

Battery and Charging System - General Information -

Vehicle Jump (Emergency) Starting - Using another vehicle

WARNINGS:



During normal use, batteries emit explosive hydrogen gas sufficient to cause severe explosions and capable of causing serious injury - keep sparks and naked lights away from the engine compartment.



DO NOT attempt to start the disabled vehicle if it is suspected that the electrolyte in the battery is frozen.



Suitable eye protection must be worn when working in the vicinity of the battery.



Take care when working near rotating parts of the engine.



Prior to attempting to start the disabled vehicle, ensure that the parking brake is applied or suitably chock the wheels. Ensure that 'P' - PARK - Automatic Transmission or NEUTRAL - Manual Transmission is selected.

CAUTIONS:



Ensure that all electrical loads are switched **OFF** prior to connecting booster cables and disconnect booster cables prior to using electrical equipment.



Ensure that the battery of the **DONOR** vehicle is of 12 volt capacity and that all electrical loads on the disabled vehicle are switched **OFF** prior to connecting booster cables.



Ensure that there is no physical contact between the donor and disabled vehicles other than the booster cables.

NOTE: Disconnect battery: If the remote control handset is not functioning, it will be necessary to manually unlock the vehicle using the key.

Carry out the following operation in the sequence given:	
1.	Connect one end of the Red (+) booster cable to the positive (+) battery terminal of the DISABLED vehicle.
2.	Connect the other end of the Red (+) booster cable to the positive (+) battery terminal of the DONOR vehicle.
3.	Connect one end of the Black (-) booster cable to the Ground (-) battery terminal of the DONOR vehicle.
4.	Connect the other end of the Black (-) booster cable to a good earth point e.g. unpainted metal surface or engine mounting at least 0.5 m (20.0 in) from the battery or fuel lines on the DISABLED vehicle.
5.	Start the engine of the DONOR vehicle and allow it to idle for a few minutes.
6.	Start the engine of the DISABLED vehicle.
7.	Allow engines of both vehicles to idle for a few minutes then switch off the engine of the DONOR vehicle.
8.	Disconnect the Black (-) booster cable from the earth point of the PREVIOUSLY DISABLED vehicle.
9.	Disconnect the Black (-) booster cable from the battery of the DONOR vehicle.
10.	Disconnect the Red (+) booster cable from the battery of the DONOR vehicle.
11.	Disconnect the Red (+) booster cable from the battery of the PREVIOUSLY DISABLED vehicle.

Vehicle Jump (Emergency) Starting - Using a Slave Battery/Starting Aid

WARNINGS:



During normal use, batteries emit explosive hydrogen gas sufficient to cause severe explosions and capable of causing serious injury - keep sparks and naked lights away from the engine compartment.



DO NOT attempt to start the disabled vehicle if it is suspected that the electrolyte in the battery is frozen.



Suitable eye protection must be worn when working in the vicinity of the battery.



Take care when working near rotating parts of the engine.



Prior to attempting to start the disabled vehicle, ensure that the parking brake is applied or suitably chock the wheels. Ensure that 'P' - PARK - Automatic Transmission or NEUTRAL - Manual Transmission is selected.

CAUTIONS:



Ensure that all electrical loads are switched **OFF** prior to connecting booster cables and disconnect booster cables prior to using electrical equipment.



Ensure that the slave battery/starting aid are of 12 volt capacity and that all electrical loads on the disabled vehicle are switched **OFF** prior to connecting booster cables.

Carry out the following operation in the sequence given:
1. Connect the end of the Red (+) booster cable to the positive (+) battery terminal vehicle of the vehicle.
2. Connect the end of the Black (-) booster cable to a good earth point e.g. unpainted metal surface or engine mounting at least 0.5 m (20.0 in) from the battery or fuel lines on the vehicle.
3. Start the engine of the vehicle and allow it to idle.
4. Disconnect the Black (-) booster cable from the earth point of the vehicle.
Disconnect the Red (+) booster cable from the battery terminal of the vehicle.

Battery and Charging System - General Information - Battery Care

Description and Operation

12V LEAD ACID BATTERY CARE MANUAL FOR DEALER / RETAILER USE

1. INTRODUCTION

2. GENERAL RULES FOR BATTERY CARE

3. EQUIPMENT (MINIMUM STANDARD)

4. HEALTH AND SAFETY PRECAUTIONS

5. DETERMINING BATTERY CONDITION

6. BATTERY CHARGING AND MAINTENANCE

7. CHARGING SYSTEM TEST AND DIAGNOSIS

8. VEHICLE QUIESCENT CURRENT TESTING

APPENDIX A: BATTERY TEST PROCESS

APPENDIX B: BATTERY REPORT FORM - IN SERVICE BATTERIES ONLY

1. INTRODUCTION

This publication sets out, for the benefit of dealers / retailers worldwide, requirements for the care and maintenance of batteries, from the vehicles hand-over to the dealer / retailer to the handover to the customer or in the case of a spare part battery from its delivery to the dealer / retailer to its fitment to a customer vehicle.

It applies to all types of 12 volt Lead Acid Batteries used, whether they are conventional flooded technology or Absorbed Glass Mat (AGM) technology and also applies to both Primary and Secondary or Auxiliary Batteries.

The clearly laid out and illustrated sections guide dealers / retailers through each stage of the vehicles or spare parts receipt, storage, pre-delivery and customer hand-over. This publication can be used as a guide to the handling and care of batteries in service. It is vital to appreciate that unless each process is rigorously applied on all vehicles, the customer will receive a vehicle with a battery or a spare part battery which will not provide a satisfactory service life.

It is very important that all tests quoted throughout this publication are adhered to. If they are applied incorrectly batteries could be scrapped unnecessarily. Refer to the battery testing section for detailed information.

It is equally important therefore to note the following key points:

- Most new vehicles leave the factory with either a transit relay installed and/or have a transit mode programmed into the vehicle control modules. The transit relay must be removed and the transit mode disabled (where applicable) using an approved diagnostic system, **NOT MORE THAN 24 HOURS** before the customer takes delivery.
- 12 Volt Lead Acid Batteries rely on internal chemical processes to create a voltage and deliver current. These processes and the internal chemical structure of the battery can be damaged if the battery is allowed to discharge over a number of weeks / months, or is left in a discharged state for a lengthy time period. For this reason the battery must be tested / re-charged if necessary every month, and **MUST BE** re-charged after every three month period of storage. Refer to the vehicle storage manual and update the vehicle history sheet.
- Under no circumstances should the battery be disconnected with the engine running because under these conditions the alternator can give a very high output voltage. This high transient voltage will damage the electronic components in the vehicle. Loose or incomplete battery connections may also cause high transient voltage.
- On vehicles with conventional ignition keys, these must not be left in the ignition lock barrel when the transit relay has been removed, otherwise quiescent current will increase and the battery will discharge more rapidly.
- Two types of Lead acid batteries are used; standard Flooded type and AGM (Absorbed Glass Mat) or VRLA (Valve regulated Lead Acid) types. AGM batteries offer improved resistance to cycling as seen in stop start applications. AGM Batteries are fully sealed and cannot have the electrolyte level topped up.

Dealers and retailers involved in the storage, handling of vehicles and spare parts batteries have a responsibility to ensure that only vehicles and spare parts having a fully satisfactory battery may be processed further through the distribution selling chain.

NOTE: It is very important that test processes quoted throughout this publication are adhered to.

If they are not adhered to correctly batteries could be scrapped unnecessarily or a battery with an issue remains in use. Refer to the battery testing section for detailed information.

2. GENERAL RULES FOR BATTERY CARE

Frequency of Battery Condition Checks.

Any battery in storage whether it is in a vehicle or in spare parts inventory must have its charge status checked every 30 days as described in Appendix A, and must be recharged every 90 days as described in the "Battery Charging and Maintenance" section of this manual.

Dealer Demonstration Vehicles

Due to the high depth of discharge a dealer demonstration vehicle battery may experience, batteries that are fitted to vehicles used as dealer demonstration vehicles must be connected to a power supply / charger capable of delivering 50 Amps or more whilst the vehicle is being demonstrated and the engine is not running. This will prevent the battery from being damaged from "energy throughput " wear out during a demonstration.

Software Reflash, SDD work or Ignition On related Workshop Activities.

Due to the high electrical current demand and high depth of Discharge that can occur during vehicle software re-flash activities, SDD work or ignition on related work in the workshop, vehicles that are undergoing such activities MUST have the electrical system on the vehicle supported with a power supply / charger / vehicle maintainer capable of delivering 50 Amps or more.

Jump Starting New vehicles Before They Have Been Delivered to the Customer.

- It is the dealer / retailers responsibility to ensure the battery is not allowed to go flat by following the instructions and processes defined in this manual.
- However if circumstances dictate that a new vehicle must be jump started due to a flat battery whilst the vehicle is in the dealer / retailers care, the battery on this vehicle must be replaced with a new one prior to delivery to the customer at the dealer / retailers liability.
- The vehicle should also undergo investigation as to why the battery went flat.
- Do not connect the jump starting cable to the negative (-) terminal of the battery. Always connect to the recommended earthing point. As defined in the owners handbook or service documentation for that vehicle.

Jump Starting or Boost Charging Vehicles in Service

Do not connect the jump starting cable to the negative (-) terminal of the battery. Always connect to the recommended earthing point. As defined in the owners handbook or service documentation for that vehicle.

Charging AGM Batteries

AGM batteries must not be charged with voltages above 14.8 Volts. Doing so will damage them.

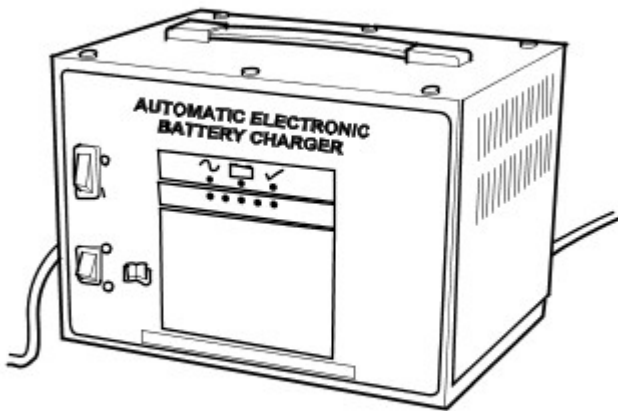
Testing AGM Batteries

Midtronics 393, 394, 493 and 494 testers are not capable of testing AGM batteries. Doing so can give an incorrect result.

When it is necessary to test an AGM battery use the Midtronics EXP1080 tester or the GR1 Diagnostics Charger.

3. EQUIPMENT (MINIMUM STANDARD) (pictures are for illustration only)

Traction Battery Charger (or similar stand-alone charger)



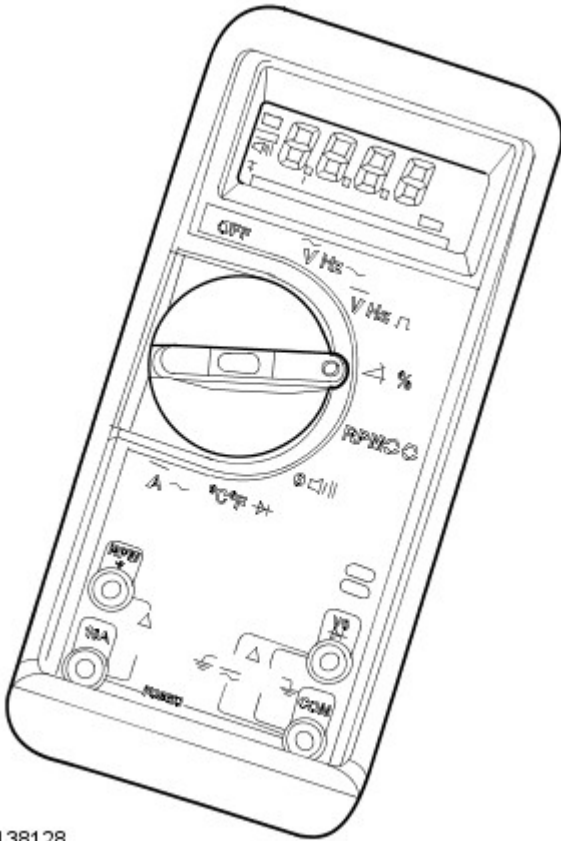
E138126

Midtronics EXP1080 Hand-Held Tester



E138131

Digital Multi-Meter or Digital Volt-Ohm Meter (DVOM)



E138128

Midtronics GR-1 Diagnostic Charger



E138129

4. HEALTH AND SAFETY PRECAUTIONS

WARNINGS:



BATTERY CELLS CONTAIN SULPHURIC ACID AND EXPLOSIVE MIXTURES OF HYDROGEN AND OXYGEN GASES. IT IS

THEREFORE ESSENTIAL THAT THE FOLLOWING SAFETY PRECAUTIONS ARE OBSERVED.



