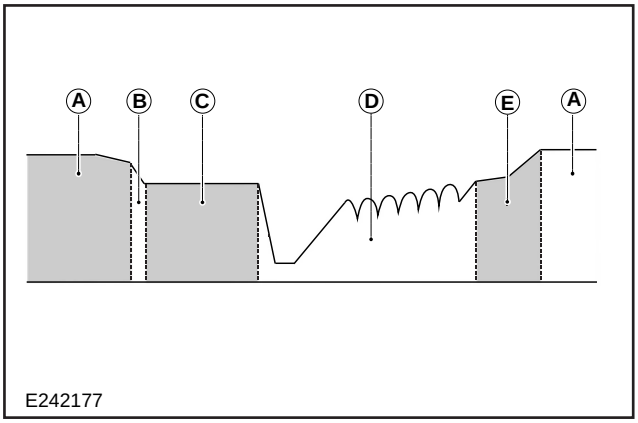
NOTE: It is not necessary to disconnect or remove engine management modules.

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

4.11.1 Cranking and Warm Cranking

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

4.11.2 Start-Stop

WARNINGS:

If required by the system, the Start-Stop function may be deactivated which will lead into an automatic restart of the engine. In normal conditions the engine will automatically restart only if the clutch or accelerator is pressed.

Switch the ignition off before opening the bonnet 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 electrical loads connected with the ignition off unless they draw less than 100mA.

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

General Information

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

Start-Stop Logic

Automatic engine stops and restarts are controlled by the Start-Stop logic within the Engine Control Module (ECM). This is connected to a number of vehicle and powertrain signals, sensors and switches and decides when to shut down and when to restart the engine, based on the particular Start-Stop strategy employed.

Stop-in-Neutral is a Start-Stop strategy applicable to manual transmission vehicles which stops the engine, subject to inhibitors, when 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.

Stop-in-Drive is a Start-Stop strategy applicable to automatic transmission vehicles which stops the engine, subject to inhibitors, when the vehicle is stationary AND the transmission is in D AND the brake is pressed AND the accelerator is released. The engine is restarted on brake release or accelerator press. The engine also stops in P (without the brake pressed).

Inhibitors

Sometimes the engine may not shut down or will request auto restart due to one or more system inhibitors being active. The engine will shut down only when all inhibitors are cleared, which may be some time after the transmission/pedal conditions are met.

Typical examples of inhibitors are:

- If the ambient temperature is below the lower limit or above the higher limit for Start-Stop
- Engine coolant temperature not warmed up (value dependent on ambient temperature)
- Heated front screen is on
- Insufficient battery charge to sustain a stop event or too high a current drain or battery is cold or battery failure
- Driver's door has been opened and vehicle has not been driven over 5kph 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 drain exceeds 70A
- Ford Engine RPM Speed Controller System is active
- Unrecognised battery fitted or BMS damaged or removed
- Start-Stop button is pressed (LED illuminated)
- Accelerator pedal or clutch pedal is not released
- Greater than 100mA continuous load at ignition off. The BMS will be unable to correctly assess battery state of charge
- Vehicle in Factory or Transport mode
- Third Party High Power mode has been set

Stall Recovery/Start Abortion Recovery

Stall Recovery is an additional feature available with Start-Stop on manual transmission vehicles, 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 Deselection - Start-Stop button with LED illuminated

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

Refer to: 4.4 Charging System (page 80).

Vehicle Modification Considerations

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

Impacts to Start-Stop Behaviour

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 shut down only if the current drain is less than 70A. High current loads may lead to this threshold being exceeded. In addition, engine stops will be inhibited if the battery state of charge is below 68%, which may occur if added electrical loads are active during key off periods. When installing extra peripherals, be aware of the continuous/quiescent current drain of such equipment, even when in Off or Standby mode. Any module should not draw more than 5mA 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 engine off but total key off load including Ford systems must not exceed 90mA.

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: 4.6 Battery Systems (page 91). Battery Monitoring Sensor

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

Refer to: 4.4 Charging System (page 80). 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 the transmission shift mechanism. To avoid compromising the safety of the system, no electrical connection should be made to any of these signals.

Impacts from Start-Stop System

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

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

The SVO 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 CCPs. Converter fit loads must not be connected to the vehicle start battery, on a twin battery system.

Using the Start-Stop Button

For vehicles with alternators only, the Start-Stop deactivation button also deactivates SRC when pressed (when LED tell-tale is illuminated). When SRC is deactivated, and the vehicle is stationary, the engine will not shut down and the battery will be charged by the alternator with Conventional Charging. The function has a delay of a few seconds before taking effect.

Automatic Engine Idle Shutdown (AEIS)

WARNING: AEIS is a safety feature to turn off engines after a set time. Carbon Monoxide (CO) can accumulate from engines left running in confined spaces. CO is poisonous and can lead to death. Using the Third Party High Power mode in this condition may inhibit AEIS, disabling this safety feature. Avoid using the Third Party High Power mode AEIS-inhibit in confined spaces.

AEIS may be inhibited by the Third Party High Power mode which will keep the engine running at idle. The Third Party High Power mode has other behaviours during engine run and engine off. Use of Third Party High Power mode at engine run may affect emissions performance and vehicle re-homologation may be required.

Refer to: 4.4 Charging System (page 80).

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

System Overview

NOTE: For RPM speed control with automatic transmission, please contact the Vehicle Converter Advisory Service at VCAS@ford.com where limited functionality can be achieved under certain conditions.

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 and at maximum of 26Nm (in lieu of the 26Nm air conditioning compressor).

The Vehicle Converter should consider any increased engine cooling requirements due to the conversion and running the vehicle's 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). This is the default mode when the option is ordered from the factory
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 25RPM 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). Variable mode can be switched to via entering the 'Learn Mode', alternatively a dealer can select it via Ford Diagnosis and Repair System (FDRS).
3. **Idle Up Speed:** This mode allows the engines normal idle to be increased (in 25RPM 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. Idle up speed mode can only be switched to via a dealer using FDRS tool.

System Availability

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

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

Vehicles which have not been ordered with this feature, may have the feature enabled at a dealer via the Ford Diagnostic Repair System (FDRS). There is a dealer charge for this service.

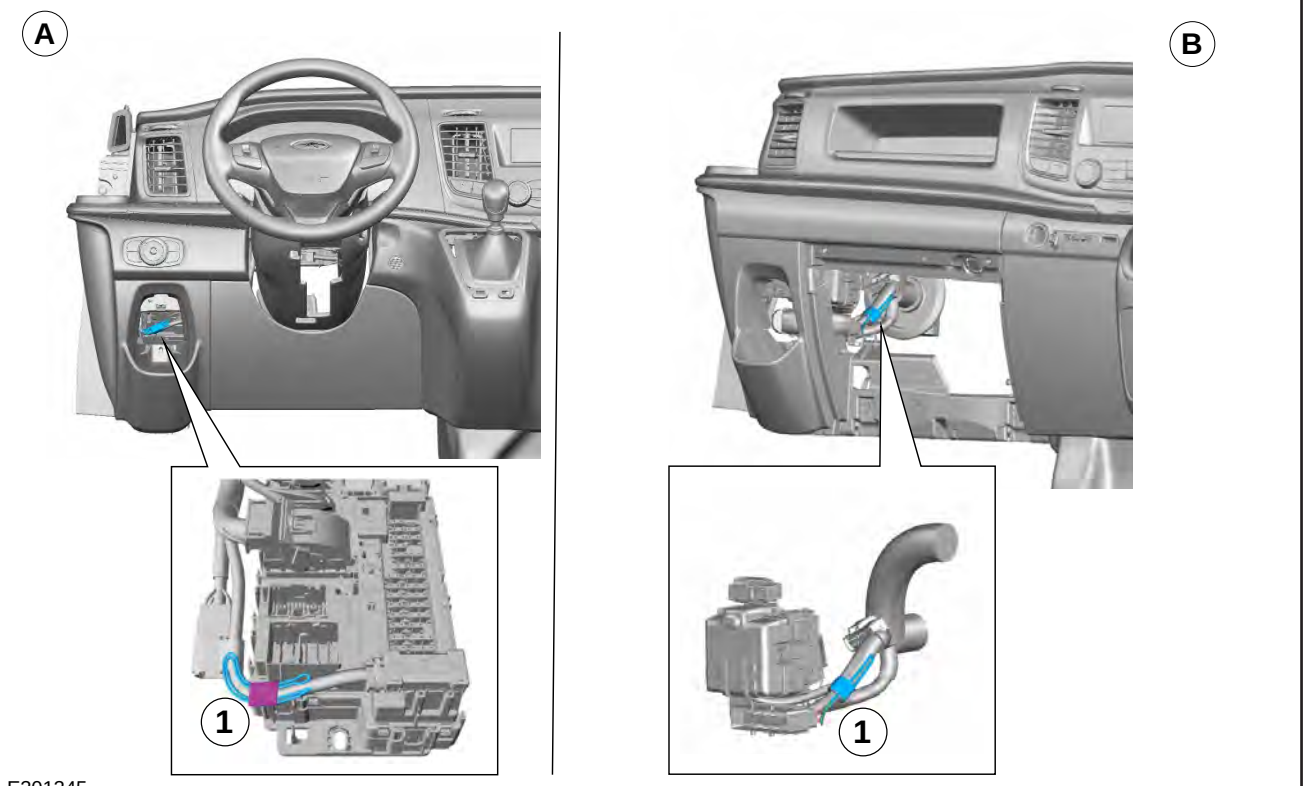
Vehicles fitted with Start-Stop technology may be converted to RPM speed control, however, the customer should turn Start-Stop off prior to starting RPM speed control. For more information refer to 'Impacts from Start-Stop System' in this section.

How to Control this Feature

NOTE: Ford does not supply the Control Box.

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

Loop Location



Item	Description
1	RPM Loop wire
A	Left Hand Drive
B	Right Hand Drive

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 resistances 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 Vehicle Converter chooses to locate the switch box in a location which is subject to an adverse environment, then the Vehicle Converter should design the switch box to withstand with these conditions.

On left hand drive vehicles, the loop is taped to the harness feeding the fuse/relay box, located behind the lower instrument panel trim to the left of the steering wheel, this can be accessed through the bottle holder, see (A) in figure E301345. Refer to Workshop Manual for removal of trim.

On right hand drive vehicles (B) the loop is taped to the harness which feeds the 64 way main instrument panel connector, located behind the lower instrument panel trim, which can be accessed through the glovebox, see figure E301345. Refer to Workshop Manual for removal of of trim.

Resistance Ladder

The resistance ladder circuit acts as a potential divider. The PCM has an internal reference voltage of 5V. Current passes through an internal 320ohm resistor (not shown above) prior to passing through the resistance ladder. There is also a (second) 220nF capacitor internally within the PCM between the 320ohm resistor and ground (not shown above) and this is to reduce EMC effects.

To ensure robust operation, it is recommended for all switches that a switch debounce specification is chosen as close to 0ms as possible.

Starting from the right of the diagram, when the key switch is closed only 2110ohms is in the circuit and the PCM software regognises this as the RPM mode being armed and ready for operation (key switch closed = off, open = on). A key switch is recommended in this position 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 vehicle's engine will stall and therefore, the vehicle cannot easily be driven away and stolen. For latest software update, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

When in 3 speed mode, pressing any of the middle 3 switches (with the feature armed) results in the engine RPM jumping to the corresponding RPM value held in memory (defaults of 1100, 1600 or 2030RPM) for the 3 switch positions. A second consecutive press of the same button returns to normal idle.

When in variable speed mode the same 3 buttons act as ramp up, ramp down and return to idle selections respectively.

The software in the PCM responds to the change of state, so it is recommended that these 3 middle switches be non-latching push button micro switches. When going from idle to an elevated RPM the execution of the command will occur as the button is released. When going to idle the execution of the command occurs as the button is pressed.

The final button (the one on the left in figure E88295) acts as a vehicle engine stop. It is recommended that this be a red and oversize non-latching micro switch button. The execution of this command will occur as the button is pressed.

All wiring connecting the PCM to the resistance ladder Control Box should be shielded and twisted (33 twists/m) to reduce EMC effects.

All resistors should have a tolerance of ± 5% or better.

Switch contact, connectors and loom (loom between the green/white wires and the Control Box) total resistance must be no greater than 5 ohm max.

The PCM to resistor ladder control switch box loom should not come within 100mm of any other harness, especially any carrying heavy loads.

Designs which do not require all the button switches must still have the complete resistor network with the switches positioned correctly within the network.

A suitable two way quality connector should be used to connect the Control Box to the 2 green/white wires.

How to Change the Default Settings

NOTE: It is not possible via either method below, to change the step value of 25RPM per press or the 250RPM per second for a held down button, in the variable RPM speed.

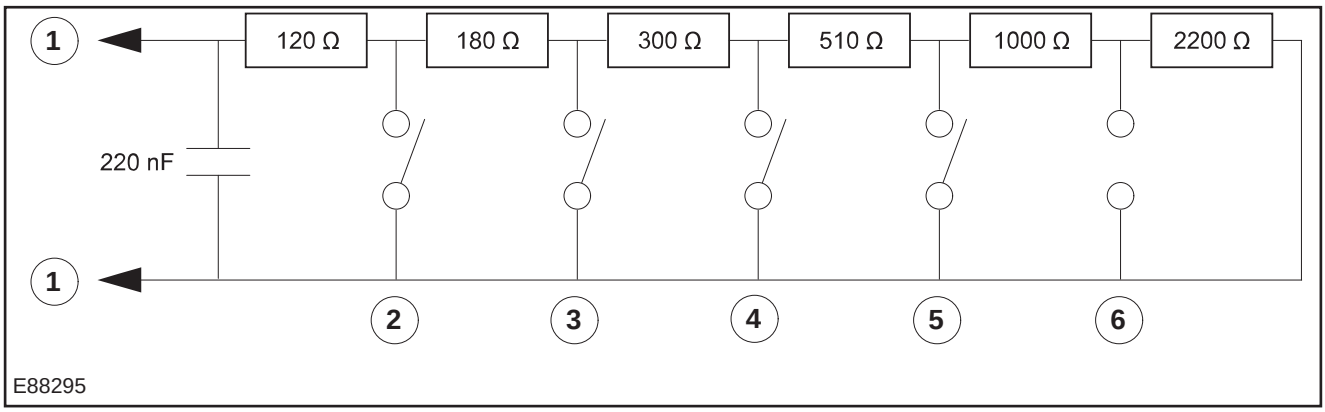
By default, when the feature is first enabled (either via factory order or via dealer using a FDRS tools), it will be set to the 3 speed mode of operation with preset RPM values of 1100, 1600 and 2030RPM for the 3 speeds.

There are two methods by which these defaults can be modified:

1. Via a FDRS at a Ford dealer (there may be a charge for this)

   Via the FDRS, the mode of operation can freely be changed between any of the 3 principle modes of operation, the feature can even be turned off

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

(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 FDRS, once you have logged into Ford ETIS and performed a 'vehicle lookup' for your vehicle, the RPM Speed Control menu is under 'Vehicle Software' - 'PCM' - 'Configuration' - 'Engine Speed (RPM) Control Configuration'. The FDRS on screen menus will guide the dealer through the options 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 and brake pressed a total of five times sequentially each)

NOTE: Steps 4 to 6 have to be started within 10 seconds of the engine start.

The vehicle should now be in 'learn mode'.

On successful entry into 'learn mode' the engine RPM will momentarily rise up to 1000RPM and drop back to normal idle, which can be seen by monitoring the rev counter needle while performing step 6 above.

How to Select Between Modes

NOTE: If the engine stalls 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 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 engine RPM
7. Release the accelerator pedal
8. Repeat steps 4 to 7 for the remaining RPM buttons.

The three RPM speeds should now be reprogrammed 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 and 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,

Troubleshooting - Reasons Why RPM Speed Control Operation May Stop or Fail to Start

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 inhibit 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 refuelling point
- If there is a MIL warning lamp illuminated, for example ABS/Traction control, then RPM Speed Control may not be possible
- If the vehicle speed exceeds approx 2.5mph while in 3 speed or variable speed modes, then RPM speed control will stop. RPM speed control should normally be operated with the handbrake 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 2110ohms 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 lock 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

4.11.4 Diesel Particulate Filter (DPF) and RPM Speed Control

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 the engine has stopped. This is a potential fire hazard.

The DPF captures soot in the exhaust fumes to improve vehicle exhaust emissions. The condition of the DPF is monitored by the vehicle's electronic systems. Under normal driving conditions a regeneration feature is automatically triggered to clean the filter. If the DPF becomes full, a red engine warning lamp illuminates on the instrument cluster and the vehicle will need to be taken into the local Ford dealer to have the DPF specially purged.

Vehicles fitted with DPF, running under RPM Speed Control with the engine running under load at elevated idle, may produce soot build up over time. With the vehicle stationary, the DPF is unable to start a regeneration event. It is therefore recommended that Vehicle Converters advise operators to break up any long periods under RPM Speed Control operation with some normal driving to permit the DPF to regenerate. Rapid cycling of the engine RPM, while in the RPM Speed Control mode, should be restricted where possible, as RPM transients increase soot generation rate. Where the anticipated use for RPM Speed Control is expected to be for longer durations, it is strongly recommended that the Operator Commanded Regeneration (OCR) option is also specified in conjunction with RPM Speed Control (check with your local Ford dealer for availability of option). OCR allows the driver/operator to manually perform a DPF regeneration while the vehicle is stationary, after confirming that it is safe to do so.

For additional information on DPF Refer to: 3.7 Exhaust System (page 56).

4.11.5 Changing Vehicle Speed Maximum Setting

The Vehicle Speed Maximum Setting can be changed via the IDS menu under the following tabs: Toolbox, Powertrain, Service, Functions, PCM. The IDS on screen menus will guide the dealer through the options and setup.

4.12 Tachograph

NOTE: For further information on fitting a Tachograph, Speed Sensor or Dedicated Short Range Communication (DSRC) Unit please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

It is recommended that any vehicle that requires a Tachograph System is sent to an authorised Continental 'Tachograph Service Centre' (previously known as Siemens VDO) for software installation and calibration.

Ford Motor Company is not responsible for calibration of any tachograph unit.

Details of all recommended service centres can be found on Continental/ VDO web sites. These sites also contain details of current regulations and tachograph operation.

4.12.1 Legislation

WARNING: All tachographs require the same wiring connections as this is controlled by tachograph legislation.

NOTE: Digital Tachograph (DTCO) & DSRC Antenna are a legal requirement under EU regulations 165/2014 from June 2019.

Pin Assignment

For detailed information about pin assignments please contact your National Sales Company representative. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

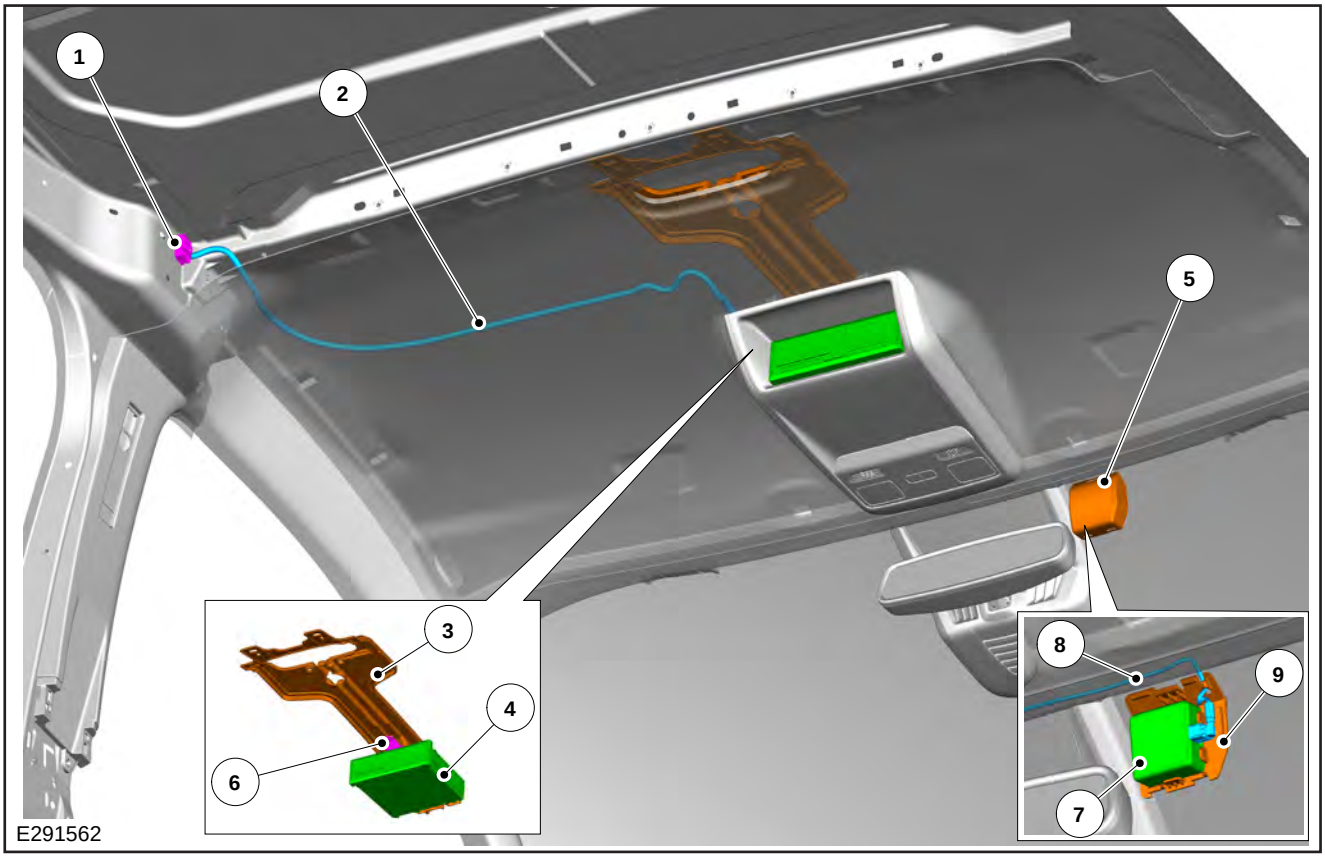
Wiring

The tachograph wiring consists of three parts:

- Speed Sensor Harness, see figure E145371 for harness routing

4.12.2 Tachograph Harness and DSRC

Tachograph and DSRC - H1 LHD shown

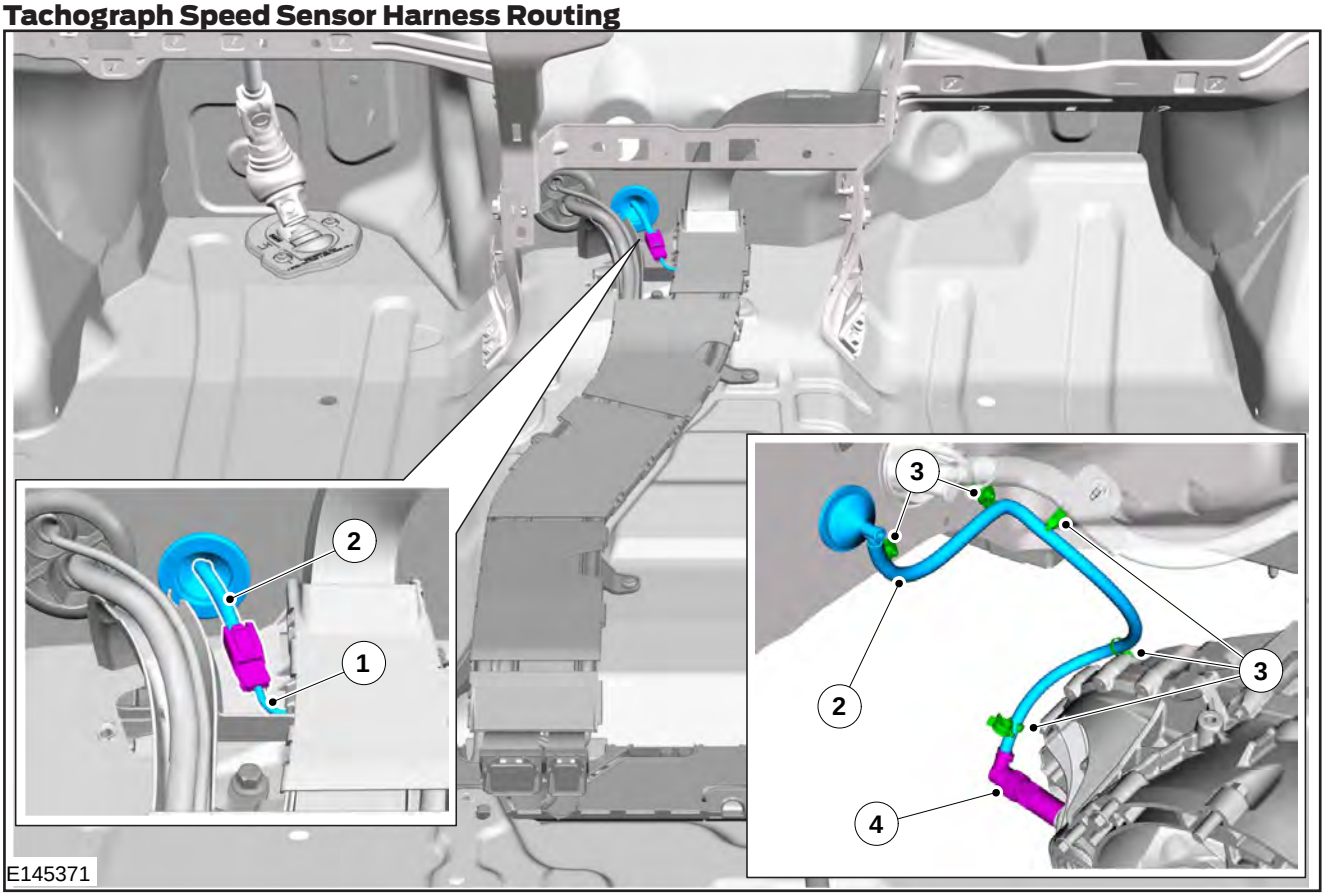


Item	Description	Item	Description
1	In-line connector to main harness	6	Bracket Console Mounting Tachograph
2	Tachograph Harness	7	DSRC Antenna
3	Bracket Roof Console	8	DSRC Harness
4	Tachograph Digital Head Unit 4.0	9	DSRC Carrier - Base
5	DSRC Carrier - Cover		

Standard Ford installation in the overhead console using DIN radio bracket.

- Tachograph Harness, see figure E291562 for mounting and harness routing
- DSRC Harness, see figure E291562 for mounting and harness routing

Tachograph Speed Sensor Harness Routing



Item	Description	Item	Description
1	Main Harness	3	Clips
2	Tachograph Speed Sensor Harness	4	Speed Sensor into Transmission

4.12.3 Retrofitting a Tachograph and DSRC

NOTE: For further retrofitting instructions please contact your National Sales Company representative or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

NOTE: If a tachograph is required, it is recommended that this is ordered on the base vehicle.

NOTE: The base vehicle ordered must have an overhead console and the correct level of trim (headliner) to support fitting a Tachograph and DSRC.

NOTE: If for any reason the DSRC Carrier needs to be replaced or fixed on the windscreen then please refer to the assembly instructions in the workshop manual.

If the system was not ordered on base vehicle then the DSRC Harness will need to be fitted accordingly. Please review the assembly instructions in the workshop manual. It is recommended that the dealership/FORD carries out fitment process for both DSRC Unit & Harness.

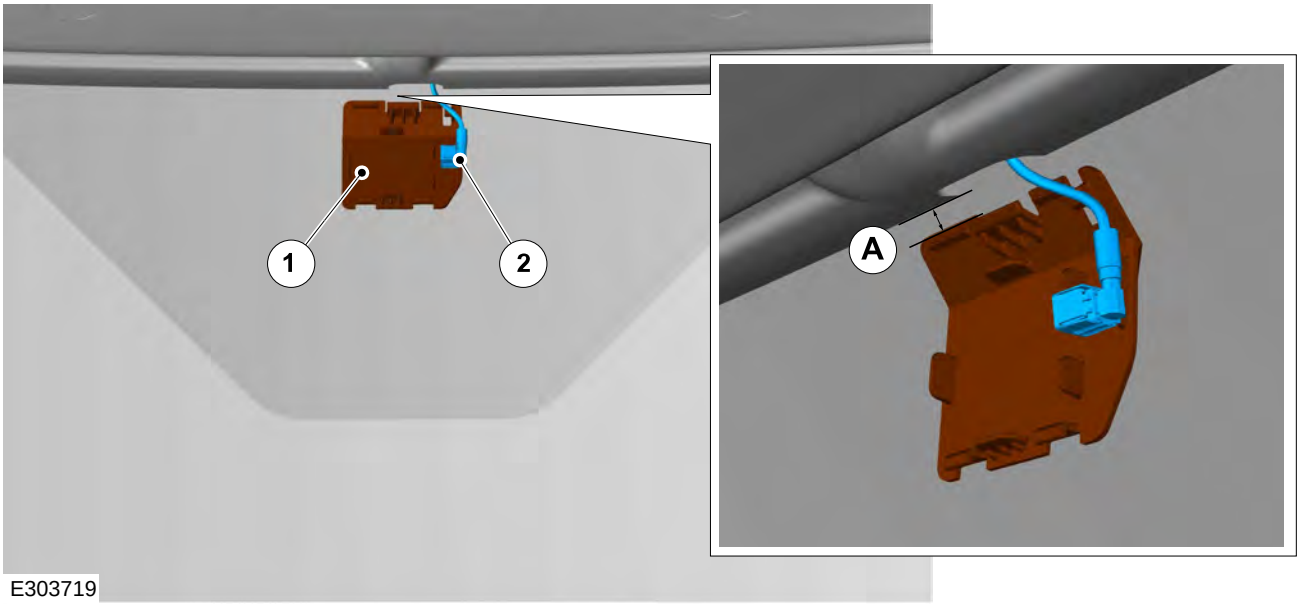
The Tachograph, Speed Sensor and DSRC will be fitted by Ford on the base vehicle as recommended. The system will still need to be calibrated by an authorised Continental/VDO workshop. Your local Ford dealer will organise The Tachograph calibration.

Retrofitting the Tachograph Unit and DSRC

NOTE: The tachograph head unit will be fitted by the Continental/VDO Calibration Centre.

The DSRC Carrier Base should be fitted as follows:

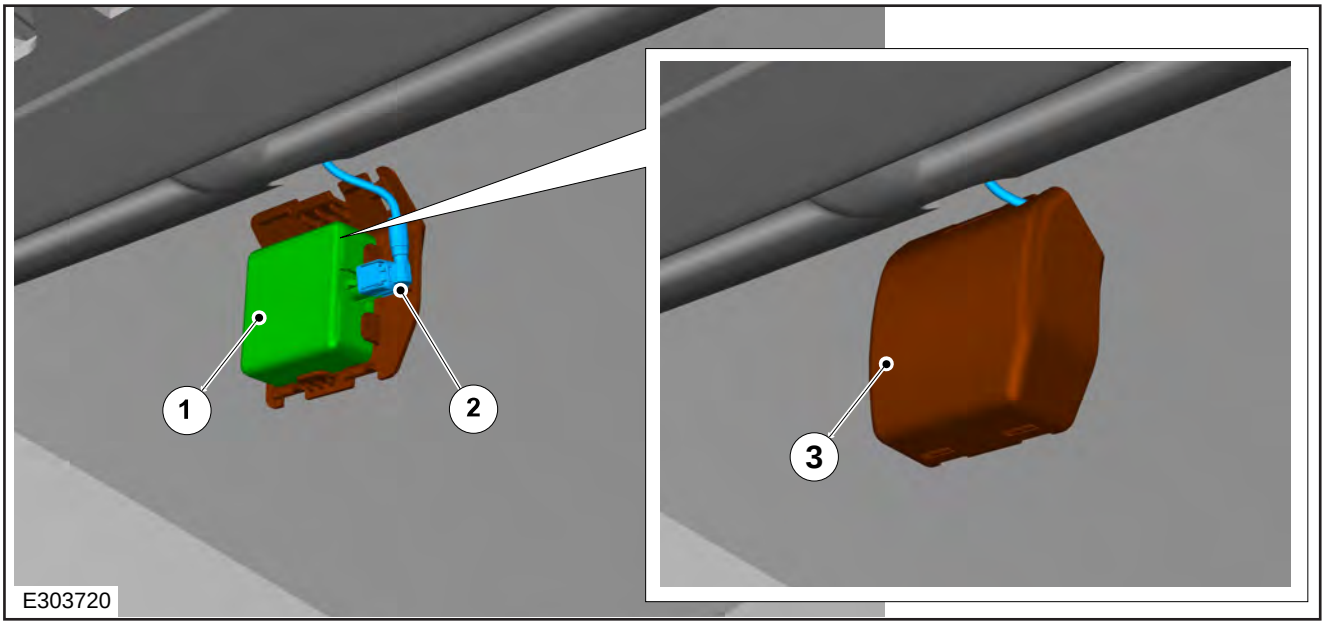
1. Ensure windscreen is dust free and clean.
2. Remove adhesive tape from carrier base and align the base to the headliner as shown by the coordinate measurements in figure E303719
3. Once aligned, stick the base to the windscreen and ensure it is oriented as shown by figure E303719



E303719

Item	Description	Item	Description
1	DSRC Carrier Base	A	9mm
2	DSRC harness		

4. Remove the adhesive on the DSRC antenna and mount the antenna into the DSRC base carrier as shown by figure E303720
5. Connect the DSRC harness to the antenna
6. Clip on the DSRC carrier cover onto the base, ensuring the entry clips align and clip into place. The fully fitted DSRC carrier is shown by figure E303720



E303720

Item	Description	Item	Description
1	DSRC	3	DSRC Carrier Cover
2	DSRC harness		

4.12.4 Calibration and Tachograph Retrofitting

EU Legal legislation requires that before the vehicle can be used on the road, the DTCO tachograph **must** be calibrated and certified. The activation process must be completed by an authorised Continental/ VDO workshop. The Ford Dealer will organise the tachograph calibration.

NOTE: The Tachograph and The Cluster have independent speed signal sources, thus a difference in distance reading between The two parts may occur.

Parts required to support aftermarket fitting of a Digital Tachograph and Speed Sensor

Part Number	Description
Mounting Parts	
EK2B-V519K22-A*	Bracket Roof Console
BK21-V045B34-A*	Bracket Console Mounting Tachograph
4C1T-18923-A*	Bracket Radio Receiver
Fixings	
W525107_S437	Rivet (4x required)
W712703_S900	Clip
W502660_S437	Screw
Tachograph Units	
KK3T-17A266-A*	Digital Head Unit 4.0
Speed Sensor	
KK2T-17K321-A*	Speed Motion Sensor
Wiring Harness	
JK2T-14K141-D*	Tachograph Harness
KK2T-14K141-L*	Speed Sensor Harness

Parts required to support aftermarket fitting of a DSRC

Part Number	Description
Mounting Parts	
KK2V-19H507-B*	DSRC Cover
KK2V-19H507-A*	DSRC Plate
DSRC Unit	
KK2V-19J269-A*	DSRC Antenna
Wiring Harness	
KK2V-18812-A*	DSRC Harness

4.13 Information and Entertainment System

4.13.1 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: For further details on Information and Entertainment System, parts and signals, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

AHU/Multimedia ICE Packs

AHU/ICE Pack	Description
30	Pre Equipment Pack (less speakers) - no audio
12	Single DIN Radio
13	Single DIN Radio with DAB
16	Connected HMI Radio
17	Connected HMI Radio with DAB
18	Low Radio with SYNC Gen 3
19	Low Radio with SYNC Gen 3 with DAB
20	Connected Touch Radio
21	Connected Touch Radio with DAB
22	Mid Radio with SYNC Gen 3
23	Mid Radio with SYNC Gen 3 with DAB
24	Navigation (NAV) SYNC Gen 3 with DAB
25	Navigation (NAV) SYNC Gen 3 with DAB with IACC (Intelligent Adaptive Cruise Control)

4.13.2 AHUs

- Single DIN Radio with/without DAB
- Connected HMI Radio with/without DAB
- Connected Touch Radio with/without DAB
- SYNC Radio With/Without DAB

4.13.3 Sub-Entry Radio

NOTE: There is a black co-axial cable for the roof-mounted AM/FM/DAB antenna that goes to the rear of the AHU. There is also a black USB cable which goes to the rear of the AHU.

AHU is connected to the instrument panel wiring harness via a single 32 pin connector.

Sub-Entry Radio Main Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	17	Not Used	-
2	Right Front Speaker -	Output	18	Not Used	-
3	Right Front Speaker +	Output	19	CAN-High	Input/ Output
4	Ground	Input	20	Not Used	-
5	Left Rear Speaker -	Output	21	Not Used	-
6	Left Rear Speaker +	Output	22	Not Used	-
7	Left Front Speaker -	Output	23	Not Used	-
8	Left Front Speaker +	Output	24	Not Used	-
9	Right Rear Speaker -	Output	25	Not Used	-
10	Right Rear Speaker +	Output	26	Microphone -	Input
11	Not Used	-	27	Not Used	-
12	Not Used	-	28	Not Used	-
13	Not Used	-	29	Not Used	-
14	Not Used	-	30	CAN - Low	Input/ Output
15	Microphone +	Input	31	Not Used	-
16	Not Used	-	32	Not Used	-

Key to Table Overleaf

Item	Description	Item	Description
(1)	Not on Tourneo, Kombi M1, N1	ACC	Accessory
(2)	Not on Tourneo	Ch	Channel
(3)	Tourneo Only	DAB	Digital Audio Broadcasting
(4)	Body style dependent	Div	Diversity
(5)	Rear Speakers dependent on body style	ICP	Instrument Control Panel
(6)	Microphone changes with Overhead Console	RVC	Rear View Camera
(7)	Only available in certain regions	TMC	Traffic Message Channel
-	Not available	TPEG	Transport Protocol Experts Group
X	Included	GNSS	Global Navigation Satellite System
O	Optional		

	Description	30
Audio Head Unit (AHU)	Less AHU	X
	1-DIN(1)	-
	1-DIN with DAB(1)	-
	Radio Low(2)	-
	Radio Low DAB(2)	-
	FM/AM Connected Touch Radio 4ch(2)	-
	FM/AM Connected Touch Radio 4ch with DAB(2)	-
	FM/AM Div 5Ch/6Ch(3)	-
	FM/AM Div 5Ch/6Ch DAB (3)	-
	FM/AM Div 5Ch/6Ch DAB - TMC TPEG	-
Speakers	Less Radio Speaker	-
	4 Speaker	X
	6 Speaker(4)	-
	10 Speakers(4)	-
Antenna	AM/FM - Non DAB	X
	AM/FM - with DAB (active antenna)	-
	AM/FM Diversity (Back glass mounted)(4)	-
	AM/FM Diversity + DAB (Back glass mounted)(4)	-
	GNSS Antenna(7)	-
	GNSS/Cellular Antenna (Available with Embedded Modem) (7)	-
Slim Display Module (SDM)	Less SDM	X
	Display Module 4”	-
	Display Module 8”	-
	Less ICP	X
	Mini ICP - 10 Buttons (CHR Radio)	-
	Mini ICP - 10 Buttons (SYNC Lite)	-
	Mini ICP - 5 Buttons	-
Steering Wheel Control	Less Radio Controls	X
	Radio Controls	-
	Radio Controls (with voice)	-
	Trip Computer	X
	Less Speed Control	X
	Cruise Control	-
	Adaptive Cruise Control	-
Cluster	Cluster S0(5)	X
	Cluster S1(5)	O
	Cluster S2(5)	O
Rear View Camera	RVC	-
Connectivity	ACC 1 USB Port-1 Remote Port	-
	2x USB + BT with connected Radio	-
	Mini Media Hub (x2 USB) with Adaptor Bezel +BT	-
	Microphone - Overhead Console Mic(6)	-
	Microphone - Headliner Mic(6)	-
Sync	Sync Gen 3	-
	Sync Gen 3 Lite	-
Navigation	Non Navigation	X
	Navigation	-
Cellphone Interface	Less Cellphone Interface	X
	Cellphone Interface	-

12	13	16	17	18	19	20	21	22	23	24	25
-	-	-	-	-	-	-	-	-	-	-	-
X	-	-	-	-	-	-	-	-	-	-	-
-	X	-	-	-	-	-	-	-	-	-	-
-	-	X	-	-	-	-	-	-	-	-	-
-	-	-	X	-	-	-	-	-	-	-	-
-	-	-	-	-	-	X	-	-	-	-	-
-	-	-	-	-	-	-	X	-	-	-	-
-	-	-	-	X	-	-	-	X	-	-	-
-	-	-	-	-	X	-	-	-	X	-	-
-	-	-	-	-	-	-	-	-	-	X	X
-	-	-	-	-	-	-	-	-	-	-	-
X	X	X	X	-	-	X	X	-	-	X	X
-	-	X	X	-	-	X	X	-	-	X	X
-	-	-	-	X	X	-	-	X	X	X	X
X	-	X	-	X	-	X	-	X	-	-	-
-	X	-	X	-	X	-	X	-	X	X	X
-	-	X	-	X	-	X	-	X	-	-	-
-	-	-	X	-	X	-	X	-	X	X	X
-	-	X	X	X	X	X	X	X	X	X	X
-	-	X	X	X	X	X	X	X	X	X	X
X	X	-	-	-	-	-	-	-	-	-	-
-	-	X	X	X	X	-	-	-	-	-	-
-	-	-	-	-	-	X	X	X	X	X	X
X	X	-	-	-	-	-	-	-	-	-	-
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-	-	-	-	X	X	-	-	-	-	-	-
-	-	-	-	-	-	X	X	X	X	X	X
-	-	-	-	-	-	-	-	-	-	-	-
X	X	-	-	-	-	X	X	-	-	-	-
-	-	-	-	X	X	-	-	X	X	X	X
X	X	X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	X	-
O	O	O	O	O	O	O	O	O	O	O	-
O	O	O	O	O	O	O	O	O	O	O	X
X	X	X	X	X	X	X	X	X	X	X	-
O	O	O	O	O	O	O	O	O	O	O	-
O	O	O	O	O	O	O	O	O	O	O	X
-	-	O	O	O	O	O	O	O	O	O	O
X	X	-	-	-	-	-	-	-	-	-	-
-	-	X	X	-	-	-	-	-	-	-	-
-	-	-	-	X	X	X	X	X	X	X	X
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-	-	-	-	X	X	-	-	-	-	-	-
X	X	X	X	X	X	X	X	X	X	-	-
-	-	-	-	-	-	-	-	-	-	X	X
X	X	-	-	-	-	-	-	-	-	-	-
-	-	X	X	X	X	X	X	X	X	X	X

4.13.4 Connected HMI Radio and Connected HMI Radio with DAB

NOTE: There is a black co-axial cable for the roof-mounted single AM/FM/DAB antenna that goes to the radio. There are two co-axial cables for diversity antenna. (Diversity antenna only available on kombi M1, N1 and buses).

NOTE: There are two black USB cables, which go to the radio. One of the USB cables has grey connector and the other one has black connector.

NOTE: There is a blue co-axial cable for global navigation satellite system (GNSS) antenna that connects to the back of the AHU.

NOTE: CHR will only work with SDM4 display and the mini-ICP version for this combination. Mini-ICP for SYNC-Sunset & SDM4 combination will not work for CHR.

NOTE: There is a black LVDS Cable which is connected to the radio via a Blue connector. SDM4 display is powered via this LVDS cable and serial communication between radio & display takes place through this cable.

Connected HMI Radio (CHR) is connected to the instrument panel wiring harness via a single 32 pin connector. Although there are two connectors on the radio side, only one connector is utilised for CHR.

Connected HMI Radio Main Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	17	External CD In L -	Input
2	Right Front Speaker -	Output	18	Not Used	-
3	Right Front Speaker +	Output	19	CAN-High	Input/ Output
4	Ground	Input	20	Not Used	-
5	Left Rear Speaker -	Output	21	Not Used	-
6	Left Rear Speaker +	Output	22	Not Used	-
7	Left Front Speaker -	Output	23	Not Used	-
8	Left Front Speaker +	Output	24	Shield & Ground RVC	Ground
9	Right Rear Speaker -	Output	25	RVC -	Input
10	Right Rear Speaker +	Output	26	Microphone -	Input
11	Not Used	-	27	External CD In L -	Input
12	Not Used	-	28	External CD In L +	Input
13	Microphone Shield	Ground	29	Not Used	-
14	RVC +	Input	30	CAN - Low	Input/ Output
15	Microphone +	Input	31	Not Used	-
16	External CD In L +	Input	32	Not Used	-

4.13.5 Connected Touch Radio and Connected Touch Radio with DAB

NOTE: There is a black co-axial cable for the roof-mounted single AM/FM/DAB antenna that goes to the radio. There are two co-axial cables for diversity antenna.

NOTE: There is a black USB cable, which go to the multimedia hub.

NOTE: There is a blue co-axial cable for global navigation satellite system (GNSS) antenna that connects to the back of the audio head unit.

NOTE: CTR will only work with SDM8 display and 5 button mini-ICP.

NOTE: There is a black LVDS Cable which is connected to the radio via a Blue connector. SDM8 display is powered via this LVDS cable and serial communication between radio & display takes place through this cable.

Connected Touch Radio (CTR) is connected to the instrument panel wiring harness via a single 32 pin connector. Although there are two connectors on the radio side, only one connector is utilised for CTR.

Connected Touch Radio Main Connector

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	17	MCM Power	Output
2	Right Front Speaker -	Output	18	Not Used	-
3	Right Front Speaker +	Output	19	CAN-High	Input/ Output
4	Ground	Input	20	Not Used	-
5	Left Rear Speaker -	Output	21	Not Used	-
6	Left Rear Speaker +	Output	22	Not Used	-
7	Left Front Speaker -	Output	23	Not Used	-
8	Left Front Speaker +	Output	24	Shield & Ground RVC	Ground
9	Right Rear Speaker -	Output	25	RVC -	Input
10	Right Rear Speaker +	Output	26	Microphone -	Input
11	Not Used	-	27	SWC -	Input
12	Not Used	-	28	MCM Ground	Ground
13	Microphone Shield	Ground	29	LIN	Input/ Output
14	RVC +	Input	30	CAN - Low	Input/ Output
15	Microphone +	Input	31	Not Used	-
16	SWC +	Input	32	Not Used	-

4.13.6 SYNC Radio and SYNC Radio with DAB

NOTE: There is a black co-axial cable for the roof-mounted single AM/FM/DAB antenna that goes to the radio. There are two co-axial cables for diversity antenna. (Diversity antenna only available on kombi M1, N1 and buses).

NOTE: SYNC Radio is present only when SYNC3 module is available.

NOTE: There is a blue co-axial cable for global navigation satellite system (GNSS) antenna that connects to the back of the AHU.

SYNC Radio is connected to the instrument panel wiring harness via two 32 pin connectors.

SYNC Radio Main Connector J1

Pin	Description	Type	Pin	Description	Type
1	Battery	Input	17	External CD in L -	Input
2	Right Front Speaker -	Output	18	Not Used	-
3	Right Front Speaker +	Output	19	CAN-High	Input/ Output
4	Ground	Input	20	Not Used	-
5	Left Rear Speaker -	Output	21	Not Used	-
6	Left Rear Speaker +	Output	22	Not Used	-
7	Left Front Speaker -	Output	23	Not Used	-
8	Left Front Speaker +	Output	24	Shield & Ground RVC	Ground
9	Right Rear Speaker -	Output	25	RVC -	Input
10	Right Rear Speaker +	Output	26	Microphone -	Input
11	Not Used	-	27	External CD In L -	Input
12	Not Used	-	28	External CD In L +	Input
13	Microphone Shield	Ground	29	LIN	Input/ Output
14	RVC +	Input	30	CAN - Low	Input/ Output
15	Microphone +	Input	31	Not Used	-
16	External CD In L +	Input	32	Not Used	-

SYNC Radio Main Connector J2

Pin	Description	Type	Pin	Description	Type
1	Not Used	-	17	Not Used	-
2	Not Used	-	18	SDL-High	Input/ Output
3	Not Used	-	19	Alert In +	Input
4	Not Used	-	20	Stereo In Left +	Input
5	Middle Left Speaker -	Output	21	Stereo In Right +	Input
6	Middle Left Speaker +	Output	22	Aux1 -	Input
7	Not Used	-	23	AE/CD	Output
8	Not Used	-	24	Not Used	-
9	Middle Right Speaker -	Output	25	Not Used	-
10	Middle Right Speaker +	Output	26	Not Used	-
11	AUX1+	Output	27	Not Used	-
12	AUX1 Shield	Ground	28	Not Used	-
13	Not Used	-	29	SDL-Low	Input/ Output
14	Not Used	-	30	Alert In -	Input
15	Not Used	-	31	Stereo In Left -	Input
16	Not Used	-	32	Stereo In Right -	Input

4.13.7 Rear View Camera

NOTE: The display screen does not have a direct input for connection to devices such as cameras. Only vehicles with SYNC radios have the capability to support aftermarket fitment of the RVC.

There are three pins on the SYNC module.

- Pin 14: Input Camera - Parking Aid Rear Video (+)
- Pin 15: Input Camera - Parking Aid Rear Video (-)
- Pin 33 Ground: Camera - Parking Aid Rear Video

The cable between the RVC and SYNC module needs to be screened twisted pair, preferably of a single run to minimise signal loss.

In addition to this, the vehicle will have certain parameters reconfigured. This needs to be carried out at an authorised Ford dealership to not invalidate warranty.

The display will only provide rear view camera information when reverse gear is engaged. For vehicles with non-SYNC audio systems, it is not possible to install an aftermarket RVC.

4.13.8 Speakers

To add additional Rear Speakers

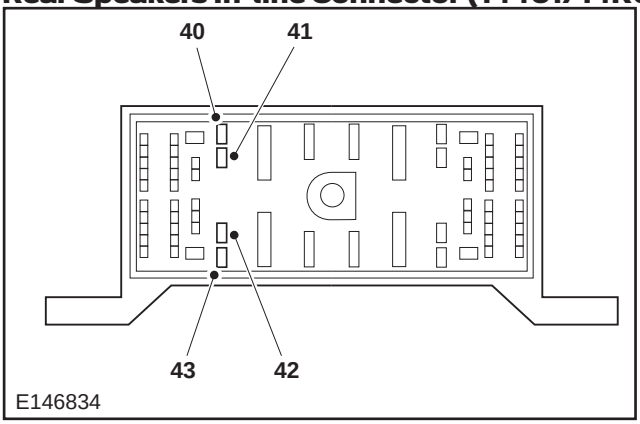
Rear speaker wiring is only present in the instrument panel harness 14K024 when 6 or 10 speakers are present. The harnesses 14401 will only support rear speakers when 6 or 10 speakers are requested. This is also the case for the 14405/14A005 they are also linked to 6 or 10 speakers.

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, if the harness is supporting 6 or 10 speakers, may be spliced into the Audio Jumper Harness at the rear of the AHU.

Rear Speakers spliced into the Audio Jumper Harness

Pin	Speaker	Wire Colour
24	Right Rear (+)	Brown/White
12	Right Rear (-)	Brown/Blue
21	Left Rear (+)	White/Green
9	Left Rear (-)	Brown/Yellow

Rear Speakers In-line Connector (14401/14K024)



Item	Description
Pin 40	Rear Speaker Left +
Pin 41	Rear Speaker Left -
Pin 42	Rear Speaker Right -
Pin 43	Rear Speaker Right +

4.14 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.

4.15 Exterior Lighting

WARNINGS:

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

Do not tamper with the base system (controlled by Body Control Module and multiplex architecture) and any feeds taken from the associated wiring or controller.

Due to significant wiring and control/ configuration differences between headlamp types, it is not possible to retrofit Bi-Xenon HID (High Intensity Discharge) or LED DRL (Daylight Running Lights) headlamps to vehicles not originally built with them. If Bi-Xenon HID or LED DRL headlamps are required, then these must be specified at time of ordering for factory fitment.

4.15.1 Reversing Lamps

Reversing lamps are activated by a high side driver in the Body Control Module (BCM). Accessories that add additional load, such as reversing sounders, connected to the reversing lamp circuit, should be connected by a relay. Connecting such loads directly to the reversing lamp circuit could damage the BCM.

The load on the reversing lamps should not exceed a total of 3A (42W), 250mA for a relay.

4.15.2 Lamps – Front and Rear Fog Lamps

NOTE: The vehicle's rear fog lights will be switched off if a trailer is connected.

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 lamp - 2 x 35W (High side driver controlled).
- Rear fog lamp - 2 x 21W (High side driver controlled).

For trailer tow, rear fog lighting, relating to that system.
Refer to: 4.23 Special Conversions (page 154).

4.15.3 Lighting Loads

The BCM exterior lighting outputs have shutdown protection in the event of an overload condition. If the overload condition is not addressed, the output will be shutdown permanently to protect the driver hardware. A dealer visit and/or BCM replacement may be required if overload condition is not removed.

4.15.4 Lamps – Hazard / Direction Indication

The standard system configuration each side:

- 1 x Front Indicator 21W and 1 x Side Repeater 5W (shared single output) - max load 27W.
- 1 x Rear Indicator 21W (single output - max load 27W.

4.15.5 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.

4.15.6 Additional External Lamps

All power for additional exterior lamps must be taken through the Auxiliary Fuse Panel with a suitable switch and/or relay as required.

Refer to: 4.22 Fuses and Relays (page 151).
Refer to: 4.24 Electrical Connectors and Connections (page 158).

Lighting Loads

BCM Outputs	Controlling Device	Max. Load	Vehicle
Number Plate and Marker Lamp Supply(1)	High Side Driver	27W	2 x 5W
Position/Parking Lamp Front - each side(3)	High Side Driver	10W	5W
Position/Parking Lamp Rear - each side	High Side Driver	6W	5W
Direction Indicator Front - each side	High Side Driver	27W(2)	21W + 5W(4)
Direction Indicator Rear - each side	High Side Driver	27W(2)	21W

(1)Number Plate and Marker Lamps not to exceed 27W. LED Markers are recommended where available.

(2)Turn Indicator Supply. Smaller loads will trigger bulb outage detection.

(3)Only present on bulb position lamp variants (not present with combined LED DRL/Position lamps).

(4)If DCUs are fitted, the 5W side repeater lamps are connected to the corresponding driver/passenger DCU.

4.16 Interior Lighting

4.16.1 Additional Internal Lamps

CAUTION: The maximum total internal lamp load must not exceed 7A (105W).

Electrical supply for additional cabin interior lighting may be obtained by directly accessing the connector inside the dome lamp in the cabin.

Electrical supply for additional load space interior lighting may be obtained by directly accessing the connector inside the load space lamps.

For additional information on BCM
Refer to: 4.3 Communications Network (page 75).

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

Power Supply for the Interior Lights.

The BCM provides power to the interior lights by three outputs, two for courtesy and one for demand:

- Cabin light courtesy function - BCM pin C3-13 with maximum load of 5A
- Cargo light courtesy function - BCM pin C3-26 with maximum load of 5A
- Combined cabin and cargo light demand function - BCM pin C3-14 with maximum load of 5A

NOTE: Tourneo Bus front and rear (over seat lights) are LED and use a master controller in the front overhead console light. The rear over seat lights are directly controlled from this. No additional lights can be added to this overhead lighting circuit.

Each interior light circuit is grounded locally to the lamp. The lamps fitted to the cabin or cargo circuit depend on the vehicle type. To determine the lamps on the rear or cargo circuit:

- Set any lights with a switch to courtesy.
- Close all the doors and allow the lights to switch off.
- Open the rear cargo door or lift gate.
- Any interior lights that switch on are in the rear cargo or rear zone.
- Some vehicle types may have no lamps on the rear circuit

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 fluorescent lighting is required, it should be connected to the Auxiliary Fuse Panel.

If enhanced bright lamps are required for the cargo area of a van, it is recommended to fit the Ford Enhanced Load Space Lighting. Option A080 and LED lamp part numbers: low roof vehicles 2x BK2V-13776-A* for the front and 2x BK2V-13773-A*W for the rear. For high roof vehicles 4x BK2V-13773-B*W for the front and rear total. Jumper wires may also be required for updates. This is variant dependent part numbers GK2T-14334-A* or C*. These are controlled from the side load or rear door being ajar or manual demand from the dome lamp in the front cabin.

For further information on required parts and configurations to order, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

4.16.2 Additional Lighting for Rear of Vehicle Interior

Where higher wattage installations are required, these should be taken through the Auxiliary Fuse Panel with a suitable switch and/or relay as required.

For additional information Refer to: 4.24 Electrical Connectors and Connections (page 158).

4.17 Emergency Call Systems

NOTE: Reception testing or loss of performance due to poor conversion/reinstallation are not the responsibility of Ford Motor Company.

NOTE: All vehicles with Ice Pack 16 and above will have the Emergency Assist function.

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

4.17.1 GNSS/4G Antenna Relocation Kit

NOTE: H1 Roof Vans should refer to directive EC26 Regulations or applicable local legislation for maximum vehicle height.

If the antenna performance is negatively affected by your conversion or you need to relocate the antenna, refer to the following table for the parts required and follow the recommended instructions on how to fit an antenna in a suitable location.

The existing antenna cable is always located on the RHS 'A' pillar.

The existing antenna should be disconnected and left in place for waterproofing. The extension cable, and splitter if needed, should be attached to the connector of the existing antenna cable at the A Pillar. This can then be routed to a suitable location on the conversion, ideally on the highest suitable vehicle surface and connected to the new antenna.

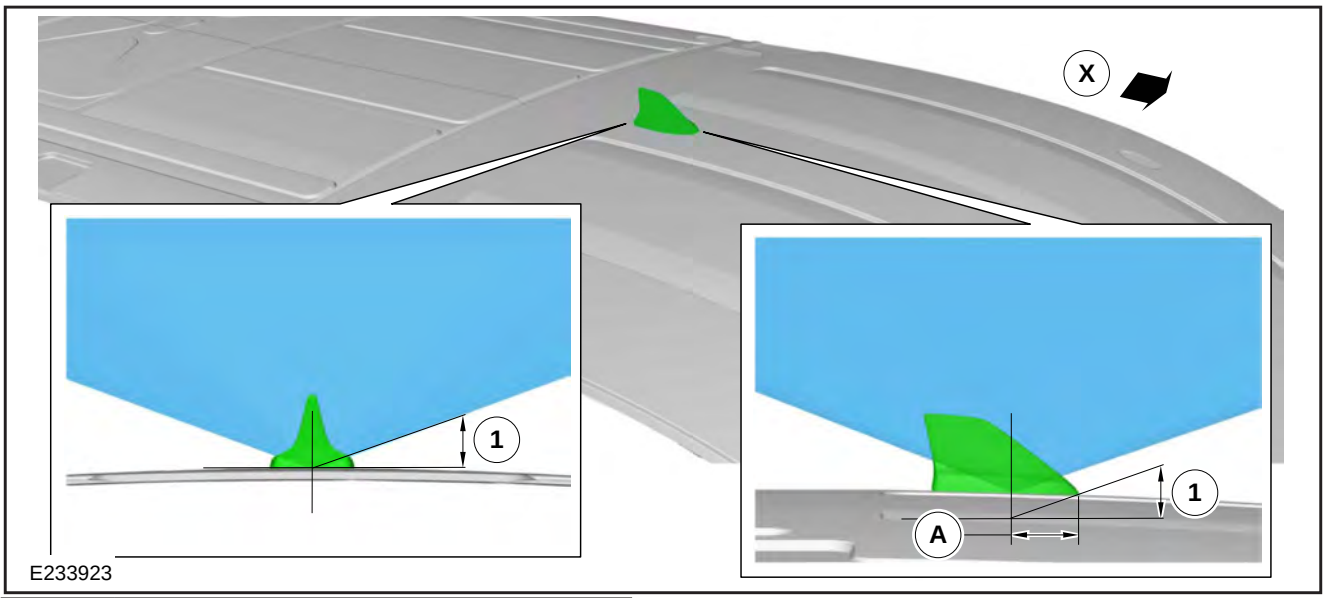
Item	Part Number
Full kit	KTKK3T-18812-AFA
Cable extension	KK3T-18812-AFA
Cable splitter	KK3T-18812-AEA
Shark fin antenna	GJ5T-19K351-AB
H1 roof antenna	KK2T-19K351-DB
Ground plate	KC3T-500A80-AA

4.17.2 Relocation of GNSS/4G Antenna

NOTE: The antenna is provided with a seal that fits to the roof surface but it is the responsibility of the Vehicle Converter to ensure an adequate waterproof seal is achieved.

If it is unavoidable and necessary to fit an antenna, the following instructions are recommended:

- The antenna should be mounted on sheet metal (ground surface/plane) supplied. A metal roof is preferred, the antenna should still function if the ground plane is fitted to a plastic/fibreglass roof. The antenna includes two functions:
  - GNSS (GPS) required for vehicle location, which is dependent on receiving satellite signals from overhead
  - GSM (cellular) required for 'phone' communication, which is dependent on a clear line of sight from ground towers, for example: 'horizontal' transmission path. Hence a repositioned antenna needs to take these requirements into account and should be positioned on the highest possible packaging location, avoiding depressions wherever possible
- The ground surface does not require any further grounding to the vehicle, it provides a reflective surface rather than acting as a grounding element



E233923

Item	Description
1	20°
A	68.8 ± 1mm
X	Front of vehicle direction

- Suitable fixings and sealing are required to secure the ground plain to the roof panel, for example 4x rivets
- The antenna base design/mounting requires a specific hole shape to ensure anti-rotation and orientation.
- The mounting on the antenna (shark-fin variant) will accommodate sheet metal thicknesses from 0.7mm to 1.5mm
- The GSM antenna family requires a **minimum** of a 150mm radius uninterrupted metallic ground surface area surrounding the mounting hole. No interruptions are allowed
- The antenna must have a **minimum** clearance of 250mm from any other antenna located on the vehicle roof
- The antenna must have a **minimum** clearance of 250mm from any metallic structures above the ground plane (if present)
- The antenna should be as close to horizontal as possible and must not be at an angle of greater than 12º to the horizontal
- The antenna is attached to the ground surface with a driven fastener from the underside of the plane. The fastener is a captured component on the antenna base
- Cabling needs to utilise RG58LL type cable as provided for each functional band with USCAR FAKRA-type SMB connectors, unless stated otherwise by the customer

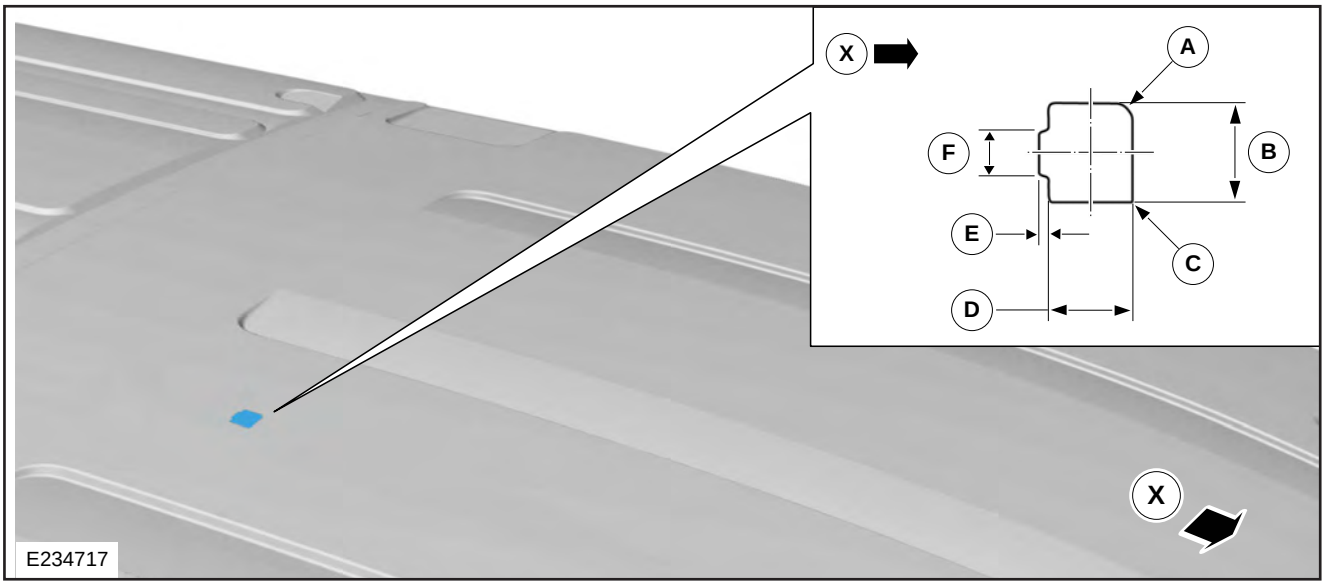
The Vehicle Converter will need to create vehicle specific versions that meet the requirements previously mentioned in this section. A full range of reception tests will need to be conducted by the Vehicle Converter to ensure system performance.

Splitter (KK3V-18812-AE) is used when the base vehicle has a scarab (KK3T-19C175-A*). An antenna for GNSS and new Shark Fin (GJ5T-19K351-AB) will be fitted to the conversion for GNSS.

If it is unavoidable and necessary to move the antenna, the following instructions are recommended:

- Provide a minimum clearance of 50mm from all electronic (powered) devices and any wiring harness
- When mounting the antenna, place it on sheet metal at the highest possible metallic packaging location
- The antenna base design/mounting requires a specific hole shape to ensure anti-rotation and orientation (figure E234717). The roof and the position on the roof shown in figure E234717 are exemplary only
- The antenna requires a minimum of 150mm radius uninterrupted metallic ground surface area surrounding the mounting hole

Antenna Anti-Rotation Mounting Hole



Item	Description
A	4mm Radius
B	19.8mm (+0.3)
C	7x 1mm Radius
D	16.8mm (+0.3)
E	2mm (+0.3)
F	9mm (+0.3)
X	Front of vehicle direction

- The antenna must be at least 250mm from any other antenna located on the vehicle roof and from any metallic structures above the ground plane (if present)
- The antenna must not sit at an angle greater than 12º to the horizontal
- The antenna is attached to the vehicle with a driven fastener from the bottom side of the metallic ground plane. The fastener will be a captured component on the antenna base

- The antenna pigtail cabling needs to utilise RG174 type cables for each functional band with USCAR FAKRA-type SMB connectors, unless stated otherwise by the customer
- A body side cable is required to use 1.5DS-QFB cable for GNSS or RG-58LL cable for cellular
- The cable length between the Audio Head Unit and the antenna should not exceed 6m to meet required system RF performance
- A full range of reception tests will need to be conducted by the Vehicle Converter to ensure system performance

4.18 Cruise Control

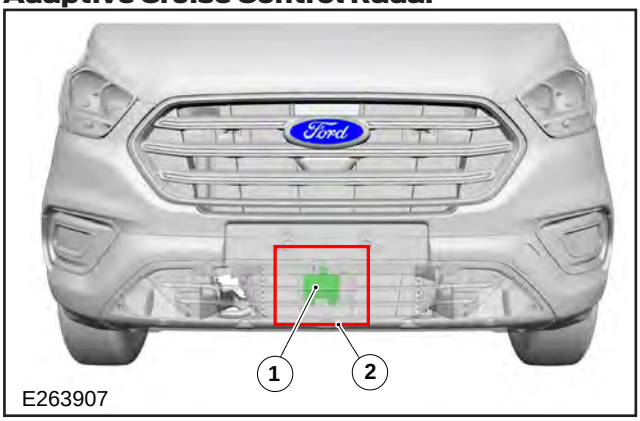
4.18.1 Adaptive Cruise Control

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 E263907.

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

Adaptive Cruise Control Radar



E263907

Item	Description
1	Adaptive Cruise Control Radar
2	Adaptive Cruise Control Radar clearance zone

4.19 Blind Spot Information System

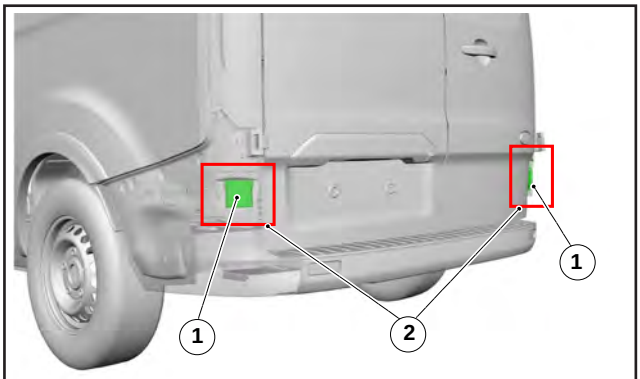
WARNING: The Blind Spot Information System (BLIS) feature will not function if any conversion or installation is in the field of the multiple-beam radar modules which are packaged in the rear quarter panels - one each side.