Batteries emit highly explosive hydrogen at all times, particularly during charging. To prevent any potential form of ignition occurring when working in the vicinity of a battery:

- Do not smoke when working near batteries.
- Avoid sparks, short circuits or other sources of ignition in the battery vicinity.
- Switch off current before making or breaking electrical connections.
- Ensure battery charging area is well ventilated.
- Ensure the charger is switched off when: a) connecting to a battery; b) disconnecting from the battery.
- Always disconnect the ground cable from the battery terminal first and reconnect it last.



Batteries contain poisonous and highly corrosive acid. To prevent personal injury, or damage to clothing or the vehicle, the following working practices should be followed when topping up, checking electrolyte specific gravity, removal, refitting or carrying batteries:

- Always wear suitable protective clothing (an apron or similar), safety glasses, a face mask and suitable gloves.
- If acid is spilled or splashed onto clothing or the body, it must be neutralized immediately and then rinsed with clean water. A solution of baking soda or household ammonia and water may be used as a neutralizer.
- In the event of contact with the skin, drench the affected area with water. In the case of contact with the eyes, bathe the affected area with cool clean water for approximately 15 minutes and seek urgent medical attention.
- If battery acid is spilled or splashed on any surface of a vehicle, it should be neutralized and rinsed with clean water.
- Heat is generated when acid is mixed with water. If it becomes necessary to prepare electrolyte of a desired specific gravity, SLOWLY pour the concentrated acid into water (not water into acid), adding small amounts of acid while stirring. Allow the electrolyte to cool if noticeable heat develops. With the exception of lead or lead-lined containers, always use non-metallic receptacles or funnels. Do not store acid in excessively warm locations or in direct sunlight.



Due to their hazardous contents, the disposal of batteries is strictly controlled. When a battery is scrapped, ensure it is disposed of safely, complying with local environmental regulations. If in doubt, contact your local authority for advice on disposal facilities.

5. DETERMINING BATTERY CONDITION

The tools used for determining the condition of the battery will depend upon whether it is installed in a vehicle or in spare parts inventory. Concerning an installed battery, procedures will vary if the vehicle is new, or already in service with a customer.

NOTE: The term 'New Vehicle' refers to a vehicle at any part of the delivery process from leaving the factory to arriving at a port of entry, dealership, retailer, including any storage facilities en route or a vehicle being stored prior to sale at dealership / retailer.

NOTE: Midtronics 393, 394, 493 and 494 testers must not be used to test AGM batteries as these testers are not capable of correctly testing AGM batteries and can give an incorrect result. For AGM battery testing use the EXP1080 tester or the GR1 Diagnostics charger.

NEW VEHICLES

A Midtronics tester should be used to assess the condition of the battery for new vehicles. The test results should be recorded on the Storage History Sheet (see Vehicle Storage manual).

Scenario 1 - Dealership / Retailer (Responsibility: Dealer / Retailer)

1. Within 24 hours of arrival at the dealer / retailer proceed as follows:

- Perform a Midtronics battery test (See Appendix A.)
- Carry out the recommended actions accordingly.

2. If the Midtronics result is "Good Battery" the vehicle may be stored.

- For all new vehicles in storage the transit relay MUST be fitted, or the Transit Mode enabled where used. For vehicles without a transit relay or a Transit Mode, the battery negative cable MUST BE DISCONNECTED from the battery.

3. The battery must be tested and/or re-charged every month and MUST be re-charged after every three month period.

4. Record your test results on the Storage History Sheet (see Vehicle Storage Manual) to indicate when a re-charge will be necessary.

Scenario 2 - Delivery to the Customer (Responsibility: Dealer / Retailer)

NOTE: It is essential that the following actions are conducted in the 24 hours prior to the agreed hand over time:

1. Perform a Midtronics Battery test (See Appendix A).
2. Carry out the recommended actions accordingly.

3. The vehicle should only be released to the customer if Midtronics has tested the battery as "Good Battery"

Spare Part Batteries

Lead acid batteries will, as a result of natural chemical processes, slowly self discharge themselves over a period of time (even when open circuit and no electrical load applied).

In the case of spare parts batteries, a Midtronics tester should be used to assess the condition of new spare parts batteries.

The batteries must be stored such that they cannot get wet and are not in direct sunlight.

Any batteries which are dropped must be scrapped. This applies even if no external damage is apparent.

Scenario 1 - Spare Part Batteries Within Dealer Stock But Not Yet Fitted To A Vehicle (Responsibility: Dealer / Retailer)

1. For a battery in the Dealer parts or in ready to use stock but not yet fitted to a vehicle the following rules must be followed:

- Check the battery condition on receipt by performing a Midtronics battery test (See Appendix A).
- Batteries should only be returned to storage if the Midtronics tester indicates "Good Battery".
- The battery condition should be rechecked every 30 days by performing a Midtronics battery test (See Appendix A).
- If required batteries should be recharged as described in the "Battery Charging and Maintenance" section of this manual.

2. 2 All batteries must be controlled via a FIFO (First In First Out) process to ensure aged batteries are not held and the batteries are not allowed to age unnecessarily.

VEHICLES IN SERVICE

The Midtronics hand-held tester or the Midtronics Diagnostic Charger are the preferred tools to assess battery condition for vehicles in service. The test results should be recorded on the In-Service Battery Report Form (See Appendix B).

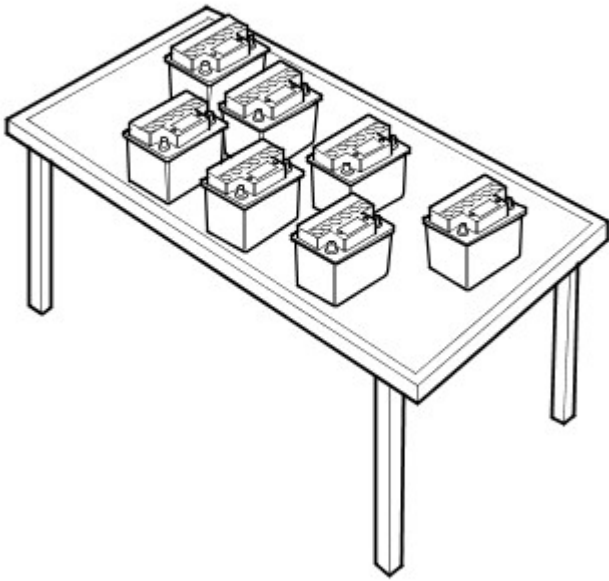
Midtronics Testing - In-Service Testing Only

NOTE: The battery surface charge must be removed before this test in accordance with the procedure in Appendix A. Ensure that the battery terminal connectors are clean. When connecting the Midtronics testing equipment, connect the RED clip to the positive (+) battery terminal first, and then connect the BLACK clip to the negative (-) battery terminal. Rock the clips backward and forward to ensure a good connection to the battery.

1. Perform a Midtronics battery test (See Appendix A).
2. Carry out the recommended actions accordingly.

6. BATTERY CHARGING AND MAINTENANCE

BATTERY CHARGING



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It is essential that a suitably ventilated defined area exists in each dealership / retailer for battery charging. Likewise, an area should be allotted for scrap batteries, and clearly indicated as such. It is recommended that dealers / retailers always have fully charged batteries ready for use. However the battery **MUST BE** tested and charged if necessary every month, and charged after three months irrespective of any test.

CAUTIONS:



Batteries must be re-charged after a maximum of 3 months storage (see Storage History sheet in the New Vehicle Storage Manual).



It is very important that when charging batteries using the traction charger or other stand-alone chargers that the charger is set for the correct type of battery before charging commences. If the wrong switch is selected the result would be a battery that is not charged fully and / or overheating can occur. Follow the manufacturers operating instructions.



Do not charge AGM batteries with voltages over 14.8 volts as this will damage the battery.

To bring a serviceable but discharged battery back to a fully charged condition proceed as follows:

- Check and if necessary top-up the battery electrolyte level.
- Charge the battery using the Midtronics Diagnostic Charger (USA) or Traction Charger (all other markets) following the manufacturers operating instructions.

NOTE: When using the Midtronics Diagnostic Charger, automatic mode must always be used. After charging and analysis, the charger may display 'Top-Off Charging', press STOP to end. Do not stop charging until the current falls to 5A or less, otherwise the battery will not be fully charged.

POST-CHARGE TEST METHODS

New Batteries, Batteries in Storage and In-Service Batteries

The purpose of this test is to ensure that the charging process has fully charged the battery.

NOTE: IT IS RECOMMENDED THAT THIS TEST IS CONDUCTED AT LEAST 24 HOURS AFTER THE CHARGE CYCLE IS COMPLETED.



⚠ CAUTION: DO NOT connect the tester to any other circuit or chassis point.

1. Attach the Midtronics Tester to the battery.
2. Follow the instructions on the tester to test the battery. Ensure the correct battery type and size is selected.
3. Perform the action based on the tester results (see the tester results chart in the Vehicles in Service sub -section of Determining Battery Condition Section).
4. Enter the readings and test code obtained on the In Service Battery Report Form.

NOTE: Midtronics 393, 394, 493 and 494 testers must not be used to test AGM batteries as these testers are not capable of correctly testing AGM batteries and can give an incorrect result. For AGM battery testing use the EXP1080 tester or the GR1 Diagnostics charger.

BATTERY REPLACEMENT

If it is determined that a battery requires replacement, always refer to the appropriate section of the workshop manual for instructions on removing and installing the battery from the vehicle.

On in service vehicles fitted with a Battery Monitoring System (BMS), the BMS module must be reset following the installation of a new battery. The BMS module reset procedure must be performed using an approved diagnostic system.

CHECK/TOP-UP BATTERY ELECTROLYTE – Only Applicable to certain Flooded Types of Battery.

WARNINGS:

⚠ AGM TECHNOLOGY BATTERIES ARE FULLY SEALED FOR LIFE AND NO ATTEMPT SHOULD BE MADE TO CHECK OR TOP UP THE ELECTROLYTE LEVEL.

⚠ BEFORE CHECKING AND TOPPING-UP THE BATTERY ELECTROLYTE, REFER TO THE HEALTH AND SAFETY PRECAUTIONS SECTION.

Check to ensure the battery is of a type suitable for topping up. These types of batteries will have cell plugs visible on the top face of the battery or a removable access panel to allow access to the cells.

On batteries with a clear or opaque case and level marks, check the electrolyte level by visual inspection of the maximum level indicator mark on the battery casing indicating adequate level above the battery separators.

On batteries with black cases, remove the cell plugs or access panel and ensure the electrolyte level is level with the indicator

in the cell hole. A flashlight may be required to see the electrolyte level on this type of battery.



CAUTION: DO NOT overfill.

If the electrolyte level is low, top-up using distilled water.

Maintenance free and Valve Regulated (AGM) batteries are sealed and therefore cannot be topped up.

CHARGING SYSTEM TEST AND DIAGNOSIS

For all vehicles, refer to the Charging System - Diagnosis and Testing in section 414-00 of the Workshop Manual.

VEHICLE QUIESCENT CURRENT TESTING

NOTE: On vehicles fitted with a Battery Monitoring System (BMS), the diagnostic routine for quiescent drain testing in the approved diagnostic system should be utilized.

NOTE: If a customer complains of a vehicle battery that discharges continuously or when left for a prolonged period of time, it is recommended that a quiescent drain test is performed as described below.

NOTE: The battery drain should be measured using an approved diagnostic system or a Digital Multi-Meter (DVOM).

The vehicle should be in the locked/armed state (for example vehicle alarm fully armed), all doors, engine and luggage compartment lids are open and latched (so as to appear closed from an electrical point of view). The test should take place after the vehicle has entered shutdown mode. The time taken for this to occur after the ignition is switched off varies according to model - Refer to Quiescent Drain in section 414-00 of the Workshop Manual.

NOTE: When the vehicle is armed, the effect of the security system Light Emitting Diode (LED) flashing is to cause a pulsation in the measured current drain. In this case, either the average current should be taken (using a Digital Multi-Meter (DVOM) with an averaging system) or the current reading taken, ignoring the brief high current peaks.

EQUIPMENT

Approved diagnostic system with current probe or Digital Multi-Meter (DVOM) with current probe.

METHOD OF MEASUREMENT

Using an Approved Diagnostic System

1. Switch off all electrical loads and ensure that the ignition is off.
2. Connect the current probe to the approved diagnostic system.
3. Calibrate the probe.
4. Install a clamp around the battery lead/junction box lead.
5. Go to the Quiescent Current Testing section.

Using a Digital Multi-Meter (DVOM)

NOTE: Do not use an in-line DVOM to measure the quiescent drain on vehicles fitted with an electronic throttle. The current exceeds the maximum amount the fuse in the DVOM is capable of handling.

1. Switch off all electrical loads and ensure that the ignition is off.
2. Connect the current probe to the DVOM.
3. Calibrate the probe.
4. Install a clamp around the battery lead/junction box lead.
5. Go to the following Quiescent Current Testing section.