NOTE: Do not apply bumper stickers and/or repair compound to these areas, this can cause degraded system performance.

NOTE: The BLIS alert indicator(s) may turn on during heavy rain even though no vehicle(s) has entered the blind zone.

NOTE: If your vehicle has a tow bar with a factory equipped trailer tow module and it is towing a trailer, the sensors will automatically turn the BLIS off. If your vehicle has a tow bar but no factory equipped trailer tow module, it is recommended to turn the BLIS off manually. Operating the BLIS without the Blind Spot Trailer Tow package and a trailer attached will cause poor system performance.

BLIS location



E263904

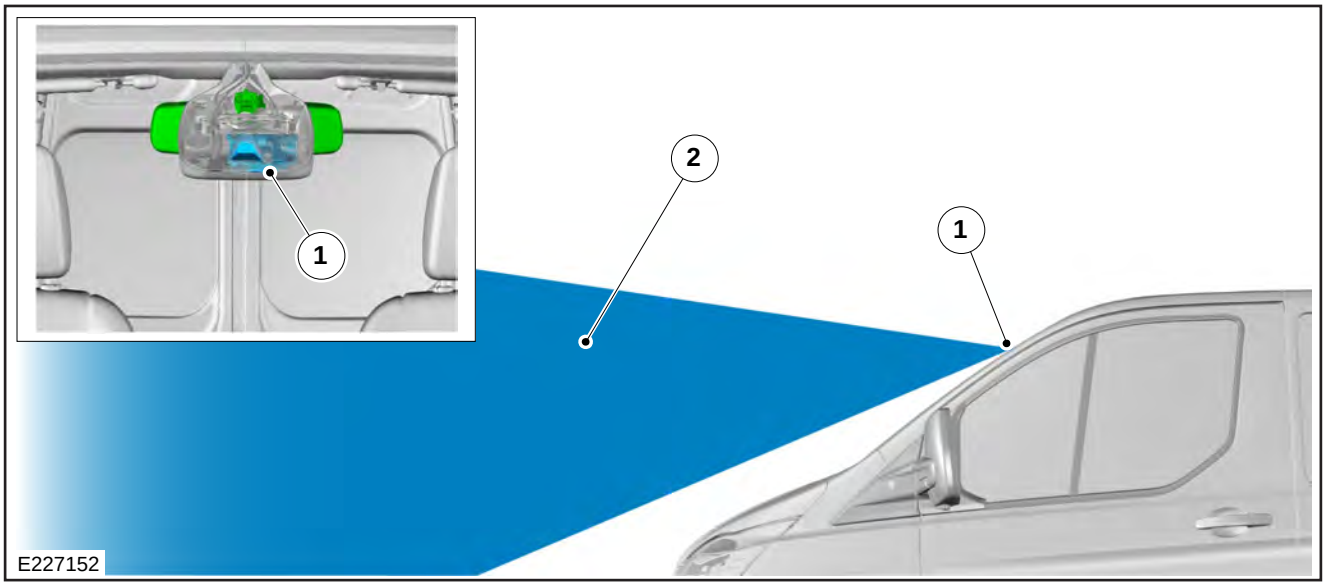
Item	Description
1	Multiple-beam radar module
2	Clearance zone

4.20 Lane Keeping System

NOTE: The lane keep alert feature will not function if any conversion or installation is in the field of view from the lane keeping system camera.

NOTE: For converted vehicles fitted with lane keeping system, where vehicle mass or geometry is significantly altered, a new calibration for the camera sensor needs to be made.

For additional information for vehicles with large overhangs Refer to: 4.23 Special Conversions (page 154).



Item	Description
1	Lane keeping system camera located behind the interior rear view mirror trim
2	View cone from camera, horizontal direction and downwards to the bonnet edge of the vehicle

4.21 Handles, Locks, Latches and Entry Systems

4.21.1 Door Removal or Modification

CAUTION: If an additional third party control system is incorporated into the Ford Locking/Unlocking System the Crash Event Mid Speed Can Signal must be utilised to override the third party control system to trigger a crash unlock feature within the locking system in case of a relevant event.

NOTE: If any modified doors have ajar switches fitted and operating in accordance with the above, the original alarm and interior lighting functions can be maintained.

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

In the event of the requirement to remove the doors for derivatives requiring no doors, certain circuits will need to be linked to ensure door ajar warnings do not appear on the Instrument Cluster. The interior light will also stay on if this is not done.

It is possible to maintain a certain state by configuring the Body Control Module (BCM) C3 in the following way.

- C5-33 Front Left Ajar -Ground
- C5-21 Front Right Ajar - Ground
- C5-34 Ajar Liftgate switch & Rear Cargo doors - Ground
- C5-46 Ajar Left Side Cargo Switch - not connected
- C5-19 Ajar Left Side Cargo Switch - not connected

4.21.2 Central Locking

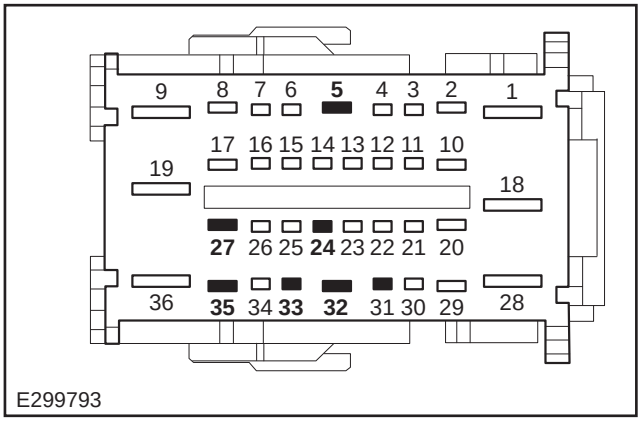
Locking is controlled by the BCM. There is current sensing on certain locking circuit pins as part of the security system – if these are tampered with locking performance cannot be guaranteed. However, it is possible to add additional lock(s) via relays (max 300mA coil current Permitted) per unlock circuit. All latch lock and unlock pulse durations are 110ms.

The use of Ford Transit lock mechanisms is strongly recommended as the BCM is designed to drive these latches for the correct amount of time.

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 Instrument Cluster (Ford Dealerships can set this). Once enabled, the parameter can be set and unset via the cluster menu.
2. Slam locking – this is a configurable parameter in the BCM (dealerships can only switch off this feature, but not switch on).
3. Lock reconfiguration into no deadlocks – this can be reconfigured to be central-locking only by a Ford Dealer (via Dealership hotline, as requires vehicle As-Built to be updated).

Pins to Control Additional Door Locks



E299793

Item	Description
C3-05	Passenger Door Unlock
C3-27	Driver's Door Unlock
C3-24	Unlock RH Sliding Door or Child Lock PSD
C3-35	Central Lock
C3-33	Unlock LH Sliding Door or Unlock PSD LH and RH
C3-32	Double Lock
C3-31	Unlock Liftgate/Cargo

BCM	14A631 in-line Drive Side	14A631 in-line Passenger Side	Function
C3-35	A16	A16	Central Lock
C3-27	A17	-	Driver's Door Unlock
C3-32	B17	B17	Double Lock
C3-05	-	A17	Passenger Door Unlock

BCM	19L540	Function
C3-24	1	Manual Sliding Door - Unlock RH Sliding Door
C3-33	1	Manual Sliding Door - Unlock LH Sliding Door

BCM	13A409	Function
C3-31	6	Unlock Liftgate/Cargo

4.21.3 Remote Keyless Entry/ Tyre Pressure Monitoring System Receiver (RKE/TPMS Receiver)

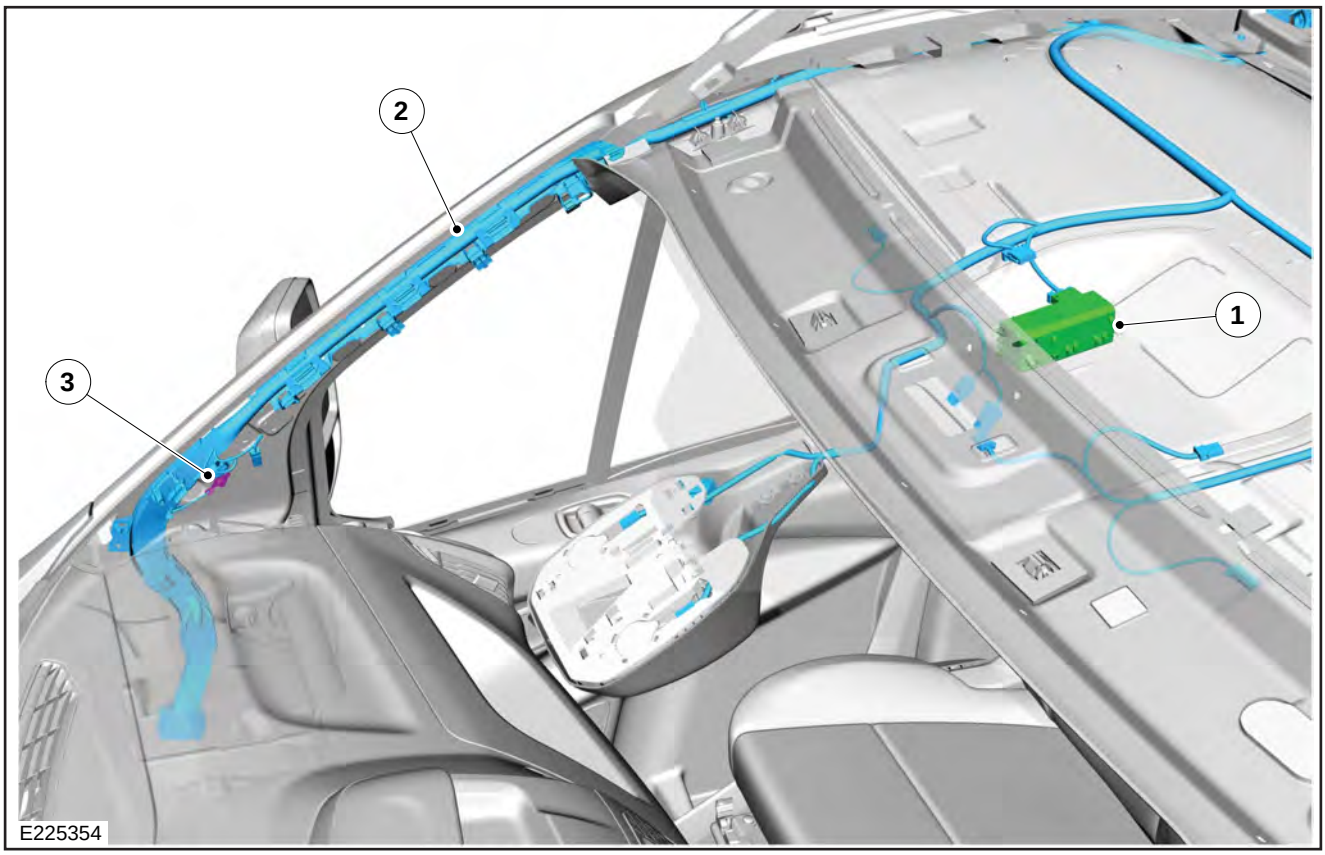
WARNING: For best performance, the RKE/ TPMS receiver must be a minimum distance of 25mm away from any metal objects and 100mm away from high switch loads.

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 locations

Refer to: 4.25 Grounding (page 182). For additional information
Refer to: 2.4 Wheels and Tyres (page 45).

Remote Keyless Entry/Tyre Pressure Monitoring System Receiver



Item	Description
1	RKE/TPMS Receiver
2	Harness 14A005
3	Ground Point Location

4.22 Fuses and Relays

4.22.1 Fuses

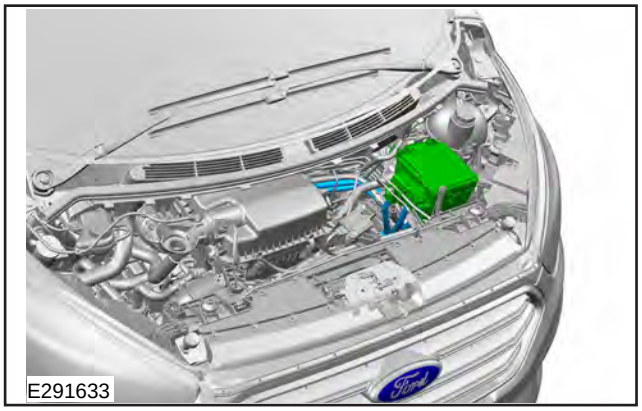
WARNING: No increase in existing vehicle standard fuse capacity is allowed under any circumstances. There are no spare fuses in the Power Distribution Box (PDB), Smart Relay Box (SRB) or Body Control Module (BCM). The Vehicle Converter must provide additional fuses as required. Please refer to the table below.

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

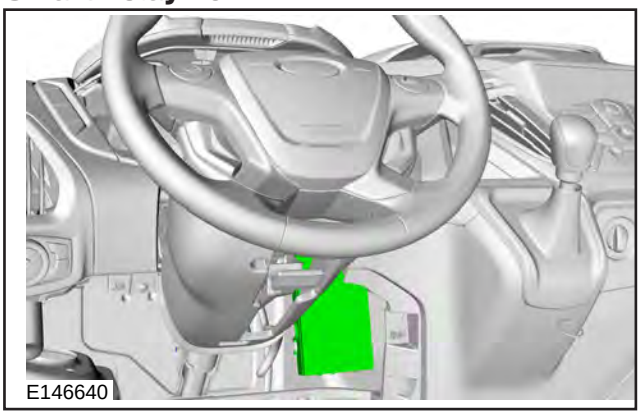
Ford Fuses

Part Number	Ampere Rating	Colour
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
1L3T-14A094-J*	25A	Clear
1L3T-14A094-K*	30A	Green
Micro2 Fuse		
DG9T-14A094-F*	5A	Tan
DG9T-14A094-G*	7.5A	Brown
DG9T-14A094-H*	10A	Red
DG9T-14A094-J*	15A	Blue
DG9T-14A094-K*	20A	Yellow
DG9T-14A094-L*	25A	White
DG9T-14A094-M*	30A	Green
Micro3 Fuse		
DG9T-14A094-N*	5A	Tan
DG9T-14A094-S*	7.5A	Brown
DG9T-14A094-P*	10A	Red
M-Case Fuse		
DG9T-14A094-A*	15A	Grey
DG9T-14A094-B*	20A	Light Blue
DG9T-14A094-C*	25A	White
DG9T-14A094-D*	30A	Pink
DG9T-14A094-E*	40A	Green
J-Case Fuse		
F8SB-14A094-A*	20A	Blue
6E5T-14A094-A*	20A	Blue
2L5T-14A094-A*	25A	Natural
F8SB-14A094-B*	30A	Pink
6E5T-14A094-B*	30A	Pink
7T4T-14A094-D*	40A	Green
F8SB-14A094-C*	40A	Green
6EST-14A094-C*	40A	Green
7T4T-14A094-E*	50A	Red
F8SB-14A094-D*	50A	Red
6E5T-14A094-D*	50A	Red
7T47-14A094-F*	60A	Yellow
XS21-14A094-A*	60A	Yellow

Power Distribution Box



Smart Relay Box



4.22.2 Relays

NOTE: Only use Ford Relays shown in table.

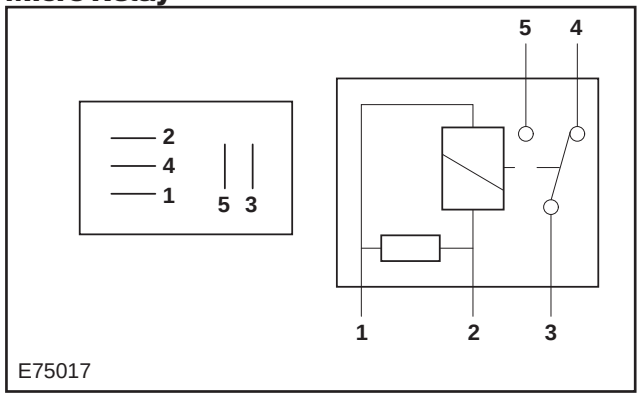
Ford standard relays have a nominal coil current of 300mA (max) at 25ºC. Relays with higher loads should not be used.

For maximum switching currents please refer to Relay Figure E75017.

Ford Relays

Part Number	Ampere Rating	Colour
5M5T-14B192-A*	20A	Black
5M5T-14B192-C*	40A	Black
5M5T-14B192-D*	40A	Black
5M5T-14B192-E*	70A	Grey
8T2T-14B192-C*	20A	Black
8T2T-14B192-A*	40A	Black
8T2T-14B192-B*	40A	Black
FU5T-14B192-A*	40A	Blue

Micro Relay

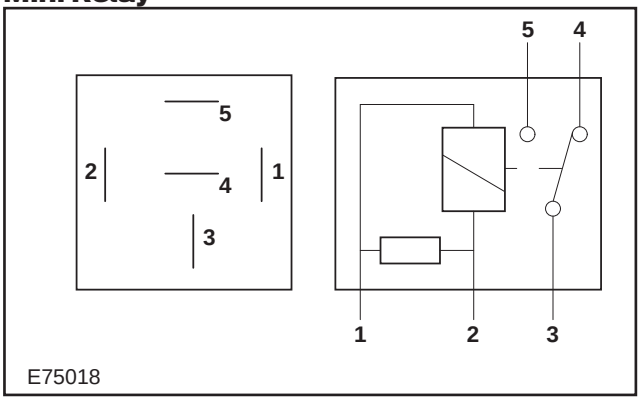


Micro Relay Parameters	
Open contacts	20A
Closed contacts	16A
Nominal coil current	300mA (max)

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

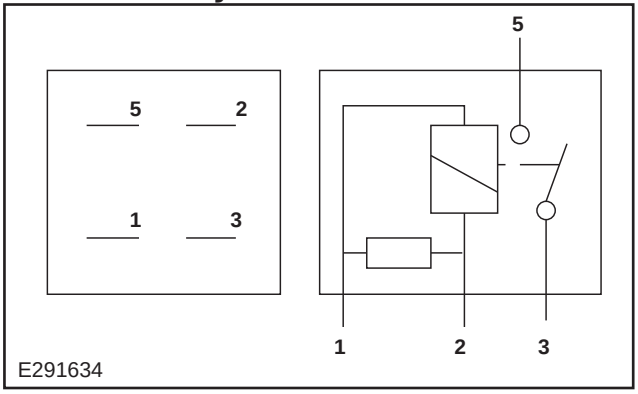


Mini Relay Parameters	
Normally open contacts	40A
Normally closed contacts	20A
Nominal coil current	300mA (max)

Medium current changeover relay — Part number: 6G9T-14B192-D*

Medium current normally open relay — Part number: 6G9T-14B192-C* (pin 4 not present)

Ultra Mini Relay



Mini Relay Parameters	
Normally open contacts	40A
Normally closed contacts	20A
Nominal coil current	300mA (max)

Medium current normally open relay — Part number: 8T2T-14B192-C*

4.22.3 Windscreen Wipers

The base wiper system should not be tampered with (controlled by Steering Column Control Module 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 200).

4.23 Special Conversions

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

4.23.1 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.

In addition to the Auxiliary Fuse Panel, a number of other kits are available to meet customer needs, see the 'Special Vehicle Option Harnesses and Aftermarket Kits' table.

4.23.2 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: 4.3 Communications Network (page 75).
BCM Output Information table.

For additional information on lighting loads
Refer to: 4.15 Exterior Lighting (page 141).

Special Vehicle Option Harnesses and Aftermarket Kits

Part Number	Description
GK2Z-14A411-AK	Refrigeration unit jumper harness(1)
KK2Z-14A411-K	C1 connector jumper harness (for Auxiliary Fuse Panel)
KK2Z-14A411-L	C2 switch connector jumper harness (for Auxiliary Fuse Panel)
KK2Z-14A411-M	Mating kit for vehicle interface connector
KK2Z-14A411-Y	Kit populated with 22 flyleads for populating A608 High Specification Vehicle Interface Connector
KK2Z-14A411-Z	Mating kit for A608 High Specification Vehicle Interface Connector
KK2Z-14A411-N	Utility pack connector jumper harness
BK2Z-14A411-AX	Beacon connector jumper harness
BK2Z-14A411-BM	C3 service jumper (for 2-way radio connector)
KK2Z-14A303-D	Beacon preparation pack (front switch harness)
KK2Z-14A303-E	Utility vehicle switch pack (front switch harness)
KK2Z-13A409-E	Utility vehicle switch pack (rear harness LHD)
KK2Z-13A409-F	Utility vehicle switch pack (rear harness RHD)
KK2Z-14A411-X	Trailer tow jumper
DG9Z-19H332-M	Trailer Tow Module (TTM)

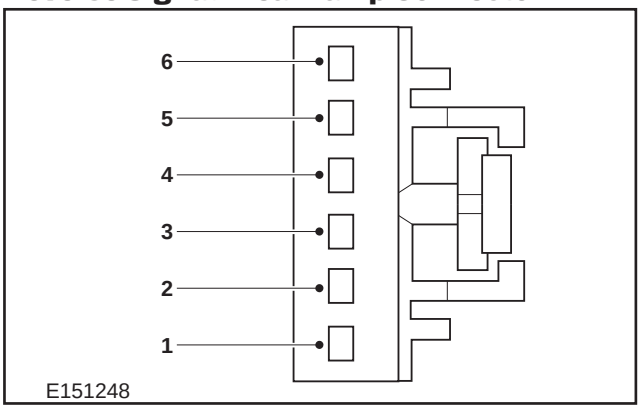
(1) If refrigeration pack is ordered, this jumper is included as part of the base vehicle

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.

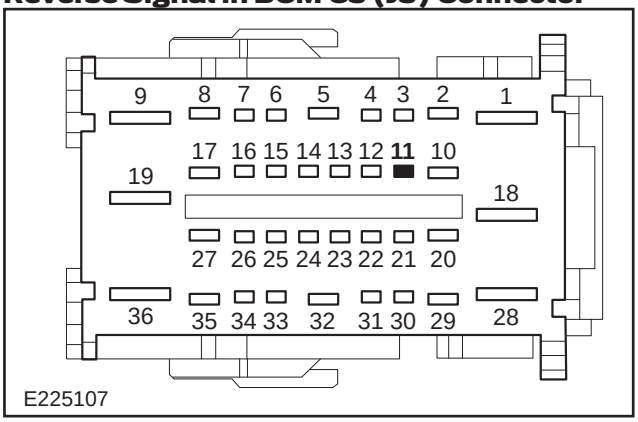
Reverse Signal/Rear Lamp Connector



Reverse Signal / Rear Lamp Connector - Van, Bus and Kombi

Pin		Function	Wire CSA	Colour	
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	Grey/Violet	Grey/Violet
6	1	Ground	1.5	Black/White	Black/Green
4	3	Fog lamp	0.5	White/Blue	White/Blue

Reverse Signal in BCM C3 (J3) Connector



Item	Description
Pin 11	Reverse signal

Pin 11 can be accessed from either male or female connector between harnesses 14401 to 14A005 or 14401 to 14405 (Green/Brown wire).

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.**

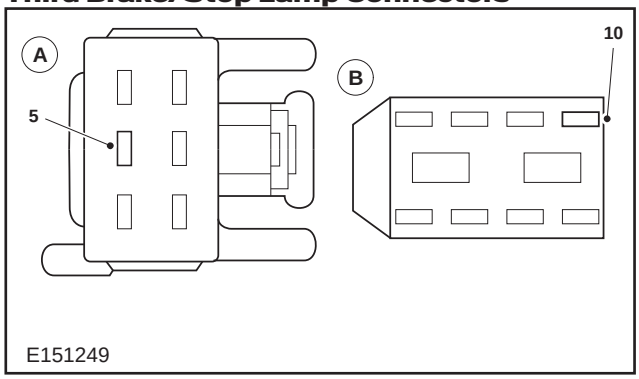
For more information refer to E225107 or
Refer to: 4.2 Wiring Installation and Routing Guides (page 63).
Refer to: 4.3 Communications Network (page 75).

Third Brake/Stop Lamp

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.

Third Brake/Stop Lamp Connectors



Item	Description
A	Left connector pin 5 on 14405 harness - Yellow/Grey
B	Right connector pin 10 on 14A005 harness - Yellow/Grey

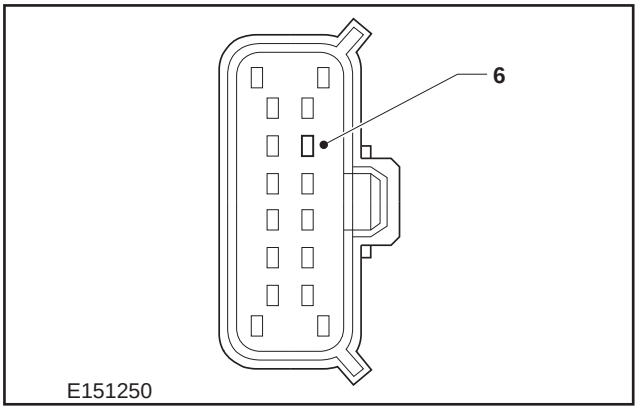
For connectivity, see Figure E151249 and the details given in the section for reverse signal. The third brake lamp feed can be accessed from the body side connector of 14405 harness (left, pin 5) or 14A005 harness (right, pin 10) which connects to the door

harness 13B472. These connectors are located at the rear of the vehicle near the interface of the rear door or lift gate wiring. This circuit can only have a relay added (maximum 300mA) to control additional lighting. Check with your local Ford dealer or National Company Sales representative for conversion compatibility.

Trailer Tow Connector

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 DG9T-19H517-AJ will need to be fitted to get the system active. For full trailer tow kit, BK2T-13B576-D* is also required.

Trailer Tow Connector



Item	Description
Pin 6	Stop lamp feed

For additional information on electrics for tow bars:
Refer to: 4.2 Wiring Installation and Routing Guides (page 63).

Additional Position Lamps at the Rear of the Vehicle

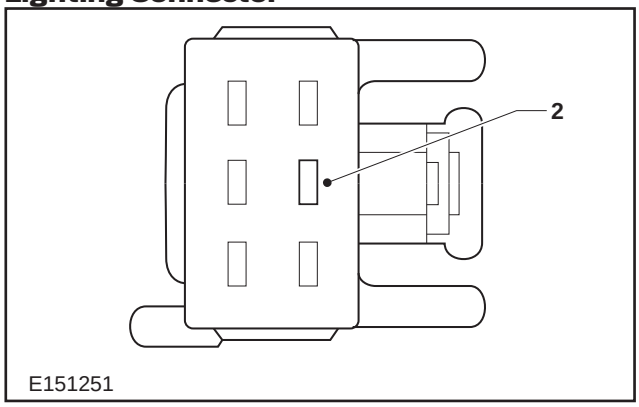
The feed for position lamps can be taken from the lighting connector, at the rear of the vehicle on 13B472 harness, pin 2, see figure E151251 or direct from the number plate feed connector, see figure E151252, which is located in the door.

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

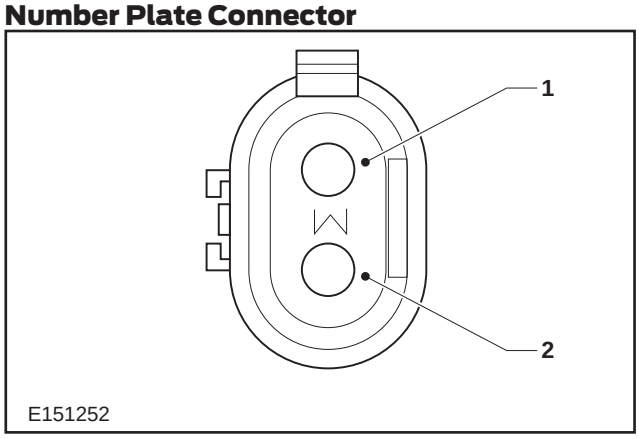
The electrical connections must be such that the front and rear position lamps, the end-outline marker lamps (if they exist), the side-marker lamps (if they exist) and the rear registration plate lamp can only be switched on and off simultaneously. This condition does not apply when using front and rear 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.

Lighting Connector



Item	Description
Pin 2	Position Lamps

Number Plate Connector



Item	Description
1	12V feed
2	Ground

For Lighting Loads:
Refer to: 4.15 Exterior Lighting (page 141).

Front Fog Lamps

NOTE: In case front fog lamps are required, it is strongly recommended to order the base vehicle with fog lamps fitted already in the plant. Retrofit of front fog lamps may require major rework, dependent upon the level of features on the vehicle. Please contact VCAS@ford.com for any front fog lamp retrofit questions.

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 directly per side is 1 x 21W rear and 1 x 21W (+5W side repeater in mirror) at front.

4.23.3 Auto Wipe and Auto Lamp for vehicles with large overhangs

NOTE: Where the modified vehicle has an overhang likely to cover part or all of the rain/light sensor position on the screen, see figure E147777, this may affect the sensor's ability to detect light or moisture to the defined calibration and will not function correctly.

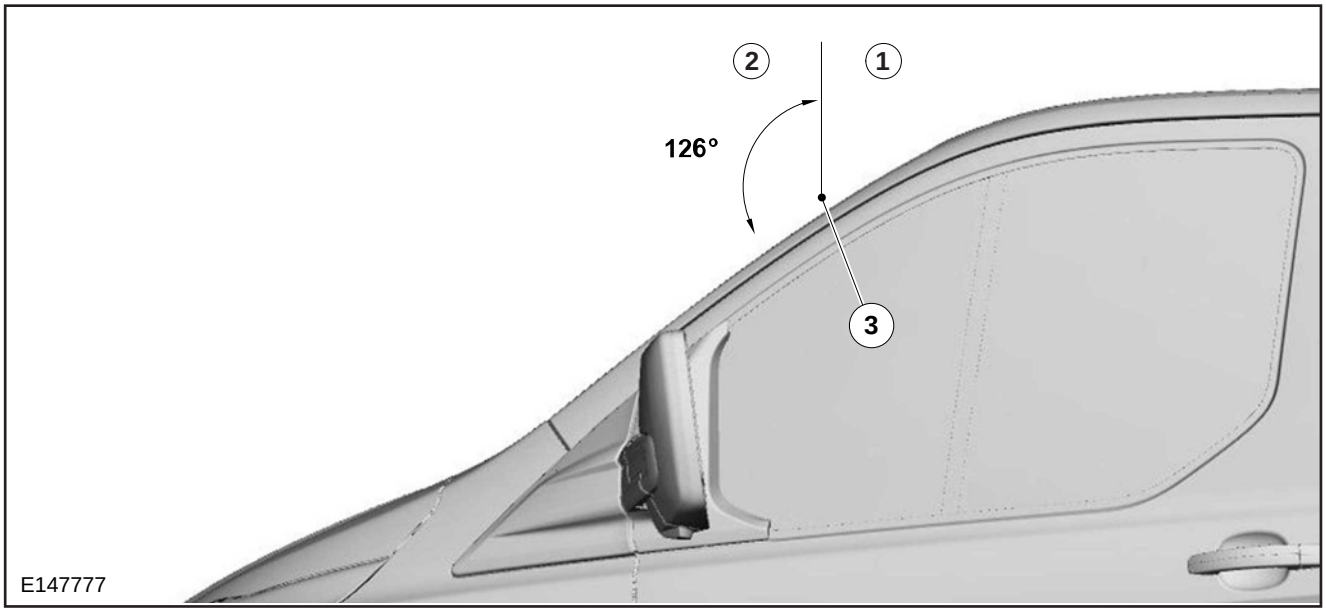
In the event that a donor vehicle has been supplied with these features, the vehicle can be modified to have manual wipers and headlamps in the following way.

For wipers, there is a cluster menu option to switch wipers to variable intermittent rather than rain sensing. Use this setting instead.

For Auto Lamps, changing the headlamp switch to a non-auto switch will remove the auto position and the system will operate as if no sensor was present. If the Auto Lamp headlamp switch remains the customer may experience dipped beam remaining lit instead of daytime running lights with the ignition on and the switch in Auto. A Ford dealer can help advise which switch should be ordered and fitted, starting with part number JX7T-13D061-**

Be aware, when no headlamp switch Auto position is available (or Auto is not selected on the original switch), auto high beam (provided with forward facing camera) will also not be available or shown in the cluster.

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

4.24 Electrical Connectors and Connections

WARNINGS:

The CAN-Bus should not be tampered with as this may lead to failure of safety critical components such as Anti-Lock Braking System (ABS). To access the CAN, ensure the High Specification Vehicle Interface Connector (A608) is ordered and the procedure followed, see later in this section for more details.

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

CAUTION: Only use Ford approved connectors.

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

4.24.1 General Information

Main Fuses

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. Vehicle Converter fit peripherals must not use this fuse as its sole purpose is protection of the starting and charging system.

This main fuse is not repairable; use only a Ford replacement part.

Wiring

NOTE: Ford approved jumper harnesses should be used.

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 (A608)
- 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 waterproof and with a drip loop.

Where wires are required to be extended, break in points should only be at existing connector points. If splicing into existing wiring is unavoidable, see wiring splicing procedures in this manual.

Refer to: 4.2 Wiring Installation and Routing Guides (page 63).

4.24.2 Customer Connection Points (CCP)

WARNINGS:

Before connecting to the vehicle you must remove the main vehicle ground to isolate the 12V system.

Only use the Ford approved kit for adding fuses to the CCPs.

DO NOT connect the same load to both CCP1 and CCP2. The system is not designed to work together as the fuses have different values.

CAUTION: When connecting to the CCP, it is recommended to disconnect the battery ground so as to avoid a short circuit. The fixing torque for CCP1 (M5) is 3.5–4.5Nm and for CCP2 (M8) is 12Nm.