QUIESCENT CURRENT TESTING

1. Switch ignition to 'on' or select ignition mode in keyless vehicles and switch to 'off' (do not crank).
2. Remove key from ignition switch (where applicable).
3. Open and latch all doors, hood and luggage compartment lid.
4. Lock the vehicle using the remote function on the remote handset. (Single lock only to avoid volumetric alarm arming).
5. Remove any other potential electrical drains such as accessories plugged into accessory sockets.
6. Record the amperage readings after the shutdown period. The model specific Amperage readings for quiescent drain are referenced in Quiescent Drain in section 414-00 of the Workshop Manual

7. Record the final reading on the battery report form Appendix B.

NOTE: The preferred method of testing following an excessive current consumption figure is to use a current probe around individual junction box leads to the various suspected circuits to identify a potential cause. This is in preference to the old method of removing fuses for the following reasons:

- Many modules take a considerable time to power down. Each time a fuse is removed and re-fitted, the quiescent drain current may take an extended period of time to return to normal (typically up to 45 minutes).
- The drain may be caused by a module remaining active and preventing the quiescent drain from reducing to normal levels.
- The drain may be caused by a relay winding that is activated. Pulling the fuse can allow this to 'reset' and the drain will be lost and go un-diagnosed.

APPENDIX A BATTERY TEST PROCESS

It is recommended that this test is conducted at least 24 hours after the vehicle engine has been run or the battery charged to avoid the need of surface charge removal or if this time constraint is unacceptable due to circumstances, then conduct the charge strip removal process.

Part 1 - Surface Charge Removal

NOTE: Before carrying out a battery test you must ensure that there is no battery surface charge present.

NOTE: The battery may be tested either on a bench or on the vehicle.

- In the case of on-vehicle testing, the battery must be isolated from the vehicle by removal of the battery negative (-) cable from the battery terminal before the measurement is taken unless the vehicle has a transit relay fitted or is in transit mode.

A vehicle which has had its battery charged or been driven in a 24 hour period before the test, must have its surface charge removed using one of the following methods:

1. If 24 hours have passed since the last time the engine was run or the battery charged, proceed to 'Part 2 - Battery Test'.
2. Turn on the ignition. Switch on the headlamps on high beam for a minimum 3 minutes.
3. Switch off the headlamps. For vehicles tested after the transit relay has been removed, disconnect the battery by removal of the negative (-) cable. Vehicles with a transit relay fitted or with a low current transport mode enabled do not need to have the battery disconnected.
4. Wait a maximum of 5 minutes before recording test results for any battery measurements.

Part 2 - Battery Test

NOTE: The battery surface charge must be removed before this test in accordance with the procedure in Part 1 above. Ensure that the battery terminal connectors are clean. When connecting the Midtronics testing equipment, connect the RED clip to the positive (+) battery terminal first, and then connect the BLACK clip to the negative (-) battery terminal. Rock the clips backward and forward to ensure a good connection to the battery.

NOTE: Midtronics 393, 394, 493 and 494 testers must not be used to test AGM batteries as these testers are not capable of correctly testing AGM batteries and can give an incorrect result. For AGM battery testing use the EXP1080 tester or the GR1 Diagnostics charger.



CAUTION: **DO NOT** connect the tester to any other circuit or chassis point other than the battery negative terminal.

1. Attach the Midtronics tester to the battery.
2. Follow the instructions on the tester to test the battery. Ensure the correct battery type and size is selected.
3. Perform the action based on the tester results (see table below).
4. Enter the readings and test code obtained on the Battery Report Form (Appendix B) or equivalent which records as a minimum the technician's name, Vehicle Identification Number (VIN), Date of check, Midtronics code and Battery Voltage from the Midtronics tester.

At the end of the test, the battery negative (-) cable should be re-attached to the battery terminal.

TESTER RESULTS	ACTION
GOOD BATTERY	Return to service.
GOOD RE-CHARGE	Fully charge battery and return to service.
CHARGE AND RE-TEST	Fully charge battery. Remove surface charge. Re-test battery. If same result replace battery.
REPLACE BATTERY OR BAD CELL BATTERY	Verify surface charge removed. Disconnect battery from vehicle and re-test. If result repeats after surface charge removal, replace battery. DO NOT RECHARGE.
UNABLE TO DO TEST	Disconnect battery from vehicle and re-test.

APPENDIX B : BATTERY REPORT FORM - IN SERVICE BATTERIES ONLY

NOTE: Fields marked with * are mandatory and must be completed.

General Information	YES / NO		YES / NO	
Customer Name:		Dealer/Retailer Code:	*	
Repair Order Number:	*	Battery Date Code:	*	
Repair Order Date:	*	Number of Times Battery Charged:	*	
Repair Order Date:		Technicians Name:	*	
Vehicle Identification Number (VIN):	*	Technicians Signature:	*	
Give a detailed description of the symptoms experienced by the customer (attach a separate sheet if necessary)				
-				
-				
-				
-				
-				
-				
Diagnostics (Battery Testing)				
1: Loose battery clamps	Yes	*	No	*
2: Loose hold down clamps	Yes		No	
3: Corroded terminal posts	Yes	*	No	*
4: Physical damage/leaks	Yes		No	
5: Low electrolyte	Yes	*	No	*
6: FEAD belt tension	OK	*	Not OK	*
7: Surface charge removed	Yes	*	No	*
8: Voltage (appendix A)	Yes	*	No	*
9: Quiescent Drain	mA	*		
10: Vent tube correctly installed	Yes		No	
11: Midtronics test				
Code before charging	*			
If Midtronics indicates that the battery needs re-charging, charge the battery for 24 hours				
Code after charge	*			
Result after charge	*			
If "good and re-charge" charge the battery for an additional 24 hours.				
If "charge and re-test" for both before and after 24 hours charge renew the battery				
Only renew the battery if "renew battery", "bad cell" or charge and re-test has been displayed twice.				
Comments				
-				
-				
-				
-				
-				

Battery and Charging System - General Information - Quiescent Drain

Description and Operation

QUIESCENT DRAIN - TYPICAL VALUES

NOTE: The quiescent drain after the initial shutdown period should not exceed the value shown in the table.

Land Rover Quiescent Drain Values

MODEL	SHUT DOWN PERIOD (minutes)	TYPICAL VALUES BATTERY DRAIN (mA)
Range Rover (LM) - Up to 2009MY	30	16.0 - 18.0
Range Rover (LM) - From 2010MY	20 (after lock/arm condition) ²	<30
	33 (unlocked)	<30
Range Rover Sport (LS) - Up to 2007MY	20	<22
Range Rover Sport (LS) - From 2007MY to 2010MY	30	<25
Range Rover Sport (LS) - From 2010MY	3 (after lock/arm condition) ²	<30
	33 (unlocked)	<30
Range Rover Evoque (LV) - From 2012MY	20 (after lock and arm condition)	<20
Discovery 3/LR3 (LA) - Up to 2007MY	20	<22
Discovery 3/LR3 (LA) - From 2007MY to 2010MY	30	<25
Discovery 4/LR4 (LA) - From 2010MY	3 (after lock/arm condition) ²	<30
	33 (unlocked)	<30
Freelander 2/LR2 (LF) - From 2007MY	35 (single locked or unlocked)	<23.6
	12 (double locked)	<23.6
Freelander (LN) - Up to 2007MY	10	24-25 - without Becker Navigation system
	10	27-28 - with Becker Navigation system
Defender (LD) - 1998MY to 2007MY	30	<21
Defender (LD) - from 2007MY	<30	<30
Discovery Series 2 (LT)	30	<30

NOTE:

1. The total current drain will be higher if certain approved accessories are fitted (for example: tracker, trailer module, etc.)
2. Applies to vehicles without Tire Pressure Monitoring System (TPMS). Vehicle shut-down period with TPMS is approximately 15 minutes.

Battery and Charging System - General Information - Charging System

Diagnosis and Testing

Principles of Operation

For a detailed description of the charging system, refer to the relevant Description and Operation section in the workshop manual. REFER to:

[Battery Care](#) (414-00 Battery and Charging System - General Information, Description and Operation),
 Battery and Cables (414-01, Description and Operation),
 Generator - ID4 2.4L Diesel (414-02, Description and Operation).

Inspection and Verification



CAUTION: Diagnosis by substitution from a donor vehicle is **NOT** acceptable. Substitution of control modules does not guarantee confirmation of a fault, and may also cause additional faults in the vehicle being tested and/or the donor vehicle.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.

NOTE: Check the vehicle battery condition and state of charge before condemning any of the charging system components. For additional information, refer to the battery care manual.

For a complete list of all diagnostic trouble codes that could be logged on this vehicle, please refer to section 100-00. REFER to: (100-00)

Diagnostic Trouble Code (DTC) Index - DTC: Engine Control Module (PCM) (Description and Operation),
 Diagnostic Trouble Code (DTC) Index - DTC: Instrument Cluster (IPC) (Description and Operation).

Visual Inspection

Mechanical	Electrical
<ul style="list-style-type: none"> ● Generator ● Drive belt ● Drive belt tensioner ● Generator pulley ● Check the security of the generator fixings 	<ul style="list-style-type: none"> ● Generator ● Battery ● Mega-fuse ● Engine/generator ground connection ● Harness(s) ● Electrical connector(s) ● Engine Control Module (ECM) ● Central junction box (Freelander 2 only)

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step
4. If the cause is not visually evident, check for Diagnostic Trouble Codes (DTCs) and refer to the DTC Index.

DTC Index

NOTE: If the control module or a component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual (section B1.2), or determine if any prior approval programme is in operation, prior to the installation of a new module/component.

NOTE: Generic scan tools may not read the codes listed, or may read only five digit codes. Match the five digits from the scan tool to the first five digits of the seven digit code listed to identify the fault (the last two digits give extra information read by the manufacturer-approved diagnostic system).

NOTE: When performing electrical voltage or resistance tests, always use a digital multimeter (DMM) accurate to three decimal places, and with an up-to-date calibration certificate. When testing resistance, always take the resistance of the DMM leads into account.

NOTE: Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.

NOTE: If DTCs are recorded and, after performing the pinpoint tests, a fault is not present, an intermittent concern may be the cause. Always check for loose connections and corroded terminals.

Symptom	Possible Cause	Action
Charge warning lamp does not illuminate	<ul style="list-style-type: none"> ● Warning lamp/circuit - fault ● Generator - internal fault ● CAN Bus - circuit fault ● Engine control module 	<ul style="list-style-type: none"> ● Check the warning lamp function with the ignition on and the engine off ● Repair the circuit as necessary ● Check for DTCs indicating a generator, CAN or engine control module fault

Symptom	Possible Cause	Action
	- internal fault	
Charge warning lamp stays on/battery discharges	<ul style="list-style-type: none"> ● Accessory drive belt - fault ● Generator pulley slipping on shaft ● Generator - internal fault ● Battery cable - fault ● CAN Bus - circuit fault ● Engine control module internal fault ● Central junction box 	<ul style="list-style-type: none"> ● Check the battery and generator cables ● Refer to the electrical guides ● Check for DTCs indicating a generator fault ● Check the accessory drive belt condition and tension ● Check that the pulley does not rotate independently of the generator ● Check for DTCs indicating a CAN, central junction box or engine control module fault
Charge warning lamp intermittent	<ul style="list-style-type: none"> ● Accessory drive belt slipping ● Battery cable - fault ● Generator - circuit fault ● Generator - internal fault ● CAN Bus - circuit fault 	<p>NOTE: Use of a power pack or boost charger may bring the warning lamp on until disconnected</p> <ul style="list-style-type: none"> ● Check the accessory drive belt condition and tension ● Check the battery and generator cables refer to the electrical guides ● Check for DTCs indicating a generator or CAN circuit fault
Battery discharges without the charge warning lamp staying on	<ul style="list-style-type: none"> ● Battery - fault ● Battery quiescent drain ● Intermittent generator - fault 	<ul style="list-style-type: none"> ● Check the battery condition ● Check for battery quiescent drain ● Check for DTCs indicating a generator fault ● If no other reason for discharge can be found, check the circuit. Refer to the electrical guides
Noise (mechanical)	<ul style="list-style-type: none"> ● Accessory drive belt slipping 	<ul style="list-style-type: none"> ● Check the accessory drive belt condition and tension ● Disconnect the accessory drive belt and check that the generator rotates freely

Test Procedure

PINPOINT TEST A : BOSCH NON-BMS GENERATOR DIAGNOSTIC FLOW CHART

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
A1: MIDTRONICS BATTERY TEST	
NOTE: The battery must be fully charged and any battery defects rectified before continuing with generator diagnosis	
NOTE: The voltmeter must display readings to three decimal places (i.e. 0.001V)	
NOTE: Ignition on is position 2 on a keyed ignition system	
NOTE: Ignition on is two short presses of the start button (power mode 6) with keyless ignition system	
1	Using a Midtronics hand held tester or the Midtronics GR-1 diagnostic charger, carry out the "Midtronics battery test" as detailed in the battery care manual. REFER to: Battery Care (414-00 Battery and Charging System - General Information, Description and Operation).
2	Record battery diagnostic result on the provided form
	Does the battery pass the "Midtronics battery test"? Yes GO to B1. No Rectify any battery defects before continuing with generator diagnosis GO to Pinpoint Test B.

PINPOINT TEST B : BOSCH NON-BMS GENERATOR DIAGNOSTIC FLOW CHART

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
B1: GENERATOR OUTPUT	
NOTE: Freelander 2 = The heated rear screen is timed to operate for 12 minutes	
NOTE: Defender = The heated rear screen is timed to operate for 8 minutes	
1	Connect a voltmeter to the vehicle battery
2	Switch ignition state to on (engine off)
3	Turn off all electrical loads e.g. (blower, radio, interior lights etc.)
4	Start the engine, switch on the heated rear screen <ul style="list-style-type: none"> ● Ensure the heated rear screen is on (see note above) and that the air conditioning system is off.
5	Wait 90 seconds

	6 Record the battery voltage (V1) shown on the multimeter
	Does battery voltage (V1) = 14.8 volts or greater at idle? Yes Install a new generator. Refer to the warranty policy and procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component No GO to B2.
B2: BATTERY VOLTAGE AT IDLE	
	1 Using battery voltage reading (V1)
	Does battery voltage (V1) = 13 volts or greater at idle (But less than 14.8 volts)? Yes GO to B3. No GO to Pinpoint Test C.
B3: BATTERY WARNING LAMP	
	1 The battery voltage is (V1) = 13 volts or greater at idle (but less than 14.8 volts)
	Is the battery warning lamp illuminated? Yes GO to Pinpoint Test C. No The generator output is within the expected range, Do not replace the generator . If customer concern is still evident contact dealer technical support

PINPOINT TEST C : BOSCH NON-BMS GENERATOR DIAGNOSTIC FLOW CHART

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
C1: CIRCUIT CHECKS	
NOTE: Freelander 2 = Charge warning lamp is driven by the central junction box (from the powertrain control module) to the instrument panel cluster via the CAN bus	
NOTE: Defender = Charge warning lamp is driven by the powertrain control module to the instrument panel cluster via the CAN bus	
	1 Freelander 2 = Refer to the electrical circuit diagrams and check the (LIN) circuit between the generator and the engine control module for short circuit to ground, short circuit to power, open circuit, high resistance faults
	2 Defender = Refer to the electrical circuit diagrams and check the (D+ and ALTMON) circuits between the generator and the engine control module for short circuit to ground, short circuit to power, open circuit, high resistance faults
	Are any circuit faults evident? Yes Repair the circuit as required GO to Pinpoint Test B. No GO to Pinpoint Test D.

PINPOINT TEST D : BOSCH NON-BMS GENERATOR DIAGNOSTIC FLOW CHART

TEST CONDITIONS	DETAILS/RESULTS/ACTIONS
D1: CIRCUIT CHECKS 1	
NOTE: Freelander 2 = The heated rear screen is timed to operate for 12 minutes	
NOTE: Defender = The heated rear screen is timed to operate for 8 minutes	
	1 Connect a voltmeter to the vehicle battery
	2 Switch ignition state to on (engine off)
	3 Turn off all electrical loads e.g. (blower, radio, interior lights etc.)
	4 Start the engine, switch on the heated rear screen <ul style="list-style-type: none"> Ensure the heated rear screen is on (see note above) and that the air conditioning system is off.
	5 Voltage measurement <ul style="list-style-type: none"> Measure the voltage drop between the generator body and battery negative terminal and record the value (V2)
	Does the voltage drop value (V2) = less than 0.3 Volts ? Yes GO to D2. No Switch off engine. Circuit check. Refer to the electrical circuit diagrams, check the generator body and battery negative cables for loose or corroded connections. Repair any circuit faults, retest the generator GO to Pinpoint Test B.
D2: CIRCUIT CHECKS 2	

	<div><div>1</div><div>Voltage measurements</div><div><ul style="list-style-type: none">Measure the voltage drop between the generator B+ terminal and battery positive terminal and record value (V3)</div></div>
	<div><div>Does the voltage drop value (V3) = less than 0.3 Volts ?</div><div><div>Yes</div><div>Install a new generator. Refer to the warranty policy and procedures manual, or determine if any prior approval programme is in operation, prior to the installation of a new module/component</div></div><div><div>No</div><div>Switch off engine. Circuit check. Refer to the electrical circuit diagrams check the generator B+ terminal and positive battery cables for loose or corroded connections. Repair any circuit faults, retest the generator GO to Pinpoint Test B.</div></div></div>

Battery, Mounting and Cables -

General Specification

Item	Specification
Battery - All models:	
Type	Exide H7
Capacity	80Ah/700CCA
Reserve capacity	125 minutes

Battery Disconnect/Connect



CAUTION: The vehicle status and battery condition must be established before attempting battery disconnect/connect. Reference must be then made to the following table to establish the relevant procedure to be followed.

NOTE: Vehicles fitted with a fuel fired booster heater will require a 5 minute wait before telestart function will operate. Cycle the ignition off->on->off. Wait 5 minutes to allow fuel fired booster heater to store vehicle configuration parameters.

Vehicle status	Battery charged Procedure	Battery discharged Procedure
Engine running	1	
Vehicle powered down, locked and alarmed	2	3
Vehicle unlocked	4	5

Procedure 1

Disconnect battery	Connect battery
1. Apply parking brake or alternatively, chock wheels	1. Ensure that all electrical loads are switched OFF
2. Switch off ignition and remove the remote control.	2. Connect battery leads - GROUND lead last
3. Wait 2 minutes for engine management system to 'power down'	3. Switch on ignition
4. Open the hood	4. Reset radio station preset buttons.
5. Disconnect battery - GROUND lead first	5. Reset clock
	6. Reset electric window one-touch facility. Power window up to hard stop, release switch, reapply and hold for 1 second (relay in door will click). Lower window to stop, reapply and hold for one second. One touch should now work

Procedure 2

Disconnect battery	Connect battery
1. Unlock the vehicle and disarm the alarm using the remote control	1. Ensure that all electrical loads are switched OFF
2. Apply parking brake or alternatively, chock wheels	2. Connect battery leads - GROUND lead last
3. Wait 2 minutes for engine management system to 'power down'	3. Switch on ignition
4. Open the hood	4. Reset radio station preset buttons.
5. Disconnect battery - GROUND lead first	5. Reset clock
	6. Reset electric window one-touch facility. Power window up to hard stop, release switch, reapply and hold for 1 second (relay in door will click). Lower window to stop, reapply and hold for one second. One touch should now work

NOTE: 1. Disconnect battery - If the remote control is not functioning, it will be necessary to manually unlock the vehicle using the key.

Procedure 3

Disconnect battery	Connect battery
1. Unlock the vehicle from the LH front door using the key	1. Ensure that all electrical loads are switched OFF
2. Enter the vehicle, and dock the remote control to silence the alarm.	2. Connect battery leads - GROUND lead last
3. Remove the remote control and wait 2 minutes for engine management system to 'power down'	3. Switch on ignition
4. Open the hood	4. Reset radio station preset buttons.
5. Disconnect battery - GROUND lead first	5. Reset clock

<p>6. Reset electric window one-touch facility. Power window up to hard stop, release switch, reapply and hold for 1 second (relay in door will click). Lower window to stop, reapply and hold for one second. One touch should now work</p>

NOTE: 1. Connect battery - If there is insufficient capacity in the battery to disarm the alarm, the alarm may sound on reconnection of the battery - Step 2 will disarm the alarm

Procedure 4

Disconnect battery	Connect battery
1. Apply parking brake or alternatively, chock wheels	1. Ensure that all electrical loads are switched OFF
2. Open the hood	2. Connect battery leads - GROUND lead last
3. Disconnect battery - GROUND lead first	3. Switch on ignition
	4. Reset radio station preset buttons.
	5. Reset clock
	6. Reset electric window one-touch facility. Power window up to hard stop, release switch, reapply and hold for 1 second (relay in door will click). Lower window to stop, reapply and hold for one second. One touch should now work

Procedure 5

Disconnect battery	Connect battery
1. Apply parking brake or alternatively, chock wheels	1. Ensure that all electrical loads are switched OFF
2. Open the hood	2. Connect battery leads - GROUND lead last
3. Disconnect battery - GROUND lead first	3. Switch on ignition
	4. Reset radio station preset buttons.
	5. Reset clock
	6. Reset electric window one-touch facility. Power window up to hard stop, release switch, reapply and hold for 1 second (relay in door will click). Lower window to stop, reapply and hold for one second. One touch should now work

Torque Specifications

Description	Nm	lb-ft
Battery tray to support bracket	10	7
Battery terminal nuts	10	7
Battery support bracket to body:		
M8 nut	24	18
M8 bolt	24	18

Part Number

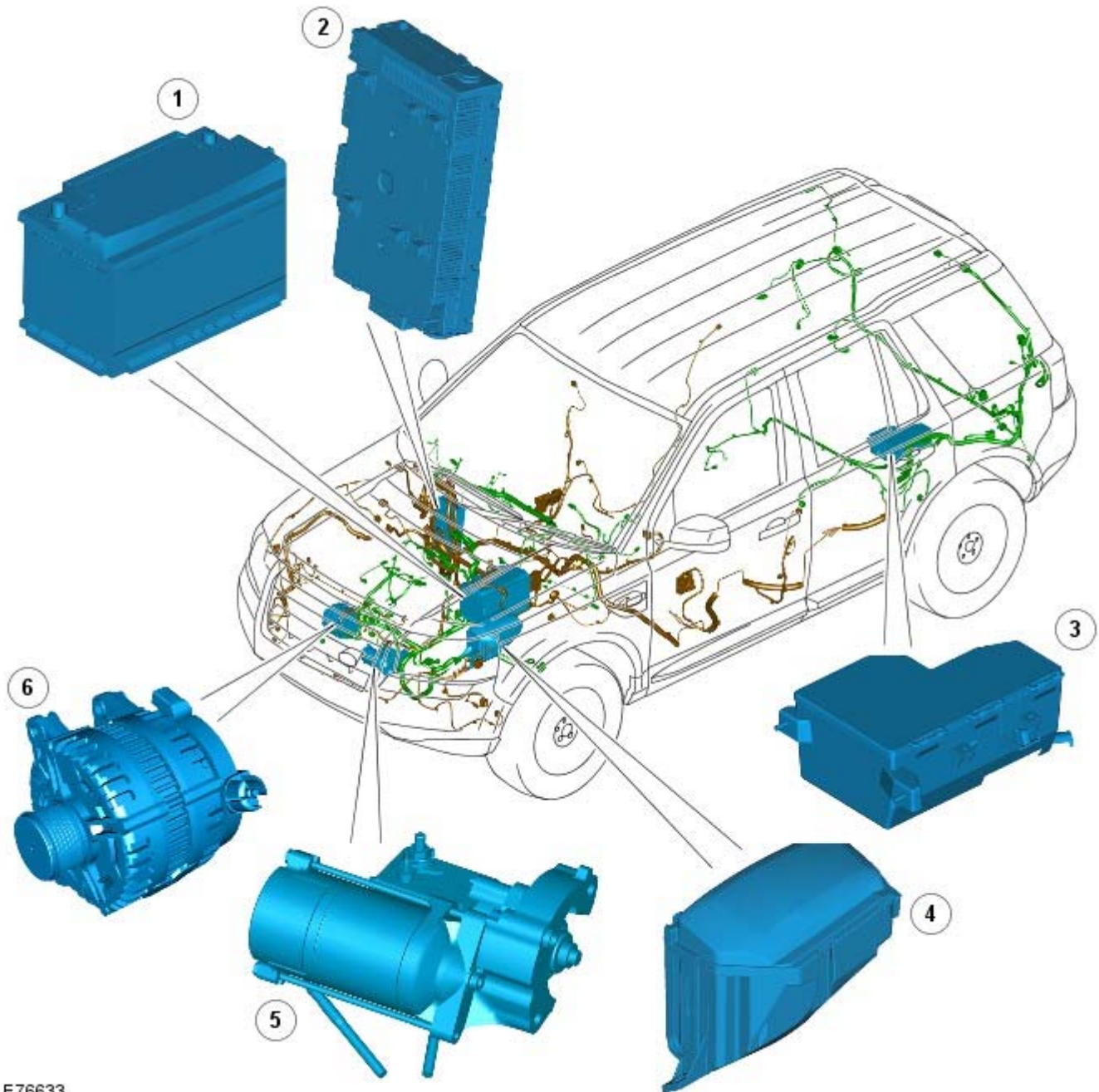
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Battery, Mounting and Cables - Battery and Cables

Description and Operation

COMPONENT LOCATION

NOTE: TD4 shown, i6 similar



E76633

Item	Part Number	Description
1	-	Battery
2	-	Central Junction Box (CJB)
3	-	Auxiliary Junction Box (AJB)
4	-	Battery Junction Box (BJB)
5	-	Starter motor
6	-	Generator

OVERVIEW

The battery is located behind a cover on the Left Hand (LH) side of the engine compartment. The battery sits in a tray and is secured in position with a clamp plate and bolt assembly. The battery supplies electrical power to the starter motor, generator

and BJB.