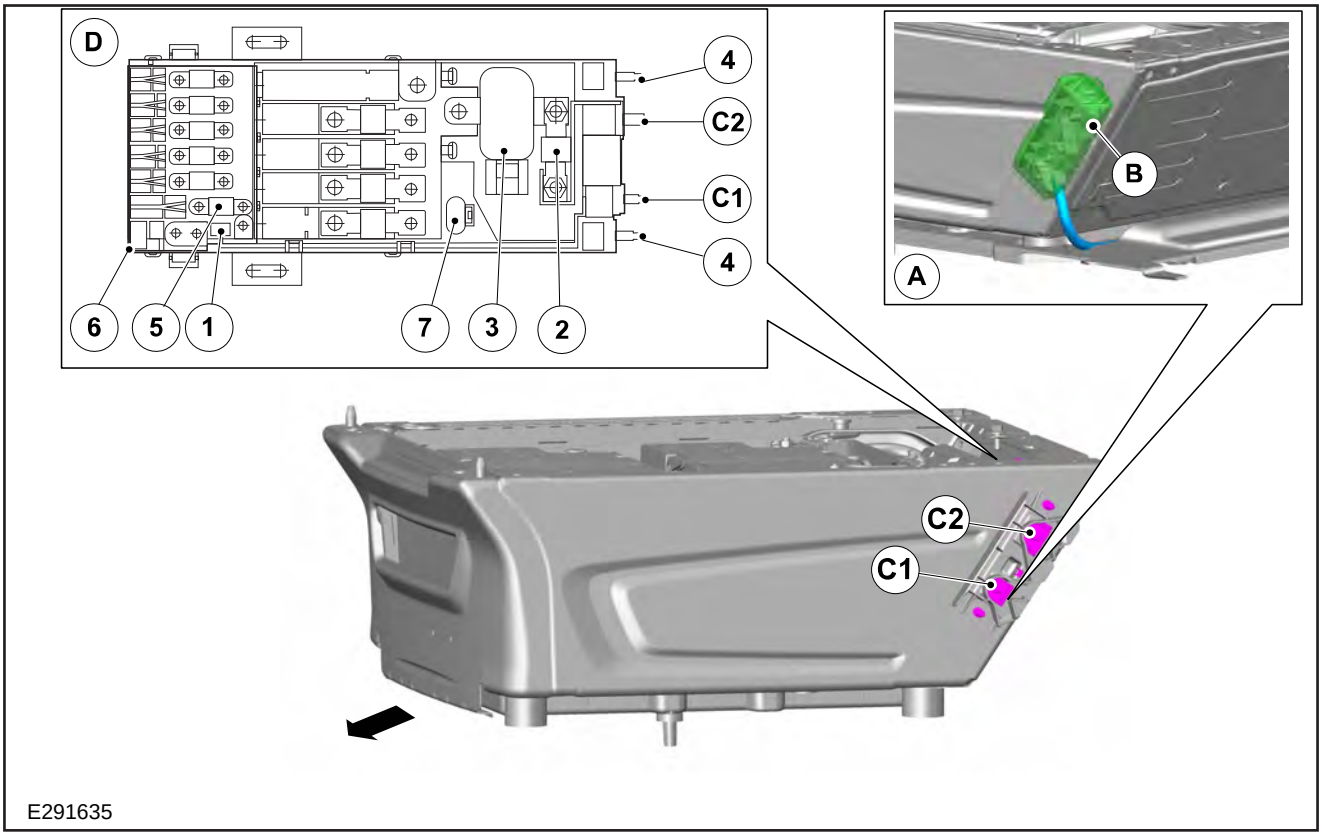
NOTE: When fitting additional power wiring feeds, the protective cover will need to be revised to allow routing for the extra wires. The cover is pre marked with the relevant areas so that they can be easily removed.

NOTE: There is a maximum of two CCPs. These points are always located on the driver's seat pedestal and are protected by a cover. CCP1 which is capable of supplying a max current of 60A and CCP2 which is capable of supplying a max current of 175A.

NOTE: Most vehicles with single battery will not have CCP2. Only those vehicles with twin batteries or certain SVO options with will have CCP2, check with your local Ford dealer for details. If CCP2 is required then order kit KU5T-14D089-B*.

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

CCP Location and Pre Fuse Panel



E291635

Item	Description
A	Suggested wiring location
B	CCP Cover
D	Pre Fuse Panel
C1	CCP1 (60A)
C2	CCP2 (175A)
1	60A fuse - supplies CCP1, High Specification Interface Connector (A608), Camper
2	175A fuse - supplies CCP2
3	CCP2 Load-shedding, and Standard Battery Guard (SBG) Relay
4	CCP cassette fixing studs (NOT to be used as grounding points)
5	150A SVO Auxiliary Fuse Panel feed
6	If any of the fuses in this area have failed, this section of the Pre-Fuse Panel will need replacing. Please contact VCAS@ford.com for service kit number.
7	Park position for relay connector control when single battery donor

E291635 shows the left hand drive situation where CCP2 is in the upper position. On a right hand drive vehicle the high current fuse box is rotated 180 degrees so CCP2 will be in the lower position.

For high current supply and ground connections Refer to: 4.6 Battery Systems (page 91).

4.24.3 High Current Supply and Ground Connections

For additional third party ground and +12V power cable connections to the Ford system Refer to: 4.6 Battery Systems (page 91).

Any peripherals totalling more than 60A added to the power supply must be connected via the CCPs, from dedicated fuses such as: the Auxiliary Fuse Panel (A526), the High Specification Interface Connector (A608) or the FPBG (A540). When the vehicle does not offer adequate power from the CCPs, see 'Third Party PTO for loads exceeding 175A' in this section of the BEMM.

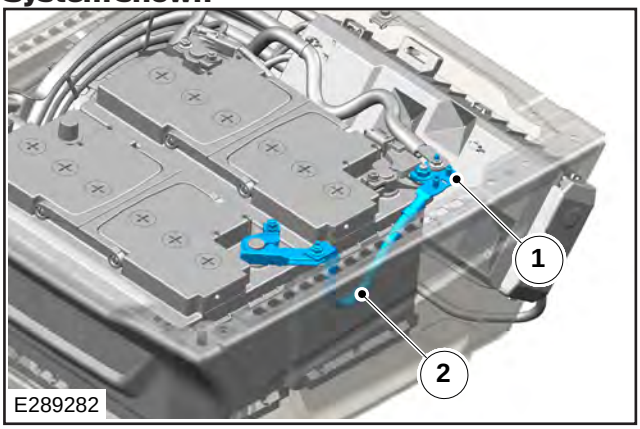
Camper vehicles: When fitting an additional battery, and an auxiliary battery circuit, if high loads are to be supplied, exceeding the CCP supplies or high in general, especially at ignition off loads, then an isolation switch disconnect relay should be fitted and controlled via the load-shedding signal.

This is to protect the vehicle start battery from a failed start and to protect system voltage when vehicle is moving. 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 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: 4.6 Battery Systems (page 91).

Auxiliary Ground Stud Eyelet - Twin Battery System shown



Item	Description
1	6mm Auxiliary Ground Stud for Converter Equipment - Torque 8Nm ± 0.8Nm
2	Battery Ground Jumper Cable part number KK2V-14301-K* for Twin Battery System

4.24.4 Camper Central Connectors

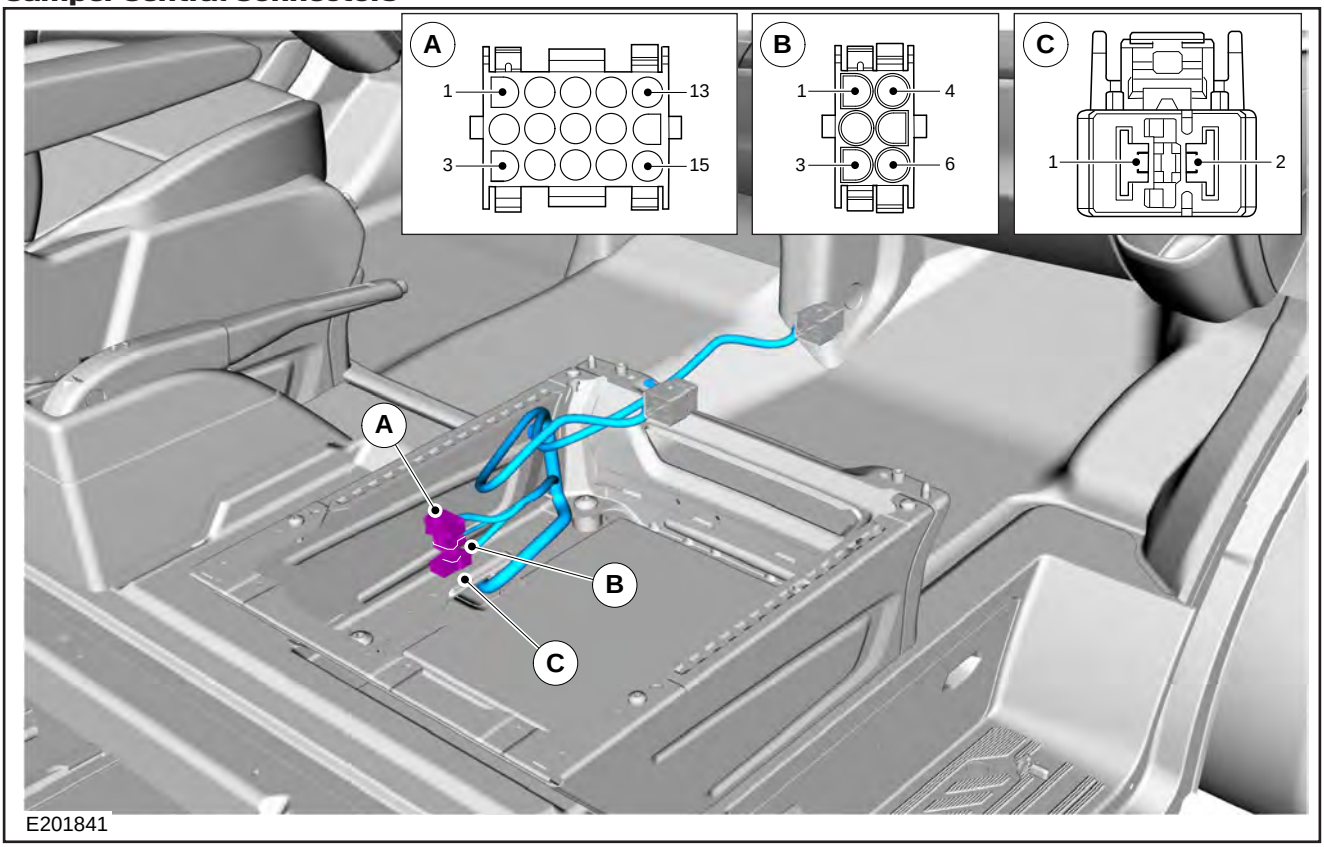
WARNING: If multiple systems are to use this supply, the total system load must not exceed the 60A short term loading.

Camper conversions are fitted with a dedicated main wiring harness. There is no CCP. Instead 3 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 Vehicle Converter during the installation. See CCP in this section for further information. The Vehicle Converter is responsible for good protection of the exposed wire to the CCP, 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 4ohm 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 8ohm.

For additional information
Refer to: 4.2 Wiring Installation and Routing Guides (page 63). Wiring Specification table for characteristics on continuous loads versus temperature.

Camper Central Connectors



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

Part Numbers for Vehicle Connectors and 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	Colour	Comments
Connector C2-1 (Figure E201841 - Item A)				
1	Stop lamp (CHMSL)	0.5	Yellow/Grey	16W max
2	Engine Run	0.5	Brown/Yellow	2.5A including existing lamps
3	Vehicle Speed Output	0.5	Violet/Orange	138Hz@100KPH, 50% duty cycle
4	Interior Lock Switch Input(1)	0.5	Grey/Yellow	Lock switch momentary signal to ground
5	Interior Unlock Switch Input(1)	0.5	Violet/Grey	Unlock switch momentary signal to ground
6	Rear Door Ajar	0.5	Grey	Local switch to ground (Circuit Closed=Door Closed).
7	Interior Light feed(2)	0.5	Green/Grey	300mA max
8	Auto Trans in Park	0.5	Grey/Brown	-
9	Lock Motor Output(1)	1.0	Violet/Green	15A Total (3A per latch) - Total load for locking all vehicle latches
10	Unlock Motor Output(1)	1.0	White/ Orange	15A Total (3A per latch) - Total load for unlocking all vehicle latches
11	Courtesy Light Dimming High Side Rear	0.75	White/Blue	PWM +12V 5A max including all existing rear interior lights
12	Auto Trans in Neutral	0.75	Green/White	-
13	Ignition (KL15)	0.75	Grey/Yellow	10A/F21 (SRB)
14	Third Party High Power mode	0.5	Violet/Grey	Grounded = Third Party High Power mode is Active
15	Reverse Signal	0.75	Green/Brown	+12V 300mA max

AEIS = Automated Engine Idle Shutdown

(1) The lock and unlock signals are intended to operate with Ford lock sets, or components with equivalent function and operational characteristics: – Central Locking and unlocking are a 110ms high side pulse. There is no double locking available via this connector.

(2) Interior light feed is a high side output used for demand lighting. It is battery saver timed to switch off after 30 minutes. Do not use this high demand load which will re-energise every time the door is opened.

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

Pin	Function	Wire CSA	Colour	Comments
Connector C2-2 (Figure E201841 - Item B)				
1	Load-shedding control	0.75	Black/White	Switched ground
2	Rear Speaker Left +	1.5	White/Green	Twisted pair
3	Rear Speaker Left -	1.5	Brown/Yellow	-
4	Rear Speaker Right +	1.5	Brown/White	twisted pair
5	Rear Speaker Right -	1.5	Brown/Blue	-
6	IP Illumination(1)	0.5	Brown	PWM +12V 300mA (nominal)
Connector C2-3 (Figure E201841 - Item C)				
1 (A)	B+ (KL30)	6.0	Green	60A Fed from Pre Fuse Box
2 (B)	B-	6.0	Black/White	Ground

IP= Instrument Panel, PWM= Pulse Width Modulation

(1) PWM output optimised for LED switch back lighting & dimmable when vehicle has IP dimmer fitted. Do not fit relays to this output.

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

4.24.5 Vehicle Interface Connector

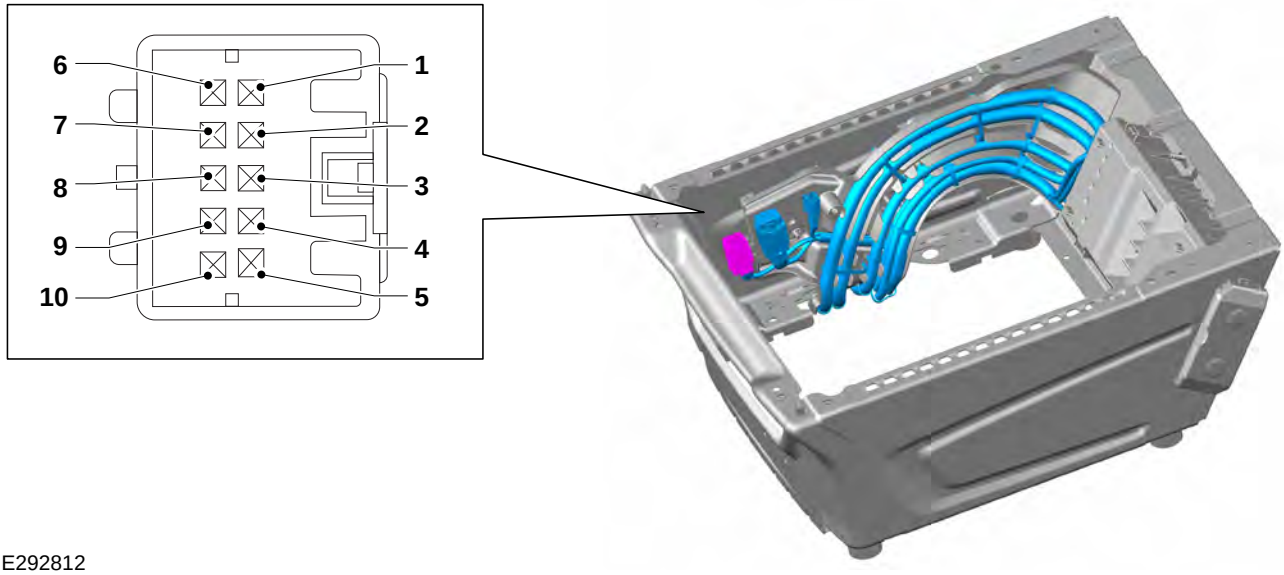
WARNINGS:

Signals 3 and 5 on the Vehicle Interface Connector are for sensing purposes only and not to be loaded by high current consumers.

The max current rating for signal 6 is 10A and signal 8 is 15A. These are not to be exceeded in any situation, this includes the total of the Ford system and third party system requirements.

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

The Vehicle Interface Connector provides a direct interface to signals. See figure E292812 for location and the following table for signals.



E292812

10 Way Vehicle Interface Connector Signals	
1	Ground
2	Engine Run
3	Third Party High Power mode
4	Load-shedding and SBG
5	Vehicle Speed
6	Ignition (10A to System Relay Box 1 F52)
7	IP Switch Illumination
8	Ford Programmable Battery Guard (15A to System Relay Box 1 F48) - +12V KL30
9	A608 only load-shedding and SBG (Pin not used if less A608)
10	Not Used

A service kit (KTKK2V-14A411-C*) can be ordered from your local Ford dealer, the kit contains the mating connector to access these signals, and 3m of wiring.

When the Auxiliary Fuse Panel is fitted to the vehicle, the Interface Connector is occupied by the attached wiring harness. In this case, these signals and some additional features are available through the C1 connector. For more details refer to Auxiliary Fuse Panel section.

Vehicle Speed

Square Wave Characteristics

	Specifications
Max High Signal	Battery Voltage
Min High Signal	3.67V
Max Low Signal	1.1V
Min Low Signal	- 1.1V
Max Ground Offset	± 1.0V
Rise Time	10µs <= tr <= 250µs
Fall Time	10µs <= tf <= 250µs
Duty Cycle	50% ± 10%
Pulse Rate	2.2Hz/MPH (1.3808Hz/KPH)

WARNING: Do not interface with the CAN (Controller Area Network) for vehicle speed.

Pin 5: Vehicle Speed signal is a direct current coupled square wave that varies in frequency in proportion to vehicle speed. This provides a square wave-form (50% duty cycle) signal, where a frequency of 138Hz equates to 100km/h.

Ignition

Pin 6: Ignition signal is protected by a 10A fuse. It is +12V active at ignition positions: Accessory (1) and Run (2). It is not active at Ignition Off (0) or Crank (3). Whilst it can drive equipment directly it is recommended to use this feed to control a converter fitted relay, especially for high current applications.

Switch Illumination

Pin 7: Switch illumination signal is only to be used for sensing. It is a PWM signal only for low current illumination 300mA max, that can be dimmed and not used 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'.

The load-shedding 10A ground signal must be used for power control. The engine run feature can only be used to control power if the load-shedding signal has overall control, for example to activate a power relay. Engine run can be used for other systems such as telematics and data loggers.

Pin 4: Load-shedding with Battery SOC Protection switched ground signal is a signal that must always be the primary controlling signal to be used to handle third party loads totalling over 60A.

Refer to: 4.7 Battery Protection (page 105).

The engine run feature can only be used to control power if the load-shedding signal has overall control, for example through a power relay. Engine run can be used for other systems such as telematics and data loggers.

This feature will supply power at engine run, and at engine off it will isolate when the battery reaches the timer or SOC value. At engine run, the signal will extinguish if voltage drops to below 11V. This is to protect critical systems such as EPAS. The voltage of the system should not drop below 13V for continuous periods. If this occurs, the extra equipment added, is exceeding supply and supplemental energy sources may be required, such as additional alternators.

Pin 2: Engine run signal will only support a sense line or relay control that is in **AND** logic with the load-shedding signal.

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.

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)

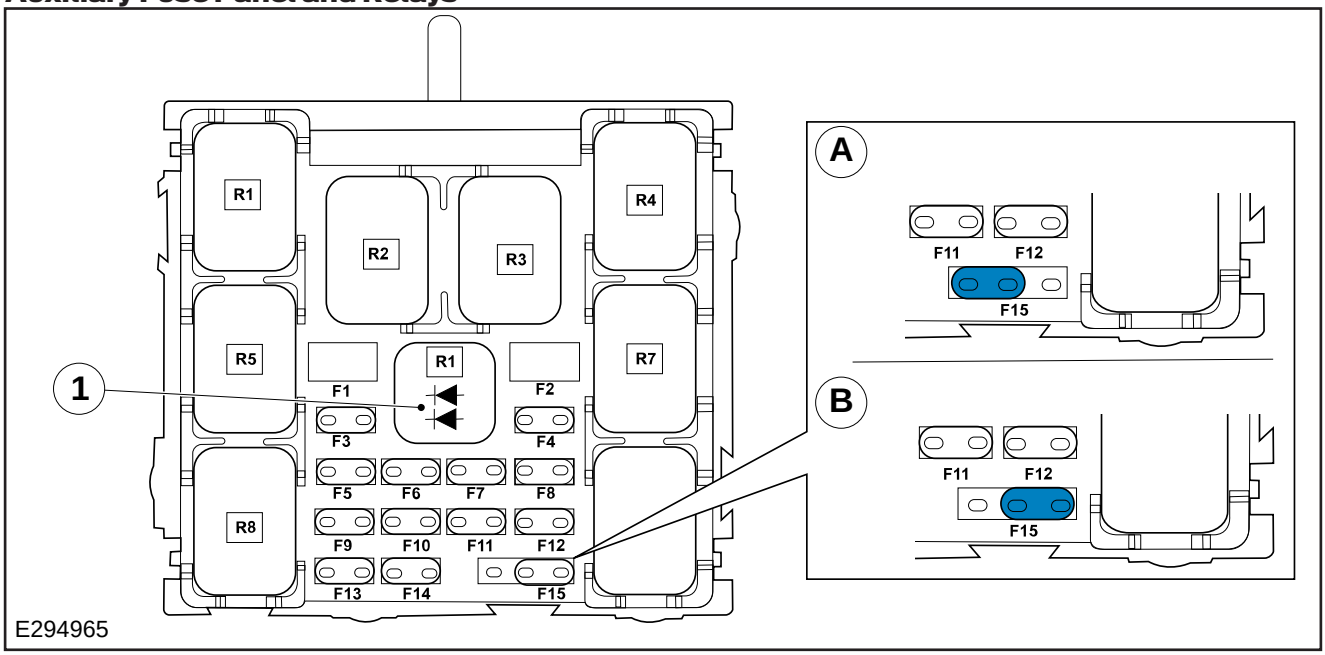
Due to Start-Stop vehicles, the signal may switch up to 300,000 times. Provision is required for control relays switched by this signal to meet this durability cycle.

4.24.6 Auxiliary Fuse Panel (A526)

NOTE: The Auxiliary Fuse Panel cannot be retrofitted and so must be ordered for factory fitment.

NOTE: Where a load-shedding relay in the fuse panel is controlled by a separate 12V input, it is recommended that a diode is added to avoid any sneak current path and uncontrolled battery drain or incorrect functionality.

Auxiliary Fuse Panel and Relays



Item	Description
A	Ignition Only position of F15
B	Permanent Power Only position of F15
1	Diodes (1A rated) - Make sure the diodes are orientated correctly (as above) or they will not work

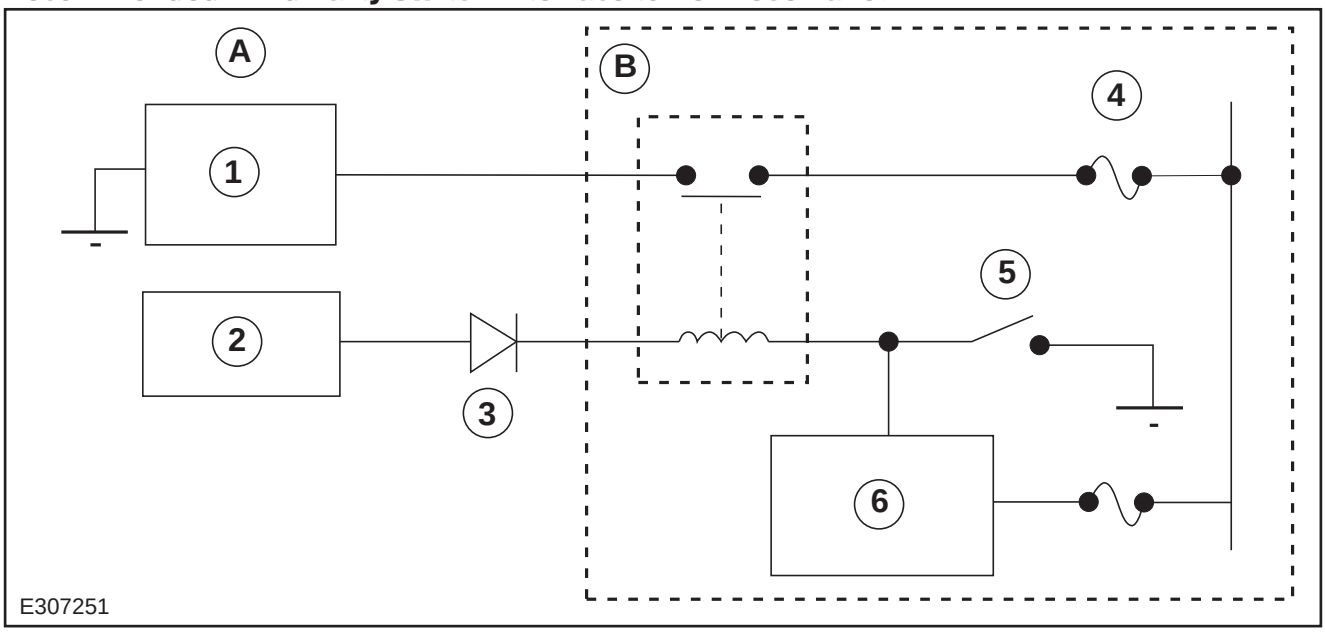
Item	Description	Item	Description
F1	40A Fuse	F14	5A Fuse
F2	40A Fuse	F15	3A Fuse
F3	20A Fuse	R1	20A Relay (Beacon(1))
F4	20A Fuse	R2	40A Relay (Aux1 power)
F5	10A Fuse	R3	40A Relay (Aux2 power)
F6	3A Fuse	R4	20A Relay (Ignition)
F8	10A Fuse	R5	20A Relay (LHS Indicator)
F9	15A Fuse	R6	Ultra micro relay. Ground to set Third Party High Power mode when Beacon Switch is ON
F10	5A Fuse	R7	20A relay (Interior light)
F11	5A Fuse	R8	20A Relay (RHS Indicator)

(1)When specified on Ford options
Any pin/fuse not listed in the table above are not to be used.

The Auxiliary Fuse Panel is recommended for Vehicle Converters where access to fused power connections are required (for example, additional lighting), see figures E260372 and E260373 A dedicated wiring harness (KK2V-14517-A*/B*) is used to implement the Auxiliary Fuse Panel to the vehicle. The Auxiliary Fuse Panel is located behind the glove box and slightly outboard behind the removable cup holder. The main power is supplied by a 150A fuse in the high current fuse panel, located in the driver's seat pedestal. Critical signals are obtained from the standard interface connector. If the signals are still needed for other third party add-on systems, the fuse panel comes with a cloned standard interface connector, packaged slightly higher in the driver's seat pedestal. The Auxiliary Fuse Panel uses the Vehicle Interface Connector, shown in figure E292812, 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.

There are 4 relays that can be controlled via third party input switches (when ordering the stand alone fuse panel A526). Two of the outputs can switch 40A per circuit.

Recommended Third Party Switch Interface to Aux Fuse Panel



Item	Description
A	Third Party Fit System
B	Fuse Box Sub-System
1	Third Party Device to Power
2	Third Party +12V Input
3	Recommended To Add a Diode to the 12V Input Feed to Avoid a Back Feed Sneak Path
4	Fused Supply to Contacts
5	Load Shedding Ground
6	Other Auxiliary Fuse Panel Relays

Features

- The fuse panel comes from production, 'powered at ignition position 2' only and 'not powered at all times'. This is to avoid any discharged batteries during the shipping and conversion process. Once switched and peripherals are added, the fuse panel can be configured to 'powered at all times' by the jumper fuse relocation from position A to B, as shown in figure E294965. It is recommended to change to the permanent power mode after the third party equipment has been added and near the end of the total conversion.
- In the Auxiliary Fuse Panel, all switched relays are now controlled via the 'load shed' signal, which also functions as a 'battery guard' feature at 'engine off'. There are no 'engine run' controlled signals. If 'engine run' control is added, it must be '**AND** logic', not '**OR** logic' with the 'load shed' system. Even when 'engine run' control is required, the total vehicle third party system load must not exceed 60A. This total includes use of CCP1.
- At 'engine off', under 'SBG' control, the BCM provides the following timers and SOC values before disconnect. The timer resets each 'ignition on' and in 'engine run'.
  - For a single battery and non-AGM, 30 minutes activation limit and 60% SOC limit.
  - For a twin AGM battery (in vehicle configuration) the timeout is 75 minutes and SOC limit is 40%.
- If the 'Third Party High Power Mode' feature is activated, the timeout on the SBG is suppressed so the system will isolate only on the battery SOC limit. The FPBG (A540) operation is unaffected. If a more finely tuned and prolonged energy availability is required, it is recommended to also order the Ford Programmable Battery Guard (A540) which allows a 3 hour timer and down to 20% SOC performance.

Refer to: 4.7 Battery Protection (page 105).

- The Auxiliary Fuse Panel outputs, controlled by 'load shedding', and excluding the relay driven direction indicators, may switch off at engine 'drive run' mode in the event of a low voltage (11V). This is designed to protect EPAS which is now standard on the Ford Transit. If the system is continuously reaching this low voltage, there may be an issue with the energy sources or the third party system demand is greater than the supply. System voltage should not drop below 13V for continuous periods. Check each system's energy supply is compatible with the add on third party equipment and Ford system demands.
- There is a dedicated 40A output connection,

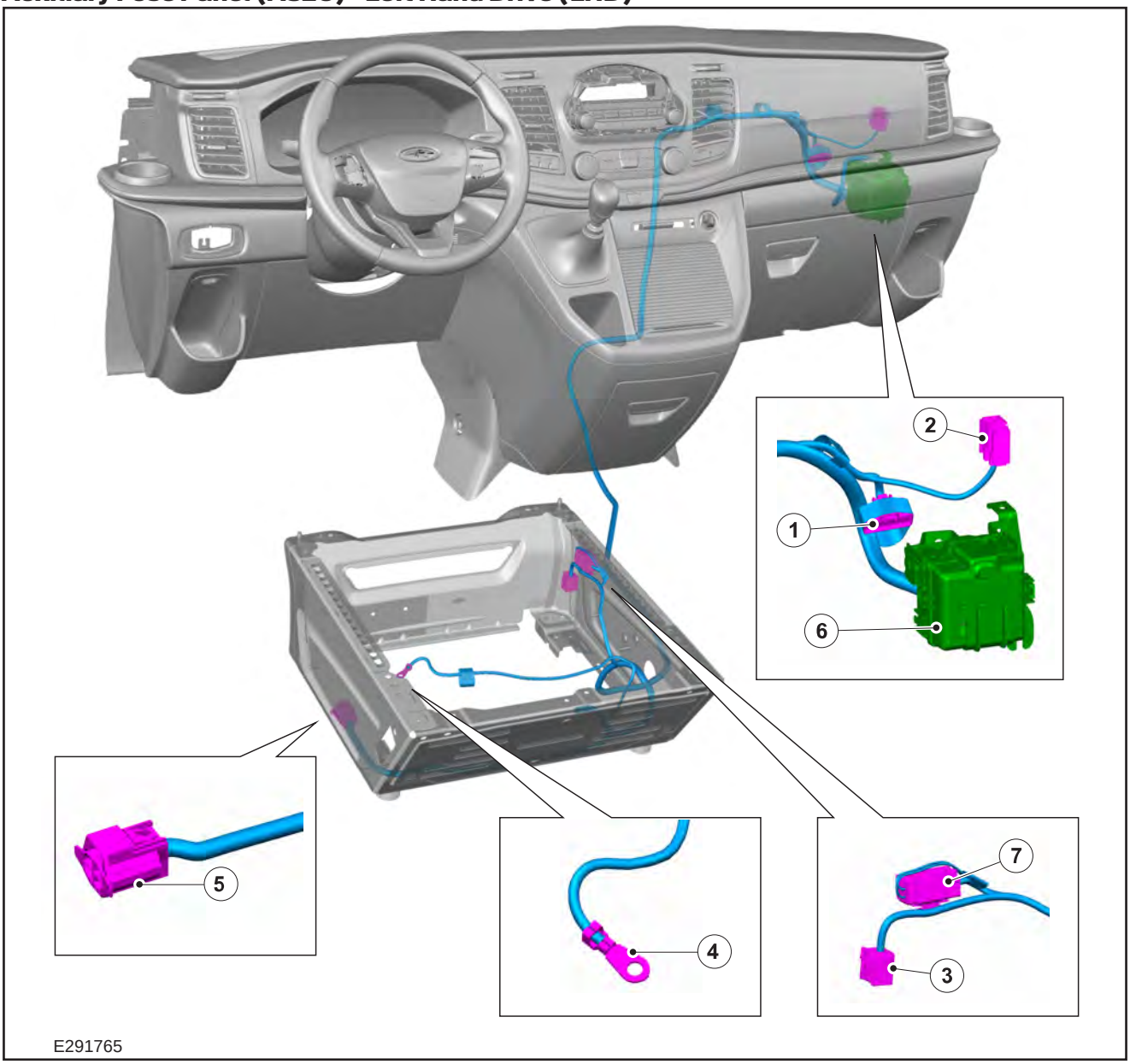
separate to the C1 and C2 traditional connectors. This is mounted onto the fuse box housing.

- The 43-way interface connector (when ordering A608) is also mounted to the fuse box housing.
- The 10-way standard interface connector, shown in figure E292812, is cloned nearby and is located in the driver's seat area. Extra signals for third party equipment can be obtained from here with the same dealer service kit part number KTKK2V-14A411-C*. If the FPBG is also fitted, this cloned connector will be utilised. To get the same signals for other equipment, the FPBG will offer these signals.

Refer to: 4.7 Battery Protection (page 105).