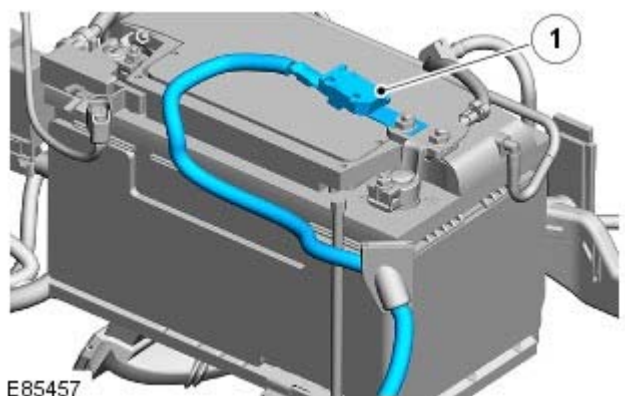
The BJB is mounted adjacent the LH front suspension turret. The BJB contains fusible links, blade and J-case fuses, and relays to distribute electrical power to various vehicle systems and junction boxes.

NOTE: The fusible links are mounted on the inboard side of the BJB behind a series of removable covers.

The CJB is mounted behind the glovebox and receives its main power supply from the BJB. In addition to containing blade fuses, the CJB is the main controller for a number of vehicle systems. These functions are outlined in the relevant sections of this manual.

The AJB is located beneath the luggage compartment carpet, adjacent the spare wheel well. The AJB is a modular design, and comprises up to 3 individual elements depending on vehicle specification. The AJB contains blade and J-case fuses, and relays to distribute electrical power to systems used at the rear of the vehicle. The AJB receives its main power supply from the BJB.

Starter Fuse



Item	Description
1	Starter fuse

Incorporated in the cable between the battery and the starter motor/generator is a CAL3 starter fuse. The fuse is mounted adjacent the battery positive terminal and is integral with the cable assembly. In the event of fuse failure, the complete cable assembly must be replaced.

Wire Color Codes

New wire color codes have been introduced in the Electrical Circuit Diagrams. These new codes are shown in the table below.

Color	Code
Black	BK
Blue	BU
Brown	BN
Green	GN
Grey	GY
Orange	OG
Red	RD
Violet	VT
White	WH
Yellow	YE

Tracer wire color codes are separated from the main wire color code by a hyphen, thus BU-RD equates to a blue wire with a red tracer. For more information, refer to the Electrical Circuit Diagrams and the Electrical Library.

POWER MODES

The CJB controls the power supplies for the various vehicle functions. There are 9 power modes available which are used by various systems to determine the operating condition of the vehicle. Only 3 of these modes will be noticeable to the driver and technicians as follows:

- Power mode 4 - Accessory
- Power mode 6 - Ignition
- Power mode 9 - Engine crank.

Transport Mode

All new vehicles will be delivered from the factory in transport mode. Transport mode replaces the traditional transit relay and inhibits a number of electrical systems and features to eliminate quiescent drain from the battery during delivery. When the vehicle is in transport mode 'transp' will be displayed in the instrument cluster odometer.

To remove the vehicle from transport mode, the Land Rover approved diagnostic system must be connected during the

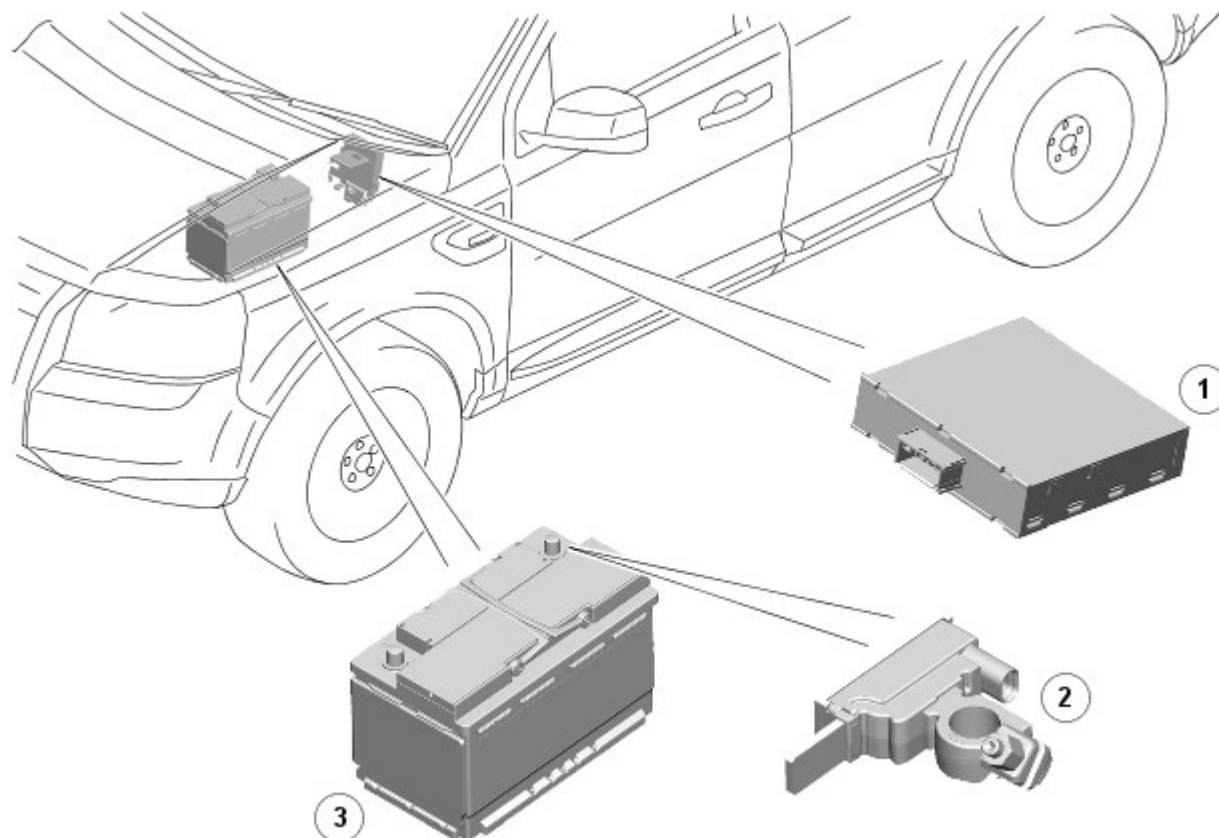
Pre-Delivery Inspection (PDI). For more information, refer to the PDI manual.

Stop/Start Vehicles - From 2010 MY

Component Location

The TD4_e is the first Land Rover fitted with an intelligent 'Stop/Start' system; the following components have been introduced to support the Stop/Start vehicle.

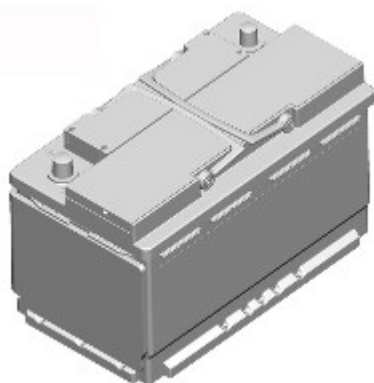
For additional information, refer to: [Starting System](#) (303-06C Starting System - TD4 2.2L Diesel, Vehicles Built From: 01-03-2009, Description and Operation).



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Item	Description
1	Voltage quality module
2	Battery monitoring module
3	Absorption glass mat battery

Absorption Glass Mat Battery

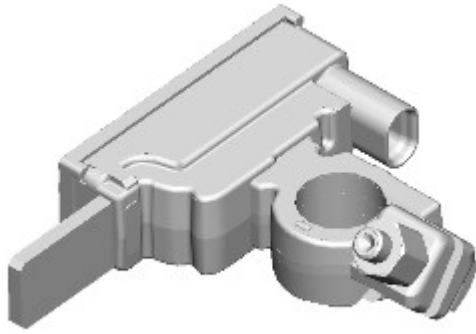


E115178

To counteract the extreme power consumption of a Stop/Start system, a high-performance battery based on Absorption Glass Mat technology has been introduced. The battery owes its superiority over a conventional battery to the 'absorbent glass mat' which is a fine fibreglass mat compressed between the lead plates.

For additional information, refer to: [Starting System](#) (303-06C Starting System - TD4 2.2L Diesel, Vehicles Built From: 01-03-2009, Description and Operation).

Battery Monitoring System



E115177

Optimal battery health is a fundamental factor in the correct operation of the Stop/Start system, therefore to calculate and communicate the battery status a Battery Monitoring System (BMS) module is introduced.

For additional information, refer to: [Starting System](#) (303-06C Starting System - TD4 2.2L Diesel, Vehicles Built From: 01-03-2009, Description and Operation).

Voltage Quality Module



E115176

During an engine Stop/Start cycle the Voltage Quality Module (VQM) maintains the vehicle's electrical systems by supplying a support voltage around the vehicle's electronic components during an engine restart. This allows crucial vehicle systems to continue uninterrupted when there is a sudden draw of current from the battery.

For additional information, refer to: [Starting System](#) (303-06C Starting System - TD4 2.2L Diesel, Vehicles Built From: 01-03-2009, Description and Operation).

BATTERY JUNCTION BOX



Relays

Name	Item Number	Vehicle	Description
Relay R1	46	All	Starter motor
Relay R2	49	TD4	BJB fuses 6, 8, 9, 11, 12 and 14
Relay R2	49	i6	BJB fuses 1, 6, 8, 9, 11 and 12
Relay R3	47	All	Air Conditioning (A/C) compressor clutch
Relay R4	48	TD4	Glow plugs, BJB fuse 1
Relay R5	36	All	BJB fuses 39 (climate control) and 45 (cigar lighter/accessory socket)
Relay R6	29	All	BJB fuses 34 and 35 (heated windshield)
Relay R7	25	All	BJB fuses 37, 38, 41, 42, 43 and 44
Relay R8	35	All	Windshield wiper motor (fast/slow speed)
Relay R9	32	All	Headlamp washer pump
Relay R10	28	All	LH horn, Right Hand (RH) horn
Relay R11	34	All	BJB relay 8 (windshield wipers)
Relay R12	31	All	Headlamp washer pump

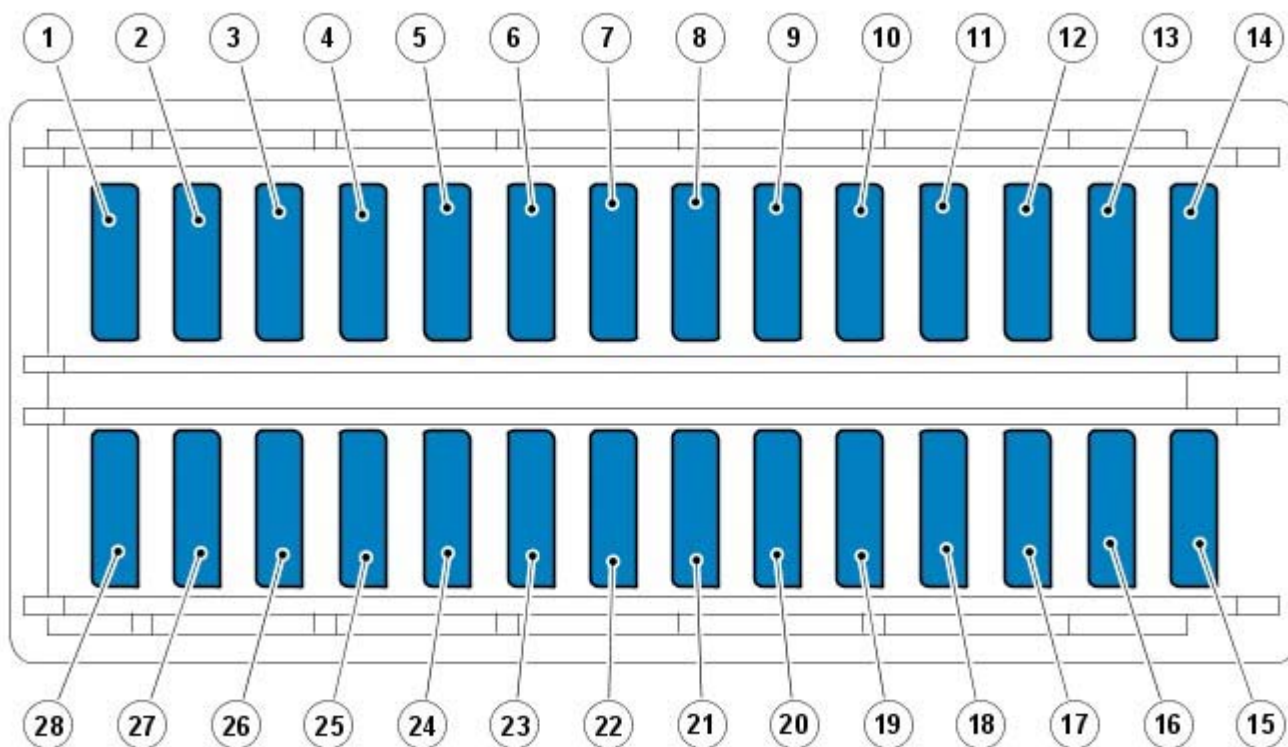
Fuses

Name	Item Number	Vehicle	Description
Fuse F1	1	TD4	Engine Control Module (ECM) (glowplug monitoring)
Fuse F1	1	i6	Diagnostic Monitoring of Tank Leakage (DMTL) leak detection pump
Fuse F2	2	Automatic transmission	Transmission Control Module (TCM)
Fuse F3	5	All	Engine cooling fan module
Fuse F4	6	TD4	BJB relay R4 (glow plugs)
Fuse F5	7	All	Not used
Fuse F6	56	TD4	Front heated oxygen sensor (HO2S)
Fuse F6	56	i6	HO2S', purge control valve
Fuse F7	57	All	BJB relays R2 and R3
Fuse F8	3	TD4	ECM (fuel injectors)

Name	Item Number	Vehicle	Description
Fuse F8	3	i6	ECM (electric throttle)
Fuse F9	55	TD4	Mass Air Flow (MAF) sensor
Fuse F9	55	i6	Fuel injectors, MAF sensor, ECM
Fuse F10	54	TD4	Not used
Fuse F10	54	i6	ECM
Fuse F11	4	TD4	Fuel rail pressure control valve, BJB relay R4 coil
Fuse F11	4	i6	Intake Camshaft Position (CMP) sensor, exhaust CMP sensor, Variable Camshaft Timing (VCT) solenoid, variable plenum valve, variable intake tract valve, ECM, A/C compressor clutch
Fuse F12	53	TD4	Exhaust Gas Recirculation (EGR) valve, port deactivation actuator
Fuse F12	53	i6	Ignition coils
Fuse F13	52	All	BJB relay R3 (A/C compressor clutch)
Fuse F14	51	TD4	Fuel pump (volume control valve)
Fuse F14	51	i6	Not used
Fuse F15	50	All	BJB relay R1 (starter motor)
Fuse F16	8	TD4	Electric booster heater
Fuse F16	8	i6	Not used
Fuse F17	9	All	CJB fuses 6, 8, 21, 22, 23, 24, 25, 26, 27 and 28, interior lamp Field Effect Transistor (FET), exterior lamp FET's, (CJB), electric steering column lock/instrument cluster relay (CJB), battery saver relay, central electronic module (CJB)
Fuse F18	10	All	CJB fuses 7, 9, 10, 11, 13 and 14, exterior lamp FET's
Fuse F19	11	All	AJB fuses FA1 to FA11
Fuse F20	13	All	AJB fuses FB9, AJB relay RB1
Fuse F21	15	All	AJB relay RD1
Fuse F22	44	All	BJB relays R8 and R11 (windshield wipers)
Fuse F23	45	All	Not used
Fuse F24	12	All	BJB relays R9 and R12 (headlamp washer pump)
Fuse F25	14	All	Anti-lock Brake System (ABS) module (valves)
Fuse F26	16	All	ABS module (pump)
Fuse F27	17	All	Not used
Fuse F28	18	All	Blower motor, blower motor control module
Fuse F29	19	All	Not used
Fuse F30	42	All	Not used
Fuse F31	41	All	BJB relay R10 (horn)
Fuse F32	43	TD4	Fuel fired booster heater
Fuse F32	43	i6	Not used

Name	Item Number	Vehicle	Description
Fuse F33	20	All	BJB relays R5, R6, R7 and R10, light control module
Fuse F34	22	All	LH heated windshield element
Fuse F35	21	All	RH heated windshield element
Fuse F36	40	All	Not used
Fuse F37	39	All	Heated washer jets
Fuse F38	33	Adaptive Front lighting System (AFS)	RH headlamp motor
Fuse F39	26	All	Pollution sensor, air intake stepper motor, LH temperature blend stepper motor, RH temperature blend stepper motor, face/feet distribution stepper motor, windshield (defrost) distribution stepper motor
Fuse F40	38	All	Not used
Fuse F41	37	All	CJB fuses 1 to 4
Fuse F42	30	Manual transmission	ECM
Fuse F42	30	Automatic transmission	ECM, TCM
Fuse F43	27	AFS	AFS control module
Fuse F43	27	Headlamp leveling	Headlamp leveling control module
Fuse F44	24	AFS	LH headlamp motor
Fuse F45	23	All	Cigar lighter/accessory socket

CENTRAL JUNCTION BOX



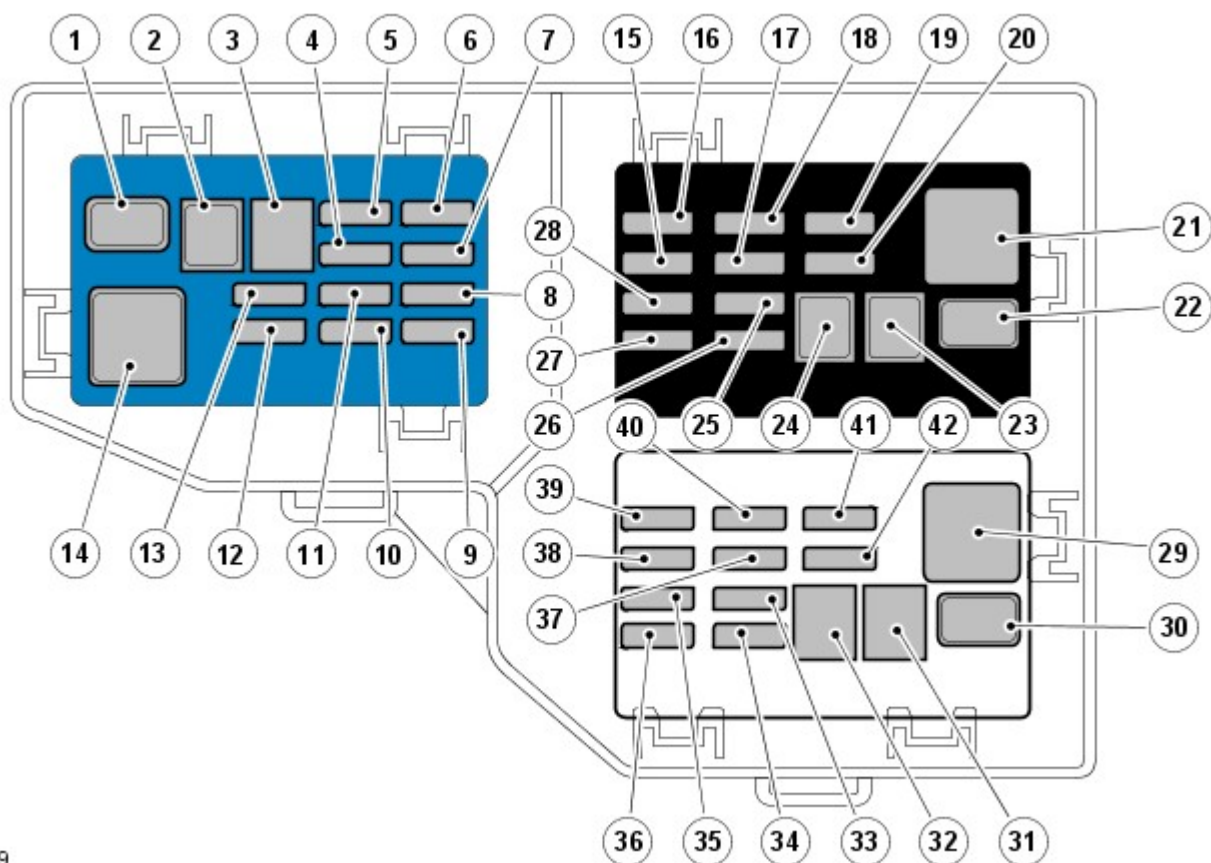
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Fuses

Name	Item	Vehicle	Description
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	Number		
Fuse F1	1	All	Rain/light sensor
Fuse F2	2	All	Restraints Control Module (RCM), occupant classification system sensor
Fuse F3	3	All	ABS module
Fuse F4	4	TD4	Instrument cluster, electric booster heater, Terrain Optimization™ rotary control, automatic dimming interior mirror, light switch module, passenger airbag disabled indicator, Accelerator Pedal Position (APP) sensor
Fuse F4	4	i6	Instrument cluster, Terrain Optimization™ rotary control, automatic dimming interior mirror, light switch module, passenger airbag disabled indicator, Accelerator Pedal Position (APP) sensor
Fuse F5	5	All	Not used
Fuse F6	6	All	Audio head unit, Infotainment Control Module (ICM)
Fuse F7	7	All	LH steering column multi-function switch
Fuse F8	8	All	Instrument cluster
Fuse F9	9	All	LH headlamp main beam, RH headlamp main beam
Fuse F10	10	All	Roof opening panel control unit
Fuse F11	11	All	LH reversing lamp, RH reversing lamp, automatic dimming interior mirror
Fuse F12	12	All	Not used
Fuse F13	13	All	LH front fog lamp, RH front fog lamp
Fuse F14	14	All	Windshield and rear screen washer pump
Fuse F15	28	All	Not used
Fuse F16	27	All	Not used
Fuse F17	26	All	Front interior lamp, rear interior lamp, LH vanity mirror lamp, RH vanity mirror lamp, glovebox lamp, driver door latch switch, luggage compartment lamp
Fuse F18	25	All	Not used
Fuse F19	24	All	Drivers seat control module, drivers seat switch pack, lumbar support switch, battery power save relay
Fuse F20	23	All	Rear screen wiper motor, AJB relay RA2
Fuse F21	22	All	Radio Frequency (RF) receiver, intrusion detection module
Fuse F22	21	All	Fuel delivery module
Fuse F23	20	All	Electric steering column lock
Fuse F24	19	All	Not used
Fuse F25	18	All	Fuel filler flap release motor and liftgate latch
Fuse F26	17	All	Diagnostic socket, battery backed sounder
Fuse F27	16	All	Automatic Temperature Control (ATC) module, start control module
Fuse F28	15	All	Stop lamp switch

AUXILIARY JUNCTION BOX



E84209

The Auxiliary Junction Box (AJB) comprises up to 3 individual elements, depending on vehicle specification. The casing of each junction box is color coded as follows:

- AJB 1 = Black
- AJB 2 = White
- AJB 4 = Blue

NOTE: AJB 3 is not used on Freelander 2

Auxiliary Junction Box 1 Relays

Name	Item Number	Vehicle	Description
Relay RA1	21	All	Heated rear screen
Relay RA2	22	All	Rear screen wiper motor

Auxiliary Junction Box 1 Fuses

Name	Item Number	Vehicle	Description
Fuse FA1	16	All	Driver door module
Fuse FA2	15	All	Passenger door module
Fuse FA3	28	All	LH rear door module
Fuse FA4	27	All	RH rear door module
Fuse FA5	18	All	Not used
Fuse FA6	17	All	Rear accessory socket
Fuse FA7	25	All	AJB relay RA1
Fuse FA8	26	All	Not used
Fuse FA9	19	All	Trailer connector (battery feed)
Fuse FA10	20	All	Drivers seat control module, drivers seat switch pack
Fuse FA11	23	All	Trailer control module
Fuse FA12	24	All	Not used

Auxiliary Junction Box 2 Relays

Name	Item Number	Vehicle	Description
Relay RB1	29	All	AJB fuses FB1 to FB8
Relay RB2	30	All	Not used

Auxiliary Junction Box 2 Fuses

Name	Item Number	Vehicle	Description
Fuse FB1	39	All	Parking aid module
Fuse FB2	38	All	Not used
Fuse FB3	35	All	Driver seat heat control module
Fuse FB4	36	All	Passenger seat heat control module

Name	Item Number	Vehicle	Description
Fuse FB5	40	All	Trailer connector (fridge)
Fuse FB6	37	All	Active on-demand coupling
Fuse FB7	33	All	Not used
Fuse FB8	34	All	Not used
Fuse FB9	41	All	Passenger power operated seat relay
Fuse FB10	42	All	Not used
Fuse FB11	31	All	Not used
Fuse FB12	32	All	Not used

Auxiliary Junction Box 4 Relays

Name	Item Number	Vehicle	Description
Relay RD1	14	All	Media Orientated System Transport (MOST) ring break
Relay RD2	1	All	Not used

NOTE: Relay RD1 is a 'plug in' ring break, not a relay

Auxiliary Junction Box 4 Fuses

Name	Item Number	Vehicle	Description
Fuse FD1	9	All	Infotainment Control Module (ICM), navigation computer
Fuse FD2	8	All	Not used
Fuse FD3	7	All	Digital Audio Broadcast (DAB) amplifier, DAB/Satellite Digital Audio Radio Service (SDARS) tuner
Fuse FD4	6	All	Telephone control module
Fuse FD5	10	All	Not used
Fuse FD6	11	All	Audio head unit, Integrated Audio Module (IAM)
Fuse FD7	4	All	Not used
Fuse FD8	5	All	Not used
Fuse FD9	12	All	Audio amplifier
Fuse FD10	13	All	Not used
Fuse FD11	2	All	Not used
Fuse FD12	3	All	Not used

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Battery, Mounting and Cables - Battery

Diagnosis and Testing

For further information, refer to battery care manual and
REFER to: Charging System (414-00, Diagnosis and Testing).