- The Auxiliary Fuse Box is fed from a 150A fuse F06, in the driver's seat pedestal, high current fuse panel, with the control grounds from the battery ground stud. If this fuse is an open circuit, then a complete fuse assembly is required.
- The SBG signal in the standard interface connector (cloned pin 3) must be used to control a third party relay (non-latched normally open type) if the CCP2 cannot be utilised and more than 60A is required.
- The mating connector supplier part number for the switch output wiring is 4S7T-14A4599-YL*

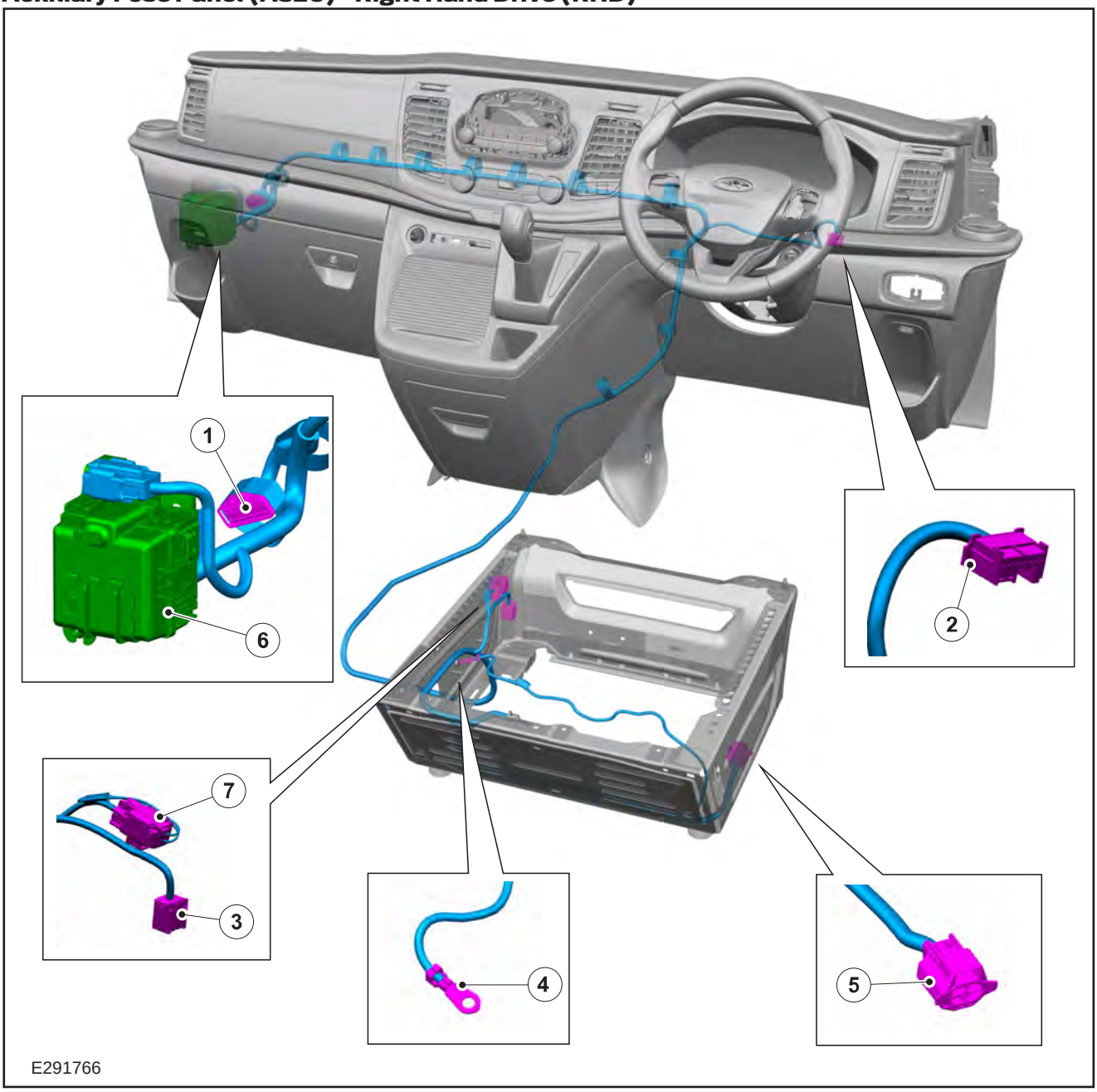
Auxiliary Fuse Panel (A526) - Left Hand Drive (LHD)



Item	Description	Item	Description
1	C1 Connector	5	C3 - 2 Way Radio Connector
2	C2 Switch Connector	6	Auxiliary Fuse Panel
3	Vehicle Interface Connector 1	7	Vehicle Interface Connector 2*
4	Ground		

* Only suitable to be used with FPBG (A540). No other connections to be made via this connector. If certain signals are required go to the Auxiliary Fuse Panel (A526), FPBG (A540) or High Specification Interface Connector (608) directly.

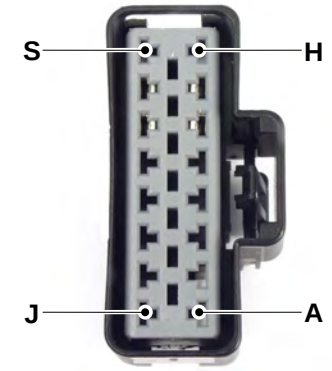
Auxiliary Fuse Panel (A526) - Right Hand Drive (RHD)



Item	Description	Item	Description
1	C1 Connector	5	C3 - 2 Way Radio Connector
2	C2 Switch Connector	6	Auxiliary Fuse Panel
3	Vehicle Interface Connector 1	7	Vehicle Interface Connector 2*
4	Ground		

* Only suitable to be used with FPBG (A540). No other connections to be made via this connector. If certain signals are required go to the Auxiliary Fuse Panel (A526), FPBG (A540) or High Specification Interface Connector (608) directly.

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 E291765 and E291766. The mating connector for the C1 is DELPHI 15326956. The fuse ratings, relays and circuits are shown in figure E102527 and table. A service kit (KTKK2V-14A411-A*) can be ordered from your local Ford dealer, this kit contains the mating connector, and 3m of wiring.

C3 - 2 Way Radio Connector

E152951

Item	Description
1	KL30 20A
2	Ground

C3 Mating Kit - KTBK2V-14A411-H*

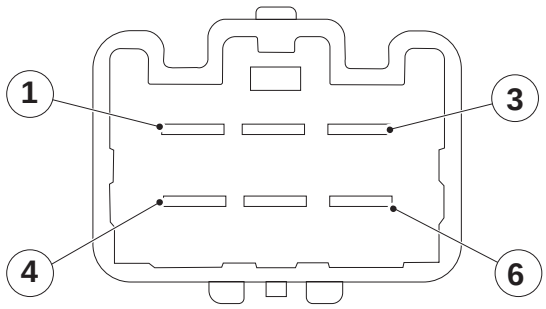
C2 Switch Connector

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 Kit — KTKK2V-14A411-B*

C4 Connector



E308466

Item	Description
1	Relay 2 Output (40A)
2	Not to be used
3	Ground
4	Relay 3 Output (40A)
5	Not to be used
6	Ground

4.24.7 Beacon Preparation Pack (A606)

NOTE: The Beacon switch symbol is now illuminated at 'ignition' on or by permanent power, depending on fuse F15 position in the Auxiliary Fuse Panel.

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, KK2V-13D768-A*, see figure E175195 for switches and see figures E291765 and E291766 for Auxiliary Fuse Panel, shown in this section.

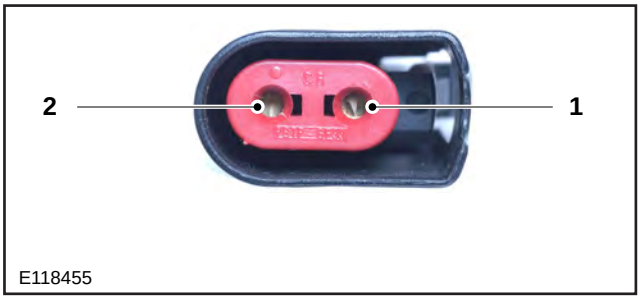
The Beacon Switch pack (A606) switches 20A of 12V power and is switch protected by F15 (20A output by F3). The beacon power at 'engine off' is now protected by the SBG so that in the event of excessive battery drain, isolation occurs, the operator can still start the engine, reactivate the beacons and drive away from a potential hazardous location. Beacons could also be deactivated in an overload condition at 'engine run', for example, the voltage falls to 11V whilst driving and the alternator or DC/DC is active. This is to protect EPAS. If this regularly occurs there may be an issue with the vehicle where the energy demand is exceeding supply, saturating energy supplies leading to a voltage drop.

Refer to: 4.7 Battery Protection (page 105).

The fuse box relay control is factory set to 'ignition supply' only. If the conversion requires direct from the battery supply (KL30 but on SBG) the logic fuse (F15) needs to be moved to a permanent power mode.

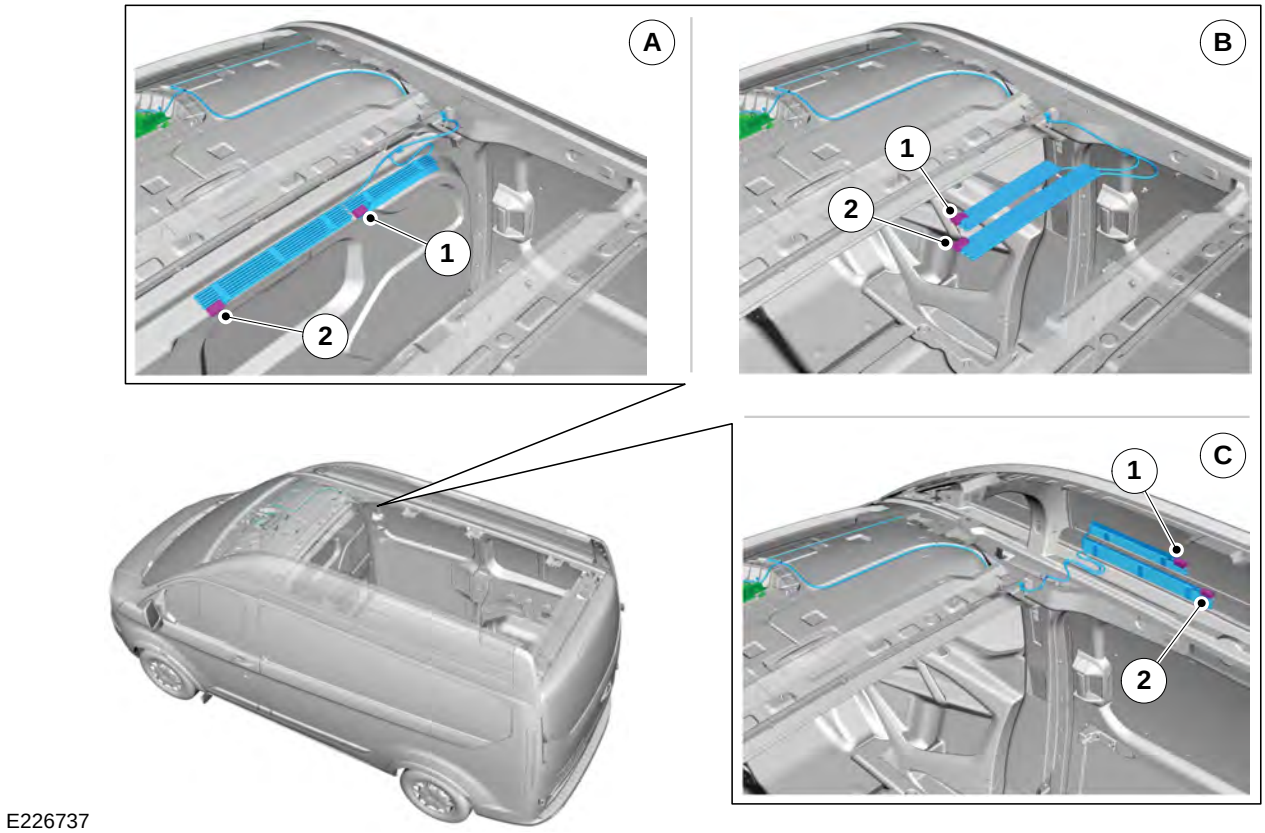
If 'ignition logic', the beacon symbol will only illuminate when the vehicle key is in the ignition position. If in permanent power mode, the symbol will always be illuminated, even with the key out.

The illumination will be turned off by the vehicle the SBG or FPBG (A540). The illumination will also be turned off in a 'load shedding' event whilst driving. To reactivate the system, either an ignition cycle may be required or the vehicle will need to be restarted. Another solution could be to plug in an external power charging source for the 12V system, as the battery guard system may have been initiated due to the vehicle's batteries having a low SOC.



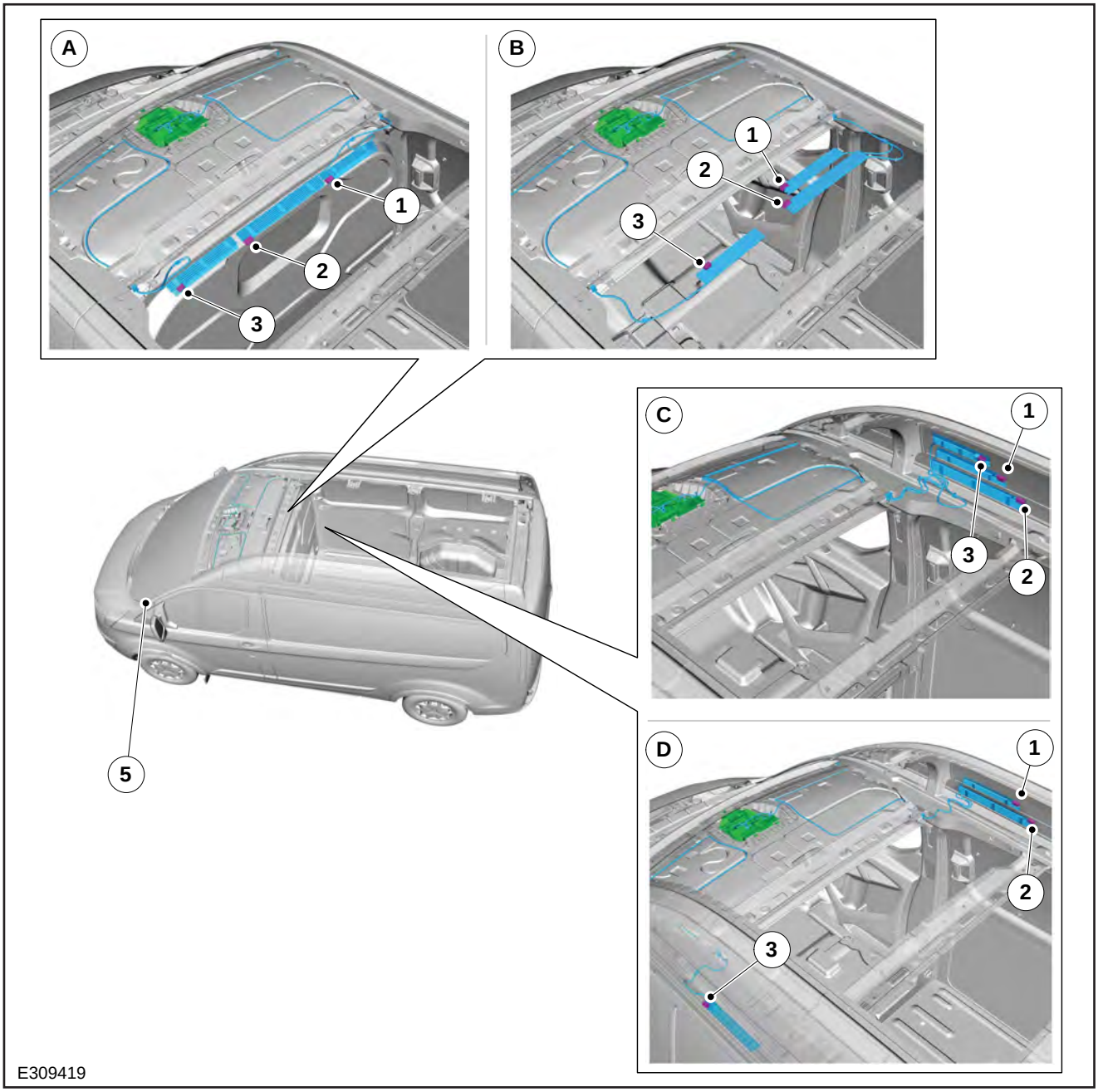
Item	Description
1	Ground
2	Beacon Supply

Beacon Preparation Pack



Item	Description
A	Vehicles with a bulkhead
B	Low Roof vehicles (without bulkhead)
C	High Roof vehicles (without bulkhead)
1	Front Beacon harness on LHD KK3V-14659-J* (shown)/ RHD KK3V-14659-R*
2	Rear Beacon harness on BK3V-10A933-B*

Utility Vehicle Switch Pack - 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(1)
D	High Roof LHD Vehicles (without bulkhead)	5	C1 and C2 Mating Connector - See E291765 (LHD) or E291766 (RHD) for location

(1) Limited availability

4.24.8 Utility Vehicle Switch Pack (A626)

The Utility Vehicle Switch pack has the Beacon Preparation Pack included.

Harness KK3V-14659-** is always on the passenger side of the vehicle. The beacon wiring connects to the C2 connector of the fuse box harness 14517. The utility pack shares the C2 connector with the beacon wiring and its power outputs connect to the C3 connector of the fuse box harness KK2V-14517-**; see figures E291765 and E291766 for C1 connector location and also figure E152954 for switches.

The Utility Switch Pack (A626) contains a Beacon switch and Aux1 and Aux2 switches. This option is now compatible with the High Specification Interface Connector (A608). The Beacon Switch functionality is as described in the Beacon Preparation Pack (A606). Aux 1 and Aux 2 supply is the same as the Beacon with factory fit ignition logic that can be changed to permanent battery power by the Vehicle Converter, by changing the logic control fuse as identified in the Auxiliary Fuse Panel section. The Aux 1 and Aux 2

switched outputs are 40A each. Outputs Beacon and AUX2 are located in the cargo area. Output AUX1 is located on the lower A-Pillar, behind the IP. There is no longer 'engine run only logic' on the Aux 2 switched output. This has been replaced by the 'battery guard' feature to prevent a failed start.

If similar logic is required, it is recommended to utilise the ignition status and control third party power relay.

NOTE: The Beacon, Aux 1 and Aux 2 switch symbols are now illuminated at 'ignition on' or by permanent power depending the position of fuse F15 in the Auxiliary Fuse Panel.

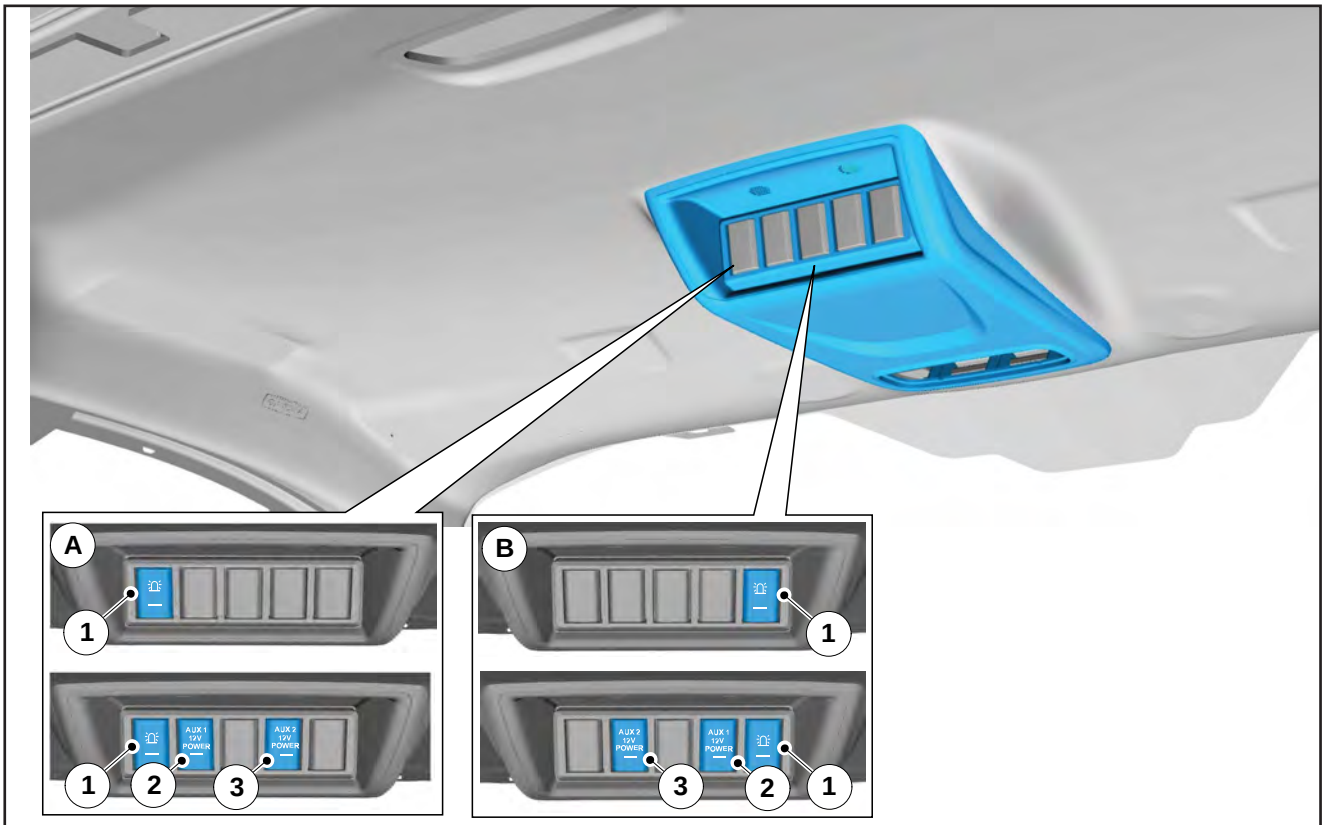
If ignition logic, the switch symbol will only illuminate when the vehicle key is in the ignition position. If in permanent power mode, the symbol will always be illuminated, even with keys out. The illumination will be turned off by the vehicle SBG or FPBG (A540). The illumination will also be turned off in a 'load shedding' event whilst driving. To reactivate the system, either an ignition cycle may be required or the vehicle will need to be restarted. Another solution could be to plug in an external power charging source for the 12V system as the 'battery guard' system may have been initiated due to the vehicle's batteries having a low SOC.

4.24.9 Auxiliary Switches

NOTE: Aux 1 and Aux 2 switches will be powered at all times. They will be controlled by 'load shedding' and SBG or FPBG. Any device from previous installations, relying on the engine run control only, will now be powered at 'engine off'. Therefore, extra cycling should be considered; for example, with a water heater.

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 or 40A output.

Switch Locations



E152954

Item	Description
A	LHD Switch options
B	RHD Switch options
1	Beacon
2	Aux 1 — Part of Utility Vehicle Switch pack (A626)
3	Aux 2 — Part of Utility Vehicle Switch pack (A626)

Switches and Harness Part Numbers

Harness	Beacon	Aux 1 (12V)	Aux 2 (12V)
KK2V-14A303-A*	KK2V-13D768-A*	-	-
KK2V-14A303-F*	KK2V-13D768-A*	KK2V-13D734-A*	KK2V-13D734-B*

If heavy loads are required, controlled via these switches (especially at 'engine off'), it is recommended to install the High Performance Deep Cycle AGM Battery option (HFQ). The switches are illuminated red when the lights are: side, dipped, full beam or auto lights on. They switch +12V and can switch up to 8A directly.

4.24.10 High Specification Vehicle Interface Connector (A608)

NOTE: For access to individual CAN-Bus relay signals, please contact the Vehicle Converter Advisory Service at VCAS@ford.com

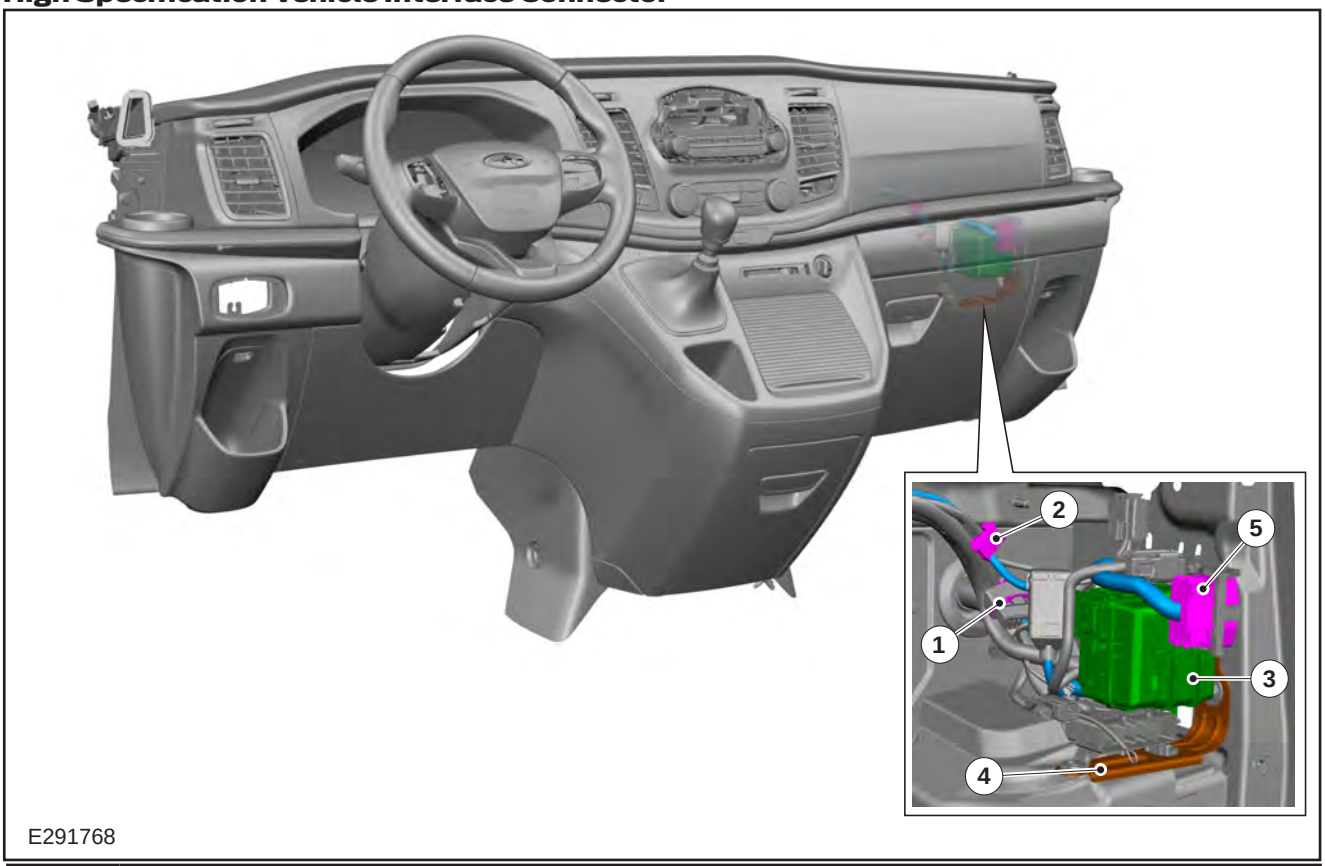
The standard system includes the Auxiliary Fuse Panel and a 6-way supplemental fuse panel, located in the Instrument Panel, behind the glove box. It is powered by 1 x 60A fuse in the High Current Fuse Panel and connected at the factory. The CCP2 175A is unused for the Blue Light system and can be utilised for high powered devices separately. The High Specification Interface connector (43-way) is an order only option (A608) and cannot be updated after the vehicle is built. The connector is located behind the glove box and mounted to the Auxiliary Fuse Panel casing, see figure E291768. The system provides multiple signals, power and ground with extra features over previous versions. This can be utilised for high specification utility, Police and emergency services. New features include a SBG and 'load shedding' control signal which must be utilised if the CCP2 relay is not available or sufficient. AC active is now present, where third party systems can remotely control the Ford AC system. There is a RunLock +12V Input pin designed to receive 12V feed into the ignition circuit to maintain engine run, with keys out (please note that safe and secure third party added interlocks would be required to finish off the system). This is at the discretion of the installer with no liability by Ford.

A standard mating connector with the link wire is provided production fit. A service kit is available (KK2Z-14A411-Y) which includes 22 crimped pins wired at 1 meter but not populated. Ensure correct population by referencing the High Specification Vehicle Interface Connector for the features required and by ensuring that the large power and ground cavities get the large size wires from the kit. If more than 22 circuits per vehicle are required, then a second kit should be purchased. When all routing and splicing is complete, it is advised to mechanically protect and control all wiring near sharp edges.

NOTE: Mating change on the 43-way connector of the SVO A608. The supplied connector on the Vehicle harness is now male instead of female. Male connector on the 14401 (was female) Female connector in the service kit 14A411 (was male)

Refer to: 4.2 Wiring Installation and Routing Guides (page 63).

High Specification Vehicle Interface Connector



E291768

Item	Description
1	C1 Connector
2	C2 Connector
3	Fuse Box — For High Specification Vehicle Interface Connector
4	Fuse Box Bracket
5	High Specification Vehicle Interface Connector

High Specification Vehicle Interface Connector

Cavity	Wire	Signal	Comments	Fuse	Fuse Rating	Nominal Rating
1	1.00	KL58 - shed		8Aux	10A	8A
2	Not Used	-	-	-	-	-
3	2.50	KL31-unshed	Ground	6 BL	20A	16A
4	Not Used	-	-	-	-	-
5	2.50	KL31-unshed	Ground	5BL	20A	16A
6	2.50	KL31-unshed	Ground	4BL	20A	16A
7	0.75	KL30-unshed	Battery Supply	1BL	10A	8A
8	0.50	KL30-unshed	Battery Supply	2BL	5A	4A
9	1.00	KL30-unshed	Battery Supply	3BL	15A	12A
10	Not Used	-	-	-	-	-
11	Not Used	-	-	-	-	-
12	0.75	Load-shedding and SBG	Load-shedding and SBG switched ground signal	-	-	-
13	1.50	Lock Motor Output	reverse polarity with pin 14 for lock/unlock	-	-	-
14	1.50	Lock Motor Output	reverse polarity with pin 13 for lock/unlock	-	-	-
15	0.75	KL15 -shed	Ignition from R4	10Aux	5A	4A
16	1.00	KL15 -shed	Ignition from R4	11Aux	10A	8A
17	0.75	KL15 -shed	Ignition from R4	14Aux	5A	4A
18	0.75	RunLock	Spliced into ignition barrel position 2, apply 12V to keep ignition alive.	-	-	-
19	0.5	Rear Door Ajar Switch	Door Open = Ground (<50ohms)	-	-	-
20	0.5	IP and Switch Illumination	Pulse Width Modulation Signal from BCM	-	-	300mA
21	0.5	AC Active	Ground = AC Active (<50ohms)	-	-	-
22	0.75	Stop Lamp Signal	Pulse Width Modulation Signal from PCM	-	-	2.5A[4]
23	0.50	Third Party High Power mode	Ground = Third Party High Power mode	-	-	-
24	0.50	LHS Sliding Door Ajar	Door Open = Ground (<50ohms)	-	-	-
25	0.50	Passenger Door Ajar	Door Closed = Ground (<50ohms)			-
26	0.50	Parking Lamps	Pulse Width Modulation Signal from BCM	-	-	300mA
27	0.50	RHS Sliding Door Ajar	Door Open = Ground (<50ohms)	-	-	-
28	1.00	Turn Indicator LHS	Fuse and Relay located in Aux Fuse Panel in seat pedestal	5Aux	10A	8A
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. 138Hz@100KPH, 50% duty cycle	-	-	-
32	0.75	Reverse Signal	PWM Signal from BCM	-	-	300mA
33	0.75	High Beam	Output from BCM	-	-	300mA
34	0.75	Low Beam	Output from BCM	-	-	300mA
35	Not Used	-	-	-	-	-
36	0.75	KL50	-	-	-	300mA
37	0.50	Handbrake Signal	Handbrake Activated = Ground (<50ohms)	-	-	-
38	0.50	Engine Run	Engine Running Ground [3]	-	-	-
39	0.75	No Start Function	-	-	-	300mA
40	0.75	Key In[2]	12V	-	-	30mA
41	0.50	Driver Door Ajar	Door Closed = Ground (<50ohms)	-	-	-
42	0.50	Lock Switch Input	Lock switch momentary signal to ground	-	-	-
43	0.50	Unlock Switch Input	Unlock switch momentary signal to ground	-	-	-

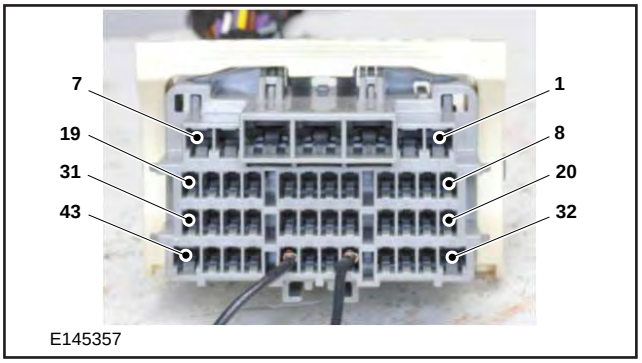
[1] Bridged via circuit on mating connector to enable crank/start. If mating connector is removed, vehicle will not start.

[2] Ignition switch 3M5T-11572-A* is required for Key In Signal. To replace the ignition switch refer to the Workshop Manual, 'Removal and Installation for Steering Wheel and Column Electrical Components' - 'Ignition Switch'.

[3] Attached system impedance must be between 6K-10Kohms if a true 12V to ground value is needed. To use as an input signal a 10Kohms pull up resistor is needed.

[4] Including existing lamps

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.



Supplementary Fuse Box

WARNINGS:

The fuse ratings and nominal ratings within the table should be followed strictly. Any deviation will interfere with the validated fusing strategy and wiring architecture. Some inputs are provided via electronic modules and any overloading could cause serious vehicle malfunction and may conflict with legal requirements.

No increase in existing vehicle standard fuse capacity is allowed under any circumstances.

On high specification vehicles, the C1 connector is not available as a customer interface and only the 43-way Interface Connector should be used. The connector to add wiring for switches and beacons is still available.