Published: 11-May-2011

Battery, Mounting and Cables - Battery

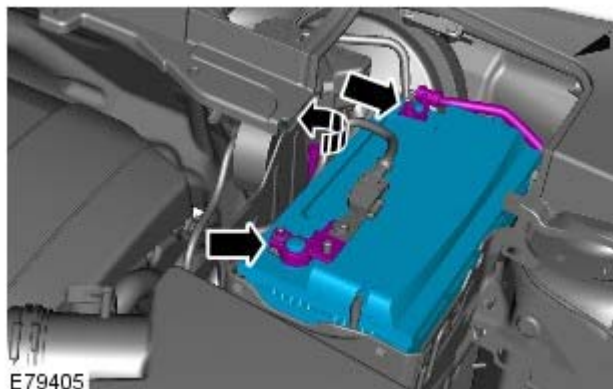
Removal and Installation

Removal

NOTE: Removal steps in this procedure may contain installation details.

1. Remove the cover and disconnect the battery ground cable.

Refer to: [Specifications](#) (414-00 Battery and Charging System - General Information, Specifications).



2. **NOTE:** Apply petroleum jelly to the battery terminals.

Torque: 5 Nm



- 3.

Installation

1. To install, reverse the removal procedure.

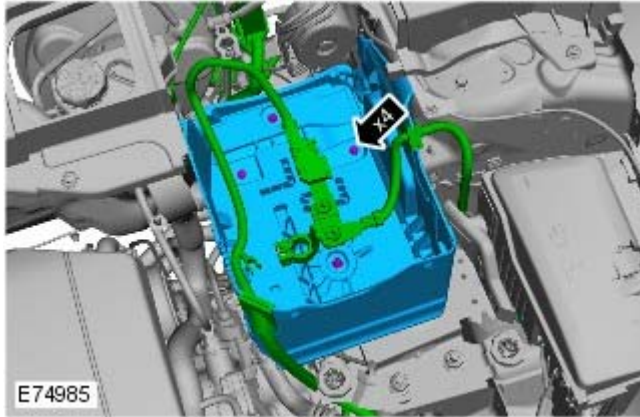
Battery, Mounting and Cables - Battery Tray

Removal and Installation

Removal

1. Remove the battery.

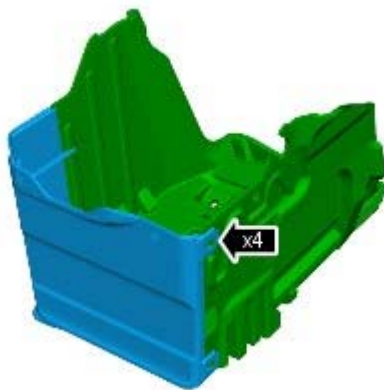
Refer to: [Battery](#) (414-01 Battery, Mounting and Cables, Removal and Installation).



2. **NOTE:** Removal steps in this procedure may contain installation details.

Torque: 10 Nm

3. **NOTE:** Do not disassemble further if the component is removed for access only.



Installation

1. To install, reverse the removal procedure.

Generator and Regulator -

General Specification

Item	Specification
Generator - 3.2L Petrol:	
Make/type	Bosch
Output	90/150 amps @25° C
Voltage control	Externally controlled by EMS using LIN protocol to communicate.
Voltage setpoint regulation	Controlled by software resident in EMS
Generator - 2.2L Diesel:	
Make/type	Bosch
Output - Standard	90/150 amps @25° C
Output - Optional	105/180 amps @ 25° C
Voltage Control	Externally controlled by EMS using LIN protocol to communicate.
Voltage Regulation	Controlled by software resident in EMS

Torque Specifications

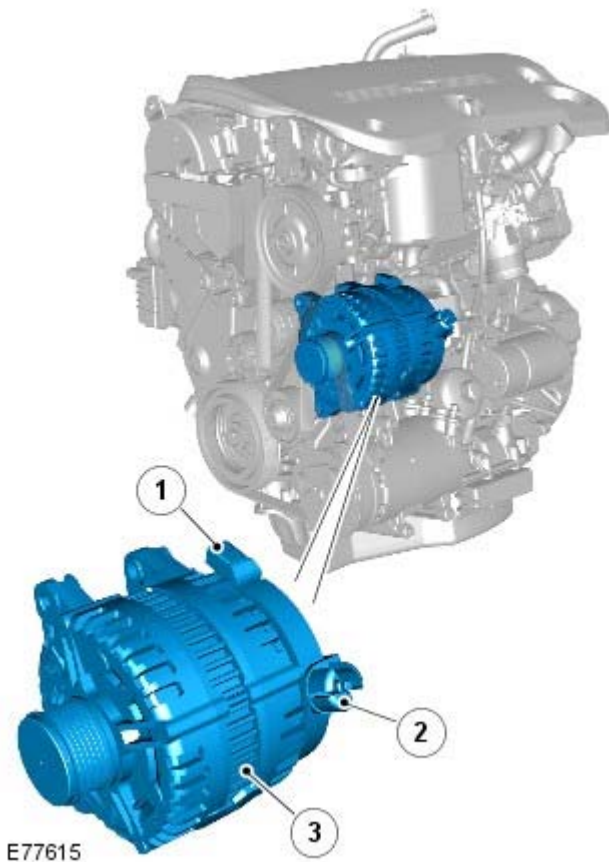
Description	Nm	lb-ft
Battery harness connection nut - 3.2L Petrol	12	9
battery cable to the generator nut - 2.2L Diesel	24	18
Drive belt idler pulley - 2.2L Diesel	48	35
Generator coupling	75	55
Generator bolts - 3.2L Petrol	24	18
Generator bolts - 2.2L Diesel	48	35

Part Number

Published: 11-May-2011

Generator and Regulator - GeneratorTD4 2.2L Diesel

Description and Operation

COMPONENT LOCATION

Item	Part Number	Description
1	-	Local Interconnect Network (LIN) bus connection
2	-	Battery positive connection
3	-	Generator

OVERVIEW

A single self-exciting generator is located at the front of the engine on the Left-Hand (LH) side of the cylinder block. Two generators are available for the TD4 engine, dependent on vehicle specification. The generators are rated at 90/150 amps and 115/180 amps respectively. The larger rated generator is used on cold climate market vehicles installed with a heated front windshield and electric booster heater.

For additional information, refer to: [Electric Booster Heater](#) (412-02B Auxiliary Climate Control, Description and Operation).

The generator pulley incorporates a one-way clutch that reduces Noise, Vibration and Harshness (NVH), and improves the life of the accessory drive belt. The one-way clutch allows the belt to drive the pulley without slip occurring, but prevents the generator from driving the belt during transients in engine speed ('belt whip') due to the high rotational inertia of the generator internal components.

The generator comprises the following major components:

- Stator
- Rotor
- Rectifier pack
- Regulator.

The stator consists of a flat core pack into which the stator wires are pressed.

The rotor comprises a field winding, wound around an iron core and mounted on a shaft. The rotor is housed within the stator and mounted on bearings to provide smooth running and support, due to the side loading applied by the drive belt tension.

The rectifier comprises 6 semi-conductor diodes mounted on a heat sink. The heat sink dissipates the resultant heat created in the electrical conversion process. The rectifier converts the Alternating Current (AC) produced in the stator coils into Direct Current (DC) that is required by the vehicle electrical system.

The regulator provides a controlled variable voltage output from the generator. Two electrical terminals are provided on the outer casing of the generator. One terminal supplies the rectified and regulated DC current from the generator, via a large diameter cable to the battery positive terminal. The second terminal provides the LIN bus connection between the regulator and the Engine Control Module (ECM).

The regulator is connected via the LIN bus to the ECM, the ECM is also connected via the high speed Controller Area Network (CAN) bus to the Central Junction Box (CJB). The CJB contains software maps that provide a mathematical model of battery electrolyte temperature, and constantly receives information from the ECM regarding the actual battery voltage. Based on the information received, the CJB then communicates via the high speed CAN bus to the ECM a predicted output voltage that is required from the regulator to effectively charge the battery. A corresponding message is then communicated by the ECM to the regulator via the LIN bus, to meet the output voltage determined by the CJB. This control cycle is repeated under a closed-loop condition.

The LIN bus is also used to communicate a mechanical failure, or fault in the wiring and connections from the generator to the ECM. A Diagnostic Trouble Code (DTC) is stored in the ECM and if necessary, the charge warning indicator lamp is illuminated in the instrument cluster after a short delay.

During engine starting the charge warning indicator lamp is illuminated in the instrument cluster when the ignition is energized, and is extinguished when the engine starts and the ECM detects a generator output voltage.

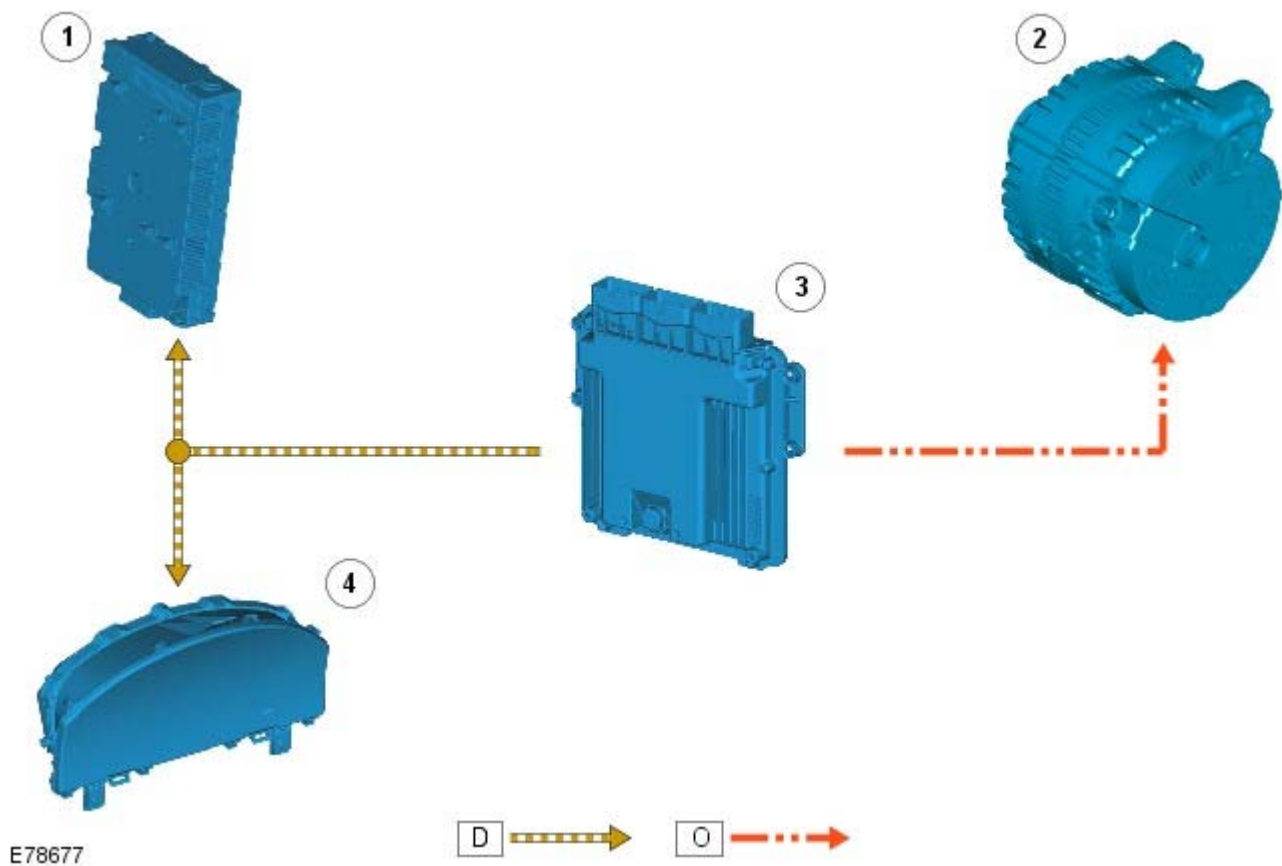
Stop/Start Vehicles - From 2010 MY

Due to the additional loads a higher rated 180 amp generator is used on Stop/Start vehicles.

For additional information, refer to: [Starting System](#) (303-06C Starting System - TD4 2.2L Diesel, Vehicles Built From: 01-03-2009, Description and Operation).

CONTROL DIAGRAM

NOTE: **D** = High speed CAN bus; **O** = LIN bus



Item		Description
1		CJB
2		Generator
3		ECM
4		Instrument cluster

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Generator and Regulator - Generator

Diagnosis and Testing

For additional information.

REFER to: Charging System (414-00, Diagnosis and Testing).

Generator and Regulator - GeneratorTD4 2.2L Diesel

Removal and Installation

Removal

1. Remove the cover and disconnect the battery ground cable.

Refer to: [Specifications](#) (414-00 Battery and Charging System - General Information, Specifications).