125kb/s MS CAN Access Interface

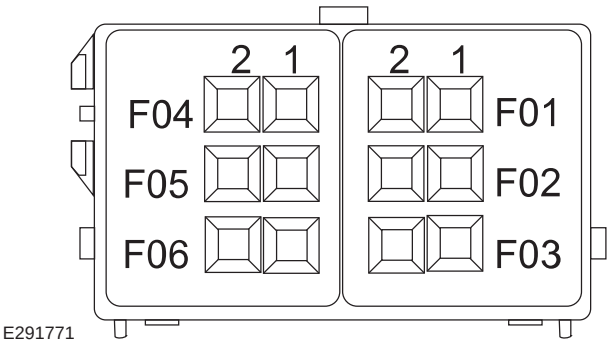
WARNING: It is not allowed to transmit DATA on any of the CAN lines. The system provided to splice into the 125kb/s MS CAN-Bus is for modules that will read only. If messages are transmitted from a third party fit module, vehicle functionality can be compromised and lead to serious failure. It is vital that any CAN stubs added must comply to the twisted rate, length, correct parity, with routing away from any high EMP (Electromagnetic Pulse) devices.

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

Refer to: 4.2 Wiring Installation and Routing Guides (page 63).

KL Terminology	
KL15	Ignition - Position 2
KL30	B+ (Always +12V)
KL31	Chassis or Body Ground
KL50	Crank/Start Position 3
KL58	Side Marker and Number Plate Lighting
KL75	Accessory - Position 1

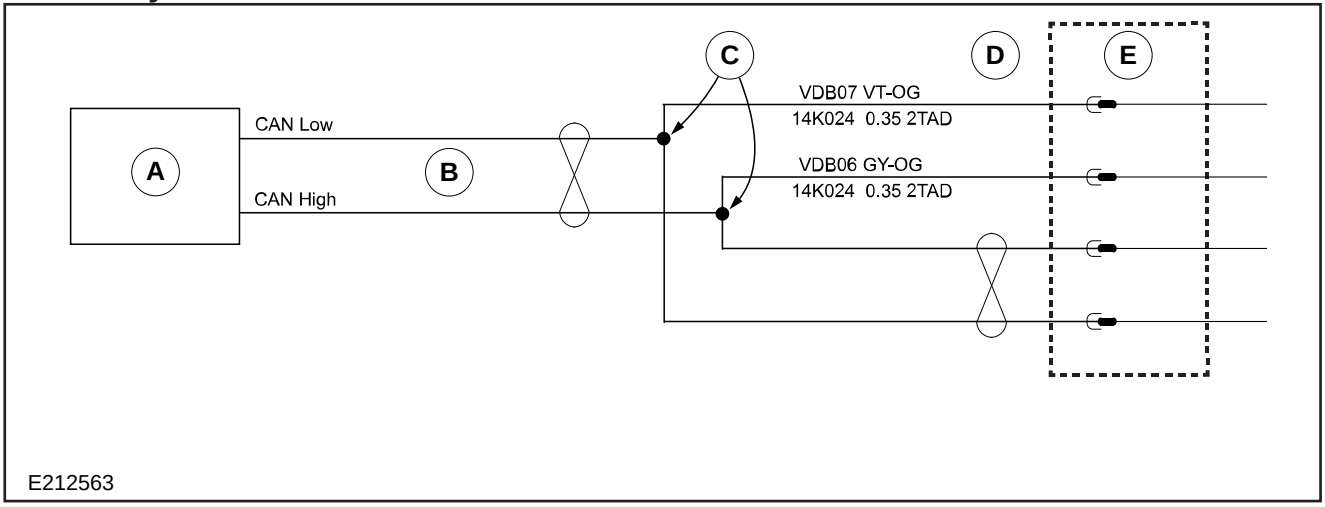
Supplementary Fuse Box - for High Specification Interface Connector



Fuse Ratings

Fuse	Type	Rating (A)	Colour	Function	Part Number
F1	Mini	10	Red	Battery KL30	1L3T-14A094-FA
F2	Mini	5	Tan	Battery KL30	1L3T-14A094-DA
F3	Mini	15	Blue	Battery KL30	1L3T-14A094-GA
F4	Mini	20	Yellow	Fused Ground	1L3T-14A094-HA
F5	Mini	20	Yellow	Fused Ground	1L3T-14A094-HA
F6	Mini	20	Yellow	Fused Ground	1L3T-14A094-HA

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

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 is located near the 43 way Interface Connector, behind the glove box and outboard to the wheel arch. The halfway 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 Violet/Orange wire. CAN High is the Grey/Orange wire.

Third Party Fit CAN Read Module

CAN-Bus network stubs must comply with the following standards, they must:

- 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.

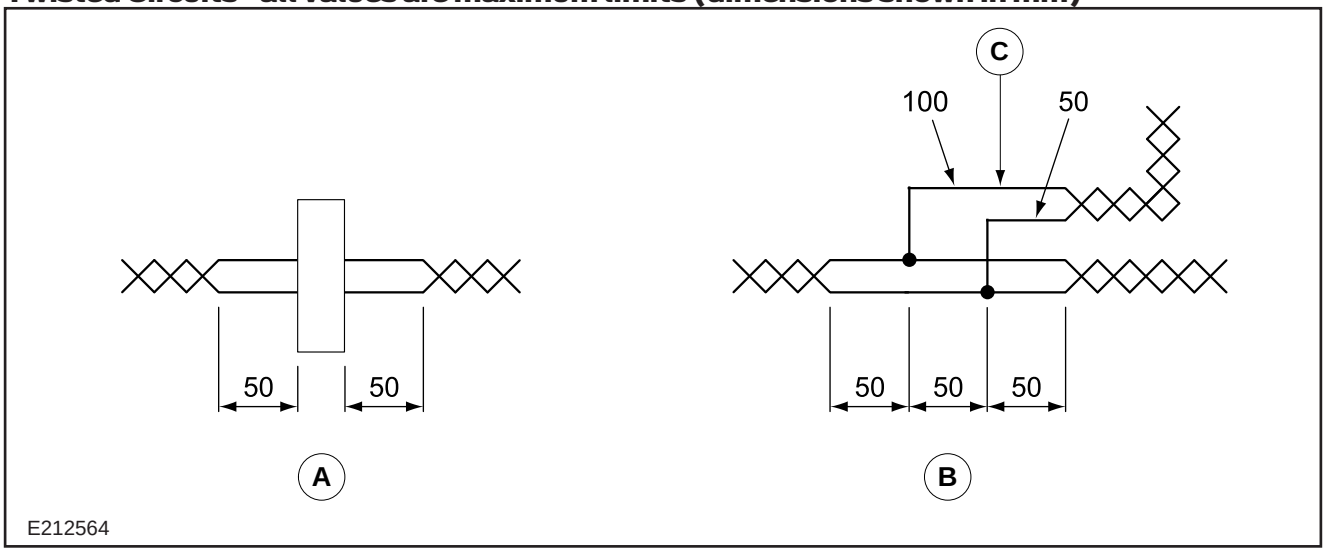
Physical Interface of splice in EDS Requirements

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 high and CAN low contact points.

Physical Interface of splice in EDS Requirements

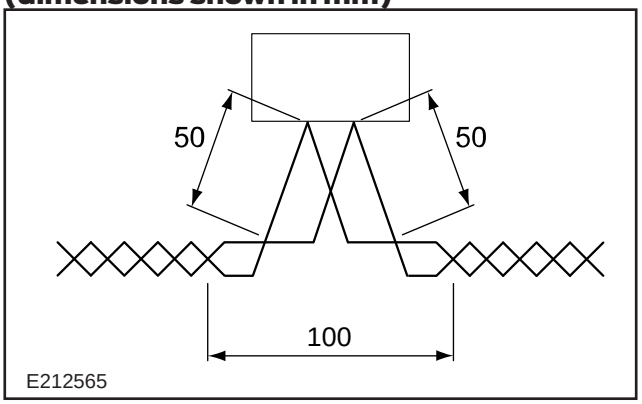
Parameter	Minimum	Nominal	Maximum	Units
Impedance	108	120	132	Ohm
Resistance	-	-	175	mOhm/m
Signal Speed	-	-	5.5	nS/m
Twisting	3	-	-	Twisted/50mm
Phase Shift	-	-	3.4	nS
Differential Mode Offset	-	-	0.5	V

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)



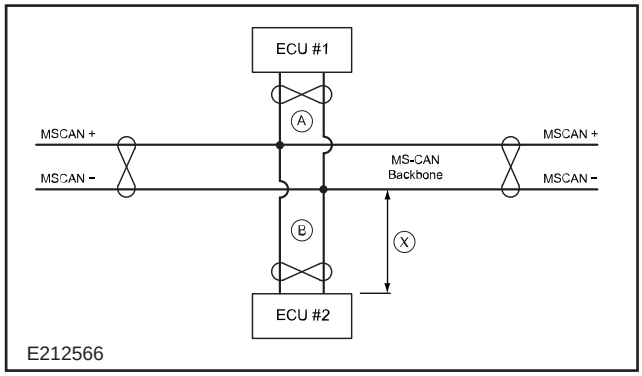
It is allowed to connect modules to the backbone using a series chain method instead of a stub. If the series chain method is selected, the untwisted wire on each side of the double crimp in the connector cannot exceed 50mm. See figure E212565.

The two terminating ECUs (Electronic Control Unit) 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.

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 ECUs.

Cable Stub Circuit



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

Maximum CAN Network Lengths

Network Speed	Between terminating ECUs	SAE J1962 Connector to Furthest Terminating ECU[1]
125kbps	50m	45m
500kbps	33.5m	28.5m

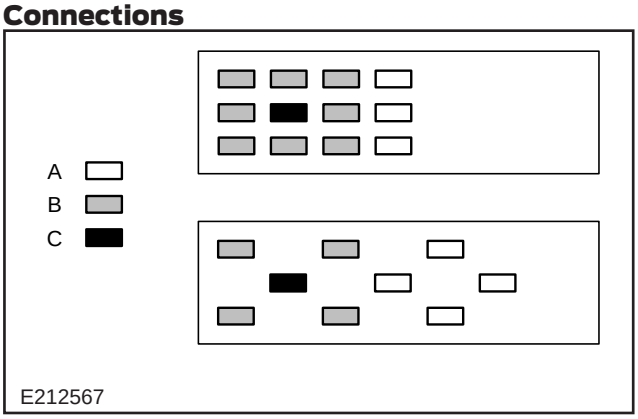
[1] This allows for an off-board tester cable of up to 5m.

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 125kbps MS CAN-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 High and CAN Low) are available or making the CAN-Bus connection through the module if 4 pins are available (2 x CAN High and 2 x CAN Low).

CAN High and CAN Low Adjacent Pin Connections



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

The maximum number of ECUs on network transmission speed 125 kbps, including the off-board tester, is 32.

The two wires forming each pair of CAN High and CAN Low connections shall be routed via physically adjacent pins as shown in the figure E212567.

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 (PCB) 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 Voltage battery.

The CAN network shall be fully functional, as a minimum, over the operating range 9V to 16V, as measured at the module's 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 ECUs with the agreement of the relevant FMC design authority, for each vehicle programme to which the ECU shall be fitted.

Suppliers may use Electrostatic Component Discharge components as long as they pass tests:

- Conducted Immunity (CI)
  - 280 Electrostatic Discharge
  - 270-C Immunity to Voltage Overstress (24V), applied to CAN High and CAN Low

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 (Electrostatic Discharge) 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 (printed circuit board).

Transceiver shall be located as close to edge connector as possible. Other IC's are not permitted between edge connector and the transceiver.

CAN High/CAN Low circuits between edge connector and transceiver shall be as short as possible and routed side-by-side. Guard tracks are required for all CAN High/CAN Low, TXD and RXD circuits on the same PCB layer. Guard tracks should not be placed between CAN High and CAN Low.

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.

4.24.11 Programmable CAN Interface Module (PCIM)

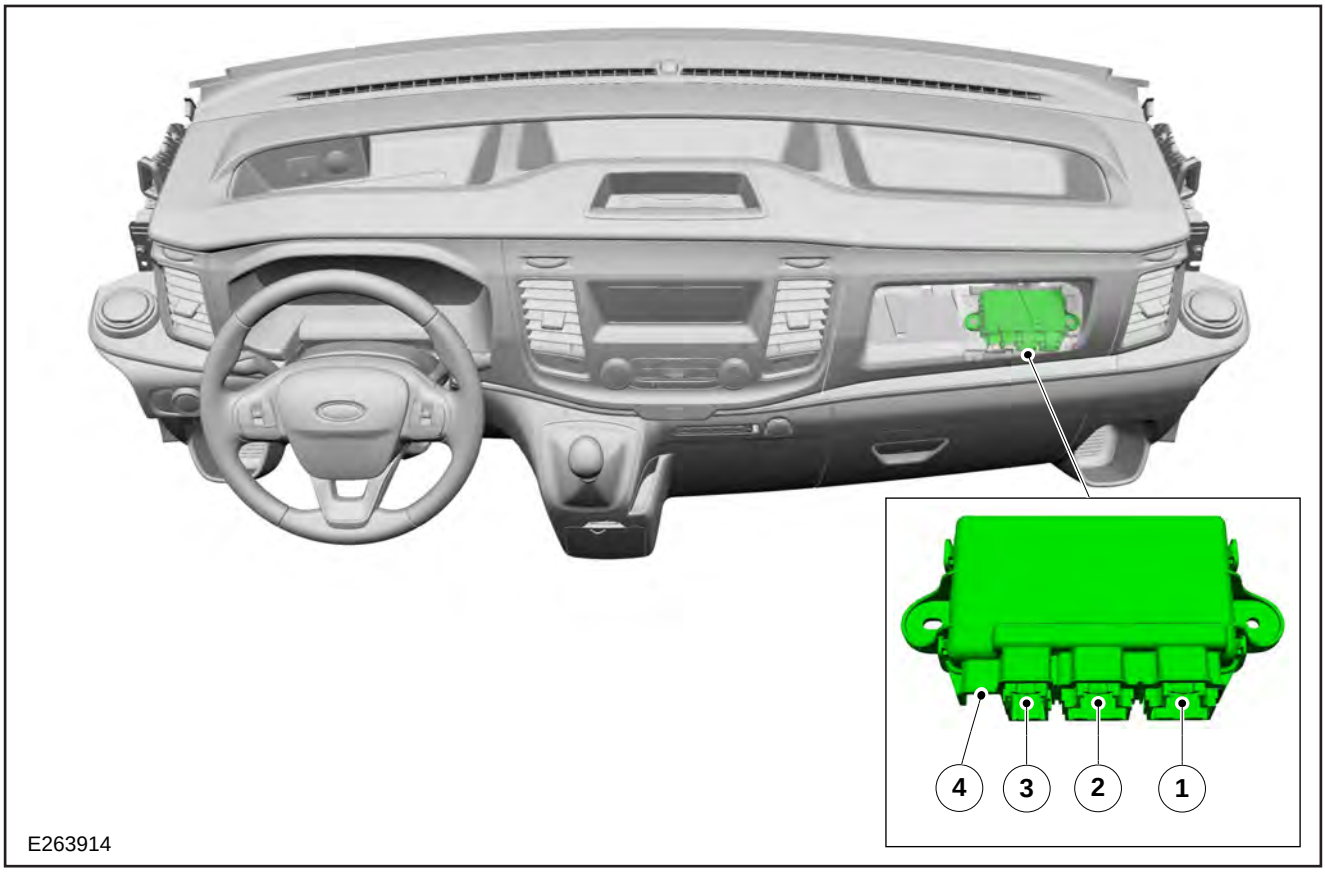
WARNING: It is the responsibility of the installer to ensure all safety checks have been carried out prior to installing any systems that interface to the PCIM connections.

NOTE: The harness of the base vehicle needs to consist of the interface connector to the PCIM at factory fit. Only if the base vehicle is configured to support the PCIM, can the module be retrofitted.

NOTE: The PCIM does not have functionality from factory fit. To activate the control logic, inputs and outputs pins, the converter will need to access the supplemental documentation and Graphical User Interface (GUI) via ETIS.

The PCIM is an electronic control module that has the ability to operate equipment (such as lift buckets, cranes, motors, salt spreaders, snowploughs, etc), with external automotive grade relays via customer programmable logic based on switch inputs and CAN signals. The operation of such equipment is limited to the load parameters of the PCIM. The user should not excess those load limits.

PCIM location



Item	Description
1	C1
2	C2
3	C3
4	USB

C1 Connector

Description	PU/ PD	Voltage (V)			Current (A)			State		
		Min	Nom	Max	Min	Nom	Max	Active	Inactive	Nom
Digital										
Input	PU	9	13.5	16	0.005	-	0.05	GND (ON)	OPEN (OFF)	OPEN (OFF)
Input	PD	9	13.5	16	0.007	-	0.012	VBATT (ON)	OPEN/ GND (OFF)	OPEN/ GND (OFF)
Analogue										
Input Hall Effect Sensor	-	9	13.5	16	0.003	-	0.025	-	-	-

PU=Pull Up, PD = Pull Down, Min = Minimal, Nom = Nominal, Max = Maximum

C1 Connector Pins

Pin	Type	Voltage (V)		Current (mA)	
		Min	Max	Min	Max
Digital					
1	Input	9	16	8	-
2	Input	9	16	8	-
3	Input	9	16	8	-
4	Input	9	16	8	-
5	Input	9	16	8	-
6	Input	9	16	8	-
7	Input	9	16	8	-
8	Input	9	16	8	-
9	Input	9	16	8	-
10	Input	9	16	8	-
Digital I/O					
11	CAN High 250kbps	9 (Steady State)	24	0	8
12	CAN Low 250kbps	9 (Steady State)	24	0	8
Analogue					
13	Hall Effect Sensor Feed	-	-	-	-
14	Not used	-	-	-	-
15	Switch -Hall Effect Sensor	-	-	-	-
16	Hall Effect Sensor Return	-	-	-	-

Min = Minimal, Nom = Nominal, Max = Maximum

Hall Effect Sensor

The Hall Effect Sensor can be used as the Seatbelt Circuit. The PCIM will diagnose the status by applying a regulated voltage in the range of 4.5V to 16V relative to the PCIM ground and measuring the resulting current. Refer to vehicle or aftermarket seatbelt design transmission for specific sensor details.

- The PCIM will block reverse current in the event of a reverse battery condition
- The Hall Effect Sensor (e.g. Seatbelt Buckle Sensor) will function as a current sink from its feed circuit to its return circuit
- The Hall Effect Sensor return will return to the PCIM and be shared with other sensor returns as determined by the restraints grounding strategy
- The sensor status shall be determined by the amount of current drawn by the sensor
- If a sensor is resistive, rather than constant current, the range shall be normalised to the specified thresholds, based upon the assumption of an applied 5.0V
- A capacitance <=100nF ± 20% (initial tolerance) may be placed between the feed and return pin of each sensor. The capacitance may be 0nF

Connector 2 (Digital)

Pin	Description	Driver	Voltage (V)			Current(A)	
		High/ Low	Min	Nom	Max	Min	Max
1	External Relay Control 1	Low	9	13.5	16	0.170	0.320
2	External Relay Control 2	Low	9	13.5	16	0.170	0.320
3	Not used	-	-	-	-	-	-
4	External Relay Control 3	Low	9	13.5	16	0.170	0.320
5	External Relay Control 4	Low	9	13.5	16	0.170	0.320
6	External Relay Control 5	Low	9	13.5	16	0.170	0.320
7	External Relay Control 6	Low	9	13.5	16	0.170	0.320
8	External Relay Control 7	Low	9	13.5	16	0.170	0.320
9	External Relay Control 8	High	9	13.5	16	0.170	0.500
10	External Relay Control 9	High	9	13.5	16	0.170	0.500
11	External Relay Control 10	High	9	13.5	16	0.170	0.500
12	External Relay Control 11	High	9	13.5	16	0.170	0.500
13	External Relay Control 12	High	9	13.5	16	0.170	0.500
14	External Relay Control 13	High	9	13.5	16	0.170	0.500
15	External Relay Control 14	High	9	13.5	16	0.170	0.500
16	External Relay Control 15	High	9	13.5	16	0.170	0.500

Min = Minimal, Nom = Nominal, Max = Maximum

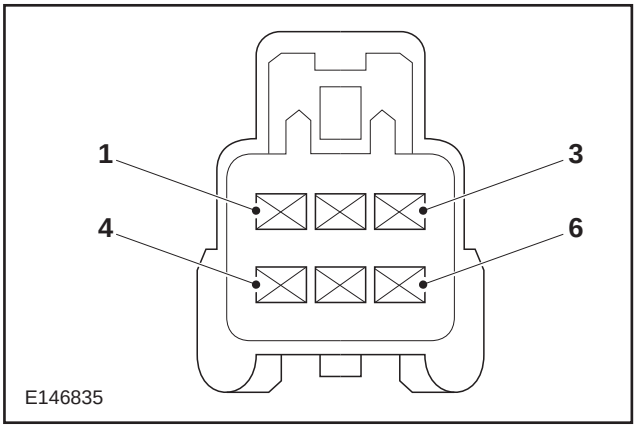
C3 Connector

Pin	Type	Voltage (V)		Current (mA)	
		Min	Max	Min	Max
1	Power	9	16	-	-
4	Ground	9	16	-	-
6	Vehicle CAN High	9	16	0 (Steady State)	8
7	Vehicle CAN Low	9	16	0 (Steady State)	8

The C3 connector is the power and CAN feed from the base vehicle. Do not splice into those wires or modify the connector.
Min = Minimal, Max = Maximum

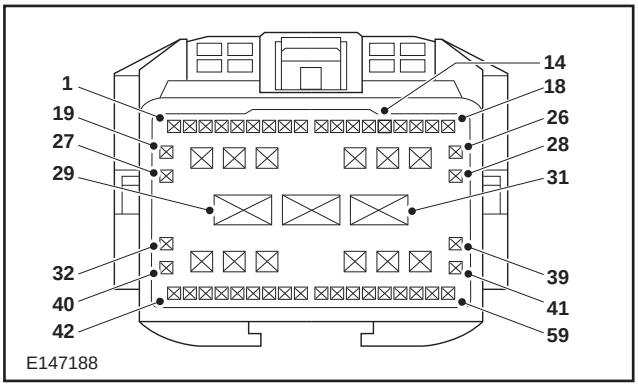
4.24.12 Adding Connectors

Additional Lighting for Rear of Vehicle Interior



Item	Description
Pin 1	Supply through Battery Saver
Pin 5	Ground - Dimming

Marker Lamps



Item	Description
Pin 14	Side Marker Supply - Yellow/Violet

WARNING: Maximum load on pin 14 is 2.5A, including existing number plate bulbs. Do not exceed 2.5A on this circuit. Recommend only LED side markers be added.

Additional Rear Speakers

NOTE: The connectors on the Instrument Panel harness (14K024) and the main harness (14401) are reversed between Left Hand Drive (LHD) and Right Hand Drive (RHD) vehicles, hence different sets of terminals/wires are required to cover all the markets.

For information on rear speakers:
Refer to: 4.13 Information and Entertainment System (page 132).

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

NOTE: The timer is reset when a door is opened, the vehicle is unlocked or ignition is switched on.

Both features adopt a 20A fusing strategy. Continued loading on these outlets will lead to battery drain, and risk the vehicle not starting.

At engine Off, all power outlets will switch off after 30 minutes.

If longer duration electrical power is required after ignition off, a second battery option should be installed and the CCPs, where fitted, utilised.

4.25 Grounding

4.25.1 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 E291288 and the following table for recommended ground points that can be used.

The wiper motor bracket must not be used as a ground as it is isolated from the body.

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.

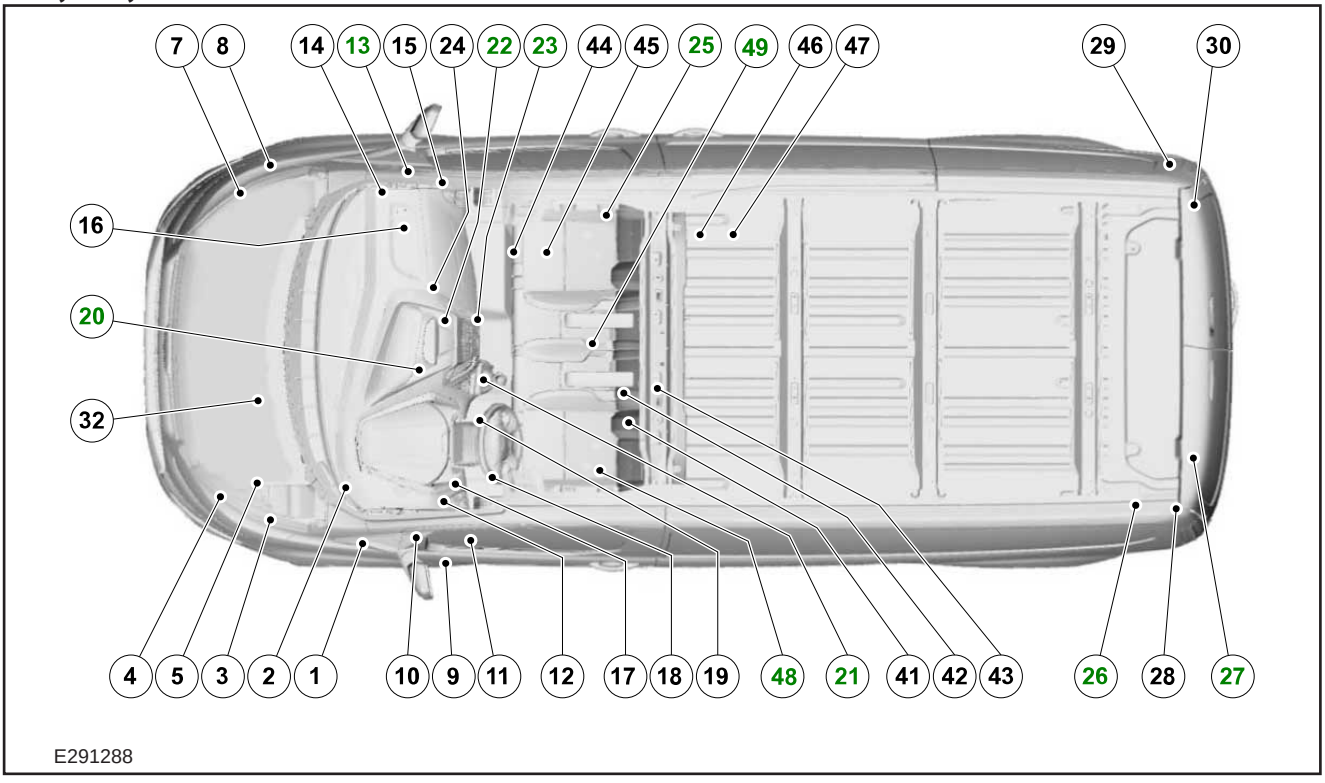
NOTE: The Ground Point (GP) numbers are only for reference to show the location of the GP.

Ground wires should be brought back to the Ford ground points provided. 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.

Refer to: 4.7 Battery Systems (page 105).

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 in-rush current and improve electromagnetic compatibility.

Van, Bus, Kombi Recommended Ground Points



E291288

Ground Point	Location	Type	Harness
1	Cross Car Beam LHS	Miscellaneous Power Electric	14K024
2	A Pillar RHS Upper	Rear Lamp	14A005
3	Cross Car Beam RHS	Miscellaneous Power Electric	14K024
4	Cross Car Beam LHS	Miscellaneous Power Electric	14K024
5	Cross Car Beam RHS	Miscellaneous Power Electric	14K024
6	Floor Pan RHS	Miscellaneous Power Electric	14401
7	Floor Pan LHS	Miscellaneous Power Electric	14401
8	Cross Car Beam LHS	Miscellaneous Power Electric	-
9	D Pillar LHS Lower	Miscellaneous Power Electric	14405

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

5.1 Body

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

5.1.1 Body Structures - General Information

WARNINGS:

Before drilling see figure E146882 for Boron Steel parts, in this section of the manual.

Before drilling the floor, check the Precautionary Drill Zones, see Figure E224822 in this section.

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

When carrying out vehicle conversions the following points should be considered:

- Make sure that the vehicle structural integrity is maintained
- Do not drill into closed frame body members
- Make sure that the design for the body alterations or additional structure disperses the load evenly
- 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). For additional Precautionary Drill Zones
Refer to: 4.2 Wiring Installation and Routing Guides (page 63).
Refer to: 5.6 Body Closures (page 194).

5.1.2 Welding

WARNING: Before welding see figure E146882 for Boron Steel parts, in this section of the manual.

Before welding work is performed on a vehicle body, all safety measures for the protection of people, modules and electrical components must be observed.

Electronic Components

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.

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.

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 with 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 minimise spattering when welding.

The following points must be noted when welding:

- Zinc starts to melt at about 420°C

- Zinc vaporises 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 primer is achieved later
- If the join area is not accessible from the inside, the cleaning and sanding work is not done. For this reason, ensure that there is as little contamination as possible in the area of the repair. This allows the cavity wax applied later to penetrate the join area without hindrance

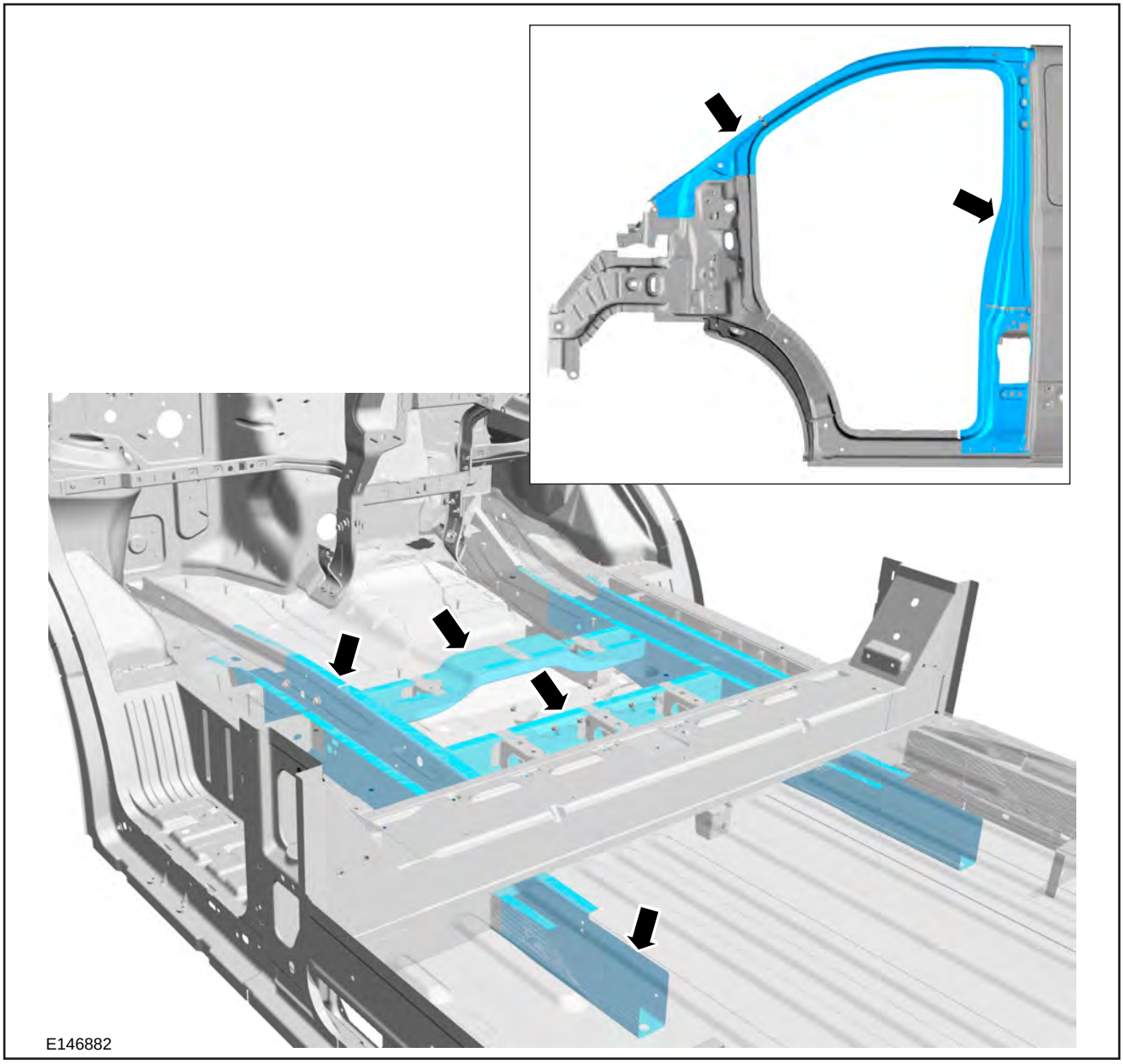
NOTE: Only apply a small amount of panel cleaner to the cleaning cloth when cleaning the area. Make sure that no cleaner reaches the connecting flange, so that the welding primer is not washed away again.

Priming after welding

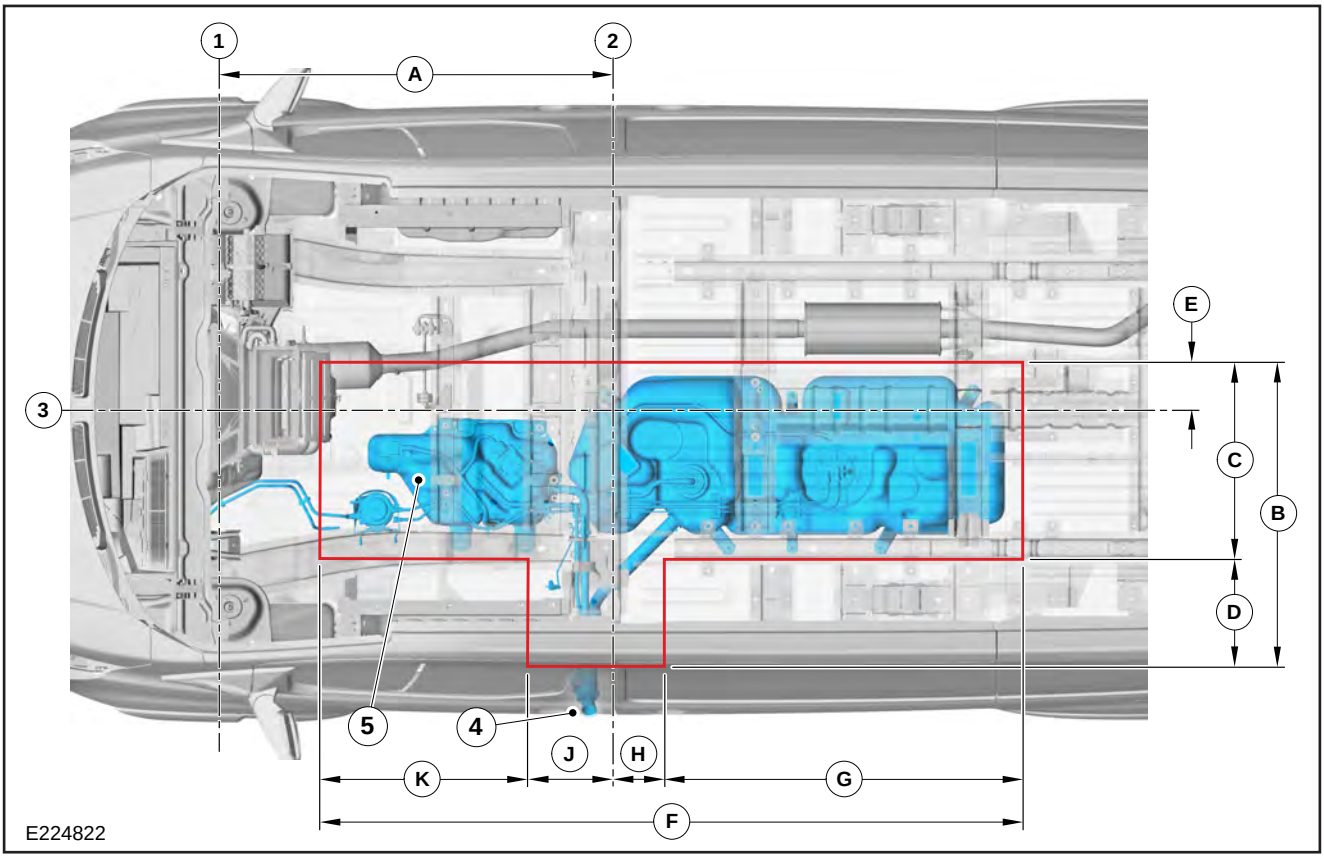
Primer is applied to the welded flanges after cleaning. A check must also be made that the production corrosion protection is present in the area of the flanges. Any damage must also be re-primed.

5.1.3 Boron Steel Parts

Boron Steel Parts - Precautionary Drill or Weld Zones



5.1.4 Floor Precautionary Drill Zones - Fuel Tank



Floor Precautionary Drill Zone Dimensions (mm)	
1	Centre Line Front Wheel Axle
2	Centre of 'B' Pillar
3	Centre Line of Vehicle
4	Fuel Filler - Driver's Side 'B' Pillar
5	UREA Tank
A	1235mm
B	990mm
C	660mm
D	330mm
E	150mm
F	2300mm
G	1140mm
H	260mm
J	230mm
K	670mm

5.1.5 Front End Integrity for Cooling, Crash, Aerodynamics and Lighting

Cooling: Continuous air flow through the front end and engine compartment is not to be hindered by adding any additional equipment.

Lighting: Do not alter the lighting system.

Crash: Do not cut, drill or weld any parts that are load path relevant in case of crash. Do not add material in the crash zone. This could affect the crash sensor calibration.

The side airbag system is not permitted if:

- A 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 Hydraulic Lifting Equipment

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

5.2.1 Hydraulic Lifting Equipment for Van, Bus and Kombi

General Information

WARNINGS:

Do not cut away any structural member.

Equipped vehicles must be designed to be stable under 'worst case' operating conditions with support legs extended, if fitted.

Do not lift vehicle off the ground.

CAUTIONS:

Safety devices must ensure the legs are deployed when operating the lifting equipment.

Safety devices must ensure the legs are stowed and locked away prior to engaging vehicle drive.

NOTE: There are no tie down locations in the floor. It is the converter's responsibility to fix with adequate 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
- Routing electrics and hydraulics separately and away from original Ford equipment
- Using suitable clips to fix on vehicle body and subframe
- Offering master switch in the cab to isolate the whole system

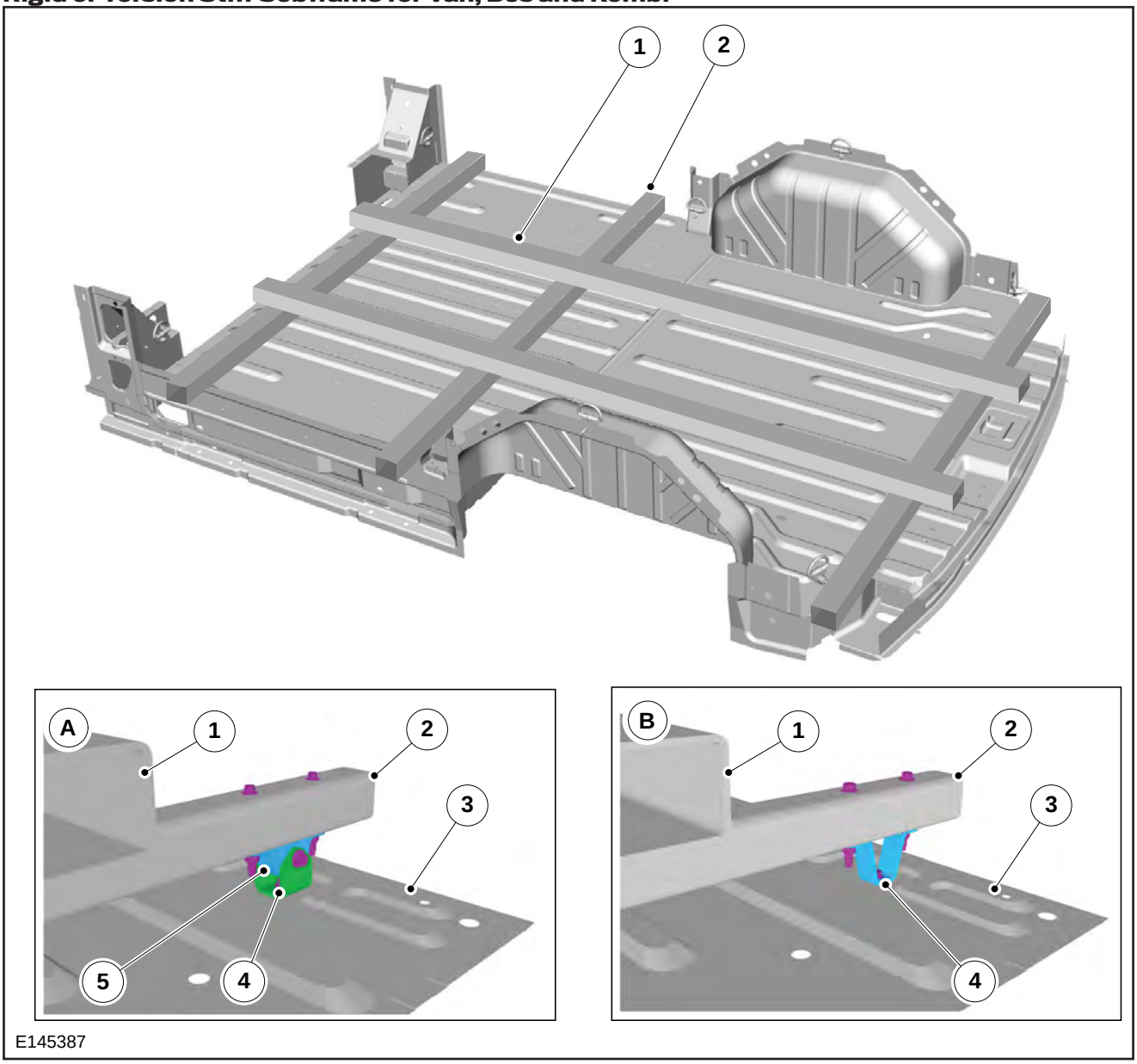
Cranes and Platforms

It is recommended to design subframes in the 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 Subframe for Van, Bus and Kombi



E145387

Item	Description
A	Compliant Mount
B	Fixed Mount
1	Subframe longitudinal
2	Subframe 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 centre line, load capacity is up to 700kg at 1000mm from floor edge to centre of load.

If mounted asymmetrical to the vehicle centre line or if mounted at side load door, load capacity is up to 500kg at 1000mm from floor edge to centre 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 stabilising 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 stabilising equipment such as outriggers or ground jacks. It is recommended not to increase vehicle body stress over limit as given by load factors above.

It is the vehicle converter's 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 converter's responsibility to guarantee safe functioning of the equipment.

5.3 Racking Systems

5.3.1 Racking Systems

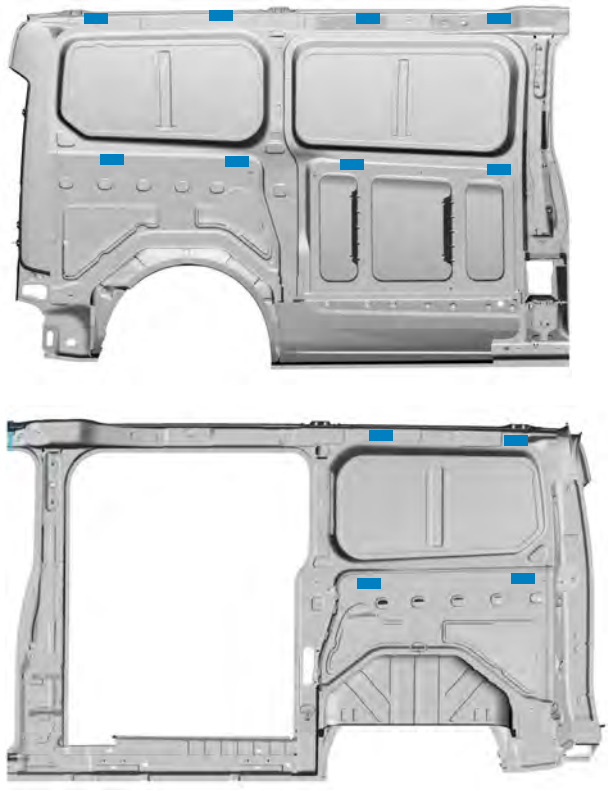
For attaching a racking system, it is recommended to use the marked areas shown in figure E146883.

- 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, refer to Frame and Body Mounting section of this manual, 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 minimise 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).

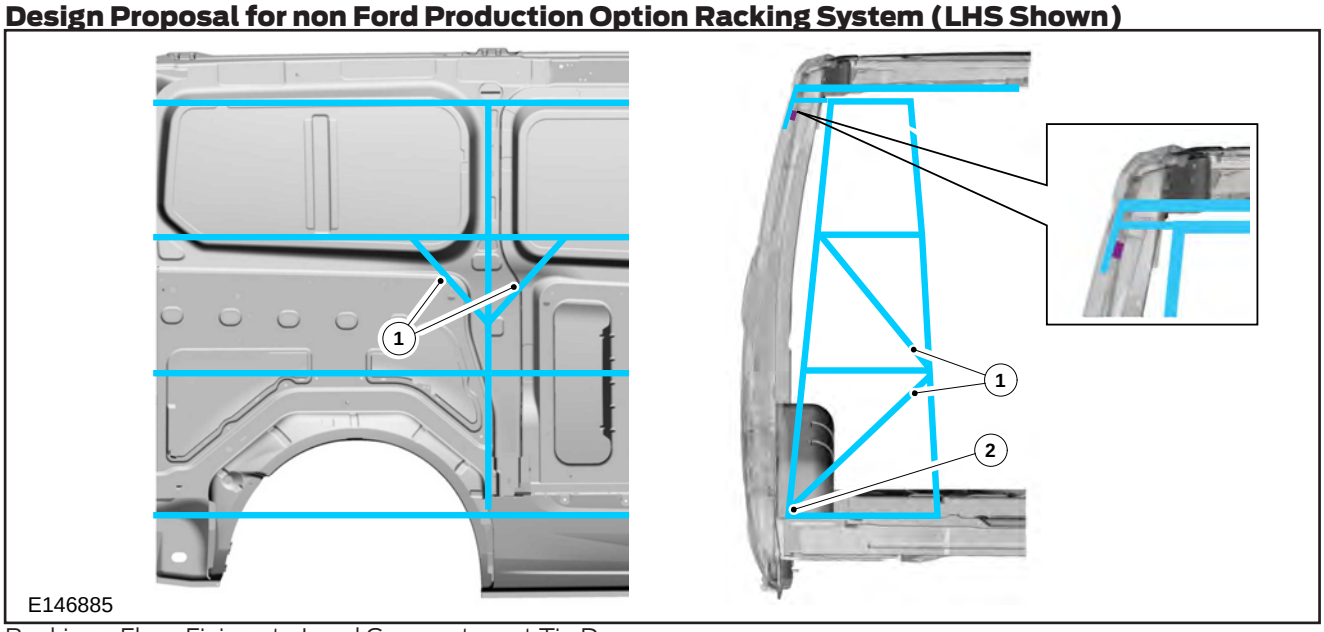
For additional information on Precautionary/No Drill Zones
Refer to: 4.2 Wiring Installation and Routing Guides (page 63).
Refer to: 5.1 Body (page 183).
Refer to: 5.6 Body Closures (page 194).

Recommended Fixing Locations



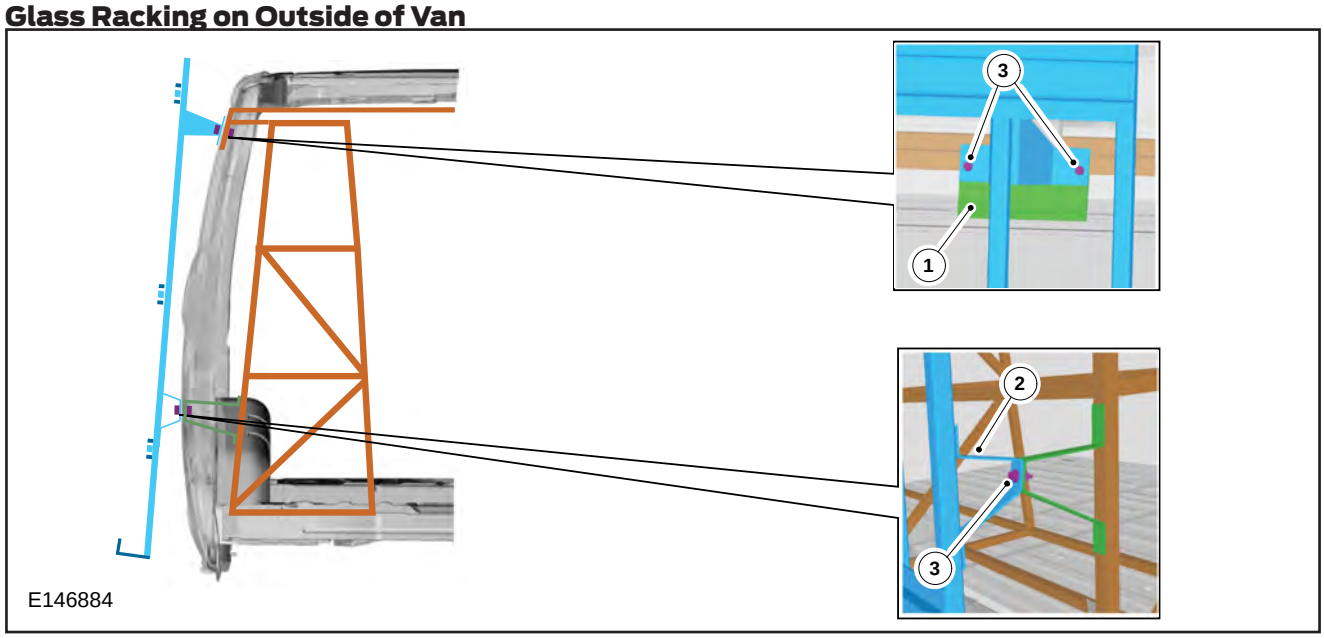
E146883

Design Proposal for non Ford Production Option Racking System (LHS Shown)



Racking - Floor Fixings to Load Compartment Tie Downs

Glass Racking on Outside of Van



Item	Description
1	Rigid Self-Supporting Racking Framework
2	Fixing to floor

Glass Racking on Outside of Van - Through Fixed to Internal Racking (Recommended Minimum)

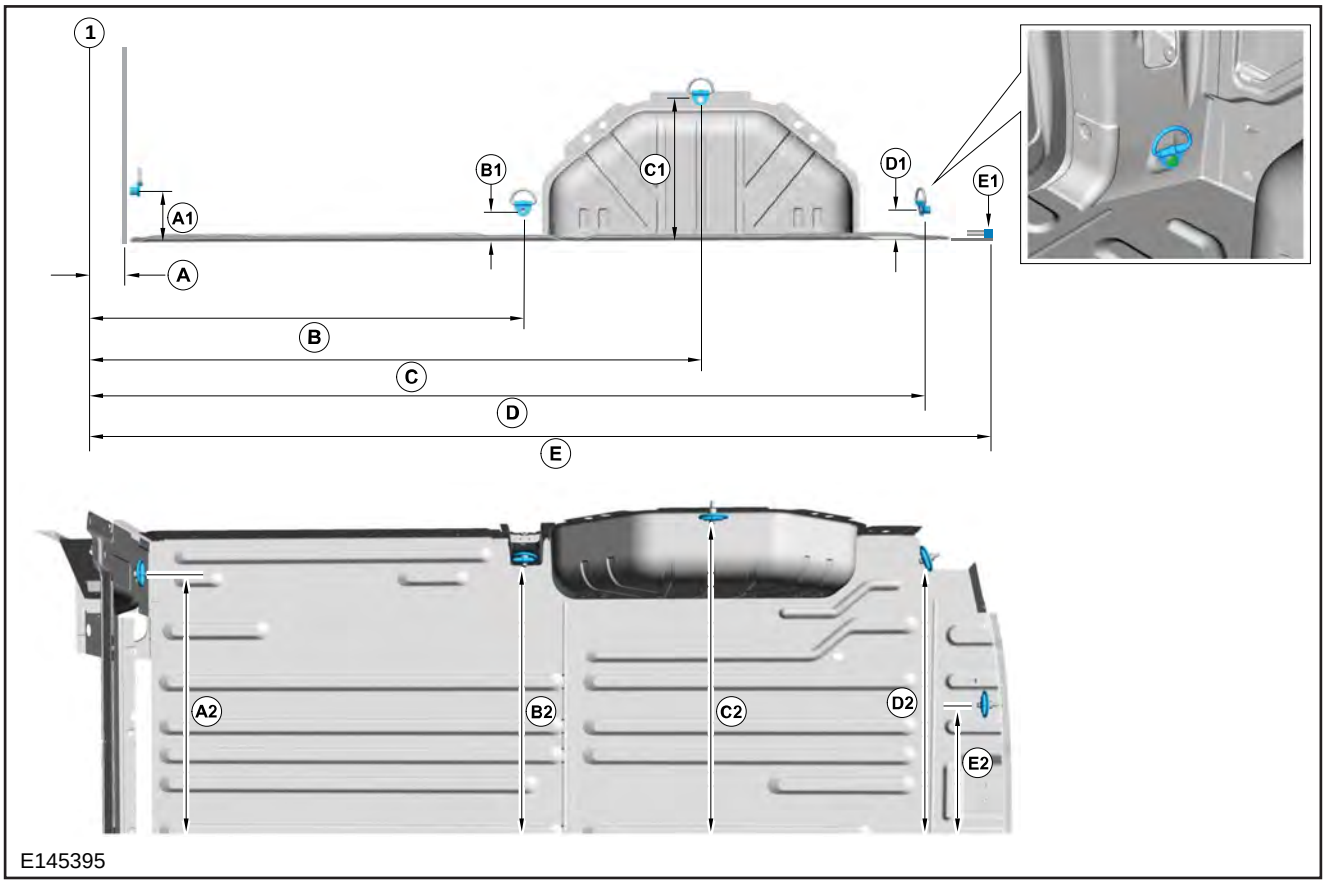
For designing glass carrying rack on body side outer, construct internal rack and bolt through the body side to the internal rack, see figure E146885.

5.4 Loadspace

5.4.1 Load Compartment Tie Downs

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 183).



E145395

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 centre line of vehicle		
A2	733	
B2	817	
C2	882	
D2	791	
E2	450	

L1 = 2933mm Wheel Base, L2 = 3300mm Wheelbase

5.5 Front End Body Panels

5.5.1 Partitions (Bulkhead) - Driver and Front Passenger(s) Protection on Van, Bus and Kombi

CAUTION: Bulkheads serve an important function and are legally required in some territories.

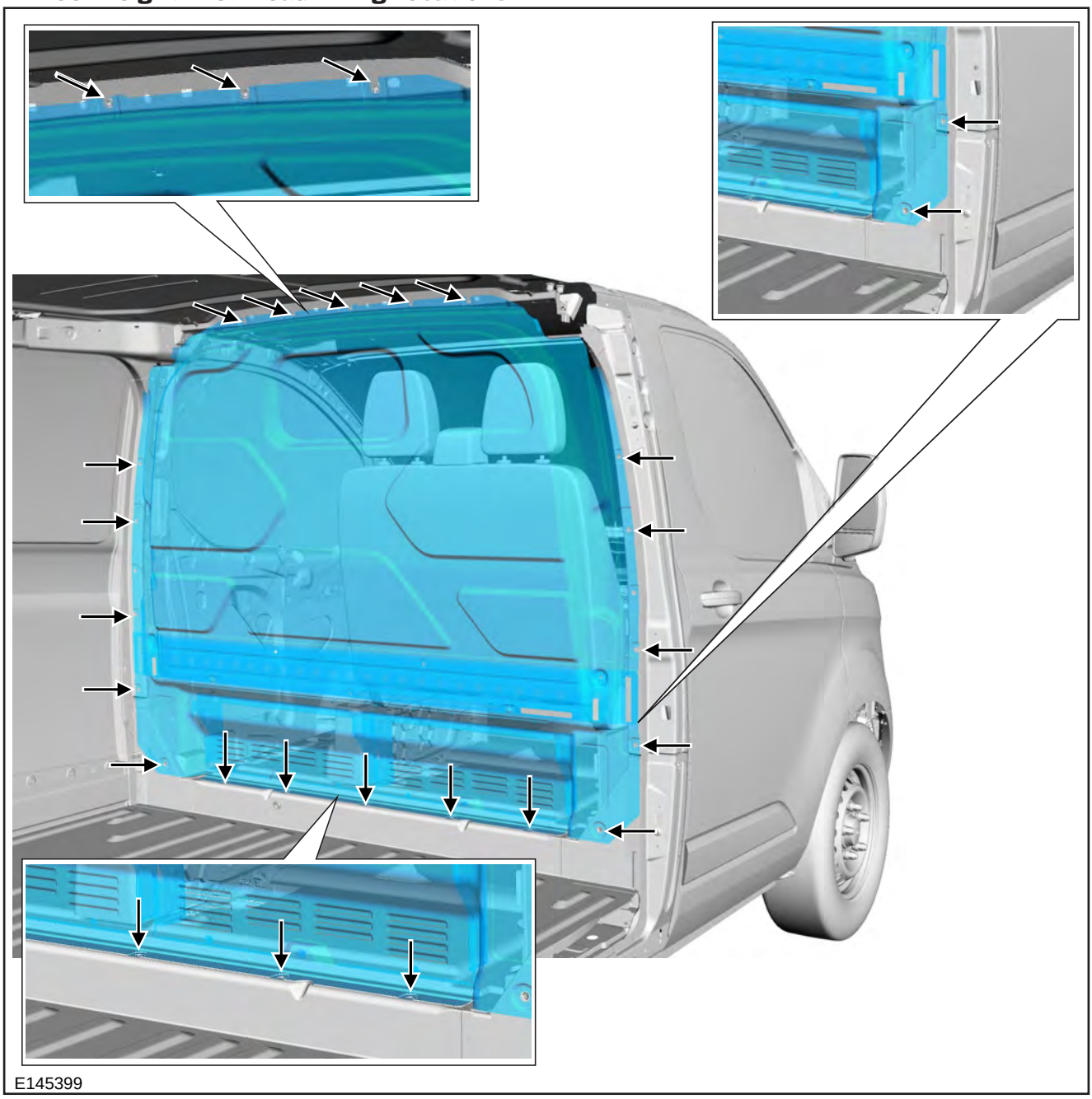
It is the vehicle converter's responsibility to ensure local current legislation governing bulkheads and protective window grilles is met. It is also the converter's responsibility to ensure legal load constraint requirements if using a non Ford standard bulkhead.

Standard Ford bulkheads do have a clearance between bulkhead and body structure to allow natural body flexing and an air circulation from the cab to the rear load space for ventilation control.

Air circulation and body flexing must be also given consideration when engineering an alternative bulkhead. It is not recommended to restrict driver's or passenger's seat adjustment travel.

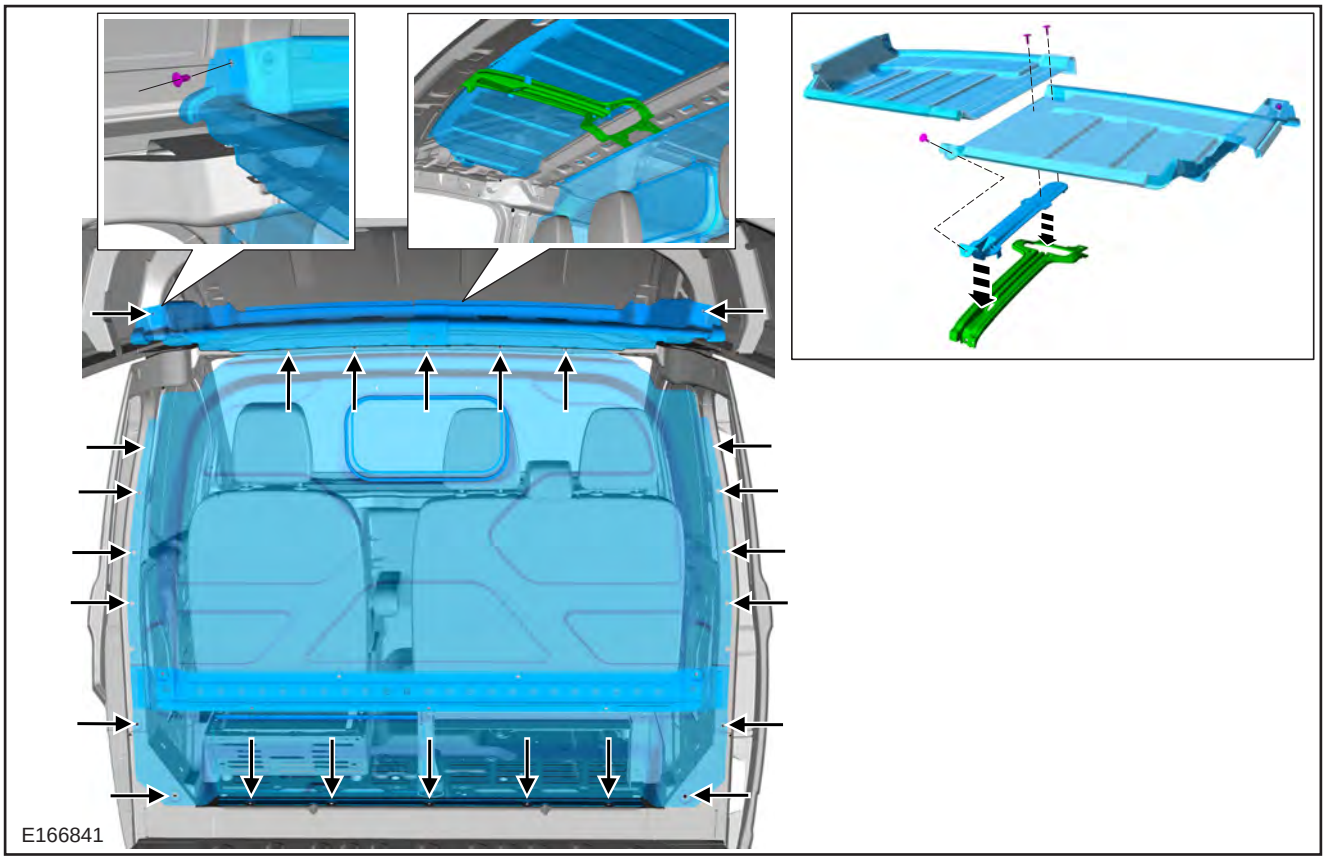
The following figures, E145399 and E166841, show the standard bulkhead fixing locations on 'B' pillar. These are standard weld nuts for M6. The standard range of Ford bulkheads can be retro-fitted at these points.

H1 Roof Height - Bulkhead Fixing Locations

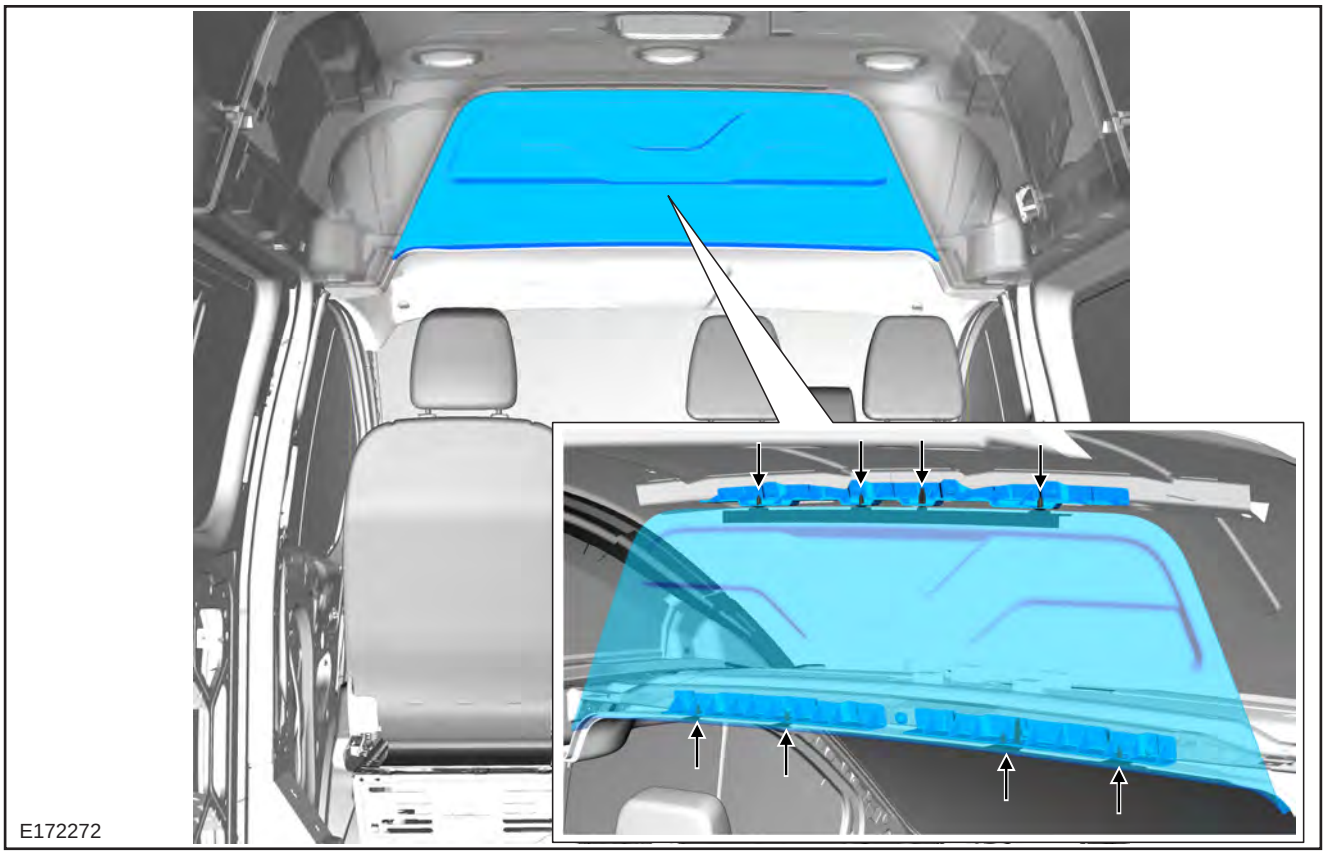


E145399

H2 Roof Height - Bulkhead and Parcel Shelf Fixing locations



H2 Roof Height - Kombi Close Out Panel



5.6 Body Closures

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

5.6.1 Security, Anti-Theft and Locking System

CAUTION: To avoid locking system security complications, it is recommended to discuss with your local Ford dealer prior to conversions taking place.

NOTE: It is not recommended to alter the locking system or damage the security shielding around the lock and latch.

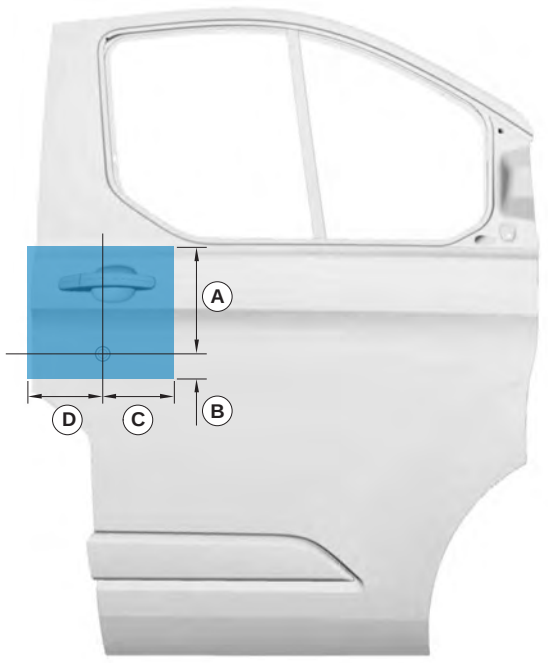
When removing and reapplying door seals take care to fit correctly, using the same seals, as this is critical to door closing efforts. Any conversions to the sealing flanges or surfaces will require consultation with your local Ford dealer. This may also include air extraction/ venting adjustments to 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.

Refer to: 4.21 Handles, Locks, Latched and Entry Systems (page 149).

The following figures outline the areas in which it is not advisable to drill.