2. Remove the fuel filter.

Refer to: [Fuel Filter](#) (310-01B Fuel Tank and Lines - TD4 2.2L Diesel, Removal and Installation).

3.  **WARNING:** Make sure to support the vehicle with axle stands.

Raise and support the vehicle.

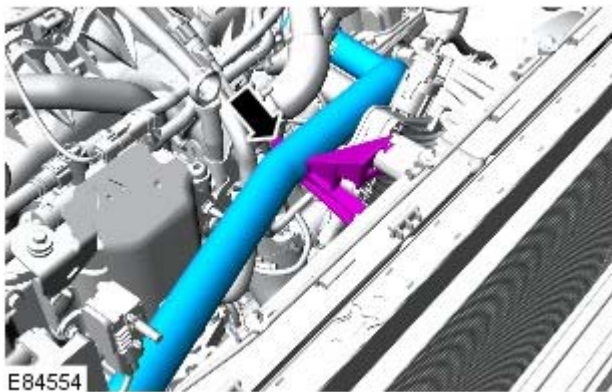
4. Remove the engine undershield.

Refer to: [Engine Undershield](#) (501-02 Front End Body Panels, Removal and Installation).

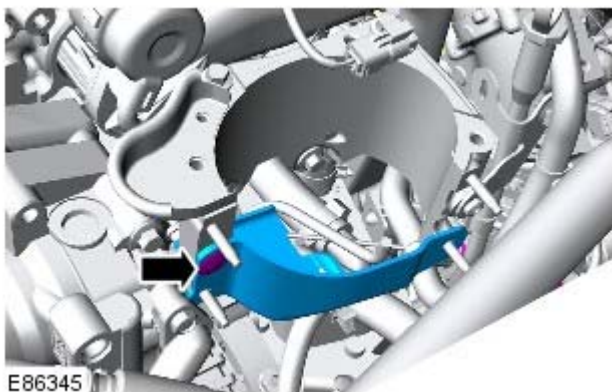
5. Remove the accessory drive belt.

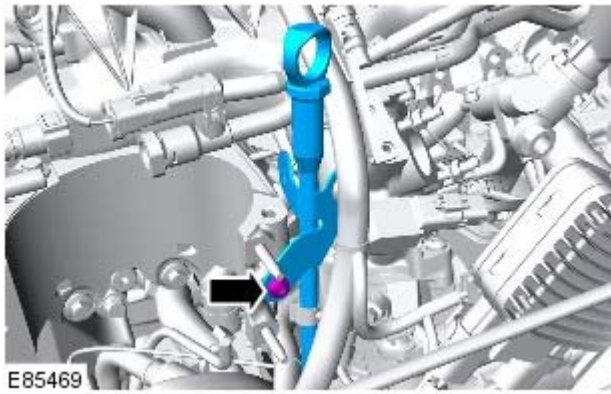
Refer to: [Accessory Drive Belt](#) (303-05B Accessory Drive - TD4 2.2L Diesel, Removal and Installation).

- 6.

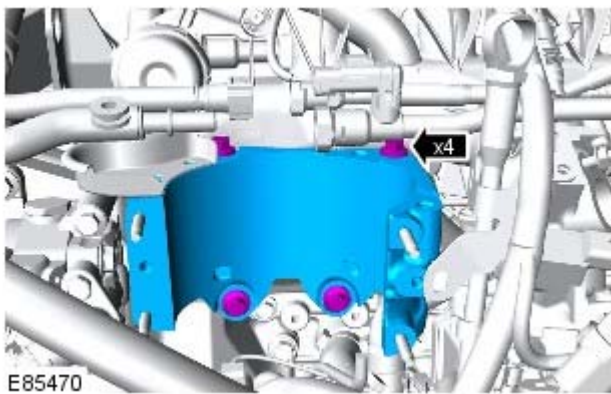


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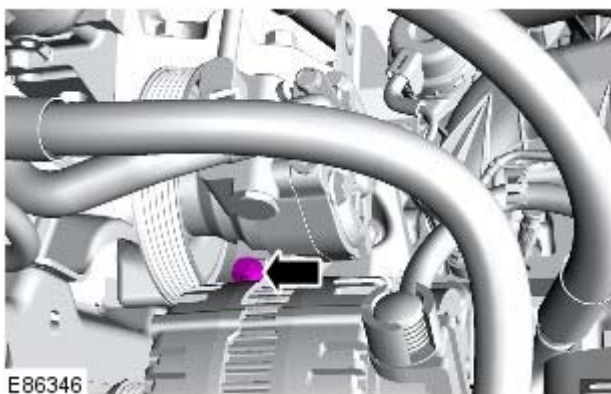




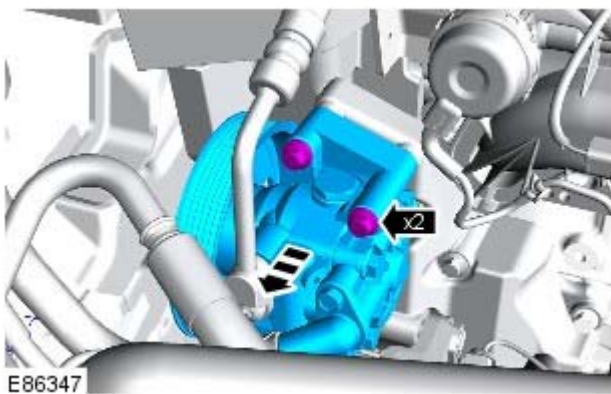
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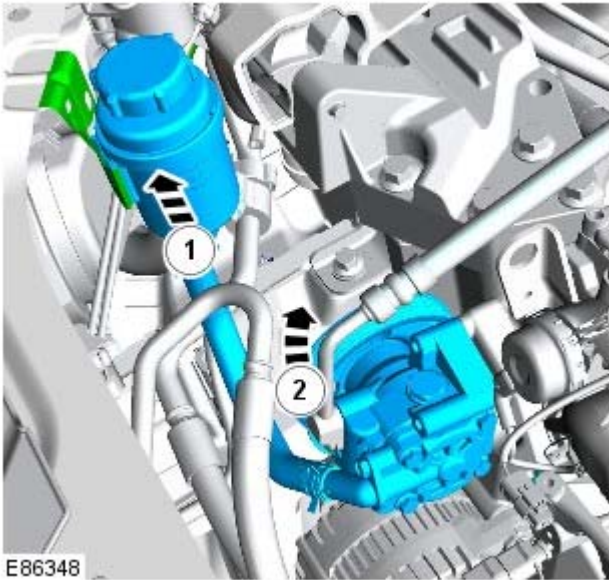
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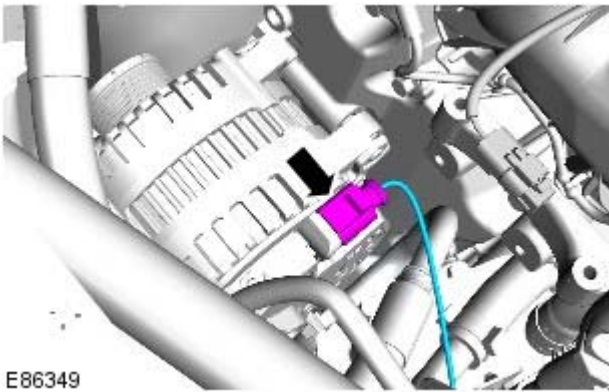
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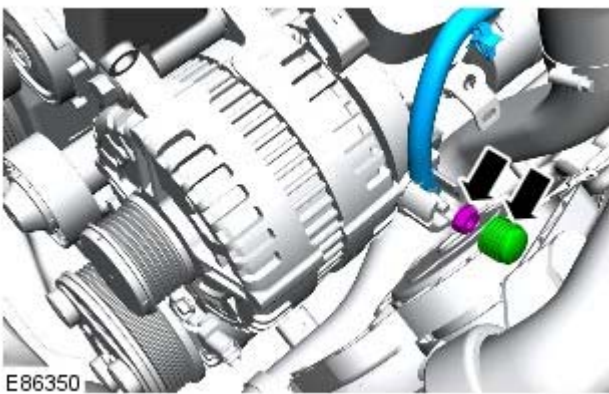
11. Release the power steering pump.



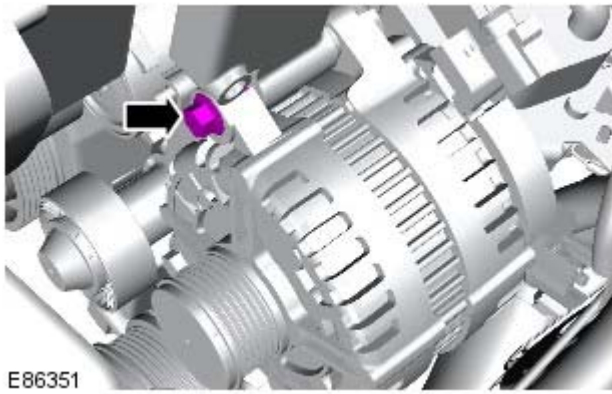
12.  **WARNING:** Power steering fluid is extremely flammable. Make sure that power steering fluid is not spilt over the engine and that the power steering fluid reservoir cap is sealed.



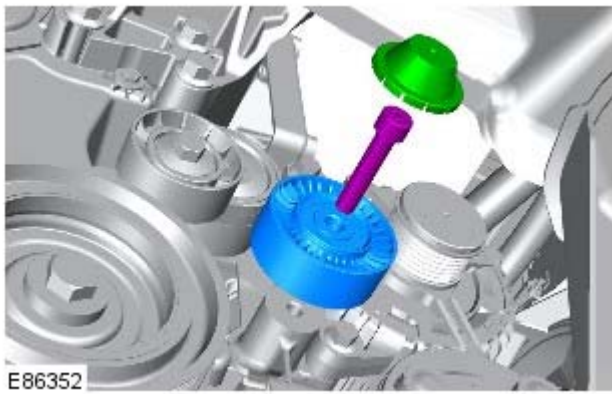
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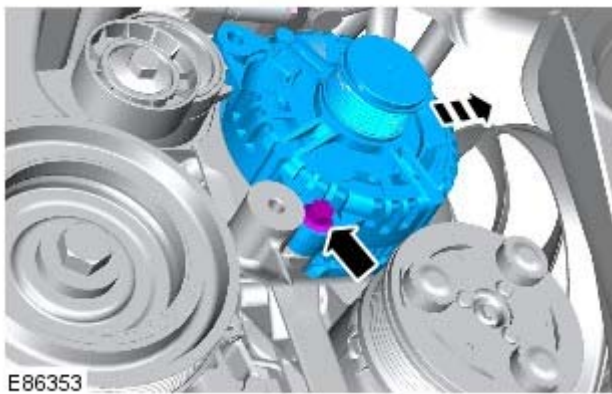
- 14.



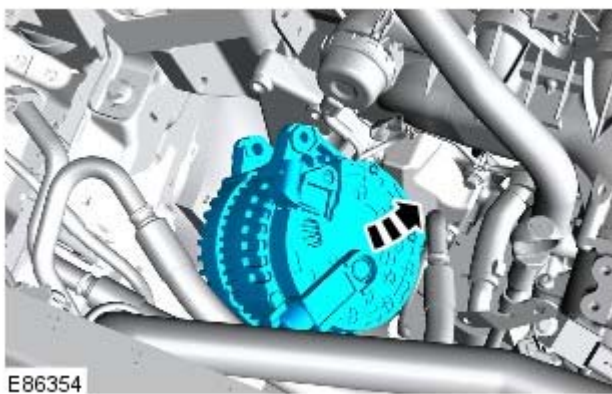
15.



16.  **CAUTION:** Make sure that the mating faces are clean and free of foreign material.



17.



18.

Installation

1.  **CAUTION:** Make sure that the mating faces are clean and free of foreign material.

Install the generator.

2. Install the 2 generator bolts.

Torque: 48 Nm

3. Install the accessory drive belt idler pulley.

Torque: 48 Nm


4. Install the accessory drive belt idler pulley dust cap.

5. Connect the generator electrical connector.

6. Connect the battery cable to the generator.

Torque: 24 Nm

7. Attach the power steering fluid reservoir.

8.  **CAUTION:** Make sure that the mating faces are clean and free of foreign material.

Install the power steering pump.

Torque: 24 Nm

9. Install the fuel filter support bracket.

Torque: 20 Nm

10. Attach the oil level indicator tube to the fuel filter support bracket.

Torque: 10 Nm

11. Install the inner fuel filter shield.

12. Secure the coolant top hose.

13. Install the accessory drive belt.

Refer to: [Accessory Drive Belt](#) (303-05B Accessory Drive - TD4 2.2L Diesel, Removal and Installation).

14. Install the engine undershield.

Refer to: [Engine Undershield](#) (501-02 Front End Body Panels, Removal and Installation).

15. Install the fuel filter.

Refer to: [Fuel Filter](#) (310-01B Fuel Tank and Lines - TD4 2.2L Diesel, Removal and Installation).