No Drill Zone - Driver and Passenger Doors



E145401

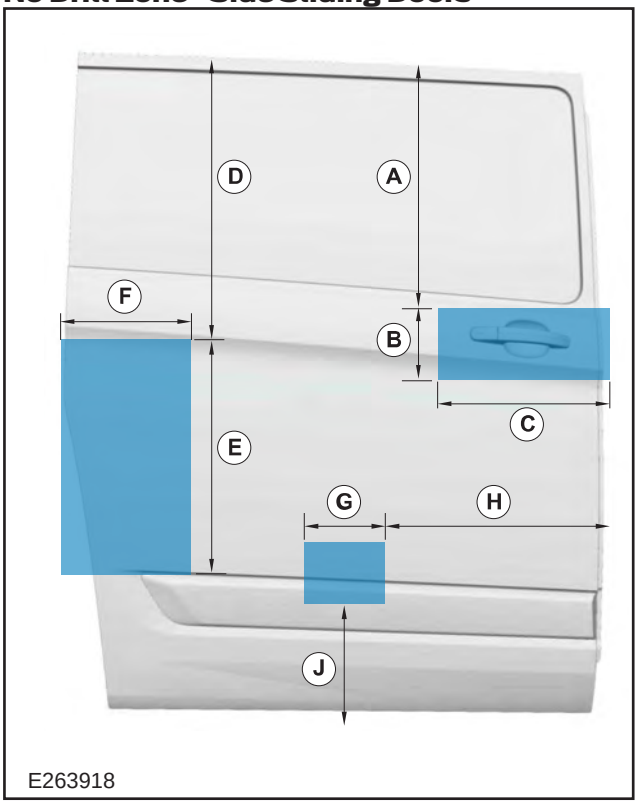
Item	Description
A	300mm
B	55mm
C	150mm
D	190mm

No Drill Zone - Lift-Gate

E145402

Item	Description
A	480mm
B	430mm
C	305mm

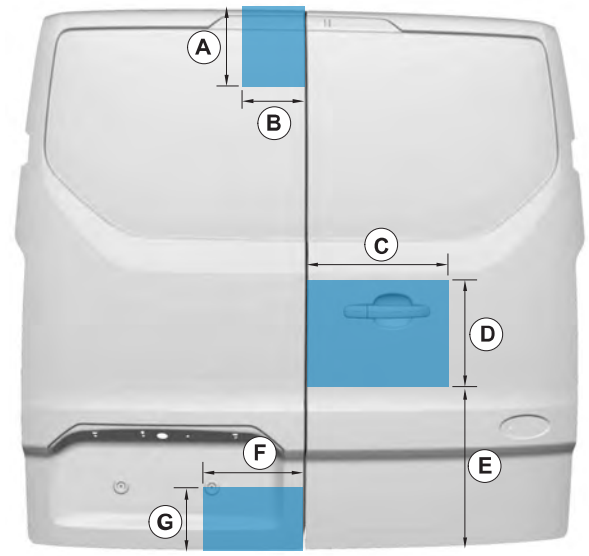
No Drill Zone - Side Sliding Doors



E263918

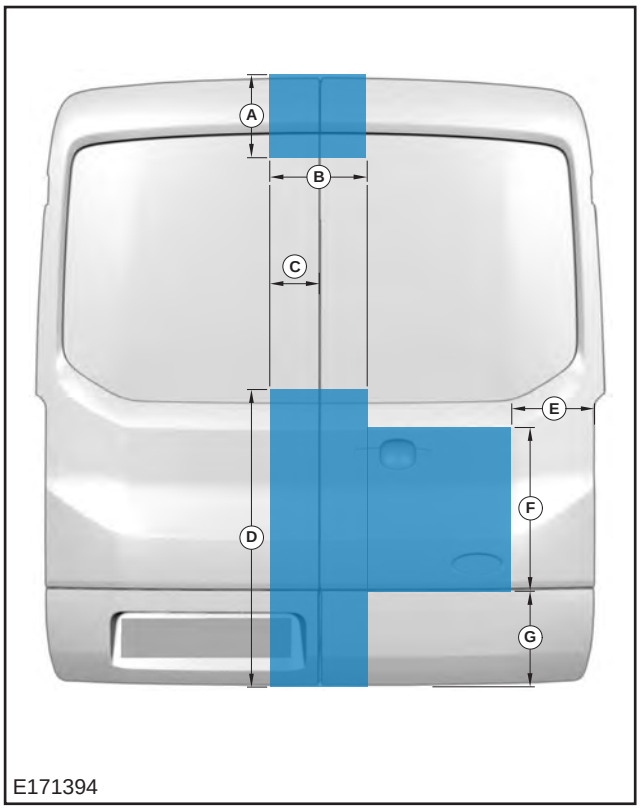
Item	Description
A	620mm
B	165mm
C	360mm
D	650mm
E	400mm
F	250mm
G	215mm
H	500mm
J	300mm

No Drill Zone - Rear Cargo Doors

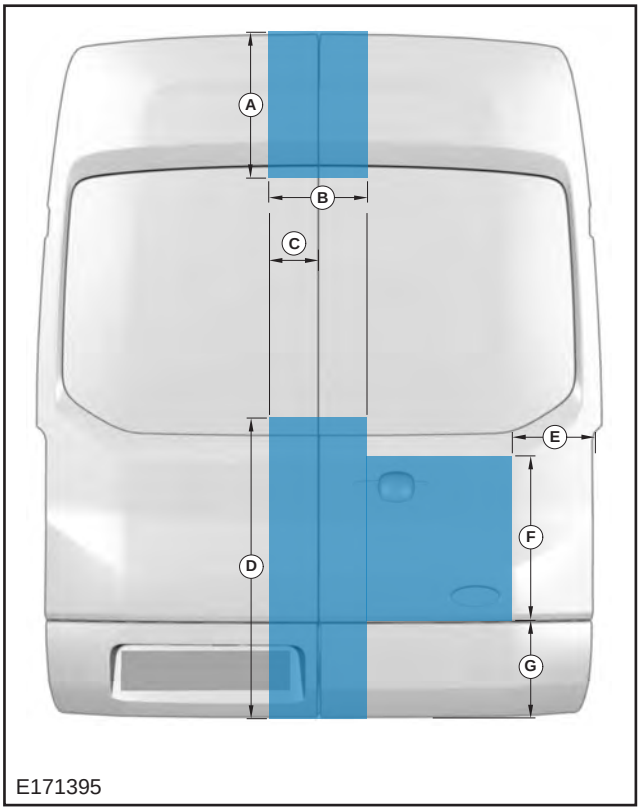


E145404

Item	Description
A	250mm
B	115mm
C	385mm
D	250mm
E	480mm
F	260mm
G	175mm



E171394



E171395

5.7 Interior Trim

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

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.

- 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 aluminium 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

Refer to: 4.2 Wiring Installation and Routing Guides (page 63).
Refer to: 5.6 Body Closures (page 194).
Refer to: 5.1 Body (page 183).

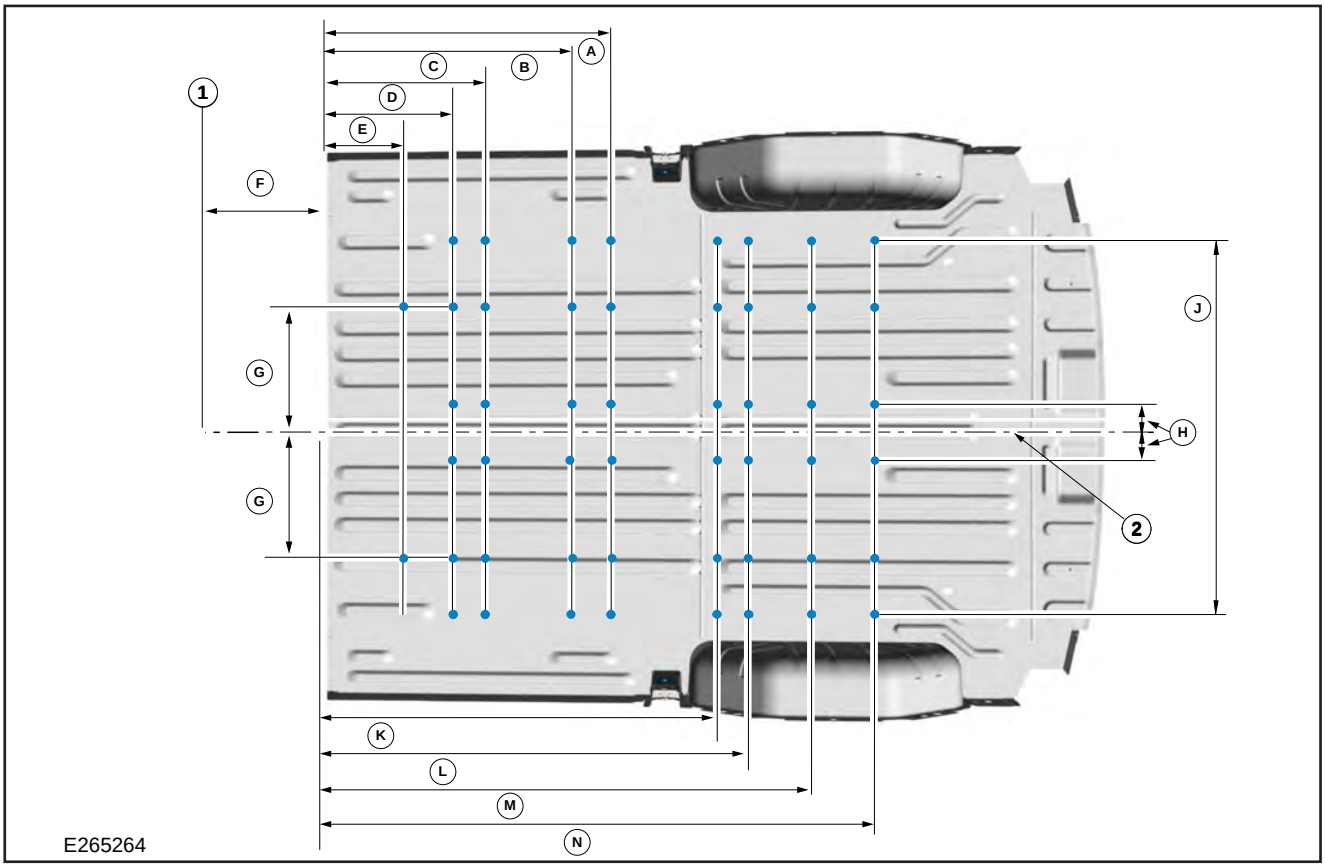
5.8 Seats

NOTE: When reassembling the seat and the seat belt, use specified bolts and ensure to apply the specified torque. For torque specifications, please contact your National Sales Company representative, or local Ford dealer. If they are unable to help you then please contact the Vehicle Converter Advisory Service at VCAS@ford.com

5.8.1 Van

CAUTION: Do not install seats in the rear cargo area of a van.

Rear Seat Fixing Positions



Item	Second Row (mm)	Third Row (mm)
1	Front Axle	
2	Centre line of vehicle	
A	937	-
B	782	-
C	538	-
D	433	-
E	269	-
F	1302	1302
G	378	378
H	88	88
J	1232	1232
K		1291
L	-	1396
M	-	1658
N	-	1794

5.8.2 Windowed Van

The body and floor of a windowed van are not equipped with the appropriate reinforcements required for Original Equipment Manufacturers (OEM) rear seats and seat belt systems. Do not install original rear seats or rear seat belts.

For installation of non OEM rear seats, the rear seats and seat belt systems need to comply with the relevant legal requirements and ECE directives or ADR 3,4,5 or applicable local legislation.

Refer to: 3.7 Exhaust System (page 56).

5.8.3 Heated Seats

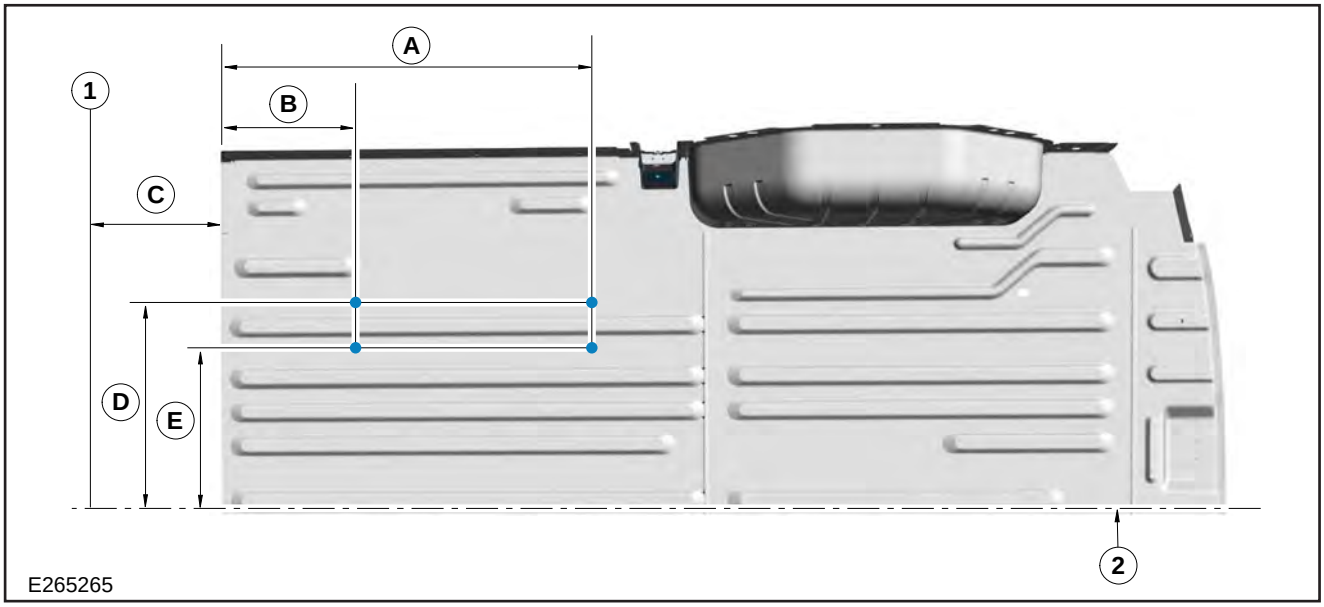
WARNING: The electrical feed for the original heated Ford seat must not be used for other purposes, e.g. other electrical consumers.

It is not advisable to retrofit heated seats due to potential airbag operation or malfunction (incorrect configuration).

5.8.4 Rear Seat Fixing Positions

Figures E265264 and E265265 show the second/second and third row seat fixing positions in the floor. These positions are independent of the wheelbase. The fixings are always present but access to the fixing is dependent on floorpan. Access holes in the floorpan may be required to gain access to the fixing.

Double Cab in Van (DCIV) - Rear Seat Fixing Locations (Left Hand Side Shown)



Item	Triple Seat - Second Row (mm)
1	Front Axle
2	Centre line of vehicle
A	937
B	269
C	1302
D	522
E	377.8

Right Hand Side symmetrically opposite

5.9 Glass, Frames and Mechanisms

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

5.9.1 Heated Windscreen and Heated Rear Window

WARNING: The base system should not be tampered with (controlled by body control module and multiplex architecture) and no feeds taken from the associated wiring or controller.

These options are not suitable for aftermarket or Vehicle Converter fit.

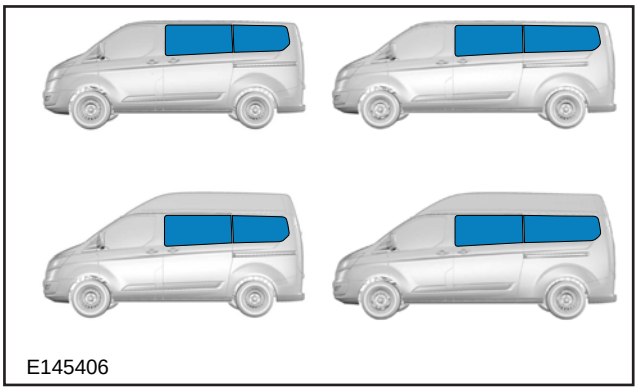
5.9.2 Rear and Side Windows

For windows, it is recommended to specify the base vehicle as a Kombi or Bus body - however, when converting a van, the following should be adhered to:

- Cut the outer panel of the body side and door to within 1mm of the inner panel flange
- Do not cut across panel joints or pillars
- Use approved glass for installation according to legal requirements
- After cutting the outer panel, join the inner panel and the outer panel robustly together.

WARNING: For rear seat installation

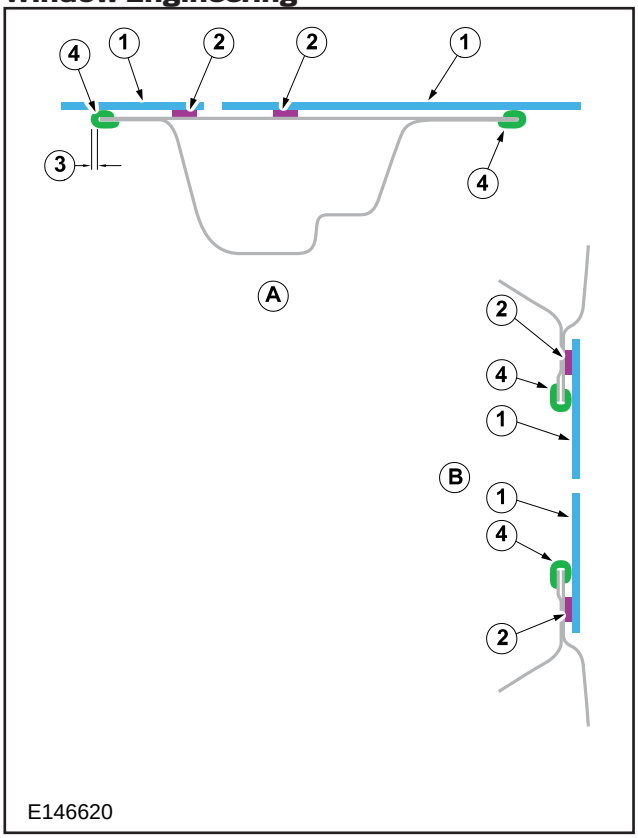
Refer to: 5.8 Seats (page 198).



E145406

For vehicle wheelbase and overall vehicle height key dimensions
Refer to: 1.14 Package and Ergonomics (page 28).

Section through Typical Van Body Side for Window Engineering



E146620

Item	Description
A	Horizontal Section Through 'C' Pillar
B	Vertical Section Through Side Window (Non Side Load Door)
1	Glass
2	Adhesive
3	Cut outer panel flange flush with inner panel flange edge all round within 0 and 1.5mm
4	Window trim strip

5.10 Airbag Supplemental Restraint System (SRS)

5.10.1 Airbags

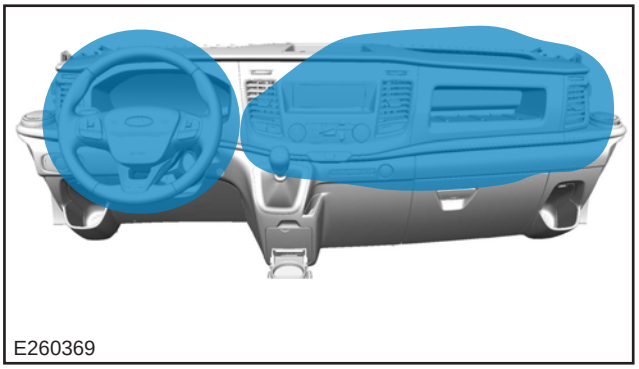
Front Airbag Deployment Zones

WARNINGS:

Do not place accessories in the deployment zone of the driver and passenger airbags as they may impair airbag deployment.

Do not place stickers or decals over the airbag covers as this may impair airbag deployment.

NOTE: All M1 Vehicles are specified with passenger airbag as standard fitment. Passenger airbag includes the driver belt minder function.



E260369

Side and Curtain Airbag Deployment Zones

WARNINGS:

Do not place accessories in the deployment zone of the side and curtain airbags as they may impair airbag deployment.

Do not place stickers or decals over the airbag covers as this may impair airbag deployment.

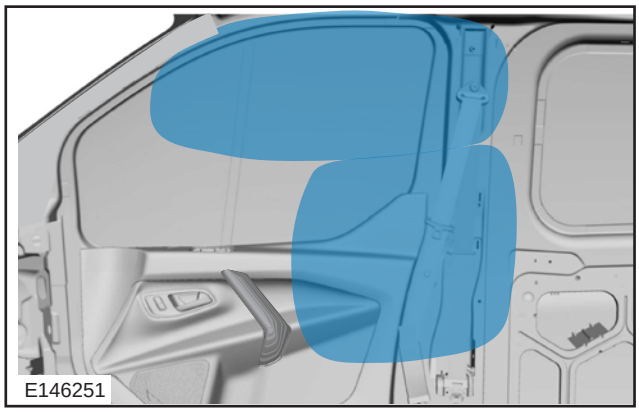
NOTE: It is recommended to specify a base vehicle without airbags if planning conversions in this area.

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 conversions 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)

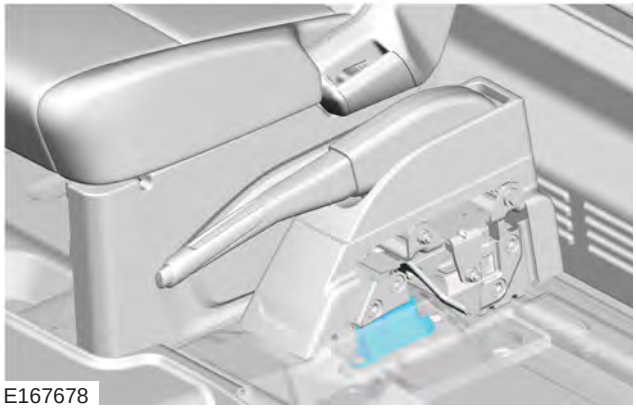
The RCM is located between the front seats, underneath the parking brake console, see figure E145413.

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)



E167678

Front and Side Sensors

The airbag sensor for the front airbags is located behind the front grille, see figure E263912.

The sensors for the side airbags are located at the bottom of the B-pillars, see figure E145412

WARNINGS:

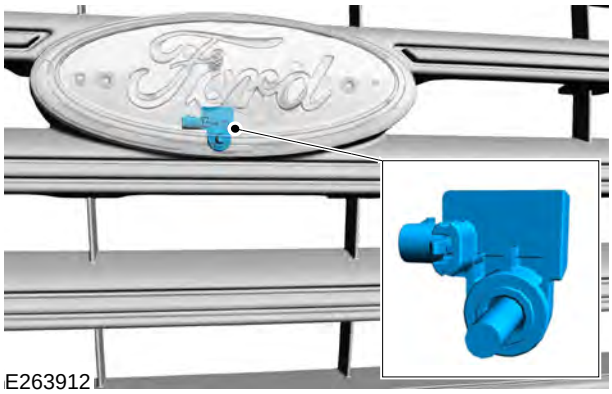
Modifications or reinforcements in the area of the sensors may affect the side airbags deployment timing and result in uncontrolled side airbag deployment.

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

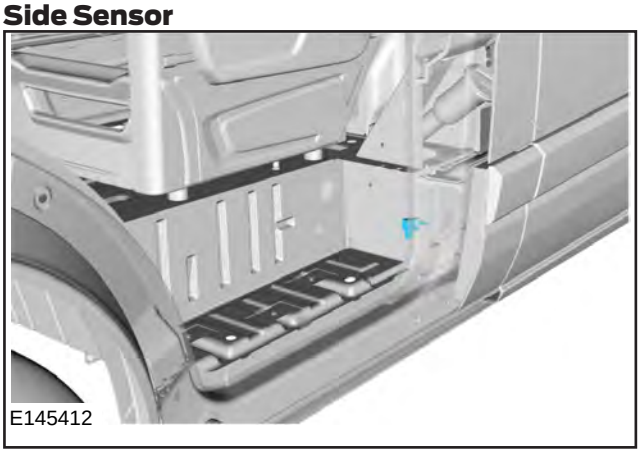
If the vehicle is specified with side and curtain airbags, ensure any accessories fitted to the doors are clear of the airbag deployment zones and that any holes created in the door trim, inner or outer sheet metal are sealed to retain the integrity of the door cavity. Failure to seal holes in the door trim or sheet metal may affect the sensitivity of the restraints system.

If the battery is disconnected Refer to: 4.6 Battery Systems (page 91). Battery and Monitoring Sensor section for reconnecting battery.

Front Sensor



Side Sensor



5.11 Seatbelt Systems

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

5.11.1 Seatbelts

WARNING: Follow removal and installation procedures for the seatbelt system to ensure correct function of the restraints system.

The removal and re-installation of the seatbelt, buckle or any component of the seatbelt 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 seatbelt system as described in the workshop manual.

When removing the seatbelt 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 re-installing, 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 seatbelt wearing status of the driver. If an M1 vehicle is modified, this function must be retained.

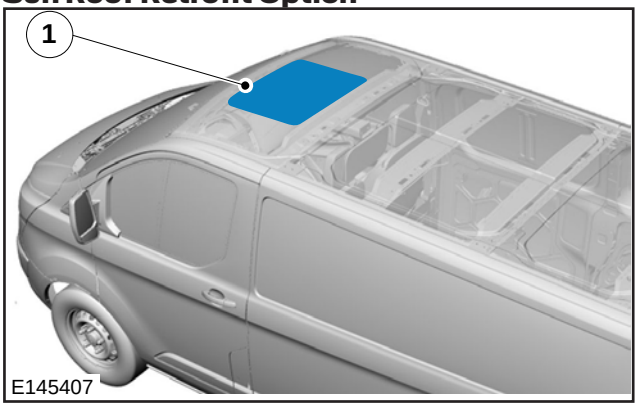
Belt minder is included with the front passenger airbag.

5.12 Roof

5.12.1 Roof Ventilation

WARNING: Avoid all antenna positions when retrofitting a sunroof or any roof mounted units.

Sun Roof Retrofit Option



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 the full length of the roof rails between the 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

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.

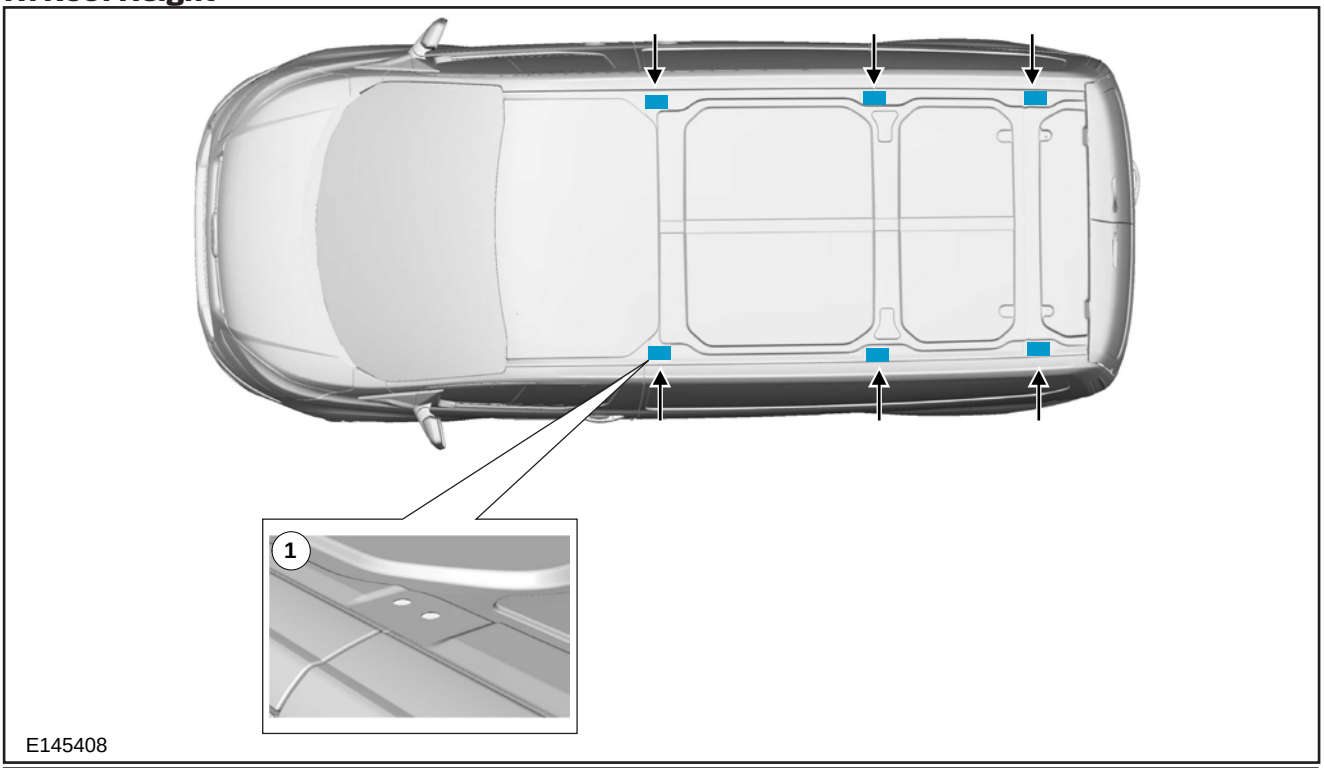
NOTE: Maximum roof rack length for H1 roof height vehicles should consider liftgate in fully opened position.

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

H1 Roof Height



Item	Description
1	Roof Rack Supports, 3 attachments each side. Positions depend on wheelbase.

- The load is evenly distributed (Vehicle Converter to ensure Owner's information book identifies this limitation)
- The load of a single attachment under worst case loading, must not exceed 75kg
- The roof rack should be fixed to the roof using one or two M8 bolt/s per attachment as shown in figure E145408
- It is recommended that the rack leading edge should not be located forward of the rear edge of the driver's door, or 'B' pillar

5.13 Corrosion Prevention

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

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
- Endeavour 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 183).

5.13.2 Repairing Damaged Paint

After cutting or reworking any sheet metal on the vehicle, the damaged paint must be repaired.

Ensure all materials are compatible with the relevant Ford specifications and maintain the original performance where possible.

5.13.3 Under Body Protection and Material

WARNING: Do not over-coat or contaminate surfaces of components such as brakes or catalytic converters.

Ensure all materials are compatible with the relevant Ford specifications and maintain the original performance where possible.

Some proprietary products affect the original coatings.

5.13.4 Painting Road Wheels

WARNING: Do not paint wheel clamp surfaces in contact with other wheels, brake drum or disc, hub and holes or surface under wheel nuts. Any further treatment in these areas may affect the wheel clamp performance and the vehicle safety. Mask the wheel when changing the colour 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

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

5.14.1 Mounting Points and Tubing

The holes on the 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 E176204. 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).

5.14.2 Frame Drilling and Tube Reinforcing

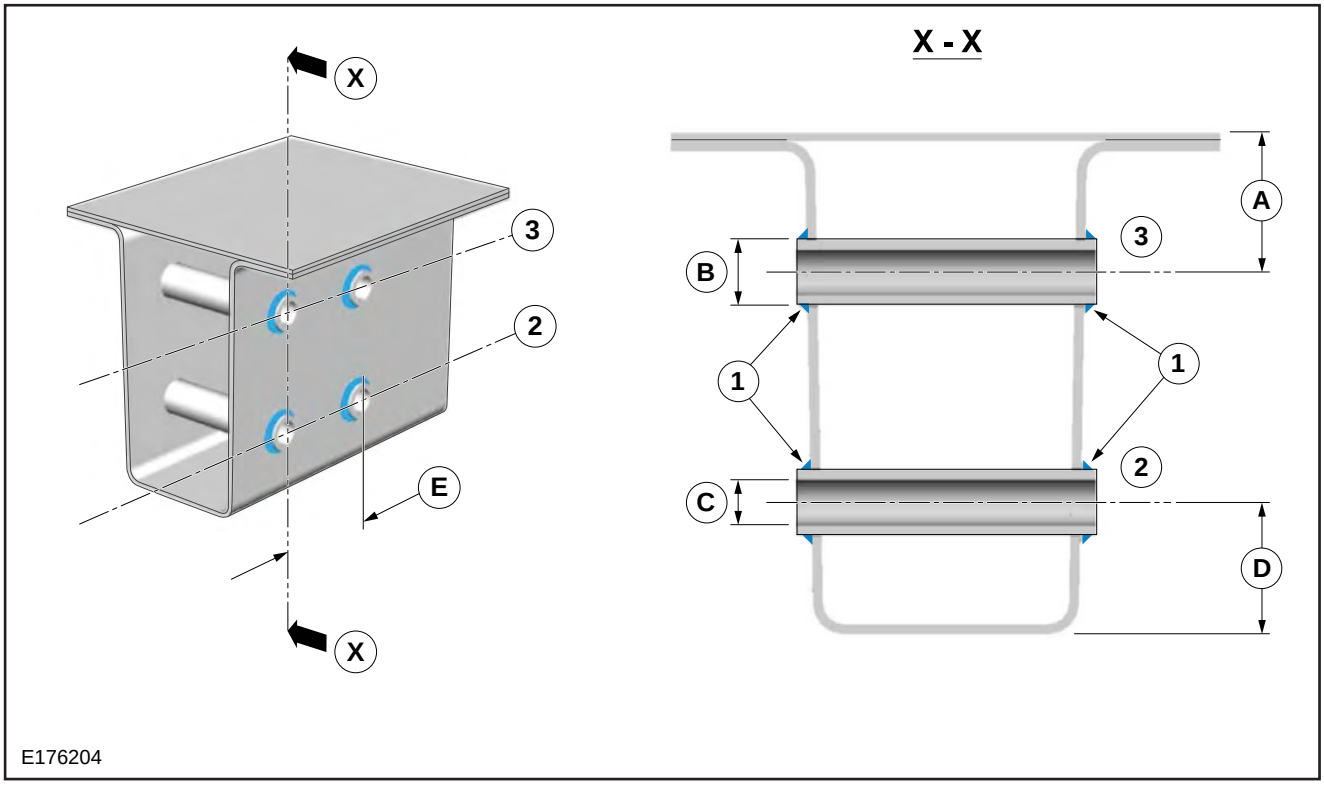
The chassis frame may be drilled and reinforcing spacer tubes may be welded in place, providing the following is applied:

- Adhere to all details shown in figure E176204
- 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 centre line (allow for side member draft angle)
- Drill undersize and ream out to size
- Endeavour 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 E176204
- 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

Frame Drilling and Tube Reinforcing



E176204

Item	Description	Item	Description
1	Full Penetration; Full diameter weld each side	B	Diameter 16.5mm maximum
2	Centre line of holes/tubing	C	Diameter 11mm
3	Centre line of holes/tubing	D	30mm to 35mm
A	30mm to 35mm	E	50mm minimum

- 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.

Refer to: 5.1 Body (page 183). 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 rearward 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 centre line.

It is not the manufacturer's 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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